

Larson Engineering, Inc.
2801 E. Enterprise Avenue, Suite 200
Appleton, WI 54913-8559
920.734.9867
www.larsonengr.com



Flood Elevation Analysis
Alexander Property
Greentree Road
Town of Plymouth
Sheboygan County, Wisconsin

Book 1 of 1
Calculation Release #1

Prepared for
Lee Alexander
Springfield, TN

Larson Engineering, Inc.
Appleton, Wisconsin
Project Number 32240004.000



Larson

**Floodplain Analysis
Alexander Property
Town of Plymouth
Sheboygan County, Wisconsin**

Introduction

Lee Alexander is the owner of a parcel on Greentree Road in the Town of Plymouth, Sheboygan County, Wisconsin. The property is located in the SE ¼ of the NW 1/4, Section 2, T 15 N, R 21 E, Sheboygan County, Wisconsin; on the south side of Greentree Road, between STH 57 and CTH E. The location is shown on the attached map. The waterway adjacent to this property is Otter Creek, a tributary of the Sheboygan River flowing east and south Green Bay. At this location is the confluence of two stream branches, a north branch which crosses Greentree Road, and a west branch which crosses CTH E and has its headwater near Little Elkhart Lake. The north branch flows through Gerber Lake before reaching Greentree Road.

The current flood hazard map for this area is 55117C0190F, and it includes an A zone along the stream, although the stream has not been previously analyzed. The April 2009 FIS for Sheboygan County (55117CV001A) did not include detailed study of Otter Creek.

Hydrologic Analysis

The drainage basin was delineated on USGS topographic mapping, and basin characteristics were obtained from the Purdue L-THIA GLWMS, for each of the branches of the stream above the location of interest. The basin outline is shown in Figure 2. Although Little Elkhart Lake is in the basin for the west branch of Otter Creek, there is no direct surface connection from the lake to the west branch of Otter Creek; the normal water elevation of the lake is about 40 feet above the wetland area from which the west branch arises.

The National Streamflow Statistics web application was used to estimate the one-percent flood flow for each branch and the main stem. This application uses the regression equations developed in SIR2022-5118, Estimating Flood Magnitude and Frequency for Unregulated Streams in Wisconsin, published by USGS. The basin is located in Region 3, and the relevant characteristics include drainage area, open water area, and wetland area. The resulting flows are shown in Table 1 below.

For comparison, the drainage basin was modeled in Hydrocad, applying the SCS unit hydrograph. Curve numbers were assigned to each of the land uses and soil types tabulated in the L-THIA basin parameters, and time-of-concentration developed for both sub-basins. Precipitation totals were obtained from the NOAA Precipitation Frequency Data Server (tabular output attached).

The results of the regression equation analysis and the SCS model differed significantly. One possible reason is the significant amount of wetlands located in the basins. The SCS curve numbers do not publish a value for wetlands, and the effective curve number can vary widely from open water to grassland or forest. Further, the wetlands provide significant buffering of runoff.

As a check, the regression equations provided in SIR 2016-5140, the predecessor to the NSS equations, were evaluated using the relevant parameters of drainage area and developed land use. The results are included in the table, as are the flows used in the hydraulic analysis.

Table 1 – Hydrology Summary

	West Branch	Main Stem below Confluence
NSS 1% peak	223 cfs	324 cfs
Hydrocad	710 cfs	1035 cfs
SIR 2016-5140	332 cfs	371 cfs
Used in hydraulic analysis	300 cfs	400 cfs

Hydraulic Analysis

The hydraulic analysis was performed using the Army Corps of Engineers HEC-RAS program, version 6.3.1. Cross sections were surveyed on site at the stream confluence, at the proposed stream crossing, and near the point where the west branch crosses the west property line. There is an existing snowmobile bridge located downstream from the stream confluence, and cross sections were taken upstream and downstream of the structure as well. The resulting backwater analysis indicated that the bridge did not affect the water surface profile, due to the stream gradient upstream of the confluence. Interpolated cross section were included from the downstream side of the proposed stream crossing to the confluence. Starting conditions were

The results of the initial model run is summarized in the attached table. The 100-year base flood elevation varies from 821.00 ft at the east property line, to 826.14 ft at the upstream limit of the property. The analysis predicts critical depth flow at most sections presumably due to the longitudinal slope of the stream valley.

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
ottercrk-w	11016	PF 1	300.00	823.32	826.14	826.14	826.66	0.007098	6.87	98.36	109.52	0.83
ottercrk-w	10950	PF 1	300.00	822.24	825.41	825.41	825.84	0.006669	6.27	111.09	158.66	0.77
ottercrk-w	10925	PF 1	300.00	822.65	825.26	825.26	825.63	0.006117	6.01	133.27	183.32	0.75
ottercrk-w	10900	PF 1	300.00	821.84	824.79	824.79	825.14	0.005178	6.74	157.26	194.15	0.72
ottercrk-w	10835	PF 1	300.00	821.09	824.19	824.19	824.64	0.005672	6.82	134.86	162.84	0.73
ottercrk-w	10743.8*	PF 1	300.00	820.65	823.62	823.62	824.06	0.005152	6.45	128.36	161.31	0.70
ottercrk-w	10652.6*	PF 1	300.00	820.21	823.00	823.00	823.47	0.005333	6.36	115.24	154.50	0.71
ottercrk-w	10561.5*	PF 1	300.00	819.77	822.40	822.40	822.88	0.005425	6.20	105.49	147.21	0.72
ottercrk-w	10470.3*	PF 1	300.00	819.32	821.77	821.77	822.28	0.005986	6.22	92.44	133.47	0.75
ottercrk-w	10379.1*	PF 1	300.00	818.88	821.53		821.79	0.002947	4.65	134.05	157.09	0.53
ottercrk-w	10288	PF 1	400.00	818.44	821.00	820.84	821.43	0.004805	5.82	132.86	145.12	0.68

A culvert and roadway were added at the proposed stream crossing at section 10925. The proposed culvert is a 48-inch diameter steel pipe culvert. Upstream from this location, the existing culvert at CTH E is a 108-inch diameter steel pipe culvert. There is about 14.5 feet of elevation change in the channel invert between the exit of the CTH E pipe and the proposed driveway pipe, in a stream valley distance of about 1300 feet (the channel meanders through the stream valley and thus is longer).

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
ottercrk-w	11016	PF 1	300.00	823.32	826.13	826.13	826.66	0.007287	6.94	97.07	108.75	0.84
ottercrk-w	10950	PF 1	300.00	822.24	825.41	825.41	825.84	0.006669	6.27	111.09	158.66	0.77
ottercrk-w	10924		Culvert									
ottercrk-w	10900	PF 1	300.00	821.84	824.79	824.79	825.14	0.005178	6.74	157.26	194.15	0.72
ottercrk-w	10835	PF 1	300.00	821.09	824.19	824.19	824.64	0.005672	6.82	134.86	162.84	0.73
ottercrk-w	10743.8*	PF 1	300.00	820.65	823.62	823.62	824.06	0.005152	6.45	128.36	161.31	0.70
ottercrk-w	10652.6*	PF 1	300.00	820.21	823.00	823.00	823.47	0.005333	6.36	115.24	154.50	0.71
ottercrk-w	10561.5*	PF 1	300.00	819.77	822.40	822.40	822.88	0.005425	6.20	105.49	147.21	0.72
ottercrk-w	10470.3*	PF 1	300.00	819.32	821.77	821.77	822.28	0.005986	6.22	92.44	133.47	0.75
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ottercrk-w	10288	PF 1	400.00	818.44	821.00	820.84	821.43	0.004805	5.82	132.86	145.12	0.68

The water surface elevations at the upstream property boundary, for the existing and proposed conditions, match within 0.01 feet. About one foot of overtopping of the proposed driveway would occur during the 1% chance flood.

