PRELIMINARY STORMWATER REPORT
FOR
Lee's Summit Joint Operations Campus

Project Location:

10 NE Tudor Road, Lee's Summit, MO 64086

BHC Project # 041470.00.01

7/25/2024
Revision #1: 8/27/2024

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8/27/2024

CIVIL ENGINEERING / SURVEYING / UTILITIES

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1.0 Introduction

This Preliminary Stormwater Management Study is prepared for the expansion of the existing Lee's Summit Joint Operations Campus located at 10 NE Tudor Road, Lee's Summit, Missouri. The purpose of this study is to evaluate the existing on-site detention pond and the impacts of the expanded development on the existing detention pond and surrounding area. The project will result in the construction of a new Fire Administration building and associated Parking.

Governing design criteria is based on the APWA 5600 comprehensive control and the capacity of the downstream system to convey discharge during the systems design events.

Figure 1: Project Location Aerial

1. 1 Methodology

The unit hydrograph modeling for this report was conducted using TR-55 methodologies within HydroCAD.

Runoff for this report was determined using a SCS Type II 24-Hour rainfall event.

The design storms used for this report were the 2-year (50%), 10-year (10%), and 100-year (1%) events. Rainfall depths for these events were determined from NOAA Atlas 14. The table below contains these rainfall depths.

Table I: Report Design Storms

Report Design Storms	
Storm Event	**Rainfall Depth (in)**
2-Year	3.70
10-Year	5.66
100-Year	9.23

The following documents were used as the design criteria for this report:

- Kansas City Metropolitan Chapter of APWA Standards, Specification and Design Criteria, Section 5600 (2011)

Comprehensive Control Requirement

APWA 5600 requires that rainfall events are held to the following to the following release rates. 0.5 cfs for the 2-year, 2.0 cfs for the 10-yr, and 3.0 cfs for the 100-yr for any newly developed area. For this site the area considered new development would the eastern third of the site where the Fire Administration be located. BHC and the City of Lee's Summit have been unable to find the existing drainage study for the project and have not quantified release rates. BHC has reached out to the engineer of record (Bartlett and West), but at the submission of this report has not yet received that information.

2.0 Existing Conditions

2.1 Project Site

The existing project site is currently occupied by the existing Lee's Summit Municipal Court Facility basin on the site grading, the project site has 11.41 acres tributary to the detention pond, and additional 0.78 acres of off-site runoff from the right-of-way of Tudor. Total tributary area is 12.19 acres.

2.2 Hydrology

A majority of the project site drains towards the existing detention pond. This drainage area is summarized below in Table II.

Table II: Existing Drainage Areas

		AREA		PERVIOUS		IMPERVIOUS		CN-Value	C-VALUE
	Total	631,858 SF	(14.51 ac)	294518.55 SF	(6.76 ac)	337,339 SF	(7.74 ac)	90	0.62
To Pond	Onsite	497,121 SF	(11.41 ac)	237177.93 SF	(5.44 ac)	259,943 SF	(5.97 ac)	89	0.61
	Offsite	33,883 SF	(0.78 ac)	12318.70 SF	(0.28 ac)	21,564 SF	(0.50 ac)	91	0.68
Not to Pond	Onsite	26,149 SF	(0.60 ac)	21777.89 SF	(0.50 ac)	4,371 SF	(0.10 ac)	83	0.40
	Offsite	74,704 SF	(1.71 ac)	23244.02 SF	(0.53 ac)	51,460 SF	(1.18 ac)	92	0.71

The drainage area was analyzed in HydroCAD, using TR-55 methodologies to calculate the peak runoff from the existing site in the 2-, 10-, and 100-year storm events to the existing detention pond. These calculations are found in Appendix A1. Table III below summarizes these quantities.

Table III: Existing Site Generated Runoff

Existing Site Generated Runoff (cfs)		
2-Year	**10-Year**	**100-Year**
47.16	78.42	134.50

2.3 Existing Detention

The existing detention pond was evaluated in the all runoff events. The storm events are attenuated through the pond by two existing 30" CMP culvert pipes. It is assumed that there is some additional outlet control reducing these peak release rates, but the existing report is yet to be obtained from Bartlett and West.

This results in the following pond peak release rates:

Existing Detention Pond		
Storm Event	**Peak Release (cfs)**	**Stage Storage Elevation**
2-year	33.34	1001.64
10-year	51.43	1002.47
100-year	74.77	1004.00

3.0 Proposed Condition

3.1 Project Site

The project will result in the construction of a Fire Administration building, associated parking and site grading changes. This will result in an increase of the tributary area to the detention pond from 12.19 acres to 12.39 (11.59 acres from project site and 0.8 acres from Tudor right-of-way).

3.2 Hydrology

A majority of the project site drains towards the existing detention pond. This drainage area is summarized below in Table IV.

Table IV: Proposed Drainage Areas

		AREA		PERVIOUS		IMPERVIOUS		CN-Value	C-VALUE
	Total	632,704 SF	(14.52 ac)	226,996 SF	(5.21 ac)	405,708 SF	(9.31 ac)	92	0.68
To Pond	Onsite	504,869 SF	(11.59 ac)	175,873 SF	(4.04 ac)	328,996 SF	(7.55 ac)	92	0.69
	Offsite	34,740 SF	(0.80 ac)	13,154 SF	(0.30 ac)	21,586 SF	(0.50 ac)	91	0.67
Not to Pond	Onsite	19,248 SF	(0.44 ac)	15,814 SF	(0.36 ac)	3,434 SF	(0.08 ac)	83	0.41
	Offsite	73,848 SF	(1.70 ac)	22,155 SF	(0.51 ac)	51,692 SF	(1.19 ac)	93	0.72

The drainage area was analyzed in HydroCAD, using TR-55 methodologies to calculate the peak runoff from the existing site in the 2-, 10-, and 100-year storm events. These calculations are found in Appendix A1. Table V below summarizes these quantities.

Table V: Proposed Site Generated Runoff

Proposed Site Generated Runoff (cfs)		
2-Year	**10-Year**	**100-Year**
50.58	82.12	138.64

The proposed development of the site results in an increase in peak runoff rates in all analyzed storm events. To manage runoff to pre-development levels the existing detention pond will need to be expanded.

3.3 Controlling Release Rate

Comprehensive Control Requirement

As the most recent storm study could not be located BHC has not been able to determine designed release rates for the existing detention facility, however, they are likely similar to the release rates documented in paragraph 2.3 above.

Downstream Analysis

The City of Lee's Summit provided the Final Development Plans submitted by for the multi-family development located north of the project site. BHC has reviewed the plans and sheet C202 indicates that a release rate from the pond located on the Joint Operations Center property considered a release rate of 36 cfs in the 10-year storm, and 54 CFS in the 100-year storm.

3.3 Proposed Detention

Detention will be provided by modification of the existing dry detention pond. Presently, the outlet of the pond includes two 30" CMP outlet pipes, the proposed solutions considers replacing the existing CMP structures an outlet control structure with a weir wall. The weir wall will have a 3" opening for the water quality storm (extended dry detention released over 40 hours). The 10 and 100-yr events will be controlled by 4" wide by 18" tall opening. The depth an area of the pond has been increased to allow for (1) additional detention and (2) a direct connection to the proposed inlet 1-6 located on the development to the north.

Information regarding the downstream system has been provided in Appendix A2.

This controls the release rate to the flows assumed for the project.

Proposed Detention Pond		
Storm Event	**Peak Release (cfs)**	**Stage Storage Elevation**
Water Quality	0.68	997.7
*2-year	24.58	999.7
10-year	35.62	1001.0
100-year	56.32	1002.8
Bottom of Spillway	--	1003.3
**Top of Spillway	--	1004.3

*The 2-year event was not defined in the downstream system.
**Spillway sizing is provided in Appendix A3.

4.0 Downstream Analysis

As part of the Stormwater Management Study. Downstream conditions were considered. The site drains to proposed Douglas Station Commercial Park. BHC has reviewed the design of the downstream and stormwater management study provided with that development and is rescripted the release rate of our system with the assumed release rates of the downstream system. Additionally, BHC recommends a direct connection to the Douglas Station system to in lieu of an overland flow.

4.0 Water Quality

Per the Lee Summit design and construction manual “volumetric and/or extended detention control of the 90% mean annual event storm event shall be provided for broad protection of the receiving system, including channel erosion protection and flood peak reductions over a range of return periods.”

This is achieved as described above with the use of the restricted 3” orifice to manage runoff from the 1.37 inch event.

6.0 Permitting

6.1 United State Army Corps of Engineers (USACE)

The National Wetland Inventory and USGS Mapping does not Identify and jurisdictional waters within the site area. There are no known USACE regulated levees with 500-feet of the site.

6.2 Federal Emergency Management Agency (FEMA)

The site is located within the Zone X, and outside of the 1% and 0.2% annual chance flood hazard, as shown on FEMA FIRM Map 29095C0417G, effective 1/20/2017. The FEMA Firmette for the project site can be found in Appendix A4

6.3 Missouri Department of Natural Resources (MoDNR)

The area to be disturbed by the project site exceeds 1-arce; a Notice of Intent (NOI) is required to be submitted to MoDNR and a Stormwater Pollution Prevention Plan (SWPPP) will be prepared for the project.

6.0 Conclusion

Multiple stormwater control criteria were considered for the development of the proposed project. Following a review of the design criteria, the limitations of the downstream system were considered for the governing criteria. The proposed site meets the release rates of the proposed downstream system for the Douglas Station Commercial Park.

Additionally, the stormwater design meets the Lee's Summit Design and Construction manual requirements for water quality control through the use of an Extended Dry Detention system.

BHC will continue to work with staff and the neighboring development through the preparation of final development plans and issuance of a permit.

Appendix A – Reference Documents

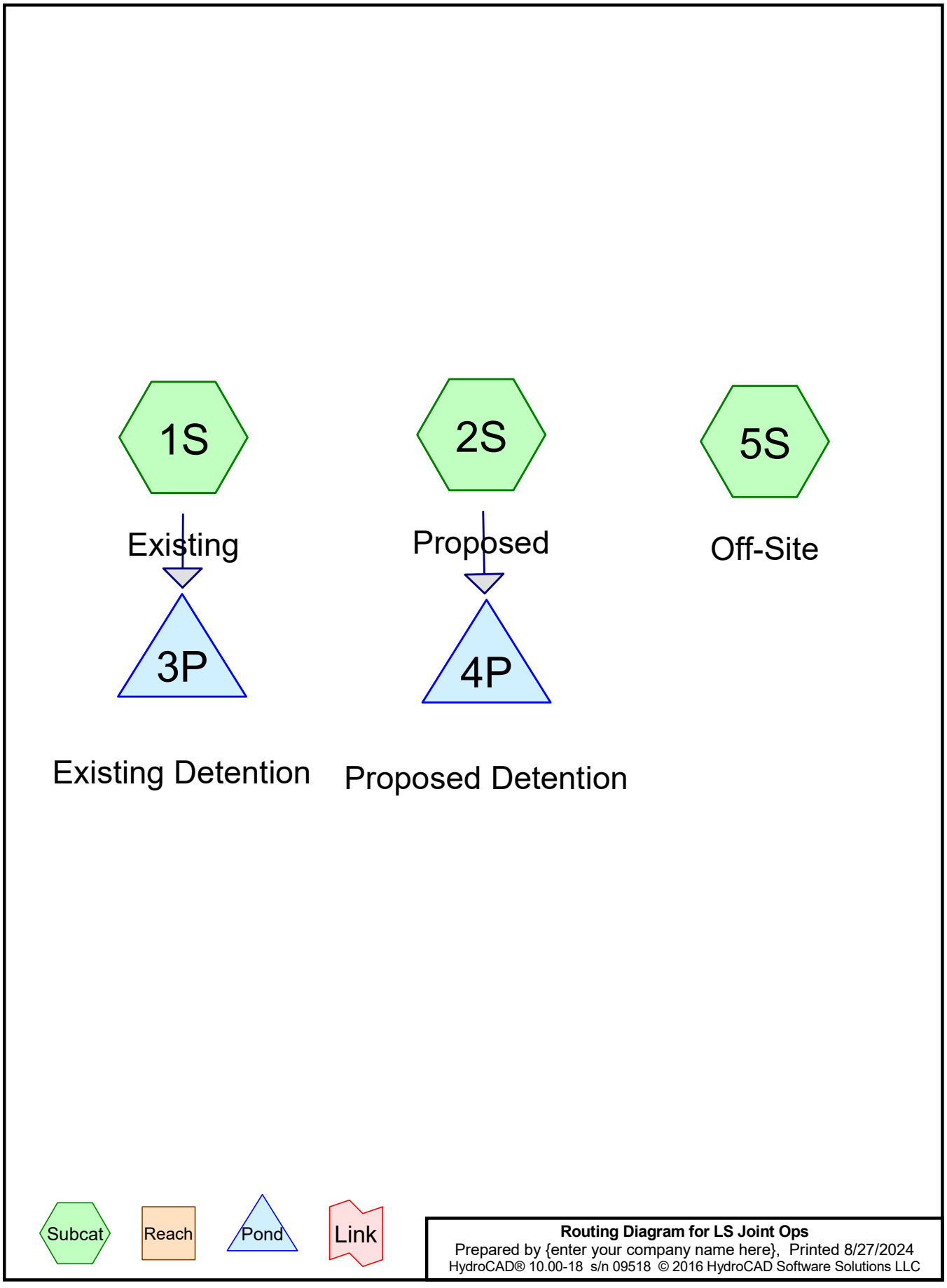
A1 – HyrdoCAD Output Summary

A2 – Douglass Station Commercial Park Reference Documents

A3 – Spillway Design

A4 – FEMA Firmette

Appendix A1


1S
2S
5S
Existing
Proposed
Off-Site
3P
4P
Existing Detention
Proposed Detention
Subcat
Reach
Pond
Link
Routing Diagram for LS Joint Ops
Prepared by {enter your company name here}, Printed 8/27/2024
HydroCAD® 10.00-18 s/n 09518 © 2016 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
12.190	90	(1S)
12.390	92	(2S)
0.500	91	(5S)
25.080	**91**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
25.080	Other	1S, 2S, 5S
25.080		**TOTAL AREA**

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	25.080	25.080		1S, 2S, 5S
0.000	**0.000**	**0.000**	**0.000**	**25.080**	**25.080**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	3P	999.50	999.00	40.0	0.0125	0.025	30.0	0.0	0.0
2	4P	994.90	994.50	40.0	0.0100	0.012	30.0	0.0	0.0

Time span=5.00-60.00 hrs, dt=0.05 hrs, 1101 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: Existing Runoff Area=12.190 ac 0.00% Impervious Runoff Depth>2.64"
Tc=10.0 min CN=90 Runoff=47.16 cfs 2.677 af

Subcatchment 2S: Proposed Runoff Area=12.390 ac 0.00% Impervious Runoff Depth>2.83"
Tc=10.0 min CN=92 Runoff=50.58 cfs 2.918 af

Subcatchment 5S: Off-Site Runoff Area=0.500 ac 0.00% Impervious Runoff Depth>2.73"
Tc=5.0 min CN=91 Runoff=2.33 cfs 0.114 af

Pond 3P: Existing Detention Peak Elev=1,001.64' Storage=17,273 cf Inflow=47.16 cfs 2.677 af
30.0" Round Culvert x 2.00 n=0.025 L=40.0' S=0.0125 '/' Outflow=33.34 cfs 2.670 af

Pond 4P: Proposed Detention Peak Elev=999.67' Storage=45,051 cf Inflow=50.58 cfs 2.918 af
Outflow=25.48 cfs 2.918 af

Total Runoff Area = 25.080 ac Runoff Volume = 5.709 af Average Runoff Depth = 2.73"
100.00% Pervious = 25.080 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Existing

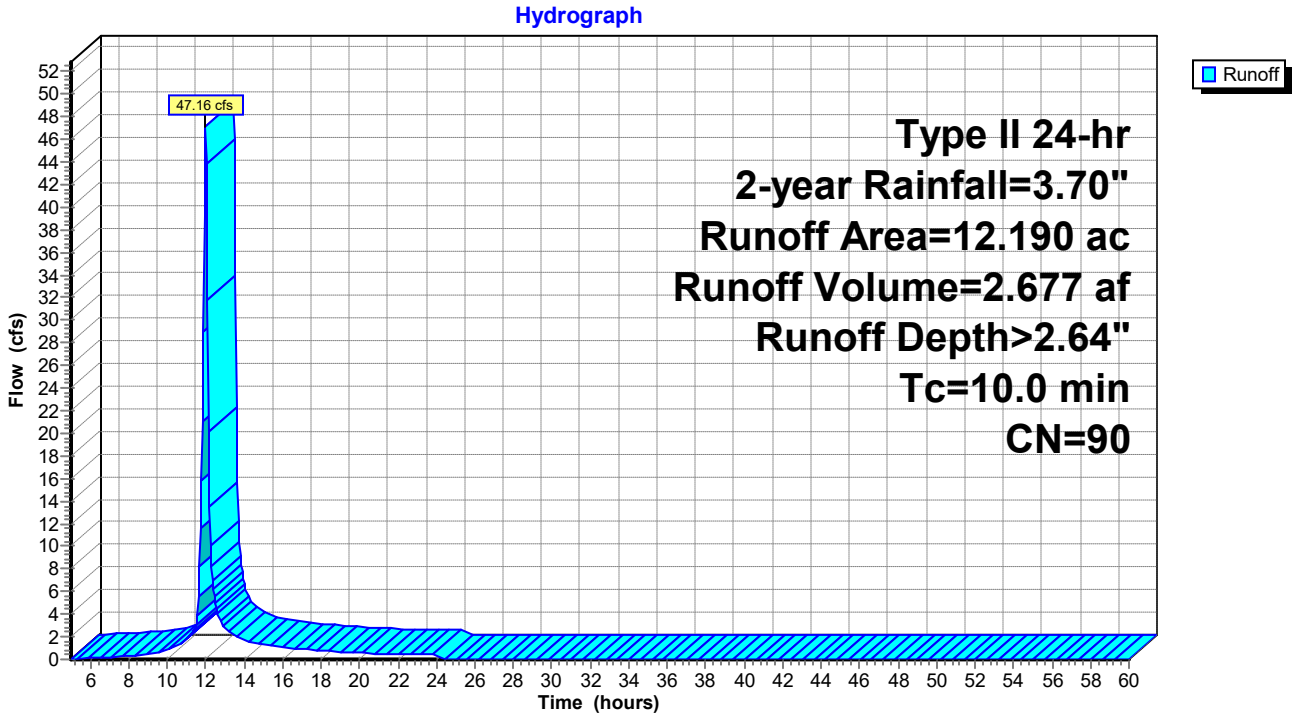
Runoff = 47.16 cfs @ 12.01 hrs, Volume= 2.677 af, Depth> 2.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-year Rainfall=3.70"

