FRA-33-27.51 PID 119387

Hydraulic Report

Bridge No. FRA-33-27.51L/R SFN 2502100/2502135

US 33 over Coble-Bowman Ditch

The environmental review, consultation, and other actions required by applicable federal environmental laws for these projects are being, or have been, carried out by ODOT pursuant to 23 U.S.C. 327 and a memorandum of understanding dated December 11, 2015, and executed by FHWA and ODOT.

Submitted to *Ohio Department of Transportation District 6*
May 2025

Prepared by

WOOLPERT

OHIO DEPARTMENT OF TRANSPORTATION

TABLE OF CONTENTS

APPENDICES

INTRODUCTION AND PROJECT DESCRIPTION

Woolpert is preparing preliminary plans for the Ohio Department of Transportation (ODOT) in support of FRA-33-24.76 PID 119387. The project involves widening U.S. Route 33 (US-33) for a third lane, including widening or replacement of the existing FRA-33-2751 L/R structures over Coble-Bowman Ditch. The purpose of this hydraulic report is to determine the impacts of the proposed widened structure on the water surface elevations of Coble-Bowman Ditch, determine the hydraulic adequacy of the proposed structure, and evaluate the flood hazard potential.

This hydraulic report was prepared in conjunction with the Structure Type Study, dated May 2025, and includes hydraulic models for the existing conditions and the proposed structure alternatives for the widened roadway.

Coble-Bowman Ditch is a perennial, straight waterway with a sinuosity of approximately 1.02 in the region near the site, shown in Figure 1. Nearby historic borings indicate that the channel bottom is a mixture of silt and clay, clay, sandy silt, and gravel and/or stone fragment layers. The banks of the channels are steeply sloped with vegetation.

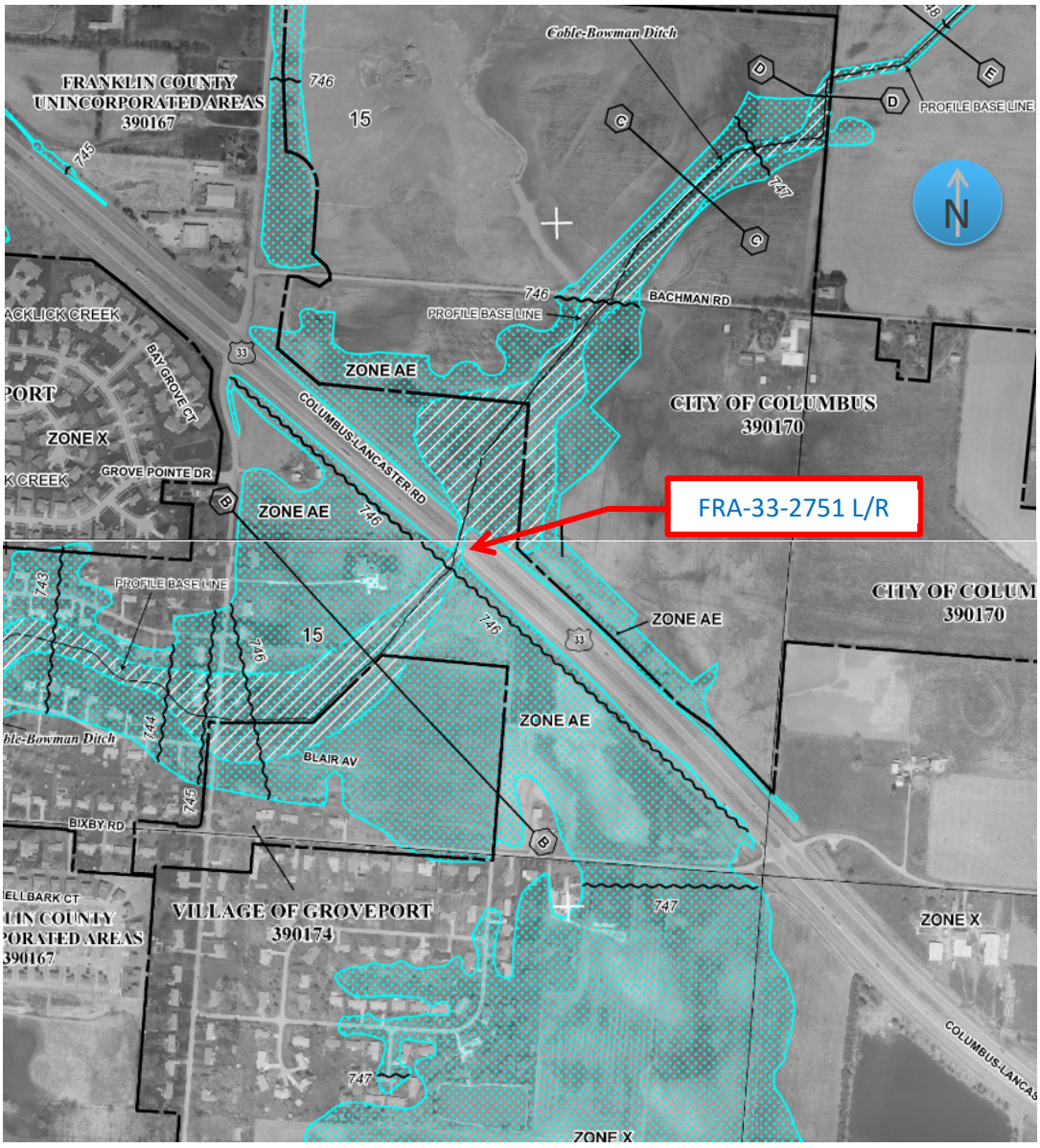

Figure 1: FEMA Floodplain

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Existing Conditions - The crossing over Coble-Bowman Ditch is within a Federal Emergency Management Agency (FEMA) Zone AE regulated floodplain with a regulatory floodway, with 100-year flood discharge elevations provided. The crossing is approximately 1.4 miles upstream from the confluence with Blacklick Creek. The FEMA Flood Insurance Study (FIS), effective June 2011, provided existing channel elevations and flow rates for the hydraulic analysis. The Flood Insurance Rate Map (FIRM) and portions of the FIS can be seen in Figure 1 and in Appendix 2 of this report. Photographs of the bridge opening can be seen in Figure 2 through Figure 5.

Bridge No. FRA-33-2751 L/R carries the existing two-lane US-33 westbound/eastbound over Coble-Bowman Ditch. Both structures are 42-ft wide single-span, simple span reinforced concrete slab on reinforced concrete abutments. The bridges are located approximately 2.8-mi southeast of IR-270 and 4-mi northwest of Canal Winchester, Ohio.

Figure 2: Bridge Opening Looking Upstream

Figure 3: Upstream Bridge Opening

Figure 4: Channel Looking Downstream

Figure 5: Channel Looking Upstream

Proposed Conditions - The project will widen the existing US-33 roadway to provide width for a third lane in each direction. The existing single span bridges will be replaced with a culvert spanning the both the westbound and eastbound directions and designed to carry three 12-ft lanes, one 10-ft shoulder, and one 16.5-ft shoulder in each direction.

DESIGN CRITERIA

The proposed crossing is in a FEMA regulated floodplain (Zone AE) and the requirements of the National Flood Insurance Program (NFIP) will apply. The existing conditions model is used for determining if the proposed conditions result in an increase in water surface elevations and impacts to other parameters such as velocity.

US-33 is a Principal Arterial Freeway with Design ADT of 75,882 (68,004 and 7,878, for South and North directions respectively) per data from ODOT Transportation Information Mapping System (TIMS). Per ODOT L&D Manual Volume 2 Section 1004.2, the design Annual Exceedance Probability (AEP) event is the 2% AEP (50-year). Section 1008.10.5 indicates the corresponding scour design and scour check flood frequencies should be the 1% AEP (100-year) and the 0.2% AEP (500-year) events, respectively.

HYDROLOGIC ANALYSIS

Peak discharge rates were obtained from USGS StreamStats and the FEMA FIS for Franklin County, dated June 2011. StreamStats lists a drainage basin of 2.26 square miles and approximately 2-percent forest. A drainage basin area of 1.4 square miles was provided in the FIS. An aerial view of the drainage basin provided by USGS StreamStats is shown in Figure 6. Flood volumetric flow rates from StreamStats and the FIS are given in Table 1.

Hydraulic analysis was performed in HEC-RAS using a 1D model. The FIS and StreamStats flow rates for the proposed bridge location are very close in value, however the FIS did not provide a flowrate for a 500-year flood

event. Within the model, the FIS flow rates were used for the 25-year, 50-year, and 100-year profiles and the StreamStats flow rate was used for the 500-year profile.

Table 1: Blacklick Creek Flood Flow Rates at US Highway 33

Annual Exceedance/ Return Period	4% AEP/ 25year	2% AEP/ 50-year	1% AEP/ 100-year	0.2% AEP/ 500-year
StreamStats (cfs)	424	511	605	**852**
FIS (cfs)	**462**	**540**	**584**	-

The structure is located downstream of FIS cross section C and upstream from cross section B. A culvert on Bachman Road is located approximately 1,300 ft upstream and a bridge on Ebright Road is located approximately 1,500 ft downstream. The two structures were not included within the model as they were not within 1,000 feet of the FRA-33 structure, per ODOT L&D Manual Volume 2 Section 1007.2. Flood elevations taken from the FIS flood profile for Coble-Bowman Ditch are shown in Table 2 and Figure 7. The flat water surface elevation coincides with the 1% annual chance of backwater effects from George's Creek. Water surface elevations coinciding with the 0.2% chance flood are pulled from the George's Creek flood profile. This is due to the Coble-Bowman structure location being within the George's Creek flood plain for 1% AEP and lower probability storms. The George's Creek FIS profile can be seen in Figure 8.

Table 2: Coble-Bowman Ditch FIS Flood Elevations

FIS (ft)		
Location	100-yr	500-yr
Upstream of Ebright Bridge	745.8	749.56
FEMA Section B	745.8	749.56
Downstream of Bachman Road	745.8	749.56

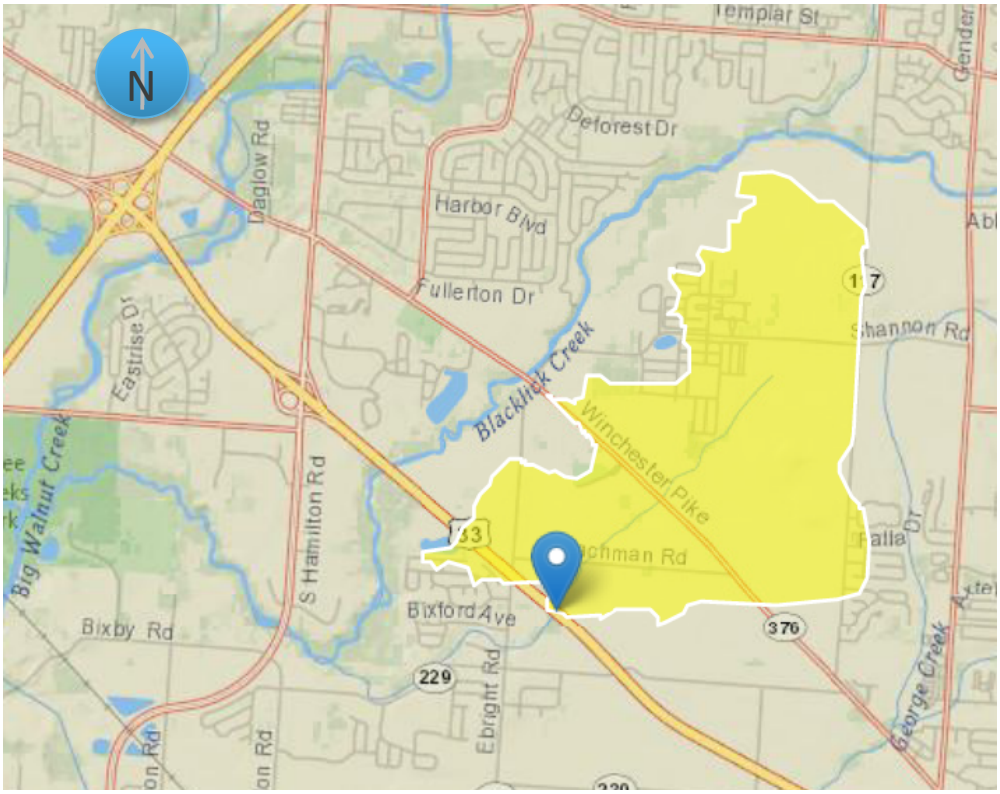


Figure 6: Drainage Basin from USGS StreamStats

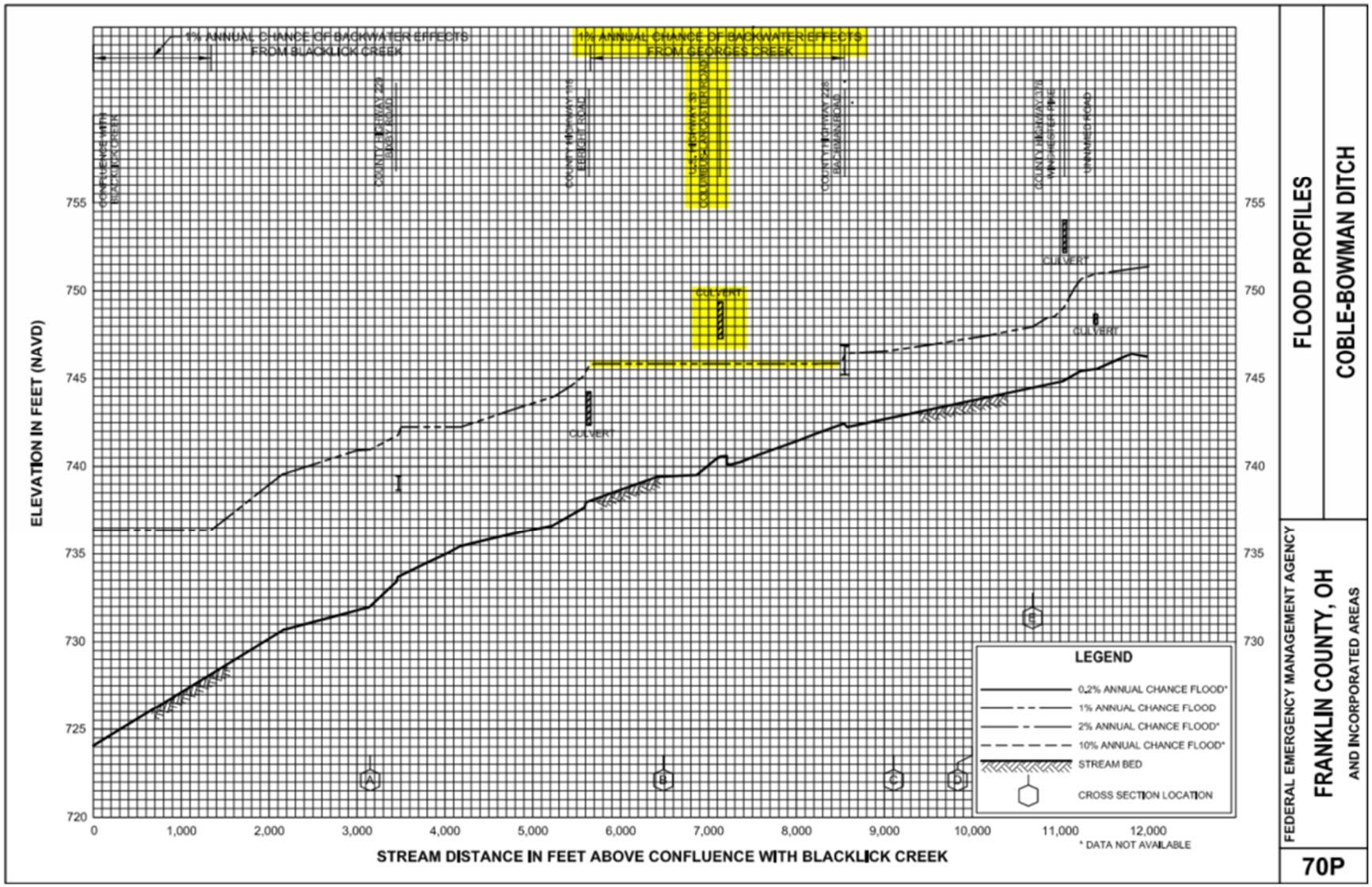


Figure 7: FIS Flood Profile

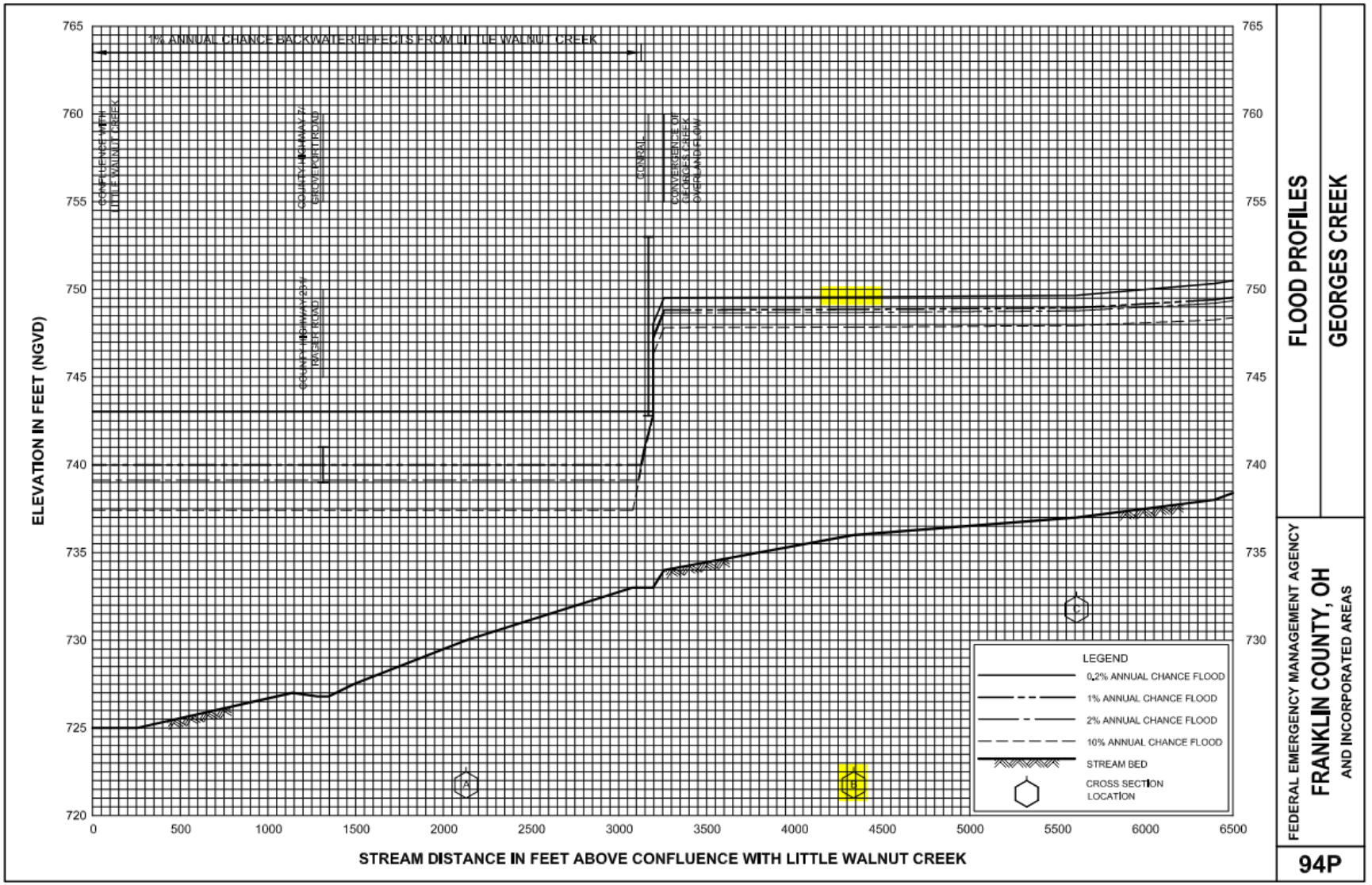


Figure 8: FIS Flood Profile for 500-yr Flood Profile

HYDRAULIC ANALYSIS - EXISTING CONDITIONS

The existing structure was modeled and analyzed within HEC-RAS. The conditions within the model were entered to depict the existing condition of the site at the time of this study. The structure crossing is within a FEMA floodplain with flood elevations as provided in Table 2 and shown in Figure 7.

A surface of survey data and supplemented with OSIP aerial lidar was built in OpenRoads Designer. The surface contours and aerial imagery were used to locate the channel centerline and create cross sections that were imported into HEC-RAS. A portion of the stream layout can be seen in Figure 9 below. Aerial imagery and field visits were used to determine the Manning's "n" values for entry into the hydraulic model which were found to be consistent with the ranges listed within the FIS. The applied and FIS Manning's "n" values can be found in Table 3 and Table 4. Ineffective flow areas for the existing conditions were input in accordance with the HEC-RAS 6.4 User's Manual. A 1:1 contraction ratio was used to define the areas upstream of the bridge. A 1.5:1 expansion ratio was used downstream of the bridge.

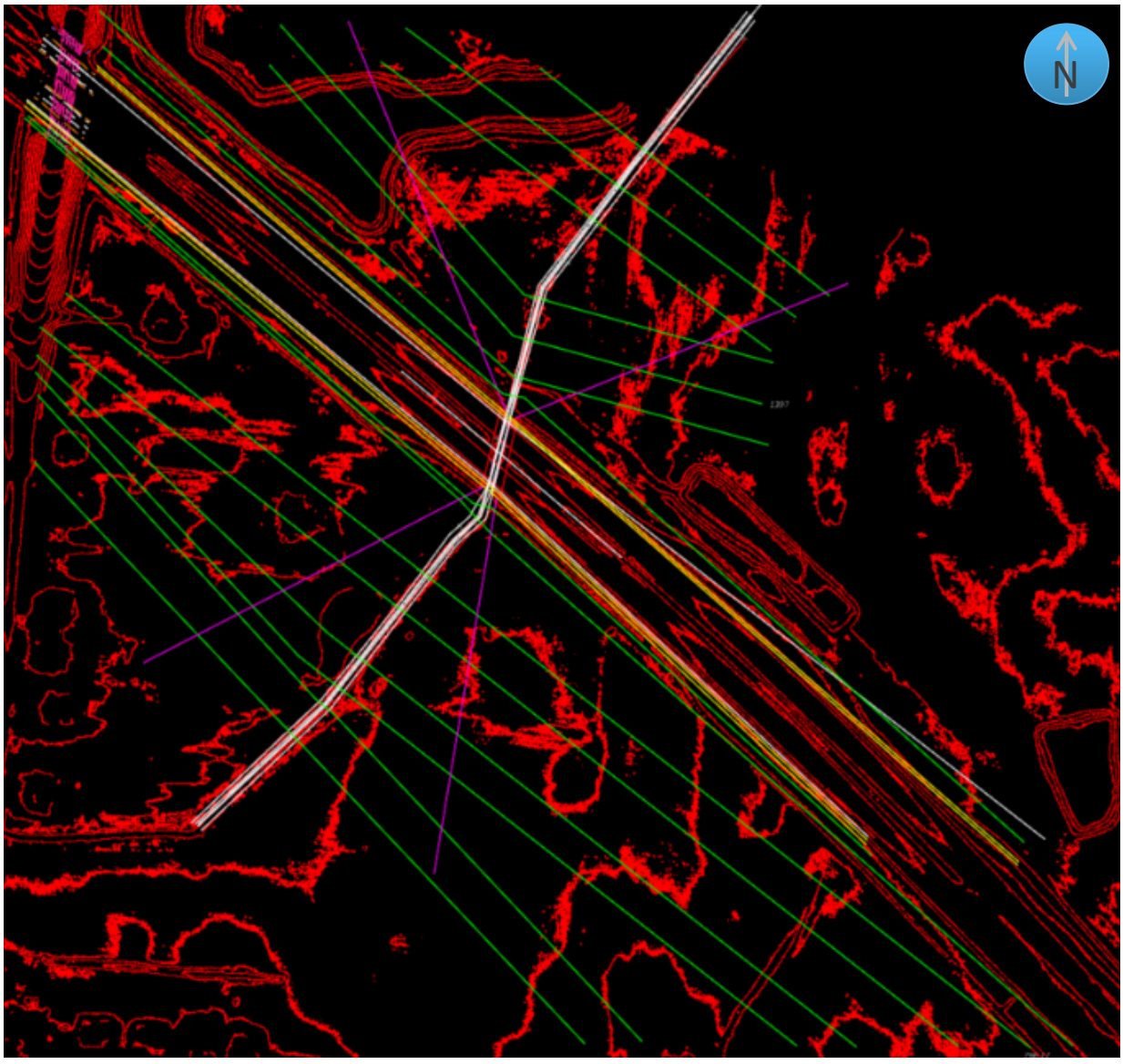


Figure 9: Existing Conditions Geometry

Table 3: Coble-Bowman Applied Manning's "n" Values

Type	Description	Value
Main Channel	Sluggish reaches, weedy. deep pools	0.070
Main Channel	Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush	0.100
Flood Plains	Pasture no brush, high grass	0.030
Flood Plains	Brush, Medium to dense brush, in summer	0.100
Flood Plains	Brush, Light brush and trees, in summer	0.060
Concrete	Trowel finish	0.013
Asphalt	Smooth	0.013
Flood Plains	Cultivated Area, mature row crops	0.035
Excavated or Dredged Channels	Dragline-excavated or dredged, no vegetation	0.028
Excavated or Dredged Channels	Dragline-excavated or dredged, light brush on banks	0.050

Table 4: Cable-Bowman Ditch FIS Manning's "n" Values

Location	"n"
Channel	0.058 - 0.073
Overbank	0.090 - 0.105

Typically, an existing model would be modified until the results closely resemble those of the FIS. However, after extensive modifications and matching existing conditions as closely as possible, the existing model was not able to result in the upstream flood elevations equivalent to those downstream as can be seen in the FIS flood profile shown in Figure 7. The primary reason for this is that the Coble-Bowman reach between Ebright Road and Bachman Road is within the 1% annual chance of backwater effects from George's Creek per the FIS. The model area was limited and the use of a 1D hydraulic model as requested by the District, and the effects of George's creek are therefore not explicitly accounted for in the model. While the ODOT L&D Manual Volume 2, Section 1107.2.1 suggests the usage of a 2D analysis may have been more applicable due to the wide floodplain surrounding the structure the overall impact on the hydraulic design is likely to be small, and the assumptions used in this study are conservative. In order to fully capture these effects a large regional model including Blacklick Creek, George's Creek, and Coble-Bowman Ditch would be required.

The model was analyzed for 4% AEP (25-yr), 2% AEP (50-yr), 1% AEP (100-yr), and 0.2% AEP (500-yr) storms. Since the 0.2% AEP (500-year) will also be impacted by the effects of George's Creek, and no 0.2% AEP data for Coble-Bowman Ditch was included in the FIS, the 0.2% AEP elevation at of George's Creek confluence Section B (749.56) was used. The known water surface elevations for the 1% AEP and 0.2% AEP were used as the downstream boundary conditions, with upstream boundary conditions using normal depth assumptions. For the 2% AEP and lower flow rates the normal depth boundary condition was used for both the upstream and the downstream.

Once the existing geometry was finalized, the results were used as an existing flood elevation baseline for the proposed alternatives.

HYDRAULIC ANALYSIS - PROPOSED CONDITIONS

In accordance with ODOT L&D Manual Volume 2, Section 1006.3, the hydraulic results determined by the proposed structure were compared to existing conditions, and it is preferred to match or improve existing conditions to the maximum extent practical.

The Structure Type Study (STS) investigated structure alternatives to allow for a roadway width of 62.5-ft toe-to-toe of barriers with the addition of a third travel lane in each direction. The existing structure will be replaced completely with one of three culvert options analyzed within the hydraulic model. The alternatives modeled were a four-sided precast box, three-sided precast section, and a corrugated metal pipe arch.

HEC-RAS results showing water surface elevations and velocities upstream of the bridge have been tabulated in Table 5 (Four-Sided Precast Box), Table 7 (Three-Sided Precast), and Table 9 (Corrugated Metal Pipe Arch). A reduced selection of cross-sections upstream and downstream of the structure have been included within the table for simplicity as results for the remaining sections are identical between the existing and proposed models.

Each alternative was analyzed using two different boundary conditions: one for known downstream water surface elevation and one for normal depth. This was to determine both the worst case elevation change as well as worst case velocity change. Plan names ending with “E” indicate the known elevation boundary condition and plan name ending with “V” indicate the normal depth boundary condition.

The results indicate lower water surface elevations upstream and no change in water surface elevations downstream with all three proposed structures. Downstream velocities were also unchanged in the proposed condition, with only minor increases upstream of the structures. The proposed structure clears the 100-year storm by 6.38-ft. These results can also be graphically seen in the profiles in Figure 10, Figure 11, and Figure 12.

Table 5: Hydraulic Results – 50-yr Water Surface Elevations and Velocities
(Four-Sided Precast Box)

River Sta	Profile	Plan	Q Total	16x5		16x6	
				W.S. Elev	Vel Chnl	W.S. Elev	Vel Chnl
			(cfs)	(ft)	(ft/s)	(ft)	(ft/s)
1917.216	50-yr	ExE	540	748.01	0.28	748.01	0.28
1917.216	50-yr	PBE	540	746.05	1.26	746.05	1.26
1917.216	50-yr	ExV	540	748.01	0.28	748.01	0.28
1917.216	50-yr	PBV	540	746.05	1.26	746.05	1.26
1815.309	50-yr	ExE	540	748.01	0.27	748.01	0.27
1815.309	50-yr	PBE	540	746.01	0.87	746.01	0.87
1815.309	50-yr	ExV	540	748.01	0.27	748.01	0.27
1815.309	50-yr	PBV	540	746.01	0.87	746.01	0.87
1718.108	50-yr	ExE	540	748.01	0.2	748.01	0.2
1718.108	50-yr	PBE	540	746	0.55	746	0.55
1718.108	50-yr	ExV	540	748.01	0.2	748.01	0.2
1718.108	50-yr	PBV	540	746	0.55	746	0.55
1494.218	50-yr	ExE	540	748.01	0.16	748.01	0.16
1494.218	50-yr	PBE	540	745.98	0.35	745.98	0.35
1494.218	50-yr	ExV	540	748.01	0.16	748.01	0.16
1494.218	50-yr	PBV	540	745.98	0.35	745.98	0.35
1396.953	50-yr	ExE	540	748.01	0.31	748.01	0.31
1396.953	50-yr	PBE	540	745.98	0.61	745.98	0.61
1396.953	50-yr	ExV	540	748.01	0.31	748.01	0.31
1396.953	50-yr	PBV	540	745.98	0.61	745.98	0.61
1307.234	50-yr	ExE	540	748	0.69	748	0.69
1307.234	50-yr	PBE	540	745.95	1.25	745.95	1.25
1307.234	50-yr	ExV	540	748	0.69	748	0.69
1307.234	50-yr	PBV	540	745.95	1.25	745.95	1.25
1262.11	50-yr	ExE	540	747.97	0.66	747.97	0.66
1262.11	50-yr	PBE	540	745.86	1.27	745.86	1.27
1262.11	50-yr	ExV	540	747.97	0.66	747.97	0.66
1262.11	50-yr	PBV	540	745.86	1.27	745.86	1.27
1127			Culvert				
997.3811	50-yr	ExE	540	744.59	3.39	744.59	3.39
997.3811	50-yr	PBE	540	744.59	3.39	744.59	3.39
997.3811	50-yr	ExV	540	744.59	3.39	744.59	3.39
997.3811	50-yr	PBV	540	744.59	3.39	744.59	3.39
301.5571	50-yr	ExE	540	742.82	1.59	742.82	1.59
301.5571	50-yr	PBE	540	742.82	1.59	742.82	1.59
301.5571	50-yr	ExV	540	742.82	1.59	742.82	1.59
301.5571	50-yr	PBV	540	742.82	1.59	742.82	1.59

Table 6: Hydraulic Results – 100-yr Water Surface Elevations and Velocities
(Four-Sided Precast Box)

River Sta	Profile	Plan	Q Total	16x5		16x6	
				W.S. Elev	Vel Chnl	W.S. Elev	Vel Chnl
			(cfs)	(ft)	(ft/s)	(ft)	(ft/s)
1917.216	100-yr	ExE	584	748.54	0.24	748.54	0.24
1917.216	100-yr	PBE	584	747.31	0.47	746.86	0.68
1917.216	100-yr	ExV	584	748.35	0.26	748.35	0.26
1917.216	100-yr	PBV	584	746.27	1.07	746.27	1.07
1815.309	100-yr	ExE	584	748.54	0.24	748.54	0.24
1815.309	100-yr	PBE	584	747.31	0.4	746.85	0.52
1815.309	100-yr	ExV	584	748.34	0.25	748.34	0.25
1815.309	100-yr	PBV	584	746.25	0.78	746.25	0.78
1718.108	100-yr	ExE	584	748.54	0.19	748.54	0.19
1718.108	100-yr	PBE	584	747.31	0.29	746.84	0.36
1718.108	100-yr	ExV	584	748.34	0.2	748.34	0.2
1718.108	100-yr	PBV	584	746.24	0.51	746.24	0.51
1494.218	100-yr	ExE	584	748.54	0.15	748.54	0.15
1494.218	100-yr	PBE	584	747.3	0.22	746.84	0.26
1494.218	100-yr	ExV	584	748.34	0.16	748.34	0.16
1494.218	100-yr	PBV	584	746.22	0.33	746.22	0.33
1396.953	100-yr	ExE	584	748.54	0.3	748.54	0.3
1396.953	100-yr	PBE	584	747.3	0.41	746.83	0.47
1396.953	100-yr	ExV	584	748.34	0.31	748.34	0.31
1396.953	100-yr	PBV	584	746.22	0.59	746.22	0.59
1307.234	100-yr	ExE	584	748.53	0.66	748.53	0.66
1307.234	100-yr	PBE	584	747.29	0.88	746.82	1.01
1307.234	100-yr	ExV	584	748.34	0.69	748.34	0.69
1307.234	100-yr	PBV	584	746.19	1.24	746.19	1.24
1262.11	100-yr	ExE	584	748.51	0.64	748.51	0.64
1262.11	100-yr	PBE	584	747.25	0.86	746.76	1
1262.11	100-yr	ExV	584	748.31	0.67	748.31	0.67
1262.11	100-yr	PBV	584	746.11	1.25	746.11	1.25
1127			Culvert				
997.3811	100-yr	ExE	584	745.84	2.51	745.84	2.51
997.3811	100-yr	PBE	584	745.84	2.51	745.84	2.51
997.3811	100-yr	ExV	584	744.66	3.57	744.66	3.57
997.3811	100-yr	PBV	584	744.66	3.57	744.66	3.57
301.5571	100-yr	ExE	584	745.8	0.16	745.8	0.16
301.5571	100-yr	PBE	584	745.8	0.16	745.8	0.16
301.5571	100-yr	ExV	584	742.87	1.6	742.87	1.6
301.5571	100-yr	PBV	584	742.87	1.6	742.87	1.6

Table 7: Hydraulic Results – 50-yr Water Surface Elevations and Velocities

(Three-Sided Precast)

