E.L. ROBINSON
ENGINEERING

T: 614.586.0642
F: 614.586.0648

950 Goodale Boulevard, Suite 180
Grandview Heights, OH 43212

elrobinsonengineering.com

MEMORANDUM

TO: Ken Fertal, PE
Kathryn Gruver, PE

FROM: Erik Brokamp, PE

DATE: 15 December 2022

RE: FRA-161-15.80
PID No. 116322
Storm System 7 In-line Storage

With the widening of SR 161, the impervious area into the existing storm sewer system maintained by the City of Columbus will increase by approximately 17,000 sq. ft (0.39 acres). The City of Columbus has concerns about the additional impervious area being added to Storm System 7 because the threshold exceeds their 10,000 sq. ft limit. This system currently outlets into the roadside ditch between the eastbound exit ramp to Little Turtle Way and Dublin-Granville Road near Sta. 2085+00 of SR-161. The additional impervious area to the existing system will result in hydraulic grade line conditions the do not comply with ODOT's design criteria and increase runoff volume requirements with the City of Columbus Stormwater Drainage Manual. This memo provides a brief summary of the analysis, results and recommendation.

Existing calculations were performed for Storm System 7 and the existing outlet pipe, an 18" conduit with a 1% slope, was found to be undersized with a just full capacity of 9.79 cfs and a 10-year system discharge of 13.1 cfs. The proposed calculations were performed for Storm System 7 with the increased impervious area. The existing 18" outlet pipe is to remain and therefore has the same just full capacity of 9.79 cfs. The proposed 10-year system discharge was increased to 14.1 cfs (4.3 cfs above capacity and 1 cfs above the existing conditions) due to the additional impervious area. With the existing 18" outlet pipe acting as an orifice, the flow discharging from the outlet will not increase. However, the hydraulic grade line (HGL) will increase to between approximately 0.62 feet and 2.25 feet above the top of casting for several drainage structures upstream of the existing 18" pipe. Storm sewer calculations for both existing and proposed conditions are attached.

To add the storage volume needed and improve the function of the system so the HGL does not overtop the drainage structure castings, upsizing the existing 240'-15" conduit between the existing manhole E576 and the proposed catch basin D577 to a 48" conduit is proposed in order to provide the necessary storage for the increase in volume due to the increased impervious area.

HydroCAD calculations were performed using the Rational Method to verify the storage capacity of the proposed 48" conduit. An existing HydroCAD model was created with subcatchment "1S" representing the catchment area hydrology present at existing manhole E576 and subcatchment "3S" representing the catchment area hydrology added at existing catch basin E577. Pond "6P"

E.L. ROBINSON
ENGINEERING

T: 614.586.0642
F: 614.586.0648

950 Goodale Boulevard, Suite 180
Grandview Heights, OH 43212

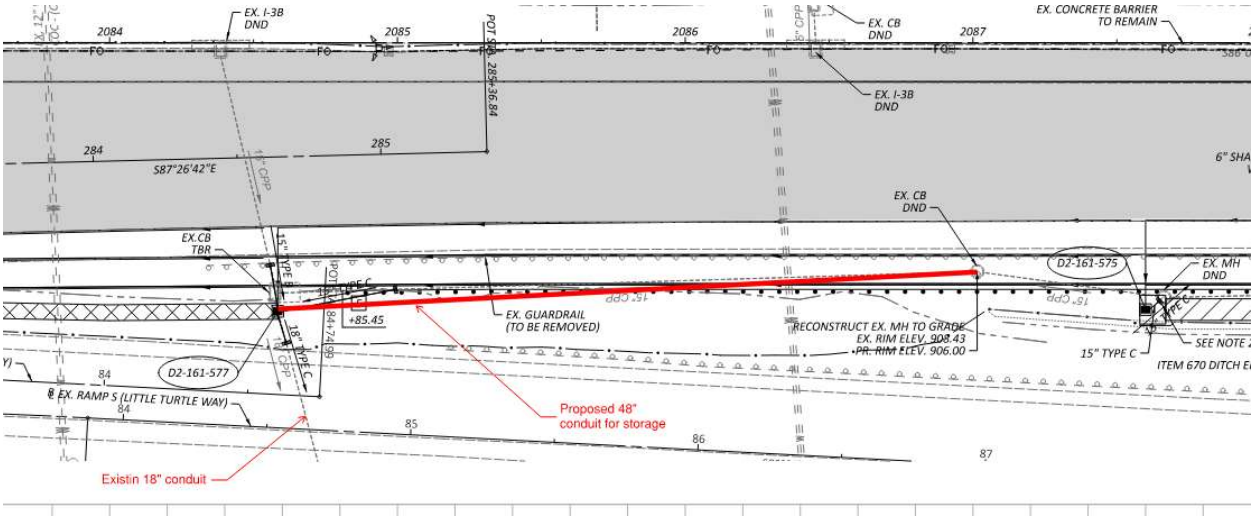
elrobinsonengineering.com

is the existing 15" conduit between E576 and E577. Pond "8P" is the existing 18" outlet conduit. This results in a peak ponding elevation at existing catch basin E577 of 901.50.

A proposed HydroCAD model, similar to the existing conditions, was developed. For this model, subcatchments "1S" and "3S" hydrology were adjusted for the increased impervious area. Pond "6P" was changed to a proposed 48" conduit between E576 and D577 and Pond "8P" remained as the existing 18" outfall. This resulted in a peak ponding elevation at catch basin D577 of 901.78.

Upsizing the existing 15" conduit with a 48" conduit will reduce the 25-year HGL elevation throughout Storm System 7 and keep it contained within the system. It will also provide the ability to store the additional 10-year volume created by the additional impervious area. Because of this, it is recommended that the 240' of existing 15" conduit be upsized to 48" conduit.

Please do not hesitate to reach out to me should you have any questions about this information.



STORM SEWER SYSTEM

PID : 116322 **Date :** 12/07/2022 **Project :** FRA-161-15.80 **Location :** Section 2

Description : Existing Storm System 7 - SR 161 Sta. 2094+82 to Sta. 2084+58 **Designer :** E. L. Robinson - ctw

Rainfall Area: C **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 15.00 **Tailwater Elevation (ft.):** 898.19

