16-1602 THE HARBOR AT EAST GULL

SITE DRAINAGE NARRATIVE & CALCULATIONS

DATE: JUNE 30, 2016

This project proposes the subdivision of an existing 20-acre parcel of land into a single-family residential subdivision.

EXISTING CONDITIONS

The existing site is undeveloped and mostly open space with wetlands. The site in its entirely drains to the surrounding wetlands and then to Gull Lake via site a navigable channel. Wetlands were delineated by Ben Meister on 10-21-2013.

PROPOSED CONDITIONS

Proposed improvements include a bituminous roadway, utility improvements (sanitary sewer, water main and storm sewer) and storm water management improvements. Mass grading is proposed.

TOTAL PROPOSED IMPERVIOUS AREA = 134,550 SF
= 3.09 ACRES

APPROX. DISTURBED AREA = 9.5 ACRES

MPCA STORMWATER TREATMENT REQUIREMENTS

Where a project's ultimate development replaces vegetation and/or other pervious surfaces with one (1) or more acres of cumulative impervious surface, the Permittee(s) must design the project so that the water quality volume of one (1) inch of runoff from the new impervious surfaces created by the project is retained on site (i.e. infiltration or other volume reduction practices) and not discharged to a surface water. For purposes of this part, surface waters does not include man-made drainage systems that convey stormwater to a compliant permanent stormwater management system.

REQUIRED VOLUME = 134,500 SF X 1.0 IN X (1 FT/12 IN)
= 11,208 CUBIC FEET

PROVIDED VOLUME = 43,562 CUBIC FEET

Infiltration is deemed not feasible for this site given inadequate separation to water table and predominantly clay (HSG D) soils. Because of this, wet sedimentation basins are proposed. See Table 1 for summary of water quality volumes.

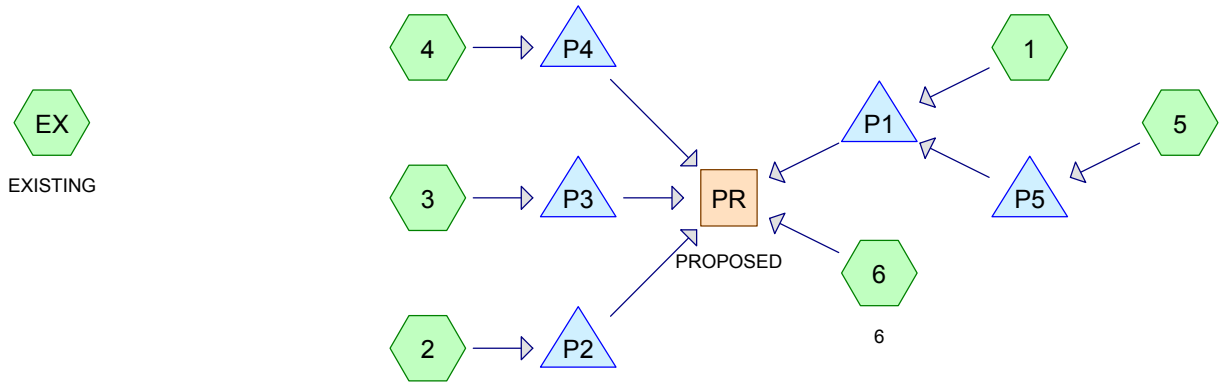
Rate control is not deemed critical due to proximity and storage of Gull Lake; however, below is a comparison of analyzed storm events:

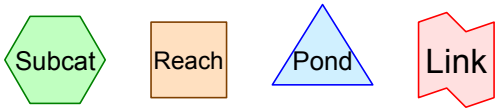
	2-YEAR (CFS)	10-YEAR (CFS)	100-YEAR (CFS)
EXISTING	**5.56**	**13.48**	**30.27**
PROPOSED	**5.11**	**9.95**	**19.21**

Basin high water levels (HWLs) have been computer using HydroCAD and Atlas 14 rainfall data and measurements are as shown on the grading plan.

PONDING BASIN	SUBCATCHMENT IMPERVIOUS AREA (SF)	1.0" REQUIRED VOLUME (CF)	PROVIDED VOLUME (CF)
1	19,950	1,663	**22,341**
2	33,740	2,812	**3,121**
3	22,530	1,878	**5,444**
4	19,540	1,628	**12,656**
		TOTAL VOLUME	**43,562**

TABLE 1 - WATER QUALITY VOLUME





Routing Diagram for 16-1602 HARSTAD_V1
Prepared by PLOWE ENGINEERING, INC., Printed 6/29/2016
HydroCAD® 10.00-16 s/n 01574 © 2015 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
667,435	74	>75% Grass cover, Good, HSG C (1, 2, 3, 4, 5, 6, EX)
134,550	98	IMPERVIOUS (1, 2, 3, 4, 5, 6)
24,915	98	POND (1, 2, 3, 4)
826,900	**79**	**TOTAL AREA**

Time span=0.00-100.00 hrs, dt=0.01 hrs, 10001 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Runoff Area=67,113 sf 44.73% Impervious Runoff Depth=1.44"
Tc=10.0 min CN=74/98 Runoff=2.98 cfs 8,072 cf

Subcatchment 2: Runoff Area=67,623 sf 54.56% Impervious Runoff Depth=1.61"
Tc=10.0 min CN=74/98 Runoff=3.37 cfs 9,081 cf

Subcatchment 3: Runoff Area=51,479 sf 52.33% Impervious Runoff Depth=1.57"
Tc=10.0 min CN=74/98 Runoff=2.50 cfs 6,750 cf

Subcatchment 4: Runoff Area=56,661 sf 47.33% Impervious Runoff Depth=1.49"
Tc=10.0 min CN=74/98 Runoff=2.60 cfs 7,025 cf

Subcatchment 5: Runoff Area=90,215 sf 16.63% Impervious Runoff Depth=0.96"
Tc=10.0 min CN=74/98 Runoff=2.61 cfs 7,230 cf

Subcatchment 6: 6 Runoff Area=80,358 sf 29.61% Impervious Runoff Depth=1.18"
Tc=10.0 min CN=74/98 Runoff=2.89 cfs 7,929 cf

Subcatchment EX: EXISTING Runoff Area=413,451 sf 0.00% Impervious Runoff Depth=0.68"
Flow Length=300' Slope=0.0232 '/' Tc=24.6 min CN=74/0 Runoff=5.56 cfs 23,322 cf

Reach PR: PROPOSED Inflow=5.11 cfs 43,777 cf
Outflow=5.11 cfs 43,777 cf

Pond P1: Peak Elev=1,197.04' Storage=28,230 cf Inflow=2.98 cfs 13,263 cf
Outflow=0.73 cfs 13,099 cf

Pond P2: Peak Elev=1,197.75' Storage=6,027 cf Inflow=3.37 cfs 9,081 cf
12.0" Round Culvert n=0.012 L=33.0' S=0.0061 '/' Outflow=1.51 cfs 9,067 cf

