Florida Department of
TRANSPORTATION

Final
Location Hydraulic Report

SR 514 (Malabar Road) PD&E Study

From Babcock Road to US 1

Brevard County

Financial Project ID: 430136 1 22 01

ETDM Project Number: 13026

The environmental review, consultation, and other actions required by applicable federal environmental laws for this project are being, or have been, carried out by the Florida Department of Transportation (FDOT) pursuant to 23 U.S.C. §327 and a Memorandum of Understanding (MOU) dated December 14, 2016 and executed by the Federal Highway Administration (FHWA) and FDOT.

April 2018

RICHARD A. WAWRZYNIAK
LICENSE
No. 34935
STATE OF
FLORIDA
PROFESSIONAL ENGINEER

Digitally signed by Richard A Wawrzyniak
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OID.0.9.2342.19200300.100.1.1=A0109800000015BC9BDAC870000B2F8,
CN=Richard A Wawrzyniak, O=IdenTrust ACES Unaffiliated Individual,
C=US
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EXECUTIVE SUMMARY

The Florida Department of Transportation (FDOT), District Five, conducted a Project Development and Environment (PD&E) Study to evaluate improvements to Malabar Road [State Road (SR) 514] in Brevard County, Florida. The study limits begin east of Babcock Street (SR 507) [milepost (MP) 3.102] and extend to US 1 (MP 6.742), a distance of 3.64 miles. The purpose of the study was to provide documented environmental and engineering analyses to determine the type, location, and conceptual design of roadway improvements to Malabar Road (SR 514). The PD&E Study Class of Action is a State Environmental Impact Report (SEIR) since no federal funds are anticipated for any phases of this project.

The purpose of this Location Hydraulic Report (LHR) was to address base floodplain encroachments resulting from the roadway improvements. The report was prepared in accordance with FDOT's PD&E Manual, Part 2, Chapter 24 including the Minimal Encroachment Checklist for the Federal Emergency Management Agency (FEMA) Maps. This analysis ensures that all base floodplains are identified and provides recommendations regarding minimization and elimination of floodplain impacts. As a result of this process, a preliminary determination of impact was made as to the level of significance of the encroachment.

There are 5 crossdrain locations along the project limits within the 100-year (base) floodplain. **The widened roadway, with extended or replaced cross drains, will result in transverse impacts with minimal floodplain encroachments**. This project will not result in any new or increased adverse environmental impacts. There will not be a significant change in the potential interruption or termination of emergency service or emergency evacuation routes. The FDOT drainage design standards as well as the SJRWMD procedures will be applied during the design phase to prevent increasing flood elevations or changing floodplain limits. Typical for a roadway that traverses the floodplain, any potential impacts will be mitigated by the increased capacity of the cross culverts with no rise in the flood stages and with the storage capacity gained by the construction of new treatment ponds where no storage exists today.

It should be noted that all elevations discussed in this document are in reference to North America Vertical Datum 1988 (NAVD'88). The conversion between NAVD'88 and National Geodetic Vertical Datum 1929 (NGVD'29) at this location is NGVD'29 is equal to NAVD'88 plus 1.38 feet. For example, elevation 20 in this report is equal to elevation 21.38 NGVD'29.

1.0 PROJECT DESCRIPTION

Malabar Road (SR 514) is an east-west urban minor arterial located in Brevard County that begins approximately 7.4 miles west of its interchange with I-95 and continues east to US 1, traversing the City of Palm Bay and the Town of Malabar. East of Babcock Street, the Malabar Road is primarily a two-lane, undivided rural roadway. There are two signalized intersections within the project limits: at Babcock Street (SR 507) and at US 1. Land use within the corridor includes commercial, conservation, recreation, and low-density residential development. The Florida Division of Emergency Management has designated Malabar Road (SR 514) as an evacuation route. There is also a Florida East Coast (FEC) rail crossing approximately 600 feet west of US 1.

The PD&E Study analyzed alternatives for widening SR 514, Malabar Road from a two-lane to a four-lane facility from Babcock Street to US 1. This project corridor traverses the City of Palm Bay and the Town of Malabar. The west end of the project falls within the limits of the City of Palm Bay and within the boundary of the local water control district, Melbourne-Tillman Water Control District or MTWCD. Palm Bay Community Hospital and large sections of conservation lands are located along the north side of the road. Single-family residences, the Florida East Coast Railroad, and light commercial developments can be found in the Town of Malabar at the east end of the project.

The proposed improvements will include the addition of sidewalks and bike lanes, and water quality treatment within new project ponds. The roadway typical section will vary along the project corridor and will include both urban and rural drainage features. The project limits are depicted on the following location map and aerial exhibit - **Figures 1 and 2.**

2.0 EXISTING DRAINAGE CONDITIONS

The USGS maps show the project alignment surrounded by a broad, low-lying, partially wooded area interspersed with irregularly-shaped drainage ways and swamps. The existing topography is comprised of level terrain with elevations varying from 17 ft to 19 ft NAVD, and slightly higher elevations near the western end of the alignment and also near a few isolated knolls and ridges on the eastern end.

The offsite area south of the roadway generally drains north. The western two-thirds of the project are within the drainage basin for Turkey Creek. Five ditches and the MTWCD C-78 Canal cross under the SR 514 alignment and combine as branches of Turkey Creek. The side ditches along the north and south edge of SR 514 drain towards these flowage ways and, in some locations, through smaller sized crossdrains that function as equalizer pipes. To the west of Marie Street, the drainage pattern is eastward through an FDOT ditch easement under the railroad and into Indian River. FDOT owns and maintains a section of drainage easement north of several of the crossdrains.

The C-78 Canal is maintained by MTWCD. The SR 514 ditches are regularly maintained by FDOT. However, the various branches of Turkey Creek upstream of SR 514 are overgrown and not well maintained. During major rainfall events like Tropical Storm Fay, the area experiences flooding on the local roads and surrounding properties. This flooding was most noted at the east side of the conservation lands that drain through offsite wetlands with ill-defined outfalls. The city and county have recently completed maintenance upgrades within the roadside ditches and the overall drainage conditions have improved.

Camp Road maintenance yard for FDOT was contacted regarding historic flooding problems for the project corridor. FDOT reported they have recently cleared the drainage easement downstream of the culvert near Eva Lane in order to solve a local flooding concern. Based upon interviews, overtopping of portions of the project corridor was noted during Tropical Storm Fay.

Runoff from SR 514 is collected in roadside swales and conveyed to cross culverts serving the ditches that pass through the area. The flat terrain of the roadway and surrounding area creates conditions where culvert.

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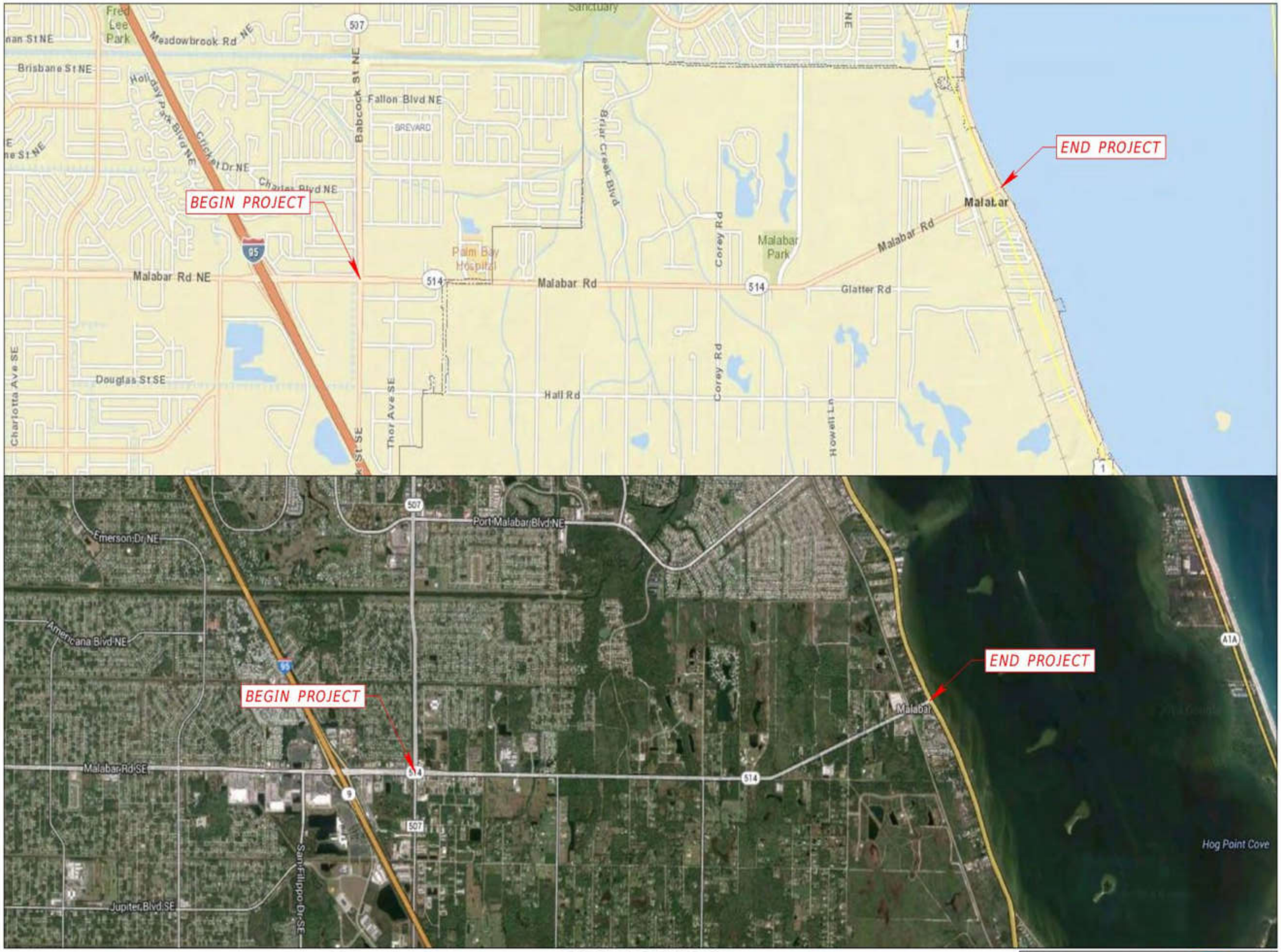


FIGURE 1 & FIGURE 2
SR514 - MALABAR ROAD
LOCATION MAP & AERIAL EXHIBIT

FDOT Malabar Road (SR 514)
PROJECT DEVELOPMENT & ENVIRONMENT STUDY, BREVARD COUNTY

flow interconnects with the adjacent cross culvert and the limit of each basin is not distinctively defined. The offsite basins contributing to the crossdrains are also loosely delineated. There are linear ditches throughout the offsite areas and interconnecting ditches that follow the local roads. During flood events, flow is anticipated to overtop basin boundaries interconnecting several of the delineated basins. **Figure 3** shows the location of the existing culverts along the project corridor. **Figure 4** presents the drainage basins upstream of the project for each of the crossdrains and delineates the floodplain boundaries in the vicinity of the project.

It should be noted that the basin divides are based upon limited data available for the PD&E Study. In establishing the basin divides, significant differences were noted when previous studies were compared to each other. These differences emphasize the preliminary nature of the culvert analysis and the details needed during the design phase.

Three issues concerning the offsite basins are noted here. Culvert #2 is an 8’x4’ box culvert for the MTWCD C-78 Canal. On historical basin maps for MTWCD, the upstream basin area is defined by the boundary limits of the water control district. However, field review south of Malabar Road showed a changed ditch network near Atz Road and it is possible that a much larger basin area drains to the C-78 Canal. This shifts basin area that would have otherwise drained to Culvert #3. To account for this situation, Figure 4 lists two drainage basin acreage values for Culvert #2 and Culvert #3. A conservative approach was suggested by FDOT District Five. The assumption for this LHR analysis was to use the largest basin area for both culverts. A discussion was held with MTWCD. They were not aware of the circumstances behind the field conditions and suggested the system could change in the future. In addition, during a discussion with the City of Palm Bay, they reported a concern that the flowline of the existing MTWCD culvert is set too high. They request that FDOT revisit the flowline condition during the design phase of this project. MTWCD also provided a flow estimate obtained from the regional hydraulic model of their canal system. However, MTWCD limits the allowable runoff rate from the lands within the district. For example, the 25-yr flow is restricted to 0.08 cfs/acre and the 100-yr flow is restricted to 0.10 cfs/acre. These allowable rates are significantly less than discharge values generated from regression or rational formulas and typically would not be used for FDOT design.

A second concern stems from review of the published Flood Insurance Study (FIS) for the Turkey Creek floodplain. Table 4 of the FIS, titled *Summary of Discharges*, lists drainage areas for each branch of Turkey Creek. Several of the drainage areas in the FIS do not match well with the offsite drainage basin map established for this project. For example, the drainage areas for Channel C and for Channel G are both listed as 1.1 square miles at the point the branch connects into the main section of Turkey Creek. However, the size of Culvert #6 (which drains Channel G) is 30-inches and the size of Culvert #7 (which drains Channel C) is 8’x4’. Since the basin areas for these two culverts are different, it appears the FIS oversimplified this parameter by comingling of the flow for each basin.

The third issue about the ill-defined drainage basins has already been mentioned. The drainage basin divides are often drawn across linear ditches where the prevailing flow direction is unclear. For example, the southern basin limits of Turkey Creek have ditches that continue into Goat Creek Basin. The network of ditches throughout the offsite area continues to change through time. When a section of land is developed, it is typical to create a small borrow pond to raise the grade on portion of the developed property. It appears the swales through the area are either improved by the site work for better conveyance or in some cases the swale was eliminated.

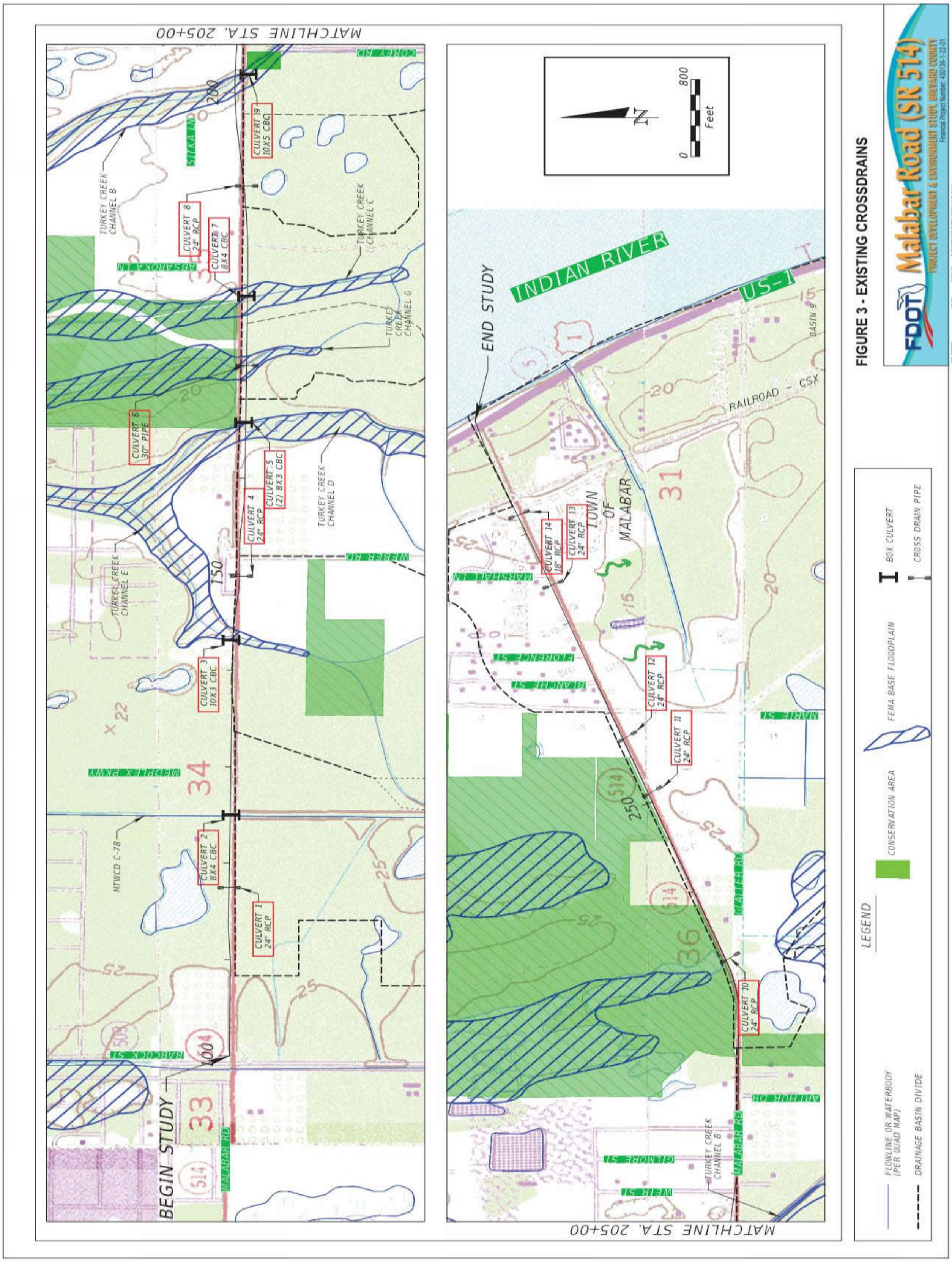


FIGURE 3 - EXISTING CROSSDRAINS
Malabar Road (SR 514)
PROJECT DEVELOPMENT & ENVIRONMENT STUDY, BREVARD COUNTY
MATCHLINE STA. 205+00
BEGIN STUDY
END STUDY
INDIAN RIVER
US-1
RAILROAD - CSX
TOWN OF MALABAR
CULVERT 1 24" RCP
CULVERT 2 8X4 CBC
CULVERT 3 10X3 CBC
CULVERT 4 24" RCP
CULVERT 5 (2) 8X3 CBC
CULVERT 6 30" PIPE
CULVERT 7 8X4 CBC
CULVERT 8 24" RCP
CULVERT 9 10X5 CBC
CULVERT 10 24" RCP
CULVERT 11 24" RCP
CULVERT 12 24" RCP
CULVERT 13 24" RCP
CULVERT 14 18" RCP
TURKEY CREEK CHANNEL B
TURKEY CREEK CHANNEL C
TURKEY CREEK CHANNEL D
TURKEY CREEK CHANNEL E
TURKEY CREEK CHANNEL G
MTWCD C-78
MALABAR RD
BABCOCK ST
WEBER RD
COREY RD
MARSHALL LN
FLORENCE ST
BLANCHE ST
MARIE ST
GLATTER RD
ARTHUR DR
GILMORE ST
WEIR ST
0 800 Feet
N
LEGEND
FLOWLINE OR WATERBODY (PER QUAD MAP)
DRAINAGE BASIN DIVIDE
CONSERVATION AREA
FEMA BASE FLOODPLAIN
BOX CULVERT
CROSS DRAIN PIPE

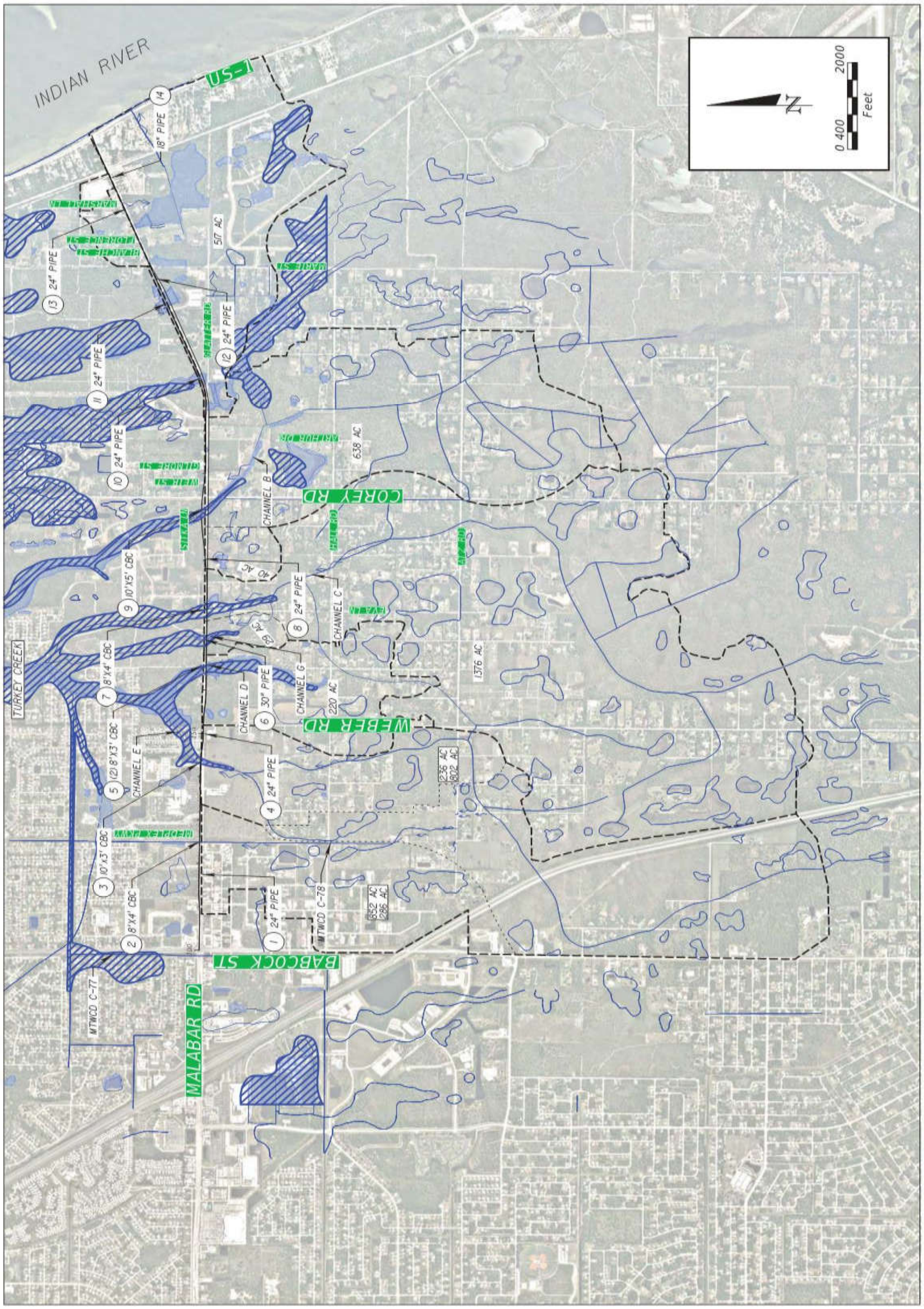


FIGURE 4 - OFFSITE DRAINAGE BASINS

Malabar Road (SR 514)

2.1 CROSSDRAINS

Refer to **Figure 3**. There are fourteen (14) existing crossdrains under SR 514, six (6) of which serve as crossings for the Turkey Creek Branches or the MTWCD C-78 Canal. Within the project limits, other smaller culverts act as equalizer pipes for the roadside ditches. Most of the fourteen culverts were extended as part of a 1998 roadway project that widened the shoulders of SR 514. Given the limited right-of-way, lateral pipe connections were added to the extended culverts to convey flow from the side ditches. **Figure 5** presents the detail of the culvert extensions and the lateral connections. Information about the existing crossdrains within the project limits is presented in the two tables that follow.

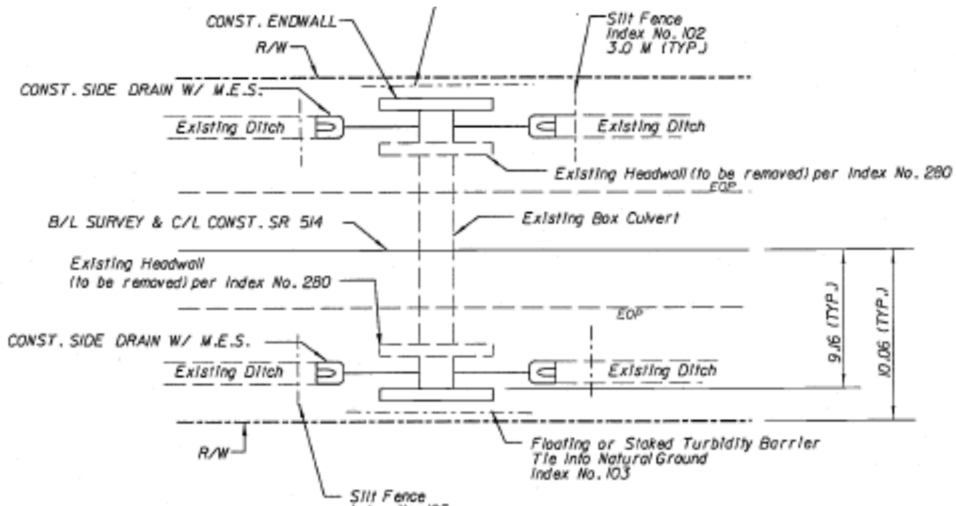


Figure 5
Detail of Culvert Extensions Constructed in 1998

Table 1 – Existing Crossdrains

Cross Drain ID	Location	Size	Length	No. Barrels	Type
1	117+44	24 -inch	58’	1	Conc. Pipe[(1)]
2	125+05	8’x4’	62’	1	Conc. Box Culvert
3	143+20	10’x3’	96’	1	Conc. Box Culvert
4	149+80	24 -inch	48’	1	Conc. pipe
5	165+70	(2) 8’x3’	62’	2	Conc. Box Culvert
6	171+65	30 -inch	42’	1	Conc. pipe
7	178+60	8’x4’	54’	1	Conc. Box Culvert
8	190+24	24 -inch	42’	1	Conc. pipe
9	201+70	10’x5’	67’	1	Conc. Box Culvert
10	232+30	24 -inch	42’	1	Conc. pipe
11	250+92	24 -inch	46’	1	Conc. pipe
12	256+96	24 -inch	46’	1	Conc. pipe
13	270+35	24 -inch	36’	1	Conc. pipe
14	282+05	18 -inch	36’	1	Conc. Pipe[(1)]

[(1)] Stormsewer conveyance pipe

Table 2 – Existing Crossdrain Parameters

Crossdrain ID	Flowlines (S. to N.)	FEMA Flood Stage (NAVD'88)	Water Mark Elev.	Comments/Condition
1	20.4 / 20.4	--	--	
2	17.08 /17.02	--	19.02 (54-in from headwall top)	MTWCD C-78 Canal, connects to Turkey Creek via C-76
3	15.59 / 15.43	Approx. 19.1	17.93 (42-in from headwall top)	Channel E of Turkey Creek FDOT R/W downstream
4	15.74 / 15.68	--	--	
5	12.08 / 12.14	Approx. 16.0	14.4 (39-in from headwall top)	Channel D of Turkey Creek
6	14.55 / 14.36	Approx. 18.1	16.11 (18-in below crown)	Channel G of Turkey Creek
7	14.02 / 14.17	Approx. 17.9	17.5 (6-in below crown)	Channel C of Turkey Creek FDOT R/W downstream
8	17.05 / 17.02	--	--	
9	12.94 / 12.79	Approx. 17	16.3 (47-in from headwall top)	Channel B of Turkey Creek FDOT R/W downstream
10	18.34 / 18.45	--	19.53 (2-in above crown)	
11	19.94 / 18.77	--	21.48 (11-in below crown)	FDOT R/W downstream
12	19.33 / 19.36	--	21.33 (At crown)	
13	16.8 / 16.8	--	--	
14	19.0 / 19.0	--	--	

Notes:

1- There are several stormsewer pipes that run from the south side of Malabar Road to the north side that were constructed as part of the intersection improvements at Babcock Street. These pipe segments continue towards Babcock Street, then north and into the existing FDOT pond in the northeast corner of the intersection. One of these stormsewer pipes connected to Babcock Street drainage (Crossdrain #1) is located where the road transitions back to two lanes (east of Enterprise Road).

2.2 FLOODPLAINS

Refer to **Figure 4**. Malabar Road traverses five branches of Turkey Creek, each with established flood profiles immediately downstream, i.e., north of the roadway. SR 514 also traverses MTWCD C-78 Canal, which connects to the floodplain at its confluence with the C-76 canal. Flood Insurance Rate Maps (FIRM) for Brevard County dated August 18, 1992, with Map Numbers 12009C0540F and 12009C0605E, cover the project limits. These maps show a defined floodway that begins at the mouth of Turkey Creek and ends just downstream of SR 514. The maps also show "Flood Zone A – No Base Flood Elevations Determined" generally confined to the area at the creeks. **The creek crossings under SR 514 are not in the floodway.**

There was a recent update to the FIS for Brevard County. For the Turkey Creek Basin, the notable change with this revision was the conversion to NAVD'88 datum for the listed flood stages. The update was considered "Preliminary" at the beginning of this study, but the new maps have recently been adopted with an effective date of March 17, 2014. Excerpts of the new FIS for Brevard County covering the project area, along with FIRM Maps (Numbers 12009C0613G, 12009C0614G, 12009C0677G, and 12009C0680G) are included in **Appendix A**.

The proposed culverts will not increase flood stages. The FDOT drainage design standards as well as SJRWMD procedures will be applied during the design phase to prevent increasing flood elevations or changing floodplain limits. As such, **all anticipated floodplain encroachments are expected to be minimal.** Floodplain compensation ponds are not typically required for linear projects that transverse a floodplain. Preliminary conversation with SJRWMD indicated their agreement; i.e., this project is similar to others, where hydraulic-equivalent crossdrains and the new treatment ponds for the corridor will suffice for any floodplain impact. This approach was also discussed with the Brevard County FEMA coordinator, Frank Karvelis, who confirmed that floodplain compensation would not be required for the proposed conditions along Malabar Road.

3.0 FUTURE DRAINAGE CONDITIONS

The existing drainage boundaries and local drainage patterns will be maintained in the proposed condition. Water quality treatment will be achieved with new stormwater ponds. The stormwater runoff from SR 514 will be conveyed to the proposed ponds by closed stormsewer systems before discharging to the outfall points. There are locations where drainage from adjacent properties will be collected along with the roadway runoff and conveyed through the proposed ponds. However, according to House Bill 599, no additional treatment is required for these offsite areas. Therefore, the pond size estimates in the Pond Siting Report only considers water quality and attenuation for the onsite project area.

For the roadway widening, existing crossdrains will need to be replaced with greater or hydraulically equivalent structures. Backwater surface elevations are not expected to increase when FDOT guidelines are followed during the design phase. As a result, the project will not affect existing flood stages or floodplain limits.

Preliminary estimates of the replacement culverts have been established as part of this LHR. These culvert sizes are based upon limited available information for the offsite drainage basins and their respective runoff estimates. During the design phase of the project, these crossdrains will require a complete hydrologic and hydraulic study. **Table 3** presents anticipated crossdrain parameters for the widening project. Backup calculations are presented within **Appendix B.**

Table 3 – Proposed Crossdrains

Cross Drain ID	Location	Size	Length	No. Barrels	Type
1	117+44	30 -inch	112'	1	Conc. Pipe(1)
2	125+05	(2) 6'x4'	126'	2	Conc. Box Culvert
3	143+20	(2) 8'x4'	126'	2	Conc. Box Culvert
4	149+80	30 -inch	112'	1	Conc. pipe
5	165+70	(2) 8'x4'	160'	2	Conc. Box Culvert
6	171+65	(2) 30 -inch	152'	2	Conc. pipe
7	178+60	(2) 6'x4'	162'	2	Conc. Box Culvert
8	190+24	(2) 36 -inch	148'	2	Conc. pipe
9	201+70	10'x5'	190'	1	Conc. Box Culvert
10	232+30	30 -inch	74'	1	Conc. pipe
11	250+92	24 -inch	70'	1	Conc. pipe
12	256+96	30 -inch	86'	1	Conc. pipe
13	270+35	36 -inch	60'	1	Conc. Pipe(1)
14	282+05	24 -inch	60'	1	Conc. Pipe(1)

(1) Stormsewer conveyance pipe

4.0 CONCLUSION

There is no change in flood "Risk" associated with this project. The proposed floodplain encroachments are classified as "minimal".

The proposed structures will perform hydraulically in a manner equal to or greater than the existing structures, and backwater surfaces are not expected to increase. *The widened roadway, with extended cross drains, will result in transverse impacts with minimal floodplain encroachments. As a result, the project will not affect existing flood heights or floodplain limits. This project will not result in any new or increased adverse environmental impacts. There will not be a significant change in the potential interruption or termination of emergency service or emergency evacuation routes.*

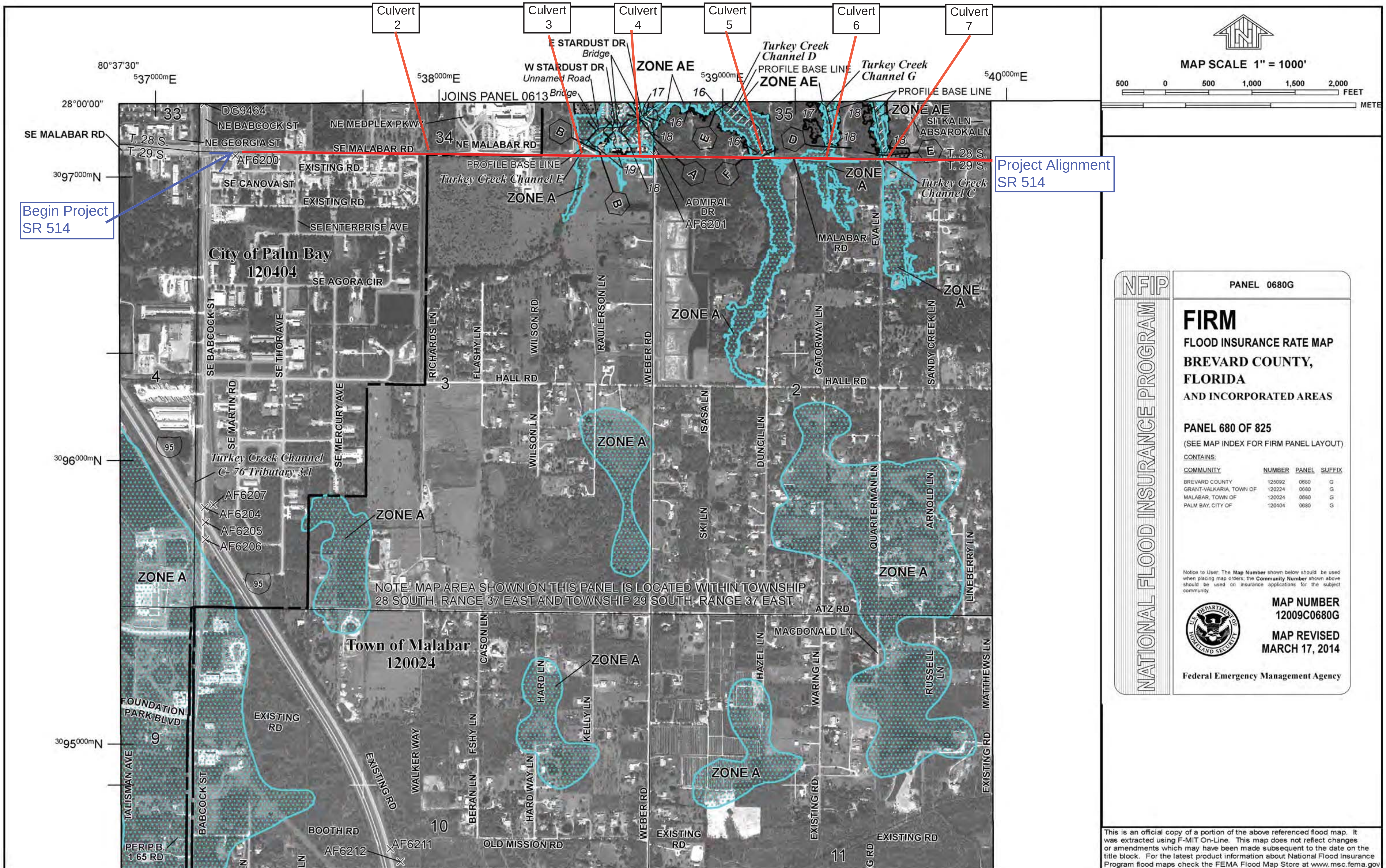
It has been determined, through consultation with local, state, and federal water resources and floodplain management agencies that there is no regulatory floodway involvement on the proposed project and that the project will not support base floodplain development that is incompatible with existing floodplain management programs

APPENDIX A

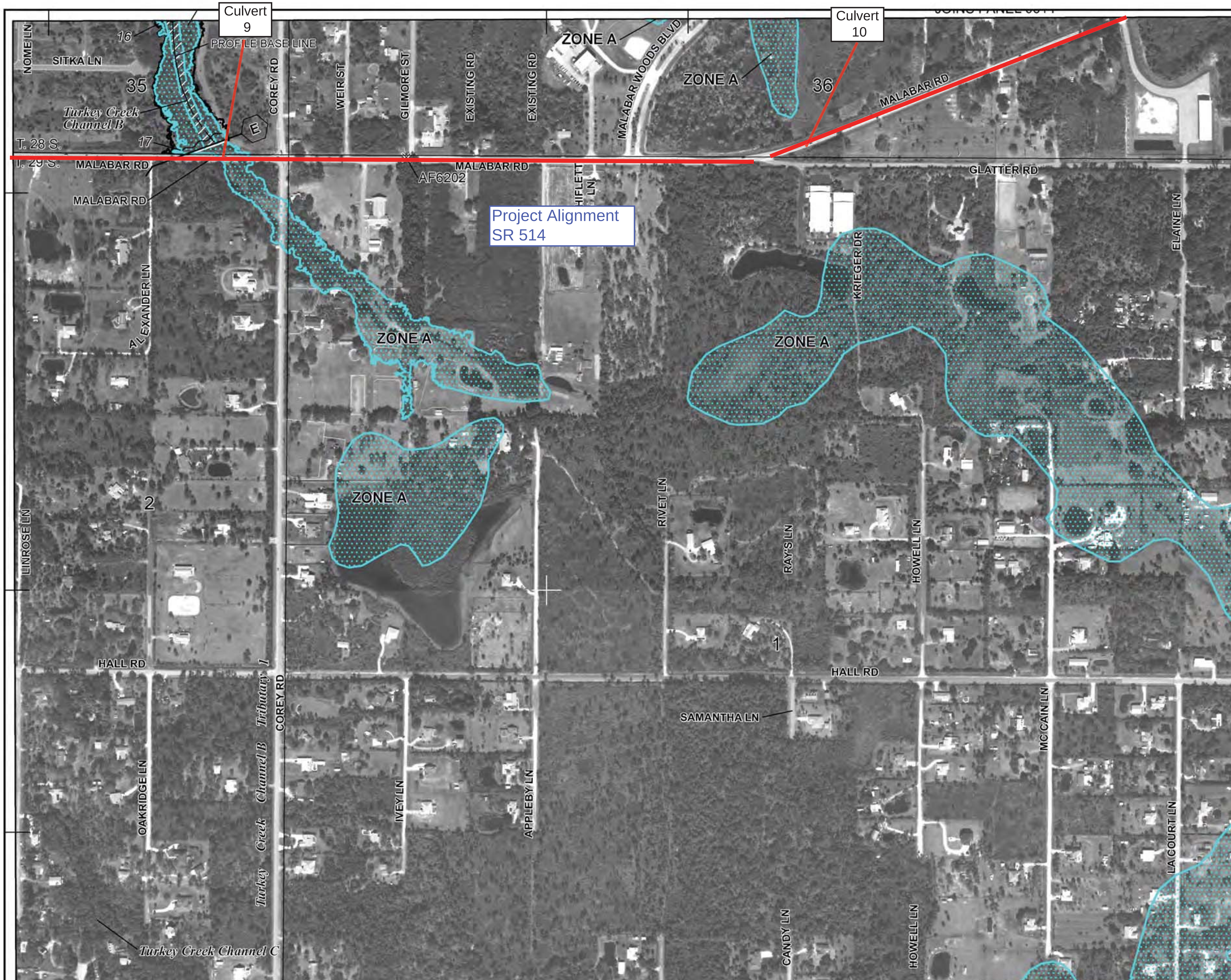
FEMA MAPS AND FIS

- UPDATED EFFECTIVE FIS

MARCH 17, 2014



Culvert 2
Culvert 3
Culvert 4
Culvert 5
Culvert 6
Culvert 7
Begin Project SR 514
Project Alignment SR 514
JOINS PANEL 0613
ZONE AE
ZONE A
Turkey Creek Channel D
Turkey Creek Channel G
Turkey Creek Channel E
Turkey Creek Channel C
Turkey Creek Channel C-76 Tributary 3.1
PROFILE BASE LINE
City of Palm Bay 120404
Town of Malabar 120024
NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 28 SOUTH, RANGE 37 EAST AND TOWNSHIP 29 SOUTH, RANGE 37 EAST.
MAP SCALE 1" = 1000'
NFIP
NATIONAL FLOOD INSURANCE PROGRAM
PANEL 0680G
FIRM
FLOOD INSURANCE RATE MAP
BREVARD COUNTY, FLORIDA
AND INCORPORATED AREAS
PANEL 680 OF 825
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
BREVARD COUNTY 125092 0680 G
GRANT-VALKARIA, TOWN OF 120224 0680 G
MALABAR, TOWN OF 120024 0680 G
PALM BAY, CITY OF 120404 0680 G
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.
MAP NUMBER 12009C0680G
MAP REVISED MARCH 17, 2014
Federal Emergency Management Agency
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov



MAP SCALE 1" = 500'

250 0 250 500 750 1,000 FEET

NATIONAL FLOOD INSURANCE PROGRAM

NFIP

PANEL 0677G

FIRM

FLOOD INSURANCE RATE MAP

BREVARD COUNTY, FLORIDA

AND INCORPORATED AREAS

PANEL 677 OF 825

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
GRANT-VALKARIA, TOWN OF	120224	0677	G
MALABAR, TOWN OF	120024	0677	G

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.

MAP NUMBER
12009C0677G

MAP REVISED
MARCH 17, 2014

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

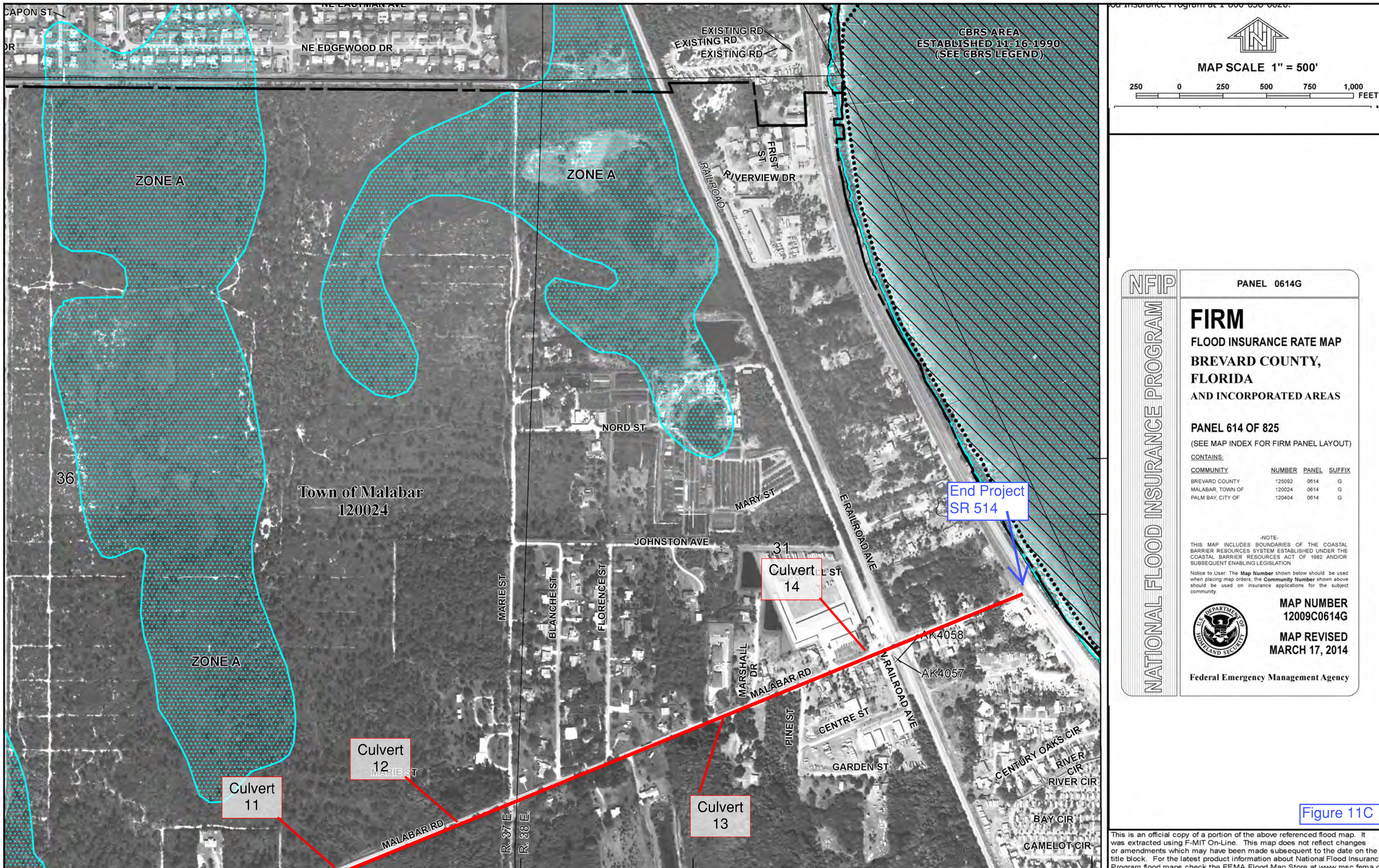
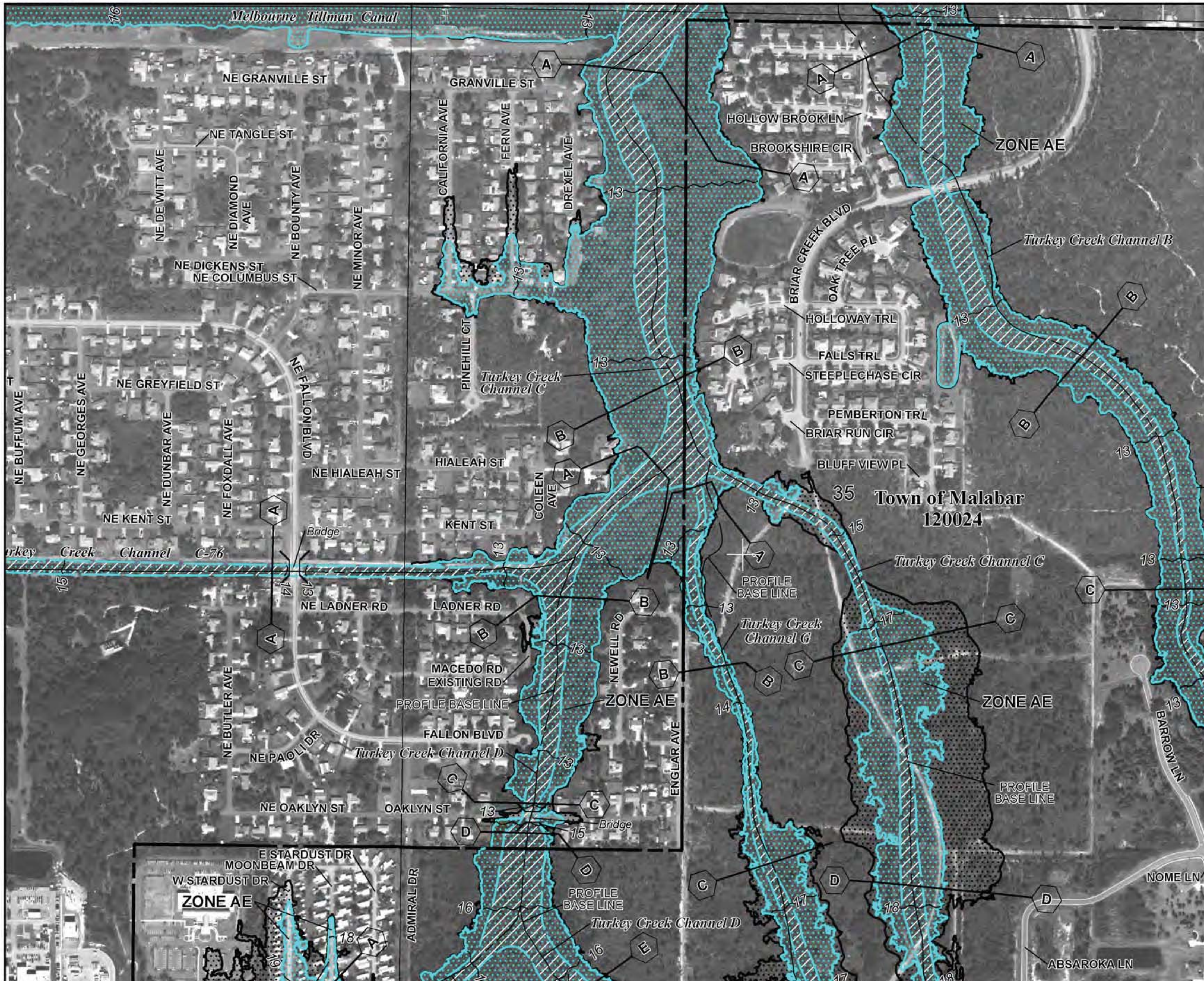

CAPON ST
NE EDGEWOOD DR
EXISTING RD
EXISTING RD
EXISTING RD
CBRS AREA
ESTABLISHED 11-16-1990
(SEE CBRS LEGEND)
ZONE A
ZONE A
FIRST ST
RAILROAD
RIVERVIEW DR
NORD ST
36
Town of Malabar
120024
MARY ST
End Project
SR 514
JOHNSTON AVE
31
Culvert
14
E RAILROAD AVE
MARIE ST
BLANCHE ST
FLORENCE ST
MARSHALL DR
AK4058
AK4057
ZONE A
MALABAR RD
W RAILROAD AVE
CENTRE ST
PINE ST
Culvert
12
MARIE ST
Culvert
11
Culvert
13
GARDEN ST
CENTURY OAKS CIR
RIVER CIR
RIVER CIR
BAY CIR
CAMELOT CIR
MALABAR RD
R. 37 E.
R. 38 E.
MAP SCALE 1" = 500'
250
0
250
500
750
1,000
FEET
NFIP
NATIONAL FLOOD INSURANCE PROGRAM
PANEL 0614G
FIRM
FLOOD INSURANCE RATE MAP
BREVARD COUNTY,
FLORIDA
AND INCORPORATED AREAS
PANEL 614 OF 825
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)
CONTAINS:
COMMUNITY NUMBER PANEL SUFFIX
BREVARD COUNTY 125092 0614 G
MALABAR, TOWN OF 120024 0614 G
PALM BAY, CITY OF 120404 0614 G
-NOTE-
THIS MAP INCLUDES BOUNDARIES OF THE COASTAL BARRIER RESOURCES SYSTEM ESTABLISHED UNDER THE COASTAL BARRIER RESOURCES ACT OF 1982 AND/OR SUBSEQUENT ENABLING LEGISLATION.
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.
MAP NUMBER
12009C0614G
MAP REVISED
MARCH 17, 2014
Federal Emergency Management Agency
This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Figure 11C



d Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 250 500 750 1,000 FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0613G

FIRM

FLOOD INSURANCE RATE MAP

BREVARD COUNTY, FLORIDA

AND INCORPORATED AREAS

PANEL 613 OF 825

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BREVARD COUNTY	125092	0613	G
MALABAR, TOWN OF	120024	0613	G
PALM BAY, CITY OF	120404	0613	G

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.

MAP NUMBER 12009C0613G

MAP REVISED MARCH 17, 2014

Federal Emergency Management Agency

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FLOOD INSURANCE STUDY

BREVARD COUNTY, FLORIDA
AND INCORPORATED AREAS

Reduced for SR 514 Study Area Only

Community Name	Community Number
BREVARD COUNTY (UNINCORPORATED AREAS)	125092
CAPE CANAVERAL PORT AUTHORITY	120619
CAPE CANAVERAL, CITY OF	125094
COCOA , CITY OF	120020
COCOA BEACH, CITY OF	125097
GRANT-VALKARIA, TOWN OF	120224
INDIALANTIC, TOWN OF	125115
INDIAN HARBOUR BEACH, CITY OF	125116
MALABAR, TOWN OF	120024
MELBOURNE BEACH, TOWN OF	125128
MELBOURNE VILLAGE, TOWN OF	120329
MELBOURNE, CITY OF	120025
PALM BAY, CITY OF	120404
PALM SHORES, TOWN OF	120612
ROCKLEDGE, CITY OF	120027
SATELLITE BEACH, CITY OF	120028
TITUSVILLE, CITY OF	125152
WEST MELBOURNE, CITY OF	120335

REVISED:

Federal Emergency Management Agency

FLOOD INSURANCE STUDY NUMBER
12009CV000A

NOTICE TO
FLOOD INSURANCE STUDY USERS

Communities participating in the National Flood Insurance Program have established repositories of flood hazard data for floodplain management and flood insurance purposes. This Flood Insurance Study may not contain all data available within the repository. It is advisable to contact the community repository for any additional data.

This preliminary Flood Insurance Study contains profiles presented at a reduced scale to minimize reproduction costs. All profiles will be included and printed at full scale in the final published report.

Part or all of this Flood Insurance Study may be revised and republished at any time. In addition, part of this Flood Insurance Study may be revised by the Letter of Map Revision process, which does not involve republication or redistribution of the Flood Insurance Study. It is, therefore, the responsibility of the user to consult with community officials and to check the community repository to obtain the most current Flood Insurance Study components. A listing of the Community Map Repositories can be found on the Index Map.

Initial Countywide FIS Effective Date: April 3, 1989

First Countywide FIS Revision Date: August 18, 1992 (Flood Insurance Rate Map Only)

Second Countywide FIS Revision Date: November 19, 1997

Third Countywide FIS Revision Date: <to be determined>

FLOOD INSURANCE STUDY

BREVARD COUNTY, FLORIDA AND INCORPORATED AREAS

1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study (FIS) revises and updates information on the existence and severity of flood hazards in the geographic area of Brevard County, including the Cities of Cape Canaveral, Cocoa, Cocoa Beach, Indian Harbour Beach, Melbourne, Palm Bay, Rockledge, Satellite Beach, Titusville, and West Melbourne; the Towns of Grant-Valkaria, Indialantic, Malabar, Melbourne Beach, Melbourne Village, and Palm Shores; the Cape Canaveral Port Authority; and the unincorporated areas of Brevard County (referred to collectively herein as Brevard County), and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study has developed flood-risk data for various areas of the community that will be used to establish actuarial flood insurance rates and to assist the community in its efforts to promote sound floodplain management. Minimum floodplain management requirements for participation in the National Flood Insurance Program (NFIP) are set forth in the Code of Federal Regulations at 44 CFR, 60.3.

In some States or communities, floodplain management criteria or regulations may exist that are more restrictive or comprehensive than the minimum Federal requirements. In such cases, the more restrictive criteria take precedence, and the State (or other jurisdictional agency) will be able to explain them.

1.2 Authority and Acknowledgments

The sources of authority for this FIS report are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The original April 3, 1989 countywide FIS was prepared to include all jurisdictions within Brevard County into a countywide format FIS. Information on the authority and acknowledgements for each jurisdiction with a previously printed FIS report included in this countywide FIS is shown below.

For the original April 3, 1989, countywide FIS, the coastal analysis for the open coast of the Atlantic Ocean was prepared by Greenhorne & O'Mara, Inc., under contract to FEMA. The analysis included wave setup, wave runup, dune erosion, and wave heights. The hydrologic and hydraulic analyses were performed by Gee & Jenson, Inc., for FEMA, under Contract No. EMW-84-C-1609. That work was completed in December 1986 (Reference 1).

For the November 19, 1997, revision, the floodway for Otter Creek was added from the City of Melbourne FIS (Reference 2) to correct the omission of this data during the preparation of the original countywide FIS for Brevard County. In support of this revision, profiles for Otter Creek and Horse Creek were added (Reference 3).

For this revision of the countywide FIS report, new hydrologic and hydraulic analyses were performed by the Watershed IV Alliance for the Federal Emergency Management Agency (FEMA), under Contract No. EMA-2002-CO-011A, Task Order No. 022B. This study was completed in January 2011. Various ponding areas within the North Merrit Island area of Brevard County were included in these analyses.

The topographic information consisted of 10 meter Digital Elevation Models produced by the U.S. Geological Survey (USGS) (Reference 2). Planimetric base map information shown on all FIRM panels was derived from multiple sources. Road centerlines, stream centerlines and political boundary files were provided by Brevard County and Florida Division of Emergency Management, and St. John's River Water Management District, and additional stream centerlines were downloaded from the National Hydrography Dataset provided by the USGS (Reference 3). Users of this FIRM should be aware that minor adjustments may have been made to specific base map features.

Base map information shown on this FIRM was provided in digital format by Brevard County and the Florida Division of Emergency management. The ortho photography is dated 2009.

The coordinate system used for the production of this FIRM is Transverse Mercator State Plane Florida East FIPS 0901, North American Datum of 1983 (NAD 83) HARN, GRS 80 spheroid. Differences in the datum and spheroid used in the production of FIRMs for adjacent counties may result in slight positional differences in map features at the county boundaries. These differences do not affect the accuracy of information shown on the FIRM.

1.3 Coordination

An initial Consultation Coordination Officer (CCO) meeting (also occasionally referred to as the Scoping meeting) is held with representatives of the communities, FEMA, and the study contractors to explain the nature and purpose of the FIS and to identify the streams to be studied by detailed methods. A final CCO (often referred to as the Preliminary DFIRM Community Coordination, or PDCC, meeting) is held with representatives of the communities, FEMA, and the study contractors to review the results of the study.

For the original April 3, 1989, FIS report, an initial CCO meeting was held in April 1984 and a final CCO meeting was held on May 9, 1988. Both meetings were attended by representatives of the county, Gee & Jenson, Inc., and FEMA. Coordination with community officials and Federal, state, and regional agencies produced various information pertaining to floodplain regulations, available maps and topography, flood history, and other hydrographic data. Agencies contacted for information included the National Ocean Service, Tide and Water Levels Division and Data Control Section; the Melbourne-Tillman Water Control District; the Florida Institute of Technology; the

Florida Department of Natural Resources (FDNR), Division of Beaches and Shores; the Harbor Branch Foundation; the Press Journal and Today Newspapers; the Florida East Coast Railway; the U.S. Army Corps of Engineers (USACE), Jacksonville District; the St. John's River Water Management District; the U.S. Soil Conservation Service (now the Natural Resources Conservation Service); the U.S. Geological Survey (USGS); the Florida Department of Transportation (FDOT); and the Florida Department of Environmental Regulation.

For the November 19, 1997, revision, the county was notified by FEMA in a letter dated August 7, 1995, that flood hazard information from the City of Melbourne FIS was being incorporated into the countywide FIS.

For this revision of the countywide FIS, the initial CCO meeting was held on August 29, 2008, and attended by representatives of FEMA, the Watershed IV Alliance, community officials, Canaveral Port Authority, the State of Florida, and various consulting firms.

The results of the study were reviewed at the final CCO meeting held on __________, and attended by representatives of ________________________________. All problems raised at that meeting have been addressed in this study.

2.0 AREA STUDIED

2.1 Scope of Study

This FIS report covers the geographic area of Brevard County, Florida, including the incorporated communities listed in Section 1.1.

For this revision, 17.5 square miles of new ponding areas within the North Merrit Island area were studied using detailed methods. Floodplain boundaries of Coastal AE areas, streams and ponding areas that had been previously studied by detailed methods were redelineated based on more detailed and up-to-date topographic data. Coastal VE zones were remapped based on the new Primary Frontal Dune (PFD) location, according to FEMA's 2007 Guidance for Atlantic and Gulf Coasts of the United States. All other coastal zone breaks were digitized from the previous effective maps and remain unchanged due to the datum shift not being at a whole foot interval. Re-running the effective coastal model for overland analysis was not included in the scope of work for this study. In addition, the lack of accurate transect location information would not have resulted in a desirable outcome. Redelineated coastal and ponding areas within the county are now shown to the tenth of a foot on the FIRM panels to reflect the datum conversion from National Geodetic Vertical Datum of 1929 (NGVD29) to North American Vertical Datum of 1988 (NAVD).

For the 1997 revision, a detailed coastal flooding analysis was performed on the complete coastline of Brevard County, where the flooding sources are the Atlantic Ocean, the Indian and Banana Rivers, Mosquito Lagoon, and New Found Harbour. Also, detailed analyses for Horse Creek and Otter Creek within the City of Melbourne were incorporated. The Melbourne-Tillman Canal, Horse Creek, Otter Creek, several lakes and ponds in Cocoa, Channel F in Palm Bay, and Sloughs A, B, and C in Rockledge were not restudied for the 1997 revision but previous information for those streams was used in that study.

For the original 1989 countywide FIS report, the following flooding sources were studied by detailed methods: the Eau Gallie River; Crane Creek, including Channel A and Channel B; Turkey Creek, including the main channel and Channels A, B, C, D, E, and G and C-76; Goat, Kid, Trout, North and South Prong Creeks; and ponding in and around the City of Titusville.

The areas studied by detailed methods were selected with priority given to all known flood hazards and areas of projected development or proposed construction. "Flooding Sources Studied by Detailed Methods" are presented in Table 1.

Table 1: Flooding Sources Studied by Detailed Methods

Flooding Source	Reach Length (miles)	Study Area
Atlantic Ocean	70.0	Brevard County Coastline
Channel F	1.4	From approximately 200 feet downstream of Dowse Court to Norwood Street
Crane Creek	4.6	From its confluence with Indian River to Evans Road
Crane Creek Channel A	1.1	From its confluence with Crane Creek to approximately 440 feet upstream of Rialto Place
Crane Creek Channel B	0.9	From its confluence with Crane Creek to approximately 300 feet upstream of Spring Oak Drive
Crane Creek Diversion	2.8	From John Rodes Boulevard to Evans Road
Eau Gallie River	4.1	From confluence with Indian River to a point approximately 240 feet downstream of Aurora Drive
Elbow Creek	0.9	From the confluence with Eau Gallie River to a point approximately 1,400 feet upstream of Laurie Street
Goat Creek	3.5	From the confluence with Indian River to a point approximately 3,450 feet upstream of Leghorn Road
Horse Creek	1.2	From confluence with Indian River to approximately 1,600 feet upstream of Croton Road

Table 1: Flooding Sources Studied by Detailed Methods (continued)

Flooding Source	Reach Length (miles)	Study Area
Kid Creek	1.0	From the confluence with Indian River to approximately 3,375 feet upstream of William Avenue
Melbourne Tillman Canal	7.2	From the confluence with Melbourne Tillman Canal Tributary 1 to the confluence with Turkey Creek Channel C
North Prong Creek	2.2	From the confluence with Sebastian Creek to a point approximately 50 feet upstream of Wilden Road
Otter Creek	0.7	From approximately 400 feet downstream of Robin Hood Drive to a point approximately 1,450 feet upstream of Sherwood Boulevard
Sebastian Creek	1.4	From the confluence with Sebastian Creek Tributary 3 to the confluence with Sebastian River
South Prong Creek	2.6	From the confluence with Indian River to the County boundary
St. John’s River	83.5	From the Volusia/Seminole County boundary to the Brevard/Indian River County boundary
Trout Creek	1.3	From confluence with Indian River to Grant Road
Turkey Creek	2.8	From the confluence with Indian River to approximately 450 feet upstream of the divergence of the Melbourne Tillman Canal
Turkey Creek Channel A	2.0	From confluence with Turkey Creek to approximately 525 feet downstream of Babcock Street
Turkey Creek Channel B	1.3	From confluence with Turkey Creek to approximately 110 feet downstream of Malabar Road
Turkey Creek Channel C	1.1	From confluence with Turkey Creek to Malabar Road
Turkey Creek Channel C-76	1.9	From confluence with Turkey Creek Channel D to a point approximately 1,400 feet upstream of Charles Boulevard
Turkey Creek Channel D	0.7	From the confluence with Turkey Creek Channel C to Malabar Road
Turkey Creek Channel E	0.3	From confluence with Turkey Creek Channel D to approximately 100 feet downstream of Malabar Road

Table 1: Flooding Sources Studied by Detailed Methods (continued)

Flooding Source	Reach Length (miles)	Study Area
Turkey Creek Channel G	0.6	From the confluence with Turkey Creek Channel C to a point approximately 150 feet downstream of Malabar Road
Various Zone AE Ponds*	1.4 sq. mi.	North – State Route 528, East –Clearlake Road, South – Pluckebaum Road, West – St. John's River Basin
Various Zone AE Ponds	3.9 sq. mi.	East of I-95, South of La Flor Drive, North of Wickham Road, and West of US-1
Various Zone AH Ponds	1.5 sq. mi.	Countywide

* Flooding source with new or revised analysis incorporated as part of the current study update

Numerous streams were studied by approximate methods, as indicated in Table 2, "Flooding Sources Studied by Approximate Methods." Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon, by FEMA and the Watershed Alliance IV. All the approximate zones for streams and ponding areas in this table were refined and re-established for this revision to the countywide FIS report.

Table 2: Flooding Sources Studied by Approximate Methods

Addison Creek	Jane Green Creek	Spoil Bank
Ellis Creek	Kid Creek	Ten Mile Creek
Eau Gallie River Tributary 5	North Prong	Trout Creek
Eau Gallie River Tributary 7	Otter Creek	Wolf Creek
Goat Creek	Sebastian Creek	Various Unnamed Streams
Horse Creek	Sixmile Creek	Various Unnamed Ponding Areas

Mapping for Brevard County, Florida, and incorporated areas has been prepared using digital data. Previously published FIRM and Flood Boundary and Floodway Map data produced manually have been converted to vector digital data by a digitizing process.

This countywide FIS also incorporates the determination of letters issued by FEMA, resulting in Letters of Map Revision as shown in Table 3, "Letters of Map Revision."

Table 3: Letters of Map Revision

Case Number	Flooding Source(s)	Communities Affected	Effective Date
00-04-277P	Ponding Areas 1-5	Brevard County City of Rockledge	2/16/2001
05-04-3609P	N/A	Brevard County	9/26/2005
11-04-2906P	Atlantic Ocean	Brevard County	2/28/2011

2.2 Community Description

Brevard County is located near the middle of the east coast of Florida along the Atlantic Ocean. The county is bordered on the north by Volusia County; on the east by the Atlantic Ocean; on the south by Indian River County, Florida; on the southwest by Osceola County, Florida; on the west by Orange County, Florida; and on the northwest by Seminole County. The county encompasses an area of 1,557 square miles which includes 539 square miles of water (primarily the Atlantic Ocean, the St. John’s River, and the Indian River Lagoon).

Brevard County has a mild, subtropical climate, with average temperatures in the City of Titusville ranging from 60.5 degrees Fahrenheit (°F) in January to 80.2 °F in August (Reference 4). The wet season extends from June through November with September as the wettest month, averaging 7.83 inches of rainfall. Average annual rainfall is approximately 57 inches. Prevailing winds are from the southeast and east in the spring and summer and from the northeast in the fall. Brevard County is less frequently impacted by direct hurricane landfalls than portions of the Panhandle or South Florida because the hurricanes are often steered northwest and offshore or they weaken to a tropical storm.

The topography of Brevard County is divided into three major features: the barrier islands; the coastal ridge, which forms the eastern boundary of the mainland; and the low and marshy St. John's River Valley, which includes all of the area west of the coastal ridge. Elevations along the coastal areas vary from approximately 6 feet North American Vertical Datum of 1988 (NAVD) on Merritt Island to elevations over 20 feet NAVD along the mainland ridge, dropping to approximately 14 feet NAVD at Titusville (Reference 5). Elevations along the barrier island dunes reach 15 to 20 feet NAVD.

The primary north-south transportation arteries serving Brevard County are U.S. Route 1 and Interstate 95. State Roads 3, 5, 9, 46, 50, 192, 402, 515, 520, 524, and 528 serve the inland portions of the county and connect to Florida's Turnpike and Interstate 4. Other transportation arteries include the Florida East Coast Railway, which parallels the mainland coast, and the Intracoastal Waterway within the Indian River and Mosquito Lagoon.

The year 2010 population of Brevard County was reported as 543,376 (Reference 6). The population for the county grew by 107.1% in the last three decades of the 1900s.

Residential, commercial, and industrial development in Brevard County occurs mainly along the coastal barrier islands and the western shore of the Indian River, east of Interstate 95. Areas west of Interstate 95 are generally undeveloped or agricultural, although the City of Palm Bay is experiencing significant development. In 2007 retail trade was the largest of 20 major economic sectors in Brevard County.

The county seat of Brevard County is the City of Titusville, which is located along the Indian River on the coastal ridge approximately 40 miles east of the City of Orlando, Florida. The year 2006 population for Titusville was estimated as 44,027 (Reference 6). Population figures for other communities discussed here are based on the year 2000. The communities of Cocoa (population 16,412), Rockledge (population 20,170), Palm Shores (population 794), Melbourne (population 71,382), Melbourne Village (706), West Melbourne (population 9,824), Palm Bay (79,413), and Malabar (population 2,622) are distributed between Interstate 95 and U.S. Route 1 on the coastal ridge south of Titusville. The John F. Kennedy Space Center and the Cape Canaveral Air Force Base are located east of Titusville on Merritt Island and the adjacent barrier islands. The communities of Cape Canaveral (population 8,829), Cocoa Beach (population 12,482), Satellite Beach (population 9,577), Indian Harbour Beach (population 8,152), Indialantic (2,944), and Melbourne Beach (3,335) are located on the barrier islands south of Merritt Island. The Canaveral Port Authority is an independent governmental agency created by the Florida Legislature that has jurisdiction over all fiscal and regulatory policies and operation of the Port, which is in the community of Cape Canaveral.

The northwestern boundary of Brevard County is the St. John’s River. The St. John's River is the largest river in Florida, with a basin of approximately 9,430 square miles measured at its discharge into the Atlantic Ocean near the City of Jacksonville. From its headwaters in Indian River County to the south, the St. John’s River flows northward through Brevard County and into Volusia County. Several small tributaries, including Jane Green Creek, Ten Mile Creek, Wolf Creek, and Sixmile Creek, are included in this study.

The eastern edge of Brevard County contains the waterways of the Indian River Lagoon. This 156-mile long estuary lies between the mainland and barrier islands from Volusia County to the north, through Brevard County, and extending south to Palm Beach County. The Atlantic Intracoastal Waterway runs through the Indian River Lagoon for its length. Five inlets allow for exchange of fresh and saltwater in the lagoon. In Brevard County, the Indian River Lagoon begins as Mosquito Lagoon in the north, picks up the Banana River on the east side of Merritt Island, and continues as the Indian River south of Merritt Island, encountering Sebastian Inlet at the southern boundary of Brevard County. Other small streams, such as the Eau Gallie River and Turkey, Crane, Goat, Kid, Trout, and Sebastian Creeks (and the North and South Prongs) drain the coastal highland areas and discharge into the Indian River.

2.3 Principal Flood Problems

Floods resulting from prolonged, heavy rainfall can occur in streams that drain the coastal highland areas and discharge into the Indian and St. John's Rivers. Flooding from heavy rainfall occurs in lowland areas and streams including the Eau Gallie River, Crane Creek, Crane Creek Channels A and B, Turkey Creek, Turkey Creek Channels A, B, C, D, E, F, G, and C-76, and Goat, Kid, Trout, and North and South Prong Creeks, and their respective tributaries. In the Cocoa West area, new residential and light industrial development has flooded in areas that are shown as outside the Special Flood Hazard Areas. Repeated flooding has also been reported in areas around North Titusville and Mims.

Coastal areas of the county on the Atlantic Ocean are subject to storm surge flooding as a result of hurricane and tropical storm activity. Large tidal surges, combined with wave action and the heavy rainfall that accompanies the storms, have caused flooding. Areas along the Banana and Indian Rivers and Mosquito Lagoon experience flooding from wind tides caused by hurricane winds piling water against shorelines and various causeways and bridges over the rivers. North Merritt Island has had repeated flooding since the last major FIS revision.

There is considerable historical evidence of storms affecting the southeastern coast of the United States before the 20th century (Reference 7). Some of the most significant 20th (Reference 8) and 21st century storms (Reference 9) that have affected the study area are described below.

September 6-22, 1926 - The Cities of Titusville and Melbourne had tide levels in the Indian River estimated at 5 feet NGVD.

September 6-20, 1928 - Hurricane winds of 80 miles per hour (mph) lasted nearly 6 hours along the Indian River. Tide levels in the Indian River were estimated at 3.5 feet NGVD in the Town of Mims, 5 feet NGVD in Titusville, and 7 feet NGVD in Melbourne.

October 13-21, 1944 - A tide level of 3.9 feet NGVD was measured in the Eau Gallie River at the Atlantic Ocean, and the tide level was estimated at 3.4 feet NGVD in the Banana River at the City of Audubon.

September 11-19, 1947 - A hurricane made landfall at the City of Fort Lauderdale, with the Eau Gallie River measuring 4.6 feet NGVD at the Atlantic Ocean. The City of Fort Pierce reported tide levels of 6.8 to 8.8 feet NGVD at the Atlantic Ocean and the river areas near the inlet.

September 19-25, 1948 - The Eau Gallie River had tides at the Atlantic Ocean of 4.9 feet NGVD. The Indian River had a tide level of 4.8 feet NGVD at Melbourne and the Banana River had a tide level of 3.3 feet NGVD at Audubon.

August 24-29, 1949 - The Eau Gallie River had tide levels at the Atlantic Ocean of 4.5 feet NGVD. Melbourne estimated tide levels to be 3.5 feet NGVD in the Indian River, and the City of Sebastian measured tide levels at 1.8 feet NGVD in the Indian River.

October 15-19, 1950 - Hurricane King made landfall at the City of Miami and traveled inland parallel to the coastline. The Eau Gallie River measured 3.4 feet NGVD at the

Atlantic Ocean, the Indian River at Titusville was 5.0 feet NGVD, and the Banana River at Audubon was 2.3 feet NGVD.

October 7-12, 1953 - Tropical Storm Hazel exited into the Atlantic Ocean near Vero Beach. Tide levels in the Atlantic Ocean at Eau Caine were measured at 5.0 feet NGVD, and the Indian River at Titusville measured 2.3 feet NGVD.

August 25-September 7, 1979 - Hurricane David - The Kennedy Space Center reported tides of 5 feet above normal at the Atlantic Ocean, the Port Canaveral Coast Guard reported tides 4 feet above normal, and Patrick Air Force Base recorded a total rainfall of 6.28 inches (Reference 10).

August 2, 1995 - Tropical Storm Erin storm dropped 7–10 inches of rain, flooding much of Palm Bay and Melbourne. Most major and secondary roads were impassable and over 100 homes and businesses received some flood damage, while one department had its roof collapse due to the weight of the water (Reference 9).

September 3, 2004 – Hurricane Frances struck neighboring Vero Beach, Indian County directly and caused widespread flooding of roads, residences, and businesses in Brevard County.

September 25-26, 2004 - Hurricane Jeanne struck Vero Beach directly, following nearly the same path as Hurricane Frances. Palm Bay reported flooded streets and roads.

October 24, 2005 – Hurricane Wilma produced 10–13 inches of rain in the northern part of the county, flooding approximately 200 homes in Cocoa.

August 19-20, 2008 - Tropical Storm Fay dropped more than 27 inches of rain in Melbourne. The storm caused flooding or damage to over 1,600 homes and businesses across the county, with a loss of nearly 60 million dollars in private property and an additional 10 million dollars in damage to public infrastructure.

2.4 Flood Protection Measures

A series of levees exist in the eastern portion of the St. John’s River floodplain. Breaks occur in the levees and the elevations are not uniform. In addition, they do not have a consistent 3-foot freeboard above 1-percent-annual-chance frequency levels. It has therefore been ascertained that the levees may not protect the community from rare events such as the 1-percent-annual-chance flood, although they do afford some protection from lower flood stages. Levees and dikes exist along canals in other areas and are generally not considered adequate for flood control for the same reasons.

A water control structure (the Melbourne-Tillman Water Control Structure MS-1) to control water levels in the Melbourne-Tillman canal system is located just above Port Malabar road in Palm Bay. Although not designed as a flood control structure, it provides some protection during low level flood conditions.

No other flood protection measures are known to exist within the study area.

3.0 ENGINEERING METHODS

For the flooding sources studied by detailed methods in the county, standard hydrologic and hydraulic study methods were used to determine the flood-hazard data required for this study. Flood events of a magnitude that is expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10-, 2-, 1-, and 0.2-percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term, <u>average</u> period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood that equals or exceeds the 1-percent-annual-chance flood in any 50-year period is approximately 40 percent (4 in 10); for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish peak discharge-frequency relationships for each flooding source studied by detailed methods affecting Brevard County, including both riverine and coastal sources.

Information on the methods used to determine peak discharge-frequency relationships for the streams studied by detailed methods is shown below.

3.1.1 Methods for Flooding Sources Incorporated from Previous Studies

The 1-percent-annual-chance flood profile for the St. John's River was obtained from the St. John's River Water Management District (Reference 11). The flood profile was completed by conducting statistical frequency analyses on observed or simulated annual peak flow data and then performing backwater computations on flood flows of the desired frequencies, mean annual peak flow, and the 20-, 10-, 4-, 2-, and 1-percent-annual-chance floods. These flood profiles supersede those presented in the USAGE "General Design Memorandum" (Reference 12).

Regionalized regression equations developed by the USGS, in cooperation with the Florida Department of Transportation, were used for determining peak discharge-frequency relationships for the Eau Gallie River, Crane, Goat, Trout, Kid, and North Prong Creeks, and Tributaries of Turkey Creek (Reference 13). The peak discharges for Turkey Creek east of the Melbourne-Tillman Water Control District water control structure MS-1 were adopted from a detailed hydrologic study (Reference 14). Storm water runoff hydrographs were generated for over 380 individual drainage subbasins and then routed hydrodynamically through Turkey Creek and its associated canals and tributaries.

The upstream portion of Crane Creek is a manmade canal that cuts through a land ridge, which formerly divided the natural drainage areas of the St. John's River and the Indian River. During high flood stages, this allows a portion of the flow to go westward into the St. John's River floodplain. The drainage areas shown in Table 4 represent the areas under low flow conditions. During the period of high flood stages, the actual contributing drainage areas may vary due to overflow toward the St. John's River. The rates of overflow westward were computed based on the hydraulic conditions of Crane Creek and the St. John's River. The westerly flow rates were computed with the assumption that the starting water-surface elevations at the west side of John Rodes Boulevard are the same elevations as the St. John's River flood elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance frequencies.

Some of the flood conditions in the Titusville area were considered as ponding-type flooding. The flood elevations were determined with a volumetric analysis of the stormwater runoff. The study area was divided into five subbasins and stage-storage relationships were computed using topographic maps developed by the City of Titusville (Reference 15).

For Horse Creek and Otter Creek, rainfall-frequency estimates were obtained by statistical analysis of records prepared by the U.S. Weather Bureau, Technical Paper No. 40 (Reference 16). The amount of rainfall that will run off (rainfall excess) from a particular basin is less than the rainfall due to soil permeability, vegetation cover, and other characteristics. To estimate the rainfall excess, the SCS has developed Runoff Curve Numbers which relate rainfall to direct runoff (Reference 17). The Runoff Curve Numbers were used to calculate the infiltration losses based on the soil type and land use.

The hydrology for Horse Creek and Otter Creek were formulated by the TRACOR Method (Reference 18). The TRACOR method of urban hydrology uses mathematical equations derived from field experiments and observations to calculate volume and peak rates of storm runoff at a desired location as a result of recurring storms of 10-, 2-, 1-, and 0.2-percent-annual-chance frequencies. The SCS method was used to check the TRACOR method (Reference 17). The SCS method uses mathematical equations derived from field experiments and observations to calculate peak flows and volumes.