River Sta	Profile	Plan	Q Total	14x6		16x6		18x6	
				W.S. Elev	Vel Chnl	W.S. Elev	Vel Chnl	W.S. Elev	Vel Chnl
			(cfs)	(ft)	(ft/s)	(ft)	(ft/s)	(ft)	(ft/s)
1917.216	50-yr	ExE	540	748.01	0.28	748.01	0.28	748.01	0.28
1917.216	50-yr	P3E	540	747.63	0.35	747.02	0.54	746.6	0.78
1917.216	50-yr	ExV	540	748.01	0.28	748.01	0.28	748.01	0.28
1917.216	50-yr	P3V	540	747.63	0.35	747.02	0.54	746.6	0.78
1815.309	50-yr	ExE	540	748.01	0.27	748.01	0.27	748.01	0.27
1815.309	50-yr	P3E	540	747.63	0.32	747.01	0.44	746.59	0.57
1815.309	50-yr	ExV	540	748.01	0.27	748.01	0.27	748.01	0.27
1815.309	50-yr	P3V	540	747.63	0.32	747.01	0.44	746.59	0.57
1718.108	50-yr	ExE	540	748.01	0.2	748.01	0.2	748.01	0.2
1718.108	50-yr	P3E	540	747.63	0.23	747.01	0.31	746.59	0.38
1718.108	50-yr	ExV	540	748.01	0.2	748.01	0.2	748.01	0.2
1718.108	50-yr	P3V	540	747.63	0.23	747.01	0.31	746.59	0.38
1494.218	50-yr	ExE	540	748.01	0.16	748.01	0.16	748.01	0.16
1494.218	50-yr	P3E	540	747.63	0.18	747.01	0.22	746.58	0.26
1494.218	50-yr	ExV	540	748.01	0.16	748.01	0.16	748.01	0.16
1494.218	50-yr	P3V	540	747.63	0.18	747.01	0.22	746.58	0.26
1396.953	50-yr	ExE	540	748.01	0.31	748.01	0.31	748.01	0.31
1396.953	50-yr	P3E	540	747.63	0.35	747	0.41	746.58	0.48
1396.953	50-yr	ExV	540	748.01	0.31	748.01	0.31	748.01	0.31
1396.953	50-yr	P3V	540	747.63	0.35	747	0.41	746.58	0.48
1307.234	50-yr	ExE	540	748	0.69	748	0.69	748	0.69
1307.234	50-yr	P3E	540	747.62	0.75	746.99	0.89	746.56	1.01
1307.234	50-yr	ExV	540	748	0.69	748	0.69	748	0.69
1307.234	50-yr	P3V	540	747.62	0.75	746.99	0.89	746.56	1.01
1262.11	50-yr	ExE	540	747.97	0.66	747.97	0.66	747.97	0.66
1262.11	50-yr	P3E	540	747.59	0.73	746.95	0.87	746.5	1
1262.11	50-yr	ExV	540	747.97	0.66	747.97	0.66	747.97	0.66
1262.11	50-yr	P3V	540	747.59	0.73	746.95	0.87	746.5	1
1127			Culvert						
997.3811	50-yr	ExE	540	744.59	3.39	744.59	3.39	744.59	3.39
997.3811	50-yr	P3E	540	744.59	3.39	744.59	3.39	744.59	3.39
997.3811	50-yr	ExV	540	744.59	3.39	744.59	3.39	744.59	3.39
997.3811	50-yr	P3V	540	744.59	3.39	744.59	3.39	744.59	3.39
301.5571	50-yr	ExE	540	742.82	1.59	742.82	1.59	742.82	1.59
301.5571	50-yr	P3E	540	742.82	1.59	742.82	1.59	742.82	1.59
301.5571	50-yr	ExV	540	742.82	1.59	742.82	1.59	742.82	1.59
301.5571	50-yr	P3V	540	742.82	1.59	742.82	1.59	742.82	1.59

Table 8: Hydraulic Results – 100-yr Water Surface Elevations and Velocities
(Three-Sided Precast)

River Sta	Profile	Plan	Q Total	14x6		16x6		18x6	
				W.S. Elev	Vel Chnl	W.S. Elev	Vel Chnl	W.S. Elev	Vel Chnl
			(cfs)	(ft)	(ft/s)	(ft)	(ft/s)	(ft)	(ft/s)
1917.216	100-yr	ExE	584	748.54	0.24	748.54	0.24	748.54	0.24
1917.216	100-yr	P3E	584	748.62	0.23	747.96	0.32	747.52	0.41
1917.216	100-yr	ExV	584	748.35	0.26	748.35	0.26	748.35	0.26
1917.216	100-yr	P3V	584	748.1	0.29	747.38	0.45	746.9	0.66
1815.309	100-yr	ExE	584	748.54	0.24	748.54	0.24	748.54	0.24
1815.309	100-yr	P3E	584	748.62	0.23	747.96	0.3	747.52	0.36
1815.309	100-yr	ExV	584	748.34	0.25	748.34	0.25	748.34	0.25
1815.309	100-yr	P3V	584	748.1	0.28	747.38	0.39	746.89	0.51
1718.108	100-yr	ExE	584	748.54	0.19	748.54	0.19	748.54	0.19
1718.108	100-yr	P3E	584	748.62	0.18	747.96	0.23	747.51	0.27
1718.108	100-yr	ExV	584	748.34	0.2	748.34	0.2	748.34	0.2
1718.108	100-yr	P3V	584	748.1	0.21	747.37	0.28	746.88	0.35
1494.218	100-yr	ExE	584	748.54	0.15	748.54	0.15	748.54	0.15
1494.218	100-yr	P3E	584	748.61	0.15	747.96	0.18	747.51	0.2
1494.218	100-yr	ExV	584	748.34	0.16	748.34	0.16	748.34	0.16
1494.218	100-yr	P3V	584	748.1	0.17	747.37	0.21	746.88	0.25
1396.953	100-yr	ExE	584	748.54	0.3	748.54	0.3	748.54	0.3
1396.953	100-yr	P3E	584	748.61	0.3	747.96	0.34	747.51	0.39
1396.953	100-yr	ExV	584	748.34	0.31	748.34	0.31	748.34	0.31
1396.953	100-yr	P3V	584	748.09	0.33	747.37	0.4	746.88	0.47
1307.234	100-yr	ExE	584	748.53	0.66	748.53	0.66	748.53	0.66
1307.234	100-yr	P3E	584	748.61	0.65	747.95	0.75	747.5	0.84
1307.234	100-yr	ExV	584	748.34	0.69	748.34	0.69	748.34	0.69
1307.234	100-yr	P3V	584	748.09	0.73	747.36	0.87	746.86	1
1262.11	100-yr	ExE	584	748.51	0.64	748.51	0.64	748.51	0.64
1262.11	100-yr	P3E	584	748.58	0.63	747.92	0.73	747.46	0.81
1262.11	100-yr	ExV	584	748.31	0.67	748.31	0.67	748.31	0.67
1262.11	100-yr	P3V	584	748.06	0.7	747.32	0.85	746.81	0.98
1127			Culvert						
997.3811	100-yr	ExE	584	745.84	2.51	745.84	2.51	745.84	2.51
997.3811	100-yr	P3E	584	745.84	2.51	745.84	2.51	745.84	2.51
997.3811	100-yr	ExV	584	744.66	3.57	744.66	3.57	744.66	3.57
997.3811	100-yr	P3V	584	744.66	3.57	744.66	3.57	744.66	3.57
301.5571	100-yr	ExE	584	745.8	0.16	745.8	0.16	745.8	0.16
301.5571	100-yr	P3E	584	745.8	0.16	745.8	0.16	745.8	0.16
301.5571	100-yr	ExV	584	742.87	1.6	742.87	1.6	742.87	1.6
301.5571	100-yr	P3V	584	742.87	1.6	742.87	1.6	742.87	1.6

Table 9: Hydraulic Results – 50-yr Water Surface Elevations and Velocities

(Corrugated Metal Pipe Arch)

River Sta	Profile	Plan	Q Total	Double 112x75		Double 103x71		Double 95x67	
				W.S. Elev	Vel Chnl	W.S. Elev	Vel Chnl	W.S. Elev	Vel Chnl
			(cfs)	(ft)	(ft/s)	(ft)	(ft/s)	(ft)	(ft/s)
1917.216	50-yr	ExE	540	748.01	0.28	748.01	0.28	748.01	0.28
1917.216	50-yr	PSE	540	746.4	0.87	746.71	0.7	747.32	0.43
1917.216	50-yr	ExV	540	748.01	0.28	748.01	0.28	748.01	0.28
1917.216	50-yr	PSV	540	746.4	0.87	746.71	0.7	747.32	0.43
1815.309	50-yr	ExE	540	748.01	0.27	748.01	0.27	748.01	0.27
1815.309	50-yr	PSE	540	746.39	0.65	746.7	0.52	747.32	0.37
1815.309	50-yr	ExV	540	748.01	0.27	748.01	0.27	748.01	0.27
1815.309	50-yr	PSV	540	746.39	0.65	746.7	0.52	747.32	0.37
1718.108	50-yr	ExE	540	748.01	0.2	748.01	0.2	748.01	0.2
1718.108	50-yr	PSE	540	746.38	0.43	746.7	0.36	747.32	0.27
1718.108	50-yr	ExV	540	748.01	0.2	748.01	0.2	748.01	0.2
1718.108	50-yr	PSV	540	746.38	0.43	746.7	0.36	747.32	0.27
1494.218	50-yr	ExE	540	748.01	0.16	748.01	0.16	748.01	0.16
1494.218	50-yr	PSE	540	746.37	0.29	746.69	0.25	747.31	0.2
1494.218	50-yr	ExV	540	748.01	0.16	748.01	0.16	748.01	0.16
1494.218	50-yr	PSV	540	746.37	0.29	746.69	0.25	747.31	0.2
1396.953	50-yr	ExE	540	748.01	0.31	748.01	0.31	748.01	0.31
1396.953	50-yr	PSE	540	746.36	0.52	746.69	0.46	747.31	0.38
1396.953	50-yr	ExV	540	748.01	0.31	748.01	0.31	748.01	0.31
1396.953	50-yr	PSV	540	746.36	0.52	746.69	0.46	747.31	0.38
1307.234	50-yr	ExE	540	748	0.69	748	0.69	748	0.69
1307.234	50-yr	PSE	540	746.35	1.08	746.68	0.97	747.3	0.81
1307.234	50-yr	ExV	540	748	0.69	748	0.69	748	0.69
1307.234	50-yr	PSV	540	746.35	1.08	746.68	0.97	747.3	0.81
1262.11	50-yr	ExE	540	747.97	0.66	747.97	0.66	747.97	0.66
1262.11	50-yr	PSE	540	746.28	1.08	746.63	0.96	747.27	0.79
1262.11	50-yr	ExV	540	747.97	0.66	747.97	0.66	747.97	0.66
1262.11	50-yr	PSV	540	746.28	1.08	746.63	0.96	747.27	0.79
1127			Culvert						
997.3811	50-yr	ExE	540	744.59	3.39	744.59	3.39	744.59	3.39
997.3811	50-yr	PSE	540	744.59	3.39	744.59	3.39	744.59	3.39
997.3811	50-yr	ExV	540	744.59	3.39	744.59	3.39	744.59	3.39
997.3811	50-yr	PSV	540	744.59	3.39	744.59	3.39	744.59	3.39
301.5571	50-yr	ExE	540	742.82	1.59	742.82	1.59	742.82	1.59
301.5571	50-yr	PSE	540	742.82	1.59	742.82	1.59	742.82	1.59
301.5571	50-yr	ExV	540	742.82	1.59	742.82	1.59	742.82	1.59
301.5571	50-yr	PSV	540	742.82	1.59	742.82	1.59	742.82	1.59

Table 10: Hydraulic Results – 100-yr Water Surface Elevations and Velocities
(Corrugated Metal Pipe Arch)

River Sta	Profile	Plan	Q Total	Double 112x75		Double 103x71		Double 95x67	
				W.S. Elev	Vel Chnl	W.S. Elev	Vel Chnl	W.S. Elev	Vel Chnl
			(cfs)	(ft)	(ft/s)	(ft)	(ft/s)	(ft)	(ft/s)
1917.216	100-yr	ExE	584	748.54	0.24	748.54	0.24	748.54	0.24
1917.216	100-yr	PSE	584	747.56	0.4	748.07	0.3	748.85	0.22
1917.216	100-yr	ExV	584	748.35	0.26	748.35	0.26	748.35	0.26
1917.216	100-yr	PSV	584	746.69	0.77	747.09	0.56	747.84	0.34
1815.309	100-yr	ExE	584	748.54	0.24	748.54	0.24	748.54	0.24
1815.309	100-yr	PSE	584	747.55	0.36	748.07	0.28	748.85	0.23
1815.309	100-yr	ExV	584	748.34	0.25	748.34	0.25	748.34	0.25
1815.309	100-yr	PSV	584	746.68	0.58	747.08	0.46	747.84	0.31
1718.108	100-yr	ExE	584	748.54	0.19	748.54	0.19	748.54	0.19
1718.108	100-yr	PSE	584	747.55	0.26	748.06	0.22	748.85	0.19
1718.108	100-yr	ExV	584	748.34	0.2	748.34	0.2	748.34	0.2
1718.108	100-yr	PSV	584	746.67	0.39	747.08	0.32	747.84	0.24
1494.218	100-yr	ExE	584	748.54	0.15	748.54	0.15	748.54	0.15
1494.218	100-yr	PSE	584	747.55	0.2	748.06	0.17	748.84	0.17
1494.218	100-yr	ExV	584	748.34	0.16	748.34	0.16	748.34	0.16
1494.218	100-yr	PSV	584	746.67	0.27	747.07	0.23	747.83	0.18
1396.953	100-yr	ExE	584	748.54	0.3	748.54	0.3	748.54	0.3
1396.953	100-yr	PSE	584	747.55	0.38	748.06	0.33	748.84	0.32
1396.953	100-yr	ExV	584	748.34	0.31	748.34	0.31	748.34	0.31
1396.953	100-yr	PSV	584	746.66	0.5	747.07	0.44	747.83	0.35
1307.234	100-yr	ExE	584	748.53	0.66	748.53	0.66	748.53	0.66
1307.234	100-yr	PSE	584	747.54	0.83	748.05	0.73	748.83	1.15
1307.234	100-yr	ExV	584	748.34	0.69	748.34	0.69	748.34	0.69
1307.234	100-yr	PSV	584	746.65	1.06	747.06	0.94	747.82	0.77
1262.11	100-yr	ExE	584	748.51	0.64	748.51	0.64	748.51	0.64
1262.11	100-yr	PSE	584	747.5	0.81	748.02	0.71	748.76	2.45
1262.11	100-yr	ExV	584	748.31	0.67	748.31	0.67	748.31	0.67
1262.11	100-yr	PSV	584	746.58	1.05	747.01	0.92	747.79	0.75
1127			Culvert						
997.3811	100-yr	ExE	584	745.84	2.51	745.84	2.51	745.84	2.51
997.3811	100-yr	PSE	584	745.84	2.51	745.84	2.51	745.84	2.51
997.3811	100-yr	ExV	584	744.66	3.57	744.66	3.57	744.66	3.57
997.3811	100-yr	PSV	584	744.66	3.57	744.66	3.57	744.66	3.57
301.5571	100-yr	ExE	584	745.8	0.16	745.8	0.16	745.8	0.16
301.5571	100-yr	PSE	584	745.8	0.16	745.8	0.16	745.8	0.16
301.5571	100-yr	ExV	584	742.87	1.6	742.87	1.6	742.87	1.6
301.5571	100-yr	PSV	584	742.87	1.6	742.87	1.6	742.87	1.6

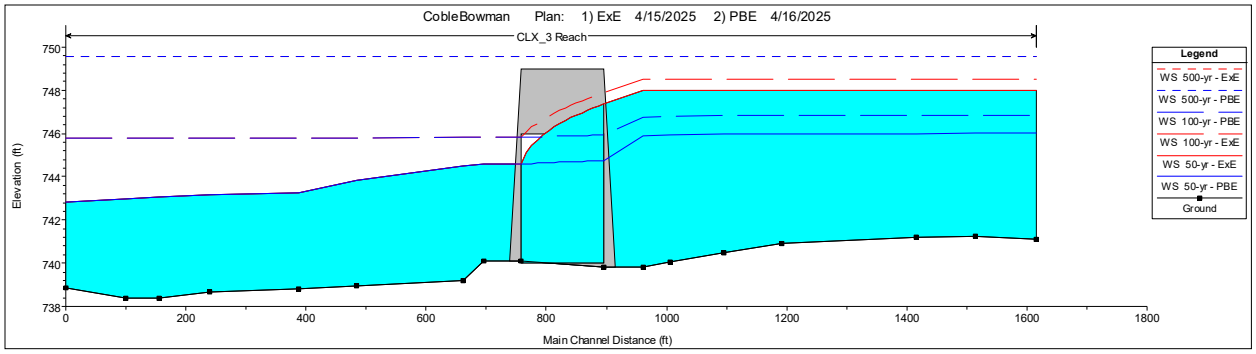


Figure 10: Water Surface Profiles – Existing and Proposed Precast Box (16x6)

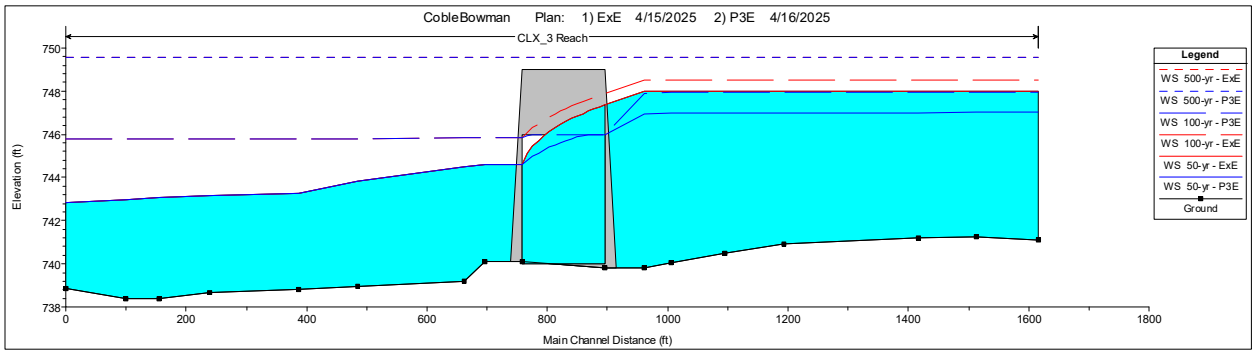


Figure 11: Water Surface Profiles – Existing and Proposed Three-Sided Precast (16x6)

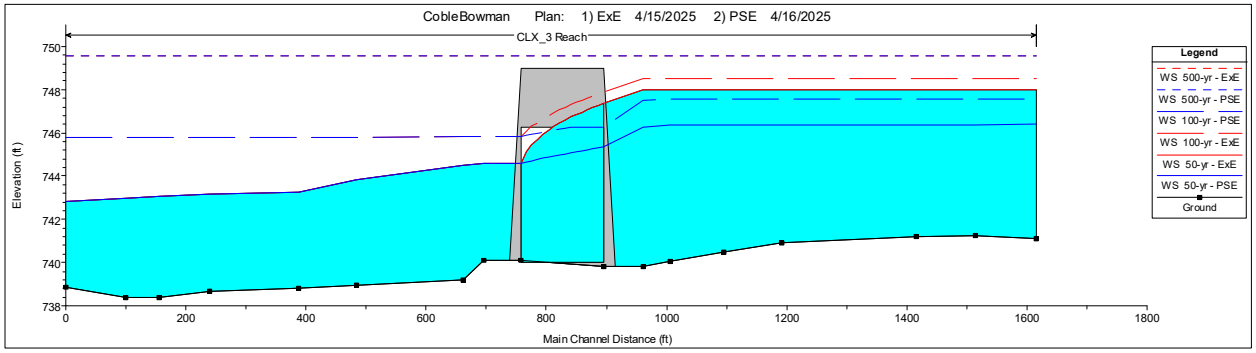


Figure 12: Water Surface Profiles – Existing and Proposed Metal Pipe Arch (Double 112x75)

FLOOD HAZARD EVALUATION

The FIRM indicates there are several inhabitable structures within the modeled floodplain limits. The hydraulic modeling of the existing and proposed conditions indicates that the modifications associated with the structure replacement will not have an adverse effect on the water surface elevations within the study area. Therefore, there is no change in the risk previously associated with those structure locations.

RISK ASSESSMENT

Risks of flooding have been defined by the FEMA assessment previously completed, and this project will have a no-rise impact to the floodplain as determined by modeling in HEC-RAS. The structure is of greater risk as an urban Principal Arterial Freeway with a speed limit of 60 mph, however none of the 100-yr water profiles cause inundation of the roadway. Although the 500-yr flood event elevations display as inundating the roadway, this is

likely due to the limitations of the model in relation to the FIS and it is not anticipated for these waters to overtop the roadway.

Resiliency of structures due to changing climatic conditions has been assessed. The 2014 "Climate Change Impacts in the United States", regional impacts of the Third National Climate Assessment indicates a 60-100% increase in number of days exceeding 1.25-in. of precipitation per year and 20% increase in total precipitation and 32% increase in the number of heavy precipitation events in the 1951-2012 assessment period. If this continues at the same rate as the past 60 years, the likelihood of larger storms will impact the structure by reducing the return period of the storm currently considered as the 100-year event, and correspondingly increasing the flow rates that should be considered for each event. While this will have impacts, given the assumption that the 500-year event is not anticipated to overtop the roadway, the design consideration for scour, the risk to human life and for capital costs due to this structure replacement is limited.

SCOUR ANALYSIS

Due to limited geotechnical information at this time, a full scour analysis was not performed. Final analysis will be performed following additional geotechnical investigation if warranted for the alternative selected.

Based on using a 50-year design flood, the scour design flood frequency is listed as the 100-year storm and the scour check flood frequency as the 500-year storm per L&D Volume 2 Table 1008-1. However, due to the reservoir effects of the floodplain in this area, the lower 10-year and 25-year storms may have slightly higher velocities at lower flow elevations and will be investigated as well. However, for all flow rates analyzed, velocities through the channel remain low (under 2.0 ft/s) and minimal scour is anticipated.

Based on historic boring information, much of the material at the structure consists of silt and clay, clay, sandy silt, and gravel and/or stone fragment layers. A preliminary scour analysis was performed using the FHWA Hydraulic Toolbox and HEC-18 equations for contraction scour, the results of which are shown below in Table 11. Analysis was performed assuming no additional slope protection is installed. The minimum 0.2mm value was used for the D50 input until additional information can be provided.

Table 11: Preliminary Contraction Scour Analysis Results

Storm	Alt 1: Box		Alt 2: 3-Sided		Alt 3: Pipe	
	Clear Water	Live Bed	Clear Water	Live Bed	Clear Water	Live Bed
25-Year	**0.25ft**	0.90ft	**0.00ft**	0.84ft	**0.00ft**	0.25ft
50-Year	**0.04ft**	0.91ft	**0.00ft**	0.86ft	**0.00ft**	0.88ft
100-Year	**0.00ft**	0.88ft	**0.00ft**	1.03ft	**0.00ft**	0.88ft
500-Year	**0.00ft**	0.00ft	**0.00ft**	0.00ft	**0.00ft**	0.00ft

With the given velocities and assumed D50, clear-water scour governs and less than 1-ft of scour is anticipated. This will be verified during detail design stages. Full height headwalls will be utilized for all three alternatives. A cutoff wall and armoring with type B rock channel protection per L&D Volume 2, Section 1106.2.2 will also be used for scour mitigation. Preliminary scour analysis output can be seen in Appendix 7.

TEMPORARY ACCESS FILL (TAF)

The maximum mean monthly flow from USGS StreamStats is 4.04 cfs (March), which results in a Standard Temporary Discharge (STD) of 8.08 cfs. The back water surface at the station just upstream (Section 1262) is 744.31 feet for the 50% AEP event of 149 cfs. The flow producing the OHWM elevation of 741.25 is 11.8 cfs with no TAF installed.

A full-width TAF with conduits was analyzed and found to be sufficient for the construction. The TAF was analyzed in HEC-RAS by placing circular pipes in the channel within the bridge limits to represent the restricted section during the phased construction. The use of (2)-30-inch pipes or (4)-18 inch pipes are sufficient to maintain a water surface elevation lower than the OHWM under STD conditions. The Tier 1 TAF Analysis is therefore sufficient for this evaluation.

Additional TAF documents and forms are included in the appendix.

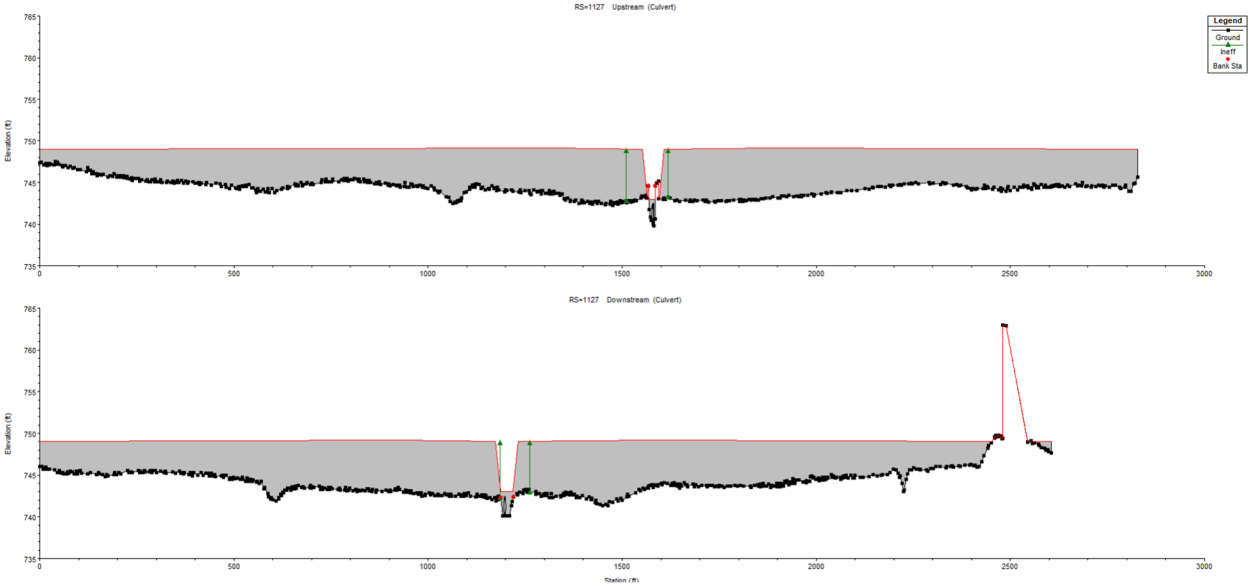
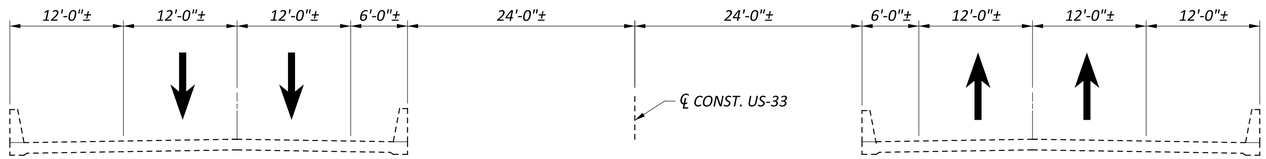


Figure 13:Full-Width Temporary Access Fill

APPENDIX 1: STRUCTURE PLANS



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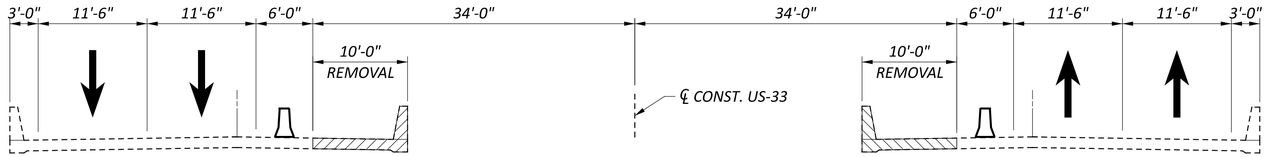
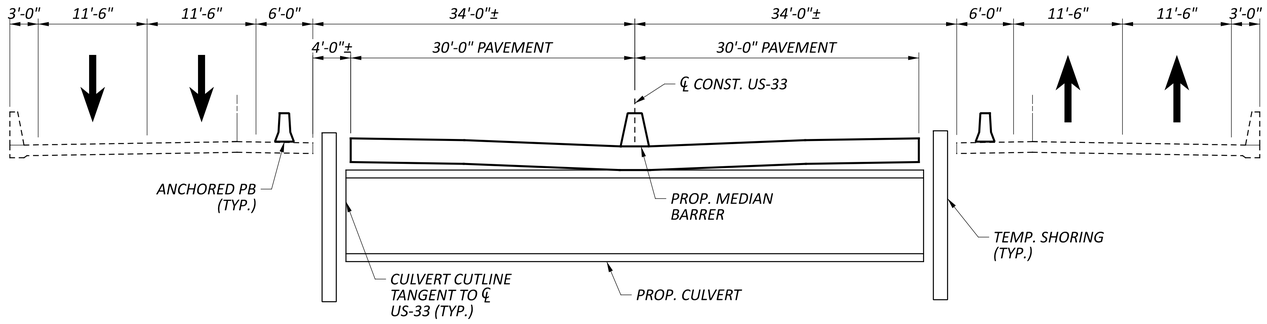
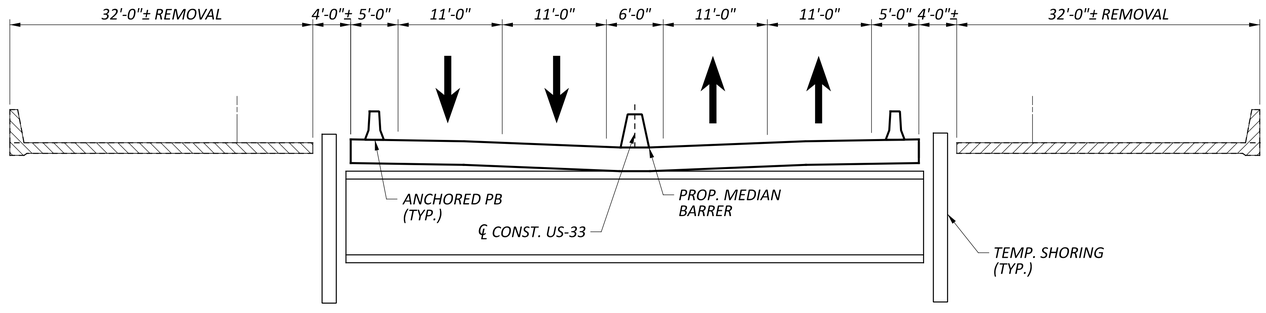


PHASE 1 REMOVAL



PHASE 1 CONSTRUCTION



PHASE 2 REMOVAL

PRE-PHASE 1

CLOSE ONE OUTSIDE LANE IN EACH DIRECTION TO INSTALL TEMPORARY FULL-DEPTH SHOULDER ON OUTSIDE ALONG US-33 WIDENING CORRIDOR.

PHASE 1 REMOVAL

SHIFT TRAFFIC TO OUTSIDE SHOULDER OF EXISTING ROADWAY AND STRUCTURE AS SHOWN. REMOVE PORTION OF DECK EDGE AND INSIDE PARAPET.

PHASE 1 CONSTRUCTION

INSTALL TEMPORARY SHORING AND CONSTRUCT CENTER OF CULVERT TO PROVIDE THE WIDTH NEEDED TO PLACE LANE CONFIGURATION AS SHOWN IN NEXT PHASE. CULVERT CUTLINE IS ANTICIPATED TO BE TANGENT TO ℄ US-33. USE PRECAST SEGMENTS EXCEPT AT UNIT ADJACENT TO CUTLINE THAT IS ASSUMED TO BE CAST-IN-PLACE ALONG THE SKEWED CUTLINE.

PHASE 2 REMOVAL

SHIFT EASTBOUND AND WESTBOUND TRAFFIC TO NEWLY CONSTRUCTED PORTION OF CULVERT AND PAVEMENT UTILIZING THE LANE CONFIGURATION SHOWN.

REMOVE REMAINING PORTIONS OF EXISTING STRUCTURE IN BOTH THE EASTBOUND AND WESTBOUND DIRECTION.

STAGED CONSTRUCTION DIAGRAMS
BRIDGE NO. FRA-33-27.51L/R
U.S.-33 OVER COBLE-BOWMAN DITCH

SFN	0
DESIGN AGENCY	WOOLPERT
DESIGNER	CML
CHECKER	PES
REVIEWER	TML 05-06-25
PROJECT ID	119387
SUBSET	4
TOTAL	5
SHEET	P.0
TOTAL	0

FRA/FAI-33-22.99/0.00

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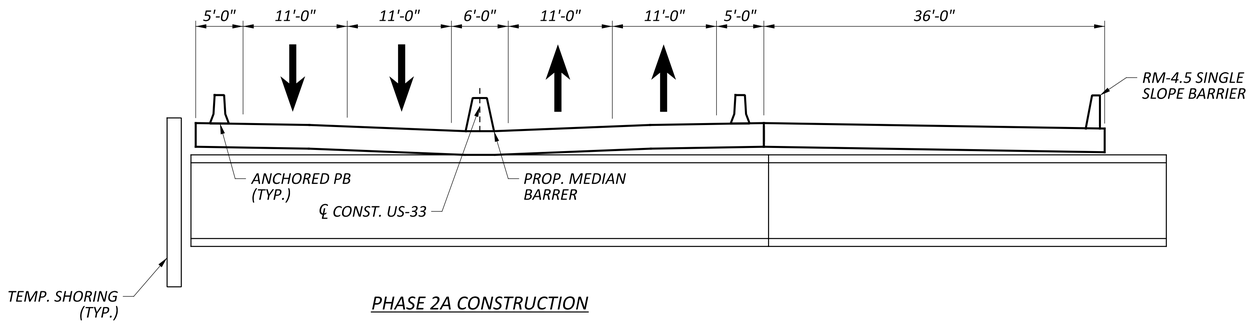
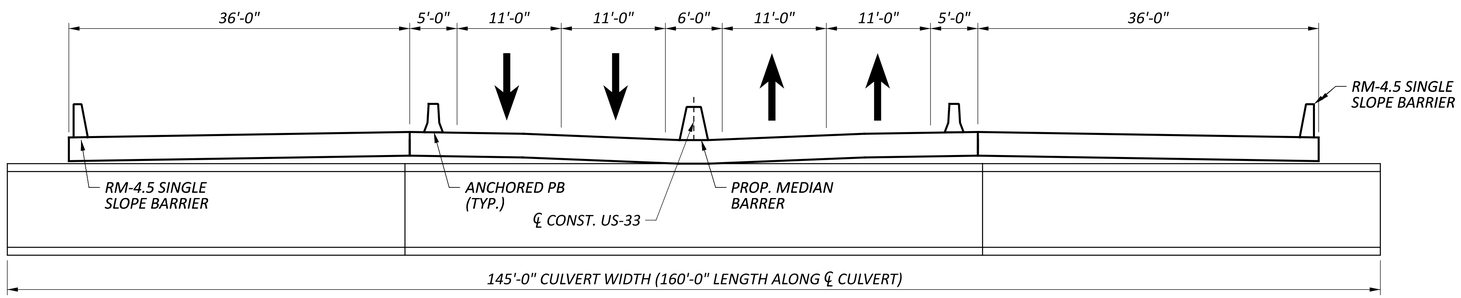
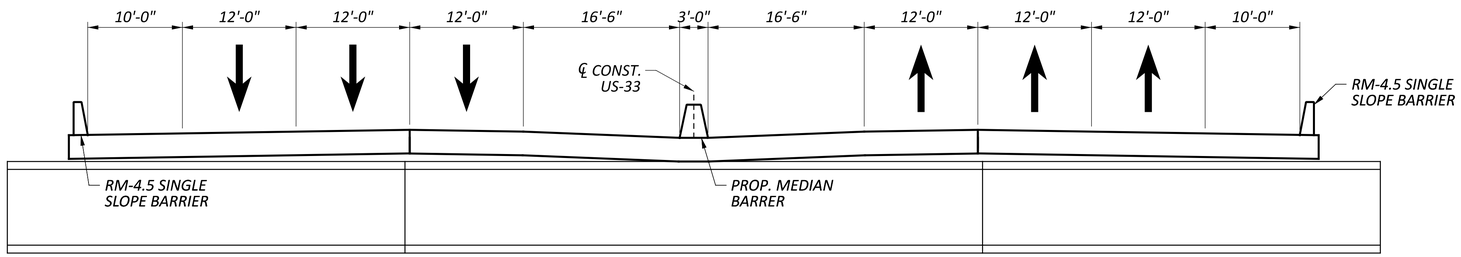


PHASE 2A CONSTRUCTION



PHASE 2B CONSTRUCTION



FINAL

PHASE 2A CONSTRUCTION

REMOVE RIGHT (EASTBOUND) TEMPORARY SHORING AND CONSTRUCT EASTBOUND PORTION OF CULVERT AND US-33 PAVEMENT.

