

CULVERT DESIGN ANALYSIS

for

Mustang Meadows, Clay County, Texas

Prepared for: *American Land & Lakes*

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Introduction

Mustang Meadows is a subdivision in Clay County, Texas consisting of 15 approximately 10-acre lots. Every parcel will be accessed via driveways that will be accessed by either Stark or Browning Roads. Parcels 2 & 3 and 6 & 7 will be accessed by shared driveways. This report will outline a design for the culverts that will be located parallel to where the driveway enters the county roads. The culverts will be designed to pass the 10-year flow using the rational method to determine the flow per TxDOT requirements. Due to lack of grading and survey data, the culvert parameters will be approximated. If field conditions differ greatly from these assumptions, Waterway Engineering should be contacted for verification.

Hydrology

Drainage Area

The existing drainage areas were delineated using a 1-meter resolution LiDAR obtained from the United States Geologic Survey (USGS). The drainage areas shown on the design sheet provided in Appendix A.

Time of Concentration

The longest flow path was used to compute the time of concentration and lag time. The time of concentration was computed by dividing the longest flow path into overland flow, shallow concentrated flow, and channel flow depending on longest flow path characteristics. The time of concentration was computed for each flow type separately then summed to determine the total time of concentration. The lag time was then computed using 0.6 of the time of concentration. The full time of concentration calculations are provided in Appendix A.

Runoff Coefficient

The composite runoff coefficient was determined using land use obtained from satellite imagery and field photographs. For areas within the road, gravel C value of 0.5 was used. For areas outside the road,

pasture/range values were used ranging from 0.47 to 0.51 depending on the steepness of the drainage area. The composite runoff calculations for each drainage area are provided in Appendix A.

Rainfall Data

The 5-, 10-, 25-, and 100-year 24-hour rainfall events were modeled for this study using precipitation depth acquired from NOAA Atlas 14 provided in Appendix B.

Flows

The 5-, 10-, and 100-year flows were calculated using the rational method. Where multiple culverts were combined into a single drainage basin, the flows were computed for the most downstream culvert and applied to each in the basin. This produces a conservative result for all culverts analyzed.

Table 1 provides the flows computed for each of the basins.

Table 1 Peak Flows (cfs) Results

Design Point	Basin	Flow (cfs)			
		5-Year	10-Year	25-Year	100-Year
1	P-1.a-g	70.3	81.2	95.6	117.7
2	P-1.d-e	13.0	15.0	17.7	21.7
3	P-1.d	12.6	14.5	17.1	21.1
4	P-1.b	1.4	1.6	1.9	2.3
5	P-1.c	0.5	0.6	0.7	0.8
6	P-2	0.5	0.6	0.7	0.8

Culvert Design

The culverts were designed using the Federal Highway Administration HY-8 software. All culverts were designed to be corrugated metal pipes, with no headwall (mitered to slope) and a 1.6% pipe slope. For design points 1 -3, rating curves for the downstream channel were computed using the cross-section data taken from LiDAR with a manning's n value of 0.035. For design points 4 -6, a triangular channel with 3:1 side slopes, manning's n value of 0.035, channel slope of 0.022 ft/ft were used. Table 2 provides the culvert sizes for each location. Appendix C provides the water surface profile for the design flow from the HY-8 model.

The analysis for the culvert is based on the worst-case lot location. For lots 12, 13, and 14 there is high ground present on the lot that, if the roads are constructed at these locations, then all water would flow away from the road. These locations would require no culvert underneath the driveway and be the preferred location for the driveway.

Table 2 Culvert Design

Design Point	Lot Number	Type	Culvert Size	Number	Fill above Pipe (ft)	Peak Capacity (cfs)	Design Flow (cfs)
1	1 - 5	Corrugated Metal	36"	2	1	83.3	81.2
2	6 – 9	Corrugated Metal	18"	2	0.5	16.3	15.0
3	10 – 12*	Corrugated Metal	18"	2	0.5	16.3	14.5
4	13*	Corrugated Metal	12"	1	0.5	3.07	1.6
5	14*	Corrugated Metal	12"	1	0.5	3.07	0.6
6	15	Corrugated Metal	12"	1	0.5	3.07	0.6

*For culvert 12, 13, & 14, if driveway is placed on high point and all water flows away from the road, no culvert is required.

Conclusion

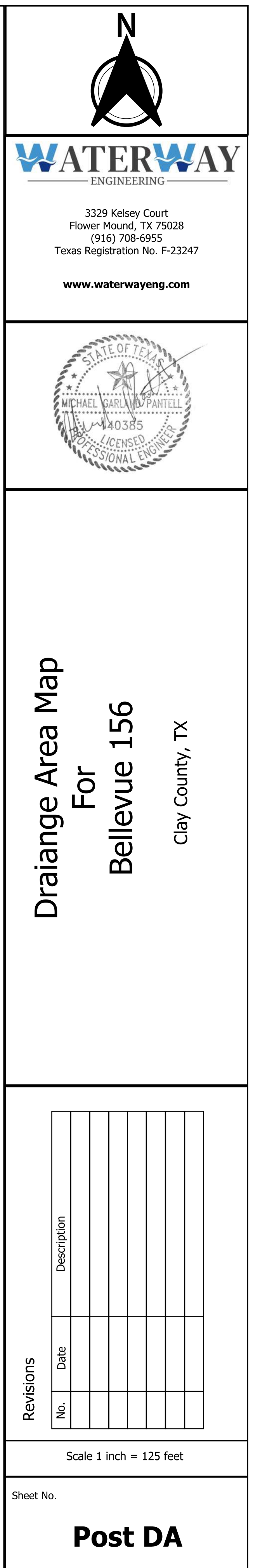
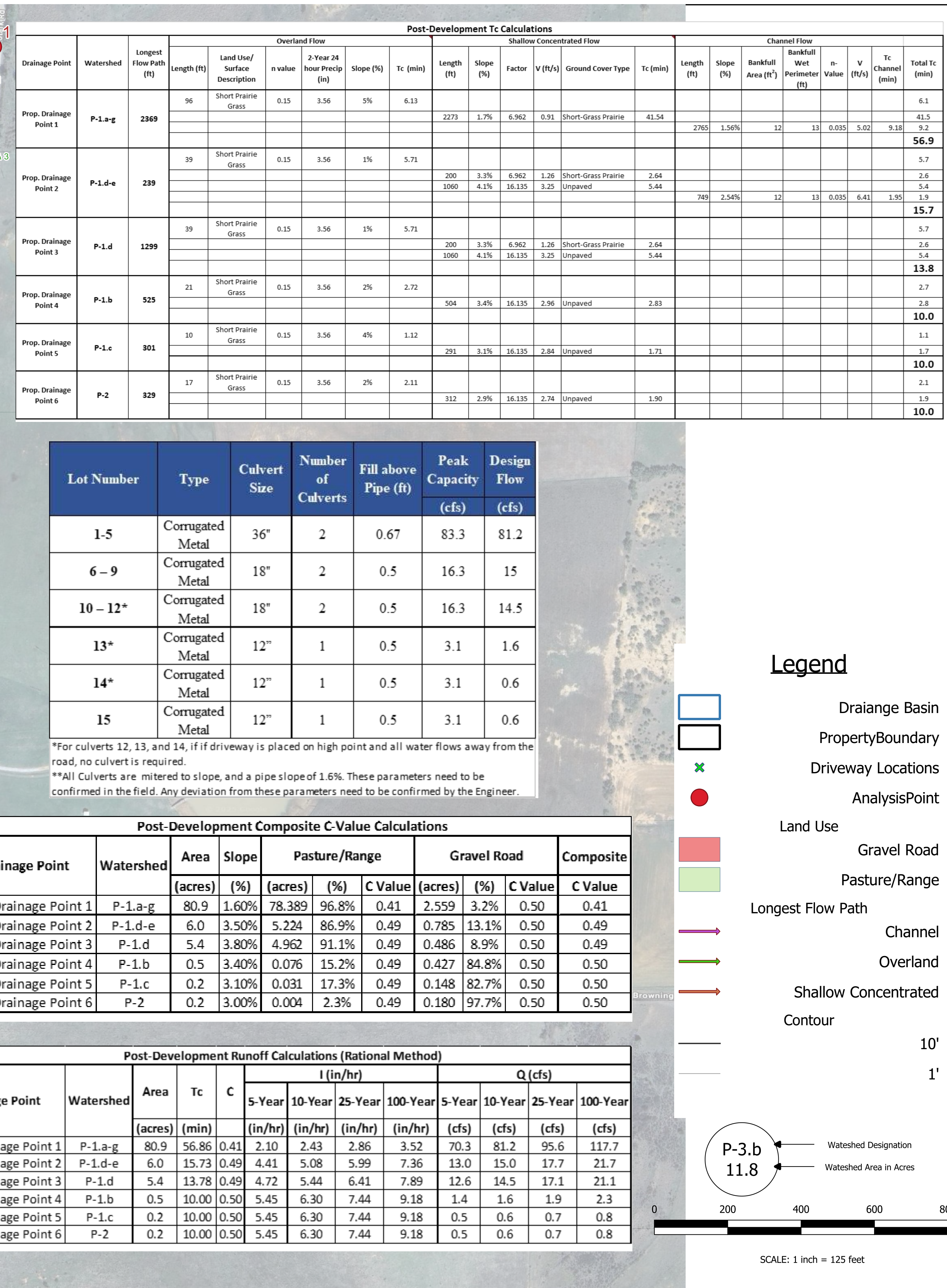
Table 2 provides the culvert sizes required for each location to pass the 10-year event without overtopping the road. This analysis is based on best available topographic data. All assumptions need to be field verified for accuracy at the time of construction. This shall include (but is not limited to) pipe slope, road depth above pipe, headwall type, pipe type, and downstream channel conditions. If these conditions vary from the assumptions Waterway Engineering (or another qualified engineering firm) should be consulted.

For lots 12, 13, and 14 there is high ground present on the lot that, if the roads are constructed at these locations, then all water would flow away from the road. It is recommended that the driveways be constructed at these locations. If done so, no culvert would be required. The exact location of the high ground should be field verified by the contractor.

Additionally, culverts are designed to the 10-year event per TxDOT design manual requirements. Larger floods will occur. In the event of larger flooding events, roadway overtopping can occur causing erosion and damage to the road. Erosion mitigation from road overtopping or culvert discharge was not part of this design.

Appendix A

Design Sheet



Appendix B

NOAA Atlas 14



NOAA Atlas 14, Volume 11, Version 2
Location name: **Bellevue, Texas, USA***
Latitude: **33.5167°**, Longitude: **-98.0705°**
Elevation: **1134 ft****
* source: ESRI Maps
** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Willhite

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps & aeriels](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches) ¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.393 (0.298-0.520)	0.458 (0.351-0.601)	0.565 (0.431-0.743)	0.652 (0.490-0.869)	0.771 (0.558-1.05)	0.858 (0.605-1.20)	0.948 (0.654-1.37)	1.05 (0.707-1.55)	1.20 (0.778-1.83)	1.32 (0.833-2.06)
10-min	0.632 (0.479-0.835)	0.736 (0.564-0.966)	0.909 (0.693-1.20)	1.05 (0.788-1.40)	1.24 (0.900-1.70)	1.38 (0.978-1.94)	1.53 (1.06-2.21)	1.69 (1.14-2.50)	1.91 (1.24-2.91)	2.08 (1.32-3.25)
15-min	0.782 (0.592-1.03)	0.909 (0.697-1.19)	1.12 (0.854-1.47)	1.29 (0.970-1.72)	1.52 (1.10-2.08)	1.70 (1.20-2.38)	1.87 (1.29-2.70)	2.07 (1.39-3.06)	2.36 (1.53-3.60)	2.59 (1.64-4.05)
30-min	1.08 (0.815-1.42)	1.25 (0.957-1.64)	1.54 (1.17-2.02)	1.77 (1.33-2.36)	2.08 (1.50-2.84)	2.31 (1.63-3.23)	2.54 (1.76-3.67)	2.82 (1.90-4.17)	3.22 (2.09-4.92)	3.55 (2.25-5.55)
60-min	1.38 (1.05-1.83)	1.61 (1.23-2.12)	1.99 (1.52-2.61)	2.30 (1.72-3.06)	2.71 (1.96-3.69)	3.02 (2.13-4.22)	3.34 (2.30-4.81)	3.71 (2.49-5.48)	4.25 (2.76-6.50)	4.70 (2.98-7.35)
2-hr	1.68 (1.28-2.19)	1.97 (1.51-2.55)	2.45 (1.88-3.19)	2.85 (2.16-3.76)	3.42 (2.50-4.63)	3.86 (2.74-5.36)	4.32 (3.00-6.17)	4.85 (3.28-7.08)	5.60 (3.65-8.46)	6.21 (3.95-9.60)
3-hr	1.84 (1.41-2.40)	2.19 (1.68-2.80)	2.73 (2.10-3.53)	3.20 (2.43-4.20)	3.88 (2.85-5.22)	4.41 (3.16-6.10)	4.99 (3.47-7.07)	5.62 (3.81-8.15)	6.52 (4.26-9.77)	7.24 (4.62-11.1)
6-hr	2.16 (1.67-2.78)	2.59 (2.00-3.26)	3.25 (2.52-4.16)	3.84 (2.94-4.99)	4.70 (3.49-6.29)	5.41 (3.90-7.42)	6.17 (4.32-8.65)	6.99 (4.76-10.0)	8.15 (5.36-12.1)	9.09 (5.82-13.8)
12-hr	2.52 (1.96-3.22)	3.05 (2.36-3.79)	3.84 (2.99-4.86)	4.55 (3.51-5.86)	5.60 (4.19-7.43)	6.48 (4.71-8.80)	7.43 (5.23-10.3)	8.45 (5.79-12.0)	9.89 (6.53-14.5)	11.0 (7.10-16.5)
24-hr	2.94 (2.30-3.72)	3.56 (2.78-4.38)	4.49 (3.53-5.62)	5.33 (4.14-6.79)	6.56 (4.94-8.60)	7.59 (5.55-10.2)	8.70 (6.17-11.9)	9.91 (6.82-13.9)	11.6 (7.72-16.8)	13.0 (8.41-19.2)
2-day	3.41 (2.70-4.27)	4.11 (3.24-5.04)	5.18 (4.11-6.44)	6.13 (4.80-7.73)	7.50 (5.67-9.70)	8.60 (6.31-11.4)	9.80 (6.99-13.3)	11.1 (7.72-15.5)	13.1 (8.74-18.7)	14.7 (9.54-21.5)
3-day	3.73 (2.96-4.64)	4.48 (3.56-5.47)	5.65 (4.50-6.98)	6.66 (5.24-8.36)	8.12 (6.16-10.4)	9.28 (6.83-12.2)	10.5 (7.54-14.2)	12.0 (8.32-16.5)	14.0 (9.40-20.0)	15.8 (10.3-22.9)
4-day	3.97 (3.16-4.92)	4.76 (3.81-5.80)	6.01 (4.81-7.40)	7.08 (5.59-8.85)	8.62 (6.55-11.0)	9.83 (7.26-12.9)	11.1 (8.00-14.9)	12.6 (8.81-17.3)	14.8 (9.94-20.9)	16.6 (10.8-24.0)
7-day	4.50 (3.61-5.54)	5.40 (4.35-6.53)	6.81 (5.49-8.32)	8.02 (6.37-9.94)	9.75 (7.46-12.4)	11.1 (8.24-14.4)	12.6 (9.06-16.7)	14.2 (9.95-19.3)	16.6 (11.2-23.2)	18.5 (12.1-26.4)
10-day	4.95 (3.98-6.05)	5.92 (4.79-7.13)	7.46 (6.04-9.06)	8.78 (7.00-10.8)	10.6 (8.18-13.4)	12.1 (9.03-15.7)	13.7 (9.91-18.1)	15.5 (10.9-20.9)	18.0 (12.1-25.0)	20.0 (13.1-28.4)
20-day	6.28 (5.10-7.61)	7.45 (6.08-8.90)	9.30 (7.59-11.2)	10.9 (8.75-13.3)	13.1 (10.2-16.4)	14.9 (11.2-19.0)	16.8 (12.2-21.9)	18.9 (13.3-25.1)	21.8 (14.8-29.9)	24.2 (16.0-33.9)
30-day	7.40 (6.03-8.90)	8.72 (7.15-10.4)	10.8 (8.88-13.0)	12.6 (10.2-15.3)	15.2 (11.8-18.8)	17.2 (12.9-21.8)	19.3 (14.1-25.0)	21.6 (15.3-28.6)	24.9 (17.0-34.0)	27.6 (18.3-38.4)
45-day	9.00 (7.38-10.8)	10.6 (8.70-12.5)	13.0 (10.7-15.5)	15.2 (12.3-18.3)	18.1 (14.2-22.4)	20.5 (15.5-25.8)	23.0 (16.9-29.6)	25.7 (18.3-33.8)	29.5 (20.2-39.9)	32.6 (21.6-44.9)
60-day	10.4 (8.59-12.4)	12.2 (10.1-14.4)	15.0 (12.4-17.8)	17.4 (14.2-20.9)	20.8 (16.3-25.6)	23.5 (17.8-29.5)	26.3 (19.4-33.7)	29.4 (20.9-38.4)	33.6 (23.0-45.2)	37.0 (24.6-50.7)