3.1.2 Methods for Flooding Sources with New or Revised Analyses in Current Study

Detailed hydrologic calculations for North Merrit Island area were performed using the ICPR program (Reference 19). The standard Soil Conservation Service (SCS) methodology was utilized, with the exception of using a peaking factor of 256 in lieu of the standard 484 peaking factor (Reference 20). This variation was adopted to account for the difference in terrain between the SCS default terrain and the terrain in Brevard County (gently rolling hills and flat areas with slight slopes, respectively). Land use data was obtained from Saint Johns River Water Management District and soil data was obtained from Natural Resources Conservation Service's Soil Data Mart. Based on guidance from NRCS TR-55 (Reference 21), a 24 hour event with SCS antecedent moisture type III distribution is used for North Merrit Island area.

A summary of the drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 4, "Summary of Discharges."

Table 4: Summary of Discharges

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
CRANE CREEK					
At mouth	19.27	712	1,300	1,488	2,077
At a point approximately 2,200 feet upstream of Florida East Coast Railway	18.21	692	1,260	1,428	1,992
At Babcock Street	13.81	559	1,025	1,133	1,537
At Country Club Road	11.32	467	863	948	1,252
At New Haven Avenue	10.84	450	830	911	1,194
At Dairy Road	9.29	387	730	793	1,015
At Evans Road	8.17	347	655	708	882
CRANE CREEK CHANNEL A					
At mouth	0.90	130	250	160	220
At a point approximately 1,500 feet upstream of mouth	0.45	90	180	220	340
At Airport Boulevard	0.27	70	120	160	220
CRANE CREEK CHANNEL B					
At mouth	0.44	90	260	400	750
At Country Club Road	0.29	70	210	350	710
At South Fairway Drive	0.19	60	170	300	590
CRANE CREEK CHANNEL B					
At mouth of unnamed tributary	1.90	185	355	470	703

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second)			
		10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
At a point approximately 1,600 feet downstream of Dairy Road	1.37	155	305	400	610
CRANE CREEK DIVERSION FROM ST. JOHN'S RIVER					
At Dayton Boulevard	6.85	295	*	*	*
At Wickham Road	5.47	*	130	272	618
At John Rodes Boulevard	3.44	83	130	272	618
EAU GALLIE RIVER					
At mouth	8.25	675	1,220	1,475	2,210
At U.S. Route 1	4.79	495	885	1,075	1,590
At Florida East Coast Railway	4.62	485	870	1,055	1,560
At Eau Gallie Boulevard	3.23	390	700	860	1,285
At Croton Road	2.78	350	635	780	1,185
At Wickham Road	1.37	193	360	435	669
GOAT CREEK					
At U.S. Route 1	9.91	298	542	680	1,038
At Old Valkaria Road	9.36	285	520	650	995
At Henderson Drive	8.74	273	492	620	947
At Highland Road	7.20	238	428	541	827
At a point approximately 800 feet downstream at Leghorn Road	6.90	230	417	528	805

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second)			
		10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
GOAT CREEK(continued)					
At Leghorn Road	0.96	75	134	185	298
HORSE CREEK					
At mouth	3.09	870	1,490	1,800	2,200
At Croton Road	1.97	530	960	1,080	1,400
KID CREEK					
At mouth	1.77	99	180	240	378
At a point approximately 600 feet upstream of Old Dixie Highway	1.59	94	170	229	360
At a point approximately 2,600 feet upstream of Old Dixie Highway	1.35	88	157	212	340
At a point approximately 0.91 mile upstream of Old Dixie Highway	1.26	84	150	205	330
NORTH PRONG CREEK					
At mouth	20.79	771	1,383	1,690	2,533
At a point approximately 1.52 miles upstream of mouth	19.43	749	1,344	1,642	2,457
At a point approximately 1.99 miles upstream of mouth	18.55	634	1,148	1,408	2,145
OTTER CREEK					
At mouth	1.08	350	650	790	980

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
At Robin Hood Drive	0.71	220	410	490	610
SOUTH PRONG CREEK					
At U.S. Route 1	202.00	2,800	5,000	6,000	9,000
At a point approximately 2.08 miles upstream of U.S. Route 1	80.80	1,950	3,400	4,150	6,100
TROUT CREEK					
At mouth	10.57	314	570	710	1,088
At Third Street	8.35	264	478	600	918
TURKEY CREEK					
At mouth	*	8,500	10,000	10,700	12,000
Just downstream of confluence of Turkey Creek Channel B	*	7,400	8,800	9,450	10,800
At Control Structure MS-1	*	6,200	7,400	8,000	9,000
TURKEY CREEK CHANNEL A					
At mouth	3.73	258	490	635	955
At Clearmont Street	2.53	210	407	535	800
TURKEY CREEK CHANNEL A					
At a point approximately 1,500 feet upstream of Clearmont Street	0.81	120	240	337	510

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
TURKEY CREEK CHANNEL B					
At mouth	1.68	173	330	442	668
At Malabar Road	1.14	140	280	380	575
TURKEY CREEK CHANNEL C					
At mouth	7.34	395	733	915	1,400
Just upstream of confluence of Turkey Creek Channel D	1.10	80	152	190	345
TURKEY CREEK CHANNEL C-76					
At mouth	1.49	164	318	427	640
At Babcock Street	0.70	110	223	320	490
TURKEY CREEK CHANNEL D					
At mouth	4.96	305	570	730	1,105
TURKEY CREEK CHANNEL D					
At a point approximately 400 feet downstream of confluence of Turkey Creek Channel E	3.40	245	468	610	912
At a point approximately 700 feet upstream of confluence of Turkey Creek Channel E	3.00	215	400	528	797
TURKEY CREEK CHANNEL E					
At mouth	3.03	30	70	82	115

Table 4: Summary of Discharges (continued)

Flooding Source and Location	Drainage Area (Square miles)	Peak Discharges (Cubic Feet per Second)			
		10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance
TURKEY CREEK CHANNEL G					
At mouth	1.10	120	230	315	410

* Data Not Available

Inundation from the Atlantic Ocean, the Indian River, and the Banana River caused by passage of storms (storm surge) was determined by the joint probability method (Reference 22). The storm populations were described by probability distributions of five parameters that influence surge heights. These parameters were central pressure depression (which measures the intensity of the storm), radius to maximum winds, forward speed of the storm, shoreline crossing point, and crossing angle. These characteristics were described statistically based on an analysis of observed storms in the vicinity of Brevard County. Primary sources of data for this analysis were the *Tropical Cyclones of the North Atlantic Ocean*; *Some Climatological Characteristics of Hurricanes and Tropical Storms, Gulf and East Coasts of the United States*; and *Meteorological Criteria for Standard Project Hurricane and Probable Maximum Hurricane Windfields, Gulf and East Coasts of the United States,* all prepared by the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA) (References 23; 24; 25). A summary of the parameters used for the area is presented in Table 5, "Parameter Values for Surge Elevations."

Table 5: Parameter Values for Surge Elevations

<table>
<tr><th>Parameter</th><th colspan="8">Assigned Values</th></tr>
<tr><td>Central pressure depression (millibars)</td><td>18.9</td><td>32.6</td><td>46.4</td><td>60.1</td><td>73.9</td><td>87.6</td><td>101.4</td><td>115.1</td></tr>
<tr><td>Probability[1]</td><td>0.274</td><td>0.358</td><td>0.181</td><td>0.092</td><td>0.047</td><td>0.024</td><td>0.012</td><td>0.012</td></tr>
<tr><td>Storm radius to maximum winds (nautical miles)</td><td colspan="4">13.0</td><td colspan="4">28.0</td></tr>
<tr><td>Probability</td><td colspan="4">0.433</td><td colspan="4">0.567</td></tr>
<tr><td>Forward speed (knots)</td><td colspan="3">7.5</td><td colspan="3">16.5</td><td colspan="2">25.5</td></tr>
<tr><td>Probability[2]</td><td colspan="3">0.533</td><td colspan="3">0.413</td><td colspan="2">0.054</td></tr>
<tr><td>Direction of storm path (degrees from true north)</td><td colspan="2">47.0</td><td colspan="2">111.0</td><td colspan="2">174.0</td><td colspan="2">238.0</td></tr>
<tr><td>Probability[2]</td><td colspan="2">0.036</td><td colspan="2">0.222</td><td colspan="2">0.353</td><td colspan="2">0.389</td></tr>
<tr><td>Frequency of storm occurrence (storm/nautical mile/year)</td><td colspan="8">0.00455</td></tr>
</table>

[1] Probabilities for entering, alongshore, and exiting

[2] Probabilities for entering

For areas subject to flooding directly from the Atlantic Ocean, the Indian River, and the Banana River, the FEMA standard storm surge model was used to simulate the coastal surge generated by any chosen storm (that is, any combination of the five storm parameters defined previously). By performing such simulations for a large number of storms, each of known total probability, the frequency distribution of surge height can be established as a function of coastal location. These distributions incorporate the large-scale surge behavior, but do not include an analysis of the added effects associated with much finer scale wave phenomena, such as wave height or runup. As the final step in the calculations, the astronomic tide for the region is then statistically combined with the computed storm surge to yield recurrence intervals of total water level (Reference 26).

Wave setup was determined to significantly contribute to the total stillwater flood levels along the Atlantic Ocean coast. The amount of wave setup was calculated using methodology outlined in the USACE "Shore Protection Manual" (Reference 27).

The storm-surge elevations for the 10-, 2-, 1-, and 0.2-percent-annual-chance floods have been determined for the Atlantic Ocean, the Indian and Banana Rivers, Mosquito Lagoon, and New Found Harbour and are shown in Table 6, "Summary of Stillwater Elevations." The analyses reported herein reflect the stillwater elevations due to tidal and wind setup effects and include the contributions from wave action effects.

Table 6: Summary of Stillwater Elevations

Flooding Source and Transect	FIRM Panel	Stillwater Elevation (Feet NAVD) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	Zone	Base Flood Elevation[1,2] (Feet NAVD)
INDIAN RIVER							
1	40	2.2	4.4	5.4	7.8	AE	5.7-6.7
2	40	2.1	4.0	5.2	7.3	AE	5.7-6.7
MOSQUITO LAGOON							
3	45	1.4	2.9	3.7	6.5	AE	3.7-5.7
INDIAN RIVER							
4	45	1.5	4.1	4.9	6.9	VE AE	6.7-7.7 4.7-6.7
5	40	1.6	3.6	4.5	6.3	AE	4.7-6.7
ATLANTIC OCEAN							
6	65	3.5	5.8	8.8[3]	9.2	VE AE	10.7-13.7 8.7-10.7
MOSQUITO LAGOON							
7	45	1.4	2.9	3.7	6.5	AE	3.7-5.7
8	45	1.4	2.9	3.7	6.5	AE	3.7-5.7
INDIAN RIVER							
9	45 45	1.2 1.2	3.2 3.2	4.0 5.1	5.7 5.9	AE AE	3.7-5.7 4.7-6.7
10	105	1.0	2.6	3.4	4.9	AE	3.7-5.7

Table 6: Summary of Stillwater Elevations (continued)

Flooding Source and Transect	FIRM Panel	Stillwater Elevation (Feet NAVD) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	Zone	Base Flood Elevation[1,2] (Feet NAVD)
11	110	0.8	3.0	3.8	5.4	AE	3.7-5.7
ATLANTIC OCEAN							
12	130	3.4 3.4	5.7 5.7	8.6[3] 6.6	9.0 9.0	VE AE AE	10.7-13.7 8.7-10.7 6.7-7.7
MOSQUITO LAGOON							
13	130	1.4	2.9	3.7	6.5	AE	3.7-5.7
14	130	1.4	2.9	3.7	6.5	AE	3.7-5.7
INDIAN RIVER							
15	110,120,130	1.3	3.5	4.3	6.0	VE AE	6.7-7.7 4.7-6.7
16	115	0.6	2.0	2.5	3.9	AE	2.7-3.7
17	110, 130 110, 130 110, 130	1.3 1.3 1.3	3.1 2.4 1.6	3.7 3.0 1.9	5.2 4.5 3.1	AE AE AE	3.7-5.7 2.7-4.7 1.7-3.7
ATLANTIC OCEAN							
18	130,135	3.4 3.4	5.7 5.7	8.6[3] 6.6	9.0 9.0	VE AE AE	10.7-13.7 8.7-10.7 6.7-7.7
MOSQUITO LAGOON							
19	130	1.4	2.9	3.7	6.5	AE	3.7-5.7

Table 6: Summary of Stillwater Elevations (continued)

Flooding Source and Transect	FIRM Panel	Stillwater Elevation (Feet NAVD) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	Zone	Base Flood Elevation[1,2] (Feet NAVD)
20	130	1.4	2.9	3.7	6.5	AE	3.7-5.7
INDIAN RIVER							
21	120,130,140	0.9	2.3	2.8	4.4	AE	2.7-4.7
	120,130,140	0.9	1.5	1.9	2.9	AE	1.7-2.7
22	115	1.0	2.1	2.7	3.8	AE	2.7-3.7
23	115,180	0.7	1.7	2.2	3.3	AE	2.7-3.7
24	185	1.0	2.0	2.5	3.6	AE	2.7-3.7
25	140,185,205	0.6	1.5	1.9	3.1	AE	1.7-3.7
26	185	0.5	1.3	1.7	2.5	AE	1.7-2.7
ATLANTIC OCEAN							
27	145,230	3.5	5.7	8.9[3]	9.3	VE	10.7-14.7
						AE	8.7-10.7
		3.5	5.7	6.9	9.3	AE	6.7-7.7
MOSQUITO LAGOON							
28	145	1.7	3.6	4.3	6.0	AE	4.7-5.7
29	145	2.1	3.8	4.6	6.1	AE	4.7-5.7
INDIAN RIVER							
30	205,210	0.5	1.6	2.1	2.9	AE	1.7-3.7
	205,210	0.5	2.0	2.3	3.3	AE	2.7-3.7
	205,210	0.5	3.0	3.7	5.2	AE	3.7
31	195	-0.1	0.8	1.1	2.1	AE	0.7-2.7

Table 6: Summary of Stillwater Elevations (continued)

Flooding Source and Transect	FIRM Panel	Stillwater Elevation (Feet NAVD) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	Zone	Base Flood Elevation[1,2] (Feet NAVD)
ATLANTIC OCEAN							
32	145,230	3.5	5.7	8.9[3]	9.3	VE AE	10.7-14.7 8.7-10.7
INDIAN RIVER							
33	215,220,280 215,220,280 215,220,280	0.2 0.4 0.4	0.9 1.8 1.5	1.1 2.3 1.6	2.7 3.4 2.0	AE AE AE	1.7-2.7 2.7 1.7-2.7
34	195,260	0.1	0.8	1.3	2.1	AE	1.7-2.7
ATLANTIC OCEAN							
35	240	3.3	5.3	8.5[3]	8.6	VE AE	10.7-13.7 8.7-10.7
INDIAN RIVER							
36	280	0.6	1.7	2.1	3.1	AE	1.7-3.7
37	260	0.3	1.1	1.6	2.7	AE	1.7-2.7
BANANA RIVER							
38	305	1.3	3.0	3.7	5.1	AE	3.7-5.7
39	285	0.6	1.5	1.9	3.0	AE	1.7-3.7
ATLANTIC OCEAN							
40	310	3.1	5.0	8.0[3]	8.0	VE AE	9.7-12.7 7.7-9.7
BANANA RIVER							
41	305	0.9	2.3	2.8	4.1	AE	2.7-4.7

Table 6: Summary of Stillwater Elevations (continued)

Flooding Source and Transect	FIRM Panel	Stillwater Elevation (Feet NAVD) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	Zone	Base Flood Elevation[1,2] (Feet NAVD)
42	285	0.3	0.9	1.2	2.0	AE	1.7-2.7
INDIAN RIVER							
43	280,290	0.6	1.7	2.7	3.8	AE	2.7-3.7
44	270	0.6	1.6	2.1	3.2	AE	1.7-3.7
ATLANTIC OCEAN							
45	312	3.0	5.0	7.9[3]	8.1	VE AE	9.7-12.7 7.7-9.7
BANANA RIVER							
46	311	1.3	2.6	3.2	4.3	AE	2.7-4.7
47	295	0.2	0.9	1.1	1.7	AE	0.7-2.7
INDIAN RIVER							
48	290,295	0.8	1.9	2.5	3.9	AE	2.7-3.7
ATLANTIC OCEAN							
49	313	3.0	5.0	7.9[3]	8.1	VE AE	9.7-12.7 7.7-9.7
BANANA RIVER							
50	313	0.6	1.6	2.1	2.9	AE	1.7-3.7
51	295	0.5	1.5	1.9	2.7	AE	1.7-2.7
INDIAN RIVER							
52	290,295	0.8	2.2	2.7	4.4	AE	2.7-3.7

Table 6: Summary of Stillwater Elevations (continued)

Flooding Source and Transect	FIRM Panel	Stillwater Elevation (Feet NAVD) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	Zone	Base Flood Elevation[1,2] (Feet NAVD)
53	270,290	0.7	1.9	2.4	3.8	AE	2.7-3.7
ATLANTIC OCEAN							
54	313,376	3.1	5.2	8.1[3]	8.5	VE AE	10.7-13.7 7.7-9.7
BANANA RIVER							
55	313,376	0.9	2.1	2.5	3.5	AE	2.7-3.7
56	295,360	0.3	1.2	1.5	2.3	AE	1.7-2.7
INDIAN RIVER							
57	290,295	0.7	2.0	2.5	3.8	AE	2.7-3.7
58	290	0.7	1.9	2.4	3.6	AE	2.7-3.7
ATLANTIC OCEAN							
59	376,378	3.2	5.5	8.4[3]	8.9	VE AE	10.7-12.7 8.7-10.7
BANANA RIVER							
60	360,378 360,378	0.5 0.9	1.3 2.1	1.7 2.6	2.5 3.5	AE AE	1.7-2.7 2.7
61	360	0.6	1.4	1.8	2.7	AE	1.7-3.7
NEWFOUND HARBOUR							
62	360	1.5	3.0	3.6	4.8	AE	3.7-4.7
63	360	1.9 1.5	3.5 3.0	4.2 3.5	5.6 4.8	AE AE	4.7 4.7

Table 6: Summary of Stillwater Elevations (continued)

Flooding Source and Transect	FIRM Panel	Stillwater Elevation (Feet NAVD) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	Zone	Base Flood Elevation[1,2] (Feet NAVD)
INDIAN RIVER							
64	355	1.1	2.5	3.1	4.6	AE	2.7-4.7
65	355	1.2	2.7	3.4	4.9	AE	3.7-4.7
BANANA RIVER							
66	360	0.4	0.9	1.1	1.8	AE	0.7-1.7
67	360	0.5	1.1	1.3	1.9	AE	1.7
NEWFOUND HARBOUR							
68	360	0.6	1.4	1.7	2.3	AE	1.7-2.7
69	360	0.8	1.7	2.2	3.0	AE	2.7
ATLANTIC OCEAN							
70	386,388	3.4 3.4	5.7 5.7	8.9[3] 6.9	9.4 9.4	VE AE AE	10.7-14.7 8.7-10.7 6.7-7.7
BANANA RIVER							
71	386,388	0.1	1.0	1.1	1.4	AE	0.7-1.7
72	370	0.3	1.0	1.4	2.1	AE	1.7-2.7
INDIAN RIVER							
73	370	0.5	1.6	2.1	3.2	AE	1.7-2.7
74	365	0.6	1.7	2.2	3.5	AE	2.7
75	370	0.5	1.5	1.9	2.9	AE	1.7-2.7

Table 6: Summary of Stillwater Elevations (continued)

Flooding Source and Transect	FIRM Panel	Stillwater Elevation (Feet NAVD) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	Zone	Base Flood Elevation[1,2] (Feet NAVD)
76	365,370	0.5	1.5	1.9	2.9	AE	1.7-2.7
BANANA RIVER							
77	388	0.1	0.6	0.8	1.1	AE	0.7-1.7
ATLANTIC OCEAN							
78	451	3.3	5.6	8.8[3]	9.2	VE AE	10.7-14.7 8.7-10.7
BANANA RIVER							
79	453	0.4	1.2	1.5	2.3	AE	1.7-2.7
80	435	0.3	1.0	1.3	2.1	AE	1.7-2.7
INDIAN RIVER							
81	435	0.3	1.3	1.8	2.7	AE	1.7-2.7
82	435	0.4	1.4	1.8	2.6	AE	1.7-2.7
ATLANTIC OCEAN							
83	451,453	3.3	5.5	8.7[3]	9.0	VE AE	10.7-13.7 8.7-10.7
BANANA RIVER							
84	451,453	0.7	1.9	2.3	3.3	AE	2.7-3.7
85	435	0.6	1.5	1.9	2.9	AE	1.7-2.7
INDIAN RIVER							
86	435	0.3	1.3	1.7	2.7	AE	1.7-2.7

Table 6: Summary of Stillwater Elevations (continued)

Flooding Source and Transect	FIRM Panel	Stillwater Elevation (Feet NAVD) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	Zone	Base Flood Elevation[1,2] (Feet NAVD)
87	435	0.3	1.3	1.8	2.6	AE	1.7-2.7
BANANA RIVER							
88	435	0.1	1.0	1.4	2.3	AE	1.7
INDIAN RIVER							
89	435	0.5	1.8	2.4	3.8	AE	2.7-3.7
ATLANTIC OCEAN							
90	453,462	3.3	5.5	8.7[3]	9.0	VE AE	10.7-13.7 8.7-10.7
BANANA RIVER							
91	461	0.3	1.1	1.4	2.3	AE	1.7
92	461	0.3	1.1	1.4	2.3	AE	1.7
INDIAN RIVER							
93	461,442	0.3	1.4	2.0	3.2	AE	1.7-2.7
94	442	0.4	1.6	2.2	3.3	AE	1.7-3.7
ATLANTIC OCEAN							
95	464	3.3	5.5	8.7	9.0	VE AE	10.7-13.7 8.7-10.7
INDIAN RIVER							
96	463	0.3	1.3	1.7	2.9	AE	1.7-2.7
97	444	0.3	1.3	1.8	2.8	AE	1.7-2.7

Table 6: Summary of Stillwater Elevations (continued)

Flooding Source and Transect	FIRM Panel	Stillwater Elevation (Feet NAVD) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	Zone	Base Flood Elevation[1,2] (Feet NAVD)
ATLANTIC OCEAN							
98	464	3.2	5.4	8.6[3]	8.8	VE AE	10.7-13.7 8.7-10.7
INDIAN RIVER							
99	527	1.1	2.2	2.7	4.0	AE	2.7-3.7
100	526	1.1	2.2	2.7	4.0	AE	2.7-3.7
ATLANTIC OCEAN							
101	527	3.2	5.4	8.6[3]	8.8	VE AE	10.7-13.7 8.7-10.7
INDIAN RIVER							
102	527	1.1	2.2	2.7	4.0	AE	2.7-3.7
103	526	1.1	2.2	2.7	4.0	AE	2.7-3.7
ATLANTIC OCEAN							
104	529,533	3.2	5.4	8.6[3]	8.8	VE AE	10.7-13.7 8.7-10.7
INDIAN RIVER							
105	529	2.0	3.2	3.7	5.0	AE	3.7-5.7
106	528	2.0	3.2	3.7	5.0	AE	3.7-5.7
ATLANTIC OCEAN							
107	533	3.2	5.4	8.6	8.8	VE AE	10.7-13.7 8.7-10.7

Table 6: Summary of Stillwater Elevations (continued)

Flooding Source and Transect	FIRM Panel	Stillwater Elevation (Feet NAVD) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	Zone	Base Flood Elevation[1,2] (Feet NAVD)
INDIAN RIVER							
108	529	2.0	3.2	3.7	5.0	AE	3.7-5.7
109	528,529	2.0	3.2	3.7	5.0	AE	3.7-5.7
ATLANTIC OCEAN							
110	541	3.2	5.3	8.4[3]	8.8	VE AE	10.7-13.7 8.7-10.7
INDIAN RIVER							
111	541	2.1	3.3	3.8	5.1	AE	3.7-5.7
112	540	2.1	3.3	3.8	5.1	AE	3.7-5.7
ATLANTIC OCEAN							
113	541,543	3.2	5.3	8.4[3]	8.8	VE AE	10.7-13.7 8.7-10.7
INDIAN RIVER							
114	543	2.1	3.3	3.8	5.1	AE	3.7-5.7
115	540	2.1	3.3	3.8	5.1	AE	3.7-5.7
ATLANTIC OCEAN							
116	607	3.2	5.3	8.4[3]	8.8	VE AE	10.7-13.7 8.7-10.7
INDIAN RIVER							
117	607	2.2	3.4	3.9	5.2	AE	3.7-5.7
118	610	2.2	3.4	3.9	5.2	AE	3.7-5.7

Table 6: Summary of Stillwater Elevations (continued)

Flooding Source and Transect	FIRM Panel	Stillwater Elevation (Feet NAVD) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	Zone	Base Flood Elevation[1,2] (Feet NAVD)
ATLANTIC OCEAN							
119	607,609	3.2	5.3	8.3[3]	8.8	VE AE	10.7-13.7 8.7-10.7
INDIAN RIVER							
120	607,609	2.2	3.4	3.9	5.2	AE	3.7-5.7
121	610	2.2	3.4	3.9	5.2	AE	3.7-5.7
ATLANTIC OCEAN							
122	636	3.2	5.3	8.3[3]	8.8	VE AE	10.7-13.7 8.7-10.7
INDIAN RIVER							
123	609,617	2.3	3.5	4.0	5.3	AE	3.7-5.7
124	617	2.3	3.5	4.0	5.3	AE	3.7-5.7
ATLANTIC OCEAN							
125	636	3.2	5.3	8.3[3]	8.7	VE AE	10.7-13.7 8.7-10.7
INDIAN RIVER							
126	617,636	2.1	3.3	3.7	4.9	AE	3.7-4.7
127	617	2.3	3.4	4.0	5.3	AE	3.7-5.7
ATLANTIC OCEAN							
128	636,638	3.1	5.2	8.2[3]	8.5	VE AE	10.7-13.7 8.7-10.7

Table 6: Summary of Stillwater Elevations (continued)

Flooding Source and Transect	FIRM Panel	Stillwater Elevation (Feet NAVD) 10-percent-annual-chance	2-percent-annual-chance	1-percent-annual-chance	0.2-percent-annual-chance	Zone	Base Flood Elevation[1,2] (Feet NAVD)
INDIAN RIVER							
129	636,638	1.7	2.7	3.3	4.5	AE	3.7-4.7
130	619	2.0	3.5	4.0	5.4	AE	3.7-5.7
ATLANTIC OCEAN							
131	639	3.1	5.2	8.2[3]	8.5	VE AE	10.7-13.7 8.7-10.7
INDIAN RIVER							
132	638,639,726,727	1.8	3.0	3.6	5.0	AE	3.7-5.7
133	726	2.1	3.6	4.2	5.6	AE	3.7-5.7
ATLANTIC OCEAN							
134	727	3.1	5.2	8.2[3]	8.5	VE AE	10.7-13.7 8.7-10.7
INDIAN RIVER							
135	727	1.9	3.2	3.8	5.4	AE	3.7-5.7

[1] May include effects of wave action
[2] Due to map scale limitations, base flood elevations shown on map may represent average elevations
[3] Includes the effects of wave setup

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals. Users should be aware that flood elevations shown on the FIRM represent rounded whole-foot elevations and may not exactly reflect the elevations shown on the Flood Profiles or in the Floodway Data tables in the FIS report. Flood elevations shown on the FIRM are primarily intended for flood insurance rating purposes. For construction and/or floodplain management purposes, users are cautioned to use the flood elevation data presented in this FIS in conjunction with the data shown on the FIRM.

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a Floodway was computed, selected cross-section locations are also shown on the FIRM (Exhibit 2).

The hydraulic analyses for this study were based on unobstructed flow. The flood elevations shown on the Flood Profiles (Exhibit 1) are thus considered valid only if hydraulic structures remain unobstructed, operate properly, and do not fail.

3.2.1 Methods for Flooding Sources with New or Revised Analyses in Current Study

The dynamic hydraulic routing for North Merrit Island area with many depression areas was performed using the Interconnected Channel and Pond Routing (ICPR) program, version 3.10 (Reference 28) to determine the 1-percent-annual-chance flood elevation. The dimensions and geometry of drainage structures and interconnected channels were obtained form field survey. Storage volume parameters are calculated using the ArcHydro ESRI toolset (Reference 29) based on digital terrain data and updated with as-built information. The available storage of ponding area was calculated in a half foot increment from the lowest elevation in the sub-basin to the highest.

3.2.2 Methods for Flooding Sources Incorporated from Previous Studies

Water-surface elevations for floods of the selected recurrence intervals were developed using the HEC-2 computer model (Reference 30). Cross sections for the backwater analyses were obtained from field surveys (Reference 31). In some cases, topographic maps were used to extend surveyed cross sections (Reference 32; 33). Some cross sections for Turkey Creek tributaries were obtained from the "Brook Hollow Stormwater Management Master Plan" (Reference 14).

All bridges and culverts were field-checked to obtain elevation data and structural geometry.

Channel roughness factors (Manning's "n" values) used in the hydraulic computations were chosen by engineering judgment on the basis of field observation and aerial photographs of the streams and floodplain areas (Reference 34; 35; 36). The detailed roughness value ranges for each stream are listed in Table 7, “Summary of Roughness Coefficients.”

Table 7: Summary of Roughness Coefficients

Flooding Source	Roughness Coefficients	
	Channel	Overbanks
Crane Creek	0.030–0.060	0.040–0.100
Crane Creek Channel A	0.030–0.060	0.040–0.100
Crane Creek Channel B	0.030–0.060	0.050–0.100
Crane Creek Diversion from St. John’s River	0.030–0.060	0.040–0.100
Eau Gallie River	0.035–0.050	0.050–0.130
Goat Creek	0.030–0.060	0.040–0.090
Horse Creek	0.060	0.150
Kid Creek	0.035–0.070	0.060–0.120
North Prong Creek	0.030–0.038	0.100
Otter Creek	0.060	0.150
South Prong Creek	0.040–0.050	0.070–0.090
Trout Creek	0.035–0.060	0.060–0.090
Turkey Creek (including Channels A–E, G, and C-76)	0.030–0.100	0.050–0.150

The slope-area method was used to set the HEC-2 starting water-surface elevation for all streams studied in detail other than Horse Creek and Otter Creek; starting water-surface elevations for those two streams were based on the computed water-surface elevation at the confluence with the receiving stream.

The water-surface profiles for the St. John's River were obtained from the USACE (Reference 12). The 0.2-percent-annual-chance frequency profiles were projected from the lower frequency levels of this study.

Hydraulic analyses were carried out to provide estimates of the elevations of floods of the selected recurrence intervals caused by storm surge along each of the shorelines. These analyses considered storm characteristics and the shoreline and bathymetric characteristics of the flooding sources. The FEMA standard coastal storm surge model is a numerical hydrodynamic computer model that calculates the coastal storm surges previously described in Section 3.1.

The FEMA storm surge model was used to simulate the hydrodynamic behavior of the surge generated by the various synthetic storms. This model utilizes a grid pattern approximating the geographical features of the study area and the adjoining areas. Surges were computed using grids of 5 nautical miles.

Water depths and land heights for the model grid systems were obtained from topographic maps, bathymetric maps, hydrographic surveys, nautical charts, beach profiles, aerial photographs, and coastal construction control line maps (References 32; 37; 38; 39; 40; 41; 42).

The methodology for analyzing the effects of wave heights associated with coastal storm surge flooding is described in a report prepared by the National Academy of Sciences (NAS) (Reference 43). This method is based on the following major concepts. First, depth-limited waves in shallow water reach a maximum breaking height that is equal to 0.78 times the stillwater depth. The wave crest is 70 percent of the total wave height above the stillwater level. The second major concept is that wave height may be diminished by dissipation of energy due to the presence of obstructions, such as sand dunes, dikes and seawalls, buildings, and vegetation. The amount of energy dissipation is a function of the physical characteristics of the obstruction and is determined by NAS procedures (Reference 43). The third major concept is that wave height can be regenerated in open fetch areas due to the transfer of wind energy to the water. This added energy is related to fetch length and depth.

Transects (cross-section lines) were located along the coastal areas as illustrated in Figure 1, The transects were located with consideration given to the physical and cultural characteristics of the land so that they would closely represent conditions in their locality. Transects were spaced close together in areas of complex topography and dense development. In areas having more uniform characteristics, they were spaced at large intervals. It was also necessary to locate transects in areas where unique flooding existed and in areas where computed wave heights varied significantly between adjacent transects.

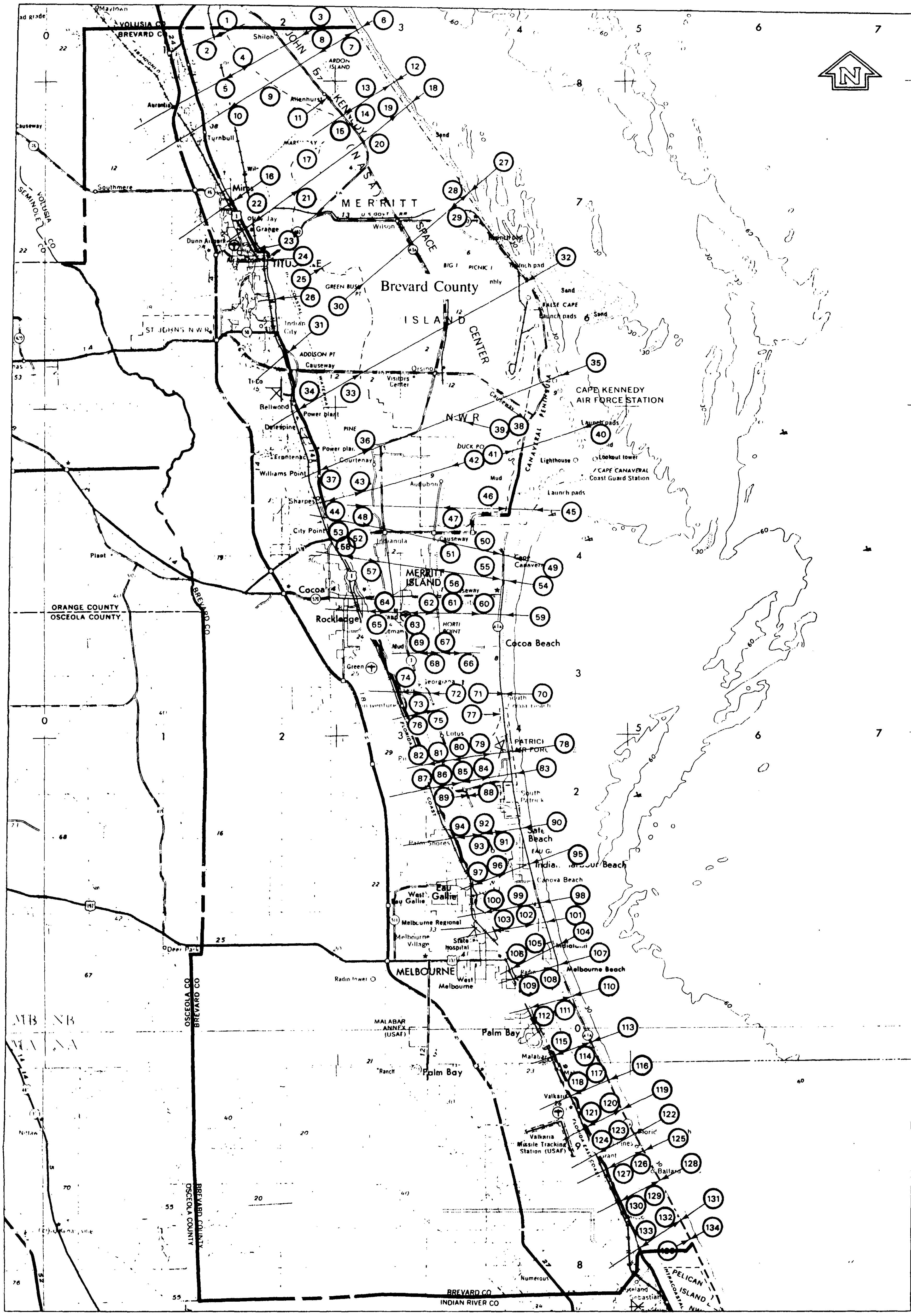

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL AND INCORPORATED AREAS

TRANSECT LOCATION MAP

Table 8: Transect Locations, Stillwater Starting Elevations, and Initial Wave Crest Elevations (continued)

Transect	Location	1-percent-annual-chance Elevation (Feet NAVD)	
		Stillwater	Wave Crest
134	From the Atlantic coastline, approximately 1.3 miles south of Long Point Road, extending west	8.2[6]	13.7[1]
135	From the Indian River east bank, approximately 1.3 miles south of Long Point Road, extending east	3.8	5.8[3]

FLOODING SOURCE

[1]Atlantic Ocean
[2]Mosquito Lagoon
[3]Indian River
[4]Banana River
[5]Banana River/New Found Harbour
[6]Includes the effects of wave runup

3.3 Vertical Datum

All FIS reports and FIRMs are referenced to a specific vertical datum. The vertical datum provides a starting point against which flood, ground, and structure elevations can be referenced and compared. Until recently, the standard vertical datum used for newly created or revised FIS reports and FIRMs was the National Geodetic Vertical Datum of 1929 (NGVD). With the completion of the North American Vertical Datum of 1988 (NAVD), many FIS reports and FIRMs are now prepared using NAVD as the referenced vertical datum.

Flood elevations shown in this FIS report and on the FIRM are referenced to the NAVD88. These flood elevations must be compared to structure and ground elevations referenced to the same vertical datum. Some of the data used in this revision were taken from the prior effective FIS reports and FIRMs and adjusted to NAVD88. The datum conversion factor from NGVD29 to NAVD88 in Brevard County is negative 1.3 feet.

For information regarding conversion between the NGVD and NAVD, visit the National Geodetic Survey website at www.ngs.noaa.gov, or contact the National Geodetic Survey at the following address:

Vertical Network Branch, N/CG13
National Geodetic Survey, NOAA
Silver Spring Metro Center 3
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3191

Temporary vertical monuments are often established during the preparation of a flood hazard analysis for the purpose of establishing local vertical control. Although these monuments are not shown on the FIRM, they may be found in the Technical Support Data Notebook associated with the FIS report and FIRM for this community. Interested individuals may contact FEMA to access these data.

To obtain current elevation, description, and/or location information for benchmarks shown on this map, please contact the Information Services Branch of the NGS at (301) 713-3242, or visit their Web site at www.ngs.noaa.gov.

4.0 FLOODPLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound floodplain management programs. To assist in this endeavor, each FIS report provides 1-percent-annual-chance floodplain data, which may include a combination of the following: 10-, 2-, 1-, and 0.2-percent-annual-chance flood elevations; delineations of the 1- and 0.2-percent-annual-chance floodplains; and a 1-percent-annual-chance floodway. This information is presented on the FIRM and in many components of the FIS report, including Flood Profiles, Floodway Data tables, and Summary of Stillwater Elevation tables. Users should reference the data presented in the FIS report as well as additional information that may be available at the local community map repository before making flood elevation and/or floodplain boundary determinations.

4.1 Floodplain Boundaries

To provide a national standard without regional discrimination, the 1-percent-annual-chance flood has been adopted by FEMA as the base flood for floodplain management purposes. The 0.2-percent-annual-chance flood is employed to indicate additional areas of flood risk in the community. For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section.

For each stream studied by detailed methods, the 1- and 0.2-percent-annual-chance floodplain boundaries have been delineated using the flood elevations determined at each cross section. Between cross sections, the boundaries were interpolated using elevations obtained from 10 meter Digital Elevation Models produced by the U.S. Geological Survey (Reference 2).

The 1- and 0.2-percent-annual-chance floodplain boundaries are shown on the FIRM. On this map, the 1-percent-annual-chance floodplain boundary corresponds to the boundary of the areas of special flood hazards (Zones A and AE), and the 0.2-percent-annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards. In cases where the 1- and 0.2-percent-annual-chance floodplain boundaries are close together, only the 1-percent-annual-chance floodplain boundary has been shown. Small areas within the floodplain boundaries may lie above the flood elevations, but cannot be shown due to limitations of the map scale and/or lack of detailed topographic data.

For the streams studied by approximate methods, only the 1-percent-annual-chance floodplain boundary is shown on the FIRM.

4.2 Floodways

Encroachment on floodplains, such as structures and fill, reduces flood-carrying capacity, increases flood heights and velocities, and increases flood hazards in areas beyond the encroachment itself. One aspect of floodplain management involves balancing the economic gain from floodplain development against the resulting increase in flood hazard. For purposes of the NFIP, a floodway is used as a tool to assist local communities in this aspect of floodplain management. Under this concept, the area of the 1-percent-annual-chance floodplain is divided into a floodway and a floodway fringe. The floodway is the channel of a stream, plus any adjacent floodplain areas, that must be kept free of encroachment so that the base flood can be carried without substantial increases in flood heights. Minimum Federal standards limit such increases to 1 foot, provided that hazardous velocities are not produced. The floodways in this study are presented to local agencies as minimum standards that can be adopted directly or that can be used as a basis for additional floodway studies.

The floodways presented in this study were computed for certain stream segments on the basis of equal-conveyance reduction from each side of the floodplain. Floodway widths were computed at cross sections. Between cross sections, the floodway boundaries were interpolated. The results of the floodway computations are tabulated for selected cross sections (see Table 9, “Floodway Data Table”). In cases where the floodway and 1-percent-annual-chance floodplain boundaries are either close together or collinear, only the floodway boundary is shown.

There are no cross sections located within the City of Melbourne for Otter Creek; therefore, no Floodway Data is provided for this stream. No floodway was computed for Horse Creek. Portions of the floodway width for South Prong Creek extend beyond the county boundary.

Encroachment into areas subject to inundation by floodwaters having hazardous velocities aggravates the risk of flood damage, and heightens potential flood hazards by further increasing velocities. A listing of stream velocities at selected cross sections is provided in Table 9, "Floodway Data Table." In order to reduce the risk of property damage in areas where the stream velocities are high, the community may wish to restrict development in areas outside the floodway.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD)	WITHOUT FLOODWAY (NAVD)	WITH FLOODWAY (NAVD)	INCREASE
TURKEY CREEK								
A	2,150	180	1,591	6.7	5.7	2.3[2]	3.1	0.8
B	2,481	500	5,443	2.0	3.9	3.9[2]	4.7	0.8
C	3,319	520	4,555	2.3	4.5	4.5	5.4	0.9
D	4,619	740	5,091	2.1	5.0	5.0	5.7	0.7
E	6,119	585	4,365	2.5	5.5	5.5	6.1	0.6
F	8,519	449	3,596	3.0	6.8	6.8	7.3	0.5
G	10,749	114	1,328	7.1	9.7	9.7	10.7	1.0
H	12,649	911	9,004	1.0	12.2	12.2	13.0	0.8

[1] Stream distance in feet above confluence with Indian River
[2] Elevations computed without consideration of storm surge effects from Indian River

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY
BREVARD COUNTY, FL
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FLOODWAY DATA

TURKEY CREEK

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD)	WITHOUT FLOODWAY (NAVD)	WITH FLOODWAY (NAVD)	INCREASE
TURKEY CREEK CHANNEL A								
A	1,800	47	262	2.4	8.7	4.9[2]	5.5	0.6
B	2,050	82	306	2.1	8.7	5.4[2]	6.3	0.9
C	3,450	133	367	1.7	8.7	8.4[2]	9.0	0.6
D	4,850	211	657	0.8	10.1	10.1	11.1	1.0
E	6,000	124	462	0.7	10.9	10.9	11.9	1.0
F	8,200	78	174	1.9	15.4	15.4	15.4	0.0
G	8,363	81	336	1.0	17.4	17.4	17.4	0.0
H	8,863	180	358	0.9	17.5	17.5	17.5	0.0
I	9,583	100	287	0.4	17.6	17.6	17.8	0.2
J	10,463	20	24	4.9	17.9	17.9	18.1	0.2

[1] Stream distance in feet above confluence with Turkey Creek
[2] Elevations computed without consideration of backwater effects from Turkey Creek

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY
BREVARD COUNTY, FL
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FLOODWAY DATA

TURKEY CREEK CHANNEL A

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD)	WITHOUT FLOODWAY (NAVD)	WITH FLOODWAY (NAVD)	INCREASE
TURKEY CREEK CHANNEL B								
A	1,200	54	154	2.9	12.7	2.6[2]	3.6	1.0
B	3,050	91	268	1.7	12.7	9.0[2]	9.5	0.5
C	4,350	38	160	2.8	12.7	11.7[2]	12.4	0.7
D	5,750	55	137	3.2	15.4	15.4	15.5	0.1
E	7,075	64	195	2.0	17.0	17.0	17.2	0.2

[1] Stream distance in feet above confluence with Turkey Creek
[2] Elevations computed without consideration of backwater effects from Turkey Creek

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY
BREVARD COUNTY, FL
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FLOODWAY DATA

TURKEY CREEK CHANNEL B

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD)	WITHOUT FLOODWAY (NAVD)	WITH FLOODWAY (NAVD)	INCREASE
TURKEY CREEK CHANNEL C								
A	400	270	1,041	0.9	12.7	5.7[2]	6.7	1.0
B	2,000	110	244	3.8	12.7	7.7[2]	8.7	1.0
C	3,700	12	61	3.1	17.2	17.2	18.0	0.8
D	4,800	106	363	0.5	17.7	17.7	18.7	1.0
E	5,800	36	84	2.3	17.9	17.9	18.9	1.0

[1] Stream distance in feet above confluence with Turkey Creek
[2] Elevations computed without consideration of backwater effects from Turkey Creek

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY
BREVARD COUNTY, FL
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FLOODWAY DATA

TURKEY CREEK CHANNEL C

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD)	WITHOUT FLOODWAY (NAVD)	WITH FLOODWAY (NAVD)	INCREASE
TURKEY CREEK CHANNEL C-76								
A	1,441	51	170	2.5	13.6	13.6	14.3	0.7
B	3,471	56	204	2.1	16.5	16.5	16.5	0.0
C	4,779	57	299	1.4	19.6	19.6	19.6	0.0
D	6,249	54	255	1.3	24.8	24.8	25.5	0.7
E	8,880	28	184	1.7	26.5	26.5	27.4	0.9
F	10,250	60	225	1.4	27.2	27.2	28.2	1.0

[1] Stream distance in feet above confluence with Turkey Creek Channel D

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY
BREVARD COUNTY, FL
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FLOODWAY DATA

TURKEY CREEK CHANNEL C-76

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD)	WITHOUT FLOODWAY (NAVD)	WITH FLOODWAY (NAVD)	INCREASE
TURKEY CREEK CHANNEL D								
A	200	186	828	0.9	12.7	11.6[2]	12.6	1.0
B	900	142	654	0.9	12.7	11.9[2]	12.9	1.0
C	1,825	71	164	3.7	12.9	12.9	13.8	0.9
D	2,002	190	986	0.6	15.6	15.6	16.6	1.0
E	2,802	169	697	0.9	15.7	15.7	16.7	1.0
F	3,602	76	261	2.3	16.0	16.0	17.0	1.0

[1] Stream distance in feet above confluence with Turkey Creek Channel C
[2] Elevations computed without consideration of backwater effects from Turkey Creek

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY
BREVARD COUNTY, FL
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FLOODWAY DATA

TURKEY CREEK CHANNEL D

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD)	WITHOUT FLOODWAY (NAVD)	WITH FLOODWAY (NAVD)	INCREASE
TURKEY CREEK CHANNEL E								
A	850	44	153	0.5	18.4	18.4	18.6	0.2
B	1,636	28	46	1.8	19.1	19.1	19.4	0.3

[1] Stream distance in feet above confluence with Turkey Creek Channel D

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL

AND INCORPORATED AREAS

FLOODWAY DATA

TURKEY CREEK CHANNEL E

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQUARE FEET)	MEAN VELOCITY (FEET PER SECOND)	REGULATORY (NAVD)	WITHOUT FLOODWAY (NAVD)	WITH FLOODWAY (NAVD)	INCREASE
TURKEY CREEK CHANNEL G								
A	200	40	186	1.7	12.7	11.2[2]	12.2	1.0
B	1,075	23	42	7.6	13.7	13.7	13.8	0.1
C	2,075	43	170	1.9	16.7	16.7	16.8	0.1
D	3,075	40	76	4.0	18.1	18.1	18.1	0.0

[1] Stream distance in feet above confluence with Turkey Creek Channel C
[2] Elevations computed without consideration of backwater effects from Turkey Creek

TABLE 9

FEDERAL EMERGENCY MANAGEMENT AGENCY
BREVARD COUNTY, FL
AND INCORPORATED AREAS

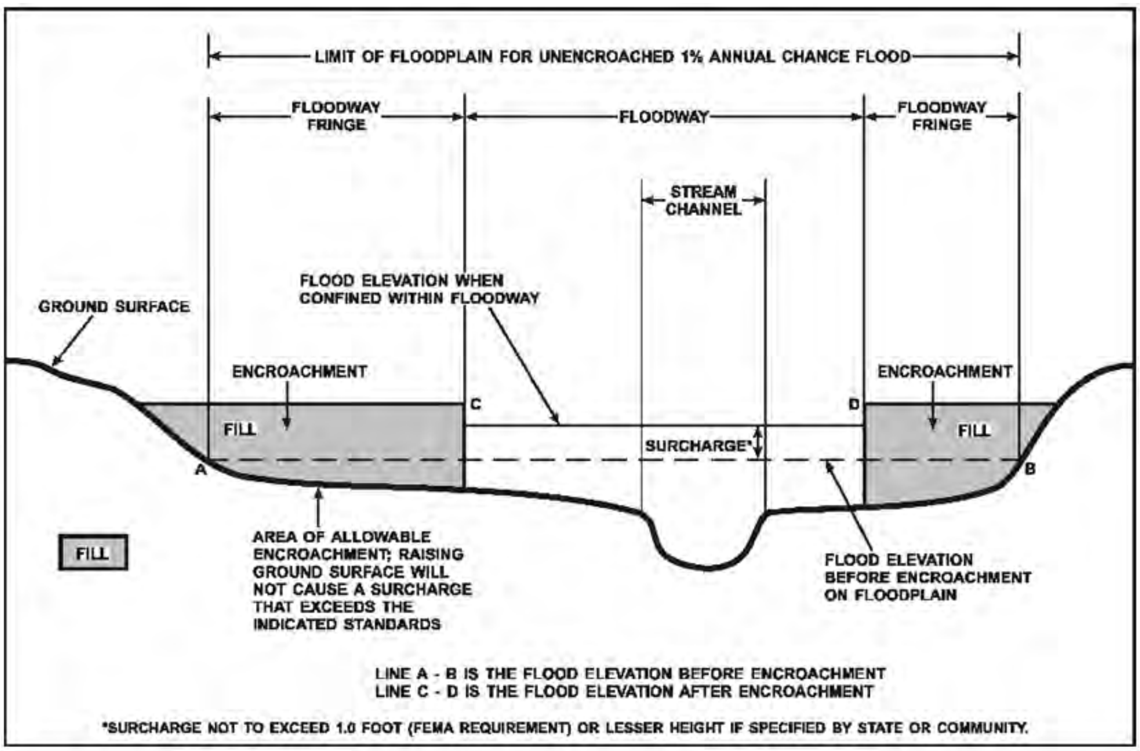
FLOODWAY DATA

TURKEY CREEK CHANNEL G

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "Without Floodway" elevations presented in Table 9 for certain downstream cross sections of the Eau Gallie River; Turkey Creek; Turkey Creek Channels A, B, C, D, and G; Goat Creek; Kid Creek; Crane Creek; North Prong Creek; and South Prong Creek are lower than the regulatory flood elevations in those areas, which must take into account the 1-percent-annual-chance flooding due to backwater from other sources.

The area between the floodway and 1-percent-annual-chance floodplain boundaries is termed the floodway fringe. The floodway fringe encompasses the portion of the floodplain that could be completely obstructed without increasing the water-surface elevation (WSEL) of the base flood more than 1 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to floodplain development are shown in Figure 3, “Floodway Schematic.”.

Figure 3: Floodway Schematic



5.0 INSURANCE APPLICATIONS

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS report by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base (1-percent-annual-chance) flood elevations (BFEs) or depths are shown within this zone.

Zone AE

Zone AE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance floodplains that are determined in the FIS report by detailed methods. Whole-foot BFEs derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AH

Zone AH is the flood insurance rate zone that corresponds to the areas of 1-percent-annual-choice shallow flooding (usually areas of ponding) where average depths are between 1 and 3 feet. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone AO

Zone AO is the flood insurance rate zone that corresponds to the areas of 1-percent-annual-chance shallow flooding (usually sheet flow on sloping terrain) where average depths are between 1 and 3 feet. Average whole-depths derived from the detailed hydraulic analyses are shown within this zone.

Zone VE

Zone VE is the flood insurance rate zone that corresponds to the 1-percent-annual-chance coastal floodplains that have additional hazards associated with storm waves. Whole-foot base flood elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 0.2-percent-annual-chance floodplain, areas within the 0.2-percent-annual-chance floodplain, areas of 1-percent-annual-chance flooding where average depths are less than 1 foot, areas of 1-percent-annual-chance flooding where the contributing drainage area is less than 1 square mile (sq. mi.), and areas protected from the base flood by levees. No BFEs or depths are shown within this zone.

6.0 FLOOD INSURANCE RATE MAP

The FIRM is designed for flood insurance and floodplain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 1-percent-annual-chance floodplains that were studied by detailed methods, shows selected whole-foot BFEs or average depths. Insurance agents use zones and BFEs in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For floodplain management applications, the map shows by tints, screens, and symbols, the 1- and 0.2-percent-annual-chance floodplains, floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

The countywide FIRM presents flooding information for the entire geographic area of Brevard County. Previously, FIRMs were prepared for each incorporated community and the unincorporated areas of the County identified as flood-prone. This countywide FIRM also includes flood-hazard information that was presented separately on Flood Boundary and Floodway Maps (FBFMs), where applicable. Historical data relating to the maps prepared for each community are presented in Table 10, “Community Map History.”

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Brevard County, Unincorporated Areas	September 22, 1972	---	September 22, 1972	August 6, 1976 September 16, 1982 October 1, 1983 April 3, 1989 August 18, 1992 November 19, 1997
Cape Canaveral, City of	September 20, 1972	---	September 30, 1972	July 1, 1974 August 15, 1975 May 20, 1977 September 16, 1982 April 3, 1989
Cape Canaveral Port Authority	October 29, 1979	---	April 3, 1989	April 3, 1989
Cocoa, City of	February 15, 1974	January 9, 1976	September 28, 1979	April 3, 1989
Cocoa Beach, City of	February 15, 1974	January 9, 1976	September 28, 1979	July 1, 1974 December 26, 1975 May 20, 1977 September 16, 1982 April 3, 1989

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL

AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Indialantic, Town of	August 18, 1972	---	August 18, 1972	July 1, 1974 May 7, 1976 September 16, 1982 April 3, 1989
Indian Harbour Beach, City of	June 16, 1972	---	June 16, 1972	July 1, 1974 September 25, 1975 September 30, 1982 April 3, 1989
Malabar, Town of	March 1, 1974	December 19, 1975	September 28, 1982	September 30, 1982 April 3, 1989 August 18, 1992
Melbourne, City of	August 30, 1974	October 1, 1976	July 1, 1979	September 30, 1982 April 3, 1989 November 19, 1997
Melbourne Beach, Town of	November 25, 1972	---	November 25, 1972	July 1, 1974 October 3, 1975 September 30, 1982 April 3, 1989 August 18, 1992 November 19, 1997

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL

AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Melbourne Village, Town of	February 15, 1974	February 13, 1976 September 24, 1976	November 15, 1979	April 3, 1989
Palm Bay, City of	September 3, 1980	---	September 3, 1980	June 15, 1984 November 1, 1985 April 3, 1989 August 18, 1992
Palm Shores, Town of	August 31, 1979	---	April 3, 1989	November 19, 1997
Rockledge, City of	March 1, 1974	May 7, 1976	November 15, 1979	April 3, 1989
Satellite Beach, City of	February 22, 1974	---	February 22, 1974	April 23, 1976 September 30, 1982 April 3, 1989

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL

AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

COMMUNITY NAME	INITIAL IDENTIFICATION	FLOOD HAZARD BOUNDARY MAP REVISIONS DATE	FIRM EFFECTIVE DATE	FIRM REVISIONS DATE
Titusville, City of	June 16, 1972	---	July 1, 1974	April 30, 1976 April 3, 1989 August 18, 1992 January 5, 1996
West Melbourne, City of	March 8, 1974	August 1, 1975	March 18, 1980	April 3, 1989

TABLE 10

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL
AND INCORPORATED AREAS

COMMUNITY MAP HISTORY

7.0 OTHER STUDIES

FIS reports were previously prepared for the unincorporated areas of Brevard County (Reference 47) and for the Cities of Melbourne, Palm Bay, and Titusville and the Town of Malabar (References 2; 48; 49; 50).

FIS reports were previously prepared for the unincorporated and incorporated areas of Volusia County, Indian River County, Osceola County, Orange County, and Seminole County (References 51; 52; 53; 54; 55). A flood hazard boundary map was prepared for the Town of Palm Shores (Reference 56)

This FIS report either supersedes or is compatible with all previous studies published on streams studied in this report and should be considered authoritative for the purposes of the NFIP.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting Federal Insurance and Mitigation Division, FEMA Region IV, Koger-Center — Rutgers Building, 3003 Chamblee Tucker Road, Atlanta, GA 30341.

9.0 BIBLIOGRAPHY AND REFERENCES

1. Federal Emergency Management Agency. *Flood Insurance Study, Brevard County, Florida, and Incorporated Areas.* Washington, D.C., April 3, 1989.

2. —. *Flood Insurance Study, City of Melbourne, Brevard County, Florida.* Washington, D.C., FIS report dated March 30, 1982; FIRM dated September 30, 1982.

3. —. *Flood Insurance Study, Brevard County, Florida, and Incorporated Areas.* Washington, D.C., November 19, 1997.

4. Southeast Regional Climate Center. Historical Climate Summaries for Florida: City of Titusville, City of Melbourne. [Online] [Cited: January 21, 2009.] http://www.sercc.com/climateinfo/historical/historical_fl.html.

5. Brevard County Planning Department. *Brevard County Data Abstract.* Viera, Florida, 1984.

6. U.S. Department of Commerce, Bureau of the Census. "State & County Quickfacts, Florida Quicklinks". [Online] [Cited: June 17, 2011.] Available http://www.census.gov/census2000/states/fl.html.

7. American Meteorological Society. *Early American Hurricanes 1492-1870.* David M. Ludlum, 1963.

8. U.S. Department of the Army, Corps of Engineers, Jacksonville District. *Analysis of Hurricane Problems in Coastal Areas of Florida.* Washington, D.C., September 1961.

9. U.S. Department of Commerce, National Oceanic and Atmospheric Administration,

National Climate Data Center. "Storm Events". [Online] [Cited: January 21, 2009.] http://www4.ncdc.noaa.gov.

10. American Meterological Society. *The Monthly Weather Review.* Volume 108, No. 7, July 1980.

11. St. John's River Water Management District, Department of Water Resources. *Technical Publication SJ85-3: Mean Annual 10-Year, 25-Year, and 100-Year Flood Profiles for the Upper St. John's River under the Existing Conditions.* Donthamsetti V. Rao, March 1985.

12. U.S. Department of the Army, Corps of Engineers, Jacksonville District. *Central and Southern Florida Project, Part III, Upper St. John's River Basin and Related Areas, Supplement 2: General Design Memorandum, Upper St. John's River Basin, Addendum 3 with Draft Environmental Impact Statement.* Jacksonville, Florida, June 1985.

13. U.S. Department of the Interior, Geological Survey, in cooperation with the Florida Department of Transportation. *Water Resources Investigations 82-4012: Technique for Estimating Magnitude and Frequency of Floods on Natural-Flow Streams in Florida*, 1982.

14. Ghioto, Singhofen & Associates, Inc. *Brook Hollow Stormwater Management Master Plan.* Prepared for DCB Investment Company, September 1986.

15. Kucera, Inc. Photogrammetric Topographical Maps, Titusville, Florida, Scale 1:2,400, Contour Interval 2 Feet. January 1974.

16. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Weather Bureau. *Technical Paper No. 40: Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years.* Washington, D.C., 1961.

17. U.S. Department of Agriculture, Soil Conservation Service. *National Engineering Handbook, Section 4, Hydrology.* Washington, D.C., 1964, Revised 1969.

18. TRACOR, Inc. *TRACOR Method: The Effects of Urbanization on Unit Hydrographs for Small Watersheds, Houston, Texas, 1964-67.* Austin, Texas, September 25, 1968.

19. Singhofen, Peter J. P.E. *Inter-Connected Pond Routing Program, version 3.10.* 2002.

20. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. Unit Hydrograph Technical Manual. *National Weather Service, National Operational Hydrologic Remote Sensing Center.* [Online] October 12, 2008. [Cited: June 1, 2009.] http://www.nohrsc.noaa.gov/technology/gis/uhg_manual.html.

21. U.S. Department of Agriculture, Soil Conservation Service. *Technical Release No. 55: Urban Hydrology for Small Watersheds.* Washington, D.C., June 1986.

22. U.S. Department of Commerce, Environmental Science Services Administration. *Technical Memorandum WBTM Hydro II: Joint Probability Method of Tide Frequency Analysis Applied to Atlantic City and Long Beach Island, New Jersey.* Vance A. Myers, April 1970.

23. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service. *Tropical Cyclones of the North Atlantic Ocean, 1871-1984.* July 1985.

24. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. *Technical Report NWS 15: Some Climatological Characteristics of Hurricanes and Tropical Storms, Gulf and East Coasts of the United States.* Frances P. Ho, Richard W. Schwerdt, and Hugo V. Goodyear, May 1975.

25. —. *Technical Report NWS 23: Meterological Criteria for Standard Project Hurricane and Probable Maximum Hurricane Windfields, Gulf and East Coasts of the United States.* September 1979.

26. Federal Emergency Management Agency. *Coastal Flooding Storm Surge Model, Part 1: Methodology, and Part II: Code and Users Guide.* Washington, D.C., February 1981.

27. U.S. Department of the Army, Corps of Engineers, Coastal Engineering Research Center. *Shore Protection Manual.* Vicksburg, Mississippi, 1984.

28. Streamline Technologies, Inc. *ICPR 3.1.0.* April 2008.

29. Maidment, David R. *Arc Hydro: GIS for Water Resources.* ESRI, Inc., 2002.

30. U.S. Department of the Army, Corps of Engineers, Hydrologic Engineering Center. *HEC-2 Water Surface Profiles, Generalized Computer Program.* Davis, California, September 1982.

31. Vislay, Cantelou & Herrera, Inc. *Ground and Bathymetric Surveys for Gee & Jenson.* 1985.

32. U.S. Department of the Interior, Geological Survey. *7.5 Minute Series Topographic Maps, Scale 1:24,000, Contour Interval 5 Feet.* Oak Hill, FL, 1949, photorevised 1970; Pardon Island, Florida, 1949, photorevised 1970; Mims, FL, 1949, photorevised 1970; Wilson, FL, 1949, photorevised 1977; Sebastian, Florida, 1949, photorevised 1970; Titusville, FL, 1949, photorevised, 1970; Orsino, FL, 1976; False Cape, FL, 1976; Sharpes, FL, 1949, photorevised, 1970; Courtenay, FL, 1976; Cape Canaveral, FL, 1976; Cocoa, FL, 1976; Cocoa Beach, FL, 1976; Eau Gallie, FL, 1949, photorevised 1970;, Tropic, FL, 1949, photorevised 1970; Melbourn West, FL, 1949, photorevised 1970; Melbourne East, FL, 1949, photorevised, 1970; Grant, FL, 1949, photorevised 1970; Sebastian NW, FL, 1949, photorevised, 1970; Fellsmere, FL, 1949, photorevised 1970.

33. Briley Wild & Associates. *Stormwater Management Master Plan: Aerial Topographic Maps, Palm Bay, Florida, Scale 1:200, Contour Interval 1 Foot.* 1978.

34. U.S. Department of Agriculture, Soil Conservation Service. *Guide for Selecting Roughness Coefficient "n" Values for Channels.* December 1963.

35. Chow, Ven Te. *Open Channel Hydraulics.* New York : McGraw-Hill, 1959.

36. U.S. Department of Transportation, Federal Highway Administration. *Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains.* , April 1984.

37. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Survey. *Bathymetric Maps at a Scale of 1:25,000, Datum Mean Low Water.* Fort Pierce, Orlando, Florida, 1972.

38. —. *Selected NOS Hydrographic Surveys.*

39. —. *Nautical Charts: No. 11460, February 1982; No. 11472, August 1976; No. 11474, March 1980; No. 11476, May 1982; No. 11480, November 1981; No. 11484, April 1983; No. 11485, July 1982; No. 11486, October 1980; No. 11488, January 1982.*

40. Florida Department of Natural Resources, Bureau of Beaches and Shores. *Brevard County Beach Profiles.* 1985.

41. Florida Department of Transportation, Topographic Bureau. *Stereoscopic Aerial Photography, Brevard County, Florida, Scale 1: 2,400 on November 1983; Scale 1:1,200 on May 1980*.

42. Florida Department of Natural Resources. *Brevard County Coastal Construction Control Line Maps, Brevard County, Scale 1:1,200, Contour Interval 2 Feet.* October 1985.

43. National Academy of Sciences. *Methodology for Calculating Wave Action Effects with Storm Surges.* 1977.

44. Federal Emergency Management Agency, Federal Insurance Administration. *User's Manual for Wave Action Effects Associated with Storm Surges.*April 1980.

45. Herchenroder, J. Hill and B. *Computational Model for Computing Dune Erosion.* Orlando, Florida : Proceedings of the ASCE Hydraulics Specialty Conference, August 1985.

46. Federal Emergency Management Agency. *Manual for Wave Runup Analysis Coastal Flood Insurance Studies.* November 1981.

47. —. *Flood Insurance Study, Brevard County, Florida, Unincorporated Areas.* Washington, D.C., September 16, 1982.

48. —. *Flood Insurance Study, City of Palm Bay, Brevard County, Florida.* Washington, D.C., June 15, 1984.

49. —. *Flood Insurance Study, City of Titusville, Brevard County, Florida.* Washington, D.C., April 30, 1976.

50. —. *Flood Insurance Study, Town of Malabar, Brevard County, Florida.* Washington, D.C., September 30, 1982.

51. —. *Flood Insurance Study, Volusia County, Florida, and Incorporated Areas.* Washington, D.C., February 19, 2003.

52. —. *Flood Insurance Study, Indian River County, Florida, and Incorporated Areas.* Washington, D.C., May 4, 1989.

53. —. *Flood Insurance Study, Osceola County, Florida, and Incorporated Areas.* Washington, D.C., May 7, 2001.

54. —. *Flood Insurance Study, Orange County, Florida, and Incorporated Areas.* Washington, D.C., December 6, 2000.

55. —. *Flood Insurance Study, Seminole County, Florida, and Incorporated Areas.* Washington, D.C., September 28, 2007.

56. U.S. Department of Housing and Urban Development, Federal Insurance Administration. *Flood Hazard Boundary Map, Town of Palm Shores, Brevard County, Florida.* Washington, D.C., August 31, 1979.

10.0 REVISION DESCRIPTIONS

This section has been added to provide information regarding significant revisions made since the original FIS was printed. Future revisions may be made that do not result in the republishing of the FIS report. To assure that the user is aware of all revisions, it is advisable to contact the community repository of flood-hazard data located at:

- Brevard County Public Works Department
  Brevard County Government Center
  2725 Judge Fran Jamieson Way
  Vierra, Florida 32940

- Cape Canaveral City Hall
  105 Polk Avenue
  Cap Canaveral, Florida 32920

- Cocoa City Hall
  603 Brevard Avenue
  Cocoa, Florida 32922

- Cocoa Beach City Hall
  Building Department
  2 South Orlando Avenue
  Cocoa Beach, Florida 32931

- Indialantic Town Hall
  216 Fifth Avenue
  Indialantic, Florida 32903

- Indian Harbour Beach City Hall
  2055 South Patrick Drive
  Indian Harbour Beach, Florida 32937

- Malabar Town Hall
  2725 Malabar Road
  Malabar, Florida 32950

- Melbourne City Hall
  900 East Strawbridge Avenue
  Melbourne, Florida 32901

- Melbourne Village Town Hall
  555 Hammock Road
  Melbourne Village, Florida 32904

- Melbourne Beach Town Hall
  507 Ocean Avenue
  Melbourne Beach, Florida 32951

- Palm Bay City Hall
  120 Malabar Road, S.E.
  Palm Bay, Florida 32907

- Palm Shores Town Clerk's Office
  151 Palm Circle
  Palm Shores, Florida 32940

- Rockledge City Hall
  Building Department
  1600 Huntington Lane
  Rockledge, Florida 32956

- Satellite Beach City Hall
  Building and Zoning Department
  565 Cassia Boulevard
  Satellite Beach, Florida 32937

- Titusville City Hall
  Department of Planning and Zoning
  555 South Washington Avenue
  Titusville, Florida 32796

- West Melbourne City Hall
  2285 Minton Road
  West Melbourne, Florida 32904

10.1 First Revision (Revised August 19, 1992)

The August 19, 1992 revision was initiated by a Physical Map Revision (PMR) request submitted to FEMA. That revision involved changes to the FIRM only.

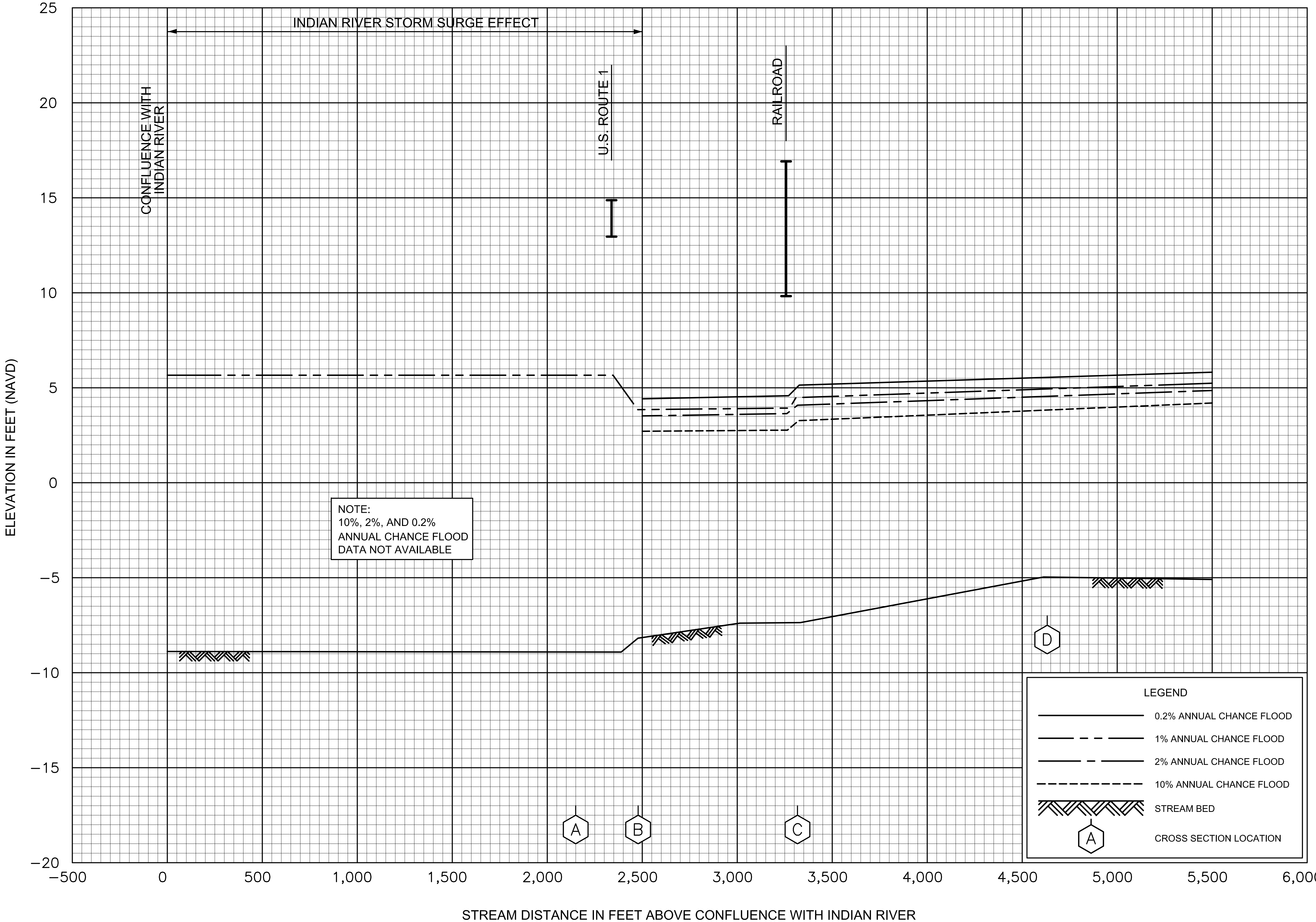
10.2 Second Revision (Revised November 19, 1997)

For the November 19, 1997 revision, detailed analyses for Horse Creek and Otter Creek, within the City of Melbourne, were incorporated into the countywide FIS.

10.3 Third Revision (Revised Month Day, Year)

This Month, Day, year revision was initiated in support of the FEMA Risk MAP Program.

This revision involved updating the mapping for the entire area of Brevard County, Florida. The revision includes new detailed hydrologic and hydraulic analyses for various ponding areas within the North Merrit Island area of Brevard County. Coastal AE zones, streams, and ponding areas that had been previously studied by detailed methods were redelineated based on more detailed and up-to-date topographic data. In addition to the coastal redelineation, the location of the zone break between the AE and VE zones was revised based on the location of the Primary Frontal Dune.



