ERI-US 0006 Connectivity Corridor
US 6 over Boo's Ditch Culvert Extension
ERI 0006 STA 1754+37.79

July 2025

Structure Hydraulics Report

Prepared for:

Ohio Department of Transportation
District 3
906 Clark Avenue
Ashland, OH 44805

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Project Number P403220071

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Hydraulic Narrative

Project Description

TranSystems is providing engineering services to the Ohio Department of Transportation, District 3 to increase the efficiency of the US Route 6 transportation corridor, increase safety, and improve multi-modal transportation options. The downstream side of the culvert carrying US Route 6 over Boos Ditch (CFN 1832187) will be extended to accommodate the construction of a shared-use path adjacent to the vehicular bridge. The purpose of this hydraulic report is to determine the impacts of the proposed improvements on the water surface elevations of Boos Ditch.

Existing Conditions

The existing structure (CFN 1832187) carries two lanes of US 6 eastbound and westbound traffic over Boos Ditch. The existing structure consists of an 8'-0 x 6'-0" reinforced concrete box culvert. The existing culvert length is approximately 81.4'.

At the bridge site, Boos Ditch is approximately 30' wide from top of bank to top of bank. In the project area and immediately upstream and downstream, the banks and overbanks consist of brush, trees and overgrowth. Downstream of the structure, the stream meanders through the Sheldon Marsh Nature Preserve and discharges to Lake Erie approximately 1 mile north of the bridge location.

Proposed Conditions

The purpose of the project is to construct a new shared-use path adjacent to the downstream side of the existing US 6 roadway. To accommodate the embankment necessary for this construction, the culvert will be extended on the downstream side by approximately 3.6' and a new headwall will be constructed. The total length of the culvert will be 85'.

Design Criteria

The proposed crossing is Federal Emergency Management Agency (FEMA) Zone X. There is a regulated floodplain downstream of the proposed crossing. The regulated floodplain is discussed in the FEMA Flood Insurance Study (FIS) for Erie County and Incorporated Areas, FIS number 39043CV000C, revised September 1, 2022. Portions of the FIS, the Flood Insurance Rate Map (FIRM), Discharges, Roughness Coefficients, Floodway Data and Flood Profile are included in Section II of this report. The hydraulic study done on Boos Ditch as part of the Flood Insurance Study was completed in 1979.

Neither the existing culvert nor the additional lengthened portion of the culvert are within the designated floodway discussed in the FIS. Efforts will still be made to ensure the proposed culvert will not increase the 100-year water surface elevation.

Hydrologic Analysis

Despite the US 6 structure being outside of the limit of study for the FEMA FIS, the drainage area published in the report is approximately equal to that of the drainage area determined using the USGS web application StreamStats. For compatibility with the FIS, the flows for the 10-year, 50-year, 100-year, and 500-year storms were taken from the FIS Discharge Summary

Table. The flows for the remaining design storms were taken from the StreamStats output, which can be found in Section III of this report.

To analyze a potential temporary construction condition, the Standard Temporary Discharge (STD) was also determined using StreamStats. The STD flow is defined as two times the maximum monthly flow. The STD flow is 7 cfs.

Hydraulic Analysis

The hydraulic analysis for the existing culvert and the proposed lengthened culvert were performed using the FHWA's HY-8 program, Version 7.50. The existing culvert size and slope used for the analysis was taken from existing survey data. The proposed culvert has the same opening size and follows the same slope, and the additional proposed length was added to the model. The tailwater channel data was determined in HY-8 using a trapezoidal channel and the downstream channel slope.

The following tables compare the results between the existing and proposed condition for the headwater (upstream of the culvert) and the tailwater (downstream of the culvert.) There is no change in the elevation or velocity at the headwater or tailwater under the proposed condition. The output of HY-8 for the existing and proposed conditions can be found, respectively, in Appendices A and B.

Table 1: Headwater Hydraulic Results

		Existing Conditions	Proposed Conditions	Difference
Design Storm	Flow (cfs)	Elevation (ft)	Elevation (ft)	(ft)
10-Year	269.00	587.05	587.05	0.0
25-Year	341.00	588.06	588.06	0.0
50-Year	412.00	589.11	589.11	0.0
100-Year	478.00	590.17	590.17	0.0
500-Year	583.00	592.12	592.12	0.0

Table 2: Tailwater Hydraulic Results

		Existing Conditions		Proposed Conditions		Difference	
Design Storm	Flow (cfs)	Elevation (ft)	Velocity (ft/s)	Elevation (ft)	Velocity (ft/s)	Velocity (ft/s)	Elevation (ft)
10-Year	269.00	582.14	7.93	582.14	7.93	0.00	0.00
25-Year	341.00	582.43	8.51	582.43	8.51	0.00	0.00
50-Year	412.00	582.70	9.00	582.70	9.00	0.00	0.00
100-Year	478.00	582.92	9.39	582.92	9.39	0.00	0.00
500-Year	583.00	583.24	9.94	583.24	9.94	0.00	0.00

Flood Hazard Evaluation

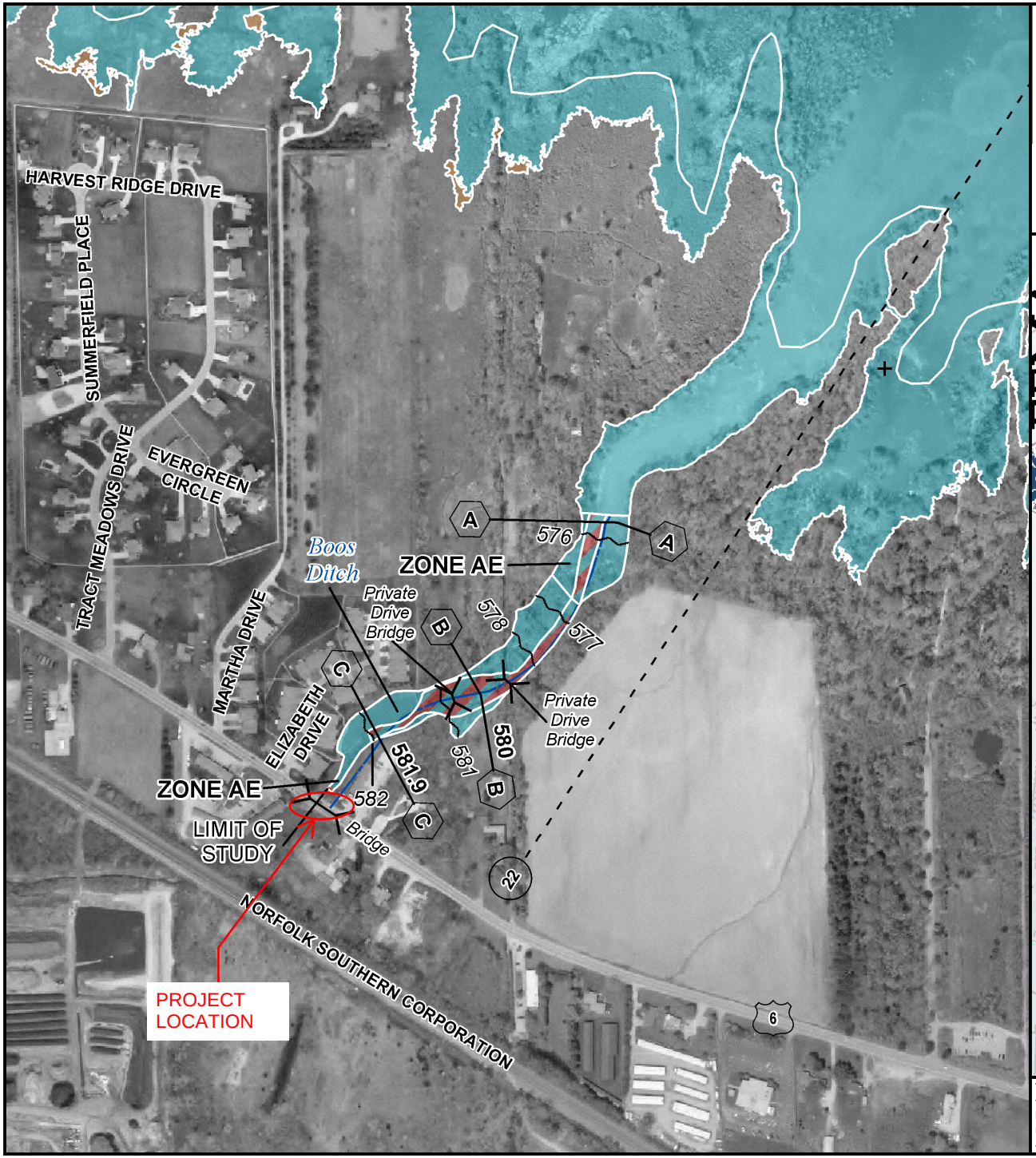
The hydraulic modeling of the existing and proposed conditions indicates that the modifications associated with the extension of the Boos Ditch Culvert will not have an adverse effect on the regulatory 100-year water surface elevations or the 25-year water surface elevations within the study area.

Temporary Conditions

The proposed construction will not required a temporary access fill (TAF) across Boos Ditch. The project site can be accessed by the existing US 6 roadway. The low STD flow can be pumped through the construction area and no temporary hydraulic analysis is required.

