Reedley Main Canal / S Englehart Avenue Crossing

Fresno County, California

Caltrans Bridge Number 42C0708

Fresno County Bridge Number 10-044

Hydraulic and Scour Report

Final

June 2024

Prepared for:

Prepared by:

MARK THOMAS

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This report has been prepared under the direction of the following registered Civil Engineer. The registered Civil Engineer attests to the technical information contained herein and the engineering data upon which the recommendations, conclusions, and decisions are based.

6/14/2024

Edgar Noriega, PE
Professional Civil Engineer, 61555

Date

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Appendices

Acronyms

ADT	Average Daily Traffic
AID	Alta Irrigation District
BFE	Base Flood Elevation
BIR	Bridge Inspection Report
BMP	Best Management Practice
CABS	California Bank and Shore Rock Slope Protection Design
Caltrans	California Department of Transportation
CIP	Cast-in-Place
CN	Curve Number
DWR	Department of Water Resources
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
HBP	Highway Bridge Program
HDM	Highway Design Manual
HEC-18	Hydraulic Engineering Circular No. 18
HEC-20	Hydraulic Engineering Circular No. 20
HEC-23	Hydraulic Engineering Circular No. 23
HEC-HMS	Hydrologic Engineering Center Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Centers River Analysis System
HSG	Hydrologic Soil Group
NAVD 88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
RSP	Rock Slope Protection
SCS	Soil Conservation Service
TR-55	Technical Release 55
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USGS	United States Geological Survey
WSE	Water Surface Elevation

Executive Summary

The purpose of this study is to determine the flow and scour characteristics of Reedley Main Canal at the S. Englehart Avenue crossing in Fresno County. The County of Fresno Department of Public Works and Planning received funding authorization for the replacement of the structure through HBP funds. The existing structure is a two span concrete slab bridge with an AC overlay that was constructed in 1936. The existing structure has two 8’ spans that are at a 52 degree skew compared to S. Englehart Avenue. The canal receives planned irrigation flow during the months of April to September, which are stated to be 100cfs by Alta Irrigation District (AID). The proposed structure is anticipated to be a two span box culvert, with span opening dimensions of 10’ by 5.17’ each.

The hydraulics of Reedley Main Canal were investigated using HEC-RAS 5.0.1 software for both the existing and proposed structure. Each model utilized a known downstream water surface elevation which was determined based on measurements obtained from a downstream weir. The existing HEC-RAS model showed that the design irrigation flow (100 cfs) cleared the existing structure with 0.5” of freeboard. The proposed structure, which is designed to have slightly larger span heights, showed 1.5” of available freeboard during irrigation flow.

Total scour for each proposed abutment was calculated as the summation of long term degradation, contraction scour and local abutment scour. Based on previous bridge inspection reports and a field visit of the site, long term degradation was determined to be negligible. Contraction and local scour were calculated based on methodologies found in FHWA HEC 18. Results from geotechnical investigations for the site performed in July and August, 2016 by Technicon Engineering Services, Inc., were utilized for calculations. Total anticipated scour for the proposed structure was calculated to be 2.7 feet.

1 Project Understanding

1.1 Project Description

Reedley Main Canal is an irrigation canal located in the southern portion of Fresno County near the City of Reedley. The canal flows north to south, beginning at a connection at the Alta East Canal as shown in Figure 1.1. The major tributary that feeds the Alta East Canal is Wahtoke Lake, which is located south of State Route 180. Reedley Main Canal is owned by the privately owned Alta Irrigation District (AID). The canal is utilized for irrigation flow from April through September.

The project site is approximately 0.7’ miles downstream of the connection with Alta East Canal. The connection at Alta East is a gate valve which is closed during winter months. The canal has side banks which are 2’ to 3’ higher than adjacent farmlands. Because of these geometric factors of the canal and upstream connection, the canal only receives planned irrigation flow and does not receive significant storm flow rates. AID provided flow rates, as shown in Appendix A of this report, of 100 cfs at the project location site.

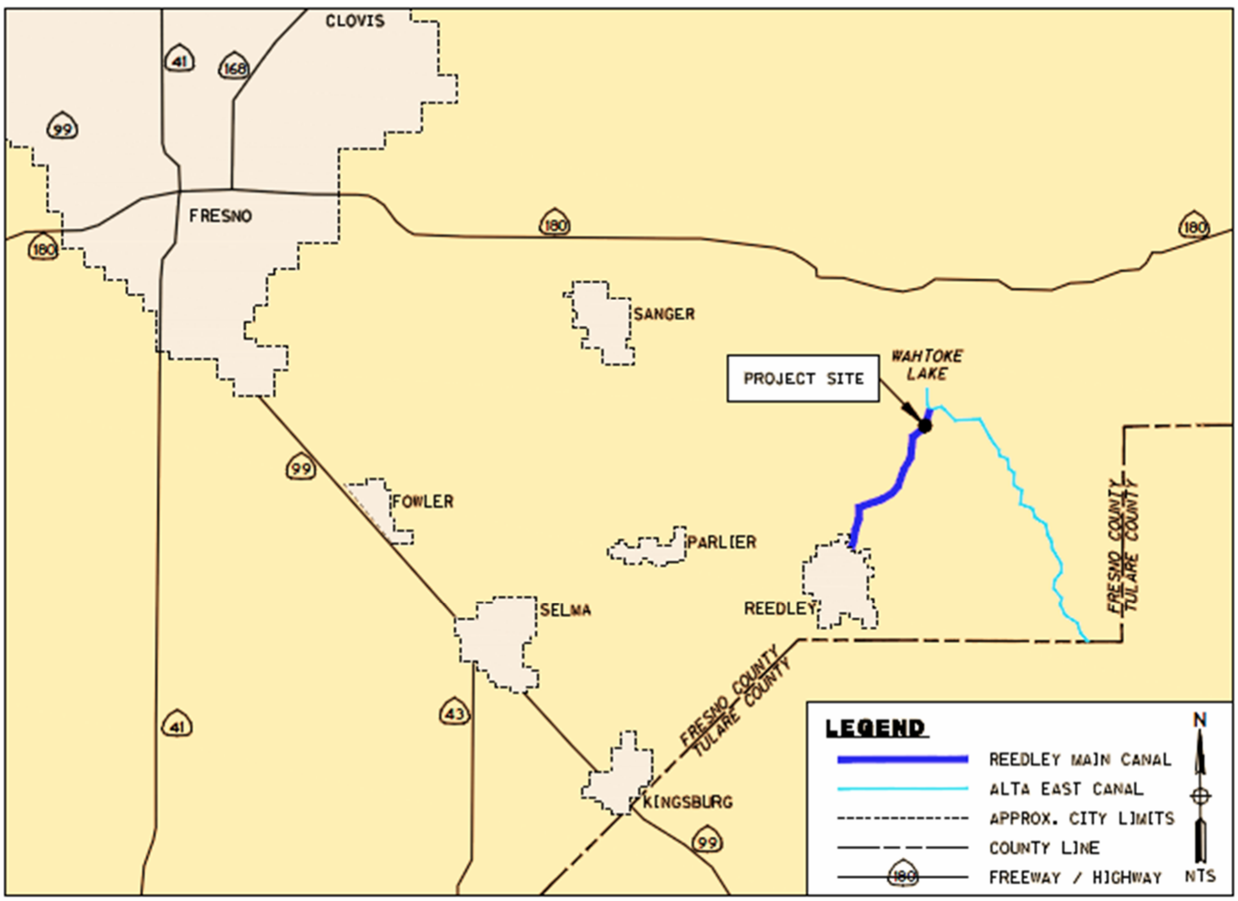


Figure 1.1: Project Location

The existing structure, as shown in Figure 1.2, is a two span cast in place slab bridge. The existing structure spans are approximately 8' wide by 5' in height. The canal is at a 52 degree skew compared to the roadway alignment of S. Englehart Road. The existing structure is wide enough for two lanes of vehicle traffic with no shoulders. The structure is anticipated to be replaced with a proposed two-span, four sided box culvert with span openings of 10' width by 5.17' height. The proposed structure will be wider than the existing to allow for the addition of shoulders. The geometric approval drawing for the proposed structure is shown in Appendix B of this report.

Figure 1.2: Existing Structure

1.2 <u>Project Need</u>

The County of Fresno received funding authorization to proceed with preliminary engineering for the replacement of this structure in 2016. Replacement of the structure will be funded through federal HBP funds in addition to local funds. The structure is eligible for HBP funds based its structural deficiency.

1.3 <u>Key Tasks</u>

This report has been prepared as an aid in the design of the replacement structure at the crossing of S. Englehart Avenue and the Reedley Main Canal. The major key tasks associated with this report include the following items:

- Obtain irrigation flow rates from AID and review available hydrological data for Reedley Main Canal

- Utilize HEC computer modeling software to verify freeboard and other flow data for existing and proposed conditions
- Evaluate net degradation, contraction scour, and local scour for the proposed structure
- Provide recommendations for the design of abutments and other applicable scour countermeasures

1.4 Project Data

Survey project data utilized for Hydraulic modeling was provided by the County of Fresno. The project data references the National Geodetic Vertical Datum of 1929 (NGVD29). At the time of this report there is no available stream gage data recorded for Reedley Main canal near the project site. Other data sources utilized for hydrologic and hydraulic analysis are described in later sections of this report.

1.5 Report Limitations

This report is only intended to be used as a design aid for the described project. All work present in this report is in accordance with generally accepted engineering practices and has been prepared under the guidance of a professional engineer. Recommendations, results, and conclusions in this report are professional opinions, and are contingent upon assumptions stated in this report.

2 Hydraulic Analysis

2.1 Review of Available Hydrology / Flow Data

As the Reedley Main Canal is a private irrigation canal that carries low volume flow, there is limited data available for the existing canal. Data obtained from the owner of the canal, AID, is presented in Appendix A of this report. The FEMA FIRM map, as shown in Appendix C of this report, was obtained to verify that the project is not located in a floodplain. No additional USGS data was found available during the preliminary data gathering phase of the project. As the canal banks are 2'-3' higher compared to the adjacent farmland, and the project is not in a floodplain, the flow rates utilized for the project were determined to be the flow rates stated by AID. These irrigation flow rates observed during the irrigation season (April through September) do not coincide with the storm season, therefore the irrigation flow rates will represent the maximum design flow rates to be utilized in hydraulic analysis.

2.2 Existing Hydraulic Model

To determine the surface water elevation for existing conditions, a HEC-RAS 5.0.1 model was created utilizing topographic and bridge data provided by the County of Fresno. A total of 600' of upstream data and 100' of downstream data was modeled in HEC RAS. HEC RAS cross sections were created at 50' intervals along the canal. HEC RAS levees were added along the canal banks to verify that modeled flow was contained in the canal and not the adjacent farmlands. Irrigation flow rates from AID were utilized as steady flow data in HEC-RAS. The downstream reach boundary condition was based on the known downstream elevation, which was determined based on field measurements from the downstream weir. Measurements of the existing structure, including the skew of the structure, were added at HEC RAS station 1000.

As shown in Figure 2.1, the existing structure HEC RAS results show minimal available freeboard during full irrigation flow rates. The water surface elevation at the structure is largely impacted by the downstream weir.

2.3 Proposed Hydraulic Model

The proposed structure HEC RAS model was created utilizing 600' of upstream data and 100' of downstream data. The proposed structure (replacement structure) geometric data was entered into HEC RAS based on the 30% geometric drawing. The same manning's n value of 0.03 was used in both models since the existing creek bottom does not have significant vegetation that would be altered during clearing and grubbing activities. The proposed structure has an opening of 5.17' in clear height which is slightly taller compared to existing conditions. The proposed clear width of each proposed box culvert is 10' which is 2 feet larger than what is existing.

The results for the proposed structure HEC RAS model can be seen below in Table 2.1. As seen below, the freeboard increases slightly due to the slight increase in total span height. The larger span openings with the proposed model have minor to negligible effect on water surface elevation as the elevation is controlled by the downstream weir and not the effective opening of the structure.

2.4 Hydraulic Model Summary

Table 2.1 summarizes the obtained data for the irrigation flow. Full HEC-RAS outputs are provided in Appendix D and Appendix E of this report.

Table 2.1 – Proposed and Existing Structure Elevations, WSE, and Freeboard (feet)

		Existing Structure Model ***Channel n = 0.03***	**Proposed Structure Model** ***Channel n = 0.03***
Structure Soffit Elevation*			
	Upstream Structure Edge	397.40’	397.50’
	Downstream Structure Edge	397.46’	397.50’
		Irrigation Flow	Irrigation Flow
Water Surface Elevation (WSE)			
	Upstream Structure Edge	397.36’	397.35’
	Downstream Structure Edge	397.32’	397.35’
Freeboard			
	Upstream Structure Edge	0.04’	0.15’
	Downstream Structure Edge	0.14’	0.15’

Soffit Elevation obtained from lower abutment edge

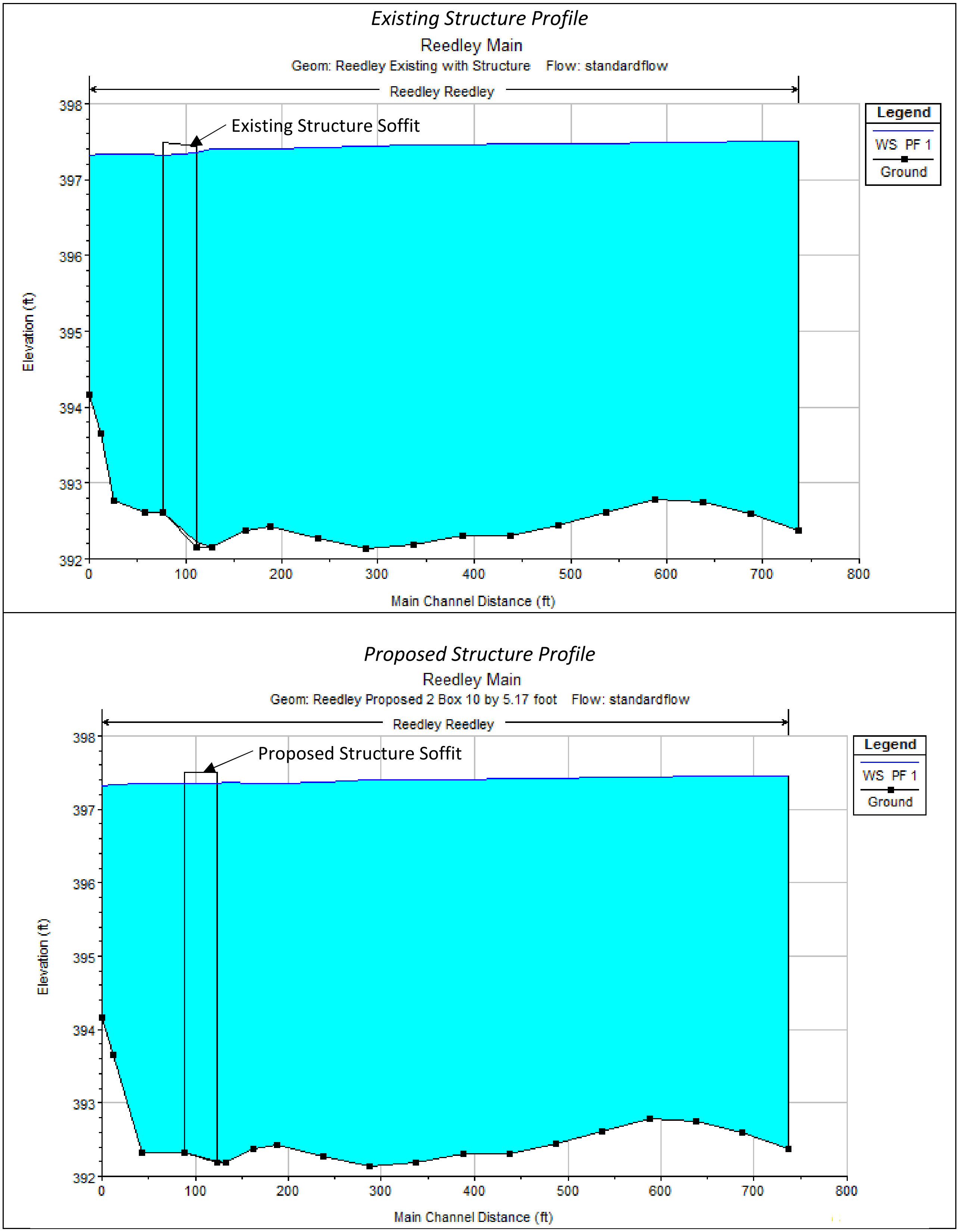


Figure 2.1: Existing Reedley Canal Structure HEC-RAS Profiles

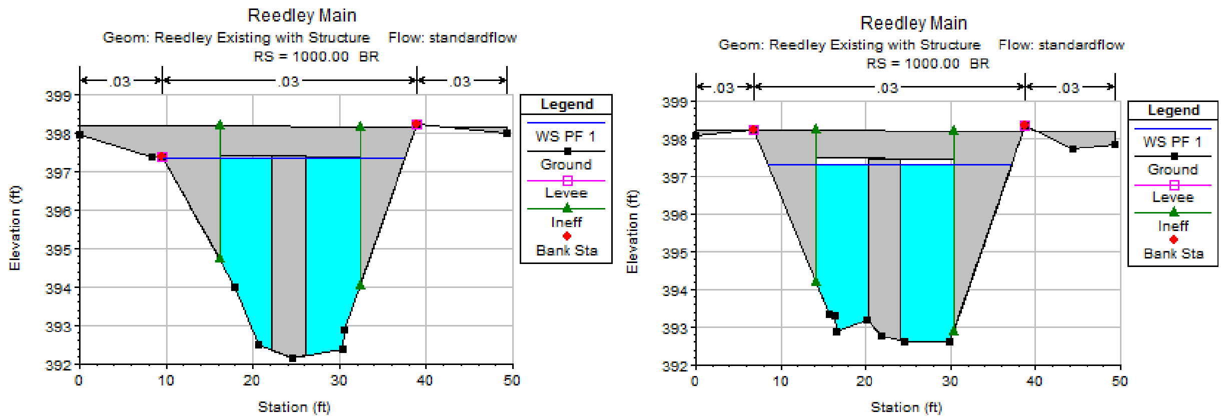


Figure 2.2: Existing Reedley Canal Structure HEC-RAS Cross Sections

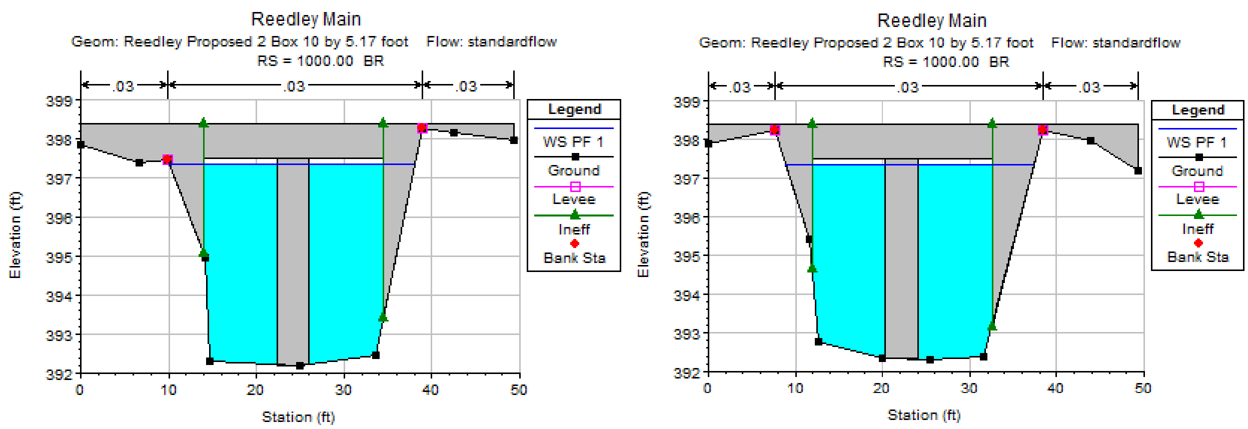


Figure 2.3: Proposed Reedley Canal Structure HEC-RAS Cross Section

3 Scour Analysis

3.1 Long-Term Bed Elevation (Degradation)

Degradation of the creek is defined as long-term stream elevation change (lowering) due to natural or man-induced causes which can affect the reach of the river where the proposed structure is located. Degradation is not local to a single spot along a reach, but is observed over relatively long lengths of the channel. For purposes of scour analysis, only degradation is considered and progressive buildup of material on a channel bed (an event called aggradation) is not considered.

To investigate degradation near the project site, multiple Caltrans Bridge Inspection Reports (BIR) for the existing structure were obtained from Caltrans Local Assistance. These BIR ranged in dates from 1978 to 2014. The existing structure was subjected to mostly routine biennial inspections. Table 3.1 below summarizes the scour findings of each BIR at the proposed structure.

Table 3.1 – Existing Structure Bridge Inspection Report Summary

Inspection Type	Inspection Date	Scour Information
Routine	11/18/2014	No data on scour
Routine	11/14/2012	No scour was observed
Routine	12/09/2010	No scour was observed
Other – (Hydraulic Analysis Only)	01/26/2010*	Small amount of aggradation in Span 1, 2 foot drop near Pier 2 and Abutment 3, could be influenced by channel grading. Small hole at upstream end of Pier 2. Bridge can be adequately managed through routine inspections.
Routine	11/18/2008	No scour was observed
Routine	01/23/2007	No scour was observed
Routine	03/25/2004*	No data on scour
Routine	03/21/2002	No data on scour
Routine	12/20/2000	No significant structural deficiency found
Biennial	02/12/1997	No scour present
Biennial	03/30/1995	No scour found
Biennial	02/24/1993*	No scour found
Biennial	11/07/1990	No scour found
Biennial	11/15/1988	The footing at abutment 1 is exposed.
Routine	10/16/1984	No data on scour
Routine	07/10/1978	No data on scour
Routine	05/04/1978*	There is a small hole at the left curb of abutment 1.

***Inspection with Canal Cross-sections Taken**

As shown in Table 3.1 above, cross section data was obtained for this structure four separate years. Cross section data obtained from these reports was plotted as shown in Figure 3.1. Cross section data obtained on each abutment and center pier varies slightly between different inspection years. Looking at the trends between mid-span, and at the left abutment, does not reveal overall channel degradation. Therefore degradation for this channel is anticipated to be negligible.

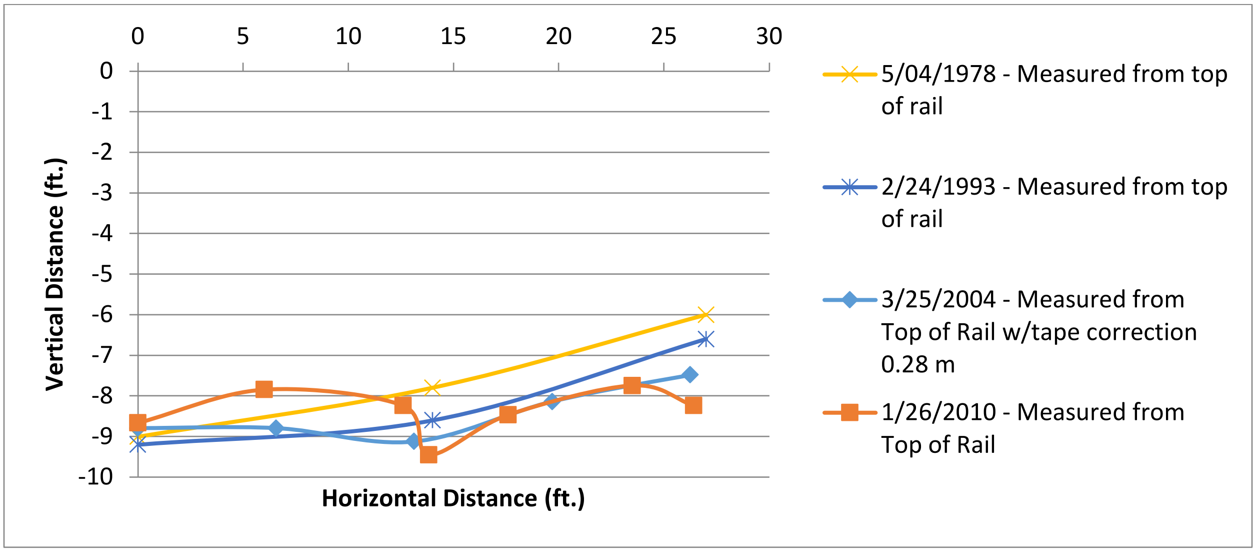


Figure 3.1: Cross Sectional Data from Caltrans Bridge Inspection Reports at the Upstream Face of Existing Structure

3.2 <u>Contraction Scour</u>

Contraction scour of the creek is defined as scour resulting from the constriction of flow through the bottom opening or overbank opening of a channel. This contraction of flow increases water velocity and shear stress on the channel bed which results in additional removal of bed material near the physical contraction. Contraction scour is different from long-term degradation in that contraction scour occurs in the vicinity of the structure and that it may be cyclic in nature.

A velocity profile from the proposed HEC-RAS model was utilized to determine the channel velocity for contraction scour calculations. The largest velocity near the proposed structure utilized for calculations. Methodologies present in FHWA HEC-18 were utilized to calculate contraction scour for the proposed structure. These methodologies utilize equations based on the principles of conservation of sediment transport and continuity. The D_{50} value obtained from Technicon Engineering Services, Inc., was used to determine the contraction scour type anticipated for the crossing will be clear water contraction scour.

For calculation of clear water contraction scour, the Laursen (1963) equation was utilized. Based on the proposed geometrics of the channel, the average equilibrium depth for the contracted section was determined to be higher than the proposed channel bottom elevation, meaning that there is negligible contraction scour. Full calculations for contraction scour can be found as part of Appendix F of this report.

3.3 <u>Local Scour</u>

Local scour is scour caused by an acceleration of flow and resulting flow turbidity induced by bridge structural elements (such as abutments, piers, spurs or embankments) interacting with channel flow. Local scour is different than contraction scour as local scour occurs in the immediate vicinity of individual structural elements and not the entire channel bed. Local scour is often cyclic in nature and difficult to observe or measure in the field.

Methodologies presented in FHWA HEC-18 were utilized to calculate local scour. Results from the proposed HEC-RAS model were utilized in the equation. Based on the equation, the total local abutment scour was calculated ranged from 1.2 feet to 2.7 feet. The largest local scour value is utilized for calculation of total scour. Full calculations for local scour can be found as part of Appendix F of this report.

3.4 Total Scour

Total scour for each abutment is calculated as the summation of long-term bed elevation (degradation), contraction scour, and local scour. The estimated scour depths for the proposed structure are shown in Table 4.2 below.

Table 3.2 – Proposed Reedley Main Canal Structure Scour Depths*

	Degradation (ft)	Contraction Scour (ft)	Local Scour (ft)	Total Calculated Scour Depth (ft)
Anticipated Scour Depth	0.0	0.0	2.7	2.7

Scour values rounded to the nearest 0.1 ft.

References

California Department of Transportation. (October 2014). *Bridge Inspection Report, Bridge Number 42C0317.*

Federal Emergency Management Agency (FEMA). (February 2009). Flood Insurance Rate Map Fresno County, California and Incorporated Areas, Panel 1100 of 3525.

Federal Highway Administration. (April 2012). *Hyraulic Engineering Circular No. 18, Evaluating Scour at Bridges* (Fifth Edition ed.).

Federal Highway Administration. (April 2012). *Hyrdualic Engineering Circular No. 20, Stream Stability at Highway Structures* (Fourth Edition ed.).

Federal Highway Administration. (September 2009). *Hydraulic Engineering Circular No. 23, Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance* (Third Edition ed.).

Federal Highway Administration. (September 2009, revised August 2013). *Hyraulic Engineering Circular No. 22, Urban Drainage Design Manual* (Third Edition ed.).

National Oceanic and Atmospheric Administration (NOAA). (n.d.). *NOAA Atlas 14 Point Percipitation Frequency Estimates: CA0=*. Retrieved December 2015, from http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ca

State of California Department of Transportation (Caltrans). (2010). Standard Plans. CA.

United States Army Corps of Engineers- Hydrologic Engineering Center. (2015, December). *Hydrologic Modeling System, HEC-HMS, 4.1.0 (Computer Software)*. Retrieved from http://www.hec.usace.army.mil/software/hec-hms/

United States Army Corps of Engineers- Hydrologic Engineering Center. (2015, December). *River Analysis System, HEC-RAS Version 4.1.0 (Computer Software)*. Retrieved from http://www.hec.usace.army.mil/software/hec-ras/

United States Department of Agriculture. (June 1986). *Urban Hydrology for Small Watersheds, TR-55.*

United States Department of Agriculture. (n.d.). *Web Soil Survey, National Resources Conversation Services*. Retrieved from http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

United States Geological Survey (USGS). (n.d.). *Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains.* Retrieved from http://www.fhwa.dot.gov/BRIDGE/wsp2339.pdf

United States Geological Survey. (n.d.). *StreamStats National State Application, California*. Retrieved December 2015, from http://water.usgs.gov/osw/streamstats/california.html

Appendix A: Alta Irrigation District Correspondence

Michael Burchard

From: Luis Rios <luis@altaid.org>
Sent: Thursday, August 11, 2016 10:48 AM
To: Michael Burchard
Subject: FW: AID - Reedley Main and Travers Creek Projects
Attachments: Reedley Main Traver Creek Projects.docx

Michael, please see attached file.

If you have any questions feel free to contact me.

Thank you,

Luis M. Rios
Data Coordinator/IT Support

Alta Irrigation District
289 N. L St.
Dinuba CA. 93618

559-591-0800 ext. 12
lmr@altaid.org
www.altaid.org

From: Javier Cavazos
Sent: Thursday, August 11, 2016 10:47 AM
To: Luis Rios
Subject: RE: AID - Reedley Main and Travers Creek Projects

Please see attached answers.
Thank you,
Javier

From: Luis Rios
Sent: Monday, July 25, 2016 4:17 PM
To: Chris Kapheim; Chad Wegley; Javier Cavazos
Subject: FW: AID - Reedley Main and Travers Creek Projects

Hello All,
Please see email below Michael Burchard.

Luis

From: Michael Burchard [mailto:mburchard@markthomas.com]
Sent: Monday, July 25, 2016 4:04 PM
To: Luis Rios
Cc: Kevin Smith
Subject: AID - Reedley Main and Travers Creek Projects

Hello Mr. Rios,

Thank you for taking my call earlier today.

The intent of this email is to make AID aware of three upcoming projects we are working on with Fresno County and determine the design criteria AID would like to use for the project design. Three structures are proposed to be replaced with 4-sided, reinforced concrete box culverts. These projects are proposed over the Travers Creek at Lincoln Avenue, Travers Creek at Parlier Avenue, and the Reedley Main Canal at Englehart Avenue.

If you can please answer the questions below, it would greatly help us with our project design:

Reedley Main/ Englehart Road:

- What months does AID typically run Irrigation?
- What is the Irrigation flow rate (maximum)?
- Does AID have the dimensions of weir directly downstream of structure
- Confirmation that the canal storm flows will not exceed design irrigation flows (we believe the upstream condition to be gate-controlled)
- Desired freeboard for a proposed box culvert

Travers/Lincoln Ave:

- Irrigation Season (months)
- Irrigation flow rate (maximum)
- Confirmation that the canal storm flows will not exceed design irrigation flows (we believe the upstream condition to be gate-controlled)
- Desired freeboard for a proposed box culvert

Travers/Parlier Ave:

- Irrigation Season (months)
- Irrigation flow rate (maximum)
- Confirmation that the canal storm flows will not exceed design irrigation flows (we believe the upstream condition to be gate-controlled)
- Desired freeboard for a proposed box culvert

Thank you,
Michael

Michael Burchard
Engineering Technician
(559) 447-1938 x3116 | (559) 374-3116 direct

Mark Thomas & Company
Providing Engineering, Surveying and Planning Services
www.markthomas.com

Reedley Main Traver Creek Projects
Fresno County
Proposed Concrete Box Structures

Reedley Main/ Englehart Road:

- What months does AID typically run Irrigation?

A. Average operational season is April to September.

- What is the Irrigation flow rate (maximum)?

A. Control flows can reach 100cfs.

- Does AID have the dimensions of weir directly downstream of structure

A. No.

- Confirmation that the canal storm flows will not exceed design irrigation flows (we believe the upstream condition to be gate-controlled)

A. At this location the District only operates control flows, no storm water.

- Desired freeboard for a proposed box culvert

A. 2.5 feet

Travers/Lincoln Ave:

- Irrigation Season (months)

A. Average operational season is April to September.

- Irrigation flow rate (maximum)

A. Control flows can reach 200cfs.

- Confirmation that the canal storm flows will not exceed design irrigation flows (we believe the upstream condition to be gate-controlled)

A. Storm water flows are much greater than control flows for operational season.

- Desired freeboard for a proposed box culvert

A. 2.5 feet

Travers/Parlier Ave:

- Irrigation Season (months)

A. Average operational season is April to September.

- Irrigation flow rate (maximum)

A. Control flows can reach 200cfs.

- Confirmation that the canal storm flows will not exceed design irrigation flows (we believe the upstream condition to be gate-controlled)

A. Storm water flows are much greater than control flows for operational season.

- Desired freeboard for a proposed box culvert

A. 2.5 feet

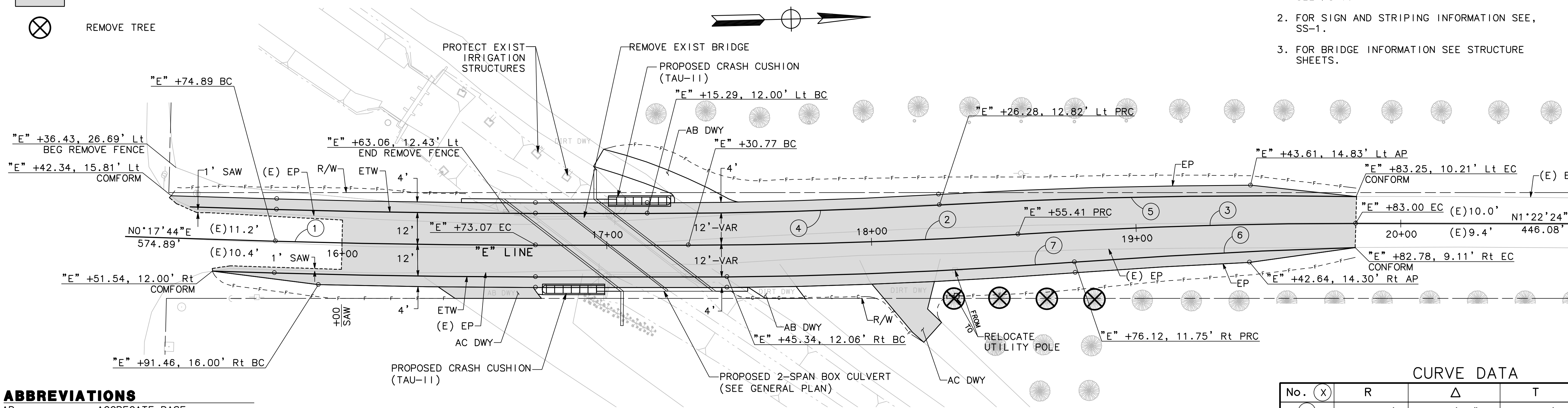
Appendix B: Proposed Plan and Profile

LEGEND:

- NEW PAVEMENT
- ⊗ REMOVE TREE

GENERAL NOTES

1. FOR CONTROL LINE & MONUMENT INFORMATION, SEE PC-1.
2. FOR SIGN AND STRIPING INFORMATION SEE, SS-1.
3. FOR BRIDGE INFORMATION SEE STRUCTURE SHEETS.



ENGLEHART AVENUE

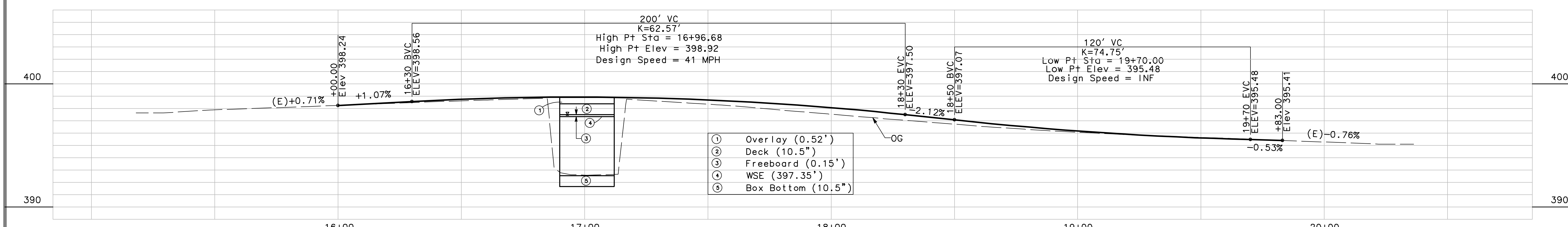
SCALE: 1" = 20'

CURVE DATA

No.	R	Δ	T	L
1	3200.00'	1°45'29"	49.09'	98.18'
2	1900.00'	3°45'30"	62.34'	124.63'
3	1900.00'	3°50'52"	63.82'	127.59'
4	1900.00'	3°19'42"	55.20'	110.37'
5	2189.61'	4°07'22"	78.81'	157.55'
6	2615.38'	2°19'28"	53.06'	106.10'
7	1948.23'	3°51'47"	65.70'	131.35'

ABBREVIATIONS

AB	AGGREGATE BASE
AP	ANGLE POINT
BC	BEGIN CURVE
C	CUT SLOPE
DWY	DRIVEWAY
(E)	EXISTING
EC	END CURVE
EP	EDGE OF PAVEMENT
ETW	EDGE OF TRAVEL WAY
F	FILL SLOPE
HP	HINGE POINT
OG	ORIGINAL GROUND
PRC	POINT OF REVERSING CURVE
R/W	RIGHT OF WAY
SAW	SAWCUT
SHLD	SHOULDER
VAR	VARIES
VPD	VEHICLES PER DAY
WSE	WATER SURFACE ELEVATION



"E" LINE PROFILE

SCALE : H: 1"=20'
V: 1"=4'

60% SUBMITTAL

DESIGNED: MPB	DATE 08/17/2016	RECORD DRAWING		SCALE		PROJECT	DEPARTMENT OF PUBLIC WORKS AND PLANNING
DRAWN: MPB	08/17/2016	RESIDENT ENGINEER	DATE	0 10 20 40	SUPERVISING ENGINEER / DATE	REEDLEY MAIN AT ENGLEHART AVE COUNTY OF FRESNO, CA	PLAN AND PROFILE
CHECKED: KPS	####			SCALE: 1" = 20'		ROAD NO. #### BRIDGE NO. 42C0276	DRAWING NO. PP-1 SHEET NO. 4 TOTAL 12

FOR RIGHT OF WAY DATA AND ACCURATE ACCESS DETERMINATION, SEE DOCUMENTS IN THE DEPARTMENT OF PUBLIC WORKS AND PLANNING.

THE COUNTY OF FRESNO 1856

Appendix C: FEMA FIRM Map

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables 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 California State Plane Zone IV (FIPS 404). The **horizontal datum** was NAD 83, GRS80 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 transportation information shown on this FIRM was provided in digital format from Fresno County. Public Land Survey System information was derived from U.S. Geological Survey Digital Orthophoto Quadrangles produced at a scale of 1:12,000 from photography dated 1997 or later.

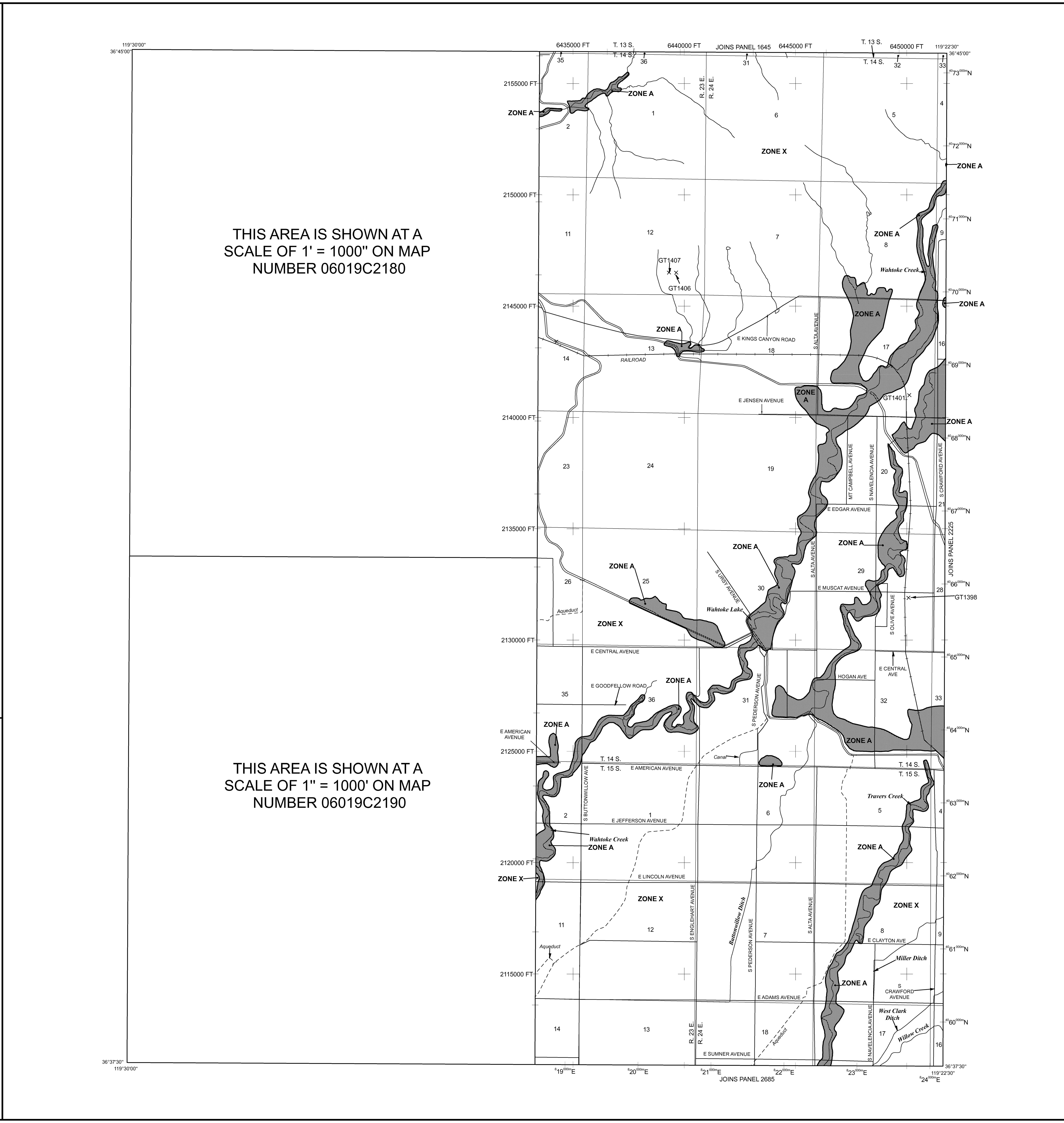
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to confirm to these new stream channel configurations. As a result,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

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

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

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

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



LEGEND

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

The 1% annual 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	Area to be protected from 1% annual chance flood 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.

	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
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
2476000mN	1000-meter Universal Transverse Mercator grid values, zone 10
600000 FT	5000-foot grid ticks: California State Plane coordinate system, zone IV (FIPSZONE 0404), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
●M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
July 19, 2001

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
February 18, 2009 - to update corporate limits, to change base flood elevations, floodway, and Special Flood Hazard Areas, to add roads and road names and to incorporate previously issued Letters of Map Revision

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'

1000 0 2000 4000 FEET
600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2200H

FIRM
FLOOD INSURANCE RATE MAP

FRESNO COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 2200 OF 3525

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
FRESNO COUNTY	065029	2200	H

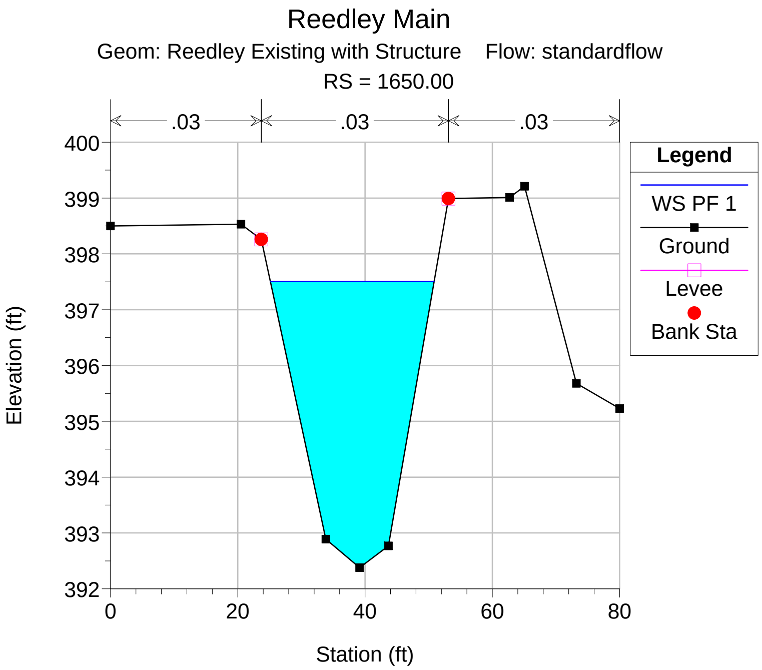
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

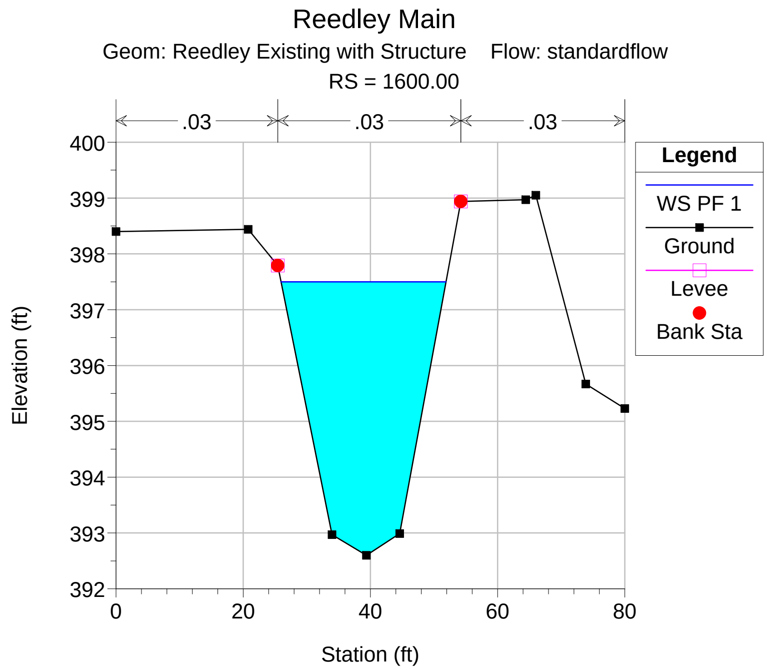
MAP NUMBER
06019C2200H

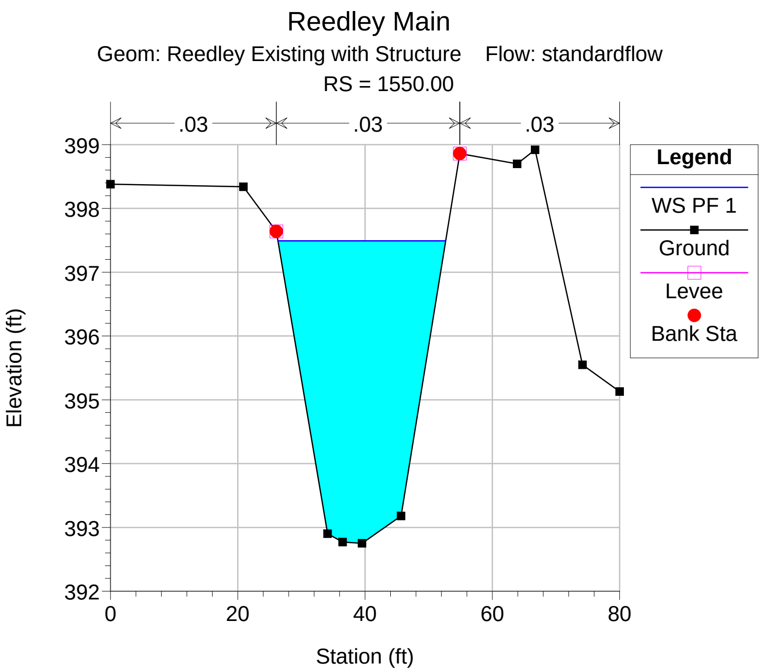
MAP REVISED
FEBRUARY 18, 2009

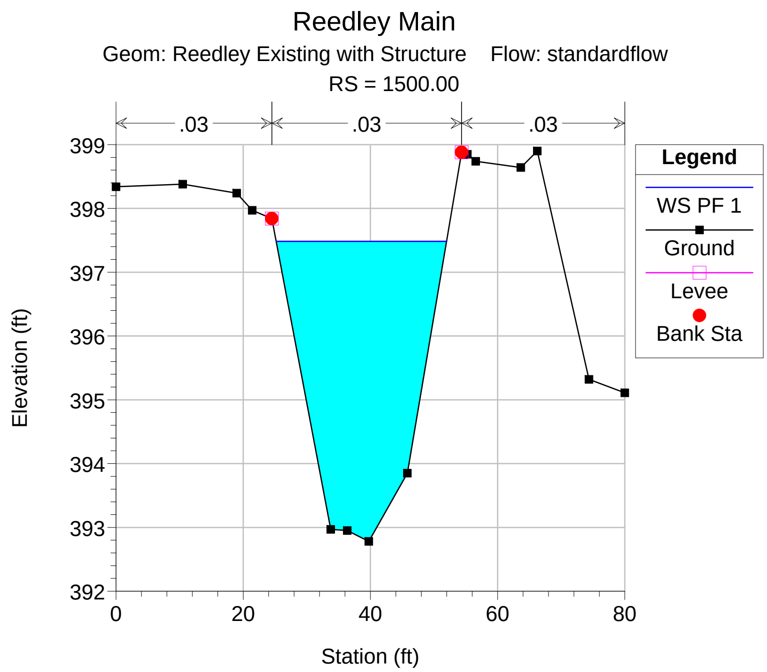
Federal Emergency Management Agency

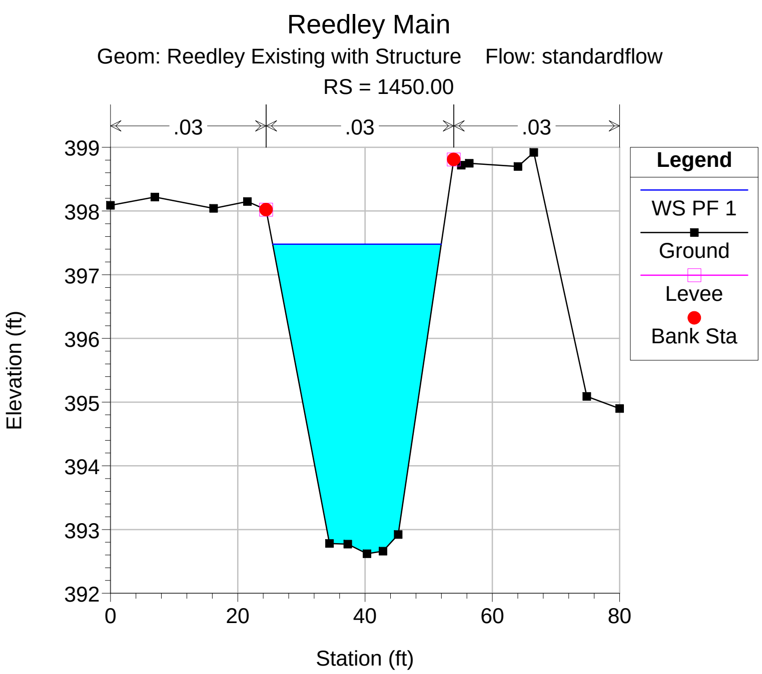
Appendix D: HEC-RAS Output for Existing Structure

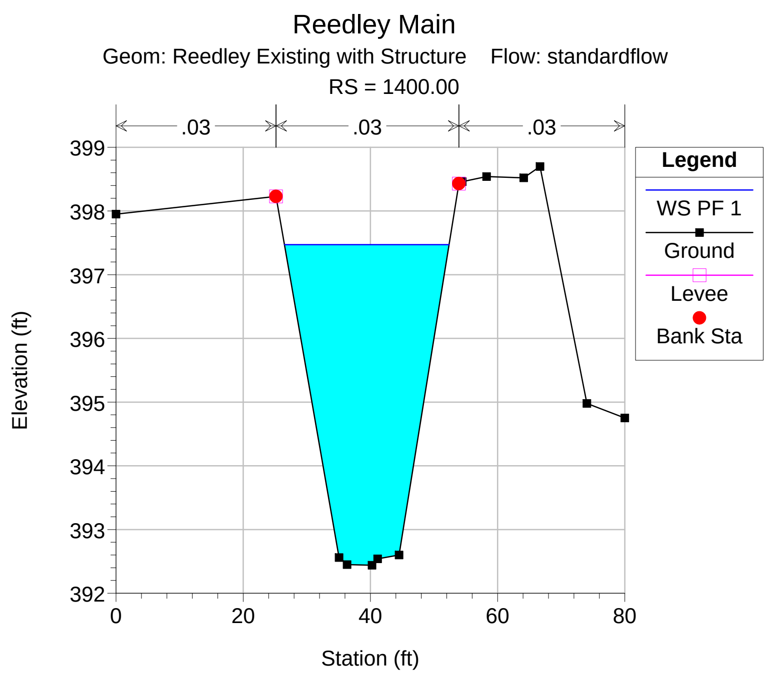

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1650.00
.03 .03 .03
Elevation (ft)
Station (ft)
392 393 394 395 396 397 398 399 400
0 20 40 60 80
Legend
WS PF 1
Ground
Levee
Bank Sta

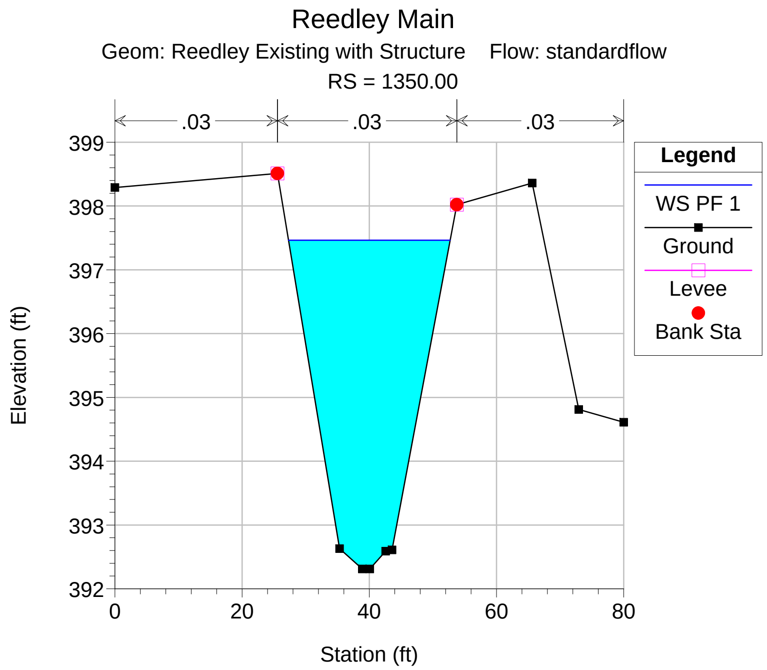

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1600.00
.03 .03 .03
Elevation (ft)
Station (ft)
392 393 394 395 396 397 398 399 400
0 20 40 60 80
Legend
WS PF 1
Ground
Levee
Bank Sta

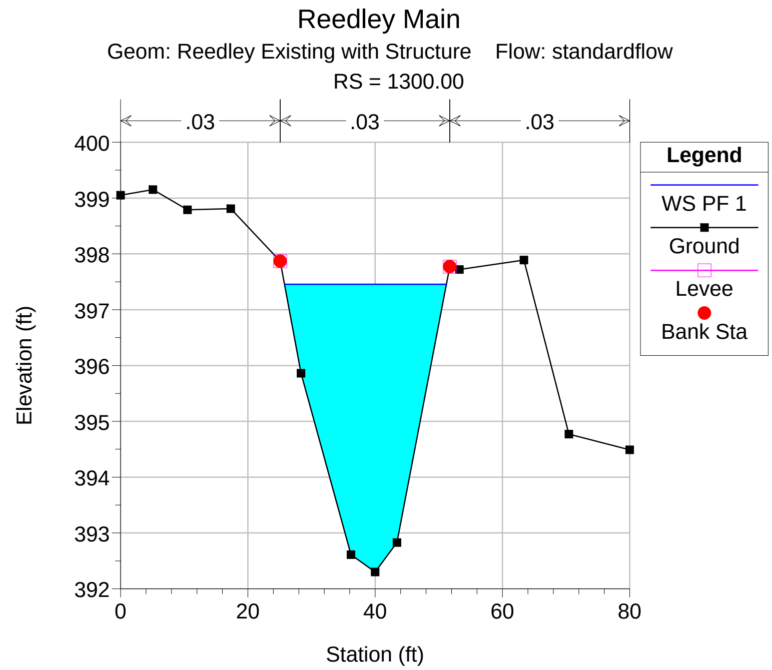

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1550.00
.03 .03 .03
Elevation (ft)
Station (ft)
392 393 394 395 396 397 398 399
0 20 40 60 80
Legend
WS PF 1
Ground
Levee
Bank Sta

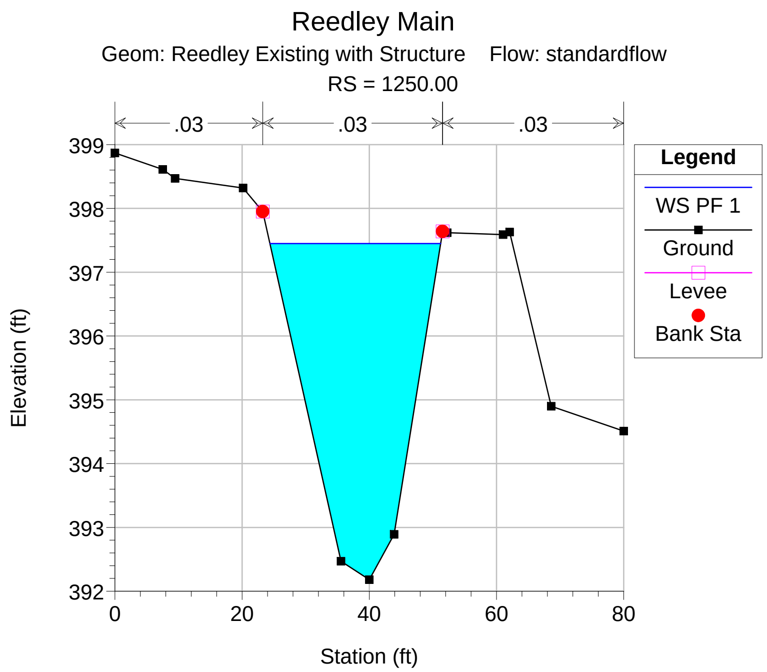

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1500.00
.03 .03 .03
Elevation (ft)
Station (ft)
392 393 394 395 396 397 398 399
0 20 40 60 80
Legend
WS PF 1
Ground
Levee
Bank Sta

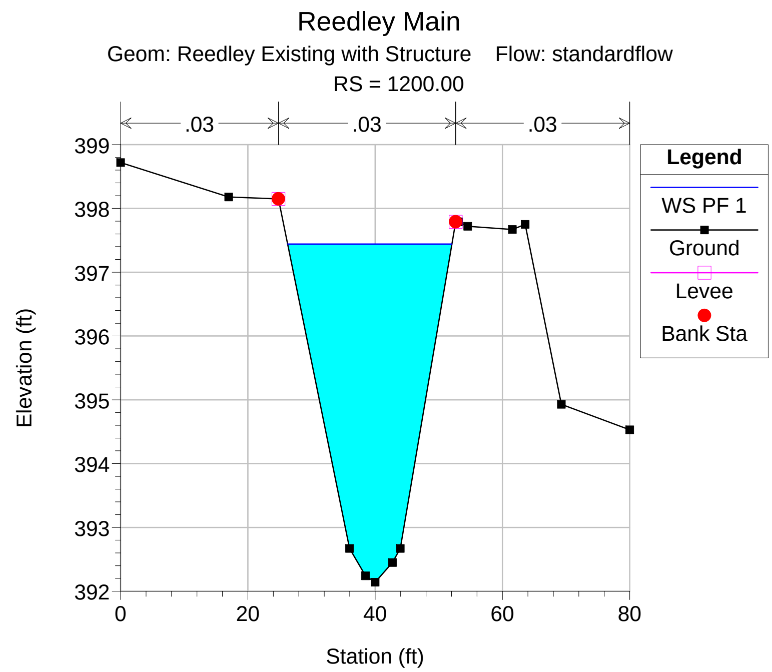

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1450.00
.03 .03 .03
Elevation (ft)
Station (ft)
392 393 394 395 396 397 398 399
0 20 40 60 80
Legend
WS PF 1
Ground
Levee
Bank Sta

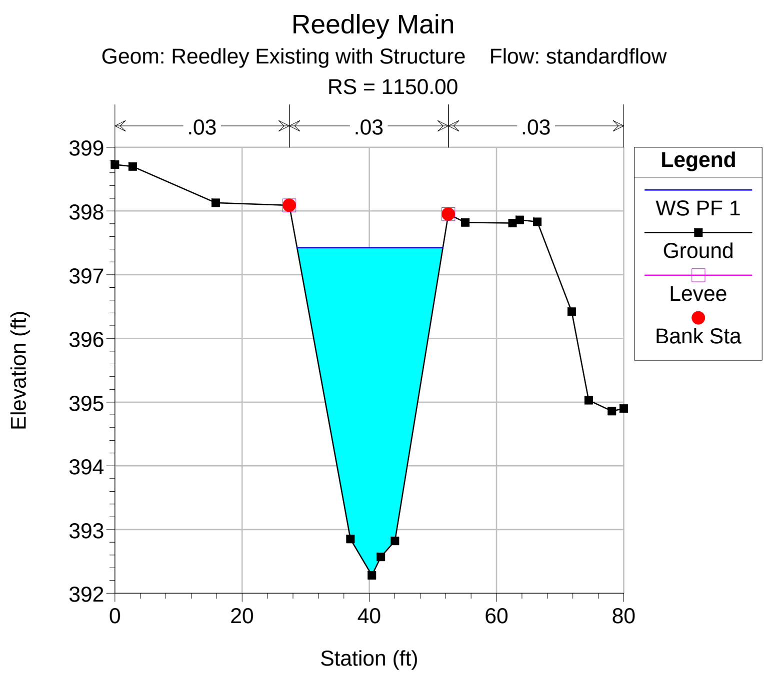

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1400.00
.03 .03 .03
Elevation (ft)
Station (ft)
392 393 394 395 396 397 398 399
0 20 40 60 80
Legend
WS PF 1
Ground
Levee
Bank Sta

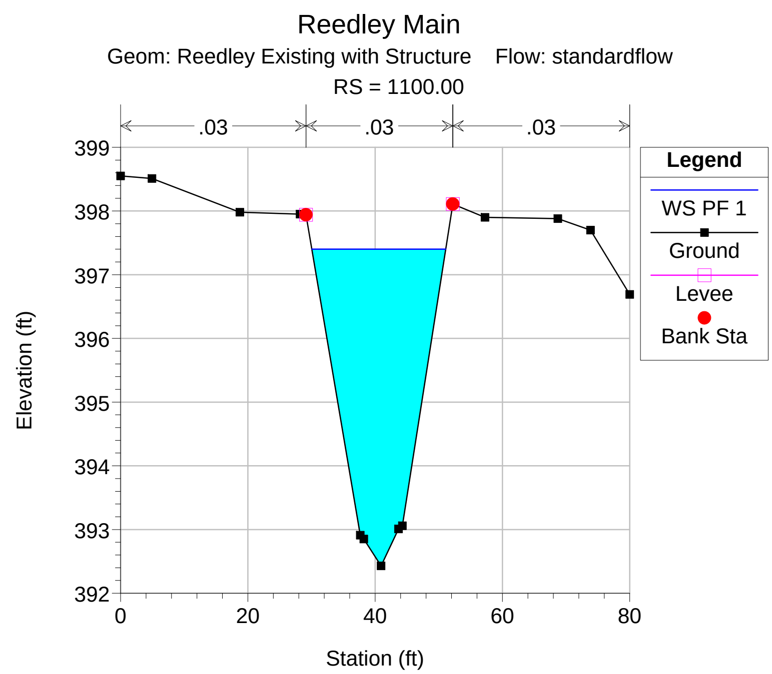

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1350.00
.03 .03 .03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

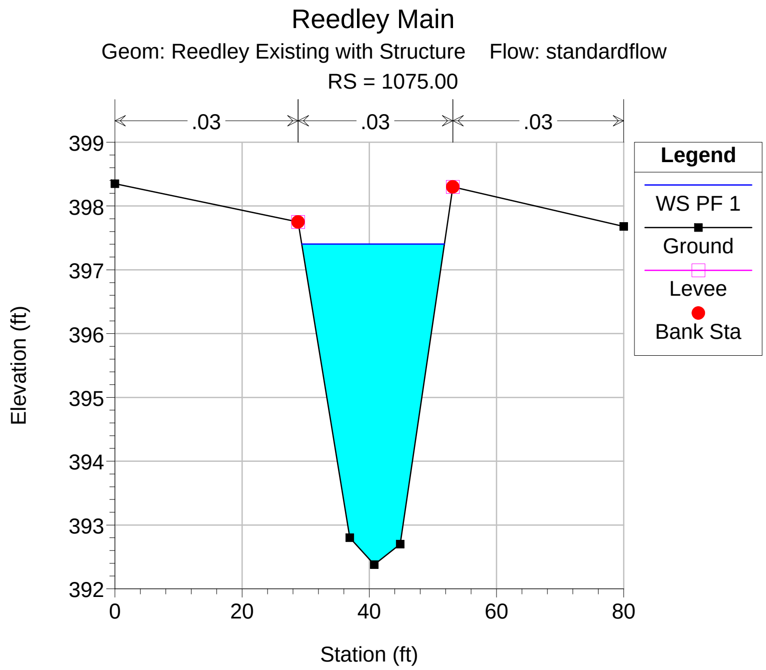

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1300.00
.03 .03 .03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

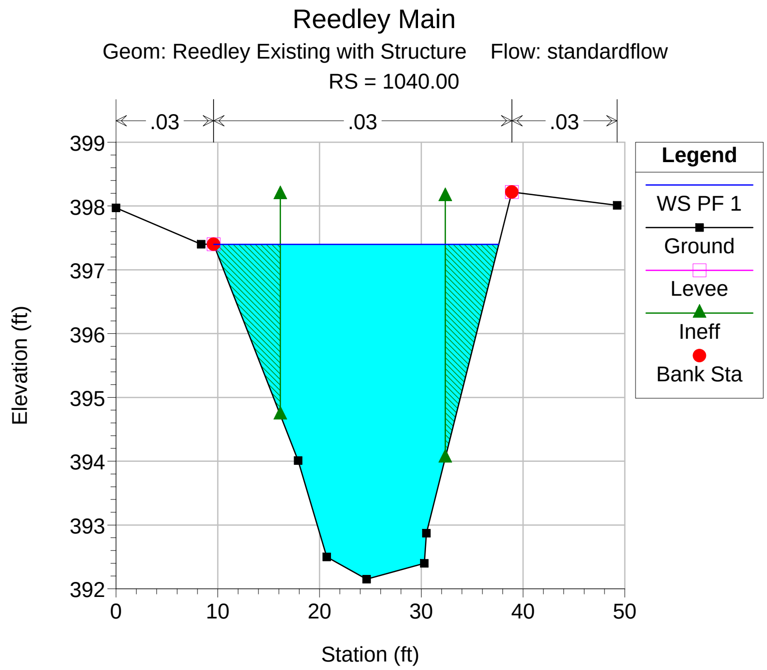

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1250.00
.03 .03 .03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

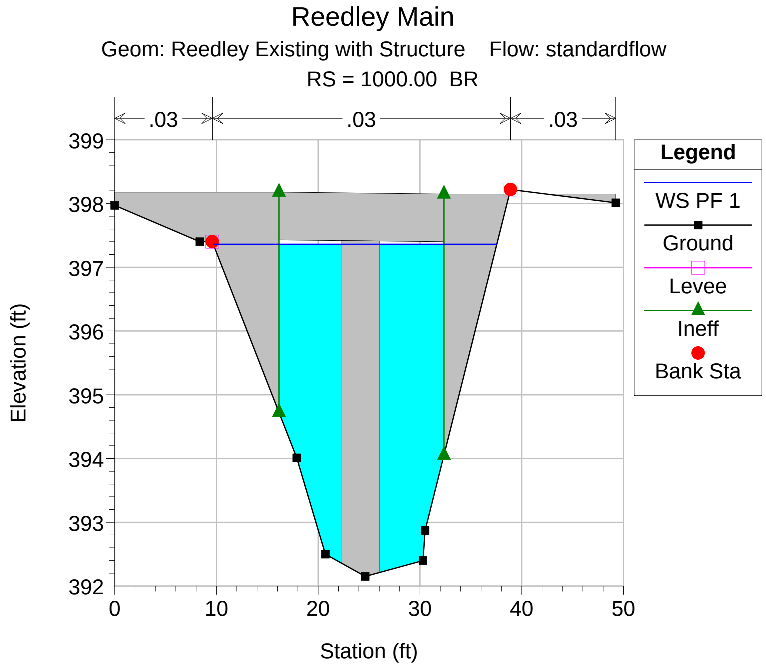

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1200.00
.03 .03 .03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

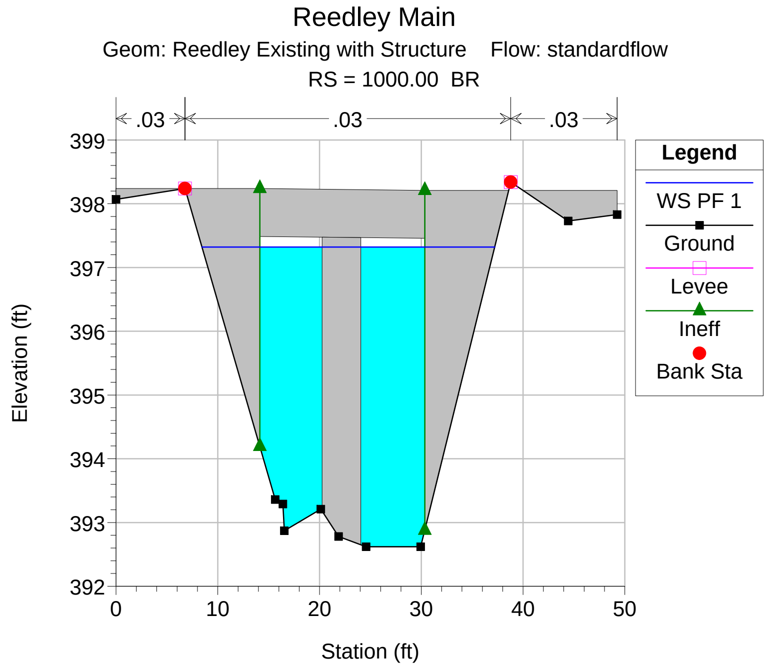

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1150.00
.03 .03 .03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

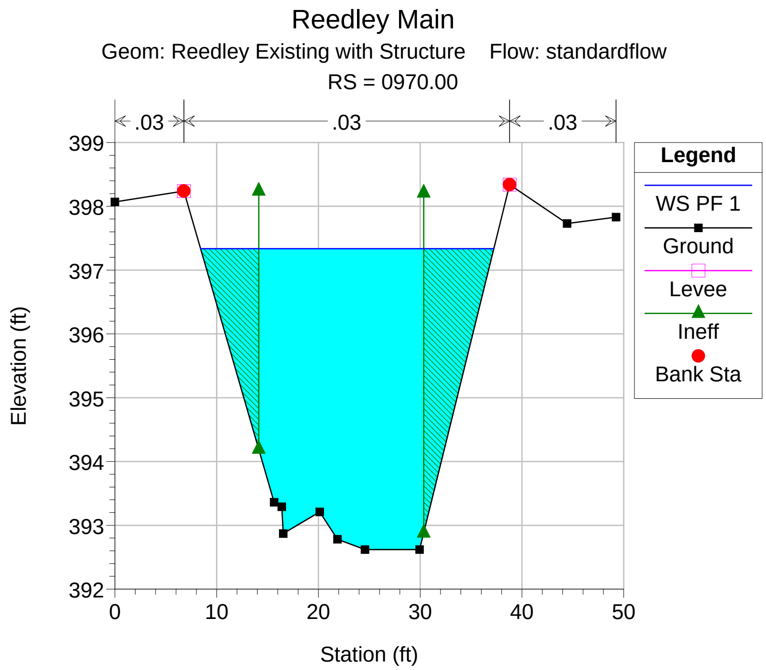

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1100.00
.03 .03 .03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

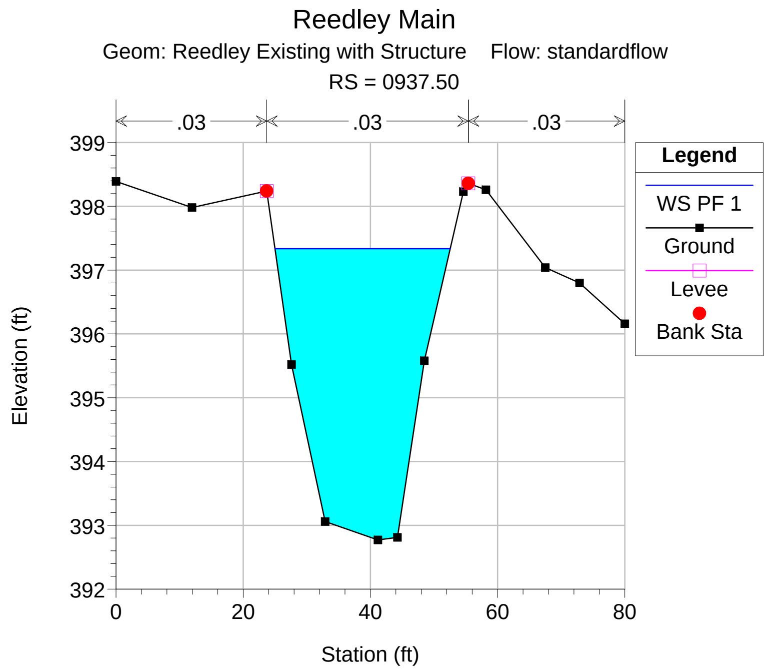

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1075.00
.03 .03 .03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

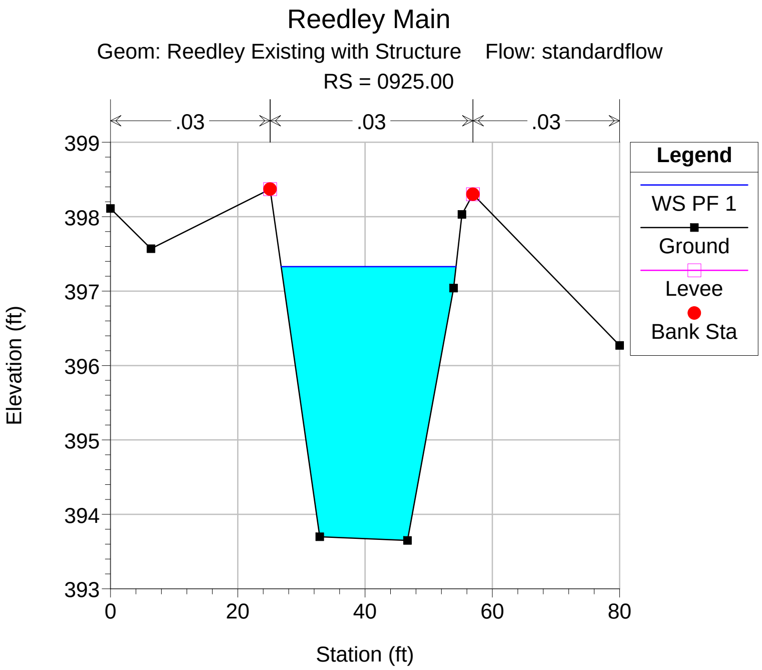

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1040.00
.03 .03 .03
Legend
WS PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1000.00 BR
.03 .03 .03
Legend
WS PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

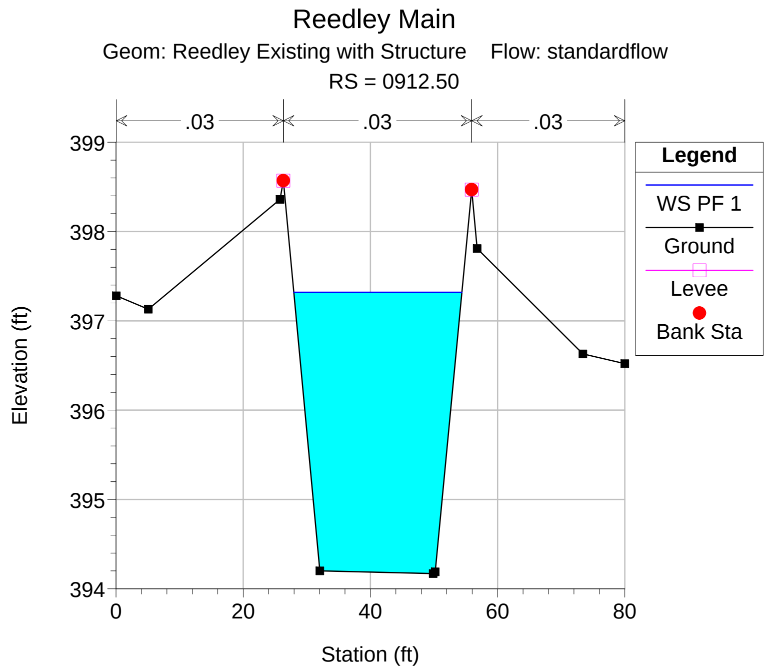

Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 1000.00 BR
.03 .03 .03
Legend
WS PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 0970.00
.03 .03 .03
Legend
WS PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 0937.50
.03 .03 .03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)



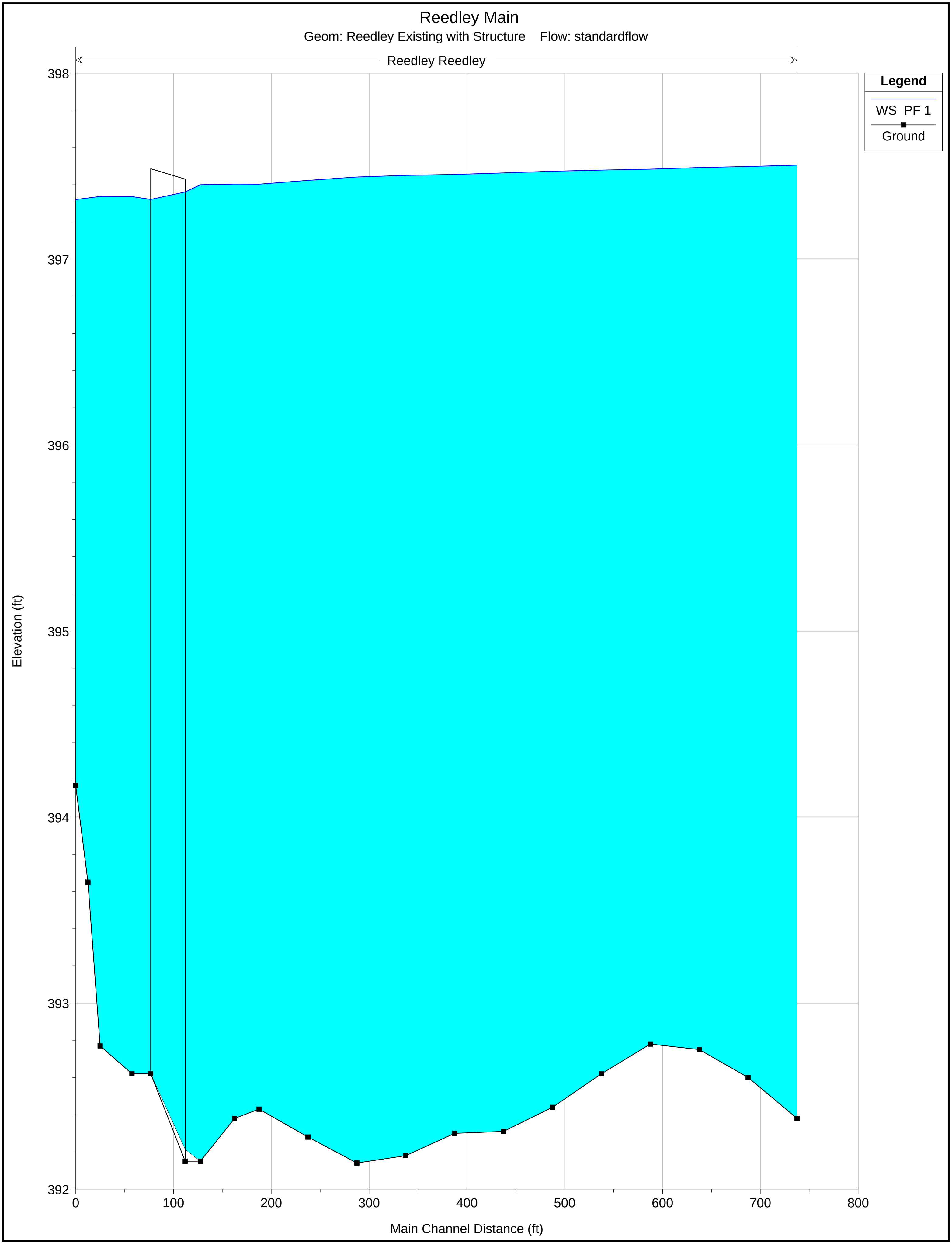
Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 0925.00
.03
.03
.03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
399
398
397
396
395
394
393
0
20
40
60
80
Station (ft)



Reedley Main
Geom: Reedley Existing with Structure Flow: standardflow
RS = 0912.50
.03
.03
.03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
399
398
397
396
395
394
0
20
40
60
80
Station (ft)

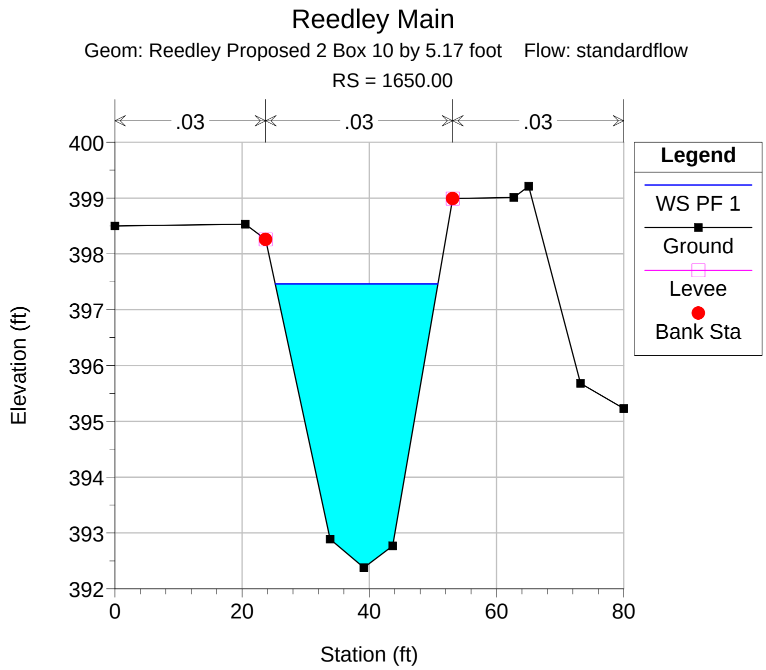
HEC-RAS Plan: Plan 37 River: Reedley Reach: Reedley Profile: PF 1

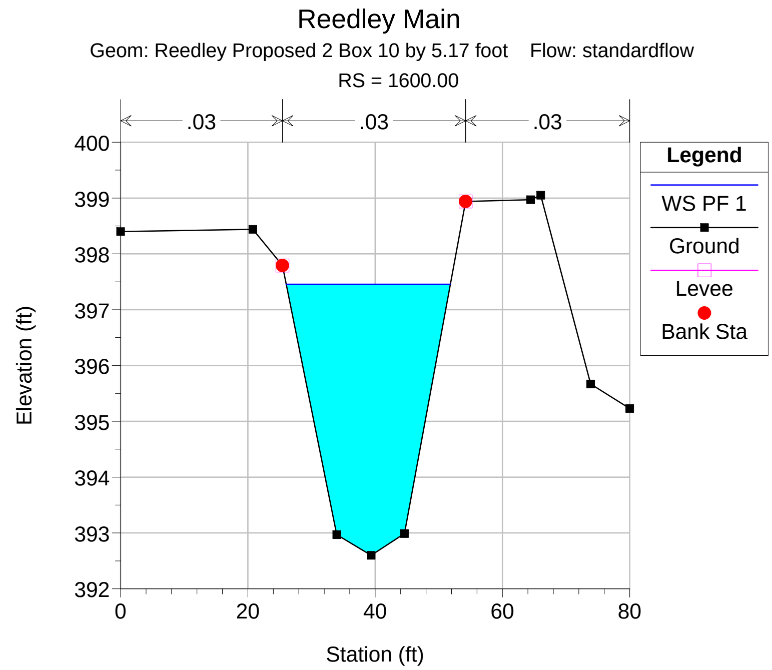
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reedley	1650.00	PF 1	100.00	392.38	397.50	394.02	397.53	0.000129	1.17	85.27	25.72	0.11
Reedley	1600.00	PF 1	100.00	392.60	397.50	394.13	397.52	0.000133	1.18	84.70	25.94	0.12
Reedley	1550.00	PF 1	100.00	392.75	397.49	394.16	397.51	0.000127	1.16	86.28	26.37	0.11
Reedley	1500.00	PF 1	100.00	392.78	397.48	394.34	397.51	0.000144	1.20	83.25	26.79	0.12
Reedley	1450.00	PF 1	100.00	392.62	397.48	394.04	397.50	0.000121	1.14	87.73	26.48	0.11
Reedley	1400.00	PF 1	100.00	392.44	397.47	393.91	397.49	0.000121	1.15	87.12	25.87	0.11
Reedley	1350.00	PF 1	100.00	392.31	397.46	393.99	397.49	0.000140	1.21	82.86	25.40	0.12
Reedley	1300.00	PF 1	100.00	392.30	397.45	394.13	397.48	0.000150	1.23	81.01	25.44	0.12
Reedley	1250.00	PF 1	100.00	392.18	397.45	393.95	397.47	0.000129	1.16	86.48	26.85	0.11
Reedley	1200.00	PF 1	100.00	392.14	397.44	393.96	397.46	0.000141	1.21	82.96	25.80	0.12
Reedley	1150.00	PF 1	100.00	392.28	397.42	394.29	397.45	0.000212	1.42	70.46	22.94	0.14
Reedley	1100.00	PF 1	100.00	392.43	397.40	394.48	397.44	0.000280	1.59	62.88	21.06	0.16
Reedley	1075.00	PF 1	100.00	392.38	397.40	394.16	397.43	0.000193	1.39	72.06	22.43	0.14
Reedley	1040.00	PF 1	100.00	392.15	397.40	393.74	397.43	0.000107	1.35	74.18	28.01	0.11
Reedley	1000.00		Bridge									
Reedley	0970.00	PF 1	100.00	392.62	397.34	393.96	397.37	0.000115	1.40	71.67	28.81	0.12
Reedley	0937.50	PF 1	100.00	392.77	397.34	394.15	397.36	0.000135	1.16	85.98	27.55	0.12
Reedley	0925.00	PF 1	100.00	393.65	397.33	394.79	397.36	0.000200	1.32	75.80	27.48	0.14
Reedley	0912.50	PF 1	100.00	394.17	397.32	395.14	397.35	0.000253	1.43	69.82	26.43	0.16

