STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION

TECHNICAL REPORT COVERSHEET

650-050-38
ENVIRONMENTAL
MANAGEMENT
08/22

DRAFT LOCATION HYDRAULICS REPORT

Florida Department of Transportation

District 5

S.R. 60 Project Development and Environment (PD&E) Study

Limits of Project: Prairie Lake Road to Florida's Turnpike

Osceola County, Florida

Financial Management Number: 452574-1

ETDM Number: 14563

Date: June 2025

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 dated May 26, 2022 and executed by the Federal Highway Administration and FDOT.

Authorized Signature

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Issue and revision record

Revision	Date	Originator	Checker	Approver	Description

Document reference: 452574-1-22-01

Information class: Standard

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The above named Professional Engineer shall be responsible for the following sheets in accordance with Rule 61G15-23.004, F.A.C.

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1 Introduction

1.1 Purpose

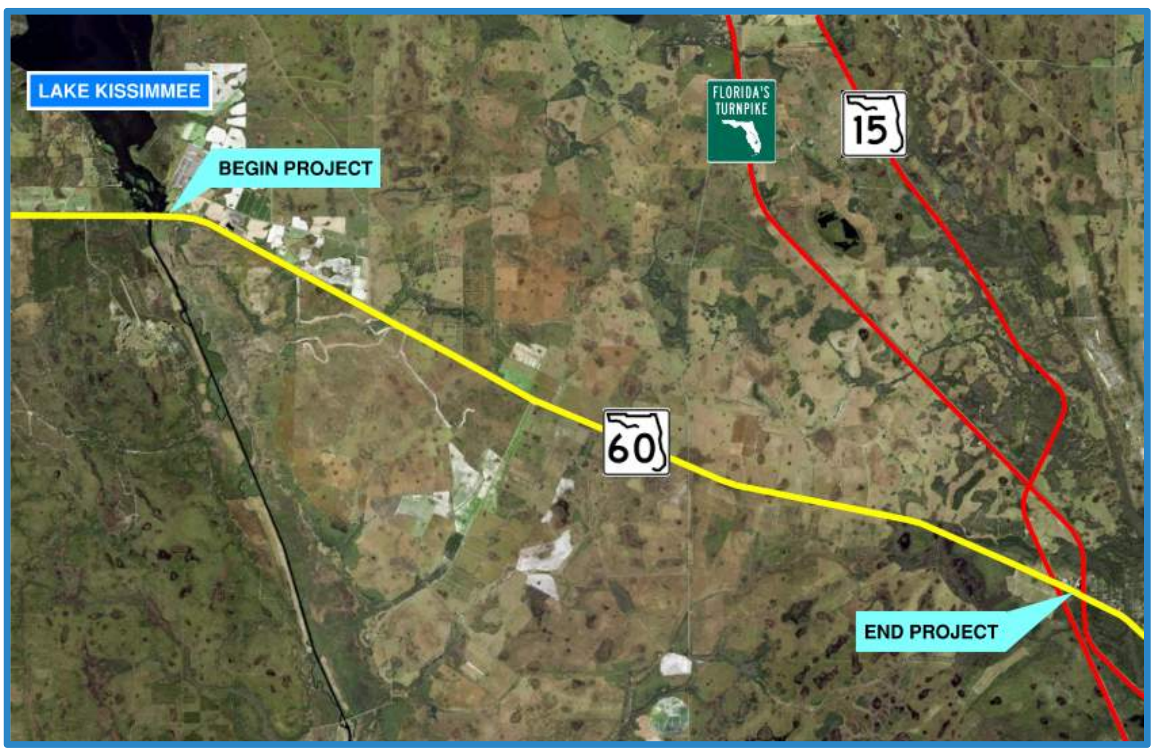
Mott MacDonald (MM) has been authorized by Volkert, Inc. on behalf of the FDOT to prepare planning documents for the SR 60 improvements in Osceola County. This project begins at Prairie Lake Road on the east side of Lake Kissimmee and ends just west of the bridge crossing over SR 91 (Florida's Turnpike).

The development of a Location Hydraulics Report is essential in the preparation of the SR 60 design improvements. The primary goal of the report is to identify and evaluate floodplain impacts created by the project.

1.2 Project Description

This project involves the improvement of SR 60 from Prairie Lake Road to SR 91 in Osceola County, approximately 20 miles in total mainline length. A project location map is provided in **Figure 1**.

Figure 1 – Project Location Map



The existing roadway is classified as a rural principal arterial and is a two-lane, undivided roadway consisting of two 12-foot travel lanes with 4-foot outside paved shoulders in each direction.

The proposed improvements include widening to four, 12-foot travel lanes with 5-foot paved outside shoulders and 4-foot paved inside shoulders on both sides of the roadway. A median will be constructed to provide division between the opposing travel lanes. The purpose of the proposed roadway is to improve safety with considerations to the Target Zero Initiative. The project further aims to improve regional mobility by adding capacity to the mainline, which also increases safety for motorists and bicyclists, as well as increasing emergency evacuation accessibility in the surrounding areas.

This project was evaluated through FDOT's Efficient Transportation Decision Making (ETDM) process. It is designated as project #14563. Feedback from the Environmental Technical Advisory Team (ETAT) was compiled in the Preliminary Programming Screen that was published on November 26, 2024. The impact of the proposed project was evaluated in this screen for many factors such as natural, physical, social resources, etc.

This project is located in Sections 1, 2, 11, and 12, Township 31 South, Range 31 East, Sections 1, 7, 8, 12, 15, 16, 17, 18, 22, 23, 25, 26, 29, 30 31, 32, 33, and 34, Township 31 South, Range 33 East, and Sections 5, 6, 8, 9, 10, 14, and 15, Township 32 South, Range 34 East. Elevations in this report are based on the 1988 North American Vertical Datum (NAVD).

2 Existing Conditions

2.1 Roadway

The existing typical section from the begin project to SR 15 (US 441) is a two-lane, undivided roadway consisting of two 12-foot travel lanes, as well as 4-foot outside paved shoulders in each direction. Within these limits, there are four sections of roadway that widen out to provide a passing lane. There are two passing lanes for both eastbound and westbound directions. These passing lanes are typically about 1 mile in length and provide an additional 12-foot wide lane.

Between US 441 and SR 91, the existing roadway uses a three-lane section with a two-way left turn lane separating the eastbound and westbound travel lanes. East of the SR 91 on and off-ramps, the roadway transitions to a four-lane, divided roadway prior to the overpass bridges over SR 91.

2.2 Drainage

Existing drainage infrastructure and patterns were evaluated by review of the project location through existing as-built plans and other available FDOT construction plans, Straight Line Diagrams (SLD) of Road Inventory, Geographic Information System (GIS) maps, and Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs). Further existing permit information was obtained from the St. Johns River Water Management District (SJRWMD) and the South Florida Water Management District (SFWMD).

The project limits span over six primary drainage basins and discharge into two Hydrologic Unit Code (HUC) Basins. Lake Kissimmee, Blanket Bay Slough and Skeeter Slough drain into the Kissimmee River (HUC 03090101). Lokosee ditches, unnamed ditch near Yeehaw Junction, and unnamed tributary to Cow Log Branch drain into the Upper St. Johns (HUC 03080101).

The land use is primarily agriculture with commercial and mixed use near US 441 and SR 91. The existing drainage for SR 60 from Prairie Lake Road to SR 91 consists predominantly of flat, open ditches that convey runoff to existing cross drain locations. Runoff generally leaves the right-of-way at these cross drain locations to either an existing channel or a man-made ditch. Much of the surrounding area is used for agricultural purposes and irrigation ditches or canals are present just outside the existing right-of-way in many locations on the project. Most of these irrigation canals are located on the north side of the roadway and many do not receive any flow from the Department's right-of-way unless under an extreme event. These locations are generally assumed to be isolated basins that contain runoff from offsite areas. However, there are some locations where runoff does leave the R/W and drain into these man-made canals. Refer to **Appendix D** for Drainage Maps of the project area.

2.2.1 *Basin Divides and Outfalls*

The existing drainage divides were determined using one-foot contours generated from LiDAR data from NOAA Coastal Service Center's Digital Coast Data Access Viewer and the USGS topographic quad maps.

Overall, the project was delineated into 27 mainline subbasins as shown in the Drainage Maps. All basins are considered open basins. **Table 1** below lists the limits of the existing drainage basins and the associated cross drains.

Table 1 – Basin Limits and Cross Drains

Basin No.	Existing Basin Limits		Waterbody ID	Watershed	WMD	Outfall	
	From Station	To Station				Type	Station
1	14+10.00	72+50.00	3183E2	Lake Kissimmee	SFWMD	Ditch	20+00
2	72+50.00	158+75.00	3186G	Blanket Bay Slough	SFWMD	30" CD	134+63
3	158+75.00	188+45.00	3186G	Blanket Bay Slough	SFWMD	30" CD	179+38
4	188+45.00	214+45.00	3186G	Blanket Bay Slough	SFWMD	36" CD	197+93
5	214+45.00	257+00.00	3186G	Blanket Bay Slough	SFWMD	30" CD	231+91
6	257+00.00	290+75.00	3186G	Blanket Bay Slough	SFWMD	Bridge	290+75
7	290+75.00	324+90.00	3186G	Blanket Bay Slough	SFWMD	Bridge	290+75
8	324+90.00	357+30.00	3186G	Blanket Bay Slough	SFWMD	24" CD	326+17
9	357+30.00	386+80.00	3186G	Blanket Bay Slough	SFWMD	24" CD	359+88
10	386+80.00	402+50.00	3186G	Blanket Bay Slough	SFWMD	30" CD	391+46
11	402+50.00	477+55.00	3186F	Skeeter Slough	SFWMD	36" CD	415+23
12	477+55.00	487+00.00	3186F	Skeeter Slough	SFWMD	24" CD	481+92
13	487+00.00	551+95.00	3186F	Skeeter Slough	SFWMD	8'X3' CBC	540+56
14	551+95.00	570+30.00	3186F	Skeeter Slough	SFWMD	24" CD	562+90
15	570+30.00	611+70.00	3186F	Skeeter Slough	SFWMD	8'X3' CBC	584+20
16	611+70.00	632+75.00	3186F	Skeeter Slough	SFWMD	30" CD	626+59
17	632+75.00	670+60.00	3186F	Skeeter Slough	SJRWMD	30" CD	638+99
18	670+60.00	695+10.00	3186F	Skeeter Slough	SJRWMD	30" CD	684+77
19	695+10.00	757+40.00	3186F	Skeeter Slough	SJRWMD	30" CD	705+90
20	757+40.00	812+90.00	3186F	Skeeter Slough	SJRWMD	24" CD	782+44
21	812+90.00	869+55.00	3148	Unnamed Ditch Near Yeehaw Junction	SJRWMD	6'X3' CBC	860+86
22	869+55.00	889+65.00	3143	Lokosee Ditches	SJRWMD	6'X3' CBC	872+89
23	889+65.00	915+80.00	3148	Unnamed Ditch Near Yeehaw Junction	SJRWMD	36" CD	912+04
24	915+80.00	937+90.00	3148	Unnamed Ditch Near Yeehaw Junction	SJRWMD	36" CD	929+65
25	937+90.00	999+20.00	3148	Unnamed Ditch Near Yeehaw Junction	SJRWMD	8'X5' CBC	959+64
26	999+20.00	1046+35.00	3148	Unnamed Ditch Near Yeehaw Junction	SJRWMD	CD – Size Unknown	1039+29
27	1046+35.00	1079+70.00	3148	Unnamed Ditch Near Yeehaw Junction	SFWMD	19"x30" CD	1068+00

3 Proposed Conditions

3.1 Proposed Roadway Configuration

The proposed roadway improvements strive to improve safety by accounting for the Target Zero Initiative. The capacity and operations for this roadway will be improved by utilizing both rural and urban typical sections.

For much of the project, the existing roadway will be reconstructed to use a rural typical. This will include two 12-foot lanes, a 5-foot paved outside shoulder, and 4-foot paved inside shoulder in each direction. A 40-foot median will be constructed to divide the eastbound and westbound lanes. Most of the project will utilize a 15-foot wide ditch to provide linear retention for stormwater requirements. This ditch is proposed to be constructed 3-feet above the seasonal high water level to provide sufficient separation from the water table and improve recovery performance. A modified version of this typical section is proposed to be used at the beginning of the project to reduce the footprint and impacts of the roadway. This modified rural typical section will have the same roadway characteristics, but will not use linear retention for stormwater requirements. Instead, a minimal ditch will be constructed on either side of the roadway to collect runoff. A closed drainage system will be used to collect runoff from this ditch and convey it to an offsite stormwater pond.

As the roadway nears US 441, the typical section will transition to an urban typical section to minimize impacts. This typical section will consist of two 12-foot lanes and a 7-foot bike lane on each side of the roadway separated by a 22-foot median. Type E curb will be used along the median and Type F curb constructed along the outside of the roadway. 6-foot sidewalks will be constructed on either side directly behind the curb and gutter. Figures 2, 3 and 4 illustrate the proposed typical sections for the roadway.

Figure 2 – Roadway Typical Section 1

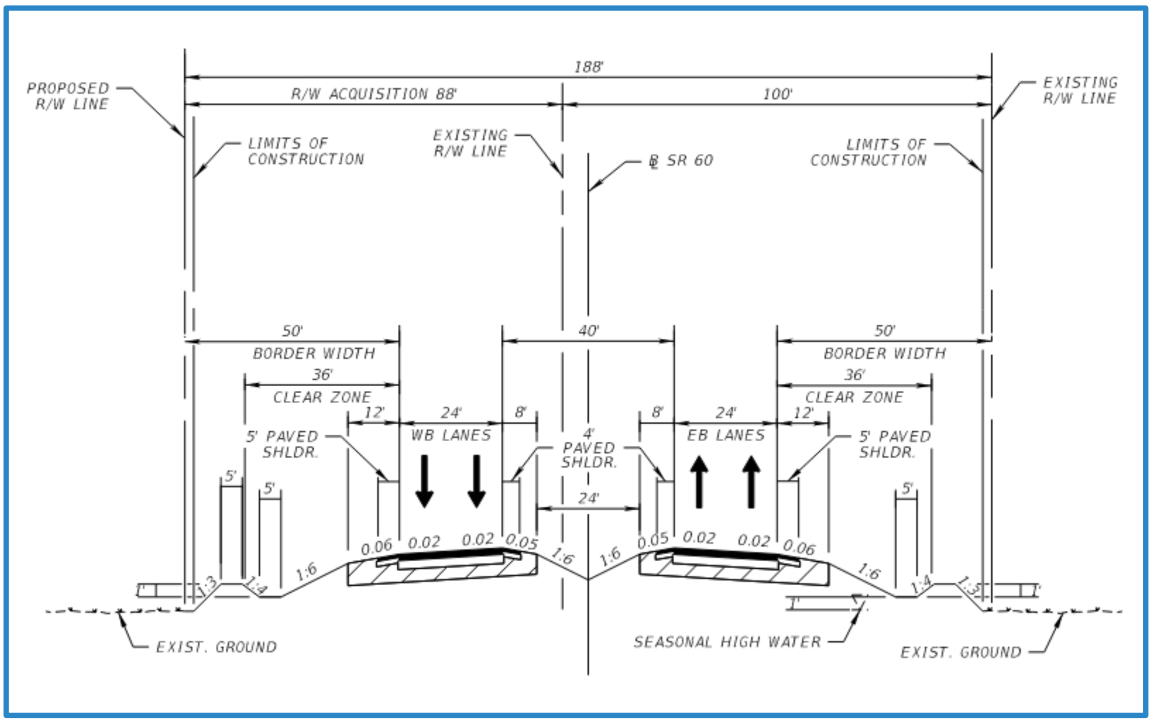


Figure 3 – Roadway Typical Section 2

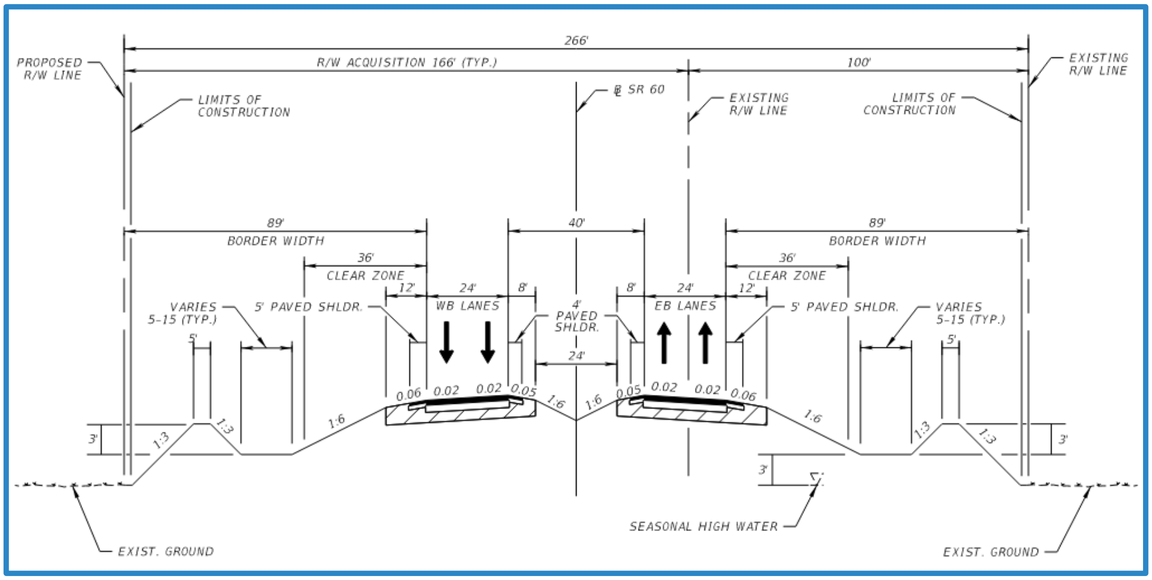
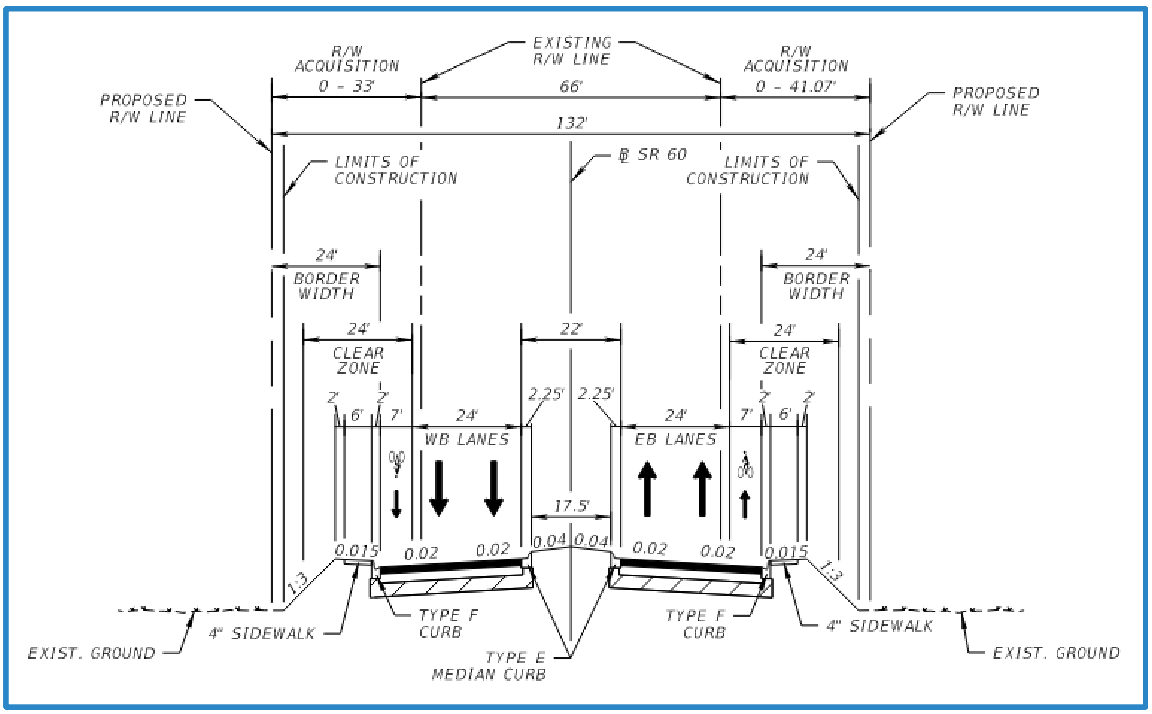


Figure 4 – Roadway Typical Section 3



3.2 Proposed Drainage

Most of the project will utilize linear retention on either side of the roadway for stormwater requirements. Runoff from the median will be conveyed in a ditch and collected in ditch bottom inlets and piped under the roadway to the linear retention pond on either side of the roadway. The linear retention systems will be sized to provide sufficient treatment and attenuation volume for the basins. Outfall systems will discharge runoff from the linear treatment systems to the existing outfall location, which is typically near the existing cross drains.

As mentioned in the previous section, the beginning portion of the project will have a rural typical section but will not use linear retention for stormwater. This section of roadway will instead have minimal roadside ditches with an inlet system within the ditch to collect and convey runoff to an offsite stormwater pond. Similarly, the end of the project will use an urban typical section that will have a closed system to collect runoff along the curb and gutter and this system will be piped to an offsite stormwater pond.

Offsite drainage conditions for all basins will be maintained and routed to existing cross drains and outfalls. Unless unavoidable, these offsite basins will not be co-mingled with the onsite runoff from SR 60.

4 Cross Drain Evaluation

There are currently 24 cross drains within the project limits. These cross drains were summarized in Section 2 of this report in Table 1. FDOT straight line diagrams were used to identify the location and size of the existing crossings. Refer to **Appendix E** for these diagrams.

FDOT Maintenance was contacted during the pre-advertisement and did not note any specific drainage or flooding concerns within the limits. Per the *FDOT Drainage Design Guide* Section 4.7.1, Method 1 was chosen for conducting hydrologic and hydraulic analysis since there are no known historical problems in the area. Method 1 estimates the 25-year discharge using the culvert area and an assumed velocity of 6 feet per second. The 100-year flow was estimated as being 40% larger than the 25-year discharge and the 500-year flow was estimated as being 70% larger than the 100-year discharge. The 50-year discharge was then determined reading from a best fit curve of flow vs. frequency of the 25, 100, and 500-year events. A hydraulic analysis was then conducted to estimate stages for these various frequency events using FHWA HDS 5 techniques. All charts listed below are within the FHWA Hydraulic Design of Highway Culverts – Hydraulic Design Series Number 5 (HDS 5).

Headwaters were calculated for both inlet and outlet control conditions. For inlet control, headwater depths were determined using data from Chart 1B for pipes and from Chart 8B for box culverts. For outlet control, entrance loss coefficients (Ke) were selected based on the type of end treatments for the pipe or box culvert. Factors for pipes were then determined using Charts 5B and 4B. Factors for box culverts were determined using Chart 15B and 14B.

The controlling headwater condition, either inlet or outlet control, was determined for each cross drain based on the higher computed stage. Refer to **Appendix C** for the cross drain calculations. These results gave preliminary recommendations for replacement, resizing, or rehabilitation of existing structures to ensure compliance with FDOT hydraulic performance criteria. Based on the methodology used, many of the cross drains show headwaters for the design event that are higher than the existing shoulder point. During the design phase, a full hydrologic and hydraulic analysis should be performed that would account for the characteristics of the contributing basin. The proposed roadway will likely be raised significantly above existing at most cross drain locations. Therefore, meeting headwater requirements for the design storm is likely not a concern, but raising the stages of areas outside of the right-of-way should be evaluated.

There is one existing bridge within the project limits. SR 60 currently crosses over Blanket Bay Slough with an approximately 120-foot bridge (#920172) that was constructed in 1999. A separate Bridge Hydraulics Report has not been prepared as part of this PD&E Study.

5 Floodplain Evaluation

Flood Insurance Rate Maps (FIRMs) published by the Federal Emergency Management Agency (FEMA) were reviewed to assess potential floodplain involvement within the project limits **(see Table 2**). The current effective FIRMs for Osceola County, dated 2013, indicate multiple areas of encroachment into Special Flood Hazard Zone A, and one area of encroachment into Zone AE. Refer to **Appendix A** for the FEMA FIRM panels within the project limits.

Table 2 – FEMA FIRMs

Map No.	Effective Date
12097C0725G	6/18/2013
12097C0750G	6/18/2013
12097C0850G	6/18/2013
12097C0875G	6/18/2013

As required by the applicable water management districts, the project must avoid any net loss of flood storage volume within the 100-year floodplain. Given the proposed roadway improvements and the ultimate typical section, all designated floodplain areas located within the project right-of-way are anticipated to be impacted. Consequently, floodplain compensation will be necessary to offset the loss of storage volume.

Fifteen locations have been identified that will impact the FEMA floodplain. These locations are identified on the FEMA FIRM panels in **Appendix A** and summarized in Table 3. Most of these encroachments are considered transverse, however there are some locations of longitudinal encroachments. These longitudinal impacts are due to impacts to existing irrigation ditches and low areas that run parallel to SR 60. As discussed in the Conceptual Drainage Design Report, many of these irrigation ditches are to be impacted due to the widening of the roadway. It is anticipated that many of these would be reconstructed by the property owner outside of the proposed right-of-way to maintain patterns of their existing agricultural facilities. Most of the surrounding project area is used for agriculture or is undeveloped. Some of the undeveloped areas are conservation areas. Due to the characteristics of the surrounding area, the floodplain encroachments are considered minimal. There is floodplain involvement, but these encroachments will not impact human life or transportation facilities. Mitigation to these impacts can be resolved with minimal efforts.

Floodplain A is the only location that is within Zone AE. All other floodplain areas are within Zone A and therefore do not have a base flood elevation identified. To estimate impacts to the floodplain, preliminary cross sections were created using available LiDAR data and an approximate proposed typical section. These sections were drawn at each end of a floodplain area and every 500-feet in between. A floodplain elevation was then drawn in the cross section, using either the base flood elevation provided for Zone AE or an approximate elevation of the Zone A floodplain areas using the LiDAR data. Fill impacts were then drawn within each cross section for areas of proposed fill below the approximated floodplain elevation. Volumes of impacts for each floodplain area were calculated using the average end-area method. Refer to **Appendix B** for the floodplain impact calculations.

The floodplain impacts shown will need to be mitigated for using floodplain compensation sites. Floodplain compensation sites have not been identified as part of this PD&E Study, as only the estimated volume of floodplain compensation has been quantified. Compensation sites will need to ensure that there is sufficient fill below the floodplain elevation and above seasonal high water table that can be excavated out to provide an offset to fill added as part of this project.

Table 3 – Estimated Floodplain Impacts Areas for North Shift Alternative

Floodplain	Flood Zone	Base Flood Elevation (ft)	Floodplain Encroachment Volume (acre-feet)
A	AE	54	11.14
B	A	-	2.47
C	A	-	5.93
D	A	-	12.34
E	A	-	10.57
F	A	-	2.04
G	A	-	15.65
H	A	-	0.10
I	A	-	28.23
J	A	-	7.66
K	A	-	2.76
L	A	-	6.98
M	A	-	10.10
N	A	-	6.77
O	A	-	0.05
		TOTAL	**122.78**

6 Conclusion

The roadway widening of SR 60 from Prairie Lake Road to SR 91 will impact numerous floodplains with the project limits. An estimation of these impacts has been quantified. Mitigation to offset these impacts will be needed and specific compensation sites will be identified during the design phase of the project. Existing cross drains have also been evaluated for estimation of flow rates and headwaters at each crossing location. This report is preliminary and should be used as a tool for evaluation of potential impacts to the floodplains and performance of cross drains within the project. Any assumptions made within this report will be verified and updated through the design process.

APPENDIX A – FEMA Flood Insurance Rate Maps

NOTES TO USERS

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

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

Coastal Base Flood Elevations (BFEs) shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Transverse Mercator State Plane Florida East FIPS 0901. The **horizontal datum** was NAD83 HARN, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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

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

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

Base map information shown on this FIRM was provided in digital format by the Osceola County Planning Office. Orthophotography was collected in late 2007 early 2008.

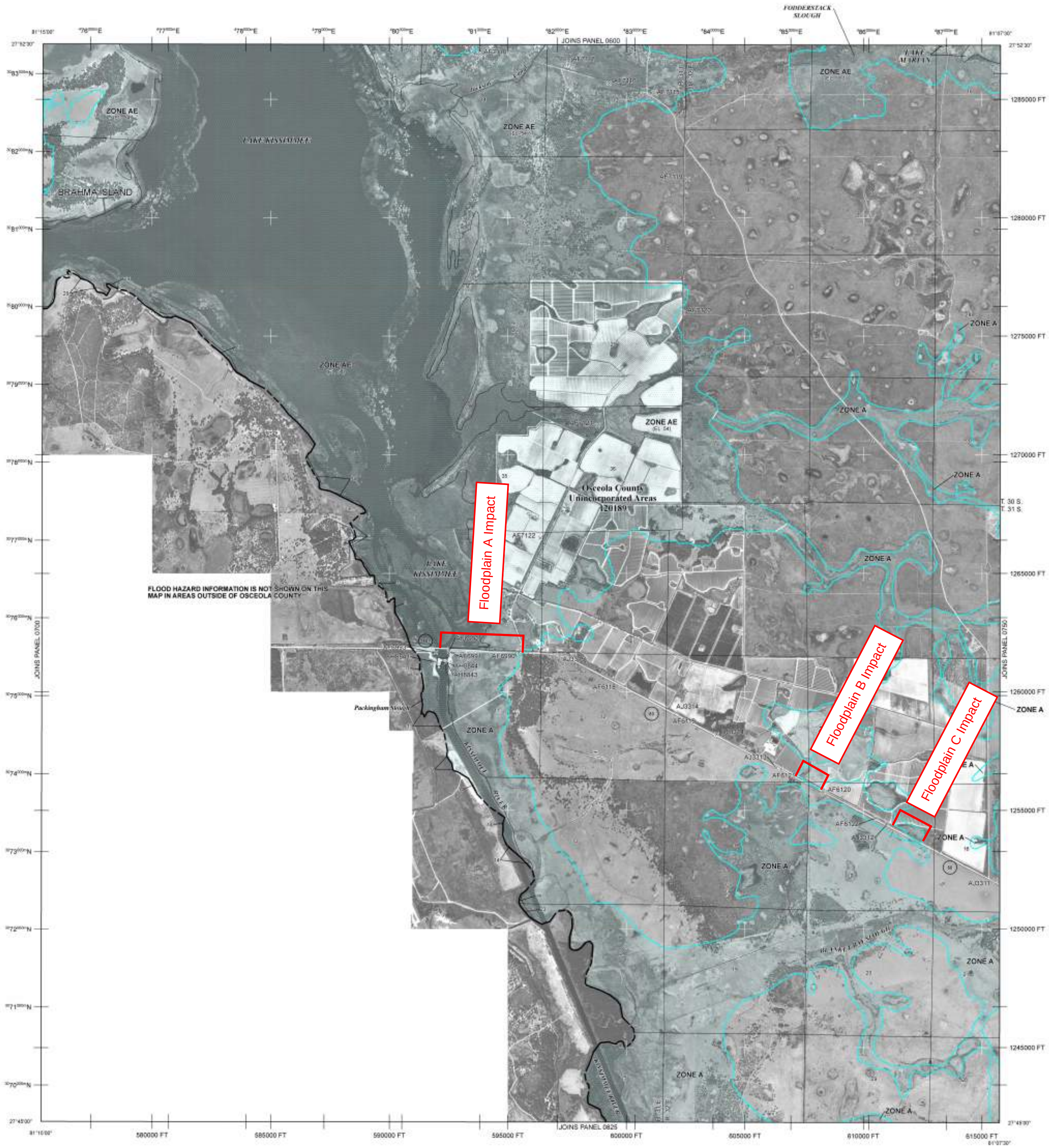
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result,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

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

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

For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the **FEMA Mapping Information eXchange** at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service website at http://www.msc.fema.gov/. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the website. Users may determine the current map date for each FIRM panel by visiting the FEMA Map Service Center website or by calling the FEMA Map Information eXchange.

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



LEGEND

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

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

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Areas to be protected from 1% annual chance flood event by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

	1% annual chance floodplain boundary
	0.2% annual chance floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities
~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)———(A)	Cross section line
(23)- - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
⁴²75⁰⁰⁰ᵐE	1000-meter Universal Transverse Mercator grid ticks, zone 17
6000000 FT	5000-foot grid values: Florida State Plane coordinate system, East Zone (FIPSZONE = 0901), Transverse Mercator projection
DX5510 x	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories List on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
MAY 7, 2001

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
JUNE 6, 2001 - To correct datum reference note.

JUNE 18, 2013 - To update corporate limits, change Base Flood Elevations, add Base Flood Elevations, change Special Flood Hazard Areas, change zone designations, update roads and road names, incorporate previously issued Letters of Map Revision, and reflect updated topographic information.

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

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

MAP SCALE 1" = 2000'

1,000 0 1,000 2,000 3,000 4,000 FEET

500 0 500 1,200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0725G

FIRM

FLOOD INSURANCE RATE MAP

OSCEOLA COUNTY, FLORIDA

AND INCORPORATED AREAS

PANEL 725 OF 900

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
OSCEOLA COUNTY	120189	0725	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
12097C0725G

MAP REVISED
JUNE 18, 2013

Federal Emergency Management Agency

NOTES TO USERS

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Coastal Base Flood Elevations (BFEs) shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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The **projection** used in the preparation of this map was Transverse Mercator State Plane Florida East FIPS 0901. The **horizontal datum** was NAD83 HARN, GRS1980 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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

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

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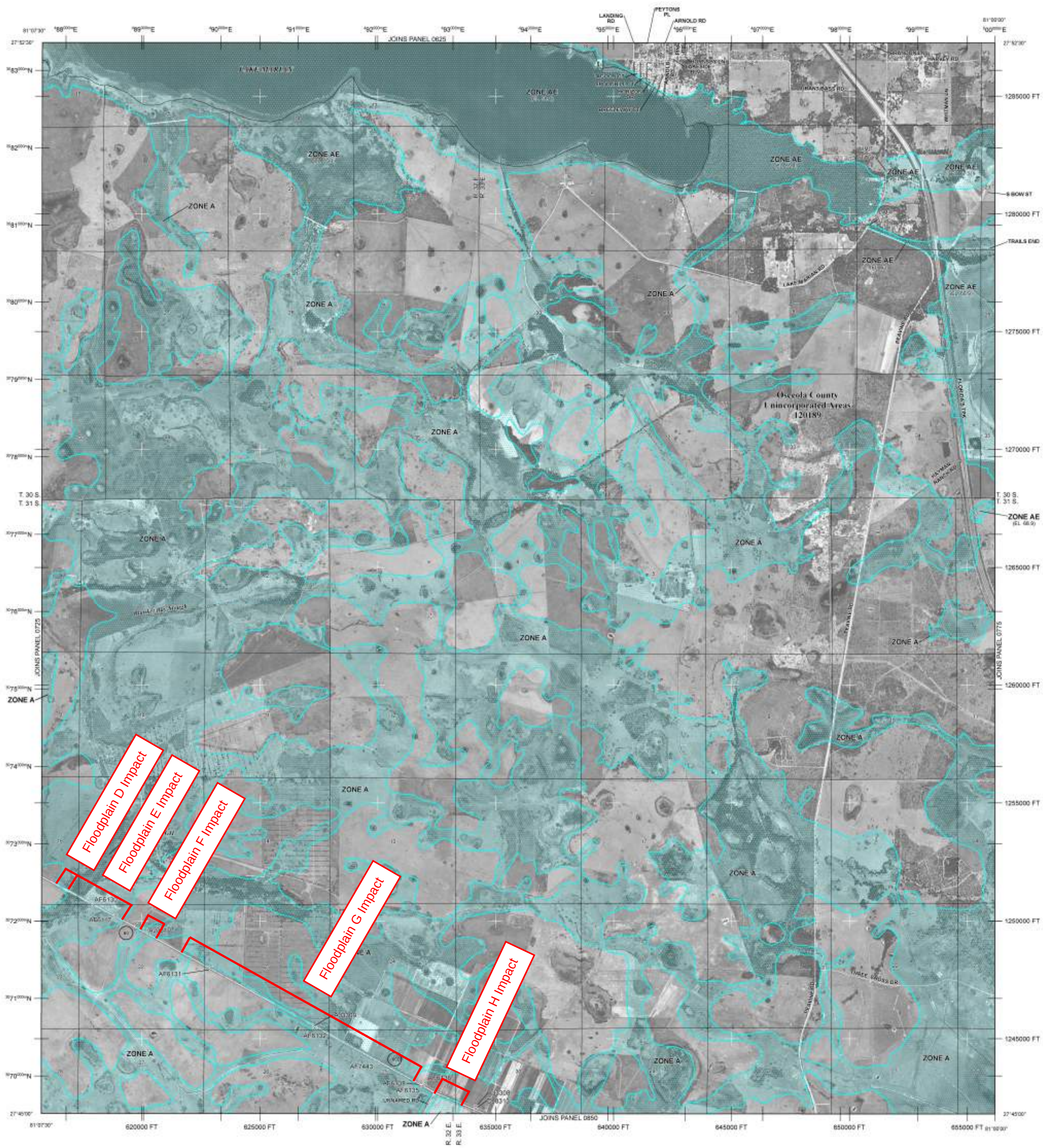

LEGEND

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

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

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Areas to be protected from 1% annual chance flood event by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

	1% annual chance floodplain boundary
	0.2% annual chance floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)——(A)	Cross section line
(23)- - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
4275000mE	1000-meter Universal Transverse Mercator grid ticks, zone 17
6000000 FT	5000-foot grid values: Florida State Plane coordinate system, East Zone (FIPSZONE = 0901), Transverse Mercator projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories List on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
MAY 7, 2001

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
JUNE 6, 2001 - To correct datum reference note.

JUNE 18, 2013 - To update corporate limits, change Base Flood Elevations, add Base Flood Elevations, change Special Flood Hazard Areas, change zone designations, update roads and road names, incorporate previously issued Letters of Map Revision, and reflect updated topographic information.

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MAP SCALE 1" = 2000'

1000 0 1000 2000 3000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0750G

FIRM

FLOOD INSURANCE RATE MAP

OSCEOLA COUNTY, FLORIDA

AND INCORPORATED AREAS

PANEL 750 OF 900

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
OSCEOLA COUNTY	120189	0750	G

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MAP NUMBER
12097C0750G

MAP REVISED
JUNE 18, 2013

Federal Emergency Management Agency

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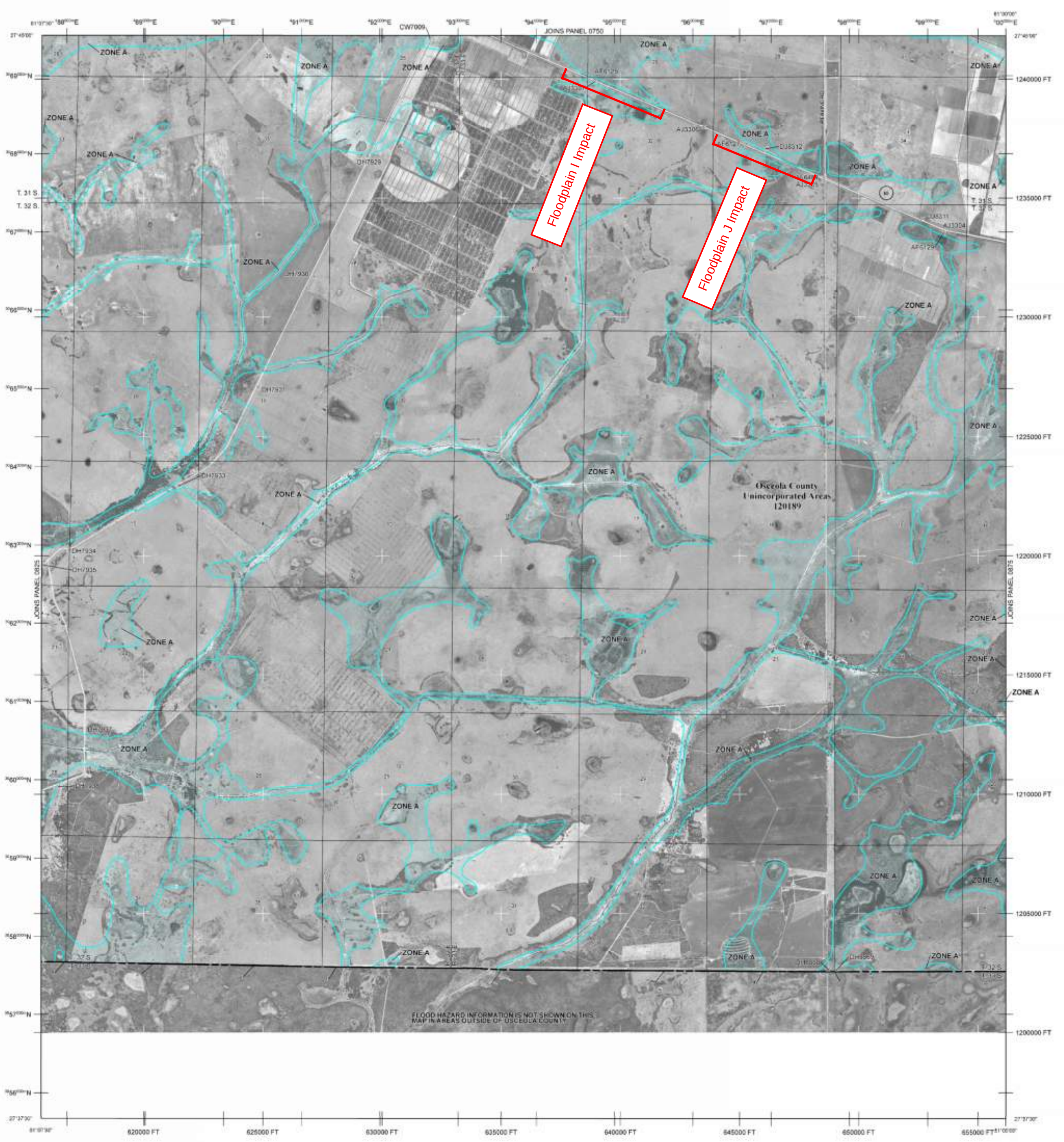

LEGEND

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FLOODWAY AREAS IN ZONE AE

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OTHER FLOOD AREAS

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

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COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

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1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities

~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)——(A)	Cross section line
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MAP REPOSITORIES
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EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
MAY 7, 2001

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
JUNE 6, 2001 - To correct datum reference note.