SECTION II

FIRM MAPS AND FIS DATA



NAD 1983 StatePlane Ohio North FIPS 3401 Feet; Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet

0 500 1,000

FEMA

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

ERIE COUNTY, OHIO
and Incorporated Areas

PANEL 111 OF 290

FEMA

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
ERIE COUNTY	390153	0111	E
SANDUSKY, CITY OF	390156	0111	E

VERSION NUMBER
2.3.3.5

MAP NUMBER
39043C0111E

MAP REVISED

This is an official FIRMette showing a portion of the above-referenced flood map created from the MSC FIRMette Web tool. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For additional information about how to make sure the map is current, please see the Flood Hazard Mapping Updates Overview Fact Sheet available on the FEMA Flood Map Service Center home page at https://msc.fema.gov.

FLOOD INSURANCE STUDY

FEDERAL EMERGENCY MANAGEMENT AGENCY

VOLUME 1 OF 1

ERIE COUNTY, OHIO

AND INCORPORATED AREAS

COMMUNITY NAME	COMMUNITY NUMBER
BAY VIEW, VILLAGE OF	**390595**
(1) BELLEVUE, CITY OF	**390487**
BERLIN HEIGHTS, VILLAGE OF	**390650**
***CASTALIA, VILLAGE OF**	**390653**
ERIE COUNTY, UNINCORPORATED AREAS	**390153**
HURON, CITY OF	**390154**
KELLEYS ISLAND, VILLAGE OF	**390738**
(2) MILAN, VILLAGE OF	**390155**
SANDUSKY, CITY OF	**390156**
(3) VERMILION, CITY OF	**395374**

*No Special Flood Hazard Areas Identified

(1) The City of Bellevue is a tri-county community located in Erie, Huron, and Sandusky Counties. It is not included in the Erie FIS Report and will be mapped with Huron County.

(2) The Village of Milan is a dual county community located in Erie and Huron Counties. Information for the entire community is included in the Erie County FIS report.

(3) The City of Vermilion is located in Erie and Lorain Counties.The entire community will be mapped with Lorain County. See Lorain County FIS Report.

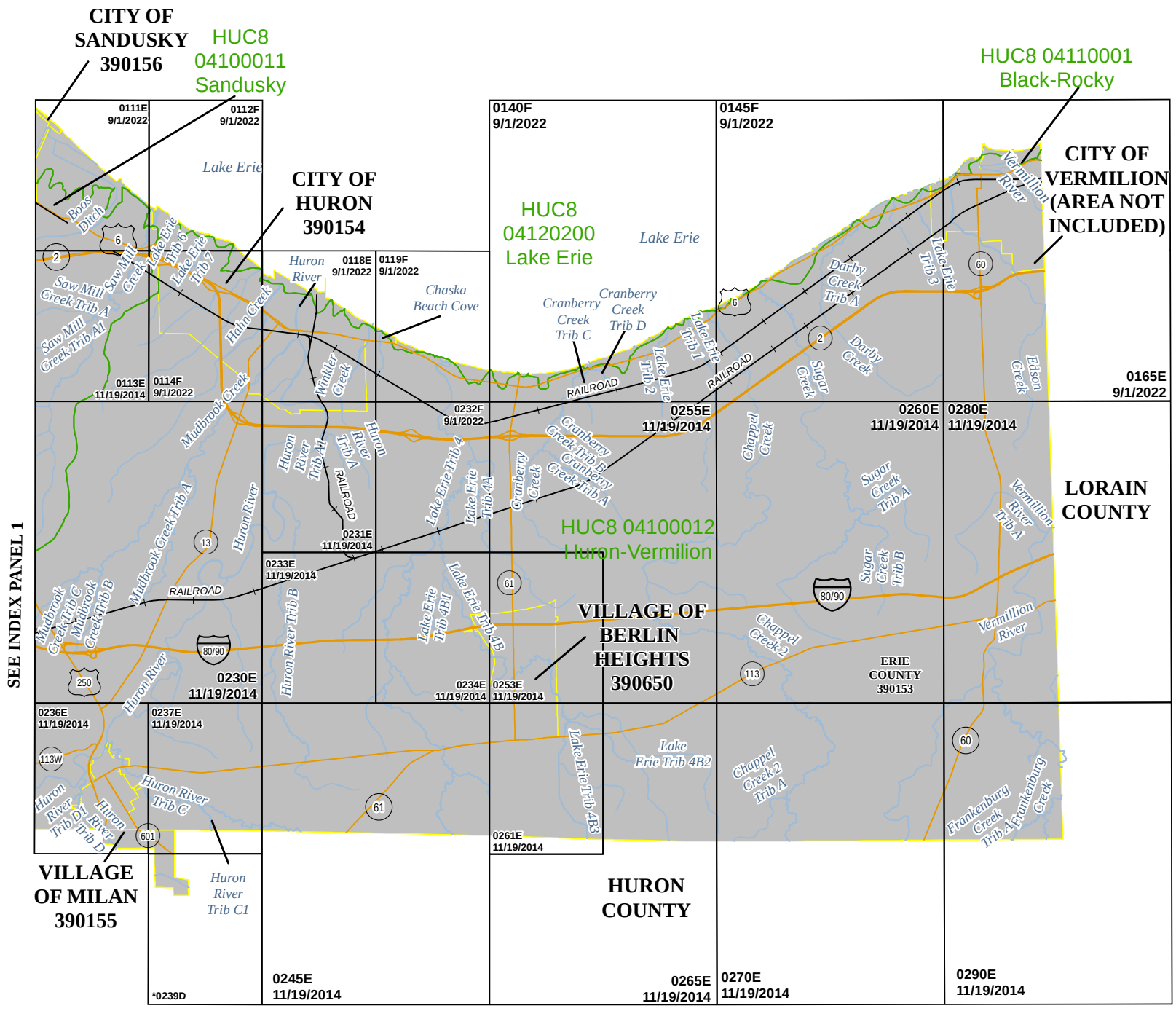
REVISED:

SEPTEMBER 1, 2022

FLOOD INSURANCE STUDY NUMBER
39043CV000C
Version Number 2.3.3.5

FEMA

Figure 1: FIRM Panel Index



ATTENTION: The corporate limits shown on this FIRM Index are based on the best information available at the time of publication. As such, they may be more current than those shown on FIRM panels issued before September 1, 2022.

1 inch = 2 miles 1:126,720

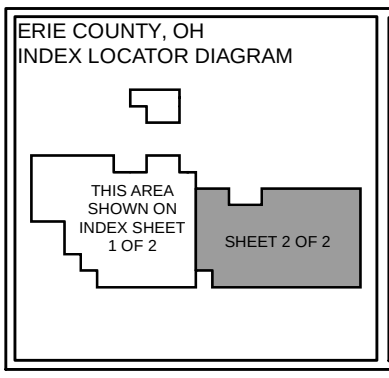
0 5,000 10,000 20,000 Feet

Map Projection:
NAD 1983 StatePlane Ohio North FIPS 3401 Feet
North American Datum of 1983

THE INFORMATION DEPICTED ON THIS MAP AND SUPPORTING DOCUMENTATION ARE ALSO AVAILABLE IN DIGITAL FORMAT AT
HTTPS://MSC.FEMA.GOV

SEE FIS REPORT FOR ADDITIONAL INFORMATION

* PANEL NOT PRINTED - NO SPECIAL FLOOD HAZARD AREAS



NATIONAL FLOOD INSURANCE PROGRAM

FLOOD INSURANCE RATE MAP INDEX
(SHEET 2 OF 2)

ERIE COUNTY, OH AND INCORPORATED AREAS

PANELS PRINTED:
0111, 0112, 0113, 0114, 0118, 0119, 0140, 0145, 0165, 0230, 0231, 0232, 0233, 0234, 0236, 0237, 0245, 0253, 0255,0260, 0261, 0265, 0270, 0280 0290

FEMA

MAP NUMBER
39043CIND2C

MAP REVISED
SEPTEMBER 1, 2022

Table 2: Flooding Sources Included in this FIS Report

Flooding Source	Community	Downstream Limit	Upstream Limit	HUC-8 Sub-Basin(s)	Length (mi) (streams or coastlines)	Area (mi^2) (estuaries or ponding)	Floodway (Y/N)	Zone shown on FIRM	Date of Analysis
Boos Ditch	Erie County, Unincorporated Areas	Mouth at Sandusky Bay	US Route 6	04100011	0.3	N/A	Y	AE	March 1979
Chappel Creek	Erie County, Unincorporated Areas	US Highway 6	Approximately 700 feet upstream of Poorman Road	04100012	1.4	N/A	N	A	April 2013
Chappel Creek 2	Erie County, Unincorporated Areas	Approximately 1,900 feet downstream of Furnace Road	County Boundary	04100012	10.9	N/A	N	A	April 2013
Chappel Creek 2 Trib A	Erie County, Unincorporated Areas	Confluence with Chappel Creek 2	Approximately 0.4 miles upstream of confluence	04100012	0.4	N/A	N	A	April 2013
Chaska Beach Cove Ditch	Erie County, Unincorporated Areas; Huron, City of	US Highway 6	Railroad Bridge	04100012	0.6	N/A	N	A	April 2013
Chaska Beach Cove Ditch	Erie County, Unincorporated Areas; Huron, City of	Lake Erie Coastline	US Highway 6	04100012 04120200	0.2	N/A	N	AE	March 1979; April 1977
Cold Creek	Erie County, Unincorporated Areas; Sandusky, City of	State Route 2	Approximately 0.2 miles upstream	04100011	0.2	N/A	N	A	April 2013
Cold Creek Main Branch	Sandusky, City of	Mouth at Sandusky Bay	State Route 2	04100011	0.7	N/A	Y	AE	January 1977
Cold Creek Trib A	Sandusky, City of	Confluence with Cold Creek	Sandusky Corporate Limits	04100011	1.2	N/A	N	A	April 2013
Cranberry Creek	Erie County, Unincorporated Areas	US Highway 6	Approximately 500 feet downstream of railroad bridge	04100012	2.5	N/A	N	A	April 2013
Cranberry Creek Trib A	Erie County, Unincorporated Areas	Confluence with Cranberry Creek	Approximately 1.1 miles upstream of confluence	04100012	1.1	N/A	N	A	April 2013
Cranberry Creek Trib B	Erie County, Unincorporated Areas	Confluence with Cranberry Creek	Approximately 1.0 miles upstream of confluence	04100012	1.0	N/A	N	A	April 2013