Pond P3: Peak Elev=1,197.54' Storage=8,130 cf Inflow=2.50 cfs 6,750 cf
12.0" Round Culvert n=0.012 L=32.0' S=0.0063 '/' Outflow=0.86 cfs 6,724 cf

Pond P4: Peak Elev=1,197.44' Storage=16,043 cf Inflow=2.60 cfs 7,025 cf
12.0" Round Culvert n=0.012 L=35.0' S=0.0057 '/' Outflow=0.60 cfs 6,958 cf

Pond P5: Peak Elev=1,198.57' Storage=2,987 cf Inflow=2.61 cfs 7,230 cf
12.0" Round Culvert n=0.012 L=77.0' S=0.0065 '/' Outflow=1.03 cfs 5,191 cf

Total Runoff Area = 826,900 sf Runoff Volume = 69,409 cf Average Runoff Depth = 1.01"
80.72% Pervious = 667,435 sf 19.28% Impervious = 159,465 sf

Summary for Subcatchment 1:

Runoff = 2.98 cfs @ 12.09 hrs, Volume= 8,072 cf, Depth= 1.44"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 2-yr Rainfall=2.62"

	Area (sf)	CN	Description
*	19,950	98	IMPERVIOUS
*	10,072	98	POND
	37,091	74	>75% Grass cover, Good, HSG C
	67,113	85	Weighted Average
	37,091		55.27% Pervious Area
	30,022		44.73% Impervious Area

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

Summary for Subcatchment 2:

Runoff = 3.37 cfs @ 12.09 hrs, Volume= 9,081 cf, Depth= 1.61"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 2-yr Rainfall=2.62"

	Area (sf)	CN	Description
*	33,740	98	IMPERVIOUS
*	3,152	98	POND
	30,731	74	>75% Grass cover, Good, HSG C
	67,623	87	Weighted Average
	30,731		45.44% Pervious Area
	36,892		54.56% Impervious Area

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

Summary for Subcatchment 3:

Runoff = 2.50 cfs @ 12.09 hrs, Volume= 6,750 cf, Depth= 1.57"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 2-yr Rainfall=2.62"

	Area (sf)	CN	Description
*	22,530	98	IMPERVIOUS
*	4,411	98	POND
	24,538	74	>75% Grass cover, Good, HSG C
	51,479	87	Weighted Average
	24,538		47.67% Pervious Area
	26,941		52.33% Impervious Area

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

Summary for Subcatchment 4:

Runoff = 2.60 cfs @ 12.09 hrs, Volume= 7,025 cf, Depth= 1.49"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 2-yr Rainfall=2.62"

	Area (sf)	CN	Description
*	19,540	98	IMPERVIOUS
*	7,280	98	POND
	29,841	74	>75% Grass cover, Good, HSG C
	56,661	85	Weighted Average
	29,841		52.67% Pervious Area
	26,820		47.33% Impervious Area

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

Summary for Subcatchment 5:

Runoff = 2.61 cfs @ 12.10 hrs, Volume= 7,230 cf, Depth= 0.96"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 2-yr Rainfall=2.62"

	Area (sf)	CN	Description
*	15,000	98	IMPERVIOUS
*	0	98	POND
	75,215	74	>75% Grass cover, Good, HSG C
	90,215	78	Weighted Average
	75,215		83.37% Pervious Area
	15,000		16.63% Impervious Area

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

Summary for Subcatchment 6: 6

Runoff = 2.89 cfs @ 12.10 hrs, Volume= 7,929 cf, Depth= 1.18"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 2-yr Rainfall=2.62"

	Area (sf)	CN	Description
*	23,790	98	IMPERVIOUS
	56,568	74	>75% Grass cover, Good, HSG C
	80,358	81	Weighted Average
	56,568		70.39% Pervious Area
	23,790		29.61% Impervious Area

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

Summary for Subcatchment EX: EXISTING

Runoff = 5.56 cfs @ 12.34 hrs, Volume= 23,322 cf, Depth= 0.68"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 2-yr Rainfall=2.62"

Area (sf)	CN	Description
413,451	74	>75% Grass cover, Good, HSG C
413,451		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.6	300	0.0232	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.62"

Summary for Reach PR: PROPOSED

Inflow Area = 413,449 sf, 38.57% Impervious, Inflow Depth > 1.27" for 2-yr event
Inflow = 5.11 cfs @ 12.17 hrs, Volume= 43,777 cf
Outflow = 5.11 cfs @ 12.17 hrs, Volume= 43,777 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs

Summary for Pond P1:

Inflow Area = 157,328 sf, 28.62% Impervious, Inflow Depth = 1.01" for 2-yr event
Inflow = 2.98 cfs @ 12.09 hrs, Volume= 13,263 cf
Outflow = 0.73 cfs @ 12.95 hrs, Volume= 13,099 cf, Atten= 76%, Lag= 51.2 min
Primary = 0.73 cfs @ 12.95 hrs, Volume= 13,099 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
Starting Elev= 1,196.50' Surf.Area= 10,072 sf Storage= 22,341 cf
Peak Elev= 1,197.04' @ 12.95 hrs Surf.Area= 11,811 sf Storage= 28,230 cf (5,889 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= 263.0 min (1,092.8 - 829.8)

Volume	Invert	Avail.Storage	Storage Description
#1	1,192.00'	44,815 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,192.00	2,650	0	0
1,194.00	4,260	6,910	6,910
1,195.50	5,760	7,515	14,425
1,196.50	10,072	7,916	22,341
1,198.00	14,920	18,744	41,085
1,198.50	0	3,730	44,815

Device	Routing	Invert	Outlet Devices
#1	Primary	1,196.50'	**12.0" Round Culvert** L= 27.0' Ke= 0.500 Inlet / Outlet Invert= 1,196.50' / 1,196.40' S= 0.0037 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Primary	1,197.80'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=0.73 cfs @ 12.95 hrs HW=1,197.04' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.73 cfs @ 2.44 fps)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond P2:

Inflow Area = 67,623 sf, 54.56% Impervious, Inflow Depth = 1.61" for 2-yr event
Inflow = 3.37 cfs @ 12.09 hrs, Volume= 9,081 cf
Outflow = 1.51 cfs @ 12.29 hrs, Volume= 9,067 cf, Atten= 55%, Lag= 12.2 min
Primary = 1.51 cfs @ 12.29 hrs, Volume= 9,067 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
Starting Elev= 1,197.00' Surf.Area= 3,152 sf Storage= 3,121 cf
Peak Elev= 1,197.75' @ 12.29 hrs Surf.Area= 4,553 sf Storage= 6,027 cf (2,906 cf above start)

Plug-Flow detention time= 241.4 min calculated for 5,945 cf (65% of inflow)
Center-of-Mass det. time= 79.1 min (855.6 - 776.5)

Volume	Invert	Avail.Storage	Storage Description
#1	1,194.00'	20,006 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,194.00	198	0	0
1,196.00	898	1,096	1,096
1,197.00	3,152	2,025	3,121
1,198.00	5,009	4,081	7,202
1,199.00	6,400	5,705	12,906
1,200.00	7,800	7,100	20,006

