

**FINAL DRAINAGE REPORT FOR  
WATERBURY FILING NO. 1  
EL PASO COUNTY, COLORADO**

**PCD FILE NO:  
SF237**

**DECEMBER 2024**

Prepared For:

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**DESIGN ENGINEER'S STATEMENT:**

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

\_\_\_\_\_  
Quentin Armijo, P.E. 37170                      Date  
On behalf of Terra Nova Engineering, Inc.

**OWNER/DEVELOPER'S STATEMENT:**

I, the owner/developer have read and will comply with all of the requirements specified in this drainage report and plan.

\_\_\_\_\_  
Authorized Signature

\_\_\_\_\_  
Date

Andrew R. Klein Authorized Representative  
Printed Name, Title

ACM ALF VIII JV SUB II LLC  
Business Name

4100 E. Mississippi Ave., Ste. 500, Denver, CO 80246  
Address

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**EL PASO COUNTY:**

Filed in accordance with the requirements of the Drainage Criteria Manual, Volumes 1 and 2, El Paso County Engineering Criteria Manual and Land Development Code as amended.

\_\_\_\_\_  
Joshua Palmer, P.E.  
County Engineer / ECM Administrator  
Conditions:

\_\_\_\_\_  
Date

# **FINAL DRAINAGE REPORT FOR WATERBURY FILING NO. 1 EL PASO COUNTY, COLORADO**

## **INTRODUCTION**

### ***PURPOSE***

The purpose of this Final Drainage Report is to identify and analyze the proposed drainage patterns, determine proposed runoff quantities, size drainage structures for conveyance of developed runoff based upon the overall development of single-family homes along with all the supporting infrastructure, while following the guidelines of the 4-step process.

This site was previously submitted as Waterbury Phase 1 Preliminary Plan with 3 separate filings by Classic Consulting Engineers & Surveyors, LLC. The Final Drainage Report for Filing 1 along with the construction drawings were approved in September of 2016 by EL Paso County Development Services and the Final Drainage Report for Filing 2 along with the construction drawings were submitted for review in September of 2017 and comments given back in September of 2017. Filing 3 had been preliminary designed but nothing submitted to EL Paso County. Since this time the owner had revised the lot layout and removed the alleys shown in Filing 1. All the public roadways have remained the same with the exception of the ROW for Saybrook Road from Stapleton to Bayshore Way, where it changes from 65' to 89'. With these changes El Paso County Development Services requested that we submit a new PUD and Preliminary Plan and the associated MDDP for these revisions. An Early Grading Permit was also submitted. These have been approved and this Final Drainage Report is being submitted with the Final Plat and Construction drawings. The new PUD was processed as Waterbury Filings 1 & 2 but will now be platted as Waterbury Filing 1 along with the appropriate construction drawings. The overall proposed drainage patterns do not differ much and follow the previous studies closely.

The Waterbury site lies within the Geick Ranch and the Haegler Drainage Basins, storm runoff drains southerly via 2 existing natural waterways, one bordering the site on the west (Haegler Drainage Basin) and one on the east (Geick Ranch Drainage Basin). The "Haegler Drainage Basin Planning Study" was prepared by URS and approved in June of 2009. Drexel Barrel & Co prepared the "Geick Ranch Drainage Basin Planning Study" submitted for approval February 2008 but it has yet to be

approved by El Paso County, and therefore there are no drainage fees in this basin. In the Haegler DBPS it is noted that “a portion of the Haegler Ranch as delineated by the County map was found to be part of the Geick Ranch Drainage Basin at Judge Orr Road, due to a lack of a roadway culvert at the crossing. This is excluded from the Haegler Ranch DBPS and is included as part of the Geick Ranch DBPS, per the County.” These 2 channels eventually drain to Black Squirrel Creek and ultimately the Arkansas River.

### ***PROJECT CHARACTERISTICS***

Waterbury Filing 1 plat consists of 198 single family lots on 61.87 acres and is part of a larger development of 322.0 acres to be developed over time and in multiple filings. A PUD Development Plan, Zoning and Conceptual plans have all been previously processed and approved with El Paso County. The area of disturbance of 74.33 acres is larger than the platted area due to offsite drainage improvements and street improvements.

The site is in the SW 1/4 of Sections 28, SE ¼ 29 & NW 1/4 33, Township 12 South, Range 64 West of the 6<sup>th</sup> Principal Meridian within El Paso County, Colorado. The site is bounded to the west by natural channel and 4-Way Ranch Filing No. 1. To the south by Stapleton Drive. To the north by unplatted land consisting of future Waterbury Filings, and to the west by a natural channel unplatted land consisting of future Waterbury Filings (See vicinity map, Appendix A).

The site consists of 100% Columbine Gravelly (19) per the USDA, NRCS web soil survey. The hydrologic soil group “A” was used to represent the soil types and determine the onsite basin overland flow. (See map in appendix)

The study area consists of undeveloped land that has existing vegetation consisting of established native grasses. A ridge running north to south splits the site with the west 1/3 draining southwest with average slopes of 0% to 3% and the remaining 2/3 drains southwest with average slopes of 0% to 3%. There are no existing on-site improvements.

The site has been analyzed in several approved studies including the following “Revision to the MDDP for Meridian Ranch, EL Paso County, Colorado”, approved October 2005, and prepared by PBS&J. “Final Drainage Report for 4-Way Ranch Phase 1” by JR Engineering Dated March 2006.

The “Geick Ranch Drainage Basin Planning Study” dated February 2008, and prepared by Drexel Barrel & Co. The “Preliminary/Final Drainage Report for Meridian Ranch filing No. 3” by Tech Contractors, November 2011. The “Master Development Drainage Plan, 4-Way Ranch – Phase 1” by Advanced Design Professionals, Inc. dated January 2012. The “Preliminary Drainage Report for Waterbury (Phase 1 Preliminary Plan) dated June 2013 by Classic Consulting analyzes this area in more detail and then Classic followed up with the “Final Drainage Report for Waterbury Filing No. 1” dated September 2016 which studied a portion of the area now being developed. Kiowa Engineering also prepared a 2004 LOMR (04-08-0012).

As-built field survey data is the basis for the design of the drainage basins.

## **FLOODPLAIN STATEMENT**

A portion of this site along the western edge is within a designated F.E.M.A. floodplain, as determined by Flood Insurance Rate Map No. 08041C0552G December 7, 2018 (see appendix). The floodplain is shown on the proposed Drainage Map in the appendix along with the FEMA Firmette. Lots from Filing 1 abut the channel with rear lots lines, but are set to be outside of the FEMA floodplain. As mentioned in the previously approved “Final Drainage Report for Waterbury Filing 1” dated September 2016 prepared by Classic Consulting Engineering & Surveying the floodplain was determined by Kiowa Engineering in a 2004 LOMR (04-08-0012) using a HEC-RAS analysis modeling developed flows along the channel from the 3-42” culverts under Eastonville Road south to the existing stock pond (Design Point 13) south of Stapleton Drive with proposed and existing improvements such as the proposed 42” dual culverts located at the Gilbert Road crossing and existing dual 4’ x 8’ box culverts at Stapleton Drive. A CLOMR will need to be submitted and approved by FEMA as *“the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will increase the water surface elevation of the base flood more than one-half (1/2) foot at any point within the community.”*

The Base Floodplain Elevations are shown on the Final Plat and based upon the HECRAS model discussed below in the West Channel Developed Analysis section (see appendix for HEC-RAS model). Elevations have also been provided on the east channel but it is not currently a FEMA

floodplain.

## **HYDROLOGIC ANALYSIS**

The Drainage Criteria Manual El Paso County (DCMEPC), dated January 2015 was the resource used in this analysis. Runoff was calculated using the Rational Method for developed conditions (see appendix). The DCM EPC Update includes the City of Colorado Spring's DCM Chapter 6. Runoff coefficients were calculated using weighted impervious values for each specific basin.

### ***EXISTING CONDITIONS***

In the existing condition runoff sheet flows southwest and southeast overland to the existing channels on the west and east side of the site. Below is a description of the existing condition's Design Points, Basins and site runoff.

The geotechnical report states that groundwater was encountered at a depth of 6.5' in some locations. In the proposed conditions mitigation efforts are discussed for dealing with the shallow groundwater.

There are 4 offsite basins that drain existing runoff onto the site from the north under Eastonville Road through culverts. There is also un-platted open space just north of the proposed Waterbury Filing No. 1.

At Design Point 10A 3-42" RCP that routes runoff from a temporary sediment pond south onto the property (Basin OS-5). The "Preliminary/Final Drainage Report for Meridian Ranch Filing No. 3" and shows flows of  $Q_5 = 28$  cfs,  $Q_{100} = 153$  cfs while the Meridian Ranch MDDP shows a 100-year flow of 185 cfs. This larger flow of 185 cfs is used in the HEC-RAS model for downstream channel analysis and culvert design. As mentioned above in the Floodplain Statement section the natural channel along the west side of the site is a recognized FEMA floodplain. This channel in the Haegler Creek Basin drains south to Stapleton Drive where dual 4' high x 8' wide concrete box culverts route the water south in its natural path.

Design Point EX1A consist of onsite Basin EXA's 9.62 acres and offsite Basin OS-5's 6.74 acres, which both consist of undeveloped open space prairie and the FEMA flood channel and the runoff from Design Point EX10A mentioned above travel in the channel south to the northern boundary of

our site. The combined flow from these upstream basins and onto our site is  $Q_5 = 30$  cfs,  $Q_{100} = 202$  cfs.

Design Point EX1 consist of onsite Basin EXA's 9.62 acres and offsite Basin OS-5's 6.74 acres, which both consist of undeveloped open space prairie and the FEMA flood channel and the runoff from Design Point EX10A mentioned above travel in the channel south to the southern boundary of our site. The combined flow from these upstream basins and our onsite basins that contribute to the flow is  $Q_5 = 33$  cfs,  $Q_{100} = 219$  cfs. This report does not analyze the flow coming from the adjacent Subdivision as the culverts were previously sized and installed in the approved Classic Consulting "Final Drainage Report for Waterbury Filing No. 1" dated September 2016.

Design Point EX2 is a point at the southern boundary of Filing 1 where runoff ( $Q_5 = 1$  cfs,  $Q_{100} = 9$  cfs) from Basin EXB's 4.09 acres of undeveloped prairie flow into Stapleton Road.

Design Point EX3A consists of the runoff ( $Q_5 = 0$  cfs,  $Q_{100} = 1$  cfs) from Basin OS-4's 0.29 acres that is directed south onto the site and Basin EXC.

Design Point EX3 consists of a shallow swale that leaves the site at the southeast boundary. Runoff ( $Q_5 = 0$  cfs,  $Q_{100} = 1$  cfs) from Basin OS-4's 0.29 acres is directed south onto Basin EXC. The runoff ( $Q_5 = 7$  cfs,  $Q_{100} = 45$  cfs) from Basin EXC's 24.80 acres is combined with the Basin's OS-4. The combined runoff ( $Q_5 = 7$  cfs,  $Q_{100} = 45$  cfs) is directed offsite and shortly later in the existing channel in the Geick Ranch Basin.

Design Point EX4A is a point at the northern boundary of Filing 1 where runoff ( $Q_5 = 0$  cfs,  $Q_{100} = 2$  cfs) from Basin OS-3's 1.11 acres of undeveloped prairie flows south onto the site and Basin EXD.

Design Point EX4 is a point at the eastern boundary of Filing 1 where runoff ( $Q_5 = 0$  cfs,  $Q_{100} = 2$  cfs) from Basin OS-3's 1.11 acres of undeveloped prairie flows south onto Basin EXD's 15.87 acres ( $Q_5 = 5$  cfs,  $Q_{100} = 31$  cfs). The combined flow ( $Q_5 = 5$  cfs,  $Q_{100} = 33$  cfs) travels south and drains into the existing channel along the eastern boundary.

At Design Point EX10 an existing 30" CMP culvert (corresponds to DP10 in the FDR) that drains from north to south under Eastonville Road (Basin OS-8) onto the undeveloped open space north (Basin OS-2) of the proposed Filing 2 layout. The Meridian Ranch MDDP states the runoff is  $Q_5 = 5$  cfs,  $Q_{100} = 11$  cfs.

Design Point EX5A consists of runoff ( $Q_5 = 3$  cfs,  $Q_{100} = 22$  cfs) from Basin OS-2's 11.40 acres and Design Point EX10 that is directed south onto Basin EXE at the northern boundary of the site. The combined runoff ( $Q_5 = 8$  cfs,  $Q_{100} = 33$  cfs) of the 2 basins is directed onto the site and routed as described below.

Design Point EX5 consists of a swale that leaves the site at the southeast boundary. Runoff ( $Q_5 = 3$  cfs,  $Q_{100} = 22$  cfs) from Basin OS-2's 11.40 acres and Design Point EX10 is directed south onto Basin EXE. The runoff ( $Q_5 = 2$  cfs,  $Q_{100} = 14$  cfs) from Basin EXE's 5.83 acres is combined with Basin's OS-2 & Design Point EX10. The combined runoff ( $Q_5 = 10$  cfs,  $Q_{100} = 44$  cfs) of the 3 basins is directed offsite and into the existing channel in the Geick Ranch Basin.

At Design Point EX9 (Basin OS-9) is an existing 30" culvert (corresponds to DP9 in the FDR) that routes the runoff ( $Q_5 = 8$  cfs,  $Q_{100} = 19$  cfs) under Eastonville Road and onto the open space in Basin OS-1. The runoff ( $Q_5 = 13$  cfs,  $Q_{100} = 85$  cfs) from Basin OS-1's 45.02 acres is routed south via the existing channel located in the Geick Ranch Basin. An analysis found that this drainage channel is a jurisdictional water of the U.S. with associated jurisdictional wetland habitat. Basin EXF's 1.62 acres is a small area consisting of open space prairies located at the northeast corner of the site. Runoff  $Q_5 = 1$  cfs,  $Q_{100} = 4$  cfs) from Basin EXF is directed onto Basin OS-1 along the eastern boundary at Design Point EX6.

Design Point EX7 is a point in the channel that corresponds to the proposed Design Point 30. The combined flow of Basin OS-1, Design Points EX5, EX6, & EX9 at DP EX7 is  $Q_5 = 31$  cfs,  $Q_{100} = 151$  cfs).

Design Point EX7A is a point in the eastern channel that lines up with the beginning of the Waterbury Filing 1 development. The combined flow of Basin OS-1 & EX9 at DP EX7 is  $Q_5 = 21$  cfs,  $Q_{100} =$

104 cfs).

Design Point 13 in this report corresponds to Design Point 13 in Classic Consulting's previously approved "Final Drainage Report for Waterbury Filing 1" dated September 2016. Design Point 13 is an existing Stormwater Quality Pond 3 (SWQ Pond 3) that was an existing stock pond south of Stapleton Drive that has been converted to an EDB and treat 40.4 acres of 4-Way Ranch Filing No. 1 from their Basins OS-5, OS-6, D, E, N 40% of L, 50% of O, Q & basins I, J & N of Waterbury Filing No. 1. The EDB was designed using a 4' x 4' outlet set at 6907.50 with an orifice plate with 1 column of 8-1/8" diameter holes spaced 4" apart. The forebay top is set at 6915.00 with the bottom at 6914.75. The required volume was calculated to be 0.66 ac-ft and the design volume shown is 1.20 ac-ft. The release out of the pond was calculated to be  $Q_5 = 69$  cfs,  $Q_{100} = 396$  cfs (See Classic Consulting Drainage Map in Appendix). This online EDB is no longer considered a viable solution to treating for WQCV for Waterbury Filing 1 basins I, J & N.

### PROPOSED CONDITIONS

The overall site will be developed in several Filings with each filing requiring its own final drainage report. The Proposed Major Basin Descriptions below is for Waterbury Filing 1 development and the preliminary layout of the future filings to the north tributary to the storm drain system and detention ponds in Filing 1. This future area is shown as fully developed to analyze the ultimate storm drain capacity and pond volumes. In the section below labeled Hydrologic Analysis for Filing 1 FDR the interim condition will be discussed and how runoff is captured and routed safely to the proposed private EDB for Filing 1 construction. See the Proposed FDR Drainage Map in the appendix for a visual representation of the below Basin descriptions.

revised to 8" per discussion  
w/ Entech

verify capacity (previously called out as 8")

As mentioned above groundwater can be encountered in some places as shallow as 6.5'. To mitigate this, dewatering will be used by the contractor during construction of the utilities and storm sewer, a 6" active underdrain paralleling the sanitary sewer will collect groundwater and route it to an injection pit located in Tract I. Also, the PUD and GEC show where no basements will be allowed to be built due to high groundwater.

Design Point 1 is a proposed public 10' CDOT TYPE R sump inlet located in the west flowline of Saybrook drive just north of the roundabout. Basin A's 3.39 acres consists of roadway and single-

family development. Runoff ( $Q_5 = 5$  cfs,  $Q_{100} = 12$  cfs) sheet flows into street sections and then is routed south via c&g where the inlet captures all the flow.

Design Point 2 is a proposed public 5' CDOT TYPE R sump inlet located in the west flowline of Saybrook drive opposite of DP 1. Basin C's 0.86 acres is comprised of roadway and single-family development. Runoff ( $Q_5 = 2$  cfs,  $Q_{100} = 4$  cfs) drains overland to the street and then to the inlet where it is fully captured. Pipe run 1 an 18" RCP routes the flow to a junction at DP 1. Pipe Run 2 a public 24" RCP routes the combined flow ( $Q_5 = 7$  cfs,  $Q_{100} = 15$  cfs) of DP 1 & 2 down Saybrook Road and then down Bayshore Drive over to manhole junction in Sandy Neck Way.

Design Point 3 is a proposed public 5' CDOT TYPE R sump inlet located in the east flowline of Sandy Neck Way. Basin B1's 2.30 acres consists of roadway and single-family development. Runoff ( $Q_5 = 4$  cfs,  $Q_{100} = 8$  cfs) is directed south to Design Point 3. The 5' CDOT TYPE R sump inlet captures the entire flow. Pipe run 3 an 18" public RCP storm sewer routes the flow west to a manhole junction with Pipe run 4.

Design Point 4 is a proposed public 10' CDOT TYPE R sump inlet located in the west flowline of Sandy Neck Way opposite of DP 3. Basin B2's 3.58 acres consists of roadway and single-family development. Runoff ( $Q_5 = 6$  cfs,  $Q_{100} = 13$  cfs) is routed to Design Point 4. The 10' CDOT TYPE R sump inlet captures the entire flow. Pipe run 4 a 18" public RCP storm sewer routes the flow west to a manhole junction with Pipe run 3. Pipe run 5 a 24" RCP routes the combined ( $Q_5 = 9$  cfs,  $Q_{100} = 21$  cfs) flow of Pipe runs 3 & 4 south down Sandy Neck Way to the manhole junction with Pipe run 2. Pipe run 6 a public 36" RCP then routes the combined ( $Q_5 = 16$  cfs,  $Q_{100} = 35$  cfs) flow of Pipe runs 2 & 5 south down Sandy Neck Way to a junction at Design Point 5.

Design Point 5 is a proposed public 10' CDOT TYPE R sump inlet located in the flowline of Sandy Neck Way cul-de-sac. Runoff ( $Q_5 = 4$  cfs,  $Q_{100} = 9$  cfs) from Basin F's 2.18 acres consisting of single-family development is directed to the east flow line of Sandy Neck Way and then south to the cul-de-sac bulb low point. Runoff ( $Q_5 = 3$  cfs,  $Q_{100} = 6$  cfs) from Basin H's 1.46 acres consisting of single-family development is directed to the west flow line of Sandy Neck Way and then south to the cul-de-sac bulb low point. The combined flow ( $Q_5 = 7$  cfs,  $Q_{100} = 16$  cfs) at DP 5 is captured in the 10'

CDOT TYPE R sump inlet and then is routed to the pond along with the flow from Pipe Run 6 via a proposed 36" public RCP storm sewer (Pipe run 7,  $Q_5 = 22$  cfs,  $Q_{100} = 48$  cfs) to Design Point 8. If this inlet were blocked, runoff would overtop the curb and flow down the storm drain tract and into the proposed FSD Pond 1 (Design Point 8).

Design Point 6 is a proposed public 5' CDOT TYPE R sump inlet located in the west flowline of Saybrook Road. Runoff ( $Q_5 = 4$  cfs,  $Q_{100} = 8$  cfs) from Basin D's 2.11 acres consisting of single-family development is directed to the low point in Saybrook Road where the entire flow is captured. It is then routed via a proposed 18" public RCP storm sewer (Pipe run 8) to a manhole junction with Pipe run 9.

Design Point 7 is a proposed public 5' CDOT TYPE R sump inlet located opposite of DP 6 in Saybrook Road. Runoff ( $Q_5 = 4$  cfs,  $Q_{100} = 8$  cfs) from Basin E's 2.18 acres consisting of roadway and single-family lots is directed via side lot line swales and C&G to the proposed inlet. The 5' inlet captures all of the flow and Pipe run 9 a public 18" diameter RCP storm sewer routes the flow to a manhole junction at with Pipe run 8. The combined flows ( $Q_5 = 7$  cfs,  $Q_{100} = 16$  cfs) of Pipe runs 8 & 9 are routed south down Saybrook Road in Pipe run 10 a public 24' diameter RCP to the proposed FSD Pond 1 Design (Design Point 8).

Design Point 7A is a proposed public 5' CDOT TYPE R at-grade inlet located in the east flowline of Saybrook Road at the south boundary. Runoff ( $Q_5 = 1$  cfs,  $Q_{100} = 3$  cfs) from Basin G1's 0.53 acres consisting of single-family development is directed to the at-grade inlet. The flow captured is  $Q_5 = 1$  cfs,  $Q_{100} = 2$  cfs, while the flow by is  $Q_5 = 0$  cfs,  $Q_{100} = 1$  cfs. The captured flow is then routed via a proposed 18" public RCP elliptical storm sewer (Pipe run 10A) to a Design Point 7B. The flow by is routed into Stapleton Drive and the west into the channel via an asphalt rundown

Design Point 7B is a proposed public 5' CDOT TYPE R at-grade inlet located opposite of DP 7A in Saybrook Road. Runoff ( $Q_5 = 2$  cfs,  $Q_{100} = 4$  cfs) from Basin G2's 0.69 acres consisting of roadway and single-family lots is directed via side lot line swales and C&G to the proposed inlet. The flow captured is  $Q_5 = 2$  cfs,  $Q_{100} = 2$  cfs, while the flow by is  $Q_5 = 0$  cfs,  $Q_{100} = 2$  cfs. Pipe run 10B a public 24" diameter RCP storm sewer routes the combined flows ( $Q_5 = 9$  cfs,  $Q_{100} = 20$  cfs) of Pipe runs 10,

10A & Design Point 7B are routed west to the proposed FSD Pond 1 Design (Design Point 8). The flow by is routed into Stapleton Drive and the west into the channel via an asphalt rundown.

Design Point 8 is a proposed private Full Spectrum Detention Basin called FSD Pond 1. Design Points 1-7B are routed to the pond and treated for Water Quality and Detention along with Basin K's 3.06 acres consisting mainly of the EDB area and rear yards. Runoff ( $Q_5 = 3$  cfs,  $Q_{100} = 11$  cfs) sheet flows into the EDB. The basins tributary to Design Point 8 are Basins A, B1, B2, C, D, E, F, G1, G2, H & K with a total area of 22.34 acres. The 100-year effective impervious area of 51.9% was calculated using UD-BMP Version 3.07 IRF spreadsheet. This information was entered into the UD-Detention\_v4.06 spreadsheet and the calculation yielded a required a WQCV of 0.394 ac-ft, a EURV of 0.957 ac-ft and a 100-year total required volume of 2.127 ac-ft. The top of pond is set at 6930.00, with the bottom of pond at 6923.50. The pipes and swales to the pond discharge into two concrete forebays (3% WQCV see calcs in appendix) with 18" high walls and a 3" notch to release minor flows into 2' wide concrete trickle channel. The trickle channel directs runoff to the proposed concrete micro-pool at the surcharge elevation of 6923.83. The bottom of the micro-pool is set at 6921.00 and the top set at 6923.50. A proposed 4' x 4' grate set at 6927.10 on top of a concrete outlet box, an outlet plate on the front to meet the 3-orifice requirement and an 24" outlet pipe with no restrictor will route all runoff from the pond. The metal plate will have 1 column containing 3 rows of 2" diameter orifice holes spaced 13.80" apart starting at 6923.50. The WQCV release is 0.20 cfs with a ponding elevation of 6925.29 and takes 40 hours to release. The EURV release is 0.5 cfs, with an elevation of 6926.94 and takes 73 hours to release. The 100-year detention release is 14.6 cfs, with an elevation of 6927.77 and takes 78 hours to release. A 30' long riprap emergency spillway set at 6928.00 will allow the 100-year developed peak in flow ( $Q_{100} = 59.9$  cfs) with a depth of 0.72' (top of water = 6928.72) to be routed west into the natural channel. 1.00' freeboard is provided (see appendix for all pond calcs). The spillway and downhill slope will be armored with d50= L 9" soil riprap buried 18" deep and a concrete cutoff wall. Pipe Run 10C a private 24" RCP will route the pond release into the existing natural channel. (See Pond Calculations in appendix).

El Paso County is in coordination with 2 consultants HR Green and Stanley Consultants Inc. to widen Eastonville Road and add a Roundabout at the intersection of Londonderry. With these public improvements new storm sewer inlets and pipes will route the runoff from Eastonville and the

previous culverts to the required detention and water quality ponds. The design shows 1 Full Spectrum Detention Pond and 1 Water Quality Pond. The timing of these projects is ahead of Waterbury's schedule and therefore we are assuming these improvements will be installed prior to our development and are shown as existing in our developed condition. The 2 drainage reports "Final Drainage Report Eastonville Road Corridor – Phase 1 El Paso County" submitted November 2024, prepared by Stanley consultants and "Eastonville Road – Londonderry Drive to Rex Road Segment 1 Improvements Final Drainage Report" submitted October 2024, prepared by HR Greene for the projects are referenced for the flow entering our site.

Design Point 9 is an existing 30" RCP culvert under Eastonville Road where Offsite Basin OS-9 discharges onto offsite Basin OS-2. Per the Eastonville Road – Londonderry Drive to Rex Road Segment 1 Improvements Final Drainage Report runoff ( $Q_5 = 3.6$  cfs,  $Q_{100} = 24.2$  cfs, see Design Point 3 summary from aforementioned report) from Basin OS-9's 12.33 acres is routed south under Eastonville Road in the existing 30" RCP culvert (Pipe run 41) to an existing channel. In Waterbury's design a manhole junction will combine this flow and the flow from the release of water quality pond at DP 9A.

Design Point 9A is an existing public Water Quality Pond. Runoff ( $Q_5 = 4$  cfs,  $Q_{100} = 7$  cfs) to the WQ pond was taken from the Eastonville Road – Londonderry Drive to Rex Road Segment 1 Improvements Final Drainage Report (Pond SFB A). The release rate from the pond ( $Q_5 = 0.06$  cfs,  $Q_{100} = 1$  cfs) is routed to the same channel via an 18" pipe. The Waterbury design will extend this 18" RCP (Pipe run 42) to the manhole junction with Pipe run 41. The combined flow ( $Q_5 = 4$  cfs,  $Q_{100} = 25$  cfs) from Pipe runs 41 & 42 is routed via Pipe run 43 a public 24" RCP to a manhole junction with Pipe run 44 in a future public ROW.

Design Point 10 is an existing Full Spectrum Detention Pond Runoff ( $Q_5 = 5$  cfs,  $Q_{100} = 12$  cfs) to the WQ pond was taken from the Final Drainage Report Eastonville Road Corridor – Phase 1 El Paso County (Pond E). The release rate from the pond ( $Q_5 = 0.3$  cfs,  $Q_{100} = 5$  cfs) is routed to an existing channel via an 18" pipe. The Waterbury design will reroute this 18" RCP (Pipe run 44) to the manhole junction with Pipe run 43 in a future public ROW. The combined flow ( $Q_5 = 5$  cfs,  $Q_{100} = 30$  cfs) from Pipe runs 43 & 44 is routed via Pipe run 45 a public 30" RCP downstream and discharged into

the same existing channel This is shown as OS-8 on the Proposed Drainage Map.

Swale E-E is a temporary 4' wide, 2' deep trapezoidal swale designed to catch runoff in the interim condition prior to the upstream development of the future Waterbury Filings just north of Filing 1. This swale will capture the combined undeveloped overland runoff ( $Q_5 = 8$  cfs,  $Q_{100} = 33$  cfs) from Existing Basins OS-2 & OS-8. The runoff is routed east along the northern boundary to the existing eastern channel and released onto a Type VL d50=6" riprap pad 16' Wide x 20' long with a bury depth = 1'. This swale will remain in place to protect the downstream Lots 113-118 until the future Waterbury is developed.

Design Point 10A is where existing 3-42" RCP culverts from the temporary Meridian Ranch Pond cross under Eastonville Road per the "Preliminary/Final Drainage Report for Meridian Ranch Filing No. 3" and shows flows of  $Q_5 = 28$  cfs,  $Q_{100} = 153$  cfs while the Meridian Ranch MDDP shows a 100-year flow of 185 cfs. The pipes discharge onto Offsite Basin OS-5. Offsite Basin OS-5's 5.64 acres consists of future Waterbury rear lots, open space and the natural channel. Runoff ( $Q_5 = 10$  cfs,  $Q_{100} = 23$  cfs) from OS-5 sheet flows to the channel. The flow is then routed south to Design Point 11.

Design Point 13 in this report corresponds to Design Point 13 in Classic Consulting's previously approved "Final Drainage Report for Waterbury Filing 1" dated September 2016. Design Point 13 is an existing Stormwater Quality Pond 3 (SWQ Pond 3) that was an existing stock pond south of Stapleton Drive that has been converted to an EDB and treat 40.4 acres of 4-Way Ranch Filing No. 1 from their Basins OS-5, OS-6, D, E, N 40% of L, 50% of O, Q & basins I, J & N of Waterbury Filing No. 1. The EDB was designed using a 4' x 4' outlet set at 6907.50 with an orifice plate with 1 column of 8-1/8" diameter holes spaced 4" apart. The forebay top is set at 6915.00 with the bottom at 6914.75. The required volume was calculated to be 0.66 ac-ft and the design volume shown is 1.20 ac-ft. The release out of the pond was calculated to be  $Q_5 = 69$  cfs,  $Q_{100} = 396$  cfs (See Classic Consulting Drainage Map in Appendix). This online EDB is no longer considered a viable solution to treating for WQCV for Waterbury Filing 1 basins I, J & N.

Design Point 11 is a proposed crossing under the proposed continuation of Gilbert Drive with dual

42" RCP culverts. Basin I's 4.97 acres consists of rear lots of 131-137, & 150-162 and the natural channel. Runoff ( $Q_5 = 4$  cfs,  $Q_{100} = 16$  cfs) sheet flows to the channel and is directed south to Design Points 11. As mentioned above Kiowas Engineering did a HEC-RAS analysis modeling developed flows along the channel. Tera Nova Engineering has done a new HEC-RAS analysis modeling developed flows. This information can be found under the Hydraulic analysis section below. The combined flow of Design Point 10A along with Basins OS-5 and I is  $Q_5 = 34$  cfs,  $Q_{100} = 216$  cfs. This flow is routed south under Gilbert drive and onto Basin J. Basin I's runoff as mentioned above was intended to be treated downstream in the existing EDB at Design Point 13. This online EDB is no longer considered a viable solution for treating for WQCV due to new regulations. Basin I's rear 20' of several lots consists of the rear setback where no structure can be built with this restriction the entire acreage consists of undeveloped pervious area. Therefore, this Basin is listed as excluded from Water Quality per the exclusion in ECM Appendix I.7.1.B.7 - Sites with Land Disturbance to Undeveloped Land that will Remain Undeveloped.

Design Point 12 is a proposed 18" RCP culvert under Gilbert Drive that routes the runoff ( $Q_5 = 2$  cfs,  $Q_{100} = 4$  cfs) from offsite Basin OS-6's 1.06 acres that is comprised of the eastern half of Thatcher Court located in 4-Way Ranch Filing 1 to the existing natural channel.

Basin J's 1.44 acres is comprised of the 20' of rear lots of 156-162 and the existing channel along the west boundary. Runoff ( $Q_5 = 3$  cfs,  $Q_{100} = 6$  cfs) sheet flows into the channel and then is routed south to Design Point 13, an on-line existing stock pond that was converted to an EDB to provide water quality for part of 4-Way Ranch Filing No. 1 and Waterbury Basins I, J & N. As mentioned above this online EDB is no longer considered a viable solution for treating for WQCV. Basin I's rear 20' of several lots consists of the rear setback where no structure can be built with this restriction the entire acreage consists of undeveloped pervious area. Therefore, this Basin is listed as excluded from Water Quality per the exclusion in ECM Appendix I.7.1.B.7 - Sites with Land Disturbance to Undeveloped Land that will Remain Undeveloped .

Design Point 11A is a point at the south end of the property used to show the total flow in the west channel. The total runoff ( $Q_5 = 37$  cfs,  $Q_{100} = 222$  cfs) from Basin J's area and Design Point 11 is used in modeling analysis of the stream in Hydraulic section below.

Basin N's 0.22 acres is comprised of the proposed extension of Gilbert Road from 4-Way Ranch into Waterbury. Runoff ( $Q_5 = 1$  cfs,  $Q_{100} = 1$  cfs) sheet flows into the channel and then is routed south to Design Point 13, an on-line existing stock pond that is being converted to an EDB to provide water quality for part of 4-Way Ranch Filing No. 1 and Waterbury Basins I, J & N. Once again, this online EDB is no longer considered a viable solution to treating for WQCV. Therefore, the UD-BMP Version 3.07 Runoff Reduction was used to show that this area can be treated using Runoff Reduction. The results show that we have a 100% WQCV reduction for Basin N. A Drainage Easement will need to be placed over these areas on the Final Plat with the note "*No lots shall have any impervious improvements constructed within the rear setback (i.e. patios, hardscape, recreational facilities, etc.) for Lots 40-42, 156, & Tract C*". The area will be vegetated with the final GEC plan. The Preliminary Plan/PUD also places impervious restrictions on this Basin area and the O and M manual also lists how to maintain this space. This acreage of 0.35 is within the allowable limits.

In the previously approved "Final Drainage Report for Waterbury Filing No. 1" by Classic Consulting it was stated that there were 3 Stormwater Quality Ponds that needed to be provided for the adjacent 4-Way Ranch per conditions set forth by the Board of County Commissioners at approval of the Waterbury PUD Development Plan. Because there have been no changes to the tributary areas to these 3 Ponds and they have already been designed and constructed. The original approved calculations and results can be found in the appendix of the original report by Classic Consulting (EPC Review No. SF-13-012) along with the Basin Exhibit Map.

Basin M1's 0.99 acres is comprised of the rear yards of lots 35-39 & open space tract along Stapleton Drive along. Runoff ( $Q_5 = 2$  cfs,  $Q_{100} = 4$  cfs) sheet flows over the 20' back yard setback and open space tract onto Stapleton Drive and then is routed east via curb & gutter to an existing storm drain system from here it is routed to the eastern channel located in the Geick Ranch Basin. Basin M1 contains the rear 20' of several lots which consists of the rear setback where no structure can be built. The entire acreage consists of undeveloped pervious area. Therefore, this Basin is listed as excluded from Water Quality per the exclusion in ECM Appendix I.7.1.B.7 - Sites with Land Disturbance to Undeveloped Land that will Remain Undeveloped.

Basin M2's 0.35 acres is comprised of the rear yards of lots 40-42 adjacent to undeveloped land east of the site. Runoff ( $Q_5 = 1$  cfs,  $Q_{100} = 2$  cfs) sheet flows from the back yard onto the undeveloped land. This rear lot area is not treated for water quality but is pervious area. The UD-BMP Version 3.07 Runoff Reduction was used to show that this area has 100% WQCV reduction based upon the Unconnected Impervious Area being routed over the Receiving Pervious Area. Only developed land in Basin M2 is the rear 40' which 20' of that consists of the rear setback where no structure can be built. A Drainage Easement will need to be placed over these areas on the Final Plat with the note *"No lots shall have any impervious improvements constructed within the rear setback (i.e. patios, hardscape, recreational facilities, etc.) for Lots 40-42, 156, & Tract C"*. The area will be vegetated with the final GEC plan. The Preliminary Plan/PUD also places impervious restrictions on this Basin area and the O and M manual also lists how to maintain this space. This acreage of 0.35 is within the allowable limits.

Basin P's 0.70 acres is comprised of open space Tract I adjacent to undeveloped land east of the site. Runoff ( $Q_5 = 0$  cfs,  $Q_{100} = 2$  cfs) sheet flows from the open space onto the undeveloped land. The entire acreage consists of undeveloped pervious area. Therefore, this Basin is listed as excluded from Water Quality per the exclusion in ECM Appendix I.7.1.B.7 - Sites with Land Disturbance to Undeveloped Land that will Remain Undeveloped.

Design Point 14 is a low point in the knuckle of Beech Creek Drive with a proposed public 10' CDOT TYPE R sump inlet. Runoff ( $Q_5 = 6$  cfs,  $Q_{100} = 13$  cfs) from Basin L1's 3.79 acres consisting of roadway and single-family lots is directed via side lot line swales and C&G to the proposed inlet. The 10' inlet captures all of the flow and Pipe run 11 a public 24" diameter RCP storm sewer routes the flow to a manhole junction with Pipe run 12.

Design Point 15 is a proposed public 5' CDOT TYPE R sump inlet opposite of DP 14 in Beech Creek Drive Runoff ( $Q_5 = 3$  cfs,  $Q_{100} = 7$  cfs) from Basin L2's 2.00 acres consisting of roadway and single-family lots is directed via side lot line swales and C&G to the proposed inlet. The 5' inlet captures all of the flow and Pipe run 12 a public 18" diameter RCP storm sewer routes the flow to a manhole junction with Pipe run 11. Pipe run 13 a 30" RCP routes the combined flow ( $Q_5 = 9$  cfs,  $Q_{100} = 19$  cfs) of Pipe Runs 11 & 12 north in Beech Creek Drive to a manhole junction with Pipe run 14.

Design Point 16 is a proposed public 5' CDOT TYPE R sump inlet located in the proposed western half of the private street of Beech Creek Drive. Runoff ( $Q_5 = 5$  cfs,  $Q_{100} = 10$  cfs) from Basin O1's 2.82 acres consisting of roadway and single-family lots is directed via side lot line swales and C&G to the proposed inlet. The 5' inlet captures all of the flow and Pipe run 14 a public 24" diameter RCP storm sewer routes the flow to a manhole junction with Pipe run 13. Pipe run 15 a 36" RCP routes the combined flow ( $Q_5 = 13$  cfs,  $Q_{100} = 29$  cfs) of Pipe Runs 13 & 14 west to a manhole junction with Pipe run 16.

Design Point 17 is a proposed public 5' CDOT TYPE R sump inlet located opposite of DP 16 in Beech Creek Drive. Runoff ( $Q_5 = 1$  cfs,  $Q_{100} = 2$  cfs) from Basin O2's 0.71 acres consisting of roadway, parking, roof and landscape area sheet flows to the east flowline of Beech Creek Drive and to the proposed inlet. After all the flow is captured by the inlet Pipe run 16 routes the runoff to a junction with Pipe run 15. Pipe run 17 routes the combined flows ( $Q_5 = 15$  cfs,  $Q_{100} = 34$  cfs) of Pipe runs 15, 16, 39 & 40 and is routed west offsite via a private 36" diameter RCP to Design Point 18 a proposed private temporary EDB (FSD Pond 2) to be in place until future final design of a pond accommodates the future Waterbury development tributary to this pond. The alignment and outlet of the proposed 36" pipe along with the concrete forebay are to remain as is when the permanent FSD pond is revised and enlarged to accommodate the future development. In the future design permanent trickle channels, additional forebays, micro pools, outlet structures, berms and the emergency overflow weir will be designed built to be permanent.

Design Point 33 consists of 4-18" diameter area inlets located at the rear lot line in the downhill side yard swale. A 1' high berm along the back of Lots 46-49 in Basin O3's 0.45 acres will keep runoff ( $Q_5 = 1$  cfs,  $Q_{100} = 3$  cfs) from back yards and rear lot downspouts from sheet flowing into the existing wetlands untreated. Each area inlet can capture 1.40 cfs based upon a head of 0.25'. Therefore the 4 inlets can capture all of the flow. Pipe run 39 a 12" HDPE will route the captured flow to pipe run 17.

Design Point 34 consists of 3-18" diameter area inlets located at the rear lot line in the downhill side yard swale. A 1' high berm along the back of Lots 43-45 in Basin O4's 0.38 acres will keep runoff ( $Q_5 = 1$  cfs,  $Q_{100} = 2$  cfs) from back yards and rear lot downspouts from sheet flowing into the existing

wetlands untreated. Each area inlet can capture 1.40 cfs based upon a head of 0.25'. Therefore the 3 inlets can capture all of the flow. Pipe run 40 a 12" HDPE will route the captured flow to pipe run 17.

Design Point 18 is a proposed temporary private Full Spectrum Detention Basin called FSD Pond 2. This pond will be reevaluated and resized when future filings to the east and north are final designed. There are no set time frames at this time to when the final design of the permanent pond will happen but at that time the alignment and outlet of the proposed 36" pipe (Pipe Run 17) along with the concrete forebay are to remain as is when the permanent FSD pond is revised and enlarged to accommodate the future development. In the future design permanent trickle channels, additional forebays, micro pools, outlet structures, berms and the emergency overflow weir will be redesigned and updated as permanent. In the time being Design Points 14-17 are routed to the pond and treated for Water Quality and Detention along with the Basin OS-4's 10.90 acres consisting of the EDB area and undeveloped upstream tributary area. Runoff ( $Q_5 = 2$  cfs,  $Q_{100} = 16$  cfs) from Basin OS-4 sheet flows into the EDB. The basins tributary to Design Point 18 are L1, L2, O1, O2 and OS-4 with a total area of 21.05 acres. The 100-year effective impervious area of 25.76% was calculated using UD-BMP Version 3.07 IRF spreadsheet. This information was entered into the UD-Detention\_v4.06spreadsheet and the calculation yielded a required a WQCV of 0.241 ac-ft, a EURV of 0.278 ac-ft and a 100-year detention total required volume of 1.026 ac-ft. The top of pond is set at 6906.00, with a bottom of pond at 6899.00. The pipes and swales to the pond discharge into a concrete forebay (3% WQCV see calcs in appendix) with 18" high walls and a 3" notch to release minor flows into 2' wide concrete trickle channel. The trickle channel directs runoff to the proposed concrete micro-pool at the surcharge elevation of 6899.33. The bottom of the micro-pool is set at 6896.50 and the top set at 6899.00. A proposed 4' x 4' grate set at 6902.10 on top of a concrete outlet box, an outlet plate on the front to meet the 3-orifice requirement and an 18" outlet pipe with no restrictor plate will route all runoff from the pond. The metal plate will have 1 column containing 3 rows of 1-1/4" diameter orifice holes spaced 12.4" apart starting at 6899.00. The WQCV release is 0.10 cfs with a ponding elevation of 6901.21 and takes 40 hours to release. The EURV release is 0.2 cfs, with an elevation of 6902.09 and takes 60 hours to release. The 100-year detention release is 14.8 cfs, with an elevation of 6902.78 and takes 60 hours to release. A 20' long riprap emergency spillway set at 6904.00 will allow the 100-year developed peak in flow ( $Q_{100} = 29.30$  cfs) with a depth of 0.58' (top of water = 6904.58) to be routed west into the natural channel. 1.00' freeboard is provided (see appendix). The spillway and

downhill slope will be armored with d50= VL 6" soil riprap buried 12" deep and a concrete cutoff wall. Pipe Run 17A a private 18" RCP will route the pond release into the existing natural channel. (See Pond Calculations in appendix). When future filings are developed this temporary Pond 2 will be replaced with a permanent Pond as shown in the "Conceptual Drainage Report for Waterbury PUD Plan" prepared by Classic Consulting and dated November 2012.

Design Point 19 is a proposed 10' CDOT TYPE R sump inlet located in the south curb of Muddy Pond Street. Runoff ( $Q_5 = 8$  cfs,  $Q_{100} = 16$  cfs) from Basin OS-Q1's 4.31 acres consists of future single-family development and will be directed via lot line swales and c&g onto Basin Q1. Runoff ( $Q_5 = 3$  cfs,  $Q_{100} = 6$  cfs) from Basin Q1's 1.46 acres is directed to the 10' inlet. The combined flow ( $Q_5 = 8$  cfs,  $Q_{100} = 16$  cfs) is fully captured in the inlet and Pipe run 18 a 24" RCP diameter storm routes the flows to a manhole junction with Pipe run 19.

Design Point 20 is a proposed 5' CDOT TYPE R sump inlet located opposite of DP 19. Runoff ( $Q_5 = 2$  cfs,  $Q_{100} = 4$  cfs) from Basin OS-Q2's 0.96 acres consists of future single-family development and will be directed via lot line swales and c&g onto Basin Q2. Runoff ( $Q_5 = 2$  cfs,  $Q_{100} = 4$  cfs) from Basin Q2's 0.96 acres is directed to the 5' inlet. The combined flow ( $Q_5 = 3$  cfs,  $Q_{100} = 7$  cfs) is fully captured in the inlet and Pipe run 19 an 18" RCP diameter storm routes the flows to a manhole junction with Pipe run 18. Pipe Run 20 a 24" RCP storm routes the combined flow ( $Q_5 = 10$  cfs,  $Q_{100} = 22$  cfs) of Pipe runs 19 & 20 east down Muddy Pond Street to a manhole junction with Pipe run 21.

Design Point 21 is a proposed 10' CDOT TYPE R at-grade inlet located in the north curb of Muddy Pond Street just east of Masonboro Way intersection. Runoff ( $Q_5 = 11$  cfs,  $Q_{100} = 24$  cfs) from Basin OS-R's 6.05 acres consists of future single-family development and will be directed via lot line swales and c&g onto Basin R. Runoff ( $Q_5 = 2$  cfs,  $Q_{100} = 4$  cfs) from Basin R's 1.02 acres is directed to the 10' inlet. The combined flow ( $Q_5 = 12$  cfs,  $Q_{100} = 28$  cfs) is routed to the inlet at Design Point 21 and  $Q_5 = 7$  cfs,  $Q_{100} = 11$  cfs is captured by the at-grad inlet. The bypass flow ( $Q_5 = 5$  cfs,  $Q_{100} = 17$  cfs) at DP 21 travels in the north flow line of Muddy Pond Street to Design Point 22. Pipe run 21 an 18" RCP diameter storm routes the captured flow to a manhole junction with Pipe run 20. Pipe run 22 routes the combined flow ( $Q_5 = 18$  cfs,  $Q_{100} = 36$  cfs) of Pipe runs 20 & 21 east down Muddy Pond Street to a manhole junction with Pipe run 25. The bypass flow ( $Q_5 = 5$  cfs,  $Q_{100} = 17$  cfs) at DP 21

travels in the north flow line of Muddy Pond Street to Design Point 22.

Design Point 22 is a proposed 15' CDOT TYPE R sump inlet located in the west curb of Megansett Way. Runoff ( $Q_5 = 8$  cfs,  $Q_{100} = 18$  cfs) from Basin OS-S1's 5.59 acres consists of future single-family development and will be directed via lot line swales and c&g onto Basin S1. Runoff ( $Q_5 = 3$  cfs,  $Q_{100} = 7$  cfs) from Basin S1's 1.55 acres is directed to the 10' inlet. The combined flow ( $Q_5 = 15$  cfs,  $Q_{100} = 38$  cfs) of Basins OS-S1, S1 & the bypass flow from DP 21 is routed to the low point.

Design Point 23 is a proposed 15' CDOT TYPE R sump inlet located opposite of DP 22. Runoff ( $Q_5 = 0$  cfs,  $Q_{100} = 1$  cfs) from Basin OS-S2's 0.17 acres consists of future single-family development and will be directed via lot line swales and c&g onto Basin S2. Runoff ( $Q_5 = 0$  cfs,  $Q_{100} = 1$  cfs) from Basin S2's 0.13 acres is directed to the 10' inlet. The combined flow at DP 23 is  $Q_5 = 1$  cfs,  $Q_{100} = 1$  cfs. It is presumed that the combined flow ( $Q_5 = 16$  cfs,  $Q_{100} = 39$  cfs) at DP 22 & 23 is evenly split between the 2-15' CDOT TYPE R sump inlets. Pipe run 23 a 24" RCP diameter storm routes the flow ( $Q_5 = 8$  cfs,  $Q_{100} = 19$  cfs) from the inlet at DP 22 to a manhole junction with Pipe run 24. Pipe Run 24 a 24" RCP storm routes the flow ( $Q_5 = 8$  cfs,  $Q_{100} = 19$  cfs) to the manhole junction with Pipe run 23. Pipe Run 25 a 36" RCP routes the combined flow ( $Q_5 = 15$  cfs,  $Q_{100} = 39$  cfs) of Pipe runs 23 & 24 south to a manhole junction with Pipe run 22 in Muddy Pond Street. Pipe run 26 a 36" RCP then routes the combined flow ( $Q_5 = 31$  cfs,  $Q_{100} = 63$  cfs) of Pipe runs 22 & 25 east in Muddy Pond to a manhole junction with Pipe runs 27 & 28.

Design Point 24 is a proposed 5' CDOT TYPE R sump inlet located in the south curb of Muddy Pond Street. Runoff ( $Q_5 = 3$  cfs,  $Q_{100} = 6$  cfs) from Basin T1's 1.42 acres consists of single-family development and will be directed via lot line swales and c&g to the 5' inlet. Pipe run 27 an 18" RCP diameter storm routes the fully captured flow from the inlet to a manhole junction with Pipe runs 26 & 28.

Design Point 25 is a proposed 5' CDOT TYPE R sump inlet located opposite of DP 24. Runoff ( $Q_5 = 1$  cfs,  $Q_{100} = 3$  cfs) from Basin OS-T2's 0.76 acres consists of future single-family development and will be directed via lot line swales and c&g onto Basin T2. Runoff ( $Q_5 = 2$  cfs,  $Q_{100} = 5$  cfs) from Basin T2's 1.23 acres is directed to the 5' inlet. The combined flow at DP 25 is  $Q_5 = 3$  cfs,  $Q_{100} = 7$

cfs. Pipe run 28 an 18" RCP diameter storm routes the fully captured flow from the inlet to a manhole junction with Pipe runs 26 & 27. Pipe run 29 a 42" RCP then routes the combined flow ( $Q_5 = 36$  cfs,  $Q_{100} = 78$  cfs) of Pipe runs 26, 27 & 28 east in Muddy Pond Street and then south down Fish Camp Circle to a manhole junction with Pipe run 30.

Design Point 26 is a proposed 10' CDOT TYPE R sump inlet located in the west curb of Fish Camp Circle near the Knuckle. Runoff ( $Q_5 = 7$  cfs,  $Q_{100} = 16$  cfs) from Basin U1's 4.38 acres consists of single-family development and will be directed via lot line swales and c&g to the 10' inlet. Pipe run 30 a 24" RCP diameter storm routes the fully captured flow from the inlet to a manhole junction with Pipe run 29. Pipe run 31 a 42" RCP transports the combined flow ( $Q_5 = 41$  cfs,  $Q_{100} = 91$  cfs) of Pipe runs 29 & 30.

Design Point 27 is a proposed 5' CDOT TYPE R sump inlet located opposite of DP 26. Runoff ( $Q_5 = 3$  cfs,  $Q_{100} = 7$  cfs) from Basin U2's 1.89 acres consists of future single-family development and will be directed via lot line swales to the 5' inlet. Pipe run 32 an 18" RCP diameter storm routes the fully captured flow from the inlet to a manhole junction with Pipe runs 31.

Design Point 31 consists of 3-18" diameter area inlets located at the rear lot line in the downhill side yard swale. A 1' high berm along the back of Lots 90-92 in Basin V's 0.54 acres will keep runoff ( $Q_5 = 1$  cfs,  $Q_{100} = 3$  cfs) from back yards and rear lot downspouts from sheet flowing into the existing wetlands untreated. Each area inlet can capture 1.40 cfs based upon a head of 0.25'. Therefore the 3 inlets can capture all of the flow. Pipe run 37 a 12" HDPE will route the captured flow to pipe run 33. Pipe run 33 a 42" RCP then routes the combined flow ( $Q_5 = 44$  cfs,  $Q_{100} = 98$  cfs) of Pipe runs 31, 32 & 37 east through a Drainage Tract to FSD Pond 3.

Design Point 32 consists of 2-18" diameter area inlets located at the rear lot line in the downhill side yard swale. A 1' high berm along the back of Lots 88-89 in Basin X's 0.43 acres will keep runoff ( $Q_5 = 1$  cfs,  $Q_{100} = 2$  cfs) from back yards and rear lot downspouts from sheet flowing into the existing wetlands untreated. Each area inlet can capture 1.40 cfs based upon a head of 0.25'. Therefore the 2 inlets can capture all of the flow. Pipe run 38 a 12" HDPE will route the fully captured flow to the north inlet at Design Point 28.

Design Point 28 are 2 proposed 10' CDOT TYPE R sump inlets located in the north and south curb of Sunken Meadow Road. These inlets are offsite in a future phase and will be built within a proposed drainage easement. The offsite curb and gutter in this area will also need to be built along with some asphalt to direct runoff to the 10' inlet. Runoff ( $Q_5 = 3$  cfs,  $Q_{100} = 5$  cfs) from Basin OS-W's 0.57 acres is directed onto basin w. runoff ( $Q_5 = 10$  cfs,  $Q_{100} = 21$  cfs) from Basin W's 5.20 acres is combined with Basin OS-W's and assumed to be evenly split between the 2-10' inlets and fully captured by them. Pipe run 34 a 24" RCP routes the captured runoff ( $Q_5 = 5$  cfs,  $Q_{100} = 11$  cfs) from the south inlet to the north inlet. Pipe run 34A a 30" RCP routes the combined flow ( $Q_5 = 11$  cfs,  $Q_{100} = 24$  cfs) from Pipe run 34 Design Points 32, described above via Pipe run 34A a 30" RCP.

Basin Y's 0.35 acres is comprised of undeveloped open space Tracts adjacent to the existing natural channel along the east side of the site. Runoff ( $Q_5 = 1$  cfs,  $Q_{100} = 2$  cfs) from Basin Y sheet flows east into the channel. The entire acreage consists of undeveloped pervious area. Therefore, this Basin is listed as excluded from Water Quality per the exclusion in ECM Appendix I.7.1.B.7 - Sites with Land Disturbance to Undeveloped Land that will Remain Undeveloped and I.7.1.C.1.a – Less than 1 acres of developed roadway area.

The following Basins are for future Waterbury Filings to the north and east that will be tributary to FSD Pond 3. All the basin descriptions are the same, they are comprised of future single-family development and will be directed via lot line swales and c&g to future storm drain systems the future drain systems will be routed to FSD Pond 3. The exact routes and design have not been finalized at this time but will be with a future Final Drainage Report at the time of development. Below is the summary of the flow and acreage.

Basin OS-1: 11.81 acres, Runoff ( $Q_5 = 18$  cfs,  $Q_{100} = 41$  cfs)

Basin OS-2: 11.53 acres Runoff ( $Q_5 = 16$  cfs,  $Q_{100} = 36$  cfs)

Basin OS-3A: 0.79 acres Runoff ( $Q_5 = 1$  cfs,  $Q_{100} = 3$  cfs)

Basin OS-3B: 5.66 acres Runoff ( $Q_5 = 9$  cfs,  $Q_{100} = 20$  cfs)

Design Point 29 is a proposed private Full Spectrum Detention Basin called FSD Pond 3. basins Q1,

Q2, R, S1, S2, T1, T2, U1, U2, V, 2, X, and Offsite Basins OS-1, OS-2, OS-3A, OS-3B, OS-S1, OS-S2, OS-T2, OS-R, OS-Q1, OS-Q1, and OS-W, along with Basin OS-7's 3.75 acres consisting of the EDB area. Combined runoff ( $Q_5=111$  cfs,  $Q_{100}=270$  cfs) sheet flows into the EDB with a total area of 72.14 acres routed to the pond and treated for Water Quality and Detention. The 100-year effective impervious area of 53.95% was calculated using UD-BMP Version 3.07 IRF spreadsheet. This information was entered into the UD-Detention\_v4.06 spreadsheet and the calculation yielded a required a WQCV of 1.307 ac-ft, a EURV of 3.278 ac-ft and a 100-year total required detention volume of 7.144 ac-ft. The top of pond is set at 6930.00, with a bottom of pond at 6922.00. The pipes and swales to the pond discharge into a concrete forebay (3% WQCV see calcs in appendix) with 30" high walls and a 5" notch to release minor flows into 3' wide concrete tickle channel. The trickle channel directs runoff to the proposed concrete micro-pool at the surcharge elevation of 6922.33. The bottom of the micro-pool is set at 6919.50 and the top set at 6922.00. A proposed 12' x 6' grate set at 6927.05 on top of a concrete outlet box, an outlet plate on the front to meet the 3-orifice requirement and a 36" outlet pipe with no restrictor plate will route all runoff from the pond. The metal plate will have 1 column containing 3 rows of orifice holes spaced 20.16" apart starting at 6922.00. The first hole is 3.5" W x 2" H, the second one is 4.25" W x 2" H, and the third one is 4.5" W x 2" H. The WQCV release is 0.7 cfs with a ponding elevation of 6924.81 and takes 40 hours to release. The EURV release is 1.4 cfs, with an elevation of 6926.76 and takes 77 hours to release. The 100-year detention release is 37.7 cfs, with an elevation of 6927.80 and takes 85 hours to release. An 64' long riprap emergency spillway set at 69287.80 will allow the 100-year developed peak in flow ( $Q_{100}=269.0$  cfs) with a depth of 1.2' (top of water = 6929.00) to be routed west into the natural channel. 1.00' freeboard is provided (see appendix). The spillway and downhill slope will be armored with d50= L 9" soil riprap buried 18" deep and a concrete cutoff wall. Pipe Run 35 a private 36" RCP will route the pond release into the existing natural channel. (See Pond Calculations in appendix).

Design Point 30 is a triple 36" RCP culvert crossing under Sunken Meadow Road. Offsite Basin OS-10's 3.41 acres consists of open space containing the natural channel. Runoff ( $Q_5 = 1$  cfs,  $Q_{100} = 8$  cfs) is directed south through the wetlands to the culverts. Runoff ( $Q_5 = 4$  cfs,  $Q_{100} = 30$  cfs) from the Pipe run 45 that is discharged into the channel and runoff ( $Q_5 = 1$  cfs,  $Q_{100} = 2$  cfs) from Basin Y's 0.35 acres that sheet flow offsite on Basin OS-10 are combined for a flow of  $Q_5 = 6$  cfs,  $Q_{100} = 39$  cfs at DP 30 does not warrant the triple 36" RCP culverts alone but in case of failure in the Pond 3 outlet

runoff from the emergency spillway ( $Q_{100} = 268.3$  cfs) will be safely routed through the triple 36" RCP culverts (See appendix).

To protect receiving water and as part of the "four step process to minimize adverse impacts of urbanization" this site was analyzed in the following manner:

1. Reduce Runoff- The proposed impervious areas on the site are surrounded by landscaping and green space areas. Additionally, the new improvements and impervious areas on the site will be routed to a proposed private Extended Detention Basin. These items will reduce the volume of runoff using ponding and infiltration.
2. Stabilize Drainageways- There are 2 existing drainageways onsite. The westerly channel has been studied in HEC-RAS model and based upon calculations velocities are within the range for stabilized flow. The easterly channel has wetlands that allow the channel to stay stabilized.
3. Provide Water Quality Capture Volume (WQCV)- The 3 Extended Detention Basin have been sized and designed to sufficiently capture the required WQCV and slowly release it through the three-hole outlet, thereby allowing solids and contaminants to settle out.
4. Consider Need for Industrial and Commercial BMPs- The proposed development is single family site; therefore, no Industrial and Commercial BMPs have been proposed.

## **HYDRAULIC ANALYSIS**

As mentioned above there are 2 major drainage ways on the east and west side of the site. In the previously approved "Final Drainage Report for Waterbury Filing 1" dated September 2016 prepared by Classic Consulting Engineering & Surveying the floodplain along the west side of the site was determined by Kiowa Engineering in a 2004 LOMR (04-08-0012) using a HEC-RAS analysis modeling developed flows along the channel from the 3-42" culverts under Eastonville Road south to the existing stock pond (Design Point 13) south of Stapleton Drive with proposed and existing improvements such as the proposed 42" dual culverts located at the Gilbert Road crossing and existing dual 4' x 8' box culverts at Stapleton Drive. Terra Nova engineering has done a new HEC-RAS study for the floodplain to establish base flood elevations (see appendix for HEC-RAS model). These channels will be contained in proposed Tracts dedicated to drainage that will allow the 4-Way Ranch Metro District to provide maintenance.

As part of the revised Preliminary Plan submittal for the site revisions an analysis of the eastern channel by ECO Systems found that this drainage channel is a jurisdictional water of the U.S. with associated jurisdictional wetland habitat. Therefore, to comply with Section 404 of the Clean Water Act, we must meet the 404(b)(1) project review criteria, which include impact avoidance and minimization. The option the client plan to take is to minimize Project-wide impacts to 0.5-acre or less such that the pre-approved Nationwide Permits (NWP) may be used. No channel grading or redesign is proposed for the channels; with the exception of the Sunken Meadow Crossing where 3-36" culverts are being placed and additional flow is routed into the channel further upstream (Design Point E-E on the PDR Map). The rest of the channel is to remain natural at this time as discussed below in the East Channel section. A USACE Section 404 Permit Preconstruction Notification was submitted to the Army Corp of Engineers in February of 2022 and the USACE Verification Letter (see Appendix) was returned in July of 2022 determining "that activities associated with the project are authorized by 2021 NWP 29 – Residential Developments."

For the analysis of the channels, the Manning's Roughness Coefficients were selected based upon investigation of the channels from site visits and the Natural features and Wetlands report for the site done by Ecosystems services. Both channels have a very substantial amount of vegetative cover containing cattails and Palustrine Emergent wetland vegetation (see attached exhibits & photos in appendix). Both channels show no sign of erosion but do have standing pools of water 1" to 6" deep in most areas along the reach.

The manning's n values are based upon Table 10-2 section *e. Channels not maintained, weeds and brush uncut* for *Dense weeds, high as flow depth*. The range is Minimum 0.05, Normal 0.80 Maximum 0.12

0.08

TNES Response:  
DONE

The west channel has more significant vegetation (cattails and brush) along the southern reach (RS x-sections 0 to 900) than the northern part (RS x-sections 900 to 2600) where it has more grasses and no cattails. For the existing condition in the southern part of the channel a manning's n of 0.10 was used. While in the northern part a manning's n of 0.06 was used. Channel bank armoring is proposed along sections of the channel. With this disturbance occurring to the natural cattails and grasses we are proposing planting some more cattails and other tall grasses in the disturbed areas and the northern

part to help with critical RS x-sections. In the proposed condition we used a manning's n value of 0.06 for the northern part and the same 0.10 for the southern part.

The east channel has significant vegetation (cattails and brush) where it widens (RS x-sections 1801.17 to 1500). Therefore, a manning's n value of 0.10 was used in the HEC-RAS model. This is between the Normal and Maximum limit for Table 10-2 section *e*. All RS x-sections north and south of the above mentioned sections have a little less cattails and more grasses therefore a manning's n value of 0.08 was used This is the Normal and Maximum limit for Table 10-2 section *e*. *Channels not maintained, weeds and brush uncut for Dense weeds, high as flow depth.*

For shear stress the Retardance Class ranges from Class A to Class C were used based upon the SCS Retardance Class Table 8.9 (Class A: 10.0 lb/sq ft, Class B: 7.64 lb/sq ft and Class C 5.60 lb/sq ft). Values for allowable sheer stress based upon the equation 8.29 and figures 8-23 & 8-24 in the appendix. The allowable soil stress values is 0.025 lb/sq ft. Equation 8.32 in appendix calculates the allowable Vegetal Stress and based upon this the allowable Vegetal Stress values are Class A: 7.50 lb/sq ft, Class B: 5.73 lb/sq ft and Class C 4.20 lb/sq ft.

## **EAST CHANNEL DEVELOPED ANALYSIS**

A HEC-RAS analysis was done of the east channel using the existing topo and the proposed contours sampled from these AutoCAD files along with the 100-year flow of 151 cfs upstream of the Sunken Meadow Road crossing and 188 cfs downstream where Pond 3 outlets. These flows are taken from DP 30\* (Existing Calculations DP EX7) and DP 30A\* (DP 30A\* & Pond 3 release). These are the largest flow the channel will see once development starts for Filing 1. This happens after development of Filing 1 and before there is development upstream in the future phases where onsite storm will route most flows in storm drain to detention/water quality ponds and not in the existing channel. The flow in the future fully developed condition is only 39 cfs (DP 30 FDR Calcs) from RS x-section 2010.09 to 1200. While from RS x-sections 1000 to 400, 97 cfs is the flow (Design Point 30A FDR Calcs). The 100-Y-MIN. FF and finished floor lot elevations shown on the HECRAS exhibit are based upon the 151 cfs and 188 cfs in case development upstream does not happen. The output information shows that the channel velocities are below the suggested velocities of 3 to 4 fps from the DCM Manual Chapter 10 and Table 8-3 located in the appendix Section H for 100-year event and are in the

range of 0.45 fps to 3.12 fps, with the exception of RS x-section 400 (discussed below). The Froude # vary from 0.04 to 0.74. The shear stress varies from 0.36 to 2.63 lbs/q ft, which is well under the above-mentioned limits. As mentioned above this is an existing channel that is not being altered with the exception of the road crossing with the 3-36" culverts and the diversion of flows from Basin OS-2 to a point higher in the channel. This channel shows no current erosion and contains wetlands with well-established cattails and grasses that we should avoid disturbing as the HECRAS results show that the channel is stable as is, with no needed improvements such as drop structures or channel armoring that is discussed in EPC ECM Section 3.3.3 C and H. At RS x-section 1200 just upstream of the culvert crossing is shown as critical flow and but the velocity is 0.47 fps, the Froude number is 0.04 and the shear stress is 0.03 lbs/sq ft, all below the requirements. There is a proposed Type M d50=12" riprap pad with a bury depth of 24" just downstream of the RS x-section 1200 as shown on the construction drawings and this will help to stabilize the channel. It is respectfully requested that no improvements be done in this area as all the results show the channel is in conformance with the maximum design values. RS x-section 400 which is downstream of our site and on someone else's property is also critical. RS x-section 400 is the last station which is always critical due to no downstream RS x-section to properly run calculations in the HECRAS program. The 4-Way Ranch Metro District will provide maintenance on the channel using access from the end of the Public ROW of Sunken Meadow Road and Muddy Pond Street and Megansett Way. There is a proposed Drainage-Maintenance Easement along the whole channel abutting Waterbury Filing 1 and to the proposed FSD Pond 2.

## **WEST CHANNEL DEVELOPED ANALYSIS**

A HEC-RAS analysis was done of the West channel for the proposed conditions using the existing topo and the proposed contours. The channel was sampled from these AutoCAD files to obtain the RS x-sections data for the HECRAS analysis. The developed 100-year flow of 216 cfs was used for RS x-section 2500 to the proposed 42" dual culvert RS x-section at 1042.5. From RS x-section 900 to 100, 222 cfs was entered into the program. These flows are based upon the FDR drainage calculations for Design Points 11 & 11A respectively. As mentioned above the northern part of the channel has a manning's n of 0.06 and the southern part 0.10 in the current condition. In the proposed analysis of the west channel the HECRAS output shows that the channel velocities are in the range of 0.60 fps to 4.00 fps for all but RS X-section 0 which 4.46 fps. The maximum suggested velocity is

3 to 4 fps from the DCM Manual Chapter 10 and Table 8-3 located in the appendix Section H for 100-year event, therefore all x-sections met the requirement except for RS X-section 300. This x-section has proposed riprap bank protection shown on the construction drawings. The shear stress varies from 0.02 to 2.43 lbs/sq. These are below the above-mentioned limits. The Froude #'s vary from 0.05 to 1.01. There are two locations where the Froude # is above the 0.90 maximum. The first one is at RS x-section 1420 (1.02) just upstream of a proposed check structure. Drop structures and channel armoring is being added per EPC ECM Section 3.3.3 C and H. We are adding selective riprap bank stabilization from station 1500 to station 1350. The second RS x-section is at 0 respectively. They both have a Froude # of 1.01. These 2 RS x-sections are also shown as Critical Water Surface locations. There are a total of 6 critical water surface RS x-sections listed in the HECRAS table, RS x-sections 1900, 1850, 1500, 1420, 1200, & 0. To help protect the channel and combat these critical flow sections, selective riprap bank stabilization has been shown on the construction drawing set for three different locations. from section 2000 to section 1800, from section 1500 to 1300 and from section 700 to 250, a grouted boulder drop structure has been added at RS x-section 1400 to shallow the channel slope downstream and planting cattails and Palustrine Emergent wetland vegetation along the bottom of the channel. These three protective measures are shown on the channel improvement plans in the Construction Drawing set. At RS x-section 1200 the velocity is 0.60 fps, the Froude # is 0.05 and the shear stress is 0.02 lbs/sq ft. This demonstrates that this RS x-section will be stable in the 100-Y event and no alternate stabilization is needed. It is proposed to armor with selective riprap bank stabilization from station 700 to station 250 and leave the bottom as is with the existing dense cattails and other tall grasses due to the existing lots to the west and the proposed detention pond to the east. RS x-section 0 is the last station which is always critical due to no downstream RS x-section to properly run calculations in HECRAS analysis. The 4-Way Ranch Metro District will provide maintenance on the channel using access from the Public ROW of the abutting Thatcher Court, Gilbert Drive and Stapleton Drive. The Hausemen Easement is also being used to gain access from Bandenero Drive

## **WEST CHANNEL EXISTING ANALYSIS**

A HEC-RAS analysis was also done of the West channel for the existing conditions using the existing topo. The channel was analyzed so we could compare the existing 100-Y MIN. FF to the proposed 100-Y MIN. FF. The channel was sampled from these AutoCAD files using the same reach alignment

and RS x-sections. The developed 100-year flow of 216 cfs was used for RS x-section 2600 to RS x-section 900 and 222 cfs was used for RS x-section 900 to RS x-section 0. RS x sections 1400, 1300, 1200, and 900 have a lowering greater than 0.50' (1400=2.97', 1300=1.39', 1200= 0.8', and 900=1.40' see table below for comparison) and therefore we do not met the requirement from the EL Paso County Floodplain Administrator *"that the cumulative effect of the proposed development, when combined with all other existing and anticipated development, will not increase the water surface elevation of the base flood more than one-half (1/2) foot at any point within the community"* and a CLOMR will need to be submitted and approved by FEMA. The HECRAS model shows that the proposed condition reduces the encroachment as compared to the existing condition analysis. The existing lots 35-37 (RS x-sections 400 to 1300) in the adjacent subdivision to the west are affected by the change in HWL as a majority of the HWL are lowered from the existing condition to the proposed condition with the exception of RS x-sections 400 to 600 where it increase a maximum of 0.11'. Below is a comparison of the Existing HWL vs the Proposed HWL and the difference in elevation.

#### WEST CHANNEL 100-Y HWL EXISTING VS PROPOSED

EX RS X- SECT	100-Y HWL	PR RS X- SECT	100-Y HWL	DIFF	
2600	6967.80	2600	6967.85	0.05	FT
2500	6965.81	2500	6965.79	-0.02	FT
2400	6964.30	2400	6964.31	0.01	FT
2300	6962.39	2300	6962.36	-0.03	FT
2200	6959.82	2200	6959.85	0.03	FT
2100	6957.62	2100	6957.55	-0.07	FT
2000	6956.26	2000	6956.33	0.07	FT
		1950	6955.36		
1900	6954.54	1900	6954.87	0.33	FT
		1850	6953.21		
1800	6951.86	1800	6951.80	-0.06	FT
1700	6949.56	1700	6949.64	0.08	FT
1600	6948.27	1600	6948.22	-0.05	FT
1500	6946.80	1500	6947.05	0.25	FT
		1420	6945.02		
1400	6945.34	1400	6942.37	-2.97	FT
		1380	6942.34		
		1340	6942.23		
1300	6943.61	1300	6942.22	-1.39	FT

What is being done to address this 0.11' increase? Higher FF elev, grading, stabilization, etc??

TNES Response: DONE added sentence discussing how the flow is still contained in channel and the minimum FF of adjacent houses is still safe.

1200	6943.00	1200	6942.20	<b>-0.80 FT</b>
1100	6942.47			
1000	6941.18			
900	6938.51	900	6937.11	<b>-1.40 FT</b>
800	6936.27	800	6936.21	<b>-0.06 FT</b>
700	6934.27	700	6934.12	<b>-0.15 FT</b>
600	6932.36	600	6932.39	<b>0.03 FT</b>
500	6929.89	500	6929.94	<b>0.05 FT</b>
400	6927.85	400	6927.96	<b>0.11 FT</b>
		350	6926.03	
300	6924.34	300	6924.66	<b>0.32 FT</b>
		250	691.88	
200	6920.93	200	6921.01	<b>0.08 FT</b>
100	6920.46	100	6920.46	<b>0.00 FT</b>
0	6919.89	0	6919.14	<b>-0.75 FT</b>

The 100-year high water elevations and limits for the east and west channels were checked against the adjacent proposed lots and the finished grade from the proposed channel HECRAS data. All lot grades were set above the adjacent 100-year highwater elevation and noted the minimum finished floor 1 foot on the Preliminary Plan /PUD. In this more detailed analysis, the minimum finished floors have been revised and are still a minimum 1' above the 100-MIN. FF (see Tabel Below). The proposed lots in Waterbury Filing 1 along the east and west channel are all set outside of the FEMA Floodplain and the calculated 100-year high water elevations and limits. The existing Lots 35 & 36 of the adjacent subdivision 4-Way Ranch Filing No. 1 to the west are shown to have the current FEMA floodplain study from December of 2018 encroach onto them. In the HECRAS analysis of the existing conditions flows from this FDR study the 100-Y MIN. FF encroaches onto their property in the existing condition at RS-x-sections 600, 700, 800, & 900 (see EXISTING 100-Y FLOODPLAIN EXHIBIT in Appendix under HECRAS ANALYSIS). The encroachment of the 100-Y MIN. FF occurs across the rear yards of the lots. This encroachment is shown to be more than the current FEMA floodplain study form December of 2018. This is an existing condition, and the Waterbury Development is not initiating this concern. In the proposed condition for this FDR study the 100-Y MIN. FF is pulled in closer to the channel at RS x-sections 800 & 900, but at RS x-sections 600 & 700 the 100-Y MIN. FF still encroaches onto Lots 35 & 36 (see PROPOSED 100-Y FLOODPLAIN EXHIBIT in Appendix under HECRAS ANALYSIS).

Unresolved:  
address superelevation around channel curves per ECM 10.5.6.

TNES Response:  
DONE added sentence discussing how the super elevation calcs show no significant increase in HWL. added calcs to appendix under HECRAS

**MINIMUM FINISHED FLOOR ELEVATIONS BASED 100-Y MIN. FF**

Lot	44	MIN. FF=	6915.00
Lot	45	MIN. FF=	6916.00
Lot	46	MIN. FF=	6919.00
Lot	47	MIN. FF=	6920.00
Lot	48	MIN. FF=	6921.00
Lot	49	MIN. FF=	6921.50
Lot	75	MIN. FF=	6925.50
Lot	88	MIN. FF=	6927.00
Lot	89	MIN. FF=	6928.00
Lot	90	MIN. FF=	6933.50
Lot	91	MIN. FF=	6935.00
Lot	92	MIN. FF=	6938.50
Lot	113	MIN. FF=	6941.00
Lot	131	MIN. FF=	6964.00
Lot	132	MIN. FF=	6962.00
Lot	133	MIN. FF=	6960.00
Lot	134	MIN. FF=	6959.00
Lot	135	MIN. FF=	6958.00
Lot	136	MIN. FF=	6957.00
Lot	137	MIN. FF=	6954.00
Lot	150	MIN. FF=	6952.00
Lot	151	MIN. FF=	6949.00
Lot	152	MIN. FF=	6947.00
Lot	153	MIN. FF=	6946.00
Lot	154	MIN. FF=	6944.00
Lot	155	MIN. FF=	6944.00
Lot	156	MIN. FF=	6941.00
Lot	157	MIN. FF=	6941.00
Lot	158	MIN. FF=	6939.00
Lot	159	MIN. FF=	6939.00
Lot	160	MIN. FF=	6938.00
Lot	161	MIN. FF=	6937.00
Lot	162	MIN. FF=	6936.00
Lot	163	MIN. FF=	6936.00
Lot	164	MIN. FF=	6935.00
Lot	165	MIN. FF=	6935.00

## FILING 1 CONSTRUCTION COST OPINION

### Private Drainage Facilities Improvements, Non-Reimbursable

	Item	Quantity	Unit Price	Cost
1.	12" HDPE	1126 LF	\$ 14/LF	\$ 15,769
2.	18" DIA INLET	12 EA	\$ 1500/EA	\$ 18,000
3.	18" RCP	465 LF	\$ 82/LF	\$ 38,130
4.	24" RCP	46 LF	\$ 98/LF	\$ 4,508
5.	36" RCP	210 LF	\$ 151/LF	\$ 31,745
6.	FES: 24"	2 EA	\$ 588/EA	\$ 1,176
7.	FES: 36"	1 EA	\$ 906/EA	\$ 906
7.	SWALE 4'x2'	565 LF	\$ 30/LF	\$ 16,950
8.	RIPRAP d30	0.83 TONS	\$ 104/TONS	\$ 87
9.	Drainage Channel Lining, Riprap	381 CY	\$135/CY	\$ 51,435
Total				<b><u>\$ 178,706</u></b>

### Public Drainage Facilities Improvements, Non-Reimbursable

	<u>Item</u>	<u>Quantity</u>	<u>Unit Price</u>	<u>Cost</u>
1.	15" RCP	66 LF	\$74/LF	\$ 4,911
2.	18" RCP	1,491 LF	\$82/LF	\$ 122,241
3.	24" RCP	795 LF	\$98/LF	\$ 77,944
4.	30" RCP	1,664 LF	\$123/LF	\$ 204,697
5.	36" RCP	2,619 LF	\$151/LF	\$ 395,418
6.	30" FES	1 EA	\$738/EA	\$ 738
7.	36" FES	1 EA	\$906/EA	\$ 906
8.	42" FES	2 EA	\$1,206/EA	\$ 2,412
9.	Headwall	4 EA	\$1,500/EA	\$ 6,000
10.	Wingwall	4 EA	\$1,500/EA	\$ 6,000
11.	5' Type R Inlet<5'	14 EA	\$7,212/EA	\$ 100,968
12.	5' Type R Inlet5'<X<10'	4 EA	\$9,377/EA	\$ 37,508
13.	10' Type R Inlet<5'	3 EA	\$9,225/EA	\$ 29,775
14.	10' Type R Inlet5'<X<10'	2 EA	\$10,230/EA	\$ 20,460
15.	15' Type R Inlet<5'	2 EA	\$12,907/EA	\$ 25,814

16	MH Box Base	28 EA	\$15,130/EA	\$ 423,640
17.	Geotextile (EC)	232 SY	\$9/SY	\$ 2,088
18.	Riprap, d50	19 TONS	\$104/TON	\$ 1,942

**Total** **\$ 1,463,462**

#### **Private Permanent BMPs, Non-Reimbursable**

	<b><u>Description</u></b>	<b><u>Quantity</u></b>	<b><u>Unit Price</u></b>	<b><u>Cost</u></b>
1.	3-Extended Detention Basins			
	- Earthwork	32,000 CY	\$ 1.32	\$ 42,250
	- Forebays	5 EA	\$ 10,000	\$ 50,000
	- Trickle Channel	1420 LF	\$ 50	\$ 71,000
	- Outlet Structures (4'x4')	2 EA	\$ 6,000	\$ 12,000
	- Outlet Structures (12'x6')	1 EA	\$ 20,000	\$ 20,000
	- Armored Emergency Spillway	3 EA	\$ 20,000	\$ 60,000
	- Stabilization	3 EA	\$ 5,000	<u>\$ 15,000</u>
			<b>Total</b>	<b><u>\$ 285,250</u></b>

#### **Drainage Channel Improvements, Non-Reimbursable**

	<b><u>Description</u></b>	<b><u>Quantity</u></b>	<b><u>Unit Price</u></b>	<b><u>Cost</u></b>
1.	West Channel Haegler Tributary No. 1			
	- Channel Construction	1,000 LF	\$ 100	\$ 100,000
	- Channel Lining Riprap	3,024 CY	\$ 145	\$ 438,480
	- Channel Lining Vegetation	11 AC	\$ 1,911	\$ 20,352
	- Drop Structures	1 EA	\$ 50,000	<u>\$ 50,000</u>
			<b>Total</b>	<b><u>\$ 608,832</u></b>

#### **DRAINAGE FEES WATERBURY FILING NO. 1**

This site lies within the Haegler Ranch Drainage Basin Diversion and Geick Ranch Basin. There is no approved Drainage Basin Planning study on file done with fees for Geick Ranch Basin, therefore

no fees will need to be paid for Geick Ranch Basin. Drainage and Bridge fees only need to be paid for the part of the site that lies within the Haegler Ranch Basin.

Total Site Acreage: 61.88 ac

Geick Ranch Basin Acreage: 48.11 ac

Haegler Ranch Basin Acreage: 13.77 ac

Appendix L of the Drainage Criteria Manual 1 Addendum states that for single-family 0.25-acre lots, an impervious percentage of 40% can be used. The combined Drainage Fees (2024) are due prior to final plat recordation.

The following calculations are based upon the 2024 Drainage & Bridge fees:

13.77 ac x 40% = 5.51 Impervious acres

Haegler Ranch Drainage Fees:  $\$13,971 \times 5.51 = \mathbf{\$76,980}$

Haegler Ranch Bridge Fees:  $\$2,062 \times 5.51 = \mathbf{\$11,616}$

## SUMMARY

Site runoff and storm drain and appurtenances associated with the development of the Waterbury Filing No. 1 site will not adversely affect the surrounding and downstream developments. Runoff will be routed to the existing and proposed detention basins and reduce the runoff to be at or below historic rates mentioned above in the report via Full Spectrum Detention while slowly treating the water quality capture volume and in turn helping to stabilize the downstream channel banks. Terra Nova Engineering requests that this report satisfy the submittal requirements for the drainage analysis for Waterbury. This report and findings are in general conformance with all previously approved reports for this site.

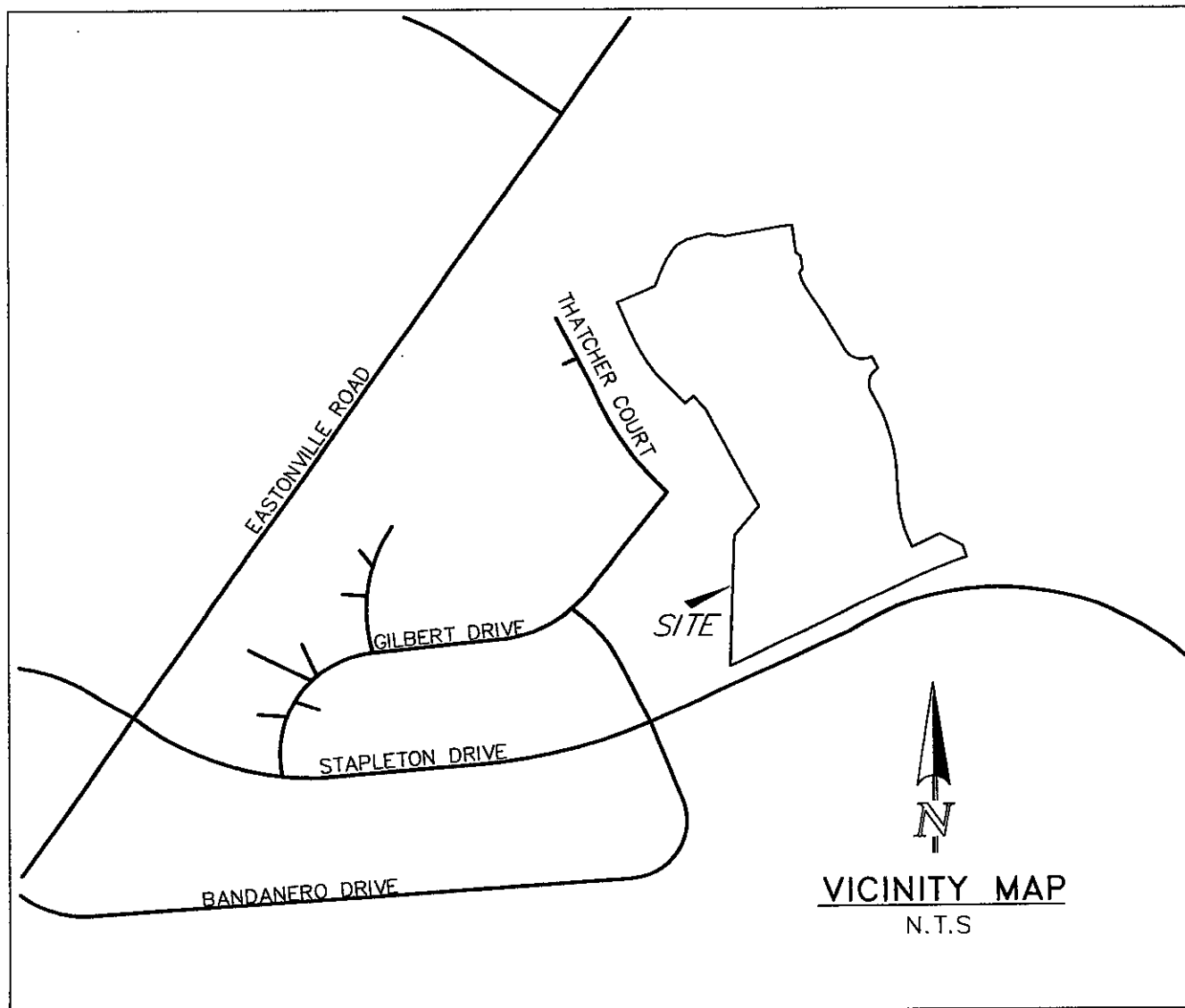
PREPARED BY:  
**TERRA NOVA ENGINEERING, INC.**

Quentin N. Armijo, P.E.  
Vice President  
Jobs/1715.00/drainage/1715.00FDR

**TNES Response:  
DONE**

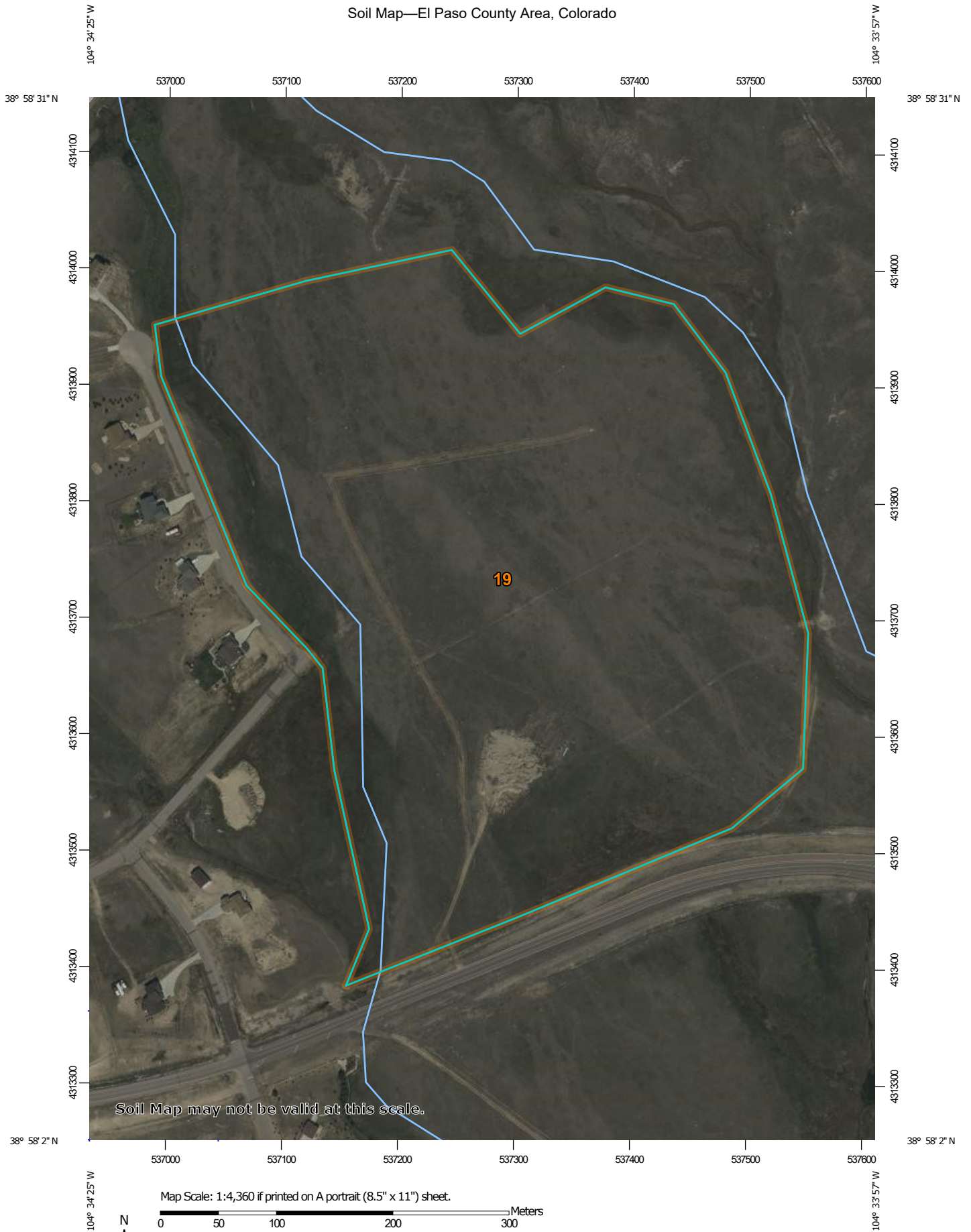
## **APPENDIX**

**APPENDIX A**  
**VICINTY MAP**




**APPENDIX B**  
**NRCS SOILS MAP**

Soil Map—El Paso County Area, Colorado



## MAP LEGEND

### Area of Interest (AOI)

 Area of Interest (AOI)

### Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

### Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

### Water Features



Streams and Canals

### Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

### Background



Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado

Survey Area Data: Version 22, Sep 3, 2024

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 11, 2018—Oct 20, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

## Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	56.6	100.0%
<b>Totals for Area of Interest</b>		<b>56.6</b>	<b>100.0%</b>

## El Paso County Area, Colorado

### 19—Columbine gravelly sandy loam, 0 to 3 percent slopes

#### Map Unit Setting

*National map unit symbol:* 367p

*Elevation:* 6,500 to 7,300 feet

*Mean annual precipitation:* 14 to 16 inches

*Mean annual air temperature:* 46 to 50 degrees F

*Frost-free period:* 125 to 145 days

*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Columbine and similar soils:* 97 percent

*Minor components:* 3 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Columbine

##### Setting

*Landform:* Fans, fan terraces, flood plains

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Alluvium

##### Typical profile

*A - 0 to 14 inches:* gravelly sandy loam

*C - 14 to 60 inches:* very gravelly loamy sand

##### Properties and qualities

*Slope:* 0 to 3 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Well drained

*Runoff class:* Very low

*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water supply, 0 to 60 inches:* Very low (about 2.5 inches)

##### Interpretive groups

*Land capability classification (irrigated):* 4e

*Land capability classification (nonirrigated):* 6e

*Hydrologic Soil Group:* A

*Ecological site:* R049XY214CO - Gravelly Foothill

*Hydric soil rating:* No

#### Minor Components

##### Fluvaquentic haplaquolls

*Percent of map unit:* 1 percent

*Landform:* Swales  
*Hydric soil rating:* Yes

**Other soils**

*Percent of map unit:* 1 percent  
*Hydric soil rating:* No

**Pleasant**

*Percent of map unit:* 1 percent  
*Landform:* Depressions  
*Hydric soil rating:* Yes

## Data Source Information

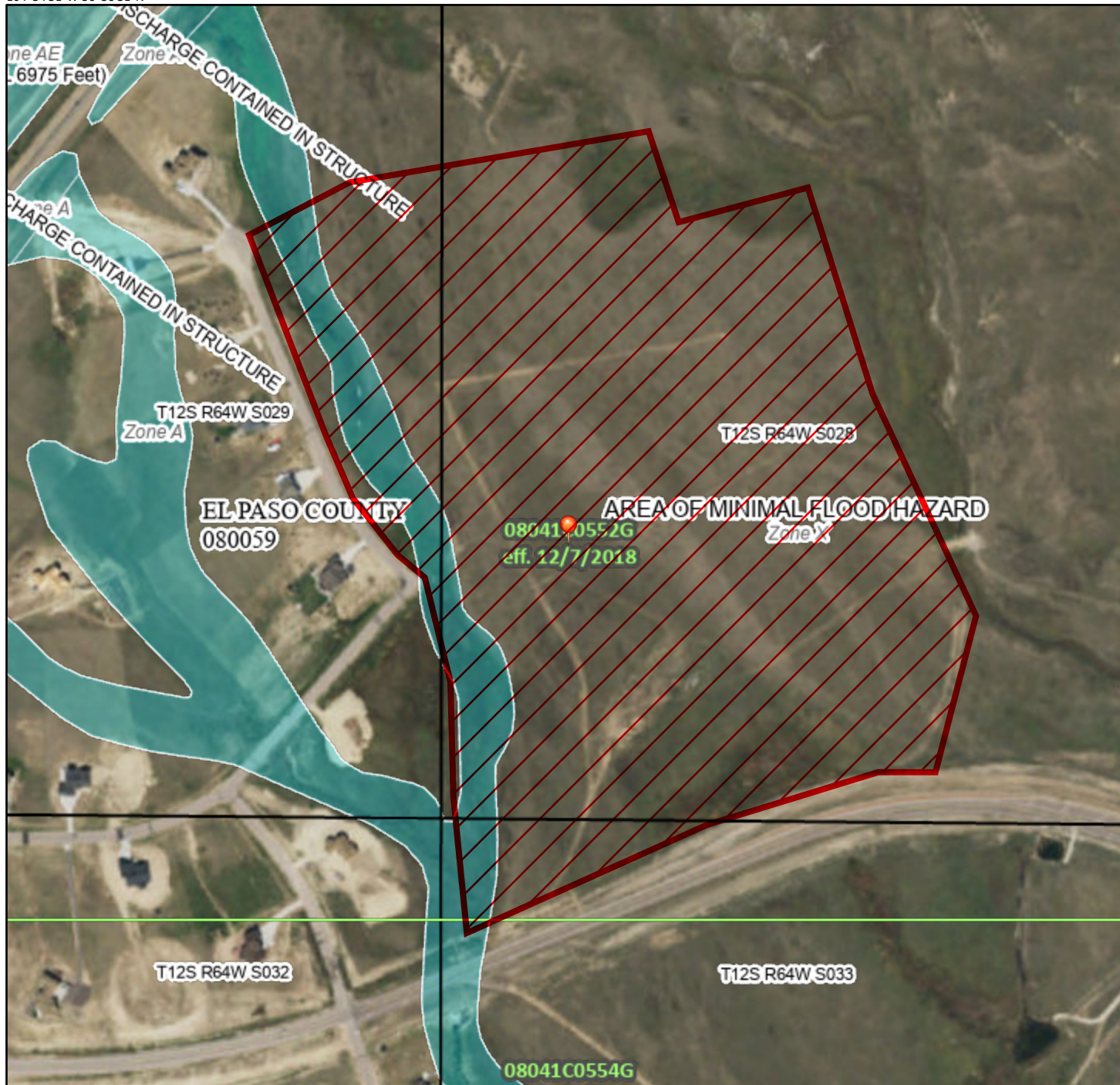
Soil Survey Area: El Paso County Area, Colorado  
Survey Area Data: Version 22, Sep 3, 2024

**APPENDIX C**  
**FEMA FIRM MAP/**  
**FLOODPLAIN PERMIT**

# National Flood Hazard Layer FIRMette



104°34'31"W 38°58'31"N



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

1:6,000

104°33'53"W 38°58'3"N

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

## Legend

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

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
MAP PANELS		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
		Digital Data Available
		No Digital Data Available
		Unmapped



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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **8/27/2021 at 4:44 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Permit # 25023

## FLOOD PLAIN DEVELOPMENT PERMIT

Date 14-Mar-2025

## Owner Information

Name: ACM ALF VIII JV SUB II LLC

Phone: (303) 984-9880

Address: 4100 E. MISSISSIPPI AVE., STE 500  
DENVER, CO 80246  
Attention: JASON POCK

## Project Location

Address: NORTH OF STAPELTON RD, EAST OF THATCHER

Location/Directions: NORTH OF STAPELTON RD, EAST OF THATCHER CT, SOUTH OF EASTONVILLE

Contractor/Engineer: TERRA NOVA ENGINEERING, INC. Phone: (719) 635-6422

## Project Description

Single Family Residential:	[ ]	Addition/Remodel (<50%):	[ ]
Multi-Family Residential:	[ ]	Rehabilitation	[ ]
Manufactured Home:	[ ]	Subst. (>50 Appraisal) Imprv:	[ ]
Non-Residential	[ ]	Fill	[ ]
New Construction	[ ]	Bridge/Culvert	[X]
Watercourse Modification:	[X]	Levee:	[ ]
Project Cost: \$0.00		Structure Market Value: \$0.00	

Creek: HAEGLER RANCH TRIB 2

Description of work: Waterbury Filing 1 and the future Waterbury Filing 2 are adjacent to Haegler Ranch Trib. 2 and is proposing the Gilbert Drive crossing with dual 42" RCP culverts. the channel also has some armoring along the side in areas and a drop structure shown. The analysis is based upon the Duplicate Effective Model being adjusted to the Corrective Effective Model and editing it to the Proposed/Post Conditions Effective Model.

## Flood Hazard Data

Location: Flood Fringe  
Base ( 1% ) Flood Elevation: na  
Lowest Floor Elevation:  
Floodproofing Level:  
Source Document:

## Permit Action

Permit Granted (Y/N): Yes  
Action Comments:

Variance Granted (Y/N): No

## Compliance Section

Elevation Certificate: N Date:

LOMA: N Date:

CLOMR: N Date:

LOMR: N Date:

Site Inspection:

Preliminary Required: N Date:

Final Required: Y Date:

**For Inspection Requests call: Keith 327-2898**

Compliance Comments:

Regional Floodplain Division:

Date 14-Mar-2025

NOTE: This permit expires twelve (12) months from the date it is issued.



# Federal Emergency Management Agency

Washington, D.C. 20472

**FEB 19 2004**

CERTIFIED MAIL  
RETURN RECEIPT REQUESTED

The Honorable Chuck Brown  
Chairman, El Paso County  
Board of Commissioners  
27 East Vermijo Avenue  
Colorado Springs, CO 80903-2208

IN REPLY REFER TO:

Case No.: 04-08-0012P  
Community Name: El Paso County, CO  
Community No.: 080059  
Effective Date of  
This Revision: **MAR 19 2004**

Dear Mr. Brown:

The Flood Insurance Rate Map for your community has been revised by this Letter of Map Revision (LOMR). Please use the enclosed annotated map panel(s) revised by this LOMR for floodplain management purposes and for all flood insurance policies and renewals issued in your community.

Additional documents are enclosed which provide information regarding this LOMR. Please see the List of Enclosures below to determine which documents are included. Other attachments specific to this request may be included as referenced in the Determination Document. If you have any questions regarding floodplain management regulations for your community or the National Flood Insurance Program (NFIP) in general, please contact the Consultation Coordination Officer for your community. If you have any technical questions regarding this LOMR, please contact the Director, Federal Insurance and Mitigation Division of the Department of Homeland Security's Federal Emergency Management Agency (FEMA) in Denver, Colorado, at (303) 235-4830, or the FEMA Map Assistance Center toll free at 1-877-336-2627 (1-877-FEMA MAP). Additional information about the NFIP is available on our website at <http://www.fema.gov/nfip>.

Sincerely,

Kevin C. Long, CFM, Project Engineer  
Hazard Identification Section  
Mitigation Division  
Emergency Preparedness  
and Response Directorate

For: Doug Bellomo, P.E., CFM, Acting Chief  
Hazard Identification Section  
Mitigation Division  
Emergency Preparedness  
and Response Directorate

List of Enclosures:

Letter of Map Revision Determination Document  
Annotated Flood Insurance Rate Map

cc: Mr. Kevin Stilson, P.E., CFM  
Floodplain Administrator  
Pikes Peak Regional Building Department

Mr. Richard N. Wray, P.E.  
Principal  
Kiowa Engineering Corporation



# Federal Emergency Management Agency

Washington, D.C. 20472

## LETTER OF MAP REVISION DETERMINATION DOCUMENT

COMMUNITY AND REVISION INFORMATION		PROJECT DESCRIPTION	BASIS OF REQUEST
COMMUNITY	El Paso County Colorado (Unincorporated Areas)	NO PROJECT	HYDROLOGIC ANALYSIS HYDRAULIC ANALYSIS NEW TOPOGRAPHIC DATA
	COMMUNITY NO.: 080059		
IDENTIFIER	Fourway Ranch Letter of Map Revision	APPROXIMATE LATITUDE & LONGITUDE: 39.974, -104.566 SOURCE: USGS QUADRANGLE    DATUM: NAD 83	
FLOODING SOURCE(S) & REVISED REACH(ES)		Haegler Ranch Tributary 1 – from approximately 1,200 feet upstream of the Cadillac and Lake City Railroad to just upstream of Eastonville Road Haegler Ranch Tributary 1A – from the confluence with Haegler Ranch Tributary 1 to just upstream of Eastonville Road Haegler Ranch Tributary 2 – from the confluence with Haegler Ranch Tributary 1 to just upstream of Eastonville Road Geick Ranch Tributary 1 – from approximately 600 feet upstream to approximately 4,000 feet upstream of the Cadillac and Lake City Railroad Geick Ranch Tributary 2 – from approximately 600 feet upstream to approximately 2,600 feet upstream of the Cadillac and Lake City Railroad	
SUMMARY OF REVISIONS			
Effective Flooding: Zone A Revised Flooding: Zone A Increases: YES Decreases: YES			
* BFEs – Base Flood Elevations			
ANNOTATED MAPPING ENCLOSURES		ANNOTATED STUDY ENCLOSURES	
TYPE: FIRM*    NO.: 08041C0575 F    Date: March 17, 1997		NO REVISION TO THE FLOOD INSURANCE STUDY REPORT	

\* FIRM – Flood Insurance Rate Map; \*\* FBFM – Flood Boundary and Floodway Map; \*\*\* FHBM – Flood Hazard Boundary Map

## DETERMINATION

This document provides the determination from the Department of Homeland Security's Federal Emergency Management Agency (FEMA) regarding a request for a Letter of Map Revision (LOMR) for the area described above. Using the information submitted, we have determined that a revision to the flood hazards depicted in the Flood Insurance Study (FIS) report and/or National Flood Insurance Program (NFIP) map is warranted. This document revises the effective NFIP map, as indicated in the attached documentation. Please use the enclosed annotated map panels revised by this LOMR for floodplain management purposes and for all flood insurance policies and renewals in your community.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2677 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional information about the NFIP is available on our website at <http://www.fema.gov/nfip>.