FLOOD PROFILES

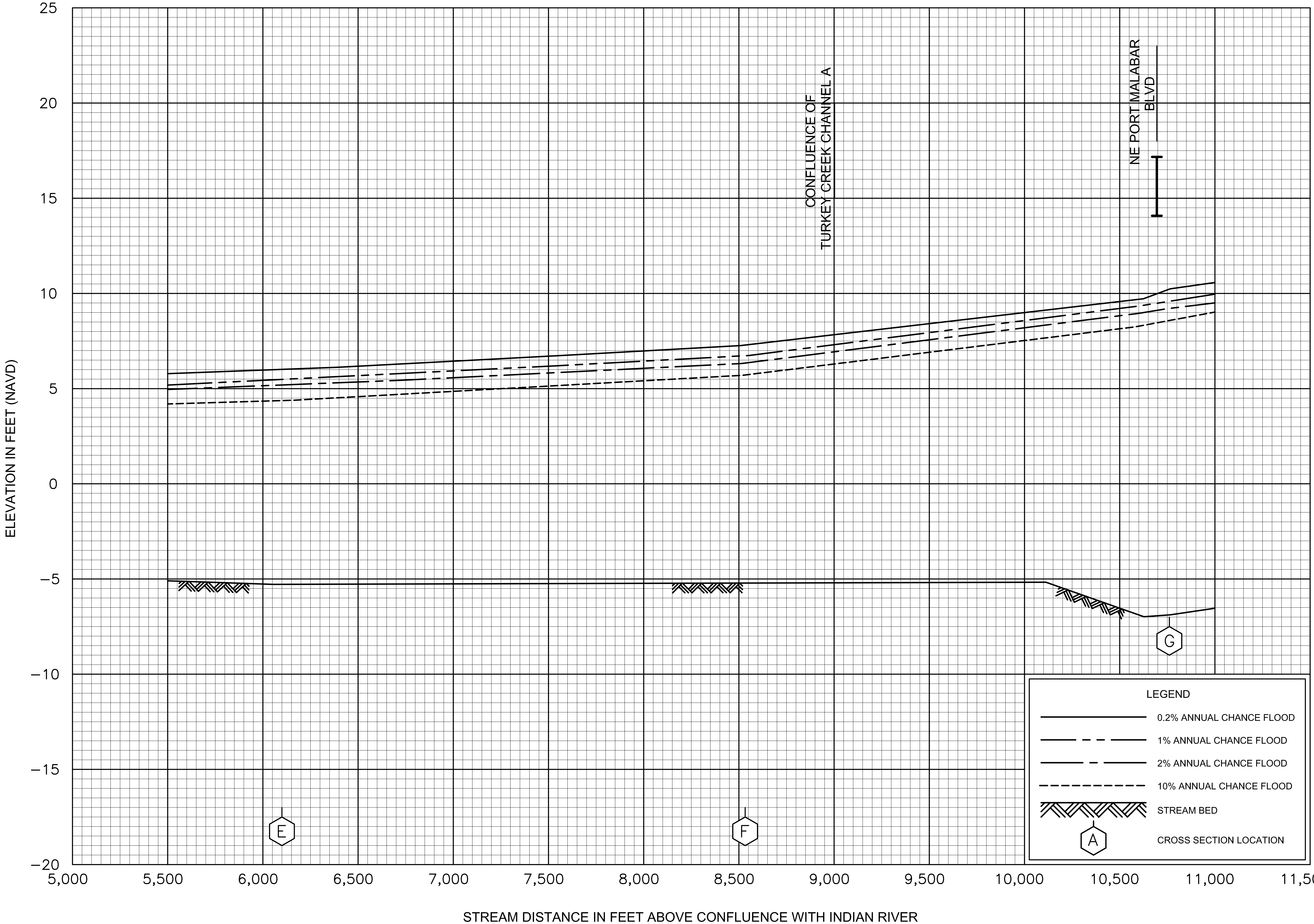
TURKEY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL

AND INCORPORATED AREAS

30P



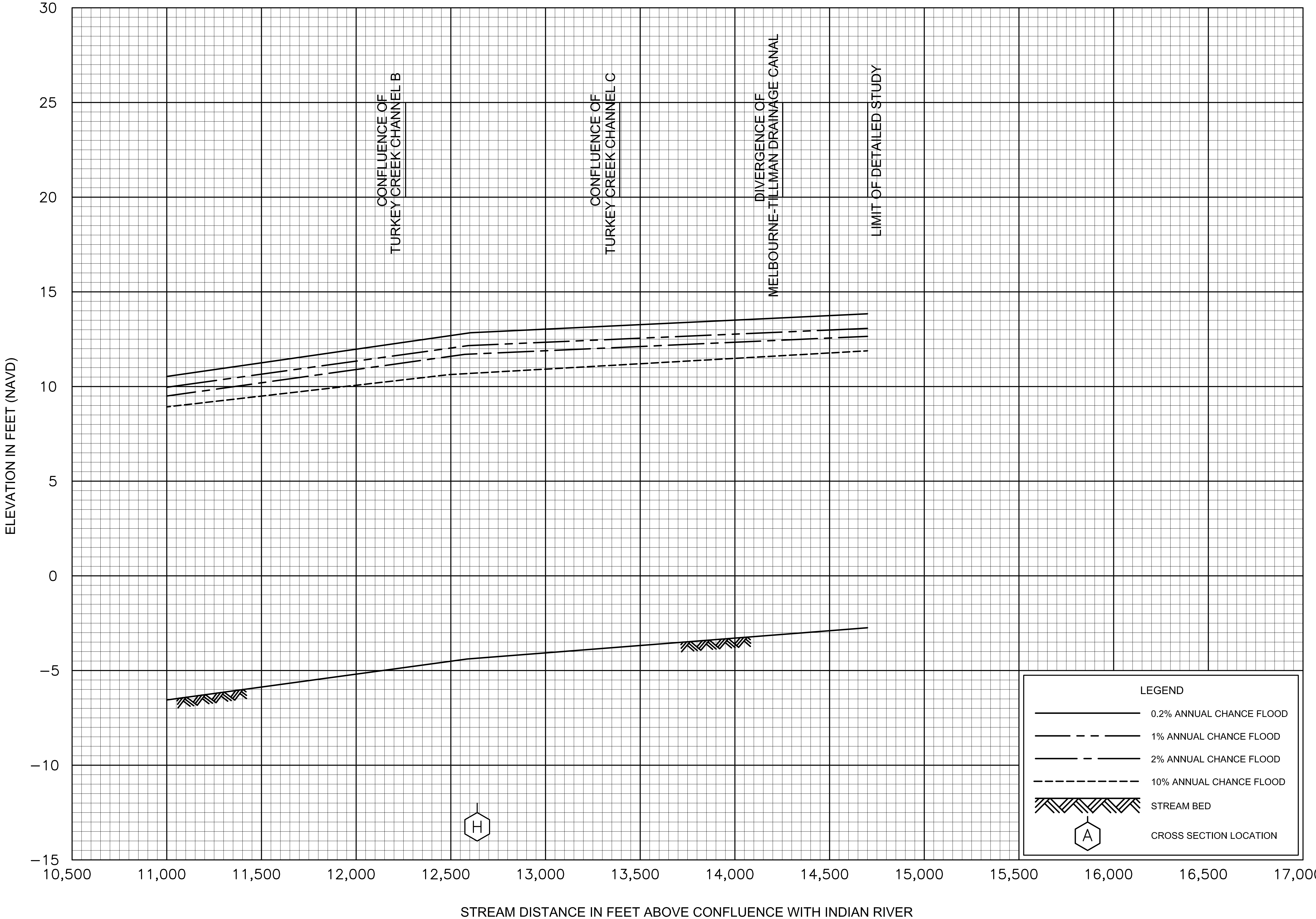
FLOOD PROFILES

TURKEY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL
AND INCORPORATED AREAS

31P



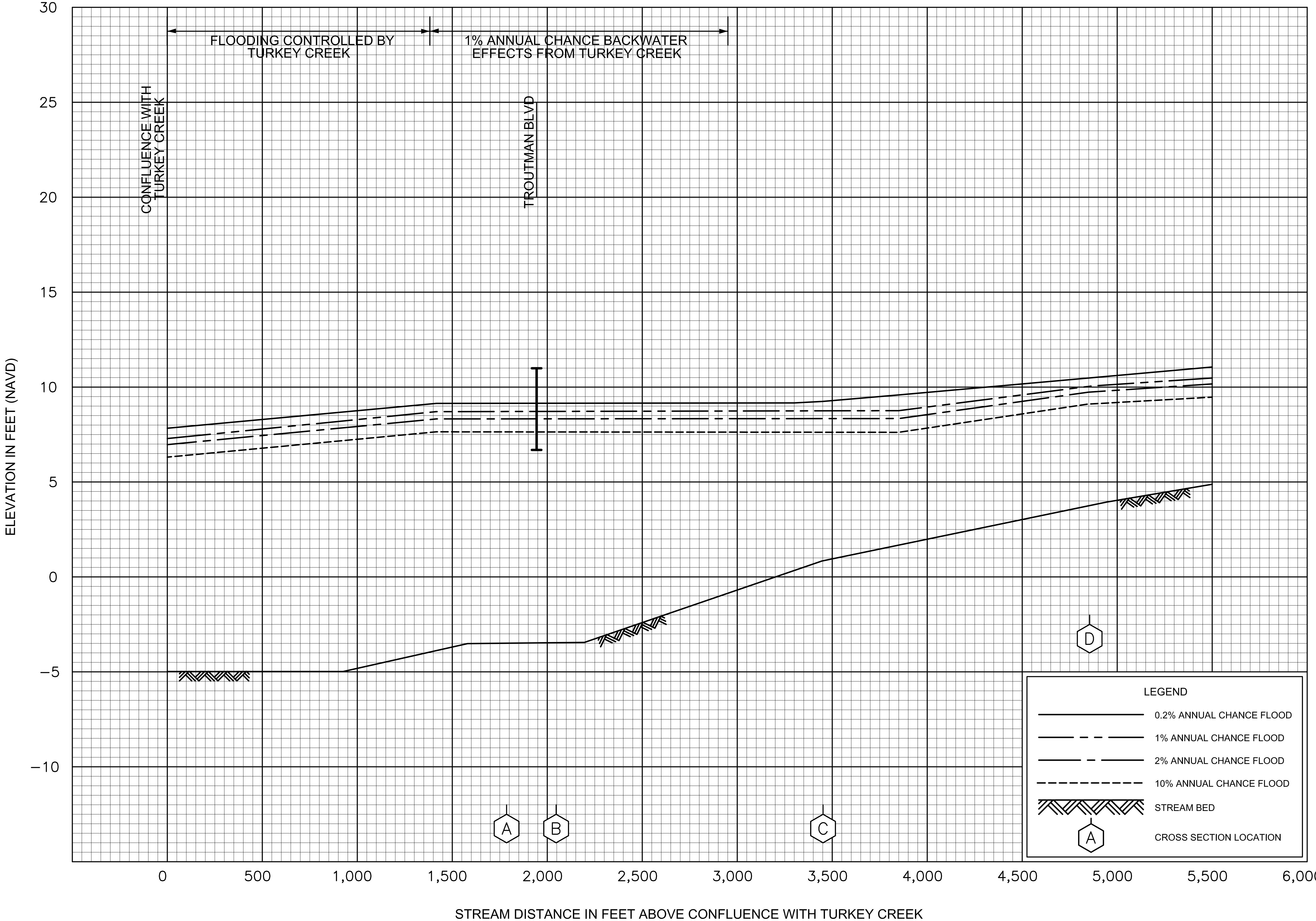
FLOOD PROFILES

TURKEY CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL

AND INCORPORATED AREAS



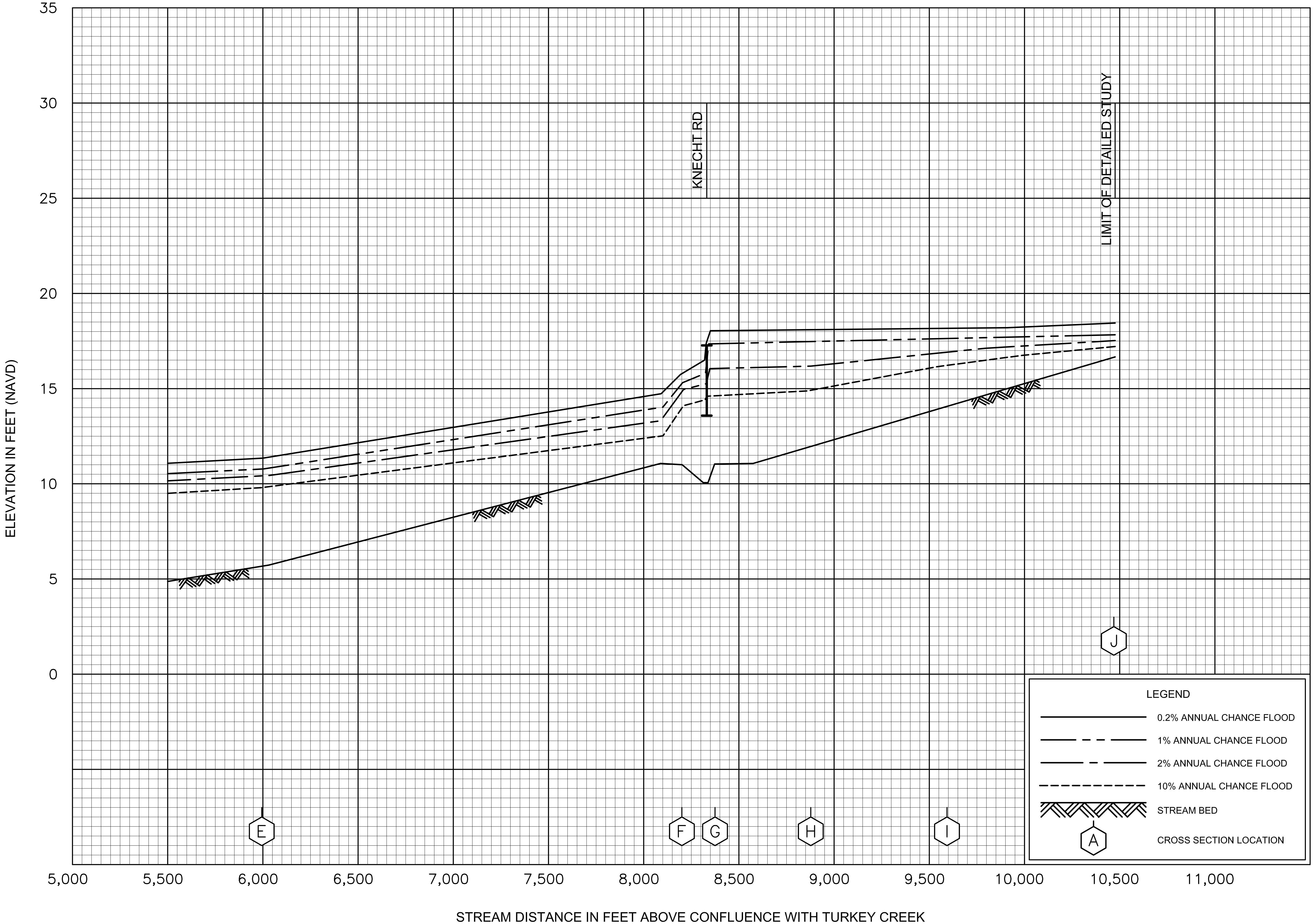
FLOOD PROFILES

TURKEY CREEK CHANNEL A

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL

AND INCORPORATED AREAS



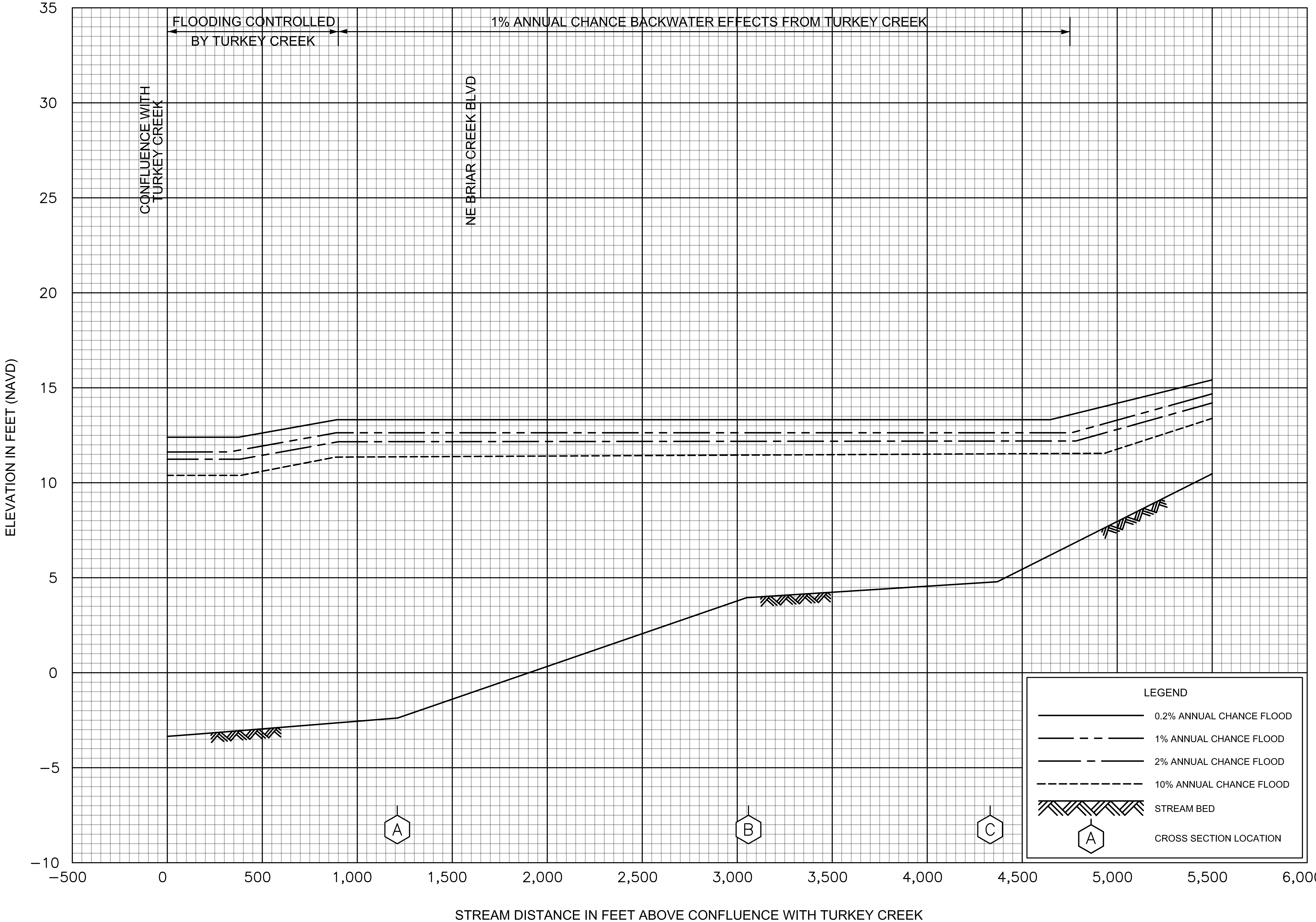
FLOOD PROFILES

TURKEY CREEK CHANNEL A

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL

AND INCORPORATED AREAS

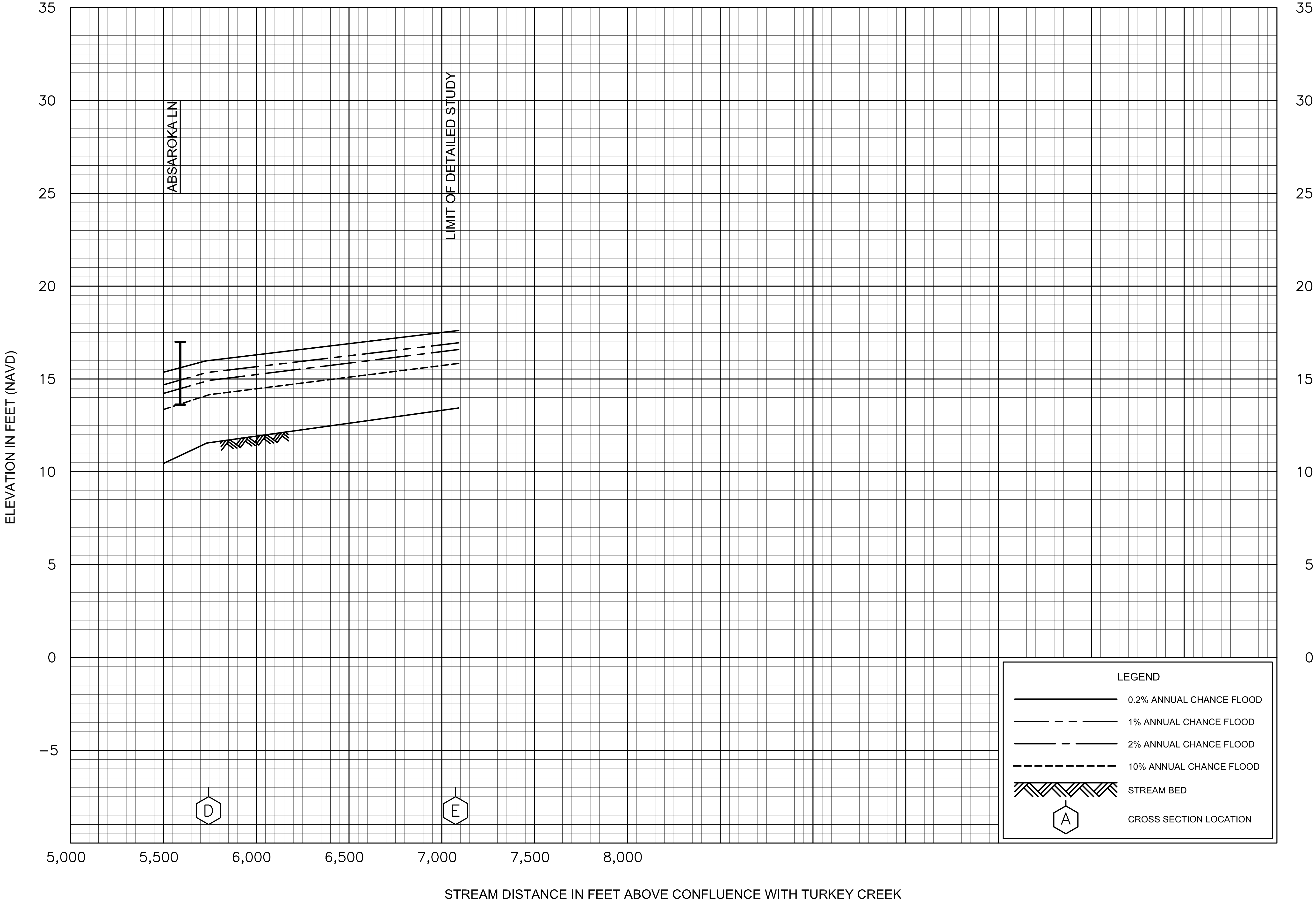


FLOOD PROFILES

TURKEY CREEK CHANNEL B

FEDERAL EMERGENCY MANAGEMENT AGENCY

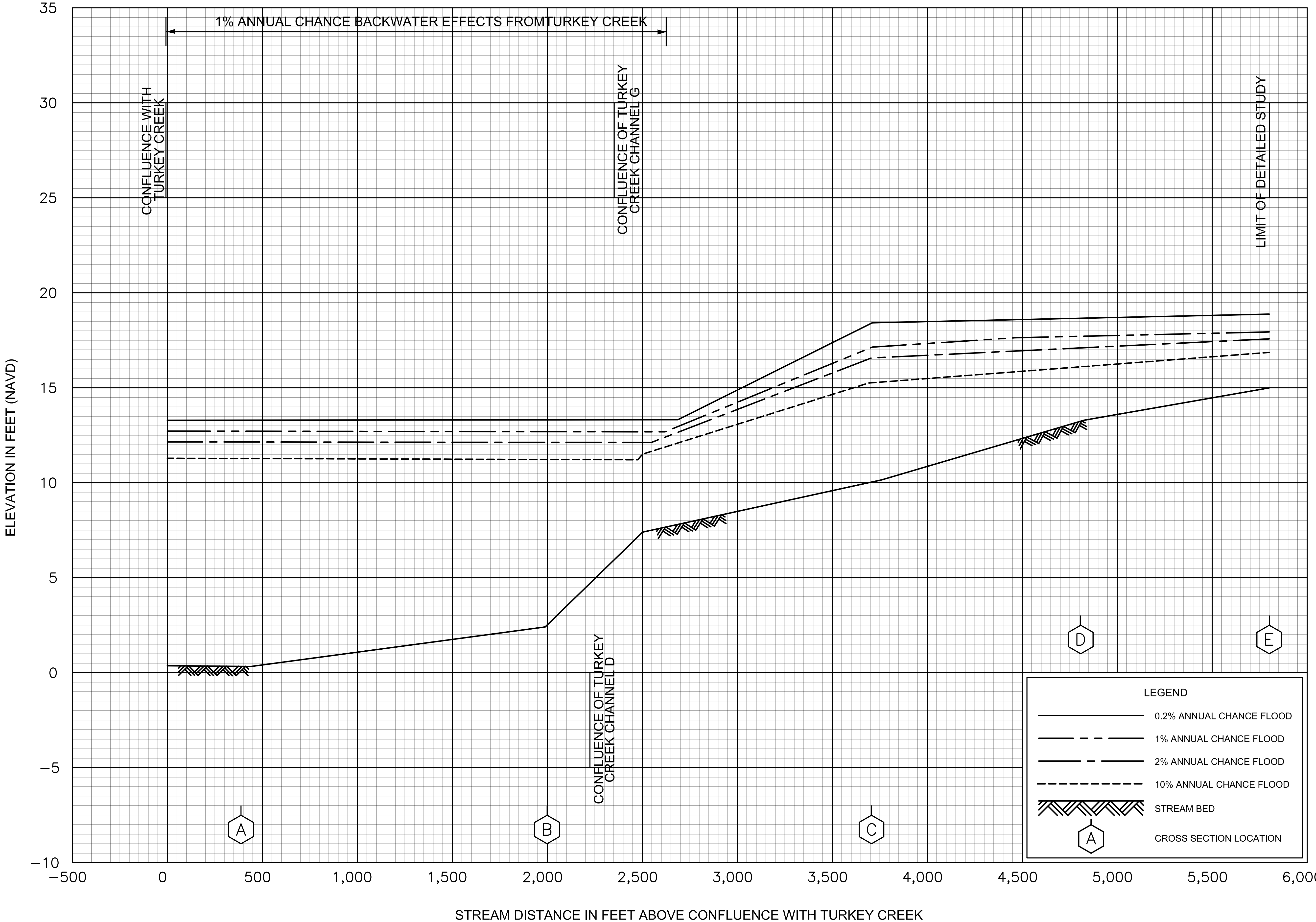
BREVARD COUNTY, FL
AND INCORPORATED AREAS



FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL

AND INCORPORATED AREAS



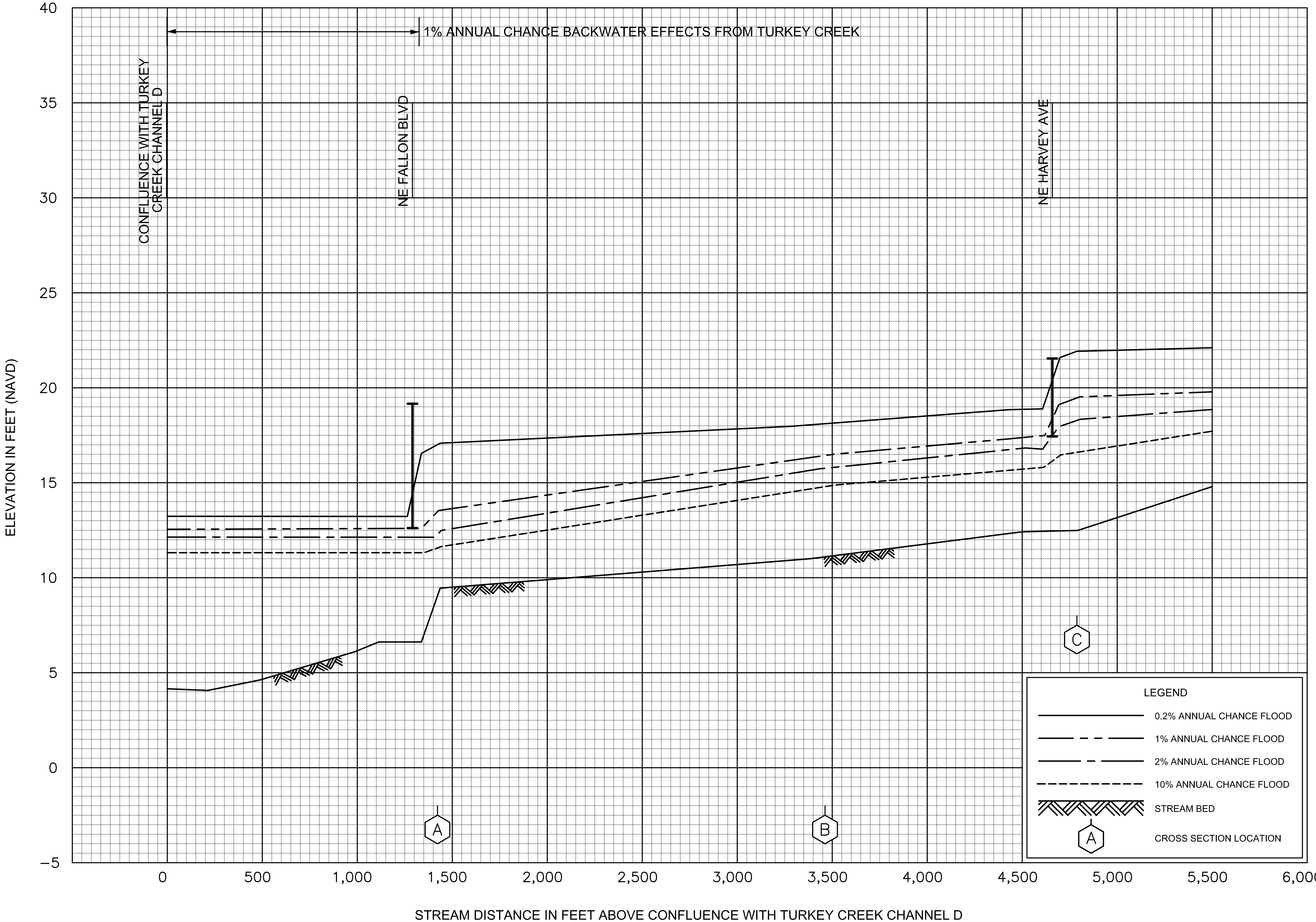
FLOOD PROFILES

TURKEY CREEK CHANNEL C

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL

AND INCORPORATED AREAS



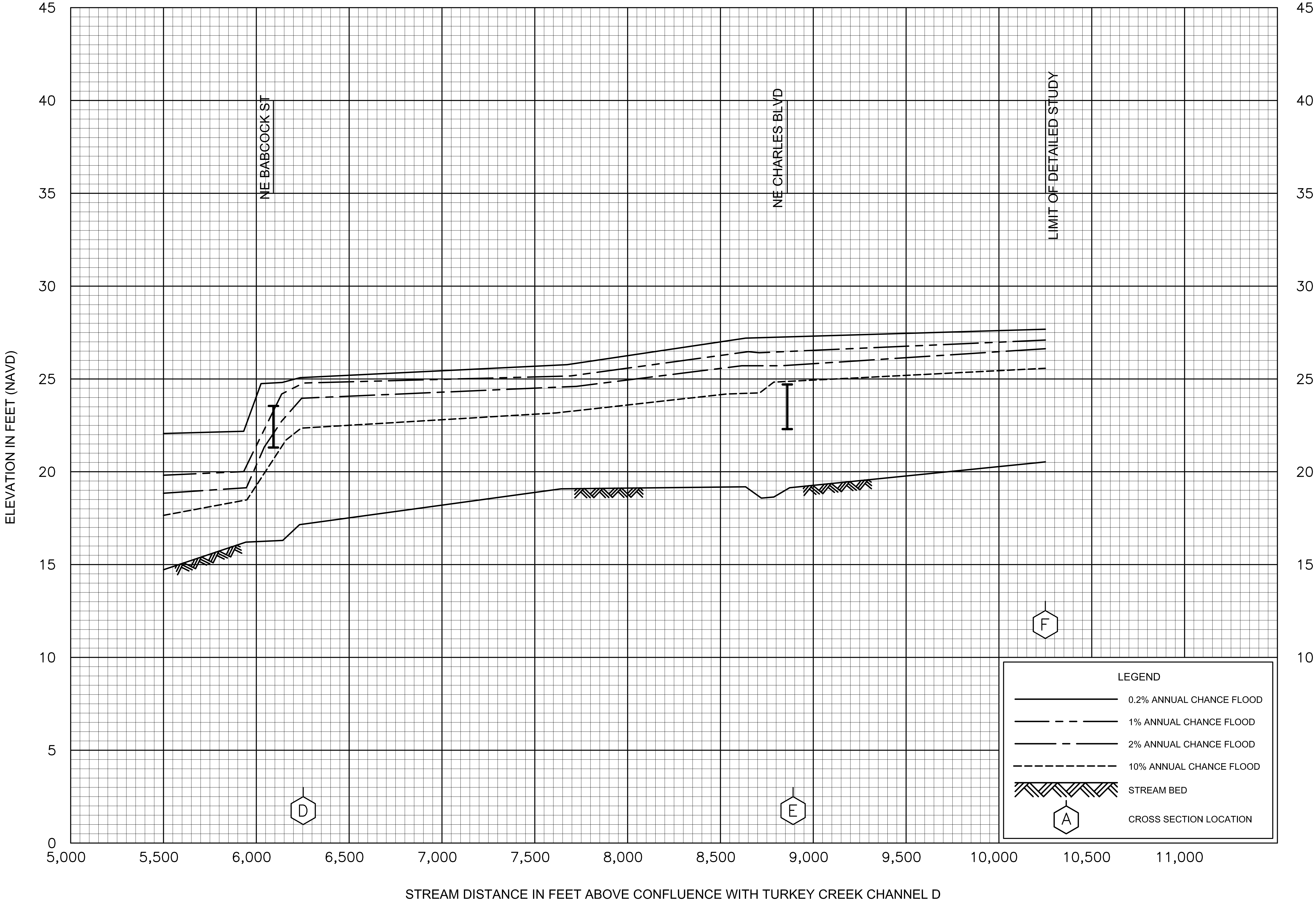
FLOOD PROFILES

TURKEY CREEK CHANNEL C-76

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL

AND INCORPORATED AREAS



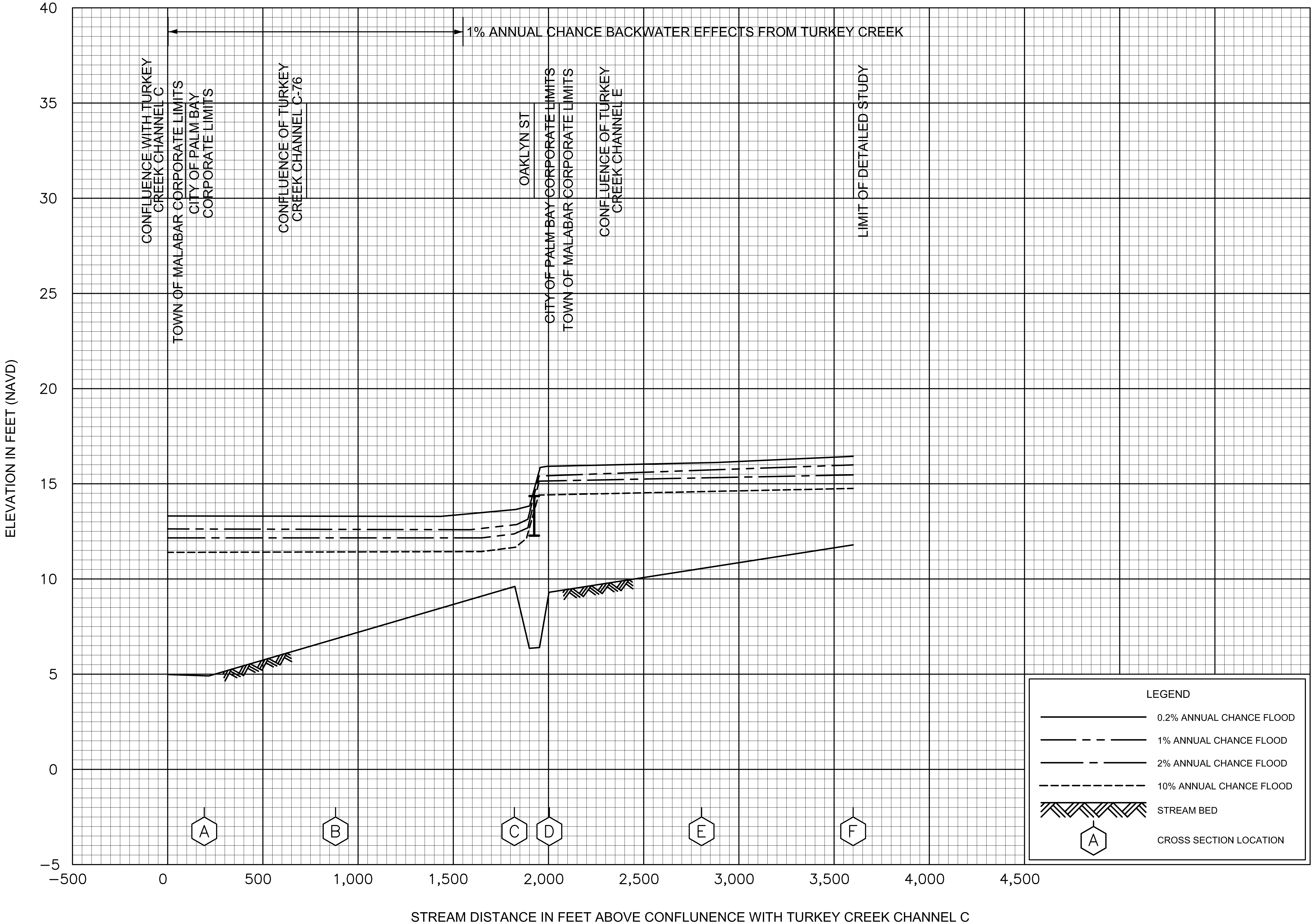
FLOOD PROFILES

TURKEY CREEK CHANNEL C-76

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL

AND INCORPORATED AREAS



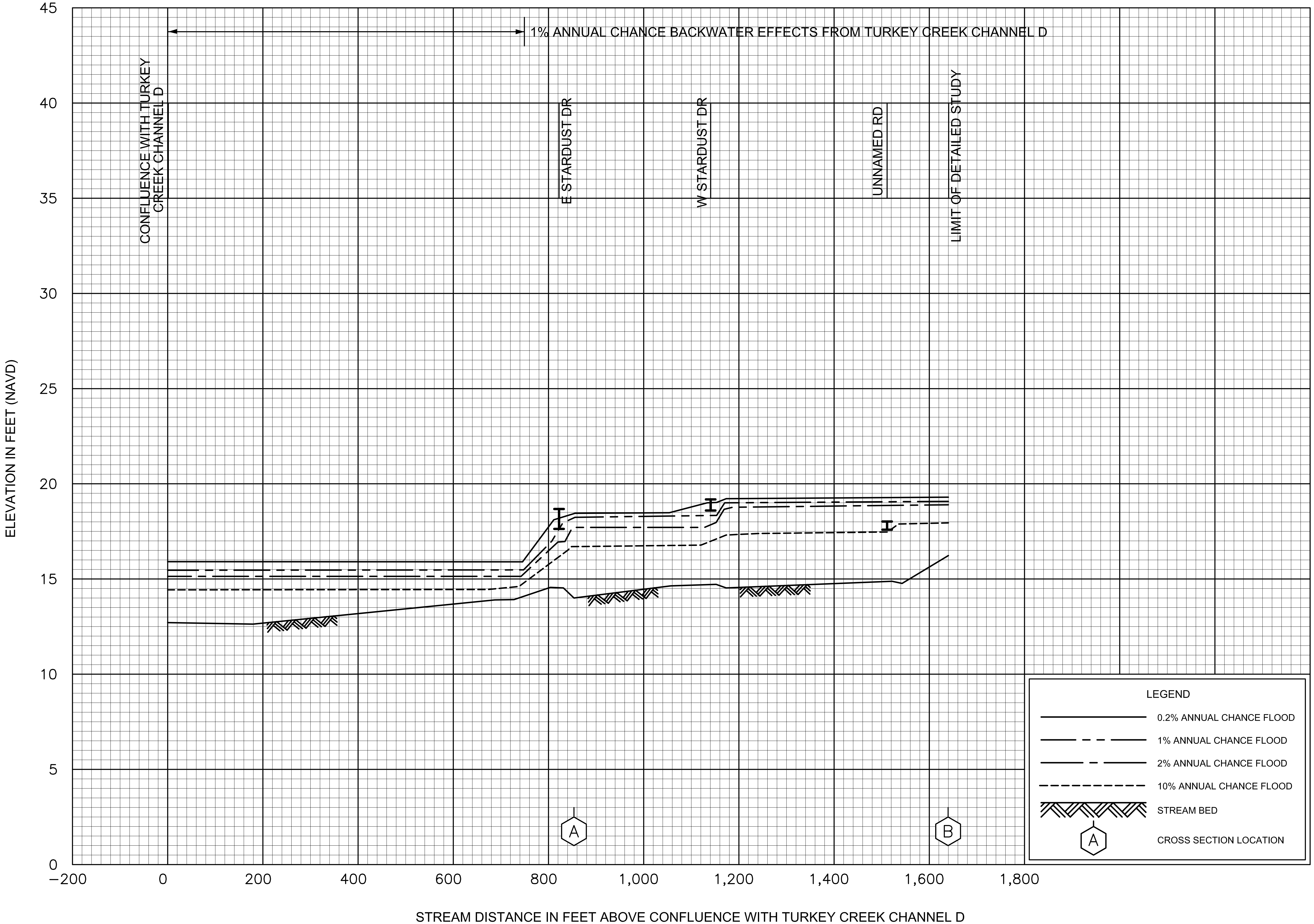
FLOOD PROFILES

TURKEY CREEK CHANNEL D

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUTNY, FL

AND INCORPORATED AREAS

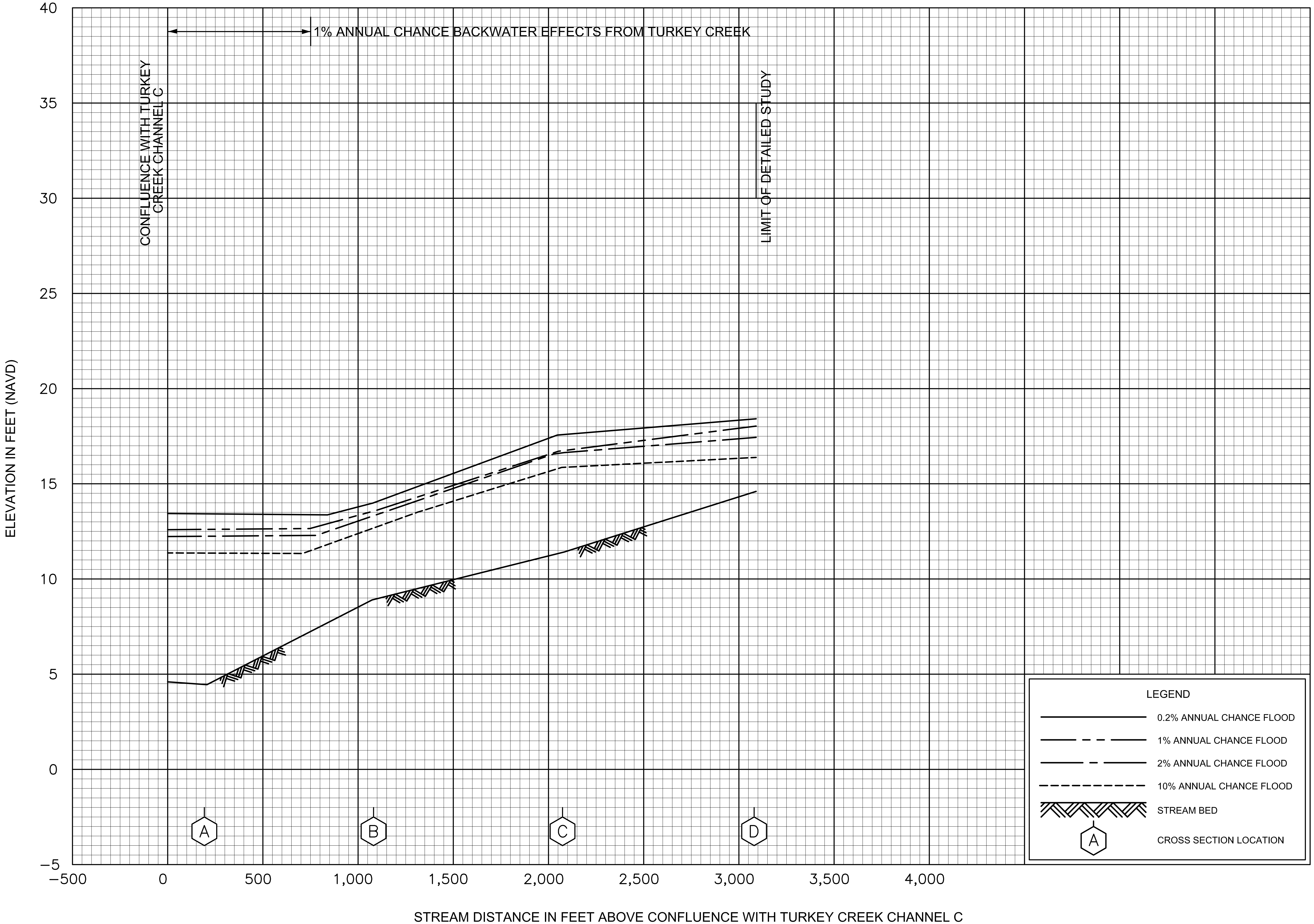


FLOOD PROFILES

TURKEY CREEK CHANNEL E

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL
AND INCORPORATED AREAS



FLOOD PROFILES

TURKEY CREEK CHANNEL G

FEDERAL EMERGENCY MANAGEMENT AGENCY

BREVARD COUNTY, FL

AND INCORPORATED AREAS

APPENDIX B

PRELIMINARY SIZING OF PROPOSED CROSSDRAINS

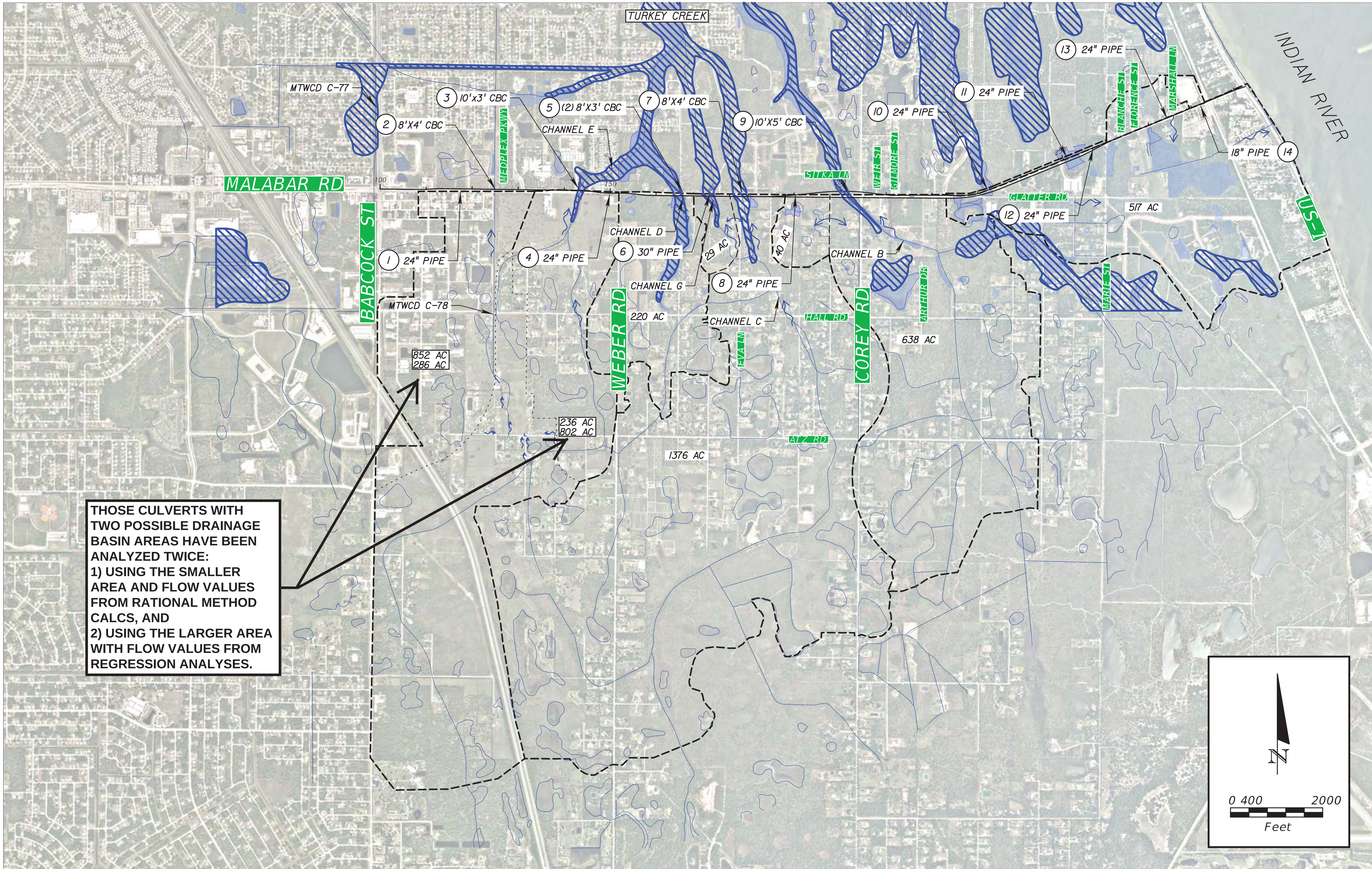
- HYDROLOGIC CALCS

- EXISTING CULVERTS

- PROPOSED CULVERTS

PRELIMINARY SIZING OF PROPOSED CROSSDRAINS

- HYDROLOGIC CALCS



LEGEND

FLOWLINE OR WATERBODY (PER QUAD MAP)
DRAINAGE BASIN BOUNDARY
BOX CULVERT
CROSS DRAIN PIPE

SR514 - MALABAR ROAD
EXISTING CROSSDRAINS AND OFFSITE DRAINAGE BASIN DIVIDES

FDOT Malabar Road (SR 514)
PROJECT DEVELOPMENT & ENVIRONMENT STUDY, BREVARD COUNTY
Financial Project Number: 430136-1-22-01

RATIONAL METHOD COMPUTATIONS - SUMMARY OF RESULTS

Rational Method Flow Calculations

Project: SR 514
Basin: 1-14
Designer: CA Estrella **Checked by:**
Date: 6/24/2014 **Date:**

1. Using the Rational Method calculate the flows for the following basins:

Basin	Structure	Tc	Storm	C	I	A (ac)	Q (cfs)
2	**Culvert 2**	127.7	2	0.38	1.38	286.00	149.38
			10	0.38	1.91	286.00	206.54
			25	0.42	2.20	286.00	262.16
			50	0.45	2.43	286.00	316.03
		(1.)	100	0.47	2.67	286.00	362.38
		(2.)	500				470.00
3 ALT	**Culvert 3**	93.0	2	0.25	1.77	236.00	104.69
			10	0.25	2.42	236.00	142.98
			25	0.28	2.79	236.00	181.21
			50	0.30	3.08	236.00	218.00
		(1.)	100	0.31	3.37	236.00	248.99
		(2.)	500				320.93
5	**Culvert 5**	56.9	2	0.35	2.51	220.00	190.47
			10	0.35	3.35	220.00	254.98
			25	0.38	3.85	220.00	321.77
			50	0.41	4.23	220.00	385.78
		(1.)	100	0.43	4.61	220.00	437.87
		(2.)	500				558.82
6	**Culvert 6**	24.7	2	0.27	4.04	29.00	31.89
			10	0.27	5.20	29.00	41.10
			25	0.30	5.90	29.00	51.28
			50	0.33	6.44	29.00	61.05
		(1.)	100	0.34	6.97	29.00	68.81
		(2.)	500				86.84
8	**Culvert 8**	21.1	2	0.30	4.36	40.00	52.37
			10	0.30	5.58	40.00	66.96
			25	0.33	6.31	40.00	83.32
			50	0.36	6.88	40.00	99.04
		(1.)	100	0.38	7.44	40.00	111.54
		(2.)	500				140.57
10	**Culvert 10**	19.5	2	0.70	4.53	4.30	13.63
			10	0.70	5.77	4.30	17.36
			25	0.77	6.52	4.30	21.58
			50	0.84	7.09	4.30	25.63
		(1.)	100	0.88	7.67	4.30	28.85
		(2.)	500				36.34
13	**Culvert 13**	31.3	2	0.40	3.57	30.00	42.82
			10	0.40	4.65	30.00	55.82
			25	0.44	5.30	30.00	69.90
			50	0.48	5.79	30.00	83.41
		(1.)	100	0.50	6.28	30.00	94.14
		(2.)	500				119.08

Intensity = A + BX + CX^2 + DX^3 X=ln Tc
(from Table T-19, FDOT Hydrology Handbook, Feb. 2012)

Zone 7	2 Yr	10 Yr	25 Yr	50 Yr	100 Yr CAE est
A	12.10821	12.49556	12.92209	13.2955	14.671
B	-2.79255	-1.67116	-1.11084	-0.70432	-1.0717
C	0.02002	-0.34901	-0.55019	-0.70152	-0.6606
D	0.02053	0.05017	0.06666	0.07933	0.0766

Notes:

3. Intensitites for the 100-yr storm have been estimated from the Zone 7, 100-year IDF curve.
2. Please refer to attached Frequency vs. Discharge Curves

RATIONAL METHOD COMPUTATIONS - TC

Method and Date	**Formulat for t_c (min)**	**Remarks**
Kirpich (1940)	t_c=0.0078 $L^{0.77}S^{-0.385}$	Developed from SCS data for several rural basins in Tennessee with well-defined channel and steep slopes (3% to 10%); for overland flow on concrete or asphalt surfaces multiply tc by 0.4; for concrete channels multiply by 0.2; no adjustments for overland flow on bare soil or flow in roadside ditches.

Variables

L= length of flow path, ft
S= slope of flow path, ft/ft

Basin	Basin Area (ac)	L (ft)	EL_1	EL_2	S (ft/ft)	t_c (min)	Average velocity ft/min	Average velocity fps
1	Equilizer Pipe. Refer to Hydraulic Calcs.							
2	286	7350	26	21.5	0.0006	128	58	1.0
2 Alt.	852	SEE REGRESSION CALCS						
3	802	SEE REGRESSION CALCS						
3 Alt.	236	6150	26	20	0.0010	93	66	1.1
4	Equilizer Pipe. Refer to Hydraulic Calcs.							
5	220	4760	26	16	0.0021	57	84	1.4
6	29	1950	23.5	17.5	0.0031	25	79	1.3
7	1376	SEE REGRESSION CALCS						
8	40	1600	24	19	0.0031	21	76	1.3
9	638	SEE REGRESSION CALCS						
10	4.3	1500	23.5	18.45	0.0034	19	77	1.3
11	Equilizer Pipe. Refer to Hydraulic Calcs.							
12	Equilizer Pipe. Refer to Hydraulic Calcs.							
13	30	2000	23	19.5	0.0018	31	64	1.1
14	Pond emergency flow. Refer to Hydraulic Calcs.							

Landuse Woodlands	Landuse Residential	C Values $C_{2,10}$	C_{25}	C_{50}	C_{100}
29.9	256.1	0.38	0.42	0.45	0.47
176.8	59.2	0.25	0.28	0.30	0.31
60	160	0.35	0.38	0.41	0.43
18.5	10.5	0.27	0.30	0.33	0.34
20	20	0.30	0.33	0.36	0.38
See Note 1 below		0.7	0.77	0.84	0.88
	30	0.40	0.44	0.48	0.50

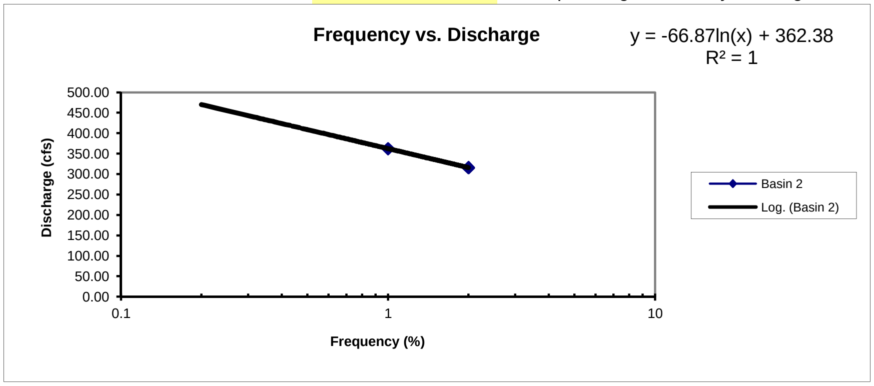
Notes:
1. Basin 10 is only composed of road right of way; C=0.7
2. Woodlands, pasturs, and grass; C=0.2
3. Single family residential, 1/2 acre lots or larger; C=0.4
4. Runoff coefficients have been multiplied by frequency factors for each storm based on Table T-5 of the FDOT Hydrology Handbook, Feb. 2012

Frequency vs. Discharge Curves

Project: SR 514 PDE
Basins: 2, 3 Alt., 5, 6, 8, 10, 13
Designer: CA Estrella
Date: 6/24/2014

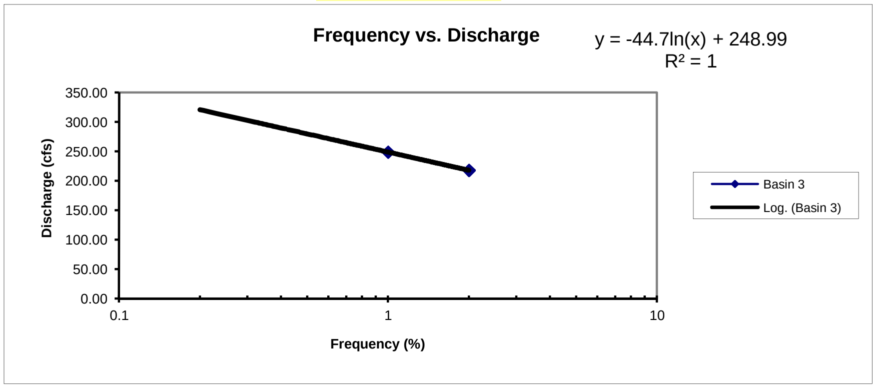
Culvert 2

Year	Frequency (%)	Discharge (cfs)	
50	2	316.03	
100	1	362.38	
500	0.2	470.00	Use equation generated by charting to obtain Q



Culvert 3 Alt.

Year	Frequency (%)	Discharge (cfs)	
50	2	218.00	
100	1	248.99	
500	0.2	320.93	Use equation generated by charting to obtain Q

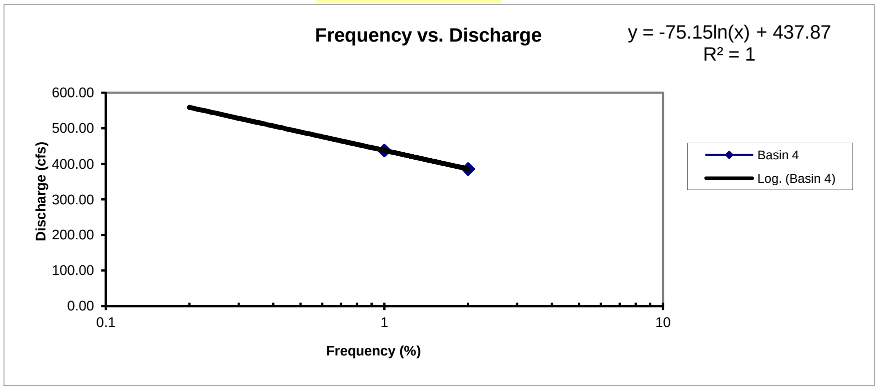


Frequency vs. Discharge Curves

Project: SR 514 PDE
Basins: 2, 3 Alt., 5, 6, 8, 10, 13
Designer: CA Estrella
Date: 6/24/2014

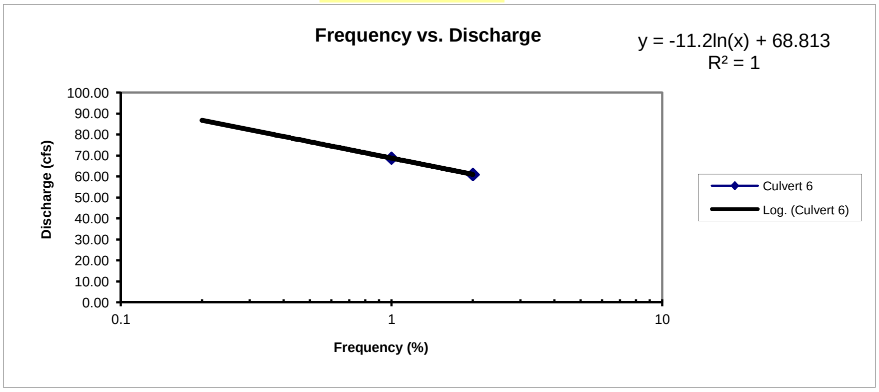
Culvert 5

Year	Frequency (%)	Discharge (cfs)	
50	2	385.78	
100	1	437.87	
500	0.2	558.82	Use equation generated by charting to obtain Q



Culvert 6

Year	Frequency (%)	Discharge (cfs)	
50	2	61.05	
100	1	68.81	
500	0.2	86.84	Use equation generated by charting to obtain Q

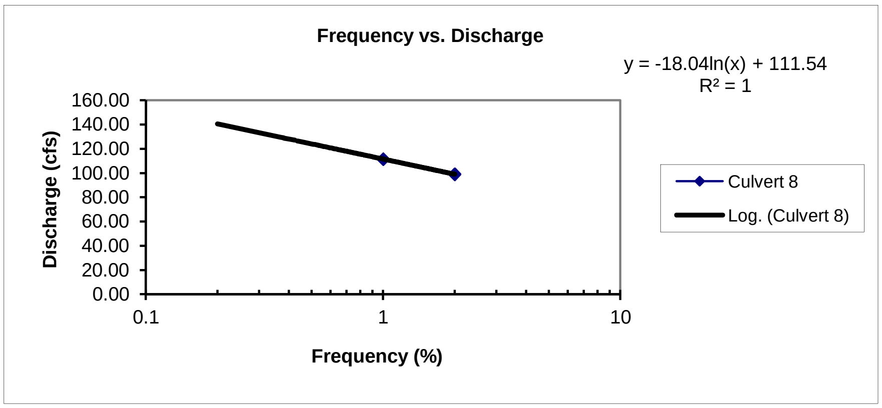


Frequency vs. Discharge Curves

Project: SR 514 PDE
Basins: 2, 3 Alt., 5, 6, 8, 10, 13
Designer: CA Estrella
Date: 6/24/2014

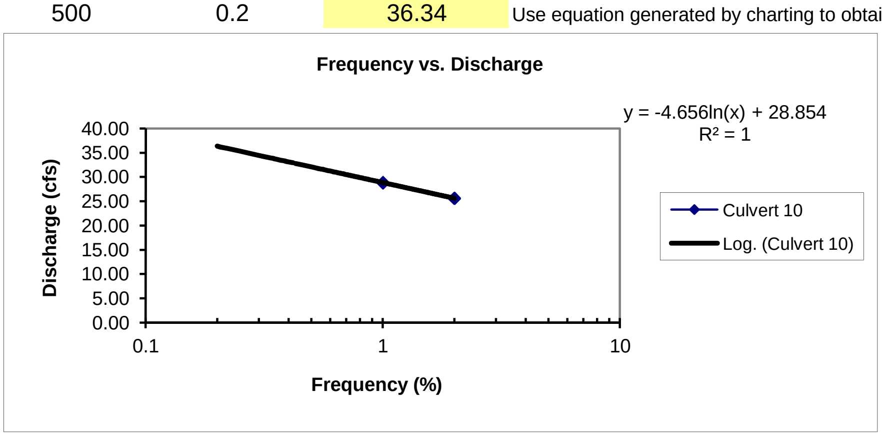
Culvert 8

Year	Frequency (%)	Discharge (cfs)	
50	2	99.04	
100	1	111.54	
500	0.2	140.57	Use equation generated by charting to obtain Q



Culvert 10

Year	Frequency (%)	Discharge (cfs)	
50	2	25.63	
100	1	28.85	
500	0.2	36.34	Use equation generated by charting to obtain Q

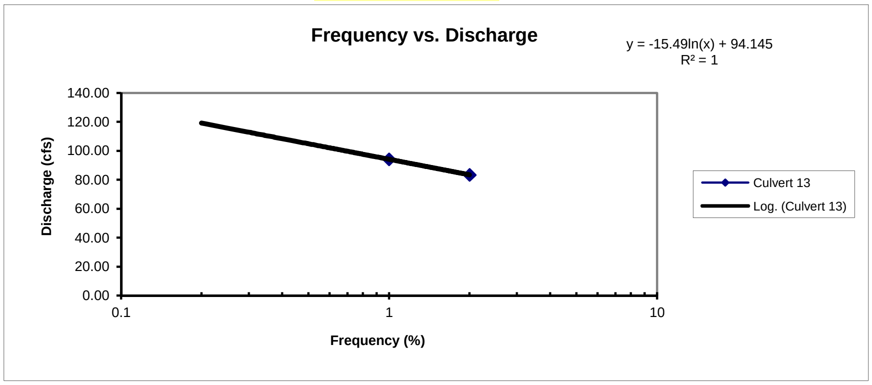


Frequency vs. Discharge Curves

Project: SR 514 PDE
Basins: 2, 3 Alt., 5, 6, 8, 10, 13
Designer: CA Estrella
Date: 6/24/2014

Culvert 13

Year	Frequency (%)	Discharge (cfs)	
50	2	83.41	
100	1	94.14	
500	0.2	119.08	Use equation generated by charting to obtain Q



REGRESSION ANALYSIS - INPUT PARAMETERS

	A	B	C	F	G
1	**Regression Equation Input Values**				
2					
3	**Variable**	**Description**	**Range of Applicability**		
4	DA	Drainage Area	0.2 miles^2 (120 acres) 120 acres to 2,833 miles^2		
5	ST	Basin Storage	0 to 34.12%		
6					
7					
8	**Culvert #**	**Basin Area (ac)**	**Basin Area (miles^2)**	**Basin Storage (ac)**	**Basin Storage (%)**
9	1	EQUILIZER PIPE. SEE HYDRAULIC CALCS.		0.00	
10	2	286	0.45	22.17	7.75
11	2 Alt.	852	1.33	44.08	5.17
12	3	802	1.25	31.68	3.95
13	3 Alt	236	0.37	9.77	4.14
14	4	EQUILIZER PIPE. SEE HYDRAULIC CALCS.		0.00	
15	5	SEE RATIONAL METHOD CALCS		17.13	
16	6	SEE RATIONAL METHOD CALCS		0.00	
17	7	1376	2.15	146.46	10.64
18	8	SEE RATIONAL METHOD CALCS		4.40	
19	9	638	1.00	34.03	5.33
20	10	SEE RATIONAL METHOD CALCS		0.00	
21	11	EQUILIZER PIPE. SEE HYDRAULIC CALCS.		0.00	
22	12	EQUILIZER PIPE. SEE HYDRAULIC CALCS.		0.00	
23	13	SEE RATIONAL METHOD CALCS		0.00	
24	14	POND EMERGENCY FLOW. SEE HYDRAULIC CALCS		0.00	
25	N/A			7.26	
26	**TOTAL**	**3,102**	**4.85**	**263.13**	

USGS REGRESSION EQUATIONS FOR NATURAL FLOW CONDITIONS IN FLORIDA: REGION 4

Project: SR514 PDE
Basin: Culvert 2
Location: Brevard County
Computed by: C. Estrella **Checked by:**
Date: 6/24/2014 **Date:**

Required Basin Data:		
Drainage Area (DA)	0.45	$miles^2$
Basin Storage (ST)	7.75	% of total area

Range of Applicability of Basin Characteristics:	
DA	120 acres to 2,833 $miles^2$
ST	0 to 34.12 %

Peak Runoff Equation	Standard Error (%)	Q_T (ft^3/s)
$Q_2 = 171\ DA^{0.628}\ (ST+1)^{-0.401}$	36.0	**44**
$Q_5 = 321\ DA^{0.618}\ (ST+1)^{-0.395}$	39.0	**84**
$Q_{10} = 447\ DA^{0.614}\ (ST+1)^{-0.396}$	43.0	**115**
$Q_{25} = 636\ DA^{0.610}\ (ST+1)^{-0.401}$	48.0	**163**
$Q_{50} = 797\ DA^{0.609}\ (ST+1)^{-0.406}$	53.0	**202**
$Q_{100} = 975\ DA^{0.608}\ (ST+1)^{-0.411}$	57.0	**245**
$Q_{200} = 1171\ DA^{0.608}\ (ST+1)^{-0.416}$	62.0	**291**
$Q_{500} = 1461\ DA^{0.609}\ (ST+1)^{-0.424}$	69.0	**357**

Calculations and Documentation	Location
1. Drainage Map showing basin area.	Figure 4
2. Calculation of Basin Storage	Attached

Reference: FDOT Hydrology Handbook, Feb. 2012, Table T-13

USGS REGRESSION EQUATIONS FOR NATURAL FLOW CONDITIONS IN FLORIDA: REGION 4

Project:	SR514 PDE		
Basin:	Culvert 2 Alt.		
Location:	Brevard County		
Computed by:	C. Estrella	**Checked by:**	
Date:	6/24/2014	**Date:**	

Required Basin Data:		
Drainage Area (DA)	1.33	$miles^2$
Basin Storage (ST)	5.17	% of total area

Range of Applicability of Basin Characteristics:	
DA	120 acres to 2,833 $miles^2$
ST	0 to 34.12 %

Peak Runoff Equation	Standard Error (%)	Q_T (ft^3/s)
$Q_2 = 171\ DA^{0.628}\ (ST+1)^{-0.401}$	36.0	**100**
$Q_5 = 321\ DA^{0.618}\ (ST+1)^{-0.395}$	39.0	**189**
$Q_{10} = 447\ DA^{0.614}\ (ST+1)^{-0.396}$	43.0	**259**
$Q_{25} = 636\ DA^{0.610}\ (ST+1)^{-0.401}$	48.0	**365**
$Q_{50} = 797\ DA^{0.609}\ (ST+1)^{-0.406}$	53.0	**453**
$Q_{100} = 975\ DA^{0.608}\ (ST+1)^{-0.411}$	57.0	**549**
$Q_{200} = 1171\ DA^{0.608}\ (ST+1)^{-0.416}$	62.0	**653**
$Q_{500} = 1461\ DA^{0.609}\ (ST+1)^{-0.424}$	69.0	**804**

Calculations and Documentation	Location
1. Drainage Map showing basin area.	Figure 4
2. Calculation of Basin Storage	Attached

Reference: FDOT Hydrology Handbook, Feb. 2012, Table T-13

USGS REGRESSION EQUATIONS FOR NATURAL FLOW CONDITIONS IN FLORIDA: REGION 4

Project: SR514 PDE
Basin: Culvert 3
Location: Brevard County
Computed by: C. Estrella **Checked by:**
Date: 6/24/2014 **Date:**

Required Basin Data:		
Drainage Area (DA)	1.25	miles^2
Basin Storage (ST)	3.95	% of total area

Range of Applicability of Basin Characteristics:	
DA	120 acres to 2,833 miles^2
ST	0 to 34.12 %

Peak Runoff Equation	Standard Error (%)	Q_T (ft^3/s)
$Q_2 = 171\ DA^{0.628}\ (ST+1)^{-0.401}$	36.0	**105**
$Q_5 = 321\ DA^{0.618}\ (ST+1)^{-0.395}$	39.0	**198**
$Q_{10} = 447\ DA^{0.614}\ (ST+1)^{-0.396}$	43.0	**273**
$Q_{25} = 636\ DA^{0.610}\ (ST+1)^{-0.401}$	48.0	**384**
$Q_{50} = 797\ DA^{0.609}\ (ST+1)^{-0.406}$	53.0	**478**
$Q_{100} = 975\ DA^{0.608}\ (ST+1)^{-0.411}$	57.0	**580**
$Q_{200} = 1171\ DA^{0.608}\ (ST+1)^{-0.416}$	62.0	**691**
$Q_{500} = 1461\ DA^{0.609}\ (ST+1)^{-0.424}$	69.0	**851**

Calculations and Documentation	Location
1. Drainage Map showing basin area.	Figure 4
2. Calculation of Basin Storage	Attached

Reference: FDOT Hydrology Handbook, Feb. 2012, Table T-13

USGS REGRESSION EQUATIONS FOR NATURAL FLOW CONDITIONS IN FLORIDA: REGION 4

Project:	SR514 PDE		
Basin:	Culvert 3 Alt.		
Location:	Brevard County		
Computed by:	C. Estrella	**Checked by:**	
Date:	6/24/2014	**Date:**	

Required Basin Data:		
Drainage Area (DA)	0.37	miles^2
Basin Storage (ST)	4.14	% of total area

Range of Applicability of Basin Characteristics:	
DA	120 acres to 2,833 miles^2
ST	0 to 34.12 %

Peak Runoff Equation	Standard Error (%)	Q_T (ft^3/s)
$Q_2 = 171\ DA^{0.628}\ (ST+1)^{-0.401}$	36.0	**48**
$Q_5 = 321\ DA^{0.618}\ (ST+1)^{-0.395}$	39.0	**92**
$Q_{10} = 447\ DA^{0.614}\ (ST+1)^{-0.396}$	43.0	**127**
$Q_{25} = 636\ DA^{0.610}\ (ST+1)^{-0.401}$	48.0	**180**
$Q_{50} = 797\ DA^{0.609}\ (ST+1)^{-0.406}$	53.0	**223**
$Q_{100} = 975\ DA^{0.608}\ (ST+1)^{-0.411}$	57.0	**271**
$Q_{200} = 1171\ DA^{0.608}\ (ST+1)^{-0.416}$	62.0	**323**
$Q_{500} = 1461\ DA^{0.609}\ (ST+1)^{-0.424}$	69.0	**398**

Calculations and Documentation	Location
1. Drainage Map showing basin area.	Figure 4
2. Calculation of Basin Storage	Attached

Reference: FDOT Hydrology Handbook, Feb. 2012, Table T-13

USGS REGRESSION EQUATIONS FOR NATURAL FLOW CONDITIONS IN FLORIDA: REGION 4

Project:	SR514 PDE		
Basin:	Culvert 7		
Location:	Brevard County		
Computed by:	C. Estrella	**Checked by:**	
Date:	6/24/2014	**Date:**	

Required Basin Data:		
Drainage Area (DA)	2.15	$miles^2$
Basin Storage (ST)	10.64	% of total area

Range of Applicability of Basin Characteristics:	
DA	120 acres to 2,833 $miles^2$
ST	0 to 34.12 %

Peak Runoff Equation	Standard Error (%)	Q_T (ft^3/s)
$Q_2 = 171\ DA^{0.628}\ (ST+1)^{-0.401}$	36.0	**105**
$Q_5 = 321\ DA^{0.618}\ (ST+1)^{-0.395}$	39.0	**197**
$Q_{10} = 447\ DA^{0.614}\ (ST+1)^{-0.396}$	43.0	**271**
$Q_{25} = 636\ DA^{0.610}\ (ST+1)^{-0.401}$	48.0	**379**
$Q_{50} = 797\ DA^{0.609}\ (ST+1)^{-0.406}$	53.0	**469**
$Q_{100} = 975\ DA^{0.608}\ (ST+1)^{-0.411}$	57.0	**566**
$Q_{200} = 1171\ DA^{0.608}\ (ST+1)^{-0.416}$	62.0	**672**
$Q_{500} = 1461\ DA^{0.609}\ (ST+1)^{-0.424}$	69.0	**822**

Calculations and Documentation	Location
1. Drainage Map showing basin area.	Figure 4
2. Calculation of Basin Storage	Attached

Reference: FDOT Hydrology Handbook, Feb. 2012, Table T-13

USGS REGRESSION EQUATIONS FOR NATURAL FLOW CONDITIONS IN FLORIDA: REGION 4

Project:	SR514 PDE		
Basin:	Culvert 9		
Location:	Brevard County		
Computed by:	C. Estrella	**Checked by:**	
Date:	6/24/2014	**Date:**	

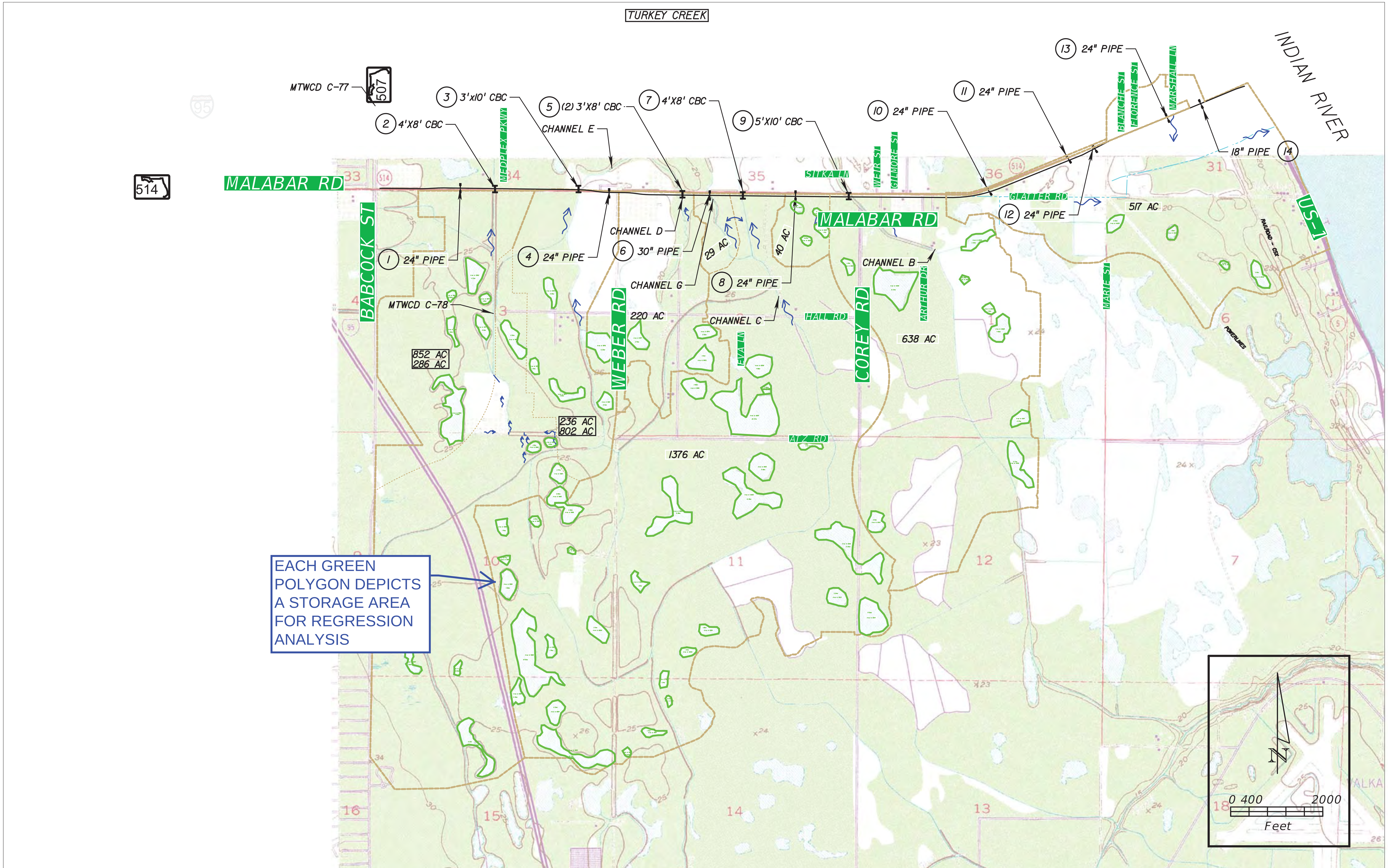
Required Basin Data:		
Drainage Area (DA)	1.00	miles^2
Basin Storage (ST)	5.33	% of total area

Range of Applicability of Basin Characteristics:	
DA	120 acres to 2,833 miles^2
ST	0 to 34.12 %

Peak Runoff Equation	**Standard Error (%)**	**Q_T (ft^3/s)**
$Q_2 = 171\ DA^{0.628}\ (ST+1)^{-0.401}$	36.0	**82**
$Q_5 = 321\ DA^{0.618}\ (ST+1)^{-0.395}$	39.0	**156**
$Q_{10} = 447\ DA^{0.614}\ (ST+1)^{-0.396}$	43.0	**215**
$Q_{25} = 636\ DA^{0.610}\ (ST+1)^{-0.401}$	48.0	**303**
$Q_{50} = 797\ DA^{0.609}\ (ST+1)^{-0.406}$	53.0	**376**
$Q_{100} = 975\ DA^{0.608}\ (ST+1)^{-0.411}$	57.0	**456**
$Q_{200} = 1171\ DA^{0.608}\ (ST+1)^{-0.416}$	62.0	**542**
$Q_{500} = 1461\ DA^{0.609}\ (ST+1)^{-0.424}$	69.0	**667**

Calculations and Documentation	**Location**
1. Drainage Map showing basin area.	Figure 4
2. Calculation of Basin Storage	Attached

Reference: FDOT Hydrology Handbook, Feb. 2012, Table T-13



LEGEND

FLOWLINE OR WATERBODY (PER QUAD MAP)

DRAINAGE BASIN BOUNDARY

BOX CULVERT

CROSS DRAIN PIPE

STORAGE POLYGONS USED IN REGRESSION ANALYSIS CALCS

Table T-4
Runoff Coefficients for a Design Storm Return Period of 10 Years or Less[a]

Slope	Land Use	Sandy Soils Min.	Sandy Soils Max.	Clay Soils Min.	Clay Soils Max.
Flat (0-2%)	Woodlands	0.10	0.15	0.15	0.20
	Pasture, grass, and farmland [b]	0.15	0.20	0.20	0.25
	Bare Earth	0.30	0.50	0.50	0.60
	Rooftops and pavement	0.95	0.95	0.95	0.95
	Pervious pavements [c]	0.75	0.95	0.90	0.95
	SFR: 1/2-acre lots and larger	0.30	0.35	0.35	0.45
	Smaller lots	0.35	0.45	0.40	0.50
	Duplexes	0.35	0.45	0.40	0.50
	MFR: Apartments, townhouses, and condominiums	0.45	0.60	0.50	0.70
	Commercial and Industrial	0.50	0.95	0.50	0.95
Rolling (2-7%)	Woodlands	0.15	0.20	0.20	0.25
	Pasture, grass, and farmland [b]	0.20	0.25	0.25	0.30
	Bare Earth	0.40	0.60	0.60	0.70
	Rooftops and pavement	0.95	0.95	0.95	0.95
	Pervious pavements [c]	0.80	0.95	0.90	0.95
	SFR: 1/2-acre lots and larger	0.35	0.50	0.40	0.55
	Smaller lots	0.40	0.55	0.45	0.60
	Duplexes	0.40	0.55	0.45	0.60
	MFR: Apartments, townhouses, and condominiums	0.50	0.70	0.60	0.80
	Commercial and Industrial	0.50	0.95	0.50	0.95
Steep (7%+)	Woodlands	0.20	0.25	0.25	0.30
	Pasture, grass, and farmland [b]	0.25	0.35	0.30	0.40
	Bare Earth	0.50	0.70	0.70	0.80
	Rooftops and pavement	0.95	0.95	0.95	0.95
	Pervious pavements [c]	0.85	0.95	0.90	0.95
	SFR: 1/2-acre lots and larger	0.40	0.55	0.50	0.65
	Smaller lots	0.45	0.60	0.55	0.70
	Duplexes	0.45	0.60	0.55	0.70
	MFR: Apartments, townhouses, and condominiums	0.60	0.75	0.65	0.85
	Commercial and Industrial	0.60	0.95	0.65	0.95

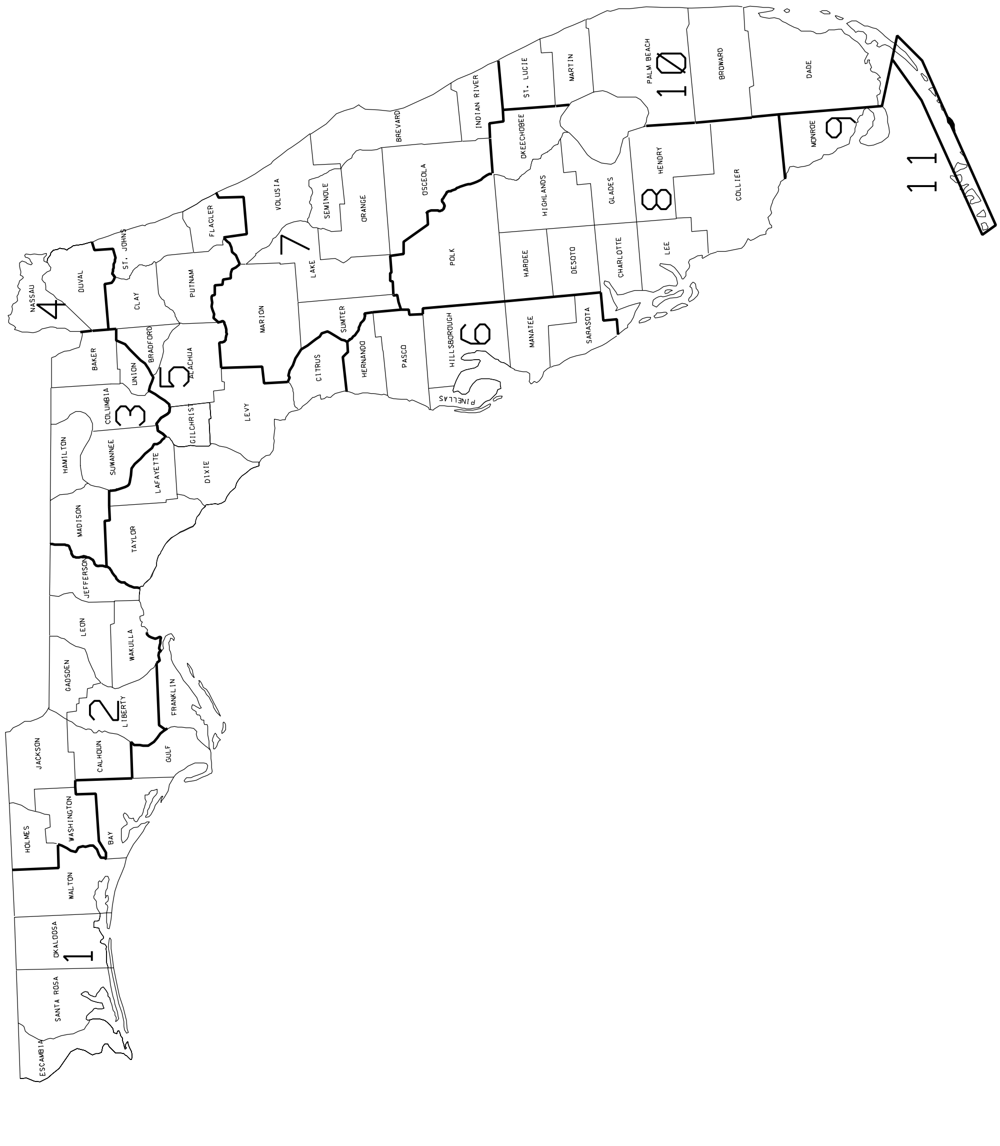
[a] Weighted coefficient based on percentage of impervious surfaces and green areas must be selected for each site.