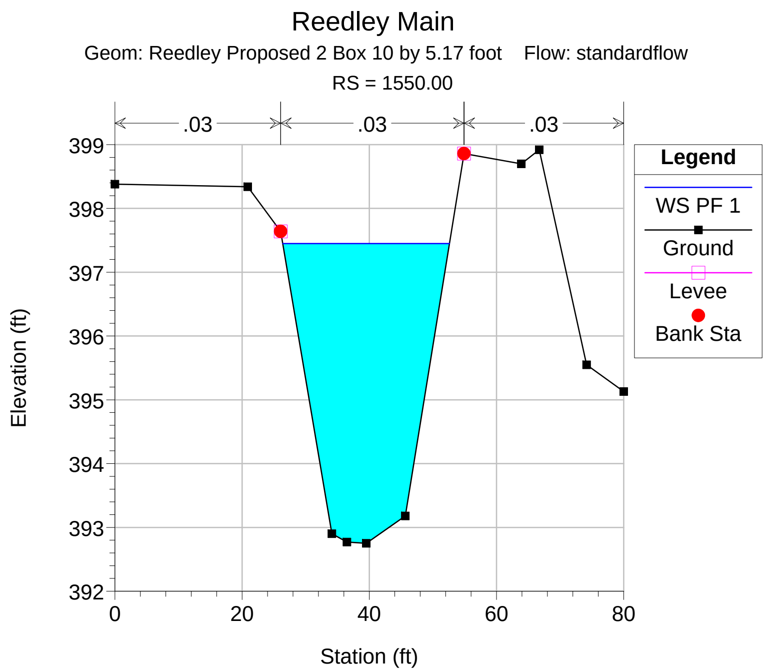


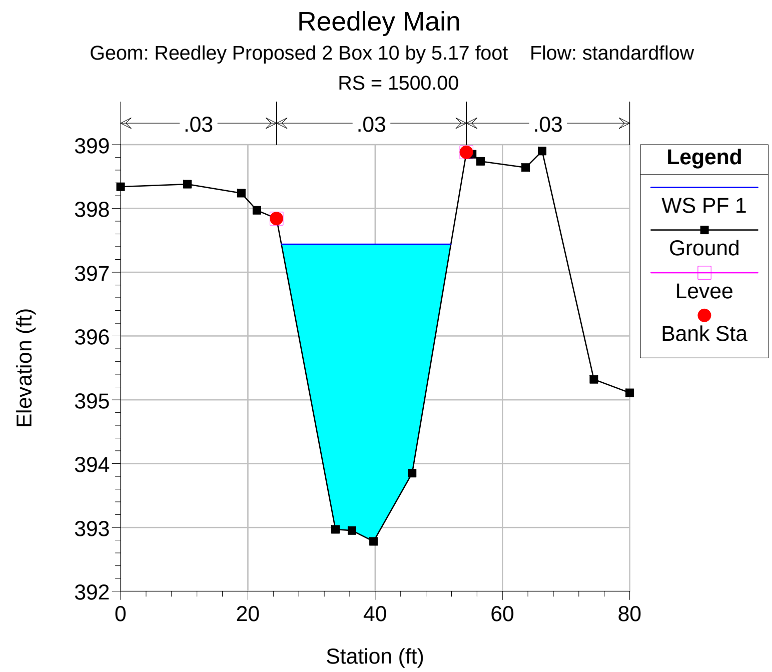
Reedley Main
Geom: Reedley Existing with Structure   Flow: standardflow
Reedley Reedley
Legend
WS PF 1
Ground
Elevation (ft)
Main Channel Distance (ft)
398
397
396
395
394
393
392
0
100
200
300
400
500
600
700
800

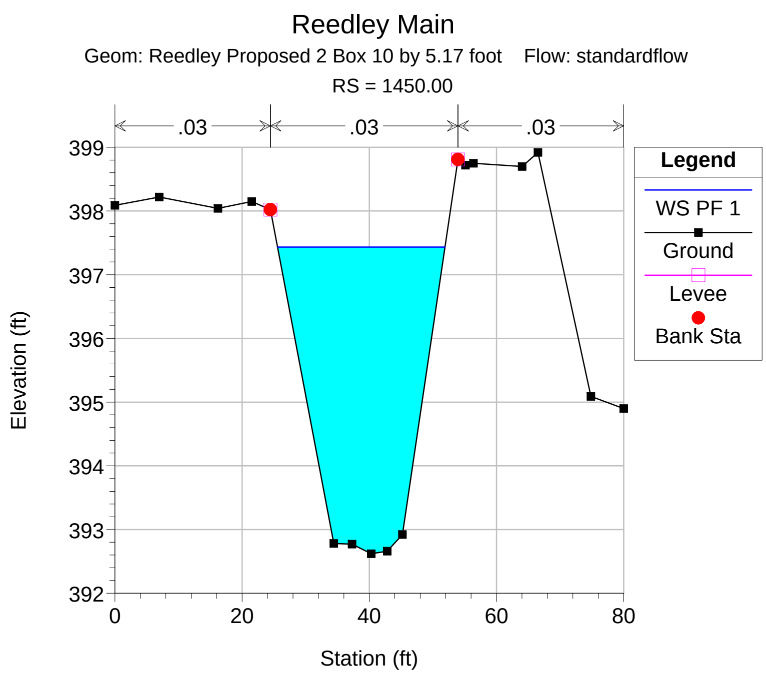
Appendix E: HEC-RAS Output for Proposed Structure

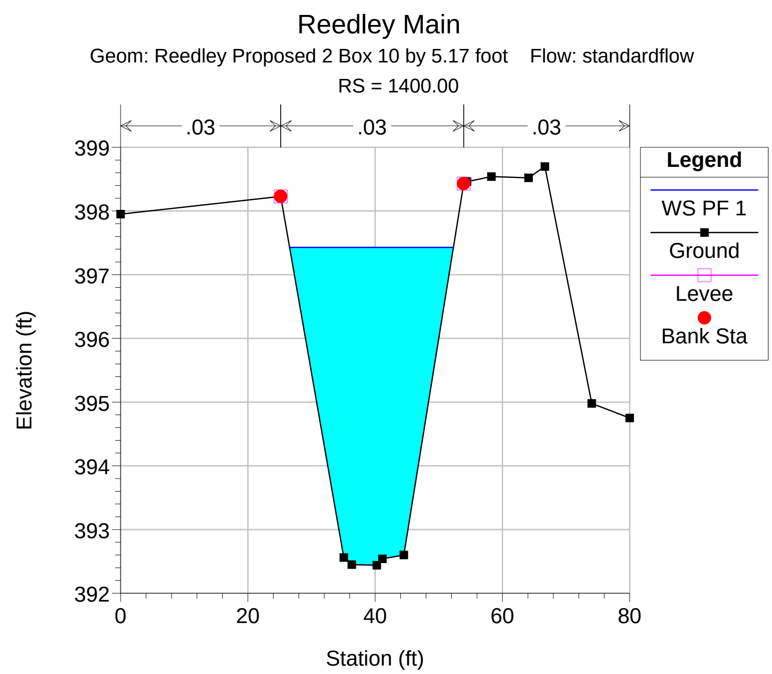

Reedley Main
Geom: Reedley Proposed 2 Box 10 by 5.17 foot Flow: standardflow
RS = 1650.00
.03
.03
.03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)

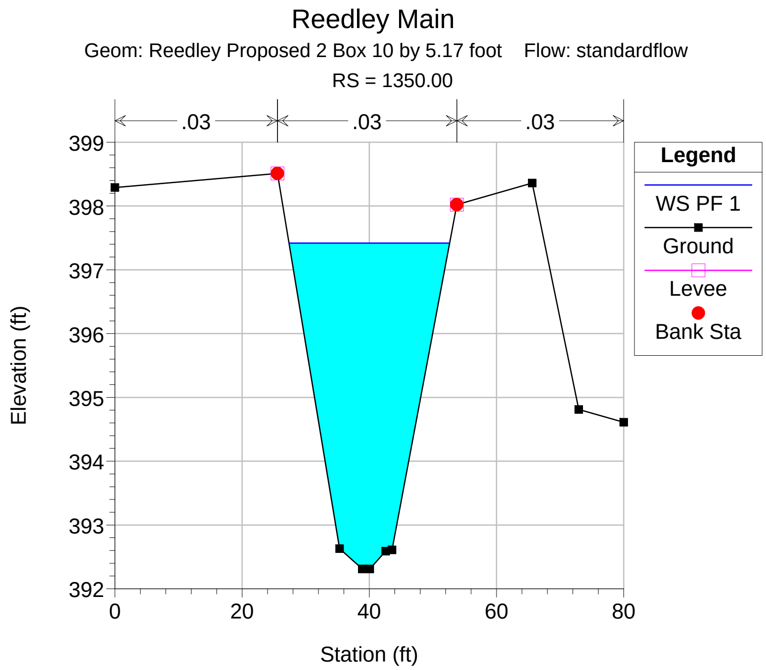

Reedley Main
Geom: Reedley Proposed 2 Box 10 by 5.17 foot Flow: standardflow
RS = 1600.00
.03
.03
.03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


Reedley Main
Geom: Reedley Proposed 2 Box 10 by 5.17 foot Flow: standardflow
RS = 1550.00
.03
.03
.03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


Reedley Main
Geom: Reedley Proposed 2 Box 10 by 5.17 foot Flow: standardflow
RS = 1500.00
.03
.03
.03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


Reedley Main
Geom: Reedley Proposed 2 Box 10 by 5.17 foot Flow: standardflow
RS = 1450.00
.03
.03
.03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


Reedley Main
Geom: Reedley Proposed 2 Box 10 by 5.17 foot Flow: standardflow
RS = 1400.00
.03
.03
.03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)


Reedley Main
Geom: Reedley Proposed 2 Box 10 by 5.17 foot Flow: standardflow
RS = 1350.00
.03
.03
.03
Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
399
398
397
396
395
394
393
392
0
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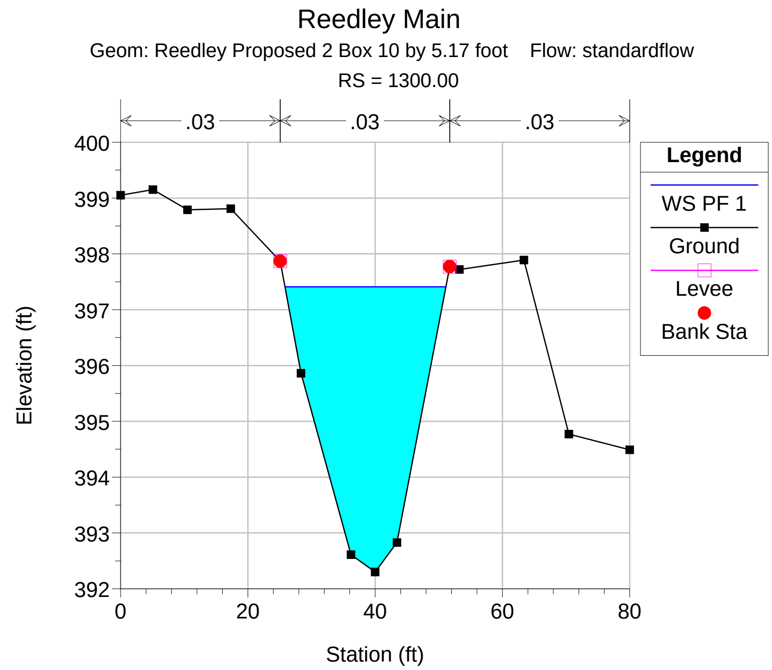
40
60
80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Elevation (ft)
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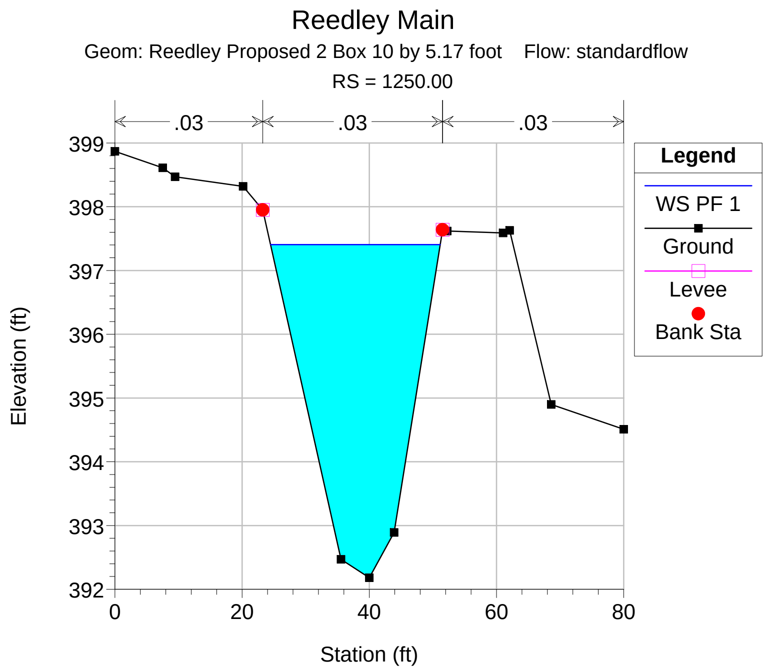
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Legend
WS PF 1
Ground
Levee
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Elevation (ft)
Station (ft)
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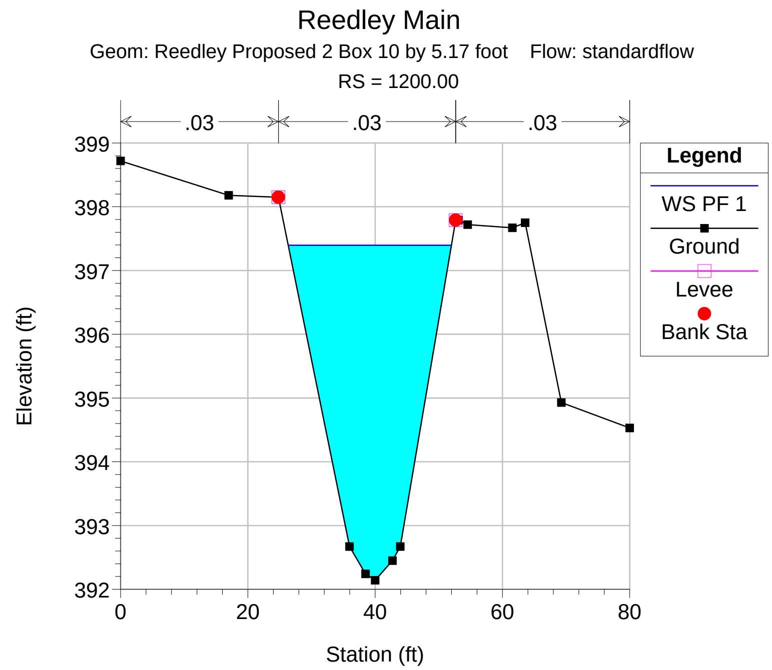
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Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
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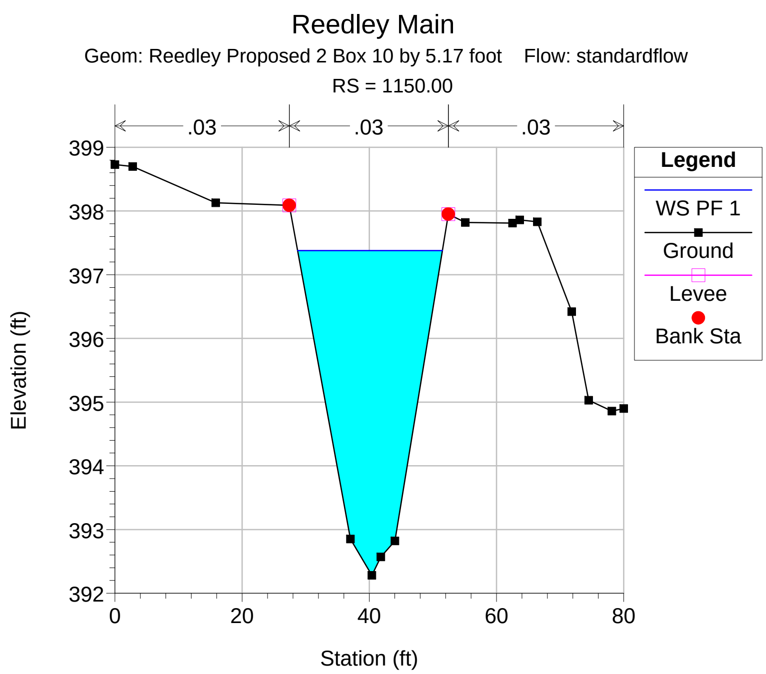
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Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
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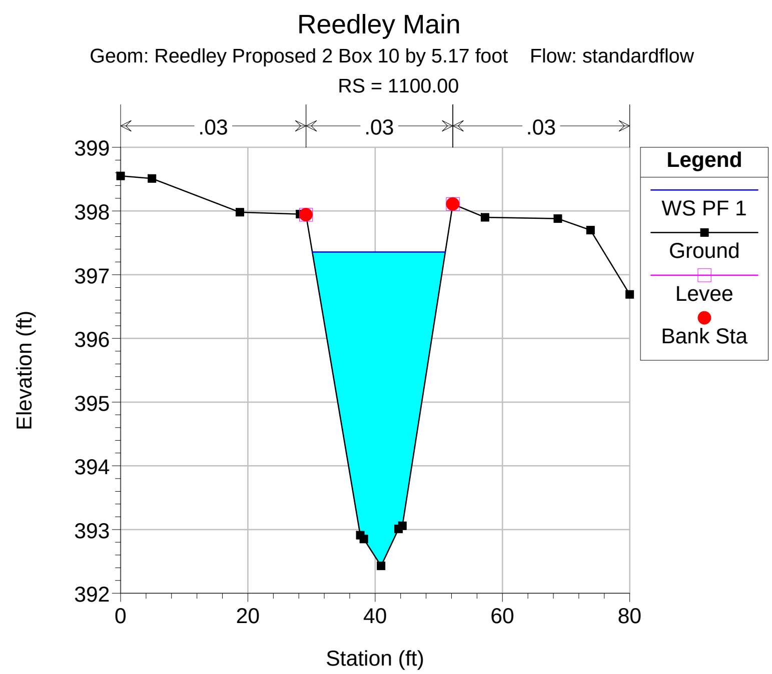
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Geom: Reedley Proposed 2 Box 10 by 5.17 foot Flow: standardflow
RS = 1100.00
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Legend
WS PF 1
Ground
Levee
Bank Sta
Elevation (ft)
Station (ft)
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393
392
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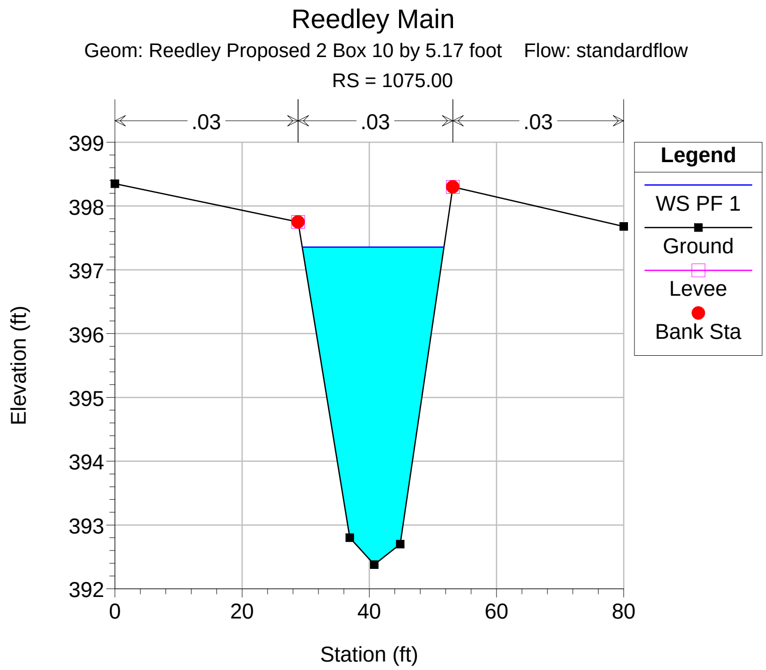
60
80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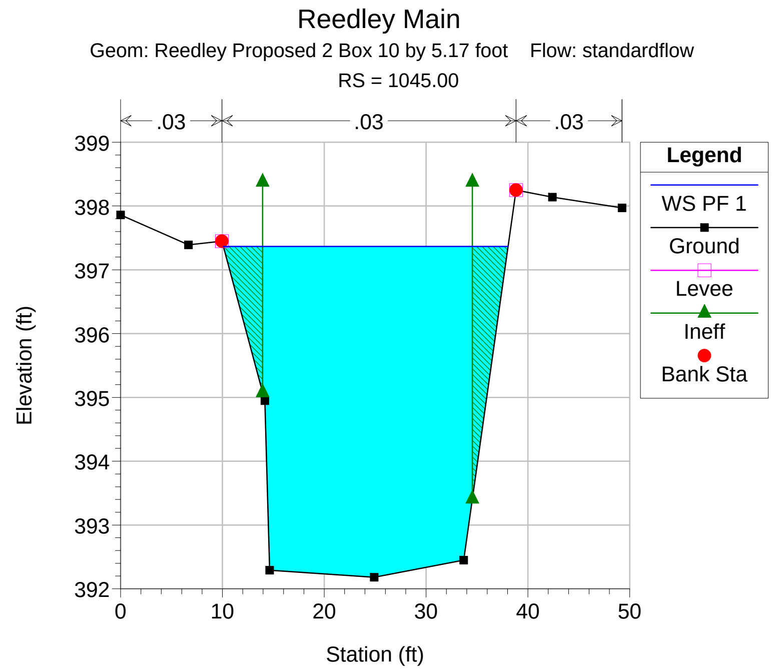
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Levee
Bank Sta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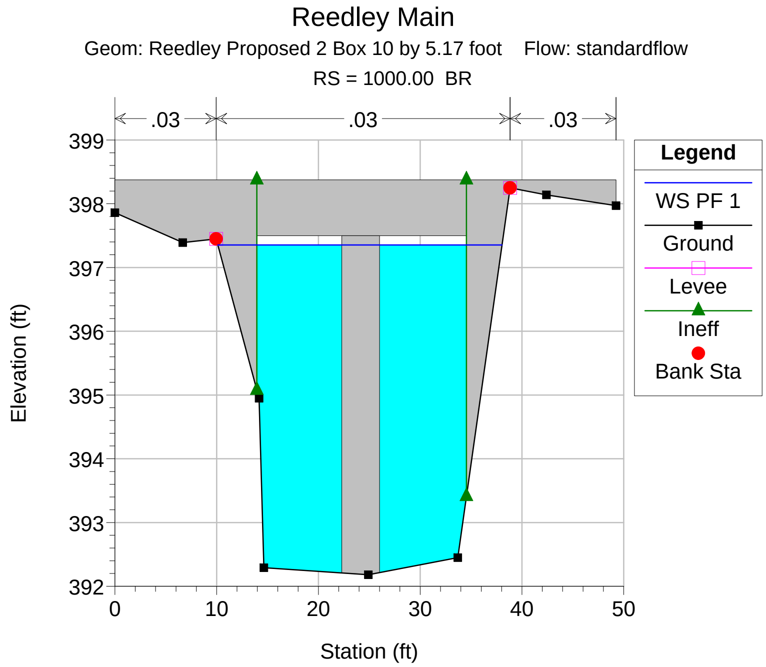
.03
.03
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Levee
Ineff
Bank Sta


Reedley Main
Geom: Reedley Proposed 2 Box 10 by 5.17 foot Flow: standardflow
RS = 1000.00 BR
.03
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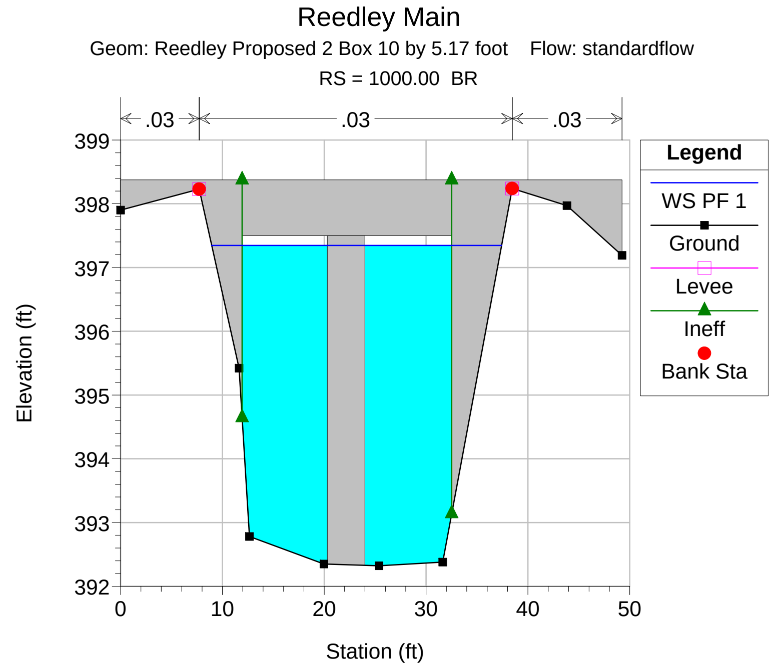
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Levee
Ineff
Bank Sta


Reedley Main
Geom: Reedley Proposed 2 Box 10 by 5.17 foot Flow: standardflow
RS = 1000.00 BR
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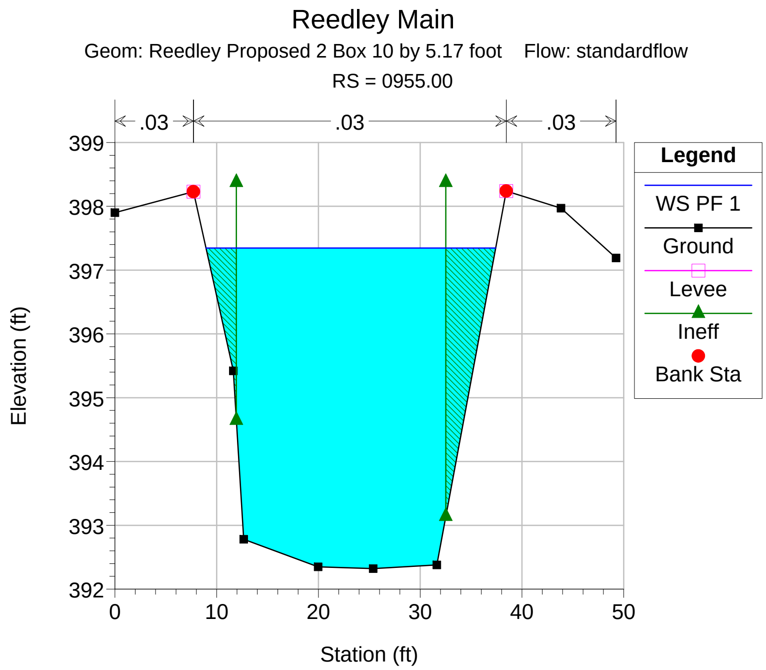
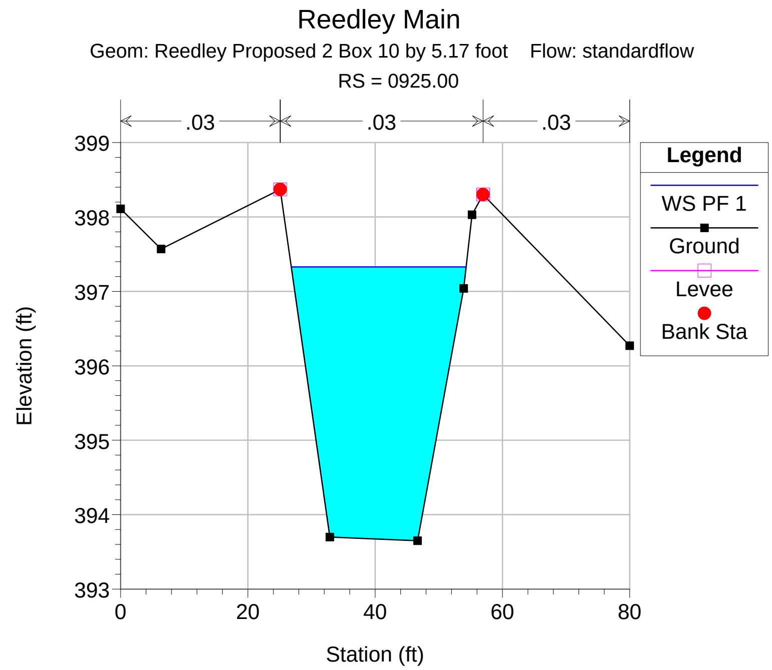
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Levee
Ineff
Bank Sta

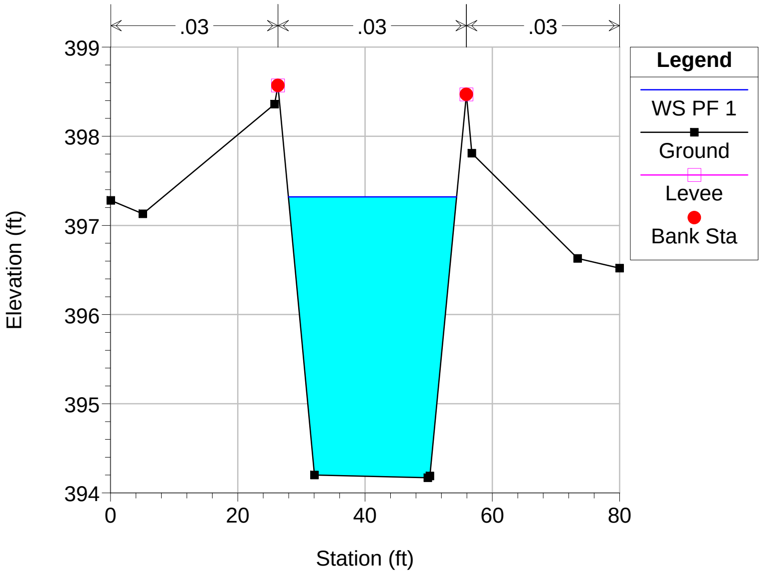

Reedley Main
Geom: Reedley Proposed 2 Box 10 by 5.17 foot Flow: standardflow
RS = 0955.00
.03
.03
.03
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Levee
Ineff
Bank Sta


Reedley Main
Geom: Reedley Proposed 2 Box 10 by 5.17 foot Flow: standardflow
RS = 0925.00
.03
.03
.03
Elevation (ft)
Station (ft)
Legend
WS PF 1
Ground
Levee
Bank Sta

Reedley Main

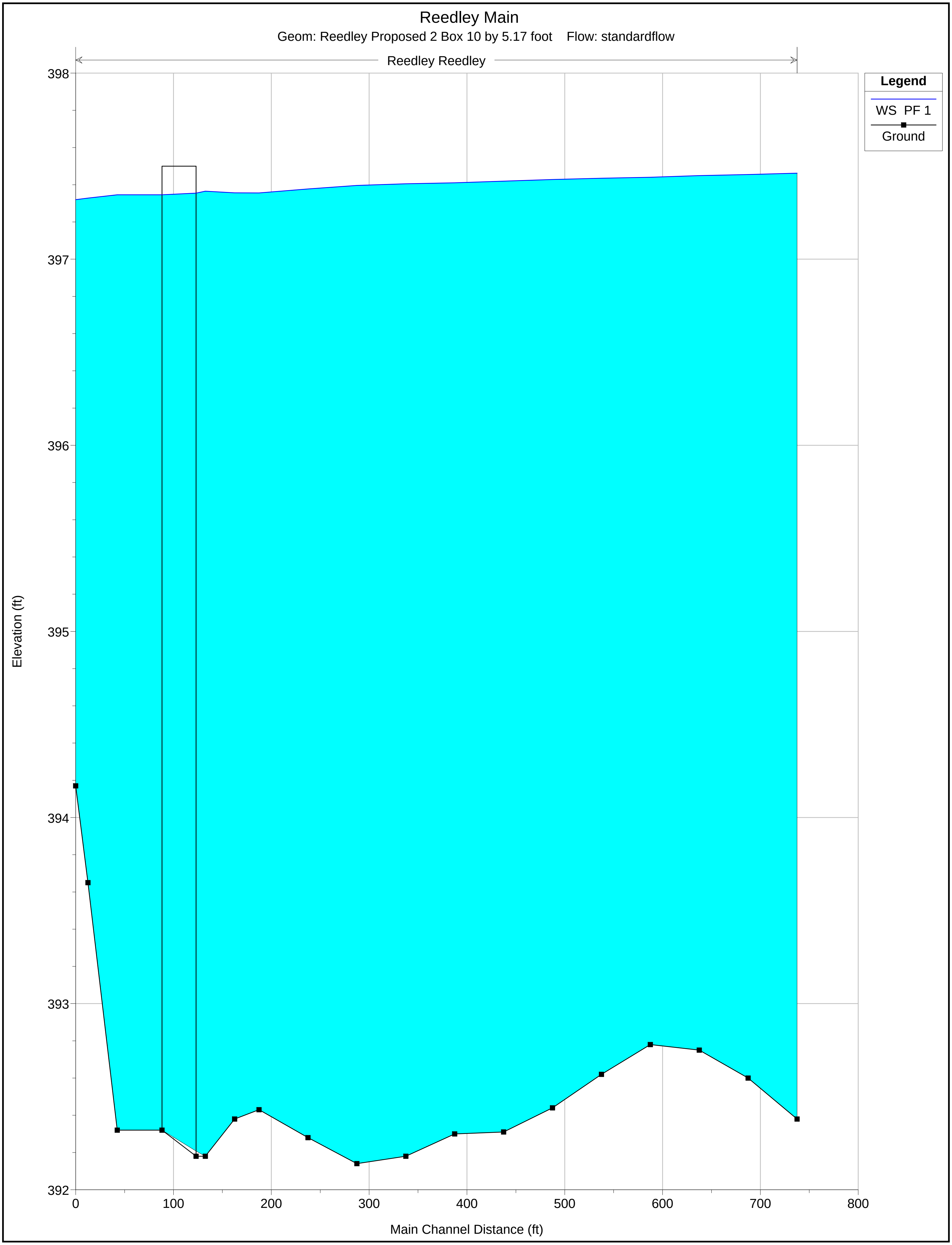
Geom: Reedley Proposed 2 Box 10 by 5.17 foot   Flow: standardflow

RS = 0912.50



HEC-RAS Plan: Plan 36 River: Reedley Reach: Reedley Profile: PF 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reedley	1650.00	PF 1	100.00	392.38	397.46	394.02	397.48	0.000134	1.19	84.18	25.58	0.12
Reedley	1600.00	PF 1	100.00	392.60	397.46	394.13	397.48	0.000137	1.20	83.59	25.79	0.12
Reedley	1550.00	PF 1	100.00	392.75	397.45	394.16	397.47	0.000132	1.17	85.15	26.22	0.11
Reedley	1500.00	PF 1	100.00	392.78	397.44	394.34	397.46	0.000150	1.22	82.09	26.63	0.12
Reedley	1450.00	PF 1	100.00	392.62	397.43	394.04	397.46	0.000126	1.15	86.58	26.33	0.11
Reedley	1400.00	PF 1	100.00	392.44	397.43	393.91	397.45	0.000126	1.16	85.99	25.73	0.11
Reedley	1350.00	PF 1	100.00	392.31	397.42	393.99	397.44	0.000145	1.22	81.74	25.24	0.12
Reedley	1300.00	PF 1	100.00	392.30	397.41	394.13	397.43	0.000156	1.25	79.88	25.29	0.12
Reedley	1250.00	PF 1	100.00	392.18	397.41	393.95	397.43	0.000134	1.17	85.28	26.68	0.12
Reedley	1200.00	PF 1	100.00	392.14	397.40	393.96	397.42	0.000146	1.22	81.81	25.63	0.12
Reedley	1150.00	PF 1	100.00	392.28	397.38	394.29	397.41	0.000220	1.44	69.41	22.78	0.15
Reedley	1100.00	PF 1	100.00	392.43	397.36	394.48	397.40	0.000292	1.62	61.91	20.91	0.17
Reedley	1075.00	PF 1	100.00	392.38	397.36	394.16	397.39	0.000201	1.41	71.02	22.28	0.14
Reedley	1045.00	PF 1	100.00	392.18	397.37	393.22	397.38	0.000053	0.97	103.09	27.96	0.08
Reedley	1000.00		Bridge									
Reedley	0955.00	PF 1	100.00	392.32	397.35	393.37	397.36	0.000055	1.00	99.97	28.47	0.08
Reedley	0925.00	PF 1	100.00	393.65	397.33	394.79	397.36	0.000200	1.32	75.80	27.48	0.14
Reedley	0912.50	PF 1	100.00	394.17	397.32	395.14	397.35	0.000253	1.43	69.82	26.43	0.16


Reedley Main
Geom: Reedley Proposed 2 Box 10 by 5.17 foot   Flow: standardflow
Reedley Reedley
Legend
WS PF 1
Ground
Elevation (ft)
398
397
396
395
394
393
392
0
100
200
300
400
500
600
700
800
Main Channel Distance (ft)

Appendix F: Scour Analysis Calculations

Contraction Scour (Live-bed & Clear-water)

Critical Velocity Equation

$$V_c = K_u y^{1/6} D^{1/3}$$

***NOTE: To view and read notes on the different cases (4 total) refer to the HEC 18 Section 6.2.2 (pages 6.2-*

Source: ***HEC 18***

V_c	critical velocity above which bed material of size D and smaller will be transported, ft/s (m/s)
y	average depth of flow upstream of the bridge, ft (m)
D	particle size for V_c, ft (m)
D_{50}	particle size in a mixture of which 50% are smaller, ft (m)
K_u	6.19 (SI Units)
	11.17 (English Units)
V	mean velocity of the flow in the main channel or overbank area upstream of the bridge opening

Critical Velocity		
V_c	1.27	*ft/s*
y	5	*ft*
D_{50}	0.000656	*ft*
K_u	11.17	
V	0.97	*ft/s*
Clear-water Contraction		

SOURCE: *Hydraulic Engineering Circular No. 18 (HEC 18) section 6.2*

Laursen's Clear-water Contraction Scour Equation

$$y_2 = \left[\frac{K_u Q^2}{{D_m}^{2/3} W^2}\right]^{3/7}$$

$$y_s = y_2 - y_0 = (average\ contraction\ scour\ depth)$$

Source: ***HEC 18***

y_2	avg. equilibrium depth in contracted section after contraction scour, ft (m)
Q	discharge through bridge or on set-back overbank area at bridge associated with the width W, ft^3/s (m^3/s)
D_m	diameter of smallest nontransportable particle in bed material ($1.25D_{50}$) in contracted section, ft (m)
D_{50}	median diameter of bed material, ft (m)
W	bottom width of contracted section less pier widths, ft (m)
y_0	average existing depth in contracted section, ft (m)
K_u	0.0077 (English Units)
	0.025 (SI Units)

Clear-water Contraction Scour		
y_s	0.00	*ft*
y_2	4.74	*ft*
Q	100	*ft^3/s*
D_m	0.00082	*ft*
D_{50}	0.000656	*ft*
W	15.27	*ft*
y_0	5	*ft*
K_u	0.0077	

SOURCE: *Hydraulic Engineering Circular No. 18 (HEC 18) section 6.4*

Local Scour (Abutment)

Froehlich's Abutment Scour Equation

$$\frac{y_s}{y_a} = 2.27 * K_1 * K_2 * \left(\frac{L'}{y_a}\right)^{.43} * Fr^{.61} + 1$$

Source: ***HEC 18***

Abutment Shape Coefficient	
Description	**K_1**
Vertical - Wall Abutment	1
Vertical wall abutment with Wing Walls	0.82
Spill through abutment	0.55

- **K_1** coefficient for abutment shape (see table 8.1)
- **K_2** coefficient for angle of embankment to flow
  $(\theta/90)^{.13}$
  θ<90° if embankment points downstream
  θ>90° if embankment points upstream
- **L'** Length of Active Flow obstructed by embankment
- **Fr** Froude Number of approach flow upstream of the abutment
- **y_a** Average depth of flow on the floodplain (feet)
- **L** Length of Embankment projected normal to the flow (feet)
- **y_s** Scour Depth (feet)

Abutment 1		Abutment 2	
Abutment Shape Type:	Vertical wall abutment with Wing Walls	**Abutment Shape Type:**	Vertical wall abutment with Wing Walls
K_1	0.82	K_1	0.82
θ	34	θ	143
K_2	0.88	K_2	1.06
L'	0	L'	0
y_a	1.15	y_a	2.61
g (ft^2/s)	32.20	g (ft^2/s)	32.20
Fr	0.08	Fr	0.08
y_s	1.15	y_s	2.61

SOURCE: *Hydraulic Engineering Circular No. 18 (HEC 18) section 8.6.1*

PIER SCOUR CALCULATIONS

HEC-18

HEC-18 pier scour equation is recommended for both live-bed and clear-water pier scour.

HEC-18 Equation:

$$\frac{y_s}{y_1} = 2.0K_1K_2K_3\left(\frac{a}{y_1}\right)^{0.65} Fr_1^{0.43}$$

OR

$$\frac{y_s}{a} = 2.0K_1K_2K_3\left(\frac{y_1}{a}\right)^{0.35} Fr_1^{0.43}$$

where:

- y_s = *scour depth, ft (m)*
- y_1 = *flow depth directly upstream of the pier, ft (m)*
- K_1 = *correction factor for pier nose shape from Figure 7.3/Table 7.1*
- K_2 = *correction factor for angle of attack of clow from Table 7.2/Equation 7.4*

EQUATION 7.4 from HEC-18:

$$K_2 = \left(\cos\Theta + \frac{L}{a}\sin\Theta\right)^{0.65}$$

- K_3 = *correction factor for bed condition from Table 7.3*
- a = *pier width, ft (m)*
- L = *length of pier, ft (m)*
- Fr_1 = *Froude Number directly upstream of the pier*

PIER SCOUR		
K_1 =	1.1	
K_2 =	1.5	
K_3 =	1.1	
a =	0.67	*ft*
L =	57	*ft*
Fr_1 =	0.08	
y_1 =	5.2	*ft*
y_s =	1.68	*ft*
y_s/y_1 =	0.32	
y_s/a =	2.51	

As a Rule of Thumb, the maximum scour depth for round nose piers aligned with the flow is:

$y_s \leq 2.4$ times the pier width (a) for **Fr** ≤ 0.8

$y_s \leq 3.0$ times the pier width (a) for **Fr** > 0.8

SOURCE: *Hydraulic Engineering Circular No. 18 (HEC-18) section 7.2*

Hydraulic and Scour Report for Travers Creek Structures at

E Lincoln Avenue & E Parlier Avenue in Fresno County

Final

June 2024

Travers Creek / E Lincoln Avenue
Caltrans Bridge No: 420683
Fresno County Bridge No: 10-065

Travers Creek / E Parlier Avenue
Caltrans Bridge No: 42C0684
Fresno County Bridge No: 10-099

Prepared for:

THE COUNTY OF FRESNO 1856

Prepared by:

MARK THOMAS

7571 North Remington Avenue Suite 102
Fresno, California 93711
www.markthomas.com

This report has been prepared under the direction of the following registered Civil Engineer. The registered Civil Engineer attests to the technical information contained herein and the engineering data upon which the recommendations, conclusions, and decisions are based.

____ 6/14/2024

Edgar Noriega, PE
Professional Civil Engineer, 61555

Date

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Fresno, CA 93711
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Table of Contents

Appendices

Acronyms

ADT	Average Daily Traffic
BFE	Base Flood Elevation
BIR	Bridge Inspection Report
BMP	Best Management Practice
CABS	California Bank and Shore Rock Slope Protection Design
Caltrans	California Department of Transportation
CIP	Cast-in-Place
CN	Curve Number
DWR	Department of Water Resources
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
HBP	Highway Bridge Program
HDM	Highway Design Manual
HEC-18	Hydraulic Engineering Circular No. 18
HEC-20	Hydraulic Engineering Circular No. 20
HEC-23	Hydraulic Engineering Circular No. 23
HEC-HMS	Hydrologic Engineering Center Hydrologic Modeling System
HEC-RAS	Hydrologic Engineering Centers River Analysis System
HSG	Hydrologic Soil Group
NAVD 88	North American Vertical Datum of 1988
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
RSP	Rock Slope Protection
SCS	Soil Conservation Service
TR-55	Technical Release 55
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USGS	United States Geological Survey
WSE	Water Surface Elevation

Executive Summary

The purpose of this study is to determine the flow and scour characteristics of Travers Creek at the E Lincoln Avenue and E Parlier Avenue crossing in Fresno County. The County of Fresno Department of Public Works and Planning received funding authorization for the replacement of these two structures through HBP funds. The existing E Lincoln Avenue structure is a 20' long simply supported single span structure. The existing E Parlier Avenue structure is a 20' long simply supported single span structure. The two existing structures are approximately 2.7 miles apart from each other.

A previous hydraulic technical memorandum conducted by West Consultants was utilized as the basis for storm flow rates utilized in the hydraulic models. Irrigation flow rates utilized in the HEC RAS models were obtained from Alta Irrigation District . The hydraulics of Travers Creek was investigated using HEC-RAS 5.0.1 software. An existing conditions model and a proposed condition model for each structure was built in HEC RAS for each structure. The existing Lincoln Ave crossing showed that both the 50 and 100 year storm cleared the existing structure with no freeboard (not overtopping). The existing Parlier model showed that the 50 year storm cleared the structure with no freeboard, but the 100 year storm overtopped the existing structure. Irrigation flow rate cleared both existing structures with over 2 feet of available freeboard. The proposed HEC RAS models were then run to verify the difference in water surface elevations. The flow patterns observed in the proposed model were similar to the existing model, and the maximum amount of water surface change was observed to be 0.53'.

Total scour for each proposed abutment was calculated as the summation of long term degradation, contraction scour and local abutment scour. Based on previous bridge inspection reports and a field visit of the site, long term degradation was determined to be negligible. Contraction and local scour were calculated based on methodologies found in FHWA HEC 18. Results from geotechnical investigations for the site performed in July, 2016 by Technicon Engineering Services, Inc., were utilized for calculations. Total anticipated scour for the proposed structures was calculated to be 5.5 feet.

RSP recommendations are generated using methodologies found in Chapter 870 of the Caltrans Highway Design Manual (HDM). Based on calculations, a light class gradation (200 lb median stone weight) and a ¼ ton gradation class, as defined by the Caltrans 2015 Standard Specifications, should be installed for the Lincoln Avenue and Parlier Avenue structures respectively. Both structures will also include Class 8 fabric, installed using placement Method B.

1 Project Understanding

1.1 Project Description

Travers Creek is an unlined creek located in the southern portion of Fresno County near the City of Reedley. The creek flows north to south, beginning at a connection at the Alta East Canal as shown in Figure 1.1 below. The major tributary that feeds the Alta East Canal is Wahtoke Lake, located south of State Route 180. Travers Creek is utilized by Alta Irrigation District (AID) for planned irrigation flow during the irrigation season in addition to receiving storm water flow during winter months. Multiple county surface streets cross Travers Creek. Structures over Travers Creek vary in construction date, structure type, and geometric configuration.

Two structures that cross Travers Creek (Lincoln Avenue Crossing and Parlier Avenue Crossing) have been identified for replacement through HBP funding. The Lincoln Avenue crossing is a single span structure with timber stringers and a concrete deck that was built in 1940 and widened in 1970. The structure is 20 feet long and 24.5 feet wide. The Parlier Avenue structure is a two span reinforced concrete slab bridge that was built in 1925 and widened in 1946. The structure is 28 feet long and 24.2 feet wide. Photographs of the existing structures are shown in Figures 1.2 and 1.3. The geometric approval drawings of the proposed structures are shown in Appendix A of this report.

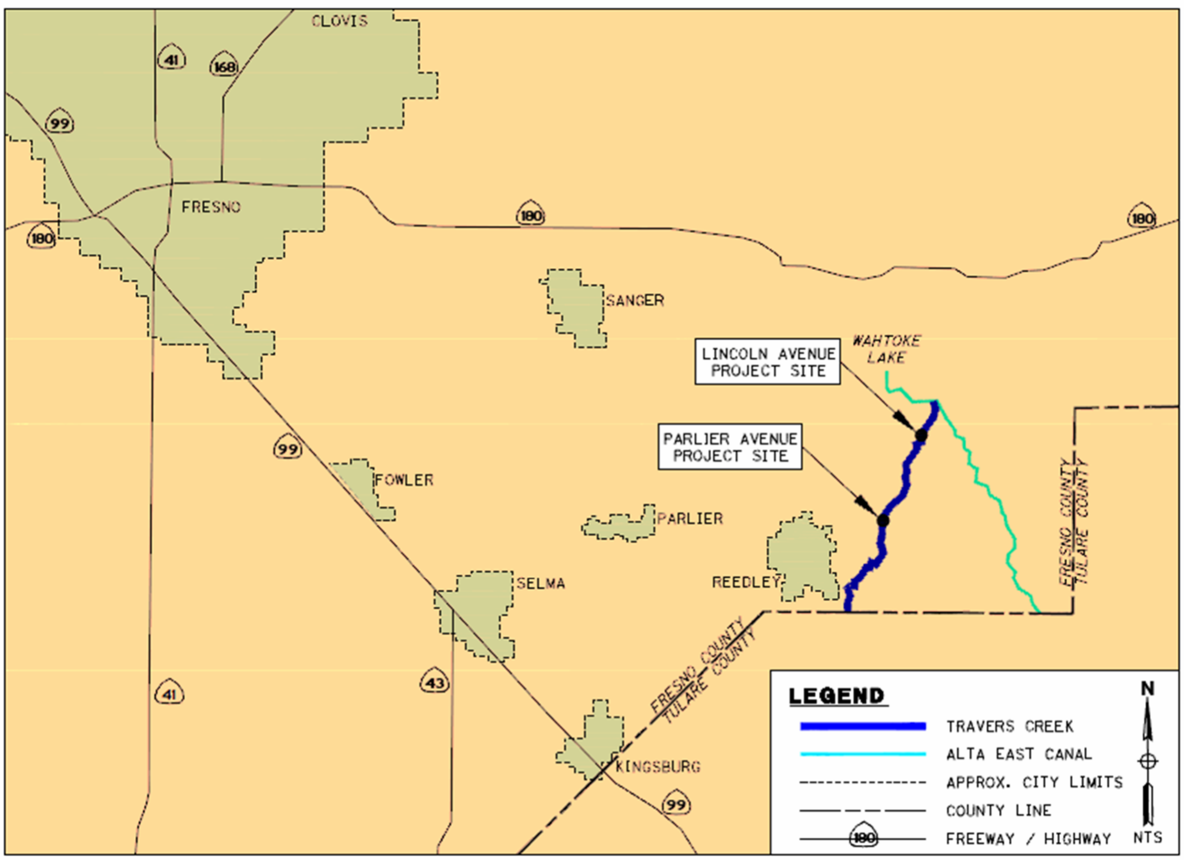


Figure 1.1: Project Locations

Figure 1.2: Existing Lincoln Avenue Structure

Figure 1.3: Existing Parlier Avenue Structure

1.2 <u>Project Need</u>

The County of Fresno received funding authorization to proceed with preliminary engineering for the replacement of the two Travers Creek structures in 2016. Replacement of the structures will be funded through federal HBP funds in addition to local funds. Both projects are eligible for HBP funds based on their structural deficiency.

1.3 <u>Key Tasks</u>

This report has been prepared as an aid in the design of the replacement structures over Travers Creek at the Lincoln Avenue Crossing and Parlier Avenue Crossing. The major key tasks associated with this report include the following items:

- Review available hydrological data for Travers Creek (including previous technical studies)
- Utilize HEC computer modeling software to verify freeboard requirements for the proposed structure
- Evaluate net degradation, contraction scour, and local abutment scour for the proposed structure
- Provide recommendations for the design of abutments and other applicable scour countermeasures

1.4 Design Criteria

AID has stated that 2.5’ of freeboard is their standard design criteria for creek crossings similar to this project. Equations and methodologies utilized in this report to preform calculations are listed in later sections of this report.

1.5 Project Data

Survey project data utilized for Hydraulic modeling was provided by the County of Fresno. The project data references the National Geodetic Vertical Datum of 1929 (NGVD29). At the time of this report there is no available stream gage data recorded for Travers Creek near the project sites. A previous study conducted by West Consultants (2014) is utilized as the basis of the hydrologic component for the HEC RAS models. Other data sources utilized for hydrologic and hydraulic analysis are described in later sections of this report.

1.6 Report Limitations

This report is only intended to be used as a design aid for the described project. All work present in this report is in accordance with generally accepted engineering practices and has been prepared under the guidance of a professional engineer. Recommendations, results and conclusions in this report are professional opinions, and are contingent upon assumptions stated in this report.

2 Hydrology

2.1 Description of Hydrology

Travers Creek is utilized for irrigation flow and storm discharge, therefore multiple flow rates will need to be considered as part of the hydraulic analysis. AID irrigation flows were determined for this study based on correspondence with AID. AID flow rate values were stated to be 200 cfs at each crossing. This flow rate value was utilized in each model as the irrigation flow rate.

The basis of storm flow rates utilized for the HEC RAS models is determined based on a previous study performed by WEST Consultants in 2014. The previous study utilized a FLO-2D model covering 134.4 square miles of tributary area in Fresno County. Several 1D creeks and irrigation canals, including the Friant Kern Canal, were added to the FLO-2D model to best determine the flow characteristics of the area. At each crossing, the largest discharge value obtained from the FLO-2D models was utilized as the design flow rate values in the HEC RAS models. These values are summarized in Table 2.1 below. The full technical memorandum from West Consultants is included in Appendix B of this report.

NOAA Atlas 14 data, Appendix C of this report, and FEMA FIRM Maps, Appendix D, were utilized to confirm storm flow rates determined by West Consultants. As Travers Creek is a small canal, historical flow data for the canal near the project sites was unavailable at the time of this report. Despite a lack of historical data, the flow rates obtained by West Consultants line up with available NOAA and FIRM data and are determined to be acceptable for this hydraulic analysis.

Table 2.1 – Discharge Values from West Consultants Inc. [2014] (cfs)

	50-year Design Storm	100-year Base Storm
Lincoln Avenue		
Alta East Canal Empty Scenario	*510 cfs*	*650 cfs*
Alta East Canal Full Scenario	*400 cfs*	*510 cfs*
Design Discharge (HEC RAS)	***510 cfs***	***650 cfs***
Parlier Avenue		
Alta East Canal Empty Scenario	*1,080 cfs*	*1,340 cfs*
Alta East Canal Full Scenario	*1,250 cfs*	*1,500 cfs*
Design Discharge (HEC RAS)	***1,250 cfs***	***1,500 cfs***

3 Hydraulic Analysis

3.1 HEC RAS Analysis

To determine the surface water elevation of Travers Creek near each project site, HEC-RAS 5.0.1 models for existing and proposed conditions were created utilizing topographic data provided by the County of Fresno. The Lincoln Avenue model was created utilizing 1000' of data downstream and 600' of data upstream data. The Parlier Avenue model was created utilizing 1000' of data downstream and 600' of data upstream data. Cross sections were created at 50' intervals for each model. Irrigation and storm flow rates were utilized in the HEC-RAS models. Reach boundary conditions utilized a downstream normal slope assumption, and each model was run as a steady state simulation. A site visit, performed in July, 2016, confirmed geometric cross sections and n-values used for the models. The n-value of 0.05 for the main channel and 0.035 for the banks was utilized for each project. The n-value, and other channel geometric factors, were verified with a site visit performed in July 2016.

Table 3.1 and Table 3.2 summarize the obtained data for the design and base storm. Full HEC-RAS outputs are provided in Appendix E through H of this report.

Table 3.1 – Proposed and Existing Structure Elevations, WSE, and Freeboard (feet)

	Lincoln Avenue Crossing-Existing			Lincoln Avenue Crossing-Proposed		
Structure Soffit Elevation*						
Upstream Soffit Elevation	380.89'			380.93'		
Downstream Soffit Elevation	380.90'			380.93'		
	Irrigation Flow	50-Year Design Storm	100-Year Base Storm	Irrigation Flow	50-Year Design Storm	100-Year Base Storm
Water Surface Elevation (WSE)						
Upstream Structure Edge	378.59'	381.32'	382.38'	378.50'	381.24'	382.22'
Downstream Structure Edge	378.41'	380.91'	381.73'	378.41'	380.95'	381.78'
Freeboard						
Upstream Structure Edge	2.30'	Hits Deck	Hits Deck	2.43'	Hits Deck	Hits Deck
Downstream Structure Edge	2.49'	Hits Deck	Hits Deck	2.52'	Hits Deck	Hits Deck

Soffit Elevation obtained from lower abutment edge

*****Water surface elevation higher than soffit elevation***

Table 3.2 – Proposed and Existing Structure Elevations, WSE, and Freeboard (feet)

		Parlier Avenue Crossing-Existing			Parlier Avenue Crossing-Proposed		
Structure Soffit Elevation*							
	Upstream Soffit Elevation	356.55’			356.75’		
	Downstream Soffit Elevation	356.62’			356.75’		
		Irrigation Flow	50-Year Design Storm	100-Year Base Storm	Irrigation Flow	50-Year Design Storm	100-Year Base Storm
Water Surface Elevation (WSE)							
	Upstream Structure Edge	352.29’	358.84’	358.95’	352.57’	359.01’	359.23’
	Downstream Structure Edge	352.00’	357.32’	358.12’	352.01’	357.38’	358.20’
Freeboard							
	Upstream Structure Edge	4.26’	Overtop	Overtop	4.18’	Overtop	Overtop
	Downstream Structure Edge	4.62’	Hits Deck	Overtop	4.74’	Hits Deck	Overtop

As shown in Table 3.1, the proposed structure on Lincoln Avenue will have slightly larger freeboard compared to the existing. This is accomplished because the proposed structure depth will be slightly thinner compared to the existing. This difference does not have an impact during larger storms, however, as both the existing and proposed models do not clear soffit during the 50 or 100 year storm. For the majority of creek, high storm flow rates are contained within the creek. Irrigation flow rates result in freeboard values that are near the desired 2.5’ of freeboard. Additional cross sections and tabular results from each HEC RAS model are provided in Appendix E and Appendix F of this report.

As shown in Table 3.2, the proposed structure on Parlier Avenue will have minimal impact on available freeboard. The existing conditions for the Parlier model show that this structure has a higher probability of flooding compared to the Lincoln Avenue structure. This is because the original ground directly to the west of the structure is lower compared to the top of canal. The proposed structure will be at similar soffit elevation compared to existing, and the difference in water surface elevation for the design and base storm are within FEMA defined variance limits. Additional cross sections and tabular results from each HEC RAS model are provided in Appendix G and Appendix H of this report.

The freeboard associated with storm flow on both of the existing and proposed structures does not meet Caltrans HDM design criteria (2-feet of freeboard for design storm per HDM 821.3). However, as both structures are located in a FEMA flood zone, raising the profile of the structure is not recommended. Raising the structure profile would create a backwater condition for floodplain flow at each structure, which would greatly change the flooding patterns of the area and would cause additional damage to adjacent properties.

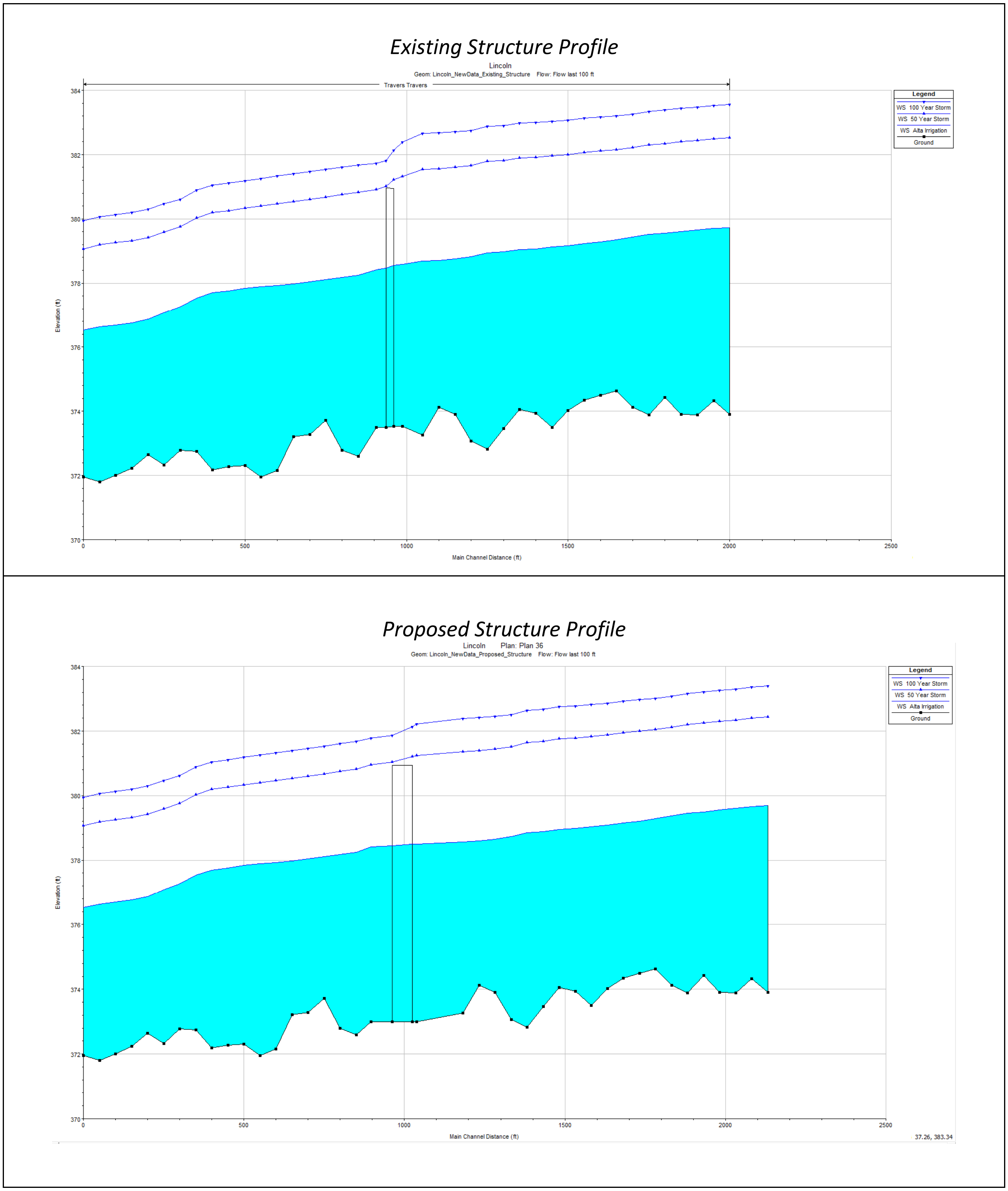
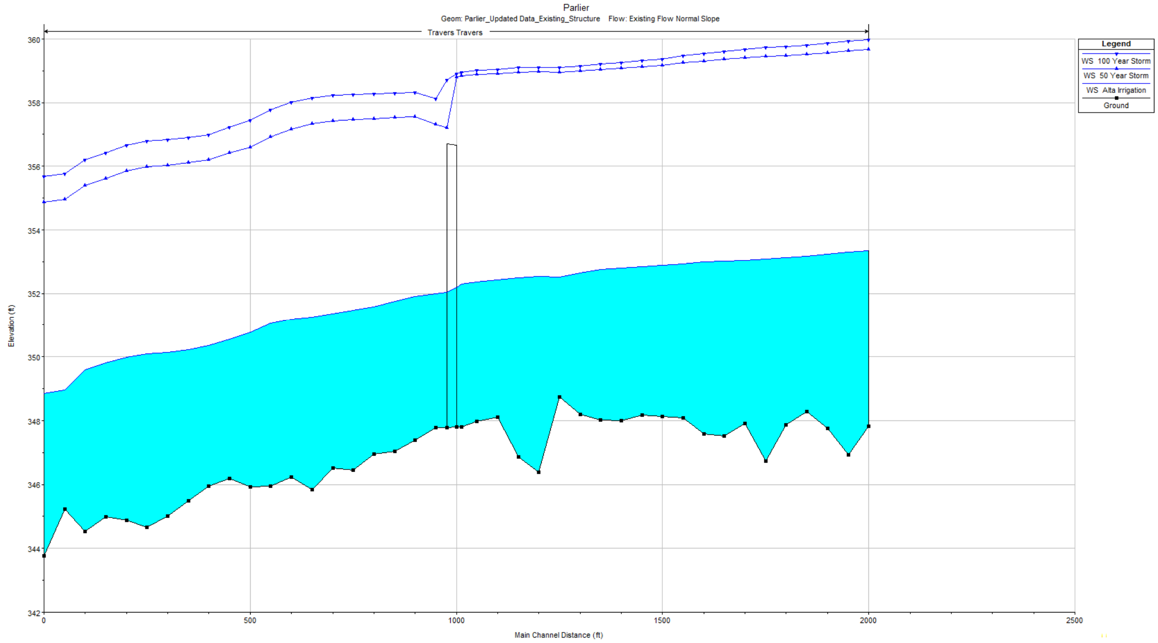


Figure 3.3: Existing and Proposed Lincoln Avenue Bridge HEC-RAS Profiles

Existing Structure Profile



Proposed Structure Profile

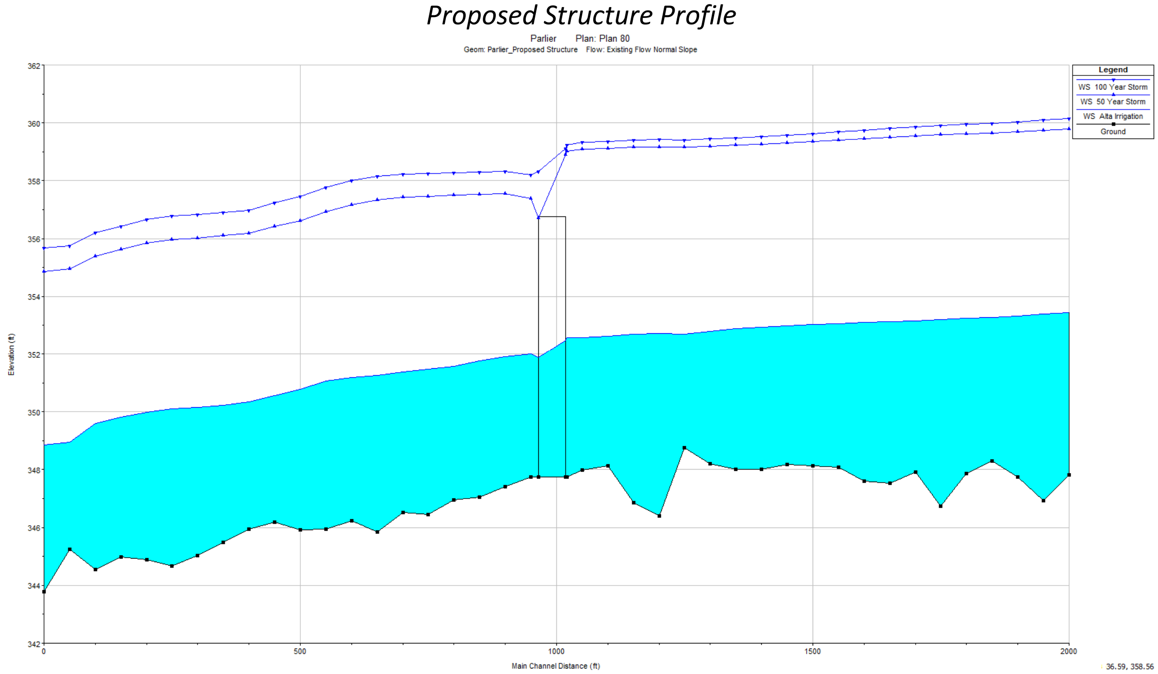


Figure 3.4: Existing and Proposed Parlier Avenue Bridge HEC-RAS Profiles

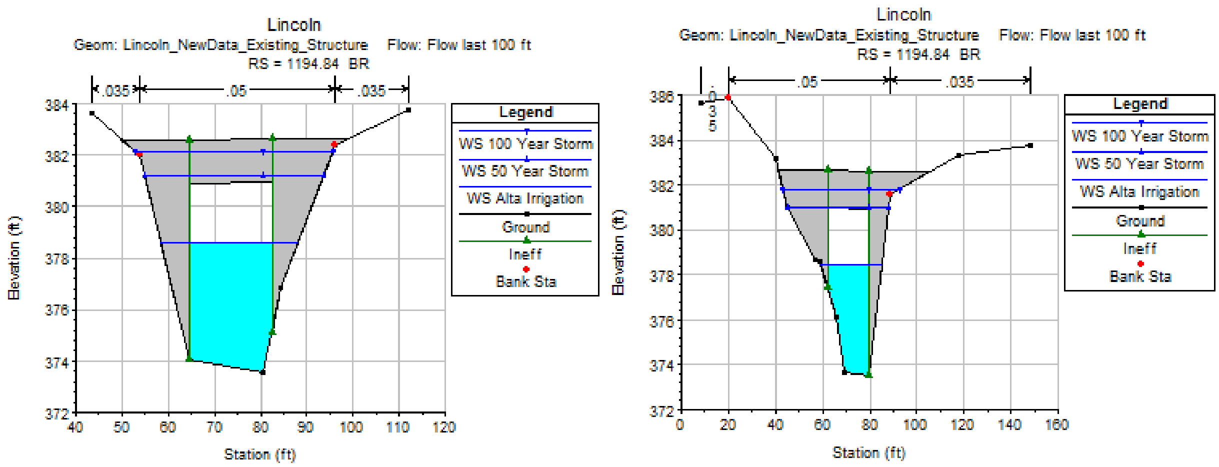


Figure 3.5: Existing Lincoln Avenue Bridge HEC-RAS Cross Sections

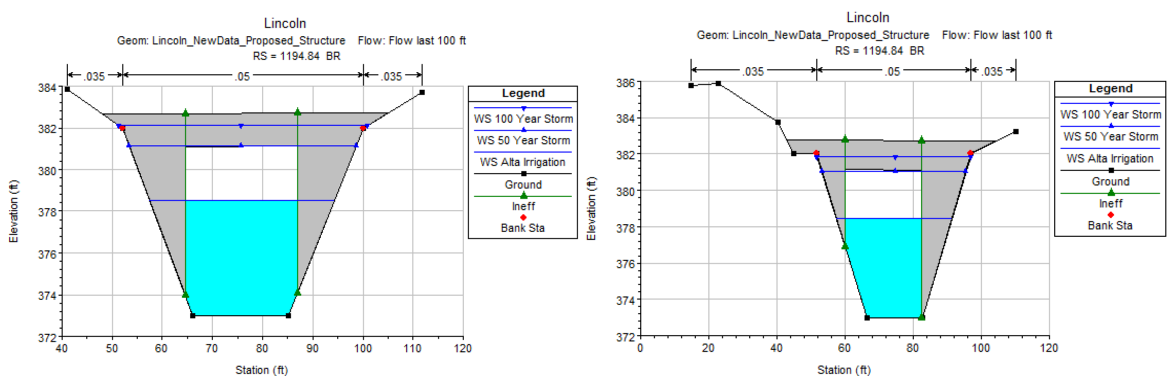


Figure 3.6: Proposed Lincoln Avenue Bridge HEC-RAS Cross Section

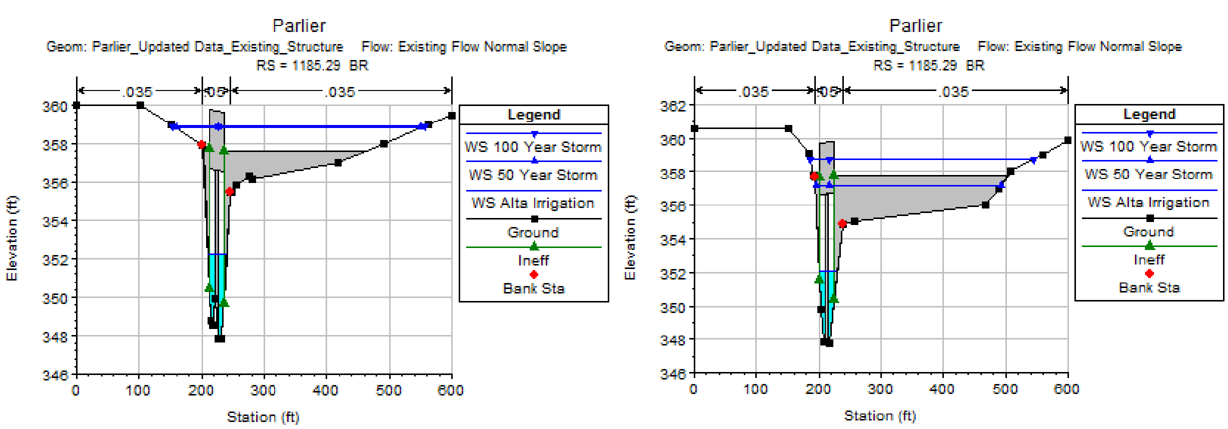


Figure 3.7: Existing Parlier Avenue Bridge HEC-RAS Cross Sections

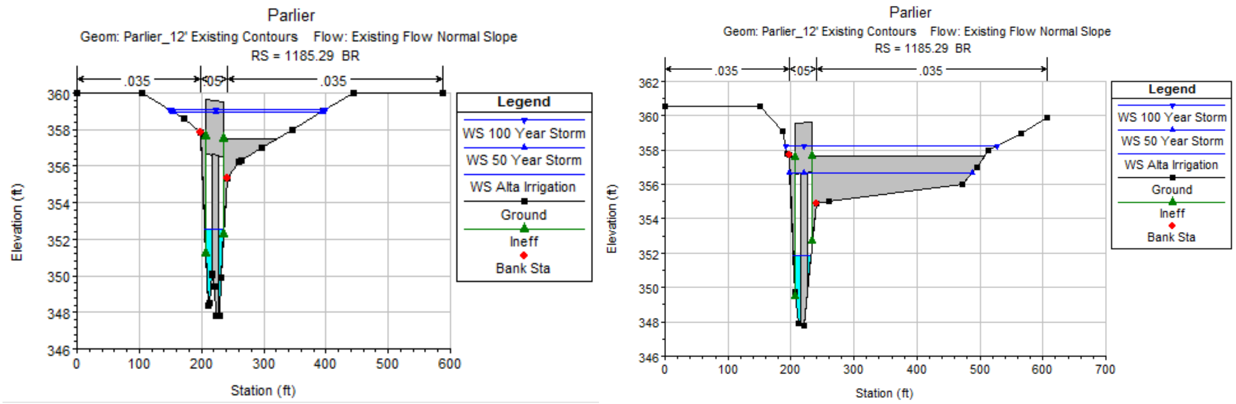


Figure 3.8: Proposed Parlier Avenue Bridge HEC-RAS Cross Sections

4 Scour Analysis

4.1 Long-Term Bed Elevation (Degradation)

Degradation of the creek is defined as long-term stream elevation change (lowering) due to natural or man-induced causes which can affect the reach of the river where the proposed structure is located. Degradation is not local to a single spot along a reach, but is observed over relatively long lengths of the channel. For purposes of scour analysis, only degradation is considered and progressive buildup of material on a channel bed (an event called aggradation) is not considered.

Multiple Caltrans Bridge Inspection Reports were utilized to calculate anticipated degradation for both sites. BIR ranged in dates from 1979 to 2014. The existing structures were mostly subject to routine biennial inspections, however each structure was also subjected to a bridge scour evaluation in 2010. Tables 4.1 and 4.2 summarize the scour findings of each BIR for the existing structures.

Table 4.1 – Existing Lincoln Structure Bridge Inspection Report Summary

Inspection Type	Inspection Date	Scour Information
Routine	11/19/2014	No information on Scour
Routine	11/30/2013	Abutment 1:Top 6 to 8 inches of footing is exposed on north side for length of 10’ Abutment 2: Moderate erosion and undercutting of wing wall on the south side. 12 in by 24 inch rock pocket on face, near base on north side
*Routine	11/18/2012	Abutment 1:Top 6 to 8 inches of footing is exposed on north side for length of 10’ Abutment 2: Moderate erosion and undercutting of wing wall on the south side. 12 in by 24 inch rock pocket on face, near base on north side
Routine	11/19/2011	Abutment 1: Top 6 to 8 inches of footing is exposed on north side for length of 10’ Abutment 2: Moderate erosion and undercutting of the wing wall on the south side
Routine	12/09/2010	Abutment 1: Top 6 to 8 inches of footing is exposed on north side for a length of 3 meters. Abutment 2: Moderate erosion and undercutting of the wing wall on the south side
Bridge Scour Evaluation Plan of Action	07/07/2010	Scour critical because it has footings that are exposed. Abutment 1: Top 6 to 8 inches of footing is exposed on north side for a length of 10 feet. Scour first reported in 2002
Routine	12/03/2009	Abutment 1: Top 6 to 8 inches of footing is exposed on north side for a length of 10 feet.
*Routine	11/12/2008	Abutment 1: Top 6 to 8 inches of footing is exposed on north side for length of 10’
Routine	01/24/2007	Abutment 1: Top 6 to 8 inches of footing is exposed on north side for length of 10’
Routine	03/24/2004	Abutment 1: Top 6 to 8 inches of footing is exposed on north side for length of 10’
Routine	03/20/2002	Abutment 1: Top 80 mm of footing is exposed on the left side for length of 3m.
*Routine	01/15/1998	No scour reported.
Biennial	11/29/1995	No scour found.
*Biennial	01/13/1994	No scour found.
Biennial	02/11/1992	No evidence of scour was found
Biennial	01/09/1990	Abutment 1: Footing is exposed
Routine	10/28/1987	No scour information.
Routine	11/19/1985	No scour information.
Routine	11/01/1983	Abutment 1: Footing is exposed
Routine	09/24/1981	No scour information.
Routine	11/15/1979	No scour information.

****Inspection with Creek Cross-sections Taken***

Table 4.2 – Existing Parlier Structure Bridge Inspection Report Summary

Inspection Type	Inspection Date	Scour Information
Routine	11/19/2014	No scour information.
*Routine	11/15/2012	Abutment 1: Top 2 inches of the south half of the footing is exposed.
Routine	12/09/2010	Abutment 1: Top 2 inches of the south half of the footing is exposed.
Bridge Scour Evaluation Plan of Action	07/07/2010	Scour critical because it has footings exposed. Abutment 1: Top 2 inches of the south half of the footing is exposed. Scour first reported in 2002.
Routine	11/18/2008	Abutment 1: Top 2 inches of the south half of the footing is exposed.
Routine	01/24/2007	Abutment 1: Top 2 inches of the south half of the footing is exposed.
*Routine	03/24/2004	Abutment 1: Top 2 inches of the south half of the footing is exposed along its full length.
Routine	03/20/2002	Abutment 1: Top 2 inches of the south half of the footing is exposed along its full length.
Biennial	07/09/1996	No scour found.
*Biennial	07/19/1994	No scour found.
*Biennial	03/19/1992	No scour observed.
Biennial	01/10/1990	The side of the footing at Abutment 1 is exposed.
Routine	10/29/1987	No scour information.
Routine	11/01/1983	The footings at Abutment 1 and Pier 2 are exposed.
Routine	11/14/1979	No scour information.

***Inspection with Creek Cross-sections Taken**

Creek cross sections of the upstream side of the structure were taken at various inspection times. This cross sectional data for each structure was plotted and is shown in Figures 4.1 and 4.2 below.

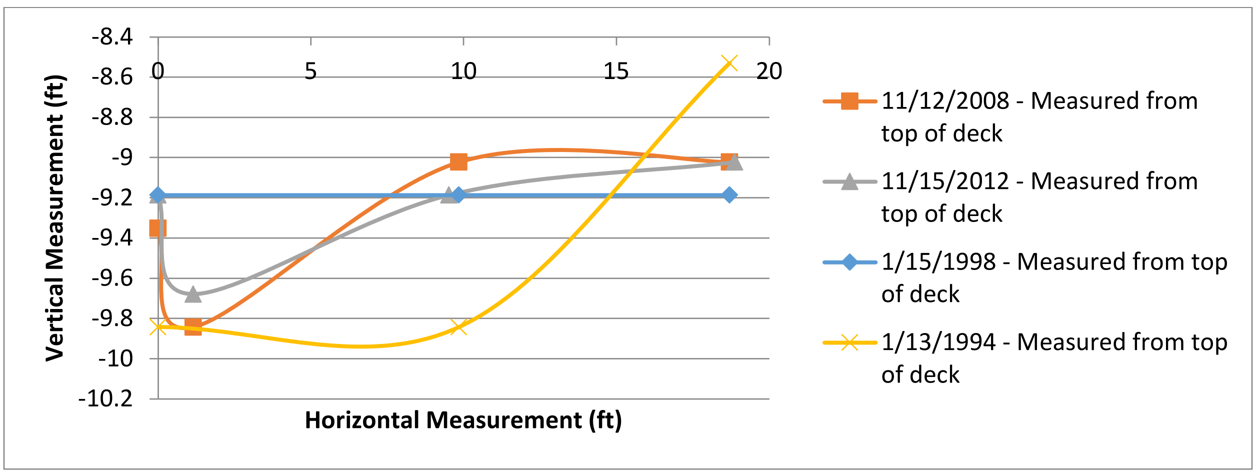


Figure 4.1: Cross Sectional Data from Caltrans Bridge Inspection Reports at the Upstream Face of Existing Structure for Lincoln

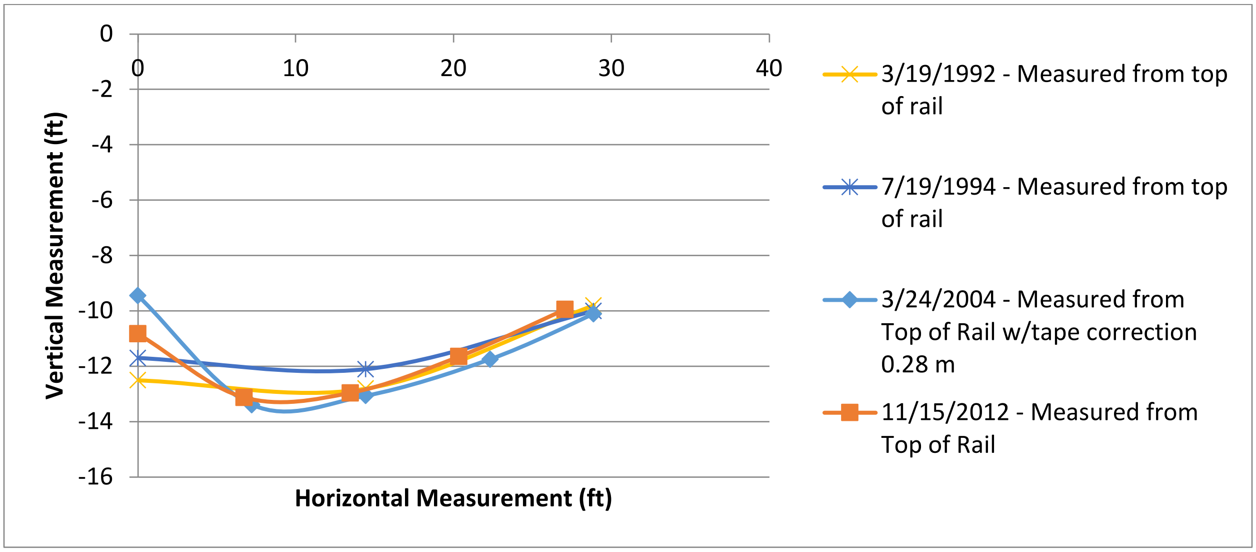


Figure 4.2: Cross Sectional Data from Caltrans Bridge Inspection Reports at the Upstream Face of Existing Structure for Parlier

The Lincoln Avenue structure had four separate inspections with cross section. All data points at the abutments and at the pier are within half of a foot from one another with the exception of data collected in 1994. It is suspected that the 1994 data was taken on the opposite rail compared to the other three years of data. The other three years of data are tightly clustered and there is no evidence of channel degradation. Therefore channel degradation is determined to be negligible for this proposed structure.

The Parlier Avenue structure had four separate inspections with cross section data. Cross sectional data at the second abutment is clustered within a foot difference with no elevation changes over 20 years of data. The pier data points are relatively clustered together and do not suggest any trends towards degradation of the creek. Therefore channel degradation is determined to be negligible for this proposed structure.

4.2 Contraction Scour

Contraction scour of the creek is defined as scour resulting from the constriction of flow through the bottom opening or overbank opening of a channel. This contraction of flow increases water velocity and shear stress on the channel bed which results in additional removal of bed material near the physical contraction. Contraction scour is different from long-term degradation in that contraction scour occurs in the vicinity of the structure and that it may be cyclic in nature.

Methodologies present in FHWA HEC-18 were utilized to calculate contraction scour for the proposed structures. These methodologies utilize equations based on the principles of conservation of sediment transport and continuity. Flow attributes for the base storm as determined in HEC RAS were utilized in these equations. Geotechnical data collected by Technicon Engineering Services, Inc., in 2016 was utilized as the basis for D_{50} values utilized in calculations. The grain size for each project is low, therefore it was determined that each structure would exhibit live bed contraction scour.

Contraction scour was determined to be larger at Lincoln Avenue, although both structures will exhibit some contraction scour. Full calculations for contraction scour can be found as part of Appendix I of this report.

4.3 Local Scour

Local scour is scour caused by an acceleration of flow and resulting flow turbidity induced by bridge structural elements (such as abutments, piers, spurs or embankments) interacting with channel flow. Local scour is different than contraction scour as local scour occurs in the immediate vicinity of individual structural elements and not the entire channel bed. Local scour is often cyclic in nature and difficult to observe or measure in the field.

Methodologies presented in FHWA HEC-18 were utilized to calculate local scour anticipated for each proposed structure. Abutment scour was calculated for both structures, and pier scour was calculated for the Parlier Avenue structure. The largest local scour value for each structure was determined based on the largest value from these calculations. Local scour is anticipated to be larger for the Parlier Avenue structure due to higher storm flow values and larger flow depths.

Full calculations for local scour can be found as part of Appendix I of this report.

4.4 Total Scour

Total scour for each abutment is calculated as the summation of long-term bed elevation (degradation), contraction scour, and local scour. The calculated total scour depths for each structure are shown in Figures 4.3 and 4.4 below.

Table 4.3 – Proposed Lincoln Avenue Bridge Scour Depths*

	Degradation (ft)	Contraction Scour (ft)	Local Scour (ft)	Total Calculated Scour Depth (ft)
Anticipated Scour Depth	0.0	1.4	4.1	5.5

Scour values rounded to the nearest 0.1 ft.

Table 4.4 – Proposed Parlier Avenue Bridge Scour Depths*

	Degradation (ft)	Contraction Scour (ft)	Local Scour (ft)	Total Calculated Scour Depth (ft)
Anticipated Scour Depth	0.0	0.4	4.5	4.9

Scour values rounded to the nearest 0.1 ft.

5 Design Recommendations

5.1 Rock Slope Protection (RSP)

Rock Slope Protection (RSP, also known as riprap) thickness and gradation was designed utilizing methodologies found in the July 2016 update of the Caltrans Highway Design Manual (HDM) Chapter 870. The methodology in the HDM is based on guidelines provided in FHWA HEC 23, Bridge Scour and Stream Instability Countermeasures. The velocities produced from the proposed HEC-RAS models were used to calculate the stone size for the riprap design of each structure. A recommended median size and nominal RSP class were selected from Table 873.3A in the HDM based on calculations. The values were then correlated to a gradation class defined in the Caltrans 2015 Standard Specifications.

For the Lincoln Avenue structure, a light class gradation (200 lb median stone weight) was calculated to be placed at a minimum thickness of 24” with a class 8 fabric. For the Parlier Avenue structure, a ¼ ton gradation class was calculated to be placed at a minimum thickness of 30” with a class 8 fabric. RSP is recommended to be placed 20’ away from the upstream and downstream edges of each structure. Minimum embedment depth values are recommended for the banks of the channel, but the RSP should extend to the full depth of the total scour value at the bottom of each channel.

Full calculations for RSP design are provided in Appendix J of this report.

References

California Department of Transportation. (2000, October). *California Bank and Shore Rock Slope Protection Design (Third Edition).* Retrieved from http://www.dot.ca.gov/hq/oppd/hydrology/ca_riprap.pdf

California Department of Transportation. (May 2012). *Highway Design Manual* (Sixth Edition ed.).

California Department of Transportation. (October 2014). *Bridge Inspection Report, Bridge Number 42C0317.*

Federal Emergency Management Agency (FEMA). (February 2009). Flood Insurance Rate Map Fresno County, California and Incorporated Areas, Panel 1100 of 3525.

Federal Highway Administration. (April 2012). *Hyraulic Engineering Circular No. 18, Evaluating Scour at Bridges* (Fifth Edition ed.).

Federal Highway Administration. (April 2012). *Hyrdualic Engineering Circular No. 20, Stream Stability at Highway Structures* (Fourth Edition ed.).

Federal Highway Administration. (September 2009). *Hydraulic Engineering Circular No. 23, Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance* (Third Edition ed.).

Federal Highway Administration. (September 2009, revised August 2013). *Hyraulic Engineering Circular No. 22, Urban Drainage Design Manual* (Third Edition ed.).

National Oceanic and Atmospheric Administration (NOAA). (n.d.). *NOAA Atlas 14 Point Percipitation Frequency Estimates: CA0=*. Retrieved December 2015, from http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=ca

State of California Department of Transportation (Caltrans). (2010). Standard Plans. CA.