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NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0850G

FIRM
FLOOD INSURANCE RATE MAP
OSCEOLA COUNTY, FLORIDA
AND INCORPORATED AREAS

PANEL 850 OF 900

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
OSCEOLA COUNTY	120189	0850	G

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MAP NUMBER
12097C0850G

MAP REVISED
JUNE 18, 2013

Federal Emergency Management Agency

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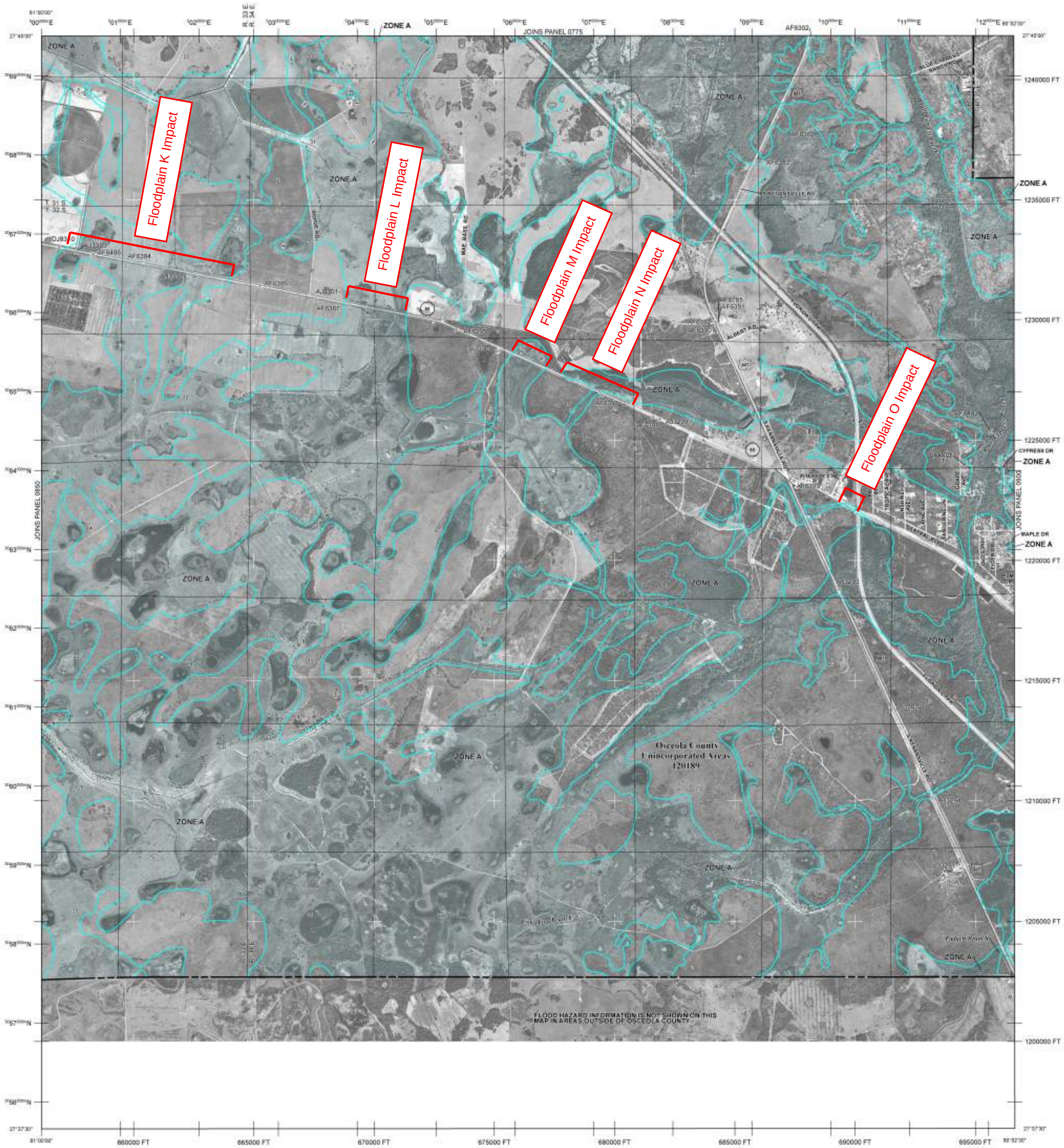

LEGEND

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OTHER FLOOD AREAS

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MAY 7, 2001

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NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0875G

FIRM

FLOOD INSURANCE RATE MAP

OSCEOLA COUNTY, FLORIDA

AND INCORPORATED AREAS

PANEL 875 OF 900

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
OSCEOLA COUNTY	120189	0875	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
12097C0875G

MAP REVISED
JUNE 18, 2013

Federal Emergency Management Agency

APPENDIX B – Floodplain Impact Calculations

Floodplain A Impacts						
Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)	Volume (CY)	Volume (acre-ft)
1006+00	**750**	375				
			700	226,399	8,385	5.197
1013+00	**543.71**	271.855				
			200	57,438	2,127	1.319
1015+00	**605.04**	302.52				
			500	95,233	3,527	2.186
1020+00	**156.82**	78.41				
			500	50,195	1,859	1.152
1025+00	**244.74**	122.37				
			500	41,608	1,541	0.955
1030+00	**88.12**	44.06				
			500	12,790	474	0.294
1035+00	**14.2**	7.1				
			400	1,420	53	0.033
1039+00	**0**	0				

TOTAL	17,966 CY	11.136 acre-ft

Floodplain B Impacts								
Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)		Volume (CY)		Volume (acre-ft)
1165+00	**0**	0						
			500	34,060		1,261		0.782
1170+00	**272.48**	136.24						
			500	53,810		1,993		1.235
1175+00	**158**	79						
			300	19,516		723		0.448
1178+00	**102.21**	51.105						

TOTAL	3,977 CY	2.465 acre-ft

Floodplain C Impacts								
Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)		Volume (CY)		Volume (acre-ft)
1210+00	**290.86**	145.43						
			500	85,850		3,180		1.971
1215+00	**395.94**	197.97						
			500	98,711		3,656		2.266
1220+00	**393.75**	196.875						
			500	73,663		2,728		1.691
1225+00	**195.55**	97.775						

TOTAL	9,564 CY	5.928 acre-ft

Floodplain D Impacts								
Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)		Volume (CY)		Volume (acre-ft)
1265+00	**86.44**	43.22						
			500	68,600		2,541		1.575
1270+00	**462.36**	231.18						
			500	161,788		5,992		3.714
1275+00	**831.94**	415.97						
			500	307,100		11,374		7.050
1280+00	**1624.86**	812.43						

TOTAL	19,907 CY	12.339 acre-ft

Floodplain E Impacts								
Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)		Volume (CY)		Volume (acre-ft)
1280+00	**1624.86**	812.43						
			500	279,289		10,344		6.412
1285+00	**609.45**	304.725						
			500	123,839		4,587		2.843
1290+00	**381.26**	190.63						
			500	52,529		1,946		1.206
1295+00	**38.97**	19.485						
			500	4,871		180		0.112
1300+00	**0**	0						
			500	0		0		0.000
1305+00	**0**	0						

TOTAL	17,057 CY	10.572 acre-ft

Floodplain F Impacts								
Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)		Volume (CY)		Volume (acre-ft)
1310+00	**263.04**	131.52						
			500	53,539		1,983		1.229
1315+00	**165.27**	82.635						
			500	28,014		1,038		0.643
1320+00	**58.84**	29.42						
			500	7,355		272		0.169
1325+00	**0**	0						

TOTAL	3,293 CY	2.041 acre-ft

Floodplain G Impacts

Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)	Volume (CY)	Volume (acre-ft)
1330+00	**537.71**	268.855				
			500	121,918	4,515	2.799
1335+00	**437.63**	218.815				
			500	111,591	4,133	2.562
1340+00	**455.1**	227.55				
			500	113,655	4,209	2.609
1345+00	**454.14**	227.07				
			500	111,729	4,138	2.565
1350+00	**439.69**	219.845				
			500	88,683	3,285	2.036
1355+00	**269.77**	134.885				
			500	59,925	2,219	1.376
1360+00	**209.63**	104.815				
			500	74,081	2,744	1.701
1365+00	**383.02**	191.51				
			500	90,294	3,344	2.073
1370+00	**339.33**	169.665				
			500	68,940	2,553	1.583
1375+00	**212.19**	106.095				
			500	71,319	2,641	1.637
1380+00	**358.36**	179.18				
			500	69,124	2,560	1.587
1385+00	**194.63**	97.315				
			500	30,411	1,126	0.698
1390+00	**48.66**	24.33				
			500	11,476	425	0.263
1395+00	**43.15**	21.575				
			500	37,519	1,390	0.861
1400+00	**257**	128.5				
			500	125,324	4,642	2.877
1405+00	**745.59**	372.795				
			500	115,283	4,270	2.647
1410+00	**176.67**	88.335				
			500	75,476	2,795	1.733
1415+00	**427.14**	213.57				
			500	86,981	3,222	1.997
1420+00	**268.71**	134.355				
			500	76,421	2,830	1.754
1425+00	**342.66**	171.33				
			500	86,236	3,194	1.980
1430+00	**347.23**	173.615				
			500	64,975	2,406	1.492
1435+00	**172.57**	86.285				
			500	30,180	1,118	0.693
1440+00	**68.87**	34.435				
			500	8,609	319	0.198
1445+00	**0**	0				

TOTAL	25,244 CY	15.647 acre-ft

Floodplain H Impacts								
Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)		Volume (CY)		Volume (acre-ft)
1455+00	**0**	0						
			500	2,151		80		0.049
1460+00	**17.21**	8.605						
			500	2,151		80		0.049
1465+00	**0**	0						

TOTAL	159 CY	0.099 acre-ft

Floodplain I Impacts						
Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)	Volume (CY)	Volume (acre-ft)
1510+00	**427.98**	213.99				
			500	106,043	3,928	2.434
1515+00	**420.36**	210.18				
			500	132,101	4,893	3.033
1520+00	**636.45**	318.225				
			500	179,165	6,636	4.113
1525+00	**796.87**	398.435				
			500	195,686	7,248	4.492
1530+00	**768.62**	384.31				
			500	208,519	7,723	4.787
1535+00	**899.53**	449.765				
			500	215,786	7,992	4.954
1540+00	**826.76**	413.38				
			500	192,454	7,128	4.418
1545+00	**712.87**	356.435				
			500	189,109	7,004	4.341
1550+00	**800**	400				
			500	100,000	3,704	2.296
1555+00		0				

TOTAL	45,546 CY	28.231 acre-ft

Floodplain J Impacts						
Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)	Volume (CY)	Volume (acre-ft)
1585+00	**463.58**	231.79				
			500	80,955	2,998	1.858
1590+00	**184.06**	92.03				
			500	31,936	1,183	0.733
1595+00	**71.43**	35.715				
			500	13,118	486	0.301
1600+00	**33.51**	16.755				
			500	10,114	375	0.232
1605+00	**47.4**	23.7				
			500	33,195	1,229	0.762
1610+00	**218.16**	109.08				
			500	75,094	2,781	1.724
1615+00	**382.59**	191.295				
			500	89,410	3,311	2.053
1620+00	**332.69**	166.345				
			500	67,095	2,485	1.540
1625+00	**204.07**	102.035				

TOTAL	12,364 CY	7.663 acre-ft

Floodplain K Impacts								
Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)		Volume (CY)		Volume (acre-ft)
1720+00	**77.9**	38.95						
			500	22,909		848		0.526
1725+00	**105.37**	52.685						
			500	44,210		1,637		1.015
1730+00	**248.31**	124.155						
			500	33,005		1,222		0.758
1735+00	**15.73**	7.865						
			500	3,089		114		0.071
1740+00	**8.98**	4.49						
			500	2,996		111		0.069
1745+00	**14.99**	7.495						
			500	2,893		107		0.066
1750+00	**8.15**	4.075						
			500	11,134		412		0.256
1755+00	**80.92**	40.46						
			500	34,631		1,283		0.795
1760+00	**196.13**	98.065						
			500	109,143		4,042		2.506
1765+00	**677.01**	338.505						
			500	156,483		5,796		3.592
1770+00	**574.85**	287.425						
			500	179,580		6,651		4.123
1775+00	**861.79**	430.895						
			500	182,686		6,766		4.194
1780+00	**599.7**	299.85						
			500	134,019		4,964		3.077
1785+00	**472.45**	236.225						
			500	79,604		2,948		1.827
1790+00	**164.38**	82.19						

TOTAL	4,453 CY	2.760 acre-ft

Floodplain L Impacts						
Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)	Volume (CY)	Volume (acre-ft)
1835+00	**0**	0				
			500	42,265	1,565	0.970
1840+00	**338.12**	169.06				
			500	70,228	2,601	1.612
1845+00	**223.7**	111.85				
			500	49,899	1,848	1.146
1850+00	**175.49**	87.745				
			500	41,050	1,520	0.942
1855+00	**152.91**	76.455				
			500	59,881	2,218	1.375
1860+00	**326.14**	163.07				
			500	40,768	1,510	0.936
1865+00	**0**	0				

TOTAL	11,263 CY	6.981 acre-ft

Floodplain M Impacts								
Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)		Volume (CY)		Volume (acre-ft)
1910+00	**0**	0						
			500	70,934		2,627		1.628
1915+00	**567.47**	283.735						
			500	147,805		5,474		3.393
1920+00	**614.97**	307.485						
			500	148,988		5,518		3.420
1925+00	**576.93**	288.465						
			500	72,116		2,671		1.656
1930+00	**0**	0						

TOTAL	16,290 CY	10.097 acre-ft

Floodplain N Impacts

Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)	Volume (CY)	Volume (acre-ft)
1930+00	**0**	0				
			500	32,900	1,219	0.755
1935+00	**263.2**	131.6				
			500	41,769	1,547	0.959
1940+00	**70.95**	35.475				
			500	34,861	1,291	0.800
1945+00	**207.94**	103.97				
			500	105,690	3,914	2.426
1950+00	**637.58**	318.79				
			500	79,698	2,952	1.830
1955+00	**0**	0				
			500	0	0	0.000
1960+00	**0**	0				

TOTAL	10,923 CY	6.770 acre-ft

Floodplain O Impacts								
Station	ORD Measured XS Area (SF)	Actual XS Area (SF)	Length (FT)	Volume (CF)		Volume (CY)		Volume (acre-ft)
2060+00	**39.37**	19.685						
			100	1,490		55		0.034
2061+00	**20.24**	10.12						
			100	506		19		0.012
2062+00	**0**	0						

TOTAL	74	CY	0.046	acre-ft

APPENDIX C – Cross Drain Calculations

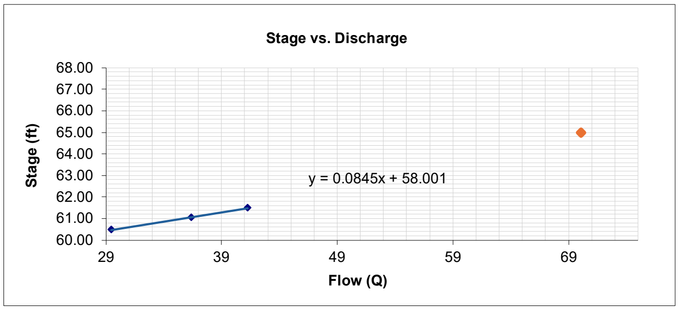
SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-1

Insert Values

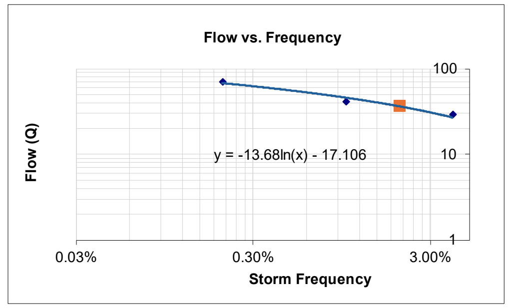
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	29	60.5	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	41	61.5	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	70	65.0	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	36	61.1	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	57.3	Upstream invert
FL (DS) =	57	Downstream invert
Edge of Travel Lane (ETL) =	60.1	Upstream elevation
Length (L)=	71.3	(Existing)
Slope (So) =	0.004	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-1	1	30	4.91	6	29	41

	in.	ft.
Diameter (D)	30	2.5
Width (B)	-	-

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.2	1.5	1.65	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	3.00	3.75	4.13	HW = (HW/D) * Diameter
HW Elev.	60.30	61.05	61.43	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2.5	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

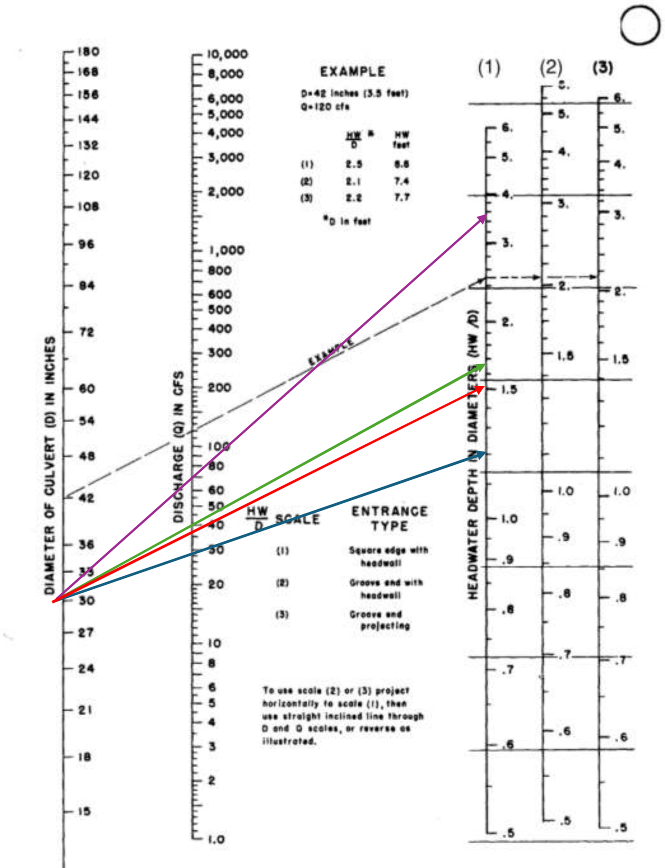
	25-yr	50-yr	100-yr	Notes:
H	1	1.50	2.00	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.70	1.90	2.20	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.1	2.2	2.35	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2.5	2.5	2.5	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	3.2	3.70	4.20	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	60.5	61.00	61.50	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	60.5	61.05	61.50	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Outlet Control	Inlet Control	Outlet Control	

Inlet Control

CHART 1B



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

	Flow (cfs)	HW/D
25	29	1.20
100	41	1.65
500	70	3.60
50	36	1.50

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

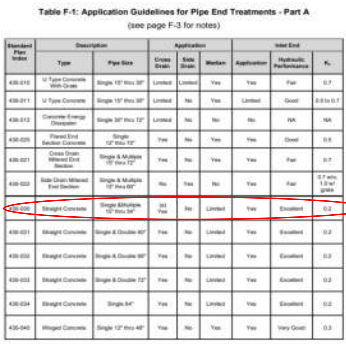


Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

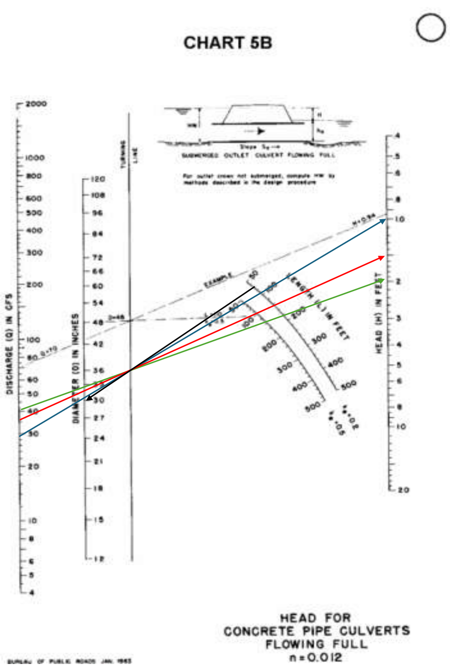
Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grass	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.5 to 0.7
430-012	Concrete Energy Dissipater	Single 36" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 15" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 54"	(4) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.3

Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	29
100	41
50	36

	25-yr	50-yr	100-yr
H	1.0	1.5	2.0

Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).

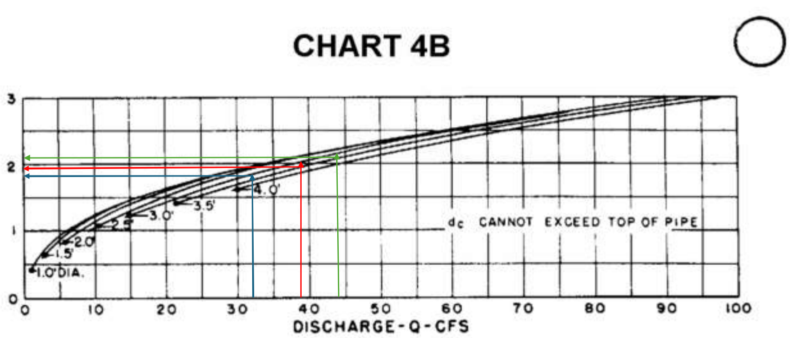


Critical Depth (dc) Found using Chart 4, FHWA HDS 5

	Flow (cfs)	dc
25	29	1.7
100	41	2.2
50	36	1.9

DIA (FT)
2.5

Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)



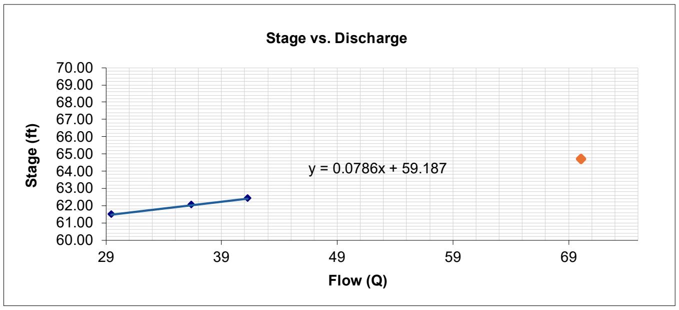
SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-2

Insert Values

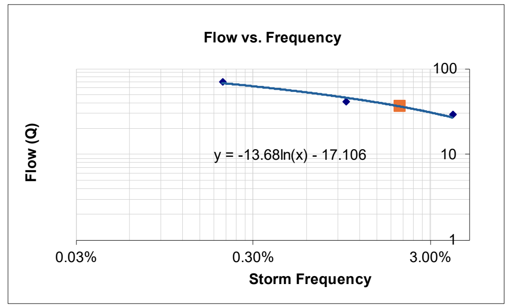
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	29	61.5	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	41	62.4	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	70	64.7	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	36	62.1	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	58.3	Upstream invert
FL (DS) =	58.0	Downstream invert
Edge of Travel Lane (ETL) =	61.5	Upstream elevation
Length (L)=	65.7	(Existing)
Slope (So) =	0.005	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-03	1	30	4.91	6	29	41

-	in.	ft.
Diameter (D)	30	2.5
Width (B)	-	-

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.2	1.5	1.65	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	3.00	3.75	4.13	HW = (HW/D) * Diameter
HW Elev.	61.30	62.05	62.43	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2.5	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

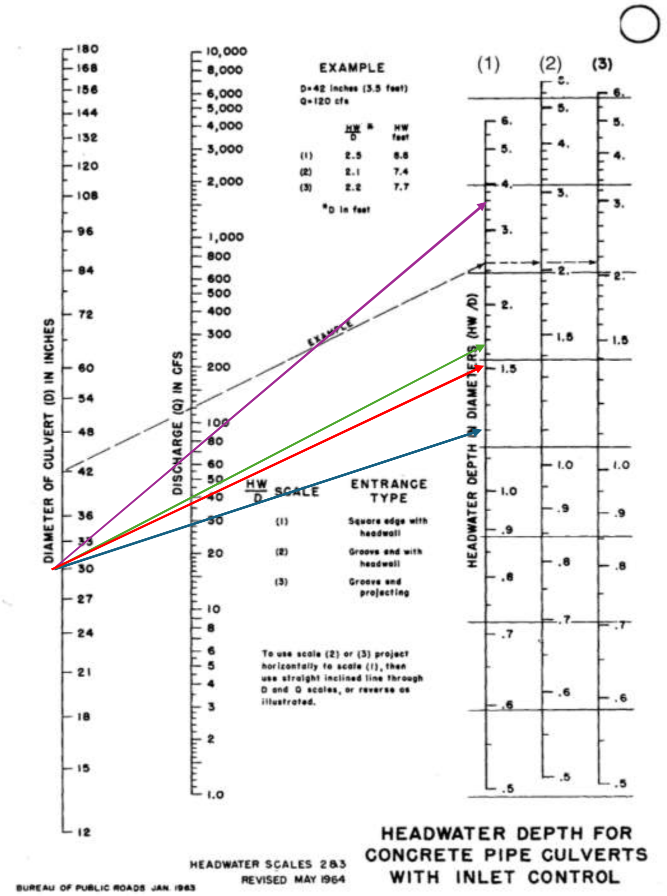
	25-yr	50-yr	100-yr	Notes:
H	1	1.50	1.90	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.70	1.90	2.20	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.1	2.2	2.35	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2.5	2.5	2.5	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	3.2	3.70	4.10	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	61.5	62.00	62.40	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	61.5	62.05	62.43	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Outlet Control	Inlet Control	Inlet Control	

Inlet Control

CHART 1B



	Flow (cfs)	HW/D
25	29	1.20
100	41	1.65
500	70	3.60
50	36	1.50

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.5 to 0.7
430-012	Concrete Energy Dissipater	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 15" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 54"	(a) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.3

0.0786 59.187

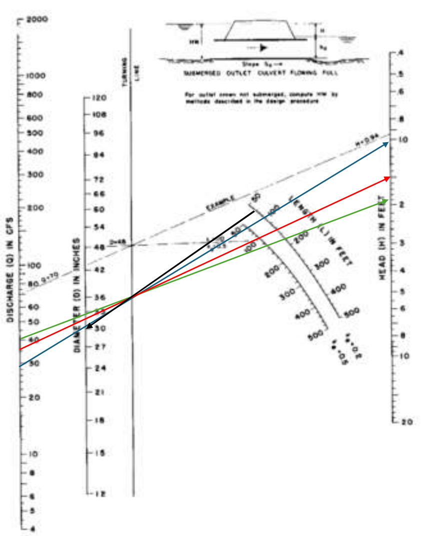
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	29
100	41
50	36

	25-yr	50-yr	100-yr
H	1.0	1.5	1.9

Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).

CHART 5B



HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

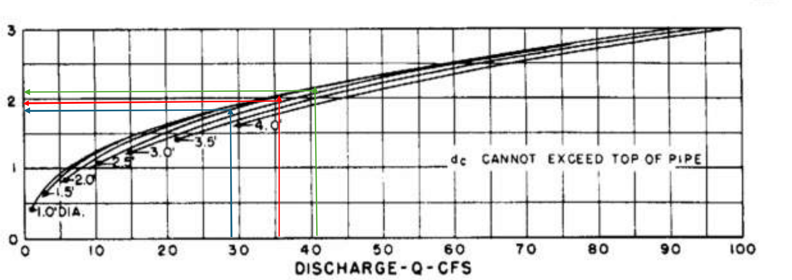
Critical Depth (dc) Found using Chart 4, FHWA HDS 5

	Flow (cfs)	dc
25	29	1.7
100	41	2.2
50	36	1.9

DIA (FT)
2.5

Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)

CHART 4B



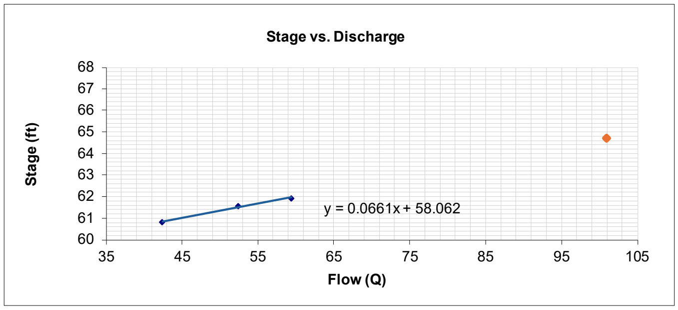
SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-3

Insert Values

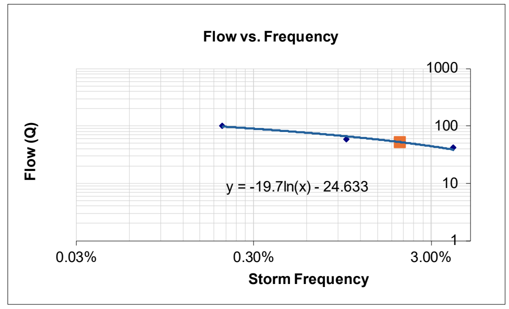
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	42	60.8	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	59	62.0	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	101	64.7	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	52	61.6	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	57.3	Upstream invert
FL (DS) =	57	Downstream invert
Edge of Travel Lane (ETL) =	61.2	Upstream elevation
Length (L)=	69.5	(Existing)
Slope (So) =	0.004	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

Pipe	in.	ft.
Diameter (D)	36	3
Width (B)	-	-

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-3	1	36	7.07	6	42	59

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.18	1.43	1.55	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	3.54	4.29	4.65	HW = (HW/D) * Diameter
HW Elev.	60.84	61.59	61.95	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	3	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

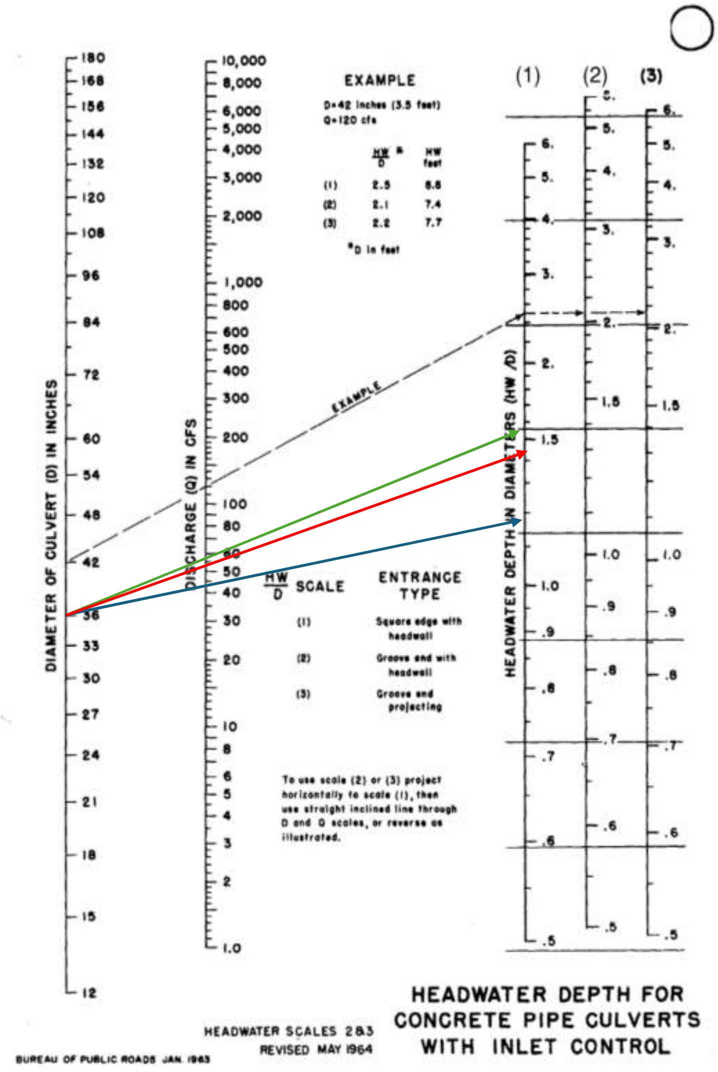
	25-yr	50-yr	100-yr	Notes:
H	0.8	1.40	1.80	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	2.10	2.60	2.90	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.55	2.8	2.95	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	3	3	3	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	3.5	4.10	4.50	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	60.8	61.40	61.80	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	60.84	61.59	61.95	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Inlet Control	Inlet Control	Inlet Control	

Inlet Control

CHART 1B



	Flow (cfs)	HW/D
25	42.41	1.18
100	59.38	1.55
50	52.43	1.43

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

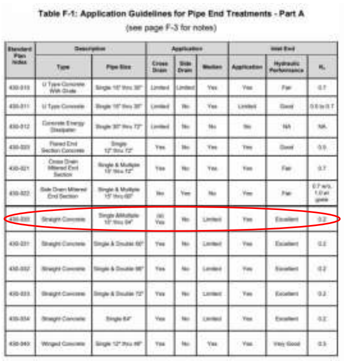


Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.5 to 0.7
430-012	Concrete Energy Dissipater	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 15" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 84"	(a) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.3

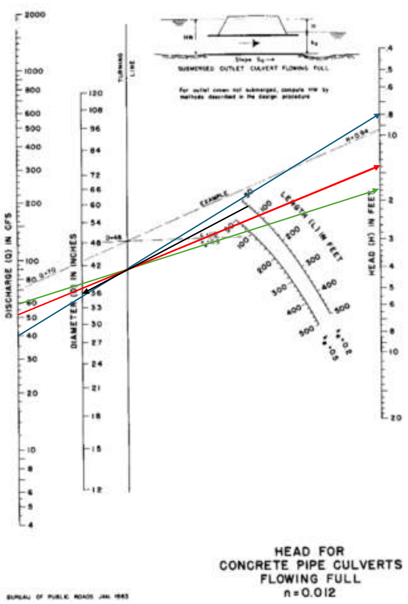
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	42
100	59
50	52

	25-yr	50-yr	100-yr
H	0.8	1.4	1.8

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B



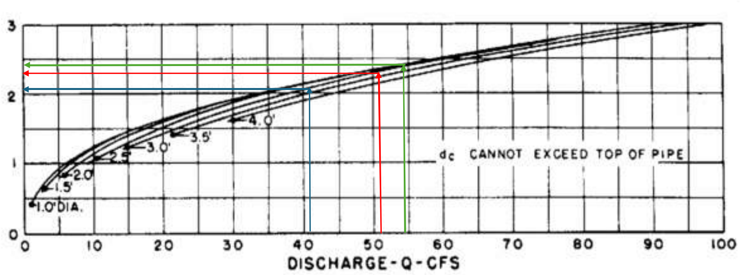
Critical Depth (dc) Found using Chart 4, FHWA HDS 5

	Flow (cfs)	dc
25	42	2.1
100	59	2.9
50	52	2.6

DIA (FT)
3

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



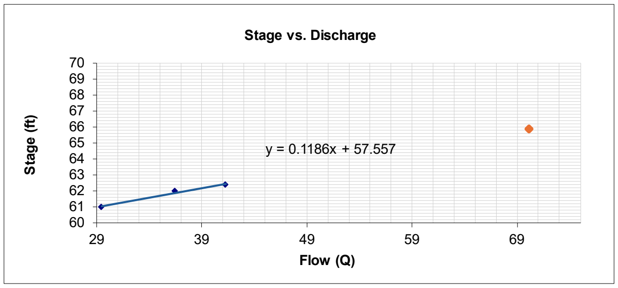
SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-4

Insert Values

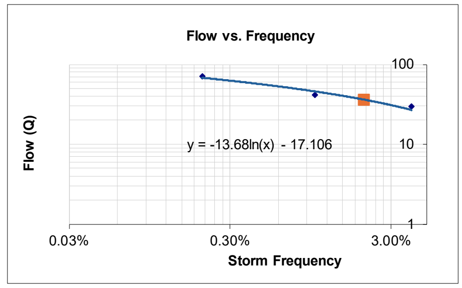
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	29	61.0	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	41	62.4	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	70	65.9	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	36	62.0	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	58	Upstream invert
FL (DS) =	57.7	Downstream invert
Edge of Travel Lane (ETL) =	61.15	Upstream elevation
Length (L)=	77.51	(Existing)
Slope (So) =	0.004	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-4	1	30	4.91	6	29	41

Pipe	in.	ft.
Diameter (D)	30	2.5
Width (B)	-	-

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.2	1.6	1.75	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	3.00	4.00	4.38	HW = (HW/D) * Diameter
HW Elev.	61.00	62.00	62.38	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

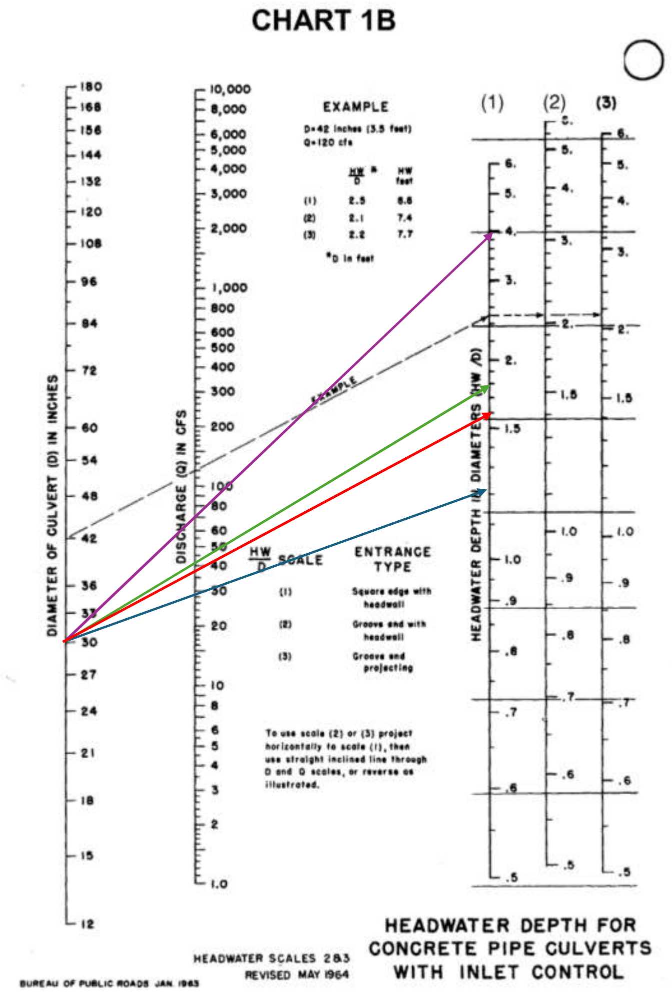
Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2.5	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	0.45	0.70	0.90	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.80	2.10	2.30	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.15	2.3	2.4	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2.5	2.5	2.5	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	2.65	2.90	3.10	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	60.65	60.90	61.10	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	61	62.00	62.38	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Inlet Control	Inlet Control	Inlet Control	

Inlet Control



	Flow (cfs)	HW/D
25	29	1.20
100	41	1.75
500	70	3.80
50	36	1.60

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.5 to 0.7
430-012	Concrete Energy Dissipater	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 15" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single & Multiple 15" thru 54"	(a) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.3