	Area (ac)	CN	Description
*	12.190	90	
	12.190		100.00% Pervious Area

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

Subcatchment 1S: Existing



Summary for Subcatchment 2S: Proposed

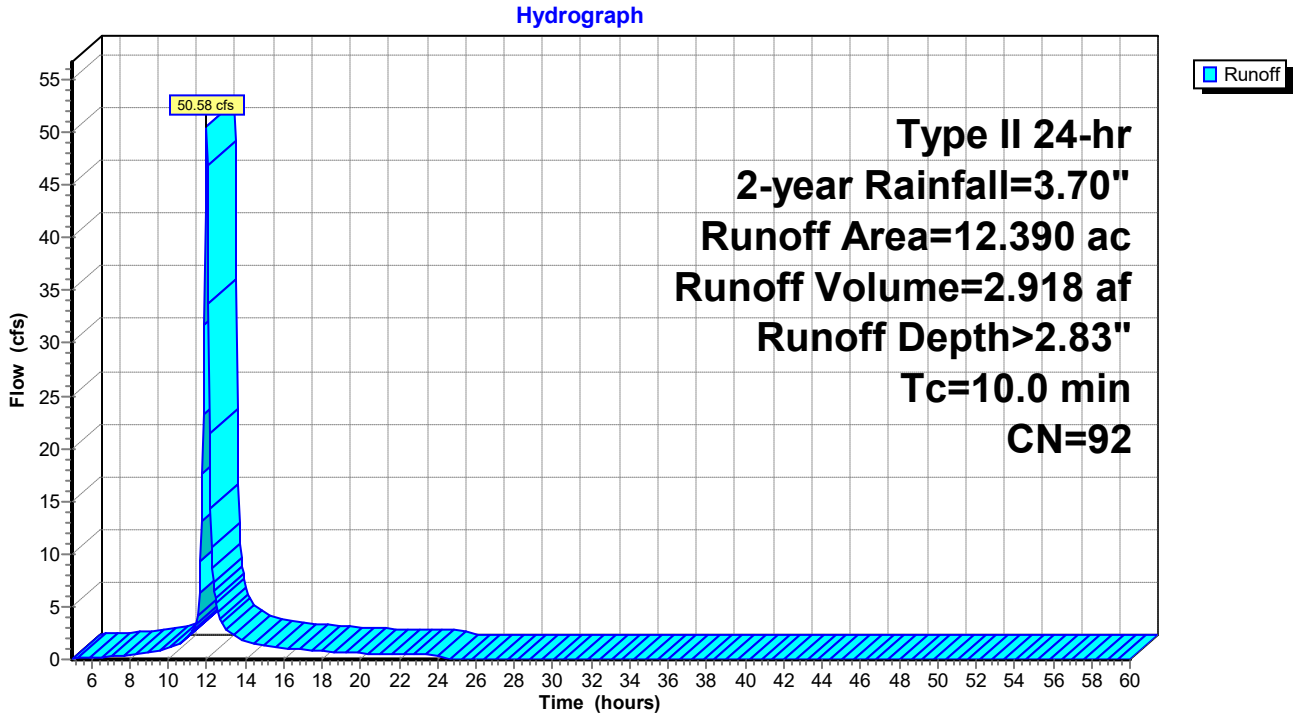
Runoff = 50.58 cfs @ 12.01 hrs, Volume= 2.918 af, Depth> 2.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-year Rainfall=3.70"

	Area (ac)	CN	Description
*	12.390	92	
	12.390		100.00% Pervious Area

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

Subcatchment 2S: Proposed



Summary for Subcatchment 5S: Off-Site

[49] Hint: Tc<2dt may require smaller dt

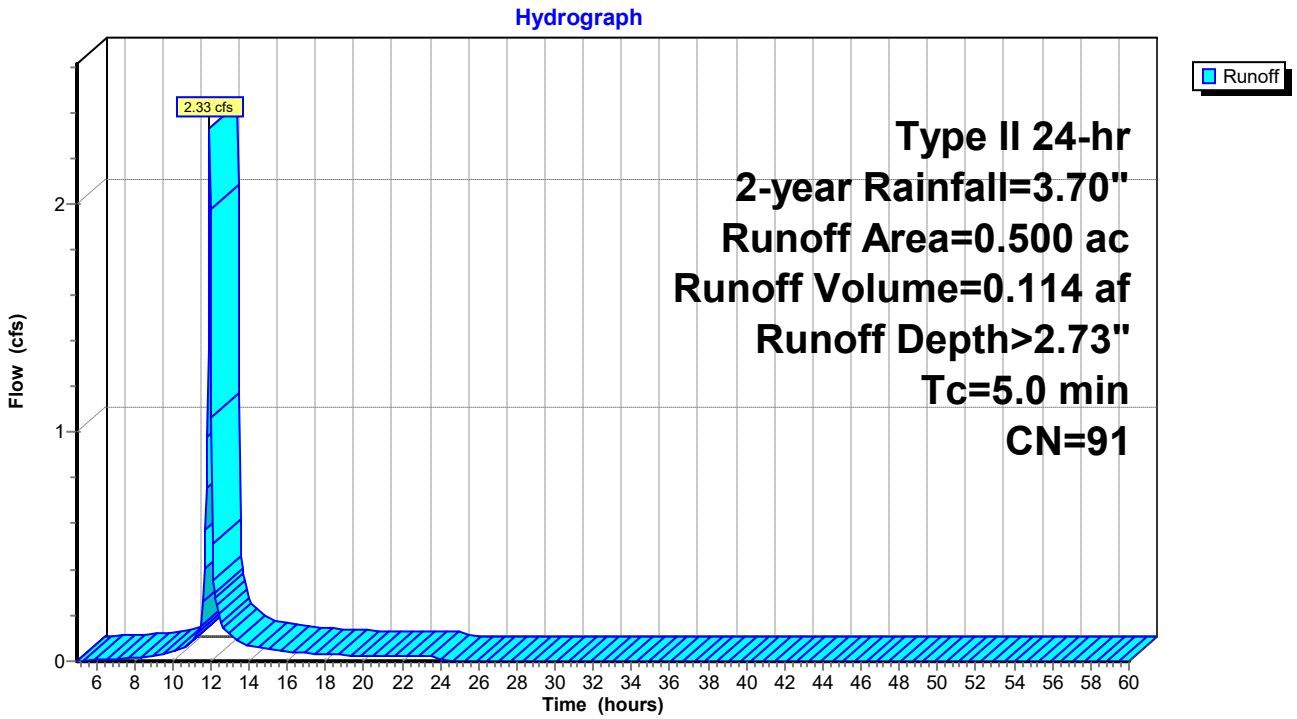
Runoff = 2.33 cfs @ 11.95 hrs, Volume= 0.114 af, Depth> 2.73"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 2-year Rainfall=3.70"

	Area (ac)	CN	Description
*	0.500	91	
	0.500		100.00% Pervious Area

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

Subcatchment 5S: Off-Site



Summary for Pond 3P: Existing Detention

Inflow Area = 12.190 ac, 0.00% Impervious, Inflow Depth > 2.64" for 2-year event
Inflow = 47.16 cfs @ 12.01 hrs, Volume= 2.677 af
Outflow = 33.34 cfs @ 12.10 hrs, Volume= 2.670 af, Atten= 29%, Lag= 5.2 min
Primary = 33.34 cfs @ 12.10 hrs, Volume= 2.670 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 1,001.64' @ 12.10 hrs Surf.Area= 15,268 sf Storage= 17,273 cf

Plug-Flow detention time= 11.6 min calculated for 2.668 af (100% of inflow)
Center-of-Mass det. time= 9.8 min (811.8 - 802.0)

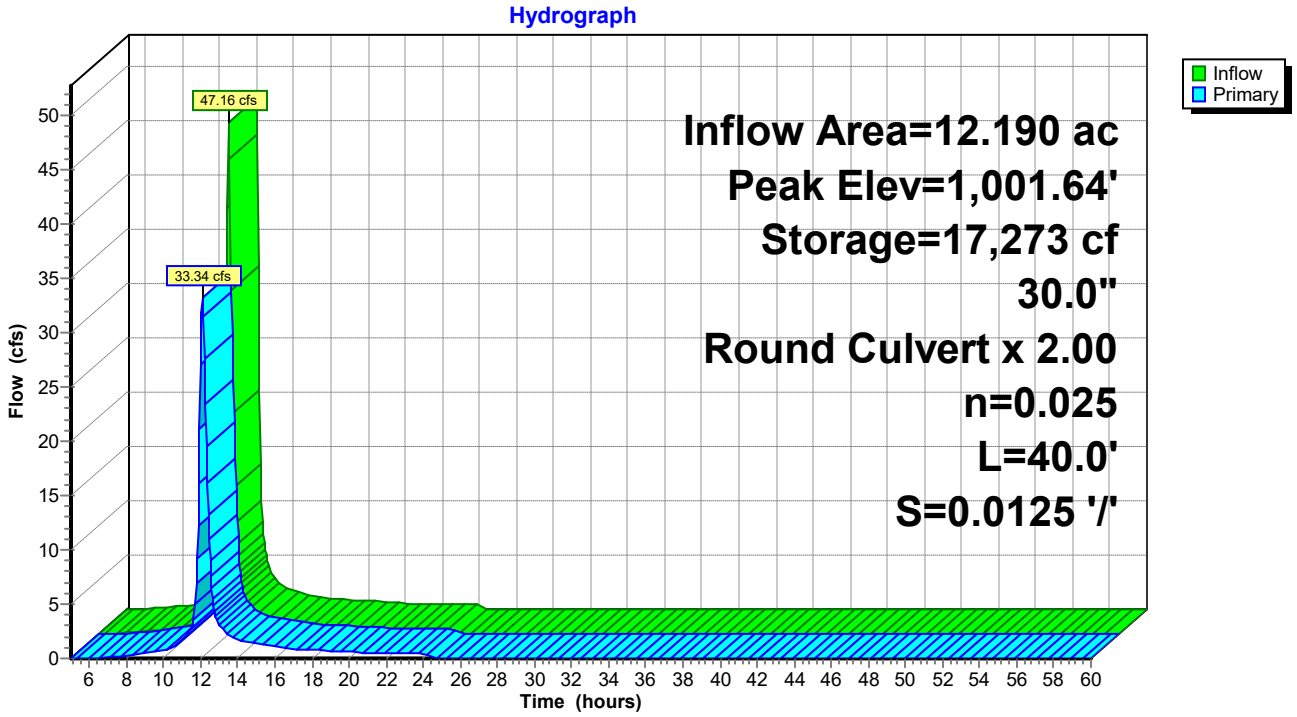
Volume	Invert	Avail.Storage	Storage Description
#1	999.00'	88,385 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
999.00	10	0	0
1,000.00	2,580	1,295	1,295
1,001.00	12,035	7,308	8,603
1,002.00	17,125	14,580	23,183
1,003.00	19,500	18,313	41,495
1,004.00	22,140	20,820	62,315
1,005.00	30,000	26,070	88,385

Device	Routing	Invert	Outlet Devices
#1	Primary	999.50'	**30.0" Round CMP_Round 30" X 2.00** L= 40.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 999.50' / 999.00' S= 0.0125 '/' Cc= 0.900 n= 0.025, Flow Area= 4.91 sf

Primary OutFlow Max=33.25 cfs @ 12.10 hrs HW=1,001.63' (Free Discharge)
↑**1=CMP_Round 30"** (Barrel Controls 33.25 cfs @ 5.02 fps)

Pond 3P: Existing Detention



Summary for Pond 4P: Proposed Detention

[82] Warning: Early inflow requires earlier time span

Inflow Area = 12.390 ac, 0.00% Impervious, Inflow Depth > 2.83" for 2-year event
Inflow = 50.58 cfs @ 12.01 hrs, Volume= 2.918 af
Outflow = 25.48 cfs @ 12.14 hrs, Volume= 2.918 af, Atten= 50%, Lag= 7.6 min
Primary = 25.48 cfs @ 12.14 hrs, Volume= 2.918 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 999.67' @ 12.14 hrs Surf.Area= 16,405 sf Storage= 45,051 cf

Plug-Flow detention time= 179.8 min calculated for 2.915 af (100% of inflow)
Center-of-Mass det. time= 180.5 min (974.1 - 793.6)

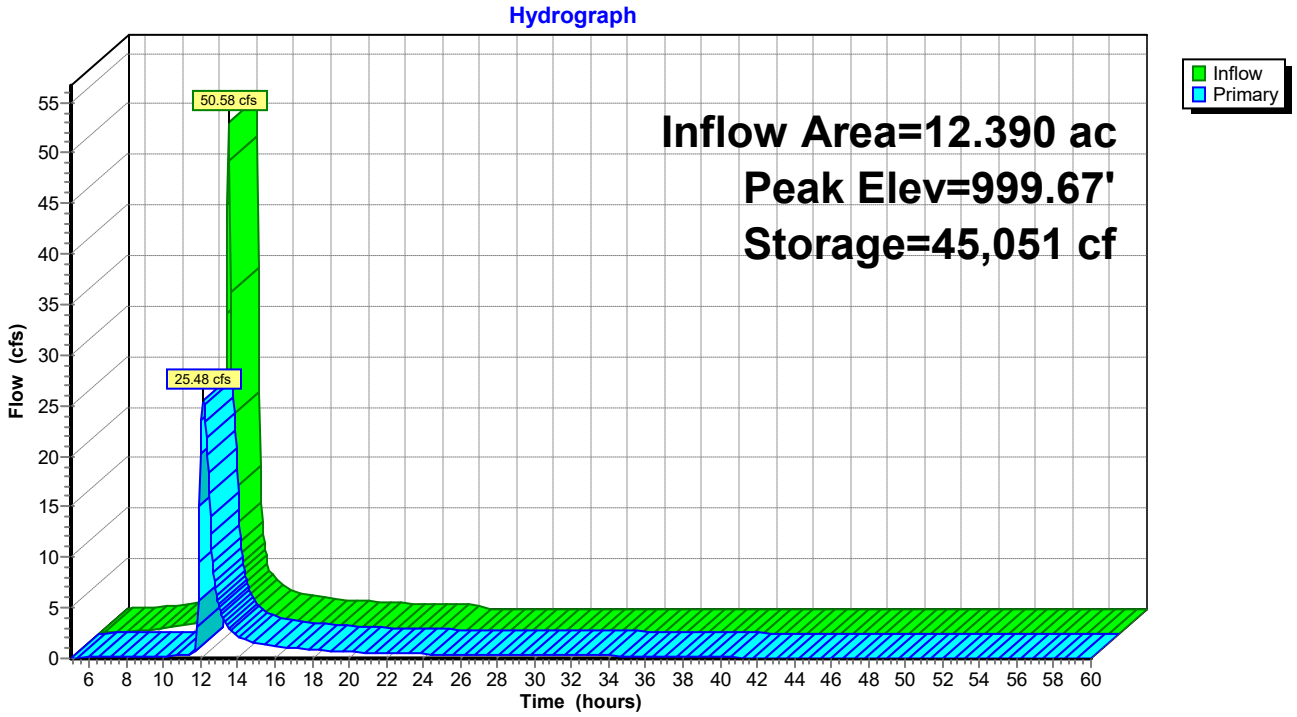
Volume	Invert	Avail.Storage	Storage Description
#1	995.00'	117,239 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
995.00	50	0	0
996.00	5,861	2,956	2,956
997.00	8,539	7,200	10,156
998.00	12,648	10,594	20,749
999.00	14,868	13,758	34,507
1,000.00	17,147	16,008	50,515
1,001.00	19,482	18,315	68,829
1,002.00	24,323	21,903	90,732
1,003.00	28,692	26,508	117,239