Doug Bellomo, P.E., CFM, Acting Chief  
Hazard Identification Section  
Mitigation Division

Emergency Preparedness and Response Directorate

102061 D.A04080012 102IC

**Federal Emergency Management Agency**

Washington, D.C. 20472

**LETTER OF MAP REVISION  
DETERMINATION DOCUMENT (CONTINUED)****COMMUNITY INFORMATION****APPLICABLE NFIP REGULATIONS/COMMUNITY OBLIGATION**

We have made this determination pursuant to Section 206 of the Flood Disaster Protection Act of 1973 (P.L. 93-234) and in accordance with the National Flood Insurance Act of 1968, as amended (Title XIII of the Housing and Urban Development Act of 1968, P.L. 90-448), 42 U.S.C. 4001-4128, and 44 CFR Part 65. Pursuant to Section 1361 of the National Flood Insurance Act of 1968, as amended, communities participating in the NFIP are required to adopt and enforce floodplain management regulations that meet or exceed NFIP criteria. These criteria, including adoption of the FIS report and FIRM, and the modifications made by this LOMR, are the minimum requirements for continued NFIP participation and do not supersede more stringent State/Commonwealth or local requirements to which the regulations apply.

**COMMUNITY REMINDERS**

We based this determination on the 1-percent-annual-chance discharges computed in the submitted hydrologic model. Future development of projects upstream could cause increased discharges, which could cause increased flood hazards. A comprehensive restudy of your community's flood hazards would consider the cumulative effects of development on discharges and could, therefore, indicate that greater flood hazards exist in this area.

Your community must regulate all proposed floodplain development and ensure that permits required by Federal and/or State/Commonwealth law have been obtained. State/Commonwealth or community officials, based on knowledge of local conditions and in the interest of safety, may set higher standards for construction or may limit development in floodplain areas. If your State/Commonwealth or community has adopted more restrictive or comprehensive floodplain management criteria, those criteria take precedence over the minimum NFIP requirements.

We will not print and distribute this LOMR to primary users, such as local insurance agents or mortgage lenders; instead, the community will serve as a repository for the new data. We encourage you to disseminate the information in this LOMR by preparing a news release for publication in your community's newspaper that describes the revision and explains how your community will provide the data and help interpret the NFIP maps. In that way, interested persons, such as property owners, insurance agents, and mortgage lenders, can benefit from the information.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2677 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional information about the NFIP is available on our website at <http://www.fema.gov/nfip>.

Doug Bellomo, P.E., CFM, Acting Chief  
Hazard Identification Section  
Mitigation Division  
Emergency Preparedness and Response Directorate

102061 D.A04080012 1021C

**Federal Emergency Management Agency**

Washington, D.C. 20472

**LETTER OF MAP REVISION  
DETERMINATION DOCUMENT (CONTINUED)****COMMUNITY INFORMATION (CONTINUED)**

We have designated a Consultation Coordination Officer (CCO) to assist your community. The CCO will be the primary liaison between your community and FEMA. For information regarding your CCO, please contact:

Mr. Steve L. Olsen  
Director, Federal Insurance and Mitigation Division  
Federal Emergency Management Agency, Region VIII  
Denver Federal Center, Building 710  
P.O. Box 25267  
Denver, CO 80225-0267  
(303) 235-4830

**STATUS OF THE COMMUNITY NFIP MAPS**

We will not physically revise and republish the FIRM and FIS report for your community to reflect the modifications made by this LOMR at this time. When changes to the previously cited FIRM panel and FIS report warrant physical revision and republication in the future, we will incorporate the modifications made by this LOMR at that time.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-336-2677 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional information about the NFIP is available on our website at <http://www.fema.gov/nfip>.

Doug Bellomo, P.E., CFM, Acting Chief  
Hazard Identification Section  
Mitigation Division  
Emergency Preparedness and Response Directorate

102061 D.A04080012 1021C



Federal Emergency Management Agency  
Washington, D.C. 20472

**LETTER OF MAP REVISION  
DETERMINATION DOCUMENT (CONTINUED)**

**PUBLIC NOTIFICATION OF REVISION**

This revision will become effective 30 days from the date of this letter. Any requests to review or alter this determination should be made within 30 days and must be based on scientific or technical data.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Map Assistance Center toll free at 1-877-338-2677 (1-877-FEMA MAP) or by letter addressed to the LOMR Depot, 3601 Eisenhower Avenue, Alexandria, VA 22304. Additional information about the NFIP is available on our website at <http://www.fema.gov/nfip>.

Doug Bellomo, P.E., CFM, Acting Chief  
Hazard Identification Section  
Mitigation Division

**APPENDIX D**  
**WETLANDS NATIONWIDE PERMIT**



**DEPARTMENT OF THE ARMY**  
**CORPS OF ENGINEERS, ALBUQUERQUE DISTRICT**  
**SOUTHERN COLORADO REGULATORY BRANCH**  
201 WEST 8TH STREET, SUITE 350  
PUEBLO, COLORADO 81003

July 14, 2022

Regulatory Division

SUBJECT: Nationwide Permit Verification (SPA-2005-00801)

4 Way Ranch JV, LLC  
c/o Peter Martz  
1271 Kelly Johnson Blvd., Suite 100  
Colorado Springs, Colorado 80920  
[pmartzlrg@comcast.net](mailto:pmartzlrg@comcast.net)

Dear Mr. Martz:

The U.S. Army Corps of Engineers (Corps), Albuquerque District, is responding to your pre-construction notification (PCN) submitted to us for verification of authorization under Nationwide Permit (NWP) 29 for the Waterbury Filings No. 1 & 2 Residential Development. The project site is located between Eastonville Road and State Highway 24, centered at approximately latitude 38.971834°, longitude -104.569206°, El Paso County, Colorado.

Based on the information provided in your PCN dated February 23, 2022, we have determined that the project involves the discharge of dredged or fill material into waters of the United States, subject to Section 404 of the Clean Water Act. The specific activities that require Corps authorization are the permanent placement of fill material in 0.225 acre of palustrine emergent wetlands to construct one road crossing (0.219 acre) and one stormwater pond outfall apron (0.006 acre). The project would also include the temporary placement of dredged and fill material into 0.103 acre of palustrine emergent wetlands for three separate utility crossings. Specific measures will be implemented to fully restore all temporary impacts to aquatic resources and all work will be conducted as described in the PCN.

The Corps has determined that activities associated with the project are authorized by 2021 NWP 29 – Residential Developments. A summary of this NWP and the 2021 Colorado Regional Conditions are available on our website at [www.spa.usace.army.mil/reg/nwp](http://www.spa.usace.army.mil/reg/nwp). Failure to comply with all terms and conditions of this NWP may result in the suspension or revocation of this authorization. As required by General Condition 30, you shall sign the enclosed Compliance Certification (Enclosure 1) and return it to this office within 30 days after completion of the authorized work. For specific information regarding compliance with water quality certification (WQC) requirements, please refer to our website at [www.spa.usace.army.mil/reg/wqc](http://www.spa.usace.army.mil/reg/wqc). In addition, the work must comply with the following **special condition(s)**:

- 1. To compensate for the loss of 0.225 acre of palustrine emergent wetlands, you shall purchase 0.230 emergent wetland credits from the Maria Lake Mitigation Bank in Huerfano County, Colorado. Evidence of this purchase shall be provided to this office via email at: [spa-rd-co@usace.army.mil](mailto:spa-rd-co@usace.army.mil), prior to initiation of construction activities in waters of the U.S. authorized by this verification.**

**2. You shall restore all temporary impacts to 0.103 acre of wetlands to their original contours and conditions within 14 days following completion of construction activities. You shall conduct all restoration of temporary impact areas in accordance with the February 23, 2022, PCN, prepared by Ecosystem Services, LLC, which is hereby incorporated by reference.**

**a. Within 30 days following completion of restoration activities, you shall submit a report to [spa-rd-co@usace.army.mil](mailto:spa-rd-co@usace.army.mil) describing the restoration activities including color photographs of the restored areas. The compass angles and positions of all photographs shall be similar to pre-construction photographs.**

Our review of this project also addressed its effects on threatened and endangered species and historic properties in accordance with General Conditions 18 and 20. Based on the information provided, we have determined that the projects are not likely to adversely affect federally listed species or their critical habitat. Additionally, no historic properties will be affected by the projects. However, these determinations may be invalidated if the project is not completed as authorized or you did not provide accurate information in your PCN.

This permit verification is valid until March 14, 2026, unless the NWPs are modified, suspended, reissued, or revoked prior to that date. Continued confirmation that an activity complies with the terms and conditions, and any changes to the NWP, is the responsibility of the permittee. Activities that have commenced, or are under contract to commence, in reliance on an NWP will remain authorized provided the activity is completed within 12 months of the date of the NWP's expiration, modification, or revocation.

This letter does not constitute approval of the project design features, nor does it imply that the construction is adequate for its intended purpose. This permit does not authorize any injury to property or invasion of rights or any infringement of federal, state, local, or tribal laws or regulations. The permittee and/or any contractors acting on behalf of the permittee must possess the authority and any other approvals required by law, including property rights, to undertake the proposed work.

The landowner must allow Corps representatives to inspect the authorized activity at any time deemed necessary to ensure that it is being, or has been, accomplished in accordance with the terms and conditions of the permit.

We would appreciate your feedback on this permit action including your interaction with our staff or suggestions for improving our program. For more information about our program or to complete our Regulatory Program national customer service survey, visit our website at [www.spa.usace.army.mil/reg](http://www.spa.usace.army.mil/reg).

Please refer to identification number SPA-2005-00801 in any correspondence concerning this project. If you have any questions, please contact me by email at [kyle.d.zibung@usace.army.mil](mailto:kyle.d.zibung@usace.army.mil), or telephone at (651) 290-5877.

Sincerely,

A handwritten signature in black ink, appearing to read "Kyle Zibung". The signature is fluid and cursive, with a long horizontal stroke extending from the end.

Kyle Zibung  
Project Manager  
Southern Colorado Branch

Enclosure

cc:  
Mr. Grant Gurnee, Ecosystem Services, LLC ([grant@ecologicalbenefits.com](mailto:grant@ecologicalbenefits.com))

## COMPLIANCE CERTIFICATION

Action Number: SPA-2005-00801

Name of Permittee: 4 Way Ranch JV, LLC c/o Peter Martz

Permit: NWP 29 – Residential Developments

Upon completion of the activity authorized by this permit and any mitigation required by the permit, sign this certification and return it to the following address:

U.S. Army Corps of Engineers, Albuquerque District  
201 West 8th Street, Suite 350  
Pueblo, Colorado 81003

or via email to: [spa-rd-co@usace.army.mil](mailto:spa-rd-co@usace.army.mil)

Please note that your permitted activity is subject to a compliance inspection by a U.S. Army Corps of Engineers representative. If you fail to comply with this permit, you are subject to permit suspension, modification, or revocation.

***I hereby certify that the work authorized by the above-referenced permit has been completed in accordance with the terms and conditions of the said permit, and required mitigation was completed in accordance with the permit conditions.***

Date Work Started \_\_\_\_\_

Date Work Completed \_\_\_\_\_

\_\_\_\_\_  
Signature of Permittee

\_\_\_\_\_  
Date

**APPENDIX E**  
**HYDROLOGIC CALCULATIONS**

## **EXISTING CONDITIONS**

JOB NAME: WATERBURY MDDP  
 JOB NUMBER: 1715.00  
 DATE: 12/22/24  
 CALCULATED BY: QNA

### FDR ~ EXISTING BASIN RUNOFF COEFFICIENT SUMMARY

BASIN	TOTAL AREA (AC)	IMPERVIOUS / DEVELOPED AREA			NONIMPERVIOUS / UNDEVELOPED AREA			WEIGHTED		WEIGHTED CA	
		AREA (AC)	C(5)	C(100)	AREA (AC)	C(5)	C(100)	C(5)	C(100)	CA(5)	CA(100)
EXA	9.62	0.00	0.45	0.59	9.62	0.09	0.36	0.09	0.36	0.87	3.46
EXB	4.09	0.00	0.45	0.59	4.09	0.09	0.36	0.09	0.36	0.37	1.47
EXC	24.80	0.00	0.45	0.59	24.80	0.09	0.36	0.09	0.36	2.23	8.93
EXD	15.87	0.00	0.45	0.59	15.87	0.09	0.36	0.09	0.36	1.43	5.71
EXE	5.83	0.00	0.45	0.59	5.83	0.09	0.36	0.09	0.36	0.52	2.10
EXF	1.62	0.00	0.45	0.59	1.62	0.09	0.36	0.09	0.36	0.15	0.58
OS-1	45.02	0.00	0.45	0.59	45.02	0.09	0.36	0.09	0.36	4.05	16.21
OS-2	11.40	0.00	0.45	0.59	11.40	0.09	0.36	0.09	0.36	1.03	4.11
OS-3	1.11	0.00	0.45	0.59	1.11	0.09	0.36	0.09	0.36	0.10	0.40
OS-4	0.29	0.00	0.45	0.59	0.29	0.09	0.36	0.09	0.36	0.03	0.11
OS-5	6.74	0.00	0.45	0.59	6.74	0.09	0.36	0.09	0.36	0.61	2.43
OS-8	2.56	FLOW TAKEN FROM MERIDAIN RANCH MDDP									
OS-9	11.80	FLOW TAKEN FROM MERIDAIN RANCH MDDP									
OS-10A	12.80	FLOW TAKEN FROM MERIDAIN RANCH MDDP									

JOB NAME: WATERBURY MDDP  
 JOB NUMBER: 1715.00  
 DATE: 12/22/24  
 CALC'D BY: QNA

### FDR ~ EXISTING BASIN RUNOFF SUMMARY

BASIN	WEIGHTED		OVERLAND				STREET / CHANNEL FLOW				Tc	INTENSITY		TOTAL FLOWS	
	CA(5)	CA(100)	C(5)	Length (ft)	Height (ft)	Tc (min)	Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	TOTAL (min)	I(5) (in/hr)	I(100) (in/hr)	Q(5) (cfs)	Q(100) (cfs)
EXA	0.87	3.46	0.25	100	3	11.1	1193	1.7%	4.5	4.4	15.4	3.43	5.81	3	20
EXB	0.37	1.47	0.25	100	2	12.6	623	2.2%	5.2	2.0	14.6	3.51	5.96	1	9
EXC	2.23	8.93	0.25	100	2.5	11.7	2420	1.7%	4.6	8.9	20.6	3.01	5.01	7	45
EXD	1.43	5.71	0.25	100	2	12.6	1615	2.6%	5.6	4.8	17.4	3.25	5.47	5	31
EXE	0.52	2.10	0.25	100	8	8.0	1063	2.1%	5.0	3.5	11.5	3.86	6.66	2	14
EXF	0.15	0.58	0.25	100	6	8.8	400	2.5%	5.5	1.2	10.0	4.06	7.07	1	4
OS-1	4.05	16.21	0.25	100	6	8.8	3219	2.3%	5.3	10.1	18.9	3.13	5.24	13	85
OS-2	1.03	4.11	0.25	100	2	12.6	1203	1.0%	3.5	5.7	18.4	3.17	5.32	3	22
OS-3	0.10	0.40	0.25	100	2	12.6	330	2.6%	5.6	1.0	13.6	3.61	6.17	0	2
OS-4	0.03	0.11	0.25	100	2	12.6	230	2.6%	5.7	0.7	13.3	3.64	6.23	0	1
OS-5	0.61	2.43	0.25	80	5	7.8	1000	2.5%	5.5	3.0	10.8	3.96	6.85	2	17
OS-8	FLOW TAKEN FROM MERIDAIN RANCH MDDP													5	11
OS-9	FLOW TAKEN FROM MERIDAIN RANCH MDDP													8	19
OS-10A	FLOW TAKEN FROM MERIDAIN RANCH MDDP													28	185

JOB NAME: WATERBURY MDDP  
 JOB NUMBER: 1715.00  
 DATE: 12/22/24  
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### FDR ~ EXISTING SURFACE ROUTING SUMMARY

Design Point(s)	Contributing Basins	Area (AC)	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Facility Size
						I(5)	I(100)	Q(5)	Q(100)	
EX1A	OS-5, & DP-EX10A	19.54	0.61	2.43	10.8	3.96	6.85	30	202	NORTH BOUNDARY
EX1	EXA, OS-5, & DP-EX10A	29.16	1.47	5.89	15.4	3.43	5.81	33	219	3-42" CULVERTS
EX2	EXB	4.09	0.37	1.47	14.6	3.51	5.96	1	9	STAPLETON ROAD
EX3A	OS-4	1.11	0.03	0.11	13.3	3.64	6.23	0	1	NORTH BOUNDARY
EX3	EXC & OS-4	25.10	2.26	9.03	20.6	3.01	5.01	7	45	EAST BOUNDARY
EX4A	OS-3	1.11	0.10	0.40	13.6	3.61	6.17	0	2	NORTH BOUNDARY
EX4	EXD & OS-3	16.98	1.53	6.11	17.4	3.25	5.47	5	33	EAST BOUNDARY
EX5A	OS-2 & OS-8	13.96	1.03	4.11	18.4	3.17	5.32	8	33	NORTH BOUNDARY
EX5	EXE, OS-2 & OS-8	17.23	1.55	6.20	18.4	3.17	5.32	10	44	EAST BOUNDARY
EX6	EXF	1.62	0.15	0.58	13.8	3.59	6.12	1	4	EAST BOUNDARY
EX7A	OS-1 & OS-9	56.82	4.05	16.21	18.9	3.13	5.24	21	104	POINT ALONG CHANNEL
EX7	EXE, EXF, OS-1, OS-2, OS-8 & OS-9	78.24	5.75	23.00	18.9	3.13	5.24	31	151	DP 30 PROP CONDITION
EX9	OS-9	11.80						8	19	EX 36" RCP Culvert
EX10	OS-8	2.56						5	11	EX 36" RCP Culvert
EX10A	MERIDIAN POND E RELEASE	Meridaian Ranch Filing 3 FDR Calculated Flows						28	185	EX 3-42" RCP Culverts
13	TOTAL OFFSITE EX. STOCK POND INFLOW	Per "Final Drainage Report for Waterbury Filing No. 1" dated September 2016, by Classic Consulting						69	396	EX STOCK POND

## **PROPOSED CONDITION**

JOB NAME: WATERBURY MDDP  
 JOB NUMBER: 1715.00  
 DATE: 12/22/24  
 CALCULATED BY: QNA

### FDR DRAINAGE REPORT ~ PROPOSED BASIN RUNOFF COEFFICIENT SUMMARY

BASIN	TOTAL AREA (AC)	IMPERVIOUS / DEVELOPED AREA			NONIMPERVIOUS / UNDEVELOPED AREA			WEIGHTED		WEIGHTED CA	
		AREA (AC)	C(5)	C(100)	AREA (AC)	C(5)	C(100)	C(5)	C(100)	CA(5)	CA(100)
A	3.39	3.39	0.45	0.59	0.00	0.09	0.36	0.45	0.59	1.52	2.00
B1	2.30	2.30	0.45	0.59	0.00	0.09	0.36	0.45	0.59	1.03	1.36
B2	3.58	3.58	0.45	0.59	0.00	0.09	0.36	0.45	0.59	1.61	2.11
C	0.86	0.86	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.39	0.51
D	2.11	2.11	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.95	1.24
E	2.18	2.18	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.98	1.29
F	2.18	2.18	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.98	1.29
G1	0.53	0.53	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.24	0.31
G2	0.69	0.69	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.31	0.41
H	1.46	1.46	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.66	0.86
I	4.97	1.45	0.45	0.59	3.53	0.09	0.36	0.19	0.43	0.97	2.12
J	1.44	1.44	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.65	0.85
K	3.06	1.14	0.45	0.59	1.92	0.09	0.36	0.22	0.45	0.69	1.37
L1	3.79	3.79	0.45	0.59	0.00	0.09	0.36	0.45	0.59	1.71	2.24
L2	2.00	2.00	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.90	1.18
M1	0.99	0.99	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.44	0.58
M2	0.35	0.35	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.16	0.21
N	0.22	0.22	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.10	0.13
O1	2.82	2.82	0.45	0.59	0.00	0.09	0.36	0.45	0.59	1.27	1.66
O2	0.59	0.59	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.27	0.35
O3	0.56	0.56	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.25	0.33
O4	0.38	0.38	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.17	0.23
P	0.70	0.00	0.45	0.59	0.70	0.09	0.36	0.09	0.36	0.06	0.25
Q1	1.48	1.48	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.66	0.87
Q2	0.96	0.96	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.43	0.56

JOB NAME: WATERBURY MDDP  
 JOB NUMBER: 1715.00  
 DATE: 12/22/24  
 CALCULATED BY: QNA

### FDR DRAINAGE REPORT ~ PROPOSED BASIN RUNOFF COEFFICIENT SUMMARY

BASIN	TOTAL AREA (AC)	IMPERVIOUS / DEVELOPED AREA			NONIMPERVIOUS / UNDEVELOPED AREA			WEIGHTED		WEIGHTED CA	
		AREA (AC)	C(5)	C(100)	AREA (AC)	C(5)	C(100)	C(5)	C(100)	CA(5)	CA(100)
R	1.02	1.02	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.46	0.60
S1	1.55	1.55	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.70	0.91
S2	0.13	0.13	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.06	0.08
T1	1.42	1.42	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.64	0.84
T2	1.23	1.23	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.55	0.73
U1	4.38	4.38	0.45	0.59	0.00	0.09	0.36	0.45	0.59	1.97	2.58
U2	1.89	1.89	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.85	1.11
V	0.54	0.54	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.24	0.32
W	5.20	5.20	0.45	0.59	0.00	0.09	0.36	0.45	0.59	2.34	3.07
X	0.43	0.43	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.19	0.25
Y	0.35	0.35	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.16	0.21
OS-1	11.81	11.81	0.45	0.59	0.00	0.09	0.36	0.45	0.59	5.31	6.97
OS-2	11.53	11.53	0.45	0.59	0.00	0.09	0.36	0.45	0.59	5.19	6.80
OS-3A	0.79	0.79	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.35	0.47
OS-3B	5.66	5.66	0.45	0.59	0.00	0.09	0.36	0.45	0.59	2.55	3.34
OS-4	10.90	0.00	0.45	0.59	10.90	0.09	0.36	0.09	0.36	0.98	3.92
OS-5	5.64	0.00	0.45	0.59	5.64	0.09	0.36	0.09	0.36	0.51	2.03
OS-6	1.06	1.06	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.48	0.63
OS-7	3.75	0.00	0.45	0.59	3.75	0.09	0.36	0.09	0.36	0.34	1.35
OS-8	8.43	INFO TAKEN FROM EASTONVILLE ROAD LONDONDERRY DR. TO REX RD. FDR									
OS-9	12.30	INFO TAKEN FROM EASTONVILLE ROAD CORRIDOR PH 1 FDR									
OS-10	3.41	0.00	0.45	0.59	3.41	0.09	0.36	0.09	0.36	0.31	1.23
OS-Q1	4.31	4.31	0.45	0.59	0.00	0.09	0.36	0.45	0.59	1.94	2.54
OS-Q2	0.94	0.94	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.42	0.55
OS-R	6.05	6.05	0.45	0.59	0.00	0.09	0.36	0.45	0.59	2.72	3.57
OS-S1	5.59	5.59	0.45	0.59	0.00	0.09	0.36	0.45	0.59	2.51	3.30
OS-S2	0.17	0.17	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.08	0.10
OS-T2	0.76	0.76	0.45	0.59	0.00	0.09	0.36	0.45	0.59	0.34	0.45
OS-W	0.57	0.57	0.90	0.96	0.00	0.09	0.36	0.90	0.96	0.51	0.54

POND TRIBUTARY AREA				
POND 1 TRIB AREA (DP 8)	<b>22.34</b> AC	BASINS A, B1, B2, C, D, E, F, H, G1, G2, & K	DCIA	5.03
			UIA	6.92
			RPA	2.46
			SPA	7.94
			<b>Total</b>	<b>22.34</b>
POND 2 TRIB AREA (DP 18)	<b>21.05</b> AC	BASINS L1, L2, O1, O2, O-3, O-4 & OS-4	DCIA	2.34
			UIA	3.23
			RPA	0.92
			SPA	14.55
			<b>Total</b>	<b>21.05</b>
POND 3 TRIB AREA (DP 29)	<b>72.14</b> AC	BASINS Q1, Q2, R, S1, S2, T1, T2, U1, U2, V, W, X, OS-1, OS-2, OS-3A, OS-3B, OS-S1, OS-S2, OS-T2, OS-R, OS-Q1, OS-Q2, OS-7, & OS-W	DCIA	19.75
			UIA	20.80
			RPA	16.16
			SPA	15.42
			<b>Total</b>	<b>72.14</b>

JOB NAME: <u>WATERBURY MDDP</u> JOB NUMBER: <u>1715.00</u> DATE: <u>12/22/24</u> CALC'D BY: <u>QNA</u>															
<b>FDR ~ PROPOSED BASIN RUNOFF SUMMARY</b>															
BASIN	WEIGHTED		OVERLAND				STREET / CHANNEL FLOW				Tc	INTENSITY		TOTAL FLOWS	
	CA(5)	CA(100)	C(5)	Length (ft)	Height (ft)	Tc (min)	Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	TOTAL (min)	I(5) (in/hr)	I(100) (in/hr)	Q(5) (cfs)	Q(100) (cfs)
A	1.52	2.00	0.25	100	2	12.6	420	1.5%	4.3	1.6	14.3	3.54	6.03	5	12
B1	1.03	1.36	0.25	100	2	12.6	400	1.5%	4.3	1.6	14.2	3.55	6.05	4	8
B2	1.61	2.11	0.25	100	2	12.6	550	1.5%	4.3	2.1	14.8	3.49	5.93	6	13
C	0.39	0.51	0.25	20	0.5	5.3	500	2.0%	4.9	1.7	6.9	4.58	8.14	2	4
D	0.95	1.24	0.25	80	2	10.5	300	2.5%	5.5	0.9	11.4	3.87	6.69	4	8
E	0.98	1.29	0.25	100	2	12.6	400	2.5%	5.5	1.2	13.8	3.59	6.12	4	8
F	0.98	1.29	0.25	50	2	7.1	620	1.5%	4.3	2.4	9.5	4.14	7.22	4	9
G1	0.24	0.31	0.25								5.0	5.00	9.06	1	3
G2	0.31	0.41	0.25								5.0	5.00	9.06	2	4
H	0.66	0.86	0.25	50	2	7.1	525	1.5%	4.3	2.0	9.2	4.19	7.33	3	6
I	0.97	2.12	0.25	80	4	8.4	250	2.0%	4.9	0.8	9.2	4.18	7.32	4	16
J	0.65	0.85	0.25	90	6	8.1	850	2.0%	4.9	2.9	10.9	3.94	6.81	3	6
K	0.69	1.37	0.25	100	18	6.1	80	1.0%	3.5	0.4	6.5	4.67	8.33	3	11
L1	1.71	2.24	0.25	100	2	12.6	860	1.4%	4.1	3.5	16.1	3.36	5.69	6	13
L2	0.90	1.18	0.25	55	1.1	9.4	860	1.4%	4.1	3.5	12.8	3.70	6.34	3	7
M1	0.44	0.58	0.25	70	1.5	10.3	200	2.0%	4.9	0.7	11.0	3.92	6.79	2	4
M2	0.16	0.21	0.25	65	3	7.7	0	0.0%	0.0	0.0	7.7	4.43	7.83	1	2

JOB NAME: <u>WATERBURY MDDP</u> JOB NUMBER: <u>1715.00</u> DATE: <u>12/22/24</u> CALC'D BY: <u>QNA</u>															
<b>FDR ~ PROPOSED BASIN RUNOFF SUMMARY</b>															
BASIN	WEIGHTED		OVERLAND				STREET / CHANNEL FLOW				Tc	INTENSITY		TOTAL FLOWS	
	CA(5)	CA(100)	C(5)	Length (ft)	Height (ft)	Tc (min)	Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	TOTAL (min)	I(5) (in/hr)	I(100) (in/hr)	Q(5) (cfs)	Q(100) (cfs)
N	0.10	0.13	0.25								5.0	5.00	9.06	1	1
O1	1.27	1.66	0.25	100	2.5	11.7	460	1.5%	4.3	1.8	13.5	3.62	6.19	5	10
O2	0.27	0.35	0.25	100	2	12.6	850	2.0%	4.9	2.9	15.5	3.42	5.80	1	2
O3	0.25	0.33	0.25								5.0	5.00	9.06	1	3
O4	0.17	0.23	0.25								5.0	5.00	9.06	1	2
P	0.06	0.25	0.25								5.0	5.00	9.06	0	2
Q1	0.66	0.87	0.25	55	1.3	8.9	445	2.0%	5.0	1.5	10.4	4.01	6.97	3	6
Q2	0.43	0.56	0.25	55	1.3	8.9	445	2.0%	5.0	1.5	10.4	4.01	6.97	2	4
R	0.46	0.60	0.25	100	4	10.1	700	2.0%	4.9	2.4	12.4	3.75	6.44	2	4
S1	0.70	0.91	0.25	100	6	8.8	175	2.0%	4.9	0.6	9.4	4.16	7.26	3	7
S2	0.06	0.08	0.25								5.0	5.00	9.06	0	1
T1	0.64	0.84	0.25	55	1.1	9.4	390	2.0%	4.9	1.3	10.7	3.97	6.88	3	6
T2	0.55	0.73	0.25	100	2	12.6	245	2.0%	5.0	0.8	13.5	3.63	6.20	2	5
U1	1.97	2.58	0.25	100	2	12.6	520	2.3%	5.3	1.6	14.3	3.54	6.03	7	16
U2	0.85	1.11	0.25	100	2	12.6	385	2.3%	5.4	1.2	13.8	3.59	6.12	3	7
V	0.24	0.32	0.25								5.0	5.00	9.06	1	3
W	2.34	3.07	0.25	100	2	12.6	630	1.6%	4.4	2.4	15.0	3.47	5.89	8	18
X	0.19	0.25	0.25								5.0	5.00	9.06	1	2
Y	0.16	0.21	0.25								5.0	5.00	9.06	1	2

JOB NAME: <u>WATERBURY MDDP</u> JOB NUMBER: <u>1715.00</u> DATE: <u>12/22/24</u> CALC'D BY: <u>QNA</u>															
<b>FDR ~ PROPOSED BASIN RUNOFF SUMMARY</b>															
BASIN	WEIGHTED		OVERLAND				STREET / CHANNEL FLOW				Tc	INTENSITY		TOTAL FLOWS	
	CA(5)	CA(100)	C(5)	Length (ft)	Height (ft)	Tc (min)	Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	TOTAL (min)	I(5) (in/hr)	I(100) (in/hr)	Q(5) (cfs)	Q(100) (cfs)
OS-1	5.31	6.97	0.25	100	2	12.6	690	2.0%	5.0	2.3	15.0	3.47	5.90	18	41
OS-2	5.19	6.80	0.25	100	2	12.6	1700	1.8%	4.6	6.1	18.7	3.14	5.27	16	36
OS-3A	0.35	0.47	0.25	55	1.1	9.4	480	1.3%	3.9	2.0	11.4	3.87	6.68	1	3
OS-3B	2.55	3.34	0.25	100	2	12.6	480	1.3%	3.9	2.0	14.7	3.50	5.95	9	20
OS-4	0.98	3.92	0.25	800	26	30.5					30.5	2.46	4.01	2	16
OS-5	0.51	2.03	0.25	80	5	7.8					7.8	4.42	7.82	2	16
OS-6	0.48	0.63	0.25	30	0.6	6.9	900	1.8%	4.7	3.2	10.1	4.05	7.04	2	4
OS-7	0.34	1.35									5.0	5.00	9.06	2	12
OS-8	INFO TAKEN FROM EASTONVILLE ROAD LONDONDERRY DR. TO REX RD. FDR													5	12
OS-9	INFO TAKEN FROM EASTONVILLE ROAD CORRIDOR PH 1 FDR													4	24
OS-10	0.31	1.23	0.25	100	2	12.6	300	2.7%	5.7	0.9	13.5	3.62	6.19	1	8
OS-Q1	1.94	2.54	0.25	200	5	16.6	1500	1.5%	4.3	5.8	22.4	2.88	4.78	6	12
OS-Q2	0.42	0.55	0.25	50	1	8.9	900	1.5%	4.3	3.5	12.4	3.75	6.43	2	4
OS-R	2.72	3.57	0.25	50	1	8.9	850	2.7%	5.8	2.5	11.4	3.87	6.69	11	24
OS-S1	2.51	3.30	0.25	100	2	12.6	920	1.2%	3.8	4.0	16.7	3.32	5.60	8	18
OS-S2	0.08	0.10	0.25	100	2	12.6					12.6	3.72	6.39	0	1
OS-T2	0.34	0.45	0.25	100	2	12.6					12.6	3.72	6.39	1	3
OS-W	0.51	0.54	0.25	10	1	2.4					5.0	5.00	9.06	3	5

JOB NAME: WATERBURY MDDP  
 JOB NUMBER: 1715.00  
 DATE: 12/22/24  
 CALCULATED BY: QNA

### FDR ~ PROPOSED SURFACE ROUTING SUMMARY

Design Point(s)	Contributing Basins	Area (AC)	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Facility Size
						I(5)	I(100)	Q(5)	Q(100)	
1	A	3.39	1.52	2.00	14.3	3.54	6.03	5	12	10' Type R Sump Inlet
2	C	0.86	0.39	0.51	6.9	4.58	8.14	2	4	5' Type R Sump Inlet
3	B1	2.30	1.03	1.36	14.2	3.55	6.05	4	8	5' Type R Sump Inlet
4	B2	3.58	1.61	2.11	14.8	3.49	5.93	6	13	10' Type R Sump Inlet
5	F & H	3.65	1.64	2.15	9.5	4.14	7.22	7	16	10' Type R Sump Inlet
6	D	2.11	0.95	1.24	11.4	3.87	6.69	4	8	5' Type R Sump Inlets
7	E	2.18	0.98	1.29	13.8	3.59	6.12	4	8	5' Type R Sump Inlets
7A	G1	0.53	0.24	0.31	5.0	5.00	9.06	1	3	5' Type R At-grade Inlet
7B	G2	0.69	0.31	0.41	5.0	5.00	9.06	2	4	5' Type R At-grade Inlet
8	DESIGN POINTS 1-7B & K	22.34	8.13	10.66	14.8	3.49	5.93	28	63	FSD Pond 1
9	OS-9	12.30	INFO TAKEN FROM EASTONVILLE ROAD CORRIDOR PH 1 FDR					4	24	EX 30" RCP Culvert
9A	EA3, EA4 & EA5	1.43	INFO TAKEN FROM EASTONVILLE ROAD CORRIDOR PH 1 FDR					4	6	WQ POND
9B	POND RELEASE & DP9	13.73	INFO TAKEN FROM EASTONVILLE ROAD CORRIDOR PH 1 FDR					4	25	PR 24" RCP
10	OS-8	8.43	INFO TAKEN FROM EASTONVILLE ROAD LONDONDERRY DR. TO REX RD. FDR					5	12	EX FSD Pond
10-1	POND RELEASE & DP10	12.30	INFO TAKEN FROM EASTONVILLE ROAD LONDONDERRY DR. TO REX RD. FDR					0.3	5	PR 18" RCP
10A	MERIDIAN POND E RELEASE	Meridaian Ranch Filing 3 FDR Calculated Flows						28	185	EX 3-42" RCP Culverts
11	OS-5, I, DP10A (MERIDIAN POND E RELEASE)	Sum of Basins						34	216	PR 2-42" RCP Culverts
11A	DP 11 & BASIN J	Sum of Basins						37	222	EX Channel

JOB NAME: WATERBURY MDDP  
 JOB NUMBER: 1715.00  
 DATE: 12/22/24  
 CALCULATED BY: QNA

### FDR ~ PROPOSED SURFACE ROUTING SUMMARY

Design Point(s)	Contributing Basins	Area (AC)	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Facility Size
						I(5)	I(100)	Q(5)	Q(100)	
12	OS-6	1.06	0.48	0.63	10.1	4.05	7.04	2	4	18" RCP Culvert
13	TOTAL OFFSITE EX. STOCK POND INFLOW	Per "Final Drainage Report for Waterbury Filing No. 1" dated September 2016, by Classic Consulting						69	396	EX STOCK POND
14	L1	3.79	1.71	2.24	16.1	3.36	5.69	6	13	10' Type R Sump Inlet
15	L2	2.00	0.90	1.18	12.8	3.70	6.34	3	7	5' Type R Sump Inlet
16	O1	2.82	1.27	1.66	13.5	3.62	6.19	5	10	10' Type R Sump Inlet
17	O2	0.59	0.27	0.35	15.5	3.42	5.80	1	2	5' Type R Sump Inlet
18	DESIGN POINTS 14-17 & 33-34 AND BASIN OS-4	21.05	5.12	5.43	16.1	3.36	5.69	17	31	Interim FSD Pond 2
19	Q1 & OS-Q1	5.78	2.60	3.41	22.4	2.88	4.78	8	16	10' Type R Sump Inlet
20	Q2 & OS-Q2	1.89	0.85	1.12	12.4	3.75	6.43	3	7	5' Type R Sump Inlet
21	R & OS-R	7.06	3.18	4.17	11.4	3.87	6.69	12	28	10' Type R At-grade Inlet
22	S1 & OS-S1 & DP 21 FLOW BY	7.14	4.46	6.76	16.7	3.32	5.60	15	38	15' Type R Sump Inlet
23	S2 & OS-S2	0.31	0.14	0.18	12.6	3.72	6.39	1	1	15' Type R Sump Inlet
22 & 23 SPLIT	S1, OS-S1, S2, OS-S2, & DP 21 FLOW BY	7.44	4.59	6.95	16.7	3.32	5.60	8	19	2-10' Type R Sump Inlets
24	T1	1.42	0.64	0.84	10.7	3.97	6.88	3	6	5' Type R Sump Inlets
25	T2 & OS-T2	1.99	0.90	1.18	13.5	3.63	6.20	3	7	5' Type R Sump Inlets

JOB NAME: WATERBURY MDDP  
 JOB NUMBER: 1715.00  
 DATE: 12/22/24  
 CALCULATED BY: QNA

### FDR ~ PROPOSED SURFACE ROUTING SUMMARY

Design Point(s)	Contributing Basins	Area (AC)	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Facility Size
						I(5)	I(100)	Q(5)	Q(100)	
26	U1	4.38	1.97	2.58	14.3	3.54	6.03	7	16	10' Type R Sump Inlets
27	U2	1.89	0.85	1.11	13.8	3.59	6.12	3	7	5' Type R Sump Inlets
28	W & OS-W	5.76	2.85	3.61	15.0	3.47	5.89	10	21	2-10' Type R Sump Inlets
29	BASINS Q1, Q2, R, S1, S2, T1, T2, U1, U2, V, W, X, OS-1, OS-2, OS-3A, OS-3B, OS-S1, OS-S2, OS-T2, OS-R, OS-Q1, OS-Q2, OS-7, & OS-W	72.14	37.28	51.38	22.4	2.88	4.78	111	270	FSD POND 3
30	PR 45, Y & OS-10	3.76	1.71	6.31	13.5	3.62	6.19	6	39	Triple 36" RCP Culverts
30*	DPEX7A	UNDEVELOPED UPSTREAM CHANNEL FLOW						31	151	Triple 36" RCP Culverts
30**	FSD POND 3 EMERGENCY SPILLWAY RELEASE & ULTIMATE DP 30	MHFD DETENTION 100Y PEAK INFLOW							308	Triple 36" RCP Culverts
30A	DP 30 & FSD POND RELEASE	MHFD DETENTION 100Y PEAK INFLOW						7	97	EAST CHANNEL FULLY DEVELOPED UPSTREAM
30A*	DP 30* & FSD POND 3 RELEASE	UPSTREAM CHANNEL FLOW & POND 3 RELEASE						32	188	EAST CHANNEL FULLY DEVELOPED UPSTREAM W/ SPILLWAY RELEASE
31	V	0.54	0.24	0.32	5.0	5.00	9.06	1	3	3-18" DIA INLETS
32	X	0.43	0.19	0.25	5.0	5.00	9.06	1	2	2-18" DIA INLETS
33	O-3	0.56	0.25	0.33	5.0	5.00	9.06	1	3	4-18" DIA INLETS
34	O-4	0.38	0.17	0.23	5.0	5.00	9.06	1	2	3-18" DIA INLETS
EX5A*	OS-2 & OS-8	13.96	1.03	4.11	18.38	3.17	5.32	8	33	NORTH BOUNDARY

ULTIMATE: DP 30 IS FLOW IN CHANNEL WHEN FUTURE UPSTREAM WATERBURY FILINGS ARE DEVELOPED

INTERIM: 30\* IS FLOW IN CHANNEL PRIOR TO FUTURE UPSTREAM WATERBURY FILINGS

ULTIMATE DP 30\*\* IS FLOW IN CHANNEL WHEN FUTURE UPSTREAM WATERBURY FILINGS ARE DEVELOPED AND THE EMERGENCY SPILLWAY IS BREACHED

ULTIMATE 30A EAST CHANNEL FULLY DEVELOPED UPSTREAM

ULTIMATE 30A\* EAST CHANNEL FULLY DEVELOPED UPSTREAM AND THE EMERGENCY SPILLWAY IS BREACHED

EX5A\* IS TAKEN FROM THE EXISTING CONDITIONS TO SHOW THE FLOW IN THE DIVERSION SWALE E-E PRIOR TO THE DEVELOPMENT OF THE FUTURE UPSTREAM FILNGS.

Extend box so all of text is visible

TNES Response:  
DONE

JOB NAME: WATERBURY MDDP  
 JOB NUMBER: 1715.00  
 DATE: 12/22/24  
 CALCULATED BY: QNA

\* PIPES ARE LISTED AT MAXIMUM SIZE REQUIRED TO ACCOMMODATE Q100 FLOWS AT MINIMUM GRADE.  
 REFER TO INDIVIDUAL PIPE SHEETS FOR HYDRAULIC INFORMATION.

### FDR ~ PIPE ROUTING SUMMARY

Pipe Run	Contributing Design Points/Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Pipe Size*
					I(5)	I(100)	Q(5)	Q(100)	
1	DP 2	0.39	0.51	6.9	4.58	8.14	2	4	18" RCP
2	DP 1 & 2	1.91	2.51	14.3	3.54	6.03	7	15	24" RCP
3	DP 3	1.03	1.36	14.2	3.55	6.05	4	8	18" RCP
4	DP-4	1.61	2.11	14.8	3.49	5.93	6	13	18" RCP
5	DP 3 & 4	2.64	3.47	14.8	3.49	5.93	9	21	24" RCP
6	DP 1-4	4.56	5.97	14.8	3.49	5.93	16	35	36" RCP
7	DP-1-5	6.20	8.12	14.8	3.49	5.93	22	48	36" RCP
8	DP-6	0.95	1.24	11.4	3.87	6.69	4	8	18" RCP
9	DP-7	0.98	1.29	13.8	3.59	6.12	4	8	18" RCP
10	DP-6 & 7	1.97	2.58	13.8	3.59	6.12	7	16	24" RCP
10A	DP-7A	0.24	0.31	5.0	5.00	9.06	1	3	15" RCP
10B	DP-6, 7, 7A, & 7B	2.51	3.30	13.8	3.59	6.12	9	20	24" RCP
10C	POND 1 RELEASE	2.95	3.87	13.8	3.59	6.12	0.4	14.6	24" RCP

JOB NAME: WATERBURY MDDP  
 JOB NUMBER: 1715.00  
 DATE: 12/22/24  
 CALCULATED BY: QNA

\* PIPES ARE LISTED AT MAXIMUM SIZE REQUIRED TO ACCOMMODATE Q100 FLOWS AT MINIMUM GRADE.  
 REFER TO INDIVIDUAL PIPE SHEETS FOR HYDRAULIC INFORMATION.

### FDR ~ PIPE ROUTING SUMMARY

Pipe Run	Contributing Design Points/Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Pipe Size*
					I(5)	I(100)	Q(5)	Q(100)	
11	DP-14	1.71	2.24	16.1	3.36	5.69	6	13	24" RCP
12	DP-15	0.90	1.18	12.8	3.70	6.34	3	7	18" RCP
13	DP 14 & 15	2.61	3.42	16.1	3.36	5.69	9	19	30" RCP
14	DP 16	1.27	1.66	13.5	3.62	6.19	5	10	24" RCP
15	DP 14, 15 & 16	3.88	5.08	16.1	3.36	5.69	13	29	36" RCP
16	DP 17	0.27	0.35	15.5	3.42	5.80	1	2	18" RCP
17	DP 14, 15, 16, 17, 33, & 34	4.57	5.99	16.1	3.36	5.69	15	34	36" RCP
17A	POND 2 RELEASE						0.2	14.8	18" RCP
18	DP 19	2.60	3.41	22.4	2.88	4.78	8	16	24" RCP
19	DP 20	0.85	1.12	12.4	3.75	6.43	3	7	18" RCP
20	DP 18 & 19	3.46	4.53	22.4	2.88	4.78	10	22	24" RCP
21	DP 21 PICK UP						8	14	18" RCP
22	DP 19, 20 & 21	6.23	7.46	22.4	2.88	4.78	18	36	30" RCP
23	DP 22	2.30	3.47	16.7	3.32	5.60	8	19	24" RCP
24	DP 23	2.30	3.47	16.7	3.32	5.60	8	19	24" RCP
25	DP 22 & 23	4.59	6.95	16.7	3.32	5.60	15	39	36" RCP
26	DP 19 -23	10.83	14.40	22.4	2.88	4.78	31	69	36" RCP
27	DP 24	0.64	0.84	10.7	3.97	6.88	3	6	18" RCP

JOB NAME: WATERBURY MDDP  
 JOB NUMBER: 1715.00  
 DATE: 12/22/24  
 CALCULATED BY: QNA

\* PIPES ARE LISTED AT MAXIMUM SIZE REQUIRED TO ACCOMMODATE Q100 FLOWS AT MINIMUM GRADE.  
 REFER TO INDIVIDUAL PIPE SHEETS FOR HYDRAULIC INFORMATION.

### FDR ~ PIPE ROUTING SUMMARY

Pipe Run	Contributing Design Points/Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Pipe Size*
					I(5)	I(100)	Q(5)	Q(100)	
28	DP 25	0.90	1.18	13.5	3.63	6.20	3	7	18" RCP
29	DP 19-25	12.36	16.42	22.4	2.88	4.78	36	78	42" RCP
30	DP 26	1.97	2.58	14.3	3.54	6.03	7	16	24" RCP
31	DP 19-26	14.33	19.00	22.4	2.89	4.79	41	91	42" RCP
32	DP 27	0.85	1.11	13.8	3.59	6.12	3	7	18" RCP
33	DP 19-27, & 31	15.42	20.43	22.4	2.88	4.78	44	98	42" RCP
33A	DPR 33 & PR 37	15.66	20.75	22.4	2.88	4.78	45	99	42" RCP
34	DP 28 SPLIT	1.42	1.81	15.0	3.47	5.89	5	11	24" RCP
34A	DP 28 & 32	3.04	3.86	13.84	3.59	6.12	11	24	30" RCP
35	Pond 3 Release	MHFD UD-DETENTION POND RELEASE					1.3	37.7	36" RCP
36	DP 30	FSD POND 3 EMERGENCY SPILLWAY RELEASE						269.3	TRIPLE 36" RCP
37	DP 31	0.24	0.32	5.00	5.00	9.06	1	3	12" HDPE
38	DP 32	0.19	0.25	5.00	5.00	9.06	1	2	12" HDPE
39	DP 33	0.25	0.33	5.00	5.00	9.06	1	3	12" HDPE
40	DP 34	0.17	0.23	5.00	5.00	9.06	1	2	12" HDPE
41	DP 9	INFO TAKEN FROM EASTONVILLE ROAD CORRIDOR PH 1 FDR					4	24	30" RCP
42	DP 9A RELEASE	INFO TAKEN FROM EASTONVILLE ROAD CORRIDOR PH 1 FDR					0.06	1	18" RCP
43	DP 9 & 9A	INFO TAKEN FROM EASTONVILLE ROAD CORRIDOR PH 1 FDR					4	25	24" RCP
44	DP 10 RELEASE	Eastonville Road – Londonderry Drive to Rex Road Segment 1 Improvements FDR					0.3	5	18" RCP
45	PR 43 & 44	Eastonville Road – Londonderry Drive to Rex Road Segment 1 Improvements FDR					5	30	30" RCP

**APPENDIX F**  
**HYDRAULIC CALCULATIONS**

## **STREET CAPACITY**

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

Modified Arterial Saybrook Rd @ 1.0%

Inputs

Water surface elevation

.67

ft

▼

Channel slope, S

1

% rise/run

▼

Results

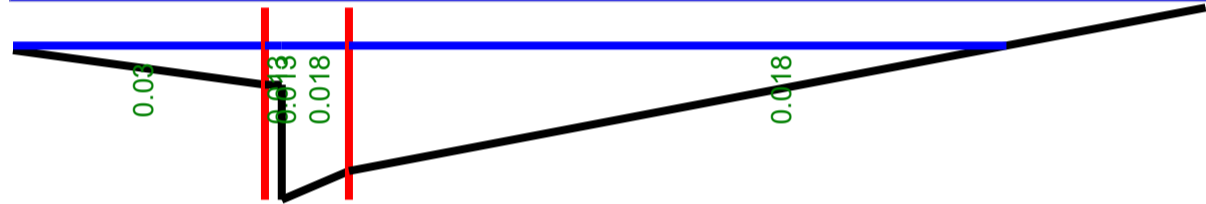
Q

26.55

cfs

▼

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	.65			0.01									
7.5	.5	0.03	<input checked="" type="checkbox"/>	0.11	7.50	7.50	0.71	0.09	0.03	1.03	0.02	0.59	0.73
8	.5	0.013	<input type="checkbox"/>	0.11	0.50	0.50	0.09						
8	0	0.013	<input type="checkbox"/>	0.42	0.00	0.00	0.00						
10	.125	0.018	<input checked="" type="checkbox"/>	0.34	2.00	2.00	1.22	0.52	0.02	5.63	0.49	1.23	7.31
35.5	.835	0.018	<input checked="" type="checkbox"/>	0.00	19.57	19.58	5.33	0.27	0.02	3.47	0.19	1.17	18.50



## Notes

### Composite n

This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

### Rock lining

Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

Modified Arterial Saybrook Rd @ 2.25%

Inputs

Water surface elevation

.67

ft

▼

Channel slope, S

2.25

% rise/run

▼

Results

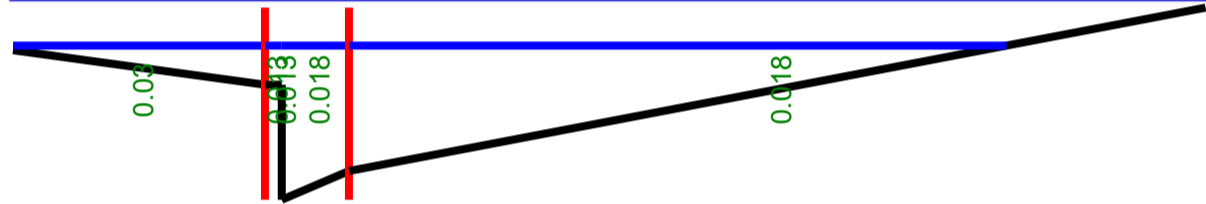
Q

39.83

cfs

▼

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	.65			0.03									
7.5	.5	0.03	<input checked="" type="checkbox"/>	0.24	7.50	7.50	0.71	0.09	0.03	1.55	0.04	0.88	1.10
8	.5	0.013	<input type="checkbox"/>	0.24	0.50	0.50	0.09						
8	0	0.013	<input type="checkbox"/>	0.94	0.00	0.00	0.00						
10	.125	0.018	<input checked="" type="checkbox"/>	0.77	2.00	2.00	1.22	0.52	0.02	8.44	1.11	1.85	10.97
35.5	.835	0.018	<input checked="" type="checkbox"/>	0.00	19.57	19.58	5.33	0.27	0.02	5.20	0.42	1.76	27.75



## Notes

- Composite n**

This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).
- Rock lining**

Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

Modified Arterial Saybrook Rd @4.42%

Inputs

Water surface elevation

.67

ft

▼

Channel slope, S

4.42

% rise/run

▼

Results

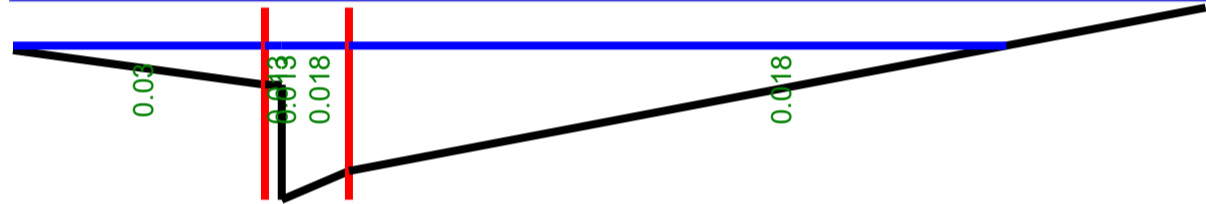
Q

55.82

cfs

▼

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	.65			0.06									
7.5	.5	0.03	<input checked="" type="checkbox"/>	0.47	7.50	7.50	0.71	0.09	0.03	2.17	0.07	1.24	1.54
8	.5	0.013	<input type="checkbox"/>	0.47	0.50	0.50	0.09						
8	0	0.013	<input type="checkbox"/>	1.85	0.00	0.00	0.00						
10	.125	0.018	<input checked="" type="checkbox"/>	1.50	2.00	2.00	1.22	0.52	0.02	11.83	2.17	2.59	15.38
35.5	.835	0.018	<input checked="" type="checkbox"/>	0.00	19.57	19.58	5.33	0.27	0.02	7.29	0.83	2.46	38.90



## Notes

### Composite n

This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

### Rock lining

Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

50' ROW 6" Curb Center Crown @ 0.50% - 7.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation

1

ft

▼

Channel slope, S

0.50

% rise/run

▼

Results

Q

25.15

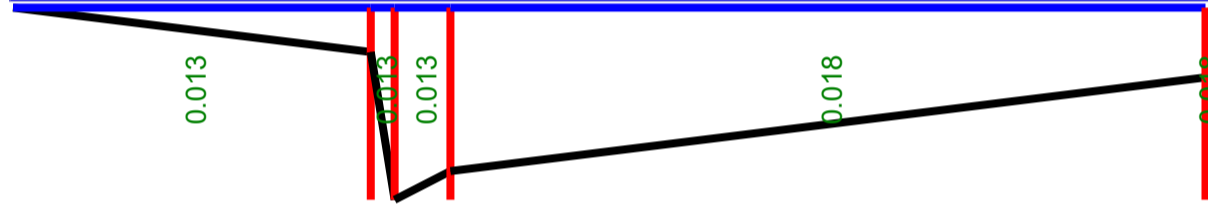
cfs

▼

Fish Camp Max Q100=16.0 cfs < 25.15 cfs

Masonboro Max Q100=4.0 cfs < 25.15 cfs

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	1			0.00									
7.5	0.85	0.013	<input checked="" type="checkbox"/>	0.05	7.50	7.50	0.56	0.07	0.01	1.44	0.03	0.93	0.81
8	0.35	0.013	<input checked="" type="checkbox"/>	0.20	0.50	0.71	0.20	0.28	0.01	3.48	0.19	0.97	0.70
9.17	0.447	0.013	<input checked="" type="checkbox"/>	0.17	1.17	1.17	0.70	0.60	0.01	5.75	0.51	1.31	4.04
25	0.764	0.018	<input checked="" type="checkbox"/>	0.07	15.83	15.83	6.25	0.39	0.02	3.14	0.15	0.88	19.61
25	0.764	0.018	<input checked="" type="checkbox"/>	0.07	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00



## Notes

**Composite n**  
This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

**Rock lining**  
Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

50' ROW 6" Curb Center Crown @ 1.00% - 7.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation

1

ft

▼

Channel slope, S

1.00

% rise/run

▼

Results

Q

35.57

cfs

▼

Sunken Meadow Max Q100=21.0 cfs < 35.57 cfs  
Fish Camp Max Q100=16.0 cfs < 35.57 cfs  
Manor Haven Max Q100=13.0 cfs < 35.57 cfs

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	1			0.00									
7.5	0.85	0.013	<input checked="" type="checkbox"/>	0.09	7.50	7.50	0.56	0.07	0.01	2.03	0.06	1.31	1.14
8	0.35	0.013	<input checked="" type="checkbox"/>	0.41	0.50	0.71	0.20	0.28	0.01	4.93	0.38	1.37	0.99
9.17	0.447	0.013	<input checked="" type="checkbox"/>	0.35	1.17	1.17	0.70	0.60	0.01	8.13	1.03	1.85	5.72
25	0.764	0.018	<input checked="" type="checkbox"/>	0.15	15.83	15.83	6.25	0.39	0.02	4.44	0.31	1.25	27.73
25	0.764	0.018	<input checked="" type="checkbox"/>	0.15	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00

0.013

0.013

0.018

## Notes

### Composite n

This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

### Rock lining

Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

50' ROW 6" Curb Center Crown @ 1.25% - 7.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation

1

ft

▼

Channel slope, S

1.25

% rise/run

▼

Results

Q

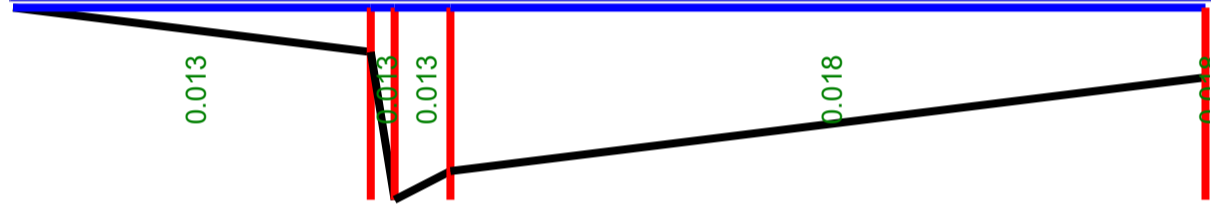
39.77

cfs

▼

Fish Camp Max Q100=16.0 cfs < 39.77 cfs  
Megansett Max Q100=32.0 cfs < 39.77 cfs

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	1			0.00									
7.5	0.85	0.013	<input checked="" type="checkbox"/>	0.12	7.50	7.50	0.56	0.07	0.01	2.27	0.08	1.46	1.28
8	0.35	0.013	<input checked="" type="checkbox"/>	0.51	0.50	0.71	0.20	0.28	0.01	5.51	0.47	1.54	1.10
9.17	0.447	0.013	<input checked="" type="checkbox"/>	0.43	1.17	1.17	0.70	0.60	0.01	9.09	1.28	2.07	6.39
25	0.764	0.018	<input checked="" type="checkbox"/>	0.18	15.83	15.83	6.25	0.39	0.02	4.96	0.38	1.39	31.00
25	0.764	0.018	<input checked="" type="checkbox"/>	0.18	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00



## Notes

### Composite n

This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

### Rock lining

Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

50' ROW 6" Curb Center Crown @ 1.50% - 7.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation1ft

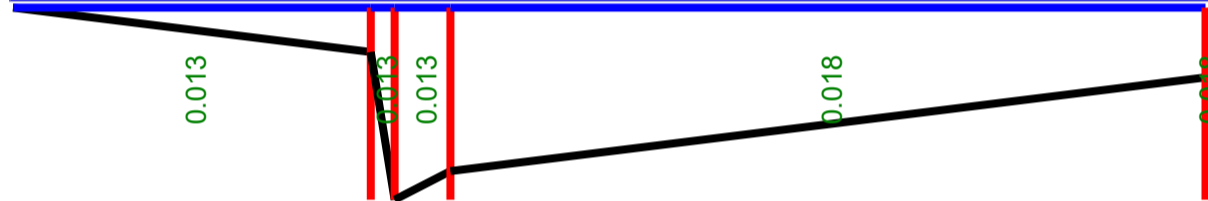
Channel slope, S1.50% rise/run

Results

Q43.57

cfs

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	1			0.00									
7.5	0.85	0.013	<input checked="" type="checkbox"/>	0.14	7.50	7.50	0.56	0.07	0.01	2.49	0.10	1.60	1.40
8	0.35	0.013	<input checked="" type="checkbox"/>	0.61	0.50	0.71	0.20	0.28	0.01	6.03	0.57	1.68	1.21
9.17	0.447	0.013	<input checked="" type="checkbox"/>	0.52	1.17	1.17	0.70	0.60	0.01	9.95	1.54	2.26	7.00
25	0.764	0.018	<input checked="" type="checkbox"/>	0.22	15.83	15.83	6.25	0.39	0.02	5.44	0.46	1.53	33.96
25	0.764	0.018	<input type="checkbox"/>	0.22	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00



## Notes

**Composite n**  
This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

**Rock lining**  
Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

- Saybrook Max Q100=12.0 cfs < 43.57 cfs
- Sandy Neck Max Q100=16.0 cfs < 43.57 cfs
- Fish Camp Max Q100=16.0 cfs < 43.57 cfs
- Manor Haven Max Q100=13.0 cfs < 43.57 cfs
- Beech Creek Max Q100=13.0 cfs < 43.57 cfs
- Muddy Pond Max Q100=28.0 cfs < 43.57 cfs
- Masonboro Max Q100=4.0 cfs < 43.57 cfs

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

50' ROW 6" Curb Center Crown @ 1.75% - 7.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation

1

ft

▼

Channel slope, S

1.75

% rise/run

▼

Results

Q

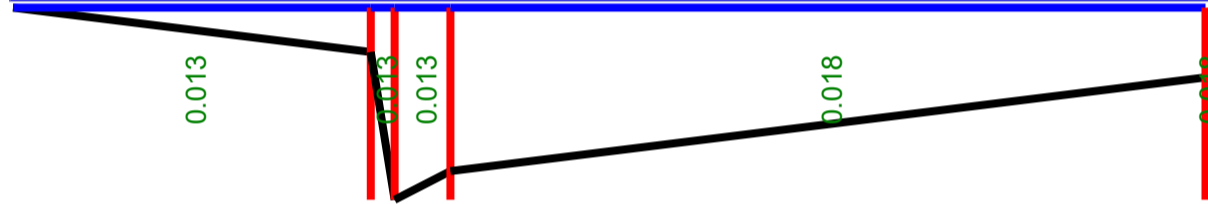
47.06

cfs

▼

Muddy Pond Max Q100=28.0 cfs < 47.06 cfs

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	1			0.00									
7.5	0.85	0.013	<input checked="" type="checkbox"/>	0.16	7.50	7.50	0.56	0.07	0.01	2.69	0.11	1.73	1.51
8	0.35	0.013	<input checked="" type="checkbox"/>	0.71	0.50	0.71	0.20	0.28	0.01	6.52	0.66	1.82	1.30
9.17	0.447	0.013	<input checked="" type="checkbox"/>	0.60	1.17	1.17	0.70	0.60	0.01	10.75	1.80	2.44	7.57
25	0.764	0.018	<input checked="" type="checkbox"/>	0.26	15.83	15.83	6.25	0.39	0.02	5.87	0.54	1.65	36.68
25	0.764	0.018	<input checked="" type="checkbox"/>	0.26	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00



## Notes

**Composite n**  
This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

**Rock lining**  
Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

50' ROW 6" Curb Center Crown @ 2.00% - 7.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation1ft

Channel slope, S2.0% rise/run

Results

Q50.31

cfs

Cross section points +/- (or Copy/Paste using data area)

Point					Segment			Region					
Sta	Elev	n for seg-	R <sub>h</sub> , Q region boundary (Bank)	Bot. shear τ	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp. n	v	H <sub>v</sub>	Fr	Q
ft	ft	ment	(Bank)	psf	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
0	1			0.00									
7.5	0.85	0.013	<input checked="" type="checkbox"/>	0.19	7.50	7.50	0.56	0.07	0.01	2.87	0.13	1.85	1.62
8	0.35	0.013	<input checked="" type="checkbox"/>	0.81	0.50	0.71	0.20	0.28	0.01	6.97	0.75	1.94	1.39
9.17	0.447	0.013	<input checked="" type="checkbox"/>	0.69	1.17	1.17	0.70	0.60	0.01	11.49	2.05	2.61	8.09
25	0.764	0.018	<input checked="" type="checkbox"/>	0.29	15.83	15.83	6.25	0.39	0.02	6.28	0.61	1.76	39.21
25	0.764	0.018	<input checked="" type="checkbox"/>	0.29	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00

Notes

Composite n

This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

Rock lining

Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

Sunken Meadow Max Q100=21.0 cfs &lt; 50.31 cfs

Fish Camp Max Q100=16.0 cfs &lt; 50.31 cfs

Manor Haven Max Q100=13.0 cfs &lt; 50.31 cfs

Beech Creek Max Q100=13.0 cfs &lt; 50.31 cfs

Muddy Pond Max Q100=28.0 cfs &lt; 50.31 cfs

Megansett Max Q100=32.0 cfs &lt; 50.31 cfs

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

50' ROW 6" Curb Center Crown @ 2.25% - 7.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation

1

ft

▼

Channel slope, S

2.25

% rise/run

▼

Results

Q

53.36

cfs

▼

Sandy Neck Max Q100=16.0 cfs < 53.36 cfs  
Muddy Pond Max Q100=28.0 cfs < 53.36 cfs

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	1			0.00									
7.5	0.85	0.013	<input checked="" type="checkbox"/>	0.21	7.50	7.50	0.56	0.07	0.01	3.05	0.14	1.96	1.71
8	0.35	0.013	<input checked="" type="checkbox"/>	0.91	0.50	0.71	0.20	0.28	0.01	7.39	0.85	2.06	1.48
9.17	0.447	0.013	<input checked="" type="checkbox"/>	0.78	1.17	1.17	0.70	0.60	0.01	12.19	2.31	2.77	8.58
25	0.764	0.018	<input checked="" type="checkbox"/>	0.33	15.83	15.83	6.25	0.39	0.02	6.66	0.69	1.87	41.59
25	0.764	0.018	<input checked="" type="checkbox"/>	0.33	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00

0.013

0.013

0.018

## Notes

### Composite n

This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

### Rock lining

Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

50' ROW 6" Curb Center Crown @ 2.50% - 7.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation

1

ft

▼

Channel slope, S

2.5

% rise/run

▼

Results

Q

56.25

cfs

▼

Sunken Meadow Max Q100=21.0 cfs < 56.25 cfs  
Manor Haven Max Q100=13.0 cfs < 56.25 cfs  
Sandy Neck Max Q100=16.0 cfs < 56.25 cfs

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	1			0.00									
7.5	0.85	0.013	<input checked="" type="checkbox"/>	0.23	7.50	7.50	0.56	0.07	0.01	3.21	0.16	2.07	1.81
8	0.35	0.013	<input checked="" type="checkbox"/>	1.01	0.50	0.71	0.20	0.28	0.01	7.79	0.94	2.17	1.56
9.17	0.447	0.013	<input checked="" type="checkbox"/>	0.86	1.17	1.17	0.70	0.60	0.01	12.85	2.57	2.92	9.04
25	0.764	0.018	<input checked="" type="checkbox"/>	0.37	15.83	15.83	6.25	0.39	0.02	7.02	0.77	1.97	43.84
25	0.764	0.018	<input checked="" type="checkbox"/>	0.37	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00

0.013

0.013

0.018

## Notes

### Composite n

This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

### Rock lining

Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

50' ROW 6" Curb Center Crown @ 2.75% - 7.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation

1

ft

▼

Channel slope, S

2.75

% rise/run

▼

Results

Q

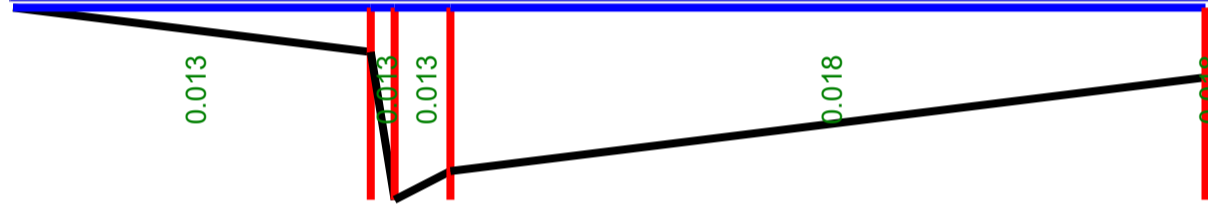
58.99

cfs

▼

Beech Creek Max Q100=13.0 cfs < 58.99 cfs

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	1			0.00									
7.5	0.85	0.013	<input checked="" type="checkbox"/>	0.26	7.50	7.50	0.56	0.07	0.01	3.37	0.18	2.17	1.90
8	0.35	0.013	<input checked="" type="checkbox"/>	1.12	0.50	0.71	0.20	0.28	0.01	8.17	1.04	2.28	1.63
9.17	0.447	0.013	<input checked="" type="checkbox"/>	0.95	1.17	1.17	0.70	0.60	0.01	13.48	2.82	3.06	9.48
25	0.764	0.018	<input checked="" type="checkbox"/>	0.41	15.83	15.83	6.25	0.39	0.02	7.36	0.84	2.07	45.98
25	0.764	0.018	<input checked="" type="checkbox"/>	0.41	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00



## Notes

**Composite n**  
This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

**Rock lining**  
Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

50' ROW 6" Curb Center Crown @ 3.25% - 7.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation

1

ft

▼

Channel slope, S

3.25

% rise/run

▼

Results

Q

64.13

cfs

▼

Sunken Meadow Max Q100=21.0 cfs < 64.13 cfs

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	1			0.00									
7.5	0.85	0.013	<input checked="" type="checkbox"/>	0.30	7.50	7.50	0.56	0.07	0.01	3.66	0.21	2.36	2.06
8	0.35	0.013	<input checked="" type="checkbox"/>	1.32	0.50	0.71	0.20	0.28	0.01	8.88	1.23	2.48	1.78
9.17	0.447	0.013	<input checked="" type="checkbox"/>	1.12	1.17	1.17	0.70	0.60	0.01	14.65	3.34	3.33	10.31
25	0.764	0.018	<input checked="" type="checkbox"/>	0.48	15.83	15.83	6.25	0.39	0.02	8.00	1.00	2.25	49.98
25	0.764	0.018	<input checked="" type="checkbox"/>	0.48	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00

0.013

0.013

0.013

0.018

## Notes

### Composite n

This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

### Rock lining

Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

50' ROW 6" Curb Center Crown @ 4.00% - 7.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation

1

ft

▼

Channel slope, S

4.00

% rise/run

▼

Results

Q

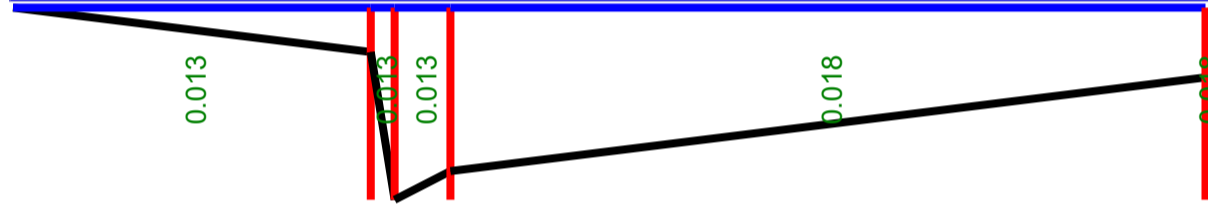
71.15

cfs

▼

Sunken Meadow Max Q100=21.0 cfs < 71.15 cfs

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	1			0.00									
7.5	0.85	0.013	<input checked="" type="checkbox"/>	0.37	7.50	7.50	0.56	0.07	0.01	4.07	0.26	2.62	2.29
8	0.35	0.013	<input checked="" type="checkbox"/>	1.62	0.50	0.71	0.20	0.28	0.01	9.85	1.51	2.75	1.97
9.17	0.447	0.013	<input checked="" type="checkbox"/>	1.38	1.17	1.17	0.70	0.60	0.01	16.25	4.11	3.70	11.44
25	0.764	0.018	<input checked="" type="checkbox"/>	0.59	15.83	15.83	6.25	0.39	0.02	8.88	1.23	2.49	55.45
25	0.764	0.018	<input checked="" type="checkbox"/>	0.59	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00



## Notes

### Composite n

This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

### Rock lining

Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

50' ROW 6" Curb Center Crown @ 4.50% - 7.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation

1

ft

▼

Channel slope, S

4.50

% rise/run

▼

Results

Q

75.46

cfs

▼

Fish Camp Max Q100=16.0 cfs < 75.46 cfs

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	1			0.00									
7.5	0.85	0.013	<input checked="" type="checkbox"/>	0.42	7.50	7.50	0.56	0.07	0.01	4.31	0.29	2.78	2.43
8	0.35	0.013	<input checked="" type="checkbox"/>	1.83	0.50	0.71	0.20	0.28	0.01	10.45	1.70	2.91	2.09
9.17	0.447	0.013	<input checked="" type="checkbox"/>	1.55	1.17	1.17	0.70	0.60	0.01	17.24	4.62	3.92	12.13
25	0.764	0.018	<input checked="" type="checkbox"/>	0.66	15.83	15.83	6.25	0.39	0.02	9.42	1.38	2.65	58.82
25	0.764	0.018	<input checked="" type="checkbox"/>	0.66	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00

0.013

0.013

0.018

## Notes

### Composite n

This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

### Rock lining

Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

50' ROW 6" Curb Center Crown @ 6.00% - 7.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation

1

ft

▼

Channel slope, S

6.00

% rise/run

▼

Results

Q

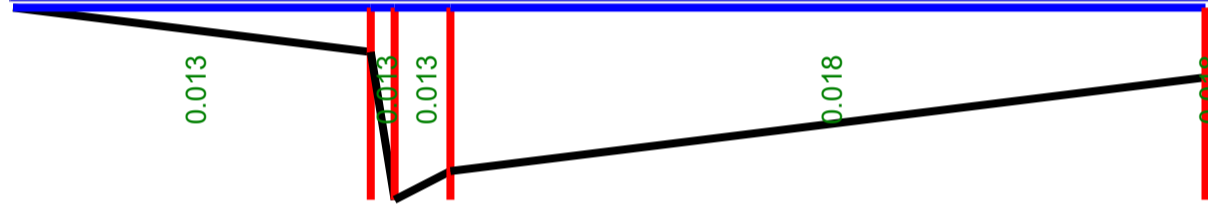
87.14

cfs

▼

Fish Camp Max Q100=16.0 cfs < 87.14 cfs

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	1			0.00									
7.5	0.85	0.013	<input checked="" type="checkbox"/>	0.56	7.50	7.50	0.56	0.07	0.01	4.98	0.39	3.21	2.80
8	0.35	0.013	<input checked="" type="checkbox"/>	2.43	0.50	0.71	0.20	0.28	0.01	12.06	2.26	3.37	2.41
9.17	0.447	0.013	<input checked="" type="checkbox"/>	2.07	1.17	1.17	0.70	0.60	0.01	19.90	6.16	4.53	14.01
25	0.764	0.018	<input checked="" type="checkbox"/>	0.88	15.83	15.83	6.25	0.39	0.02	10.88	1.84	3.06	67.91
25	0.764	0.018	<input checked="" type="checkbox"/>	0.88	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00



## Notes

**Composite n**  
This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

**Rock lining**  
Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

70' ROW 6" Curb Center Crown @ 0.55% - 17.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation

1

ft

▼

Channel slope, S

0.55

% rise/run

▼

Results

Q

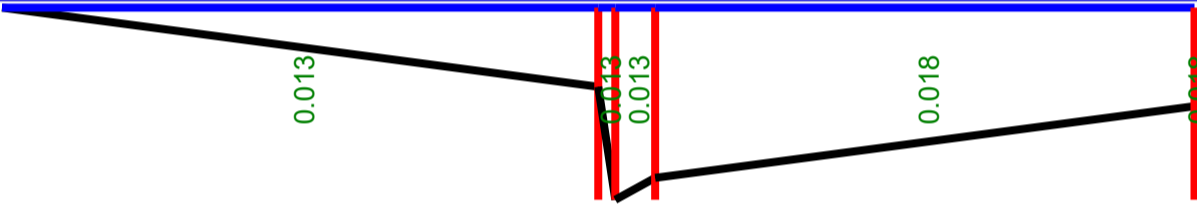
57.13

cfs

▼

Gilbert Max Q100=7.0 cfs < 57.13 cfs

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	1			0.00									
17.5	0.65	0.013	<input checked="" type="checkbox"/>	0.12	17.50	17.50	3.06	0.17	0.01	2.65	0.11	1.12	8.12
18	0.15	0.013	<input checked="" type="checkbox"/>	0.29	0.50	0.71	0.30	0.42	0.01	4.79	0.36	1.09	1.44
19.17	0.247	0.013	<input checked="" type="checkbox"/>	0.26	1.17	1.17	0.94	0.80	0.01	7.30	0.83	1.44	6.84
35	0.564	0.018	<input checked="" type="checkbox"/>	0.15	15.83	15.83	9.41	0.59	0.02	4.33	0.29	0.99	40.73
35	0.564	0.018	<input checked="" type="checkbox"/>	0.15	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00



## Notes

### Composite n

This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

### Rock lining

Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

# Irregular Channel Manning Uniform Flow Calculator

Waterbury Filing No. 1

70' ROW 6" Curb Center Crown @ 0.55% - 17.5' Back Conveyance @ 2.0%

Inputs

Water surface elevation

1

ft

▼

Channel slope, S

1.5

% rise/run

▼

Results

Q

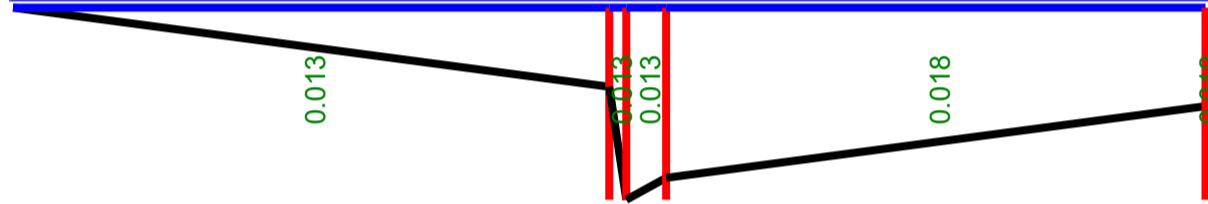
94.35

cfs

▼

Gilbert Max Q100=7.0 cfs < 94.35 cfs

Cross section points +/- (or Copy/Paste using data area)													
Point					Segment			Region					
Sta	Elev	n	R <sub>h</sub> , Q	Bot.	T	P <sub>w</sub>	A	R <sub>h</sub>	Comp.	v	H <sub>v</sub>	Fr	Q
ft	ft	for seg-	region	shear	ft	ft	ft^2	ft	n	ft/sec	ft		cfs
		ment	boundary	τ									
			(Bank)	psf									
0	1			0.00									
17.5	0.65	0.013	<input checked="" type="checkbox"/>	0.33	17.50	17.50	3.06	0.17	0.01	4.38	0.30	1.85	13.41
18	0.15	0.013	<input checked="" type="checkbox"/>	0.80	0.50	0.71	0.30	0.42	0.01	7.90	0.97	1.80	2.37
19.17	0.247	0.013	<input checked="" type="checkbox"/>	0.71	1.17	1.17	0.94	0.80	0.01	12.05	2.26	2.37	11.30
35	0.564	0.018	<input checked="" type="checkbox"/>	0.41	15.83	15.83	9.41	0.59	0.02	7.15	0.79	1.63	67.26
35	0.564	0.018	<input checked="" type="checkbox"/>	0.41	NaN	0.00	0.00	NaN	NaN	NaN	NaN	NaN	0.00

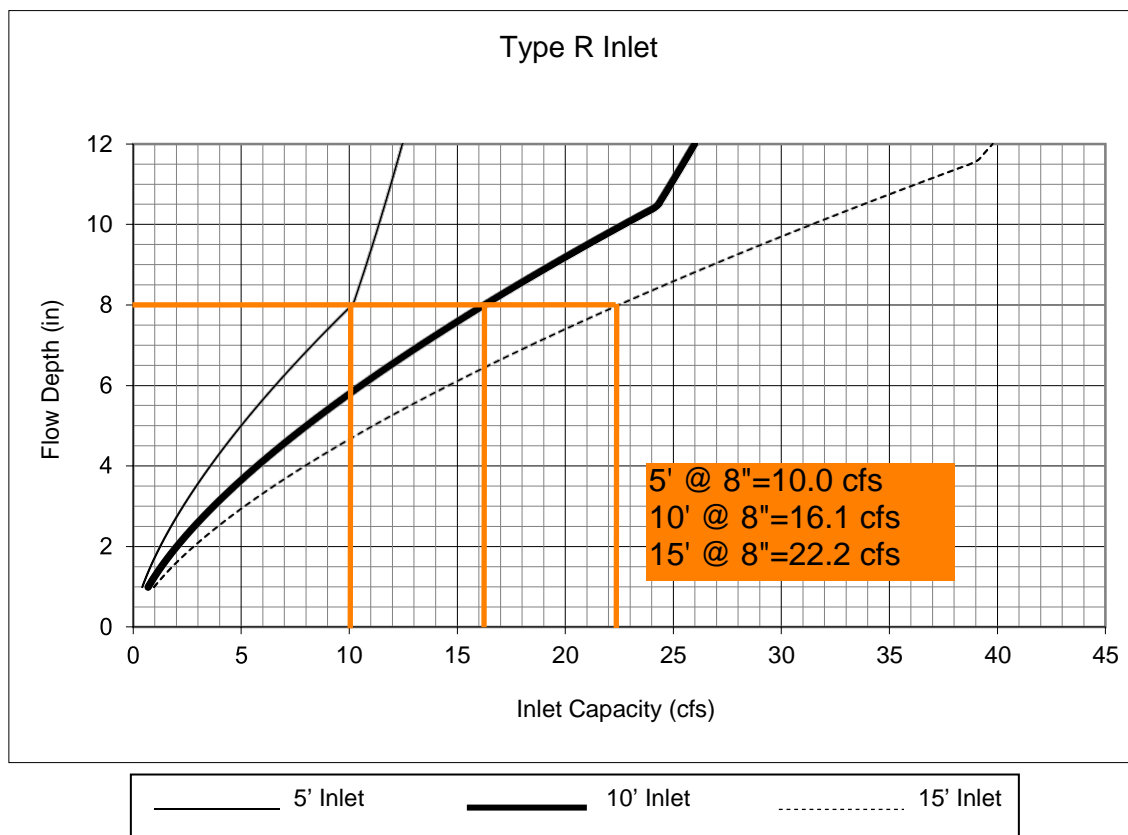


## Notes

**Composite n**  
This calculator follows HEC-RAS Reference Manual in calculating region composite n using Chow 1959, page 136, equation 6-17 (not 6-18).

**Rock lining**  
Use the Manning Trapezoidal Channel Calculator to design rock lining. This calculator is more for natural sections.

## **INLET CALCULATIONS**

**Figure 8-11. Inlet Capacity Chart Sump Conditions , Curb Opening (Type R) Inlet**

DP 1 (10') Q100=12.0 cfs < 16.1 cfs  
 DP 2 (5') Q100=4.0 cfs < 10.0 cfs  
 DP 3 (5') Q100=8.0 cfs < 10.0 cfs  
 DP 4 (10') Q100=13.0 cfs < 16.1 cfs  
 DP 5 (10') Q100=16.0 cfs < 16.1 cfs  
 DP 6 (5') Q100=8.0 cfs < 10.0 cfs  
 DP 7 (5') Q100=8.0 cfs < 10.0 cfs  
 DP 14 (10') Q100=13.0 cfs < 16.1 cfs  
 DP 15 (5') Q100=7.0 cfs < 10.0 cfs  
 DP 16 (10') Q100=10.0 cfs < 16.1 cfs  
 DP 17 (5') Q100=2.0 cfs < 10.0 cfs  
 DP 19 (10') Q100=16.0 cfs < 16.1 cfs  
 DP 20 (5') Q100=7.0 cfs < 10.0 cfs  
 DP 22 (15') Q100=19.0 cfs < 22.2 cfs  
 DP 23 (15') Q100=19.0 cfs < 22.2 cfs

DP 24 (5') Q100=6.0 cfs < 10.0 cfs  
 DP 25 (5') Q100=7.0 cfs < 10.0 cfs  
 DP 26 (10') Q100=16.0 cfs < 16.1 cfs  
 DP 27 (5') Q100=7.0 cfs < 10.0 cfs  
 DP 28 ((2) 10') Q100=21.0 cfs/2=10.5 cfs < 16.1 cfs

**Notes:**

1. The standard inlet parameters must apply to use this chart.

The inlets used have no modifications or deviations and therefore are standard per the Type R specifications

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

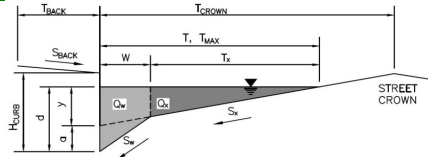
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Gold Hill Mesa Filing No. 13

Inlet ID:

Inlet DP 7A

**Gutter Geometry (Enter data in the blue cells)**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

$T_{BACK} = 13.0$  ft  
 $S_{BACK} = 0.041$  ft/ft  
 $n_{BACK} = 0.013$

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$H_{CURB} = 6.00$  inches  
 $T_{CROWN} = 23.0$  ft  
 $W = 2.00$  ft  
 $S_x = 0.020$  ft/ft  
 $S_w = 0.083$  ft/ft  
 $S_o = 0.013$  ft/ft  
 $n_{STREET} = 0.013$

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX} =$	23.0	23.0	ft
$d_{MAX} =$	6.0	12.4	inches
<input type="checkbox"/>	<input type="checkbox"/>		check = yes

**Maximum Capacity for 1/2 Street based On Allowable Spread**

Water Depth without Gutter Depression (Eq. ST-2)

Vertical Depth between Gutter Lip and Gutter Flowline (usually 2")

Gutter Depression ( $d_c - (W \cdot S_x \cdot 12)$ )

Water Depth at Gutter Flowline

Allowable Spread for Discharge outside the Gutter Section W ( $T - W$ )

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Discharge outside the Gutter Section W, carried in Section  $T_x$ Discharge within the Gutter Section W ( $Q_t - Q_x$ )

Discharge Behind the Curb (e.g., sidewalk, driveways, &amp; lawns)

**Maximum Flow Based On Allowable Spread**

Flow Velocity within the Gutter Section

 $V \cdot d$  Product: Flow Velocity times Gutter Flowline Depth

	Minor Storm	Major Storm	
$y =$	5.52	5.52	inches
$d_c =$	2.0	2.0	inches
$a =$	1.51	1.51	inches
$d =$	7.03	7.03	inches
$T_x =$	21.0	21.0	ft
$E_o =$	0.256	0.256	
$Q_x =$	24.2	24.2	cfs
$Q_w =$	8.3	8.3	cfs
$Q_{BACK} =$	0.2	0.2	cfs
$Q_t =$	32.7	32.7	cfs
$V =$	8.3	8.3	fps
$V \cdot d =$	4.9	4.9	

**Maximum Capacity for 1/2 Street based on Allowable Depth**

Theoretical Water Spread

Theoretical Spread for Discharge outside the Gutter Section W ( $T - W$ )

Gutter Flow to Design Flow Ratio by FHWA HEC-22 method (Eq. ST-7)

Theoretical Discharge outside the Gutter Section W, carried in Section  $T_{xTH}$ Actual Discharge outside the Gutter Section W, (limited by distance  $T_{CROWN}$ )Discharge within the Gutter Section W ( $Q_t - Q_x$ )

Discharge Behind the Curb (e.g., sidewalk, driveways, &amp; lawns)

Total Discharge for Major &amp; Minor Storm (Pre-Safety Factor)

Average Flow Velocity Within the Gutter Section

 $V \cdot d$  Product: Flow Velocity Times Gutter Flowline DepthSlope-Based Depth Safety Reduction Factor for Major & Minor ( $d \geq 6"$ ) Storm**Max Flow Based on Allowable Depth (Safety Factor Applied)**

Resultant Flow Depth at Gutter Flowline (Safety Factor Applied)

Resultant Flow Depth at Street Crown (Safety Factor Applied)

	Minor Storm	Major Storm	
$T_{TH} =$	18.7	45.4	ft
$T_{xTH} =$	16.7	43.4	ft
$E_o =$	0.318	0.125	
$Q_{xTH} =$	13.1	167.4	cfs
$Q_x =$	13.1	138.7	cfs
$Q_w =$	6.1	24.0	cfs
$Q_{BACK} =$	0.0	22.1	cfs
$Q =$	19.3	184.8	cfs
$V =$	7.3	12.6	fps
$V \cdot d =$	3.7	13.1	
$R =$	1.00	1.00	
$Q_d =$	19.3	184.9	cfs
$d =$	6.00	12.40	inches
$d_{CROWN} =$	0.00	5.37	inches

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Spread Criterion

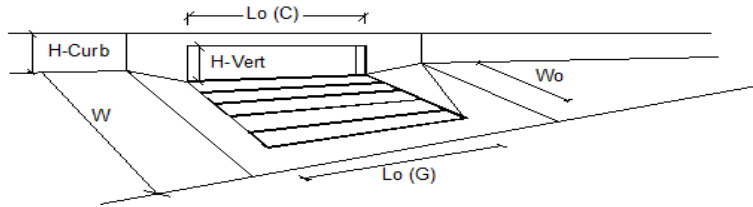
	Minor Storm	Major Storm	
$Q_{allow} =$	19.3	32.7	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

## INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input)	MINOR	MAJOR
Type of Inlet	CDOT Type R Curb Opening	
Local Depression (additional to continuous gutter depression 'a')	3.0	3.0
Total Number of Units in the Inlet (Grate or Curb Opening)	1	1
Length of a Single Unit Inlet (Grate or Curb Opening)	5.00	5.00
Width of a Unit Grate (cannot be greater than W, Gutter Width)	N/A	N/A
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	N/A	N/A
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	0.10	0.10
<b>Street Hydraulics: OK - Q &lt; Allowable Street Capacity</b>		
Total Inlet Interception Capacity	1	2
Total Inlet Carry-Over Flow (flow bypassing inlet)	0	1
Capture Percentage = $Q_i/Q_o$ =	98	72

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

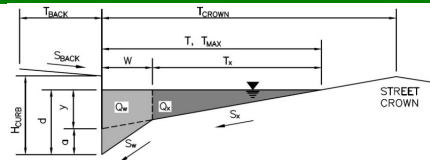
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Gold Hill Mesa Filing No. 13

Inlet ID:

Inlet DP 7B

**Gutter Geometry (Enter data in the blue cells)**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (leave blank for no)

$T_{BACK} = 9.9$  ft  
 $S_{BACK} = 0.100$  ft/ft  
 $n_{BACK} = 0.013$

$H_{CURB} = 6.00$  inches  
 $T_{CROWN} = 43.5$  ft  
 $W = 2.00$  ft  
 $S_x = 0.020$  ft/ft  
 $S_w = 0.083$  ft/ft  
 $S_o = 0.013$  ft/ft  
 $n_{STREET} = 0.013$

	Minor Storm	Major Storm	
$T_{MAX} =$	31.5	43.5	ft
$d_{MAX} =$	6.0	7.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	check = yes

MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

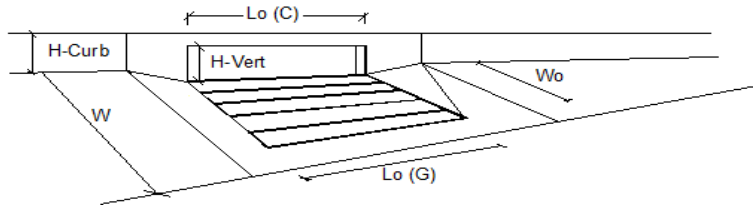
	Minor Storm	Major Storm	
$Q_{allow} =$	19.3	32.3	cfs

Minor storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design flow given on sheet 'Inlet Management'

## INLET ON A CONTINUOUS GRADE

Version 4.05 Released March 2017



Design Information (Input)	MINOR	MAJOR
Type of Inlet	CDOT Type R Curb Opening	
Local Depression (additional to continuous gutter depression 'a')	3.0	3.0
Total Number of Units in the Inlet (Grate or Curb Opening)	1	1
Length of a Single Unit Inlet (Grate or Curb Opening)	5.00	5.00
Width of a Unit Grate (cannot be greater than W, Gutter Width)	N/A	N/A
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	N/A	N/A
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	0.10	0.10
<b>Street Hydraulics: OK - Q &lt; Allowable Street Capacity</b>		
Total Inlet Interception Capacity	1	2
Total Inlet Carry-Over Flow (flow bypassing inlet)	0	1
Capture Percentage = $Q_i/Q_o$ =	91	63

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

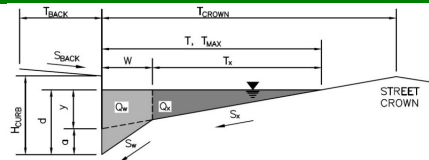
(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project:

Gold Hill Mesa Filing No. 13

Inlet ID:

Inlet DP 21

**Gutter Geometry (Enter data in the blue cells)**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (leave blank for no)

$T_{BACK} = 7.5$  ft  
 $S_{BACK} = 0.020$  ft/ft  
 $n_{BACK} = 0.013$

$H_{CURB} = 6.00$  inches  
 $T_{CROWN} = 17.5$  ft  
 $W = 2.00$  ft  
 $S_x = 0.020$  ft/ft  
 $S_w = 0.083$  ft/ft  
 $S_o = 0.018$  ft/ft  
 $n_{STREET} = 0.013$

	Minor Storm	Major Storm	
$T_{MAX} =$	11.5	17.5	ft
$d_{MAX} =$	6.0	7.8	inches
	<input type="checkbox"/>	<input type="checkbox"/>	check = yes

MINOR STORM Allowable Capacity is based on Spread Criterion

MAJOR STORM Allowable Capacity is based on Spread Criterion

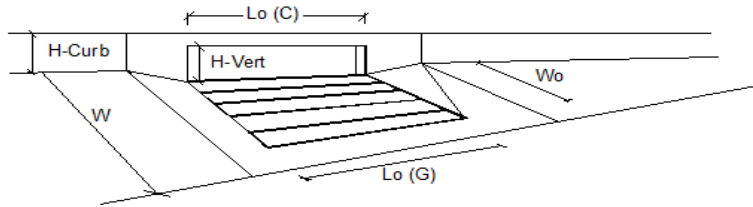
	Minor Storm	Major Storm	
$Q_{allow} =$	7.0	19.0	cfs

WARNING: MINOR STORM max. allowable capacity is less than the design flow given on sheet 'Inlet Management'

WARNING: MAJOR STORM max. allowable capacity is less than the design flow given on sheet 'Inlet Management'

## INLET ON A CONTINUOUS GRADE

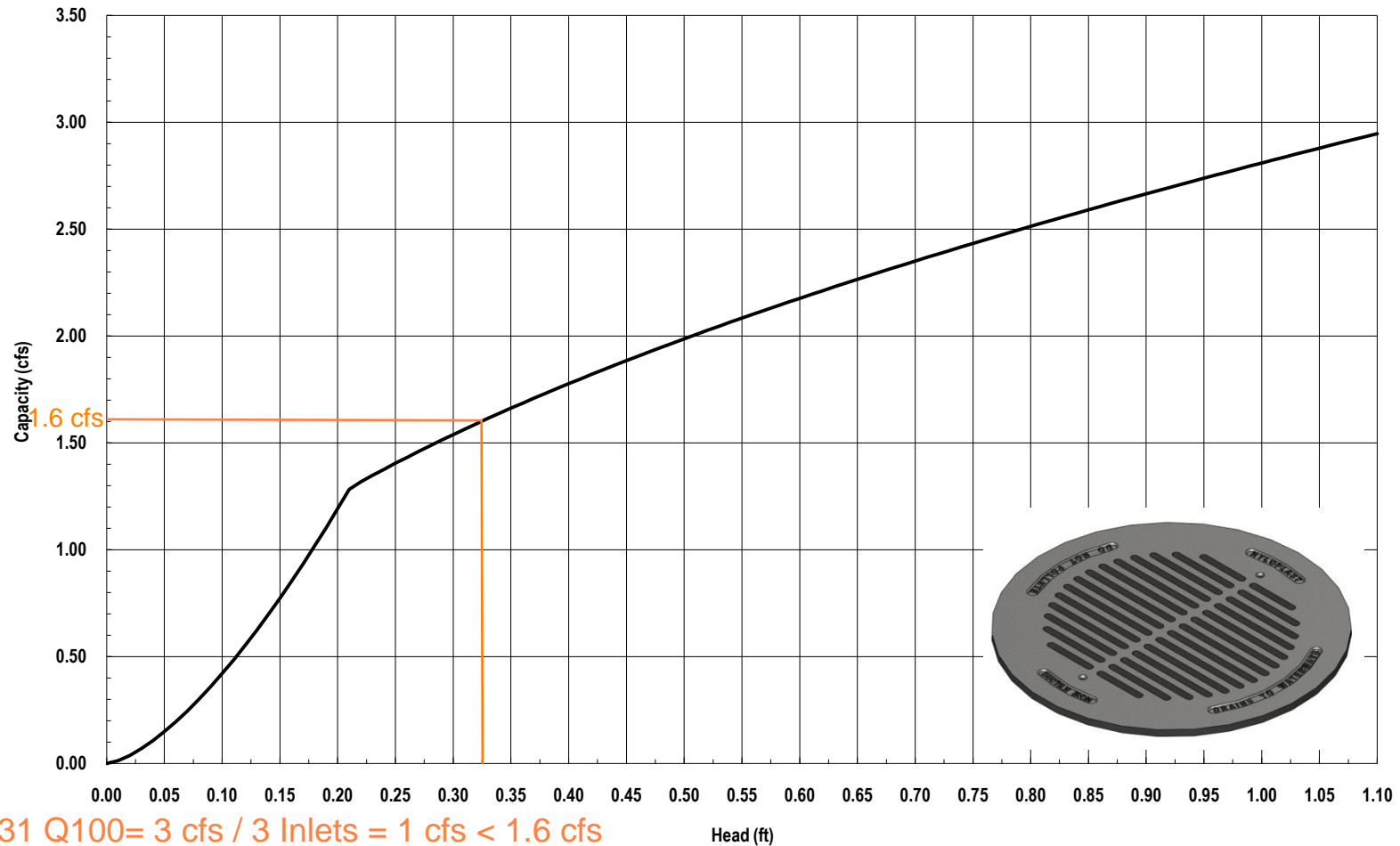
Version 4.05 Released March 2017



Design Information (Input)	MINOR	MAJOR
Type of Inlet	CDOT Type R Curb Opening	
Local Depression (additional to continuous gutter depression 'a')	3.0	3.0
Total Number of Units in the Inlet (Grate or Curb Opening)	1	1
Length of a Single Unit Inlet (Grate or Curb Opening)	10.00	10.00
Width of a Unit Grate (cannot be greater than W, Gutter Width)	N/A	N/A
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	N/A	N/A
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	0.10	0.10
<b>Street Hydraulics: WARNING: Q &gt; ALLOWABLE Q FOR MINOR &amp; MAJOR STORM</b>		
Total Inlet Interception Capacity	7	11
Total Inlet Carry-Over Flow (flow bypassing inlet)	5	17
Capture Percentage = $Q_c/Q_o$ =	61	39

# Nyloplast 18" Drop In Grate Inlet Capacity Chart

## REAR YARD PRIVATE AREA INLETS



DP 31 Q100= 3 cfs / 3 Inlets = 1 cfs < 1.6 cfs

DP 32 Q100= 2 cfs / 2 Inlets = 1 cfs < 1.6 cfs

DP 33 Q100= 3 cfs / 4 Inlets = 0.75 cfs < 1.6 cfs

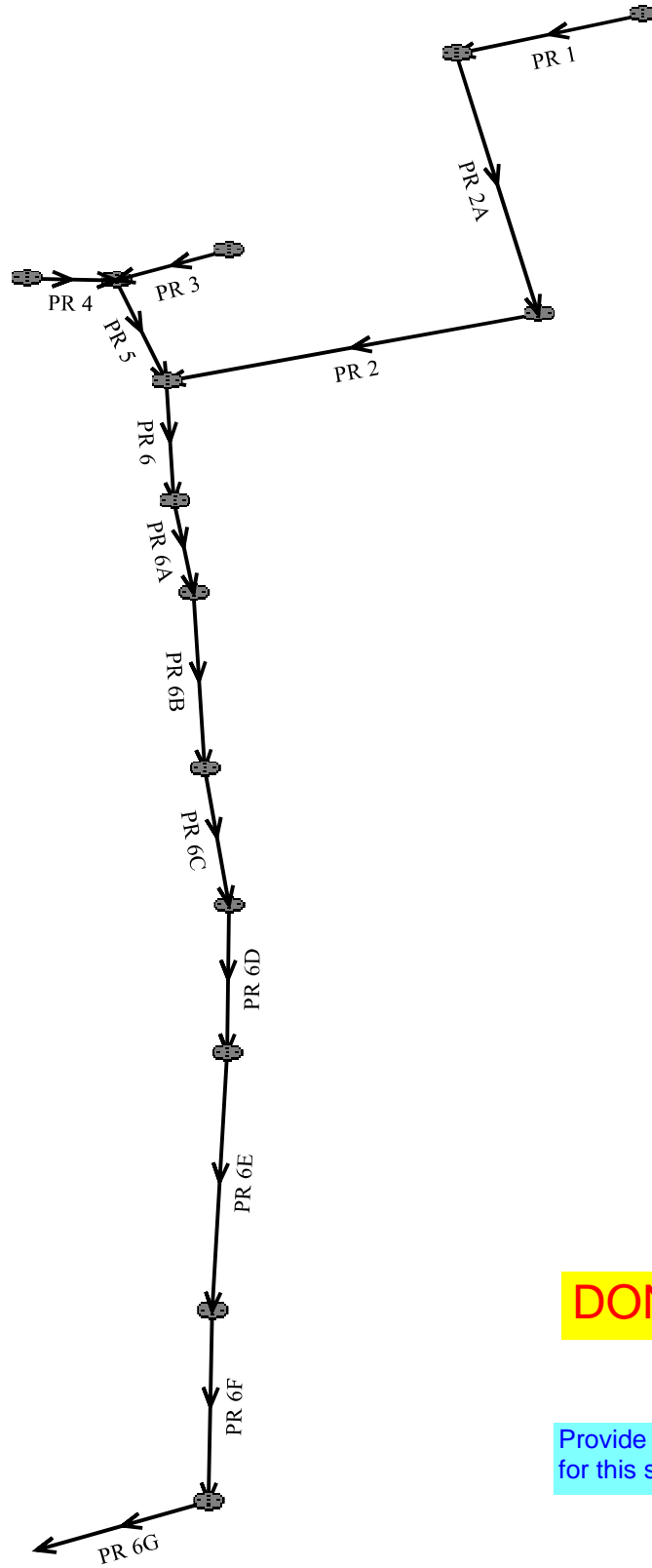
DP 34 Q100= 2 cfs / 3 Inlets = 0.66 cfs < 1.6 cfs



3130 Verona Avenue • Buford, GA 30518  
 (866) 888-8479 / (770) 932-2443 • Fax: (770) 932-2490  
 © Nyloplast Inlet Capacity Charts June 2012

## **HGL CALCULATIONS**

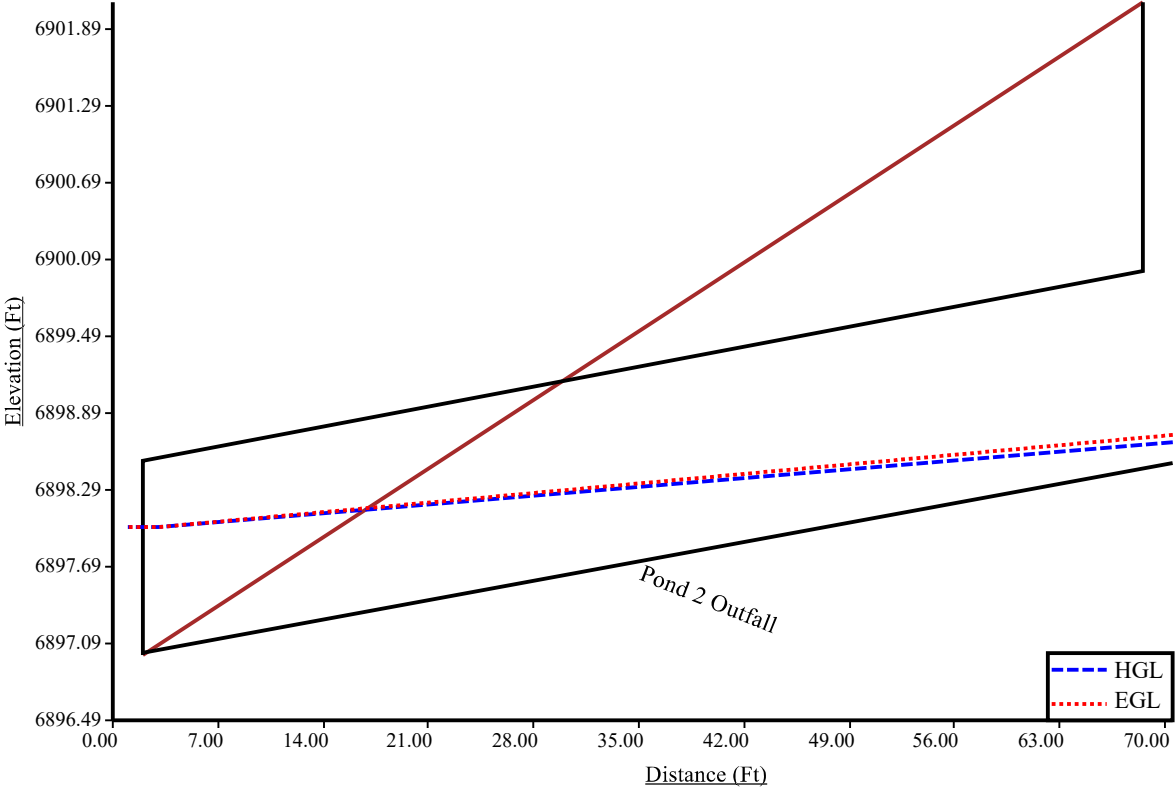
# PIPE RUN 1-7



DONE

Provide summary tables  
for this storm system

Pond 2 Outfall 5-YR HGL Profile



**Program:**  
UDSEWER Math  
Model Interface  
2.1.1.4  
**Run Date:**  
11/26/2024 1:39:23  
PM

**UDSewer Results Summary**  
  
**Project Title:** Pond 2 Outfall  
**Project Description:** 100-year

System Input Summary

Rainfall Parameters

**Rainfall Return Period:** 100  
**Rainfall Calculation Method:** Formula  
  
**One Hour Depth (in):**  
**Rainfall Constant "A":** 28.5  
**Rainfall Constant "B":** 10  
**Rainfall Constant "C":** 0.786

Rational Method Constraints

**Minimum Urban Runoff Coeff.:** 0.20  
**Maximum Rural Overland Len. (ft):** 500  
**Maximum Urban Overland Len. (ft):** 300  
**Used UDFCD Tc. Maximum:** Yes

Sizer Constraints

**Minimum Sewer Size (in):** 18.00  
**Maximum Depth to Rise Ratio:** 0.90  
**Maximum Flow Velocity (fps):** 18.0  
**Minimum Flow Velocity (fps):** 2.0

Backwater Calculations:

**Tailwater Elevation (ft):** 6898.00

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
Riprap Spillway	6897.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Pond 2 Outfall	6902.10	14.80	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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## Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
Riprap Spillway	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Surface Water Present (Upstream)
Pond 2 Outfall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.80	Surface Water Present (Downstream)

## Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
Pond 2 Outfall	70.50	6897.02	2.1	6898.50	0.013	0.00	0.00	CIRCULAR	18.00 in	18.00 in

## Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
Pond 2 Outfall	15.26	8.64	16.81	8.62	14.28	9.84	1.56	Supercritical	14.80	0.00	

- A Froude number of 0 indicates that pressurized flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

## Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
Pond 2 Outfall	14.80	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.