Device	Routing	Invert	Outlet Devices
#1	Primary	1,197.00'	**12.0" Round Culvert** L= 33.0' Ke= 0.500 Inlet / Outlet Invert= 1,197.00' / 1,196.80' S= 0.0061 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=1.51 cfs @ 12.29 hrs HW=1,197.75' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.51 cfs @ 3.30 fps)

Summary for Pond P3:

Inflow Area = 51,479 sf, 52.33% Impervious, Inflow Depth = 1.57" for 2-yr event
Inflow = 2.50 cfs @ 12.09 hrs, Volume= 6,750 cf
Outflow = 0.86 cfs @ 12.35 hrs, Volume= 6,724 cf, Atten= 65%, Lag= 15.4 min
Primary = 0.86 cfs @ 12.35 hrs, Volume= 6,724 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs

Starting Elev= 1,197.00' Surf.Area= 4,411 sf Storage= 5,444 cf
Peak Elev= 1,197.54' @ 12.35 hrs Surf.Area= 5,571 sf Storage= 8,130 cf (2,687 cf above start)

Plug-Flow detention time= 804.1 min calculated for 1,280 cf (19% of inflow)
Center-of-Mass det. time= 129.7 min (907.4 - 777.7)

Volume	Invert	Avail.Storage	Storage Description
#1	1,194.00'	14,423 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,194.00	610	0	0
1,196.00	1,752	2,362	2,362
1,197.00	4,411	3,082	5,444
1,198.00	6,565	5,488	10,932
1,198.50	7,400	3,491	14,423

Device	Routing	Invert	Outlet Devices
#1	Primary	1,197.00'	**12.0" Round Culvert** L= 32.0' Ke= 0.500 Inlet / Outlet Invert= 1,197.00' / 1,196.80' S= 0.0063 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.86 cfs @ 12.35 hrs HW=1,197.54' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 0.86 cfs @ 2.91 fps)

Summary for Pond P4:

Inflow Area = 56,661 sf, 47.33% Impervious, Inflow Depth = 1.49" for 2-yr event
Inflow = 2.60 cfs @ 12.09 hrs, Volume= 7,025 cf
Outflow = 0.60 cfs @ 12.46 hrs, Volume= 6,958 cf, Atten= 77%, Lag= 22.2 min
Primary = 0.60 cfs @ 12.46 hrs, Volume= 6,958 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
Starting Elev= 1,197.00' Surf.Area= 7,279 sf Storage= 12,656 cf
Peak Elev= 1,197.44' @ 12.46 hrs Surf.Area= 8,049 sf Storage= 16,043 cf (3,387 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= 220.4 min (1,001.2 - 780.8)

Volume	Invert	Avail.Storage	Storage Description
#1	1,192.00'	25,544 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,192.00	375	0	0
1,194.00	1,715	2,090	2,090
1,196.00	3,474	5,189	7,279
1,197.00	7,279	5,377	12,656
1,198.00	9,021	8,150	20,806
1,198.50	9,931	4,738	25,544

Device	Routing	Invert	Outlet Devices
#1	Primary	1,197.00'	**12.0" Round Culvert** L= 35.0' Ke= 0.500 Inlet / Outlet Invert= 1,197.00' / 1,196.80' S= 0.0057 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=0.60 cfs @ 12.46 hrs HW=1,197.44' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 0.60 cfs @ 2.63 fps)

Summary for Pond P5:

Inflow Area = 90,215 sf, 16.63% Impervious, Inflow Depth = 0.96" for 2-yr event
Inflow = 2.61 cfs @ 12.10 hrs, Volume= 7,230 cf
Outflow = 1.03 cfs @ 12.35 hrs, Volume= 5,191 cf, Atten= 60%, Lag= 15.1 min
Primary = 1.03 cfs @ 12.35 hrs, Volume= 5,191 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
Peak Elev= 1,198.57' @ 12.35 hrs Surf.Area= 1,885 sf Storage= 2,987 cf

Plug-Flow detention time= 179.5 min calculated for 5,191 cf (72% of inflow)
Center-of-Mass det. time= 91.6 min (903.3 - 811.7)

Volume	Invert	Avail.Storage	Storage Description
#1	1,194.00'	19,332 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,194.00	0	0	0
1,196.00	277	277	277
1,198.00	1,482	1,759	2,036
1,200.00	2,907	4,389	6,425
1,202.00	10,000	12,907	19,332

Device	Routing	Invert	Outlet Devices
#1	Primary	1,198.00'	**12.0" Round Culvert** L= 77.0' Ke= 0.500 Inlet / Outlet Invert= 1,198.00' / 1,197.50' S= 0.0065 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=1.03 cfs @ 12.35 hrs HW=1,198.56' TW=1,196.94' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 1.03 cfs @ 3.26 fps)

Time span=0.00-100.00 hrs, dt=0.01 hrs, 10001 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Runoff Area=67,113 sf 44.73% Impervious Runoff Depth=2.44"
Tc=10.0 min CN=74/98 Runoff=5.19 cfs 13,642 cf

Subcatchment 2: Runoff Area=67,623 sf 54.56% Impervious Runoff Depth=2.65"
Tc=10.0 min CN=74/98 Runoff=5.65 cfs 14,924 cf

Subcatchment 3: Runoff Area=51,479 sf 52.33% Impervious Runoff Depth=2.60"
Tc=10.0 min CN=74/98 Runoff=4.23 cfs 11,158 cf

Subcatchment 4: Runoff Area=56,661 sf 47.33% Impervious Runoff Depth=2.49"
Tc=10.0 min CN=74/98 Runoff=4.47 cfs 11,779 cf

Subcatchment 5: Runoff Area=90,215 sf 16.63% Impervious Runoff Depth=1.84"
Tc=10.0 min CN=74/98 Runoff=5.36 cfs 13,841 cf

Subcatchment 6: 6 Runoff Area=80,358 sf 29.61% Impervious Runoff Depth=2.12"
Tc=10.0 min CN=74/98 Runoff=5.43 cfs 14,178 cf

Subcatchment EX: EXISTING Runoff Area=413,451 sf 0.00% Impervious Runoff Depth=1.49"
Flow Length=300' Slope=0.0232 '/' Tc=24.6 min CN=74/0 Runoff=13.48 cfs 51,238 cf

Reach PR: PROPOSED Inflow=9.95 cfs 77,208 cf
Outflow=9.95 cfs 77,208 cf

Pond P1: Peak Elev=1,197.48' Storage=33,754 cf Inflow=7.33 cfs 25,443 cf
Outflow=1.98 cfs 25,278 cf

Pond P2: Peak Elev=1,198.09' Storage=7,658 cf Inflow=5.65 cfs 14,924 cf
12.0" Round Culvert n=0.012 L=33.0' S=0.0061 '/' Outflow=2.57 cfs 14,909 cf