Table 9: Summary of Discharges

Flooding Source	Location	Drainage Area (Square Miles)	Peak Discharge (cfs)					
			10% Annual Chance	4% Annual Chance	2% Annual Chance	1% Annual Chance Existing	1% Annual Chance Future	0.2% Annual Chance
Boos Ditch	At mouth	1.6	269	*	412	478	*	583
Edson Creek	City of Vermilion Corporate Boundary	4.7	723	*	1,124	1,318	*	1,620
Hahn Creek	At mouth	2.38	382	*	574	657	*	850
Hahn Creek	At Conrail	2.18	356	*	537	615	*	796
Hahn Creek	At southern City of Huron Corporate Boundary	1.96	337	*	509	583	*	755
Huron River	At mouth	403.4	16,478	*	22,852	25,550	*	31,836
Huron River	At southern City of Huron Corporate Boundary 1	393.5	16,193	*	22,457	25,109	*	31,287
Huron River	Downstream Erie County Boundary 2	392	15,100	*	26,000	32,400	*	41,000
Kob Ditch	City of Sandusky Corporate Boundary	3.8	541	*	827	960	*	1,185
Kob Ditch	Perkins Avenue	3.3	498	*	765	890	*	1,085
Kob Ditch	Above Storrs-Hemminger Ditch	0.6	220	*	350	430	*	600
Mills Creek	Perkins Avenue	39.7	2,818	*	4,201	4,858	*	5,890
Mills Creek	Old Railroad Road	36.9	2,649	*	3,952	4,570	*	5,510

*Not calculated for this Flood Risk Project

Table 12: Summary of Hydrologic and Hydraulic Analyses

Flooding Source	Study Limits Downstream Limit	Study Limits Upstream Limit	Hydrologic Model or Method Used	Hydraulic Model or Method Used	Date Analyses Completed	Flood Zone on FIRM	Special Considerations
Boos Ditch	Mouth at Sandusky Bay	US Route 6	ODNR, Bulletin No. 45	HEC-2	March 1979	AE w/ Floodway	2017 Redelineation from confluence with Lake Erie to approx. 380 feet upstream. (FEMA 2016)
Chappel Creek	US Highway 6	Approximately 700 feet upstream of Poorman Road	Regression Equations	HEC-RAS 4.1	April 2013	A	Manning's Roughness; Channel 0.04-0.045, Floodplain 0.045-0.08. Downstream tie-in with Lake Erie approx. 120' upstream of US 6(FEMA 2016)
Chappel Creek 2	Approximately 1,900 feet downstream of Furnace Road	County Boundary	Regression Equations	HEC-RAS 4.1	April 2013	A	Manning's Roughness; Channel 0.04-0.045, Floodplain 0.045-0.08
Chappel Creek 2 Trib A	Confluence with Chappel Creek 2	Approximately 0.4 miles upstream of confluence	Regression Equations	HEC-RAS 4.1	April 2013	A	Manning's Roughness; Channel 0.04-0.045, Floodplain 0.045-0.08
Chaska Beach Cove Ditch	US Highway 6	Railroad Bridge	Regression Equations	HEC-RAS 4.1	April 2013	A	Manning's Roughness; Channel 0.04-0.045, Floodplain 0.045-0.08
Chaska Beach Cove Ditch	Lake Erie Coastline	US Highway 6	FREQFLO computer program for log-Pearson Type III	HEC-2	March 1979; April 1977	AE	Downstream tie-in with Lake Erie (FEMA 2016). Study Superseded by Coastal Backwater from Lake Erie
Cold Creek	State Route 2	Approximately 0.2 miles upstream	Regression Equations	HEC-RAS 4.1	April 2013	A	Manning's Roughness; Channel 0.04-0.045, Floodplain 0.045-0.08

Table 23: Floodway Data

LOCATION		FLOODWAY			1% ANNUAL CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD88)			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/ SEC)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE
Boos Ditch								
A	40	67	206	2.3	*	574.9[2]	575.9	1.0
B	835	100	270	1.8	580.0	580.0	581.0	1.0
C	1,200	47	142	3.4	581.9	581.9	582.4	0.5
Cold Creek (Main Branch)								
A	1,845	44	126	0.3	586.6	586.6	586.7	0.1
B	1,930	90	378	2.8	586.9	586.9	587.4	0.5
C	2,600	76	355	3.4	587.3	587.3	588.1	0.8
Edson Creek								
A	7,790	170	231	5.7	617.9	617.9	618.0	0.1
B	9,590	79	196	6.7	627.0	627.0	627.1	0.1

[1]Feet above mouth
[2]Elevations computed without considering backwater from Lake Erie
*Controlled by coastal flooding – see FIRM for regulatory base flood elevation