United States Army Corps of Engineers- Hydrologic Engineering Center. (2015, December). *Hydrologic Modeling System, HEC-HMS, 4.1.0 (Computer Software)*. Retrieved from http://www.hec.usace.army.mil/software/hec-hms/

United States Army Corps of Engineers- Hydrologic Engineering Center. (2015, December). *River Analysis System, HEC-RAS Version 4.1.0 (Computer Software)*. Retrieved from http://www.hec.usace.army.mil/software/hec-ras/

United States Department of Agriculture. (June 1986). *Urban Hydrology for Small Watersheds, TR-55.*

United States Department of Agriculture. (n.d.). *Web Soil Survey, National Resources Conversation Services*. Retrieved from http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm

United States Geological Survey (USGS). (n.d.). *Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains.* Retrieved from http://www.fhwa.dot.gov/BRIDGE/wsp2339.pdf

United States Geological Survey. (n.d.). *StreamStats National State Application, California*. Retrieved December 2015, from http://water.usgs.gov/osw/streamstats/california.html

Appendix A: Plan and Profile of Proposed Structures

LEGEND:

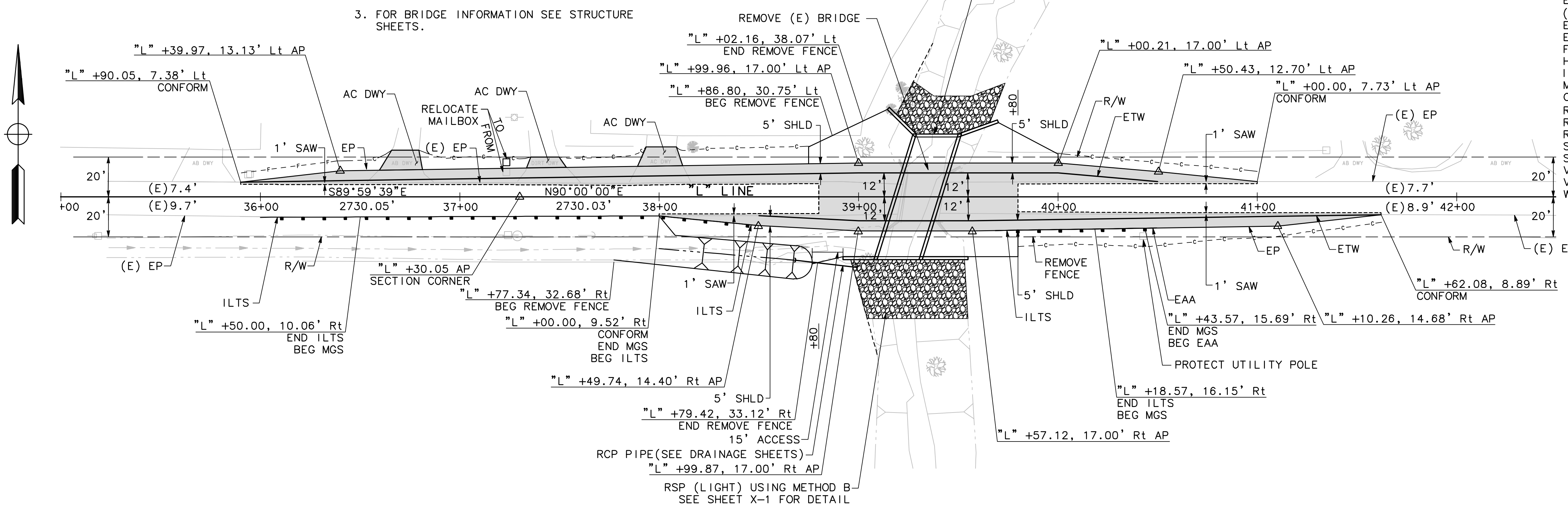
- NEW PAVEMENT
- ROCK SLOPE PROTECTION

GENERAL NOTES

1. FOR CONTROL LINE & MONUMENT INFORMATION, SEE PC-1.
2. FOR SIGN AND STRIPING INFORMATION SEE, SS-1.
3. FOR BRIDGE INFORMATION SEE STRUCTURE SHEETS.

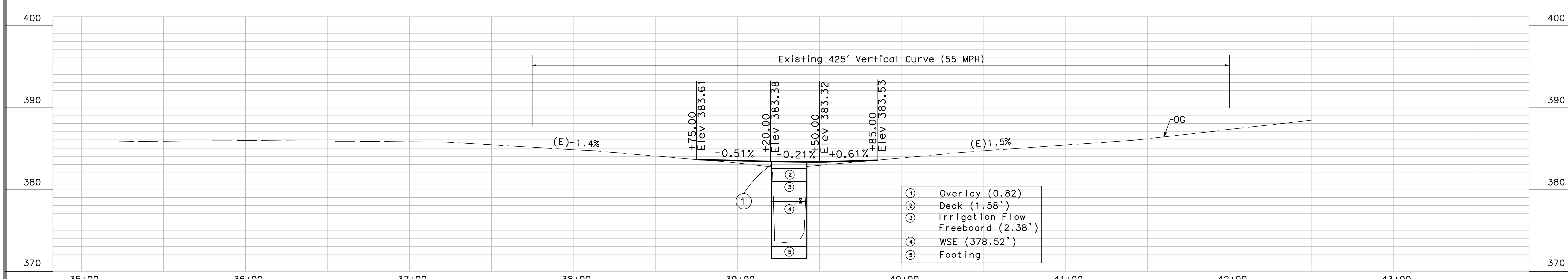
ABBREVIATIONS

AB	AGGREGATE BASE
AC	ASPHALT CONCRETE
AP	ANGLE POINT
BEG	BEGIN
C	CUT SLOPE
DWY	DRIVEWAY
EAA	END ANCHOR ASSEMBLY
(E)	EXISTING
EP	EDGE OF PAVEMENT
ETW	EDGE OF TRAVEL WAY
F	FILL SLOPE
HP	HINGE POINT
ILTS	IN-LINE TERMINAL SYSTEM
MGS	MIDWEST GUARDRAIL SYSTEM
OG	ORIGINAL GROUND
R/W	RIGHT OF WAY
RCP	REINFORCED CONCRETE PIPE
RSP	ROCK SLOPE PROTECTION
SAW	SAWCUT
SHLD	SHOULDER
VAR	VARIES
VPD	VEHICLES PER DAY
WSE	WATER SURFACE ELEVATION



LINCOLN AVENUE

SCALE: 1" = 30'



"L" LINE PROFILE

SCALE : H: 1"=30'
V: 1"=5'

60% SUBMITTAL

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DRAWN: MPB	08/10/2016			SCALE: 1" = 30'
CHECKED: KPS	03/10/2017			

FOR RIGHT OF WAY DATA AND ACCURATE ACCESS DETERMINATION, SEE DOCUMENTS IN THE DEPARTMENT OF PUBLIC WORKS AND PLANNING.

SUPERVISING ENGINEER DATE

PROJECT
TRAVERS CREEK AT LINCOLN AVE
COUNTY OF FRESNO, CA
ROAD NO. #### BRIDGE NO. 42C0413

THE COUNTY OF FRESNO 1856

DEPARTMENT OF PUBLIC WORKS AND PLANNING

PLAN AND PROFILE

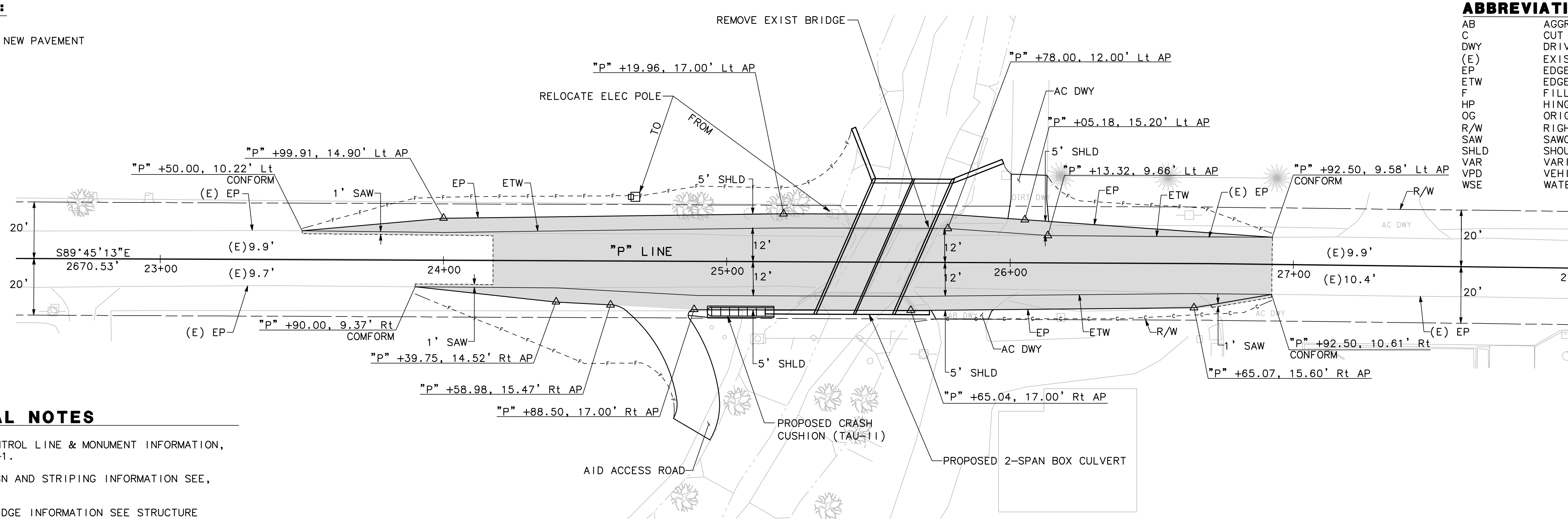
DRAWING NO. PP-1 SHEET NO. 4 TOTAL 17

LEGEND:

NEW PAVEMENT

ABBREVIATIONS

AB	AGGREGATE BASE
C	CUT
DWY	DRIVEWAY
(E)	EXISTING
EP	EDGE OF PAVEMENT
ETW	EDGE OF TRAVEL WAY
F	FILL
HP	HINGE POINT
OG	ORIGINAL GROUND
R/W	RIGHT OF WAY
SAW	SAWCUT
SHLD	SHOULDER
VAR	VARIES
VPD	VEHICLES PER DAY
WSE	WATER SURFACE ELEVATION

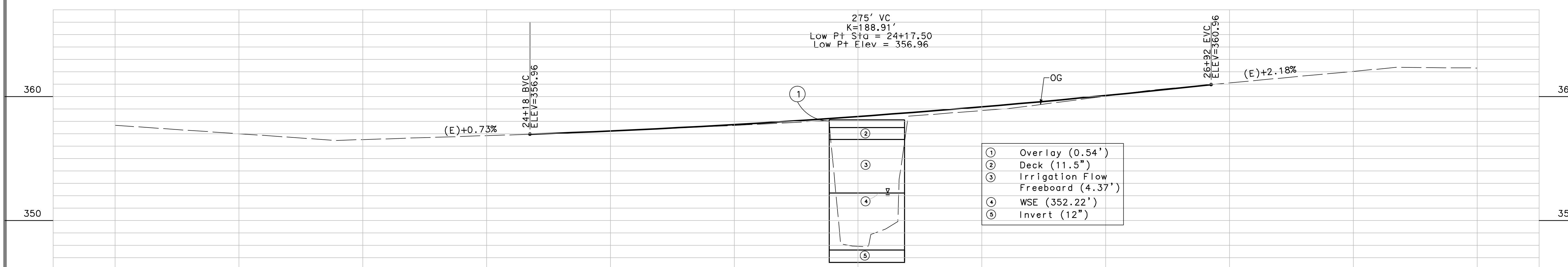


PARLIER AVENUE

SCALE: 1" = 20'

GENERAL NOTES

1. FOR CONTROL LINE & MONUMENT INFORMATION, SEE PC-1.
2. FOR SIGN AND STRIPING INFORMATION SEE, SS-1.
3. FOR BRIDGE INFORMATION SEE STRUCTURE SHEETS.
4. DRIVEWAYS SHALL BE 0.2' AC/3"COMPACTED SUBGRADE



"P" LINE PROFILE

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V: 1"=4'

60% SUBMITTAL

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DRAWN: MPB	08/11/2016			SCALE: 1" = 20'
CHECKED: KPS	03/10/2017			

FOR RIGHT OF WAY DATA AND ACCURATE ACCESS DETERMINATION, SEE DOCUMENTS IN THE DEPARTMENT OF PUBLIC WORKS AND PLANNING.

SUPERVISING ENGINEER DATE

PROJECT
TRAVERS CREEK AT PARLIER AVE
COUNTY OF FRESNO, CA
ROAD NO. #### BRIDGE NO. 42C0417

DEPARTMENT OF PUBLIC WORKS AND PLANNING

PLAN AND PROFILE

DRAWING NO. PP-1 SHEET NO. 1 TOTAL 1

Appendix B: Hydraulic Modeling Summary for Flow Near Manning Avenue Bridge Memorandum (West Consultants, Inc.)

MEMORANDUM

Project:	Fresno County Bridge 42C0175
Subject:	Hydraulic Modeling Summary for Flow near Manning Avenue Bridge
Date:	October 16, 2014
To:	Cathy Avila, Avila and Associates Consulting Engineers, Inc.
From:	David S. Smith, P.E., WEST Consultants, Inc. Cameron Jenkins, P.E., WEST Consultants, Inc.

REGISTERED PROFESSIONAL ENGINEER
David S. Smith
No. C056132
EXP. 12/31/14
CIVIL
STATE OF CALIFORNIA

David S Smith

Purpose

This memo summarizes the hydraulic analysis completed by WEST Consultants, Inc. (WEST) for Avila and Associates Consulting Engineers, Inc. to determine the 1-percent and 2-percent annual chance exceedance (100-year and 50-year) discharges at Manning Avenue Bridge (42C0175) in Fresno County near Reedley, California. The bridge is located northeast of Reedley over Travers Creek. Two other bridges upstream are also of interest—Parlier Avenue and Lincoln Avenue.

A preliminary hydrologic analysis was completed by Avlia and Associates in April 2014, in which discharges at Manning Avenue Bridge were determined to be 2,630 cfs (100-year) and 2,140 cfs (50-year). This regression equation and stream gage analysis was based on a watershed size of approximately 33.9 square miles. The precise watershed size upstream of Manning Avenue is uncertain due to the Friant-Kern Canal (FKC) and the Alta East Canal which are within the watershed and would potentially intercept or otherwise change the amount of flow crossing the canals. To estimate how much flow would likely reach Manning Avenue, WEST was tasked with developing a 2D model with two scenarios: (1) Alta East Canal and Friant-Kern Canal empty and (2) Alta East Canal and Friant-Kern Canal full.

Grid Development and Topography

The hydrology and hydraulics for this study were evaluated using the FLO-2D program (version 13.11.06). The FLO-2D model has 374,595 grid cells (100 feet x 100 feet grid cells) covering an area of approximately 134.4 square miles (see model limits in Figure 1). There are multiple irrigation canals in this area with the two largest being the Friant-Kern Canal and the Alta East Canal. All model data is either in the NAVD88 vertical datum or converted to NAVD88 by adding 2.62 feet to the NGVD29 data.

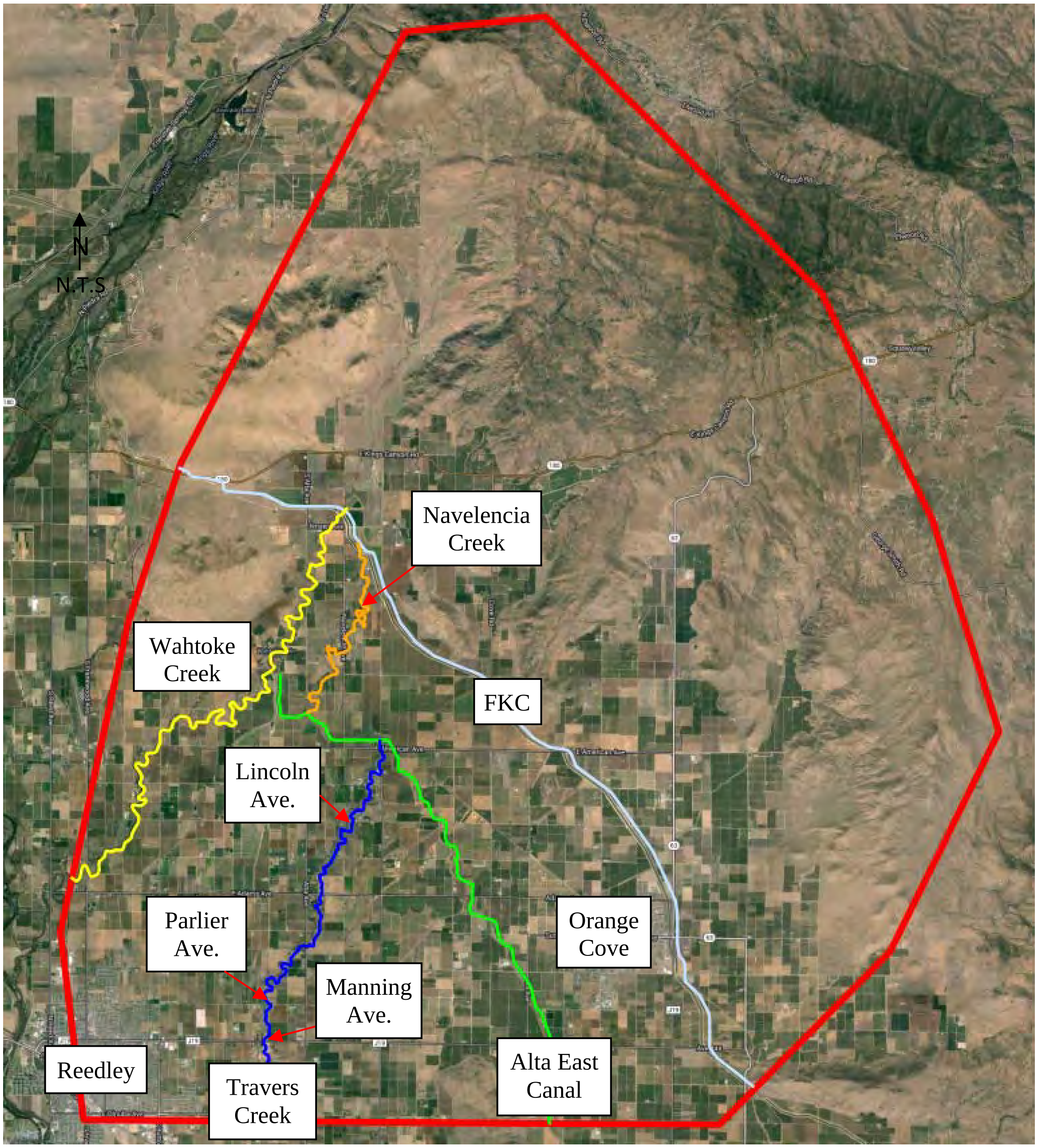


Figure 1. FLO-2D Model Limits

Two sources of topography were used in the modeling. A 5-meter resolution digital raster was obtained from Intermap Technology for the area downstream of FKC and a small ribbon of topography upstream of the FKC (about 100 feet). The red polygon shown in Figure 2 illustrates the limits of the Intermap data. USGS 10-meter raster data were used for the remaining areas of the model, and Figure 2 illustrates the combined terrain data for the model. Each grid element (i.e. center of the computational cell) was assigned a representative ground elevation from the elevation data based on the interpolation algorithm embedded in the FLO-2D interface.

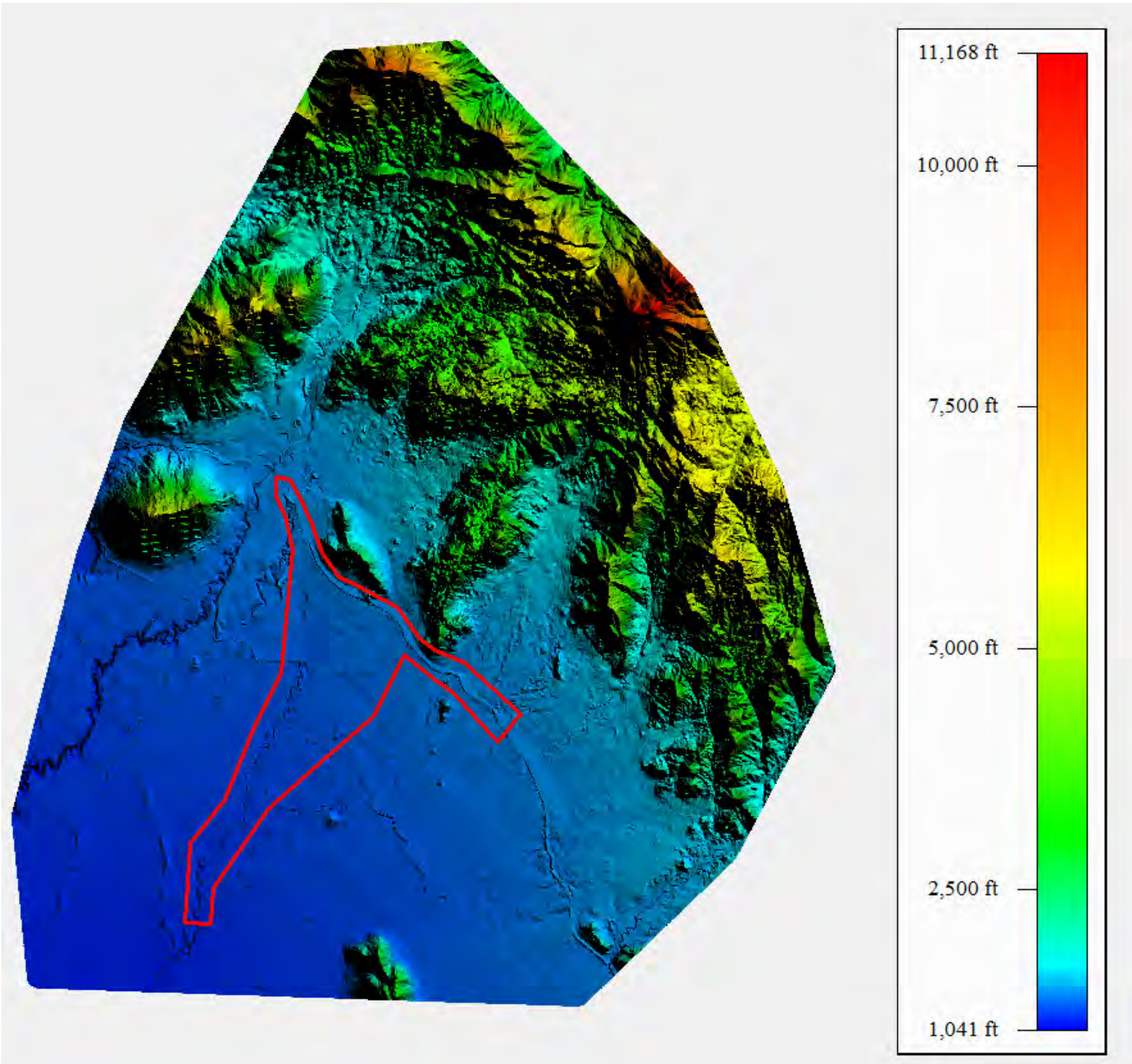


Figure 2. FLO-2D Model Elevation Data.

Precipitation Data

The 50-year and 100-year 24-hour duration rainfall events were modeled in this study. Precipitation estimates in raster format were obtained using the online National Oceanic and Atmospheric Administration (NOAA) Precipitation Frequency Data Server. Precipitation depths for the 5-minute, 15-minute, 1-hour, 2-hour, 3-hour, 6-hour, 12-hour, and 24-hour durations were obtained for the entire model extent and an average rainfall value was calculated based on the model boundary (see Table 1). The average depth for each duration was entered in the frequency storm option of HEC-HMS based on a balanced storm temporal distribution. The resulting rainfall hyetograph was used in FLO-2D.

Table 1. Precipitation Data.

Average NOAA Atlas 14 Rainfall Values for Model Extent								
Event	5 min	15 min	1 hr	2 hr	3 hr	6 hr	12 hr	24 hr
50-year	0.28	0.49	0.90	1.27	1.56	2.18	3.06	4.26
100-year	0.32	0.56	1.03	1.45	1.78	2.48	3.47	4.82

Soil, Vegetation, and Land Use

Soils data including hydrologic soil groups were obtained from the Natural Resources Conservation Service (NRCS) SSURGO database. Land use and vegetation data were downloaded from the USGS National Map website. Figure 3 and Figure 4 show the hydrologic soils groups and vegetation/land use types respectively.

Loss Rates

The SCS curve number (CN) method was used to calculate loss rates. The CN was determined for each soil and vegetation/land use combination according to "TR-55 Urban Hydrology for Small Watersheds." Table 2 summarizes the land use, Cover Description, and associated Hydrologic Soils group and CN for the project area. The composite CN (Figure 5) was used to calculate an area-weighted average CN for each grid cell in the FLO-2D model.

Table 2. Vegetation/Land Use and Curve Number.

Vegetation/Land Use	A	B	C	D
Open Water	98	98	98	98
Perennial Snow/Ice	98	98	98	98
Developed, Open Space	49	69	79	84
Developed, Low Intensity	61	75	73	87
Developed, Medium Intensity	81	88	91	93
Developed, High Intensity	89	92	94	95
Barren Land	77	86	91	94
Deciduous Forest	36	60	73	79
Evergreen Forest	36	60	73	79
Mixed Forest	36	60	73	79
Shrub/Scrub	35	56	70	77
Herbaceuous	49	69	79	84
Hay/Pasture	49	69	79	84
Cultivated Crops	72	81	88	91
Woody Wetlands	30	55	70	77

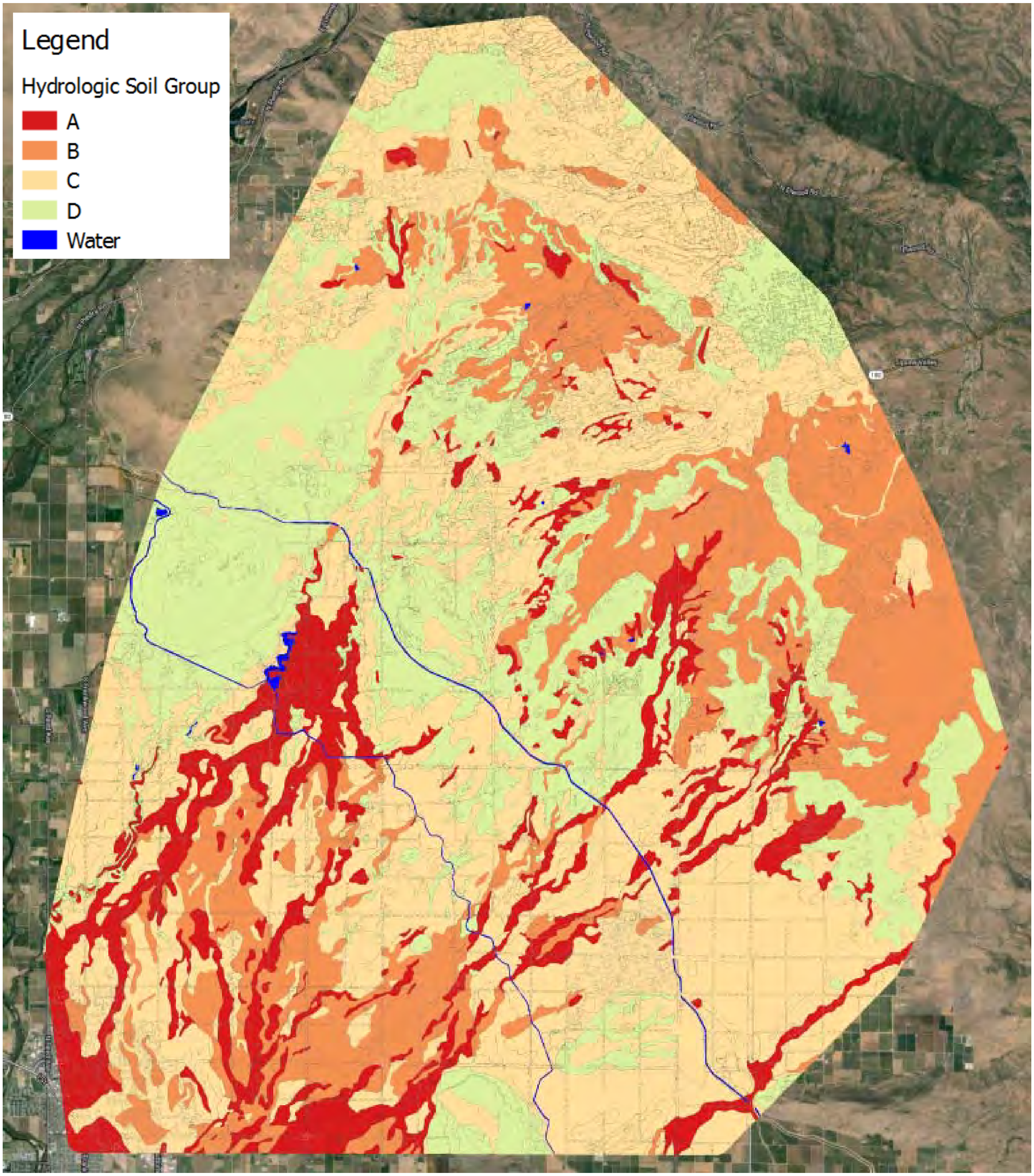


Figure 3. Hydrologic Soil Groups.

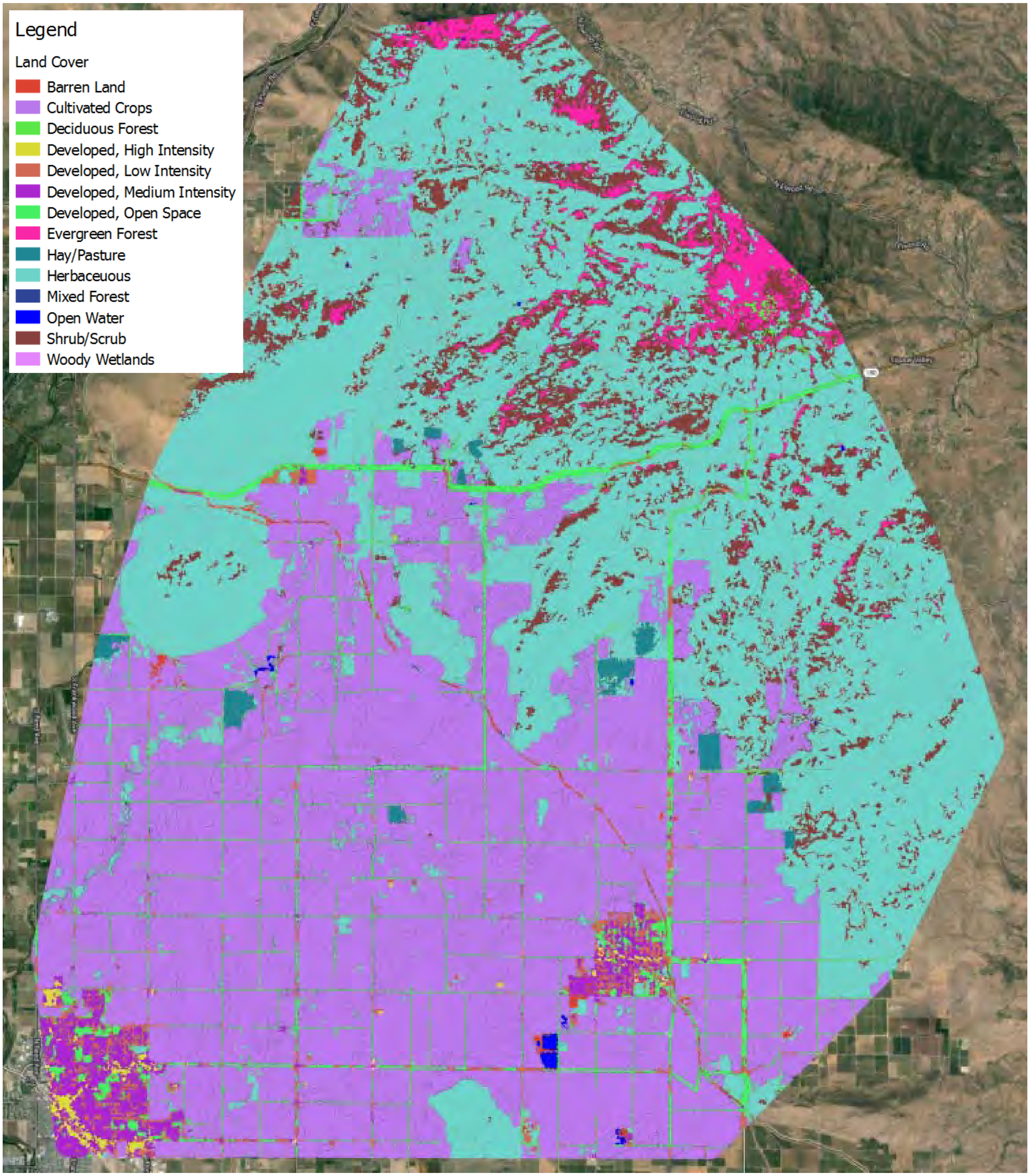


Figure 4. Land Use.

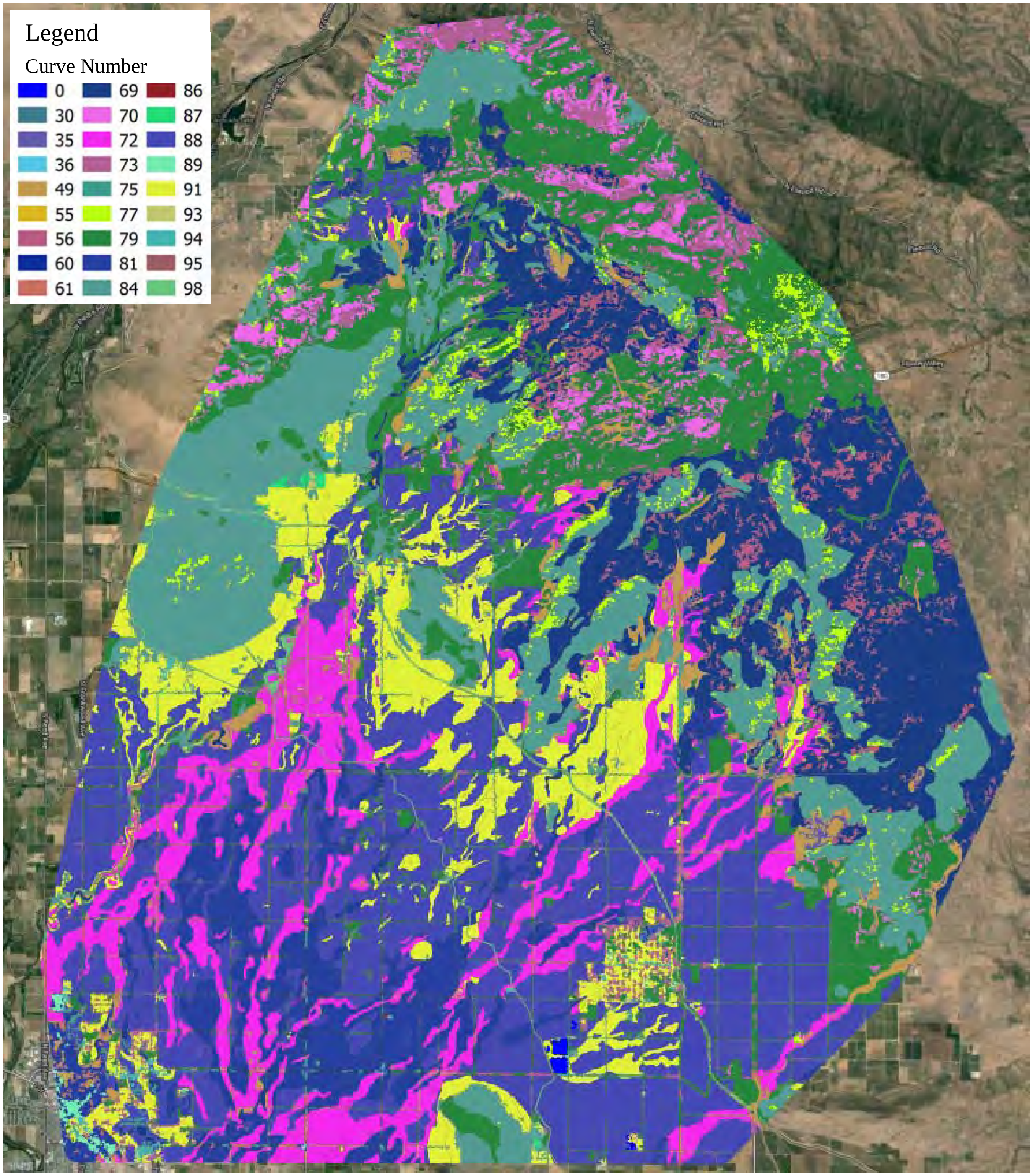


Figure 5. Curve Number.

Manning's Roughness

Overland flow resistance accounts for the effect of vegetation, surface irregularity, flow depth, and flow path redirection. Manning's roughness values were selected based on vegetation/land use with guidance from the FLO-2D manual (2009). Table 3 and Figure 6 provide a summary of the roughness values.

Table 3. Land Cover and Manning's Roughness.

Vegetation/Land Use	Manning's Roughness
Open Water	0.02
Developed, Open Space	0.02
Developed, Low Intensity	0.10
Developed, Medium Intensity	0.20
Developed, High Intensity	0.30
Barren Land	0.04
Deciduous Forest	0.10
Evergreen Forest	0.10
Mixed Forest	0.10
Shrub/Scrub	0.07
Herbaceous	0.12
Hay/Pasture	0.05
Cultivated Crops	0.06
Woody Wetlands	0.08

1D Channels

The Intermap topography data was generally not detailed enough to define invert elevations for channels or irrigation canals. Therefore, 1D channels were added to the FLO-2D model based on as-built drawings and engineering judgment. Figure 7 shows the 1D channels that were included in the model and the channel dimensions are shown in Table 4. For Navelencia Creek, a variable 1D channel depth was required to maintain the stream slope.

Table 4. 1D Channel Dimensions.

Channel/Canal	Bottom Width (ft)	Depth (ft) Empty	Depth (ft) Full	Side Slope	Manning's Roughness	Invert
FKC	64	22	1	1.5	0.04	As-built
Alta East Canal	60	10	1	0	0.04	Topo
Travers Creek	50	10	10	0	0.04	As-built
Navelencia Creek	80	Varies	Varies	0	0.04	Topo
Irrigation Ditches	20	5	5	0	0.04	Topo

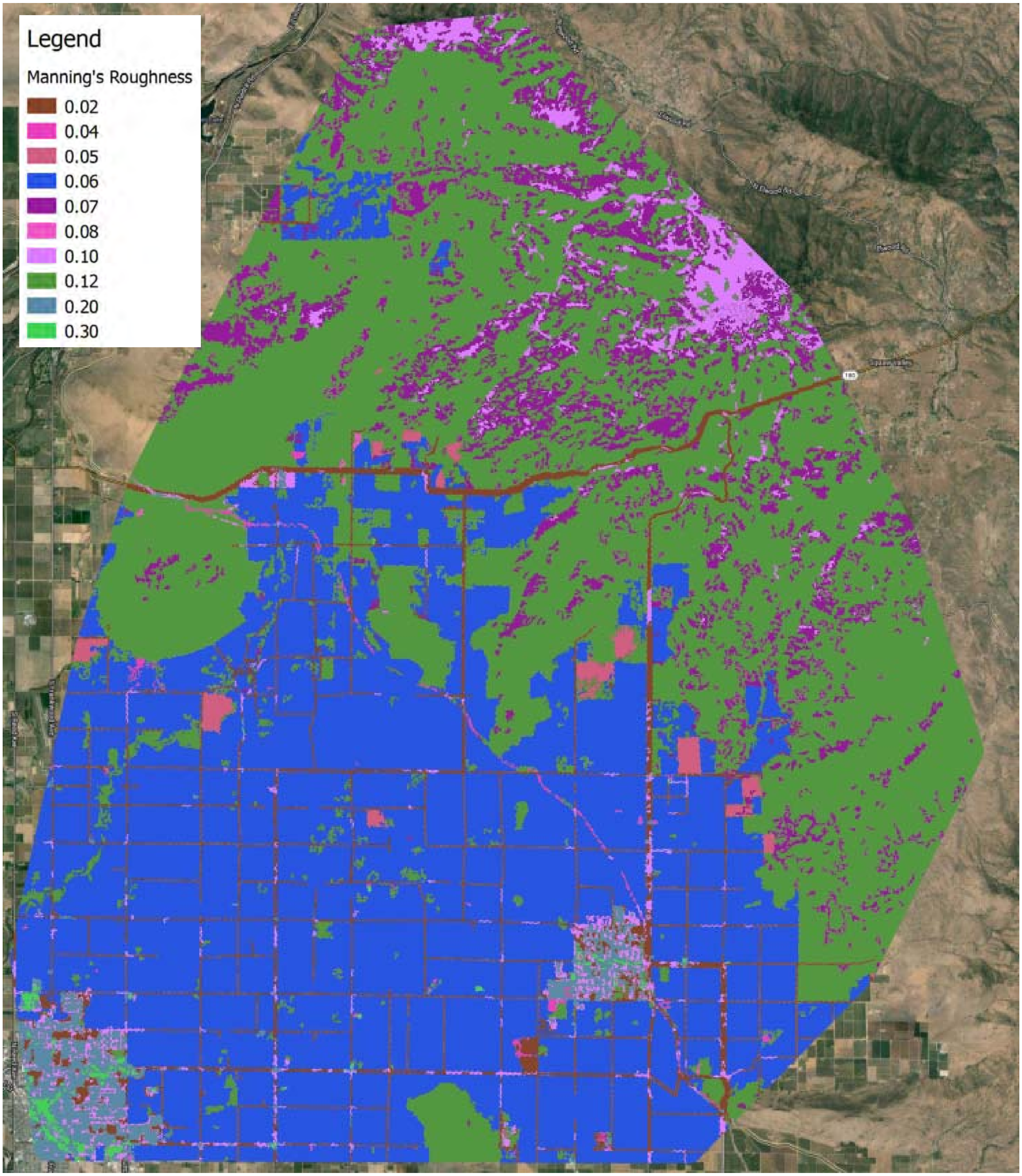


Figure 6. Manning's Roughness.

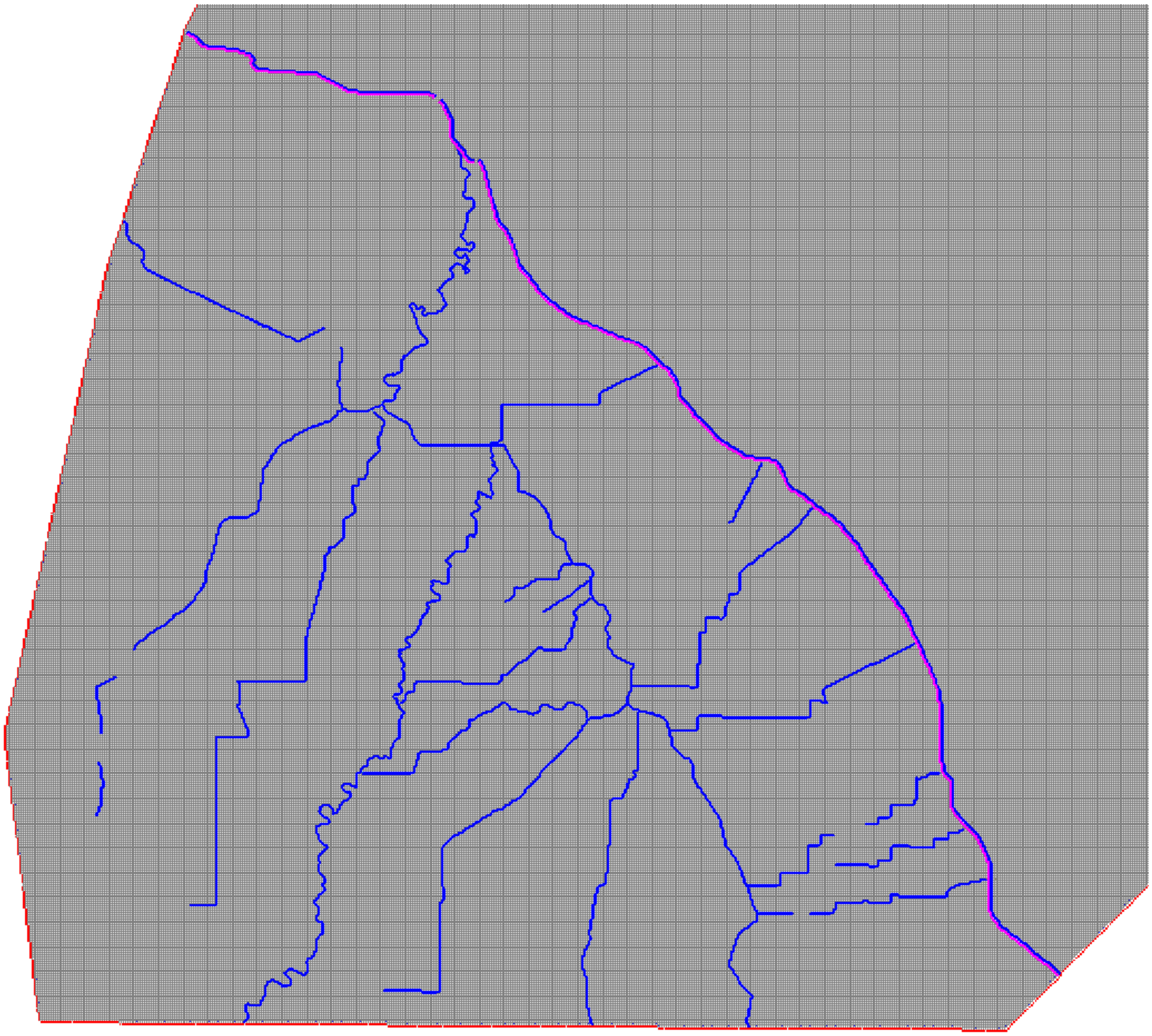


Figure 7. 1D Channels.

Hydraulic Structures

There are numerous bridges and culverts within the model boundary; and 20 were modeled in the FLO-2D model as shown in Table 5, 6, and 7 and in Figure 8. The remaining structures were not explicitly modeled because they would not likely provide a significant obstruction to flow affecting the Manning Avenue Bridge. This assumption should result in a conservative flow estimate at Manning Avenue.

HEC-RAS models for Manning Avenue Bridge and Parlier Bridge were provided by Avila and Associates and were used by WEST to generate the rating curves at these locations. For other modeled bridges, the dimensions were taken from as-built drawings or dimensions were assumed based on engineering judgment and rating curves were developed in HY-8. Culvert rating curves were also generated using the HY-8 program. The rating curves for each structure are shown in Appendix A.

Table 5. Travers Creek Bridge Dimensions.

No.	Bridge	Bridge Dimensions					
		High Chord Elevation (ft)	Low Chord Elevation (ft)	Stream Bed Elevation (ft)	Deck Length (ft)	Deck Width (ft)	Number of Pier Sets
1	Manning[1]	355.7	354.06	342.75	42	93	0
2	Parlier[1]	358	356.50	347.64	29	26	1
3	E South	360.97	359.47	350.37	22.75	29	0
5	Bridge next to House[2]	368	366.99	357.66	34	4	0
6	Sumner[2]	369	367.98	358.65	42	12	1
7	Adams[3]	384.96	372.96	363.63	30	34	1
8	Clayton[3]	378	377.92	364.5	47	27	0
9	Lincoln[2]	383	381.97	372.64	20	24	0
10	Jefferson[4]	386.97	385.72	376.39	23.29	24	0
11	American[4]	391	389.46	381.96	38.32	38	1

Note: Streambed elevations are calculated using the creek slope and known surveyed elevations. Google Earth was used for top of road elevations, which in turn provided elevations for low chords.
[1]Data obtained from HEC-RAS.
[2]Missing as-built drawings. Data was obtained from Google Earth, creek slope, and/or Adams Ave Bridge.
[3]Streambed elevation calculated from creek slope
[4]Streambed to low chord data based on Adams Ave Bridge.

Table 6. Travers Creek Culvert Dimensions used in HY-8.

No.	Culvert	Travers Creek Culvert Dimensions used in HY-8					
		Type Span (ft)	Rise (ft)	Length (ft)	Slope	Invert Elevation (ft)	Top of Road Elevation (ft)
3	E South	22.75	10.5	28.54	0.00105	350.4	361.0
4	Alta	2x10	8	40.54	0.00123	357.1	368.0
5	Bridge next to House	20	9.33	4	0.00000	357.7	368.0
6	Sumner	2x12	9.33	12	0.00083	358.7	369.0
7	Adams	2x12	9.33	34.25	0.00117	363.7	374.0
8	Clayton	25.47	11.75	26.58	0.00113	364.5	378.0
9	Lincoln	20	9.33	24	0.00125	372.7	383.0
10	Jefferson	23.3	9.33	24	0.00125	376.4	387.0
11	American	2x14	7.5	38.11	0.00105	382.0	391.0

Table 7. FKC Culvert Dimensions.

No.	Culvert	Friant-Kern Canal						
		RCB Openings	Opening Span (ft)	Rise (ft)	Length (ft)	Slope	Invert Elevation (ft)	Top of Road Elevation (ft)
12	Wahtoke Creek	5	10	5	120	0.00008	418.2	426.0
13	Navelencia Creek culvert	4	4.5	3	240	0.008	442.6	447.8
14	Irrigation crossing	5	10	5	120	0.005	429.2	437.0
15	Culvert 2	2	6	4	270	0.012	442.7	446.2
16	Surprise Creek Culvert	2	4.25	3.5	240	0.027	443.5	446.1
17	Hills Valley Creek Culvert	2	6	4.5	250	0.010	443.0	445.9
18	Wooten Creek Culvert	3	6	5	250	0.023	442.7	445.4
19	Culvert 4	1	4	3	260	0.010	442.5	444.8
20	Culvert 5	1	3	3	260	0.010	442.5	444.6

Results

Four scenarios were analyzed in FLO-2D with a simulation time of 40 hours. The scenario description and resulting peak flow at the Manning Avenue, Parlier Avenue, and Lincoln Avenue bridges are shown in Table 8. Depth graphics for each scenario are included in Appendix B.

Table 8. Peak Flow Summary.

Run	Manning Avenue Peak Flow (cfs)	Parlier Avenue Peak Flow (cfs)	Lincoln Avenue Peak Flow (cfs)
24-hr 50-year Alta East empty	1,090	1,080	510
24-hr 50-year Alta East full	1,250	1,250	400
24-hr 100-year Alta East empty	1,340	1,340	650
24-hr 100-year Alta East full	1,500	1,500	510

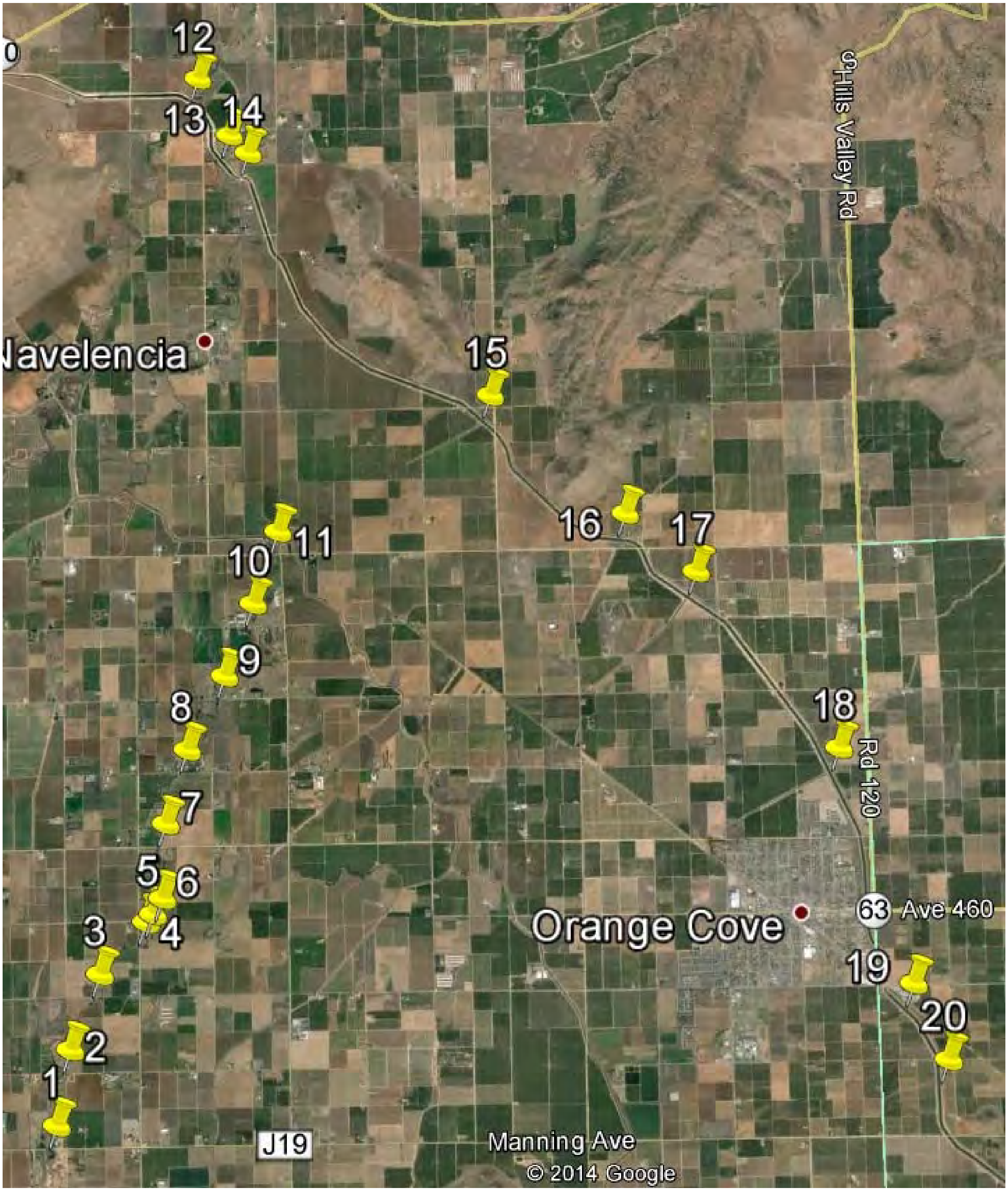


Figure 8. Hydraulic Structure Locations.

Appendix A

Structure Rating Curves

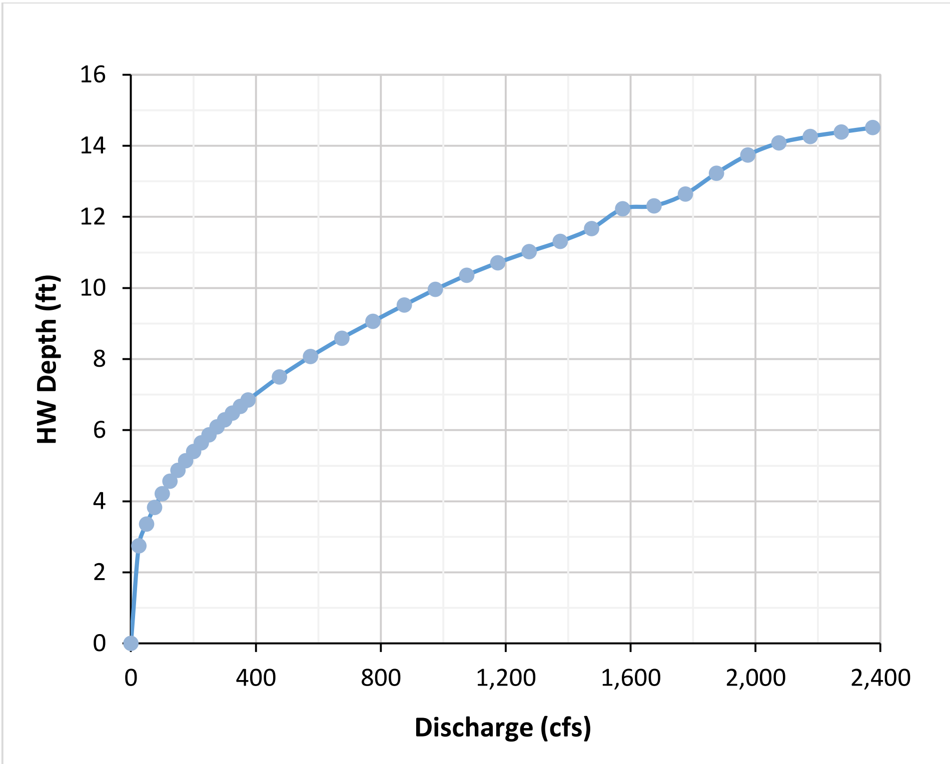


Figure A-1. Manning Avenue Bridge (#1) Rating Curve.

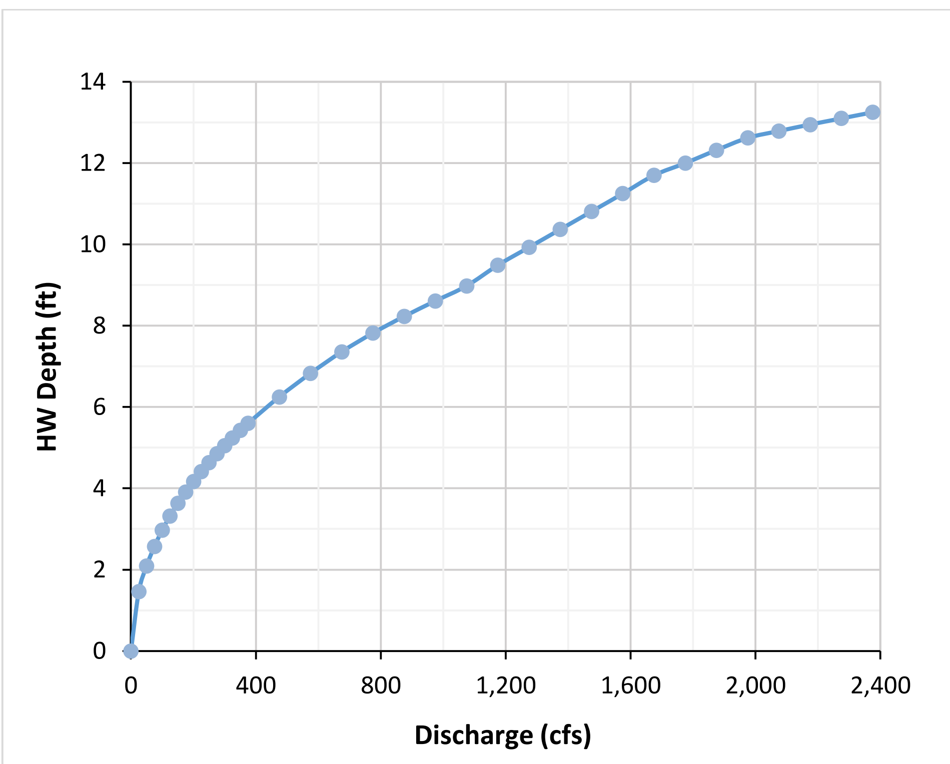


Figure A-2. Parlier Avenue Bridge (#2) Rating Curve.

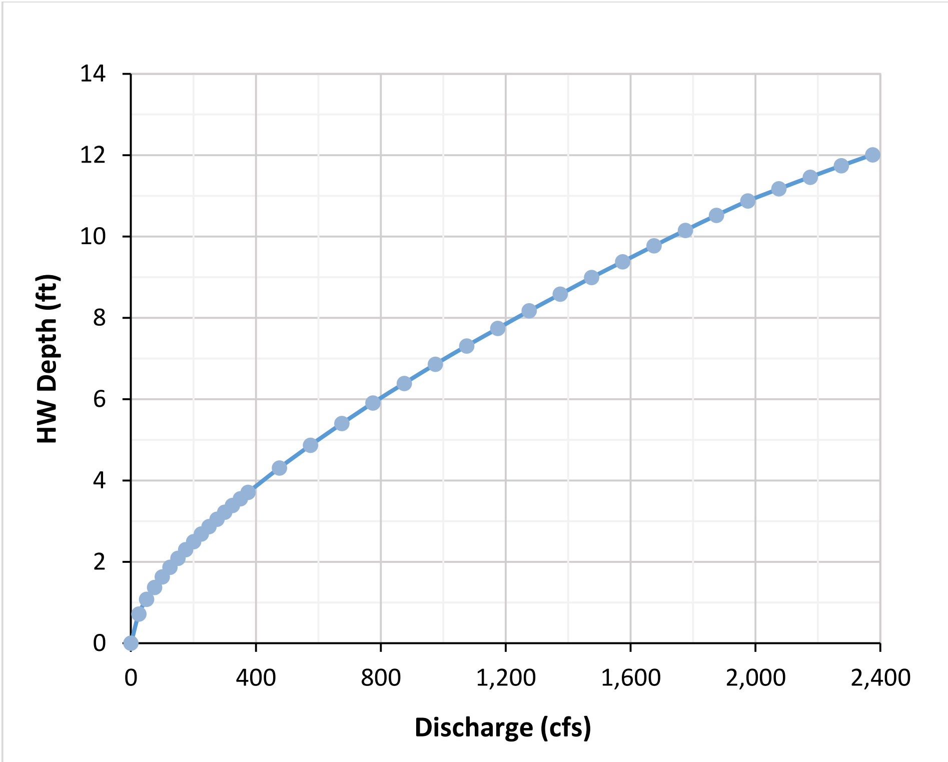


Figure A-3. E South Avenue Bridge (#3) Rating Curve.

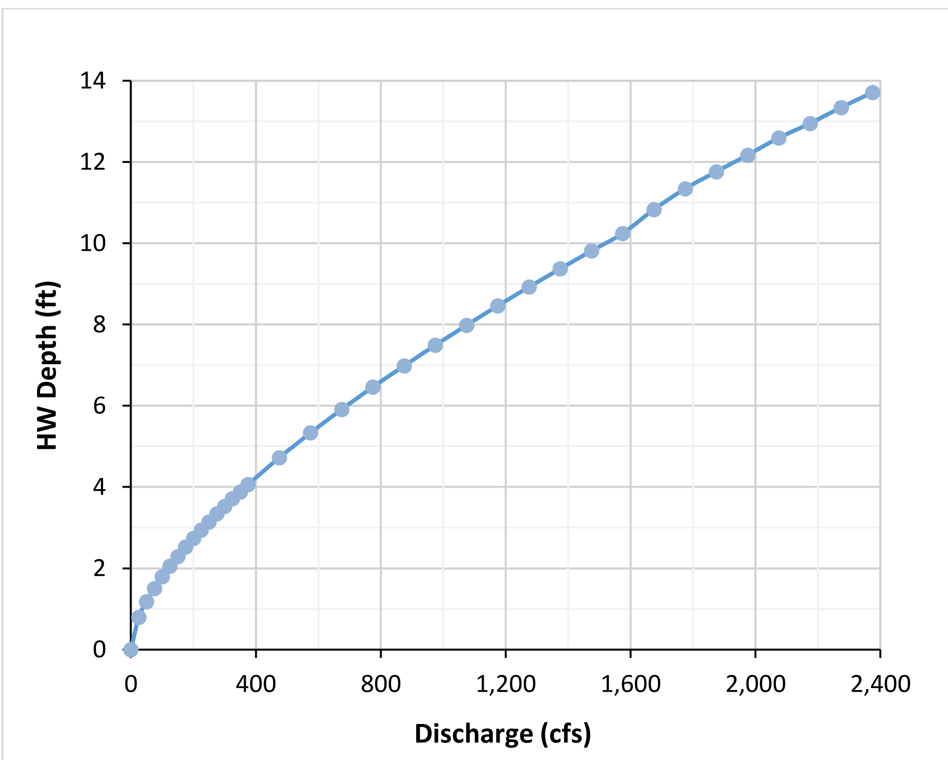


Figure A-4. Alta Avenue Bridge (#4) Rating Curve.

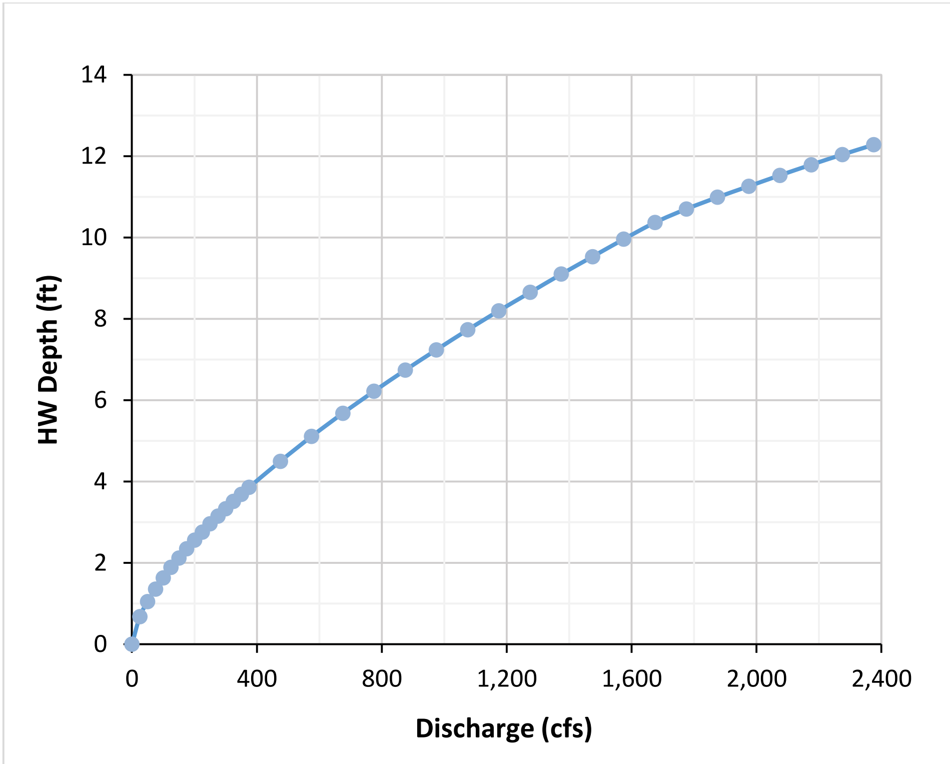


Figure A-5. Bridge next to house (#5) Rating Curve.

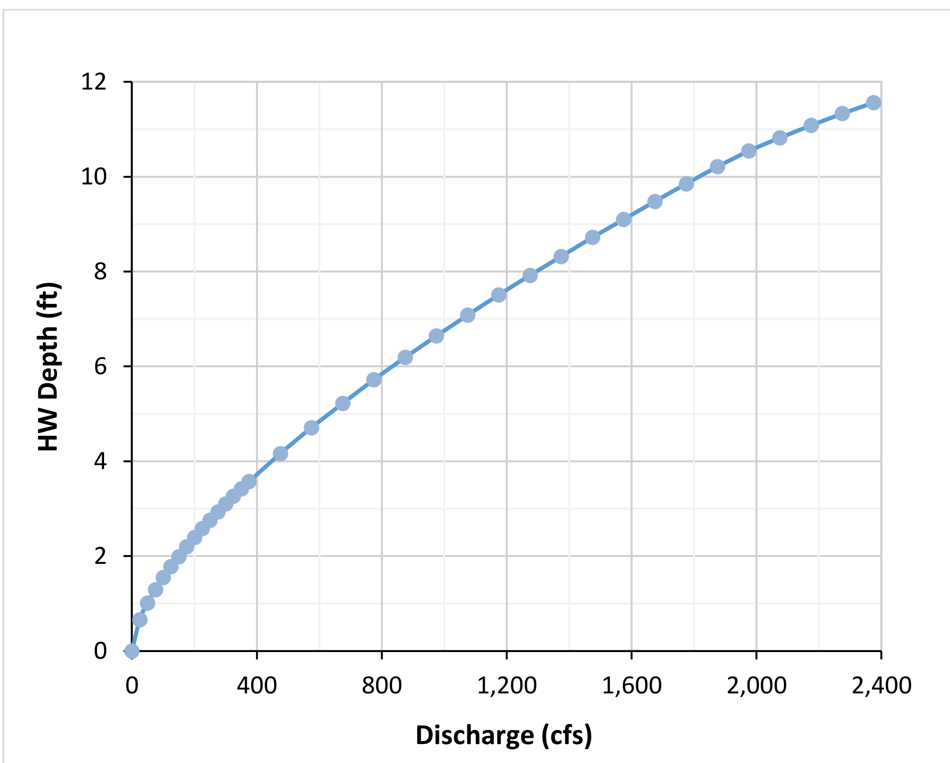


Figure A-6. Sumner Avenue Bridge (#6) Rating Curve.

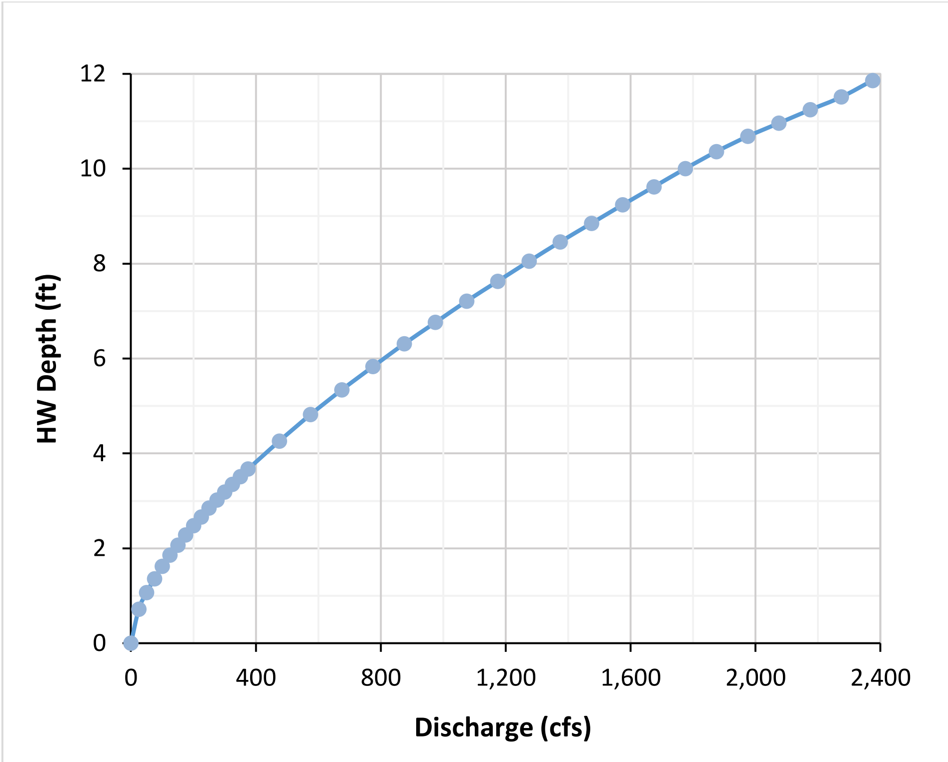


Figure A-7. Adams Avenue Bridge (#7) Rating Curve.

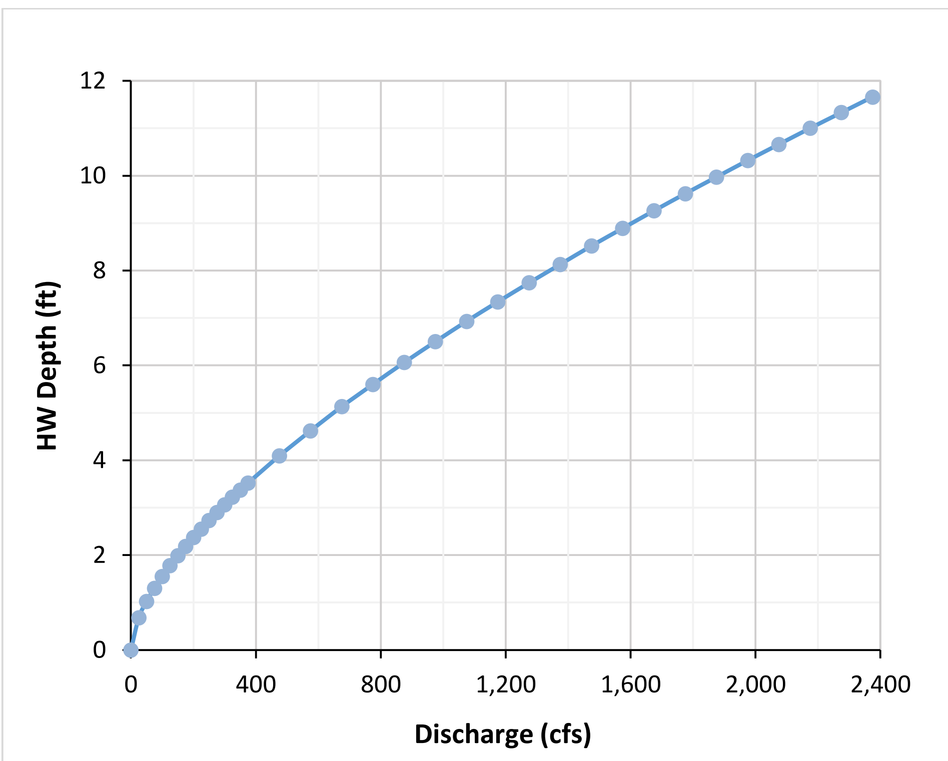


Figure A-8. Clayton Avenue Bridge (#8) Rating Curve.

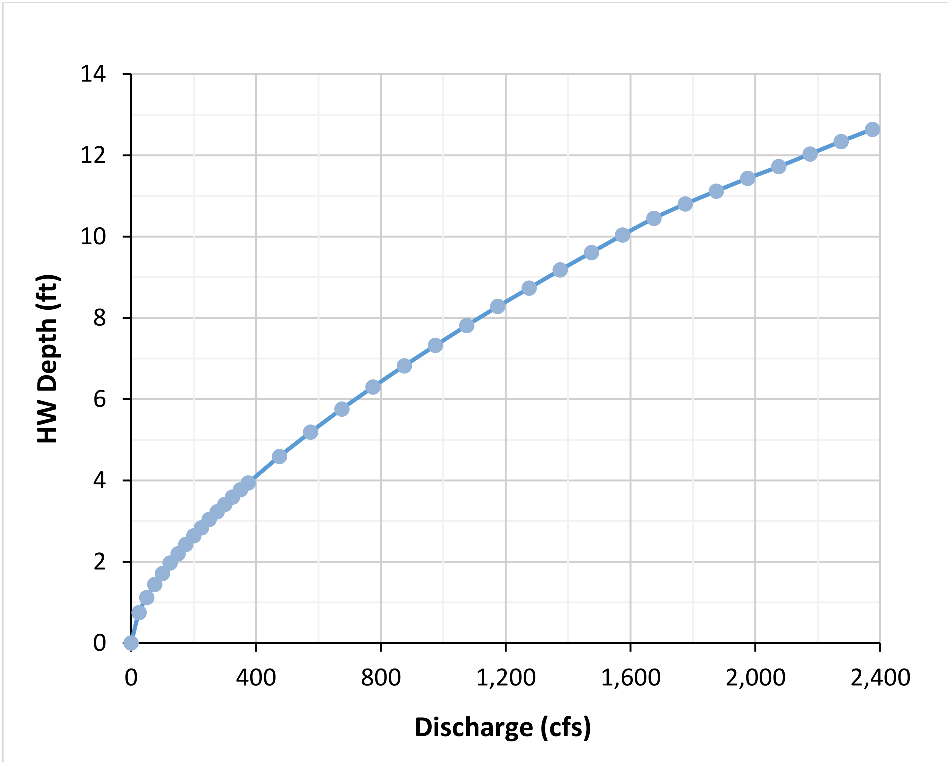


Figure A-9. Lincoln Avenue Bridge (#9) Rating Curve.

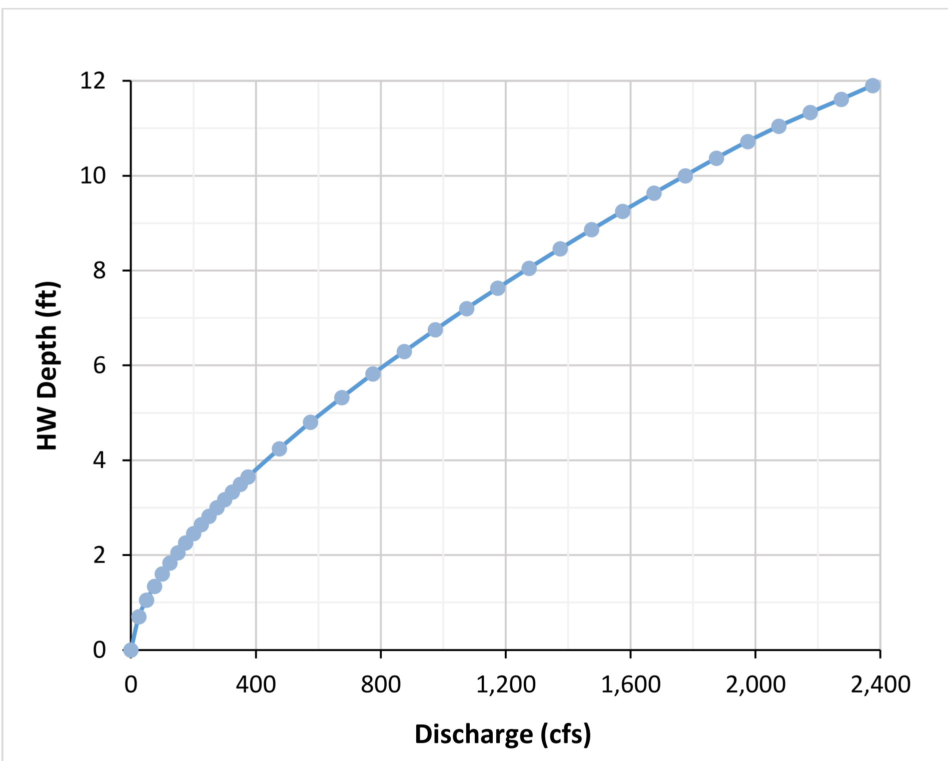


Figure A-10. Jefferson Avenue Bridge (#10) Rating Curve.

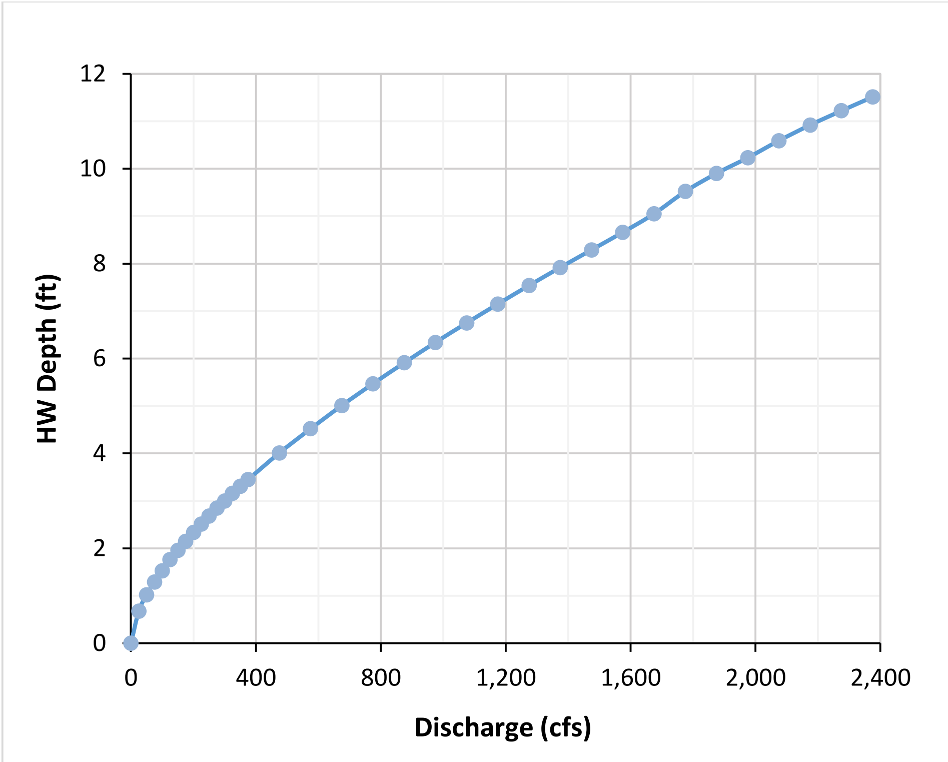


Figure A-11. American Avenue Bridge (#11) Rating Curve.

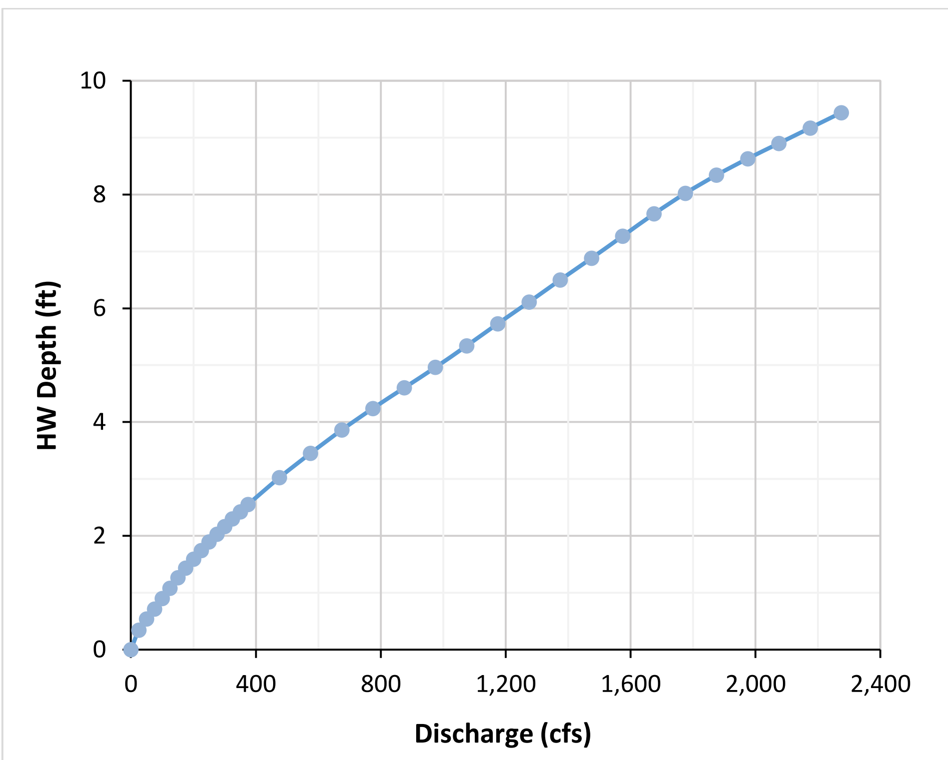


Figure A-12. Wahtoke Creek Culvert (#12) Rating Curve.

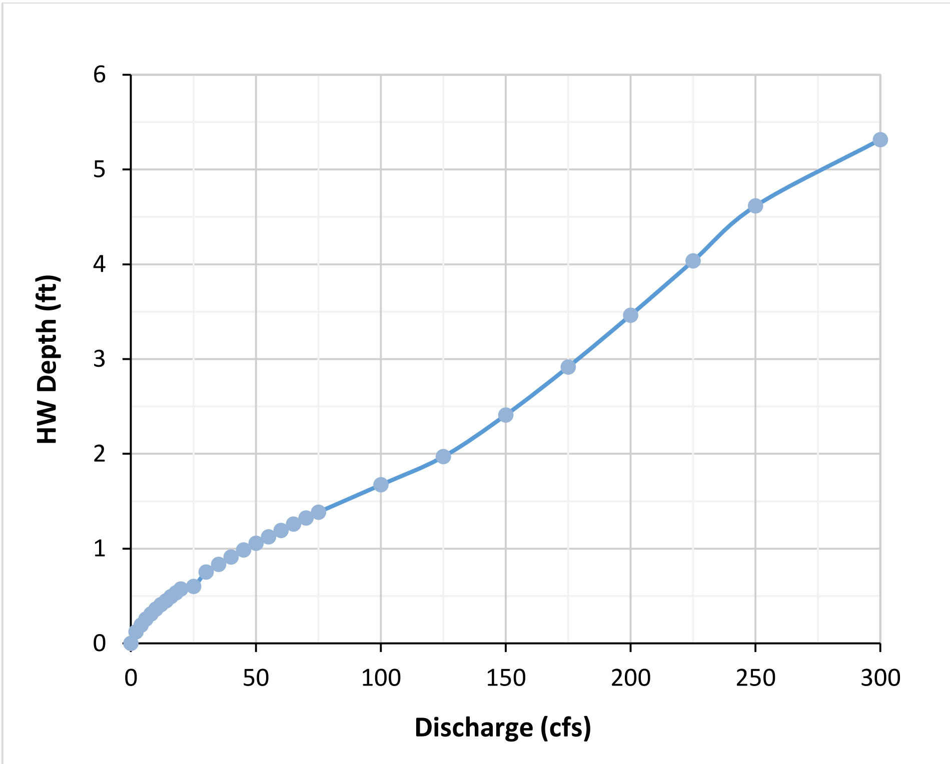


Figure A-13. Navelencia Creek Culvert (#13) Rating Curve.

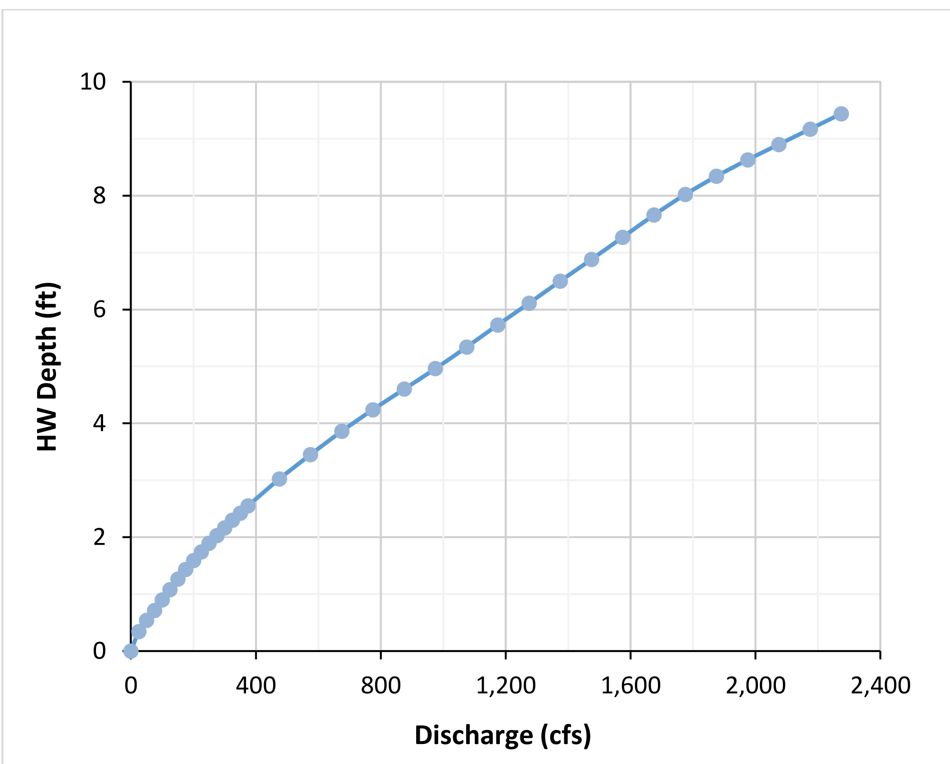


Figure A-14. Irrigation Crossing (#14) Rating Curve.

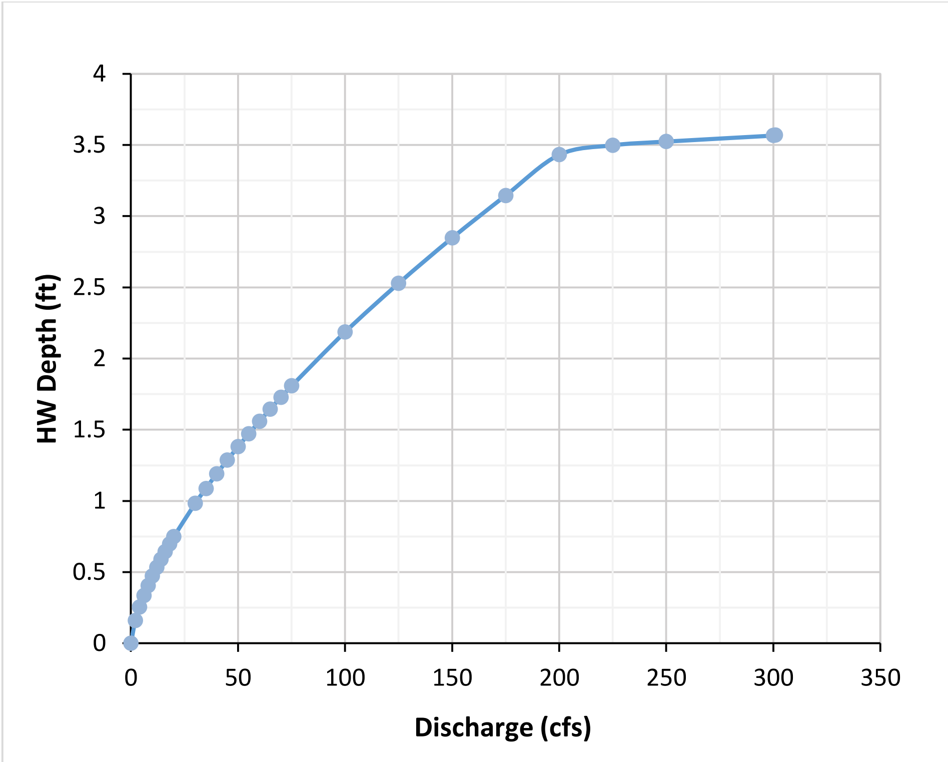


Figure A-15. Culvert 2 (#15) Rating Curve.

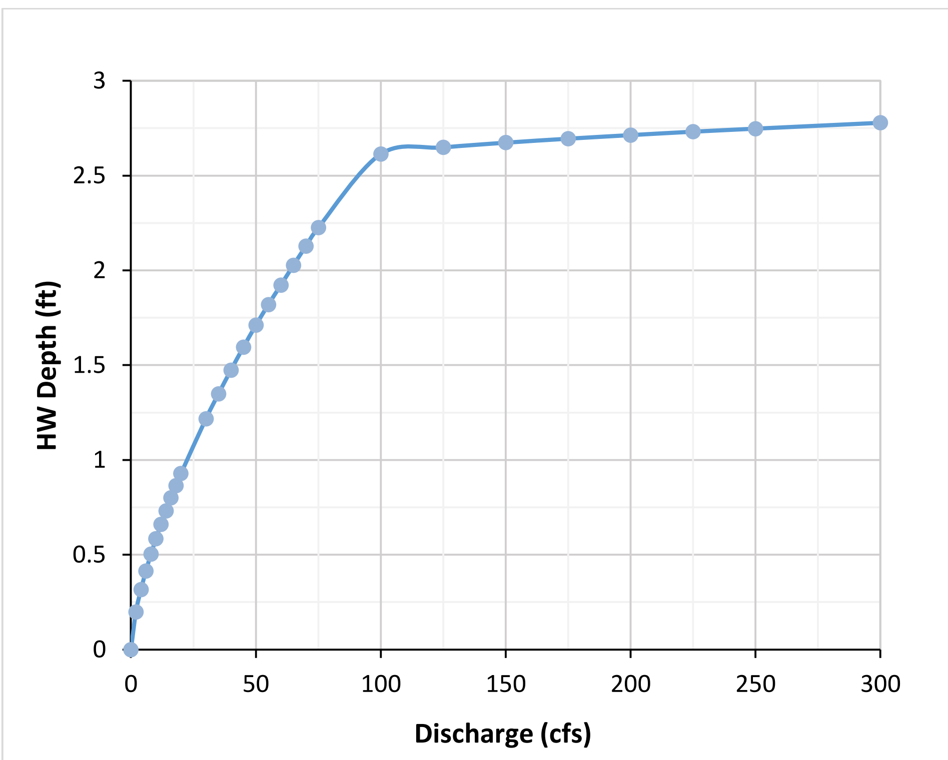


Figure A-16. Surprise Creek Culvert (#16) Rating Curve.