Pond P3: Peak Elev=1,197.79' Storage=9,583 cf Inflow=4.23 cfs 11,158 cf
12.0" Round Culvert n=0.012 L=32.0' S=0.0063 '/' Outflow=1.63 cfs 11,132 cf

Pond P4: Peak Elev=1,197.68' Storage=17,988 cf Inflow=4.47 cfs 11,779 cf
12.0" Round Culvert n=0.012 L=35.0' S=0.0057 '/' Outflow=1.26 cfs 11,711 cf

Pond P5: Peak Elev=1,199.23' Storage=4,409 cf Inflow=5.36 cfs 13,841 cf
12.0" Round Culvert n=0.012 L=77.0' S=0.0065 '/' Outflow=3.08 cfs 11,801 cf

Total Runoff Area = 826,900 sf Runoff Volume = 130,759 cf Average Runoff Depth = 1.90"
80.72% Pervious = 667,435 sf 19.28% Impervious = 159,465 sf

Summary for Subcatchment 1:

Runoff = 5.19 cfs @ 12.09 hrs, Volume= 13,642 cf, Depth= 2.44"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 10-yr Rainfall=3.85"

	Area (sf)	CN	Description
*	19,950	98	IMPERVIOUS
*	10,072	98	POND
	37,091	74	>75% Grass cover, Good, HSG C
	67,113	85	Weighted Average
	37,091		55.27% Pervious Area
	30,022		44.73% Impervious Area

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

Summary for Subcatchment 2:

Runoff = 5.65 cfs @ 12.09 hrs, Volume= 14,924 cf, Depth= 2.65"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 10-yr Rainfall=3.85"

	Area (sf)	CN	Description
*	33,740	98	IMPERVIOUS
*	3,152	98	POND
	30,731	74	>75% Grass cover, Good, HSG C
	67,623	87	Weighted Average
	30,731		45.44% Pervious Area
	36,892		54.56% Impervious Area

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

Summary for Subcatchment 3:

Runoff = 4.23 cfs @ 12.09 hrs, Volume= 11,158 cf, Depth= 2.60"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 10-yr Rainfall=3.85"

	Area (sf)	CN	Description
*	22,530	98	IMPERVIOUS
*	4,411	98	POND
	24,538	74	>75% Grass cover, Good, HSG C
	51,479	87	Weighted Average
	24,538		47.67% Pervious Area
	26,941		52.33% Impervious Area

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

Summary for Subcatchment 4:

Runoff = 4.47 cfs @ 12.09 hrs, Volume= 11,779 cf, Depth= 2.49"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 10-yr Rainfall=3.85"

	Area (sf)	CN	Description
*	19,540	98	IMPERVIOUS
*	7,280	98	POND
	29,841	74	>75% Grass cover, Good, HSG C
	56,661	85	Weighted Average
	29,841		52.67% Pervious Area
	26,820		47.33% Impervious Area

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

Summary for Subcatchment 5:

Runoff = 5.36 cfs @ 12.10 hrs, Volume= 13,841 cf, Depth= 1.84"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 10-yr Rainfall=3.85"

	Area (sf)	CN	Description
*	15,000	98	IMPERVIOUS
*	0	98	POND
	75,215	74	>75% Grass cover, Good, HSG C
	90,215	78	Weighted Average
	75,215		83.37% Pervious Area
	15,000		16.63% Impervious Area

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

Summary for Subcatchment 6: 6

Runoff = 5.43 cfs @ 12.09 hrs, Volume= 14,178 cf, Depth= 2.12"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 10-yr Rainfall=3.85"

	Area (sf)	CN	Description
*	23,790	98	IMPERVIOUS
	56,568	74	>75% Grass cover, Good, HSG C
	80,358	81	Weighted Average
	56,568		70.39% Pervious Area
	23,790		29.61% Impervious Area

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

Summary for Subcatchment EX: EXISTING

Runoff = 13.48 cfs @ 12.33 hrs, Volume= 51,238 cf, Depth= 1.49"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 10-yr Rainfall=3.85"

Area (sf)	CN	Description
413,451	74	>75% Grass cover, Good, HSG C
413,451		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.6	300	0.0232	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.62"

Summary for Reach PR: PROPOSED

Inflow Area = 413,449 sf, 38.57% Impervious, Inflow Depth = 2.24" for 10-yr event
Inflow = 9.95 cfs @ 12.16 hrs, Volume= 77,208 cf
Outflow = 9.95 cfs @ 12.16 hrs, Volume= 77,208 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs

Summary for Pond P1:

Inflow Area = 157,328 sf, 28.62% Impervious, Inflow Depth = 1.94" for 10-yr event
Inflow = 7.33 cfs @ 12.13 hrs, Volume= 25,443 cf
Outflow = 1.98 cfs @ 12.74 hrs, Volume= 25,278 cf, Atten= 73%, Lag= 36.7 min
Primary = 1.98 cfs @ 12.74 hrs, Volume= 25,278 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
Starting Elev= 1,196.50' Surf.Area= 10,072 sf Storage= 22,341 cf
Peak Elev= 1,197.48' @ 12.74 hrs Surf.Area= 13,237 sf Storage= 33,754 cf (11,413 cf above start)

Plug-Flow detention time= 1,223.1 min calculated for 2,937 cf (12% of inflow)
Center-of-Mass det. time= 183.1 min (991.6 - 808.5)

Volume	Invert	Avail.Storage	Storage Description
#1	1,192.00'	44,815 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,192.00	2,650	0	0
1,194.00	4,260	6,910	6,910
1,195.50	5,760	7,515	14,425
1,196.50	10,072	7,916	22,341
1,198.00	14,920	18,744	41,085
1,198.50	0	3,730	44,815

Device	Routing	Invert	Outlet Devices
#1	Primary	1,196.50'	**12.0" Round Culvert** L= 27.0' Ke= 0.500 Inlet / Outlet Invert= 1,196.50' / 1,196.40' S= 0.0037 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Primary	1,197.80'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=1.98 cfs @ 12.74 hrs HW=1,197.48' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.98 cfs @ 3.20 fps)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond P2:

Inflow Area = 67,623 sf, 54.56% Impervious, Inflow Depth = 2.65" for 10-yr event
Inflow = 5.65 cfs @ 12.09 hrs, Volume= 14,924 cf
Outflow = 2.57 cfs @ 12.29 hrs, Volume= 14,909 cf, Atten= 55%, Lag= 12.1 min
Primary = 2.57 cfs @ 12.29 hrs, Volume= 14,909 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
Starting Elev= 1,197.00' Surf.Area= 3,152 sf Storage= 3,121 cf
Peak Elev= 1,198.09' @ 12.29 hrs Surf.Area= 5,134 sf Storage= 7,658 cf (4,537 cf above start)

Plug-Flow detention time= 164.9 min calculated for 11,788 cf (79% of inflow)
Center-of-Mass det. time= 62.0 min (831.0 - 769.0)