JUNCTION From	To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
E570	E571	2094+82	0.31	0.28	10.00	5.32	4.62	1.5	1.3	15	25.0	0.8836	930.93	18.76	56.61	0.0005	931.06	935.93	4.87	3.75	CB 3
begin		2094+87	0.31	0.28									908.84				911.47	915.15			0.015
E571	E572	2094+87	1.24	0.97	15.00	4.47	4.62	5.6	5.8	15	14.8	0.0162	908.84	6.44	7.67	0.0106	911.47	915.15	3.68	5.06	CB 5
		2094+85	1.54	1.25									908.60				911.31	915.00			0.015
E572	E573	2094+85	0.00	0.00	15.04	4.47	4.62	5.6	5.8	15	292.0	0.0180	908.50	6.71	8.08	0.0106	911.31	915.00	3.69	5.25	MH 3
		2091+93	1.54	1.25									903.25				908.21	912.00			0.015
E573	E574	2091+93	0.00	0.00	15.76	4.37	4.62	5.5	5.8	15	298.0	0.0105	903.25	5.32	6.17	0.0106	908.21	912.00	3.79	7.50	MH 3
		2088+95	1.54	1.25									900.12				905.05	909.52			0.015
E574	E575	2088+95	0.00	0.00	16.70	4.25	4.62	5.3	5.8	15	128.6	0.0087	900.02	4.85	5.62	0.0106	905.05	909.52	4.47	8.25	MH 3
		2087+66	1.54	1.25									898.90				903.68	908.40			0.015
E575	E576	2087+66	0.00	0.00	17.14	4.19	4.62	5.2	5.8	15	65.5	0.0110	898.80	5.41	6.31	0.0106	903.68	908.40	4.72	8.35	MH 3
		2087+01	1.54	1.25									898.08				902.99	906.00			0.015
E576	E577	2087+01	0.00	0.00	17.34	4.17	4.62	5.2	5.8	15	240.0	0.0018	898.23	4.25	2.52	0.0106	902.99	906.00	3.01	6.52	MH 3
		2084+58	1.54	1.25						Warning			897.81				900.44	903.40			0.015
E578	E577	2084+39	0.09	0.08	10.00	5.32	4.62	0.4	0.4	15	92.0	0.0342	900.96	4.16	11.14	0.0000	901.12	905.66	4.54	3.45	I 3B
begin		2084+58	1.63	1.33									897.81				900.44	903.40			0.015

STORM SEWER SYSTEM

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
E577	EOUT	2084+54		2.52	1.90	18.28	4.06	4.62	13.1	14.9	18	83.6	0.0100	897.56	7.43	9.79	0.0269	900.44	903.40	2.96	4.34	CB 5
final		2084+80		4.16	3.24									896.72				898.19	898.22			0.015
											Warning											

STORM SEWER SYSTEM

PID : 116322 **Date :** 12/07/2022 **Project :** FRA-161-15.80 **Location :** Section 2

Description : Proposed Storm System 7 - SR 161 Sta. 2094+82 to Sta. 2084+58 **Designer :** E. L. Robinson - ctw

Rainfall Area: C **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 15.00 **Tailwater Elevation (ft.):** 898.19

JUNCTION From	To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
E570	D571	2094+82	0.31	0.28	10.00	5.32	4.67	1.5	1.3	15	25.0	0.8836	930.93	18.76	56.61	0.0005	931.06	935.93	4.87	3.75	CB 3
begin		2094+87	0.31	0.28									908.84				917.34	915.15			0.015
D571	E572	2094+87	1.24	1.00	15.00	4.47	4.67	5.7	6.0	15	14.8	0.0162	908.84	6.46	7.67	0.0113	917.34	915.15	-2.19	5.06	CB 5
		2094+85	1.54	1.28									908.60				917.17	915.00			0.015
E572	E573	2094+85	0.00	0.00	15.04	4.47	4.67	5.7	6.0	15	292.0	0.0180	908.50	6.73	8.08	0.0113	917.17	915.00	-2.17	5.25	MH 3
		2091+93	1.54	1.28									903.25				913.86	912.00			0.015
E573	E574	2091+93	0.00	0.00	15.76	4.37	4.67	5.6	6.0	15	298.0	0.0105	903.25	5.33	6.17	0.0113	913.86	912.00	-1.86	7.50	MH 3
		2088+95	1.54	1.28									900.12				910.48	909.52			0.015
E574	E575	2088+95	0.00	0.00	16.69	4.25	4.67	5.4	6.0	15	128.6	0.0087	900.02	4.84	5.62	0.0113	910.48	909.52	-0.96	8.25	MH 3
		2087+66	1.54	1.28									898.90				909.02	908.40			0.015
D575	E575	2087+60	1.01	0.84	15.00	4.47	4.67	3.8	3.9	15	7.7	0.0260	900.20	7.02	9.71	0.0049	909.06	907.35	-1.71	5.90	CB 5
begin		2087+66	2.56	2.12									900.00				909.02	908.40			0.015
E575	E576	2087+66	0.00	0.00	17.14	4.19	4.67	8.9	9.9	18	65.5	0.0110	898.80	6.13	10.27	0.0118	909.02	908.40	-0.62	8.10	MH 3
		2087+01	2.56	2.12									898.08				908.25	906.00			0.015
E576	D577	2087+01	0.00	0.00	17.31	4.17	4.67	8.8	9.9	15	240.0	0.0018	898.23	7.20	2.52	0.0312	908.25	906.00	-2.25	6.52	MH 3
		2084+58	2.56	2.12						**Warning**			897.81				900.77	903.40			0.015

STORM SEWER SYSTEM

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
E578	D577	2084+39		0.09	0.08	10.00	5.32	4.67	0.4	0.4	15	92.0	0.0342	900.96	4.16	11.14	0.0000	901.12	905.66	4.54	3.45	I 3B
begin		2084+58		2.65	2.20									897.81				900.77	903.40			0.015
D577	EOUT	2084+54		1.51	1.23	17.87	4.11	4.67	14.1	16.0	18	83.6	0.0100	897.56	7.95	9.79	0.0308	900.77	903.40	2.63	4.34	CB 5
final		2084+80		4.16	3.42						Warning			896.72				898.19	898.22			0.015

STORM SEWER SYSTEM

PID : 116322 **Date :** 12/15/2022 **Project :** FRA-161-15.80 **Location :** S.R. 161 / CDE/ RAMP S

Description : Proposed Storm System 7 with Storage - SR 161 Sta. 2094+82 to Sta. 2084+58 **Designer :** E. L. Robinson - ctw