Device	Routing	Invert	Outlet Devices
#1	Primary	994.90'	**30.0" Round Culvert** L= 40.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 994.90' / 994.50' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 4.91 sf
#2	Device 1	995.00'	**3.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	997.62'	**42.0" W x 15.0" H Vert. Orifice/Grate** C= 0.600
#4	Primary	1,001.10'	**24.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=25.39 cfs @ 12.14 hrs HW=999.66' (Free Discharge)
- **1=Culvert** (Passes 25.39 cfs of 44.31 cfs potential flow)
  - **2=Orifice/Grate** (Orifice Controls 0.50 cfs @ 10.26 fps)
  - **3=Orifice/Grate** (Orifice Controls 24.88 cfs @ 5.69 fps)
- **4=Orifice/Grate** (Controls 0.00 cfs)

Pond 4P: Proposed Detention



Time span=5.00-60.00 hrs, dt=0.05 hrs, 1101 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: Existing Runoff Area=12.190 ac 0.00% Impervious Runoff Depth>4.50"
Tc=10.0 min CN=90 Runoff=78.42 cfs 4.575 af

Subcatchment 2S: Proposed Runoff Area=12.390 ac 0.00% Impervious Runoff Depth>4.71"
Tc=10.0 min CN=92 Runoff=82.12 cfs 4.862 af

Subcatchment 5S: Off-Site Runoff Area=0.500 ac 0.00% Impervious Runoff Depth>4.61"
Tc=5.0 min CN=91 Runoff=3.81 cfs 0.192 af

Pond 3P: Existing Detention Peak Elev=1,002.47' Storage=31,445 cf Inflow=78.42 cfs 4.575 af
30.0" Round Culvert x 2.00 n=0.025 L=40.0' S=0.0125 '/' Outflow=51.43 cfs 4.568 af

Pond 4P: Proposed Detention Peak Elev=1,001.03' Storage=69,325 cf Inflow=82.12 cfs 4.862 af
Outflow=35.62 cfs 4.862 af

Total Runoff Area = 25.080 ac Runoff Volume = 9.629 af Average Runoff Depth = 4.61"
100.00% Pervious = 25.080 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Existing

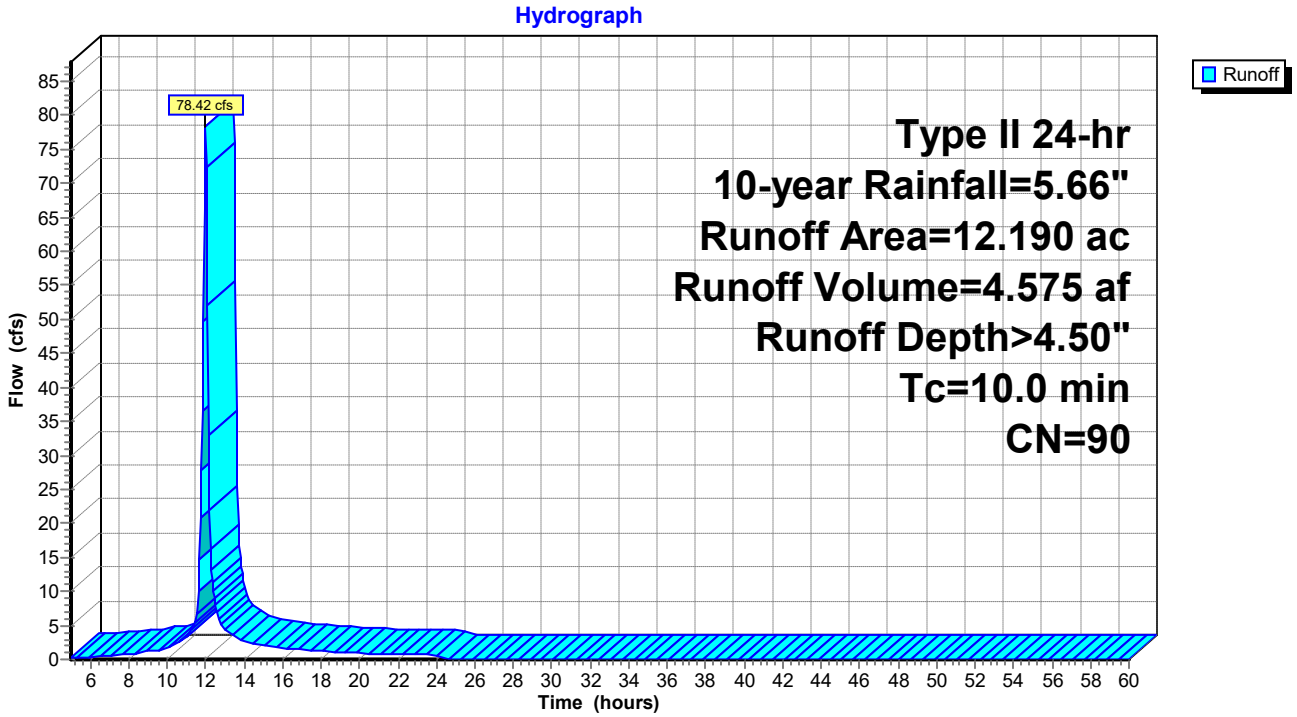
Runoff = 78.42 cfs @ 12.01 hrs, Volume= 4.575 af, Depth> 4.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-year Rainfall=5.66"

	Area (ac)	CN	Description
*	12.190	90	
	12.190		100.00% Pervious Area

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

Subcatchment 1S: Existing



Summary for Subcatchment 2S: Proposed

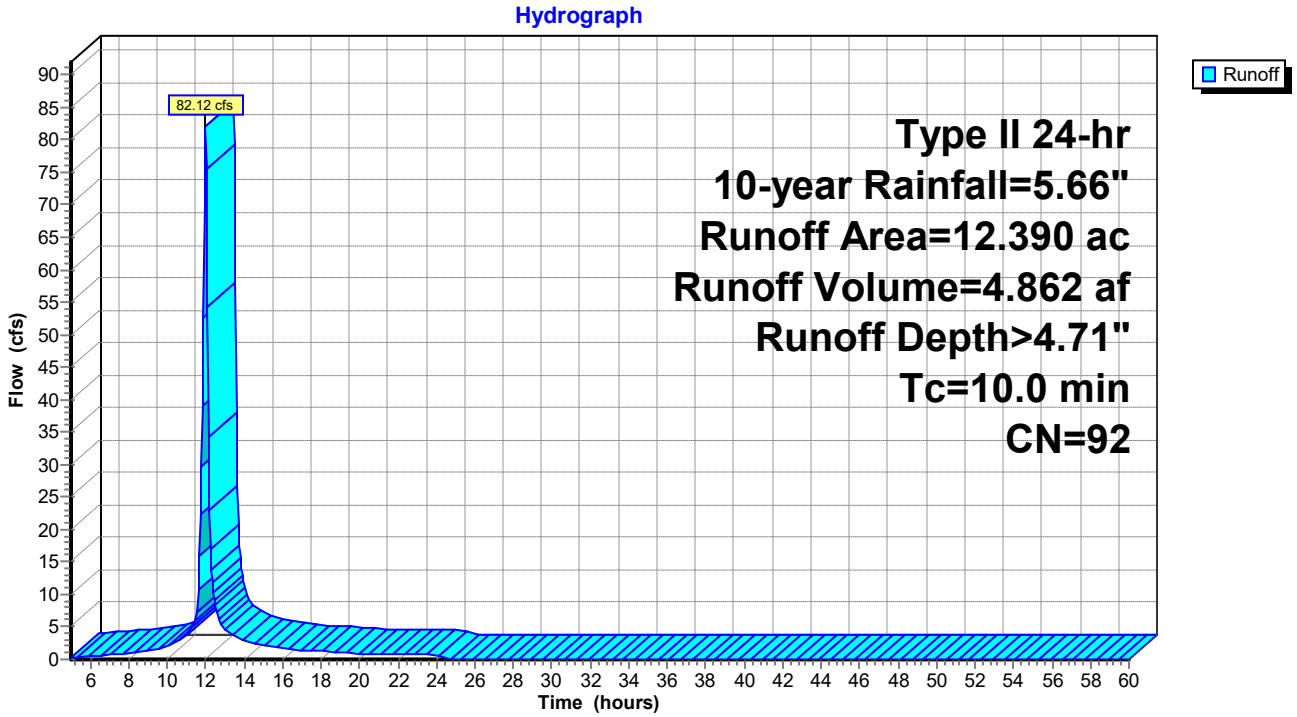
Runoff = 82.12 cfs @ 12.01 hrs, Volume= 4.862 af, Depth> 4.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-year Rainfall=5.66"

	Area (ac)	CN	Description
*	12.390	92	
	12.390		100.00% Pervious Area

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

Subcatchment 2S: Proposed



Summary for Subcatchment 5S: Off-Site

[49] Hint: Tc<2dt may require smaller dt

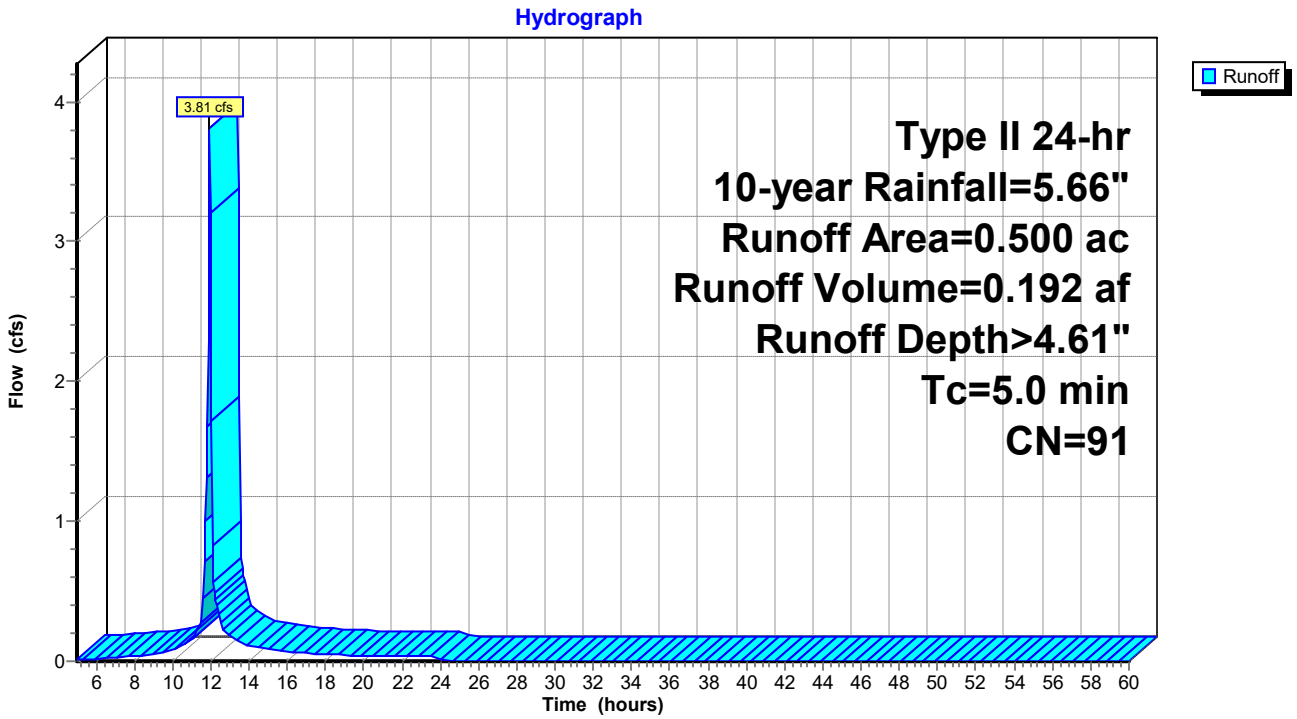
Runoff = 3.81 cfs @ 11.95 hrs, Volume= 0.192 af, Depth> 4.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 10-year Rainfall=5.66"

	Area (ac)	CN	Description
*	0.500	91	
	0.500		100.00% Pervious Area

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

Subcatchment 5S: Off-Site



Summary for Pond 3P: Existing Detention

[82] Warning: Early inflow requires earlier time span

Inflow Area = 12.190 ac, 0.00% Impervious, Inflow Depth > 4.50" for 10-year event
Inflow = 78.42 cfs @ 12.01 hrs, Volume= 4.575 af
Outflow = 51.43 cfs @ 12.10 hrs, Volume= 4.568 af, Atten= 34%, Lag= 5.8 min
Primary = 51.43 cfs @ 12.10 hrs, Volume= 4.568 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 1,002.47' @ 12.10 hrs Surf.Area= 18,235 sf Storage= 31,445 cf

Plug-Flow detention time= 10.3 min calculated for 4.563 af (100% of inflow)
Center-of-Mass det. time= 9.2 min (797.5 - 788.3)

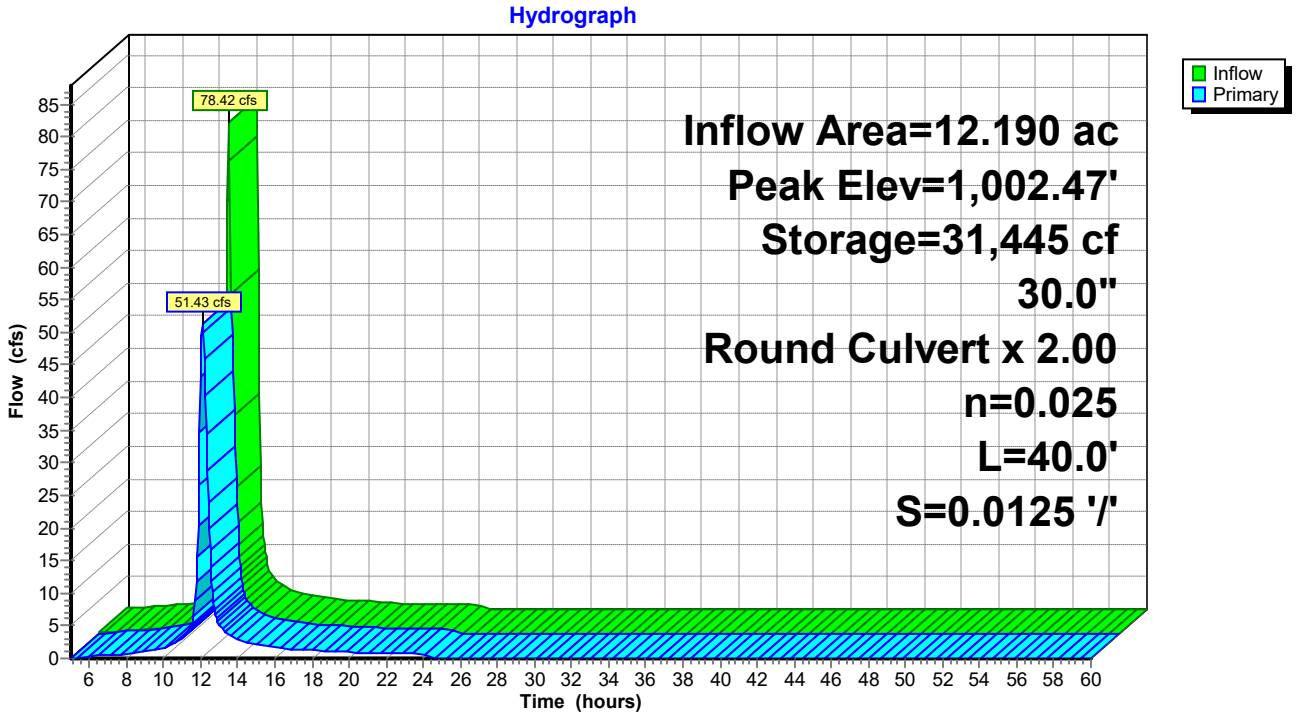
Volume	Invert	Avail.Storage	Storage Description
#1	999.00'	88,385 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
999.00	10	0	0
1,000.00	2,580	1,295	1,295
1,001.00	12,035	7,308	8,603
1,002.00	17,125	14,580	23,183
1,003.00	19,500	18,313	41,495
1,004.00	22,140	20,820	62,315
1,005.00	30,000	26,070	88,385

Device	Routing	Invert	Outlet Devices
#1	Primary	999.50'	**30.0" Round CMP_Round 30" X 2.00** L= 40.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 999.50' / 999.00' S= 0.0125 '/' Cc= 0.900 n= 0.025, Flow Area= 4.91 sf

Primary OutFlow Max=51.29 cfs @ 12.10 hrs HW=1,002.46' (Free Discharge)
↑—**1=CMP_Round 30"** (Barrel Controls 51.29 cfs @ 5.57 fps)

Pond 3P: Existing Detention



Summary for Pond 4P: Proposed Detention

[82] Warning: Early inflow requires earlier time span

Inflow Area = 12.390 ac, 0.00% Impervious, Inflow Depth > 4.71" for 10-year event
Inflow = 82.12 cfs @ 12.01 hrs, Volume= 4.862 af
Outflow = 35.62 cfs @ 12.15 hrs, Volume= 4.862 af, Atten= 57%, Lag= 8.7 min
Primary = 35.62 cfs @ 12.15 hrs, Volume= 4.862 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 1,001.03' @ 12.15 hrs Surf.Area= 19,605 sf Storage= 69,325 cf

Plug-Flow detention time= 127.6 min calculated for 4.861 af (100% of inflow)
Center-of-Mass det. time= 127.2 min (909.3 - 782.2)