Volume	Invert	Avail.Storage	Storage Description
#1	1,194.00'	20,006 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,194.00	198	0	0
1,196.00	898	1,096	1,096
1,197.00	3,152	2,025	3,121
1,198.00	5,009	4,081	7,202
1,199.00	6,400	5,705	12,906
1,200.00	7,800	7,100	20,006

Device	Routing	Invert	Outlet Devices
#1	Primary	1,197.00'	**12.0" Round Culvert** L= 33.0' Ke= 0.500 Inlet / Outlet Invert= 1,197.00' / 1,196.80' S= 0.0061 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=2.57 cfs @ 12.29 hrs HW=1,198.09' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 2.57 cfs @ 3.74 fps)

Summary for Pond P3:

Inflow Area = 51,479 sf, 52.33% Impervious, Inflow Depth = 2.60" for 10-yr event
Inflow = 4.23 cfs @ 12.09 hrs, Volume= 11,158 cf
Outflow = 1.63 cfs @ 12.33 hrs, Volume= 11,132 cf, Atten= 62%, Lag= 14.3 min
Primary = 1.63 cfs @ 12.33 hrs, Volume= 11,132 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs

Starting Elev= 1,197.00' Surf.Area= 4,411 sf Storage= 5,444 cf
Peak Elev= 1,197.79' @ 12.33 hrs Surf.Area= 6,107 sf Storage= 9,583 cf (4,139 cf above start)

Plug-Flow detention time= 318.3 min calculated for 5,688 cf (51% of inflow)
Center-of-Mass det. time= 98.9 min (869.1 - 770.2)

Volume	Invert	Avail.Storage	Storage Description
#1	1,194.00'	14,423 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,194.00	610	0	0
1,196.00	1,752	2,362	2,362
1,197.00	4,411	3,082	5,444
1,198.00	6,565	5,488	10,932
1,198.50	7,400	3,491	14,423

Device	Routing	Invert	Outlet Devices
#1	Primary	1,197.00'	**12.0" Round Culvert** L= 32.0' Ke= 0.500 Inlet / Outlet Invert= 1,197.00' / 1,196.80' S= 0.0063 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=1.63 cfs @ 12.33 hrs HW=1,197.79' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 1.63 cfs @ 3.37 fps)

Summary for Pond P4:

Inflow Area = 56,661 sf, 47.33% Impervious, Inflow Depth = 2.49" for 10-yr event
Inflow = 4.47 cfs @ 12.09 hrs, Volume= 11,779 cf
Outflow = 1.26 cfs @ 12.41 hrs, Volume= 11,711 cf, Atten= 72%, Lag= 19.5 min
Primary = 1.26 cfs @ 12.41 hrs, Volume= 11,711 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
Starting Elev= 1,197.00' Surf.Area= 7,279 sf Storage= 12,656 cf
Peak Elev= 1,197.68' @ 12.41 hrs Surf.Area= 8,459 sf Storage= 17,988 cf (5,332 cf above start)

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= 163.9 min (936.9 - 773.0)

Volume	Invert	Avail.Storage	Storage Description
#1	1,192.00'	25,544 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,192.00	375	0	0
1,194.00	1,715	2,090	2,090
1,196.00	3,474	5,189	7,279
1,197.00	7,279	5,377	12,656
1,198.00	9,021	8,150	20,806
1,198.50	9,931	4,738	25,544

Device	Routing	Invert	Outlet Devices
#1	Primary	1,197.00'	**12.0" Round Culvert** L= 35.0' Ke= 0.500 Inlet / Outlet Invert= 1,197.00' / 1,196.80' S= 0.0057 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=1.26 cfs @ 12.41 hrs HW=1,197.68' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 1.26 cfs @ 3.13 fps)

Summary for Pond P5:

Inflow Area = 90,215 sf, 16.63% Impervious, Inflow Depth = 1.84" for 10-yr event
Inflow = 5.36 cfs @ 12.10 hrs, Volume= 13,841 cf
Outflow = 3.08 cfs @ 12.26 hrs, Volume= 11,801 cf, Atten= 43%, Lag= 9.8 min
Primary = 3.08 cfs @ 12.26 hrs, Volume= 11,801 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
Peak Elev= 1,199.23' @ 12.26 hrs Surf.Area= 2,362 sf Storage= 4,409 cf

Plug-Flow detention time= 107.5 min calculated for 11,800 cf (85% of inflow)
Center-of-Mass det. time= 50.3 min (847.7 - 797.4)

Volume	Invert	Avail.Storage	Storage Description
#1	1,194.00'	19,332 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,194.00	0	0	0
1,196.00	277	277	277
1,198.00	1,482	1,759	2,036
1,200.00	2,907	4,389	6,425
1,202.00	10,000	12,907	19,332

Device	Routing	Invert	Outlet Devices
#1	Primary	1,198.00'	**12.0" Round Culvert** L= 77.0' Ke= 0.500 Inlet / Outlet Invert= 1,198.00' / 1,197.50' S= 0.0065 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=3.08 cfs @ 12.26 hrs HW=1,199.23' TW=1,197.23' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 3.08 cfs @ 4.06 fps)

Time span=0.00-100.00 hrs, dt=0.01 hrs, 10001 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1: Runoff Area=67,113 sf 44.73% Impervious Runoff Depth=4.59"
Tc=10.0 min CN=74/98 Runoff=9.30 cfs 25,691 cf

Subcatchment 2: Runoff Area=67,623 sf 54.56% Impervious Runoff Depth=4.85"
Tc=10.0 min CN=74/98 Runoff=9.79 cfs 27,337 cf

Subcatchment 3: Runoff Area=51,479 sf 52.33% Impervious Runoff Depth=4.79"
Tc=10.0 min CN=74/98 Runoff=7.38 cfs 20,561 cf

Subcatchment 4: Runoff Area=56,661 sf 47.33% Impervious Runoff Depth=4.66"
Tc=10.0 min CN=74/98 Runoff=7.94 cfs 22,012 cf

Subcatchment 5: Runoff Area=90,215 sf 16.63% Impervious Runoff Depth=3.86"
Tc=10.0 min CN=74/98 Runoff=10.89 cfs 28,999 cf

Subcatchment 6: 6 Runoff Area=80,358 sf 29.61% Impervious Runoff Depth=4.20"
Tc=10.0 min CN=74/98 Runoff=10.36 cfs 28,107 cf

Subcatchment EX: EXISTING Runoff Area=413,451 sf 0.00% Impervious Runoff Depth=3.42"
Flow Length=300' Slope=0.0232 '/' Tc=24.6 min CN=74/0 Runoff=30.27 cfs 117,893 cf

Reach PR: PROPOSED Inflow=19.21 cfs 150,391 cf
Outflow=19.21 cfs 150,391 cf

Pond P1: Peak Elev=1,198.04' Storage=41,622 cf Inflow=13.22 cfs 52,651 cf
Outflow=6.02 cfs 52,484 cf