(CAN BE DONE CONCURRENTLY WITH PHASE 2B)

PHASE 2B CONSTRUCTION

REMOVE TEMPORARY SHORING AND CONSTRUCT REMAINING PORTION OF CULVERT AND US-33 PAVEMENT.

(CAN BE DONE CONCURRENTLY WITH PHASE 2A)

FINAL

FOLLOWING CONSTRUCTION OF CULVERT AND US-33 PAVEMENT WORK, SHIFT TRAFFIC TO ITS FINAL PROPOSED LANE CONFIGURATION IN THE EASTBOUND AND WESTBOUND DIRECTIONS.

STAGED CONSTRUCTION DIAGRAMS
BRIDGE NO. FRA-33-27.51L/R
U.S.-33 OVER COBLE-BOWMAN DITCH

SFN	0
DESIGN AGENCY	WOOLPERT
DESIGNER	CML
CHECKER	PES
REVIEWER	TML 05-06-25
PROJECT ID	119387
SUBSET	5
TOTAL	5
SHEET	P.0
TOTAL	0

FRA/FAI-33-22.99/0.00

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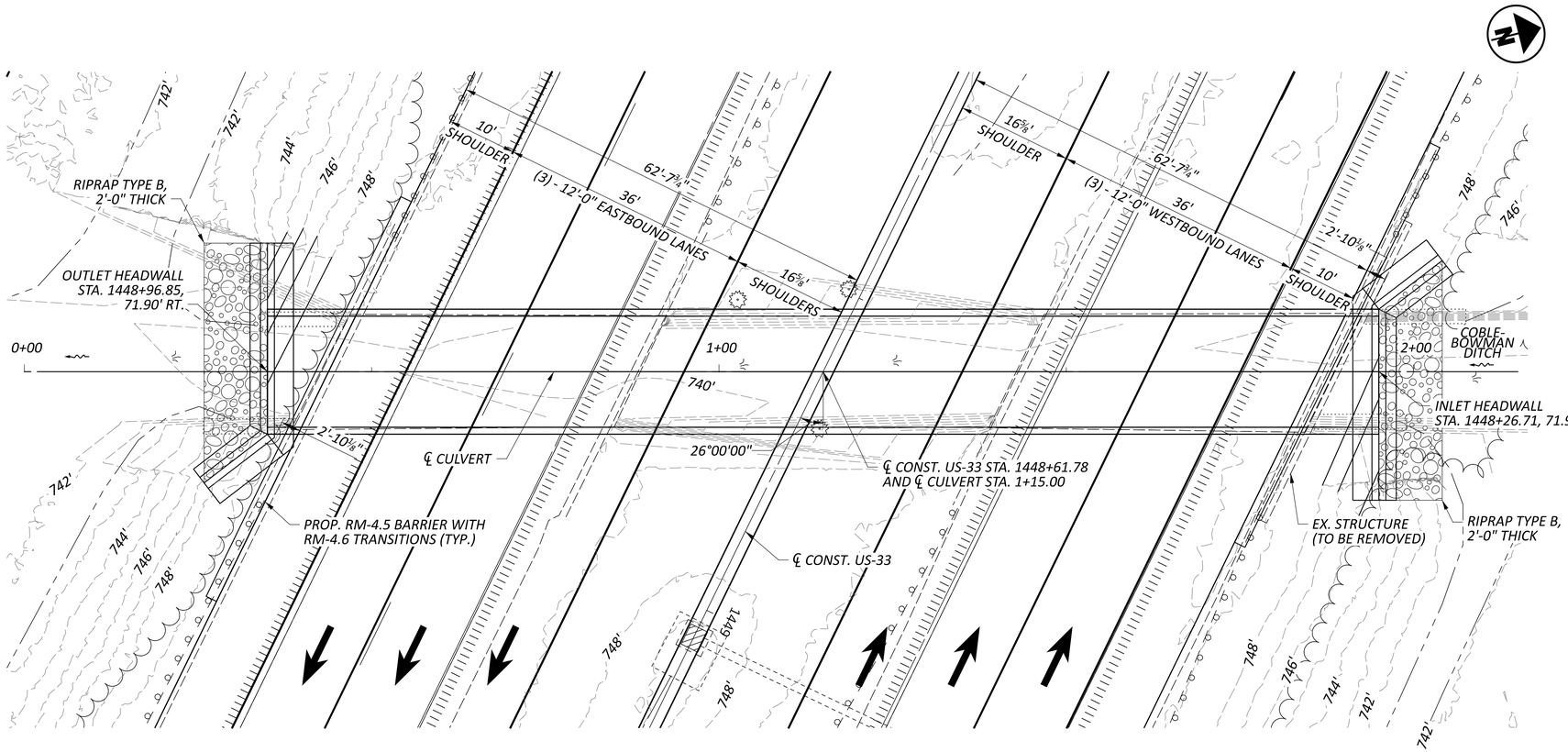

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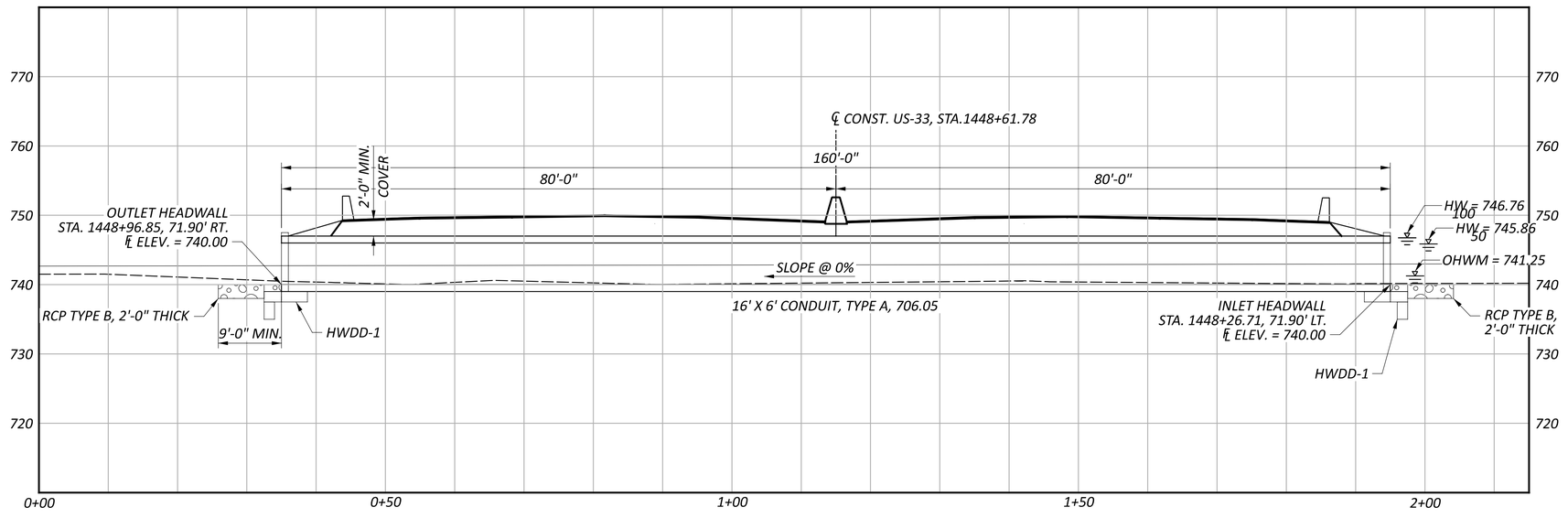


PROFILE
ALONG ℄ CULVERT

CONTROL POINT DATA

CP #6	STA. 1461+89.80,	ELEV. 748.916,	OFFSET 82.06' LT.
CP #8	STA. 1465+11.20,	ELEV. 744.143,	OFFSET 588.47' RT.
CP #9	STA. 1479+12.85,	ELEV. 754.883,	OFFSET 650.86' LT.
CP #10	STA. 1417+25.36,	ELEV. 746.032,	OFFSET 74.13' LT.

FOR ADDITIONAL CONTROL POINT INFORMATION, SEE ROADWAY PLAN SHEET

NOTES

EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.

DESIGN TRAFFIC:
2025 ADT = 75,800 2025 ADTT = 6,064
2045 ADT = 111,700 2045 ADTT = 8,836
DIRECTIONAL DISTRIBUTION =
(PENDING CERTIFIED TRAFFIC FOR 2030/2050 TSMO)

LEGEND

- RCP TYPE B, 2'-0" THICK

HYDRAULIC DATA

DRAINAGE AREA = 1447 SQ. MILES

Q (50) = 540 CFS	V (50) = 3.39 FT/S	HW (50) = 747.97 FT	(EX.)
Q (50) = 540 CFS	V (50) = 3.39 FT/S	HW (50) = 745.86 FT	(PROP.)
Q (100) = 584 CFS	V (100) = 3.57 FT/S	HW (100) = 748.51 FT	(EX.)
Q (100) = 584 CFS	V (100) = 3.57 FT/S	HW (100) = 747.25 FT	(PROP.)

ORDINARY HIGH WATER MARK: 741.25 FT
DESIGN SERVICE LIFE: 75 YEARS
ABRASION LEVEL: TBD
pH: TBD

EXISTING STRUCTURE

TYPE: SINGLE SPAN REINFORCED CONCRETE SLAB ON REINFORCED CONCRETE ABUTMENTS

SPANS: 14'-0" NORMAL TO ABUTMENTS
ROADWAY: 39'-0" F/F PARAPETS
LOADING: HS/20-44 & ALTERNATE MILITARY LOADING
SKEW: 26° RIGHT FORWARD
APPROACH SLABS: 25'-0" LONG
ALIGNMENT: TANGENT
CROWN: NORMAL
STRUCTURE FILE NUMBER: 2502100/2502135 (L/R)
DATE BUILT: 1963
DISPOSITION: STRUCTURE TO BE REMOVED

PROPOSED STRUCTURE

TYPE: 16' X 6' PRECAST CONCRETE BOX CULVERT, TYPE A WITH CAST-IN-PLACE REINFORCED CONCRETE HEADWALLS AND WINGWALLS

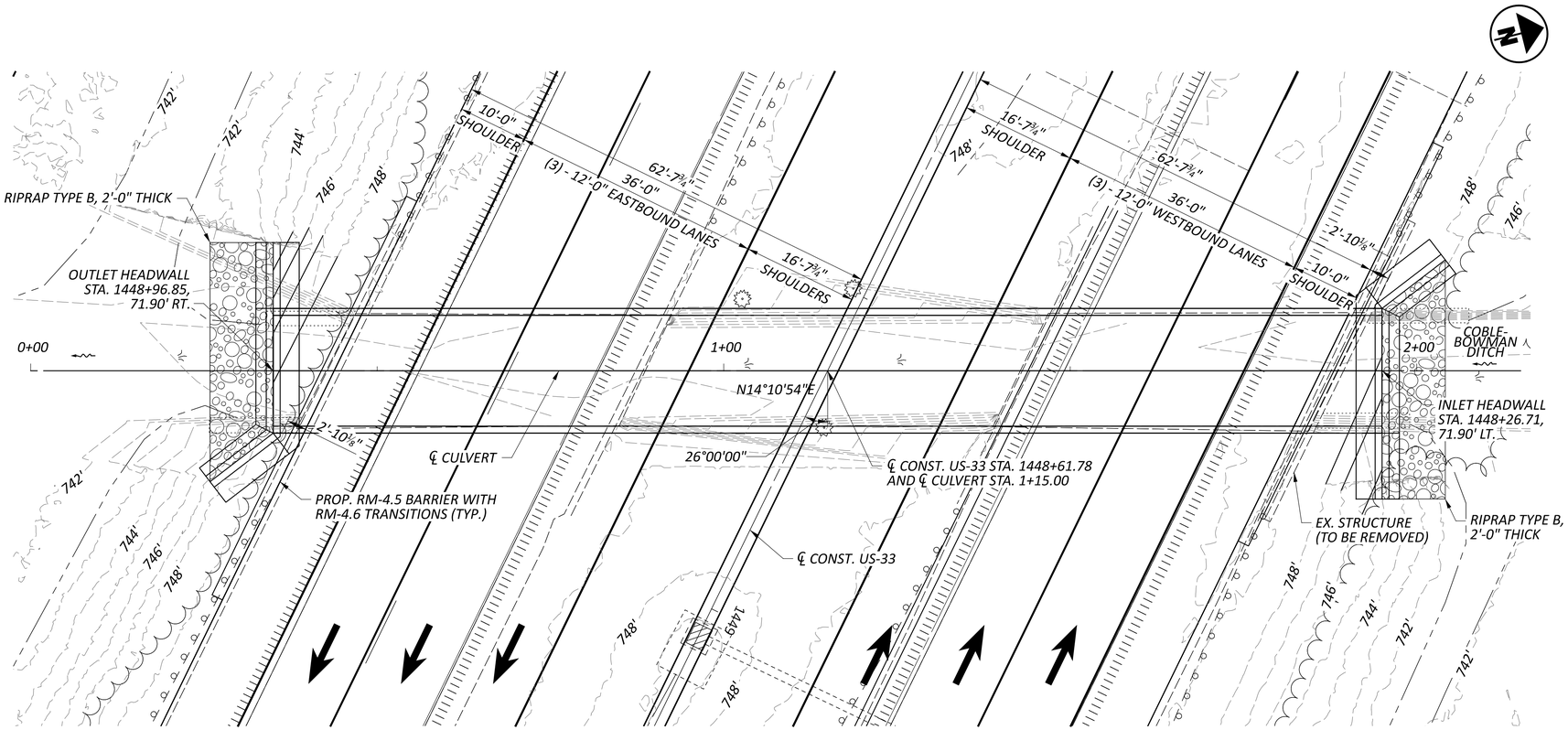
SPANS: 17'-10" ALONG CL-33
ROADWAY: 62'-7¾" TOE/TOE BARRIER
LOADING: HL93 AND 60 PSF FUTURE WEARING SURFACE
SKEW: 26° RIGHT FORWARD
APPROACH SLABS: NONE
ALIGNMENT: TANGENT
CROWN: VARIES WITH SUPERELEVATION

COORDINATES: LATITUDE 39° 52' 30.86"
LONGITUDE -82° 51' 39.26"

ALTERNATIVE 1 SITE PLAN
BRIDGE NO. FRA-33-27.51L/R
U.S.-33 OVER COBLE-BOWMAN DITCH

SFN	0
DESIGN AGENCY	WOOLPERT
DESIGNER	CML
CHECKER	PES
REVIEWER	TML 05-06-25
PROJECT ID	119387
SUBSET	1
TOTAL	5
SHEET	P.0
TOTAL	0

FRA/FAI-33-22.99/0.00



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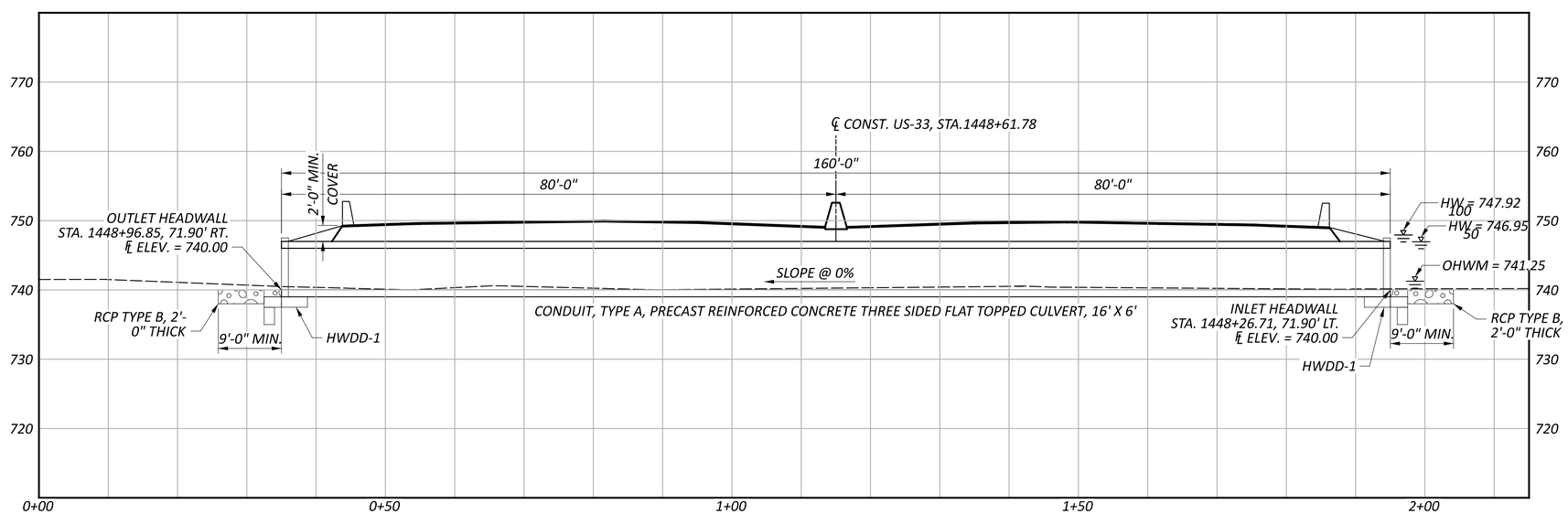


PROFILE
ALONG ℄ CULVERT

CONTROL POINT DATA

CP #6	STA. 1461+89.80,	ELEV. 748.916,	OFFSET 82.06' LT.
CP #8	STA. 1465+11.20,	ELEV. 744.143,	OFFSET 588.47' RT.
CP #9	STA. 1479+12.85,	ELEV. 754.883,	OFFSET 650.86' LT.
CP #10	STA. 1417+25.36,	ELEV. 746.032,	OFFSET 74.13' LT.

FOR ADDITIONAL CONTROL POINT INFORMATION, SEE ROADWAY PLAN SHEET

NOTES

EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.

DESIGN TRAFFIC:
2025 ADT = 75,800 2025 ADTT = 6,064
2045 ADT = 111,700 2045 ADTT = 8,836
DIRECTIONAL DISTRIBUTION =
(PENDING CERTIFIED TRAFFIC FOR 2030/2050 TSMO)

LEGEND

- RCP TYPE B, 2'-0" THICK

HYDRAULIC DATA

DRAINAGE AREA = 1447 SQ. MILES

Q (50) = 540 CFS	V (50) = 3.39 FT/S	HW (50) = 747.97 FT	(EX.)
Q (50) = 540 CFS	V (50) = 3.39 FT/S	HW (50) = 746.95 FT	(PROP.)
Q (100) = 584 CFS	V (100) = 3.57 FT/S	HW (100) = 748.51 FT	(EX.)
Q (100) = 584 CFS	V (100) = 3.57 FT/S	HW (100) = 747.92 FT	(PROP.)

ORDINARY HIGH WATER MARK: 741.25 FT
DESIGN SERVICE LIFE: 75 YEARS
ABRASION LEVEL: TBD
pH: TBD

EXISTING STRUCTURE

TYPE: SINGLE SPAN REINFORCED CONCRETE SLAB ON REINFORCED CONCRETE ABUTMENTS

SPANS: 14'-0" NORMAL TO ABUTMENTS
ROADWAY: 39'-0" F/F PARAPETS
LOADING: HS/20-44 & ALTERNATE MILITARY LOADING
SKEW: 26° RIGHT FORWARD
APPROACH SLABS: 25'-0" LONG
ALIGNMENT: TANGENT
CROWN: NORMAL
STRUCTURE FILE NUMBER: 2502100/2502135 (L/R)
DATE BUILT: 1963
DISPOSITION: STRUCTURE TO BE REMOVED

PROPOSED STRUCTURE

TYPE: 16' X 6' CONCRETE THREE-SIDED FLAT TOP CULVERT WITH CAST-IN-PLACE REINFORCED CONCRETE HEADWALLS AND WINGWALLS

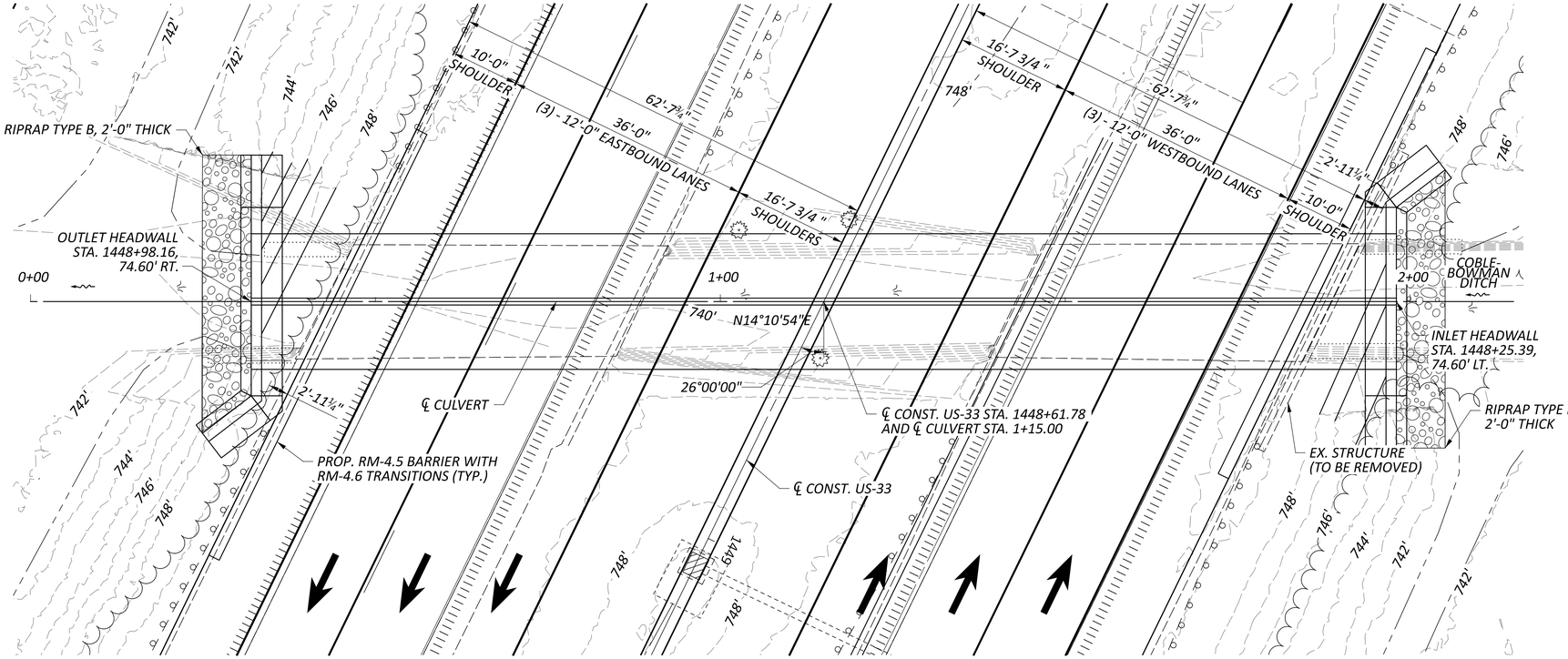
SPANS: 17'-10" ALONG CL-33
ROADWAY: 62'-7¾" TOE/TOE BARRIER
LOADING: HL93 AND 60 PSF FUTURE WEARING SURFACE
SKEW: 26° RIGHT FORWARD
APPROACH SLABS: NONE
ALIGNMENT: TANGENT
CROWN: VARIES WITH SUPERELEVATION

COORDINATES: LATITUDE 39° 52' 30.86"
LONGITUDE -82° 51' 39.26"

ALTERNATIVE 2 SITE PLAN
BRIDGE NO. FRA-33-27.51L/R
U.S.-33 OVER COBLE-BOWMAN DITCH

SFN	0
DESIGN AGENCY	WOOLPERT
DESIGNER	CML
CHECKER	PES
REVIEWER	TML 05-06-25
PROJECT ID	119387
SUBSET	2
TOTAL	5
SHEET	P.0
TOTAL	0

FRA/FAI-33-22.99/0.00



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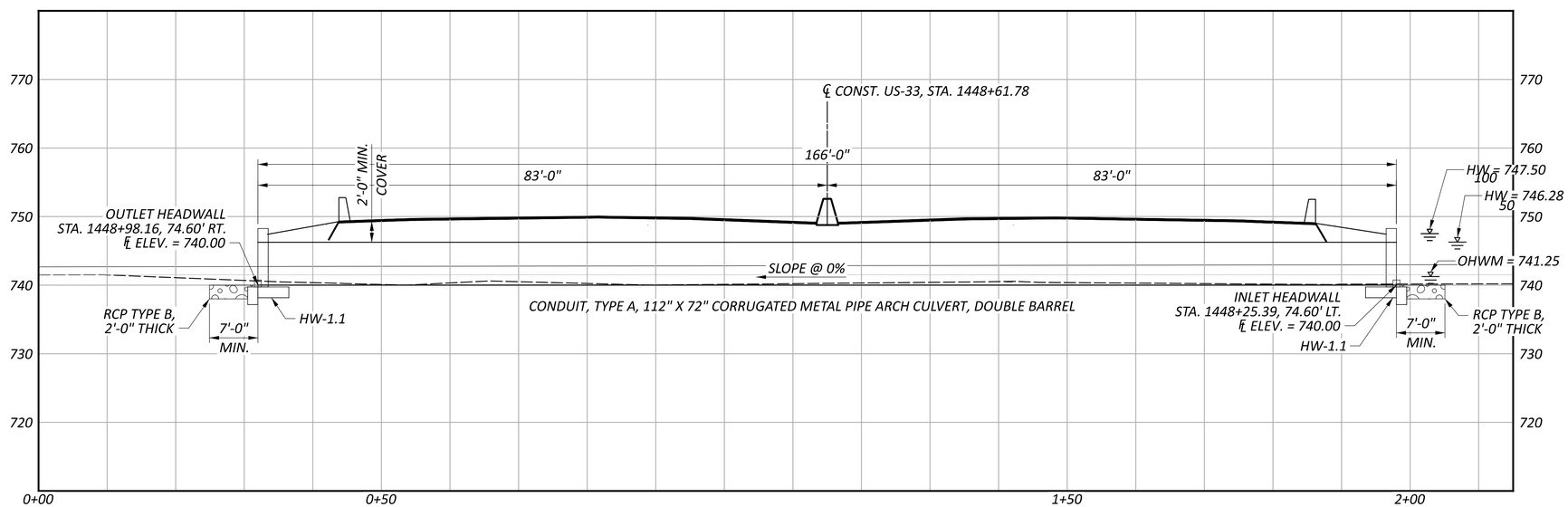


PROFILE
ALONG ℄ CULVERT

CONTROL POINT DATA

CP #6	STA. 1461+89.80,	ELEV. 748.916,	OFFSET 82.06' LT.
CP #8	STA. 1465+11.20,	ELEV. 744.143,	OFFSET 588.47' RT.
CP #9	STA. 1479+12.85,	ELEV. 754.883,	OFFSET 650.86' LT.
CP #10	STA. 1417+25.36,	ELEV. 746.032,	OFFSET 74.13' LT.

FOR ADDITIONAL CONTROL POINT INFORMATION, SEE ROADWAY PLAN SHEET

NOTES

EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.

DESIGN TRAFFIC:
2025 ADT = 75,800 2025 ADTT = 6,064
2045 ADT = 111,700 2045 ADTT = 8,836
DIRECTIONAL DISTRIBUTION =
(PENDING CERTIFIED TRAFFIC FOR 2030/2050 TSMO)

LEGEND

- RCP TYPE B, 2'-0" THICK

HYDRAULIC DATA

DRAINAGE AREA = 1447 SQ. MILES

Q (50) = 540 CFS	V (50) = 3.39 FT/S	HW (50) = 747.97 FT	(EX.)
Q (50) = 540 CFS	V (50) = 3.39 FT/S	HW (50) = 746.28 FT	(PROP.)
Q (100) = 584 CFS	V (100) = 3.57 FT/S	HW (100) = 748.51 FT	(EX.)
Q (100) = 584 CFS	V (100) = 3.57 FT/S	HW (100) = 747.50 FT	(PROP.)

ORDINARY HIGH WATER MARK: 741.25 FT
DESIGN SERVICE LIFE: 75 YEARS
ABRASION LEVEL: TBD
pH: TBD

EXISTING STRUCTURE

TYPE: SINGLE SPAN REINFORCED CONCRETE SLAB ON REINFORCED CONCRETE ABUTMENTS

SPANS: 14'-0" NORMAL TO ABUTMENTS
ROADWAY: 39'-0" F/F PARAPETS
LOADING: HS/20-44 & ALTERNATE MILITARY LOADING
SKEW: 26° RIGHT FORWARD
APPROACH SLABS: 25'-0" LONG
ALIGNMENT: TANGENT
CROWN: NORMAL
STRUCTURE FILE NUMBER: 2502100/2502135 (L/R)
DATE BUILT: 1963
DISPOSITION: STRUCTURE TO BE REMOVED

PROPOSED STRUCTURE

TYPE: DOUBLE BARREL 112" X 72" CORRUGATED STEEL PIPE ARCH CULVERT WITH CAST-IN-PLACE REINFORCED CONCRETE HEADWALLS AND WINGWALLS

SPANS: 17'-10" ALONG CL-33
ROADWAY: 62'-7¾" TOE/TOE BARRIER
LOADING: HL93 AND 60 PSF FUTURE WEARING SURFACE
SKEW: 26° RIGHT FORWARD
APPROACH SLABS: NONE
ALIGNMENT: TANGENT
CROWN: VARIES WITH SUPERELEVATION

COORDINATES: LATITUDE 39° 52' 30.86"
LONGITUDE -82° 51' 39.26"

ALTERNATIVE 3 SITE PLAN
BRIDGE NO. FRA-33-27.51L/R
U.S.-33 OVER COBLE-BOWMAN DITCH

SFN	0
DESIGN AGENCY	WOOLPERT
DESIGNER	CML
CHECKER	PES
REVIEWER	TML 05-06-25
PROJECT ID	119387
SUBSET	3
TOTAL	5
SHEET	P.0

FRA/FAI-33-22.99/0.00

APPENDIX 2: SELECT FIS PAGES AND FIRM DATA

Table 7. Summary of Discharges

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cfs)			
		10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
Bush Ditch					
At U.S. Route 33 (Columbus-Lancaster Road)	3.24	1,085	1,530	1,615	1,930
Approximately 2,250 feet DS of High Street	2.30	785	1,105	1,170	1,400
Clover Groff Ditch					
At confluence with Hellbranch Run	8.84	1,400	2,570	3,250	5,200
At Renner Road Bridge	5.70	581	1,562	1,976	3,162
At Roberts Road Bridge	4..08	568	1,042	1,374	2,108
At Scioto and Darby Creek Road Bridge	1.96	246	451	571	914
Coble-Bowman Ditch					
At confluence with Blacklick Creek	2.7	*	*	1,200	*
At Ebright Road	*	*	*	1,098[2]	*
At U.S. Highway 33	1.4	462	540	584	*
At Winchester Pike	0.78	381	451	490	*
Cosgray Ditch					
At confluence with Scioto River	2.14	529	789	911	1,290
At Dublin Road	1.94	440	631	654	668
At Interstate Route 270	1.55	440	639	733	1,016
At Wilcox Road	1.28	322	471	539	747
Cramer Ditch					
At confluence with the Scioto River	2.39	545	825	953	1,368
At Interstate Route 270	2.12	477	718	827	1,173
Just US of George Geary Ditch	1.50	366	551	634	898
At Wilcox Road	1.20	229	355	411	602
Above Dry Run Levee	6.96	1,975	2,873	3,354	4,380
Dry Run					
At confluence with the Scioto River	6.96	1,953	1,992	2,003	2,013
At confluence of South Fork Dry Run	6.32	1,831	2,663	3,107	4,230
Just US of confluence of South Fork Dry Run	2.96	947	1,390	3,107	4,230
At CONRAIL	2.88	929	1,365	1,584	2,180
At Hague Avenue	2.66	859	1,258	1,458	2,051
Dysar Ditch					
At confluence with Blacklick Creek	4.24	1,294	1,721	1,983	2,574
Early Run					
At confluence with Scioto Big Run	3.45	730	1,400	1,800	3,020
Faust County Ditch					
At Hayden Run Road US of Cosgray	2.86	397	602	692	989

FLOODING SOURCE		FLOODWAY				1-PERCENT-ANNUAL-CHANCE FLOOD WATER SURFACE ELEVATION (FEET NAVD)			
CROSS SECTION	DISTANCE	WIDTH (FEET)	WIDTH REDUCED FROM PRIOR STUDY	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY	WITHOUT FLOODWAY	WITH FLOODWAY	INCREASE (FEET)
Clover Groff Ditch[1]									
AA	6.750	390		497	0.7	936.5	936.5	937.0	0.5
AB	7.276	62		129	2.7	938.1	938.1	938.4	0.3
AC	7.741	250		565	0.6	940.5	940.5	940.8	0.3
AD	7.945	163		144	1.5	940.7	940.7	941.0	0.3
AE	8.040	29		80	2.6	941.1	941.1	941.4	0.3
AF	8.512	85		358	0.7	946.0	946.0	946.0	0.0
Coble-Bowman Ditch[2]									
A	3,150	169		696	2.1	741.0	741.0	741.5	0.5
B	6,487	240		1,108	1.0	745.8	745.8	745.9	0.1
C	9,107	85		182	2.1	746.6	746.6	746.9	0.3
D	9,997	110		344	1.1	747.3	747.3	747.6	0.3
E	10,687	30		60	2.8	748.0	748.0	748.1	0.1
F	12,035	68		182	0.7	751.4	751.4	751.8	0.4
G	13,251	21		47	5.5	752.2	752.2	752.7	0.5
H	13,801	32		84	3.1	755.5	755.5	755.7	0.2
I	15,149	80		161	1.6	758.3	758.3	758.7	0.4
Cosgray Ditch[3]									
A	1,255	42		103	8.8	803.2	803.2	803.2	0.0
B	1,778	69		178	5.1	814.0	814.0	814.1	0.1
C	2,523	36		124	7.4	834.8	834.8	835.1	0.3
D	3,300	51		112	8.2	846.2	846.2	846.2	0.0
E	4,300	63		277	3.3	857.8	857.8	858.2	0.4
F	5,300	99		457	2.0	868.9	868.9	869.2	0.3
G	6,598	62		203	4.5	877.4	877.4	877.9	0.5
H	7,700	24		133	4.9	884.8	884.8	885.1	0.3
I	9,388	92		286	2.6	895.3	895.3	895.5	0.2
J	10,200	85		253	2.9	898.9	898.9	899.2	0.3

[1]Miles above confluence with Hellbranch Run [2]Feet above confluence with Blacklick Creek [3]Feet above confluence with Scioto River