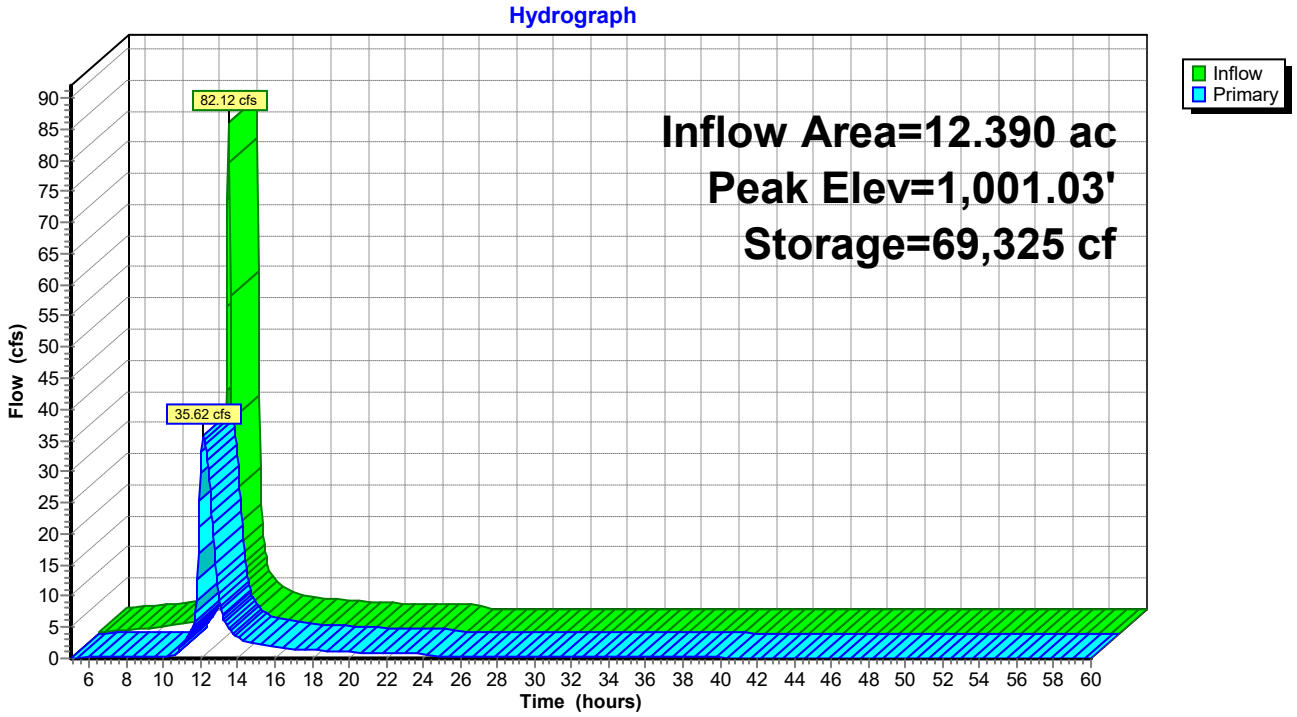
Volume	Invert	Avail.Storage	Storage Description
#1	995.00'	117,239 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
995.00	50	0	0
996.00	5,861	2,956	2,956
997.00	8,539	7,200	10,156
998.00	12,648	10,594	20,749
999.00	14,868	13,758	34,507
1,000.00	17,147	16,008	50,515
1,001.00	19,482	18,315	68,829
1,002.00	24,323	21,903	90,732
1,003.00	28,692	26,508	117,239

Device	Routing	Invert	Outlet Devices
#1	Primary	994.90'	**30.0" Round Culvert** L= 40.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 994.90' / 994.50' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 4.91 sf
#2	Device 1	995.00'	**3.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	997.62'	**42.0" W x 15.0" H Vert. Orifice/Grate** C= 0.600
#4	Primary	1,001.10'	**24.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=35.59 cfs @ 12.15 hrs HW=1,001.02' (Free Discharge)
- **1=Culvert** (Passes 35.59 cfs of 52.16 cfs potential flow)
  - **2=Orifice/Grate** (Orifice Controls 0.57 cfs @ 11.69 fps)
  - **3=Orifice/Grate** (Orifice Controls 35.02 cfs @ 8.00 fps)
- **4=Orifice/Grate** (Controls 0.00 cfs)

Pond 4P: Proposed Detention



Time span=5.00-60.00 hrs, dt=0.05 hrs, 1101 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: Existing Runoff Area=12.190 ac 0.00% Impervious Runoff Depth>7.94"
Tc=10.0 min CN=90 Runoff=134.50 cfs 8.068 af

Subcatchment 2S: Proposed Runoff Area=12.390 ac 0.00% Impervious Runoff Depth>8.15"
Tc=10.0 min CN=92 Runoff=138.64 cfs 8.411 af

Subcatchment 5S: Off-Site Runoff Area=0.500 ac 0.00% Impervious Runoff Depth>8.04"
Tc=5.0 min CN=91 Runoff=6.47 cfs 0.335 af

Pond 3P: Existing Detention Peak Elev=1,004.08' Storage=64,183 cf Inflow=134.50 cfs 8.068 af
30.0" Round Culvert x 2.00 n=0.025 L=40.0' S=0.0125 '/' Outflow=74.77 cfs 8.060 af

Pond 4P: Proposed Detention Peak Elev=1,002.83' Storage=112,390 cf Inflow=138.64 cfs 8.411 af
Outflow=56.32 cfs 8.411 af

Total Runoff Area = 25.080 ac Runoff Volume = 16.814 af Average Runoff Depth = 8.04"
100.00% Pervious = 25.080 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Existing

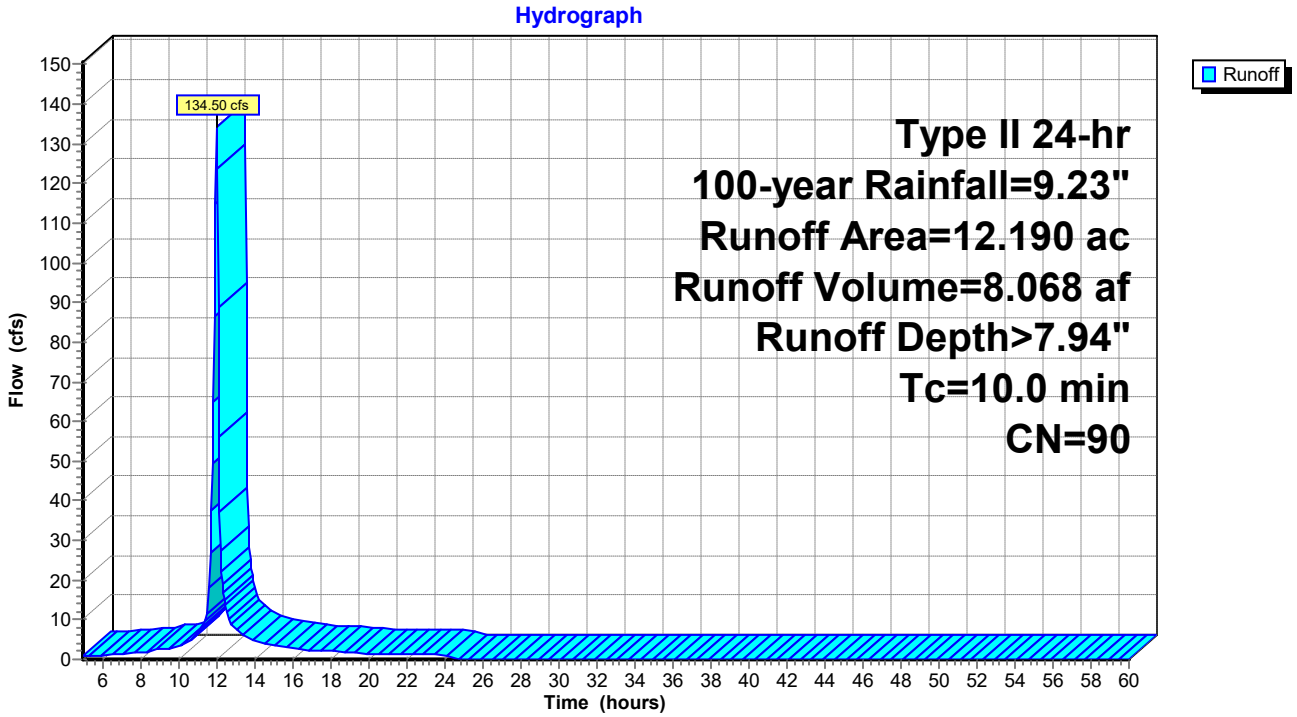
Runoff = 134.50 cfs @ 12.01 hrs, Volume= 8.068 af, Depth> 7.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-year Rainfall=9.23"

	Area (ac)	CN	Description
*	12.190	90	
	12.190		100.00% Pervious Area

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

Subcatchment 1S: Existing



Summary for Subcatchment 2S: Proposed

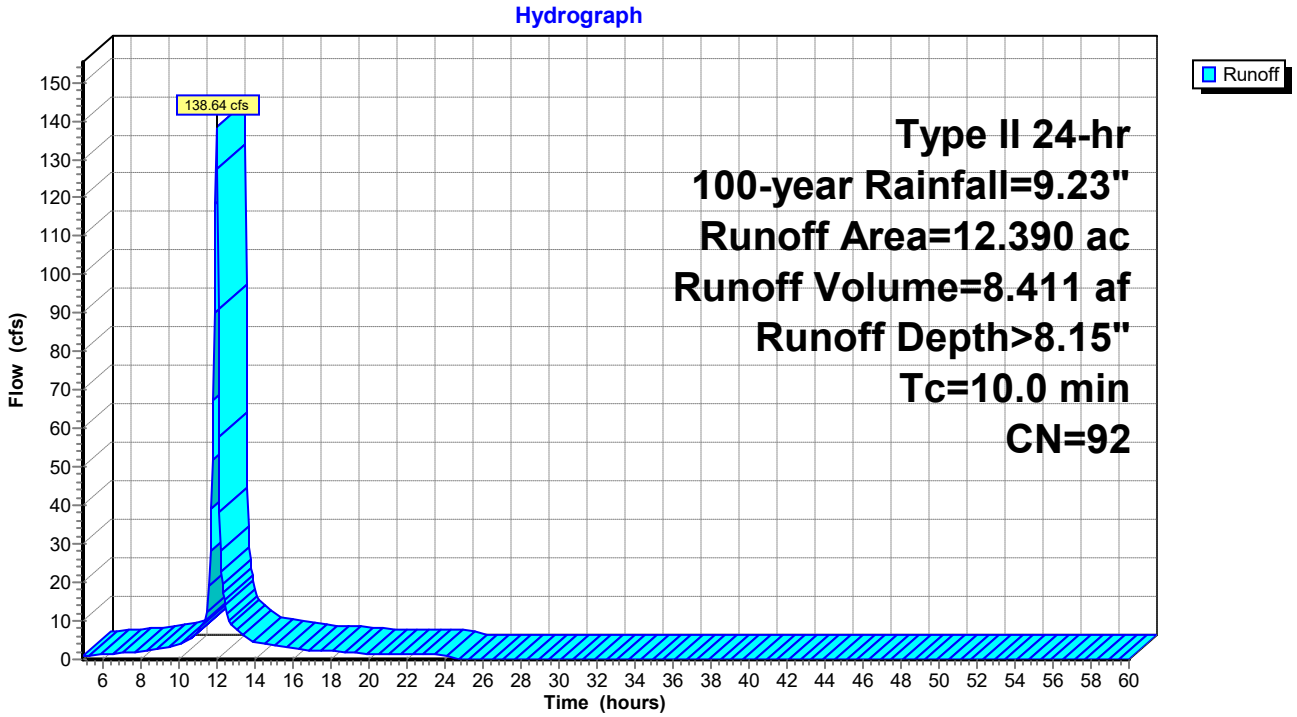
Runoff = 138.64 cfs @ 12.01 hrs, Volume= 8.411 af, Depth> 8.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-year Rainfall=9.23"

	Area (ac)	CN	Description
*	12.390	92	
	12.390		100.00% Pervious Area

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

Subcatchment 2S: Proposed



Summary for Subcatchment 5S: Off-Site

[49] Hint: Tc<2dt may require smaller dt

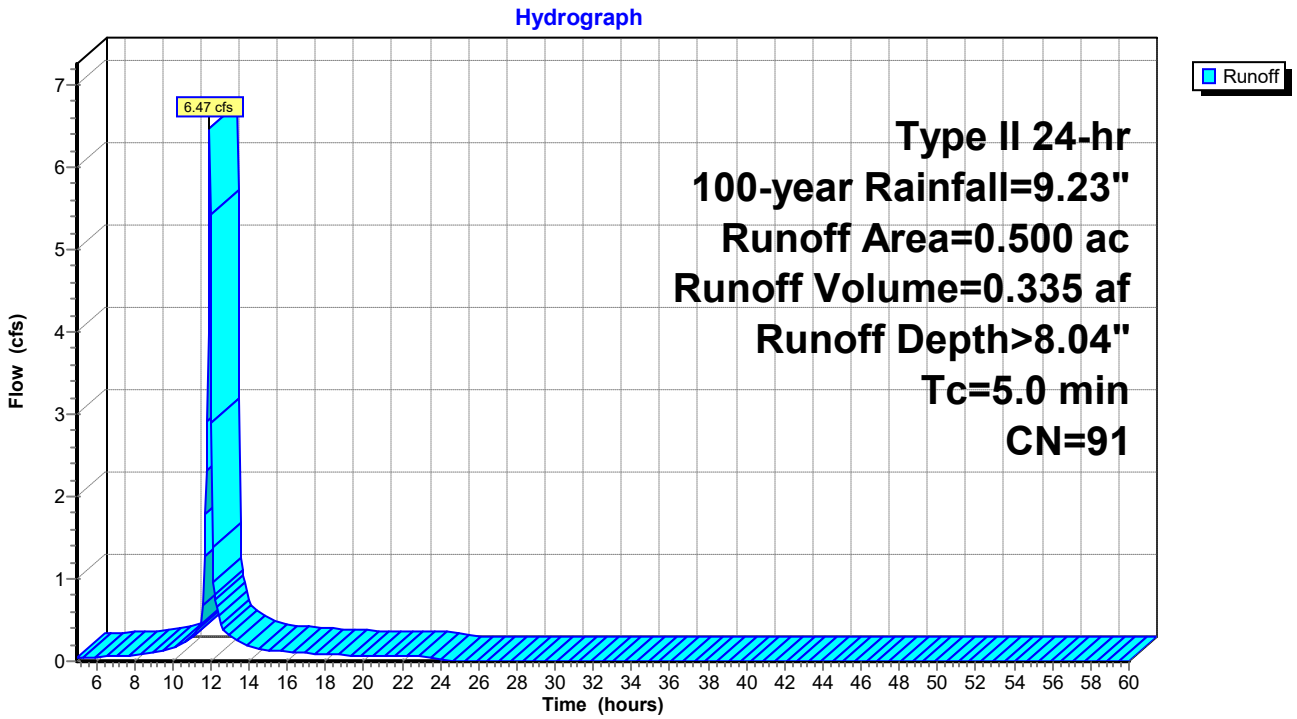
Runoff = 6.47 cfs @ 11.95 hrs, Volume= 0.335 af, Depth> 8.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr 100-year Rainfall=9.23"

	Area (ac)	CN	Description
*	0.500	91	
	0.500		100.00% Pervious Area

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

Subcatchment 5S: Off-Site



Summary for Pond 3P: Existing Detention

[82] Warning: Early inflow requires earlier time span

Inflow Area = 12.190 ac, 0.00% Impervious, Inflow Depth > 7.94" for 100-year event
Inflow = 134.50 cfs @ 12.01 hrs, Volume= 8.068 af
Outflow = 74.77 cfs @ 12.12 hrs, Volume= 8.060 af, Atten= 44%, Lag= 6.9 min
Primary = 74.77 cfs @ 12.12 hrs, Volume= 8.060 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 1,004.08' @ 12.12 hrs Surf.Area= 22,793 sf Storage= 64,183 cf

Plug-Flow detention time= 10.4 min calculated for 8.051 af (100% of inflow)
Center-of-Mass det. time= 9.6 min (786.7 - 777.1)