- Sewer sizes should not decrease downstream.
- All hydraulics were calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 6898.00

Element Name	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
Pond 2 Outfall	6897.02	6898.50	0.00	0.00	6898.21	6899.90	6899.71	1.34	6901.05

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss =  $Bend\ K * V_{fi}^2 / (2 * g)$
- Lateral loss =  $V_{fo}^2 / (2 * g) - Junction\ Loss\ K * V_{fi}^2 / (2 * g)$ .
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

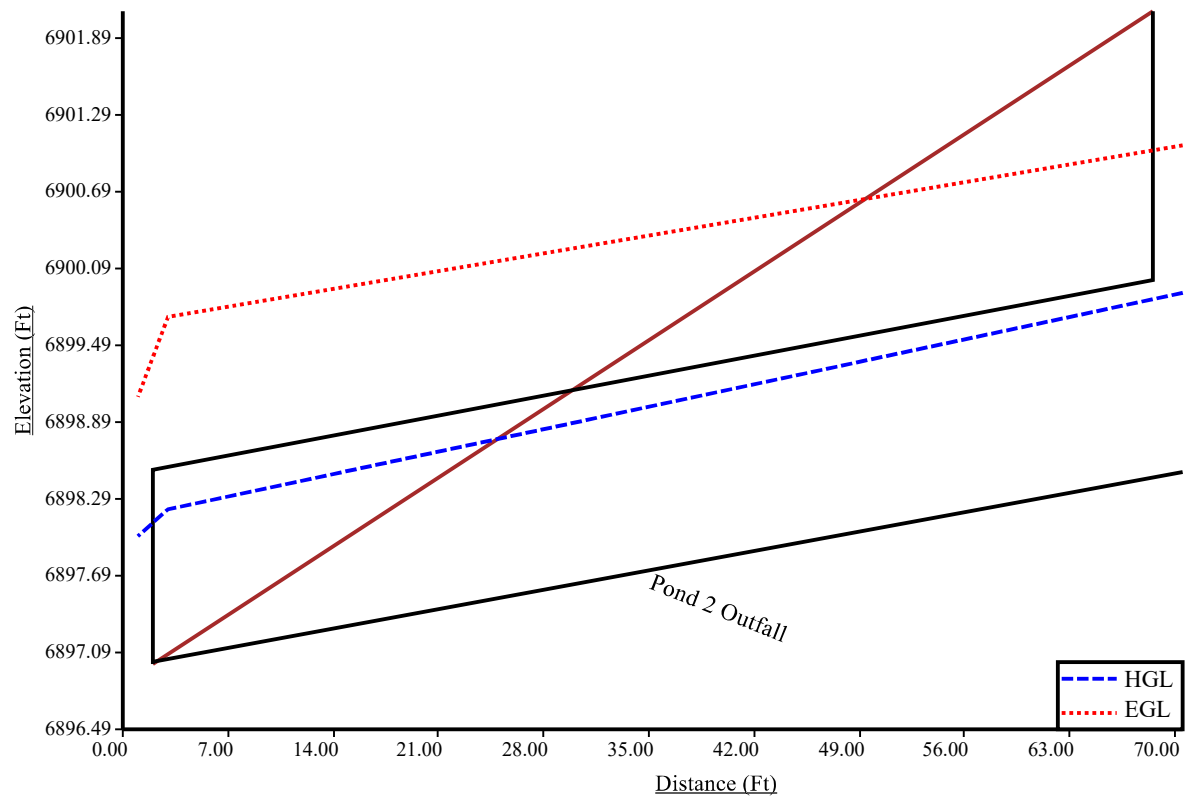
The trench side slope is 1.0 ft/ft  
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
Pond 2 Outfall	70.50	2.50	4.00	4.92	0.00	0.52	0.00	6.70	4.14	1.89	30.98	Sewer Too Shallow

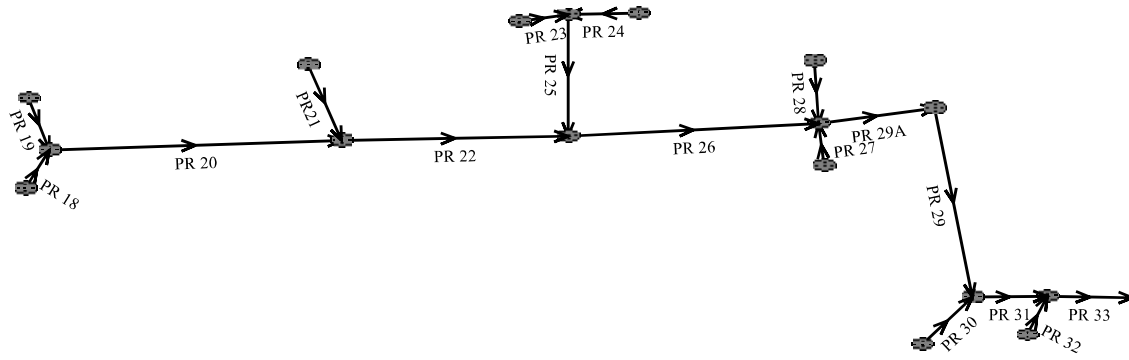
Total earth volume for sewer trenches = 31 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

Pond 2 Outfall 100-YR HGL Profile



# PIPE RUN 18-33 & ASSOCIATED LATERALS LAYOUT



<div><div><div><div>Program:</div><div>UDSEWER Math Model Interface 2.1.1.4</div></div><div><div>Run Date:</div><div>11/26/2024 2:27:27 PM</div></div></div></div> <div><div>UDSewer Results Summary</div><div><div>Project Title: New UDSEWER System Module</div><div>Project Description: Default system</div></div><div>PIPE RUN 18-33 AND ASSOCIATED LATERALS</div></div>
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System Input Summary

Rainfall Parameters

Rainfall Return Period: 5

Rainfall Calculation Method: Formula

One Hour Depth (in):

Rainfall Constant "A": 28.5

Rainfall Constant "B": 10

Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20

Maximum Rural Overland Len. (ft): 500

Maximum Urban Overland Len. (ft): 300

Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00

Maximum Depth to Rise Ratio: 0.90

Maximum Flow Velocity (fps): 18.0

Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 6927.75

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
FSD 3	6924.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 33A	6931.20	45.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PR 37	6931.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 33	6935.00	44.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 32	6935.06	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 31	6934.70	41.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 29	6941.90	36.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 29A	6941.40	36.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 28	6941.66	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 26	6947.10	31.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 25	6945.70	15.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 24	6945.98	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 23	6945.98	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 22	6952.18	18.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
PR 20	6952.70	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 18	6953.15	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 19	6953.14	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR21	6952.61	8.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 27	6941.66	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 30	6935.06	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
FSD 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Surface Water Present (Upstream)
PR 33A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	45.00	Surface Water Present (Downstream)
PR 37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
PR 33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.00	
PR 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	
PR 31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	41.00	
PR 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.00	
PR 29A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.00	
PR 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	
PR 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	31.00	
PR 25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15.00	
PR 24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	
PR 23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	
PR 22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18.00	
PR 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.00	
PR 18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	

PR 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	
PR21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.00	
PR 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	
PR 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	

## Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
PR 33A	163.90	6924.25	1.0	6925.89	0.013	0.03	0.00	CIRCULAR	42.00 in	42.00 in
PR 37	7.57	6927.89	1.1	6927.97	0.013	1.00	0.00	CIRCULAR	12.00 in	12.00 in
PR 33	126.20	6925.89	1.0	6927.15	0.013	0.05	0.00	CIRCULAR	42.00 in	42.00 in
PR 32	11.86	6928.15	11.7	6929.54	0.013	0.38	0.00	CIRCULAR	18.00 in	18.00 in
PR 31	35.39	6927.15	1.0	6927.50	0.013	0.05	0.00	CIRCULAR	42.00 in	42.00 in
PR 29	274.51	6927.71	1.8	6932.65	0.013	1.32	0.00	CIRCULAR	42.00 in	42.00 in
PR 29A	83.18	6932.97	1.6	6934.30	0.013	1.32	0.00	CIRCULAR	42.00 in	42.00 in
PR 28	25.17	6935.79	3.0	6936.55	0.013	1.32	0.00	CIRCULAR	18.00 in	18.00 in
PR 26	345.95	6934.75	1.3	6939.25	0.013	0.05	0.00	CIRCULAR	36.00 in	36.00 in
PR 25	105.89	6939.54	1.2	6940.81	0.013	1.32	0.00	CIRCULAR	36.00 in	36.00 in
PR 24	25.67	6941.31	1.0	6941.57	0.013	1.32	0.00	CIRCULAR	24.00 in	24.00 in
PR 23	5.99	6941.31	1.0	6941.37	0.013	1.32	0.00	CIRCULAR	24.00 in	24.00 in
PR 22	289.84	6939.89	1.8	6945.11	0.013	0.05	0.00	CIRCULAR	30.00 in	30.00 in
PR 20	174.56	6946.11	1.0	6947.86	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in
PR 18	7.33	6948.16	1.0	6948.23	0.013	0.38	0.00	CIRCULAR	24.00 in	24.00 in
PR 19	26.19	6948.36	1.0	6948.62	0.013	0.83	0.00	CIRCULAR	18.00 in	18.00 in
PR21	26.19	6946.62	2.0	6947.14	0.013	0.38	0.00	CIRCULAR	18.00 in	18.00 in
PR 27	5.17	6935.93	0.4	6935.95	0.013	1.32	0.00	CIRCULAR	18.00 in	18.00 in
PR 30	12.69	6928.99	4.3	6929.54	0.013	0.38	0.00	CIRCULAR	24.00 in	24.00 in

## Sewer Flow Summary:

		Full Flow Capacity		Critical Flow		Normal Flow					
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
PR 33A	100.88	10.49	25.10	7.50	19.65	10.19	1.60	Supercritical	45.00	0.00	
PR 37	3.75	4.77	5.04	3.20	4.23	4.04	1.40	Supercritical	1.00	0.00	
PR 33	100.88	10.49	24.81	7.44	19.40	10.13	1.60	Supercritical	44.00	0.00	
PR 32	36.03	20.39	7.90	4.02	3.51	12.36	4.82	Supercritical	3.00	0.00	
PR 31	100.88	10.49	23.91	7.25	18.64	9.94	1.61	Supercritical	41.00	0.00	
PR 29	135.35	14.07	22.34	6.92	14.79	11.90	2.20	Supercritical	36.00	0.00	

PR 29A	127.60	13.26	22.34	6.92	15.26	11.40	2.07	Supercritical	36.00	0.00	
PR 28	18.24	10.32	7.90	4.02	4.94	7.62	2.48	Supercritical	3.00	0.00	
PR 26	76.25	10.79	21.66	6.98	15.98	10.23	1.79	Supercritical	31.00	0.00	
PR 25	73.26	10.36	14.82	5.47	11.05	8.15	1.76	Supercritical	15.00	0.00	
PR 24	22.68	7.22	12.08	5.05	9.84	6.59	1.48	Supercritical	8.00	0.00	
PR 23	22.68	7.22	12.08	5.05	9.84	6.59	1.48	Supercritical	8.00	0.00	
PR 22	55.18	11.24	17.24	6.17	11.79	10.05	2.07	Supercritical	18.00	0.00	
PR 20	22.68	7.22	13.58	5.46	11.15	6.99	1.46	Supercritical	10.00	0.00	
PR 18	22.68	7.22	12.08	5.05	9.84	6.59	1.48	Supercritical	8.00	0.00	
PR 19	10.53	5.96	7.90	4.02	6.57	5.14	1.42	Supercritical	3.00	0.00	
PR21	14.90	8.43	13.15	5.78	9.39	8.58	1.92	Supercritical	8.00	0.00	
PR 27	6.66	3.77	7.90	4.02	8.47	3.67	0.88	Subcritical	3.00	0.00	
PR 30	47.04	14.97	11.26	4.83	6.26	10.74	3.11	Supercritical	7.00	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

## Sewer Sizing Summary:

			Existing		Calculated		Used			Comment
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft <sup>2</sup> )	
PR 33A	45.00	CIRCULAR	42.00 in	42.00 in	33.00 in	33.00 in	42.00 in	42.00 in	9.62	
PR 37	1.00	CIRCULAR	12.00 in	12.00 in	18.00 in	18.00 in	12.00 in	12.00 in	0.79	Height is too small. Width is too small. Existing height is smaller than the suggested height. Existing width is smaller than the suggested width.
PR 33	44.00	CIRCULAR	42.00 in	42.00 in	33.00 in	33.00 in	42.00 in	42.00 in	9.62	
PR 32	3.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
PR 31	41.00	CIRCULAR	42.00 in	42.00 in	33.00 in	33.00 in	42.00 in	42.00 in	9.62	
PR 29	36.00	CIRCULAR	42.00 in	42.00 in	27.00 in	27.00 in	42.00 in	42.00 in	9.62	
PR 29A	36.00	CIRCULAR	42.00 in	42.00 in	27.00 in	27.00 in	42.00 in	42.00 in	9.62	
PR 28	3.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
PR 26	31.00	CIRCULAR	36.00 in	36.00 in	27.00 in	27.00 in	36.00 in	36.00 in	7.07	
PR 25	15.00	CIRCULAR	36.00 in	36.00 in	21.00 in	21.00 in	36.00 in	36.00 in	7.07	
PR 24	8.00	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	
PR 23	8.00	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	
PR 22	18.00	CIRCULAR	30.00 in	30.00 in	21.00 in	21.00 in	30.00 in	30.00 in	4.91	
PR 20	10.00	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	
PR 18	8.00	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	
PR 19	3.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

PR21	8.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
PR 27	3.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
PR 30	7.00	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics were calculated using the 'Used' parameters.

## Grade Line Summary:

**Tailwater Elevation (ft): 6927.75**

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
PR 33A	6924.25	6925.89	0.00	0.00	6927.75	6927.98	6928.09	0.77	6928.86
PR 37	6927.89	6927.97	0.03	0.00	6928.25	6928.39	6928.48	0.07	6928.55
PR 33	6925.89	6927.15	0.02	0.00	6928.00	6929.22	6929.10	0.98	6930.08
PR 32	6928.15	6929.54	0.02	0.00	6929.23	6930.76	6930.82	0.00	6930.82
PR 31	6927.15	6927.50	0.01	0.00	6929.23	6929.49	6930.23	0.07	6930.31
PR 29	6927.71	6932.65	0.29	0.00	6929.78	6934.51	6931.14	4.12	6935.26
PR 29A	6932.97	6934.30	0.29	0.00	6934.80	6936.16	6936.26	0.65	6936.91
PR 28	6935.79	6936.55	0.06	0.00	6936.22	6937.21	6937.11	0.35	6937.46
PR 26	6934.75	6939.25	0.01	0.00	6936.18	6941.05	6937.71	4.10	6941.81
PR 25	6939.54	6940.81	0.09	0.00	6941.80	6942.04	6941.90	0.61	6942.51
PR 24	6941.31	6941.57	0.13	0.00	6942.18	6942.58	6942.81	0.16	6942.97
PR 23	6941.31	6941.37	0.13	0.00	6942.18	6942.52	6942.81	0.00	6942.81
PR 22	6939.89	6945.11	0.01	0.00	6941.07	6946.55	6942.44	4.69	6947.14
PR 20	6946.11	6947.86	0.01	0.00	6947.04	6948.99	6947.80	1.65	6949.45
PR 18	6948.16	6948.23	0.04	0.00	6949.03	6949.35	6949.65	0.00	6949.65
PR 19	6948.36	6948.62	0.04	0.00	6949.41	6949.41	6949.49	0.08	6949.57
PR21	6946.62	6947.14	0.12	0.00	6947.40	6948.24	6948.54	0.21	6948.76
PR 27	6935.93	6935.95	0.06	0.00	6936.86	6936.86	6936.96	0.01	6936.97
PR 30	6928.99	6929.54	0.03	0.00	6929.52	6931.21	6931.31	0.00	6931.31

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K \*  $V_{fi}^2 / (2 * g)$
- Lateral loss =  $V_{fo}^2 / (2 * g)$  - Junction Loss K \*  $V_{fi}^2 / (2 * g)$ .
- Friction loss is always Upstream EGL - Downstream EGL.

## Excavation Estimate:

The trench side slope is 1.0 ft/ft

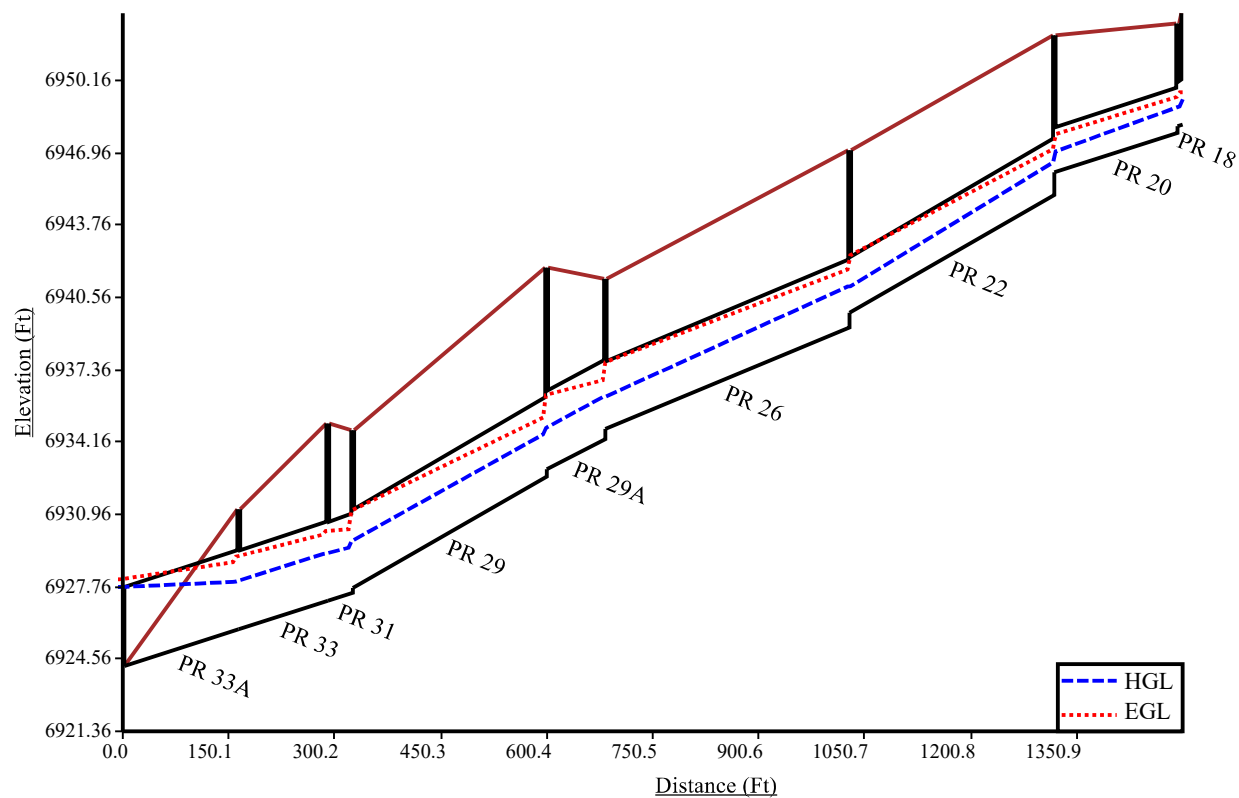
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
PR 33A	163.90	4.50	6.00	7.25	0.00	0.87	0.00	8.12	6.19	1.44	155.91	Sewer Too Shallow
PR 37	7.57	2.00	4.00	4.33	6.63	3.81	2.15	6.06	3.53	1.86	4.75	Sewer Too Shallow
PR 33	126.20	4.50	6.00	7.25	8.12	6.19	1.44	13.20	8.73	3.98	273.79	Sewer Too Shallow
PR 32	11.86	2.50	4.00	4.92	13.20	7.39	5.14	10.54	6.06	3.81	20.02	
PR 31	35.39	4.50	6.00	7.25	13.21	8.73	3.98	11.90	8.08	3.33	89.20	
PR 29	274.51	4.50	6.00	7.25	11.48	7.87	3.12	16.00	10.13	5.38	783.14	
PR 29A	83.18	4.50	6.00	7.25	15.36	9.81	5.06	11.70	7.98	3.23	231.54	
PR 28	25.17	2.50	4.00	4.92	10.71	6.15	3.90	9.72	5.65	3.40	33.64	
PR 26	345.95	4.00	6.00	6.67	11.29	7.48	3.31	13.70	8.68	4.52	803.90	
PR 25	105.89	4.00	6.00	6.67	13.12	8.39	4.23	7.78	5.72	1.56	205.59	Sewer Too Shallow
PR 24	25.67	3.00	4.00	5.50	7.77	4.97	2.14	7.82	4.99	2.16	27.30	
PR 23	5.99	3.00	4.00	5.50	7.78	4.97	2.14	8.22	5.19	2.36	6.55	
PR 22	289.84	3.50	6.00	6.08	12.91	8.00	4.42	12.64	7.86	4.28	638.17	
PR 20	174.56	3.00	4.00	5.50	11.13	6.65	3.82	8.68	5.42	2.59	248.43	
PR 18	7.33	3.00	4.00	5.50	8.09	5.13	2.29	8.84	5.50	2.67	8.54	
PR 19	26.19	2.50	4.00	4.92	8.18	4.88	2.63	8.54	5.06	2.81	26.60	
PR21	26.19	2.50	4.00	4.92	10.63	6.11	3.86	10.44	6.01	3.76	36.55	
PR 27	5.17	2.50	4.00	4.92	10.44	6.01	3.76	10.92	6.25	4.00	7.37	
PR 30	12.69	3.00	4.00	5.50	10.41	6.29	3.46	10.04	6.10	3.27	18.65	

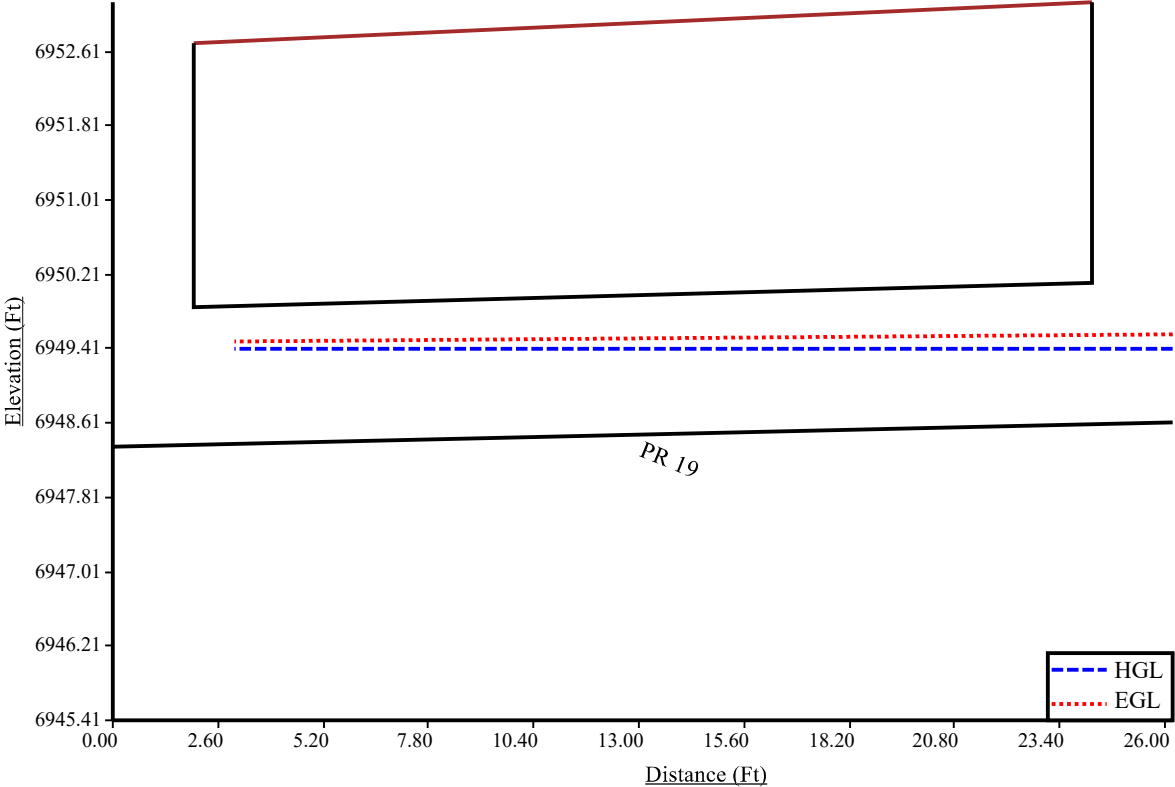
**Total earth volume for sewer trenches = 3620 cubic yards.**

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

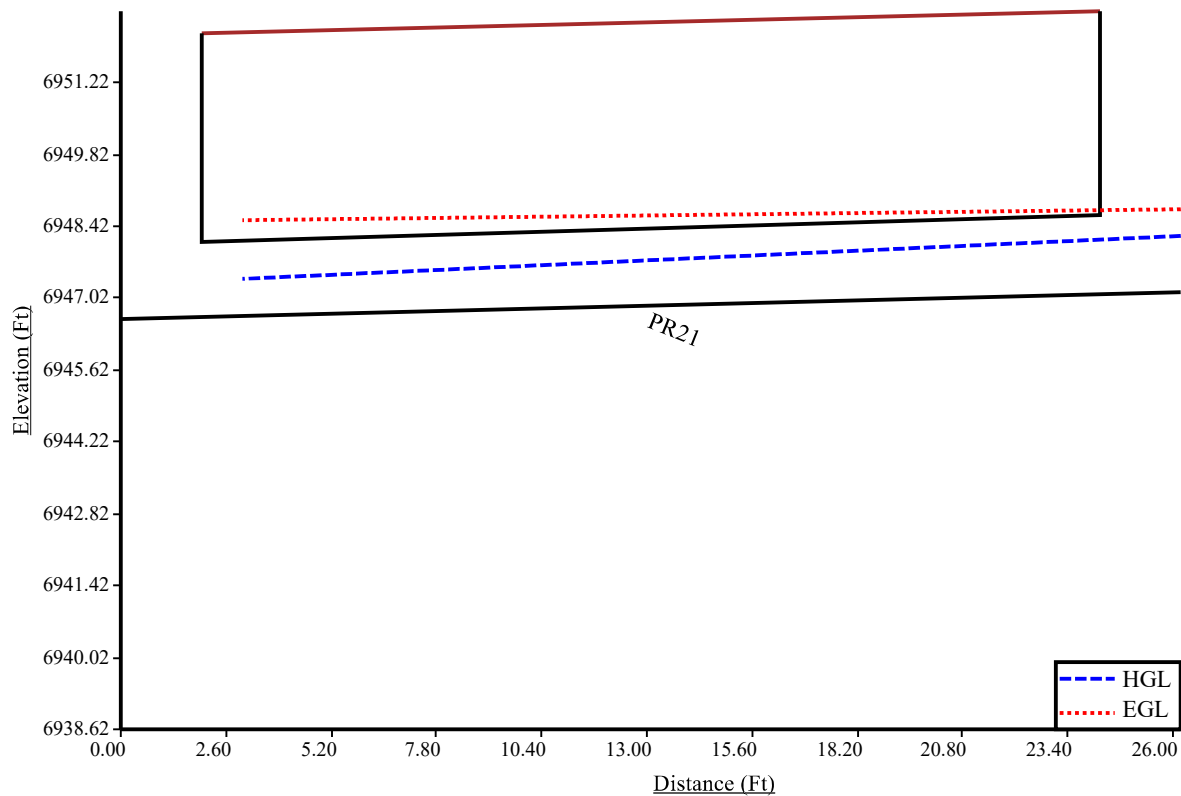
## PR 18-33 5-YR HGL Profile



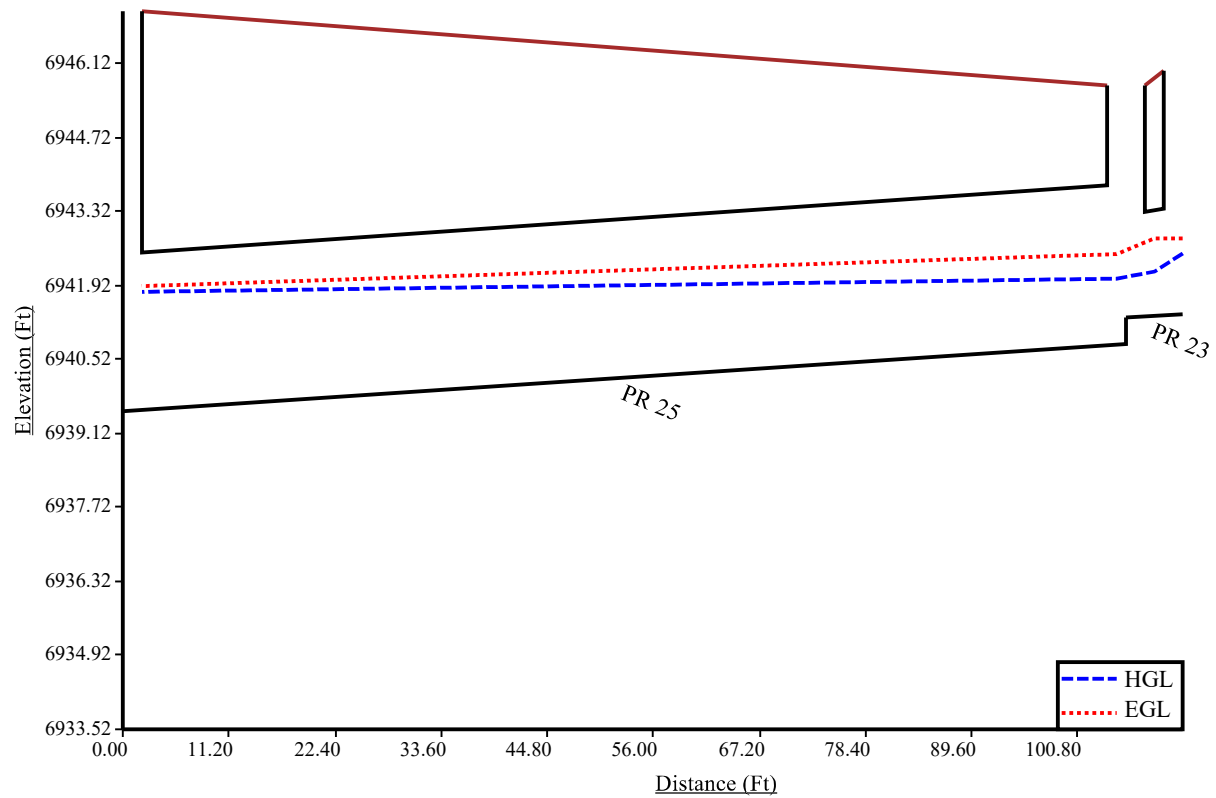
PR 19 5-YR HGL Profile



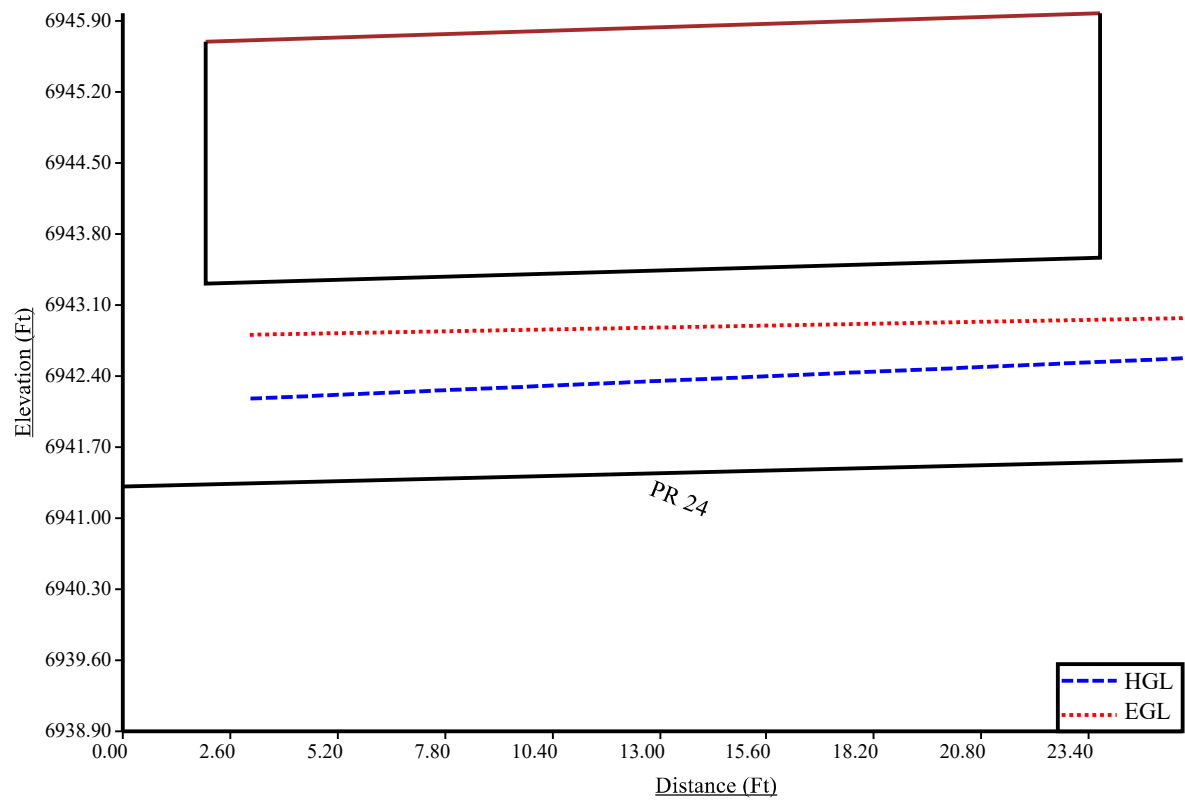
PR 21 5-YR HGL Profile



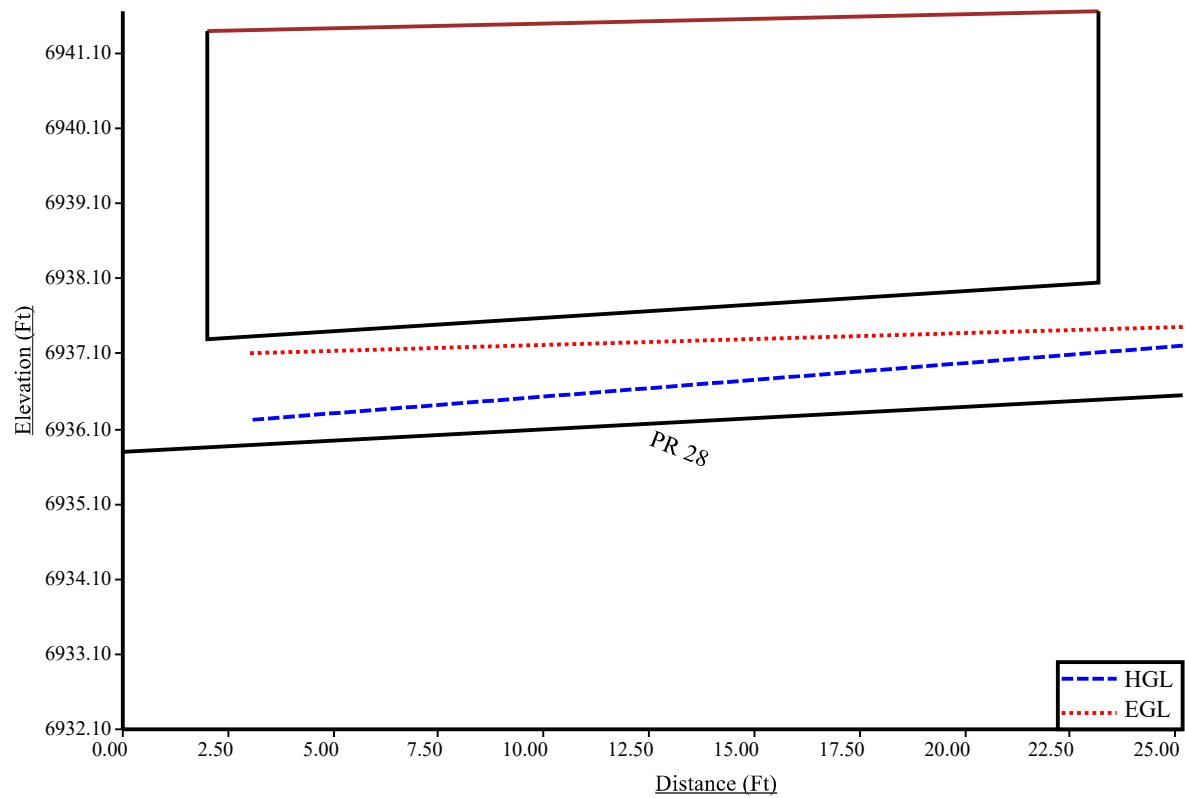
PR 23&25 5-YR HGL Profile



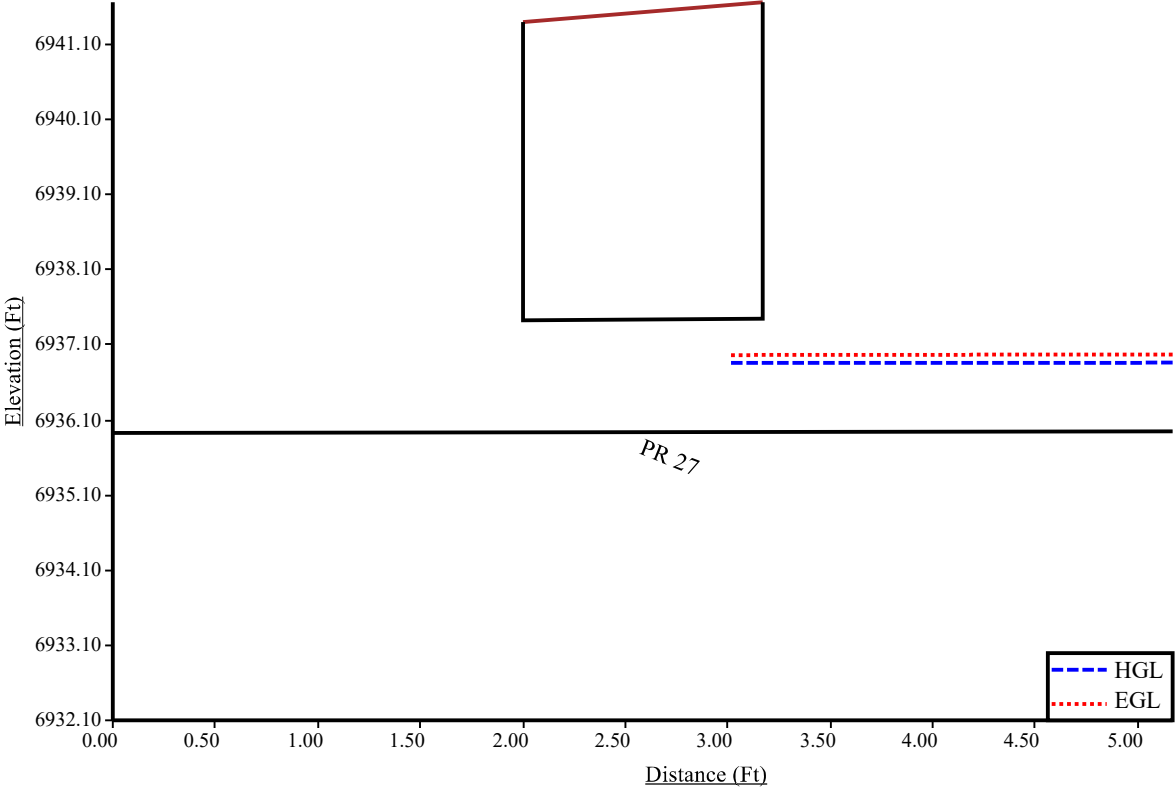
PR 24 5-YR HGL Profile



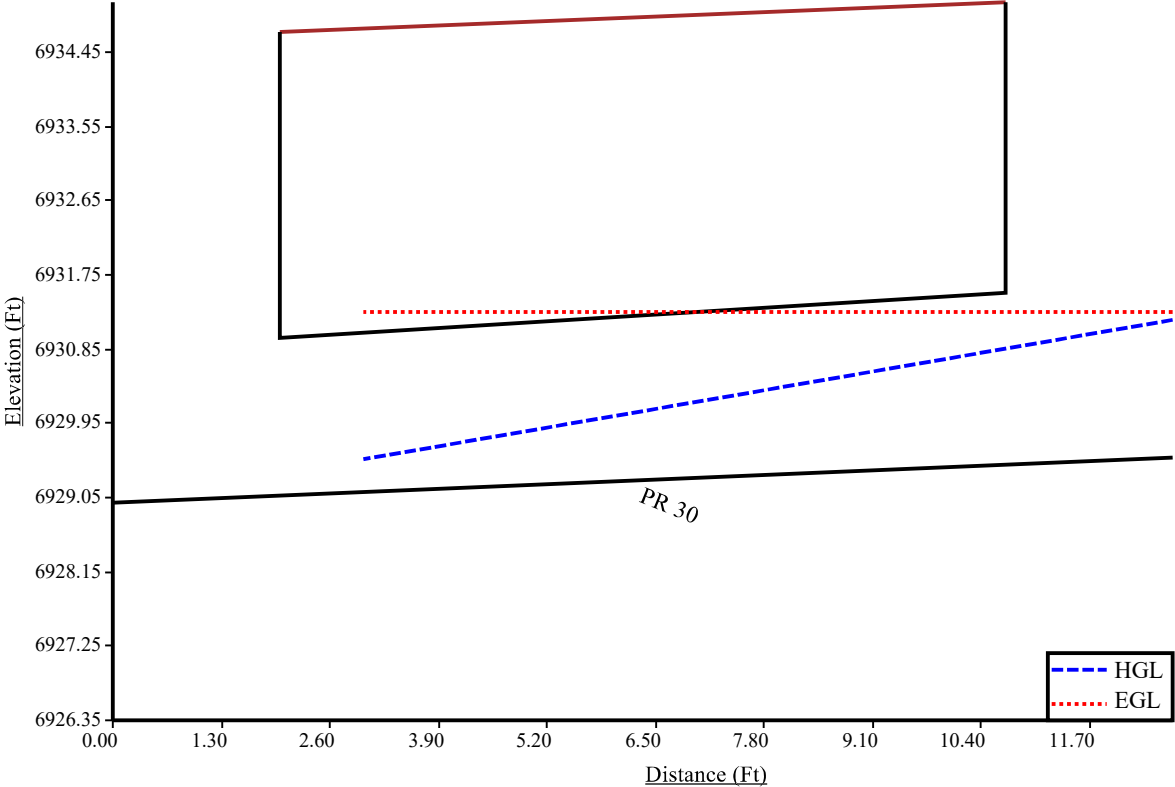
PR 28 5-YR HGL Profile



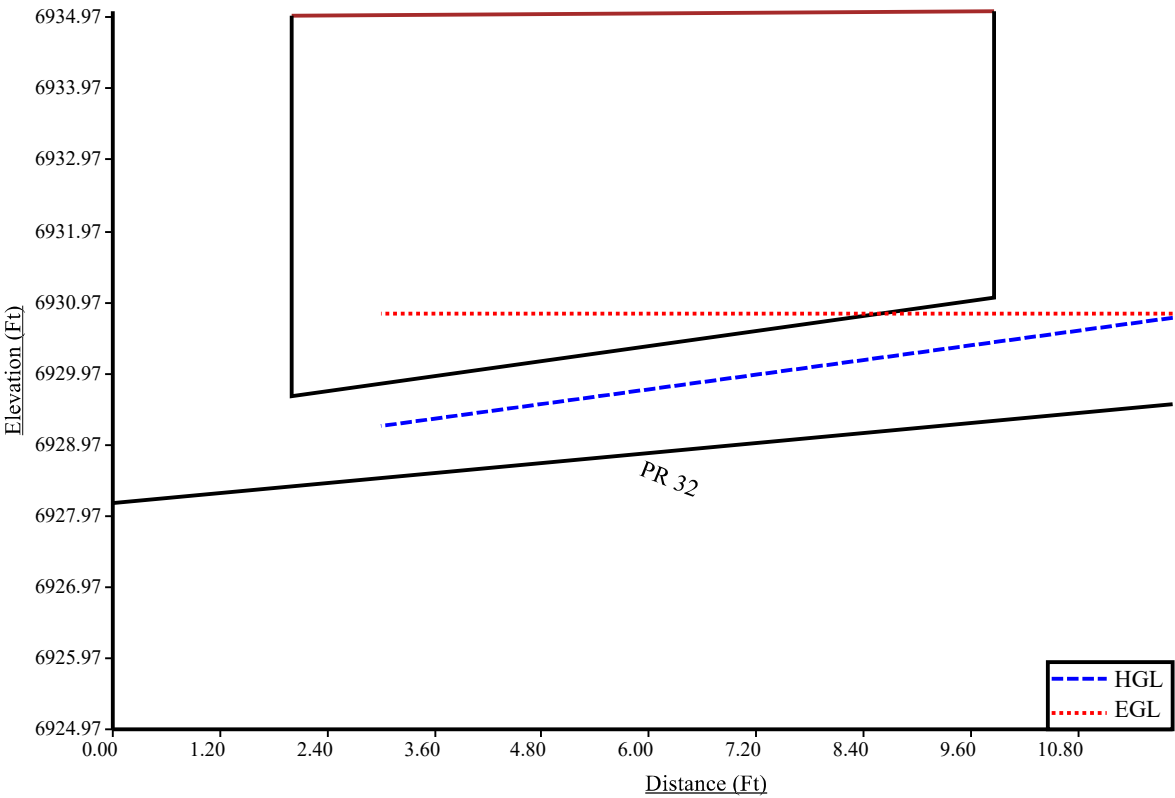
PR 27 5-YR HGL Profile



PR 30 5-YR HGL Profile



PR 32 5-YR HGL Profile



<div><div><div><div><div>Program:</div><div>UDSEWER Math Model Interface 2.1.1.4</div></div><div><div>Run Date:</div><div>11/26/2024 2:30:17 PM</div></div></div></div><div><div>UDSewer Results Summary</div><div><div>Project Title: New UDSEWER System Module</div><div>Project Description: Default system</div></div><div>PIPE RUN 18-33 AND ASSOCIATED LATERALS</div></div></div>
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System Input Summary

Rainfall Parameters

Rainfall Return Period: 100  
Rainfall Calculation Method: Formula

One Hour Depth (in):  
Rainfall Constant "A": 28.5  
Rainfall Constant "B": 10  
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20  
Maximum Rural Overland Len. (ft): 500  
Maximum Urban Overland Len. (ft): 300  
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00  
Maximum Depth to Rise Ratio: 0.90  
Maximum Flow Velocity (fps): 18.0  
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 6927.75

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
FSD 3	6924.25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 33A	6931.20	99.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PR 37	6931.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 33	6935.00	98.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 32	6935.06	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 31	6934.70	91.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 29	6941.90	78.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 29A	6941.40	78.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 27	6941.66	6.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 28	6941.66	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 26	6947.10	69.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 25	6945.70	39.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 24	6945.98	19.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 23	6945.98	19.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 22	6952.18	36.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00
PR 20	6952.70	22.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 18	6953.15	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 19	6953.14	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR21	6952.61	14.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 30	6935.06	16.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
FSD 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Surface Water Present (Upstream)
PR 33A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	99.00	Surface Water Present (Downstream)
PR 37	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	
PR 33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	98.00	
PR 32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	
PR 31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	91.00	
PR 29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	78.00	
PR 29A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	78.00	
PR 27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00	
PR 28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	
PR 26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	69.00	
PR 25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	39.00	
PR 24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.00	
PR 23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19.00	
PR 22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	36.00	
PR 20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22.00	

PR 18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.00	
PR 19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.00	
PR21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.00	
PR 30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.00	

## Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
PR 33A	163.90	6924.25	1.0	6925.89	0.013	0.03	0.00	CIRCULAR	42.00 in	42.00 in
PR 37	7.57	6927.89	1.1	6927.97	0.013	1.00	0.00	CIRCULAR	12.00 in	12.00 in
PR 33	126.20	6925.89	1.0	6927.15	0.013	0.05	0.00	CIRCULAR	42.00 in	42.00 in
PR 32	11.86	6928.15	11.7	6929.54	0.013	0.38	0.00	CIRCULAR	18.00 in	18.00 in
PR 31	35.39	6927.15	1.0	6927.50	0.013	0.05	0.00	CIRCULAR	42.00 in	42.00 in
PR 29	274.51	6927.80	1.7	6932.47	0.013	1.32	0.00	CIRCULAR	42.00 in	42.00 in
PR 29A	83.18	6932.97	1.6	6934.30	0.013	1.32	0.00	CIRCULAR	42.00 in	42.00 in
PR 27	5.17	6935.80	2.9	6935.95	0.013	1.32	0.00	CIRCULAR	18.00 in	18.00 in
PR 28	25.17	6935.79	3.0	6936.55	0.013	1.32	0.00	CIRCULAR	18.00 in	18.00 in
PR 26	345.95	6934.75	1.3	6939.25	0.013	0.05	0.00	CIRCULAR	36.00 in	36.00 in
PR 25	105.89	6939.54	1.2	6940.81	0.013	1.32	0.00	CIRCULAR	36.00 in	36.00 in
PR 24	25.67	6941.31	1.0	6941.57	0.013	1.32	0.00	CIRCULAR	24.00 in	24.00 in
PR 23	5.99	6941.31	1.0	6941.37	0.013	1.32	0.00	CIRCULAR	24.00 in	24.00 in
PR 22	289.84	6939.89	1.8	6945.11	0.013	0.05	0.00	CIRCULAR	30.00 in	30.00 in
PR 20	174.56	6945.59	1.3	6947.86	0.013	0.05	0.00	CIRCULAR	24.00 in	24.00 in
PR 18	7.33	6948.16	1.0	6948.23	0.013	0.38	0.00	CIRCULAR	24.00 in	24.00 in
PR 19	26.19	6948.36	1.0	6948.62	0.013	0.83	0.00	CIRCULAR	18.00 in	18.00 in
PR21	26.19	6946.62	2.0	6947.14	0.013	0.38	0.00	CIRCULAR	18.00 in	18.00 in
PR 30	12.69	6928.99	4.3	6929.54	0.013	0.38	0.00	CIRCULAR	24.00 in	24.00 in

## Sewer Flow Summary:

		Full Flow Capacity		Critical Flow		Normal Flow					
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
PR 33A	100.88	10.49	36.68	11.11	33.74	11.95	1.22	Supercritical	99.00	0.00	
PR 37	3.75	4.77	8.91	4.80	8.12	5.30	1.20	Pressurized	3.00	7.57	
PR 33	100.88	10.49	36.54	11.03	33.39	11.95	1.24	Supercritical	98.00	0.00	
PR 32	36.03	20.39	12.29	5.45	5.38	15.79	4.90	Pressurized	7.00	11.86	
PR 31	100.88	10.49	35.48	10.50	31.21	11.87	1.32	Pressurized	91.00	35.39	

PR 29	131.53	13.67	33.14	9.58	23.28	14.25	2.00	Supercritical Jump	78.00	132.86	
PR 29A	127.60	13.26	33.14	9.58	23.72	13.92	1.93	Supercritical Jump	78.00	51.28	
PR 27	17.94	10.15	11.35	5.11	7.17	9.14	2.41	Pressurized	6.00	5.17	
PR 28	18.24	10.32	12.29	5.45	7.74	9.64	2.43	Pressurized	7.00	25.17	
PR 26	76.25	10.79	31.73	10.46	26.82	12.22	1.46	Supercritical	69.00	0.00	
PR 25	73.26	10.36	24.39	7.65	18.68	10.53	1.67	Pressurized	39.00	105.89	
PR 24	22.68	7.22	18.82	7.19	16.81	8.09	1.26	Pressurized	19.00	25.67	
PR 23	22.68	7.22	18.82	7.19	16.81	8.09	1.26	Pressurized	19.00	5.99	
PR 22	55.18	11.24	24.42	8.41	17.66	11.98	1.91	Supercritical Jump	36.00	39.37	
PR 20	25.86	8.23	20.10	7.83	17.01	9.24	1.42	Supercritical	22.00	0.00	
PR 18	22.68	7.22	17.30	6.60	14.87	7.82	1.34	Pressurized	16.00	7.33	
PR 19	10.53	5.96	12.29	5.45	10.72	6.38	1.30	Pressurized	7.00	26.19	
PR21	14.90	8.43	16.58	8.23	13.87	9.58	1.57	Supercritical	14.00	0.00	
PR 30	47.04	14.97	17.30	6.60	9.65	13.54	3.07	Pressurized	16.00	12.69	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

## Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft <sup>2</sup> )	Comment
PR 33A	99.00	CIRCULAR	42.00 in	42.00 in	42.00 in	42.00 in	42.00 in	42.00 in	9.62	
PR 37	3.00	CIRCULAR	12.00 in	12.00 in	18.00 in	18.00 in	12.00 in	12.00 in	0.79	Height is too small. Width is too small. Existing height is smaller than the suggested height. Existing width is smaller than the suggested width.
PR 33	98.00	CIRCULAR	42.00 in	42.00 in	42.00 in	42.00 in	42.00 in	42.00 in	9.62	
PR 32	7.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
PR 31	91.00	CIRCULAR	42.00 in	42.00 in	42.00 in	42.00 in	42.00 in	42.00 in	9.62	
PR 29	78.00	CIRCULAR	42.00 in	42.00 in	36.00 in	36.00 in	42.00 in	42.00 in	9.62	
PR 29A	78.00	CIRCULAR	42.00 in	42.00 in	36.00 in	36.00 in	42.00 in	42.00 in	9.62	
PR 27	6.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
PR 28	7.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
PR 26	69.00	CIRCULAR	36.00 in	36.00 in	36.00 in	36.00 in	36.00 in	36.00 in	7.07	
PR 25	39.00	CIRCULAR	36.00 in	36.00 in	30.00 in	30.00 in	36.00 in	36.00 in	7.07	
PR 24	19.00	CIRCULAR	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	3.14	

PR 23	19.00	CIRCULAR	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	3.14	
PR 22	36.00	CIRCULAR	30.00 in	30.00 in	27.00 in	27.00 in	30.00 in	30.00 in	4.91	
PR 20	22.00	CIRCULAR	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	3.14	
PR 18	16.00	CIRCULAR	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	3.14	
PR 19	7.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
PR21	14.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
PR 30	16.00	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics were calculated using the 'Used' parameters.

## Grade Line Summary:

**Tailwater Elevation (ft): 6927.75**

Element Name	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
PR 33A	6924.25	6925.89	0.00	0.00	6927.75	6928.95	6929.39	1.47	6930.86
PR 37	6927.89	6927.97	0.23	0.00	6930.86	6930.92	6931.09	0.05	6931.14
PR 33	6925.89	6927.15	0.08	0.00	6929.32	6930.20	6930.94	1.14	6932.08
PR 32	6928.15	6929.54	0.09	0.00	6931.93	6931.98	6932.18	0.05	6932.23
PR 31	6927.15	6927.50	0.07	0.00	6930.76	6931.05	6932.15	0.29	6932.44
PR 29	6927.80	6932.47	1.35	0.00	6932.77	6935.23	6933.79	2.87	6936.66
PR 29A	6932.97	6934.30	1.35	0.00	6936.98	6937.06	6938.00	0.48	6938.49
PR 27	6935.80	6935.95	0.24	0.00	6938.54	6938.56	6938.72	0.02	6938.74
PR 28	6935.79	6936.55	0.32	0.00	6938.56	6938.68	6938.81	0.11	6938.92
PR 26	6934.75	6939.25	0.07	0.00	6937.14	6941.89	6939.31	4.29	6943.59
PR 25	6939.54	6940.81	0.62	0.00	6943.74	6944.10	6944.22	0.36	6944.58
PR 24	6941.31	6941.57	0.75	0.00	6944.85	6945.03	6945.42	0.18	6945.60
PR 23	6941.31	6941.37	0.75	0.00	6944.85	6944.90	6945.42	0.04	6945.46
PR 22	6939.89	6945.11	0.04	0.00	6942.80	6947.14	6943.64	4.61	6948.24
PR 20	6945.59	6947.86	0.04	0.00	6947.18	6949.53	6948.33	2.15	6950.49
PR 18	6948.16	6948.23	0.15	0.00	6950.24	6950.27	6950.64	0.04	6950.68
PR 19	6948.36	6948.62	0.20	0.00	6950.45	6950.56	6950.69	0.12	6950.80
PR21	6946.62	6947.14	0.37	0.00	6947.77	6948.52	6949.20	0.37	6949.57
PR 30	6928.99	6929.54	0.15	0.00	6932.19	6932.25	6932.59	0.06	6932.66

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss =  $Bend\ K * V_{fi}^2 / (2 * g)$

- Lateral loss =  $V_{fo}^2 / (2 * g) - \text{Junction Loss } K * V_{fi}^2 / (2 * g)$ .
- Friction loss is always Upstream EGL - Downstream EGL.

## Excavation Estimate:

The trench side slope is 1.0 ft/ft

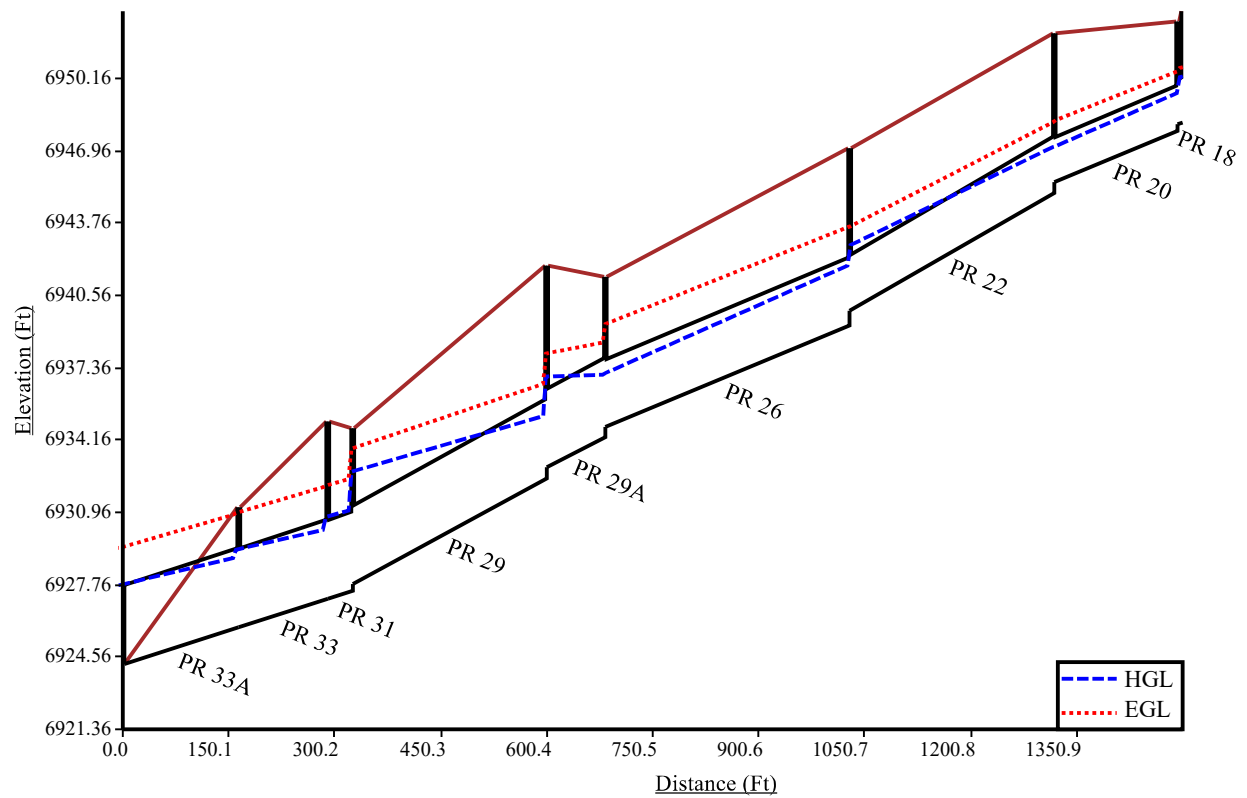
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
PR 33A	163.90	4.50	6.00	7.25	0.00	0.87	0.00	8.12	6.19	1.44	155.91	Sewer Too Shallow
PR 37	7.57	2.00	4.00	4.33	6.63	3.81	2.15	6.06	3.53	1.86	4.75	Sewer Too Shallow
PR 33	126.20	4.50	6.00	7.25	8.12	6.19	1.44	13.20	8.73	3.98	273.79	Sewer Too Shallow
PR 32	11.86	2.50	4.00	4.92	13.20	7.39	5.14	10.54	6.06	3.81	20.02	
PR 31	35.39	4.50	6.00	7.25	13.21	8.73	3.98	11.90	8.08	3.33	89.20	
PR 29	274.51	4.50	6.00	7.25	11.29	7.77	3.02	16.36	10.31	5.56	792.47	
PR 29A	83.18	4.50	6.00	7.25	15.36	9.81	5.06	11.70	7.98	3.23	231.54	
PR 27	5.17	2.50	4.00	4.92	10.70	6.14	3.89	10.92	6.25	4.00	7.50	
PR 28	25.17	2.50	4.00	4.92	10.71	6.15	3.90	9.72	5.65	3.40	33.64	
PR 26	345.95	4.00	6.00	6.67	11.29	7.48	3.31	13.70	8.68	4.52	803.90	
PR 25	105.89	4.00	6.00	6.67	13.12	8.39	4.23	7.78	5.72	1.56	205.59	Sewer Too Shallow
PR 24	25.67	3.00	4.00	5.50	7.77	4.97	2.14	7.82	4.99	2.16	27.30	
PR 23	5.99	3.00	4.00	5.50	7.78	4.97	2.14	8.22	5.19	2.36	6.55	
PR 22	289.84	3.50	6.00	6.08	12.91	8.00	4.42	12.64	7.86	4.28	638.17	
PR 20	174.56	3.00	4.00	5.50	12.18	7.17	4.34	8.68	5.42	2.59	268.16	
PR 18	7.33	3.00	4.00	5.50	8.09	5.13	2.29	8.84	5.50	2.67	8.54	
PR 19	26.19	2.50	4.00	4.92	8.18	4.88	2.63	8.54	5.06	2.81	26.60	
PR21	26.19	2.50	4.00	4.92	10.63	6.11	3.86	10.44	6.01	3.76	36.55	
PR 30	12.69	3.00	4.00	5.50	10.41	6.29	3.46	10.04	6.10	3.27	18.65	

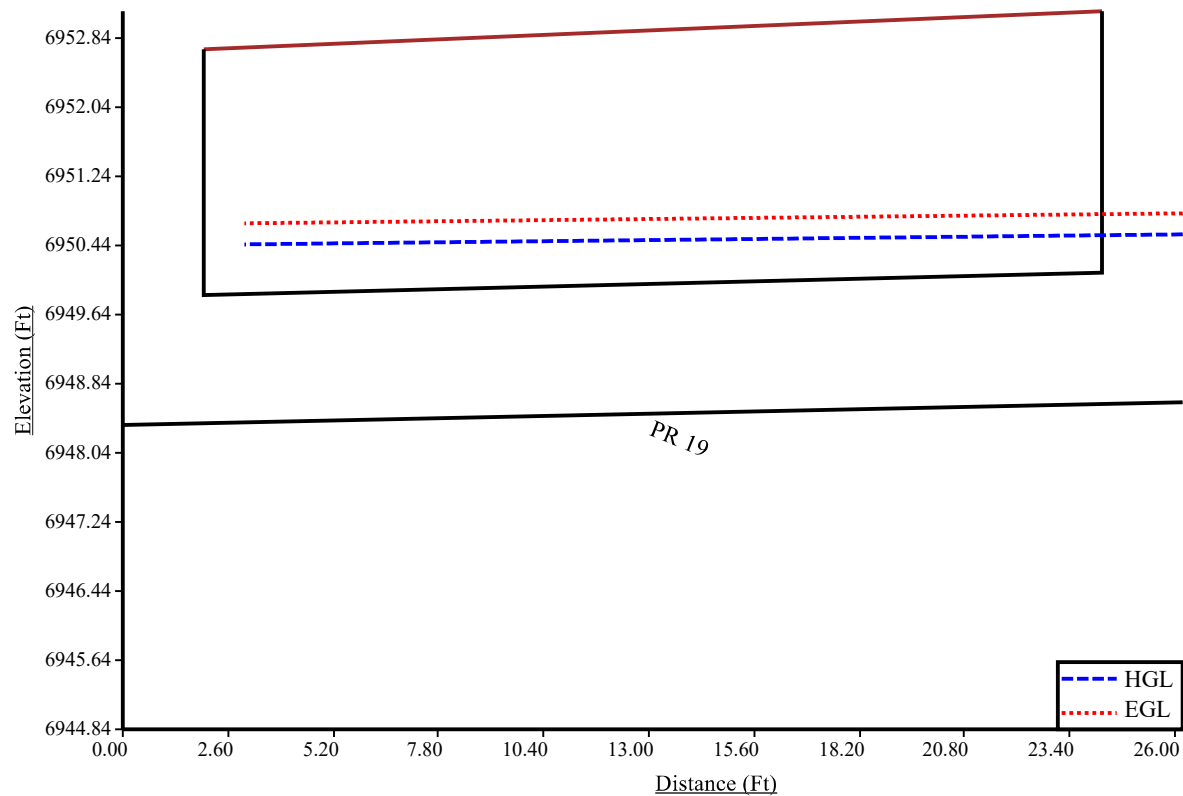
**Total earth volume for sewer trenches = 3649 cubic yards.**

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

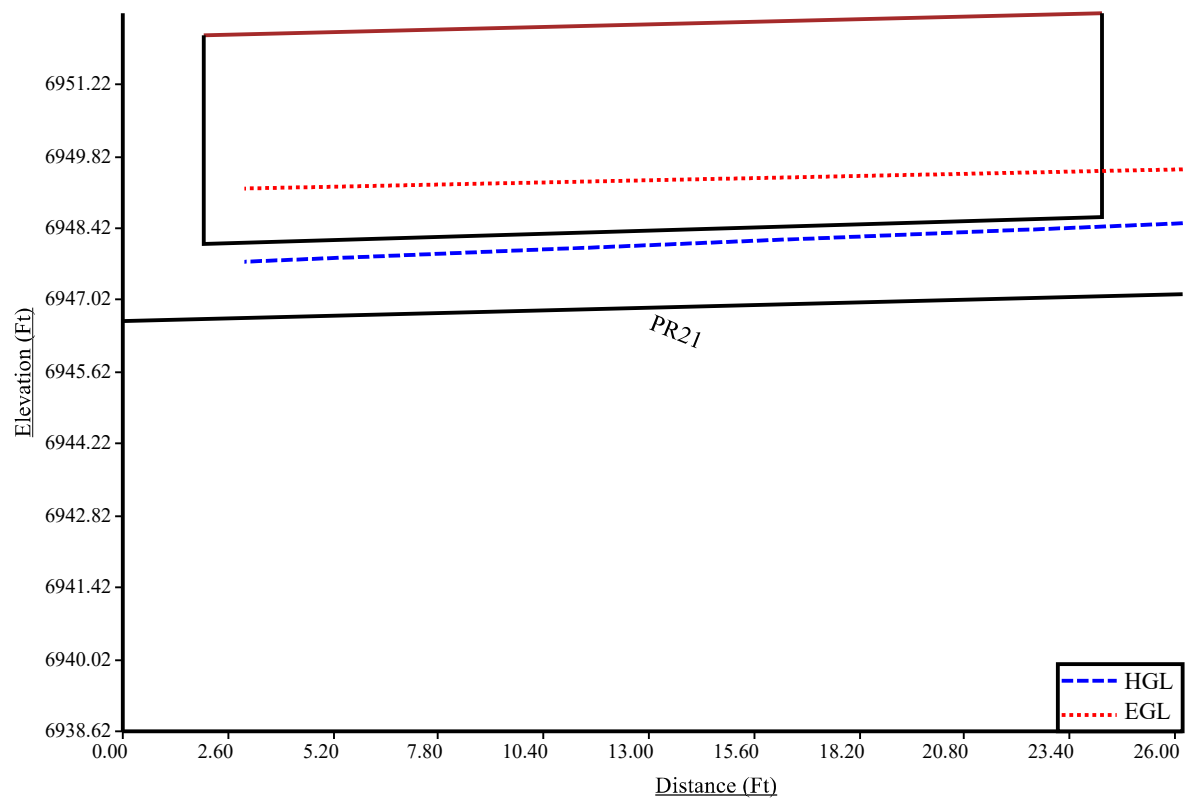
## PR 18-33 100-YR HGL Profile



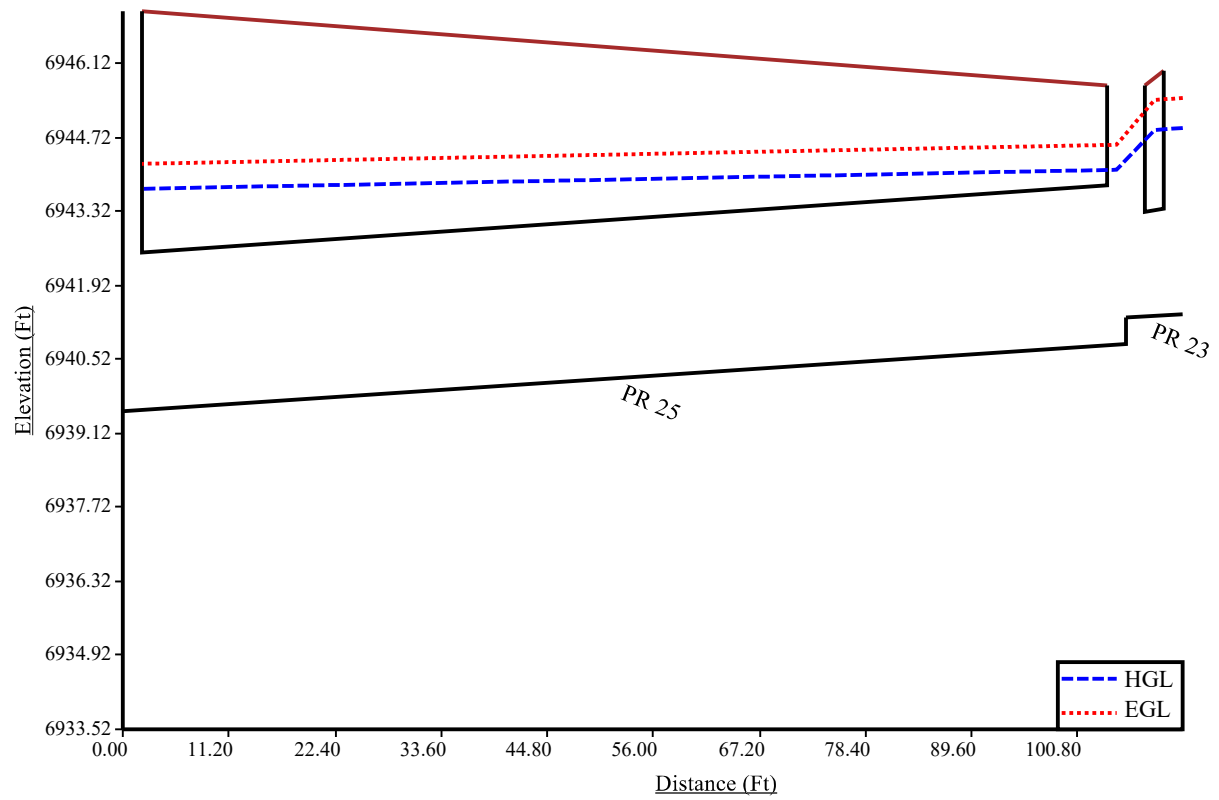
PR 19 100-YR HGL Profile



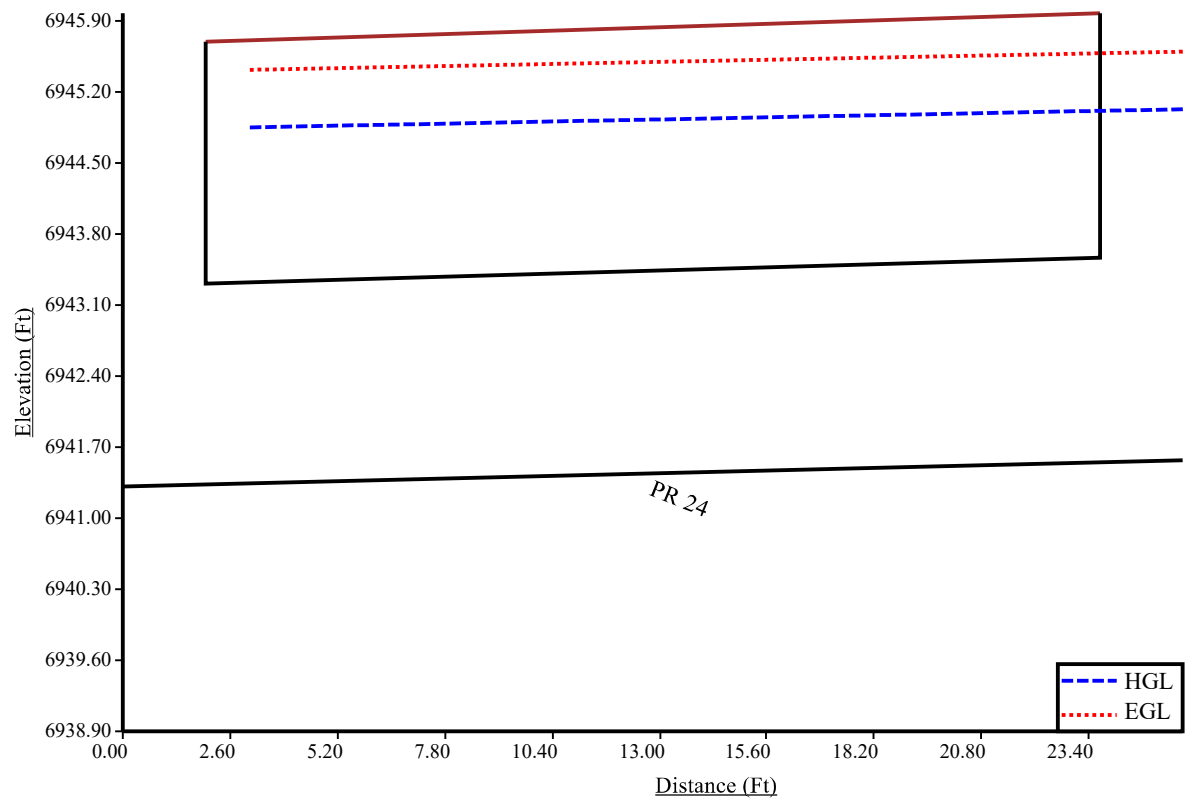
PR 21 100-YR HGL Profile



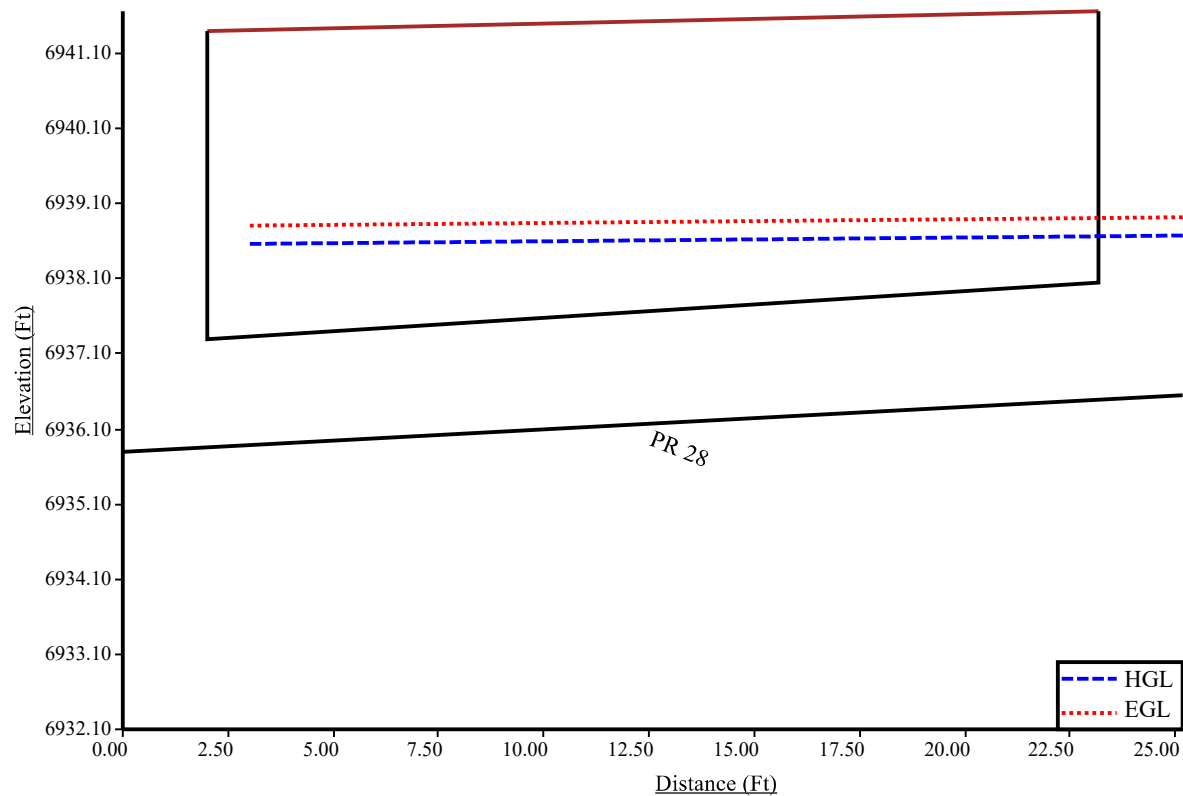
## PR 23&25 100-YR HGL Profile



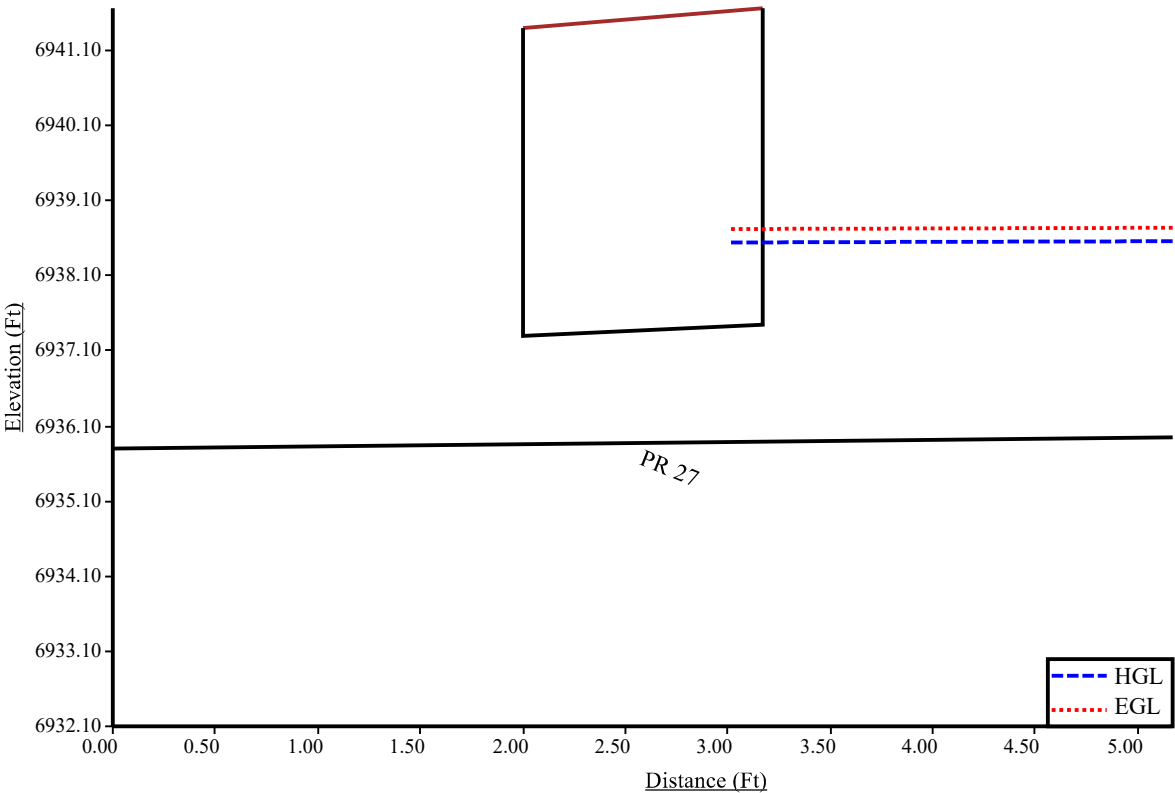
PR 24 100-YR HGL Profile



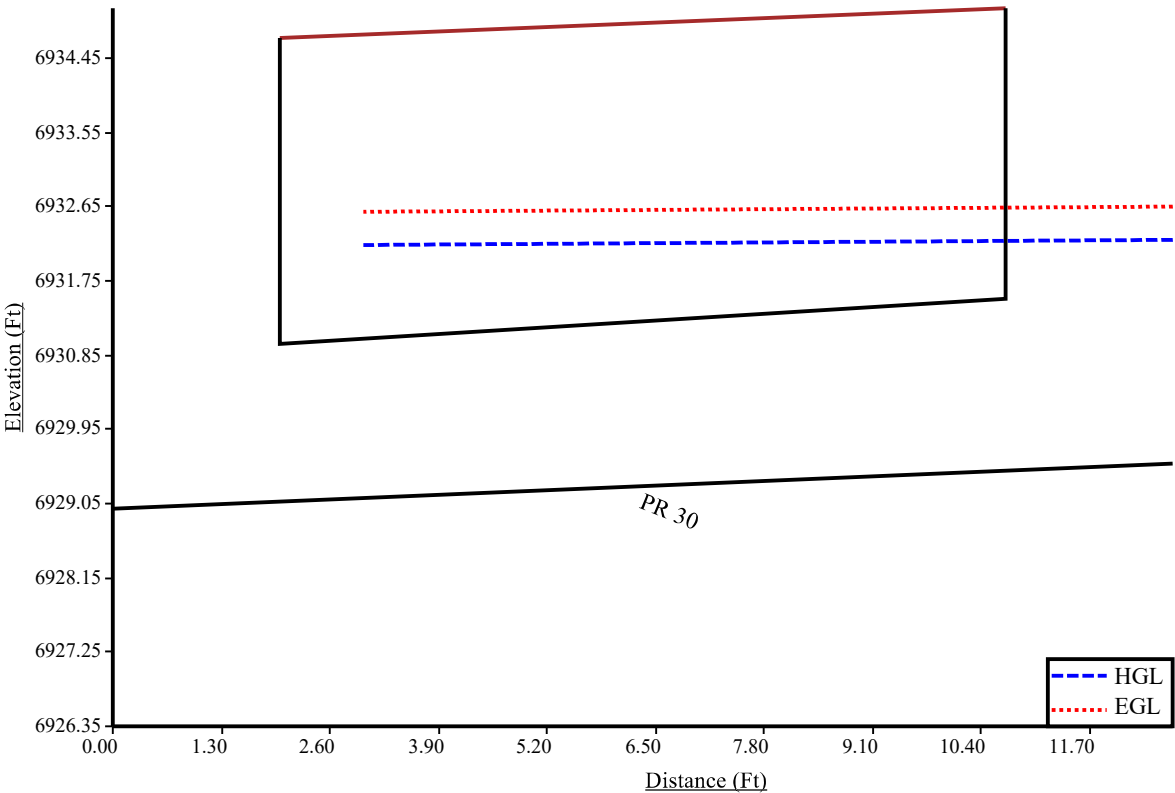
PR 28 100-YR HGL Profile



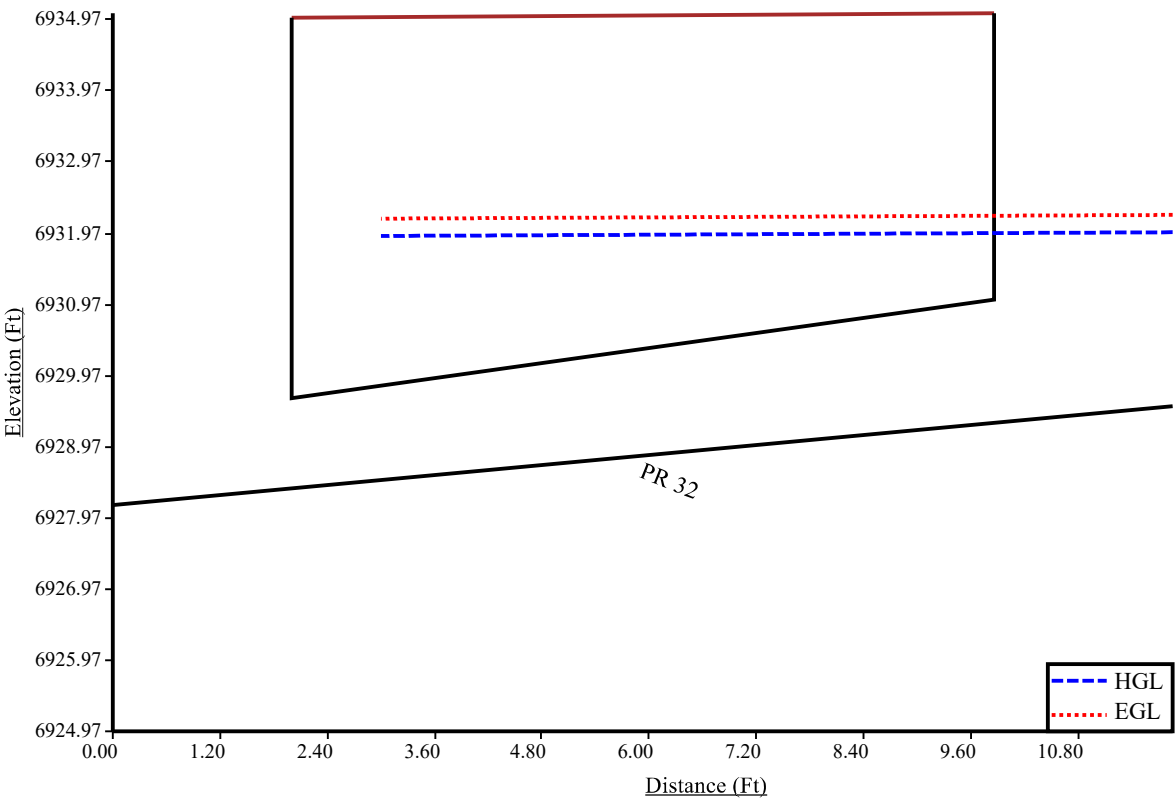
PR 27 100-YR HGL Profile



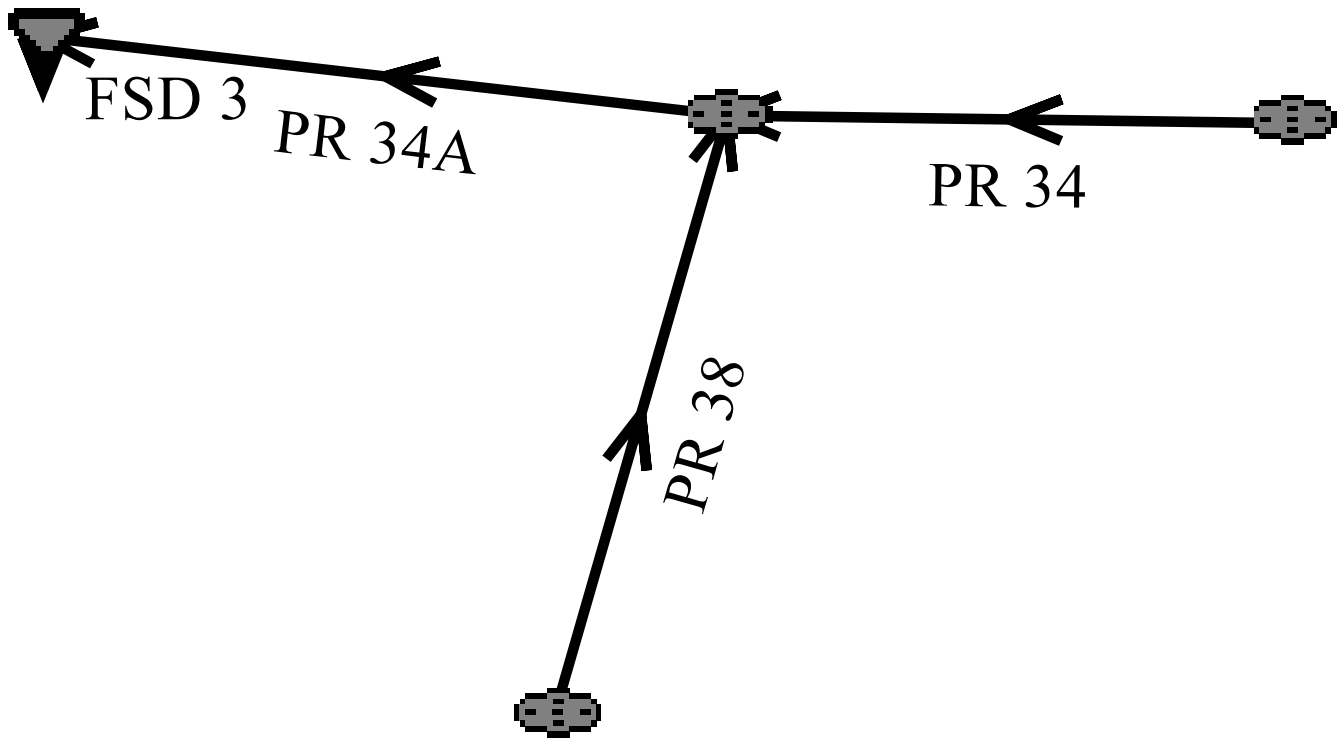
PR 30 100-YR HGL Profile



PR 32 100-YR HGL Profile



PIPE RUN 34 & ASSOCIATED LATERALS LAYOUT



Program:

UDSEWER Math Model Interface 2.1.1.4

Run Date:

11/26/2024 2:58:47 PM

UDSewer Results Summary

Project Title: New UDSEWER System Module

Project Description: Default system

PIPE RUN 34 AND ASSOCIATED LATERALS

System Input Summary

Rainfall Parameters

Rainfall Return Period: 5  
Rainfall Calculation Method: Formula

One Hour Depth (in):  
Rainfall Constant "A": 28.5  
Rainfall Constant "B": 10  
Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20  
Maximum Rural Overland Len. (ft): 500  
Maximum Urban Overland Len. (ft): 300  
Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00  
Maximum Depth to Rise Ratio: 0.90  
Maximum Flow Velocity (fps): 18.0  
Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 6926.71

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
FSD 3	6922.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 34A	6927.31	11.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PR 34	6927.31	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
FSD 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Surface Water Present (Upstream)
PR 34A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.00	Surface Water Present (Downstream)
PR 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	

Sewer Input Summary:

	Elevation				Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
PR 34A	135.58	6922.20	0.6	6923.01	0.013	0.03	0.00	CIRCULAR	30.00 in	30.00 in
PR 34	35.34	6923.50	0.8	6923.78	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
PR 34A	31.86	6.49	13.32	5.22	12.16	5.89	1.19	Pressurized	11.00	135.58	
PR 34	9.42	5.33	10.32	4.77	9.32	5.41	1.21	Pressurized	5.00	35.34	

- A Froude number of 0 indicates that pressurized flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
PR 34A	11.00	CIRCULAR	30.00 in	30.00 in	21.00 in	21.00 in	30.00 in	30.00 in	4.91	
PR 34	5.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics were calculated using the 'Used' parameters.

## Grade Line Summary:

**Tailwater Elevation (ft):** 6926.71

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
PR 34A	6922.20	6923.01	0.00	0.00	6926.71	6926.81	6926.79	0.10	6926.88
PR 34	6923.50	6923.78	0.01	0.00	6926.81	6926.89	6926.94	0.08	6927.02

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss =  $\text{Bend } K * V_{fi}^2 / (2 * g)$
- Lateral loss =  $V_{fo}^2 / (2 * g) - \text{Junction Loss } K * V_{fi}^2 / (2 * g)$ .
- Friction loss is always Upstream EGL - Downstream EGL.

## Excavation Estimate:

The trench side slope is 1.0 ft/ft

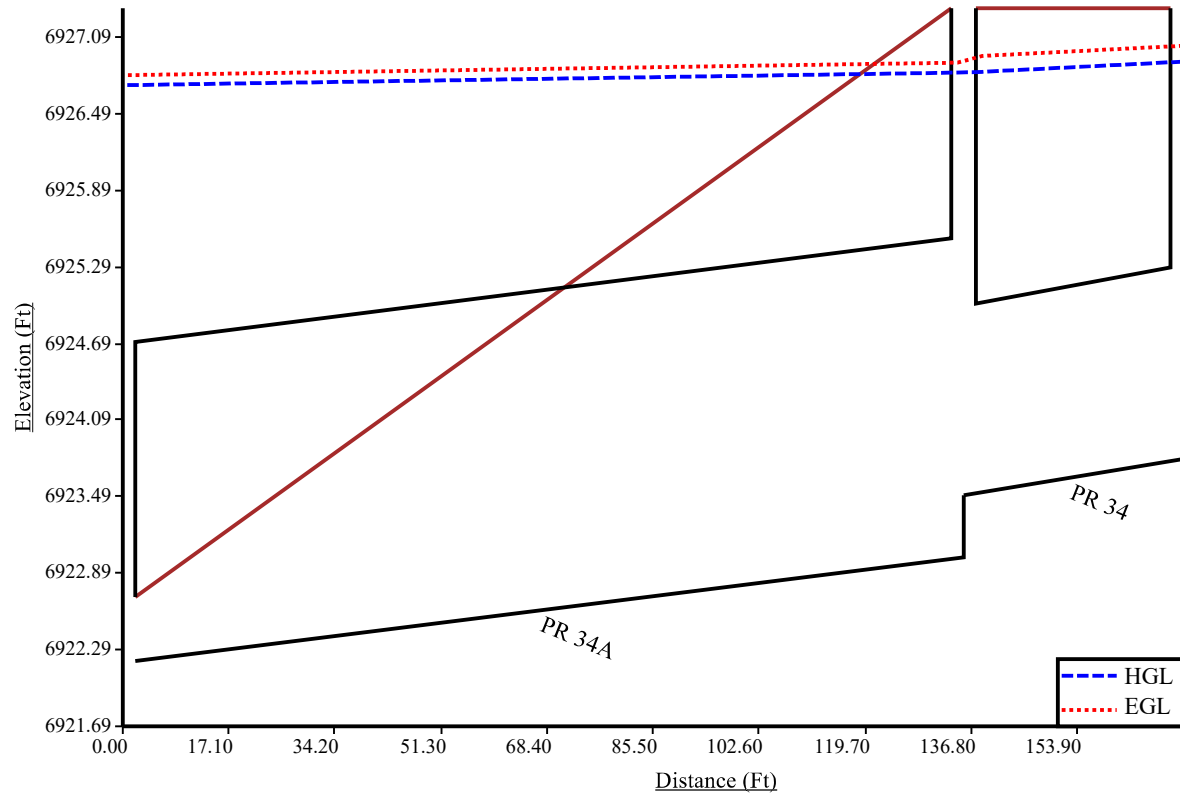
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
PR 34A	135.58	3.50	6.00	6.08	0.00	1.30	0.00	7.10	5.09	1.51	98.20	Sewer Too Shallow
PR 34	35.34	2.50	4.00	4.92	7.13	4.35	2.10	6.56	4.07	1.82	28.35	Sewer Too Shallow

**Total earth volume for sewer trenches = 127 cubic yards.**

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

## PR 34-34A 5-YR HGL Profile



<b>Program:</b> UDSEWER Math Model Interface 2.1.1.4 <b>Run Date:</b> 11/26/2024 2:59:05 PM	<b>UDSewer Results Summary</b>  <b>Project Title:</b> New UDSEWER System Module <b>Project Description:</b> Default system <div>PIPE RUN 34 AND ASSOCIATED LATERALS</div>
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System Input Summary

Rainfall Parameters

**Rainfall Return Period:** 100  
**Rainfall Calculation Method:** Formula  
  
**One Hour Depth (in):**  
**Rainfall Constant "A":** 28.5  
**Rainfall Constant "B":** 10  
**Rainfall Constant "C":** 0.786

Rational Method Constraints

**Minimum Urban Runoff Coeff.:** 0.20  
**Maximum Rural Overland Len. (ft):** 500  
**Maximum Urban Overland Len. (ft):** 300  
**Used UDFCD Tc. Maximum:** Yes

Sizer Constraints

**Minimum Sewer Size (in):** 18.00  
**Maximum Depth to Rise Ratio:** 0.90  
**Maximum Flow Velocity (fps):** 18.0  
**Minimum Flow Velocity (fps):** 2.0

Backwater Calculations:

**Tailwater Elevation (ft):** 6926.71

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
FSD 3	6922.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 34A	6927.31	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PR 34	6927.31	11.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
FSD 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Surface Water Present (Upstream)
PR 34A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.00	Surface Water Present (Downstream)
PR 34	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	11.00	Surface Water Present (Upstream)

Sewer Input Summary:

	Elevation				Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
PR 34A	135.58	6922.20	0.6	6923.01	0.013	0.03	0.00	CIRCULAR	30.00 in	30.00 in
PR 34	35.34	6923.50	0.8	6923.78	0.013	0.05	0.00	CIRCULAR	18.00 in	18.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
PR 34A	31.86	6.49	20.02	6.90	19.45	7.13	1.06	Pressurized	24.00	135.58	
PR 34	9.42	5.33	18.00	6.22	18.00	6.22	0.00	Pressurized	11.00	35.34	

- A Froude number of 0 indicates that pressurized flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
PR 34A	24.00	CIRCULAR	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	4.91	

PR 34	11.00	CIRCULAR	18.00 in	18.00 in	21.00 in	21.00 in	18.00 in	18.00 in	1.77	Existing height is smaller than the suggested height. Existing width is smaller than the suggested width. Exceeds max. Depth/Rise
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- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics were calculated using the 'Used' parameters.

## Grade Line Summary:

**Tailwater Elevation (ft): 6926.71**

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
PR 34A	6922.20	6923.01	0.00	0.00	6926.71	6927.17	6927.08	0.46	6927.54
PR 34	6923.50	6923.78	0.03	0.00	6927.20	6927.59	6927.80	0.39	6928.19

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss =  $\text{Bend } K * V_{fi}^2 / (2 * g)$
- Lateral loss =  $V_{fo}^2 / (2 * g) - \text{Junction Loss } K * V_{fi}^2 / (2 * g)$ .
- Friction loss is always Upstream EGL - Downstream EGL.