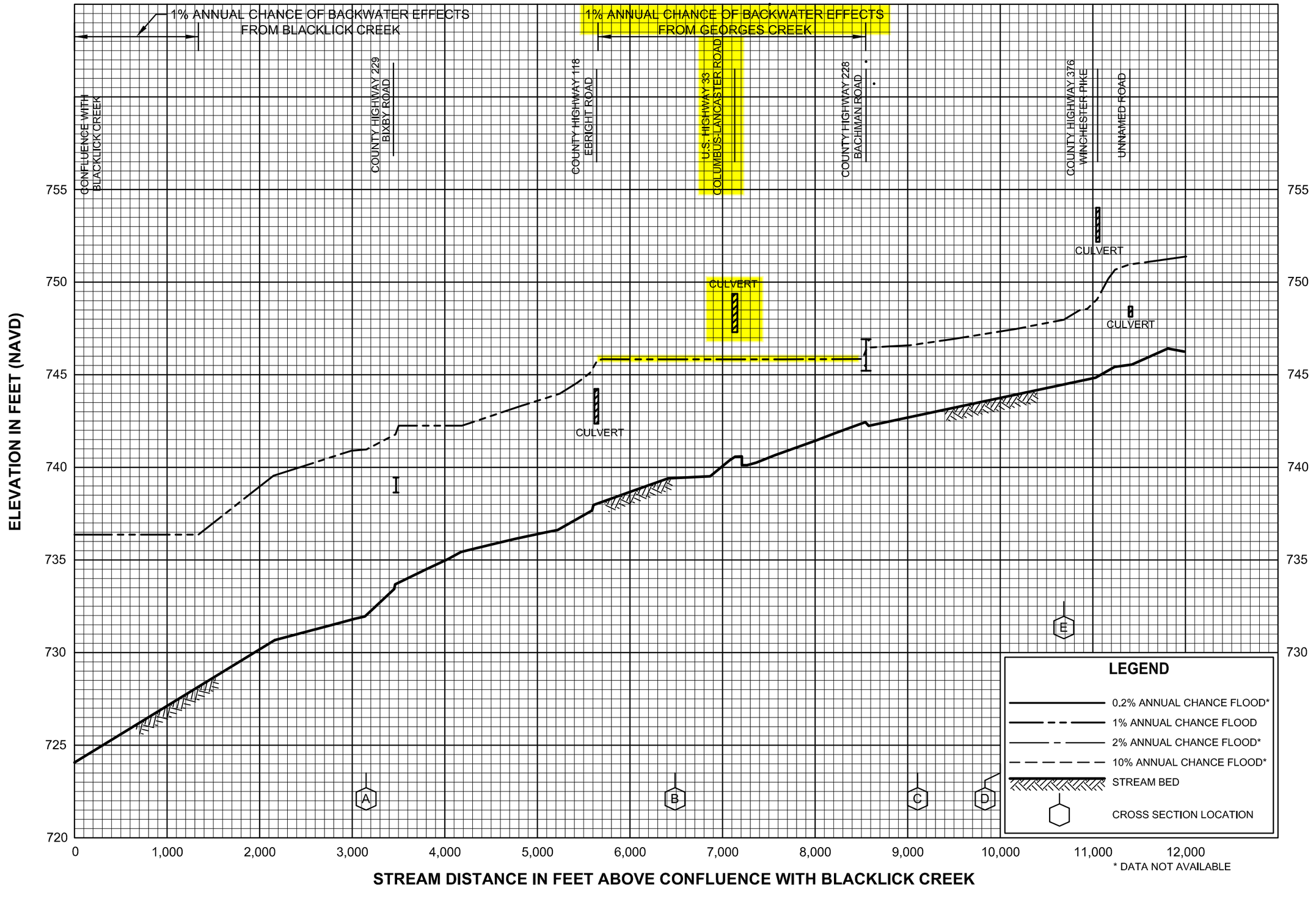
Table 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

FRANKLIN COUNTY, OHIO
AND INCORPORATED AREAS

FLOODWAY DATA

Clover Groff Ditch, Coble-Bowman Ditch, Cosgray Ditch



FLOOD PROFILES

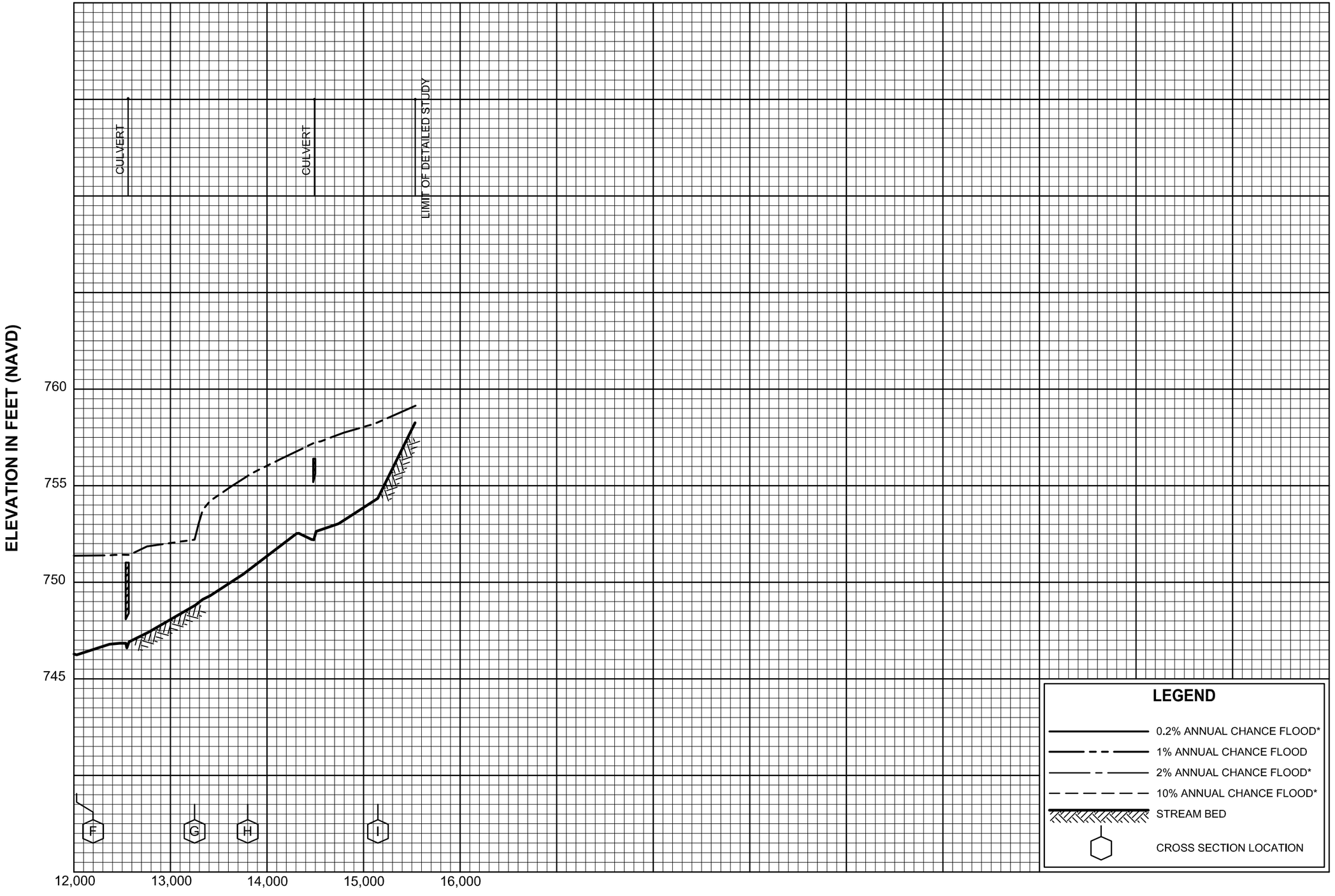
COBLE-BOWMAN DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

FRANKLIN COUNTY, OH

AND INCORPORATED AREAS

70P



* DATA NOT AVAILABLE

FLOOD PROFILES

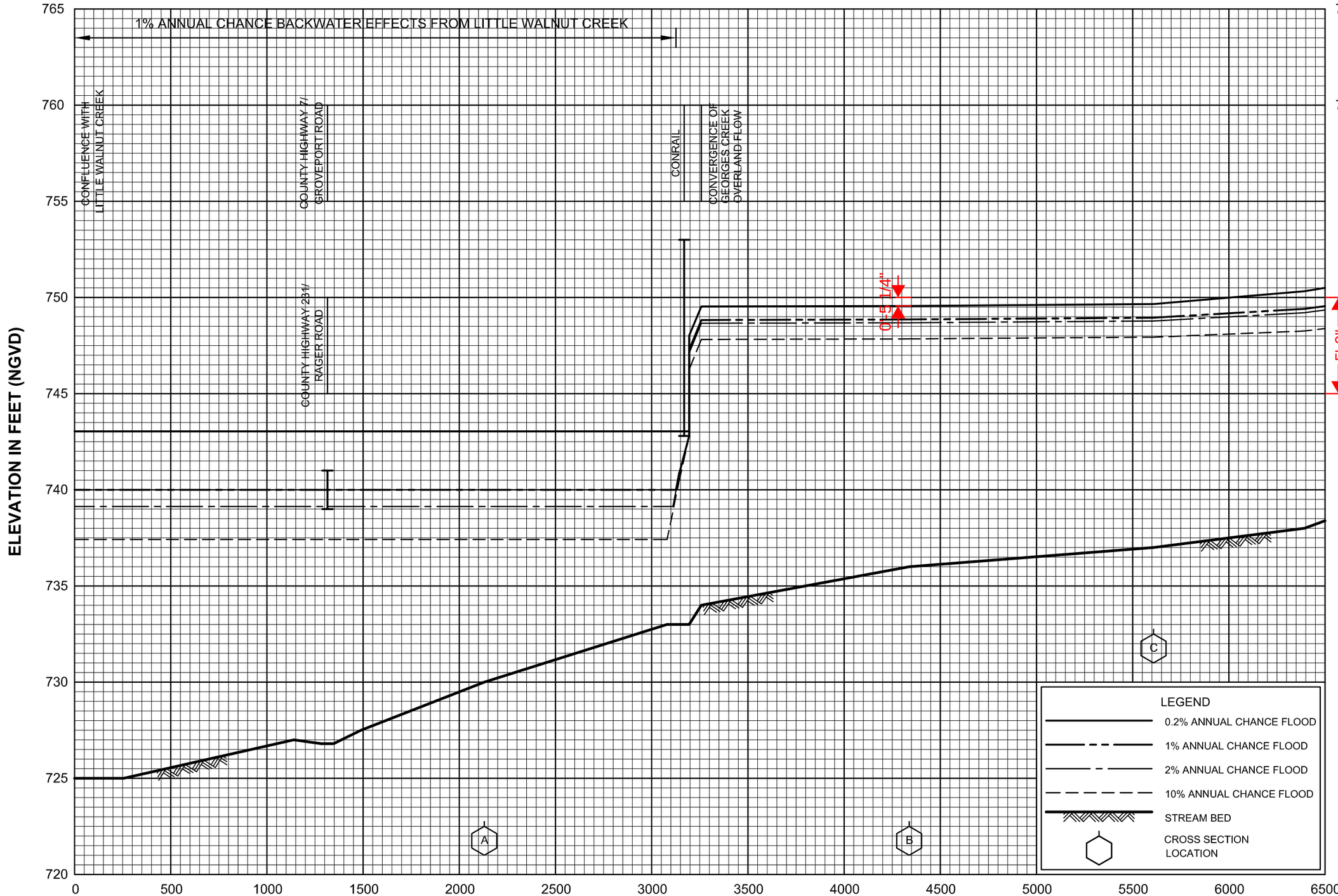
COBLE-BOWMAN DITCH

FEDERAL EMERGENCY MANAGEMENT AGENCY

FRANKLIN COUNTY, OH

AND INCORPORATED AREAS

71P



FLOOD PROFILES

GEORGES CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

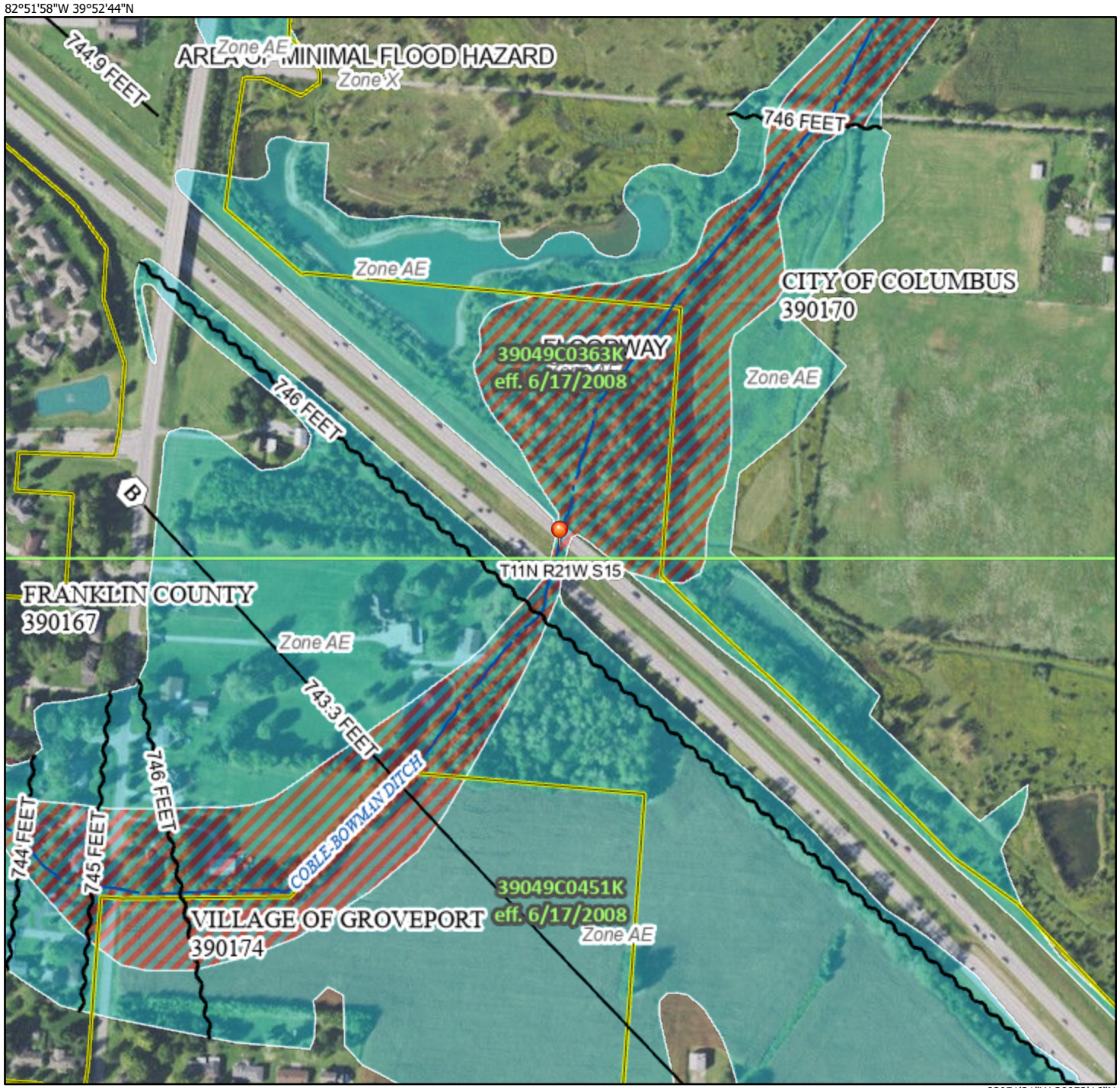
FRANKLIN COUNTY, OH

AND INCORPORATED AREAS

94P

National Flood Hazard Layer FIRMette

FEMA



Feet

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

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/8/2023 at 2:31 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Ohio State Plane South Zone 5001 (FIPSZONE 3402). The **horizontal datum** was NAD83. Differences in datum, spheroid, projection or state plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov/.

Base map information shown on this FIRM was provided in digital format by Franklin County. This information was produced at a scale of 1:1,200 from aerial photography dated 2004.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

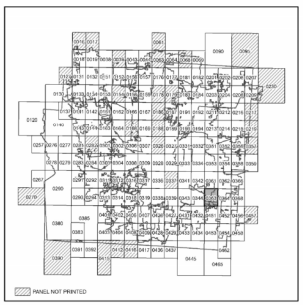
Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip/.

The "profile base lines" depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the "profile base line", in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

PANEL INDEX



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100 year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard may include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Area of special flood hazard formerly protected from the 1% annual chance flood event by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood event by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile, and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside of the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- 513 — Base Flood Elevation line and value; elevation in feet*
- (EL 10) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

- A — A — Cross section line
- 97 — 97 — Transect line
- 85°03'45.0", 41°24'22.5" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
- 4587000 M — 1000-meter Universal Transverse Mercator grid values, zone 17
- 2250000 FT — 5000-foot grid ticks: Ohio State Plane South Coordinate System, 5001 Zone (FIPSZONE 3402) Lambert Conformal Conic
- KA0015 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
AUGUST 2, 1995

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
7/16/1997
4/21/1999
3/16/2004
9/19/2007

June 17, 2008 - to update corporate limits, to change Special Flood Hazard Areas, to update map format, to add roads and road names, to incorporate previously issued Letters of Map Revision, and to reflect updated topographic information.

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

PANEL 0363K

FIRM

FLOOD INSURANCE RATE MAP

FRANKLIN COUNTY, OHIO AND INCORPORATED AREAS

PANEL 363 OF 465

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLUMBUS, CITY OF	390170	0363	K
FRANKLIN COUNTY	390167	0363	K
GROVEPORT, VILLAGE OF	390174	0363	K

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

NATIONAL FLOOD INSURANCE PROGRAM

MAP NUMBER
39049C0363K

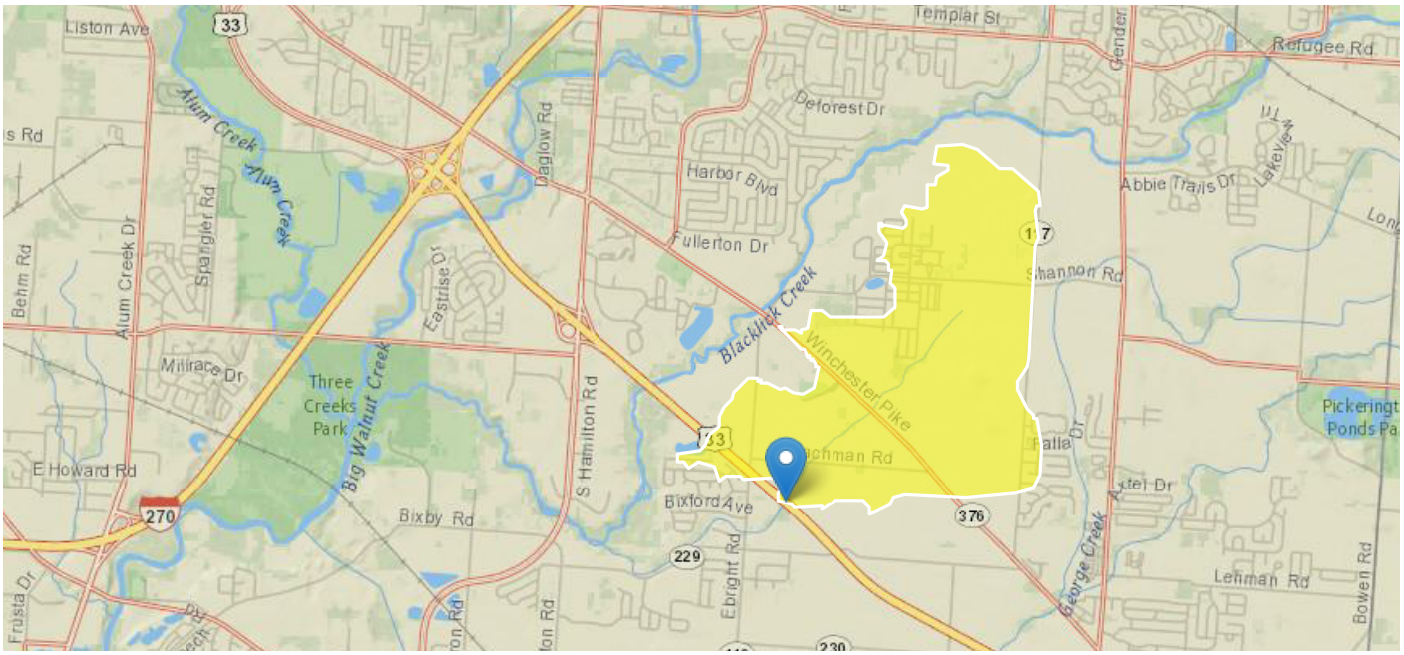
MAP REVISED
JUNE 17, 2008

Federal Emergency Management Agency

APPENDIX 3: USGS STREAMSTATS OUTPUT

FRA-33-27.51 L/R over Cable Bowman Ditch StreamStats Report

Region ID: OH
Workspace ID: OH20230808173950913000
Clicked Point (Latitude, Longitude): 39.87500, -82.86090
Time: 2023-08-08 13:40:48 -0400



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	4.77	feet per mi
DRNAREA	Area that drains to a point on a stream	2.26	square miles
FOREST	Percentage of area covered by forest	2.07	percent
LAT_CENT	Latitude of Basin Centroid	39.8862	decimal degrees
LC92STOR	Percentage of water bodies and wetlands determined from the NLCD	0.16	percent
LONG_CENT	Longitude Basin Centroid	82.8475	decimal degrees
OHREGA	Ohio Region A Indicator	1	dimensionless
OHREGC	Ohio Region C Indicator	0	dimensionless
PRECIPCENT	Mean Annual Precip at Basin Centroid	37.5	inches
STREAM_VARG	Streamflow variability index as defined in WRIR 02-4068, computed from regional grid	0.56	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	2.26	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	4.77	feet per mi	1.53	516
LC92STOR	Percent Storage from NLCD1992	0.16	percent	0	25.35

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

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PII	PIu	ASEp
50-percent AEP flood	149	ft^3/s	78	285	40.1
20-percent AEP flood	244	ft^3/s	133	446	37.2
10-percent AEP flood	318	ft^3/s	173	586	37.6
4-percent AEP flood	424	ft^3/s	228	787	38.1
2-percent AEP flood	511	ft^3/s	272	960	37.8
1-percent AEP flood	605	ft^3/s	318	1150	39.6
0.2-percent AEP flood	852	ft^3/s	442	1640	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)

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	2.26	square miles	1	1250
STREAM_VARG	Streamflow Variability Index from Grid	0.56	dimensionless	0.24	1.12

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

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE
1 Day 10 Year Low Flow	0.03	ft^3/s	53.1
7 Day 10 Year Low Flow	0.0385	ft^3/s	40

Statistic	Value	Unit	SE
30 Day 10 Year Low Flow	0.0605	ft^3/s	35.7
90 Day 10 Year Low Flow	0.0953	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/)

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	2.26	square miles	1	1250
STREAM_VARG	Streamflow Variability Index from Grid	0.56	dimensionless	0.24	1.12

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

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE
80 Percent Duration	0.201	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/)

Annual Flow Statistics

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

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.26	square miles	0.12	7422
LAT_CENT	Latitude of Basin Centroid	39.8862	decimal degrees	38.68	41.2
PRECIPCENT	Mean Annual Precip at Basin Centroid	37.5	inches	34	43.2

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

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp
Mean Annual Flow	2.19	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)

Monthly Flow Statistics

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

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.26	square miles	0.12	7422
LC92STOR	Percent Storage from NLCD1992	0.16	percent	0	19
PRECIPCENT	Mean Annual Precip at Basin Centroid	37.5	inches	34	43.2
FOREST	Percent Forest	2.07	percent	0	99.1
LAT_CENT	Latitude of Basin Centroid	39.8862	decimal degrees	38.68	41.2
STREAM_VARG	Streamflow Variability Index from Grid	0.56	dimensionless	0.25	1.13

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

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp
January Mean Flow	3.03	ft^3/s	16.6	16.6
February Mean Flow	3.69	ft^3/s	11.9	11.9
March Mean Flow	4.04	ft^3/s	14	14
April Mean Flow	3.82	ft^3/s	11.2	11.2
May Mean Flow	2.52	ft^3/s	19.5	19.5
June Mean Flow	1.74	ft^3/s	27	27
July Mean Flow	1.05	ft^3/s	28.2	28.2
August Mean Flow	0.688	ft^3/s	36.8	36.8
September Mean Flow	0.358	ft^3/s	43.6	43.6
October Mean Flow	0.453	ft^3/s	50.8	50.8
November Mean Flow	1.06	ft^3/s	37.5	37.5
December Mean Flow	2.01	ft^3/s	21.8	21.8

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 LatLE 41.2 wri02 4068]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.26	square miles	0.12	7422
LC92STOR	Percent Storage from NLCD1992	0.16	percent	0	19
STREAM_VARG	Streamflow Variability Index from Grid	0.56	dimensionless	0.25	1.13
LAT_CENT	Latitude of Basin Centroid	39.8862	decimal degrees	38.68	41.2

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

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp
Harmonic Mean Streamflow	0.242	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)

Flow Percentile Statistics

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

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.26	square miles	0.12	7422
LC92STOR	Percent Storage from NLCD1992	0.16	percent	0	19
STREAM_VARG	Streamflow Variability Index from Grid	0.56	dimensionless	0.25	1.13
LAT_CENT	Latitude of Basin Centroid	39.8862	decimal degrees	38.68	41.2
LONG_CENT	Longitude of Basin Centroid	82.8475	decimal degrees	80.53	84.6

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

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	ASEp
25th Percentile Flow	0.43	ft^3/s	29.2	29.2
50th Percentile Flow Median	1.03	ft^3/s	40.3	40.3
75th Percentile Flow	2.26	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	2.26	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	2.26	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	2.26	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [Interior Plains D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	15.6	ft
Bieger_D_channel_depth	1.75	ft
Bieger_D_channel_cross_sectional_area	31.7	ft^2

Bankfull Statistics Flow Report [Central Lowland P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	17.8	ft
Bieger_P_channel_depth	2.13	ft
Bieger_P_channel_cross_sectional_area	30.3	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	16.5	ft
Bieger_USA_channel_depth	1.43	ft
Bieger_USA_channel_cross_sectional_area	26.5	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
Bieger_D_channel_width	15.6	ft

Statistic	Value	Unit
Bieger_D_channel_depth	1.75	ft
Bieger_D_channel_cross_sectional_area	31.7	ft^2
Bieger_P_channel_width	17.8	ft
Bieger_P_channel_depth	2.13	ft
Bieger_P_channel_cross_sectional_area	30.3	ft^2
Bieger_USA_channel_width	16.5	ft
Bieger_USA_channel_depth	1.43	ft
Bieger_USA_channel_cross_sectional_area	26.5	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	2.26	square miles	1	1250
STREAM_VARG	Streamflow Variability Index from Grid	0.56	dimensionless	0.24	1.12

Probability Statistics Flow Report [P zero Flow 2012 5138]

PII: Prediction Interval-Lower, PIu: Prediction Interval-Upper, ASEp: Average Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PC
Probability zero flow 1Day	0.0345	dim	91
Probability zero flow 7Day	0.0149	dim	94
Probability zero flow 30Day	0.000646	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 [Crippen Bue Region 6]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.26	square miles	0.1	10000

Maximum Probable Flood Statistics Flow Report [Crippen Bue Region 6]

Statistic	Value	Unit
Maximum Flood Crippen Bue Regional	13300	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: 4.16.1
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

APPENDIX 4: EXISTING BORING DATA

FOUNDATION EXPLORATION SECTION

SUBSURFACE INVESTIGATION RECONNAISSANCE REPORT

Description of Work

Project under consideration consists of 7.2 miles of relocated USR 38. The project a four lane highway, starts approximately 0.3 miles west of Munks Corners on Refugee Road at sta. 200+00. It proceeds southeast to the intersection of SR 751 and existing USR 33 ending with sta. 580+00.

GEOLOGY

The project area is located on the relatively smooth Mississippi Valley Plain. It was glaciated by both the Illinoian and Wisconsin ice sheet. The deep Stage Newark River Valley is present.

TOPOGRAPHY

The terrain alternates from a gently undulating alluvial terrace to a gently underlating alluvial terrace to a gently undulating ground morinal plain (approximately 23 feet difference in elevation).

Sta. 200+00 - sta. 295+00	-	Alluvial Terrace
Sta. 254+00 - sta. 295+00	-	Ground Morinal Plain
Sta. 380+00 - sta. 386+00	-	Alluvial Terrace
Sta. 386+00 - sta. 580+00	-	Ground Morinal Plain

The ground morianl plain is undulating with few kettle holes, and with the possibility of terminal morainal deposits in the area of Sta. 275+00.

GENERAL SUBSURFACE CONDITIONS

Alluvial deposits consists of silt, sand and gravel.

Ground morinal deposits consist of light brown silty clay, gravel, (cobbles and boulders.)

WATER POINTS

Water for core drilles can be obtained from the following creeks; walnut, Blacklick and George.

FOUNDATION EXPLORATION SECTION
SUBSURFACE INVESTIGATION RECONNAISSANCE REPORT

The project under investigation by the Test Lab is that of major relocation of USR 33 beginning at Refugee Road station 200+00, ending at station 580+00 on existing USR 30 just north of Canal Winchester. The end portion of the project is on a tangent with the existing roadway which at this point is the beginning of the divided 4 lane highway extending into Lancaster and points southeast.

The area covered in this report is from station 384+00 (Blacklick Creek Crossing) to station 580+00.

The area traversed by this line is located on nearly flat expressionless Mississippi Valley Plain at an approximate elevation of 750 feet. The area was abraded and reduced by both Illinoian and Wisconsin ice sheets, both of which terminated only a few miles distant, southward. Upon retreat of the ice sheets a considerable amount of debris was deposited as moraine(terminal)which in most areas is about 100 feet in thickness.

Topography is somewhat undulating (kettle topography) as the result of post glacial stream erosion and large blocks of ice which remained after the major ice sheet melted, thus upon melting of stagnated blocks of ice a large depression(kettle hole) resulted.
Some of these depressions may have accumulated some organic material but not in great thickness.

Materials in this region will comprise primarily of dense silt clays with sand and gravel size particles. It is doubtful if any soft areas will be encountered within the limits of this line.

Boring list has been previously submitted.

GENERAL INFORMATION

INTRODUCTION

The project consists of a major relocation of USR 33, beginning at Refugee Road, extending in a southeasterly direction for 7.2 miles, terminating on existing USR 33 approximately 1.3 miles north of Canal Winchester.

The proposed grade indicates the following:

USR 33 - slight cuts and fill embankments, not greater than 15 feet in depth or height, respectively.

REFUGEE ROAD AND HAMILTON ROAD - fill embankments ranging from 0 to 24 feet in height.

GEOLOGY AND OBSERVATIONS OF THE PROJECT

The alignment traverses a relatively flat portion of the undulating Till Plain Region, presently being incised by Big Walnut Creek and Blacklick Creek and Georges Creek, where glacial-derived soil is reported to be on the order of 100 feet deep, overlying shale and sandstone bedrock, of Mississippian age. Several kettle holes and low depressed areas were observed along the proposed realignment of USR 33.

EXPLORATION

Exploratory borings were made by means of truck-mounted mechanical earth auger and hand auger (in areas of difficult access), between January 3 and 6, 1961, and January 20 and 23, 1961.

INVESTIGATIONAL DISCLOSURES

USR 33 Borings disclosed that materials that occur immediately below proposed grade are comprised predominantly of sandy silts and silty clays, in the A-1-a and A-6 classifications, having moisture contents in the lower portion of the plastic range; these materials are underlain by gravels, in the A-1-a and A-1-b classifications. It is noted that frost susceptible silt was encountered within 3 feet below grade at station 260+00.

Materials occurring in the embankment foundation areas are predominantly comprised of silty clays and clays, in the A-6 and A-7-6 classifications, overlying sands and gravels. It is noted that localized deposits of very soft, wet, compressible peat and elastic clay as much as 8 feet thick, were encountered within the upper 16 feet of foundation in the vicinity of stations 206+00 to 208+00, and 332+00 to 335+00; and that in the vicinity of stations 245+00 to 250+00 the upper 5 or 6 feet of foundation material is comprised of somewhat compressible sandy silts.

REFUGEE ROAD AND HAMILTON ROAD

Materials in the embankment foundation areas consist of fine-grained soils (A-1-a, A-6 and A-7-6 classifications) overlying sand and gravels (A-1-a and A-3a classifications). It is noted that on Refugee Road at station 32+00, 62 feet right, approximately 3 feet of soft, wet elastic clay was encountered at surface. This is considered to be a small deposit, localized adjacent to a culvert inlet.

GENERAL INFORMATION

INTRODUCTION

The project consists of a major relocation of USR 33, beginning at Refugee Road, extending in a southeasterly direction for 7.2 miles, terminating on existing USR 33 approximately 1.3 miles north of Canal Winchester.

The proposed grade indicates the following:

USR 33 - slight cuts and fill embankments, not greater than 15 feet in depth or height, respectively.

REFUGEE ROAD AND HAMILTON ROAD - fill embankments ranging from 0 to 24 feet in height.

GEOLOGY AND OBSERVATIONS OF THE PROJECT

The alignment traverses a relatively flat portion of the undulating Till Plain Region, presently being incised by Big Walnut Creek and Blacklick Creek and Georges Creek, where glacial-derived soil is reported to be on the order of 100 feet deep, overlying shale and sandstone bedrock, of Mississippian age. Several kettle holes and low depressed areas were observed along the proposed realignment of USR 33.

EXPLORATION

Exploratory borings were made by means of truck-mounted mechanical earth auger and hand auger (in areas of difficult access), between January 3 and 6, 1961, and January 20 and 23, 1961.

INVESTIGATIONAL DISCLOSURES

USR 33 Borings disclosed that materials that occur immediately below proposed grade are comprised predominantly of sandy silts and silty clays, in the A-4a and A-6 classifications, having moisture contents in the lower portion of the plastic range; these materials are underlain by gravels, in the A-1-a and A-1-b classifications. It is noted that frost susceptible silt was encountered within 3 feet below grade at station 260+00.

Materials occurring in the embankment foundation areas are predominantly comprised of silty clays and clays, in the A-6 and A-7-6 classifications, overlying sands and gravels. It is noted that localized deposits of very soft, wet, compressible peat and elastic clay as much as 3 feet thick, were encountered within the upper 16 feet of foundation in the vicinity of stations 206+00 to 209+00, and 332+00 to 335+00; and that in the vicinity of stations 245+00 to 250+00 the upper 5 or 6 feet of foundation material is comprised of somewhat compressible sandy silts.

REFUGEE ROAD AND HAMILTON ROAD

Materials in the embankment foundation areas consist of fine-grained soils (A-4a, A-6 and A-7-6 classifications) overlying sand and gravels (A-1-a and A-3a classifications). It is noted that on Refugee Road at station 32+00, 62 feet right, approximately 3 feet of soft, wet elastic clay was encountered at surface. This is considered to be a small deposit, localized adjacent to a culvert inlet.

LEGEND FOR PROJECT-AVERAGE RESULTS OF TESTS- 479 SAMPLES TESTED

DESCRIPTION	A.A.S.H.O. CLASS	OHIO CLASS	% AGG.	% C. SAND	% F. SAND	% SILT	% CLAY	LIQUID LIMIT	PLASTICITY INDEX	WATER CONTENT	SAMPLES TESTED
Gravel and/or stone fragments	A-1-a (0)	A-1-a	66	21	8	- 7 -		NP	NP	13	84
Gravel and/or stone fragments with sand	A-1-b(0)	A-1-b	104	30	13	7	6	NP	NP	15	48
Fine sand	A-3(0)	A-3	0	1	91	- 8 -		NP	NP	23	1
Coarse and fine sand	——→	A-3a	11	32	37	11	9	NP	NP	15	18
Gravel and/or stone fragments with sand and silt	A-2-4(0)	A-2-4	104	16	11	14	15	29	5	18	28
Gravel and/or stone fragments with sand, silt, and clay	A-2-6(0)	A-2-6	43	22	10	12	13	33	13	20	6
Sandy silt	A-4 (4)	A-4a	19	11	17	28	25	25	6	16	113
Silt	A-4(8)	A-4b	0	2	19	61	18	NP	NP	24	13
Silt and clay	A-6(7)	A-6a	11	12	15	28	34	34	13	21	80
Silty clay	A-6(10)	A-6a	9	7	12	30	42	38	17	24	21
Elastic clay without organic material unless otherwise noted	A-7-5(13)	A-7-5	0	2	6	12	50	68	26	58	9
Clay	A-7-6 (14)	A-7-6	5	4	8	35	48	47	22	31	51
Sedimentary Peat											9

VISUAL CLASSIFICATION

Sod and/or Topsoil X' Approximate depth.

Berm material.

Auger boring - plan view.

Auger boring plotted to vertical scale only.

Water content nearly equal to or greater than liquid limit.

Indicates a non-plastic material with high water content.

Free water.

Plastic water limit.