Pond P2: Peak Elev=1,198.71' Storage=11,112 cf Inflow=9.79 cfs 27,337 cf
12.0" Round Culvert n=0.012 L=33.0' S=0.0061 '/' Outflow=3.90 cfs 27,322 cf

Pond P3: Peak Elev=1,198.20' Storage=12,295 cf Inflow=7.38 cfs 20,561 cf
12.0" Round Culvert n=0.012 L=32.0' S=0.0063 '/' Outflow=2.87 cfs 20,534 cf

Pond P4: Peak Elev=1,198.08' Storage=21,553 cf Inflow=7.94 cfs 22,012 cf
12.0" Round Culvert n=0.012 L=35.0' S=0.0057 '/' Outflow=2.52 cfs 21,943 cf

Pond P5: Peak Elev=1,200.55' Storage=8,559 cf Inflow=10.89 cfs 28,999 cf
12.0" Round Culvert n=0.012 L=77.0' S=0.0065 '/' Outflow=4.78 cfs 26,960 cf

Total Runoff Area = 826,900 sf Runoff Volume = 270,600 cf Average Runoff Depth = 3.93"
80.72% Pervious = 667,435 sf 19.28% Impervious = 159,465 sf

Summary for Subcatchment 1:

Runoff = 9.30 cfs @ 12.09 hrs, Volume= 25,691 cf, Depth= 4.59"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 100-yr Rainfall=6.28"

	Area (sf)	CN	Description
*	19,950	98	IMPERVIOUS
*	10,072	98	POND
	37,091	74	>75% Grass cover, Good, HSG C
	67,113	85	Weighted Average
	37,091		55.27% Pervious Area
	30,022		44.73% Impervious Area

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

Summary for Subcatchment 2:

Runoff = 9.79 cfs @ 12.09 hrs, Volume= 27,337 cf, Depth= 4.85"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 100-yr Rainfall=6.28"

	Area (sf)	CN	Description
*	33,740	98	IMPERVIOUS
*	3,152	98	POND
	30,731	74	>75% Grass cover, Good, HSG C
	67,623	87	Weighted Average
	30,731		45.44% Pervious Area
	36,892		54.56% Impervious Area

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

Summary for Subcatchment 3:

Runoff = 7.38 cfs @ 12.09 hrs, Volume= 20,561 cf, Depth= 4.79"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 100-yr Rainfall=6.28"

	Area (sf)	CN	Description
*	22,530	98	IMPERVIOUS
*	4,411	98	POND
	24,538	74	>75% Grass cover, Good, HSG C
	51,479	87	Weighted Average
	24,538		47.67% Pervious Area
	26,941		52.33% Impervious Area

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

Summary for Subcatchment 4:

Runoff = 7.94 cfs @ 12.09 hrs, Volume= 22,012 cf, Depth= 4.66"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 100-yr Rainfall=6.28"

	Area (sf)	CN	Description
*	19,540	98	IMPERVIOUS
*	7,280	98	POND
	29,841	74	>75% Grass cover, Good, HSG C
	56,661	85	Weighted Average
	29,841		52.67% Pervious Area
	26,820		47.33% Impervious Area

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

Summary for Subcatchment 5:

Runoff = 10.89 cfs @ 12.09 hrs, Volume= 28,999 cf, Depth= 3.86"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 100-yr Rainfall=6.28"

	Area (sf)	CN	Description
*	15,000	98	IMPERVIOUS
*	0	98	POND
	75,215	74	>75% Grass cover, Good, HSG C
	90,215	78	Weighted Average
	75,215		83.37% Pervious Area
	15,000		16.63% Impervious Area

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

Summary for Subcatchment 6: 6

Runoff = 10.36 cfs @ 12.09 hrs, Volume= 28,107 cf, Depth= 4.20"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 100-yr Rainfall=6.28"

	Area (sf)	CN	Description
*	23,790	98	IMPERVIOUS
	56,568	74	>75% Grass cover, Good, HSG C
	80,358	81	Weighted Average
	56,568		70.39% Pervious Area
	23,790		29.61% Impervious Area

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

Summary for Subcatchment EX: EXISTING

Runoff = 30.27 cfs @ 12.30 hrs, Volume= 117,893 cf, Depth= 3.42"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
MN-East Gull Lake 24-hr S0 100-yr Rainfall=6.28"

Area (sf)	CN	Description
413,451	74	>75% Grass cover, Good, HSG C
413,451		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
24.6	300	0.0232	0.20		**Sheet Flow,** Grass: Short n= 0.150 P2= 2.62"

Summary for Reach PR: PROPOSED

Inflow Area = 413,449 sf, 38.57% Impervious, Inflow Depth = 4.36" for 100-yr event
Inflow = 19.21 cfs @ 12.14 hrs, Volume= 150,391 cf
Outflow = 19.21 cfs @ 12.14 hrs, Volume= 150,391 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs

Summary for Pond P1:

Inflow Area = 157,328 sf, 28.62% Impervious, Inflow Depth = 4.02" for 100-yr event
Inflow = 13.22 cfs @ 12.10 hrs, Volume= 52,651 cf
Outflow = 6.02 cfs @ 12.61 hrs, Volume= 52,484 cf, Atten= 54%, Lag= 30.4 min
Primary = 6.02 cfs @ 12.61 hrs, Volume= 52,484 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
Starting Elev= 1,196.50' Surf.Area= 10,072 sf Storage= 22,341 cf
Peak Elev= 1,198.04' @ 12.61 hrs Surf.Area= 13,805 sf Storage= 41,622 cf (19,281 cf above start)

Plug-Flow detention time= 339.9 min calculated for 30,143 cf (57% of inflow)
Center-of-Mass det. time= 128.2 min (926.6 - 798.5)

Volume	Invert	Avail.Storage	Storage Description
#1	1,192.00'	44,815 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,192.00	2,650	0	0
1,194.00	4,260	6,910	6,910
1,195.50	5,760	7,515	14,425
1,196.50	10,072	7,916	22,341
1,198.00	14,920	18,744	41,085
1,198.50	0	3,730	44,815

Device	Routing	Invert	Outlet Devices
#1	Primary	1,196.50'	**12.0" Round Culvert** L= 27.0' Ke= 0.500 Inlet / Outlet Invert= 1,196.50' / 1,196.40' S= 0.0037 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#2	Primary	1,197.80'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=6.02 cfs @ 12.61 hrs HW=1,198.04' TW=0.00' (Dynamic Tailwater)
- **1=Culvert** (Barrel Controls 3.28 cfs @ 4.18 fps)
- **2=Broad-Crested Rectangular Weir** (Weir Controls 2.74 cfs @ 1.15 fps)

Summary for Pond P2:

Inflow Area = 67,623 sf, 54.56% Impervious, Inflow Depth = 4.85" for 100-yr event
Inflow = 9.79 cfs @ 12.09 hrs, Volume= 27,337 cf
Outflow = 3.90 cfs @ 12.32 hrs, Volume= 27,322 cf, Atten= 60%, Lag= 13.8 min
Primary = 3.90 cfs @ 12.32 hrs, Volume= 27,322 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
Starting Elev= 1,197.00' Surf.Area= 3,152 sf Storage= 3,121 cf
Peak Elev= 1,198.71' @ 12.32 hrs Surf.Area= 5,997 sf Storage= 11,112 cf (7,991 cf above start)