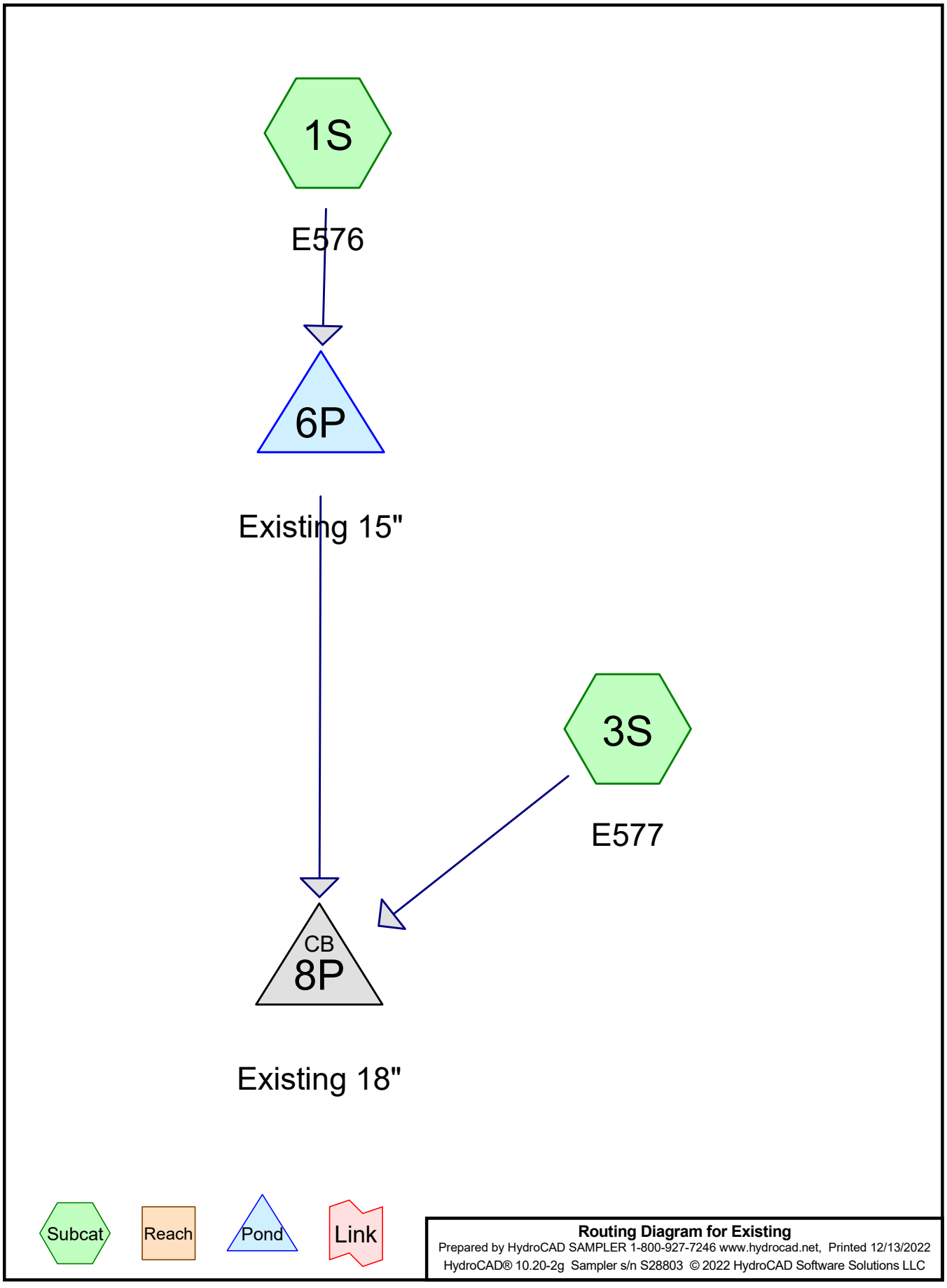
Rainfall Area: C **Just Full Capacity Frequency (yrs.) :** 10 **Hydraulic Gradient Frequency (yrs.) :** 25

Minimum Pipe Size : 15.00 **Tailwater Elevation (ft.):** 898.19

JUNCTION From	To	STATION From / To	ΔAREA / ΣAREA (acres)	ΔCA / ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
E570	D571	2094+82	0.31	0.28	10.00	5.32	5.09	1.5	1.4	15	25.0	0.8836	930.93	18.76	56.61	0.0006	931.07	935.93	4.86	3.75	CB 3
begin		2094+87	0.31	0.28									908.84				909.84	915.15			0.015
D571	E572	2094+87	1.24	1.00	15.00	4.47	5.09	5.7	6.5	15	14.8	0.0230	908.84	7.41	9.13	0.0135	909.84	915.15	5.31	5.06	CB 5
		2094+85	1.54	1.28									908.50				909.64	916.80			0.015
E572	E573	2094+85	0.00	0.00	15.03	4.47	4.58	5.7	5.8	15	292.0	0.0180	908.50	6.74	8.08	0.0109	909.33	916.80	7.47	7.05	MH 3
		2091+93	1.54	1.28									903.25				906.07	913.75			0.015
E573	E574	2091+93	0.00	0.00	15.76	4.37	4.58	5.6	5.8	15	298.0	0.0105	903.25	5.33	6.17	0.0109	906.07	913.75	7.68	9.25	MH 3
		2088+95	1.54	1.28									900.12				902.83	909.52			0.015
E574	E575	2088+95	0.00	0.00	16.69	4.25	4.58	5.4	5.8	15	128.6	0.0087	900.02	4.84	5.62	0.0109	902.83	909.52	6.69	8.25	MH 3
		2087+66	1.54	1.28									898.90				901.42	908.40			0.015
D575	E575	2087+60	1.01	0.84	15.00	4.47	4.58	3.8	3.8	15	7.7	0.0260	900.20	7.02	9.71	0.0047	901.46	907.35	5.89	5.90	CB 5
begin		2087+66	2.56	2.12									900.00				901.42	908.40			0.015
E575	E576	2087+66	0.00	0.00	17.13	4.19	4.58	8.9	9.7	18	65.5	0.0110	898.80	6.13	10.27	0.0113	901.42	908.40	6.98	8.10	MH 3
		2087+01	2.56	2.12									898.08				900.68	908.43			0.015
E576	D577	2087+01	0.00	0.00	17.31	4.17	4.58	8.8	9.7	48	240.0	0.0018	898.23	3.09	56.02	0.0001	900.68	908.43	7.75	6.20	MH 3
		284+63	2.56	2.12									897.81				900.67	903.40			0.015

STORM SEWER SYSTEM

JUNCTION From	To	STATION From	To	ΔAREA ΣAREA (acres)	ΔCA ΣCA	BEGIN TIME (min.)	RAINFALL INTENSITY (10 yrs.)	(25 yrs.)	DISCHARGE (cfs.) (10 yrs.)	(25 yrs.)	PIPE DIAM. (in.)	LENGTH (ft.)	SLOPE (ft./ft.)	F/L PIPE IN / OUT (ft.)	MEAN VEL (fps.)	JUST FULL CAPACITY (cfs.)	FRICT SLOPE (ft./ft.)	HYGR EL. IN / OUT (ft.)	COVER IN / OUT (ft.)	COVER MINUS HY GR	COVER MINUS CROWN	INLET TYPE MANNING'S 'n'
E578	D577	2084+39		0.09	0.08	10.00	5.32	4.58	0.4	0.4	15	92.0	0.0342	900.96	4.16	11.14	0.0000	901.12	905.66	4.54	3.45	I 3B
begin		284+63		2.65	2.20									897.81				900.67	903.40			0.015
D577	E579	284+63		1.51	1.23	18.60	4.02	4.58	13.8	15.7	18	83.6	0.0100	897.56	7.79	9.79	0.0296	900.67	903.40	2.73	4.34	CB 5
final		84+70		4.16	3.42						Warning			896.72				898.19	898.22			0.015



Routing Diagram for Existing

Prepared by HydroCAD SAMPLER 1-800-927-7246 www.hydrocad.net, Printed 12/13/2022
HydroCAD® 10.20-2g Sampler s/n S28803 © 2022 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	C	Description (subcatchment-numbers)
1.991	0.90	(1S, 3S)
0.785	0.50	(1S, 3S)
0.858	0.80	(1S)
0.521	0.70	(3S)
4.155	**0.78**	**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	
4.155	Other	1S, 3S
4.155		**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	4.155	4.155		1S, 3S
0.000	**0.000**	**0.000**	**0.000**	**4.155**	**4.155**	**TOTAL AREA**	

Pipe Listing (all 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	6P	898.23	897.89	240.0	0.0014	0.015	0.0	15.0	0.0
2	8P	897.59	896.75	83.6	0.0100	0.015	0.0	18.0	0.0