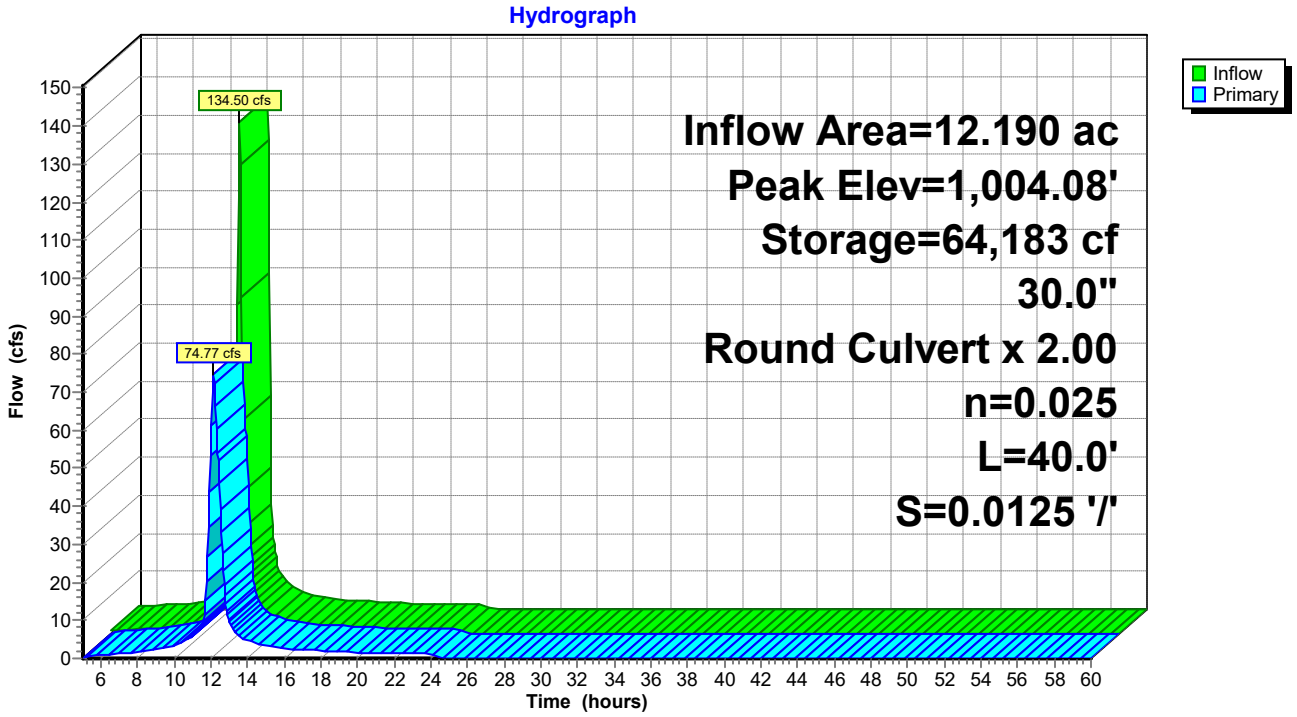
Volume	Invert	Avail.Storage	Storage Description
#1	999.00'	88,385 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
999.00	10	0	0
1,000.00	2,580	1,295	1,295
1,001.00	12,035	7,308	8,603
1,002.00	17,125	14,580	23,183
1,003.00	19,500	18,313	41,495
1,004.00	22,140	20,820	62,315
1,005.00	30,000	26,070	88,385

Device	Routing	Invert	Outlet Devices
#1	Primary	999.50'	**30.0" Round CMP_Round 30" X 2.00** L= 40.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 999.50' / 999.00' S= 0.0125 '/' Cc= 0.900 n= 0.025, Flow Area= 4.91 sf

Primary OutFlow Max=74.23 cfs @ 12.12 hrs HW=1,004.05' (Free Discharge)
↑—**1=CMP_Round 30"** (Barrel Controls 74.23 cfs @ 7.56 fps)

Pond 3P: Existing Detention



Summary for Pond 4P: Proposed Detention

[82] Warning: Early inflow requires earlier time span

Inflow Area = 12.390 ac, 0.00% Impervious, Inflow Depth > 8.15" for 100-year event
Inflow = 138.64 cfs @ 12.01 hrs, Volume= 8.411 af
Outflow = 56.32 cfs @ 12.16 hrs, Volume= 8.411 af, Atten= 59%, Lag= 9.2 min
Primary = 56.32 cfs @ 12.16 hrs, Volume= 8.411 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 1,002.83' @ 12.16 hrs Surf.Area= 27,944 sf Storage= 112,390 cf

Plug-Flow detention time= 90.1 min calculated for 8.409 af (100% of inflow)
Center-of-Mass det. time= 89.6 min (862.5 - 773.0)

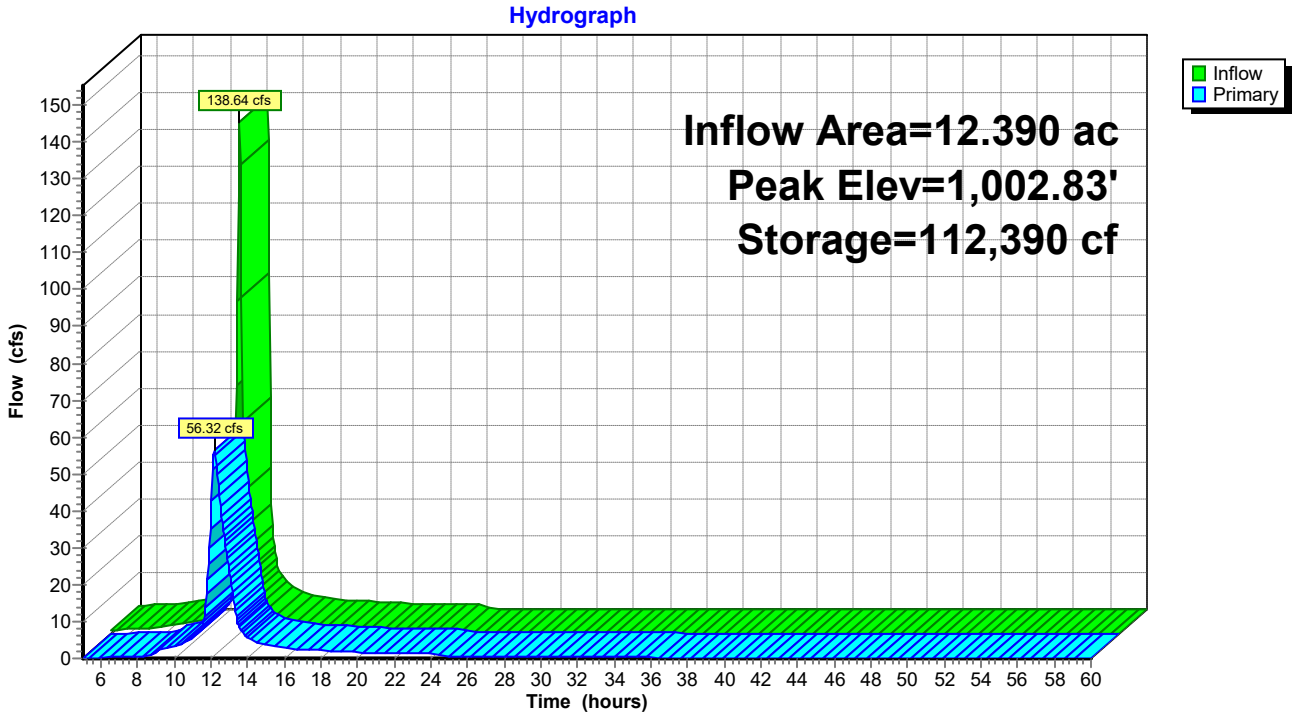
Volume	Invert	Avail.Storage	Storage Description
#1	995.00'	117,239 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
995.00	50	0	0
996.00	5,861	2,956	2,956
997.00	8,539	7,200	10,156
998.00	12,648	10,594	20,749
999.00	14,868	13,758	34,507
1,000.00	17,147	16,008	50,515
1,001.00	19,482	18,315	68,829
1,002.00	24,323	21,903	90,732
1,003.00	28,692	26,508	117,239

Device	Routing	Invert	Outlet Devices
#1	Primary	994.90'	**30.0" Round Culvert** L= 40.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 994.90' / 994.50' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 4.91 sf
#2	Device 1	995.00'	**3.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	997.62'	**42.0" W x 15.0" H Vert. Orifice/Grate** C= 0.600
#4	Primary	1,001.10'	**24.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=56.19 cfs @ 12.16 hrs HW=1,002.81' (Free Discharge)
- **1=Culvert** (Passes 45.65 cfs of 61.02 cfs potential flow)
  - **2=Orifice/Grate** (Orifice Controls 0.66 cfs @ 13.35 fps)
  - **3=Orifice/Grate** (Orifice Controls 45.00 cfs @ 10.28 fps)
- **4=Orifice/Grate** (Orifice Controls 10.54 cfs @ 5.27 fps)

Pond 4P: Proposed Detention



Time span=5.00-60.00 hrs, dt=0.05 hrs, 1101 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: Existing Runoff Area=12.190 ac 0.00% Impervious Runoff Depth=0.58"
Tc=10.0 min CN=90 Runoff=10.74 cfs 0.592 af

Subcatchment 2S: Proposed Runoff Area=12.390 ac 0.00% Impervious Runoff Depth=0.69"
Tc=10.0 min CN=92 Runoff=13.00 cfs 0.715 af

Subcatchment 5S: Off-Site Runoff Area=0.500 ac 0.00% Impervious Runoff Depth=0.64"
Tc=5.0 min CN=91 Runoff=0.57 cfs 0.026 af

Pond 3P: Existing Detention Peak Elev=1,000.47' Storage=3,527 cf Inflow=10.74 cfs 0.592 af
30.0" Round Culvert x 2.00 n=0.025 L=40.0' S=0.0125 '/' Outflow=8.31 cfs 0.585 af

Pond 4P: Proposed Detention Peak Elev=997.71' Storage=17,223 cf Inflow=13.00 cfs 0.715 af
Outflow=0.68 cfs 0.715 af

Total Runoff Area = 25.080 ac Runoff Volume = 1.334 af Average Runoff Depth = 0.64"
100.00% Pervious = 25.080 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: Existing

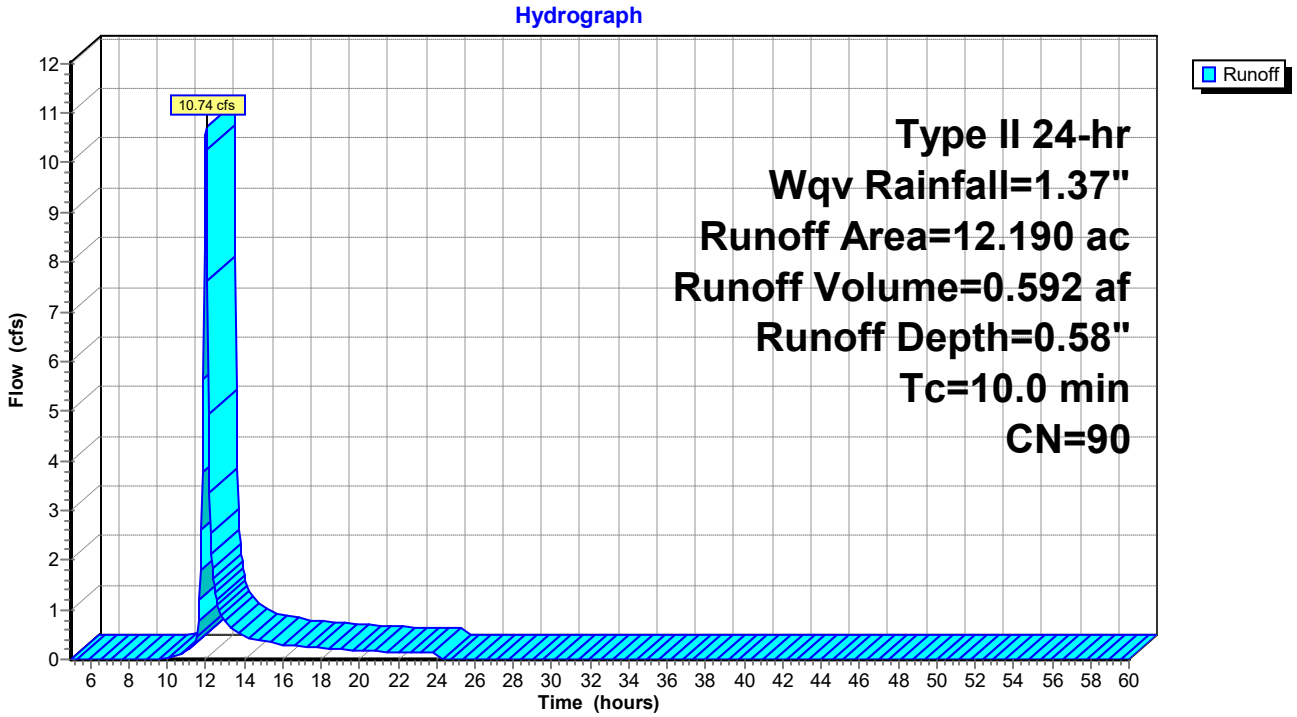
Runoff = 10.74 cfs @ 12.02 hrs, Volume= 0.592 af, Depth= 0.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr Wqv Rainfall=1.37"

	Area (ac)	CN	Description
*	12.190	90	
	12.190		100.00% Pervious Area

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

Subcatchment 1S: Existing



Summary for Subcatchment 2S: Proposed

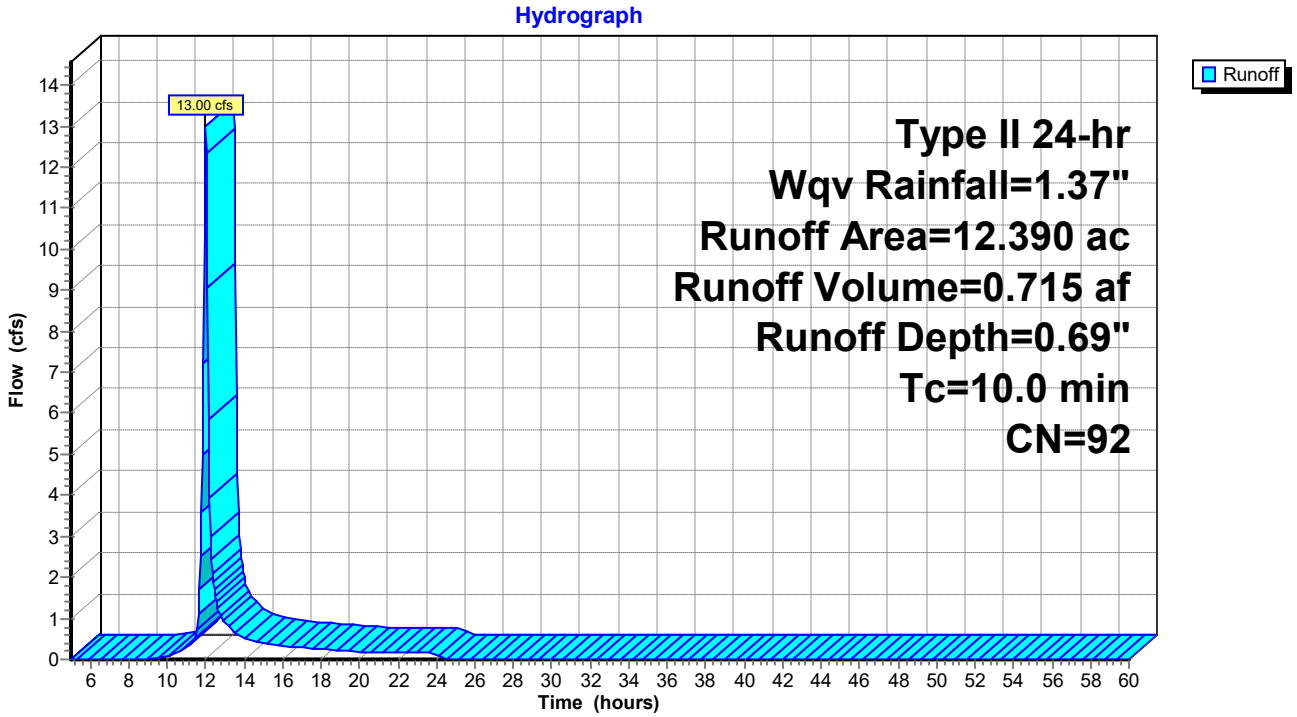
Runoff = 13.00 cfs @ 12.02 hrs, Volume= 0.715 af, Depth= 0.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr Wqv Rainfall=1.37"

	Area (ac)	CN	Description
*	12.390	92	
	12.390		100.00% Pervious Area

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

Subcatchment 2S: Proposed



Summary for Subcatchment 5S: Off-Site

[49] Hint: Tc<2dt may require smaller dt

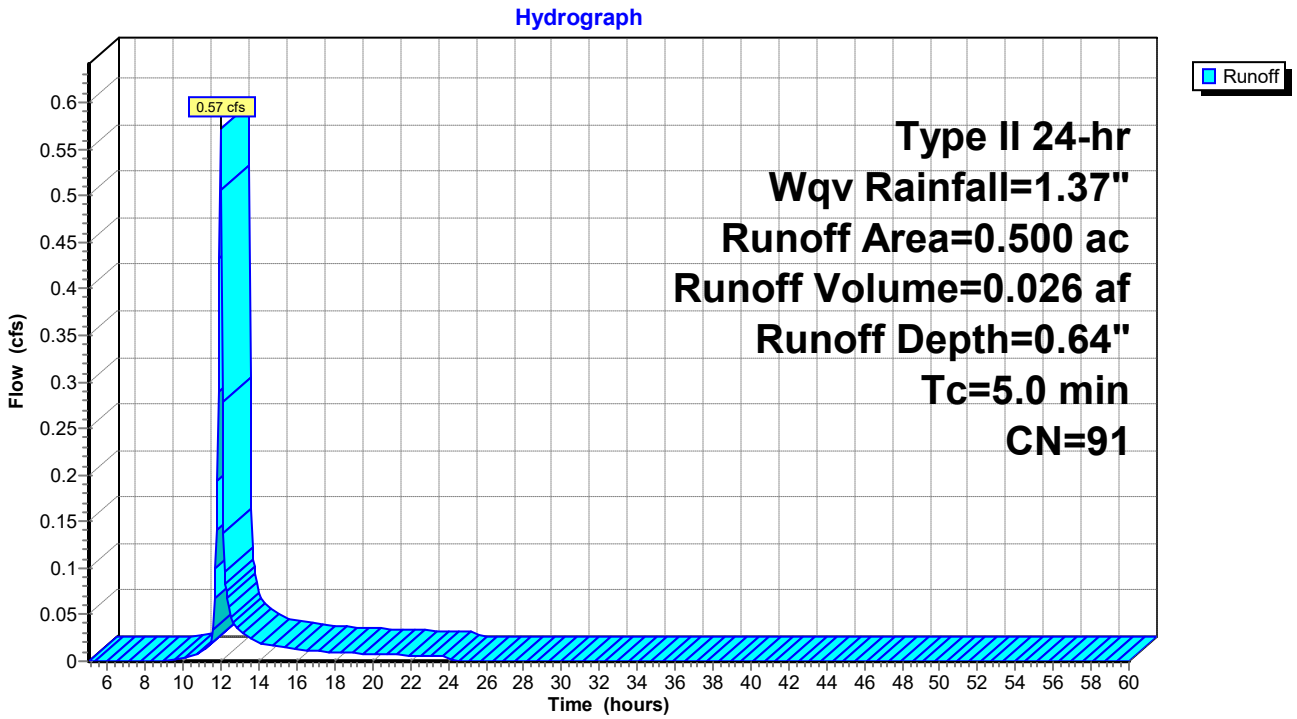
Runoff = 0.57 cfs @ 11.96 hrs, Volume= 0.026 af, Depth= 0.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Type II 24-hr Wqv Rainfall=1.37"