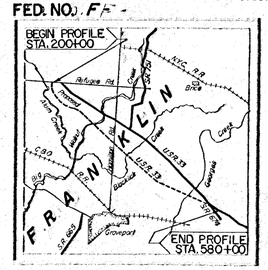
NOTE: Figures beside borings indicate water content in percent, e.g. 15

SOIL PROFILE
FRANKLIN COUNTY
FRA-33-22.95
CHIO STATE HIGHWAY TESTING LABORATORY
O. S. U. CAMPUS, COLUMBUS, OHIO

1 / 20

NOTE: INFORMATION SHOWN BY THIS SUBGRADE PROFILE WAS OBTAINED SOLELY FOR USE IN ESTABLISHING DESIGN CONTROLS FOR THE PROJECT. THE STATE OF OHIO DOES NOT GUARANTEE THE ACCURACY OF THIS DATA AND IT IS NOT TO BE CONSTRUED AS A PART OF THE PLANS GOVERNING CONSTRUCTION OF THE PROJECT.

FED. NO. FA -



LOCATION MAP

Recon. - J.T.B. - 12-30-60

Drilling - Auger - J.R.G.-C.E.G.-J.A.G.-L.M.O.

Additional Drilling - J.A.G./J.R.G.-B.D.L.-J.R.F.-1-20-to-23-61

Drafting - L.N.L.-R.L.F.-C.L.I.-D.A.P.-D.J.E.

SUMMARY OF SOIL TEST DATA

NOTE: NP shown in Liquid Limit and Plasticity Index columns indicates that the material is non-plastic.
*Denotes sample taken at or near grade.

STATION & OFFSET		DEPTH FROM-TO	% AGG.	% C.S.	% F.S.	% SILT	% CLAY	L.L.	P.I.	% W.C.	SHTL CLASS.
202+00	CL	0.4-5.0	11	22	18	15	34	35	10	19	A-4a
		5.0-7.0	33	7	13	28	29	39	17	28	A-6a
		7.0-12.0	30	12	12	7	9	NP	NP	15	A-1-b
207+00	CL	0.4-5.0	0	1	4	46	45	42	17	23	A-7-6
		5.0-8.0	0	1	1	41	57	51	24	32	A-7-6
		8.0-10.0	Gray Sedimentary Peat					132	64	110	Visual
		10.0-12.0	0	1	3	58	41	97	42	62	A-7-5
		12.0-16.0	0	3	10	43	44	83	41	71	A-7-5
212+00	CL	0.4-5.0	0	1	4	58	45	42	16	25	A-7-6
		5.0-7.0	0	2	19	32	47	42	26	27	A-7-6
		7.0-12.0	51	12	10	13	14	27	8	22	A-2-4
		12.0-15.0	45	15	11	13	15	28	8	22	A-2-4
219+00	CL	0.4-5.0	0	4	5	35	56	45	19	28	A-7-6
		5.0-8.0	0	7	7	29	57	45	21	31	A-7-6
		8.0-13.0	70	10	4	12	4	28	5	20	A-1-b
		13.0-15.0	70	10	4	9	7	NP	NP	20	A-1-b
224+00	CL	0.4-3.0	22	14	15	17	32	35	15	23	A-6a
		3.0-6.0	64	18	5	6	7	NP	NP	10	A-1-a
228+00	CL	0.4-5.0	33	21	11	11	19	30	10	22	A-2-4
		5.0-8.0	57	20	6	9	8	25	3	11	A-1-a
232+00	CL	0.4-3.0	21	11	11	27	30	34	11	19	A-6a
		3.0-8.0	76	11	5	5	3	NP	NP	8	A-1-a
236+00	CL	0.4-5.0	30	11	16	22	21	32	7	20	A-4a
		5.0-10.0	73	12	5	- 5 -		NP	NP	13	A-1-a
		10.0-12.0	71	12	5	7	5	NP	NP	14	A-1-a
240+00	CL	0.4-4.0	3	8	36	21	32	29	8	22	A-4a
		4.0-6.0	56	9	9	15	11	27	3	24	A-2-4
		6.0-10.0	70	19	5	- 6 -		NP	NP	12	A-1-a
		10.0-14.0	65	26	6	- 3 -		NP	NP	14	A-1-a
245+00	CL	0.4-5.0	18	8	20	23	25	23	7	20	A-4a
		5.0-9.0	62	11	9	10	8	21	3	21	A-1-b
		9.0-14.0	10	3	73	7	7	NP	NP	5	A-3a
		14.0-17.0	19	10	30	6	5	NP	NP	18	A-3a

Additional borings see sheet 3

STATION & OFFSET		DEPTH FROM-TO	% AGG.	% C.S.	% F.S.	% SILT	% CLAY	L.L.	P.I.	% W.C.	SHTL CLASS.
249+00	CL	0.4-5.0	38	6	13	24	19	27	4	31	A-4a
		5.0-6.0	27	12	11	29	21	26	8	28	A-4a
		6.0-9.0	61	14	9	10	6	NP	NP	16	A-1-b
		9.0-12.0	31	34	6	- 9 -		NP	NP	18	A-1-b
251+00	CL	0.4-5.0	10	14	20	21	35	39	18	28	A-6b
		5.0-7.0	38	7	9	16	12	33	11	26	A-2-6
		7.0-11.0	39	31	6	- 4 -		NP	NP	12	A-1-a
256+00	CL	0.0-2.0	38	19	18	6	19	38	9	18	A-2-4
		2.0-6.5	48	15	14	13	9	NP	NP	15	A-1-b
		6.5-13.0	63	15	7	8	7	22	4	14	A-1-a
260+00	CL	0.0-5.0	0	4	33	15	31	25	8	19	A-4a
		5.0-10.0	2	5	32	24	30	23	7	21	A-4a *
		10.0-16.0	19	9	28	23	21	19	4	17	A-4a *
		16.0-20.0	40	22	15	14	9	NP	NP	16	A-1-b
265+00	CL	0.0-3.0	8	4	12	35	41	30	11	25	A-6a *
		3.0-7.0	4	5	15	33	43	32	14	23	A-6a *
		7.0-12.0	20	5	13	24	38	32	11	23	A-6a
273+00	CL	0.0-4.0	30	5	11	25	29	35	13	28	A-6a
		4.0-10.0	37	15	8	22	18	26	6	25	A-4a
		10.0-15.0	23	14	15	28	20	18	3	12	A-4a
278+00	CL	0.0-2.0	0	3	13	41	43	-	-	17	A-4a
		2.0-7.0	17	7	17	29	30	23	7	19	A-4a
		7.0-12.0	30	10	15	23	20	23	7	19	A-4a
		12.0-15.0	56	8	7	18	11	24	5	25	A-2-4
281+00	CL	0.0-2.0	16	5	15	27	37	34	16	22	A-6b *
		2.0-8.0	16	12	16	24	32	30	12	16	A-6a *
		8.0-12.0	57	5	7	18	13	23	8	13	A-2-4
288+00	CL	0.5-5.5	15	2	10	29	44	39	18	23	A-6b *
		5.5-7.0	30	8	25	17	20	24	9	25	A-4a *
		7.0-12.0	44	7	11	22	16	22	6	17	A-4a
293+00	CL	0.0-5.0	0	4	33	33	32	45	19	27	A-6b
		5.0-10.0	12	5	15	28	39	31	13	23	A-6a *
		10.0-14.0	45	7	11	20	17	20	8	10	A-1a

STATION & OFFSET		DEPTH FROM-TO	% AGG.	% C.S.	% F.S.	% SILT	% CLAY	L.L.	P.I.	% W.C.	SHTL CLASS.
297+00	CL	0.4-6.0	0	4	12	47	37	39	11	23	A-6a
		6.0-13.0	75	14	4	- 7 -		NP	NP	15	A-1-a
		13.0-17.0	18	37	38	+ 7 -		NP	NP	17	A-1-b
302+00	CL	0.4-5.0	0	2	5	47	46	42	17	25	A-7-6
		5.0-11.0	87	6	2	4	1	NP	NP	15	A-1-a
		11.0-17.0	78	11	3	5	3	NP	NP	12	A-1-a
308+00	CL	0.4-3.0	0	1	18	42	39	33	13	22	A-6a
		3.0-10.0	73	12	4	8	3	NP	NP	12	A-1-a
		10.0-17.0	50	43	4	+ 3 -		NP	NP	13	A-1-a
308+00		0.4-3.0	0	9	30	39	22	NP	NP	24	A-4a
		3.0-5.0	53	11	18	12	8	NP	NP	10	A-1-b
313+50	CL	0.4-6.0	0	3	9	48	40	64	34	19	A-7-6
		6.0-12.0	82	10	4	- 4 -		NP	NP	12	A-1-a
		12.0-18.0	75	21	3	- 1 -		NP	NP	12	A-1-a
317+00	CL	0.4-6.0	0	3	10	39	48	36	13	23	A-6a
		6.0-10.0	71	15	4	6	4	NP	NP	15	A-1-a
		10.0-15.0	63	30	4	- 3 -		NP	NP	13	A-1-a
		15.0-20.0	63	31	4	- 2 -		NP	NP	11	A-1-a
319+00	CL	0.5-5.0	0	2	9	31	58	-	-	27	A-7-6
		5.0-15.0	65	18	9	- 8 -		NP	NP	15	A-1-a
324+00	CL	0.5-4.0	0	3	9	35	53	41	18	27	A-7-6
		4.0-10.0	81	16	11	6	6	NP	NP	18	A-1-a
		10.0-15.0	51	28	10	6	5	NP	NP	15	A-1-a
328+00	CL	0.5-3.5	0	11	43	2	44	23	7	17	A-4a
		3.5-7.0	78	7	8	5	4	NP	NP	18	A-1-a
		7.0-12.0	87	22	5	- 8 -		NP	NP	18	A-1-a
		12.0-15.0	33	36	13	10	8	NP	NP	17	A-1-b
332+00	CL	0.5-2.5	0	1	4	38	57	57	15	58	A-7-5
		2.5-4.5	0	1	1	34	64	82	29	32	A-7-6
		4.5-10.0	(0	1	4	38	5	NP	NP)	77	A-7-5

Continued on following sheet

NOTE: Classification characteristics in parentheses indicate test data for a sample determined by visual examination to have characteristics essentially the same as the sample obtained as representative of the given interval.

TE 7.1 B
DOD 4.03

SOIL PROFILE
FRANKLIN COUNTY
FRA-33-22.95
OHIO STATE HIGHWAY
TESTING LABORATORY
O. S. U. CAMPUS, COLUMBUS, OHIO

10
20

Hay
Corn
Hay
Corn
Hay
Corn
Hay
Corn
℄, Proposed U.S.R. 33
Small low area
Abandoned water well
424
425
430
435
440
445
450
455
456

760
750
740
730
720

℄ TS +0.8'
23
17
12
11
℄ TS +0.8'
25
28
℄ TS +0.8'
32
24
11
Hole caved @ at elev. 736.8
℄ TS +0.8'
3
3
4
14
Hole caved in at elev. 737.5
℄ TS +0.8'
22
15
12
11
Hole caved in at elev. 740' and 737.0'
℄ TS +0.8'
19
12
11
Hole caved in at elev. 739.1
℄ TS +0.8'
20
9
7

424 425 426 427 428 429 430 431 432 433 434 435 436 437 438 439 440 441 442 443 444 445 446 447 448 449 450 451 452 453 454 455 456

FIELD BORING LOG

742.8

County, Route No., Section FRA-33-22.95

Station 436+0 Offset R Elev. 6

Date 1-5-61 Water Elev. 6.0

Crew C G H D.S. Equipment Rig

Drafting		

Depth Feet	Field Number	Description
0.0 1.8		plow depth
	576	Gr silt clay
7b		
	32	
5		
9a	526	Br wet silts x sand mix
10b	536	Br water bearing sand + gravel
10	11	
		742.8 / 6.0 / 736.8
		complete
		caved @ 6.0
15		
20		
25		
30		

Use reverse side of this sheet for additional notes.

FIELD BORING LOG — 744.5

County, Route No., Section FTH - 33 - 22.95

Station 442+10 Offset Q Elev. 6

Date 1-5-61 Water Elev. 8.0

Crew C.C. + D.S. Equipment P.C.

Drafting

Depth Feet	Field Number	Description
0.0		Plow depth.
	406	Br clay silt w/stone
76		Fmg.
	21	
5		
	416	Br wet sandy silt
6a	310	
10	426	Br wet to very wet sandy silt
10a		poorly sorted.
	14	
15		Complete
		Caved @ 7.0
20		
25		
30		

Use reverse side of this sheet for additional notes.

APPENDIX 5: HEC-RAS EXISTING CONDITION MODEL

HEC-RAS HEC-RAS 6.4.1 June 2023
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X      X   X     X  X    X
X     X  X        X           X   X    X    X   X

XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X        X
X     X  X        X    X       X   X    X    X        X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: CobleBowman
Project File : CobleBowman.prj
Run Date and Time: 4/15/2025 11:51:55 AM
Project in English units

PLAN DATA

Plan Title: ExistElev
Plan File : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.p01

Geometry Title: CobleBowmanEx
Geometry File : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.g01

Flow Title : Elevations
Flow File : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.f01

Plan Summary Information:
Number of: Cross Sections = 15 Multiple Openings = 0
Culverts = 1 Inline Structures = 0
Bridges = 0 Lateral Structures = 0

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20
Maximum difference tolerance = 0.3

    Flow tolerance factor   = 0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method: Average Conveyance
    Computational Flow Regime: Subcritical Flow

FLOW DATA

Flow Title: Elevations
Flow File : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.f01

Flow Data (cfs)

River	Reach	RS	25-yr	50-yr	100-yr	500-yr	2-yr	2xMMF	OHWM
CLX_3	Reach	1917.216	462	540	584	852	149	8.08	11.8

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
CLX_3	Reach	25-yr	Normal S = 0.0013	Normal S = 0.0013
CLX_3	Reach	50-yr	Normal S = 0.0013	Normal S = 0.0013
CLX_3	Reach	100-yr	Normal S = 0.0013	Known WS = 745.8
CLX_3	Reach	500-yr	Normal S = 0.0013	Known WS = 749.56
CLX_3	Reach	2-yr	Normal S = 0.0013	Normal S = 0.0013

CULVERT

RIVER: CLX_3
REACH: Reach RS: 1127

CULVERT OUTPUT Profile #25-yr Culv Group: Culvert #1

Q Culv Group (cfs)	462.00	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	4.83
Q Barrel (cfs)	462.00	Culv Vel DS (ft/s)	7.42
E.G. US. (ft)	747.38	Culv Inv El Up (ft)	740.00
W.S. US. (ft)	747.36	Culv Inv El Dn (ft)	740.00
E.G. DS (ft)	744.57	Culv Frctn Ls (ft)	1.90
W.S. DS (ft)	744.45	Culv Exit Loss (ft)	0.73
Delta EG (ft)	2.81	Culv Entr Loss (ft)	0.18

Delta WS (ft)	2.91	Q Weir (cfs)	
E.G. IC (ft)	745.49	Weir Sta Lft (ft)	
E.G. OC (ft)	747.38	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	746.84	Weir Max Depth (ft)	
Culv WS Outlet (ft)	744.45	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.23	Min El Weir Flow (ft)	749.01

CULVERT OUTPUT Profile #50-yr Culv Group: Culvert #1

Q Culv Group (cfs)	540.00	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	5.24
Q Barrel (cfs)	540.00	Culv Vel DS (ft/s)	8.40
E.G. US. (ft)	748.00	Culv Inv El Up (ft)	740.00
W.S. US. (ft)	747.97	Culv Inv El Dn (ft)	740.00
E.G. DS (ft)	744.74	Culv Frctn Ls (ft)	2.10
W.S. DS (ft)	744.59	Culv Exit Loss (ft)	0.95
Delta EG (ft)	3.26	Culv Entr Loss (ft)	0.21
Delta WS (ft)	3.38	Q Weir (cfs)	
E.G. IC (ft)	746.11	Weir Sta Lft (ft)	
E.G. OC (ft)	748.00	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	747.36	Weir Max Depth (ft)	
Culv WS Outlet (ft)	744.59	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.59	Min El Weir Flow (ft)	749.01

CULVERT OUTPUT Profile #100-yr Culv Group: Culvert #1

Q Culv Group (cfs)	584.00	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	5.30
Q Barrel (cfs)	584.00	Culv Vel DS (ft/s)	7.14
E.G. US. (ft)	748.53	Culv Inv El Up (ft)	740.00
W.S. US. (ft)	748.51	Culv Inv El Dn (ft)	740.00
E.G. DS (ft)	745.92	Culv Frctn Ls (ft)	1.68
W.S. DS (ft)	745.84	Culv Exit Loss (ft)	0.72
Delta EG (ft)	2.61	Culv Entr Loss (ft)	0.22
Delta WS (ft)	2.67	Q Weir (cfs)	
E.G. IC (ft)	746.44	Weir Sta Lft (ft)	
E.G. OC (ft)	748.53	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	747.87	Weir Max Depth (ft)	
Culv WS Outlet (ft)	745.84	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.78	Min El Weir Flow (ft)	749.01

CULVERT OUTPUT Profile #500-yr Culv Group: Culvert #1

Q Culv Group (cfs)	25.66	Culv Full Len (ft)	138.00
# Barrels	1	Culv Vel US (ft/s)	0.22
Q Barrel (cfs)	25.66	Culv Vel DS (ft/s)	0.22
E.G. US. (ft)	749.58	Culv Inv El Up (ft)	740.00
W.S. US. (ft)	749.57	Culv Inv El Dn (ft)	740.00
E.G. DS (ft)	749.57	Culv Frctn Ls (ft)	0.00
W.S. DS (ft)	749.56	Culv Exit Loss (ft)	0.00
Delta EG (ft)	0.00	Culv Entr Loss (ft)	0.00
Delta WS (ft)	0.01	Q Weir (cfs)	826.34
E.G. IC (ft)	748.31	Weir Sta Lft (ft)	0.00
E.G. OC (ft)	749.58	Weir Sta Rgt (ft)	2828.79
Culvert Control	Outlet	Weir Submerg	0.99
Culv WS Inlet (ft)	748.50	Weir Max Depth (ft)	0.58
Culv WS Outlet (ft)	748.50	Weir Avg Depth (ft)	0.46
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	1310.73
Culv Crt Depth (ft)	0.47	Min El Weir Flow (ft)	749.01

Warning: The weir over culvert is submerged.
Warning: During the culvert inlet control computations, the program could not balance the culvert/weir flow. The reported inlet energy grade answer may not be valid.

SUMMARY OF MANNING'S N VALUES

River:CLX_3

Reach	River Sta.	n1	n2	n3	n4	n5	n6	n7	n8	n9	n10	n11	n12
Reach	1917.216	.03	.1	.07	.1	.05	.05						
Reach	1815.309	.035	.1	.07	.1	.1	.06	.06					
Reach	1718.108	.03	.1	.07	.1	.1	.05	.05					
Reach	1494.218	.03	.1	.07	.1	.06	.1	.03	.03				
Reach	1396.953	.03	.1	.07	.1	.06	.1	.1	.1				
Reach	1307.234	.03	.1	.07	.1	.1							
Reach	1262.110	.03	.07	.1	.1								
Reach	1127	Culvert											
Reach	997.3811	.1	.07	.1	.1								
Reach	963.3603	.03	.1	.07	.1	.03	.013	.03	.03				
Reach	786.1729	.035	.1	.07	.1	.013	.3	.1	.03	.03			
Reach	688.7350	.035	.1	.07	.1	.03	.013	.03	.1	.03			
Reach	540.9222	.035	.1	.07	.1	.028	.03	.013	.03	.1	.03	.03	
Reach	455.8073	.035	.1	.07	.1	.03	.013	.03	.03				
Reach	401.3965	.035	.1	.07	.1	.03	.013	.03	.03				
Reach	301.5571	.035	.1	.07	.1	.03	.1	.03	.013	.03	.013	.03	.03

SUMMARY OF REACH LENGTHS

River: CLX_3

Reach	River Sta.	Left	Channel	Right
Reach	1917.216	101.4	101.91	102.13
Reach	1815.309	97.22	97.2	97.21
Reach	1718.108	219.83	223.89	228.41
Reach	1494.218	97.27	97.26	97.29
Reach	1396.953	89.72	89.72	89.74
Reach	1307.234	44.16	45.12	45.79
Reach	1262.110	265.75	264.73	265.71
Reach	1127	Culvert		
Reach	997.3811	42.25	34.02	23.58
Reach	963.3603	175.27	177.19	180.28
Reach	786.1729	97.44	97.44	97.49
Reach	688.7350	147.81	147.81	147.83
Reach	540.9222	85.12	85.11	85.13
Reach	455.8073	54.41	54.41	54.42
Reach	401.3965	102.02	99.84	97.58
Reach	301.5571	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: CLX_3

Reach	River Sta.	Contr.	Expan.
Reach	1917.216	.1	.3
Reach	1815.309	.1	.3
Reach	1718.108	.1	.3
Reach	1494.218	.1	.3
Reach	1396.953	.1	.3
Reach	1307.234	.1	.3
Reach	1262.110	.1	.3
Reach	1127	Culvert	
Reach	997.3811	.1	.3
Reach	963.3603	.1	.3
Reach	786.1729	.1	.3
Reach	688.7350	.1	.3
Reach	540.9222	.1	.3
Reach	455.8073	.1	.3
Reach	401.3965	.1	.3
Reach	301.5571	.1	.3

Profile Output Table - Standard Table 1

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
Reach	1917.216	25-yr	462.00	741.10	747.40		747.40	0.000028	0.35	1370.68	852.94	0.03
Reach	1917.216	50-yr	540.00	741.10	748.01		748.01	0.000016	0.28	1751.18	852.94	0.02
Reach	1917.216	100-yr	584.00	741.10	748.54		748.54	0.000010	0.24	2079.27	852.94	0.02
Reach	1917.216	500-yr	852.00	741.10	749.59		749.59	0.000009	0.24	2922.52	852.94	0.02
Reach	1815.309	25-yr	462.00	741.24	747.40		747.40	0.000026	0.31	1749.56	1124.66	0.02
Reach	1815.309	50-yr	540.00	741.24	748.01		748.01	0.000017	0.27	2157.92	1124.66	0.02
Reach	1815.309	100-yr	584.00	741.24	748.54		748.54	0.000012	0.24	2509.90	1124.66	0.02
Reach	1815.309	500-yr	852.00	741.24	749.59		749.59	0.000011	0.26	3589.40	1124.66	0.02
Reach	1718.108	25-yr	462.00	741.20	747.39		747.40	0.000013	0.22	2380.86	1124.59	0.02
Reach	1718.108	50-yr	540.00	741.20	748.01		748.01	0.000009	0.20	2839.85	1124.59	0.02
Reach	1718.108	100-yr	584.00	741.20	748.54		748.54	0.000007	0.19	3235.46	1124.59	0.01
Reach	1718.108	500-yr	852.00	741.20	749.58		749.59	0.000008	0.22	4332.00	1124.59	0.01
Reach	1494.218	25-yr	462.00	740.90	747.39		747.39	0.000007	0.17	3161.14	1441.24	0.01
Reach	1494.218	50-yr	540.00	740.90	748.01		748.01	0.000006	0.16	3672.14	1441.24	0.01
Reach	1494.218	100-yr	584.00	740.90	748.54		748.54	0.000005	0.15	4112.50	1441.24	0.01
Reach	1494.218	500-yr	852.00	740.90	749.58		749.58	0.000006	0.19	5490.22	1441.24	0.01
Reach	1396.953	25-yr	462.00	740.47	747.39		747.39	0.000023	0.32	2202.31	1337.82	0.02
Reach	1396.953	50-yr	540.00	740.47	748.01		748.01	0.000020	0.31	2529.64	1441.57	0.02
Reach	1396.953	100-yr	584.00	740.47	748.54		748.54	0.000017	0.30	2811.73	1441.57	0.02
Reach	1396.953	500-yr	852.00	740.47	749.58		749.58	0.000019	0.35	4124.95	1441.57	0.02
Reach	1307.234	25-yr	462.00	740.05	747.39		747.39	0.000087	0.68	1169.70	1857.17	0.05
Reach	1307.234	50-yr	540.00	740.05	748.00		748.00	0.000078	0.69	1327.27	1875.55	0.04
Reach	1307.234	100-yr	584.00	740.05	748.53		748.53	0.000066	0.66	1463.13	1876.90	0.04
Reach	1307.234	500-yr	852.00	740.05	749.58		749.58	0.000091	0.84	3072.96	1880.10	0.05
Reach	1262.110	25-yr	462.00	739.83	747.36	743.50	747.38	0.000113	0.66	489.85	2819.61	0.05
Reach	1262.110	50-yr	540.00	739.83	747.97	743.62	748.00	0.000101	0.66	556.20	2828.79	0.04
Reach	1262.110	100-yr	584.00	739.83	748.51	743.65	748.53	0.000085	0.64	613.66	2828.79	0.04
Reach	1262.110	500-yr	852.00	739.83	749.57	743.95	749.58	0.000059	0.58	2970.75	2828.79	0.03
Reach	1127		Culvert									
Reach	997.3811	25-yr	462.00	740.10	744.45		744.57	0.003578	3.06	194.02	1468.95	0.28
Reach	997.3811	50-yr	540.00	740.10	744.59		744.74	0.004192	3.39	205.01	1519.29	0.30
Reach	997.3811	100-yr	584.00	740.10	745.84		745.92	0.001590	2.51	301.24	2289.09	0.19
Reach	997.3811	500-yr	852.00	740.10	749.56		749.57	0.000217	1.33	2562.93	2528.33	0.08
Reach	963.3603	25-yr	462.00	739.20	744.36		744.45	0.003406	2.84	238.64	1836.88	0.27

Reach	963.3603	50-yr	540.00	739.20	744.49		744.59	0.003945	3.13	252.50	1907.20	0.29
Reach	963.3603	100-yr	584.00	739.20	745.82		745.86	0.001200	2.12	393.33	2525.99	0.17
Reach	963.3603	500-yr	852.00	739.20	749.56		749.57	0.000108	0.92	3177.89	3098.75	0.05
Reach	786.1729	25-yr	462.00	738.95	743.71		743.80	0.003905	3.04	275.34	751.06	0.28
Reach	786.1729	50-yr	540.00	738.95	743.82		743.90	0.003781	3.05	305.79	861.47	0.28
Reach	786.1729	100-yr	584.00	738.95	745.80		745.82	0.000077	0.58	882.25	2559.48	0.04
Reach	786.1729	500-yr	852.00	738.95	749.56		749.56	0.000007	0.24	4038.22	2837.96	0.01
Reach	688.7350	25-yr	462.00	738.83	743.15		743.30	0.006886	3.56	195.89	301.16	0.36
Reach	688.7350	50-yr	540.00	738.83	743.26		743.41	0.006786	3.62	231.31	322.83	0.36
Reach	688.7350	100-yr	584.00	738.83	745.80		745.81	0.000073	0.56	1154.65	2436.42	0.04
Reach	688.7350	500-yr	852.00	738.83	749.56		749.56	0.000008	0.26	4449.53	2684.08	0.01
Reach	540.9222	25-yr	462.00	738.65	743.07		743.10	0.000421	0.86	414.56	374.39	0.09
Reach	540.9222	50-yr	540.00	738.65	743.16		743.20	0.000491	0.95	447.60	394.81	0.10
Reach	540.9222	100-yr	584.00	738.65	745.80		745.80	0.000016	0.26	1784.10	2354.72	0.02
Reach	540.9222	500-yr	852.00	738.65	749.56		749.56	0.000003	0.17	5339.11	2478.40	0.01
Reach	455.8073	25-yr	462.00	738.38	742.99		743.03	0.002239	1.92	353.33	544.63	0.21
Reach	455.8073	50-yr	540.00	738.38	743.08		743.12	0.002287	1.98	393.49	656.32	0.21
Reach	455.8073	100-yr	584.00	738.38	745.80		745.80	0.000015	0.25	2013.65	2317.36	0.02
Reach	455.8073	500-yr	852.00	738.38	749.56		749.56	0.000004	0.18	5706.17	2362.09	0.01
Reach	401.3965	25-yr	462.00	738.38	742.89		742.92	0.001746	1.76	328.59	671.68	0.18
Reach	401.3965	50-yr	540.00	738.38	742.97		743.01	0.001814	1.82	366.31	732.28	0.19
Reach	401.3965	100-yr	584.00	738.38	745.80		745.80	0.000008	0.19	2292.17	1842.71	0.01
Reach	401.3965	500-yr	852.00	738.38	749.56		749.56	0.000002	0.14	5980.09	2051.00	0.01
Reach	301.5571	25-yr	462.00	738.88	742.75	742.01	742.77	0.001300	1.56	385.19	833.50	0.16
Reach	301.5571	50-yr	540.00	738.88	742.82	742.07	742.85	0.001301	1.59	437.63	871.40	0.16
Reach	301.5571	100-yr	584.00	738.88	745.80	742.15	745.80	0.000005	0.16	2757.98	1839.12	0.01
Reach	301.5571	500-yr	852.00	738.88	749.56	742.37	749.56	0.000002	0.12	6600.11	1855.28	0.01

Profile Output Table - Standard Table 2

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Vel Head (ft)	Frctn Loss (ft)	C & E Loss (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Top Width (ft)
Reach	1917.216	25-yr	747.40	747.40	0.00	0.00	0.00	395.61	21.77	44.61	852.94
Reach	1917.216	50-yr	748.01	748.01	0.00	0.00	0.00	474.46	19.64	45.90	852.94
Reach	1917.216	100-yr	748.54	748.54	0.00	0.00	0.00	520.00	18.01	45.99	852.94
Reach	1917.216	500-yr	749.59	749.59	0.00	0.00	0.00	768.10	21.01	62.89	852.94
Reach	1815.309	25-yr	747.40	747.40	0.00	0.00	0.00	319.11	58.47	84.42	1124.66
Reach	1815.309	50-yr	748.01	748.01	0.00	0.00	0.00	389.70	57.75	92.55	1124.66
Reach	1815.309	100-yr	748.54	748.54	0.00	0.00	0.00	431.86	55.99	96.14	1124.66
Reach	1815.309	500-yr	749.59	749.59	0.00	0.00	0.00	644.46	71.29	136.25	1124.66

Reach	1718.108	25-yr	747.40	747.39	0.00	0.00	0.00	318.17	29.07	114.76	1124.59
Reach	1718.108	50-yr	748.01	748.01	0.00	0.00	0.00	377.43	30.22	132.35	1124.59
Reach	1718.108	100-yr	748.54	748.54	0.00	0.00	0.00	411.90	30.22	141.88	1124.59
Reach	1718.108	500-yr	749.59	749.58	0.00	0.00	0.00	592.26	41.79	217.95	1124.59
Reach	1494.218	25-yr	747.39	747.39	0.00	0.00	0.00	236.17	30.74	195.09	1441.24
Reach	1494.218	50-yr	748.01	748.01	0.00	0.00	0.00	277.76	33.56	228.68	1441.24
Reach	1494.218	100-yr	748.54	748.54	0.00	0.00	0.00	301.60	34.63	247.77	1441.24
Reach	1494.218	500-yr	749.58	749.58	0.00	0.00	0.00	407.06	50.56	394.39	1441.24
Reach	1396.953	25-yr	747.39	747.39	0.00	0.00	0.00	222.55	45.93	193.51	1337.82
Reach	1396.953	50-yr	748.01	748.01	0.00	0.00	0.00	260.72	50.78	228.50	1441.57
Reach	1396.953	100-yr	748.54	748.54	0.00	0.00	0.00	282.38	52.83	248.80	1441.57
Reach	1396.953	500-yr	749.58	749.58	0.00	0.00	0.00	403.84	71.34	376.82	1441.57
Reach	1307.234	25-yr	747.39	747.39	0.00	0.00	0.00	211.79	53.01	197.20	1857.17
Reach	1307.234	50-yr	748.00	748.00	0.00	0.00	0.00	252.36	58.29	229.35	1875.55
Reach	1307.234	100-yr	748.53	748.53	0.00	0.00	0.00	276.50	60.35	247.15	1876.90
Reach	1307.234	500-yr	749.58	749.58	0.00	0.00	0.00	472.89	87.18	291.94	1880.10
Reach	1262.110	25-yr	747.38	747.36	0.02			336.57	77.99	47.44	2819.61
Reach	1262.110	50-yr	748.00	747.97	0.02			397.16	85.39	57.45	2828.79
Reach	1262.110	100-yr	748.53	748.51	0.02			432.26	88.12	63.62	2828.79
Reach	1262.110	500-yr	749.58	749.57	0.00			627.45	91.39	133.16	2828.79
Reach	1127		Culvert								
Reach	997.3811	25-yr	744.57	744.45	0.12	0.11	0.01	8.51	375.52	77.97	1468.95
Reach	997.3811	50-yr	744.74	744.59	0.15	0.13	0.01	10.22	432.03	97.75	1519.29
Reach	997.3811	100-yr	745.92	745.84	0.08	0.04	0.01	12.76	419.85	151.39	2289.09
Reach	997.3811	500-yr	749.57	749.56	0.01	0.00	0.00	188.35	380.76	282.89	2528.33
Reach	963.3603	25-yr	744.45	744.36	0.09	0.65	0.00	54.42	288.24	119.34	1836.88
Reach	963.3603	50-yr	744.59	744.49	0.11	0.69	0.01	66.16	329.38	144.46	1907.20
Reach	963.3603	100-yr	745.86	745.82	0.05	0.03	0.01	89.79	302.87	191.34	2525.99
Reach	963.3603	500-yr	749.57	749.56	0.00	0.00	0.00	305.69	229.39	316.92	3098.75
Reach	786.1729	25-yr	743.80	743.71	0.09	0.50	0.01	135.96	257.72	68.32	751.06
Reach	786.1729	50-yr	743.90	743.82	0.09	0.48	0.01	157.36	266.05	116.59	861.47
Reach	786.1729	100-yr	745.82	745.80	0.02	0.01	0.00	121.26	77.39	385.35	2559.48
Reach	786.1729	500-yr	749.56	749.56	0.00	0.00	0.00	190.09	54.38	607.53	2837.96
Reach	688.7350	25-yr	743.30	743.15	0.15	0.16	0.04	35.54	324.60	101.86	301.16
Reach	688.7350	50-yr	743.41	743.26	0.15	0.18	0.03	51.10	342.77	146.13	322.83
Reach	688.7350	100-yr	745.81	745.80	0.01	0.00	0.00	134.00	96.52	353.48	2436.42
Reach	688.7350	500-yr	749.56	749.56	0.00	0.00	0.00	233.92	73.62	544.46	2684.08
Reach	540.9222	25-yr	743.10	743.07	0.03	0.07	0.00	19.47	79.05	363.49	374.39
Reach	540.9222	50-yr	743.20	743.16	0.04	0.08	0.00	25.96	89.77	424.27	394.81
Reach	540.9222	100-yr	745.80	745.80	0.00	0.00	0.00	122.96	47.32	413.72	2354.72

Reach	540.9222	500-yr	749.56	749.56	0.00	0.00	0.00	244.97	51.02	556.02	2478.40
Reach	455.8073	25-yr	743.03	742.99	0.04	0.11	0.00	142.86	249.68	69.47	544.63
Reach	455.8073	50-yr	743.12	743.08	0.04	0.11	0.00	175.59	265.56	98.85	656.32
Reach	455.8073	100-yr	745.80	745.80	0.00	0.00	0.00	282.21	66.55	235.24	2317.36
Reach	455.8073	500-yr	749.56	749.56	0.00	0.00	0.00	374.02	80.72	397.26	2362.09
Reach	401.3965	25-yr	742.92	742.89	0.03	0.15	0.00	227.14	177.68	57.19	671.68
Reach	401.3965	50-yr	743.01	742.97	0.04	0.15	0.00	272.10	189.62	78.28	732.28
Reach	401.3965	100-yr	745.80	745.80	0.00	0.00	0.00	319.54	39.55	224.91	1842.71
Reach	401.3965	500-yr	749.56	749.56	0.00	0.00	0.00	417.30	48.33	386.37	2051.00
Reach	301.5571	25-yr	742.77	742.75	0.02			305.72	92.85	63.43	833.50
Reach	301.5571	50-yr	742.85	742.82	0.03			361.25	96.84	81.91	871.40
Reach	301.5571	100-yr	745.80	745.80	0.00			367.20	18.93	197.88	1839.12
Reach	301.5571	500-yr	749.56	749.56	0.00			479.91	22.63	349.46	1855.28