Time span=0.00-3.00 hrs, dt=0.01 hrs, 301 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: E576 Runoff Area=1.544 ac 0.00% Impervious Runoff Depth=0.99"
Tc=17.3 min C=0.81 Runoff=5.18 cfs 0.128 af

Subcatchment 3S: E577 Runoff Area=2.611 ac 0.00% Impervious Runoff Depth=0.93"
Tc=15.0 min C=0.76 Runoff=8.18 cfs 0.203 af

Pond 6P: Existing 15" Peak Elev=904.21' Storage=0.007 af Inflow=5.18 cfs 0.128 af
15.0" Round Culvert n=0.015 L=240.0' S=0.0014 '/' Outflow=5.42 cfs 0.121 af

Pond 8P: Existing 18" Peak Elev=901.50' Inflow=13.61 cfs 0.324 af
18.0" Round Culvert n=0.015 L=83.6' S=0.0100 '/' Outflow=13.61 cfs 0.324 af

Total Runoff Area = 4.155 ac Runoff Volume = 0.331 af Average Runoff Depth = 0.96"
100.00% Pervious = 4.155 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: E576

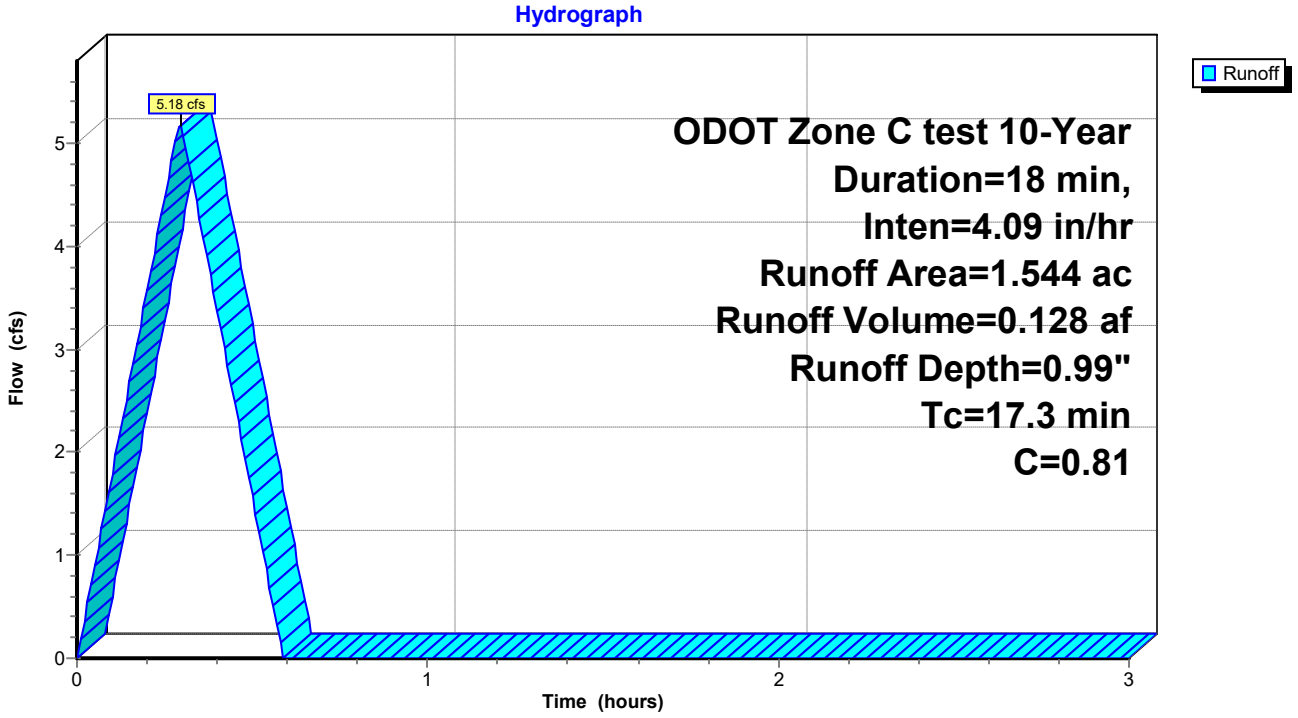
Runoff = 5.18 cfs @ 0.30 hrs, Volume= 0.128 af, Depth= 0.99"
Routed to Pond 6P : Existing 15"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
ODOT Zone C test 10-Year Duration=18 min, Inten=4.09 in/hr

Area (ac)	C	Description
0.306	0.90	
0.245	0.90	
0.135	0.50	
0.858	0.80	
1.544	0.81	Weighted Average
1.544		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.3					**Direct Entry, Time at E576**

Subcatchment 1S: E576



Summary for Subcatchment 3S: E577

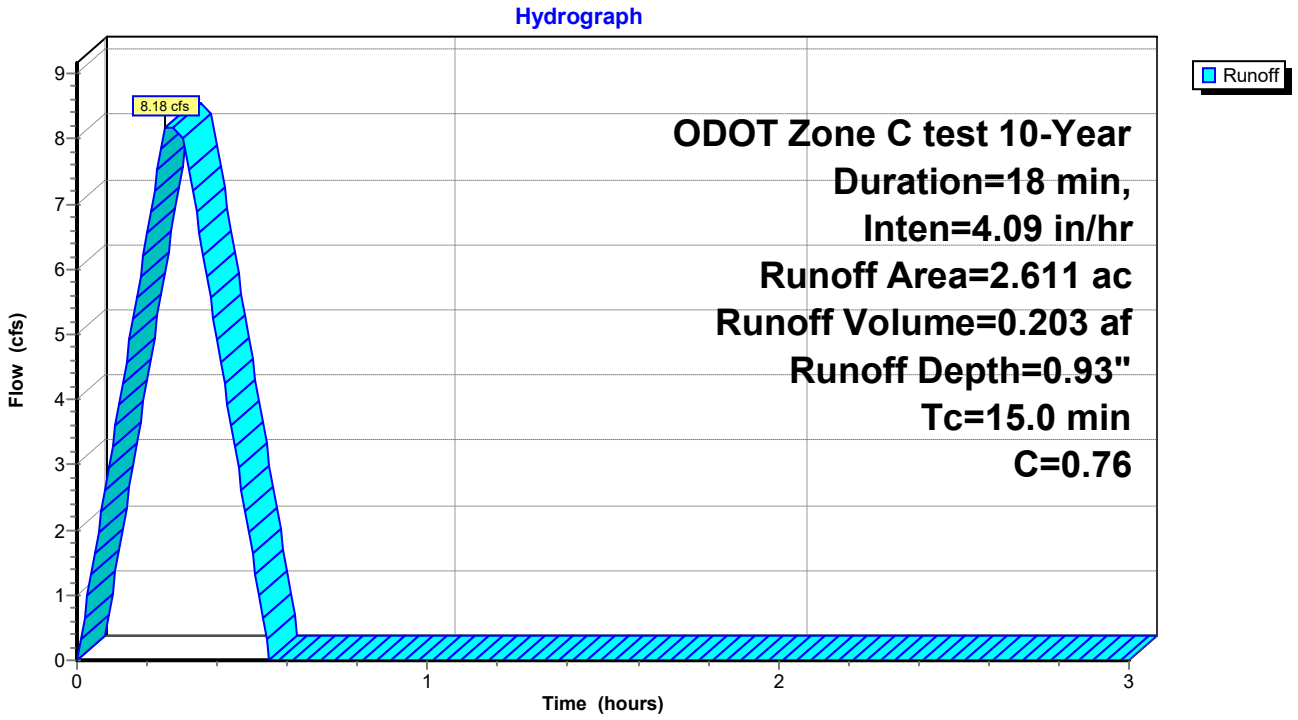
Runoff = 8.18 cfs @ 0.25 hrs, Volume= 0.203 af, Depth= 0.93"
Routed to Pond 8P : Existing 18"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
ODOT Zone C test 10-Year Duration=18 min, Inten=4.09 in/hr