## Excavation Estimate:

The trench side slope is 1.0 ft/ft

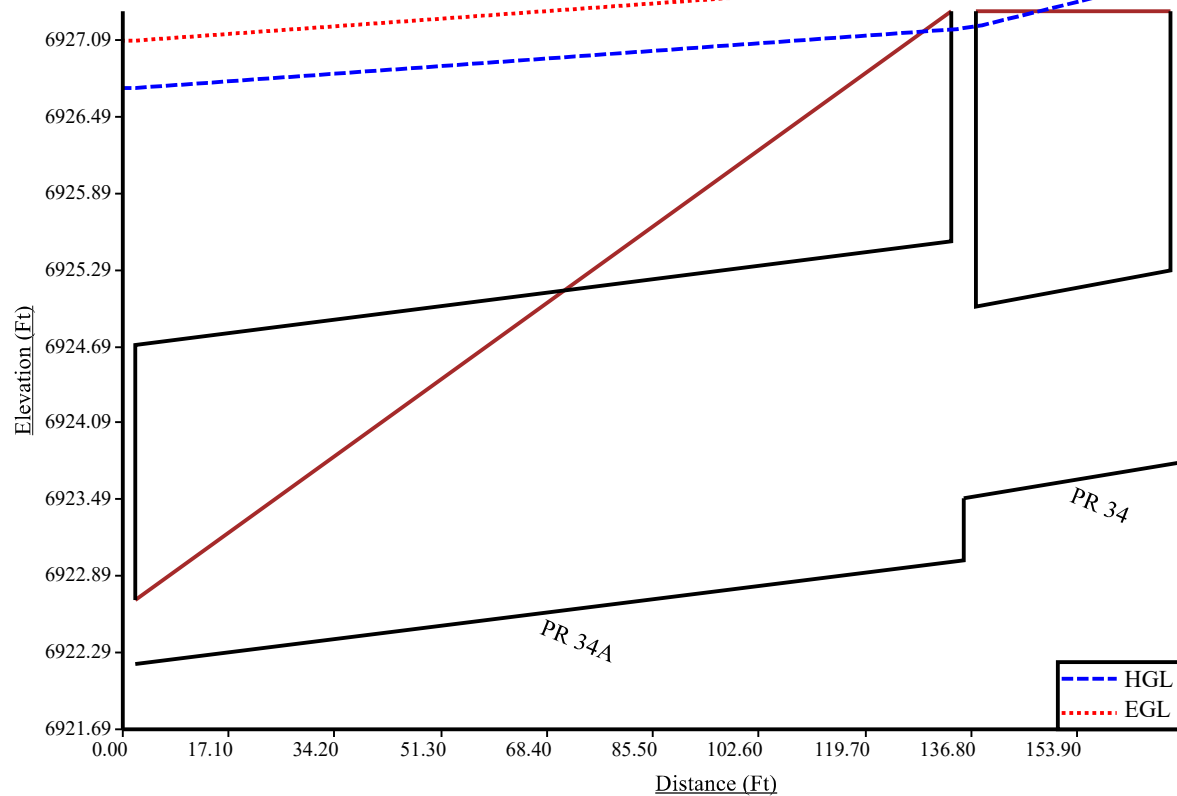
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
PR 34A	135.58	3.50	6.00	6.08	0.00	1.30	0.00	7.10	5.09	1.51	98.20	Sewer Too Shallow
PR 34	35.34	2.50	4.00	4.92	7.13	4.35	2.10	6.56	4.07	1.82	28.35	Sewer Too Shallow

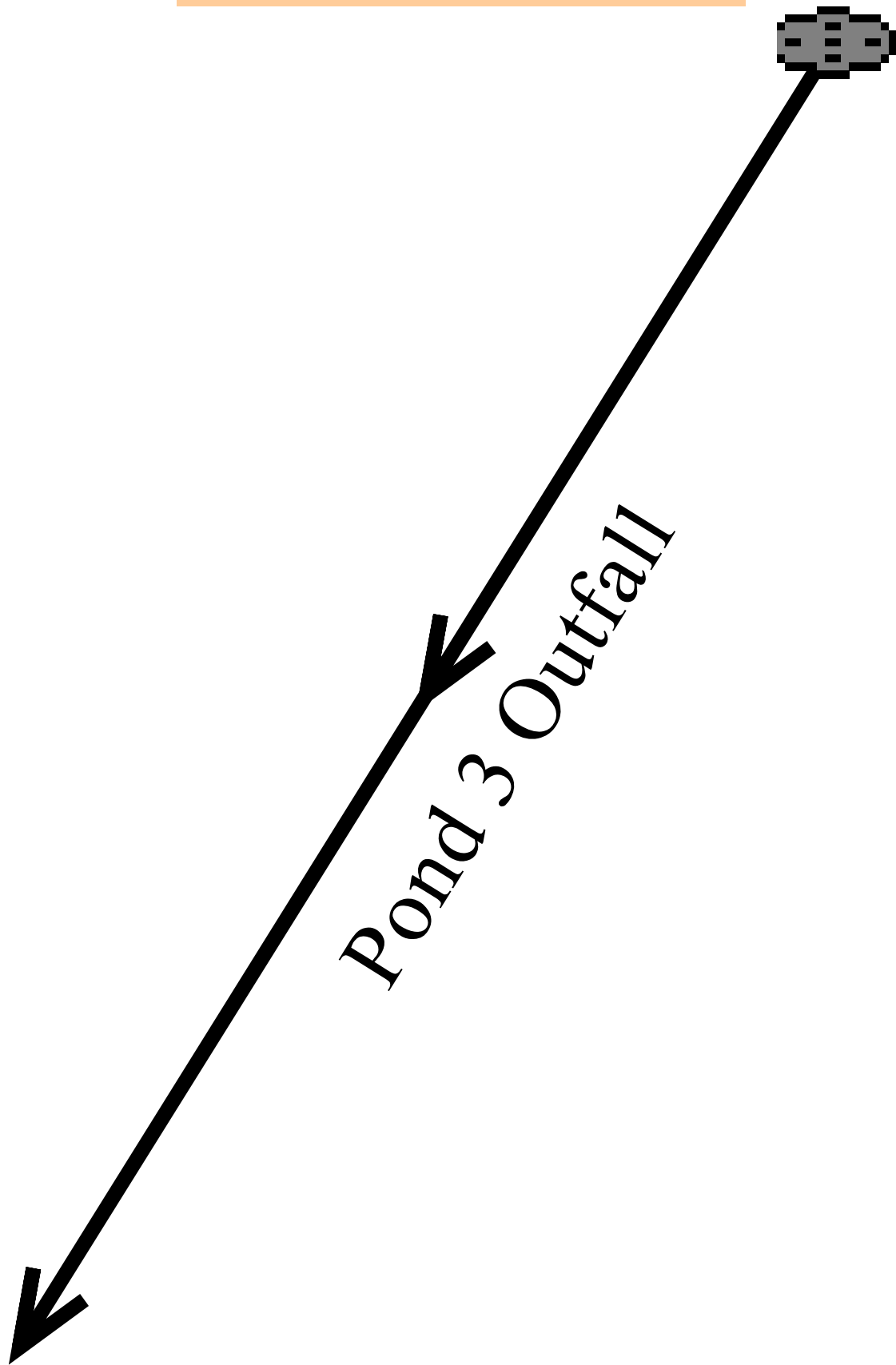
**Total earth volume for sewer trenches = 127 cubic yards.**

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.

# PR 34-34A 100-YR HGL Profile



POND 3 OUTFALL (PR 35) LAYOUT



<b>Program:</b> UDSEWER Math Model Interface 2.1.1.4 <b>Run Date:</b> 11/26/2024 1:30:50 PM	<b>UDSewer Results Summary</b>  <b>Project Title:</b> Pond 3 Outfall <b>Project Description:</b> 5-year
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System Input Summary

Rainfall Parameters

**Rainfall Return Period:** 5  
**Rainfall Calculation Method:** Formula  
  
**One Hour Depth (in):**  
**Rainfall Constant "A":** 28.5  
**Rainfall Constant "B":** 10  
**Rainfall Constant "C":** 0.786

Rational Method Constraints

**Minimum Urban Runoff Coeff.:** 0.20  
**Maximum Rural Overland Len. (ft):** 500  
**Maximum Urban Overland Len. (ft):** 300  
**Used UDFCD Tc. Maximum:** Yes

Sizer Constraints

**Minimum Sewer Size (in):** 18.00  
**Maximum Depth to Rise Ratio:** 0.90  
**Maximum Flow Velocity (fps):** 18.0  
**Minimum Flow Velocity (fps):** 2.0

Backwater Calculations:

**Tailwater Elevation (ft):** 6918.62

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
10x10 Rirap	6919.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Pad										
Pond 3 Outfall	6927.05	1.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
10x10 Riprap Pad	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Pond 3 Outfall	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.30	Surface Water Present (Downstream)

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
Pond 3 Outfall	216.23	6918.99	1.3	6921.80	0.013	0.00	0.00	CIRCULAR	36.00 in	36.00 in

Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
Pond 3 Outfall	76.25	10.79	4.23	2.79	3.27	4.07	1.67	Supercritical	1.30	0.00	

- A Froude number of 0 indicates that pressurized flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
Pond 3 Outfall	1.30	CIRCULAR	36.00 in	36.00 in	18.00 in	18.00 in	36.00 in	36.00 in	7.07	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics were calculated using the 'Used' parameters.

## Grade Line Summary:

**Tailwater Elevation (ft):** 6918.62

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
Pond 3 Outfall	6918.99	6921.80	0.00	0.00	6919.26	6922.15	6919.52	2.75	6922.27

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss =  $Bend\ K * V_{fi}^2 / (2 * g)$
- Lateral loss =  $V_{fo}^2 / (2 * g) - Junction\ Loss\ K * V_{fi}^2 / (2 * g)$ .
- Friction loss is always Upstream EGL - Downstream EGL.

## Excavation Estimate:

The trench side slope is 1.0 ft/ft

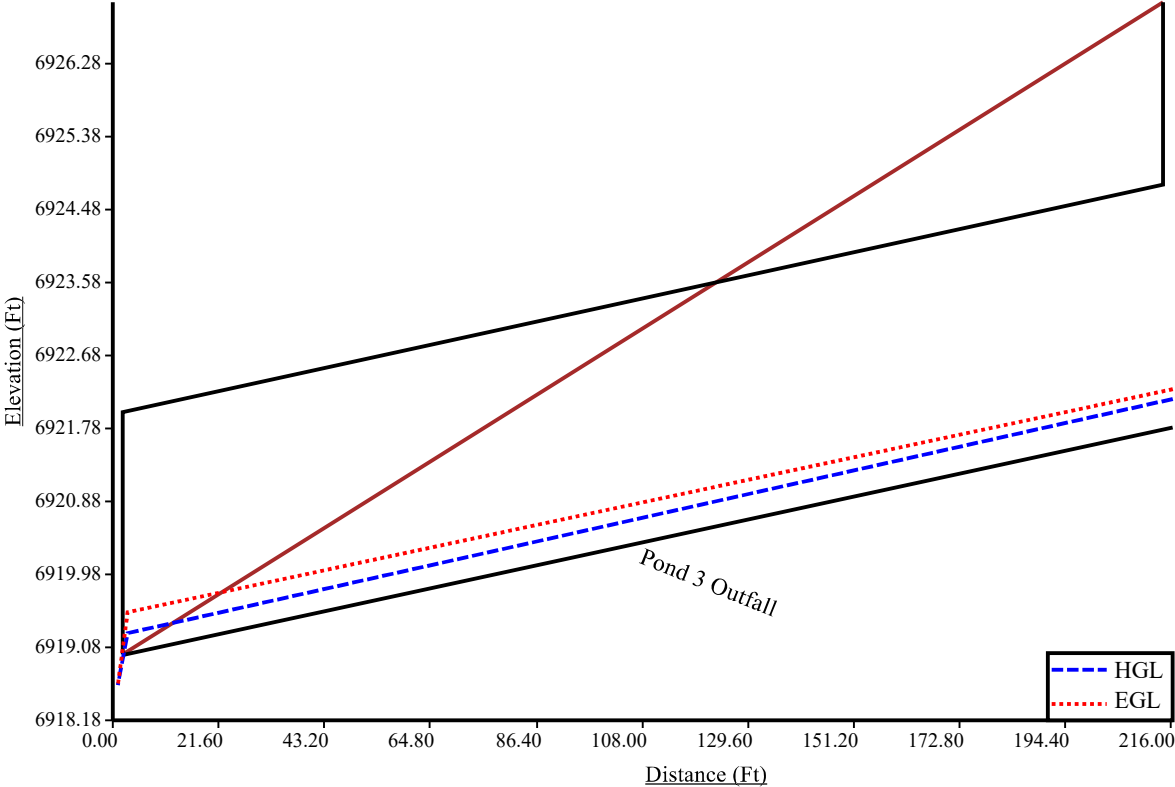
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
Pond 3 Outfall	216.23	4.00	6.00	6.67	0.00	0.84	0.00	8.50	6.08	1.92	188.30	Sewer Too Shallow

**Total earth volume for sewer trenches = 188 cubic yards.**

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

Pond 3 Outfall 5-YR HGL Profile



<b>Program:</b> UDSEWER Math Model Interface 2.1.1.4 <b>Run Date:</b> 11/26/2024 2:43:21 PM	<b>UDSewer Results Summary</b>  <b>Project Title:</b> New UDSEWER System Module <b>Project Description:</b> Default system <b>POND 3 OUTFALL (PR 35)</b>
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System Input Summary

Rainfall Parameters

**Rainfall Return Period:** 100  
**Rainfall Calculation Method:** Formula  
  
**One Hour Depth (in):**  
**Rainfall Constant "A":** 28.5  
**Rainfall Constant "B":** 10  
**Rainfall Constant "C":** 0.786

Rational Method Constraints

**Minimum Urban Runoff Coeff.:** 0.20  
**Maximum Rural Overland Len. (ft):** 500  
**Maximum Urban Overland Len. (ft):** 300  
**Used UDFCD Tc. Maximum:** Yes

Sizer Constraints

**Minimum Sewer Size (in):** 18.00  
**Maximum Depth to Rise Ratio:** 0.90  
**Maximum Flow Velocity (fps):** 18.0  
**Minimum Flow Velocity (fps):** 2.0

Backwater Calculations:

**Tailwater Elevation (ft):** 6922.00

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL 1	6921.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PR 35	6926.54	50.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Surface Water Present (Upstream)
PR 35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	50.50	Surface Water Present (Downstream)

## Sewer Input Summary:

	Elevation				Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)
PR 35	216.23	6918.01	1.8	6921.90	0.013	0.03	0.00	CIRCULAR	36.00 in	36.00 in

## Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
PR 35	89.73	12.69	27.75	8.64	19.32	13.07	2.03	Supercritical Jump	50.50	80.68	

- A Froude number of 0 indicates that pressurized flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

## Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
PR 35	50.50	CIRCULAR	36.00 in	36.00 in	30.00 in	30.00 in	36.00 in	36.00 in	7.07	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics were calculated using the 'Used' parameters.

Grade Line Summary:

Tailwater Elevation (ft): 6922.00

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
PR 35	6918.01	6921.90	0.00	0.00	6922.00	6924.21	6922.79	2.58	6925.37

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss = Bend K \* V<sub>fi</sub> ^ 2/(2\*g)
- Lateral loss = V<sub>fo</sub> ^ 2/(2\*g)- Junction Loss K \* V<sub>fi</sub> ^ 2/(2\*g).
- Friction loss is always Upstream EGL - Downstream EGL.

Excavation Estimate:

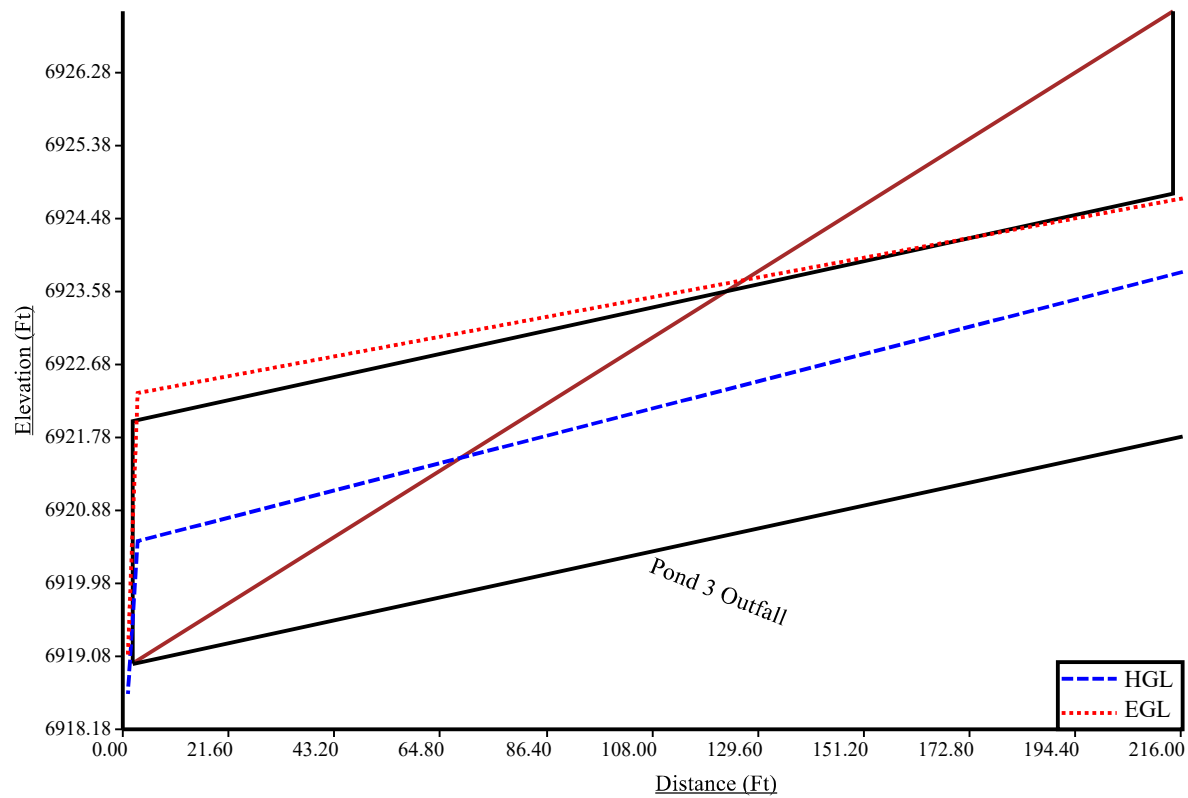
The trench side slope is 1.0 ft/ft  
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
PR 35	216.23	4.00	6.00	6.67	0.00	3.83	0.00	7.28	5.47	1.31	248.61	Sewer Too Shallow

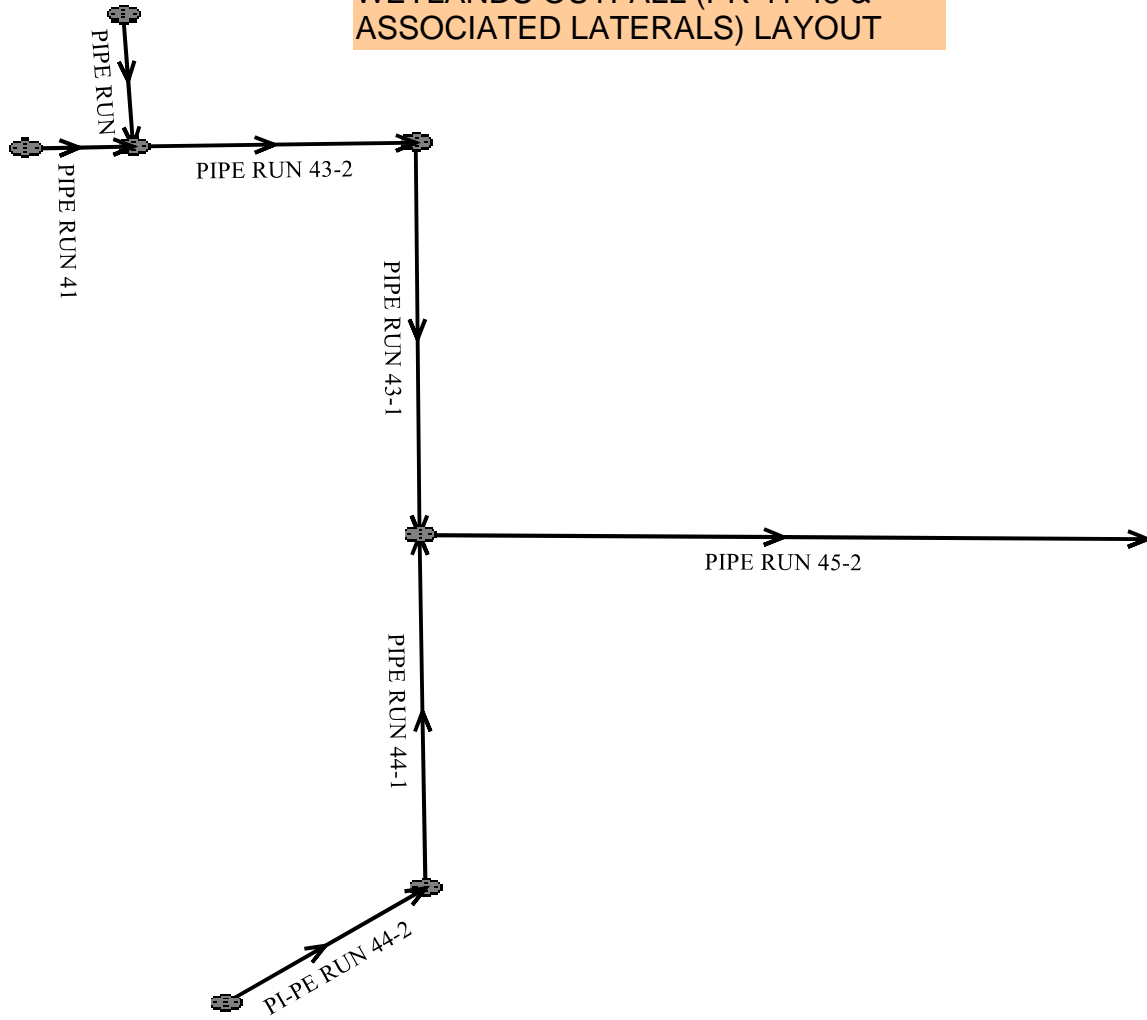
Total earth volume for sewer trenches = 249 cubic yards.

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

Pond 3 Outfall 100-YR HGL Profile



WETLANDS OUTFALL (PR 41-45 &  
ASSOCIATED LATERALS) LAYOUT



<div><div><div>Program:</div><div>UDSEWER Math Model Interface 2.1.1.4</div><div>Run Date:</div><div>11/26/2024 2:45:44 PM</div></div></div> <div><div>UDSewer Results Summary</div><div><div>Project Title: New UDSEWER System Module</div><div>Project Description: Default system</div></div><div>WETLANDS OUTFALL (PIPE RUN 41-45 AND ASSOCIATED LATERALS)</div></div>
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System Input Summary

Rainfall Parameters

Rainfall Return Period: 5

Rainfall Calculation Method: Formula

One Hour Depth (in):

Rainfall Constant "A": 28.5

Rainfall Constant "B": 10

Rainfall Constant "C": 0.786

Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20

Maximum Rural Overland Len. (ft): 500

Maximum Urban Overland Len. (ft): 300

Used UDFCD Tc. Maximum: Yes

Sizer Constraints

Minimum Sewer Size (in): 18.00

Maximum Depth to Rise Ratio: 0.90

Maximum Flow Velocity (fps): 18.0

Minimum Flow Velocity (fps): 2.0

Backwater Calculations:

Tailwater Elevation (ft): 0.00

Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL 1	6950.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

11/26/24, 3:15 PMUDSEWER Math Model Interface Results: New UDSEWER System Module 11/26/2024 14:45

PIPE RUN 45-1	6956.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIPE RUN 45-2	6972.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIPE RUN 43-1	6973.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIPE RUN 43-2	6980.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIPE RUN 41	6980.00	4.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIPE RUN 42	6981.00	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIPE RUN 44-1	6970.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PI-PE RUN 44-2	6965.00	0.30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
PIPE RUN 45-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	Surface Water Present (Downstream)
PIPE RUN 45-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	
PIPE RUN 43-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	
PIPE RUN 43-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	
PIPE RUN 41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.00	
PIPE RUN 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	
PIPE RUN 44-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	
PI-PE RUN 44-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)

PIPE RUN 45-1	66.50	6950.01	1.0	6950.67	0.013	0.03	0.00	CIRCULAR	30.00 in	30.00 in
PIPE RUN 45-2	600.00	6950.75	0.9	6956.15	0.013	0.38	0.00	CIRCULAR	30.00 in	30.00 in
PIPE RUN 43-1	500.00	6957.66	2.2	6968.66	0.013	1.32	0.00	CIRCULAR	24.00 in	24.00 in
PIPE RUN 43-2	101.35	6968.97	2.0	6971.00	0.013	1.32	0.00	CIRCULAR	24.00 in	24.00 in
PIPE RUN 41	6.50	6976.00	1.2	6976.08	0.013	0.05	0.00	CIRCULAR	30.00 in	30.00 in
PIPE RUN 42	30.00	6977.01	3.3	6978.00	0.013	1.32	0.00	CIRCULAR	18.00 in	18.00 in
PIPE RUN 44-1	478.00	6958.15	0.6	6961.02	0.013	1.32	0.00	CIRCULAR	18.00 in	18.00 in
PI-PE RUN 44-2	129.30	6961.22	0.6	6962.00	0.013	0.38	0.00	CIRCULAR	18.00 in	18.00 in

## Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
PIPE RUN 45-1	41.13	8.38	8.85	4.13	7.06	5.67	1.55	Supercritical	5.00	0.00	
PIPE RUN 45-2	39.02	7.95	8.85	4.13	7.25	5.46	1.47	Supercritical	5.00	0.00	
PIPE RUN 43-1	33.64	10.71	8.42	4.07	5.59	7.20	2.21	Supercritical	4.00	0.00	
PIPE RUN 43-2	32.08	10.21	8.42	4.07	5.72	6.96	2.11	Supercritical	4.00	0.00	
PIPE RUN 41	45.05	9.18	7.89	3.88	6.04	5.67	1.68	Supercritical	4.00	0.00	
PIPE RUN 42	19.13	10.83	1.08	1.40	0.74	2.44	2.12	Supercritical	0.06	0.00	
PIPE RUN 44-1	8.16	4.62	2.42	2.11	2.36	2.20	1.05	Supercritical	0.30	0.00	
PI-PE RUN 44-2	8.16	4.62	2.42	2.11	2.36	2.20	1.05	Supercritical	0.30	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

## Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
PIPE RUN 45-1	5.00	CIRCULAR	30.00 in	30.00 in	18.00 in	18.00 in	30.00 in	30.00 in	4.91	
PIPE RUN 45-2	5.00	CIRCULAR	30.00 in	30.00 in	18.00 in	18.00 in	30.00 in	30.00 in	4.91	
PIPE RUN 43-1	4.00	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	

PIPE RUN 43-2	4.00	CIRCULAR	24.00 in	24.00 in	18.00 in	18.00 in	24.00 in	24.00 in	3.14	
PIPE RUN 41	4.00	CIRCULAR	30.00 in	30.00 in	18.00 in	18.00 in	30.00 in	30.00 in	4.91	
PIPE RUN 42	0.06	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
PIPE RUN 44-1	0.30	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
PI-PE RUN 44-2	0.30	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics were calculated using the 'Used' parameters.

## Grade Line Summary:

Tailwater Elevation (ft): 0.00

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
PIPE RUN 45-1	6950.01	6950.67	0.00	0.00	6950.59	6951.41	6951.09	0.58	6951.67
PIPE RUN 45-2	6950.75	6956.15	0.01	0.00	6951.41	6956.89	6951.82	5.33	6957.15
PIPE RUN 43-1	6957.66	6968.66	0.03	0.00	6958.13	6969.36	6958.93	10.69	6969.62
PIPE RUN 43-2	6968.97	6971.00	0.03	0.00	6969.45	6971.70	6970.20	1.76	6971.96
PIPE RUN 41	6976.00	6976.08	0.00	0.00	6976.51	6976.86	6977.00	0.00	6977.00
PIPE RUN 42	6977.01	6978.00	0.00	0.00	6977.07	6978.09	6977.16	0.96	6978.12
PIPE RUN 44-1	6958.15	6961.02	0.00	0.00	6958.35	6961.22	6958.42	2.87	6961.29
PI-PE RUN 44-2	6961.22	6962.00	0.00	0.00	6961.42	6962.20	6961.50	0.78	6962.27

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss =  $\text{Bend K} * V_{fi}^2 / (2 * g)$
- Lateral loss =  $V_{fo}^2 / (2 * g) - \text{Junction Loss K} * V_{fi}^2 / (2 * g)$ .
- Friction loss is always Upstream EGL - Downstream EGL.

## Excavation Estimate:

The trench side slope is 1.0 ft/ft

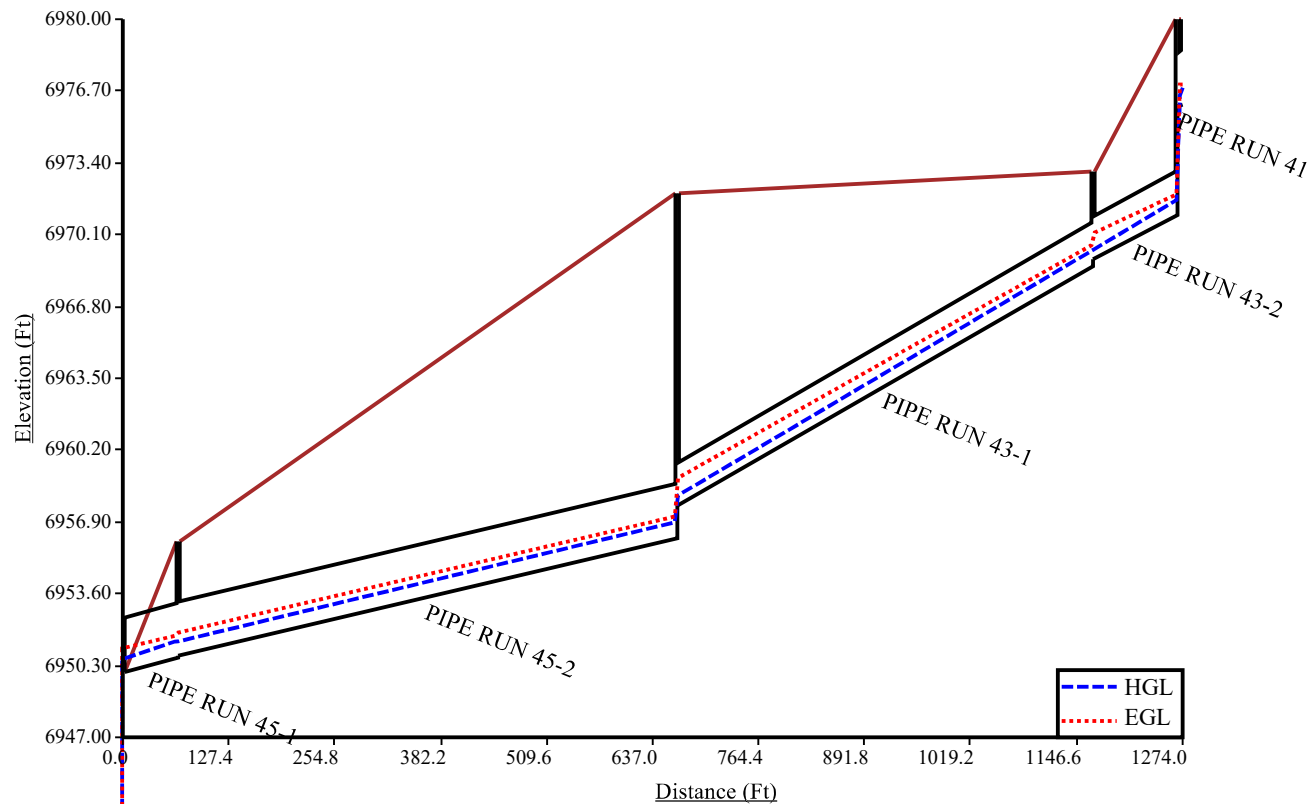
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
PIPE RUN 45-1	66.50	3.50	6.00	6.08	0.00	0.79	0.00	9.16	6.12	2.54	54.67	Sewer Too Shallow
PIPE RUN 45-2	600.00	3.50	6.00	6.08	9.00	6.04	2.46	30.20	16.64	13.06	3172.45	
PIPE RUN 43-1	500.00	3.00	4.00	5.50	27.68	14.92	12.09	7.68	4.92	2.09	2160.49	
PIPE RUN 43-2	101.35	3.00	4.00	5.50	7.05	4.61	1.78	17.00	9.58	6.75	209.70	Sewer Too Shallow
PIPE RUN 41	6.50	3.50	6.00	6.08	6.50	4.79	1.21	6.34	4.71	1.13	6.96	Sewer Too Shallow
PIPE RUN 42	30.00	2.50	4.00	4.92	5.48	3.53	1.28	5.50	3.54	1.29	19.41	Sewer Too Shallow
PIPE RUN 44-1	478.00	2.50	4.00	4.92	27.20	14.39	12.14	17.46	9.52	7.27	2487.28	
PI-PE RUN 44-2	129.30	2.50	4.00	4.92	17.05	9.32	7.07	5.50	3.54	1.29	239.74	Sewer Too Shallow

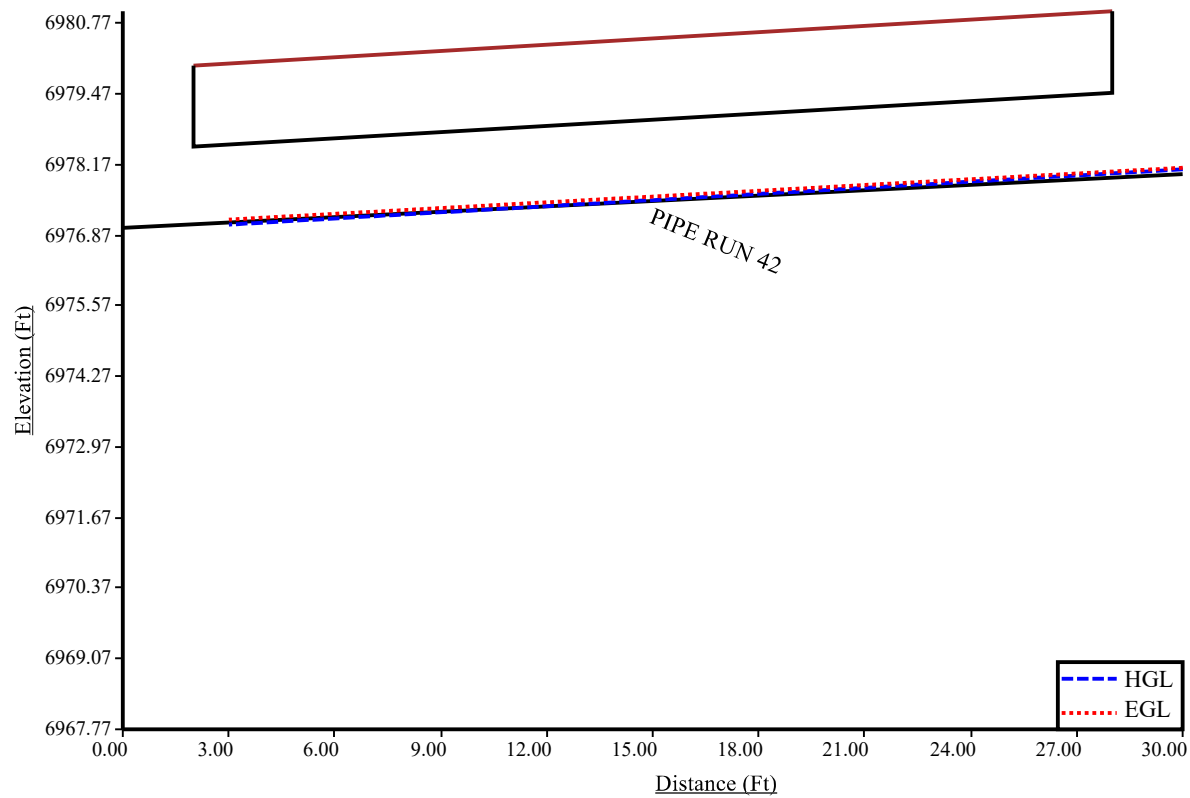
**Total earth volume for sewer trenches = 8351 cubic yards.**

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

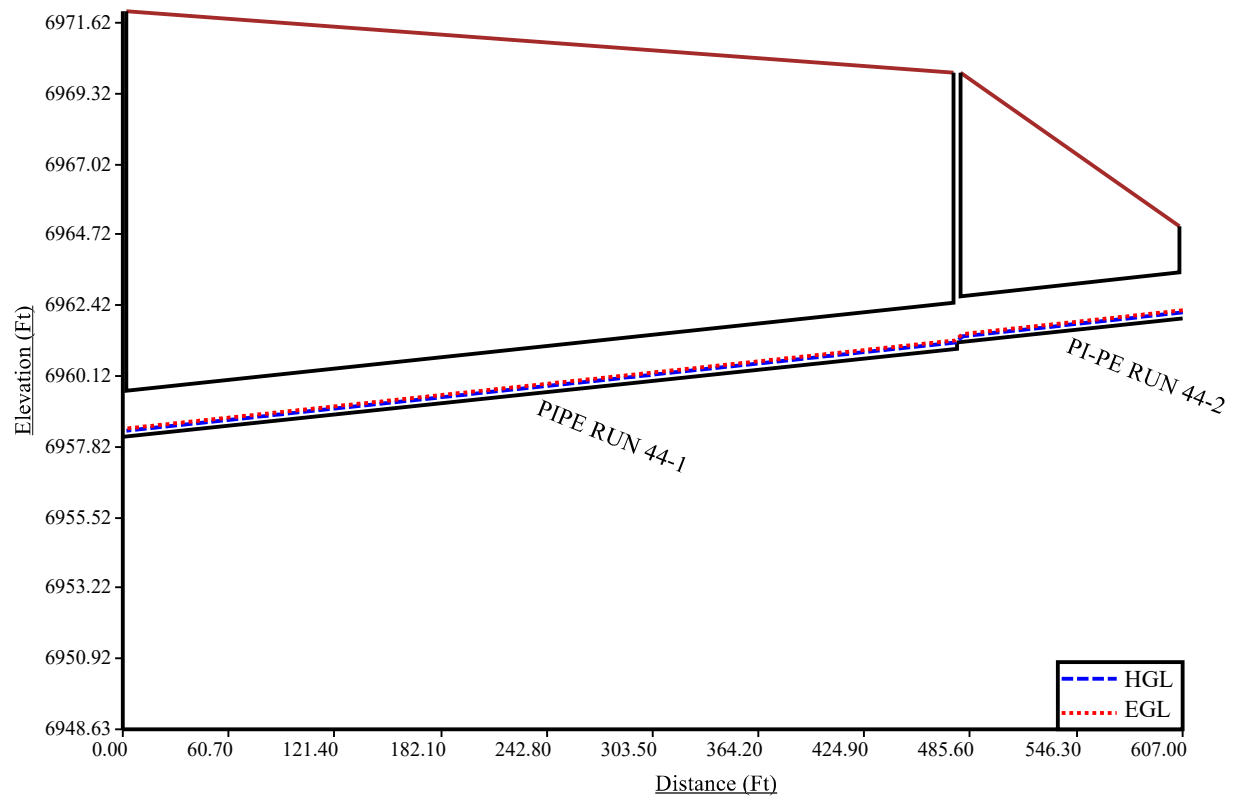
## PR 41-45 5-YR HGL Profile



PR 42 5-YR HGL Profile



PR 44 5-YR HGL Profile



<div><div><div>Program:</div><div>UDSEWER Math Model Interface 2.1.1.4</div><div>Run Date:</div><div>11/26/2024 2:48:41 PM</div></div></div> <div><div>UDSewer Results Summary</div><div><div>Project Title: New UDSEWER System Module</div><div>Project Description: Default system</div></div><div>WETLANDS OUTFALL (PR 41-45 AND ASSOCIATED LATERALS)</div></div>
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## System Input Summary

### Rainfall Parameters

Rainfall Return Period: 100  
Rainfall Calculation Method: Formula

One Hour Depth (in):  
Rainfall Constant "A": 28.5  
Rainfall Constant "B": 10  
Rainfall Constant "C": 0.786

### Rational Method Constraints

Minimum Urban Runoff Coeff.: 0.20  
Maximum Rural Overland Len. (ft): 500  
Maximum Urban Overland Len. (ft): 300  
Used UDFCD Tc. Maximum: Yes

### Sizer Constraints

Minimum Sewer Size (in): 18.00  
Maximum Depth to Rise Ratio: 0.90  
Maximum Flow Velocity (fps): 18.0  
Minimum Flow Velocity (fps): 2.0

### Backwater Calculations:

Tailwater Elevation (ft): 0.00

## Manhole Input Summary:

		Given Flow		Sub Basin Information						
Element Name	Ground Elevation (ft)	Total Known Flow (cfs)	Local Contribution (cfs)	Drainage Area (Ac.)	Runoff Coefficient	5yr Coefficient	Overland Length (ft)	Overland Slope (%)	Gutter Length (ft)	Gutter Velocity (fps)
OUTFALL 1	6950.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

PIPE RUN 45-1	6956.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIPE RUN 45-2	6972.00	30.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIPE RUN 43-1	6973.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIPE RUN 43-2	6980.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIPE RUN 41	6980.00	24.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIPE RUN 42	6981.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PIPE RUN 44-1	6970.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PI-PE RUN 44-2	6965.00	5.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Manhole Output Summary:

	Local Contribution					Total Design Flow				
Element Name	Overland Time (min)	Gutter Time (min)	Basin Tc (min)	Intensity (in/hr)	Local Contrib (cfs)	Coeff. Area	Intensity (in/hr)	Manhole Tc (min)	Peak Flow (cfs)	Comment
OUTFALL 1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
PIPE RUN 45-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.00	Surface Water Present (Downstream)
PIPE RUN 45-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	30.00	
PIPE RUN 43-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	
PIPE RUN 43-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.00	
PIPE RUN 41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	24.00	
PIPE RUN 42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	
PIPE RUN 44-1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	
PI-PE RUN 44-2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	

Sewer Input Summary:

		Elevation			Loss Coefficients			Given Dimensions		
Element Name	Sewer Length (ft)	Downstream Invert (ft)	Slope (%)	Upstream Invert (ft)	Mannings n	Bend Loss	Lateral Loss	Cross Section	Rise (ft or in)	Span (ft or in)

PIPE RUN 45-1	66.50	6950.01	1.0	6950.67	0.013	0.03	0.00	CIRCULAR	30.00 in	30.00 in
PIPE RUN 45-2	600.00	6950.75	0.9	6956.15	0.013	0.38	0.00	CIRCULAR	30.00 in	30.00 in
PIPE RUN 43-1	500.00	6957.66	2.2	6968.66	0.013	1.32	0.00	CIRCULAR	24.00 in	24.00 in
PIPE RUN 43-2	101.35	6968.97	2.0	6971.00	0.013	1.32	0.00	CIRCULAR	24.00 in	24.00 in
PIPE RUN 41	6.50	6976.00	1.2	6976.08	0.013	0.05	0.00	CIRCULAR	30.00 in	30.00 in
PIPE RUN 42	30.00	6977.01	3.3	6978.00	0.013	1.32	0.00	CIRCULAR	18.00 in	18.00 in
PIPE RUN 44-1	478.00	6958.15	0.6	6961.02	0.013	1.32	0.00	CIRCULAR	18.00 in	18.00 in
PI-PE RUN 44-2	129.30	6961.22	0.6	6962.00	0.013	0.38	0.00	CIRCULAR	18.00 in	18.00 in

## Sewer Flow Summary:

	Full Flow Capacity		Critical Flow		Normal Flow						
Element Name	Flow (cfs)	Velocity (fps)	Depth (in)	Velocity (fps)	Depth (in)	Velocity (fps)	Froude Number	Flow Condition	Flow (cfs)	Surcharged Length (ft)	Comment
PIPE RUN 45-1	41.13	8.38	22.40	7.63	19.02	9.14	1.38	Supercritical	30.00	0.00	
PIPE RUN 45-2	39.02	7.95	22.40	7.63	19.73	8.77	1.29	Supercritical	30.00	0.00	
PIPE RUN 43-1	33.64	10.71	21.14	8.53	15.41	11.73	1.96	Supercritical	25.00	0.00	
PIPE RUN 43-2	32.08	10.21	21.14	8.53	15.93	11.29	1.84	Pressurized	25.00	101.35	
PIPE RUN 41	45.05	9.18	20.02	6.90	15.58	9.32	1.62	Supercritical	24.00	0.00	
PIPE RUN 42	19.13	10.83	4.47	2.92	2.80	5.72	2.51	Supercritical	1.00	0.00	
PIPE RUN 44-1	8.16	4.62	10.32	4.77	10.18	4.85	1.03	Supercritical	5.00	0.00	
PI-PE RUN 44-2	8.16	4.62	10.32	4.77	10.18	4.85	1.03	Supercritical	5.00	0.00	

- A Froude number of 0 indicates that pressured flow occurs (adverse slope or undersized pipe).
- If the sewer is not pressurized, full flow represents the maximum gravity flow in the sewer.
- If the sewer is pressurized, full flow represents the pressurized flow conditions.

## Sewer Sizing Summary:

			Existing		Calculated		Used			
Element Name	Peak Flow (cfs)	Cross Section	Rise	Span	Rise	Span	Rise	Span	Area (ft^2)	Comment
PIPE RUN 45-1	30.00	CIRCULAR	30.00 in	30.00 in	27.00 in	27.00 in	30.00 in	30.00 in	4.91	
PIPE RUN 45-2	30.00	CIRCULAR	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	30.00 in	4.91	
PIPE RUN 43-1	25.00	CIRCULAR	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	3.14	

PIPE RUN 43-2	25.00	CIRCULAR	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	24.00 in	3.14	
PIPE RUN 41	24.00	CIRCULAR	30.00 in	30.00 in	24.00 in	24.00 in	30.00 in	30.00 in	4.91	
PIPE RUN 42	1.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
PIPE RUN 44-1	5.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	
PI-PE RUN 44-2	5.00	CIRCULAR	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	18.00 in	1.77	

- Calculated diameter was determined by sewer hydraulic capacity rounded up to the nearest commercially available size.
- Sewer sizes should not decrease downstream.
- All hydraulics were calculated using the 'Used' parameters.

## Grade Line Summary:

Tailwater Elevation (ft): 0.00

	Invert Elev.		Downstream Manhole Losses		HGL		EGL		
Element Name	Downstream (ft)	Upstream (ft)	Bend Loss (ft)	Lateral Loss (ft)	Downstream (ft)	Upstream (ft)	Downstream (ft)	Friction Loss (ft)	Upstream (ft)
PIPE RUN 45-1	6950.01	6950.67	0.00	0.00	6951.59	6952.54	6952.89	0.55	6953.44
PIPE RUN 45-2	6950.75	6956.15	0.22	0.00	6953.03	6958.02	6953.66	5.26	6958.92
PIPE RUN 43-1	6957.66	6968.66	1.30	0.00	6959.31	6970.42	6961.08	10.47	6971.55
PIPE RUN 43-2	6968.97	6971.00	1.30	0.00	6971.87	6973.10	6972.85	1.23	6974.08
PIPE RUN 41	6976.00	6976.08	0.02	0.00	6977.30	6978.19	6978.65	0.00	6978.65
PIPE RUN 42	6977.01	6978.00	0.01	0.00	6977.24	6978.37	6977.75	0.75	6978.51
PIPE RUN 44-1	6958.15	6961.02	0.16	0.00	6959.00	6961.88	6959.37	2.87	6962.23
PI-PE RUN 44-2	6961.22	6962.00	0.05	0.00	6962.07	6962.86	6962.44	0.78	6963.21

- Bend and Lateral losses only apply when there is an outgoing sewer. The system outfall, sewer #0, is not considered a sewer.
- Bend loss =  $Bend\ K * V_{fi}^2 / (2 * g)$
- Lateral loss =  $V_{fo}^2 / (2 * g) - Junction\ Loss\ K * V_{fi}^2 / (2 * g)$ .
- Friction loss is always Upstream EGL - Downstream EGL.

## Excavation Estimate:

The trench side slope is 1.0 ft/ft

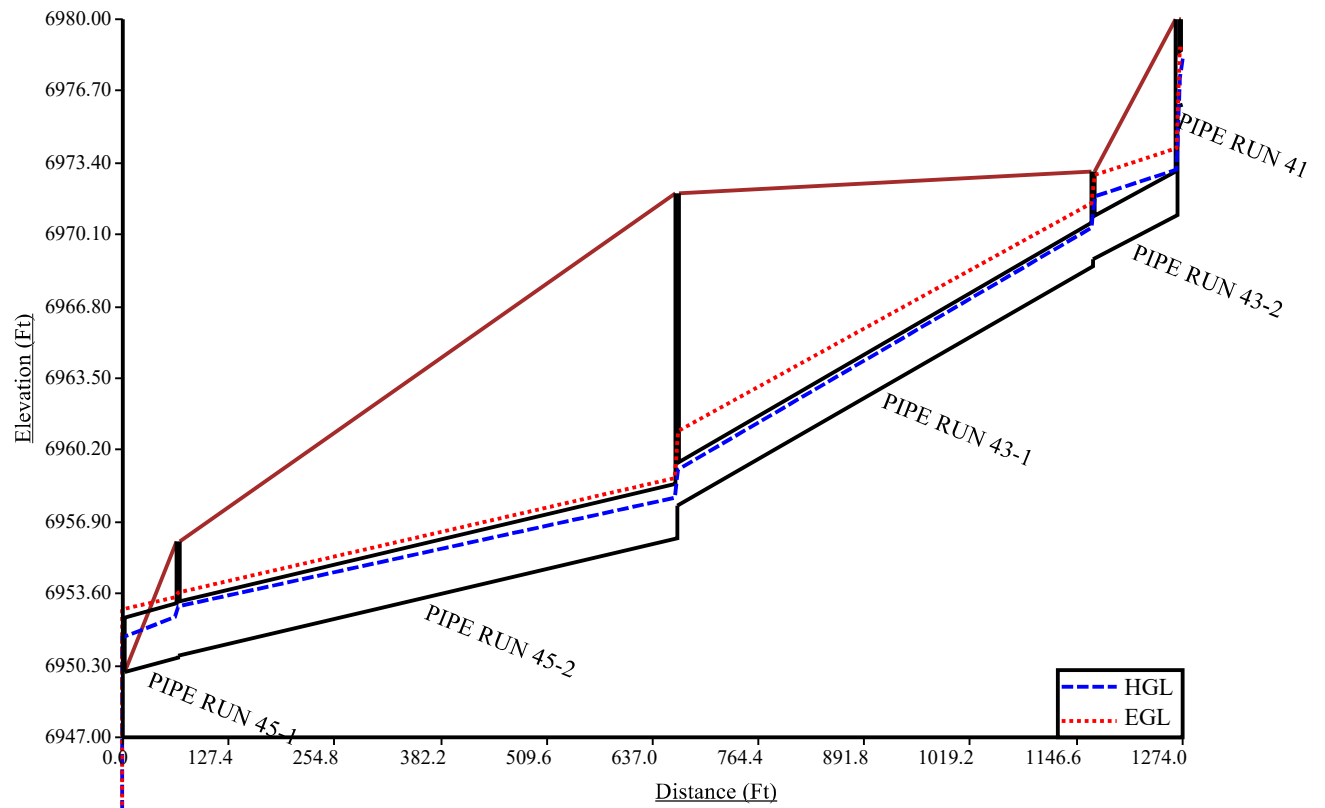
The minimum trench width is 2.00 ft

					Downstream			Upstream				
Element Name	Length (ft)	Wall (in)	Bedding (in)	Bottom Width (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Top Width (ft)	Trench Depth (ft)	Cover (ft)	Volume (cu. yd)	Comment
PIPE RUN 45-1	66.50	3.50	6.00	6.08	0.00	0.79	0.00	9.16	6.12	2.54	54.67	Sewer Too Shallow
PIPE RUN 45-2	600.00	3.50	6.00	6.08	9.00	6.04	2.46	30.20	16.64	13.06	3172.45	
PIPE RUN 43-1	500.00	3.00	4.00	5.50	27.68	14.92	12.09	7.68	4.92	2.09	2160.49	
PIPE RUN 43-2	101.35	3.00	4.00	5.50	7.05	4.61	1.78	17.00	9.58	6.75	209.70	Sewer Too Shallow
PIPE RUN 41	6.50	3.50	6.00	6.08	6.50	4.79	1.21	6.34	4.71	1.13	6.96	Sewer Too Shallow
PIPE RUN 42	30.00	2.50	4.00	4.92	5.48	3.53	1.28	5.50	3.54	1.29	19.41	Sewer Too Shallow
PIPE RUN 44-1	478.00	2.50	4.00	4.92	27.20	14.39	12.14	17.46	9.52	7.27	2487.28	
PI-PE RUN 44-2	129.30	2.50	4.00	4.92	17.05	9.32	7.07	5.50	3.54	1.29	239.74	Sewer Too Shallow

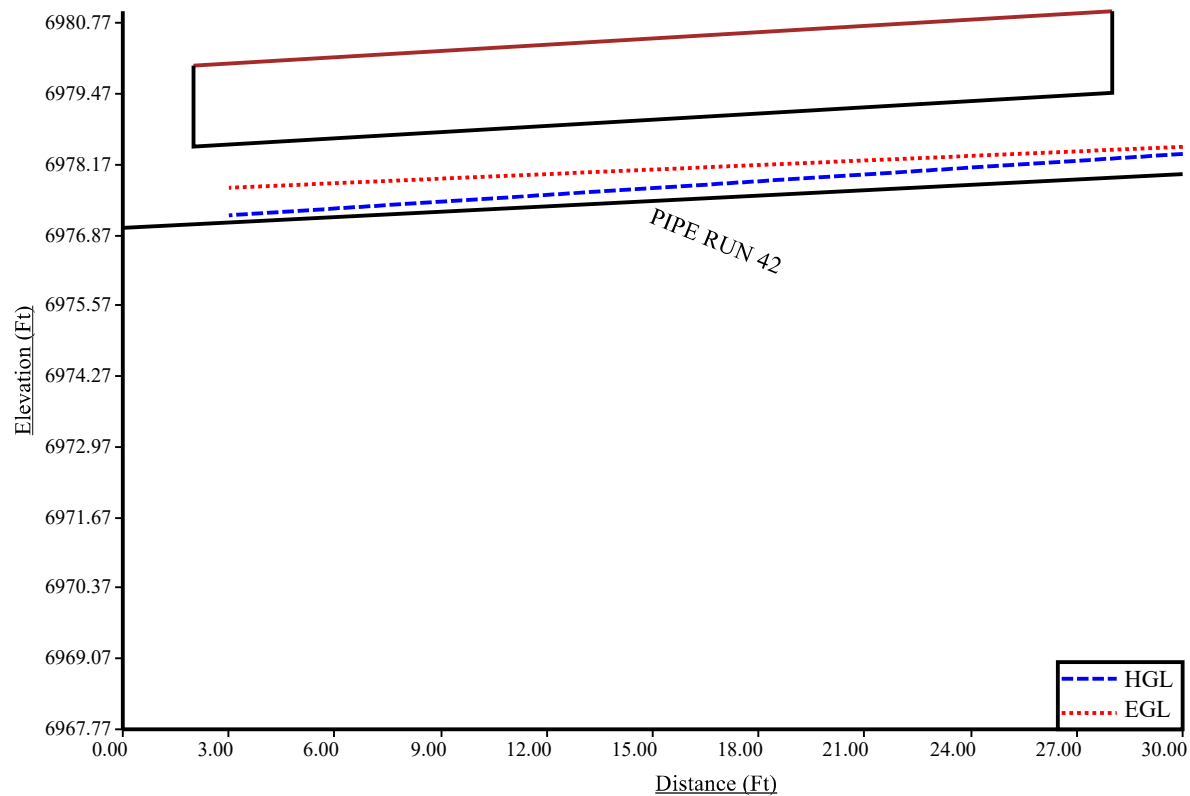
**Total earth volume for sewer trenches = 8351 cubic yards.**

- The trench was estimated to have a bottom width equal to the outer pipe diameter plus 36 inches.
- If the calculated width of the trench bottom is less than the minimum acceptable width, the minimum acceptable width was used.
- The sewer wall thickness is equal to: (equivalent diameter in inches/12)+1 inches
- The sewer bedding thickness is equal to:
  - Four inches for pipes less than 33 inches.
  - Six inches for pipes less than 60 inches.
  - Eight inches for all larger sizes.

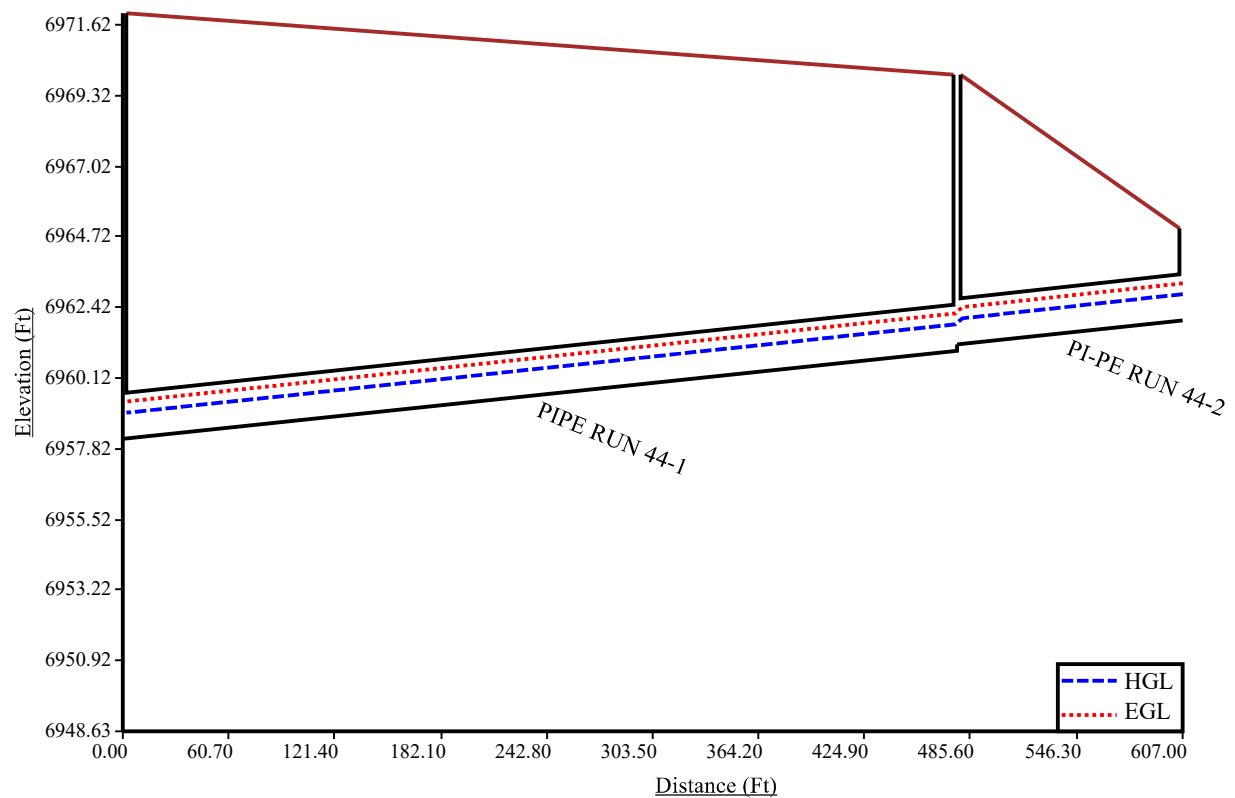
# PR 41-45 100-YR HGL Profile



PR 42 100-YR HGL Profile



PR 44 100-YR HGL Profile



# Manning Formula Uniform Pipe Flow at Given Slope and Depth

## PIPE RUN 37

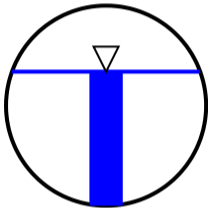
12" HDPE @ 1.00%

### Inputs

Pipe diameter, $d_0$	12	in	▼
<a href="#">Manning roughness, <math>n</math></a>	0.012		
Pressure slope (possibly <a href="#">?</a> equal to pipe slope), $S_0$	1	% rise/run	▼
Relative flow depth, $y/d_0$	67	%	▼

### Results

Flow depth, $y$	0.6700	ft	▼
Flow area, $a$	0.5594	ft^2	▼
Pipe area, $a_0$	0.7854	ft^2	▼
Relative area, $a/a_0$	0.7122	fraction	▼
Wetted perimeter, $P_w$	1.9177	ft	▼
Hydraulic radius, $R_h$	0.2917	ft	▼
Top width, $T$	0.9404	ft	▼
Velocity, $v$	5.4461	ft/sec	▼
Velocity head, $h_v$	0.4610	ft H2O	▼
<a href="#">Froude number, <math>F</math></a>	1.25		
Average shear stress (tractive force), $\tau$	0.1821	psf	▼
<b>Flow, <math>Q</math></b> (See notes)	3.0462	cfs	▼
Full flow, $Q_0$	3.8593	cfs	▼
Ratio to full flow, $Q/Q_0$	0.7893	fraction	▼



### Notes:

**This is the flow and depth inside an *infinitely long* pipe.**

Getting the flow into the pipe may require significantly higher headwater depth. Add at least 1.5 times the velocity head to get the headwater depth or [see my 2-minute tutorial](#) for standard culvert headwater calculations using HY-8.

# Manning Formula Uniform Pipe Flow at Given Slope and Depth

PIPE RUN 38

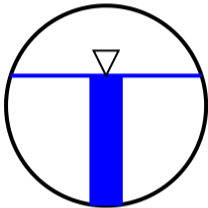
12" HDPE @ 0.50%

Inputs

Pipe diameter, $d_0$	12	in	▼
<a href="#">Manning roughness, <math>n</math></a>	0.012		
Pressure slope (possibly <a href="#">?</a> equal to pipe slope), $S_0$	0.5	% rise/run	▼
Relative flow depth, $y/d_0$	65	%	▼

Results

Flow depth, $y$	0.6500	ft	▼
Flow area, $a$	0.5404	ft^2	▼
Pipe area, $a_0$	0.7854	ft^2	▼
Relative area, $a/a_0$	0.6881	fraction	▼
Wetted perimeter, $P_w$	1.8755	ft	▼
Hydraulic radius, $R_h$	0.2881	ft	▼
Top width, $T$	0.9539	ft	▼
Velocity, $v$	3.8198	ft/sec	▼
Velocity head, $h_v$	0.2268	ft H2O	▼
<a href="#">Froude number, <math>F</math></a>	0.89		
Average shear stress (tractive force), $\tau$	0.0899	psf	▼
<b>Flow, <math>Q</math></b> (See notes)	2.0642	cfs	▼
Full flow, $Q_0$	2.7290	cfs	▼
Ratio to full flow, $Q/Q_0$	0.7564	fraction	▼



Notes:

**This is the flow and depth inside an *infinitely long* pipe.**  
Getting the flow into the pipe may require significantly higher headwater depth. Add at least 1.5 times the velocity head to get the headwater depth or [see my 2-minute tutorial](#) for standard culvert headwater calculations using HY-8.

# Manning Formula Uniform Pipe Flow at Given Slope and Depth

PIPE RUN 39

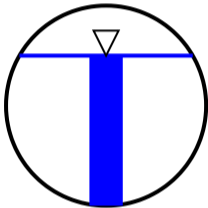
12" HDPE @ 0.77%

Inputs

Pipe diameter, $d_0$	12	in	▼
<a href="#">Manning roughness, <math>n</math></a>	0.012		
Pressure slope (possibly <a href="#">?</a> equal to pipe slope), $S_0$	0.77	% rise/run	▼
Relative flow depth, $y/d_0$	75	%	▼

Results

Flow depth, $y$	0.7500	ft	▼
Flow area, $a$	0.6319	ft^2	▼
Pipe area, $a_0$	0.7854	ft^2	▼
Relative area, $a/a_0$	0.8045	fraction	▼
Wetted perimeter, $P_w$	2.0944	ft	▼
Hydraulic radius, $R_h$	0.3017	ft	▼
Top width, $T$	0.8660	ft	▼
Velocity, $v$	4.8876	ft/sec	▼
Velocity head, $h_v$	0.3713	ft H2O	▼
<a href="#">Froude number, <math>F</math></a>	1.01		
Average shear stress (tractive force), $\tau$	0.1450	psf	▼
<b>Flow, <math>Q</math></b> (See notes)	3.0881	cfs	▼
Full flow, $Q_0$	3.3866	cfs	▼
Ratio to full flow, $Q/Q_0$	0.9119	fraction	▼



Notes:

**This is the flow and depth inside an *infinitely long* pipe.**  
Getting the flow into the pipe may require significantly higher headwater depth. Add at least 1.5 times the velocity head to get the headwater depth or [see my 2-minute tutorial](#) for standard culvert headwater calculations using HY-8.

# Manning Formula Uniform Pipe Flow at Given Slope and Depth

PIPE RUN 40

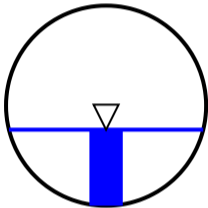
12" HDPE @ 3.12%

Inputs

Pipe diameter, d <sub>0</sub>	12	in ▾
<a href="#">Manning roughness, n</a>	0.012	
Pressure slope (possibly <a href="#">?</a> equal to pipe slope), S <sub>0</sub>	3.12	% rise/run ▾
Relative flow depth, y/d <sub>0</sub>	38	% ▾

Results

Flow depth, y	0.3800	ft ▾
Flow area, a	0.2739	ft^2 ▾
Pipe area, a <sub>0</sub>	0.7854	ft^2 ▾
Relative area, a/a <sub>0</sub>	0.3487	fraction ▾
Wetted perimeter, P <sub>w</sub>	1.3284	ft ▾
Hydraulic radius, R <sub>h</sub>	0.2062	ft ▾
Top width, T	0.9708	ft ▾
Velocity, v	7.6327	ft/sec ▾
Velocity head, h <sub>v</sub>	0.9054	ft H2O ▾
<a href="#">Froude number, F</a>	2.53	
Average shear stress (tractive force), tau	0.4015	psf ▾
<b>Flow, Q</b> (See notes)	2.0902	cfs ▾
Full flow, Q <sub>0</sub>	6.8169	cfs ▾
Ratio to full flow, Q/Q <sub>0</sub>	0.3066	fraction ▾



Notes:

**This is the flow and depth inside an *infinitely long* pipe.**

Getting the flow into the pipe may require significantly higher headwater depth. Add at least 1.5 times the velocity head to get the headwater depth or [see my 2-minute tutorial](#) for standard culvert headwater calculations using HY-8.

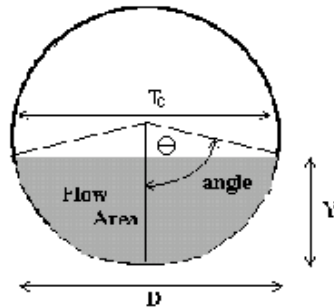
## **CULVERT CALCULATIONS**

# CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Waterbury Fil #1**

Pipe ID: **Gilbert Double Culvert for Design Point 11**



## Design Information (Input)

Pipe Invert Slope	$S_o =$	0.0128	ft/ft
Pipe Manning's n-value	$n =$	0.0130	
Pipe Diameter	$D =$	42.00	inches
Design discharge	$Q =$	108.00	cfs

## Full-Flow Capacity (Calculated)

Full-flow area	$A_f =$	9.62	sq ft
Full-flow wetted perimeter	$P_f =$	11.00	ft
Half Central Angle	$\text{Theta} =$	3.14	radians
Full-flow capacity	$Q_f =$	114.13	cfs

## Calculation of Normal Flow Condition

Half Central Angle ( $0 < \text{Theta} < 3.14$ )	$\text{Theta} =$	2.15	radians
Flow area	$A_n =$	8.00	sq ft
Top width	$T_n =$	2.92	ft
Wetted perimeter	$P_n =$	7.54	ft
Flow depth	$Y_n =$	2.71	ft
Flow velocity	$V_n =$	13.50	fps
Discharge	$Q_n =$	108.00	cfs
Percent of Full Flow	$\text{Flow} =$	94.6%	of full flow
Normal Depth Froude Number	$Fr_n =$	1.44	supercritical

## Calculation of Critical Flow Condition

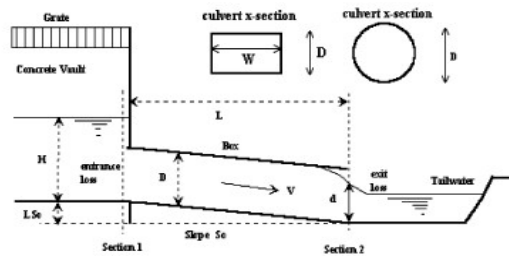
Half Central Angle ( $0 < \text{Theta-c} < 3.14$ )	$\text{Theta-c} =$	2.50	radians
Critical flow area	$A_c =$	9.12	sq ft
Critical top width	$T_c =$	2.10	ft
Critical flow depth	$Y_c =$	3.15	ft
Critical flow velocity	$V_c =$	11.84	fps
Critical Depth Froude Number	$Fr_c =$	1.00	

# CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Waterbury Fil #1**

ID: **Gilbert Double Culvert for Design Point 11**



## Design Information (Input):

Circular Culvert: Barrel Diameter in Inches  
Inlet Edge Type (Choose from pull-down list)

D = 42 inches  
Square Edge with Headwall

OR:  
Box Culvert: Barrel Height (Rise) in Feet  
Barrel Width (Span) in Feet  
Inlet Edge Type (Choose from pull-down list)

H (Rise) = ft  
W (Span) = ft

Number of Barrels  
Inlet Elevation at Culvert Invert  
Outlet Elevation **OR** Slope  
Culvert Length  
Manning's Roughness  
Bend Loss Coefficient  
Exit Loss Coefficient

# Barrels = 2  
Elev IN = 6935.82 ft  
Elev OUT = 6934.18 ft  
L = 128 ft  
n = 0.013  
K<sub>b</sub> = 0  
K<sub>x</sub> = 1

## Design Information (calculated):

Entrance Loss Coefficient  
Friction Loss Coefficient  
Sum of All Loss Coefficients  
Minimum Energy Condition Coefficient  
Orifice Inlet Condition Coefficient

K<sub>e</sub> = 0.50  
K<sub>f</sub> = 0.75  
K<sub>s</sub> = 2.25  
K<sub>E<sub>low</sub></sub> = 0.0018  
C<sub>d</sub> = 0.60

## Calculations of Culvert Capacity (output):

Backwater calculations required to obtain Outlet Control Flowrate when H<sub>W0</sub> < 0.75 \* Culvert Rise

Headwater Surface Elevation (ft)	Tailwater Surface Elevation (ft)	Inlet Control Equation Used	Inlet Control Flowrate (cfs)	Outlet Control Flowrate (cfs)	Controlling Culvert Flowrate (cfs)	Flow Control Used
6935.82		No Flow (WS < inlet)	0.00	0.00	0.00	N/A
6936.07		Min. Energy. Eqn.	0.64	#N/A	#N/A	#N/A
6936.32		Min. Energy. Eqn.	2.62	#N/A	#N/A	#N/A
6936.57		Min. Energy. Eqn.	7.02	#N/A	#N/A	#N/A
6936.82		Min. Energy. Eqn.	12.14	#N/A	#N/A	#N/A
6937.07		Min. Energy. Eqn.	18.62	#N/A	#N/A	#N/A
6937.32		Min. Energy. Eqn.	26.26	#N/A	#N/A	#N/A
6937.57		Min. Energy. Eqn.	35.02	#N/A	#N/A	#N/A
6937.82		Regression Eqn.	43.04	#N/A	#N/A	#N/A
6938.07		Regression Eqn.	51.92	#N/A	#N/A	#N/A
6938.32		Regression Eqn.	61.62	#N/A	#N/A	#N/A
6938.57		Regression Eqn.	71.88	122.33	71.88	INLET
6938.82		Regression Eqn.	82.62	131.03	82.62	INLET
6939.07		Regression Eqn.	93.46	139.26	93.46	INLET
6939.32		Regression Eqn.	104.22	147.21	104.22	INLET
6939.57		Regression Eqn.	114.42	154.82	114.42	INLET
6939.82		Regression Eqn.	124.22	162.18	124.22	INLET
6940.07		Regression Eqn.	133.46	169.33	133.46	INLET
6940.32		Regression Eqn.	142.22	176.20	142.22	INLET
6940.57		Regression Eqn.	150.42	182.91	150.42	INLET
6940.82		Regression Eqn.	158.22	189.43	158.22	INLET
6941.07		Regression Eqn.	165.62	195.78	165.62	INLET
6941.32		Regression Eqn.	172.66	201.97	172.66	INLET
6941.57		Regression Eqn.	179.42	207.98	179.42	INLET
6941.82		Regression Eqn.	185.86	213.92	185.86	INLET
6942.07		Regression Eqn.	192.08	219.69	192.08	INLET
6942.32		Regression Eqn.	198.06	225.35	198.06	INLET
6942.57		Regression Eqn.	203.88	230.91	203.88	INLET
6942.82		Regression Eqn.	209.50	236.35	209.50	INLET
6943.07		Regression Eqn.	215.02	241.70	215.02	INLET

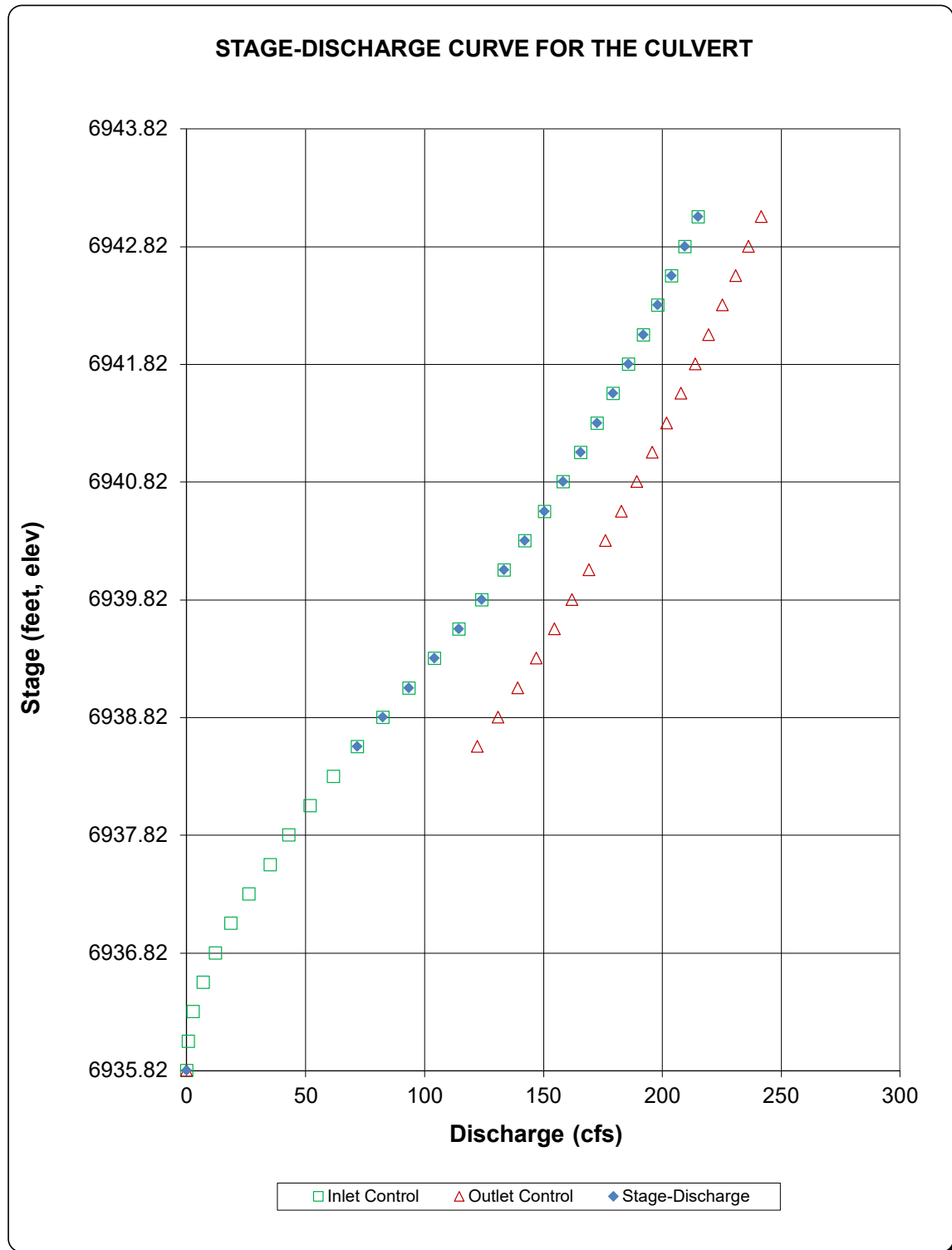
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# CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Waterbury Fil #1

ID: Gilbert Double Culvert for Design Point 11

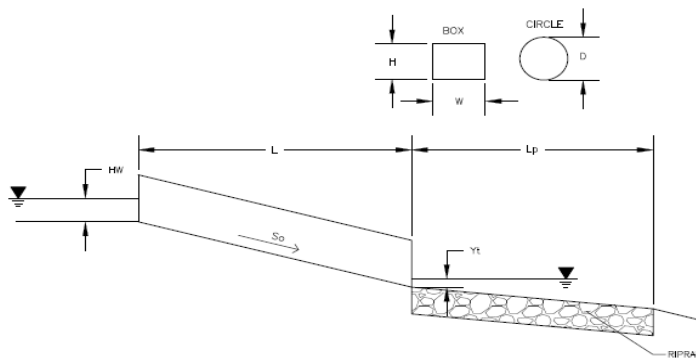


# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Waterbury Fil #1**

ID: **Gilbert Double Culvert for Design Point 11**



Soil Type:

Choose One:

☒ Sandy

☐ Non-Sandy

**Supercritical Flow! Using Adjusted Diameter to calculate protection type.**

## Design Information:

Design Discharge

Q = 216 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 42 inches

Inlet Edge Type (Choose from pull-down list)

Beveled Edge (1:1)

OR:

Box Culvert:

Barrel Height (Rise) in Feet

H (Rise) =

Barrel Width (Span) in Feet

W (Span) =

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

# Barrels = 2

Inlet Elevation

Elev IN = 6935.82 ft

Outlet Elevation OR Slope

Elev OUT = 6934.18 ft

Culvert Length

L = 128 ft

Manning's Roughness

n = 0.013

Bend Loss Coefficient

k<sub>b</sub> = 0

Exit Loss Coefficient

k<sub>x</sub> = 1

Tailwater Surface Elevation

Y<sub>t</sub> Elevation = 6935.518 ft

Max Allowable Channel Velocity

V = 5 ft/s

## Calculated Results:

Culvert Cross Sectional Area Available

A = 9.62 ft<sup>2</sup>

Culvert Normal Depth

Y<sub>n</sub> = 2.71 ft

Culvert Critical Depth

Y<sub>c</sub> = 3.15 ft

Froude Number

Fr = 1.44

Entrance Loss Coefficient

k<sub>e</sub> = 0.20

Friction Loss Coefficient

k<sub>f</sub> = 0.75

Sum of All Loss Coefficients

k<sub>s</sub> = 1.95

Headwater:

Inlet Control Headwater

HW<sub>I</sub> = 6.80 ft

Outlet Control Headwater

HW<sub>O</sub> = 5.50 ft

Design Headwater Elevation

HW = 6942.62 ft

Headwater/Diameter OR Headwater/Rise F

HW/D > 1.5!

Outlet Protection:

Flow/(Diameter<sup>2.5</sup>)

ft<sup>0.5</sup>/s

Tailwater Surface Height

ft

Tailwater/Diameter

ft

Expansion Factor

ft<sup>2</sup>

Flow Area at Max Channel Velocity

ft<sup>2</sup>

Width of Equivalent Conduit for Multiple Barrels

ft

Length of Riprap Protection

L<sub>p</sub> = 35 ft

Width of Riprap Protection at Downstream End

T = 21 ft

Adjusted Diameter for Supercritical Flow

Da = 3.11 ft

Minimum Theoretical Riprap Size

d<sub>50</sub> min = 15 in

Nominal Riprap Size

d<sub>50</sub> nominal = 18 in

MHFD Riprap Type

Type = H

added sentence in Design Point 11 text. did not find a statement in EPC DC manual that states we can't have HW/D greater then 1.5.

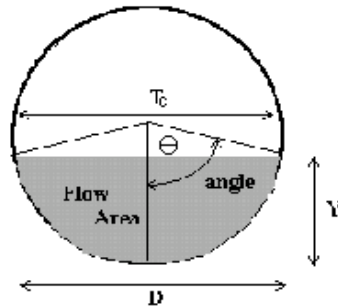
Address what is being done for supercritical flow and HW/D being greater than 1.5

# CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Waterbury Fil #1**

Pipe ID: **Pipe Run #12 - Gilbert Road Side Ditch Culvert for Design Point 12**



## Design Information (Input)

Pipe Invert Slope	So =	0.0575	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	18.00	inches
Design discharge	Q =	4.00	cfs

## Full-Flow Capacity (Calculated)

Full-flow area	Af =	1.77	sq ft
Full-flow wetted perimeter	Pf =	4.71	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	25.26	cfs

## Calculation of Normal Flow Condition

Half Central Angle ( $0 < \theta < 3.14$ )	Theta =	1.09	radians
Flow area	An =	0.38	sq ft
Top width	Tn =	1.33	ft
Wetted perimeter	Pn =	1.64	ft
Flow depth	Yn =	0.40	ft
Flow velocity	Vn =	10.44	fps
Discharge	Qn =	4.00	cfs
Percent of Full Flow	Flow =	15.8%	of full flow
Normal Depth Froude Number	Fr <sub>n</sub> =	3.43	supercritical

## Calculation of Critical Flow Condition

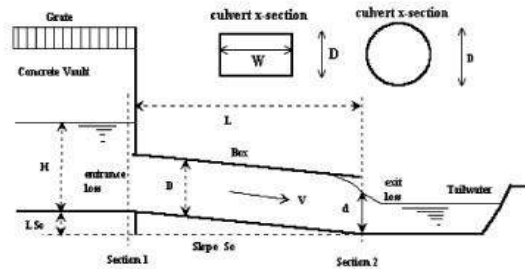
Half Central Angle ( $0 < \theta_c < 3.14$ )	Theta-c =	1.59	radians
Critical flow area	Ac =	0.91	sq ft
Critical top width	Tc =	1.50	ft
Critical flow depth	Yc =	0.77	ft
Critical flow velocity	Vc =	4.41	fps
Critical Depth Froude Number	Fr <sub>c</sub> =	1.00	

# CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Waterbury Fil #1**

ID: **Pipe Run #12 - Gilbert Road Side Ditch Culvert for Design Point 12**



## Design Information (Input):

Circular Culvert: Barrel Diameter in Inches  
Inlet Edge Type (Choose from pull-down list)

D = 18 inches  
Beveled Edge (1:1)

### OR:

Box Culvert: Barrel Height (Rise) in Feet  
Barrel Width (Span) in Feet  
Inlet Edge Type (Choose from pull-down list)

H (Rise) = ft  
W (Span) = ft

Number of Barrels  
Inlet Elevation at Culvert Invert  
Outlet Elevation **OR** Slope  
Culvert Length  
Manning's Roughness  
Bend Loss Coefficient  
Exit Loss Coefficient

# Barrels = 1  
Elev IN = 6940.17 ft  
Elev OUT = 6934.42 ft  
L = 100 ft  
n = 0.013  
K<sub>b</sub> = 0  
K<sub>e</sub> = 1

## Design Information (calculated):

Entrance Loss Coefficient  
Friction Loss Coefficient  
Sum of All Loss Coefficients  
Minimum Energy Condition Coefficient  
Orifice Inlet Condition Coefficient

K<sub>e</sub> = 0.20  
K<sub>f</sub> = 1.81  
K<sub>s</sub> = 3.01  
K<sub>E<sub>low</sub></sub> = -0.1813  
C<sub>d</sub> = 0.65

## Calculations of Culvert Capacity (output):

Backwater calculations required to obtain Outlet Control Flowrate when  $H_{W0} < 0.75 * \text{Culvert Rise}$

Headwater Surface Elevation (ft)	Tailwater Surface Elevation (ft)	Inlet Control Equation Used	Inlet Control Flowrate (cfs)	Outlet Control Flowrate (cfs)	Controlling Culvert Flowrate (cfs)	Flow Control Used
6940.17		No Flow (WS < inlet)	0.00	0.00	<b>0.00</b>	N/A
6940.27		Min. Energy. Eqn.	0.04	#N/A	#N/A	#N/A
6940.37		Min. Energy. Eqn.	0.16	#N/A	#N/A	#N/A
6940.47		Min. Energy. Eqn.	0.41	#N/A	#N/A	#N/A
6940.57		Min. Energy. Eqn.	0.71	#N/A	#N/A	#N/A
6940.67		Min. Energy. Eqn.	1.11	#N/A	#N/A	#N/A
6940.77		Min. Energy. Eqn.	1.53	#N/A	#N/A	#N/A
6940.87		Min. Energy. Eqn.	2.04	#N/A	#N/A	#N/A
6940.97		Regression Eqn.	2.54	#N/A	#N/A	#N/A
6941.07		Regression Eqn.	3.05	#N/A	#N/A	#N/A
6941.17		Regression Eqn.	3.62	#N/A	#N/A	#N/A
6941.27		Regression Eqn.	4.24	#N/A	#N/A	#N/A
6941.37		Regression Eqn.	4.91	19.08	<b>4.91</b>	INLET
6941.47		Regression Eqn.	5.61	19.25	<b>5.61</b>	INLET
6941.57		Regression Eqn.	6.24	19.42	<b>6.24</b>	INLET
6941.67		Regression Eqn.	6.91	19.59	<b>6.91</b>	INLET
6941.77		Regression Eqn.	7.51	19.76	<b>7.51</b>	INLET
6941.87		Regression Eqn.	8.05	19.93	<b>8.05</b>	INLET
6941.97		Regression Eqn.	8.61	20.10	<b>8.61</b>	INLET
6942.07		Regression Eqn.	9.11	20.26	<b>9.11</b>	INLET
6942.17		Regression Eqn.	9.56	20.43	<b>9.56</b>	INLET
6942.27		Regression Eqn.	10.01	20.59	<b>10.01</b>	INLET
6942.37		Regression Eqn.	10.44	20.75	<b>10.44</b>	INLET
6942.47		Regression Eqn.	10.85	20.91	<b>10.85</b>	INLET
6942.57		Regression Eqn.	11.25	21.07	<b>11.25</b>	INLET
6942.67		Regression Eqn.	11.63	21.23	<b>11.63</b>	INLET
6942.77		Regression Eqn.	12.01	21.39	<b>12.01</b>	INLET
6942.87		Regression Eqn.	12.41	21.54	<b>12.41</b>	INLET
6942.97		Regression Eqn.	12.72	21.69	<b>12.72</b>	INLET
6943.07		Regression Eqn.	13.11	21.85	<b>13.11</b>	INLET

Processing Time: **00.20 Seconds**

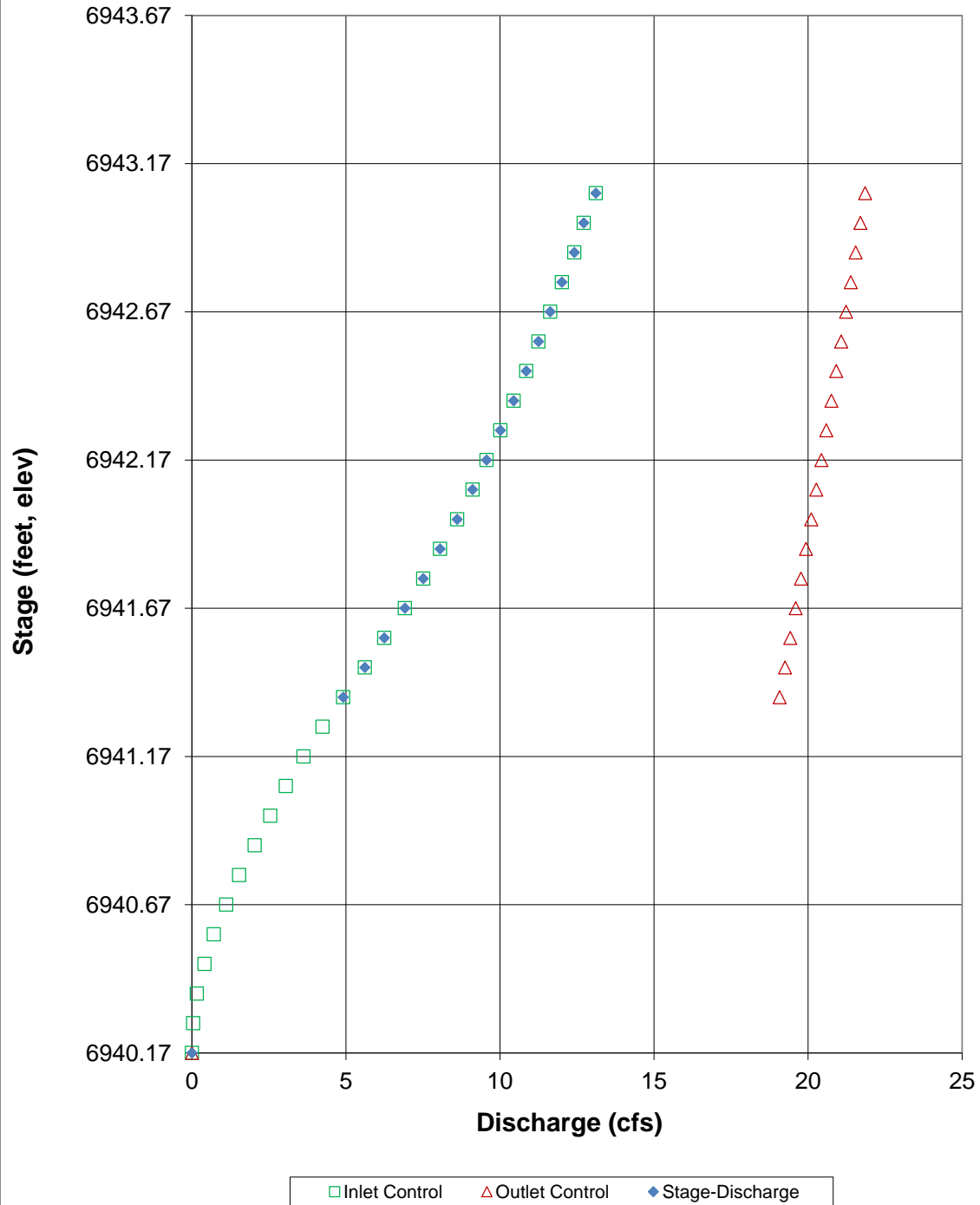
# CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Waterbury Fil #1**

ID: **Pipe Run #12 - Gilbert Road Side Ditch Culvert for Design Point 12**

## STAGE-DISCHARGE CURVE FOR THE CULVERT

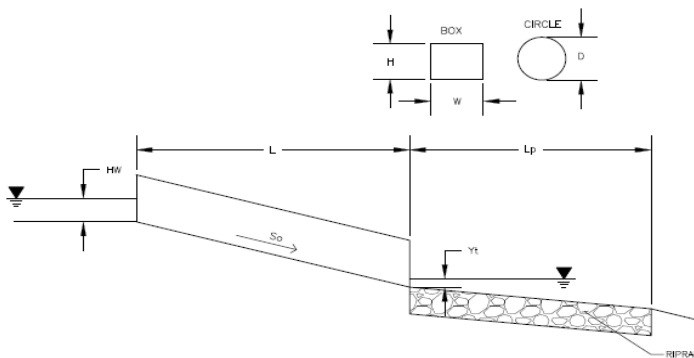


# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Waterbury Fil #1**

ID: **Pipe Run #12 - Gilbert Road Side Ditch Culvert for Design Point 12**



## Soil Type:

Choose One:

☒ Sandy

☐ Non-Sandy

**Supercritical Flow! Using Adjusted Diameter to calculate protection type.**

## Design Information:

Design Discharge

Q = 4 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 18 inches

Inlet Edge Type (Choose from pull-down list)

Beveled Edge (1:1)

**OR:**

Box Culvert:

Barrel Height (Rise) in Feet

H (Rise) =

Barrel Width (Span) in Feet

W (Span) =

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

# Barrels = 1

Inlet Elevation

Elev IN = 6940.17 ft

Outlet Elevation **OR** Slope

Elev OUT = 6934.42 ft

Culvert Length

L = 100 ft

Manning's Roughness

n = 0.013

Bend Loss Coefficient

k<sub>b</sub> = 0

Exit Loss Coefficient

k<sub>x</sub> = 1

Tailwater Surface Elevation

Y<sub>t</sub> Elevation = 6935.02 ft

Max Allowable Channel Velocity

V = 5 ft/s

## Calculated Results:

Culvert Cross Sectional Area Available

A = 1.77 ft<sup>2</sup>

Culvert Normal Depth

Y<sub>n</sub> = 0.40 ft

Culvert Critical Depth

Y<sub>c</sub> = 0.77 ft

Froude Number

Fr = 3.43 **Supercritical!**

Entrance Loss Coefficient

k<sub>e</sub> = 0.20

Friction Loss Coefficient

k<sub>f</sub> = 1.81

Sum of All Loss Coefficients

k<sub>s</sub> = 3.01 ft

Headwater:

Inlet Control Headwater

HW<sub>i</sub> = 1.06 ft

Outlet Control Headwater

HW<sub>o</sub> = N/A ft

**Design Headwater Elevation**

**HW = N/A ft**

**Headwater/Diameter OR Headwater/Rise Ratio**

**HW/D = N/A**

**Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required**

Outlet Protection:

Flow/(Diameter<sup>2.5</sup>)

Q/D<sup>2.5</sup> = 1.45 ft<sup>0.5</sup>/s

Tailwater Surface Height

Y<sub>t</sub> = 0.60 ft

Tailwater/Diameter

Y<sub>t</sub>/D = 0.40

Expansion Factor

1/(2\*tan(θ)) = 6.27

Flow Area at Max Channel Velocity

A<sub>t</sub> = 0.80 ft<sup>2</sup>

Width of Equivalent Conduit for Multiple Barrels

W<sub>eq</sub> = - ft

**Length of Riprap Protection**

**L<sub>p</sub> = 5 ft**

**Width of Riprap Protection at Downstream End**

**T = 3 ft**

Adjusted Diameter for Supercritical Flow

Da = 0.95 ft

Minimum Theoretical Riprap Size

d<sub>50 min</sub> = 2 in

Nominal Riprap Size

d<sub>50 nominal</sub> = 6 in

**MHFD Riprap Type**

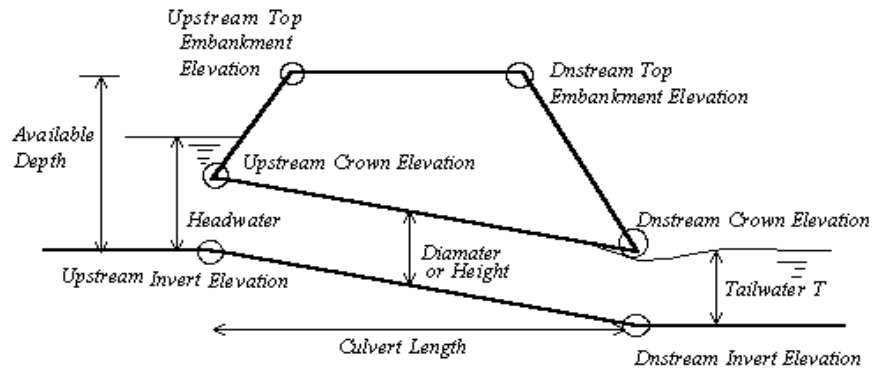
**Type = VL**

# VERTICAL PROFILE FOR THE CULVERT

MHFD-Culvert, Version 4.00 (May 2020)

Project = **Waterbury Fil #1**

ID = **Pipe Run #12 - Gilbert Road Side Ditch Culvert for Design Point 12**



## Culvert Information (Input)

Barrel Diameter or Height	D or H =	18.00	inches
Barrel Length	L =	100.00	ft
Barrel Invert Slope	So =	0.0575	ft/ft
Downstream Invert Elevation	EDI =	6934.42	ft
Downstream Top Embankment Elevation	EDT =	6942.00	ft
Upstream Top Embankment Elevation	EUT =	6942.70	ft
Design Headwater Depth (not elev.)	Hw =	1.06	ft
Tailwater Depth (not elev.)	Yt =	0.60	ft

## Culvert Hydraulics (Calculated)

Available Headwater Depth	HW-a =	2.53	ft
Design Hw/D ratio	Hw/D =	0.71	

## Culvert Vertical Profile

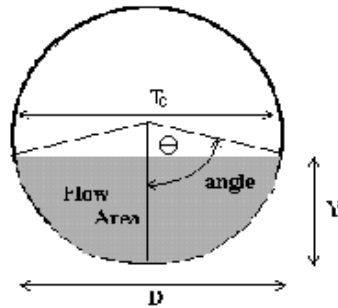
Upstream Invert Elevation	EUI =	6940.17	ft
Upstream Crown Elevation	EUC =	6941.67	ft
Upstream Soil Cover Depth	Upsoil =	1.03	ft
Downstream Crown Elevation	EDC =	6935.92	ft
Downstream Soil Cover Depth	Dnsoil =	6.08	ft

# CIRCULAR CONDUIT FLOW (Normal & Critical Depth Computation)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Waterbury Fil #13**

Pipe ID: **Pipe Run #36 - Sunken Meadow Triple Culvert for Design Point 30**



## Design Information (Input)

Pipe Invert Slope	So =	0.0225	ft/ft
Pipe Manning's n-value	n =	0.0130	
Pipe Diameter	D =	36.00	inches
Design discharge	Q =	39.00	cfs

## Full-Flow Capacity (Calculated)

Full-flow area	Af =	7.07	sq ft
Full-flow wetted perimeter	Pf =	9.42	ft
Half Central Angle	Theta =	3.14	radians
Full-flow capacity	Qf =	100.32	cfs

## Calculation of Normal Flow Condition

Half Central Angle ( $0 < \theta < 3.14$ )	Theta =	1.44	radians
Flow area	An =	2.93	sq ft
Top width	Tn =	2.97	ft
Wetted perimeter	Pn =	4.31	ft
Flow depth	Yn =	1.30	ft
Flow velocity	Vn =	13.30	fps
Discharge	Qn =	39.00	cfs
Percent of Full Flow	Flow =	38.9%	of full flow
Normal Depth Froude Number	Fr <sub>n</sub> =	2.36	supercritical

## Calculation of Critical Flow Condition

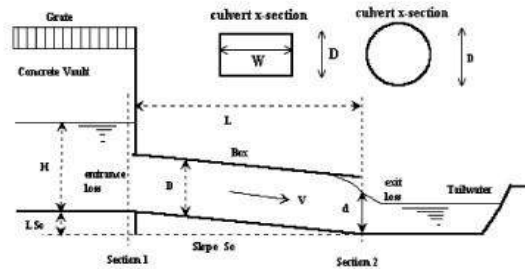
Half Central Angle ( $0 < \theta_c < 3.14$ )	Theta-c =	1.93	radians
Critical flow area	Ac =	5.10	sq ft
Critical top width	Tc =	2.80	ft
Critical flow depth	Yc =	2.03	ft
Critical flow velocity	Vc =	7.65	fps
Critical Depth Froude Number	Fr <sub>c</sub> =	1.00	

# CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Waterbury Fil #13**

ID: **Pipe Run #36 - Sunken Meadow Triple Culvert for Design Point 30**



## Design Information (Input):

Circular Culvert: Barrel Diameter in Inches  
Inlet Edge Type (Choose from pull-down list)

D = 36 inches  
Beveled Edge (1:1)

## OR:

Box Culvert: Barrel Height (Rise) in Feet  
Barrel Width (Span) in Feet  
Inlet Edge Type (Choose from pull-down list)

H (Rise) = ft  
W (Span) = ft

Number of Barrels  
Inlet Elevation at Culvert Invert  
Outlet Elevation **OR** Slope  
Culvert Length  
Manning's Roughness  
Bend Loss Coefficient  
Exit Loss Coefficient

# Barrels = 3  
Elev IN = 6920 ft  
Elev OUT = 6917 ft  
L = 133.53 ft  
n = 0.013  
K<sub>b</sub> = 0  
K<sub>e</sub> = 1

## Design Information (calculated):

Entrance Loss Coefficient  
Friction Loss Coefficient  
Sum of All Loss Coefficients  
Minimum Energy Condition Coefficient  
Orifice Inlet Condition Coefficient

K<sub>e</sub> = 0.20  
K<sub>f</sub> = 0.96  
K<sub>s</sub> = 2.16  
K<sub>E<sub>low</sub></sub> = -0.0654  
C<sub>d</sub> = 0.65

## Calculations of Culvert Capacity (output):

Backwater calculations required to obtain Outlet Control Flowrate when  $H_{W0} < 0.75 * \text{Culvert Rise}$

Headwater Surface Elevation (ft)	Tailwater Surface Elevation (ft)	Inlet Control Equation Used	Inlet Control Flowrate (cfs)	Outlet Control Flowrate (cfs)	Controlling Culvert Flowrate (cfs)	Flow Control Used
6920.00		No Flow (WS < inlet)	0.00	0.00	<b>0.00</b>	N/A
6920.30		Min. Energy. Eqn.	1.32	#N/A	#N/A	#N/A
6920.60		Min. Energy. Eqn.	6.42	#N/A	#N/A	#N/A
6920.90		Min. Energy. Eqn.	14.07	#N/A	#N/A	#N/A
6921.20		Min. Energy. Eqn.	24.33	#N/A	#N/A	#N/A
6921.50		Min. Energy. Eqn.	36.96	#N/A	#N/A	#N/A
6921.80		Regression Eqn.	49.32	#N/A	#N/A	#N/A
6922.10		Regression Eqn.	63.81	#N/A	#N/A	#N/A
6922.40		Regression Eqn.	80.16	187.80	<b>80.16</b>	INLET
6922.70		Regression Eqn.	97.29	197.36	<b>97.29</b>	INLET
6923.00		Regression Eqn.	113.91	206.57	<b>113.91</b>	INLET
6923.30		Regression Eqn.	129.24	215.47	<b>129.24</b>	INLET
6923.60		Regression Eqn.	143.22	224.07	<b>143.22</b>	INLET
6923.90		Regression Eqn.	156.03	232.45	<b>156.03</b>	INLET
6924.20		Regression Eqn.	167.79	240.61	<b>167.79</b>	INLET
6924.50		Regression Eqn.	178.83	248.50	<b>178.83</b>	INLET
6924.80		Regression Eqn.	189.09	256.19	<b>189.09</b>	INLET
6925.10		Regression Eqn.	198.93	263.69	<b>198.93</b>	INLET
6925.40		Regression Eqn.	208.23	271.03	<b>208.23</b>	INLET
6925.70		Regression Eqn.	217.23	278.20	<b>217.23</b>	INLET
6926.00		Regression Eqn.	225.93	285.20	<b>225.93</b>	INLET
6926.30		Regression Eqn.	234.24	292.02	<b>234.24</b>	INLET
6926.60		Regression Eqn.	242.40	298.73	<b>242.40</b>	INLET
6926.90		Regression Eqn.	250.35	305.29	<b>250.35</b>	INLET
6927.20		Regression Eqn.	258.15	311.74	<b>258.15</b>	INLET
6927.50		Regression Eqn.	265.77	318.03	<b>265.77</b>	INLET
6927.80		Regression Eqn.	273.24	324.23	<b>273.24</b>	INLET
6928.10		Regression Eqn.	280.56	330.34	<b>280.56</b>	INLET
6928.40		Regression Eqn.	287.79	336.31	<b>287.79</b>	INLET
6928.70		Regression Eqn.	294.87	342.21	<b>294.87</b>	INLET