Profile Output Table - Culvert Only

Reach	River Sta		Profile	E.G. US. (ft)	W.S. US. (ft)	E.G. IC (ft)	E.G. OC (ft)	Min El Weir Flow (ft)	Q Culv Group (cfs)	Q Weir (cfs)	Delta WS (ft)	Culv Vel US (ft/s)	Culv Vel DS (ft/s)
Reach	1127	Culvert #1	25-yr	747.38	747.36	745.49	747.38	749.01	462.00		2.91	4.83	7.42
Reach	1127	Culvert #1	50-yr	748.00	747.97	746.11	748.00	749.01	540.00		3.38	5.24	8.40
Reach	1127	Culvert #1	100-yr	748.53	748.51	746.44	748.53	749.01	584.00		2.67	5.30	7.14
Reach	1127	Culvert #1	500-yr	749.58	749.57	748.31	749.58	749.01	25.66	826.34	0.01	0.22	0.22

APPENDIX 6: HEC-RAS PROPOSED CONDITION MODEL

HEC-RAS HEC-RAS 6.4.1 June 2023
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X       X   X     X  X    X
X     X  X        X            X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X        X
X     X  X        X    X       X   X    X    X        X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: CobleBowman
Project File : CobleBowman.prj
Run Date and Time: 4/16/2025 11:26:27 AM

Project in English units

PLAN DATA

Plan Title: PropBoxElev
Plan File : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.p02

Geometry Title: CobleBowmanPropBox
Geometry File : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.g02

Flow Title : Elevations
Flow File : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.f01

Plan Summary Information:
Number of: Cross Sections = 15 Multiple Openings = 0
Culverts = 1 Inline Structures = 0
Bridges = 0 Lateral Structures = 0

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20

```
    Maximum difference tolerance         =  0.3
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow



FLOW DATA

Flow Title: Elevations
Flow File : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.f01

Flow Data (cfs)

  River           Reach           RS                  25-yr          50-yr          100-yr          500-yr           2-yr           2xMMF           OHWM
  CLX_3           Reach           1917.216              462            540            584             852            149            8.08           11.8


Boundary Conditions

  River           Reach           Profile                     Upstream                Downstream

  CLX_3           Reach           25-yr                   Normal S = 0.0013       Normal S = 0.0013
  CLX_3           Reach           50-yr                   Normal S = 0.0013       Normal S = 0.0013
  CLX_3           Reach           100-yr                  Normal S = 0.0013        Known WS = 745.8
  CLX_3           Reach           500-yr                  Normal S = 0.0013       Known WS = 749.56
  CLX_3           Reach           2-yr                    Normal S = 0.0013       Normal S = 0.0013


CULVERT


RIVER: CLX_3
REACH: Reach              RS: 1127


CULVERT OUTPUT  Profile #25-yr  Culv Group:  Culvert #1

  Q Culv Group (cfs)        462.00    Culv Full Len (ft)
  # Barrels                      1    Culv Vel US (ft/s)         6.32
  Q Barrel (cfs)            462.00    Culv Vel DS (ft/s)         6.49
  E.G. US. (ft)             745.50    Culv Inv El Up (ft)      740.00
  W.S. US. (ft)             745.44    Culv Inv El Dn (ft)      740.00
  E.G. DS (ft)              744.57    Culv Frctn Ls (ft)         0.09
  W.S. DS (ft)              744.45    Culv Exit Loss (ft)        0.53
```

Delta EG (ft)	0.93	Culv Entr Loss (ft)	0.31
Delta WS (ft)	0.99	Q Weir (cfs)	
E.G. IC (ft)	745.05	Weir Sta Lft (ft)	
E.G. OC (ft)	745.50	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	744.57	Weir Max Depth (ft)	
Culv WS Outlet (ft)	744.45	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	2.96	Min El Weir Flow (ft)	749.01

CULVERT OUTPUT Profile #50-yr Culv Group: Culvert #1

Q Culv Group (cfs)	540.00	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	7.09
Q Barrel (cfs)	540.00	Culv Vel DS (ft/s)	7.35
E.G. US. (ft)	745.93	Culv Inv El Up (ft)	740.00
W.S. US. (ft)	745.86	Culv Inv El Dn (ft)	740.00
E.G. DS (ft)	744.74	Culv Frctn Ls (ft)	0.11
W.S. DS (ft)	744.59	Culv Exit Loss (ft)	0.69
Delta EG (ft)	1.19	Culv Entr Loss (ft)	0.39
Delta WS (ft)	1.28	Q Weir (cfs)	
E.G. IC (ft)	745.61	Weir Sta Lft (ft)	
E.G. OC (ft)	745.93	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	744.76	Weir Max Depth (ft)	
Culv WS Outlet (ft)	744.59	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.28	Min El Weir Flow (ft)	749.01

CULVERT OUTPUT Profile #100-yr Culv Group: Culvert #1

Q Culv Group (cfs)	584.00	Culv Full Len (ft)	
# Barrels	1	Culv Vel US (ft/s)	6.16
Q Barrel (cfs)	584.00	Culv Vel DS (ft/s)	6.25
E.G. US. (ft)	746.81	Culv Inv El Up (ft)	740.00
W.S. US. (ft)	746.76	Culv Inv El Dn (ft)	740.00
E.G. DS (ft)	745.92	Culv Frctn Ls (ft)	0.07
W.S. DS (ft)	745.84	Culv Exit Loss (ft)	0.53
Delta EG (ft)	0.89	Culv Entr Loss (ft)	0.29
Delta WS (ft)	0.92	Q Weir (cfs)	
E.G. IC (ft)	745.91	Weir Sta Lft (ft)	
E.G. OC (ft)	746.81	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	745.92	Weir Max Depth (ft)	
Culv WS Outlet (ft)	745.84	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.46	Min El Weir Flow (ft)	749.01

CULVERT OUTPUT Profile #500-yr Culv Group: Culvert #1

Q Culv Group (cfs)	44.08	Culv Full Len (ft)	138.00
# Barrels	1	Culv Vel US (ft/s)	0.46
Q Barrel (cfs)	44.08	Culv Vel DS (ft/s)	0.46
E.G. US. (ft)	749.58	Culv Inv El Up (ft)	740.00
W.S. US. (ft)	749.57	Culv Inv El Dn (ft)	740.00
E.G. DS (ft)	749.57	Culv Frctn Ls (ft)	0.00
W.S. DS (ft)	749.56	Culv Exit Loss (ft)	0.00
Delta EG (ft)	0.00	Culv Entr Loss (ft)	0.00
Delta WS (ft)	0.01	Q Weir (cfs)	807.92
E.G. IC (ft)	747.71	Weir Sta Lft (ft)	0.00
E.G. OC (ft)	749.58	Weir Sta Rgt (ft)	2828.79
Culvert Control	Outlet	Weir Submerg	0.99
Culv WS Inlet (ft)	746.00	Weir Max Depth (ft)	0.58
Culv WS Outlet (ft)	746.00	Weir Avg Depth (ft)	0.46
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	1310.37
Culv Crt Depth (ft)	0.62	Min El Weir Flow (ft)	749.01

Warning: The weir over culvert is submerged.
Warning: During the culvert inlet control computations, the program could not balance the culvert/weir flow. The reported inlet energy grade answer may not be valid.

SUMMARY OF MANNING'S N VALUES

River:CLX_3

Reach	River Sta.	n1	n2	n3	n4	n5	n6	n7	n8	n9	n10	n11	n12
Reach	1917.216	.03	.1	.07	.1	.05	.05						
Reach	1815.309	.035	.1	.07	.1	.1	.06	.06					
Reach	1718.108	.03	.1	.07	.1	.1	.05	.05					
Reach	1494.218	.03	.1	.07	.1	.06	.1	.03	.03				
Reach	1396.953	.03	.1	.07	.1	.06	.1	.1	.1				
Reach	1307.234	.03	.1	.07	.1	.1							
Reach	1262.110	.03	.07	.1	.1								
Reach	1127	Culvert											
Reach	997.3811	.1	.07	.1	.1								
Reach	963.3603	.03	.1	.07	.1	.03	.013	.03	.03				
Reach	786.1729	.035	.1	.07	.1	.013	.3	.1	.03	.03			
Reach	688.7350	.035	.1	.07	.1	.03	.013	.03	.1	.03			
Reach	540.9222	.035	.1	.07	.1	.028	.03	.013	.03	.1	.03	.03	
Reach	455.8073	.035	.1	.07	.1	.03	.013	.03	.03				
Reach	401.3965	.035	.1	.07	.1	.03	.013	.03	.03				
Reach	301.5571	.035	.1	.07	.1	.03	.1	.03	.013	.03	.013	.03	.03

SUMMARY OF REACH LENGTHS

River: CLX_3

Reach	River Sta.	Left	Channel	Right
Reach	1917.216	101.4	101.91	102.13
Reach	1815.309	97.22	97.2	97.21
Reach	1718.108	219.83	223.89	228.41
Reach	1494.218	97.27	97.26	97.29
Reach	1396.953	89.72	89.72	89.74
Reach	1307.234	44.16	45.12	45.79
Reach	1262.110	265.75	264.73	265.71
Reach	1127	Culvert		
Reach	997.3811	42.25	34.02	23.58
Reach	963.3603	175.27	177.19	180.28
Reach	786.1729	97.44	97.44	97.49
Reach	688.7350	147.81	147.81	147.83
Reach	540.9222	85.12	85.11	85.13
Reach	455.8073	54.41	54.41	54.42
Reach	401.3965	102.02	99.84	97.58
Reach	301.5571	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: CLX_3

Reach	River Sta.	Contr.	Expan.
Reach	1917.216	.1	.3
Reach	1815.309	.1	.3
Reach	1718.108	.1	.3
Reach	1494.218	.1	.3
Reach	1396.953	.1	.3
Reach	1307.234	.1	.3
Reach	1262.110	.1	.3
Reach	1127	Culvert	
Reach	997.3811	.1	.3
Reach	963.3603	.1	.3
Reach	786.1729	.1	.3
Reach	688.7350	.1	.3
Reach	540.9222	.1	.3
Reach	455.8073	.1	.3
Reach	401.3965	.1	.3

Reach 301.5571 .1 .3

Profile Output Table - Standard Table 1

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
Reach	1917.216	25-yr	462.00	741.10	745.68		745.71	0.000975	1.61	427.23	626.07	0.14
Reach	1917.216	50-yr	540.00	741.10	746.05		746.07	0.000529	1.26	586.59	656.13	0.11
Reach	1917.216	100-yr	584.00	741.10	746.86		746.86	0.000123	0.68	1033.65	852.94	0.05
Reach	1917.216	500-yr	852.00	741.10	749.59		749.59	0.000009	0.24	2922.67	852.94	0.02
Reach	1815.309	25-yr	462.00	741.24	745.61		745.62	0.000624	1.10	659.00	764.68	0.11
Reach	1815.309	50-yr	540.00	741.24	746.01		746.02	0.000333	0.87	882.11	815.87	0.08
Reach	1815.309	100-yr	584.00	741.24	746.85		746.85	0.000090	0.52	1388.42	1044.03	0.04
Reach	1815.309	500-yr	852.00	741.24	749.59		749.59	0.000011	0.26	3589.61	1124.66	0.02
Reach	1718.108	25-yr	462.00	741.20	745.59		745.59	0.000196	0.65	1055.27	892.31	0.06
Reach	1718.108	50-yr	540.00	741.20	746.00		746.00	0.000118	0.55	1344.02	940.73	0.05
Reach	1718.108	100-yr	584.00	741.20	746.84		746.84	0.000039	0.36	1967.79	1106.74	0.03
Reach	1718.108	500-yr	852.00	741.20	749.58		749.59	0.000008	0.22	4332.21	1124.59	0.01
Reach	1494.218	25-yr	462.00	740.90	745.56		745.57	0.000068	0.39	1641.76	1112.11	0.04
Reach	1494.218	50-yr	540.00	740.90	745.98		745.98	0.000048	0.35	1989.96	1150.61	0.03
Reach	1494.218	100-yr	584.00	740.90	746.84		746.84	0.000019	0.26	2698.72	1312.88	0.02
Reach	1494.218	500-yr	852.00	740.90	749.58		749.58	0.000006	0.19	5490.48	1441.24	0.01
Reach	1396.953	25-yr	462.00	740.47	745.55		745.56	0.000162	0.64	1224.24	1151.12	0.06
Reach	1396.953	50-yr	540.00	740.47	745.98		745.98	0.000127	0.61	1448.61	1175.35	0.05
Reach	1396.953	100-yr	584.00	740.47	746.83		746.83	0.000060	0.47	1904.89	1298.28	0.04
Reach	1396.953	500-yr	852.00	740.47	749.58		749.58	0.000019	0.35	4125.21	1441.57	0.02
Reach	1307.234	25-yr	462.00	740.05	745.52		745.53	0.000471	1.28	693.00	1359.35	0.10
Reach	1307.234	50-yr	540.00	740.05	745.95		745.96	0.000403	1.25	802.08	1475.30	0.10
Reach	1307.234	100-yr	584.00	740.05	746.82		746.82	0.000213	1.01	1024.56	1733.06	0.07
Reach	1307.234	500-yr	852.00	740.05	749.58		749.58	0.000091	0.84	3073.30	1880.10	0.05
Reach	1262.110	25-yr	462.00	739.83	745.44	743.50	745.50	0.000710	1.32	282.30	2573.96	0.11
Reach	1262.110	50-yr	540.00	739.83	745.86	743.62	745.93	0.000587	1.27	328.47	2659.22	0.10
Reach	1262.110	100-yr	584.00	739.83	746.76	743.65	746.81	0.000290	1.00	425.33	2742.08	0.07
Reach	1262.110	500-yr	852.00	739.83	749.57	743.95	749.58	0.000059	0.58	2971.27	2828.79	0.03
Reach	1127		Culvert									
Reach	997.3811	25-yr	462.00	740.10	744.45		744.57	0.003578	3.06	194.02	1468.95	0.28
Reach	997.3811	50-yr	540.00	740.10	744.59		744.74	0.004192	3.39	205.01	1519.29	0.30
Reach	997.3811	100-yr	584.00	740.10	745.84		745.92	0.001590	2.51	301.24	2289.09	0.19
Reach	997.3811	500-yr	852.00	740.10	749.56		749.57	0.000217	1.33	2562.93	2528.33	0.08

Reach	963.3603	25-yr	462.00	739.20	744.36	744.45	0.003406	2.84	238.64	1836.88	0.27
Reach	963.3603	50-yr	540.00	739.20	744.49	744.59	0.003945	3.13	252.50	1907.20	0.29
Reach	963.3603	100-yr	584.00	739.20	745.82	745.86	0.001200	2.12	393.33	2525.99	0.17
Reach	963.3603	500-yr	852.00	739.20	749.56	749.57	0.000108	0.92	3177.89	3098.75	0.05
Reach	786.1729	25-yr	462.00	738.95	743.71	743.80	0.003905	3.04	275.34	751.06	0.28
Reach	786.1729	50-yr	540.00	738.95	743.82	743.90	0.003782	3.05	305.77	861.42	0.28
Reach	786.1729	100-yr	584.00	738.95	745.80	745.82	0.000077	0.58	882.25	2559.48	0.04
Reach	786.1729	500-yr	852.00	738.95	749.56	749.56	0.000007	0.24	4038.22	2837.96	0.01
Reach	688.7350	25-yr	462.00	738.83	743.15	743.30	0.006886	3.56	195.89	301.16	0.36
Reach	688.7350	50-yr	540.00	738.83	743.26	743.41	0.006784	3.62	231.33	322.83	0.36
Reach	688.7350	100-yr	584.00	738.83	745.80	745.81	0.000073	0.56	1154.65	2436.42	0.04
Reach	688.7350	500-yr	852.00	738.83	749.56	749.56	0.000008	0.26	4449.53	2684.08	0.01
Reach	540.9222	25-yr	462.00	738.65	743.07	743.10	0.000421	0.86	414.56	374.39	0.09
Reach	540.9222	50-yr	540.00	738.65	743.16	743.20	0.000491	0.95	447.65	394.84	0.10
Reach	540.9222	100-yr	584.00	738.65	745.80	745.80	0.000016	0.26	1784.10	2354.72	0.02
Reach	540.9222	500-yr	852.00	738.65	749.56	749.56	0.000003	0.17	5339.11	2478.40	0.01
Reach	455.8073	25-yr	462.00	738.38	742.99	743.03	0.002239	1.92	353.33	544.63	0.21
Reach	455.8073	50-yr	540.00	738.38	743.08	743.12	0.002286	1.98	393.55	656.48	0.21
Reach	455.8073	100-yr	584.00	738.38	745.80	745.80	0.000015	0.25	2013.65	2317.36	0.02
Reach	455.8073	500-yr	852.00	738.38	749.56	749.56	0.000004	0.18	5706.17	2362.09	0.01
Reach	401.3965	25-yr	462.00	738.38	742.89	742.92	0.001746	1.76	328.59	671.68	0.18
Reach	401.3965	50-yr	540.00	738.38	742.97	743.01	0.001813	1.82	366.37	732.38	0.19
Reach	401.3965	100-yr	584.00	738.38	745.80	745.80	0.000008	0.19	2292.17	1842.71	0.01
Reach	401.3965	500-yr	852.00	738.38	749.56	749.56	0.000002	0.14	5980.09	2051.00	0.01
Reach	301.5571	25-yr	462.00	738.88	742.75	742.01	742.77	0.001300	1.56	385.19	833.50	0.16
Reach	301.5571	50-yr	540.00	738.88	742.82	742.07	742.85	0.001301	1.59	437.63	871.40	0.16
Reach	301.5571	100-yr	584.00	738.88	745.80	742.15	745.80	0.000005	0.16	2757.98	1839.12	0.01
Reach	301.5571	500-yr	852.00	738.88	749.56	742.37	749.56	0.000002	0.12	6600.11	1855.28	0.01

Profile Output Table - Standard Table 2

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Vel Head (ft)	Frctn Loss (ft)	C & E Loss (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Top Width (ft)
Reach	1917.216	25-yr	745.71	745.68	0.02	0.08	0.00	314.09	69.69	78.22	626.07
Reach	1917.216	50-yr	746.07	746.05	0.02	0.04	0.00	400.42	59.57	80.01	656.13
Reach	1917.216	100-yr	746.86	746.86	0.01	0.01	0.00	478.45	38.34	67.21	852.94
Reach	1917.216	500-yr	749.59	749.59	0.00	0.00	0.00	768.10	21.01	62.89	852.94
Reach	1815.309	25-yr	745.62	745.61	0.01	0.03	0.00	210.76	131.08	120.16	764.68
Reach	1815.309	50-yr	746.02	746.01	0.01	0.02	0.00	294.50	117.86	127.64	815.87
Reach	1815.309	100-yr	746.85	746.85	0.00	0.01	0.00	376.83	88.33	118.84	1044.03
Reach	1815.309	500-yr	749.59	749.59	0.00	0.00	0.00	644.45	71.29	136.26	1124.66

Reach	1718.108	25-yr	745.59	745.59	0.00	0.02	0.00	282.46	55.46	124.07	892.31
Reach	1718.108	50-yr	746.00	746.00	0.00	0.02	0.00	345.79	52.29	141.93	940.73
Reach	1718.108	100-yr	746.84	746.84	0.00	0.01	0.00	394.14	42.36	147.50	1106.74
Reach	1718.108	500-yr	749.59	749.58	0.00	0.00	0.00	592.26	41.79	217.95	1124.59
Reach	1494.218	25-yr	745.57	745.56	0.00	0.01	0.00	225.63	45.82	190.56	1112.11
Reach	1494.218	50-yr	745.98	745.98	0.00	0.01	0.00	268.37	46.79	224.84	1150.61
Reach	1494.218	100-yr	746.84	746.84	0.00	0.00	0.00	296.19	42.14	245.67	1312.88
Reach	1494.218	500-yr	749.58	749.58	0.00	0.00	0.00	407.06	50.56	394.38	1441.24
Reach	1396.953	25-yr	745.56	745.55	0.00	0.02	0.00	218.85	62.22	180.92	1151.12
Reach	1396.953	50-yr	745.98	745.98	0.00	0.02	0.00	257.44	65.89	216.67	1175.35
Reach	1396.953	100-yr	746.83	746.83	0.00	0.01	0.00	280.51	61.93	241.56	1298.28
Reach	1396.953	500-yr	749.58	749.58	0.00	0.00	0.00	403.84	71.34	376.82	1441.57
Reach	1307.234	25-yr	745.53	745.52	0.01	0.03	0.01	188.07	72.01	201.92	1359.35
Reach	1307.234	50-yr	745.96	745.95	0.01	0.02	0.01	229.03	76.59	234.38	1475.30
Reach	1307.234	100-yr	746.82	746.82	0.01	0.01	0.00	261.52	71.81	250.67	1733.06
Reach	1307.234	500-yr	749.58	749.58	0.00	0.00	0.00	472.88	87.16	291.96	1880.10
Reach	1262.110	25-yr	745.50	745.44	0.06			314.39	110.50	37.11	2573.96
Reach	1262.110	50-yr	745.93	745.86	0.07			376.54	116.13	47.32	2659.22
Reach	1262.110	100-yr	746.81	746.76	0.05			420.06	106.70	57.24	2742.08
Reach	1262.110	500-yr	749.58	749.57	0.00			627.46	91.37	133.17	2828.79
Reach	1127		Culvert								
Reach	997.3811	25-yr	744.57	744.45	0.12	0.11	0.01	8.51	375.52	77.97	1468.95
Reach	997.3811	50-yr	744.74	744.59	0.15	0.13	0.01	10.22	432.03	97.75	1519.29
Reach	997.3811	100-yr	745.92	745.84	0.08	0.04	0.01	12.76	419.85	151.39	2289.09
Reach	997.3811	500-yr	749.57	749.56	0.01	0.00	0.00	188.35	380.76	282.89	2528.33
Reach	963.3603	25-yr	744.45	744.36	0.09	0.65	0.00	54.42	288.24	119.34	1836.88
Reach	963.3603	50-yr	744.59	744.49	0.11	0.69	0.01	66.16	329.38	144.46	1907.20
Reach	963.3603	100-yr	745.86	745.82	0.05	0.03	0.01	89.79	302.87	191.34	2525.99
Reach	963.3603	500-yr	749.57	749.56	0.00	0.00	0.00	305.69	229.39	316.92	3098.75
Reach	786.1729	25-yr	743.80	743.71	0.09	0.50	0.01	135.96	257.72	68.32	751.06
Reach	786.1729	50-yr	743.90	743.82	0.09	0.48	0.01	157.36	266.07	116.57	861.42
Reach	786.1729	100-yr	745.82	745.80	0.02	0.01	0.00	121.26	77.39	385.35	2559.48
Reach	786.1729	500-yr	749.56	749.56	0.00	0.00	0.00	190.09	54.38	607.53	2837.96
Reach	688.7350	25-yr	743.30	743.15	0.15	0.16	0.04	35.54	324.60	101.86	301.16
Reach	688.7350	50-yr	743.41	743.26	0.15	0.18	0.03	51.11	342.75	146.15	322.83
Reach	688.7350	100-yr	745.81	745.80	0.01	0.00	0.00	134.00	96.52	353.48	2436.42
Reach	688.7350	500-yr	749.56	749.56	0.00	0.00	0.00	233.92	73.62	544.46	2684.08
Reach	540.9222	25-yr	743.10	743.07	0.03	0.07	0.00	19.47	79.05	363.49	374.39
Reach	540.9222	50-yr	743.20	743.16	0.04	0.08	0.00	25.96	89.76	424.27	394.84

Reach	540.9222	100-yr	745.80	745.80	0.00	0.00	0.00	122.96	47.32	413.72	2354.72
Reach	540.9222	500-yr	749.56	749.56	0.00	0.00	0.00	244.97	51.02	556.02	2478.40
Reach	455.8073	25-yr	743.03	742.99	0.04	0.11	0.00	142.86	249.68	69.47	544.63
Reach	455.8073	50-yr	743.12	743.08	0.04	0.11	0.00	175.60	265.53	98.87	656.48
Reach	455.8073	100-yr	745.80	745.80	0.00	0.00	0.00	282.21	66.55	235.24	2317.36
Reach	455.8073	500-yr	749.56	749.56	0.00	0.00	0.00	374.02	80.72	397.26	2362.09
Reach	401.3965	25-yr	742.92	742.89	0.03	0.15	0.00	227.14	177.68	57.19	671.68
Reach	401.3965	50-yr	743.01	742.97	0.04	0.15	0.00	272.11	189.60	78.30	732.38
Reach	401.3965	100-yr	745.80	745.80	0.00	0.00	0.00	319.54	39.55	224.91	1842.71
Reach	401.3965	500-yr	749.56	749.56	0.00	0.00	0.00	417.30	48.33	386.37	2051.00
Reach	301.5571	25-yr	742.77	742.75	0.02			305.72	92.85	63.43	833.50
Reach	301.5571	50-yr	742.85	742.82	0.03			361.25	96.84	81.91	871.40
Reach	301.5571	100-yr	745.80	745.80	0.00			367.20	18.93	197.88	1839.12
Reach	301.5571	500-yr	749.56	749.56	0.00			479.91	22.63	349.46	1855.28

Profile Output Table - Culvert Only

Reach	River Sta		Profile	E.G. US. (ft)	W.S. US. (ft)	E.G. IC (ft)	E.G. OC (ft)	Min El Weir Flow (ft)	Q Culv Group (cfs)	Q Weir (cfs)	Delta WS (ft)	Culv Vel US (ft/s)	Culv Vel DS (ft/s)
Reach	1127	Culvert #1	25-yr	745.50	745.44	745.05	745.50	749.01	462.00		0.99	6.32	6.49
Reach	1127	Culvert #1	50-yr	745.93	745.86	745.61	745.93	749.01	540.00		1.28	7.09	7.35
Reach	1127	Culvert #1	100-yr	746.81	746.76	745.91	746.81	749.01	584.00		0.92	6.16	6.25
Reach	1127	Culvert #1	500-yr	749.58	749.57	747.71	749.58	749.01	44.08	807.92	0.01	0.46	0.46

HEC-RAS HEC-RAS 6.4.1 June 2023
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

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X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X       X   X     X  X    X
X     X  X        X            X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X        X
X     X  X        X    X       X   X    X    X        X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
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PROJECT DATA
Project Title: CobleBowman
Project File : CobleBowman.prj
Run Date and Time: 4/16/2025 1:16:35 PM

Project in English units

PLAN DATA

Plan Title: Prop3SCElev
Plan File : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.p06

Geometry Title: CobleBowmanProp3SC
Geometry File : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.g03

Flow Title   : Elevations
Flow File   : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.f01

Plan Summary Information:
Number of: Cross Sections =   15   Multiple Openings =   0
            Culverts   =   1   Inline Structures =   0
            Bridges   =   0   Lateral Structures =   0

Computational Information
    Water surface calculation tolerance = 0.01
    Critical depth calculation tolerance = 0.01
    Maximum number of iterations   = 20

```
    Maximum difference tolerance         =  0.3
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow



FLOW DATA

Flow Title: Elevations
Flow File : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.f01

Flow Data (cfs)

  River           Reach           RS                  25-yr          50-yr          100-yr          500-yr           2-yr           2xMMF           OHWM
  CLX_3           Reach           1917.216              462            540            584             852            149            8.08           11.8


Boundary Conditions

  River           Reach           Profile                     Upstream                Downstream

  CLX_3           Reach           25-yr                   Normal S = 0.0013       Normal S = 0.0013
  CLX_3           Reach           50-yr                   Normal S = 0.0013       Normal S = 0.0013
  CLX_3           Reach           100-yr                  Normal S = 0.0013        Known WS = 745.8
  CLX_3           Reach           500-yr                  Normal S = 0.0013       Known WS = 749.56
  CLX_3           Reach           2-yr                    Normal S = 0.0013       Normal S = 0.0013


CULVERT


RIVER: CLX_3
REACH: Reach              RS: 1127


CULVERT OUTPUT  Profile #25-yr  Culv Group:  Culvert #1

  Q Culv Group (cfs)        462.00    Culv Full Len (ft)
  # Barrels                      1    Culv Vel US (ft/s)         4.95
  Q Barrel (cfs)            462.00    Culv Vel DS (ft/s)         6.49
  E.G. US. (ft)             746.41    Culv Inv El Up (ft)      740.00
  W.S. US. (ft)             746.37    Culv Inv El Dn (ft)      740.00
  E.G. DS (ft)              744.57    Culv Frctn Ls (ft)         1.11
  W.S. DS (ft)              744.45    Culv Exit Loss (ft)        0.53
```

Delta EG (ft)	1.84	Culv Entr Loss (ft)	0.19
Delta WS (ft)	1.92	Q Weir (cfs)	
E.G. IC (ft)	745.05	Weir Sta Lft (ft)	
E.G. OC (ft)	746.41	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	745.84	Weir Max Depth (ft)	
Culv WS Outlet (ft)	744.45	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	2.96	Min El Weir Flow (ft)	749.01

CULVERT OUTPUT Profile #50-yr Culv Group: Culvert #1

Q Culv Group (cfs)	540.00	Culv Full Len (ft)	32.89
# Barrels	1	Culv Vel US (ft/s)	5.63
Q Barrel (cfs)	540.00	Culv Vel DS (ft/s)	7.35
E.G. US. (ft)	746.99	Culv Inv El Up (ft)	740.00
W.S. US. (ft)	746.95	Culv Inv El Dn (ft)	740.00
E.G. DS (ft)	744.74	Culv Frctn Ls (ft)	1.31
W.S. DS (ft)	744.59	Culv Exit Loss (ft)	0.69
Delta EG (ft)	2.25	Culv Entr Loss (ft)	0.25
Delta WS (ft)	2.36	Q Weir (cfs)	
E.G. IC (ft)	745.61	Weir Sta Lft (ft)	
E.G. OC (ft)	746.99	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	746.00	Weir Max Depth (ft)	
Culv WS Outlet (ft)	744.59	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.28	Min El Weir Flow (ft)	749.01

CULVERT OUTPUT Profile #100-yr Culv Group: Culvert #1

Q Culv Group (cfs)	584.00	Culv Full Len (ft)	122.82
# Barrels	1	Culv Vel US (ft/s)	6.08
Q Barrel (cfs)	584.00	Culv Vel DS (ft/s)	6.25
E.G. US. (ft)	747.95	Culv Inv El Up (ft)	740.00
W.S. US. (ft)	747.92	Culv Inv El Dn (ft)	740.00
E.G. DS (ft)	745.92	Culv Frctn Ls (ft)	1.21
W.S. DS (ft)	745.84	Culv Exit Loss (ft)	0.53
Delta EG (ft)	2.03	Culv Entr Loss (ft)	0.29
Delta WS (ft)	2.08	Q Weir (cfs)	
E.G. IC (ft)	745.91	Weir Sta Lft (ft)	
E.G. OC (ft)	747.95	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	746.00	Weir Max Depth (ft)	
Culv WS Outlet (ft)	745.84	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.46	Min El Weir Flow (ft)	749.01

CULVERT OUTPUT Profile #500-yr Culv Group: Culvert #1

Q Culv Group (cfs)	25.76	Culv Full Len (ft)	138.00
# Barrels	1	Culv Vel US (ft/s)	0.27
Q Barrel (cfs)	25.76	Culv Vel DS (ft/s)	0.27
E.G. US. (ft)	749.58	Culv Inv El Up (ft)	740.00
W.S. US. (ft)	749.57	Culv Inv El Dn (ft)	740.00
E.G. DS (ft)	749.57	Culv Frctn Ls (ft)	0.00
W.S. DS (ft)	749.56	Culv Exit Loss (ft)	0.00
Delta EG (ft)	0.00	Culv Entr Loss (ft)	0.00
Delta WS (ft)	0.01	Q Weir (cfs)	826.24
E.G. IC (ft)	747.71	Weir Sta Lft (ft)	0.00
E.G. OC (ft)	749.58	Weir Sta Rgt (ft)	2828.79
Culvert Control	Outlet	Weir Submerg	0.99
Culv WS Inlet (ft)	746.00	Weir Max Depth (ft)	0.58
Culv WS Outlet (ft)	746.00	Weir Avg Depth (ft)	0.46
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	1310.54
Culv Crt Depth (ft)	0.43	Min El Weir Flow (ft)	749.01

Warning: The weir over culvert is submerged.
Warning: During the culvert inlet control computations, the program could not balance the culvert/weir flow. The reported inlet energy grade answer may not be valid.