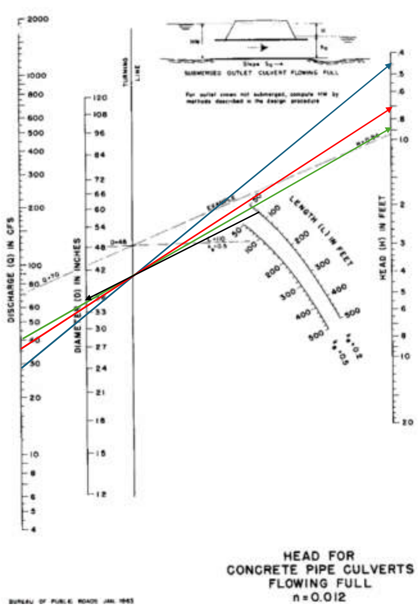
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	29
100	41
50	36

	25-yr	50-yr	100-yr
H	0.45	0.70	0.90

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B



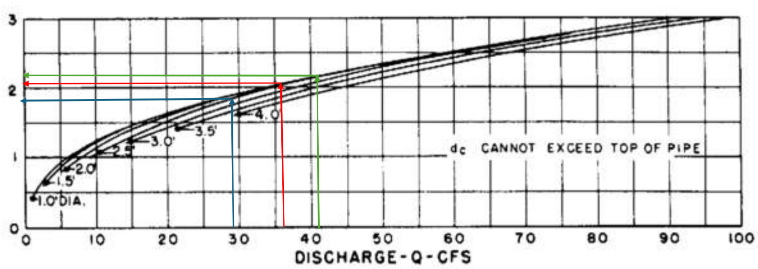
Critical Depth (dc) Found using Chart 4, FHWA HDS 5

	Flow (cfs)	dc
25	29	1.8
100	41	2.3
50	36	2.1

DIA (FT)
2.5

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



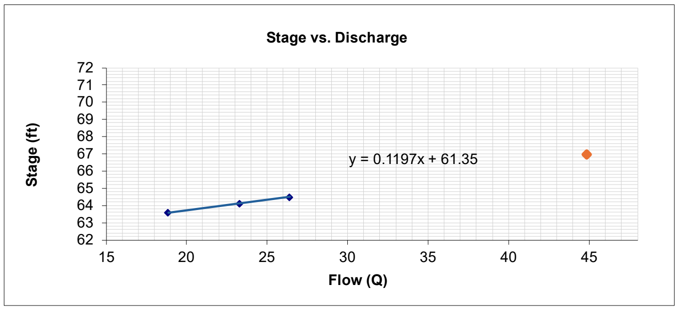
SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-5

Insert Values

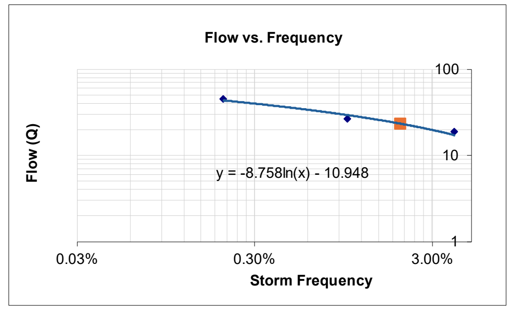
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	19	63.6	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	26	64.5	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	45	67.0	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	23	64.2	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	60.8	Upstream invert
FL (DS) =	60.5	Downstream invert
Edge of Travel Lane (ETL) =	63.5	Upstream elevation
Length (L)=	68.48	(Existing)
Slope (So) =	0.004	

A. Calculate Discharge

Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-5	1	24	3.14	6	19	26

	in.	ft.
Diameter (D)	24	2
Width (B)	-	-

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.35	1.65	1.8	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	2.70	3.30	3.60	HW = (HW/D) * Diameter
HW Elev.	63.50	64.10	64.40	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

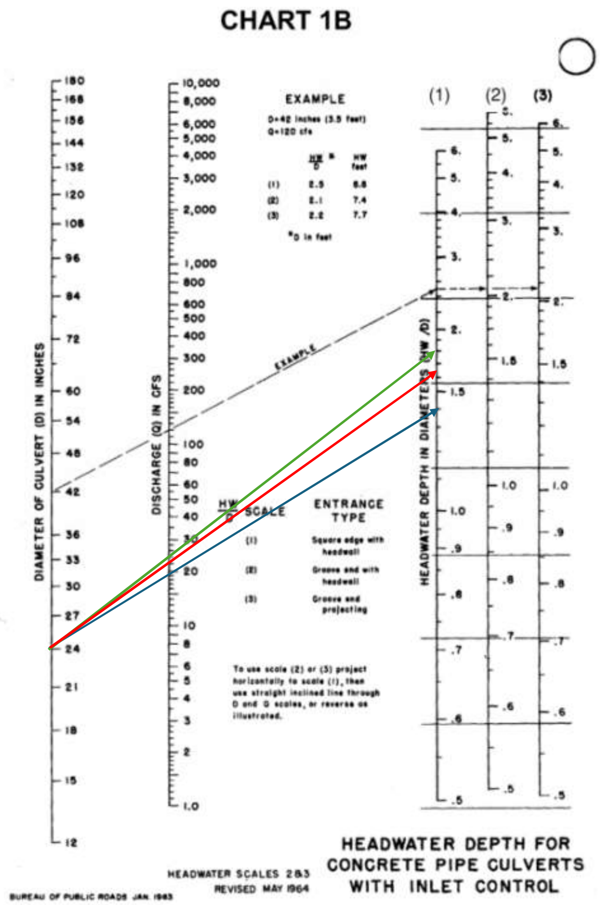
Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	1.1	1.65	2.00	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.55	1.70	1.75	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	1.775	1.85	1.875	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2	2	2	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	2.8	3.35	3.70	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	63.6	64.15	64.50	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	63.6	64.15	64.50	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Outlet Control	Outlet Control	Outlet Control	

Inlet Control



	Flow (cfs)	HW/D
25	19	1.35
100	26	1.80
50	23	1.65

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

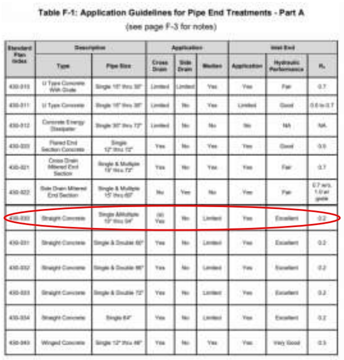


Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.6 to 0.7
430-012	Concrete Energy Dissipator	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 18" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 54"	(a) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.3

Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	19
100	26
50	23

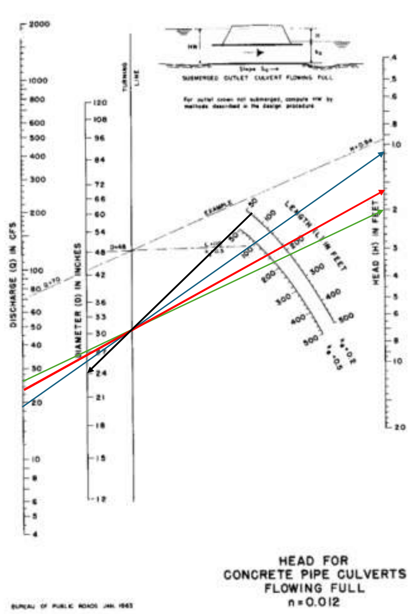
	25-yr	50-yr	100-yr
H	1.1	1.7	2.0

Headwater (H) found using Chart 5, FHWA HDS 5.

Pipe Lengh (ft)	68.48

	In
Diameter (D)	24

CHART 5B



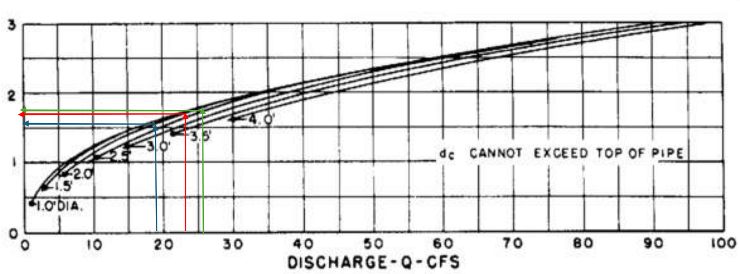
dc =

	Flow (cfs)	dc
25	19	1.55
100	26	1.75
50	23	1.70

DIA (FT)
2

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



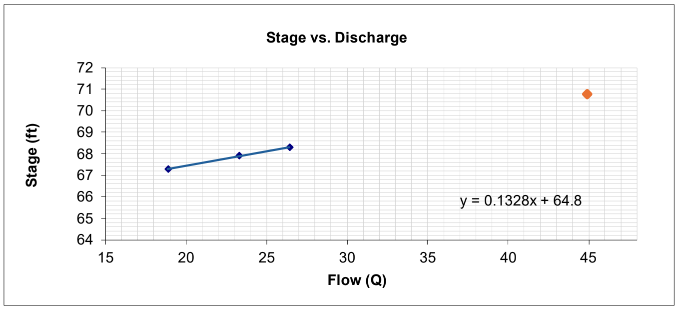
SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-6

Insert Values

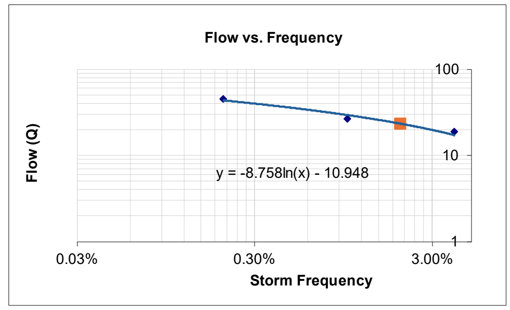
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	19	67.3	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	26	68.3	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	45	70.8	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	23	67.9	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	64.5	Upstream invert
FL (DS) =	64.2	Downstream invert
Edge of Travel Lane (ETL) =	67	Upstream elevation
Length (L)=	64.25	(Existing)
Slope (So) =	0.005	

A. Calculate Discharge

Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-6	1	24	3.14	6	19	26

	in.	ft.
Diameter (D)	24	2
Width (B)	-	-

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.4	1.7	1.85	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	2.80	3.40	3.70	HW = (HW/D) * Diameter
HW Elev.	67.30	67.90	68.20	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

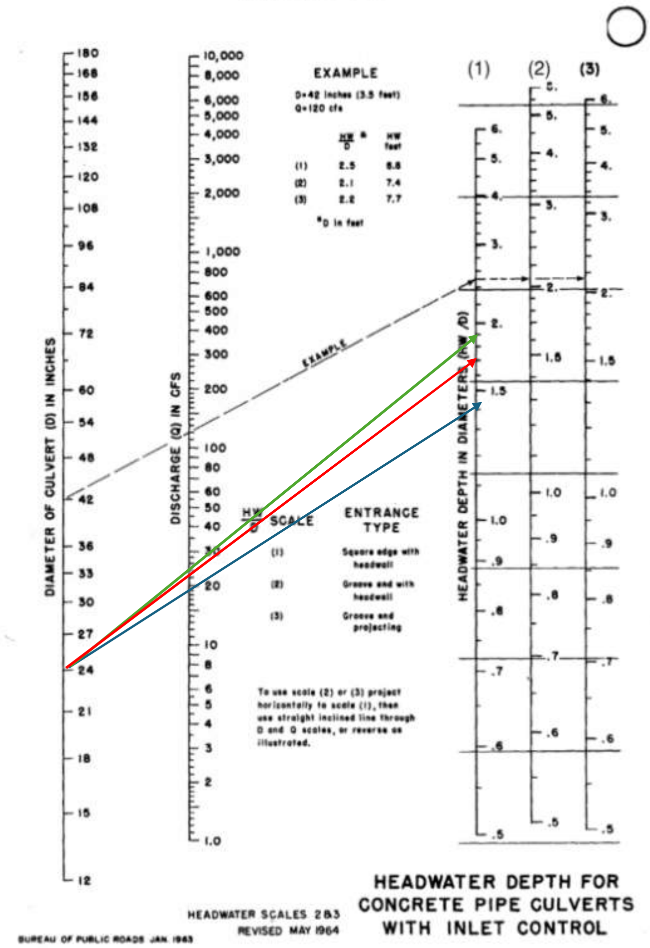
	25-yr	50-yr	100-yr	Notes:
H	1.09	1.55	2.10	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.55	1.75	1.85	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	1.775	1.875	1.925	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2	2	2	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	2.79	3.25	3.80	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	67.29	67.75	68.30	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	67.3	67.90	68.30	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Inlet Control	Inlet Control	Outlet Control	

Inlet Control

CHART 1B



	Flow (cfs)	HW/D
25	19	1.40
100	26	1.85
50	23	1.70

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.5 to 0.7
430-012	Concrete Energy Dissipater	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 18" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 84"	(4) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.5

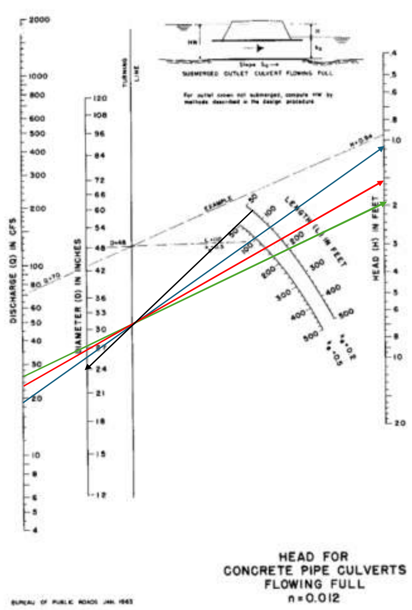
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	19
100	26
50	23

	25-yr	50-yr	100-yr
H	1.1	1.6	2.1

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B

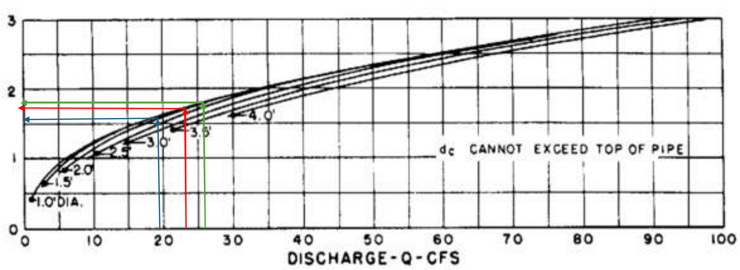


	Flow (cfs)	dc
25	19	1.55
100	26	1.85
50	23	1.75

DIA (FT)
2

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-7

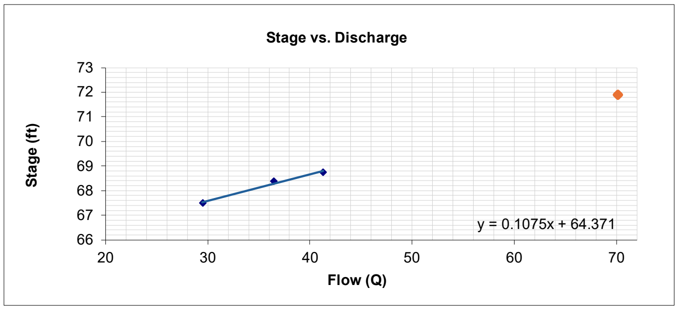
Insert Values

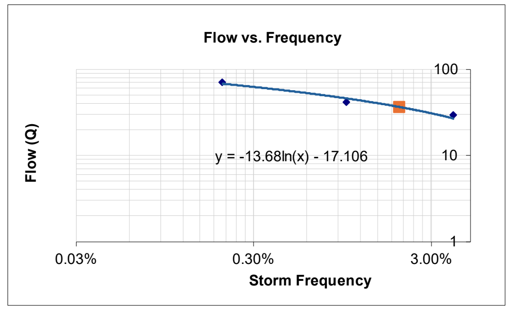
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	29	67.5	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	41	68.8	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	70	71.9	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	36	68.4	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge

Flow vs. Frequency - For the 50-yr and 500-yr flow rates





Given Information

FL (US) =	64.5	Upstream invert
FL (DS) =	64	Downstream invert
Edge of Travel Lane (ETL) =	68.08	Upstream elevation
Length (L)=	68.2	(Existing)
Slope (So) =	0.007	

A. Calculate Discharge

Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-7	1	30	4.91	6	29	41

	in.	ft.
Diameter (D)	30	2.5
Width (B)	-	-

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.2	1.55	1.7	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	3.00	3.88	4.25	HW = (HW/D) * Diameter
HW Elev.	67.50	68.38	68.75	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

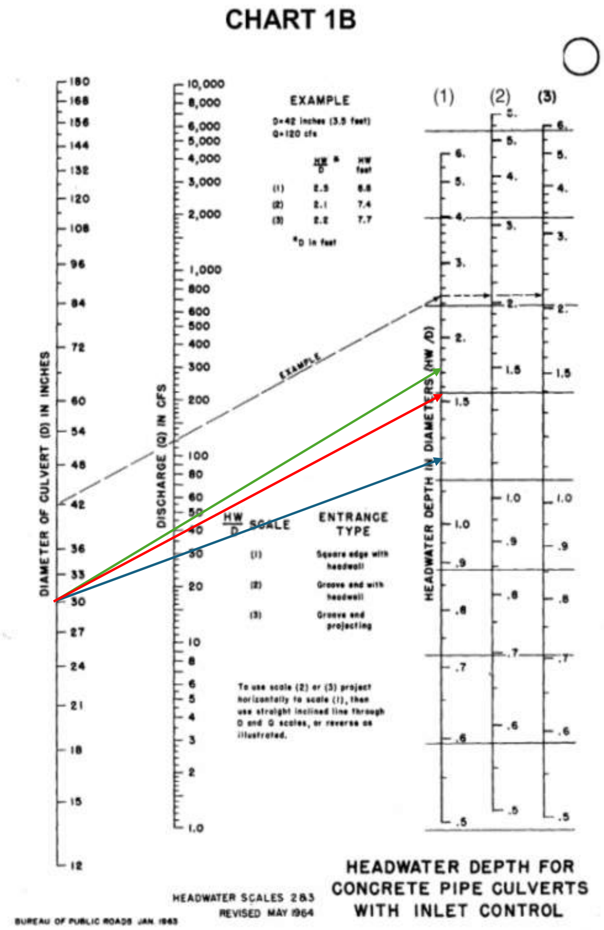
Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2.5	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.5	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	0.9	1.45	1.80	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.80	2.00	2.20	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.15	2.25	2.35	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2.5	2.5	2.5	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	2.9	3.45	3.80	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	67.4	67.95	68.30	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	67.5	68.38	68.75	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Inlet Control	Inlet Control	Inlet Control	

Inlet Control



	Flow (cfs)	HW/D
25	29	1.20
100	41	1.70
50	36	1.55

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.5 to 0.7
430-012	Concrete Energy Dissipater	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 18" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 84"	(4) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.5

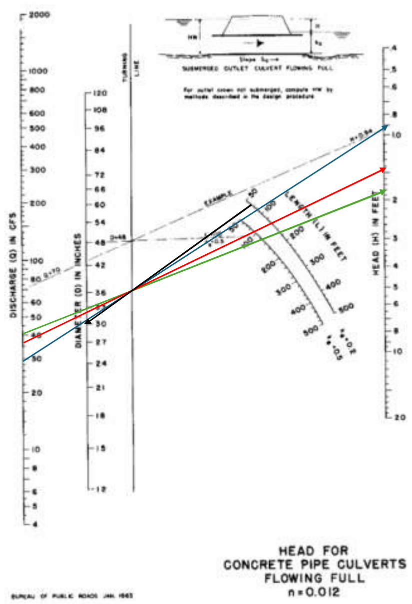
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	29
100	41
50	36

	25-yr	50-yr	100-yr
H	0.9	1.5	1.8

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B

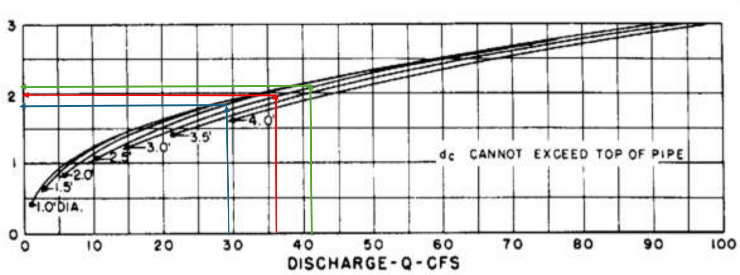


	Flow (cfs)	dc
25	29	1.8
100	41	2.2
50	36	2.0

DIA (FT)
2.5

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-8

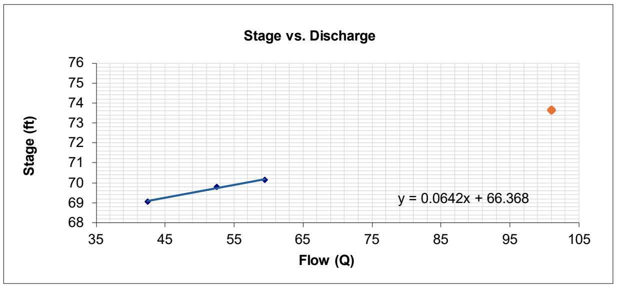
Insert Values

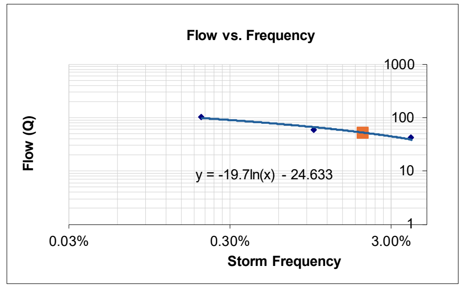
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	42	69.1	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	59	70.2	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	101	73.6	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	52	69.8	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge

Flow vs. Frequency - For the 50-yr and 500-yr flow rates





Given Information

FL (US) =	65.5	Upstream invert
FL (DS) =	65.2	Downstream invert
Edge of Travel Lane (ETL) =	69.22	Upstream elevation
Length (L)=	70.76	(Existing)
Slope (So) =	0.004	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-8	1	36	7.07	6	42	59

	in.	ft.
Diameter (D)	36	3
Width (B)	-	-

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.18	1.43	1.55	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	3.54	4.29	4.65	HW = (HW/D) * Diameter
HW Elev.	69.04	69.79	70.15	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

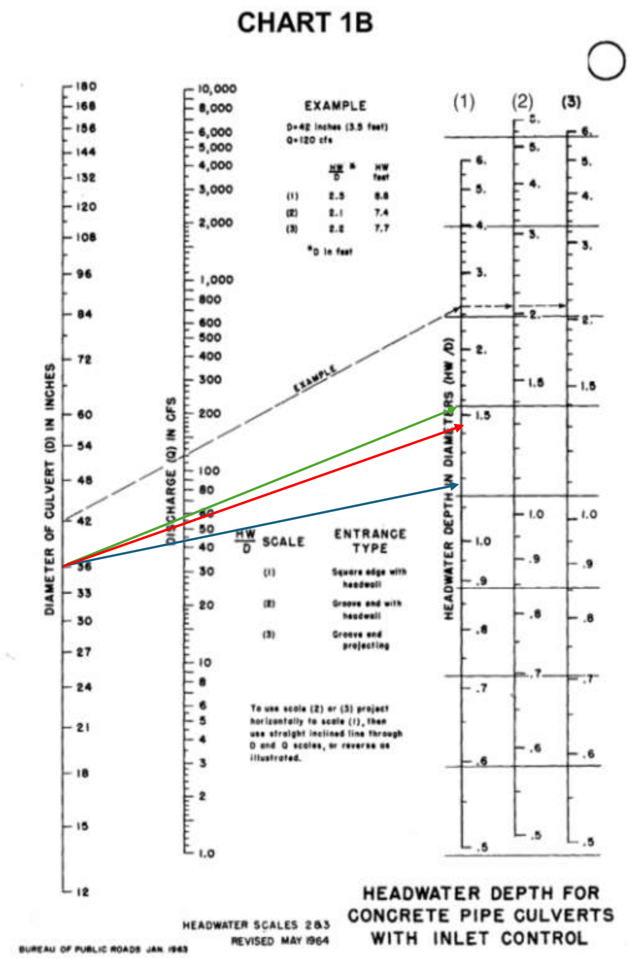
Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	3	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	0.87	1.40	1.80	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	2.10	2.60	2.90	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.55	2.8	2.95	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	3	3	3	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	3.57	4.10	4.50	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	69.07	69.60	70.00	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	69.07	69.79	70.15	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Outlet Control	Inlet Control	Inlet Control	

Inlet Control



	Flow (cfs)	HW/D
25	42	1.18
100	59	1.55
50	52	1.43

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

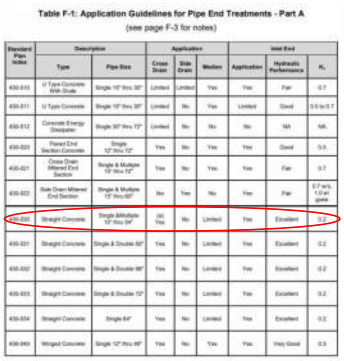


Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.5 to 0.7
430-012	Concrete Energy Dissipater	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 15" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 84"	(a) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.5

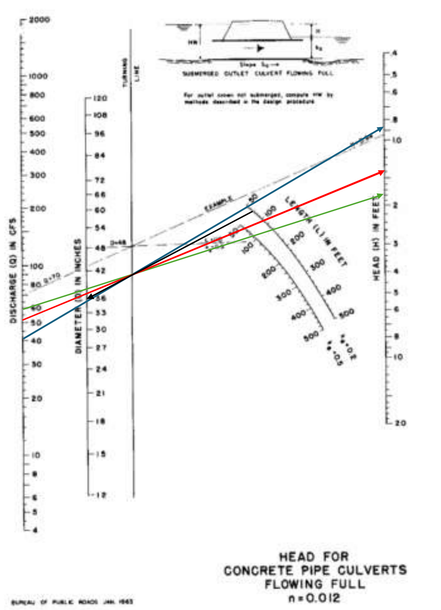
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	42
100	59
50	52

	25-yr	50-yr	100-yr
H	0.9	1.4	1.8

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B

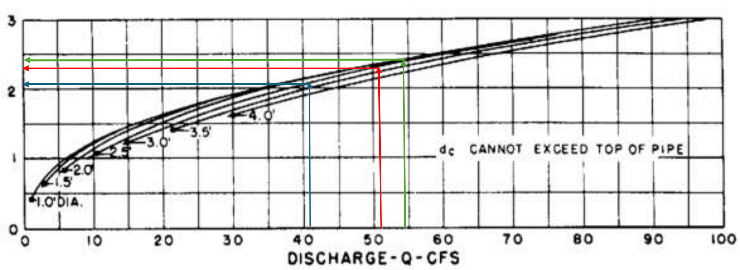


	Flow (cfs)	dc
25	42	2.1
100	59	2.9
50	52	2.6

DIA (FT)
3

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-9

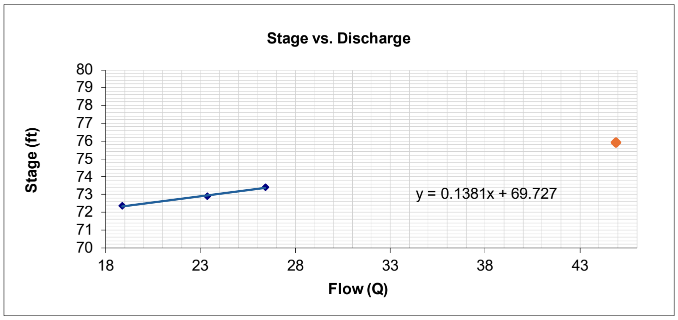
Insert Values

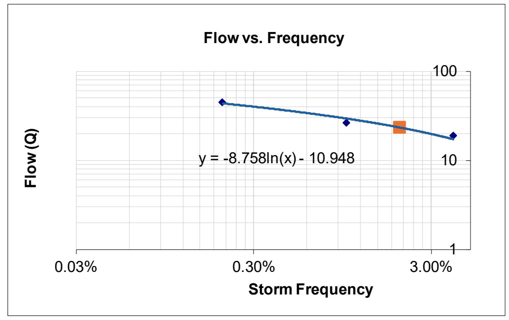
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	19	72.4	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	26	73.4	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	45	75.9	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	23	72.9	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge

Flow vs. Frequency - For the 50-yr and 500-yr flow rates





Given Information

FL (US) =	69.5	Upstream invert
FL (DS) =	69.2	Downstream invert
Edge of Travel Lane (ETL) =	72	Upstream elevation
Length (L)=	86.88	(Existing)
Slope (So) =	0.003	

A. Calculate Discharge

Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-9	1	24	3.14	6	19	26

	in.	ft.
Diameter (D)	24	2
Width (B)	-	-

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.4	1.6	1.8	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	2.80	3.20	3.60	HW = (HW/D) * Diameter
HW Elev.	72.30	72.70	73.10	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

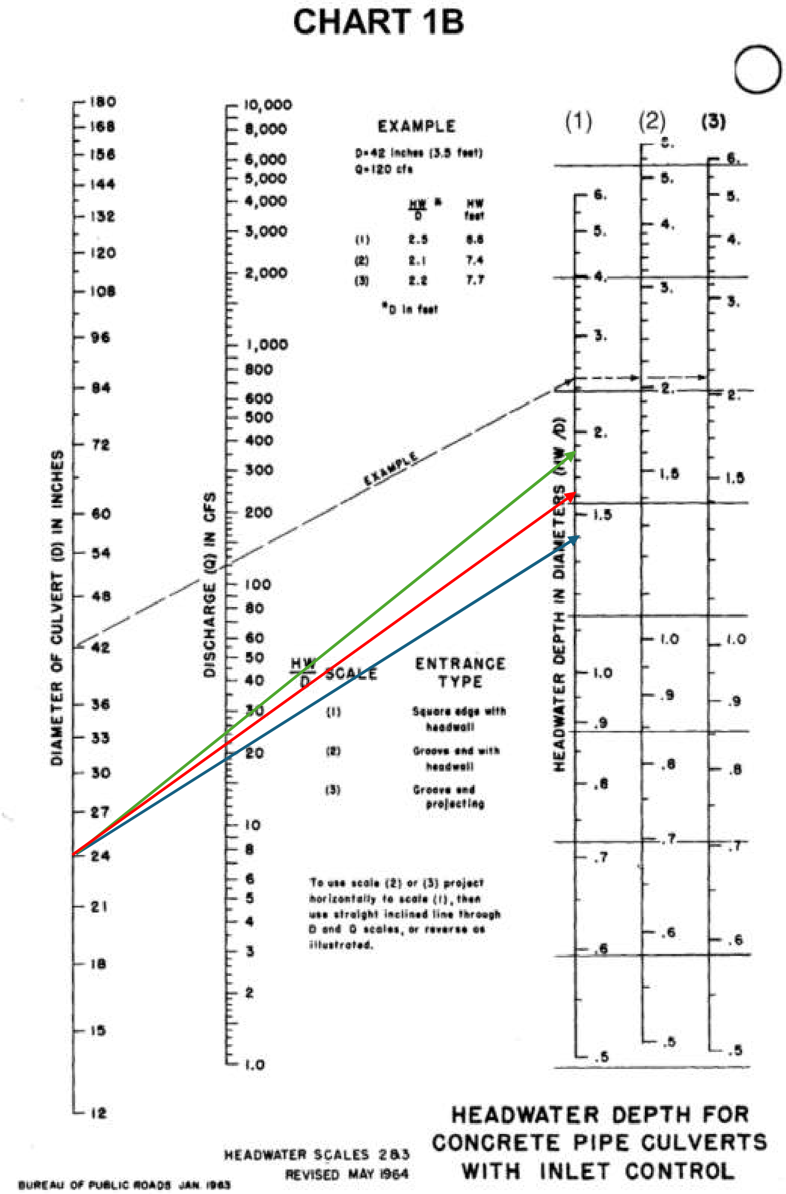
Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	1.15	1.70	2.20	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.50	1.70	1.80	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	1.75	1.85	1.9	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2	2	2	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	2.85	3.40	3.90	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	72.35	72.90	73.40	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	72.35	72.90	73.40	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Outlet Control	Outlet Control	Outlet Control	

Inlet Control



	Flow (cfs)	HW/D
25	19	1.40
100	26	1.80
50	23	1.60

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.6 to 0.7
430-012	Concrete Energy Dissipator	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 18" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 54"	(9) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.3

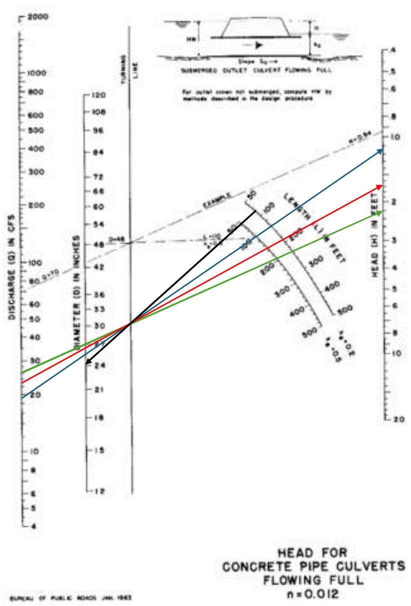
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	19
100	26
50	23

	25-yr	50-yr	100-yr
H	1.2	1.7	2.2

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B

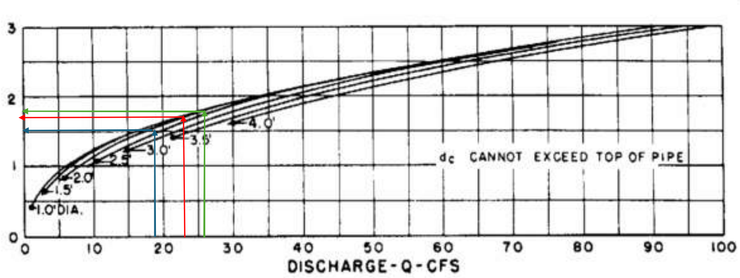


	Flow (cfs)	dc
25	19	1.5
100	26	1.8
50	23	1.7

DIA (FT)
2

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



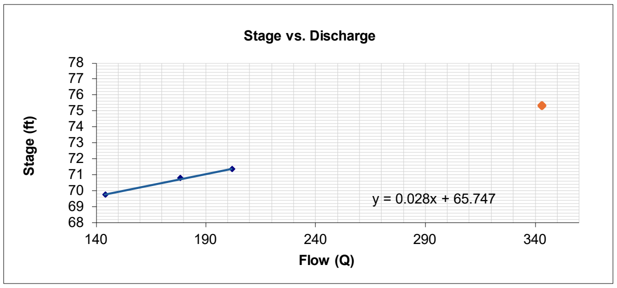
SR-60 LHR
FPID
Cross Drain Flow/Stage Calulations
CD-10

Insert Values

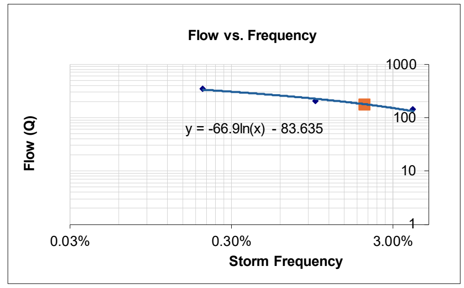
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	144	69.8	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	202	71.4	25-yr , 50-yr and 100-yr stages found using Chart 8B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	343	75.3	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	178	70.8	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	66	Upstream invert
FL (DS) =	65.5	Downstream invert
Edge of Travel Lane (ETL) =	70.3	Upstream elevation
Length (L)=	85.16	(Existing)
Slope (So) =	0.006	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Culvert Size	Culvert Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-10	1	8x3'	24.00	6	144	202

	in.	ft.
Height (D)	36	3
Width (B)	96	8

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	18.0	22.3	25.2	Box Culverts
HW/D	1.25	1.60	1.75	Headwater Depth Found using Chart 8B, FHWA HDS 5 (see attached)
HW	3.75	4.80	5.25	HW = (HW/D) * Diameter
HW Elev.	69.75	70.80	71.25	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

Ke	0.5	Entrance Loss Coeficient (Ke) found using FHWA HDS 5 (Table 12) - Box culvert
TW	3	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.5	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

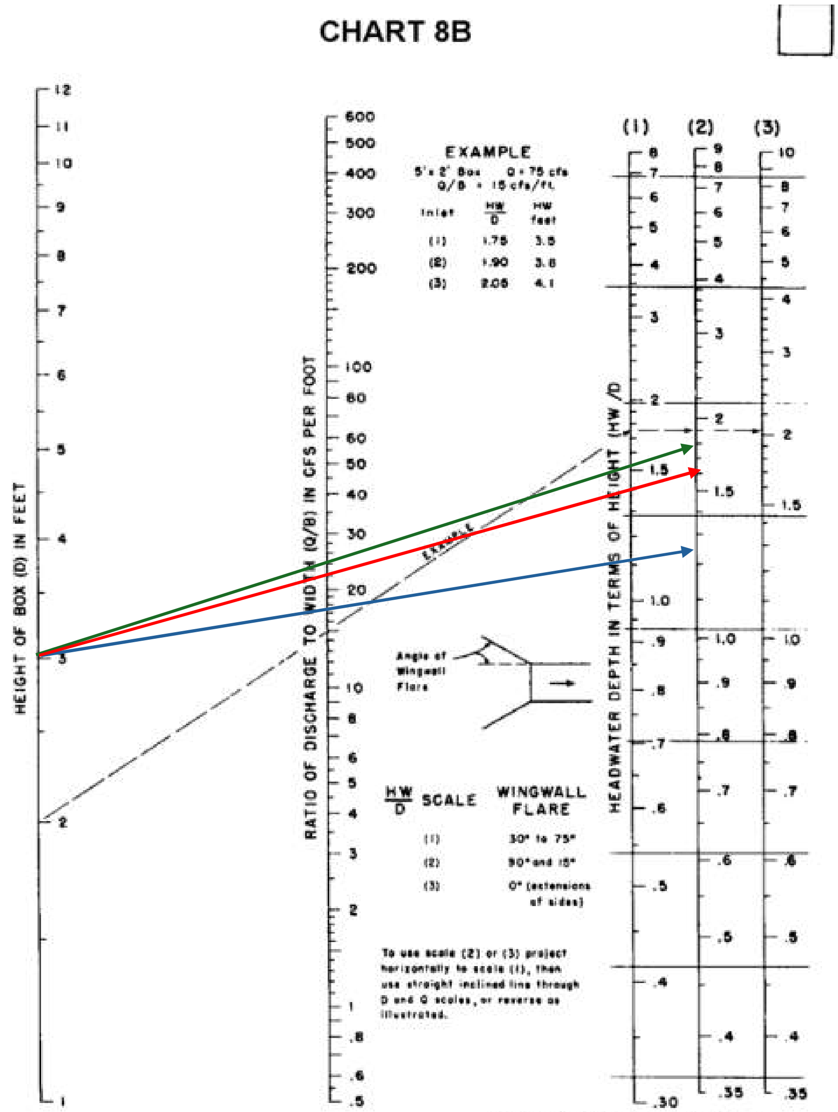
	25-yr	50-yr	100-yr	Notes:
H	0.7	1.50	2.85	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	2.25	2.50	2.75	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.625	2.75	2.875	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	3	3	3	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	3.2	4.00	5.35	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	69.2	70.00	71.35	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	69.75	70.80	71.35	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Inlet Control	Inlet Control	Outlet Control	

Inlet Control

CHART 8B



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

BUREAU OF PUBLIC ROADS JAN. 1963

	Q/B (cfs)	HW/D
25	18	1.25
50	22	1.60
100	25	1.75

Outlet Control

Table 12–Entrance Loss Coefficients.

Outlet Control, Full or Partly Full Entrance Head Loss

$$H_e = K_e\left[\frac{V^2}{2g}\right]$$

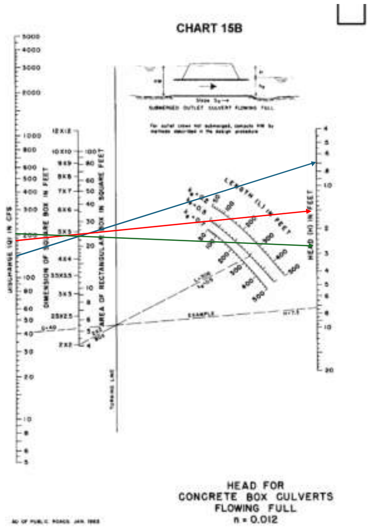
Type of Structure and Design of Entrance	Coefficient K_e
• Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end	0.2
Square-edge	0.5
Rounded (radius = D/12	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
• Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
• Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of D/12 or B/12 or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of D/12 or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side- or slope-tapered inlet	0.2

Headwater (H) found using Chart 15B, FHWA HDS 5:

	Q/B (cfs)
25	18
50	22
100	25

	25-yr	50-yr	100-yr
H	0.7	1.5	2.9

Headwater (H) found using Chart 15B, FHWA HDS 5.