Area (ac)	C	Description
1.350	0.90	
0.521	0.70	
0.650	0.50	
0.090	0.90	
2.611	0.76	Weighted Average
2.611		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Time to E577**

Subcatchment 3S: E577



Summary for Pond 6P: Existing 15"

[93] Warning: Storage range exceeded by 4.40'
[88] Warning: Qout>Qin may require smaller dt or Finer Routing
[85] Warning: Oscillations may require smaller dt or Finer Routing (severity=22)

Inflow Area = 1.544 ac, 0.00% Impervious, Inflow Depth = 0.99" for 10-Year event
Inflow = 5.18 cfs @ 0.30 hrs, Volume= 0.128 af
Outflow = 5.42 cfs @ 0.29 hrs, Volume= 0.121 af, Atten= 0%, Lag= 0.0 min
Primary = 5.42 cfs @ 0.29 hrs, Volume= 0.121 af
Routed to Pond 8P : Existing 18"

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 904.21' @ 0.29 hrs Storage= 0.007 af

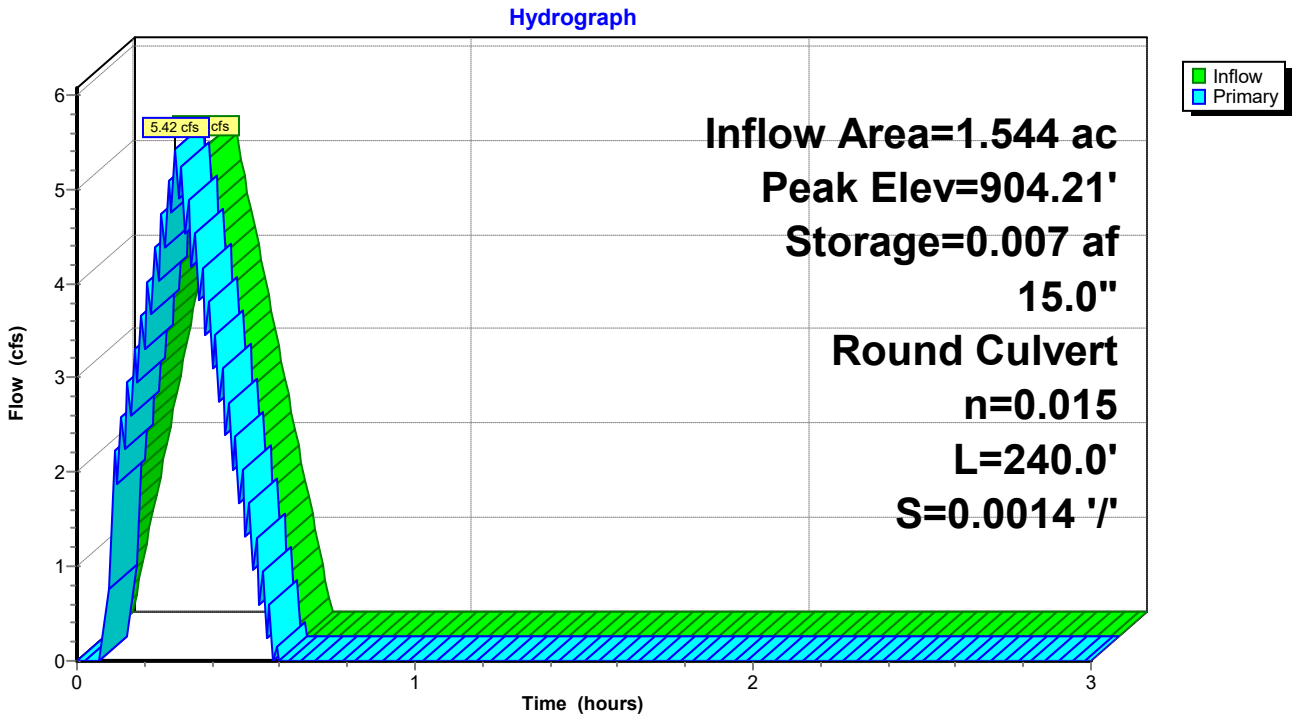
Plug-Flow detention time= 1.5 min calculated for 0.121 af (94% of inflow)
Center-of-Mass det. time= 0.8 min (18.4 - 17.7)

Volume	Invert	Avail.Storage	Storage Description
#1	898.23'	0.007 af	**15.0" Round Pipe Storage** L= 240.0' S= 0.0014 '/'

Device	Routing	Invert	Outlet Devices
#1	Primary	898.23'	**15.0" Round Culvert** L= 240.0' Ke= 0.500 Inlet / Outlet Invert= 898.23' / 897.89' S= 0.0014 '/' Cc= 0.900 n= 0.015, Flow Area= 1.23 sf

Primary OutFlow Max=5.39 cfs @ 0.29 hrs HW=904.18' TW=901.50' (Fixed TW Elev= 901.50')
1=Culvert (Outlet Controls 5.39 cfs @ 4.39 fps)

Pond 6P: Existing 15"



Summary for Pond 8P: Existing 18"

[57] Hint: Peaked at 901.50' (Flood elevation advised)
[79] Warning: Submerged Pond 6P Primary device # 1 INLET by 3.27'