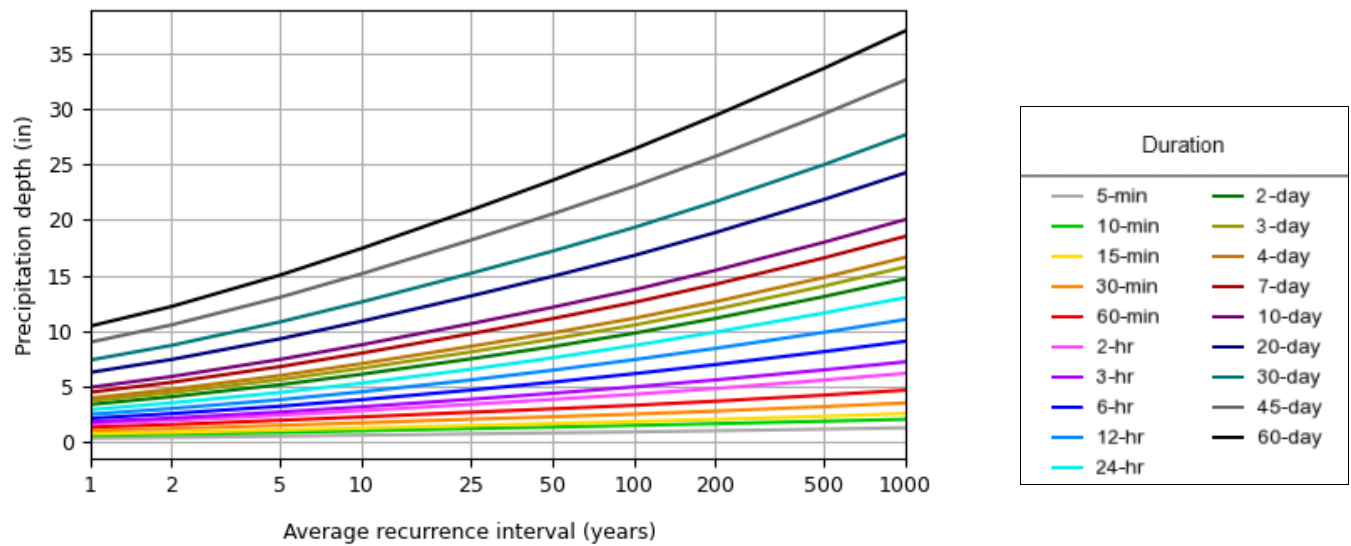
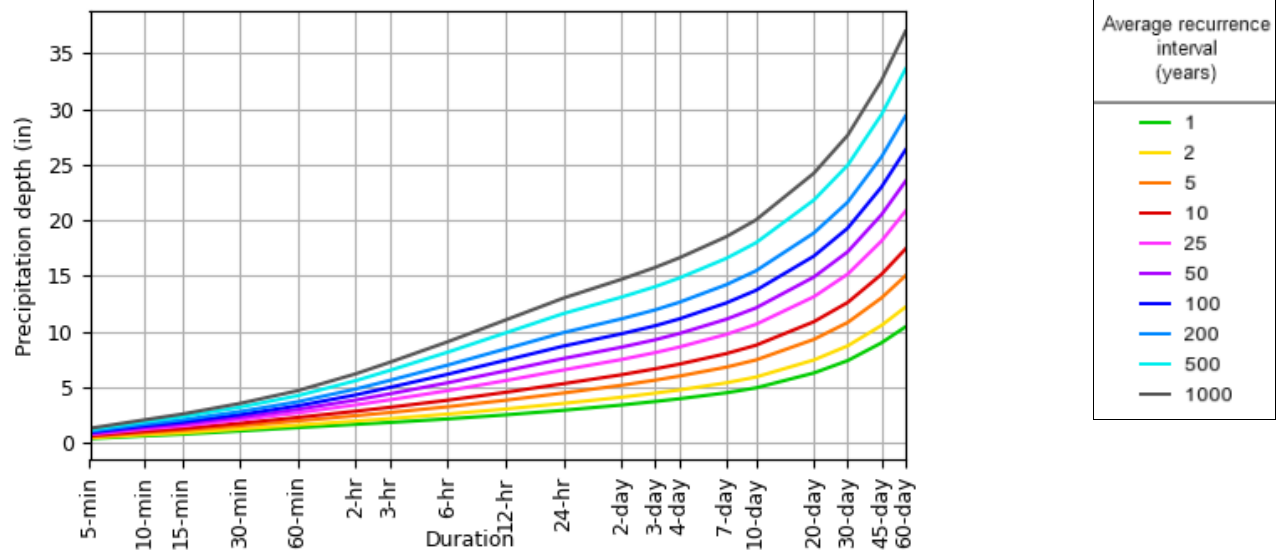
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average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

[Back to Top](#)

PF graphical

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

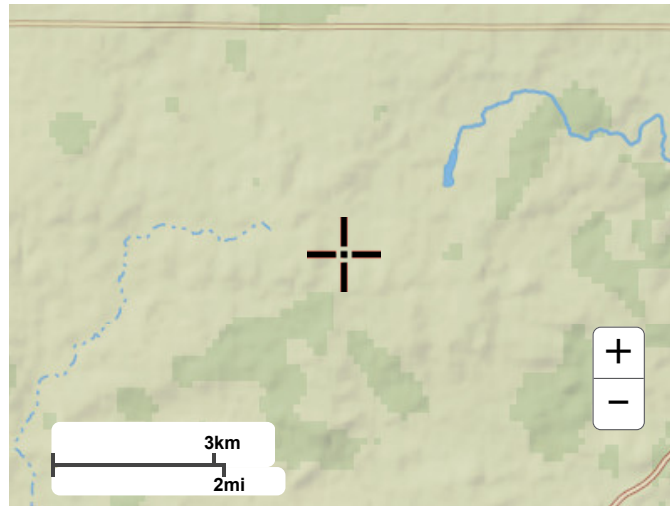
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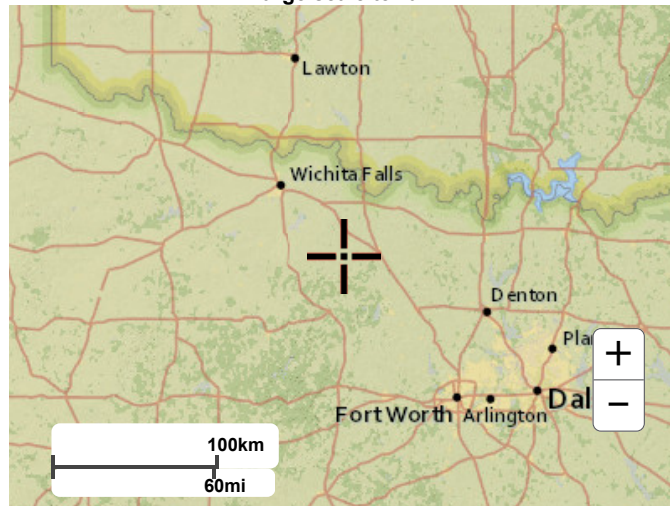
NOAA Atlas 14, Volume 11, Version 2

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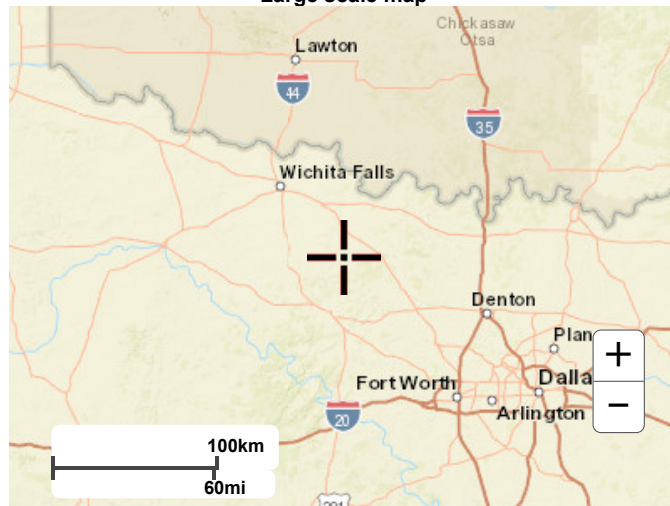
[Back to Top](#)**Maps & aerials****Small scale terrain**



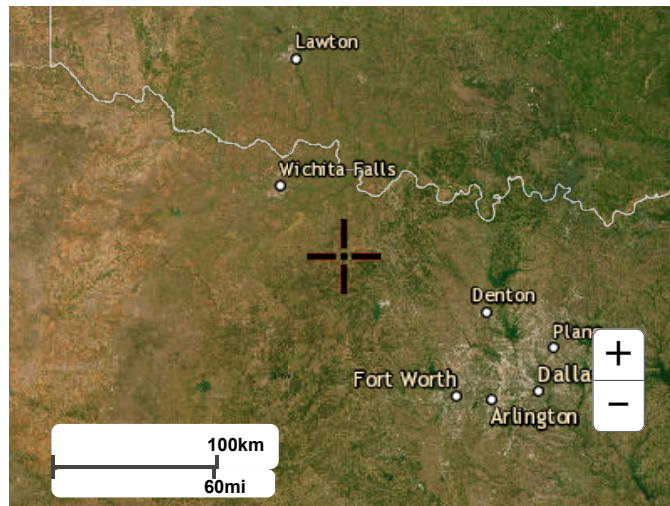
Large scale terrain



Large scale map



Large scale aerial

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Appendix C

HY-8 Results

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 12.60

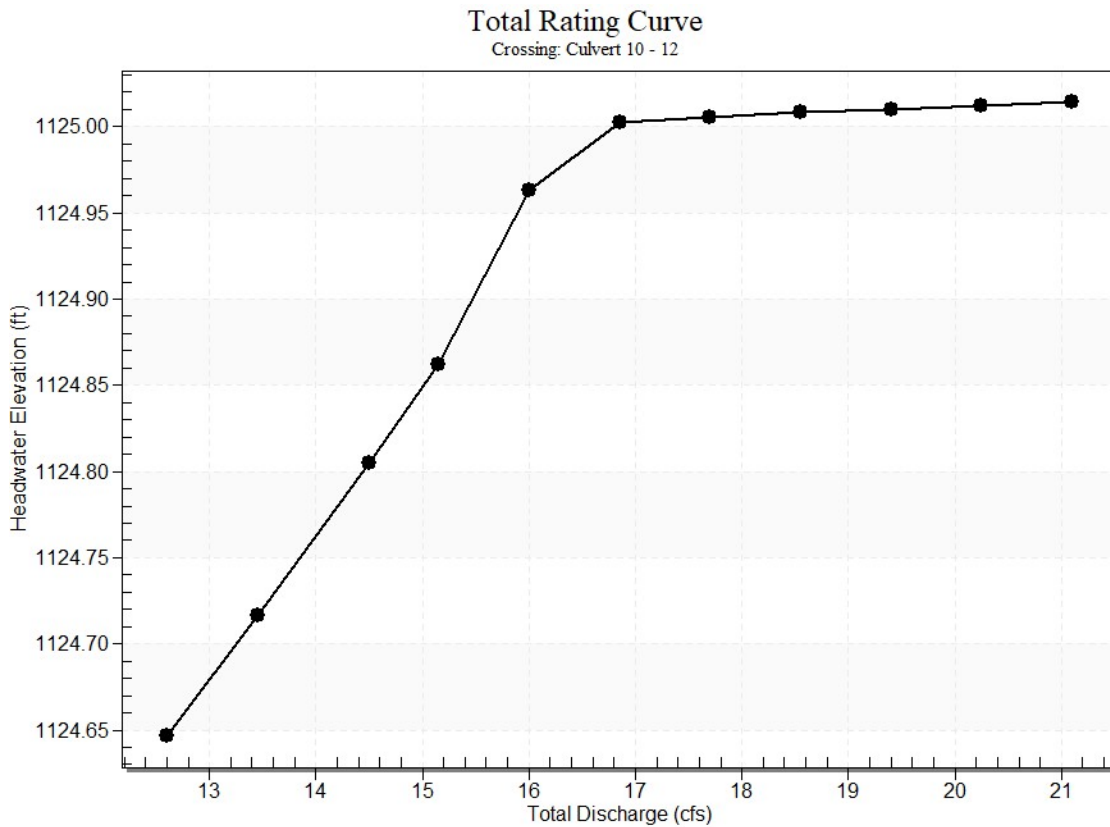
Design Flow: 14.50

Maximum Flow: 21.10

Table 1 - Summary of Culvert Flows at Crossing: Culvert 10 - 12

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 10-12 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1124.65	12.60	12.60	0.00	1
1124.72	13.45	13.45	0.00	1
1124.80	14.50	14.50	0.00	1
1124.86	15.15	15.15	0.00	1
1124.96	16.00	16.00	0.00	1
1125.00	16.85	16.30	0.45	25
1125.01	17.70	16.32	1.24	4
1125.01	18.55	16.34	2.13	4
1125.01	19.40	16.36	2.91	3
1125.01	20.25	16.37	3.76	3
1125.01	21.10	16.39	4.62	3
1125.00	16.28	16.28	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 10 - 12