TABLE 23

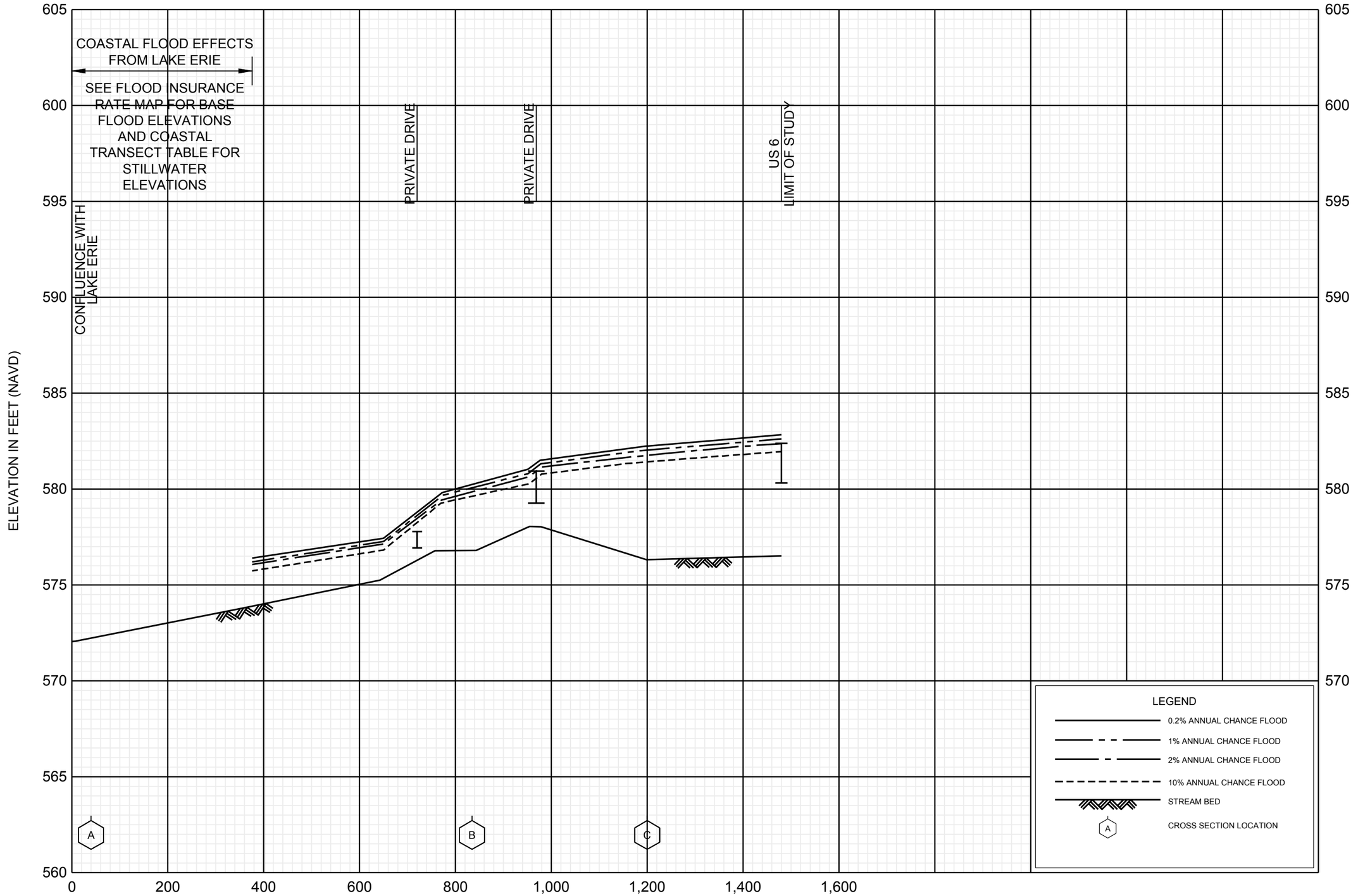
FEDERAL EMERGENCY MANAGEMENT AGENCY

ERIE COUNTY, OH

AND INCORPORATED AREAS

FLOODWAY DATA

FLOODING SOURCE: BOOS DITCH, COLD CREEK (MAIN BRANCH), & EDSON CREEK



FLOOD PROFILES

BOOS DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

ERIE COUNTY, OHIO

AND INCORPORATED AREAS

01P

SECTION III

STORM DISCHARGE

CALCULATIONS

StreamStats Report

Region ID: OH
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Clicked Point (Latitude, Longitude): 41.41047, -82.61028
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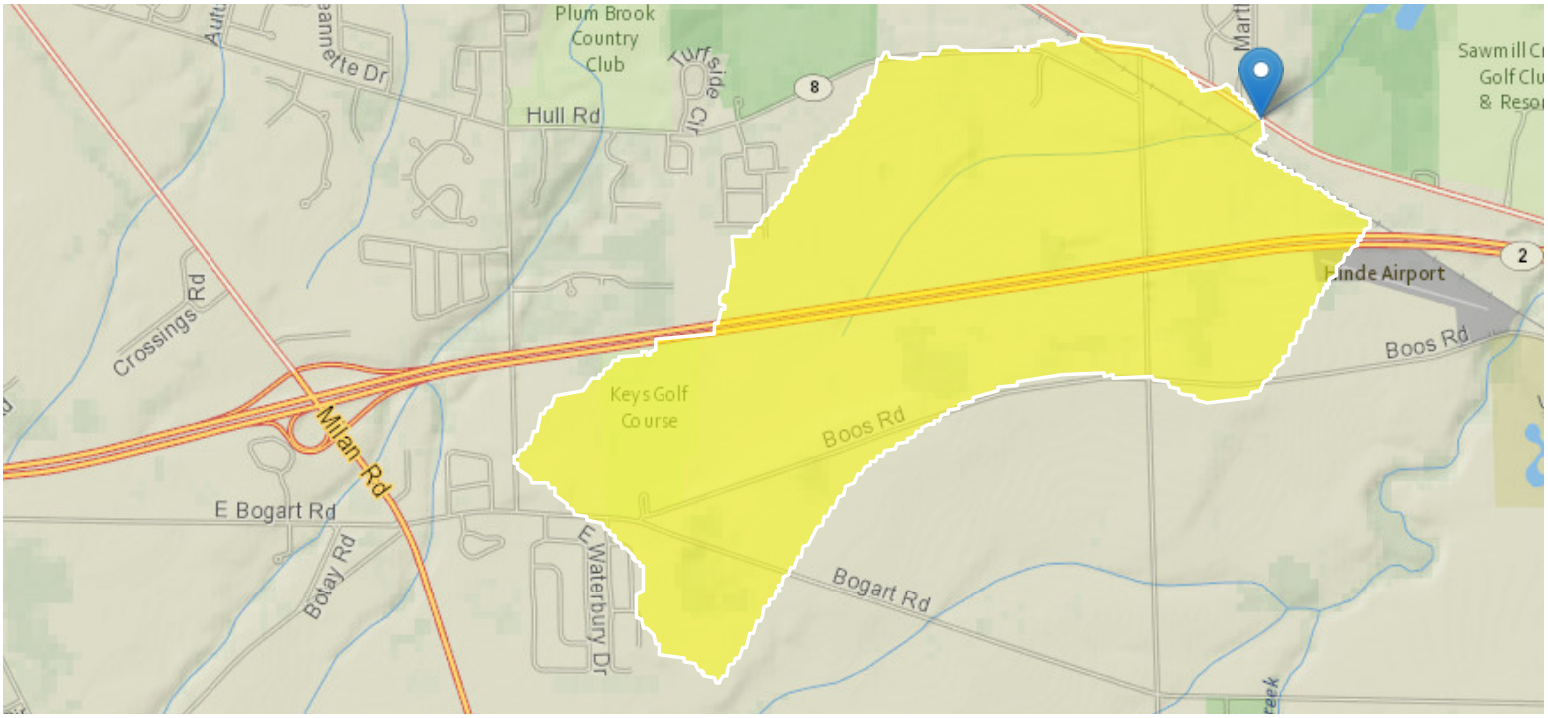


Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
CSL1085LFP	Change in elevation divided by length between points 10 and 85 percent of distance along the longest flow path to the basin divide, LFP from 2D grid	11.1	feet per mi
DRNAREA	Area that drains to a point on a stream	1.54	square miles
FOREST	Percentage of area covered by forest	12	percent
LAT_CENT	Latitude of Basin Centroid	41.4037	decimal degrees
LC92STOR	Percentage of water bodies and wetlands determined from the NLCD	1.1	percent
LONG_CENT	Longitude Basin Centroid	82.6257	decimal degrees
OHREGA	Ohio Region A Indicator	1	dimensionless
OHREGC	Ohio Region C Indicator	0	dimensionless
PRECIPCENT	Mean Annual Precip at Basin Centroid	34.2	inches

Parameter Code	Parameter Description	Value	Unit
STREAM_VARG	Streamflow variability index as defined in WRIR 02-4068, computed from regional grid	0.62	dimensionless

Peak-Flow Statistics

Peak-Flow Statistics Parameters [Peak Flow Full Model Reg A SIR2019 5018]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.54	square miles	0.04	5989
OHREGC	Ohio Region C Indicator 1 if in C else 0	0	dimensionless	0	1
OHREGA	Ohio Region A Indicator 1 if in A else 0	1	dimensionless	0	1
CSL1085LFP	Stream Slope 10 and 85 Longest Flow Path	11.1	feet per mi	1.53	516
LC92STOR	Percent Storage from NLCD1992	1.1	percent	0	25.35

Peak-Flow Statistics Flow Report [Peak Flow Full Model Reg A SIR2019 5018]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIL	PIU	ASEp
50-percent AEP flood	117	ft^3/s	61.7	222	40.1
20-percent AEP flood	194	ft^3/s	107	352	37.2
10-percent AEP flood	255	ft^3/s	140	466	37.6
4-percent AEP flood	341	ft^3/s	185	627	38.1
2-percent AEP flood	412	ft^3/s	221	767	37.8
1-percent AEP flood	488	ft^3/s	259	918	39.6
0.2-percent AEP flood	687	ft^3/s	361	1310	40.3

Peak-Flow Statistics Citations

Koltun, G.F.,2019, Flood-frequency estimates for Ohio streamgages based on data through water year 2015 and techniques for estimating flood-frequency characteristics of rural, unregulated Ohio streams: U.S. Geological Survey Scientific Investigations Report 2019–5018, 25 p. (https://dx.doi.org/10.3133/sir20195018)

Flow-Duration Statistics

Flow-Duration Statistics Parameters [Low Flow Region A 2012 5138]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.54	square miles	1	1250
STREAM_VARG	Streamflow Variability Index from Grid	0.62	dimensionless	0.24	1.12

Flow-Duration Statistics Flow Report [Low Flow Region A 2012 5138]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE
80 Percent Duration	0.103	ft^3/s	29.1

Flow-Duration Statistics Citations

Koltun, G.F., and Kula, S.P.,2013, Methods for estimating selected low-flow statistics and development of annual flow-duration statistics for Ohio: U.S. Geological Survey Scientific Investigations Report 2012–5138, 195 p. (http://pubs.usgs.gov/sir/2012/5138/)

Low-Flow Statistics

Low-Flow Statistics Parameters [Low Flow Region A 2012 5138]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.54	square miles	1	1250
STREAM_VARG	Streamflow Variability Index from Grid	0.62	dimensionless	0.24	1.12

Low-Flow Statistics Flow Report [Low Flow Region A 2012 5138]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE
1 Day 10 Year Low Flow	0.01	ft^3/s	53.1
7 Day 10 Year Low Flow	0.0138	ft^3/s	40
30 Day 10 Year Low Flow	0.0234	ft^3/s	35.7
90 Day 10 Year Low Flow	0.0426	ft^3/s	29.8

Low-Flow Statistics Citations

Koltun, G.F., and Kula, S.P.,2013, Methods for estimating selected low-flow statistics and development of annual flow-duration statistics for Ohio: U.S. Geological Survey Scientific Investigations Report 2012–5138, 195 p. (http://pubs.usgs.gov/sir/2012/5138/)

Monthly Flow Statistics

Monthly Flow Statistics Parameters [Low Flow LatGT 41.2 wri02 4068]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.54	square miles	0.12	7422
LC92STOR	Percent Storage from NLCD1992	1.1	percent	0	19
PRECIPCENT	Mean Annual Precip at Basin Centroid	34.2	inches	34	43.2
FOREST	Percent Forest	12	percent	0	99.1

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
LAT_CENT	Latitude of Basin Centroid	41.4037	decimal degrees	41.2	41.59
STREAM_VARG	Streamflow Variability Index from Grid	0.62	dimensionless	0.25	1.13

Monthly Flow Statistics Flow Report [Low Flow LatGT 41.2 wri02 4068]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp
January Mean Flow	1.78	ft^3/s	16.6	16.6
February Mean Flow	2.77	ft^3/s	11.9	11.9
March Mean Flow	3.08	ft^3/s	14	14
April Mean Flow	2.59	ft^3/s	11.2	11.2
May Mean Flow	1.89	ft^3/s	19.5	19.5
June Mean Flow	1	ft^3/s	27	27
July Mean Flow	0.628	ft^3/s	28.2	28.2
August Mean Flow	0.3	ft^3/s	36.8	36.8
September Mean Flow	0.181	ft^3/s	43.6	43.6
October Mean Flow	0.746	ft^3/s	50.8	50.8
November Mean Flow	1.24	ft^3/s	37.5	37.5
December Mean Flow	2.03	ft^3/s	21.8	21.8