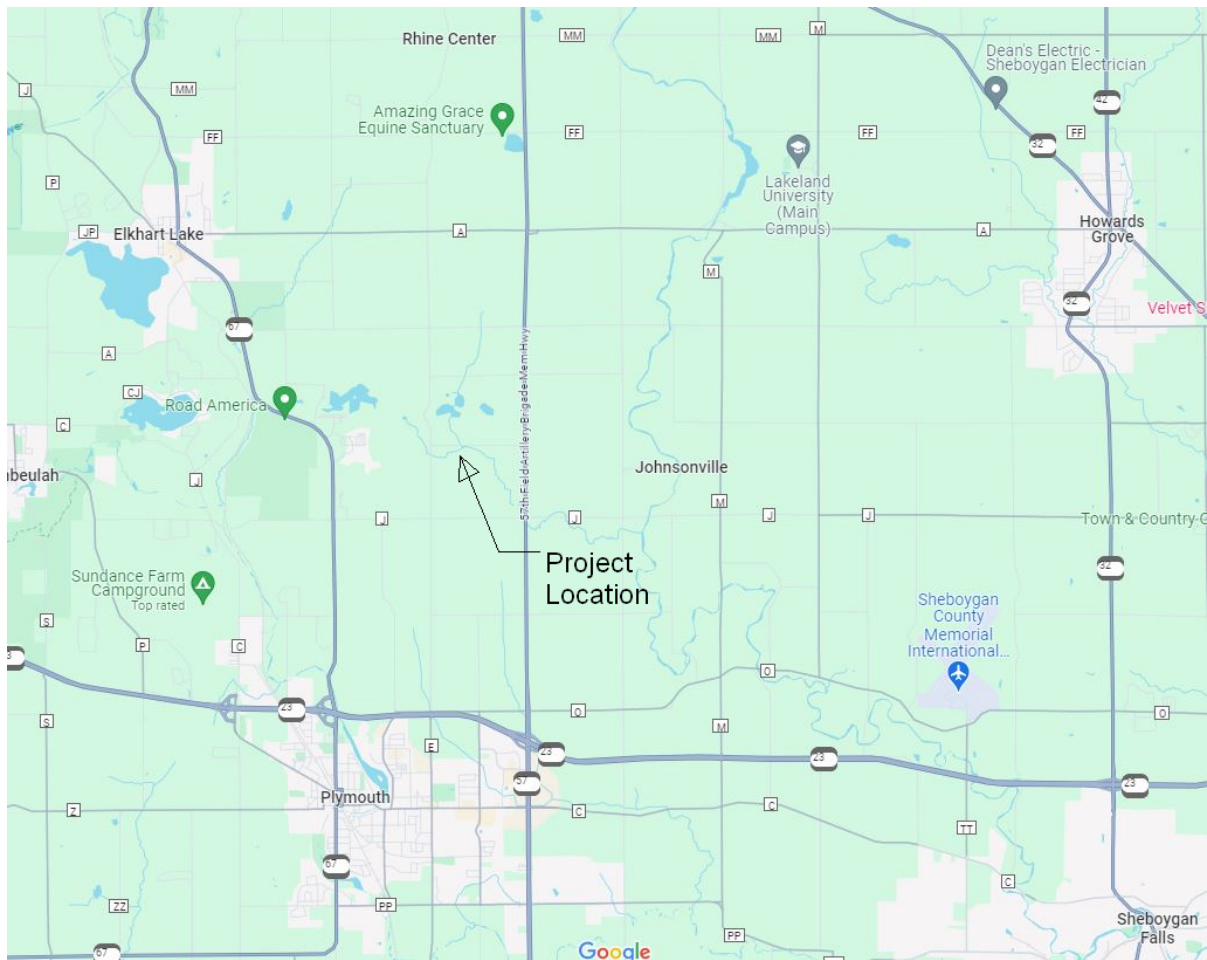


Figure 1. Site Location Map

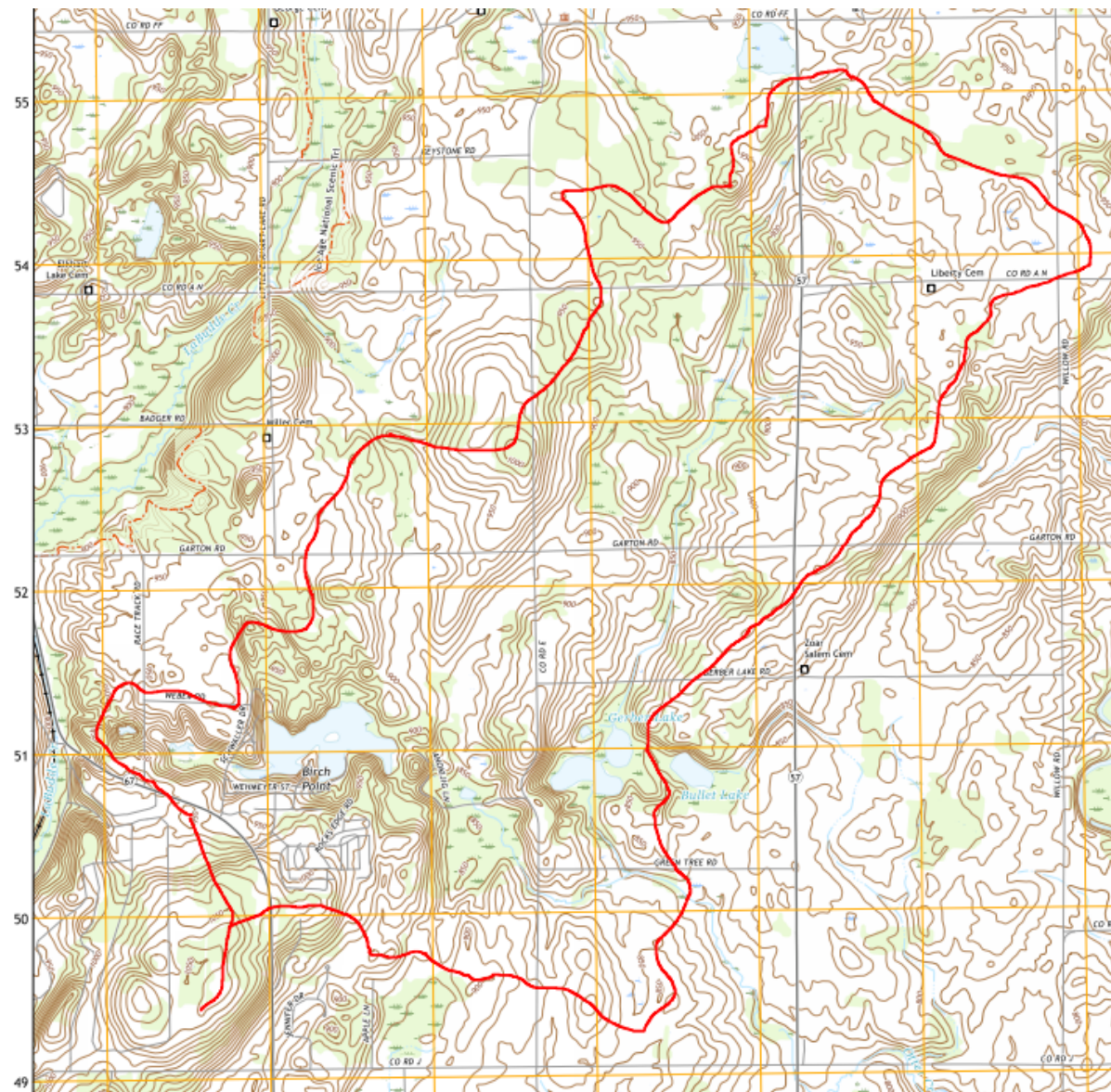


Figure 2. Otter Creek Basin

NSS Report

April 30, 2024 02:34PM

Study Area:

Wisconsin

Regression Region(s):

Wisconsin_Peakflow_Region_3_2022_5118

Peak-Flow Statistics

Wisconsin_Peakflow_Region_3_2022_5118 Region

Drainage Area = 4.845 (mi²)

LC01WATER = 0.74 (%)

Percent Wetlands = 9.63 (%)

[SEe, Standard Error of Estimate; SEp, Standard Error of Prediction; SE, Standard Error (other -- see report)]

Wisconsin_Peakflow_Region_3_2022_5118 Region	Value	90% Prediction Interval		Errors (%)
Description	(ft ³ /s)	Low	High	ASEp
Maximum instantaneous flow that occurs with a 1% annual exceedance probability (PK1AEP)	324	134	786	57.3931544 815749

Citations

Levin, Sara B., Sanocki, Chris A.
2022, Estimating Flood Magnitude and Frequency for Unregulated Streams in Wisconsin: U.S. Geological Survey Scientific Investigations Report 2022-5118, 25p.

Appendix

Equations

Wisconsin_Peakflow_Region_3_2022_5118	
PK1AEP =	$10^{2.3101+0.7573\cdot\log N(DRNAREA,10)-0.6300\cdot\log N((LC01WATER+1),10)-0.0174\cdot WETLAND}$

Explanatory Variable Definitions

Name	Abbrev	Description
Drainage Area	DRNAREA	Area that drains to a point on a stream
LC01WATER	LC01WATER	Percentage of open water, class 11, from NLCD 2001
Percent Wetlands	WETLAND	Percentage of Wetlands

Unit Types

Abbrev	Unit
(mi ²)	square miles
(%)	percent

NSS Report

April 30, 2024 02:34PM

Study Area:

Wisconsin

Regression Region(s):

Wisconsin_Peakflow_Region_3_2022_5118

Peak-Flow Statistics

Wisconsin_Peakflow_Region_3_2022_5118 Region

Drainage Area = 1.756 (mi²)

LC01WATER = 0.02 (%)

Percent Wetlands = 8.08 (%)

[SEe, Standard Error of Estimate; SEp, Standard Error of Prediction; SE, Standard Error (other -- see report)]

Wisconsin_Peakflow_Region_3_2022_5118 Region	Value	90% Prediction Interval		Errors (%)
Description	(ft ³ /s)	Low	High	ASEp
Maximum instantaneous flow that occurs with a 1% annual exceedance probability (PK1AEP)	223	91	546	57.3931544 815749

Citations

Levin, Sara B., Sanocki, Chris A.
2022, Estimating Flood Magnitude and Frequency for Unregulated Streams in Wisconsin: U.S. Geological Survey Scientific Investigations Report 2022-5118, 25p.