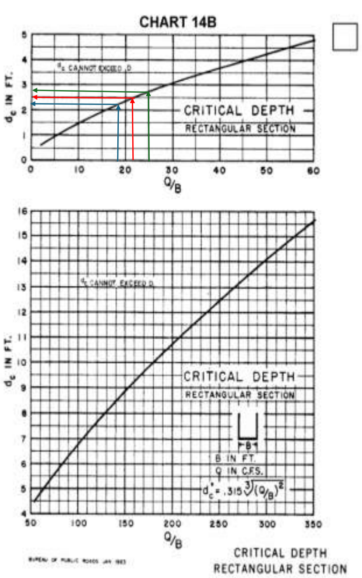


Critical Depth (dc) Found using Chart 14B, FHWA HDS 5

	Q/B (cfs)	dc
25	18	2.3
50	22	2.5
100	25	2.8

DIA (FT)
8

Critical Depth (dc) Found using Chart 14B, FHWA HDS 5.



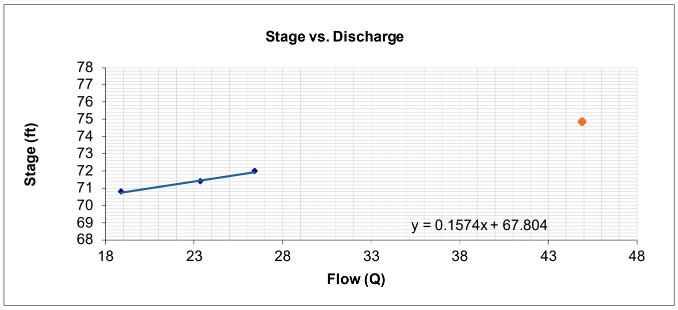
SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-11

Insert Values

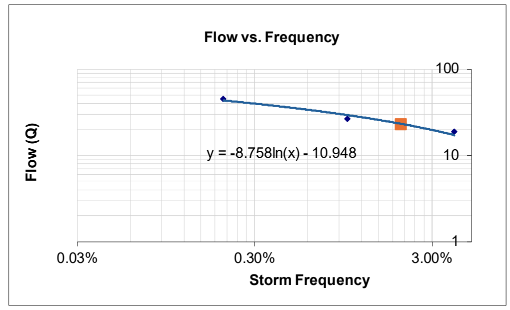
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	19	70.8	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	26	72.0	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	45	74.9	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	23	71.4	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	68	Upstream invert
FL (DS) =	67.7	Downstream invert
Edge of Travel Lane (ETL) =	70.5	Upstream elevation
Length (L)=	81.86	(Existing)
Slope (So) =	0.004	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-11	1	24	3.14	6	19	26

	in.	ft.
Diameter (D)	24	2
Width (B)	-	-

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.37	1.7	2	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	2.74	3.40	4.00	HW = (HW/D) * Diameter
HW Elev.	70.74	71.40	72.00	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

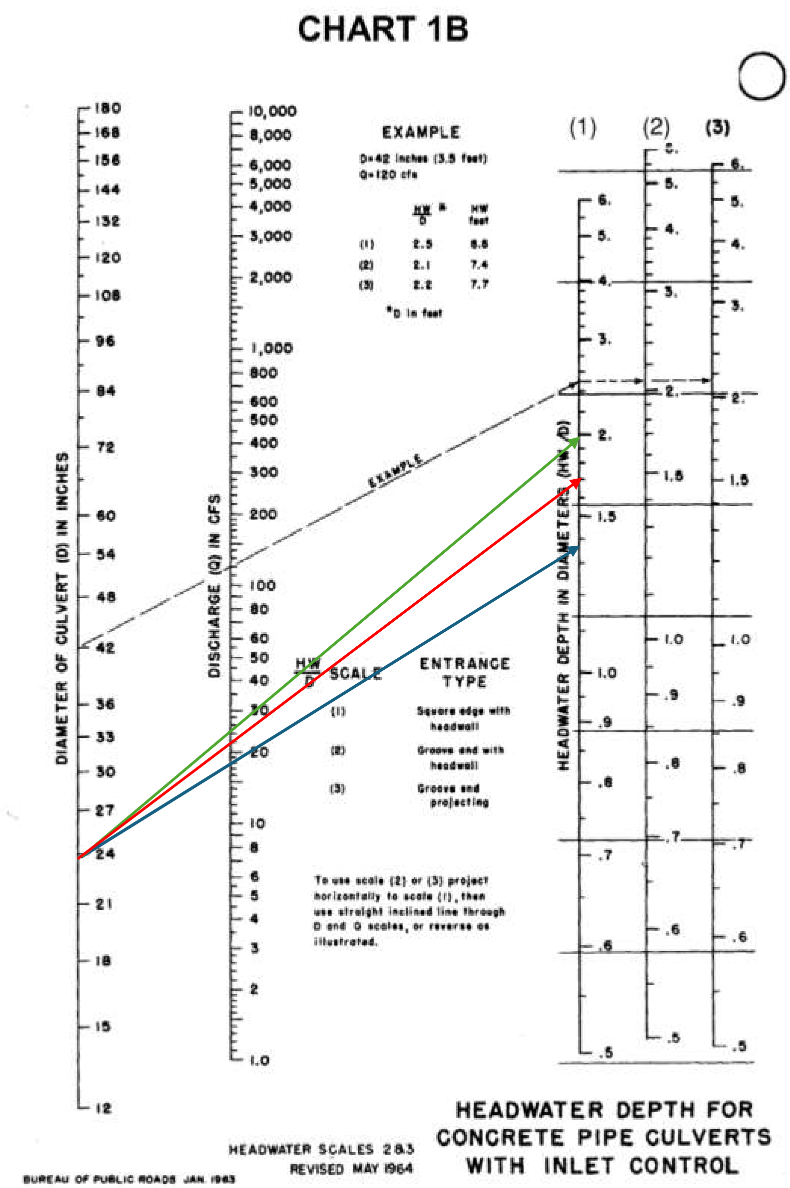
Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	1.1	1.60	2.20	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.55	1.70	1.80	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	1.775	1.85	1.9	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2	2	2	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	2.8	3.30	3.90	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	70.8	71.30	71.90	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	70.8	71.40	72.00	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Outlet Control	Inlet Control	Inlet Control	

Inlet Control



	Flow (cfs)	HW/D
25	19	1.37
100	26	2.00
50	23	1.70

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.6 to 0.7
430-012	Concrete Energy Dissipater	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 18" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 54"	(a) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.3

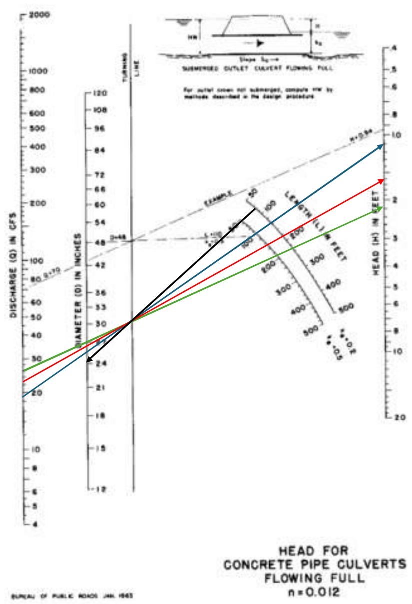
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	19
100	26
50	23

	25-yr	50-yr	100-yr
H	1.1	1.6	2.2

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B

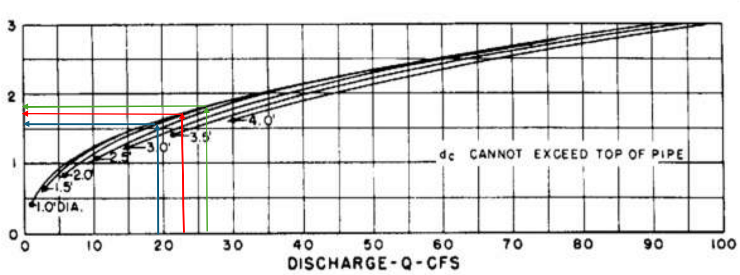


	Flow (cfs)	dc
25	19	1.55
100	26	1.80
50	23	1.70

DIA (FT)
2

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



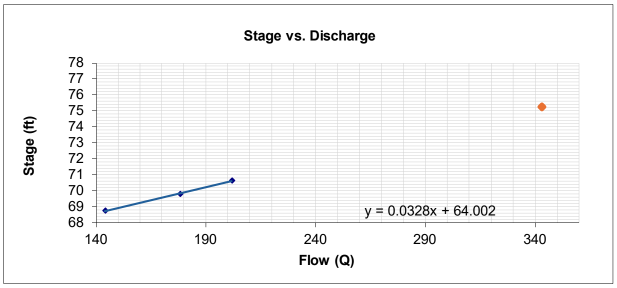
SR-60 LHR
FPID
Cross Drain Flow/Stage Calulations
CD-12

Insert Values

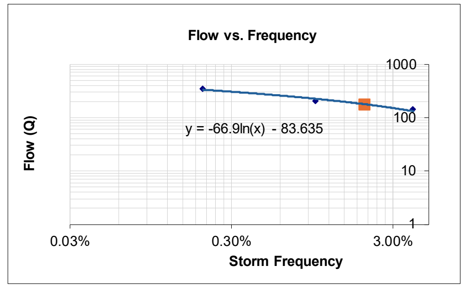
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	144	68.8	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	202	70.7	25-yr , 50-yr and 100-yr stages found using Chart 8B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	343	75.2	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	178	69.8	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	65	Upstream invert
FL (DS) =	64.8	Downstream invert
Edge of Travel Lane (ETL) =	70	Upstream elevation
Length (L)=	83.41	(Existing)
Slope (So) =	0.002	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Culvert Size	Culvert Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-10	1	8x3'	24.00	6	144	202

	in.	ft.
Height (D)	36	3
Width (B)	96	8

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	18.0	22.3	25.2	Box Culverts
HW/D	1.25	1.60	1.75	Headwater Depth Found using Chart 8B, FHWA HDS 5 (see attached)
HW	3.75	4.80	5.25	HW = (HW/D) * Diameter
HW Elev.	68.75	69.80	70.25	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

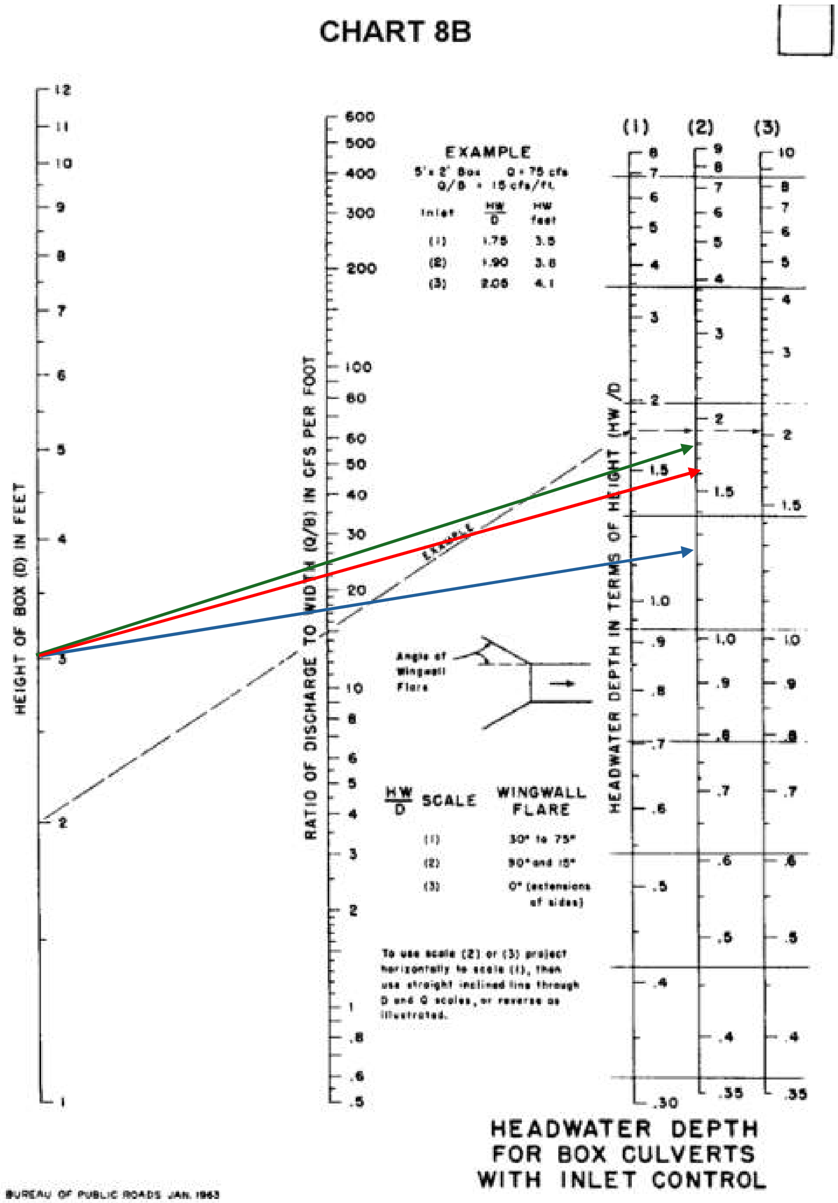
Ke	0.5	Entrance Loss Coeficient (Ke) found using FHWA HDS 5 (Table 12) - Box culvert
TW	3	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.2	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	0.7	1.50	2.85	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	2.25	2.50	2.75	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.625	2.75	2.875	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	3	3	3	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	3.5	4.30	5.65	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	68.5	69.30	70.65	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	68.75	69.80	70.65	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Inlet Control	Inlet Control	Outlet Control	

Inlet Control



	Q/B (cfs)	HW/D
25	18	1.25
50	22	1.60
100	25	1.75

Outlet Control

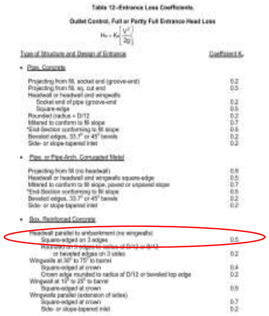


Table 12–Entrance Loss Coefficients.

Outlet Control, Full or Partly Full Entrance Head Loss

$$H_e = K_e\left[\frac{V^2}{2g}\right]$$

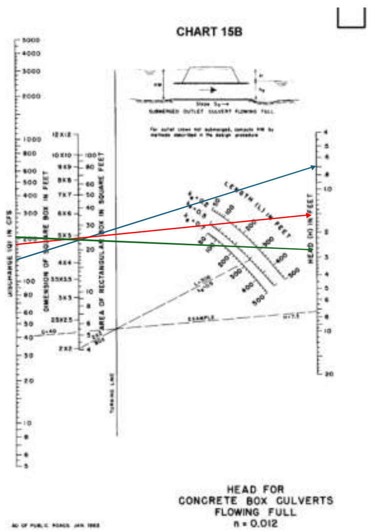
Type of Structure and Design of Entrance	Coefficient K_e
• Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = D/12	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
• Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
• Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of D/12 or B/12 or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of D/12 or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side- or slope-tapered inlet	0.2

Headwater (H) found using Chart 15B, FHWA HDS 5:

	Q/B (cfs)
25	18
50	22
100	25

	25-yr	50-yr	100-yr
H	0.7	1.5	2.9

Headwater (H) found using Chart 15B, FHWA HDS 5.

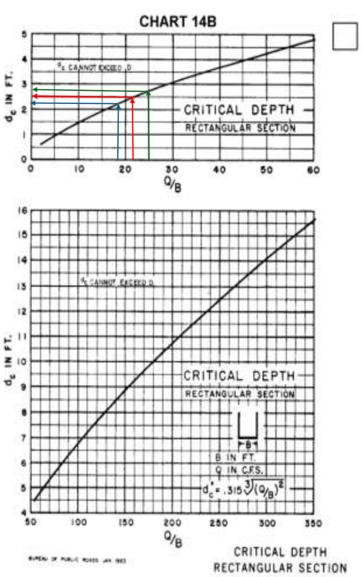


Critical Depth (dc) Found using Chart 14B, FHWA HDS 5

	Q/B (cfs)	dc
25	18	2.3
50	22	2.5
100	25	2.8

DIA (FT)
8

Critical Depth (dc) Found using Chart 14B, FHWA HDS 5.



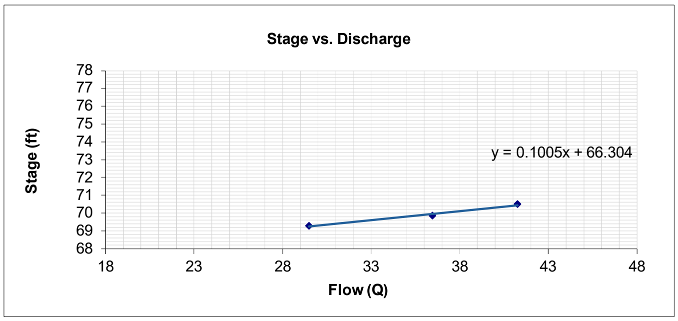
SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-13

Insert Values

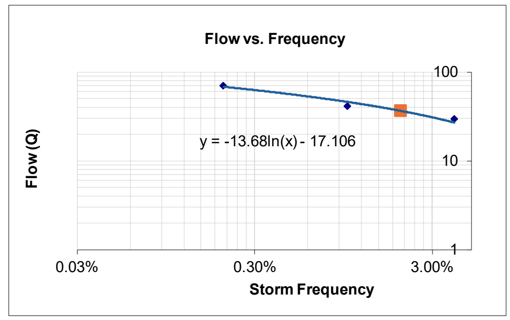
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	29	69.3	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	41	70.5	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	70	73.3	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	36	69.9	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	66	Upstream invert
FL (DS) =	65.7	Downstream invert
Edge of Travel Lane (ETL) =	69.5	Upstream elevation
Length (L)=	82.16	(Existing)
Slope (So) =	0.004	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-13	1	30	4.91	6	29	41

	in.	ft.
Diameter (D)	30	2.5
Width (B)	-	-

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.2	1.55	1.8	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	3.00	3.88	4.50	HW = (HW/D) * Diameter
HW Elev.	69.00	69.88	70.50	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

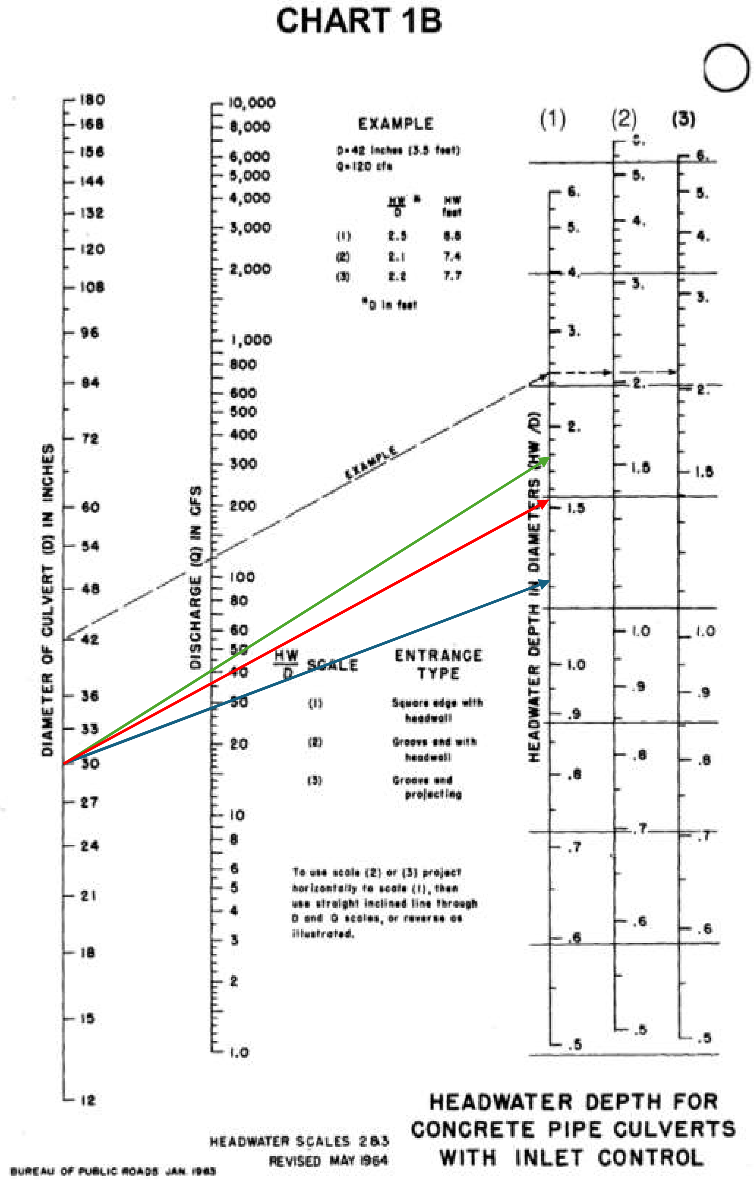
Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2.5	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	1.1	1.65	2.20	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.80	2.10	2.30	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.15	2.3	2.4	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2.5	2.5	2.5	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	3.3	3.85	4.40	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	69.3	69.85	70.40	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	69.3	69.88	70.50	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Outlet Control	Inlet Control	Inlet Control	

Inlet Control



	Flow (cfs)	HW/D
25	29.45	1.20
100	41.23	1.80
50	36.41	1.55

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

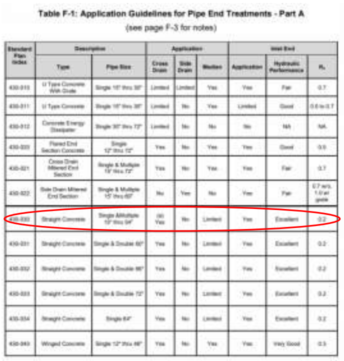


Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.6 to 0.7
430-012	Concrete Energy Dissipator	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 18" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o 1.0 at grate
430-030	Straight Concrete	Single &Multiple 15" thru 84"	(a) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.3

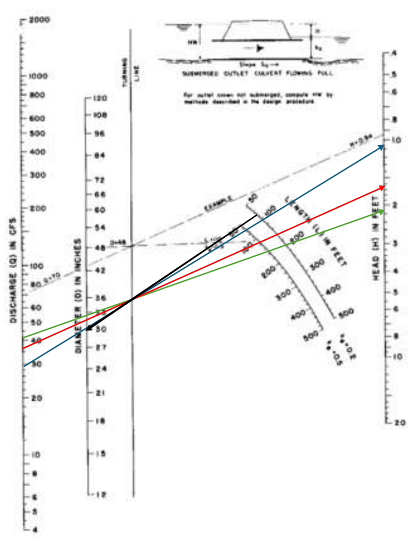
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	29
100	41
50	36

	25-yr	50-yr	100-yr
H	1.1	1.7	2.2

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B



HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

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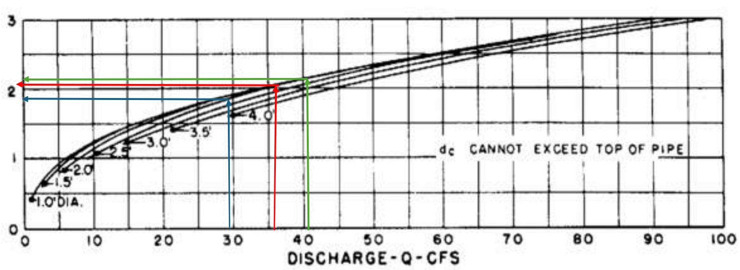
	Flow (cfs)	dc
25	29	1.8
100	41	2.3
50	36	2.1

DIA (FT)
2.5

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-14

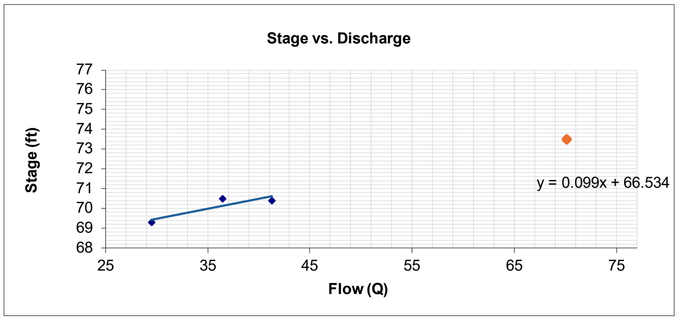
Insert Values

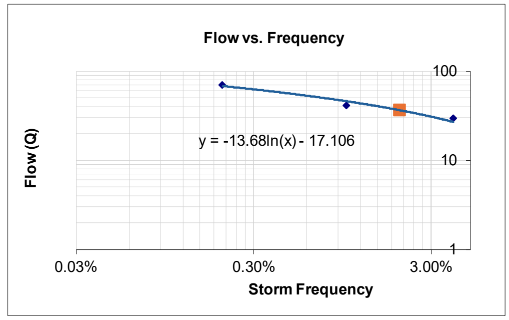
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	29	69.3	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	41	70.4	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	70	73.5	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	36	70.5	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge

Flow vs. Frequency - For the 50-yr and 500-yr flow rates





Given Information

FL (US) =	66	Upstream invert
FL (DS) =	65.7	Downstream invert
Edge of Travel Lane (ETL) =	70.3	Upstream elevation
Length (L)=	87.85	(Existing)
Slope (So) =	0.003	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-14	1	30	4.91	6	29	41

	in.	ft.
Diameter (D)	30	2.5
Width (B)	-	-

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.25	1.8	1.55	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	3.13	4.50	3.88	HW = (HW/D) * Diameter
HW Elev.	69.13	70.50	69.88	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

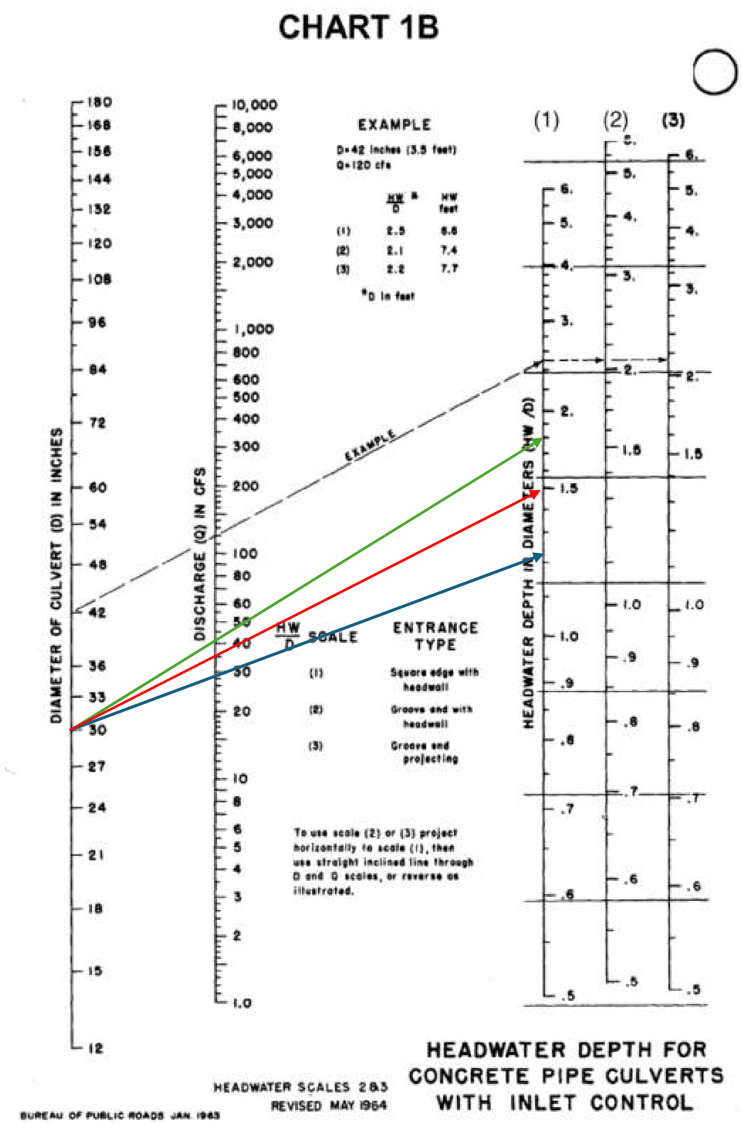
Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2.5	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	1.1	1.60	2.20	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.80	2.00	2.20	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.15	2.25	2.35	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2.5	2.5	2.5	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	3.3	3.80	4.40	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	69.3	69.80	70.40	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	69.3	70.50	70.40	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Outlet Control	Inlet Control	Outlet Control	

Inlet Control



	Flow (cfs)	HW/D
25	29.45	1.25
100	41.23	1.55
50	36.41	1.80

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.5 to 0.7
430-012	Concrete Energy Dissipater	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 15" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 54"	(a) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.3

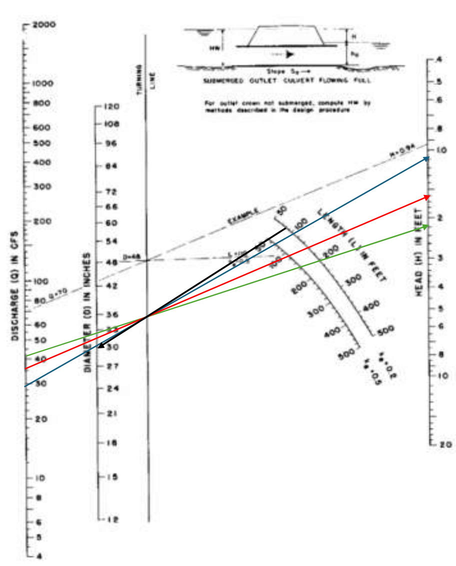
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	29
100	41
50	36

	25-yr	50-yr	100-yr
H	1.1	1.6	2.2

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B



HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

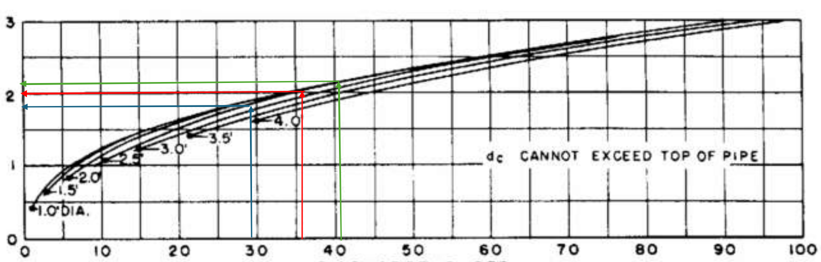
BUREAU OF PUBLIC ROADS JAN. 1963

	Flow (cfs)	dc
25	29	1.8
100	41	2.2
50	36	2.0

DIA (FT)
2.5

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



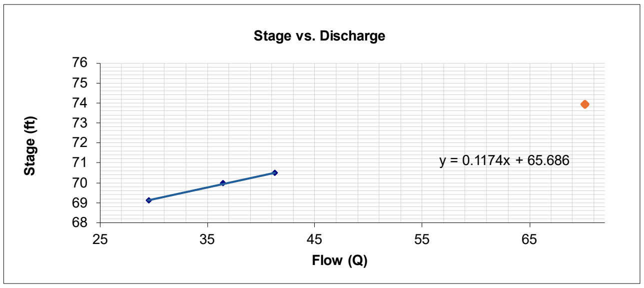
SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-15

Insert Values

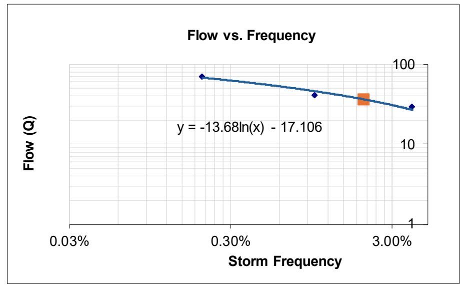
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	29	69.1	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	41	70.5	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	70	73.9	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	36	70.0	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	66	Upstream invert
FL (DS) =	65.7	Downstream invert
Edge of Travel Lane (ETL) =	70	Upstream elevation
Length (L)=	68.61	(Existing)
Slope (So) =	0.004	

A. Calculate Discharge

36

Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-15	1	30	4.91	6	29	41

	in.	ft.
Diameter (D)	30	2.5
Width (B)		

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.25	1.6	1.8	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	3.13	4.00	4.50	HW = (HW/D) * Diameter
HW Elev.	69.13	70.00	70.50	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

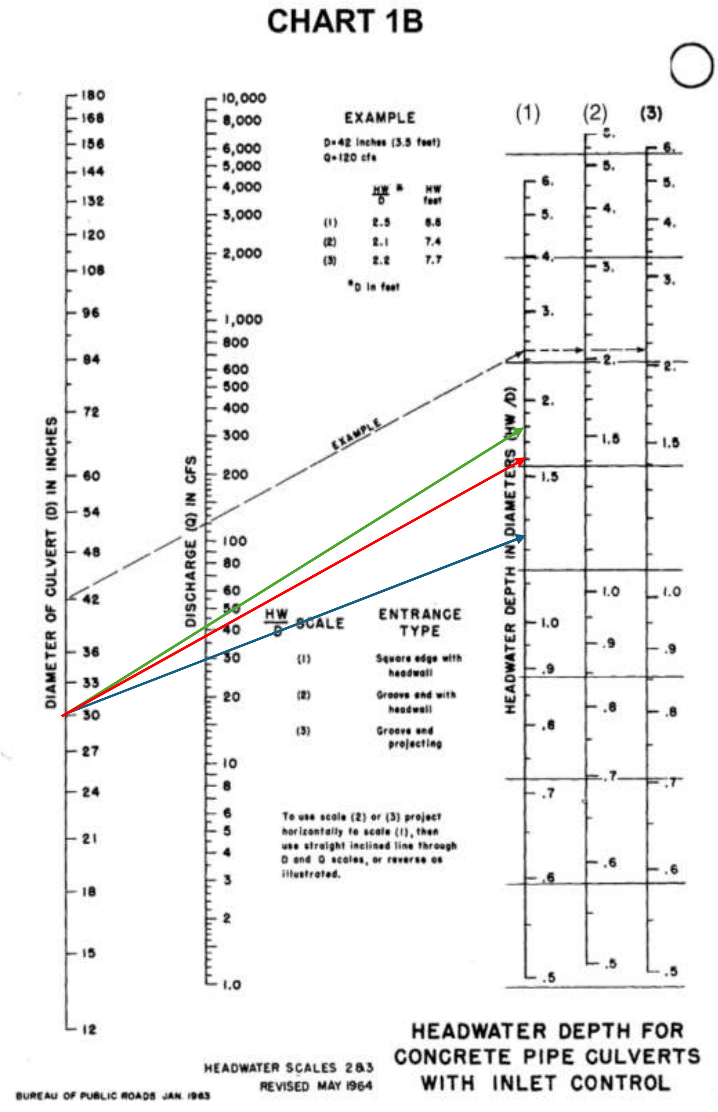
Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2.5	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	0.9	1.50	1.90	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.80	2.10	2.45	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.15	2.3	2.475	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2.5	2.5	2.5	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	3.1	3.70	4.10	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	69.1	69.70	70.10	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	69.125	70.00	70.50	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Inlet Control	Inlet Control	Inlet Control	

Inlet Control



	Flow (cfs)	HW/D
25	29.45	1.25
100	41.23	1.80
50	36.41	1.60

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

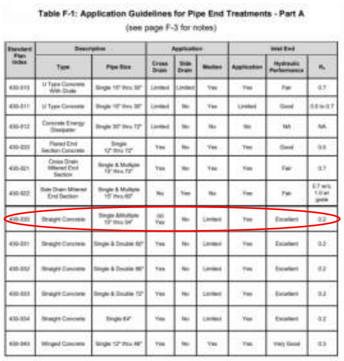


Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.6 to 0.7
430-012	Concrete Energy Dissipator	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 18" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 84"	(a) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.5

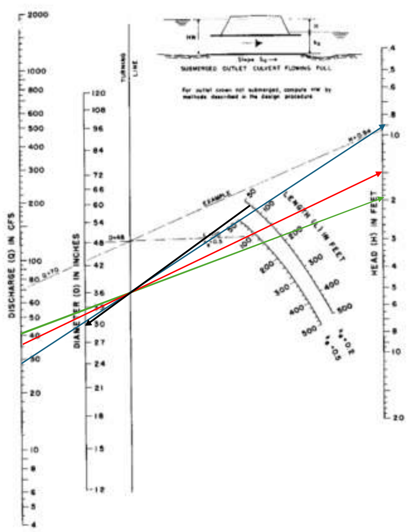
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	29
100	41
50	36

	25-yr	50-yr	100-yr
H	0.9	1.5	1.9

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B



HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

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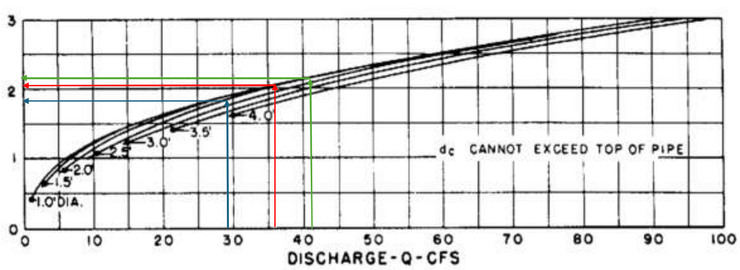
	Flow (cfs)	dc
25	29	1.8
100	41	2.5
50	36	2.1

DIA (FT)
2.5

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



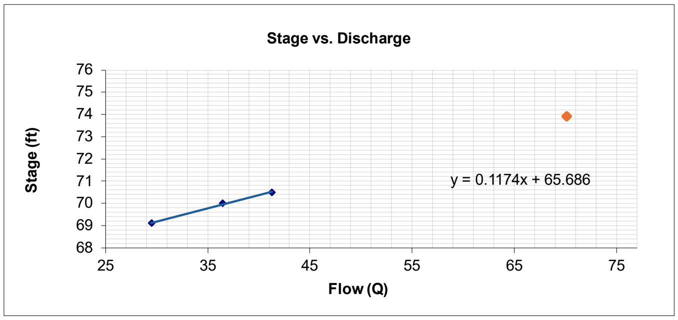
SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-16

Insert Values

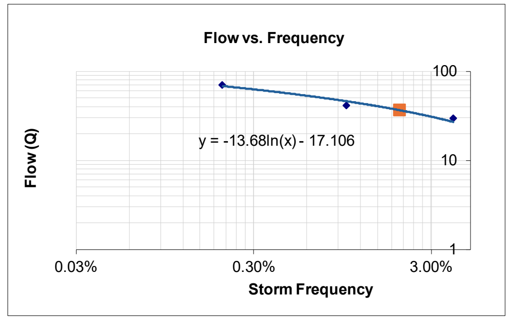
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	29	69.1	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	41	70.5	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	70	73.9	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	36	70.0	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	66	Upstream invert
FL (DS) =	65.7	Downstream invert
Edge of Travel Lane (ETL) =	70	Upstream elevation
Length (L)=	90.15	(Existing)
Slope (So) =	0.003	

A. Calculate Discharge

Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-16	1	30	4.91	6	29	41

	in.	ft.
Diameter (D)	30	2.5
Width (B)		

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.25	1.6	1.8	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	3.13	4.00	4.50	HW = (HW/D) * Diameter
HW Elev.	69.13	70.00	70.50	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2.5	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

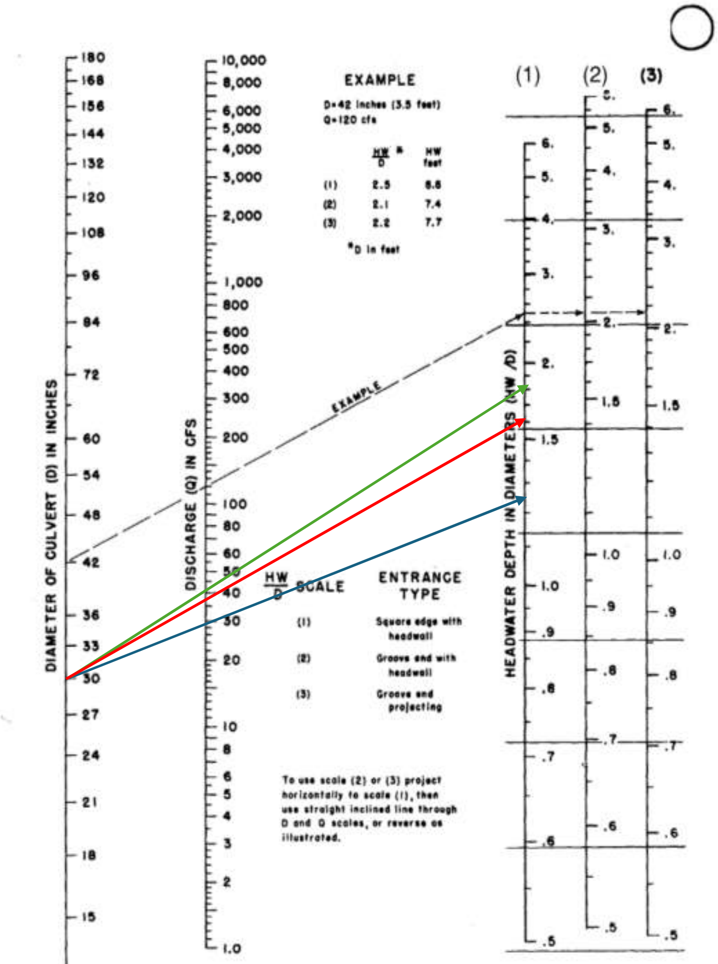
	25-yr	50-yr	100-yr	Notes:
H	0.8	1.40	1.80	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.80	2.10	2.45	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.15	2.3	2.475	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2.5	2.5	2.5	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	3	3.60	4.00	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	69	69.60	70.00	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	69.125	70.00	70.50	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Inlet Control	Inlet Control	Inlet Control	