STD Flow = 2 x Maximum Monthly Flow = 3.08 cfs x 2 = 6.16 cfs SAY 7 cfs

Monthly Flow Statistics Citations

Koltun, G. F., and Whitehead, M. T.,2002, Techniques for Estimating Selected Streamflow Characteristics of Rural, Unregulated Streams in Ohio: U. S. Geological Survey Water-Resources Investigations Report 02-4068, 50 p (https://pubs.er.usgs.gov/publication/wri024068)

General Flow Statistics

General Flow Statistics Parameters [Low Flow LatGT 41.2 wri02 4068]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.54	square miles	0.12	7422
LC92STOR	Percent Storage from NLCD1992	1.1	percent	0	19
STREAM_VARG	Streamflow Variability Index from Grid	0.62	dimensionless	0.25	1.13
LAT_CENT	Latitude of Basin Centroid	41.4037	decimal degrees	41.2	41.59

General Flow Statistics Flow Report [Low Flow LatGT 41.2 wri02 4068]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp
Harmonic Mean Streamflow	0.108	ft^3/s	65.9	65.9

General Flow Statistics Citations

Koltun, G. F., and Whitehead, M. T.,2002, Techniques for Estimating Selected Streamflow Characteristics of Rural, Unregulated Streams in Ohio: U. S. Geological Survey Water-Resources Investigations Report 02-4068, 50 p (https://pubs.er.usgs.gov/publication/wri024068)

Annual Flow Statistics

Annual Flow Statistics Parameters [Low Flow LatGT 41.2 wri02 4068]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.54	square miles	0.12	7422
LAT_CENT	Latitude of Basin Centroid	41.4037	decimal degrees	41.2	41.59
PRECIPCENT	Mean Annual Precip at Basin Centroid	34.2	inches	34	43.2

Annual Flow Statistics Flow Report [Low Flow LatGT 41.2 wri02 4068]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp
Mean Annual Flow	1.31	ft^3/s	11.4	11.4

Annual Flow Statistics Citations

Koltun, G. F., and Whitehead, M. T.,2002, Techniques for Estimating Selected Streamflow Characteristics of Rural, Unregulated Streams in Ohio: U. S. Geological Survey Water-Resources Investigations Report 02-4068, 50 p (https://pubs.er.usgs.gov/publication/wri024068)

Flow Percentile Statistics

Flow Percentile Statistics Parameters [Low Flow LatGT 41.2 wri02 4068]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.54	square miles	0.12	7422
LC92STOR	Percent Storage from NLCD1992	1.1	percent	0	19
STREAM_VARG	Streamflow Variability Index from Grid	0.62	dimensionless	0.25	1.13
LAT_CENT	Latitude of Basin Centroid	41.4037	decimal degrees	41.2	41.59
LONG_CENT	Longitude of Basin Centroid	82.6257	decimal degrees	80.53	84.6

Flow Percentile Statistics Flow Report [Low Flow LatGT 41.2 wri02 4068]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp
25th Percentile Flow	0.184	ft^3/s	29.2	29.2
50th Percentile Flow Median	0.468	ft^3/s	40.3	40.3

Statistic	Value	Unit	SE	ASEp
75th Percentile Flow	1.19	ft^3/s	47.9	47.9

Flow Percentile Statistics Citations

Koltun, G. F., and Whitehead, M. T.,2002, Techniques for Estimating Selected Streamflow Characteristics of Rural, Unregulated Streams in Ohio: U. S. Geological Survey Water-Resources Investigations Report 02-4068, 50 p (https://pubs.er.usgs.gov/publication/wri024068)

Bankfull Statistics

Bankfull Statistics Parameters [Interior Plains D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.54	square miles	0.19305	59927.7393

Bankfull Statistics Parameters [Central Lowland P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.54	square miles	0.200772	59927.66594

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.54	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [Interior Plains D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	13.7	ft
Bieger_D_channel_depth	1.62	ft
Bieger_D_channel_cross_sectional_area	26.5	ft^2

Bankfull Statistics Flow Report [Central Lowland P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	15.6	ft
Bieger_P_channel_depth	1.99	ft
Bieger_P_channel_cross_sectional_area	25.4	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	14.4	ft
Bieger_USA_channel_depth	1.32	ft
Bieger_USA_channel_cross_sectional_area	21.6	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
Bieger_D_channel_width	13.7	ft
Bieger_D_channel_depth	1.62	ft
Bieger_D_channel_cross_sectional_area	26.5	ft^2
Bieger_P_channel_width	15.6	ft
Bieger_P_channel_depth	1.99	ft
Bieger_P_channel_cross_sectional_area	25.4	ft^2
Bieger_USA_channel_width	14.4	ft
Bieger_USA_channel_depth	1.32	ft
Bieger_USA_channel_cross_sectional_area	21.6	ft^2

Bankfull Statistics Citations

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. (https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_campaign=PDFCoverPag

Probability Statistics

Probability Statistics Parameters [P zero Flow 2012 5138]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.54	square miles	1	1250
STREAM_VARG	Streamflow Variability Index from Grid	0.62	dimensionless	0.24	1.12

Probability Statistics Flow Report [P zero Flow 2012 5138]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PC
Probability zero flow 1Day	0.06	dim	91
Probability zero flow 7Day	0.0276	dim	94
Probability zero flow 30Day	0.00135	dim	97

Probability Statistics Citations

Koltun, G.F., and Kula, S.P.,2013, Methods for estimating selected low-flow statistics and development of annual flow-duration statistics for Ohio: U.S. Geological Survey Scientific Investigations Report 2012–5138, 195 p. (http://pubs.usgs.gov/sir/2012/5138/)

Maximum Probable Flood Statistics

Maximum Probable Flood Statistics Parameters [63.5 Percent (0.977 square miles) Crippen Bue Region 6]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	1.54	square miles	0.1	10000

Maximum Probable Flood Statistics Disclaimers [63.5 Percent (0.977 square miles) Crippen Bue Region 6]

Weighted flows were not calculated. Users should be careful to evaluate the applicability of the provided estimates. Percentage of area falls outside where region is undefined. Whole estimates have been provided using available regional equations.

Maximum Probable Flood Statistics Flow Report [63.5 Percent (0.977 square miles) Crippen Bue Region 6]

Statistic	Value	Unit
Maximum Flood Crippen Bue Regional	9830	ft^3/s

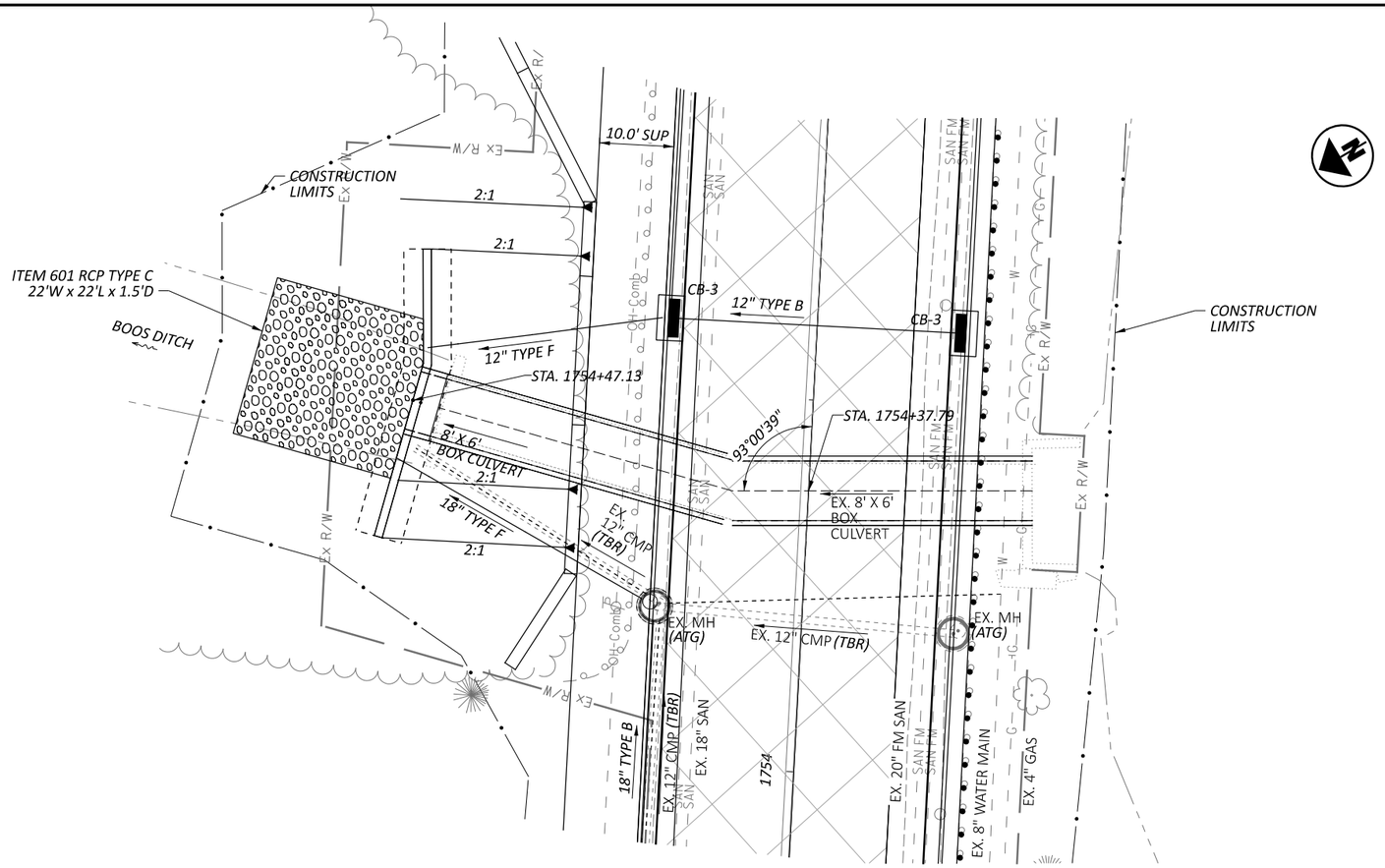
Maximum Probable Flood Statistics Citations