Appendix

Equations

Wisconsin_Peakflow_Region_3_2022_5118	
PK1AEP =	$10^{2.3101+0.7573\cdot\log N(DRNAREA,10)-0.6300\cdot\log N((LC01WATER+1),10)-0.0174\cdot WETLAND}$

Explanatory Variable Definitions

Name	Abbrev	Description
Drainage Area	DRNAREA	Area that drains to a point on a stream
LC01WATER	LC01WATER	Percentage of open water, class 11, from NLCD 2001
Percent Wetlands	WETLAND	Percentage of Wetlands

Unit Types

Abbrev	Unit
(mi ²)	square miles
(%)	percent



NOAA Atlas 14, Volume 8, Version 2
Location name: Plymouth, Wisconsin, USA*
Latitude: 43.8144°, Longitude: -87.9577°
Elevation: 909 ft**

* source: ESRI Maps

** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffrey Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerals](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.323 (0.259-0.404)	0.386 (0.309-0.482)	0.485 (0.388-0.607)	0.566 (0.450-0.710)	0.674 (0.518-0.856)	0.755 (0.570-0.966)	0.833 (0.612-1.08)	0.911 (0.645-1.20)	1.01 (0.693-1.35)	1.08 (0.729-1.47)
10-min	0.473 (0.380-0.591)	0.564 (0.452-0.706)	0.710 (0.568-0.889)	0.829 (0.659-1.04)	0.987 (0.759-1.25)	1.10 (0.834-1.42)	1.22 (0.896-1.58)	1.33 (0.945-1.76)	1.48 (1.02-1.98)	1.59 (1.07-2.15)
15-min	0.577 (0.463-0.721)	0.688 (0.552-0.860)	0.866 (0.692-1.08)	1.01 (0.804-1.27)	1.20 (0.925-1.53)	1.35 (1.02-1.73)	1.49 (1.09-1.93)	1.63 (1.15-2.14)	1.80 (1.24-2.41)	1.94 (1.30-2.62)
30-min	0.794 (0.637-0.992)	0.948 (0.760-1.18)	1.19 (0.954-1.49)	1.39 (1.11-1.75)	1.66 (1.27-2.10)	1.85 (1.40-2.37)	2.04 (1.50-2.65)	2.23 (1.58-2.94)	2.47 (1.69-3.30)	2.64 (1.78-3.58)
60-min	1.03 (0.827-1.29)	1.21 (0.973-1.52)	1.51 (1.21-1.89)	1.76 (1.40-2.21)	2.10 (1.62-2.67)	2.36 (1.78-3.02)	2.61 (1.92-3.40)	2.87 (2.04-3.79)	3.21 (2.20-4.30)	3.46 (2.33-4.69)
2-hr	1.27 (1.03-1.56)	1.48 (1.20-1.83)	1.83 (1.48-2.27)	2.13 (1.71-2.64)	2.54 (1.98-3.21)	2.86 (2.19-3.64)	3.18 (2.36-4.11)	3.51 (2.51-4.60)	3.95 (2.73-5.26)	4.28 (2.90-5.76)
3-hr	1.42 (1.16-1.74)	1.64 (1.34-2.02)	2.02 (1.64-2.49)	2.35 (1.90-2.90)	2.82 (2.22-3.55)	3.19 (2.46-4.05)	3.57 (2.67-4.60)	3.98 (2.87-5.20)	4.53 (3.15-6.02)	4.96 (3.37-6.64)
6-hr	1.69 (1.39-2.05)	1.94 (1.60-2.35)	2.38 (1.96-2.89)	2.78 (2.27-3.39)	3.38 (2.70-4.25)	3.87 (3.03-4.90)	4.40 (3.33-5.65)	4.97 (3.62-6.48)	5.77 (4.06-7.65)	6.42 (4.39-8.54)
12-hr	1.95 (1.63-2.34)	2.24 (1.87-2.69)	2.79 (2.32-3.35)	3.29 (2.72-3.96)	4.06 (3.30-5.09)	4.72 (3.74-5.94)	5.44 (4.16-6.94)	6.22 (4.58-8.07)	7.34 (5.21-9.68)	8.25 (5.68-10.9)
24-hr	2.22 (1.88-2.64)	2.56 (2.17-3.04)	3.20 (2.70-3.81)	3.81 (3.19-4.54)	4.76 (3.92-5.92)	5.58 (4.47-6.97)	6.48 (5.02-8.22)	7.47 (5.56-9.64)	8.91 (6.38-11.7)	10.1 (7.00-13.2)
2-day	2.55 (2.18-2.99)	2.91 (2.49-3.42)	3.60 (3.07-4.23)	4.27 (3.62-5.03)	5.34 (4.45-6.59)	6.27 (5.08-7.76)	7.29 (5.71-9.18)	8.44 (6.34-10.8)	10.1 (7.29-13.2)	11.5 (8.02-15.0)
3-day	2.81 (2.42-3.27)	3.17 (2.72-3.69)	3.86 (3.31-4.50)	4.54 (3.87-5.31)	5.63 (4.72-6.91)	6.58 (5.37-8.11)	7.65 (6.02-9.58)	8.83 (6.67-11.3)	10.6 (7.66-13.7)	12.0 (8.42-15.6)
4-day	3.02 (2.62-3.50)	3.39 (2.93-3.93)	4.10 (3.54-4.76)	4.80 (4.11-5.58)	5.90 (4.98-7.20)	6.88 (5.63-8.43)	7.96 (6.29-9.92)	9.16 (6.94-11.6)	10.9 (7.94-14.1)	12.4 (8.70-16.0)
7-day	3.54 (3.10-4.07)	3.99 (3.49-4.58)	4.81 (4.19-5.53)	5.59 (4.84-6.44)	6.78 (5.75-8.16)	7.82 (6.44-9.46)	8.94 (7.10-11.0)	10.2 (7.74-12.8)	11.9 (8.73-15.3)	13.4 (9.47-17.2)
10-day	4.02 (3.54-4.58)	4.53 (3.98-5.17)	5.45 (4.78-6.23)	6.29 (5.48-7.21)	7.56 (6.42-9.00)	8.62 (7.13-10.3)	9.77 (7.78-11.9)	11.0 (8.40-13.7)	12.8 (9.36-16.3)	14.2 (10.1-18.2)
20-day	5.45 (4.86-6.13)	6.10 (5.43-6.87)	7.22 (6.40-8.14)	8.18 (7.21-9.27)	9.57 (8.18-11.2)	10.7 (8.90-12.6)	11.9 (9.52-14.3)	13.1 (10.0-16.1)	14.8 (10.9-18.6)	16.1 (11.5-20.5)
30-day	6.70 (6.02-7.49)	7.48 (6.71-8.36)	8.76 (7.82-9.82)	9.83 (8.73-11.1)	11.3 (9.71-13.1)	12.5 (10.4-14.6)	13.7 (11.0-16.3)	14.9 (11.5-18.1)	16.5 (12.2-20.6)	17.7 (12.7-22.5)
45-day	8.35 (7.55-9.26)	9.30 (8.40-10.3)	10.8 (9.75-12.0)	12.1 (10.8-13.5)	13.7 (11.8-15.6)	15.0 (12.6-17.3)	16.2 (13.1-19.1)	17.4 (13.4-21.0)	18.9 (14.0-23.4)	20.0 (14.4-25.2)
60-day	9.79 (8.90-10.8)	10.9 (9.92-12.1)	12.7 (11.5-14.0)	14.1 (12.7-15.7)	15.9 (13.7-18.0)	17.2 (14.5-19.8)	18.5 (15.0-21.7)	19.7 (15.2-23.6)	21.1 (15.7-26.0)	22.1 (16.0-27.8)

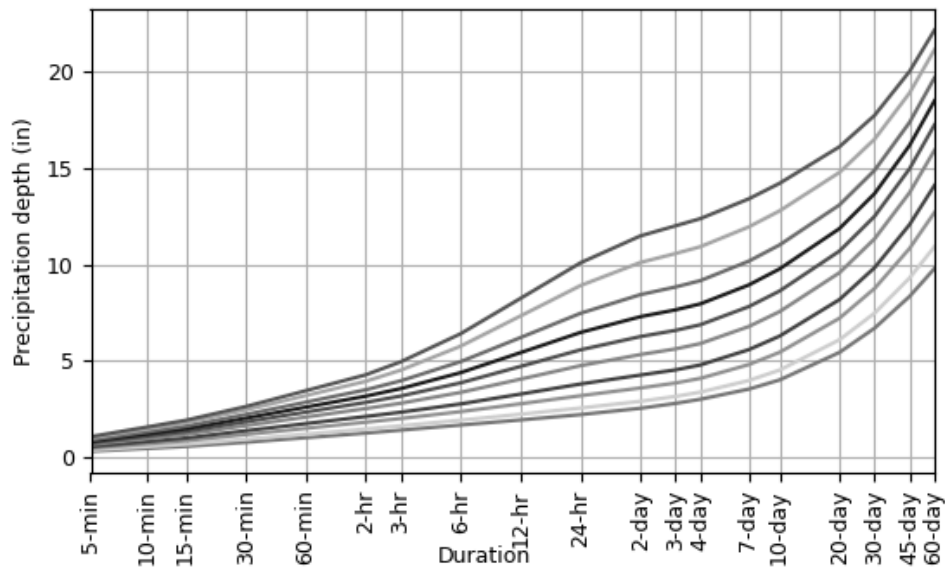
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.