[b] Coefficients assume good ground cover and conservation treatment.

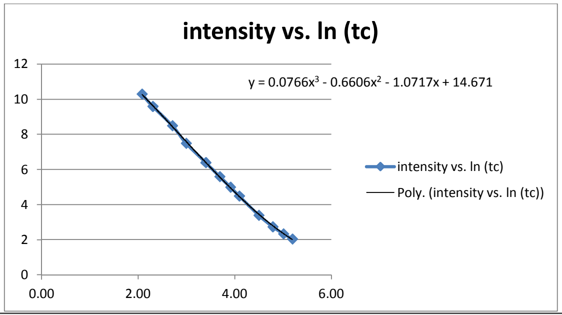
[c] Depends on depth and degree of permeability of underlying strata.

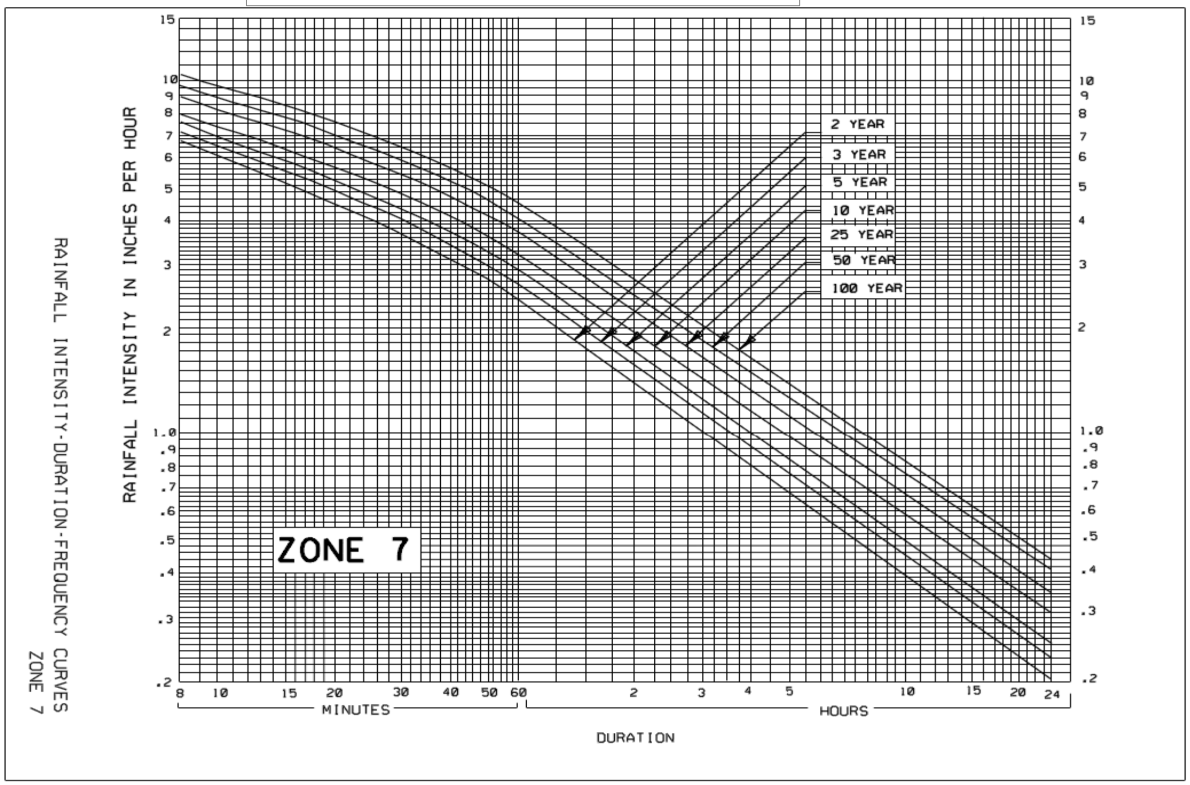
Note: SFR = Single Family Residential
MFR = Multi-Family Residential

ZONES FOR PRECIPITATION IDF CURVES DEVELOPED BY THE DEPARTMENT



tc minutes	intensity in/hr	ln tc
8	10.3	2.08
10	9.6	2.30
15	8.5	2.71
20	7.5	3.00
30	6.4	3.40
40	5.6	3.69
50	5	3.91
60	4.5	4.09
90	3.4	4.50
120	2.75	4.79
150	2.35	5.01
180	2.05	5.19





RAINFALL INTENSITY-DURATION-FREQUENCY CURVES
ZONE 7

Table T-5
Design Storm Frequency Factors for Pervious Area Runoff Coefficients *

Return Period (years)	Design Storm Frequency Factor, X_T
2 to 10	1.0
25	1.1
50	1.2
100	1.25

Reference: Wright-McLaughlin Engineers (1969).

* DUE TO THE INCREASE IN THE DURATION TIME THAT THE PEAK OR NEAR PEAK DISCHARGE RATE IS RELEASED FROM STORMWATER MANAGEMENT SYSTEMS, THE USE OF THESE SHORT DURATION PEAK RATE DISCHARGE ADJUSTMENT FACTORS IS NOT APPROPRIATE FOR FLOOD ROUTING COMPUTATIONS.

Table T-19
Department Intensity-Duration-Frequency (IDF) Regression Equation Constants and Coefficients

(Page 2 of 3)

Rainfall Zone	Storm Frequency in Years	Polynomial Coefficients for a Third Degree Polynomial			
		A	B	C	D
6	2	14.09519	-4.17207	0.31773	0.00029
6	3	14.98331	-4.44963	0.35683	-0.00224
6	5	14.54762	-3.89935	0.22564	0.00674
6	10	14.35386	-3.10140	-0.01003	0.02525
6	25	16.15961	-3.48135	-0.00160	0.02677
6	50	15.67671	-2.52635	-0.26055	0.04609
7	2	12.10821	-2.79255	0.02002	0.02053
7	3	12.43560	-2.56458	-0.06903	0.02787
7	5	12.51872	-2.17764	-0.19805	0.03849
7	10	12.49556	-1.67116	-0.34901	0.05017
7	25	12.92209	-1.11084	-0.55019	0.06666
7	50	13.29550	-0.70432	-0.70152	0.07933
8	2	11.51282	-2.10568	-0.16578	0.03515
8	3	11.13440	-1.44999	-0.34027	0.04808
8	5	11.41155	-1.34465	-0.38409	0.05149
8	10	11.54908	-0.89694	-0.53000	0.06319
8	25	10.92111	0.51710	-0.93480	0.09473
8	50	11.58787	0.73605	-1.04111	0.10384
9	2	11.08062	-1.66022	-0.28464	0.04453
9	3	11.54667	-1.49353	-0.35960	0.05071
9	5	11.76664	-1.38391	-0.39880	0.05352
9	10	12.08400	-1.00328	-0.53661	0.06491
9	25	12.38592	-0.27352	-0.77352	0.08370
9	50	14.16172	-0.73486	-0.75377	0.08518
10	2	11.33384	-1.86569	-0.22813	0.04005
10	3	11.32916	-1.38557	-0.36672	0.05012
10	5	11.19083	-0.93165	-0.48526	0.05836
10	10	10.84265	-0.18976	-0.69575	0.07495
10	25	11.83969	0.09353	-0.84451	0.08783
10	50	11.59208	1.00204	-1.10384	0.10762

	K	L	M	N	O	P	Q	R	S	T	U
1	**Storage Area Table**										
2	The regression equations for natural flow conditions are being used to estimate the Q at some of the culverts across SR514.										
3	The USGS Quadrangle Map has been used to estimate the surface area of "Storage" in each basin by delineating swamps and lakes in pre-										
4	developlment conditions.										
5	**Area ID**	**Area (ac)**	**Main Culvert**	**Alt. Culvert**							
6	9962	4.73	2	2							
7	9963	0.80	2	2							
8	9964	1.92	2	2							
9	9965	11.62	2	2							
10	9966	0.57	3	2							
11	9967	2.20	3	2							
12	9968	0.80	3	2							
13	9969	6.12	3	2							
14	9970	1.00	2	2							
15	9971	2.10	2	2							
16	9972	4.52	3	2							
17	9973	1.34	3	3							
18	9974	3.69	3	3							
19	9975	2.59	3	3							
20	9976	6.32	5	5							
21	9977	3.70	5	5							
22	9978	4.61	5	5							
23	9979	2.50	5	5							
24	9980	3.98	7	7							
25	9981	2.15	3	3							
26	9982	1.30	3	2							
27	9983	1.03	3	2							
28	9984	2.47	3	2							
29	9985	2.90	3	2							
30	9986	3.48	7	7							
31	9987	0.97	7	7							
32	9988	1.76	7	7							
33	9989	4.08	7	7							
34	9990	0.77	7	7							
35	9991	2.40	7	7							
36	9992	18.55	7	7							
37	9993	1.78	7	7							
38	9994	3.33	7	7							
39	9995	10.73	7	7							
40	9996	0.57	7	7							
41	9997	1.54	7	7							
42	9998	1.34	7	7							
43	9999	0.54	7	7							
44	10000	1.34	7	7							
45	10001	1.86	7	7							
46	10002	3.51	7	7							
47	10003	1.85	7	7							
48	10004	9.38	7	7							
49	10005	0.46	7	7							
50	10006	4.98	7	7							
51	10007	22.37	7	7							
52	10008	0.86	7	7							
53	10009	12.30	7	7							
54	10010	5.46	7	7							
55	10011	1.28	7	7							
56	10012	13.25	7	7							
57	10013	3.24	7	7							
58	10014	8.50	7	7							
59	10015	3.15	9	9							
60	10016	5.73	9	9							
61	10017	2.37	9	9							
62	10018	12.34	9	9							
63	10019	1.43	9	9							
64	10020	0.87	8	8							
65	10021	0.00	N/A	NA							
66	10022	1.25	8	8							
67	10023	0.87	8	8							
68	10024	1.41	8	8							
69	10025	3.32	9	9							
70	10026	0.59	9	9							
71	10027	1.01	9	9							
72	10028	4.09	9	9							
73	10029	2.22	N/A	N/A							
74	10030	1.29	N/A	N/A							
75	10031	0.65	N/A	N/A							
76	10032	3.10	N/A	N/A							
77											
78	**TOTAL**	**263.13**									

F-4 Regions for USGS Regression Equations for Natural Flow Conditions in Florida

Table T-13
USGS Regression Equations for Natural Flow Conditions in Florida - Region 4

Peak Runoff Equation	Standard Error of Prediction (%)
$Q_2 = 171\ A^{0.628}\ (ST+1)^{-0.401}$	36
$Q_5 = 321\ A^{0.618}\ (ST+1)^{-0.395}$	39
$Q_{10} = 447\ A^{0.614}\ (ST+1)^{-0.396}$	43
$Q_{25} = 636\ A^{0.610}\ (ST+1)^{-0.401}$	48
$Q_{50} = 797\ A^{0.609}\ (ST+1)^{-0.406}$	53
$Q_{100} = 975\ A^{0.608}\ (ST+1)^{-0.411}$	57
$Q_{200} = 1171\ A^{0.608}\ (ST+1)^{-0.416}$	62
$Q_{500} = 1461\ A^{0.609}\ (ST+1)^{-0.424}$	69

Q_T = Peak runoff rate for return period of T-years, in cfs

A = Drainage area, in miles^2

ST = Basin storage, the percentage of the drainage basin occupied by lakes, reservoirs, swamps, and wetland. In-channel storage of a temporary nature, resulting from detention ponds or roadway embankments, is not included in the computation of ST

Basin Characteristic	Range of Applicability
Drainage Area (A)	0.20 miles^2 (120 acres) to 2,833 miles^2
Storage Area (ST)	0% to 34.12%

Reference: Verdi (2006)

See Figure F-4 for zone delineation.

Existing conditions for the project's culverts have been analyzed to help determine a preliminary culvert size for Proposed Conditions. Based upon available data, the proposed pipe is sized to match or reduce the estimated 50-year headwater at each crossing. Table below summaries the results of the calculations for Existing and Proposed Conditions.

			50 yr			Existing	~ Proposed
Ex. Size	Prop. Size	Culvert	Q (cfs)	Pre HW	Post HW	Road CL EL	Road CL EL
24"	30"	1	23	24.16	23.31	24.34	25.25
8x4	8x4	2	316	24.12	24.12	24.31	25.58
8x4	(2) 6x4	2 Alt	453	24.64	23.78	24.31	25.58
10x3	(2) 8x4	3	478	21.23	20.93	20.84	24.02
10x3	10x3	3 Alt	218	20.40	20.49	20.84	24.02
24"	30"	4	20	19.86	19.21	20.46	24.66
(2) 8x3	(2) 8x4	5	386	17.24	16.86	18.3	22.98
30"	(2) 30"	6	61	19.56	19.11	19.4	23.06
8x4	(2) 6x4	7	469	21.42	21.46	21.08	23.62
24"	(2) 36"	8	99	22.13	21.42	21.76	25.65
10x5	10x5	9	376	19.06	19.06	21.07	25.01
24"	30"	10	25.6	22.41	21.43	22.9	22.9
24"	24"	11	10	22.31	22.35	24.07	24.07
24"	30"	12	10	21.64	21.51	23.97	23.97
24"	36"	13	83	24.08	24.48	23.8	24.5
18"	24"	14	10	23.62	22.94	25	25

Culvert #13 is part of the storm sewer system east of Marie Street. Results for existing conditions indicate overtopping of roadway where no problems are reported. Either runoff shifts to nearby inlet or basin area is different than assumed. Large pipe for proposed condition assumes downstream portion of storm sewer system is upsized to handle. Roadway profile affects peak stage if overtopping is present.

PRELIMINARY SIZING OF PROPOSED CROSSDRAINS

- EXISTING CULVERTS

EXISTING CULVERTS HAVE BEEN PRELIMINARILY ANALYZED USING BEST AVAILABLE DATA:

A) SURVEY OF INVERTS AND PIPE SIZES WERE OBTAINED FOR CULVERTS 2,3,5,6,7,8,9,10,11,12

B) FLOWLINES FOR OTHER CULVERTS (1,4,13, AND 14) WERE OBTAINED FROM VARIOUS CONSTRUCTION PLANS (SPN 7080-3506 AND SJRWMD ERP DATA)

HY-8 Culvert Analysis Report

EXISTING CULVERT 1

Table 1 - Summary of Culvert Flows at Crossing: Culvert 1 - 24" RCP

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 01 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
23.48	18.00	18.00	0.00	1
23.57	18.80	18.80	0.00	1
23.68	19.60	19.60	0.00	1
23.78	20.40	20.40	0.00	1
23.89	21.20	21.20	0.00	1
24.01	22.00	22.00	0.00	1
24.13	22.80	22.80	0.00	1
24.16	23.00	23.00	0.00	1
24.34	24.40	24.20	0.09	34
24.36	25.20	24.29	0.78	5
24.37	26.00	24.36	1.52	4
24.34	24.17	24.17	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 1 - 24" RCP

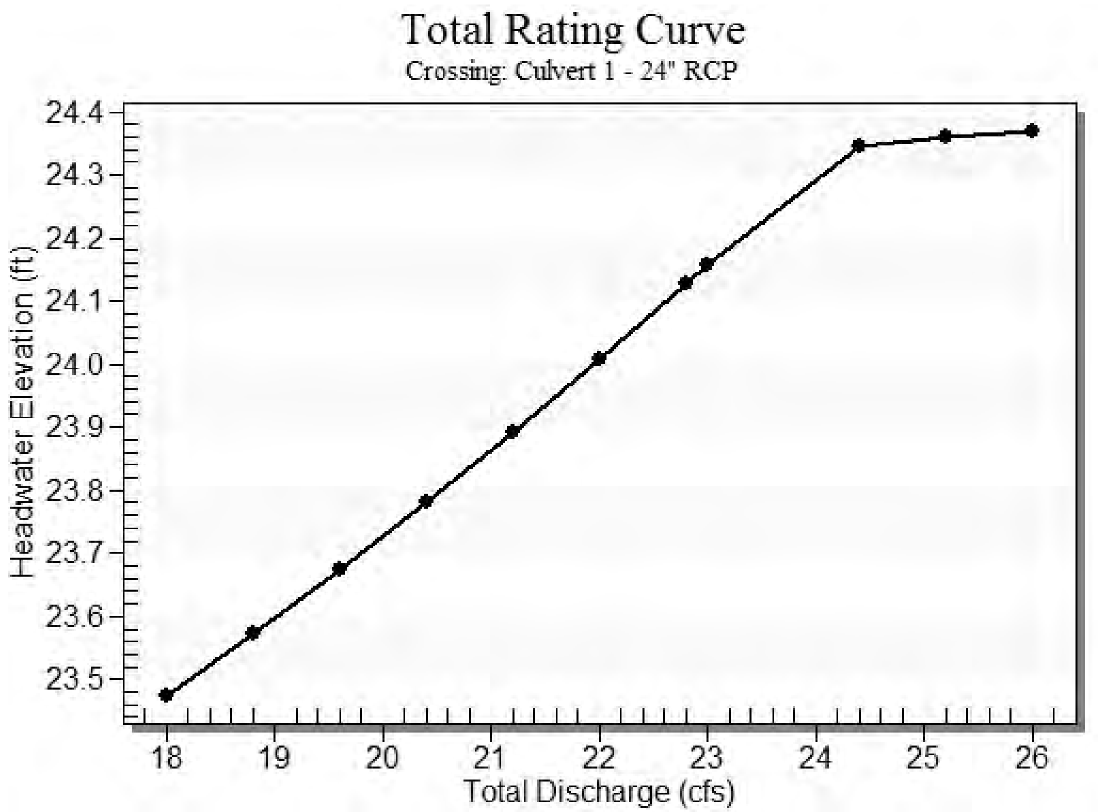


Table 2 - Culvert Summary Table: Culvert 01

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)
18.00	18.00	23.48	2.645	2.956	4-FFf	2.000	1.523	2.000	2.000	5.730	0.000
18.80	18.80	23.57	2.760	3.053	4-FFf	2.000	1.556	2.000	2.000	5.984	0.000
19.60	19.60	23.68	2.880	3.155	4-FFf	2.000	1.590	2.000	2.000	6.239	0.000
20.40	20.40	23.78	3.005	3.262	4-FFf	2.000	1.617	2.000	2.000	6.494	0.000
21.20	21.20	23.89	3.136	3.372	4-FFf	2.000	1.640	2.000	2.000	6.748	0.000
22.00	22.00	24.01	3.272	3.487	4-FFf	2.000	1.664	2.000	2.000	7.003	0.000
22.80	22.80	24.13	3.414	3.606	4-FFf	2.000	1.687	2.000	2.000	7.257	0.000
23.00	23.00	24.16	3.451	3.636	4-FFf	2.000	1.693	2.000	2.000	7.321	0.000
24.40	24.20	24.34	3.677	3.824	4-FFf	2.000	1.728	2.000	2.000	7.702	0.000
25.20	24.29	24.36	3.695	3.839	4-FFf	2.000	1.731	2.000	2.000	7.732	0.000
26.00	24.36	24.37	3.708	3.850	4-FFf	2.000	1.733	2.000	2.000	7.754	0.000

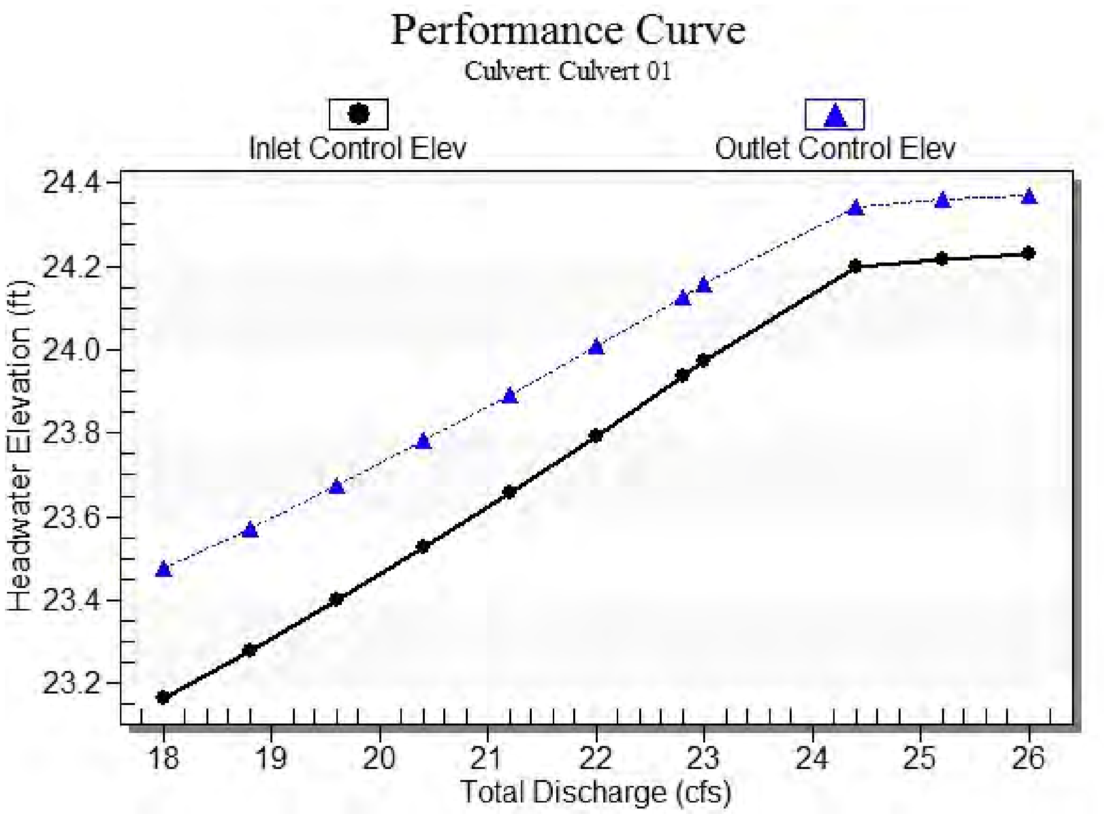
****

Inlet Elevation (invert): 20.52 ft, Outlet Elevation (invert): 20.40 ft

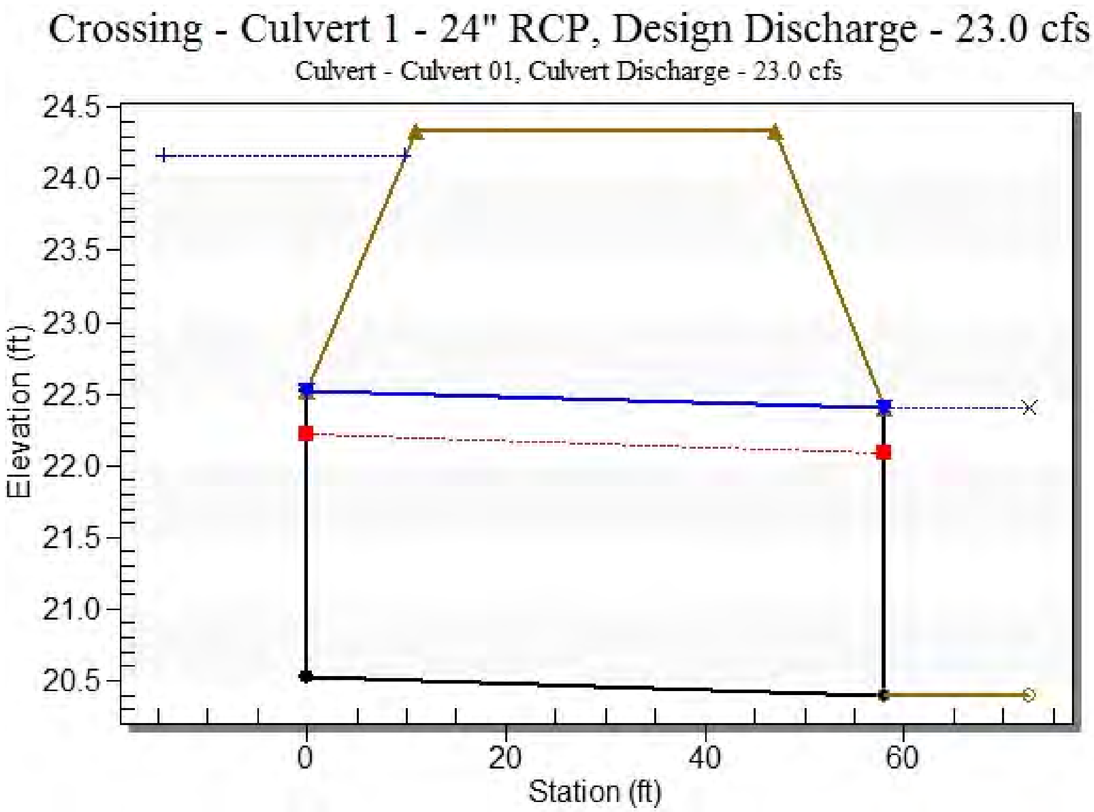
Culvert Length: 58.00 ft, Culvert Slope: 0.0021

****

Culvert Performance Curve Plot: Culvert 01



Water Surface Profile Plot for Culvert: Culvert 01



Site Data - Culvert 01

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 20.52 ft

Outlet Station: 58.00 ft

Outlet Elevation: 20.40 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 01

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 1 - 24" RCP)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
18.00	22.40	2.00
18.80	22.40	2.00
19.60	22.40	2.00
20.40	22.40	2.00
21.20	22.40	2.00
22.00	22.40	2.00
22.80	22.40	2.00
23.00	22.40	2.00
24.40	22.40	2.00
25.20	22.40	2.00
26.00	22.40	2.00

Tailwater Channel Data - Culvert 1 - 24" RCP

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 22.40 ft

Roadway Data for Crossing: Culvert 1 - 24" RCP

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 24.34 ft

Roadway Surface: Paved

Roadway Top Width: 36.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 2

Table 1 - Summary of Culvert Flows at Crossing: Culvert 02

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 02 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
21.83	207.00	207.00	0.00	1
22.32	233.30	233.30	0.00	1
22.84	259.60	259.60	0.00	1
23.41	285.90	285.90	0.00	1
24.03	312.20	312.20	0.00	1
24.12	316.00	316.00	0.00	1
24.46	364.80	329.35	35.00	9
24.52	391.10	331.75	58.91	5
24.58	417.40	333.85	83.35	5
24.63	443.70	335.71	107.58	4
24.67	470.00	337.45	132.29	4
24.31	323.41	323.41	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 02

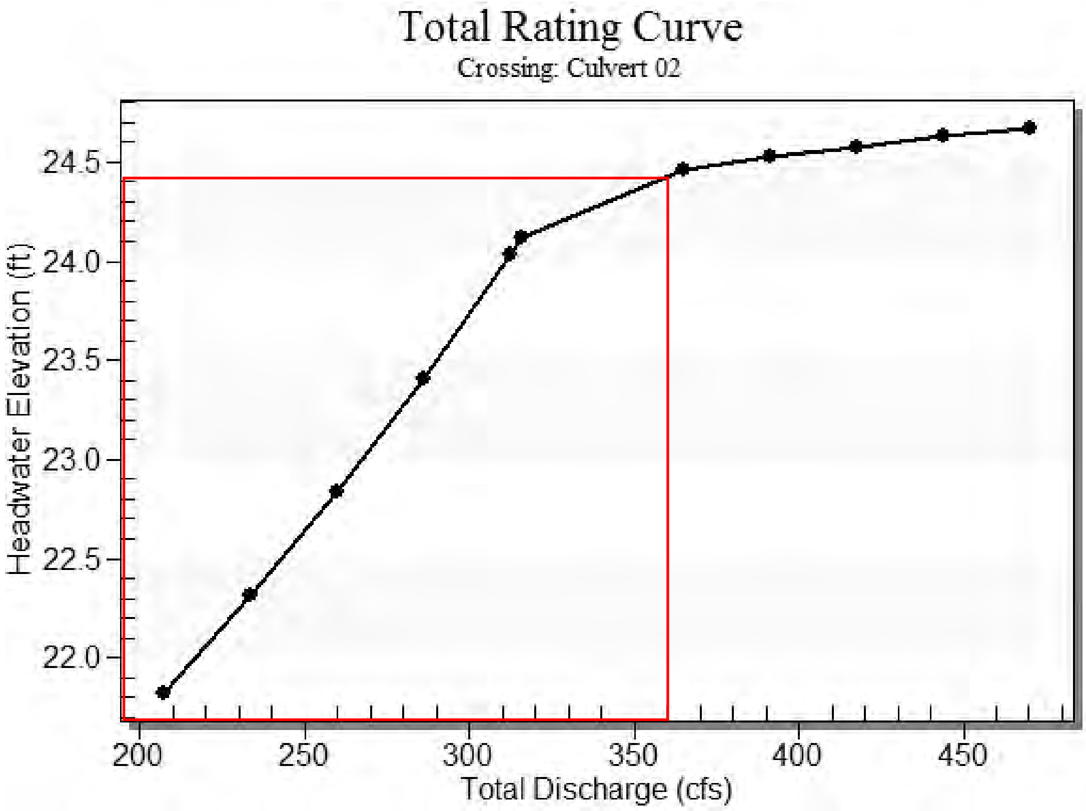


Table 2 - Culvert Summary Table: Culvert 02

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)
207.00	207.00	21.83	4.746	4.723	2-M2c	4.000	2.756	2.748	2.160	9.414	0.000
233.30	233.30	22.32	5.236	5.114	2-M2c	4.000	2.984	2.976	2.370	9.799	0.000
259.60	259.60	22.84	5.761	5.491	2-M2c	4.000	3.205	3.195	2.570	10.157	0.000
285.90	285.90	23.41	6.330	5.856	2-M2c	4.000	3.418	3.409	2.770	10.482	0.000
312.20	312.20	24.03	6.949	6.331	7-M2c	4.000	3.624	3.615	2.970	10.795	0.000
316.00	316.00	24.12	7.043	6.406	7-M2c	4.000	3.653	3.644	2.990	10.838	0.000
364.80	329.35	24.46	7.382	6.738	4-FFf	4.000	3.756	4.000	4.030	10.292	0.000
391.10	331.75	24.52	7.444	6.778	4-FFf	4.000	3.774	4.000	4.030	10.367	0.000
417.40	333.85	24.58	7.499	6.813	4-FFf	4.000	3.790	4.000	4.030	10.433	0.000
443.70	335.71	24.63	7.548	6.845	4-FFf	4.000	3.804	4.000	4.030	10.491	0.000
470.00	337.45	24.67	7.595	6.875	4-FFf	4.000	3.817	4.000	4.030	10.545	0.000

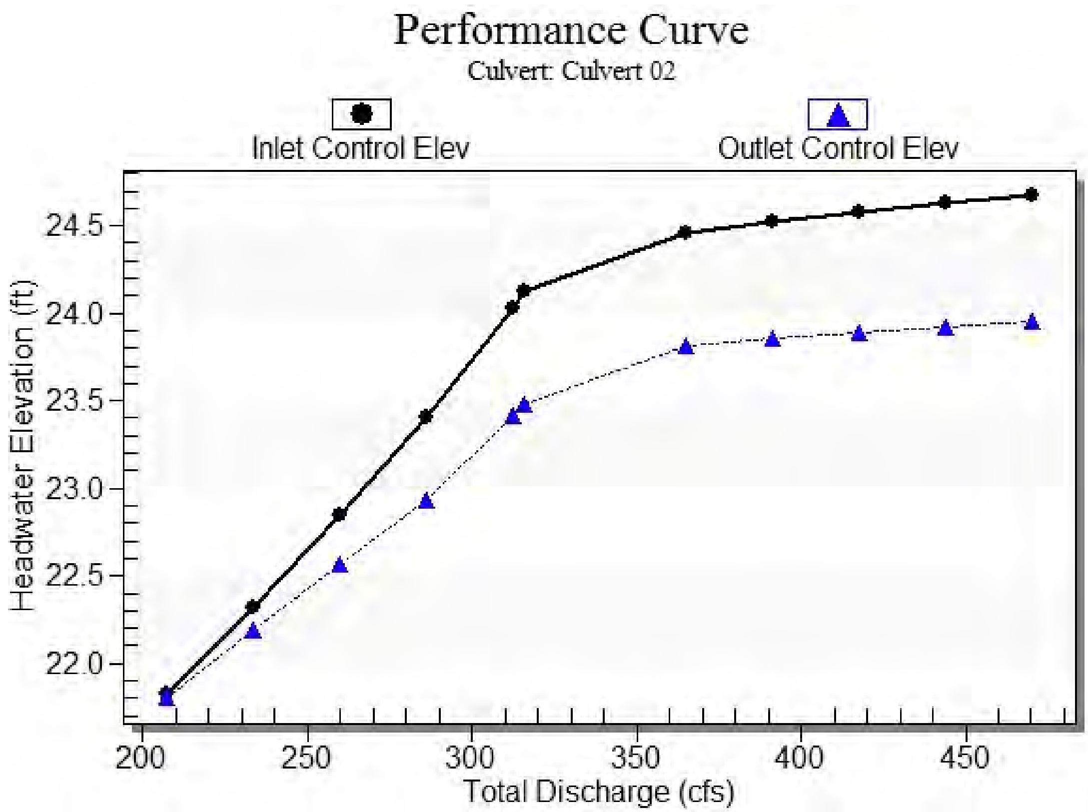
****

Inlet Elevation (invert): 17.08 ft, Outlet Elevation (invert): 17.03 ft

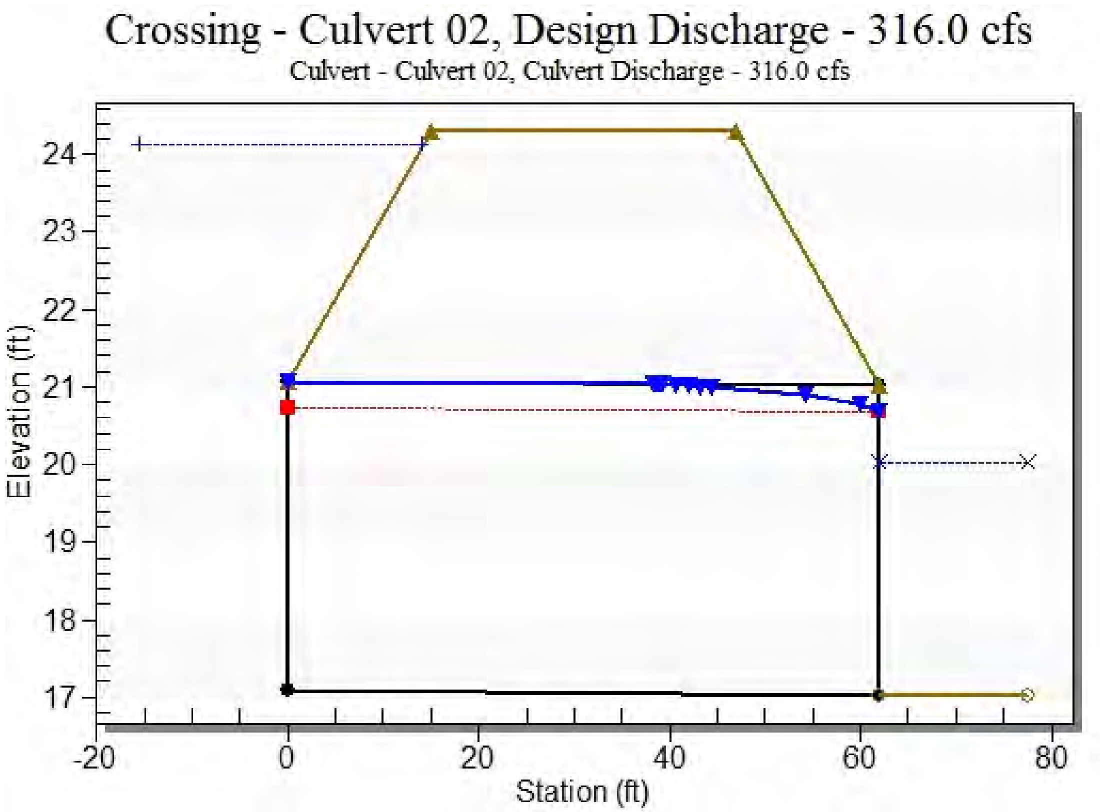
Culvert Length: 62.00 ft, Culvert Slope: 0.0008

****

Culvert Performance Curve Plot: Culvert 02



Water Surface Profile Plot for Culvert: Culvert 02



Site Data - Culvert 02

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 17.08 ft

Outlet Station: 62.00 ft

Outlet Elevation: 17.03 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 02

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 02)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
207.00	19.19	2.16
233.30	19.40	2.37
259.60	19.60	2.57
285.90	19.80	2.77
312.20	20.00	2.97
316.00	20.02	2.99
364.80	21.06	4.03
391.10	21.06	4.03
417.40	21.06	4.03
443.70	21.06	4.03
470.00	21.06	4.03

Tailwater Channel Data - Culvert 02

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 02

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 200.00 ft

Crest Elevation: 24.31 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 2 ALT

Table 1 - Summary of Culvert Flows at Crossing: Culvert 02 Alt.

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 02 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
20.01	100.00	100.00	0.00	1
21.23	170.40	170.40	0.00	1
22.46	240.80	240.80	0.00	1
24.00	311.20	311.20	0.00	1
24.50	381.60	330.93	50.26	8
24.64	452.00	336.27	115.45	6
24.64	453.00	336.32	116.09	2
24.86	592.80	344.41	248.14	5
24.96	663.20	347.88	315.06	4
25.05	733.60	351.10	382.36	4
25.13	804.00	354.09	449.22	3
24.31	323.43	323.43	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 02 Alt.

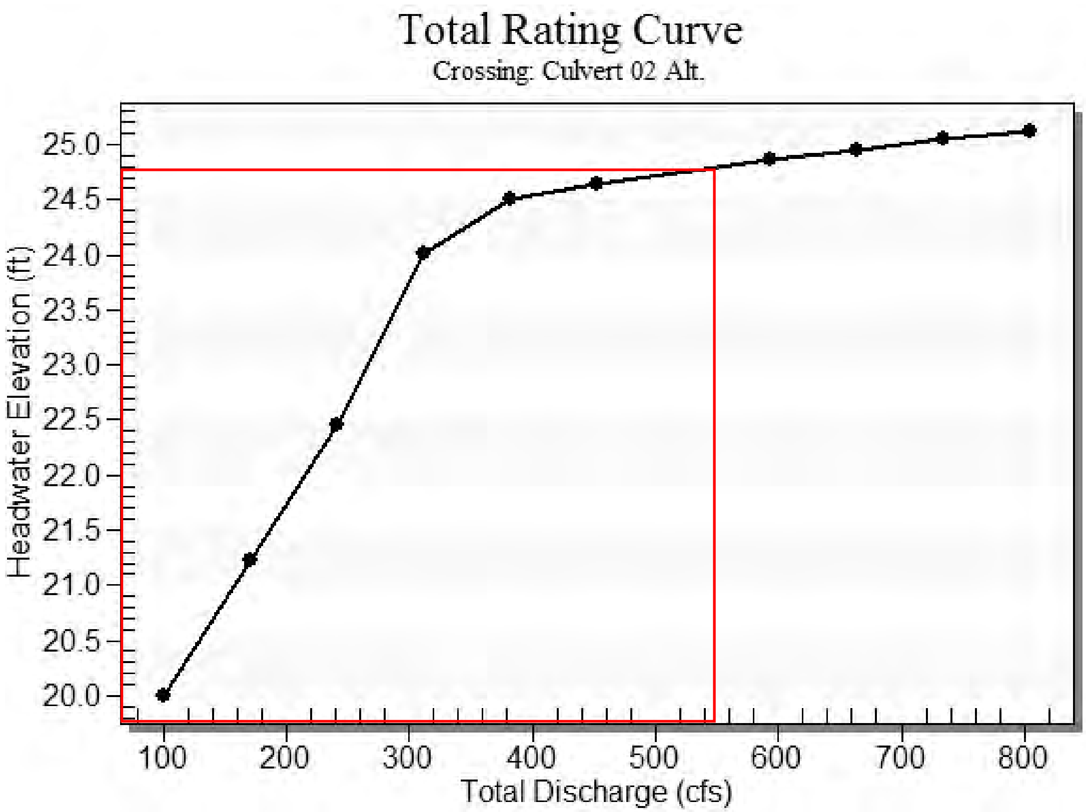


Table 2 - Culvert Summary Table: Culvert 02

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)
100.00	100.00	20.01	2.871	2.926	3-M2t	2.612	1.697	1.990	1.990	6.281	0.000
170.40	170.40	21.23	4.104	4.149	2-M2c	4.000	2.420	2.413	2.170	8.827	0.000
240.80	240.80	22.46	5.382	5.223	2-M2c	4.000	3.048	3.039	2.370	9.904	0.000
311.20	311.20	24.00	6.925	6.312	7-M2c	4.000	3.616	3.607	2.570	10.783	0.000
381.60	330.93	24.50	7.423	6.695	7-M2c	4.000	3.768	3.758	2.770	11.007	0.000
452.00	336.27	24.64	7.563	6.797	7-M2c	4.000	3.808	3.798	2.990	11.066	0.000
453.00	336.32	24.64	7.565	6.798	7-M2c	4.000	3.808	3.799	2.990	11.067	0.000
592.80	344.41	24.86	7.782	6.996	4-FFf	4.000	3.869	4.000	4.030	10.763	0.000
663.20	347.88	24.96	7.876	7.056	4-FFf	4.000	3.895	4.000	4.030	10.871	0.000
733.60	351.10	25.05	7.965	7.114	4-FFf	4.000	3.919	4.000	4.030	10.972	0.000
804.00	354.09	25.13	8.049	7.167	4-FFf	4.000	3.942	4.000	4.030	11.065	0.000

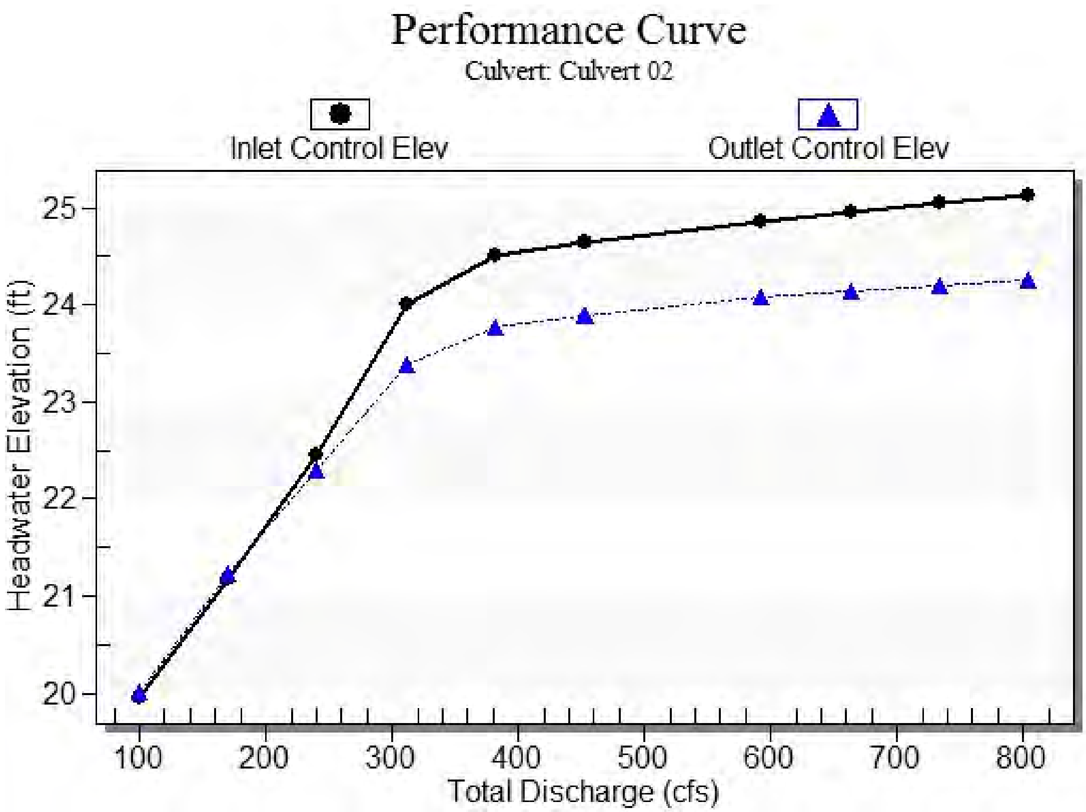
****

Inlet Elevation (invert): 17.08 ft, Outlet Elevation (invert): 17.03 ft

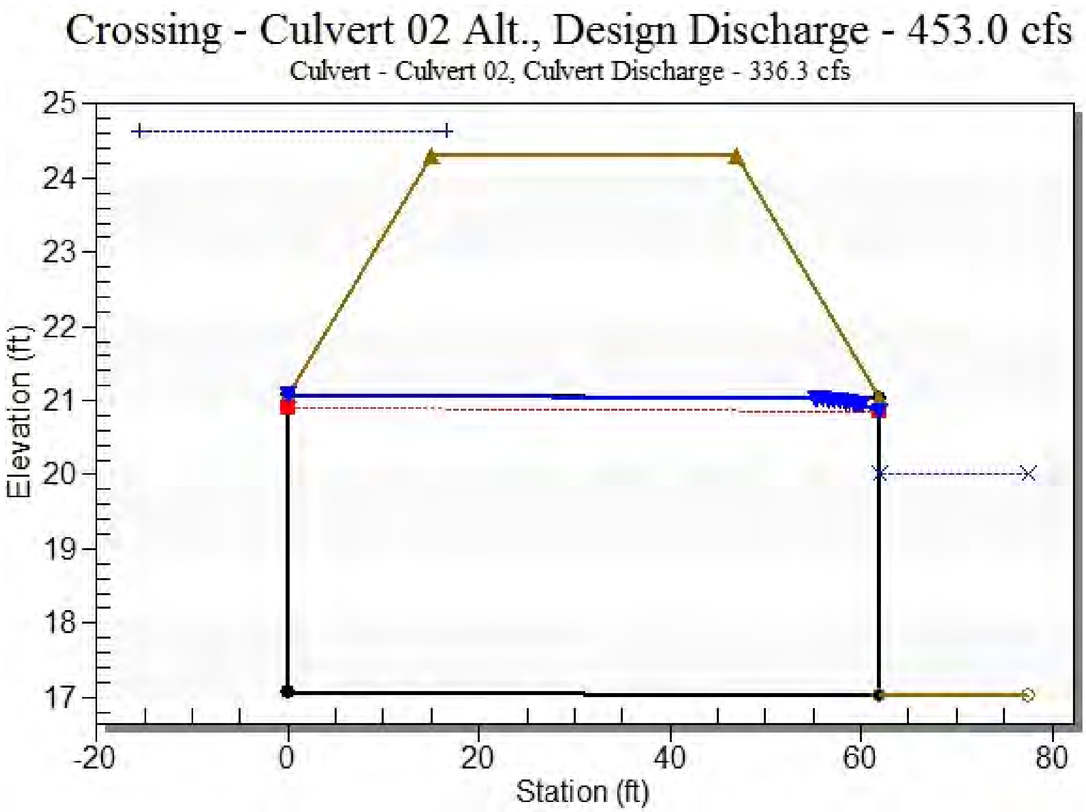
Culvert Length: 62.00 ft, Culvert Slope: 0.0008

****

Culvert Performance Curve Plot: Culvert 02



Water Surface Profile Plot for Culvert: Culvert 02



Site Data - Culvert 02

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 17.08 ft

Outlet Station: 62.00 ft

Outlet Elevation: 17.03 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 02

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 02 Alt.)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
100.00	19.02	1.99
170.40	19.20	2.17
240.80	19.40	2.37
311.20	19.60	2.57
381.60	19.80	2.77
452.00	20.02	2.99
453.00	20.02	2.99
592.80	21.06	4.03
663.20	21.06	4.03
733.60	21.06	4.03
804.00	21.06	4.03

Tailwater Channel Data - Culvert 02 Alt.

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 02 Alt.

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 200.00 ft

Crest Elevation: 24.31 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 3

Table 1 - Summary of Culvert Flows at Crossing: Culvert 03

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 03 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
18.46	105.00	105.00	0.00	1
19.34	179.60	179.60	0.00	1
20.80	254.20	253.64	0.00	41
21.01	328.80	262.47	65.58	7
21.13	403.40	267.56	135.04	5
21.23	478.00	271.56	205.50	4
21.33	552.60	265.89	285.90	4
21.42	627.20	265.19	361.70	4
21.50	701.80	264.14	437.50	4
21.58	776.40	262.78	512.68	3
21.66	851.00	261.26	589.15	3
20.81	253.89	253.89	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 03

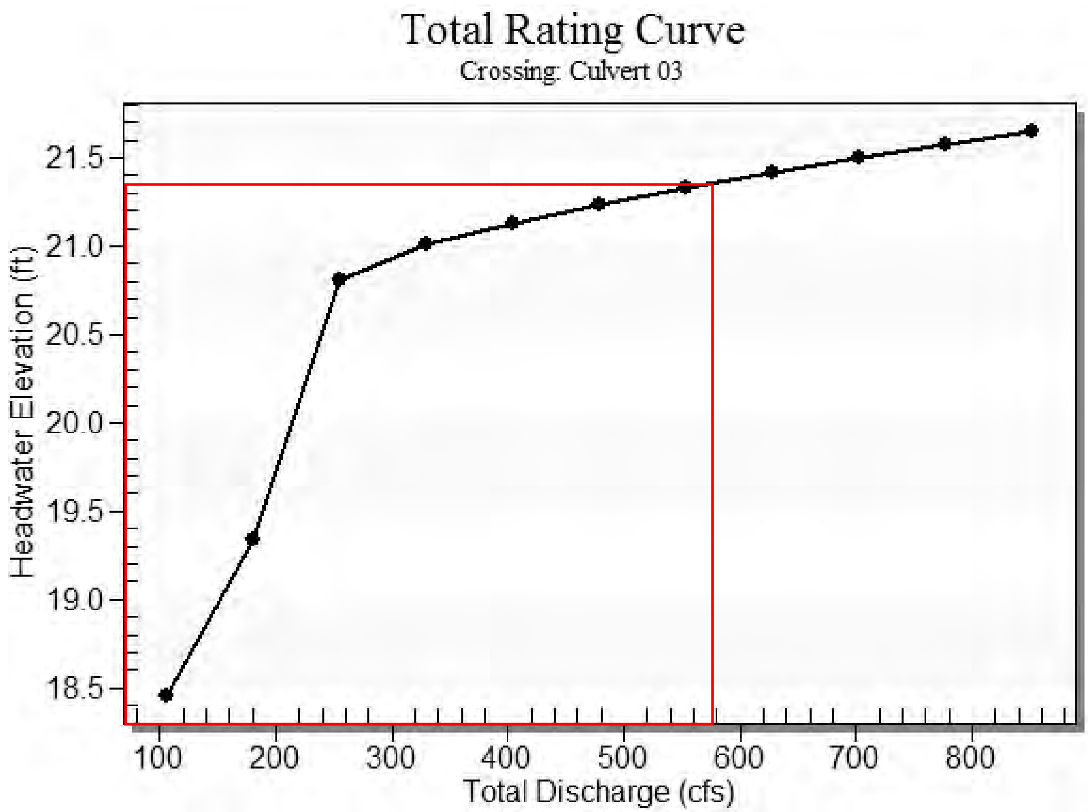


Table 2 - Culvert Summary Table: Culvert 03

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)
105.00	105.00	18.46	2.548	2.870	3-M1t	1.744	1.510	2.570	2.570	4.086	0.000
179.60	179.60	19.34	3.754	3.706	7-M1t	2.514	2.160	2.570	2.570	6.988	0.000
254.20	253.64	20.80	5.214	4.709	7-M2c	3.000	2.719	2.713	2.570	9.351	0.000
328.80	262.47	21.01	5.418	4.938	7-M2t	3.000	2.782	2.870	2.870	9.145	0.000
403.40	267.56	21.13	5.539	5.272	4-FFf	3.000	2.818	3.000	3.170	8.919	0.000
478.00	271.56	21.23	5.636	5.640	4-FFf	3.000	2.846	3.000	3.470	9.052	0.000
552.60	265.89	21.33	5.499	5.744	4-FFf	3.000	2.806	3.000	3.670	8.863	0.000
627.20	265.19	21.42	5.483	5.832	4-FFf	3.000	2.801	3.000	3.770	8.840	0.000
701.80	264.14	21.50	5.458	5.914	4-FFf	3.000	2.794	3.000	3.870	8.805	0.000
776.40	262.78	21.58	5.425	5.992	4-FFf	3.000	2.784	3.000	3.970	8.759	0.000
851.00	261.26	21.66	5.390	6.167	4-FFf	3.000	2.773	3.000	4.170	8.709	0.000

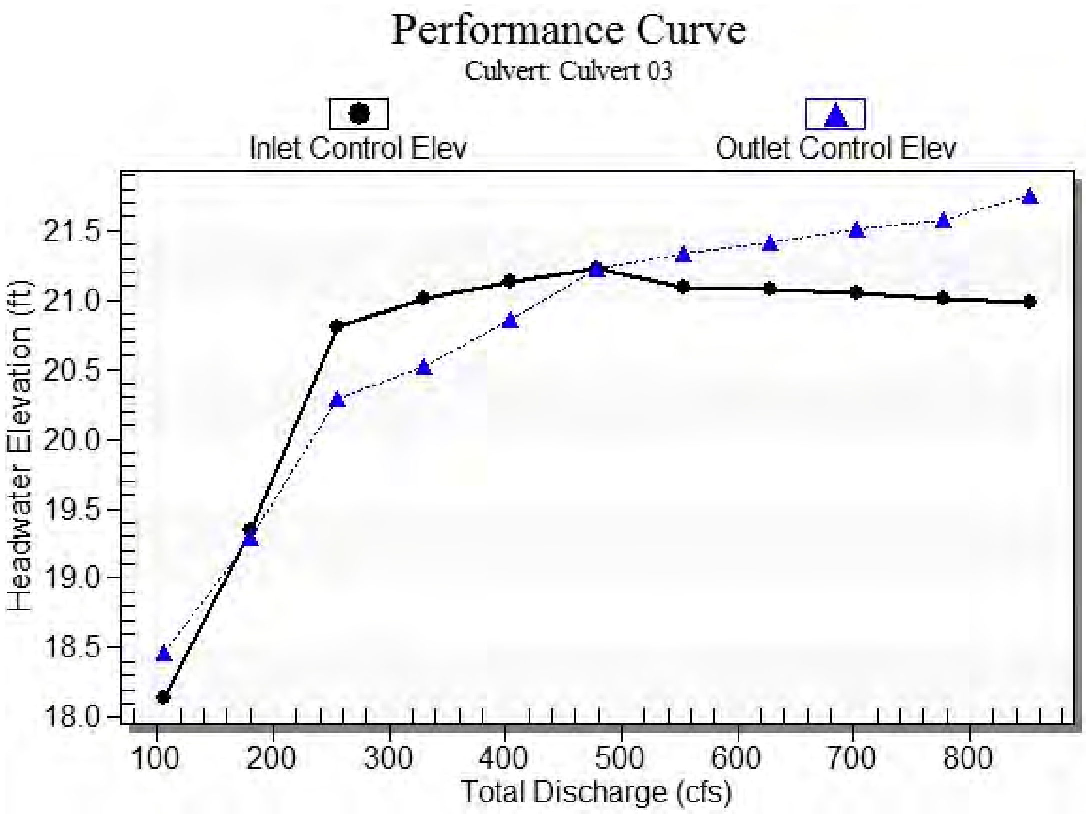
****

Inlet Elevation (invert): 15.59 ft, Outlet Elevation (invert): 15.43 ft

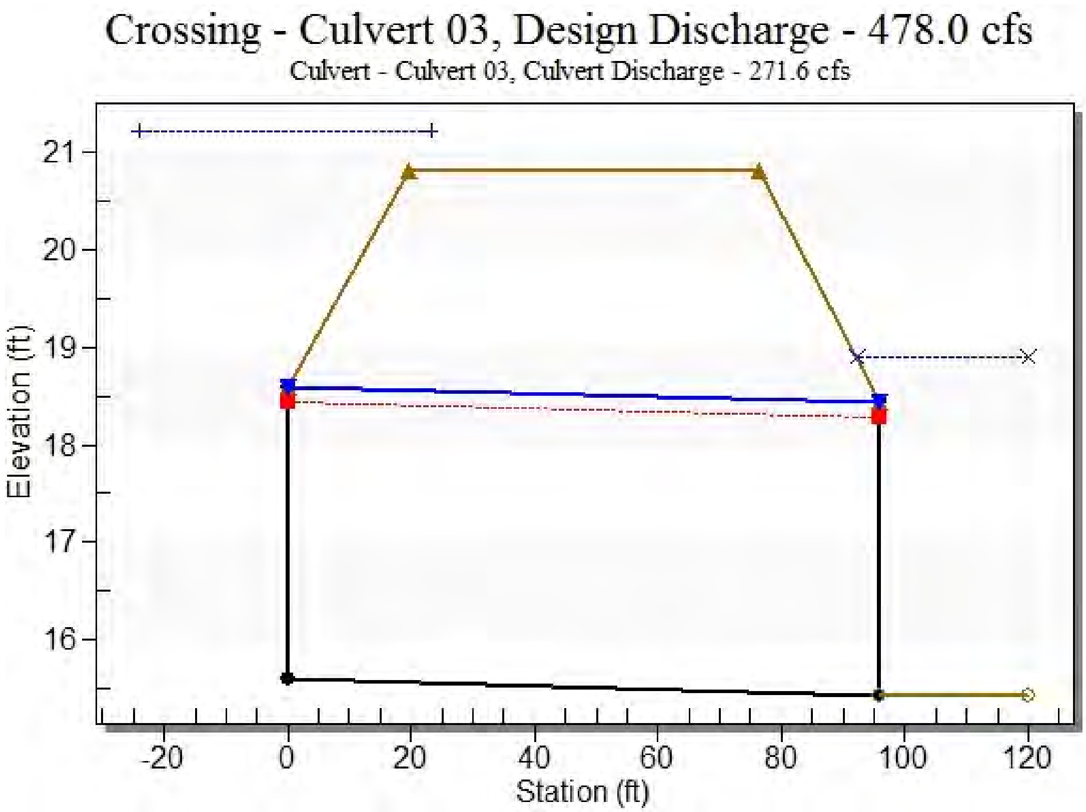
Culvert Length: 96.00 ft, Culvert Slope: 0.0017

****

Culvert Performance Curve Plot: Culvert 03



Water Surface Profile Plot for Culvert: Culvert 03



Site Data - Culvert 03

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 15.59 ft

Outlet Station: 96.00 ft

Outlet Elevation: 15.43 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 03

Barrel Shape: Concrete Box

Barrel Span: 10.00 ft

Barrel Rise: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 03)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
105.00	18.00	2.57
179.60	18.00	2.57
254.20	18.00	2.57
328.80	18.30	2.87
403.40	18.60	3.17
478.00	18.90	3.47
552.60	19.10	3.67
627.20	19.20	3.77
701.80	19.30	3.87
776.40	19.40	3.97
851.00	19.60	4.17

Tailwater Channel Data - Culvert 03

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 03

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 20.81 ft

Roadway Surface: Paved

Roadway Top Width: 57.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 3 ALT

Table 1 - Summary of Culvert Flows at Crossing: Culvert 03 Alt

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 03 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
18.42	105.00	105.00	0.00	1
18.64	126.60	126.60	0.00	1
18.90	148.20	148.20	0.00	1
19.24	169.80	169.80	0.00	1
19.76	191.40	191.40	0.00	1
20.23	213.00	213.00	0.00	1
20.40	218.00	218.00	0.00	1
20.91	256.20	232.69	23.07	11
20.97	277.80	229.98	47.36	5
21.02	299.40	226.67	72.56	5
21.07	321.00	222.80	97.78	4
20.81	238.45	238.45	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 03 Alt

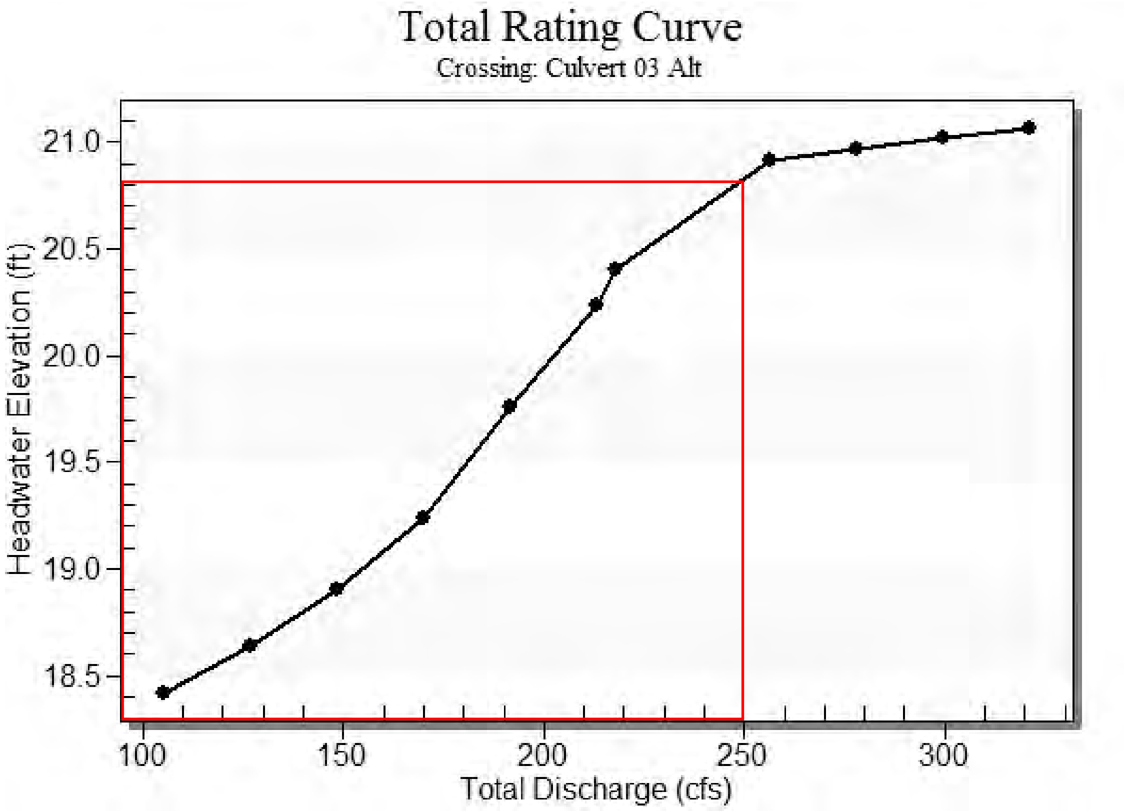


Table 2 - Culvert Summary Table: Culvert 03

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)
105.00	105.00	18.42	2.548	2.833	3-M1t	1.744	1.510	2.500	2.500	4.200	0.000
126.60	126.60	18.64	2.891	3.052	7-M1t	1.978	1.711	2.520	2.520	5.024	0.000
148.20	148.20	18.90	3.234	3.312	7-M1t	2.202	1.901	2.570	2.570	5.767	0.000
169.80	169.80	19.24	3.587	3.648	7-M1t	2.419	2.081	2.870	2.870	5.916	0.000
191.40	191.40	19.76	3.961	4.167	4-FFf	2.628	2.254	3.000	3.170	6.380	0.000
213.00	213.00	20.23	4.363	4.643	4-FFf	3.000	2.420	3.000	3.370	7.100	0.000
218.00	218.00	20.40	4.460	4.812	4-FFf	3.000	2.458	3.000	3.470	7.267	0.000
256.20	232.69	20.91	4.758	5.321	4-FFf	3.000	2.567	3.000	3.770	7.756	0.000
277.80	229.98	20.97	4.702	5.381	4-FFf	3.000	2.547	3.000	3.870	7.666	0.000
299.40	226.67	21.02	4.634	5.433	4-FFf	3.000	2.523	3.000	3.970	7.556	0.000
321.00	222.80	21.07	4.556	5.578	4-FFf	3.000	2.494	3.000	4.170	7.427	0.000

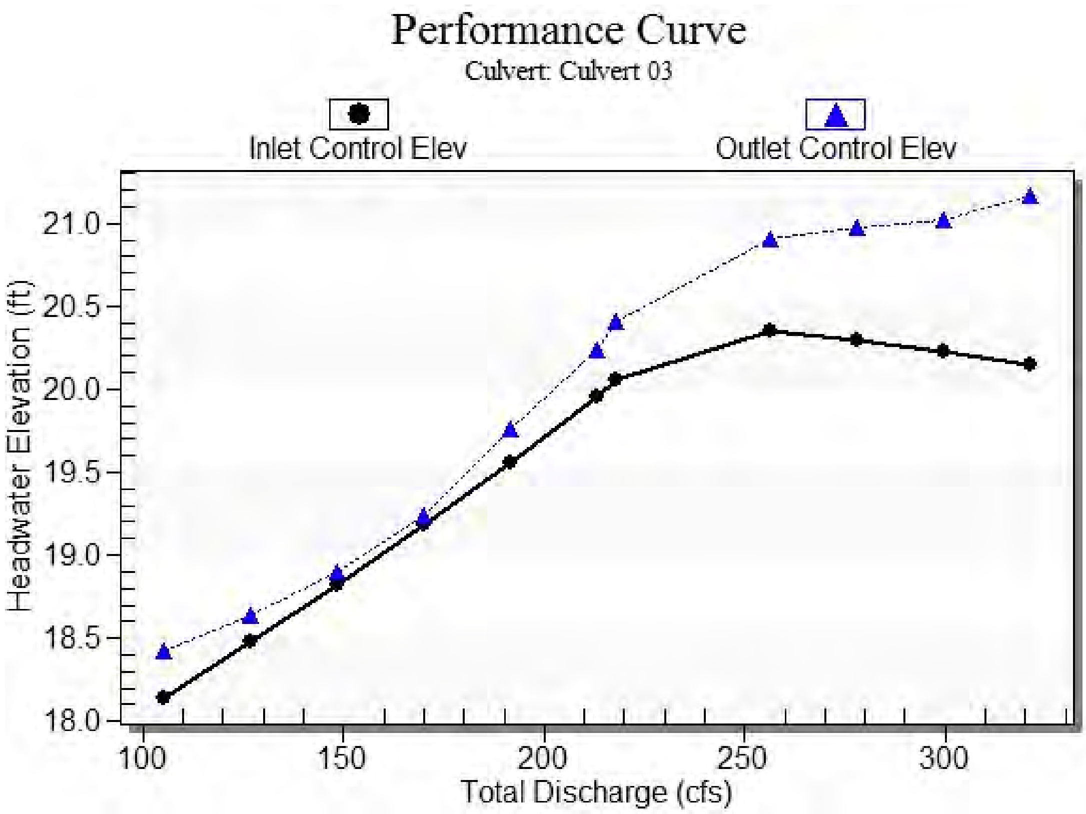
****

Inlet Elevation (invert): 15.59 ft, Outlet Elevation (invert): 15.43 ft

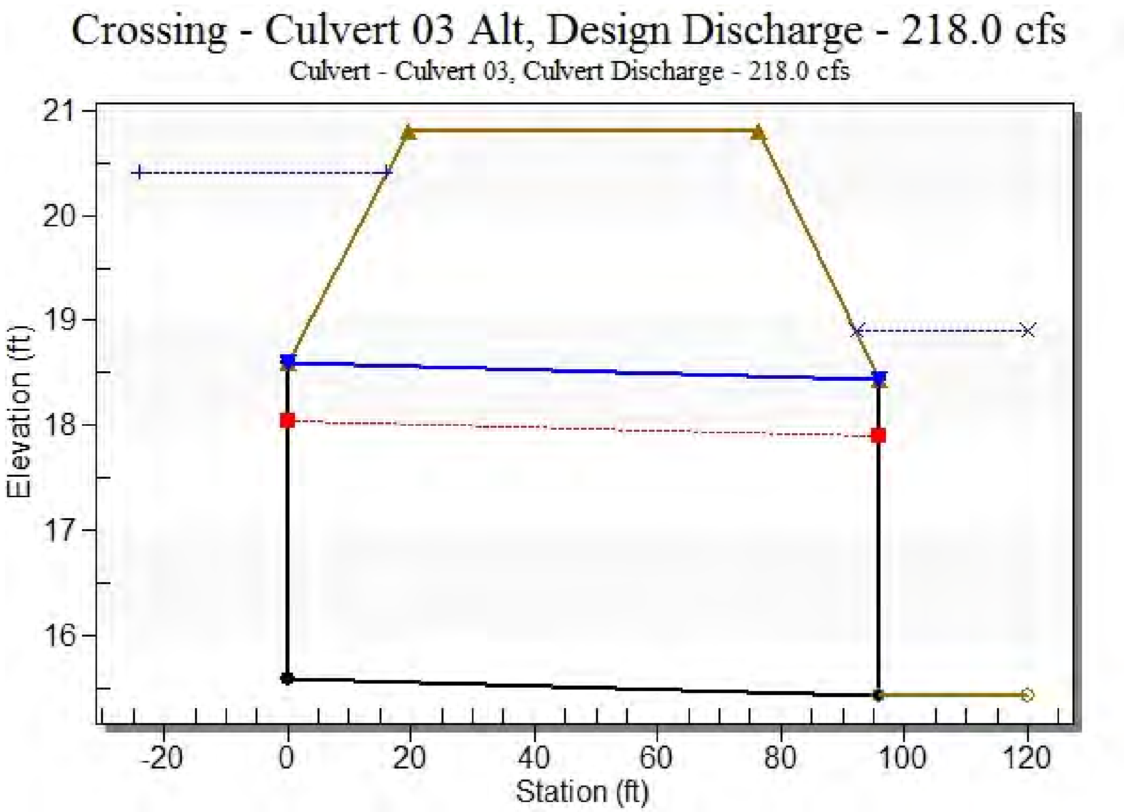
Culvert Length: 96.00 ft, Culvert Slope: 0.0017

****

Culvert Performance Curve Plot: Culvert 03



Water Surface Profile Plot for Culvert: Culvert 03



Site Data - Culvert 03

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 15.59 ft

Outlet Station: 96.00 ft

Outlet Elevation: 15.43 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 03

Barrel Shape: Concrete Box

Barrel Span: 10.00 ft

Barrel Rise: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 03 Alt)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
105.00	17.93	2.50
126.60	17.95	2.52
148.20	18.00	2.57
169.80	18.30	2.87
191.40	18.60	3.17
213.00	18.80	3.37
218.00	18.90	3.47
256.20	19.20	3.77
277.80	19.30	3.87
299.40	19.40	3.97
321.00	19.60	4.17

Tailwater Channel Data - Culvert 03 Alt

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 03 Alt

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 20.81 ft

Roadway Surface: Paved

Roadway Top Width: 57.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 4

Table 1 - Summary of Culvert Flows at Crossing: Culvert 04

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 04 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
18.71	15.00	15.00	0.00	1
18.86	16.50	16.50	0.00	1
19.02	18.00	18.00	0.00	1
19.50	19.50	19.50	0.00	1
19.86	20.00	20.00	0.00	1
20.46	22.50	22.28	0.10	40
20.51	24.00	21.13	2.78	6
20.52	25.50	20.62	4.74	4
20.54	27.00	19.92	6.98	4
20.56	28.50	19.20	9.24	4
20.57	30.00	18.46	11.35	3
20.46	22.44	22.44	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 04

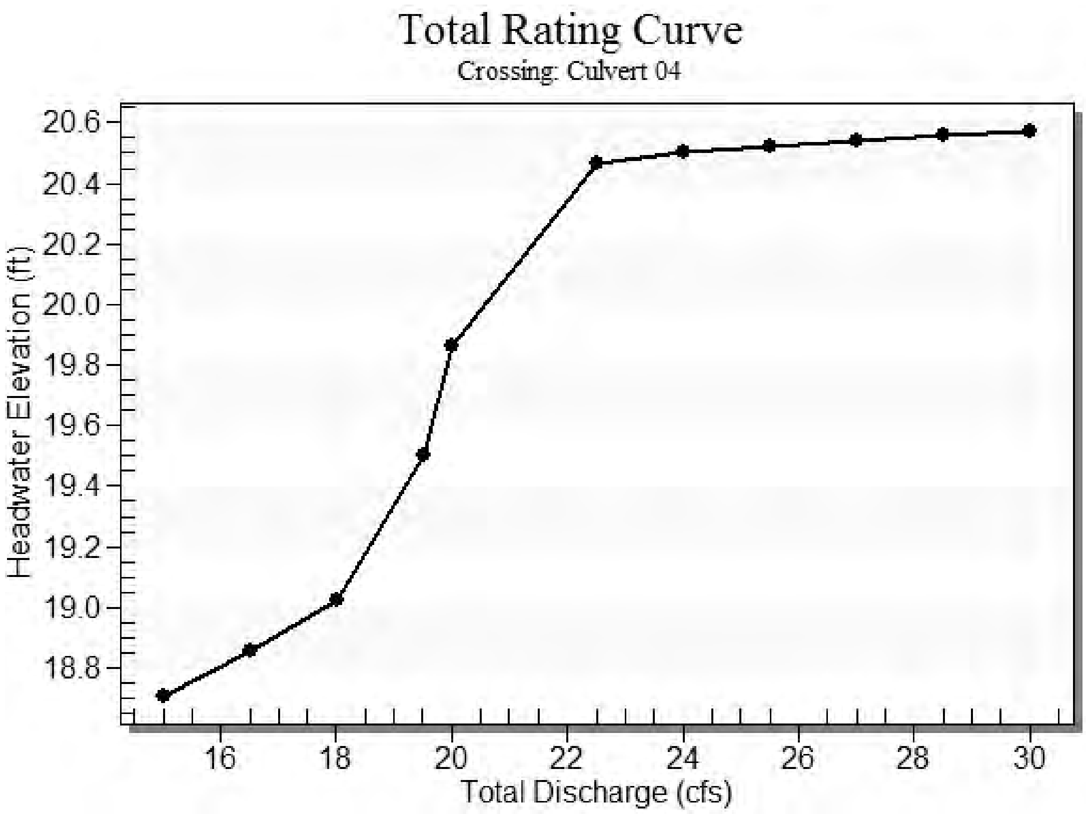


Table 2 - Culvert Summary Table: Culvert 04

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)
15.00	15.00	18.71	2.259	2.990	4-FFf	2.000	1.395	2.000	2.570	4.775	0.000
16.50	16.50	18.86	2.445	3.139	4-FFf	2.000	1.459	2.000	2.570	5.252	0.000
18.00	18.00	19.02	2.647	3.302	4-FFf	2.000	1.523	2.000	2.570	5.730	0.000
19.50	19.50	19.50	2.866	3.780	4-FFf	2.000	1.586	2.000	2.870	6.207	0.000
20.00	20.00	19.86	2.943	4.142	4-FFf	2.000	1.605	2.000	3.170	6.366	0.000
22.50	22.28	20.46	3.323	4.745	4-FFf	2.000	1.672	2.000	3.470	7.091	0.000
24.00	21.13	20.51	3.126	4.789	4-FFf	2.000	1.638	2.000	3.670	6.727	0.000
25.50	20.62	20.52	3.042	4.822	4-FFf	2.000	1.623	2.000	3.770	6.564	0.000
27.00	19.92	20.54	2.930	4.831	4-FFf	2.000	1.602	2.000	3.870	6.340	0.000
28.50	19.20	20.56	2.821	4.843	4-FFf	2.000	1.573	2.000	3.970	6.111	0.000
30.00	18.46	20.57	2.713	4.955	4-FFf	2.000	1.542	2.000	4.170	5.877	0.000