Processing Time: **00.27 Seconds**

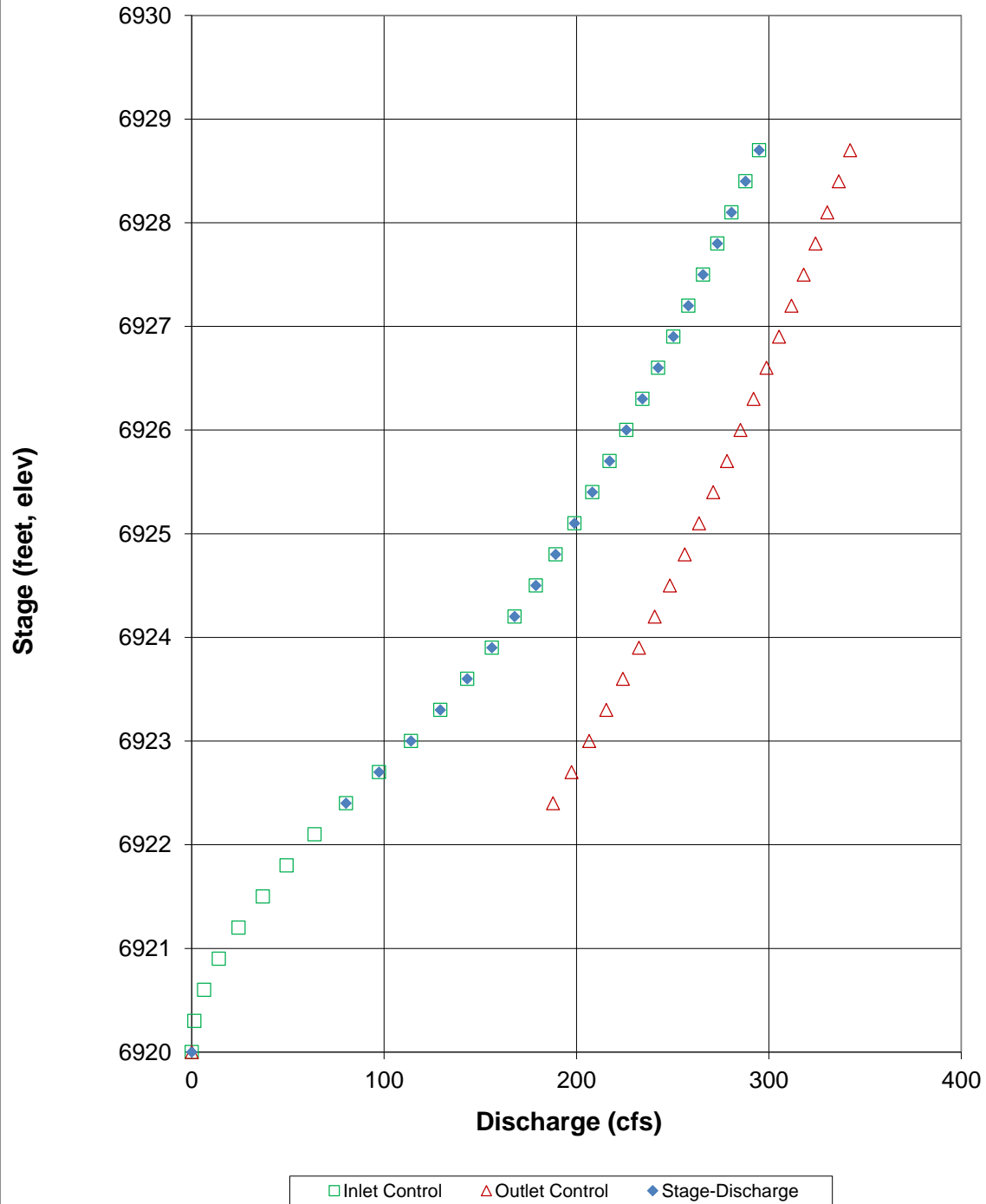
# CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Waterbury Fil #13**

ID: **Pipe Run #36 - Sunken Meadow Triple Culvert for Design Point 30**

## STAGE-DISCHARGE CURVE FOR THE CULVERT

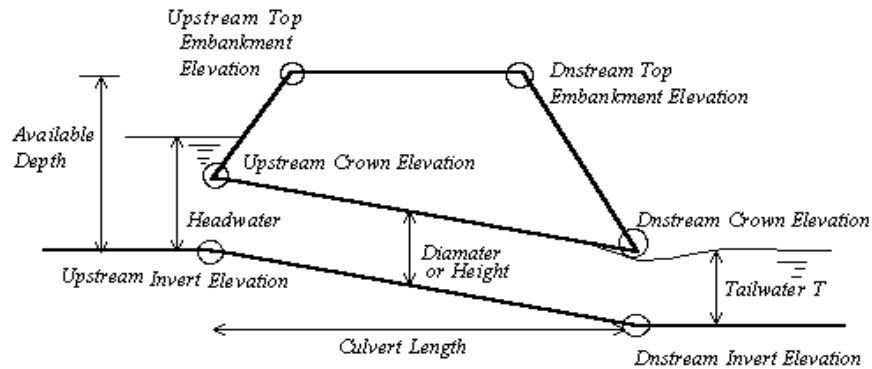


# VERTICAL PROFILE FOR THE CULVERT

MHFD-Culvert, Version 4.00 (May 2020)

Project = **Waterbury Fil #13**

ID = **Pipe Run #36 - Sunken Meadow Triple Culvert for Design Point 30**



## Culvert Information (Input)

Barrel Diameter or Height	D or H =	36.00	inches
Barrel Length	L =	133.53	ft
Barrel Invert Slope	So =	0.0225	ft/ft
Downstream Invert Elevation	EDI =	6917.00	ft
Downstream Top Embankment Elevation	EDT =	6921.67	ft
Upstream Top Embankment Elevation	EUT =	6924.67	ft
Design Headwater Depth (not elev.)	Hw =	1.55	ft
Tailwater Depth (not elev.)	Yt =	1.20	ft

## Culvert Hydraulics (Calculated)

Available Headwater Depth	HW-a =	4.67	ft
Design Hw/D ratio	Hw/D =	0.52	

## Culvert Vertical Profile

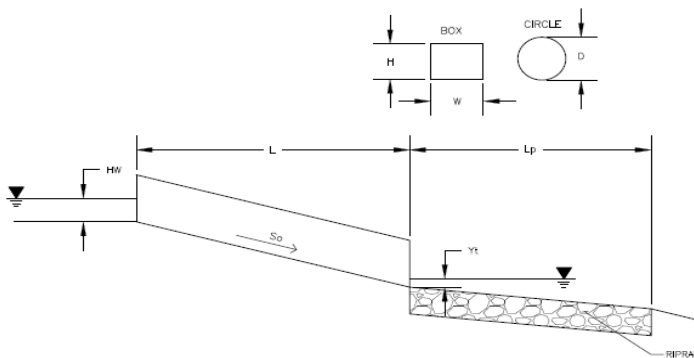
Upstream Invert Elevation	EUI =	6920.00	ft
Upstream Crown Elevation	EUC =	6923.00	ft
Upstream Soil Cover Depth	Upsoil =	1.67	ft
Downstream Crown Elevation	EDC =	6920.00	ft
Downstream Soil Cover Depth	Dnsoil =	1.67	ft

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Waterbury Fil #13**

ID: **Pipe Run #36 - Sunken Meadow Triple Culvert for Design Point 30**



## Soil Type:

Choose One:

☒ Sandy

☐ Non-Sandy

**Supercritical Flow! Using Adjusted Diameter to calculate protection type.**

## Design Information:

Design Discharge

Q = 151 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 36 inches

Inlet Edge Type (Choose from pull-down list)

Square Edge with Headwall

**OR:**

Box Culvert:

Barrel Height (Rise) in Feet

H (Rise) =

Barrel Width (Span) in Feet

W (Span) =

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

# Barrels = 3

Inlet Elevation

Elev IN = 6920 ft

Outlet Elevation **OR** Slope

Elev OUT = 6917 ft

Culvert Length

L = 133.53 ft

Manning's Roughness

n = 0.013

Bend Loss Coefficient

k<sub>b</sub> = 0

Exit Loss Coefficient

k<sub>x</sub> = 1

Tailwater Surface Elevation

Y<sub>t</sub> Elevation = 6920 ft

Max Allowable Channel Velocity

V = 5 ft/s

## Calculated Results:

Culvert Cross Sectional Area Available

A = 7.07 ft<sup>2</sup>

Culvert Normal Depth

Y<sub>n</sub> = 1.50 ft

Culvert Critical Depth

Y<sub>c</sub> = 2.31 ft

Froude Number

Fr = 2.30 **Supercritical!**

Entrance Loss Coefficient

k<sub>e</sub> = 0.50

Friction Loss Coefficient

k<sub>f</sub> = 0.96

Sum of All Loss Coefficients

k<sub>s</sub> = 2.46 ft

Headwater:

Inlet Control Headwater

HW<sub>I</sub> = 3.99 ft

Outlet Control Headwater

HW<sub>O</sub> = N/A ft

**Design Headwater Elevation**

**HW = 6923.99 ft**

**Headwater/Diameter OR Headwater/Rise Ratio**

**HW/D = 1.33**

**Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required**

Outlet Protection:

Flow/(Diameter<sup>2.5</sup>)

Q/D<sup>2.5</sup> = 3.23 ft<sup>0.5</sup>/s

Tailwater Surface Height

Y<sub>t</sub> = 3.00 ft

Tailwater/Diameter

Y<sub>t</sub>/D = 1.00

Expansion Factor

1/(2\*tan(θ)) = 6.70

Flow Area at Max Channel Velocity

A<sub>t</sub> = 30.20 ft<sup>2</sup>

Width of Equivalent Conduit for Multiple Barrels

W<sub>eq</sub> = 9.00 ft

**Length of Riprap Protection**

**L<sub>p</sub> = 9 ft**

**Width of Riprap Protection at Downstream End**

**T = 11 ft**

Adjusted Diameter for Supercritical Flow

Da = 2.25 ft

Minimum Theoretical Riprap Size

d<sub>50</sub> min = 3 in

Nominal Riprap Size

d<sub>50</sub> nominal = 6 in

**MHFD Riprap Type**

**Type = VL**

## **FDR SWALE CALCULATIONS**

# MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **WATERBURY 1 FDR**

Location: **DP-EX5A DIVERSIONS SWALE E-E FDR**

By: **QNA**

Date: **12/21/2024**

Chk By:

Date:

version 12-2004

Mannings Formula

$$Q = (1.486/n)AR_h^{2/3}S^{1/2}$$

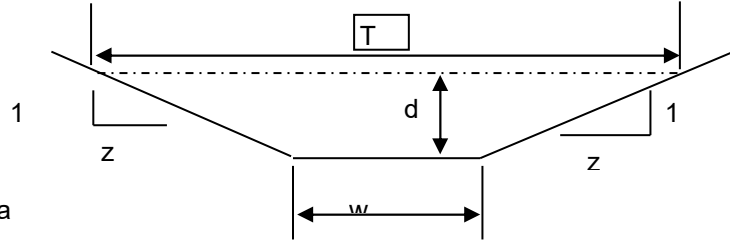
$$R = A/P$$

A = cross sectional area

P= wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$$V = (1.49/n)R_h^{2/3}S^{1/2}$$

$$Q = V \times A$$

INPUT

z (sideslope)= 4  
z (sideslope)= 4  
b (btm width, ft)= 4  
d (depth, ft)= 0.96  
S (slope, ft/ft) 0.02  
n low = 0.02  
n high = 0.035

Clear Data  
Entry Cells

		Low N		High N			
Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs
0.96	7.53	11.92	0.63	7.73498624	58.2166	4.419992	33.2666
				T =		11.68	
				Dm =		0.644	
				Sc low =		0.0069	
				Sc high =		0.0212	
				.7 Sc		1.3 Sc	
				0.0048		0.0090	
				.7 Sc		1.3 Sc	
				0.0148		0.0276	

s<sub>c</sub> = critical slope ft / ft

T = top width of the stream

d<sub>m</sub> = a/T = mean depth of flow

Created by: Mike O'Shea

**APPENDIX G**  
**FULL SPECTRUM DETENTION & WATER QUALITY CALCULATIONS**

POND TRIBUTARY AREA				
POND 1 TRIB AREA (DP 8)	<b>22.34</b> AC	BASINS A, B1, B2, C, D ,E, F, H, G1, G2, & K	DCIA	5.03
			UIA	6.92
			RPA	2.46
			SPA	7.94
			<b>Total</b>	<b>22.34</b>
POND 2 TRIB AREA (DP 18)	<b>21.05</b> AC	BASINS L1, L2, O1, O2, O-3, O-4 & OS-4	DCIA	2.34
			UIA	3.23
			RPA	0.92
			SPA	14.55
			<b>Total</b>	<b>21.05</b>
POND 3 TRIB AREA (DP 29)	<b>72.14</b> AC	BASINS Q1, Q2, R, S1, S2, T1, T2, U1, U2, V, W, X, OS-1, OS- 2, OS-3A, OS-3B, OS-S1, OS-S2, OS-T2, OS-R, OS-Q1, OS- Q2, OS-7, & OS-W	DCIA	19.75
			UIA	20.80
			RPA	16.16
			SPA	15.42
			<b>Total</b>	<b>72.14</b>

**POND 1**

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator  
LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.43	inches
***Minor Storm: 1-Hour Rain Depth	5-Year Event	1.50	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		

Max Intensity for Optional User Defined Storm 0

Designer: QNA  
Company: Terra Nova Engineering  
Date: September 17, 2024  
Project: WATERBURY FILING 1 POND 1  
Location: POND 1 Design Point 8 Full Spectrum Detention

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	DP 8 FSD																		
Receiving Pervious Area Soil Type	Loamy Sand																		
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	22.34																		
Directly Connected Impervious Area (DCIA, acres)	5.03																		
Unconnected Impervious Area (UIA, acres)	6.92																		
Receiving Pervious Area (RPA, acres)	2.46																		
Separate Pervious Area (SPA, acres)	7.94																		
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C																		

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	22.343																		
Directly Connected Impervious Area (DCIA, %)	22.5%																		
Unconnected Impervious Area (UIA, %)	31.0%																		
Receiving Pervious Area (RPA, %)	11.0%																		
Separate Pervious Area (SPA, %)	35.5%																		
A <sub>p</sub> (RPA / UIA)	0.355																		
I <sub>p</sub> Check	0.740																		
f / I for WQCV Event:	4.5																		
f / I for 5-Year Event:	0.5																		
f / I for 100-Year Event:	0.4																		
f / I for Optional User Defined Storm CUHP:																			
IRF for WQCV Event:	0.74																		
IRF for 5-Year Event:	0.93																		
IRF for 100-Year Event:	0.95																		
IRF for Optional User Defined Storm CUHP:																			
Total Site Imperviousness: I <sub>total</sub>	53.5%																		
Effective Imperviousness for WQCV Event:	45.5%																		
Effective Imperviousness for 5-Year Event:	51.3%																		
Effective Imperviousness for 100-Year Event:	51.9%																		
Effective Imperviousness for Optional User Defined Storm CUHP:																			

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

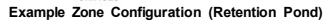
WQCV Event CREDIT: Reduce Detention By:	10.0%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	2.9%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:																			

Total Site Imperviousness:	53.5%
Total Site Effective Imperviousness for WQCV Event:	45.5%
Total Site Effective Imperviousness for 5-Year Event:	51.3%
Total Site Effective Imperviousness for 100-Year Event:	51.9%
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:  
\* Use Green-Ampt average infiltration rate values from Table 3-3.  
\*\* Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.  
\*\*\* Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

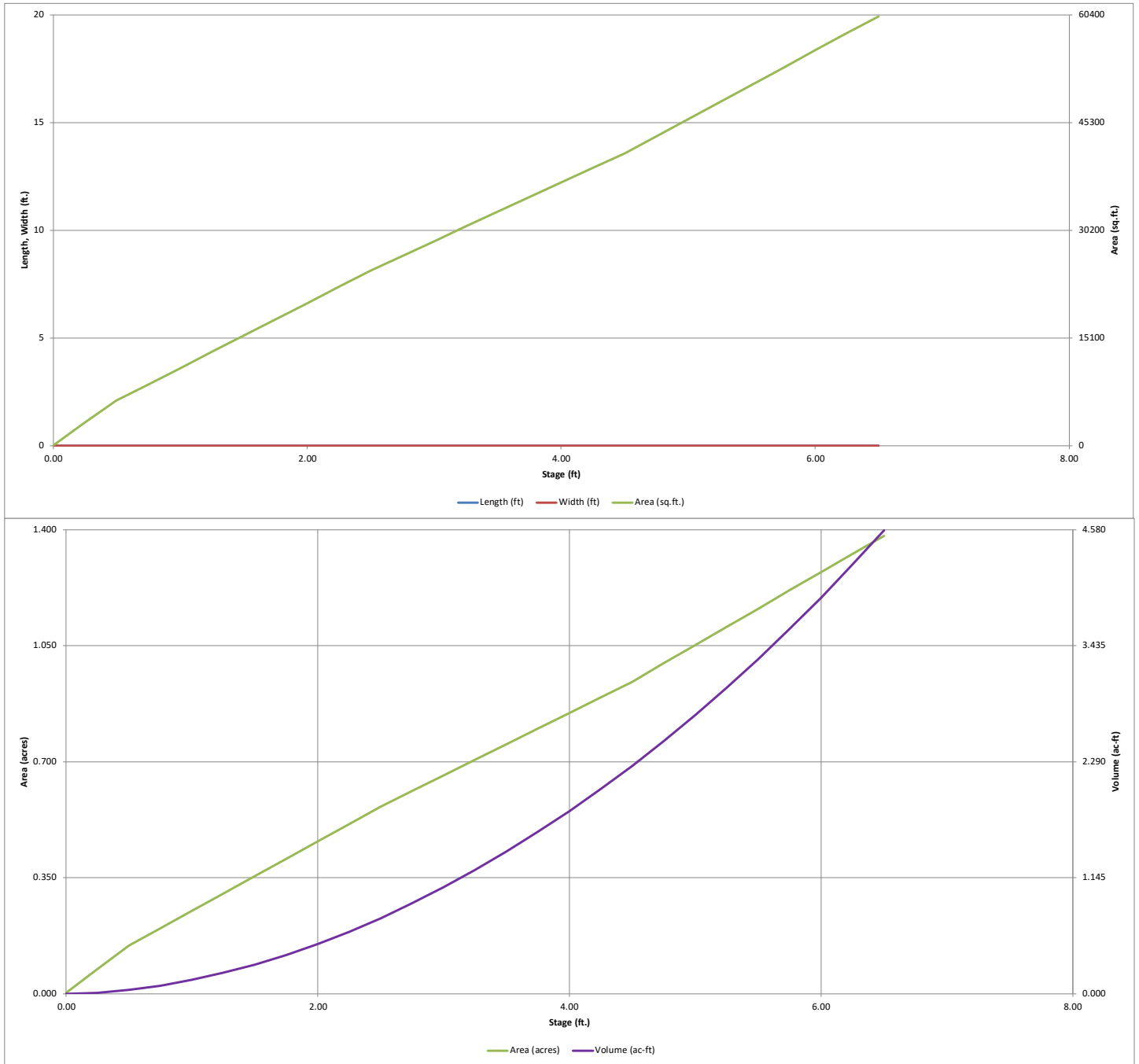
*MHFD-Detention, Version 4.06 (July 2022)*

Basin ID: POND 1 DP 8



# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

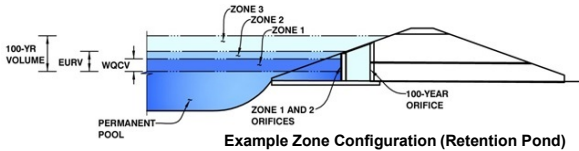


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: WATERBURY FILING NO. 1

Basin ID: POND 1 DP 8



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.79	0.394	Orifice Plate
Zone 2 (EURV)	3.44	0.957	Orifice Plate
Zone 3 (100-year)	4.37	0.775	Weir&Pipe (Restrict)
Total (all zones)		2.127	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth = N/A ft (distance below the filtration media surface)  
Underdrain Orifice Diameter = N/A inches

Calculated Parameters for Underdrain

Underdrain Orifice Area = N/A ft<sup>2</sup>  
Underdrain Orifice Centroid = N/A feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Calculated Parameters for Plate

Centroid of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate = 3.60 ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing = 13.80 inches  
Orifice Plate: Orifice Area per Row = 3.09 sq. inches (diameter = 2 inches)

WQ Orifice Area per Row = 2.146E-02 ft<sup>2</sup>  
Elliptical Half-Width = N/A feet  
Elliptical Slot Centroid = N/A feet  
Elliptical Slot Area = N/A ft<sup>2</sup>

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.20	2.40					
Orifice Area (sq. inches)	3.09	3.09	3.09					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected		Not Selected	Not Selected
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A ft <sup>2</sup>
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A feet
Vertical Orifice Diameter =	N/A	N/A	inches		

User Input: Overflow Weir (Dropbox with Flat or Sloped Gate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected		Zone 3 Weir	Not Selected
Overflow Weir Front Edge Height, H <sub>o</sub> =	3.60	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Gate Upper Edge, H <sub>g</sub> =	3.60 feet
Overflow Weir Front Edge Length =	4.00	N/A	feet	Overflow Weir Slope Length =	4.00 feet
Overflow Weir Gate Slope =	0.00	N/A	H:V	Gate Open Area / 100-yr Orifice Area =	3.54
Horiz. Length of Weir Sides =	4.00	N/A	feet	Overflow Gate Open Area w/o Debris =	11.14 ft <sup>2</sup>
Overflow Gate Type =	Type C Gate	N/A		Overflow Gate Open Area w/ Debris =	5.57 ft <sup>2</sup>
Debris Clogging % =	50%	N/A	%		

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected		Zone 3 Restrictor	Not Selected
Depth to Invert of Outlet Pipe =	0.20	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	3.14 ft <sup>2</sup>
Outlet Pipe Diameter =	24.00	N/A	inches	Outlet Orifice Centroid =	1.00 feet
Restrictor Plate Height Above Pipe Invert =	24.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14 radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage =	4.50	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth =
Spillway Crest Length =	30.00	feet	Stage at Top of Freeboard =
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =

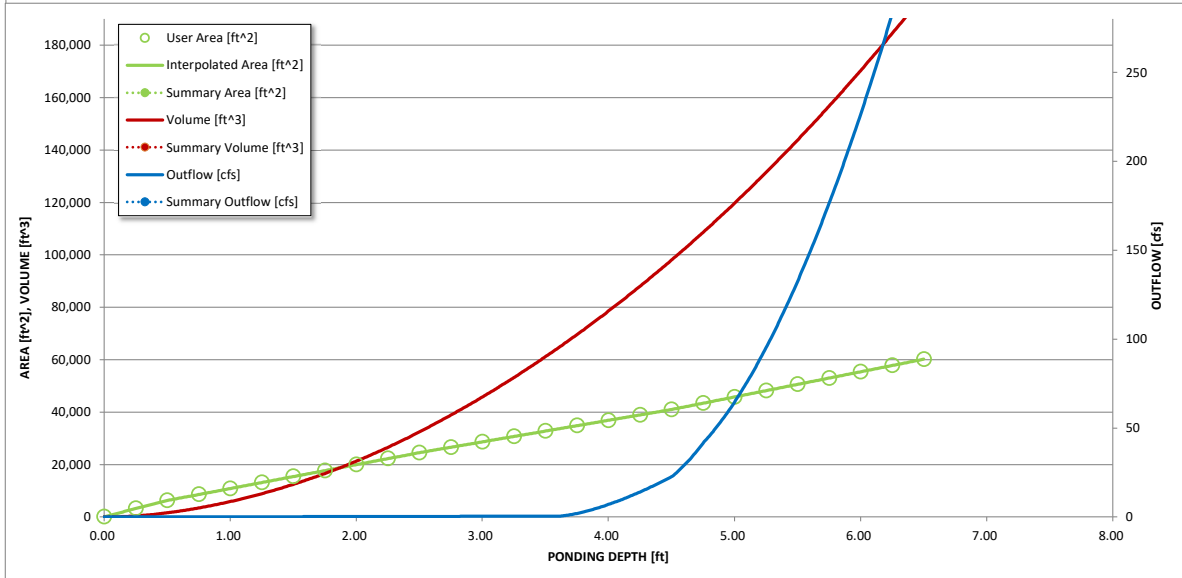
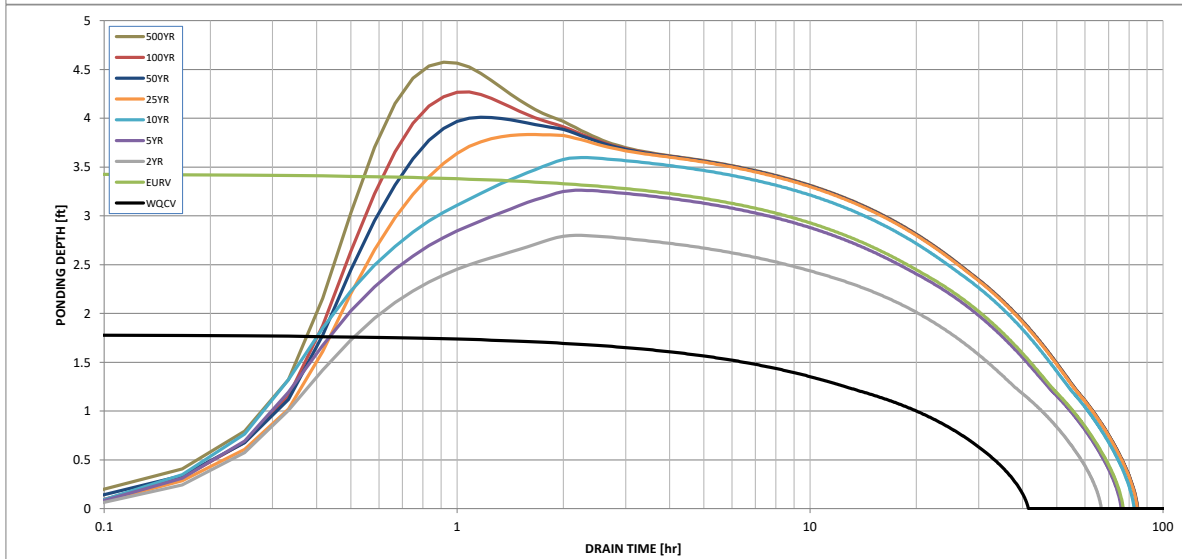
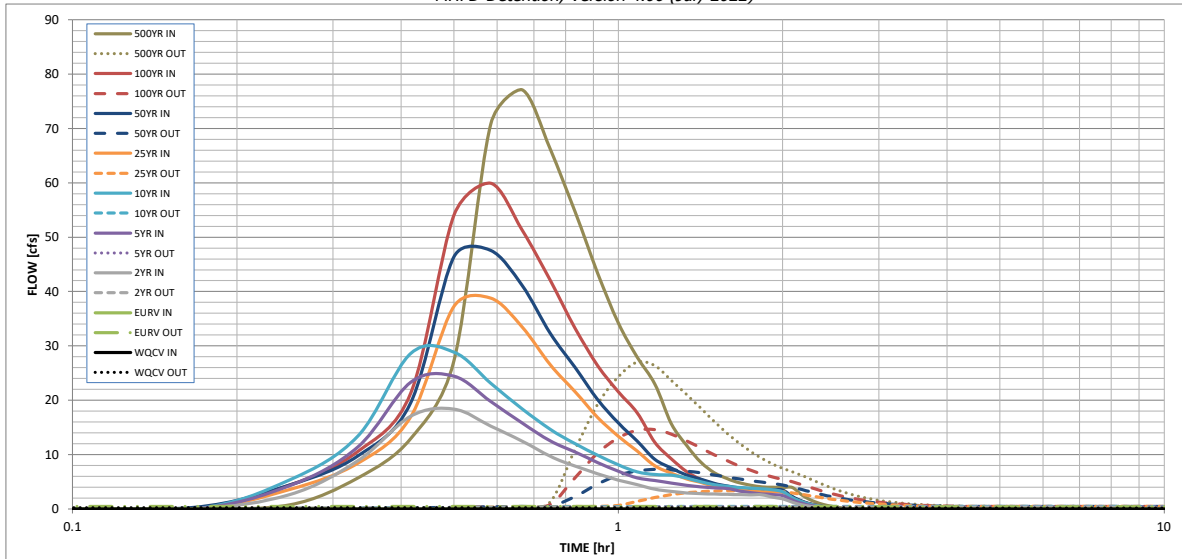
## Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.00
One-Hour Rainfall Depth (in) =	N/A	N/A	0.974	1.292	1.546	1.938	2.321	2.805	3.607
CUHP Runoff Volume (acre-ft) =	N/A	N/A	0.974	1.292	1.546	1.938	2.321	2.805	3.607
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.2	0.5	0.7	5.8	11.2	18.4	29.2
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A	0.01	0.02	0.03	0.26	0.50	0.82	1.31
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	18.4	24.4	28.8	38.8	47.6	59.9	77.1
Peak Inflow Q (cfs) =	0.2	0.5	0.4	0.4	0.5	3.3	7.3	14.6	27.0
Peak Outflow Q (cfs) =	N/A	N/A	N/A	0.9	0.7	0.6	0.6	0.8	0.9
Ratio Peak Outflow to Predevelopment Q =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Structure Controlling Flow =	N/A	N/A	N/A	N/A	N/A	0.3	0.6	1.3	2.2
Max Velocity through Gate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Gate 2 (fps) =	38	68	60	68	73	73	72	70	67
Time to Drain 97% of Inflow Volume (hours) =	40	73	64	72	79	79	79	78	77
Time to Drain 99% of Inflow Volume (hours) =	1.79	3.44	2.80	3.26	3.60	3.83	4.01	4.27	4.57
Maximum Ponding Depth (ft) =	0.41	0.74	0.62	0.71	0.77	0.81	0.85	0.90	0.96
Area at Maximum Ponding Depth (acres) =	0.398	1.358	0.916	1.228	1.471	1.661	1.802	2.029	2.316
Maximum Volume Stored (acre-ft) =									

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: \_\_\_\_\_

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.03	0.76
	0:15:00	0.00	0.00	2.64	4.29	5.33	3.59	4.43	4.38	5.73
	0:20:00	0.00	0.00	8.85	11.43	13.42	8.44	9.77	10.57	12.96
	0:25:00	0.00	0.00	17.06	23.32	28.60	16.96	19.54	21.29	27.22
	0:30:00	0.00	0.00	18.39	24.42	28.84	37.28	46.40	54.02	70.77
	0:35:00	0.00	0.00	15.26	19.78	23.13	38.77	47.57	59.90	77.10
	0:40:00	0.00	0.00	12.50	15.81	18.41	33.49	41.13	51.33	66.22
	0:45:00	0.00	0.00	9.68	12.53	14.67	26.54	32.34	42.09	54.60
	0:50:00	0.00	0.00	7.85	10.46	11.99	21.56	26.00	33.21	43.39
	0:55:00	0.00	0.00	6.49	8.54	9.90	16.82	20.10	26.37	34.22
	1:00:00	0.00	0.00	5.31	6.93	8.13	13.36	15.81	21.57	27.92
	1:05:00	0.00	0.00	4.47	5.73	6.80	10.62	12.46	17.67	22.98
	1:10:00	0.00	0.00	3.64	5.21	6.33	7.91	9.11	12.21	15.68
	1:15:00	0.00	0.00	3.21	4.77	6.20	6.61	7.54	9.23	11.71
	1:20:00	0.00	0.00	2.96	4.34	5.69	5.51	6.24	6.87	8.60
	1:25:00	0.00	0.00	2.82	4.07	4.97	4.86	5.49	5.41	6.67
	1:30:00	0.00	0.00	2.74	3.88	4.50	4.17	4.70	4.56	5.56
	1:35:00	0.00	0.00	2.67	3.78	4.17	3.74	4.21	3.99	4.82
	1:40:00	0.00	0.00	2.63	3.32	3.96	3.46	3.89	3.63	4.34
	1:45:00	0.00	0.00	2.61	3.00	3.82	3.27	3.68	3.42	4.07
	1:50:00	0.00	0.00	2.61	2.79	3.72	3.17	3.57	3.35	3.99
	1:55:00	0.00	0.00	2.17	2.65	3.53	3.11	3.50	3.32	3.95
	2:00:00	0.00	0.00	1.86	2.47	3.16	3.08	3.47	3.32	3.95
	2:05:00	0.00	0.00	1.22	1.61	2.08	2.02	2.27	2.18	2.59
	2:10:00	0.00	0.00	0.78	1.03	1.33	1.31	1.46	1.40	1.66
	2:15:00	0.00	0.00	0.49	0.64	0.84	0.82	0.92	0.88	1.04
	2:20:00	0.00	0.00	0.28	0.38	0.50	0.49	0.55	0.53	0.62
	2:25:00	0.00	0.00	0.15	0.23	0.29	0.29	0.33	0.31	0.37
	2:30:00	0.00	0.00	0.07	0.11	0.13	0.15	0.16	0.15	0.18
	2:35:00	0.00	0.00	0.02	0.04	0.04	0.05	0.05	0.05	0.06
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

# FSD POND 1 FORBAY VOLUMES

**Required Forbay Volume = 3% of WQCV**

WQCV = 0.394 ac-ft  
WQCV = 17,155 cu-ft  
3% of WQCV = 0.01 ac-ft  
3% of WQCV = 514.65 cu-ft

## FORBAY PR 7

<i>ELEV</i>	<i>AREA</i>	<i>AREA AVG.</i>	<i>DELTA ELEV.</i>	<i>VOLUME</i>	<i>VOLUME TOTAL</i>
6925.50	198	198	1.5	297	
6927.00	198				297

End Area Method: 297 C.F.  
0.007 A.F.

## FORBAY PR 10

<i>ELEV</i>	<i>AREA</i>	<i>AREA AVG.</i>	<i>DELTA ELEV.</i>	<i>VOLUME</i>	<i>VOLUME TOTAL</i>
6927.00	198	198	1.5	297	
6928.50	198				297

End Area Method: 297 C.F.  
0.007 A.F.

**TOTAL 594.000 A.F.**  
**TOTAL 0.014 A.F.**

# **WATEBURY FILING NO. 1 POND 1 FORBAY WALL NOTCH CALCS**

## **Middle Wall Notch**

Notch to releae 2% of the undetained 100-year peak discharge.

Assume split between east and west forebays

$$\begin{array}{rcl} 100\text{-y peak discharge} & = & 59.9 \text{ cfs} \\ 2.0\% & = & 1.20 \end{array}$$

The general form of the equation for horizontal crested weirs is  $Q = CLH^{3/2}$  where:

Q = Weir flow discharge (cfs)	<b>1.20</b>	
C = Weir flow coefficient	3.4	
H = Depth of flow over the weir (ft)	1.50	Opening Height
L = Length of the weir (ft)	<b>0.19</b>	Length
L = Length of the weir (in)	<b>2</b>	

**Notch to releae 2% of the undetained 100-year peak discharge is  
3" wide by 18" high**

## **West Wall Notch**

Notch to releae 2% of the undetained 100-year peak discharge.

Assume split between east and west forebays

$$\begin{array}{rcl} 100\text{-y peak discharge} & = & 59.9 \text{ cfs} \\ 2.0\% & = & 1.20 \end{array}$$

The general form of the equation for horizontal crested weirs is  $Q = CLH^{3/2}$  where:

Q = Weir flow discharge (cfs)	<b>1.20</b>	
C = Weir flow coefficient	3.4	
H = Depth of flow over the weir (ft)	1.50	Opening Height
L = Length of the weir (ft)	<b>0.19</b>	Length
L = Length of the weir (in)	<b>2</b>	

**Notch to releae 2% of the undetained 100-year peak discharge is  
3" wide by 18" high**

# POND 1 TRICKLE CHANNEL EAST

## MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **WATERBURY FILIN NO. 1**

Location: **POND 1 DP 8 EAST**

MIN SLOPE 0.6%

By: **QNA**

Date: **9/16/2024**

Chk By:

Date:

version 12-2004

Mannings Formula

$$Q = (1.486/n)AR_h^{2/3}S^{1/2}$$

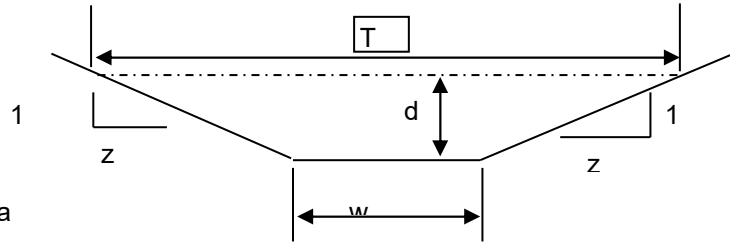
$$R = A/P$$

A = cross sectional area

P = wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$$V = (1.49/n)R_h^{2/3}S^{1/2}$$

$$Q = V \times A$$

INPUT

z (sideslope)= 0  
z (sideslope)= 0  
b (btm width, ft)= 2  
d (depth, ft)= 0.5  
S (slope, ft/ft) 0.006  
n low = 0.012  
n high = 0.015

Clear Data  
Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N		High N		T =	Dm =
				Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.5	1.00	3.00	0.33	4.61122643	4.61123	3.688981	3.68898	2	0.500

Sc low = 0.0045 Sc high = 0.0071

$s_c$  = critical slope ft / ft

T = top width of the stream

$d_m = a/T$  = mean depth of flow

.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0032	0.0059	0.0050	0.0092

## 3.69 CFS > 2% OF 59.9 CFS = 1.2 CFS

Created by: Mike O'Shea

# POND 1 TRICKLE CHANNEL MIDDLE

## MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **WATERBURY FILIN NO. 1**

Location: **POND 1 DP 8 MIDDLE**

MIN SLOPE 1.0%

By: **QNA**

Date: **9/16/2024**

version 12-2004

Chk By:

Date:

Mannings Formula

$$Q = (1.486/n)AR_h^{2/3}S^{1/2}$$

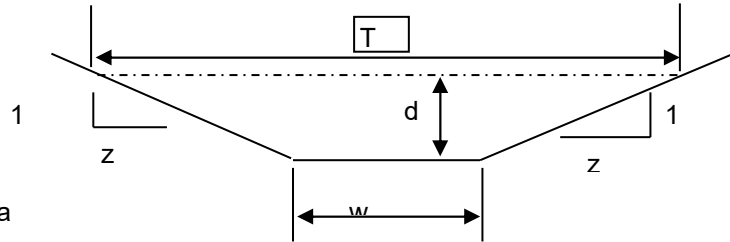
$$R = A/P$$

A = cross sectional area

P = wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$$V = (1.49/n)R_h^{2/3}S^{1/2}$$

$$Q = V \times A$$

INPUT

z (sideslope)= 0  
z (sideslope)= 0  
b (btm width, ft)= 2  
d (depth, ft)= 0.5  
S (slope, ft/ft) 0.01  
n low = 0.012  
n high = 0.015

Clear Data  
Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N		High N		T =	Dm =
				Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.5	1.00	3.00	0.33	5.95306772	5.95307	4.762454	4.76245	2	0.500

Sc low = 0.0045 Sc high = 0.0071

$s_c$  = critical slope ft / ft

T = top width of the stream

$d_m = a/T$  = mean depth of flow

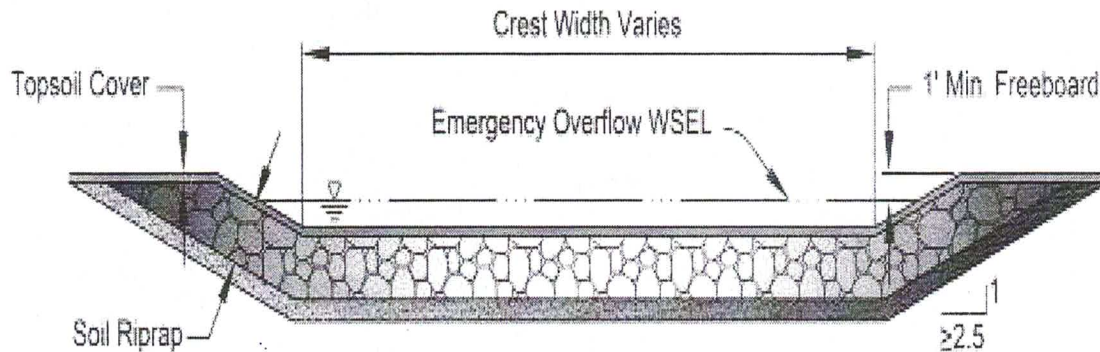
.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0032	0.0059	0.0050	0.0092

**4.76 CFS > 2% OF 59.9 CFS = 1.2 CFS**

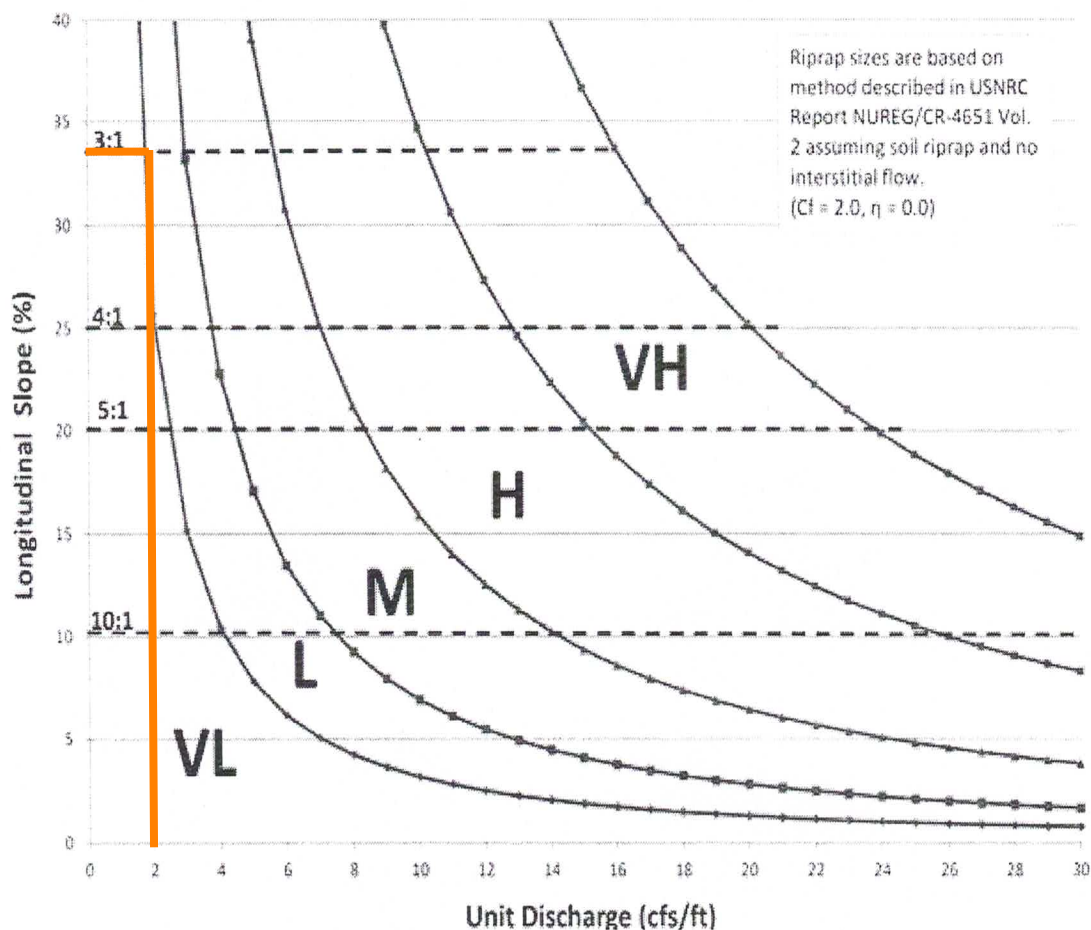
Created by: Mike O'Shea

## POND 1 EMERGENCY WEIR

**Figure 13-12c. Emergency Spillway Protection**



**Figure 13-12d. Riprap Types for Emergency Spillway Protection**



**QPEAK INFLOW = 59.9 CFS**  
**WEIR LENGTH = 30 FT**  
 **$59.9/30=2.0$**

## **POND 2**

## Site-Level Low Impact Development (LID) Design Effective Impervious Calculator

### LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

***Design Storm: 1-Hour Rain Depth	WQCV Event	0.43	inches
***Minor Storm: 1-Hour Rain Depth	5-Year Event	1.50	inches
***Major Storm: 1-Hour Rain Depth	100-Year Event	2.52	inches
Optional User Defined Storm	CUHP		
(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm	100-Year Event		

Max Intensity for Optional User Defined Storm

0

Designer: QNA

Company: Terra Nova Engineering

Date: September 17, 2024

Project: WATERBURY FILING 1 POND 2

Location: POND 2 Design Point 18 Full Spectrum Detention

## SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	DP 18 FSD																
Receiving Pervious Area Soil Type	Loamy Sand																
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	21.06																
Directly Connected Impervious Area (DCIA, acres)	2.34																
Unconnected Impervious Area (UIA, acres)	3.23																
Receiving Pervious Area (RPA, acres)	0.94																
Separate Pervious Area (SPA, acres)	14.55																
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C																

## CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	21.061																
Directly Connected Impervious Area (DCIA, %)	11.1%																
Unconnected Impervious Area (UIA, %)	15.3%																
Receiving Pervious Area (RPA, %)	4.5%																
Separate Pervious Area (SPA, %)	69.1%																
$A_p$ (RPA / UIA)	0.290																
$I_p$ Check	0.770																
$f / I$ for WQCV Event:	4.5																
$f / I$ for 5-Year Event:	0.5																
$f / I$ for 100-Year Event:	0.4																
$f / I$ for Optional User Defined Storm CUHP:																	
IRF for WQCV Event:	0.76																
IRF for 5-Year Event:	0.94																
IRF for 100-Year Event:	0.95																
IRF for Optional User Defined Storm CUHP:																	
Total Site Imperviousness: $I_{total}$	26.5%																
Effective Imperviousness for WQCV Event:	22.8%																
Effective Imperviousness for 5-Year Event:	25.5%																
Effective Imperviousness for 100-Year Event:	25.8%																
Effective Imperviousness for Optional User Defined Storm CUHP:																	

## LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	9.5%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	2.8%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:																	

Total Site Imperviousness:

26.5%

Total Site Effective Imperviousness for WQCV Event:

22.8%

Total Site Effective Imperviousness for 5-Year Event:

25.5%

Total Site Effective Imperviousness for 100-Year Event:

25.8%

Total Site Effective Imperviousness for Optional User Defined Storm CUHP:

Notes:

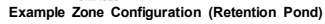
\* Use Green-Ampt average infiltration rate values from Table 3-3.

\*\* Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

\*\*\* Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

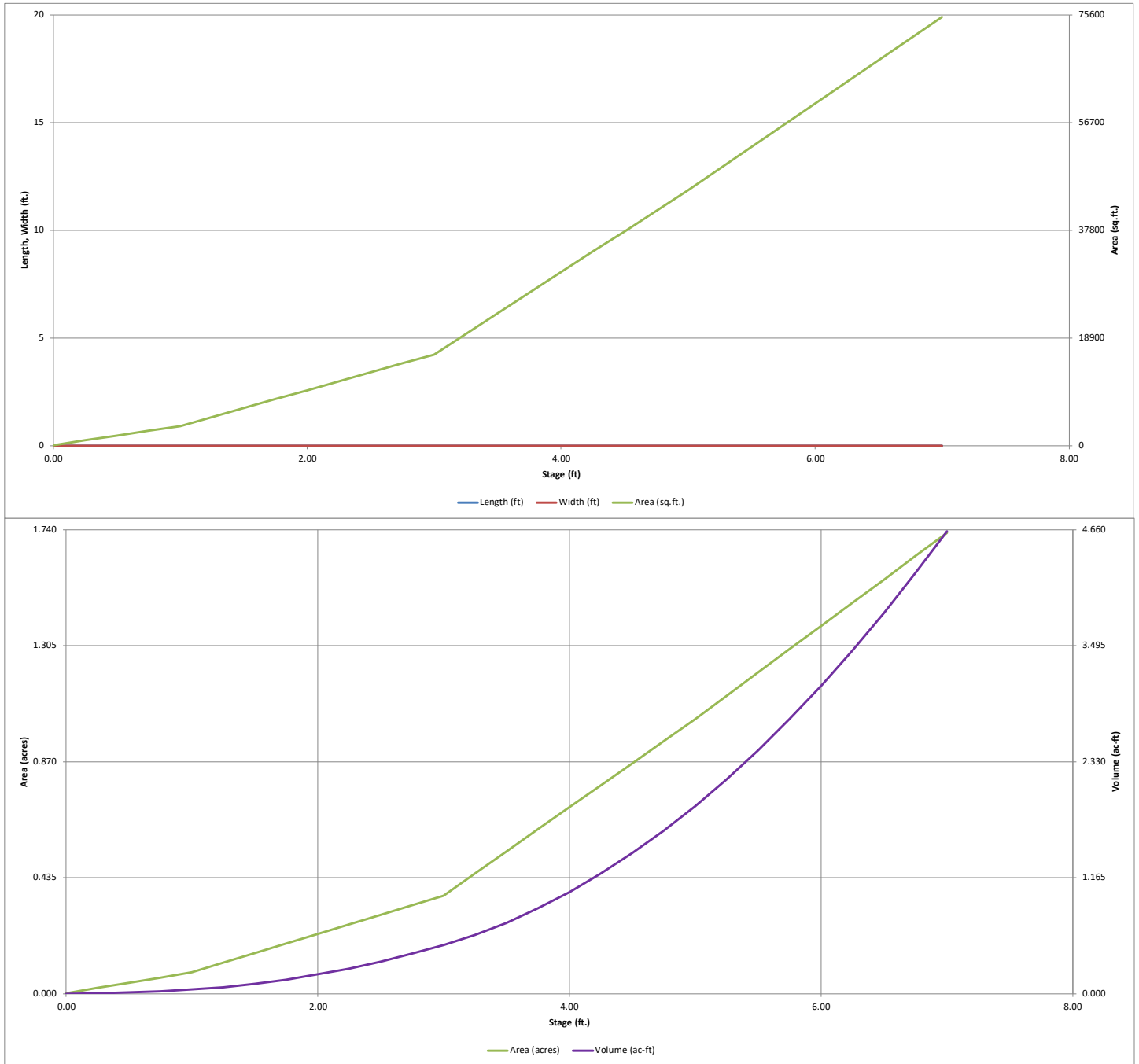
*MHFD-Detention, Version 4.06 (July 2022)*

Basin ID: POND 2 DP 18



# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

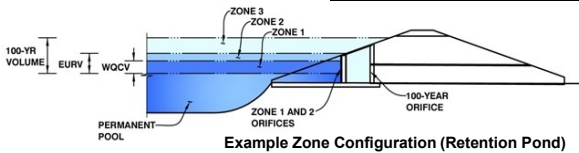


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: WATERBURY FILING NO. 1

Basin ID: POND 2 DP 18



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.21	0.241	Orifice Plate
Zone 2 (EURV)	3.09	0.278	Orifice Plate
Zone 3 (100-year)	4.01	0.507	Weir&Pipe (Restrict)
Total (all zones)		1.026	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth = N/A ft (distance below the filtration media surface)  
Underdrain Orifice Diameter = N/A inches

Calculated Parameters for Underdrain  
Underdrain Orifice Area = N/A ft<sup>2</sup>  
Underdrain Orifice Centroid = N/A feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Centroid of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate = 3.10 ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing = 12.40 inches  
Orifice Plate: Orifice Area per Row = N/A sq. inches

Calculated Parameters for Plate  
WQ Orifice Area per Row = N/A ft<sup>2</sup>  
Elliptical Half-Width = N/A feet  
Elliptical Slot Centroid = N/A feet  
Elliptical Slot Area = N/A ft<sup>2</sup>

1.23 sq inches

it is 1.32

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.03	2.07					
Orifice Area (sq. inches)	1.32	1.32	1.32					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft <sup>2</sup>
Vertical Orifice Centroid =	N/A	N/A	feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Gate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, H <sub>o</sub> =	3.10	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Gate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Gate Type =	Type C Gate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Gate Upper Edge, H <sub>u</sub> =	3.10	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Gate Open Area / 100-yr Orifice Area =	6.30	N/A	
Overflow Gate Open Area w/o Debris =	11.14	N/A	ft <sup>2</sup>
Overflow Gate Open Area w/ Debris =	5.57	N/A	ft <sup>2</sup>

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	18.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.77	N/A	ft <sup>2</sup>
Outlet Orifice Centroid =	0.75	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	5.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	20.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth =	0.58	feet
Stage at Top of Freeboard =	6.58	feet
Basin Area at Top of Freeboard =	1.58	acres
Basin Volume at Top of Freeboard =	3.95	acre-ft

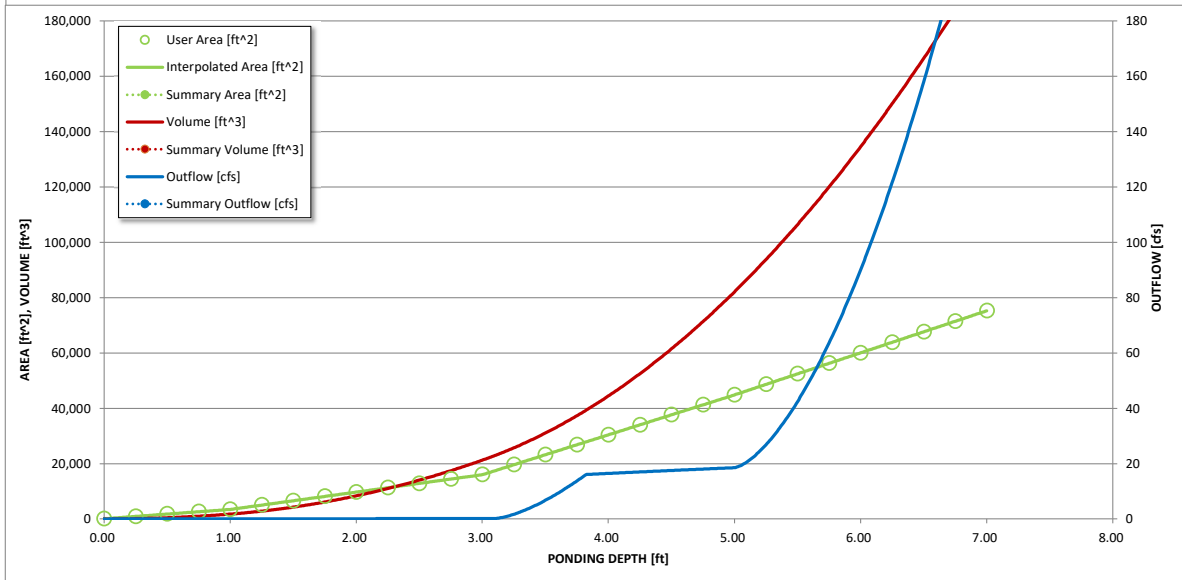
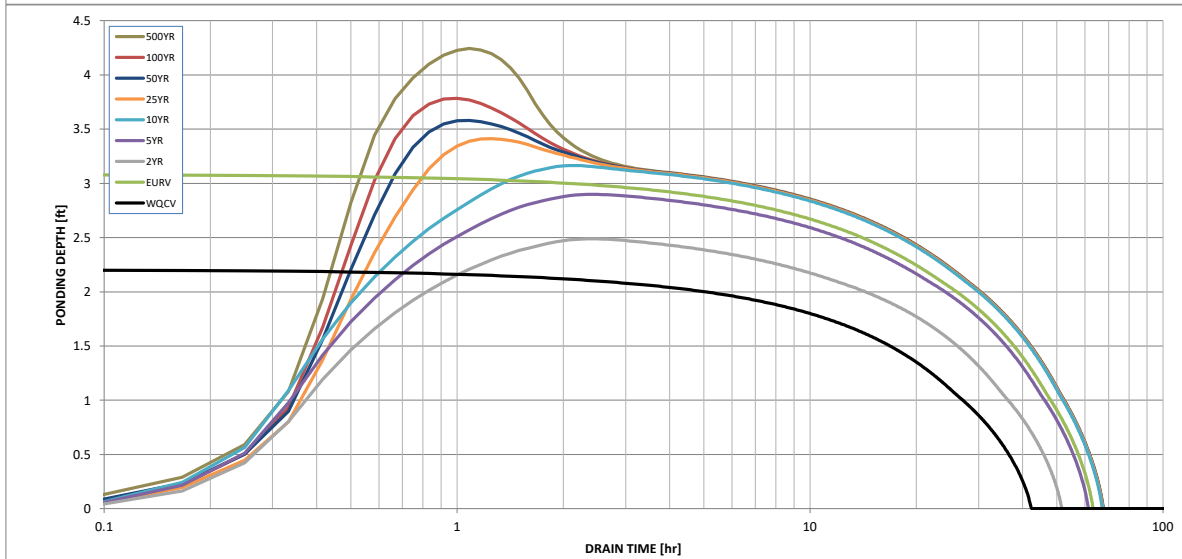
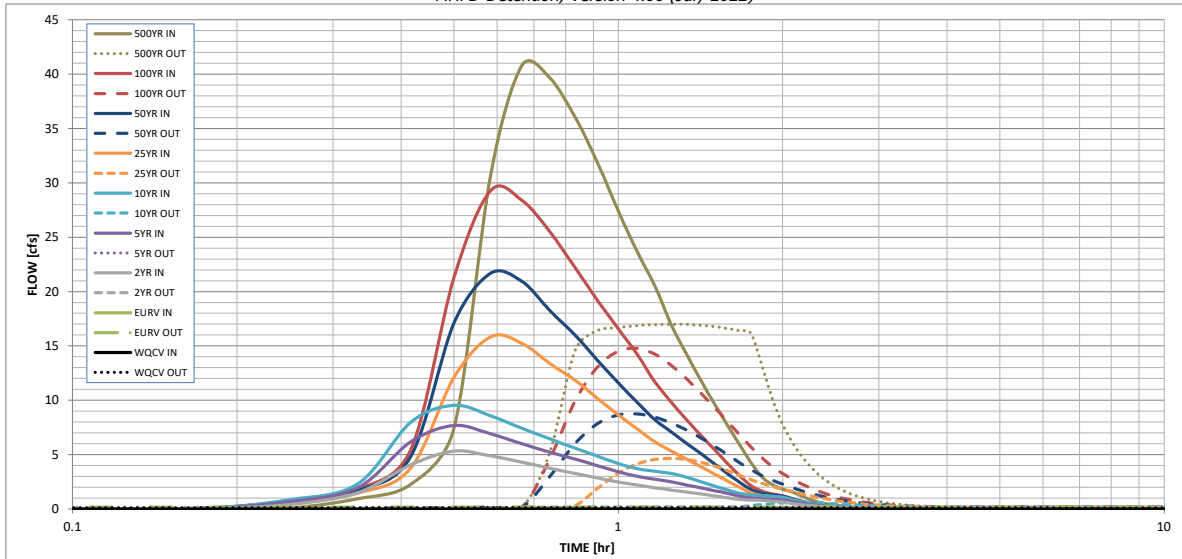
## Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.00
One-Hour Rainfall Depth (in) =	0.241	0.519	0.343	0.481	0.601	0.938	1.254	1.679	2.376
CUHP Runoff Volume (acre-ft) =	N/A	N/A	0.343	0.481	0.601	0.938	1.254	1.679	2.376
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.2	0.5	0.6	5.5	10.8	17.5	27.8
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A							
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.03	0.26	0.51	0.83	1.32
Peak Inflow Q (cfs) =	N/A	N/A	5.3	7.7	9.5	15.8	21.7	29.3	40.8
Peak Outflow Q (cfs) =	0.1	0.2	0.2	0.2	0.6	4.7	8.7	14.8	17.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	1.0	0.8	0.8	0.8	0.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1
Max Velocity through Gate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.4	0.8	1.3	1.5
Max Velocity through Gate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	56	46	54	59	56	53	50	47
Time to Drain 99% of Inflow Volume (hours) =	40	60	49	58	64	62	61	60	58
Maximum Ponding Depth (ft) =	2.21	3.09	2.49	2.90	3.16	3.41	3.58	3.78	4.24
Area at Maximum Ponding Depth (acres) =	0.25	0.40	0.29	0.35	0.42	0.50	0.56	0.63	0.78
Maximum Volume Stored (acre-ft) =	0.243	0.522	0.316	0.448	0.551	0.666	0.751	0.875	1.198

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: \_\_\_\_\_

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.12
	0:15:00	0.00	0.00	0.42	0.68	0.85	0.57	0.71	0.70	0.94
	0:20:00	0.00	0.00	1.50	1.97	2.32	1.47	1.71	1.83	2.27
	0:25:00	0.00	0.00	4.07	6.18	7.97	3.75	4.83	5.44	7.40
	0:30:00	0.00	0.00	5.33	7.68	9.53	12.08	17.09	21.28	30.73
	0:35:00	0.00	0.00	4.87	6.91	8.58	15.84	21.68	29.30	40.83
	0:40:00	0.00	0.00	4.31	6.00	7.42	15.23	20.92	28.38	39.60
	0:45:00	0.00	0.00	3.73	5.21	6.44	13.35	18.21	25.47	36.01
	0:50:00	0.00	0.00	3.26	4.59	5.60	11.85	15.99	22.18	31.83
	0:55:00	0.00	0.00	2.85	3.98	4.85	10.15	13.67	19.17	27.39
	1:00:00	0.00	0.00	2.48	3.42	4.17	8.65	11.60	16.57	23.66
	1:05:00	0.00	0.00	2.20	3.01	3.72	7.35	9.79	14.23	20.51
	1:10:00	0.00	0.00	1.95	2.75	3.47	6.17	8.21	11.70	16.95
	1:15:00	0.00	0.00	1.75	2.49	3.28	5.33	7.09	9.83	14.26
	1:20:00	0.00	0.00	1.56	2.22	2.92	4.58	6.05	8.21	11.83
	1:25:00	0.00	0.00	1.38	1.95	2.51	3.90	5.09	6.78	9.68
	1:30:00	0.00	0.00	1.20	1.69	2.11	3.22	4.16	5.46	7.75
	1:35:00	0.00	0.00	1.03	1.45	1.76	2.58	3.28	4.22	5.94
	1:40:00	0.00	0.00	0.89	1.18	1.45	1.99	2.46	3.08	4.26
	1:45:00	0.00	0.00	0.82	1.03	1.31	1.49	1.80	2.15	2.94
	1:50:00	0.00	0.00	0.79	0.95	1.24	1.23	1.46	1.64	2.23
	1:55:00	0.00	0.00	0.71	0.89	1.17	1.10	1.28	1.38	1.83
	2:00:00	0.00	0.00	0.63	0.83	1.08	1.03	1.19	1.22	1.57
	2:05:00	0.00	0.00	0.51	0.66	0.86	0.81	0.93	0.93	1.18
	2:10:00	0.00	0.00	0.40	0.52	0.67	0.62	0.71	0.70	0.87
	2:15:00	0.00	0.00	0.31	0.41	0.52	0.48	0.55	0.52	0.63
	2:20:00	0.00	0.00	0.24	0.31	0.40	0.37	0.42	0.38	0.46
	2:25:00	0.00	0.00	0.19	0.24	0.30	0.28	0.32	0.29	0.35
	2:30:00	0.00	0.00	0.14	0.18	0.23	0.21	0.24	0.22	0.26
	2:35:00	0.00	0.00	0.11	0.14	0.17	0.16	0.18	0.17	0.20
	2:40:00	0.00	0.00	0.08	0.10	0.13	0.12	0.13	0.13	0.15
	2:45:00	0.00	0.00	0.06	0.07	0.10	0.09	0.10	0.10	0.11
	2:50:00	0.00	0.00	0.04	0.05	0.07	0.06	0.07	0.07	0.08
	2:55:00	0.00	0.00	0.02	0.03	0.04	0.04	0.05	0.04	0.05
	3:00:00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.03
	3:05:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## **FSD POND 2 FORBAY VOLUMES**

**Required Forbay Volume = 3% of WQCV**

WQCV = 0.241 ac-ft  
WQCV = 10,513 cu-ft  
3% of WQCV = 0.01 ac-ft  
3% of WQCV = 315.38 cu-ft

### **FORBAY PR 17**

<i><b>ELEV</b></i>	<i><b>AREA</b></i>	<i><b>AREA AVG.</b></i>	<i><b>DELTA ELEV.</b></i>	<i><b>VOLUME</b></i>	<i><b>VOLUME TOTAL</b></i>
6900.25	382	382	1.5	573	573
6901.75	382				

End Area Method: 573 C.F.  
0.013 A.F.

## **WATEBURY FILING NO. 1 POND 2 FORBAY WALL NOTCH CALCS**

### **Wall Notch**

Notch to releae 2% of the undetained 100-year peak discharge.

Assume split between east and west forebays

$$\begin{array}{rcl} 100\text{-y peak discharge} & = & 29.3 \text{ cfs} \\ 2.0\% & = & 0.59 \end{array}$$

The general form of the equation for horizontal crested weirs is  $Q = CLH^{3/2}$  where:

Q = Weir flow discharge (cfs)	<b>0.59</b>	
C = Weir flow coefficient	3.4	
H = Depth of flow over the weir (ft)	1.50	Opening Height
L = Length of the weir (ft)	<b>0.09</b>	Length
L = Length of the weir (in)	<b>1</b>	

**Notch to releae 2% of the undetained 100-year peak discharge is  
3" wide by 18" high**

## POND 2 EMERGENCY WEIR

Figure 13-12c. Emergency Spillway Protection

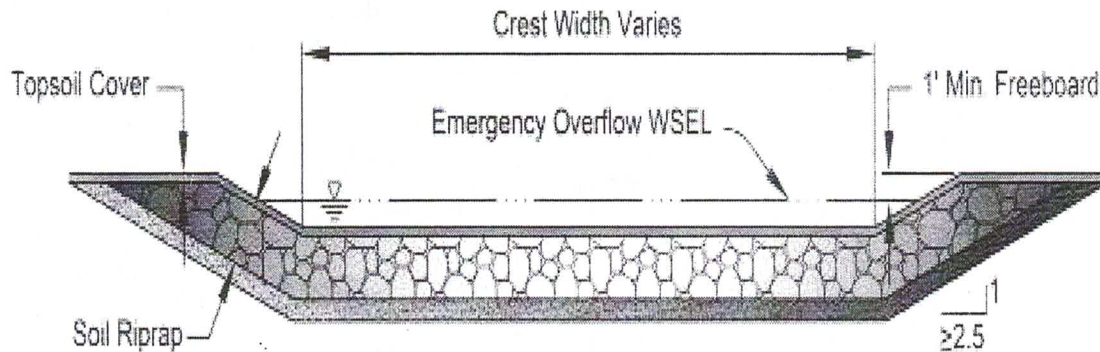
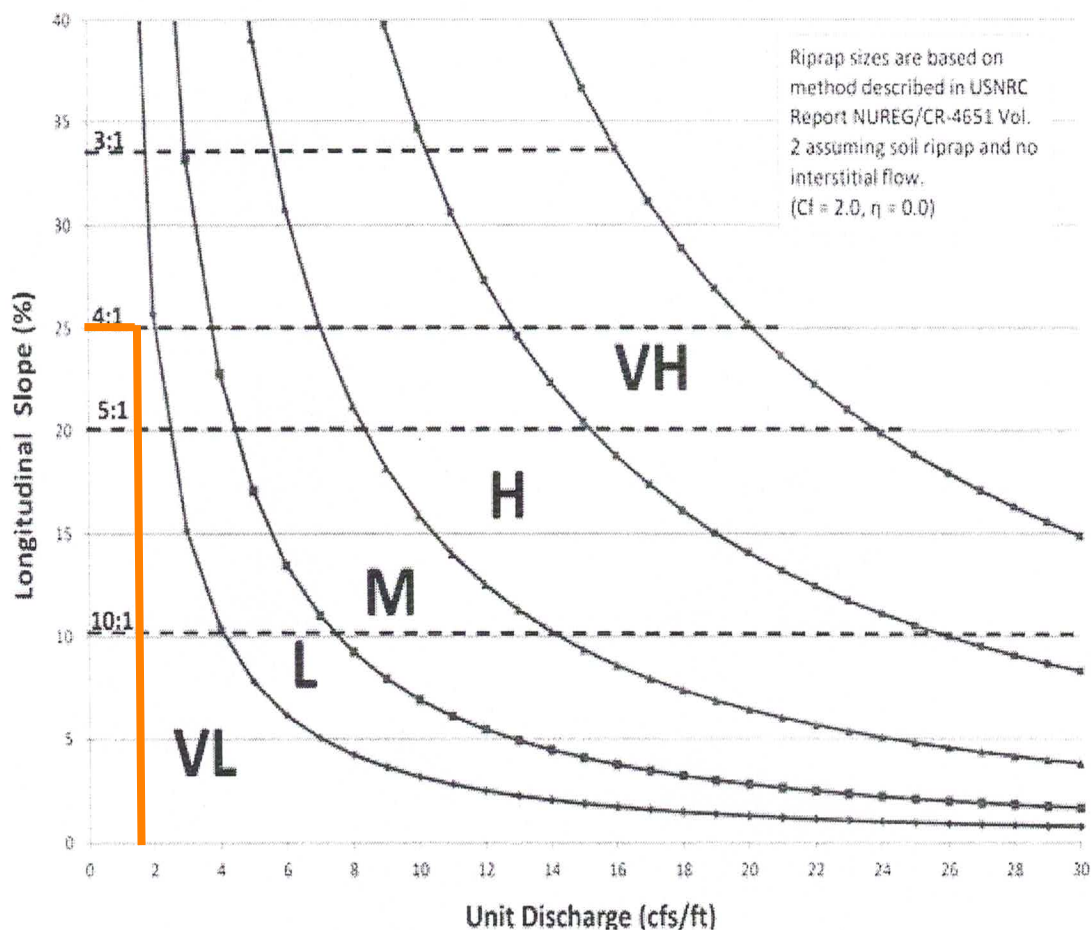


Figure 13-12d. Riprap Types for Emergency Spillway Protection



QPEAK INFLOW = 29.3 CFS  
WEIR LENGTH = 20 FT  
 $29.3/20=1.47$

### **POND 3**

Site-Level Low Impact Development (LID) Design Effective Impervious Calculator  
LID Credit by Impervious Reduction Factor (IRF) Method

UD-BMP (Version 3.06, November 2016)

User Input

Calculated cells

\*\*\*Design Storm: 1-Hour Rain Depth

WQCV Event

0.43

inches

\*\*\*Minor Storm: 1-Hour Rain Depth

5-Year Event

1.50

inches

\*\*\*Major Storm: 1-Hour Rain Depth

100-Year Event

2.52

inches

Optional User Defined Storm

CUHP

(CUHP) NOAA 1 Hour Rainfall Depth and Frequency for User Defined Storm

100-Year Event

Max Intensity for Optional User Defined Storm

0

Designer: QNA

Company: Terra Nova Engineering

Date: December 21, 2024

Project: WATERBURY FILING 1 POND 3

Location: POND 3 Design Point 29 Full Spectrum Detention

SITE INFORMATION (USER-INPUT)

Sub-basin Identifier	DP 29 FSD																		
Receiving Pervious Area Soil Type	Loamy Sand																		
Total Area (ac., Sum of DCIA, UIA, RPA, & SPA)	72.14																		
Directly Connected Impervious Area (DCIA, acres)	19.75																		
Unconnected Impervious Area (UIA, acres)	20.80																		
Receiving Pervious Area (RPA, acres)	16.16																		
Separate Pervious Area (SPA, acres)	15.42																		
RPA Treatment Type: Conveyance (C), Volume (V), or Permeable Pavement (PP)	C																		

CALCULATED RESULTS (OUTPUT)

Total Calculated Area (ac, check against input)	72.137																		
Directly Connected Impervious Area (DCIA, %)	27.4%																		
Unconnected Impervious Area (UIA, %)	28.8%																		
Receiving Pervious Area (RPA, %)	22.4%																		
Separate Pervious Area (SPA, %)	21.4%																		
$A_p$ (RPA / UIA)	0.777																		
$I_p$ Check	0.560																		
$f / I$ for WQCV Event:	4.5																		
$f / I$ for 5-Year Event:	0.5																		
$f / I$ for 100-Year Event:	0.4																		
$f / I$ for Optional User Defined Storm CUHP:																			
IRF for WQCV Event:	0.64																		
IRF for 5-Year Event:	0.90																		
IRF for 100-Year Event:	0.92																		
IRF for Optional User Defined Storm CUHP:																			
Total Site Imperviousness: $I_{total}$	56.2%																		
Effective Imperviousness for WQCV Event:	45.8%																		
Effective Imperviousness for 5-Year Event:	53.3%																		
Effective Imperviousness for 100-Year Event:	54.0%																		
Effective Imperviousness for Optional User Defined Storm CUHP:																			

LID / EFFECTIVE IMPERVIOUSNESS CREDITS

WQCV Event CREDIT: Reduce Detention By:	12.9%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
This line only for 10-Year Event	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100-Year Event CREDIT**: Reduce Detention By:	3.9%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
User Defined CUHP CREDIT: Reduce Detention By:																			

Total Site Imperviousness:	56.21%
Total Site Effective Imperviousness for WQCV Event:	45.84%
Total Site Effective Imperviousness for 5-Year Event:	53.33%
Total Site Effective Imperviousness for 100-Year Event:	53.95%
Total Site Effective Imperviousness for Optional User Defined Storm CUHP:	

Notes:

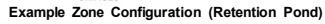
\* Use Green-Ampt average infiltration rate values from Table 3-3.

\*\* Flood control detention volume credits based on empirical equations from Storage Chapter of USDCM.

\*\*\* Method assumes that 1-hour rainfall depth is equivalent to 1-hour intensity for calculation purposed

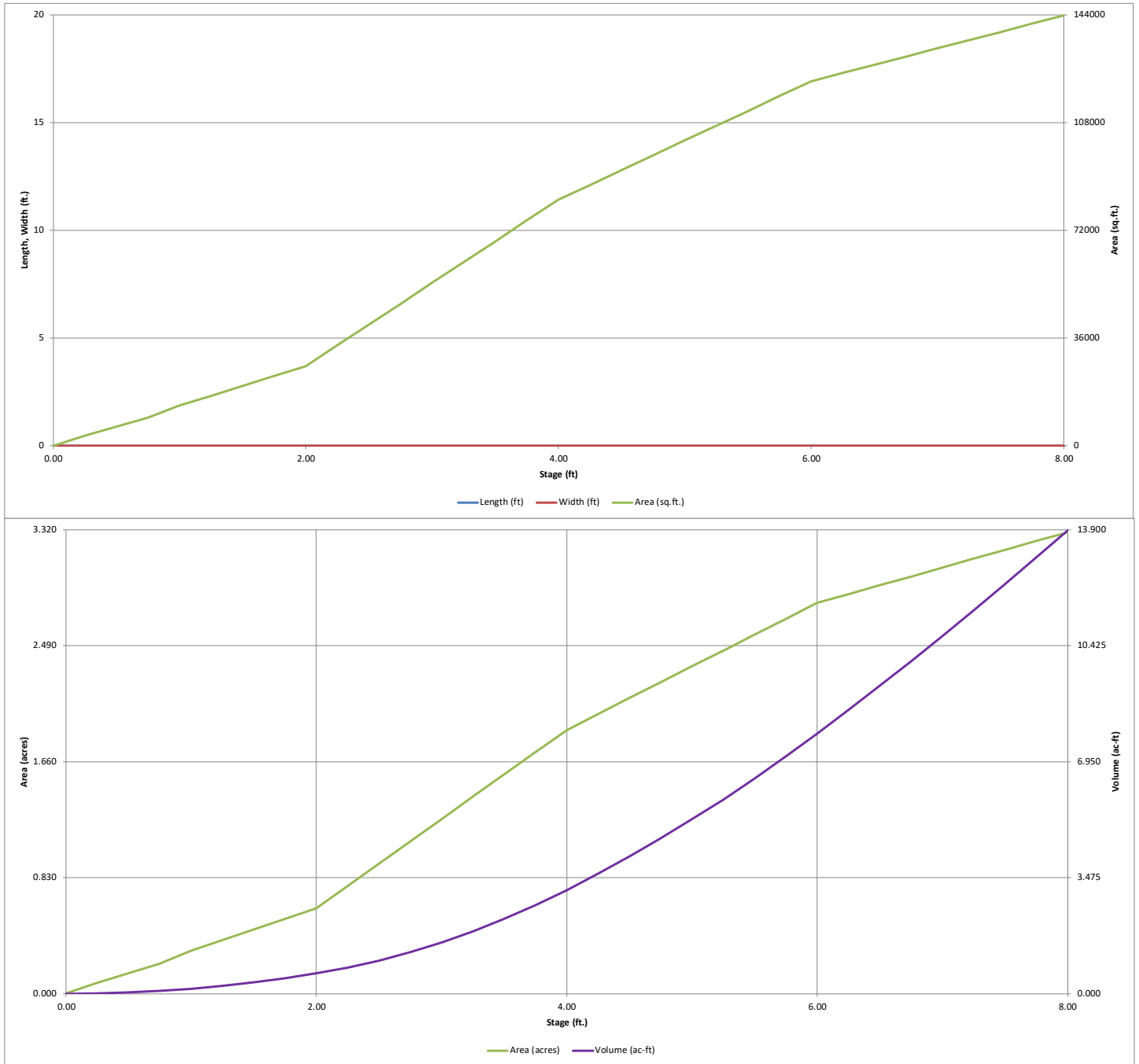
*MHFD-Detention, Version 4.06 (July 2022)*

Basin ID: POND 3 DP 29



# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

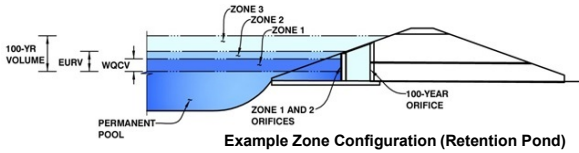


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: WATERBURY FILING NO. 1

Basin ID: POND 3 DP 29



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.81	1.307	Orifice Plate
Zone 2 (EURV)	4.73	3.278	Orifice Plate
Zone 3 (100-year)	5.77	2.559	Weir&Pipe (Restrict)
Total (all zones)		7.144	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Calculated Parameters for Plate

Centroid of Lowest Orifice =  0.00 ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  4.76 ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  N/A inches  
Orifice Plate: Orifice Area per Row =  N/A sq. inches

WQ Orifice Area per Row =  N/A ft<sup>2</sup>  
Elliptical Half-Width =  N/A feet  
Elliptical Slot Centroid =  N/A feet  
Elliptical Slot Area =  N/A ft<sup>2</sup>

User Input: Stage and Total Area of Each Orifice Row (numbered from lowest to highest)

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.68	3.37					
Orifice Area (sq. inches)	7.00	8.50	9.00					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

Calculated Parameters for Vertical Orifice

Invert of Vertical Orifice =  Not Selected  Not Selected ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  N/A  N/A ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  N/A  N/A inches

Vertical Orifice Area =  Not Selected  Not Selected ft<sup>2</sup>  
Vertical Orifice Centroid =  N/A  N/A feet

User Input: Overflow Weir (Dropbox with Flat or Sloped Gate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

Calculated Parameters for Overflow Weir

Overflow Weir Front Edge Height, H<sub>o</sub> =  Zone 3 Weir  Not Selected ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  5.05  N/A feet  
Overflow Weir Gate Slope =  12.00  N/A feet  
Horiz. Length of Weir Sides =  0.00  N/A H:V  
Overflow Gate Type =  6.00  N/A feet  
Debris Clogging % =  Type C Gate  N/A  
 50%  N/A %

Height of Gate Upper Edge, H<sub>u</sub> =  Zone 3 Weir  Not Selected feet  
Overflow Weir Slope Length =  5.05  N/A feet  
Grate Open Area / 100-yr Orifice Area =  6.00  N/A  
Overflow Gate Open Area w/o Debris =  7.09  N/A ft<sup>2</sup>  
Overflow Gate Open Area w/ Debris =  50.11  N/A ft<sup>2</sup>  
 25.06  N/A ft<sup>2</sup>

User Input: Outlet Pipe w/ Flow Restriction Plate (Circular Orifice, Restrictor Plate, or Rectangular Orifice)

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Depth to Invert of Outlet Pipe =  Zone 3 Restrictor  Not Selected ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  0.20  N/A inches  
Restrictor Plate Height Above Pipe Invert =  36.00  N/A inches

Outlet Orifice Area =  Zone 3 Restrictor  Not Selected ft<sup>2</sup>  
Outlet Orifice Centroid =  7.07  N/A feet  
Half-Central Angle of Restrictor Plate on Pipe =  1.50  N/A radians  
 3.14  N/A

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage =  5.80 ft (relative to basin bottom at Stage = 0 ft)  
Spillway Crest Length =  64.00 feet  
Spillway End Slopes =  4.00 H:V  
Freeboard above Max Water Surface =  1.00 feet

Spillway Design Flow Depth =  1.20 feet  
Stage at Top of Freeboard =  8.00 feet  
Basin Area at Top of Freeboard =  3.30 acres  
Basin Volume at Top of Freeboard =  13.88 acre-ft

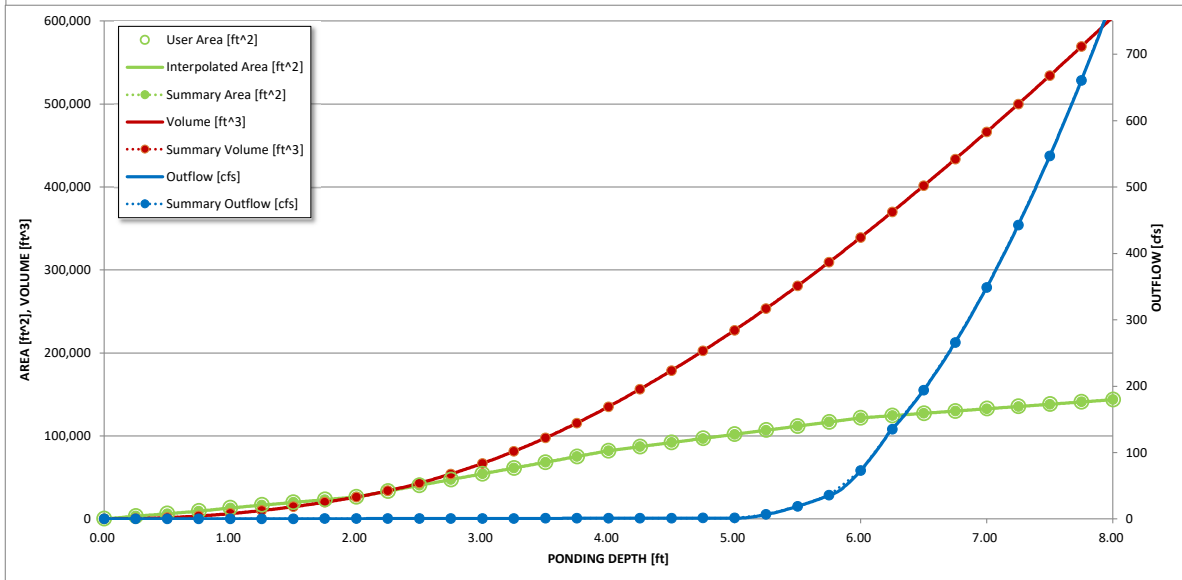
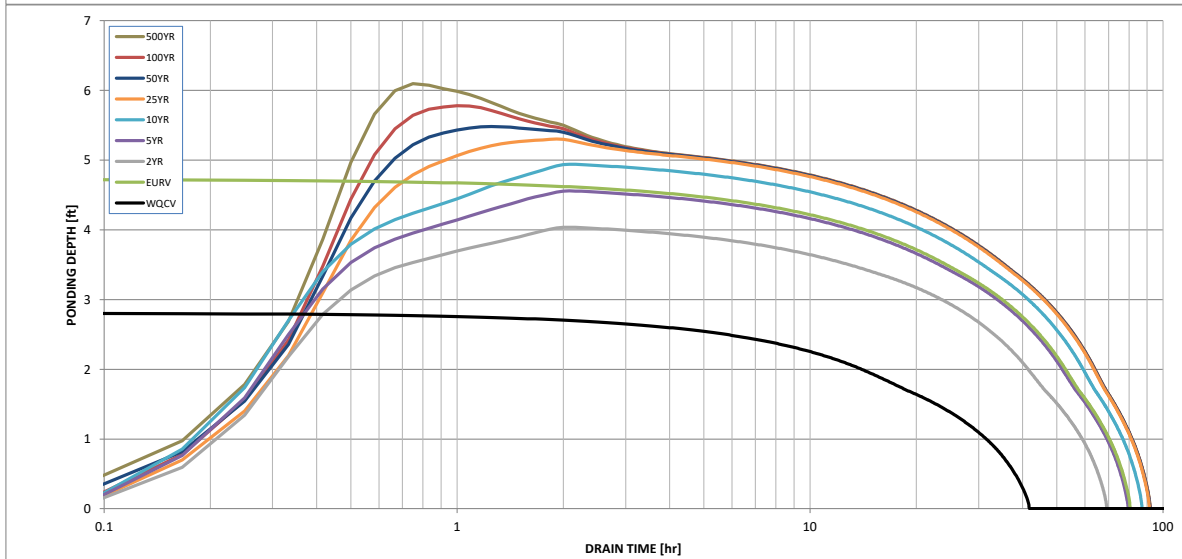
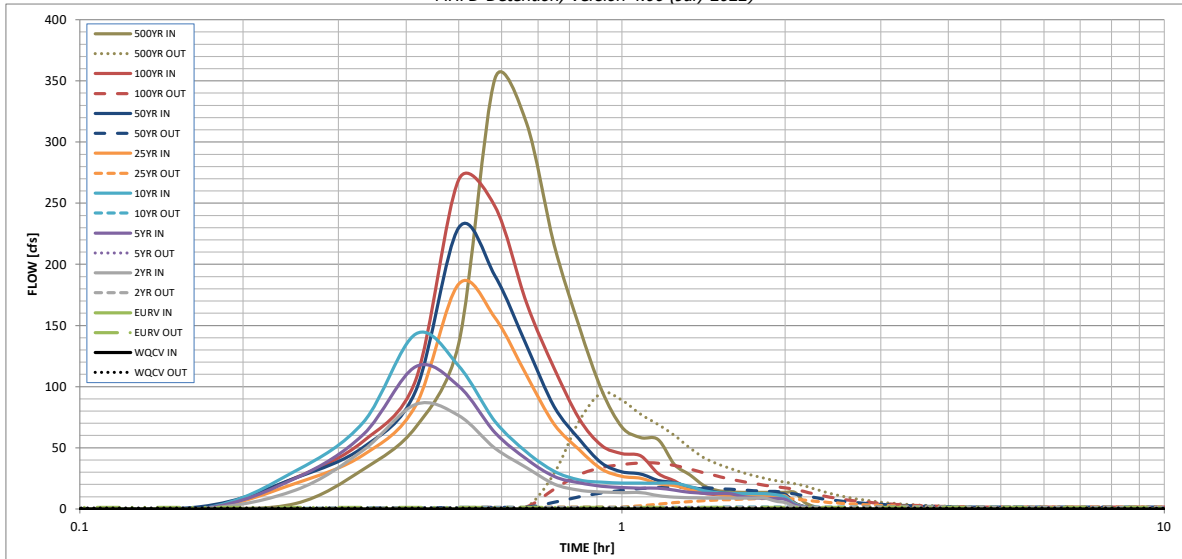
## Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.00
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.00
CUHP Runoff Volume (acre-ft) =	1.307	4.584	3.326	4.403	5.271	6.568	7.836	9.430	12.081
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.326	4.403	5.271	6.568	7.836	9.430	12.081
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.2	2.4	3.2	29.9	56.5	92.4	144.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.02	0.03	0.04	0.41	0.78	1.28	2.01
Peak Inflow Q (cfs) =	N/A	N/A	85.6	116.4	143.1	183.9	230.0	269.3	351.7
Peak Outflow Q (cfs) =	0.7	1.4	1.2	1.3	1.4	8.7	17.8	37.7	94.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.4	0.3	0.3	0.4	0.7
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Gate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.1	0.3	0.7	1.2
Max Velocity through Gate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	71	62	70	76	79	77	75	72
Time to Drain 99% of Inflow Volume (hours) =	40	77	66	76	83	86	85	85	83
Maximum Ponding Depth (ft) =	2.81	4.73	4.04	4.55	4.94	5.30	5.48	5.78	6.09
Area at Maximum Ponding Depth (acres) =	1.13	2.22	1.90	2.14	2.31	2.47	2.55	2.69	2.82
Maximum Volume Stored (acre-ft) =	1.310	4.602	3.161	4.210	5.055	5.916	6.368	7.155	8.039

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: \_\_\_\_\_

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	1.75	0.18	4.40
	0:15:00	0.00	0.00	15.44	25.11	31.16	20.96	25.41	25.53	32.31
	0:20:00	0.00	0.00	48.04	60.77	70.81	44.14	50.54	55.41	66.92
	0:25:00	0.00	0.00	85.57	116.37	143.08	84.82	96.82	105.70	135.12
	0:30:00	0.00	0.00	76.34	100.43	116.83	183.95	230.01	269.26	351.71
	0:35:00	0.00	0.00	49.60	62.47	71.71	156.30	190.69	247.51	315.63
	0:40:00	0.00	0.00	33.73	40.73	46.60	109.19	133.55	168.46	216.19
	0:45:00	0.00	0.00	20.36	26.49	30.82	69.37	83.74	115.14	149.60
	0:50:00	0.00	0.00	15.24	21.50	23.69	48.58	57.22	74.05	97.62
	0:55:00	0.00	0.00	13.90	18.56	21.85	32.52	37.56	51.94	67.02
	1:00:00	0.00	0.00	13.39	17.44	21.23	26.70	30.38	45.26	58.31
	1:05:00	0.00	0.00	13.39	17.06	21.02	24.95	28.58	43.33	56.62
	1:10:00	0.00	0.00	10.81	16.88	21.02	20.57	23.33	28.88	36.37
	1:15:00	0.00	0.00	9.67	15.25	21.02	19.03	21.51	22.86	28.05
	1:20:00	0.00	0.00	9.18	13.56	18.35	15.75	17.76	15.83	19.13
	1:25:00	0.00	0.00	8.93	12.82	14.90	14.27	16.07	12.63	15.04
	1:30:00	0.00	0.00	8.92	12.47	13.38	12.03	13.54	11.79	14.05
	1:35:00	0.00	0.00	8.92	12.37	12.70	11.02	12.41	11.39	13.58
	1:40:00	0.00	0.00	8.92	10.10	12.48	10.69	12.04	11.39	13.58
	1:45:00	0.00	0.00	8.92	9.10	12.48	10.53	11.85	11.39	13.58
	1:50:00	0.00	0.00	8.92	8.66	12.48	10.53	11.85	11.39	13.58
	1:55:00	0.00	0.00	6.35	8.44	11.72	10.53	11.85	11.39	13.58
	2:00:00	0.00	0.00	5.21	7.79	9.86	10.53	11.85	11.39	13.58
	2:05:00	0.00	0.00	2.14	3.28	4.10	4.41	4.96	4.75	5.65
	2:10:00	0.00	0.00	0.75	1.29	1.56	1.73	1.94	1.85	2.19
	2:15:00	0.00	0.00	0.25	0.42	0.47	0.57	0.63	0.60	0.71
	2:20:00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
	2:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

# FSD POND 3 FORBAY VOLUMES

**Required Forbay Volume = 3% of WQCV**

WQCV = 1.307 ac-ft  
WQCV = 56,917 cu-ft  
3% of WQCV = 0.04 ac-ft  
3% of WQCV = 1707.51 cu-ft

## FORBAY PR 33A

<i>ELEV</i>	<i>AREA</i>	<i>AREA AVG.</i>	<i>DELTA ELEV.</i>	<i>VOLUME</i>	<i>VOLUME TOTAL</i>
6900.25	900	900	1.5	1350	
6901.75	900				1350

End Area Method: 1350 C.F.  
0.031 A.F.

## FORBAY PR 34A

<i>ELEV</i>	<i>AREA</i>	<i>AREA AVG.</i>	<i>DELTA ELEV.</i>	<i>VOLUME</i>	<i>VOLUME TOTAL</i>
6900.25	425	425	1.5	638	
6901.75	425				638

End Area Method: 638 C.F.  
0.015 A.F.

**TOTAL 1987.500 A.F.**  
**TOTAL 0.046 A.F.**

## **WATEBURY FILING NO. 1 POND 3 FORBAY WALL NOTCH CALCS**

### **North Wall Notch**

Notch to releae 2% of the undetained 100-year peak discharge.

$$\begin{array}{rcl} 100\text{-y peak discharge} & = & 269 \text{ cfs} \\ 2.0\% & = & 5.39 \end{array}$$

The general form of the equation for horizontal crested weirs is  $Q = CLH^{3/2}$  where:

Q = Weir flow discharge (cfs)	<b>5.39</b>	
C = Weir flow coefficient	3.4	
H = Depth of flow over the weir (ft)	2.50	Opening Height
L = Length of the weir (ft)	<b>0.40</b>	Length
L = Length of the weir (in)	<b>5</b>	

**Notch to releae 2% of the undetained 100-year peak discharge is  
5" wide by 30" high**

### **South Wall Notch**

Notch to releae 2% of the undetained 100-year peak discharge.

$$\begin{array}{rcl} 100\text{-y peak discharge} & = & 269 \text{ cfs} \\ 2.0\% & = & 5.39 \end{array}$$

The general form of the equation for horizontal crested weirs is  $Q = CLH^{3/2}$  where:

Q = Weir flow discharge (cfs)	<b>5.39</b>	
C = Weir flow coefficient	3.4	
H = Depth of flow over the weir (ft)	2.50	Opening Height
L = Length of the weir (ft)	<b>0.40</b>	Length
L = Length of the weir (in)	<b>5</b>	

**Notch to releae 2% of the undetained 100-year peak discharge is  
5" wide by 30" high**

# POND 3 TRICKLE CHANNEL NORTH

## MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **WATERBURY FILIN NO. 1** Location: **POND 3 DP 29 NORTH** MIN SLOPE 0.5%  
 By: **QNA** Date: **9/16/2024**  
 Chk By: Date: version 12-2004

Mannings Formula

$$Q = (1.486/n)AR_h^{2/3}S^{1/2}$$

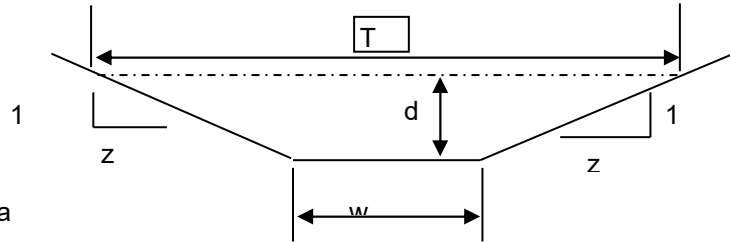
$$R = A/P$$

A = cross sectional area

P = wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$$V = (1.49/n)R_h^{2/3}S^{1/2}$$

$$Q = V \times A$$

INPUT

z (sideslope)= 0  
 z (sideslope)= 0  
 b (btm width, ft)= 3  
 d (depth, ft)= 0.5  
 S (slope, ft/ft) 0.005  
 n low = 0.012  
 n high = 0.015

Clear Data  
Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N		High N		T =	Dm =
				Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.5	1.50	4.00	0.38	4.55333089	6.83	3.642665	5.464	3	0.500

Sc low = 0.0039 Sc high = 0.0061

$s_c$  = critical slope ft / ft

T = top width of the stream

$d_m = a/T$  = mean depth of flow

.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0027	0.0050	0.0042	0.0079

**5.46 CFS > 2% OF 269 CFS = 5.38 CFS**

Created by: Mike O'Shea

# POND 3 TRICKLE CHANNEL SOUTH

## MANNING'S EQUATION for OPEN CHANNEL FLOW

Project: **WATERBURY FILIN NO. 1** Location: **POND 3 DP 29 SOUTH** MIN SLOPE 0.88%  
 By: **QNA** Date: **9/16/2024**  
 Chk By: Date: version 12-2004

Mannings Formula

$$Q = (1.486/n)AR_h^{2/3}S^{1/2}$$

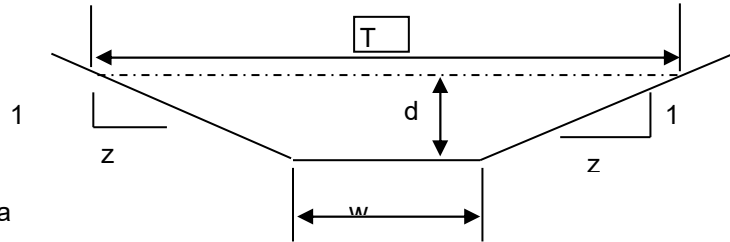
$$R = A/P$$

A = cross sectional area

P = wetted perimeter

S = slope of channel

n = Manning's roughness coefficient



$$V = (1.49/n)R_h^{2/3}S^{1/2}$$

$$Q = V \times A$$

INPUT

z (sideslope)= 0  
 z (sideslope)= 0  
 b (btm width, ft)= 3  
 d (depth, ft)= 0.5  
 S (slope, ft/ft) 0.0088  
 n low = 0.012  
 n high = 0.015

Clear Data  
Entry Cells

Depth, ft	Area, sf	Wetted Perimeter, ft	Hydraulic Radius, ft	Low N		High N		T =	Dm =
				Velocity, fps	Flow, cfs	Velocity, fps	Flow, cfs		
0.5	1.50	4.00	0.38	6.04067605	9.06101	4.832541	7.24881	3	0.500

Sc low = 0.0039 Sc high = 0.0061

$s_c$  = critical slope ft / ft

T = top width of the stream

$d_m = a/T$  = mean depth of flow

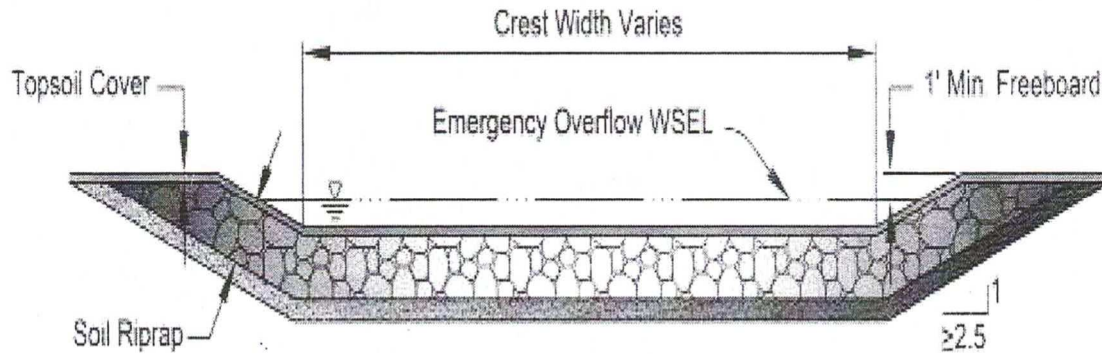
.7 Sc	1.3 Sc	.7 Sc	1.3 Sc
0.0027	0.0050	0.0042	0.0079

## 7.25 CFS > 2% OF 269 CFS = 5.38 CFS

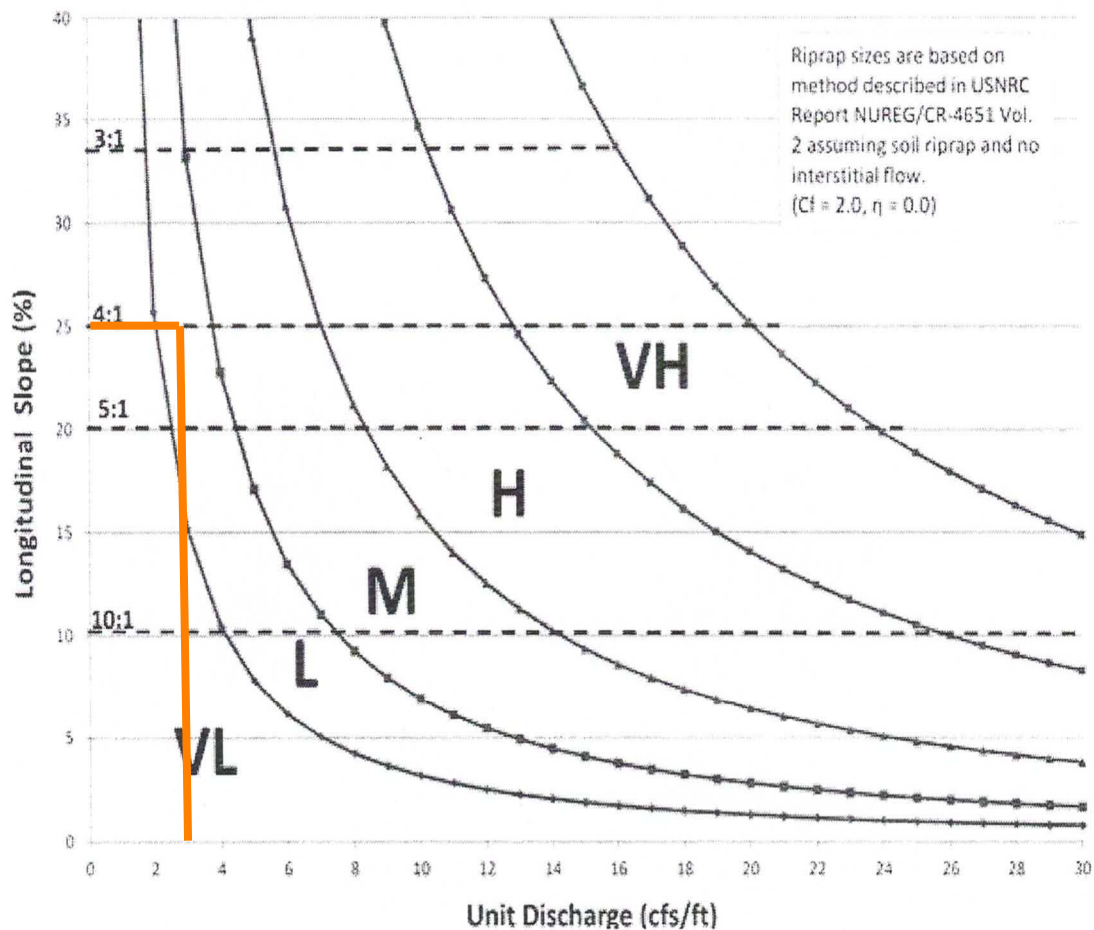
Created by: Mike O'Shea

## POND 3 EMERGENCY WEIR

**Figure 13-12c. Emergency Spillway Protection**



**Figure 13-12d. Riprap Types for Emergency Spillway Protection**



**QPEAK INFLOW = 269 CFS**

**WIER LENGTH = 87 FT**

**$269/87 = 3.09$**

**RUNOFF REDUCTION  
& EXCLUDED UNDEVELOPED PERVIOUS AREA**

# Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 1

**Designer:** QUENTIN ARMIJO  
**Company:** TERRA NOVA ENGINEERING, INC.  
**Date:** November 19, 2022  
**Project:** WATERBURY FILING 1 & 2  
**Location:** BASIN M2 EASTERN CHANNEL DIRECT RELEASE

## SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth 0.60 inches  
 Depth of Average Runoff Producing Storm,  $d_0$  = 0.43 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA												
Area ID	M2												
Downstream Design Point ID	EAST CH												
Downstream BMP Type	None												
DCIA (ft <sup>2</sup> )	--												
UIA (ft <sup>2</sup> )	5,300												
RPA (ft <sup>2</sup> )	7,000												
SPA (ft <sup>2</sup> )	--												
HSG A (%)	100%												
HSG B (%)	0%												
HSG C/D (%)	0%												
Average Slope of RPA (ft/ft)	0.020												
UIA:RPA Interface Width (ft)	60.00												

## CALCULATED RUNOFF RESULTS

Area ID	M2												
UIA:RPA Area (ft <sup>2</sup> )	12,300												
L / W Ratio	3.42												
UIA / Area	0.4309												
Runoff (in)	0.00												
Runoff (ft <sup>3</sup> )	0												
Runoff Reduction (ft <sup>3</sup> )	221												

## CALCULATED WQCV RESULTS

Area ID	M2												
WQCV (ft <sup>3</sup> )	221												
WQCV Reduction (ft <sup>3</sup> )	221												
WQCV Reduction (%)	100%												
Untreated WQCV (ft <sup>3</sup> )	0												

## CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	EAST CH												
DCIA (ft <sup>2</sup> )	0												
UIA (ft <sup>2</sup> )	5,300												
RPA (ft <sup>2</sup> )	7,000												
SPA (ft <sup>2</sup> )	0												
Total Area (ft <sup>2</sup> )	12,300												
Total Impervious Area (ft <sup>2</sup> )	5,300												
WQCV (ft <sup>3</sup> )	221												
WQCV Reduction (ft <sup>3</sup> )	221												
WQCV Reduction (%)	100%												
Untreated WQCV (ft <sup>3</sup> )	0												

## CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft <sup>2</sup> )	12,300
Total Impervious Area (ft <sup>2</sup> )	5,300
WQCV (ft <sup>3</sup> )	221
WQCV Reduction (ft <sup>3</sup> )	221
WQCV Reduction (%)	100%
Untreated WQCV (ft <sup>3</sup> )	0

# Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 1

**Designer:** Quentin Armijo  
**Company:** Terra Nova Engineering, Inc.  
**Date:** November 19, 2022  
**Project:** Waterbury Filings 1 & 2  
**Location:** \*BASIN N WESTERN CHANNEL DIRECT RELEASE.

## SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth 0.60 inches  
Depth of Average Runoff Producing Storm,  $d_0$  = 0.43 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA												
Area ID	N												
Downstream Design Point ID	WEST CH												
Downstream BMP Type	None												
DCIA (ft <sup>2</sup> )	--												
UIA (ft <sup>2</sup> )	1,105												
RPA (ft <sup>2</sup> )	1,895												
SPA (ft <sup>2</sup> )	--												
HSG A (%)	100%												
HSG B (%)	0%												
HSG C/D (%)	0%												
Average Slope of RPA (ft/ft)	0.020												
UIA:RPA Interface Width (ft)	60.00												

## CALCULATED RUNOFF RESULTS

Area ID	N												
UIA:RPA Area (ft <sup>2</sup> )	3,000												
L / W Ratio	0.83												
UIA / Area	0.3683												
Runoff (in)	0.00												
Runoff (ft <sup>3</sup> )	0												
Runoff Reduction (ft <sup>3</sup> )	46												

## CALCULATED WQCV RESULTS

Area ID	N												
WQCV (ft <sup>3</sup> )	46												
WQCV Reduction (ft <sup>3</sup> )	46												
WQCV Reduction (%)	100%												
Untreated WQCV (ft <sup>3</sup> )	0												

## CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	WEST CH												
DCIA (ft <sup>2</sup> )	0												
UIA (ft <sup>2</sup> )	1,105												
RPA (ft <sup>2</sup> )	1,895												
SPA (ft <sup>2</sup> )	0												
Total Area (ft <sup>2</sup> )	3,000												
Total Impervious Area (ft <sup>2</sup> )	1,105												
WQCV (ft <sup>3</sup> )	46												
WQCV Reduction (ft <sup>3</sup> )	46												
WQCV Reduction (%)	100%												
Untreated WQCV (ft <sup>3</sup> )	0												

## CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft <sup>2</sup> )	3,000
Total Impervious Area (ft <sup>2</sup> )	1,105
WQCV (ft <sup>3</sup> )	46
WQCV Reduction (ft <sup>3</sup> )	46
WQCV Reduction (%)	100%
Untreated WQCV (ft <sup>3</sup> )	0

## **APPENDIX H**

### **HEC-RAS ANALYSIS**

**Table 3.** Adjustment values for factors that affect roughness of flood plains

[Modified from Aldridge and Garrett, 1973, table 2]

Flood-plain conditions		<i>n</i> value adjustment	Example
Degree of irregularity ( <i>n</i> <sub>1</sub> )	Smooth	0.000	Compares to the smoothest, flattest flood plain attainable in a given bed material.
	Minor	0.001–0.005	Is a flood plain slightly irregular in shape. A few rises and dips or sloughs may be visible on the flood plain.
	Moderate	0.006–0.010	Has more rises and dips. Sloughs and hummocks may occur.
	Severe	0.011–0.020	Flood plain very irregular in shape. Many rises and dips or sloughs are visible. Irregular ground surfaces in pastureland and furrows perpendicular to the flow are also included.
Variation of flood-plain cross section ( <i>n</i> <sub>2</sub> )		0.0	Not applicable.
Effect of obstructions ( <i>n</i> <sub>3</sub> )	Negligible	0.000–0.004	Few scattered obstructions, which include debris deposits, stumps, exposed roots, logs, or isolated boulders, occupy less than 5 percent of the cross-sectional area.
	Minor	0.005–0.019	Obstructions occupy less than 15 percent of the cross-sectional area.
	Appreciable	0.020–0.030	Obstructions occupy from 15 to 50 percent of the cross-sectional area.
Amount of vegetation ( <i>n</i> <sub>4</sub> )	Small	0.001–0.010	Dense growth of flexible turf grass, such as Bermuda, or weeds growing where the average depth of flow is at least two times the height of the vegetation, or supple tree seedlings such as willow, cottonwood, arrowweed, or saltcedar growing where the average depth of flow is at least three times the height of the vegetation.
	Medium	0.011–0.025	Turf grass growing where the average depth of flow is from one to two times the height of the vegetation, or moderately dense stemmy grass, weeds, or tree seedlings growing where the average depth of flow is from two to three times the height of the vegetation; brushy, moderately dense vegetation, similar to 1- to 2-year-old willow trees in the dormant season.
	Large	0.025–0.050	Turf grass growing where the average depth of flow is about equal to the height of the vegetation, or 8- to 10-year-old willow or cottonwood trees intergrown with some weeds and brush (none of the vegetation in foliage) where the hydraulic radius exceeds 2 ft, or mature row crops such as small vegetables, or mature field crops where depth of flow is at least twice the height of the vegetation.
	Very large	0.050–0.100	Turf grass growing where the average depth of flow is less than half the height of the vegetation, or moderate to dense brush, or heavy stand of timber with few down trees and little undergrowth where depth of flow is below branches, or mature field crops where depth of flow is less than the height of the vegetation.
	Extreme	0.100–0.200	Dense bushy willow, mesquite, and saltcedar (all vegetation in full foliage), or heavy stand of timber, few down trees, depth of flow reaching branches.
Degree of meander ( <i>m</i> )		1.0	Not applicable.

Chow (1959) presents a table showing minimum, normal, and maximum values of *n* for flood plains covered by pasture and crops. These values are helpful for comparing the roughness values of flood plains having similar vegetation.

### Vegetation-Density Method

For a wooded flood plain, the vegetation-density method can be used as an alternative to the previous method for determining *n* values for flood plains. In a wooded flood plain, where the tree diameters can be measured, the vegetation density of the flood plain can be determined.

Determining the vegetation density is an effective way of relating plant height and density characteristics, as a function of depth of flow, to the flow resistance of vegetation. Application of the flow-resistance model presented below requires an estimate of the vegetation density as a function of depth of flow. The procedure requires a direct or indirect determination of vegetation density at a given depth. If the change in *n* value through a range in depth is required, then an estimation of vegetation density through that range is necessary.

### Techniques for Determining Vegetation Density

Petryk and Bosmajian (1975) developed a method of analysis of the vegetation density to determine the rough-

**Classification of Vegetal Covers**

<b>Retardance Class</b>	<b>Cover</b>	<b>Condition</b>
A	Weeping lovegrass	Excellent stand, tall, average 30 in.
	Yellow bluestem <i>Ischaemum</i>	Excellent stand, tall, average 36 in.
	Bermuda grass	Good stand, tall, average 12 in.
	Native grass mixture (little bluestem, bluestem, blue gamma, and other long and short Midwest grasses)	Good stand, unmowed
	Weeping lovegrass	Good stand, tall, average 24 in.
B	Lespedeza serica	Good stand, not woody, tall, average 19 in.
	Alfalfa	Good stand uncut, average 11 in.
	Weeping lovegrass	Good stand, unmowed, average 13 in.
	Kudzu	Dense growth, uncut
	Blue gamma	Good stand, uncut, average 13 in.
	Crabgrass	Fair stand, uncut, avg. 10 in.
	Bermuda grass	Good stand, mowed, average 6 in.
C	Common lespedeza	Good stand, uncut, average 11 in.
	Grass-legume mixture - summer (orchard grass, redtop Italian ryegrass, and common lespedeza)	Good stand, uncut, average 6 to 8 in.
	Centipedegrass	Very dense cover, average 6 in.
	Kentucky Bluegrass	Good stand, headed, 6 to 12 in.
	Bermuda grass	Good stand, cut to 2.5 in. height
	Common lespedeza	Excellent stand, uncut, average 4.5 in.
	Buffalo Grass	Good stand, uncut, 3 to 6 in.
D	Grass-legume mixture - fall (orchard grass, redtop Italian ryegrass, and common lespedeza)	Good stand, uncut, 3 to 5 in.
	Lespedeza serica	After cutting to 2 in. height, good stand before cutting
E	Bermuda grass	Good stand, cut to average 1.5 in. height
	Bermuda grass	Burned stubble

Note: Covers classified have been tested in experimental channels. Covers were green and generally uniform.

Source: HEC-15



### Coefficients for Roughness of Grass-Lined Channels

SCS	
Retardance Class	C <sub>n</sub>
A	0.605
B	0.418
C	0.220
D	0.147
E	0.093

*Source: HEC-15*

#### Composite Roughness

Culverts using different materials for portions of the perimeter such as embedded culverts or culverts with an invert liner should use a composite Manning's n value. A weighted n value based on the materials can be derived using the following equation:

$$n_c = \left[ \frac{\sum (p_i n_i^{1.5})}{p} \right]^{0.67}$$

Where:

$n_c$  = Composite/weighted Manning's n.

$p_i$  = Wetted perimeter for the material, ft.

$n_i$  = Manning's n value for the material.

$p$  = Total wetted perimeter, ft.

#### 750.1.4.1.2 Hydraulic Radius

The hydraulic radius is a characteristic depth of flow and is defined as the cross-sectional area of flow divided by the wetted perimeter of the channel. The hydraulic radius is computed as follows:

$$R = \frac{A}{P}$$

where:

$R$  = hydraulic radius, ft

$A$  = cross-sectional area of flow, ft<sup>2</sup>

$P$  = wetted perimeter of the channel cross section, ft

#### 750.1.4.1.3 Slope

**Table 8-8** Characteristics of selected grass species for use in channels and waterways

Grass species	Height at maturity	
	(ft)	(m)
<b>Cool-season grasses</b>		
Creeping foxtail	3-4	0.9-1.2
Crested wheatgrass	2-3	0.6-0.9
Green needlegrass	3-4	0.9-1.2
Russian wild rye	3-4	0.9-1.2
Smooth brome grass	3-4	0.9-1.2
Tall fescue	3-4	0.9-1.2
Tall wheatgrass		1.2-1.5
Western wheatgrass	2-3	0.6-0.9
<b>Warm-season grasses</b>		
Bermudagrass	3/4-2	0.2-0.6
Big bluestem	4-6	1.2-1.8
Blue grama	1-2	0.3-0.6
Buffalograss	1/3-1	0.1-0.3
Green spangle top	3-4	0.9-1.2
Indiangrass	5-6	1.5-1.8
Klein grass	3-4	0.9-1.2
Little bluestem	3-4	0.9-1.2
Plains bristlegrass	1-2	0.3-0.6
Sand bluestem	5-6	1.5-1.8
Sideoats grama	2-3	0.6-0.9
Switchgrass	4-5	1.2-1.5
Vine mesquitegrass	1-2	0.3-0.6
Weeping lovegrass	3-4	0.9-1.2
<b>Old World bluestems</b>		
Caucasian bluestem	4-5	1.2-1.5
Ganada yellow bluestem	3-4	0.9-1.2

this table were obtained from a review of the available qualitative descriptions and stem counts reported by researchers studying channel resistance and stability.

Since cover conditions vary from year to year and season to season, it is recommended that an upper and lower bound be determined for  $C_F$ . The lower bound should be used in stability computations, and the upper bound should be used to determine channel capacity. Some practitioners find that the use of SCS retardance class (table 8-9) is a preferable approach.

The vegetal cover index,  $C_F$ , depends primarily on the density and uniformity of density in the immediate vicinity of the soil boundary. Because this parameter is associated with the prevention of local erosion damage which may lead to channel unraveling, the cover factor should represent the weakest area in a reach, rather than the average for the cover species. Recommended values for the cover factor are presented in table 8-10. Values in this table do not account for such considerations as maintenance practices or uniformity of soil fertility or moisture. Therefore, appropriate engineering judgment should be used in its application.

**Table 8-10** Properties of grass channel linings values (apply to good uniform stands of each cover)

Cover factor ( $C_F$ )	Covers tested	Reference stem density (stems/ft <sup>2</sup> )	Reference stem density (stems/m <sup>2</sup> )
0.90	Bermudagrass	500	5,380
	Centipede grass	500	5,380
0.87	Buffalograss	400	4,300
	Kentucky bluegrass	350	3,770
	Blue grama	350	3,770
0.75	Grass mixture	200	2,150
0.50	Weeping lovegrass	350	3,770
	Yellow bluestem	250	2,690
0.50	Alfalfa	500	5,380
	Lespedeza sericea	300	3,280
0.50	Common lespedeza	150	1,610
	Sudangrass	50	538

Multiply the stem densities given by 1/3, 2/3, 1, 4/3, and 5/3 for poor, fair, good, very good, and excellent covers, respectively. Reduce the  $C_F$  by 20% for fair stands and 50% for poor stands.

**Table 8-9** Retardance curve index by SCS retardance class

SCS retardance class	Retardance curve index
A	10.0
B	7.64
C	5.60
D	4.44
E	2.88

Two soil parameters are required for application of effective stress concepts to the stability design of lined or unlined channels having an erodible soil boundary: soil grain roughness,  $n_s$ , and allowable effective stress,  $\tau_a$ . When the effective stress approach is used, the soil parameters are the same for both lined and unlined channels with negligible bed-material sediment transport.

Soil grain roughness is defined as the roughness associated with particles or aggregates of a size that can be independently moved by the flow at incipient channel failure. For noncohesive soils, the soil grain roughness and effective shear stress are both a function of the  $D_{75}$  grain size. When  $D_{75}$  is greater than 1.3 millimeter, the soil is considered coarse grained. When  $D_{75}$  is less than 1.3 millimeter, the soil is considered fine grained. Fine-grained roughness is considered to have a constant value of 0.0156. Fine-grained effective shear stress is taken to have a constant value of 0.02 pound per square foot. Coarse-grained shear stress and roughness are given in figures 8-21 and 8-22.

A soil grain roughness of 0.0156 is assigned to all cohesive soils. The allowable effective stresses are a function of the unified soil classification system soil type, the plasticity index, and the void ratio. The basic allowable shear stress,  $\tau_{ab}$ , is determined from the plasticity index and soil classification, and then adjusted by the void ratio correction factor,  $C_e$ , using the following equation:

$$\tau_a = \tau_{ab} C_e^2 \quad (\text{eq. 8-29})$$

The basic allowable effective stress can be determined from figure 8-23 and the void ratio correction factor from figure 8-24. These two figures were developed directly from the allowable velocity curves in AH 667. Stress partitioning (slope partitioning) is essential to application of figures 8-21 to 8-24, with or without vegetation (Temple et al. 1987).

### (e) General design procedure

Use the basic shear stress equation to determine effective shear stress on the soil beneath the vegetation. Use any consistent units of measurement.

$$\tau_e = \gamma d S (1 - C_f) \left( \frac{n_s}{n} \right)^2 \quad (\text{eq. 8-30})$$

where:

- $\tau_e$  = effective shear stress exerted on the soil beneath vegetation (lb/ft<sup>2</sup> or N/m<sup>2</sup>)
- $\gamma$  = specific weight of water (lb/ft<sup>3</sup> or N/m<sup>3</sup>)
- $d$  = maximum depth of flow in the cross section (ft or m)
- $S$  = energy slope, dimensionless
- $C_f$  = vegetation cover factor (0 for unlined channel), dimensionless
- $n_s$  = grain roughness of underlying soil, typically taken as dimensionless
- $n$  = roughness coefficient of vegetation, typically taken as dimensionless

The flow depth is used instead of the hydraulic radius because this will result in the maximum local shear stress, rather than the average shear stress. The cover factor is a function of the grass and stem density. Roughness coefficients are standard Manning's roughness values;  $n_s$  can be determined from figure 8-22,  $n$  can be determined from the old SCS curves (fig. 8-20) or from the following equation.

$$n_R = \exp \left\{ C_1 \left[ 0.0133 (\ln R_v)^2 - 0.0954 \ln R_v + 0.297 \right] - 4.16 \right\} \quad (\text{eq. 8-31})$$

where:

- $R_v$  =  $(VR/v) \times 10^{-5}$  (this dimensionless term reduces to VR for practical application in English units)
- $V$  = channel velocity (ft/s or m/s)
- $R$  = hydraulic radius (ft or m)
- Limited to  $0.0025 C_1^{2.5} < R_v < 36$

A reference value of Manning's resistance coefficient,  $n_R$ , is applicable to vegetation established on relatively smoothly graded fine-grained soil.

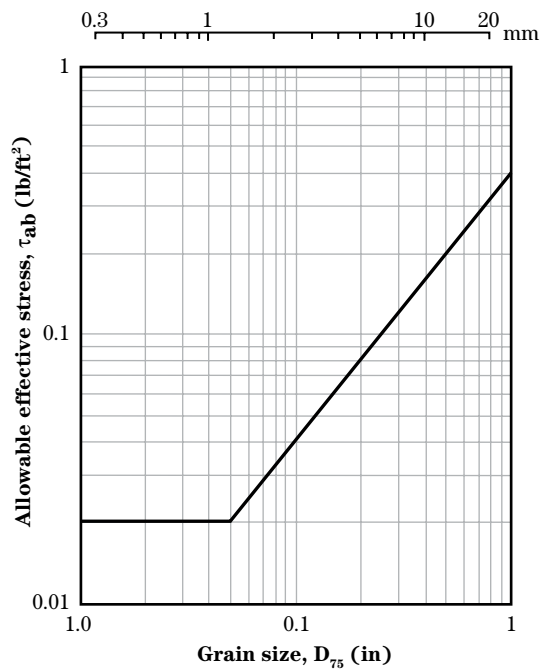
If vegetated channel liner mats are used, manufacturer-supplied roughness coefficients for particular mats may be used in the equation.



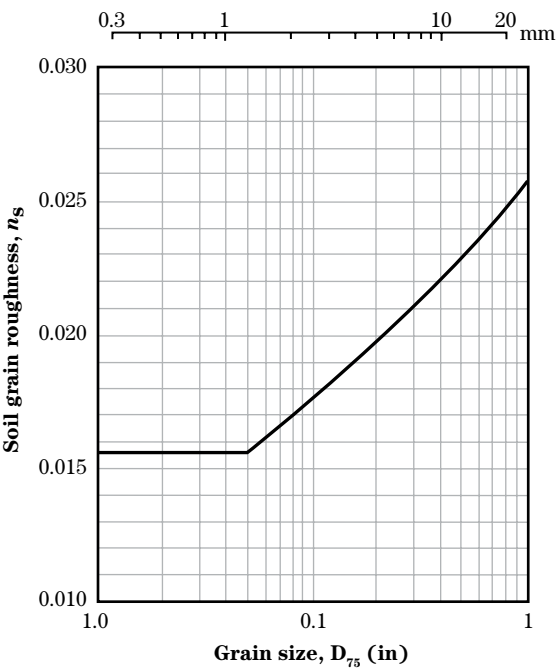
Maximum allowable shear stress,  $\tau_{va}$ , in pound per square foot is determined as a function of the retardance curve index,  $C_r$ . Very little information is available for vegetal performance under very high stresses and this relation is believed to be conservative.

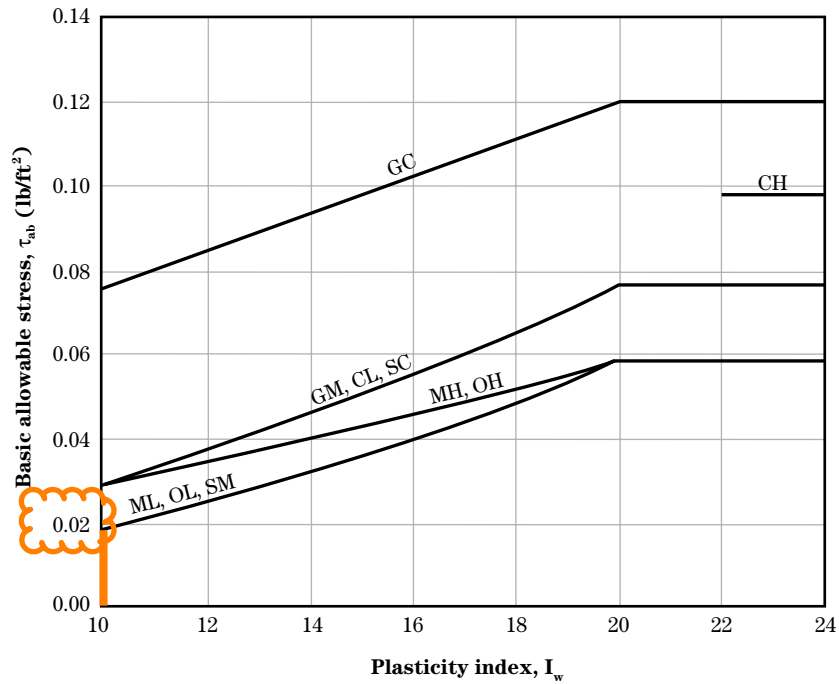
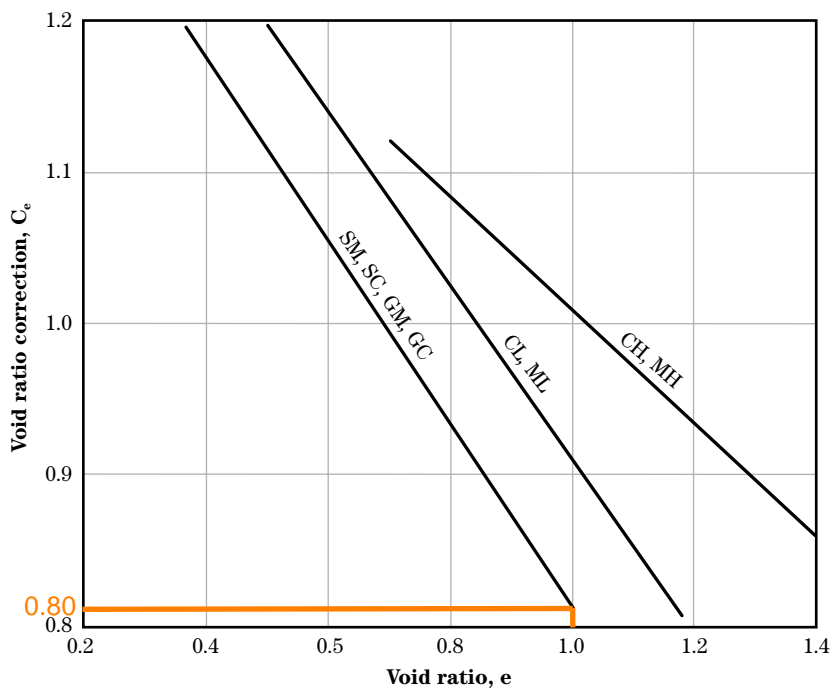
$$\tau_{va} = 0.75 C_r \quad (\text{eq. 8-32})$$

**Figure 8–21** Allowable shear stress for noncohesive soils



**Figure 8–22** Soil grain roughness for noncohesive soils



**Figure 8–23** Basic allowable shear stress for cohesive soils**Figure 8–24** Void ratio correction factor for cohesive soils

Channel Slope	Lining	Permissible Mean Channel Velocity* (ft/sec)
0 - 5%	Sodded grass	7
	Bermudagrass	6
	Reed canarygrass	5
	Tall fescue	5
	Kentucky bluegrass	5
	Grass-legume mixture	4
	Red fescue	2.5
	Redtop	2.5
	Sericea lespedeza	2.5
	Annual lespedeza	2.5
	Small grains (temporary)	2.5
5 - 10%	Sodded grass	6
	Bermudagrass	5
	Reed canarygrass	4
	Tall fescue	4
	Kentucky bluegrass	4

Channel Slope	Lining	Permissible Mean Channel Velocity* (ft/sec)
	Grass-legume mixture	3
Greater than 10%	Sodded grass	5
	Bermudagrass	4
	Reed canarygrass	3
	Tall fescue	3
	Kentucky bluegrass	3
*For highly erodible soils, decrease permissible velocities by 25%.		
*Grass lined channels are dependent upon assurances of continuous growth and maintenance of grass.		

**Table 8-3. Design parameters for naturalized channels**

Design Parameter	Design Value	Results East Channel	Results West Channel
Maximum 100-year depth outside of bankfull channel	5 ft	< than 5 ft	< than 5 ft
Roughness values Per Table 10-2 section e. (Channels not maintained, weeds and brush uncut for Dense weeds, high as flow depth)	0.05 to 0.12	0.6 to 1.0	0.6 to 1.0
Maximum 100-year velocity, main channel (within bankfull channel width) (ft/s)	3-4 ft/s	4.00 ft/s	4.00 ft/s
Froude No., 5-year, main channel (within bankfull channel width low Manning's n)	0.7	1.02	1.02
Froude No., 100-year, main channel (within bankfull channel width)	0.8	0.74	0.76 (1.01)*
Maximum Vegetal shear stress, 100-year, main channel (within bankfull channel width) <i>using shear retardance</i>	Class A: 7.50 lb/sq ft Class B: 5.73 lb/sq ft Class C: 4.20 lb/sq ft	2.63 lb/sq ft	2.43 lb/sq ft
Minimum bankfull capacity of bankfull channel (based on future development conditions)	70% of 2-year discharge or 10% of 100-yr discharge, whichever is greater	100% of 100-year	100% of 100-year
Maximum longitudinal slope of low flow channel (assuming lined, vegetated low flow channel)	0.20%	5.62%**	3.95%**
Maximum Overbank Side Slopes	4:1	4:1	4:1
Maximum Bankful Side Slopes	2.5:1	2.5:1	2.5:1
Minimum radius of curvature	2.5 times top width	Max Top W=140', Min R=350'	Max Top W=245', Min R=613'

\*critical water surface cross sections with proposed drop structure and stabilization

\*\*Slope is in the proposed condition but a product of the Existing condition as we are trying not to disturb well vegetated channels. A deviation is being requested.

**SUBMITTED  
VARIANCE**

**Unresolved:**

Identify deviations from County criteria and provide deviation request. (ECM 3.3.3, DCM Ch. 10, DCM Update 9.1... Approval of deviations is needed prior to further design revisions.



Figure 3

Figure 4



PHOTO LOCATION MAP



PP1 - DRAINAGE A, C-D UPLAND BREAK (LOOKING UPSTREAM FROM LAZOR POINT DRIVE)



PP1 - DRAINAGE A, C-D UPLAND BREAK (LOOKING DOWNSTREAM FROM LAZOR POINT DRIVE)



PP2 - DRAINAGE A, C-D UPLAND BREAK (LOOKING UPSTREAM FROM LAZOR POINT PRIVATE DRIVE)



PP2 - DRAINAGE A, C-D UPLAND BREAK (LOOKING DOWNSTREAM FROM LAZOR POINT PRIVATE DRIVE)



PP3 – WETLAND/CHANNEL B (FROM UPSTREAM END LOOKING SOUTH)



PP4 – WETLAND/CHANNEL B (LOOKING UPSTREAM)



PP4 – WETLAND/CHANNEL B (LOOKING DOWNSTREAM)



PP5– WETLAND/CHANNEL B (LOOKING UPSTREAM)



PP5– WETLAND/CHANNEL B (LOOKING DOWNSTREAM)



PP6– WETLAND/CHANNEL B (LOOKING UPSTREAM)



PP6– WETLAND/CHANNEL B (LOOKING DOWNSTREAM)



PP7– WETLAND/CHANNEL B (LOOKING UPSTREAM)



PP7 – WETLAND/CHANNEL B (LOOKING DOWNSTREAM)



PP8 – WETLAND/CHANNEL B (LOOKING UPSTREAM)



PP8 – WETLAND/CHANNEL B (LOOKING DOWNSTREAM)



PP9 – SITE OVERVIEW FROM SOUTHEAST CORNER (LOOKING WEST)



PP9 – SITE OVERVIEW FROM SOUTHEAST CORNER (LOOKING NORTH)



PP10 – SITE OVERVIEW FROM SOUTHWEST CORNER (LOOKING NORTH)



PP10 – SITE OVERVIEW FROM SOUTHWEST CORNER (LOOKING WEST)



PP11 – SITE OVERVIEW FROM NORTHWEST CORNER (LOOKING EAST)



PP11 – SITE OVERVIEW FROM NORTHWEST CORNER (LOOKING SOUTH)



PP12 – SITE OVERVIEW FROM NORTHEASTCORNER (LOOKING WEST)



PP12 – SITE OVERVIEW FROM NORTHEASTCORNER CORNER (LOOKING SOUTH)



SAMPLE POINT B1 – WETLAND PHOTO (LOOKING UPSTREAM)



SAMPLE POINT B1 – WETLAND PHOTO (LOOKING DOWNSTREAM)

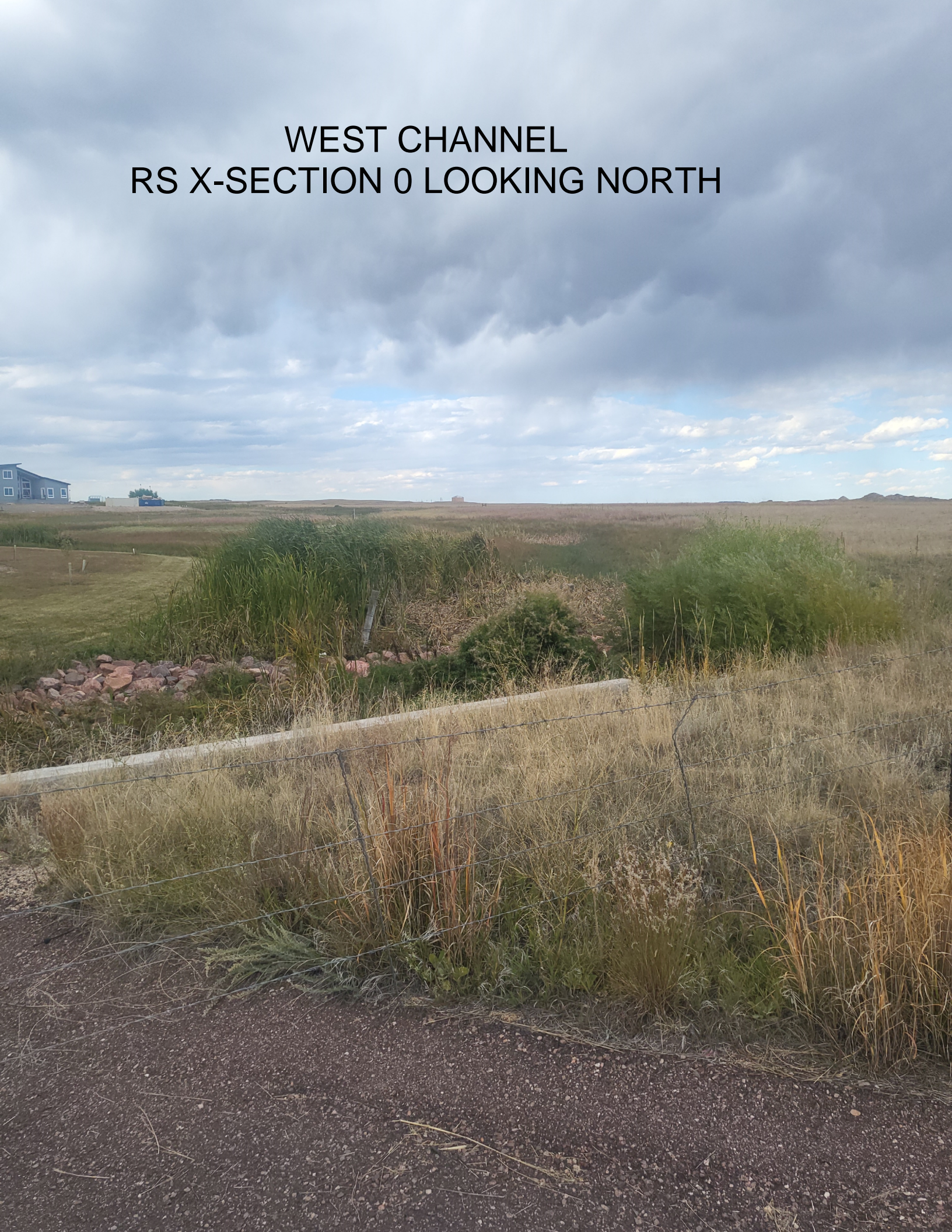


SAMPLE POINT B2 – WETLAND PHOTO (LOOKING UPSTREAM)



SAMPLE POINT B2 – WETLAND PHOTO (LOOKING DOWNSTREAM)

WEST CHANNEL  
RS X-SECTION 0 LOOKING NORTH



WEST CHANNEL  
RS X-SECTION 900 LOOKING SOUTH



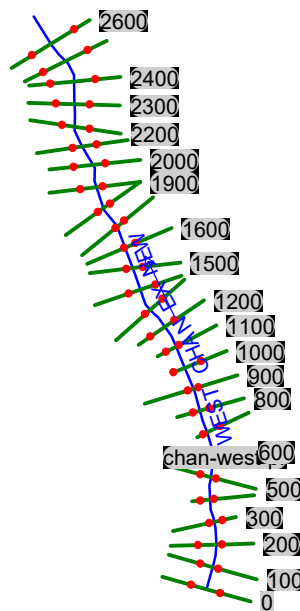
WEST CHANNEL  
RS X-SECTION 900 LOOKING EAST



WEST CHANNEL  
RS X-SECTION 1500 LOOKING NORTH



# WEST CHANNEL EXISTING CONDITIONS



# EXISTING WEST CHANNEL 100-Y

HEC-RAS Plan: Plan 02 River: WEST CHAN EX NEW Reach: chan-west-pr 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)	
chan-west-pr	2600	PF 1	219.00	6966.83	6967.84		6967.93	0.019536	2.37	92.25	162.38	0.56
chan-west-pr	2500	PF 1	219.00	6964.90	6965.81		6965.91	0.020926	2.59	84.70	138.14	0.58
chan-west-pr	2400	PF 1	219.00	6963.25	6964.30		6964.37	0.011755	2.09	104.95	153.17	0.44
chan-west-pr	2300	PF 1	219.00	6961.27	6962.39		6962.53	0.032804	2.97	73.77	137.42	0.71
chan-west-pr	2200	PF 1	219.00	6958.46	6959.82		6959.94	0.020694	2.71	80.96	127.03	0.59
chan-west-pr	2100	PF 1	219.00	6955.98	6957.62		6957.79	0.022265	3.35	65.40	75.74	0.64
chan-west-pr	2000	PF 1	219.00	6954.57	6956.26		6956.35	0.009751	2.37	92.24	96.35	0.43
chan-west-pr	1900	PF 1	219.00	6952.76	6954.54	6954.40	6954.71	0.032488	3.39	64.75	100.15	0.73
chan-west-pr	1800	PF 1	219.00	6949.31	6951.86		6952.07	0.021810	3.67	59.71	59.03	0.64
chan-west-pr	1700	PF 1	219.00	6947.11	6949.56		6949.84	0.022659	4.23	51.75	42.27	0.67
chan-west-pr	1600	PF 1	219.00	6945.84	6948.27		6948.40	0.009453	2.98	74.76	64.69	0.45
chan-west-pr	1500	PF 1	219.00	6944.91	6946.80		6946.99	0.023587	3.45	63.94	80.32	0.65
chan-west-pr	1400	PF 1	219.00	6943.78	6945.34		6945.42	0.010717	2.27	96.66	116.26	0.44
chan-west-pr	1300	PF 1	219.00	6942.19	6943.61		6943.79	0.027384	3.35	65.41	88.53	0.69
chan-west-pr	1200	PF 1	219.00	6940.78	6943.00		6943.03	0.003204	1.37	164.44	152.72	0.22
chan-west-pr	1100	PF 1	219.00	6940.72	6942.47		6942.54	0.008194	2.39	111.15	165.41	0.40
chan-west-pr	1000	PF 1	219.00	6939.66	6941.18		6941.25	0.022125	2.15	101.76	105.80	0.39
chan-west-pr	900	PF 1	219.00	6937.05	6938.51		6938.58	0.032181	2.55	119.86	247.82	0.46
chan-west-pr	800	PF 1	219.00	6934.82	6936.27		6936.32	0.016822	2.05	129.79	189.89	0.35
chan-west-pr	700	PF 1	219.00	6932.96	6934.27		6934.34	0.023433	2.23	111.48	157.10	0.40
chan-west-pr	600	PF 1	219.00	6930.96	6932.36		6932.40	0.015395	1.88	150.73	251.93	0.33
chan-west-pr	500	PF 1	219.00	6928.39	6929.89		6930.03	0.041420	3.02	75.24	90.48	0.53
chan-west-pr	400	PF 1	219.00	6924.96	6927.85	6926.99	6927.93	0.012549	2.22	106.06	92.44	0.31
chan-west-pr	300	PF 1	219.00	6923.02	6924.34	6924.34	6924.79	0.153741	5.37	40.78	45.95	1.01
chan-west-pr	200	PF 1	219.00	6919.08	6920.93		6920.98	0.009384	1.74	125.54	93.95	0.27
chan-west-pr	100	PF 1	219.00	6918.00	6920.46		6920.49	0.002988	1.31	171.12	102.93	0.16
chan-west-pr	0	PF 1	219.00	6918.00	6919.89	6919.12	6919.94	0.013006	1.71	127.72	125.43	0.30

# EXISTING WEST CHANNEL 100-Y

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 2600 Profile: PF 1

E.G. Elev (ft)	6967.93	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.09	Wt. n-Val.		0.060	
W.S. Elev (ft)	6967.84	Reach Len. (ft)	108.00	100.00	88.00
Crit W.S. (ft)		Flow Area (sq ft)		92.25	
E.G. Slope (ft/ft)	0.019536	Area (sq ft)		92.25	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	162.38	Top Width (ft)		162.38	
Vel Total (ft/s)	2.37	Avg. Vel. (ft/s)		2.37	
Max Chl Dpth (ft)	1.01	Hydr. Depth (ft)		0.57	
Conv. Total (cfs)	1566.9	Conv. (cfs)		1566.9	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		162.40	
Min Ch El (ft)	6966.83	Shear (lb/sq ft)		0.69	
Alpha	1.00	Stream Power (lb/ft s)		1.64	
Frctn Loss (ft)	2.02	Cum Volume (acre-ft)	0.37	5.02	0.38
C & E Loss (ft)	0.00	Cum SA (acres)	0.91	5.32	1.02

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 2500 Profile: PF 1

E.G. Elev (ft)	6965.91	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.10	Wt. n-Val.		0.060	
W.S. Elev (ft)	6965.81	Reach Len. (ft)	132.00	100.00	59.00
Crit W.S. (ft)		Flow Area (sq ft)		84.70	
E.G. Slope (ft/ft)	0.020926	Area (sq ft)		84.70	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	138.14	Top Width (ft)		138.14	
Vel Total (ft/s)	2.59	Avg. Vel. (ft/s)		2.59	
Max Chl Dpth (ft)	0.91	Hydr. Depth (ft)		0.61	
Conv. Total (cfs)	1513.9	Conv. (cfs)		1513.9	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		138.16	
Min Ch El (ft)	6964.90	Shear (lb/sq ft)		0.80	
Alpha	1.00	Stream Power (lb/ft s)		2.07	
Frctn Loss (ft)	1.54	Cum Volume (acre-ft)	0.37	4.82	0.38
C & E Loss (ft)	0.01	Cum SA (acres)	0.91	4.98	1.02

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 2400 Profile: PF 1

E.G. Elev (ft)	6964.37	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.07	Wt. n-Val.		0.060	
W.S. Elev (ft)	6964.30	Reach Len. (ft)	113.00	100.00	91.00
Crit W.S. (ft)		Flow Area (sq ft)		104.95	
E.G. Slope (ft/ft)	0.011755	Area (sq ft)		104.95	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	153.17	Top Width (ft)		153.17	
Vel Total (ft/s)	2.09	Avg. Vel. (ft/s)		2.09	
Max Chl Dpth (ft)	1.05	Hydr. Depth (ft)		0.69	
Conv. Total (cfs)	2019.9	Conv. (cfs)		2019.9	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		153.19	
Min Ch El (ft)	6963.25	Shear (lb/sq ft)		0.50	
Alpha	1.00	Stream Power (lb/ft s)		1.05	
Frctn Loss (ft)	1.84	Cum Volume (acre-ft)	0.37	4.60	0.38
C & E Loss (ft)	0.01	Cum SA (acres)	0.91	4.64	1.02

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 2300 Profile: PF 1

E.G. Elev (ft)	6962.53	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.14	Wt. n-Val.		0.060	0.000
W.S. Elev (ft)	6962.39	Reach Len. (ft)	107.00	100.00	97.00
Crit W.S. (ft)		Flow Area (sq ft)		73.76	0.00
E.G. Slope (ft/ft)	0.032804	Area (sq ft)		73.76	0.00
Q Total (cfs)	219.00	Flow (cfs)		219.00	0.00

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 2300 Profile: PF 1 (Continued)

Top Width (ft)	137.42	Top Width (ft)		136.89	0.53
Vel Total (ft/s)	2.97	Avg. Vel. (ft/s)		2.97	0.18
Max Chl Dpth (ft)	1.12	Hydr. Depth (ft)		0.54	0.01
Conv. Total (cfs)	1209.1	Conv. (cfs)		1209.1	0.0
Length Wtd. (ft)	100.00	Wetted Per. (ft)		136.98	0.53
Min Ch El (ft)	6961.27	Shear (lb/sq ft)		1.10	
Alpha	1.00	Stream Power (lb/ft s)		3.27	
Frctn Loss (ft)	2.57	Cum Volume (acre-ft)	0.37	4.40	0.38
C & E Loss (ft)	0.01	Cum SA (acres)	0.91	4.31	1.02

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 2200 Profile: PF 1

E.G. Elev (ft)	6959.94	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.11	Wt. n-Val.	0.060	0.060	0.060
W.S. Elev (ft)	6959.82	Reach Len. (ft)	74.00	100.00	110.00
Crit W.S. (ft)		Flow Area (sq ft)	0.12	80.80	0.04
E.G. Slope (ft/ft)	0.020694	Area (sq ft)	0.12	80.80	0.04
Q Total (cfs)	219.00	Flow (cfs)	0.05	218.94	0.01
Top Width (ft)	127.03	Top Width (ft)	3.52	121.67	1.84
Vel Total (ft/s)	2.70	Avg. Vel. (ft/s)	0.38	2.71	0.28
Max Chl Dpth (ft)	1.36	Hydr. Depth (ft)	0.03	0.66	0.02
Conv. Total (cfs)	1522.4	Conv. (cfs)	0.3	1522.0	0.1
Length Wtd. (ft)	100.00	Wetted Per. (ft)	3.52	121.81	1.85
Min Ch El (ft)	6958.46	Shear (lb/sq ft)	0.04	0.86	0.03
Alpha	1.00	Stream Power (lb/ft s)	0.02	2.32	0.01
Frctn Loss (ft)	2.15	Cum Volume (acre-ft)	0.37	4.22	0.38
C & E Loss (ft)	0.01	Cum SA (acres)	0.90	4.01	1.01

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 2100 Profile: PF 1

E.G. Elev (ft)	6957.79	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.17	Wt. n-Val.		0.060	
W.S. Elev (ft)	6957.62	Reach Len. (ft)	92.00	100.00	83.00
Crit W.S. (ft)		Flow Area (sq ft)		65.40	
E.G. Slope (ft/ft)	0.022265	Area (sq ft)		65.40	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	75.74	Top Width (ft)		75.74	
Vel Total (ft/s)	3.35	Avg. Vel. (ft/s)		3.35	
Max Chl Dpth (ft)	1.64	Hydr. Depth (ft)		0.86	
Conv. Total (cfs)	1467.7	Conv. (cfs)		1467.7	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		75.82	
Min Ch El (ft)	6955.98	Shear (lb/sq ft)		1.20	
Alpha	1.00	Stream Power (lb/ft s)		4.02	
Frctn Loss (ft)	1.41	Cum Volume (acre-ft)	0.36	4.05	0.38
C & E Loss (ft)	0.03	Cum SA (acres)	0.90	3.79	1.01

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 2000 Profile: PF 1

E.G. Elev (ft)	6956.35	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.09	Wt. n-Val.		0.060	
W.S. Elev (ft)	6956.26	Reach Len. (ft)	101.00	100.00	102.00
Crit W.S. (ft)		Flow Area (sq ft)		92.24	
E.G. Slope (ft/ft)	0.009751	Area (sq ft)		92.24	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	96.35	Top Width (ft)		96.35	
Vel Total (ft/s)	2.37	Avg. Vel. (ft/s)		2.37	
Max Chl Dpth (ft)	1.69	Hydr. Depth (ft)		0.96	
Conv. Total (cfs)	2217.7	Conv. (cfs)		2217.7	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		96.43	
Min Ch El (ft)	6954.57	Shear (lb/sq ft)		0.58	

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 2000 Profile: PF 1 (Continued)

Alpha	1.00	Stream Power (lb/ft s)		1.38	
Frctn Loss (ft)	1.63	Cum Volume (acre-ft)	0.36	3.87	0.38
C & E Loss (ft)	0.01	Cum SA (acres)	0.90	3.59	1.01

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 1900 Profile: PF 1

E.G. Elev (ft)	6954.71	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.18	Wt. n-Val.		0.060	0.060
W.S. Elev (ft)	6954.54	Reach Len. (ft)	81.00	100.00	134.00
Crit W.S. (ft)	6954.40	Flow Area (sq ft)		64.40	0.35
E.G. Slope (ft/ft)	0.032488	Area (sq ft)		64.40	0.35
Q Total (cfs)	219.00	Flow (cfs)		218.65	0.35
Top Width (ft)	100.15	Top Width (ft)		96.95	3.20
Vel Total (ft/s)	3.38	Avg. Vel. (ft/s)		3.39	1.01
Max Chl Dpth (ft)	1.78	Hydr. Depth (ft)		0.66	0.11
Conv. Total (cfs)	1215.0	Conv. (cfs)		1213.1	1.9
Length Wtd. (ft)	100.03	Wetted Per. (ft)		97.10	3.21
Min Ch El (ft)	6952.76	Shear (lb/sq ft)		1.35	0.22
Alpha	1.01	Stream Power (lb/ft s)		4.57	0.22
Frctn Loss (ft)	2.64	Cum Volume (acre-ft)	0.36	3.69	0.38
C & E Loss (ft)	0.00	Cum SA (acres)	0.90	3.37	1.01

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 1800 Profile: PF 1

E.G. Elev (ft)	6952.07	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.21	Wt. n-Val.		0.060	
W.S. Elev (ft)	6951.86	Reach Len. (ft)	97.00	100.00	124.00
Crit W.S. (ft)		Flow Area (sq ft)		59.71	
E.G. Slope (ft/ft)	0.021810	Area (sq ft)		59.71	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	59.03	Top Width (ft)		59.03	
Vel Total (ft/s)	3.67	Avg. Vel. (ft/s)		3.67	
Max Chl Dpth (ft)	2.55	Hydr. Depth (ft)		1.01	
Conv. Total (cfs)	1482.9	Conv. (cfs)		1482.9	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		59.46	
Min Ch El (ft)	6949.31	Shear (lb/sq ft)		1.37	
Alpha	1.00	Stream Power (lb/ft s)		5.01	
Frctn Loss (ft)	2.22	Cum Volume (acre-ft)	0.36	3.55	0.37
C & E Loss (ft)	0.01	Cum SA (acres)	0.90	3.19	1.00

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 1700 Profile: PF 1

E.G. Elev (ft)	6949.84	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.28	Wt. n-Val.		0.060	
W.S. Elev (ft)	6949.56	Reach Len. (ft)	110.00	100.00	96.00
Crit W.S. (ft)		Flow Area (sq ft)		51.75	
E.G. Slope (ft/ft)	0.022659	Area (sq ft)		51.75	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	42.27	Top Width (ft)		42.27	
Vel Total (ft/s)	4.23	Avg. Vel. (ft/s)		4.23	
Max Chl Dpth (ft)	2.45	Hydr. Depth (ft)		1.22	
Conv. Total (cfs)	1454.9	Conv. (cfs)		1454.9	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		42.79	
Min Ch El (ft)	6947.11	Shear (lb/sq ft)		1.71	
Alpha	1.00	Stream Power (lb/ft s)		7.24	
Frctn Loss (ft)	1.40	Cum Volume (acre-ft)	0.36	3.42	0.37
C & E Loss (ft)	0.04	Cum SA (acres)	0.90	3.07	1.00

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 1600 Profile: PF 1

E.G. Elev (ft)	6948.40	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.14	Wt. n-Val.	0.060	0.060	0.060
W.S. Elev (ft)	6948.27	Reach Len. (ft)	109.00	100.00	92.00
Crit W.S. (ft)		Flow Area (sq ft)	0.27	73.21	1.28
E.G. Slope (ft/ft)	0.009453	Area (sq ft)	0.27	73.21	1.28
Q Total (cfs)	219.00	Flow (cfs)	0.14	218.02	0.84
Top Width (ft)	64.69	Top Width (ft)	2.67	53.00	9.02
Vel Total (ft/s)	2.93	Avg. Vel. (ft/s)	0.53	2.98	0.65
Max Chl Dpth (ft)	2.43	Hydr. Depth (ft)	0.10	1.38	0.14
Conv. Total (cfs)	2252.4	Conv. (cfs)	1.5	2242.4	8.6
Length Wtd. (ft)	99.99	Wetted Per. (ft)	2.68	53.22	9.03
Min Ch El (ft)	6945.84	Shear (lb/sq ft)	0.06	0.81	0.08
Alpha	1.03	Stream Power (lb/ft s)	0.03	2.42	0.05
Frctn Loss (ft)	1.42	Cum Volume (acre-ft)	0.36	3.28	0.37
C & E Loss (ft)	0.00	Cum SA (acres)	0.89	2.96	0.99

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 1500 Profile: PF 1

E.G. Elev (ft)	6946.99	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.18	Wt. n-Val.	0.060	0.060	0.060
W.S. Elev (ft)	6946.80	Reach Len. (ft)	95.00	100.00	109.00
Crit W.S. (ft)		Flow Area (sq ft)	0.26	63.27	0.41
E.G. Slope (ft/ft)	0.023587	Area (sq ft)	0.26	63.27	0.41
Q Total (cfs)	219.00	Flow (cfs)	0.19	218.48	0.33
Top Width (ft)	80.32	Top Width (ft)	3.09	73.00	4.22
Vel Total (ft/s)	3.42	Avg. Vel. (ft/s)	0.74	3.45	0.80
Max Chl Dpth (ft)	1.89	Hydr. Depth (ft)	0.09	0.87	0.10
Conv. Total (cfs)	1426.0	Conv. (cfs)	1.3	1422.5	2.1
Length Wtd. (ft)	100.00	Wetted Per. (ft)	3.10	73.14	4.23
Min Ch El (ft)	6944.91	Shear (lb/sq ft)	0.13	1.27	0.14
Alpha	1.01	Stream Power (lb/ft s)	0.09	4.40	0.11
Frctn Loss (ft)	1.53	Cum Volume (acre-ft)	0.36	3.12	0.37
C & E Loss (ft)	0.03	Cum SA (acres)	0.89	2.82	0.98

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 1400 Profile: PF 1

E.G. Elev (ft)	6945.42	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.08	Wt. n-Val.		0.060	
W.S. Elev (ft)	6945.34	Reach Len. (ft)	69.00	100.00	114.80
Crit W.S. (ft)		Flow Area (sq ft)		96.66	
E.G. Slope (ft/ft)	0.010717	Area (sq ft)		96.66	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	116.26	Top Width (ft)		116.26	
Vel Total (ft/s)	2.27	Avg. Vel. (ft/s)		2.27	
Max Chl Dpth (ft)	1.56	Hydr. Depth (ft)		0.83	
Conv. Total (cfs)	2115.5	Conv. (cfs)		2115.5	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		116.35	
Min Ch El (ft)	6943.78	Shear (lb/sq ft)		0.56	
Alpha	1.00	Stream Power (lb/ft s)		1.26	
Frctn Loss (ft)	1.62	Cum Volume (acre-ft)	0.36	2.94	0.37
C & E Loss (ft)	0.01	Cum SA (acres)	0.88	2.60	0.97

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 1300 Profile: PF 1

E.G. Elev (ft)	6943.79	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.17	Wt. n-Val.		0.060	
W.S. Elev (ft)	6943.61	Reach Len. (ft)	108.00	100.00	101.00
Crit W.S. (ft)		Flow Area (sq ft)		65.41	
E.G. Slope (ft/ft)	0.027384	Area (sq ft)		65.41	
Q Total (cfs)	219.00	Flow (cfs)		219.00	

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 1300 Profile: PF 1 (Continued)

Top Width (ft)	88.53	Top Width (ft)		88.53	
Vel Total (ft/s)	3.35	Avg. Vel. (ft/s)		3.35	
Max Chl Dpth (ft)	1.42	Hydr. Depth (ft)		0.74	
Conv. Total (cfs)	1323.4	Conv. (cfs)		1323.4	
Length Wtd. (ft)	100.06	Wetted Per. (ft)		88.60	
Min Ch El (ft)	6942.19	Shear (lb/sq ft)		1.26	
Alpha	1.00	Stream Power (lb/ft s)		4.23	
Frctn Loss (ft)	0.71	Cum Volume (acre-ft)	0.36	2.75	0.37
C & E Loss (ft)	0.04	Cum SA (acres)	0.88	2.37	0.97

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 1200 Profile: PF 1

E.G. Elev (ft)	6943.03	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.03	Wt. n-Val.	0.060	0.070	0.060
W.S. Elev (ft)	6943.00	Reach Len. (ft)	110.00	100.00	95.00
Crit W.S. (ft)		Flow Area (sq ft)	3.97	154.69	5.78
E.G. Slope (ft/ft)	0.003204	Area (sq ft)	3.97	154.69	5.78
Q Total (cfs)	219.00	Flow (cfs)	2.68	211.81	4.51
Top Width (ft)	152.72	Top Width (ft)	11.86	127.00	13.86
Vel Total (ft/s)	1.33	Avg. Vel. (ft/s)	0.68	1.37	0.78
Max Chl Dpth (ft)	2.22	Hydr. Depth (ft)	0.33	1.22	0.42
Conv. Total (cfs)	3868.7	Conv. (cfs)	47.4	3741.6	79.7
Length Wtd. (ft)	100.85	Wetted Per. (ft)	11.88	127.18	13.88
Min Ch El (ft)	6940.78	Shear (lb/sq ft)	0.07	0.24	0.08
Alpha	1.03	Stream Power (lb/ft s)	0.05	0.33	0.07
Frctn Loss (ft)	0.49	Cum Volume (acre-ft)	0.36	2.50	0.36
C & E Loss (ft)	0.00	Cum SA (acres)	0.87	2.12	0.96

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 1100 Profile: PF 1

E.G. Elev (ft)	6942.54	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.07	Wt. n-Val.	0.060	0.060	0.060
W.S. Elev (ft)	6942.47	Reach Len. (ft)	119.00	100.00	95.00
Crit W.S. (ft)		Flow Area (sq ft)	31.32	70.48	9.35
E.G. Slope (ft/ft)	0.008194	Area (sq ft)	31.32	70.48	9.35
Q Total (cfs)	219.00	Flow (cfs)	41.51	168.36	9.13
Top Width (ft)	165.41	Top Width (ft)	68.91	64.00	32.49
Vel Total (ft/s)	1.97	Avg. Vel. (ft/s)	1.33	2.39	0.98
Max Chl Dpth (ft)	1.74	Hydr. Depth (ft)	0.45	1.10	0.29
Conv. Total (cfs)	2419.3	Conv. (cfs)	458.5	1859.9	100.9
Length Wtd. (ft)	101.70	Wetted Per. (ft)	68.93	64.07	32.50
Min Ch El (ft)	6940.72	Shear (lb/sq ft)	0.23	0.56	0.15
Alpha	1.23	Stream Power (lb/ft s)	0.31	1.34	0.14
Frctn Loss (ft)	1.29	Cum Volume (acre-ft)	0.31	2.24	0.35
C & E Loss (ft)	0.00	Cum SA (acres)	0.77	1.90	0.91

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 1000 Profile: PF 1

E.G. Elev (ft)	6941.25	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.07	Wt. n-Val.		0.100	
W.S. Elev (ft)	6941.18	Reach Len. (ft)	114.00	100.00	102.00
Crit W.S. (ft)		Flow Area (sq ft)		101.76	
E.G. Slope (ft/ft)	0.022125	Area (sq ft)		101.76	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	105.80	Top Width (ft)		105.80	
Vel Total (ft/s)	2.15	Avg. Vel. (ft/s)		2.15	
Max Chl Dpth (ft)	1.52	Hydr. Depth (ft)		0.96	
Conv. Total (cfs)	1472.3	Conv. (cfs)		1472.3	
Length Wtd. (ft)	100.62	Wetted Per. (ft)		105.92	
Min Ch El (ft)	6939.66	Shear (lb/sq ft)		1.33	

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 1000 Profile: PF 1 (Continued)

Alpha	1.00	Stream Power (lb/ft s)		2.86	
Frctn Loss (ft)	2.66	Cum Volume (acre-ft)	0.27	2.04	0.34
C & E Loss (ft)	0.00	Cum SA (acres)	0.67	1.70	0.87

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 900 Profile: PF 1

E.G. Elev (ft)	6938.58	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.07	Wt. n-Val.	0.100	0.100	0.100
W.S. Elev (ft)	6938.51	Reach Len. (ft)	102.00	100.00	99.00
Crit W.S. (ft)		Flow Area (sq ft)	5.00	45.00	69.86
E.G. Slope (ft/ft)	0.032181	Area (sq ft)	5.00	45.00	69.86
Q Total (cfs)	219.00	Flow (cfs)	5.35	114.64	99.02
Top Width (ft)	247.82	Top Width (ft)	19.70	48.00	180.12
Vel Total (ft/s)	1.83	Avg. Vel. (ft/s)	1.07	2.55	1.42
Max Chl Dpth (ft)	1.46	Hydr. Depth (ft)	0.25	0.94	0.39
Conv. Total (cfs)	1220.8	Conv. (cfs)	29.8	639.0	552.0
Length Wtd. (ft)	99.82	Wetted Per. (ft)	19.71	48.17	180.16
Min Ch El (ft)	6937.05	Shear (lb/sq ft)	0.51	1.88	0.78
Alpha	1.30	Stream Power (lb/ft s)	0.55	4.78	1.10
Frctn Loss (ft)	2.26	Cum Volume (acre-ft)	0.26	1.88	0.26
C & E Loss (ft)	0.00	Cum SA (acres)	0.65	1.53	0.66

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 800 Profile: PF 1

E.G. Elev (ft)	6936.32	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.05	Wt. n-Val.	0.100	0.100	0.100
W.S. Elev (ft)	6936.27	Reach Len. (ft)	92.00	100.00	105.00
Crit W.S. (ft)		Flow Area (sq ft)	17.86	81.23	30.70
E.G. Slope (ft/ft)	0.016822	Area (sq ft)	17.86	81.23	30.70
Q Total (cfs)	219.00	Flow (cfs)	20.07	166.58	32.35
Top Width (ft)	189.89	Top Width (ft)	40.10	74.00	75.79
Vel Total (ft/s)	1.69	Avg. Vel. (ft/s)	1.12	2.05	1.05
Max Chl Dpth (ft)	1.44	Hydr. Depth (ft)	0.45	1.10	0.41
Conv. Total (cfs)	1688.5	Conv. (cfs)	154.7	1284.4	249.5
Length Wtd. (ft)	99.78	Wetted Per. (ft)	40.11	74.01	75.92
Min Ch El (ft)	6934.82	Shear (lb/sq ft)	0.47	1.15	0.42
Alpha	1.22	Stream Power (lb/ft s)	0.53	2.36	0.45
Frctn Loss (ft)	1.97	Cum Volume (acre-ft)	0.24	1.73	0.14
C & E Loss (ft)	0.00	Cum SA (acres)	0.58	1.39	0.37

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 700 Profile: PF 1

E.G. Elev (ft)	6934.34	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.07	Wt. n-Val.	0.100	0.100	0.100
W.S. Elev (ft)	6934.27	Reach Len. (ft)	123.00	100.00	93.00
Crit W.S. (ft)		Flow Area (sq ft)	16.55	79.73	15.20
E.G. Slope (ft/ft)	0.023433	Area (sq ft)	16.55	79.73	15.20
Q Total (cfs)	219.00	Flow (cfs)	23.21	177.99	17.81
Top Width (ft)	157.10	Top Width (ft)	34.17	82.00	40.93
Vel Total (ft/s)	1.96	Avg. Vel. (ft/s)	1.40	2.23	1.17
Max Chl Dpth (ft)	1.31	Hydr. Depth (ft)	0.48	0.97	0.37
Conv. Total (cfs)	1430.7	Conv. (cfs)	151.6	1162.7	116.3
Length Wtd. (ft)	103.16	Wetted Per. (ft)	34.19	82.01	41.11
Min Ch El (ft)	6932.96	Shear (lb/sq ft)	0.71	1.42	0.54
Alpha	1.13	Stream Power (lb/ft s)	0.99	3.17	0.63
Frctn Loss (ft)	1.94	Cum Volume (acre-ft)	0.20	1.55	0.09
C & E Loss (ft)	0.01	Cum SA (acres)	0.50	1.21	0.23

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 600 Profile: PF 1

E.G. Elev (ft)	6932.40	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.04	Wt. n-Val.	0.100	0.100	0.100
W.S. Elev (ft)	6932.36	Reach Len. (ft)	106.00	100.00	82.00
Crit W.S. (ft)		Flow Area (sq ft)	51.16	73.05	26.53
E.G. Slope (ft/ft)	0.015395	Area (sq ft)	51.16	73.05	26.53
Q Total (cfs)	219.00	Flow (cfs)	51.63	137.23	30.14
Top Width (ft)	251.93	Top Width (ft)	126.26	71.00	54.67
Vel Total (ft/s)	1.45	Avg. Vel. (ft/s)	1.01	1.88	1.14
Max Chl Dpth (ft)	1.40	Hydr. Depth (ft)	0.41	1.03	0.49
Conv. Total (cfs)	1765.1	Conv. (cfs)	416.2	1106.0	242.9
Length Wtd. (ft)	99.43	Wetted Per. (ft)	126.30	71.02	54.84
Min Ch El (ft)	6930.96	Shear (lb/sq ft)	0.39	0.99	0.46
Alpha	1.25	Stream Power (lb/ft s)	0.39	1.86	0.53
Frctn Loss (ft)	2.36	Cum Volume (acre-ft)	0.11	1.37	0.04
C & E Loss (ft)	0.01	Cum SA (acres)	0.27	1.03	0.13

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 500 Profile: PF 1

E.G. Elev (ft)	6930.03	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.14	Wt. n-Val.	0.100	0.100	0.100
W.S. Elev (ft)	6929.89	Reach Len. (ft)	91.00	100.00	115.00
Crit W.S. (ft)		Flow Area (sq ft)	2.45	70.91	1.88
E.G. Slope (ft/ft)	0.041420	Area (sq ft)	2.45	70.91	1.88
Q Total (cfs)	219.00	Flow (cfs)	2.83	214.18	1.98
Top Width (ft)	90.48	Top Width (ft)	10.32	71.00	9.16
Vel Total (ft/s)	2.91	Avg. Vel. (ft/s)	1.16	3.02	1.05
Max Chl Dpth (ft)	1.50	Hydr. Depth (ft)	0.24	1.00	0.21
Conv. Total (cfs)	1076.1	Conv. (cfs)	13.9	1052.4	9.7
Length Wtd. (ft)	99.82	Wetted Per. (ft)	10.33	71.04	9.17
Min Ch El (ft)	6928.39	Shear (lb/sq ft)	0.61	2.58	0.53
Alpha	1.06	Stream Power (lb/ft s)	0.71	7.80	0.56
Frctn Loss (ft)	2.08	Cum Volume (acre-ft)	0.04	1.20	0.02
C & E Loss (ft)	0.02	Cum SA (acres)	0.11	0.87	0.07

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 400 Profile: PF 1

E.G. Elev (ft)	6927.93	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.07	Wt. n-Val.	0.100	0.100	0.100
W.S. Elev (ft)	6927.85	Reach Len. (ft)	172.00	100.00	180.00
Crit W.S. (ft)	6926.99	Flow Area (sq ft)	11.20	93.39	1.48
E.G. Slope (ft/ft)	0.012549	Area (sq ft)	11.20	93.39	1.48
Q Total (cfs)	219.00	Flow (cfs)	10.71	207.39	0.90
Top Width (ft)	92.44	Top Width (ft)	25.67	60.00	6.76
Vel Total (ft/s)	2.06	Avg. Vel. (ft/s)	0.96	2.22	0.60
Max Chl Dpth (ft)	2.89	Hydr. Depth (ft)	0.44	1.56	0.22
Conv. Total (cfs)	1955.0	Conv. (cfs)	95.6	1851.4	8.0
Length Wtd. (ft)	101.92	Wetted Per. (ft)	25.69	60.60	6.78
Min Ch El (ft)	6924.96	Shear (lb/sq ft)	0.34	1.21	0.17
Alpha	1.11	Stream Power (lb/ft s)	0.33	2.68	0.10
Frctn Loss (ft)	3.10	Cum Volume (acre-ft)	0.03	1.02	0.01
C & E Loss (ft)	0.04	Cum SA (acres)	0.07	0.72	0.05

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 300 Profile: PF 1

E.G. Elev (ft)	6924.79	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.45	Wt. n-Val.		0.100	
W.S. Elev (ft)	6924.34	Reach Len. (ft)	106.00	100.00	108.00
Crit W.S. (ft)	6924.34	Flow Area (sq ft)		40.78	
E.G. Slope (ft/ft)	0.153741	Area (sq ft)		40.78	
Q Total (cfs)	219.00	Flow (cfs)		219.00	

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 300 Profile: PF 1 (Continued)

Top Width (ft)	45.95	Top Width (ft)		45.95	
Vel Total (ft/s)	5.37	Avg. Vel. (ft/s)		5.37	
Max Chl Dpth (ft)	1.32	Hydr. Depth (ft)		0.89	
Conv. Total (cfs)	558.5	Conv. (cfs)		558.5	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		46.07	
Min Ch El (ft)	6923.02	Shear (lb/sq ft)		8.49	
Alpha	1.00	Stream Power (lb/ft s)		45.62	
Frctn Loss (ft)	2.41	Cum Volume (acre-ft)	0.00	0.86	0.01
C & E Loss (ft)	0.12	Cum SA (acres)	0.02	0.60	0.03

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 200 Profile: PF 1

E.G. Elev (ft)	6920.98	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.05	Wt. n-Val.		0.100	
W.S. Elev (ft)	6920.93	Reach Len. (ft)	81.00	100.00	107.00
Crit W.S. (ft)		Flow Area (sq ft)		125.54	
E.G. Slope (ft/ft)	0.009384	Area (sq ft)		125.54	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	93.95	Top Width (ft)		93.95	
Vel Total (ft/s)	1.74	Avg. Vel. (ft/s)		1.74	
Max Chl Dpth (ft)	1.85	Hydr. Depth (ft)		1.34	
Conv. Total (cfs)	2260.7	Conv. (cfs)		2260.7	
Length Wtd. (ft)	99.99	Wetted Per. (ft)		94.10	
Min Ch El (ft)	6919.08	Shear (lb/sq ft)		0.78	
Alpha	1.00	Stream Power (lb/ft s)		1.36	
Frctn Loss (ft)	0.49	Cum Volume (acre-ft)	0.00	0.67	0.01
C & E Loss (ft)	0.01	Cum SA (acres)	0.02	0.44	0.03

Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 100 Profile: PF 1

E.G. Elev (ft)	6920.49	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.03	Wt. n-Val.	0.100	0.100	0.100
W.S. Elev (ft)	6920.46	Reach Len. (ft)	101.00	100.00	107.00
Crit W.S. (ft)		Flow Area (sq ft)	2.16	165.86	3.09
E.G. Slope (ft/ft)	0.002988	Area (sq ft)	2.16	165.86	3.09
Q Total (cfs)	219.00	Flow (cfs)	0.69	217.37	0.94
Top Width (ft)	102.93	Top Width (ft)	8.80	80.70	13.44
Vel Total (ft/s)	1.28	Avg. Vel. (ft/s)	0.32	1.31	0.30
Max Chl Dpth (ft)	2.46	Hydr. Depth (ft)	0.25	2.06	0.23
Conv. Total (cfs)	4006.3	Conv. (cfs)	12.6	3976.4	17.3
Length Wtd. (ft)	100.02	Wetted Per. (ft)	8.81	80.93	13.44
Min Ch El (ft)	6918.00	Shear (lb/sq ft)	0.05	0.38	0.04
Alpha	1.04	Stream Power (lb/ft s)	0.01	0.50	0.01
Frctn Loss (ft)	0.55	Cum Volume (acre-ft)	0.00	0.34	0.00
C & E Loss (ft)	0.00	Cum SA (acres)	0.01	0.24	0.02

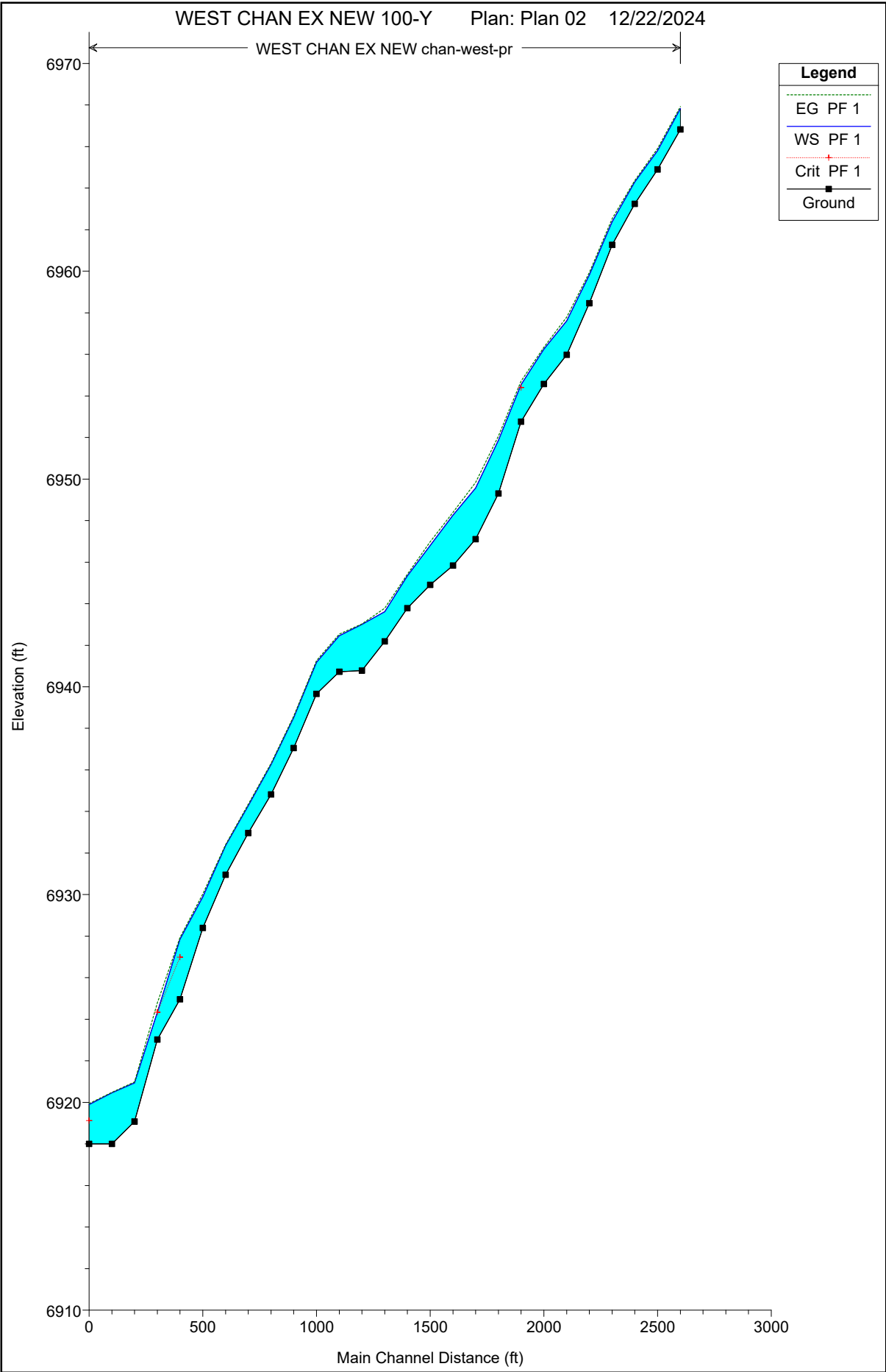
Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 0 Profile: PF 1

E.G. Elev (ft)	6919.94	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.05	Wt. n-Val.		0.100	
W.S. Elev (ft)	6919.89	Reach Len. (ft)			
Crit W.S. (ft)	6919.12	Flow Area (sq ft)		127.72	
E.G. Slope (ft/ft)	0.013006	Area (sq ft)		127.72	
Q Total (cfs)	219.00	Flow (cfs)		219.00	
Top Width (ft)	125.43	Top Width (ft)		125.43	
Vel Total (ft/s)	1.71	Avg. Vel. (ft/s)		1.71	
Max Chl Dpth (ft)	1.89	Hydr. Depth (ft)		1.02	
Conv. Total (cfs)	1920.3	Conv. (cfs)		1920.3	
Length Wtd. (ft)		Wetted Per. (ft)		125.49	
Min Ch El (ft)	6918.00	Shear (lb/sq ft)		0.83	

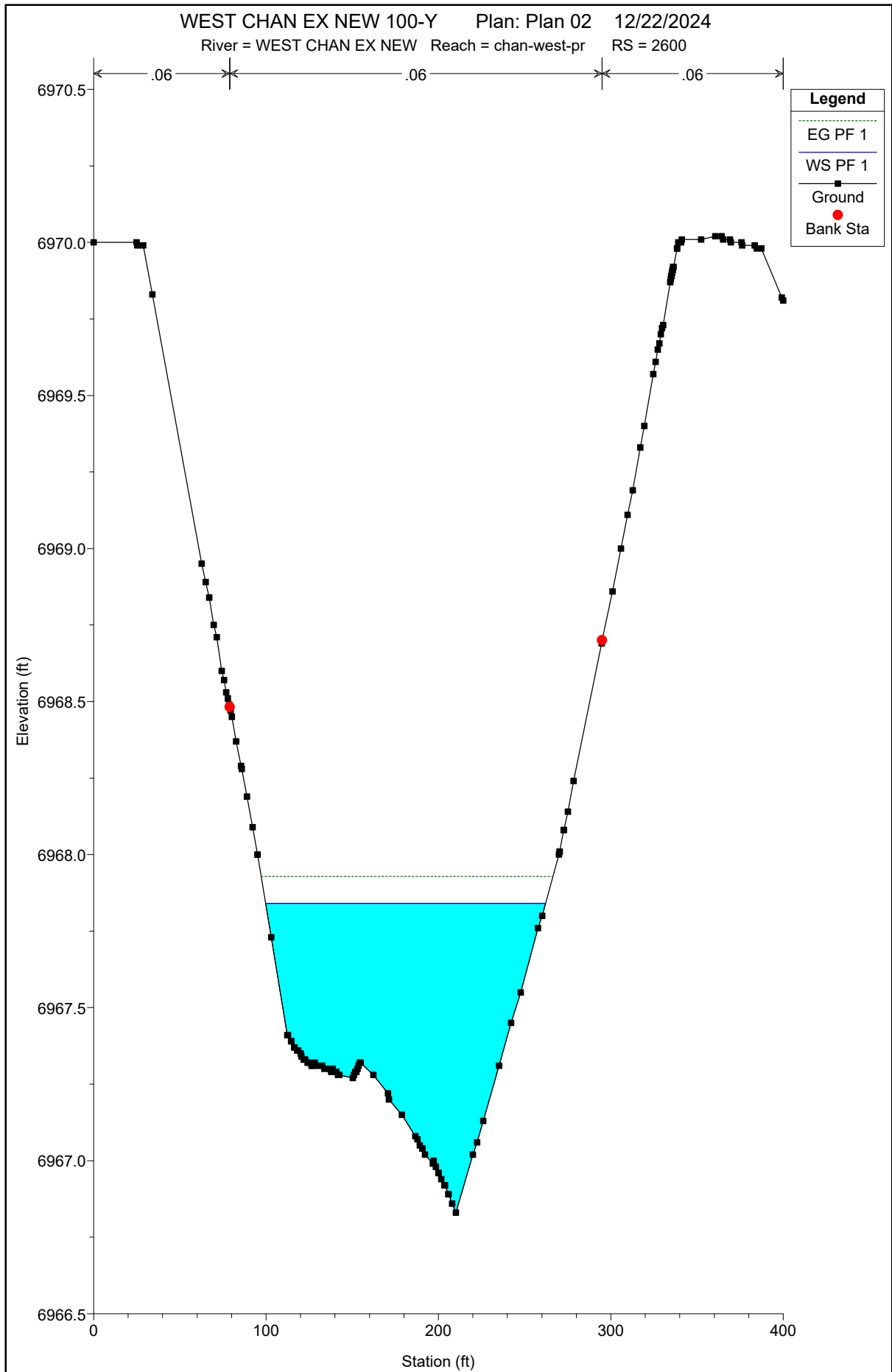
Plan: Plan 02 WEST CHAN EX NEW chan-west-pr RS: 0 Profile: PF 1 (Continued)

Alpha	1.00	Stream Power (lb/ft s)		1.42	
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			

# EXISTING WEST CHANNEL 100-Y

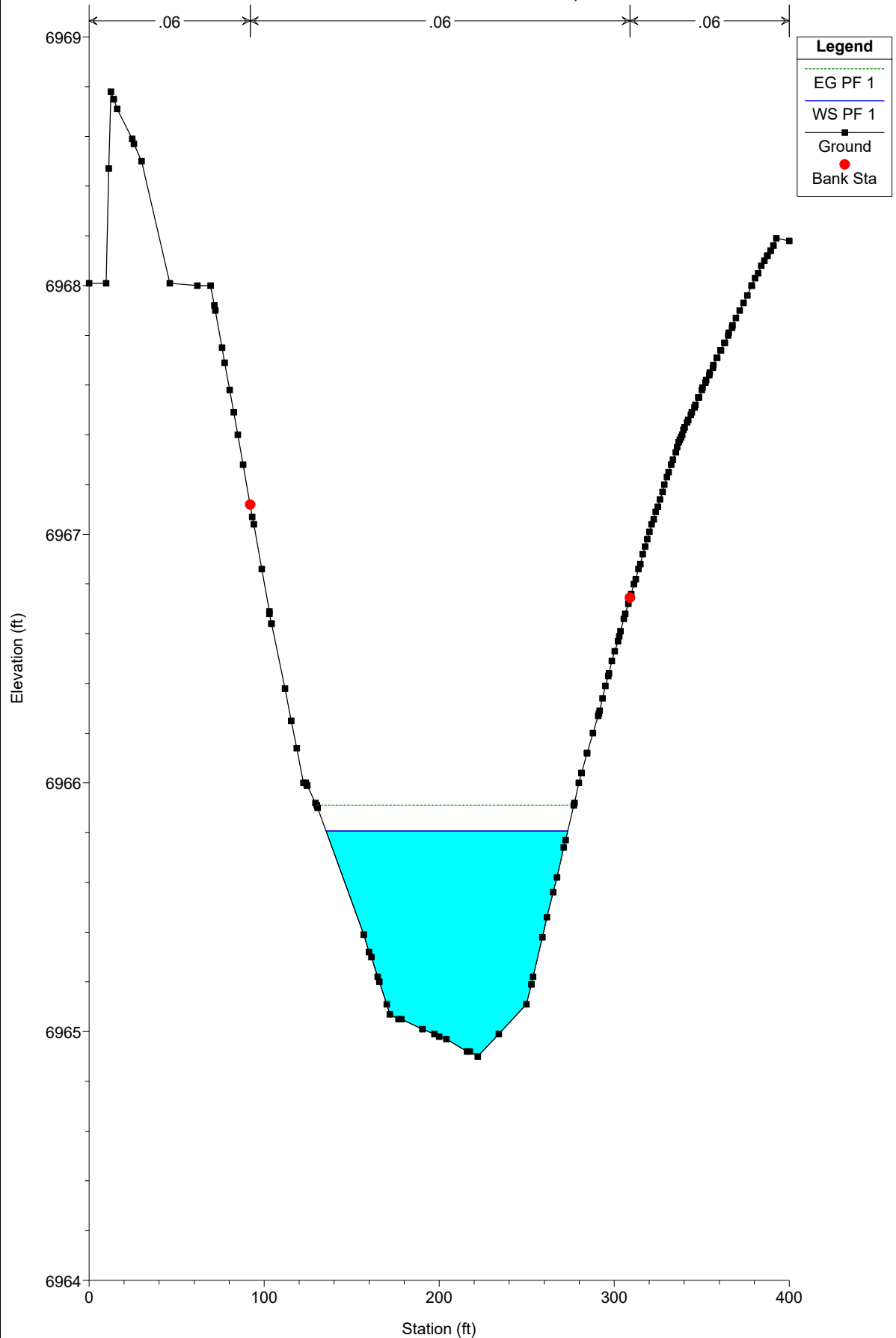


# EXISTING WEST CHANNEL 100-Y



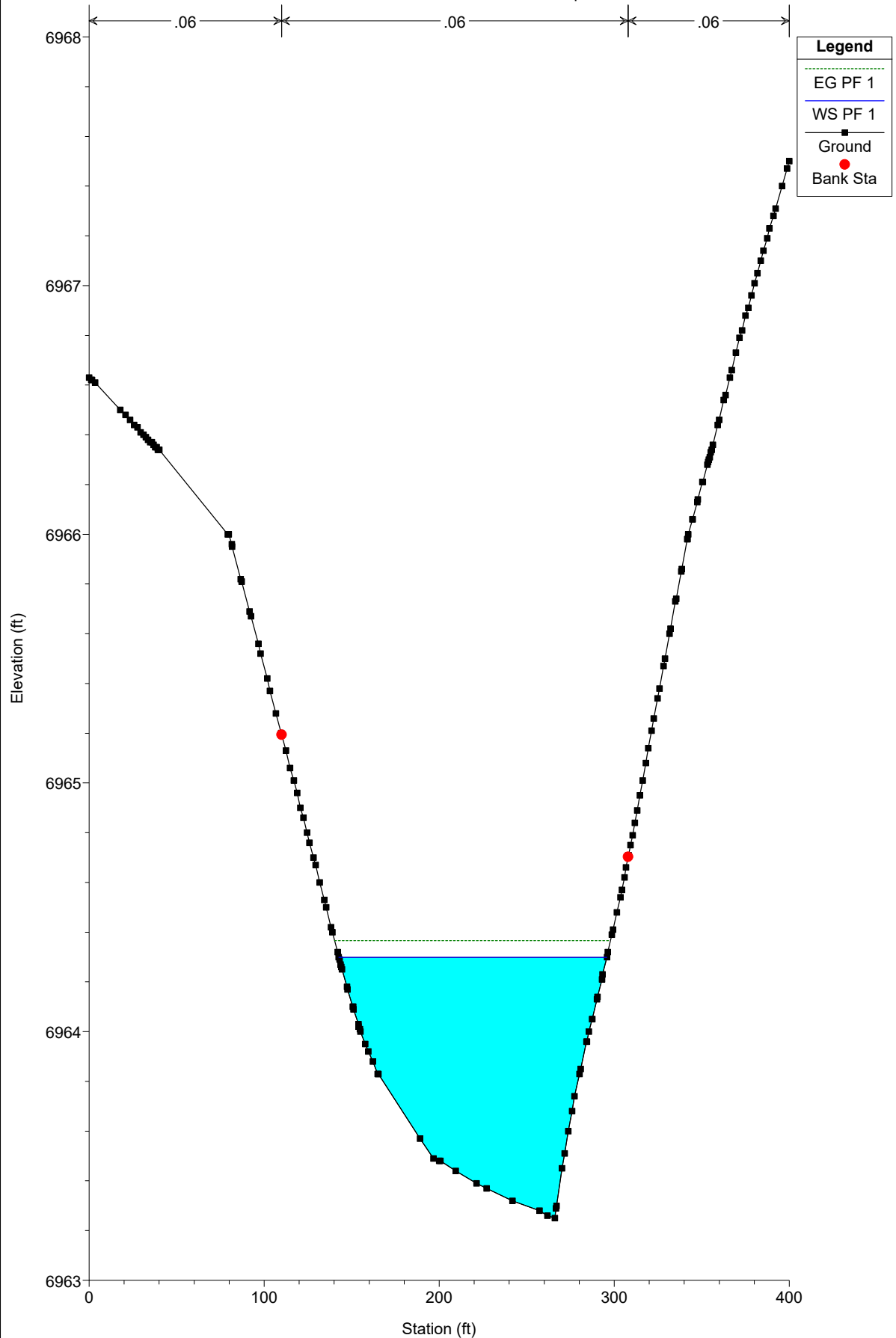
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 2500



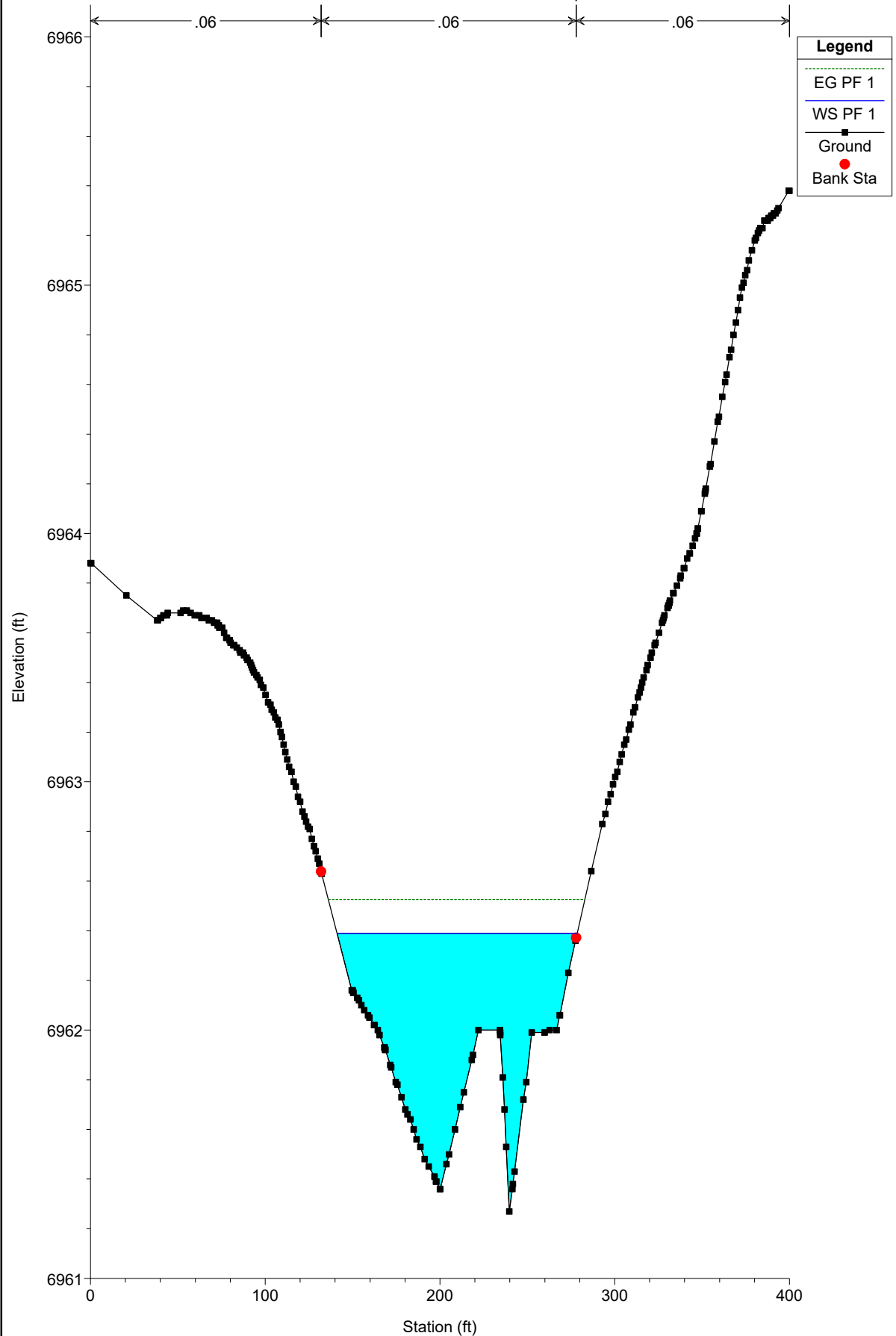
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 2400



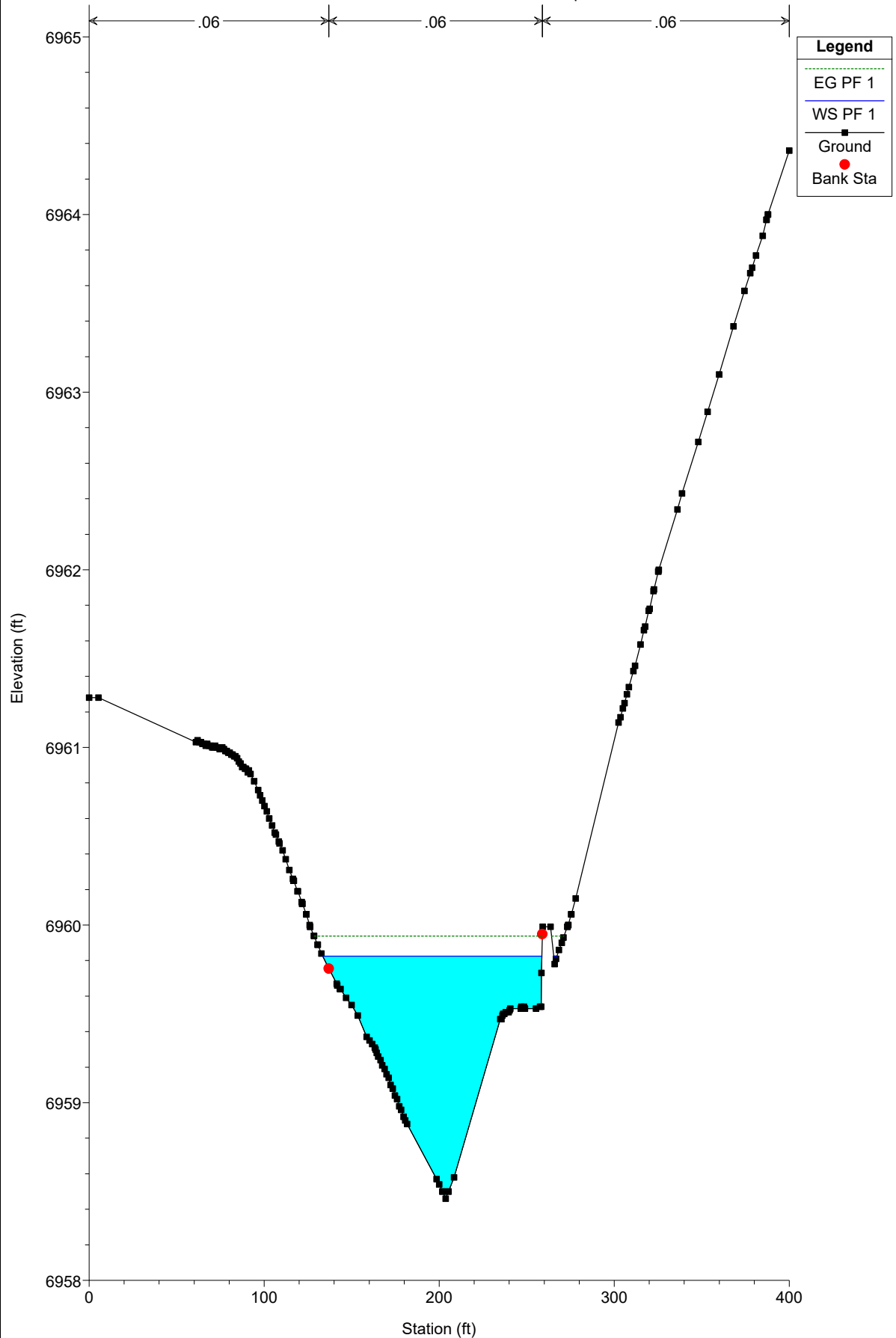
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 2300



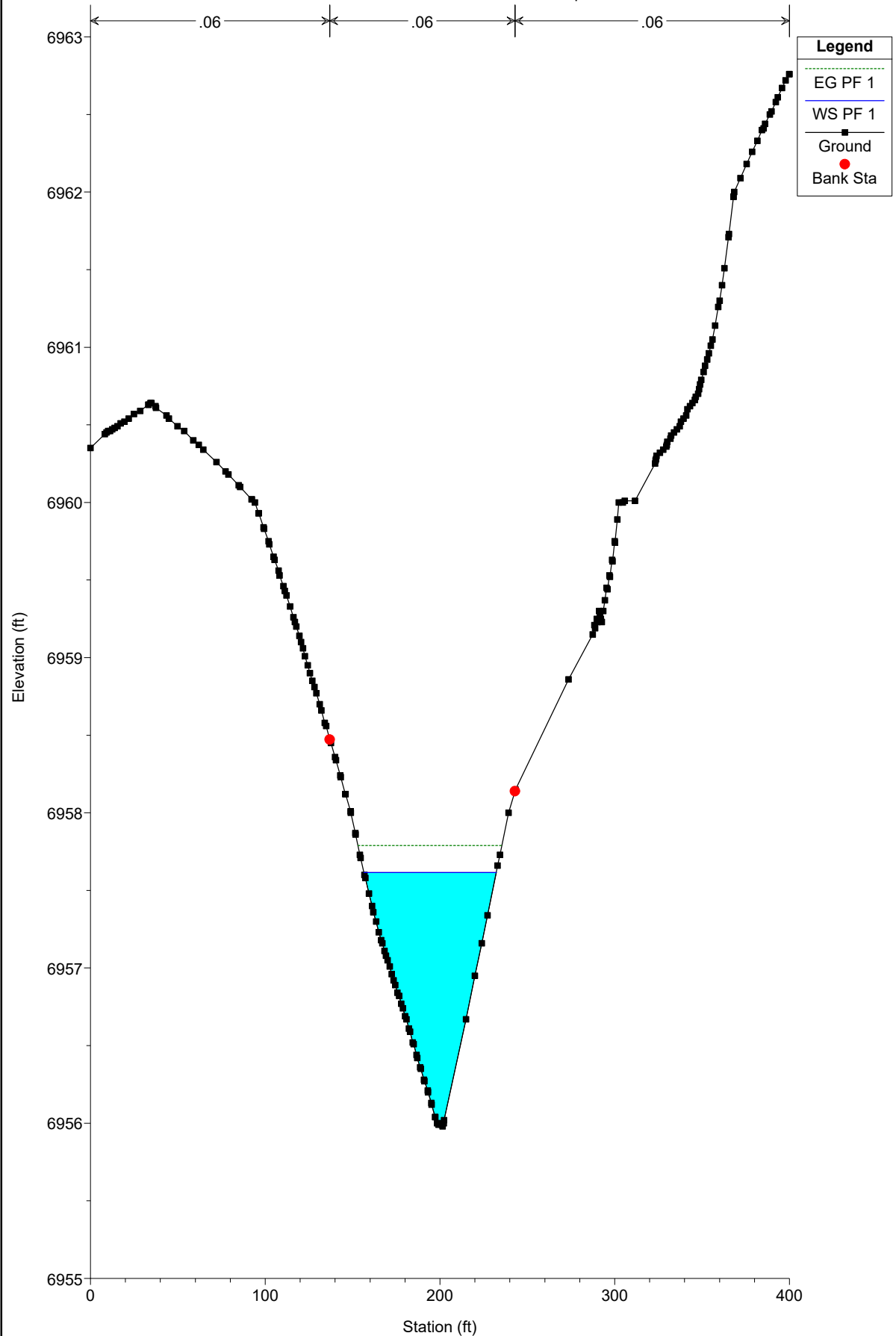
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 2200



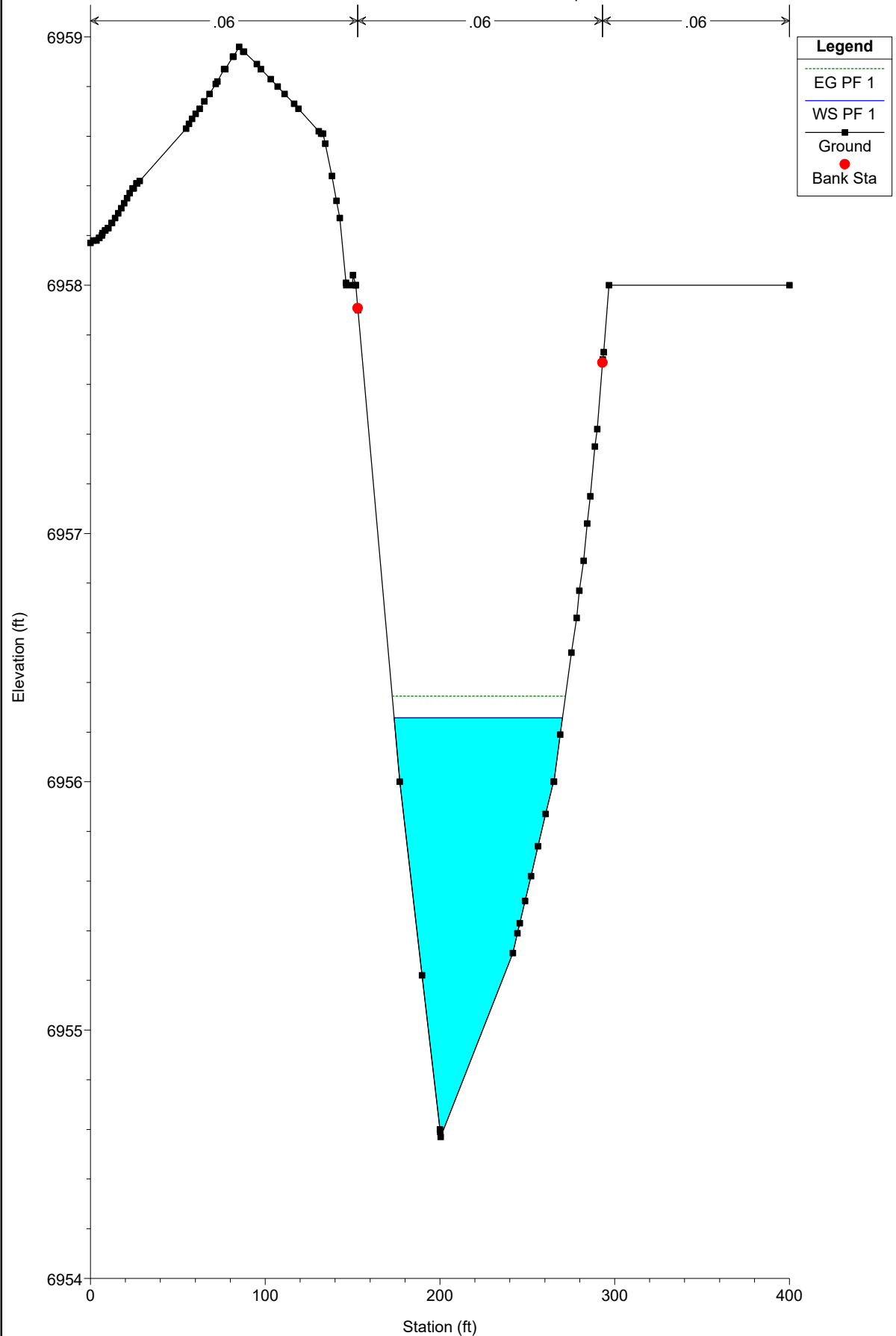
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 2100



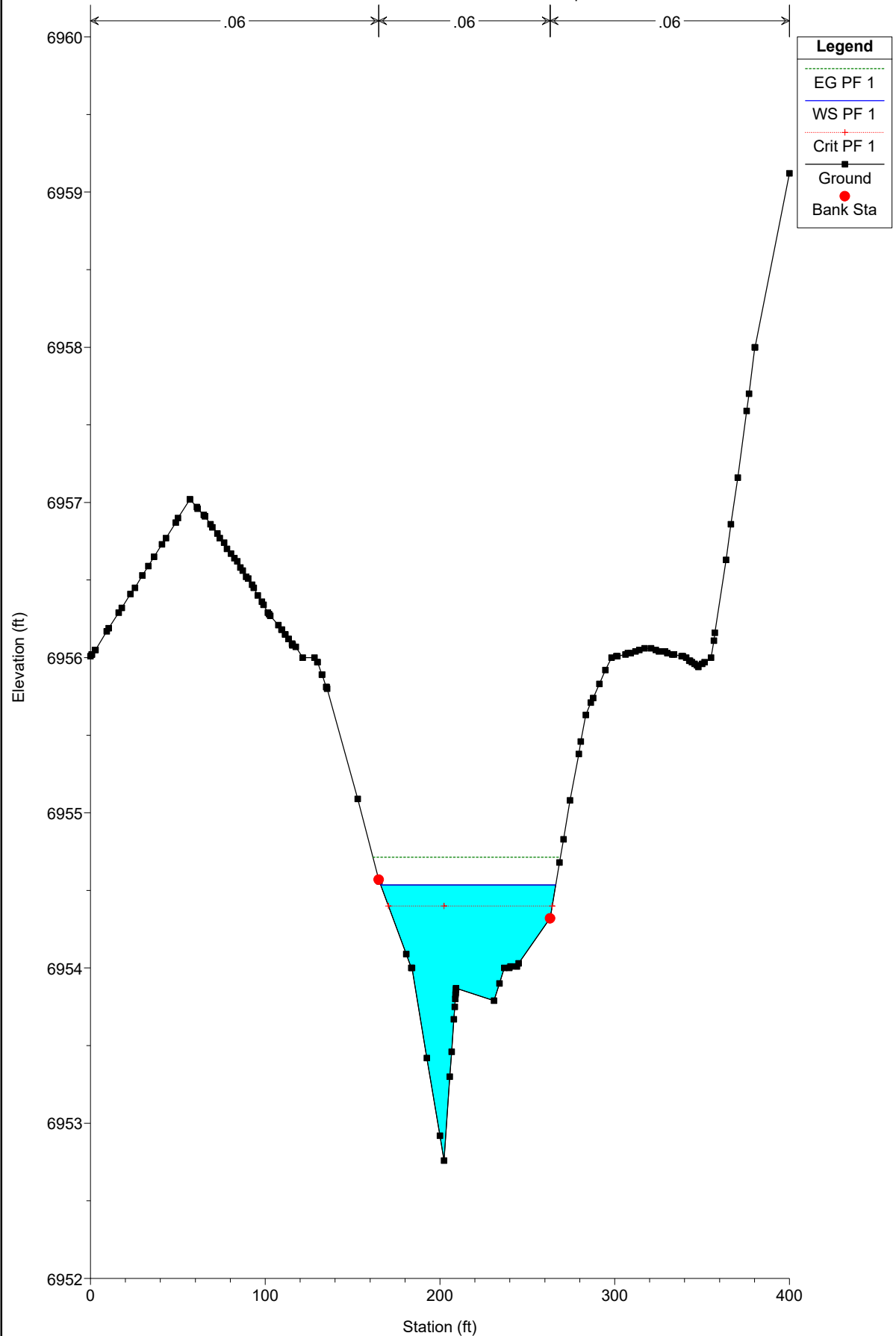
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 2000