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PF graphical

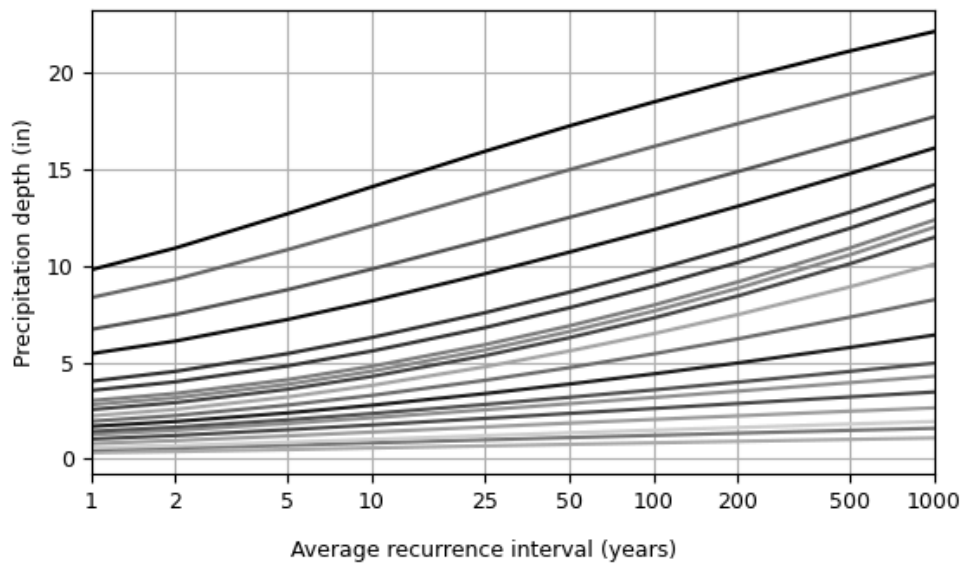
PDS-based depth-duration-frequency (DDF) curves

Latitude: 43.8144°, Longitude: -87.9577°



Average recurrence interval (years)

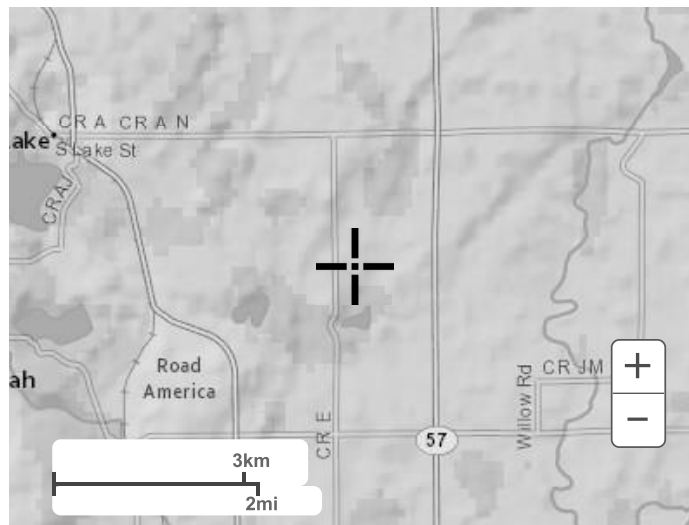
1
2
5
10
25
50
100
200
500
1000



Duration

5-min 2-day
10-min 3-day
15-min 4-day
30-min 7-day
60-min 10-day
2-hr 20-day
3-hr 30-day
6-hr 45-day
12-hr 60-day
24-hr

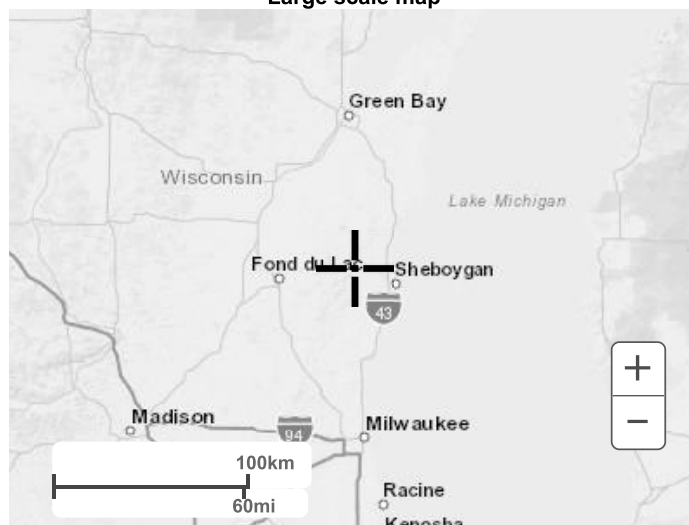
[Back to Top](#)**Maps & aeriels****Small scale terrain**