	Area (ac)	CN	Description
*	0.500	91	
	0.500		100.00% Pervious Area

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

Subcatchment 5S: Off-Site



Summary for Pond 3P: Existing Detention

Inflow Area = 12.190 ac, 0.00% Impervious, Inflow Depth = 0.58" for Wqv event
Inflow = 10.74 cfs @ 12.02 hrs, Volume= 0.592 af
Outflow = 8.31 cfs @ 12.09 hrs, Volume= 0.585 af, Atten= 23%, Lag= 4.3 min
Primary = 8.31 cfs @ 12.09 hrs, Volume= 0.585 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 1,000.47' @ 12.09 hrs Surf.Area= 6,990 sf Storage= 3,527 cf

Plug-Flow detention time= 22.3 min calculated for 0.585 af (99% of inflow)
Center-of-Mass det. time= 14.0 min (859.1 - 845.1)

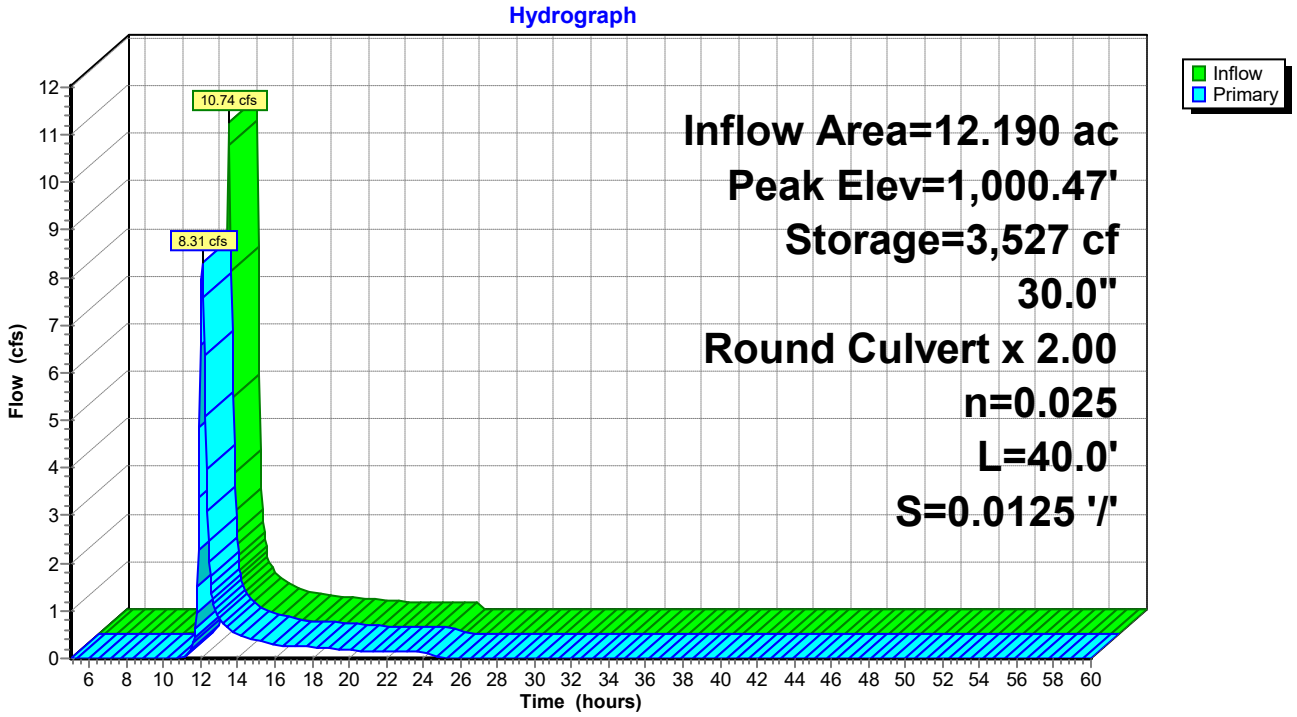
Volume	Invert	Avail.Storage	Storage Description
#1	999.00'	88,385 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
999.00	10	0	0
1,000.00	2,580	1,295	1,295
1,001.00	12,035	7,308	8,603
1,002.00	17,125	14,580	23,183
1,003.00	19,500	18,313	41,495
1,004.00	22,140	20,820	62,315
1,005.00	30,000	26,070	88,385

Device	Routing	Invert	Outlet Devices
#1	Primary	999.50'	**30.0" Round CMP_Round 30" X 2.00** L= 40.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 999.50' / 999.00' S= 0.0125 '/' Cc= 0.900 n= 0.025, Flow Area= 4.91 sf

Primary OutFlow Max=8.23 cfs @ 12.09 hrs HW=1,000.46' (Free Discharge)
↑**1=CMP_Round 30"** (Barrel Controls 8.23 cfs @ 3.51 fps)

Pond 3P: Existing Detention



Summary for Pond 4P: Proposed Detention

Inflow Area = 12.390 ac, 0.00% Impervious, Inflow Depth = 0.69" for Wqv event
Inflow = 13.00 cfs @ 12.02 hrs, Volume= 0.715 af
Outflow = 0.68 cfs @ 13.46 hrs, Volume= 0.715 af, Atten= 95%, Lag= 86.5 min
Primary = 0.68 cfs @ 13.46 hrs, Volume= 0.715 af

Routing by Stor-Ind method, Time Span= 5.00-60.00 hrs, dt= 0.05 hrs
Peak Elev= 997.71' @ 13.46 hrs Surf.Area= 11,445 sf Storage= 17,223 cf

Plug-Flow detention time= 491.0 min calculated for 0.714 af (100% of inflow)
Center-of-Mass det. time= 491.4 min (1,324.5 - 833.1)

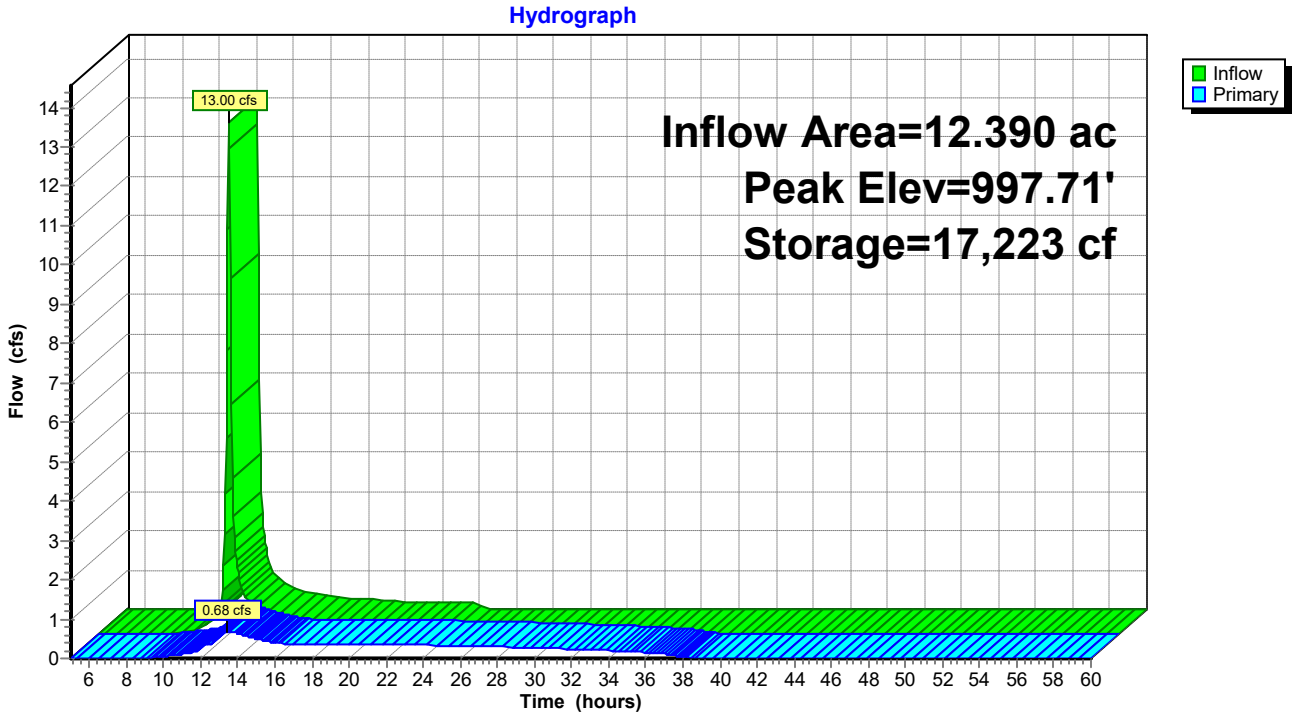
Volume	Invert	Avail.Storage	Storage Description
#1	995.00'	117,239 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
995.00	50	0	0
996.00	5,861	2,956	2,956
997.00	8,539	7,200	10,156
998.00	12,648	10,594	20,749
999.00	14,868	13,758	34,507
1,000.00	17,147	16,008	50,515
1,001.00	19,482	18,315	68,829
1,002.00	24,323	21,903	90,732
1,003.00	28,692	26,508	117,239

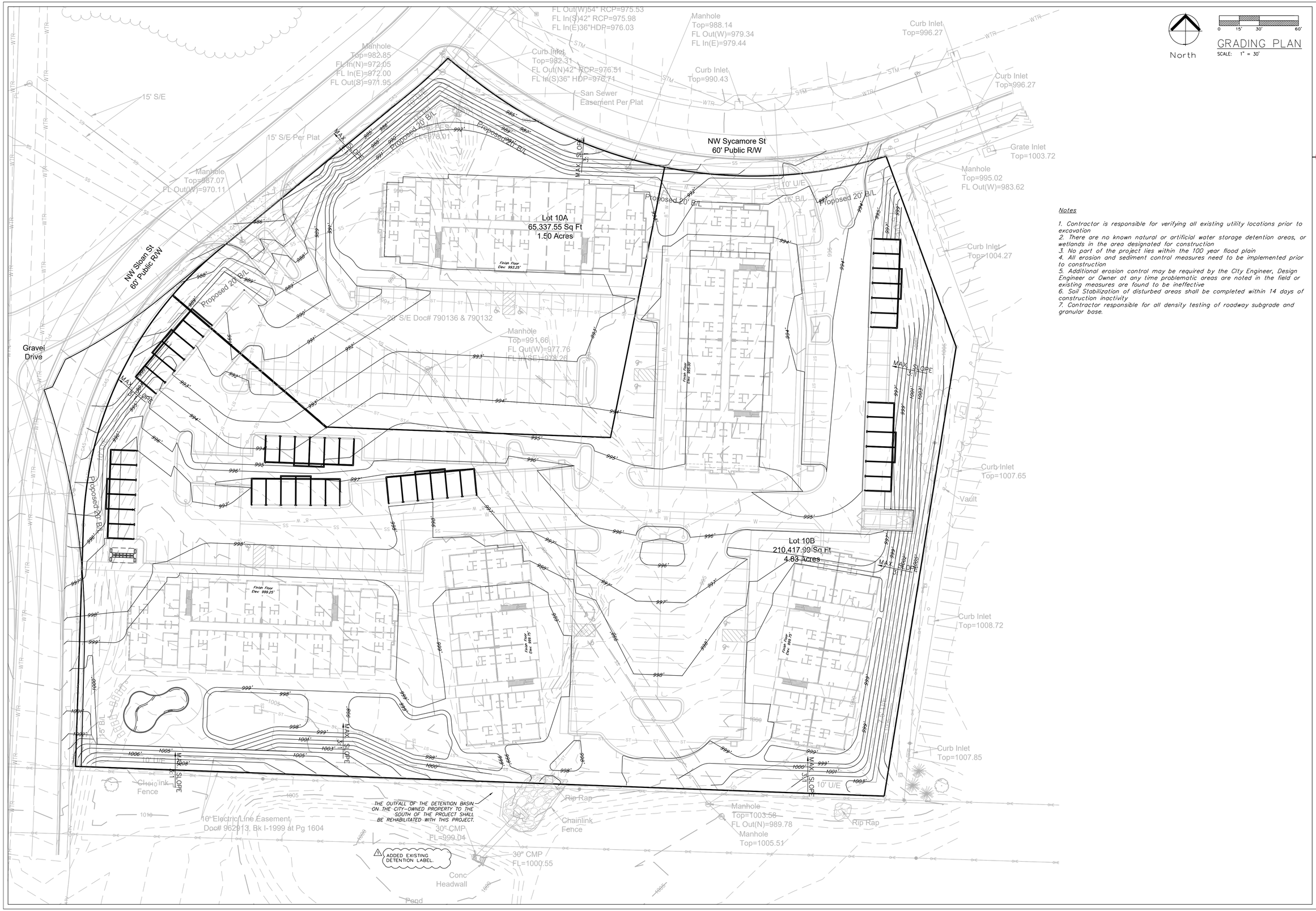
Device	Routing	Invert	Outlet Devices
#1	Primary	994.90'	**30.0" Round Culvert** L= 40.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 994.90' / 994.50' S= 0.0100 '/' Cc= 0.900 n= 0.012, Flow Area= 4.91 sf
#2	Device 1	995.00'	**3.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	997.62'	**42.0" W x 15.0" H Vert. Orifice/Grate** C= 0.600
#4	Primary	1,001.10'	**24.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600

Primary OutFlow Max=0.67 cfs @ 13.46 hrs HW=997.71' (Free Discharge)
- **1=Culvert** (Passes 0.67 cfs of 28.15 cfs potential flow)
  - **2=Orifice/Grate** (Orifice Controls 0.38 cfs @ 7.74 fps)
  - **3=Orifice/Grate** (Orifice Controls 0.29 cfs @ 0.95 fps)
- **4=Orifice/Grate** (Controls 0.00 cfs)

Pond 4P: Proposed Detention



Appendix A2



Notes

1. Contractor is responsible for verifying all existing utility locations prior to excavation
2. There are no known natural or artificial water storage detention areas, or wetlands in the area designated for construction
3. No part of the project lies within the 100 year flood plain
4. All erosion and sediment control measures need to be implemented prior to construction
5. Additional erosion control may be required by the City Engineer, Design Engineer or Owner at any time problematic areas are noted in the field or existing measures are found to be ineffective
6. Soil Stabilization of disturbed areas shall be completed within 14 days of construction inactivity
7. Contractor responsible for all density testing of roadway subgrade and granular base.