Inlet Control

CHART 1B



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3 REVISED MAY 1964

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	Flow (cfs)	HW/D
25	29	1.25
100	41	1.80
50	36	1.60

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.6 to 0.7
430-012	Concrete Energy Dissipater	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 18" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 84"	(a) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.5

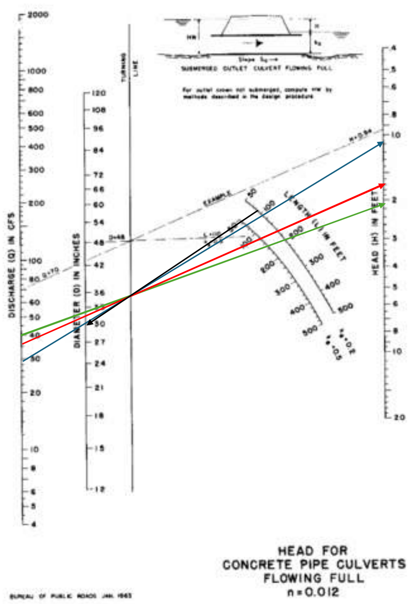
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	29
100	41
50	36

	25-yr	50-yr	100-yr
H	0.8	1.4	1.8

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B

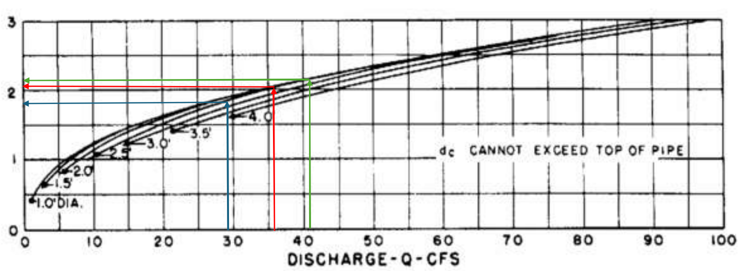


	Flow (cfs)	dc
25	29	1.8
100	41	2.5
50	36	2.1

DIA (FT)
2.5

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-17

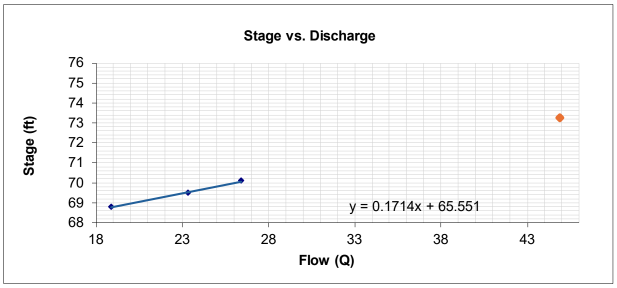
Insert Values

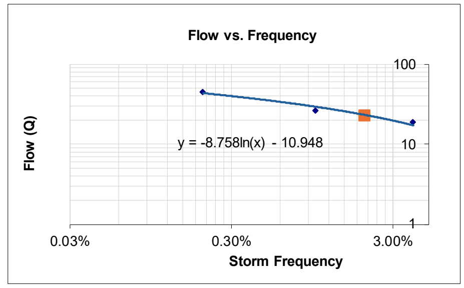
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	19	68.8	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	26	70.1	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	45	73.2	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	23	69.5	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge

Flow vs. Frequency - For the 50-yr and 500-yr flow rates





Given Information

FL (US) =	66	Upstream invert
FL (DS) =	65.7	Downstream invert
Edge of Travel Lane (ETL) =	69.25	Upstream elevation
Length (L)=	90.21	(Existing)
Slope (So) =	0.003	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

	in.	ft.
Diameter (D)	24	2
Width (B)		

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-17	1	24	3.14	6	19	26

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.4	1.6	1.8	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	2.80	3.20	3.60	HW = (HW/D) * Diameter
HW Elev.	68.80	69.20	69.60	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

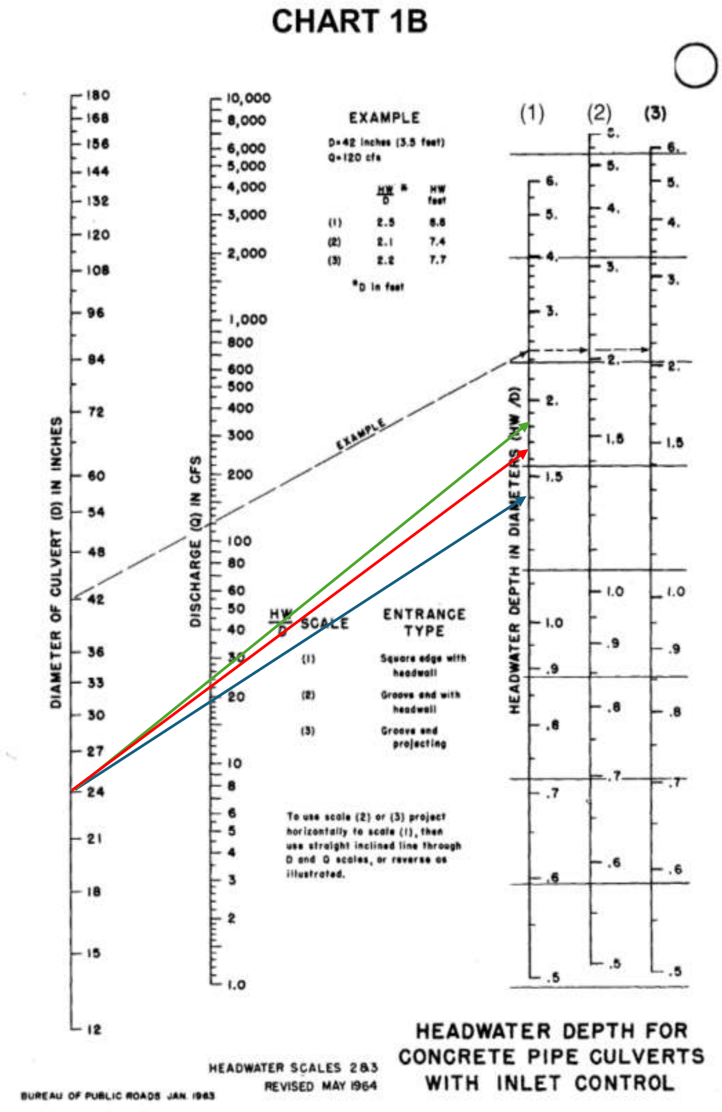
Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	1.1	1.80	2.40	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.50	1.65	1.85	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	1.75	1.825	1.925	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2	2	2	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	2.8	3.50	4.10	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	68.8	69.50	70.10	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	68.8	69.50	70.10	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Outlet Control	Outlet Control	Outlet Control	

Inlet Control



	Flow (cfs)	HW/D
25	19	1.40
100	26	1.80
50	23	1.60

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.6 to 0.7
430-012	Concrete Energy Dissipater	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 18" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 54"	(4) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.3

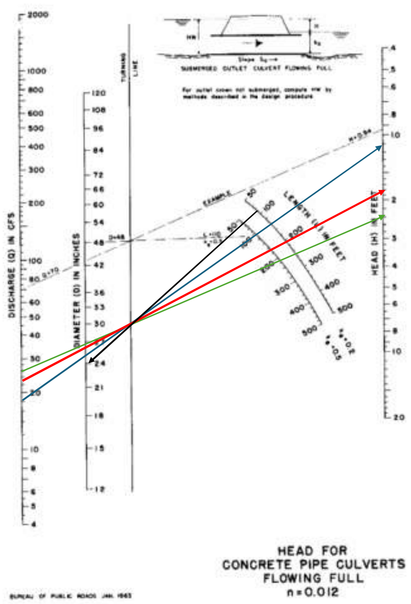
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	19
100	26
50	23

	25-yr	50-yr	100-yr
H	1.1	1.8	2.4

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B



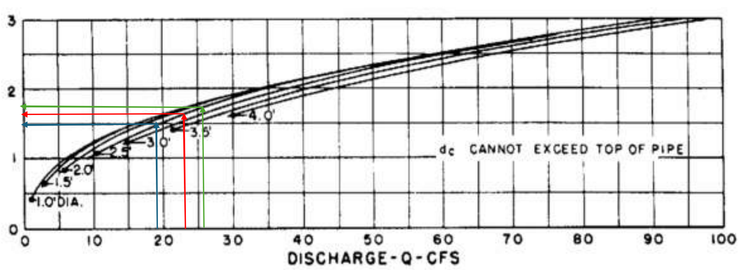
HEAD FOR
CONCRETE PIPE CULVERTS
FLOWING FULL
n = 0.012

	Flow (cfs)	dc
25	19	1.50
100	26	1.85
50	23	1.65

DIA (FT)
2

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



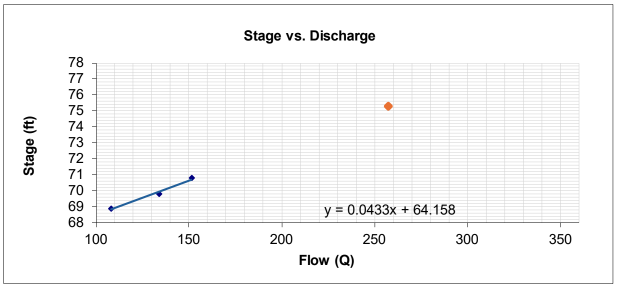
SR-60 LHR
FPID
Cross Drain Flow/Stage Calulations Insert Values
CD-18

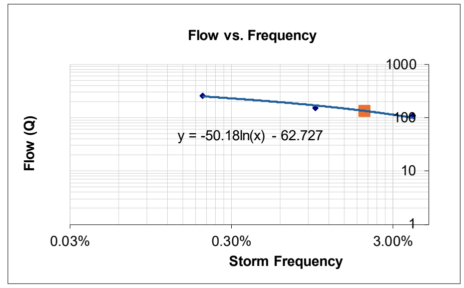
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	108	68.9	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	151	70.8	25-yr , 50-yr and 100-yr stages found using Chart 8B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	257	75.3	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	134	69.8	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge

Flow vs. Frequency - For the 50-yr and 500-yr flow rates





Given Information

FL (US) =	65	Upstream invert
FL (DS) =	64.8	Downstream invert
Edge of Travel Lane (ETL) =	69	Upstream elevation
Length (L)=	89.5	(Existing)
Slope (So) =	0.002	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Culvert Size	Culvert Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-10	1	6x3'	18.00	6	108	151

	in.	ft.
Height (D)	36	3
Width (B)	72	6

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	18.0	22.3	25.2	Box Culverts
HW/D	1.30	1.60	1.85	Headwater Depth Found using Chart 8B, FHWA HDS 5 (see attached)
HW	3.90	4.80	5.55	HW = (HW/D) * Diameter
HW Elev.	68.90	69.80	70.55	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

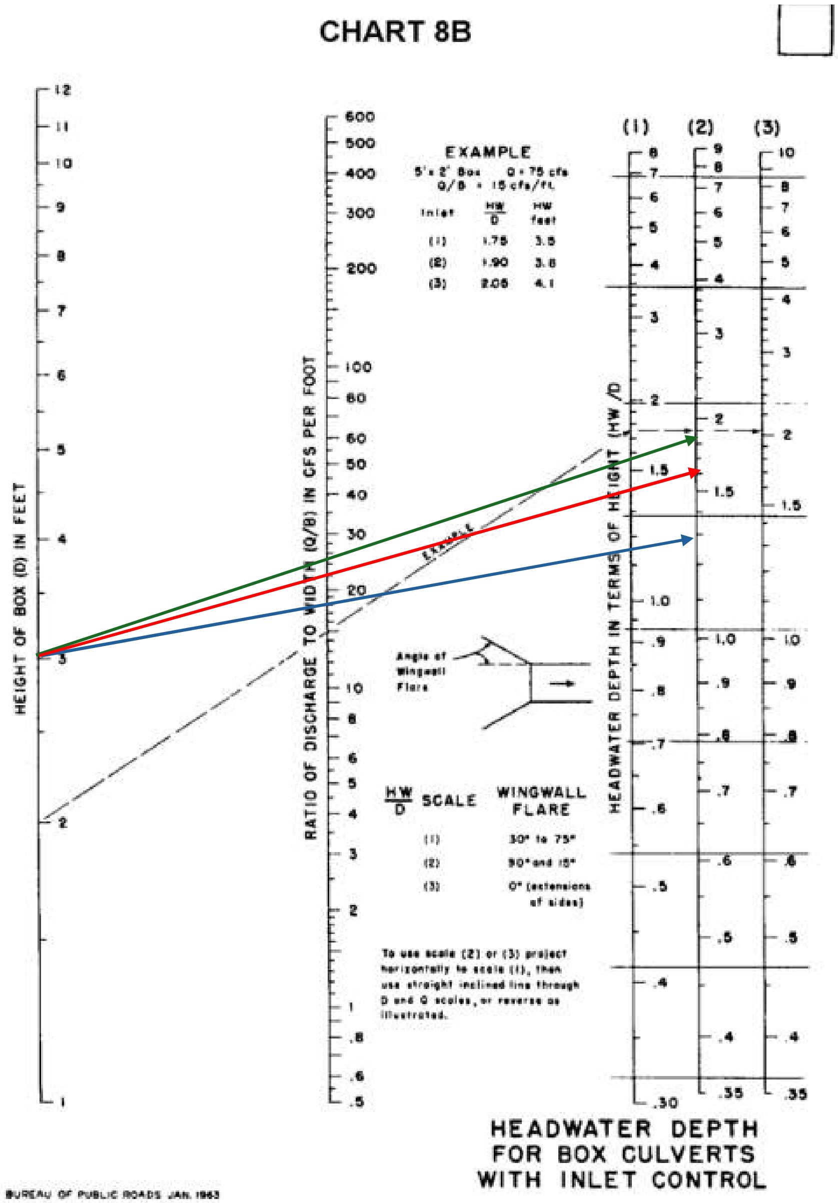
Ke	0.5	Entrance Loss Coeficient (Ke) found using FHWA HDS 5 (Table 12) - Box culvert
TW	3	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.2	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	0.85	1.50	3.00	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	2.25	2.50	2.75	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.625	2.75	2.875	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	3	3	3	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	3.65	4.30	5.80	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	68.65	69.30	70.80	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	68.9	69.80	70.80	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Inlet Control	Inlet Control	Outlet Control	

Inlet Control



	Q/B (cfs)	HW/D
25	18	1.30
50	22	1.60
100	25	1.85

Outlet Control

Table 12–Entrance Loss Coefficients.

Outlet Control, Full or Partly Full Entrance Head Loss

$$H_e = K_e\left[\frac{V^2}{2g}\right]$$

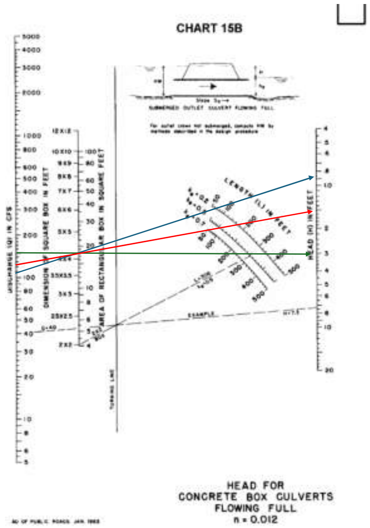
Type of Structure and Design of Entrance	Coefficient K_e
• Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end	0.2
Square-edge	0.5
Rounded (radius = D/12	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
• Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
• Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of D/12 or B/12 or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of D/12 or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side- or slope-tapered inlet	0.2

Headwater (H) found using Chart 15B, FHWA HDS 5:

	Q/B (cfs)
25	18
50	22
100	25

	25-yr	50-yr	100-yr
H	0.85	1.5	3.0

Headwater (H) found using Chart 15B, FHWA HDS 5.

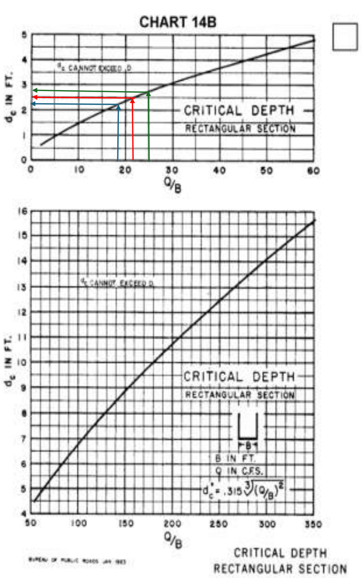


Critical Depth (dc) Found using Chart 14B, FHWA HDS 5

	Q/B (cfs)	dc
25	18	2.3
50	22	2.5
100	25	2.8

DIA (FT)
6

Critical Depth (dc) Found using Chart 14B, FHWA HDS 5.



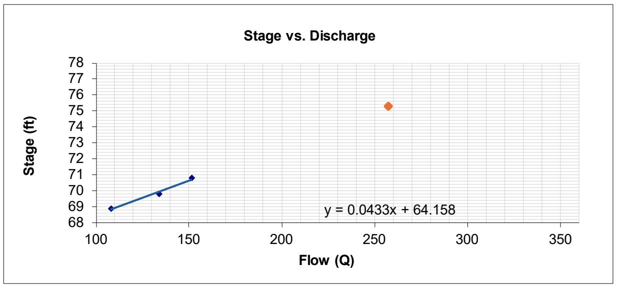
SR-60 LHR
FPID
Cross Drain Flow/Stage Calulations
CD-19

Insert Values

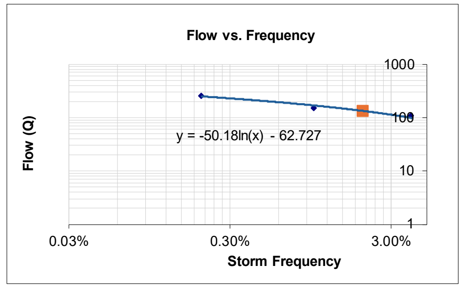
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	108	68.9	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	151	70.8	25-yr , 50-yr and 100-yr stages found using Chart 8B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	257	75.3	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	134	69.8	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	65	Upstream invert
FL (DS) =	64.8	Downstream invert
Edge of Travel Lane (ETL) =	69	Upstream elevation
Length (L)=	87	(Existing)
Slope (So) =	0.002	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Culvert Size	Culvert Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-10	1	6x3'	18.00	6	108	151

	in.	ft.
Height (D)	36	3
Width (B)	72	6

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	18.0	22.3	25.2	Box Culverts
HW/D	1.30	1.60	1.85	Headwater Depth Found using Chart 8B, FHWA HDS 5 (see attached)
HW	3.90	4.80	5.55	HW = (HW/D) * Diameter
HW Elev.	68.90	69.80	70.55	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

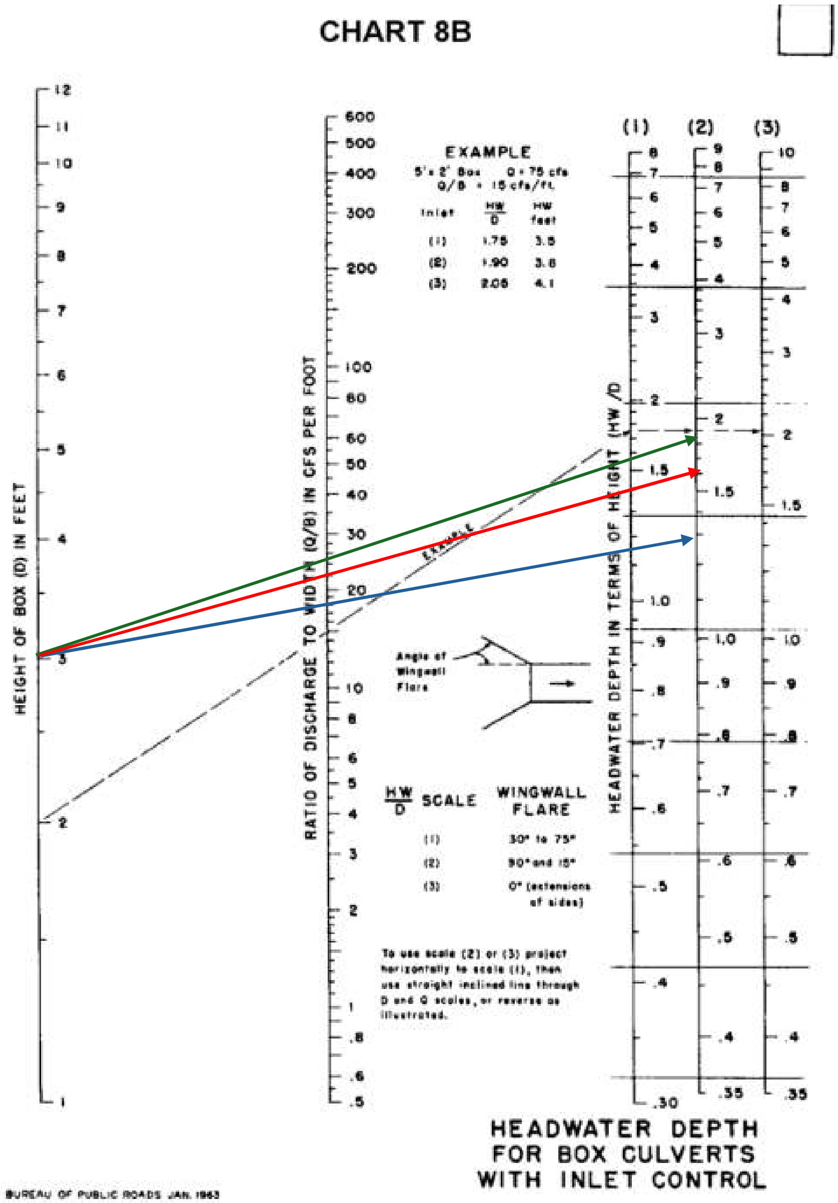
Ke	0.5	Entrance Loss Coeficient (Ke) found using FHWA HDS 5 (Table 12) - Box culvert
TW	3	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.2	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	0.85	1.50	3.00	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	2.25	2.50	2.75	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.625	2.75	2.875	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	3	3	3	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	3.65	4.30	5.80	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	68.65	69.30	70.80	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	68.9	69.80	70.80	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Inlet Control	Inlet Control	Outlet Control	

Inlet Control



	Q/B (cfs)	HW/D
25	18	1.30
50	22	1.60
100	25	1.85

Outlet Control

Table 12–Entrance Loss Coefficients.

Outlet Control, Full or Partly Full Entrance Head Loss

$$H_e = K_e\left[\frac{V^2}{2g}\right]$$

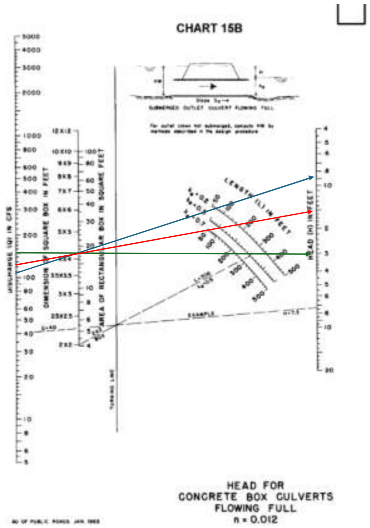
Type of Structure and Design of Entrance	Coefficient K_e
• Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end	0.2
Square-edge	0.5
Rounded (radius = D/12	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
• Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
• Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of D/12 or B/12 or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of D/12 or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side- or slope-tapered inlet	0.2

Headwater (H) found using Chart 15B, FHWA HDS 5:

	Q/B (cfs)
25	18
50	22
100	25

	25-yr	50-yr	100-yr
H	0.85	1.5	3.0

Headwater (H) found using Chart 15B, FHWA HDS 5.

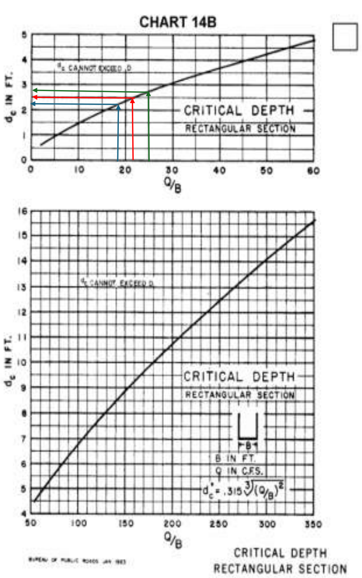


Critical Depth (dc) Found using Chart 14B, FHWA HDS 5

	Q/B (cfs)	dc
25	18	2.3
50	22	2.5
100	25	2.8

DIA (FT)
6

Critical Depth (dc) Found using Chart 14B, FHWA HDS 5.



SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-20

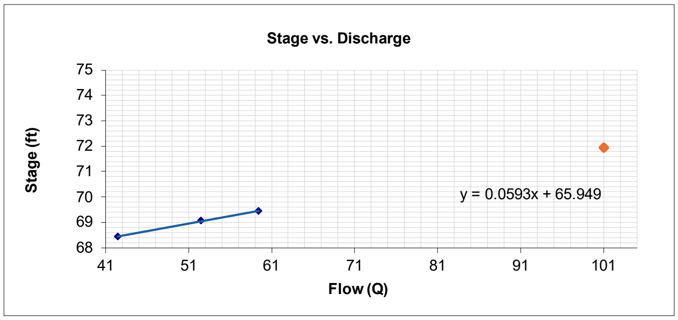
Insert Values

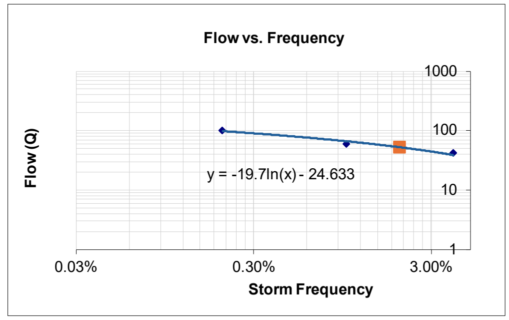
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	42	68.5	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	59	69.5	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	101	71.9	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	52	69.1	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge

Flow vs. Frequency - For the 50-yr and 500-yr flow rates





Given Information

FL (US) =	64.8	Upstream invert
FL (DS) =	64.5	Downstream invert
Edge of Travel Lane (ETL) =	68.5	Upstream elevation
Length (L)=	84.68	(Existing)
Slope (So) =	0.004	

A. Calculate Discharge

Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-20	1	36	7.07	6	42	59

	in.	ft.
Diameter (D)	36	3
Width (B)		

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.18	1.43	1.55	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	3.54	4.29	4.65	HW = (HW/D) * Diameter
HW Elev.	68.34	69.09	69.45	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

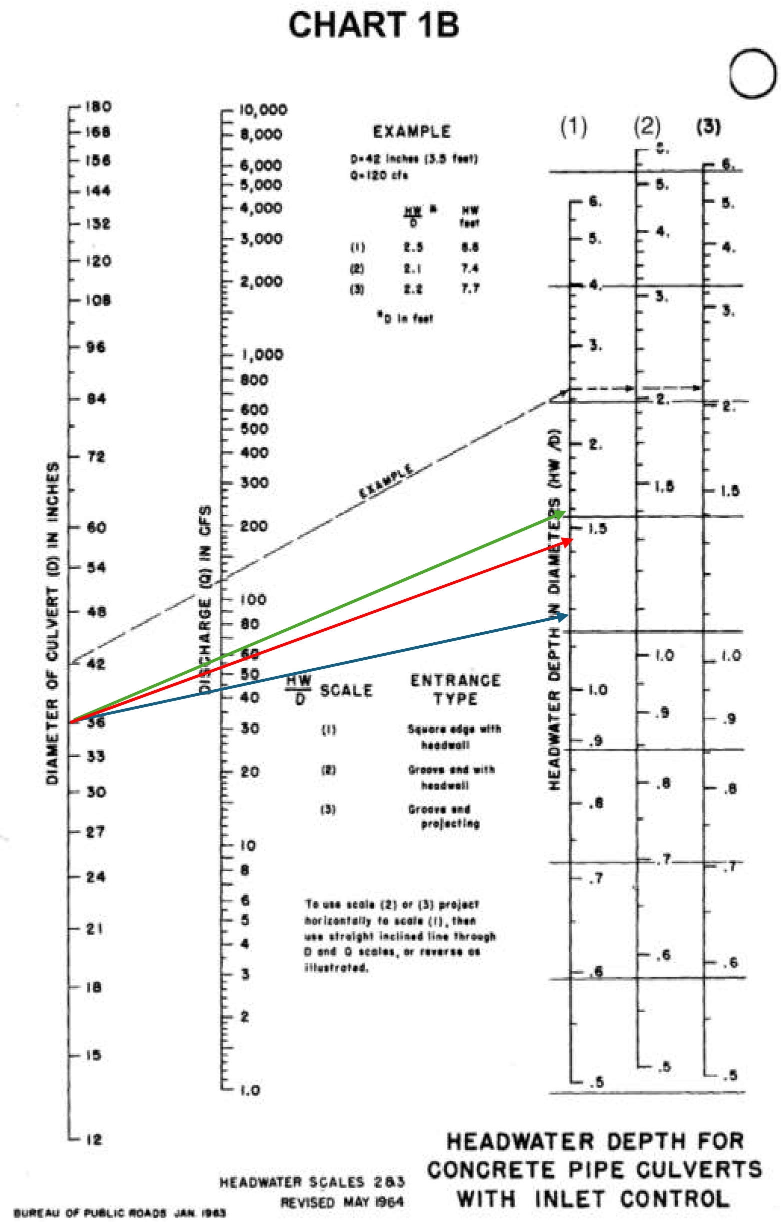
Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	3	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	0.95	1.50	1.90	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	2.10	2.60	2.90	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.55	2.8	2.95	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	3	3	3	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	3.65	4.20	4.60	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	68.45	69.00	69.40	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	68.45	69.09	69.45	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Outlet Control	Inlet Control	Inlet Control	

Inlet Control



	Flow (cfs)	HW/D
25	42	1.18
100	59	1.55
50	52	1.43

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.5 to 0.7
430-012	Concrete Energy Dissipater	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 15" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 54"	(a) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.5

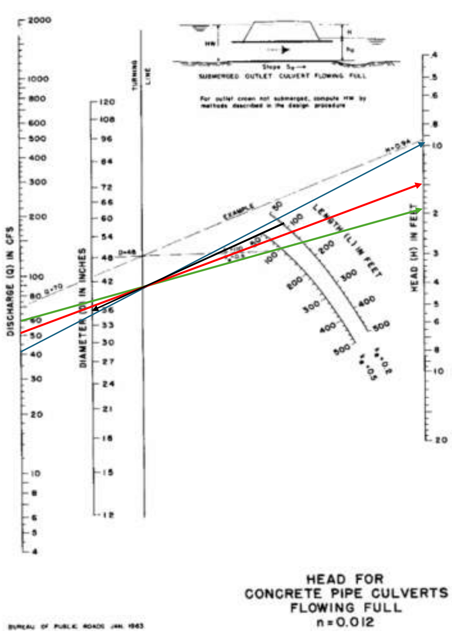
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	42
100	59
50	52

	25-yr	50-yr	100-yr
H	1.0	1.5	1.9

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B



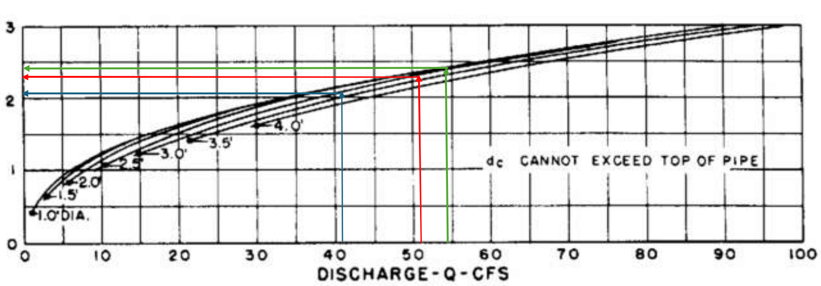
Critical Depth (dc) Found using Chart 4, FHWA HDS 5

	Flow (cfs)	dc
25	42	2.1
100	59	2.9
50	52	2.6

DIA (FT)
3

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



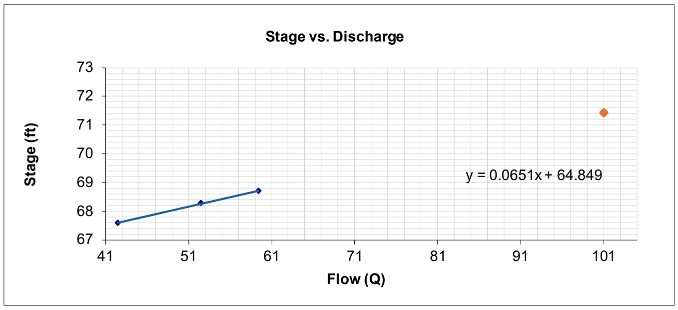
SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-21

Insert Values

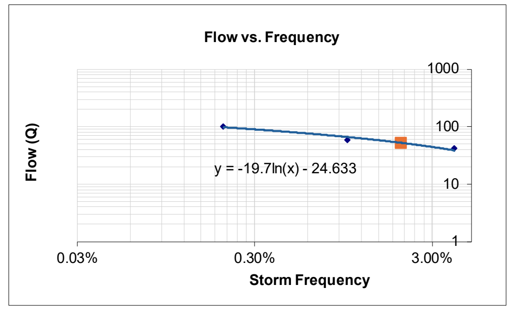
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	42	67.6	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	59	68.7	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	101	71.4	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	52	68.3	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	64	Upstream invert
FL (DS) =	63.7	Downstream invert
Edge of Travel Lane (ETL) =	68	Upstream elevation
Length (L)=	91.12	(Existing)
Slope (So) =	0.0033	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-21	1	36	7.07	6	42	59

	in.	ft.
Diameter (D)	36	3
Width (B)	-	-

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.18	1.43	1.55	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	3.54	4.29	4.65	HW = (HW/D) * Diameter
HW Elev.	67.54	68.29	68.65	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

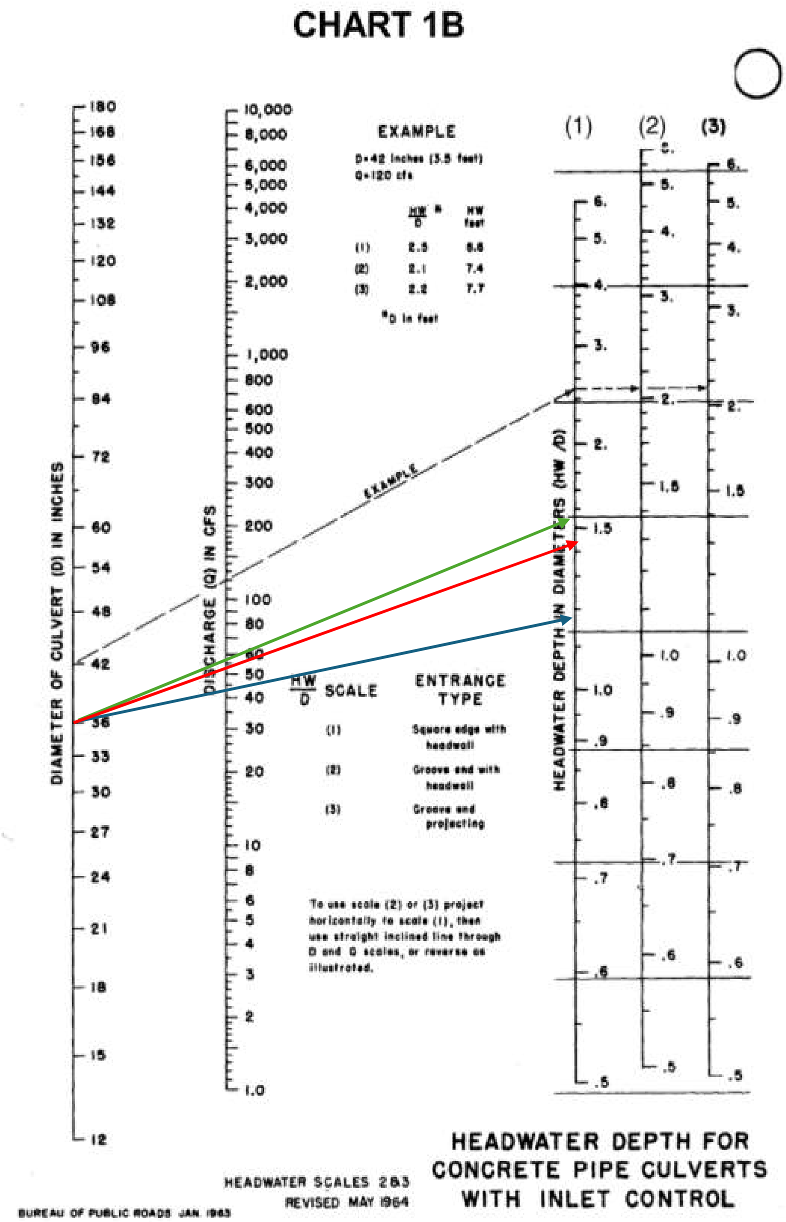
Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	3	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	0.9	1.50	2.00	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	2.10	2.60	2.90	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	2.55	2.8	2.95	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	3	3	3	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	3.6	4.20	4.70	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	67.6	68.20	68.70	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	67.6	68.29	68.70	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Outlet Control	Inlet Control	Outlet Control	

Inlet Control



	Flow (cfs)	HW/D
25	42	1.18
100	59	1.55
50	52	1.43

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

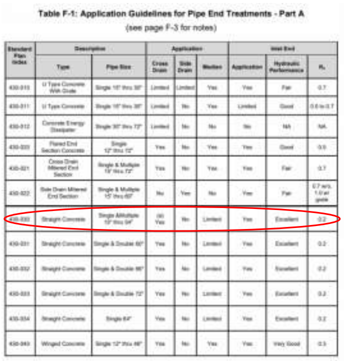


Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.6 to 0.7
430-012	Concrete Energy Dissipator	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 18" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 at grate
430-030	Straight Concrete	Single &Multiple 15" thru 84"	(d) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.3

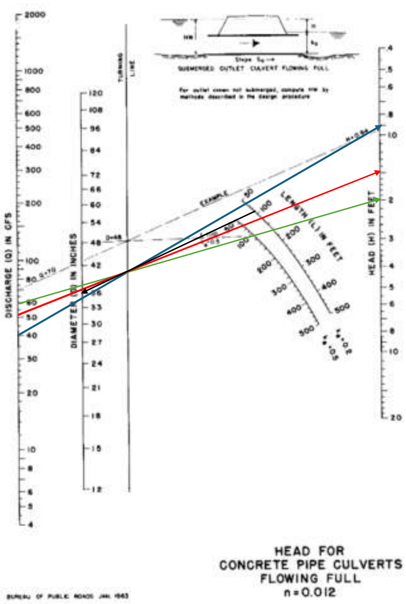
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	42
100	59
50	52

	25-yr	50-yr	100-yr
H	0.9	1.5	2.0

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B



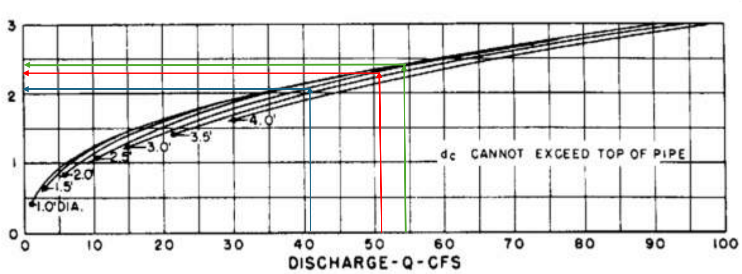
Critical Depth (dc) Found using Chart 4, FHWA HDS 5

	Flow (cfs)	dc
25	42	2.1
100	59	2.9
50	52	2.6

DIA (FT)
3

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



SR-60 LHR
FPID
Cross Drain Flow/Stage Calulations
CD-22

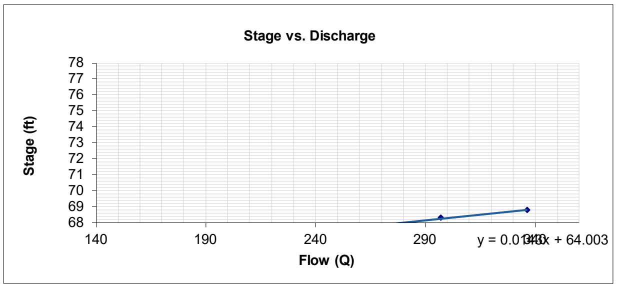
Insert Values

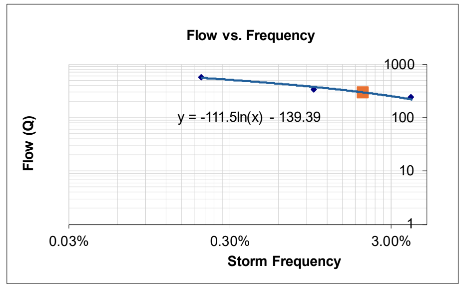
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	240	67.4	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	336	68.8	25-yr , 50-yr and 100-yr stages found using Chart 8B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	571	77.4	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	297	68.3	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge

Flow vs. Frequency - For the 50-yr and 500-yr flow rates





Given Information

FL (US) =	62.3	Upstream invert
FL (DS) =	62	Downstream invert
Edge of Travel Lane (ETL) =	67.2	Upstream elevation
Length (L)=	83.41	(Existing)
Slope (So) =	0.004	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Culvert Size	Culvert Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-10	1	8x5'	40.00	6	240	336

	in.	ft.
Height (D)	60	5
Width (B)	96	8

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	30.0	37.1	42.0	Box Culverts
HW/D	1.00	1.20	1.30	Headwater Depth Found using Chart 8B, FHWA HDS 5 (see attached)
HW	5.00	6.00	6.50	HW = (HW/D) * Diameter
HW Elev.	67.30	68.30	68.80	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

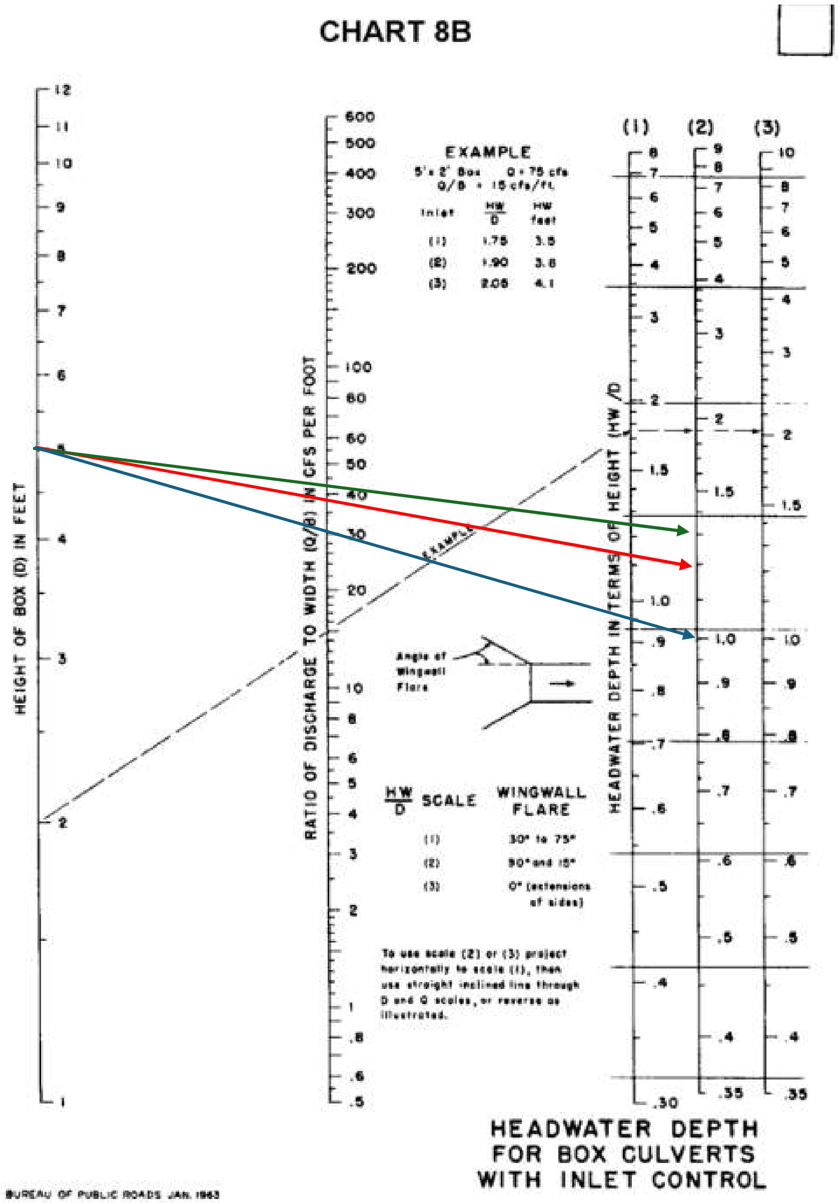
Ke	0.5	Entrance Loss Coeficient (Ke) found using FHWA HDS 5 (Table 12) - Box culvert
TW	5	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	0.43	1.05	1.70	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	3.00	3.50	3.80	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	4	4.25	4.4	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	5	5	5	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	5.13	5.75	6.40	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	67.43	68.05	68.70	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	67.43	68.30	68.80	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Outlet Control	Inlet Control	Inlet Control	

Inlet Control



	Q/B (cfs)	HW/D
25	30	1.00
50	37	1.20
100	42	1.30

Outlet Control

Table 12–Entrance Loss Coefficients.