Culvert Data: Culvert 10-12

Table 2 - Culvert Summary Table: Culvert 10-12

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
12.60	12.60	1124.65	1.57	1.647	7-M2c	1.07	0.97	0.97	0.72	5.21	3.32
13.45	13.45	1124.72	1.66	1.716	7-M2c	1.13	1.00	1.00	0.74	5.35	3.38
14.50	14.50	1124.80	1.78	1.805	7-M2c	1.21	1.04	1.04	0.76	5.53	3.45
15.15	15.15	1124.86	1.86	1.862	7-M2c	1.27	1.07	1.07	0.77	5.64	3.49

16.00	16.00	1124.9 6	1.96	1.94 3	7- M2 c	1.50	1.10	1.1 0	0.79	5.78	3.54
16.85	16.30	1125.0 0	2.00	1.97 4	7- M2 c	1.50	1.11	1.1 1	0.81	5.84	3.59
17.70	16.32	1125.0 1	2.01	1.97 6	7- M2 c	1.50	1.11	1.1 1	0.82	5.84	3.63
18.55	16.34	1125.0 1	2.01	1.97 8	7- M2 c	1.50	1.11	1.1 1	0.84	5.84	3.68
19.40	16.36	1125.0 1	2.01	1.98 0	7- M2 c	1.50	1.11	1.1 1	0.86	5.85	3.72
20.25	16.37	1125.0 1	2.01	1.98 1	7- M2 c	1.50	1.11	1.1 1	0.87	5.85	3.75
21.10	16.39	1125.0 1	2.01	1.98 3	7- M2 c	1.50	1.11	1.1 1	0.89	5.85	3.77

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

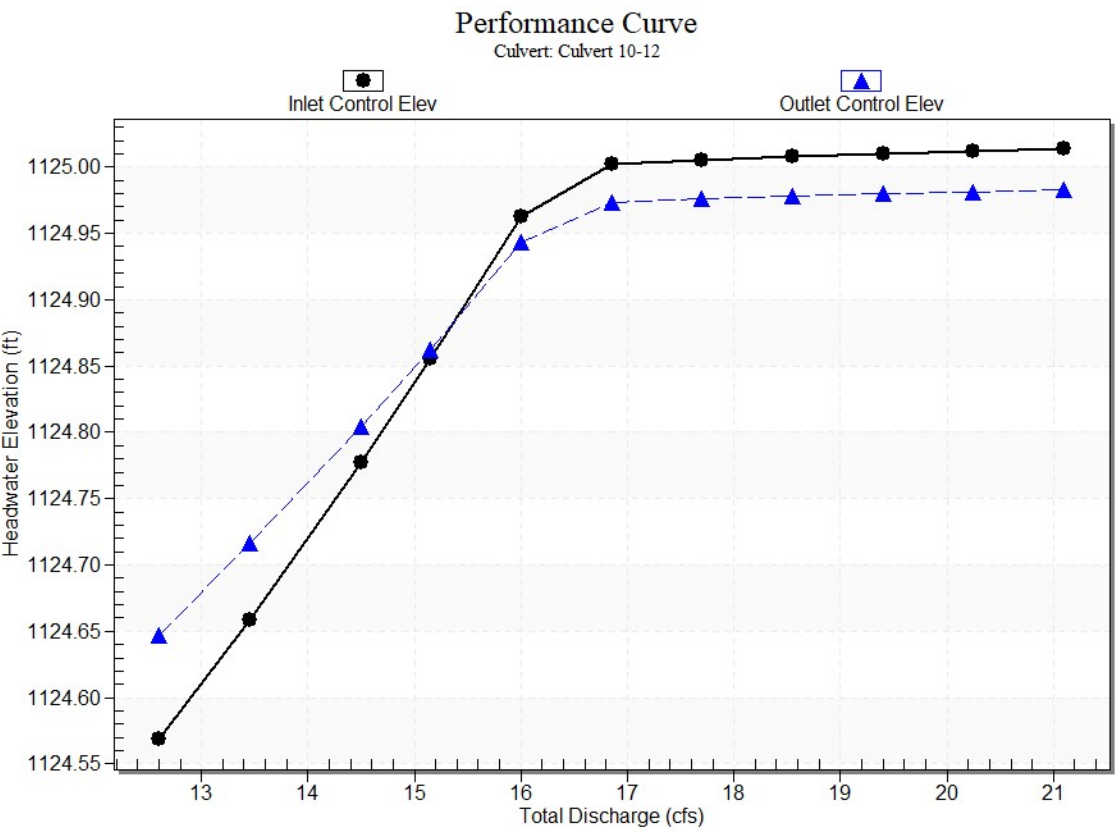
Inlet Elevation (invert): 1123.00 ft,

Outlet Elevation (invert): 1122.50 ft

Culvert Length: 30.00 ft,

Culvert Slope: 0.0167

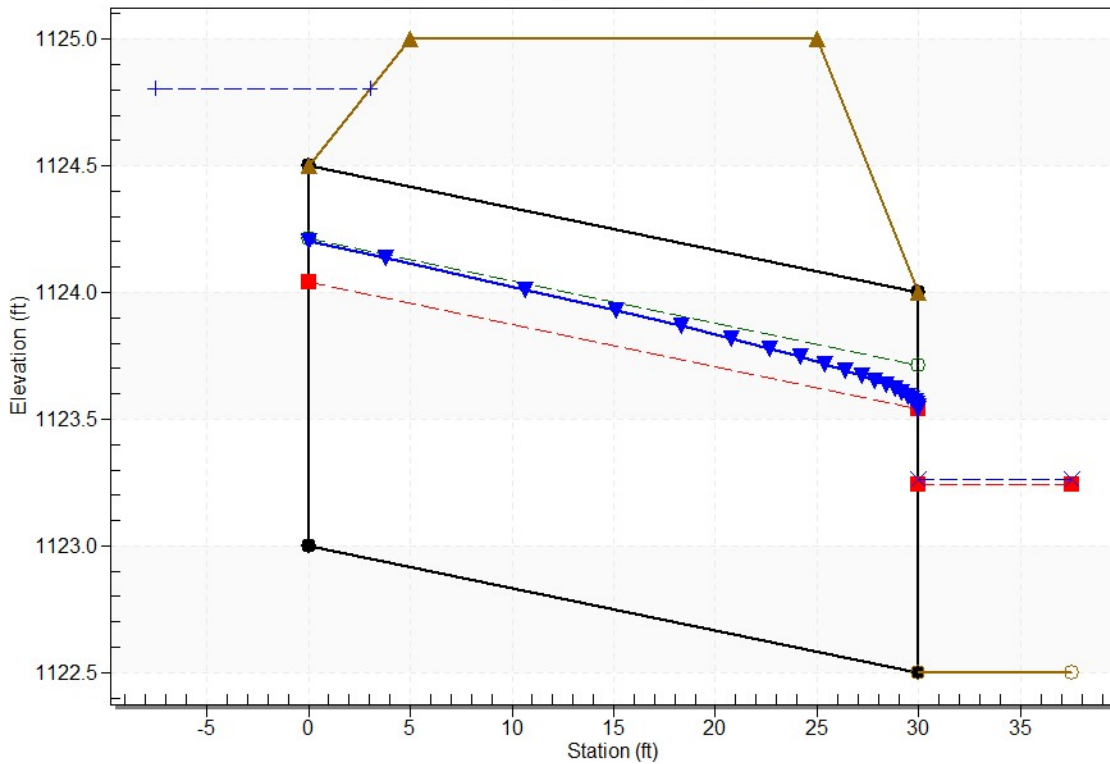
Culvert Performance Curve Plot: Culvert 10-12



Water Surface Profile Plot for Culvert: Culvert 10-12

Crossing - Culvert 10 - 12, Design Discharge - 14.5 cfs

Culvert - Culvert 10-12, Culvert Discharge - 14.5 cfs



Site Data - Culvert 10-12

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1123.00 ft

Outlet Station: 30.00 ft

Outlet Elevation: 1122.50 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 10-12

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope (Ke=0.7)

Inlet Depression: None

Tailwater Data for Crossing: Culvert 10 - 12

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 10 - 12)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
12.60	1123.22	0.72	3.32	0.99	0.94
13.45	1123.24	0.74	3.38	1.01	0.94
14.50	1123.26	0.76	3.45	1.05	0.95
15.15	1123.27	0.77	3.49	1.06	0.95
16.00	1123.29	0.79	3.54	1.09	0.95
16.85	1123.31	0.81	3.59	1.11	0.96
17.70	1123.32	0.82	3.63	1.13	0.96
18.55	1123.34	0.84	3.68	1.15	0.96
19.40	1123.36	0.86	3.72	1.17	0.97
20.25	1123.37	0.87	3.75	1.20	0.97
21.10	1123.39	0.89	3.77	1.22	0.97

Tailwater Channel Data - Culvert 10 - 12

Tailwater Channel Option: Irregular Channel

Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	1125.24	0.0350
2	0.09	1125.24	0.0350
3	2.93	1125.18	0.0350
4	3.13	1125.17	0.0350
5	3.33	1125.15	0.0350
6	6.26	1124.79	0.0350
7	6.41	1124.77	0.0350
8	9.70	1123.93	0.0350
9	9.70	1123.93	0.0350
10	9.80	1123.90	0.0350
11	12.98	1122.87	0.0350
12	12.98	1122.87	0.0350
13	13.04	1122.87	0.0350
14	16.26	1122.50	0.0350
15	19.52	1122.97	0.0350
16	19.54	1122.97	0.0350
17	19.56	1122.97	0.0350
18	19.88	1123.01	0.0350

19	19.88	1123.01	0.0350
20	22.76	1123.35	0.0350
21	22.89	1123.36	0.0350
22	26.11	1123.57	0.0350
23	29.39	1123.70	0.0350
24	29.39	1123.70	0.0350
25	32.48	1123.73	0.0350
26	32.67	1123.73	0.0350
27	32.67	1123.73	0.0350
28	32.67	1123.73	0.0000

Roadway Data for Crossing: Culvert 10 - 12

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 1125.00 ft

Roadway Surface: Gravel

Roadway Top Width: 20.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 70.30

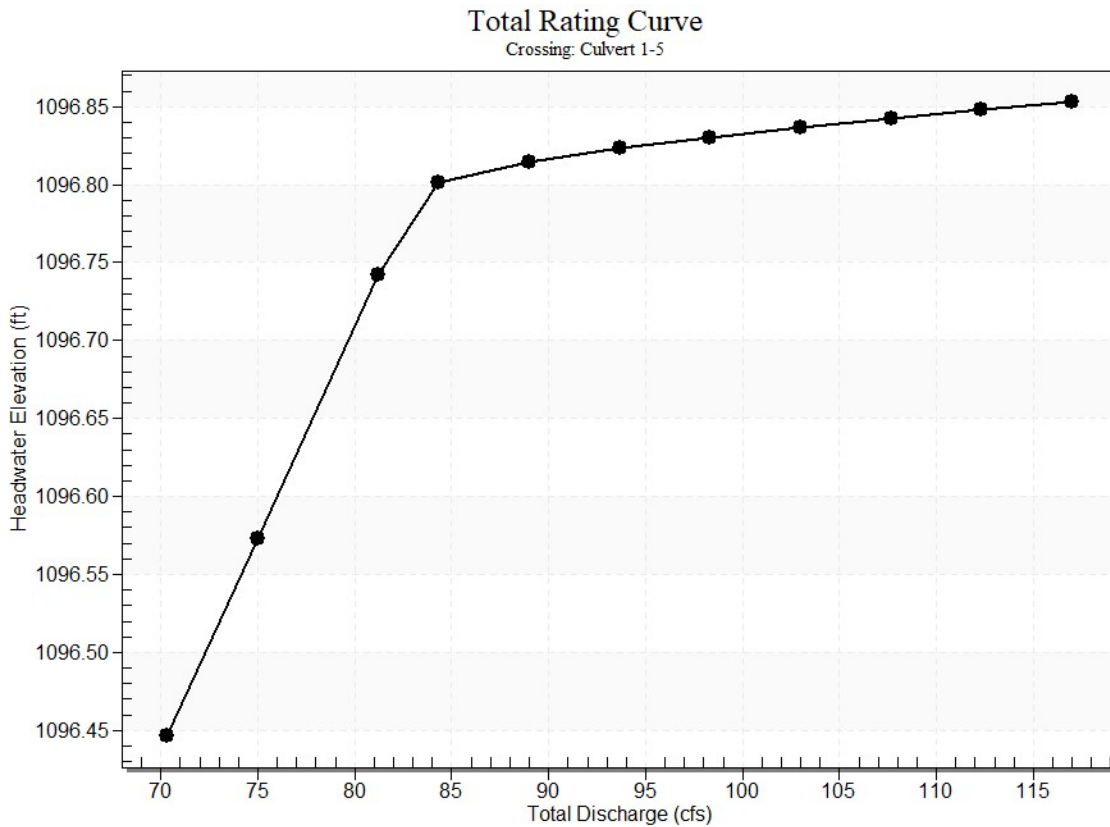
Design Flow: 81.20

Maximum Flow: 117.00

Table 4 - Summary of Culvert Flows at Crossing: Culvert 1-5

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1-5 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1096.45	70.30	70.30	0.00	1
1096.57	74.97	74.97	0.00	1
1096.74	81.20	81.20	0.00	1
1096.80	84.31	83.35	0.17	27
1096.81	88.98	83.82	4.42	5
1096.82	93.65	84.14	8.93	4
1096.83	98.32	84.37	13.03	3
1096.84	102.99	84.60	17.56	3
1096.84	107.66	84.82	22.20	3
1096.85	112.33	85.02	26.84	3
1096.85	117.00	85.20	31.44	3
1096.80	83.30	83.30	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 1-5