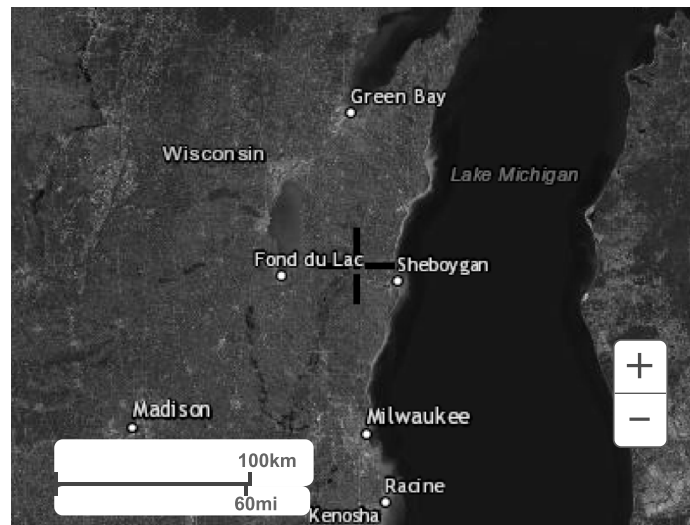
Large scale terrain



Large scale map



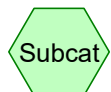
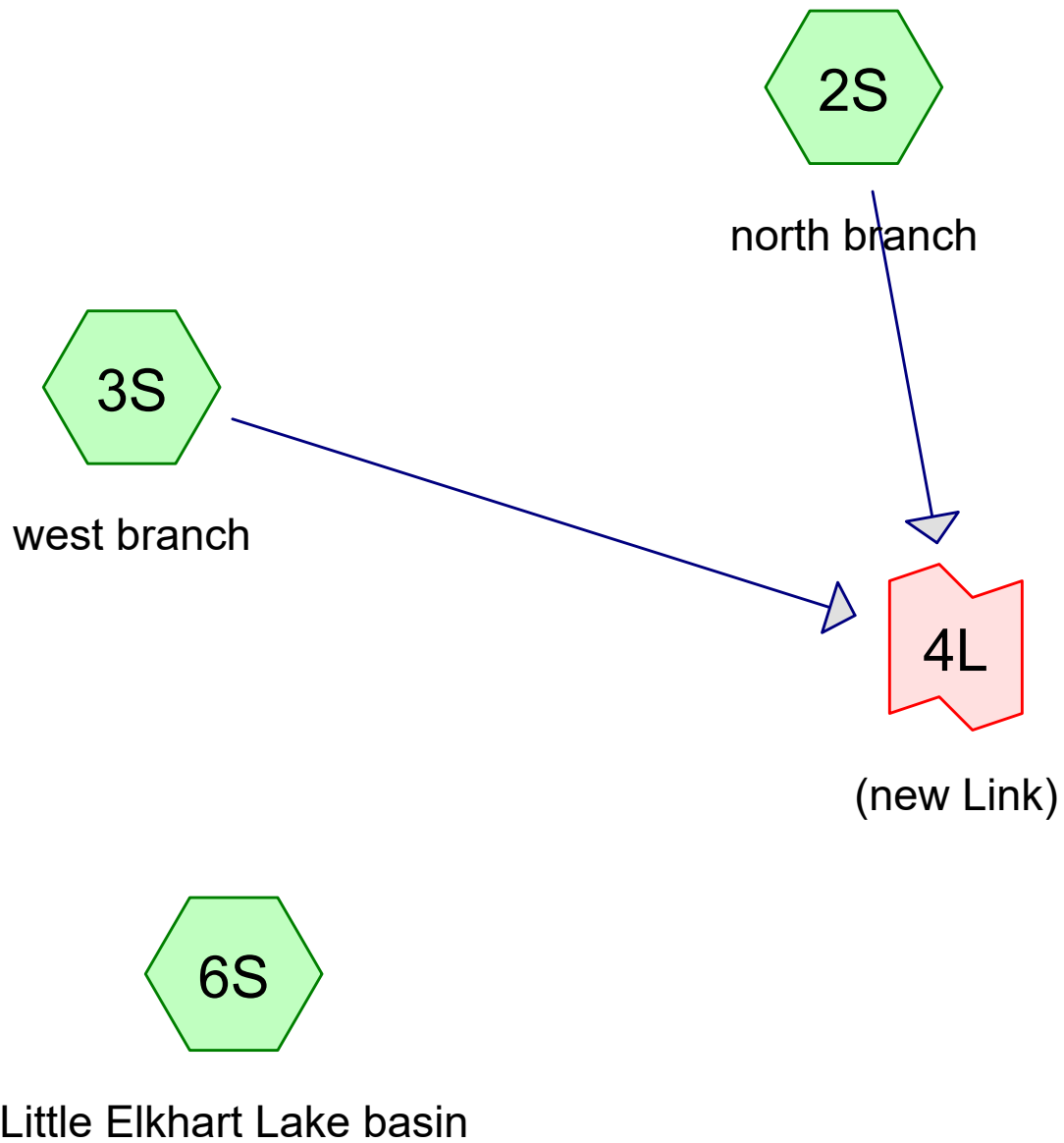
Large scale aerial



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[National Weather Service](#)
[National Water Center](#)
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

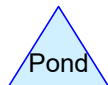
[Disclaimer](#)



Subcat



Reach



Pond



Link

Routing Diagram for otter3scs-wlcn

Prepared by Larson Engineering, Printed 5/7/2024

HydroCAD® 10.20-5a s/n 02642 © 2023 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.781	94	Barren Land (Rock/Sand/Clay) (2S, 3S)
9.341	58	Cultivated Crops (2S)
110.530	72	Cultivated Crops (2S, 3S, 6S)
296.897	80	Cultivated Crops (2S, 3S)
1,119.091	84	Cultivated Crops (2S, 3S, 6S)
0.667	30	Deciduous Forest (2S)
126.097	55	Deciduous Forest (2S, 3S, 6S)
38.697	70	Deciduous Forest (2S, 3S, 6S)
367.396	79	Deciduous Forest (2S, 3S, 6S)
1.334	83	Developed, High Intensity (2S, 3S)
7.562	87	Developed, High Intensity (2S, 3S, 6S)
1.334	75	Developed, High Intensity (6S)
1.779	51	Developed, Low Intensity (2S)
35.582	68	Developed, Low Intensity (2S, 3S, 6S)
34.249	79	Developed, Low Intensity (2S, 3S, 6S)
108.306	84	Developed, Low Intensity (2S, 3S, 6S)
10.675	70	Developed, Medium Intensity (2S, 3S, 6S)
5.115	80	Developed, Medium Intensity (2S, 3S, 6S)
30.691	85	Developed, Medium Intensity (2S, 3S, 6S)
1.557	49	Developed, Open Space (2S, 3S)
32.025	69	Developed, Open Space (2S, 3S, 6S)
17.346	79	Developed, Open Space (2S, 3S, 6S)
68.942	84	Developed, Open Space (2S, 3S, 6S)
60.936	30	Emergent Herbaceous Wetlands (2S, 3S)
1.112	55	Emergent Herbaceous Wetlands (6S)
12.232	77	Emergent Herbaceous Wetlands (6S)
0.667	70	Evergreen Forest (2S)
14.678	79	Evergreen Forest (2S, 3S)
4.892	55	Evergreen Forest (3S, 6S)
0.667	84	Grassland/Herbaceous (2S, 6S)
1.334	61	Grassland/Herbaceous (6S)
1.779	30	Mixed Forest (2S)
48.704	55	Mixed Forest (2S, 3S, 6S)
14.234	70	Mixed Forest (2S, 3S, 6S)
142.110	79	Mixed Forest (2S, 3S, 6S)
67.830	98	Open Water (2S, 3S, 6S)
9.785	49	Pasture/Hay (2S)
123.207	61	Pasture/Hay (2S, 3S, 6S)
64.272	79	Pasture/Hay (2S, 3S, 6S)
439.230	84	Pasture/Hay (2S, 3S, 6S)
0.222	70	Shrub/Scrub (2S)

Area Listing (all nodes) (continued)

Area (acres)	CN	Description (subcatchment-numbers)
2.002	77	Shrub/Scrub (2S)
3.558	56	Shrub/Scrub (6S)
237.518	30	Woody Wetlands (2S, 3S)
10.008	55	Woody Wetlands (6S)
14.900	79	Woody Wetlands (6S)
3,704.871	75	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	
3,704.871	Other	2S, 3S, 6S
3,704.871		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	3.781	3.781	Barren Land (Rock/Sand/Clay)	2 S , 3 S
0.000	0.000	0.000	0.000	1,535.859	1,535.859	Cultivated Crops	2 S , 3 S , 6 S
0.000	0.000	0.000	0.000	532.857	532.857	Deciduous Forest	2 S , 3 S , 6 S
0.000	0.000	0.000	0.000	10.230	10.230	Developed, High Intensity	2 S , 3 S , 6 S
0.000	0.000	0.000	0.000	179.916	179.916	Developed, Low Intensity	2 S , 3 S , 6 S
0.000	0.000	0.000	0.000	46.481	46.481	Developed, Medium Intensity	2 S , 3 S , 6 S

Ground Covers (all nodes) (continued)

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	119.870	119.870	Developed, Open Space	2 S , 3 S , 6 S
0.000	0.000	0.000	0.000	74.280	74.280	Emergent Herbaceous Wetlands	2 S , 3 S , 6 S
0.000	0.000	0.000	0.000	20.237	20.237	Evergreen Forest	2 S , 3 S , 6 S
0.000	0.000	0.000	0.000	2.001	2.001	Grassland/Herbaceous	2 S , 6 S
0.000	0.000	0.000	0.000	206.827	206.827	Mixed Forest	2 S , 3 S , 6 S
0.000	0.000	0.000	0.000	67.830	67.830	Open Water	2 S , 3 S , 6 S

Ground Covers (all nodes) (continued)

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	636.494	636.494	Pasture/Hay	2 S , 3 S , 6 S
0.000	0.000	0.000	0.000	5.782	5.782	Shrub/Scrub	2 S , 6 S
0.000	0.000	0.000	0.000	262.426	262.426	Woody Wetlands	2 S , 3 S , 6 S
0.000	0.000	0.000	0.000	3,704.871	3,704.871	TOTAL AREA	

Time span=5.00-25.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment2S: north branch Runoff Area=1,977.087 ac 1.15% Impervious Runoff Depth>2.65"
Flow Length=22,300' Tc=595.0 min CN=75 Runoff=646.02 cfs 436.056 af

Subcatchment3S: west branch Runoff Area=1,124.207 ac 0.02% Impervious Runoff Depth>3.65"
Flow Length=13,300' Tc=281.3 min CN=77 Runoff=709.76 cfs 342.098 af

Subcatchment6S: Little Elkhart Lake Runoff Area=603.577 ac 7.44% Impervious Runoff Depth>3.27"
Flow Length=3,000' Tc=82.3 min CN=71 Runoff=828.99 cfs 164.409 af

Link 4L: (new Link) Inflow=1,034.84 cfs 778.154 af
Primary=1,034.84 cfs 778.154 af

Total Runoff Area = 3,704.871 ac Runoff Volume = 942.563 af Average Runoff Depth = 3.05"
98.17% Pervious = 3,637.041 ac 1.83% Impervious = 67.830 ac

Summary for Subcatchment 2S: north branch

[47] Hint: Peak is 5477% of capacity of segment #3

[47] Hint: Peak is 8952% of capacity of segment #4

Runoff = 646.02 cfs @ 19.83 hrs, Volume= 436.056 af, Depth> 2.65"
Routed to Link 4L : (new Link)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 Rainfall=6.48"

otter3scs-wlcn

Type II 24-hr 100 Rainfall=6.48"