Outlet Control, Full or Partly Full Entrance Head Loss

$$H_e = K_e\left[\frac{V^2}{2g}\right]$$

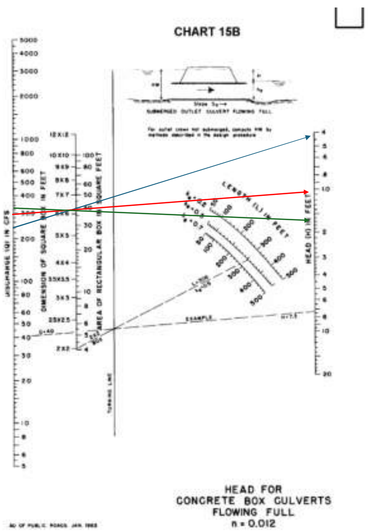
Type of Structure and Design of Entrance	Coefficient K_e
• Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or headwall and wingwalls	
Socket end of pipe (groove-end	0.2
Square-edge	0.5
Rounded (radius = D/12	0.2
Mitered to conform to fill slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
• Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side- or slope-tapered inlet	0.2
• Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edged on 3 edges	0.5
Rounded on 3 edges to radius of D/12 or B/12 or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edged at crown	0.4
Crown edge rounded to radius of D/12 or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side- or slope-tapered inlet	0.2

Headwater (H) found using Chart 15B, FHWA HDS 5:

	Q/B (cfs)
25	30
50	37
100	42

	25-yr	50-yr	100-yr
H	0.4	1.1	1.7

Headwater (H) found using Chart 15B, FHWA HDS 5.

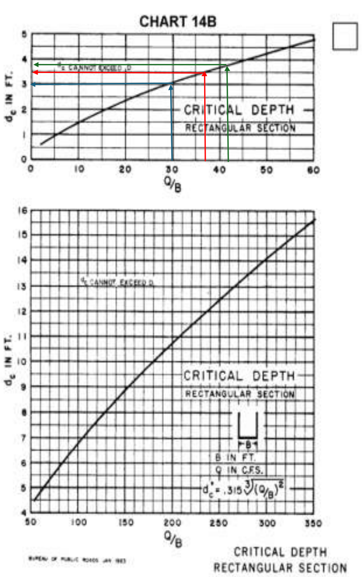


Critical Depth (dc) Found using Chart 14B, FHWA HDS 5

	Q/B (cfs)	dc
25	30	3.0
50	37	3.5
100	42	3.8

DIA (FT)
8

Critical Depth (dc) Found using Chart 14B, FHWA HDS 5.



SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-23 (Assuming pipe size of 24")

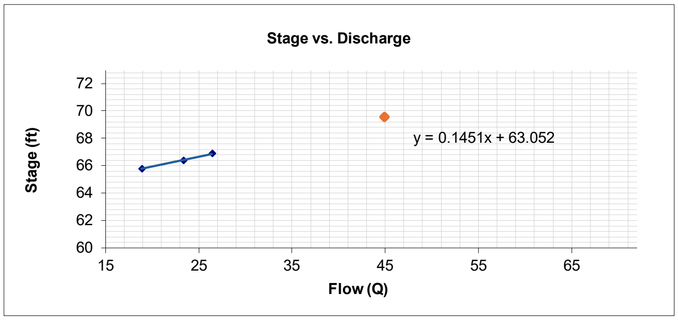
Insert Values

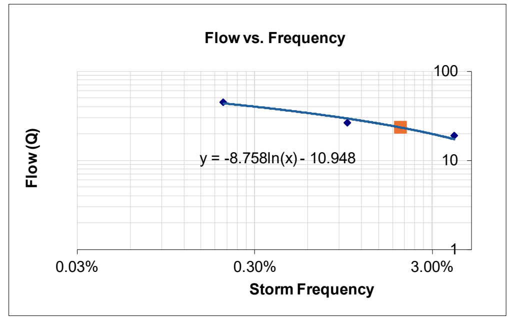
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	19	65.8	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	26	66.9	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	45	69.6	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	23	66.4	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge

Flow vs. Frequency - For the 50-yr and 500-yr flow rates





Given Information

FL (US) =	63	Upstream invert
FL (DS) =	62.7	Downstream invert
Edge of Travel Lane (ETL) =	65.1	Upstream elevation
Length (L)=	75	(Existing)
Slope (So) =	0.0040	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-23	1	24	3.14	6	19	26

	in.	ft.
Diameter (D)	24	2
Width (B)		

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.3	1.7	1.95	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	2.60	3.40	3.90	HW = (HW/D) * Diameter
HW Elev.	65.60	66.40	66.90	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

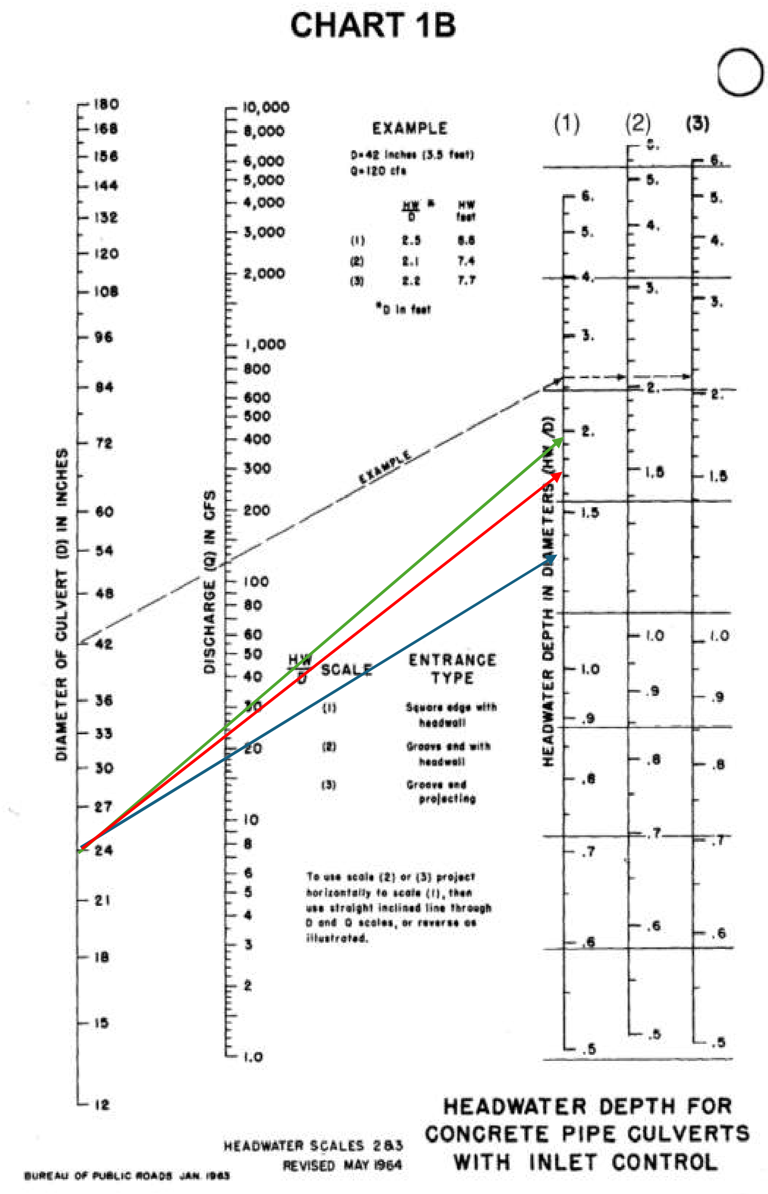
Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	1.1	1.70	2.00	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.50	1.70	1.80	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	1.75	1.85	1.9	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2	2	2	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	2.8	3.40	3.70	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	65.8	66.40	66.70	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	65.8	66.40	66.90	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Outlet Control	Outlet Control	Inlet Control	

Inlet Control



	Flow (cfs)	HW/D
25	19	1.30
100	26	1.95
50	23	1.70

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

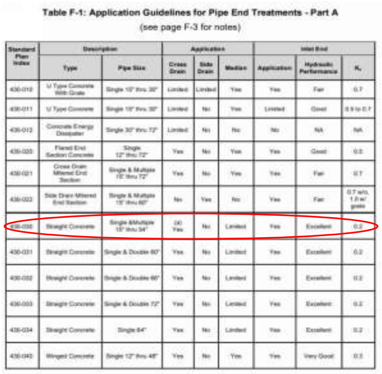


Table F-1: Application Guidelines for Pipe End Treatments - Part A
(see page F-3 for notes)

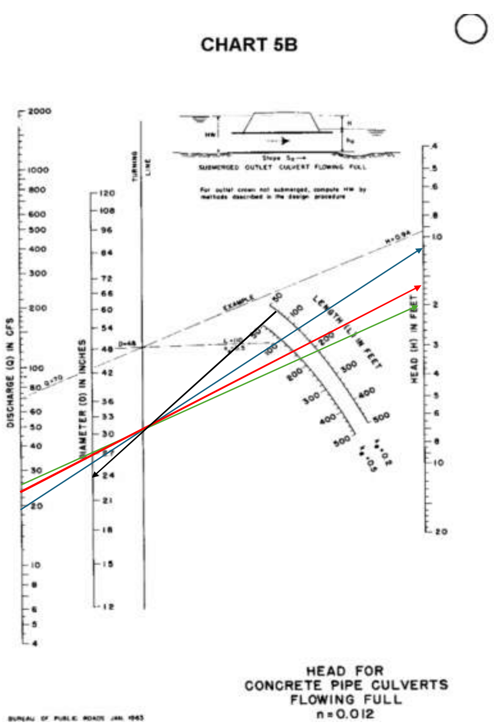
Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.5 to 0.7
430-012	Concrete Energy Dissipater	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 15" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 54"	(a) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.5

Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	19
100	26
50	23

	25-yr	50-yr	100-yr
H	1.1	1.7	2.0

Headwater (H) found using Chart 5, FHWA HDS 5.

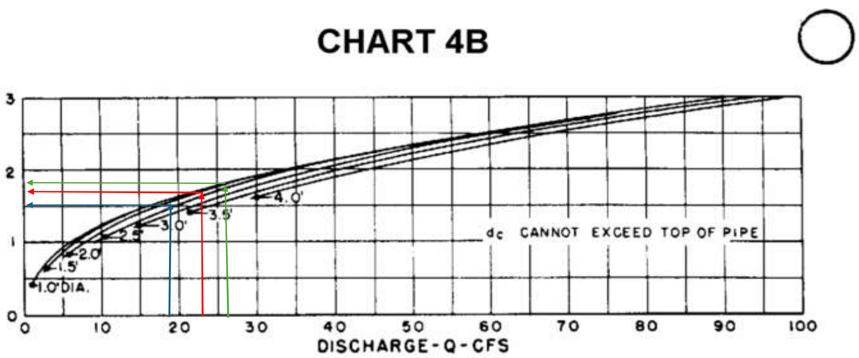


Critical Depth (dc) Found using Chart 4, FHWA HDS 5

	Flow (cfs)	dc
25	19	1.5
100	26	1.8
50	23	1.7

DIA (FT)
2

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.



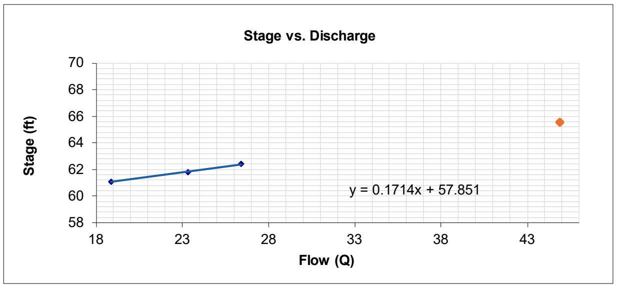
SR-60 LHR
FPID: 452574-1-22-01
Cross Drain Flow/Stage Calulations
CD-24

Insert Values

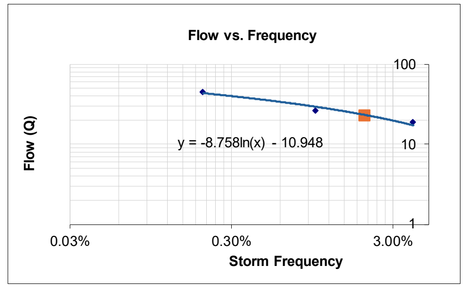
	Storm	Frequency (%)	Flow (cfs)	Stage (ft)	Notes
	25	4.00%	19	61.1	25-yr, 100-yr, and 500-yr flow rates calculated per Drainage Design Guide (see below, Section A).
Base Flood	100	1.00%	26	62.4	25-yr , 50-yr and 100-yr stages found using Chart 1B, FHWA HDS 5 (see below, Section B).
Greatest	500	0.20%	45	65.5	500-yr stage calculated using Stage vs. Discharge equation (obtained from graphing 25-yr to 100-yr stages
Design Flood	50	2.00%	23	61.8	50-yr flow rate calculated using Flow vs. Frequency equation (obtained from graphing 25-yr, 100-yr, and 500-yr rates).

Note: 25 and 100 year flows calculated per Drainage Design Guide, see below:

Stage vs. Discharge



Flow vs. Frequency - For the 50-yr and 500-yr flow rates



Given Information

FL (US) =	58.3	Upstream invert
FL (DS) =	58	Downstream invert
Edge of Travel Lane (ETL) =	61	Upstream elevation
Length (L)=	90.21	(Existing)
Slope (So) =	0.003	

A. Calculate Discharge
Q25= (Velocity) x (Area)
Velocity = 6 ft/sec per Drainage design Guide, Chapter 4, Method 1.
Q100=Q25*1.4

	in.	ft.
Diameter (D)	24	2
Width (B)		

CD Name	Barrels	Pipe Size (in)	Pipe Area (sq. ft)	Velocity (ft/s)	Flow (25-yr) (cfs)	Flow (100-yr) (cfs)
CD-17	1	24	3.14	6	19	26

B. Compute stages using FHWA HDS 5 assuming Inlet Control

	25-yr	50-yr	100-yr	Notes
Q/B	-	-	-	Box Culverts
HW/D	1.4	1.6	1.8	Headwater Depth Found using Chart 1B, FHWA HDS 5 (see attached)
HW	2.80	3.20	3.60	HW = (HW/D) * Diameter
HW Elev.	61.10	61.50	61.90	HW Elev. = HW + FL (US)

C. Compute stages using FHWA HDS 5 assuming Outlet Control

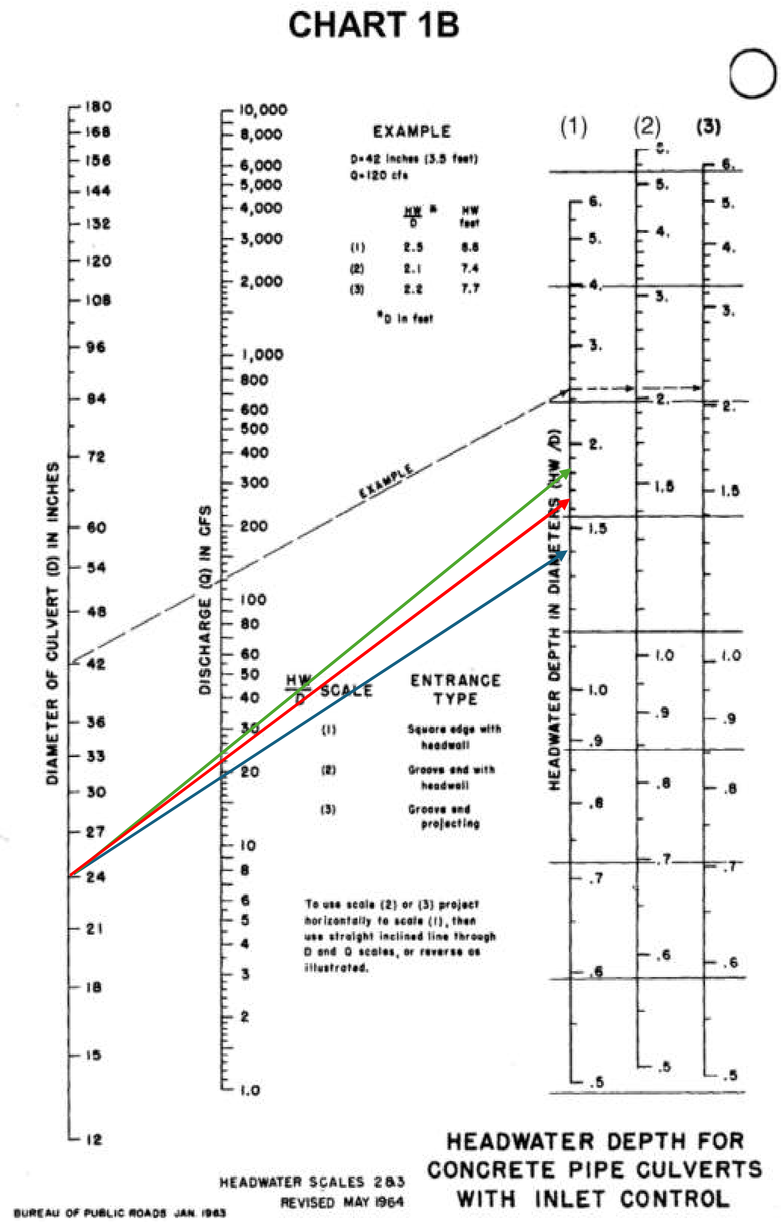
Ke	0.2	Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F) (see attached).
TW	2	If outlet is in a free-flowing condition, assume the crown of the pipe at the outlet is the tailwater
LSo	0.3	LSo = Pipe Lengh * Pipe Slope
Outlet Velocity	6	Outlet Velocity (f/s) = 6 ft/s (Same as inlet velocity used to calculate discharges for the 25-yr storm).

	25-yr	50-yr	100-yr	Notes:
H	1.1	1.80	2.40	Headwater (H) found using Chart 5, FHWA HDS 5 (see attached).
dc	1.50	1.65	1.85	Critical Depth (dc) Found using Chart 4, FHWA HDS 5 (see attached)
ho	1.75	1.825	1.925	Equivalent Hydraulic Elevation (ho) = (D+dc)/2
DTW	2	2	2	Design Tail Water (DTW) = TW or ho, whichever is greater
HW Depth	2.8	3.50	4.10	Headwater Depth (HW) = H + DTW - LSo
HW Elevation	61.1	61.80	62.40	US Pipe inv. + HW depth

D. Controlling HW (Inlet or Outlet Control)

	25-yr	50-yr	100-yr	Notes:
Controling HW	61.1	61.80	62.40	If inlet HW Elev. > outlet HW Elev., then Controling HW Elev.=Inlet HW Elv.
	Outlet Control	Outlet Control	Outlet Control	

Inlet Control



	Flow (cfs)	HW/D
25	19	1.40
100	26	1.80
50	23	1.60

Outlet Control

Entrance Loss Coeficient (Ke) found using Apllication Guidelines for Pipe End Treatment, Appendix F (based on the structure having a standard end wall treatment).

Table F-1: Application Guidelines for Pipe End Treatments - Part A

(see page F-3 for notes)

Standard Plan Index	Description		Application			Inlet End		
	Type	Pipe Size	Cross Drain	Side Drain	Median	Application	Hydraulic Performance	K_e
430-010	U Type Concrete With Grate	Single 15" thru 30"	Limited	Limited	Yes	Yes	Fair	0.7
430-011	U Type Concrete	Single 15" thru 30"	Limited	No	Yes	Limited	Good	0.5 to 0.7
430-012	Concrete Energy Dissipater	Single 30" thru 72"	Limited	No	No	No	NA	NA
430-020	Flared End Section Concrete	Single 12" thru 72"	Yes	No	Yes	Yes	Good	0.5
430-021	Cross Drain Mitered End Section	Single & Multiple 15" thru 72"	Yes	No	Yes	Yes	Fair	0.7
430-022	Side Drain Mitered End Section	Single & Multiple 15" thru 60"	No	Yes	No	Yes	Fair	0.7 w/o, 1.0 w/ grate
430-030	Straight Concrete	Single &Multiple 15" thru 54"	(a) Yes	No	Limited	Yes	Excellent	0.2
430-031	Straight Concrete	Single & Double 60"	Yes	No	Limited	Yes	Excellent	0.2
430-032	Straight Concrete	Single & Double 66"	Yes	No	Limited	Yes	Excellent	0.2
430-033	Straight Concrete	Single & Double 72"	Yes	No	Limited	Yes	Excellent	0.2
430-034	Straight Concrete	Single 84"	Yes	No	Limited	Yes	Excellent	0.2
430-040	Winged Concrete	Single 12" thru 48"	Yes	No	Yes	Yes	Very Good	0.5

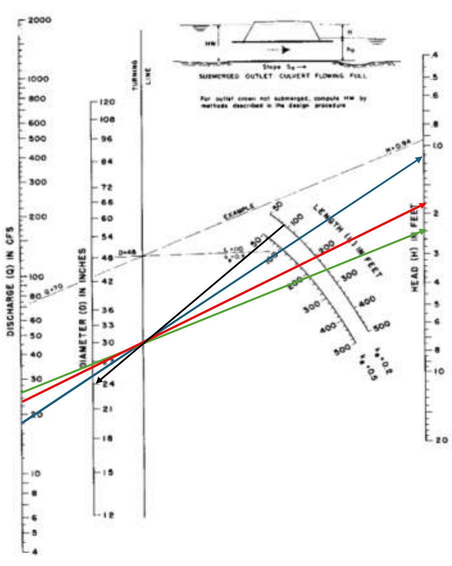
Headwater (H) found using Chart 5, FHWA HDS 5:

	Flow (cfs)
25	19
100	26
50	23

	25-yr	50-yr	100-yr
H	1.1	1.8	2.4

Headwater (H) found using Chart 5, FHWA HDS 5.

CHART 5B



HEAD FOR CONCRETE PIPE CULVERTS FLOWING FULL n=0.012

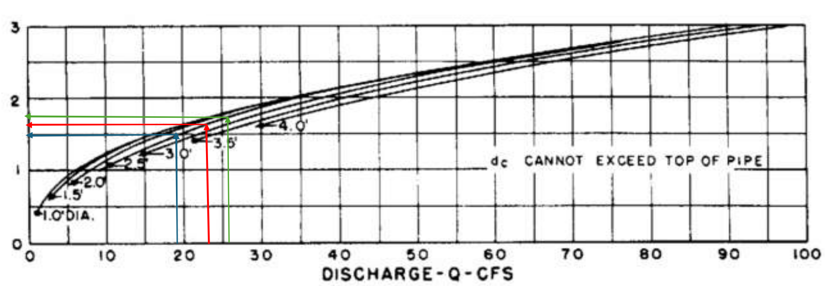
BUREAU OF PUBLIC ROADS JAN. 1963

	Flow (cfs)	dc
25	19	1.50
100	26	1.85
50	23	1.65

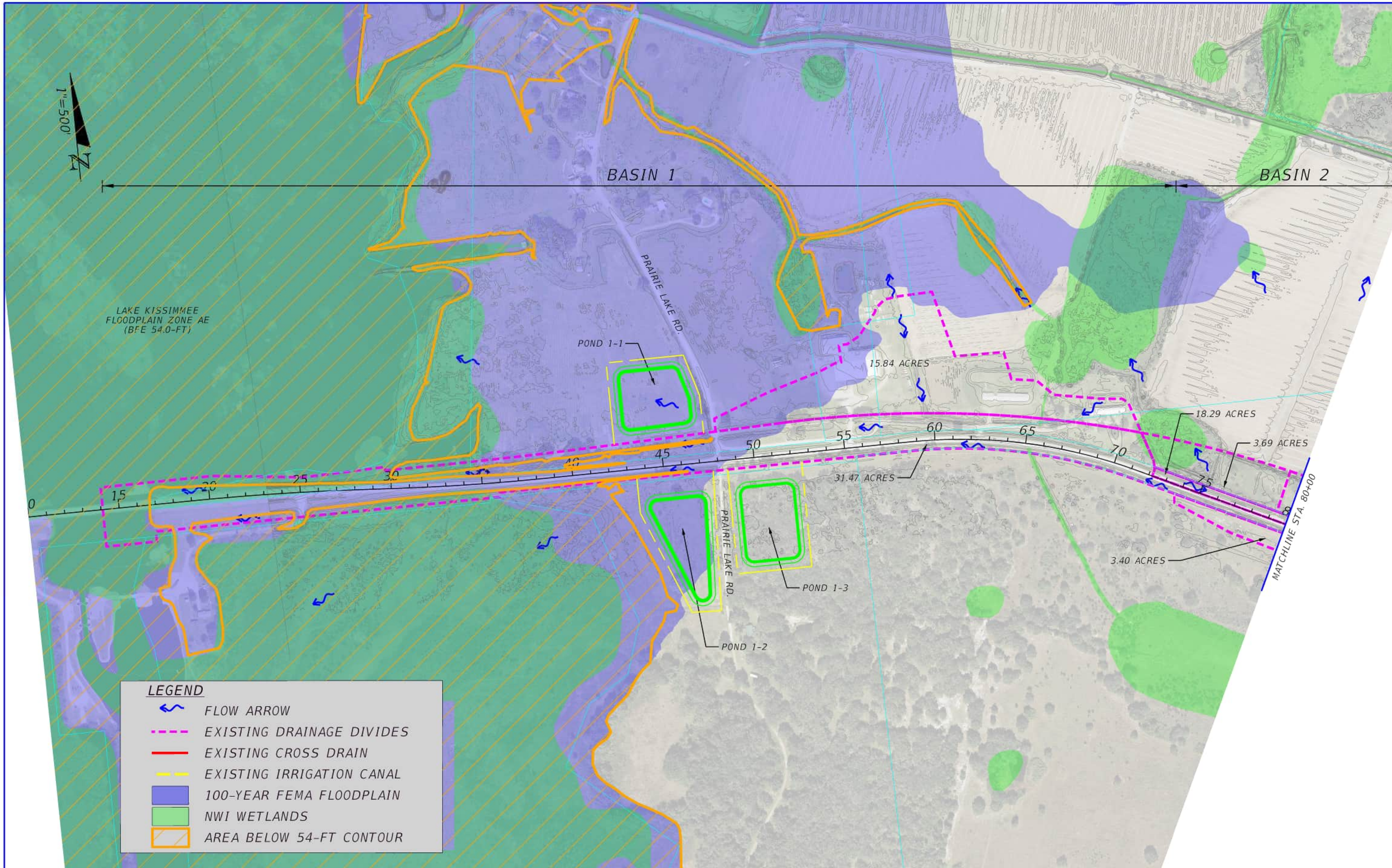
DIA (FT)
2

Critical Depth (dc) Found using Chart 4, FHWA HDS 5.

CHART 4B



APPENDIX D – Drainage Maps



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DATE	DESCRIPTION	DATE	DESCRIPTION

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DANIEL P. SHULL, P.E.
LICENSE NUMBER: 86494
MOTT MACDONALD FLORIDA, LLC.
220 WEST GARDEN STREET, SUITE 700
PENSACOLA, FLORIDA 32502

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 60	OSCEOLA	452574-1-22-01

DRAINAGE MAP

SHEET NO. 1

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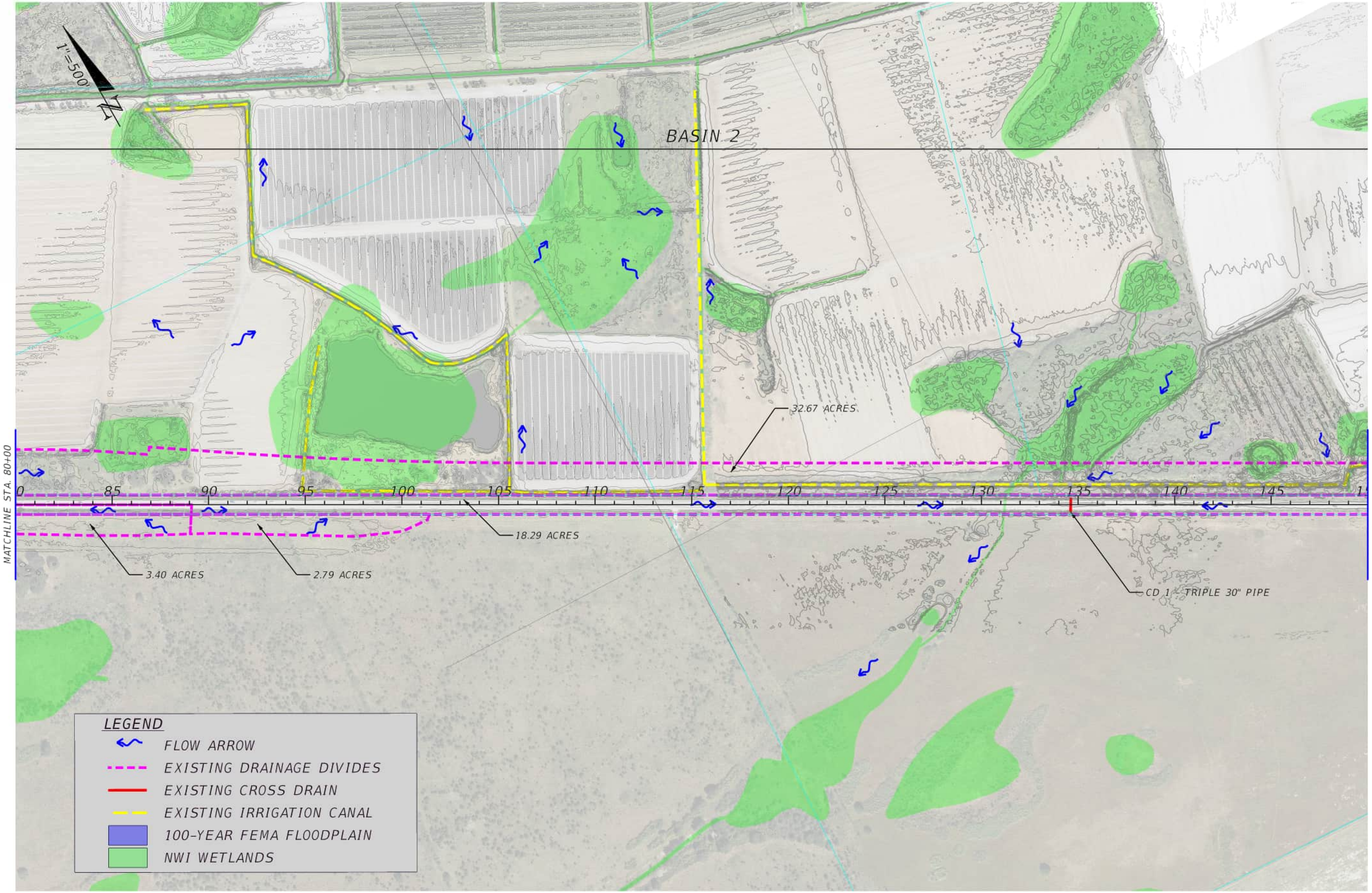

REVISIONS				ENGINEER OF RECORD	STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION				SHEET NO.
DATE	DESCRIPTION	DATE	DESCRIPTION	DANIEL P. SHULL, P.E. LICENSE NUMBER: 86494 MOTT MACDONALD FLORIDA, LLC. 220 WEST GARDEN STREET, SUITE 700 PENSACOLA, FLORIDA 32502	ROAD NO.	COUNTY	FINANCIAL PROJECT ID	DRAINAGE MAP	
					SR 60	OSCEOLA	452574-1-22-01		2

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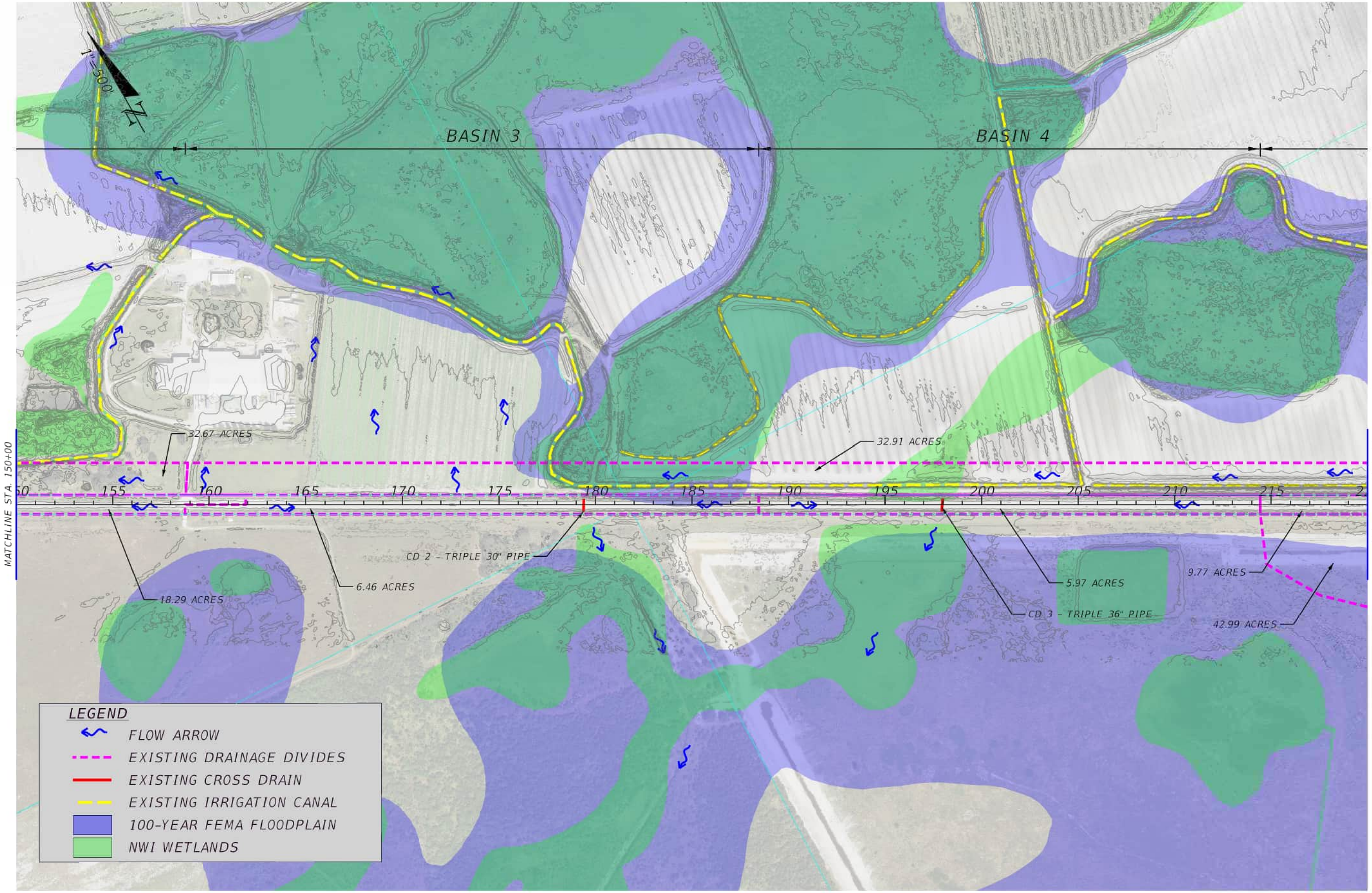