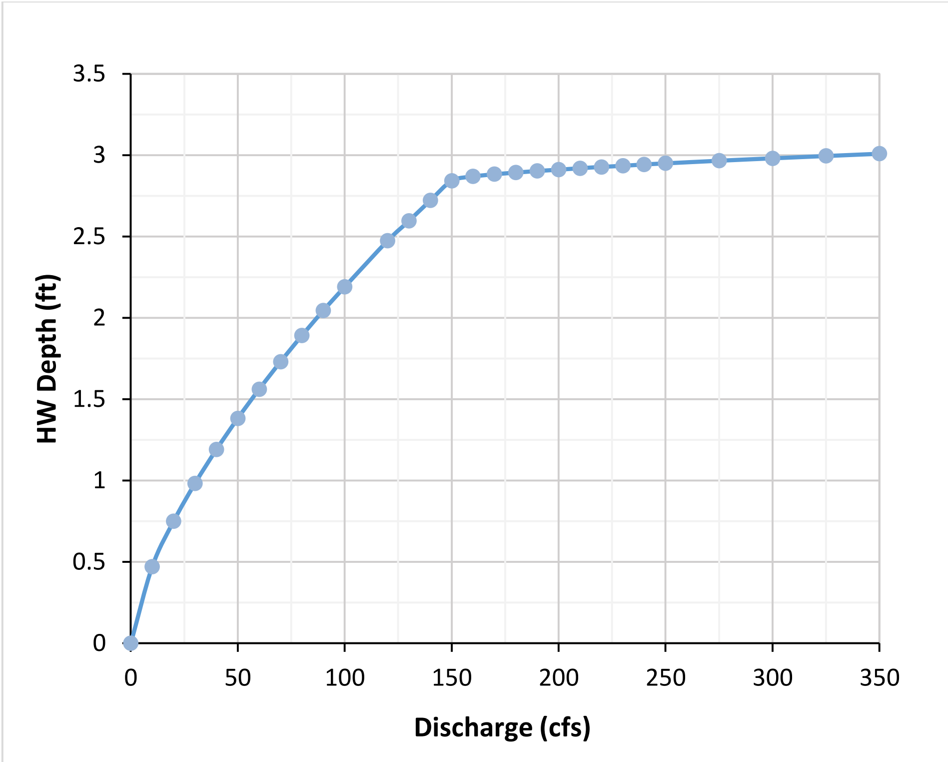


Figure A-17. Hills Valley Creek Culvert (#17) Rating Curve.

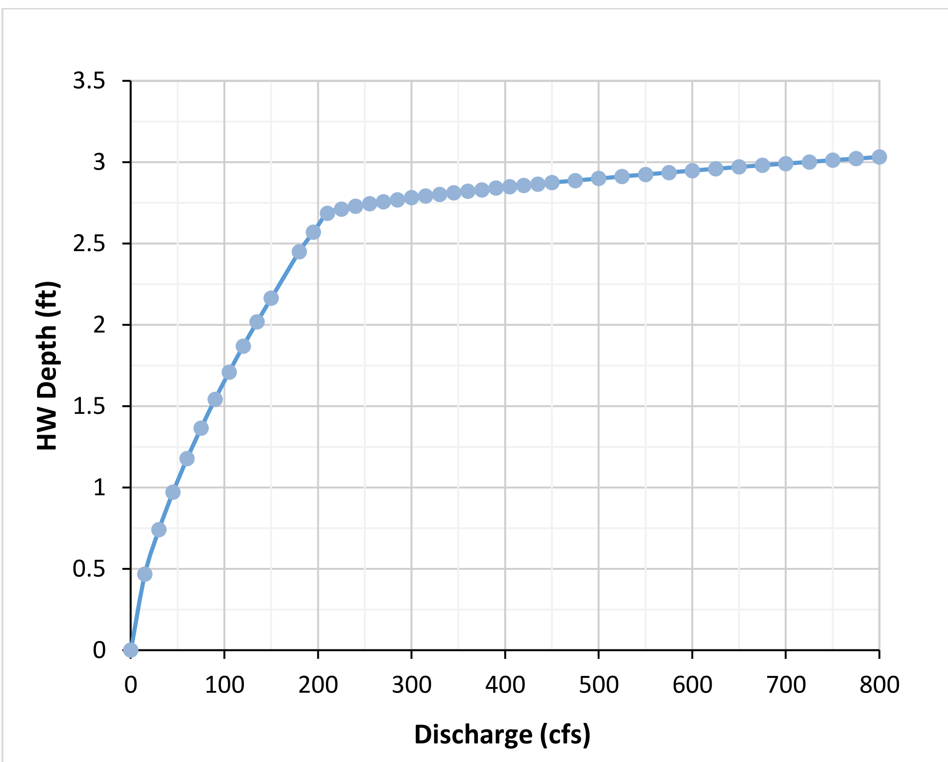


Figure A-18. Wooten Creek Culvert (#18) Rating Curve.

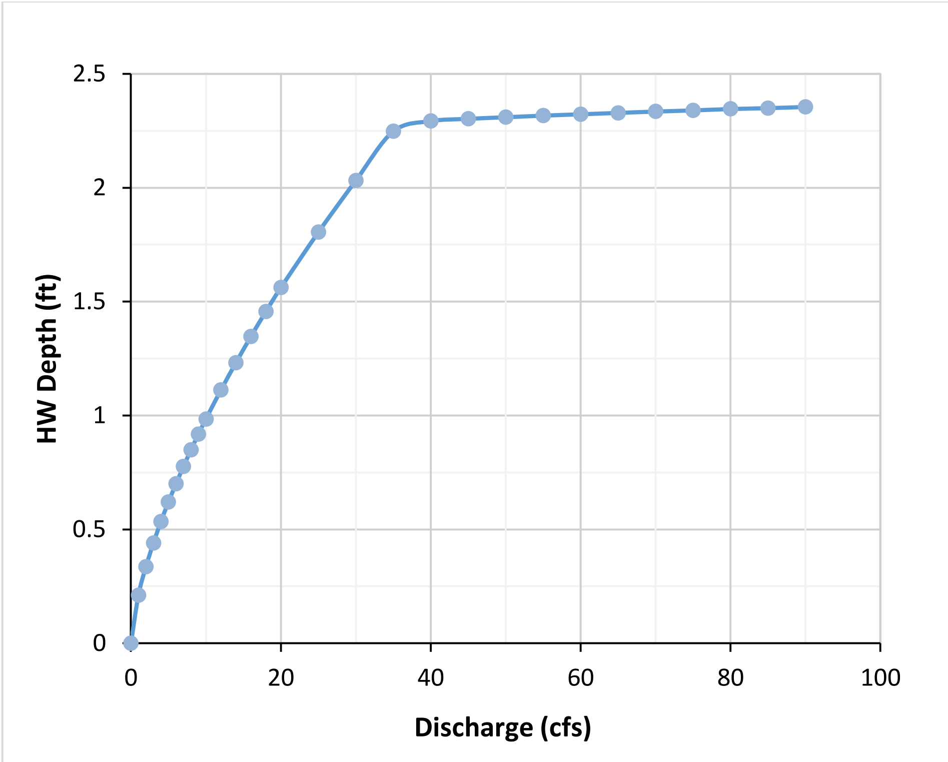


Figure A-19. Culvert 4 (#19) Rating Curve.

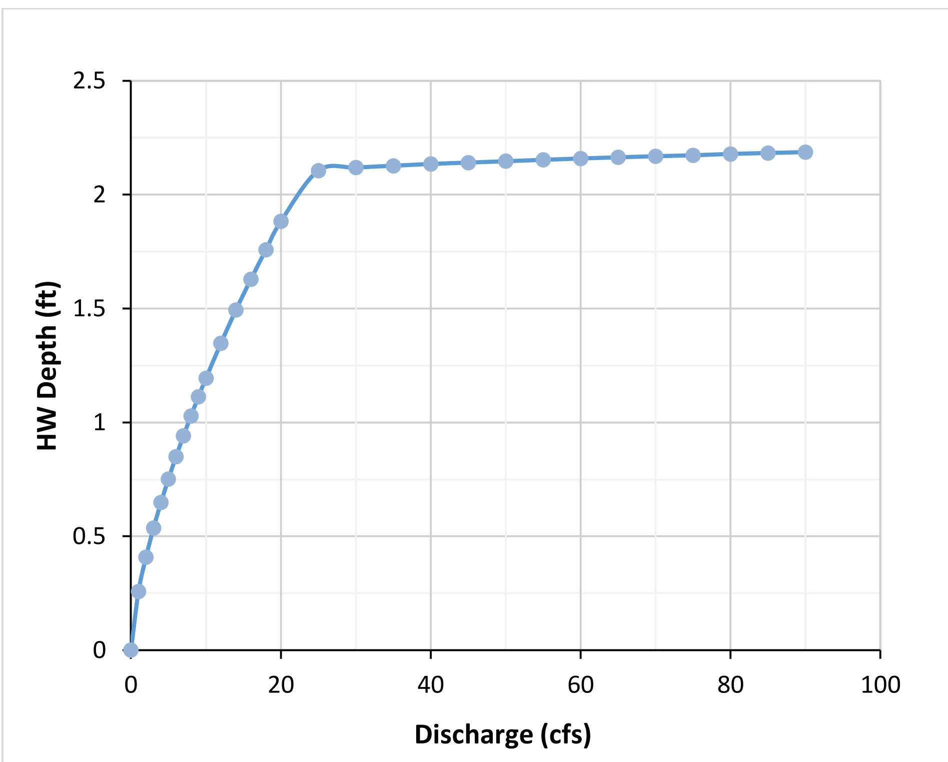
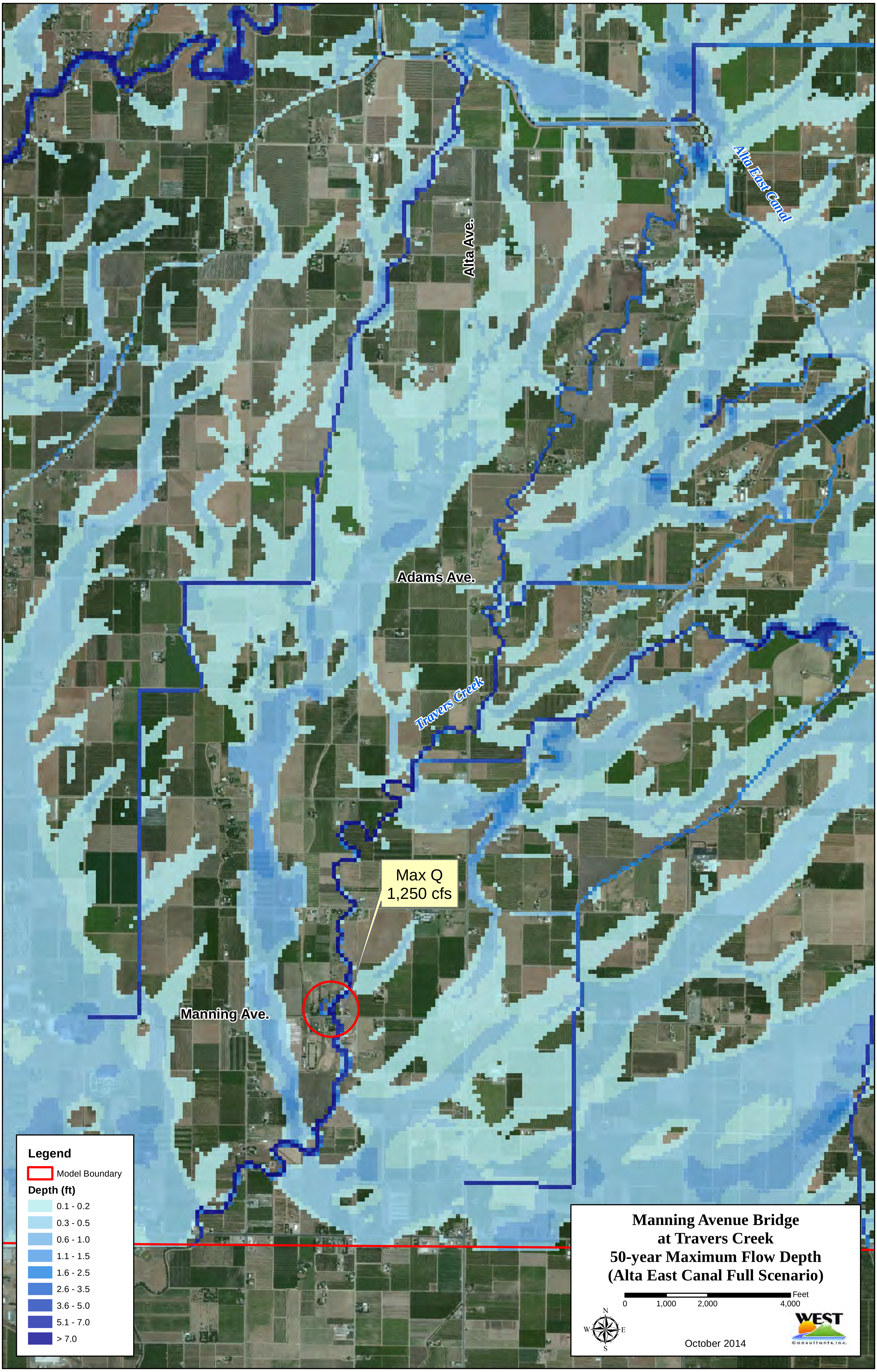


Figure A-20. Culvert 5 (#20) Rating Curve.

Appendix B

FLO-2D Results

Alta Ave.
Alta East Canal
Adams Ave.
Travers Creek
Max Q
1,090 cfs
Manning Ave.
Legend
Model Boundary
Depth (ft)
0.1 - 0.2
0.3 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.5
2.6 - 3.5
3.6 - 5.0
5.1 - 7.0
> 7.0
Manning Avenue Bridge
at Travers Creek
50-year Maximum Flow Depth
(Alta East Canal Empty Scenario)
0
1,000
2,000
4,000
Feet
N
W
E
S
October 2014
WEST
Consultants, Inc.



Alta Ave.
Alta East Canal
Adams Ave.
Travers Creek
Max Q
1,250 cfs
Manning Ave.
Legend
Model Boundary
Depth (ft)
0.1 - 0.2
0.3 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.5
2.6 - 3.5
3.6 - 5.0
5.1 - 7.0
> 7.0
Manning Avenue Bridge
at Travers Creek
50-year Maximum Flow Depth
(Alta East Canal Full Scenario)
0
1,000
2,000
4,000
Feet
N
W
E
S
October 2014
WEST
Consultants, Inc.


Alta East Canal
Alta Ave.
Adams Ave.
Travers Creek
Max Q
1,340 cfs
Manning Ave.
Legend
Model Boundary
Depth (ft)
0.1 - 0.2
0.3 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.5
2.6 - 3.5
3.6 - 5.0
5.1 - 7.0
> 7.0
Manning Avenue Bridge
at Travers Creek
100-year Maximum Flow Depth
(Alta East Canal Empty Scenario)
Feet
0
1,000
2,000
4,000
N
W
E
S
October 2014
WEST
Consultants, Inc.

Alta East Canal
Alta Ave.
Adams Ave.
Travers Creek
Max Q
1,500 cfs
Manning Ave.
Legend
Model Boundary
Depth (ft)
0.1 - 0.2
0.3 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.5
2.6 - 3.5
3.6 - 5.0
5.1 - 7.0
> 7.0
Manning Avenue Bridge
at Travers Creek
100-year Maximum Flow Depth
(Alta East Canal Full Scenario)
0
1,000
2,000
4,000
Feet
N
E
S
W
October 2014
WEST
Consultants, Inc.


Manning Avenue Bridge
at Travers Creek
50-year Maximum Flow Depth
(Alta East Canal Empty Scenario)
Legend
Model Boundary
Depth (ft)
0.1 - 0.2
0.3 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.5
2.6 - 3.5
3.6 - 5.0
5.1 - 7.0
> 7.0
Max Q
1,090 cfs
Wahtoke Creek
Friant-Kern Canal
Alta East Canal
Travers Creek
Alta Avenue
Adams Avenue
Manning Avenue
0 2,500 5,000 10,000 15,000 Feet
N S E W
October 2014
WEST Consultants, Inc.

Manning Avenue Bridge
at Travers Creek
50-year Maximum Flow Depth
(Alta East Canal Full Scenario)
Legend
Model Boundary
Depth (ft)
0.1 - 0.2
0.3 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.5
2.6 - 3.5
3.6 - 5.0
5.1 - 7.0
> 7.0
Max Q
1,250 cfs
Wahtoke Creek
Friant-Kern Canal
Alta East Canal
Travers Creek
Alta Avenue
Adams Avenue
Manning Avenue
0 2,500 5,000 10,000 15,000 Feet
N E S W
WEST
Consultants, Inc.
October 2014


Manning Avenue Bridge
at Travers Creek
100-year Maximum Flow Depth
(Alta East Canal Empty Scenario)
Legend
Model Boundary
Depth (ft)
0.1 - 0.2
0.3 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.5
2.6 - 3.5
3.6 - 5.0
5.1 - 7.0
> 7.0
Max Q
1,340 cfs
Wahtoke Creek
Friant-Kern Canal
Alta East Canal
Travers Creek
Alta Avenue
Adams Avenue
Manning Avenue
Feet
0
2,500
5,000
10,000
15,000
N
S
E
W
October 2014
WEST
Consultants, Inc.


Manning Avenue Bridge
at Travers Creek
100-year Maximum Flow Depth
(Alta East Canal Full Scenario)
Legend
Model Boundary
Depth (ft)
0.1 - 0.2
0.3 - 0.5
0.6 - 1.0
1.1 - 1.5
1.6 - 2.5
2.6 - 3.5
3.6 - 5.0
5.1 - 7.0
> 7.0
Max Q
1,500 cfs
Wahtoke Creek
Friant-Kern Canal
Alta East Canal
Travers Creek
Alta Avenue
Adams Avenue
Manning Avenue
0 2,500 5,000 10,000 15,000
Feet
N
S
E
W
October 2014
WEST
Consultants, Inc.

Appendix C: NOAA Precipitation Data

NOAA Atlas 14, Volume 6, Version 2
Location name: Reedley, California, US*
Latitude: 36.6473°, Longitude: -119.3848°
Elevation: 382 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.083 (0.069-0.101)	0.108 (0.089-0.131)	0.142 (0.117-0.174)	0.171 (0.141-0.211)	0.214 (0.169-0.272)	0.248 (0.193-0.323)	0.285 (0.216-0.380)	0.325 (0.239-0.446)	0.382 (0.270-0.547)	0.429 (0.293-0.636)
10-min	0.118 (0.098-0.144)	0.154 (0.128-0.188)	0.204 (0.168-0.249)	0.246 (0.201-0.303)	0.306 (0.243-0.390)	0.356 (0.276-0.463)	0.408 (0.309-0.545)	0.465 (0.342-0.639)	0.547 (0.386-0.784)	0.615 (0.419-0.912)
15-min	0.143 (0.119-0.174)	0.186 (0.154-0.227)	0.246 (0.203-0.301)	0.297 (0.244-0.366)	0.371 (0.294-0.472)	0.430 (0.334-0.560)	0.494 (0.374-0.659)	0.563 (0.414-0.772)	0.662 (0.467-0.948)	0.744 (0.507-1.10)
30-min	0.199 (0.165-0.243)	0.259 (0.215-0.316)	0.343 (0.283-0.419)	0.414 (0.339-0.510)	0.516 (0.409-0.657)	0.599 (0.465-0.780)	0.688 (0.521-0.917)	0.784 (0.577-1.07)	0.922 (0.651-1.32)	1.04 (0.706-1.54)
60-min	0.267 (0.221-0.325)	0.347 (0.288-0.423)	0.459 (0.379-0.561)	0.554 (0.454-0.682)	0.691 (0.547-0.880)	0.802 (0.622-1.04)	0.920 (0.697-1.23)	1.05 (0.772-1.44)	1.23 (0.871-1.77)	1.39 (0.945-2.06)
2-hr	0.386 (0.321-0.470)	0.496 (0.411-0.605)	0.649 (0.536-0.793)	0.779 (0.639-0.960)	0.968 (0.767-1.23)	1.12 (0.871-1.46)	1.29 (0.973-1.72)	1.46 (1.08-2.01)	1.72 (1.21-2.46)	1.92 (1.31-2.85)
3-hr	0.477 (0.396-0.581)	0.611 (0.506-0.744)	0.796 (0.658-0.972)	0.955 (0.783-1.18)	1.18 (0.939-1.51)	1.37 (1.06-1.78)	1.57 (1.19-2.10)	1.79 (1.31-2.45)	2.09 (1.48-3.00)	2.34 (1.60-3.47)
6-hr	0.664 (0.551-0.808)	0.850 (0.705-1.04)	1.11 (0.916-1.35)	1.33 (1.09-1.64)	1.64 (1.30-2.09)	1.90 (1.47-2.47)	2.17 (1.64-2.89)	2.46 (1.81-3.38)	2.87 (2.03-4.11)	3.21 (2.19-4.75)
12-hr	0.899 (0.746-1.09)	1.17 (0.972-1.43)	1.54 (1.28-1.89)	1.85 (1.52-2.29)	2.29 (1.82-2.92)	2.64 (2.05-3.44)	3.00 (2.27-4.01)	3.39 (2.49-4.65)	3.92 (2.77-5.62)	4.35 (2.97-6.45)
24-hr	1.20 (1.07-1.37)	1.59 (1.42-1.82)	2.12 (1.89-2.43)	2.56 (2.26-2.96)	3.17 (2.70-3.78)	3.64 (3.04-4.45)	4.13 (3.37-5.18)	4.65 (3.69-5.99)	5.37 (4.08-7.21)	5.94 (4.36-8.26)
2-day	1.52 (1.36-1.74)	2.02 (1.81-2.31)	2.70 (2.41-3.10)	3.27 (2.89-3.78)	4.06 (3.47-4.86)	4.69 (3.92-5.73)	5.34 (4.36-6.69)	6.03 (4.78-7.77)	6.99 (5.31-9.39)	7.76 (5.69-10.8)
3-day	1.69 (1.51-1.93)	2.25 (2.01-2.57)	3.01 (2.68-3.45)	3.65 (3.22-4.21)	4.54 (3.88-5.43)	5.25 (4.39-6.41)	6.00 (4.89-7.51)	6.79 (5.38-8.75)	7.91 (6.01-10.6)	8.80 (6.46-12.2)
4-day	1.85 (1.65-2.11)	2.45 (2.19-2.80)	3.28 (2.92-3.76)	3.98 (3.51-4.60)	4.96 (4.24-5.93)	5.75 (4.80-7.02)	6.57 (5.36-8.23)	7.45 (5.91-9.60)	8.69 (6.60-11.7)	9.69 (7.11-13.5)
7-day	2.20 (1.97-2.52)	2.90 (2.59-3.32)	3.87 (3.45-4.44)	4.69 (4.14-5.42)	5.86 (5.00-7.00)	6.79 (5.68-8.30)	7.78 (6.34-9.73)	8.82 (6.99-11.4)	10.3 (7.83-13.8)	11.5 (8.44-16.0)
10-day	2.42 (2.17-2.77)	3.19 (2.85-3.64)	4.24 (3.78-4.86)	5.14 (4.54-5.94)	6.42 (5.48-7.67)	7.44 (6.22-9.09)	8.52 (6.95-10.7)	9.67 (7.66-12.4)	11.3 (8.58-15.2)	12.6 (9.24-17.5)
20-day	3.09 (2.76-3.53)	4.08 (3.64-4.66)	5.43 (4.84-6.23)	6.58 (5.81-7.60)	8.20 (7.00-9.80)	9.49 (7.93-11.6)	10.8 (8.84-13.6)	12.3 (9.73-15.8)	14.3 (10.8-19.2)	15.9 (11.6-22.0)
30-day	3.69 (3.30-4.22)	4.88 (4.35-5.57)	6.49 (5.78-7.44)	7.85 (6.93-9.07)	9.76 (8.33-11.7)	11.3 (9.41-13.8)	12.8 (10.5-16.0)	14.5 (11.5-18.6)	16.7 (12.7-22.4)	18.5 (13.6-25.7)
45-day	4.53 (4.05-5.17)	5.97 (5.33-6.82)	7.92 (7.05-9.07)	9.54 (8.42-11.0)	11.8 (10.1-14.1)	13.6 (11.3-16.6)	15.4 (12.5-19.2)	17.2 (13.7-22.2)	19.8 (15.0-26.6)	21.8 (16.0-30.3)
60-day	5.38 (4.81-6.15)	7.08 (6.32-8.09)	9.34 (8.31-10.7)	11.2 (9.89-12.9)	13.8 (11.8-16.5)	15.8 (13.2-19.3)	17.8 (14.5-22.3)	19.9 (15.8-25.6)	22.7 (17.2-30.4)	24.8 (18.2-34.5)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) values and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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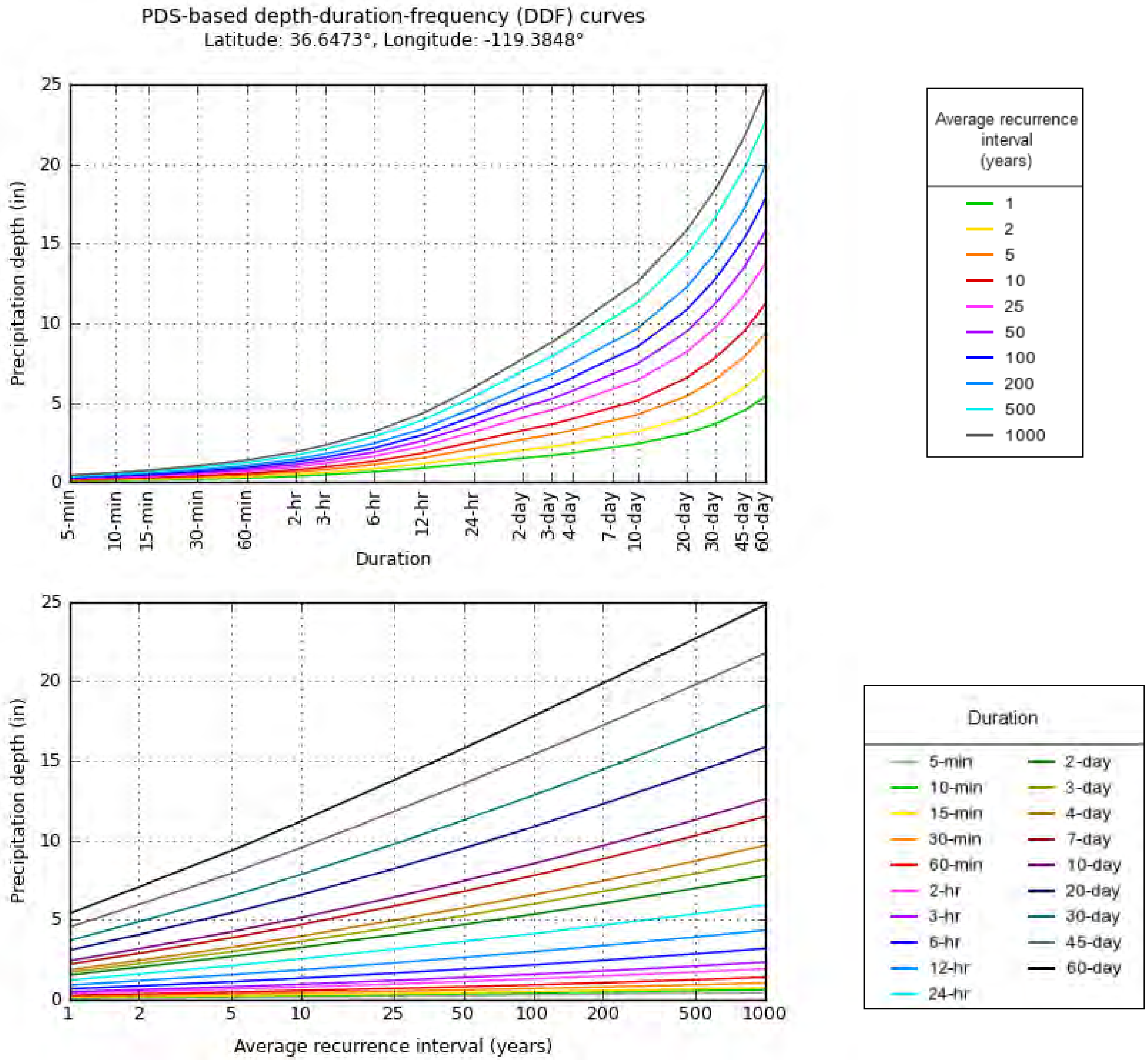
PF graphical



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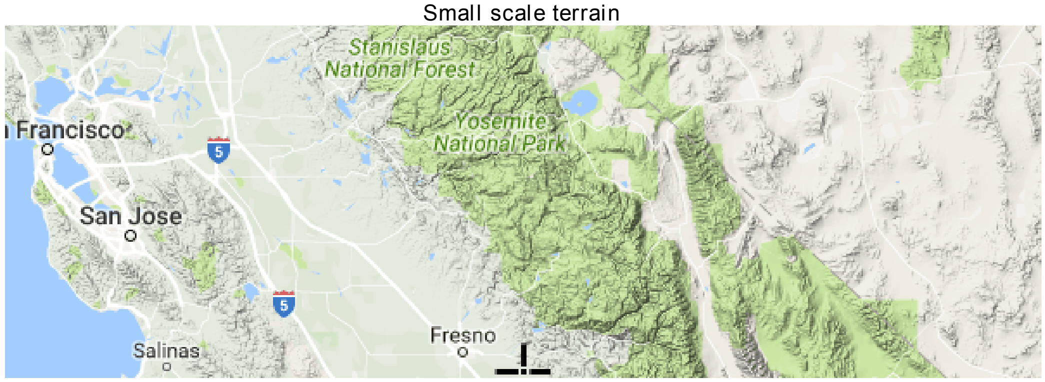
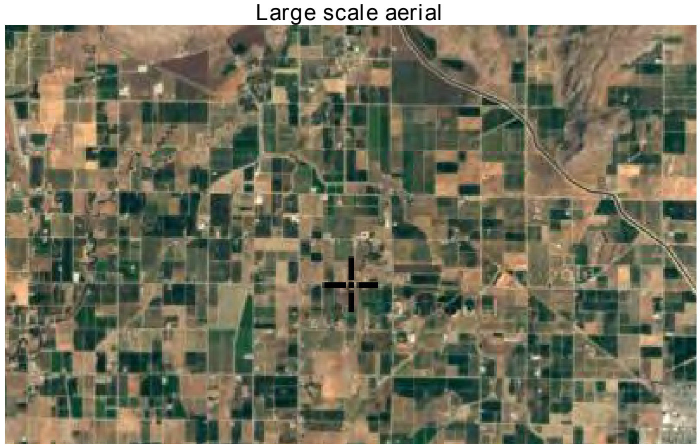
Small scale terrain



Large scale terrain

Large scale map

Large scale aerial



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NOAA Atlas 14, Volume 6, Version 2
Location name: Reedley, California, US*
Latitude: 36.6473°, Longitude: -119.3848°
Elevation: 382 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

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PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.996 (0.828-1.21)	1.30 (1.07-1.57)	1.70 (1.40-2.09)	2.05 (1.69-2.53)	2.57 (2.03-3.26)	2.98 (2.32-3.88)	3.42 (2.59-4.56)	3.90 (2.87-5.35)	4.58 (3.24-6.56)	5.15 (3.52-7.63)
10-min	0.708 (0.588-0.864)	0.924 (0.768-1.13)	1.22 (1.01-1.49)	1.48 (1.21-1.82)	1.84 (1.46-2.34)	2.14 (1.66-2.78)	2.45 (1.85-3.27)	2.79 (2.05-3.83)	3.28 (2.32-4.70)	3.69 (2.51-5.47)
15-min	0.572 (0.476-0.696)	0.744 (0.616-0.908)	0.984 (0.812-1.20)	1.19 (0.976-1.46)	1.48 (1.18-1.89)	1.72 (1.34-2.24)	1.98 (1.50-2.64)	2.25 (1.66-3.09)	2.65 (1.87-3.79)	2.98 (2.03-4.41)
30-min	0.398 (0.330-0.486)	0.518 (0.430-0.632)	0.686 (0.566-0.838)	0.828 (0.678-1.02)	1.03 (0.818-1.31)	1.20 (0.930-1.56)	1.38 (1.04-1.83)	1.57 (1.15-2.15)	1.84 (1.30-2.64)	2.07 (1.41-3.07)
60-min	0.267 (0.221-0.325)	0.347 (0.288-0.423)	0.459 (0.379-0.561)	0.554 (0.454-0.682)	0.691 (0.547-0.880)	0.802 (0.622-1.04)	0.920 (0.697-1.23)	1.05 (0.772-1.44)	1.23 (0.871-1.77)	1.39 (0.945-2.06)
2-hr	0.193 (0.160-0.235)	0.248 (0.206-0.302)	0.324 (0.268-0.396)	0.390 (0.320-0.480)	0.484 (0.384-0.617)	0.561 (0.436-0.730)	0.643 (0.486-0.858)	0.732 (0.538-1.00)	0.858 (0.606-1.23)	0.962 (0.656-1.43)
3-hr	0.159 (0.132-0.193)	0.203 (0.168-0.248)	0.265 (0.219-0.324)	0.318 (0.261-0.392)	0.394 (0.313-0.502)	0.457 (0.354-0.594)	0.523 (0.396-0.698)	0.595 (0.438-0.816)	0.697 (0.492-0.998)	0.781 (0.532-1.16)
6-hr	0.111 (0.092-0.135)	0.142 (0.118-0.173)	0.185 (0.153-0.226)	0.222 (0.182-0.273)	0.274 (0.218-0.350)	0.317 (0.246-0.413)	0.362 (0.274-0.483)	0.411 (0.302-0.564)	0.480 (0.339-0.687)	0.536 (0.365-0.794)
12-hr	0.075 (0.062-0.091)	0.097 (0.081-0.119)	0.128 (0.106-0.157)	0.154 (0.126-0.190)	0.190 (0.151-0.243)	0.219 (0.170-0.285)	0.249 (0.189-0.333)	0.281 (0.207-0.386)	0.326 (0.230-0.466)	0.361 (0.246-0.535)
24-hr	0.050 (0.045-0.057)	0.066 (0.059-0.076)	0.088 (0.079-0.101)	0.107 (0.094-0.123)	0.132 (0.113-0.158)	0.152 (0.127-0.185)	0.172 (0.140-0.216)	0.194 (0.154-0.250)	0.224 (0.170-0.301)	0.247 (0.182-0.344)
2-day	0.032 (0.028-0.036)	0.042 (0.038-0.048)	0.056 (0.050-0.065)	0.068 (0.060-0.079)	0.085 (0.072-0.101)	0.098 (0.082-0.119)	0.111 (0.091-0.139)	0.126 (0.100-0.162)	0.146 (0.111-0.196)	0.162 (0.119-0.225)
3-day	0.024 (0.021-0.027)	0.031 (0.028-0.036)	0.042 (0.037-0.048)	0.051 (0.045-0.059)	0.063 (0.054-0.075)	0.073 (0.061-0.089)	0.083 (0.068-0.104)	0.094 (0.075-0.121)	0.110 (0.083-0.147)	0.122 (0.090-0.170)
4-day	0.019 (0.017-0.022)	0.026 (0.023-0.029)	0.034 (0.030-0.039)	0.041 (0.037-0.048)	0.052 (0.044-0.062)	0.060 (0.050-0.073)	0.068 (0.056-0.086)	0.078 (0.062-0.100)	0.091 (0.069-0.122)	0.101 (0.074-0.140)
7-day	0.013 (0.012-0.015)	0.017 (0.015-0.020)	0.023 (0.021-0.026)	0.028 (0.025-0.032)	0.035 (0.030-0.042)	0.040 (0.034-0.049)	0.046 (0.038-0.058)	0.053 (0.042-0.068)	0.061 (0.047-0.082)	0.068 (0.050-0.095)
10-day	0.010 (0.009-0.012)	0.013 (0.012-0.015)	0.018 (0.016-0.020)	0.021 (0.019-0.025)	0.027 (0.023-0.032)	0.031 (0.026-0.038)	0.036 (0.029-0.044)	0.040 (0.032-0.052)	0.047 (0.036-0.063)	0.052 (0.039-0.073)
20-day	0.006 (0.006-0.007)	0.008 (0.008-0.010)	0.011 (0.010-0.013)	0.014 (0.012-0.016)	0.017 (0.015-0.020)	0.020 (0.017-0.024)	0.023 (0.018-0.028)	0.026 (0.020-0.033)	0.030 (0.023-0.040)	0.033 (0.024-0.046)
30-day	0.005 (0.005-0.006)	0.007 (0.006-0.008)	0.009 (0.008-0.010)	0.011 (0.010-0.013)	0.014 (0.012-0.016)	0.016 (0.013-0.019)	0.018 (0.015-0.022)	0.020 (0.016-0.026)	0.023 (0.018-0.031)	0.026 (0.019-0.036)
45-day	0.004 (0.004-0.005)	0.006 (0.005-0.006)	0.007 (0.007-0.008)	0.009 (0.008-0.010)	0.011 (0.009-0.013)	0.013 (0.010-0.015)	0.014 (0.012-0.018)	0.016 (0.013-0.021)	0.018 (0.014-0.025)	0.020 (0.015-0.028)
60-day	0.004 (0.003-0.004)	0.005 (0.004-0.006)	0.006 (0.006-0.007)	0.008 (0.007-0.009)	0.010 (0.008-0.011)	0.011 (0.009-0.013)	0.012 (0.010-0.015)	0.014 (0.011-0.018)	0.016 (0.012-0.021)	0.017 (0.013-0.024)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

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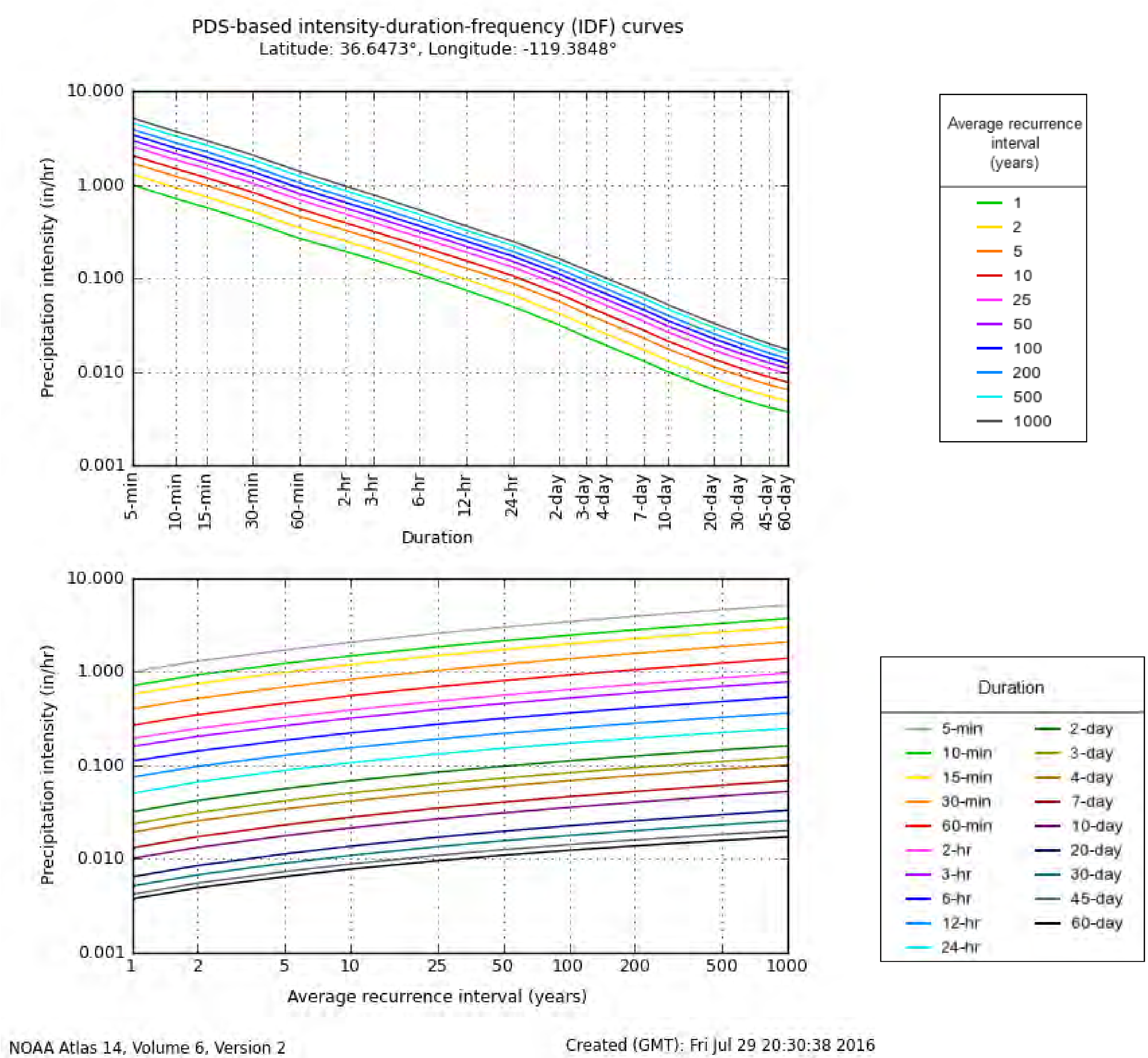
PF graphical



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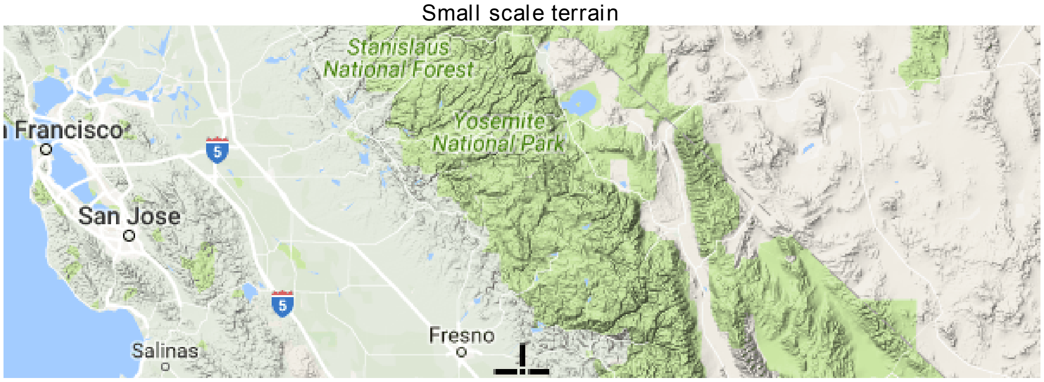
Maps & aerials

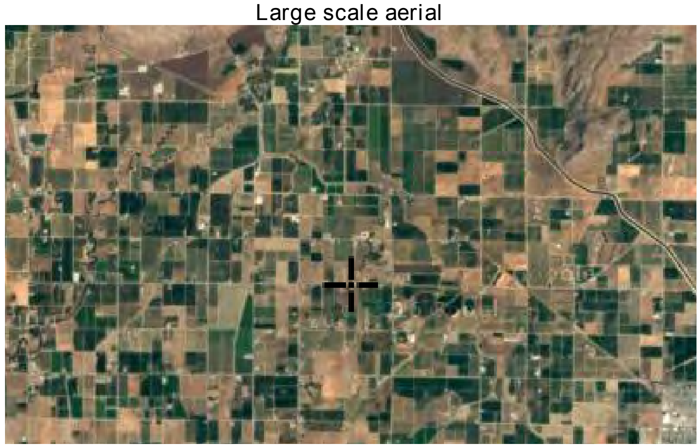
Small scale terrain



Large scale terrain

Large scale map

Large scale aerial



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NOAA Atlas 14, Volume 6, Version 2
Location name: Reedley, California, US*
Latitude: 36.6112°, Longitude: -119.4043°
Elevation: 356 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

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PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.081 (0.068-0.099)	0.106 (0.088-0.129)	0.140 (0.116-0.171)	0.169 (0.139-0.208)	0.211 (0.168-0.269)	0.246 (0.191-0.320)	0.283 (0.214-0.377)	0.323 (0.237-0.443)	0.381 (0.268-0.545)	0.429 (0.292-0.636)
10-min	0.117 (0.097-0.142)	0.152 (0.126-0.185)	0.201 (0.166-0.245)	0.243 (0.199-0.299)	0.303 (0.240-0.386)	0.352 (0.274-0.459)	0.405 (0.307-0.541)	0.463 (0.340-0.635)	0.546 (0.385-0.782)	0.614 (0.418-0.912)
15-min	0.141 (0.117-0.172)	0.184 (0.152-0.224)	0.243 (0.201-0.296)	0.293 (0.241-0.361)	0.366 (0.291-0.467)	0.426 (0.331-0.555)	0.490 (0.371-0.654)	0.560 (0.412-0.768)	0.660 (0.465-0.945)	0.743 (0.506-1.10)
30-min	0.196 (0.163-0.238)	0.255 (0.212-0.311)	0.337 (0.279-0.412)	0.407 (0.334-0.502)	0.509 (0.404-0.648)	0.592 (0.459-0.770)	0.681 (0.515-0.908)	0.777 (0.572-1.07)	0.917 (0.646-1.31)	1.03 (0.702-1.53)
60-min	0.264 (0.219-0.321)	0.343 (0.285-0.418)	0.454 (0.375-0.554)	0.548 (0.450-0.675)	0.685 (0.543-0.872)	0.796 (0.618-1.04)	0.916 (0.693-1.22)	1.04 (0.769-1.44)	1.23 (0.869-1.77)	1.39 (0.945-2.06)
2-hr	0.381 (0.317-0.464)	0.490 (0.406-0.596)	0.641 (0.530-0.782)	0.771 (0.632-0.949)	0.959 (0.760-1.22)	1.11 (0.864-1.45)	1.28 (0.967-1.71)	1.46 (1.07-2.00)	1.71 (1.21-2.45)	1.93 (1.31-2.86)
3-hr	0.470 (0.391-0.572)	0.602 (0.500-0.733)	0.786 (0.650-0.959)	0.944 (0.775-1.16)	1.17 (0.930-1.49)	1.36 (1.06-1.77)	1.56 (1.18-2.08)	1.78 (1.31-2.44)	2.09 (1.47-2.99)	2.35 (1.60-3.48)
6-hr	0.652 (0.541-0.792)	0.835 (0.693-1.02)	1.09 (0.902-1.33)	1.31 (1.07-1.61)	1.62 (1.29-2.07)	1.88 (1.46-2.44)	2.15 (1.63-2.87)	2.44 (1.80-3.35)	2.86 (2.02-4.10)	3.21 (2.18-4.76)
12-hr	0.879 (0.730-1.07)	1.14 (0.949-1.39)	1.51 (1.25-1.84)	1.81 (1.49-2.23)	2.25 (1.78-2.86)	2.59 (2.01-3.37)	2.96 (2.24-3.95)	3.35 (2.46-4.60)	3.90 (2.75-5.58)	4.34 (2.96-6.44)
24-hr	1.17 (1.04-1.33)	1.55 (1.38-1.77)	2.06 (1.83-2.36)	2.48 (2.19-2.87)	3.08 (2.62-3.68)	3.55 (2.96-4.34)	4.04 (3.29-5.07)	4.57 (3.61-5.89)	5.30 (4.01-7.13)	5.89 (4.31-8.21)
2-day	1.48 (1.32-1.69)	1.96 (1.75-2.23)	2.60 (2.32-2.98)	3.15 (2.78-3.64)	3.91 (3.34-4.68)	4.52 (3.77-5.53)	5.16 (4.20-6.47)	5.84 (4.62-7.53)	6.79 (5.15-9.14)	7.55 (5.53-10.5)
3-day	1.65 (1.47-1.88)	2.17 (1.94-2.48)	2.89 (2.58-3.32)	3.50 (3.09-4.05)	4.36 (3.72-5.22)	5.05 (4.21-6.17)	5.77 (4.69-7.23)	6.54 (5.17-8.43)	7.62 (5.77-10.3)	8.50 (6.21-11.9)
4-day	1.80 (1.61-2.05)	2.37 (2.11-2.71)	3.15 (2.81-3.62)	3.82 (3.37-4.41)	4.76 (4.06-5.69)	5.51 (4.60-6.74)	6.30 (5.13-7.90)	7.15 (5.66-9.23)	8.35 (6.33-11.2)	9.32 (6.82-13.0)
7-day	2.14 (1.91-2.44)	2.80 (2.50-3.20)	3.71 (3.31-4.26)	4.49 (3.96-5.19)	5.60 (4.78-6.70)	6.50 (5.42-7.94)	7.44 (6.05-9.32)	8.45 (6.68-10.9)	9.88 (7.49-13.3)	11.0 (8.08-15.4)
10-day	2.35 (2.10-2.69)	3.07 (2.74-3.51)	4.07 (3.62-4.66)	4.92 (4.34-5.68)	6.13 (5.23-7.33)	7.11 (5.93-8.69)	8.14 (6.63-10.2)	9.24 (7.31-11.9)	10.8 (8.20-14.6)	12.1 (8.84-16.9)
20-day	2.99 (2.67-3.42)	3.92 (3.50-4.48)	5.20 (4.62-5.96)	6.28 (5.54-7.26)	7.82 (6.67-9.35)	9.04 (7.55-11.1)	10.3 (8.41-13.0)	11.7 (9.26-15.1)	13.6 (10.3-18.3)	15.2 (11.1-21.2)
30-day	3.58 (3.20-4.08)	4.69 (4.19-5.36)	6.21 (5.53-7.13)	7.50 (6.62-8.67)	9.31 (7.94-11.1)	10.7 (8.97-13.1)	12.2 (9.96-15.3)	13.8 (10.9-17.8)	16.0 (12.1-21.5)	17.7 (12.9-24.7)
45-day	4.38 (3.91-5.00)	5.74 (5.13-6.56)	7.59 (6.75-8.70)	9.12 (8.05-10.5)	11.3 (9.61-13.5)	12.9 (10.8-15.8)	14.7 (11.9-18.4)	16.5 (13.0-21.2)	18.9 (14.3-25.5)	20.8 (15.2-29.0)
60-day	5.19 (4.64-5.93)	6.80 (6.07-7.77)	8.95 (7.96-10.3)	10.7 (9.46-12.4)	13.2 (11.2-15.7)	15.1 (12.6-18.4)	17.0 (13.8-21.3)	19.0 (15.0-24.5)	21.7 (16.4-29.2)	23.7 (17.3-33.1)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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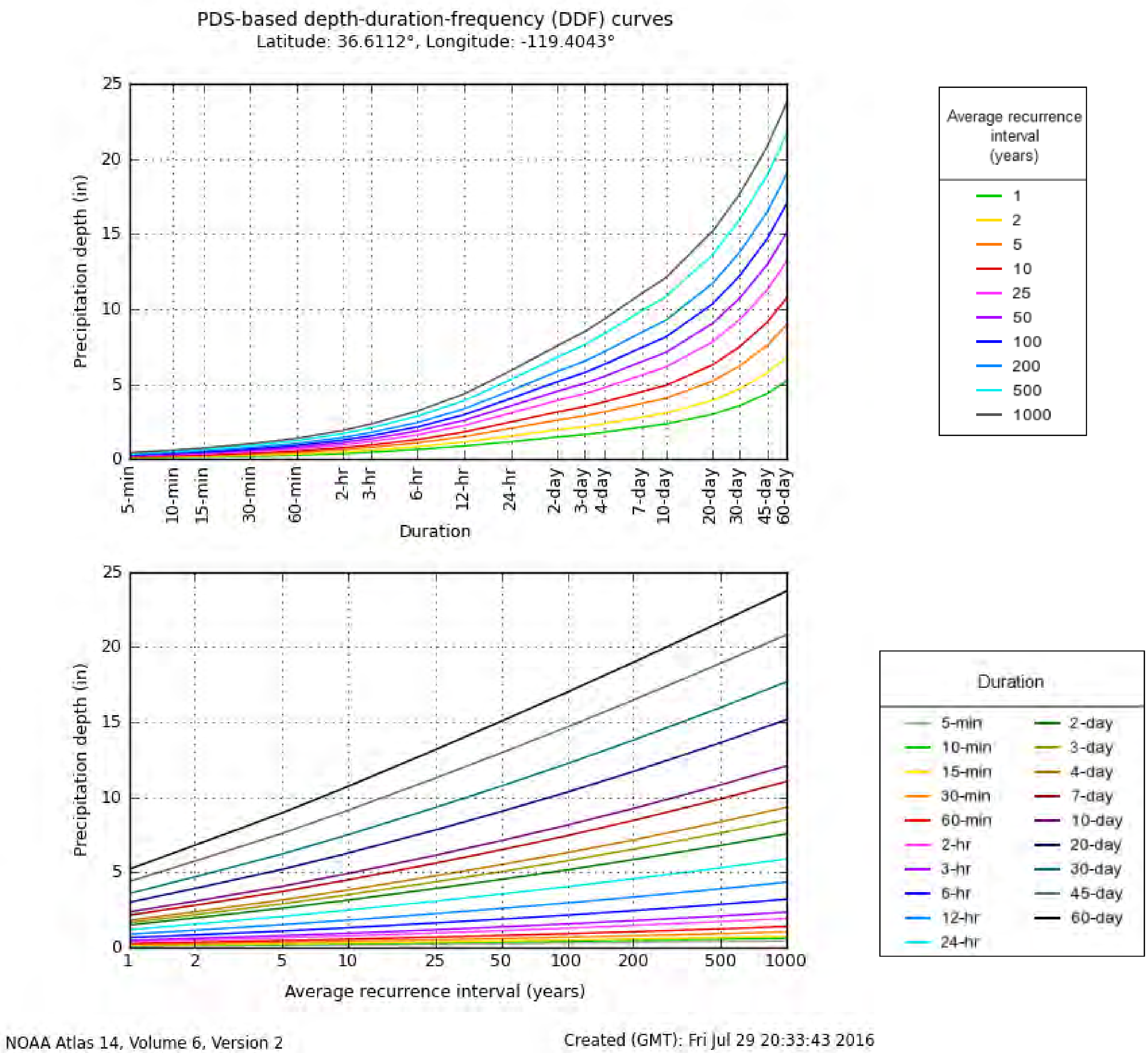
PF graphical



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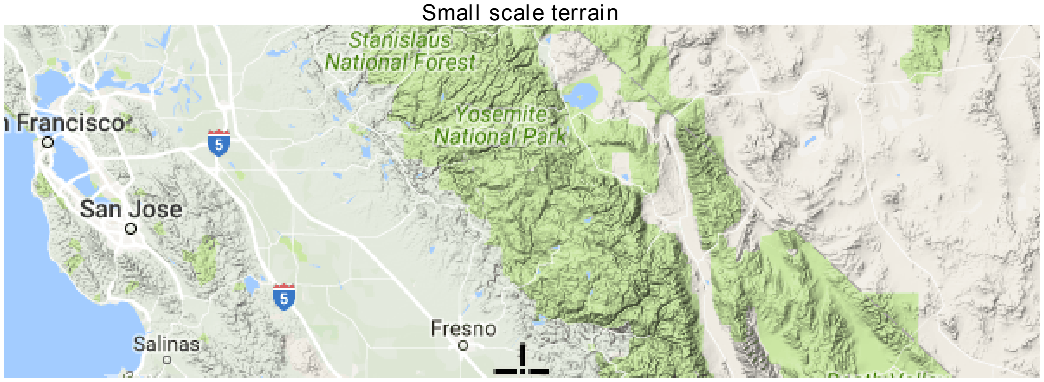
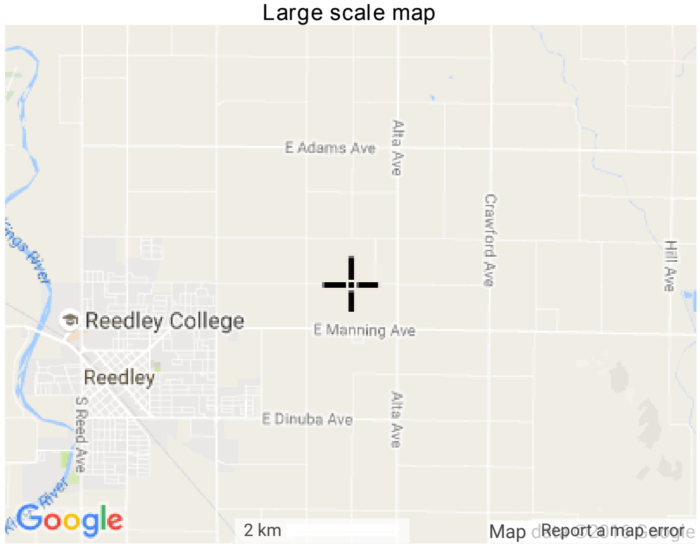
Maps & aerials

Small scale terrain

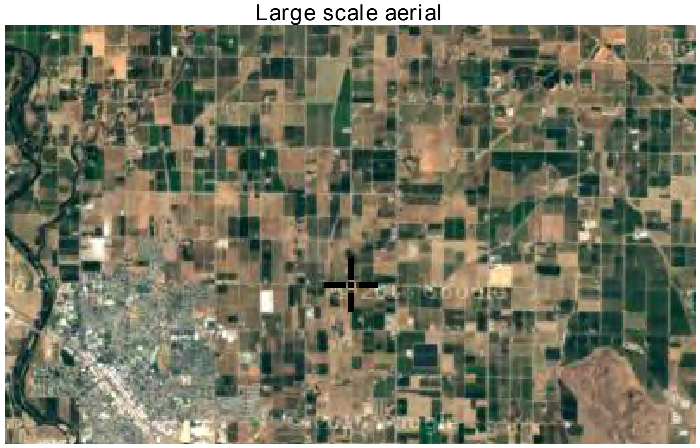


Large scale terrain

Large scale map



Large scale aerial



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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

NOAA Atlas 14, Volume 6, Version 2
Location name: Reedley, California, US*
Latitude: 36.6112°, Longitude: -119.4043°
Elevation: 356 ft*
* source: Google Maps

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.972 (0.816-1.19)	1.27 (1.06-1.55)	1.68 (1.39-2.05)	2.03 (1.67-2.50)	2.53 (2.02-3.23)	2.95 (2.29-3.84)	3.40 (2.57-4.52)	3.88 (2.84-5.32)	4.57 (3.22-6.54)	5.15 (3.50-7.63)
10-min	0.702 (0.582-0.852)	0.912 (0.756-1.11)	1.21 (0.996-1.47)	1.46 (1.19-1.79)	1.82 (1.44-2.32)	2.11 (1.64-2.75)	2.43 (1.84-3.25)	2.78 (2.04-3.81)	3.28 (2.31-4.69)	3.68 (2.51-5.47)
15-min	0.564 (0.468-0.688)	0.736 (0.608-0.896)	0.972 (0.804-1.18)	1.17 (0.964-1.44)	1.46 (1.16-1.87)	1.70 (1.32-2.22)	1.96 (1.48-2.62)	2.24 (1.65-3.07)	2.64 (1.86-3.78)	2.97 (2.02-4.41)
30-min	0.392 (0.326-0.476)	0.510 (0.424-0.622)	0.674 (0.558-0.824)	0.814 (0.668-1.00)	1.02 (0.808-1.30)	1.18 (0.918-1.54)	1.36 (1.03-1.82)	1.55 (1.14-2.13)	1.83 (1.29-2.63)	2.06 (1.40-3.06)
60-min	0.264 (0.219-0.321)	0.343 (0.285-0.418)	0.454 (0.375-0.554)	0.548 (0.450-0.675)	0.685 (0.543-0.872)	0.796 (0.618-1.04)	0.916 (0.693-1.22)	1.04 (0.769-1.44)	1.23 (0.869-1.77)	1.39 (0.945-2.06)
2-hr	0.190 (0.158-0.232)	0.245 (0.203-0.298)	0.320 (0.265-0.391)	0.386 (0.316-0.474)	0.480 (0.380-0.610)	0.556 (0.432-0.724)	0.639 (0.484-0.852)	0.728 (0.536-1.00)	0.856 (0.604-1.23)	0.962 (0.655-1.43)
3-hr	0.157 (0.130-0.190)	0.200 (0.166-0.244)	0.262 (0.216-0.319)	0.314 (0.258-0.387)	0.391 (0.310-0.498)	0.453 (0.352-0.589)	0.520 (0.393-0.693)	0.592 (0.436-0.813)	0.696 (0.491-0.997)	0.781 (0.531-1.16)
6-hr	0.109 (0.090-0.132)	0.139 (0.116-0.170)	0.182 (0.151-0.222)	0.218 (0.179-0.269)	0.271 (0.215-0.345)	0.314 (0.243-0.408)	0.359 (0.272-0.479)	0.408 (0.300-0.560)	0.478 (0.337-0.685)	0.535 (0.364-0.794)
12-hr	0.073 (0.061-0.089)	0.095 (0.079-0.116)	0.125 (0.103-0.153)	0.150 (0.123-0.185)	0.186 (0.148-0.237)	0.215 (0.167-0.280)	0.246 (0.186-0.328)	0.278 (0.204-0.381)	0.323 (0.228-0.463)	0.360 (0.245-0.535)
24-hr	0.049 (0.044-0.056)	0.064 (0.058-0.074)	0.086 (0.076-0.098)	0.103 (0.091-0.119)	0.128 (0.109-0.153)	0.148 (0.123-0.181)	0.168 (0.137-0.211)	0.190 (0.150-0.245)	0.221 (0.167-0.297)	0.245 (0.179-0.342)
2-day	0.031 (0.028-0.035)	0.041 (0.036-0.047)	0.054 (0.048-0.062)	0.066 (0.058-0.076)	0.082 (0.070-0.098)	0.094 (0.079-0.115)	0.108 (0.087-0.135)	0.122 (0.096-0.157)	0.141 (0.107-0.190)	0.157 (0.115-0.220)
3-day	0.023 (0.020-0.026)	0.030 (0.027-0.035)	0.040 (0.036-0.046)	0.049 (0.043-0.056)	0.061 (0.052-0.072)	0.070 (0.059-0.086)	0.080 (0.065-0.100)	0.091 (0.072-0.117)	0.106 (0.080-0.142)	0.118 (0.086-0.165)
4-day	0.019 (0.017-0.021)	0.025 (0.022-0.028)	0.033 (0.029-0.038)	0.040 (0.035-0.046)	0.050 (0.042-0.059)	0.057 (0.048-0.070)	0.066 (0.053-0.082)	0.075 (0.059-0.096)	0.087 (0.066-0.117)	0.097 (0.071-0.135)
7-day	0.013 (0.011-0.015)	0.017 (0.015-0.019)	0.022 (0.020-0.025)	0.027 (0.024-0.031)	0.033 (0.028-0.040)	0.039 (0.032-0.047)	0.044 (0.036-0.056)	0.050 (0.040-0.065)	0.059 (0.045-0.079)	0.066 (0.048-0.092)
10-day	0.010 (0.009-0.011)	0.013 (0.011-0.015)	0.017 (0.015-0.019)	0.020 (0.018-0.024)	0.026 (0.022-0.031)	0.030 (0.025-0.036)	0.034 (0.028-0.043)	0.039 (0.030-0.050)	0.045 (0.034-0.061)	0.050 (0.037-0.070)
20-day	0.006 (0.006-0.007)	0.008 (0.007-0.009)	0.011 (0.010-0.012)	0.013 (0.012-0.015)	0.016 (0.014-0.019)	0.019 (0.016-0.023)	0.022 (0.018-0.027)	0.024 (0.019-0.031)	0.028 (0.022-0.038)	0.032 (0.023-0.044)
30-day	0.005 (0.004-0.006)	0.007 (0.006-0.007)	0.009 (0.008-0.010)	0.010 (0.009-0.012)	0.013 (0.011-0.015)	0.015 (0.012-0.018)	0.017 (0.014-0.021)	0.019 (0.015-0.025)	0.022 (0.017-0.030)	0.025 (0.018-0.034)
45-day	0.004 (0.004-0.005)	0.005 (0.005-0.006)	0.007 (0.006-0.008)	0.008 (0.007-0.010)	0.010 (0.009-0.012)	0.012 (0.010-0.015)	0.014 (0.011-0.017)	0.015 (0.012-0.020)	0.018 (0.013-0.024)	0.019 (0.014-0.027)
60-day	0.004 (0.003-0.004)	0.005 (0.004-0.005)	0.006 (0.006-0.007)	0.007 (0.007-0.009)	0.009 (0.008-0.011)	0.010 (0.009-0.013)	0.012 (0.010-0.015)	0.013 (0.010-0.017)	0.015 (0.011-0.020)	0.016 (0.012-0.023)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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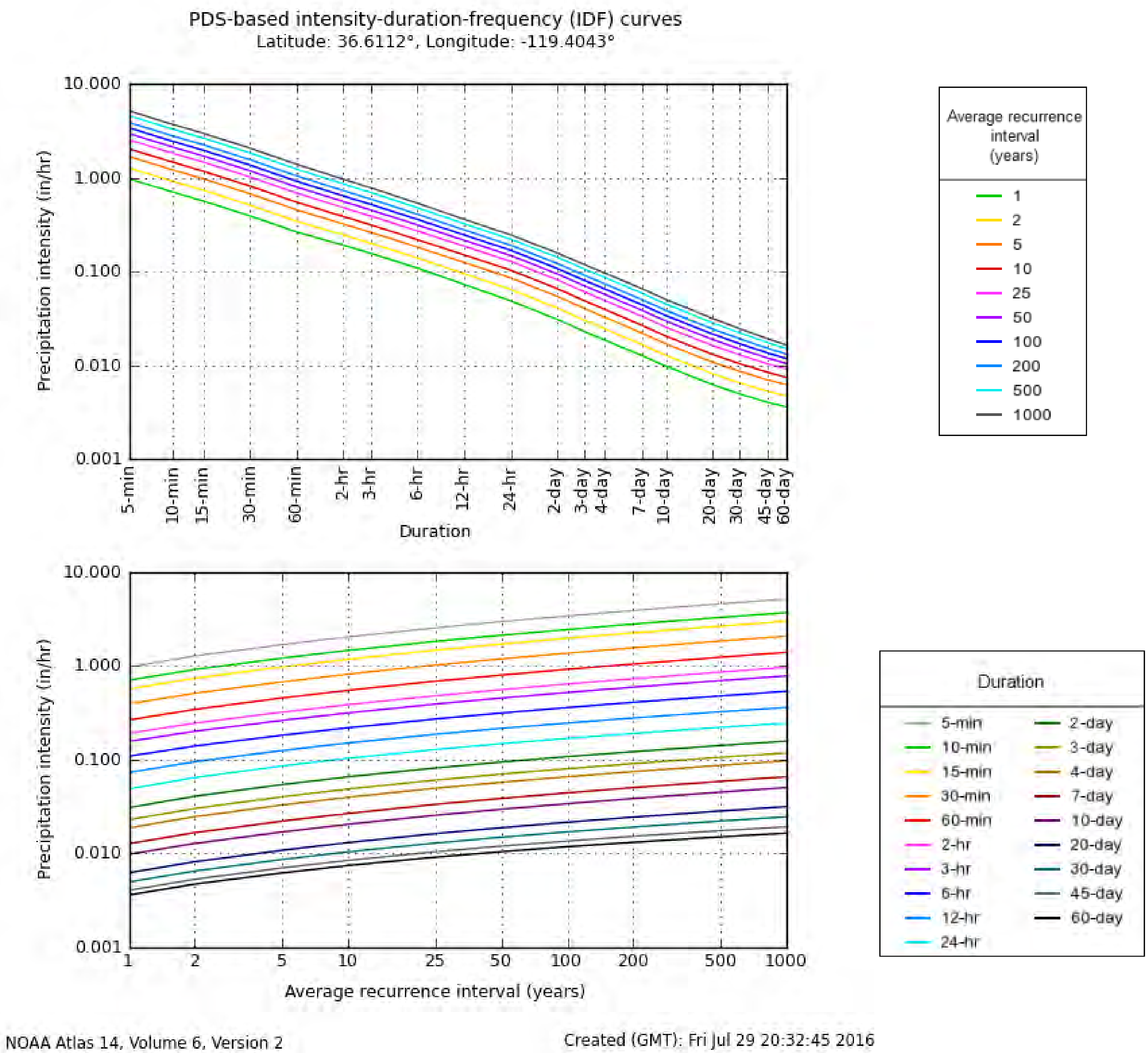
PF graphical



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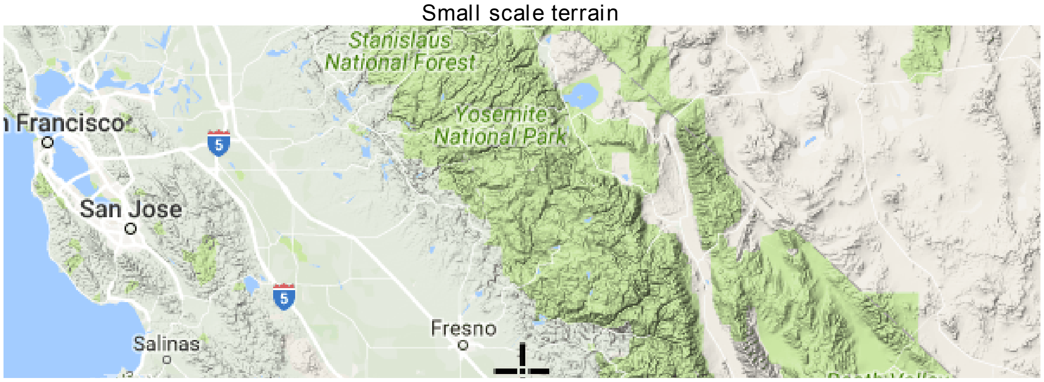
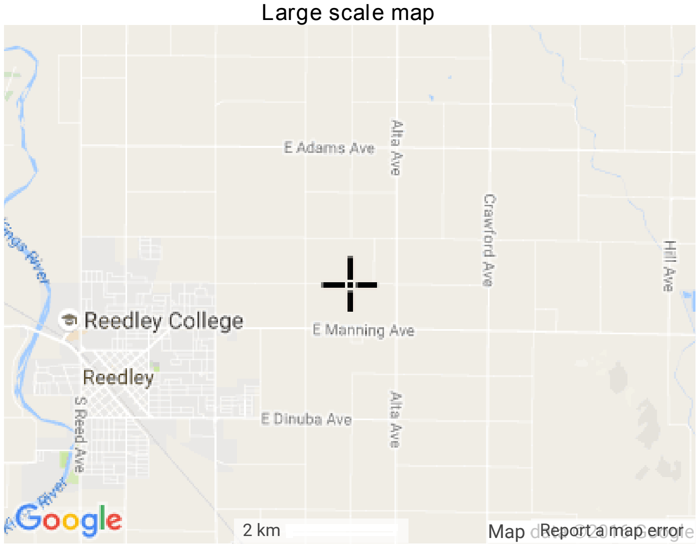
Maps & aerials

Small scale terrain



Large scale terrain

Large scale map



Large scale aerial

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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Appendix D: FEMA FIRM 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 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 tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables 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 California State Plane Zone IV (FIPS 404). The **horizontal datum** was NAD 83, GRS80 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 transportation information shown on this FIRM was provided in digital format from Fresno County. Public Land Survey System information was derived from U.S. Geological Survey Digital Orthophoto Quadrangles produced at a scale of 1:12,000 from photography dated 1997 or later.

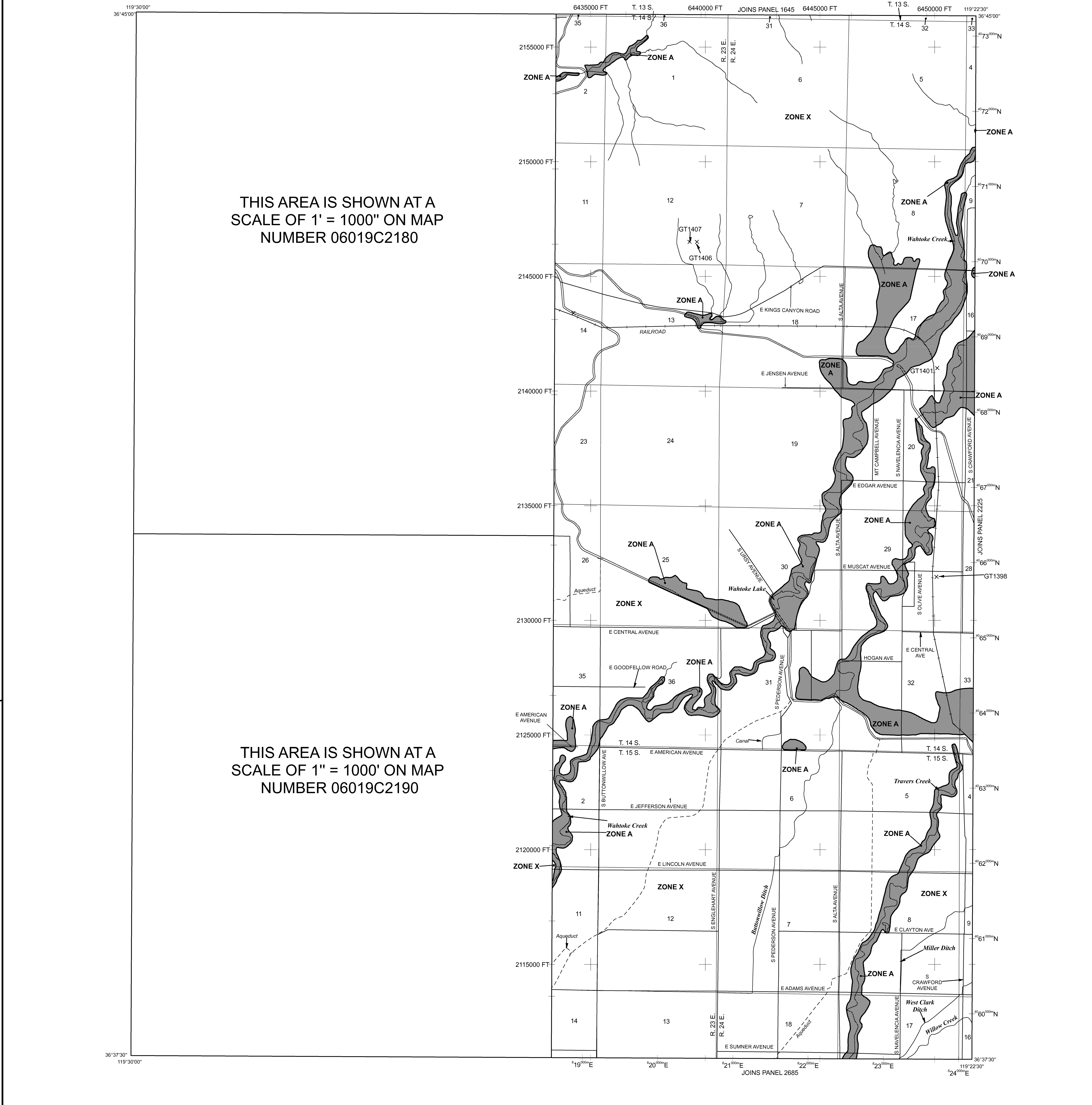
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to confirm to these new stream channel configurations. As a result,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

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

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

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

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



LEGEND

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

The 1% annual 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	Area to be protected from 1% annual chance flood 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.

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
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
2476000mN	1000-meter Universal Transverse Mercator grid values, zone 10
600000 FT	5000-foot grid ticks: California State Plane coordinate system, zone IV (FIPSZONE 0404), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
●M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
July 19, 2001

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
February 18, 2009 - to update corporate limits, to change base flood elevations, floodway, and Special Flood Hazard Areas, to add roads and road names and to incorporate previously issued Letters of Map Revision

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.

N

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2200H

FIRM
FLOOD INSURANCE RATE MAP

FRESNO COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 2200 OF 3525

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
FRESNO COUNTY	065029	2200	H

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
06019C2200H

MAP REVISED
FEBRUARY 18, 2009

Federal Emergency Management Agency

NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables 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 California State Plane Zone IV (FIPS 404). The **horizontal datum** was NAD 83, GRS80 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 transportation information shown on this FIRM was provided in digital format from Fresno County. Public Land Survey System information was derived from U.S. Geological Survey Digital Orthophoto Quadrangles produced at a scale of 1:12,000 from photography dated 1997 or later.

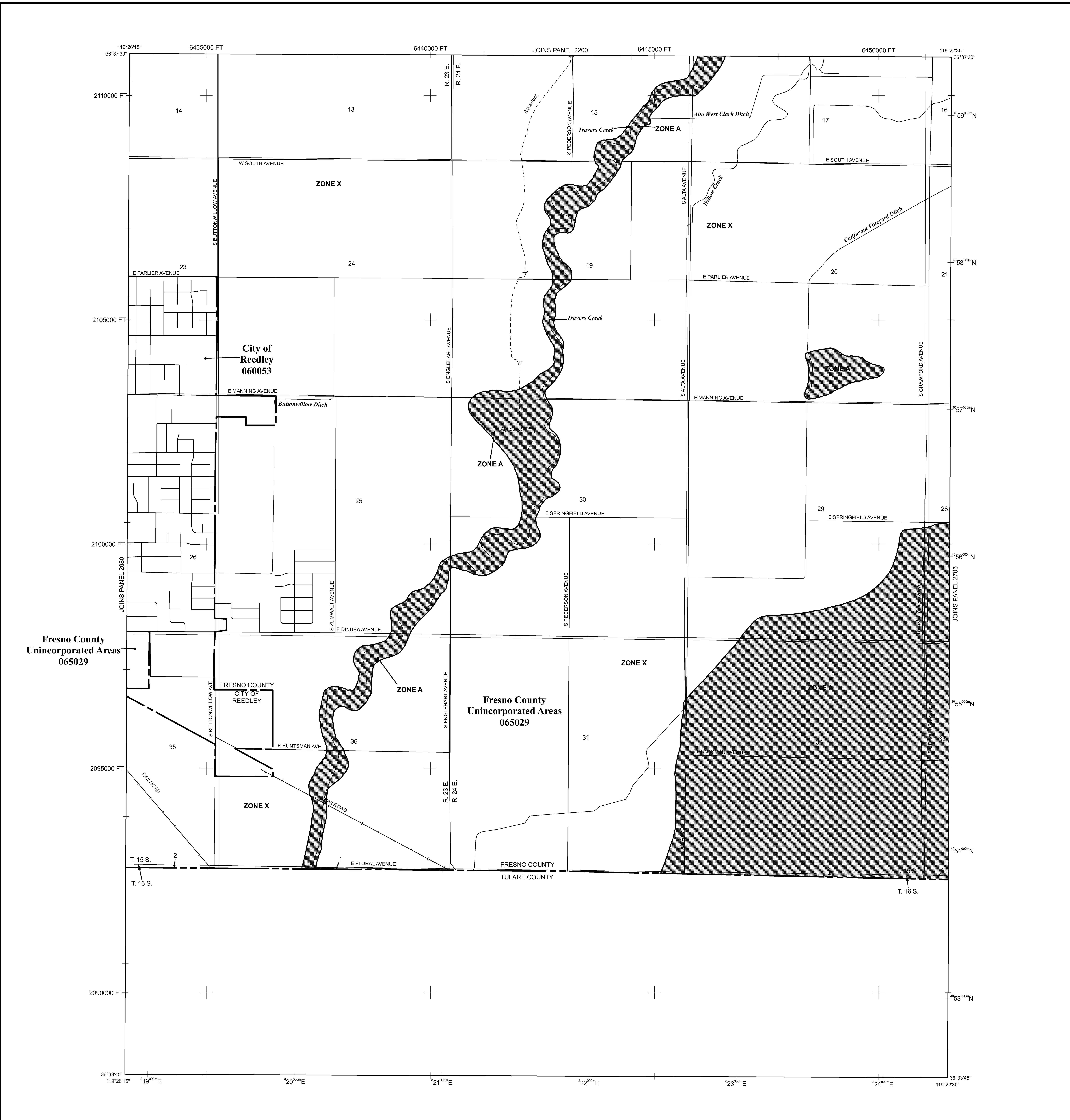
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to confirm to these new stream channel configurations. As a result,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

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

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

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

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



LEGEND

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

The 1% annual 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	Area to be protected from 1% annual chance flood 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.