Prepared by Larson Engineering

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	Area (ac)	CN	Description
*	0.000	98	Open Water
*	1.112	49	Developed, Open Space
*	1.779	51	Developed, Low Intensity
*	0.000	54	Developed, Medium Intensity
*	0.000	61	Developed, High Intensity
*	0.667	30	Deciduous Forest
*	0.000	30	Evergreen Forest
*	1.779	30	Mixed Forest
*	0.000	35	Shrub/Scrub
*	0.000	39	Grassland/Herbaceous
*	9.785	49	Pasture/Hay
*	9.341	58	Cultivated Crops
*	0.000	30	Woody Wetlands
*	0.222	30	Emergent Herbaceous Wetlands
*	0.000	98	Open Water
*	1.334	69	Developed, Open Space
*	2.446	68	Developed, Low Intensity
*	0.445	70	Developed, Medium Intensity
*	0.000	75	Developed, High Intensity
*	25.353	55	Deciduous Forest
*	0.000	55	Evergreen Forest
*	6.449	55	Mixed Forest
*	0.000	56	Shrub/Scrub
*	0.000	61	Grassland/Herbaceous
*	13.788	61	Pasture/Hay
*	45.591	72	Cultivated Crops
*	2.446	30	Woody Wetlands
*	0.890	30	Emergent Herbaceous Wetlands
*	0.000	98	Open Water
*	7.561	79	Developed, Open Space
*	19.793	79	Developed, Low Intensity
*	3.558	80	Developed, Medium Intensity
*	0.667	83	Developed, High Intensity
*	27.799	70	Deciduous Forest
*	0.667	70	Evergreen Forest
*	12.899	70	Mixed Forest
*	0.222	70	Shrub/Scrub
*	0.000	79	Grassland/Herbaceous
*	38.919	79	Pasture/Hay
*	237.073	80	Cultivated Crops
*	5.560	30	Woody Wetlands
*	0.222	30	Emergent Herbaceous Wetlands
*	22.684	98	Open Water
*	27.132	84	Developed, Open Space
*	42.477	84	Developed, Low Intensity
*	8.229	85	Developed, Medium Intensity
*	3.336	87	Developed, High Intensity
*	2.669	94	Barren Land (Rock/Sand/Clay)
*	213.499	79	Deciduous Forest
*	13.121	79	Evergreen Forest
*	77.171	79	Mixed Forest

otter3scs-wlcn

Prepared by Larson Engineering

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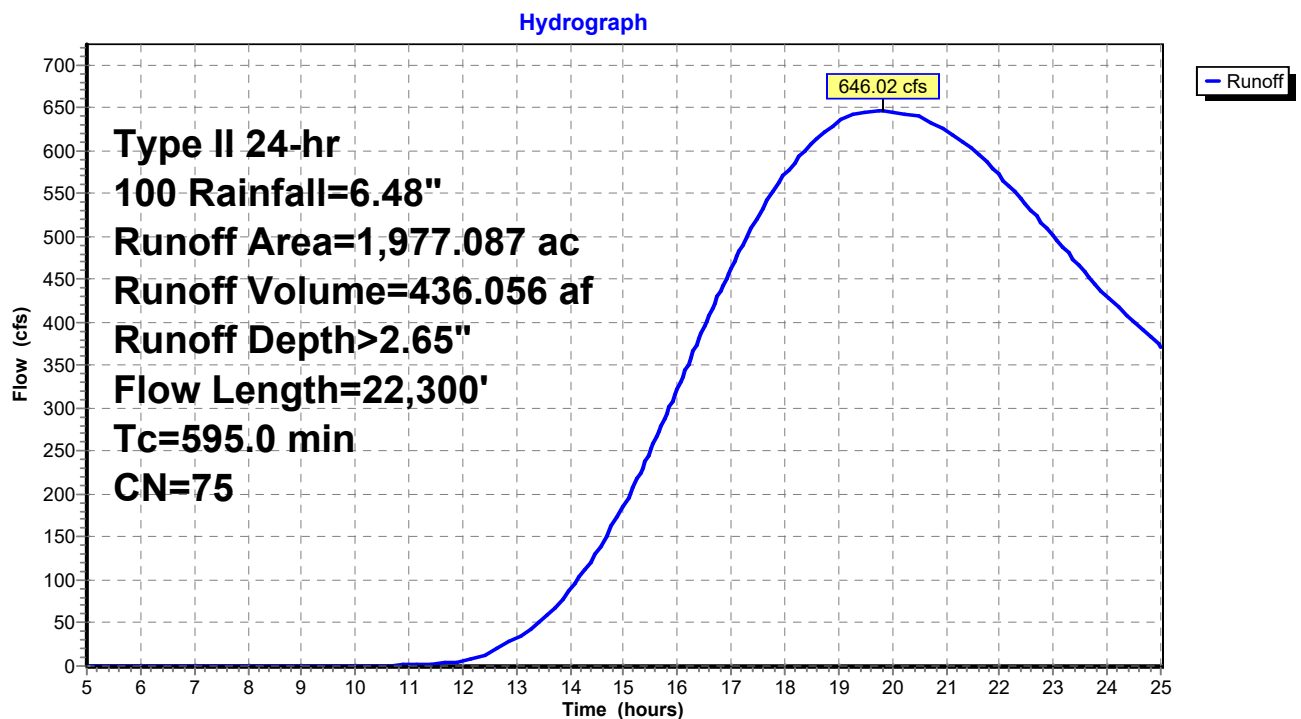
Type II 24-hr 100 Rainfall=6.48"

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*	2.002	77	Shrub/Scrub
*	0.445	84	Grassland/Herbaceous
*	227.510	84	Pasture/Hay
*	660.068	84	Cultivated Crops
*	161.459	30	Woody Wetlands
*	36.918	30	Emergent Herbaceous Wetlands
	1,977.087	75	Weighted Average
	1,954.403		98.85% Pervious Area
	22.684		1.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
121.5	300	0.0125	0.04		Sheet Flow, Woods: Dense underbrush n= 0.800 P2= 2.56"
33.3	1,000	0.0100	0.50		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
70.7	5,000	0.0100	1.18	11.79	Channel Flow, Area= 10.0 sf Perim= 40.0' r= 0.25' n= 0.050 Scattered brush, heavy weeds
369.5	16,000	0.0050	0.72	7.22	Channel Flow, Area= 10.0 sf Perim= 30.0' r= 0.33' n= 0.070 Sluggish weedy reaches w/pools
595.0	22,300	Total			

Subcatchment 2S: north branch

Summary for Subcatchment 3S: west branch

[47] Hint: Peak is 6018% of capacity of segment #3

[47] Hint: Peak is 1511% of capacity of segment #4

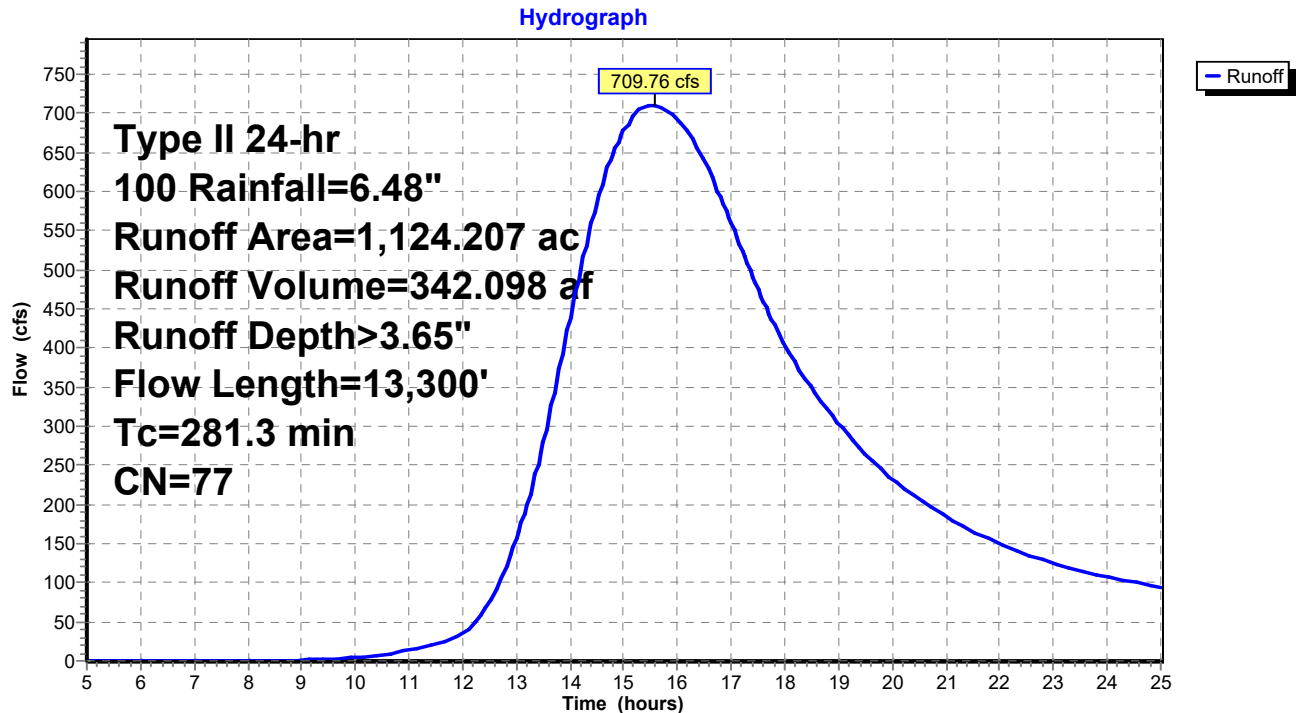
Runoff = 709.76 cfs @ 15.58 hrs, Volume= 342.098 af, Depth> 3.65"
Routed to Link 4L : (new Link)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 Rainfall=6.48"