Plug-Flow detention time= 124.4 min calculated for 24,199 cf (89% of inflow)
Center-of-Mass det. time= 51.1 min (815.0 - 763.9)

Volume	Invert	Avail.Storage	Storage Description
#1	1,194.00'	20,006 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,194.00	198	0	0
1,196.00	898	1,096	1,096
1,197.00	3,152	2,025	3,121
1,198.00	5,009	4,081	7,202
1,199.00	6,400	5,705	12,906
1,200.00	7,800	7,100	20,006

Device	Routing	Invert	Outlet Devices
#1	Primary	1,197.00'	**12.0" Round Culvert** L= 33.0' Ke= 0.500 Inlet / Outlet Invert= 1,197.00' / 1,196.80' S= 0.0061 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=3.90 cfs @ 12.32 hrs HW=1,198.71' TW=0.00' (Dynamic Tailwater)
- **1=Culvert** (Barrel Controls 3.90 cfs @ 4.96 fps)

Summary for Pond P3:

Inflow Area = 51,479 sf, 52.33% Impervious, Inflow Depth = 4.79" for 100-yr event
Inflow = 7.38 cfs @ 12.09 hrs, Volume= 20,561 cf
Outflow = 2.87 cfs @ 12.32 hrs, Volume= 20,534 cf, Atten= 61%, Lag= 14.2 min
Primary = 2.87 cfs @ 12.32 hrs, Volume= 20,534 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs

Starting Elev= 1,197.00' Surf.Area= 4,411 sf Storage= 5,444 cf
Peak Elev= 1,198.20' @ 12.32 hrs Surf.Area= 6,903 sf Storage= 12,295 cf (6,852 cf above start)

Plug-Flow detention time= 198.5 min calculated for 15,089 cf (73% of inflow)
Center-of-Mass det. time= 76.3 min (841.3 - 765.0)

Volume	Invert	Avail.Storage	Storage Description
#1	1,194.00'	14,423 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,194.00	610	0	0
1,196.00	1,752	2,362	2,362
1,197.00	4,411	3,082	5,444
1,198.00	6,565	5,488	10,932
1,198.50	7,400	3,491	14,423

Device	Routing	Invert	Outlet Devices
#1	Primary	1,197.00'	**12.0" Round Culvert** L= 32.0' Ke= 0.500 Inlet / Outlet Invert= 1,197.00' / 1,196.80' S= 0.0063 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=2.87 cfs @ 12.32 hrs HW=1,198.20' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 2.87 cfs @ 3.85 fps)

Summary for Pond P4:

Inflow Area = 56,661 sf, 47.33% Impervious, Inflow Depth = 4.66" for 100-yr event
Inflow = 7.94 cfs @ 12.09 hrs, Volume= 22,012 cf
Outflow = 2.52 cfs @ 12.38 hrs, Volume= 21,943 cf, Atten= 68%, Lag= 17.4 min
Primary = 2.52 cfs @ 12.38 hrs, Volume= 21,943 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
Starting Elev= 1,197.00' Surf.Area= 7,279 sf Storage= 12,656 cf
Peak Elev= 1,198.08' @ 12.38 hrs Surf.Area= 9,171 sf Storage= 21,553 cf (8,897 cf above start)

Plug-Flow detention time= 413.7 min calculated for 9,288 cf (42% of inflow)
Center-of-Mass det. time= 121.6 min (889.3 - 767.7)

Volume	Invert	Avail.Storage	Storage Description
#1	1,192.00'	25,544 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,192.00	375	0	0
1,194.00	1,715	2,090	2,090
1,196.00	3,474	5,189	7,279
1,197.00	7,279	5,377	12,656
1,198.00	9,021	8,150	20,806
1,198.50	9,931	4,738	25,544

Device	Routing	Invert	Outlet Devices
#1	Primary	1,197.00'	**12.0" Round Culvert** L= 35.0' Ke= 0.500 Inlet / Outlet Invert= 1,197.00' / 1,196.80' S= 0.0057 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=2.52 cfs @ 12.38 hrs HW=1,198.08' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 2.52 cfs @ 3.69 fps)

Summary for Pond P5:

Inflow Area = 90,215 sf, 16.63% Impervious, Inflow Depth = 3.86" for 100-yr event
Inflow = 10.89 cfs @ 12.09 hrs, Volume= 28,999 cf
Outflow = 4.78 cfs @ 12.31 hrs, Volume= 26,960 cf, Atten= 56%, Lag= 13.0 min
Primary = 4.78 cfs @ 12.31 hrs, Volume= 26,960 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-100.00 hrs, dt= 0.01 hrs
Peak Elev= 1,200.55' @ 12.31 hrs Surf.Area= 4,857 sf Storage= 8,559 cf

Plug-Flow detention time= 72.9 min calculated for 26,960 cf (93% of inflow)
Center-of-Mass det. time= 37.9 min (826.4 - 788.4)

Volume	Invert	Avail.Storage	Storage Description
#1	1,194.00'	19,332 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