SUMMARY OF MANNING'S N VALUES

River:CLX_3

Reach	River Sta.	n1	n2	n3	n4	n5	n6	n7	n8	n9	n10	n11	n12
Reach	1917.216	.03	.1	.07	.1	.05	.05						
Reach	1815.309	.035	.1	.07	.1	.1	.06	.06					
Reach	1718.108	.03	.1	.07	.1	.1	.05	.05					
Reach	1494.218	.03	.1	.07	.1	.06	.1	.03	.03				
Reach	1396.953	.03	.1	.07	.1	.06	.1	.1	.1				
Reach	1307.234	.03	.1	.07	.1	.1							
Reach	1262.110	.03	.07	.1	.1								
Reach	1127	Culvert											
Reach	997.3811	.1	.07	.1	.1								
Reach	963.3603	.03	.1	.07	.1	.03	.013	.03	.03				
Reach	786.1729	.035	.1	.07	.1	.013	.3	.1	.03	.03			
Reach	688.7350	.035	.1	.07	.1	.03	.013	.03	.1	.03			
Reach	540.9222	.035	.1	.07	.1	.028	.03	.013	.03	.1	.03	.03	
Reach	455.8073	.035	.1	.07	.1	.03	.013	.03	.03				
Reach	401.3965	.035	.1	.07	.1	.03	.013	.03	.03				
Reach	301.5571	.035	.1	.07	.1	.03	.1	.03	.013	.03	.013	.03	.03

SUMMARY OF REACH LENGTHS

River: CLX_3

Reach	River Sta.	Left	Channel	Right
Reach	1917.216	101.4	101.91	102.13
Reach	1815.309	97.22	97.2	97.21
Reach	1718.108	219.83	223.89	228.41
Reach	1494.218	97.27	97.26	97.29
Reach	1396.953	89.72	89.72	89.74
Reach	1307.234	44.16	45.12	45.79
Reach	1262.110	265.75	264.73	265.71
Reach	1127	Culvert		
Reach	997.3811	42.25	34.02	23.58
Reach	963.3603	175.27	177.19	180.28
Reach	786.1729	97.44	97.44	97.49
Reach	688.7350	147.81	147.81	147.83
Reach	540.9222	85.12	85.11	85.13
Reach	455.8073	54.41	54.41	54.42
Reach	401.3965	102.02	99.84	97.58
Reach	301.5571	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: CLX_3

Reach	River Sta.	Contr.	Expan.
Reach	1917.216	.1	.3
Reach	1815.309	.1	.3
Reach	1718.108	.1	.3
Reach	1494.218	.1	.3
Reach	1396.953	.1	.3
Reach	1307.234	.1	.3
Reach	1262.110	.1	.3
Reach	1127	Culvert	
Reach	997.3811	.1	.3
Reach	963.3603	.1	.3
Reach	786.1729	.1	.3
Reach	688.7350	.1	.3
Reach	540.9222	.1	.3
Reach	455.8073	.1	.3
Reach	401.3965	.1	.3

Reach 301.5571 .1 .3

Profile Output Table - Standard Table 1

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
Reach	1917.216	25-yr	462.00	741.10	746.45		746.46	0.000149	0.71	786.82	799.35	0.06
Reach	1917.216	50-yr	540.00	741.10	747.02		747.02	0.000075	0.54	1134.66	852.94	0.04
Reach	1917.216	100-yr	584.00	741.10	747.96		747.96	0.000020	0.32	1720.32	852.94	0.02
Reach	1917.216	500-yr	852.00	741.10	749.59		749.59	0.000009	0.24	2923.19	852.94	0.02
Reach	1815.309	25-yr	462.00	741.24	746.44		746.44	0.000106	0.53	1135.16	889.68	0.05
Reach	1815.309	50-yr	540.00	741.24	747.01		747.01	0.000060	0.44	1496.66	1094.76	0.04
Reach	1815.309	100-yr	584.00	741.24	747.96		747.96	0.000021	0.30	2124.64	1124.66	0.02
Reach	1815.309	500-yr	852.00	741.24	749.59		749.59	0.000011	0.26	3590.30	1124.66	0.02
Reach	1718.108	25-yr	462.00	741.20	746.44		746.44	0.000044	0.36	1664.83	997.58	0.03
Reach	1718.108	50-yr	540.00	741.20	747.01		747.01	0.000027	0.31	2092.90	1123.19	0.02
Reach	1718.108	100-yr	584.00	741.20	747.96		747.96	0.000011	0.23	2802.33	1124.59	0.02
Reach	1718.108	500-yr	852.00	741.20	749.59		749.59	0.000008	0.22	4332.89	1124.59	0.01
Reach	1494.218	25-yr	462.00	740.90	746.43		746.43	0.000019	0.24	2361.28	1199.81	0.02
Reach	1494.218	50-yr	540.00	740.90	747.01		747.01	0.000014	0.22	2839.22	1379.74	0.02
Reach	1494.218	100-yr	584.00	740.90	747.96		747.96	0.000007	0.18	3630.10	1441.24	0.01
Reach	1494.218	500-yr	852.00	740.90	749.58		749.58	0.000006	0.19	5491.36	1441.24	0.01
Reach	1396.953	25-yr	462.00	740.47	746.43		746.43	0.000056	0.43	1688.93	1236.75	0.04
Reach	1396.953	50-yr	540.00	740.47	747.00		747.00	0.000044	0.41	1995.41	1310.48	0.03
Reach	1396.953	100-yr	584.00	740.47	747.96		747.96	0.000024	0.34	2502.52	1441.57	0.02
Reach	1396.953	500-yr	852.00	740.47	749.58		749.58	0.000019	0.35	4126.09	1441.57	0.02
Reach	1307.234	25-yr	462.00	740.05	746.41		746.42	0.000189	0.91	921.13	1613.29	0.07
Reach	1307.234	50-yr	540.00	740.05	746.99		747.00	0.000159	0.89	1069.00	1788.04	0.06
Reach	1307.234	100-yr	584.00	740.05	747.95		747.95	0.000095	0.75	1313.94	1875.46	0.05
Reach	1307.234	500-yr	852.00	740.05	749.58		749.58	0.000091	0.84	3074.45	1880.11	0.05
Reach	1262.110	25-yr	462.00	739.83	746.37	743.50	746.41	0.000257	0.90	383.03	2700.07	0.07
Reach	1262.110	50-yr	540.00	739.83	746.95	743.62	746.99	0.000212	0.87	445.46	2763.41	0.06
Reach	1262.110	100-yr	584.00	739.83	747.92	743.65	747.94	0.000122	0.73	549.99	2828.79	0.05
Reach	1262.110	500-yr	852.00	739.83	749.57	743.95	749.58	0.000059	0.58	2973.00	2828.79	0.03
Reach	1127		Culvert									
Reach	997.3811	25-yr	462.00	740.10	744.45		744.57	0.003578	3.06	194.02	1468.95	0.28
Reach	997.3811	50-yr	540.00	740.10	744.59		744.74	0.004192	3.39	205.01	1519.29	0.30
Reach	997.3811	100-yr	584.00	740.10	745.84		745.92	0.001590	2.51	301.24	2289.09	0.19
Reach	997.3811	500-yr	852.00	740.10	749.56		749.57	0.000217	1.33	2562.93	2528.33	0.08

Reach	963.3603	25-yr	462.00	739.20	744.36		744.45	0.003406	2.84	238.64	1836.88	0.27
Reach	963.3603	50-yr	540.00	739.20	744.49		744.59	0.003945	3.13	252.50	1907.20	0.29
Reach	963.3603	100-yr	584.00	739.20	745.82		745.86	0.001200	2.12	393.33	2525.99	0.17
Reach	963.3603	500-yr	852.00	739.20	749.56		749.57	0.000108	0.92	3177.89	3098.75	0.05
Reach	786.1729	25-yr	462.00	738.95	743.71		743.80	0.003905	3.04	275.34	751.06	0.28
Reach	786.1729	50-yr	540.00	738.95	743.82		743.90	0.003782	3.05	305.77	861.42	0.28
Reach	786.1729	100-yr	584.00	738.95	745.80		745.82	0.000077	0.58	882.25	2559.48	0.04
Reach	786.1729	500-yr	852.00	738.95	749.56		749.56	0.000007	0.24	4038.22	2837.96	0.01
Reach	688.7350	25-yr	462.00	738.83	743.15		743.30	0.006886	3.56	195.89	301.16	0.36
Reach	688.7350	50-yr	540.00	738.83	743.26		743.41	0.006784	3.62	231.33	322.83	0.36
Reach	688.7350	100-yr	584.00	738.83	745.80		745.81	0.000073	0.56	1154.65	2436.42	0.04
Reach	688.7350	500-yr	852.00	738.83	749.56		749.56	0.000008	0.26	4449.53	2684.08	0.01
Reach	540.9222	25-yr	462.00	738.65	743.07		743.10	0.000421	0.86	414.56	374.39	0.09
Reach	540.9222	50-yr	540.00	738.65	743.16		743.20	0.000491	0.95	447.62	394.83	0.10
Reach	540.9222	100-yr	584.00	738.65	745.80		745.80	0.000016	0.26	1784.10	2354.72	0.02
Reach	540.9222	500-yr	852.00	738.65	749.56		749.56	0.000003	0.17	5339.11	2478.40	0.01
Reach	455.8073	25-yr	462.00	738.38	742.99		743.03	0.002239	1.92	353.33	544.63	0.21
Reach	455.8073	50-yr	540.00	738.38	743.08		743.12	0.002286	1.98	393.52	656.40	0.21
Reach	455.8073	100-yr	584.00	738.38	745.80		745.80	0.000015	0.25	2013.65	2317.36	0.02
Reach	455.8073	500-yr	852.00	738.38	749.56		749.56	0.000004	0.18	5706.17	2362.09	0.01
Reach	401.3965	25-yr	462.00	738.38	742.89		742.92	0.001746	1.76	328.59	671.68	0.18
Reach	401.3965	50-yr	540.00	738.38	742.97		743.01	0.001814	1.82	366.34	732.33	0.19
Reach	401.3965	100-yr	584.00	738.38	745.80		745.80	0.000008	0.19	2292.17	1842.71	0.01
Reach	401.3965	500-yr	852.00	738.38	749.56		749.56	0.000002	0.14	5980.09	2051.00	0.01
Reach	301.5571	25-yr	462.00	738.88	742.75	742.01	742.77	0.001300	1.56	385.19	833.50	0.16
Reach	301.5571	50-yr	540.00	738.88	742.82	742.07	742.85	0.001301	1.59	437.63	871.40	0.16
Reach	301.5571	100-yr	584.00	738.88	745.80	742.15	745.80	0.000005	0.16	2757.98	1839.12	0.01
Reach	301.5571	500-yr	852.00	738.88	749.56	742.37	749.56	0.000002	0.12	6600.11	1855.28	0.01

Profile Output Table - Standard Table 2

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Vel Head (ft)	Frctn Loss (ft)	C & E Loss (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Top Width (ft)
Reach	1917.216	25-yr	746.46	746.45	0.01	0.01	0.00	367.99	36.77	57.24	799.35
Reach	1917.216	50-yr	747.02	747.02	0.00	0.01	0.00	449.90	31.66	58.44	852.94
Reach	1917.216	100-yr	747.96	747.96	0.00	0.00	0.00	512.31	21.62	50.07	852.94
Reach	1917.216	500-yr	749.59	749.59	0.00	0.00	0.00	768.09	21.01	62.90	852.94
Reach	1815.309	25-yr	746.44	746.44	0.00	0.01	0.00	280.90	81.19	99.90	889.68
Reach	1815.309	50-yr	747.01	747.01	0.00	0.00	0.00	355.89	77.05	107.05	1094.76
Reach	1815.309	100-yr	747.96	747.96	0.00	0.00	0.00	420.27	63.20	100.54	1124.66
Reach	1815.309	500-yr	749.59	749.59	0.00	0.00	0.00	644.45	71.28	136.27	1124.66

Reach	1718.108	25-yr	746.44	746.44	0.00	0.01	0.00	304.08	38.38	119.54	997.58
Reach	1718.108	50-yr	747.01	747.01	0.00	0.00	0.00	367.04	37.34	135.62	1123.19
Reach	1718.108	100-yr	747.96	747.96	0.00	0.00	0.00	407.78	32.95	143.27	1124.59
Reach	1718.108	500-yr	749.59	749.59	0.00	0.00	0.00	592.26	41.78	217.96	1124.59
Reach	1494.218	25-yr	746.43	746.43	0.00	0.00	0.00	232.46	35.96	193.59	1199.81
Reach	1494.218	50-yr	747.01	747.01	0.00	0.00	0.00	274.61	37.93	227.46	1379.74
Reach	1494.218	100-yr	747.96	747.96	0.00	0.00	0.00	300.26	36.47	247.27	1441.24
Reach	1494.218	500-yr	749.58	749.58	0.00	0.00	0.00	407.07	50.55	394.38	1441.24
Reach	1396.953	25-yr	746.43	746.43	0.00	0.01	0.00	221.26	51.95	188.79	1236.75
Reach	1396.953	50-yr	747.00	747.00	0.00	0.01	0.00	259.63	56.06	224.31	1310.48
Reach	1396.953	100-yr	747.96	747.96	0.00	0.00	0.00	281.92	55.15	246.94	1441.57
Reach	1396.953	500-yr	749.58	749.58	0.00	0.00	0.00	403.86	71.33	376.81	1441.57
Reach	1307.234	25-yr	746.42	746.41	0.00	0.01	0.00	202.45	60.30	199.25	1613.29
Reach	1307.234	50-yr	747.00	746.99	0.00	0.01	0.00	243.74	64.90	231.36	1788.04
Reach	1307.234	100-yr	747.95	747.95	0.00	0.00	0.00	272.53	63.34	248.13	1875.46
Reach	1307.234	500-yr	749.58	749.58	0.00	0.00	0.00	472.86	87.13	292.02	1880.11
Reach	1262.110	25-yr	746.41	746.37	0.04			328.60	89.93	43.47	2700.07
Reach	1262.110	50-yr	746.99	746.95	0.04			390.14	96.07	53.79	2763.41
Reach	1262.110	100-yr	747.94	747.92	0.03			429.19	92.86	61.95	2828.79
Reach	1262.110	500-yr	749.58	749.57	0.00			627.52	91.29	133.19	2828.79
Reach	1127		Culvert								
Reach	997.3811	25-yr	744.57	744.45	0.12	0.11	0.01	8.51	375.52	77.97	1468.95
Reach	997.3811	50-yr	744.74	744.59	0.15	0.13	0.01	10.22	432.03	97.75	1519.29
Reach	997.3811	100-yr	745.92	745.84	0.08	0.04	0.01	12.76	419.85	151.39	2289.09
Reach	997.3811	500-yr	749.57	749.56	0.01	0.00	0.00	188.35	380.76	282.89	2528.33
Reach	963.3603	25-yr	744.45	744.36	0.09	0.65	0.00	54.42	288.24	119.34	1836.88
Reach	963.3603	50-yr	744.59	744.49	0.11	0.69	0.01	66.16	329.38	144.46	1907.20
Reach	963.3603	100-yr	745.86	745.82	0.05	0.03	0.01	89.79	302.87	191.34	2525.99
Reach	963.3603	500-yr	749.57	749.56	0.00	0.00	0.00	305.69	229.39	316.92	3098.75
Reach	786.1729	25-yr	743.80	743.71	0.09	0.50	0.01	135.96	257.72	68.32	751.06
Reach	786.1729	50-yr	743.90	743.82	0.09	0.48	0.01	157.36	266.07	116.57	861.42
Reach	786.1729	100-yr	745.82	745.80	0.02	0.01	0.00	121.26	77.39	385.35	2559.48
Reach	786.1729	500-yr	749.56	749.56	0.00	0.00	0.00	190.09	54.38	607.53	2837.96
Reach	688.7350	25-yr	743.30	743.15	0.15	0.16	0.04	35.54	324.60	101.86	301.16
Reach	688.7350	50-yr	743.41	743.26	0.15	0.18	0.03	51.11	342.75	146.15	322.83
Reach	688.7350	100-yr	745.81	745.80	0.01	0.00	0.00	134.00	96.52	353.48	2436.42
Reach	688.7350	500-yr	749.56	749.56	0.00	0.00	0.00	233.92	73.62	544.46	2684.08
Reach	540.9222	25-yr	743.10	743.07	0.03	0.07	0.00	19.47	79.05	363.49	374.39
Reach	540.9222	50-yr	743.20	743.16	0.04	0.08	0.00	25.96	89.77	424.27	394.83

Reach	540.9222	100-yr	745.80	745.80	0.00	0.00	0.00	122.96	47.32	413.72	2354.72
Reach	540.9222	500-yr	749.56	749.56	0.00	0.00	0.00	244.97	51.02	556.02	2478.40
Reach	455.8073	25-yr	743.03	742.99	0.04	0.11	0.00	142.86	249.68	69.47	544.63
Reach	455.8073	50-yr	743.12	743.08	0.04	0.11	0.00	175.59	265.55	98.86	656.40
Reach	455.8073	100-yr	745.80	745.80	0.00	0.00	0.00	282.21	66.55	235.24	2317.36
Reach	455.8073	500-yr	749.56	749.56	0.00	0.00	0.00	374.02	80.72	397.26	2362.09
Reach	401.3965	25-yr	742.92	742.89	0.03	0.15	0.00	227.14	177.68	57.19	671.68
Reach	401.3965	50-yr	743.01	742.97	0.04	0.15	0.00	272.10	189.61	78.29	732.33
Reach	401.3965	100-yr	745.80	745.80	0.00	0.00	0.00	319.54	39.55	224.91	1842.71
Reach	401.3965	500-yr	749.56	749.56	0.00	0.00	0.00	417.30	48.33	386.37	2051.00
Reach	301.5571	25-yr	742.77	742.75	0.02			305.72	92.85	63.43	833.50
Reach	301.5571	50-yr	742.85	742.82	0.03			361.25	96.84	81.91	871.40
Reach	301.5571	100-yr	745.80	745.80	0.00			367.20	18.93	197.88	1839.12
Reach	301.5571	500-yr	749.56	749.56	0.00			479.91	22.63	349.46	1855.28

Profile Output Table - Culvert Only

Reach	River Sta		Profile	E.G. US. (ft)	W.S. US. (ft)	E.G. IC (ft)	E.G. OC (ft)	Min El Weir Flow (ft)	Q Culv Group (cfs)	Q Weir (cfs)	Delta WS (ft)	Culv Vel US (ft/s)	Culv Vel DS (ft/s)
Reach	1127	Culvert #1	25-yr	746.41	746.37	745.05	746.41	749.01	462.00		1.92	4.95	6.49
Reach	1127	Culvert #1	50-yr	746.99	746.95	745.61	746.99	749.01	540.00		2.36	5.63	7.35
Reach	1127	Culvert #1	100-yr	747.95	747.92	745.91	747.95	749.01	584.00		2.08	6.08	6.25
Reach	1127	Culvert #1	500-yr	749.58	749.57	747.71	749.58	749.01	25.76	826.24	0.01	0.27	0.27

HEC-RAS HEC-RAS 6.4.1 June 2023
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

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X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X       X   X     X  X    X
X     X  X        X            X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X        X
X     X  X        X    X       X   X    X    X        X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
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PROJECT DATA
Project Title: CobleBowman
Project File : CobleBowman.prj
Run Date and Time: 4/16/2025 1:23:53 PM

Project in English units

PLAN DATA

Plan Title: PropSteelElev
Plan File : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.p07

Geometry Title: CobleBowmanPropSteelPipe
Geometry File : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.g04

Flow Title   : Elevations
Flow File   : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.f01

Plan Summary Information:
Number of: Cross Sections =   15   Multiple Openings =   0
            Culverts   =   1   Inline Structures =   0
            Bridges   =   0   Lateral Structures =   0