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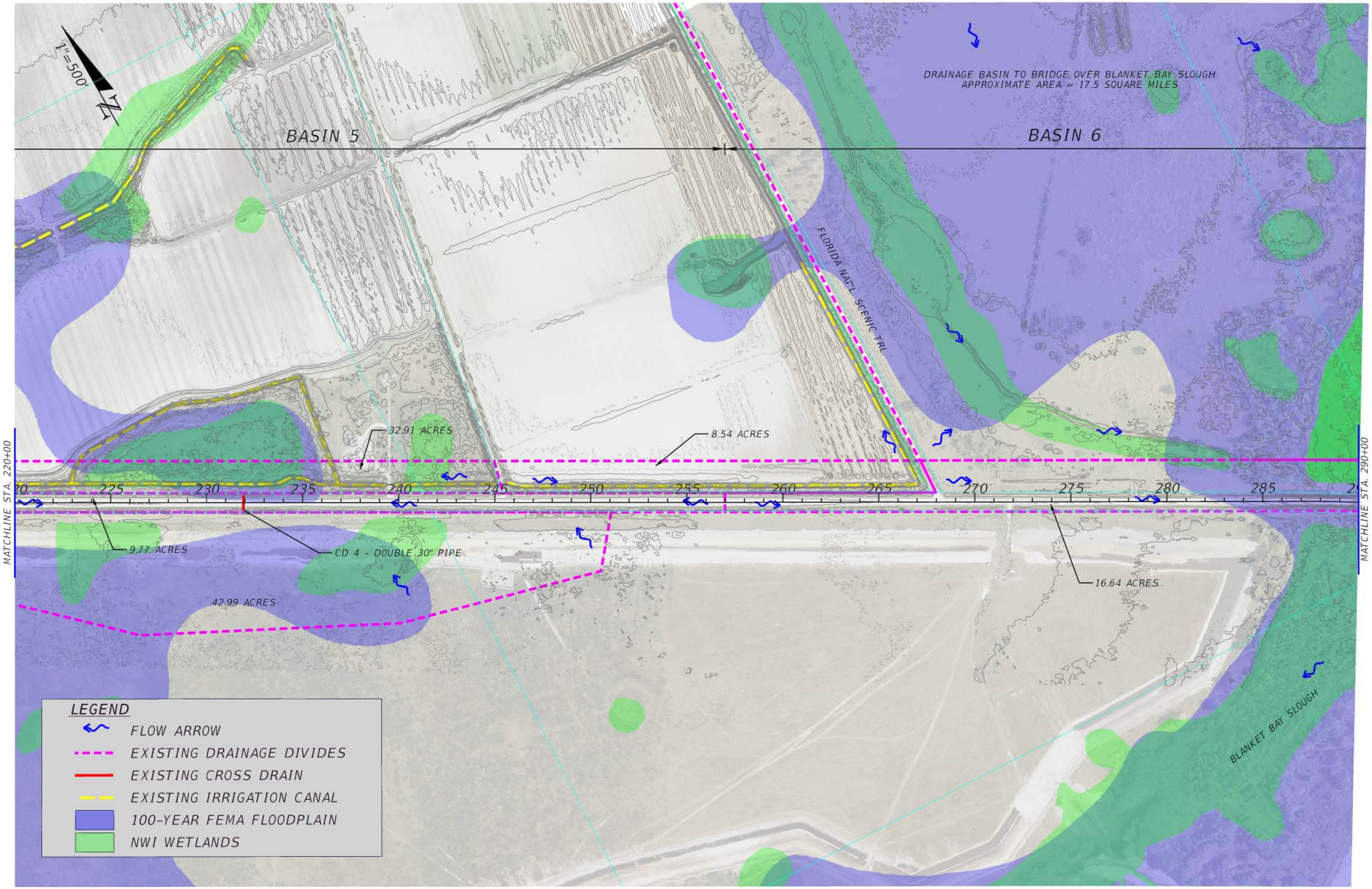
220 WEST GARDEN STREET, SUITE 700
PENSACOLA, FLORIDA 32502

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 60	OSCEOLA	452574-1-22-01

DRAINAGE MAP

SHEET NO.
3



REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ENGINEER OF RECORD

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LICENSE NUMBER: 86494
MOTT MACDONALD FLORIDA, LLC.
220 WEST GARDEN STREET, SUITE 700
PENSACOLA, FLORIDA 32502

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 60	OSCEOLA	452574-1-22-01

DRAINAGE MAP

SHEET NO. 4

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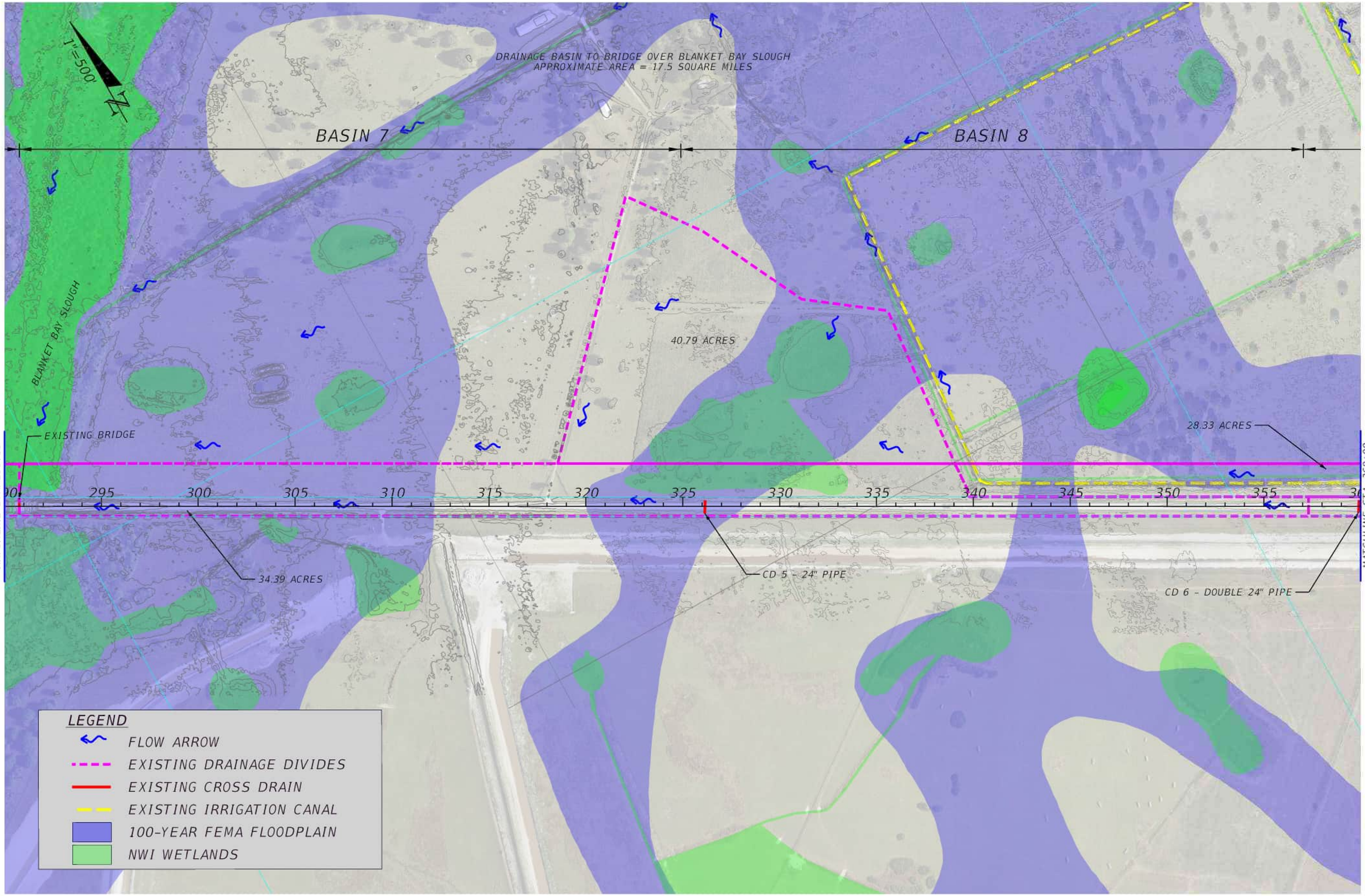

REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ENGINEER OF RECORD
DANIEL P. SHULL, P.E.
LICENSE NUMBER: 86494
MOTT MACDONALD FLORIDA, LLC.
220 WEST GARDEN STREET, SUITE 700
PENSACOLA, FLORIDA 32502

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 60	OSCEOLA	452574-1-22-01

DRAINAGE MAP

SHEET NO.
5

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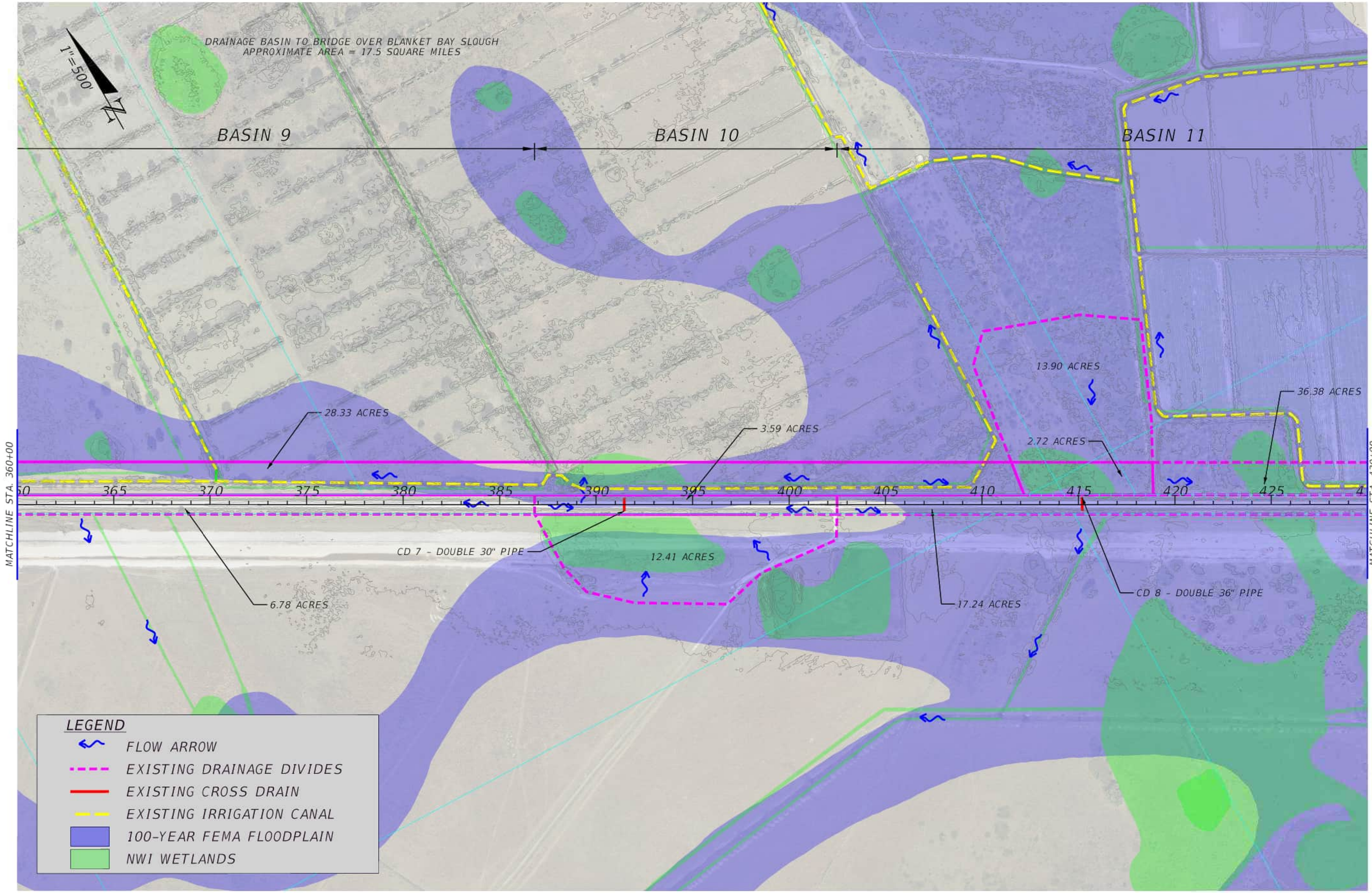

REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

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LICENSE NUMBER: 86494
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220 WEST GARDEN STREET, SUITE 700
PENSACOLA, FLORIDA 32502

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

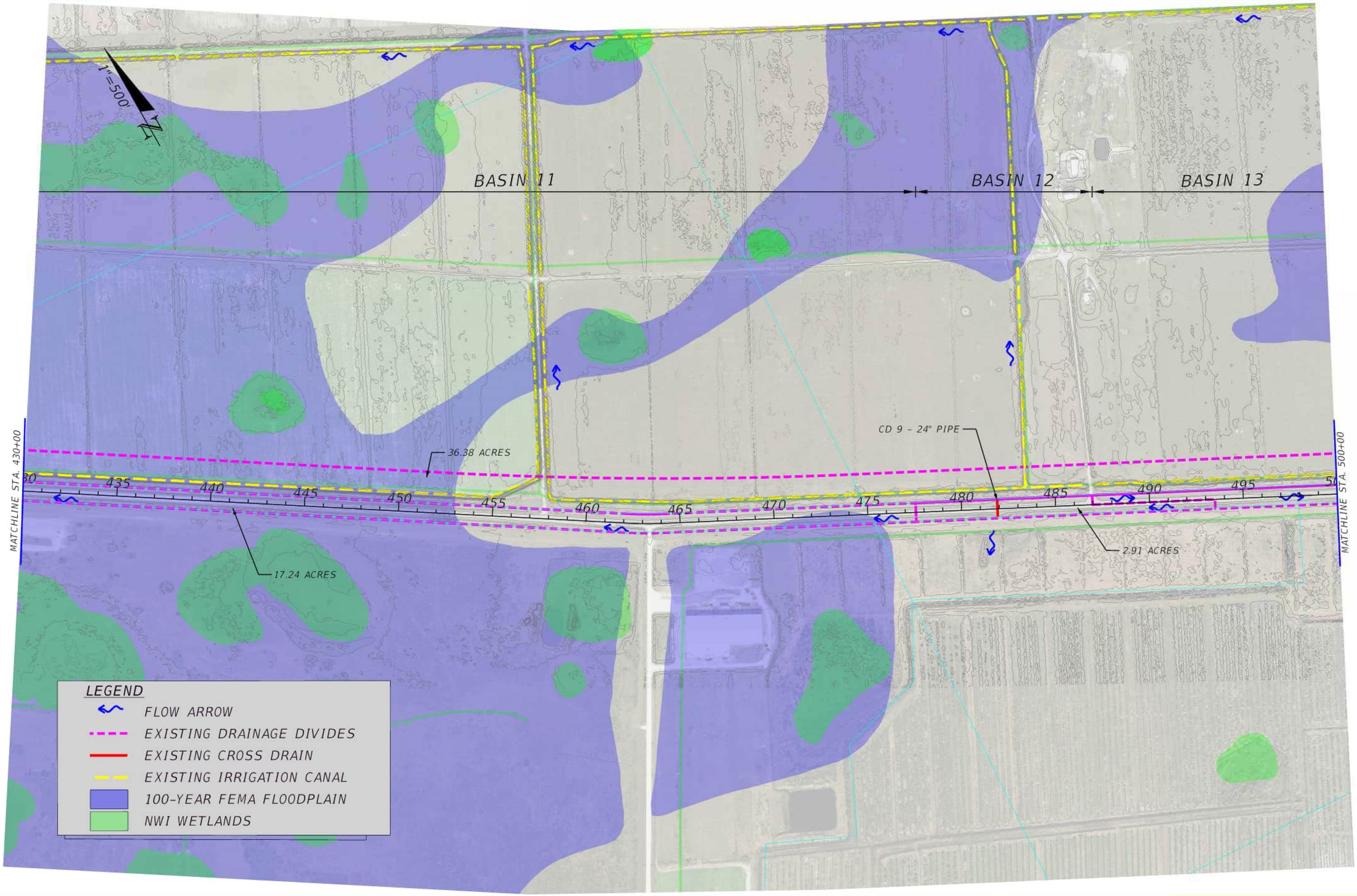
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 60	OSCEOLA	452574-1-22-01

DRAINAGE MAP

SHEET NO.
6

THE OFFICIAL RECORD OF THIS SHEET IS THE ELECTRONIC FILE DIGITALLY SIGNED AND SEALED UNDER RULE 61G15-23.004, F.A.C.

SHU66190 6/16/2025 3:47:48 PM



THE OFFICIAL RECORD OF THIS SHEET IS THE ELECTRONIC FILE DIGITALLY SIGNED AND SEALED UNDER RULE 61G15-23.004, F.A.C.

REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ENGINEER OF RECORD

DANIEL P. SHULL, P.E.
LICENSE NUMBER: 86494
MOTT MACDONALD FLORIDA, LLC.
220 WEST GARDEN STREET, SUITE 700
PENSACOLA, FLORIDA 32502

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 60	OSCEOLA	452574-1-22-01

DRAINAGE MAP

SHEET NO.
7

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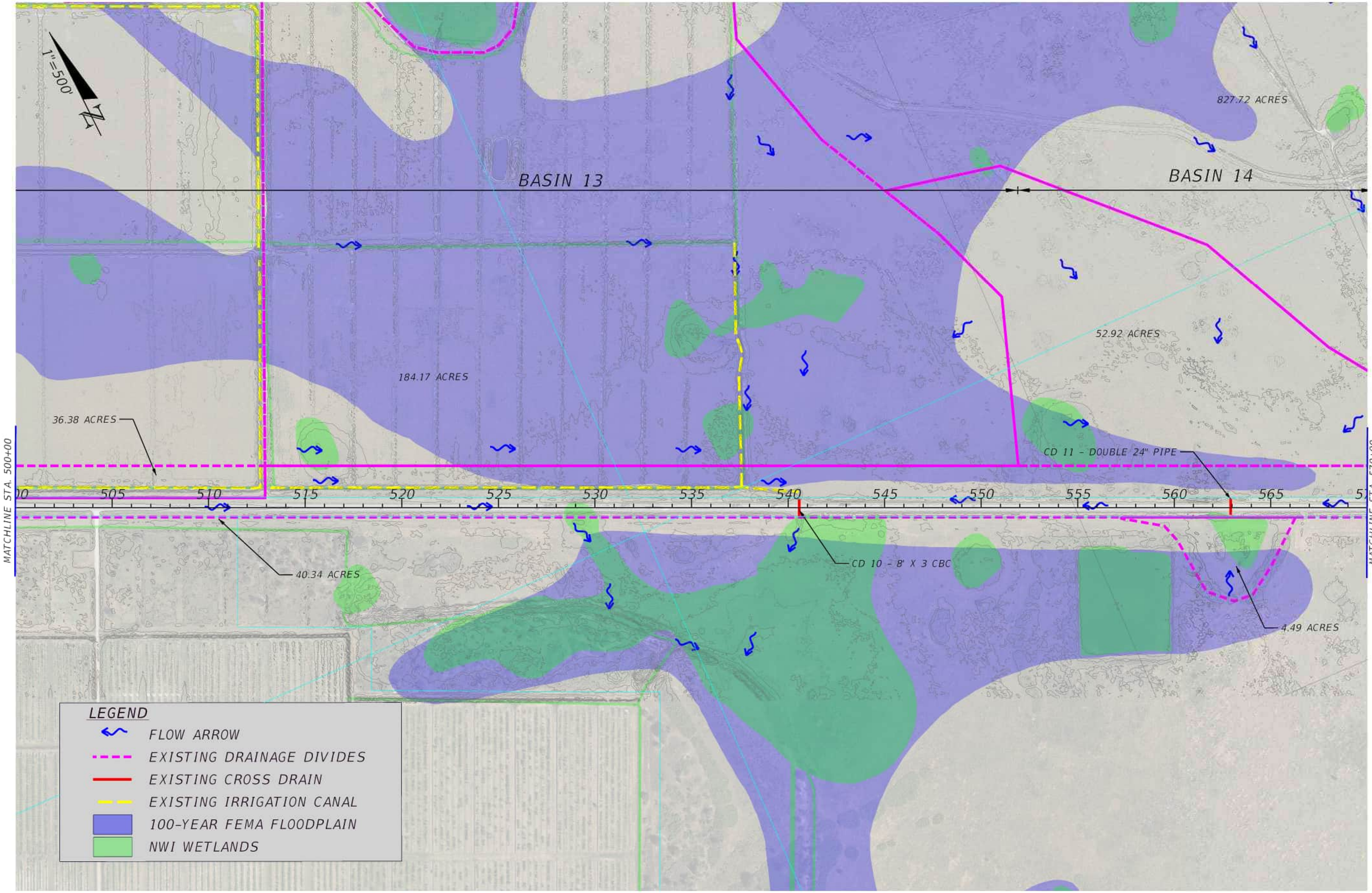

REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ENGINEER OF RECORD

DANIEL P. SHULL, P.E.
LICENSE NUMBER: 86494
MOTT MACDONALD FLORIDA, LLC.
220 WEST GARDEN STREET, SUITE 700
PENSACOLA, FLORIDA 32502

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 60	OSCEOLA	452574-1-22-01

DRAINAGE MAP

SHEET NO. 8

THE OFFICIAL RECORD OF THIS SHEET IS THE ELECTRONIC FILE DIGITALLY SIGNED AND SEALED UNDER RULE 61G15-23.004, F.A.C.

c:\pwworking\mm\transportation\sh66190\dms58873\PLANRD_LARGE_DRAINAGEMAP_01.dgn : B16 - PLAN 8 [SHEET]
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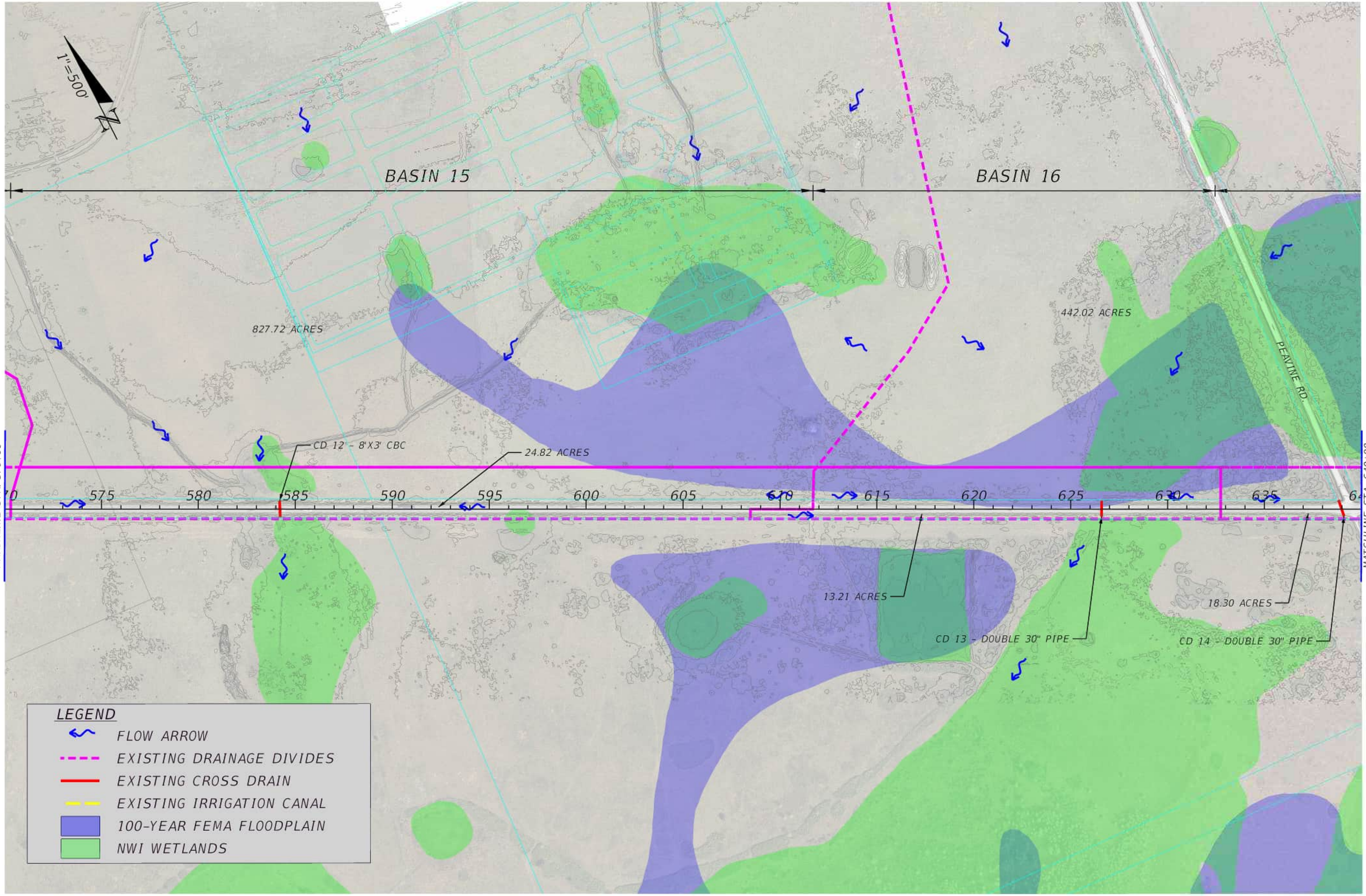


REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ENGINEER OF RECORD

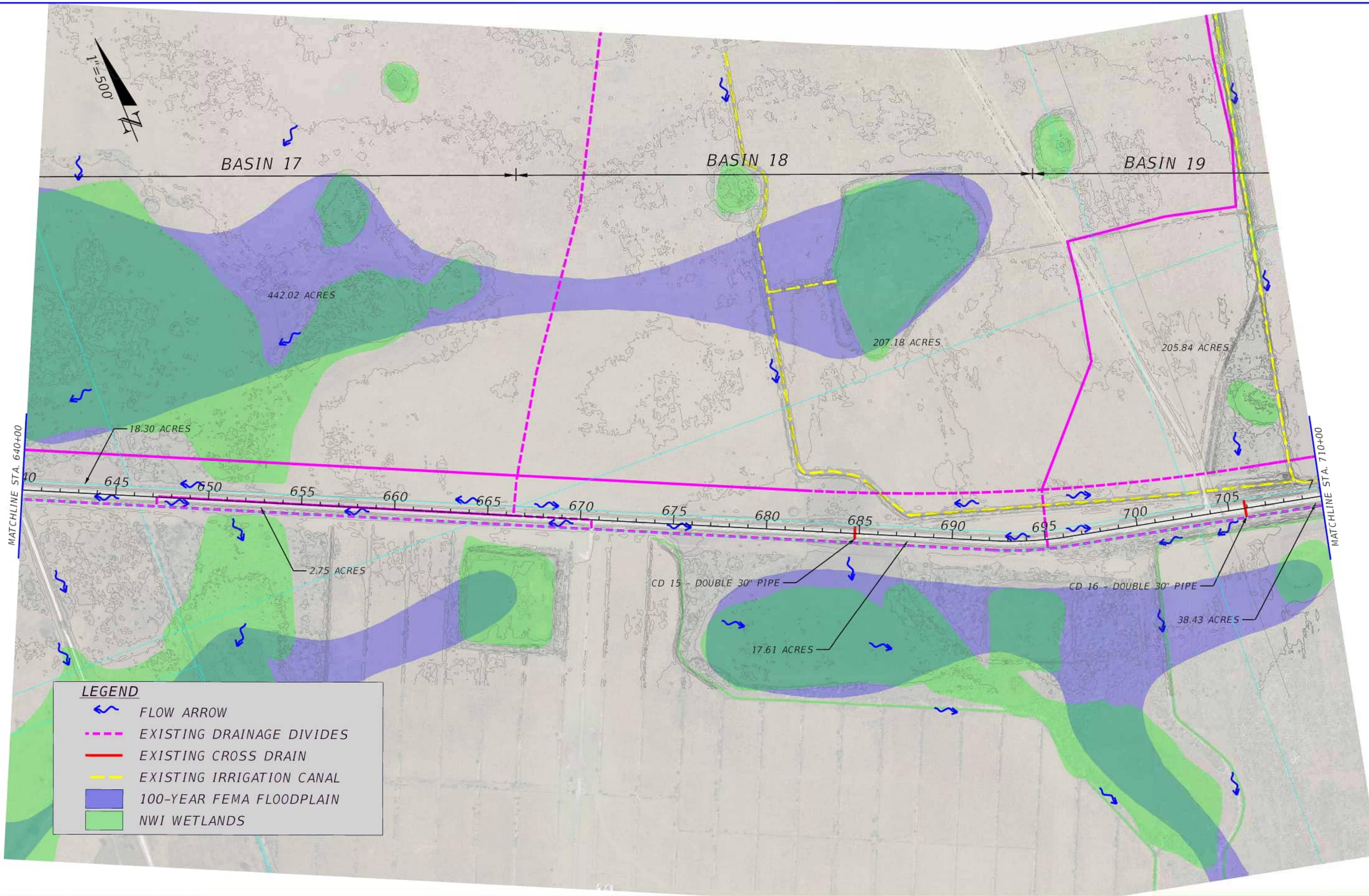
DANIEL P. SHULL, P.E.
LICENSE NUMBER: 86494
MOTT MACDONALD FLORIDA, LLC.
220 WEST GARDEN STREET, SUITE 700
PENSACOLA, FLORIDA 32502

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 60	OSCEOLA	452574-1-22-01

DRAINAGE MAP

SHEET NO. 9



REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ENGINEER OF RECORD

DANIEL P. SHULL, P.E.
LICENSE NUMBER: 86494
MOTT MACDONALD FLORIDA, LLC.
220 WEST GARDEN STREET, SUITE 700
PENSACOLA, FLORIDA 32502

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

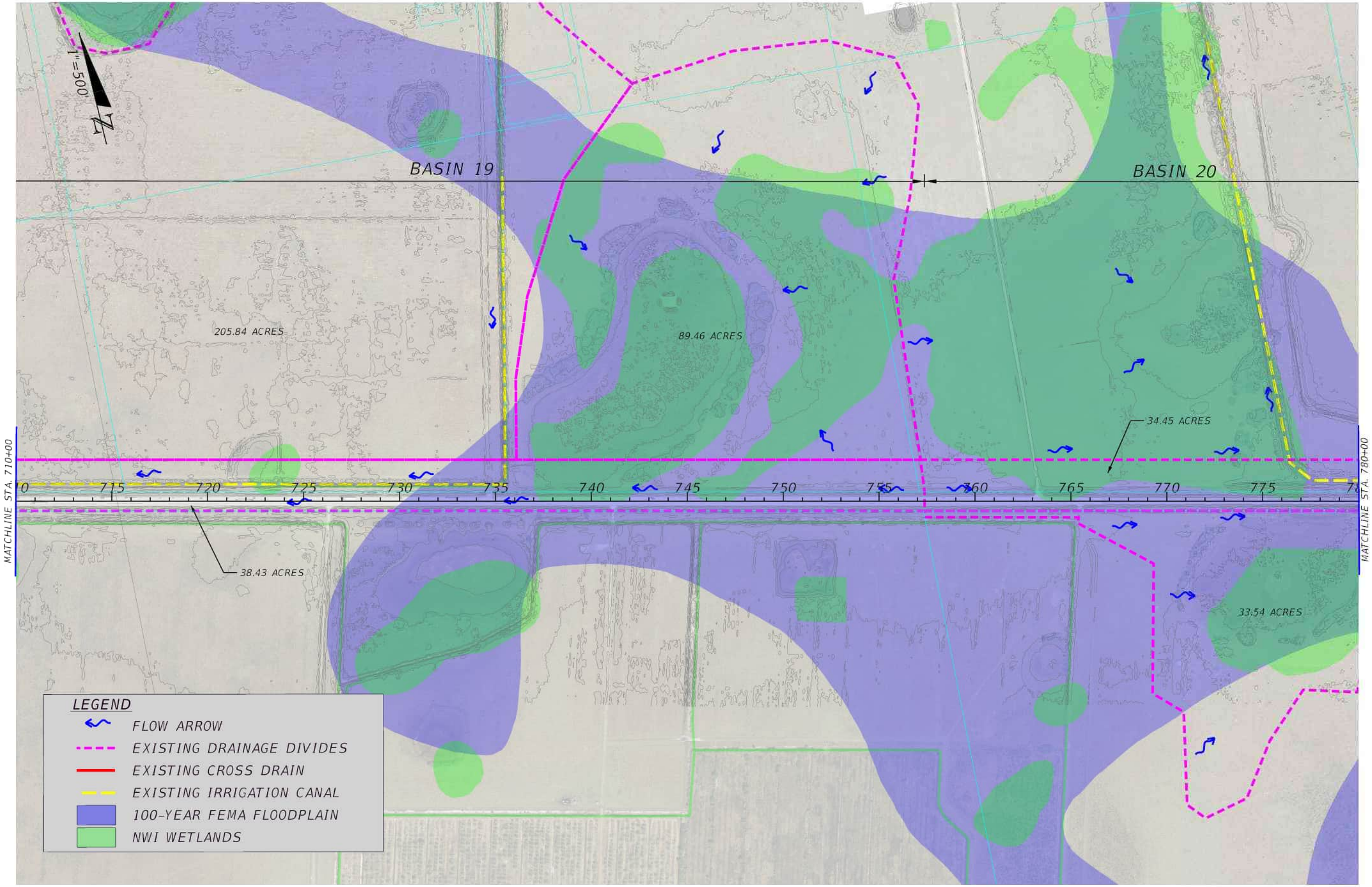
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 60	OSCEOLA	452574-1-22-01

DRAINAGE MAP

SHEET NO.
10

THE OFFICIAL RECORD OF THIS SHEET IS THE ELECTRONIC FILE DIGITALLY SIGNED AND SEALED UNDER RULE 61G15-23.004, F.A.C.

SHU66190 6/16/2025 4:00:49 PM



REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ENGINEER OF RECORD

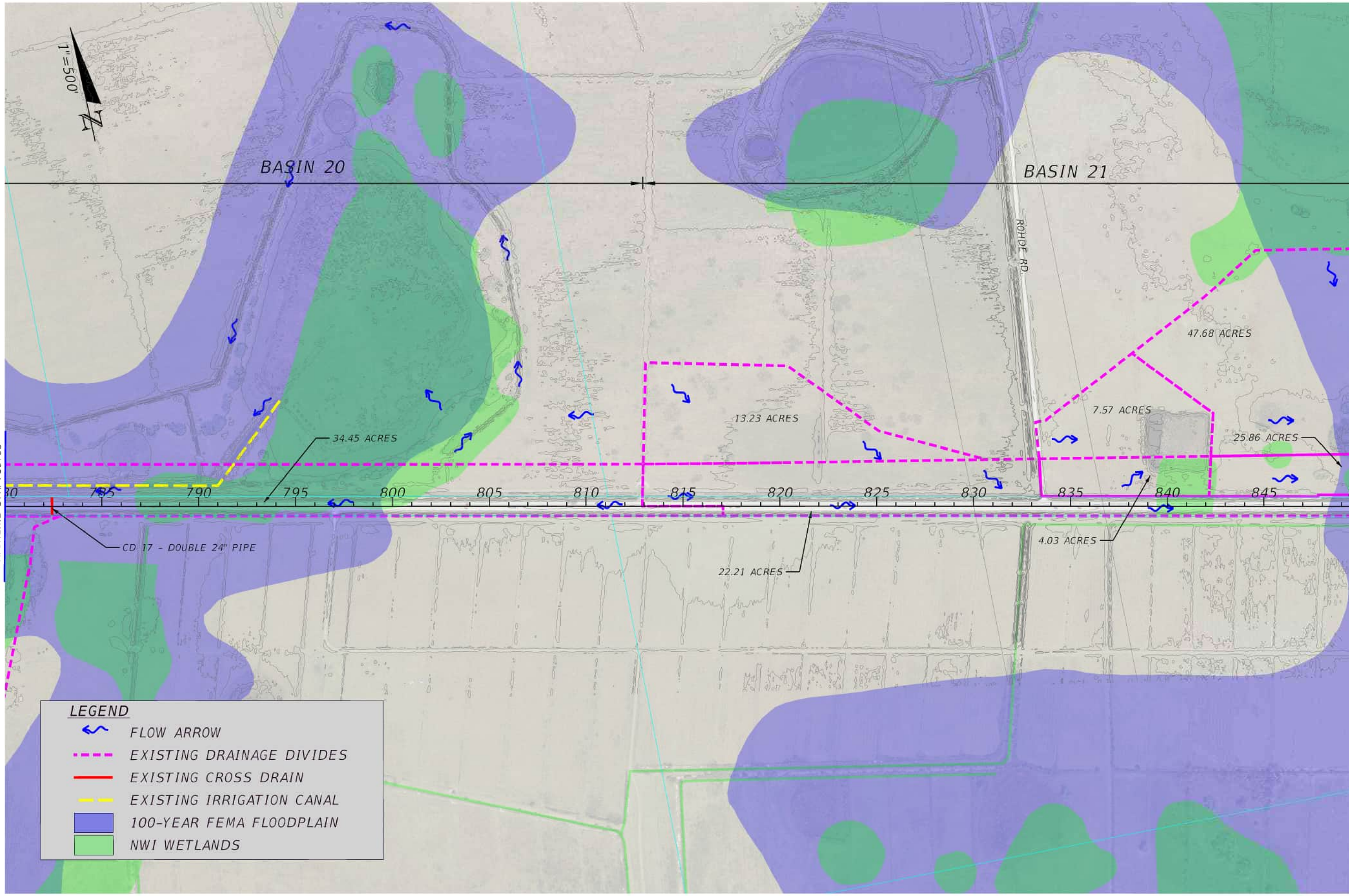
DANIEL P. SHULL, P.E.
LICENSE NUMBER: 86494
MOTT MACDONALD FLORIDA, LLC.
220 WEST GARDEN STREET, SUITE 700
PENSACOLA, FLORIDA 32502

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 60	OSCEOLA	452574-1-22-01

DRAINAGE MAP

SHEET NO. 11



REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ENGINEER OF RECORD

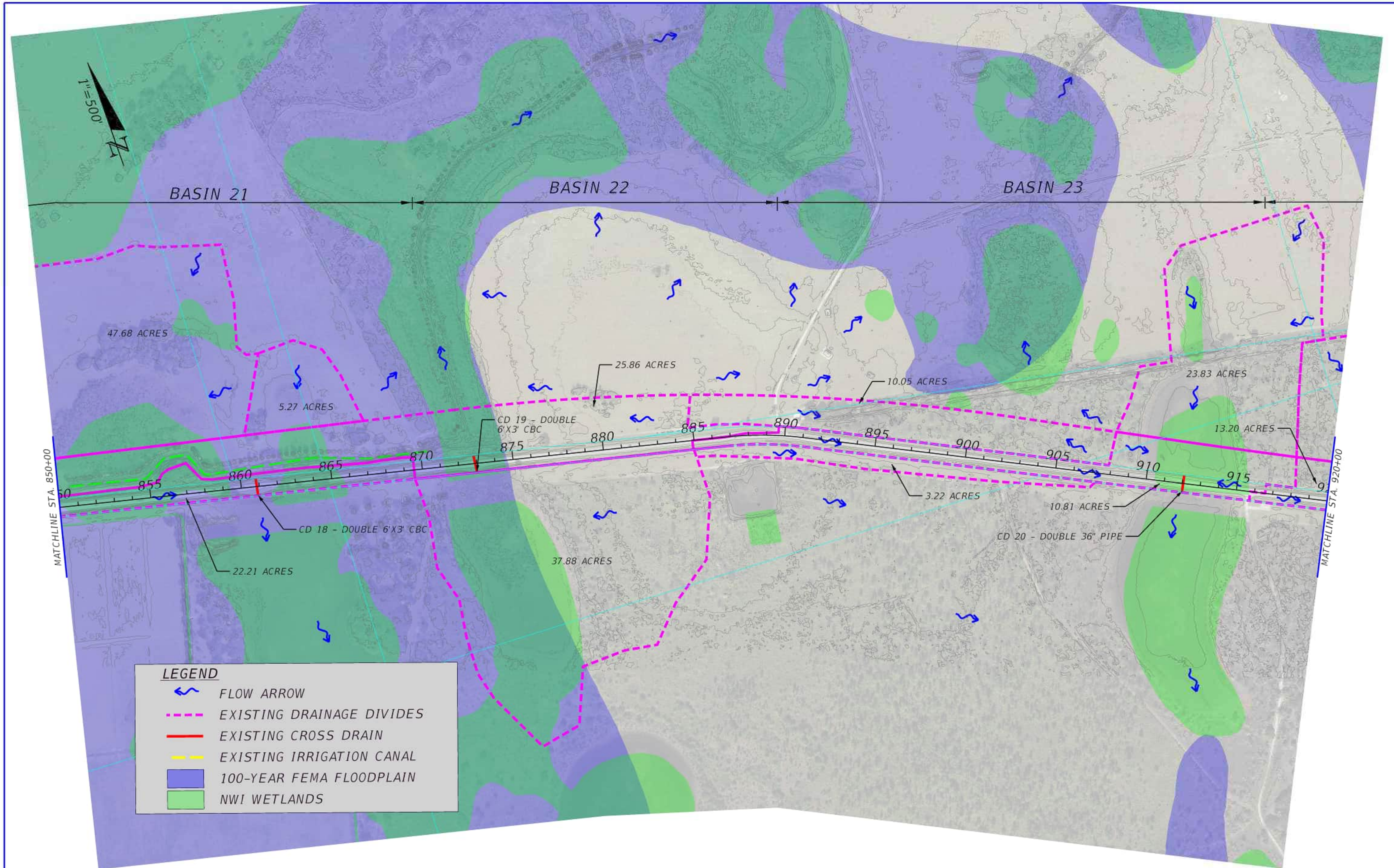
DANIEL P. SHULL, P.E.
LICENSE NUMBER: 86494
MOTT MACDONALD FLORIDA, LLC.
220 WEST GARDEN STREET, SUITE 700
PENSACOLA, FLORIDA 32502