	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
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{24}76^{000m}$N	1000-meter Universal Transverse Mercator grid values, zone 10
600000 FT	5000-foot grid ticks: California State Plane coordinate system, zone IV (FIPSZONE 0404), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
● M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
July 19, 2001

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
February 18, 2009 - to update corporate limits, to change base flood elevations, floodway, and Special Flood Hazard Areas, to add roads and road names and to incorporate previously issued Letters of Map Revision

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" = 1000'

500 0 1000 2000 FEET
300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2685H

FIRM
FLOOD INSURANCE RATE MAP

FRESNO COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 2685 OF 3525

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
FRESNO COUNTY	065029	2685	H
REEDLEY, CITY OF	060053	2685	H

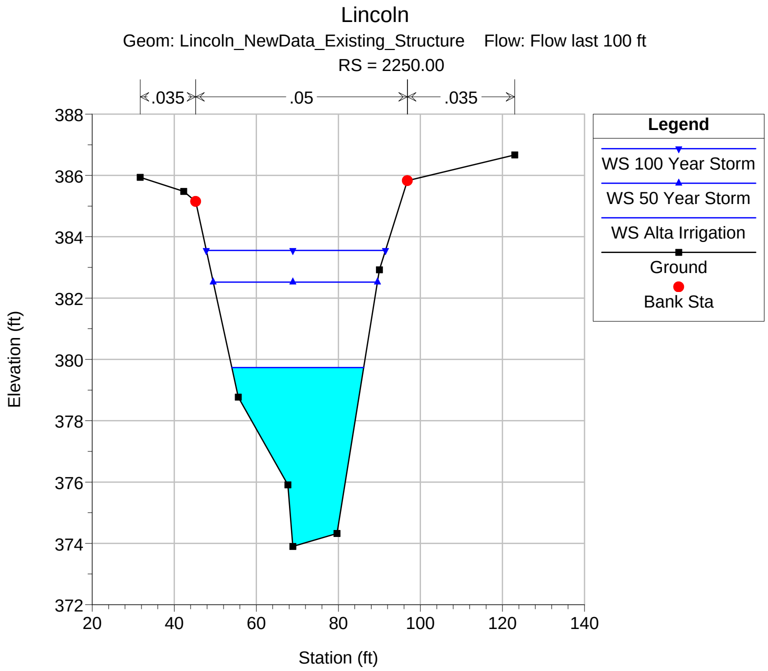
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06019C2685H

MAP REVISED
FEBRUARY 18, 2009

Federal Emergency Management Agency

Appendix E: HEC-RAS Output for Lincoln Avenue Existing Structure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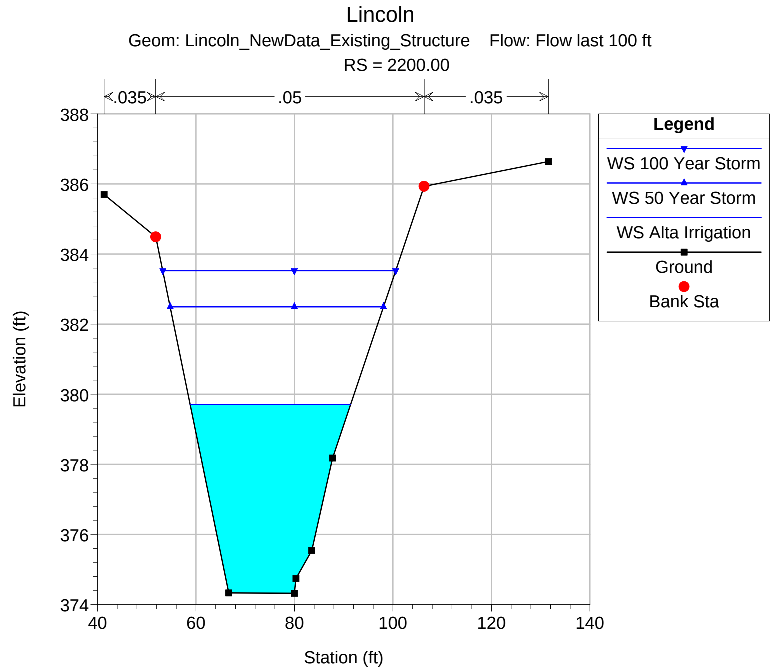
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)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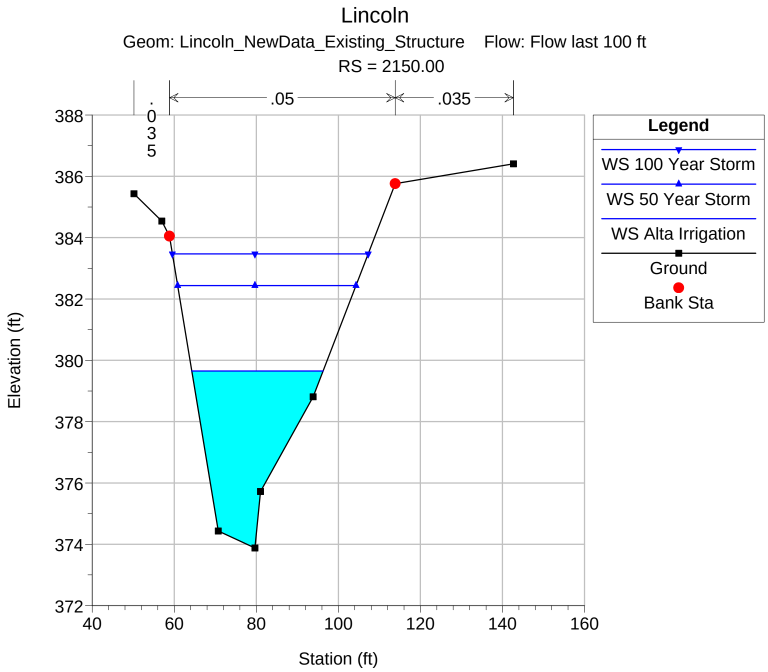
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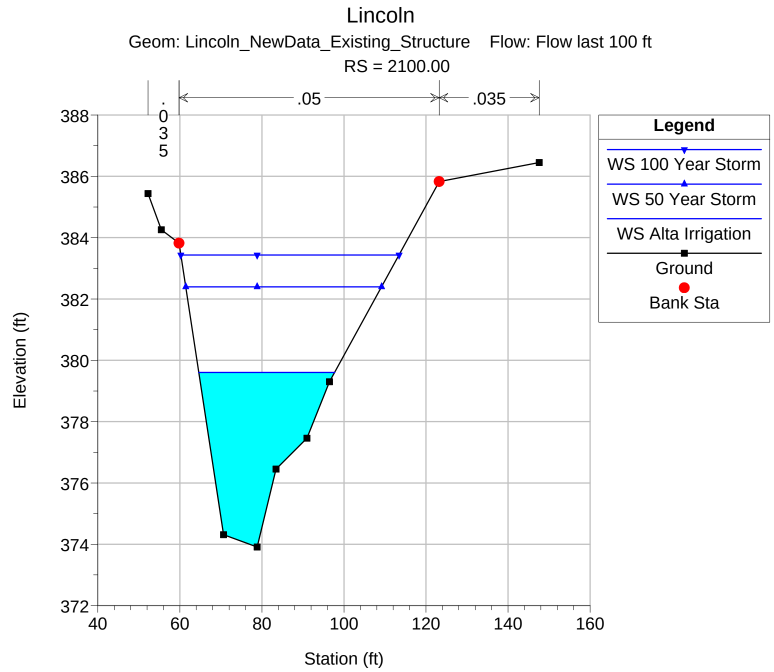
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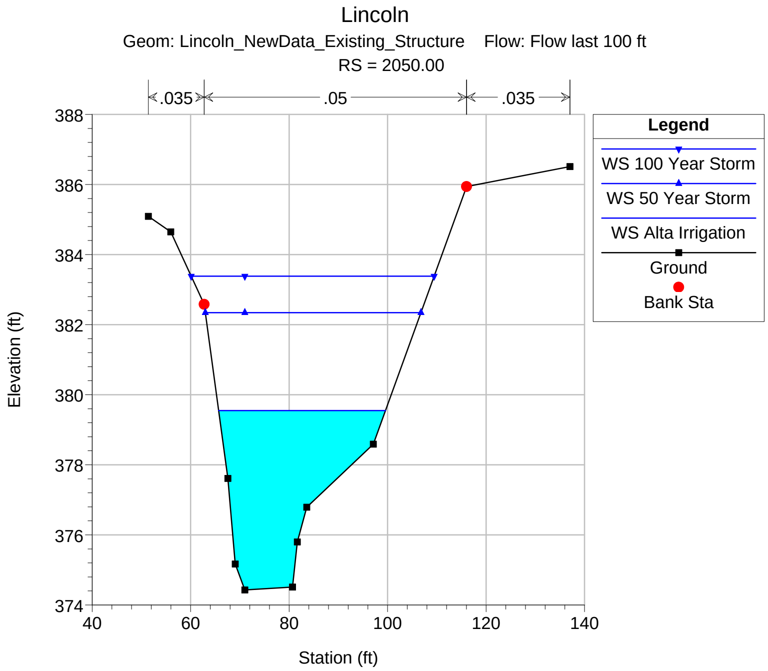
Station (ft)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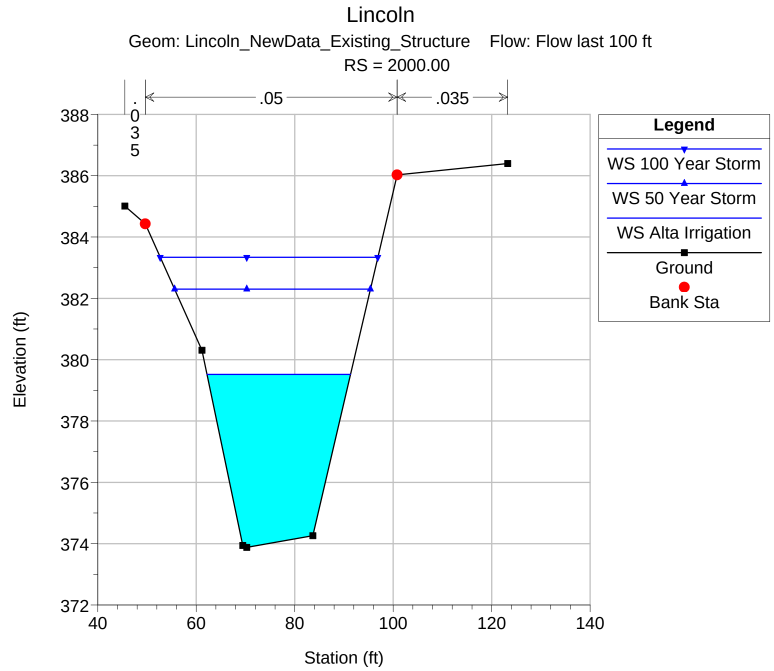
Station (ft)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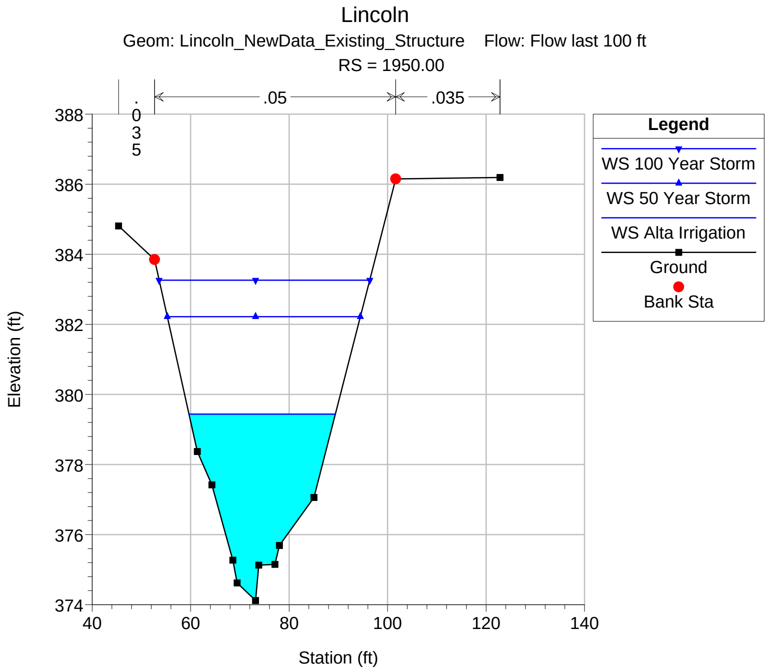
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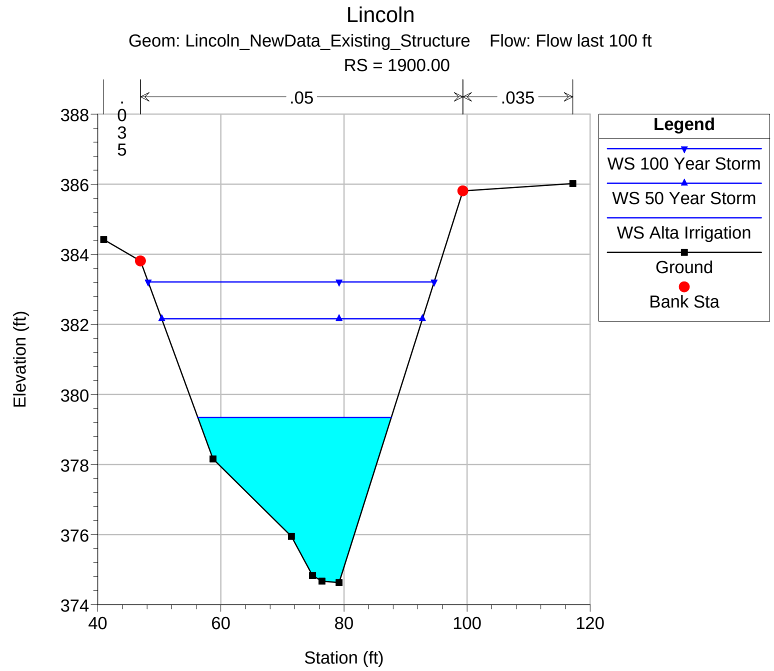
Station (ft)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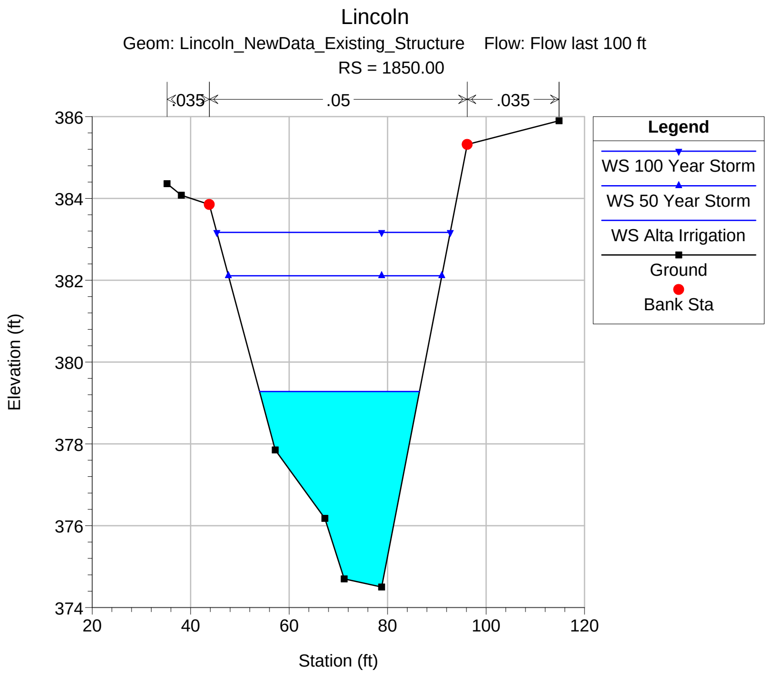
Station (ft)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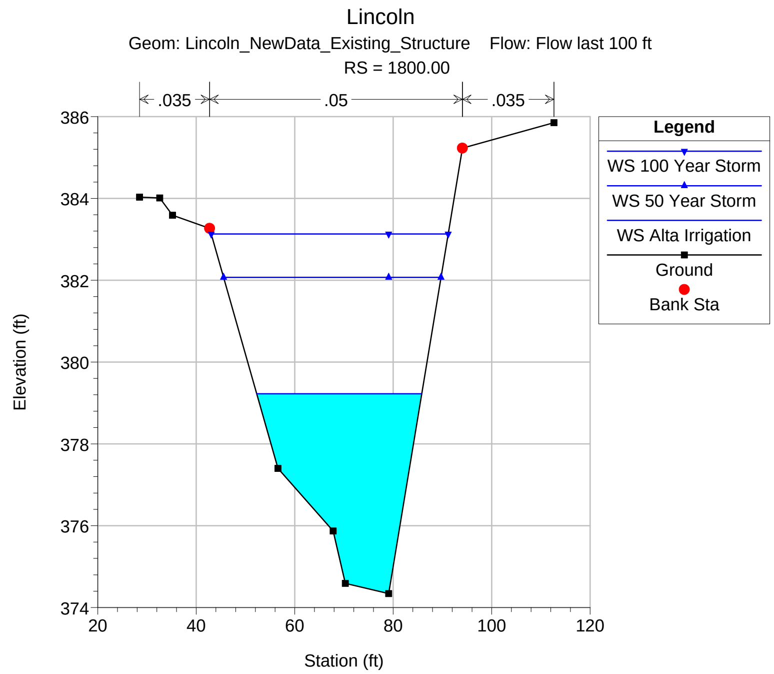
Station (ft)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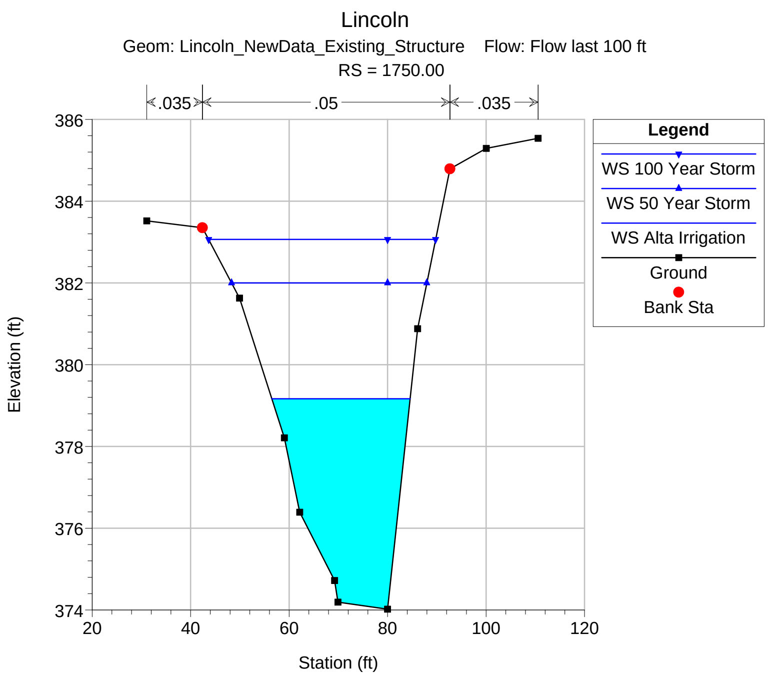
Station (ft)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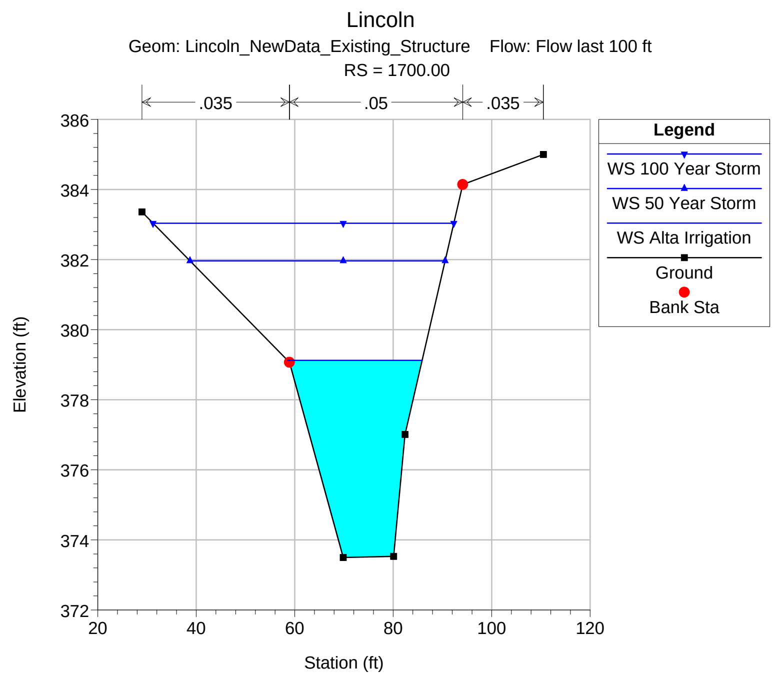
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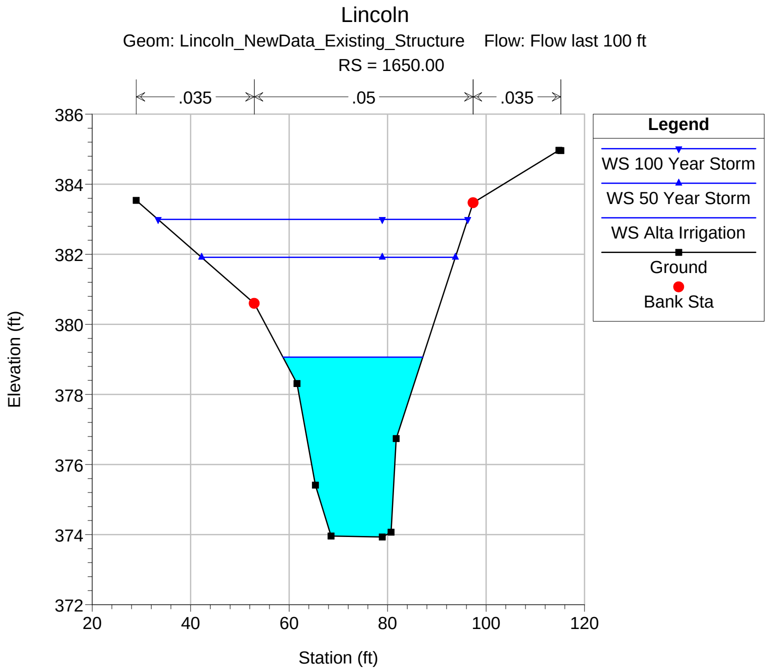
Station (ft)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WS Alta Irrigation
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Station (ft)
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384
382
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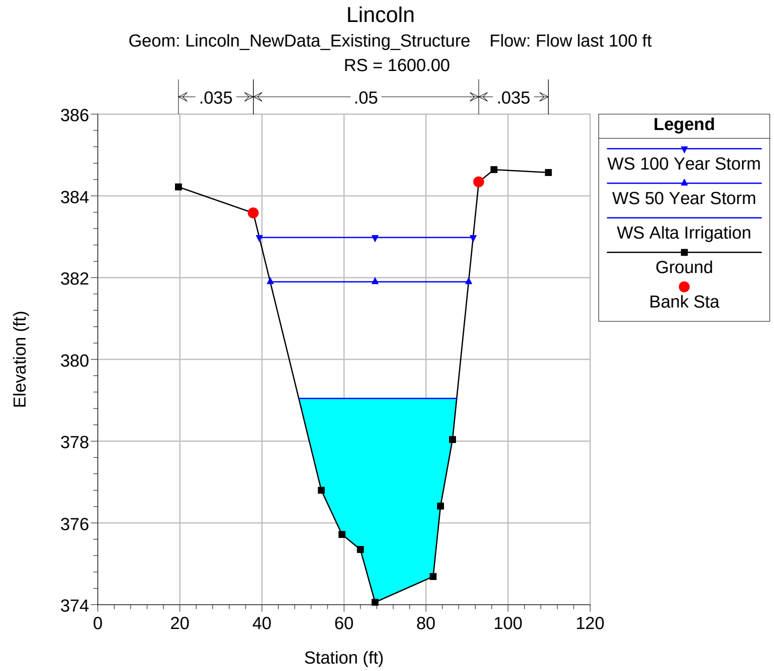
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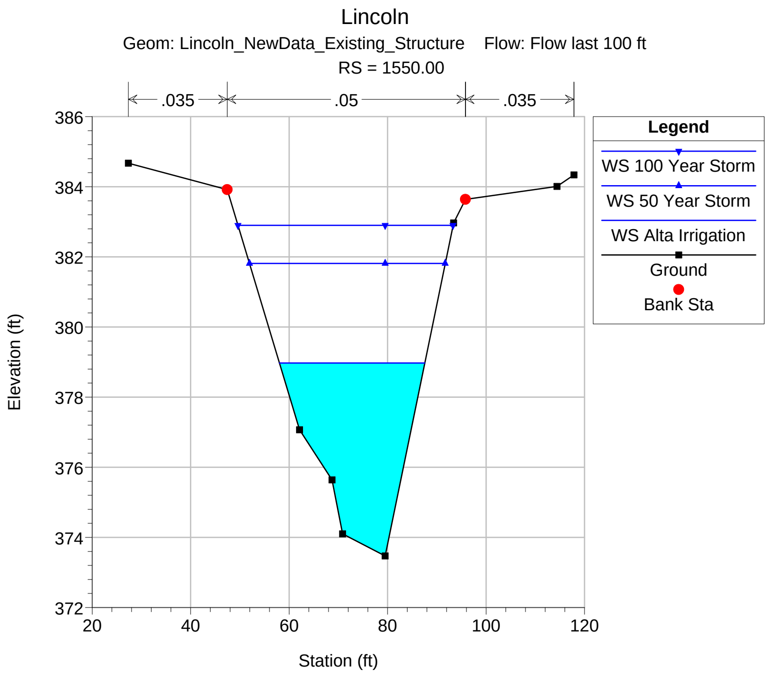
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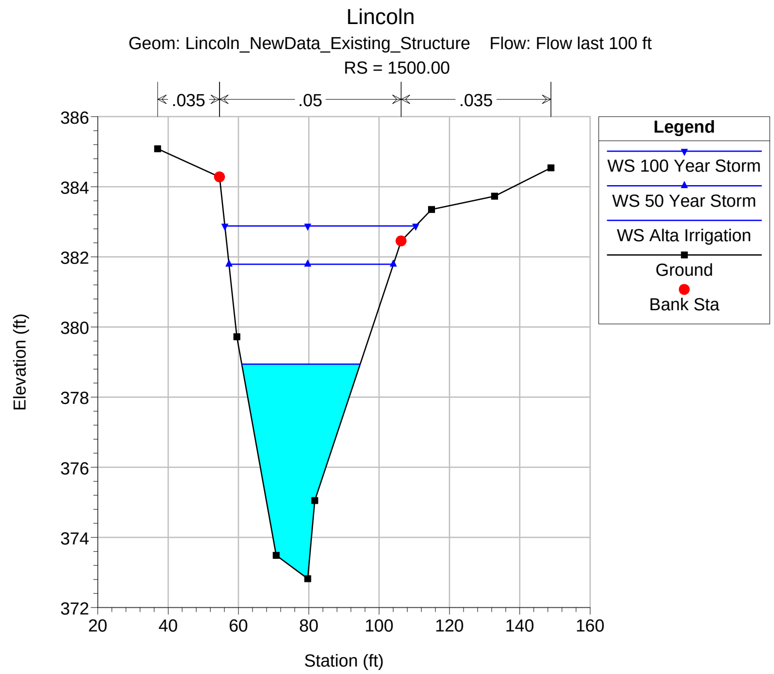
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Ground
Bank Sta
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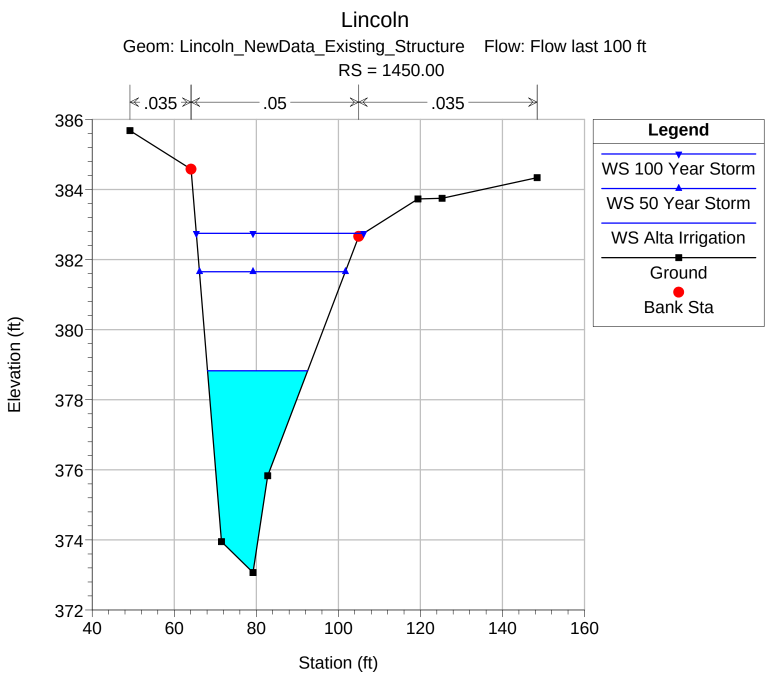
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WS 50 Year Storm
WS Alta Irrigation
Ground
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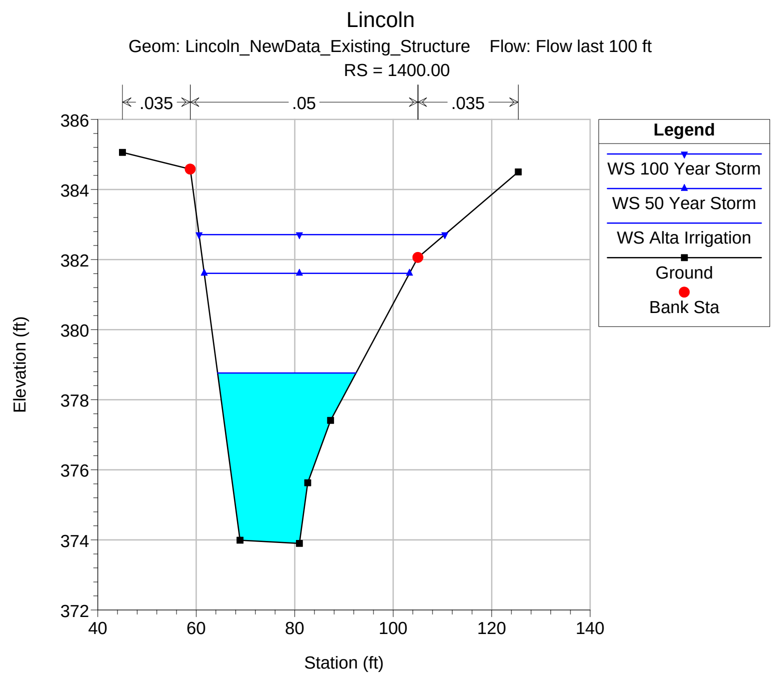
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WS 50 Year Storm
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Station (ft)
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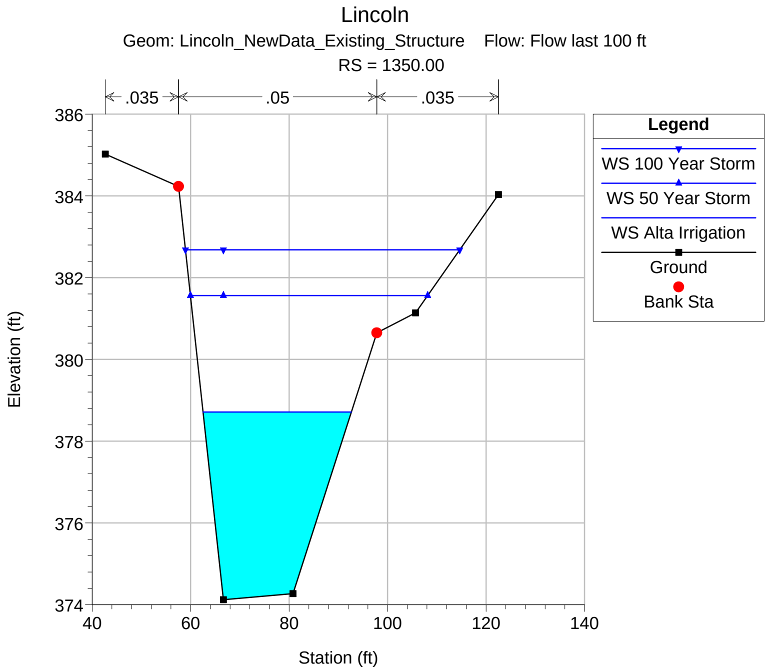
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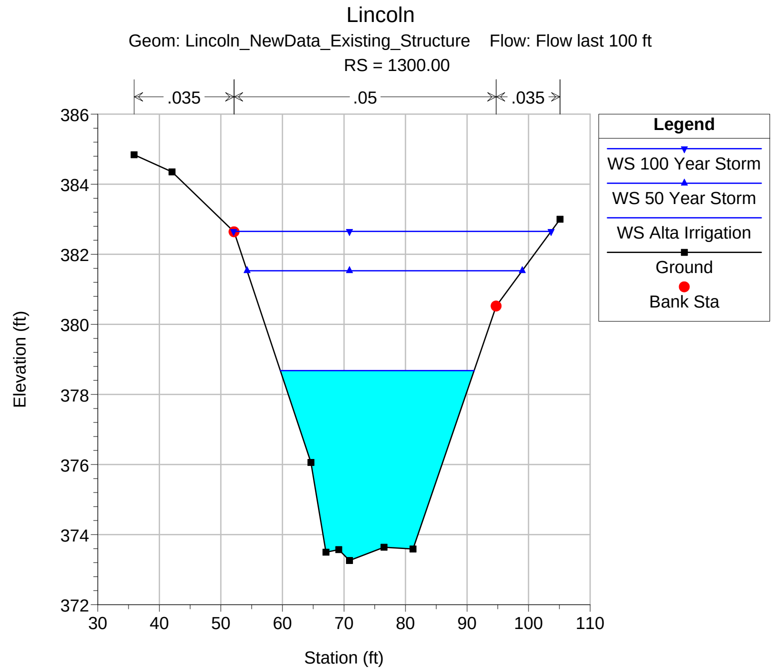
WS Alta Irrigation
Ground
Bank Sta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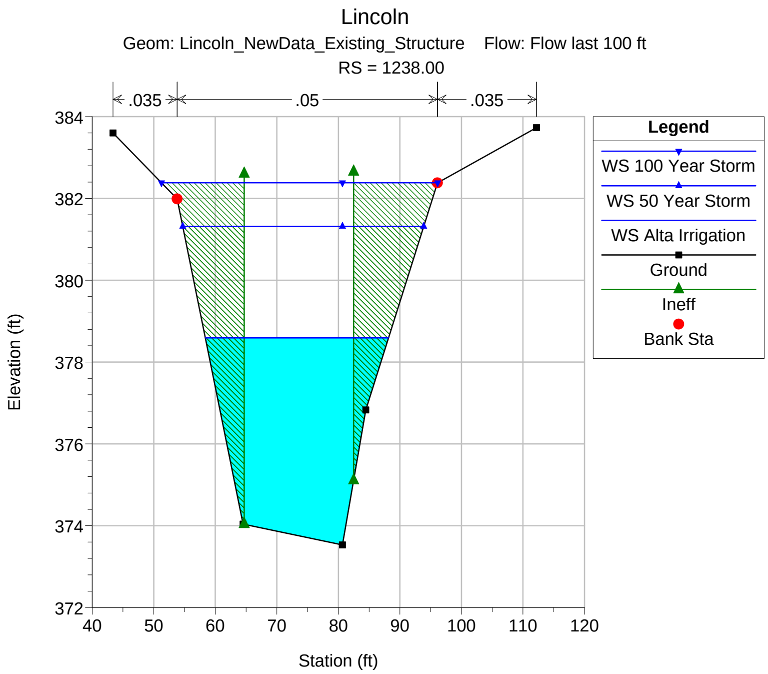
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta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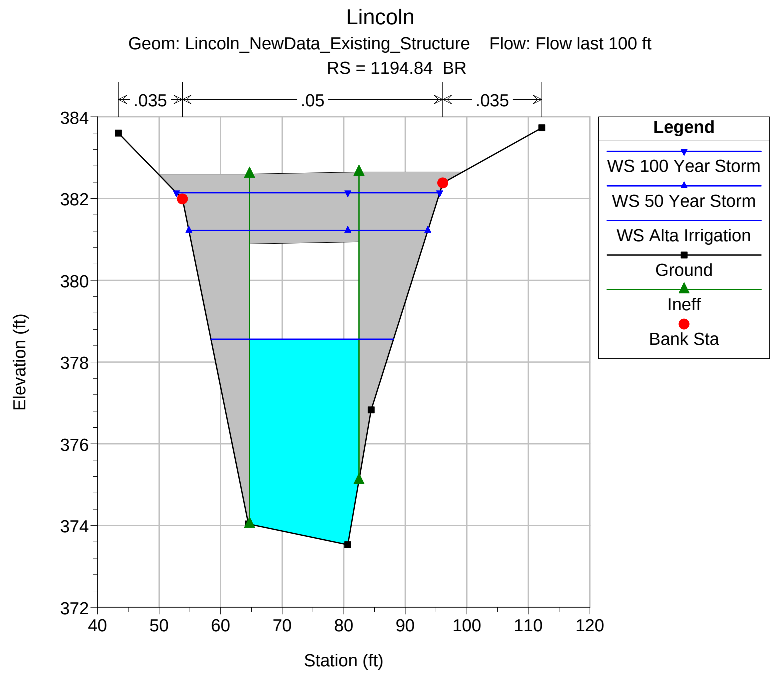
WS 50 Year Storm
WS Alta Irrigation
Ground
Ineff
Bank Sta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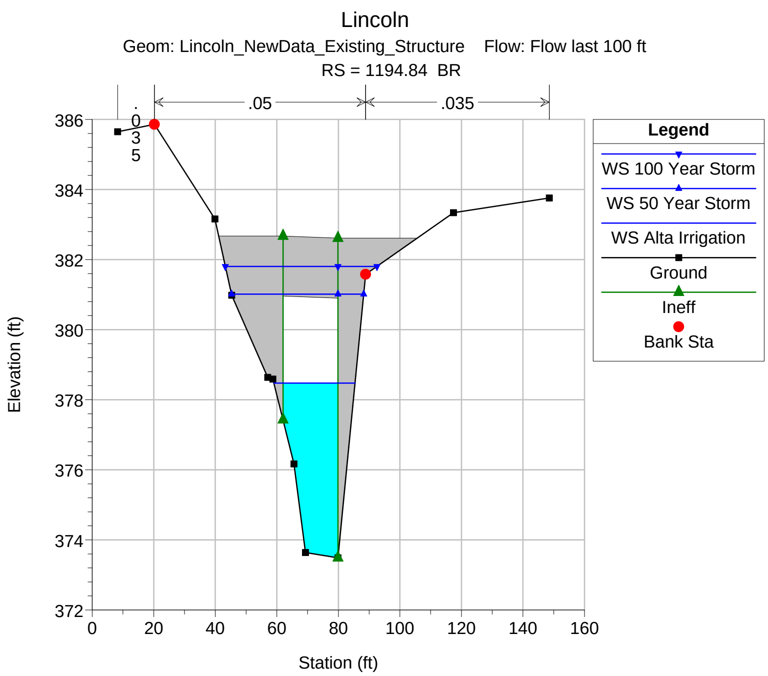
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Ineff
Bank Sta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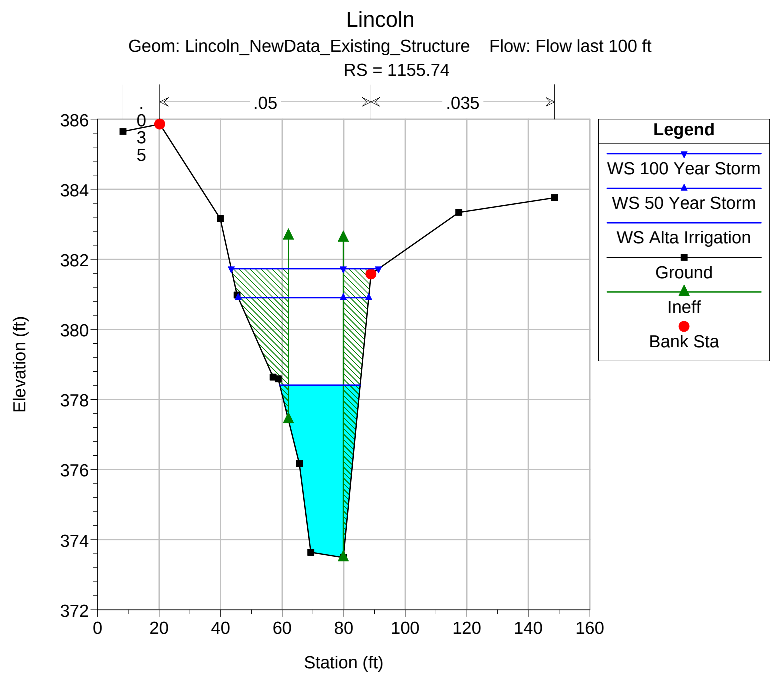
WS 50 Year Storm
WS Alta Irrigation
Ground
Ineff
Bank Sta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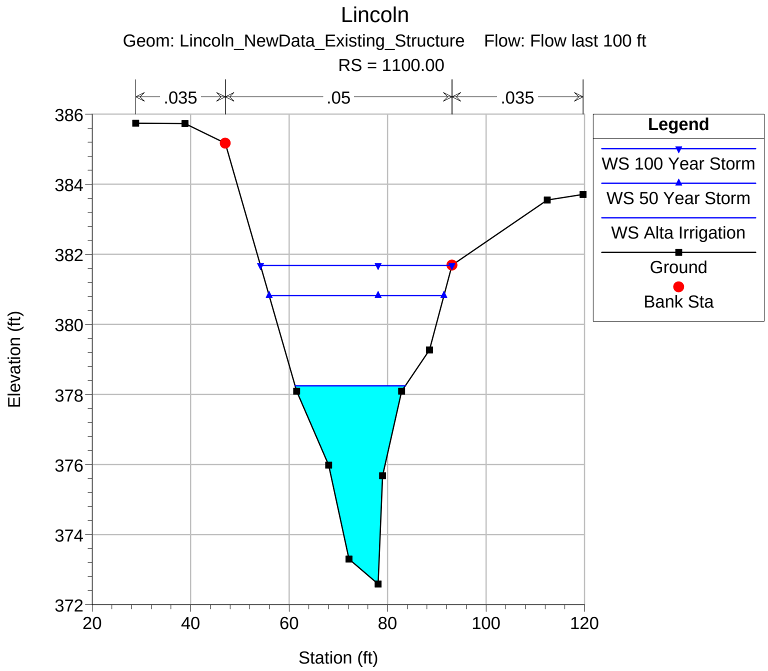
WS 50 Year Storm
WS Alta Irrigation
Ground
Ineff
Bank Sta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WS Alta Irrigation
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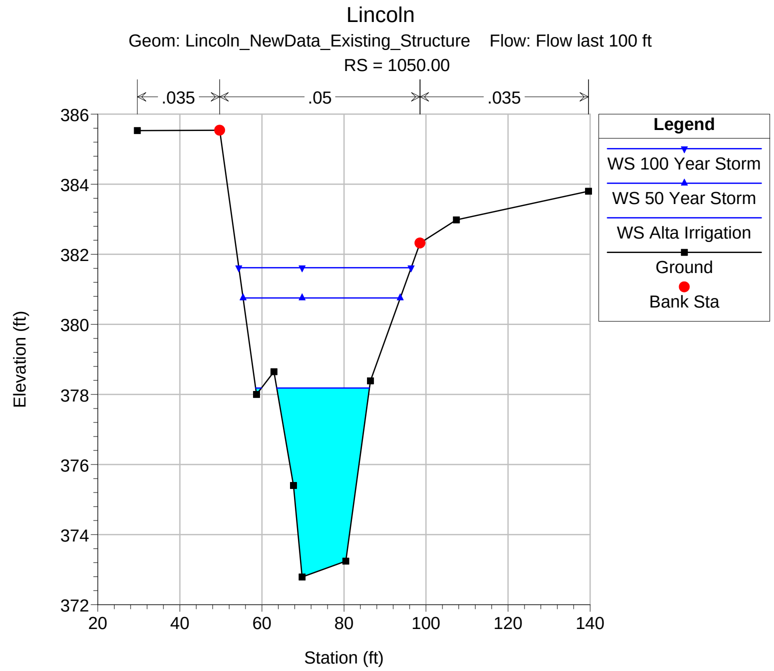
Station (ft)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WS 50 Year Storm
WS Alta Irrigation
Ground
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Elevation (ft)
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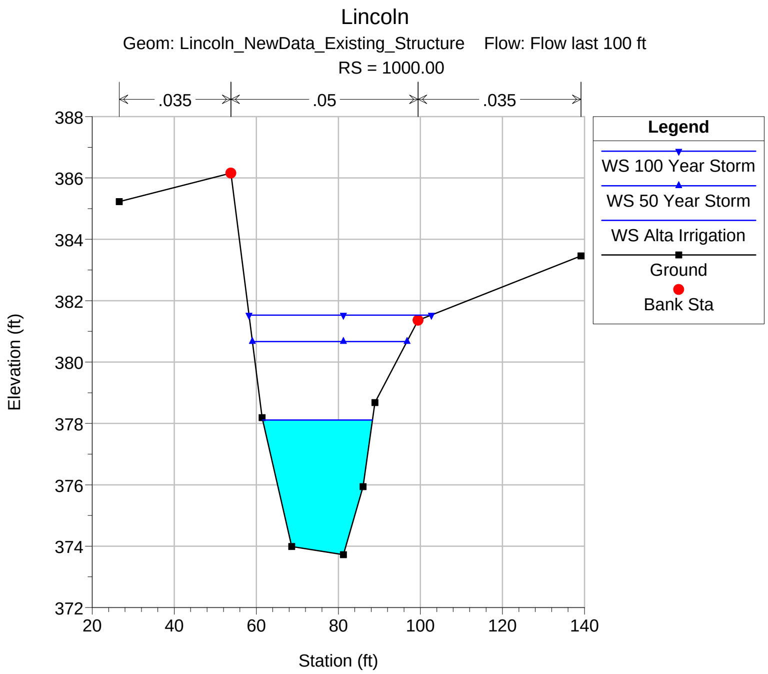
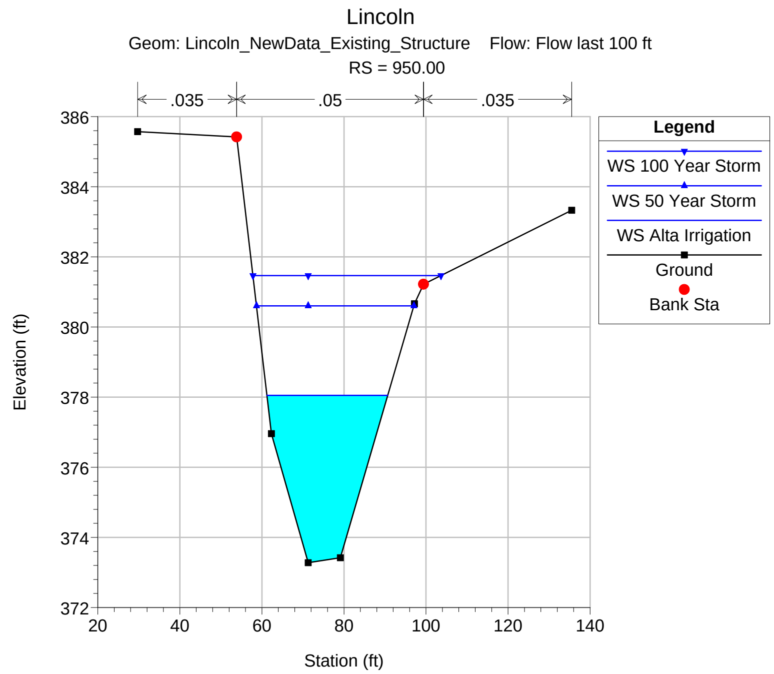
140
Station (ft)


Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 1000.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
388
386
384
382
380
378
376
374
372
20
40
60
80
100
120
140
Station (ft)


Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 950.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
386
384
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372
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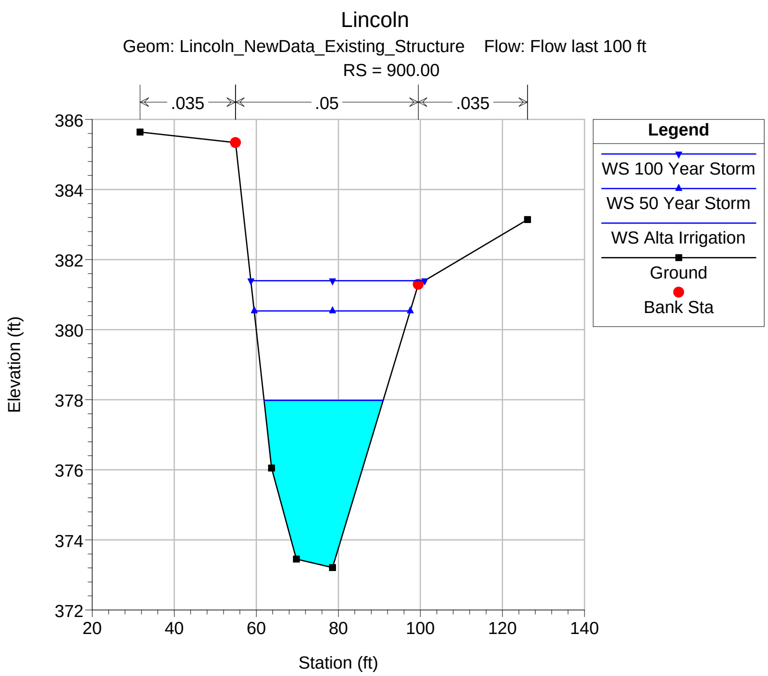
40
60
80
100
120
140
Station (ft)


Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 900.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
386
384
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376
374
372
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40
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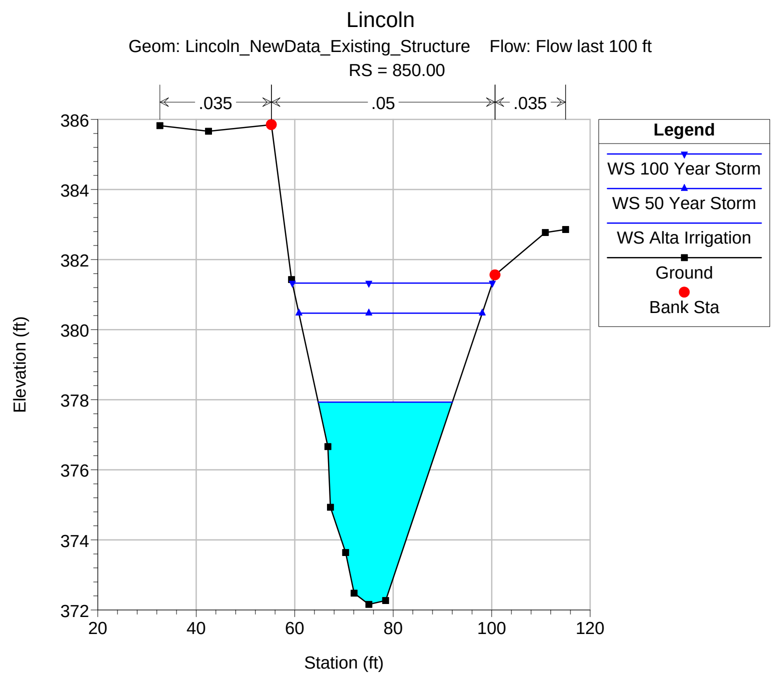
80
100
120
140
Station (ft)


Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 850.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
386
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378
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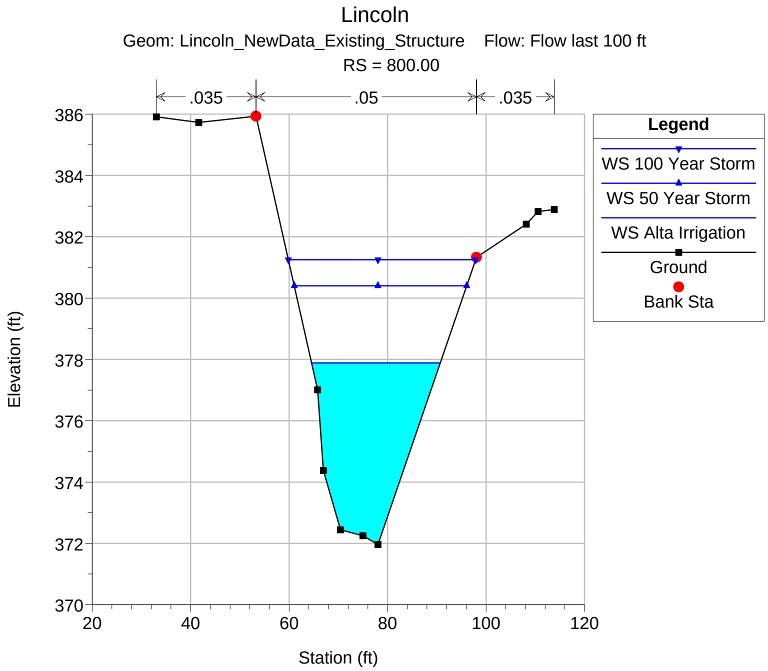
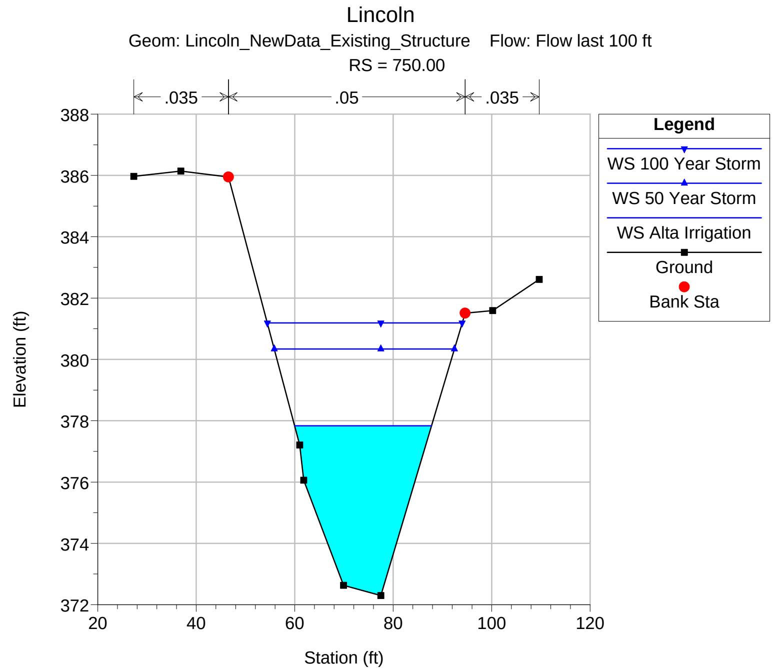
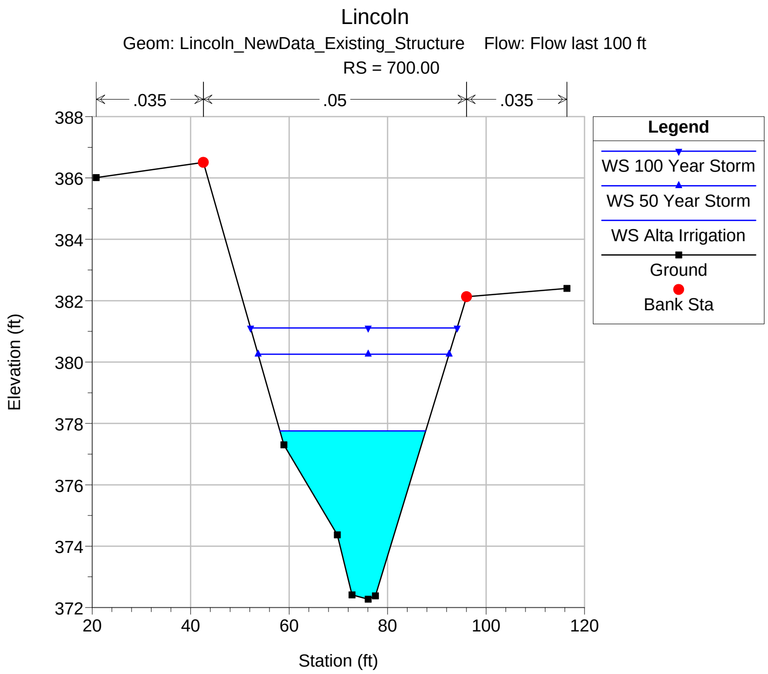
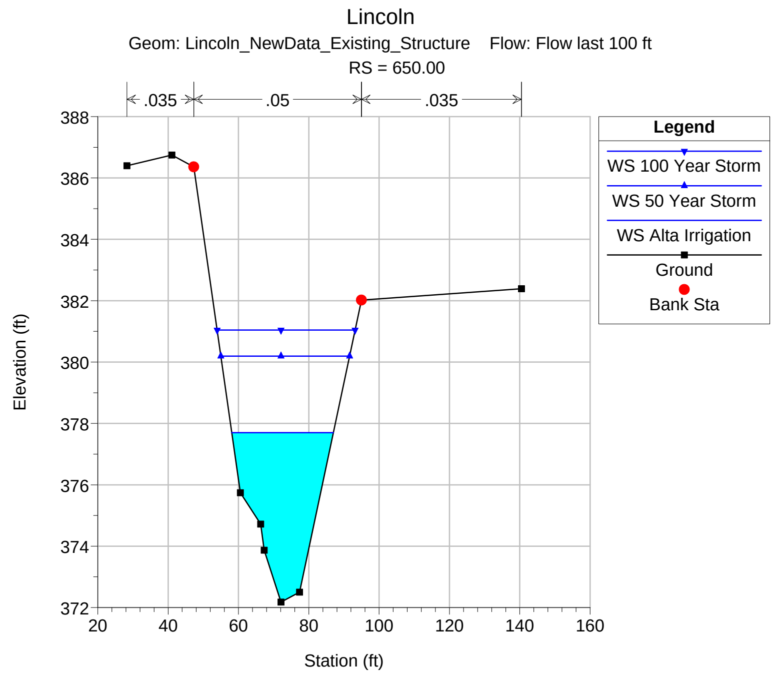
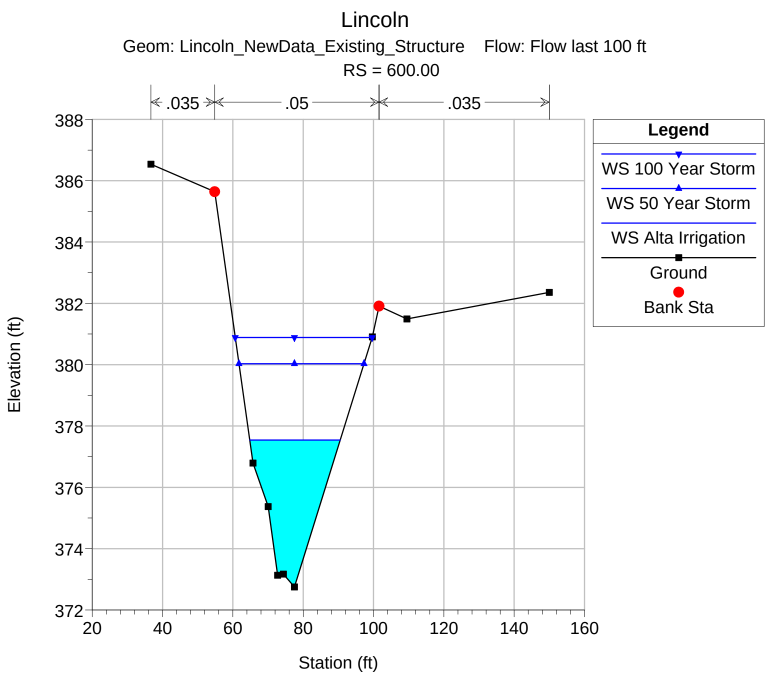
374
372
20
40
60
80
100
120
Station (ft)

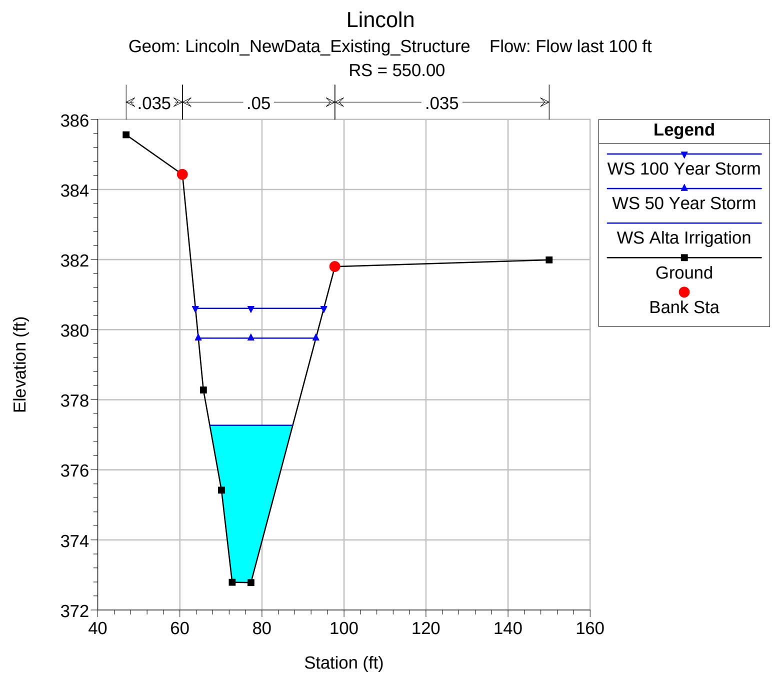

Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 800.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

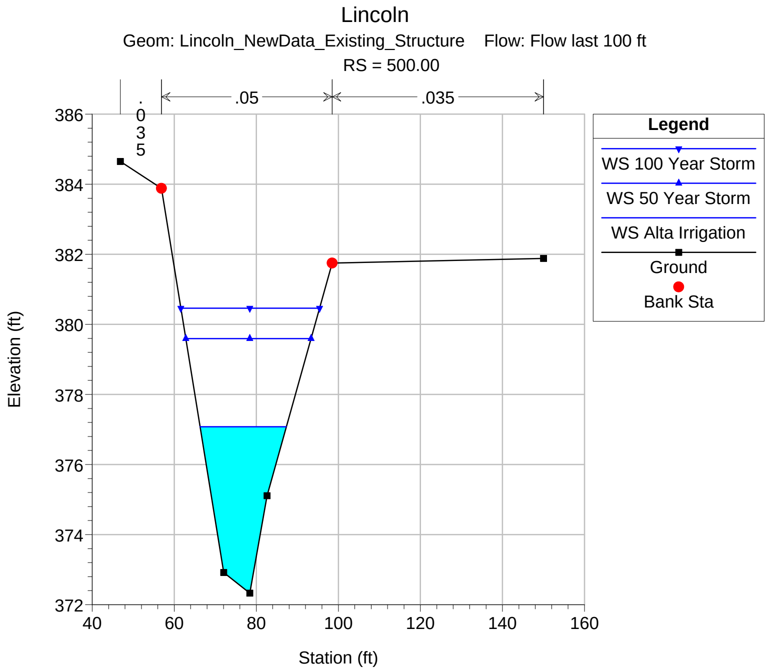

Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 750.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 700.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 650.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 600.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 550.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 500.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
386
384
382
380
378
376
374
372
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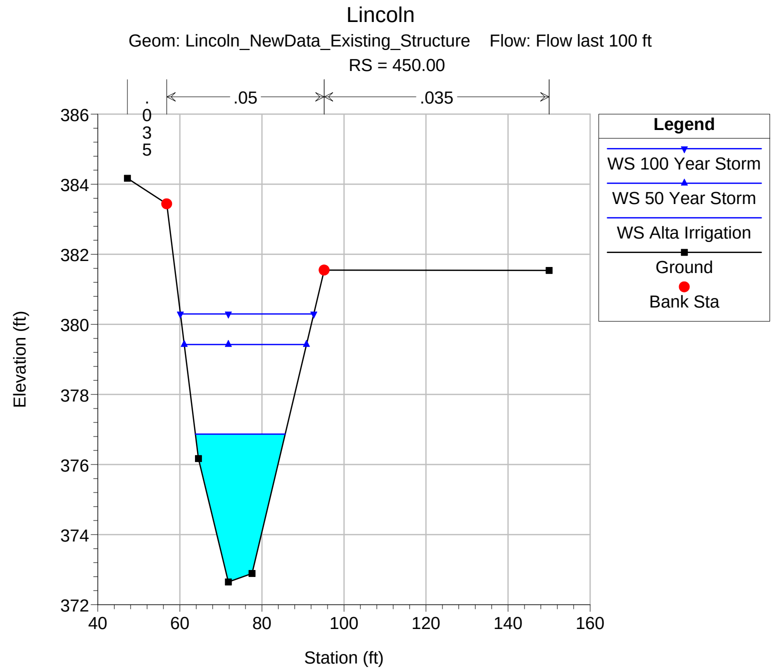
60
80
100
120
140
160


Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 450.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
386
384
382
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378
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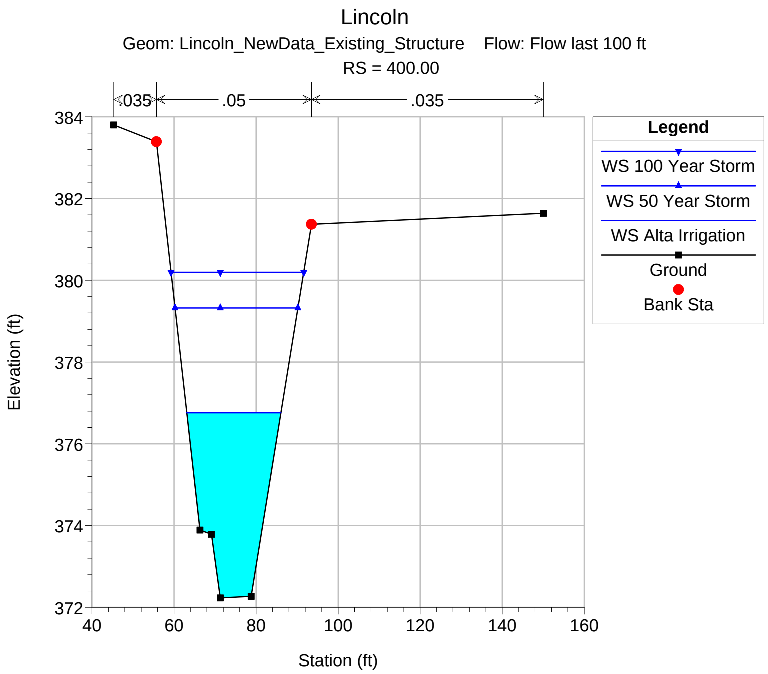
160


Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 400.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
384
382
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376
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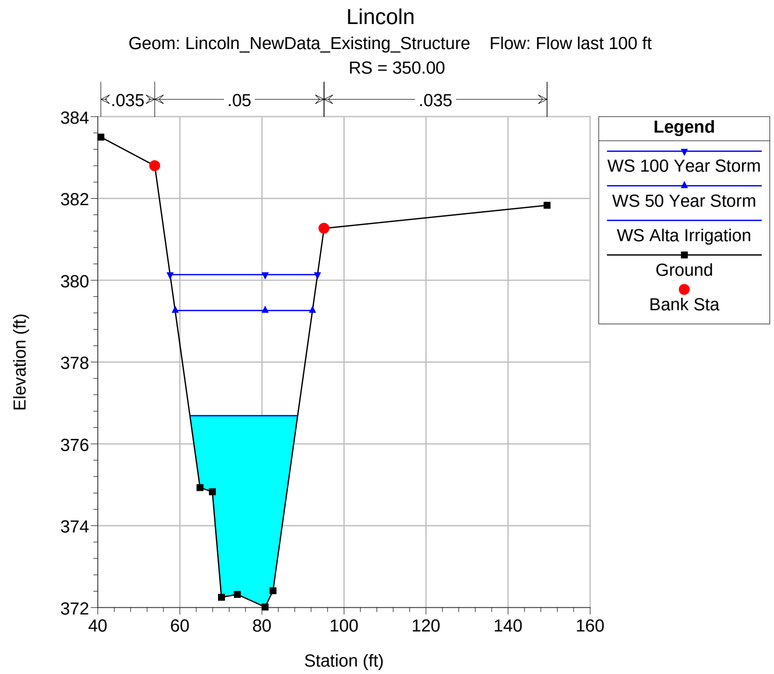
Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 350.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
384
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376
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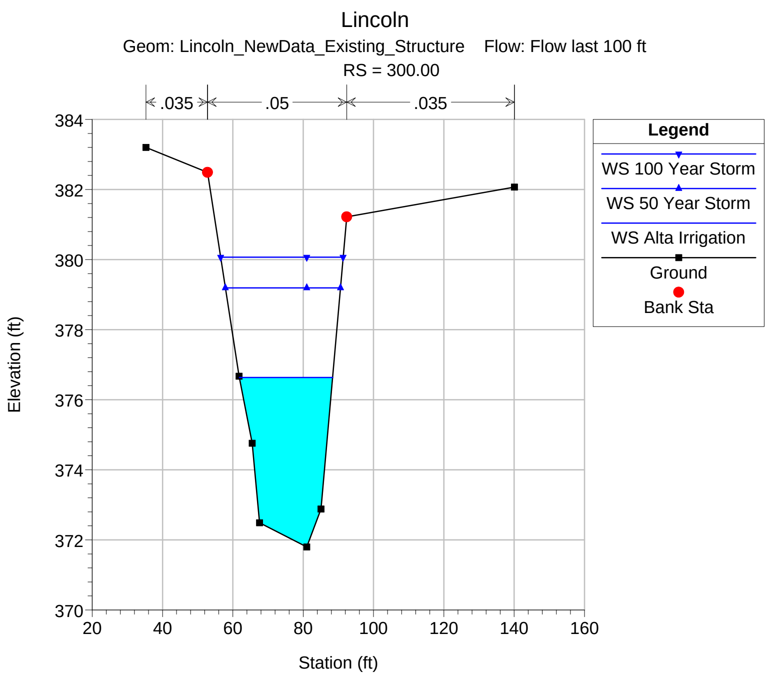
140
160


Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 300.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
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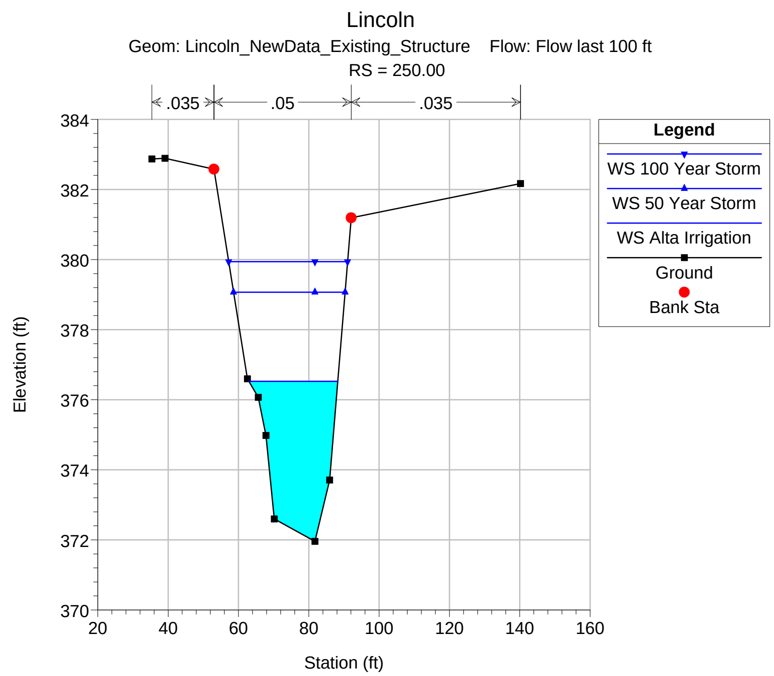
Lincoln
Geom: Lincoln_NewData_Existing_Structure Flow: Flow last 100 ft
RS = 250.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
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HEC-RAS Plan: Plan 35 River: Travers Reach: Travers

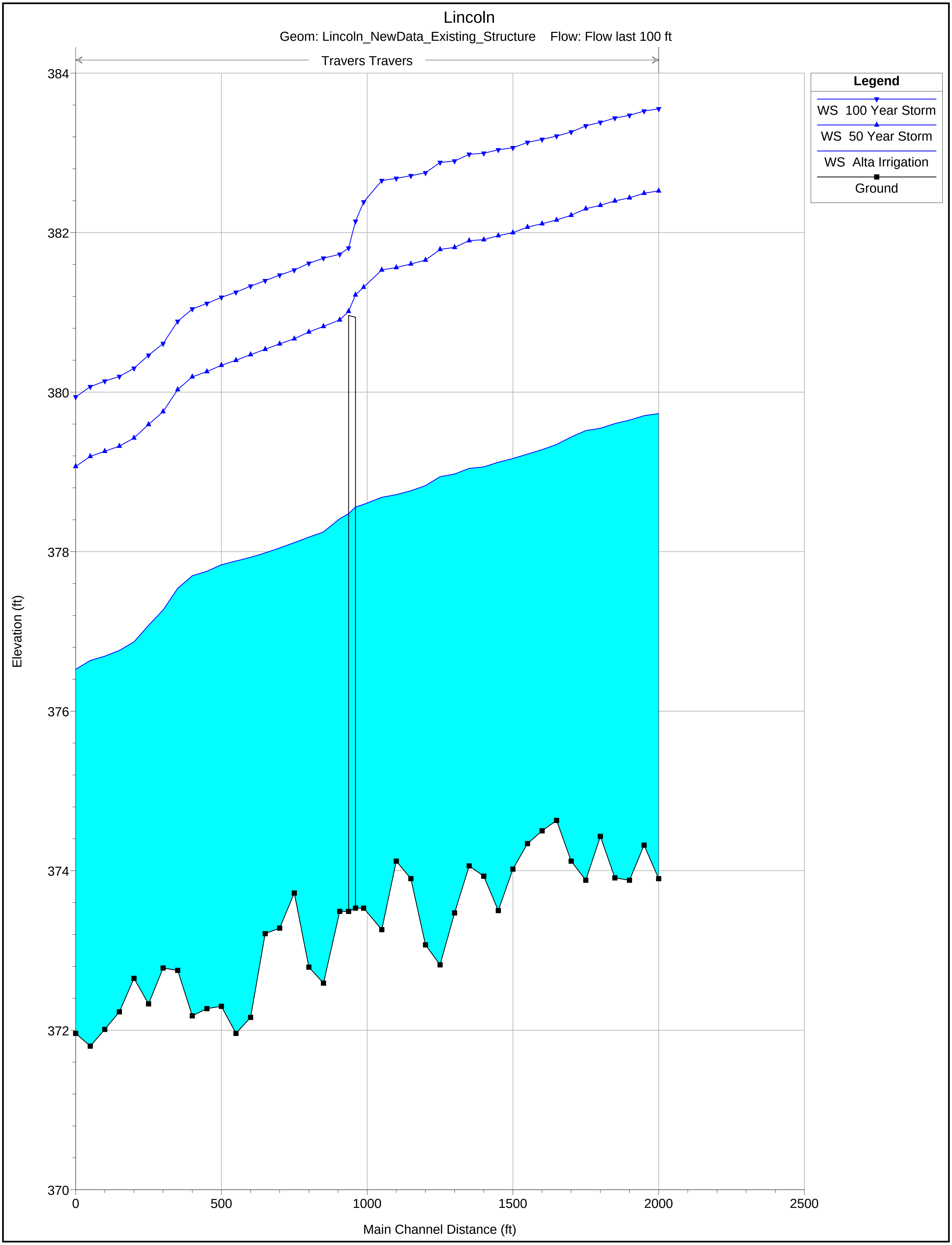
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Travers	2250.00	Alta Irrigation	200.00	373.90	379.73		379.78	0.000753	1.76	113.63	32.13	0.16
Travers	2250.00	50 Year Storm	510.00	373.90	382.52		382.61	0.000812	2.38	214.33	40.02	0.18
Travers	2250.00	100 Year Storm	650.00	373.90	383.55		383.65	0.000808	2.53	257.23	43.66	0.18
Travers	2200.00	Alta Irrigation	200.00	374.32	379.70		379.74	0.000560	1.61	123.85	32.58	0.15
Travers	2200.00	50 Year Storm	510.00	374.32	382.49		382.57	0.000688	2.22	229.71	43.33	0.17
Travers	2200.00	100 Year Storm	650.00	374.32	383.52		383.61	0.000680	2.35	276.41	47.31	0.17
Travers	2150.00	Alta Irrigation	200.00	373.88	379.65		379.71	0.000986	1.92	104.16	32.00	0.19
Travers	2150.00	50 Year Storm	510.00	373.88	382.44		382.53	0.000949	2.44	209.30	43.46	0.20
Travers	2150.00	100 Year Storm	650.00	373.88	383.47		383.57	0.000889	2.53	256.42	47.71	0.19
Travers	2100.00	Alta Irrigation	200.00	373.91	379.61		379.66	0.000898	1.85	108.21	33.12	0.18
Travers	2100.00	50 Year Storm	510.00	373.91	382.40		382.48	0.000879	2.31	221.08	47.74	0.19
Travers	2100.00	100 Year Storm	650.00	373.91	383.44		383.52	0.000811	2.38	273.50	53.18	0.18
Travers	2050.00	Alta Irrigation	200.00	374.43	379.55		379.61	0.001148	1.96	101.86	33.90	0.20
Travers	2050.00	50 Year Storm	510.00	374.43	382.34		382.43	0.000953	2.42	210.46	43.81	0.19
Travers	2050.00	100 Year Storm	650.00	374.43	383.38		383.48	0.000857	2.52	258.69	49.35	0.19
Travers	2000.00	Alta Irrigation	200.00	373.88	379.52		379.56	0.000587	1.70	117.98	29.14	0.15
Travers	2000.00	50 Year Storm	510.00	373.88	382.30		382.39	0.000816	2.40	212.62	39.77	0.18
Travers	2000.00	100 Year Storm	650.00	373.88	383.34		383.44	0.000818	2.54	256.26	44.19	0.19
Travers	1950.00	Alta Irrigation	200.00	374.12	379.44		379.52	0.001486	2.25	88.98	29.71	0.23
Travers	1950.00	50 Year Storm	510.00	374.12	382.22		382.34	0.001249	2.76	184.82	39.21	0.22
Travers	1950.00	100 Year Storm	650.00	374.12	383.26		383.39	0.001144	2.86	227.62	42.78	0.22
Travers	1900.00	Alta Irrigation	200.00	374.63	379.34		379.43	0.001846	2.37	84.32	31.43	0.26
Travers	1900.00	50 Year Storm	510.00	374.63	382.16		382.27	0.001257	2.71	188.13	42.36	0.23
Travers	1900.00	100 Year Storm	650.00	374.63	383.21		383.33	0.001108	2.77	234.88	46.45	0.22
Travers	1850.00	Alta Irrigation	200.00	374.50	379.28		379.35	0.001345	2.13	94.10	32.48	0.22
Travers	1850.00	50 Year Storm	510.00	374.50	382.11		382.21	0.001037	2.53	201.53	43.36	0.21
Travers	1850.00	100 Year Storm	650.00	374.50	383.17		383.27	0.000935	2.60	249.56	47.42	0.20
Travers	1800.00	Alta Irrigation	200.00	374.34	379.22		379.28	0.001112	1.98	101.15	33.52	0.20
Travers	1800.00	50 Year Storm	510.00	374.34	382.07		382.16	0.000910	2.41	211.68	44.16	0.19
Travers	1800.00	100 Year Storm	650.00	374.34	383.13		383.23	0.000832	2.49	260.69	48.13	0.19
Travers	1750.00	Alta Irrigation	200.00	374.02	379.17		379.23	0.001013	2.03	98.65	28.09	0.19
Travers	1750.00	50 Year Storm	510.00	374.02	382.00		382.11	0.001120	2.64	193.01	39.65	0.21
Travers	1750.00	100 Year Storm	650.00	374.02	383.06		383.18	0.001085	2.72	238.67	46.11	0.21
Travers	1700.00	Alta Irrigation	200.00	373.50	379.12		379.18	0.000909	1.98	101.02	27.31	0.18
Travers	1700.00	50 Year Storm	510.00	373.50	381.96		382.06	0.000824	2.52	213.40	51.81	0.18
Travers	1700.00	100 Year Storm	650.00	373.50	383.04		383.13	0.000704	2.52	274.13	61.09	0.17
Travers	1650.00	Alta Irrigation	200.00	373.93	379.06		379.13	0.001160	2.09	95.52	28.38	0.20
Travers	1650.00	50 Year Storm	510.00	373.93	381.91		382.01	0.001024	2.54	204.95	51.53	0.20
Travers	1650.00	100 Year Storm	650.00	373.93	383.00		383.09	0.000837	2.54	267.01	62.90	0.19
Travers	1600.00	Alta Irrigation	200.00	374.06	379.04		379.08	0.000577	1.54	129.66	38.49	0.15
Travers	1600.00	50 Year Storm	510.00	374.06	381.90		381.96	0.000559	2.01	253.65	48.37	0.15
Travers	1600.00	100 Year Storm	650.00	374.06	382.98		383.05	0.000530	2.11	308.04	52.11	0.15
Travers	1550.00	Alta Irrigation	200.00	373.47	378.97		379.04	0.001115	2.06	96.91	29.52	0.20
Travers	1550.00	50 Year Storm	510.00	373.47	381.81		381.92	0.001060	2.61	195.34	39.77	0.21
Travers	1550.00	100 Year Storm	650.00	373.47	382.90		383.01	0.000979	2.70	240.55	43.67	0.20
Travers	1500.00	Alta Irrigation	200.00	372.82	378.94		378.99	0.000778	1.76	113.53	33.65	0.17
Travers	1500.00	50 Year Storm	510.00	372.82	381.79		381.87	0.000766	2.23	228.67	46.75	0.18
Travers	1500.00	100 Year Storm	650.00	372.82	382.88		382.96	0.000682	2.30	282.79	54.25	0.17
Travers	1450.00	Alta Irrigation	200.00	373.07	378.83		378.93	0.001816	2.52	79.52	24.42	0.25
Travers	1450.00	50 Year Storm	510.00	373.07	381.65		381.80	0.001739	3.10	164.32	35.57	0.25
Travers	1450.00	100 Year Storm	650.00	373.07	382.75		382.91	0.001546	3.16	205.68	40.81	0.24
Travers	1400.00	Alta Irrigation	200.00	373.90	378.76		378.84	0.001389	2.23	89.68	28.12	0.22
Travers	1400.00	50 Year Storm	510.00	373.90	381.61		381.72	0.001275	2.70	188.89	41.68	0.22
Travers	1400.00	100 Year Storm	650.00	373.90	382.71		382.83	0.001059	2.74	238.95	49.92	0.21
Travers	1350.00	Alta Irrigation	200.00	374.12	378.71		378.78	0.001041	2.00	99.77	30.15	0.19

HEC-RAS Plan: Plan 35 River: Travers Reach: Travers (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Travers	1350.00	50 Year Storm	510.00	374.12	381.56		381.66	0.000926	2.54	204.77	48.20	0.20
Travers	1350.00	100 Year Storm	650.00	374.12	382.68		382.78	0.000767	2.57	262.89	55.71	0.18
Travers	1300.00	Alta Irrigation	200.00	373.26	378.68		378.73	0.000700	1.75	114.38	31.49	0.16
Travers	1300.00	50 Year Storm	510.00	373.26	381.53		381.62	0.000735	2.32	220.89	44.72	0.18
Travers	1300.00	100 Year Storm	650.00	373.26	382.65		382.74	0.000655	2.41	274.83	51.59	0.17
Travers	1238.00	Alta Irrigation	200.00	373.53	378.59	375.41	378.68	0.000827	2.36	84.59	29.77	0.19
Travers	1238.00	50 Year Storm	510.00	373.53	381.32	376.77	381.54	0.001189	3.83	133.05	39.15	0.25
Travers	1238.00	100 Year Storm	650.00	373.53	382.38	377.30	382.67	0.001237	4.27	152.05	44.88	0.26
Travers	1194.84		Bridge									
Travers	1155.74	Alta Irrigation	200.00	373.49	378.41		378.54	0.001602	2.85	70.09	26.13	0.25
Travers	1155.74	50 Year Storm	510.00	373.49	380.91		381.21	0.002021	4.45	114.64	42.40	0.31
Travers	1155.74	100 Year Storm	650.00	373.49	381.73		382.12	0.002196	5.03	129.33	47.82	0.33
Travers	1100.00	Alta Irrigation	200.00	372.59	378.25		378.40	0.003576	3.16	63.22	22.39	0.33
Travers	1100.00	50 Year Storm	510.00	372.59	380.82		381.03	0.002896	3.64	140.14	35.51	0.32
Travers	1100.00	100 Year Storm	650.00	372.59	381.68		381.90	0.002675	3.78	171.97	38.88	0.32
Travers	1050.00	Alta Irrigation	200.00	372.79	378.18		378.27	0.001510	2.39	83.58	23.99	0.23
Travers	1050.00	50 Year Storm	510.00	372.79	380.75		380.90	0.001773	3.05	167.21	38.33	0.26
Travers	1050.00	100 Year Storm	650.00	372.79	381.62		381.78	0.001735	3.22	201.78	42.00	0.26
Travers	1000.00	Alta Irrigation	200.00	373.72	378.11		378.20	0.001427	2.31	86.46	26.77	0.23
Travers	1000.00	50 Year Storm	510.00	373.72	380.67		380.81	0.001652	3.05	167.30	37.69	0.26
Travers	1000.00	100 Year Storm	650.00	373.72	381.53		381.69	0.001629	3.22	201.82	44.46	0.26
Travers	950.00	Alta Irrigation	200.00	373.28	378.05		378.12	0.001356	2.21	90.49	29.45	0.22
Travers	950.00	50 Year Storm	510.00	373.28	380.60		380.73	0.001376	2.88	177.20	38.38	0.24
Travers	950.00	100 Year Storm	650.00	373.28	381.47		381.61	0.001375	3.07	212.48	45.84	0.24
Travers	900.00	Alta Irrigation	200.00	373.21	377.98		378.06	0.001283	2.18	91.72	29.02	0.22
Travers	900.00	50 Year Storm	510.00	373.21	380.54		380.67	0.001368	2.88	177.30	38.03	0.23
Travers	900.00	100 Year Storm	650.00	373.21	381.40		381.54	0.001368	3.08	211.43	42.35	0.24
Travers	850.00	Alta Irrigation	200.00	372.16	377.93		378.00	0.001051	2.07	96.61	27.23	0.19
Travers	850.00	50 Year Storm	510.00	372.16	380.47		380.60	0.001341	2.86	178.45	37.24	0.23
Travers	850.00	100 Year Storm	650.00	372.16	381.33		381.48	0.001380	3.07	211.92	40.63	0.24
Travers	800.00	Alta Irrigation	200.00	371.96	377.88		377.95	0.000941	2.02	98.92	26.12	0.18
Travers	800.00	50 Year Storm	510.00	371.96	380.40		380.53	0.001333	2.90	175.81	35.02	0.23
Travers	800.00	100 Year Storm	650.00	371.96	381.25		381.41	0.001404	3.14	206.98	38.04	0.24
Travers	750.00	Alta Irrigation	200.00	372.30	377.84		377.90	0.000980	2.03	98.65	27.79	0.19
Travers	750.00	50 Year Storm	510.00	372.30	380.34		380.46	0.001275	2.85	179.18	36.59	0.23
Travers	750.00	100 Year Storm	650.00	372.30	381.19		381.33	0.001325	3.07	211.61	39.58	0.23
Travers	700.00	Alta Irrigation	200.00	372.27	377.75		377.84	0.001567	2.29	87.20	29.59	0.24
Travers	700.00	50 Year Storm	510.00	372.27	380.26		380.39	0.001520	2.95	172.78	38.79	0.25
Travers	700.00	100 Year Storm	650.00	372.27	381.11		381.26	0.001500	3.14	207.25	41.93	0.25
Travers	650.00	Alta Irrigation	200.00	372.18	377.70		377.77	0.001130	2.09	95.66	28.89	0.20
Travers	650.00	50 Year Storm	510.00	372.18	380.19		380.32	0.001322	2.88	177.32	36.61	0.23
Travers	650.00	100 Year Storm	650.00	372.18	381.04		381.19	0.001358	3.10	209.60	39.25	0.24
Travers	600.00	Alta Irrigation	200.00	372.75	377.54		377.67	0.002952	2.93	68.25	25.73	0.32
Travers	600.00	50 Year Storm	510.00	372.75	380.03		380.23	0.002459	3.53	144.65	35.57	0.31
Travers	600.00	100 Year Storm	650.00	372.75	380.89		381.10	0.002329	3.68	176.53	38.94	0.30
Travers	550.00	Alta Irrigation	200.00	372.78	377.27		377.48	0.004839	3.68	54.28	20.23	0.40
Travers	550.00	50 Year Storm	510.00	372.78	379.76		380.06	0.004098	4.41	115.62	28.65	0.39
Travers	550.00	100 Year Storm	650.00	372.78	380.61		380.94	0.003874	4.60	141.21	31.30	0.38
Travers	500.00	Alta Irrigation	200.00	372.33	377.08		377.25	0.003834	3.39	59.02	21.02	0.36
Travers	500.00	50 Year Storm	510.00	372.33	379.59		379.86	0.003479	4.12	123.92	30.52	0.36
Travers	500.00	100 Year Storm	650.00	372.33	380.46		380.75	0.003294	4.28	151.82	33.80	0.36
Travers	450.00	Alta Irrigation	200.00	372.65	376.87		377.05	0.004149	3.45	57.92	21.89	0.37
Travers	450.00	50 Year Storm	510.00	372.65	379.42		379.69	0.003339	4.11	123.95	29.79	0.36
Travers	450.00	100 Year Storm	650.00	372.65	380.30		380.59	0.003167	4.30	151.17	32.50	0.35

HEC-RAS Plan: Plan 35 River: Travers Reach: Travers (Continued)

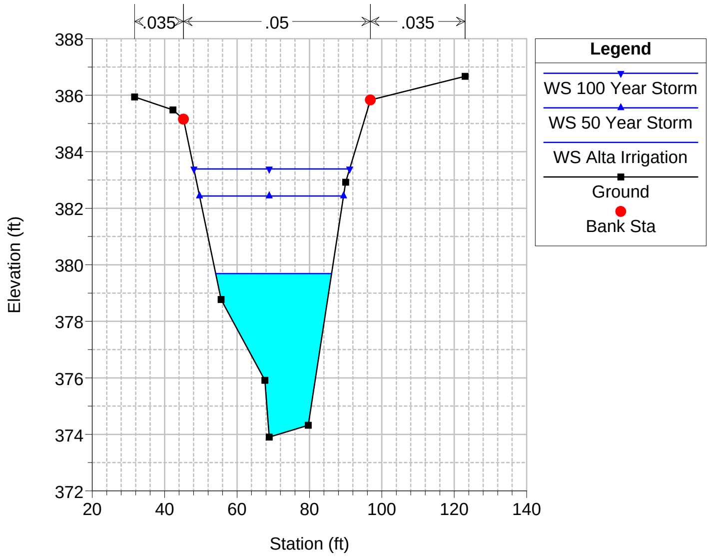
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Travers	400.00	Alta Irrigation	200.00	372.23	376.76		376.88	0.002321	2.81	71.13	22.96	0.28
Travers	400.00	50 Year Storm	510.00	372.23	379.32		379.53	0.002389	3.67	138.88	29.96	0.30
Travers	400.00	100 Year Storm	650.00	372.23	380.20		380.43	0.002384	3.91	166.14	32.35	0.30
Travers	350.00	Alta Irrigation	200.00	372.01	376.69		376.78	0.001599	2.39	83.78	26.26	0.24
Travers	350.00	50 Year Storm	510.00	372.01	379.26		379.42	0.001691	3.18	160.49	33.46	0.26
Travers	350.00	100 Year Storm	650.00	372.01	380.14		380.32	0.001703	3.40	190.96	35.92	0.26
Travers	300.00	Alta Irrigation	200.00	371.80	376.64		376.71	0.001125	2.14	93.62	26.53	0.20
Travers	300.00	50 Year Storm	510.00	371.80	379.19		379.33	0.001396	3.01	169.42	32.72	0.23
Travers	300.00	100 Year Storm	650.00	371.80	380.07		380.23	0.001457	3.27	198.98	34.84	0.24
Travers	250.00	Alta Irrigation	200.00	371.96	376.52	374.12	376.63	0.002002	2.59	77.08	25.28	0.26
Travers	250.00	50 Year Storm	510.00	371.96	379.07	375.54	379.25	0.002001	3.40	149.96	31.73	0.28
Travers	250.00	100 Year Storm	650.00	371.96	379.94	376.07	380.15	0.002002	3.64	178.53	33.83	0.28



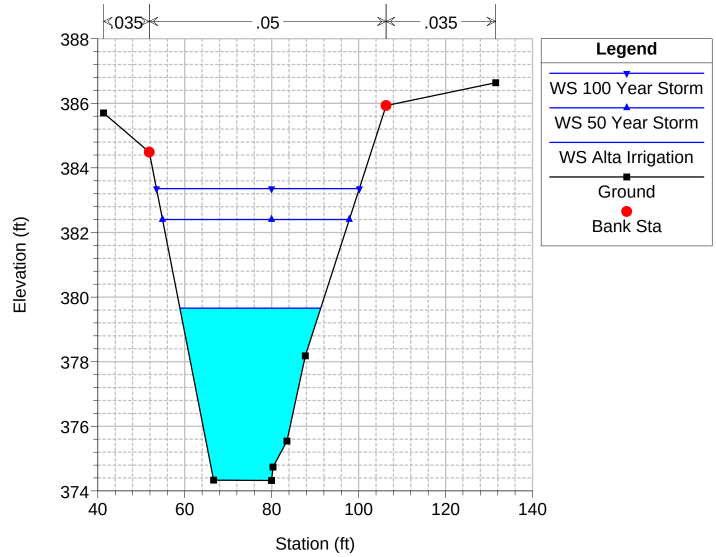
Lincoln
Geom: Lincoln_NewData_Existing_Structure   Flow: Flow last 100 ft
Travers Travers
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
384
382
380
378
376
374
372
370
Elevation (ft)
0
500
1000
1500
2000
2500
Main Channel Distance (ft)

Appendix F: HEC-RAS Output for Lincoln Avenue Proposed Structure

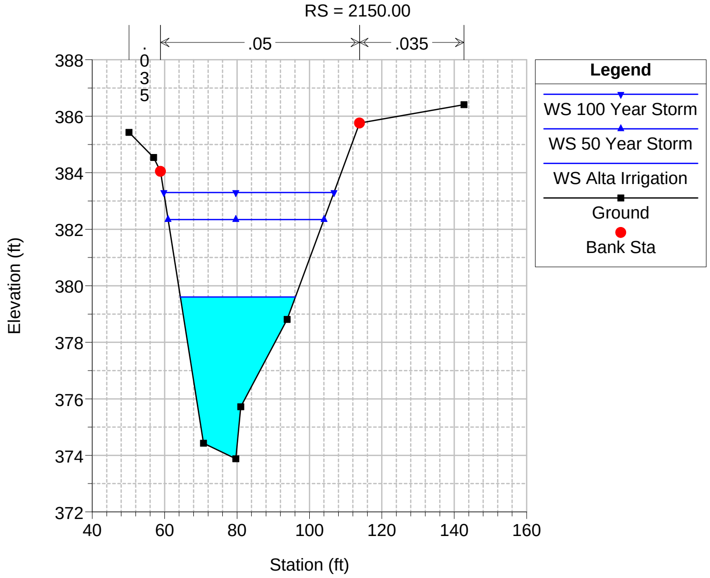
Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 2250.00



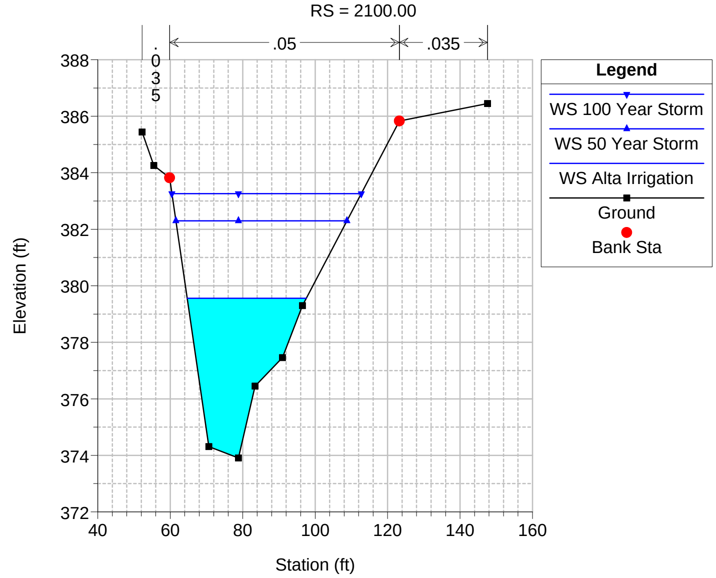
Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 2200.00



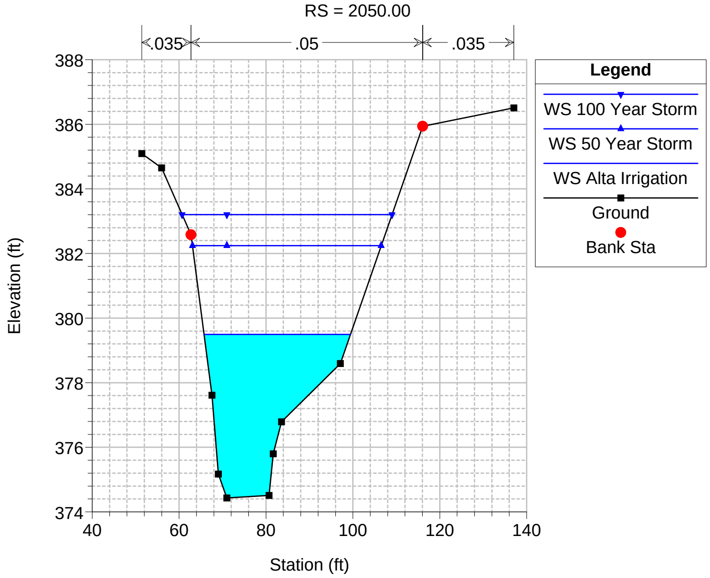
Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 2150.00