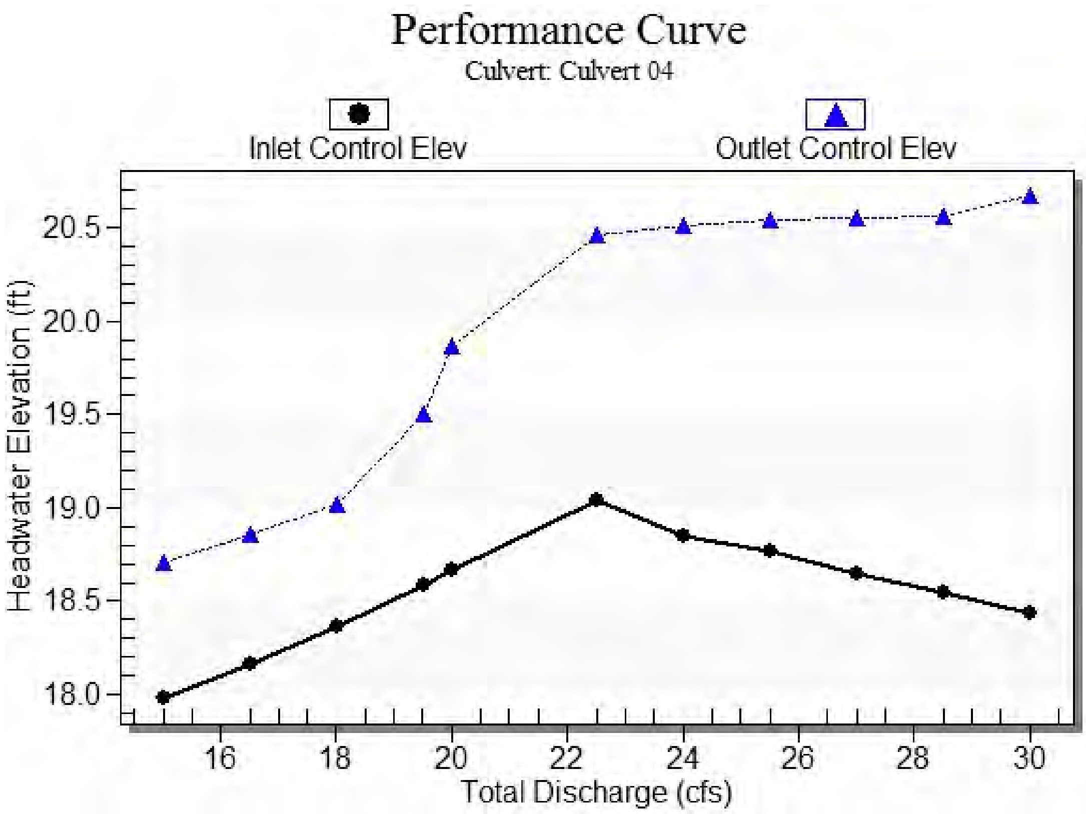
****

Inlet Elevation (invert): 15.72 ft, Outlet Elevation (invert): 15.71 ft

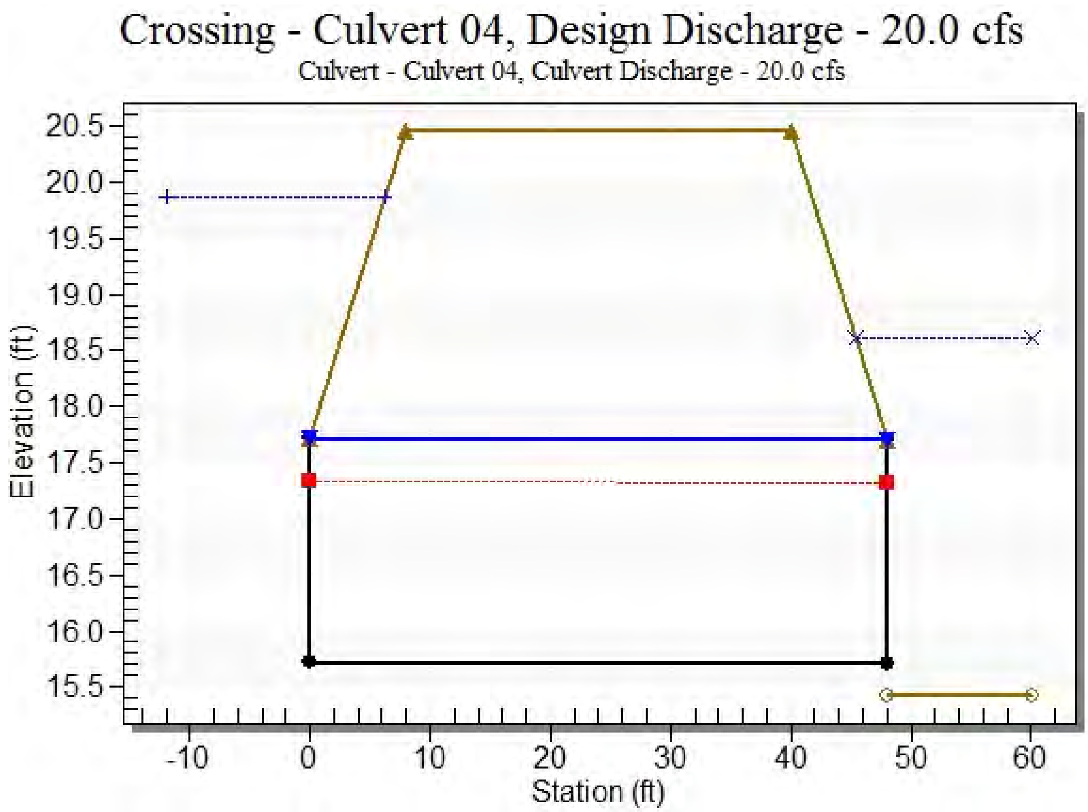
Culvert Length: 48.00 ft, Culvert Slope: 0.0002

****

Culvert Performance Curve Plot: Culvert 04



Water Surface Profile Plot for Culvert: Culvert 04



Site Data - Culvert 04

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 15.72 ft

Outlet Station: 48.00 ft

Outlet Elevation: 15.71 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 04

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 04)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
15.00	18.00	2.57
16.50	18.00	2.57
18.00	18.00	2.57
19.50	18.30	2.87
20.00	18.60	3.17
22.50	18.90	3.47
24.00	19.10	3.67
25.50	19.20	3.77
27.00	19.30	3.87
28.50	19.40	3.97
30.00	19.60	4.17

Tailwater Channel Data - Culvert 04

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 04

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 20.46 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 5

Table 1 - Summary of Culvert Flows at Crossing: Culvert 05

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 05 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
15.10	190.00	190.00	0.00	1
15.44	227.00	227.00	0.00	1
15.76	264.00	264.00	0.00	1
16.08	301.00	301.00	0.00	1
16.53	338.00	338.00	0.00	1
17.04	375.00	375.00	0.00	1
17.24	386.00	386.00	0.00	1
18.32	449.00	446.38	2.03	13
18.48	486.00	441.87	43.76	7
18.58	523.00	432.68	89.61	5
18.67	560.00	421.87	137.87	5
18.30	447.58	447.58	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 05

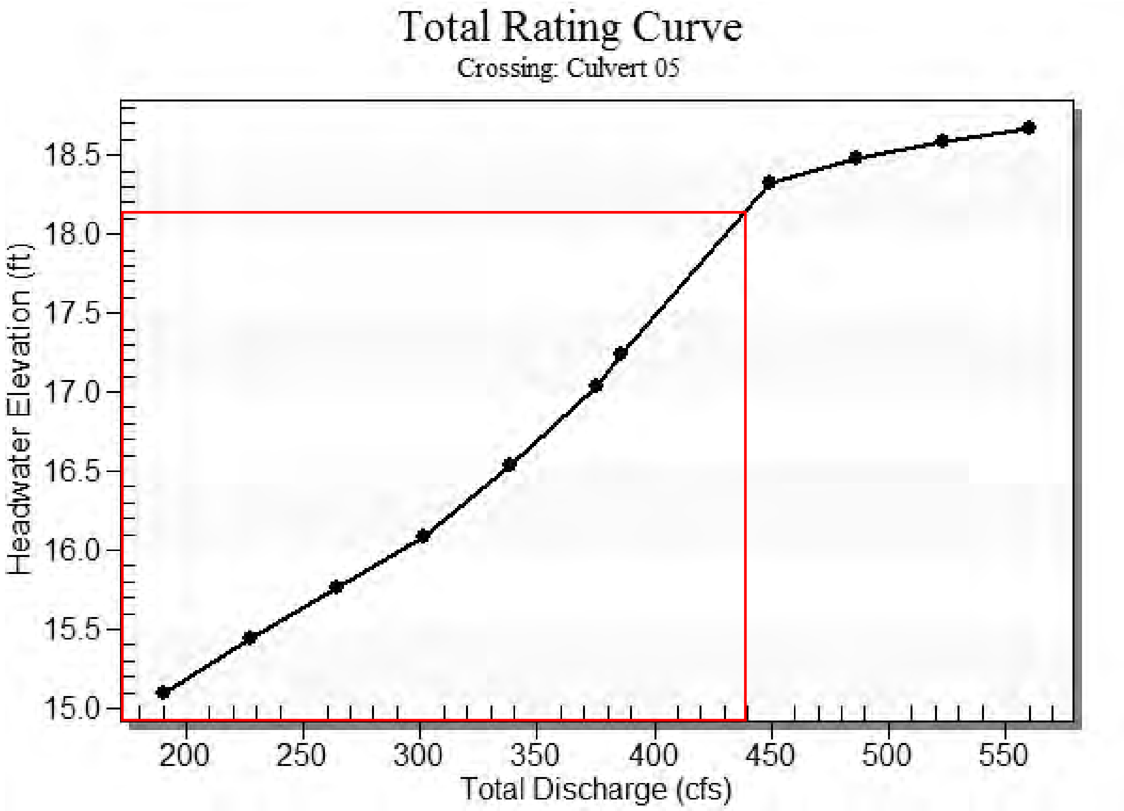


Table 2 - Culvert Summary Table: Culvert 05

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)
190.00	190.00	15.10	2.768	2.921	3-M2t	3.000	1.640	2.260	2.260	5.254	0.000
227.00	227.00	15.44	3.134	3.257	3-M2t	3.000	1.846	2.460	2.460	5.767	0.000
264.00	264.00	15.76	3.509	3.581	3-M2t	3.000	2.042	2.660	2.660	6.203	0.000
301.00	301.00	16.08	3.904	3.894	3-M2t	3.000	2.228	2.860	2.860	6.578	0.000
338.00	338.00	16.53	4.331	4.352	4-FFf	3.000	2.407	3.000	3.060	7.042	0.000
375.00	375.00	17.04	4.795	4.860	4-FFf	3.000	2.580	3.000	3.260	7.813	0.000
386.00	386.00	17.24	4.942	5.058	4-FFf	3.000	2.630	3.000	3.360	8.042	0.000
449.00	446.38	18.32	5.820	6.144	4-FFf	3.000	2.898	3.000	3.860	9.300	0.000
486.00	441.87	18.48	5.750	6.297	4-FFf	3.000	2.878	3.000	4.060	9.206	0.000
523.00	432.68	18.58	5.610	6.403	4-FFf	3.000	2.838	3.000	4.260	9.014	0.000
560.00	421.87	18.67	5.448	6.396	4-FFf	3.000	2.791	3.000	4.360	8.789	0.000

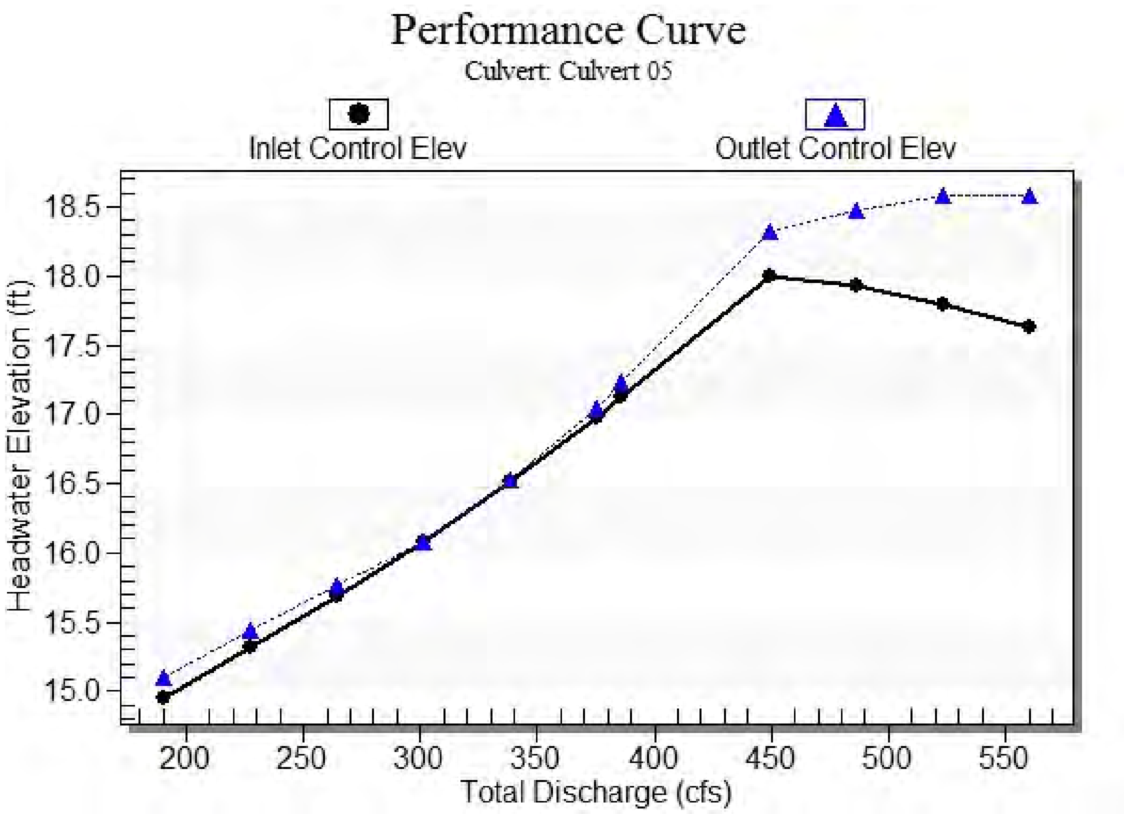
****

Inlet Elevation (invert): 12.18 ft, Outlet Elevation (invert): 12.14 ft

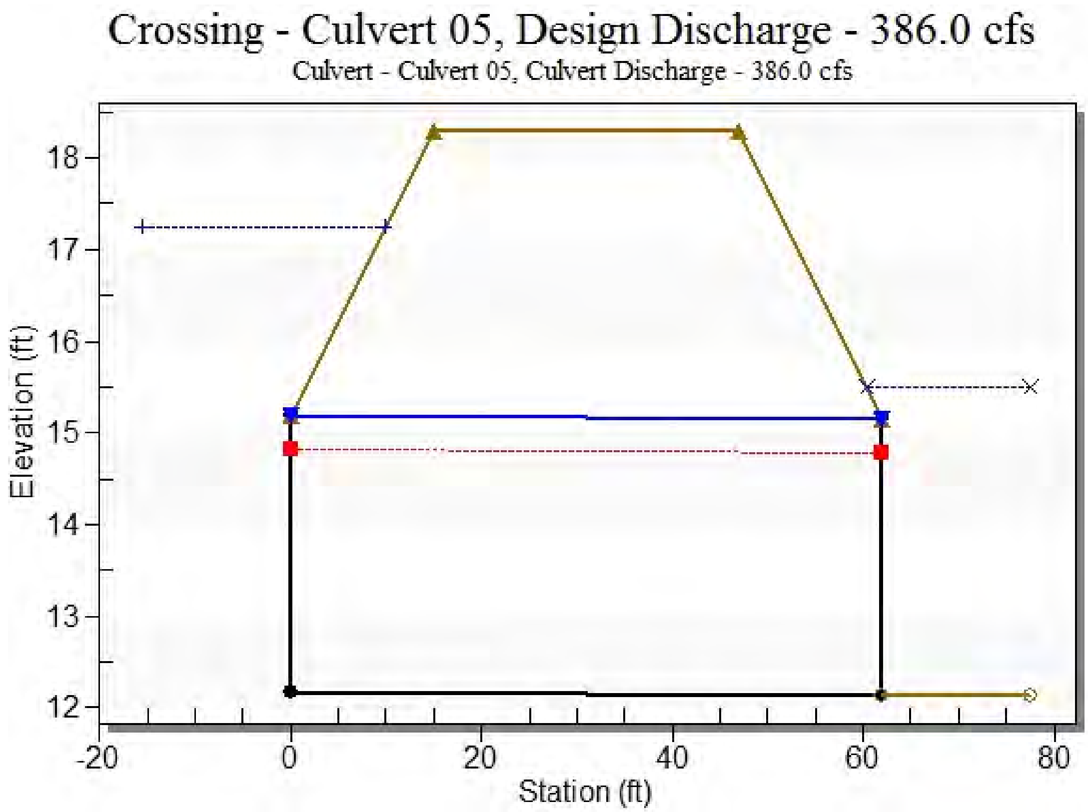
Culvert Length: 62.00 ft, Culvert Slope: 0.0006

****

Culvert Performance Curve Plot: Culvert 05



Water Surface Profile Plot for Culvert: Culvert 05



Site Data - Culvert 05

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 12.18 ft

Outlet Station: 62.00 ft

Outlet Elevation: 12.14 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 05

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 05)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
190.00	14.40	2.26
227.00	14.60	2.46
264.00	14.80	2.66
301.00	15.00	2.86
338.00	15.20	3.06
375.00	15.40	3.26
386.00	15.50	3.36
449.00	16.00	3.86
486.00	16.20	4.06
523.00	16.40	4.26
560.00	16.50	4.36

Tailwater Channel Data - Culvert 05

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 05

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 200.00 ft

Crest Elevation: 18.30 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 6

Table 1 - Summary of Culvert Flows at Crossing: Culvert 06

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 06 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
16.87	20.00	20.00	0.00	1
17.50	26.70	26.70	0.00	1
18.06	33.40	33.40	0.00	1
18.85	40.10	40.10	0.00	1
19.44	46.80	44.34	2.24	24
19.50	53.50	44.73	8.67	6
19.54	60.20	44.58	15.55	5
19.56	61.00	41.83	18.94	4
19.65	73.60	36.28	37.13	4
19.68	80.30	35.47	44.59	3
19.71	87.00	34.64	52.21	3
19.40	44.07	44.07	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 06

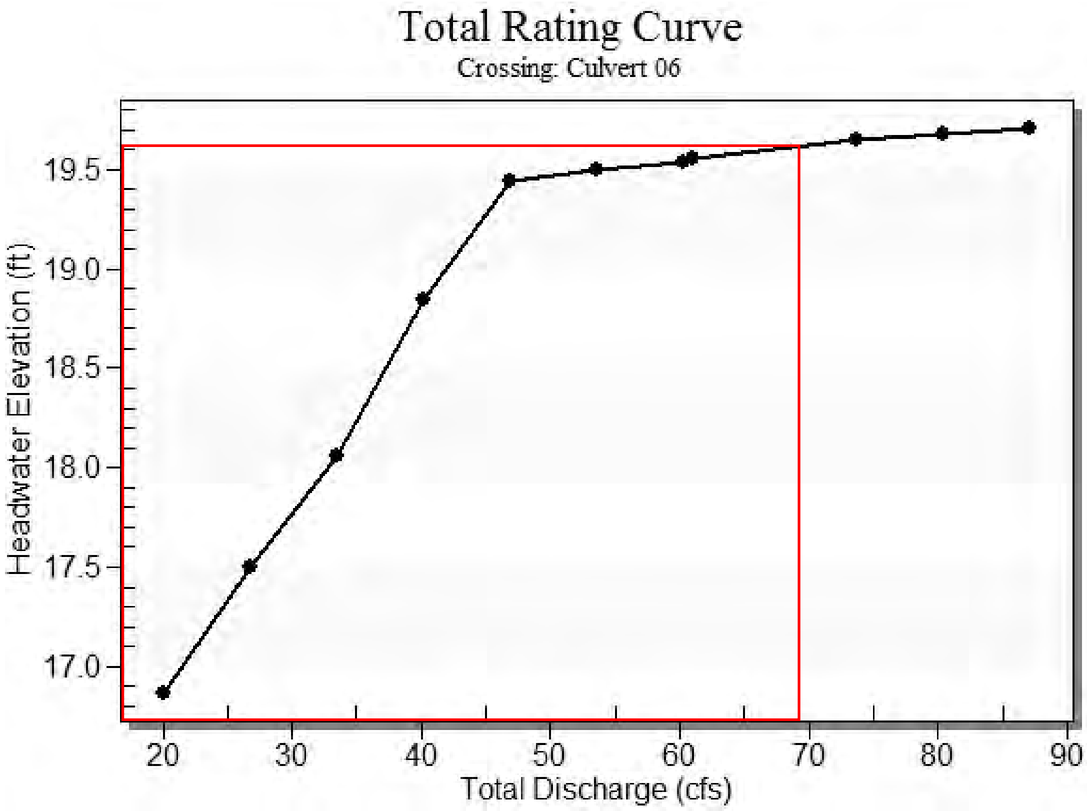


Table 2 - Culvert Summary Table: Culvert 06

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)
20.00	20.00	16.87	2.320	0.0*	1-S2n	1.494	1.516	1.495	1.740	6.528	0.000
26.70	26.70	17.50	2.861	2.954	2-M2c	1.847	1.760	1.761	1.740	7.224	0.000
33.40	33.40	18.06	3.506	3.447	2-M2c	2.500	1.962	1.966	1.740	8.073	0.000
40.10	40.10	18.85	4.300	4.046	2-M2c	2.500	2.115	2.130	2.040	9.031	0.000
46.80	44.34	19.44	4.889	4.550	7-M2t	2.500	2.204	2.340	2.340	9.344	0.000
53.50	44.73	19.50	4.945	4.807	4-FFf	2.500	2.212	2.500	2.640	9.112	0.000
60.20	44.58	19.54	4.923	4.991	4-FFf	2.500	2.209	2.500	2.840	9.081	0.000
61.00	41.83	19.56	4.532	5.011	4-FFf	2.500	2.151	2.500	3.140	8.521	0.000
73.60	36.28	19.65	3.827	5.100	4-FFf	2.500	2.034	2.500	3.740	7.390	0.000
80.30	35.47	19.68	3.734	5.132	4-FFf	2.500	2.017	2.500	3.840	7.226	0.000
87.00	34.64	19.71	3.640	5.263	4-FFf	2.500	1.999	2.500	4.040	7.056	0.000

* theoretical depth is impractical.   Depth reported is corrected.

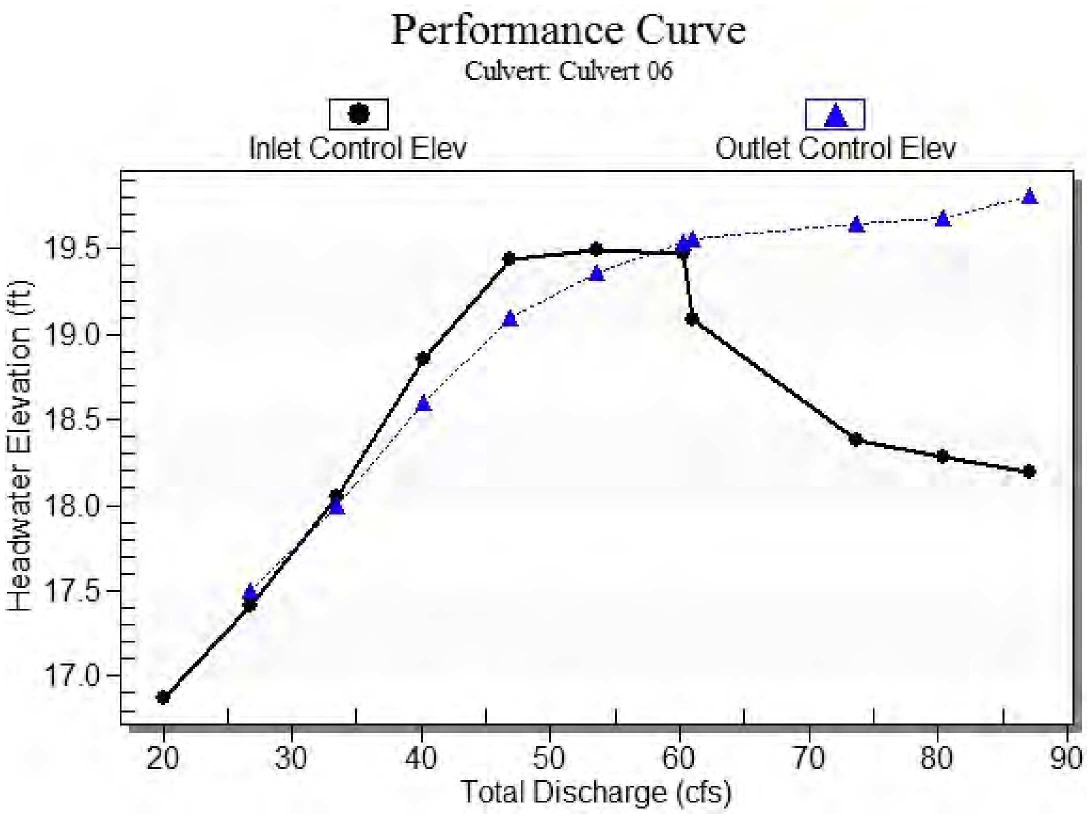
****

Inlet Elevation (invert): 14.55 ft,   Outlet Elevation (invert): 14.36 ft

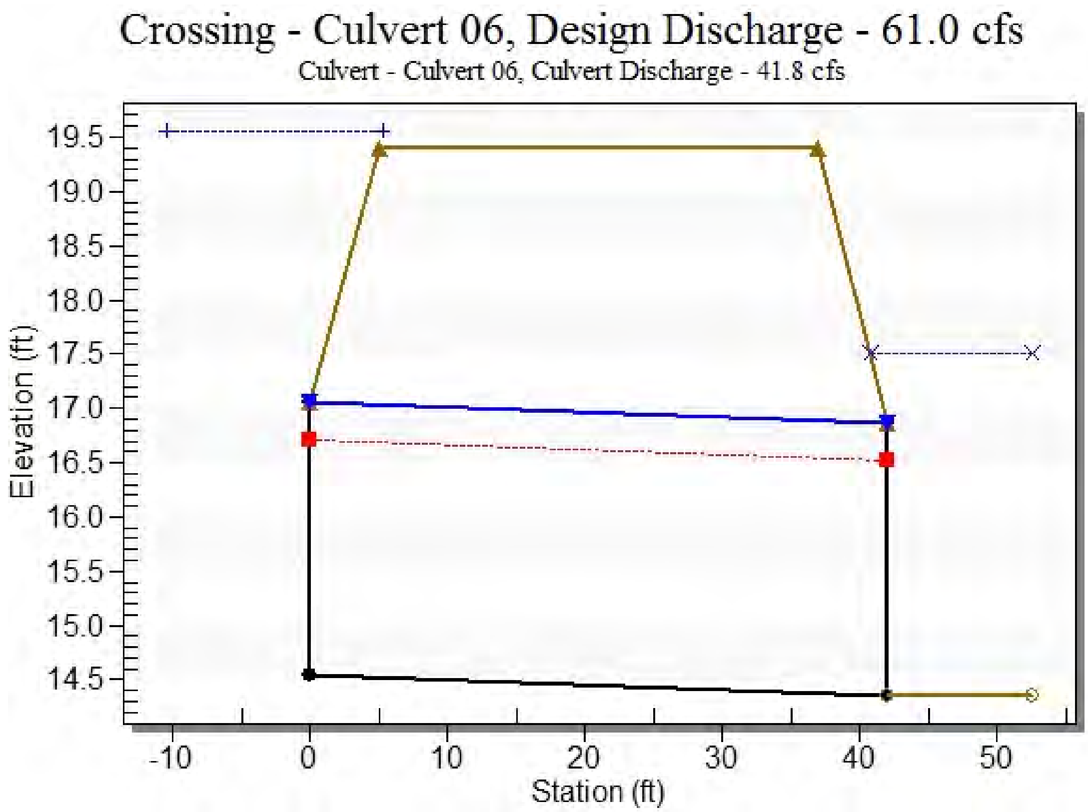
Culvert Length: 42.00 ft,   Culvert Slope: 0.0045

****

Culvert Performance Curve Plot: Culvert 06



Water Surface Profile Plot for Culvert: Culvert 06



Site Data - Culvert 06

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 14.55 ft

Outlet Station: 42.00 ft

Outlet Elevation: 14.36 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 06

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 06)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
20.00	16.10	1.74
26.70	16.10	1.74
33.40	16.10	1.74
40.10	16.40	2.04
46.80	16.70	2.34
53.50	17.00	2.64
60.20	17.20	2.84
61.00	17.50	3.14
73.60	18.10	3.74
80.30	18.20	3.84
87.00	18.40	4.04

Tailwater Channel Data - Culvert 06

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 06

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 19.40 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 7

Table 1 - Summary of Culvert Flows at Crossing: Culvert 07

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 07 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
19.77	250.00	250.00	0.00	1
21.03	307.20	307.20	0.00	1
21.24	364.40	315.91	47.85	8
21.34	421.60	320.03	101.20	6
21.42	469.00	322.85	145.80	5
21.50	536.00	326.35	208.83	4
21.58	593.20	329.09	263.68	4
21.64	650.40	331.63	318.53	4
21.70	707.60	333.98	372.63	3
21.76	764.80	336.25	427.78	3
21.82	822.00	335.60	485.72	3
21.08	309.33	309.33	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 07

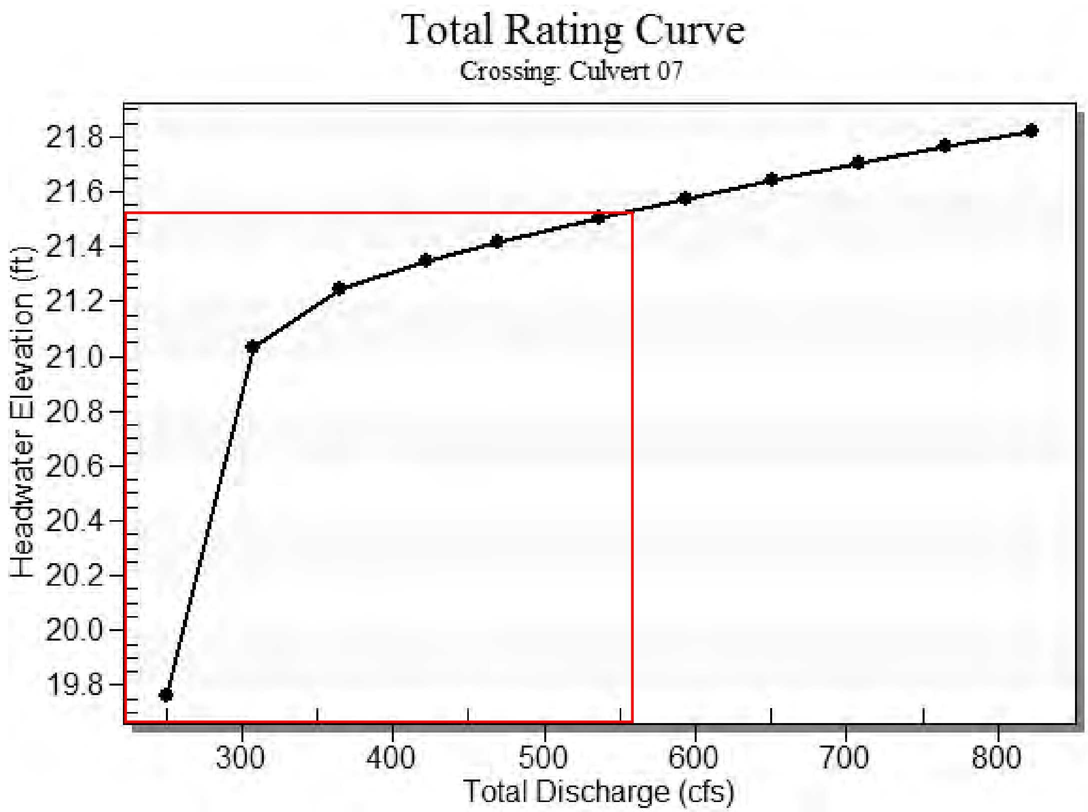


Table 2 - Culvert Summary Table: Culvert 07

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)
250.00	250.00	19.77	5.565	5.357	3-M2t	4.000	3.125	3.330	3.330	9.384	0.000
307.20	307.20	21.03	6.828	6.227	7-M2c	4.000	3.585	3.577	3.350	10.737	0.000
364.40	315.91	21.24	7.041	6.394	7-M2c	4.000	3.653	3.644	3.380	10.837	0.000
421.60	320.03	21.34	7.144	6.472	7-M2c	4.000	3.684	3.675	3.410	10.884	0.000
469.00	322.85	21.42	7.216	6.526	7-M2c	4.000	3.706	3.697	3.430	10.916	0.000
536.00	326.35	21.50	7.305	6.592	7-M2c	4.000	3.733	3.723	3.530	10.956	0.000
593.20	329.09	21.58	7.376	6.644	7-M2c	4.000	3.754	3.744	3.730	10.986	0.000
650.40	331.63	21.64	7.442	6.711	7-M2t	4.000	3.773	3.930	3.930	10.548	0.000
707.60	333.98	21.70	7.503	6.997	4-FFf	4.000	3.791	4.000	4.230	10.437	0.000
764.80	336.25	21.76	7.563	7.335	4-FFf	4.000	3.808	4.000	4.530	10.508	0.000
822.00	335.60	21.82	7.546	7.524	4-FFf	4.000	3.803	4.000	4.730	10.487	0.000

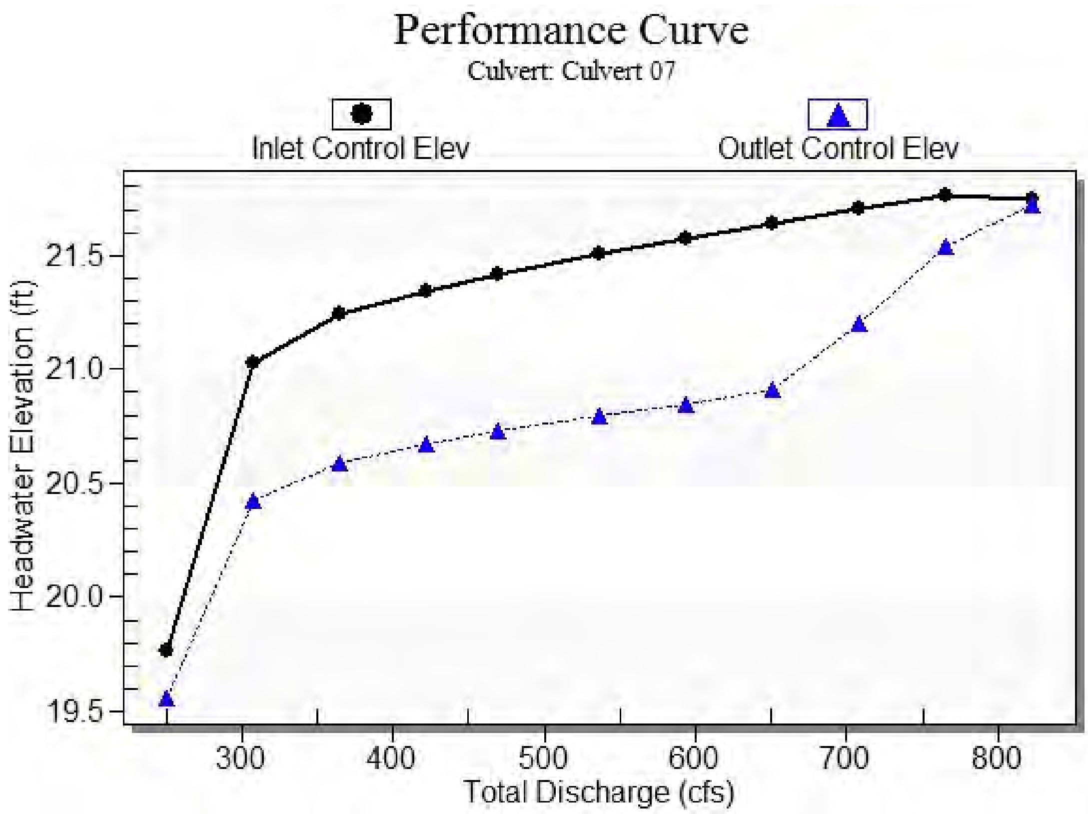
****

Inlet Elevation (invert): 14.20 ft, Outlet Elevation (invert): 14.17 ft

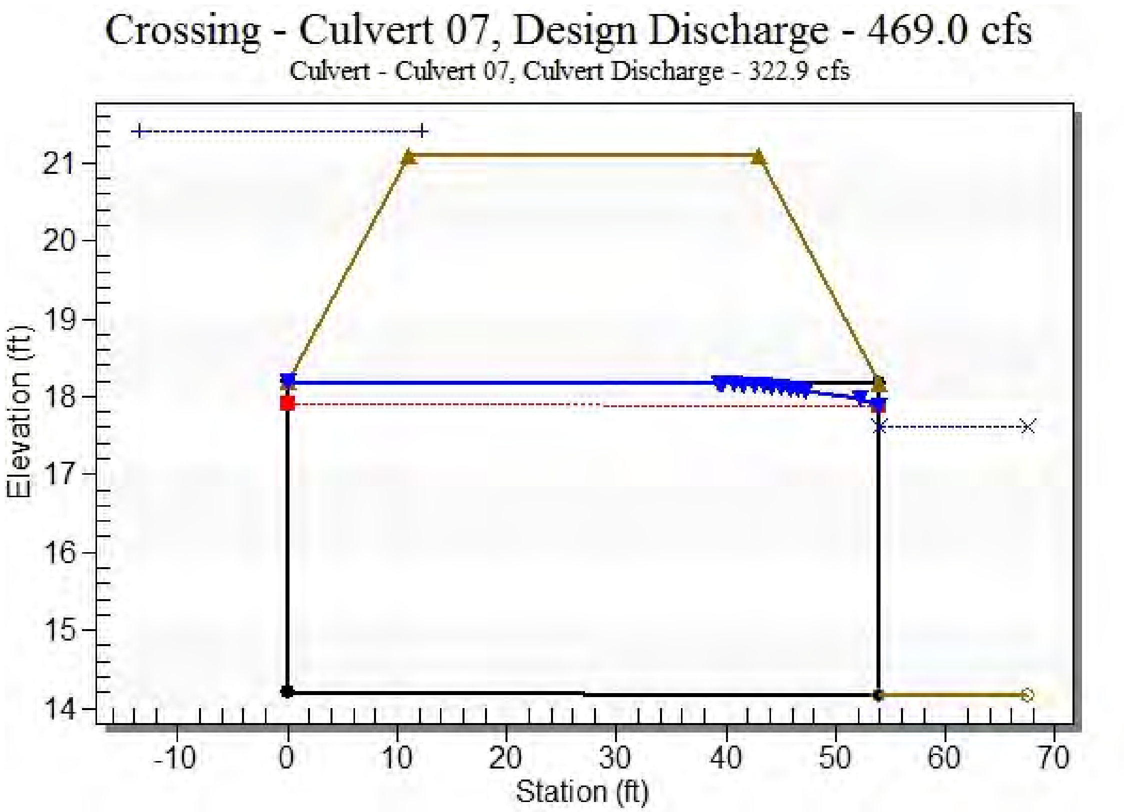
Culvert Length: 54.00 ft, Culvert Slope: 0.0006

****

Culvert Performance Curve Plot: Culvert 07



Water Surface Profile Plot for Culvert: Culvert 07



Site Data - Culvert 07

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 14.20 ft

Outlet Station: 54.00 ft

Outlet Elevation: 14.17 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 07

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 07)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
250.00	17.50	3.33
307.20	17.52	3.35
364.40	17.55	3.38
421.60	17.58	3.41
469.00	17.60	3.43
536.00	17.70	3.53
593.20	17.90	3.73
650.40	18.10	3.93
707.60	18.40	4.23
764.80	18.70	4.53
822.00	18.90	4.73

Tailwater Channel Data - Culvert 07

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 07

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 21.08 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 8

Table 1 - Summary of Culvert Flows at Crossing: Culvert 08

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 08 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
20.06	20.00	20.00	0.00	1
21.81	32.10	29.18	2.79	21
21.89	44.20	29.55	14.47	6
21.96	56.30	29.82	26.37	5
22.01	68.40	30.04	38.19	4
22.06	80.50	30.25	50.17	4
22.11	92.60	30.43	61.91	3
22.13	99.00	30.52	68.35	3
22.19	116.80	30.77	85.91	3
22.23	128.90	30.92	97.93	3
22.27	141.00	31.07	109.91	3
21.76	28.99	28.99	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 08

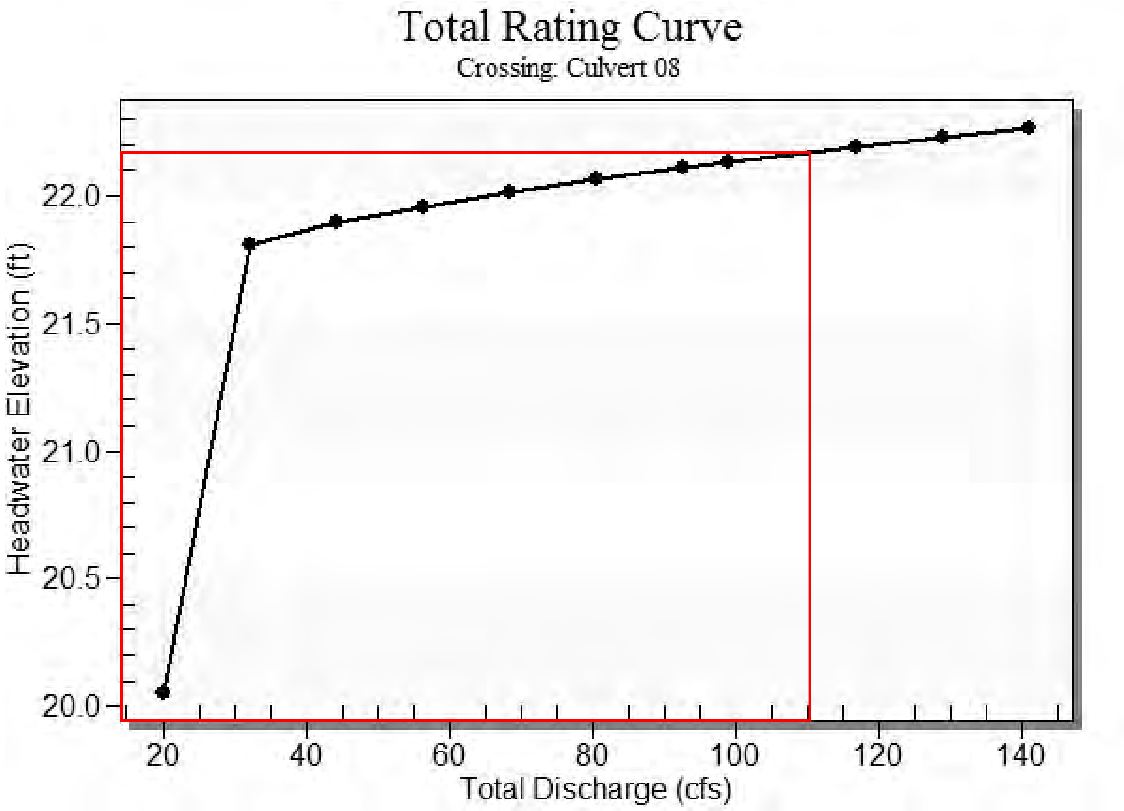


Table 2 - Culvert Summary Table: Culvert 08

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)
20.00	20.00	20.06	2.943	3.006	7-M2c	2.000	1.605	1.606	3.330	7.395	0.000
32.10	29.18	21.81	4.755	4.536	7-M2c	2.000	1.875	1.845	3.340	9.594	0.000
44.20	29.55	21.89	4.844	4.608	7-M2c	2.000	1.886	1.850	3.350	9.787	0.000
56.30	29.82	21.96	4.909	4.660	7-M2c	2.000	1.894	1.879	3.360	9.800	0.000
68.40	30.04	22.01	4.964	4.704	7-M2c	2.000	1.901	1.915	3.370	9.779	0.000
80.50	30.25	22.06	5.014	4.744	7-M2c	2.000	1.907	1.931	3.380	9.803	0.000
92.60	30.43	22.11	5.059	4.780	7-M2c	2.000	1.912	1.941	3.410	9.837	0.000
99.00	30.52	22.13	5.083	4.798	7-M2c	2.000	1.915	1.945	3.430	9.857	0.000
116.80	30.77	22.19	5.143	4.846	7-M2c	2.000	1.922	1.953	3.730	9.914	0.000
128.90	30.92	22.23	5.182	4.877	7-M2c	2.000	1.927	1.957	4.230	9.953	0.000
141.00	31.07	22.27	5.219	4.906	7-M2c	2.000	1.931	1.961	4.730	9.992	0.000

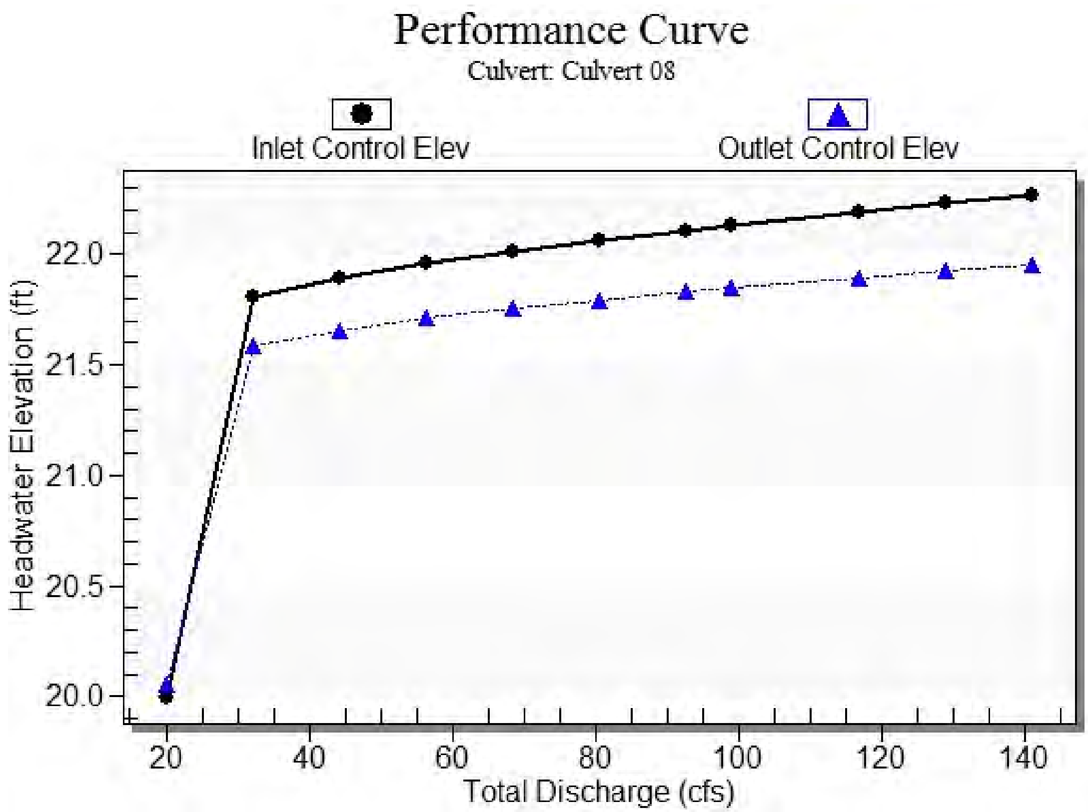
****

Inlet Elevation (invert): 17.05 ft, Outlet Elevation (invert): 17.02 ft

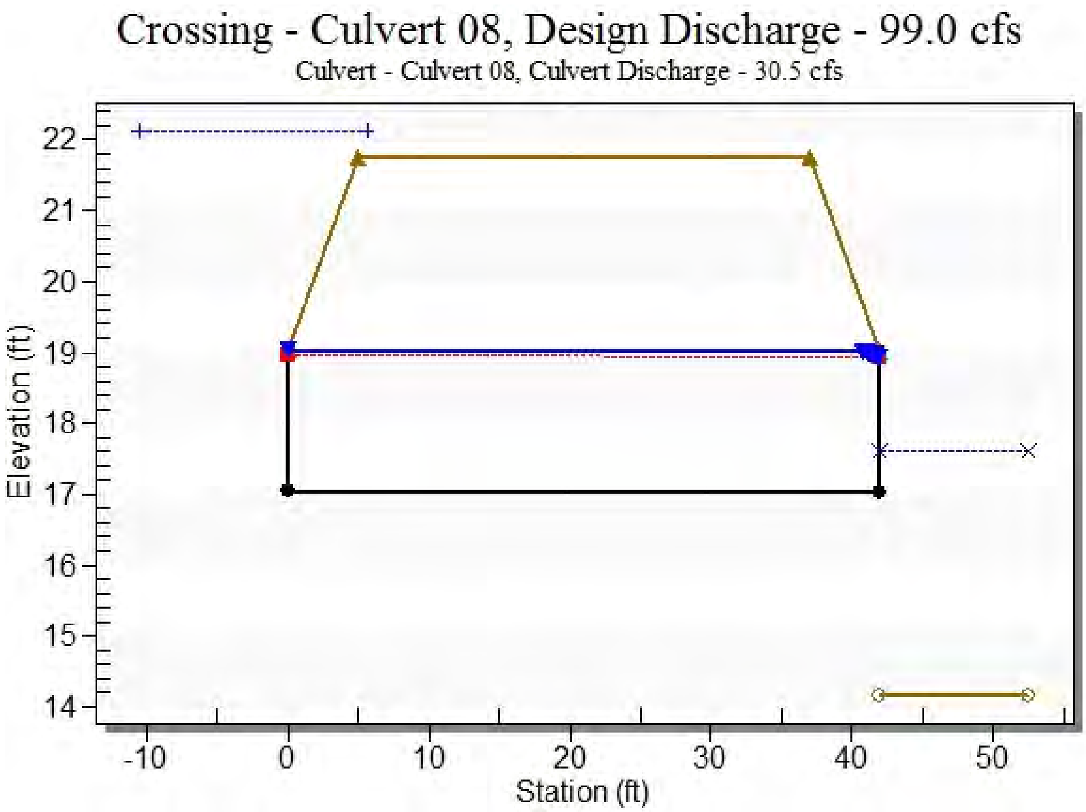
Culvert Length: 42.00 ft, Culvert Slope: 0.0007

****

Culvert Performance Curve Plot: Culvert 08



Water Surface Profile Plot for Culvert: Culvert 08



Site Data - Culvert 08

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 17.05 ft

Outlet Station: 42.00 ft

Outlet Elevation: 17.02 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 08

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 08)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
20.00	17.50	3.33
32.10	17.51	3.34
44.20	17.52	3.35
56.30	17.53	3.36
68.40	17.54	3.37
80.50	17.55	3.38
92.60	17.58	3.41
99.00	17.60	3.43
116.80	17.90	3.73
128.90	18.40	4.23
141.00	18.90	4.73

Tailwater Channel Data - Culvert 08

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 08

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 21.76 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 9

Table 1 - Summary of Culvert Flows at Crossing: Culvert 09

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 09 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
17.26	215.00	215.00	0.00	1
17.72	260.20	260.20	0.00	1
18.21	305.40	305.40	0.00	1
18.74	350.60	350.60	0.00	1
19.06	376.00	376.00	0.00	1
19.95	441.00	441.00	0.00	1
20.64	486.20	486.20	0.00	1
21.15	531.40	517.83	13.19	12
21.27	576.60	524.71	51.19	6
21.36	621.80	529.97	91.21	5
21.43	667.00	534.61	132.16	5
21.07	513.01	513.01	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 09

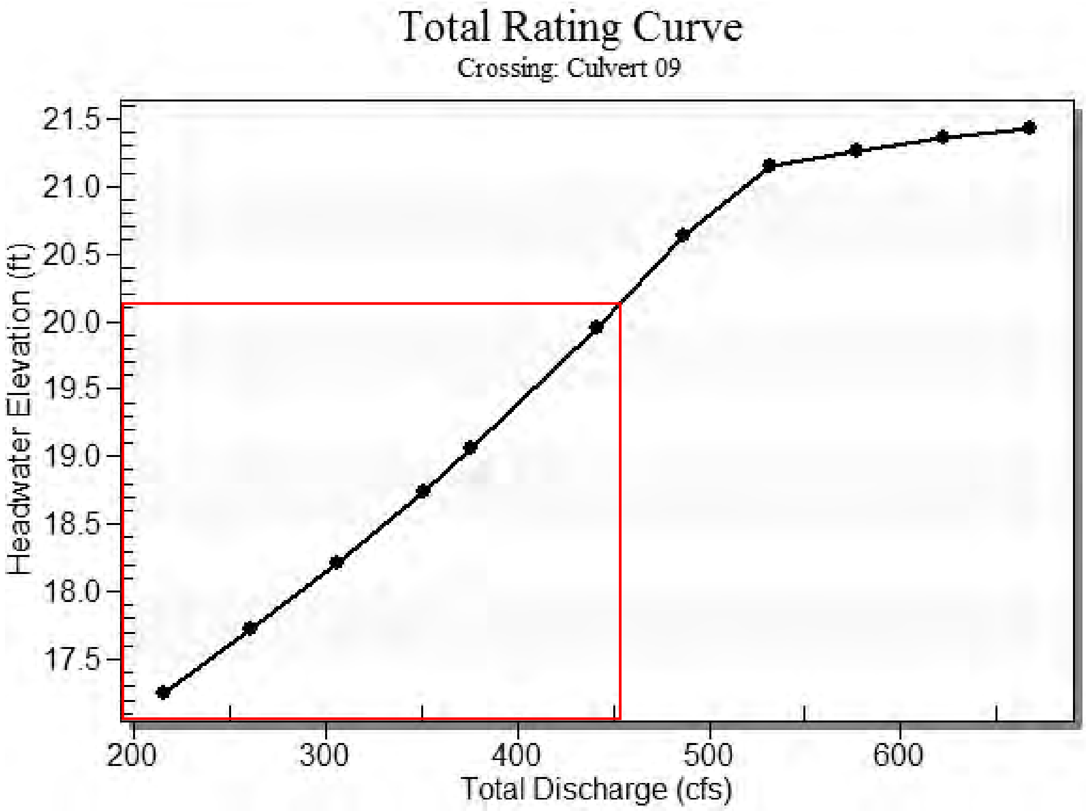


Table 2 - Culvert Summary Table: Culvert 09

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)
215.00	215.00	17.26	4.106	4.316	1-S1t	2.412	2.436	3.540	3.540	6.073	0.000
260.20	260.20	17.72	4.666	4.780	1-S1t	2.754	2.766	3.640	3.640	7.148	0.000
305.40	305.40	18.21	5.220	5.275	7-M1t	3.085	3.078	3.740	3.740	8.166	0.000
350.60	350.60	18.74	5.786	5.800	7-M1t	3.403	3.374	3.790	3.790	9.251	0.000
376.00	376.00	19.06	6.116	6.102	7-M1t	3.579	3.535	3.840	3.840	9.792	0.000
441.00	441.00	19.95	7.013	6.820	7-M1t	4.019	3.932	4.040	4.040	10.916	0.000
486.20	486.20	20.64	7.697	7.275	3-M2t	4.316	4.196	4.240	4.240	11.467	0.000
531.40	517.83	21.15	8.210	7.582	3-M2t	5.000	4.376	4.440	4.440	11.663	0.000
576.60	524.71	21.27	8.325	7.619	3-M2t	5.000	4.415	4.640	4.640	11.308	0.000
621.80	529.97	21.36	8.415	7.652	3-M2t	5.000	4.444	4.740	4.740	11.181	0.000
667.00	534.61	21.43	8.494	7.682	3-M2t	5.000	4.470	4.840	4.840	11.046	0.000

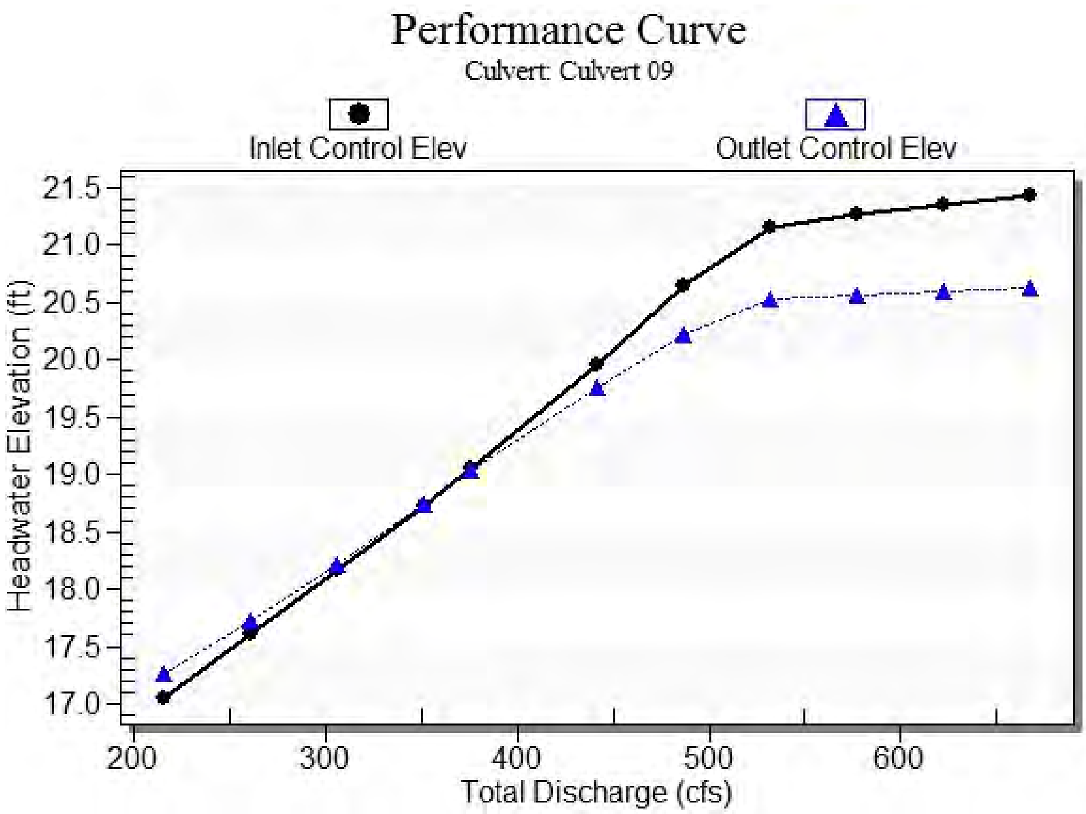
****

Inlet Elevation (invert): 12.94 ft, Outlet Elevation (invert): 12.76 ft

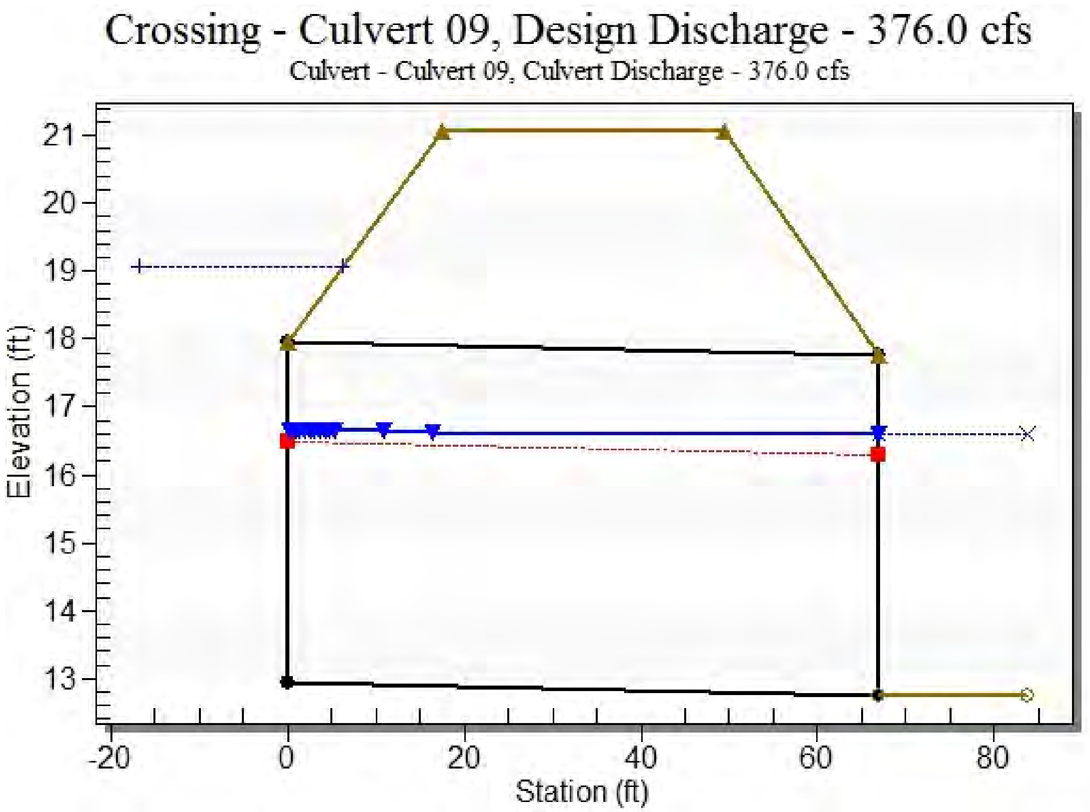
Culvert Length: 67.00 ft, Culvert Slope: 0.0027

****

Culvert Performance Curve Plot: Culvert 09



Water Surface Profile Plot for Culvert: Culvert 09



Site Data - Culvert 09

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 12.94 ft

Outlet Station: 67.00 ft

Outlet Elevation: 12.76 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 09

Barrel Shape: Concrete Box

Barrel Span: 10.00 ft

Barrel Rise: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 09)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
215.00	16.30	3.54
260.20	16.40	3.64
305.40	16.50	3.74
350.60	16.55	3.79
376.00	16.60	3.84
441.00	16.80	4.04
486.20	17.00	4.24
531.40	17.20	4.44
576.60	17.40	4.64
621.80	17.50	4.74
667.00	17.60	4.84

Tailwater Channel Data - Culvert 09

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 09

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 200.00 ft

Crest Elevation: 21.07 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 10

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

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 10 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
20.25	10.00	10.00	0.00	1
20.53	12.60	12.60	0.00	1
20.80	15.20	15.20	0.00	1
21.09	17.80	17.80	0.00	1
21.45	20.40	20.40	0.00	1
21.90	23.00	23.00	0.00	1
22.41	25.60	25.60	0.00	1
22.49	26.00	26.00	0.00	1
22.94	30.80	28.06	2.58	15
22.97	33.40	28.17	5.09	4
22.99	36.00	28.26	7.67	4
22.90	27.87	27.87	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 10

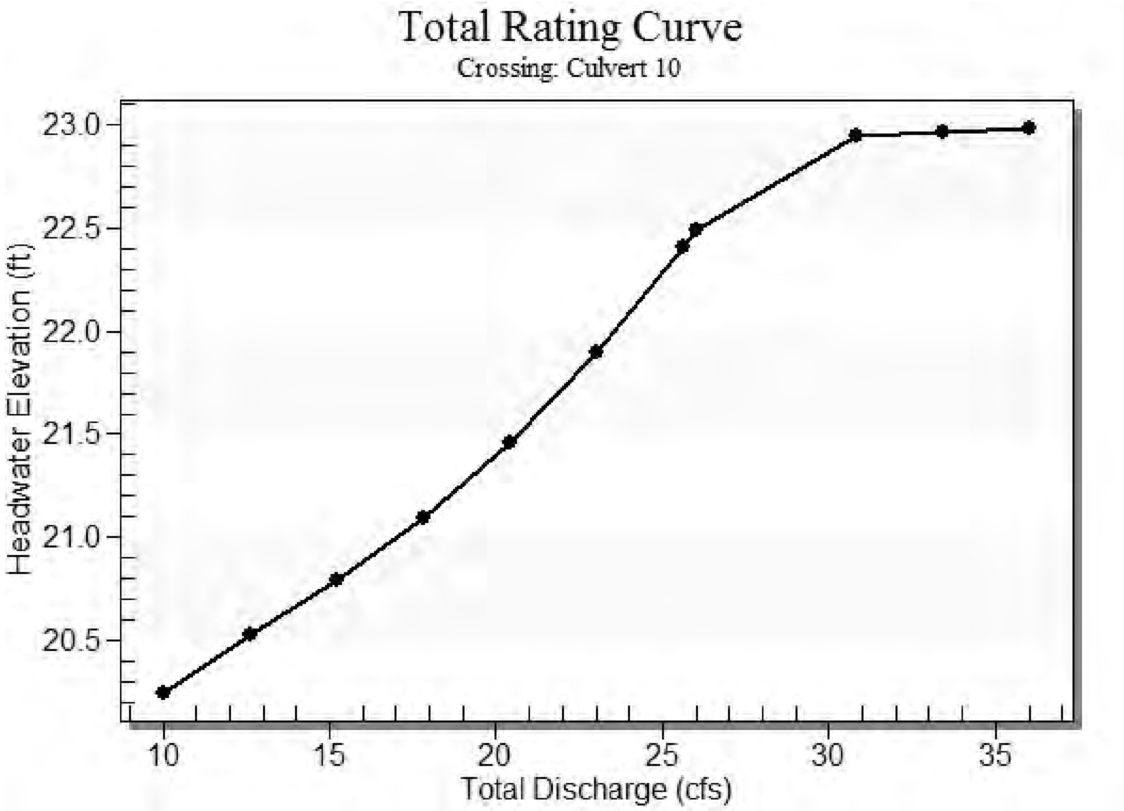


Table 2 - Culvert Summary Table: Culvert 10

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)
10.00	10.00	20.25	1.704	1.798	3-M2t	1.350	1.128	1.160	1.160	5.293	0.000
12.60	12.60	20.53	1.983	2.077	2-M2c	1.657	1.272	1.276	1.260	5.955	0.000
15.20	15.20	20.80	2.280	2.346	2-M2c	2.000	1.405	1.405	1.360	6.445	0.000
17.80	17.80	21.09	2.617	2.639	2-M2c	2.000	1.514	1.520	1.460	6.948	0.000
20.40	20.40	21.45	3.004	2.987	7-M2t	2.000	1.617	1.660	1.660	7.340	0.000
23.00	23.00	21.90	3.450	3.425	7-M2t	2.000	1.693	1.860	1.860	7.598	0.000
25.60	25.60	22.41	3.957	3.892	4-FFf	2.000	1.770	2.000	2.000	8.149	0.000
26.00	26.00	22.49	4.041	3.955	4-FFf	2.000	1.782	2.000	2.000	8.276	0.000
30.80	28.06	22.94	4.493	4.296	4-FFf	2.000	1.842	2.000	2.000	8.932	0.000
33.40	28.17	22.97	4.517	4.314	4-FFf	2.000	1.846	2.000	2.000	8.966	0.000
36.00	28.26	22.99	4.538	4.330	4-FFf	2.000	1.848	2.000	2.000	8.995	0.000

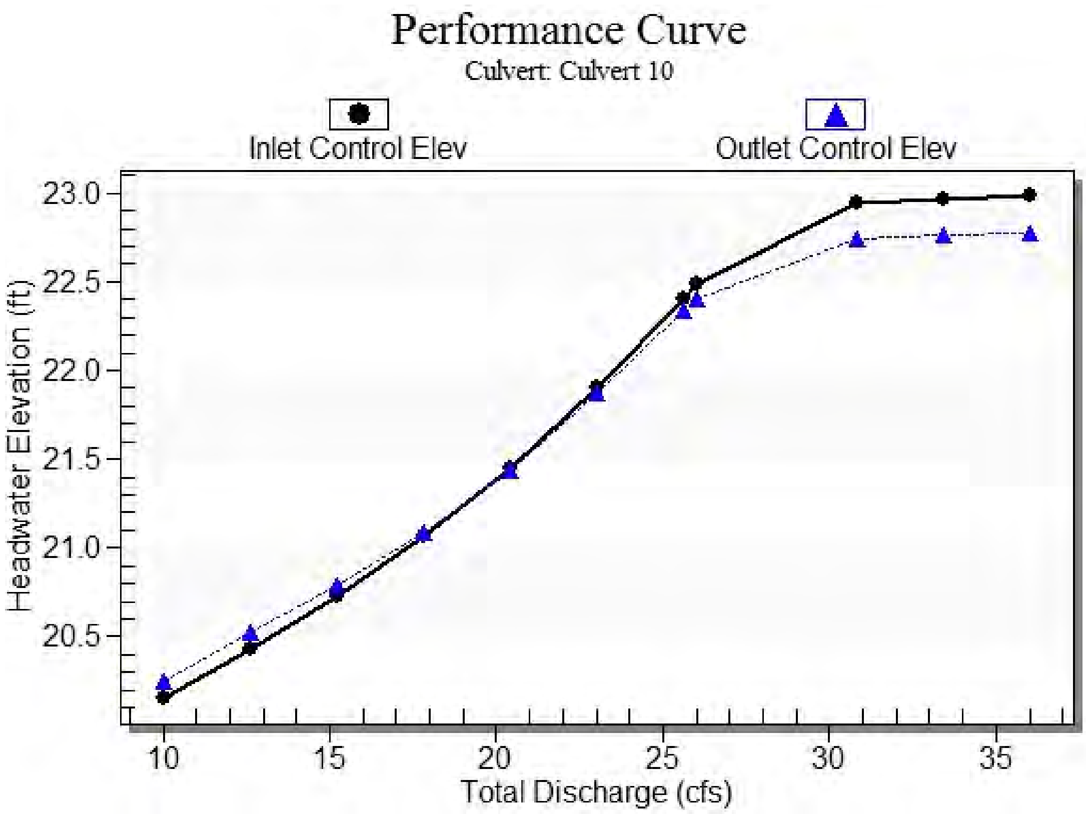
****

Inlet Elevation (invert): 18.45 ft, Outlet Elevation (invert): 18.34 ft

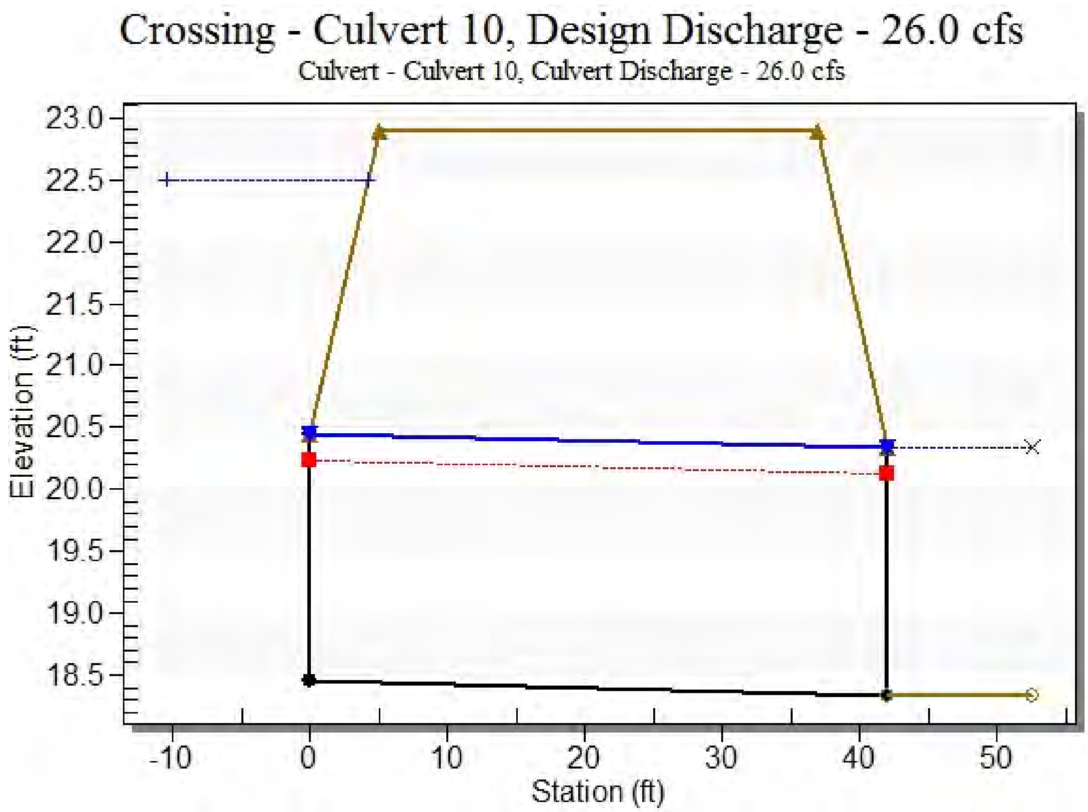
Culvert Length: 42.00 ft, Culvert Slope: 0.0026

****

Culvert Performance Curve Plot: Culvert 10



Water Surface Profile Plot for Culvert: Culvert 10



Site Data - Culvert 10

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 18.45 ft

Outlet Station: 42.00 ft

Outlet Elevation: 18.34 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 10

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

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

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
10.00	19.50	1.16
12.60	19.60	1.26
15.20	19.70	1.36
17.80	19.80	1.46
20.40	20.00	1.66
23.00	20.20	1.86
25.60	20.34	2.00
26.00	20.34	2.00
30.80	20.34	2.00
33.40	20.34	2.00
36.00	20.34	2.00

Tailwater Channel Data - Culvert 10

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 10

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 22.90 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 11

Table 1 - Summary of Culvert Flows at Crossing: Culvert 11

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 11 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
22.08	5.00	5.00	0.00	1
22.11	6.00	6.00	0.00	1
22.15	7.00	7.00	0.00	1
22.20	8.00	8.00	0.00	1
22.25	9.00	9.00	0.00	1
22.31	10.00	10.00	0.00	1
22.38	11.00	11.00	0.00	1
22.45	12.00	12.00	0.00	1
22.53	13.00	13.00	0.00	1
22.61	14.00	14.00	0.00	1
22.70	15.00	15.00	0.00	1
24.07	25.75	25.75	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 11

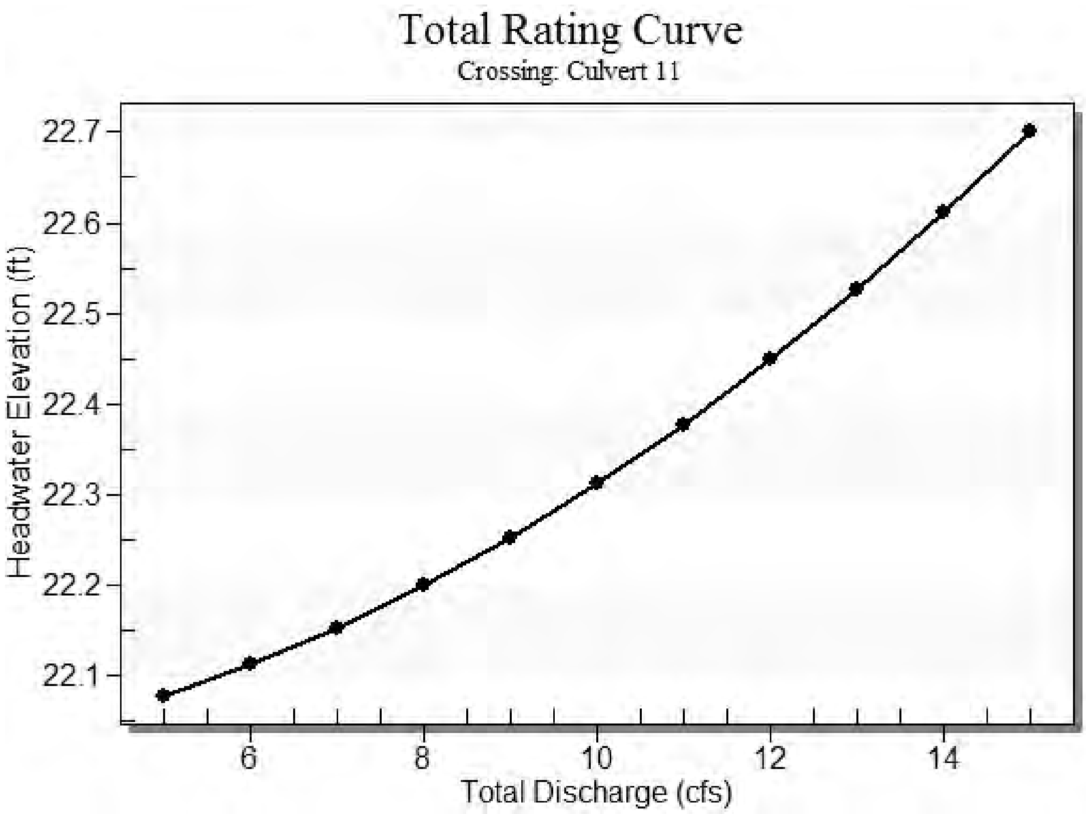


Table 2 - Culvert Summary Table: Culvert 11

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)
5.00	5.00	22.08	1.087	2.138	4-FFf	0.474	0.786	2.000	3.230	1.592	0.000
6.00	6.00	22.11	1.222	2.172	4-FFf	0.521	0.862	2.000	3.230	1.910	0.000
7.00	7.00	22.15	1.346	2.213	4-FFf	0.568	0.935	2.000	3.230	2.228	0.000
8.00	8.00	22.20	1.462	2.259	4-FFf	0.612	1.006	2.000	3.230	2.546	0.000
9.00	9.00	22.25	1.573	2.312	4-FFf	0.648	1.067	2.000	3.230	2.865	0.000
10.00	10.00	22.31	1.681	2.372	4-FFf	0.684	1.128	2.000	3.230	3.183	0.000
11.00	11.00	22.38	1.788	2.437	4-FFf	0.720	1.188	2.000	3.230	3.501	0.000
12.00	12.00	22.45	1.895	2.509	4-FFf	0.757	1.241	2.000	3.230	3.820	0.000
13.00	13.00	22.53	2.004	2.587	4-FFf	0.793	1.293	2.000	3.230	4.138	0.000
14.00	14.00	22.61	2.116	2.671	4-FFf	0.825	1.344	2.000	3.230	4.456	0.000
15.00	15.00	22.70	2.233	2.762	4-FFf	0.856	1.395	2.000	3.230	4.775	0.000

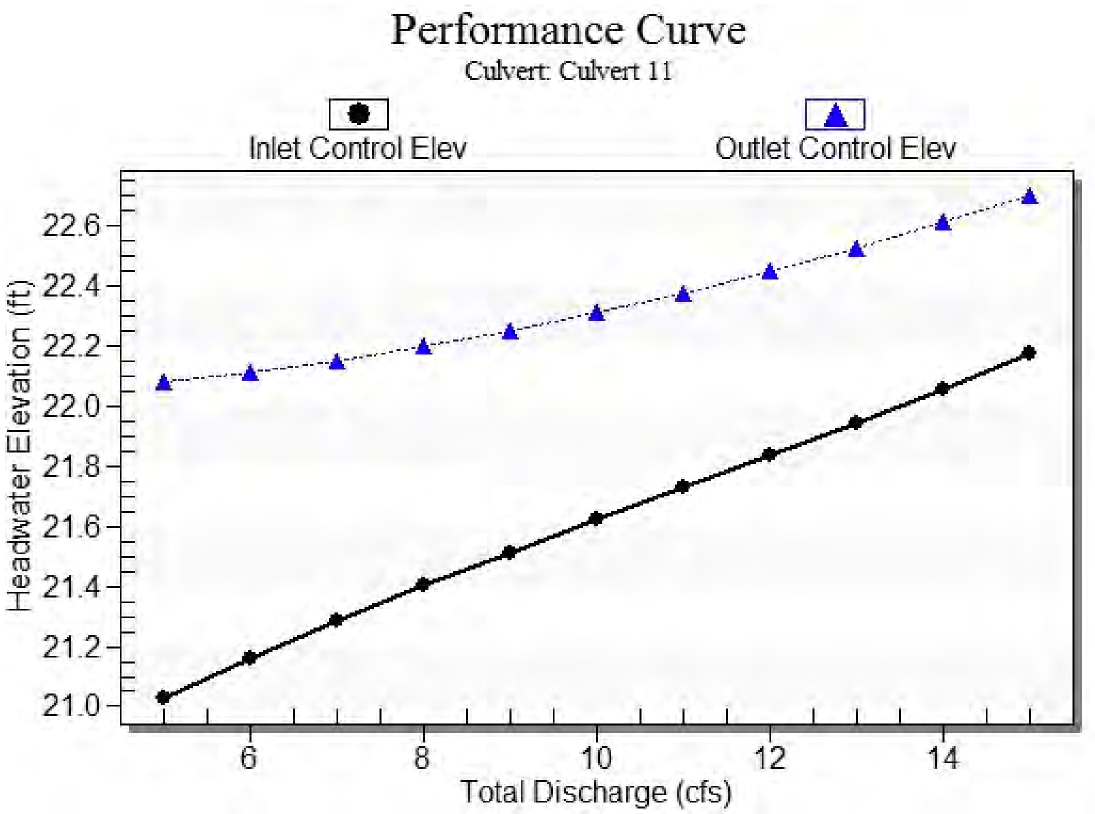
****

Inlet Elevation (invert): 19.94 ft,   Outlet Elevation (invert): 18.77 ft

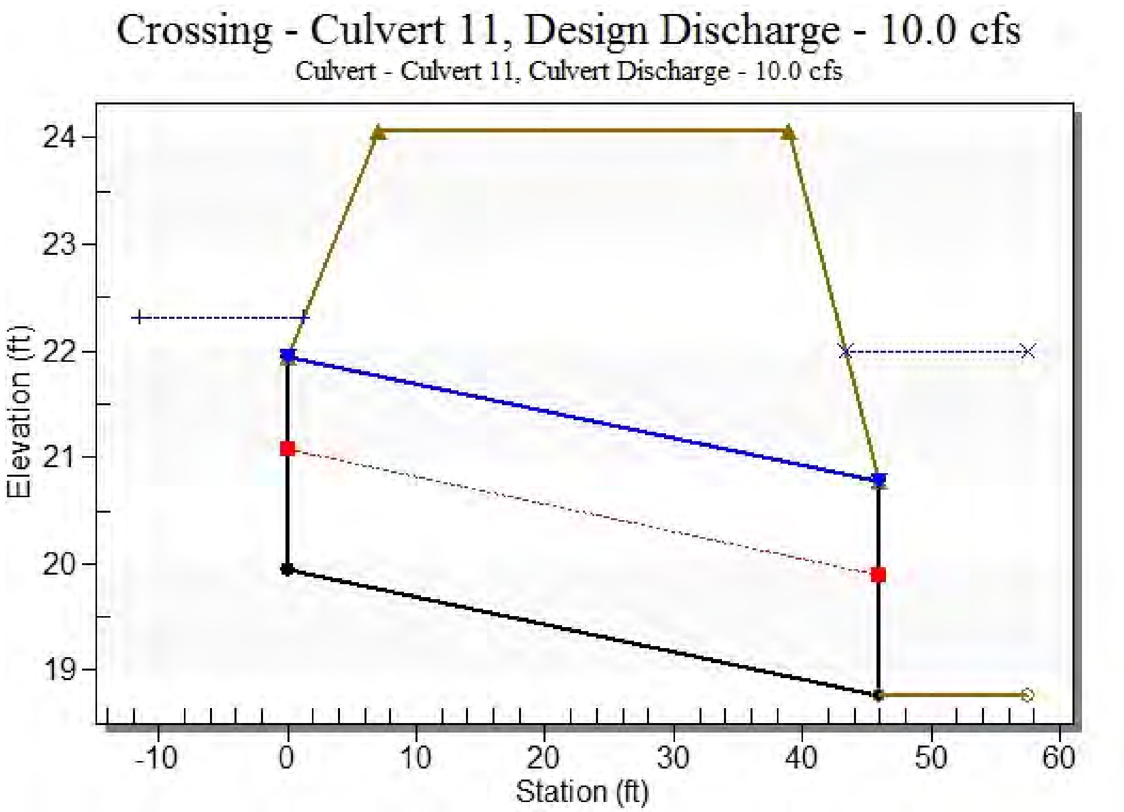
Culvert Length: 46.01 ft,   Culvert Slope: 0.0254