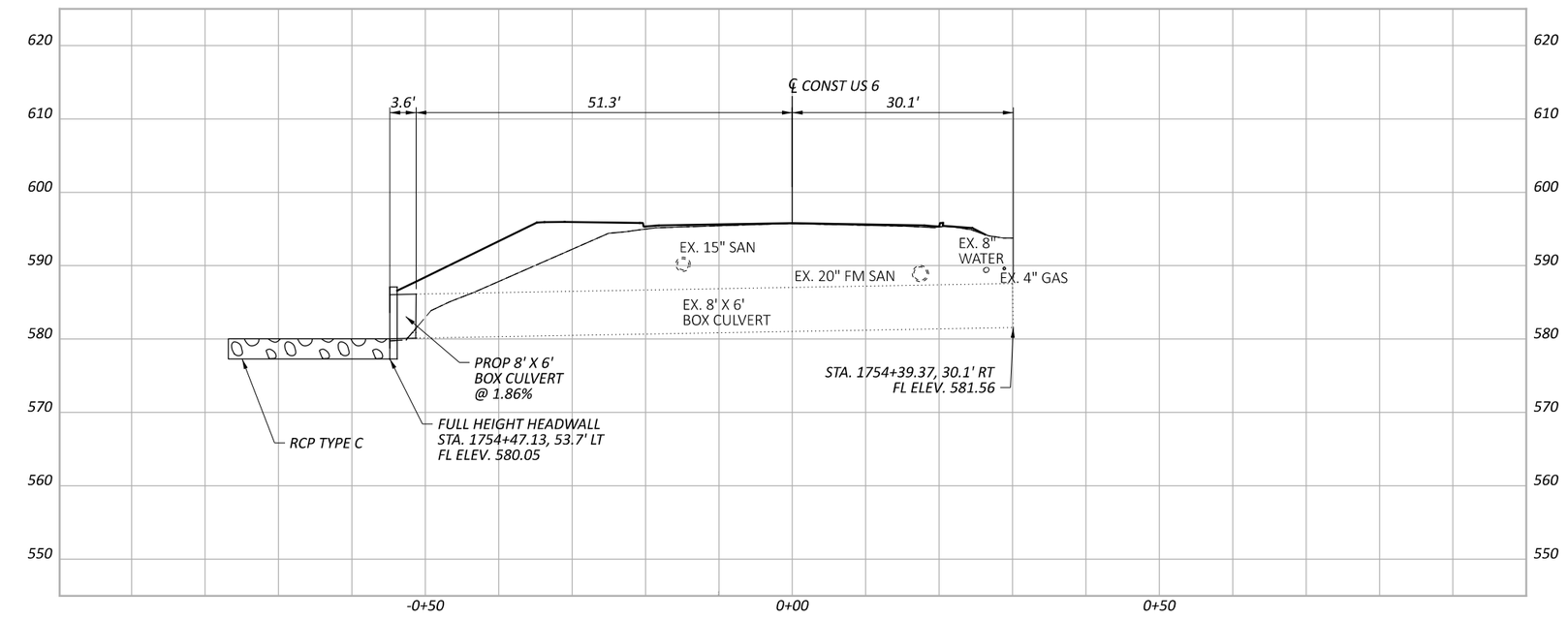
Crippen, J.R. and Bue, Conrad D.1977, Maximum Floodflows in the Conterminous United States, Geological Survey Water-Supply Paper 1887, 52p. (https://pubs.usgs.gov/wsp/1887/report.pdf)

Application Version: 4.18.1
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

SECTION IV

BRIDGE PLANS





ESTIMATED QUANTITIES

ITEM	QUANTITY	UNIT	DESCRIPTION

HYDRAULIC DATA

DRAINAGE AREA = 985.6 ACRES

Q (25) = 341 CFS V (25) = 8.51 FT/S HW (25) = 588.06 FT

Q (100) = 488 CFS V (100) = 9.39 FT/S HW (100) = 590.17 FT

ORDINARY HIGH WATER MARK: FT

DESIGN SERVICE LIFE: YEARS

ABRASION LEVEL: 1

pH: ___

EXISTING STRUCTURE

TYPE: BOX CULVERT

SIZE: 8' X 6'

SKEW: 93°00'39"

ALIGNMENT: TANGENT

DATE BUILT:

CONDITION: GOOD

CFN: 1832187

HORIZONTAL SCALE IN FEET
0 5 10 20

CULVERT DETAILS
US 6 STA. 1754+38

DESIGN AGENCY
TRANSYSTEMS
400 W. NATIONWIDE BLVD., STE 225
COLUMBUS, OHIO 43215

DESIGNER NLD

REVIEWER MHT 02/28/24

PROJECT ID 116570

SHEET P.608 TOTAL 768

ERI-US 0006-CONNECTIVITY CORRIDOR

MODEL: Culvert 754+38 - Plan [Sheet] PAPERSIZE: 17x11 (in.) DATE: 2/29/2024 TIME: 7:25:45 PM USER: mhterrell
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APPENDIX A

HYDRAULIC CALCULATIONS – EXISTING CONDITIONS

HY-8 Culvert Analysis Report

US 6 over Boos Ditch
Existing Conditions
By: TRS Date: 2/21/2024
Checked by: KLM Date: 2/27/2024

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: Existing Condition

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
584.73	2-Year	117.00	117.00	0.00	1
585.97	5-Year	194.00	194.00	0.00	1
587.05	10-Year	269.00	269.00	0.00	1
588.06	25-Year	341.00	341.00	0.00	1
589.11	50-Year	412.00	412.00	0.00	1
590.17	100-Year	478.00	478.00	0.00	1
592.12	500-Year	583.00	583.00	0.00	1
595.00	Overtopping	709.57	709.57	0.00	Overtopping

Rating Curve Plot for Crossing: Existing Conditions

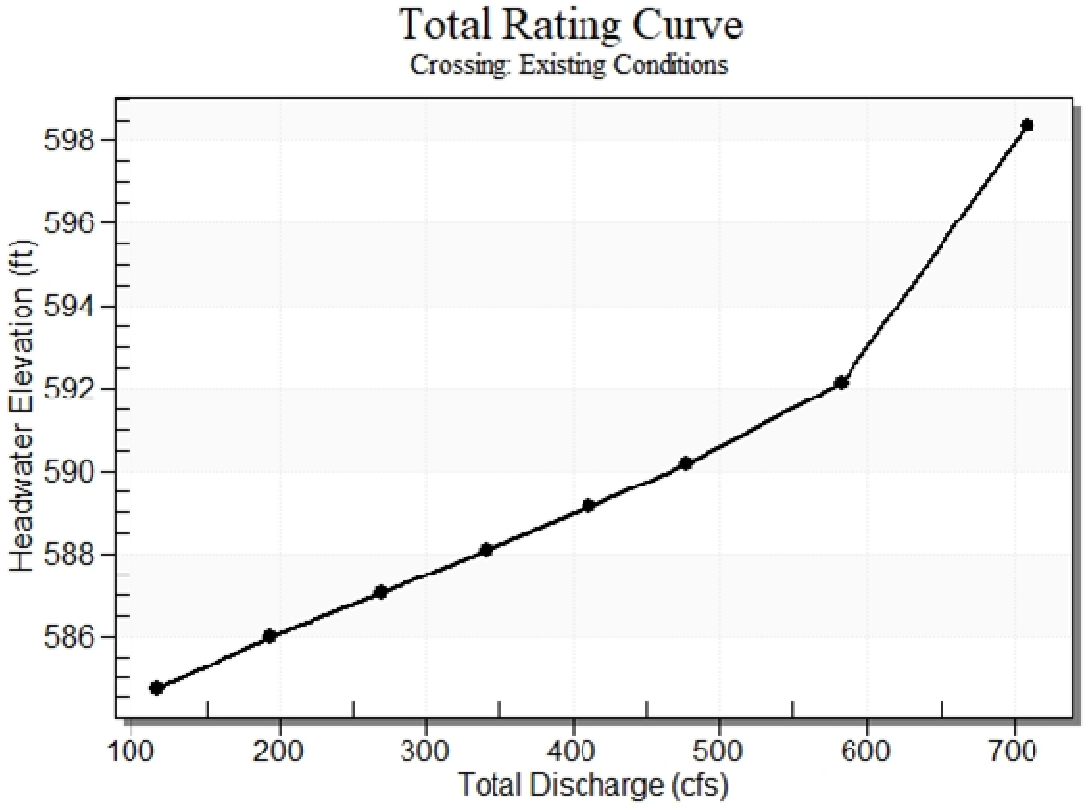


Table 2 - Culvert Summary Table: Culvert 1

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2-Year	117.00	117.00	584.73	3.167	0.593	1-S2n	0.991	1.880	1.175	1.339	12.452	6.120
5-Year	194.00	194.00	585.97	4.412	1.616	1-S2n	1.386	2.633	1.727	1.782	14.041	7.180
10-Year	269.00	269.00	587.05	5.490	2.647	1-S2n	1.729	3.275	2.220	2.137	15.144	7.931
25-Year	341.00	341.00	588.06	6.500	3.701	5-S2n	2.037	3.836	2.666	2.433	15.990	8.511
50-Year	412.00	412.00	589.11	7.546	4.817	5-S2n	2.325	4.351	3.083	2.696	16.704	8.996
100-Year	478.00	478.00	590.17	8.610	6.527	5-S2n	2.584	4.804	3.456	2.919	17.291	9.389
500-Year	583.00	583.00	592.12	10.564	8.118	5-S2n	2.981	5.484	4.025	3.244	18.107	9.935