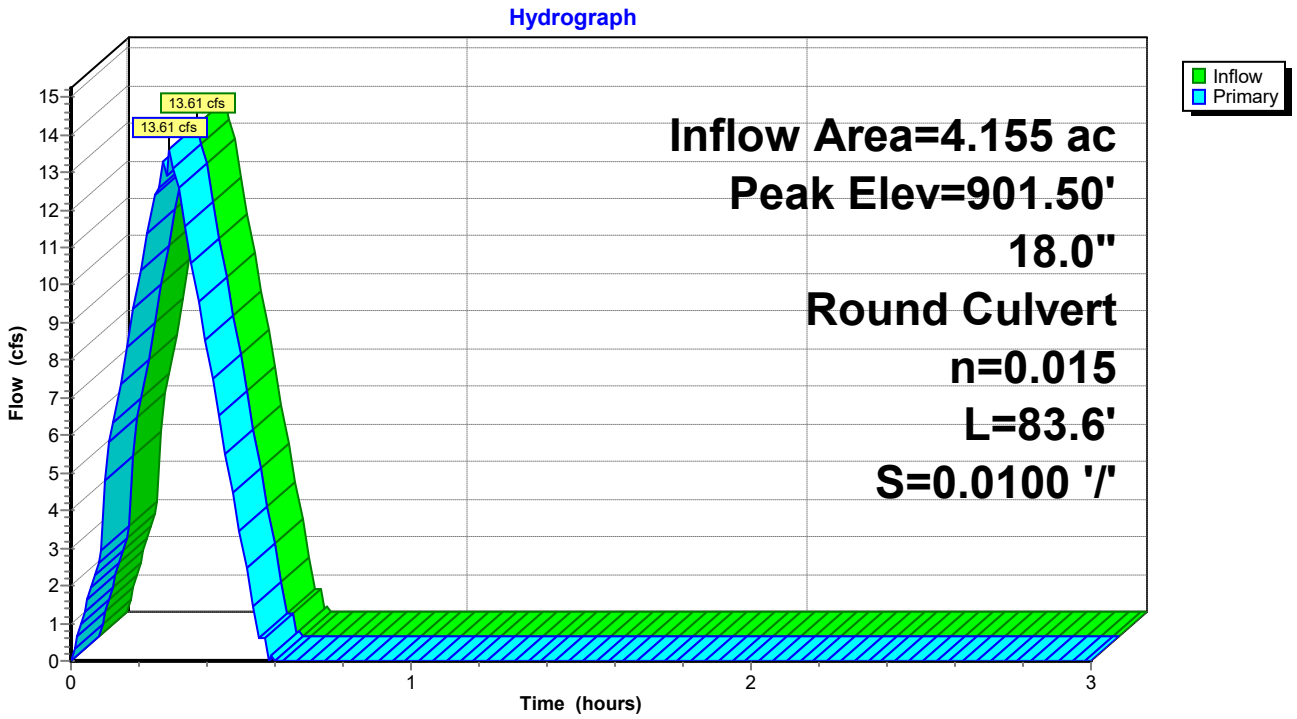
Inflow Area = 4.155 ac, 0.00% Impervious, Inflow Depth = 0.94" for 10-Year event
Inflow = 13.61 cfs @ 0.29 hrs, Volume= 0.324 af
Outflow = 13.61 cfs @ 0.29 hrs, Volume= 0.324 af, Atten= 0%, Lag= 0.0 min
Primary = 13.61 cfs @ 0.29 hrs, Volume= 0.324 af

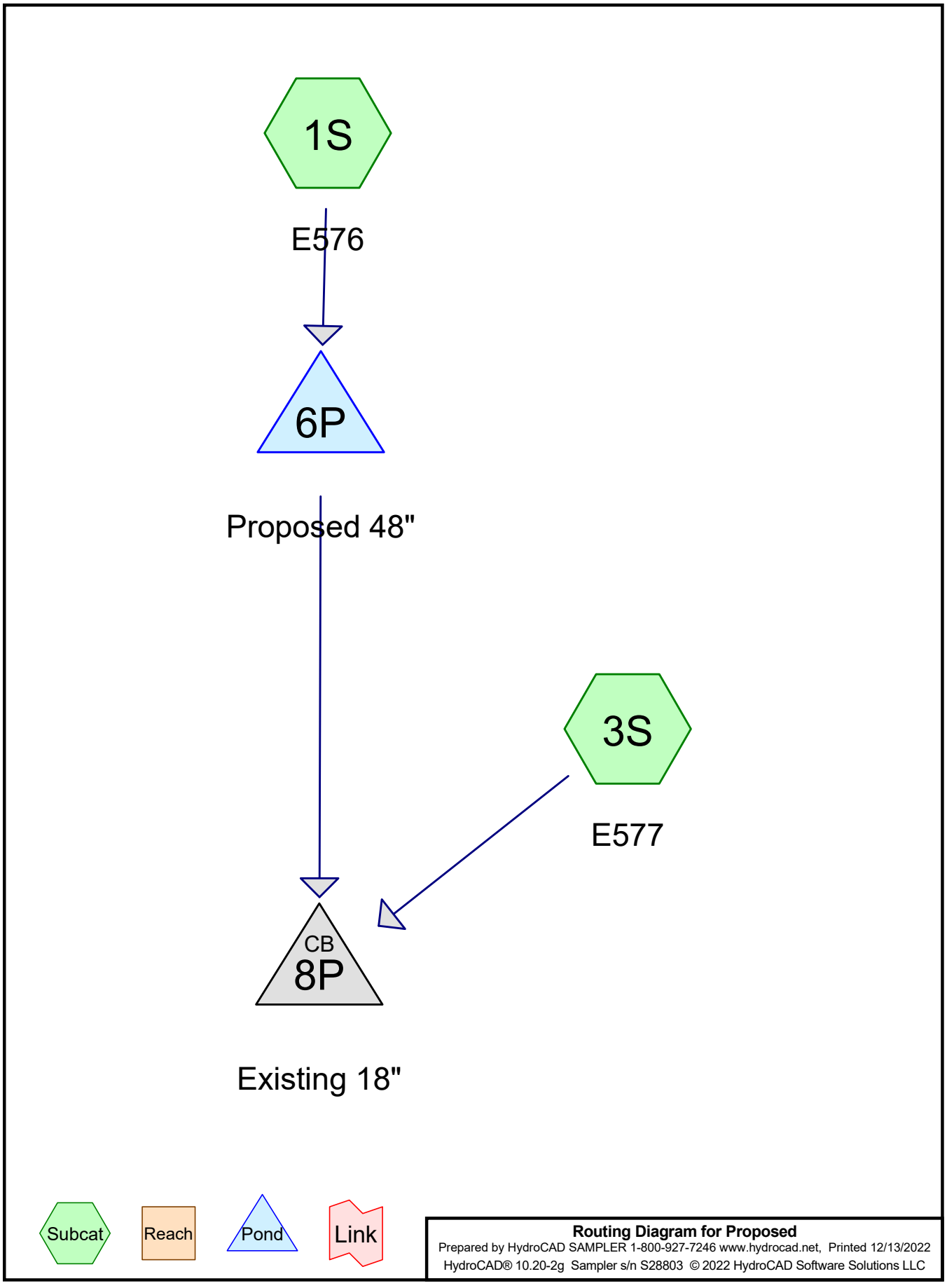
Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 901.50' @ 0.29 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	897.59'	**18.0" Round Culvert** L= 83.6' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 897.59' / 896.75' S= 0.0100 '/' Cc= 0.900 n= 0.015, Flow Area= 1.77 sf

Primary OutFlow Max=13.57 cfs @ 0.29 hrs HW=901.49' TW=897.95' (Fixed TW Elev= 897.95')
↑—**1=Culvert** (Barrel Controls 13.57 cfs @ 7.68 fps)

Pond 8P: Existing 18"





Routing Diagram for Proposed

Prepared by HydroCAD SAMPLER 1-800-927-7246 www.hydrocad.net, Printed 12/13/2022
HydroCAD® 10.20-2g Sampler s/n S28803 © 2022 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	C	Description (subcatchment-numbers)
1.619	0.90	(1S, 3S)
0.151	0.50	(1S, 3S)
0.858	0.80	(1S)
1.012	0.83	(1S)
0.521	0.70	(3S)
4.161	**0.82**	**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	
4.161	Other	1S, 3S
4.161		**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	4.161	4.161		1S, 3S
0.000	**0.000**	**0.000**	**0.000**	**4.161**	**4.161**	**TOTAL AREA**	