Computational Information
    Water surface calculation tolerance = 0.01
    Critical depth calculation tolerance = 0.01
    Maximum number of iterations   = 20

```
    Maximum difference tolerance         =  0.3
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Subcritical Flow



FLOW DATA

Flow Title: Elevations
Flow File : g:\DE\Clients\LJB\10017857_FRA-33-24-76\119387\400-Engineering\Structures\SFN_2502135_CableBowman\Hydraulics\Coble Bowman HECRAS\CobleBowman.f01

Flow Data (cfs)

  River           Reach           RS                  25-yr          50-yr          100-yr          500-yr           2-yr           2xMMF           OHWM
  CLX_3           Reach           1917.216              462            540            584             852            149            8.08           11.8


Boundary Conditions

  River           Reach           Profile                     Upstream                Downstream

  CLX_3           Reach           25-yr                   Normal S = 0.0013       Normal S = 0.0013
  CLX_3           Reach           50-yr                   Normal S = 0.0013       Normal S = 0.0013
  CLX_3           Reach           100-yr                  Normal S = 0.0013        Known WS = 745.8
  CLX_3           Reach           500-yr                  Normal S = 0.0013       Known WS = 749.56
  CLX_3           Reach           2-yr                    Normal S = 0.0013       Normal S = 0.0013


CULVERT


RIVER: CLX_3
REACH: Reach              RS: 1127


CULVERT OUTPUT  Profile #25-yr  Culv Group:  Culvert #1

  Q Culv Group (cfs)        462.00    Culv Full Len (ft)
  # Barrels                      2    Culv Vel US (ft/s)         5.81
  Q Barrel (cfs)            231.00    Culv Vel DS (ft/s)         6.41
  E.G. US. (ft)             745.81    Culv Inv El Up (ft)      740.00
  W.S. US. (ft)             745.76    Culv Inv El Dn (ft)      740.00
  E.G. DS (ft)              744.57    Culv Frctn Ls (ft)         0.47
  W.S. DS (ft)              744.45    Culv Exit Loss (ft)        0.52
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Delta EG (ft)	1.24	Culv Entr Loss (ft)	0.26
Delta WS (ft)	1.32	Q Weir (cfs)	
E.G. IC (ft)	744.55	Weir Sta Lft (ft)	
E.G. OC (ft)	745.81	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	745.03	Weir Max Depth (ft)	
Culv WS Outlet (ft)	744.45	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.00	Min El Weir Flow (ft)	749.01

CULVERT OUTPUT Profile #50-yr Culv Group: Culvert #1

Q Culv Group (cfs)	540.00	Culv Full Len (ft)	
# Barrels	2	Culv Vel US (ft/s)	6.48
Q Barrel (cfs)	270.00	Culv Vel DS (ft/s)	7.31
E.G. US. (ft)	746.33	Culv Inv El Up (ft)	740.00
W.S. US. (ft)	746.28	Culv Inv El Dn (ft)	740.00
E.G. DS (ft)	744.74	Culv Frctn Ls (ft)	0.59
W.S. DS (ft)	744.59	Culv Exit Loss (ft)	0.68
Delta EG (ft)	1.60	Culv Entr Loss (ft)	0.33
Delta WS (ft)	1.69	Q Weir (cfs)	
E.G. IC (ft)	745.09	Weir Sta Lft (ft)	
E.G. OC (ft)	746.33	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	745.35	Weir Max Depth (ft)	
Culv WS Outlet (ft)	744.59	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.14	Min El Weir Flow (ft)	749.01

CULVERT OUTPUT Profile #100-yr Culv Group: Culvert #1

Q Culv Group (cfs)	584.00	Culv Full Len (ft)	60.85
# Barrels	2	Culv Vel US (ft/s)	6.49
Q Barrel (cfs)	292.00	Culv Vel DS (ft/s)	6.66
E.G. US. (ft)	747.53	Culv Inv El Up (ft)	740.00
W.S. US. (ft)	747.50	Culv Inv El Dn (ft)	740.00
E.G. DS (ft)	745.92	Culv Frctn Ls (ft)	0.68
W.S. DS (ft)	745.84	Culv Exit Loss (ft)	0.61
Delta EG (ft)	1.62	Culv Entr Loss (ft)	0.33
Delta WS (ft)	1.66	Q Weir (cfs)	
E.G. IC (ft)	745.40	Weir Sta Lft (ft)	
E.G. OC (ft)	747.53	Weir Sta Rgt (ft)	
Culvert Control	Outlet	Weir Submerg	
Culv WS Inlet (ft)	746.25	Weir Max Depth (ft)	
Culv WS Outlet (ft)	745.84	Weir Avg Depth (ft)	
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	
Culv Crt Depth (ft)	3.31	Min El Weir Flow (ft)	749.01

CULVERT OUTPUT Profile #500-yr Culv Group: Culvert #1

Q Culv Group (cfs)	25.66	Culv Full Len (ft)	138.00
# Barrels	2	Culv Vel US (ft/s)	0.29
Q Barrel (cfs)	12.83	Culv Vel DS (ft/s)	0.29
E.G. US. (ft)	749.58	Culv Inv El Up (ft)	740.00
W.S. US. (ft)	749.57	Culv Inv El Dn (ft)	740.00
E.G. DS (ft)	749.57	Culv Frctn Ls (ft)	0.00
W.S. DS (ft)	749.56	Culv Exit Loss (ft)	0.00
Delta EG (ft)	0.00	Culv Entr Loss (ft)	0.00
Delta WS (ft)	0.01	Q Weir (cfs)	826.34
E.G. IC (ft)	747.55	Weir Sta Lft (ft)	0.00
E.G. OC (ft)	749.58	Weir Sta Rgt (ft)	2828.79
Culvert Control	Outlet	Weir Submerg	0.99
Culv WS Inlet (ft)	746.25	Weir Max Depth (ft)	0.58
Culv WS Outlet (ft)	746.25	Weir Avg Depth (ft)	0.46
Culv Nml Depth (ft)		Weir Flow Area (sq ft)	1310.73
Culv Crt Depth (ft)	0.53	Min El Weir Flow (ft)	749.01

Warning: The weir over culvert is submerged.
Warning: During the culvert inlet control computations, the program could not balance the culvert/weir flow. The reported inlet energy grade answer may not be valid.

SUMMARY OF MANNING'S N VALUES

River:CLX_3

Reach	River Sta.	n1	n2	n3	n4	n5	n6	n7	n8	n9	n10	n11	n12
Reach	1917.216	.03	.1	.07	.1	.05	.05						
Reach	1815.309	.035	.1	.07	.1	.1	.06	.06					
Reach	1718.108	.03	.1	.07	.1	.1	.05	.05					
Reach	1494.218	.03	.1	.07	.1	.06	.1	.03	.03				
Reach	1396.953	.03	.1	.07	.1	.06	.1	.1	.1				
Reach	1307.234	.03	.1	.07	.1	.1							
Reach	1262.110	.03	.07	.1	.1								
Reach	1127	Culvert											
Reach	997.3811	.1	.07	.1	.1								
Reach	963.3603	.03	.1	.07	.1	.03	.013	.03	.03				
Reach	786.1729	.035	.1	.07	.1	.013	.3	.1	.03	.03			
Reach	688.7350	.035	.1	.07	.1	.03	.013	.03	.1	.03			
Reach	540.9222	.035	.1	.07	.1	.028	.03	.013	.03	.1	.03	.03	
Reach	455.8073	.035	.1	.07	.1	.03	.013	.03	.03				
Reach	401.3965	.035	.1	.07	.1	.03	.013	.03	.03				
Reach	301.5571	.035	.1	.07	.1	.03	.1	.03	.013	.03	.013	.03	.03

SUMMARY OF REACH LENGTHS

River: CLX_3

Reach	River Sta.	Left	Channel	Right
Reach	1917.216	101.4	101.91	102.13
Reach	1815.309	97.22	97.2	97.21
Reach	1718.108	219.83	223.89	228.41
Reach	1494.218	97.27	97.26	97.29
Reach	1396.953	89.72	89.72	89.74
Reach	1307.234	44.16	45.12	45.79
Reach	1262.110	265.75	264.73	265.71
Reach	1127	Culvert		
Reach	997.3811	42.25	34.02	23.58
Reach	963.3603	175.27	177.19	180.28
Reach	786.1729	97.44	97.44	97.49
Reach	688.7350	147.81	147.81	147.83
Reach	540.9222	85.12	85.11	85.13
Reach	455.8073	54.41	54.41	54.42
Reach	401.3965	102.02	99.84	97.58
Reach	301.5571	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: CLX_3

Reach	River Sta.	Contr.	Expan.
Reach	1917.216	.1	.3
Reach	1815.309	.1	.3
Reach	1718.108	.1	.3
Reach	1494.218	.1	.3
Reach	1396.953	.1	.3
Reach	1307.234	.1	.3
Reach	1262.110	.1	.3
Reach	1127	Culvert	
Reach	997.3811	.1	.3
Reach	963.3603	.1	.3
Reach	786.1729	.1	.3
Reach	688.7350	.1	.3
Reach	540.9222	.1	.3
Reach	455.8073	.1	.3
Reach	401.3965	.1	.3

Reach 301.5571 .1 .3

Profile Output Table - Standard Table 1

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
Reach	1917.216	25-yr	462.00	741.10	745.92		745.94	0.000552	1.26	529.99	652.16	0.11
Reach	1917.216	50-yr	540.00	741.10	746.40		746.41	0.000227	0.87	758.03	778.79	0.07
Reach	1917.216	100-yr	584.00	741.10	747.56		747.56	0.000035	0.40	1469.60	852.94	0.03
Reach	1917.216	500-yr	852.00	741.10	749.59		749.59	0.000009	0.24	2922.36	852.94	0.02
Reach	1815.309	25-yr	462.00	741.24	745.89		745.89	0.000326	0.84	808.71	799.31	0.08
Reach	1815.309	50-yr	540.00	741.24	746.39		746.39	0.000161	0.65	1101.64	874.56	0.06
Reach	1815.309	100-yr	584.00	741.24	747.55		747.56	0.000034	0.36	1855.17	1124.66	0.03
Reach	1815.309	500-yr	852.00	741.24	749.59		749.59	0.000011	0.26	3589.20	1124.66	0.02
Reach	1718.108	25-yr	462.00	741.20	745.87		745.87	0.000109	0.51	1252.86	923.75	0.05
Reach	1718.108	50-yr	540.00	741.20	746.38		746.38	0.000065	0.43	1621.53	987.54	0.04
Reach	1718.108	100-yr	584.00	741.20	747.55		747.55	0.000017	0.26	2499.13	1124.59	0.02
Reach	1718.108	500-yr	852.00	741.20	749.58		749.59	0.000008	0.22	4331.79	1124.59	0.01
Reach	1494.218	25-yr	462.00	740.90	745.86		745.86	0.000042	0.32	1885.17	1136.02	0.03
Reach	1494.218	50-yr	540.00	740.90	746.37		746.37	0.000029	0.29	2310.56	1183.88	0.03
Reach	1494.218	100-yr	584.00	740.90	747.55		747.55	0.000010	0.20	3292.20	1441.24	0.02
Reach	1494.218	500-yr	852.00	740.90	749.58		749.58	0.000006	0.19	5489.96	1441.24	0.01
Reach	1396.953	25-yr	462.00	740.47	745.85		745.85	0.000109	0.55	1382.13	1171.40	0.05
Reach	1396.953	50-yr	540.00	740.47	746.36		746.37	0.000082	0.52	1655.58	1224.89	0.04
Reach	1396.953	100-yr	584.00	740.47	747.55		747.55	0.000033	0.38	2285.88	1388.22	0.03
Reach	1396.953	500-yr	852.00	740.47	749.58		749.58	0.000019	0.35	4124.69	1441.57	0.02
Reach	1307.234	25-yr	462.00	740.05	745.83		745.84	0.000335	1.12	771.17	1441.35	0.09
Reach	1307.234	50-yr	540.00	740.05	746.35		746.35	0.000274	1.08	903.69	1586.88	0.08
Reach	1307.234	100-yr	584.00	740.05	747.54		747.54	0.000124	0.83	1209.25	1873.24	0.06
Reach	1307.234	500-yr	852.00	740.05	749.58		749.58	0.000091	0.85	3072.61	1880.10	0.05
Reach	1262.110	25-yr	462.00	739.83	745.76	743.50	745.81	0.000481	1.14	317.36	2639.11	0.09
Reach	1262.110	50-yr	540.00	739.83	746.28	743.62	746.33	0.000382	1.08	373.54	2696.47	0.08
Reach	1262.110	100-yr	584.00	739.83	747.50	743.65	747.53	0.000163	0.81	505.12	2828.79	0.05
Reach	1262.110	500-yr	852.00	739.83	749.57	743.95	749.58	0.000059	0.58	2970.23	2828.79	0.03
Reach	1127		Culvert									
Reach	997.3811	25-yr	462.00	740.10	744.45		744.57	0.003578	3.06	194.02	1468.95	0.28
Reach	997.3811	50-yr	540.00	740.10	744.59		744.74	0.004192	3.39	205.01	1519.29	0.30
Reach	997.3811	100-yr	584.00	740.10	745.84		745.92	0.001590	2.51	301.24	2289.09	0.19
Reach	997.3811	500-yr	852.00	740.10	749.56		749.57	0.000217	1.33	2562.93	2528.33	0.08

Reach	963.3603	25-yr	462.00	739.20	744.36	744.45	0.003406	2.84	238.64	1836.88	0.27
Reach	963.3603	50-yr	540.00	739.20	744.49	744.59	0.003945	3.13	252.50	1907.20	0.29
Reach	963.3603	100-yr	584.00	739.20	745.82	745.86	0.001200	2.12	393.33	2525.99	0.17
Reach	963.3603	500-yr	852.00	739.20	749.56	749.57	0.000108	0.92	3177.89	3098.75	0.05
Reach	786.1729	25-yr	462.00	738.95	743.71	743.80	0.003905	3.04	275.34	751.06	0.28
Reach	786.1729	50-yr	540.00	738.95	743.82	743.90	0.003782	3.05	305.77	861.42	0.28
Reach	786.1729	100-yr	584.00	738.95	745.80	745.82	0.000077	0.58	882.25	2559.48	0.04
Reach	786.1729	500-yr	852.00	738.95	749.56	749.56	0.000007	0.24	4038.22	2837.96	0.01
Reach	688.7350	25-yr	462.00	738.83	743.15	743.30	0.006886	3.56	195.89	301.16	0.36
Reach	688.7350	50-yr	540.00	738.83	743.26	743.41	0.006784	3.62	231.33	322.83	0.36
Reach	688.7350	100-yr	584.00	738.83	745.80	745.81	0.000073	0.56	1154.65	2436.42	0.04
Reach	688.7350	500-yr	852.00	738.83	749.56	749.56	0.000008	0.26	4449.53	2684.08	0.01
Reach	540.9222	25-yr	462.00	738.65	743.07	743.10	0.000421	0.86	414.56	374.39	0.09
Reach	540.9222	50-yr	540.00	738.65	743.16	743.20	0.000491	0.95	447.62	394.83	0.10
Reach	540.9222	100-yr	584.00	738.65	745.80	745.80	0.000016	0.26	1784.10	2354.72	0.02
Reach	540.9222	500-yr	852.00	738.65	749.56	749.56	0.000003	0.17	5339.11	2478.40	0.01
Reach	455.8073	25-yr	462.00	738.38	742.99	743.03	0.002239	1.92	353.33	544.63	0.21
Reach	455.8073	50-yr	540.00	738.38	743.08	743.12	0.002286	1.98	393.52	656.40	0.21
Reach	455.8073	100-yr	584.00	738.38	745.80	745.80	0.000015	0.25	2013.65	2317.36	0.02
Reach	455.8073	500-yr	852.00	738.38	749.56	749.56	0.000004	0.18	5706.17	2362.09	0.01
Reach	401.3965	25-yr	462.00	738.38	742.89	742.92	0.001746	1.76	328.59	671.68	0.18
Reach	401.3965	50-yr	540.00	738.38	742.97	743.01	0.001814	1.82	366.34	732.33	0.19
Reach	401.3965	100-yr	584.00	738.38	745.80	745.80	0.000008	0.19	2292.17	1842.71	0.01
Reach	401.3965	500-yr	852.00	738.38	749.56	749.56	0.000002	0.14	5980.09	2051.00	0.01
Reach	301.5571	25-yr	462.00	738.88	742.75	742.01	742.77	0.001300	1.56	385.19	833.50	0.16
Reach	301.5571	50-yr	540.00	738.88	742.82	742.07	742.85	0.001301	1.59	437.63	871.40	0.16
Reach	301.5571	100-yr	584.00	738.88	745.80	742.15	745.80	0.000005	0.16	2757.98	1839.12	0.01
Reach	301.5571	500-yr	852.00	738.88	749.56	742.37	749.56	0.000002	0.12	6600.11	1855.28	0.01

Profile Output Table - Standard Table 2

Reach	River Sta	Profile	E.G. Elev (ft)	W.S. Elev (ft)	Vel Head (ft)	Frctn Loss (ft)	C & E Loss (ft)	Q Left (cfs)	Q Channel (cfs)	Q Right (cfs)	Top Width (ft)
Reach	1917.216	25-yr	745.94	745.92	0.01	0.04	0.00	331.03	57.89	73.08	652.16
Reach	1917.216	50-yr	746.41	746.40	0.01	0.02	0.00	426.77	44.56	68.67	778.79
Reach	1917.216	100-yr	747.56	747.56	0.00	0.00	0.00	504.24	25.50	54.26	852.94
Reach	1917.216	500-yr	749.59	749.59	0.00	0.00	0.00	768.10	21.01	62.88	852.94
Reach	1815.309	25-yr	745.89	745.89	0.01	0.02	0.00	239.58	109.39	113.03	799.31
Reach	1815.309	50-yr	746.39	746.39	0.00	0.01	0.00	324.20	97.53	118.27	874.56
Reach	1815.309	100-yr	747.56	747.55	0.00	0.00	0.00	408.91	70.37	104.72	1124.66
Reach	1815.309	500-yr	749.59	749.59	0.00	0.00	0.00	644.46	71.29	136.25	1124.66

Reach	1718.108	25-yr	745.87	745.87	0.00	0.01	0.00	291.82	47.51	122.67	923.75
Reach	1718.108	50-yr	746.38	746.38	0.00	0.01	0.00	352.36	45.70	141.93	987.54
Reach	1718.108	100-yr	747.55	747.55	0.00	0.00	0.00	403.96	35.53	144.51	1124.59
Reach	1718.108	500-yr	749.59	749.58	0.00	0.00	0.00	592.26	41.79	217.95	1124.59
Reach	1494.218	25-yr	745.86	745.86	0.00	0.01	0.00	228.58	41.52	191.90	1136.02
Reach	1494.218	50-yr	746.37	746.37	0.00	0.00	0.00	271.32	42.58	226.11	1183.88
Reach	1494.218	100-yr	747.55	747.55	0.00	0.00	0.00	299.07	38.12	246.81	1441.24
Reach	1494.218	500-yr	749.58	749.58	0.00	0.00	0.00	407.05	50.56	394.39	1441.24
Reach	1396.953	25-yr	745.85	745.85	0.00	0.02	0.00	219.90	57.89	184.21	1171.40
Reach	1396.953	50-yr	746.37	746.36	0.00	0.01	0.00	258.48	61.34	220.18	1224.89
Reach	1396.953	100-yr	747.55	747.55	0.00	0.01	0.00	281.51	57.17	245.32	1388.22
Reach	1396.953	500-yr	749.58	749.58	0.00	0.00	0.00	403.84	71.34	376.82	1441.57
Reach	1307.234	25-yr	745.84	745.83	0.01	0.02	0.00	193.94	67.17	200.90	1441.35
Reach	1307.234	50-yr	746.35	746.35	0.01	0.01	0.00	235.64	71.27	233.09	1586.88
Reach	1307.234	100-yr	747.54	747.54	0.00	0.01	0.00	269.15	65.91	248.94	1873.24
Reach	1307.234	500-yr	749.58	749.58	0.00	0.00	0.00	472.89	87.19	291.92	1880.10
Reach	1262.110	25-yr	745.81	745.76	0.05			320.52	101.72	39.76	2639.11
Reach	1262.110	50-yr	746.33	746.28	0.05			382.95	106.77	50.28	2696.47
Reach	1262.110	100-yr	747.53	747.50	0.03			426.50	96.99	60.52	2828.79
Reach	1262.110	500-yr	749.58	749.57	0.00			627.43	91.41	133.16	2828.79
Reach	1127		Culvert								
Reach	997.3811	25-yr	744.57	744.45	0.12	0.11	0.01	8.51	375.52	77.97	1468.95
Reach	997.3811	50-yr	744.74	744.59	0.15	0.13	0.01	10.22	432.03	97.75	1519.29
Reach	997.3811	100-yr	745.92	745.84	0.08	0.04	0.01	12.76	419.85	151.39	2289.09
Reach	997.3811	500-yr	749.57	749.56	0.01	0.00	0.00	188.35	380.76	282.89	2528.33
Reach	963.3603	25-yr	744.45	744.36	0.09	0.65	0.00	54.42	288.24	119.34	1836.88
Reach	963.3603	50-yr	744.59	744.49	0.11	0.69	0.01	66.16	329.38	144.46	1907.20
Reach	963.3603	100-yr	745.86	745.82	0.05	0.03	0.01	89.79	302.87	191.34	2525.99
Reach	963.3603	500-yr	749.57	749.56	0.00	0.00	0.00	305.69	229.39	316.92	3098.75
Reach	786.1729	25-yr	743.80	743.71	0.09	0.50	0.01	135.96	257.72	68.32	751.06
Reach	786.1729	50-yr	743.90	743.82	0.09	0.48	0.01	157.36	266.07	116.57	861.42
Reach	786.1729	100-yr	745.82	745.80	0.02	0.01	0.00	121.26	77.39	385.35	2559.48
Reach	786.1729	500-yr	749.56	749.56	0.00	0.00	0.00	190.09	54.38	607.53	2837.96
Reach	688.7350	25-yr	743.30	743.15	0.15	0.16	0.04	35.54	324.60	101.86	301.16
Reach	688.7350	50-yr	743.41	743.26	0.15	0.18	0.03	51.11	342.75	146.15	322.83
Reach	688.7350	100-yr	745.81	745.80	0.01	0.00	0.00	134.00	96.52	353.48	2436.42
Reach	688.7350	500-yr	749.56	749.56	0.00	0.00	0.00	233.92	73.62	544.46	2684.08
Reach	540.9222	25-yr	743.10	743.07	0.03	0.07	0.00	19.47	79.05	363.49	374.39
Reach	540.9222	50-yr	743.20	743.16	0.04	0.08	0.00	25.96	89.77	424.27	394.83

Reach	540.9222	100-yr	745.80	745.80	0.00	0.00	0.00	122.96	47.32	413.72	2354.72
Reach	540.9222	500-yr	749.56	749.56	0.00	0.00	0.00	244.97	51.02	556.02	2478.40
Reach	455.8073	25-yr	743.03	742.99	0.04	0.11	0.00	142.86	249.68	69.47	544.63
Reach	455.8073	50-yr	743.12	743.08	0.04	0.11	0.00	175.59	265.55	98.86	656.40
Reach	455.8073	100-yr	745.80	745.80	0.00	0.00	0.00	282.21	66.55	235.24	2317.36
Reach	455.8073	500-yr	749.56	749.56	0.00	0.00	0.00	374.02	80.72	397.26	2362.09
Reach	401.3965	25-yr	742.92	742.89	0.03	0.15	0.00	227.14	177.68	57.19	671.68
Reach	401.3965	50-yr	743.01	742.97	0.04	0.15	0.00	272.10	189.61	78.29	732.33
Reach	401.3965	100-yr	745.80	745.80	0.00	0.00	0.00	319.54	39.55	224.91	1842.71
Reach	401.3965	500-yr	749.56	749.56	0.00	0.00	0.00	417.30	48.33	386.37	2051.00
Reach	301.5571	25-yr	742.77	742.75	0.02			305.72	92.85	63.43	833.50
Reach	301.5571	50-yr	742.85	742.82	0.03			361.25	96.84	81.91	871.40
Reach	301.5571	100-yr	745.80	745.80	0.00			367.20	18.93	197.88	1839.12
Reach	301.5571	500-yr	749.56	749.56	0.00			479.91	22.63	349.46	1855.28

Profile Output Table - Culvert Only

Reach	River Sta		Profile	E.G. US. (ft)	W.S. US. (ft)	E.G. IC (ft)	E.G. OC (ft)	Min El Weir Flow (ft)	Q Culv Group (cfs)	Q Weir (cfs)	Delta WS (ft)	Culv Vel US (ft/s)	Culv Vel DS (ft/s)
Reach	1127	Culvert #1	25-yr	745.81	745.76	744.55	745.81	749.01	462.00		1.32	5.81	6.41
Reach	1127	Culvert #1	50-yr	746.33	746.28	745.09	746.33	749.01	540.00		1.69	6.48	7.31
Reach	1127	Culvert #1	100-yr	747.53	747.50	745.40	747.53	749.01	584.00		1.66	6.49	6.66
Reach	1127	Culvert #1	500-yr	749.58	749.57	747.55	749.58	749.01	25.66	826.34	0.01	0.29	0.29

APPENDIX 7: PRELIMINARY SCOUR ANALYSIS

Preliminary Scour Analysis Report

Project Data

Project Title: FRA/FAI-33-22.99/0.00 – Coble Bowman Structure Replacement

Designer: Christina Larry

Project Date: Wednesday, April 30, 2025

Project Units: U.S. Customary Units

Bridge Scour Analysis: Box - 25Yr Scour Analysis

Scenario: Scour Scenario

Contraction Scour Summary

Contraction & Long Term Scour is applied method due to greater scour.

Applied Contraction Scour Depth 0.25 ft

Contraction & Long Term Scour is applied method due to greater scour.

Pressure Scour Depth 0.25 ft

Clear Water Contraction Scour Depth 0.25 ft

Live Bed Contraction Scour Depth 0.90 ft

Main Channel Contraction Scour

Computation Type: Clear-Water and Live-Bed Scour

Input Parameters

Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 4.86 ft

D50 (D50): 0.200000 mm

Average Velocity Upstream (V): 1.28 ft/s

Computed Contraction Scour Condition: Live Bed

Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.000471 ft/ft

Discharge in Contracted Section (Q2): 110.50 cfs

Discharge Upstream that is Transporting Sediment (Q1): 72.01 cfs

Bottom Width in Contracted Section (W2): 16.00 ft

Width Upstream that is Transporting Sediment (W1): 11.58 ft

Depth Prior to Scour in Contracted Section (y0): 4.71 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

Results

Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 1.26 ft/s

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material (Dm): 0.250000 mm

Average Depth in Contracted Section after Scour (y2): 4.96 ft

Scour Depth (ys): 0.25 ft

Results of Live Bed Method

k1 (k1): 0.69

Shear Velocity (V*): 0.27 ft/s

Fall Velocity (V*): 0.08 ft/s

Scour Depth (ys): 0.90 ft

Shear Applied to Bed by Live-Bed Scour (theta 0): 0.0076 lb/ft^2

Shear Required for Movement of D50 Particle (Tau c): 0.0026 lb/ft^2

Recommendations

Recommended Scour Condition: Clear Water

Recommended Scour Depth: 0.25 ft

Scour Summary Table

Long Term Degradation

Contraction Scour

Parameter	Value	Units	Notes
Applied Contraction Scour Depth	0.25	ft	Clear Water
Clear Water Contraction Scour Depth	0.25	ft	
Live Bed Contraction Scour Depth	0.90	ft	

Bridge Scour Analysis: Box - 50Yr Scour Analysis

Scenario: Scour Scenario

Contraction Scour Summary

Contraction & Long Term Scour is applied method due to greater scour.

Applied Contraction Scour Depth 0.04 ft

Contraction & Long Term Scour is applied method due to greater scour.

Pressure Scour Depth 0.04 ft

Clear Water Contraction Scour Depth 0.04 ft

Live Bed Contraction Scour Depth 0.91 ft

Main Channel Contraction Scour

Computation Type: Clear-Water and Live-Bed Scour

Input Parameters

Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 5.28 ft

D50 (D50): 0.200000 mm

Average Velocity Upstream (V): 1.25 ft/s

Computed Contraction Scour Condition: Clear Water

Input Parameters for Clear Water

Discharge in Contracted Section (Q): 116.13 cfs

Bottom Width in Contracted Section (W): 16.00 ft

Depth Prior to Scour in Contracted Section (y0): 5.13 ft

Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.000403 ft/ft

Discharge in Contracted Section (Q2): 116.13 cfs

Discharge Upstream that is Transporting Sediment (Q1): 76.59 cfs

Bottom Width in Contracted Section (W2): 16.00 ft

Width Upstream that is Transporting Sediment (W1): 11.58 ft

Depth Prior to Scour in Contracted Section (y0): 5.13 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

Results

Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 1.28 ft/s

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material (Dm): 0.250000 mm

Average Depth in Contracted Section after Scour (y2): 5.17 ft

Scour Depth (ys): 0.04 ft

Results of Live Bed Method

k1 (k1): 0.69

Shear Velocity (V*): 0.26 ft/s

Fall Velocity (V*): 0.08 ft/s

Scour Depth (ys): 0.91 ft

Shear Applied to Bed by Live-Bed Scour (theta 0): 0.0075 lb/ft^2

Shear Required for Movement of D50 Particle (Tau c): 0.0026 lb/ft^2

Recommendations

Recommended Scour Condition: Clear Water

Recommended Scour Depth: 0.04 ft

Scour Summary Table

Long Term Degradation

Contraction Scour

Parameter	Value	Units	Notes
Applied Contraction Scour Depth	0.04	ft	Clear Water
Clear Water Contraction Scour Depth	0.04	ft	
Live Bed Contraction Scour Depth	0.91	ft	

Bridge Scour Analysis: Box - 100Yr Scour Analysis

Scenario: Scour Scenario

Contraction Scour Summary

Contraction & Long Term Scour is applied method due to greater scour.

Live Bed Contraction Scour Depth 0.88 ft

Main Channel Contraction Scour

Computation Type: Clear-Water and Live-Bed Scour

Input Parameters

Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 6.15 ft

D50 (D50): 0.200000 mm

Average Velocity Upstream (V): 1.01 ft/s

Computed Contraction Scour Condition: Clear Water

Input Parameters for Clear Water

Discharge in Contracted Section (Q): 106.70 cfs

Bottom Width in Contracted Section (W): 16.00 ft

Depth Prior to Scour in Contracted Section (y0): 6.03 ft

Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.000213 ft/ft

Discharge in Contracted Section (Q2): 106.70 cfs

Discharge Upstream that is Transporting Sediment (Q1): 71.81 cfs

Bottom Width in Contracted Section (W2): 16.00 ft

Width Upstream that is Transporting Sediment (W1): 11.58 ft

Depth Prior to Scour in Contracted Section (y0): 6.03 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

Results

Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 1.31 ft/s

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material (Dm): 0.250000 mm

Average Depth in Contracted Section after Scour (y2): 4.81 ft

Scour Depth (ys): -1.22 ft

Results of Live Bed Method

k1 (k1): 0.69

Shear Velocity (V*): 0.21 ft/s

Fall Velocity (V*): 0.08 ft/s

Scour Depth (ys): 0.88 ft

Shear Applied to Bed by Live-Bed Scour (theta 0): 0.0050 lb/ft^2

Shear Required for Movement of D50 Particle (Tau c): 0.0026 lb/ft^2

Recommendations

Recommended Scour Condition: Clear Water

Recommended Scour Depth: 0.00 ft

Scour Summary Table

Long Term Degradation

Contraction Scour

Parameter	Value	Units	Notes
Applied Contraction Scour Depth	0.00	ft	Clear Water
Clear Water Contraction Scour Depth	-1.22	ft	
Live Bed Contraction Scour Depth	0.88	ft	

Bridge Scour Analysis: Box - 500Yr Scour Analysis

Scenario: Scour Scenario

Contraction Scour Summary

Contraction & Long Term Scour is applied method due to greater scour.

Main Channel Contraction Scour

Computation Type: Clear-Water and Live-Bed Scour

Input Parameters

Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 8.91 ft

D50 (D50): 0.200000 mm

Average Velocity Upstream (V): 0.84 ft/s

Computed Contraction Scour Condition: Clear Water

Input Parameters for Clear Water

Discharge in Contracted Section (Q): 91.37 cfs

Bottom Width in Contracted Section (W): 16.00 ft

Depth Prior to Scour in Contracted Section (y0): 8.84 ft

Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.000091 ft/ft

Discharge in Contracted Section (Q2): 91.37 cfs

Discharge Upstream that is Transporting Sediment (Q1): 87.16 cfs

Bottom Width in Contracted Section (W2): 16.00 ft

Width Upstream that is Transporting Sediment (W1): 11.58 ft

Depth Prior to Scour in Contracted Section (y0): 8.84 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

Results

Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 1.40 ft/s

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material (Dm): 0.250000 mm

Average Depth in Contracted Section after Scour (y2): 4.21 ft

Scour Depth (ys): -4.63 ft

Results of Live Bed Method

k1 (k1): 0.69

Shear Velocity (V*): 0.16 ft/s

Fall Velocity (V*): 0.08 ft/s

Scour Depth (ys): -1.42 ft

Shear Applied to Bed by Live-Bed Scour (theta 0): 0.0033 lb/ft^2

Shear Required for Movement of D50 Particle (Tau c): 0.0026 lb/ft^2

Recommendations

Recommended Scour Condition: Clear Water

Recommended Scour Depth: 0.00 ft

Scour Summary Table

Long Term Degradation

Contraction Scour

Parameter	Value	Units	Notes
Applied Contraction Scour Depth	0.00	ft	Clear Water
Clear Water Contraction Scour Depth	-4.63	ft	
Live Bed Contraction Scour Depth	-1.42	ft	

Bridge Scour Analysis: 3Sided - 25Yr Scour Analysis

Scenario: Scour Scenario

Contraction Scour Summary

Contraction & Long Term Scour is applied method due to greater scour.

Live Bed Contraction Scour Depth 0.84 ft

Main Channel Contraction Scour

Computation Type: Clear-Water and Live-Bed Scour

Input Parameters

Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 5.75 ft

D50 (D50): 0.200000 mm

Average Velocity Upstream (V): 0.91 ft/s

Computed Contraction Scour Condition: Clear Water

Input Parameters for Clear Water

Discharge in Contracted Section (Q): 89.93 cfs

Bottom Width in Contracted Section (W): 16.00 ft

Depth Prior to Scour in Contracted Section (y0): 5.64 ft

Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.000189 ft/ft

Discharge in Contracted Section (Q2): 89.93 cfs

Discharge Upstream that is Transporting Sediment (Q1): 60.30 cfs

Bottom Width in Contracted Section (W2): 16.00 ft

Width Upstream that is Transporting Sediment (W1): 11.58 ft

Depth Prior to Scour in Contracted Section (y0): 5.64 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

Results

Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 1.30 ft/s

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material (Dm): 0.250000 mm

Average Depth in Contracted Section after Scour (y2): 4.16 ft

Scour Depth (ys): -1.48 ft

Results of Live Bed Method

k1 (k1): 0.69

Shear Velocity (V*): 0.19 ft/s

Fall Velocity (V*): 0.08 ft/s

Scour Depth (ys): 0.84 ft

Shear Applied to Bed by Live-Bed Scour (theta 0): 0.0040 lb/ft^2

Shear Required for Movement of D50 Particle (Tau c): 0.0026 lb/ft^2

Recommendations

Recommended Scour Condition: Clear Water

Recommended Scour Depth: 0.00 ft

Scour Summary Table

Long Term Degradation

Contraction Scour

Parameter	Value	Units	Notes
Applied Contraction Scour Depth	0.00	ft	Clear Water
Clear Water Contraction Scour Depth	-1.48	ft	
Live Bed Contraction Scour Depth	0.84	ft	

Bridge Scour Analysis: 3Sided - 50Yr Scour Analysis

Scenario: Scour Scenario

Contraction Scour Summary

Contraction & Long Term Scour is applied method due to greater scour.

Live Bed Contraction Scour Depth 0.86 ft

Main Channel Contraction Scour

Computation Type: Clear-Water and Live-Bed Scour

Input Parameters

Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 6.32 ft

D50 (D50): 0.200000 mm

Average Velocity Upstream (V): 0.89 ft/s

Computed Contraction Scour Condition: Clear Water

Input Parameters for Clear Water

Discharge in Contracted Section (Q): 96.07 cfs

Bottom Width in Contracted Section (W): 16.00 ft

Depth Prior to Scour in Contracted Section (y0): 6.22 ft

Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.000159 ft/ft

Discharge in Contracted Section (Q2): 96.07 cfs

Discharge Upstream that is Transporting Sediment (Q1): 64.90 cfs

Bottom Width in Contracted Section (W2): 16.00 ft

Width Upstream that is Transporting Sediment (W1): 11.58 ft

Depth Prior to Scour in Contracted Section (y0): 6.22 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

Results

Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 1.32 ft/s

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material (Dm): 0.250000 mm

Average Depth in Contracted Section after Scour (y2): 4.40 ft

Scour Depth (ys): -1.82 ft

Results of Live Bed Method

k1 (k1): 0.69

Shear Velocity (V*): 0.18 ft/s

Fall Velocity (V*): 0.08 ft/s

Scour Depth (ys): 0.86 ft

Shear Applied to Bed by Live-Bed Scour (theta 0): 0.0039 lb/ft^2

Shear Required for Movement of D50 Particle (Tau c): 0.0026 lb/ft^2

Recommendations

Recommended Scour Condition: Clear Water

Recommended Scour Depth: 0.00 ft

Scour Summary Table

Long Term Degradation

Contraction Scour

Parameter	Value	Units	Notes
Applied Contraction Scour Depth	0.00	ft	Clear Water
Clear Water Contraction Scour Depth	-1.82	ft	
Live Bed Contraction Scour Depth	0.86	ft	

Bridge Scour Analysis: 3Sided - 100Yr Scour Analysis

Scenario: Scour Scenario

Contraction Scour Summary

Contraction & Long Term Scour is applied method due to greater scour.

Live Bed Contraction Scour Depth 1.03 ft

Main Channel Contraction Scour

Computation Type: Clear-Water and Live-Bed Scour

Input Parameters

Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 7.28 ft

D50 (D50): 0.200000 mm

Average Velocity Upstream (V): 0.75 ft/s

Computed Contraction Scour Condition: Clear Water

Input Parameters for Clear Water

Discharge in Contracted Section (Q): 92.86 cfs

Bottom Width in Contracted Section (W): 16.00 ft

Depth Prior to Scour in Contracted Section (y0): 7.19 ft

Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.000095 ft/ft

Discharge in Contracted Section (Q2): 92.86 cfs

Discharge Upstream that is Transporting Sediment (Q1): 63.34 cfs

Bottom Width in Contracted Section (W2): 16.00 ft

Width Upstream that is Transporting Sediment (W1): 11.58 ft

Depth Prior to Scour in Contracted Section (y0): 7.19 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

Results

Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 1.35 ft/s

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material (Dm): 0.250000 mm

Average Depth in Contracted Section after Scour (y2): 4.27 ft

Scour Depth (ys): -2.92 ft

Results of Live Bed Method

k1 (k1): 0.64

Shear Velocity (V*): 0.15 ft/s

Fall Velocity (V*): 0.08 ft/s

Scour Depth (ys): 1.03 ft

Shear Applied to Bed by Live-Bed Scour (theta 0): 0.0029 lb/ft^2

Shear Required for Movement of D50 Particle (Tau c): 0.0026 lb/ft^2

Recommendations

Recommended Scour Condition: Clear Water

Recommended Scour Depth: 0.00 ft

Scour Summary Table

Long Term Degradation

Contraction Scour

Parameter	Value	Units	Notes
Applied Contraction Scour Depth	0.00	ft	Clear Water
Clear Water Contraction Scour Depth	-2.92	ft	
Live Bed Contraction Scour Depth	1.03	ft	

Bridge Scour Analysis: 3Sided - 500Yr Scour Analysis

Scenario: Scour Scenario

Contraction Scour Summary

Contraction & Long Term Scour is applied method due to greater scour.

Main Channel Contraction Scour

Computation Type: Clear-Water and Live-Bed Scour

Input Parameters

Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 8.91 ft

D50 (D50): 0.200000 mm

Average Velocity Upstream (V): 0.84 ft/s

Computed Contraction Scour Condition: Clear Water

Input Parameters for Clear Water

Discharge in Contracted Section (Q): 91.29 cfs

Bottom Width in Contracted Section (W): 16.00 ft

Depth Prior to Scour in Contracted Section (y0): 8.84 ft

Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.000091 ft/ft

Discharge in Contracted Section (Q2): 91.29 cfs

Discharge Upstream that is Transporting Sediment (Q1): 87.13 cfs

Bottom Width in Contracted Section (W2): 16.00 ft

Width Upstream that is Transporting Sediment (W1): 11.58 ft

Depth Prior to Scour in Contracted Section (y0): 8.84 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

Results

Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 1.40 ft/s

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material (Dm): 0.250000 mm

Average Depth in Contracted Section after Scour (y2): 4.21 ft

Scour Depth (ys): -4.63 ft

Results of Live Bed Method

k1 (k1): 0.69

Shear Velocity (V*): 0.16 ft/s

Fall Velocity (V*): 0.08 ft/s

Scour Depth (ys): -1.42 ft

Shear Applied to Bed by Live-Bed Scour (theta 0): 0.0033 lb/ft^2

Shear Required for Movement of D50 Particle (Tau c): 0.0026 lb/ft^2

Recommendations

Recommended Scour Condition: Clear Water

Recommended Scour Depth: 0.00 ft

Scour Summary Table

Long Term Degradation

Contraction Scour

Parameter	Value	Units	Notes
Applied Contraction Scour Depth	0.00	ft	Clear Water
Clear Water Contraction Scour Depth	-4.63	ft	
Live Bed Contraction Scour Depth	-1.42	ft	

Bridge Scour Analysis: Pipe - 25Yr Scour Analysis

Scenario: Scour Scenario

Contraction Scour Summary

Contraction & Long Term Scour is applied method due to greater scour.

Live Bed Contraction Scour Depth 0.25 ft

Main Channel Contraction Scour

Computation Type: Clear-Water and Live-Bed Scour

Input Parameters

Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 5.16 ft

D50 (D50): 0.200000 mm

Average Velocity Upstream (V): 1.12 ft/s

Computed Contraction Scour Condition: Clear Water

Input Parameters for Clear Water

Discharge in Contracted Section (Q): 89.41 cfs

Bottom Width in Contracted Section (W): 16.00 ft

Depth Prior to Scour in Contracted Section (y0): 5.03 ft

Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.000335 ft/ft

Discharge in Contracted Section (Q2): 89.41 cfs

Discharge Upstream that is Transporting Sediment (Q1): 67.17 cfs

Bottom Width in Contracted Section (W2): 16.00 ft

Width Upstream that is Transporting Sediment (W1): 11.58 ft

Depth Prior to Scour in Contracted Section (y0): 5.03 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

Results

Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 1.28 ft/s

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material (Dm): 0.250000 mm

Average Depth in Contracted Section after Scour (y2): 4.13 ft

Scour Depth (ys): -0.90 ft

Results of Live Bed Method

k1 (k1): 0.69

Shear Velocity (V*): 0.24 ft/s

Fall Velocity (V*): 0.08 ft/s

Scour Depth (ys): 0.25 ft

Shear Applied to Bed by Live-Bed Scour (theta 0): 0.0055 lb/ft^2

Shear Required for Movement of D50 Particle (Tau c): 0.0026 lb/ft^2

Recommendations

Recommended Scour Condition: Clear Water

Recommended Scour Depth: 0.00 ft

Scour Summary Table

Long Term Degradation

Contraction Scour

Parameter	Value	Units	Notes
Applied Contraction Scour Depth	0.00	ft	Clear Water
Clear Water Contraction Scour Depth	-0.90	ft	
Live Bed Contraction Scour Depth	0.25	ft	

Bridge Scour Analysis: Pipe - 50Yr Scour Analysis

Scenario: Scour Scenario

Contraction Scour Summary

Contraction & Long Term Scour is applied method due to greater scour.

Live Bed Contraction Scour Depth 0.88 ft

Local Scour at Abutments Summary

Input Parameters

Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 5.68 ft

D50 (D50): 0.200000 mm

Average Velocity Upstream (V): 1.08 ft/s

Computed Contraction Scour Condition: Clear Water

Input Parameters for Clear Water

Discharge in Contracted Section (Q): 106.77 cfs

Bottom Width in Contracted Section (W): 16.00 ft

Depth Prior to Scour in Contracted Section (y0): 5.55 ft

Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.000274 ft/ft

Discharge in Contracted Section (Q2): 106.77 cfs

Discharge Upstream that is Transporting Sediment (Q1): 71.27 cfs

Bottom Width in Contracted Section (W2): 16.00 ft

Width Upstream that is Transporting Sediment (W1): 11.58 ft

Depth Prior to Scour in Contracted Section (y0): 5.55 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

Results

Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 1.30 ft/s

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material (Dm): 0.250000 mm

Average Depth in Contracted Section after Scour (y2): 4.81 ft

Scour Depth (ys): -0.74 ft

Results of Live Bed Method

k1 (k1): 0.69

Shear Velocity (V*): 0.22 ft/s

Fall Velocity (V*): 0.08 ft/s

Scour Depth (ys): 0.88 ft

Shear Applied to Bed by Live-Bed Scour (theta 0): 0.0057 lb/ft^2

Shear Required for Movement of D50 Particle (Tau c): 0.0026 lb/ft^2

Recommendations

Recommended Scour Condition: Clear Water

Scour Summary Table

Long Term Degradation

Contraction Scour

Parameter	Value	Units	Notes
Applied Contraction Scour Depth	0.00	ft	Clear Water
Clear Water Contraction Scour Depth	-0.74	ft	
Live Bed Contraction Scour Depth	0.88	ft	

Bridge Scour Analysis: Pipe - 100Yr Scour Analysis

Scenario: Scour Scenario

Contraction Scour Summary

Contraction & Long Term Scour is applied method due to greater scour.

Live Bed Contraction Scour Depth 0.88 ft

Main Channel Contraction Scour

Computation Type: Clear-Water and Live-Bed Scour

Input Parameters

Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 6.87 ft

D50 (D50): 0.200000 mm

Average Velocity Upstream (V): 0.83 ft/s

Computed Contraction Scour Condition: Clear Water

Input Parameters for Clear Water

Discharge in Contracted Section (Q): 96.99 cfs

Bottom Width in Contracted Section (W): 16.00 ft

Depth Prior to Scour in Contracted Section (y0): 6.77 ft

Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.000124 ft/ft

Discharge in Contracted Section (Q2): 96.99 cfs

Discharge Upstream that is Transporting Sediment (Q1): 65.91 cfs

Bottom Width in Contracted Section (W2): 16.00 ft

Width Upstream that is Transporting Sediment (W1): 11.58 ft

Depth Prior to Scour in Contracted Section (y0): 6.77 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

Results

Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 1.34 ft/s

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material (Dm): 0.250000 mm

Average Depth in Contracted Section after Scour (y2): 4.43 ft

Scour Depth (ys): -2.34 ft

Results of Live Bed Method

k1 (k1): 0.69

Shear Velocity (V*): 0.17 ft/s

Fall Velocity (V*): 0.08 ft/s

Scour Depth (ys): 0.88 ft

Shear Applied to Bed by Live-Bed Scour (theta 0): 0.0035 lb/ft^2

Shear Required for Movement of D50 Particle (Tau c): 0.0026 lb/ft^2

Recommendations

Recommended Scour Condition: Clear Water

Recommended Scour Depth: 0.00 ft

Scour Summary Table

Long Term Degradation

Contraction Scour

Parameter	Value	Units	Notes
Applied Contraction Scour Depth	0.00	ft	Clear Water
Clear Water Contraction Scour Depth	-2.34	ft	
Live Bed Contraction Scour Depth	0.88	ft	

Bridge Scour Analysis: Pipe - 500Yr Scour Analysis

Scenario: Scour Scenario

Contraction Scour Summary

Contraction & Long Term Scour is applied method due to greater scour.

Main Channel Contraction Scour

Computation Type: Clear-Water and Live-Bed Scour

Input Parameters

Input Parameters for Scour Condition

Average Depth Upstream of Contraction (y1): 8.91 ft

D50 (D50): 0.200000 mm

Average Velocity Upstream (V): 0.85 ft/s

Computed Contraction Scour Condition: Clear Water

Input Parameters for Clear Water

Discharge in Contracted Section (Q): 91.41 cfs

Bottom Width in Contracted Section (W): 16.00 ft

Depth Prior to Scour in Contracted Section (y0): 8.84 ft

Input Parameters for Live Bed

Temperature of Water: 60.00 ºF

Slope of Energy Grade Line at Approach Section (S1): 0.000091 ft/ft

Discharge in Contracted Section (Q2): 91.41 cfs

Discharge Upstream that is Transporting Sediment (Q1): 87.19 cfs

Bottom Width in Contracted Section (W2): 16.00 ft

Width Upstream that is Transporting Sediment (W1): 11.58 ft

Depth Prior to Scour in Contracted Section (y0): 8.84 ft

Unit Weight of Water (gamma w): 62.40 lb/ft^3

Unit Weight of Sediment (gamma s): 165.00 lb/ft^3

Results

Results of Scour Condition

Critical velocity above which bed material of size D and smaller will be transported (Vc): 1.40 ft/s

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material (Dm): 0.250000 mm

Average Depth in Contracted Section after Scour (y2): 4.21 ft

Scour Depth (ys): -4.63 ft

Results of Live Bed Method

k1 (k1): 0.69

Shear Velocity (V*): 0.16 ft/s

Fall Velocity (V*): 0.08 ft/s

Scour Depth (ys): -1.42 ft

Shear Applied to Bed by Live-Bed Scour (theta 0): 0.0033 lb/ft^2

Shear Required for Movement of D50 Particle (Tau c): 0.0026 lb/ft^2

Recommendations

Recommended Scour Condition: Clear Water

Recommended Scour Depth: 0.00 ft

Scour Summary Table

Long Term Degradation

Contraction Scour

Parameter	Value	Units	Notes
Applied Contraction Scour Depth	0.00	ft	Clear Water
Clear Water Contraction Scour Depth	-4.63	ft	
Live Bed Contraction Scour Depth	-1.42	ft	

APPENDIX 8: ODOT TAF CHECKLIST AND WORKSHEET

Temporary Construction, Access and Dewatering Activities Checklist

The purpose of this form is to aid the Office of Environmental Services - Waterway Permits Unit (OES-WPU) in the Permit Determination and Special Provisions processes. This form shall be completed by the project designer for each aquatic resource and reflect the anticipated temporary fill activities in the aquatic resource (including streams, impounded streams, lakes, reservoirs, rivers). If the type and amount of temporary fill is unknown, assume a reasonable and logical worst-case scenario of what could be needed. A complete copy of this form shall be provided to the District Environmental Coordinator (DEC) to be included in the Permit Determination Request submitted to OES-WPU. Please use the current version of this TAF Checklist found on the Waterway Permits website.

CRS:	FRA-33-27.51	PID:	119387
Aquatic resource name*	Coble-Bowman Ditch		

*Provide stationing if more than one location on the same aquatic resource will be impacted

1. During the construction of this project, the following fill activities in the aquatic resource are anticipated: (check all that apply)

☐	Temporary bridge or structure (CMS Item 502)
☐	Cofferdams (temporary dewatering)
☐	Demolition and debris (intentional fill)
☒	Causeways and work pads

2. ODOT requires that the temporary activity accommodates a minimum flow equal to twice the maximum mean monthly flow without creating a rise in backwater above the OHWM. This flow is the Standard Temporary Discharge (STD).

Yes	Is U.S. Geological Survey Stream Stats data available for this location?
8.08 cfs	Provide the minimum flow (cfs) to be maintained throughout construction for this location

3. The method that will most likely be implemented by the Contractor to maintain this flow will be (check all that apply):

☒	Conduits (Provide TAF Design Worksheet and hydraulic calculations when the STD is 10 cfs or greater)
☐	Open channel(s)/temporary bridge (Provide TAF Design Worksheet and hydraulic calculations when the STD is 10 cfs or greater)
☐	Pump around (TAF Design Worksheet and hydraulic calculations are NOT required for cofferdams with pump around scenarios). For minimum flows over 15 cfs, work will be limited to months <15 cfs.
Yes	Verify if the project meet flow requirements outlined in the Location & Design Manual Vol. 2 Section 1010? Provide TAF Design Worksheet and attach hydraulic calculations when specified above.

4. Additional information

12 months	Provide the proposed duration (weeks, months or years) of temporary fill in the aquatic resource.
No	Will temporary fill occur within a flowage easement of a federal flood control facility? *This item only applies to federal flood control facilities. Flowage easements associated with these facilities can occur several miles away from the facility. If uncertain that the project is in a flowage easement area, please consult the district's real estate office for assistance.*

Click on the link below to access ODOT's Waterway Permits manual, guidance, and other resources:

https://www.transportation.ohio.gov/wps/portal/gov/odot/programs/waterway-permits-program/waterway-permits

OHIO DEPARTMENT OF TRANSPORTATION

TAF DESIGN WORKSHEET

January 19, 2024

Project:	FRA-33-24.76	**PID:**	119387
PERFORMED BY:	CML	**DATE:**	4/10/2025
CHECKED BY:	PES	**DATE:**	4/25/2025
SUBJECT:	FRA-33-24.76 Bridge Replacement		
STREAM:	Coble-Bowman		

TAF DESIGN

STREAM CHARACTERISTICS AT PROPOSED TAF LOCATION (NO TAF INSTALLED)

Is StreamStats data for the site available?	Yes
Is the stream's flow influenced by hydraulic controlling features (i.e. dams)?	No
Basin drainage area (mi^2)	2.26
Ordinary High Water Mark elevation [OHWM] (ft)	741.3
Top of bank elevation (ft)	
50% AEP flow water surface elevation (ft)	744.3
OHWM flow rate [without TAF] (cfs)	11.8
Maximum mean monthly flow (cfs)	4.04
2x maximum mean monthly flow (cfs)	8.08
2x maximum mean monthly flow water surface elevation (ft)	741.02

Tier 1 TAF Analysis

Proposed TAF obstruction	Full Channel
For partial TAFs: minimum channel opening width (ft) at the OHWM elevation	
Calculated backwater elevation (ft) with the TAF in place.	741.23
Does the site pass two-times highest monthly flow without backwater rise above OHWM with TAF in place?	Yes

End Analysis: Proceed to TAF Stability section and Summary.

After verifying OHWM, does the site pass 2x highest monthly flow?	Yes

Tier 2 TAF Analysis

Do not complete this section, analysis complete.

Calculated backwater elevation	
Modified height of TAF (backwater elevation+1' freeboard)	1
Calculated backwater from modified TAF height	
Calculated freeboard	1

TAF Design acceptable (greater than 0.5-feet)

Is the TAF height acceptable based on viability considerations?	

Proceed to Tier 3 TAF Design

Final top of TAF elevation (ft)	1.0

OHIO DEPARTMENT OF TRANSPORTATION

TAF DESIGN WORKSHEET

January 19, 2024

Tier 3 TAF Analysis

Complete if adjusted STD is necessary

Initial height of TAF (1' above OHWM or necessary to facilitate construction)	
Calculated STD (flow producing WSE equal to height of TAF)	
Is historical waterway flow available (USGS Gage data availability)?	
Does probability of exceedance of STD facilitate the project schedule?	

TAF STABILITY- Based on Bureau of Reclamation

Suggested rock sizing and corresponding Manning's n based on hydraulic analysis velocities

Note: Sizing based on velocity due to unavailability of accurate point shear in 1D models

Velocity at edge of TAF corresponding to 20% AEP flow (ft/s)	
Suggested dumped rock size	

SUMMARY

Streamflow data source	**Stream Stats**
Stream contains hydraulic controlling features?	**No**
Top of TAF elevation (ft)	**742.25**
Partial TAF: minimum channel opening width (ft) at the OHWM elevation:	**N/A**
Suggested size for TAF dumped rock:	
Suggested HEC-RAS scoping (1D or 2D)	**1D Hydraulic Model**