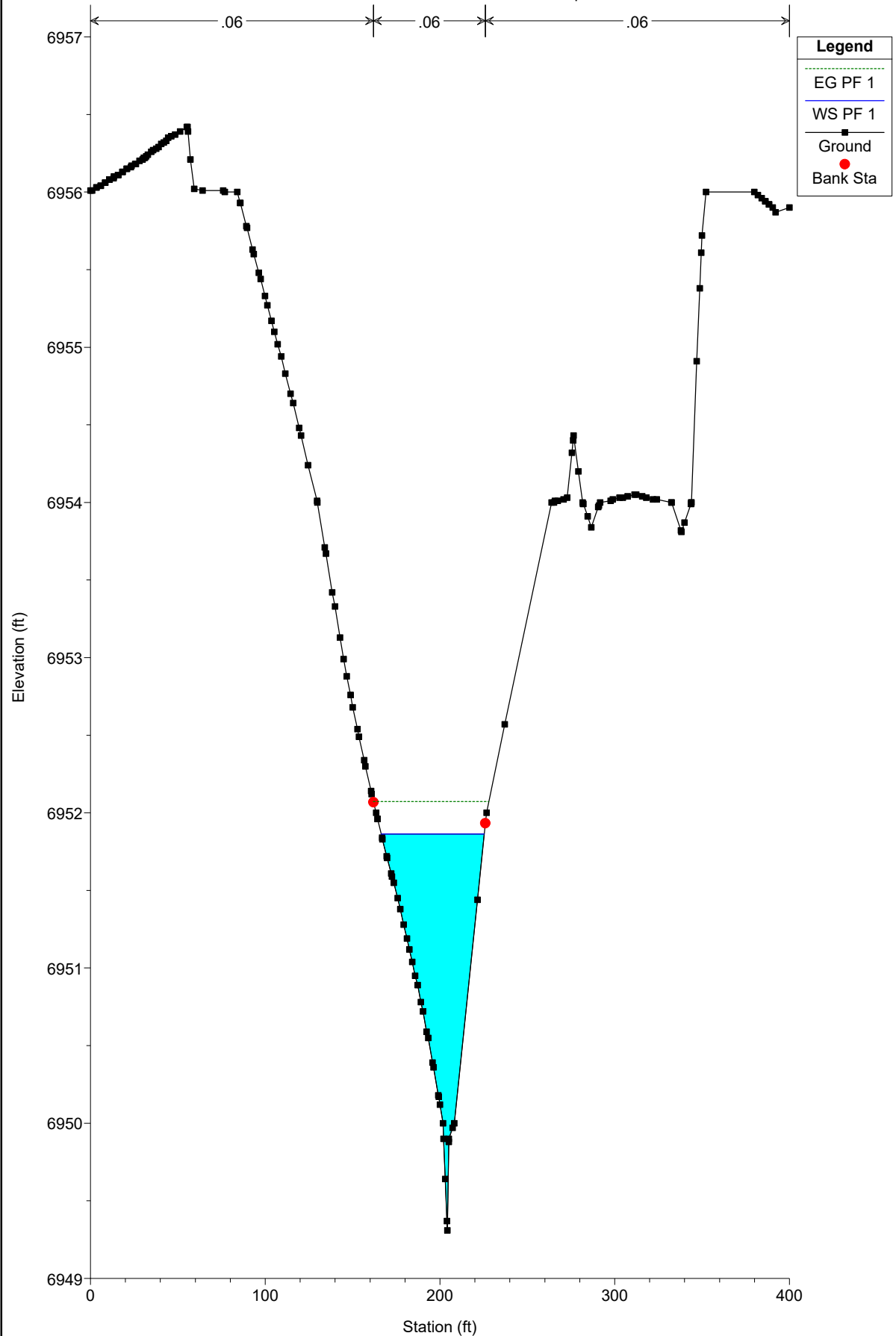
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 1900



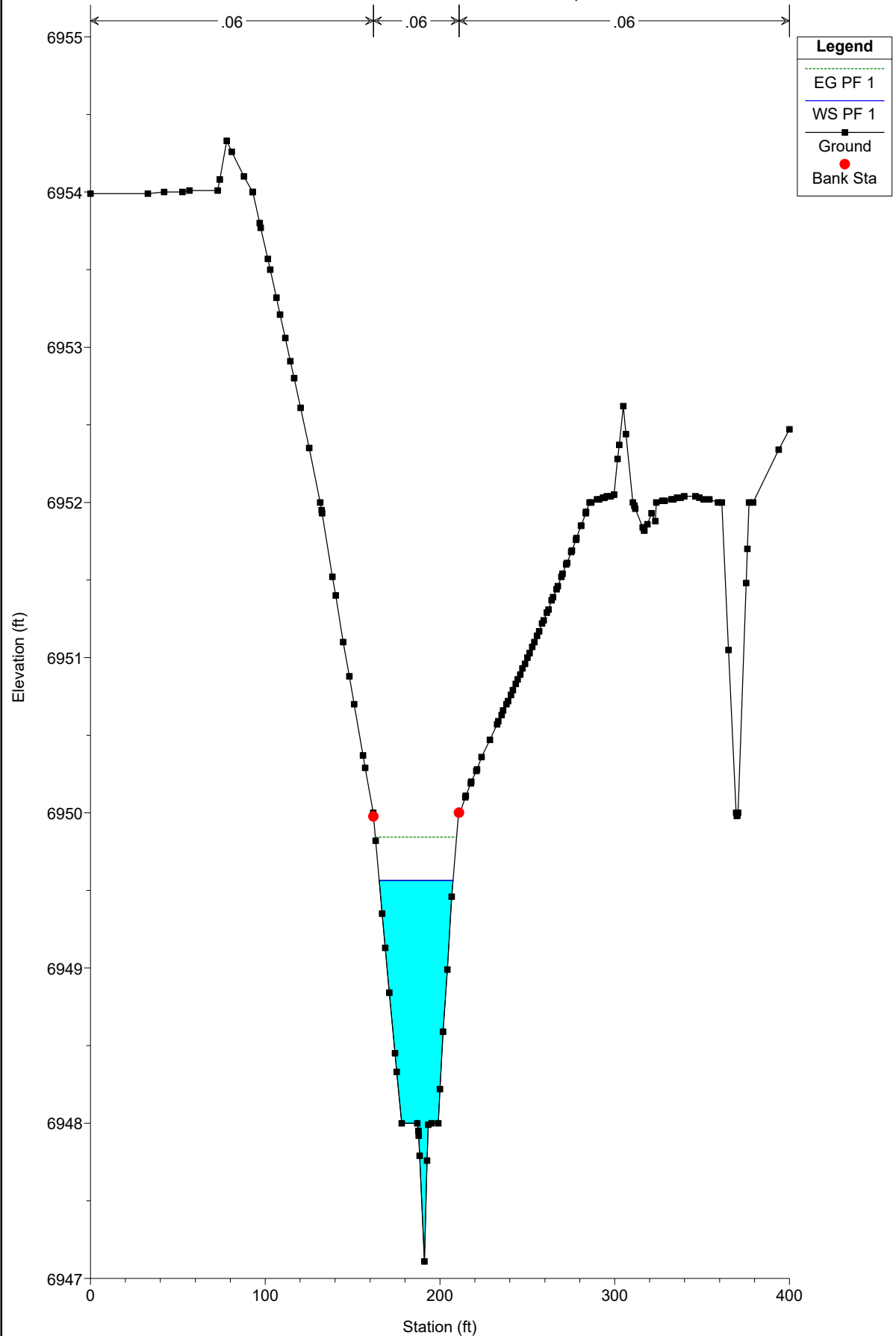
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 1800



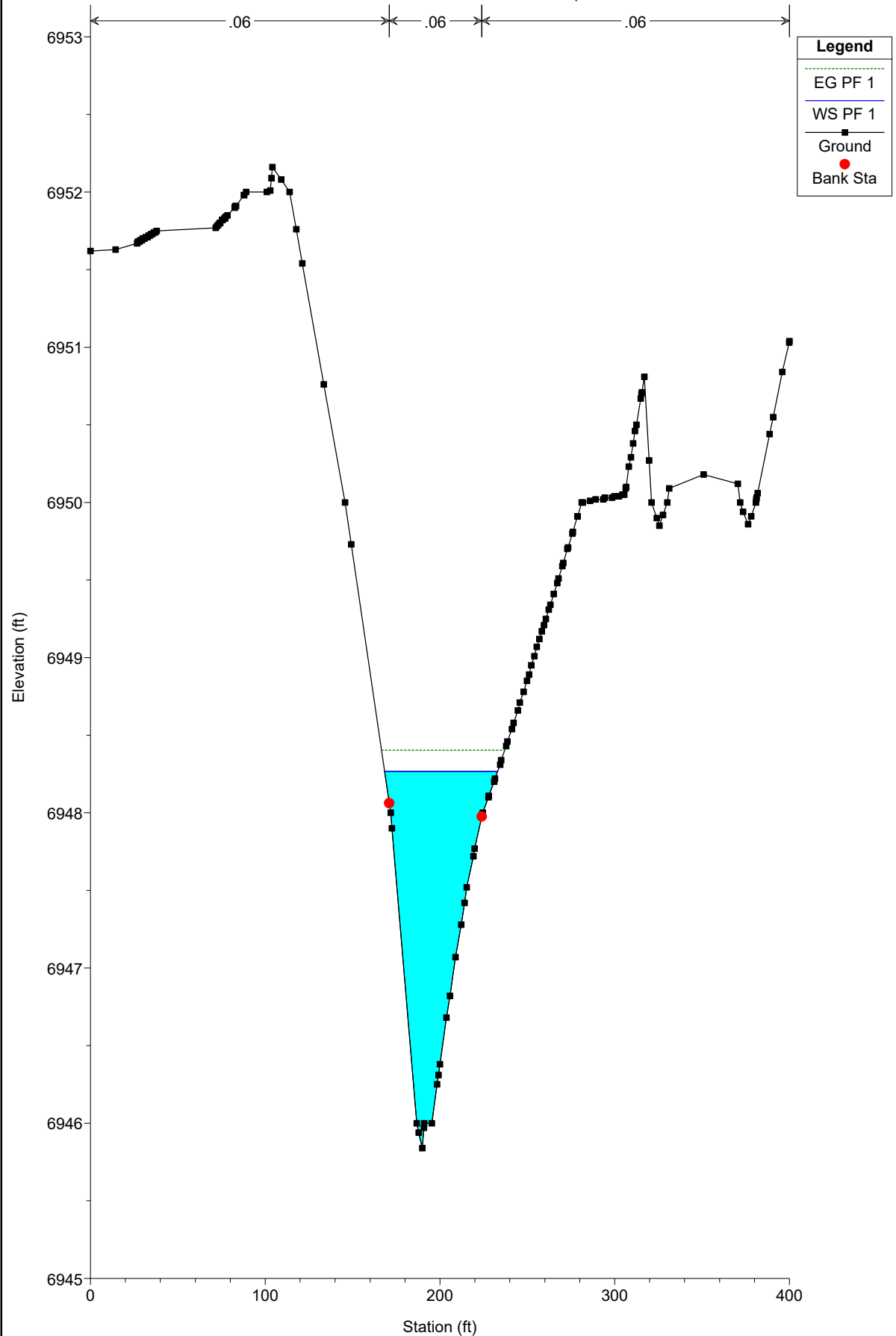
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 1700



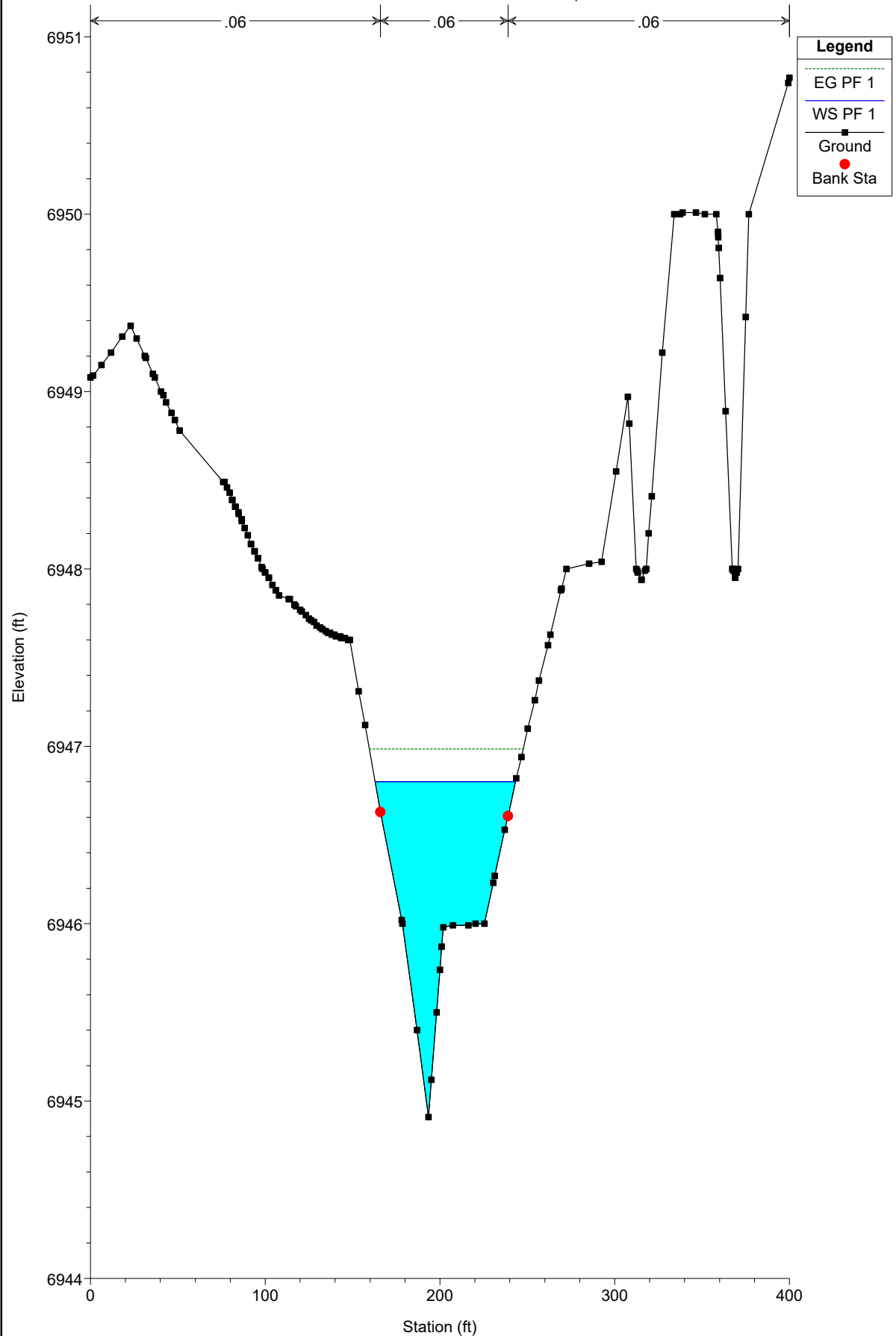
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 1600



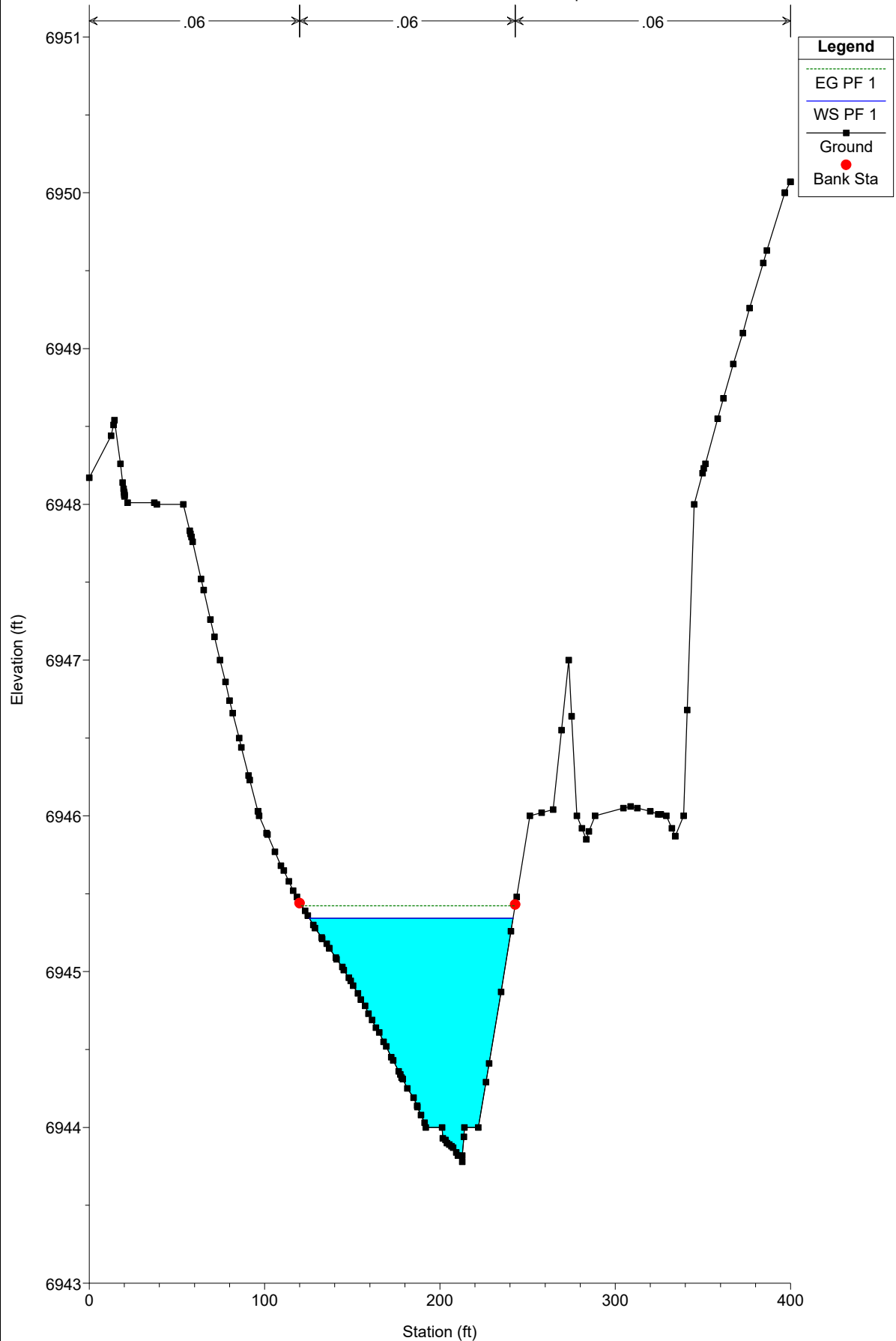
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 1500



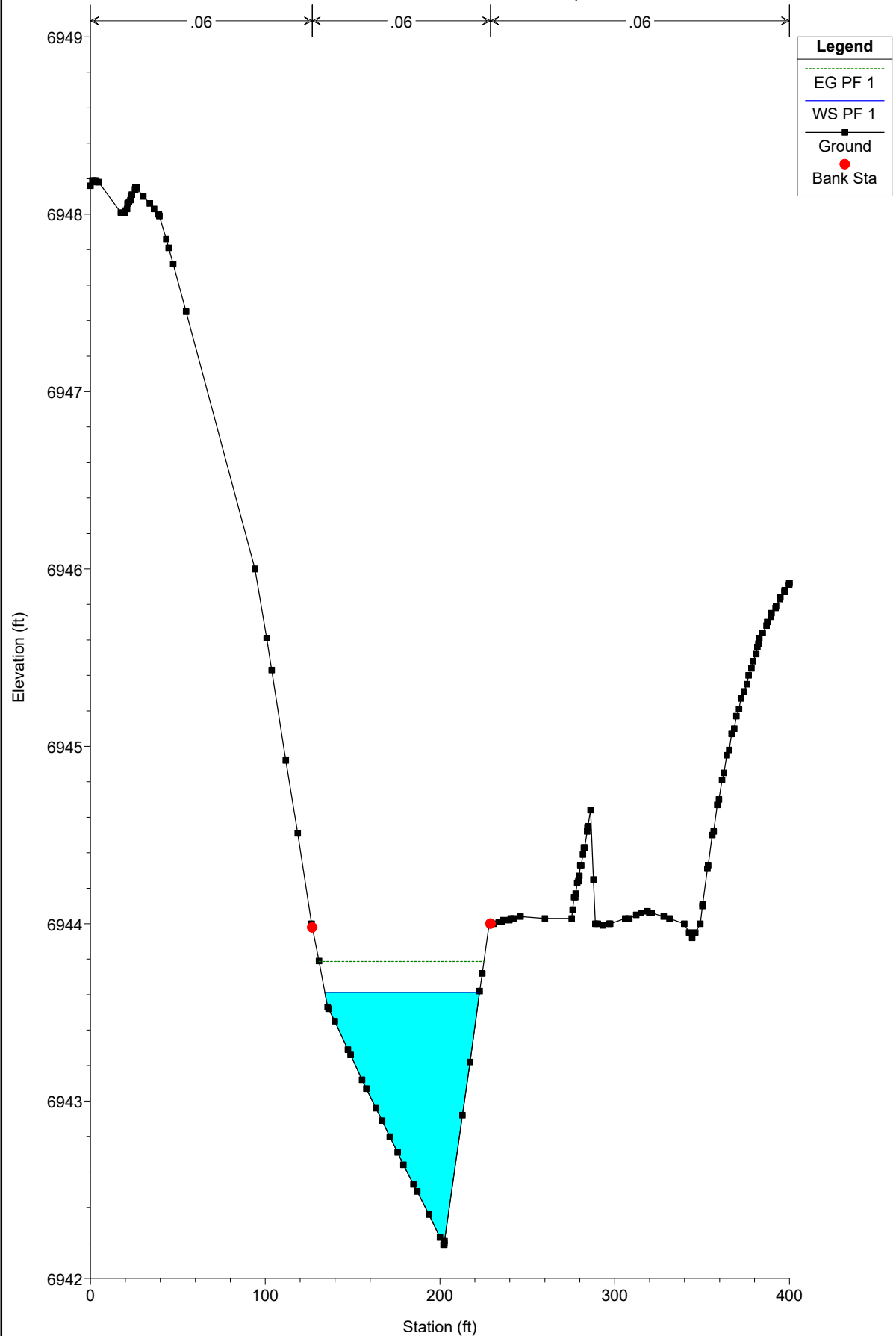
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 1400



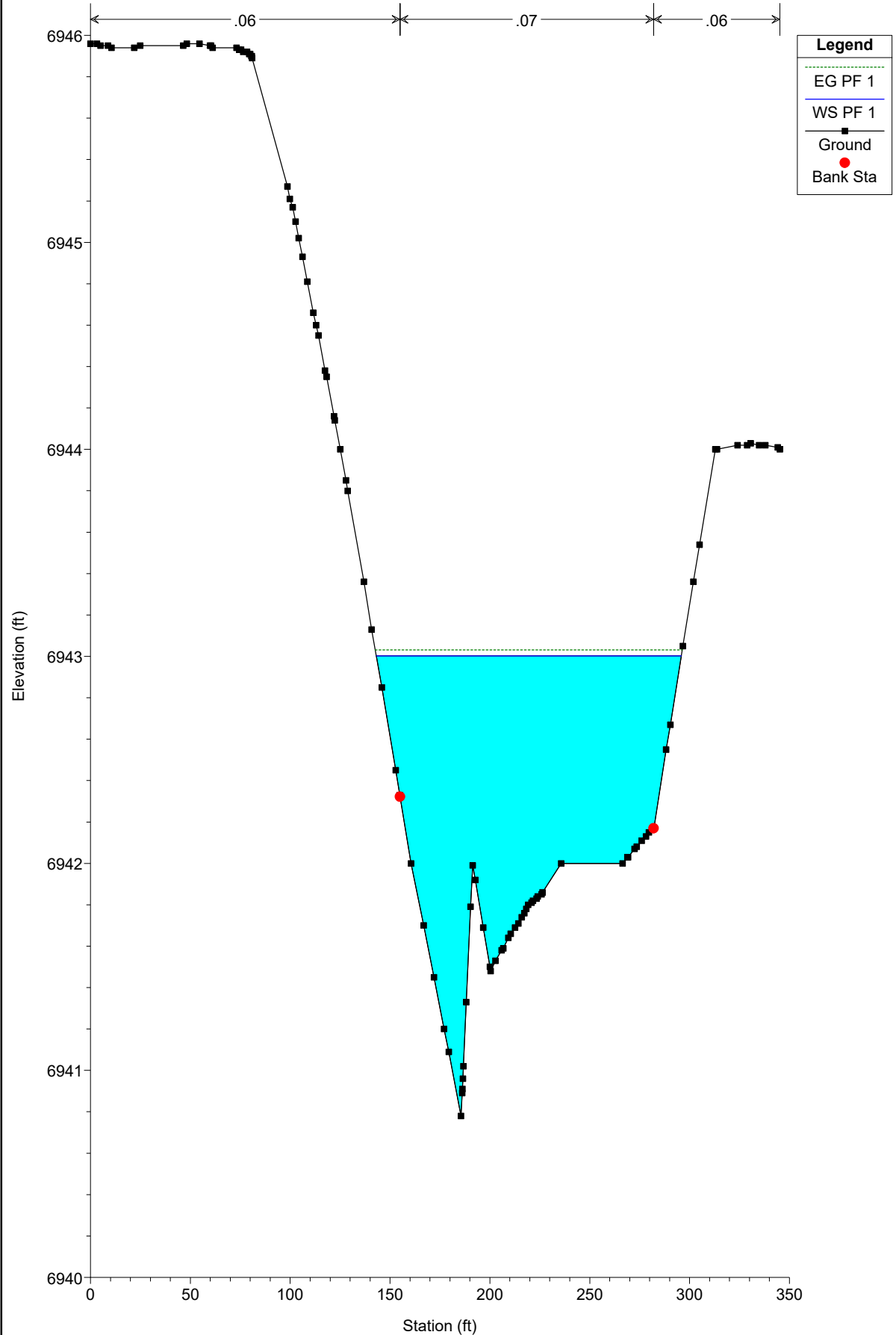
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 1300



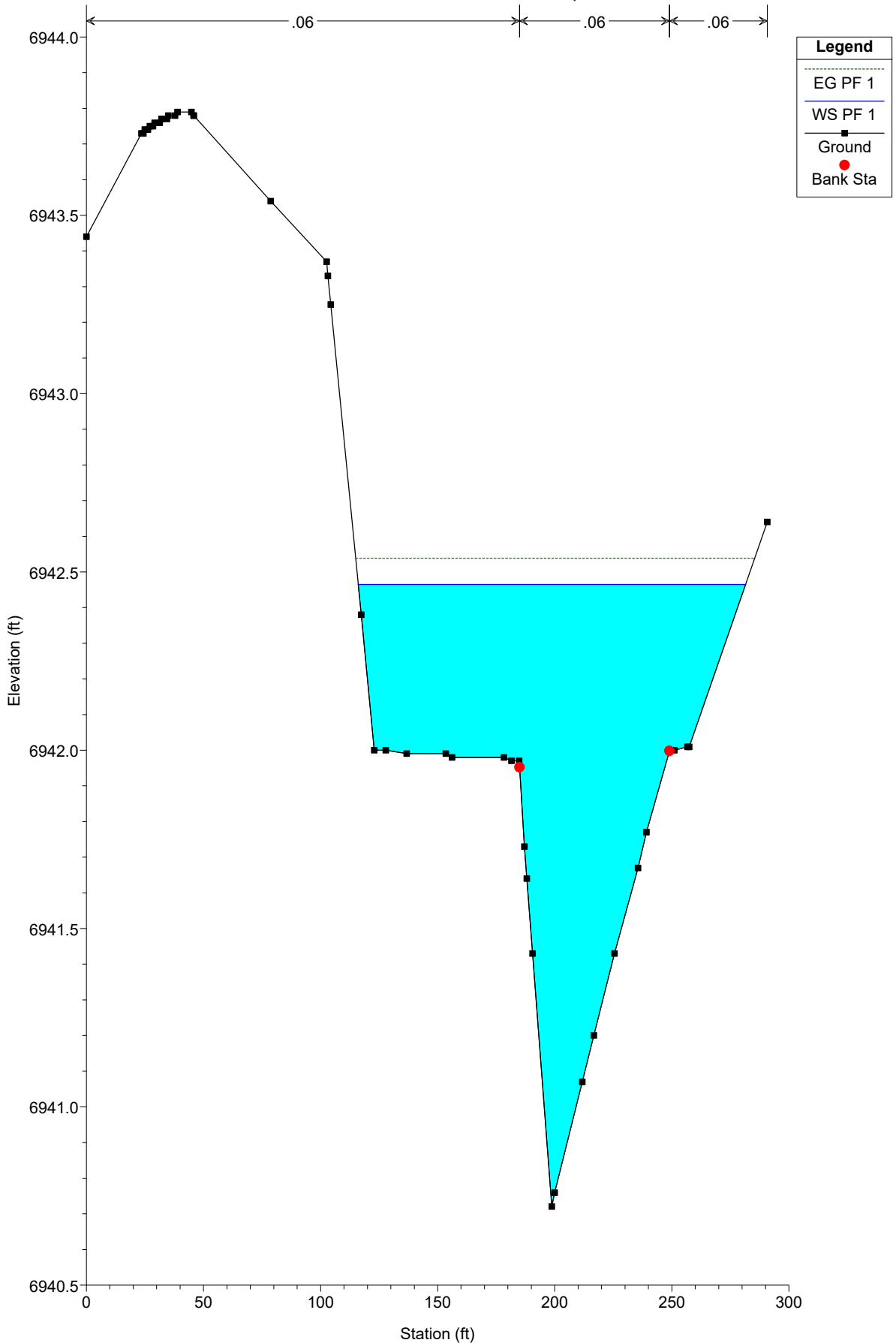
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 1200



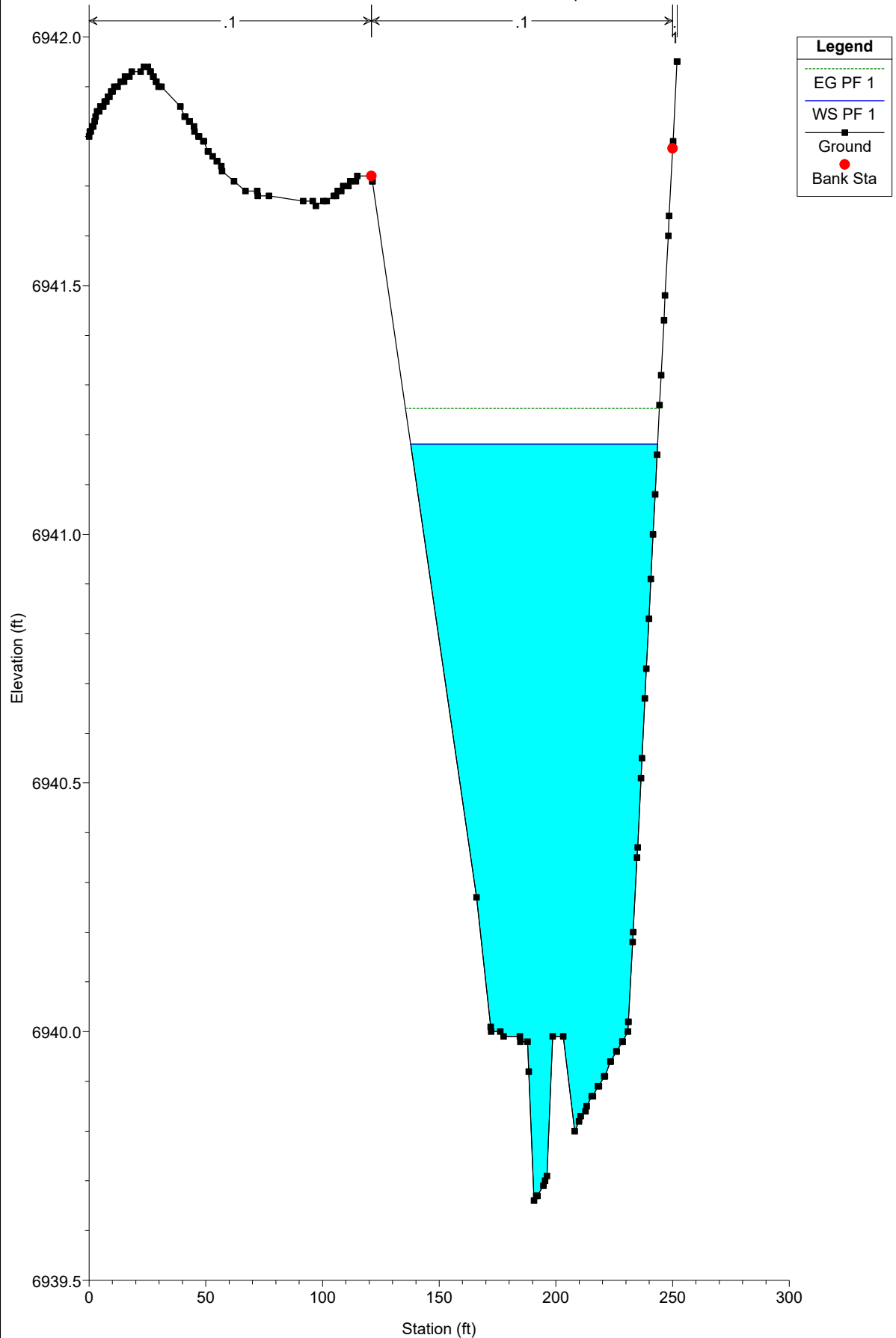
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 1100



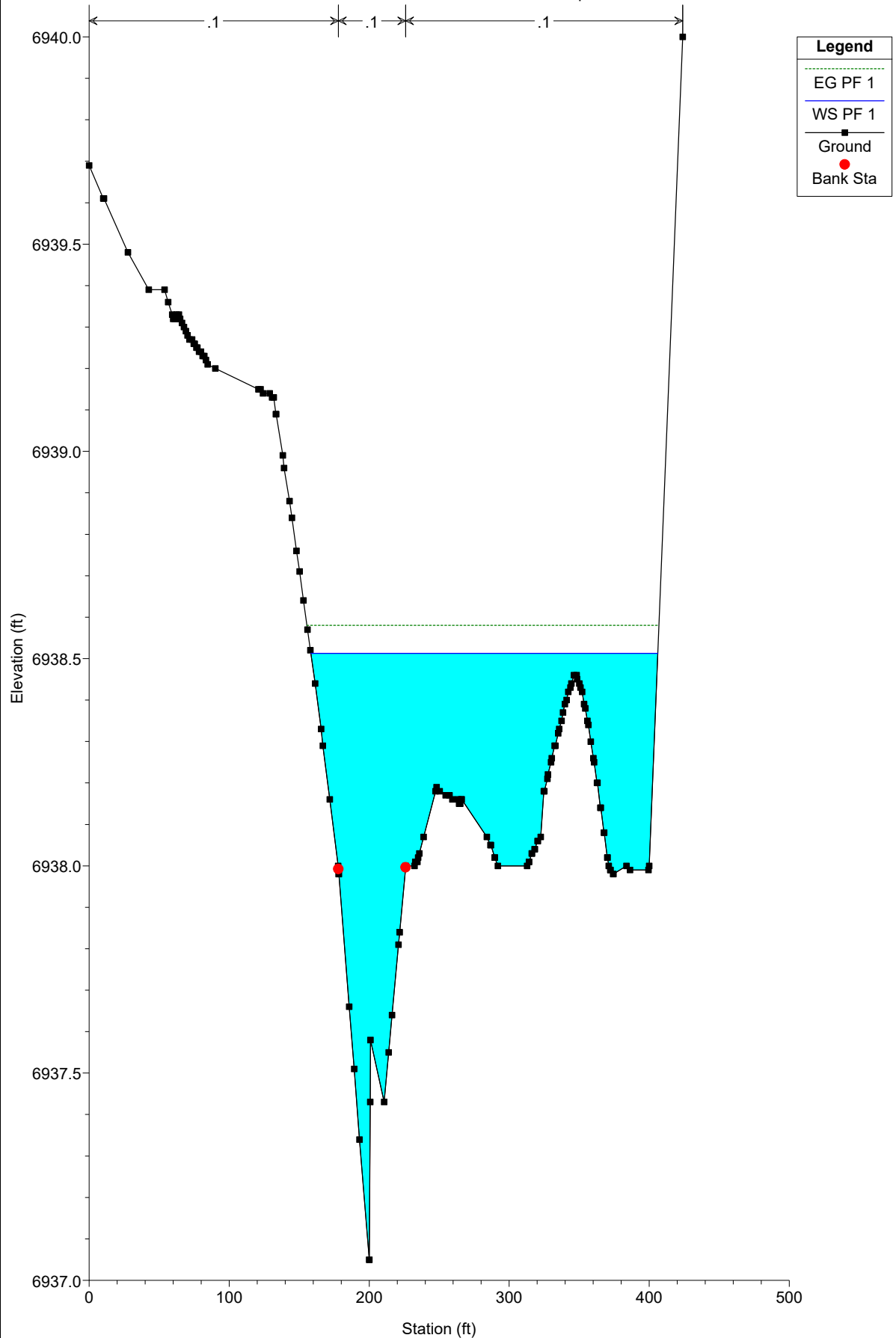
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 1000



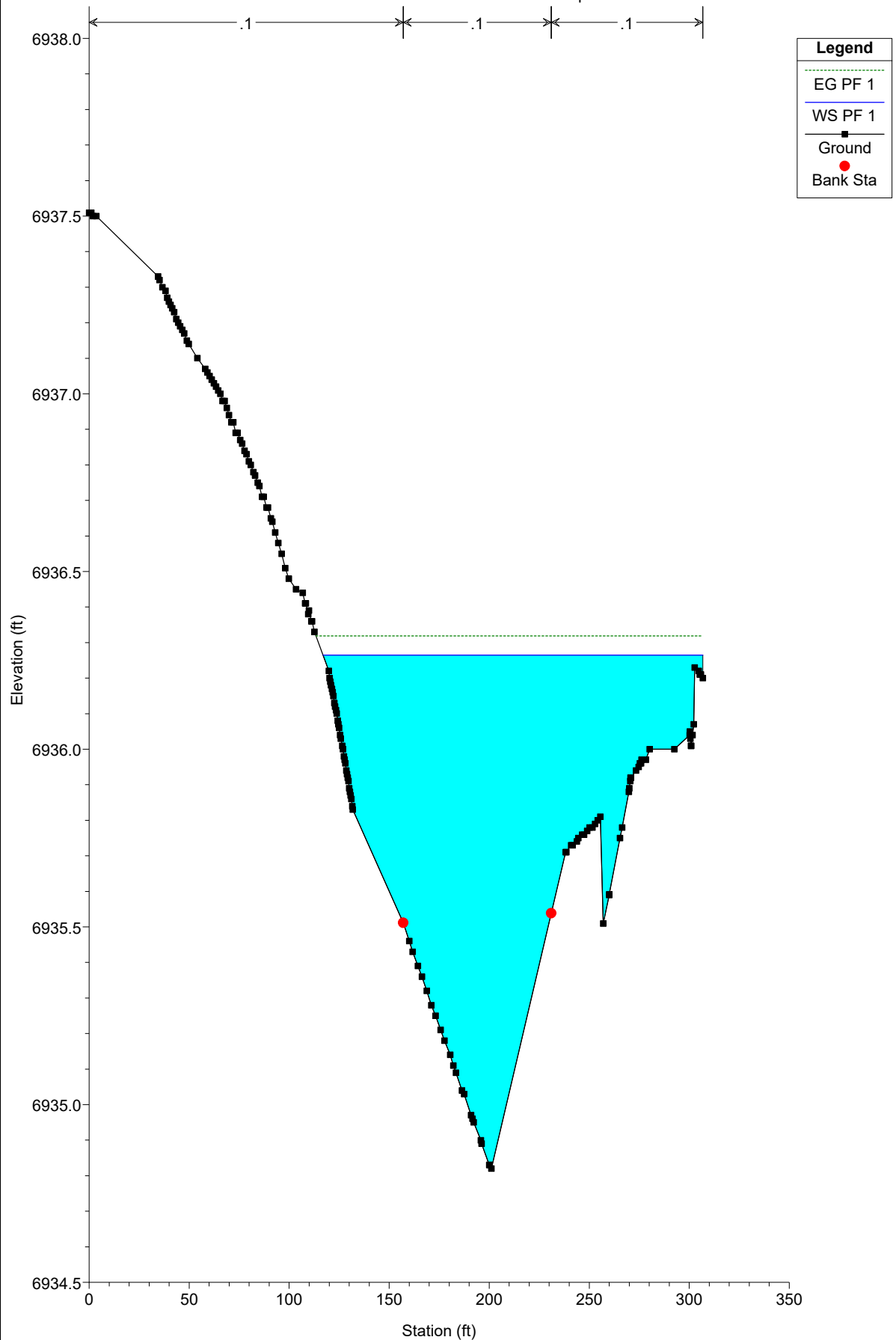
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 900



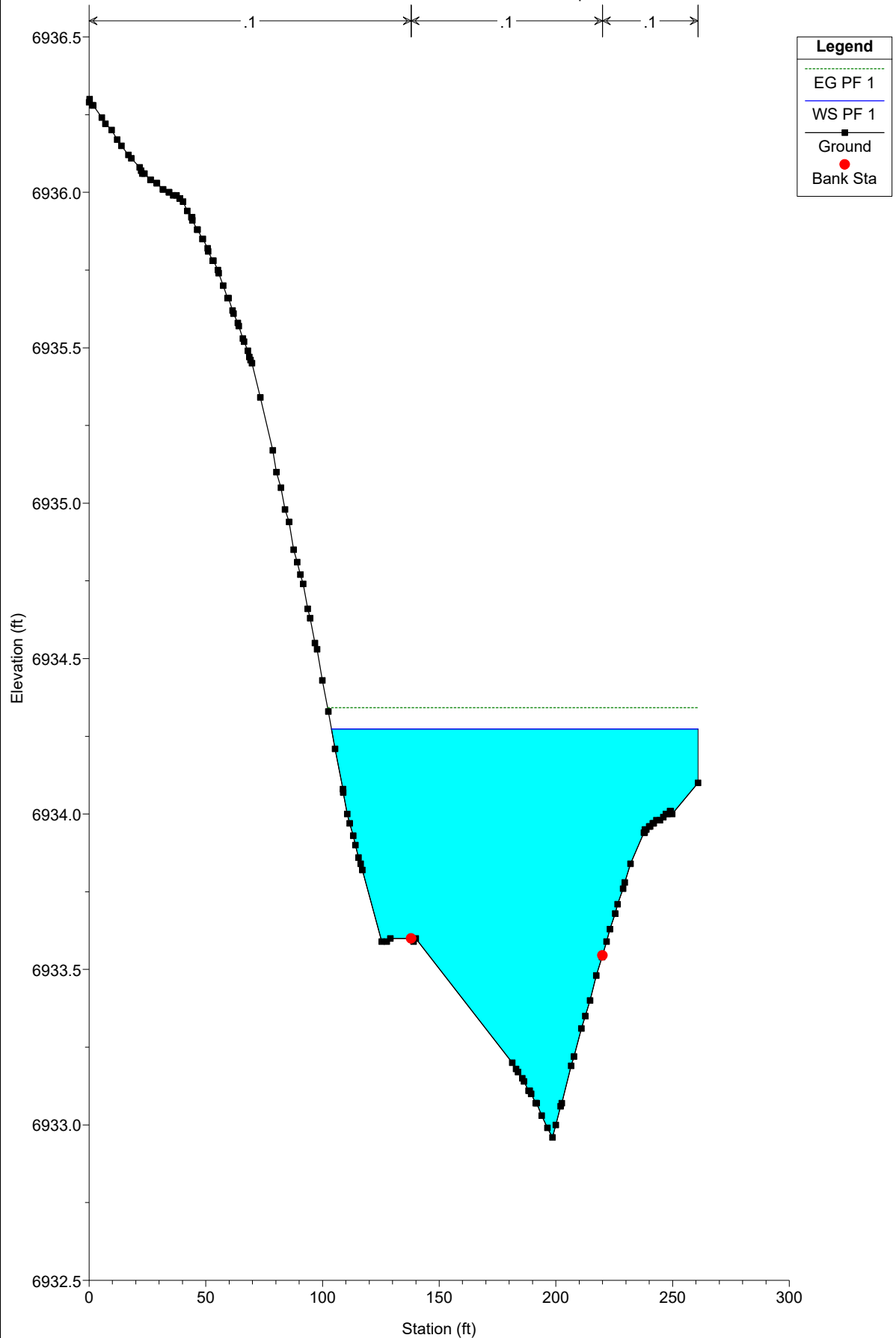
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 800



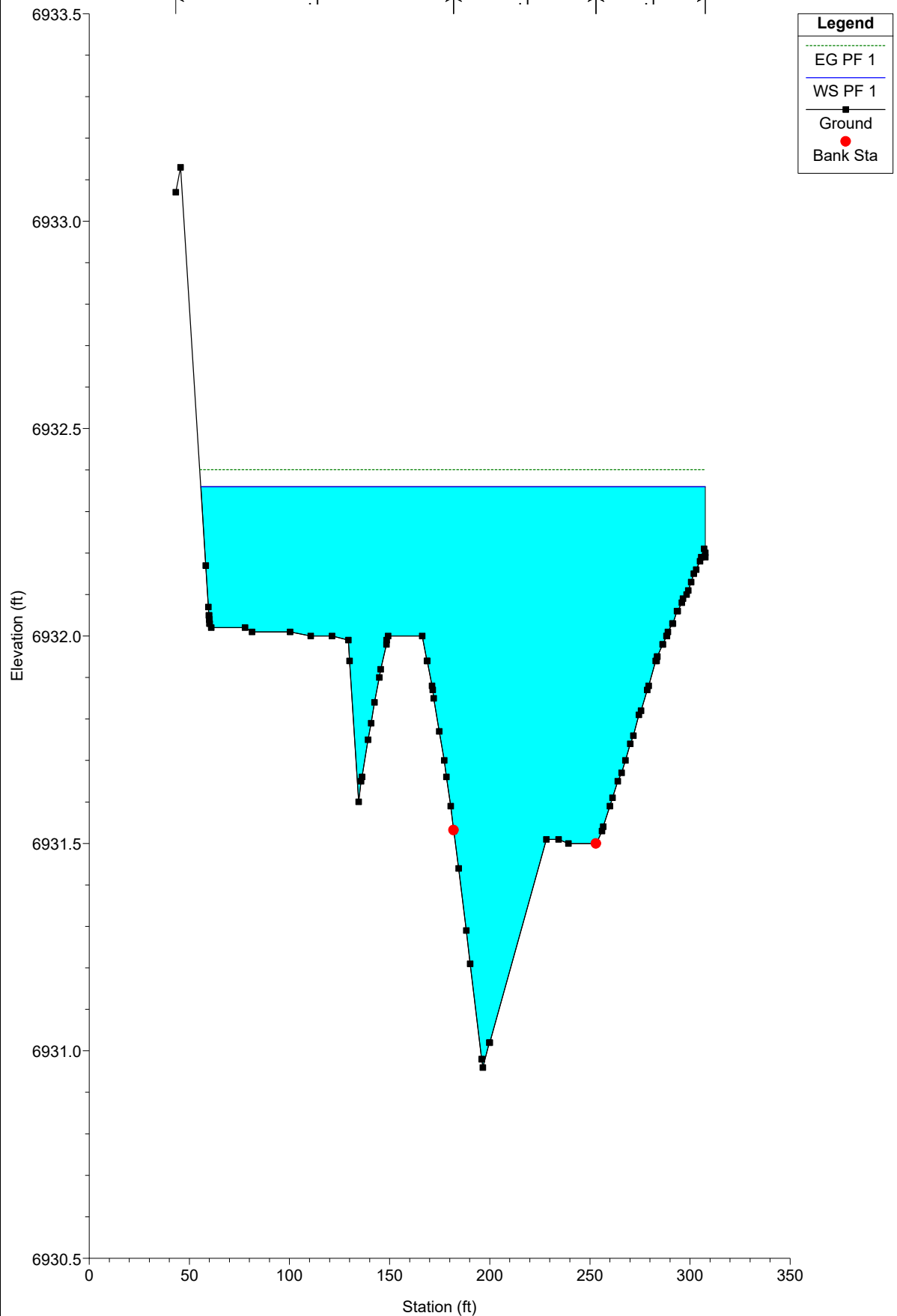
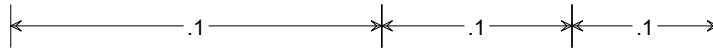
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 700



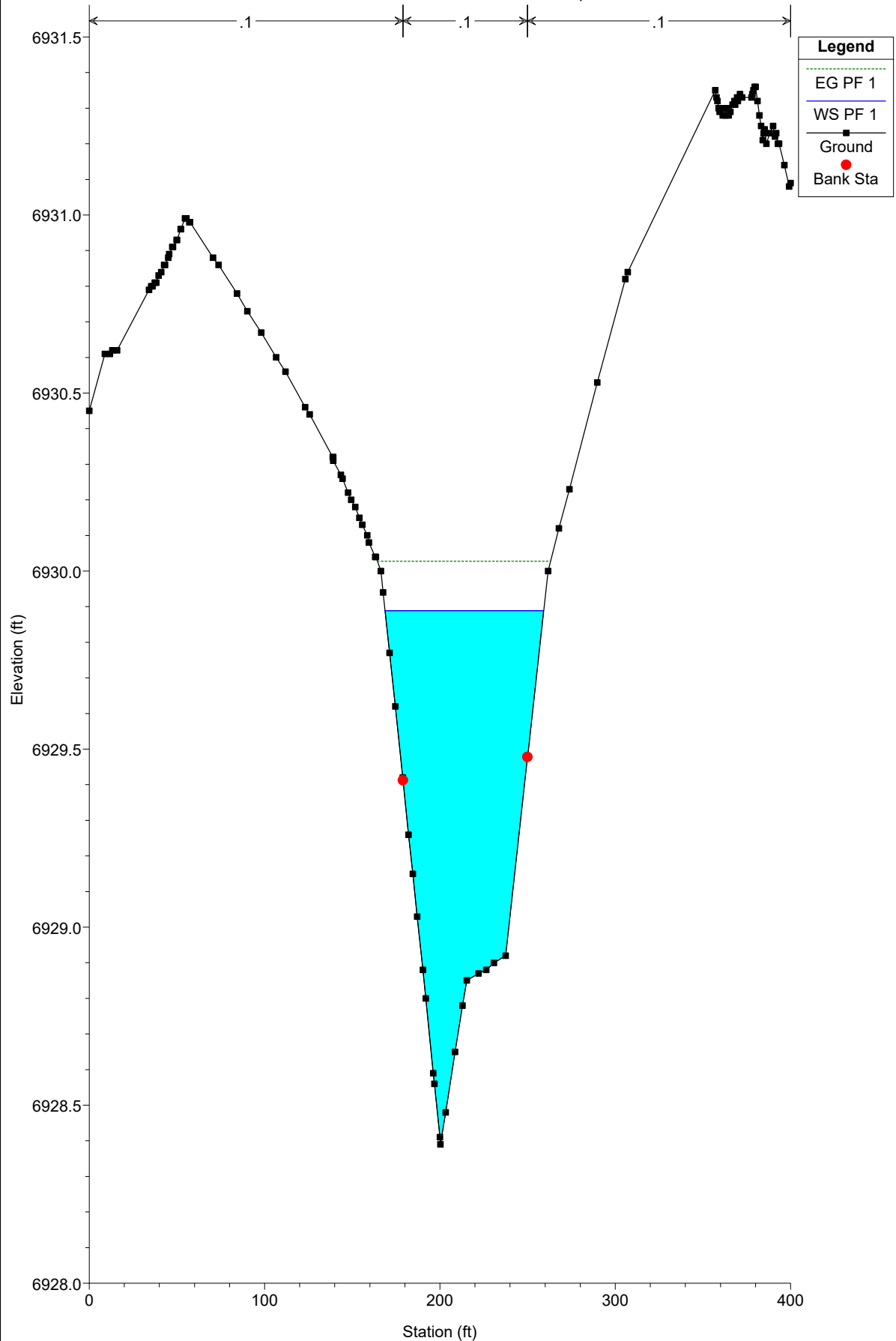
WEST CHAN EX NEW 100-Y    Plan: Plan 02    12/22/2024

River = WEST CHAN EX NEW    Reach = chan-west-pr    RS = 600



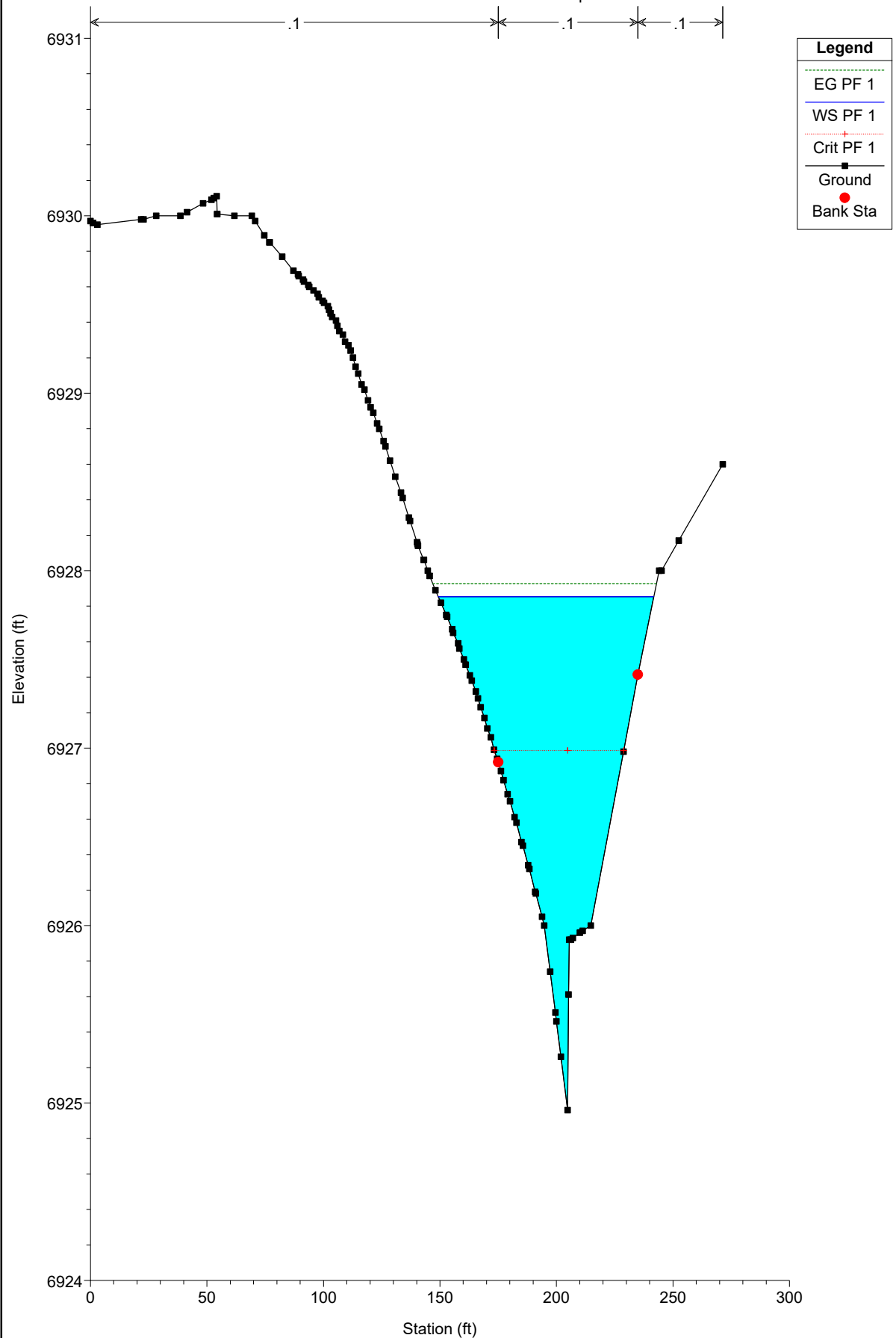
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 500



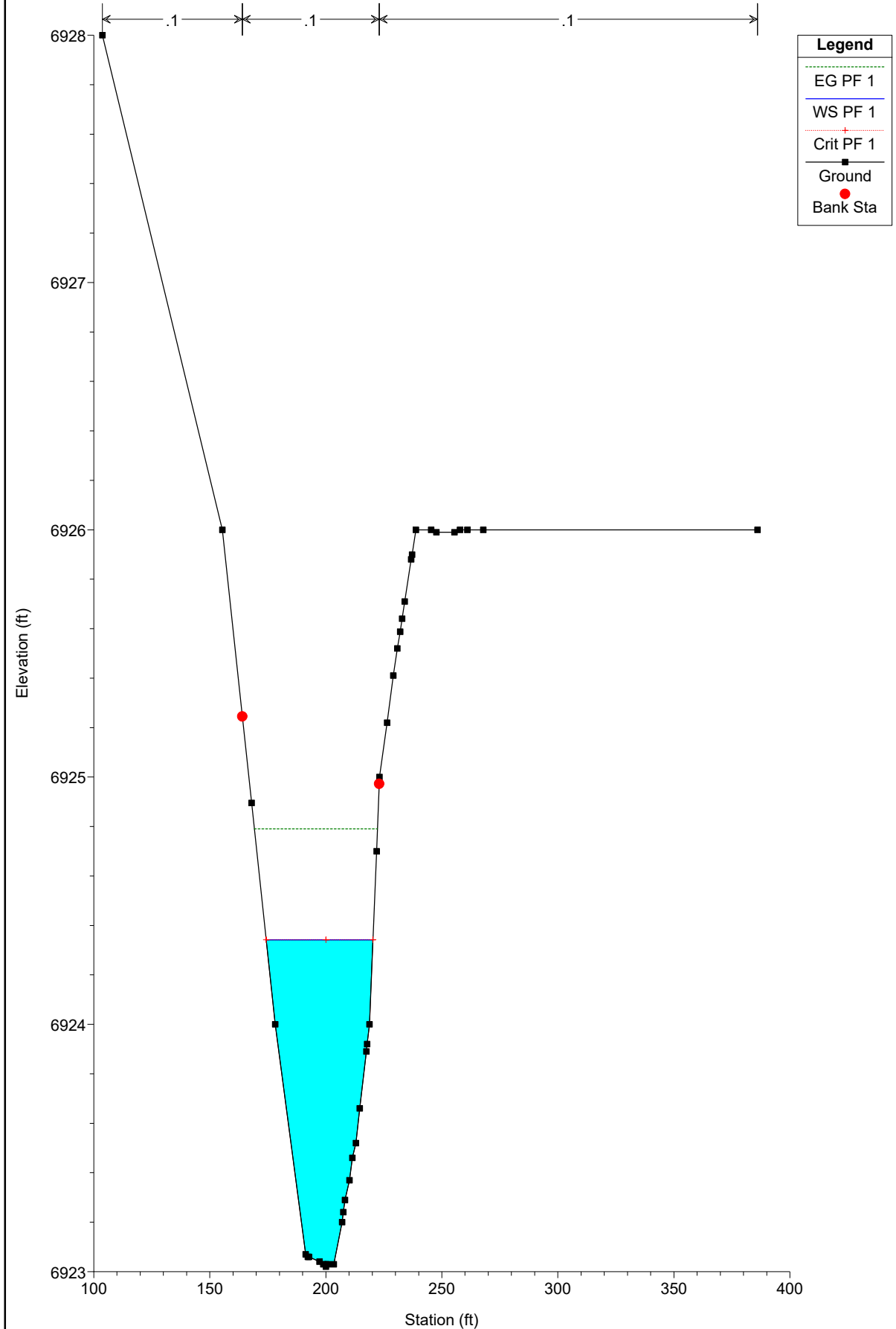
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 400



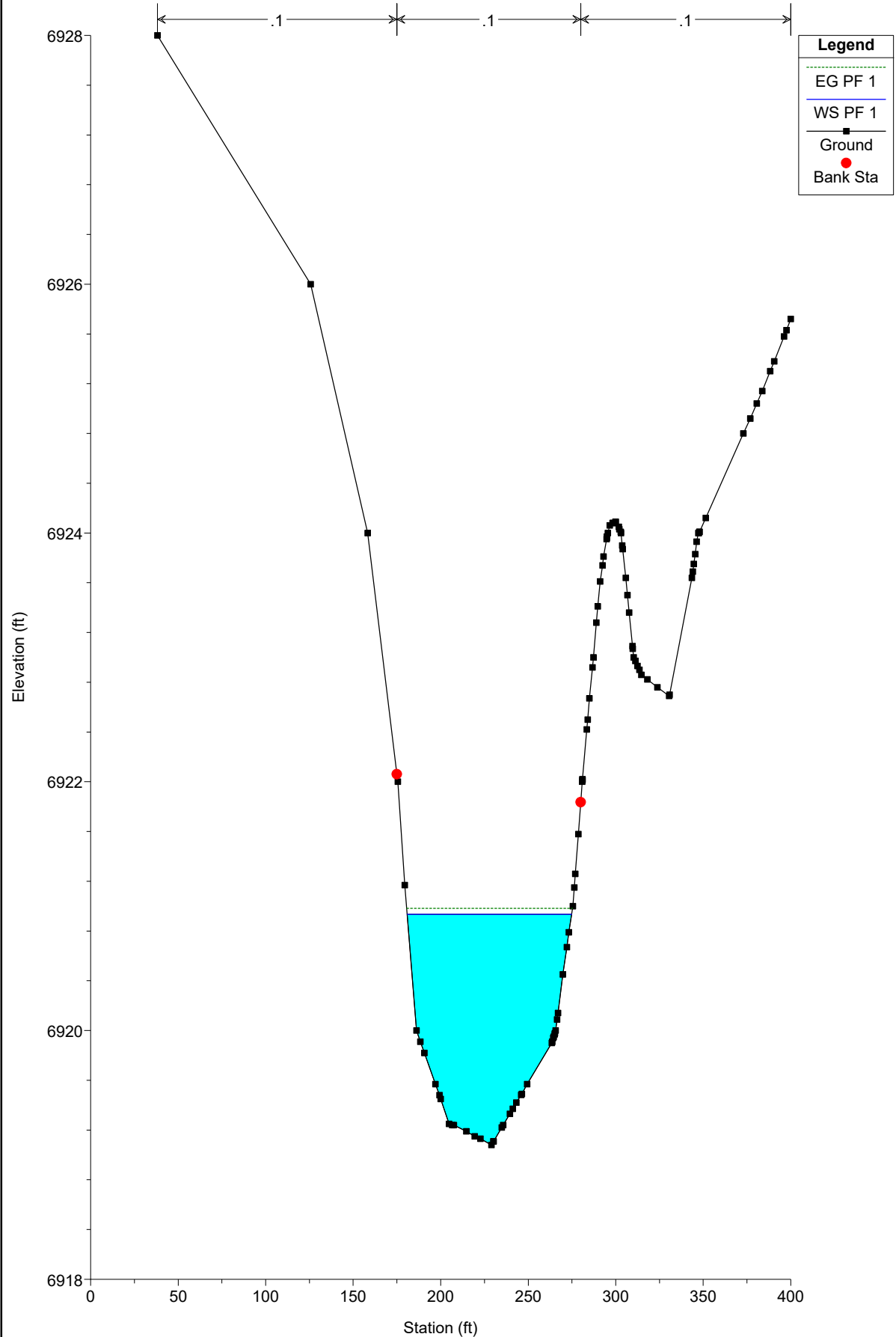
WEST CHAN EX NEW 100-Y    Plan: Plan 02    12/22/2024

River = WEST CHAN EX NEW    Reach = chan-west-pr    RS = 300



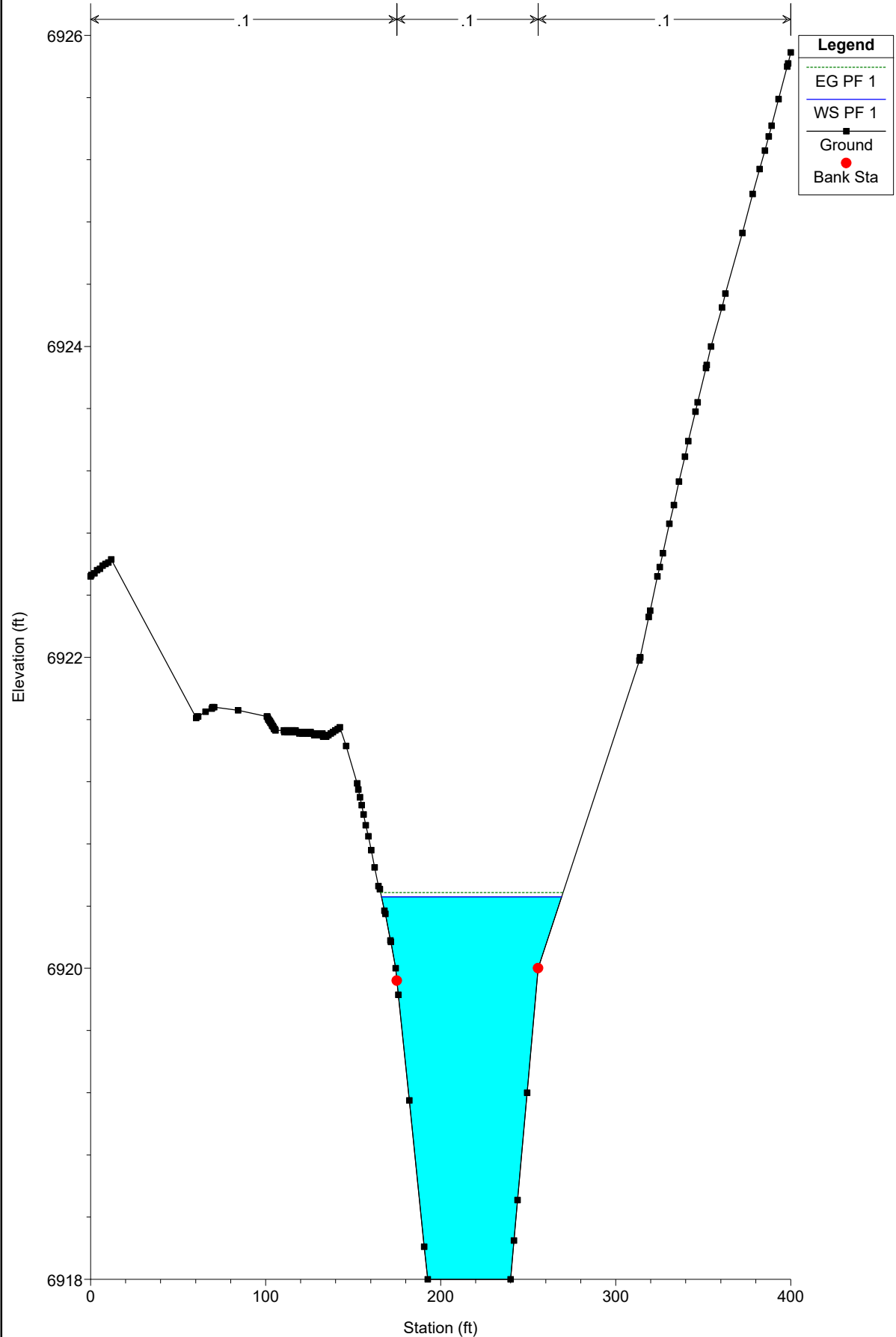
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 200



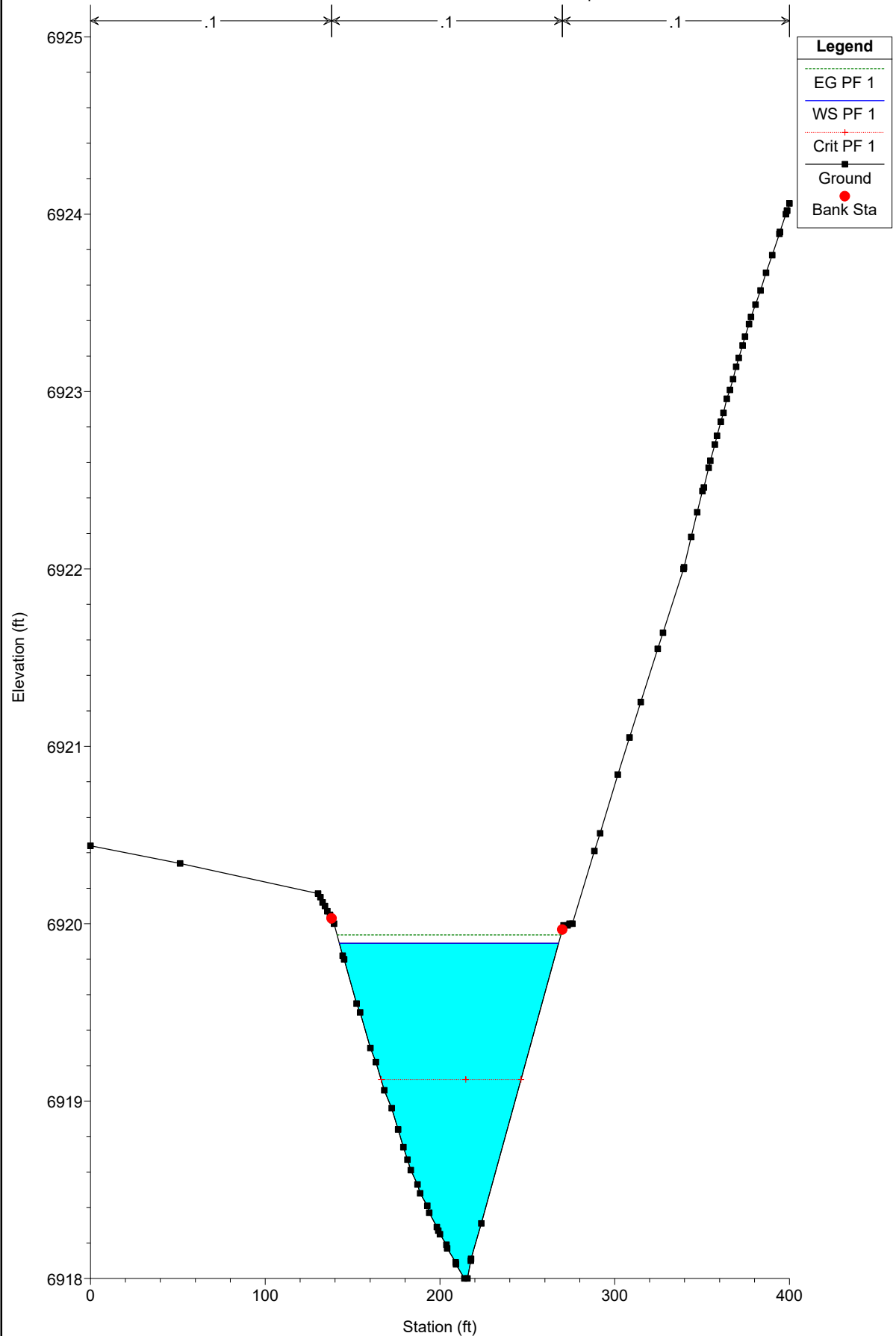
WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 100

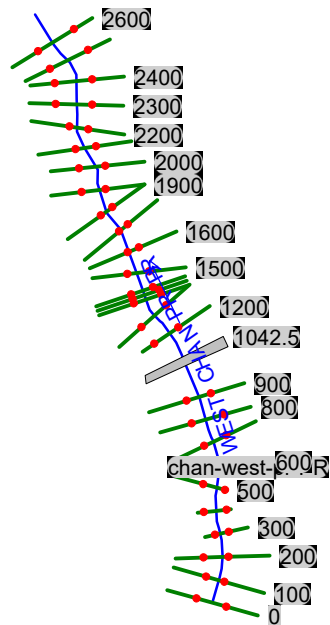


WEST CHAN EX NEW 100-Y Plan: Plan 02 12/22/2024

River = WEST CHAN EX NEW Reach = chan-west-pr RS = 0



# WEST CHANNEL PROPOSED CONDITIONS



# PROPOSED WEST CHANNEL 100-Y

HEC-RAS Plan: Plan p02 River: WEST PR Reach: chan-west-pr 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)	
chan-west-pr	2600	PF 1	216.00	6966.83	6967.85		6967.93	0.018480	2.32	93.12	162.80	0.54
chan-west-pr	2500	PF 1	216.00	6964.90	6965.79		6965.90	0.022300	2.63	82.02	136.48	0.60
chan-west-pr	2400	PF 1	216.00	6963.25	6964.31		6964.37	0.010916	2.03	106.60	153.80	0.43
chan-west-pr	2300	PF 1	216.00	6961.27	6962.36		6962.51	0.038187	3.10	69.57	135.31	0.76
chan-west-pr	2200	PF 1	216.00	6958.46	6959.85		6959.95	0.018192	2.56	84.60	129.59	0.55
chan-west-pr	2100	PF 1	216.00	6955.98	6957.55		6957.75	0.026921	3.58	60.39	73.05	0.69
chan-west-pr	2000	PF 1	216.00	6954.57	6956.33		6956.40	0.007727	2.18	99.00	98.58	0.38
chan-west-pr	1950	PF 1	216.00	6953.44	6955.36		6955.46	0.011788	2.46	87.67	99.87	0.46
chan-west-pr	1900	PF 1	216.00	6952.76	6954.87	6954.38	6954.94	0.008956	2.16	100.08	113.09	0.40
chan-west-pr	1850	PF 1	216.00	6951.60	6953.21	6953.01	6953.42	0.030541	3.71	58.24	73.36	0.73
chan-west-pr	1800	PF 1	216.00	6949.31	6951.80		6952.03	0.025255	3.86	55.89	57.00	0.69
chan-west-pr	1700	PF 1	216.00	6947.11	6949.64		6949.88	0.018555	3.92	55.10	43.46	0.61
chan-west-pr	1600	PF 1	216.00	6945.84	6948.22		6948.36	0.012317	3.01	71.84	62.56	0.49
chan-west-pr	1500	PF 1	216.00	6944.87	6947.05	6946.56	6947.15	0.011620	2.58	83.70	87.87	0.47
chan-west-pr	1420	PF 1	216.00	6944.50	6945.02	6945.02	6945.27	0.068516	4.00	54.01	111.39	1.01
chan-west-pr	1400	PF 1	216.00	6941.00	6942.37		6942.41	0.002807	1.55	138.97	107.50	0.24
chan-west-pr	1380	PF 1	216.00	6940.70	6942.34		6942.36	0.001351	1.25	173.31	109.24	0.17
chan-west-pr	1340	PF 1	216.00	6940.60	6942.23		6942.25	0.001417	1.23	175.39	115.13	0.18
chan-west-pr	1300	PF 1	216.00	6939.80	6942.22		6942.22	0.000333	0.77	279.82	126.09	0.09
chan-west-pr	1200	PF 1	216.00	6938.25	6942.20	6938.86	6942.21	0.000098	0.60	372.36	110.12	0.05
chan-west-pr	1042.5		Culvert									
chan-west-pr	900	PF 1	222.00	6935.37	6937.11		6937.14	0.004750	1.34	165.57	110.24	0.19
chan-west-pr	800	PF 1	222.00	6934.42	6936.21		6936.25	0.022095	1.63	144.44	278.92	0.36
chan-west-pr	700	PF 1	222.00	6932.80	6934.12		6934.18	0.019070	1.95	116.30	143.24	0.36
chan-west-pr	600	PF 1	222.00	6930.86	6932.39		6932.44	0.016205	1.95	149.98	250.89	0.34
chan-west-pr	500	PF 1	222.00	6928.40	6929.94		6930.06	0.039501	2.71	81.86	92.95	0.51
chan-west-pr	400	PF 1	222.00	6924.97	6927.96		6928.01	0.012296	1.94	114.60	89.83	0.30
chan-west-pr	350	PF 1	222.00	6924.50	6926.03		6926.15	0.031127	2.79	79.58	74.47	0.47
chan-west-pr	300	PF 1	222.00	6922.38	6924.66		6924.78	0.024170	2.76	80.46	61.39	0.42
chan-west-pr	250	PF 1	222.00	6920.20	6921.88		6922.03	0.031497	3.04	73.10	58.98	0.48
chan-west-pr	200	PF 1	222.00	6919.30	6921.01		6921.07	0.012198	1.85	119.81	99.73	0.30
chan-west-pr	100	PF 1	222.00	6918.00	6920.46		6920.49	0.003285	1.33	169.27	98.32	0.17
chan-west-pr	0	PF 1	222.00	6918.00	6919.14	6919.14	6919.45	0.172225	4.46	49.81	81.02	1.00

Please add station on each side of 1420 to verify limits of supercritical flows

added one upstream at 1440 already have one 20' feet downstream that should suffice.

# PROPOSED WEST CHANNEL 100-Y W/ 0.05 MANNING'S M

HEC-RAS Plan: Plan p02 River: WEST PR Reach: chan-west-pr 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)	
chan-west-pr	2600	PF 1	216.00	6966.83	6967.79	6967.63	6967.89	0.017175	2.56	84.41	158.48	0.62
chan-west-pr	2500	PF 1	216.00	6964.90	6965.69		6965.84	0.024719	3.11	69.55	128.33	0.74
chan-west-pr	2400	PF 1	216.00	6963.25	6964.24		6964.32	0.010073	2.23	96.68	149.12	0.49
chan-west-pr	2300	PF 1	216.00	6961.27	6962.28	6962.26	6962.49	0.041941	3.62	59.72	130.26	0.94
chan-west-pr	2200	PF 1	216.00	6958.46	6959.79		6959.91	0.017246	2.83	76.25	123.46	0.63
chan-west-pr	2100	PF 1	216.00	6955.98	6957.42	6957.32	6957.70	0.029231	4.21	51.33	68.02	0.85
chan-west-pr	2000	PF 1	216.00	6954.57	6956.21		6956.31	0.007626	2.46	87.71	94.82	0.45
chan-west-pr	1950	PF 1	216.00	6953.44	6955.25		6955.37	0.011652	2.82	76.73	93.26	0.55
chan-west-pr	1900	PF 1	216.00	6952.76	6954.78	6954.38	6954.87	0.008390	2.39	90.40	109.75	0.46
chan-west-pr	1850	PF 1	216.00	6951.60	6953.08	6953.01	6953.38	0.032710	4.36	49.50	67.61	0.90
chan-west-pr	1800	PF 1	216.00	6949.31	6951.68		6951.98	0.024247	4.38	49.32	53.15	0.80
chan-west-pr	1700	PF 1	216.00	6947.11	6949.45		6949.78	0.020085	4.61	46.90	40.52	0.75
chan-west-pr	1600	PF 1	216.00	6945.84	6948.07		6948.26	0.011361	3.42	63.14	56.04	0.57
chan-west-pr	1500	PF 1	216.00	6944.87	6946.90	6946.56	6947.05	0.012741	3.04	70.97	81.92	0.58
chan-west-pr	1420	PF 1	216.00	6944.50	6945.02	6945.02	6945.27	0.047580	4.00	54.01	111.39	1.01
chan-west-pr	1400	PF 1	216.00	6941.00	6942.32		6942.36	0.002224	1.62	133.37	107.07	0.26
chan-west-pr	1380	PF 1	216.00	6940.70	6942.30		6942.32	0.001025	1.28	168.68	108.87	0.18
chan-west-pr	1340	PF 1	216.00	6940.60	6942.22		6942.24	0.001009	1.24	173.98	115.03	0.18
chan-west-pr	1300	PF 1	216.00	6939.80	6942.21		6942.22	0.000233	0.77	279.20	126.05	0.09
chan-west-pr	1200	PF 1	216.00	6938.25	6942.20	6938.86	6942.21	0.000068	0.60	372.36	110.12	0.05
chan-west-pr	1042.5		Culvert									
chan-west-pr	900	PF 1	222.00	6935.37	6936.69		6936.75	0.003267	1.84	120.60	106.71	0.31
chan-west-pr	800	PF 1	222.00	6934.42	6935.91	6935.77	6936.05	0.024326	3.02	73.53	142.09	0.73
chan-west-pr	700	PF 1	222.00	6932.80	6933.81	6933.64	6933.94	0.018335	2.96	75.02	120.07	0.66
chan-west-pr	600	PF 1	222.00	6930.86	6932.16	6932.02	6932.29	0.015242	3.19	92.43	239.64	0.62
chan-west-pr	500	PF 1	222.00	6928.40	6929.54	6929.54	6929.87	0.043896	4.61	48.16	75.54	1.02
chan-west-pr	400	PF 1	222.00	6924.97	6927.42	6927.00	6927.58	0.011766	3.15	70.51	72.58	0.56
chan-west-pr	350	PF 1	222.00	6924.50	6925.65		6925.92	0.024709	4.14	53.58	64.05	0.80
chan-west-pr	300	PF 1	222.00	6922.38	6924.03	6924.00	6924.42	0.036342	5.02	44.26	53.01	0.97
chan-west-pr	250	PF 1	222.00	6920.20	6921.53	6921.30	6921.80	0.019310	4.16	53.37	52.66	0.73
chan-west-pr	200	PF 1	222.00	6919.30	6920.34		6920.58	0.031158	3.93	56.53	87.22	0.86
chan-west-pr	100	PF 1	222.00	6918.00	6919.96		6920.01	0.001986	1.78	124.92	80.15	0.25
chan-west-pr	0	PF 1	222.00	6918.00	6919.14	6919.14	6919.45	0.043056	4.46	49.81	81.02	1.00

# PROPOSED WEST CHANNEL 5-Y

HEC-RAS Plan: Plan p02 River: WEST PR Reach: chan-west-pr 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)	
chan-west-pr	2600	PF 1	34.00	6966.83	6967.39	6967.26	6967.42	0.019407	1.25	27.18	124.51	0.47
chan-west-pr	2500	PF 1	34.00	6964.90	6965.27	6965.18	6965.31	0.023072	1.48	22.93	92.66	0.53
chan-west-pr	2400	PF 1	34.00	6963.25	6963.72		6963.74	0.011246	1.15	29.48	101.26	0.38
chan-west-pr	2300	PF 1	34.00	6961.27	6961.88		6961.94	0.032970	1.93	17.64	62.76	0.64
chan-west-pr	2200	PF 1	34.00	6958.46	6959.12		6959.17	0.023467	1.87	18.22	52.79	0.56
chan-west-pr	2100	PF 1	34.00	6955.98	6956.76		6956.83	0.023358	2.11	16.09	38.55	0.58
chan-west-pr	2000	PF 1	34.00	6954.57	6955.41		6955.44	0.009227	1.36	25.06	58.15	0.36
chan-west-pr	1950	PF 1	34.00	6953.44	6954.52		6954.55	0.008387	1.39	24.48	51.04	0.35
chan-west-pr	1900	PF 1	34.00	6952.76	6954.13		6954.15	0.007689	1.18	28.79	71.67	0.33
chan-west-pr	1850	PF 1	34.00	6951.60	6952.31	6952.28	6952.45	0.063385	3.08	11.03	31.69	0.92
chan-west-pr	1800	PF 1	34.00	6949.31	6950.83		6950.91	0.017923	2.22	15.33	27.65	0.53
chan-west-pr	1700	PF 1	34.00	6947.11	6948.42	6948.32	6948.54	0.032435	2.70	12.60	26.41	0.69
chan-west-pr	1600	PF 1	34.00	6945.84	6947.03		6947.08	0.008140	1.71	19.85	29.43	0.37
chan-west-pr	1500	PF 1	34.00	6944.87	6946.24	6945.79	6946.27	0.007907	1.32	25.84	55.78	0.34
chan-west-pr	1420	PF 1	34.00	6944.50	6944.65	6944.65	6944.73	0.099195	2.21	15.36	101.65	1.00
chan-west-pr	1400	PF 1	34.00	6941.00	6941.28		6941.30	0.014911	1.27	26.74	97.99	0.43
chan-west-pr	1380	PF 1	34.00	6940.70	6941.22		6941.22	0.001572	0.63	54.06	104.98	0.15
chan-west-pr	1340	PF 1	34.00	6940.60	6940.75	6940.75	6940.83	0.098507	2.21	15.38	101.36	1.00
chan-west-pr	1300	PF 1	34.00	6939.80	6940.14		6940.15	0.006408	0.95	35.90	108.65	0.29
chan-west-pr	1200	PF 1	34.00	6938.25	6938.43	6938.43	6938.52	0.096858	2.42	14.04	79.74	1.02
chan-west-pr	1042.5		Culvert									
chan-west-pr	900	PF 1	37.00	6935.37	6936.14		6936.15	0.002971	0.59	63.01	102.01	0.13
chan-west-pr	800	PF 1	37.00	6934.42	6935.48		6935.51	0.022046	1.25	29.59	69.26	0.34
chan-west-pr	700	PF 1	37.00	6932.80	6933.46		6933.48	0.018734	1.01	36.53	103.87	0.30
chan-west-pr	600	PF 1	37.00	6930.86	6931.79		6931.81	0.015012	1.18	35.30	108.59	0.29
chan-west-pr	500	PF 1	37.00	6928.40	6929.11		6929.16	0.058101	1.86	19.90	53.15	0.54
chan-west-pr	400	PF 1	37.00	6924.97	6926.72		6926.75	0.013131	1.26	29.31	45.48	0.28
chan-west-pr	350	PF 1	37.00	6924.50	6925.24		6925.26	0.016955	1.27	29.06	54.39	0.31
chan-west-pr	300	PF 1	37.00	6922.38	6923.24		6923.39	0.137106	3.12	11.87	27.76	0.84
chan-west-pr	250	PF 1	37.00	6920.20	6921.11		6921.13	0.008662	1.12	33.03	45.23	0.23
chan-west-pr	200	PF 1	37.00	6919.30	6919.78	6919.78	6919.90	0.234212	2.78	13.33	55.53	1.00
chan-west-pr	100	PF 1	37.00	6918.00	6919.17		6919.17	0.001401	0.55	66.69	66.81	0.10
chan-west-pr	0	PF 1	37.00	6918.00	6918.53	6918.53	6918.68	0.231293	3.07	12.05	42.77	1.02

# PROPOSED WEST CHANNEL 2-Y

HEC-RAS Plan: Plan p02 River: WEST PR Reach: chan-west-pr 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)	
chan-west-pr	2600	PF 1	22.00	6966.83	6967.33	6967.19	6967.35	0.020117	1.10	19.95	113.38	0.46
chan-west-pr	2500	PF 1	22.00	6964.90	6965.21		6965.24	0.022153	1.26	17.51	87.97	0.50
chan-west-pr	2400	PF 1	22.00	6963.25	6963.63		6963.65	0.011997	1.03	21.38	91.49	0.38
chan-west-pr	2300	PF 1	22.00	6961.27	6961.81		6961.85	0.029694	1.65	13.30	55.03	0.59
chan-west-pr	2200	PF 1	22.00	6958.46	6959.01		6959.05	0.026173	1.73	12.73	44.90	0.57
chan-west-pr	2100	PF 1	22.00	6955.98	6956.65		6956.70	0.021236	1.83	12.01	33.18	0.54
chan-west-pr	2000	PF 1	22.00	6954.57	6955.28		6955.30	0.009888	1.23	17.92	50.86	0.36
chan-west-pr	1950	PF 1	22.00	6953.44	6954.38		6954.40	0.008119	1.24	17.71	42.62	0.34
chan-west-pr	1900	PF 1	22.00	6952.76	6954.01		6954.02	0.007109	1.06	20.67	56.66	0.31
chan-west-pr	1850	PF 1	22.00	6951.60	6952.17	6952.17	6952.32	0.081723	3.05	7.22	25.51	1.01
chan-west-pr	1800	PF 1	22.00	6949.31	6950.69		6950.75	0.015060	1.88	11.73	23.85	0.47
chan-west-pr	1700	PF 1	22.00	6947.11	6948.27	6948.19	6948.37	0.042397	2.53	8.68	24.46	0.75
chan-west-pr	1600	PF 1	22.00	6945.84	6946.85		6946.89	0.007356	1.47	14.97	25.90	0.34
chan-west-pr	1500	PF 1	22.00	6944.87	6946.13		6946.14	0.007503	1.12	19.58	51.49	0.32
chan-west-pr	1420	PF 1	22.00	6944.50	6944.62	6944.62	6944.67	0.098664	1.86	11.81	100.70	0.96
chan-west-pr	1400	PF 1	22.00	6941.00	6941.17		6941.20	0.029371	1.31	16.74	97.06	0.56
chan-west-pr	1380	PF 1	22.00	6940.70	6941.12		6941.12	0.001353	0.51	43.50	104.80	0.14
chan-west-pr	1340	PF 1	22.00	6940.60	6940.72	6940.72	6940.77	0.093407	1.83	12.02	101.05	0.94
chan-west-pr	1300	PF 1	22.00	6939.80	6940.06		6940.07	0.006238	0.79	27.80	108.02	0.27
chan-west-pr	1200	PF 1	22.00	6938.25	6938.38	6938.38	6938.45	0.104661	2.09	10.55	79.38	1.01
chan-west-pr	1042.5		Culvert									
chan-west-pr	900	PF 1	24.00	6935.37	6935.98		6935.99	0.003222	0.51	46.99	99.69	0.13
chan-west-pr	800	PF 1	24.00	6934.42	6935.31		6935.33	0.018974	1.19	20.13	45.24	0.32
chan-west-pr	700	PF 1	24.00	6932.80	6933.35		6933.37	0.020207	0.93	25.84	88.60	0.30
chan-west-pr	600	PF 1	24.00	6930.86	6931.67		6931.69	0.014339	1.02	24.64	77.53	0.27
chan-west-pr	500	PF 1	24.00	6928.40	6928.99		6929.03	0.064695	1.72	13.96	45.44	0.55
chan-west-pr	400	PF 1	24.00	6924.97	6926.53		6926.55	0.013000	1.13	21.20	38.42	0.27
chan-west-pr	350	PF 1	24.00	6924.50	6925.12		6925.13	0.015306	1.06	22.62	51.55	0.28
chan-west-pr	300	PF 1	24.00	6922.38	6923.05	6923.05	6923.22	0.215184	3.31	7.24	21.69	1.01
chan-west-pr	250	PF 1	24.00	6920.20	6920.94		6920.95	0.007874	0.94	25.48	42.14	0.21
chan-west-pr	200	PF 1	24.00	6919.30	6919.70	6919.70	6919.80	0.246084	2.54	9.45	46.77	1.00
chan-west-pr	100	PF 1	24.00	6918.00	6918.97		6918.98	0.001118	0.44	53.93	63.53	0.09
chan-west-pr	0	PF 1	24.00	6918.00	6918.45	6918.45	6918.57	0.237386	2.76	8.70	36.96	1.00

# PROPOSED WEST CHANNEL 100-Y

Plan: Plan p02 WEST PR chan-west-pr RS: 2600 Profile: PF 1

E.G. Elev (ft)	6967.93	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.08	Wt. n-Val.		0.060	
W.S. Elev (ft)	6967.85	Reach Len. (ft)	92.00	100.00	105.00
Crit W.S. (ft)		Flow Area (sq ft)		93.12	
E.G. Slope (ft/ft)	0.018480	Area (sq ft)		93.12	
Q Total (cfs)	216.00	Flow (cfs)		216.00	
Top Width (ft)	162.80	Top Width (ft)		162.80	
Vel Total (ft/s)	2.32	Avg. Vel. (ft/s)		2.32	
Max Chl Dpth (ft)	1.02	Hydr. Depth (ft)		0.57	
Conv. Total (cfs)	1588.9	Conv. (cfs)		1588.9	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		162.82	
Min Ch El (ft)	6966.83	Shear (lb/sq ft)		0.66	
Alpha	1.00	Stream Power (lb/ft s)		1.53	
Frctn Loss (ft)	2.03	Cum Volume (acre-ft)	0.07	6.48	0.19
C & E Loss (ft)	0.00	Cum SA (acres)	0.18	6.55	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 2500 Profile: PF 1

E.G. Elev (ft)	6965.90	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.11	Wt. n-Val.		0.060	
W.S. Elev (ft)	6965.79	Reach Len. (ft)	148.70	100.00	20.00
Crit W.S. (ft)		Flow Area (sq ft)		82.02	
E.G. Slope (ft/ft)	0.022300	Area (sq ft)		82.02	
Q Total (cfs)	216.00	Flow (cfs)		216.00	
Top Width (ft)	136.48	Top Width (ft)		136.48	
Vel Total (ft/s)	2.63	Avg. Vel. (ft/s)		2.63	
Max Chl Dpth (ft)	0.89	Hydr. Depth (ft)		0.60	
Conv. Total (cfs)	1446.5	Conv. (cfs)		1446.5	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		136.50	
Min Ch El (ft)	6964.90	Shear (lb/sq ft)		0.84	
Alpha	1.00	Stream Power (lb/ft s)		2.20	
Frctn Loss (ft)	1.51	Cum Volume (acre-ft)	0.07	6.28	0.19
C & E Loss (ft)	0.01	Cum SA (acres)	0.18	6.21	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 2400 Profile: PF 1

E.G. Elev (ft)	6964.37	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.06	Wt. n-Val.		0.060	
W.S. Elev (ft)	6964.31	Reach Len. (ft)	119.30	100.00	96.70
Crit W.S. (ft)		Flow Area (sq ft)		106.60	
E.G. Slope (ft/ft)	0.010916	Area (sq ft)		106.60	
Q Total (cfs)	216.00	Flow (cfs)		216.00	
Top Width (ft)	153.80	Top Width (ft)		153.80	
Vel Total (ft/s)	2.03	Avg. Vel. (ft/s)		2.03	
Max Chl Dpth (ft)	1.06	Hydr. Depth (ft)		0.69	
Conv. Total (cfs)	2067.4	Conv. (cfs)		2067.4	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		153.82	
Min Ch El (ft)	6963.25	Shear (lb/sq ft)		0.47	
Alpha	1.00	Stream Power (lb/ft s)		0.96	
Frctn Loss (ft)	1.85	Cum Volume (acre-ft)	0.07	6.06	0.19
C & E Loss (ft)	0.01	Cum SA (acres)	0.18	5.87	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 2300 Profile: PF 1

E.G. Elev (ft)	6962.51	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.15	Wt. n-Val.		0.060	
W.S. Elev (ft)	6962.36	Reach Len. (ft)	113.10	100.00	97.60
Crit W.S. (ft)		Flow Area (sq ft)		69.57	
E.G. Slope (ft/ft)	0.038187	Area (sq ft)		69.57	
Q Total (cfs)	216.00	Flow (cfs)		216.00	

Plan: Plan p02 WEST PR chan-west-pr RS: 2300 Profile: PF 1 (Continued)

Top Width (ft)	135.31	Top Width (ft)		135.31	
Vel Total (ft/s)	3.10	Avg. Vel. (ft/s)		3.10	
Max Chl Dpth (ft)	1.09	Hydr. Depth (ft)		0.51	
Conv. Total (cfs)	1105.3	Conv. (cfs)		1105.3	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		135.41	
Min Ch El (ft)	6961.27	Shear (lb/sq ft)		1.22	
Alpha	1.00	Stream Power (lb/ft s)		3.80	
Frctn Loss (ft)	2.55	Cum Volume (acre-ft)	0.07	5.86	0.19
C & E Loss (ft)	0.01	Cum SA (acres)	0.18	5.54	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 2200 Profile: PF 1

E.G. Elev (ft)	6959.95	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.10	Wt. n-Val.	0.000	0.060	0.060
W.S. Elev (ft)	6959.85	Reach Len. (ft)	115.00	100.00	72.00
Crit W.S. (ft)		Flow Area (sq ft)	0.00	84.48	0.11
E.G. Slope (ft/ft)	0.018192	Area (sq ft)	0.00	84.48	0.11
Q Total (cfs)	216.00	Flow (cfs)	0.00	215.96	0.04
Top Width (ft)	129.59	Top Width (ft)	0.51	126.05	3.03
Vel Total (ft/s)	2.55	Avg. Vel. (ft/s)	0.11	2.56	0.37
Max Chl Dpth (ft)	1.39	Hydr. Depth (ft)	0.01	0.67	0.04
Conv. Total (cfs)	1601.4	Conv. (cfs)	0.0	1601.1	0.3
Length Wtd. (ft)	100.00	Wetted Per. (ft)	0.51	126.20	3.03
Min Ch El (ft)	6958.46	Shear (lb/sq ft)		0.76	0.04
Alpha	1.00	Stream Power (lb/ft s)		1.94	0.02
Frctn Loss (ft)	2.19	Cum Volume (acre-ft)	0.07	5.68	0.19
C & E Loss (ft)	0.01	Cum SA (acres)	0.18	5.24	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 2100 Profile: PF 1

E.G. Elev (ft)	6957.75	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.20	Wt. n-Val.		0.060	
W.S. Elev (ft)	6957.55	Reach Len. (ft)	71.61	100.00	83.53
Crit W.S. (ft)		Flow Area (sq ft)		60.39	
E.G. Slope (ft/ft)	0.026921	Area (sq ft)		60.39	
Q Total (cfs)	216.00	Flow (cfs)		216.00	
Top Width (ft)	73.05	Top Width (ft)		73.05	
Vel Total (ft/s)	3.58	Avg. Vel. (ft/s)		3.58	
Max Chl Dpth (ft)	1.57	Hydr. Depth (ft)		0.83	
Conv. Total (cfs)	1316.5	Conv. (cfs)		1316.5	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		73.12	
Min Ch El (ft)	6955.98	Shear (lb/sq ft)		1.39	
Alpha	1.00	Stream Power (lb/ft s)		4.96	
Frctn Loss (ft)	1.31	Cum Volume (acre-ft)	0.07	5.52	0.19
C & E Loss (ft)	0.04	Cum SA (acres)	0.18	5.01	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 2000 Profile: PF 1

E.G. Elev (ft)	6956.40	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.07	Wt. n-Val.		0.060	
W.S. Elev (ft)	6956.33	Reach Len. (ft)	91.80	100.00	81.50
Crit W.S. (ft)		Flow Area (sq ft)		99.00	
E.G. Slope (ft/ft)	0.007727	Area (sq ft)		99.00	
Q Total (cfs)	216.00	Flow (cfs)		216.00	
Top Width (ft)	98.58	Top Width (ft)		98.58	
Vel Total (ft/s)	2.18	Avg. Vel. (ft/s)		2.18	
Max Chl Dpth (ft)	1.76	Hydr. Depth (ft)		1.00	
Conv. Total (cfs)	2457.2	Conv. (cfs)		2457.2	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		98.67	
Min Ch El (ft)	6954.57	Shear (lb/sq ft)		0.48	

Plan: Plan p02 WEST PR chan-west-pr RS: 2000 Profile: PF 1 (Continued)

Alpha	1.00	Stream Power (lb/ft s)		1.06	
Frctn Loss (ft)	0.94	Cum Volume (acre-ft)	0.07	5.33	0.19
C & E Loss (ft)	0.00	Cum SA (acres)	0.18	4.82	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 1950 Profile: PF 1

E.G. Elev (ft)	6955.46	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.09	Wt. n-Val.		0.060	
W.S. Elev (ft)	6955.36	Reach Len. (ft)	45.30	50.00	59.50
Crit W.S. (ft)		Flow Area (sq ft)		87.67	
E.G. Slope (ft/ft)	0.011788	Area (sq ft)		87.67	
Q Total (cfs)	216.00	Flow (cfs)		216.00	
Top Width (ft)	99.87	Top Width (ft)		99.87	
Vel Total (ft/s)	2.46	Avg. Vel. (ft/s)		2.46	
Max Chl Dpth (ft)	1.92	Hydr. Depth (ft)		0.88	
Conv. Total (cfs)	1989.4	Conv. (cfs)		1989.4	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		99.95	
Min Ch El (ft)	6953.44	Shear (lb/sq ft)		0.65	
Alpha	1.00	Stream Power (lb/ft s)		1.59	
Frctn Loss (ft)	0.51	Cum Volume (acre-ft)	0.07	5.12	0.19
C & E Loss (ft)	0.01	Cum SA (acres)	0.18	4.59	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 1900 Profile: PF 1

E.G. Elev (ft)	6954.94	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.07	Wt. n-Val.		0.060	
W.S. Elev (ft)	6954.87	Reach Len. (ft)	674.00	100.00	141.40
Crit W.S. (ft)	6954.38	Flow Area (sq ft)		100.08	
E.G. Slope (ft/ft)	0.008956	Area (sq ft)		100.08	
Q Total (cfs)	216.00	Flow (cfs)		216.00	
Top Width (ft)	113.09	Top Width (ft)		113.09	
Vel Total (ft/s)	2.16	Avg. Vel. (ft/s)		2.16	
Max Chl Dpth (ft)	2.11	Hydr. Depth (ft)		0.88	
Conv. Total (cfs)	2282.4	Conv. (cfs)		2282.4	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		113.26	
Min Ch El (ft)	6952.76	Shear (lb/sq ft)		0.49	
Alpha	1.00	Stream Power (lb/ft s)		1.07	
Frctn Loss (ft)	1.51	Cum Volume (acre-ft)	0.07	5.01	0.19
C & E Loss (ft)	0.01	Cum SA (acres)	0.18	4.47	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 1850 Profile: PF 1

E.G. Elev (ft)	6953.42	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.21	Wt. n-Val.		0.060	
W.S. Elev (ft)	6953.21	Reach Len. (ft)	42.60	50.00	58.70
Crit W.S. (ft)	6953.01	Flow Area (sq ft)		58.24	
E.G. Slope (ft/ft)	0.030541	Area (sq ft)		58.24	
Q Total (cfs)	216.00	Flow (cfs)		216.00	
Top Width (ft)	73.36	Top Width (ft)		73.36	
Vel Total (ft/s)	3.71	Avg. Vel. (ft/s)		3.71	
Max Chl Dpth (ft)	1.60	Hydr. Depth (ft)		0.79	
Conv. Total (cfs)	1236.0	Conv. (cfs)		1236.0	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		73.43	
Min Ch El (ft)	6951.60	Shear (lb/sq ft)		1.51	
Alpha	1.00	Stream Power (lb/ft s)		5.61	
Frctn Loss (ft)	1.39	Cum Volume (acre-ft)	0.07	4.83	0.19
C & E Loss (ft)	0.00	Cum SA (acres)	0.18	4.25	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 1800 Profile: PF 1

E.G. Elev (ft)	6952.03	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.23	Wt. n-Val.		0.060	
W.S. Elev (ft)	6951.80	Reach Len. (ft)	99.30	100.00	113.30
Crit W.S. (ft)		Flow Area (sq ft)		55.89	
E.G. Slope (ft/ft)	0.025255	Area (sq ft)		55.89	
Q Total (cfs)	216.00	Flow (cfs)		216.00	
Top Width (ft)	57.00	Top Width (ft)		57.00	
Vel Total (ft/s)	3.86	Avg. Vel. (ft/s)		3.86	
Max Chl Dpth (ft)	2.49	Hydr. Depth (ft)		0.98	
Conv. Total (cfs)	1359.2	Conv. (cfs)		1359.2	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		57.43	
Min Ch El (ft)	6949.31	Shear (lb/sq ft)		1.53	
Alpha	1.00	Stream Power (lb/ft s)		5.93	
Frctn Loss (ft)	2.15	Cum Volume (acre-ft)	0.07	4.76	0.19
C & E Loss (ft)	0.00	Cum SA (acres)	0.18	4.18	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 1700 Profile: PF 1

E.G. Elev (ft)	6949.88	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.24	Wt. n-Val.		0.060	
W.S. Elev (ft)	6949.64	Reach Len. (ft)	113.00	100.00	112.30
Crit W.S. (ft)		Flow Area (sq ft)		55.10	
E.G. Slope (ft/ft)	0.018555	Area (sq ft)		55.10	
Q Total (cfs)	216.00	Flow (cfs)		216.00	
Top Width (ft)	43.46	Top Width (ft)		43.46	
Vel Total (ft/s)	3.92	Avg. Vel. (ft/s)		3.92	
Max Chl Dpth (ft)	2.53	Hydr. Depth (ft)		1.27	
Conv. Total (cfs)	1585.7	Conv. (cfs)		1585.7	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		43.99	
Min Ch El (ft)	6947.11	Shear (lb/sq ft)		1.45	
Alpha	1.00	Stream Power (lb/ft s)		5.69	
Frctn Loss (ft)	1.50	Cum Volume (acre-ft)	0.07	4.64	0.19
C & E Loss (ft)	0.03	Cum SA (acres)	0.18	4.06	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 1600 Profile: PF 1