Culvert Data: Culvert 1-5

Table 5 - Culvert Summary Table: Culvert 1-5

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
70.30	70.30	1096.45	3.10	3.317	7-M2c	1.97	1.93	1.93	1.56	7.33	5.94
74.97	74.97	1096.57	3.27	3.443	7-M2c	2.07	1.99	1.99	1.72	7.52	5.26
81.20	81.20	1096.74	3.52	3.612	7-M2c	2.20	2.07	2.07	1.79	7.78	5.27
84.31	83.35	1096.80	3.61	3.672	7-M2c	2.25	2.10	2.10	1.82	7.88	5.27

88.98	83.82	1096.8 1	3.63	3.68 5	7- M2 c	2.26	2.11	2.1 1	1.86	7.90	5.28
93.65	84.14	1096.8 2	3.64	3.69 3	7- M2 c	2.27	2.11	2.1 1	1.90	7.91	5.29
98.32	84.37	1096.8 3	3.65	3.70 0	7- M2 c	2.27	2.12	2.1 2	1.93	7.92	5.30
102.9 9	84.60	1096.8 4	3.66	3.70 6	7- M2 c	2.28	2.12	2.1 2	1.96	7.93	5.33
107.6 6	84.82	1096.8 4	3.67	3.71 2	7- M2 c	2.28	2.12	2.1 2	1.99	7.94	5.37
112.3 3	85.02	1096.8 5	3.68	3.71 8	7- M2 c	2.29	2.12	2.1 2	2.02	7.95	5.40
117.0 0	85.20	1096.8 5	3.69	3.72 3	7- M2 c	2.29	2.13	2.1 3	2.31	7.95	3.19

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

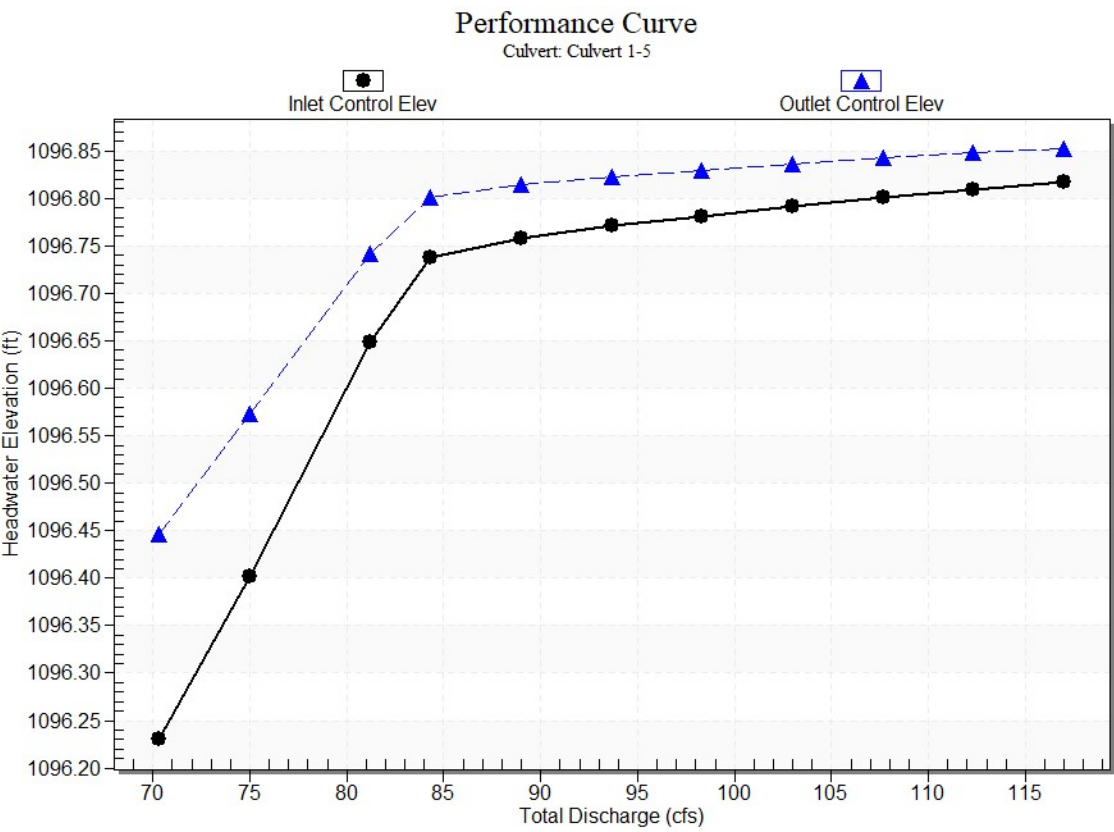
Inlet Elevation (invert): 1093.13 ft,

Outlet Elevation (invert): 1092.73 ft

Culvert Length: 25.00 ft,

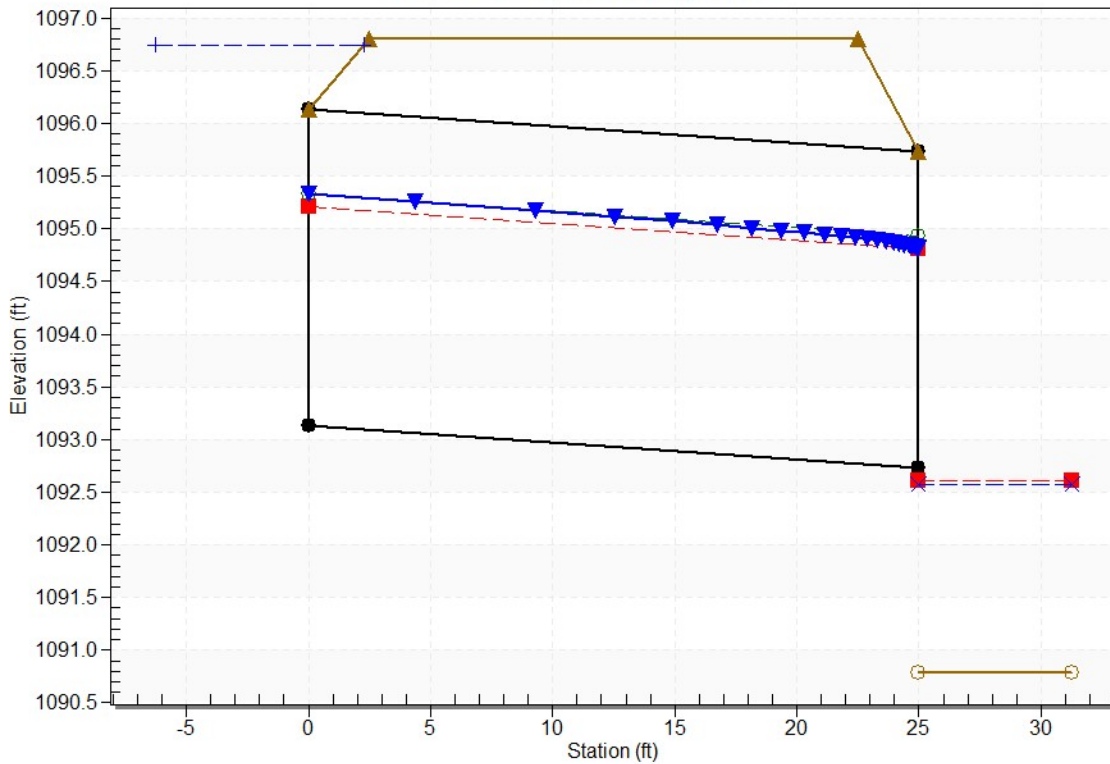
Culvert Slope: 0.0160

Culvert Performance Curve Plot: Culvert 1-5



Water Surface Profile Plot for Culvert: Culvert 1-5
 Crossing - Culvert 1-5, Design Discharge - 81.2 cfs
 Culvert - Culvert 1-5, Culvert Discharge - 81.2 cfs

Culvert - Culvert 1-5, Culvert Discharge - 81.2 cfs



Site Data - Culvert 1-5

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1093.13 ft

Outlet Station: 25.00 ft

Outlet Elevation: 1092.73 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 1-5

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope (Ke=0.7)

Inlet Depression: None

Tailwater Data for Crossing: Culvert 1-5

Table 6 - Downstream Channel Rating Curve (Crossing: Culvert 1-5)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
70.30	1092.35	1.56	5.94	2.14	1.07
74.97	1092.51	1.72	5.26	2.37	1.05
81.20	1092.57	1.79	5.27	2.45	1.05
84.31	1092.60	1.82	5.27	2.49	1.05
88.98	1092.64	1.86	5.28	2.55	1.05
93.65	1092.68	1.90	5.29	2.60	1.05
98.32	1092.72	1.93	5.30	2.65	1.05
102.99	1092.75	1.96	5.33	2.70	1.05
107.66	1092.78	1.99	5.37	2.74	1.05
112.33	1092.81	2.02	5.40	2.78	1.06
117.00	1093.10	2.31	3.19	3.17	0.93

Tailwater Channel Data - Culvert 1-5

Tailwater Channel Option: Irregular Channel

Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	1095.08	0.0350
2	2.12	1095.04	0.0350
3	4.46	1094.99	0.0350
4	7.08	1094.93	0.0350
5	10.93	1094.80	0.0350
6	11.44	1094.78	0.0350
7	12.00	1094.75	0.0350
8	15.33	1094.59	0.0350
9	15.33	1094.59	0.0350
10	16.08	1094.54	0.0350
11	19.73	1094.29	0.0350
12	20.73	1094.23	0.0350
13	21.85	1094.15	0.0350
14	21.85	1094.15	0.0350
15	23.06	1094.07	0.0350
16	24.13	1094.01	0.0350
17	26.77	1093.88	0.0350
18	26.77	1093.88	0.0350

19	27.70	1093.85	0.0350
20	28.54	1093.81	0.0350
21	28.54	1093.81	0.0350
22	30.03	1093.71	0.0350
23	31.70	1093.58	0.0350
24	31.70	1093.58	0.0350
25	32.35	1093.52	0.0350
26	32.94	1093.45	0.0350
27	32.94	1093.45	0.0350
28	34.68	1093.18	0.0350
29	36.62	1092.79	0.0350
30	36.62	1092.79	0.0350
31	37.00	1092.70	0.0350
32	37.34	1092.62	0.0350
33	37.34	1092.62	0.0350
34	39.32	1092.03	0.0350
35	41.54	1091.30	0.0350
36	41.54	1091.30	0.0350
37	41.74	1091.24	0.0350
38	41.74	1091.24	0.0350
39	43.40	1090.96	0.0350
40	43.97	1090.86	0.0350
41	46.14	1090.79	0.0350
42	46.14	1090.79	0.0350
43	46.30	1090.80	0.0350
44	46.47	1090.85	0.0350
45	46.47	1090.85	0.0350
46	48.62	1091.59	0.0350
47	50.54	1092.30	0.0350
48	50.54	1092.30	0.0350
49	50.94	1092.44	0.0350
50	51.39	1092.56	0.0350
51	51.39	1092.56	0.0350
52	53.27	1092.89	0.0350
53	54.95	1093.04	0.0350
54	54.95	1093.04	0.0350
55	55.59	1093.08	0.0350
56	56.31	1093.10	0.0350
57	56.31	1093.10	0.0350
58	57.92	1093.16	0.0350
59	59.35	1093.18	0.0350
60	59.35	1093.18	0.0350
61	60.24	1093.23	0.0350
62	61.24	1093.30	0.0350
63	62.67	1093.21	0.0350
64	63.17	1093.19	0.0350
65	64.55	1093.11	0.0350
66	64.55	1093.11	0.0350
67	65.81	1093.06	0.0350
68	67.83	1092.98	0.0350

69	67.83	1092.98	0.0350
70	68.95	1093.02	0.0350
71	70.05	1093.01	0.0350
72	71.12	1093.03	0.0350
73	71.12	1093.03	0.0350
74	72.09	1093.04	0.0350
75	73.50	1093.04	0.0350
76	74.40	1093.04	0.0350
77	74.40	1093.04	0.0350
78	75.23	1093.01	0.0350
79	76.94	1093.01	0.0350
80	77.69	1092.99	0.0350
81	77.69	1092.99	0.0350
82	78.37	1093.02	0.0350
83	80.39	1093.14	0.0350
84	80.97	1093.16	0.0350
85	80.97	1093.16	0.0350
86	81.51	1093.17	0.0350
87	83.83	1093.23	0.0350
88	84.26	1093.24	0.0350
89	84.26	1093.24	0.0350
90	84.65	1093.23	0.0350
91	87.27	1093.16	0.0350
92	87.79	1093.15	0.0350
93	90.72	1093.04	0.0350
94	90.83	1093.04	0.0350
95	90.83	1093.04	0.0350
96	90.93	1093.04	0.0350
97	93.14	1093.05	0.0350
98	93.14	1093.05	0.0350
99	94.07	1093.05	0.0350
100	94.11	1093.05	0.0350
101	94.11	1093.05	0.0350
102	94.16	1093.05	0.0350
103	97.21	1093.22	0.0350
104	97.40	1093.22	0.0350
105	97.40	1093.22	0.0350
106	97.60	1093.23	0.0350
107	100.68	1093.28	0.0350
108	100.68	1093.28	0.0350
109	101.05	1093.27	0.0350
110	103.49	1093.16	0.0350
111	103.97	1093.15	0.0350
112	103.97	1093.15	0.0350
113	104.49	1093.13	0.0350
114	106.63	1093.03	0.0350
115	107.25	1093.01	0.0350
116	107.25	1093.01	0.0350
117	107.94	1092.99	0.0350
118	109.77	1092.95	0.0350