Pipe Listing (all 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	6P	898.23	897.89	240.0	0.0014	0.015	0.0	48.0	0.0
2	8P	897.59	896.75	83.6	0.0100	0.015	0.0	18.0	0.0

Time span=0.00-3.00 hrs, dt=0.01 hrs, 301 points
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: E576 Runoff Area=2.557 ac 0.00% Impervious Runoff Depth=1.02"
Tc=17.3 min C=0.83 Runoff=8.78 cfs 0.217 af

Subcatchment 3S: E577 Runoff Area=1.604 ac 0.00% Impervious Runoff Depth=0.99"
Tc=15.0 min C=0.81 Runoff=5.36 cfs 0.133 af

Pond 6P: Proposed 48" Peak Elev=902.68' Storage=0.069 af Inflow=8.78 cfs 0.217 af
48.0" Round Culvert n=0.015 L=240.0' S=0.0014 '/' Outflow=8.80 cfs 0.148 af

Pond 8P: Existing 18" Peak Elev=901.79' Inflow=14.18 cfs 0.281 af
18.0" Round Culvert n=0.015 L=83.6' S=0.0100 '/' Outflow=14.18 cfs 0.281 af

Total Runoff Area = 4.161 ac Runoff Volume = 0.350 af Average Runoff Depth = 1.01"
100.00% Pervious = 4.161 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment 1S: E576

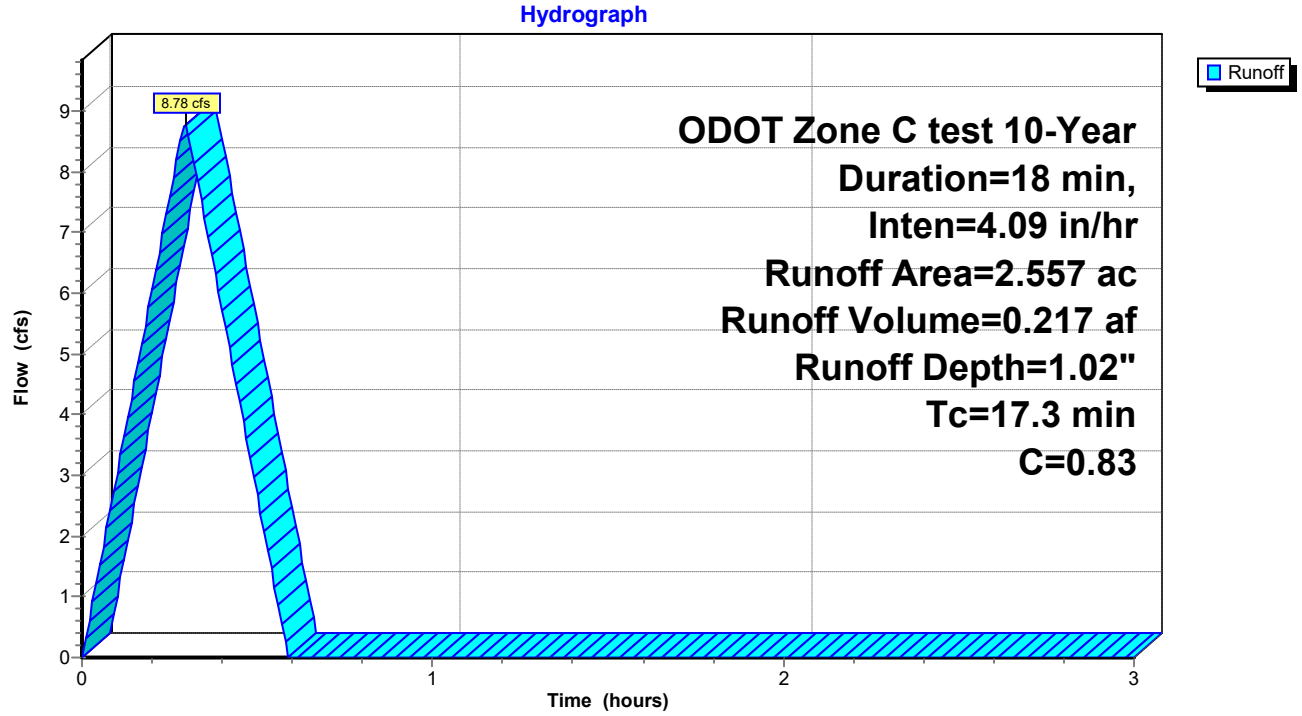
Runoff = 8.78 cfs @ 0.30 hrs, Volume= 0.217 af, Depth= 1.02"
Routed to Pond 6P : Proposed 48"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
ODOT Zone C test 10-Year Duration=18 min, Inten=4.09 in/hr

Area (ac)	C	Description
0.306	0.90	
0.311	0.90	
0.070	0.50	
0.858	0.80	
1.012	0.83	
2.557	0.83	Weighted Average
2.557		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.3					**Direct Entry, Time at E576**

Subcatchment 1S: E576



Summary for Subcatchment 3S: E577

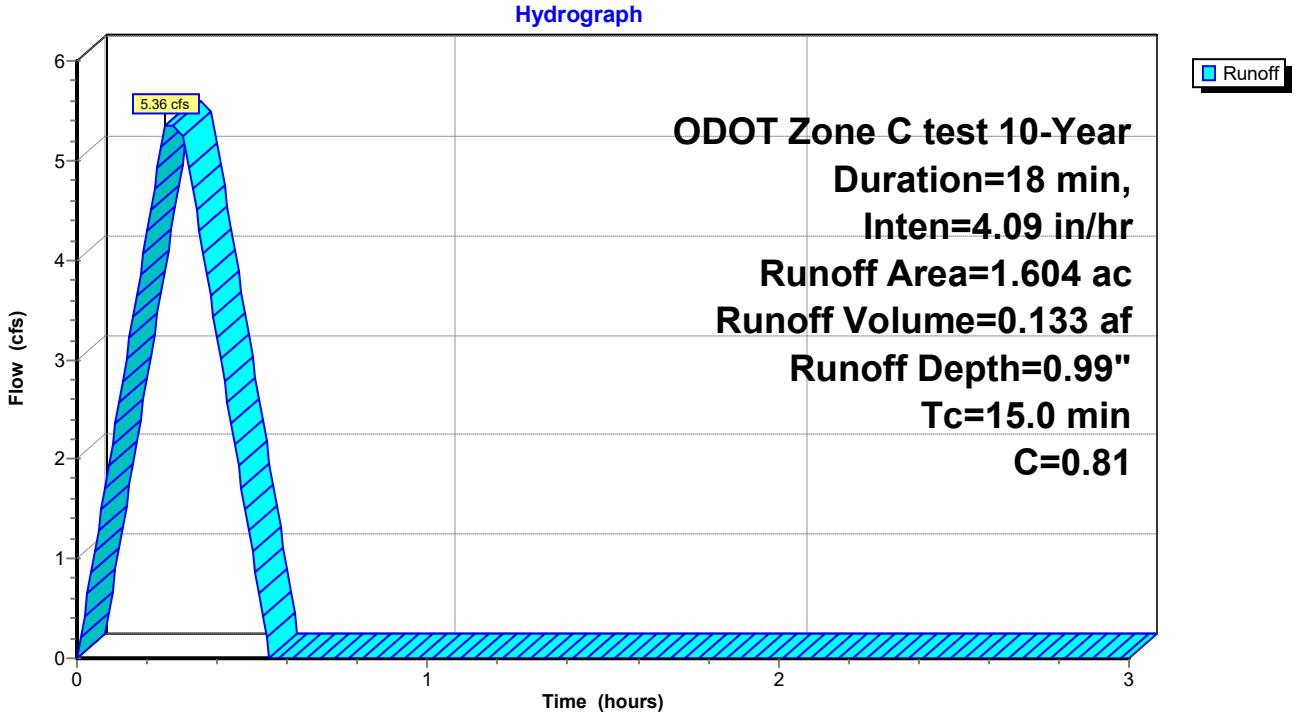
Runoff = 5.36 cfs @ 0.25 hrs, Volume= 0.133 af, Depth= 0.99"
Routed to Pond 8P : Existing 18"