****

Culvert Performance Curve Plot: Culvert 11



Water Surface Profile Plot for Culvert: Culvert 11



Site Data - Culvert 11

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 19.94 ft

Outlet Station: 46.00 ft

Outlet Elevation: 18.77 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 11

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 11)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
5.00	22.00	3.23
6.00	22.00	3.23
7.00	22.00	3.23
8.00	22.00	3.23
9.00	22.00	3.23
10.00	22.00	3.23
11.00	22.00	3.23
12.00	22.00	3.23
13.00	22.00	3.23
14.00	22.00	3.23
15.00	22.00	3.23

Tailwater Channel Data - Culvert 11

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 22.00 ft

Roadway Data for Crossing: Culvert 11

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 24.07 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 12

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

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 12 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
21.41	5.00	5.00	0.00	1
21.44	6.00	6.00	0.00	1
21.48	7.00	7.00	0.00	1
21.53	8.00	8.00	0.00	1
21.58	9.00	9.00	0.00	1
21.64	10.00	10.00	0.00	1
21.71	11.00	11.00	0.00	1
21.78	12.00	12.00	0.00	1
21.86	13.00	13.00	0.00	1
21.94	14.00	14.00	0.00	1
22.03	15.00	15.00	0.00	1
23.97	28.56	28.56	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 12

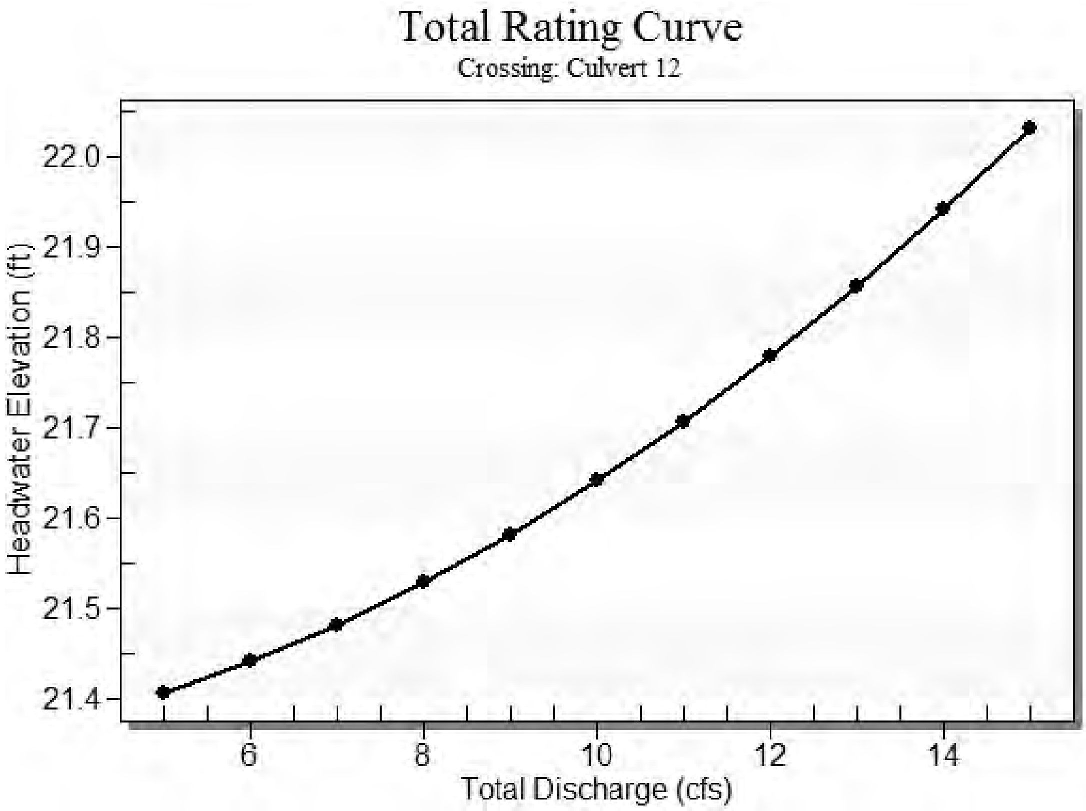


Table 2 - Culvert Summary Table: Culvert 12

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)
5.00	5.00	21.41	1.112	2.048	4-FFf	1.352	0.786	2.000	2.000	1.592	0.000
6.00	6.00	21.44	1.246	2.082	4-FFf	1.570	0.862	2.000	2.000	1.910	0.000
7.00	7.00	21.48	1.370	2.123	4-FFf	2.000	0.935	2.000	2.000	2.228	0.000
8.00	8.00	21.53	1.487	2.170	4-FFf	2.000	1.006	2.000	2.000	2.546	0.000
9.00	9.00	21.58	1.598	2.223	4-FFf	2.000	1.067	2.000	2.000	2.865	0.000
10.00	10.00	21.64	1.706	2.282	4-FFf	2.000	1.128	2.000	2.000	3.183	0.000
11.00	11.00	21.71	1.812	2.348	4-FFf	2.000	1.188	2.000	2.000	3.501	0.000
12.00	12.00	21.78	1.919	2.420	4-FFf	2.000	1.241	2.000	2.000	3.820	0.000
13.00	13.00	21.86	2.029	2.498	4-FFf	2.000	1.293	2.000	2.000	4.138	0.000
14.00	14.00	21.94	2.141	2.582	4-FFf	2.000	1.344	2.000	2.000	4.456	0.000
15.00	15.00	22.03	2.258	2.672	4-FFf	2.000	1.395	2.000	2.000	4.775	0.000

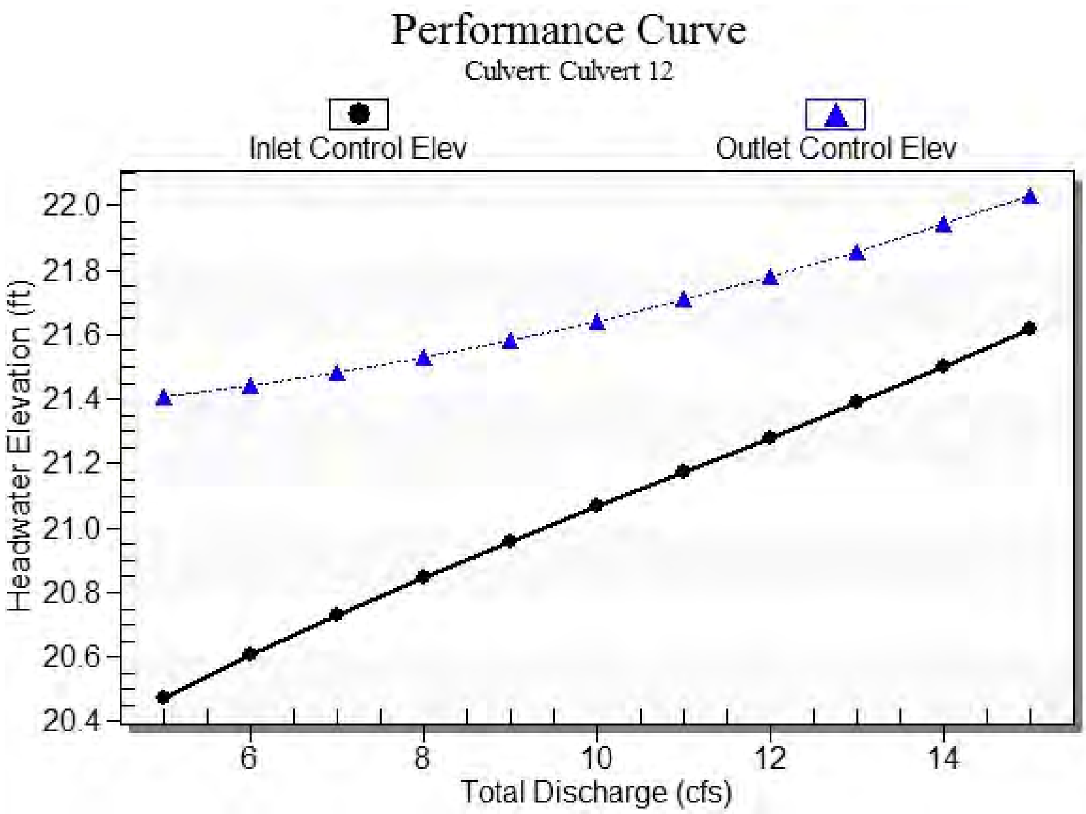
****

Inlet Elevation (invert): 19.36 ft, Outlet Elevation (invert): 19.33 ft

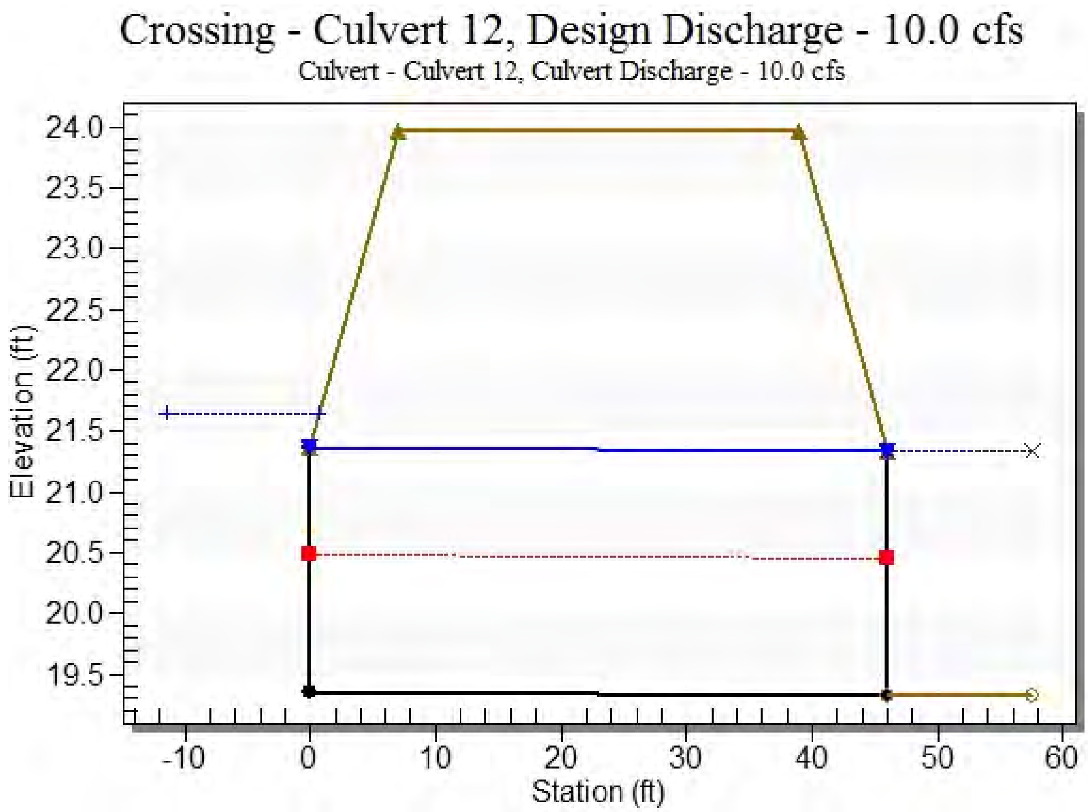
Culvert Length: 46.00 ft, Culvert Slope: 0.0007

****

Culvert Performance Curve Plot: Culvert 12



Water Surface Profile Plot for Culvert: Culvert 12



Site Data - Culvert 12

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 19.36 ft

Outlet Station: 46.00 ft

Outlet Elevation: 19.33 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 12

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

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

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
5.00	21.33	2.00
6.00	21.33	2.00
7.00	21.33	2.00
8.00	21.33	2.00
9.00	21.33	2.00
10.00	21.33	2.00
11.00	21.33	2.00
12.00	21.33	2.00
13.00	21.33	2.00
14.00	21.33	2.00
15.00	21.33	2.00

Tailwater Channel Data - Culvert 12

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 21.33 ft

Roadway Data for Crossing: Culvert 12

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 23.97 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 13

Table 1 - Summary of Culvert Flows at Crossing: Culvert 13

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 13 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
23.85	40.00	36.87	3.00	19
23.91	48.00	37.07	10.78	6
23.96	56.00	37.22	18.67	5
24.00	64.00	37.35	26.47	4
24.04	72.00	37.47	34.43	4
24.07	80.00	37.57	42.37	4
24.08	83.00	37.61	45.30	3
24.13	96.00	37.76	58.01	3
24.16	104.00	37.85	66.04	3
24.19	112.00	37.94	74.00	3
24.22	120.00	38.02	81.95	3
23.80	36.72	36.72	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 13

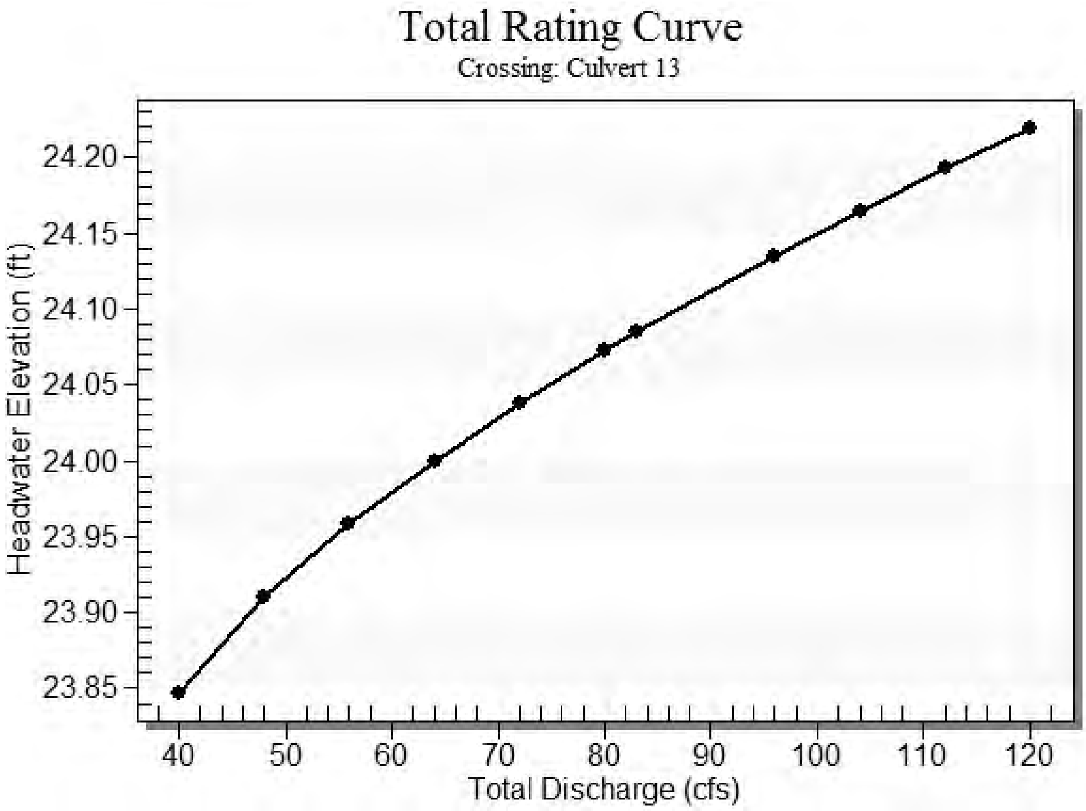


Table 2 - Culvert Summary Table: Culvert 13

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)
40.00	36.87	23.85	6.867	6.039	4-FFf	2.000	2.000	2.000	2.020	11.737	0.000
48.00	37.07	23.91	6.931	6.082	4-FFf	2.000	2.000	2.000	2.020	11.800	0.000
56.00	37.22	23.96	6.979	6.115	4-FFf	2.000	2.000	2.000	2.020	11.848	0.000
64.00	37.35	24.00	7.020	6.143	4-FFf	2.000	2.000	2.000	2.020	11.888	0.000
72.00	37.47	24.04	7.058	6.169	4-FFf	2.000	2.000	2.000	2.020	11.925	0.000
80.00	37.57	24.07	7.092	6.193	4-FFf	2.000	2.000	2.000	2.020	11.960	0.000
83.00	37.61	24.08	7.104	6.201	4-FFf	2.000	2.000	2.000	2.020	11.971	0.000
96.00	37.76	24.13	7.154	6.235	4-FFf	2.000	2.000	2.000	2.020	12.020	0.000
104.00	37.85	24.16	7.184	6.255	4-FFf	2.000	2.000	2.000	2.020	12.049	0.000
112.00	37.94	24.19	7.212	6.275	4-FFf	2.000	2.000	2.000	2.020	12.076	0.000
120.00	38.02	24.22	7.239	6.293	4-FFf	2.000	2.000	2.000	2.020	12.103	0.000

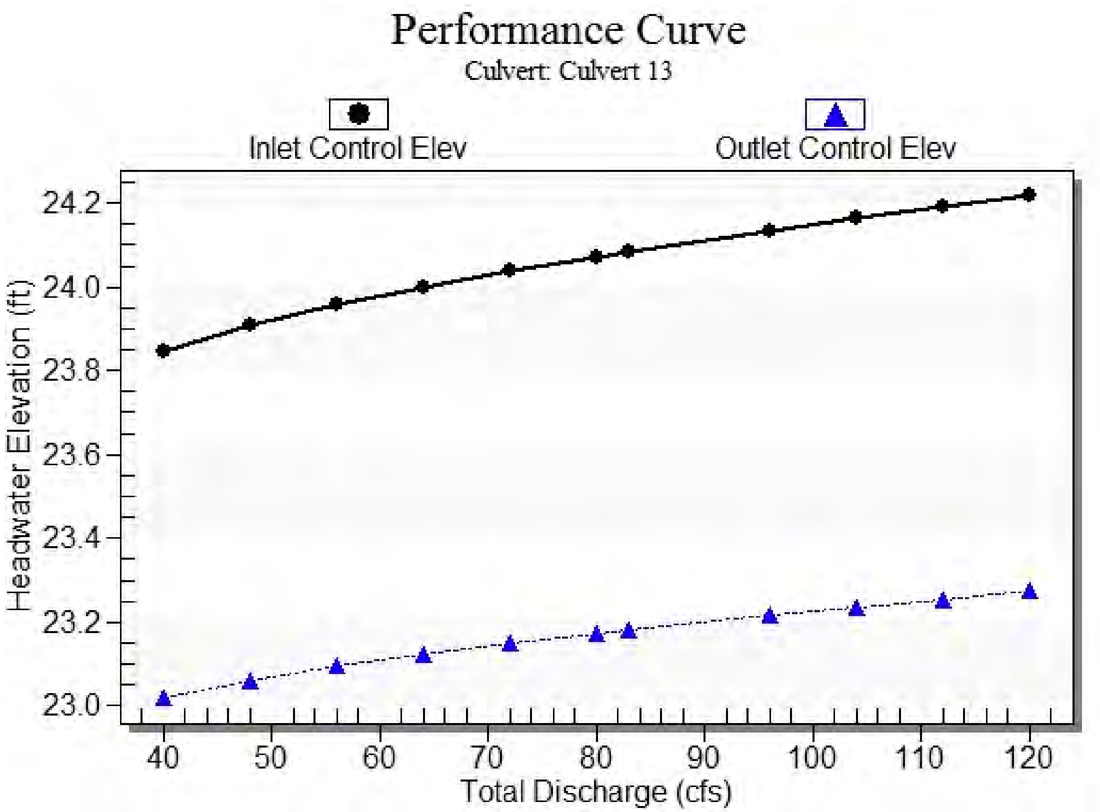
****

Inlet Elevation (invert): 16.98 ft, Outlet Elevation (invert): 16.88 ft

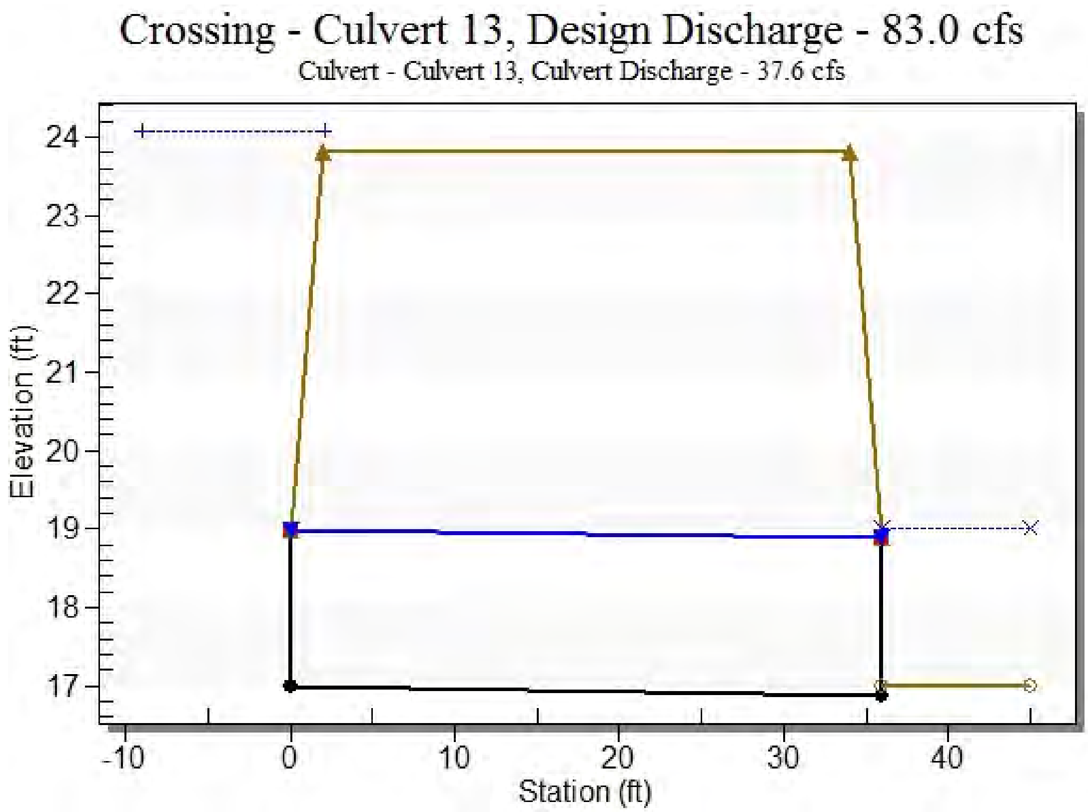
Culvert Length: 36.00 ft, Culvert Slope: 0.0028

****

Culvert Performance Curve Plot: Culvert 13



Water Surface Profile Plot for Culvert: Culvert 13



Site Data - Culvert 13

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 16.98 ft

Outlet Station: 36.00 ft

Outlet Elevation: 16.88 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 13

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 13)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
40.00	19.00	2.02
48.00	19.00	2.02
56.00	19.00	2.02
64.00	19.00	2.02
72.00	19.00	2.02
80.00	19.00	2.02
83.00	19.00	2.02
96.00	19.00	2.02
104.00	19.00	2.02
112.00	19.00	2.02
120.00	19.00	2.02

Tailwater Channel Data - Culvert 13

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 19.00 ft

Roadway Data for Crossing: Culvert 13

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 23.80 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

EXISTING CULVERT 14

Table 1 - Summary of Culvert Flows at Crossing: Culvert 14

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 14 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
22.69	3.00	3.00	0.00	1
22.79	4.30	4.30	0.00	1
22.92	5.60	5.60	0.00	1
23.09	6.90	6.90	0.00	1
23.29	8.20	8.20	0.00	1
23.52	9.50	9.50	0.00	1
23.62	10.00	10.00	0.00	1
24.10	12.10	12.10	0.00	1
24.44	13.40	13.40	0.00	1
24.81	14.70	14.70	0.00	1
25.02	16.00	15.37	0.54	20
25.00	15.32	15.32	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 14

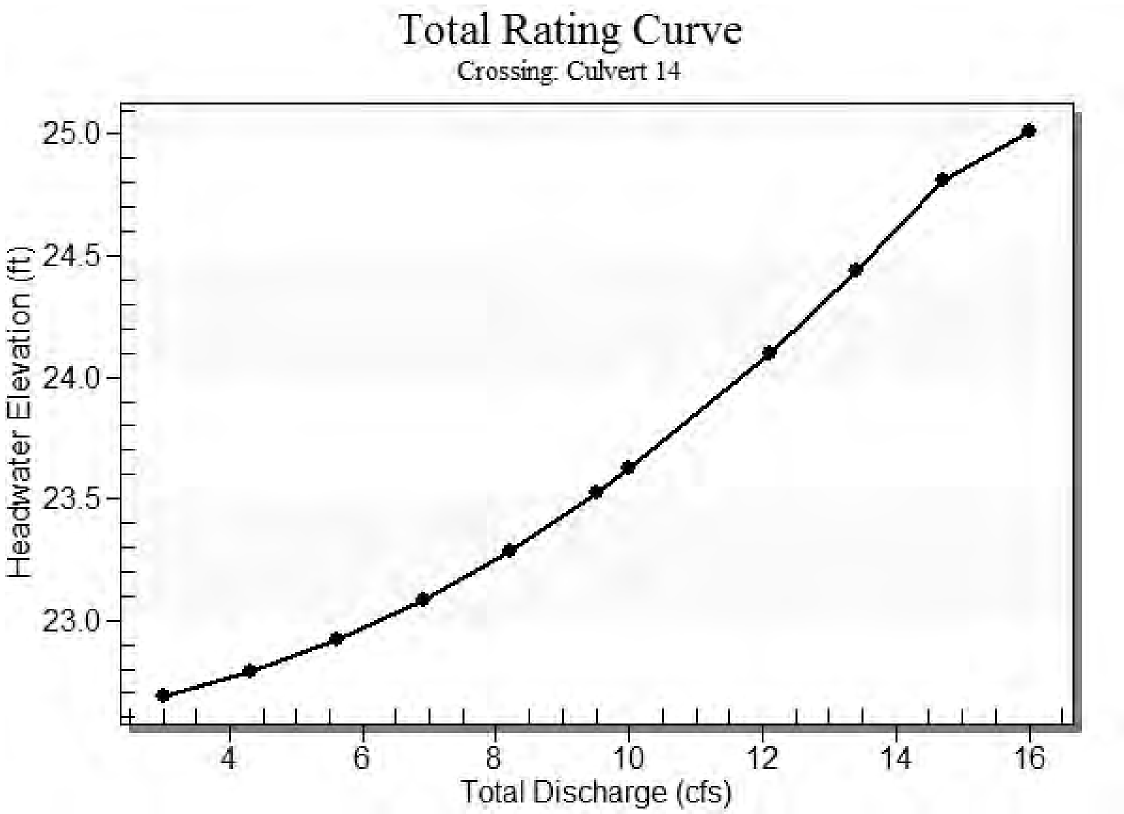


Table 2 - Culvert Summary Table: Culvert 14

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)
3.00	3.00	22.69	0.949	2.022	4-FFf	0.876	0.655	1.500	2.000	1.698	0.000
4.30	4.30	22.79	1.183	2.119	4-FFf	1.143	0.792	1.500	2.000	2.433	0.000
5.60	5.60	22.92	1.398	2.251	4-FFf	1.500	0.912	1.500	2.000	3.169	0.000
6.90	6.90	23.09	1.619	2.417	4-FFf	1.500	1.014	1.500	2.000	3.905	0.000
8.20	8.20	23.29	1.865	2.617	4-FFf	1.500	1.105	1.500	2.000	4.640	0.000
9.50	9.50	23.52	2.149	2.853	4-FFf	1.500	1.189	1.500	2.000	5.376	0.000
10.00	10.00	23.62	2.269	2.952	4-FFf	1.500	1.215	1.500	2.000	5.659	0.000
12.10	12.10	24.10	2.853	3.427	4-FFf	1.500	1.311	1.500	2.000	6.847	0.000
13.40	13.40	24.44	3.277	3.766	4-FFf	1.500	1.370	1.500	2.000	7.583	0.000
14.70	14.70	24.81	3.747	4.139	4-FFf	1.500	1.429	1.500	2.000	8.318	0.000
16.00	15.37	25.02	4.006	4.345	4-FFf	1.500	1.459	1.500	2.000	8.698	0.000

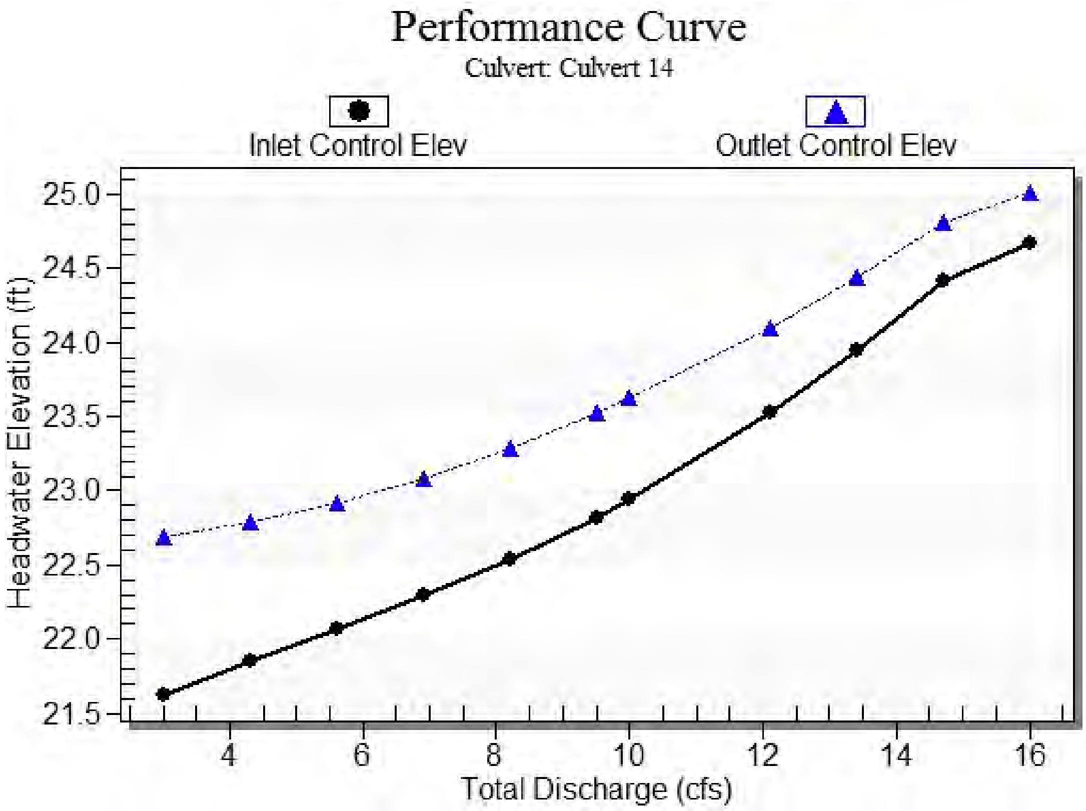
****

Inlet Elevation (invert): 20.67 ft,   Outlet Elevation (invert): 20.61 ft

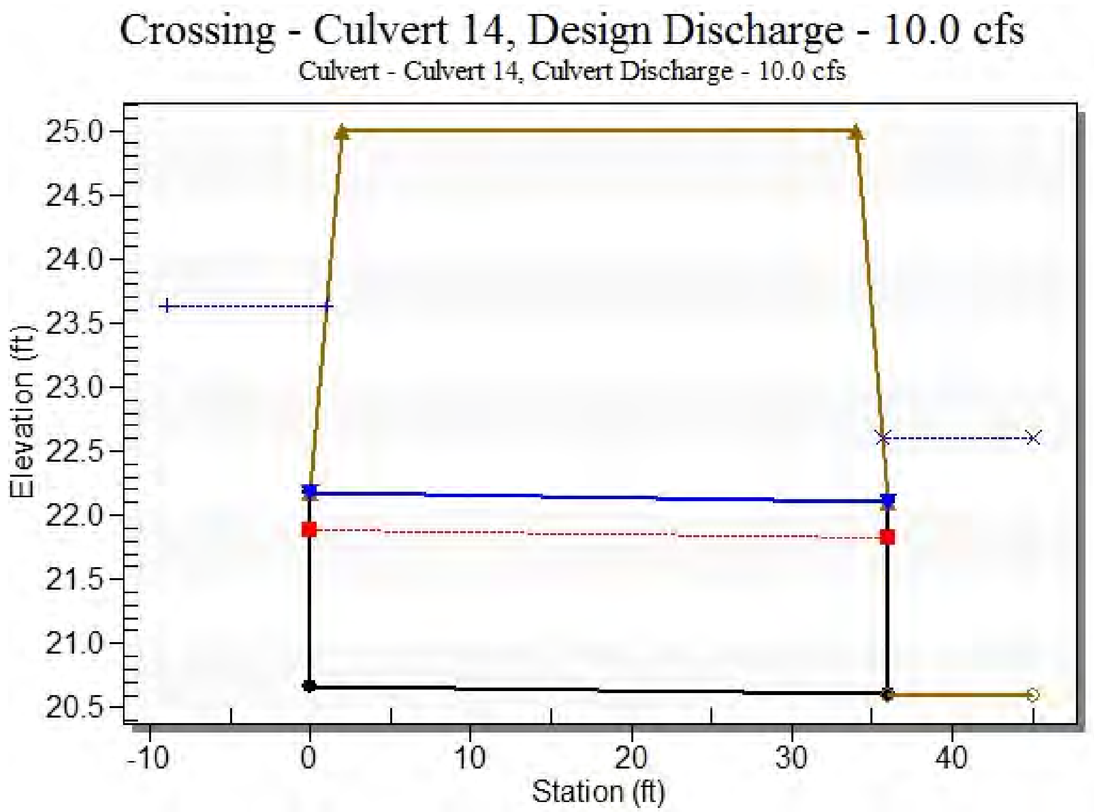
Culvert Length: 36.00 ft,   Culvert Slope: 0.0017

****

Culvert Performance Curve Plot: Culvert 14



Water Surface Profile Plot for Culvert: Culvert 14



Site Data - Culvert 14

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 20.67 ft

Outlet Station: 36.00 ft

Outlet Elevation: 20.61 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 14

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 14)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
3.00	22.60	2.00
4.30	22.60	2.00
5.60	22.60	2.00
6.90	22.60	2.00
8.20	22.60	2.00
9.50	22.60	2.00
10.00	22.60	2.00
12.10	22.60	2.00
13.40	22.60	2.00
14.70	22.60	2.00
16.00	22.60	2.00

Tailwater Channel Data - Culvert 14

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 22.60 ft

Roadway Data for Crossing: Culvert 14

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 25.00 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

PRELIMINARY SIZING OF PROPOSED CROSSDRAINS

.
PROPOSED CULVERTS HAVE BEEN PRELIMINARILY SIZED BY MATCHING OR REDUCING THE ESTIMATED 50-YR HEADWATER AT EACH CROSSING. THE TABLE BELOW SUMMARIZES THE RESULTS.

- PROPOSED CULVERTS

Ex. Size	Prop. Size	Culvert	50 yr Q (cfs)	50 yr Pre HW	50 yr Post HW	Existing Road CL EL	~ Proposed Road CL EL
24"	30"	1	23	24.16	23.31	24.34	25.25
8x4	8x4	2	316	24.12	24.12	24.31	25.58
8x4	(2) 6x4	2 Alt	453	24.64	23.78	24.31	25.58
10x3	(2) 8x4	3	478	21.23	20.93	20.84	24.02
10x3	10x3	3 Alt	218	20.40	20.49	20.84	24.02
24"	30"	4	20	19.86	19.21	20.46	24.66
(2) 8x3	(2) 8x4	5	386	17.24	16.86	18.3	22.98
30"	(2) 30"	6	61	19.56	19.11	19.4	23.06
8x4	(2) 6x4	7	469	21.42	21.46	21.08	23.62
24"	(2) 36"	8	99	22.13	21.42	21.76	25.65
10x5	10x5	9	376	19.06	19.06	21.07	25.01
24"	30"	10	25.6	22.41	21.43	22.9	22.9
24"	24"	11	10	22.31	22.35	24.07	24.07
24"	30"	12	10	21.64	21.51	23.97	23.97
24"	36"	13	83	24.08	24.48	23.8	24.5
18"	24"	14	10	23.62	22.94	25	25

HY-8 Culvert Analysis Report

PROPOSED CULVERT 1

Table 1 - Summary of Culvert Flows at Crossing: P_Culvert 1 - 30" RCP

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 01 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
22.98	18.00	18.00	0.00	1
23.03	18.80	18.80	0.00	1
23.08	19.60	19.60	0.00	1
23.13	20.40	20.40	0.00	1
23.18	21.20	21.20	0.00	1
23.24	22.00	22.00	0.00	1
23.29	22.80	22.80	0.00	1
23.31	23.00	23.00	0.00	1
23.41	24.40	24.40	0.00	1
23.46	25.20	25.20	0.00	1
23.52	26.00	26.00	0.00	1
25.25	41.13	41.13	0.00	Overtopping

Rating Curve Plot for Crossing: P_Culvert 1 - 30" RCP

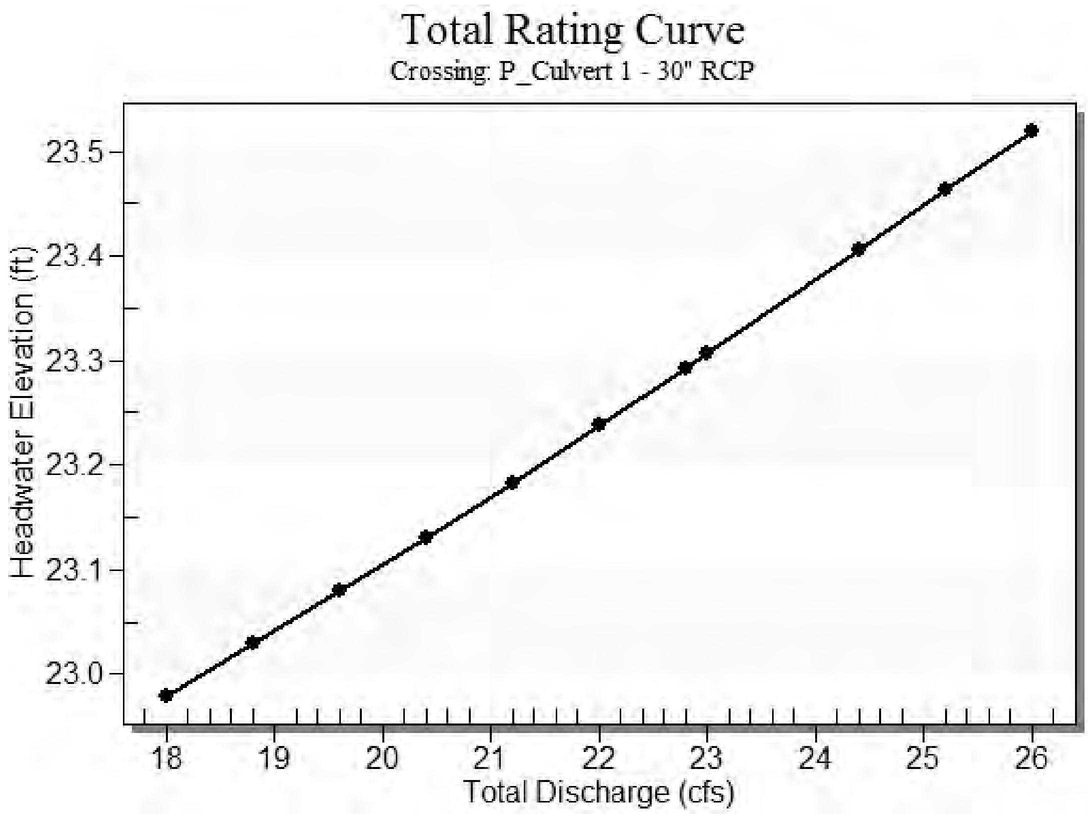


Table 2 - Culvert Summary Table: Culvert 01

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)
18.00	18.00	22.98	2.171	2.460	3-M1t	1.884	1.433	2.100	2.100	4.089	0.000
18.80	18.80	23.03	2.232	2.509	7-M1t	1.956	1.467	2.100	2.100	4.271	0.000
19.60	19.60	23.08	2.293	2.559	7-M1t	2.045	1.502	2.100	2.100	4.453	0.000
20.40	20.40	23.13	2.354	2.610	3-M2t	2.159	1.531	2.100	2.100	4.634	0.000
21.20	21.20	23.18	2.416	2.663	3-M2t	2.500	1.561	2.100	2.100	4.816	0.000
22.00	22.00	23.24	2.478	2.718	3-M2t	2.500	1.590	2.100	2.100	4.998	0.000
22.80	22.80	23.29	2.541	2.773	3-M2t	2.500	1.619	2.100	2.100	5.180	0.000
23.00	23.00	23.31	2.557	2.787	3-M2t	2.500	1.627	2.100	2.100	5.225	0.000
24.40	24.40	23.41	2.670	2.886	3-M2t	2.500	1.678	2.100	2.100	5.543	0.000
25.20	25.20	23.46	2.736	2.944	3-M2t	2.500	1.707	2.100	2.100	5.725	0.000
26.00	26.00	23.52	2.804	3.000	3-M2t	2.500	1.737	2.100	2.100	5.907	0.000

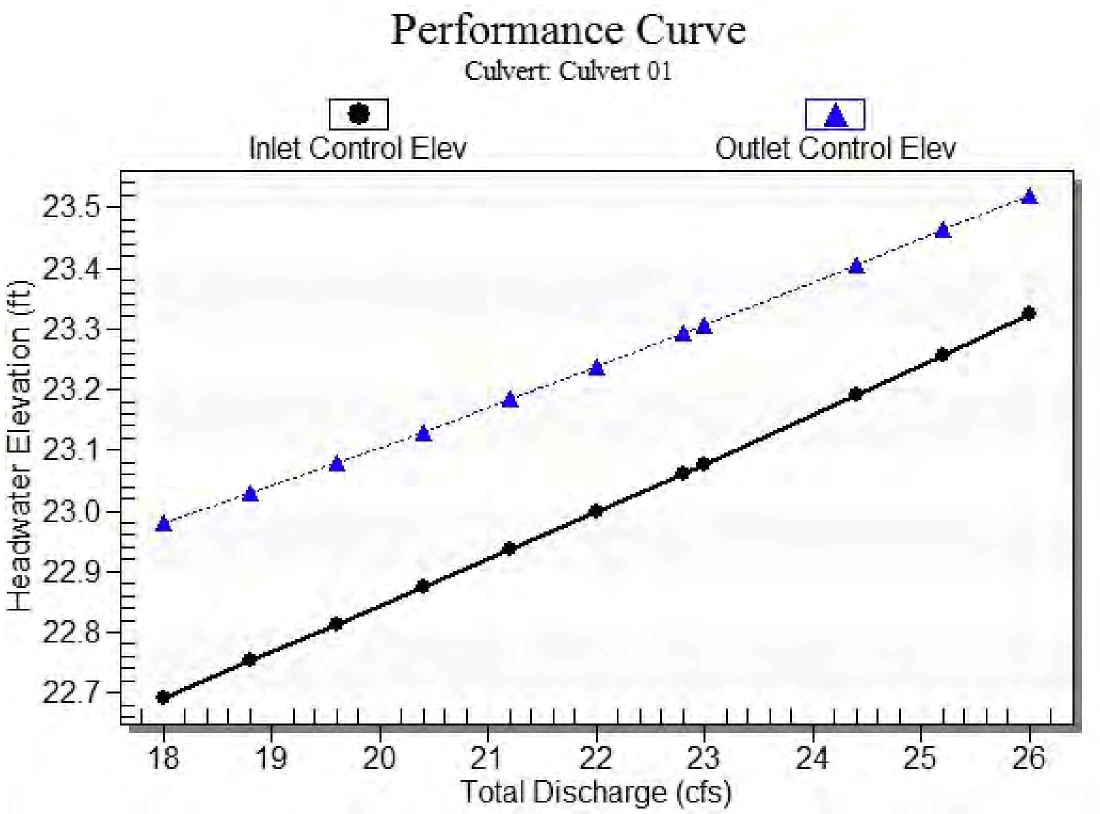
****

Inlet Elevation (invert): 20.52 ft, Outlet Elevation (invert): 20.30 ft

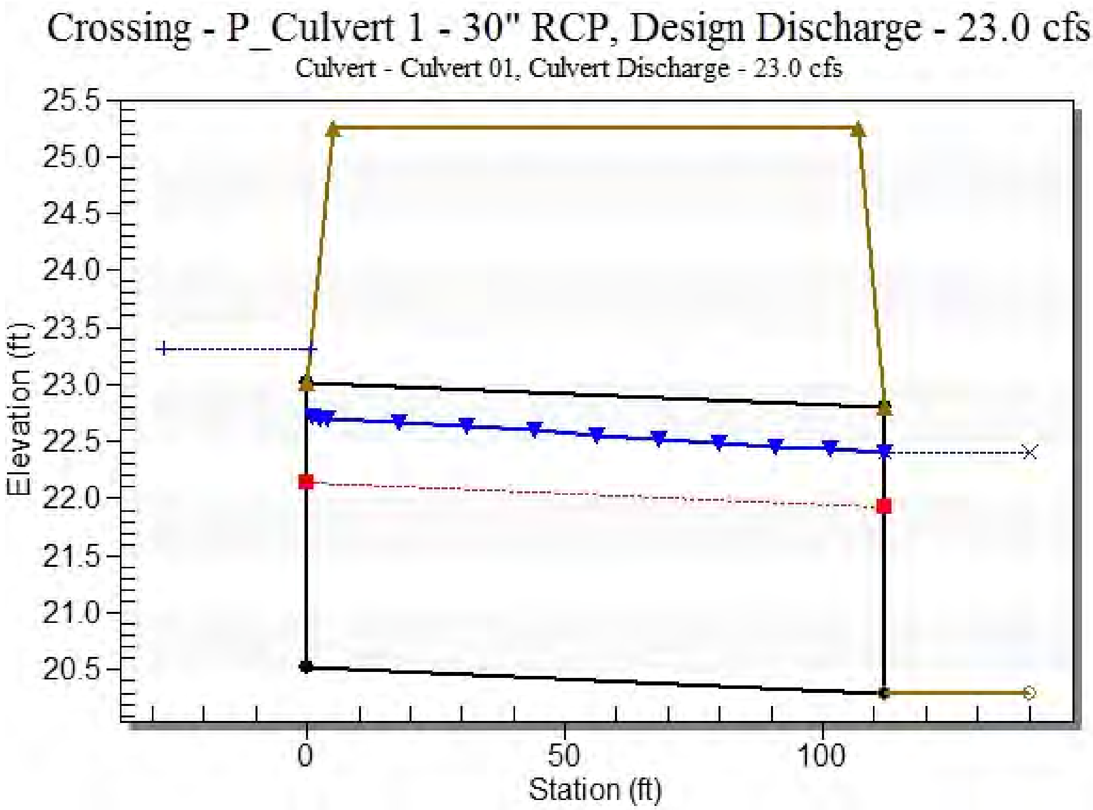
Culvert Length: 112.00 ft, Culvert Slope: 0.0020

****

Culvert Performance Curve Plot: Culvert 01



Water Surface Profile Plot for Culvert: Culvert 01



Site Data - Culvert 01

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 20.52 ft

Outlet Station: 112.00 ft

Outlet Elevation: 20.30 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 01

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: P_Culvert 1 - 30" RCP)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
18.00	22.40	2.10
18.80	22.40	2.10
19.60	22.40	2.10
20.40	22.40	2.10
21.20	22.40	2.10
22.00	22.40	2.10
22.80	22.40	2.10
23.00	22.40	2.10
24.40	22.40	2.10
25.20	22.40	2.10
26.00	22.40	2.10

Tailwater Channel Data - P_Culvert 1 - 30" RCP

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 22.40 ft

Roadway Data for Crossing: P_Culvert 1 - 30" RCP

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 25.25 ft

Roadway Surface: Paved

Roadway Top Width: 102.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 2

Table 1 - Summary of Culvert Flows at Crossing: Culvert 02

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 02 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
21.83	207.00	207.00	0.00	1
22.32	233.30	233.30	0.00	1
22.84	259.60	259.60	0.00	1
23.41	285.90	285.90	0.00	1
24.03	312.20	312.20	0.00	1
24.12	316.00	316.00	0.00	1
25.43	364.80	364.80	0.00	1
25.68	391.10	373.09	17.51	11
25.75	417.40	375.57	41.48	6
25.81	443.70	377.58	65.76	5
25.86	470.00	379.34	90.04	4
25.58	369.82	369.82	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 02

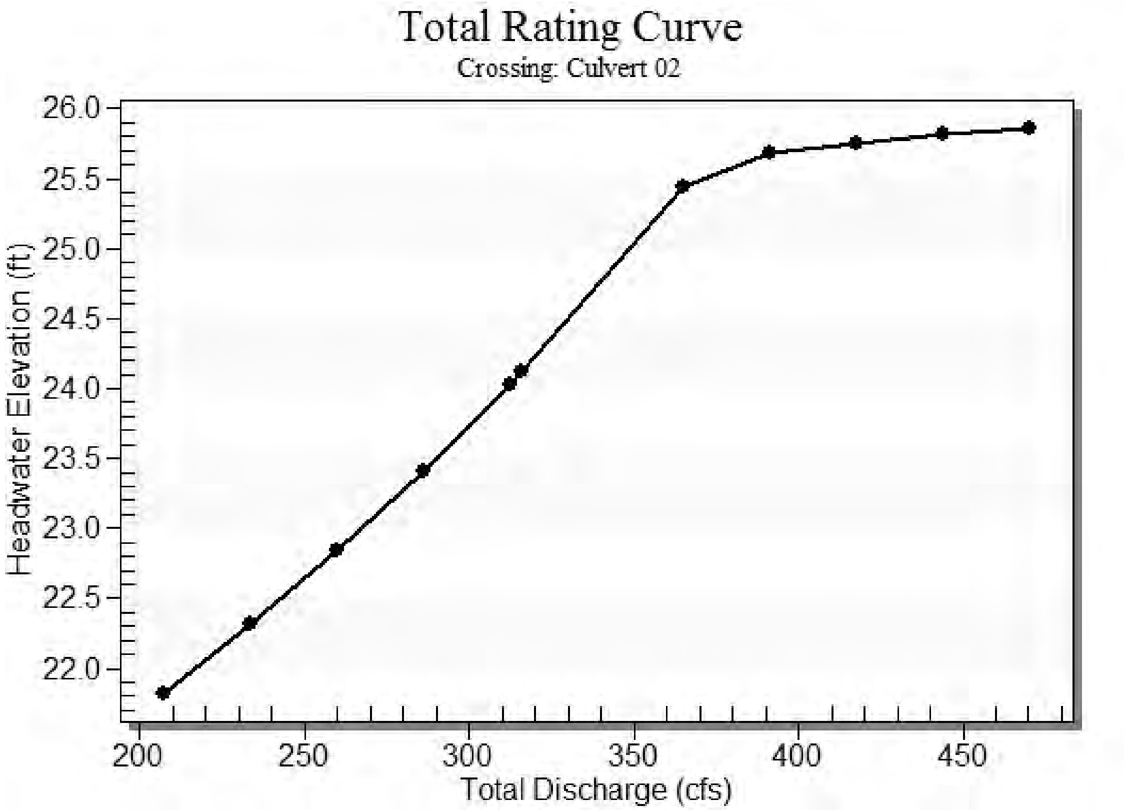


Table 2 - Culvert Summary Table: Culvert 02

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)
207.00	207.00	21.83	4.746	4.741	2-M2c	4.000	2.756	2.748	2.210	9.414	0.000
233.30	233.30	22.32	5.236	5.133	2-M2c	4.000	2.984	2.976	2.420	9.799	0.000
259.60	259.60	22.84	5.761	5.508	2-M2c	4.000	3.205	3.195	2.620	10.157	0.000
285.90	285.90	23.41	6.330	5.988	7-M2c	4.000	3.418	3.409	2.820	10.482	0.000
312.20	312.20	24.03	6.949	6.551	7-M2c	4.000	3.624	3.615	3.020	10.795	0.000
316.00	316.00	24.12	7.043	6.632	7-M2c	4.000	3.653	3.644	3.040	10.838	0.000
364.80	364.80	25.43	8.354	7.731	4-FFf	4.000	4.000	4.000	4.080	11.400	0.000
391.10	373.09	25.68	8.596	7.903	4-FFf	4.000	4.000	4.000	4.080	11.659	0.000
417.40	375.57	25.75	8.670	7.955	4-FFf	4.000	4.000	4.000	4.080	11.736	0.000
443.70	377.58	25.81	8.730	7.998	4-FFf	4.000	4.000	4.000	4.080	11.800	0.000
470.00	379.34	25.86	8.783	8.036	4-FFf	4.000	4.000	4.000	4.080	11.854	0.000

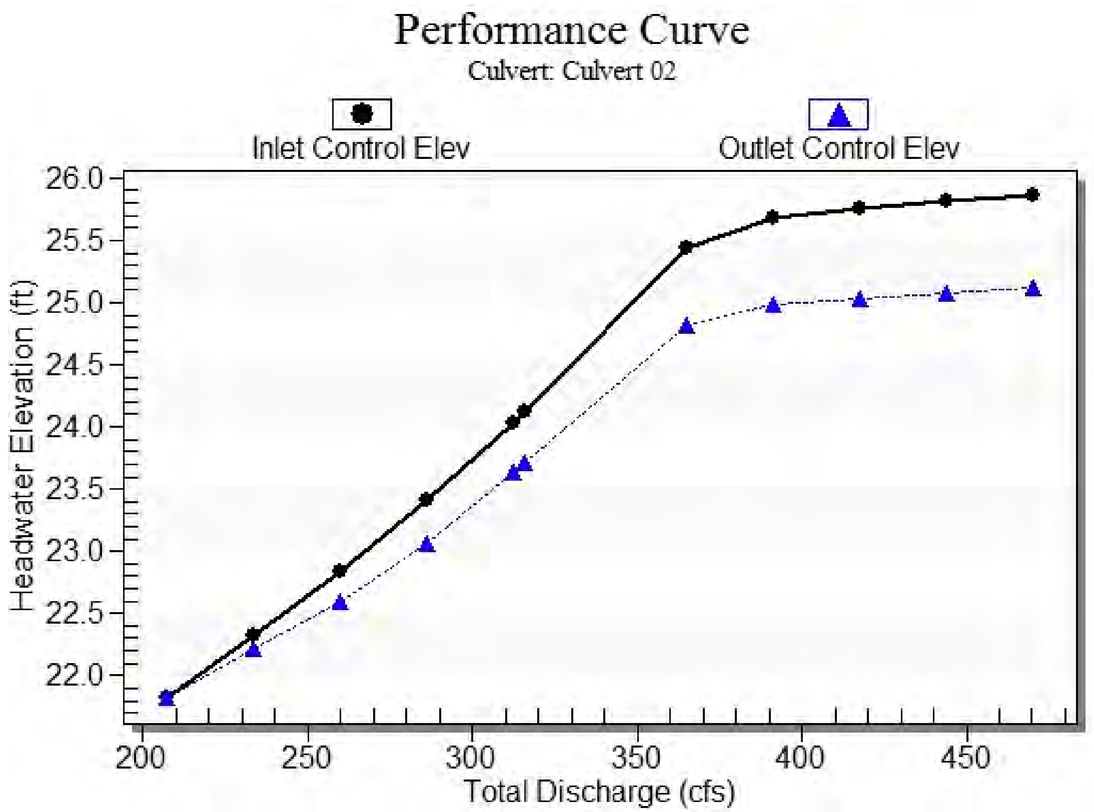
****

Inlet Elevation (invert): 17.08 ft, Outlet Elevation (invert): 16.98 ft

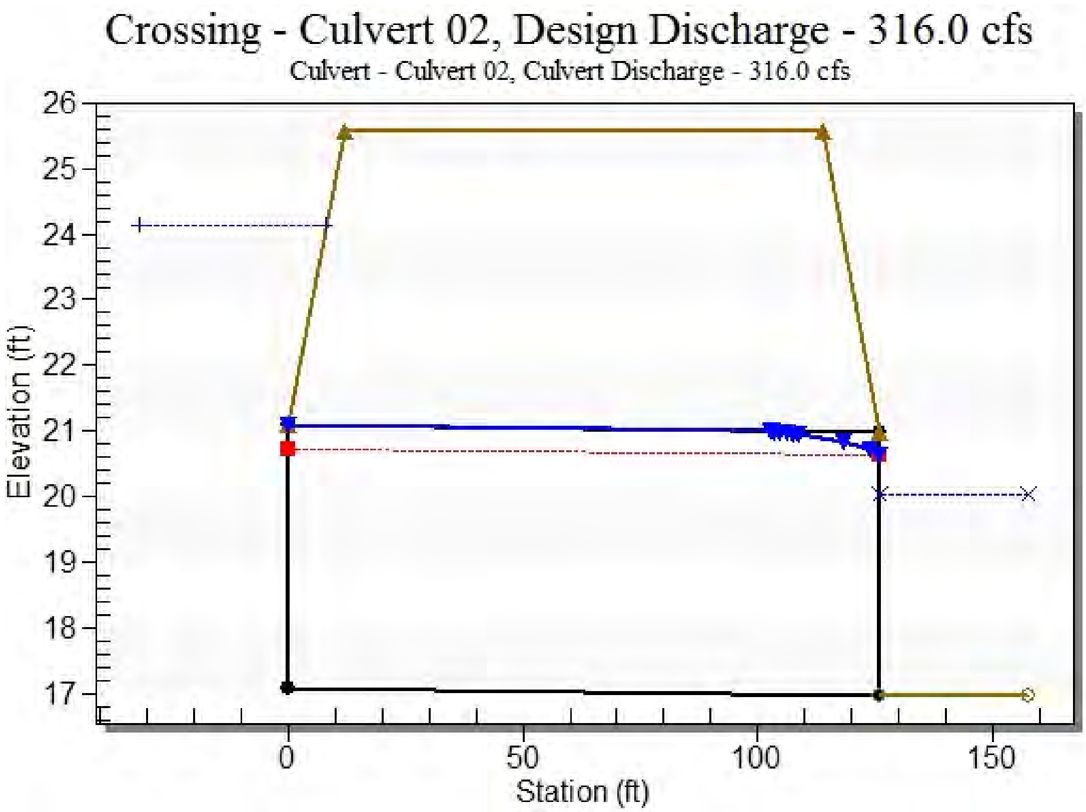
Culvert Length: 126.00 ft, Culvert Slope: 0.0008

****

Culvert Performance Curve Plot: Culvert 02



Water Surface Profile Plot for Culvert: Culvert 02



Site Data - Culvert 02

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 17.08 ft

Outlet Station: 126.00 ft

Outlet Elevation: 16.98 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 02

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 02)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
207.00	19.19	2.21
233.30	19.40	2.42
259.60	19.60	2.62
285.90	19.80	2.82
312.20	20.00	3.02
316.00	20.02	3.04
364.80	21.06	4.08
391.10	21.06	4.08
417.40	21.06	4.08
443.70	21.06	4.08
470.00	21.06	4.08

Tailwater Channel Data - Culvert 02

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 02

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 200.00 ft

Crest Elevation: 25.58 ft

Roadway Surface: Paved

Roadway Top Width: 102.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 2 ALT.

Table 1 - Summary of Culvert Flows at Crossing: Culvert 02 Alt. - (2) 6x4

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 02 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
19.51	100.00	100.00	0.00	1
20.31	170.40	170.40	0.00	1
21.10	240.80	240.80	0.00	1
21.84	311.20	311.20	0.00	1
22.73	381.60	381.60	0.00	1
23.77	452.00	452.00	0.00	1
23.78	453.00	453.00	0.00	1
25.72	592.80	561.84	30.86	6
25.87	663.20	569.36	93.44	6
25.99	733.60	575.22	158.00	5
26.09	804.00	580.34	222.95	4
25.58	554.73	554.73	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 02 Alt. - (2) 6x4

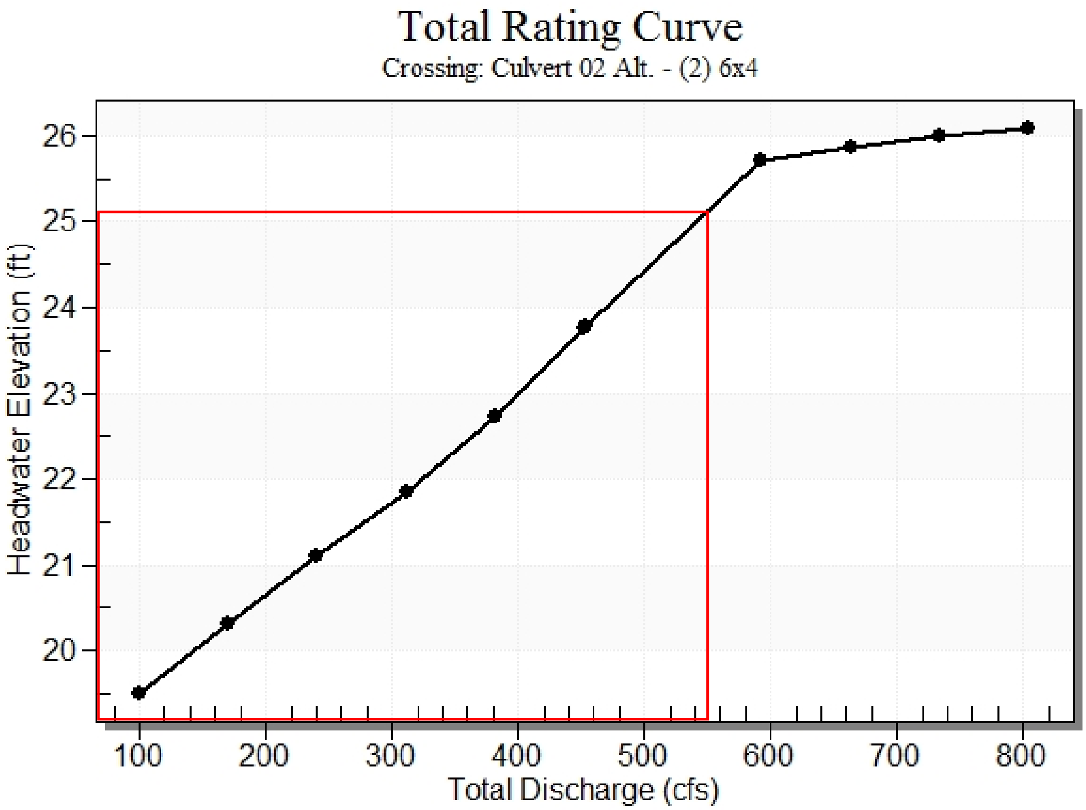


Table 2 - Culvert Summary Table: Culvert 02

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)
100.00	100.00	19.51	2.209	2.432	3-M2t	2.077	1.295	2.040	2.040	4.085	0.000
170.40	170.40	20.31	3.120	3.228	3-M2t	3.074	1.847	2.220	2.220	6.396	0.000
240.80	240.80	21.10	3.935	4.023	3-M2t	4.000	2.326	2.420	2.420	8.292	0.000
311.20	311.20	21.84	4.755	4.764	2-M2c	4.000	2.760	2.753	2.620	9.422	0.000
381.60	381.60	22.73	5.654	5.453	2-M2c	4.000	3.162	3.152	2.820	10.088	0.000
452.00	452.00	23.77	6.687	6.408	7-M2c	4.000	3.540	3.531	3.040	10.668	0.000
453.00	453.00	23.78	6.703	6.422	7-M2c	4.000	3.545	3.536	3.040	10.676	0.000
592.80	561.84	25.72	8.640	8.049	4-FFf	4.000	4.000	4.000	4.080	11.705	0.000
663.20	569.36	25.87	8.790	8.159	4-FFf	4.000	4.000	4.000	4.080	11.862	0.000
733.60	575.22	25.99	8.909	8.245	4-FFf	4.000	4.000	4.000	4.080	11.984	0.000
804.00	580.34	26.09	9.014	8.321	4-FFf	4.000	4.000	4.000	4.080	12.091	0.000

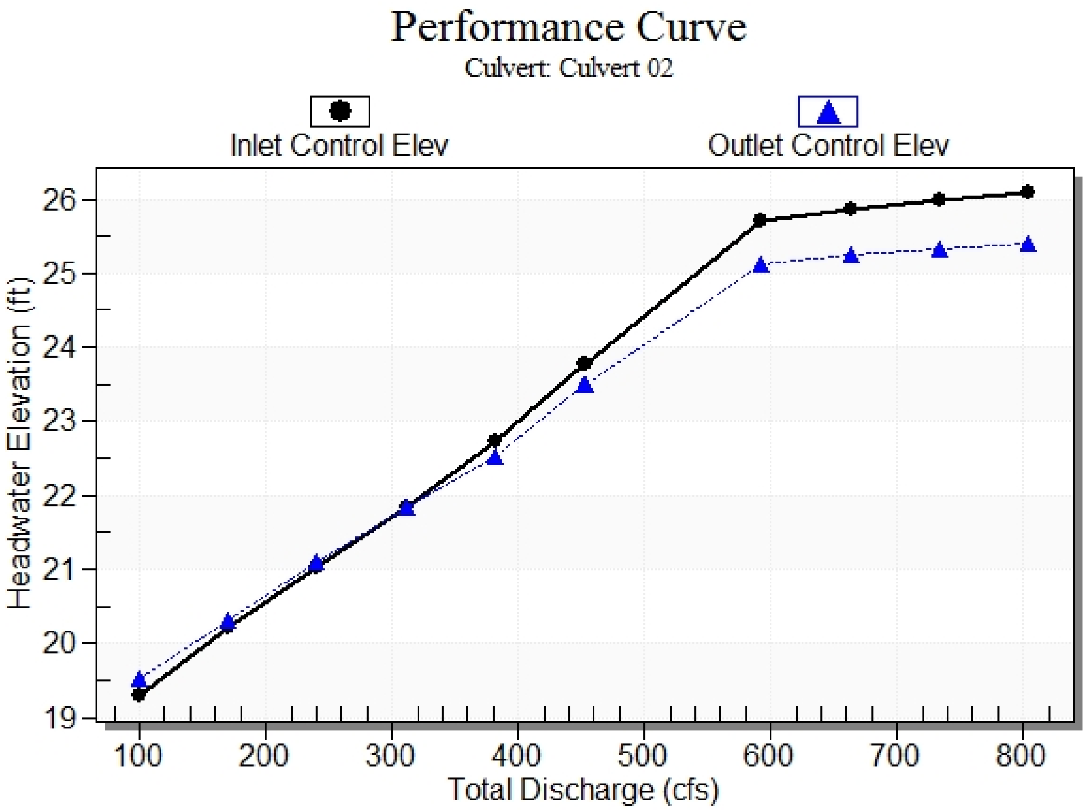
****

Inlet Elevation (invert): 17.08 ft, Outlet Elevation (invert): 16.98 ft

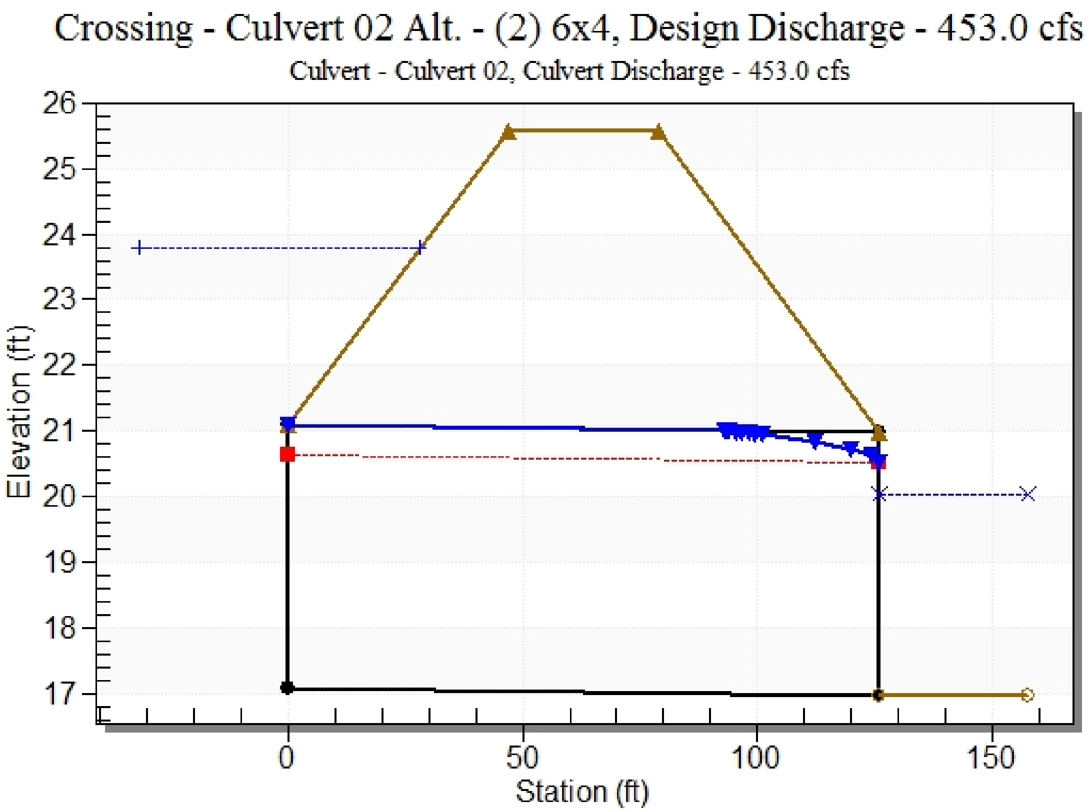
Culvert Length: 126.00 ft, Culvert Slope: 0.0008

****

Culvert Performance Curve Plot: Culvert 02



Water Surface Profile Plot for Culvert: Culvert 02



Site Data - Culvert 02

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 17.08 ft

Outlet Station: 126.00 ft

Outlet Elevation: 16.98 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 02

Barrel Shape: Concrete Box

Barrel Span: 6.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 02 Alt. - (2) 6x4)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
100.00	19.02	2.04
170.40	19.20	2.22
240.80	19.40	2.42
311.20	19.60	2.62
381.60	19.80	2.82
452.00	20.02	3.04
453.00	20.02	3.04
592.80	21.06	4.08
663.20	21.06	4.08
733.60	21.06	4.08
804.00	21.06	4.08

Tailwater Channel Data - Culvert 02 Alt. - (2) 6x4

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 02 Alt. - (2) 6x4

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 200.00 ft

Crest Elevation: 25.58 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 3

Table 1 - Summary of Culvert Flows at Crossing: Culvert 03 - (2) 8x4

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 03 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
18.19	105.00	105.00	0.00	1
18.54	179.60	179.60	0.00	1
19.04	254.20	254.20	0.00	1
19.66	328.80	328.80	0.00	1
20.24	403.40	403.40	0.00	1
20.93	478.00	478.00	0.00	1
21.71	552.60	552.60	0.00	1
22.57	627.20	627.20	0.00	1
23.55	701.80	701.80	0.00	1
24.14	776.40	743.45	32.29	9
24.28	851.00	752.49	97.98	6
24.02	734.95	734.95	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 03 - (2) 8x4

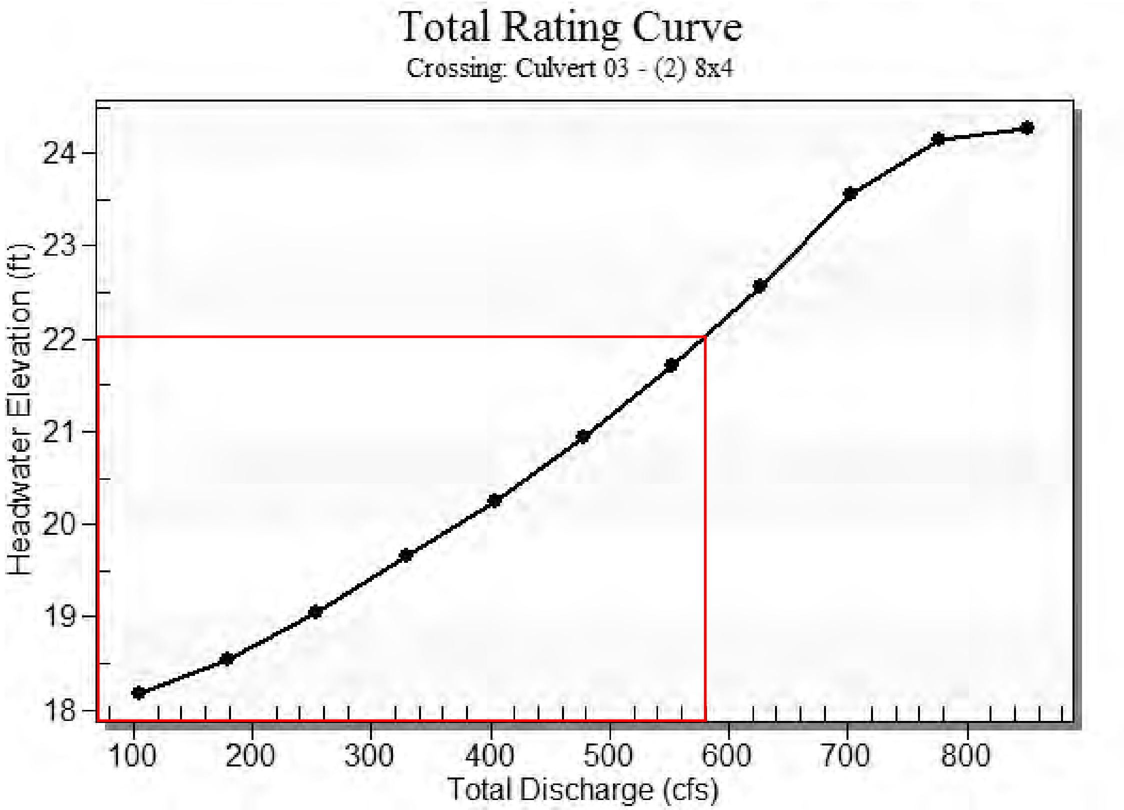


Table 2 - Culvert Summary Table: Culvert 03

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)
105.00	105.00	18.19	1.893	2.596	3-M1t	1.303	1.104	2.620	2.620	2.505	0.000
179.60	179.60	18.54	2.676	2.947	3-M1t	1.877	1.579	2.620	2.620	4.284	0.000
254.20	254.20	19.04	3.358	3.454	3-M1t	2.395	1.991	2.620	2.620	6.064	0.000
328.80	328.80	19.66	3.999	4.071	7-M1t	2.877	2.363	2.920	2.920	7.038	0.000
403.40	403.40	20.24	4.649	4.653	3-M2t	3.338	2.708	3.220	3.220	7.830	0.000
478.00	478.00	20.93	5.345	5.206	3-M2t	4.000	3.033	3.520	3.520	8.487	0.000
552.60	552.60	21.71	6.115	5.727	3-M2t	4.000	3.341	3.720	3.720	9.284	0.000
627.20	627.20	22.57	6.982	6.464	7-M2t	4.000	3.635	3.820	3.820	10.262	0.000
701.80	701.80	23.55	7.958	7.253	7-M2t	4.000	3.918	3.920	3.920	11.189	0.000
776.40	743.45	24.14	8.554	7.704	4-FFf	4.000	4.000	4.000	4.020	11.616	0.000
851.00	752.49	24.28	8.689	8.000	4-FFf	4.000	4.000	4.000	4.220	11.758	0.000

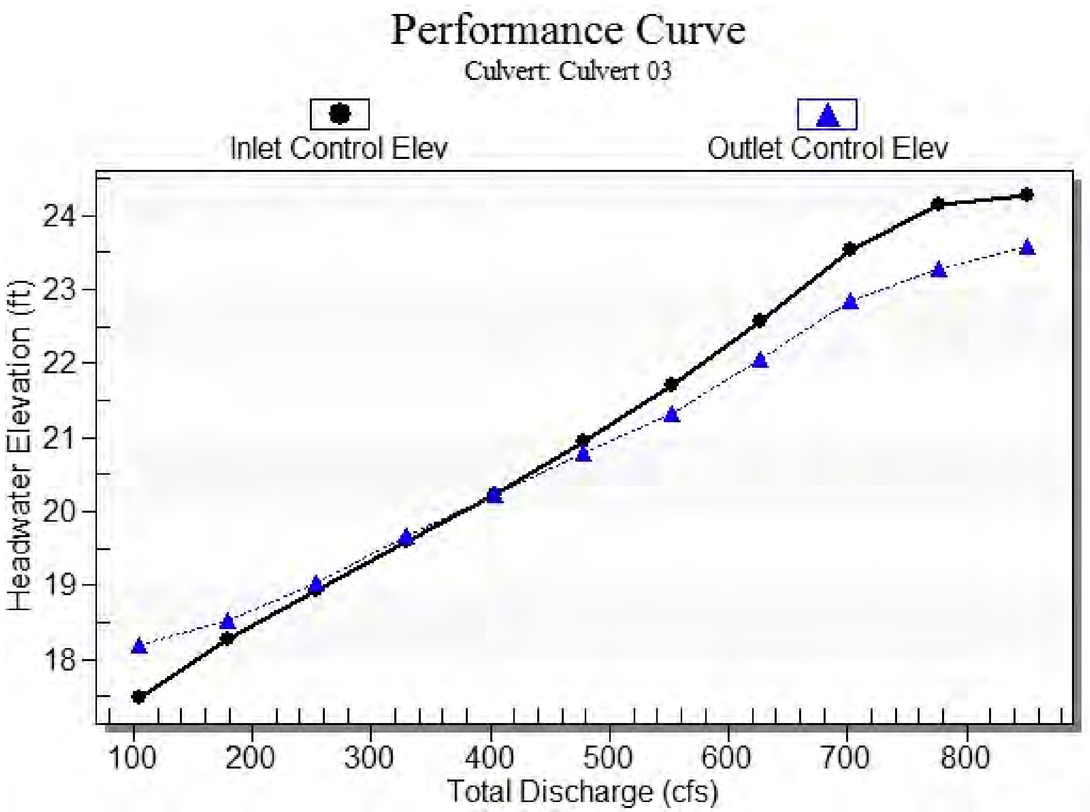
****

Inlet Elevation (invert): 15.59 ft, Outlet Elevation (invert): 15.38 ft

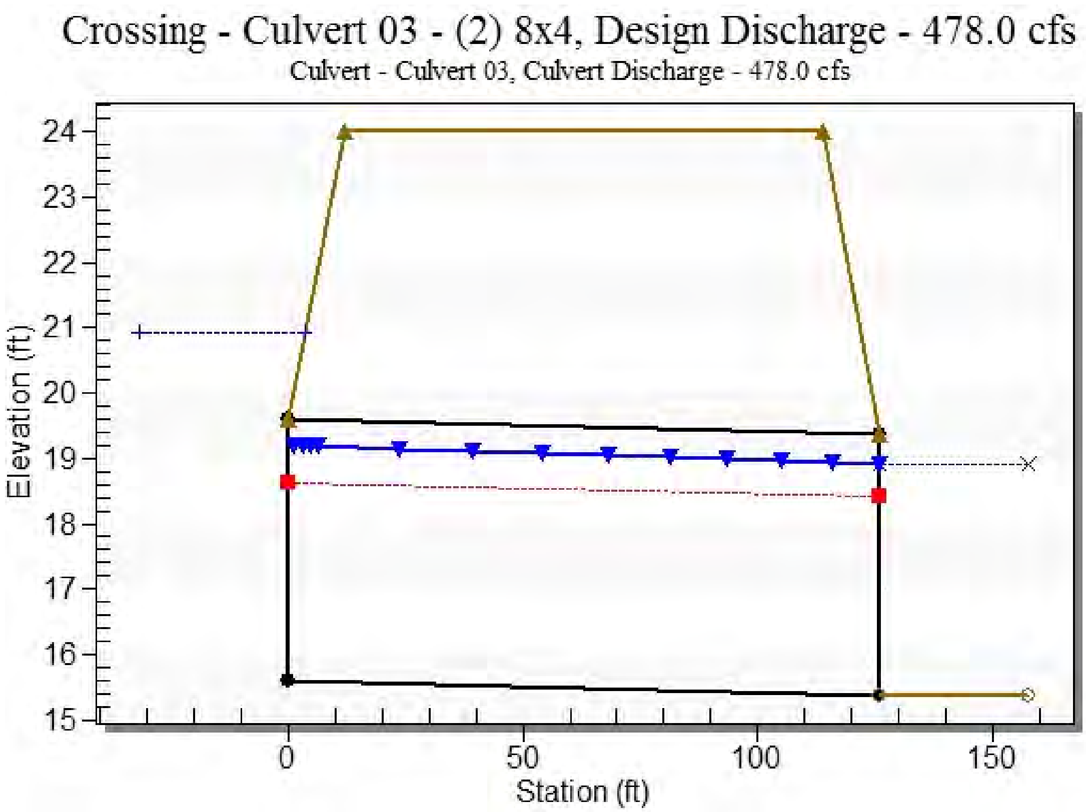
Culvert Length: 126.00 ft, Culvert Slope: 0.0017