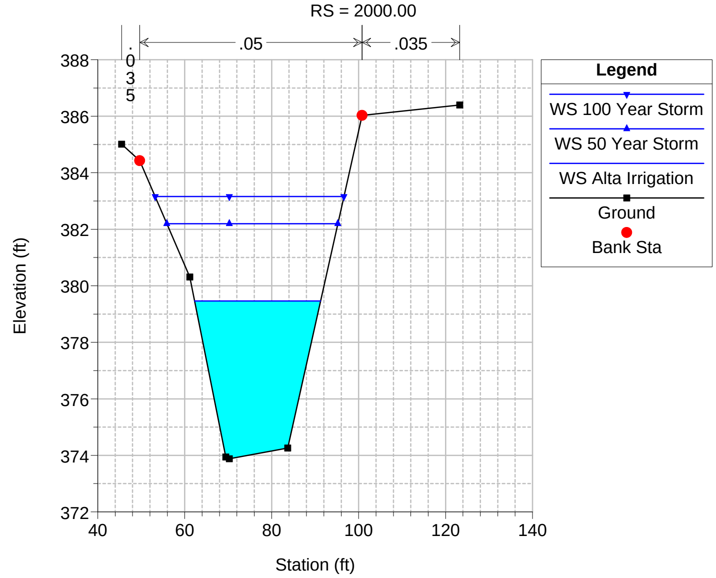
Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 2100.00

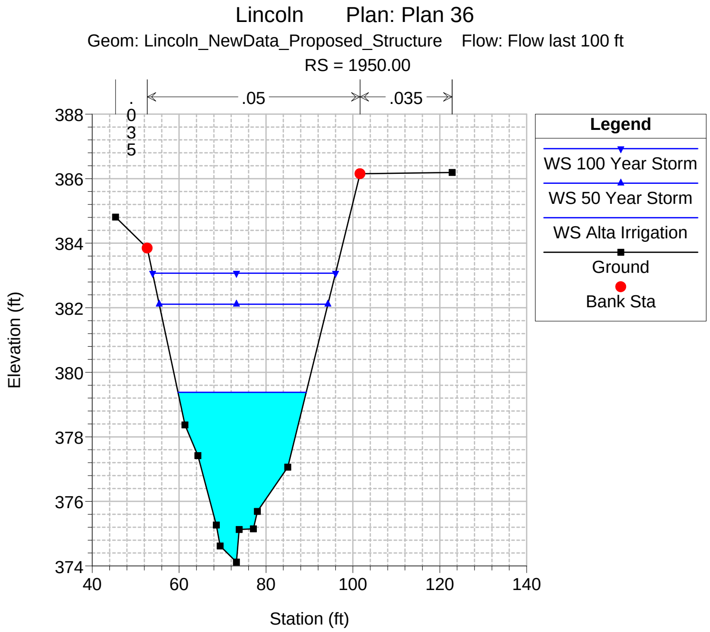


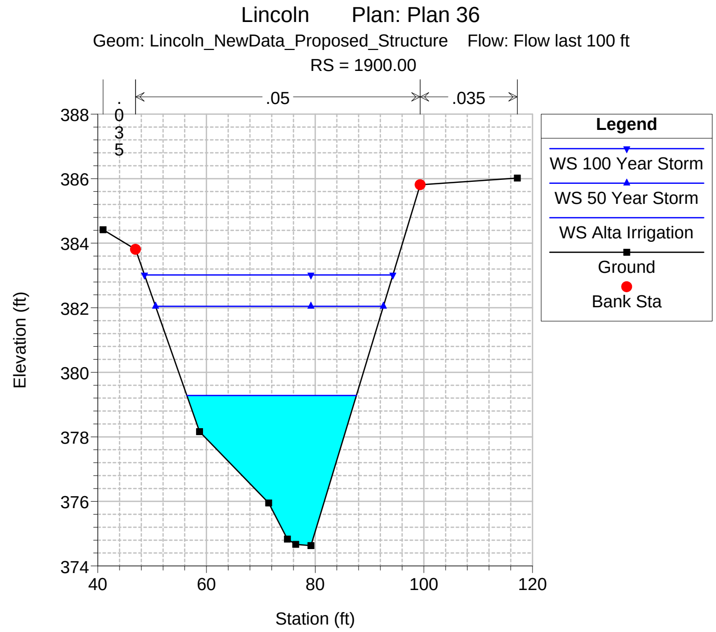
Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 2050.00

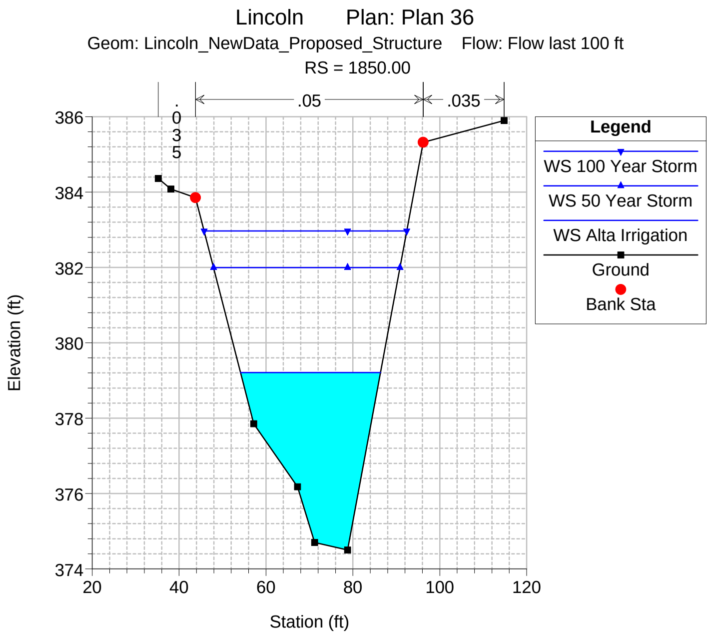


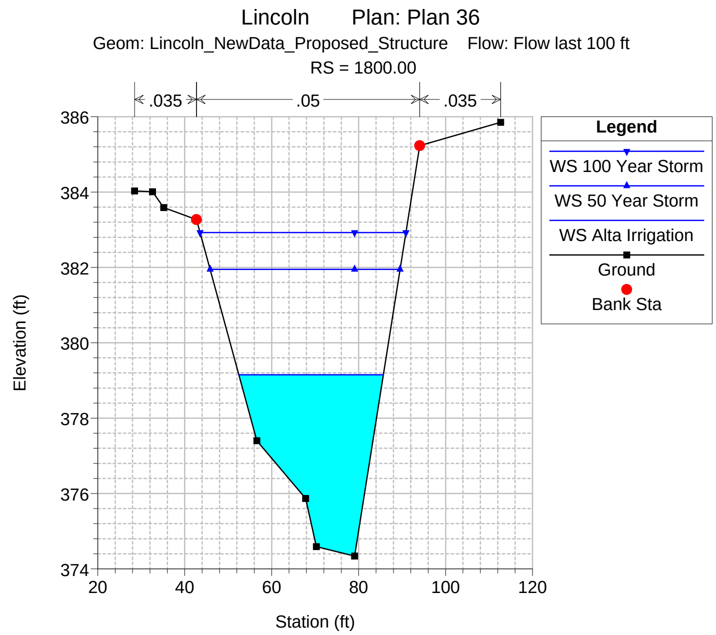
Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 2000.00

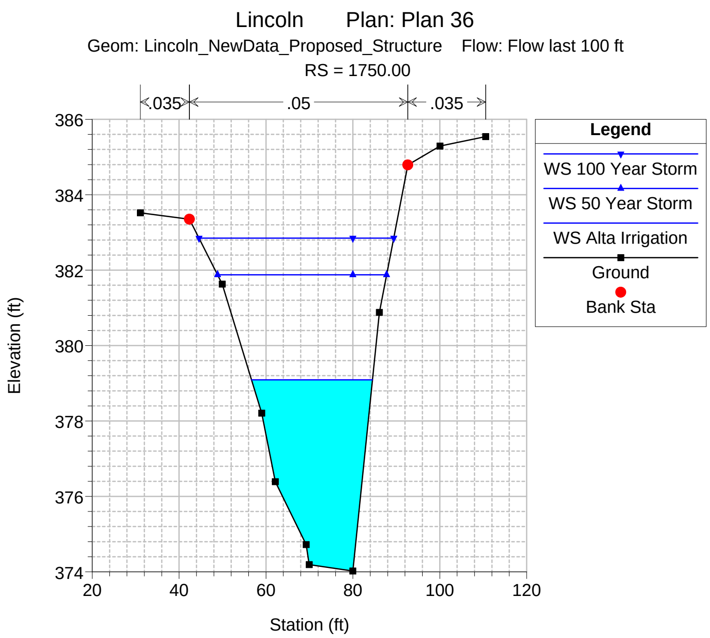


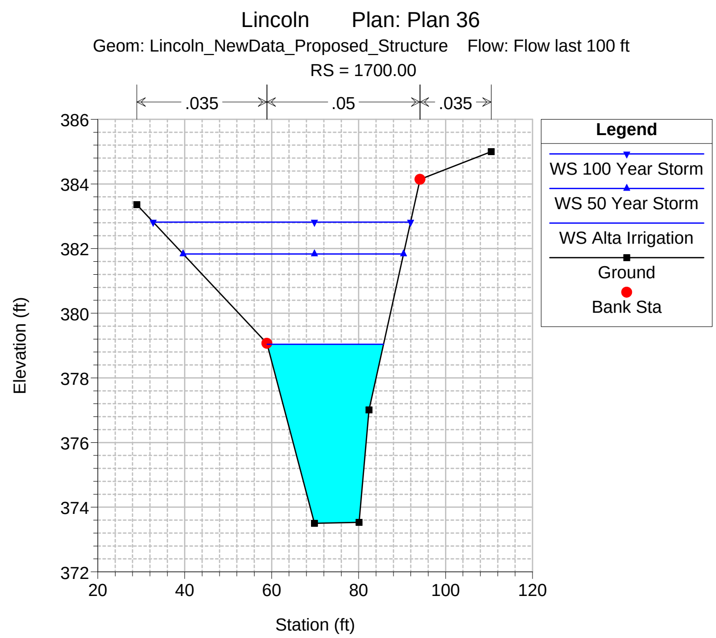

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1950.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

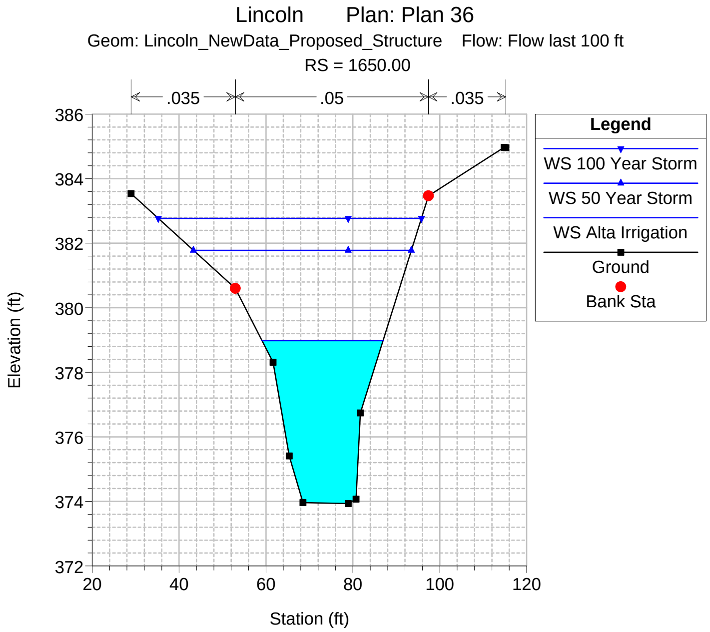

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1900.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

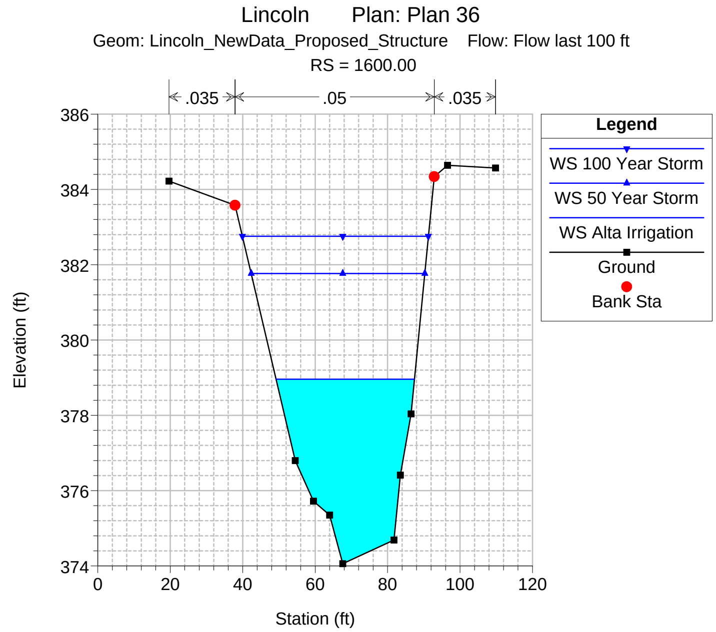

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1850.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

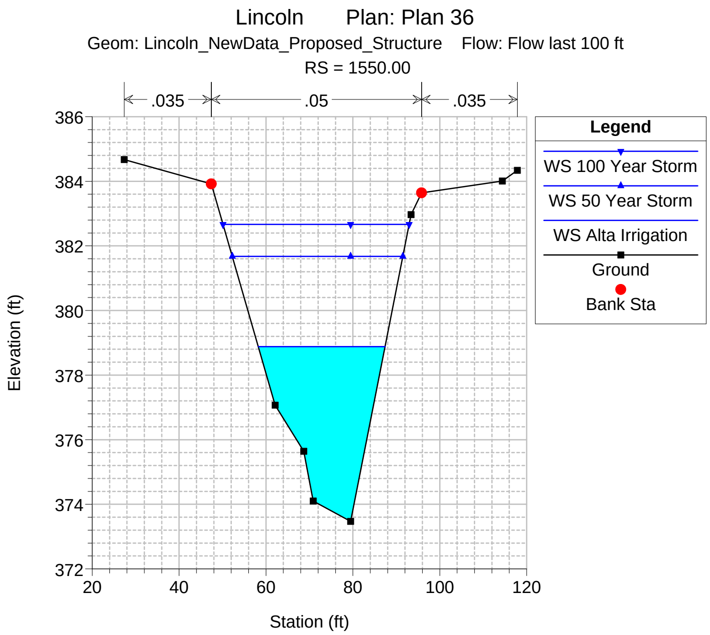

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1800.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

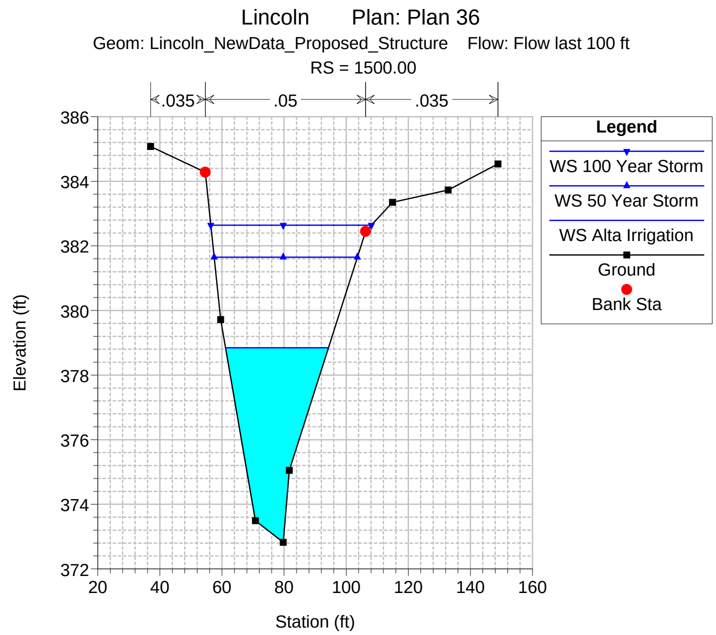

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1750.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

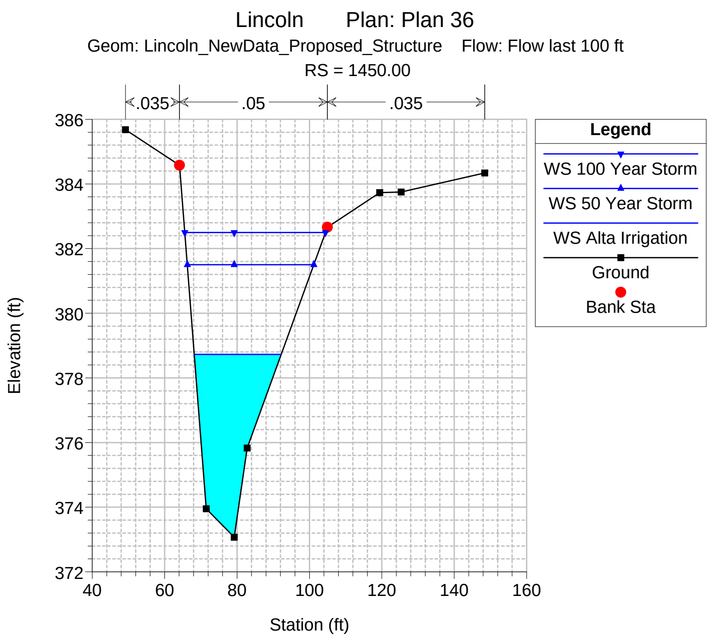

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1700.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

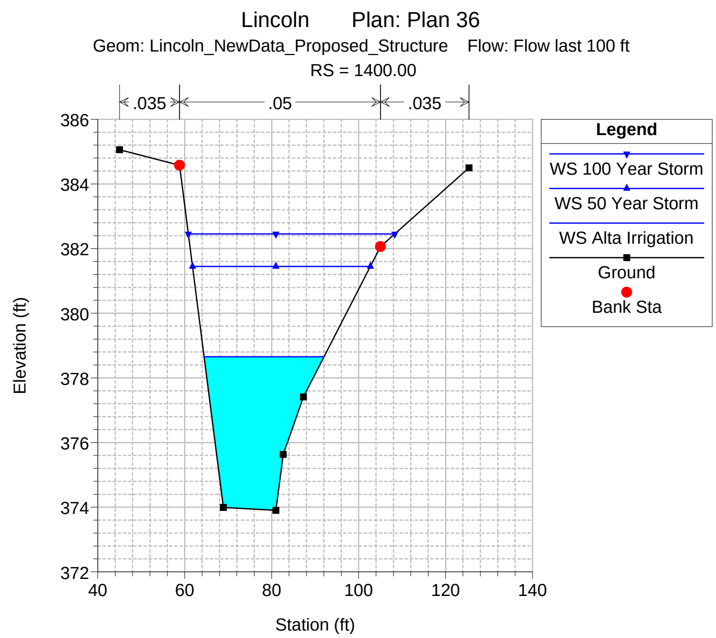

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1650.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

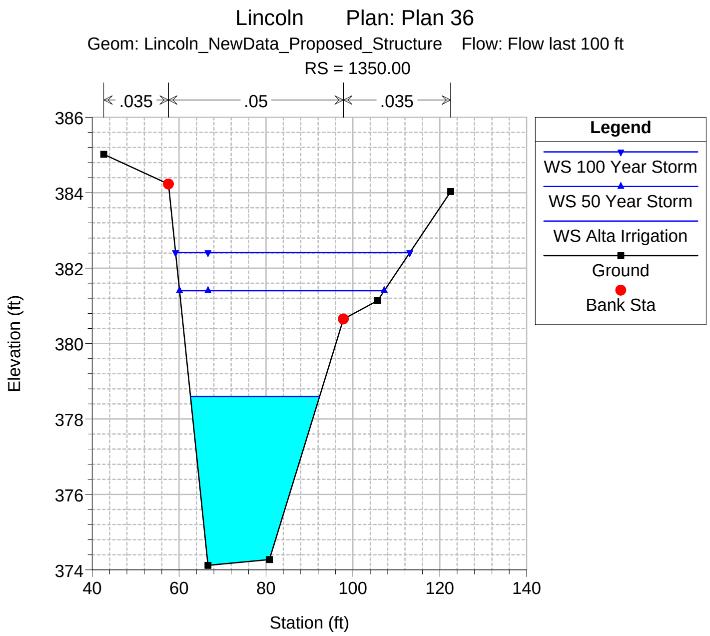

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1600.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

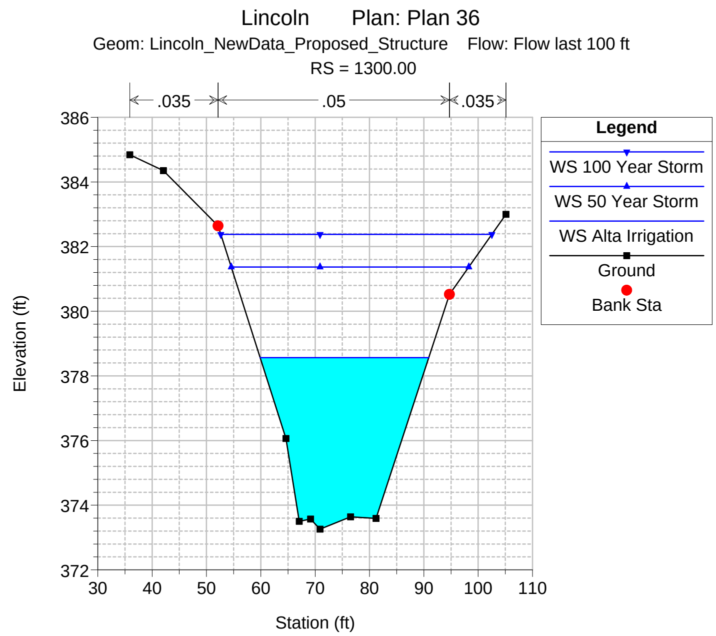

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1550.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

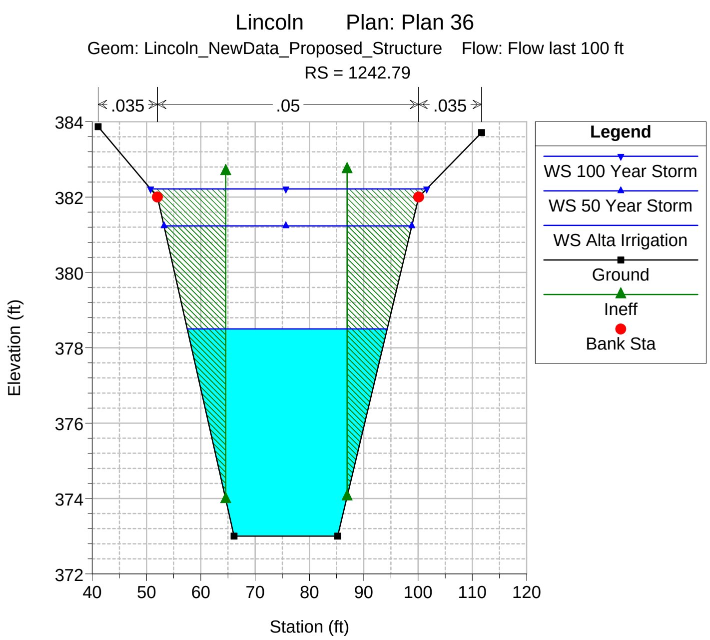

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1500.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

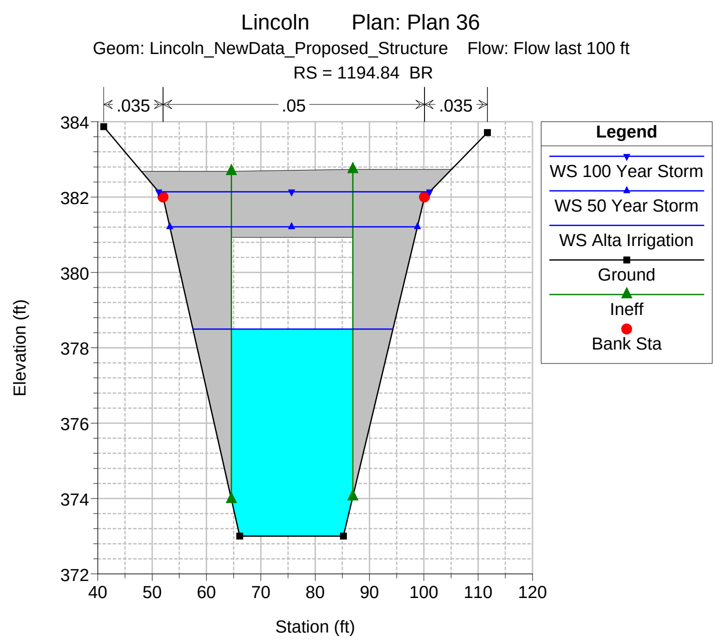

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1450.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

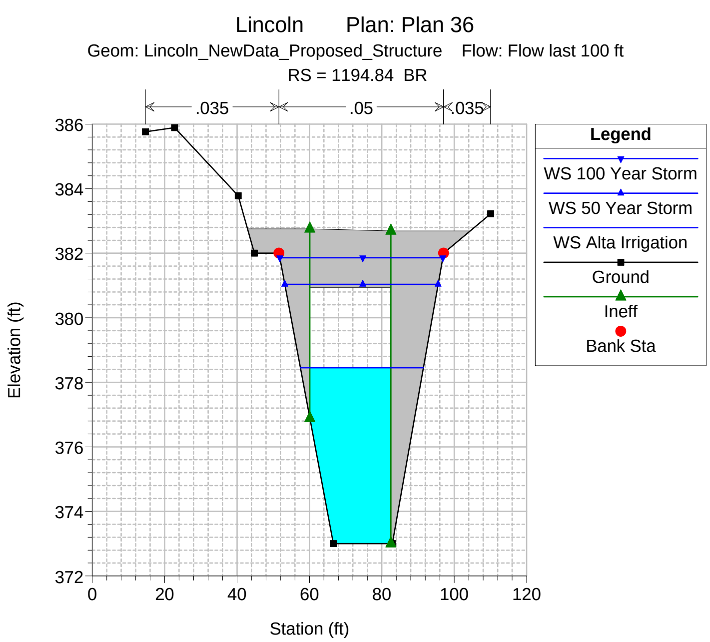

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1400.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

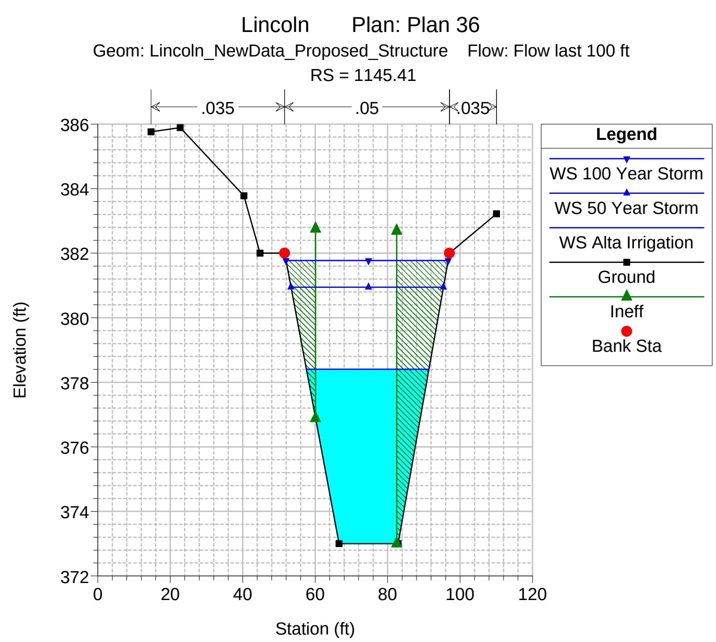

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1350.00
.035
.05
.035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta

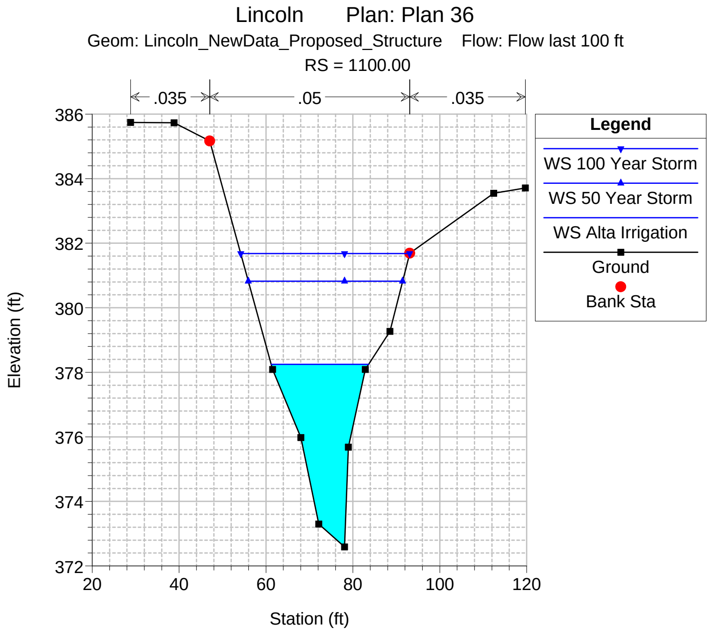

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1300.00
.035
.05
.035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta

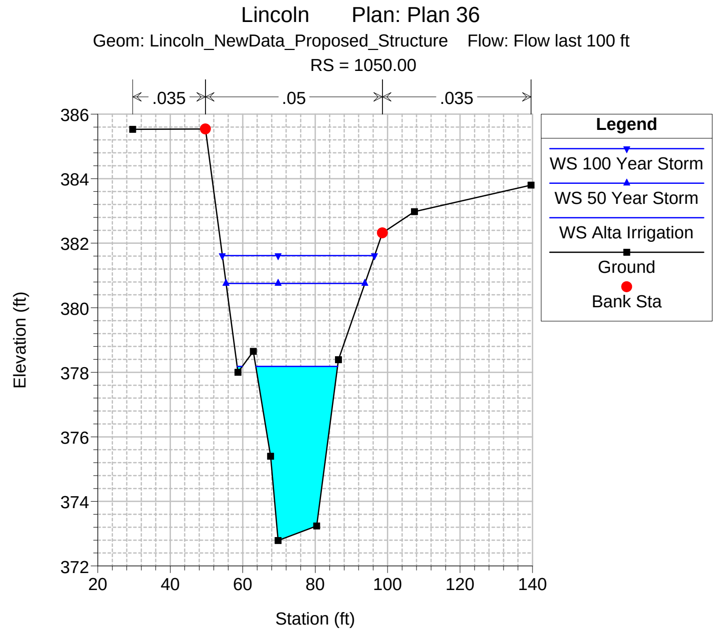

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1242.79
.035
.05
.035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Ineff
Bank Sta

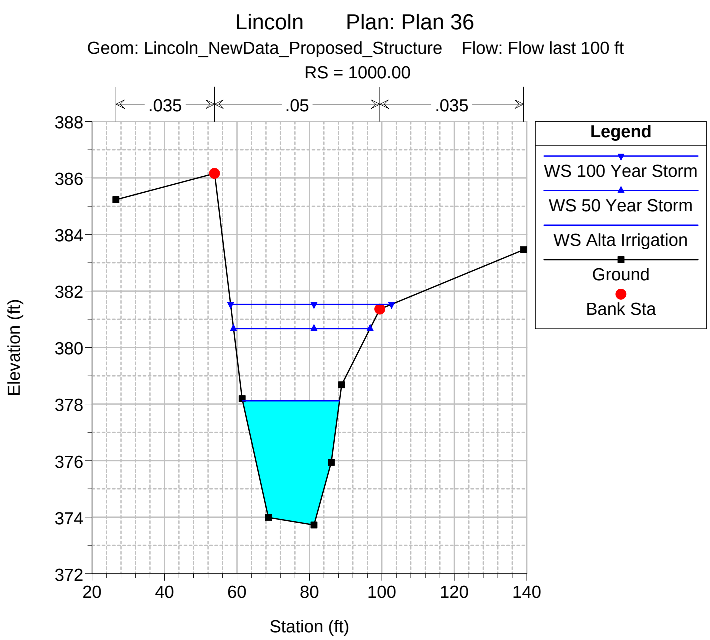

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1194.84 BR
.035
.05
.035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Ineff
Bank Sta

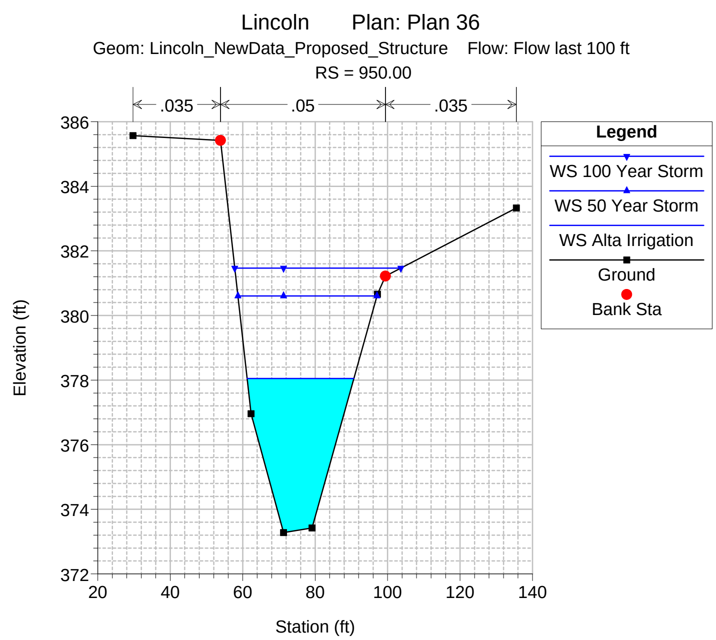

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1194.84 BR
.035
.05
.035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Ineff
Bank Sta

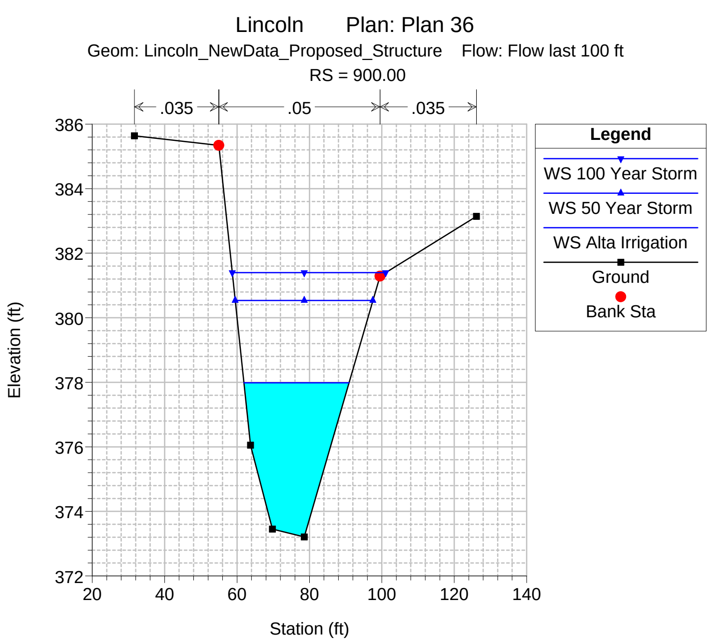

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1145.41
.035
.05
.035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Ineff
Bank Sta

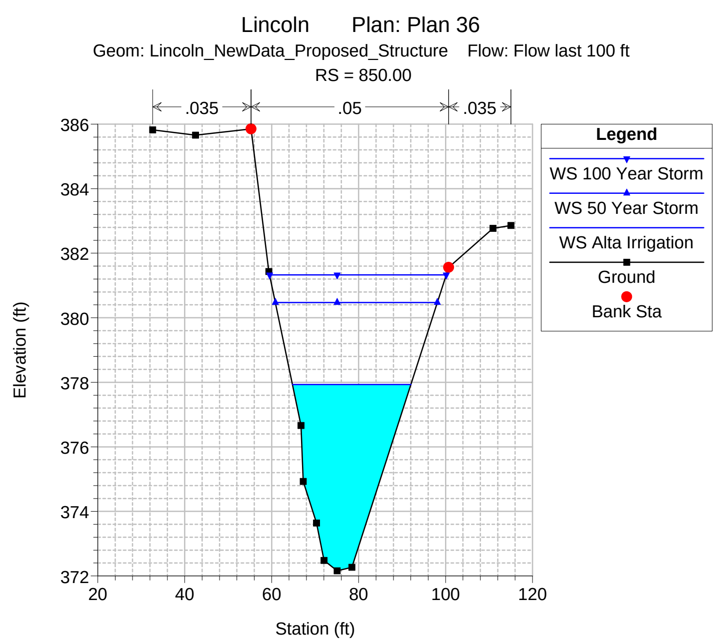

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1100.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
386
384
382
380
378
376
374
372
20
40
60
80
100
120


Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1050.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
386
384
382
380
378
376
374
372
20
40
60
80
100
120
140

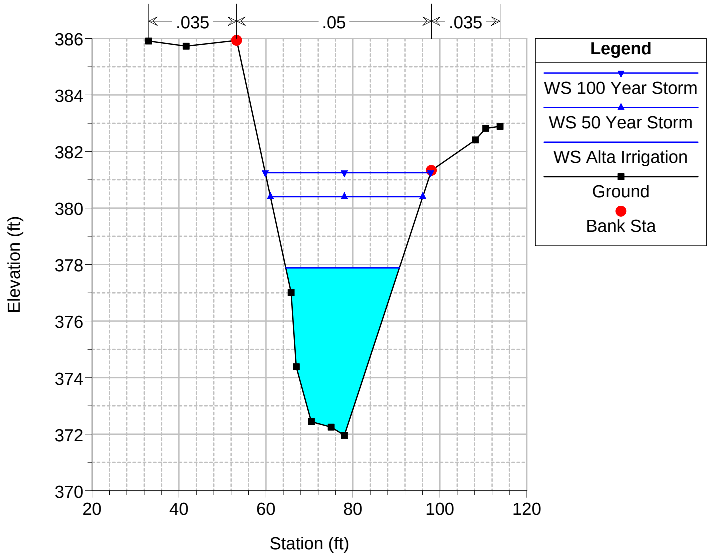

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 1000.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
388
386
384
382
380
378
376
374
372
20
40
60
80
100
120
140


Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 950.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
386
384
382
380
378
376
374
372
20
40
60
80
100
120
140

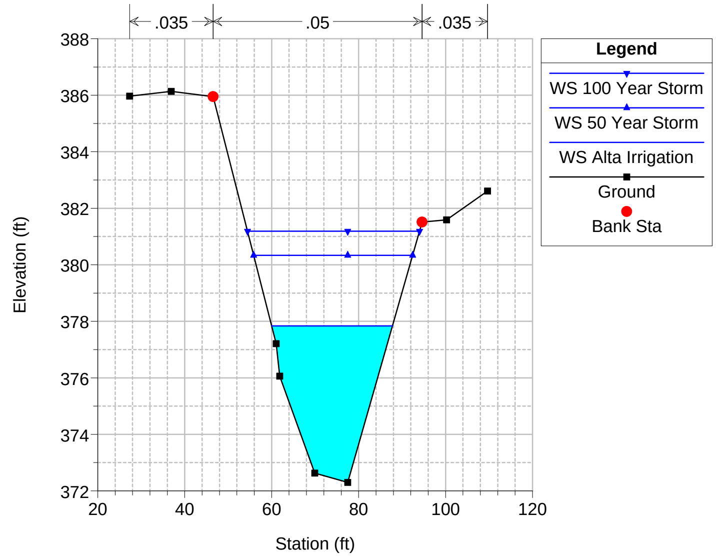

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 900.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
386
384
382
380
378
376
374
372
20
40
60
80
100
120
140


Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 850.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
386
384
382
380
378
376
374
372
20
40
60
80
100
120

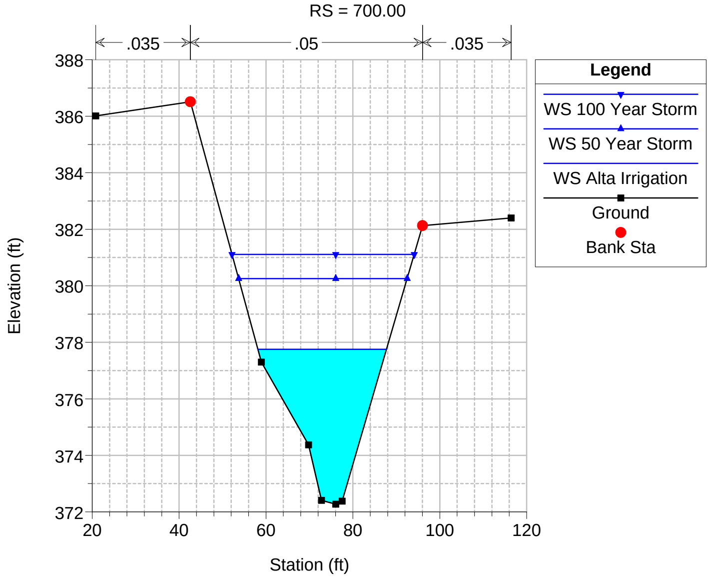
Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 800.00



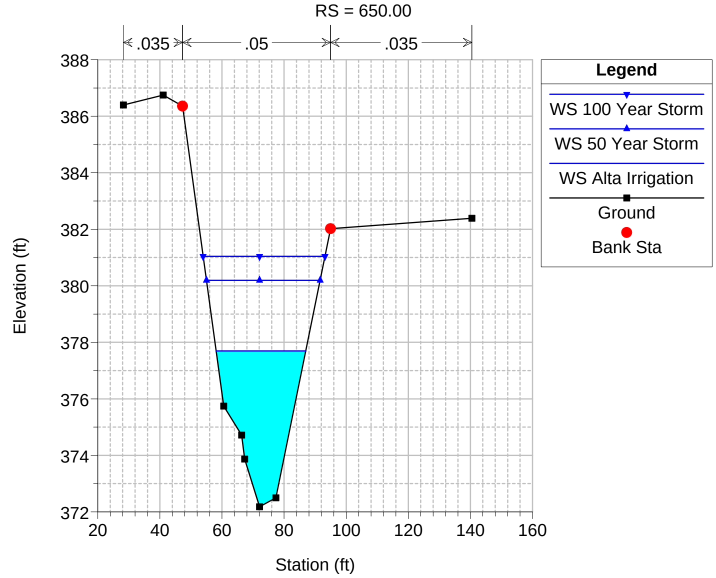
Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 750.00



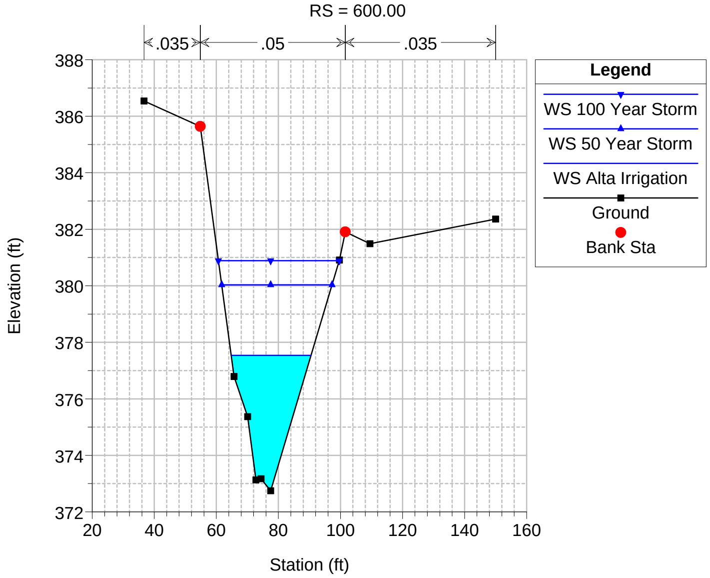
Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 700.00



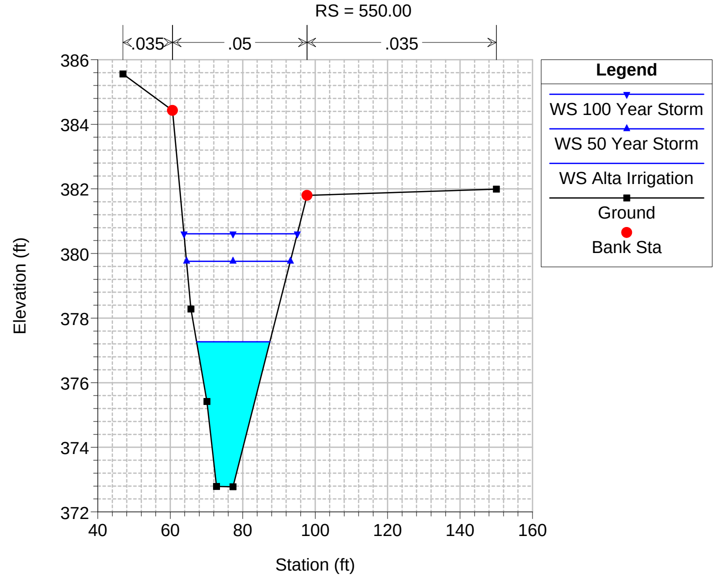
Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 650.00

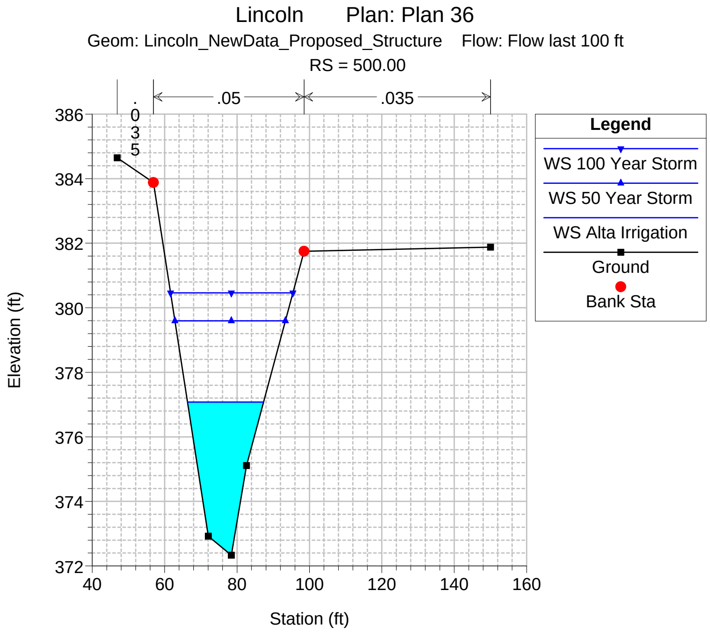


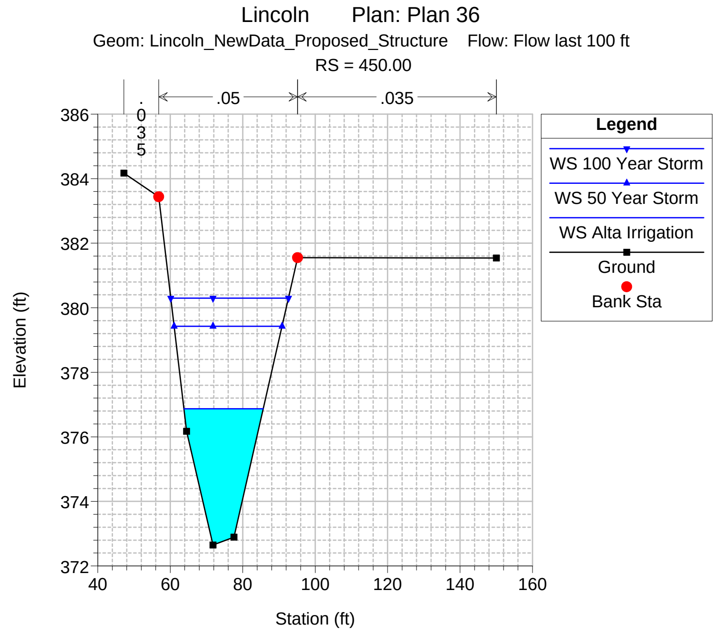
Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 600.00

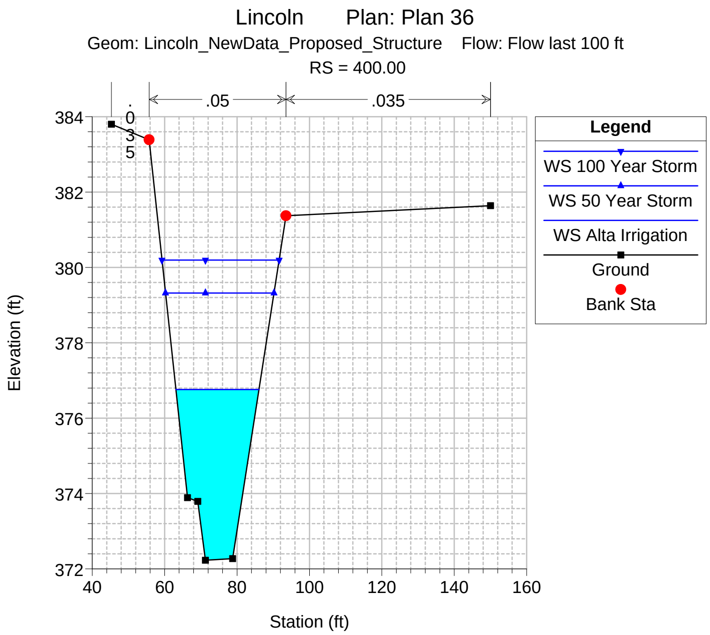


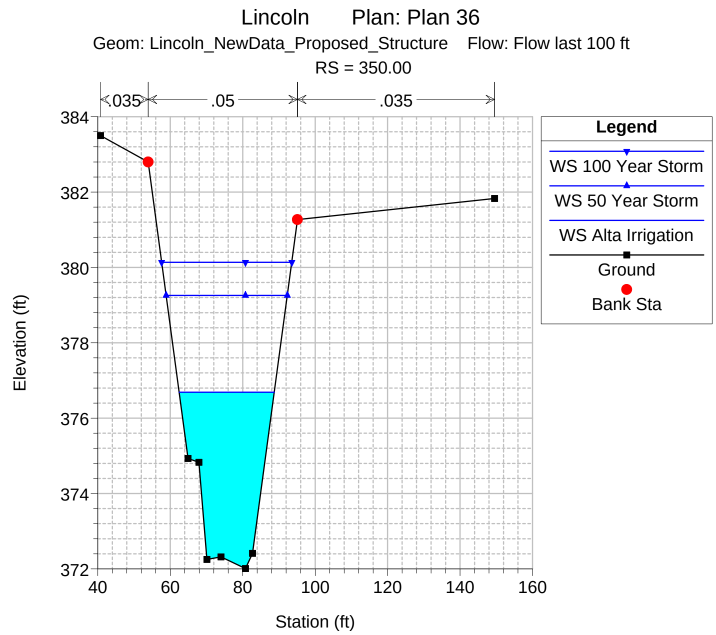
Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 550.00

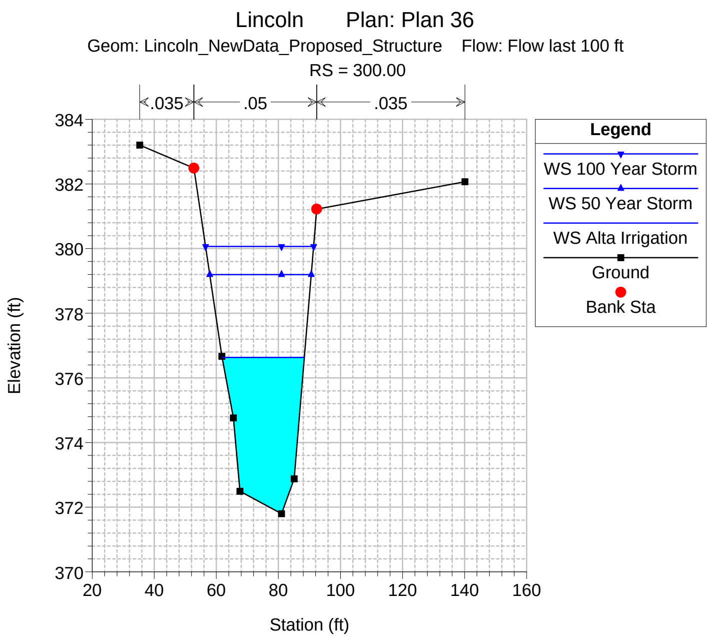


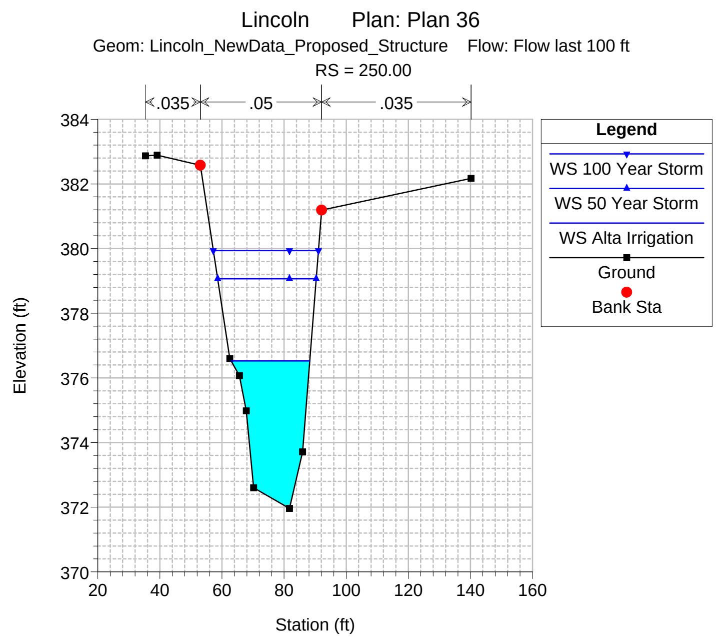

Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 500.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
386
384
382
380
378
376
374
372
40
60
80
100
120
140
160


Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 450.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
386
384
382
380
378
376
374
372
40
60
80
100
120
140
160


Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 400.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
384
382
380
378
376
374
372
40
60
80
100
120
140
160


Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 350.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
384
382
380
378
376
374
372
40
60
80
100
120
140
160


Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 300.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
384
382
380
378
376
374
372
370
20
40
60
80
100
120
140
160


Lincoln Plan: Plan 36
Geom: Lincoln_NewData_Proposed_Structure Flow: Flow last 100 ft
RS = 250.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)
384
382
380
378
376
374
372
370
20
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60
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100
120
140
160

HEC-RAS Plan: Plan 36 River: Travers Reach: Travers

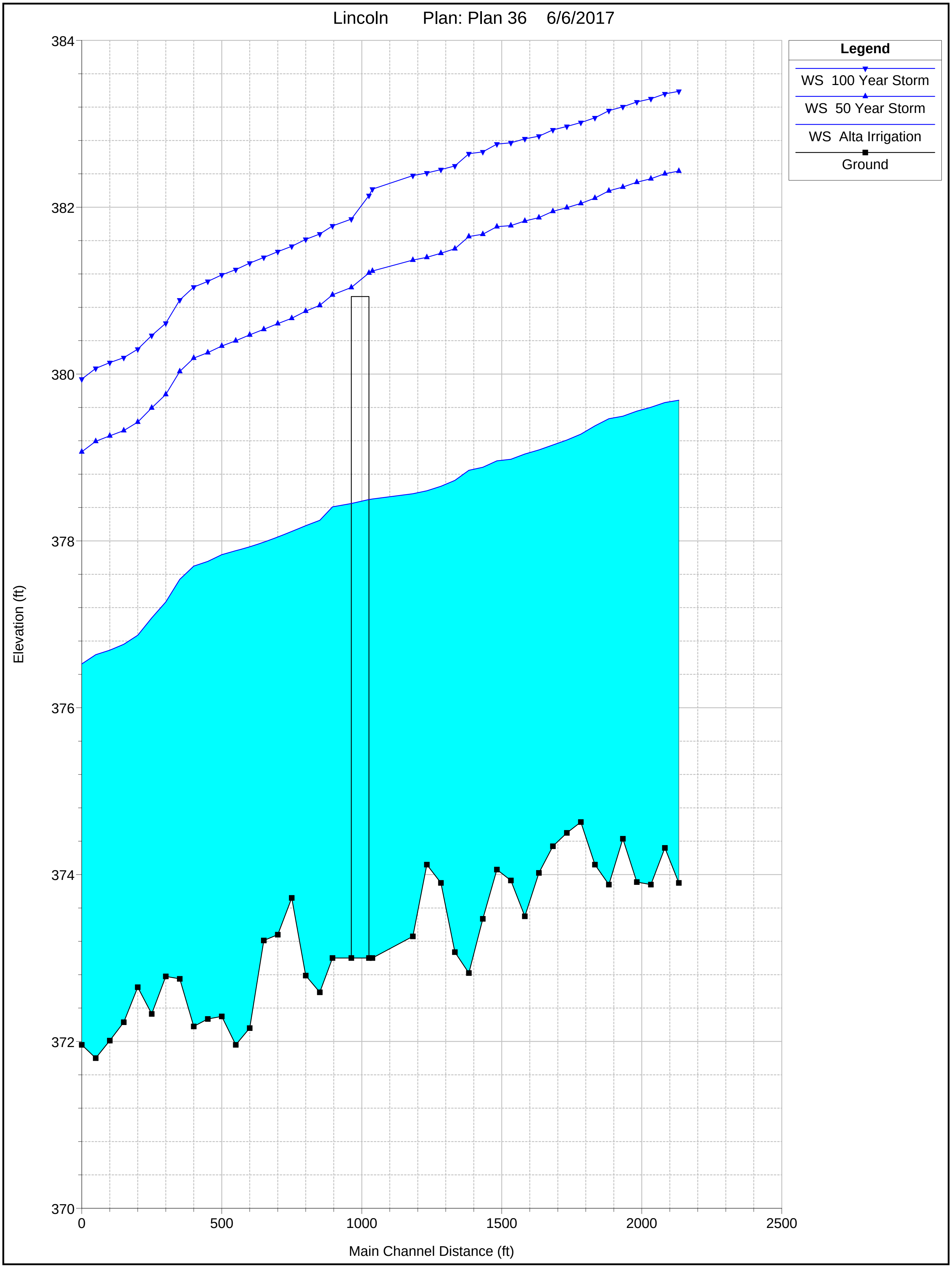
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Travers	2250.00	Alta Irrigation	200.00	373.90	379.69		379.74	0.000781	1.78	112.21	32.00	0.17
Travers	2250.00	50 Year Storm	510.00	373.90	382.43		382.52	0.000852	2.42	210.75	39.77	0.19
Travers	2250.00	100 Year Storm	650.00	373.90	383.39		383.49	0.000869	2.60	250.21	43.02	0.19
Travers	2200.00	Alta Irrigation	200.00	374.32	379.66		379.70	0.000579	1.63	122.38	32.40	0.15
Travers	2200.00	50 Year Storm	510.00	374.32	382.40		382.48	0.000721	2.26	225.76	42.98	0.17
Travers	2200.00	100 Year Storm	650.00	374.32	383.36		383.45	0.000734	2.42	268.67	46.67	0.18
Travers	2150.00	Alta Irrigation	200.00	373.88	379.60		379.66	0.001027	1.95	102.64	31.81	0.19
Travers	2150.00	50 Year Storm	510.00	373.88	382.34		382.44	0.001002	2.49	205.21	43.07	0.20
Travers	2150.00	100 Year Storm	650.00	373.88	383.30		383.41	0.000969	2.62	248.39	47.02	0.20
Travers	2100.00	Alta Irrigation	200.00	373.91	379.56		379.61	0.000934	1.88	106.58	32.86	0.18
Travers	2100.00	50 Year Storm	510.00	373.91	382.30		382.39	0.000930	2.36	216.47	47.23	0.19
Travers	2100.00	100 Year Storm	650.00	373.91	383.26		383.36	0.000888	2.46	264.37	52.28	0.19
Travers	2050.00	Alta Irrigation	200.00	374.43	379.50		379.56	0.001208	2.00	100.10	33.72	0.20
Travers	2050.00	50 Year Storm	510.00	374.43	382.24		382.34	0.001011	2.47	206.08	43.46	0.20
Travers	2050.00	100 Year Storm	650.00	374.43	383.20		383.31	0.000944	2.61	250.00	48.31	0.20
Travers	2000.00	Alta Irrigation	200.00	373.88	379.46		379.51	0.000609	1.72	116.43	28.99	0.15
Travers	2000.00	50 Year Storm	510.00	373.88	382.20		382.29	0.000858	2.45	208.57	39.34	0.19
Travers	2000.00	100 Year Storm	650.00	373.88	383.16		383.26	0.000888	2.62	248.31	43.42	0.19
Travers	1950.00	Alta Irrigation	200.00	374.12	379.38		379.46	0.001570	2.29	87.28	29.51	0.23
Travers	1950.00	50 Year Storm	510.00	374.12	382.11		382.23	0.001330	2.82	180.63	38.85	0.23
Travers	1950.00	100 Year Storm	650.00	374.12	383.07		383.21	0.001262	2.96	219.58	42.13	0.23
Travers	1900.00	Alta Irrigation	200.00	374.63	379.28		379.37	0.001978	2.43	82.31	31.19	0.26
Travers	1900.00	50 Year Storm	510.00	374.63	382.05		382.17	0.001349	2.78	183.41	41.92	0.23
Travers	1900.00	100 Year Storm	650.00	374.63	383.02		383.14	0.001234	2.88	225.87	45.69	0.23
Travers	1850.00	Alta Irrigation	200.00	374.50	379.21		379.28	0.001441	2.18	91.86	32.22	0.23
Travers	1850.00	50 Year Storm	510.00	374.50	382.00		382.10	0.001111	2.59	196.54	42.92	0.21
Travers	1850.00	100 Year Storm	650.00	374.50	382.97		383.08	0.001040	2.71	240.13	46.65	0.21
Travers	1800.00	Alta Irrigation	200.00	374.34	379.15		379.21	0.001193	2.03	98.71	33.25	0.21
Travers	1800.00	50 Year Storm	510.00	374.34	381.95		382.05	0.000975	2.47	206.46	43.71	0.20
Travers	1800.00	100 Year Storm	650.00	374.34	382.93		383.03	0.000925	2.59	250.91	47.36	0.20
Travers	1750.00	Alta Irrigation	200.00	374.02	379.09		379.16	0.001075	2.07	96.52	27.82	0.20
Travers	1750.00	50 Year Storm	510.00	374.02	381.88		381.99	0.001190	2.71	188.17	38.90	0.22
Travers	1750.00	100 Year Storm	650.00	374.02	382.85		382.98	0.001201	2.84	229.01	44.82	0.22
Travers	1700.00	Alta Irrigation	200.00	373.50	379.04		379.11	0.000967	2.02	98.88	26.76	0.19
Travers	1700.00	50 Year Storm	510.00	373.50	381.84		381.93	0.000892	2.60	206.89	50.71	0.19
Travers	1700.00	100 Year Storm	650.00	373.50	382.82		382.92	0.000798	2.65	261.04	59.21	0.18
Travers	1650.00	Alta Irrigation	200.00	373.93	378.98		379.05	0.001233	2.15	93.17	27.87	0.21
Travers	1650.00	50 Year Storm	510.00	373.93	381.78		381.89	0.001118	2.62	198.26	50.15	0.21
Travers	1650.00	100 Year Storm	650.00	373.93	382.77		382.88	0.000960	2.66	253.18	60.55	0.20
Travers	1600.00	Alta Irrigation	200.00	374.06	378.96		379.00	0.000621	1.58	126.40	38.19	0.15
Travers	1600.00	50 Year Storm	510.00	374.06	381.77		381.83	0.000601	2.06	247.29	47.91	0.16
Travers	1600.00	100 Year Storm	650.00	374.06	382.76		382.83	0.000589	2.19	296.41	51.33	0.16
Travers	1550.00	Alta Irrigation	200.00	373.47	378.88		378.95	0.001204	2.12	94.27	29.19	0.21
Travers	1550.00	50 Year Storm	510.00	373.47	381.68		381.79	0.001145	2.69	189.87	39.27	0.22
Travers	1550.00	100 Year Storm	650.00	373.47	382.66		382.79	0.001100	2.82	230.42	42.83	0.21
Travers	1500.00	Alta Irrigation	200.00	372.82	378.85		378.90	0.000838	1.81	110.42	33.17	0.18
Travers	1500.00	50 Year Storm	510.00	372.82	381.65		381.73	0.000828	2.30	222.13	46.13	0.18
Travers	1500.00	100 Year Storm	650.00	372.82	382.64		382.73	0.000781	2.41	270.20	51.70	0.18
Travers	1450.00	Alta Irrigation	200.00	373.07	378.73		378.83	0.001972	2.60	77.05	24.02	0.26
Travers	1450.00	50 Year Storm	510.00	373.07	381.50		381.66	0.001898	3.21	158.97	34.97	0.27
Travers	1450.00	100 Year Storm	650.00	373.07	382.50		382.67	0.001780	3.32	195.61	38.89	0.26
Travers	1400.00	Alta Irrigation	200.00	373.90	378.66		378.74	0.001519	2.31	86.67	27.60	0.23
Travers	1400.00	50 Year Storm	510.00	373.90	381.45		381.57	0.001398	2.80	182.40	40.93	0.23
Travers	1400.00	100 Year Storm	650.00	373.90	382.45		382.58	0.001244	2.88	226.16	47.48	0.22
Travers	1350.00	Alta Irrigation	200.00	374.12	378.60		378.67	0.001145	2.08	96.38	29.74	0.20
Travers	1350.00	50 Year Storm	510.00	374.12	381.40		381.51	0.001028	2.63	197.03	47.11	0.20
Travers	1350.00	100 Year Storm	650.00	374.12	382.41		382.52	0.000896	2.71	248.11	53.90	0.20
Travers	1300.00	Alta Irrigation	200.00	373.26	378.57		378.62	0.000765	1.81	110.75	31.04	0.17
Travers	1300.00	50 Year Storm	510.00	373.26	381.37		381.46	0.000808	2.40	213.57	43.71	0.18

HEC-RAS Plan: Plan 36 River: Travers Reach: Travers (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Travers	1300.00	100 Year Storm	650.00	373.26	382.38		382.48	0.000754	2.53	260.95	49.87	0.18
Travers	1242.79	Alta Irrigation	200.00	373.00	378.50	374.42	378.54	0.000333	1.65	121.39	36.83	0.12
Travers	1242.79	50 Year Storm	510.00	373.00	381.24	375.59	381.36	0.000557	2.79	182.53	45.65	0.17
Travers	1242.79	100 Year Storm	650.00	373.00	382.22	376.04	382.37	0.000619	3.18	204.47	50.84	0.19
Travers	1194.84		Bridge									
Travers	1145.41	Alta Irrigation	200.00	373.00	378.41		378.46	0.000501	1.85	108.34	33.83	0.15
Travers	1145.41	50 Year Storm	510.00	373.00	380.95		381.10	0.000799	3.09	165.18	42.08	0.20
Travers	1145.41	100 Year Storm	650.00	373.00	381.78		381.97	0.000911	3.54	183.66	44.77	0.22
Travers	1100.00	Alta Irrigation	200.00	372.59	378.25		378.40	0.003576	3.16	63.22	22.39	0.33
Travers	1100.00	50 Year Storm	510.00	372.59	380.82		381.03	0.002896	3.64	140.14	35.51	0.32
Travers	1100.00	100 Year Storm	650.00	372.59	381.68		381.90	0.002675	3.78	171.97	38.88	0.32
Travers	1050.00	Alta Irrigation	200.00	372.79	378.18		378.27	0.001510	2.39	83.58	23.99	0.23
Travers	1050.00	50 Year Storm	510.00	372.79	380.75		380.90	0.001773	3.05	167.21	38.33	0.26
Travers	1050.00	100 Year Storm	650.00	372.79	381.62		381.78	0.001735	3.22	201.78	42.00	0.26
Travers	1000.00	Alta Irrigation	200.00	373.72	378.11		378.20	0.001427	2.31	86.46	26.77	0.23
Travers	1000.00	50 Year Storm	510.00	373.72	380.67		380.81	0.001652	3.05	167.30	37.69	0.26
Travers	1000.00	100 Year Storm	650.00	373.72	381.53		381.69	0.001629	3.22	201.82	44.46	0.26
Travers	950.00	Alta Irrigation	200.00	373.28	378.05		378.12	0.001356	2.21	90.49	29.45	0.22
Travers	950.00	50 Year Storm	510.00	373.28	380.60		380.73	0.001376	2.88	177.20	38.38	0.24
Travers	950.00	100 Year Storm	650.00	373.28	381.47		381.61	0.001375	3.07	212.48	45.84	0.24
Travers	900.00	Alta Irrigation	200.00	373.21	377.98		378.06	0.001283	2.18	91.72	29.02	0.22
Travers	900.00	50 Year Storm	510.00	373.21	380.54		380.67	0.001368	2.88	177.30	38.03	0.23
Travers	900.00	100 Year Storm	650.00	373.21	381.40		381.54	0.001368	3.08	211.43	42.35	0.24
Travers	850.00	Alta Irrigation	200.00	372.16	377.93		378.00	0.001051	2.07	96.61	27.23	0.19
Travers	850.00	50 Year Storm	510.00	372.16	380.47		380.60	0.001341	2.86	178.45	37.24	0.23
Travers	850.00	100 Year Storm	650.00	372.16	381.33		381.48	0.001380	3.07	211.92	40.63	0.24
Travers	800.00	Alta Irrigation	200.00	371.96	377.88		377.95	0.000941	2.02	98.92	26.12	0.18
Travers	800.00	50 Year Storm	510.00	371.96	380.40		380.53	0.001333	2.90	175.81	35.02	0.23
Travers	800.00	100 Year Storm	650.00	371.96	381.25		381.41	0.001404	3.14	206.98	38.04	0.24
Travers	750.00	Alta Irrigation	200.00	372.30	377.84		377.90	0.000980	2.03	98.65	27.79	0.19
Travers	750.00	50 Year Storm	510.00	372.30	380.34		380.46	0.001275	2.85	179.18	36.59	0.23
Travers	750.00	100 Year Storm	650.00	372.30	381.19		381.33	0.001325	3.07	211.61	39.58	0.23
Travers	700.00	Alta Irrigation	200.00	372.27	377.75		377.84	0.001567	2.29	87.20	29.59	0.24
Travers	700.00	50 Year Storm	510.00	372.27	380.26		380.39	0.001520	2.95	172.78	38.79	0.25
Travers	700.00	100 Year Storm	650.00	372.27	381.11		381.26	0.001500	3.14	207.25	41.93	0.25
Travers	650.00	Alta Irrigation	200.00	372.18	377.70		377.77	0.001130	2.09	95.66	28.89	0.20
Travers	650.00	50 Year Storm	510.00	372.18	380.19		380.32	0.001322	2.88	177.32	36.61	0.23
Travers	650.00	100 Year Storm	650.00	372.18	381.04		381.19	0.001358	3.10	209.60	39.25	0.24
Travers	600.00	Alta Irrigation	200.00	372.75	377.54		377.67	0.002952	2.93	68.25	25.73	0.32
Travers	600.00	50 Year Storm	510.00	372.75	380.03		380.23	0.002459	3.53	144.65	35.57	0.31
Travers	600.00	100 Year Storm	650.00	372.75	380.89		381.10	0.002329	3.68	176.53	38.94	0.30
Travers	550.00	Alta Irrigation	200.00	372.78	377.27		377.48	0.004839	3.68	54.28	20.23	0.40
Travers	550.00	50 Year Storm	510.00	372.78	379.76		380.06	0.004098	4.41	115.62	28.65	0.39
Travers	550.00	100 Year Storm	650.00	372.78	380.61		380.94	0.003874	4.60	141.21	31.30	0.38
Travers	500.00	Alta Irrigation	200.00	372.33	377.08		377.25	0.003834	3.39	59.02	21.02	0.36
Travers	500.00	50 Year Storm	510.00	372.33	379.59		379.86	0.003479	4.12	123.92	30.52	0.36
Travers	500.00	100 Year Storm	650.00	372.33	380.46		380.75	0.003294	4.28	151.82	33.80	0.36
Travers	450.00	Alta Irrigation	200.00	372.65	376.87		377.05	0.004149	3.45	57.92	21.89	0.37
Travers	450.00	50 Year Storm	510.00	372.65	379.42		379.69	0.003339	4.11	123.95	29.79	0.36
Travers	450.00	100 Year Storm	650.00	372.65	380.30		380.59	0.003167	4.30	151.17	32.50	0.35
Travers	400.00	Alta Irrigation	200.00	372.23	376.76		376.88	0.002321	2.81	71.13	22.96	0.28
Travers	400.00	50 Year Storm	510.00	372.23	379.32		379.53	0.002389	3.67	138.88	29.96	0.30
Travers	400.00	100 Year Storm	650.00	372.23	380.20		380.43	0.002384	3.91	166.14	32.35	0.30
Travers	350.00	Alta Irrigation	200.00	372.01	376.69		376.78	0.001599	2.39	83.78	26.26	0.24
Travers	350.00	50 Year Storm	510.00	372.01	379.26		379.42	0.001691	3.18	160.49	33.46	0.26
Travers	350.00	100 Year Storm	650.00	372.01	380.14		380.32	0.001703	3.40	190.96	35.92	0.26
Travers	300.00	Alta Irrigation	200.00	371.80	376.64		376.71	0.001125	2.14	93.62	26.53	0.20
Travers	300.00	50 Year Storm	510.00	371.80	379.19		379.33	0.001396	3.01	169.42	32.72	0.23

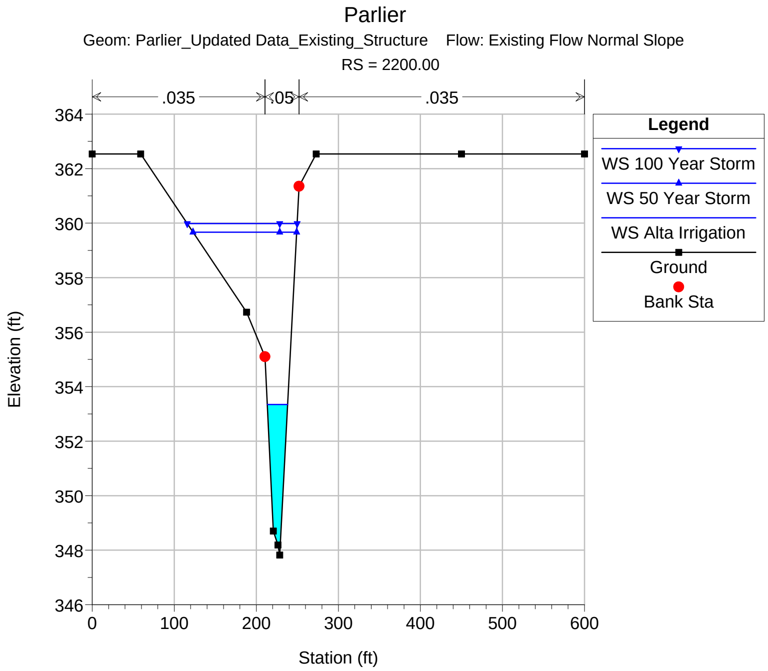
HEC-RAS Plan: Plan 36 River: Travers Reach: Travers (Continued)

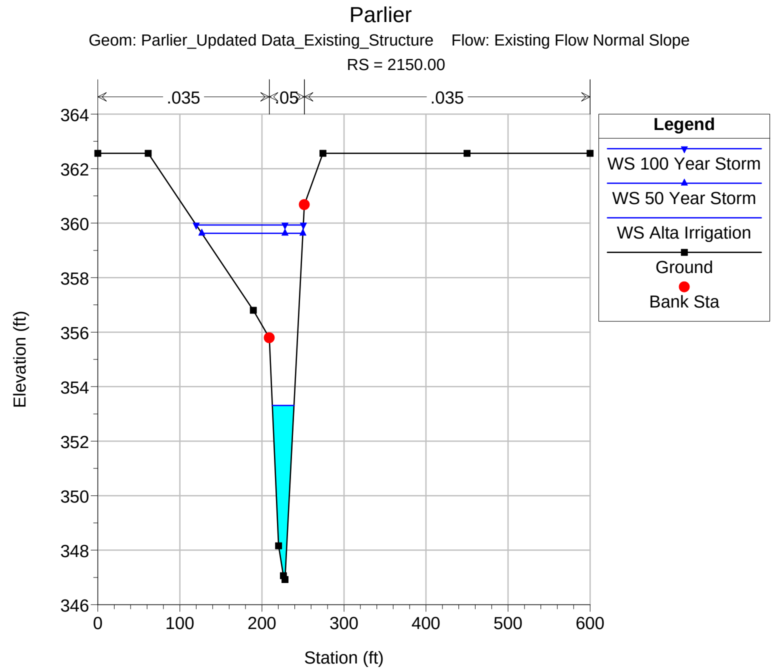
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Travers	300.00	100 Year Storm	650.00	371.80	380.07		380.23	0.001457	3.27	198.98	34.84	0.24
Travers	250.00	Alta Irrigation	200.00	371.96	376.52	374.12	376.63	0.002002	2.59	77.08	25.28	0.26
Travers	250.00	50 Year Storm	510.00	371.96	379.07	375.54	379.25	0.002001	3.40	149.96	31.73	0.28
Travers	250.00	100 Year Storm	650.00	371.96	379.94	376.07	380.15	0.002002	3.64	178.53	33.83	0.28

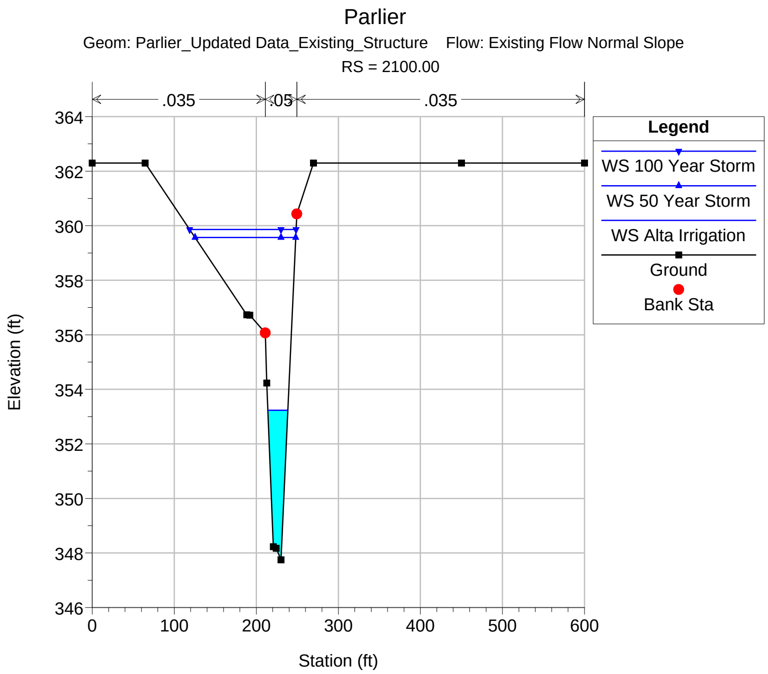


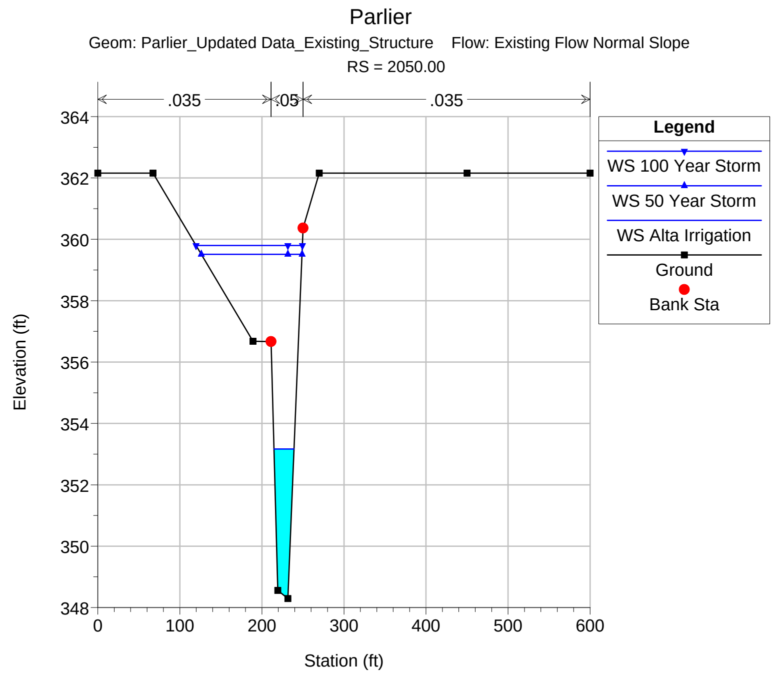
Lincoln Plan: Plan 36 6/6/2017
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Elevation (ft)
384
382
380
378
376
374
372
370
0
500
1000
1500
2000
2500
Main Channel Distance (ft)

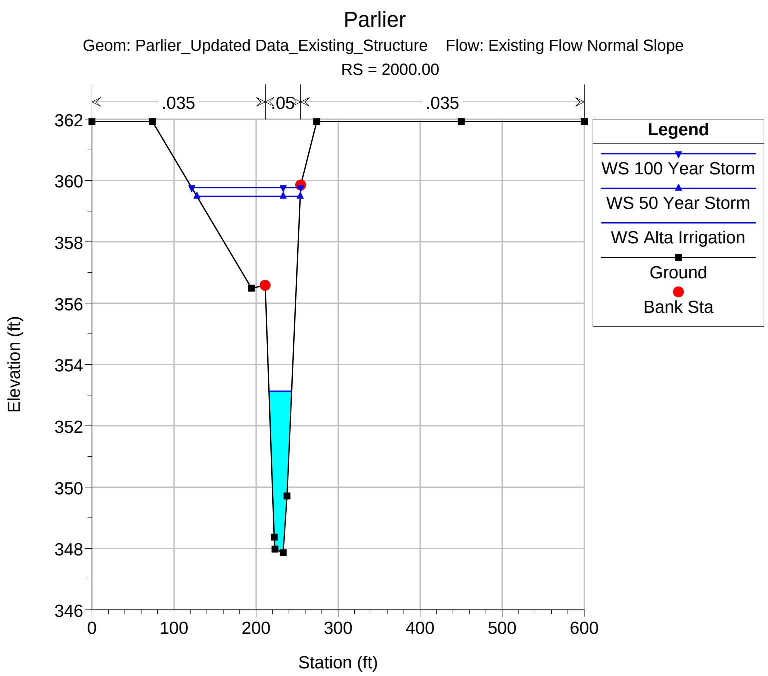
Appendix G: HEC-RAS Output for Parlier Avenue Existing Structure

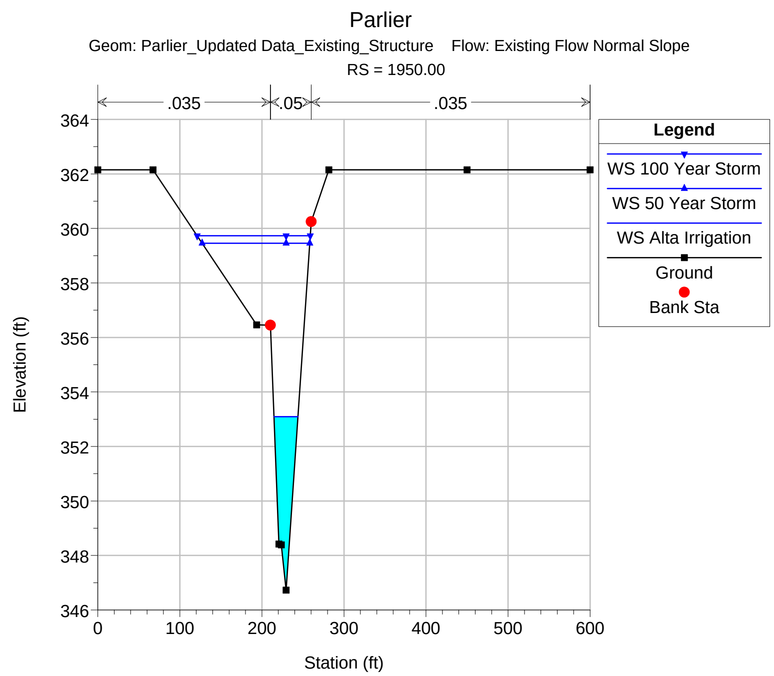

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 2200.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

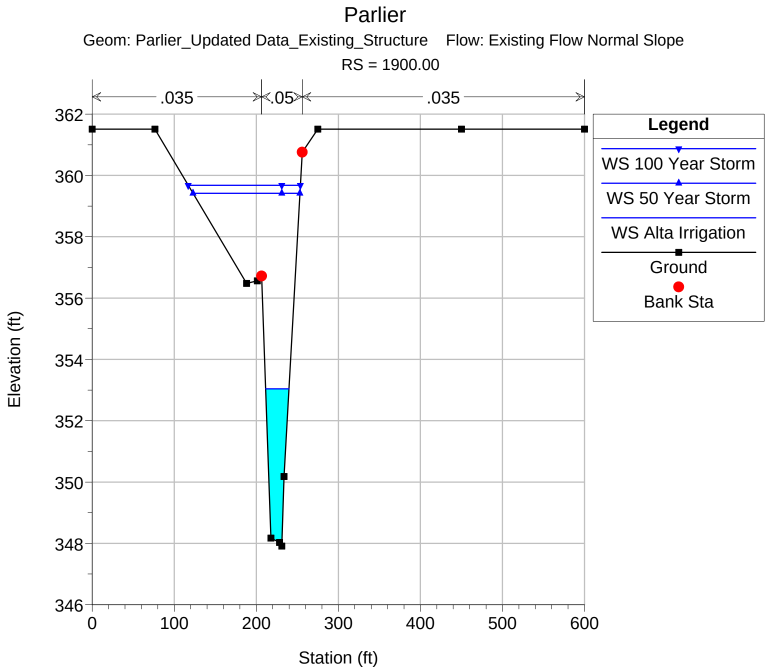

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 2150.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

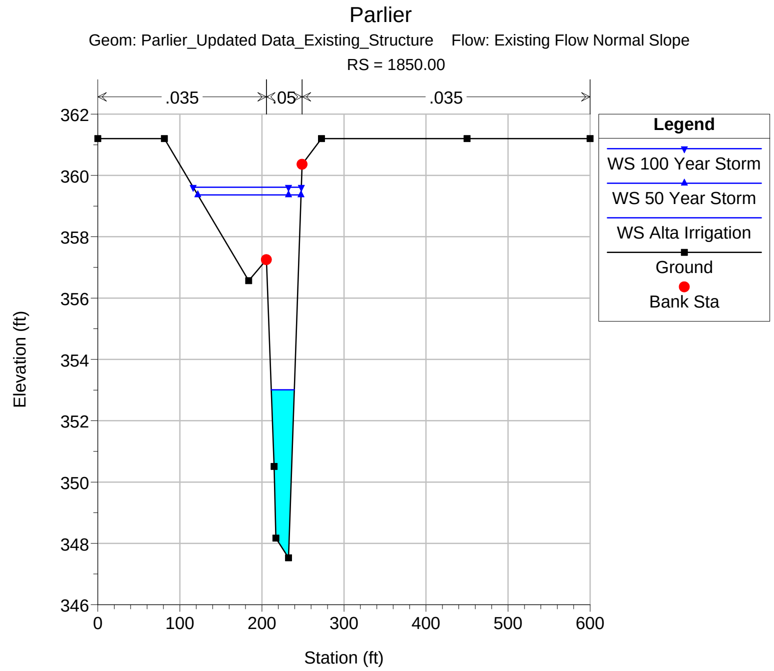

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 2100.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

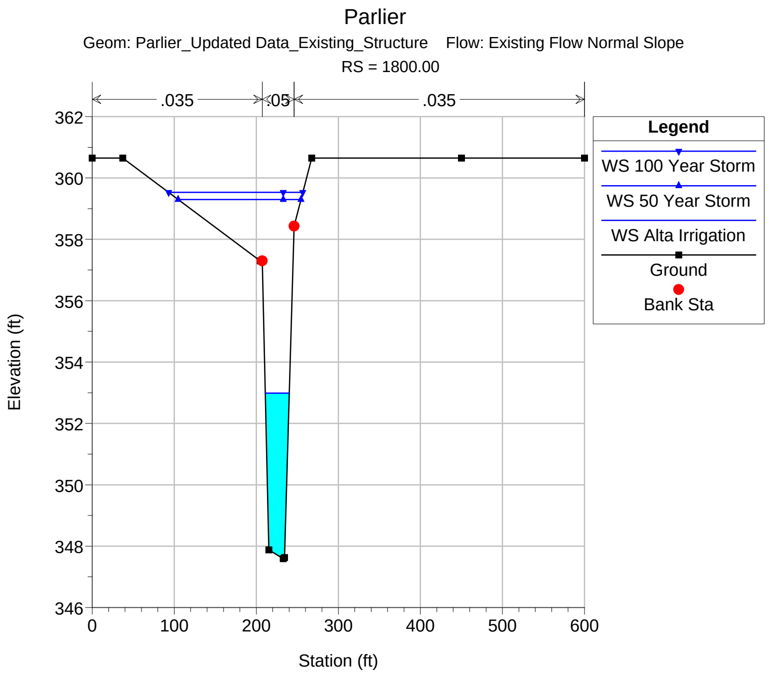

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 2050.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