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Surveying 2005000319-D
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Oklahoma
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Engineering CA2821

Douglas Station Commercial Park
Lee's Summit, Jackson County, Missouri

Project: DOUGLAS STATION LSMO
Issue Date: August 11, 2023

Grading Plan
Construction Plans for:
Douglas Station Commercial Park
Lee's Summit, Jackson County, Missouri

STATE OF MISSOURI
MATTHEW J. SCHLICHT
NUMBER
PE-2006019708
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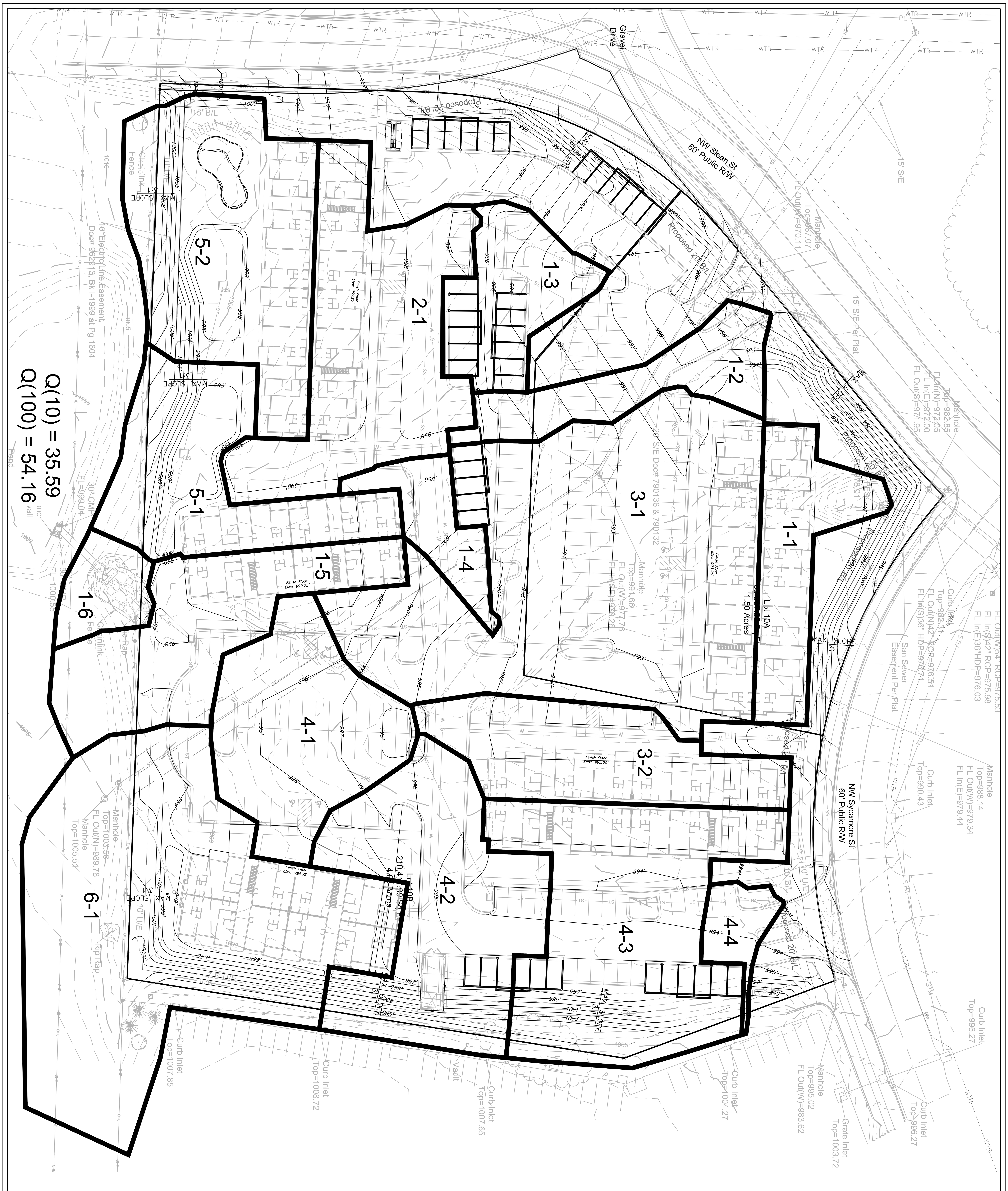
C.200



APWA STORM DRAINAGE "TC" COMPUTATIONS FOR: DOUGLAS STATION (LSMO)

yellow areas are self computing
overwrite if necessary

Surface types:	Asph/Conc	Bus/Com	Dirt	Grass/Park	Lake	MultFam	SnglFam	Undev	Other
SURFACE CODES	A	B	D	G	L	M	S	U	Z
"C" Values	0.90	0.87	0.60	0.30	0.90	0.66	0.51	0.3	

TOTAL WATERSHED — OVERLAND FLOW - 100' MAX (Overwrite Length - DnElev or Slope if necessary) — SURFACE CODE P=Paved U=Unpaved — FLOW - FIRST REACH (Overwrite Slope or Elevations if necessary) — TC COMPUTATION

AREA ID	TOTAL SQ.FT.	TOTAL ACRES	WTRSHD LENGTH	UP ELEV	DN ELEV	SURFACE CODE	"C" VALUE	OVRLND LENGTH	UP ELEV	DN ELEV	SLOPE %	P or U	CHANNEL LENGTH	UP ELEV	DN ELEV	SLOPE %	VELOCITY F/S	Cal Overland Flow T(I)	Used Min 5 Max 15 T(I)	Cal Channel One T(T)	Cal Channel Two T(T)	Total T© 10	Intensity 10 I	Intensity 100 I	CFS 10 Q	K 1.25 CFS 100 Q	AREA ID
POST																											POST
1-1	8941	0.21	232.00	993.75	989.00	M	0.66	35.0	993.8	993.25	1.4	P	197.0	993.3	989.0	2.16	3.0	4.2	5.0	1.1	0.0	6.1	7.0	9.9	0.95	1.67	1-1
1-2	7710	0.18	205.00	997.25	986.25	M	0.66	100.0	997.3	992.00	5.3	P	105.0	992.0	986.3	5.48	4.8	4.6	5.0	0.4	0.0	5.4	7.2	10.2	0.85	1.49	1-2
1-3	8221	0.19	150.00	997.00	992.00	M	0.66	28.0	997.0	995.00	7.1	P	122.0	995.0	992.0	2.46	3.2	2.2	5.0	0.6	0.0	5.6	7.2	10.1	0.89	1.57	1-3
1-4	4385	0.10	158.00	999.00	996.00	M	0.66	48.0	999.0	998.00	2.1	P	110.0	998.0	996.0	1.82	2.7	4.3	5.0	0.7	0.0	5.7	7.2	10.1	0.48	0.83	1-4
1-5	14772	0.34	121.00	1005.00	998.00	M	0.66	80.0	1005.0	999.00	7.5	P	41.0	999.0	998.0	2.44	3.2	3.6	5.0	0.2	0.0	5.2	7.3	10.2	1.63	2.86	1-5
1-6	3575	0.08	65.00	1026.25	999.00	M	0.66	65.0	1026.3	1025.50	1.2	U	0.0	1025.5	999.0		0.0	6.1	6.1		0.0	6.1	7.0	9.9	0.38	0.67	1-6
2-1	20721	0.48	293.00	999.50	996.00	M	0.66	100.0	999.5	997.50	2.0	P	193.0	997.5	996.0	0.78	1.8	6.3	6.3	1.8	0.0	8.1	6.5	9.2	2.04	3.60	2-1
3-1	44340	1.02	390.00	999.50	990.50	M	0.66	100.0	999.5	995.60	3.9	P	290.0	995.6	990.5	1.76	2.7	5.0	5.0	1.8	0.0	6.8	6.8	9.6	4.59	8.07	3-1
3-2	12979	0.30	164.00	996.00	993.80	M	0.66	100.0	996.0	995.00	1.0	P	64.0	995.0	993.8	1.88	2.8	7.9	7.9	0.4	0.0	8.3	6.5	9.1	1.27	2.24	3-2
4-1	15058	0.35	138.00	999.00	995.00	M	0.66	100.0	999.0	996.25	2.8	P	38.0	996.3	995.0	3.29	3.7	5.7	5.7	0.2	0.0	5.8	7.1	10.0	1.62	2.85	4-1
4-2	20476	0.47	157.00	999.50	993.50	M	0.66	100.0	999.5	995.00	4.5	P	57.0	995.0	993.5	2.63	3.3	4.8	5.0	0.3	0.0	5.3	7.3	10.2	2.25	3.96	4-2
4-3	24522	0.56	165.00	1006.00	993.50	M	0.66	87.0	1006.0	997.00	10.3	P	78.0	997.0	993.5	4.49	4.3	3.4	5.0	0.3	0.0	5.3	7.3	10.2	2.70	4.74	4-3
4-4	2438	0.06	65.00	995.00	993.25	M	0.66	65.0	995.0	993.25	2.7	P	0.0	993.3	993.3		0.0	4.6	5.0		0.0	5.0	7.4	10.3	0.27	0.48	4-4
5-1	14125	0.32	75.00	999.25	997.00	M	0.66	75.0	999.3	997.00	3.0	P	0.0	997.0	997.0		0.0	4.8	5.0		0.0	5.0	7.4	10.3	1.57	2.76	5-1
5-2	21986	0.50	125.00	1000.50	996.50	M	0.66	100.0	1000.5	998.50	2.0	P	25.0	998.5	996.5	8.00	5.7	6.3	6.3	0.1	0.0	6.4	7.0	9.8	2.32	4.08	5-2
6-1	41482	0.95	233.00	1009.00	998.00	M	0.66	100.0	1009.0	1003.50	5.5	U	133.0	1003.5	998.0	4.14	3.3	4.5	5.0	0.7	0.0	5.7	7.1	10.0	4.49	7.89	6-1

C.202

REVISIONS
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STATE OF MISSOURI / MATTHEW J. SCHLICHT / NUMBER PE2006019708 / PROFESSIONAL ENGINEER

Drainage Map
Construction Plans for:
Douglas Station Commercial Park
Lee's Summit, Jackson County, Missouri

Project: DOUGLAS STATION LSMO
Issue Date: August 11, 2023

Douglas Station Commercial Park
Lee's Summit, Jackson County, Missouri

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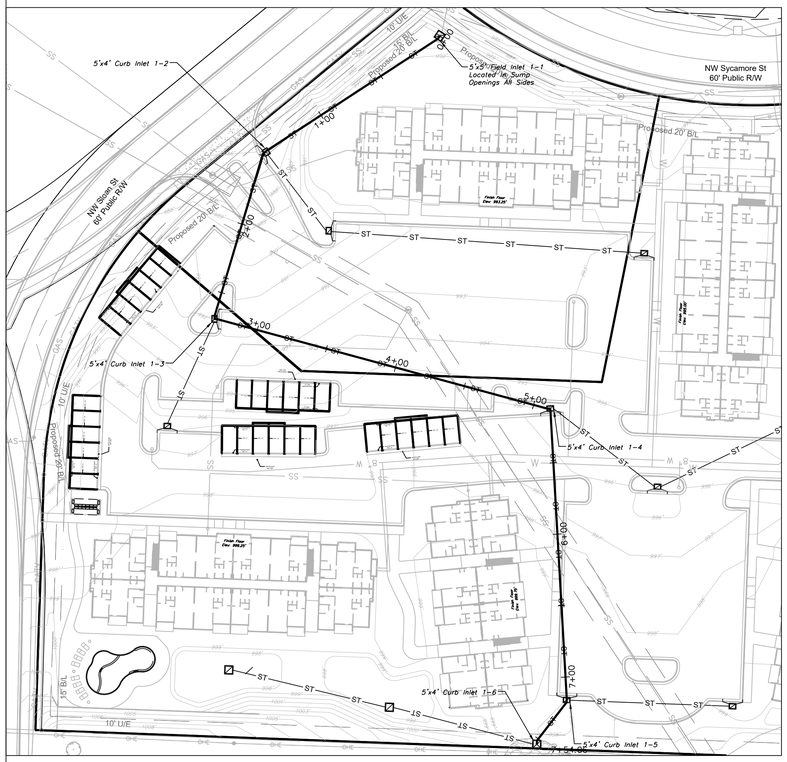
STORM SEWER PLAN AND PROFILE

SCALE: 1" = 50'

0 25' 50' 100'

North



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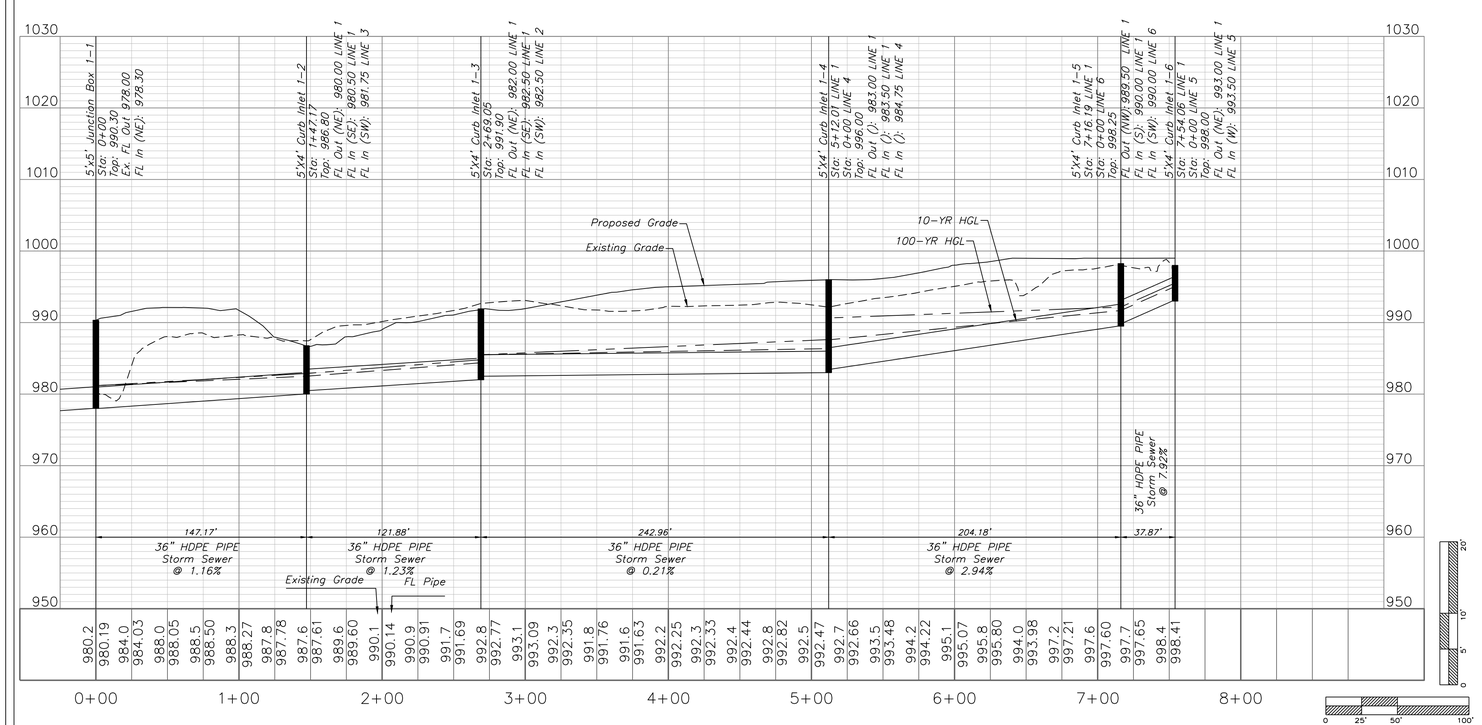


STORM SEWER PLAN AND PROFILE

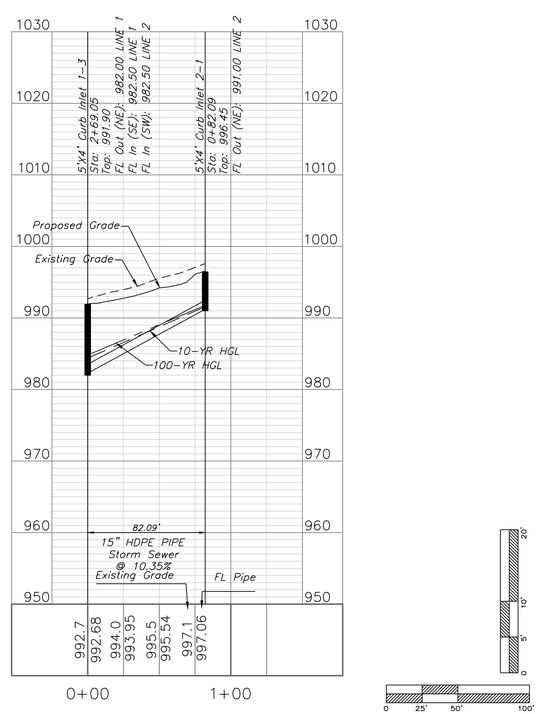
SCALE: 1" = 50'

0 25' 50' 100'

North

REVISED SCALE.

STORM LINE 2



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Douglas Station Commercial Park
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Storm Sewer Plan and Profile
Construction Plans for:
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REVISIONS

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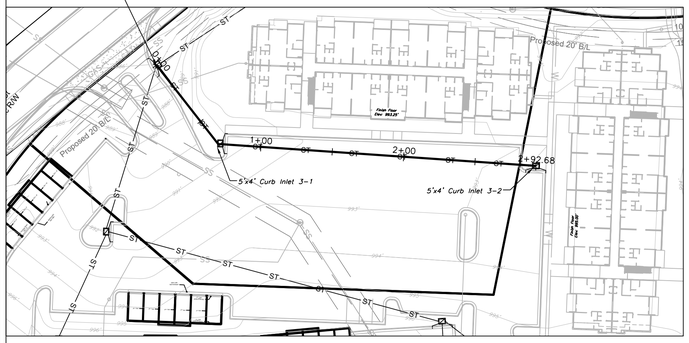
SCALE: 1" = 50'

North

0 25' 50' 100'

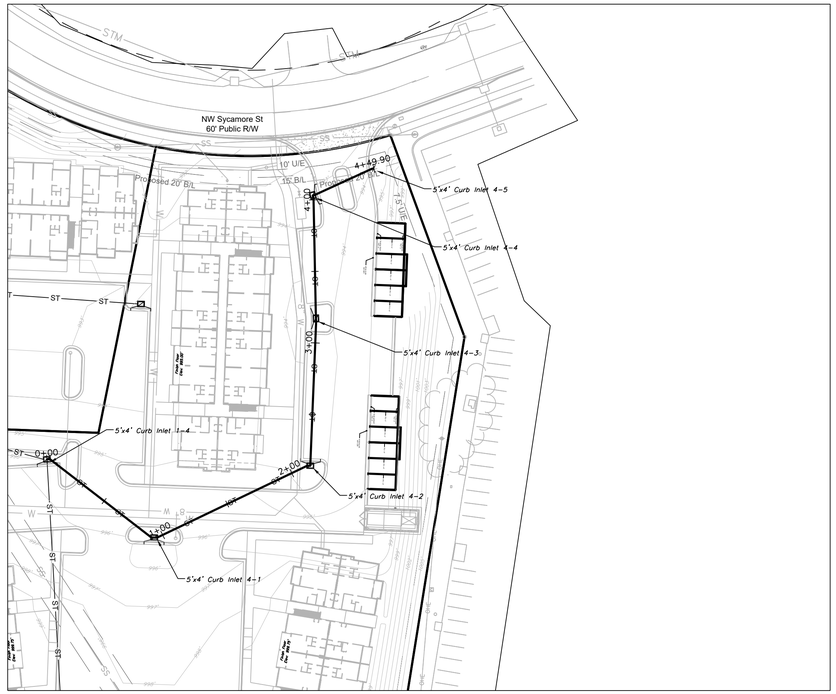


STORM SEWER PLAN AND PROFILE

SCALE: 1" = 50'

North

0 25' 50' 100'



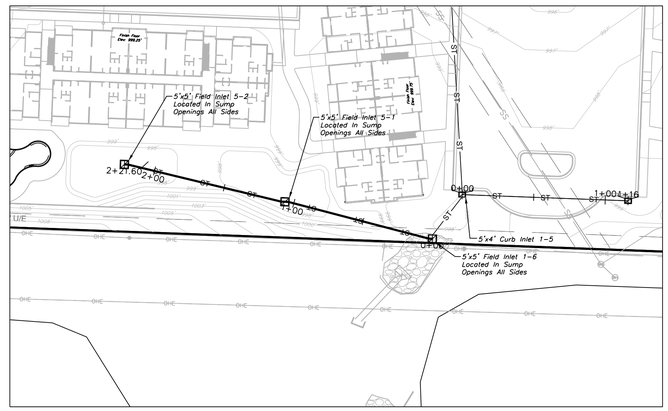
STORM SEWER PLAN AND PROFILE

SCALE: 1" = 50'

North

0 25' 50' 100'

REVISED SCALE.