119	110.54	1092.93	0.0350
120	110.54	1092.93	0.0350
121	111.38	1092.92	0.0350
122	112.91	1092.89	0.0350
123	113.82	1092.87	0.0350
124	114.82	1092.88	0.0350
125	116.05	1092.88	0.0350
126	117.11	1092.89	0.0350
127	117.11	1092.89	0.0350
128	118.27	1092.89	0.0350
129	119.19	1092.89	0.0350
130	120.39	1092.89	0.0350
131	120.39	1092.89	0.0350
132	121.71	1092.92	0.0350
133	122.33	1092.94	0.0350
134	123.68	1092.97	0.0350
135	123.68	1092.97	0.0350
136	125.15	1093.00	0.0350
137	125.47	1093.00	0.0350
138	126.96	1093.02	0.0350
139	126.96	1093.02	0.0350
140	128.60	1093.00	0.0350
141	128.61	1093.00	0.0350
142	130.25	1092.97	0.0350
143	130.25	1092.97	0.0350
144	131.75	1092.95	0.0350
145	133.53	1092.93	0.0350
146	133.53	1092.93	0.0350
147	134.89	1092.94	0.0350
148	135.49	1092.94	0.0350
149	136.82	1092.95	0.0350
150	136.82	1092.95	0.0350
151	138.03	1092.97	0.0350
152	138.93	1092.98	0.0350
153	140.10	1093.00	0.0350
154	140.10	1093.00	0.0350
155	141.17	1093.00	0.0350
156	142.37	1092.99	0.0350
157	143.39	1092.99	0.0350
158	143.39	1092.99	0.0350
159	144.31	1093.00	0.0350
160	145.82	1092.99	0.0350
161	146.67	1093.00	0.0350
162	150.59	1093.08	0.0350
163	152.70	1093.15	0.0350
164	153.24	1093.17	0.0350
165	153.24	1093.17	0.0350
166	153.74	1093.19	0.0350
167	156.15	1093.29	0.0350
168	156.53	1093.31	0.0350

169	156.88	1093.32	0.0350
170	159.59	1093.35	0.0350
171	159.81	1093.36	0.0350
172	159.81	1093.36	0.0350
173	160.01	1093.35	0.0350
174	163.03	1093.31	0.0350
175	163.10	1093.31	0.0350
176	163.10	1093.31	0.0350
177	163.16	1093.31	0.0350
178	164.40	1093.32	0.0350
179	164.40	1093.32	0.0350
180	166.30	1093.34	0.0350
181	166.38	1093.34	0.0350
182	166.38	1093.34	0.0350
183	169.67	1093.35	0.0350
184	169.67	1093.35	0.0350
185	169.92	1093.33	0.0350
186	172.95	1092.99	0.0350
187	172.95	1092.99	0.0350
188	173.37	1092.92	0.0350
189	175.72	1092.59	0.0350
190	176.24	1092.51	0.0350
191	176.24	1092.51	0.0350
192	176.81	1092.49	0.0350
193	179.52	1092.39	0.0350
194	179.52	1092.39	0.0350
195	180.25	1092.46	0.0350
196	182.00	1092.64	0.0350
197	182.81	1092.72	0.0350
198	182.81	1092.72	0.0350
199	183.70	1092.87	0.0350
200	185.14	1093.12	0.0350
201	186.09	1093.28	0.0350
202	186.09	1093.28	0.0350
203	187.14	1093.33	0.0350
204	188.28	1093.36	0.0350
205	189.38	1093.41	0.0350
206	190.59	1093.41	0.0350
207	192.66	1093.40	0.0350
208	192.66	1093.40	0.0350
209	195.95	1093.49	0.0350
210	195.95	1093.49	0.0350
211	197.47	1093.51	0.0350
212	197.70	1093.51	0.0350
213	199.23	1093.53	0.0350
214	199.23	1093.53	0.0350
215	200.84	1093.52	0.0350
216	200.92	1093.52	0.0350
217	202.52	1093.50	0.0350
218	202.52	1093.50	0.0350

219	203.98	1093.48	0.0350
220	204.36	1093.47	0.0350
221	205.80	1093.45	0.0350
222	207.12	1093.43	0.0350
223	207.80	1093.42	0.0350
224	209.09	1093.40	0.0350
225	209.09	1093.40	0.0350
226	210.26	1093.36	0.0350
227	211.25	1093.32	0.0350
228	212.37	1093.28	0.0350
229	212.37	1093.28	0.0350
230	213.12	1093.28	0.0000

Roadway Data for Crossing: Culvert 1-5

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 1096.80 ft

Roadway Surface: Gravel

Roadway Top Width: 20.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 12.60

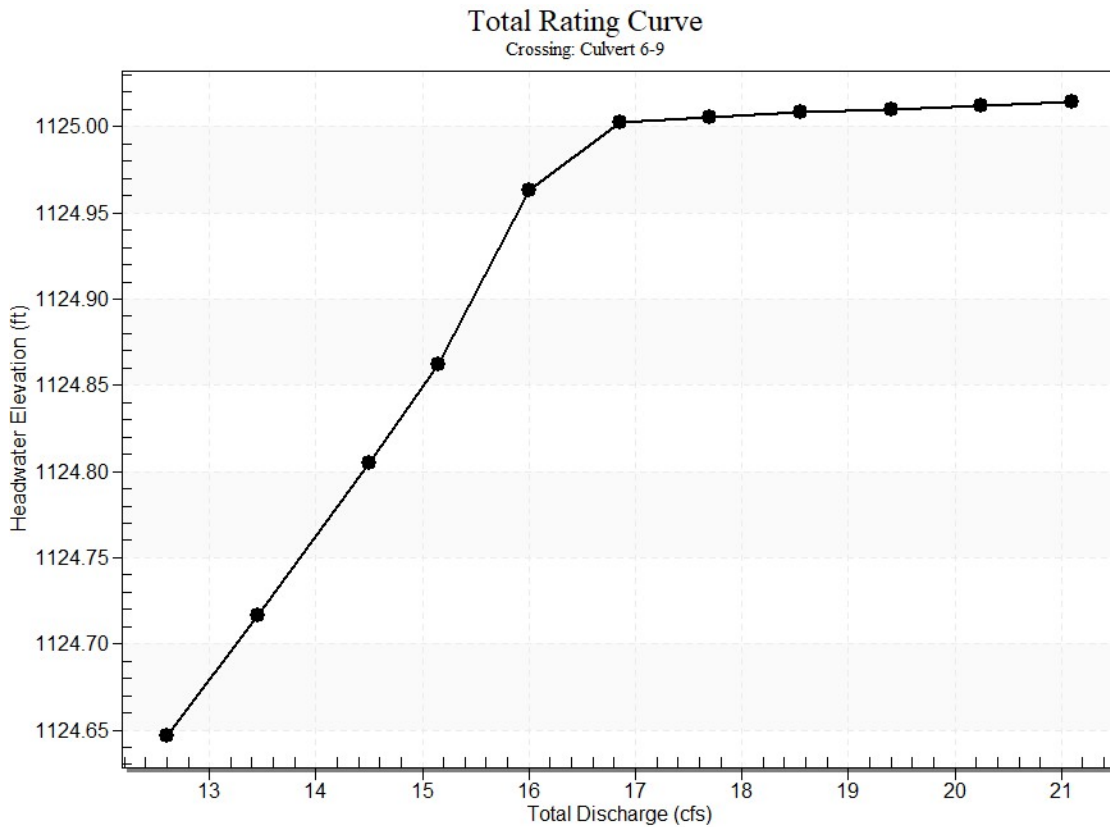
Design Flow: 14.50

Maximum Flow: 21.10

Table 7 - Summary of Culvert Flows at Crossing: Culvert 6-9

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 6-9 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1124.65	12.60	12.60	0.00	1
1124.72	13.45	13.45	0.00	1
1124.80	14.50	14.50	0.00	1
1124.86	15.15	15.15	0.00	1
1124.96	16.00	16.00	0.00	1
1125.00	16.85	16.30	0.45	25
1125.01	17.70	16.32	1.24	4
1125.01	18.55	16.34	2.13	4
1125.01	19.40	16.36	2.91	3
1125.01	20.25	16.37	3.76	3
1125.01	21.10	16.39	4.62	3
1125.00	16.28	16.28	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 6-9



Culvert Data: Culvert 6-9

Table 8 - Culvert Summary Table: Culvert 6-9

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
12.60	12.60	1124.65	1.57	1.647	7-M2c	1.07	0.97	0.97	0.72	5.21	3.32
13.45	13.45	1124.72	1.66	1.716	7-M2c	1.13	1.00	1.00	0.74	5.35	3.38
14.50	14.50	1124.80	1.78	1.805	7-M2c	1.21	1.04	1.04	0.76	5.53	3.45
15.15	15.15	1124.86	1.86	1.862	7-M2c	1.27	1.07	1.07	0.77	5.64	3.49

16.00	16.00	1124.9 6	1.96	1.94 3	7- M2 c	1.50	1.10	1.1 0	0.79	5.78	3.54
16.85	16.30	1125.0 0	2.00	1.97 4	7- M2 c	1.50	1.11	1.1 1	0.81	5.84	3.59
17.70	16.32	1125.0 1	2.01	1.97 6	7- M2 c	1.50	1.11	1.1 1	0.82	5.84	3.63
18.55	16.34	1125.0 1	2.01	1.97 8	7- M2 c	1.50	1.11	1.1 1	0.84	5.84	3.68
19.40	16.36	1125.0 1	2.01	1.98 0	7- M2 c	1.50	1.11	1.1 1	0.86	5.85	3.72
20.25	16.37	1125.0 1	2.01	1.98 1	7- M2 c	1.50	1.11	1.1 1	0.87	5.85	3.75
21.10	16.39	1125.0 1	2.01	1.98 3	7- M2 c	1.50	1.11	1.1 1	0.89	5.85	3.77

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

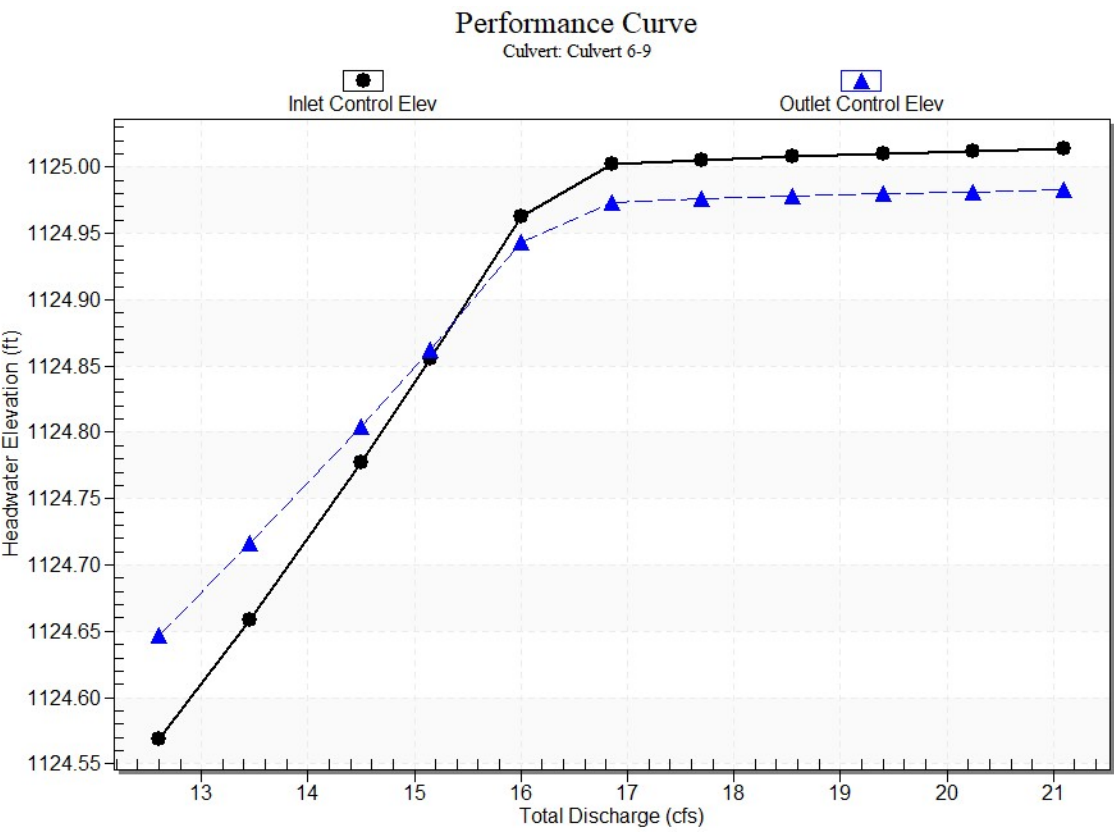
Inlet Elevation (invert): 1123.00 ft,

Outlet Elevation (invert): 1122.50 ft

Culvert Length: 30.00 ft,

Culvert Slope: 0.0167

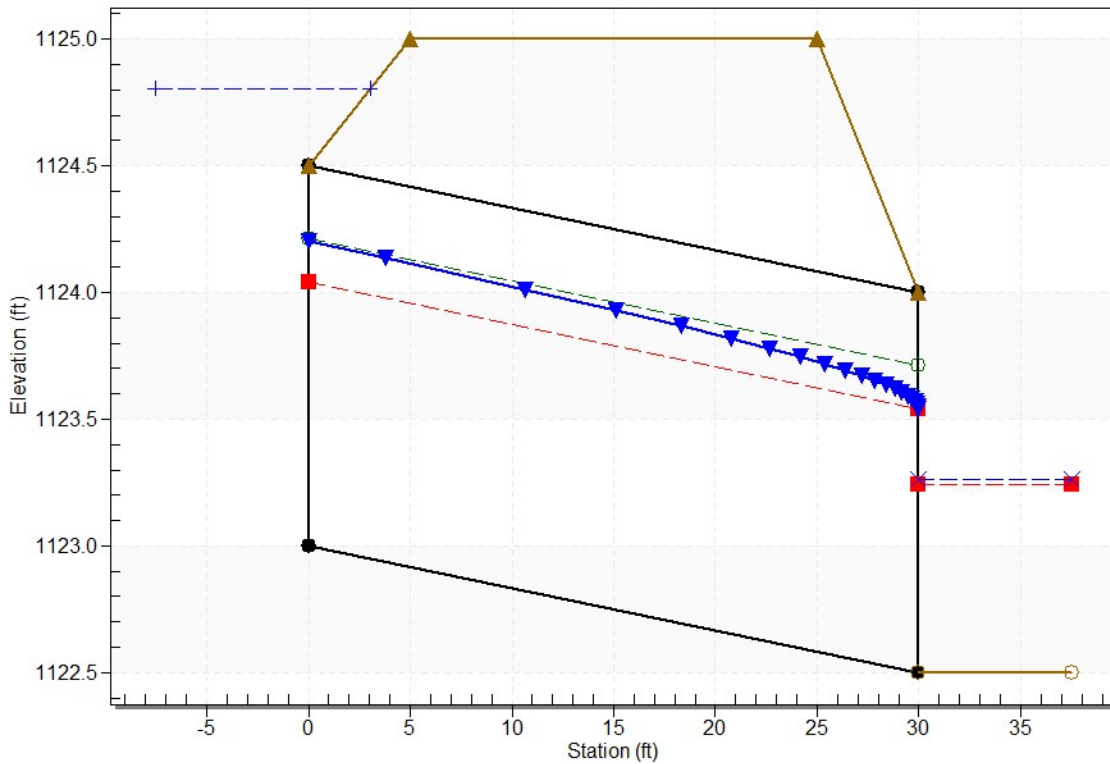
Culvert Performance Curve Plot: Culvert 6-9