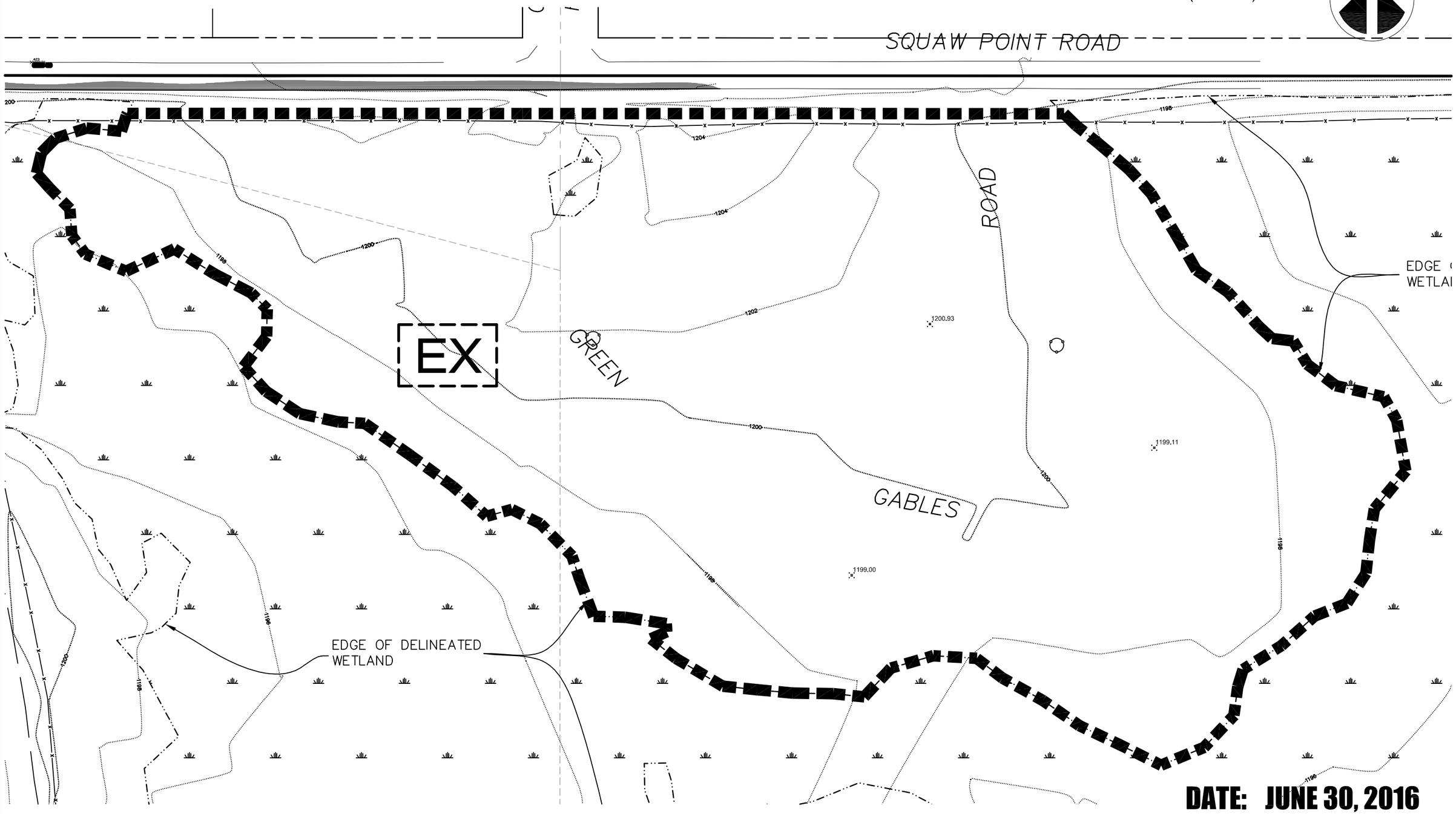
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
1,194.00	0	0	0
1,196.00	277	277	277
1,198.00	1,482	1,759	2,036
1,200.00	2,907	4,389	6,425
1,202.00	10,000	12,907	19,332

Device	Routing	Invert	Outlet Devices
#1	Primary	1,198.00'	**12.0" Round Culvert** L= 77.0' Ke= 0.500 Inlet / Outlet Invert= 1,198.00' / 1,197.50' S= 0.0065 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=4.78 cfs @ 12.31 hrs HW=1,200.55' TW=1,197.90' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 4.78 cfs @ 6.09 fps)

EAST GULL LAKE

DRAINAGE AREAS - EXISTING



DATE: JUNE 30, 2016

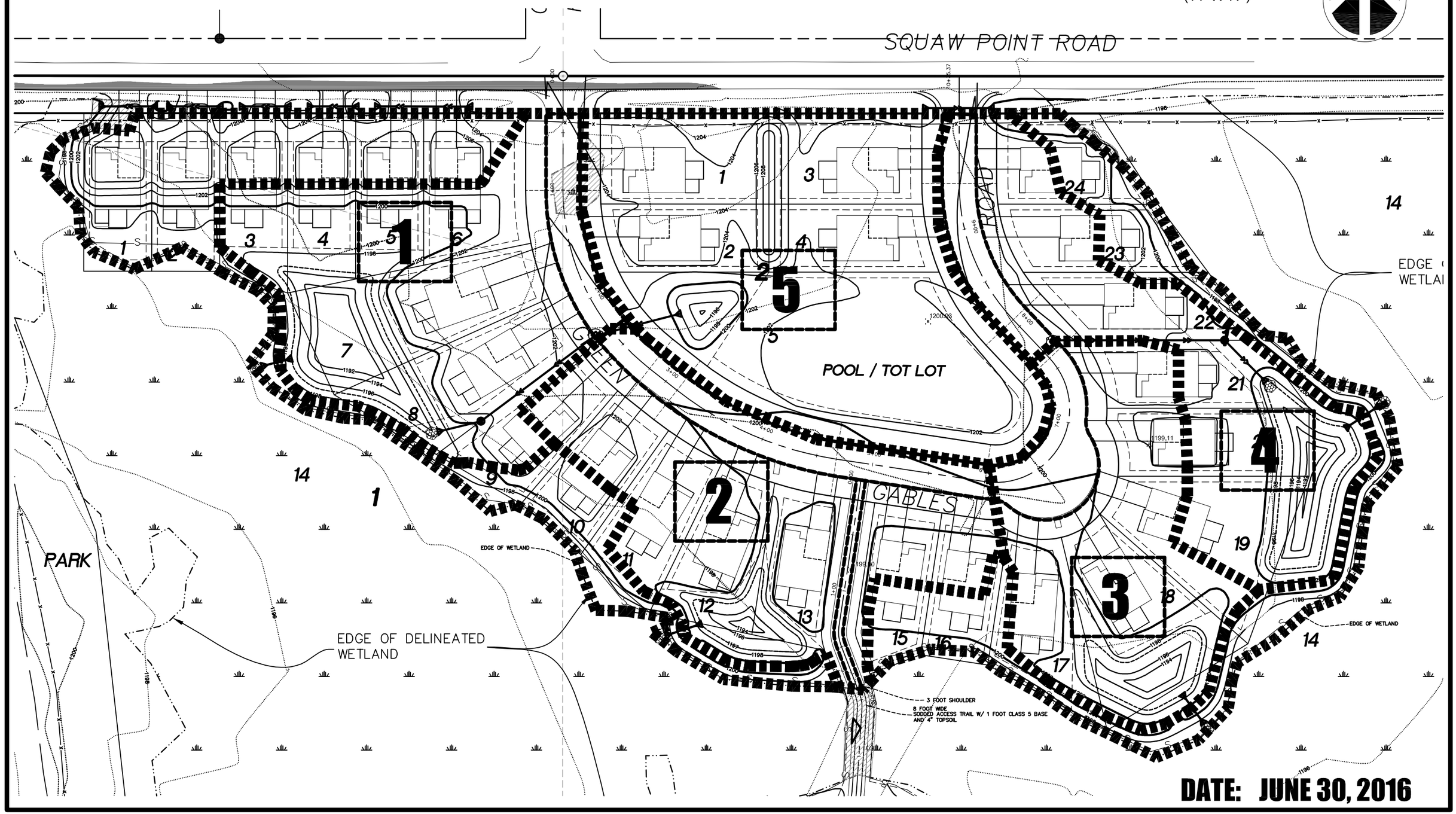
EAST GULL LAKE

DRAINAGE AREAS - PROPOSED

0 40 80

1 INCH = 80 FEET
(11" X 17")

NORTH



DATE: JUNE 30, 2016