****

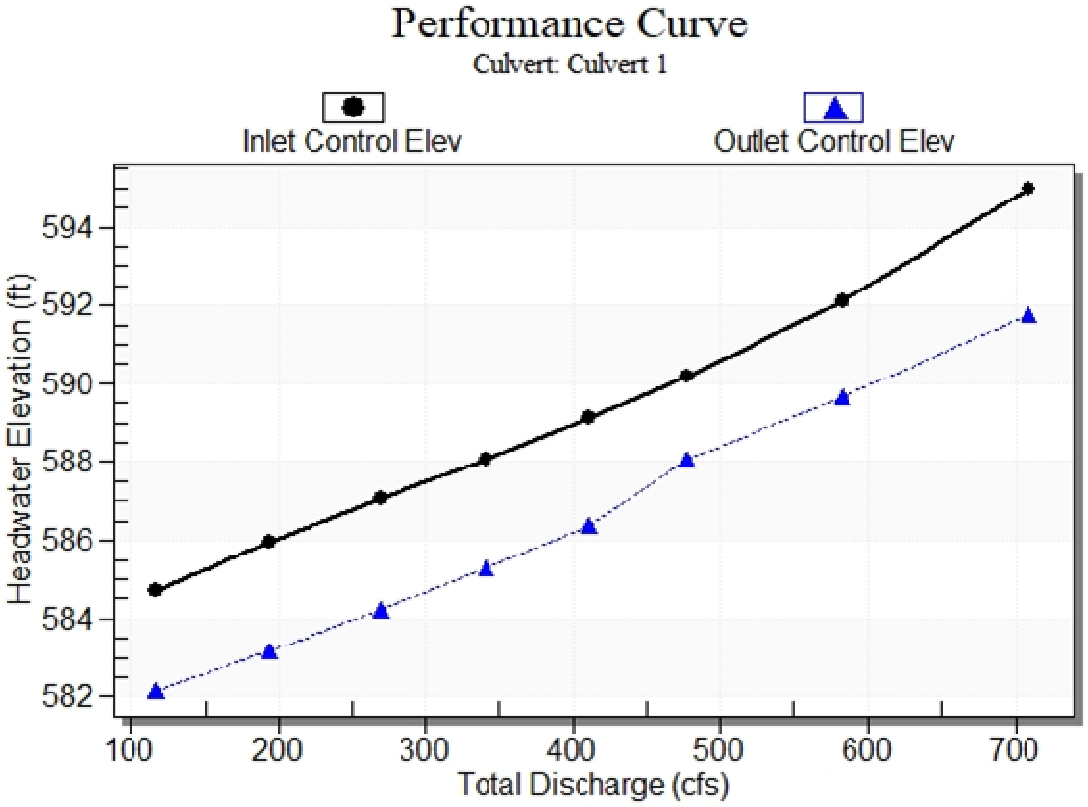
Straight Culvert

Inlet Elevation (invert): 581.56 ft, Outlet Elevation (invert): 580.12 ft

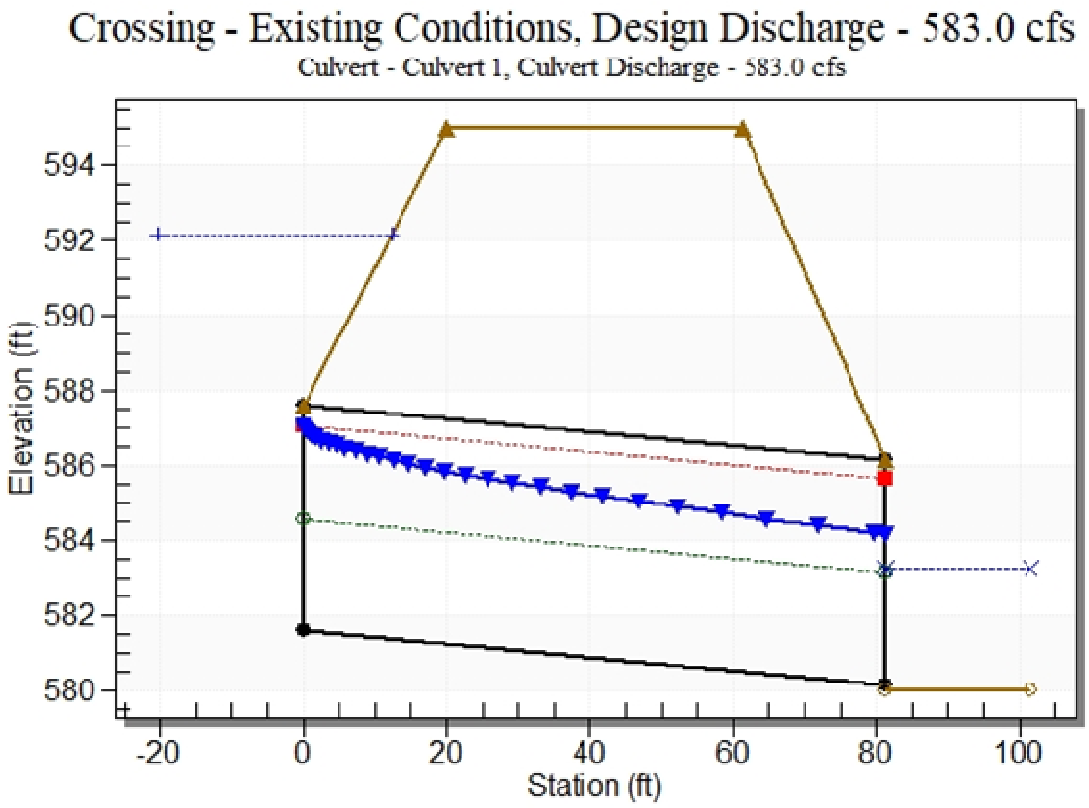
Culvert Length: 81.41 ft, Culvert Slope: 0.0177

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 581.56 ft

Outlet Station: 81.40 ft

Outlet Elevation: 580.12 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Existing Conditions)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
117.00	581.34	1.34	6.12	1.55	1.02
194.00	581.78	1.78	7.18	2.07	1.05
269.00	582.14	2.14	7.93	2.48	1.08
341.00	582.43	2.43	8.51	2.82	1.09
412.00	582.70	2.70	9.00	3.13	1.11
478.00	582.92	2.92	9.39	3.39	1.12
583.00	583.24	3.24	9.94	3.77	1.13

Tailwater Channel Data - Existing Conditions

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 11.60 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0186

Channel Manning's n: 0.0350

Channel Invert Elevation: 580.00 ft

Roadway Data for Crossing: Existing Conditions

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 595.00 ft

Roadway Surface: Paved

Roadway Top Width: 41.30 ft

APPENDIX B

HYDRAULIC CALCULATIONS – PROPOSED CONDITIONS

HY-8 Culvert Analysis Report

US 6 over Boos Ditch
Proposed Conditions
By: TRS Date: 2/21/2024
Checked by: KLM Date: 2/27/2024

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: Proposed Conditions

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
584.73	2-Year	117.00	117.00	0.00	1
585.97	5-Year	194.00	194.00	0.00	1
587.05	10-Year	269.00	269.00	0.00	1
588.06	25-Year	341.00	341.00	0.00	1
589.11	50-Year	412.00	412.00	0.00	1
590.17	100-Year	478.00	478.00	0.00	1
592.12	500-Year	583.00	583.00	0.00	1
595.00	Overtopping	709.58	709.58	0.00	Overtopping