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 60	OSCEOLA	452574-1-22-01

DRAINAGE MAP

SHEET NO. 12



REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ENGINEER OF RECORD

DANIEL P. SHULL, P.E.
LICENSE NUMBER: 86494
MOTT MACDONALD FLORIDA, LLC.
220 WEST GARDEN STREET, SUITE 700
PENSACOLA, FLORIDA 32502

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 60	OSCEOLA	452574-1-22-01

DRAINAGE MAP

SHEET NO. 13

THE OFFICIAL RECORD OF THIS SHEET IS THE ELECTRONIC FILE DIGITALLY SIGNED AND SEALED UNDER RULE 61G15-23.004, F.A.C.

c:\pwworking\hmm\transportation\shu66190\dms58873\PLANRD_LARGE_DRAINAGEMAP_01.dgn : B16 - PLAN 13 [SHEET]
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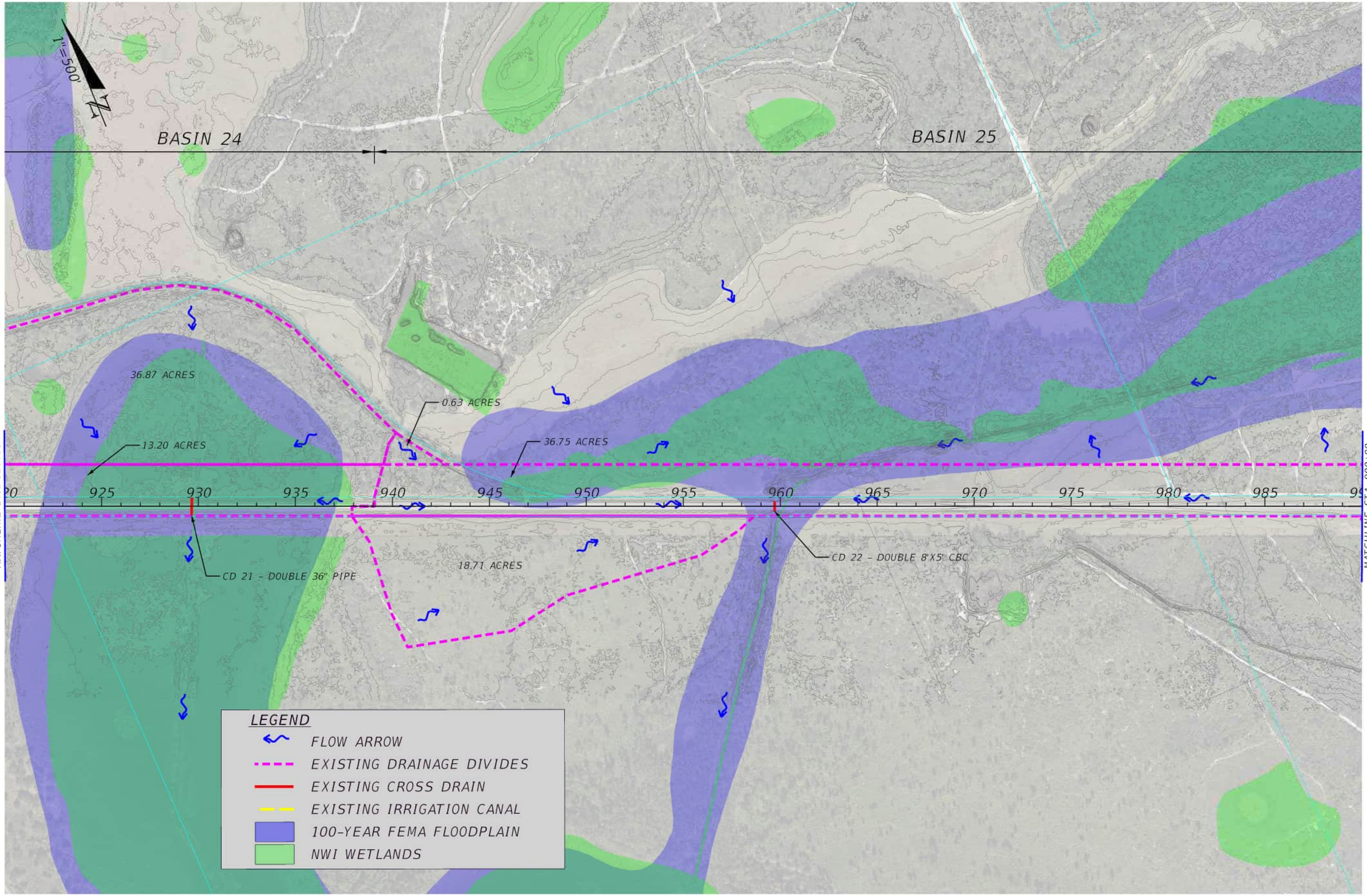
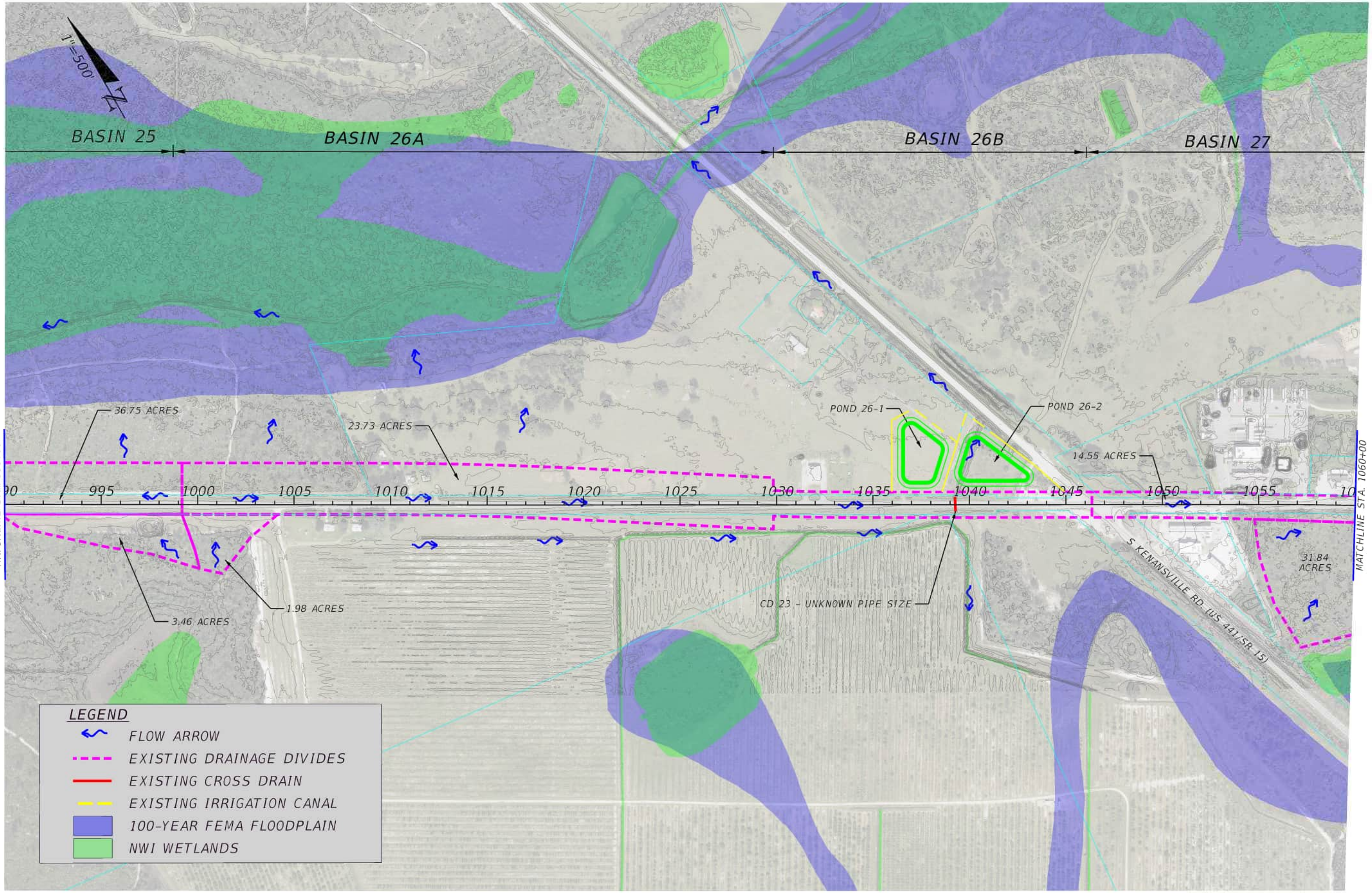


REVISIONS				ENGINEER OF RECORD	STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION				SHEET NO.
DATE	DESCRIPTION	DATE	DESCRIPTION	DANIEL P. SHULL, P.E. LICENSE NUMBER: 86494 MOTT MACDONALD FLORIDA, LLC. 220 WEST GARDEN STREET, SUITE 700 PENSACOLA, FLORIDA 32502	ROAD NO.	COUNTY	FINANCIAL PROJECT ID	DRAINAGE MAP	
					SR 60	OSCEOLA	452574-1-22-01		14



THE OFFICIAL RECORD OF THIS SHEET IS THE ELECTRONIC FILE DIGITALLY SIGNED AND SEALED UNDER RULE 61G15-23.004, F.A.C.

REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ENGINEER OF RECORD

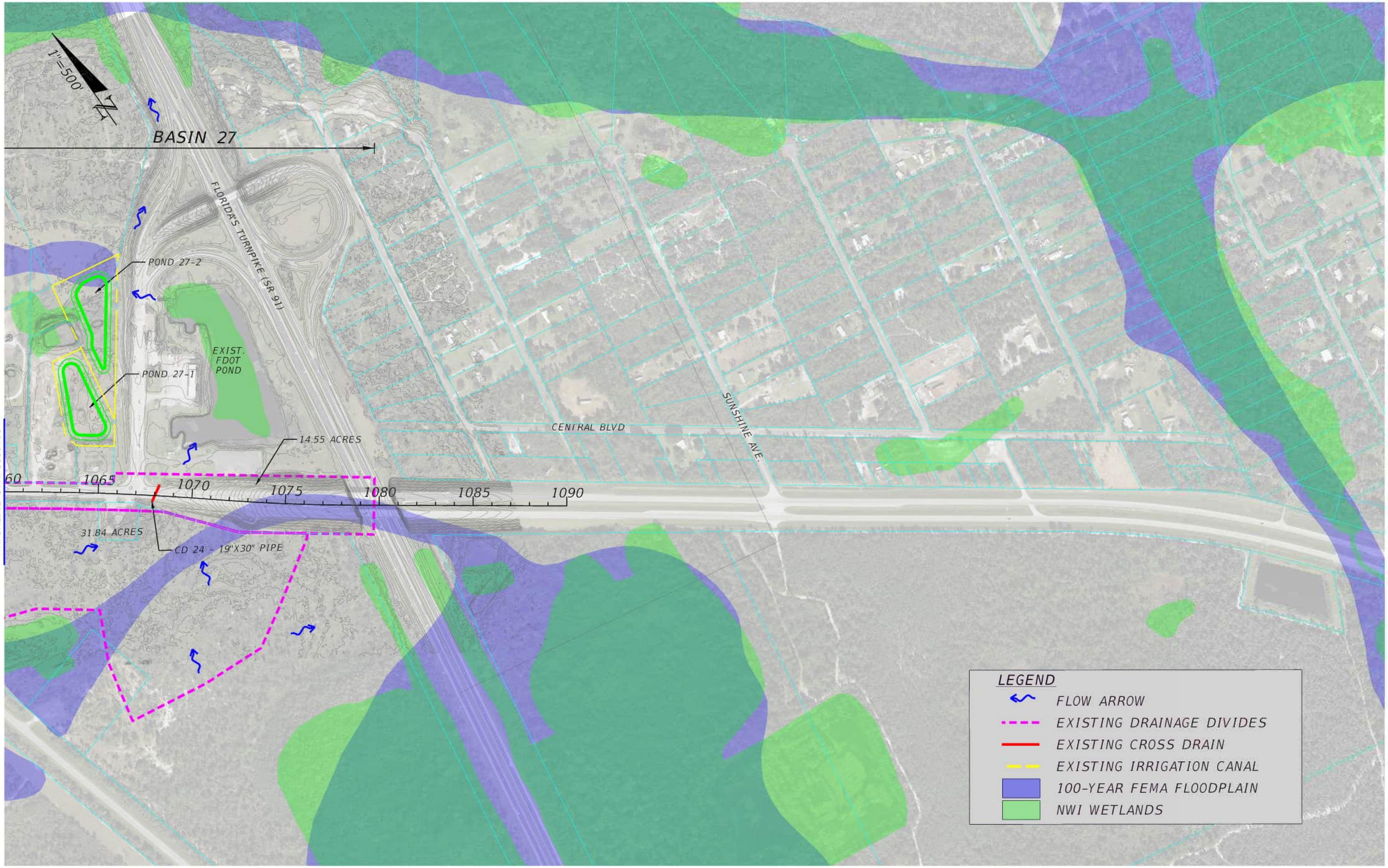
DANIEL P. SHULL, P.E.
LICENSE NUMBER: 86494
MOTT MACDONALD FLORIDA, LLC.
220 WEST GARDEN STREET, SUITE 700
PENSACOLA, FLORIDA 32502

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 60	OSCEOLA	452574-1-22-01

DRAINAGE MAP

SHEET NO.
15



REVISIONS			
DATE	DESCRIPTION	DATE	DESCRIPTION

ENGINEER OF RECORD

DANIEL P. SHULL, P.E.
LICENSE NUMBER: 86494
MOTT MACDONALD FLORIDA, LLC.
220 WEST GARDEN STREET, SUITE 700
PENSACOLA, FLORIDA 32502

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
SR 60	OSCEOLA	452574-1-22-01

DRAINAGE MAP

SHEET NO.
16

THE OFFICIAL RECORD OF THIS SHEET IS THE ELECTRONIC FILE DIGITALLY SIGNED AND SEALED UNDER RULE 61G15-23.004, F.A.C.

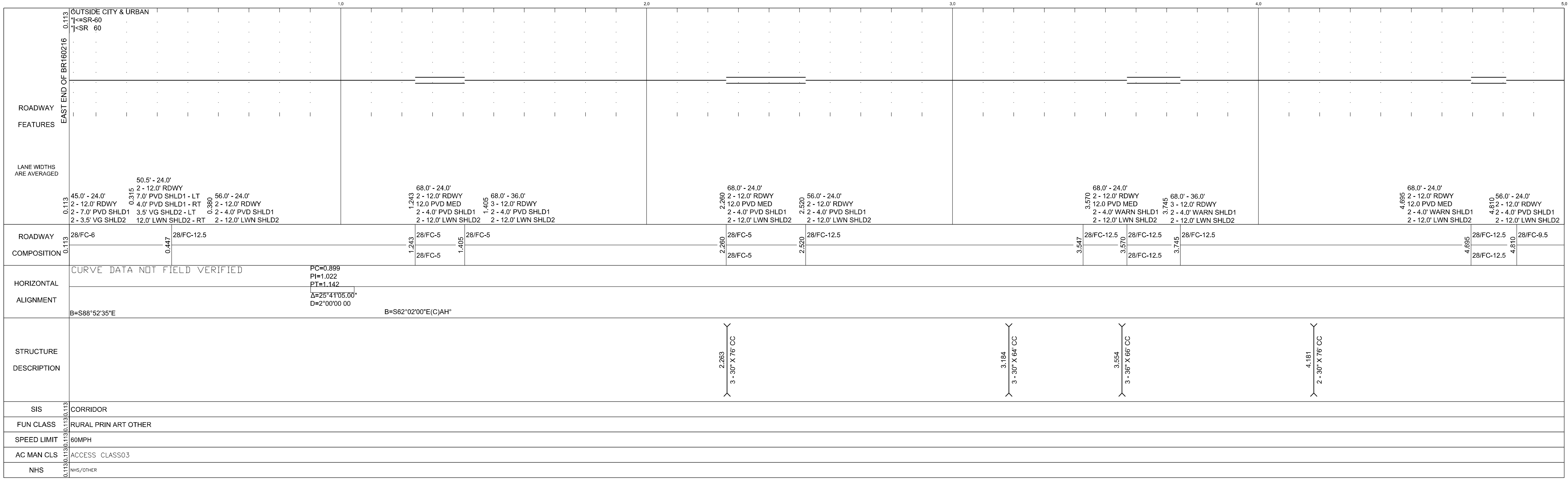
APPENDIX E – FDOT Straight Line Diagrams

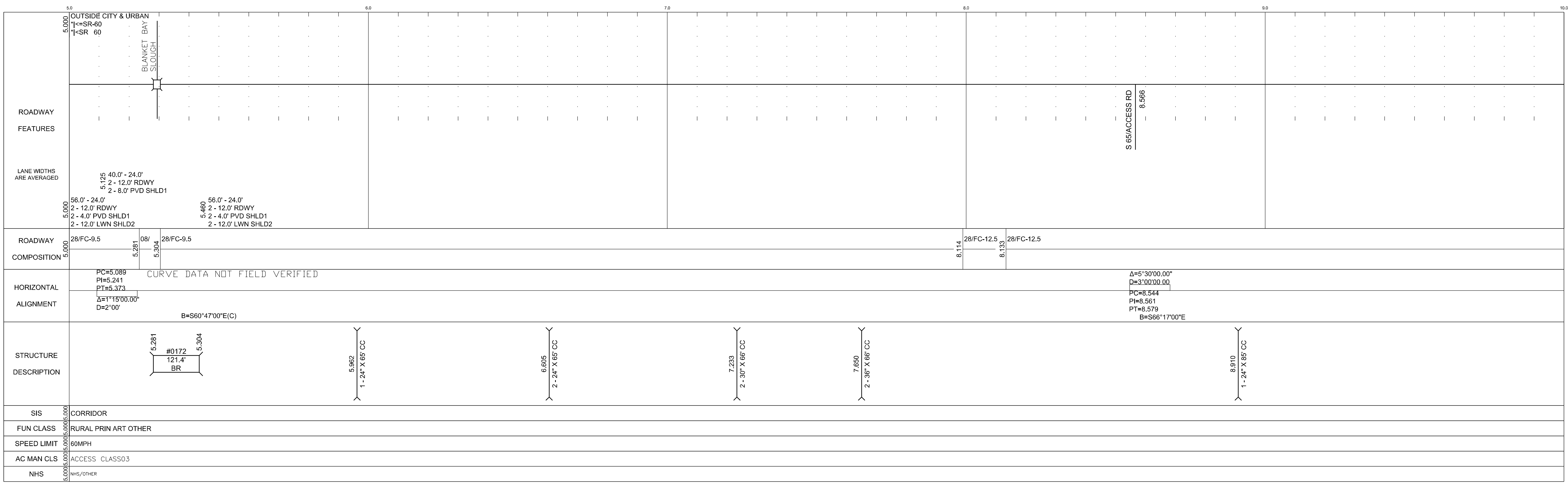
	5 YR INV	SLD REV	BMP	EMP	INV	SLD REV
DATE	11/01/2021	12/10/2021	19.548	20.431	06/13/2022 HNTB	07/13/2022 HNTB
BY	HNTB	HNTB				

FLORIDA DEPARTMENT OF TRANSPORTATION

STRAIGHT LINE DIAGRAM OF ROAD INVENTORY

SECTION STATUS	INT. or US ROUTE NO.	STATE ROAD NO.	COUNTY	DISTRICT	ROADWAY ID	SHEET NO:
02		SR 60	OSCEOLA	05	92070000	1 OF 4





Version: 1.4.2.27 07/14/2022

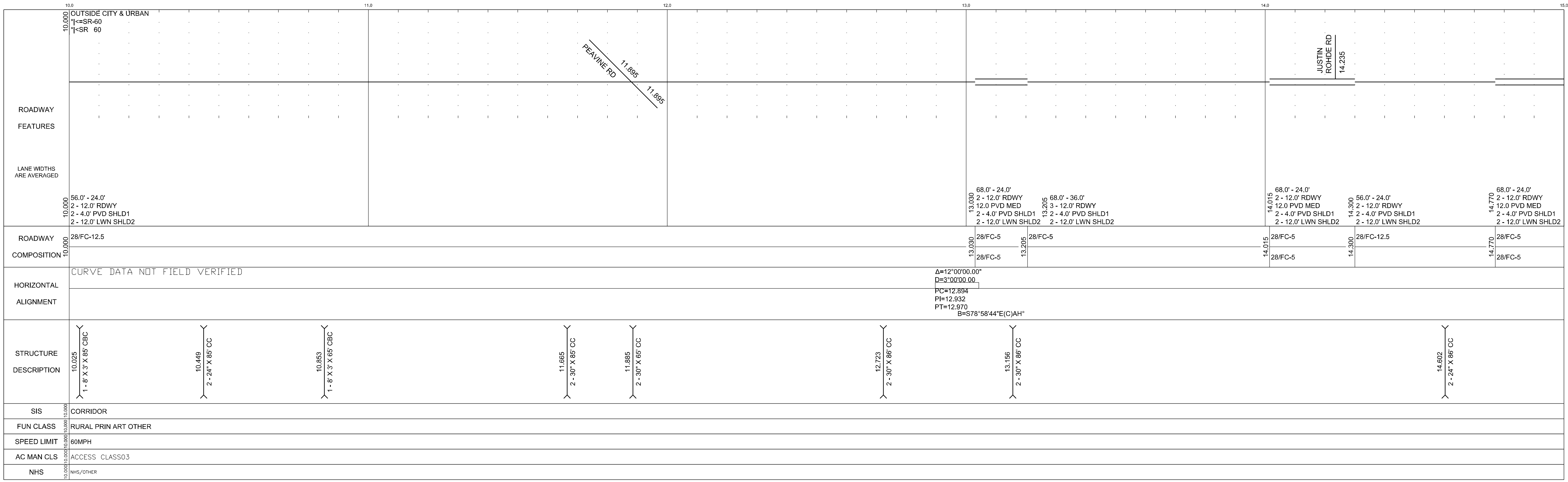
	5 YR INV	SLD REV	BMP	EMP	INV	SLD REV
DATE	11/01/2021	12/10/2021	19.548	20.431	06/13/2022 HNTB	07/13/2022 HNTB
BY	HNTB	HNTB				

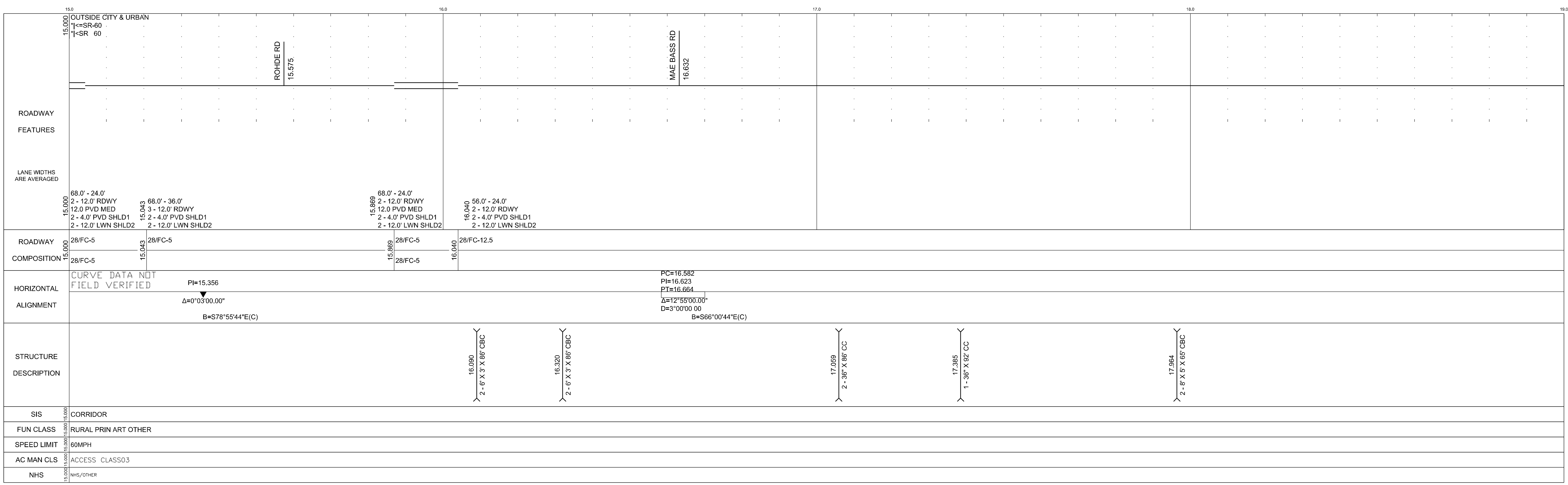
FLORIDA DEPARTMENT OF TRANSPORTATION

FDOT

STRAIGHT LINE DIAGRAM OF ROAD INVENTORY

SECTION STATUS	INT. or US ROUTE NO.	STATE ROAD NO.	COUNTY	DISTRICT	ROADWAY ID	SHEET NO:
02		SR 60	OSCEOLA	05	92070000	2 OF 4





	5 YR INV	SLD REV	BMP	EMP	INV	SLD REV
DATE	11/01/2021	12/10/2021	19.548	20.431	06/13/2022 HNTB	07/13/2022 HNTB
BY	HNTB	HNTB				

FLORIDA DEPARTMENT OF TRANSPORTATION FDOT

STRAIGHT LINE DIAGRAM OF ROAD INVENTORY

SECTION STATUS	INT. or US ROUTE NO.	STATE ROAD NO.	COUNTY	DISTRICT	ROADWAY ID	SHEET NO:
02		SR 60	OSCEOLA	05	92070000	3 OF 4

19.0 — 20.0

ROADWAY FEATURES

19.000 OUTSIDE CITY & URBAN
*|<=SR-60
*|<SR 60

19.439 (0058)
S KENANSVILLE RD 19.603
19.603 19.634 FROM KENANSVILLE RD
19.648 (0027)
92470010 NB OFF 19.978
19.994 TO/FROM RAMPS

LANE WIDTHS ARE AVERAGED

19.000 56.0' - 24.0'
2 - 12.0' RDWY
2 - 4.0' PVD SHLD1
2 - 12.0' LWN SHLD2

19.548 64.0' - 24.0'
2 - 12.0' RDWY
2 - 8.0' PVD SHLD1
2 - 12.0' LWN SHLD2

19.568 77.0' - 13.0'L+12.0'R
1 - 13.0'L + 1 - 12.0'R RDWY
12.0 PVD MED
2 - 8.0' PVD SHLD1
2 - 12.0' LWN SHLD2

19.705 77.0' - 13.0'L+12.0'R
1 - 13.0'L + 1 - 12.0'R RDWY
12.0 PAVED TURN LANE (TWLTL/TURN) MED
2 - 8.0' PVD SHLD1
2 - 12.0' LWN SHLD2

19.909 77.0' - 13.0'L+12.0'R
1 - 13.0'L + 1 - 12.0'R RDWY
12.0 PVD MED
2 - 8.0' PVD SHLD1
2 - 12.0' LWN SHLD2

19.994 96.0' - 24.0'L+12.0'R
2 - 12.0'L + 1 - 12.0'R RDWY
20.0 PVD MED
2 - 8.0' PVD SHLD1
2 - 12.0' LWN SHLD2

ROADWAY COMPOSITION

19.000 28/FC-12.5 | 19.568 28/FC-12.5 | 19.956 28/FC-12.5
19.568 28/FC-12.5 | 19.956 28/FC-12.5

HORIZONTAL ALIGNMENT

CURVE DATA NOT FIELD VERIFIED
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PI=19.031
B=S66°09'44"E(C)

PC=19.835
PI=19.847
PT=19.859
Δ=2°33'00.00"
D=2°00'00 00
B=S63°34'44"E

STRUCTURE DESCRIPTION

SIS	19.000 CORRIDOR
FUN CLASS	19.000 RURAL PRIN ART OTHER
SPEED LIMIT	19.000 55MPH; 19.303 45MPH
AC MAN CLS	19.000 ACCESS CLASS03
NHS	19.000 NHS/OTHER

20.0

ROADWAY FEATURES

20.000 OUTSIDE CITY & URBAN
*|<=SR-60
*|<SR 60

92470020 NB ON 20.006
TURNPIKE
FL
20.310

20.108 131.5' - 24.0'L+12.0'R
2 - 12.0'L + 1 - 12.0'R RDWY
52.0 VEG MED
2.0' PVD INSHLD1 - LT
14.0' WARN INSHLD1 - RT
8.0' PVD SHLD1 - LT
20.0' PVD SHLD1 - RT
12.0' LWN SHLD2 - LT
3.5' VG SHLD2 - RT

20.146 135.0' - 48.0'
4 - 12.0' RDWY
52.0 VEG MED
2.0' PVD INSHLD1 - LT
14.0' WARN INSHLD1 - RT
8.0' PVD SHLD1 - LT
20.0' PVD SHLD1 - RT
2 - 3.5' VG SHLD2

20.204 133.5' - 48.0'
4 - 12.0' RDWY
52.0 VEG W/ GRD MED
2.0' PVD INSHLD1 - LT
14.0' WARN INSHLD1 - RT
10.0' PVD SHLD1 - LT
20.0' PVD SHLD1 - RT
3.5' VG SHLD2 - RT

20.262 132.5' - 48.0'
4 - 12.0' RDWY
63.0 OTHER W/ GRD MED
2.0' PVD INSHLD1 - LT
5.0' PVD INSHLD1 - RT
8.0' PVD SHLD1 - LT
10.0' PVD SHLD1 - RT
3.5' VG SHLD2 - LT

20.275 146.0' - 48.0'
4 - 12.0' RDWY
63.0 OTHER W/ GRD MED
2 - 2.0' PVD INSHLD1
2 - 8.0' PVD SHLD1
2 - 3.5' VG SHLD2
12.0' LWN SHLD3 - RT

LANE WIDTHS ARE AVERAGED

20.000 96.0' - 24.0'L+12.0'R
2 - 12.0'L + 1 - 12.0'R RDWY
20.0 PVD MED
2 - 8.0' PVD SHLD1
2 - 12.0' LWN SHLD2

20.081 128.0' - 24.0'L+12.0'R
2 - 12.0'L + 1 - 12.0'R RDWY
52.0 VEG MED
2.0' PVD INSHLD1 - LT
14.0' WARN INSHLD1 - RT
2 - 8.0' PVD SHLD1
2 - 12.0' LWN SHLD2

20.135 143.5' - 48.0'
4 - 12.0' RDWY
52.0 VEG MED
2.0' PVD INSHLD1 - LT
14.0' WARN INSHLD1 - RT
8.0' PVD SHLD1 - LT
20.0' PVD SHLD1 - RT
12.0' LWN SHLD2 - LT
3.5' VG SHLD2 - RT

20.181 135.0' - 48.0'
4 - 12.0' RDWY
52.0 VEG W/ GRD MED
2.0' PVD INSHLD1 - LT
14.0' WARN INSHLD1 - RT
8.0' PVD SHLD1 - LT
20.0' PVD SHLD1 - RT
2 - 3.5' VG SHLD2

20.208 133.5' - 48.0'
4 - 12.0' RDWY
52.0 VEG W/ GRD MED
5.0' PVD INSHLD1 - LT
14.0' WARN INSHLD1 - RT
10.0' PVD SHLD1 - LT
20.0' PVD SHLD1 - RT
3.5' VG SHLD2 - RT

20.218 144.5' - 48.0'
4 - 12.0' RDWY
63.0 OTHER W/ GRD MED
2 - 5.0' PVD INSHLD1
10.0' PVD SHLD1 - LT
20.0' PVD SHLD1 - RT
3.5' VG SHLD2 - RT

20.220 131.0' - 48.0'
4 - 12.0' RDWY
63.0 OTHER W/ GRD MED
2 - 5.0' PVD INSHLD1
2 - 10.0' PVD SHLD1

20.258 132.5' - 48.0'
4 - 12.0' RDWY
63.0 OTHER W/ GRD MED
2 - 5.0' PVD INSHLD1
8.0' PVD SHLD1 - LT
10.0' PVD SHLD1 - RT
3.5' VG SHLD2 - LT

20.268 146.0' - 48.0'
4 - 12.0' RDWY
63.0 OTHER W/ GRD MED
2.0' PVD INSHLD1 - LT
5.0' PVD INSHLD1 - RT
2 - 8.0' PVD SHLD1
2 - 3.5' VG SHLD2
12.0' LWN SHLD3 - RT

20.304 146.0' - 48.0'
4 - 12.0' RDWY
63.0 VEG W/ GRD MED
2 - 2.0' PVD INSHLD1
2 - 8.0' PVD SHLD1
2 - 3.5' VG SHLD2
12.0' LWN SHLD3 - RT

20.309 146.0' - 48.0'
4 - 12.0' RDWY
63.0 VEG MED
2 - 2.0' PVD INSHLD1
2 - 8.0' PVD SHLD1
2 - 3.5' VG SHLD2
12.0' LWN SHLD3 - RT

20.310 158.0' - 48.0'
4 - 12.0' RDWY
63.0 VEG MED
2 - 2.0' PVD INSHLD1
2 - 8.0' PVD SHLD1
2 - 3.5' VG SHLD2
2 - 12.0' LWN SHLD3

20.431 169.0' - 48.0'
4 - 12.0' RDWY
74.0 VEG MED
2 - 2.0' PVD INSHLD1
2 - 8.0' PVD SHLD1
2 - 3.5' VG SHLD2
2 - 12.0' LWN SHLD3

20.475 162.5' - 48.0'
4 - 12.0' RDWY
74.0 VEG MED
2 - 2.0' PVD INSHLD1
5.0' PVD SHLD1 - LT
8.0' PVD SHLD1 - RT
12.0' LWN SHLD2 - LT
3.5' VG SHLD2 - RT
12.0' LWN SHLD3 - RT

20.495 156.0' - 48.0'
4 - 12.0' RDWY
74.0 VEG MED
2 - 2.0' PVD INSHLD1
2 - 5.0' PVD SHLD1
2 - 12.0' LWN SHLD2

ROADWAY COMPOSITION

20.000 28/FC-12.5 | 20.112 28/FC-12.5 | 20.148 28/FC-12.5 | 20.220 08/FC-12.5 | 20.261 28/FC-12.5 | 20.431 28/FC-5
20.000 28/FC-12.5 | 20.112 28/FC-12.5 | 20.148 28/FC-12.5 | 20.220 08/FC-5 | 20.261 28/FC-5 | 20.431 28/FC-5

HORIZONTAL ALIGNMENT

CURVE DATA NOT FIELD VERIFIED
Δ=0°04'00.00"
PI=20.193
B=S63°40'44"E

STRUCTURE DESCRIPTION

20.014 1 - 30" X 19" X 98' CC
20.096 1 - 30" X 19" X 73' CC
20.220 20.261
#0199 216.5' BR
#0200 216.5' BR
20.220 20.261

SIS	20.000 CORRIDOR
FUN CLASS	20.000 RURAL PRIN ART OTHER
SPEED LIMIT	20.000 45MPH; 20.312 45MPH; 20.380 55MPH
AC MAN CLS	20.000 ACCESS CLASS03
NHS	20.000 NHS/OTHER

Version: 1.4.2.27 07/14/2022

	5 YR INV	SLD REV	BMP	EMP	INV	SLD REV
DATE	11/01/2021	12/10/2021	19.548	20.431	06/13/2022 HNTB	07/13/2022 HNTB
BY	HNTB	HNTB				

FLORIDA DEPARTMENT OF TRANSPORTATION FDOT

STRAIGHT LINE DIAGRAM OF ROAD INVENTORY

SECTION STATUS	INT. or US ROUTE NO.	STATE ROAD NO.	COUNTY	DISTRICT	ROADWAY ID	SHEET NO:
02		SR 60	OSCEOLA	05	92070000	4 OF 4

21.0

ROADWAY FEATURES

20.500 OUTSIDE CITY & URBAN
*|<=SR-60
*|<SR 60

SUNSHINE AVE 20.649

COW LOG BRANCH

GEIGER DR 21.434

LANE WIDTHS ARE AVERAGED

20.500 156.0' - 48.0' / 4 - 12.0' RDWY / 74.0 VEG MED / 2 - 2.0' PVD INSHLD1 / 2 - 5.0' PVD SHLD1 / 2 - 12.0' LWN SHLD2

20.532 144.0' - 48.0' / 4 - 12.0' RDWY / 62.0 VEG MED / 2 - 2.0' PVD INSHLD1 / 2 - 5.0' PVD SHLD1 / 2 - 12.0' LWN SHLD2

21.206 139.0' - 48.0' / 4 - 12.0' RDWY / 64.0 OTHER W/ GRD MED / 2 - 2.0' PVD INSHLD1 / 5.0' PVD SHLD1 - LT / 10.0' PVD SHLD1 - RT / 12.0' LWN SHLD2 - LT

21.247 133.0' - 48.0' / 4 - 12.0' RDWY / 64.0 OTHER W/ GRD MED / 2 - 2.0' PVD INSHLD1 / 11.0' PVD SHLD1 - LT / 10.0' PVD SHLD1 - RT

21.301 140.0' - 48.0' / 4 - 12.0' RDWY / 64.0 OTHER W/ GRD MED / 2 - 2.0' PVD INSHLD1 / 11.0' PVD SHLD1 - LT / 5.0' PVD SHLD1 - RT / 12.0' LWN SHLD2 - RT

21.330 140.0' - 48.0' / 4 - 12.0' RDWY / 64.0 VEG MED / 2 - 2.0' PVD INSHLD1 / 11.0' PVD SHLD1 - LT / 5.0' PVD SHLD1 - RT / 12.0' LWN SHLD2 - RT

21.352 146.0' - 48.0' / 4 - 12.0' RDWY / 64.0 VEG MED / 2 - 2.0' PVD INSHLD1 / 2 - 5.0' PVD SHLD1 / 2 - 12.0' LWN SHLD2

ROADWAY COMPOSITION

20.500 28/FC-5
28/FC-5

HORIZONTAL ALIGNMENT

CURVE DATA NOT FIELD VERIFIED

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B=S63°48'44"E

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PI=21.109
PT=21.248
Δ=15°39'08.00"
D=0°37'42"

B=S48°48'25"E

STRUCTURE DESCRIPTION

20.580 1 - 30" X 19" X 74' CC

20.879 2 - 30" X 19" X 138' CC

21.132 2 - 30" X 19" X 141' CC

21.252 1 - 30" X 19" X 146' CC

21.255 – 21.295 #0173 211.2' BR; #0198 211.2' BR

21.324 1 - 30" X 19" X 146' CC

21.470 3 - 30" X 19" X 138' CC

SIS	20.500 CORRIDOR
FUN CLASS	20.500 RURAL PRIN ART OTHER
SPEED LIMIT	20.500 55MPH; 20.760 65MPH
AC MAN CLS	20.500 ACCESS CLASS03
NHS	20.500 NHS/OTHER

ROADWAY FEATURES

21.500 OUTSIDE CITY & URBAN
*|<=SR-60
*|<SR 60

INDIAN RIVER CO LINE

LANE WIDTHS ARE AVERAGED

21.500 146.0' - 48.0' / 4 - 12.0' RDWY / 64.0 VEG MED / 2 - 2.0' PVD INSHLD1 / 2 - 5.0' PVD SHLD1 / 2 - 12.0' LWN SHLD2

END MP: 021.820
NET ROADWAY ID LENGTH: 21.707
STATE MAINTAINED LENGTH: 21.707

ROADWAY COMPOSITION

21.500 28/FC-5
28/FC-5

HORIZONTAL ALIGNMENT

CURVE DATA NOT FIELD VERIFIED

Δ=42°40'03"
D=3°45'34"
PC=21.639
PI=21.820
PT=21.820

STRUCTURE DESCRIPTION

21.654 1 - 30" X 19" X 72' CC

SIS	21.500 CORRIDOR; CORRIDOR 21.820
FUN CLASS	21.500 RURAL PRIN ART OTHER
SPEED LIMIT	21.500 65MPH
AC MAN CLS	21.500 ACCESS CLASS03; ACCESS CLASS03 21.820
NHS	21.500 NHS/OTHER; NHS/OTHER 21.820