****

Culvert Performance Curve Plot: Culvert 03



Water Surface Profile Plot for Culvert: Culvert 03



Site Data - Culvert 03

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 15.59 ft

Outlet Station: 126.00 ft

Outlet Elevation: 15.38 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 03

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 03 - (2) 8x4)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
105.00	18.00	2.62
179.60	18.00	2.62
254.20	18.00	2.62
328.80	18.30	2.92
403.40	18.60	3.22
478.00	18.90	3.52
552.60	19.10	3.72
627.20	19.20	3.82
701.80	19.30	3.92
776.40	19.40	4.02
851.00	19.60	4.22

Tailwater Channel Data - Culvert 03 - (2) 8x4

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 03 - (2) 8x4

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 24.02 ft

Roadway Surface: Paved

Roadway Top Width: 102.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 3 ALT

Table 1 - Summary of Culvert Flows at Crossing: Culvert 03 Alt - 10x3

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 03 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
18.42	105.00	105.00	0.00	1
18.65	126.60	126.60	0.00	1
18.91	148.20	148.20	0.00	1
19.24	169.80	169.80	0.00	1
19.82	191.40	191.40	0.00	1
20.31	213.00	213.00	0.00	1
20.49	218.00	218.00	0.00	1
21.39	256.20	256.20	0.00	1
21.88	277.80	277.80	0.00	1
22.39	299.40	299.40	0.00	1
23.04	321.00	321.00	0.00	1
24.02	360.43	360.43	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 03 Alt - 10x3

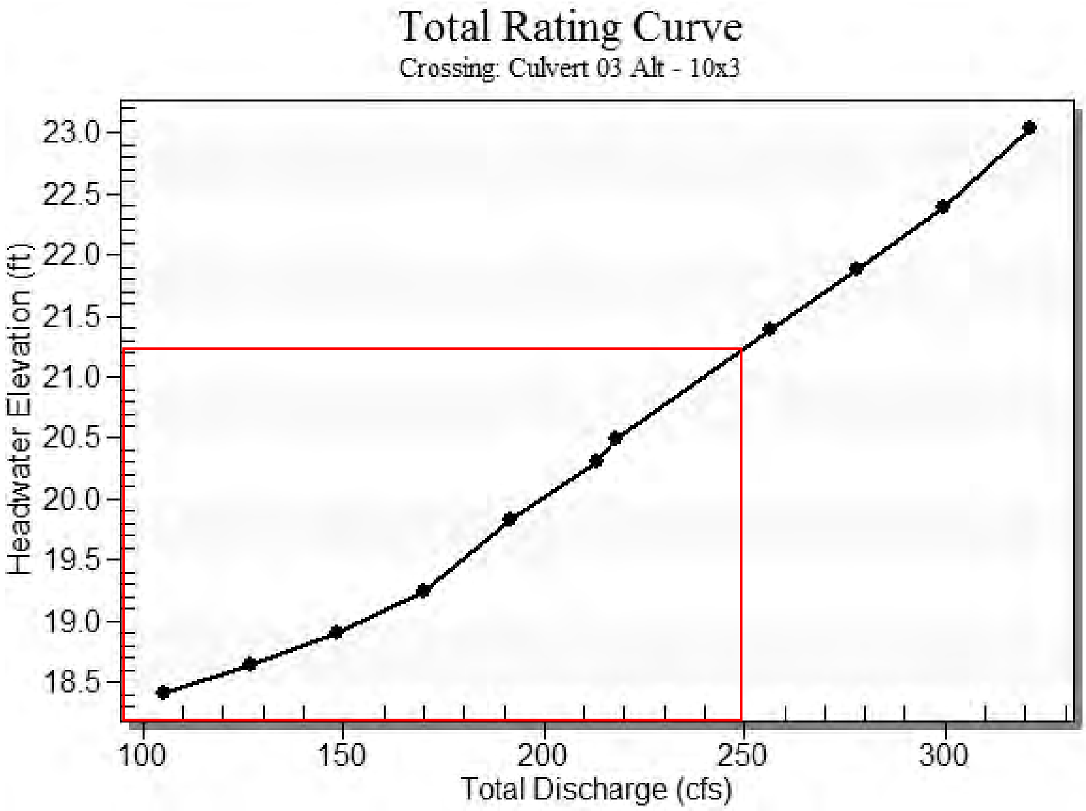


Table 2 - Culvert Summary Table: Culvert 03

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)
105.00	105.00	18.42	2.548	2.832	3-M1t	1.744	1.510	2.550	2.500	4.118	0.000
126.60	126.60	18.65	2.891	3.057	7-M1t	1.978	1.711	2.570	2.520	4.926	0.000
148.20	148.20	18.91	3.234	3.318	7-M1t	2.202	1.901	2.620	2.570	5.656	0.000
169.80	169.80	19.24	3.587	3.654	7-M1t	2.419	2.081	2.920	2.870	5.815	0.000
191.40	191.40	19.82	3.961	4.233	4-FFf	2.628	2.254	3.000	3.170	6.380	0.000
213.00	213.00	20.31	4.363	4.724	4-FFf	3.000	2.420	3.000	3.370	7.100	0.000
218.00	218.00	20.49	4.460	4.896	4-FFf	3.000	2.458	3.000	3.470	7.267	0.000
256.20	256.20	21.39	5.273	5.801	4-FFf	3.000	2.738	3.000	3.770	8.540	0.000
277.80	277.80	21.88	5.789	6.286	4-FFf	3.000	2.889	3.000	3.870	9.260	0.000
299.40	299.40	22.39	6.350	6.802	4-FFf	3.000	3.000	3.000	3.970	9.980	0.000
321.00	321.00	23.04	6.957	7.450	4-FFf	3.000	3.000	3.000	4.170	10.700	0.000

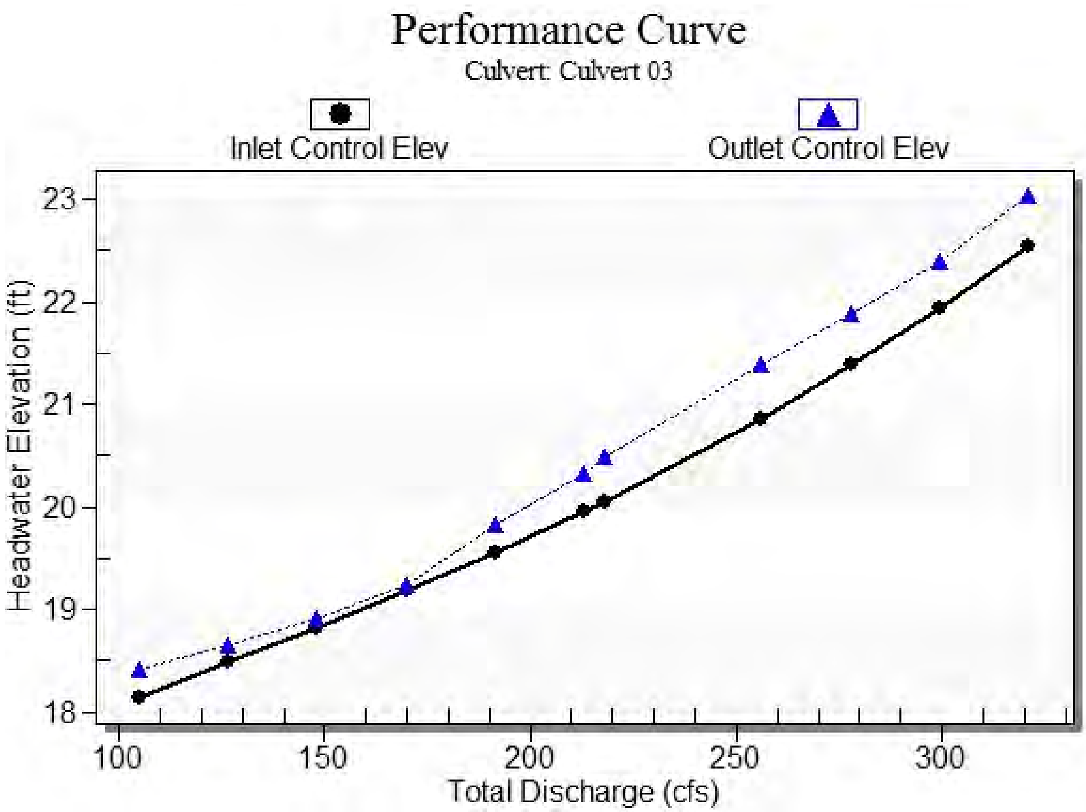
****

Inlet Elevation (invert): 15.59 ft, Outlet Elevation (invert): 15.38 ft

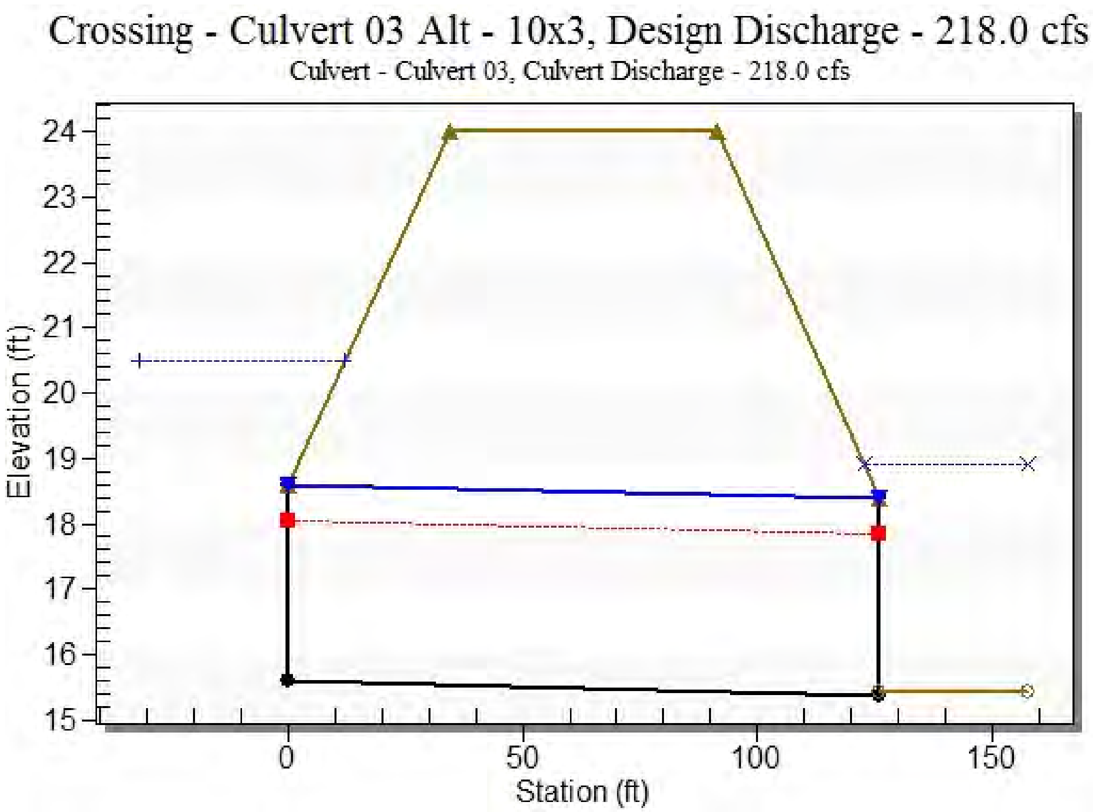
Culvert Length: 126.00 ft, Culvert Slope: 0.0017

****

Culvert Performance Curve Plot: Culvert 03



Water Surface Profile Plot for Culvert: Culvert 03



Site Data - Culvert 03

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 15.59 ft

Outlet Station: 126.00 ft

Outlet Elevation: 15.38 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 03

Barrel Shape: Concrete Box

Barrel Span: 10.00 ft

Barrel Rise: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 03 Alt - 10x3)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
105.00	17.93	2.50
126.60	17.95	2.52
148.20	18.00	2.57
169.80	18.30	2.87
191.40	18.60	3.17
213.00	18.80	3.37
218.00	18.90	3.47
256.20	19.20	3.77
277.80	19.30	3.87
299.40	19.40	3.97
321.00	19.60	4.17

Tailwater Channel Data - Culvert 03 Alt - 10x3

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 03 Alt - 10x3

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 24.02 ft

Roadway Surface: Paved

Roadway Top Width: 57.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 4

Table 1 - Summary of Culvert Flows at Crossing: Culvert 04 - 30" RCP

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 04 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
18.34	15.00	15.00	0.00	1
18.42	16.50	16.50	0.00	1
18.50	18.00	18.00	0.00	1
18.88	19.50	19.50	0.00	1
19.21	20.00	20.00	0.00	1
19.67	22.50	22.50	0.00	1
19.98	24.00	24.00	0.00	1
20.20	25.50	25.50	0.00	1
20.42	27.00	27.00	0.00	1
20.64	28.50	28.50	0.00	1
20.98	30.00	30.00	0.00	1
24.66	50.00	50.00	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 04 - 30" RCP

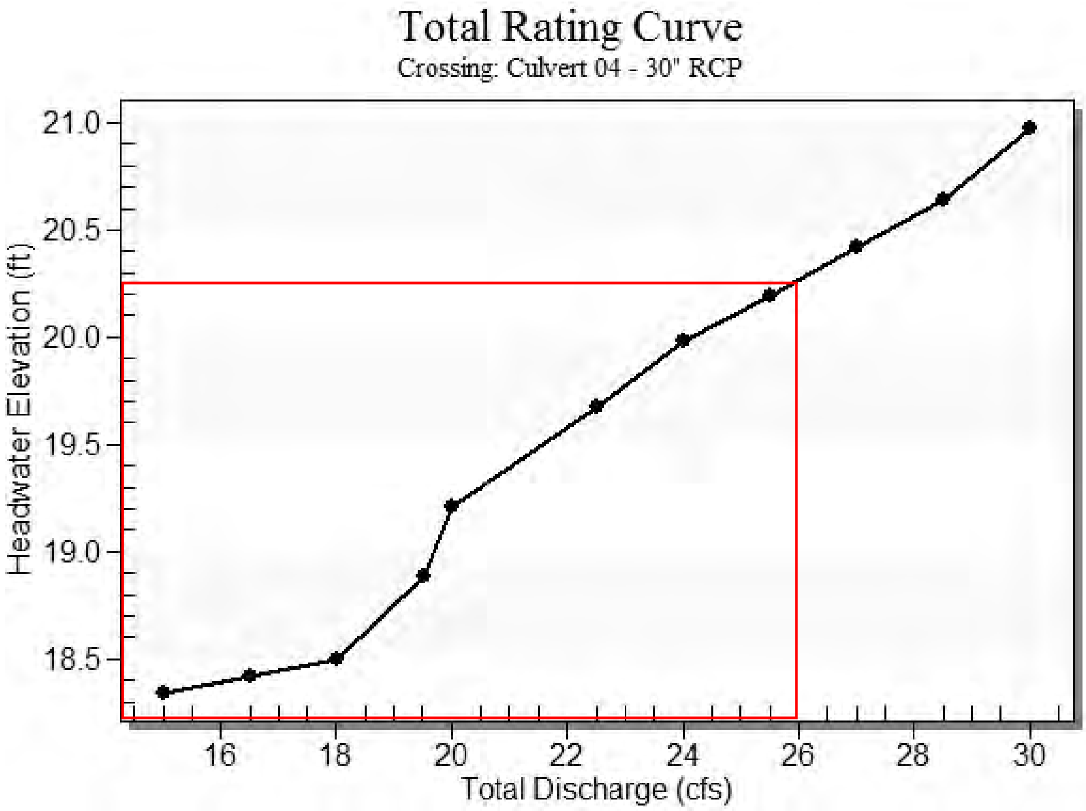


Table 2 - Culvert Summary Table: Culvert 04

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)
15.00	15.00	18.34	1.939	2.624	4-FFf	1.633	1.302	2.500	2.570	3.056	0.000
16.50	16.50	18.42	2.056	2.697	4-FFf	1.748	1.367	2.500	2.570	3.361	0.000
18.00	18.00	18.50	2.171	2.776	4-FFf	1.884	1.433	2.500	2.570	3.667	0.000
19.50	19.50	18.88	2.285	3.162	4-FFf	2.030	1.498	2.500	2.870	3.973	0.000
20.00	20.00	19.21	2.324	3.492	4-FFf	2.102	1.516	2.500	3.170	4.074	0.000
22.50	22.50	19.67	2.517	3.955	4-FFf	2.500	1.608	2.500	3.470	4.584	0.000
24.00	24.00	19.98	2.637	4.262	4-FFf	2.500	1.663	2.500	3.670	4.889	0.000
25.50	25.50	20.20	2.761	4.475	4-FFf	2.500	1.718	2.500	3.770	5.195	0.000
27.00	27.00	20.42	2.890	4.696	4-FFf	2.500	1.769	2.500	3.870	5.500	0.000
28.50	28.50	20.64	3.024	4.923	4-FFf	2.500	1.815	2.500	3.970	5.806	0.000
30.00	30.00	20.98	3.165	5.258	4-FFf	2.500	1.860	2.500	4.170	6.112	0.000

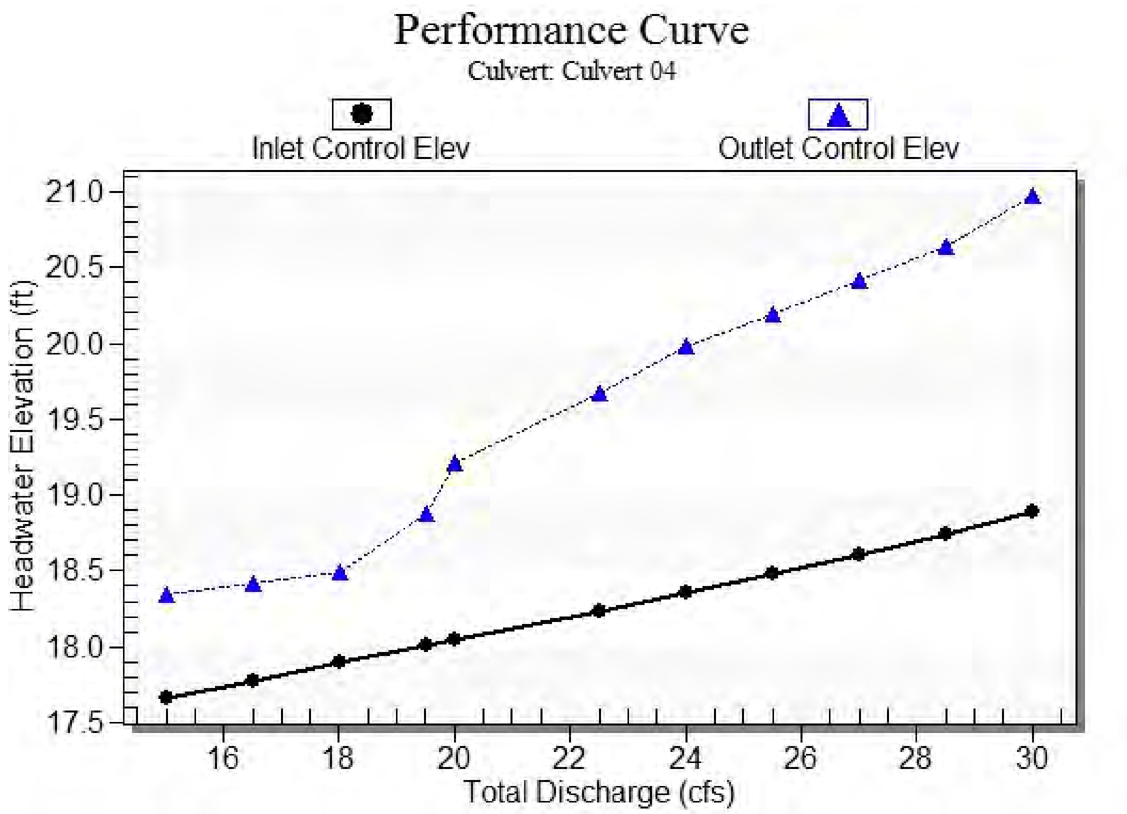
****

Inlet Elevation (invert): 15.72 ft, Outlet Elevation (invert): 15.50 ft

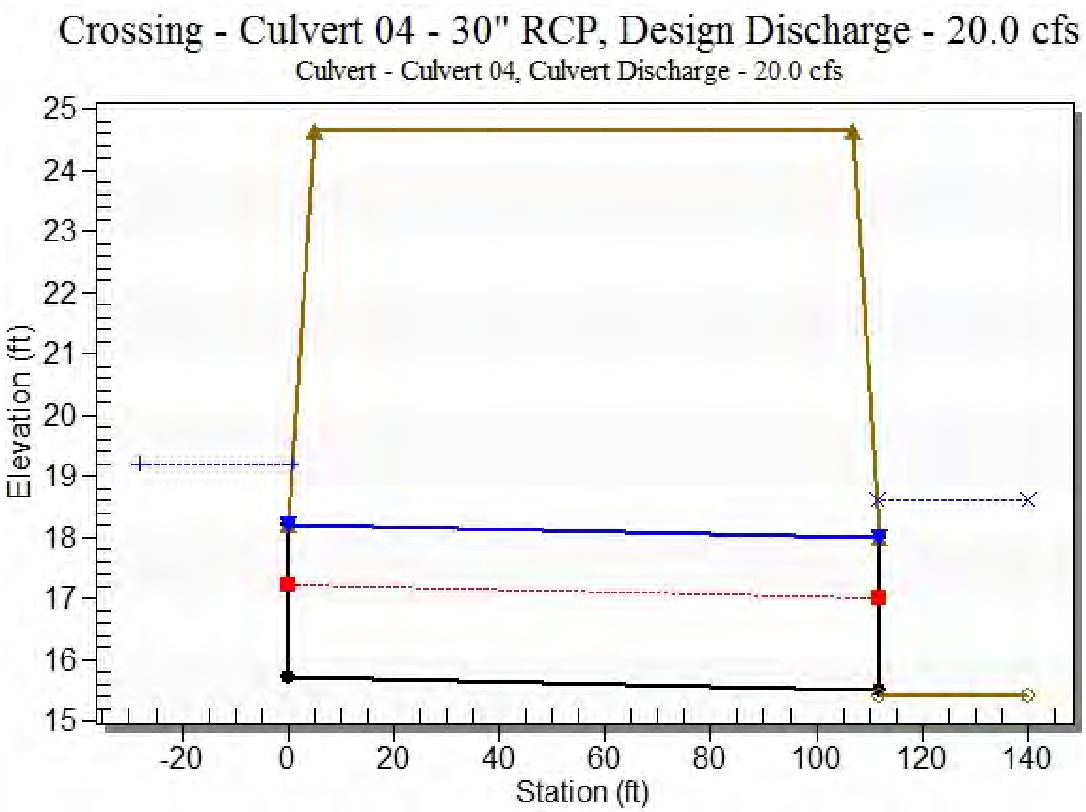
Culvert Length: 112.00 ft, Culvert Slope: 0.0020

****

Culvert Performance Curve Plot: Culvert 04



Water Surface Profile Plot for Culvert: Culvert 04



Site Data - Culvert 04

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 15.72 ft

Outlet Station: 112.00 ft

Outlet Elevation: 15.50 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 04

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 04 - 30" RCP)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
15.00	18.00	2.57
16.50	18.00	2.57
18.00	18.00	2.57
19.50	18.30	2.87
20.00	18.60	3.17
22.50	18.90	3.47
24.00	19.10	3.67
25.50	19.20	3.77
27.00	19.30	3.87
28.50	19.40	3.97
30.00	19.60	4.17

Tailwater Channel Data - Culvert 04 - 30" RCP

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 04 - 30" RCP

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 24.66 ft

Roadway Surface: Paved

Roadway Top Width: 102.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 5

Table 1 - Summary of Culvert Flows at Crossing: Culvert 05 - (2) 8x4

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 05 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
15.18	190.00	190.00	0.00	1
15.52	227.00	227.00	0.00	1
15.84	264.00	264.00	0.00	1
16.16	301.00	301.00	0.00	1
16.46	338.00	338.00	0.00	1
16.76	375.00	375.00	0.00	1
16.86	386.00	386.00	0.00	1
17.48	449.00	449.00	0.00	1
17.95	486.00	486.00	0.00	1
18.43	523.00	523.00	0.00	1
18.82	560.00	560.00	0.00	1
22.98	819.44	819.44	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 05 - (2) 8x4

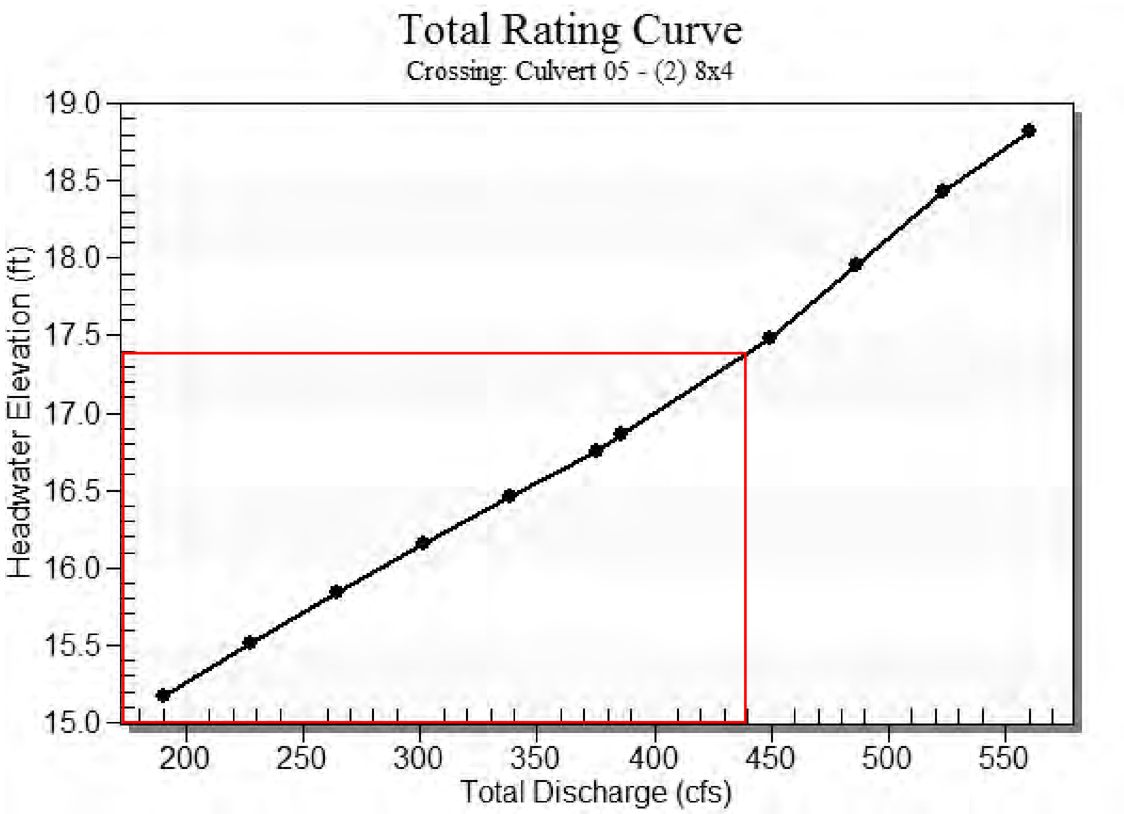


Table 2 - Culvert Summary Table: Culvert 05

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)
190.00	190.00	15.18	2.778	2.976	3-M2t	3.321	1.640	2.260	2.260	5.254	0.000
227.00	227.00	15.52	3.119	3.316	3-M2t	4.000	1.846	2.460	2.460	5.767	0.000
264.00	264.00	15.84	3.446	3.643	3-M2t	4.000	2.042	2.660	2.660	6.203	0.000
301.00	301.00	16.16	3.764	3.958	3-M2t	4.000	2.228	2.860	2.860	6.578	0.000
338.00	338.00	16.46	4.081	4.263	3-M2t	4.000	2.407	3.060	3.060	6.904	0.000
375.00	375.00	16.76	4.401	4.557	3-M2t	4.000	2.580	3.260	3.260	7.189	0.000
386.00	386.00	16.86	4.497	4.657	3-M2t	4.000	2.630	3.360	3.360	7.180	0.000
449.00	449.00	17.48	5.069	5.277	7-M2t	4.000	2.909	3.860	3.860	7.270	0.000
486.00	486.00	17.95	5.426	5.751	4-FFf	4.000	3.067	4.000	4.060	7.594	0.000
523.00	523.00	18.43	5.802	6.228	4-FFf	4.000	3.220	4.000	4.260	8.172	0.000
560.00	560.00	18.82	6.199	6.625	4-FFf	4.000	3.370	4.000	4.360	8.750	0.000

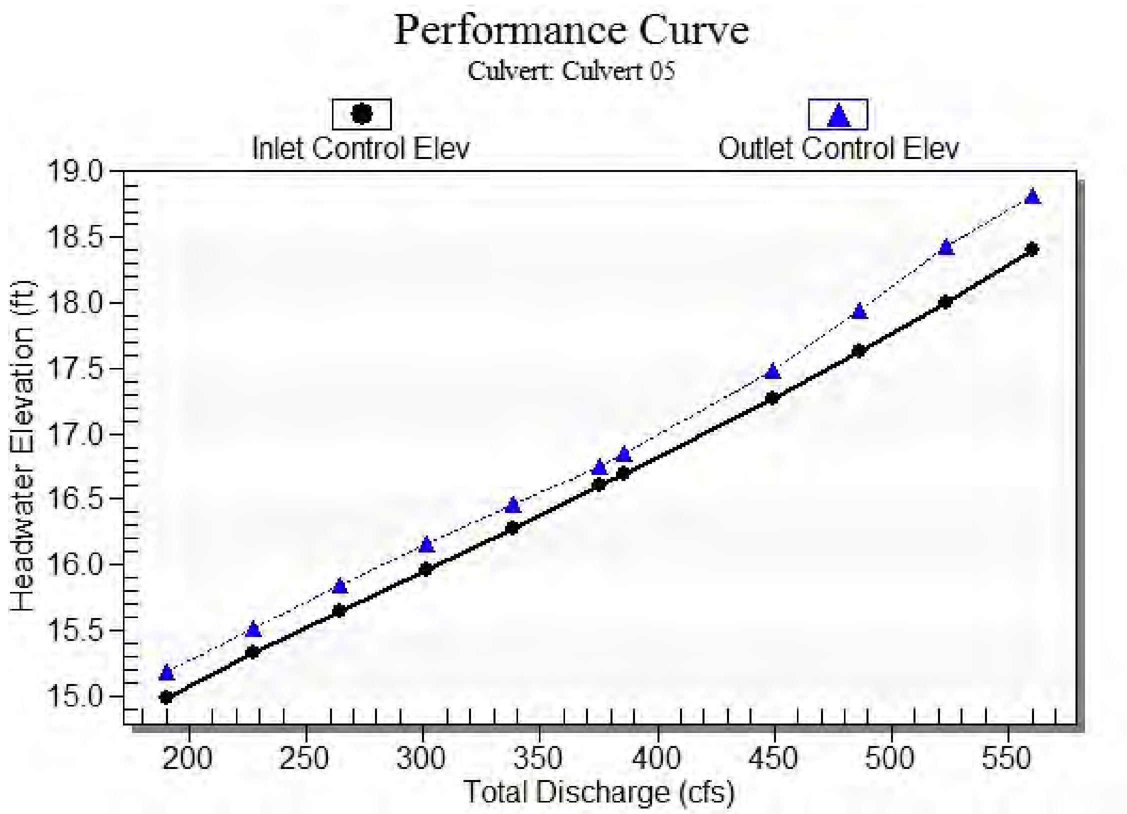
****

Inlet Elevation (invert): 12.20 ft, Outlet Elevation (invert): 12.14 ft

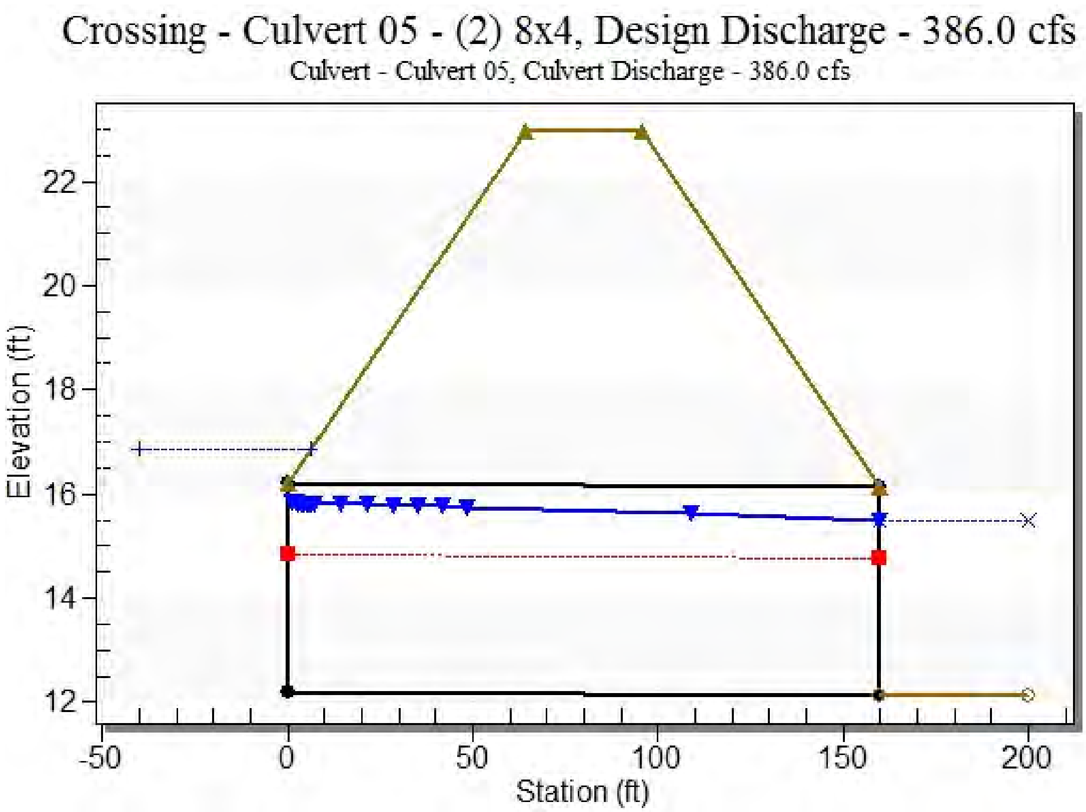
Culvert Length: 160.00 ft, Culvert Slope: 0.0004

****

Culvert Performance Curve Plot: Culvert 05



Water Surface Profile Plot for Culvert: Culvert 05



Site Data - Culvert 05

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 12.20 ft

Outlet Station: 160.00 ft

Outlet Elevation: 12.14 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 05

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 05 - (2) 8x4)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
190.00	14.40	2.26
227.00	14.60	2.46
264.00	14.80	2.66
301.00	15.00	2.86
338.00	15.20	3.06
375.00	15.40	3.26
386.00	15.50	3.36
449.00	16.00	3.86
486.00	16.20	4.06
523.00	16.40	4.26
560.00	16.50	4.36

Tailwater Channel Data - Culvert 05 - (2) 8x4

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 05 - (2) 8x4

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 200.00 ft

Crest Elevation: 22.98 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 6

Table 1 - Summary of Culvert Flows at Crossing: Culvert 06 - (2) 30" RCP

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 06 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
16.56	20.00	20.00	0.00	1
16.85	26.70	26.70	0.00	1
17.12	33.40	33.40	0.00	1
17.37	40.10	40.10	0.00	1
17.75	46.80	46.80	0.00	1
18.24	53.50	53.50	0.00	1
18.77	60.20	60.20	0.00	1
19.11	61.00	61.00	0.00	1
20.45	73.60	73.60	0.00	1
20.99	80.30	80.30	0.00	1
21.68	87.00	87.00	0.00	1
23.06	102.29	102.29	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 06 - (2) 30" RCP

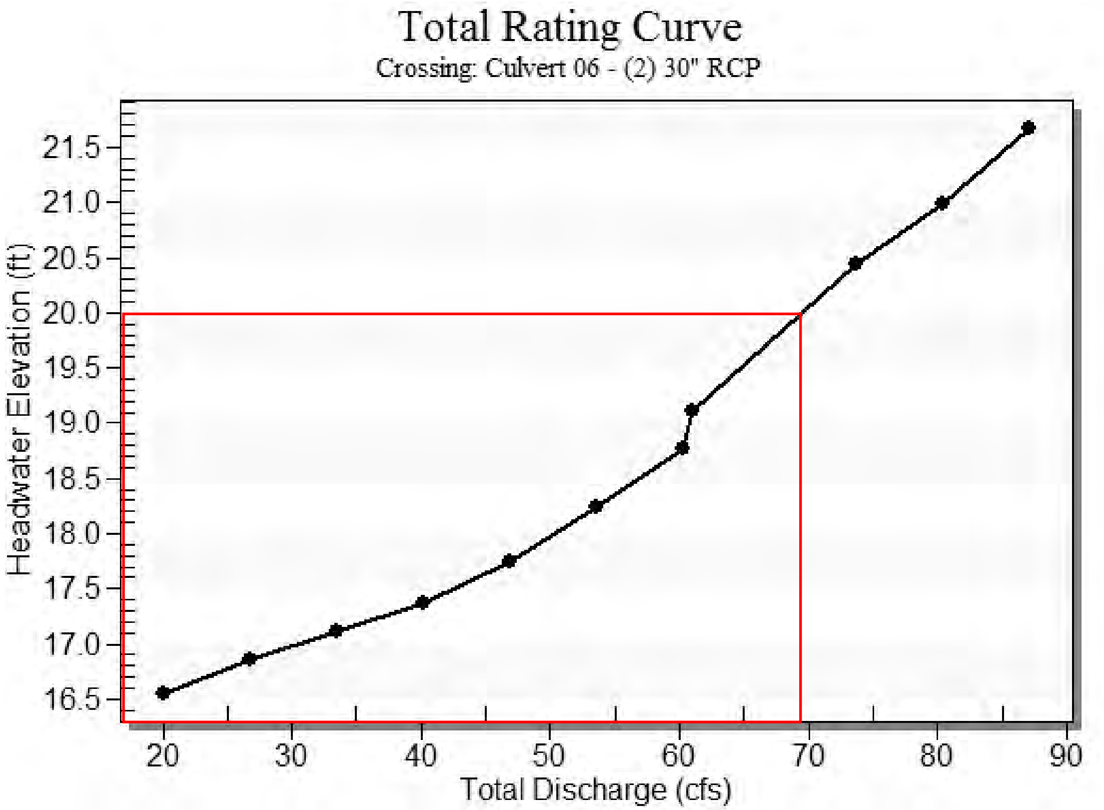


Table 2 - Culvert Summary Table: Culvert 06

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)
20.00	20.00	16.56	1.508	0.0*	1-S2n	0.994	1.052	0.994	1.740	5.497	0.000
26.70	26.70	16.85	1.803	0.0*	1-S2n	1.166	1.227	1.166	1.740	5.941	0.000
33.40	33.40	17.12	2.068	0.0*	1-S2n	1.332	1.376	1.335	1.740	6.265	0.000
40.10	40.10	17.37	2.324	0.0*	1-S2n	1.495	1.518	1.497	2.040	6.534	0.000
46.80	46.80	17.75	2.586	2.703	7-M1t	1.664	1.641	2.340	2.340	4.899	0.000
53.50	53.50	18.24	2.865	3.189	4-FFf	1.847	1.762	2.500	2.640	5.449	0.000
60.20	60.20	18.77	3.171	3.719	4-FFf	2.073	1.863	2.500	2.840	6.132	0.000
61.00	61.00	19.11	3.210	4.061	4-FFf	2.111	1.875	2.500	3.140	6.213	0.000
73.60	73.60	20.45	3.889	5.396	4-FFf	2.500	2.045	2.500	3.740	7.497	0.000
80.30	80.30	20.99	4.307	5.942	4-FFf	2.500	2.116	2.500	3.840	8.179	0.000
87.00	87.00	21.68	4.766	6.628	4-FFf	2.500	2.187	2.500	4.040	8.862	0.000

* theoretical depth is impractical.   Depth reported is corrected.

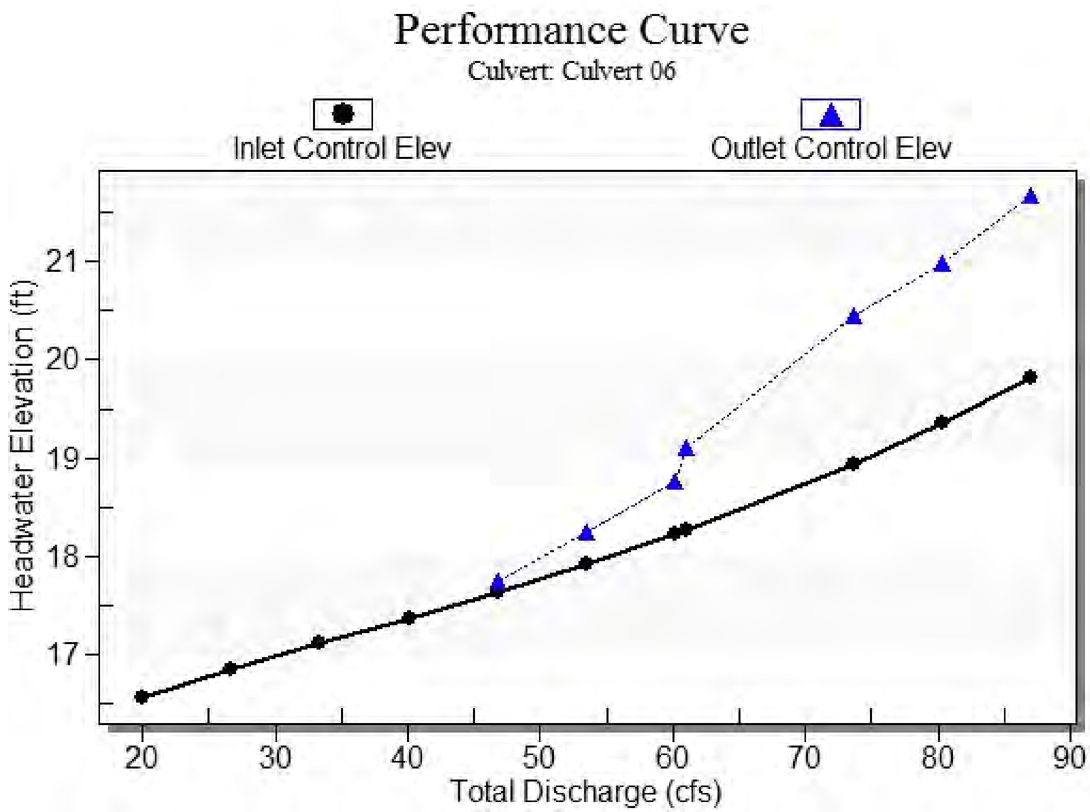
****

Inlet Elevation (invert): 15.05 ft,   Outlet Elevation (invert): 14.36 ft

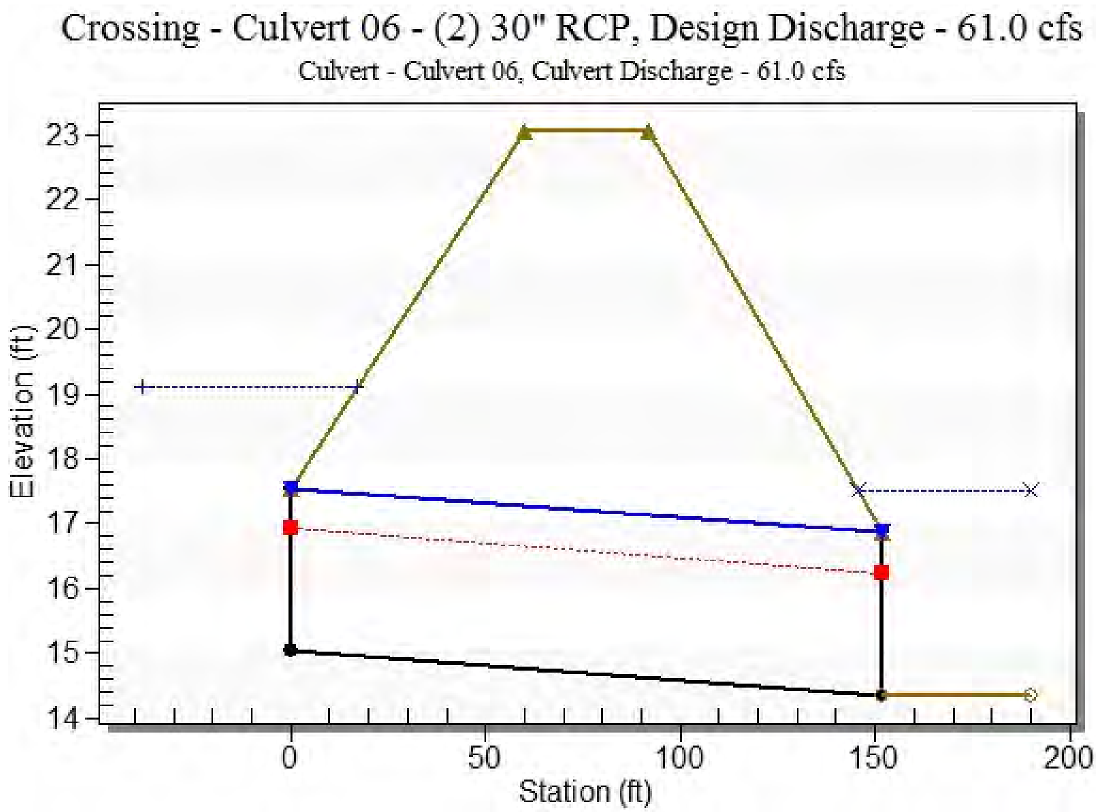
Culvert Length: 152.00 ft,   Culvert Slope: 0.0045

****

Culvert Performance Curve Plot: Culvert 06



Water Surface Profile Plot for Culvert: Culvert 06



Site Data - Culvert 06

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 15.05 ft

Outlet Station: 152.00 ft

Outlet Elevation: 14.36 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 06

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 06 - (2) 30" RCP)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
20.00	16.10	1.74
26.70	16.10	1.74
33.40	16.10	1.74
40.10	16.40	2.04
46.80	16.70	2.34
53.50	17.00	2.64
60.20	17.20	2.84
61.00	17.50	3.14
73.60	18.10	3.74
80.30	18.20	3.84
87.00	18.40	4.04

Tailwater Channel Data - Culvert 06 - (2) 30" RCP

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 06 - (2) 30" RCP

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 23.06 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 7

Table 1 - Summary of Culvert Flows at Crossing: Culvert 07 - (2) 6x4

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 07 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
18.68	250.00	250.00	0.00	1
19.21	307.20	307.20	0.00	1
19.92	364.40	364.40	0.00	1
20.72	421.60	421.60	0.00	1
21.46	469.00	469.00	0.00	1
22.64	536.00	536.00	0.00	1
23.66	593.20	587.38	5.15	8
23.80	650.40	594.08	55.66	7
23.90	707.60	598.72	108.00	5
23.98	764.80	602.63	161.83	5
24.05	822.00	606.07	215.31	4
23.62	585.60	585.60	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 07 - (2) 6x4

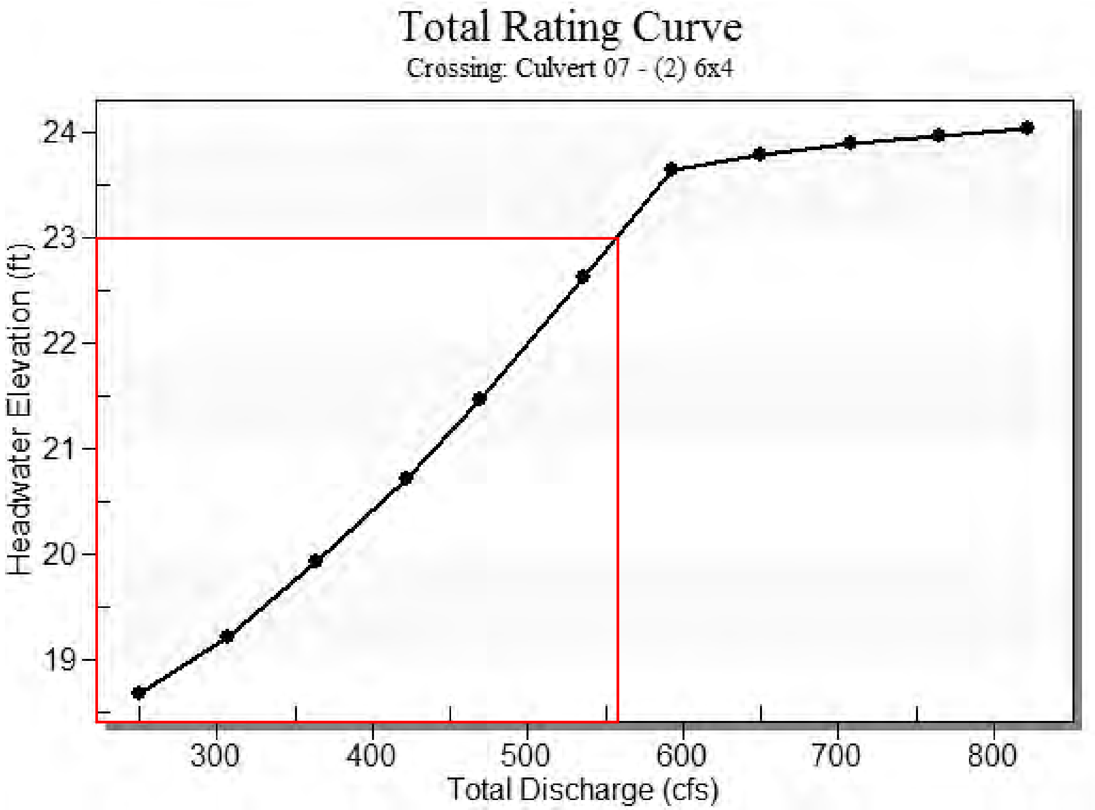


Table 2 - Culvert Summary Table: Culvert 07

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)
250.00	250.00	18.68	4.037	4.180	7-M1t	2.878	2.385	3.330	3.330	6.256	0.000
307.20	307.20	19.21	4.704	4.711	3-M2t	3.361	2.736	3.350	3.350	7.642	0.000
364.40	364.40	19.92	5.421	5.259	3-M2t	4.000	3.066	3.380	3.380	8.984	0.000
421.60	421.60	20.72	6.220	5.794	3-M2t	4.000	3.379	3.410	3.410	10.303	0.000
469.00	469.00	21.46	6.958	6.562	7-M2c	4.000	3.628	3.619	3.430	10.800	0.000
536.00	536.00	22.64	8.138	7.600	7-M2c	4.000	3.966	3.955	3.530	11.293	0.000
593.20	587.38	23.66	9.157	8.391	6-FFc	4.000	4.000	4.000	3.730	12.237	0.000
650.40	594.08	23.80	9.297	8.500	6-FFc	4.000	4.000	4.000	3.930	12.377	0.000
707.60	598.72	23.90	9.396	8.805	4-FFf	4.000	4.000	4.000	4.230	12.473	0.000
764.80	602.63	23.98	9.479	9.170	4-FFf	4.000	4.000	4.000	4.530	12.555	0.000
822.00	606.07	24.05	9.553	9.427	4-FFf	4.000	4.000	4.000	4.730	12.626	0.000

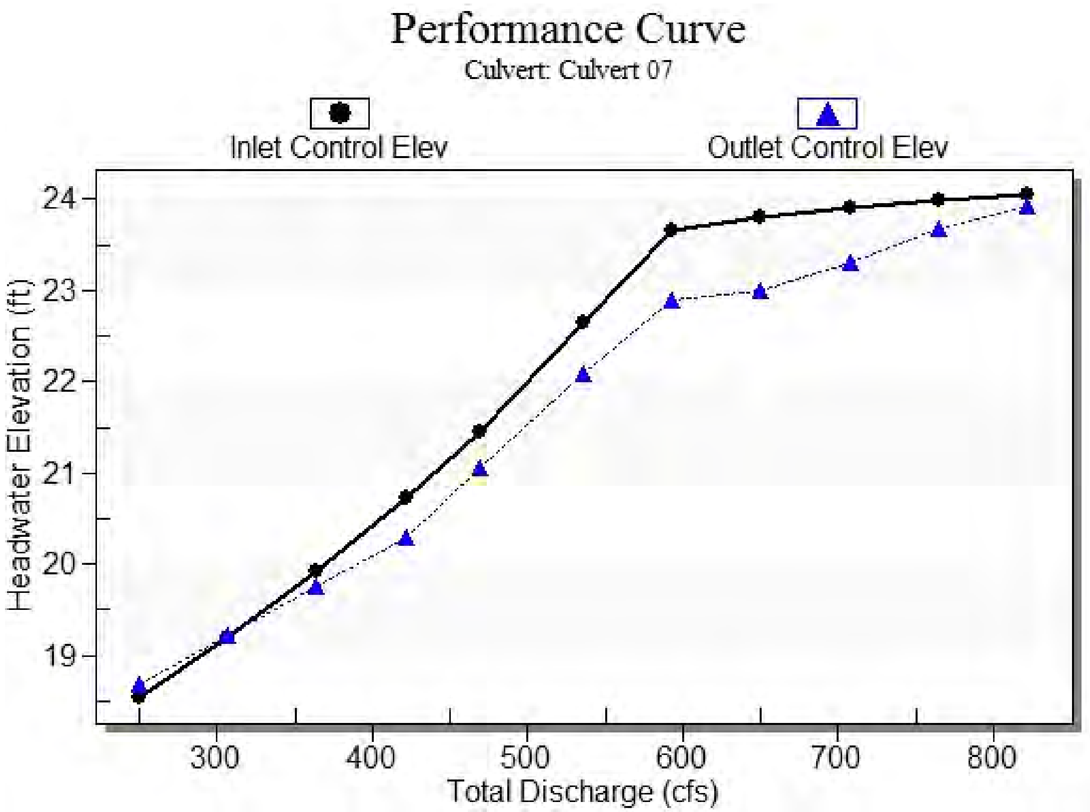
****

Inlet Elevation (invert): 14.50 ft, Outlet Elevation (invert): 14.17 ft

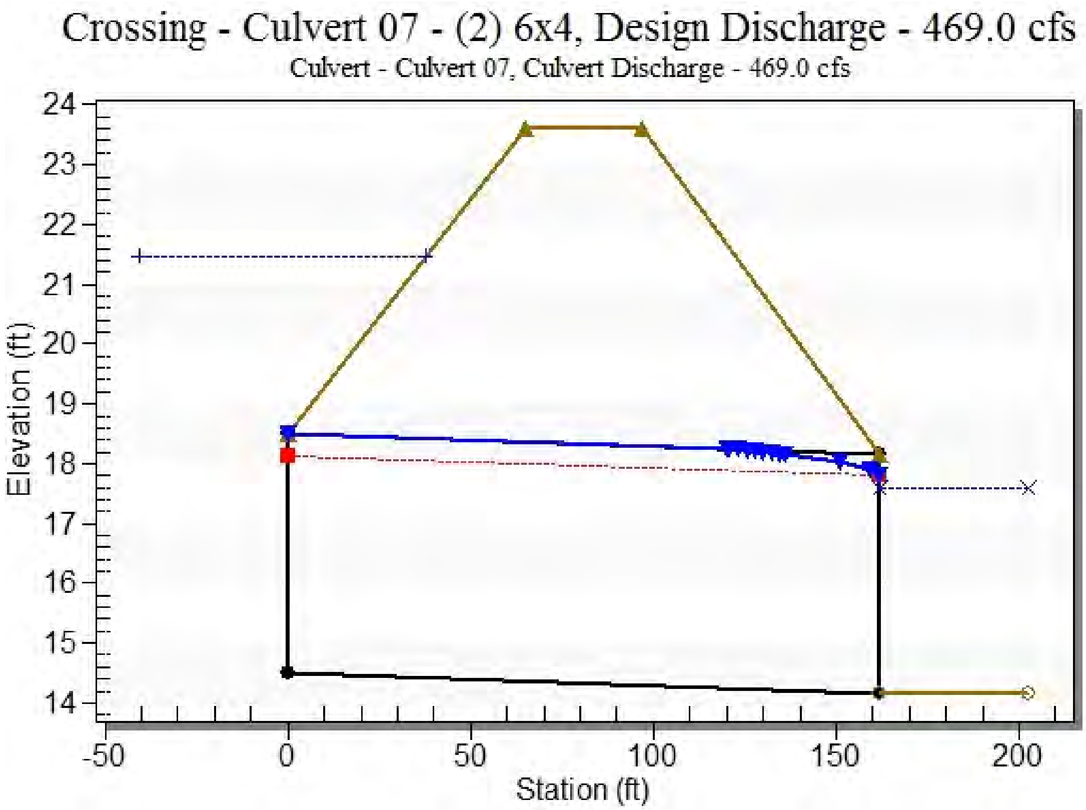
Culvert Length: 162.00 ft, Culvert Slope: 0.0020

****

Culvert Performance Curve Plot: Culvert 07



Water Surface Profile Plot for Culvert: Culvert 07



Site Data - Culvert 07

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 14.50 ft

Outlet Station: 162.00 ft

Outlet Elevation: 14.17 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 07

Barrel Shape: Concrete Box

Barrel Span: 6.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 07 - (2) 6x4)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
250.00	17.50	3.33
307.20	17.52	3.35
364.40	17.55	3.38
421.60	17.58	3.41
469.00	17.60	3.43
536.00	17.70	3.53
593.20	17.90	3.73
650.40	18.10	3.93
707.60	18.40	4.23
764.80	18.70	4.53
822.00	18.90	4.73

Tailwater Channel Data - Culvert 07 - (2) 6x4

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 07 - (2) 6x4

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 23.62 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 8

Table 1 - Summary of Culvert Flows at Crossing: Culvert 08 - (2) 36" RCP

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 08 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
18.72	20.00	20.00	0.00	1
19.18	32.10	32.10	0.00	1
19.58	44.20	44.20	0.00	1
19.96	56.30	56.30	0.00	1
20.33	68.40	68.40	0.00	1
20.70	80.50	80.50	0.00	1
21.14	92.60	92.60	0.00	1
21.42	99.00	99.00	0.00	1
22.26	116.80	116.80	0.00	1
22.89	128.90	128.90	0.00	1
23.54	141.00	141.00	0.00	1
25.65	171.39	171.39	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 08 - (2) 36" RCP

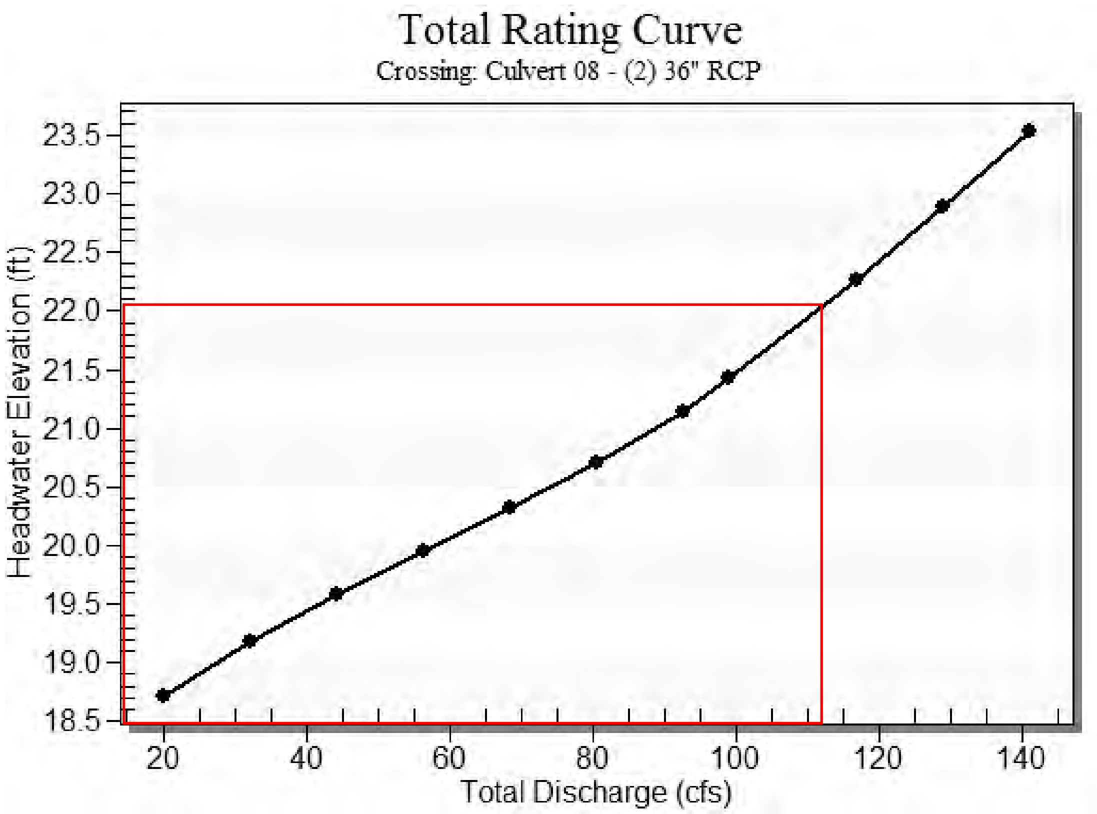


Table 2 - Culvert Summary Table: Culvert 08

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)
20.00	20.00	18.72	1.380	1.533	2-M2c	1.211	0.992	1.000	3.330	4.847	0.000
32.10	32.10	19.18	1.834	1.988	2-M2c	1.588	1.273	1.279	3.340	5.586	0.000
44.20	44.20	19.58	2.232	2.390	2-M2c	1.956	1.511	1.512	3.350	6.190	0.000
56.30	56.30	19.96	2.592	2.766	2-M2c	2.374	1.711	1.716	3.360	6.734	0.000
68.40	68.40	20.33	2.944	3.137	2-M2c	3.000	1.894	1.899	3.370	7.249	0.000
80.50	80.50	20.70	3.316	3.515	2-M2c	3.000	2.063	2.065	3.380	7.756	0.000
92.60	92.60	21.14	3.724	3.953	2-M2c	3.000	2.208	2.216	3.410	8.270	0.000
99.00	99.00	21.42	3.960	4.233	7-M2c	3.000	2.281	2.290	3.430	8.549	0.000
116.80	116.80	22.26	4.702	5.075	7-M2c	3.000	2.460	2.473	3.730	9.370	0.000
128.90	128.90	22.89	5.285	5.697	7-M2c	3.000	2.557	2.574	4.230	9.984	0.000
141.00	141.00	23.54	5.933	6.349	7-M2c	3.000	2.654	2.662	4.730	10.634	0.000

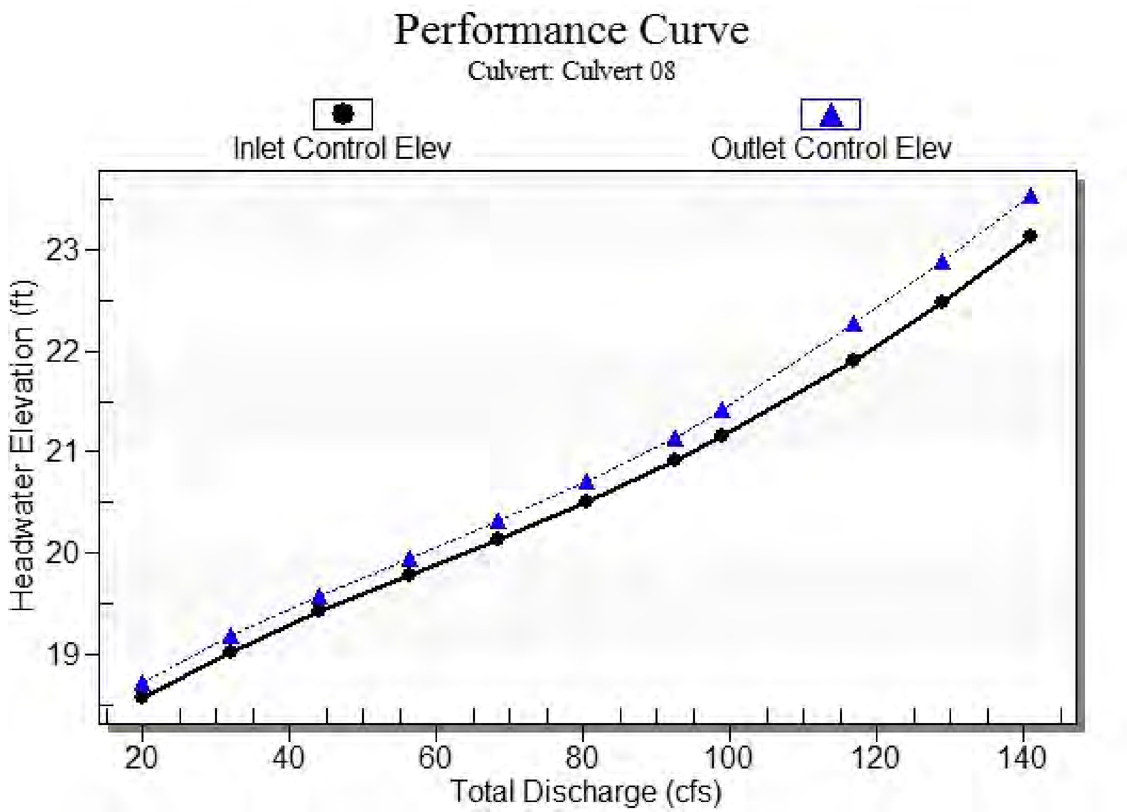
****

Inlet Elevation (invert): 17.19 ft, Outlet Elevation (invert): 16.95 ft

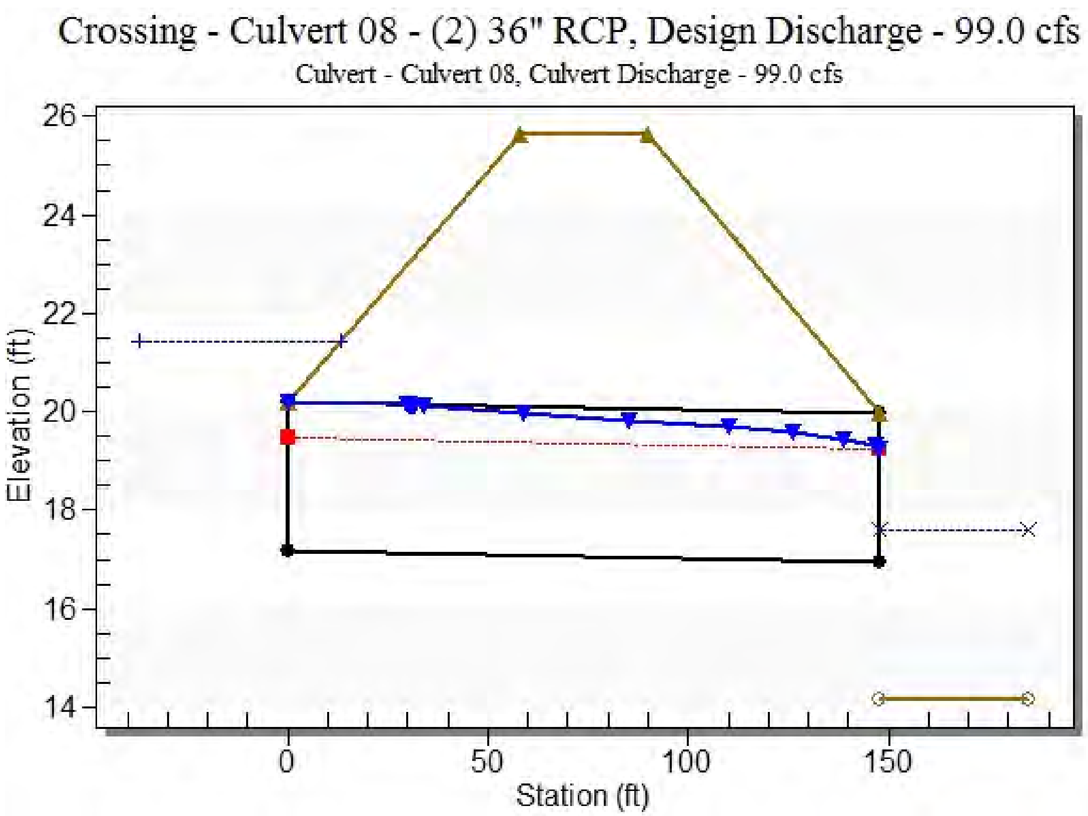
Culvert Length: 148.00 ft, Culvert Slope: 0.0016

****

Culvert Performance Curve Plot: Culvert 08



Water Surface Profile Plot for Culvert: Culvert 08



Site Data - Culvert 08

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 17.19 ft

Outlet Station: 148.00 ft

Outlet Elevation: 16.95 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 08

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 08 - (2) 36" RCP)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
20.00	17.50	3.33
32.10	17.51	3.34
44.20	17.52	3.35
56.30	17.53	3.36
68.40	17.54	3.37
80.50	17.55	3.38
92.60	17.58	3.41
99.00	17.60	3.43
116.80	17.90	3.73
128.90	18.40	4.23
141.00	18.90	4.73

Tailwater Channel Data - Culvert 08 - (2) 36" RCP

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 08 - (2) 36" RCP

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 25.65 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 9

Table 1 - Summary of Culvert Flows at Crossing: Culvert 09 - 10x5

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 09 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
17.26	215.00	215.00	0.00	1
17.72	260.20	260.20	0.00	1
18.22	305.40	305.40	0.00	1
18.73	350.60	350.60	0.00	1
19.06	376.00	376.00	0.00	1
19.95	441.00	441.00	0.00	1
20.64	486.20	486.20	0.00	1
21.38	531.40	531.40	0.00	1
22.19	576.60	576.60	0.00	1
23.06	621.80	621.80	0.00	1
24.01	667.00	667.00	0.00	1
25.01	711.43	711.43	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 09 - 10x5

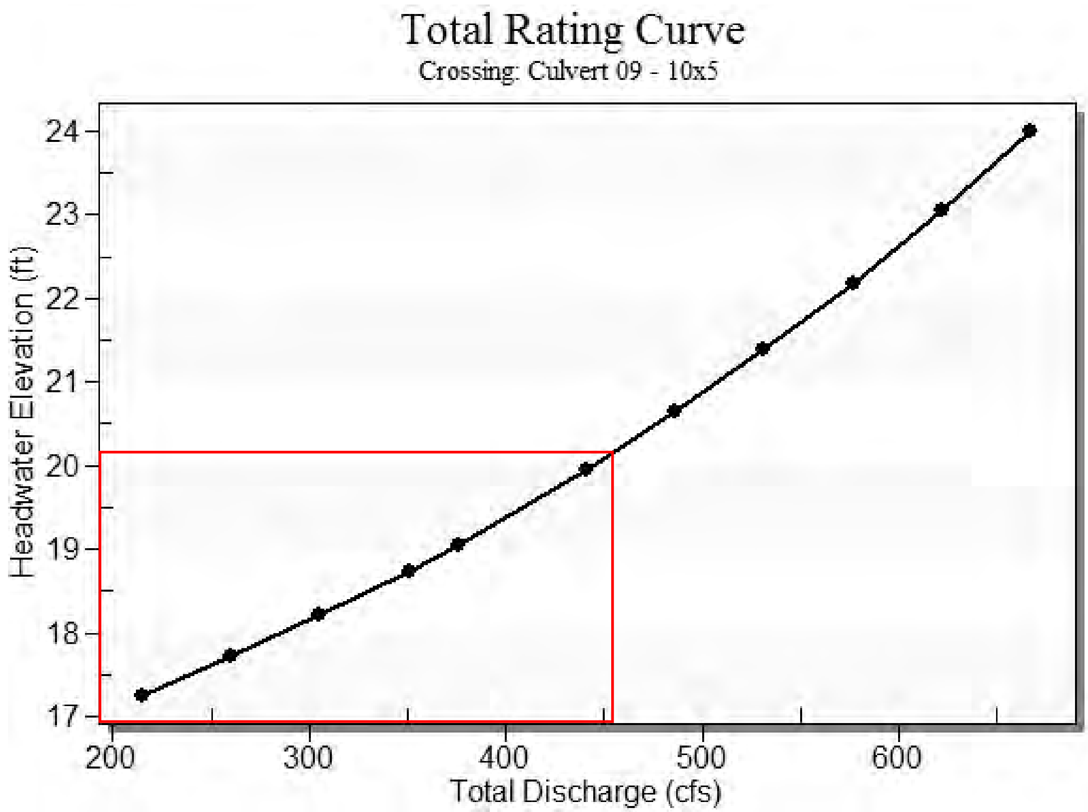


Table 2 - Culvert Summary Table: Culvert 09

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)
215.00	215.00	17.26	4.106	4.321	1-S1t	2.413	2.436	3.870	3.540	5.556	0.000
260.20	260.20	17.72	4.666	4.784	1-S1t	2.755	2.766	3.970	3.640	6.554	0.000
305.40	305.40	18.22	5.220	5.276	7-M1t	3.086	3.078	4.070	3.740	7.504	0.000
350.60	350.60	18.73	5.786	5.793	7-M1t	3.404	3.374	4.120	3.790	8.510	0.000
376.00	376.00	19.06	6.116	6.087	7-M1t	3.580	3.535	4.170	3.840	9.017	0.000
441.00	441.00	19.95	7.013	6.798	7-M1t	4.020	3.932	4.370	4.040	10.092	0.000
486.20	486.20	20.64	7.697	7.257	7-M1t	4.317	4.196	4.570	4.240	10.639	0.000
531.40	531.40	21.38	8.439	7.661	3-M2t	5.000	4.452	4.770	4.440	11.140	0.000
576.60	576.60	22.19	9.246	8.105	3-M2t	5.000	4.701	4.970	4.640	11.602	0.000
621.80	621.80	23.06	10.121	9.126	4-FFf	5.000	4.944	5.000	4.740	12.436	0.000
667.00	667.00	24.01	11.068	9.914	4-FFf	5.000	5.000	5.000	4.840	13.340	0.000

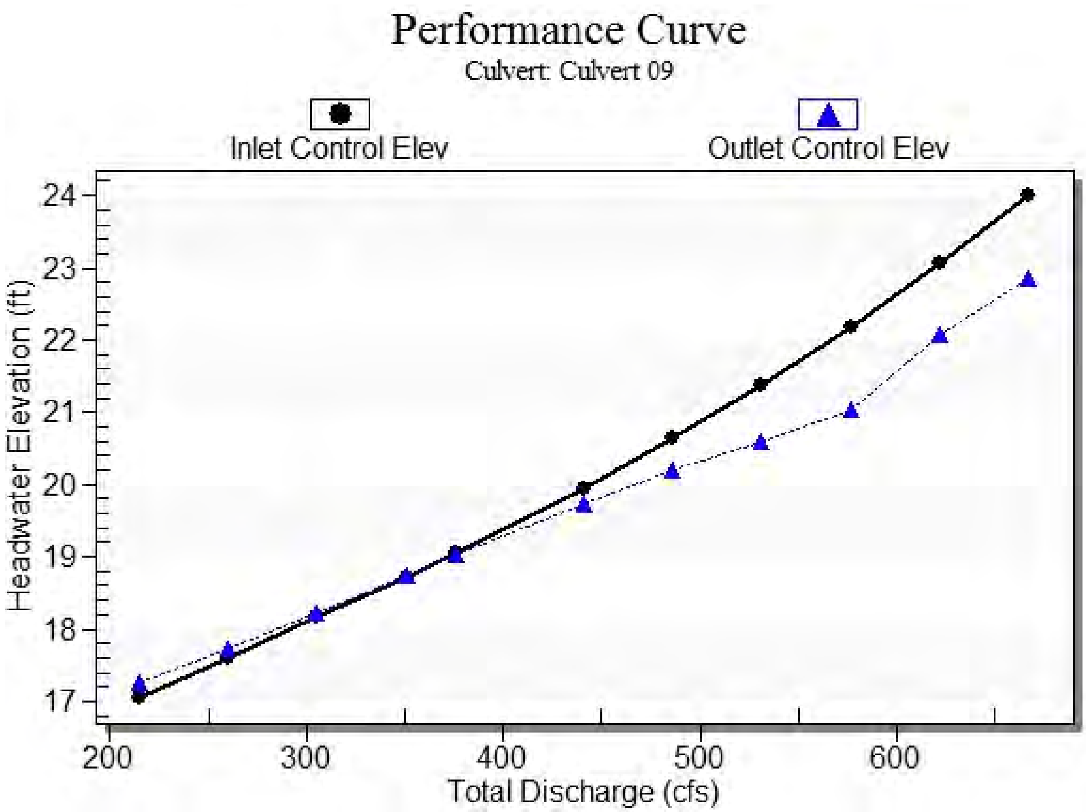
****

Inlet Elevation (invert): 12.94 ft, Outlet Elevation (invert): 12.43 ft

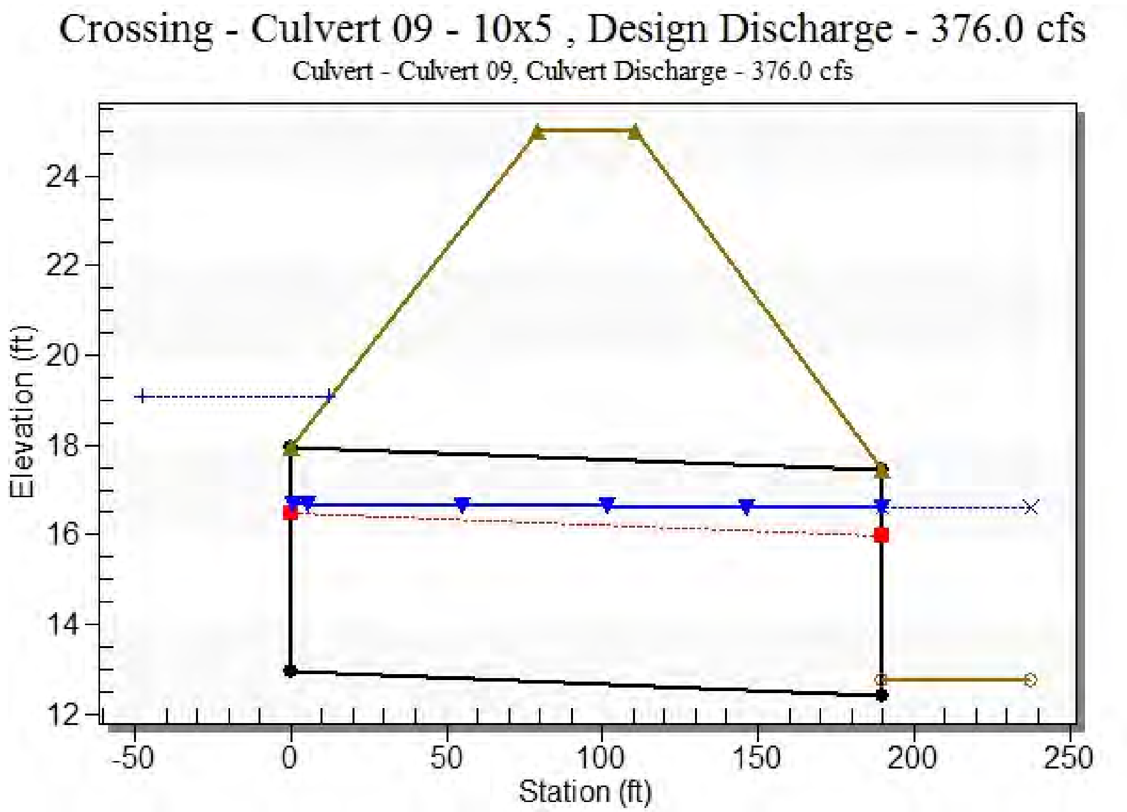
Culvert Length: 190.00 ft, Culvert Slope: 0.0027