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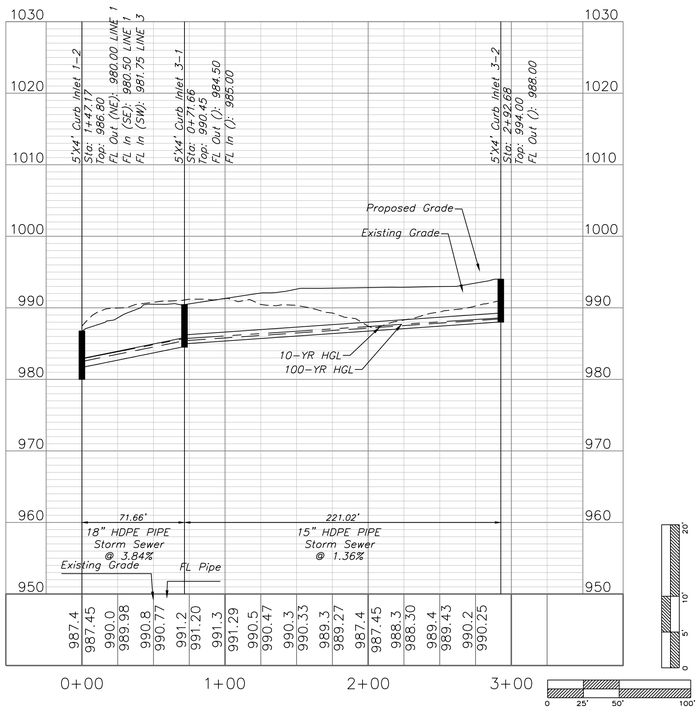

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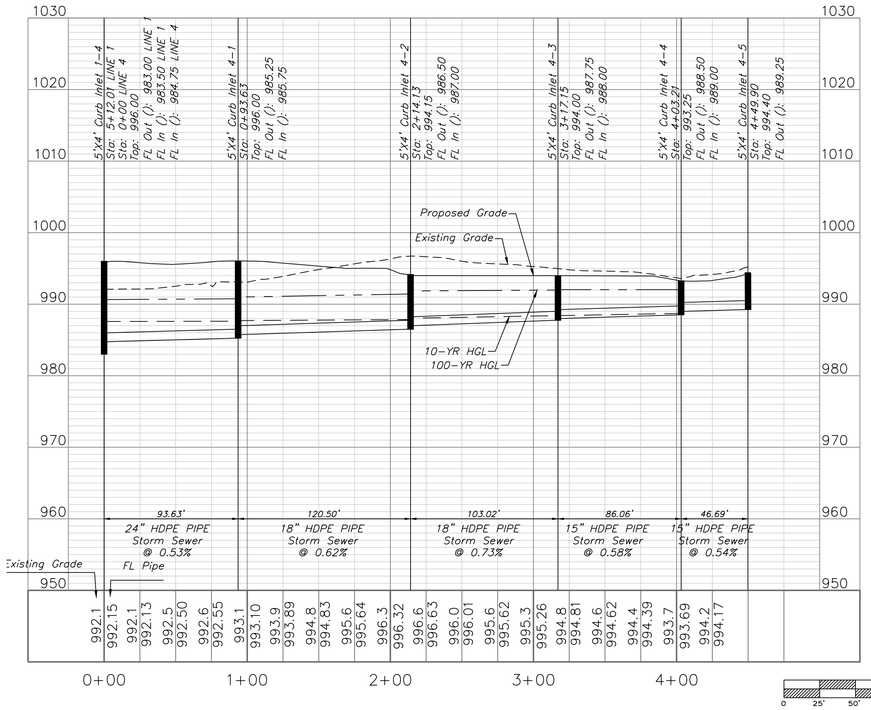

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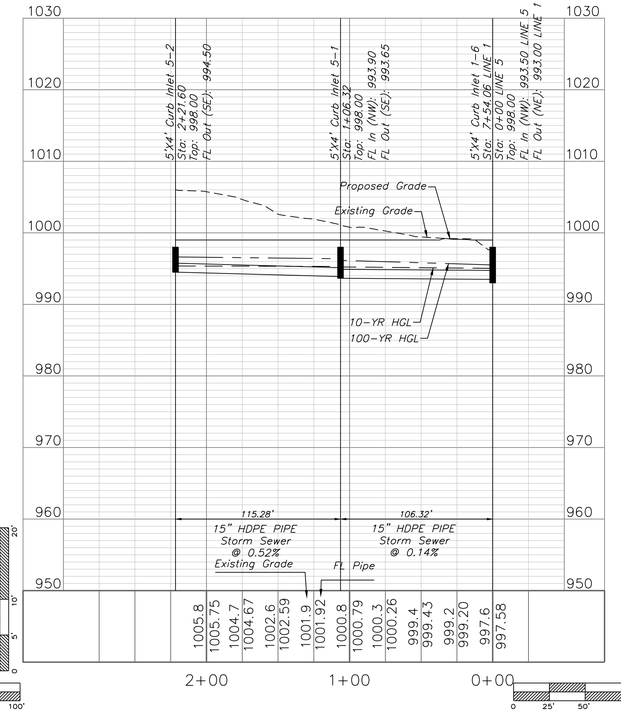

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NE PE E-14335

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C.303

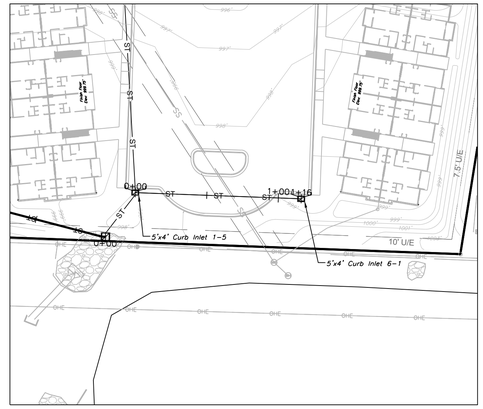
STORM SEWER PLAN AND PROFILE

SCALE: 1" = 50'

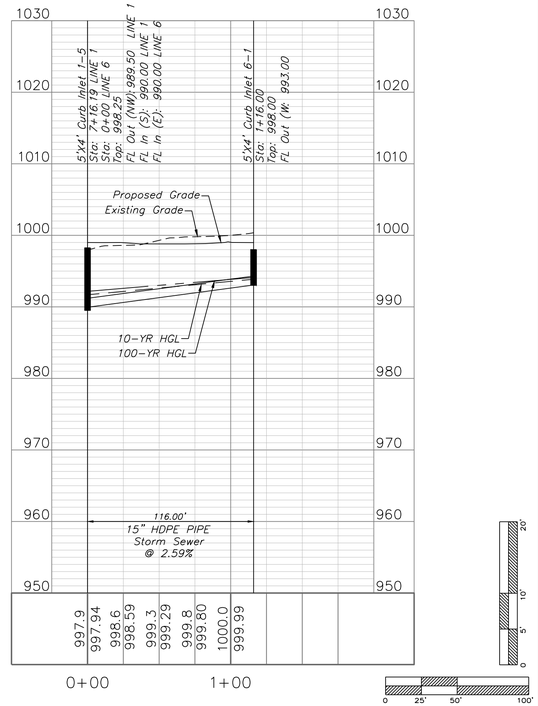
0 25' 50' 100'

1 REVISED SCALE.

North



STORM LINE 6



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Weir Report

Appendix A3

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Aug 26 2024

<Name>

Rectangular Weir

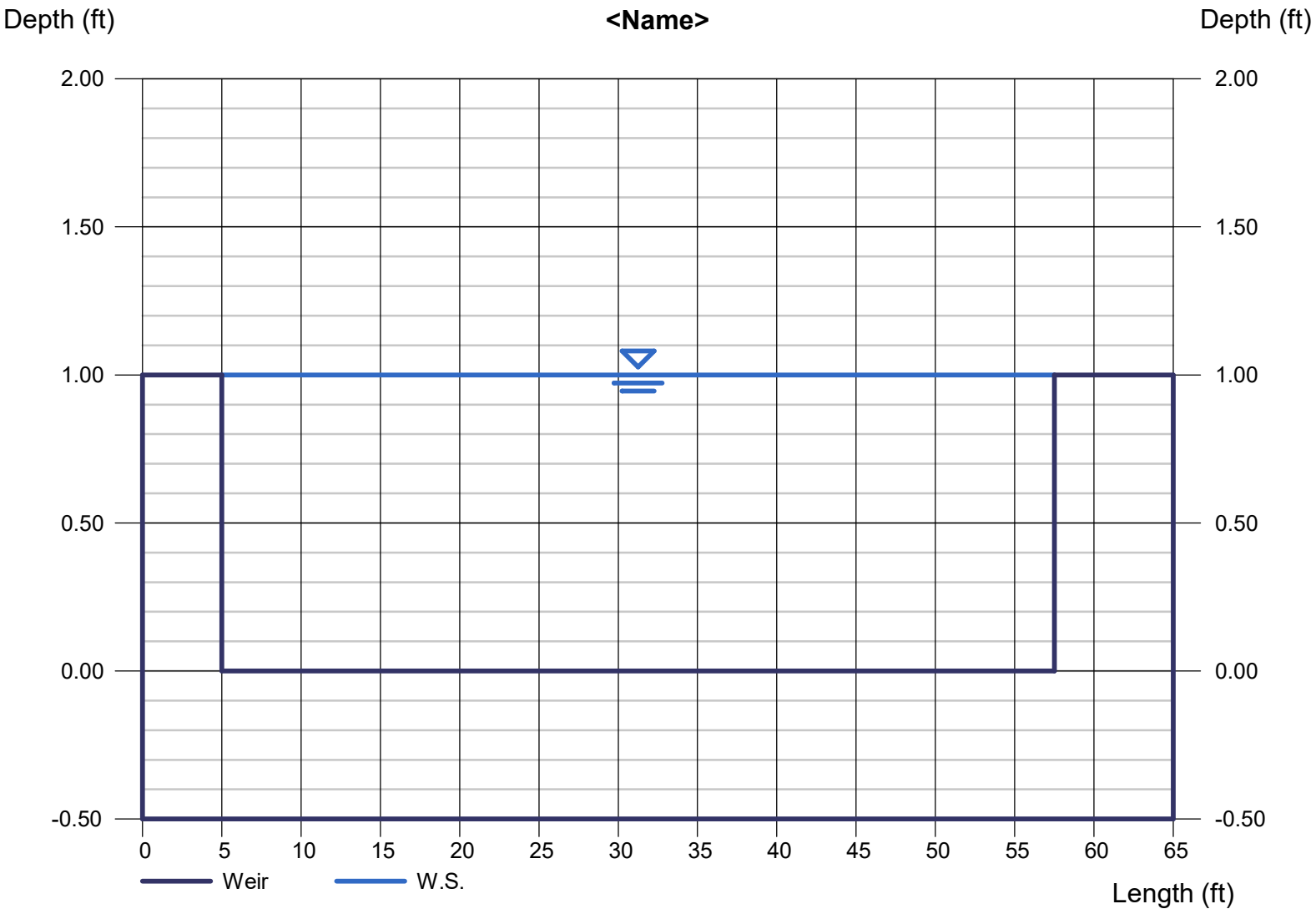
Crest	= Broad
Bottom Length (ft)	= 52.50
Total Depth (ft)	= 1.00

Calculations

Weir Coeff. Cw	= 2.60
Compute by:	Q vs Depth
No. Increments	= 10

Highlighted

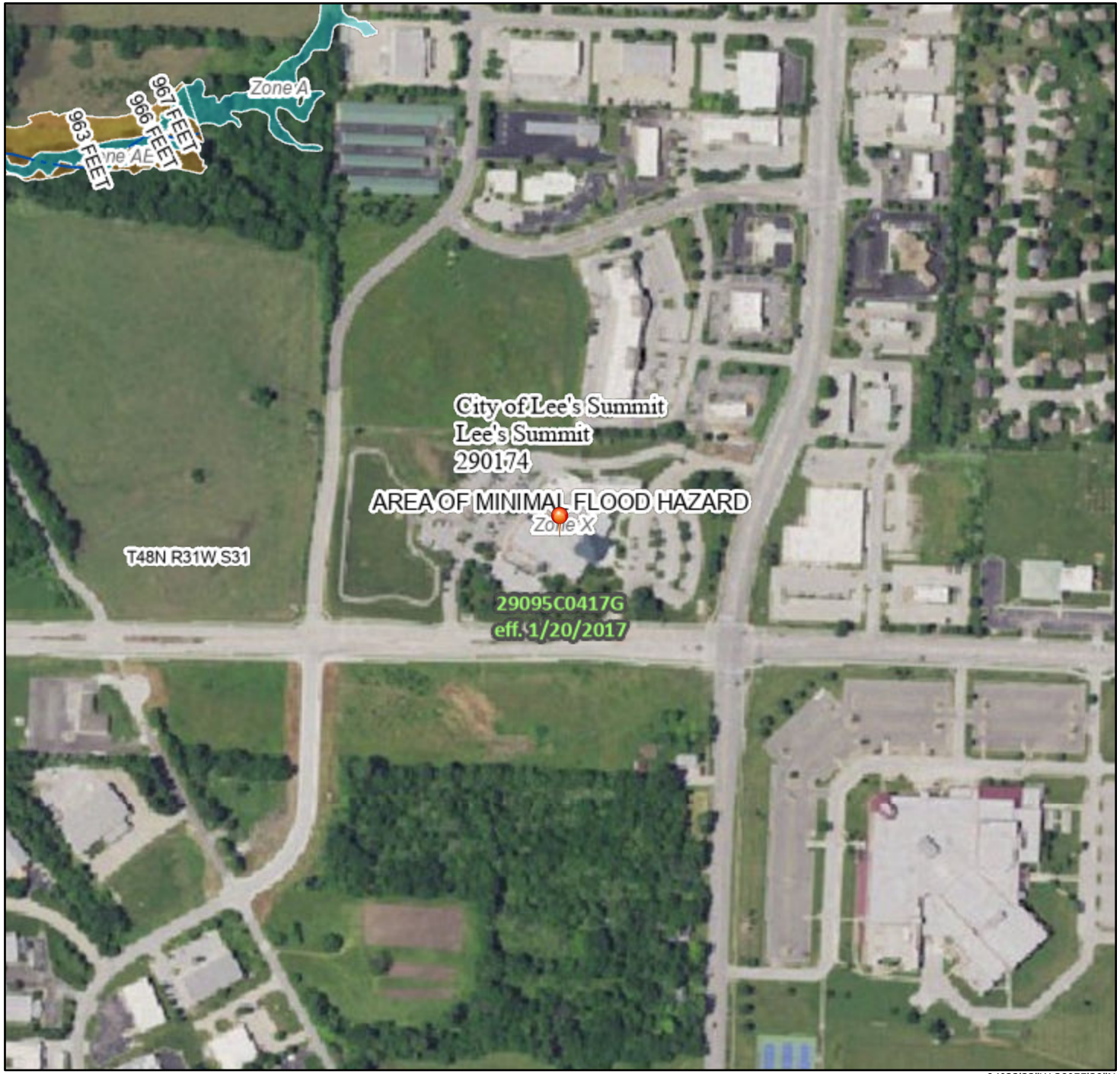
Depth (ft)	= 1.00
Q (cfs)	= 136.50
Area (sqft)	= 52.50
Velocity (ft/s)	= 2.60
Top Width (ft)	= 52.50



National Flood Hazard Layer FIRMette

FEMA

94°23'11"W 38°56'7"N



Feet

0 250 500 1,000 1,500 2,000

1:6,000

94°22'33"W 38°55'39"N

Basemap Imagery Source: USGS National Map 2023

Appendix A4

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/27/2024 at 1:29 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.