Area (ac)	CN	Description
* 0.445	49	Developed, Open Space
* 2.002	69	Developed, Open Space
* 2.446	68	Developed, Low Intensity
* 0.445	70	Developed, Medium Intensity
* 7.561	55	Deciduous Forest
* 1.334	55	Evergreen Forest
* 7.117	55	Mixed Forest
* 20.016	61	Pasture/Hay
* 20.905	72	Cultivated Crops
* 0.890	30	Woody Wetlands
* 0.445	30	Emergent Herbaceous Wetlands
* 4.448	79	Developed, Open Space
* 10.230	79	Developed, Low Intensity
* 0.445	80	Developed, Medium Intensity
* 0.667	83	Developed, High Intensity
* 10.453	70	Deciduous Forest
* 0.445	70	Mixed Forest
* 21.795	79	Pasture/Hay
* 59.824	80	Cultivated Crops
* 1.334	30	Emergent Herbaceous Wetlands
* 0.222	98	Open Water
* 26.020	84	Developed, Open Space
* 51.596	84	Developed, Low Intensity
* 12.009	85	Developed, Medium Intensity
* 1.112	87	Developed, High Intensity
* 1.112	94	Barren Land (Rock/Sand/Clay)
* 86.956	79	Deciduous Forest
* 1.557	79	Evergreen Forest
* 33.359	79	Mixed Forest
* 193.484	84	Pasture/Hay
* 455.465	84	Cultivated Crops
* 67.163	30	Woody Wetlands
* 20.905	30	Emergent Herbaceous Wetlands
1,124.207	77	Weighted Average
1,123.985		99.98% Pervious Area
0.222		0.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
47.3	300	0.0330	0.11		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 2.56"
44.5	1,000	0.0056	0.37		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
91.9	6,500	0.0100	1.18	11.79	Channel Flow, Area= 10.0 sf Perim= 40.0' r= 0.25' n= 0.050 Scattered brush, heavy weeds
97.6	5,500	0.0070	0.94	46.97	Channel Flow, Area= 50.0 sf Perim= 130.0' r= 0.38' n= 0.070 Sluggish weedy reaches w/pools
281.3	13,300	Total			

Subcatchment 3S: west branch



Summary for Subcatchment 6S: Little Elkhart Lake basin

[47] Hint: Peak is 3514% of capacity of segment #3

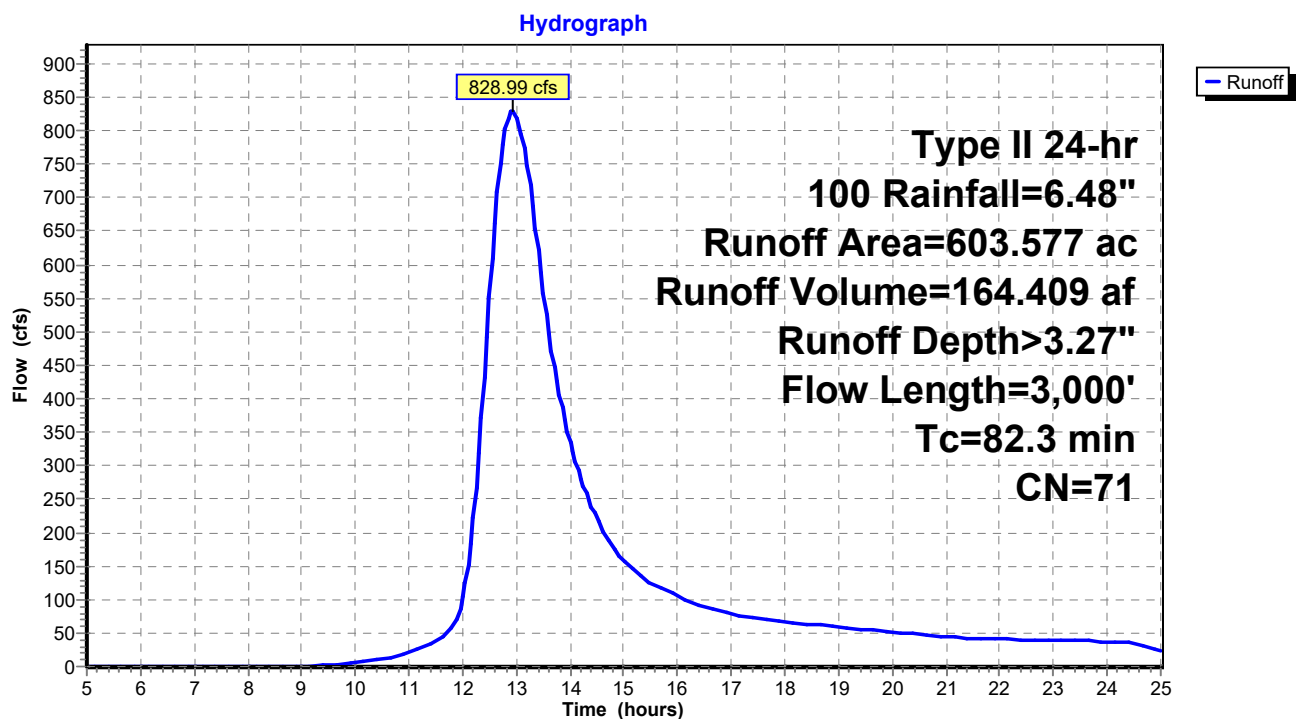
Runoff = 828.99 cfs @ 12.92 hrs, Volume= 164.409 af, Depth> 3.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs
Type II 24-hr 100 Rainfall=6.48"

Area (ac)	CN	Description
* 1.779	98	Open Water
* 28.689	69	Developed, Open Space
* 30.690	68	Developed, Low Intensity
* 9.785	70	Developed, Medium Intensity
* 1.334	75	Developed, High Intensity
* 93.183	55	Deciduous Forest
* 3.558	55	Evergreen Forest
* 35.138	55	Mixed Forest
* 3.558	56	Shrub/Scrub
* 1.334	61	Grassland/Herbaceous
* 89.403	61	Pasture/Hay
* 44.034	72	Cultivated Crops
* 10.008	55	Woody Wetlands
* 1.112	55	Emergent Herbaceous Wetlands
* 5.337	79	Developed, Open Space
* 4.226	79	Developed, Low Intensity
* 1.112	80	Developed, Medium Intensity
* 0.445	70	Deciduous Forest
* 0.890	70	Mixed Forest
* 3.558	79	Pasture/Hay
* 43.145	98	Open Water
* 15.790	84	Developed, Open Space
* 14.233	84	Developed, Low Intensity
* 10.453	85	Developed, Medium Intensity
* 3.114	87	Developed, High Intensity
* 66.941	79	Deciduous Forest
* 31.580	79	Mixed Forest
* 0.222	84	Grassland/Herbaceous
* 18.236	84	Pasture/Hay
* 3.558	84	Cultivated Crops
* 14.900	79	Woody Wetlands
* 12.232	77	Emergent Herbaceous Wetlands
603.577	71	Weighted Average
558.653		92.56% Pervious Area
44.924		7.44% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
49.2	300	0.0300	0.10		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 2.56"
21.1	1,000	0.0250	0.79		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
12.0	1,700	0.0400	2.36	23.59	Channel Flow, Area= 10.0 sf Perim= 40.0' r= 0.25' n= 0.050 Scattered brush, heavy weeds
82.3	3,000	Total			