****

Culvert Performance Curve Plot: Culvert 09



Water Surface Profile Plot for Culvert: Culvert 09



Site Data - Culvert 09

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 12.94 ft

Outlet Station: 190.00 ft

Outlet Elevation: 12.43 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 09

Barrel Shape: Concrete Box

Barrel Span: 10.00 ft

Barrel Rise: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 09 - 10x5)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
215.00	16.30	3.54
260.20	16.40	3.64
305.40	16.50	3.74
350.60	16.55	3.79
376.00	16.60	3.84
441.00	16.80	4.04
486.20	17.00	4.24
531.40	17.20	4.44
576.60	17.40	4.64
621.80	17.50	4.74
667.00	17.60	4.84

Tailwater Channel Data - Culvert 09 - 10x5

Tailwater Channel Option: Enter Rating Curve

Roadway Data for Crossing: Culvert 09 - 10x5

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 200.00 ft

Crest Elevation: 25.01 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 10

Table 1 - Summary of Culvert Flows at Crossing: Culvert 10 - 30" RCP

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 10 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
20.17	10.00	10.00	0.00	1
20.34	12.00	12.00	0.00	1
20.51	14.00	14.00	0.00	1
20.59	15.00	15.00	0.00	1
20.83	18.00	18.00	0.00	1
20.98	20.00	20.00	0.00	1
21.13	22.00	22.00	0.00	1
21.29	24.00	24.00	0.00	1
21.43	26.00	26.00	0.00	1
21.60	28.00	28.00	0.00	1
21.76	30.00	30.00	0.00	1
22.90	40.53	40.53	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 10 - 30" RCP

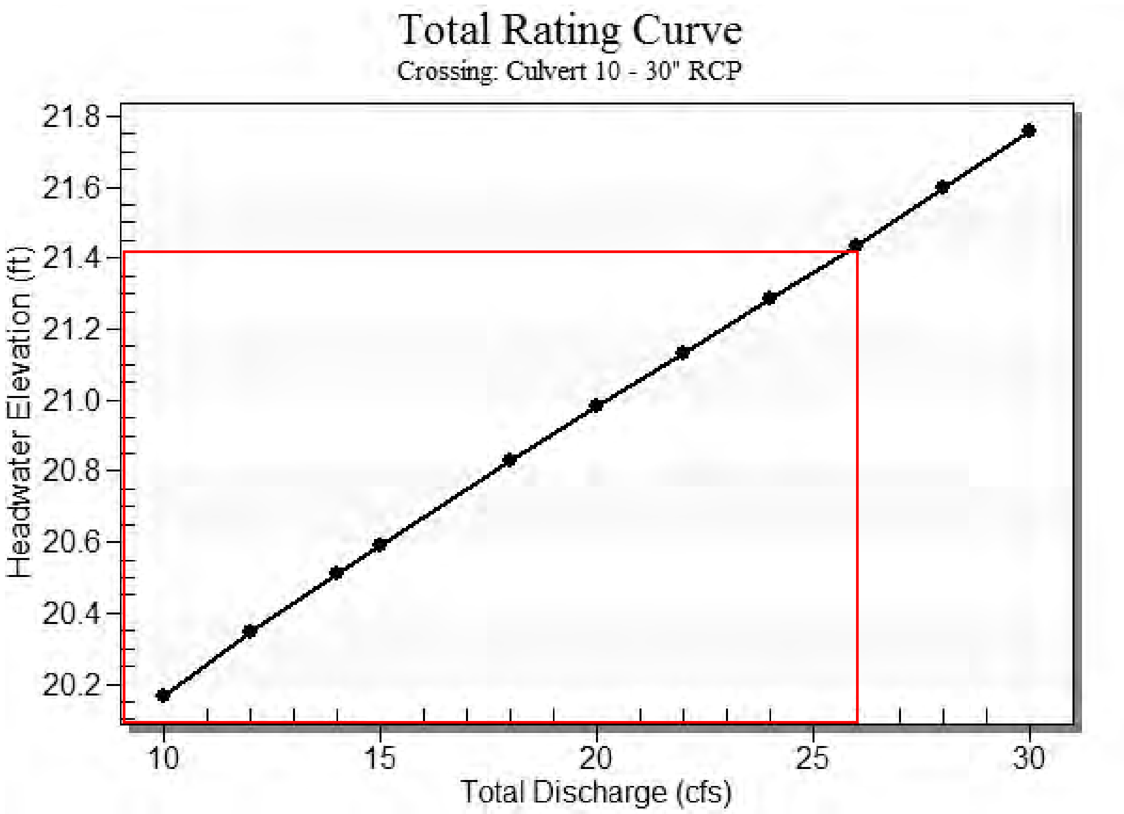


Table 2 - Culvert Summary Table: Culvert 10

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)
10.00	10.00	20.17	1.511	1.628	3-M1t	1.146	1.052	1.160	1.160	4.485	0.000
12.00	12.00	20.34	1.691	1.805	3-M2t	1.277	1.156	1.160	1.160	5.382	0.000
14.00	14.00	20.51	1.858	1.971	2-M2c	1.402	1.259	1.259	1.160	5.652	0.000
15.00	15.00	20.59	1.938	2.052	2-M2c	1.465	1.302	1.306	1.160	5.784	0.000
18.00	18.00	20.83	2.170	2.288	2-M2c	1.660	1.433	1.437	1.160	6.167	0.000
20.00	20.00	20.98	2.323	2.440	2-M2c	1.798	1.516	1.518	1.160	6.413	0.000
22.00	22.00	21.13	2.477	2.593	2-M2c	1.952	1.590	1.595	1.160	6.656	0.000
24.00	24.00	21.29	2.636	2.745	2-M2c	2.168	1.663	1.668	1.160	6.897	0.000
26.00	26.00	21.43	2.803	2.894	2-M2c	2.500	1.737	1.738	1.160	7.139	0.000
28.00	28.00	21.60	2.978	3.056	2-M2c	2.500	1.799	1.804	1.160	7.382	0.000
30.00	30.00	21.76	3.164	3.219	2-M2c	2.500	1.860	1.867	1.160	7.630	0.000

****

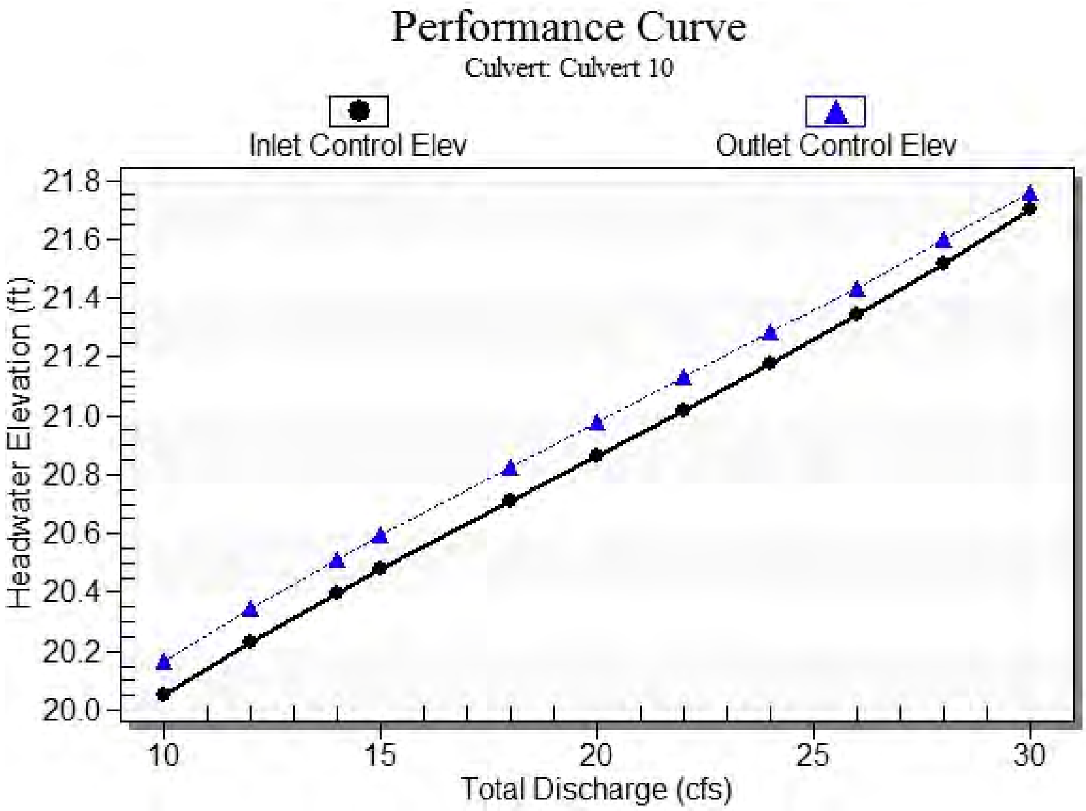
Inlet Elevation (invert): 18.54 ft, Outlet Elevation (invert): 18.34 ft

Culvert Length: 74.00 ft, Culvert Slope: 0.0027

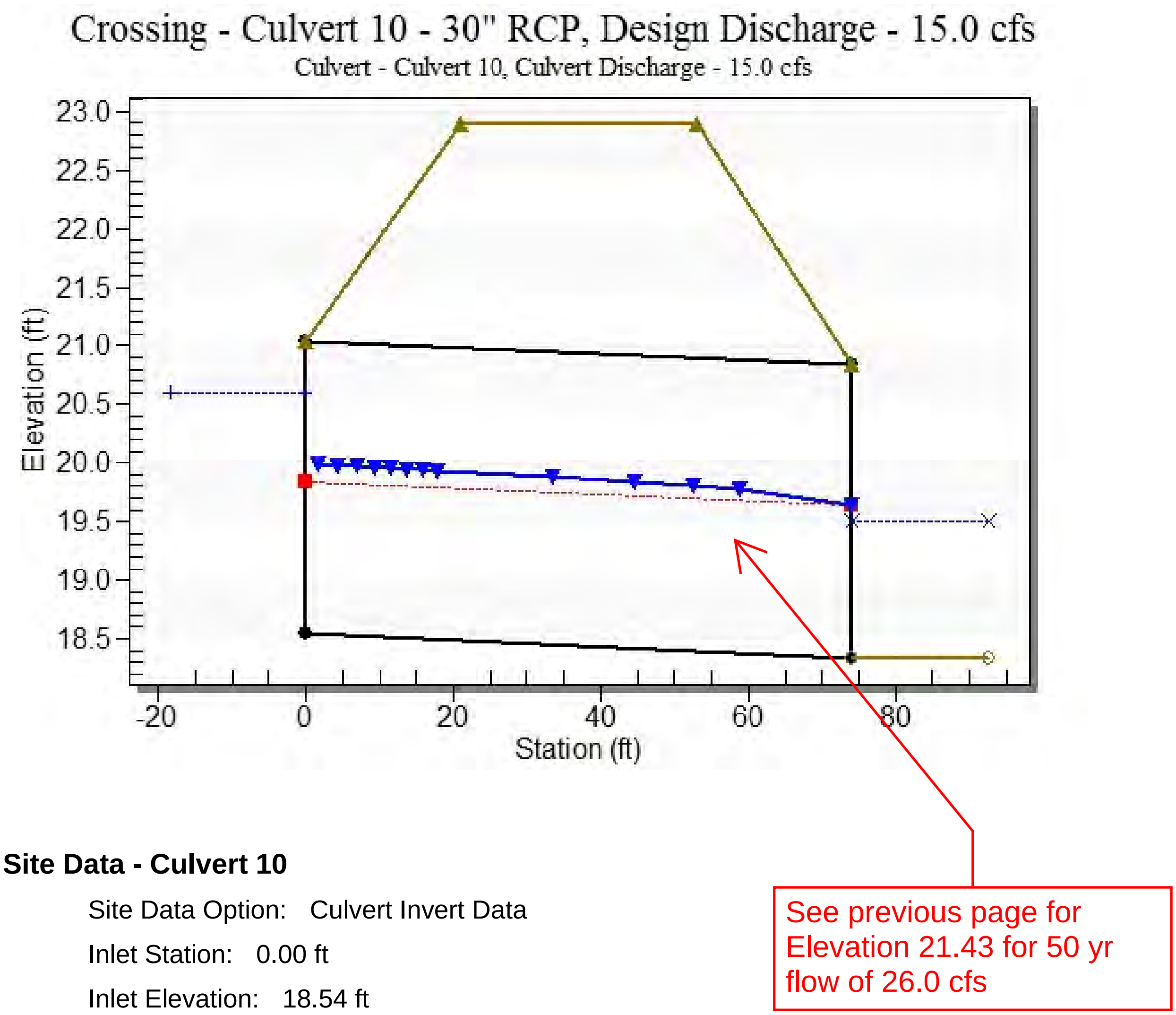
****

50 yr flow 26.0 cfs
lower stage compared
to existing

Culvert Performance Curve Plot: Culvert 10



Water Surface Profile Plot for Culvert: Culvert 10



Site Data - Culvert 10

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 18.54 ft

Outlet Station: 74.00 ft

Outlet Elevation: 18.34 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 10

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 10 - 30" RCP)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
10.00	19.50	1.16
12.00	19.50	1.16
14.00	19.50	1.16
15.00	19.50	1.16
18.00	19.50	1.16
20.00	19.50	1.16
22.00	19.50	1.16
24.00	19.50	1.16
26.00	19.50	1.16
28.00	19.50	1.16
30.00	19.50	1.16

Tailwater Channel Data - Culvert 10 - 30" RCP

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 19.50 ft

Roadway Data for Crossing: Culvert 10 - 30" RCP

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 22.90 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 11

Table 1 - Summary of Culvert Flows at Crossing: Culvert 11 - 24" RCP

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 11 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
22.09	5.00	5.00	0.00	1
22.13	6.00	6.00	0.00	1
22.17	7.00	7.00	0.00	1
22.22	8.00	8.00	0.00	1
22.28	9.00	9.00	0.00	1
22.35	10.00	10.00	0.00	1
22.43	11.00	11.00	0.00	1
22.51	12.00	12.00	0.00	1
22.59	13.00	13.00	0.00	1
22.69	14.00	14.00	0.00	1
22.79	15.00	15.00	0.00	1
24.07	24.26	24.26	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 11 - 24" RCP

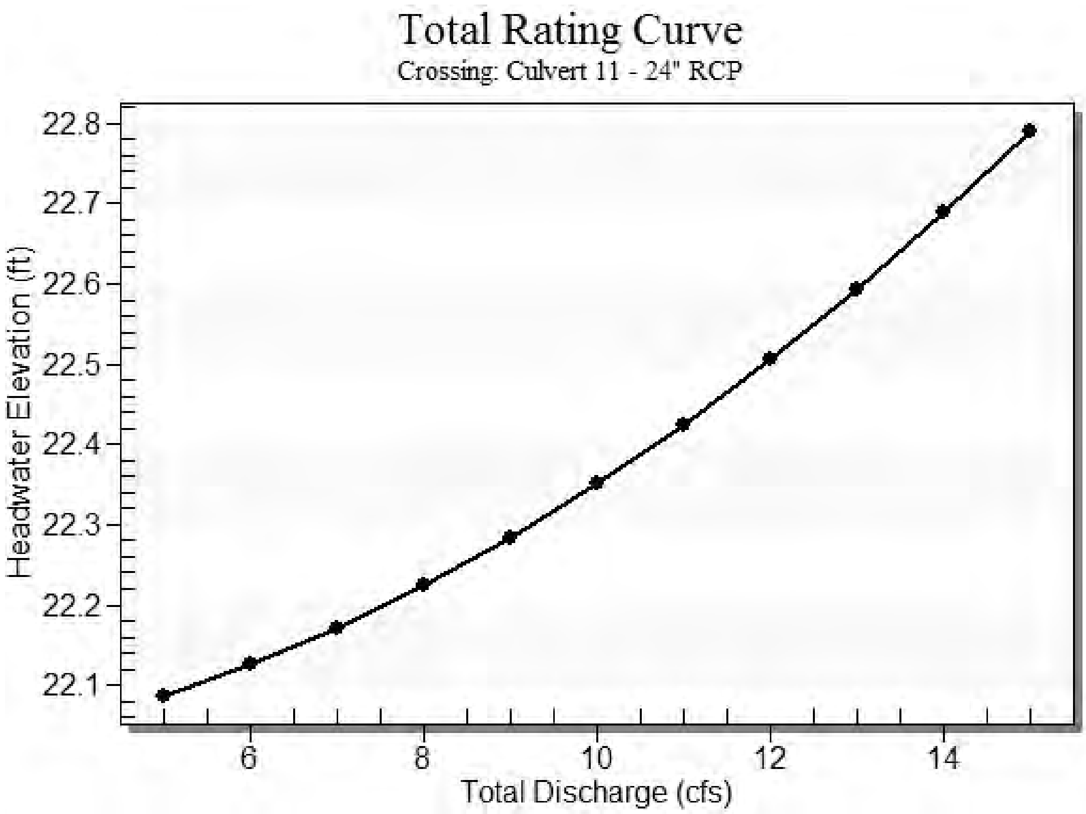


Table 2 - Culvert Summary Table: Culvert 11

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)
5.00	5.00	22.09	1.087	2.147	4-FFf	0.474	0.786	2.000	3.840	1.592	0.000
6.00	6.00	22.13	1.222	2.186	4-FFf	0.521	0.862	2.000	3.840	1.910	0.000
7.00	7.00	22.17	1.346	2.232	4-FFf	0.568	0.935	2.000	3.840	2.228	0.000
8.00	8.00	22.22	1.462	2.285	4-FFf	0.612	1.006	2.000	3.840	2.546	0.000
9.00	9.00	22.28	1.573	2.344	4-FFf	0.648	1.067	2.000	3.840	2.865	0.000
10.00	10.00	22.35	1.681	2.411	4-FFf	0.684	1.128	2.000	3.840	3.183	0.000
11.00	11.00	22.43	1.788	2.485	4-FFf	0.721	1.188	2.000	3.840	3.501	0.000
12.00	12.00	22.51	1.895	2.566	4-FFf	0.757	1.241	2.000	3.840	3.820	0.000
13.00	13.00	22.59	2.004	2.654	4-FFf	0.793	1.293	2.000	3.840	4.138	0.000
14.00	14.00	22.69	2.116	2.749	4-FFf	0.825	1.344	2.000	3.840	4.456	0.000
15.00	15.00	22.79	2.233	2.851	4-FFf	0.857	1.395	2.000	3.840	4.775	0.000

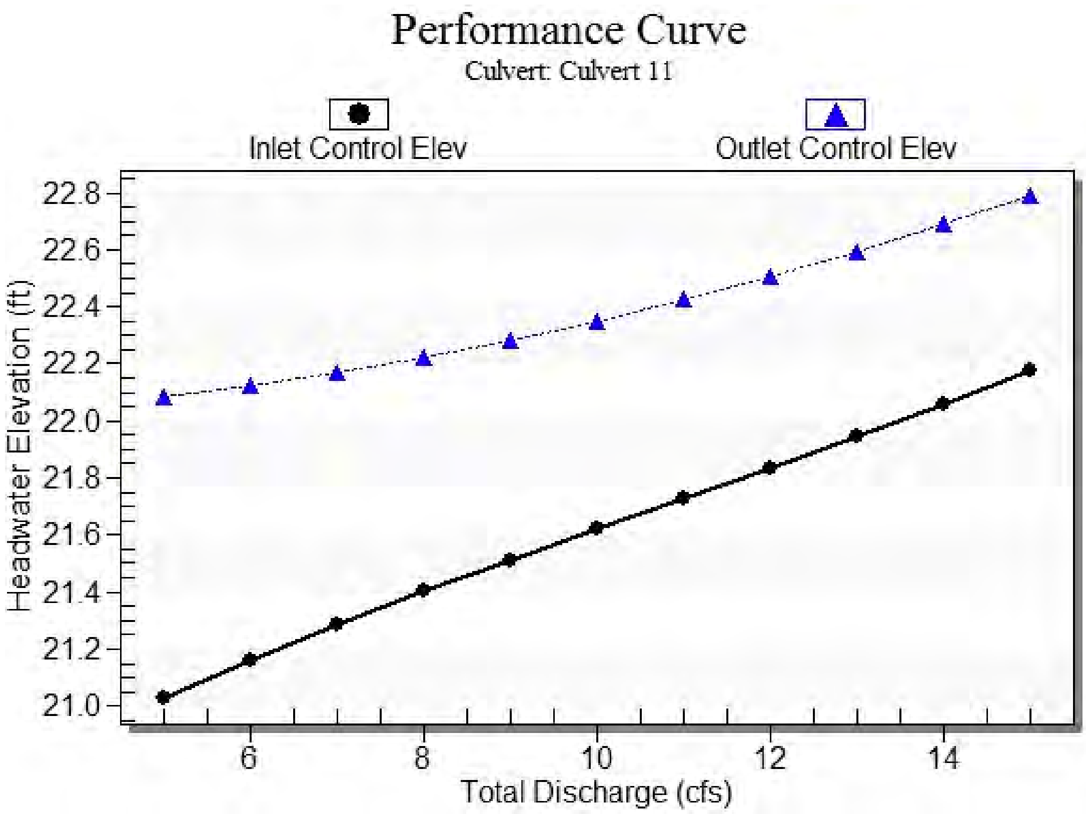
****

Inlet Elevation (invert): 19.94 ft, Outlet Elevation (invert): 18.16 ft

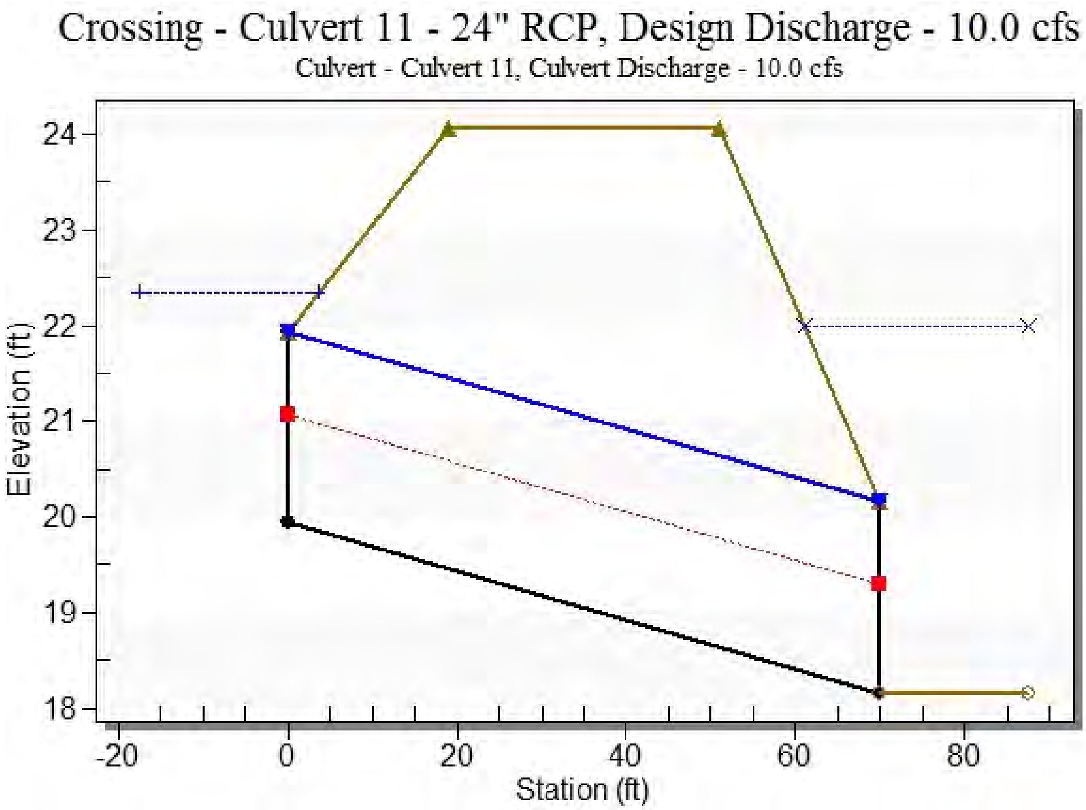
Culvert Length: 70.02 ft, Culvert Slope: 0.0254

****

Culvert Performance Curve Plot: Culvert 11



Water Surface Profile Plot for Culvert: Culvert 11



Site Data - Culvert 11

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 19.94 ft

Outlet Station: 70.00 ft

Outlet Elevation: 18.16 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 11

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 11 - 24" RCP)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
5.00	22.00	3.84
6.00	22.00	3.84
7.00	22.00	3.84
8.00	22.00	3.84
9.00	22.00	3.84
10.00	22.00	3.84
11.00	22.00	3.84
12.00	22.00	3.84
13.00	22.00	3.84
14.00	22.00	3.84
15.00	22.00	3.84

Tailwater Channel Data - Culvert 11 - 24" RCP

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 22.00 ft

Roadway Data for Crossing: Culvert 11 - 24" RCP

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 24.07 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 12

Table 1 - Summary of Culvert Flows at Crossing: Culvert 12 - 30" RCP

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 12 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
21.37	5.00	5.00	0.00	1
21.39	6.00	6.00	0.00	1
21.42	7.00	7.00	0.00	1
21.44	8.00	8.00	0.00	1
21.47	9.00	9.00	0.00	1
21.51	10.00	10.00	0.00	1
21.54	11.00	11.00	0.00	1
21.58	12.00	12.00	0.00	1
21.62	13.00	13.00	0.00	1
21.67	14.00	14.00	0.00	1
21.71	15.00	15.00	0.00	1
23.97	40.73	40.73	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 12 - 30" RCP

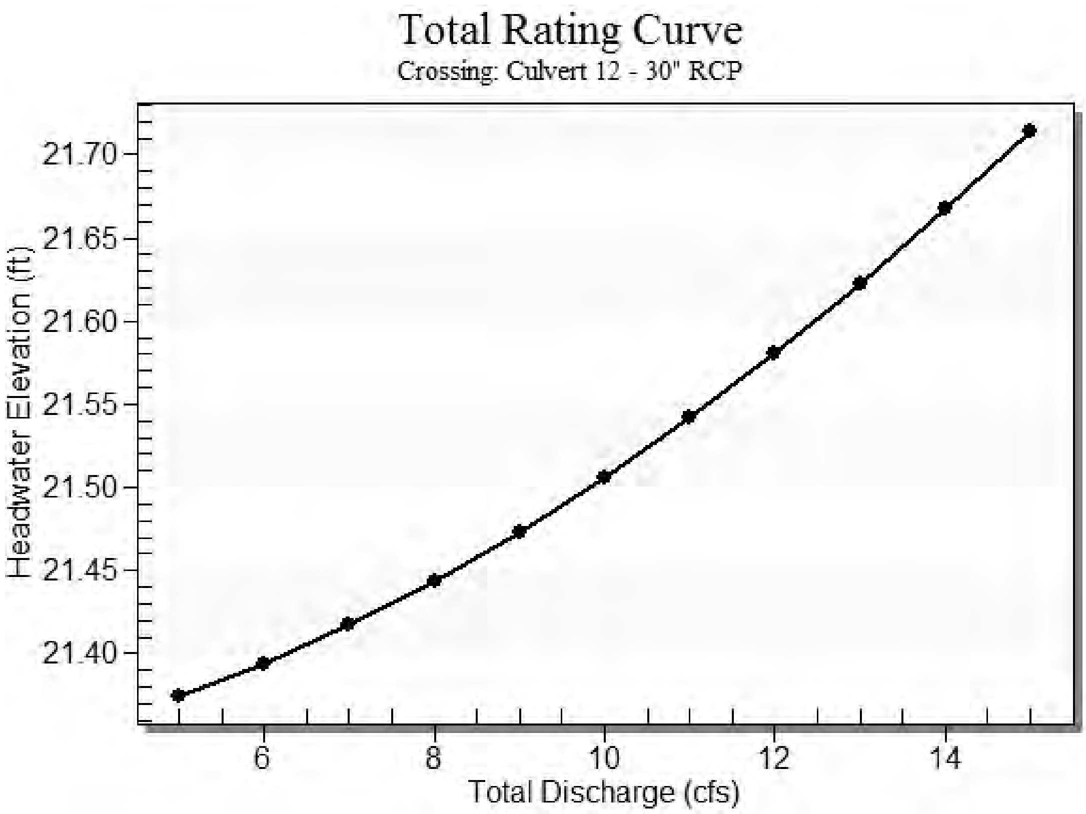


Table 2 - Culvert Summary Table: Culvert 12

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)
5.00	5.00	21.37	1.014	1.975	3-M1t	0.959	0.735	2.040	2.000	1.166	0.000
6.00	6.00	21.39	1.117	1.994	3-M1t	1.061	0.804	2.040	2.000	1.399	0.000
7.00	7.00	21.42	1.213	2.017	3-M1t	1.157	0.869	2.040	2.000	1.632	0.000
8.00	8.00	21.44	1.314	2.043	3-M1t	1.253	0.935	2.040	2.000	1.865	0.000
9.00	9.00	21.47	1.416	2.073	3-M1t	1.345	1.000	2.040	2.000	2.099	0.000
10.00	10.00	21.51	1.512	2.106	3-M1t	1.436	1.052	2.040	2.000	2.332	0.000
11.00	11.00	21.54	1.604	2.142	3-M1t	1.529	1.104	2.040	2.000	2.565	0.000
12.00	12.00	21.58	1.693	2.180	3-M1t	1.624	1.156	2.040	2.000	2.798	0.000
13.00	13.00	21.62	1.778	2.222	3-M1t	1.718	1.208	2.040	2.000	3.031	0.000
14.00	14.00	21.67	1.860	2.267	3-M1t	1.825	1.259	2.040	2.000	3.264	0.000
15.00	15.00	21.71	1.940	2.315	3-M1t	1.937	1.302	2.040	2.000	3.498	0.000

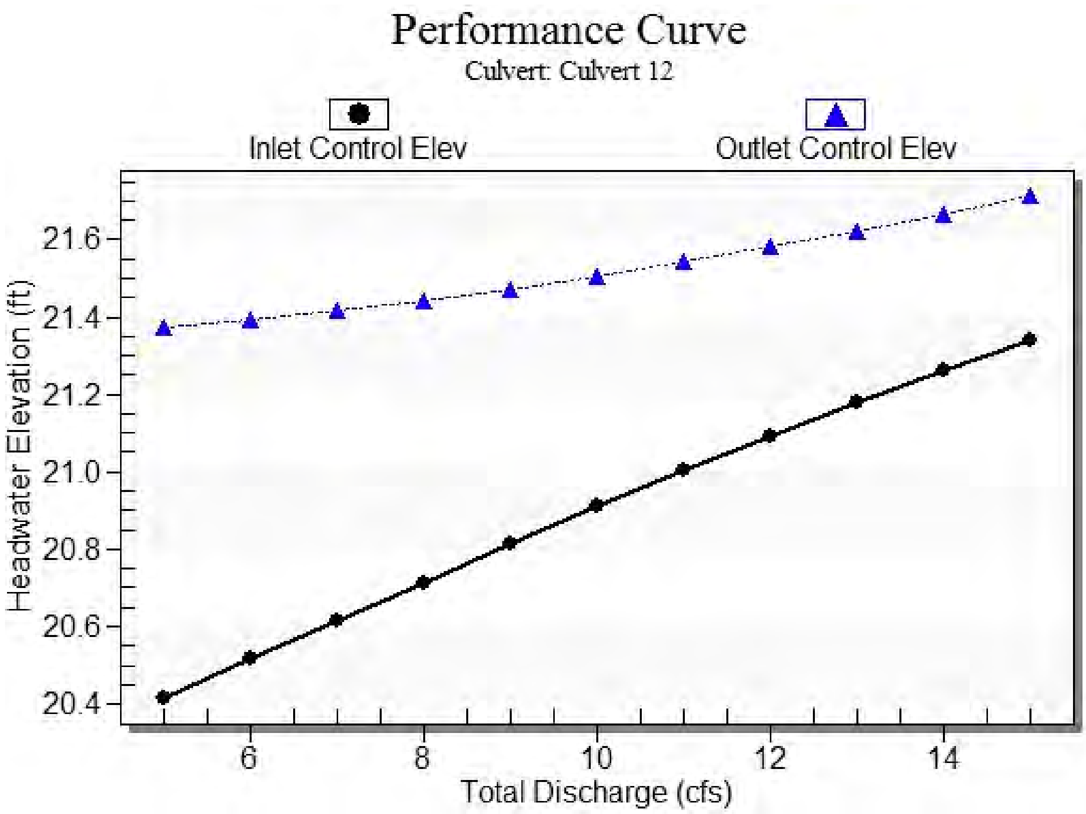
****

Inlet Elevation (invert): 19.40 ft, Outlet Elevation (invert): 19.29 ft

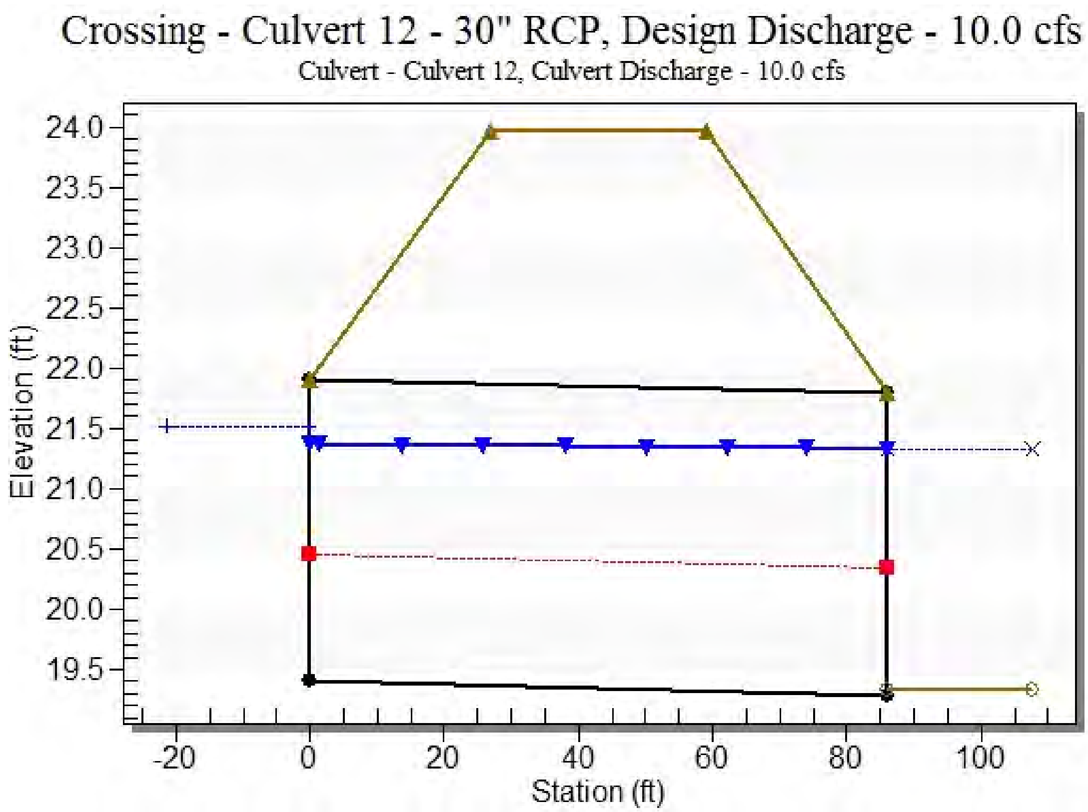
Culvert Length: 86.00 ft, Culvert Slope: 0.0013

****

Culvert Performance Curve Plot: Culvert 12



Water Surface Profile Plot for Culvert: Culvert 12



Site Data - Culvert 12

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 19.40 ft

Outlet Station: 86.00 ft

Outlet Elevation: 19.29 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 12

Barrel Shape: Circular

Barrel Diameter: 2.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 12 - 30" RCP)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
5.00	21.33	2.00
6.00	21.33	2.00
7.00	21.33	2.00
8.00	21.33	2.00
9.00	21.33	2.00
10.00	21.33	2.00
11.00	21.33	2.00
12.00	21.33	2.00
13.00	21.33	2.00
14.00	21.33	2.00
15.00	21.33	2.00

Tailwater Channel Data - Culvert 12 - 30" RCP

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 21.33 ft

Roadway Data for Crossing: Culvert 12 - 30" RCP

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 23.97 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 13

Culvert #13 is part of the storm sewer system east of Marie Street. Results for existing conditions indicate overtopping of roadway where no problems are reported. Either runoff shifts to nearby inlet or basin area is different than assumed. Large pipe for proposed condition assumes downstream portion of storm sewer system is upsized to handle. Roadway profile affects peak stage if overtopping is present.

Table 1 - Summary of Culvert Flows at Crossing: Culvert 13 - 36" RCP

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 13 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
20.46	40.00	40.00	0.00	1
20.94	48.00	48.00	0.00	1
21.50	56.00	56.00	0.00	1
22.25	64.00	64.00	0.00	1
23.11	72.00	72.00	0.00	1
24.09	80.00	80.00	0.00	1
24.48	83.00	83.00	0.00	1
24.62	96.00	83.99	11.86	7
24.66	104.00	84.33	19.57	5
24.70	112.00	84.63	27.21	4
24.74	120.00	84.90	35.01	4
24.50	83.12	83.12	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 13 - 36" RCP

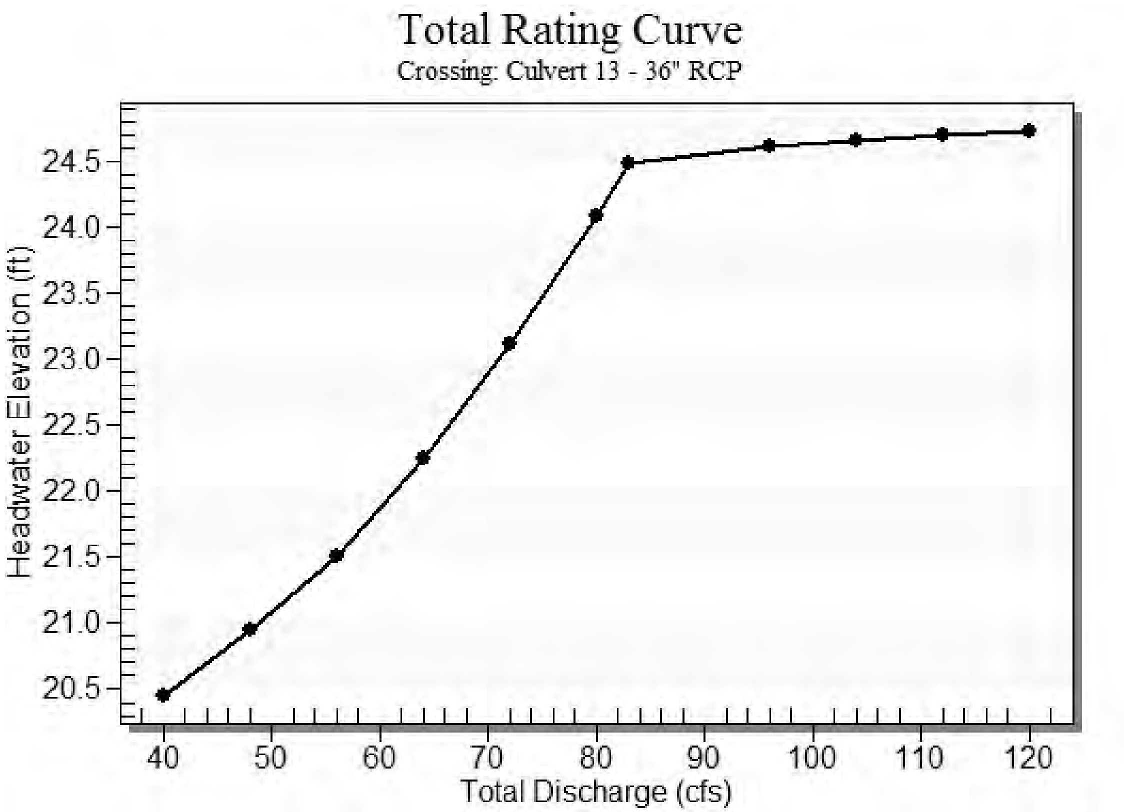


Table 2 - Culvert Summary Table: Culvert 13

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)
40.00	40.00	20.46	3.301	3.447	2-M2c	3.000	2.056	2.059	2.020	7.735	0.000
48.00	48.00	20.94	3.849	3.935	2-M2c	3.000	2.247	2.256	2.020	8.417	0.000
56.00	56.00	21.50	4.490	4.488	7-M2c	3.000	2.421	2.427	2.020	9.132	0.000
64.00	64.00	22.25	5.240	5.143	7-M2c	3.000	2.550	2.568	2.020	9.971	0.000
72.00	72.00	23.11	6.104	5.826	7-M2c	3.000	2.678	2.685	2.020	10.795	0.000
80.00	80.00	24.09	7.080	6.600	7-M2c	3.000	2.807	2.775	2.020	11.778	0.000
83.00	83.00	24.48	7.474	6.904	7-M2c	3.000	2.855	2.883	2.020	11.985	0.000
96.00	83.99	24.62	7.607	7.007	7-M2c	3.000	2.871	2.915	2.020	12.061	0.000
104.00	84.33	24.66	7.653	7.042	7-M2c	3.000	2.876	2.922	2.020	12.094	0.000
112.00	84.63	24.70	7.693	7.072	7-M2c	3.000	2.881	2.927	2.020	12.126	0.000
120.00	84.90	24.74	7.730	7.100	7-M2c	3.000	2.885	2.932	2.020	12.155	0.000

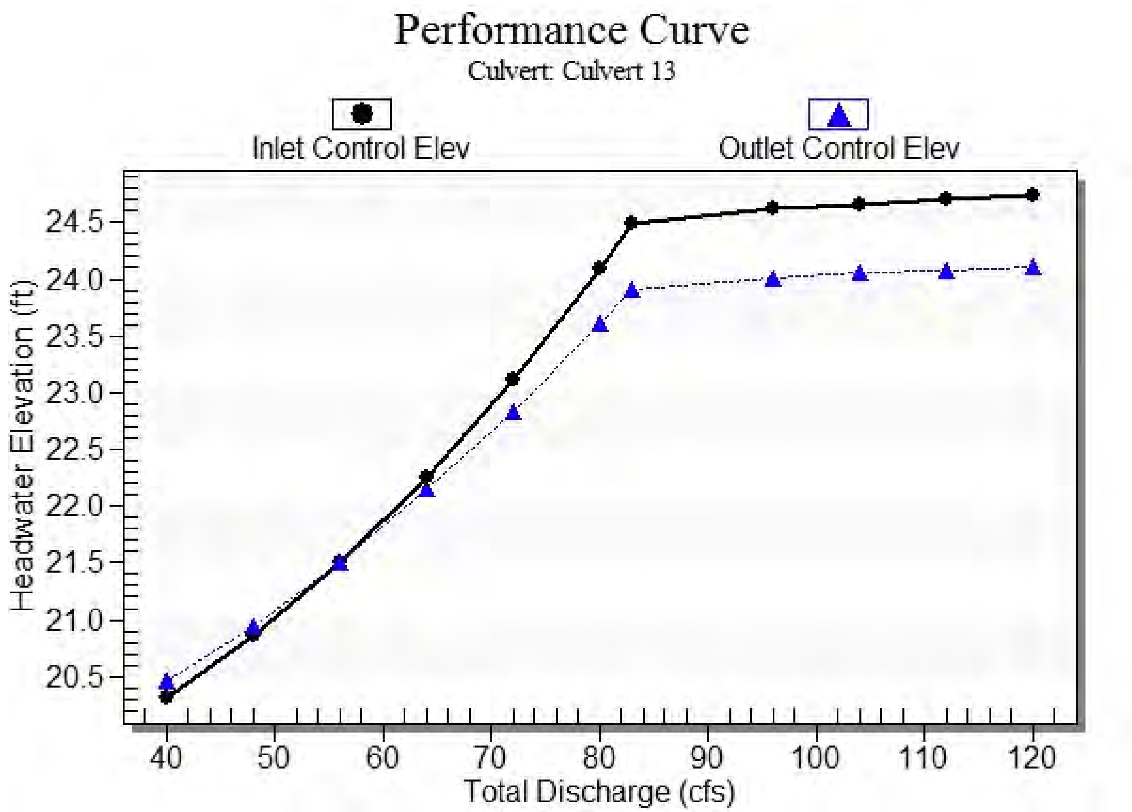
****

Inlet Elevation (invert): 17.01 ft, Outlet Elevation (invert): 16.95 ft

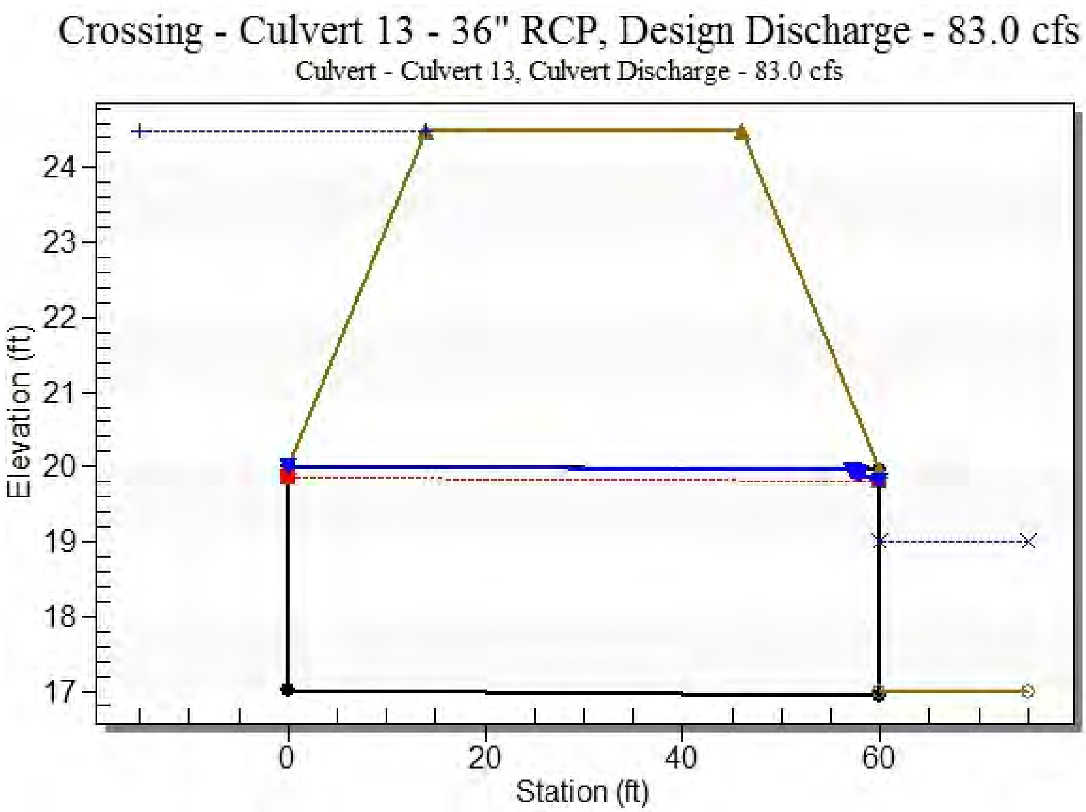
Culvert Length: 60.00 ft, Culvert Slope: 0.0010

****

Culvert Performance Curve Plot: Culvert 13



Water Surface Profile Plot for Culvert: Culvert 13



Site Data - Culvert 13

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 17.01 ft

Outlet Station: 60.00 ft

Outlet Elevation: 16.95 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 13

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 13 - 36" RCP)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
40.00	19.00	2.02
48.00	19.00	2.02
56.00	19.00	2.02
64.00	19.00	2.02
72.00	19.00	2.02
80.00	19.00	2.02
83.00	19.00	2.02
96.00	19.00	2.02
104.00	19.00	2.02
112.00	19.00	2.02
120.00	19.00	2.02

Tailwater Channel Data - Culvert 13 - 36" RCP

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 19.00 ft

Roadway Data for Crossing: Culvert 13 - 36" RCP

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 24.50 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

HY-8 Culvert Analysis Report

PROPOSED CULVERT 14

Table 1 - Summary of Culvert Flows at Crossing: Culvert 14 - 24" RCP

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 14 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
22.64	3.00	3.00	0.00	1
22.68	4.30	4.30	0.00	1
22.75	5.60	5.60	0.00	1
22.76	6.90	6.90	0.00	1
22.83	8.20	8.20	0.00	1
22.90	9.50	9.50	0.00	1
22.94	10.00	10.00	0.00	1
23.09	12.10	12.10	0.00	1
23.20	13.40	13.40	0.00	1
23.32	14.70	14.70	0.00	1
23.46	16.00	16.00	0.00	1
25.00	26.75	26.75	0.00	Overtopping

Rating Curve Plot for Crossing: Culvert 14 - 24" RCP

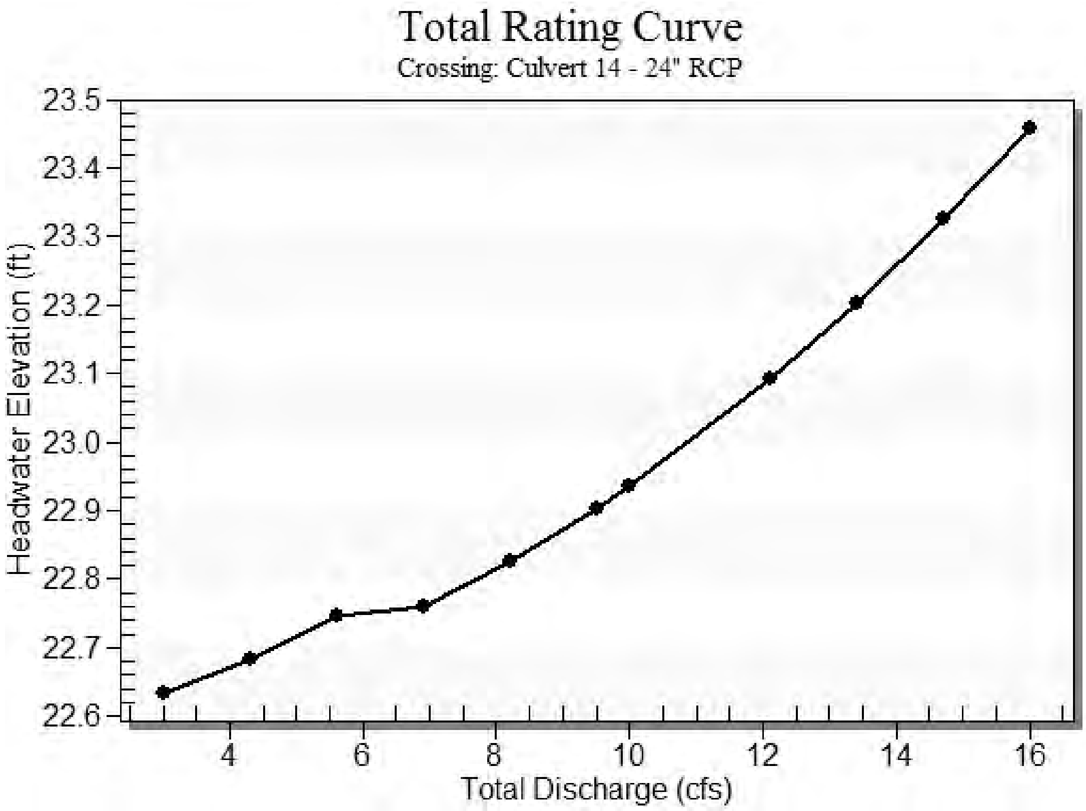


Table 2 - Culvert Summary Table: Culvert 14

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)
3.00	3.00	22.64	0.832	1.935	3-M1f	0.727	0.604	2.000	2.000	0.955	0.000
4.30	4.30	22.68	1.009	1.982	3-M1f	0.888	0.722	2.000	2.000	1.369	0.000
5.60	5.60	22.75	1.193	2.045	3-M1f	1.038	0.833	2.000	2.000	1.783	0.000
6.90	6.90	22.76	1.357	2.060	4-FFf	1.182	0.927	2.000	2.000	2.196	0.000
8.20	8.20	22.83	1.508	2.125	4-FFf	1.331	1.018	2.000	2.000	2.610	0.000
9.50	9.50	22.90	1.651	2.203	4-FFf	1.495	1.097	2.000	2.000	3.024	0.000
10.00	10.00	22.94	1.705	2.235	4-FFf	1.562	1.128	2.000	2.000	3.183	0.000
12.10	12.10	23.09	1.929	2.391	4-FFf	2.000	1.247	2.000	2.000	3.852	0.000
13.40	13.40	23.20	2.072	2.502	4-FFf	2.000	1.313	2.000	2.000	4.265	0.000
14.70	14.70	23.32	2.221	2.625	4-FFf	2.000	1.380	2.000	2.000	4.679	0.000
16.00	16.00	23.46	2.380	2.758	4-FFf	2.000	1.438	2.000	2.000	5.093	0.000

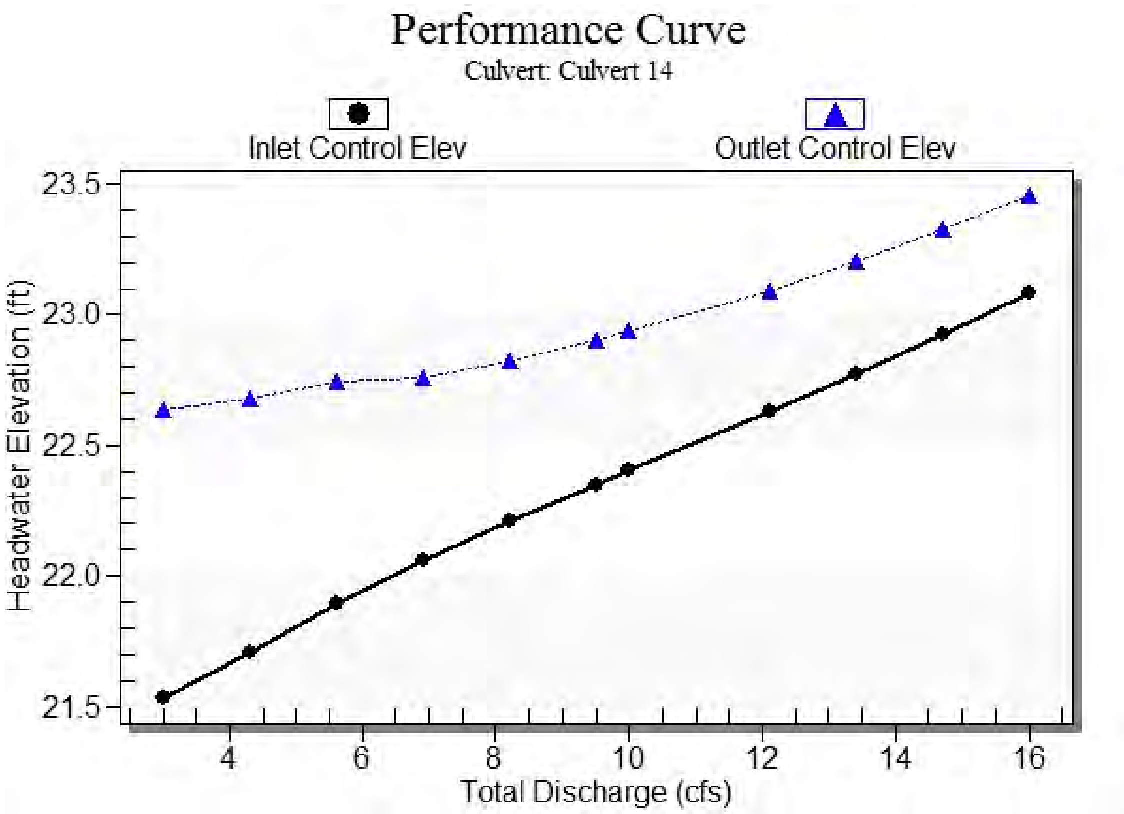
****

Inlet Elevation (invert): 20.70 ft,   Outlet Elevation (invert): 20.59 ft

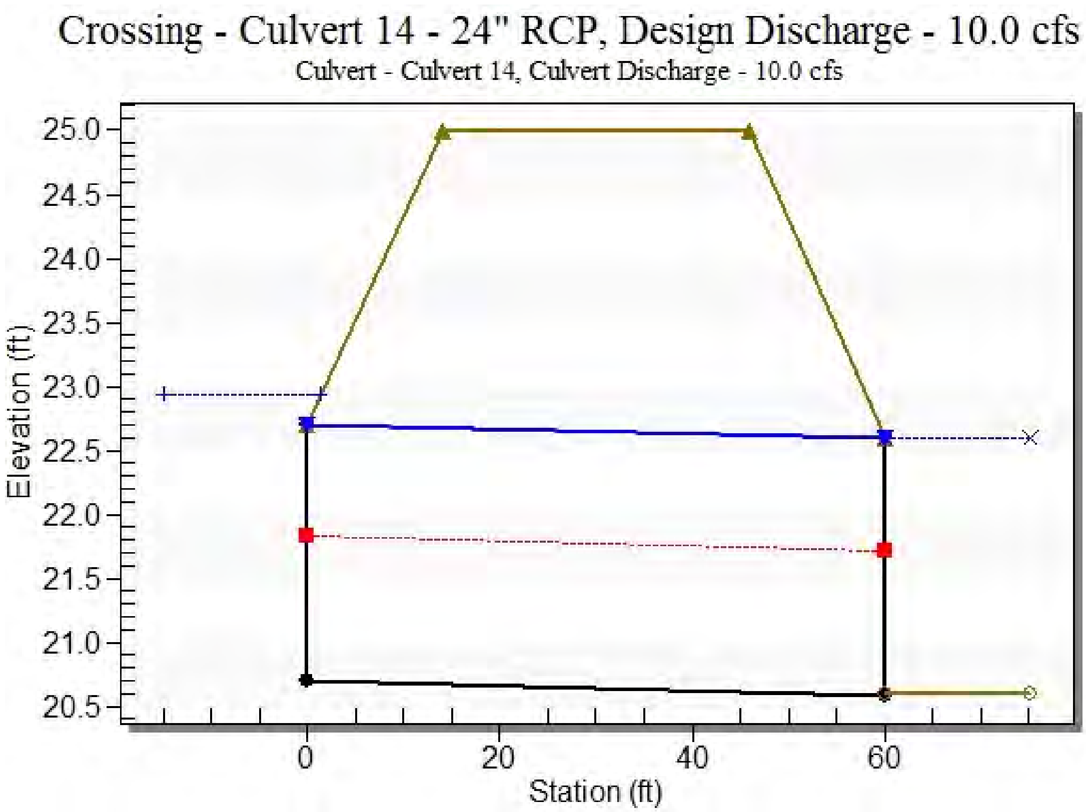
Culvert Length: 60.00 ft,   Culvert Slope: 0.0018

****

Culvert Performance Curve Plot: Culvert 14



Water Surface Profile Plot for Culvert: Culvert 14



Site Data - Culvert 14

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 20.70 ft

Outlet Station: 60.00 ft

Outlet Elevation: 20.59 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 14

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: Culvert 14 - 24" RCP)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
3.00	22.60	2.00
4.30	22.60	2.00
5.60	22.60	2.00
6.90	22.60	2.00
8.20	22.60	2.00
9.50	22.60	2.00
10.00	22.60	2.00
12.10	22.60	2.00
13.40	22.60	2.00
14.70	22.60	2.00
16.00	22.60	2.00

Tailwater Channel Data - Culvert 14 - 24" RCP

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 22.60 ft

Roadway Data for Crossing: Culvert 14 - 24" RCP

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 25.00 ft

Roadway Surface: Paved

Roadway Top Width: 32.00 ft

APPENDIX C

STRAIGHT LINE DIAGRAMS

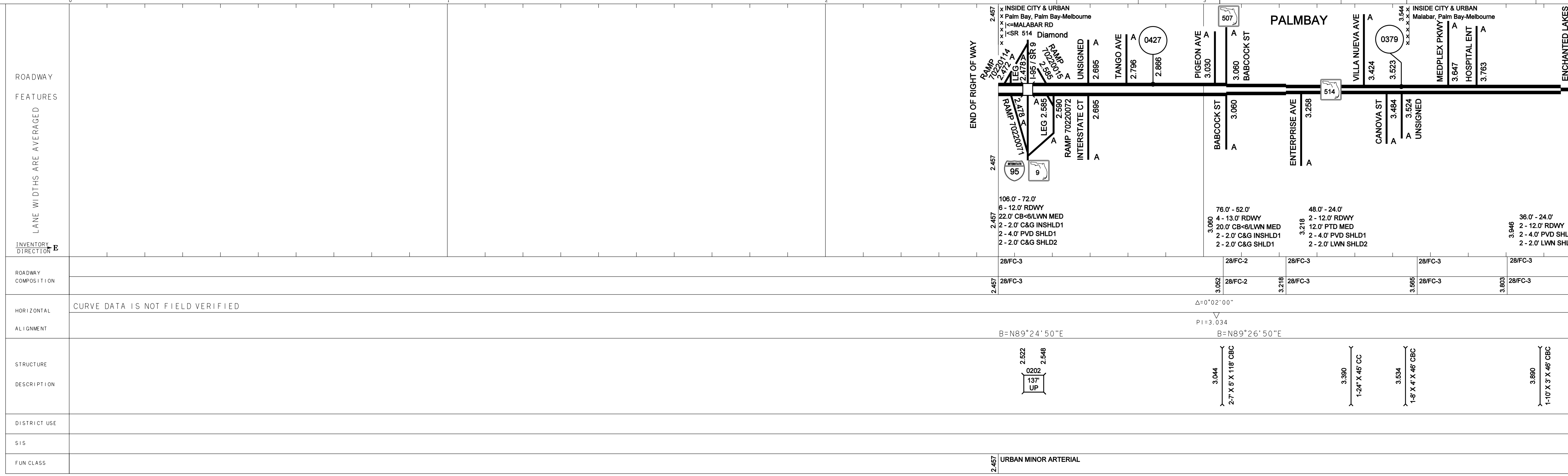
STRAIGHT LINE DIAGRAM OF ROAD INVENTORY

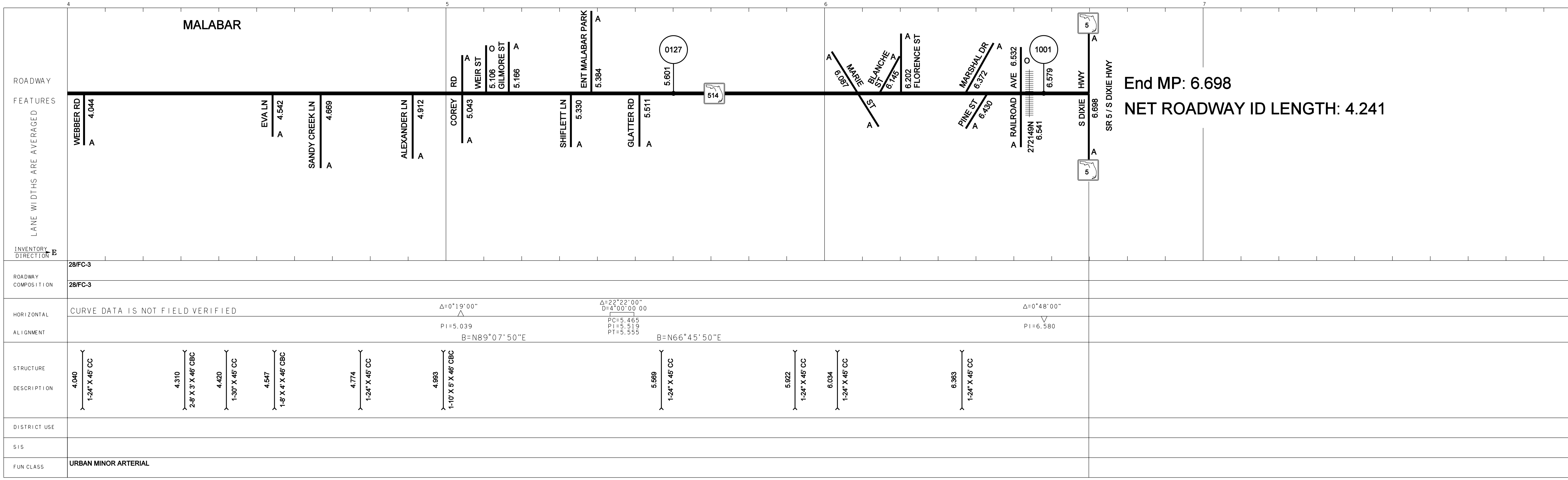
FLORIDA DEPARTMENT OF TRANSPORTATION

	5 YR INV	SLD REV	BMP	EMP	INV	SLD REV
DATE	05/11/10	06/15/10				
BY	RC	MR				

INTERIM REVISIONS: BMP, EMP, INV, SLD REV

INT. or US ROUTE NO	STATE ROAD NO.	COUNTY	DISTRICT	ROADWAY ID	SHEET NO.:
	SR 514	BREVARD	5	70 180 000	1 OF 1





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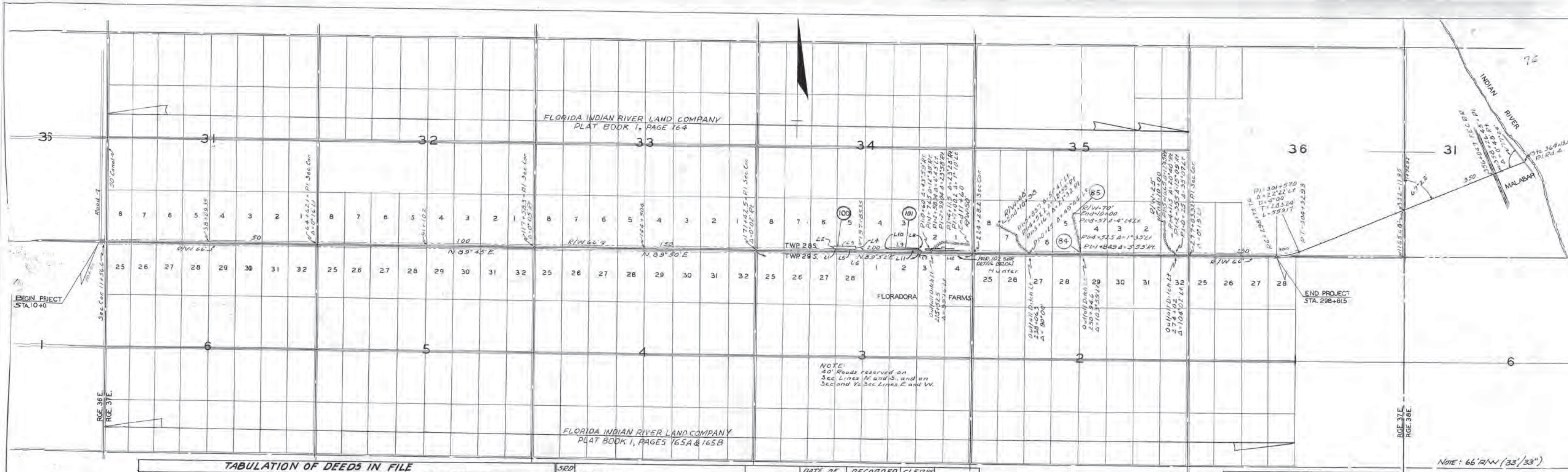


TABULATION OF DEEDS IN FILE

SRD NO.	GRANTOR	INSTRUMENT	DATE OF EXEC.	RECORDED BOOK	RECORDED PAGE	CLERKS NO.	REMARKS
1	Louis Balle et ux	Q.C. Deed	11-16-35	225	426	12093	R/W
2	Henry Ruesken et ux	" "	11-30-35	225	428	12094	"
3	Henry C. Kuck et ux	" "	11-27-35	225	430	12095	"
4	Joseph Stuber et ux	" "	11-22-35	225	432	12096	"
5	Mrs. Irene Kohten, widow	" "	12-16-35	225	434	12097	"
6	A. E. DeWolfe et ux	" "	12-10-35	225	435	12098	"
7	J. L. Kloeppel, single	" "	11-27-35	225	437	12099	"
8	B. J. Kloeppel "	" "	11-27-35	225	440	12100	"
9	Wm. F. Kloeppel et ux	" "	11-18-35	225	443	12102	"
10	Standish Hall et ux	" "	11-19-35	225	442	12101	"
11	Melbourne-Tillman Drainage Dist.	" "	11-19-35	225	406	12083	"
12	Chicago Fraternal Life Assoc.	" "	11-25-35	225	408	12084	"
13	Jessie Smith et vir	" "	11-21-35	225	409	12085	"
14	Miss Caroline Shumaker	" "	12-11-35	225	412	12086	"
15	J. J. Schumacher et ux	" "	11-29-35	225	414	12087	"
16	Frank Applegate et ux	" "	11-26-35	225	416	12088	"
17	F. C. Meinhardt et ux	" "	12-10-35	225	417	12089	"
18	A. O. Rorabaugh et ux	" "	12-10-35	225	420	12090	"
19	C. L. Davidson et ux	" "	12-10-35	225	422	12091	"
20	Louis Kolich et ux	W. "	12-11-35	225	461	12111	"
21	Helga M. Crafton, widow	" "	12-11-35	225	399	12080	"
22	Geo. W. Holt et ux	" "	12-11-35	225	403	12082	"
23	Frank Malounck et ux	" "	12-12-35	225	393	12077	"
24	" " "	" "	12-12-35	225	391	12076	"
25	" " "	" "	12-12-35	225	389	12075	"
26	Frank T. Miller et ux	" "	12-13-35	225	401	12081	"
27A	F. C. Powell et ux	F.S. "	3-6-36	226	263	12440	"
27B	" " "	" "	3-6-36	226	265	12441	"
27	" " "	Q.C. "	12-19-35	225	397	12079	"
28	Anton Baran et ux	W. "	12-11-35	225	457	12109	"
29	Frank Malounck et ux	" "	12-12-35	225	455	12108	"
30	" " "	" "	12-12-35	225	453	12107	"
31	" " "	" "	12-12-35	225	451	12106	"
32	" " "	" "	12-12-35	225	449	12105	"
33	" " "	" "	12-12-35	225	447	12104	"
34	Oscar A. Swain et al	" "	1-11-36	225	459	12110	"
35	Sarah E. Beach, widow	" "	1-10-36	225	445	12103	"
36	Kristina Zika	Q.C. "	1-11-36	225	395	12078	"
37	Tena V. Morrison, widow	W. "	1-13-36	225	463	12112	"
38	P. A. Coggey	" "	1-11-36	225	465	12113	"
39	C. W. Elliott, widower	" "	1-14-36	225	537	12166	"
40	Anton C. Nemanick et ux	" "	1-15-36	225	535	12165	"
41	Peter Schamber et ux	Q.C. "	11- -35	225	531	12163	"
42	C. W. Elliott, widower	Q.C. Deed	1-21-36	255	533	12164	R/W
43	C. L. Davidson et ux	" "	12-10-35	255	423	12092	"
44	Harry A. Levant et ux	W. "	1-17-36	226	33	12242	"
45	" " " "	" "	1-17-36	226	31	12241	"
46	Mary Kennedy Thompson et vir	" "	1-29-36	226	22	12231	"
47	Chas. W. Boynton	Q.C. "	1-24-36	226	20	12230	"
48	Mary Kennedy Thompson et vir	W "	1-29-36	226	18	12229	"
49	" " " "	" "	1-29-36	226	16	12228	"
50	" " " "	" "	1-29-36	226	14	12227	"
51	Fla. Indian River Land Co.	Q.C. "	1-21-36	225	585	12208	"
52	Andrew Hedenberg et ux	W. "	1-25-36	225	565	12189	"
53	J. W. Berglund et ux	" "	1-11-36	225	567	12190	"
54	Lyle H. Gallivan et ux	Q.C. "	12-21-31	226	24	12232	"
55	L. G. Watters et ux	" "	2-4-36	226	99	12300	"
56	Fla. Indian River Land Co.	" "	2-18-36	226	156	12358	"
57	Bertha Olseen et al	W. "	1-17-36	336	101	12301	"
58	Eula H. Bartow et vir	" "	2-6-36	226	201	12401	"
59	Malabar Realty Co.	" "	12-11-35	226	81	12277	"
60	Kristina Zika, widow	" "	3-7-36	226	308	12461	O.F.D.
61	Frank Malounck et ux	" "	4-2-36	227	118	12723	R/W
62	Anton Beran et ux	" "	4-17-36	227	219	12807	O.F.D.
63	W. C. Meagher et ux	Q.C. "	5-21-36	227	558	13051	R/W
64	F. C. Meinhardt et ux	W. "	5-2-36	228	36	13098	"
65	Wm. F. Becker et ux	" "	6-12-36	228	100	13178	"
66	P. K. Groff et ux	Q.C. "	8-1-36	229	15	13530	"
67	D. M. Bradley et ux	" "	7-29-36	229	17	13531	"
68	Jessie I. Booth et vir	" "	6-8-36	228	371	13366	"
69	Grace Porter Bean	P. Rel. Mtg.	10-14-35	29	504	13529	Frank Malounck
70	Baldwin, Lewis, Pace Co.	Q.C. Deed	9-10-36	229	257	13723	R/W
71	W. G. Tubbs et ux	" "	9-10-36	229	315	13772	"
72	Albert Duffner	" "	9-26-36	229	435	13874	"
73	R. B. Zachry et ux	" "	8-15-36	229	202	13697	"
74	R. C. Russell	P. Rel. Mtg.	9-14-36	30	81	13912	"
75	Anna Kieffner et vir	"	9-28-36	30	83	13913	"
76	Knute D. Stalland	"	10-12-36	30	98	13986	"
77	M. C. Stalland	"	10-12-36	30	96	13985	"
78	Federal Farm Mort. Corp.	P. Rel. Mtg. Lien	12-15-36	30	303	14833	"
79	Harvey R. Wallace et ux	W. Deed	1-19-37	231	134	14589	"
80	Howard I. Griffey et ux	Q.C. "	11-25-36	231	110	14576	"
81	F. C. Meinhardt et ux	Easement	10-29-38	242	151	4037	L. Ditch
82	Sarah E. Beach, widow	P. Esmt.	7-15-38	240	578	3385	Ditch
83	VOID- Cadel's Letter 9-7-38						
84	Harry A. Levant et ux	P. Esmt.	6-21-38	240	576	3384	Ditch
85	Anton C. Nemanick et ux	"	7-2-38	240	574	3383	"
86	Brevard Title & Abstract Co.	Abstract					

LINE DATA FOR PARCEL 100
(ALL DATA IS DEED)

LINE NO	BEARING	DISTANCE
L1	N 89° 28' 01" W	40.00'
L2	N 00° 17' 29" W	20.00'
L3	S 89° 28' 01" E	457.74'
L4	S 00° 19' 41" E	20.00'
L5	N 89° 28' 01" W	417.75'

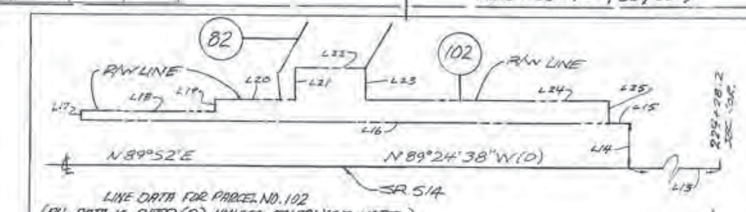
NOTE: PARCEL 100 IS A R/W DONATION.
SEE ORB 5334, PG. 1859
DATED: FEBRUARY 19, 2004.

LINE DATA FOR PARCEL NO. 101.1
(ALL DATA IS DEED (D) UNLESS OTHERWISE NOTED.)

LINE NO.	BEARING	DISTANCE
L6	N 89°52'00"E	3968.93'(D) 3968.12'(C)
L7	N 00°43'38"W	33.00'
L8	N 00°43'38"W	28.00'
L9	S 89°52'00"W	721.15'
L10	S 00°08'00"E	28.00'
L11	N 89°52'00"E	721.44'
L12	N 89°52'00"E	1317.85'(D) 1317.58'(C)

NOTE: PARCEL 101.1 IS A R/W DONATION TO THE STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION PER O.R. BK. 5809, PG. 7968 OF THE PUBLIC RECORDS OF BREVARD COUNTY, FL. DATED 08/10/2007

NOTE: 66' R/W (33'/33")



LINE DATA FOR PARCEL NO. 102
(ALL DATA IS DEED (D) UNLESS OTHERWISE NOTED.)

LINE	BEARING	LENGTH
L13	N 89°24'38"W	659.34'(D) 659.21'(C)
L14	N 00°04'19"E	33.00'
L15	N 89°24'38"W	15.00'
L16	N 89°24'38"W	375.00'
L17	N 00°35'22"E	7.40'
L18	S 89°24'38"E	93.16'
L19	N 00°35'22"E	7.82'
L20	S 89°24'38"E	58.75'
L21	N 00°35'22"E	22.35'
L22	S 89°24'38"E	50.00'
L23	S 00°35'22"W	22.31'
L24	S 89°24'38"E	173.45'
L25	S 00°04'19"W	15.26'

NOTE: PARCEL 102 IS A R/W DONATION TO THE STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION, FROM MIMA REAL STATE, LLC TRANSFER EXECUTED ON JANUARY 26, 2009 PER OR. BK. 5913, PAGE 9631 OF THE PUBLIC RECORDS OF BREVARD COUNTY, FL.

1" = 60'

7018

The above shows existing alignment as of Jan. 16, 1940.

Div. Engr. of R/W

REVISION	BY	DATE	REVISION	BY	DATE
			Add Par. 102	S. Johnson	10-29-09
			Add Parcel 101	J. Shepherd	2-25-08
Add Par. 84 & 85	J. Shepherd	9-02-10	Add Parcel 100	GJY	1-14-05

APPROVED:
STATE HIGHWAY ENGINEER

S.R. 514

Rd. No. 51

STATE OF FLORIDA
STATE ROAD DEPARTMENT

RIGHT OF WAY MAP

PROJECT W.P.S.O. 181 ROAD (19)
FORMERLY N.F.P. 1089

BREVARD COUNTY

SCALE 1" = 1000'

SHEET 1 OF 1