Water Surface Profile Plot for Culvert: Culvert 6-9

Crossing - Culvert 6-9, Design Discharge - 14.5 cfs

Culvert - Culvert 6-9, Culvert Discharge - 14.5 cfs



Site Data - Culvert 6-9

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1123.00 ft

Outlet Station: 30.00 ft

Outlet Elevation: 1122.50 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 6-9

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope (Ke=0.7)

Inlet Depression: None

Tailwater Data for Crossing: Culvert 6-9

Table 9 - Downstream Channel Rating Curve (Crossing: Culvert 6-9)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
12.60	1123.22	0.72	3.32	0.99	0.94
13.45	1123.24	0.74	3.38	1.01	0.94
14.50	1123.26	0.76	3.45	1.05	0.95
15.15	1123.27	0.77	3.49	1.06	0.95
16.00	1123.29	0.79	3.54	1.09	0.95
16.85	1123.31	0.81	3.59	1.11	0.96
17.70	1123.32	0.82	3.63	1.13	0.96
18.55	1123.34	0.84	3.68	1.15	0.96
19.40	1123.36	0.86	3.72	1.17	0.97
20.25	1123.37	0.87	3.75	1.20	0.97
21.10	1123.39	0.89	3.77	1.22	0.97

Tailwater Channel Data - Culvert 6-9

Tailwater Channel Option: Irregular Channel

Channel Slope: Irregular Channel

User Defined Channel Cross-Section

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	1125.24	0.0350
2	0.09	1125.24	0.0350
3	2.93	1125.18	0.0350
4	3.13	1125.17	0.0350
5	3.33	1125.15	0.0350
6	6.26	1124.79	0.0350
7	6.41	1124.77	0.0350
8	9.70	1123.93	0.0350
9	9.70	1123.93	0.0350
10	9.80	1123.90	0.0350
11	12.98	1122.87	0.0350
12	12.98	1122.87	0.0350
13	13.04	1122.87	0.0350
14	16.26	1122.50	0.0350
15	19.52	1122.97	0.0350
16	19.54	1122.97	0.0350
17	19.56	1122.97	0.0350
18	19.88	1123.01	0.0350

19	19.88	1123.01	0.0350
20	22.76	1123.35	0.0350
21	22.89	1123.36	0.0350
22	26.11	1123.57	0.0350
23	29.39	1123.70	0.0350
24	29.39	1123.70	0.0350
25	32.48	1123.73	0.0350
26	32.67	1123.73	0.0350
27	32.67	1123.73	0.0350
28	32.67	1123.73	0.0000

Roadway Data for Crossing: Culvert 6-9

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 1125.00 ft

Roadway Surface: Gravel

Roadway Top Width: 20.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 1.40

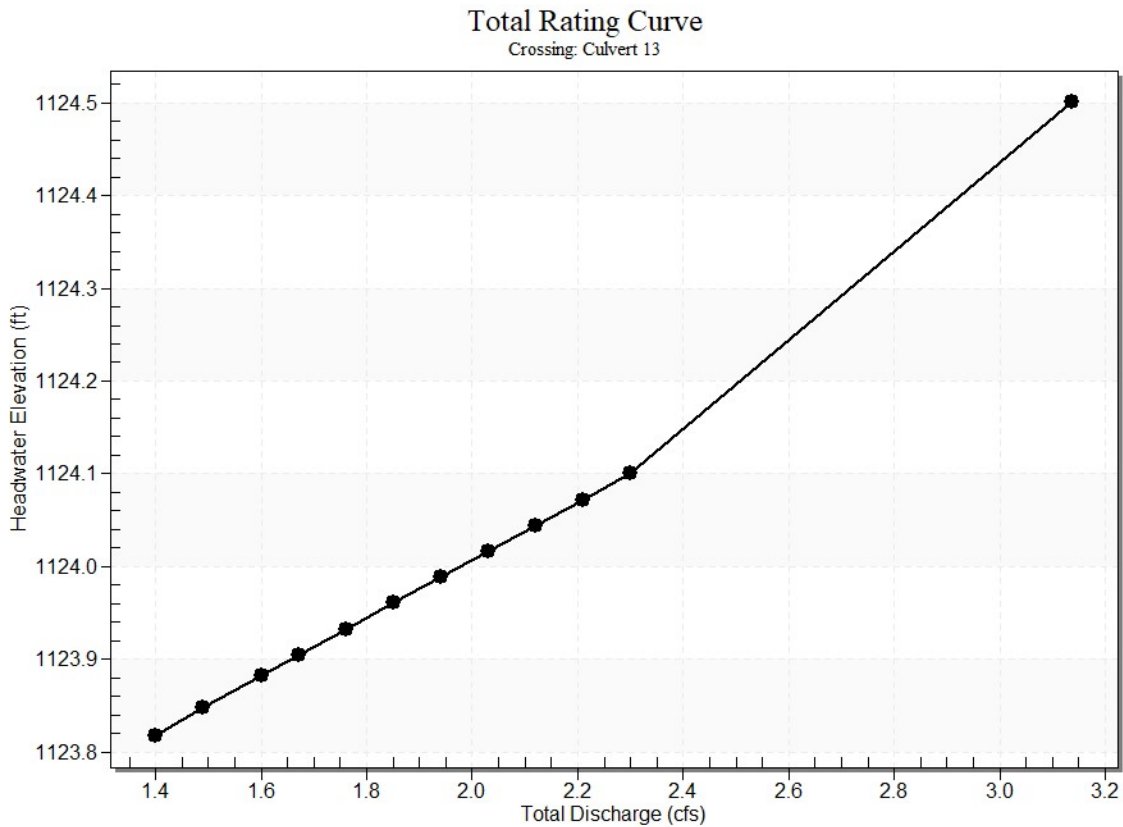
Design Flow: 1.60

Maximum Flow: 2.30

Table 10 - Summary of Culvert Flows at Crossing: Culvert 13

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 13 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1123.82	1.40	1.40	0.00	1
1123.85	1.49	1.49	0.00	1
1123.88	1.60	1.60	0.00	1
1123.90	1.67	1.67	0.00	1
1123.93	1.76	1.76	0.00	1
1123.96	1.85	1.85	0.00	1
1123.99	1.94	1.94	0.00	1
1124.02	2.03	2.03	0.00	1
1124.04	2.12	2.12	0.00	1
1124.07	2.21	2.21	0.00	1
1124.10	2.30	2.30	0.00	1
1124.50	3.08	3.08	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 13



Culvert Data: Culvert 13

Table 11 - Culvert Summary Table: Culvert 13

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
1.40	1.40	1123.82	0.75	0.818	2-M2c	0.54	0.50	0.50	0.45	3.56	2.26
1.49	1.49	1123.85	0.78	0.847	2-M2c	0.56	0.52	0.52	0.46	3.63	2.30
1.60	1.60	1123.88	0.81	0.883	2-M2c	0.58	0.54	0.54	0.48	3.72	2.34
1.67	1.67	1123.90	0.84	0.905	2-M2c	0.60	0.55	0.55	0.49	3.78	2.36

1.76	1.76	1123.9 3	0.86	0.93 3	2- M2 c	0.62	0.56	0.5 6	0.49	3.85	2.40
1.85	1.85	1123.9 6	0.89	0.96 1	2- M2 c	0.64	0.58	0.5 8	0.50	3.92	2.43
1.94	1.94	1123.9 9	0.92	0.98 8	2- M2 c	0.66	0.59	0.5 9	0.51	3.99	2.46
2.03	2.03	1124.0 2	0.95	1.01 6	7- M2 c	0.68	0.61	0.6 1	0.52	4.06	2.48
2.12	2.12	1124.0 4	0.98	1.04 4	7- M2 c	0.71	0.62	0.6 2	0.53	4.13	2.51
2.21	2.21	1124.0 7	1.02	1.07 2	7- M2 c	0.73	0.64	0.6 4	0.54	4.20	2.54
2.30	2.30	1124.1 0	1.05	1.10 0	7- M2 c	0.76	0.65	0.6 5	0.55	4.27	2.56

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

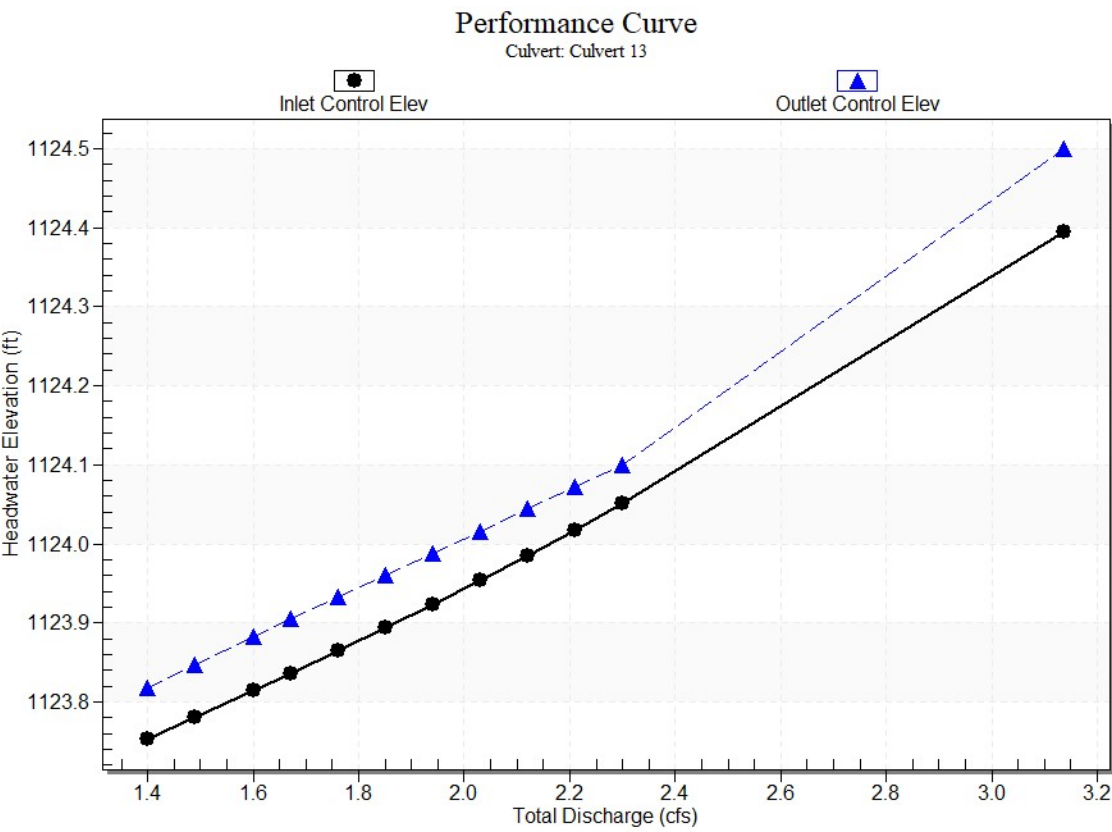
Inlet Elevation (invert): 1123.00 ft,

Outlet Elevation (invert): 1122.50 ft

Culvert Length: 30.00 ft,

Culvert Slope: 0.0167

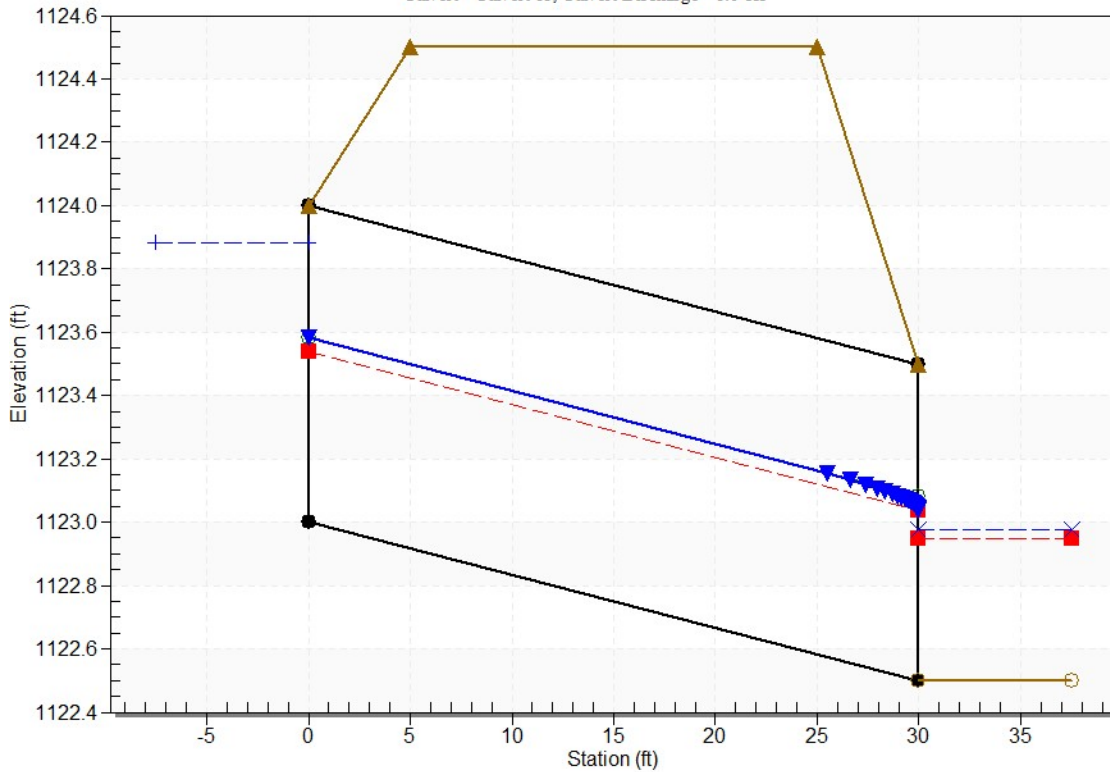
Culvert Performance Curve Plot: Culvert 13