Subcatchment 6S: Little Elkhart Lake basin



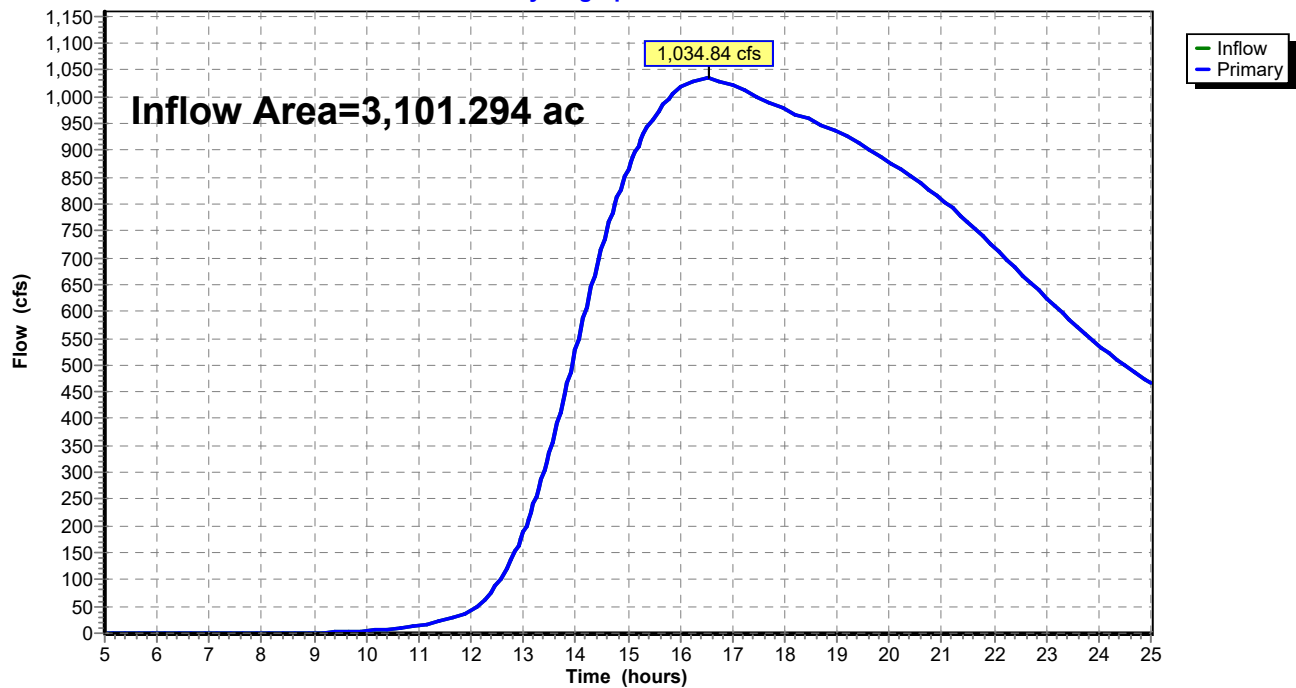
Summary for Link 4L: (new Link)

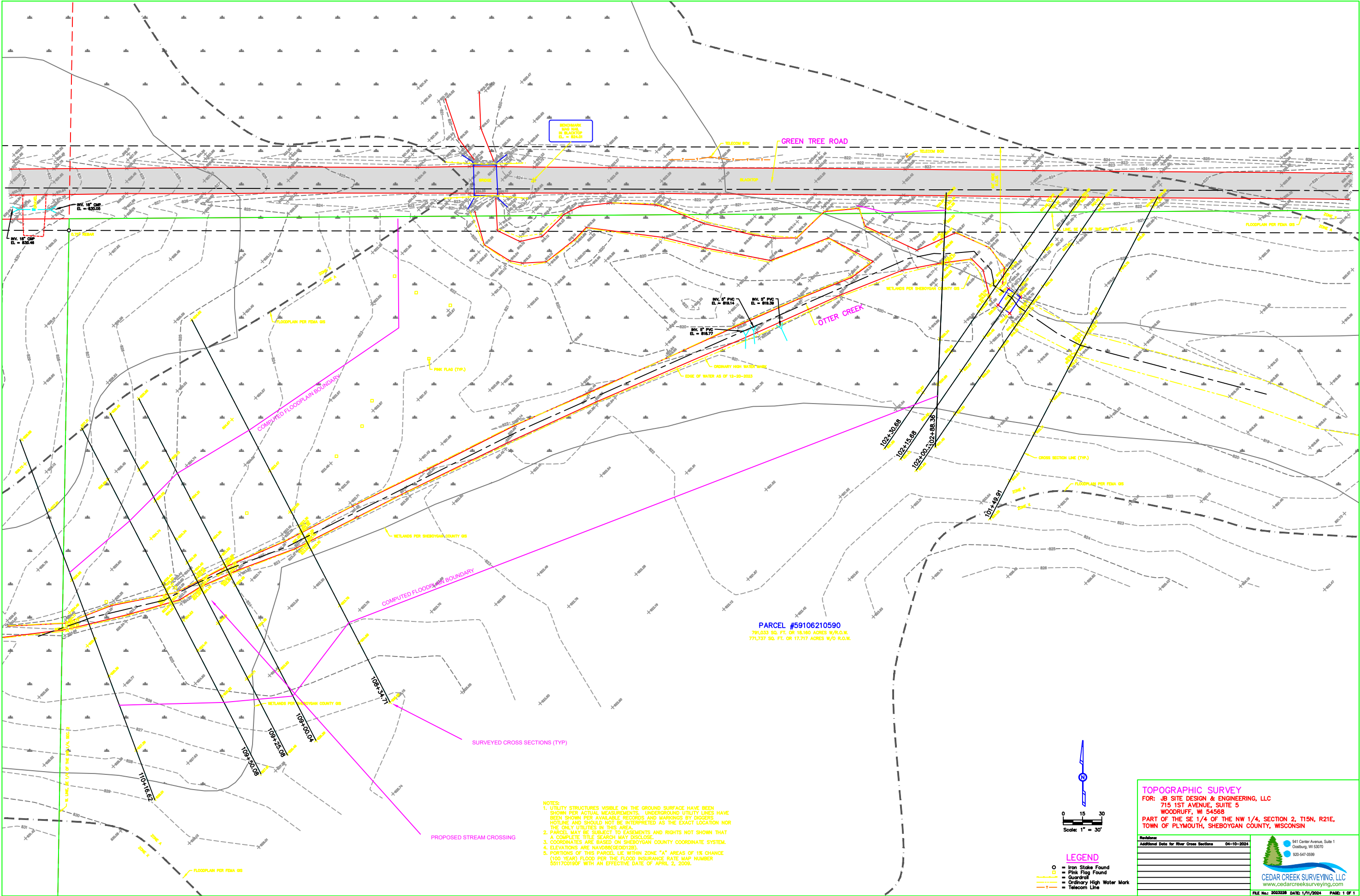
Inflow Area = 3,101.294 ac, 0.74% Impervious, Inflow Depth > 3.01" for 100 event
 Inflow = 1,034.84 cfs @ 16.55 hrs, Volume= 778.154 af
 Primary = 1,034.84 cfs @ 16.55 hrs, Volume= 778.154 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-25.00 hrs, dt= 0.05 hrs

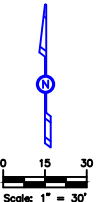
Link 4L: (new Link)

Hydrograph





NOTES:
1. UTILITY STRUCTURES VISIBLE ON THE GROUND SURFACE HAVE BEEN SHOWN PER ACTUAL MEASUREMENTS. UNDERGROUND UTILITY LINES HAVE BEEN SHOWN PER AVAILABLE RECORDS AND MARKINGS BY DIGGERS HOTLINE AND SHOULD NOT BE INTERPRETED AS THE EXACT LOCATION NOR THE ONLY UTILITIES IN THIS AREA.
2. PARCEL MAY BE SUBJECT TO EASEMENTS AND RIGHTS NOT SHOWN THAT A COMPLETE TITLE SEARCH MAY DISCLOSE.
3. COORDINATES ARE BASED ON SHEBOYGAN COUNTY COORDINATE SYSTEM.
4. ELEVATIONS ARE NAVD83(GEOD12B).
5. PORTIONS OF THIS PARCEL LIE WITHIN ZONE "A" AREAS OF 1% CHANCE (100 YEAR) FLOOD PER THE FLOOD INSURANCE RATE MAP NUMBER 551700190P WITH AN EFFECTIVE DATE OF APRIL 2, 2009.



LEGEND

- Iron Stake Found
- Pink Flag Found
- Guardrail
- Ordinary High Water Mark
- Telecom Line

TOPOGRAPHIC SURVEY
FOR: JB SITE DESIGN & ENGINEERING, LLC
715 1ST AVENUE, SUITE 5
WOODRUFF, WI 54568
PART OF THE SE 1/4 OF THE NW 1/4, SECTION 2, T15N, R21E,
TOWN OF PLYMOUTH, SHEBOYGAN COUNTY, WISCONSIN

Revisions:
Additional Data for River Cross Sections 04-10-2024

941 Center Avenue, Suite 1
Oostburg, WI 53070
920-547-0599
CEDAR CREEK SURVEYING, LLC
www.cedarcreeksurveying.com
FILE No.: 2023228 DATE: 1/11/2024 PAGE: 1 OF 1