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
ODOT Zone C test 10-Year Duration=18 min, Inten=4.09 in/hr

Area (ac)	C	Description
0.912	0.90	
0.521	0.70	
0.081	0.50	
0.090	0.90	
1.604	0.81	Weighted Average
1.604		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.0					**Direct Entry, Time to E577**

Subcatchment 3S: E577



Summary for Pond 6P: Proposed 48"

[93] Warning: Storage range exceeded by 0.12'
[88] Warning: Qout>Qin may require smaller dt or Finer Routing

Inflow Area = 2.557 ac, 0.00% Impervious, Inflow Depth = 1.02" for 10-Year event
Inflow = 8.78 cfs @ 0.30 hrs, Volume= 0.217 af
Outflow = 8.80 cfs @ 0.30 hrs, Volume= 0.148 af, Atten= 0%, Lag= 0.1 min
Primary = 8.80 cfs @ 0.30 hrs, Volume= 0.148 af
Routed to Pond 8P : Existing 18"

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 902.68' @ 0.30 hrs Storage= 0.069 af

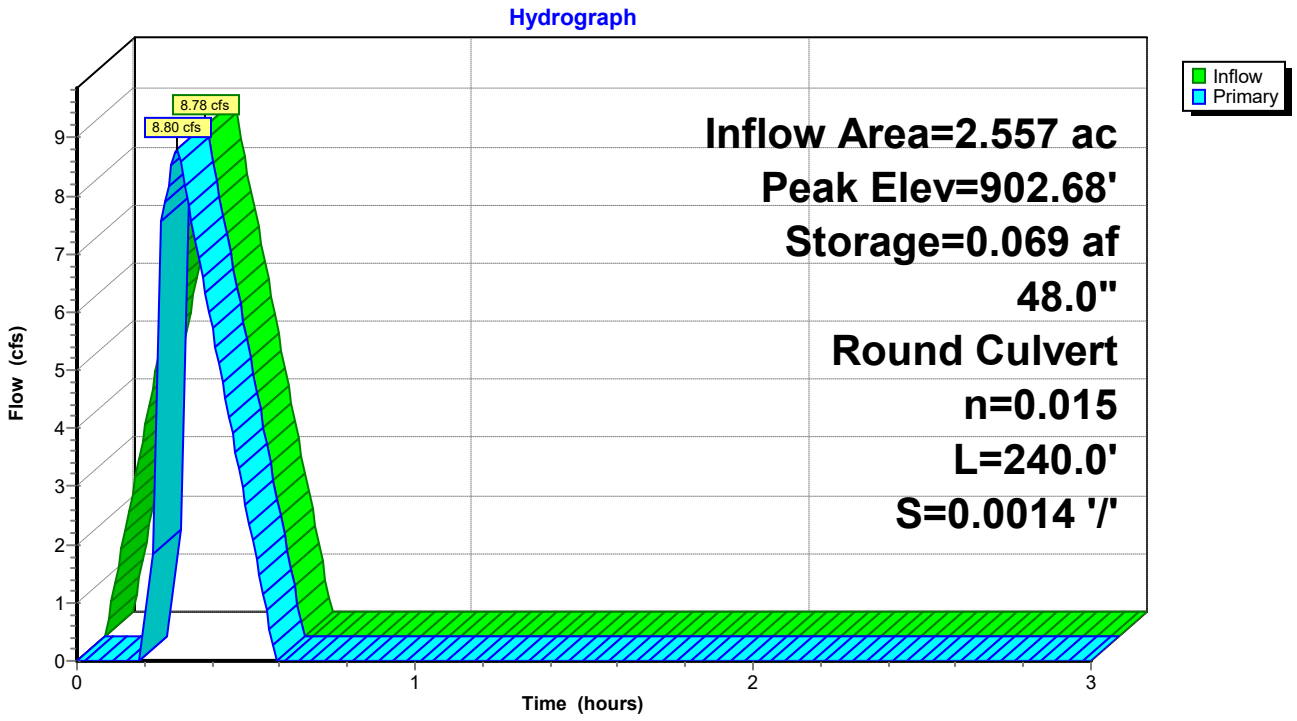
Plug-Flow detention time= 7.7 min calculated for 0.148 af (68% of inflow)
Center-of-Mass det. time= 3.9 min (21.5 - 17.7)

Volume	Invert	Avail.Storage	Storage Description
#1	898.23'	0.069 af	**48.0" Round Pipe Storage** L= 240.0' S= 0.0014 '/'

Device	Routing	Invert	Outlet Devices
#1	Primary	898.23'	**48.0" Round Culvert** L= 240.0' Ke= 0.500 Inlet / Outlet Invert= 898.23' / 897.89' S= 0.0014 '/' Cc= 0.900 n= 0.015, Flow Area= 12.57 sf

Primary OutFlow Max=10.01 cfs @ 0.30 hrs HW=902.68' TW=902.65' (Fixed TW Elev= 902.65')
1=Culvert (Outlet Controls 10.01 cfs @ 0.89 fps)

Pond 6P: Proposed 48"



Summary for Pond 8P: Existing 18"

[57] Hint: Peaked at 901.79' (Flood elevation advised)

Inflow Area = 4.161 ac, 0.00% Impervious, Inflow Depth = 0.81" for 10-Year event
Inflow = 14.18 cfs @ 0.30 hrs, Volume= 0.281 af
Outflow = 14.18 cfs @ 0.30 hrs, Volume= 0.281 af, Atten= 0%, Lag= 0.0 min
Primary = 14.18 cfs @ 0.30 hrs, Volume= 0.281 af

Routing by Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 901.79' @ 0.30 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	897.59'	**18.0" Round Culvert** L= 83.6' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 897.59' / 896.75' S= 0.0100 '/' Cc= 0.900 n= 0.015, Flow Area= 1.77 sf

Primary OutFlow Max=14.11 cfs @ 0.30 hrs HW=901.75' TW=897.95' (Fixed TW Elev= 897.95')
1=Culvert (Barrel Controls 14.11 cfs @ 7.99 fps)

Pond 8P: Existing 18"