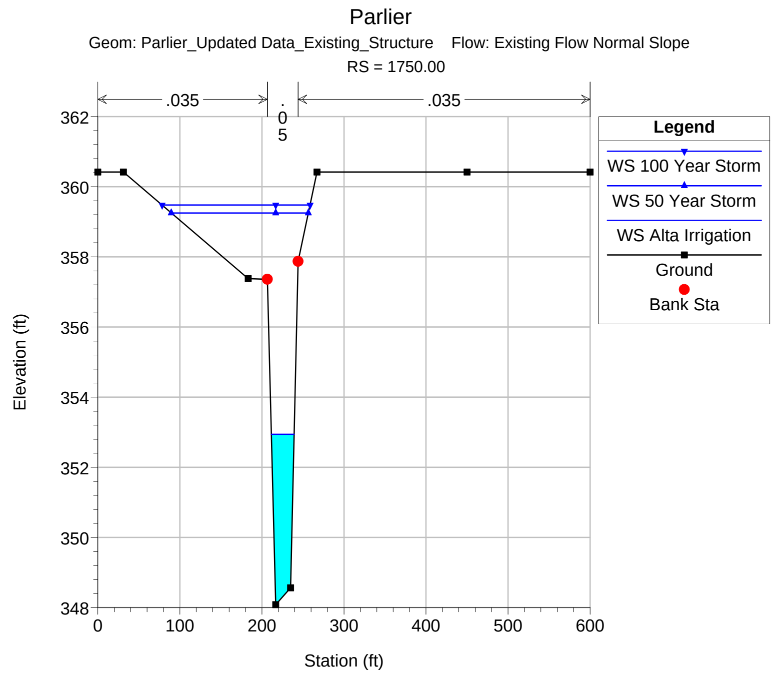

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 2000.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

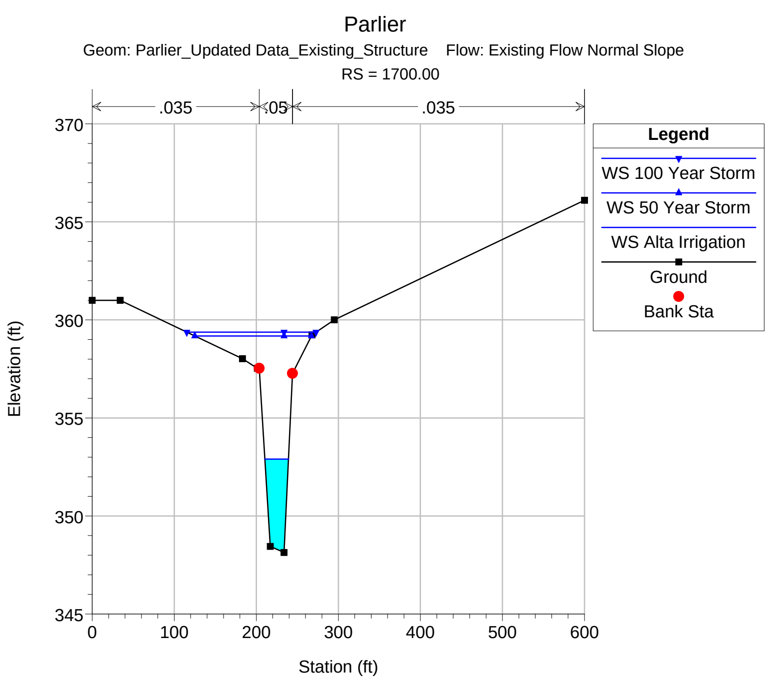

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1950.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

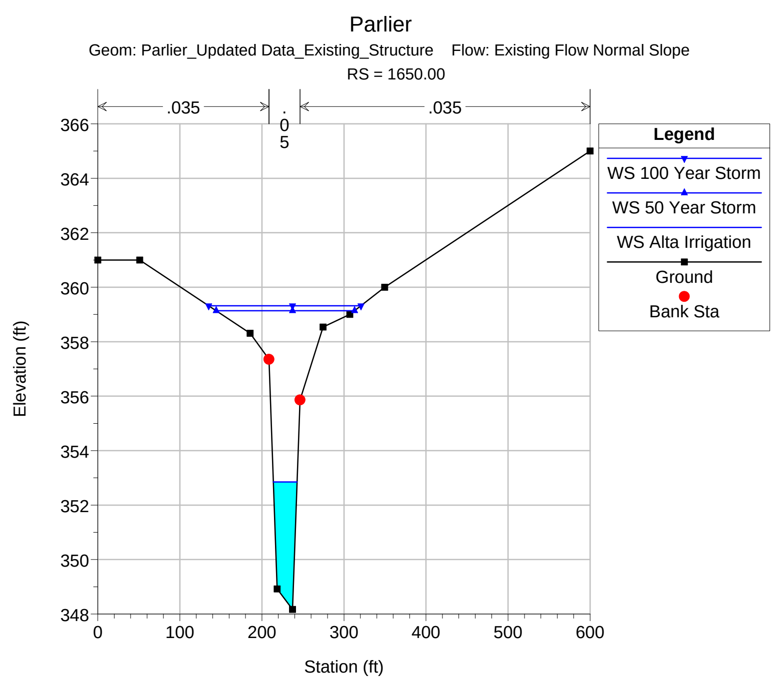

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1900.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
346
348
350
352
354
356
358
360
362
Station (ft)
0
100
200
300
400
500
600

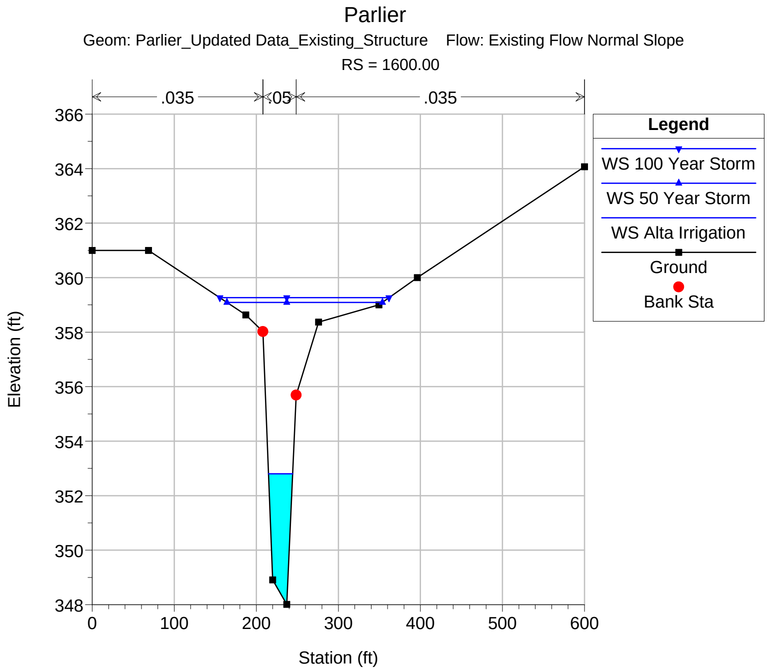

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1850.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
346
348
350
352
354
356
358
360
362
Station (ft)
0
100
200
300
400
500
600

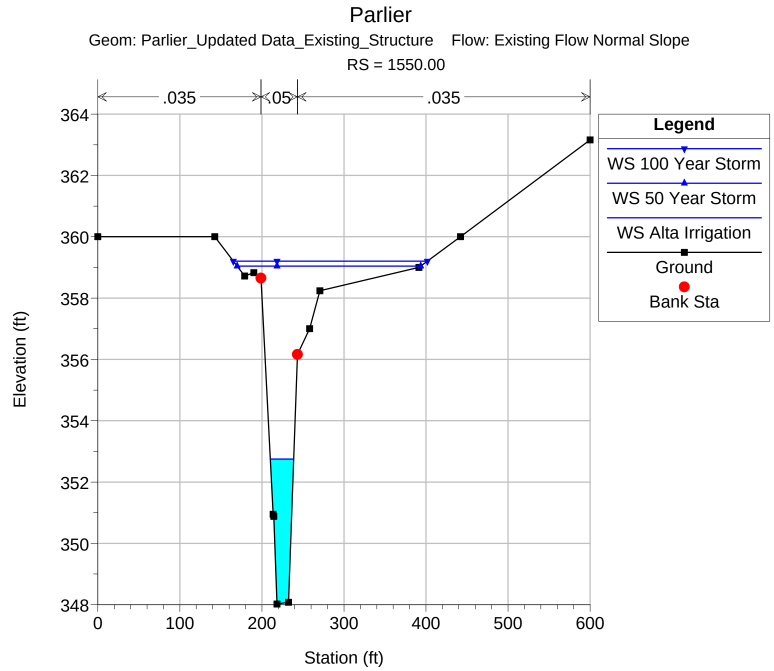

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1800.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
346
348
350
352
354
356
358
360
362
Station (ft)
0
100
200
300
400
500
600

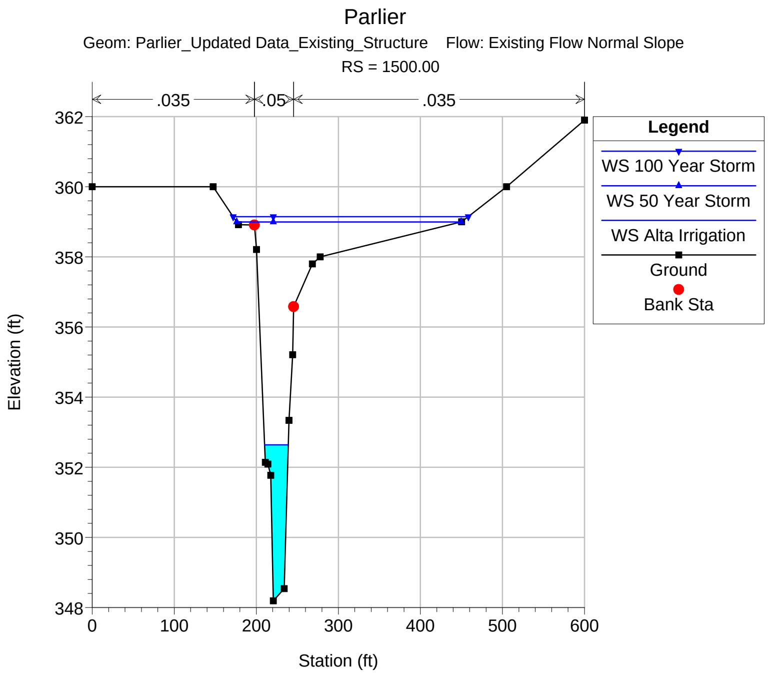

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1750.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
348
350
352
354
356
358
360
362
Station (ft)
0
100
200
300
400
500
600

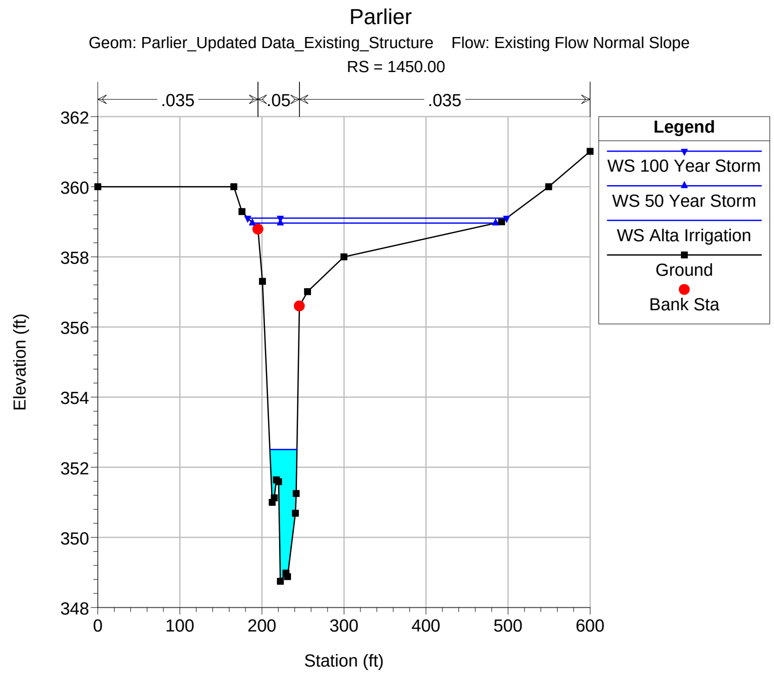

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1700.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
345
350
355
360
365
370
Station (ft)
0
100
200
300
400
500
600

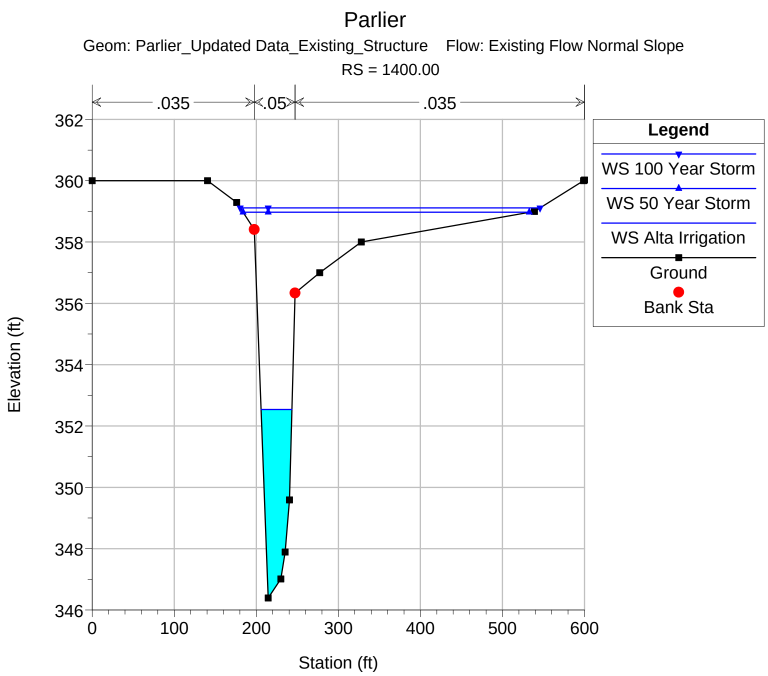

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1650.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
348
350
352
354
356
358
360
362
364
366
Station (ft)
0
100
200
300
400
500
600

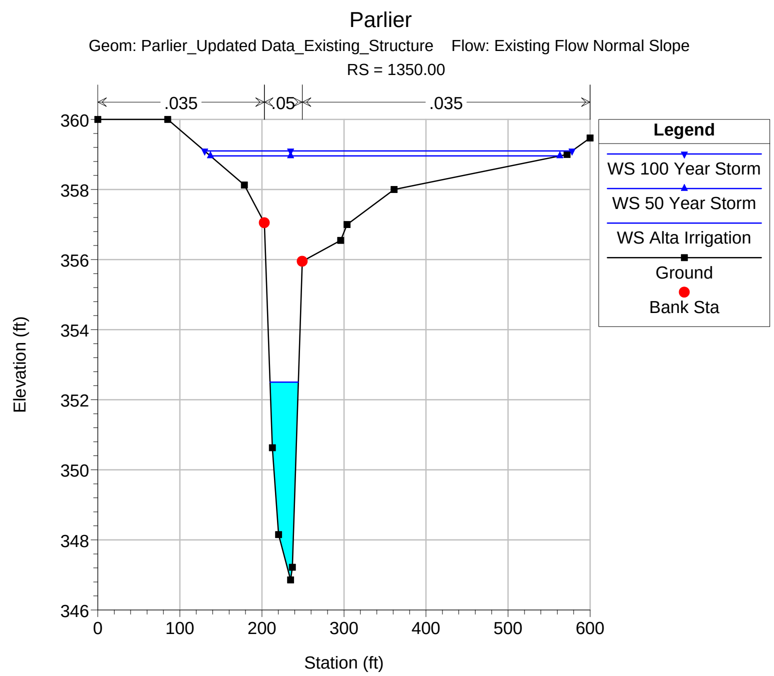

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1600.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1550.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

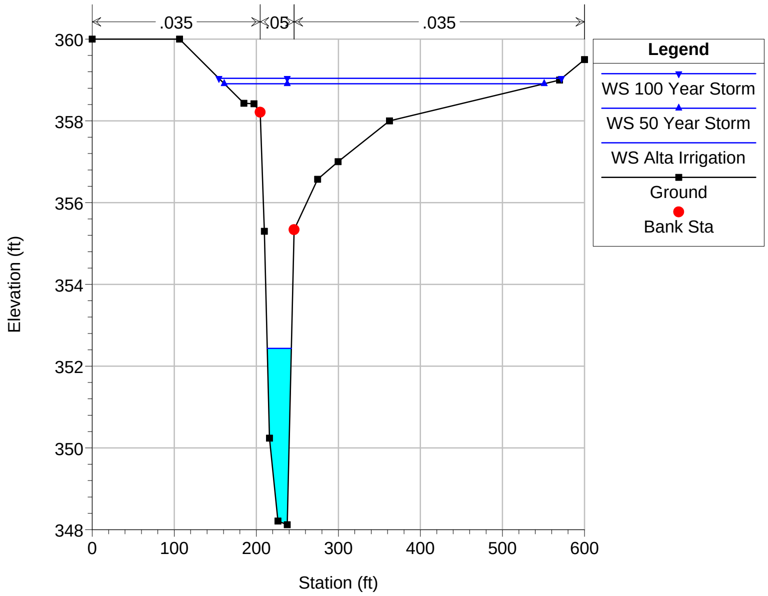

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1500.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1450.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

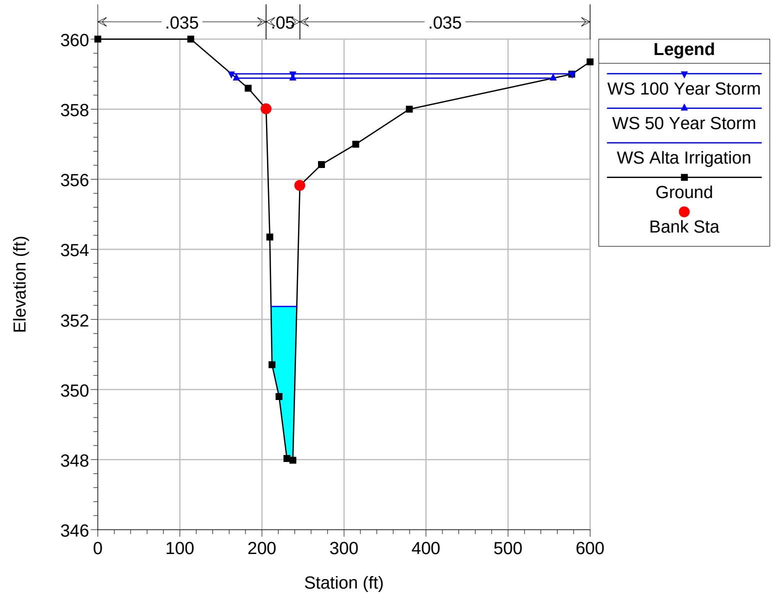

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1400.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1350.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

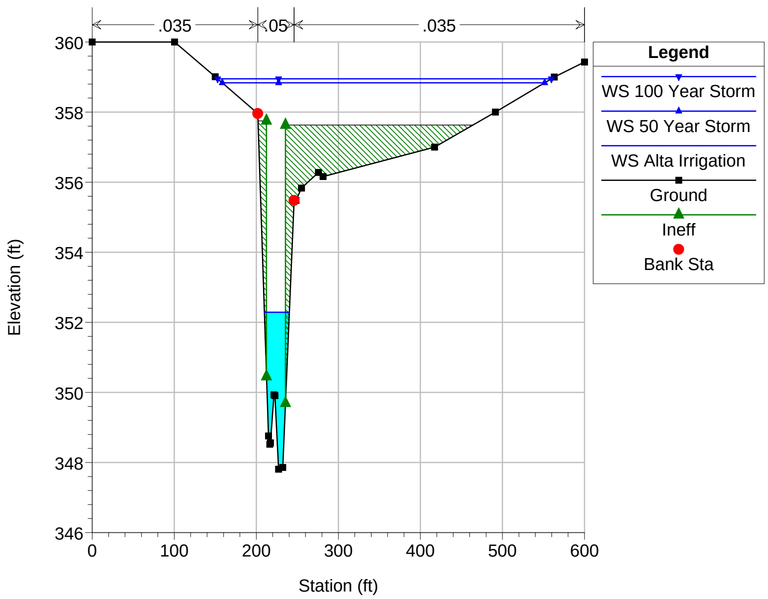
Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1300.00



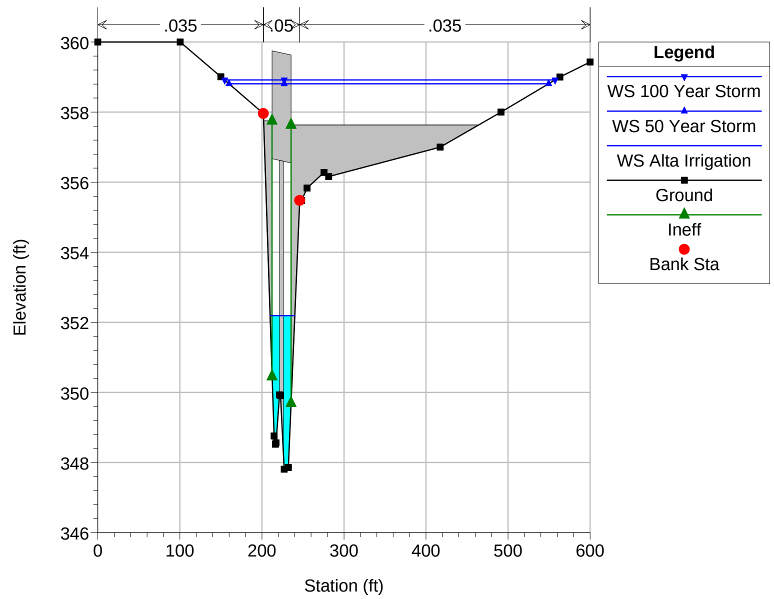
Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1250.00



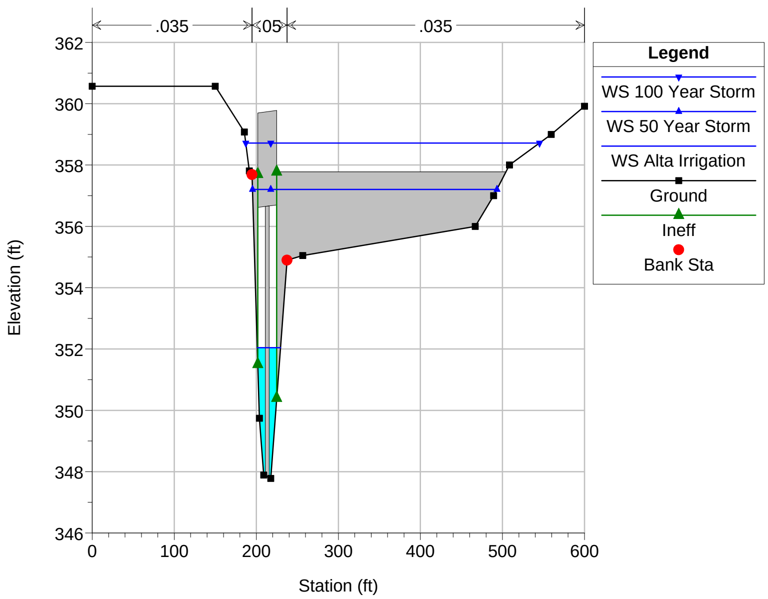
Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1212.18



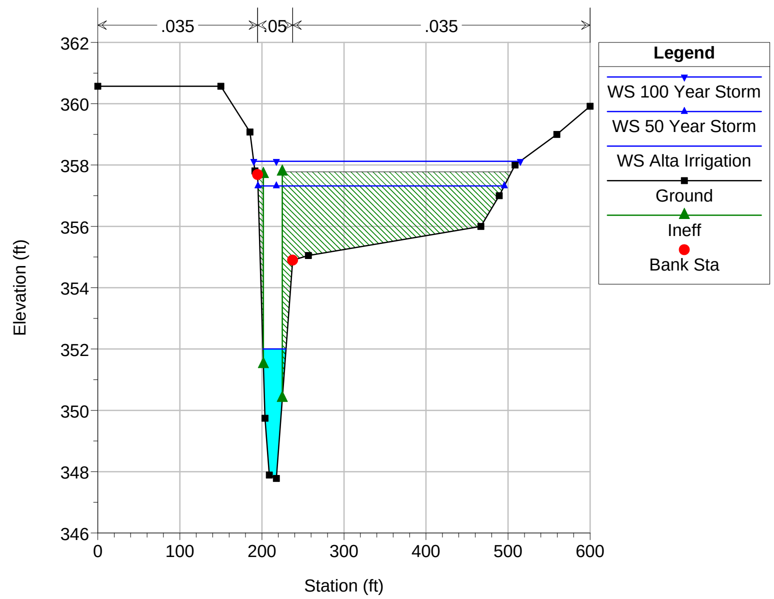
Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1185.29 BR

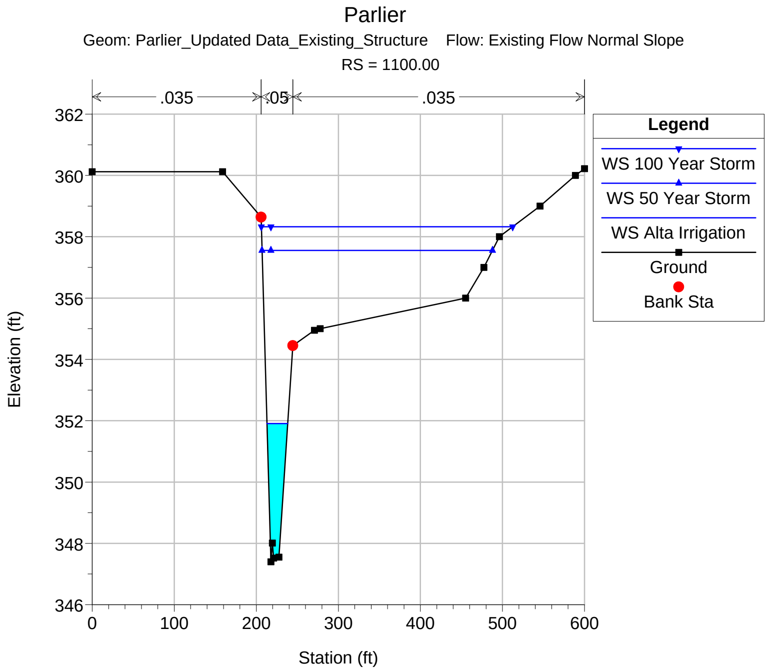


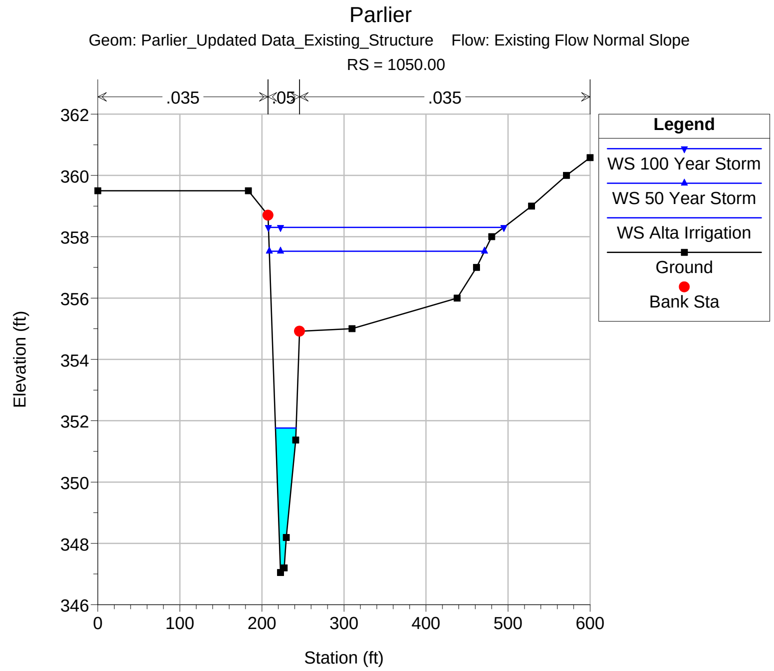
Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1185.29 BR

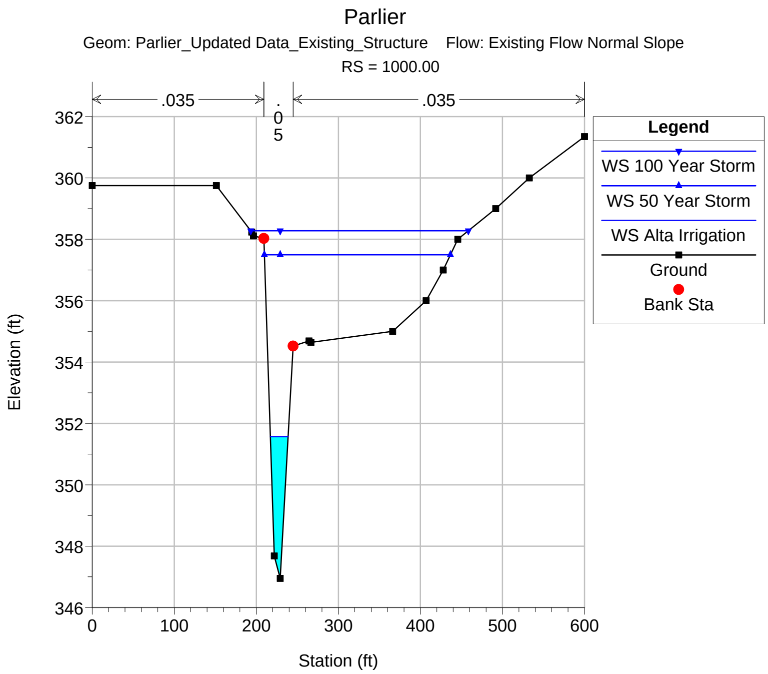


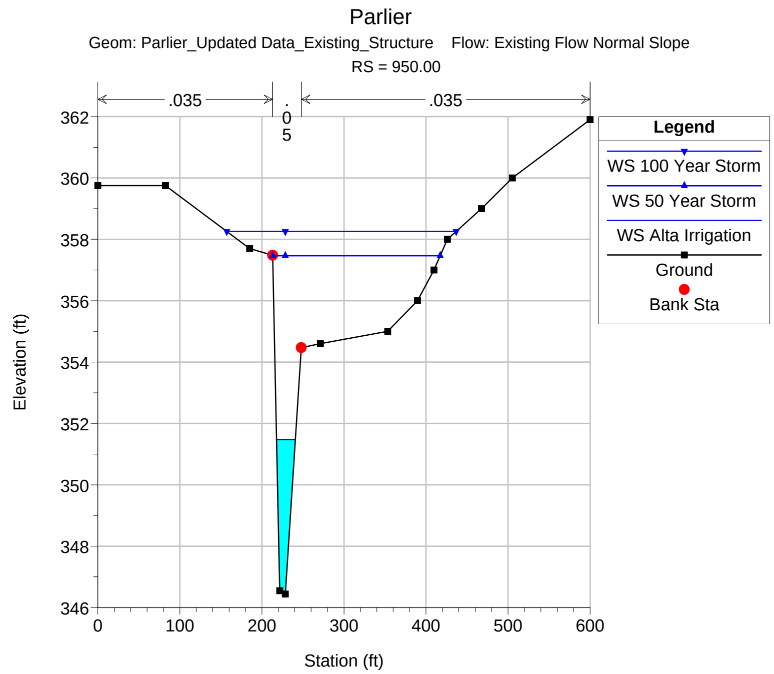
Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1149.49

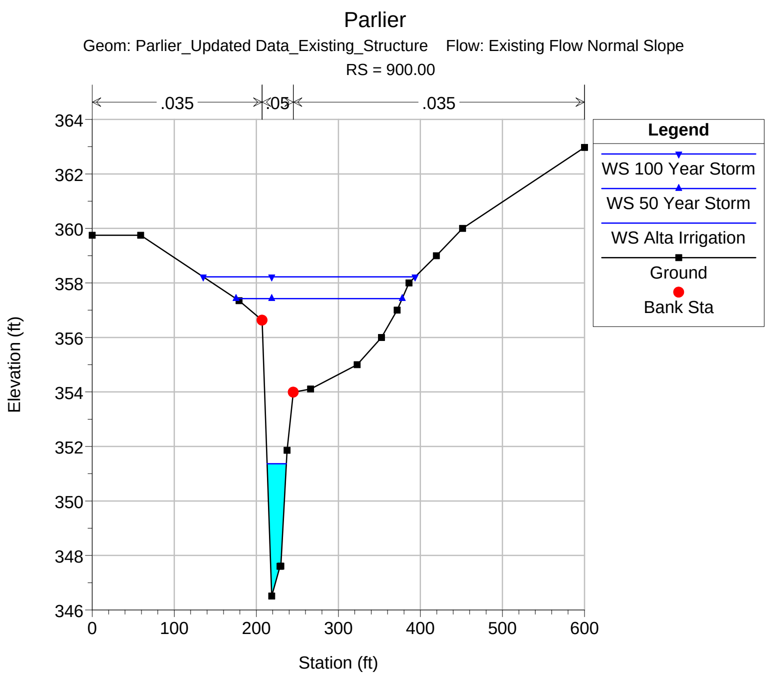


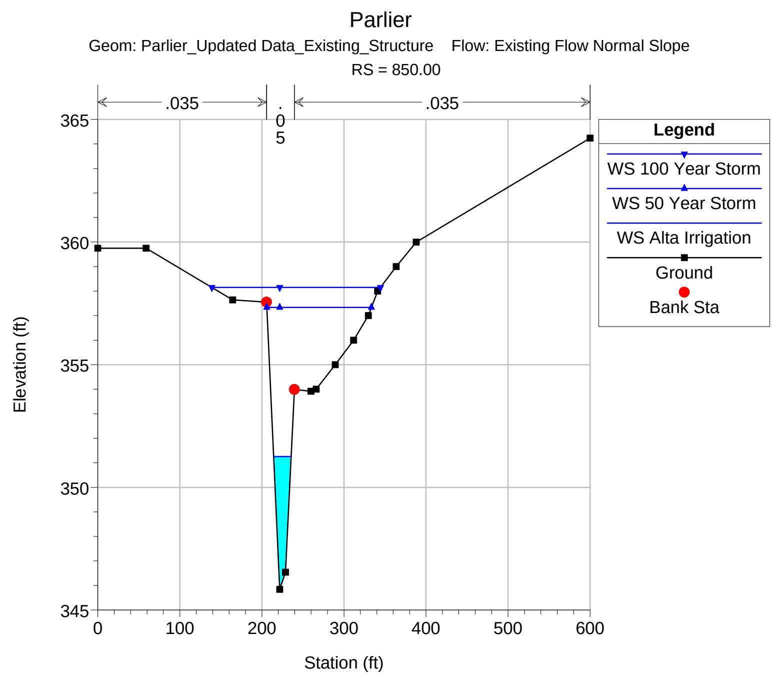

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1100.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

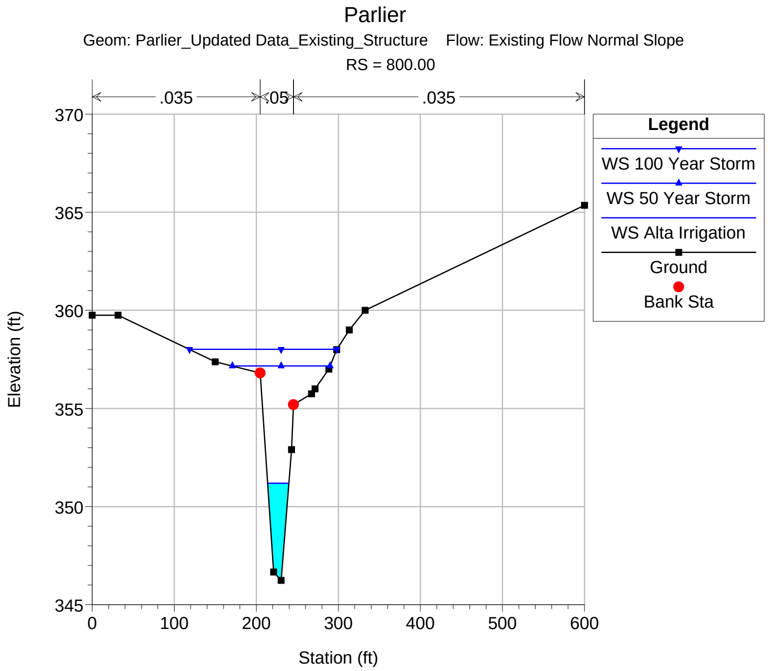

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1050.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

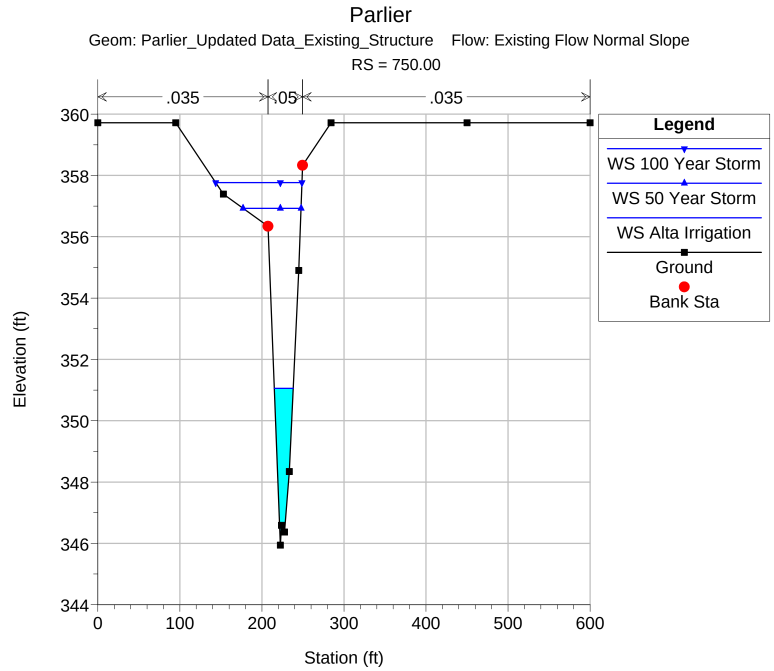

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 1000.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

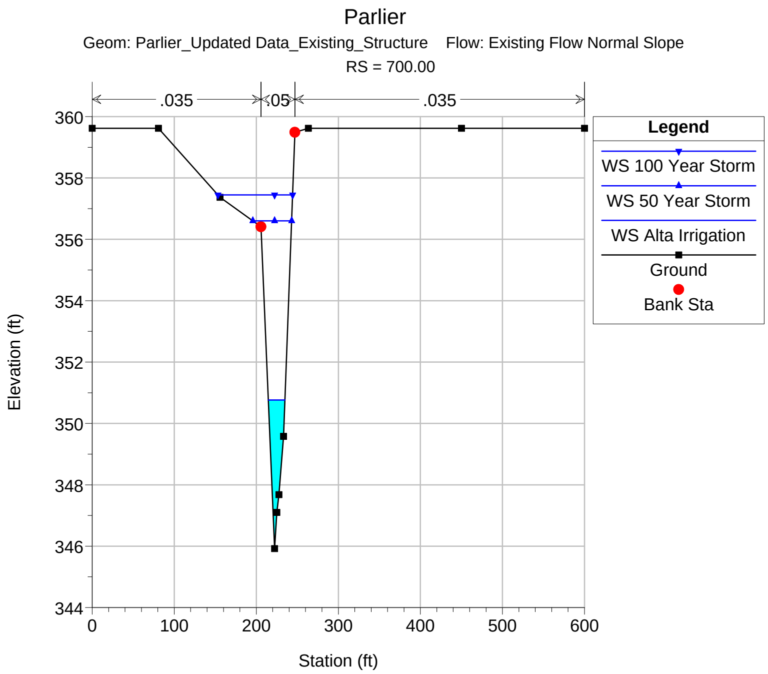

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 950.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

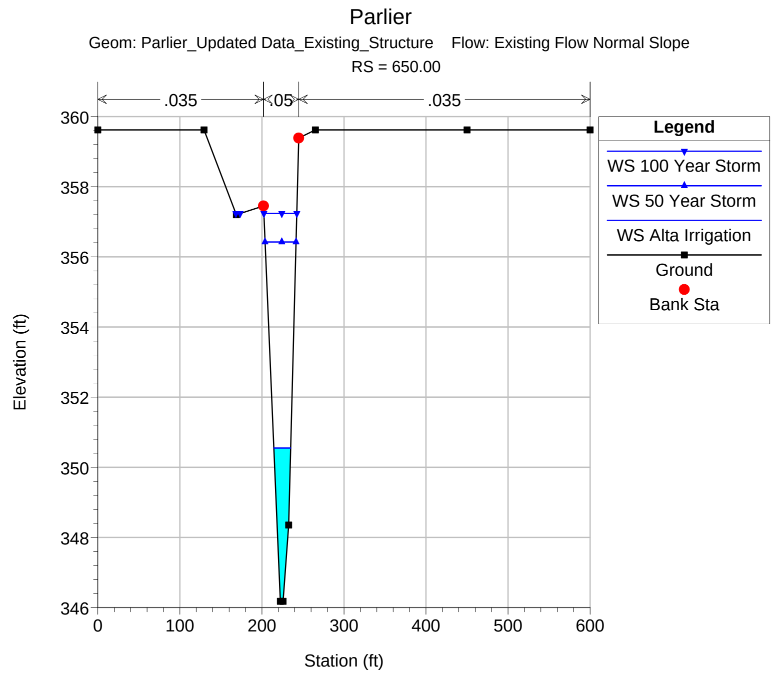

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 900.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

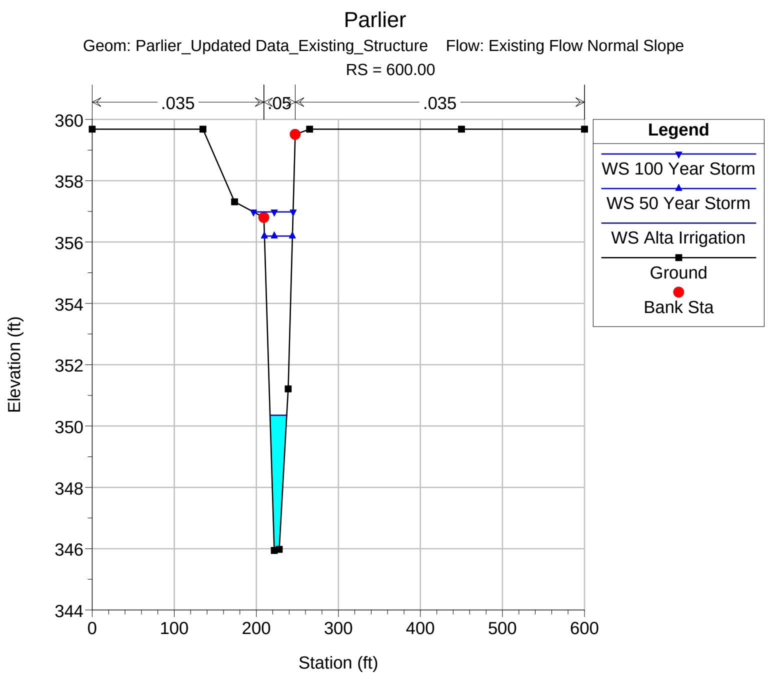

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 850.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

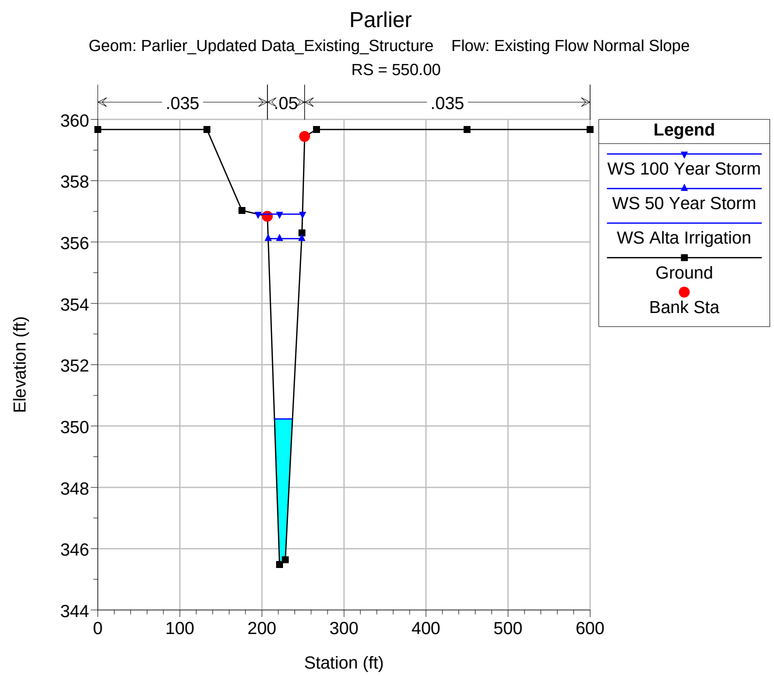

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 800.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

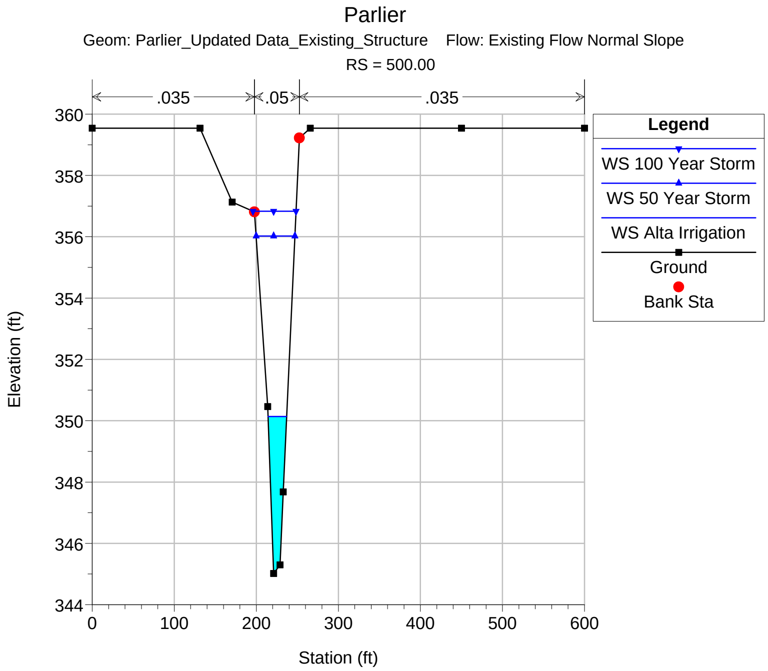

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 750.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

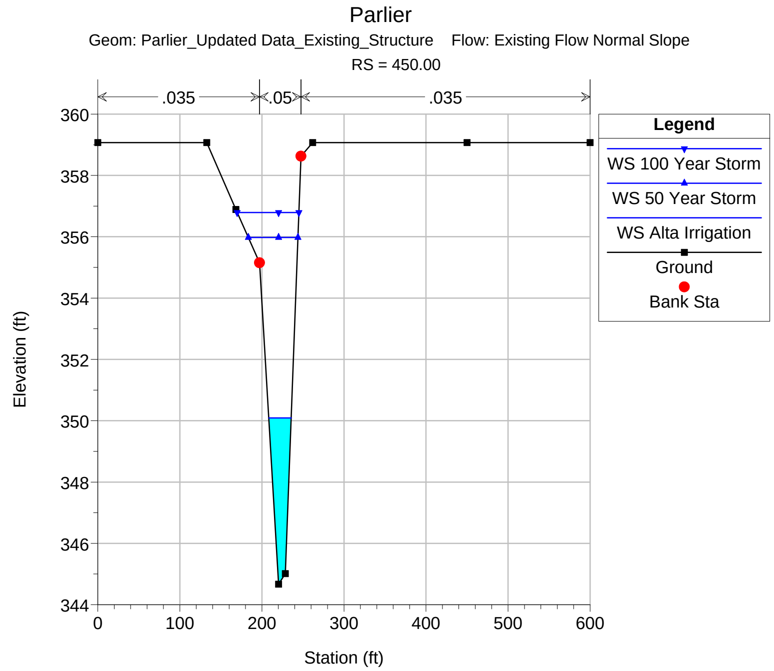

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 700.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 650.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 600.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 550.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 500.00
.035 .05 .035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta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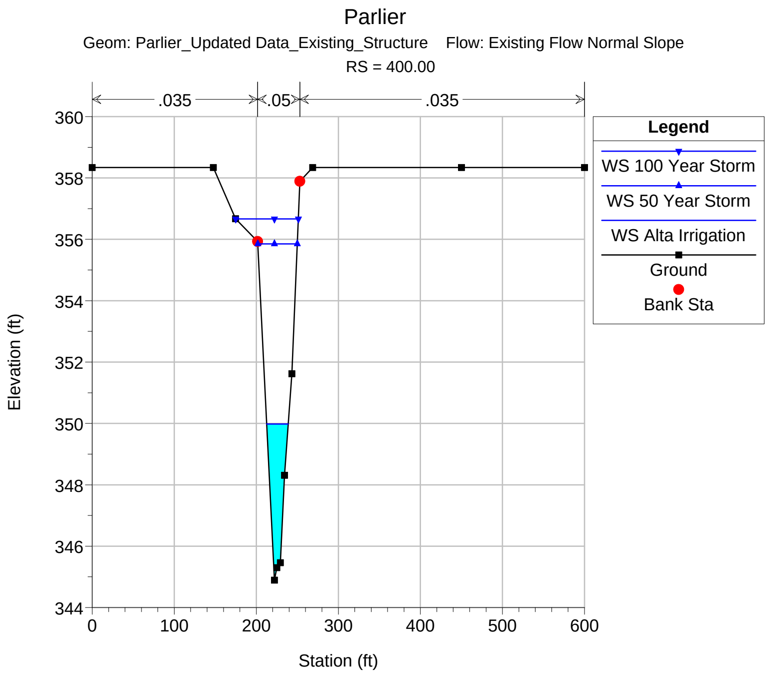
.035 .05 .035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta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Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
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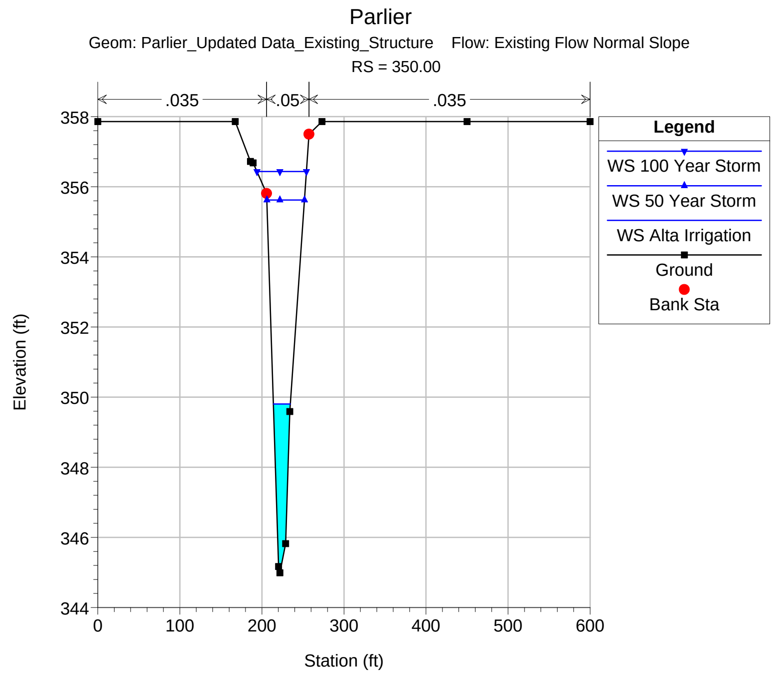
.035 .05 .035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta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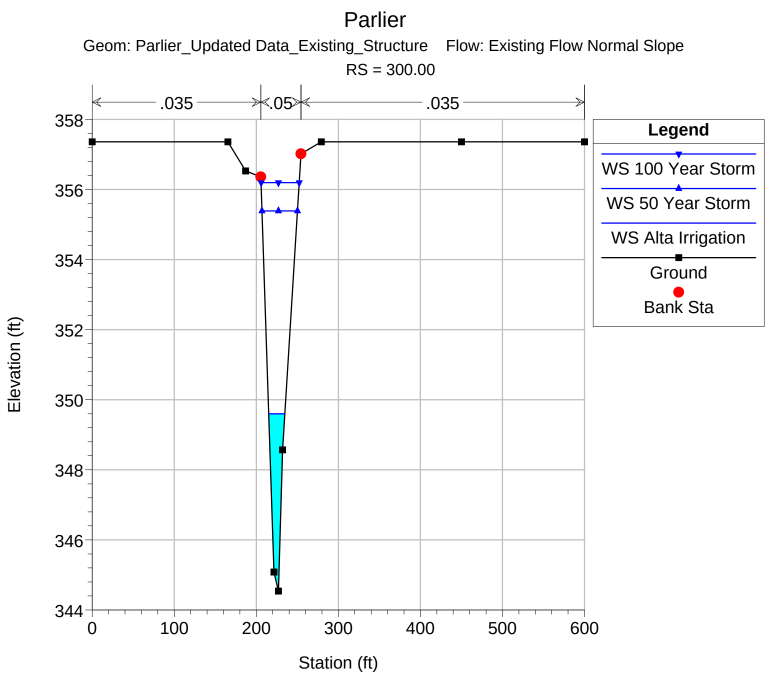
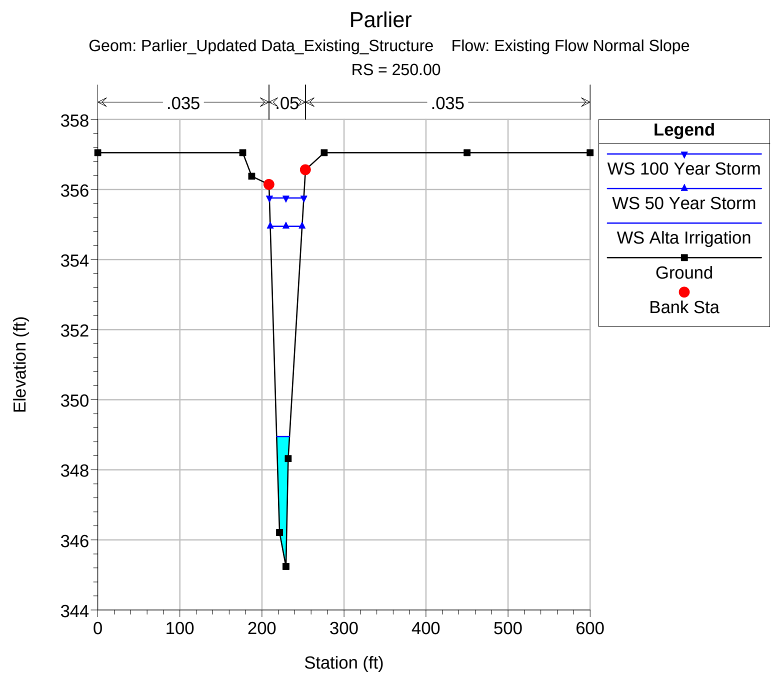
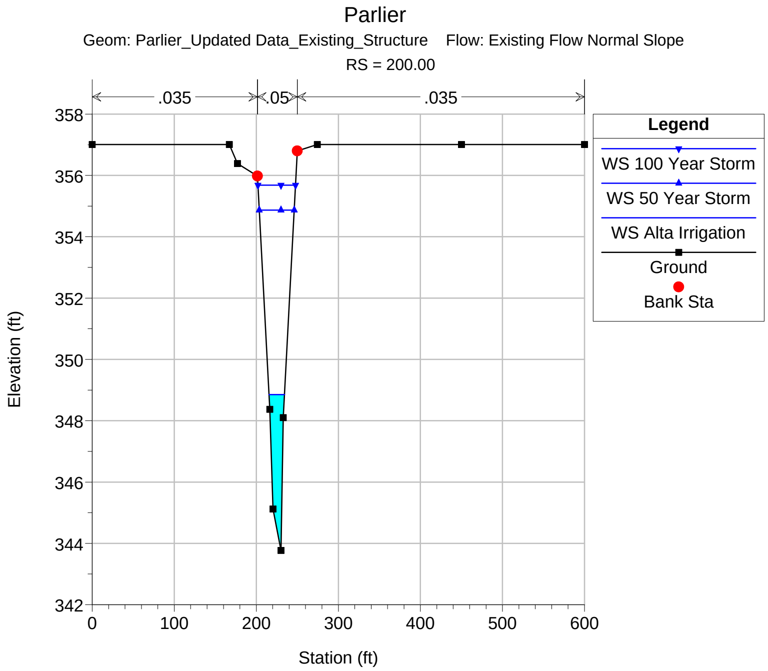
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 350.00
.035 .05 .035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta


Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 300.00
.035 .05 .035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta


Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
RS = 250.00
.035 .05 .035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta



Parlier
Geom: Parlier_Updated Data_Existing_Structure   Flow: Existing Flow Normal Slope
RS = 200.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
358
356
354
352
350
348
346
344
342
0
100
200
300
400
500
600
Station (ft)

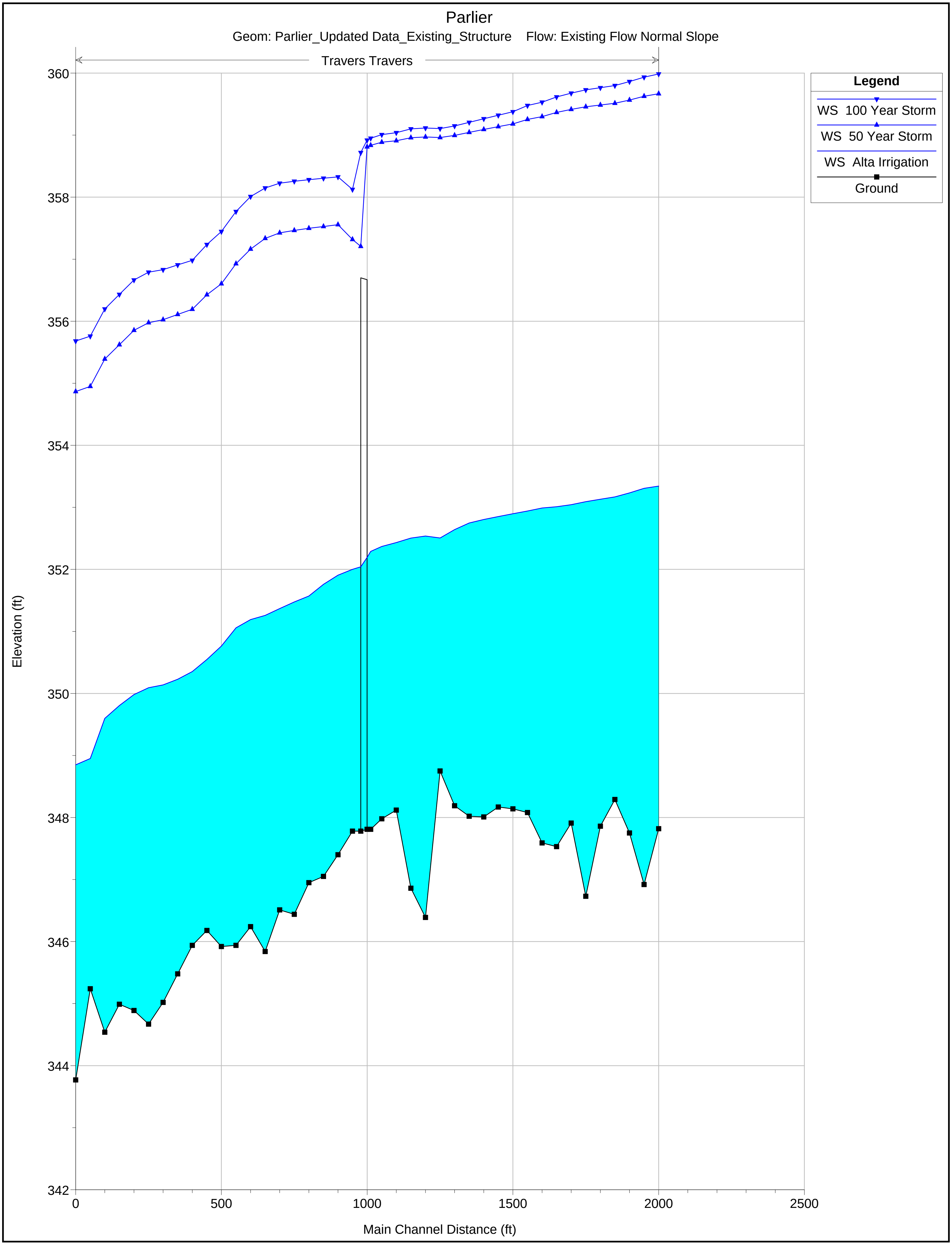
HEC-RAS Plan: Plan 48 River: Travers Reach: Travers

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Travers	2200.00	Alta Irrigation	200.00	347.82	353.34		353.43	0.001532	2.42	82.74	24.74	0.23
Travers	2200.00	50 Year Storm	1250.00	347.82	359.67		359.79	0.000858	3.07	469.46	126.33	0.20
Travers	2200.00	100 Year Storm	1500.00	347.82	359.99		360.13	0.001008	3.39	510.87	133.96	0.22
Travers	2150.00	Alta Irrigation	200.00	346.92	353.31		353.37	0.000885	1.99	100.60	26.41	0.18
Travers	2150.00	50 Year Storm	1250.00	346.92	359.63		359.75	0.000798	3.03	474.30	123.29	0.19
Travers	2150.00	100 Year Storm	1500.00	346.92	359.93		360.08	0.000955	3.37	513.47	130.67	0.21
Travers	2100.00	Alta Irrigation	200.00	347.75	353.23		353.31	0.001270	2.29	87.52	24.30	0.21
Travers	2100.00	50 Year Storm	1250.00	347.75	359.57		359.70	0.000956	3.24	447.18	122.63	0.21
Travers	2100.00	100 Year Storm	1500.00	347.75	359.86		360.03	0.001138	3.60	484.69	129.69	0.22
Travers	2050.00	Alta Irrigation	200.00	348.29	353.17		353.25	0.001292	2.29	87.29	24.45	0.21
Travers	2050.00	50 Year Storm	1250.00	348.29	359.51		359.65	0.001000	3.28	441.56	122.81	0.21
Travers	2050.00	100 Year Storm	1500.00	348.29	359.80		359.97	0.001196	3.65	477.65	129.61	0.23
Travers	2000.00	Alta Irrigation	200.00	347.86	353.13		353.19	0.000874	1.96	102.04	27.65	0.18
Travers	2000.00	50 Year Storm	1250.00	347.86	359.49		359.60	0.000776	2.98	481.40	126.04	0.19
Travers	2000.00	100 Year Storm	1500.00	347.86	359.76		359.91	0.000943	3.34	517.47	132.70	0.21
Travers	1950.00	Alta Irrigation	200.00	346.73	353.09		353.15	0.000824	1.88	106.29	29.27	0.17
Travers	1950.00	50 Year Storm	1250.00	346.73	359.46		359.56	0.000700	2.79	508.74	131.32	0.18
Travers	1950.00	100 Year Storm	1500.00	346.73	359.73		359.86	0.000855	3.13	545.40	137.99	0.20
Travers	1900.00	Alta Irrigation	200.00	347.91	353.04		353.10	0.000932	1.97	101.29	28.45	0.18
Travers	1900.00	50 Year Storm	1250.00	347.91	359.41		359.53	0.000752	2.87	495.25	130.22	0.19
Travers	1900.00	100 Year Storm	1500.00	347.91	359.68		359.82	0.000921	3.23	530.25	136.60	0.21
Travers	1850.00	Alta Irrigation	200.00	347.53	353.01		353.06	0.000691	1.80	111.17	28.10	0.16
Travers	1850.00	50 Year Storm	1250.00	347.53	359.37		359.49	0.000771	2.99	480.49	125.86	0.19
Travers	1850.00	100 Year Storm	1500.00	347.53	359.62		359.77	0.000955	3.38	512.63	131.72	0.21
Travers	1800.00	Alta Irrigation	200.00	347.59	352.99		353.03	0.000481	1.58	126.77	29.19	0.13
Travers	1800.00	50 Year Storm	1250.00	347.59	359.30		359.45	0.000821	3.22	456.03	149.63	0.19
Travers	1800.00	100 Year Storm	1500.00	347.59	359.53		359.72	0.001023	3.65	492.37	163.48	0.21
Travers	1750.00	Alta Irrigation	200.00	348.08	352.94		353.00	0.000795	1.88	106.18	27.78	0.17
Travers	1750.00	50 Year Storm	1250.00	348.08	359.25		359.40	0.000905	3.31	460.72	167.07	0.20
Travers	1750.00	100 Year Storm	1500.00	348.08	359.48		359.66	0.001110	3.73	499.73	180.32	0.22
Travers	1700.00	Alta Irrigation	200.00	348.14	352.90		352.95	0.000849	1.91	104.67	28.77	0.18
Travers	1700.00	50 Year Storm	1250.00	348.14	359.18		359.35	0.000985	3.45	418.07	142.09	0.21
Travers	1700.00	100 Year Storm	1500.00	348.14	359.38		359.60	0.001257	3.96	447.26	157.45	0.24
Travers	1650.00	Alta Irrigation	200.00	348.17	352.85		352.91	0.000913	1.95	102.57	28.89	0.18
Travers	1650.00	50 Year Storm	1250.00	348.17	359.14		359.30	0.000937	3.45	436.63	168.61	0.21
Travers	1650.00	100 Year Storm	1500.00	348.17	359.32		359.54	0.001191	3.95	469.33	185.69	0.24
Travers	1600.00	Alta Irrigation	200.00	348.01	352.80		352.86	0.000941	1.96	101.89	29.45	0.19
Travers	1600.00	50 Year Storm	1250.00	348.01	359.09		359.26	0.000940	3.41	440.39	189.46	0.21
Travers	1600.00	100 Year Storm	1500.00	348.01	359.26		359.48	0.001193	3.90	474.59	206.21	0.24
Travers	1550.00	Alta Irrigation	200.00	348.02	352.75		352.81	0.001042	2.05	97.68	28.40	0.19
Travers	1550.00	50 Year Storm	1250.00	348.02	359.04		359.21	0.001016	3.38	448.49	223.72	0.22
Travers	1550.00	100 Year Storm	1500.00	348.02	359.21		359.41	0.001277	3.84	485.80	236.58	0.24
Travers	1500.00	Alta Irrigation	200.00	348.19	352.64		352.74	0.002104	2.50	79.99	29.01	0.27
Travers	1500.00	50 Year Storm	1250.00	348.19	359.00		359.15	0.001118	3.33	469.15	273.48	0.22
Travers	1500.00	100 Year Storm	1500.00	348.19	359.15		359.34	0.001382	3.76	511.95	286.71	0.25
Travers	1450.00	Alta Irrigation	200.00	348.75	352.51		352.61	0.002901	2.64	75.80	33.00	0.31
Travers	1450.00	50 Year Storm	1250.00	348.75	358.96		359.09	0.000978	3.09	519.21	296.28	0.21
Travers	1450.00	100 Year Storm	1500.00	348.75	359.11		359.26	0.001212	3.49	563.65	315.41	0.23
Travers	1400.00	Alta Irrigation	200.00	346.39	352.54		352.56	0.000247	1.19	167.72	37.60	0.10
Travers	1400.00	50 Year Storm	1250.00	346.39	358.97		359.04	0.000384	2.34	703.16	348.93	0.14
Travers	1400.00	100 Year Storm	1500.00	346.39	359.11		359.21	0.000490	2.67	754.90	365.47	0.15
Travers	1350.00	Alta Irrigation	200.00	346.86	352.50		352.54	0.000502	1.53	130.33	34.47	0.14
Travers	1350.00	50 Year Storm	1250.00	346.86	358.96		359.02	0.000389	2.32	779.00	425.78	0.14
Travers	1350.00	100 Year Storm	1500.00	346.86	359.10		359.18	0.000485	2.62	841.48	447.76	0.15
Travers	1300.00	Alta Irrigation	200.00	348.12	352.43		352.50	0.001159	2.10	95.44	29.45	0.21

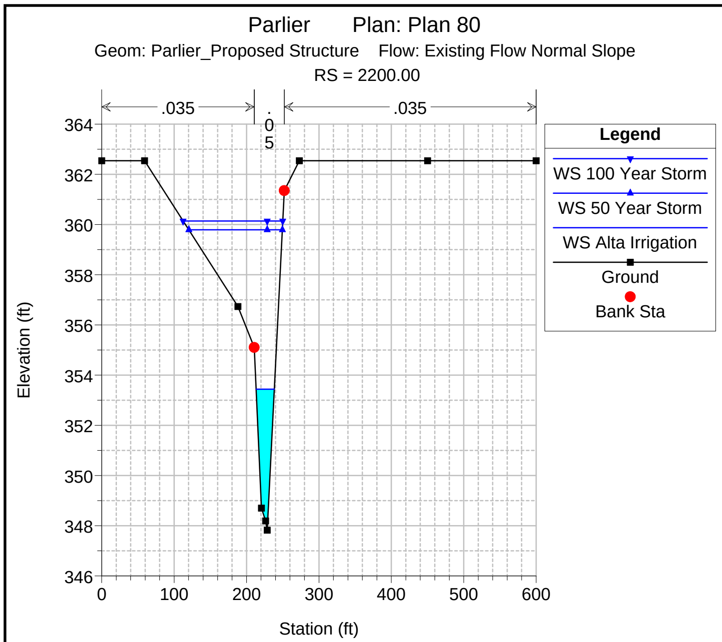
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Travers	1300.00	50 Year Storm	1250.00	348.12	358.91		359.00	0.000621	2.73	659.74	389.90	0.17
Travers	1300.00	100 Year Storm	1500.00	348.12	359.04		359.15	0.000779	3.09	712.54	417.51	0.19
Travers	1250.00	Alta Irrigation	200.00	347.98	352.37		352.44	0.001307	2.12	94.53	31.43	0.22
Travers	1250.00	50 Year Storm	1250.00	347.98	358.89		358.97	0.000574	2.63	684.23	386.13	0.16
Travers	1250.00	100 Year Storm	1500.00	347.98	359.01		359.11	0.000732	3.00	733.43	415.35	0.18
Travers	1212.18	Alta Irrigation	200.00	347.81	352.29	350.11	352.38	0.001444	2.48	80.74	30.51	0.23
Travers	1212.18	50 Year Storm	1250.00	347.81	358.84	353.29	358.93	0.001150	3.00	591.08	392.78	0.22
Travers	1212.18	100 Year Storm	1500.00	347.81	358.95	353.88	359.07	0.001393	3.35	637.13	406.74	0.24
Travers	1185.29		Bridge									
Travers	1149.49	Alta Irrigation	200.00	347.78	352.00		352.11	0.001696	2.61	76.61	28.16	0.25
Travers	1149.49	50 Year Storm	1250.00	347.78	357.32	353.18	357.93	0.002718	6.26	199.70	300.21	0.38
Travers	1149.49	100 Year Storm	1500.00	347.78	358.12	353.76	358.64	0.005112	6.03	320.54	324.95	0.46
Travers	1100.00	Alta Irrigation	200.00	347.40	351.91		352.01	0.002055	2.62	76.33	25.33	0.27
Travers	1100.00	50 Year Storm	1250.00	347.40	357.56		357.61	0.000453	2.12	747.86	280.90	0.14
Travers	1100.00	100 Year Storm	1500.00	347.40	358.33		358.37	0.000317	1.87	971.79	306.30	0.12
Travers	1050.00	Alta Irrigation	200.00	347.05	351.76		351.89	0.002845	2.91	68.67	25.23	0.31
Travers	1050.00	50 Year Storm	1250.00	347.05	357.53		357.58	0.000513	2.22	704.03	262.36	0.15
Travers	1050.00	100 Year Storm	1500.00	347.05	358.31		358.35	0.000358	1.96	915.68	286.96	0.13
Travers	1000.00	Alta Irrigation	200.00	346.95	351.57		351.73	0.003375	3.24	61.71	21.53	0.34
Travers	1000.00	50 Year Storm	1250.00	346.95	357.50		357.56	0.000517	2.21	672.40	226.75	0.15
Travers	1000.00	100 Year Storm	1500.00	346.95	358.28		358.33	0.000380	2.01	859.73	265.19	0.13
Travers	950.00	Alta Irrigation	200.00	346.44	351.48		351.59	0.002068	2.70	74.12	22.91	0.26
Travers	950.00	50 Year Storm	1250.00	346.44	357.46		357.53	0.000548	2.34	637.43	204.33	0.15
Travers	950.00	100 Year Storm	1500.00	346.44	358.26		358.31	0.000405	2.15	831.50	279.55	0.13
Travers	900.00	Alta Irrigation	200.00	346.51	351.37		351.48	0.002121	2.72	73.59	23.46	0.27
Travers	900.00	50 Year Storm	1250.00	346.51	357.42		357.50	0.000586	2.48	597.97	202.56	0.16
Travers	900.00	100 Year Storm	1500.00	346.51	358.22		358.29	0.000443	2.31	781.09	258.33	0.14
Travers	850.00	Alta Irrigation	200.00	345.84	351.26		351.38	0.002076	2.77	72.15	21.36	0.27
Travers	850.00	50 Year Storm	1250.00	345.84	357.34		357.46	0.000969	3.12	458.31	127.51	0.20
Travers	850.00	100 Year Storm	1500.00	345.84	358.15		358.26	0.000756	2.94	595.27	205.43	0.18
Travers	800.00	Alta Irrigation	200.00	346.24	351.19		351.28	0.001545	2.40	83.48	25.89	0.24
Travers	800.00	50 Year Storm	1250.00	346.24	357.16		357.39	0.001507	3.94	350.73	119.09	0.26
Travers	800.00	100 Year Storm	1500.00	346.24	358.01		358.20	0.001186	3.77	480.54	179.71	0.23
Travers	750.00	Alta Irrigation	200.00	345.94	351.06		351.18	0.002376	2.83	70.72	23.13	0.29
Travers	750.00	50 Year Storm	1250.00	345.94	356.93		357.28	0.002573	4.76	269.53	70.68	0.33
Travers	750.00	100 Year Storm	1500.00	345.94	357.77		358.11	0.002291	4.78	345.83	105.21	0.32
Travers	700.00	Alta Irrigation	200.00	345.92	350.76		351.00	0.005609	3.86	51.76	20.22	0.43
Travers	700.00	50 Year Storm	1250.00	345.92	356.60		357.10	0.004138	5.67	221.47	47.36	0.41
Travers	700.00	100 Year Storm	1500.00	345.92	357.45		357.95	0.003724	5.75	280.35	91.01	0.40
Travers	650.00	Alta Irrigation	200.00	346.18	350.55		350.74	0.004244	3.55	56.38	20.45	0.38
Travers	650.00	50 Year Storm	1250.00	346.18	356.43		356.89	0.003795	5.49	227.68	37.82	0.39
Travers	650.00	100 Year Storm	1500.00	346.18	357.24		357.76	0.003861	5.79	259.37	45.57	0.40
Travers	600.00	Alta Irrigation	200.00	345.94	350.35		350.54	0.003872	3.44	58.21	20.35	0.36
Travers	600.00	50 Year Storm	1250.00	345.94	356.19		356.70	0.003938	5.69	219.49	34.14	0.40
Travers	600.00	100 Year Storm	1500.00	345.94	356.98		357.55	0.004078	6.07	248.21	48.36	0.41
Travers	550.00	Alta Irrigation	200.00	345.48	350.23		350.37	0.002599	2.96	67.54	21.99	0.30
Travers	550.00	50 Year Storm	1250.00	345.48	356.11		356.49	0.002955	4.95	252.58	40.94	0.35
Travers	550.00	100 Year Storm	1500.00	345.48	356.91		357.34	0.003006	5.24	286.56	54.11	0.36
Travers	500.00	Alta Irrigation	200.00	345.02	350.14		350.25	0.001895	2.65	75.40	22.62	0.26
Travers	500.00	50 Year Storm	1250.00	345.02	356.02		356.33	0.002458	4.47	279.95	47.24	0.32
Travers	500.00	100 Year Storm	1500.00	345.02	356.83		357.17	0.002497	4.70	319.44	52.42	0.33
Travers	450.00	Alta Irrigation	200.00	344.67	350.09		350.16	0.001145	2.14	93.43	27.29	0.20
Travers	450.00	50 Year Storm	1250.00	344.67	355.98		356.22	0.001607	3.94	321.62	60.53	0.27
Travers	450.00	100 Year Storm	1500.00	344.67	356.79		357.05	0.001574	4.14	376.99	75.27	0.27

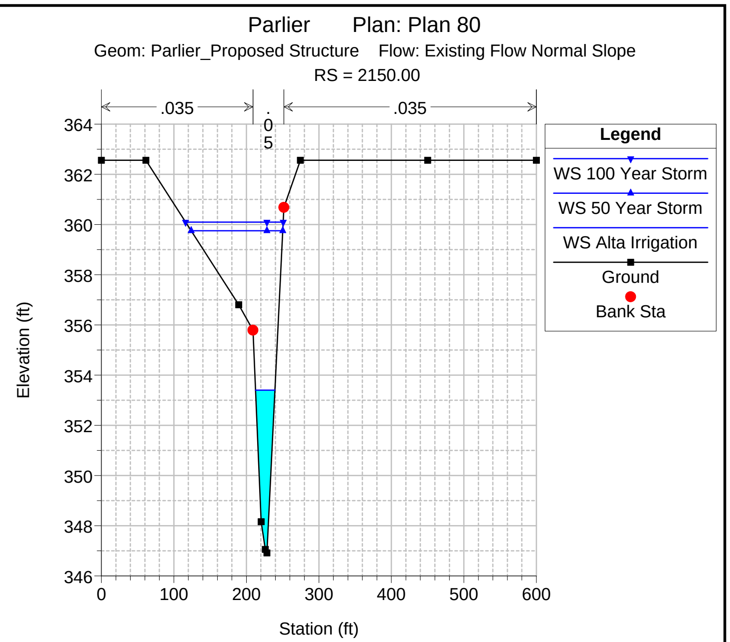
HEC-RAS Plan: Plan 48 River: Travers Reach: Travers (Continued)

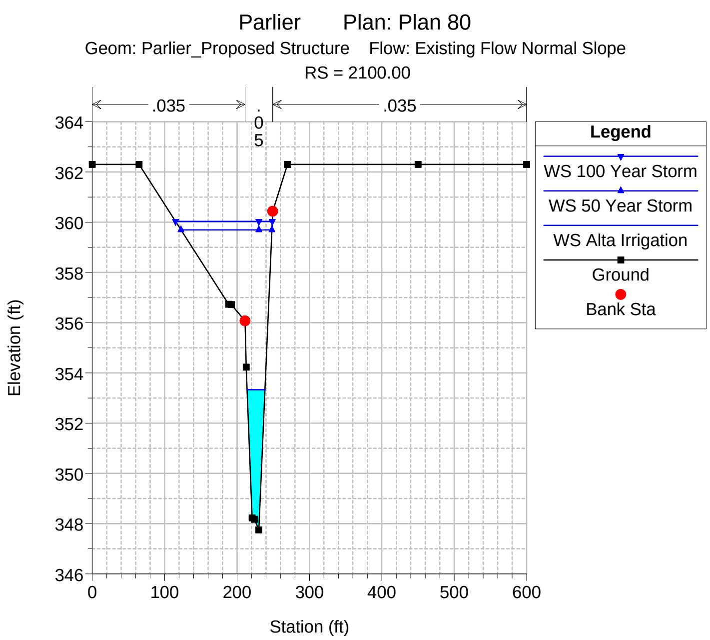
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Travers	400.00	Alta Irrigation	200.00	344.89	349.98		350.09	0.001997	2.58	77.48	26.24	0.26
Travers	400.00	50 Year Storm	1250.00	344.89	355.85		356.12	0.001977	4.17	300.08	48.25	0.29
Travers	400.00	100 Year Storm	1500.00	344.89	356.66		356.96	0.001935	4.39	349.57	76.26	0.30
Travers	350.00	Alta Irrigation	200.00	344.99	349.81		349.96	0.002982	3.15	63.47	20.61	0.32
Travers	350.00	50 Year Storm	1250.00	344.99	355.62		355.99	0.003156	4.87	256.68	45.82	0.36
Travers	350.00	100 Year Storm	1500.00	344.99	356.43		356.83	0.003055	5.07	298.66	60.30	0.36
Travers	300.00	Alta Irrigation	200.00	344.54	349.60		349.79	0.003957	3.48	57.55	19.61	0.36
Travers	300.00	50 Year Storm	1250.00	344.54	355.39		355.81	0.003740	5.22	239.48	43.21	0.39
Travers	300.00	100 Year Storm	1500.00	344.54	356.20		356.66	0.003710	5.44	275.67	46.49	0.39
Travers	250.00	Alta Irrigation	200.00	345.24	348.95		349.42	0.013644	5.51	36.29	15.61	0.64
Travers	250.00	50 Year Storm	1250.00	345.24	354.95		355.56	0.006022	6.27	199.36	38.76	0.49
Travers	250.00	100 Year Storm	1500.00	345.24	355.76	352.93	356.41	0.005795	6.47	232.02	41.88	0.48
Travers	200.00	Alta Irrigation	200.00	343.77	348.85	346.65	349.02	0.003501	3.35	59.70	18.81	0.33
Travers	200.00	50 Year Storm	1250.00	343.77	354.87	351.00	355.27	0.003505	5.11	244.56	42.64	0.38
Travers	200.00	100 Year Storm	1500.00	343.77	355.68	351.64	356.13	0.003507	5.35	280.62	45.86	0.38

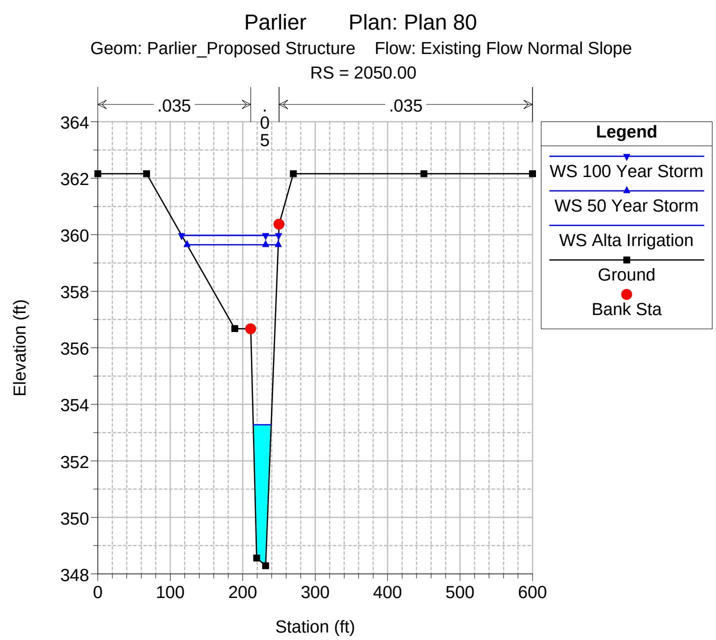

Parlier
Geom: Parlier_Updated Data_Existing_Structure Flow: Existing Flow Normal Slope
Travers Travers
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Elevation (ft)
Main Channel Distance (ft)
360
358
356
354
352
350
348
346
344
342
0
500
1000
1500
2000
2500

Appendix H: HEC-RAS Output for Parlier Avenue Proposed Structure


Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 2200.00
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta


Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 2150.00
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta


Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 2100.00
.035
.035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta


Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 2050.00
.035
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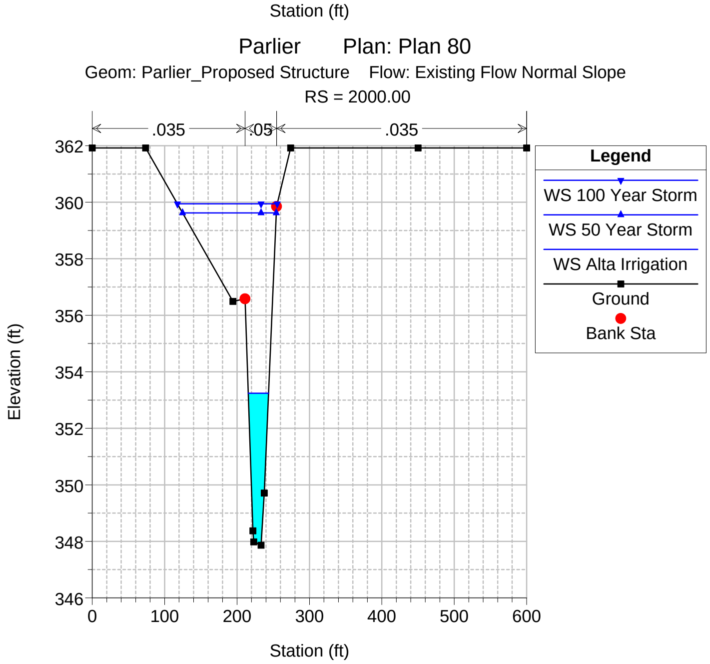
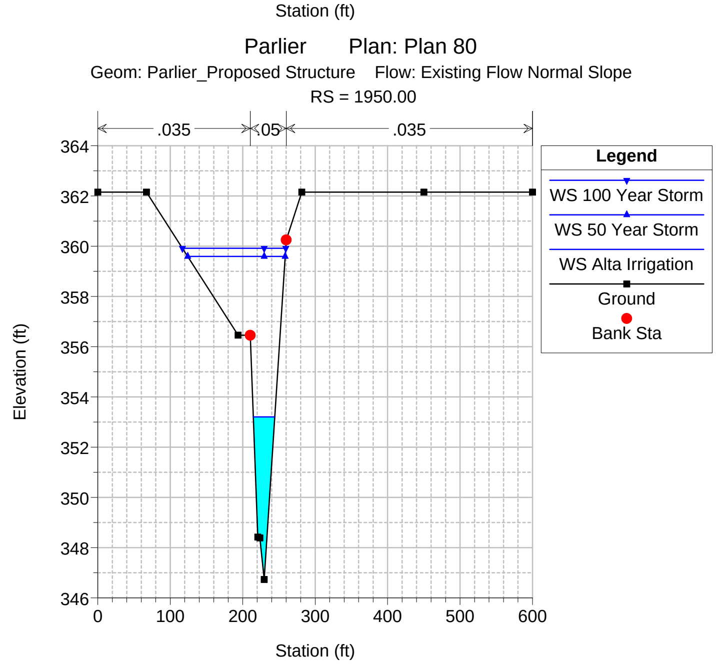
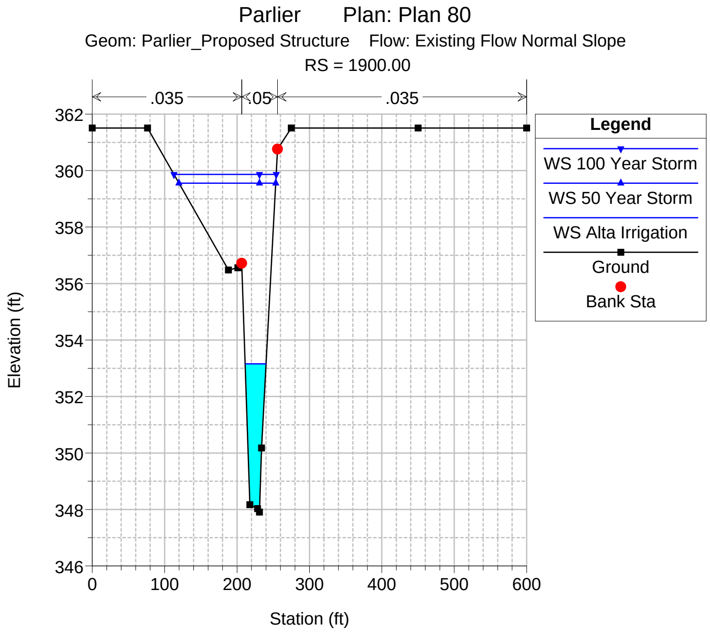
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta


Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 2000.00
.035
.05
.035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta


Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1950.00
.035
.05
.035
Elevation (ft)
Station (ft)
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta


Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1900.00
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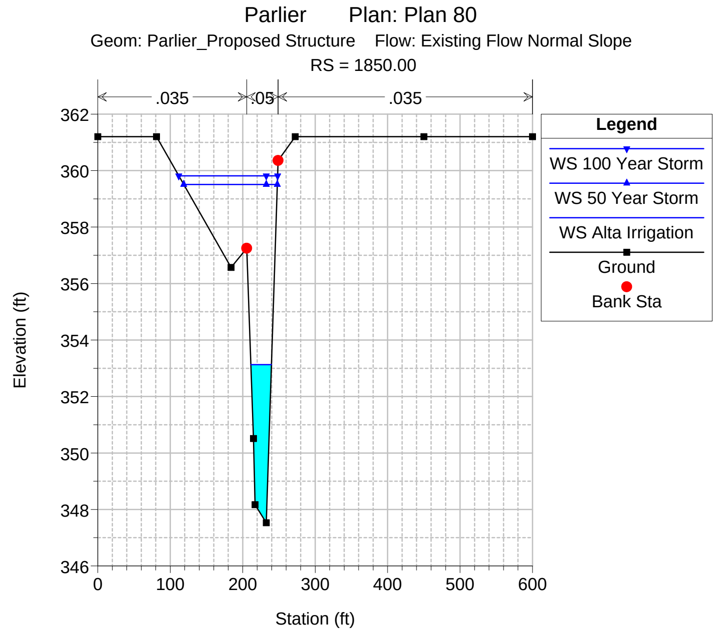
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1850.00
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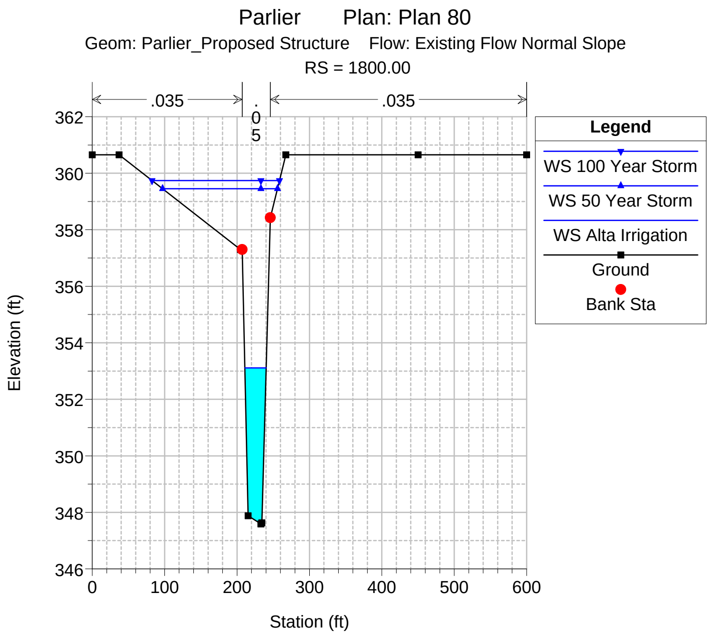
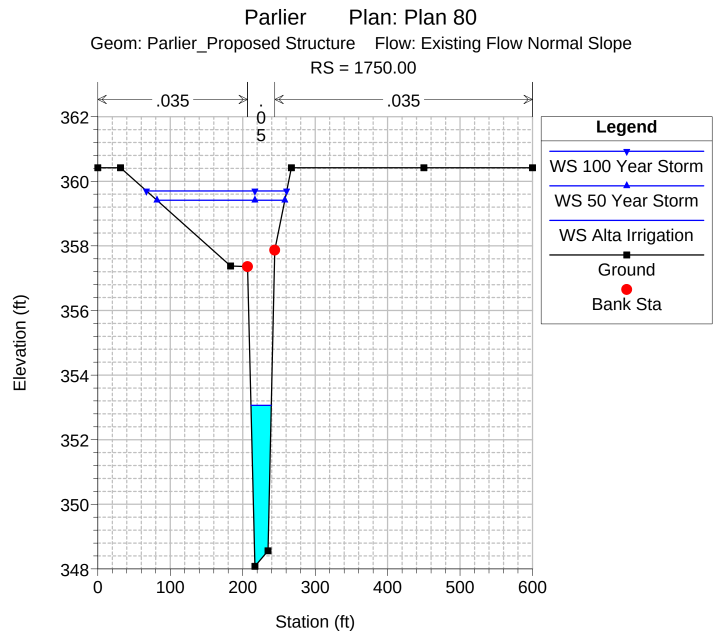
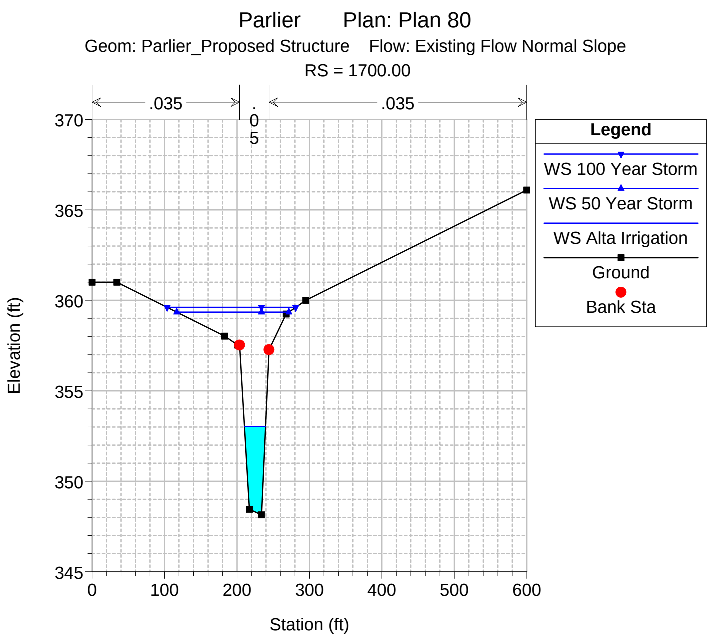
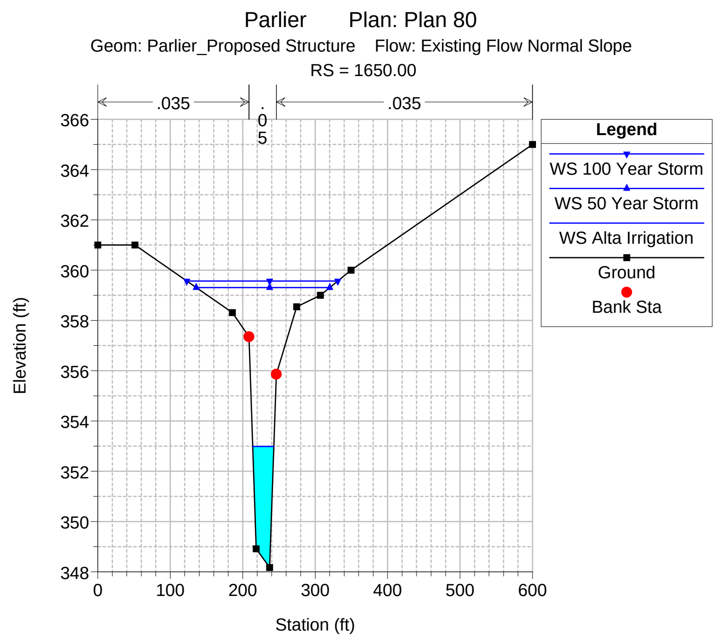
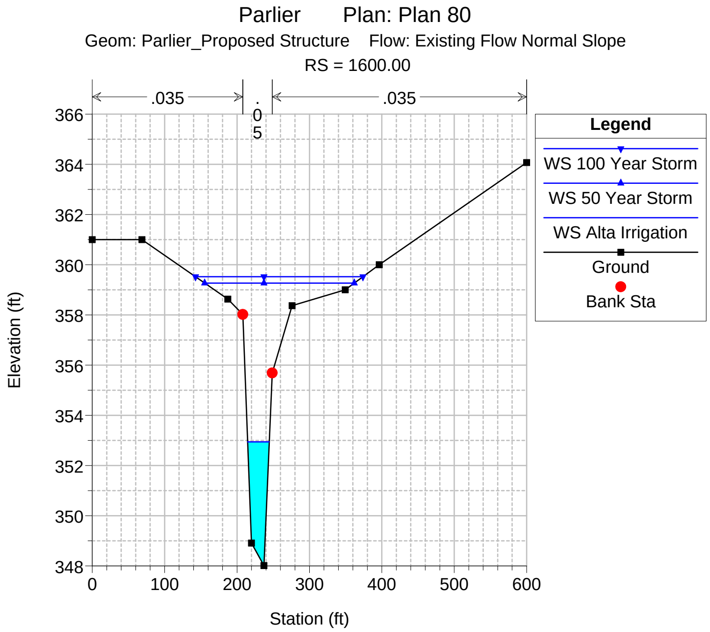
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

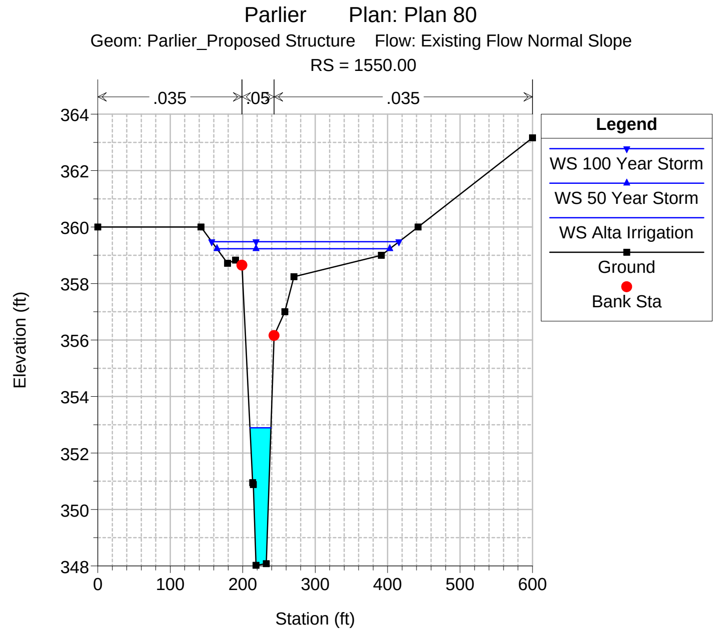

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1800.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

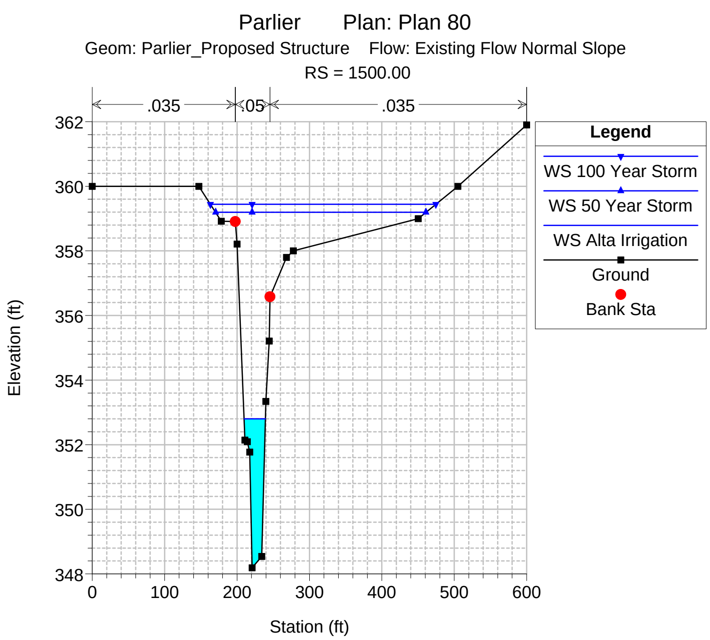

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1750.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

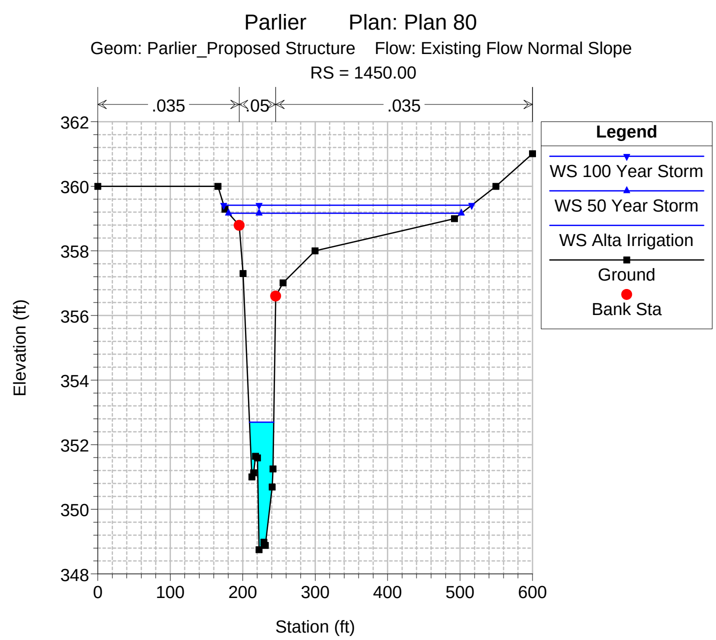

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1700.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

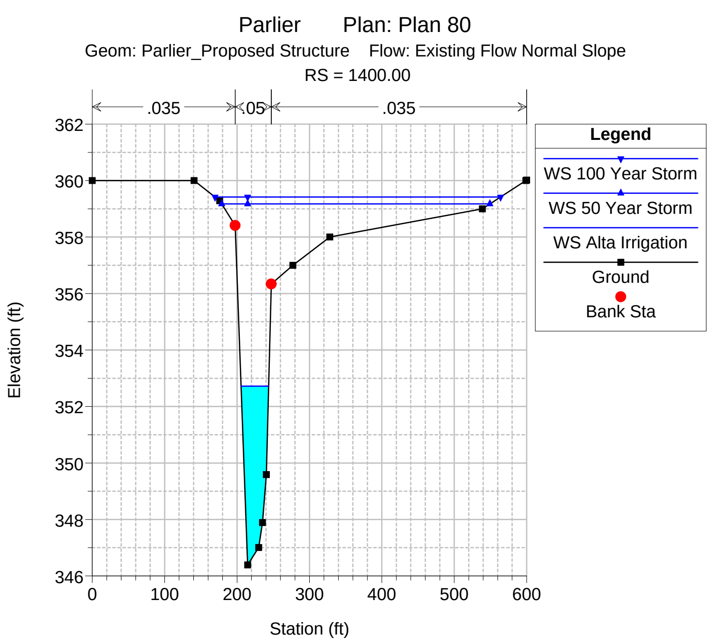

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1650.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

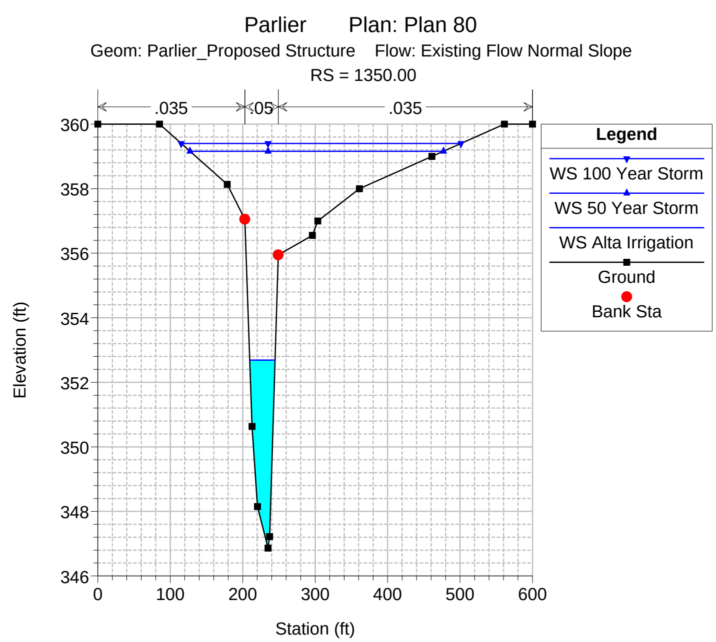

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1600.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

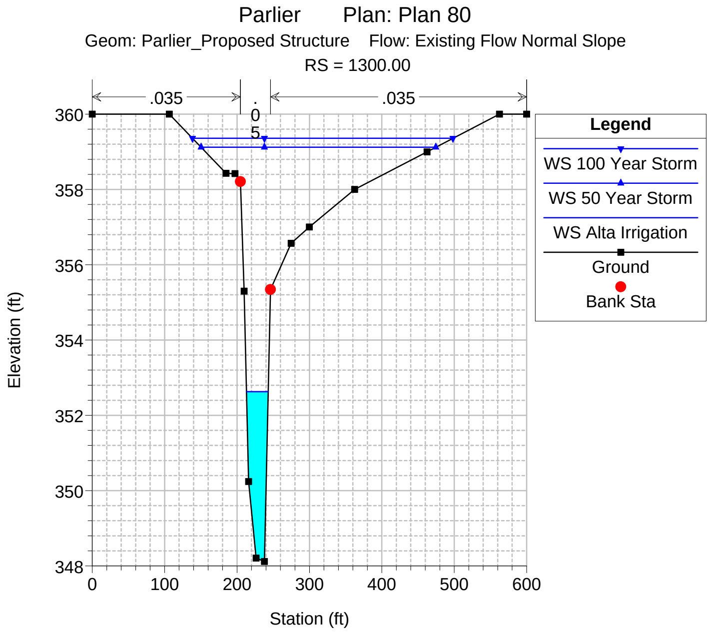

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1550.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

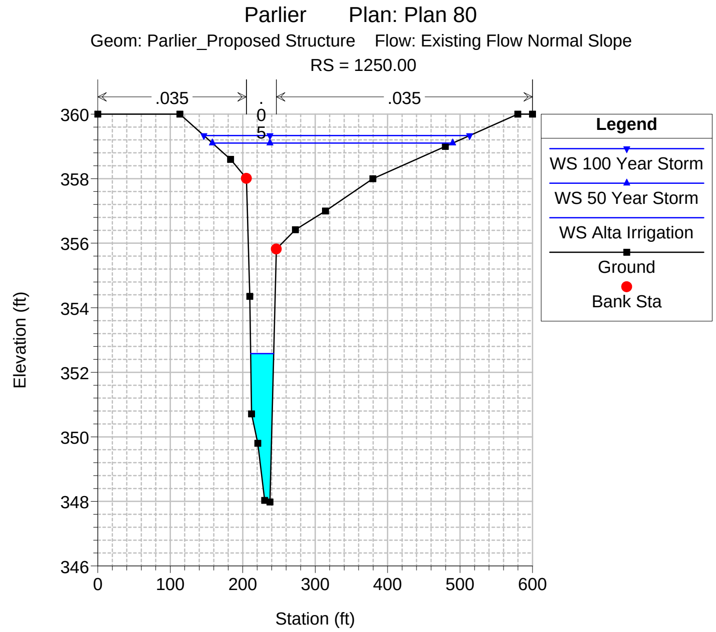

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1500.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

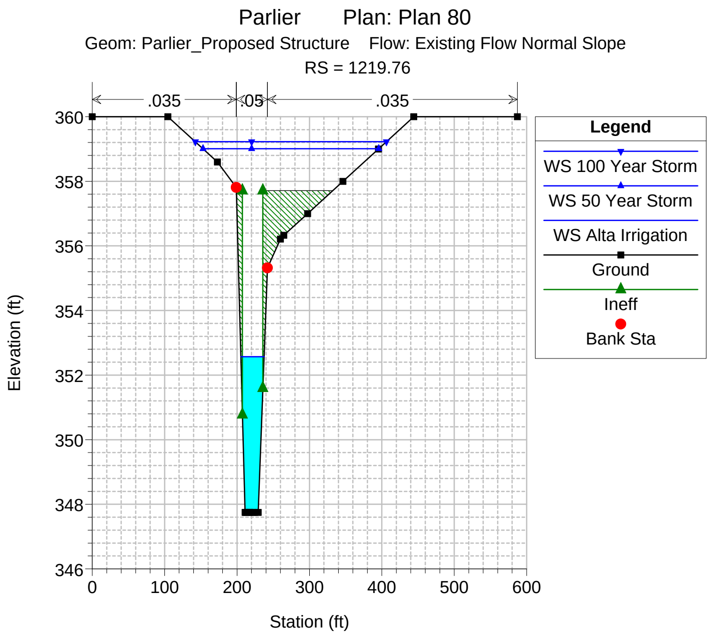

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1450.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

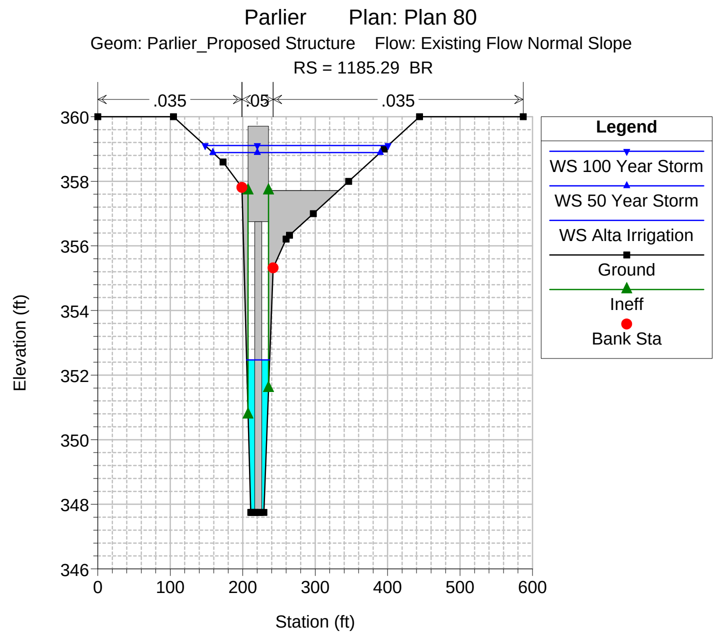

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1400.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

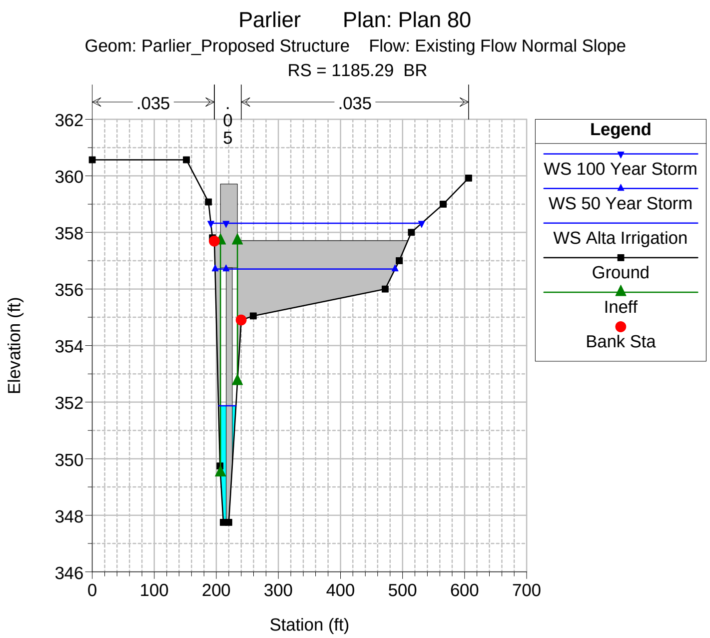

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1350.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

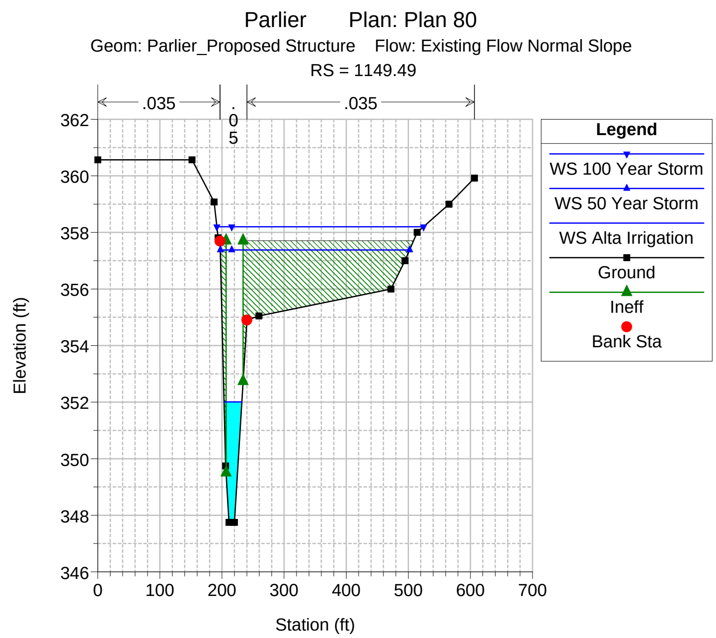

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1300.00
.035
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

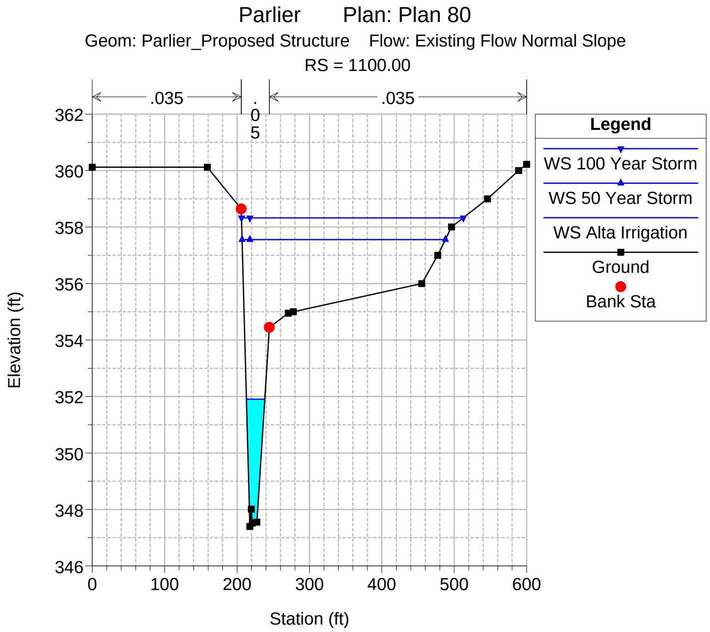

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1250.00
.035
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

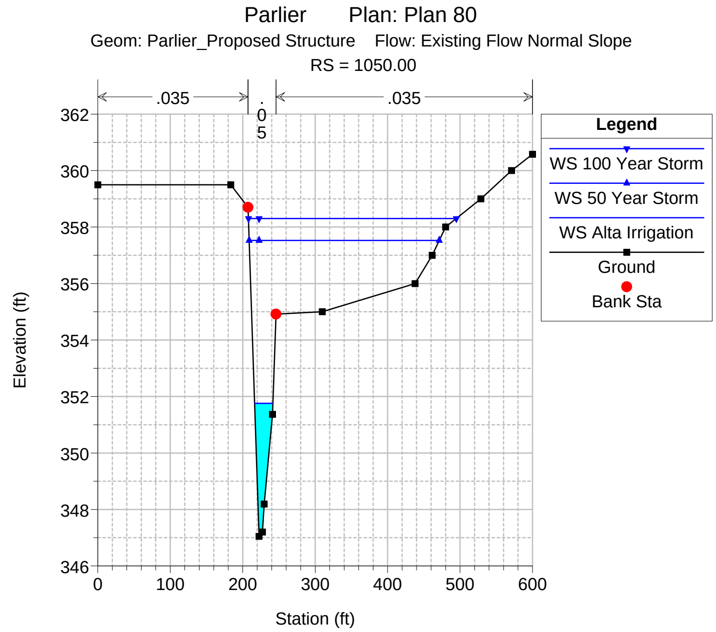

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1219.76
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

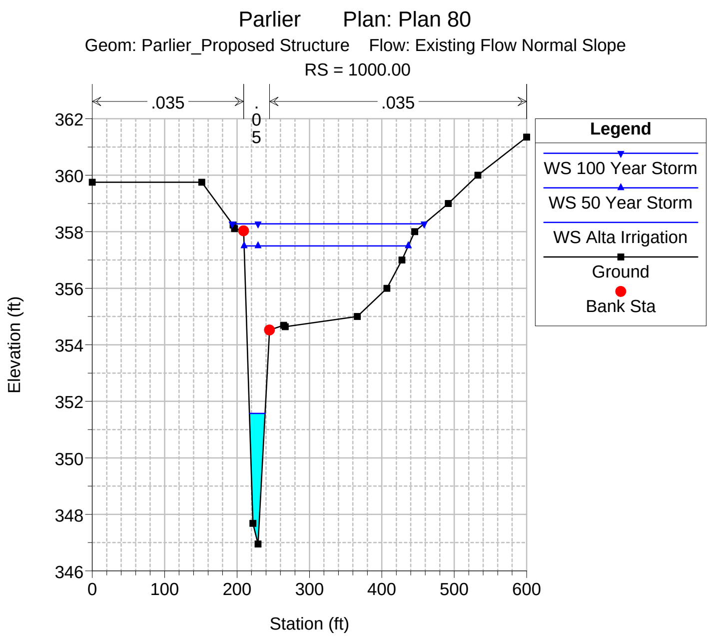

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1185.29 BR
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

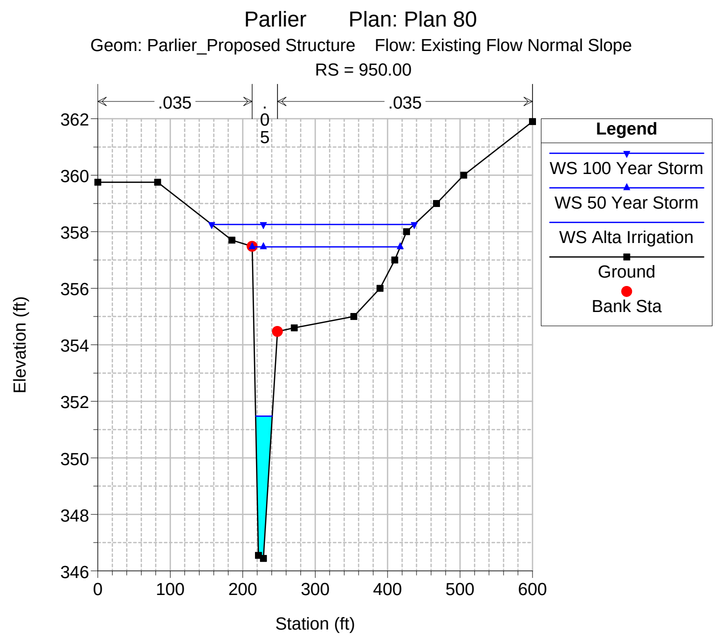

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1185.29 BR
.035
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

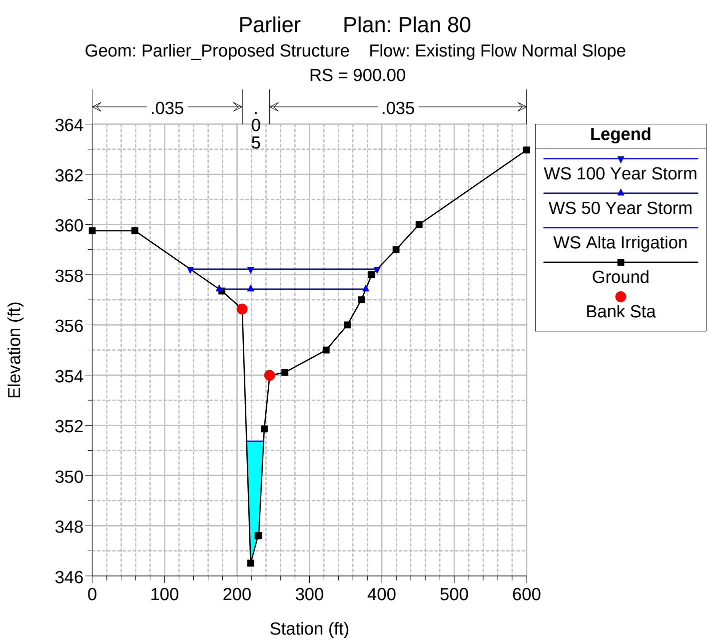

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1149.49
.035
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

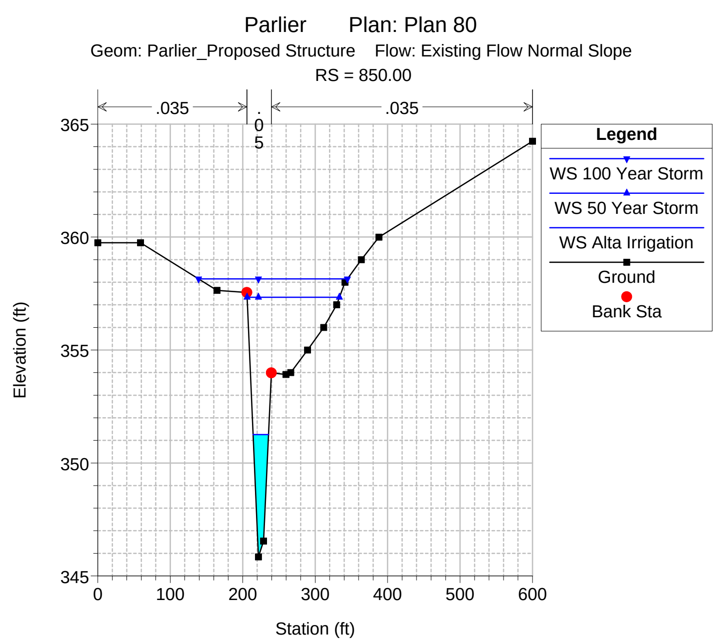

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1100.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

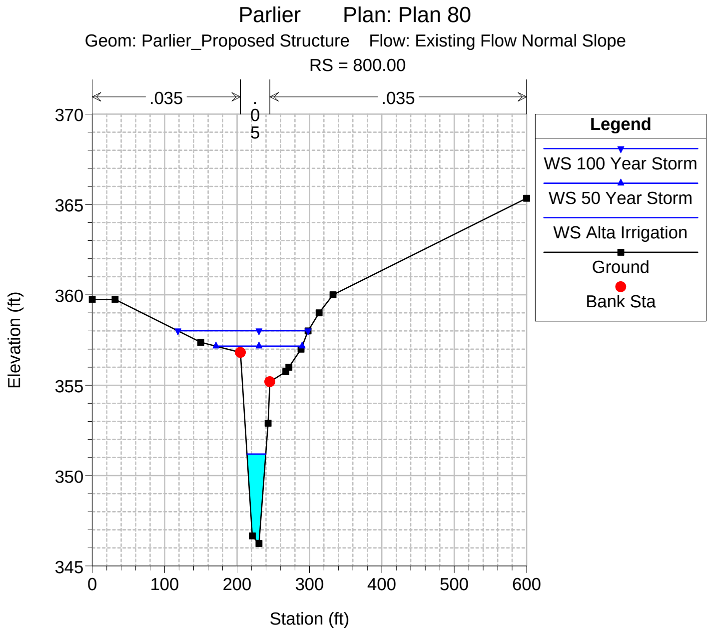

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1050.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

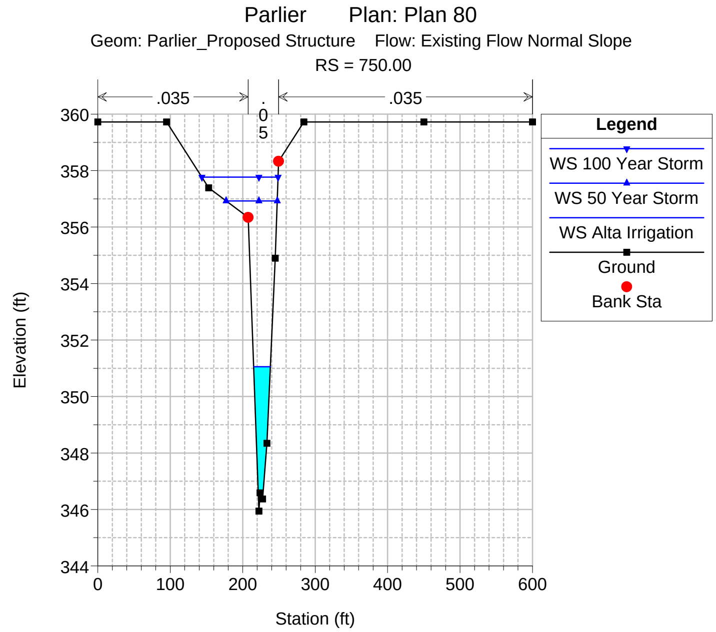

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 1000.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

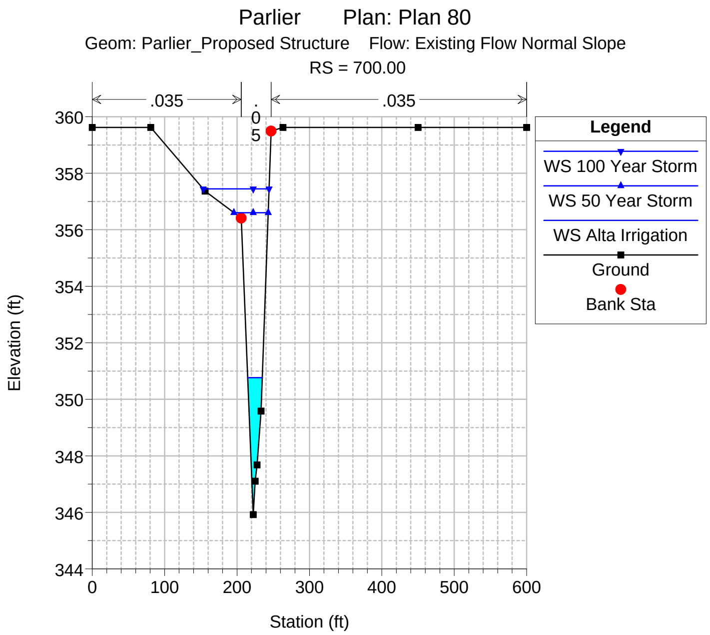

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 950.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

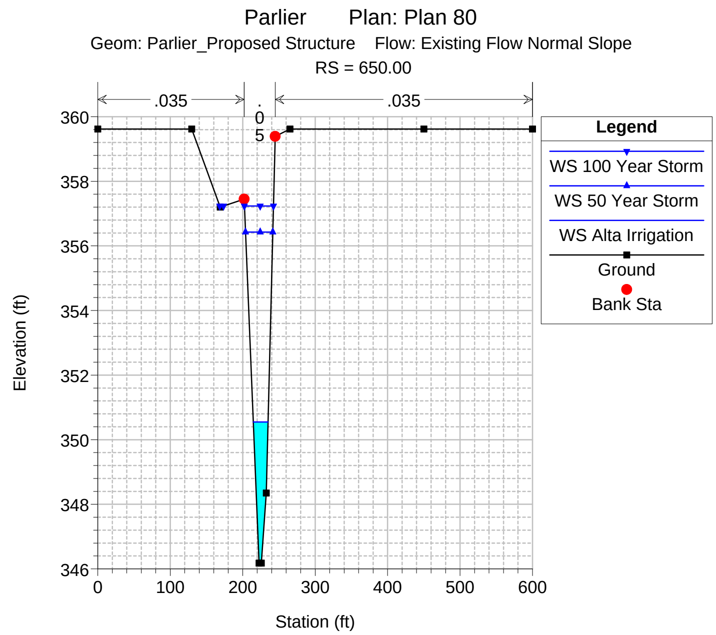

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 900.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

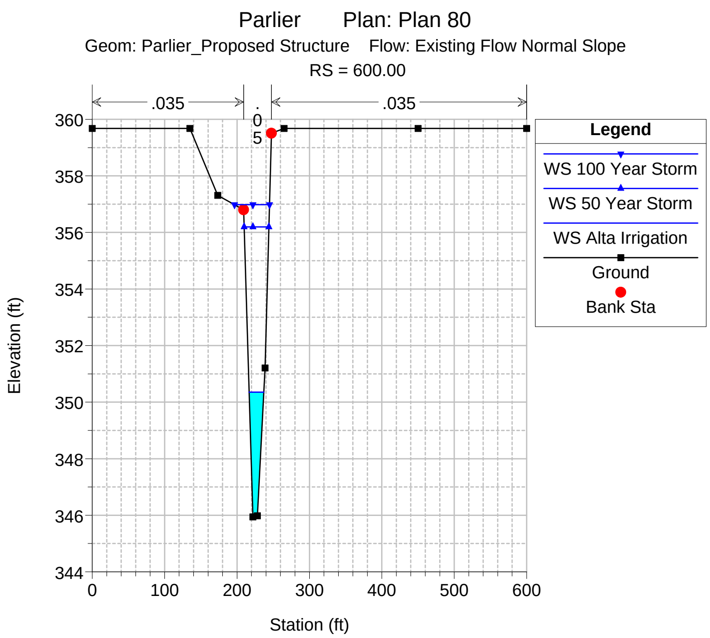

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 850.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

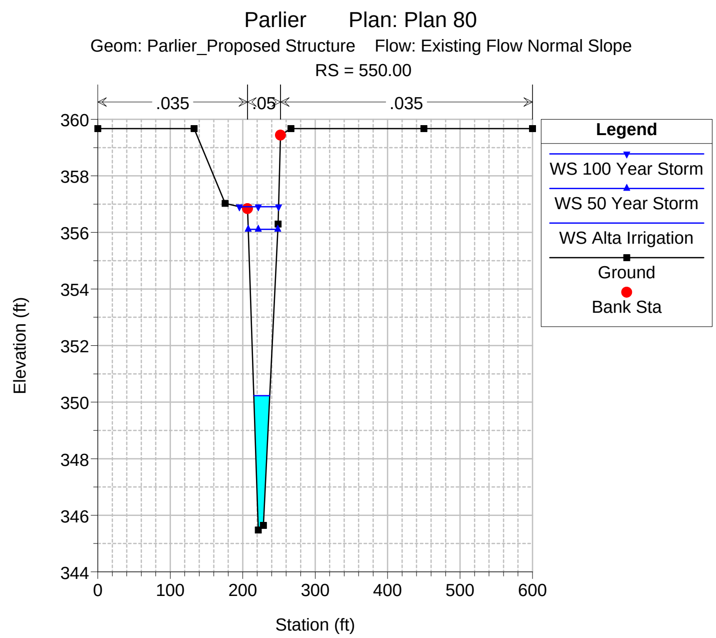

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 800.00
.035
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 750.00
.035
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

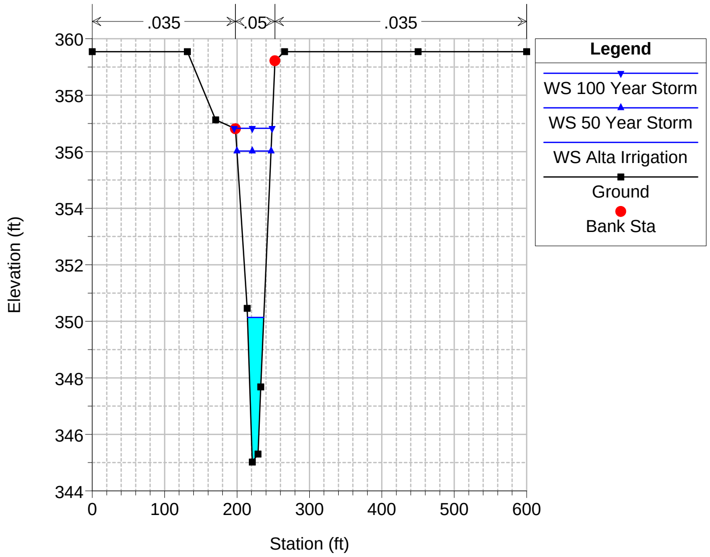

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 700.00
.035
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 650.00
.035
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

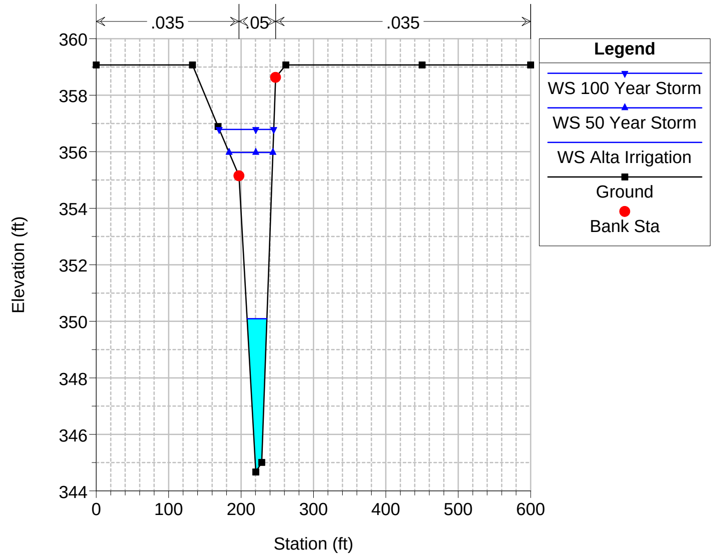

Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 600.00
.035
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)


Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 550.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
Station (ft)

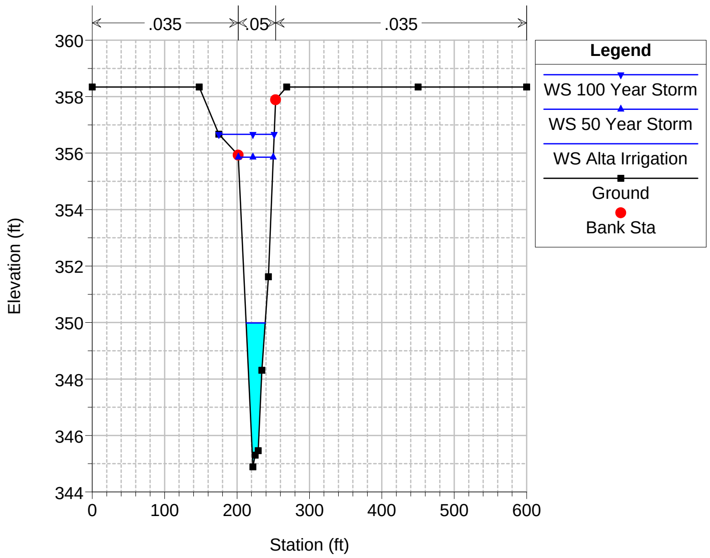
Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 500.00



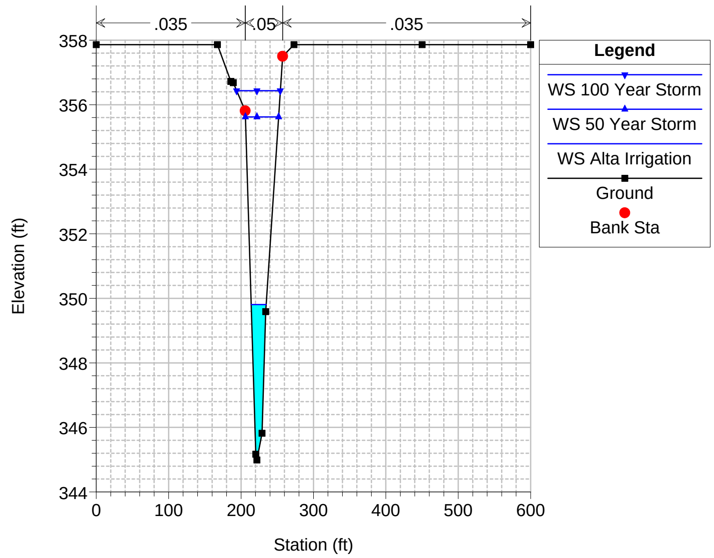
Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 450.00



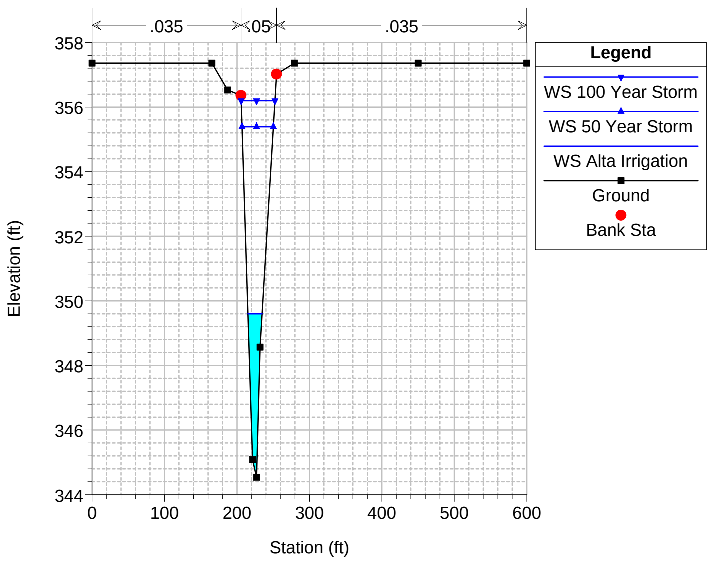
Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 400.00



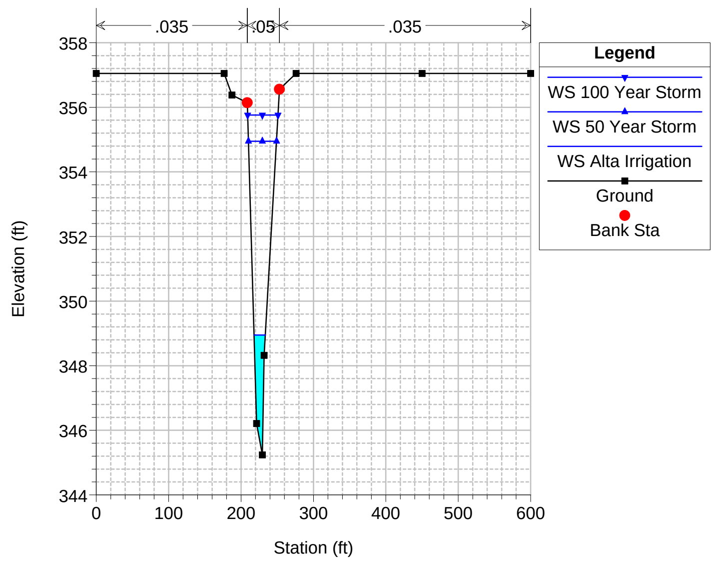
Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 350.00

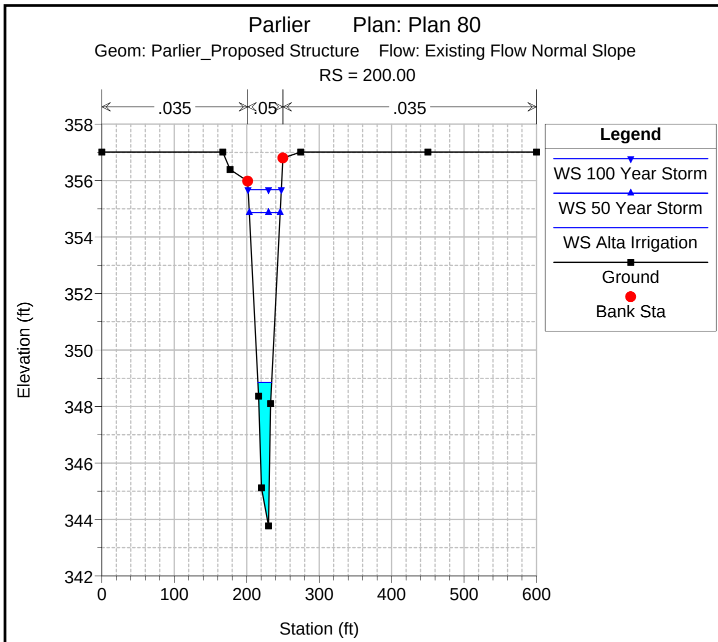


Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 300.00



Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 250.00




Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
RS = 200.00
.035
.05
.035
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
Bank Sta
Elevation (ft)
358
356
354
352
350
348
346
344
342
0
100
200
300
400
500
600
Station (ft)

HEC-RAS Plan: Plan 80 River: Travers Reach: Travers

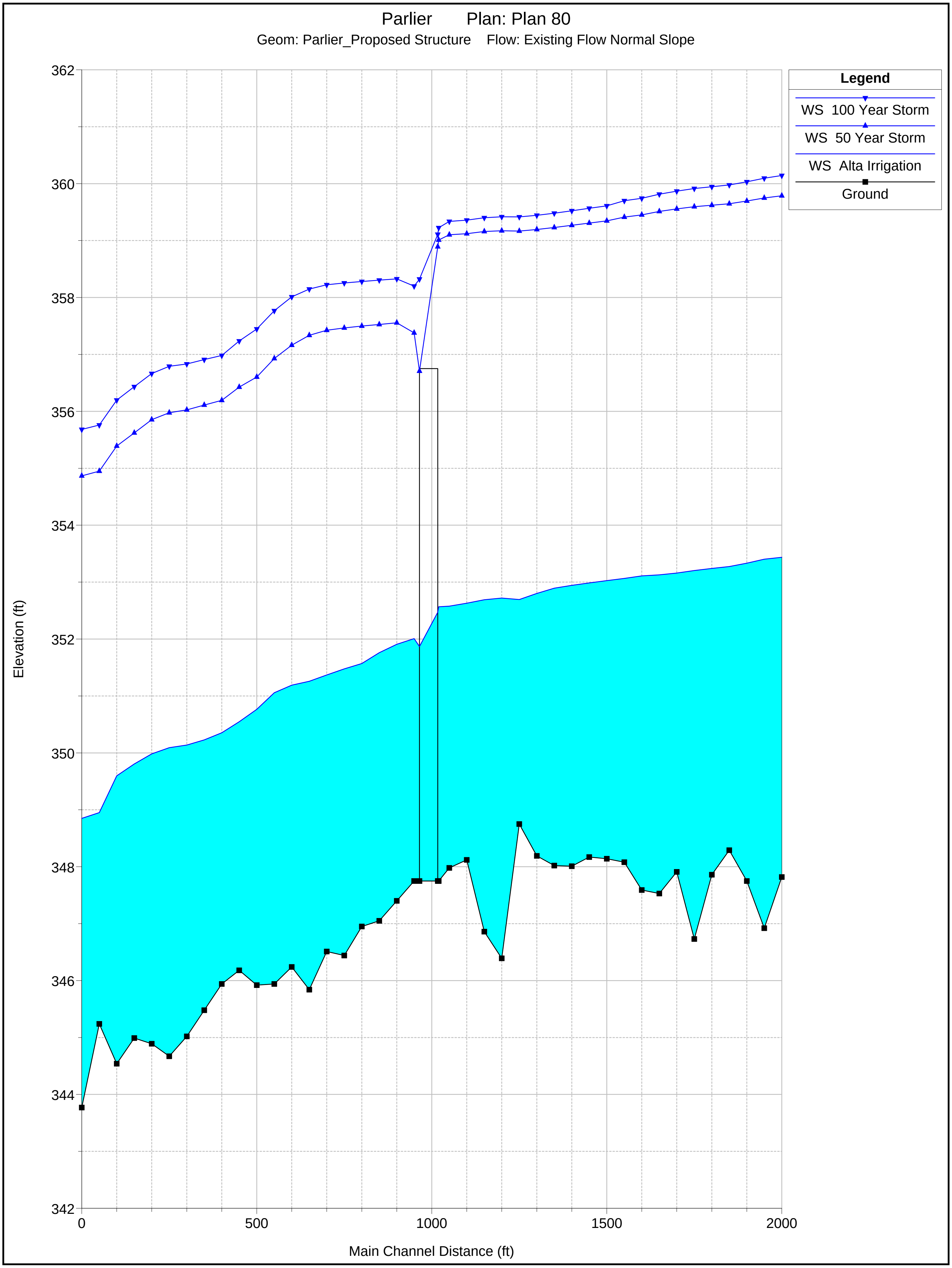
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Travers	2200.00	Alta Irrigation	200.00	347.82	353.44		353.52	0.001421	2.35	85.07	25.05	0.22
Travers	2200.00	50 Year Storm	1250.00	347.82	359.79		359.90	0.000794	2.98	484.77	129.21	0.19
Travers	2200.00	100 Year Storm	1500.00	347.82	360.14		360.28	0.000913	3.25	532.19	137.73	0.21
Travers	2150.00	Alta Irrigation	200.00	346.92	353.40		353.46	0.000827	1.94	103.15	26.72	0.17
Travers	2150.00	50 Year Storm	1250.00	346.92	359.75		359.86	0.000741	2.94	489.61	126.22	0.18
Travers	2150.00	100 Year Storm	1500.00	346.92	360.10		360.23	0.000867	3.24	534.90	134.54	0.20
Travers	2100.00	Alta Irrigation	200.00	347.75	353.33		353.41	0.001177	2.22	89.99	24.59	0.20
Travers	2100.00	50 Year Storm	1250.00	347.75	359.69		359.82	0.000880	3.14	463.14	125.69	0.20
Travers	2100.00	100 Year Storm	1500.00	347.75	360.03		360.18	0.001022	3.44	507.07	133.73	0.21
Travers	2050.00	Alta Irrigation	200.00	348.29	353.27		353.35	0.001191	2.22	89.90	24.72	0.21
Travers	2050.00	50 Year Storm	1250.00	348.29	359.65		359.78	0.000917	3.17	458.12	125.98	0.20
Travers	2050.00	100 Year Storm	1500.00	348.29	359.98		360.13	0.001066	3.48	501.08	133.83	0.22
Travers	2000.00	Alta Irrigation	200.00	347.86	353.24		353.30	0.000806	1.90	105.08	27.97	0.17
Travers	2000.00	50 Year Storm	1250.00	347.86	359.62		359.73	0.000714	2.88	498.66	129.27	0.18
Travers	2000.00	100 Year Storm	1500.00	347.86	359.95		360.08	0.000842	3.20	541.96	137.77	0.20
Travers	1950.00	Alta Irrigation	200.00	346.73	353.20		353.26	0.000758	1.82	109.61	29.67	0.17
Travers	1950.00	50 Year Storm	1250.00	346.73	359.59		359.69	0.000644	2.70	527.02	134.68	0.17
Travers	1950.00	100 Year Storm	1500.00	346.73	359.91		360.03	0.000765	2.99	571.38	142.52	0.19
Travers	1900.00	Alta Irrigation	200.00	347.91	353.16		353.22	0.000853	1.91	104.63	28.85	0.18
Travers	1900.00	50 Year Storm	1250.00	347.91	359.56		359.66	0.000689	2.77	513.90	133.65	0.18
Travers	1900.00	100 Year Storm	1500.00	347.91	359.87		359.99	0.000820	3.08	556.84	141.25	0.20
Travers	1850.00	Alta Irrigation	200.00	347.53	353.13		353.18	0.000636	1.75	114.54	28.41	0.15
Travers	1850.00	50 Year Storm	1250.00	347.53	359.51		359.62	0.000706	2.89	499.04	129.27	0.18
Travers	1850.00	100 Year Storm	1500.00	347.53	359.81		359.95	0.000848	3.22	539.24	136.39	0.20
Travers	1800.00	Alta Irrigation	200.00	347.59	353.11		353.15	0.000444	1.53	130.32	29.42	0.13
Travers	1800.00	50 Year Storm	1250.00	347.59	359.45		359.59	0.000747	3.10	479.49	158.71	0.18
Travers	1800.00	100 Year Storm	1500.00	347.59	359.74		359.91	0.000893	3.47	528.45	176.15	0.20
Travers	1750.00	Alta Irrigation	200.00	348.08	353.07		353.12	0.000725	1.82	109.67	28.04	0.16
Travers	1750.00	50 Year Storm	1250.00	348.08	359.41		359.55	0.000808	3.16	488.08	176.46	0.19
Travers	1750.00	100 Year Storm	1500.00	348.08	359.70		359.86	0.000945	3.50	541.33	193.45	0.21
Travers	1700.00	Alta Irrigation	200.00	348.14	353.03		353.08	0.000768	1.84	108.41	29.10	0.17
Travers	1700.00	50 Year Storm	1250.00	348.14	359.35		359.50	0.000890	3.32	442.29	154.73	0.20
Travers	1700.00	100 Year Storm	1500.00	348.14	359.61		359.80	0.001082	3.74	486.38	177.46	0.22
Travers	1650.00	Alta Irrigation	200.00	348.17	352.98		353.04	0.000820	1.88	106.46	29.21	0.17
Travers	1650.00	50 Year Storm	1250.00	348.17	359.31		359.46	0.000835	3.30	466.67	184.36	0.20
Travers	1650.00	100 Year Storm	1500.00	348.17	359.57		359.75	0.001003	3.69	517.75	208.42	0.22
Travers	1600.00	Alta Irrigation	200.00	348.01	352.94		353.00	0.000841	1.89	106.02	29.84	0.18
Travers	1600.00	50 Year Storm	1250.00	348.01	359.27		359.41	0.000826	3.24	475.48	206.63	0.20
Travers	1600.00	100 Year Storm	1500.00	348.01	359.52		359.70	0.000982	3.60	531.14	231.26	0.22
Travers	1550.00	Alta Irrigation	200.00	348.02	352.89		352.95	0.000929	1.96	101.83	28.88	0.18
Travers	1550.00	50 Year Storm	1250.00	348.02	359.23		359.37	0.000869	3.17	491.57	238.50	0.20
Travers	1550.00	100 Year Storm	1500.00	348.02	359.48		359.64	0.001007	3.49	553.84	258.38	0.22
Travers	1500.00	Alta Irrigation	200.00	348.19	352.80		352.89	0.001782	2.36	84.67	29.49	0.25
Travers	1500.00	50 Year Storm	1250.00	348.19	359.19		359.32	0.000916	3.07	525.14	290.52	0.20
Travers	1500.00	100 Year Storm	1500.00	348.19	359.44		359.58	0.001020	3.32	600.34	311.34	0.22
Travers	1450.00	Alta Irrigation	200.00	348.75	352.69		352.79	0.002279	2.44	82.07	33.50	0.27
Travers	1450.00	50 Year Storm	1250.00	348.75	359.17		359.27	0.000787	2.83	583.30	321.36	0.19
Travers	1450.00	100 Year Storm	1500.00	348.75	359.42		359.53	0.000866	3.03	665.74	342.11	0.20
Travers	1400.00	Alta Irrigation	200.00	346.39	352.72		352.74	0.000220	1.15	174.62	38.04	0.09
Travers	1400.00	50 Year Storm	1250.00	346.39	359.17		359.23	0.000324	2.18	776.11	370.33	0.13
Travers	1400.00	100 Year Storm	1500.00	346.39	359.42		359.49	0.000376	2.39	869.65	394.25	0.14
Travers	1350.00	Alta Irrigation	200.00	346.86	352.69		352.72	0.000437	1.46	136.81	35.02	0.13
Travers	1350.00	50 Year Storm	1250.00	346.86	359.16		359.22	0.000332	2.17	795.81	349.92	0.13
Travers	1350.00	100 Year Storm	1500.00	346.86	359.40		359.47	0.000391	2.40	884.89	386.22	0.14
Travers	1300.00	Alta Irrigation	200.00	348.12	352.63		352.69	0.000976	1.98	101.26	29.92	0.19
Travers	1300.00	50 Year Storm	1250.00	348.12	359.12		359.20	0.000514	2.53	680.49	324.12	0.16
Travers	1300.00	100 Year Storm	1500.00	348.12	359.36		359.45	0.000597	2.78	761.46	359.65	0.17
Travers	1250.00	Alta Irrigation	200.00	347.98	352.58		352.64	0.001067	1.98	101.10	31.81	0.20
Travers	1250.00	50 Year Storm	1250.00	347.98	359.10		359.17	0.000470	2.42	714.03	331.80	0.15

HEC-RAS Plan: Plan 80 River: Travers Reach: Travers (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Travers	1250.00	100 Year Storm	1500.00	347.98	359.34		359.41	0.000547	2.66	795.64	366.84	0.16
Travers	1219.76	Alta Irrigation	200.00	347.75	352.57	349.24	352.61	0.000531	1.69	118.13	32.06	0.15
Travers	1219.76	50 Year Storm	1250.00	347.75	359.01	352.32	359.14	0.000938	3.19	502.84	242.77	0.21
Travers	1219.76	100 Year Storm	1500.00	347.75	359.23	352.83	359.38	0.001106	3.53	557.44	263.86	0.23
Travers	1185.29		Bridge									
Travers	1149.49	Alta Irrigation	200.00	347.75	352.01		352.11	0.001729	2.55	78.33	28.53	0.26
Travers	1149.49	50 Year Storm	1250.00	347.75	357.38	353.19	357.86	0.002243	5.57	224.54	304.76	0.34
Travers	1149.49	100 Year Storm	1500.00	347.75	358.20		358.56	0.003174	5.12	390.82	332.69	0.37
Travers	1100.00	Alta Irrigation	200.00	347.40	351.91		352.01	0.002055	2.62	76.33	25.33	0.27
Travers	1100.00	50 Year Storm	1250.00	347.40	357.56		357.61	0.000453	2.12	747.86	280.90	0.14
Travers	1100.00	100 Year Storm	1500.00	347.40	358.33		358.37	0.000317	1.87	971.79	306.30	0.12
Travers	1050.00	Alta Irrigation	200.00	347.05	351.76		351.89	0.002845	2.91	68.67	25.23	0.31
Travers	1050.00	50 Year Storm	1250.00	347.05	357.53		357.58	0.000513	2.22	704.03	262.36	0.15
Travers	1050.00	100 Year Storm	1500.00	347.05	358.31		358.35	0.000358	1.96	915.68	286.96	0.13
Travers	1000.00	Alta Irrigation	200.00	346.95	351.57		351.73	0.003375	3.24	61.71	21.53	0.34
Travers	1000.00	50 Year Storm	1250.00	346.95	357.50		357.56	0.000517	2.21	672.40	226.75	0.15
Travers	1000.00	100 Year Storm	1500.00	346.95	358.28		358.33	0.000380	2.01	859.73	265.19	0.13
Travers	950.00	Alta Irrigation	200.00	346.44	351.48		351.59	0.002068	2.70	74.12	22.91	0.26
Travers	950.00	50 Year Storm	1250.00	346.44	357.46		357.53	0.000548	2.34	637.43	204.33	0.15
Travers	950.00	100 Year Storm	1500.00	346.44	358.26		358.31	0.000405	2.15	831.50	279.55	0.13
Travers	900.00	Alta Irrigation	200.00	346.51	351.37		351.48	0.002121	2.72	73.59	23.46	0.27
Travers	900.00	50 Year Storm	1250.00	346.51	357.42		357.50	0.000586	2.48	597.97	202.56	0.16
Travers	900.00	100 Year Storm	1500.00	346.51	358.22		358.29	0.000443	2.31	781.09	258.33	0.14
Travers	850.00	Alta Irrigation	200.00	345.84	351.26		351.38	0.002076	2.77	72.15	21.36	0.27
Travers	850.00	50 Year Storm	1250.00	345.84	357.34		357.46	0.000969	3.12	458.31	127.51	0.20
Travers	850.00	100 Year Storm	1500.00	345.84	358.15		358.26	0.000756	2.94	595.27	205.43	0.18
Travers	800.00	Alta Irrigation	200.00	346.24	351.19		351.28	0.001545	2.40	83.48	25.89	0.24
Travers	800.00	50 Year Storm	1250.00	346.24	357.16		357.39	0.001507	3.94	350.73	119.09	0.26
Travers	800.00	100 Year Storm	1500.00	346.24	358.01		358.20	0.001186	3.77	480.54	179.71	0.23
Travers	750.00	Alta Irrigation	200.00	345.94	351.06		351.18	0.002376	2.83	70.72	23.13	0.29
Travers	750.00	50 Year Storm	1250.00	345.94	356.93		357.28	0.002573	4.76	269.53	70.68	0.33
Travers	750.00	100 Year Storm	1500.00	345.94	357.77		358.11	0.002291	4.78	345.83	105.21	0.32
Travers	700.00	Alta Irrigation	200.00	345.92	350.76		351.00	0.005609	3.86	51.76	20.22	0.43
Travers	700.00	50 Year Storm	1250.00	345.92	356.60		357.10	0.004138	5.67	221.47	47.36	0.41
Travers	700.00	100 Year Storm	1500.00	345.92	357.45		357.95	0.003724	5.75	280.35	91.01	0.40
Travers	650.00	Alta Irrigation	200.00	346.18	350.55		350.74	0.004244	3.55	56.38	20.45	0.38
Travers	650.00	50 Year Storm	1250.00	346.18	356.43		356.89	0.003795	5.49	227.68	37.82	0.39
Travers	650.00	100 Year Storm	1500.00	346.18	357.24		357.76	0.003861	5.79	259.37	45.57	0.40
Travers	600.00	Alta Irrigation	200.00	345.94	350.35		350.54	0.003872	3.44	58.21	20.35	0.36
Travers	600.00	50 Year Storm	1250.00	345.94	356.19		356.70	0.003938	5.69	219.49	34.14	0.40
Travers	600.00	100 Year Storm	1500.00	345.94	356.98		357.55	0.004078	6.07	248.21	48.36	0.41
Travers	550.00	Alta Irrigation	200.00	345.48	350.23		350.37	0.002599	2.96	67.54	21.99	0.30
Travers	550.00	50 Year Storm	1250.00	345.48	356.11		356.49	0.002955	4.95	252.58	40.94	0.35
Travers	550.00	100 Year Storm	1500.00	345.48	356.91		357.34	0.003006	5.24	286.56	54.11	0.36
Travers	500.00	Alta Irrigation	200.00	345.02	350.14		350.25	0.001895	2.65	75.40	22.62	0.26
Travers	500.00	50 Year Storm	1250.00	345.02	356.02		356.33	0.002458	4.47	279.95	47.24	0.32
Travers	500.00	100 Year Storm	1500.00	345.02	356.83		357.17	0.002497	4.70	319.44	52.42	0.33
Travers	450.00	Alta Irrigation	200.00	344.67	350.09		350.16	0.001145	2.14	93.43	27.29	0.20
Travers	450.00	50 Year Storm	1250.00	344.67	355.98		356.22	0.001607	3.94	321.62	60.53	0.27
Travers	450.00	100 Year Storm	1500.00	344.67	356.79		357.05	0.001574	4.14	376.99	75.27	0.27
Travers	400.00	Alta Irrigation	200.00	344.89	349.98		350.09	0.001997	2.58	77.48	26.24	0.26
Travers	400.00	50 Year Storm	1250.00	344.89	355.85		356.12	0.001977	4.17	300.08	48.25	0.29
Travers	400.00	100 Year Storm	1500.00	344.89	356.66		356.96	0.001935	4.39	349.57	76.26	0.30
Travers	350.00	Alta Irrigation	200.00	344.99	349.81		349.96	0.002982	3.15	63.47	20.61	0.32
Travers	350.00	50 Year Storm	1250.00	344.99	355.62		355.99	0.003156	4.87	256.68	45.82	0.36
Travers	350.00	100 Year Storm	1500.00	344.99	356.43		356.83	0.003055	5.07	298.66	60.30	0.36
Travers	300.00	Alta Irrigation	200.00	344.54	349.60		349.79	0.003957	3.48	57.55	19.61	0.36
Travers	300.00	50 Year Storm	1250.00	344.54	355.39		355.81	0.003740	5.22	239.48	43.21	0.39

HEC-RAS Plan: Plan 80 River: Travers Reach: Travers (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Travers	300.00	100 Year Storm	1500.00	344.54	356.20		356.66	0.003710	5.44	275.67	46.49	0.39
Travers	250.00	Alta Irrigation	200.00	345.24	348.95		349.42	0.013644	5.51	36.29	15.61	0.64
Travers	250.00	50 Year Storm	1250.00	345.24	354.95		355.56	0.006022	6.27	199.36	38.76	0.49
Travers	250.00	100 Year Storm	1500.00	345.24	355.76	352.93	356.41	0.005795	6.47	232.01	41.88	0.48
Travers	200.00	Alta Irrigation	200.00	343.77	348.85	346.65	349.02	0.003501	3.35	59.70	18.81	0.33
Travers	200.00	50 Year Storm	1250.00	343.77	354.87	351.00	355.27	0.003505	5.11	244.56	42.64	0.38
Travers	200.00	100 Year Storm	1500.00	343.77	355.68	351.64	356.13	0.003507	5.35	280.62	45.86	0.38



Parlier Plan: Plan 80
Geom: Parlier_Proposed Structure Flow: Existing Flow Normal Slope
Legend
WS 100 Year Storm
WS 50 Year Storm
WS Alta Irrigation
Ground
362
360
358
356
354
352
350
348
346
344
342
Elevation (ft)
0
500
1000
1500
2000
Main Channel Distance (ft)

Appendix I: Scour Calculations

Lincoln Contraction Scour (Live-bed & Clear-water)

Critical Velocity Equation

$$V_c = K_u y^{1/6} D^{1/3}$$

***NOTE: To view and read notes on the different cases (4 total) refer to the HEC 18 Section 6.2.2 (pages 6.2-*

Source: ***HEC 18***

V_c	critical velocity above which bed material of size D and smaller will be transported, ft/s (m/s)
y	average depth of flow upstream of the bridge, ft (m)
D	particle size for V_c, ft (m)
D_{50}	particle size in a mixture of which 50% are smaller, ft (m)
K_u	6.19 (SI Units)
	11.17 (English Units)
V	mean velocity of the flow in the main channel or overbank area upstream of the bridge opening

Critical Velocity		
V_c	1.49	*ft/s*
y	8.98	*ft*
D_{50}	0.00079	*ft*
K_u	11.17	
V	3.19	*ft/s*

Live-bed Contraction

SOURCE: *Hydraulic Engineering Circular No. 18 (HEC 18) section 6.2*

Laursen's Clear-water Contraction Scour Equation

$$y_2 = \left[\frac{K_u Q^2}{{D_m}^{2/3} W^2}\right]^{3/7}$$

$$y_s = y_2 - y_0 = (average\ contraction\ scour\ depth)$$

Source: ***HEC 18***

y_2	avg. equilibrium depth in contracted section after contraction scour, ft (m)
Q	discharge through bridge or on set-back overbank area at bridge associated with the width W, ft^3/s (m^3/s)
D_m	diameter of smallest nontransportable particle in bed material ($1.25D_{50}$) in contracted section, ft (m)
D_{50}	median diameter of bed material, ft (m)
W	bottom width of contracted section less pier widths, ft (m)
y_0	average existing depth in contracted section, ft (m)
K_u	0.0077 (English Units)
	0.025 (SI Units)

Clear-water Contraction Scour		
y_s	0.00	*ft*
y_2	4.26	*ft*
Q	1150	*ft^3/s*
D_m	0.0984252	*ft*
D_{50}	0.075	*ft*
W	40.26	*ft*
y_0	5.27	*ft*
K_u	0.0077	

SOURCE: *Hydraulic Engineering Circular No. 18 (HEC 18) section 6.4*

Laursen's Live-bed Contraction Scour Equation (modified)

$$\frac{y_2}{y_1} = \left(\frac{Q_2}{Q_1}\right)^{6/7} \left(\frac{W_1}{W_2}\right)^{k_1}$$

$$y_s = y_2 - y_o = (average\ contraction\ scour\ depth)$$

Source: *HEC 18*

y_1	average depth in the upstream main channel, ft (m)
y_2	average depth in the contracted section, ft (m)
y_O	existing depth in the contracted section before scour, ft (m)
Q_1	flow in the upstream channel transporting sediment, ft^3/s (m^3/s)
Q_2	flow in the contracted channel, ft^3/s (m^3/s)
W_1	bottom width of upstream main channel that is transporting bed material, ft (m)
W_2	bottom width of main channel in contracted section less pier width(s), ft (m)
k_1	exponent determined below

V*/T	k_1	Mode of Bed Material Transport
<0.50	0.59	mostly contact bed material discharge
0.50 to 2.0	0.64	some suspended bad material discharge
>2.0	0.69	mostly suspended bed material discharge

V*	$(\vartheta_0/\Delta)^{1/2} = (gy_1S_1)^{1/2}$
	shear velocity in the upstream section ft/s (m/s)
T	fall velocity of bed material based on the D_{50}, m/s
	English Units (ft/s): multiply T in m/s by 3.28
g	acceleration of gravity (32.2 ft/s^2)(9.81 m/s^2)
S_1	slope of energy grade line of main channel, ft/ft (m/m)
ϑ_0	shear stress on the bed, (lb/ft^2)(Pa(N/m^2))
Δ	density of water (1.94 $slugs/ft^3$)(1000 kg/m^3)

Live-bed Contraction Scour			
y_s	1.368	*ft*	
y_1	8.98	*ft*	(avg. prop. 100 yr depths)
y_2	9.468	*ft*	
y_O	8.1	*ft*	
Q_1	650	*ft3/s*	(design flow)
Q_2	650	*ft3/s*	(design flow)
W_1	19.09	*ft*	(avg upstream top widths)
W_2	17.68	*ft*	top width 100 yr under structure
k_1	0.69		
V*/T	2.154		
V*	0.233	*ft/s*	
T	0.033	*m/s*	
	0.10824	*ft/s*	
ϑ_0		*lb/ft2*	
Δ	1.94	*slugs/ft3*	
g	32.2	*ft/s^2*	
S_1	0.000188	*ft/ft*	(avg. upstream slope)

SOURCE: *See notes in Hydraulic Engineering Circular No. 18 (HEC 18) section 6.3 for more details regarding the variables.*

Lincoln Local Scour (Abutment)

Froehlich's Abutment Scour Equation

$$\frac{y_s}{y_a} = 2.27 * K_1 * K_2 * \left(\frac{L'}{y_a}\right)^{.43} * Fr^{.61} + 1$$

Source: ***HEC 18***

- **K_1** coefficient for abutment shape (see table 8.1)
- **K_2** coefficient for angle of embankment to flow
  $(\theta/90)^{.13}$
  θ<90° if embankment points downstream
  θ>90° if embankment points upstream
- **L'** Length of Active Flow obstructed by embankment
- **Fr** Froude Number of approach flow upstream of the abutment
- **y_a** Average depth of flow on the floodplain (feet)
- **L** Length of Embankment projected normal to the flow (feet)
- **y_s** Scour Depth (feet)

Abutment Shape Coefficient	
Description	**K_1**
Vertical - Wall Abutment	1
Vertical wall abutment with Wing Walls	0.82
Spill through abutment	0.55

Abutment 1		**Abutment 2**	
Abutment Shape Type:	Vertical wall abutment with Wing Walls	**Abutment Shape Type:**	Vertical wall abutment with Wing Walls
K_1	0.82	K_1	0.82
θ	63	θ	110
K_2	0.95	K_2	1.03
L'	0	L'	0
y_a	4.07	y_a	4.03
g (ft^2/s)	32.20	g (ft^2/s)	32.20
Fr	0.19	Fr	0.19
y_s	4.07	y_s	4.03

SOURCE: *Hydraulic Engineering Circular No. 18 (HEC 18) section 8.6.1*

Parlier Contraction Scour (Live-bed & Clear-water)

Critical Velocity Equation

$$V_c = K_u y^{1/6} D^{1/3}$$

***NOTE: To view and read notes on the different cases (4 total) refer to the HEC 18 Section 6.2.2 (pages 6.2-*

Source: ***HEC 18***

V_c	critical velocity above which bed material of size D and smaller will be transported, ft/s (m/s)
y	average depth of flow upstream of the bridge, ft (m)
D	particle size for V_c, ft (m)
D_{50}	particle size in a mixture of which 50% are smaller, ft (m)
K_u	6.19 (SI Units)
	11.17 (English Units)
V	mean velocity of the flow in the main channel or overbank area upstream of the bridge opening

Critical Velocity		
V_c	1.33	*ft/s*
y	11.88	*ft*
D_{50}	0.000492	*ft*
K_u	11.17	
V	3.24	*ft/s*
Live-bed Contraction		

SOURCE: *Hydraulic Engineering Circular No. 18 (HEC 18) section 6.2*

Laursen's Clear-water Contraction Scour Equation

$$y_2 = \left[\frac{K_u Q^2}{D_m^{2/3} W^2}\right]^{3/7}$$

$$y_s = y_2 - y_0 = (average\ contraction\ scour\ depth)$$

Source: ***HEC 18***

y_2	avg. equilibrium depth in contracted section after contraction scour, ft (m)
Q	discharge through bridge or on set-back overbank area at bridge associated with the width W, ft^3/s (m^3/s)
D_m	diameter of smallest nontransportable particle in bed material ($1.25D_{50}$) in contracted section, ft (m)
D_{50}	median diameter of bed material, ft (m)
W	bottom width of contracted section less pier widths, ft (m)
y_0	average existing depth in contracted section, ft (m)
K_u	0.0077 (English Units)
	0.025 (SI Units)

Clear-water Contraction Scour		
y_s	0.00	*ft*
y_2	4.26	*ft*
Q	1150	*ft^3/s*
D_m	0.0984252	*ft*
D_{50}	0.075	*ft*
W	40.26	*ft*
y_0	5.27	*ft*
K_u	0.0077	

SOURCE: *Hydraulic Engineering Circular No. 18 (HEC 18) section 6.4*

Laursen's Live-bed Contraction Scour Equation (modified)

$$\frac{y_2}{y_1} = \left(\frac{Q_2}{Q_1}\right)^{6/7} \left(\frac{W_1}{W_2}\right)^{k_1}$$

$$y_s = y_2 - y_o = (average\ contraction\ scour\ depth)$$

Source: *HEC 18*

y_1	average depth in the upstream main channel, ft (m)
y_2	average depth in the contracted section, ft (m)
y_O	existing depth in the contracted section before scour, ft (m)
Q_1	flow in the upstream channel transporting sediment, ft^3/s (m^3/s)
Q_2	flow in the contracted channel, ft^3/s (m^3/s)
W_1	bottom width of upstream main channel that is transporting bed material, ft (m)
W_2	bottom width of main channel in contracted section less pier width(s), ft (m)
k_1	exponent determined below

V*/T	k_1	Mode of Bed Material Transport
<0.50	0.59	mostly contact bed material discharge
0.50 to 2.0	0.64	some suspended bad material discharge
>2.0	0.69	mostly suspended bed material discharge

V*	$(\vartheta_0/\Delta)^{1/2} = (gy_1S_1)^{1/2}$
	shear velocity in the upstream section ft/s (m/s)
T	fall velocity of bed material based on the D_{50}, m/s
	English Units (ft/s): multiply T in m/s by 3.28
g	acceleration of gravity (32.2 ft/s^2)(9.81 m/s^2)
S_1	slope of energy grade line of main channel, ft/ft (m/m)
ϑ_0	shear stress on the bed, (lb/ft^2)(Pa(N/m^2))
Δ	density of water (1.94 $slugs/ft^3$)(1000 kg/m^3)

SOURCE: *See notes in Hydraulic Engineering Circular No. 18 (HEC 18) section 6.3 for more details regarding the variables.*

Live-bed Contraction Scour

y_s	0.312	*ft*	
y_1	11.88	*ft*	(avg. prop. 100 yr depths)
y_2	10.782	*ft*	
y_O	10.47	*ft*	
Q_1	1500	*ft3/s*	(design flow)
Q_2	1500	*ft3/s*	(design flow)
W_1	7.29	*ft*	(avg upstream top widths)
W_2	8.39	*ft*	top width 100 yr under structure
k_1	0.69		
V*/T	16.667		
V*	0.875	*ft/s*	
T	0.016	*m/s*	
	0.05248	*ft/s*	
ϑ_0	6	*lb/ft2*	
Δ	1.94	*slugs/ft3*	
g	32.2	*ft/s^2*	
S_1	0.002	*ft/ft*	(avg. upstream slope)

Parlier Local Scour (Abutment)

Froehlich's Abutment Scour Equation

$$\frac{y_s}{y_a} = 2.27 * K_1 * K_2 * \left(\frac{L'}{y_a}\right)^{.43} * Fr^{.61} + 1$$

Source: ***HEC 18***

K_1 coefficient for abutment shape (see table 8.1)

K_2 coefficient for angle of embankment to flow

$(\theta/90)^{.13}$

θ<90° if embankment points downstream

θ>90° if embankment points upstream

L' Length of Active Flow obstructed by embankment

Fr Froude Number of approach flow upstream of the abutment

y_a Average depth of flow on the floodplain (feet)

L Length of Embankment projected normal to the flow (feet)

y_s Scour Depth (feet)

Abutment Shape Coefficient	
Description	**K_1**
Vertical - Wall Abutment	1
Vertical wall abutment with Wing Walls	0.82
Spill through abutment	0.55

Abutment 1		Abutment 2	
Abutment Shape Type:	Vertical wall abutment with Wing Walls	**Abutment Shape Type:**	Vertical wall abutment with Wing Walls
K_1	0.82	K_1	0.82
θ	60	θ	30
K_2	0.95	K_2	0.87
L'	0	L'	0
y_a	4.03	y_a	1.21
g (ft^2/s)	32.20	g (ft^2/s)	32.20
Fr	0.24	Fr	0.24
y_s	4.03	y_s	1.21

SOURCE: *Hydraulic Engineering Circular No. 18 (HEC 18) section 8.6.1*

PARLIER PIER SCOUR CALCULATIONS

HEC-18

HEC-18 pier scour equation is recommended for both live-bed and clear-water pier scour.

HEC-18 Equation:

$$\frac{y_s}{y_1} = 2.0K_1K_2K_3\left(\frac{a}{y_1}\right)^{0.65} Fr_1^{0.43}$$

OR

$$\frac{y_s}{a} = 2.0K_1K_2K_3\left(\frac{y_1}{a}\right)^{0.35} Fr_1^{0.43}$$

where:

- **y_s =** *scour depth, ft (m)*
- **y_1 =** *flow depth directly upstream of the pier, ft (m)*
- **K_1 =** *correction factor for pier nose shape from Figure 7.3/Table 7.1*
- **K_2 =** *correction factor for angle of attack of clow from Table 7.2/Equation 7.4*

EQUATION 7.4 from HEC-18:

$$K_2 = \left(\cos\theta + \frac{L}{a}\sin\theta\right)^{0.65}$$

- **K_3 =** *correction factor for bed condition from Table 7.3*
- **a =** *pier width, ft (m)*
- **L =** *length of pier, ft (m)*
- **Fr_1 =** *Froude Number directly upstream of the pier*

PIER SCOUR		
K_1 =	1	
K_2 =	2.08	
K_3 =	1.1	
a =	0.67	*ft*
L =	52.25	*ft*
Fr_1 =	0.24	
y_1 =	11.38	*ft*
y_s =	4.47	*ft*
y_s/y_1 =	0.39	
y_s/a =	6.68	

As a Rule of Thumb, the maximum scour depth for round nose piers aligned with the flow is:

y_s $\leq$ 2.4 times the pier width (a) for **Fr** $\leq$ 0.8

y_s $\leq$ 3.0 times the pier width (a) for **Fr** > 0.8

SOURCE: *Hydraulic Engineering Circular No. 18 (HEC-18) section 7.2*

Appendix J: Rock Slope Protection Calculations

ROCK SLOPE PROTECTION - LINCOLN AVENUE

Caltrans HDM Chapter 870 2016

Alternate Source: FHWA HEC 23 2009

EQUATIONS:

$$Weight\ of\ stone = \boldsymbol{W} = \mathbf{0.85}(\boldsymbol{\gamma_s d^3})$$

$$Stone\ size = \boldsymbol{d_{50}} = \mathbf{1.2}\boldsymbol{d_{30}}$$

$$\boldsymbol{d_{30}} = \boldsymbol{y}(\boldsymbol{S_f C_s C_v C_T})\left[\frac{\boldsymbol{V_{des}}}{\sqrt{\boldsymbol{K_1}(\boldsymbol{S_g} - \mathbf{1})\boldsymbol{gy}}}\right]^{2.5}$$

VARIABLES:

Avg. stream velocity =	3.95	*ft/s*
flow depth (y) =	8.72	*ft*
bank slope =	1.5	*:1*
SG =	2.65	
centerline radius (R_c)=	10	*ft*
channel width (W) =	50.7	*ft*
factor of safety =	1.2	
bank angle (Θ) =	33.7	*degrees*
blanket thickness coefficient (C_T) =	1.00	

PROCEDURE:

STEP 1: Compute the side slope correction factor.

K_1 = 0.72

STEP 2: Select the appropriate stability coefficient for riprap.

C_S = 0.3

STEP 3: Compute vertical velocity factor.

C_V = 1.42

STEP 4: Compute local velocity on the side slope for a natural channel.

V_{des} = 8.32 *ft/s*

STEP 5: Compute the d_{30} size using equation provided above.

d_{30} = 0.63 *ft*

STEP 6: Compute the d_{50} size using equation provided above.

d_{50}* = 9.1 *in* — **NOTE: Choose next larger size from Table 873.3A.*

d_{50} = **12.0** *in* — ***Class III Nominal RSP Class per Caltrans HDM Table 873.3A***

STEP 7: Layer thickness. [Choose the larger of the two.]

$1.5d_{50}$ = 18 *in*

d_{100} = 24 *in* — **RSP layer thickness (T) will be 24 inches.**

STEP 8: Determine RSP class per ***Caltrans 2015 Standard Specifications*** .

Light Class, method B placement with Class 8 fabric

MARK THOMAS

ROCK SLOPE PROTECTION - PARLIER AVENUE

Caltrans HDM Chapter 870 2016

Alternate Source: FHWA HEC 23 2009

EQUATIONS:

$$Weight\ of\ stone = \boldsymbol{W = 0.85(\gamma_s d^3)}$$

$$Stone\ size = \boldsymbol{d_{50} = 1.2 d_{30}}$$

$$\boldsymbol{d_{30} = y(S_f C_s C_v C_T)\left[\frac{V_{des}}{\sqrt{K_1(S_g - 1)gy}}\right]^{2.5}}$$

VARIABLES:

Avg. stream velocity =	4.3	*ft/s*
flow depth (y) =	11.9	*ft*
bank slope =	1.5	*:1*
SG =	2.65	
centerline radius (R_c)=	5	*ft*
channel width (W) =	43.1	*ft*
factor of safety =	1.2	
bank angle (Θ) =	33.7	*degrees*
blanket thickness coefficient (C_T) =	1.00	

PROCEDURE:

STEP 1: Compute the side slope correction factor.

K_1 = 0.72

STEP 2: Select the appropriate stability coefficient for riprap.

C_S = 0.3

STEP 3: Compute vertical velocity factor.

C_V = 1.47

STEP 4: Compute local velocity on the side slope for a natural channel.

V_{des} = 9.57 *ft/s*

STEP 5: Compute the d_{30} size using equation provided above.

d_{30} = 0.85 *ft*

STEP 6: Compute the d_{50} size using equation provided above.

d_{50}* = 12.3 *in* — **NOTE: Choose next larger size from Table 873.3A.*

d_{50} = 15.0 *in* — ***Class IV Nominal RSP Class per Caltrans HDM Table 873.3A***

STEP 7: Layer thickness. [Choose the larger of the two.]

$1.5d_{50}$ = 22.5 *in*

d_{100} = 30 *in* — **RSP layer thickness (T) will be 30 inches.**

STEP 8: Determine RSP class per ***Caltrans 2015 Standard Specifications*** .

1/4 T gradation class, method B placement with Class 8 fabric

MARK THOMAS