Water Surface Profile Plot for Culvert: Culvert 13

Crossing - Culvert 13, Design Discharge - 1.6 cfs

Culvert - Culvert 13, Culvert Discharge - 1.6 cfs



Site Data - Culvert 13

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1123.00 ft

Outlet Station: 30.00 ft

Outlet Elevation: 1122.50 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 13

Barrel Shape: Circular

Barrel Diameter: 1.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope (Ke=0.7)

Inlet Depression: None

Tailwater Data for Crossing: Culvert 13

Table 12 - Downstream Channel Rating Curve (Crossing: Culvert 13)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
1.40	1122.95	0.45	2.26	0.62	0.84
1.49	1122.96	0.46	2.30	0.64	0.84
1.60	1122.98	0.48	2.34	0.66	0.84
1.67	1122.99	0.49	2.36	0.67	0.85
1.76	1122.99	0.49	2.40	0.68	0.85
1.85	1123.00	0.50	2.43	0.69	0.85
1.94	1123.01	0.51	2.46	0.70	0.85
2.03	1123.02	0.52	2.48	0.72	0.86
2.12	1123.03	0.53	2.51	0.73	0.86
2.21	1123.04	0.54	2.54	0.74	0.86
2.30	1123.05	0.55	2.56	0.75	0.86

Tailwater Channel Data - Culvert 13

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 3.00 (:1)

Channel Slope: 0.0220

Channel Manning's n: 0.0350

Channel Invert Elevation: 1122.50 ft

Roadway Data for Crossing: Culvert 13

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 1124.50 ft

Roadway Surface: Gravel

Roadway Top Width: 20.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.50

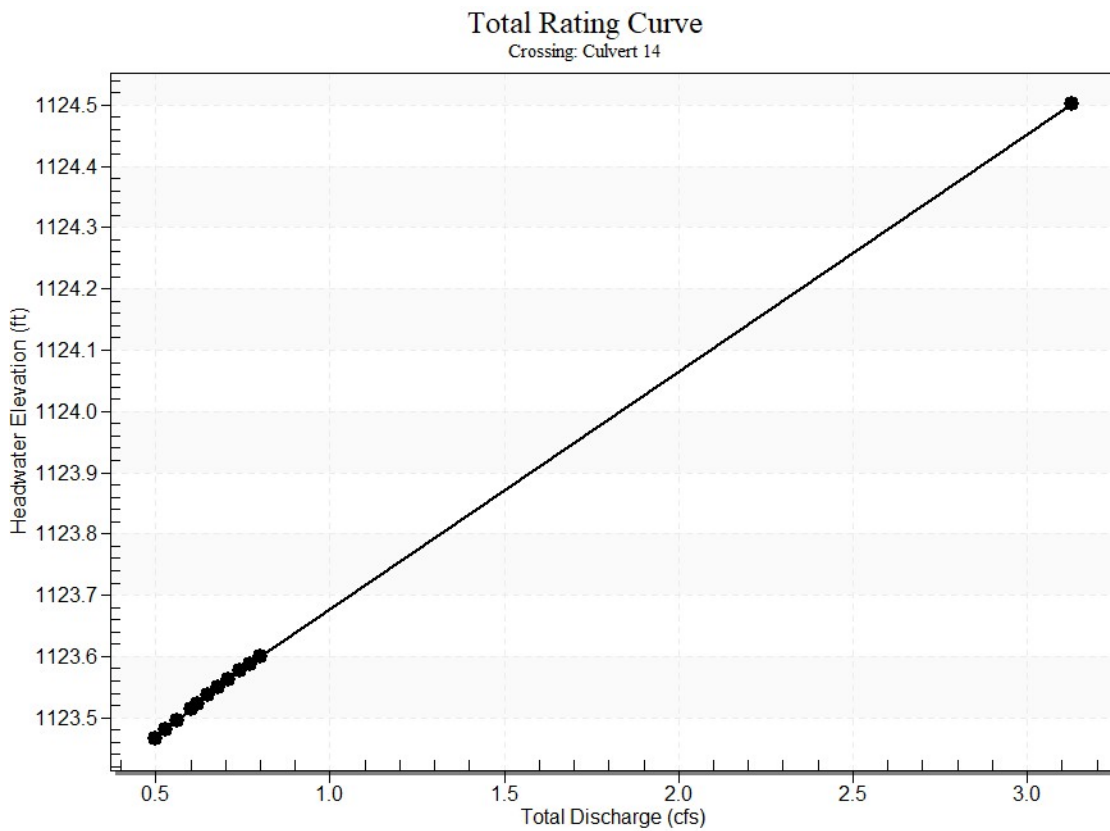
Design Flow: 0.60

Maximum Flow: 0.80

Table 13 - Summary of Culvert Flows at Crossing: Culvert 14

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 14 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1123.47	0.50	0.50	0.00	1
1123.48	0.53	0.53	0.00	1
1123.50	0.56	0.56	0.00	1
1123.51	0.60	0.60	0.00	1
1123.52	0.62	0.62	0.00	1
1123.54	0.65	0.65	0.00	1
1123.55	0.68	0.68	0.00	1
1123.56	0.71	0.71	0.00	1
1123.58	0.74	0.74	0.00	1
1123.59	0.77	0.77	0.00	1
1123.60	0.80	0.80	0.00	1
1124.50	3.07	3.07	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 14



Culvert Data: Culvert 14

Table 14 - Culvert Summary Table: Culvert 14

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.50	0.50	1123.47	0.43	0.466	3-M1t	0.30	0.29	0.31	0.31	2.43	1.75
0.53	0.53	1123.48	0.44	0.481	3-M1t	0.31	0.30	0.32	0.32	2.49	1.78
0.56	0.56	1123.50	0.45	0.496	3-M1t	0.32	0.31	0.32	0.32	2.56	1.80
0.60	0.60	1123.51	0.47	0.514	3-M2t	0.33	0.32	0.33	0.33	2.65	1.83
0.62	0.62	1123.52	0.48	0.523	3-M2t	0.34	0.33	0.33	0.33	2.69	1.85
0.65	0.65	1123.54	0.49	0.537	3-M2t	0.35	0.34	0.34	0.34	2.75	1.87
0.68	0.68	1123.55	0.50	0.550	3-M2t	0.36	0.34	0.35	0.35	2.82	1.89
0.71	0.71	1123.56	0.51	0.563	3-M2t	0.36	0.35	0.35	0.35	2.88	1.91
0.74	0.74	1123.58	0.53	0.576	2-M2c	0.37	0.36	0.36	0.36	2.92	1.93
0.77	0.77	1123.59	0.54	0.588	2-M2c	0.38	0.37	0.37	0.36	2.95	1.95
0.80	0.80	1123.60	0.55	0.601	2-M2c	0.39	0.37	0.37	0.37	2.99	1.97

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

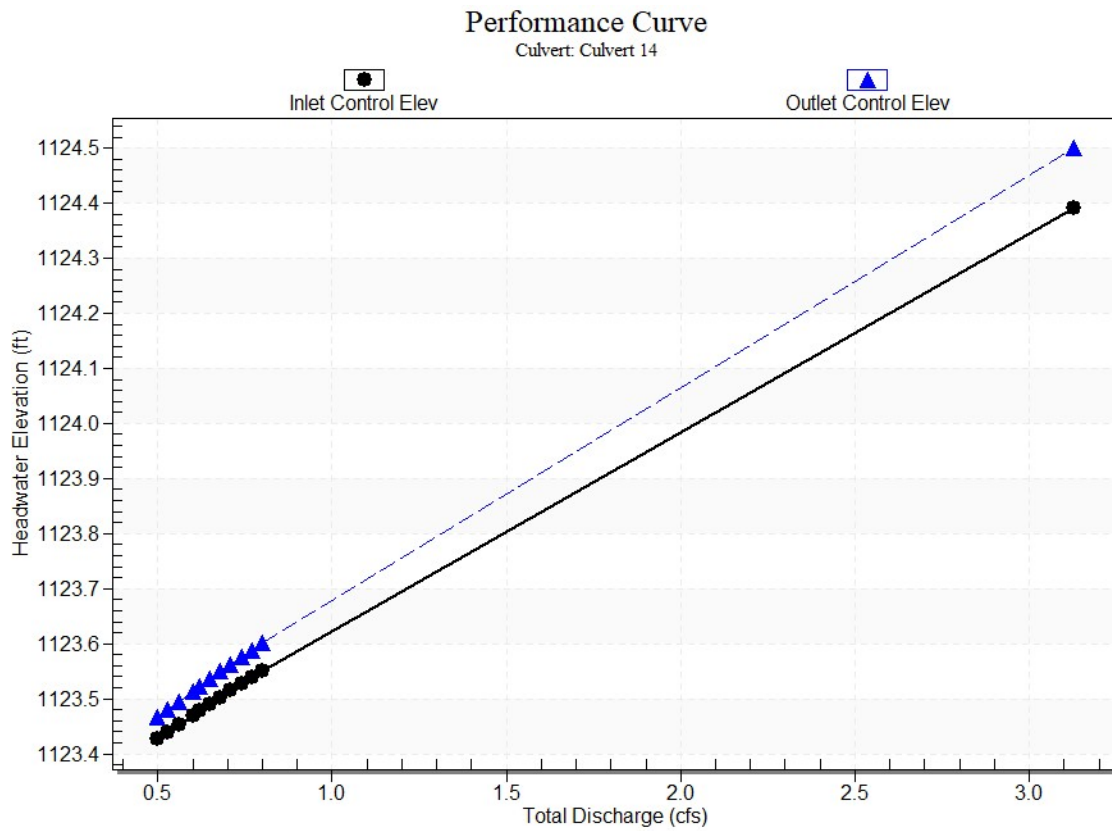
Inlet Elevation (invert): 1123.00 ft,

Outlet Elevation (invert): 1122.50 ft

Culvert Length: 30.00 ft,

Culvert Slope: 0.0167

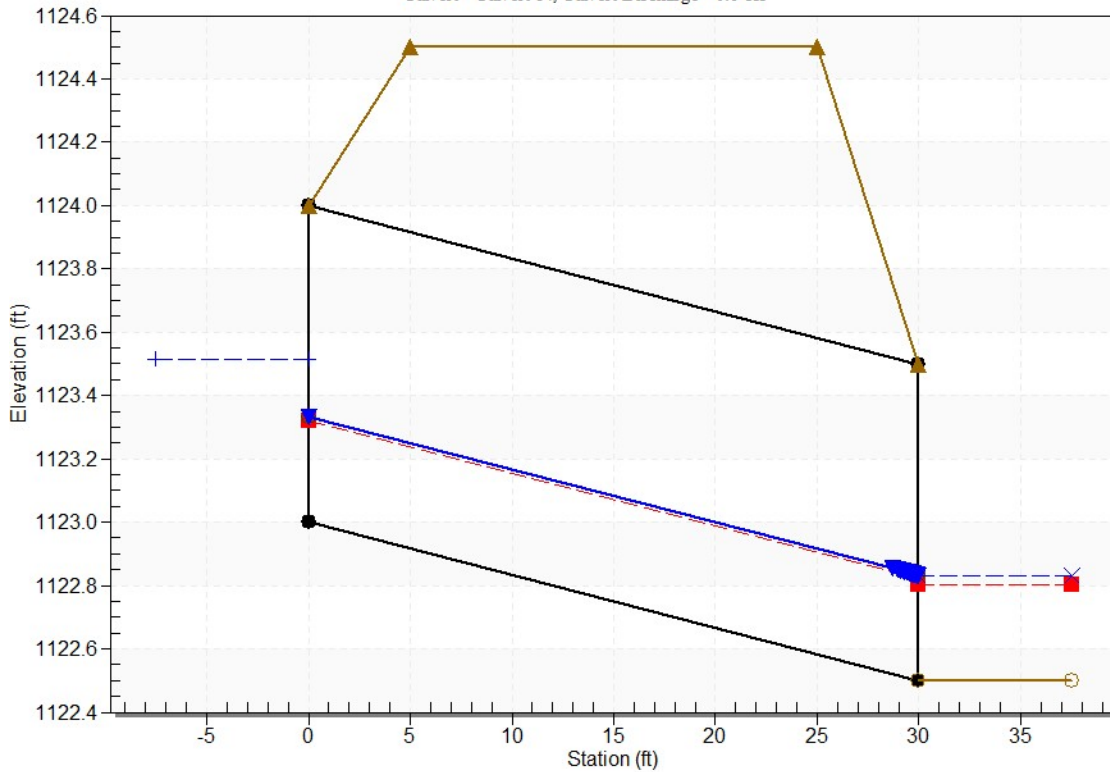
Culvert Performance Curve Plot: Culvert 14