Rating Curve Plot for Crossing: Proposed Conditions

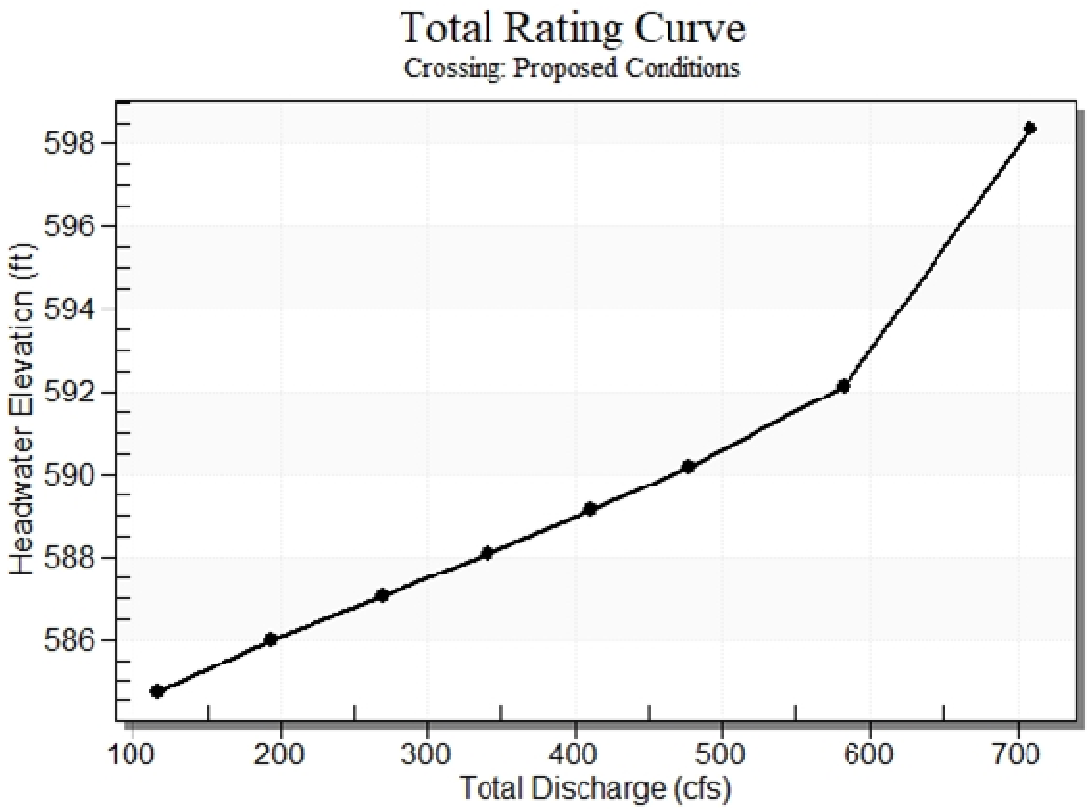


Table 2 - Culvert Summary Table: Culvert 1

Discharge Names	Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2-Year	117.00	117.00	584.73	3.167	0.524	1-S2n	0.989	1.880	1.167	1.339	12.532	6.120
5-Year	194.00	194.00	585.97	4.412	1.548	1-S2n	1.384	2.633	1.715	1.782	14.139	7.180
10-Year	269.00	269.00	587.05	5.489	2.580	1-S2n	1.726	3.275	2.205	2.137	15.249	7.931
25-Year	341.00	341.00	588.06	6.500	3.636	5-S2n	2.033	3.836	2.647	2.433	16.103	8.511
50-Year	412.00	412.00	589.11	7.545	4.755	5-S2n	2.321	4.351	3.062	2.696	16.818	8.996
100-Year	478.00	478.00	590.17	8.610	6.468	5-S2n	2.579	4.804	3.434	2.919	17.402	9.389
500-Year	583.00	583.00	592.12	10.564	8.064	5-S2n	2.975	5.484	4.000	3.244	18.221	9.935

****

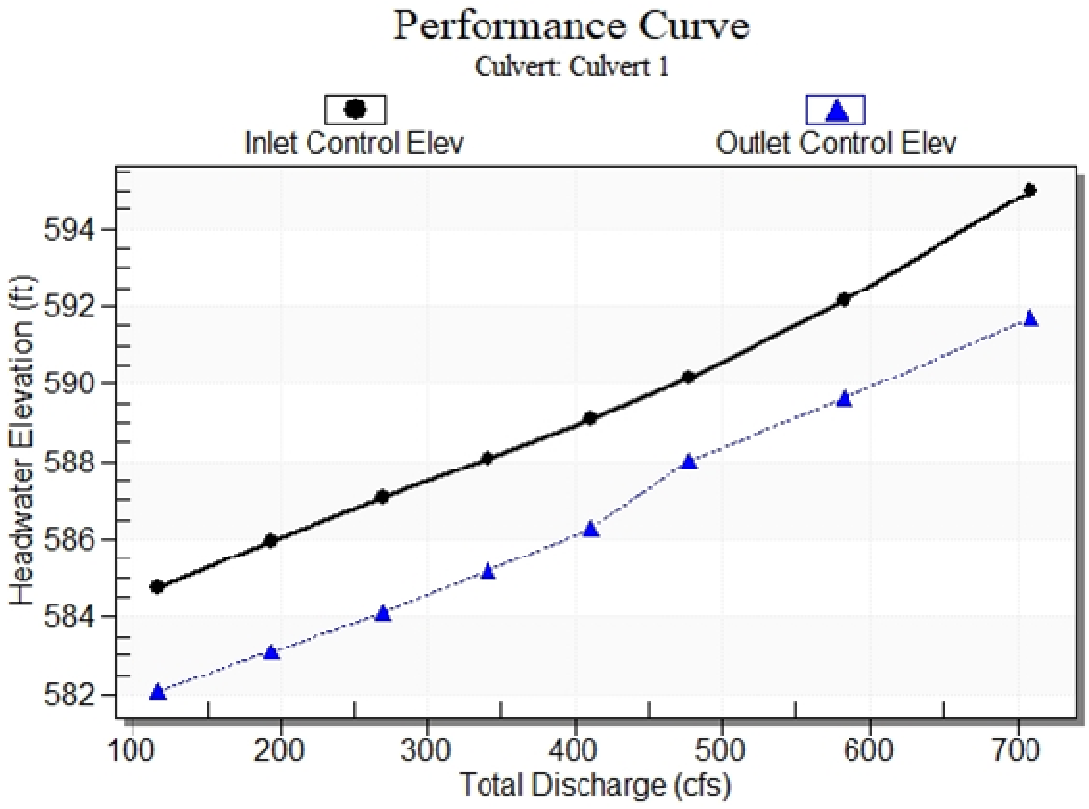
Straight Culvert

Inlet Elevation (invert): 581.56 ft, Outlet Elevation (invert): 580.05 ft

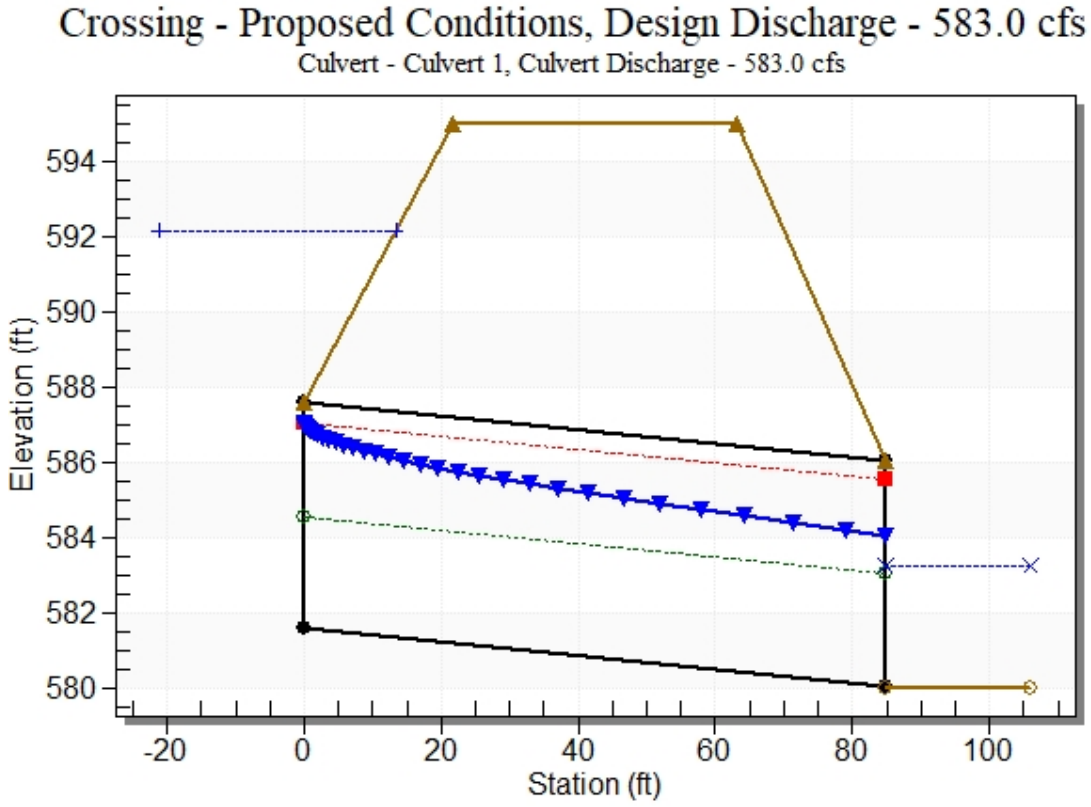
Culvert Length: 84.87 ft, Culvert Slope: 0.0178

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 581.56 ft

Outlet Station: 84.86 ft

Outlet Elevation: 580.05 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Proposed Conditions)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
117.00	581.34	1.34	6.12	1.55	1.02
194.00	581.78	1.78	7.18	2.07	1.05
269.00	582.14	2.14	7.93	2.48	1.08
341.00	582.43	2.43	8.51	2.82	1.09
412.00	582.70	2.70	9.00	3.13	1.11
478.00	582.92	2.92	9.39	3.39	1.12
583.00	583.24	3.24	9.94	3.77	1.13

Tailwater Channel Data - Proposed Conditions

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 11.60 ft

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0186

Channel Manning's n: 0.0350

Channel Invert Elevation: 580.00 ft

Roadway Data for Crossing: Proposed Conditions

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 595.00 ft

Roadway Surface: Paved

Roadway Top Width: 41.30 ft