Water Surface Profile Plot for Culvert: Culvert 14

Crossing - Culvert 14, Design Discharge - 0.6 cfs

Culvert - Culvert 14, Culvert Discharge - 0.6 cfs



Site Data - Culvert 14

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1123.00 ft

Outlet Station: 30.00 ft

Outlet Elevation: 1122.50 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 14

Barrel Shape: Circular

Barrel Diameter: 1.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope (Ke=0.7)

Inlet Depression: None

Tailwater Data for Crossing: Culvert 14

Table 15 - Downstream Channel Rating Curve (Crossing: Culvert 14)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.50	1122.81	0.31	1.75	0.42	0.78
0.53	1122.82	0.32	1.78	0.43	0.79
0.56	1122.82	0.32	1.80	0.44	0.79
0.60	1122.83	0.33	1.83	0.45	0.79
0.62	1122.83	0.33	1.85	0.46	0.80
0.65	1122.84	0.34	1.87	0.47	0.80
0.68	1122.85	0.35	1.89	0.48	0.80
0.71	1122.85	0.35	1.91	0.48	0.80
0.74	1122.86	0.36	1.93	0.49	0.80
0.77	1122.86	0.36	1.95	0.50	0.81
0.80	1122.87	0.37	1.97	0.51	0.81

Tailwater Channel Data - Culvert 14

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 3.00 (:1)

Channel Slope: 0.0220

Channel Manning's n: 0.0350

Channel Invert Elevation: 1122.50 ft

Roadway Data for Crossing: Culvert 14

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 1124.50 ft

Roadway Surface: Gravel

Roadway Top Width: 20.00 ft

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.50

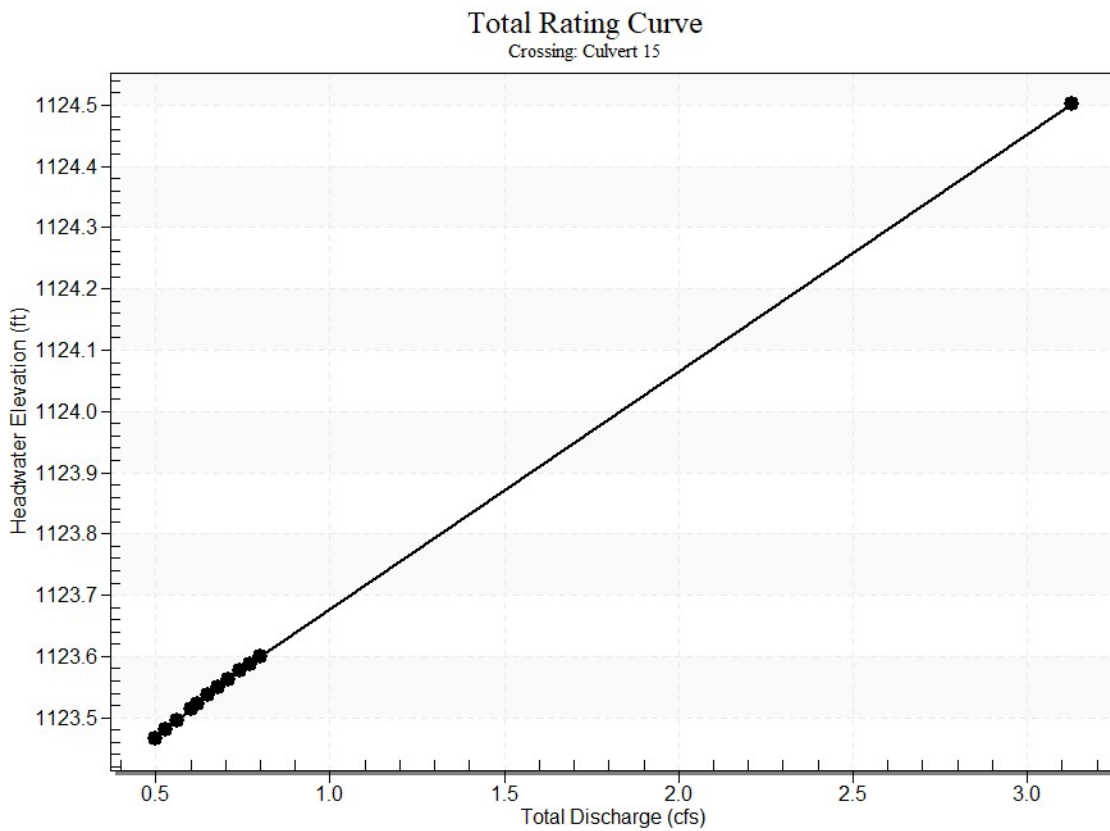
Design Flow: 0.60

Maximum Flow: 0.80

Table 16 - Summary of Culvert Flows at Crossing: Culvert 15

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 15 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1123.47	0.50	0.50	0.00	1
1123.48	0.53	0.53	0.00	1
1123.50	0.56	0.56	0.00	1
1123.51	0.60	0.60	0.00	1
1123.52	0.62	0.62	0.00	1
1123.54	0.65	0.65	0.00	1
1123.55	0.68	0.68	0.00	1
1123.56	0.71	0.71	0.00	1
1123.58	0.74	0.74	0.00	1
1123.59	0.77	0.77	0.00	1
1123.60	0.80	0.80	0.00	1
1124.50	3.07	3.07	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 15



Culvert Data: Culvert 15

Table 17 - Culvert Summary Table: Culvert 15

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.50	0.50	1123.47	0.43	0.466	3-M1t	0.30	0.29	0.31	0.31	2.43	1.75
0.53	0.53	1123.48	0.44	0.481	3-M1t	0.31	0.30	0.32	0.32	2.49	1.78
0.56	0.56	1123.50	0.45	0.496	3-M1t	0.32	0.31	0.32	0.32	2.56	1.80
0.60	0.60	1123.51	0.47	0.514	3-M2t	0.33	0.32	0.33	0.33	2.65	1.83
0.62	0.62	1123.52	0.48	0.523	3-M2t	0.34	0.33	0.33	0.33	2.69	1.85
0.65	0.65	1123.54	0.49	0.537	3-M2t	0.35	0.34	0.34	0.34	2.75	1.87
0.68	0.68	1123.55	0.50	0.550	3-M2t	0.36	0.34	0.35	0.35	2.82	1.89
0.71	0.71	1123.56	0.51	0.563	3-M2t	0.36	0.35	0.35	0.35	2.88	1.91
0.74	0.74	1123.58	0.53	0.576	2-M2c	0.37	0.36	0.36	0.36	2.92	1.93
0.77	0.77	1123.59	0.54	0.588	2-M2c	0.38	0.37	0.37	0.36	2.95	1.95
0.80	0.80	1123.60	0.55	0.601	2-M2c	0.39	0.37	0.37	0.37	2.99	1.97

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

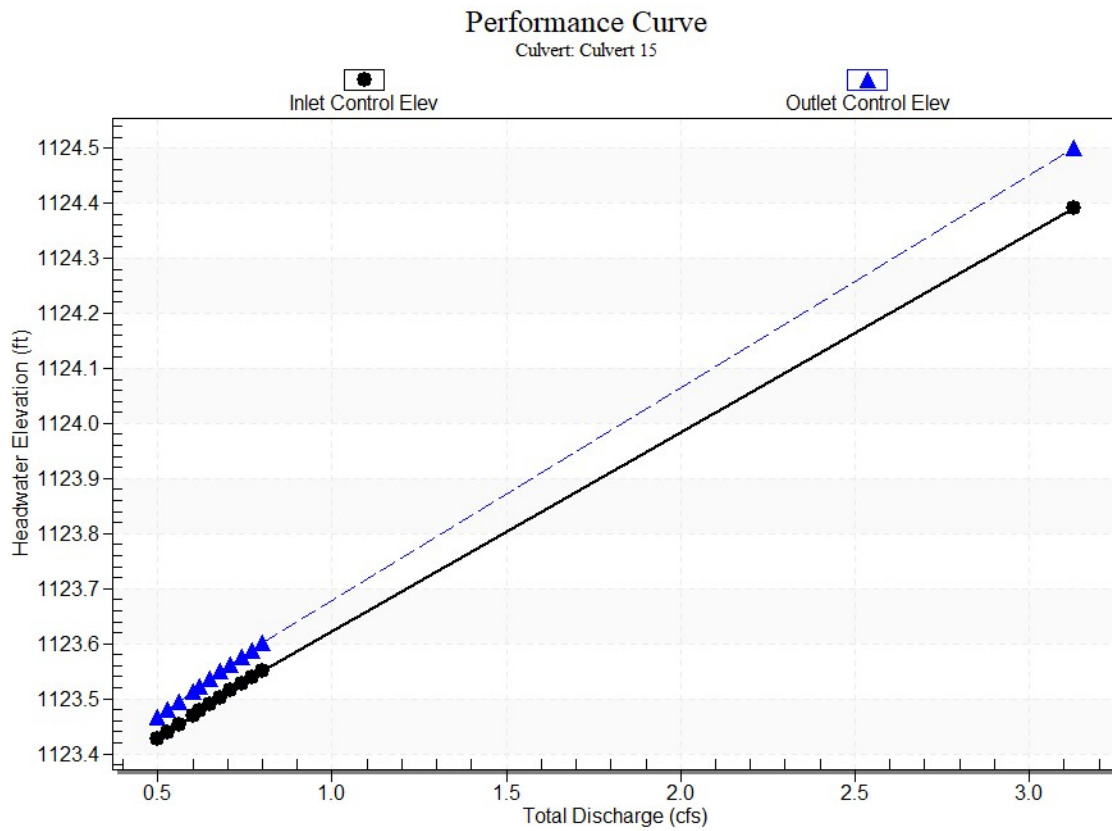
Inlet Elevation (invert): 1123.00 ft,

Outlet Elevation (invert): 1122.50 ft

Culvert Length: 30.00 ft,

Culvert Slope: 0.0167

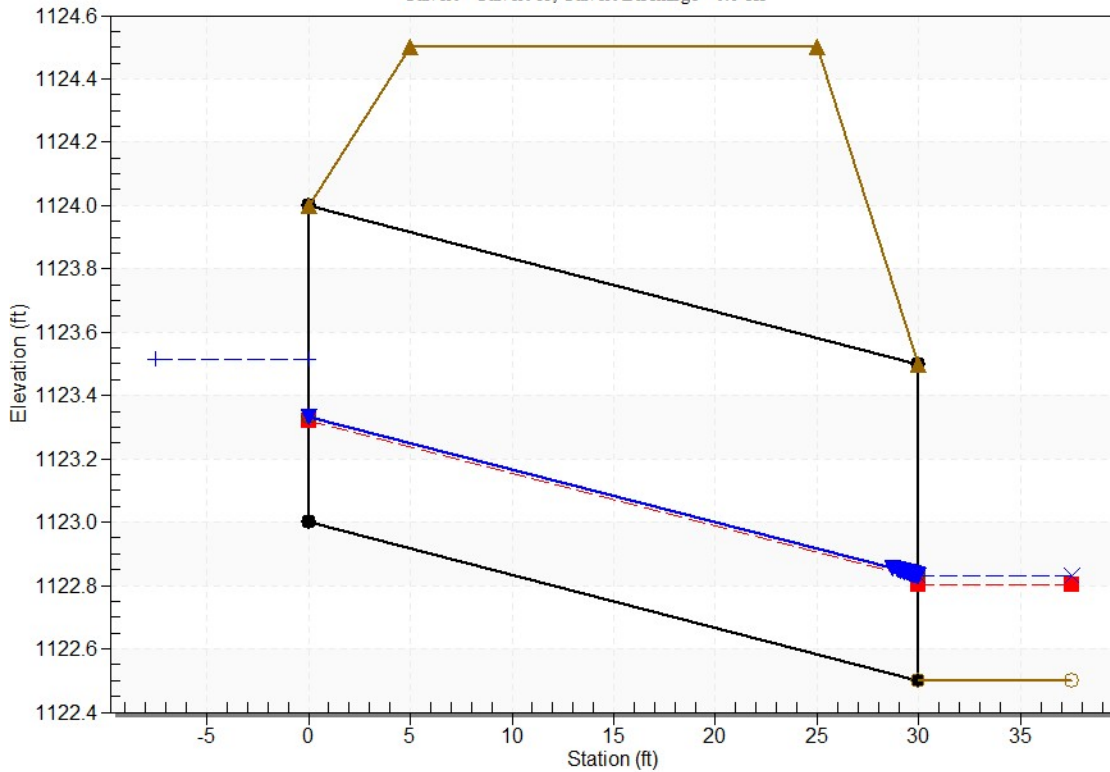
Culvert Performance Curve Plot: Culvert 15



Water Surface Profile Plot for Culvert: Culvert 15

Crossing - Culvert 15, Design Discharge - 0.6 cfs

Culvert - Culvert 15, Culvert Discharge - 0.6 cfs



Site Data - Culvert 15

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1123.00 ft

Outlet Station: 30.00 ft

Outlet Elevation: 1122.50 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 15

Barrel Shape: Circular

Barrel Diameter: 1.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0240

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope (Ke=0.7)

Inlet Depression: None

Tailwater Data for Crossing: Culvert 15

Table 18 - Downstream Channel Rating Curve (Crossing: Culvert 15)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.50	1122.81	0.31	1.75	0.42	0.78
0.53	1122.82	0.32	1.78	0.43	0.79
0.56	1122.82	0.32	1.80	0.44	0.79
0.60	1122.83	0.33	1.83	0.45	0.79
0.62	1122.83	0.33	1.85	0.46	0.80
0.65	1122.84	0.34	1.87	0.47	0.80
0.68	1122.85	0.35	1.89	0.48	0.80
0.71	1122.85	0.35	1.91	0.48	0.80
0.74	1122.86	0.36	1.93	0.49	0.80
0.77	1122.86	0.36	1.95	0.50	0.81
0.80	1122.87	0.37	1.97	0.51	0.81

Tailwater Channel Data - Culvert 15

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 3.00 (:1)

Channel Slope: 0.0220

Channel Manning's n: 0.0350

Channel Invert Elevation: 1122.50 ft

Roadway Data for Crossing: Culvert 15

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 1000.00 ft

Crest Elevation: 1124.50 ft

Roadway Surface: Gravel

Roadway Top Width: 20.00 ft