E.G. Elev (ft)	6948.36	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.14	Wt. n-Val.		0.060	
W.S. Elev (ft)	6948.22	Reach Len. (ft)	113.20	100.00	83.60
Crit W.S. (ft)		Flow Area (sq ft)		71.84	
E.G. Slope (ft/ft)	0.012317	Area (sq ft)		71.84	
Q Total (cfs)	216.00	Flow (cfs)		216.00	
Top Width (ft)	62.56	Top Width (ft)		62.56	
Vel Total (ft/s)	3.01	Avg. Vel. (ft/s)		3.01	
Max Chl Dpth (ft)	2.38	Hydr. Depth (ft)		1.15	
Conv. Total (cfs)	1946.2	Conv. (cfs)		1946.2	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		62.79	
Min Ch El (ft)	6945.84	Shear (lb/sq ft)		0.88	
Alpha	1.00	Stream Power (lb/ft s)		2.65	
Frctn Loss (ft)	1.20	Cum Volume (acre-ft)	0.07	4.49	0.19
C & E Loss (ft)	0.01	Cum SA (acres)	0.18	3.94	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 1500 Profile: PF 1

E.G. Elev (ft)	6947.15	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.10	Wt. n-Val.		0.060	
W.S. Elev (ft)	6947.05	Reach Len. (ft)	69.00	80.00	90.00
Crit W.S. (ft)	6946.56	Flow Area (sq ft)		83.70	
E.G. Slope (ft/ft)	0.011620	Area (sq ft)		83.70	
Q Total (cfs)	216.00	Flow (cfs)		216.00	

Plan: Plan p02 WEST PR chan-west-pr RS: 1500 Profile: PF 1 (Continued)

Top Width (ft)	87.87	Top Width (ft)		87.87	
Vel Total (ft/s)	2.58	Avg. Vel. (ft/s)		2.58	
Max Chl Dpth (ft)	2.18	Hydr. Depth (ft)		0.95	
Conv. Total (cfs)	2003.8	Conv. (cfs)		2003.8	
Length Wtd. (ft)	80.00	Wetted Per. (ft)		88.06	
Min Ch El (ft)	6944.87	Shear (lb/sq ft)		0.69	
Alpha	1.00	Stream Power (lb/ft s)		1.78	
Frctn Loss (ft)	1.87	Cum Volume (acre-ft)	0.07	4.31	0.19
C & E Loss (ft)	0.01	Cum SA (acres)	0.18	3.77	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 1420 Profile: PF 1

E.G. Elev (ft)	6945.27	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.25	Wt. n-Val.		0.060	
W.S. Elev (ft)	6945.02	Reach Len. (ft)	19.90	20.00	20.20
Crit W.S. (ft)	6945.02	Flow Area (sq ft)		54.01	
E.G. Slope (ft/ft)	0.068516	Area (sq ft)		54.01	
Q Total (cfs)	216.00	Flow (cfs)		216.00	
Top Width (ft)	111.39	Top Width (ft)		111.39	
Vel Total (ft/s)	4.00	Avg. Vel. (ft/s)		4.00	
Max Chl Dpth (ft)	0.52	Hydr. Depth (ft)		0.48	
Conv. Total (cfs)	825.2	Conv. (cfs)		825.2	
Length Wtd. (ft)	20.00	Wetted Per. (ft)		111.45	
Min Ch El (ft)	6944.50	Shear (lb/sq ft)		2.07	
Alpha	1.00	Stream Power (lb/ft s)		8.29	
Frctn Loss (ft)	0.16	Cum Volume (acre-ft)	0.07	4.18	0.19
C & E Loss (ft)	0.06	Cum SA (acres)	0.18	3.59	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 1400 Profile: PF 1

E.G. Elev (ft)	6942.41	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.04	Wt. n-Val.		0.060	
W.S. Elev (ft)	6942.37	Reach Len. (ft)	19.90	20.00	21.00
Crit W.S. (ft)		Flow Area (sq ft)		138.97	
E.G. Slope (ft/ft)	0.002807	Area (sq ft)		138.97	
Q Total (cfs)	216.00	Flow (cfs)		216.00	
Top Width (ft)	107.50	Top Width (ft)		107.50	
Vel Total (ft/s)	1.55	Avg. Vel. (ft/s)		1.55	
Max Chl Dpth (ft)	1.37	Hydr. Depth (ft)		1.29	
Conv. Total (cfs)	4076.6	Conv. (cfs)		4076.6	
Length Wtd. (ft)	20.00	Wetted Per. (ft)		107.81	
Min Ch El (ft)	6941.00	Shear (lb/sq ft)		0.23	
Alpha	1.00	Stream Power (lb/ft s)		0.35	
Frctn Loss (ft)	0.04	Cum Volume (acre-ft)	0.07	4.14	0.19
C & E Loss (ft)	0.00	Cum SA (acres)	0.18	3.54	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 1380 Profile: PF 1

E.G. Elev (ft)	6942.36	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.02	Wt. n-Val.	0.060	0.060	0.060
W.S. Elev (ft)	6942.34	Reach Len. (ft)	53.20	80.00	101.00
Crit W.S. (ft)		Flow Area (sq ft)	0.23	172.81	0.27
E.G. Slope (ft/ft)	0.001351	Area (sq ft)	0.23	172.81	0.27
Q Total (cfs)	216.00	Flow (cfs)	0.06	215.86	0.08
Top Width (ft)	109.24	Top Width (ft)	1.34	106.30	1.59
Vel Total (ft/s)	1.25	Avg. Vel. (ft/s)	0.27	1.25	0.28
Max Chl Dpth (ft)	1.64	Hydr. Depth (ft)	0.17	1.63	0.17
Conv. Total (cfs)	5876.6	Conv. (cfs)	1.7	5872.9	2.1
Length Wtd. (ft)	80.00	Wetted Per. (ft)	1.38	107.51	1.63
Min Ch El (ft)	6940.70	Shear (lb/sq ft)	0.01	0.14	0.01

Plan: Plan p02 WEST PR chan-west-pr RS: 1380 Profile: PF 1 (Continued)

Alpha	1.00	Stream Power (lb/ft s)	0.00	0.17	0.00
Frctn Loss (ft)	0.11	Cum Volume (acre-ft)	0.07	4.07	0.19
C & E Loss (ft)	0.00	Cum SA (acres)	0.18	3.49	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 1340 Profile: PF 1

E.G. Elev (ft)	6942.25	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.02	Wt. n-Val.		0.060	
W.S. Elev (ft)	6942.23	Reach Len. (ft)	29.00	40.00	51.00
Crit W.S. (ft)		Flow Area (sq ft)		175.39	
E.G. Slope (ft/ft)	0.001417	Area (sq ft)		175.39	
Q Total (cfs)	216.00	Flow (cfs)		216.00	
Top Width (ft)	115.13	Top Width (ft)		115.13	
Vel Total (ft/s)	1.23	Avg. Vel. (ft/s)		1.23	
Max Chl Dpth (ft)	1.63	Hydr. Depth (ft)		1.52	
Conv. Total (cfs)	5738.6	Conv. (cfs)		5738.6	
Length Wtd. (ft)	40.00	Wetted Per. (ft)		115.49	
Min Ch El (ft)	6940.60	Shear (lb/sq ft)		0.13	
Alpha	1.00	Stream Power (lb/ft s)		0.17	
Frctn Loss (ft)	0.02	Cum Volume (acre-ft)	0.07	3.75	0.19
C & E Loss (ft)	0.00	Cum SA (acres)	0.18	3.28	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 1300 Profile: PF 1

E.G. Elev (ft)	6942.22	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.01	Wt. n-Val.	0.060	0.060	0.060
W.S. Elev (ft)	6942.22	Reach Len. (ft)	107.40	100.00	88.80
Crit W.S. (ft)		Flow Area (sq ft)	0.05	279.68	0.09
E.G. Slope (ft/ft)	0.000333	Area (sq ft)	0.05	279.68	0.09
Q Total (cfs)	216.00	Flow (cfs)	0.00	215.99	0.01
Top Width (ft)	126.09	Top Width (ft)	0.64	124.60	0.85
Vel Total (ft/s)	0.77	Avg. Vel. (ft/s)	0.08	0.77	0.10
Max Chl Dpth (ft)	2.42	Hydr. Depth (ft)	0.07	2.24	0.11
Conv. Total (cfs)	11843.2	Conv. (cfs)	0.2	11842.5	0.5
Length Wtd. (ft)	99.98	Wetted Per. (ft)	0.66	125.10	0.88
Min Ch El (ft)	6939.80	Shear (lb/sq ft)	0.00	0.05	0.00
Alpha	1.00	Stream Power (lb/ft s)	0.00	0.04	0.00
Frctn Loss (ft)	0.02	Cum Volume (acre-ft)	0.07	3.54	0.19
C & E Loss (ft)	0.00	Cum SA (acres)	0.18	3.17	0.59

Plan: Plan p02 WEST PR chan-west-pr RS: 1200 Profile: PF 1

E.G. Elev (ft)	6942.21	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.01	Wt. n-Val.	0.060	0.060	0.060
W.S. Elev (ft)	6942.20	Reach Len. (ft)	313.70	300.00	276.40
Crit W.S. (ft)	6938.86	Flow Area (sq ft)	9.72	352.84	9.80
E.G. Slope (ft/ft)	0.000098	Area (sq ft)	9.72	352.84	9.80
Q Total (cfs)	216.00	Flow (cfs)	2.50	210.98	2.52
Top Width (ft)	110.12	Top Width (ft)	8.82	92.43	8.88
Vel Total (ft/s)	0.58	Avg. Vel. (ft/s)	0.26	0.60	0.26
Max Chl Dpth (ft)	3.95	Hydr. Depth (ft)	1.10	3.82	1.10
Conv. Total (cfs)	21784.3	Conv. (cfs)	251.9	21278.3	254.0
Length Wtd. (ft)	300.00	Wetted Per. (ft)	9.09	92.86	9.14
Min Ch El (ft)	6938.25	Shear (lb/sq ft)	0.01	0.02	0.01
Alpha	1.04	Stream Power (lb/ft s)	0.00	0.01	0.00
Frctn Loss (ft)		Cum Volume (acre-ft)	0.06	2.81	0.18
C & E Loss (ft)		Cum SA (acres)	0.16	2.92	0.58

Plan: Plan p02 WEST PR chan-west-pr RS: 900 Profile: PF 1

E.G. Elev (ft)	6937.14	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.03	Wt. n-Val.		0.100	
W.S. Elev (ft)	6937.11	Reach Len. (ft)	104.20	100.00	101.80
Crit W.S. (ft)		Flow Area (sq ft)		165.57	
E.G. Slope (ft/ft)	0.004750	Area (sq ft)		165.57	
Q Total (cfs)	222.00	Flow (cfs)		222.00	
Top Width (ft)	110.24	Top Width (ft)		110.24	
Vel Total (ft/s)	1.34	Avg. Vel. (ft/s)		1.34	
Max Chl Dpth (ft)	1.74	Hydr. Depth (ft)		1.50	
Conv. Total (cfs)	3221.0	Conv. (cfs)		3221.0	
Length Wtd. (ft)	100.05	Wetted Per. (ft)		110.52	
Min Ch El (ft)	6935.37	Shear (lb/sq ft)		0.44	
Alpha	1.00	Stream Power (lb/ft s)		0.60	
Frctn Loss (ft)	0.89	Cum Volume (acre-ft)	0.06	2.39	0.18
C & E Loss (ft)	0.00	Cum SA (acres)	0.13	2.23	0.55

Plan: Plan p02 WEST PR chan-west-pr RS: 800 Profile: PF 1

E.G. Elev (ft)	6936.25	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.04	Wt. n-Val.		0.100	0.100
W.S. Elev (ft)	6936.21	Reach Len. (ft)	96.40	100.00	114.30
Crit W.S. (ft)		Flow Area (sq ft)		128.33	16.11
E.G. Slope (ft/ft)	0.022095	Area (sq ft)		128.33	16.11
Q Total (cfs)	222.00	Flow (cfs)		209.51	12.49
Top Width (ft)	278.92	Top Width (ft)		201.88	77.04
Vel Total (ft/s)	1.54	Avg. Vel. (ft/s)		1.63	0.78
Max Chl Dpth (ft)	1.79	Hydr. Depth (ft)		0.64	0.21
Conv. Total (cfs)	1493.5	Conv. (cfs)		1409.5	84.1
Length Wtd. (ft)	100.48	Wetted Per. (ft)		201.96	77.36
Min Ch El (ft)	6934.42	Shear (lb/sq ft)		0.88	0.29
Alpha	1.08	Stream Power (lb/ft s)		1.43	0.22
Frctn Loss (ft)	2.06	Cum Volume (acre-ft)	0.06	2.06	0.16
C & E Loss (ft)	0.00	Cum SA (acres)	0.13	1.87	0.46

Plan: Plan p02 WEST PR chan-west-pr RS: 700 Profile: PF 1

E.G. Elev (ft)	6934.18	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.06	Wt. n-Val.	0.100	0.100	0.100
W.S. Elev (ft)	6934.12	Reach Len. (ft)	114.30	100.00	85.80
Crit W.S. (ft)		Flow Area (sq ft)	0.03	112.56	3.71
E.G. Slope (ft/ft)	0.019070	Area (sq ft)	0.03	112.56	3.71
Q Total (cfs)	222.00	Flow (cfs)	0.01	219.62	2.37
Top Width (ft)	143.24	Top Width (ft)	0.52	121.30	21.42
Vel Total (ft/s)	1.91	Avg. Vel. (ft/s)	0.31	1.95	0.64
Max Chl Dpth (ft)	1.32	Hydr. Depth (ft)	0.06	0.93	0.17
Conv. Total (cfs)	1607.6	Conv. (cfs)	0.1	1590.4	17.1
Length Wtd. (ft)	98.61	Wetted Per. (ft)	0.53	121.38	21.43
Min Ch El (ft)	6932.80	Shear (lb/sq ft)	0.07	1.10	0.21
Alpha	1.03	Stream Power (lb/ft s)	0.02	2.15	0.13
Frctn Loss (ft)	1.73	Cum Volume (acre-ft)	0.06	1.78	0.13
C & E Loss (ft)	0.00	Cum SA (acres)	0.13	1.50	0.33

Plan: Plan p02 WEST PR chan-west-pr RS: 600 Profile: PF 1

E.G. Elev (ft)	6932.44	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.04	Wt. n-Val.	0.100	0.100	0.100
W.S. Elev (ft)	6932.39	Reach Len. (ft)	110.80	100.00	88.00
Crit W.S. (ft)		Flow Area (sq ft)	22.49	67.41	60.08
E.G. Slope (ft/ft)	0.016205	Area (sq ft)	22.49	67.41	60.08
Q Total (cfs)	222.00	Flow (cfs)	24.75	131.27	65.98

Plan: Plan p02 WEST PR chan-west-pr RS: 600 Profile: PF 1 (Continued)

Top Width (ft)	250.89	Top Width (ft)	50.59	64.50	135.79
Vel Total (ft/s)	1.48	Avg. Vel. (ft/s)	1.10	1.95	1.10
Max Chl Dpth (ft)	1.53	Hydr. Depth (ft)	0.44	1.05	0.44
Conv. Total (cfs)	1743.9	Conv. (cfs)	194.4	1031.2	518.3
Length Wtd. (ft)	98.82	Wetted Per. (ft)	50.70	64.53	135.80
Min Ch El (ft)	6930.86	Shear (lb/sq ft)	0.45	1.06	0.45
Alpha	1.25	Stream Power (lb/ft s)	0.49	2.06	0.49
Frctn Loss (ft)	2.38	Cum Volume (acre-ft)	0.03	1.57	0.07
C & E Loss (ft)	0.01	Cum SA (acres)	0.07	1.28	0.17

Plan: Plan p02 WEST PR chan-west-pr RS: 500 Profile: PF 1

E.G. Elev (ft)	6930.06	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.11	Wt. n-Val.		0.100	
W.S. Elev (ft)	6929.94	Reach Len. (ft)	85.20	100.00	105.50
Crit W.S. (ft)		Flow Area (sq ft)		81.86	
E.G. Slope (ft/ft)	0.039501	Area (sq ft)		81.86	
Q Total (cfs)	222.00	Flow (cfs)		222.00	
Top Width (ft)	92.95	Top Width (ft)		92.95	
Vel Total (ft/s)	2.71	Avg. Vel. (ft/s)		2.71	
Max Chl Dpth (ft)	1.54	Hydr. Depth (ft)		0.88	
Conv. Total (cfs)	1117.0	Conv. (cfs)		1117.0	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		93.01	
Min Ch El (ft)	6928.40	Shear (lb/sq ft)		2.17	
Alpha	1.00	Stream Power (lb/ft s)		5.89	
Frctn Loss (ft)	2.03	Cum Volume (acre-ft)	0.00	1.40	0.01
C & E Loss (ft)	0.02	Cum SA (acres)	0.00	1.10	0.04

Plan: Plan p02 WEST PR chan-west-pr RS: 400 Profile: PF 1

E.G. Elev (ft)	6928.01	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.06	Wt. n-Val.	0.100	0.100	
W.S. Elev (ft)	6927.96	Reach Len. (ft)	95.20	100.00	105.50
Crit W.S. (ft)		Flow Area (sq ft)	0.04	114.56	
E.G. Slope (ft/ft)	0.012296	Area (sq ft)	0.04	114.56	
Q Total (cfs)	222.00	Flow (cfs)	0.01	221.99	
Top Width (ft)	89.83	Top Width (ft)	0.50	89.33	
Vel Total (ft/s)	1.94	Avg. Vel. (ft/s)	0.31	1.94	
Max Chl Dpth (ft)	2.98	Hydr. Depth (ft)	0.09	1.28	
Conv. Total (cfs)	2002.0	Conv. (cfs)	0.1	2001.9	
Length Wtd. (ft)	100.00	Wetted Per. (ft)	0.53	89.82	
Min Ch El (ft)	6924.97	Shear (lb/sq ft)	0.06	0.98	
Alpha	1.00	Stream Power (lb/ft s)	0.02	1.90	
Frctn Loss (ft)	1.85	Cum Volume (acre-ft)	0.00	1.18	0.01
C & E Loss (ft)	0.01	Cum SA (acres)	0.00	0.89	0.04

Plan: Plan p02 WEST PR chan-west-pr RS: 350 Profile: PF 1

E.G. Elev (ft)	6926.15	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.12	Wt. n-Val.		0.100	0.100
W.S. Elev (ft)	6926.03	Reach Len. (ft)	54.40	50.00	47.00
Crit W.S. (ft)		Flow Area (sq ft)		79.55	0.03
E.G. Slope (ft/ft)	0.031127	Area (sq ft)		79.55	0.03
Q Total (cfs)	222.00	Flow (cfs)		221.99	0.01
Top Width (ft)	74.47	Top Width (ft)		72.29	2.18
Vel Total (ft/s)	2.79	Avg. Vel. (ft/s)		2.79	0.16
Max Chl Dpth (ft)	1.53	Hydr. Depth (ft)		1.10	0.01
Conv. Total (cfs)	1258.3	Conv. (cfs)		1258.3	0.0
Length Wtd. (ft)	50.00	Wetted Per. (ft)		72.43	2.18
Min Ch El (ft)	6924.50	Shear (lb/sq ft)		2.13	0.03

Plan: Plan p02 WEST PR chan-west-pr RS: 350 Profile: PF 1 (Continued)

Alpha	1.00	Stream Power (lb/ft s)		5.96	0.00
Frctn Loss (ft)	1.37	Cum Volume (acre-ft)		0.95	0.01
C & E Loss (ft)	0.00	Cum SA (acres)		0.71	0.03

Plan: Plan p02 WEST PR chan-west-pr RS: 300 Profile: PF 1

E.G. Elev (ft)	6924.78	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.12	Wt. n-Val.		0.100	
W.S. Elev (ft)	6924.66	Reach Len. (ft)	113.50	100.00	139.70
Crit W.S. (ft)		Flow Area (sq ft)		80.46	
E.G. Slope (ft/ft)	0.024170	Area (sq ft)		80.46	
Q Total (cfs)	222.00	Flow (cfs)		222.00	
Top Width (ft)	61.39	Top Width (ft)		61.39	
Vel Total (ft/s)	2.76	Avg. Vel. (ft/s)		2.76	
Max Chl Dpth (ft)	2.28	Hydr. Depth (ft)		1.31	
Conv. Total (cfs)	1428.0	Conv. (cfs)		1428.0	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		61.63	
Min Ch El (ft)	6922.38	Shear (lb/sq ft)		1.97	
Alpha	1.00	Stream Power (lb/ft s)		5.44	
Frctn Loss (ft)	2.75	Cum Volume (acre-ft)		0.86	0.01
C & E Loss (ft)	0.00	Cum SA (acres)		0.63	0.03

Plan: Plan p02 WEST PR chan-west-pr RS: 250 Profile: PF 1

E.G. Elev (ft)	6922.03	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.14	Wt. n-Val.		0.100	
W.S. Elev (ft)	6921.88	Reach Len. (ft)	53.00	50.00	52.00
Crit W.S. (ft)		Flow Area (sq ft)		73.10	
E.G. Slope (ft/ft)	0.031497	Area (sq ft)		73.10	
Q Total (cfs)	222.00	Flow (cfs)		222.00	
Top Width (ft)	58.98	Top Width (ft)		58.98	
Vel Total (ft/s)	3.04	Avg. Vel. (ft/s)		3.04	
Max Chl Dpth (ft)	1.68	Hydr. Depth (ft)		1.24	
Conv. Total (cfs)	1250.9	Conv. (cfs)		1250.9	
Length Wtd. (ft)	50.00	Wetted Per. (ft)		59.16	
Min Ch El (ft)	6920.20	Shear (lb/sq ft)		2.43	
Alpha	1.00	Stream Power (lb/ft s)		7.38	
Frctn Loss (ft)	0.93	Cum Volume (acre-ft)		0.69	0.01
C & E Loss (ft)	0.03	Cum SA (acres)		0.49	0.03

Plan: Plan p02 WEST PR chan-west-pr RS: 200 Profile: PF 1

E.G. Elev (ft)	6921.07	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.05	Wt. n-Val.		0.100	
W.S. Elev (ft)	6921.01	Reach Len. (ft)	109.50	100.00	110.20
Crit W.S. (ft)		Flow Area (sq ft)		119.81	
E.G. Slope (ft/ft)	0.012198	Area (sq ft)		119.81	
Q Total (cfs)	222.00	Flow (cfs)		222.00	
Top Width (ft)	99.73	Top Width (ft)		99.73	
Vel Total (ft/s)	1.85	Avg. Vel. (ft/s)		1.85	
Max Chl Dpth (ft)	1.71	Hydr. Depth (ft)		1.20	
Conv. Total (cfs)	2010.1	Conv. (cfs)		2010.1	
Length Wtd. (ft)	100.02	Wetted Per. (ft)		99.86	
Min Ch El (ft)	6919.30	Shear (lb/sq ft)		0.91	
Alpha	1.00	Stream Power (lb/ft s)		1.69	
Frctn Loss (ft)	0.57	Cum Volume (acre-ft)		0.58	0.01
C & E Loss (ft)	0.01	Cum SA (acres)		0.40	0.03

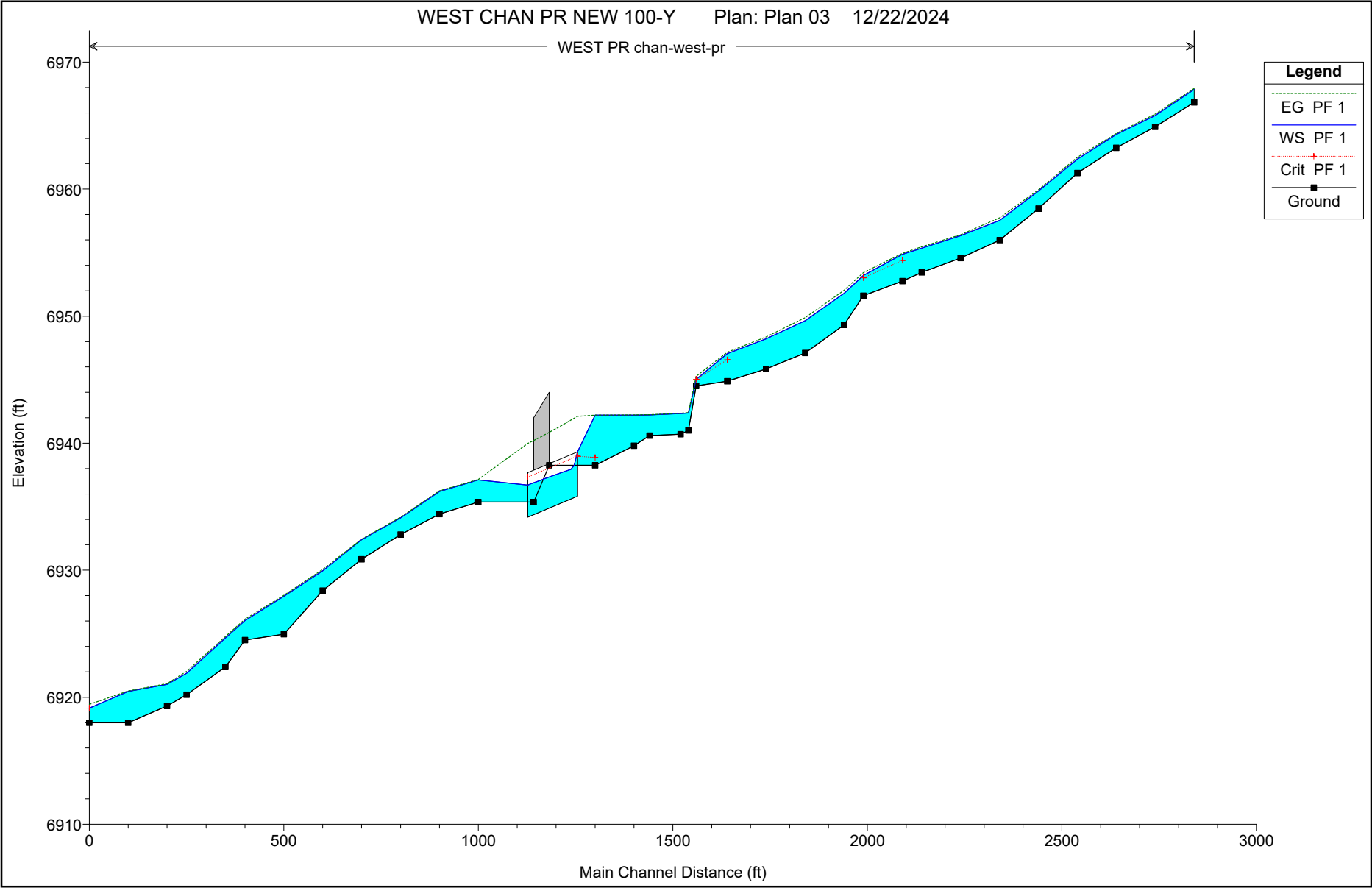
Plan: Plan p02 WEST PR chan-west-pr RS: 100 Profile: PF 1

E.G. Elev (ft)	6920.49	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.03	Wt. n-Val.		0.100	0.100
W.S. Elev (ft)	6920.46	Reach Len. (ft)	97.00	100.00	105.00
Crit W.S. (ft)		Flow Area (sq ft)		166.17	3.10
E.G. Slope (ft/ft)	0.003285	Area (sq ft)		166.17	3.10
Q Total (cfs)	222.00	Flow (cfs)		221.01	0.99
Top Width (ft)	98.32	Top Width (ft)		84.87	13.45
Vel Total (ft/s)	1.31	Avg. Vel. (ft/s)		1.33	0.32
Max Chl Dpth (ft)	2.46	Hydr. Depth (ft)		1.96	0.23
Conv. Total (cfs)	3873.6	Conv. (cfs)		3856.3	17.3
Length Wtd. (ft)	100.01	Wetted Per. (ft)		85.14	13.46
Min Ch El (ft)	6918.00	Shear (lb/sq ft)		0.40	0.05
Alpha	1.02	Stream Power (lb/ft s)		0.53	0.02
Frctn Loss (ft)	1.01	Cum Volume (acre-ft)		0.25	0.00
C & E Loss (ft)	0.03	Cum SA (acres)		0.19	0.02

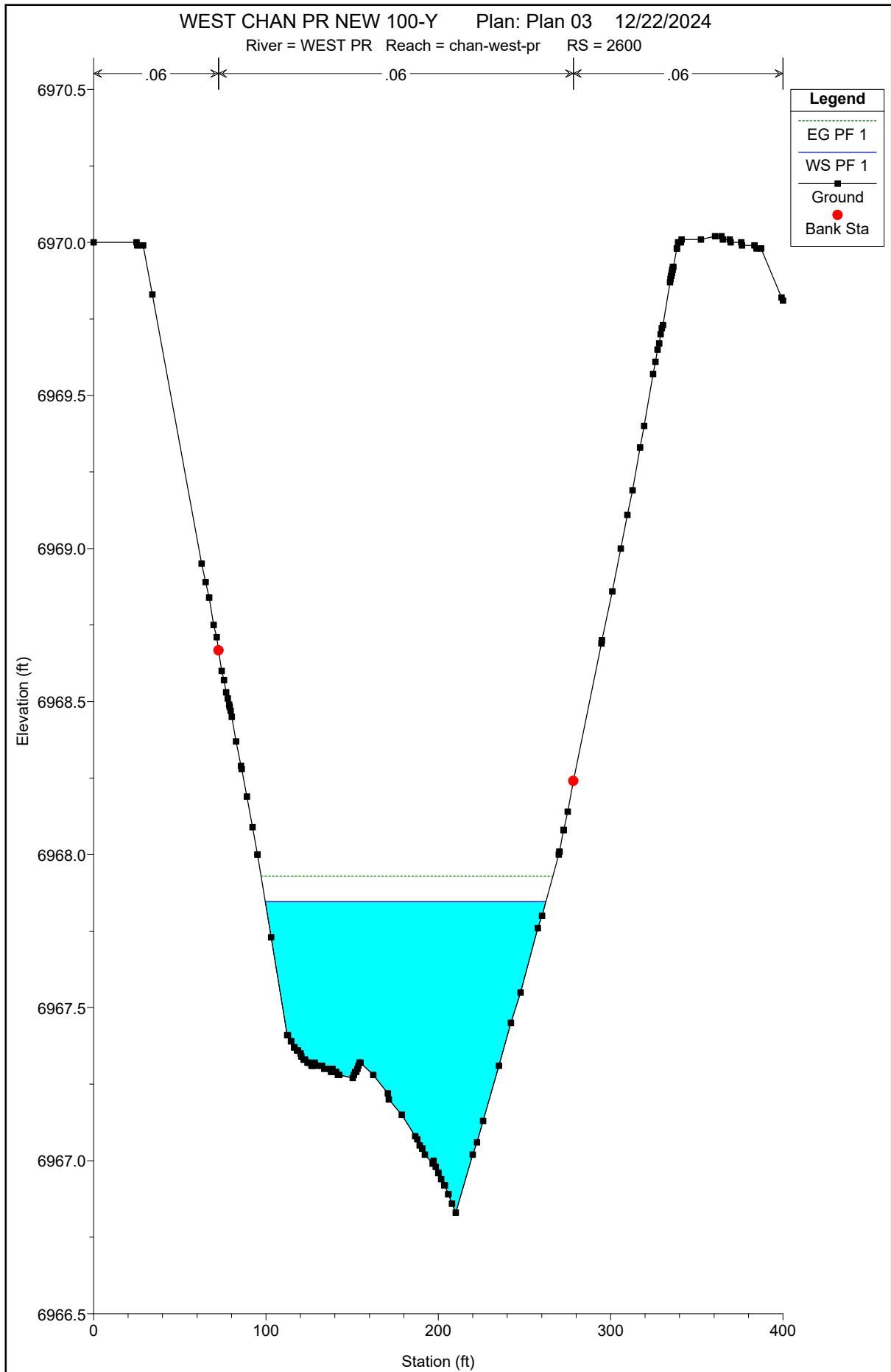
Plan: Plan p02 WEST PR chan-west-pr RS: 0 Profile: PF 1

E.G. Elev (ft)	6919.45	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.31	Wt. n-Val.		0.100	
W.S. Elev (ft)	6919.14	Reach Len. (ft)			
Crit W.S. (ft)	6919.14	Flow Area (sq ft)		49.81	
E.G. Slope (ft/ft)	0.172225	Area (sq ft)		49.81	
Q Total (cfs)	222.00	Flow (cfs)		222.00	
Top Width (ft)	81.02	Top Width (ft)		81.02	
Vel Total (ft/s)	4.46	Avg. Vel. (ft/s)		4.46	
Max Chl Dpth (ft)	1.14	Hydr. Depth (ft)		0.61	
Conv. Total (cfs)	534.9	Conv. (cfs)		534.9	
Length Wtd. (ft)		Wetted Per. (ft)		81.06	
Min Ch El (ft)	6918.00	Shear (lb/sq ft)		6.61	
Alpha	1.00	Stream Power (lb/ft s)		29.45	
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			

# PROPOSED WEST CHANNEL 100-Y

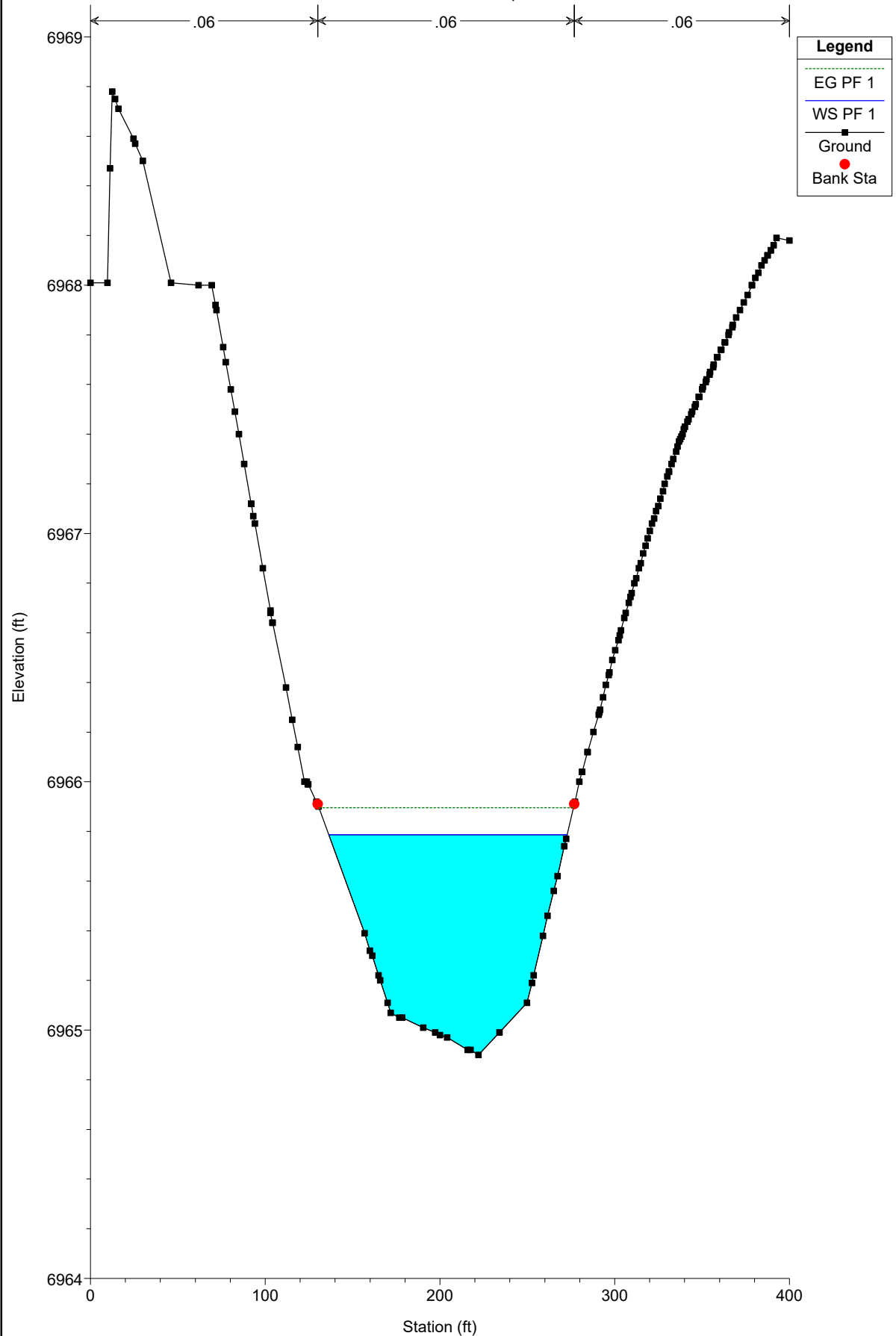


# PROPOSED WEST CHANNEL 100-Y



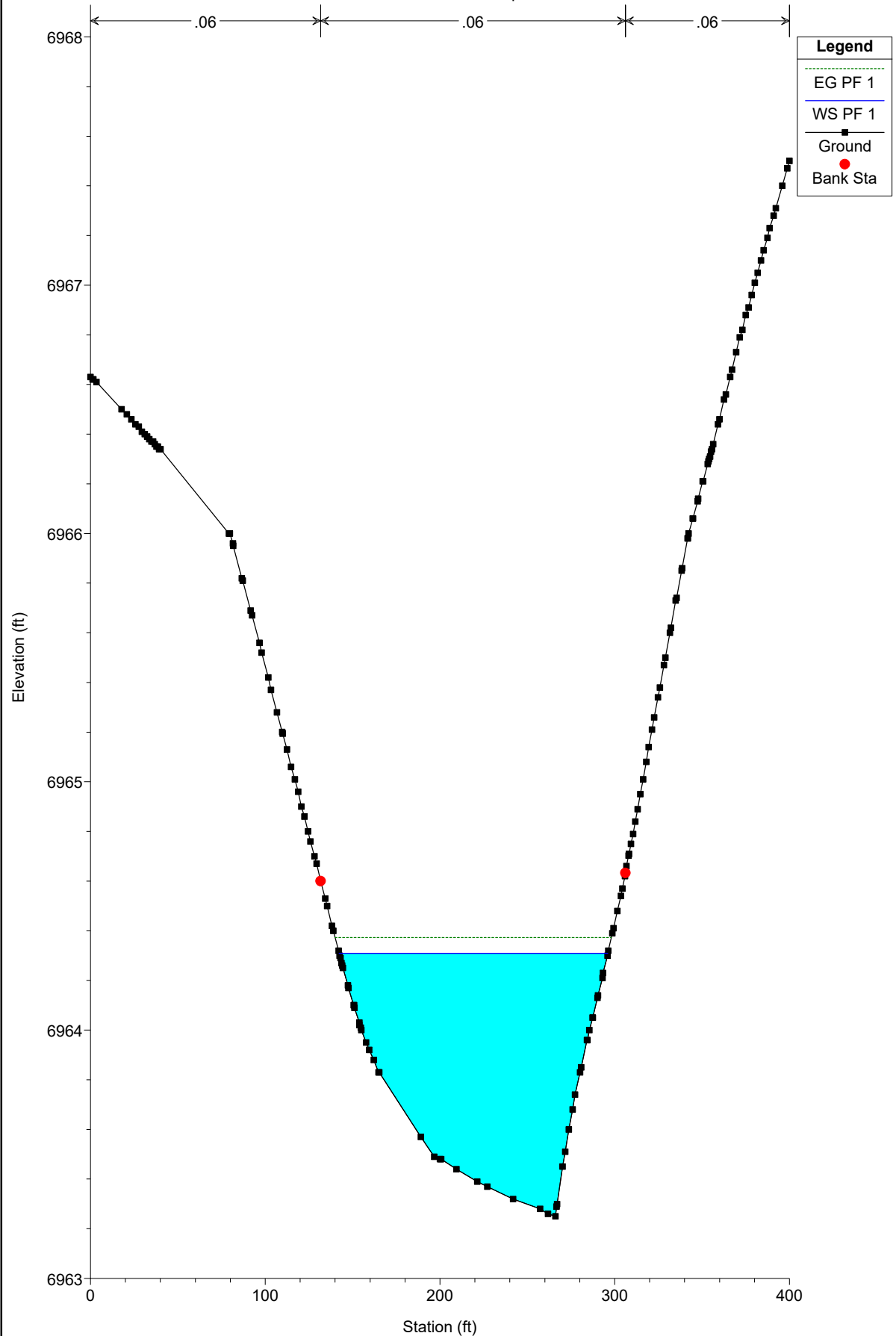
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 2500 2500



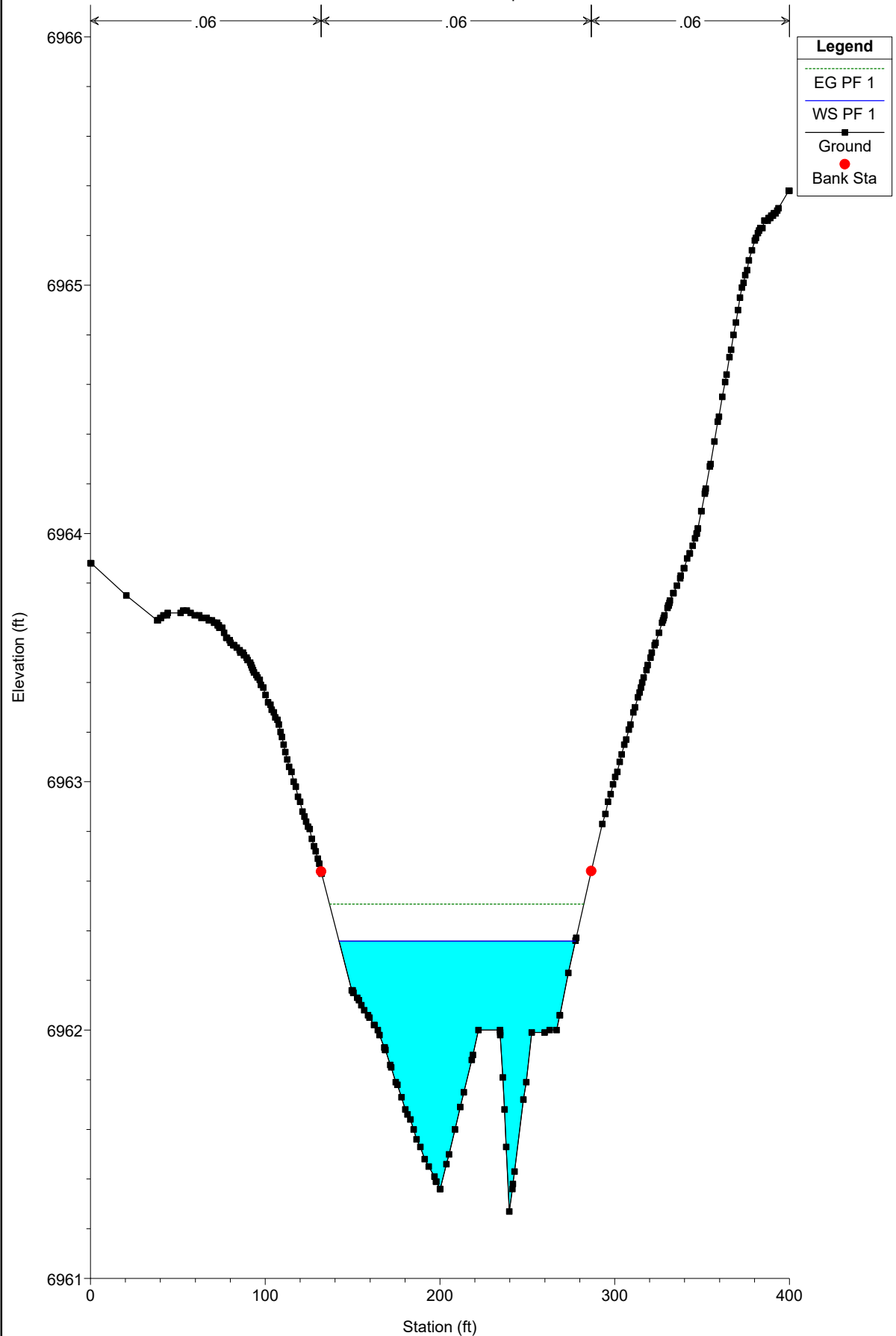
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 2400 2400



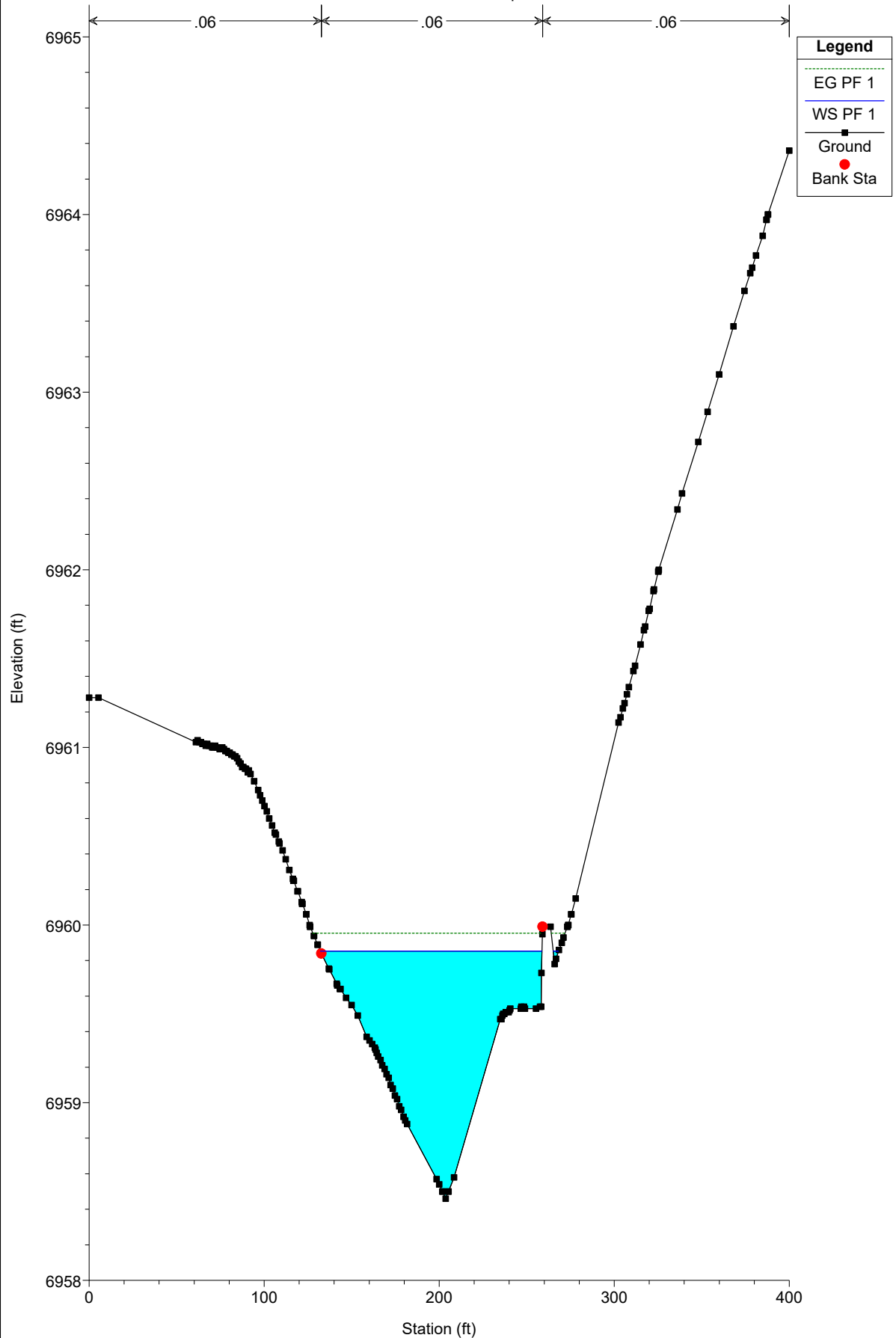
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 2300 2300



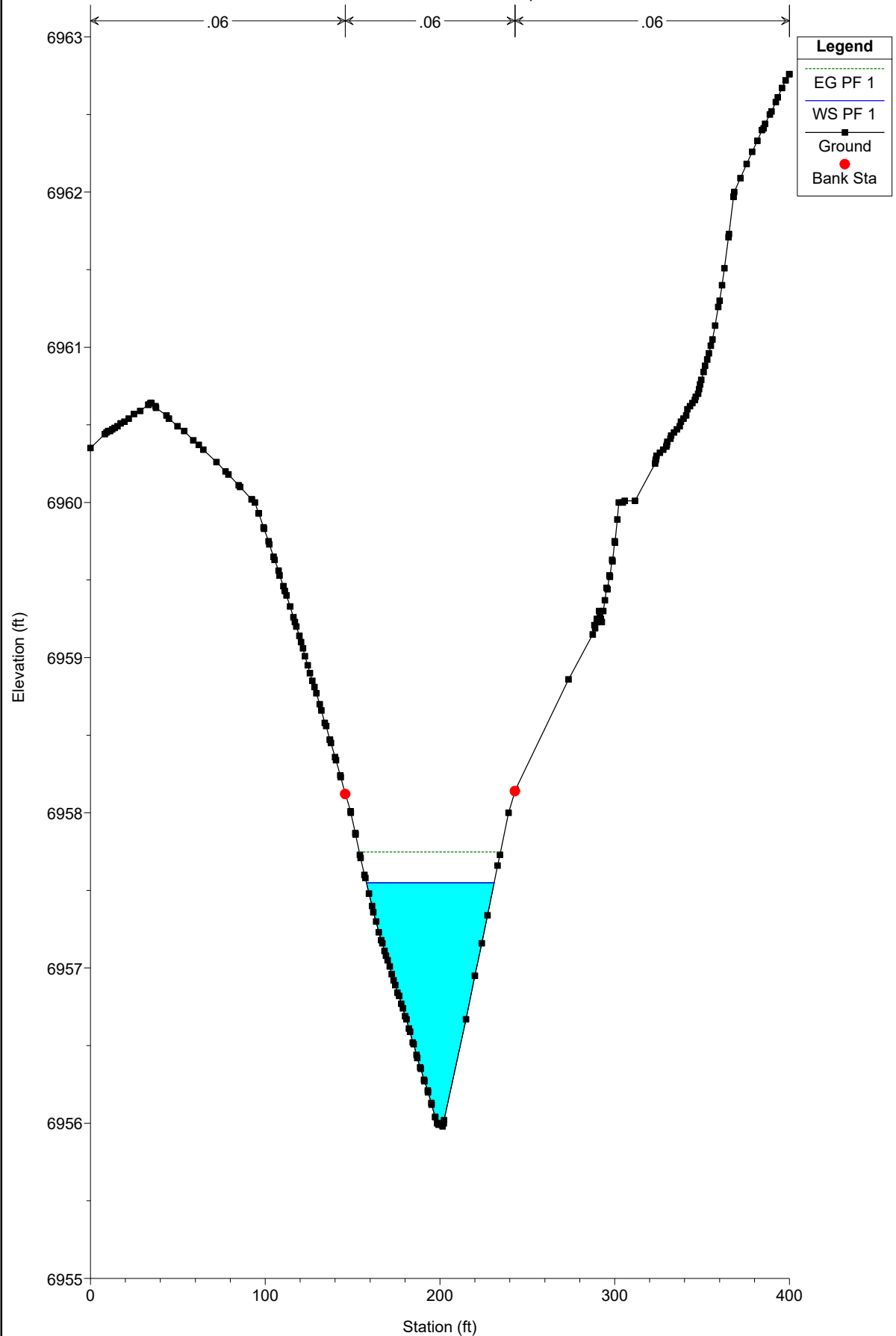
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 2200 2200



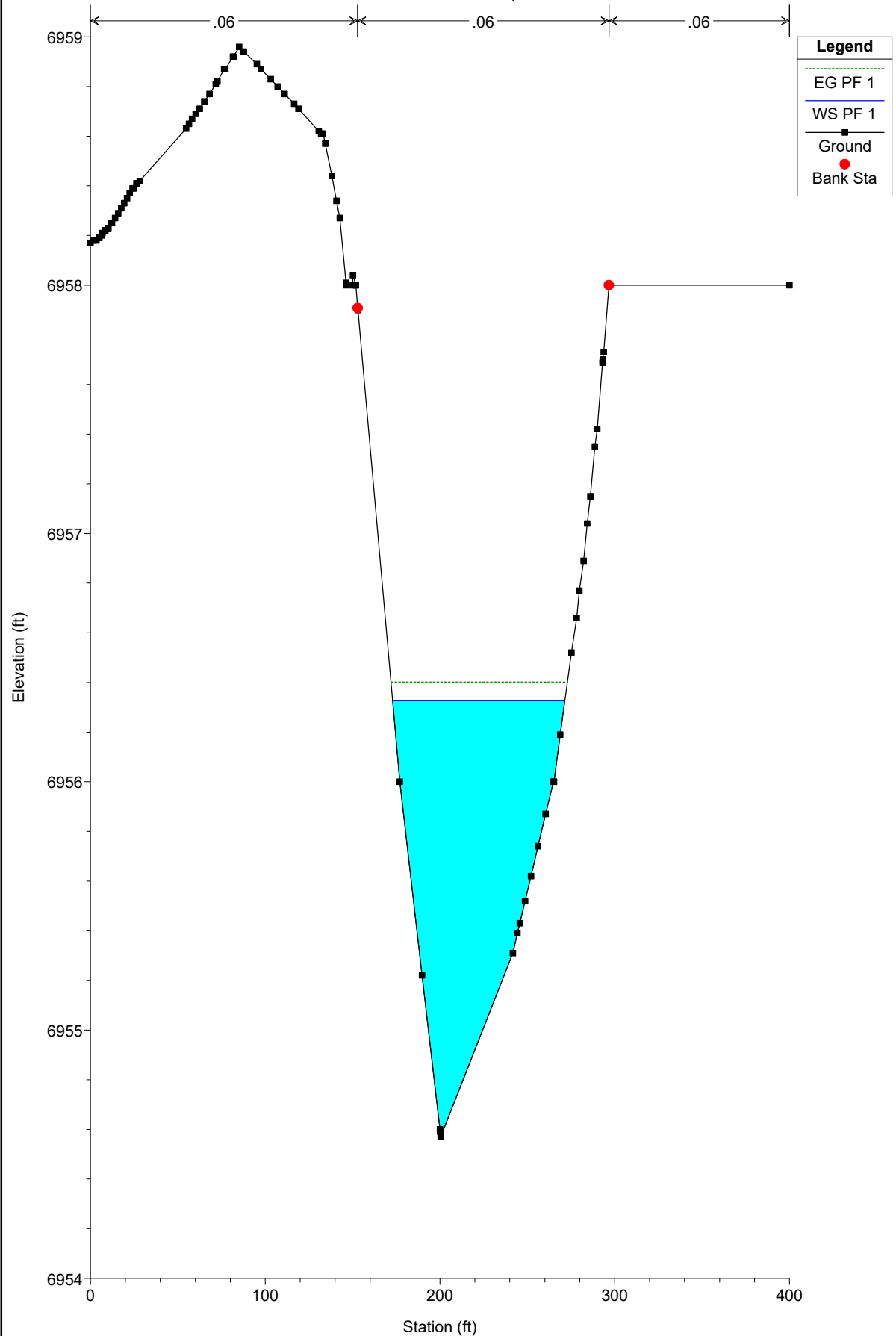
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 2100



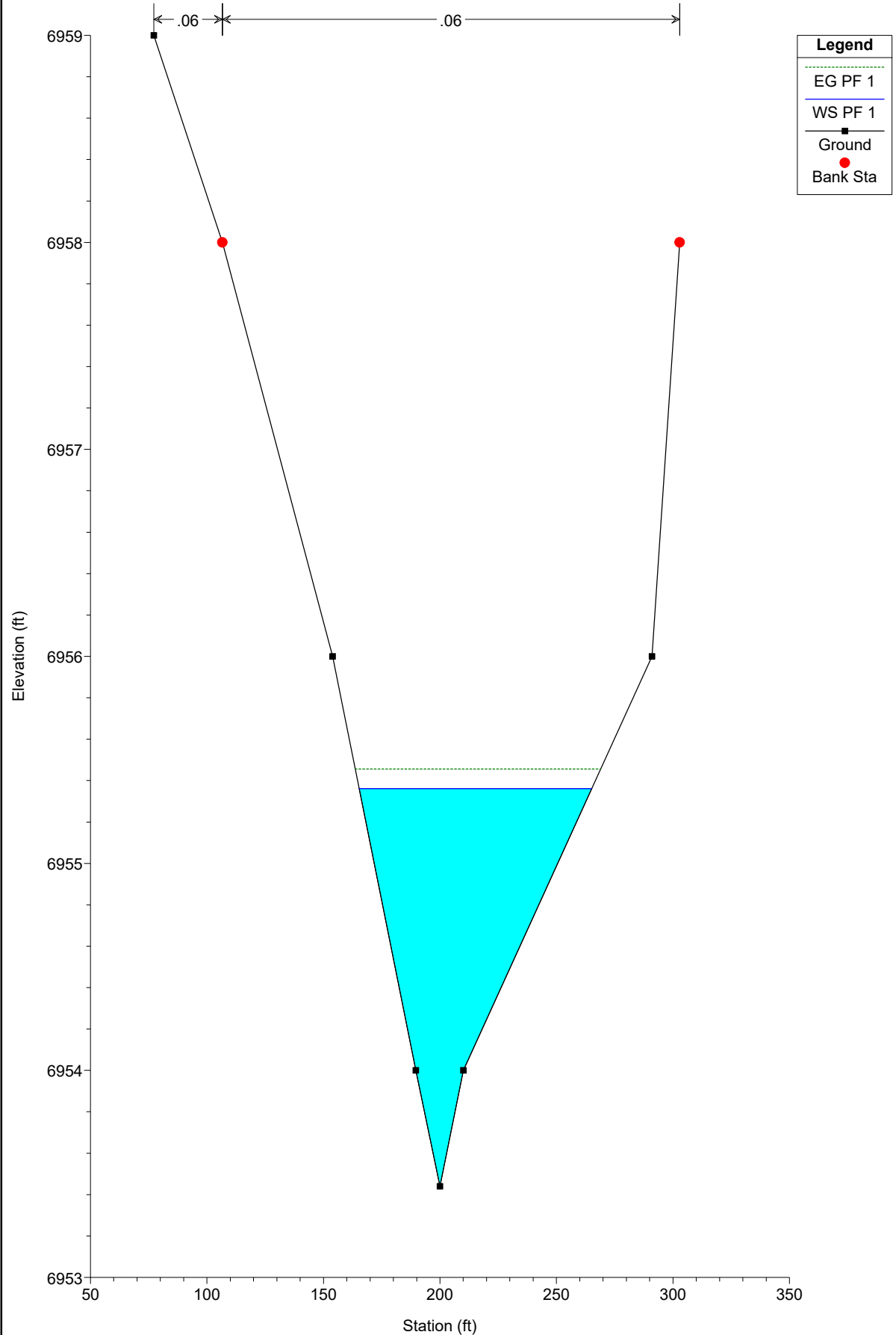
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 2000 2000



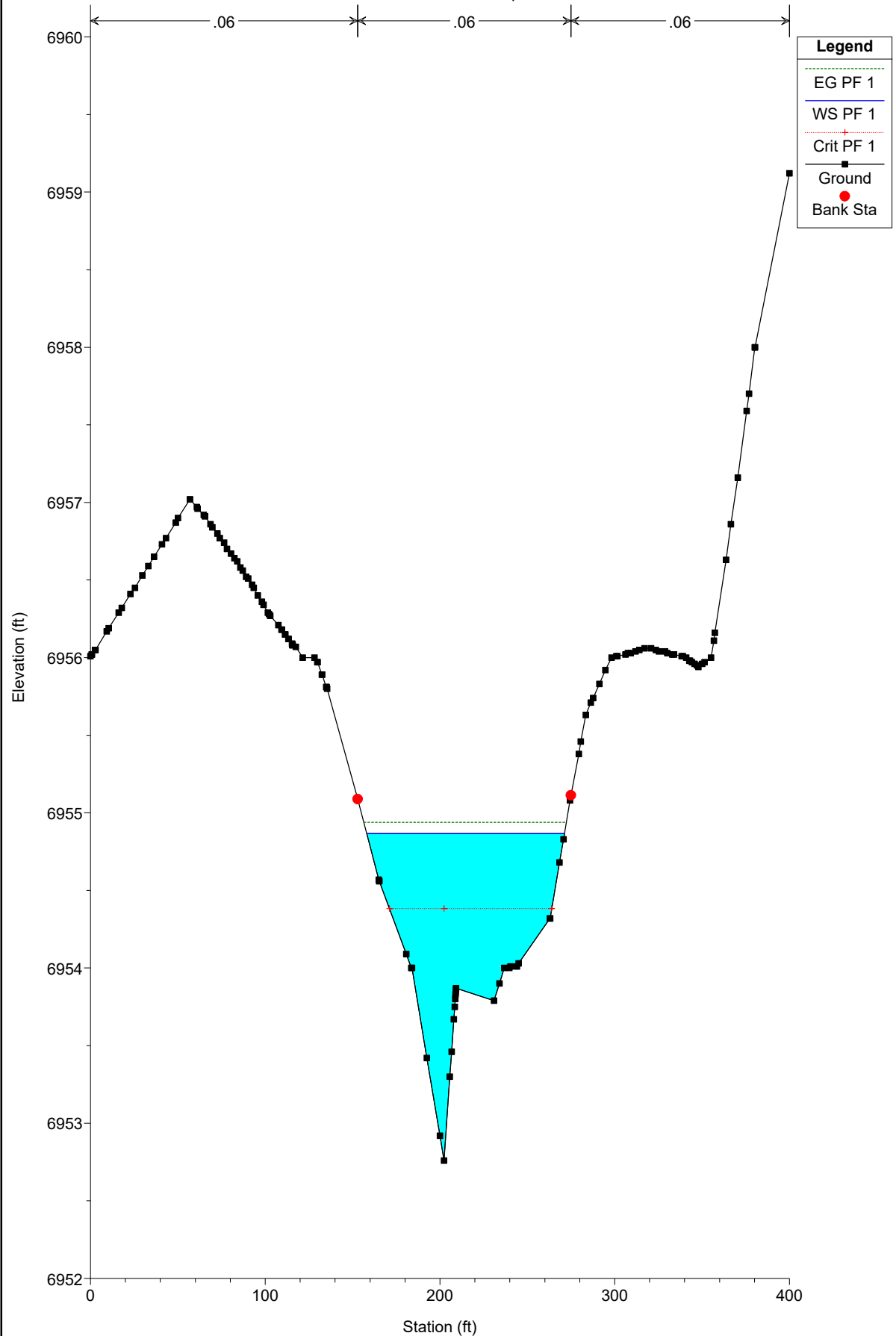
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 1950



WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

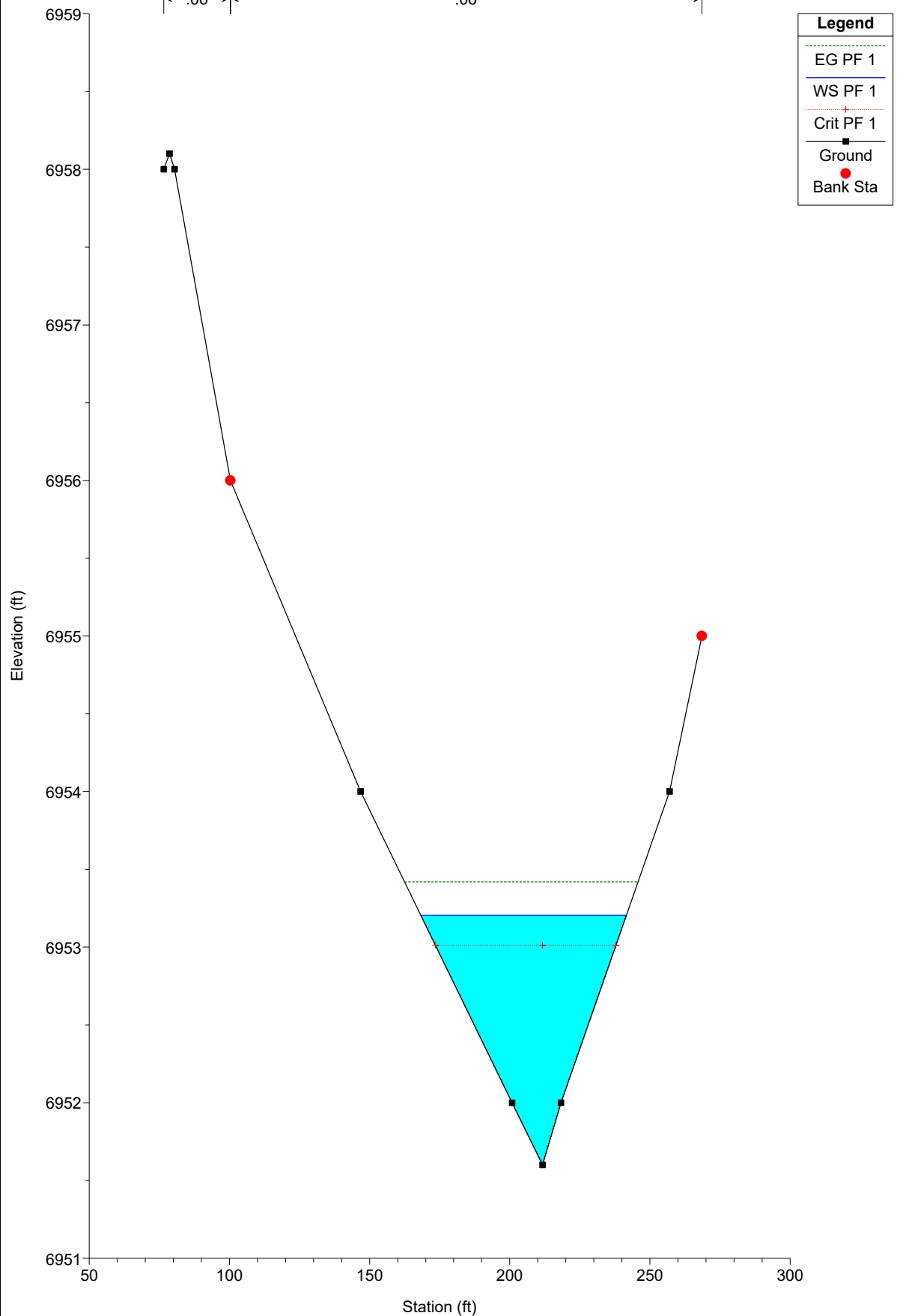
River = WEST PR Reach = chan-west-pr RS = 1900 1900



WEST CHAN PR NEW 100-Y    Plan: Plan 03    12/22/2024

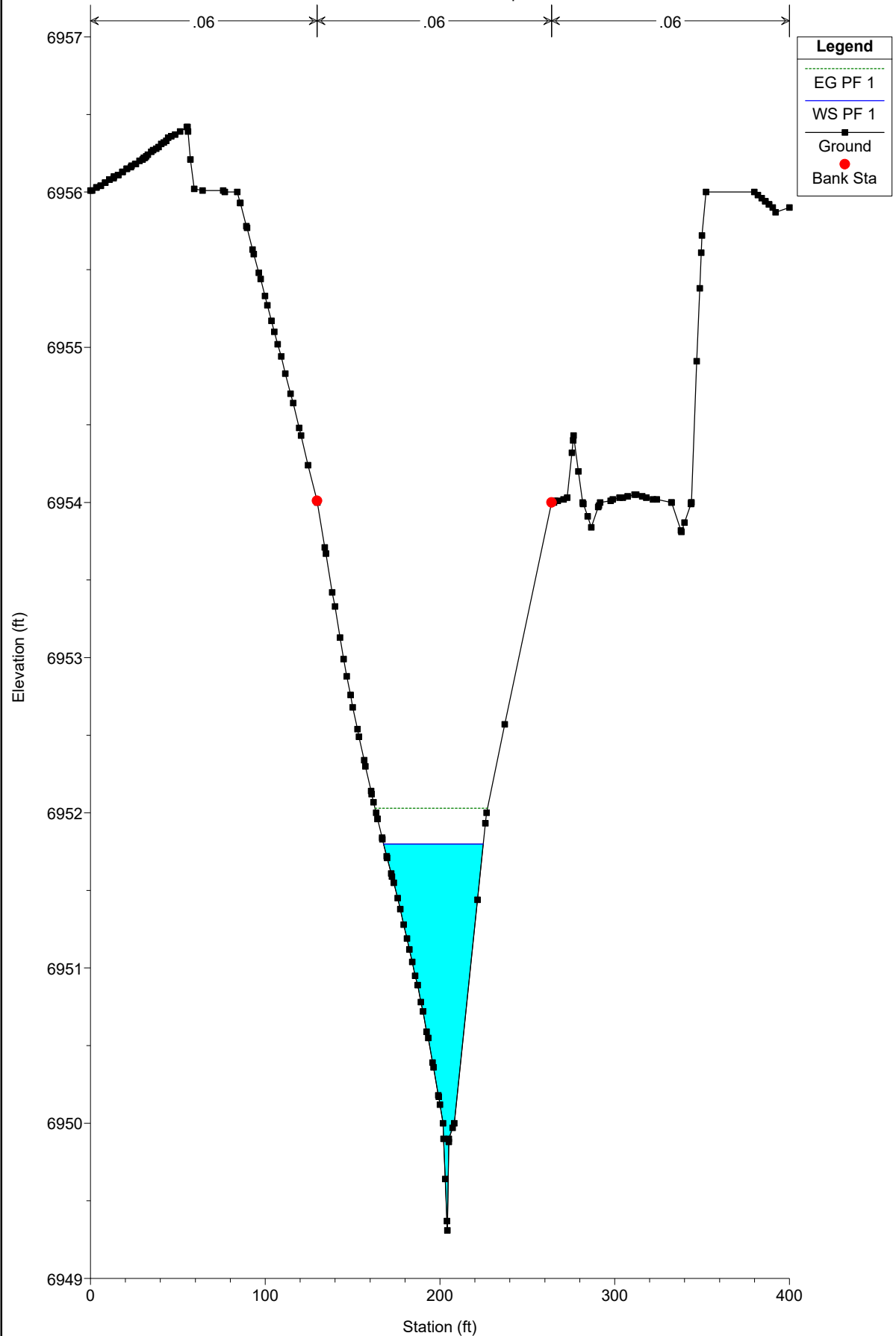
River = WEST PR    Reach = chan-west-pr    RS = 1850

← .06 →    .06    →



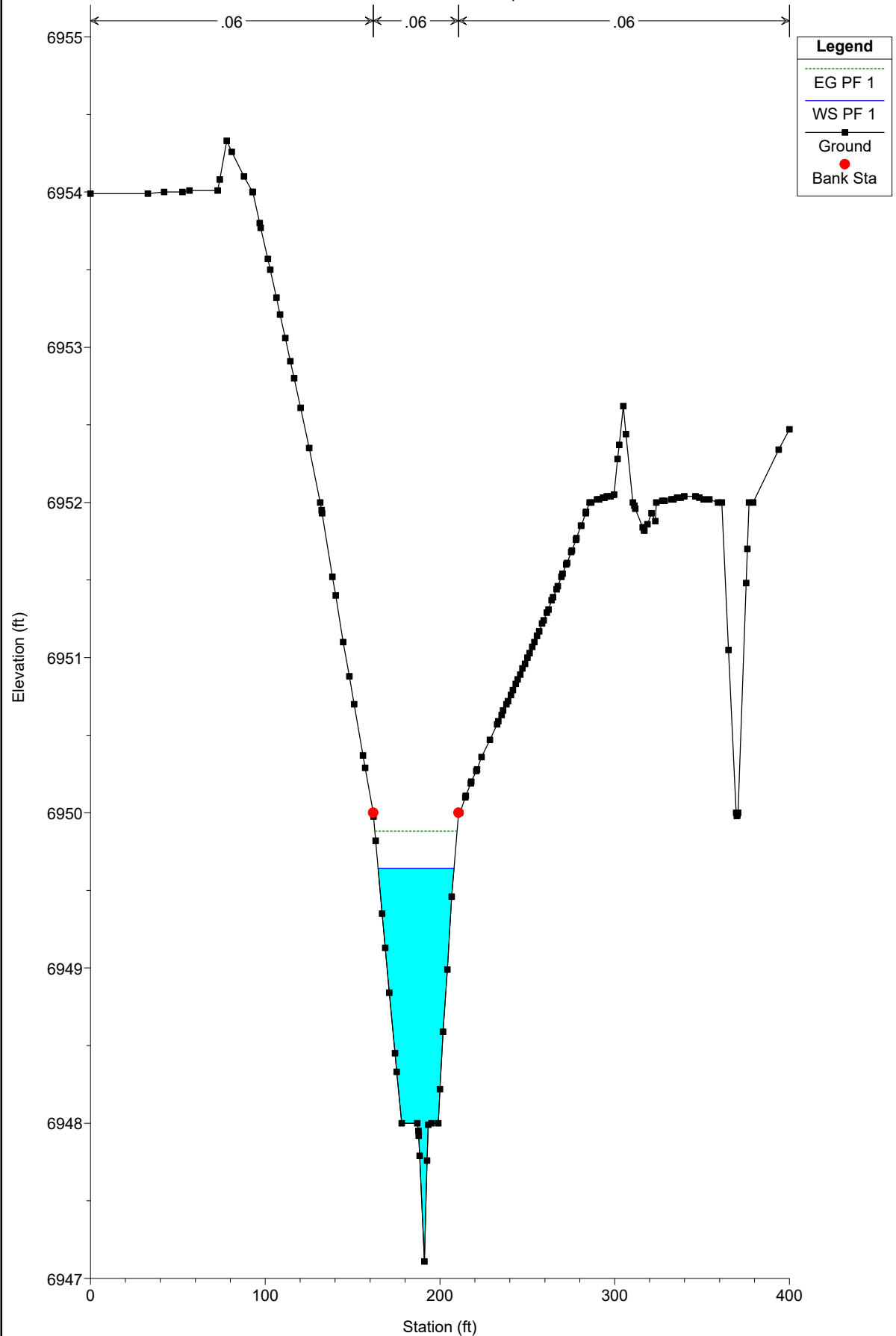
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 1800 1800



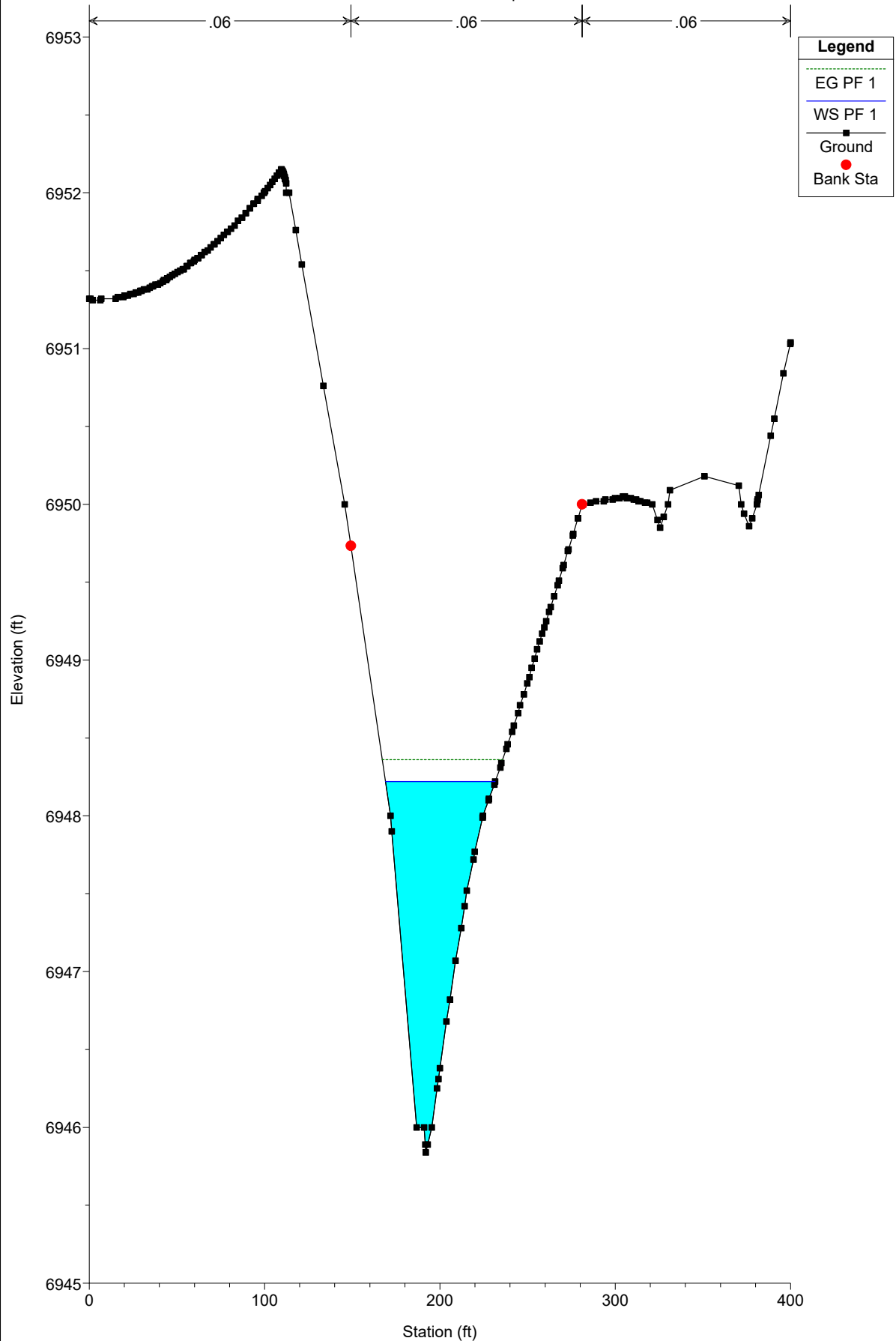
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 1700 1700



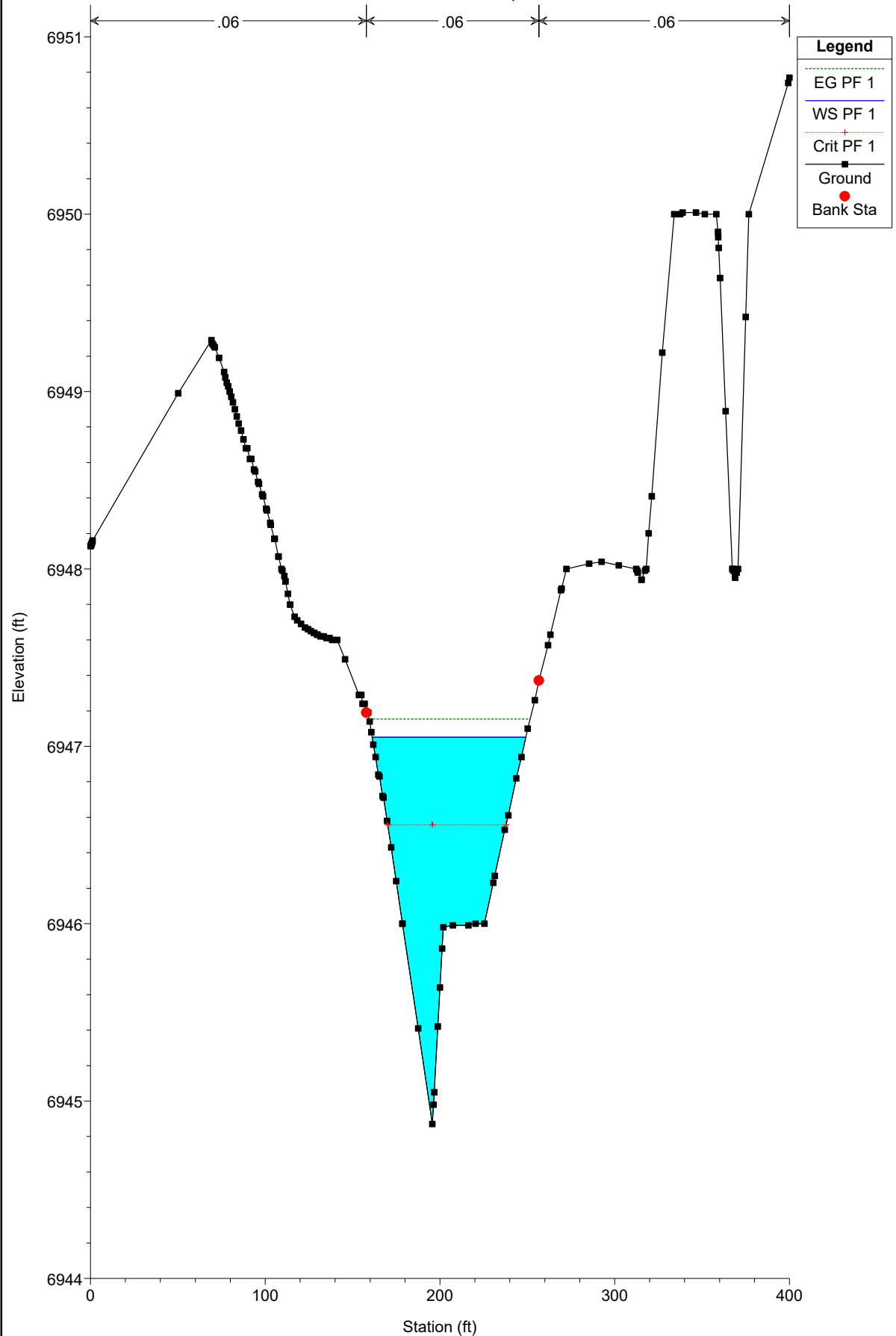
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

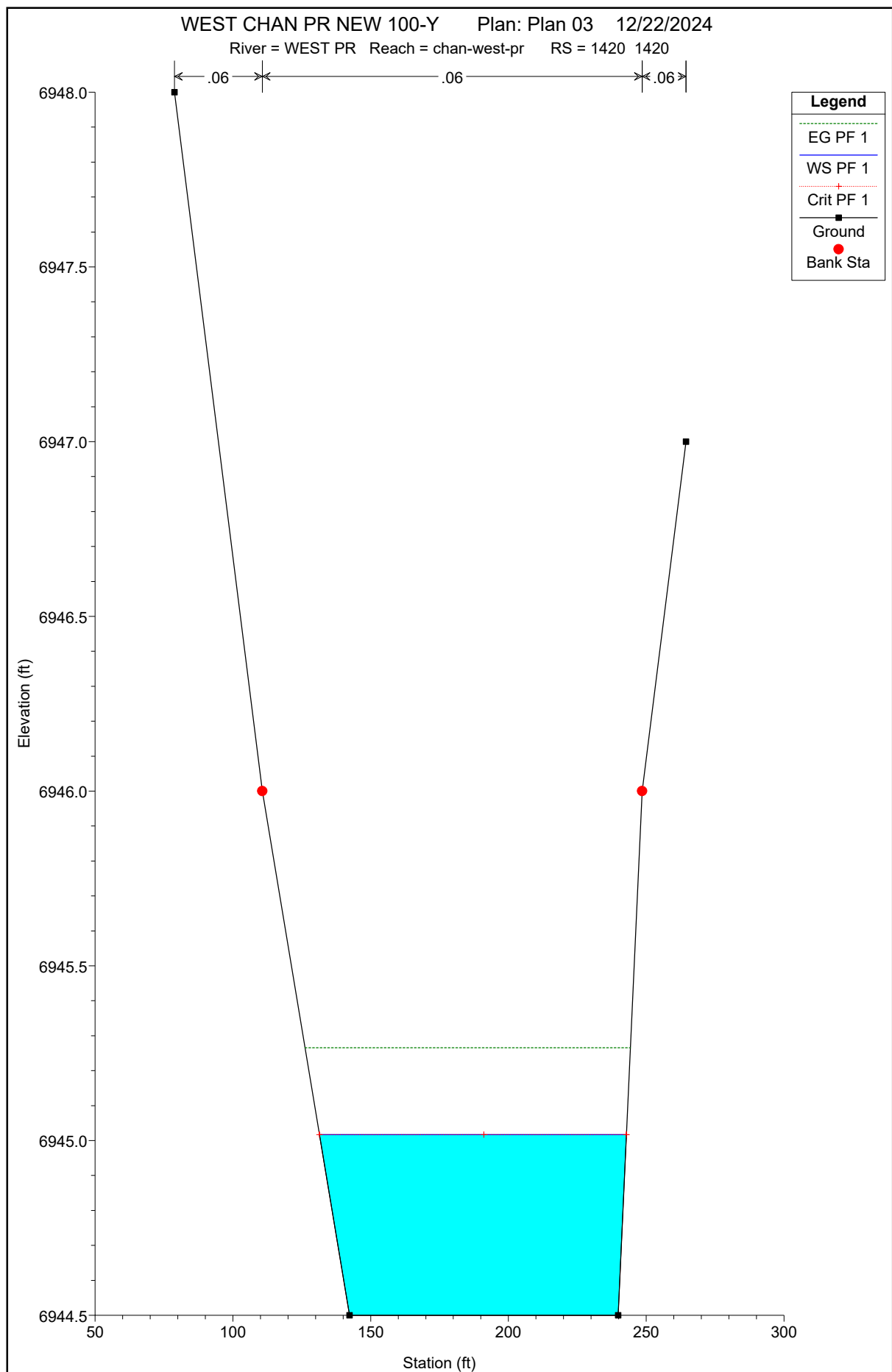
River = WEST PR Reach = chan-west-pr RS = 1600 1600



WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

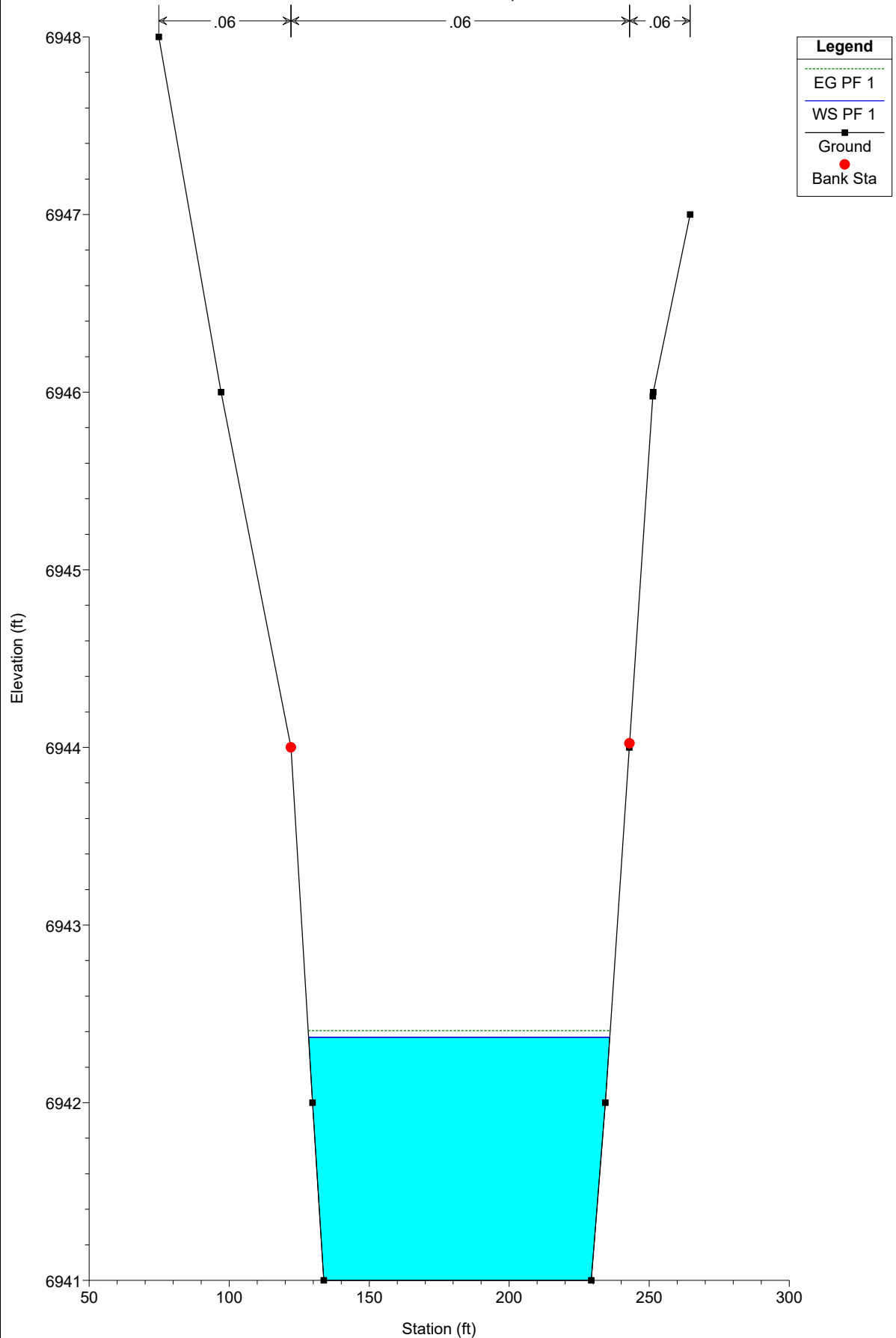
River = WEST PR Reach = chan-west-pr RS = 1500 1500





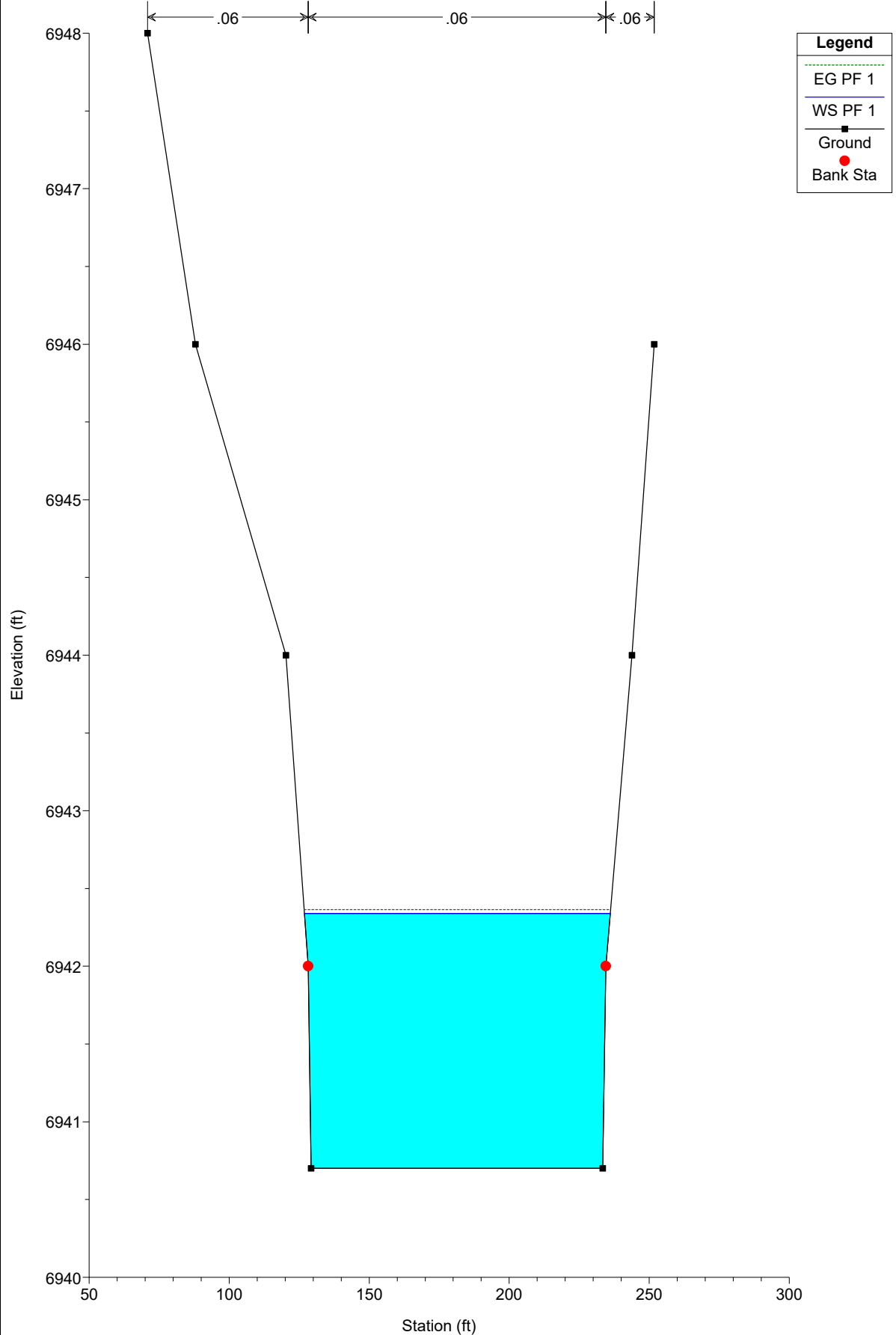
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 1400 1400



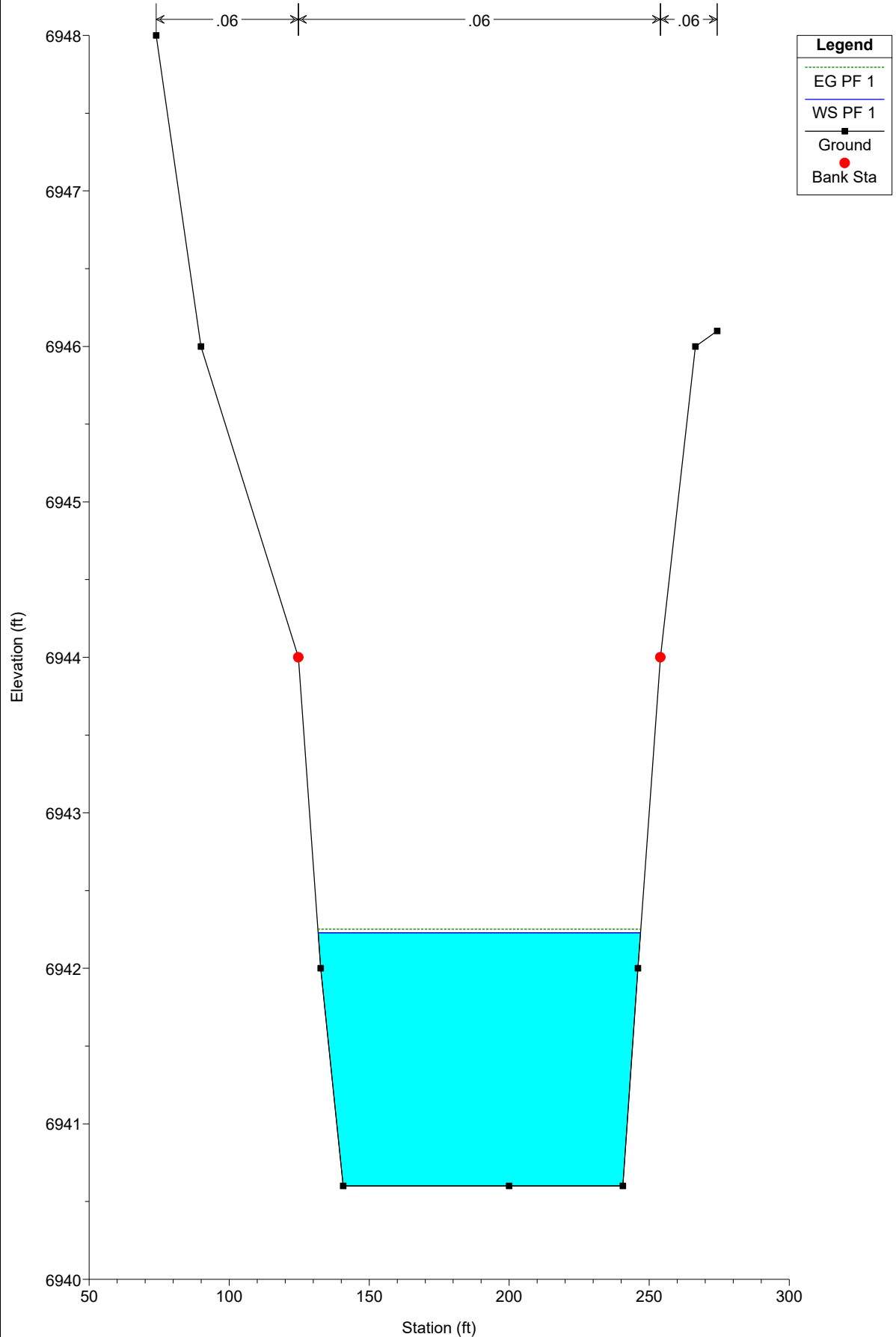
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 1380 1380



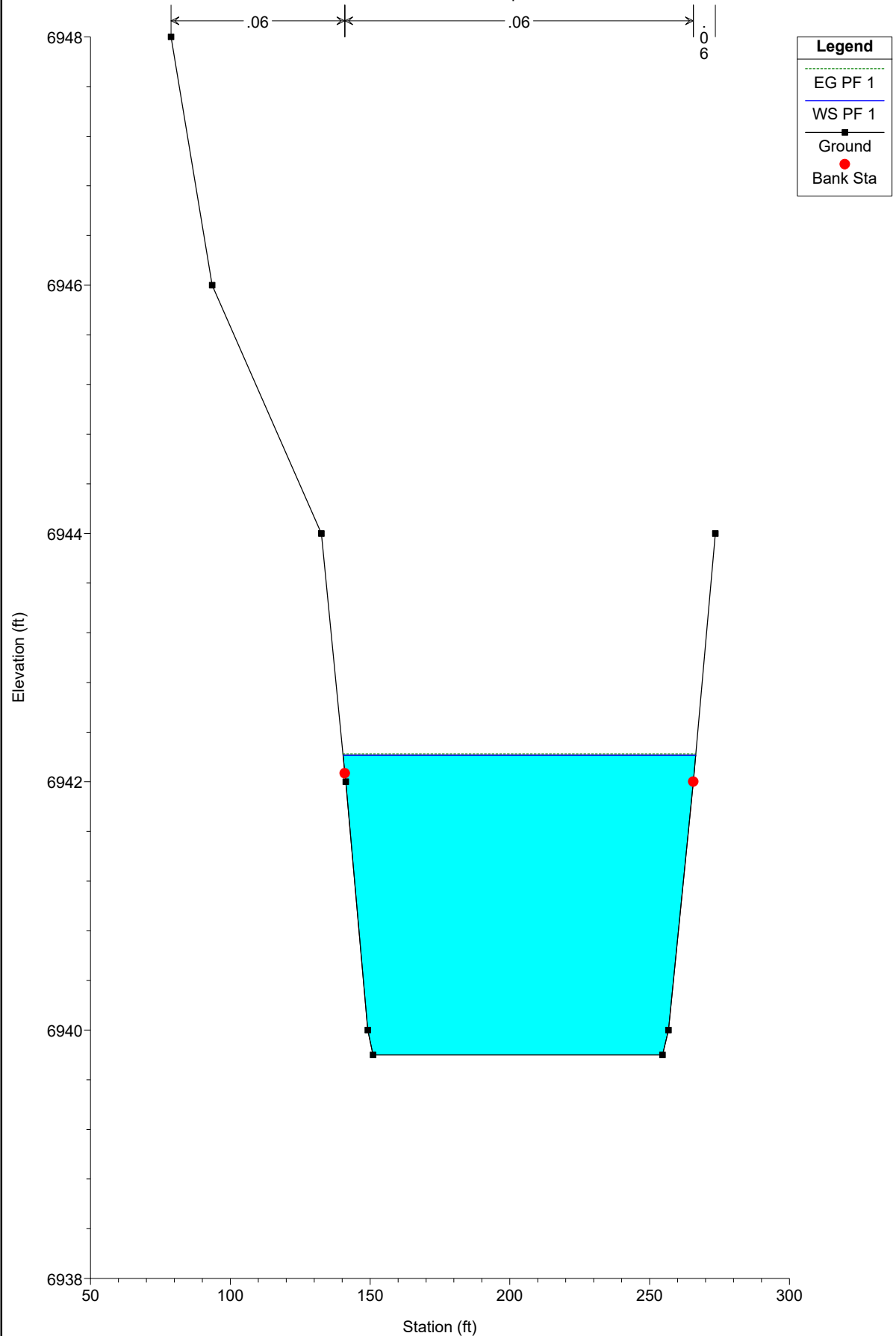
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 1340



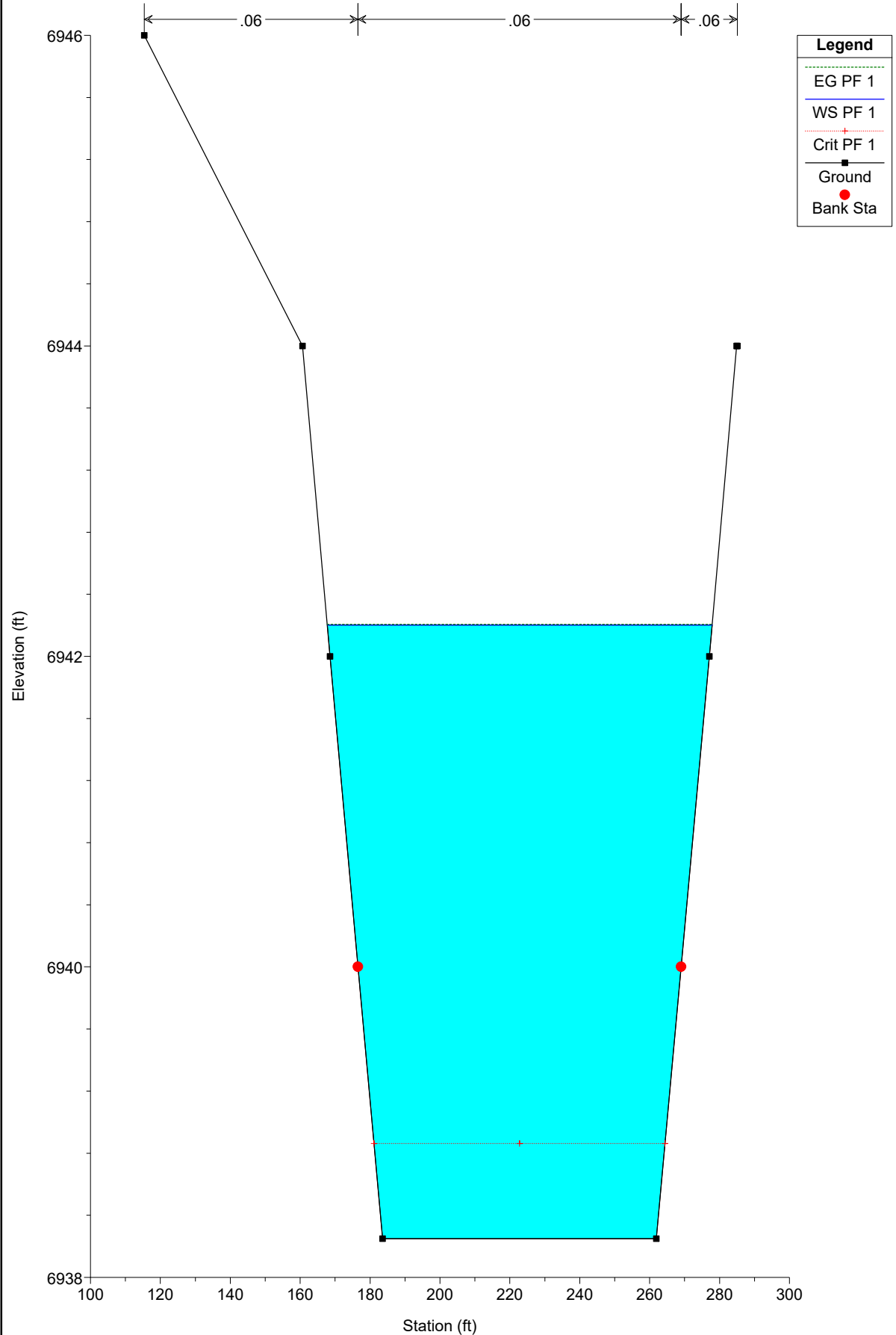
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 1300 1300



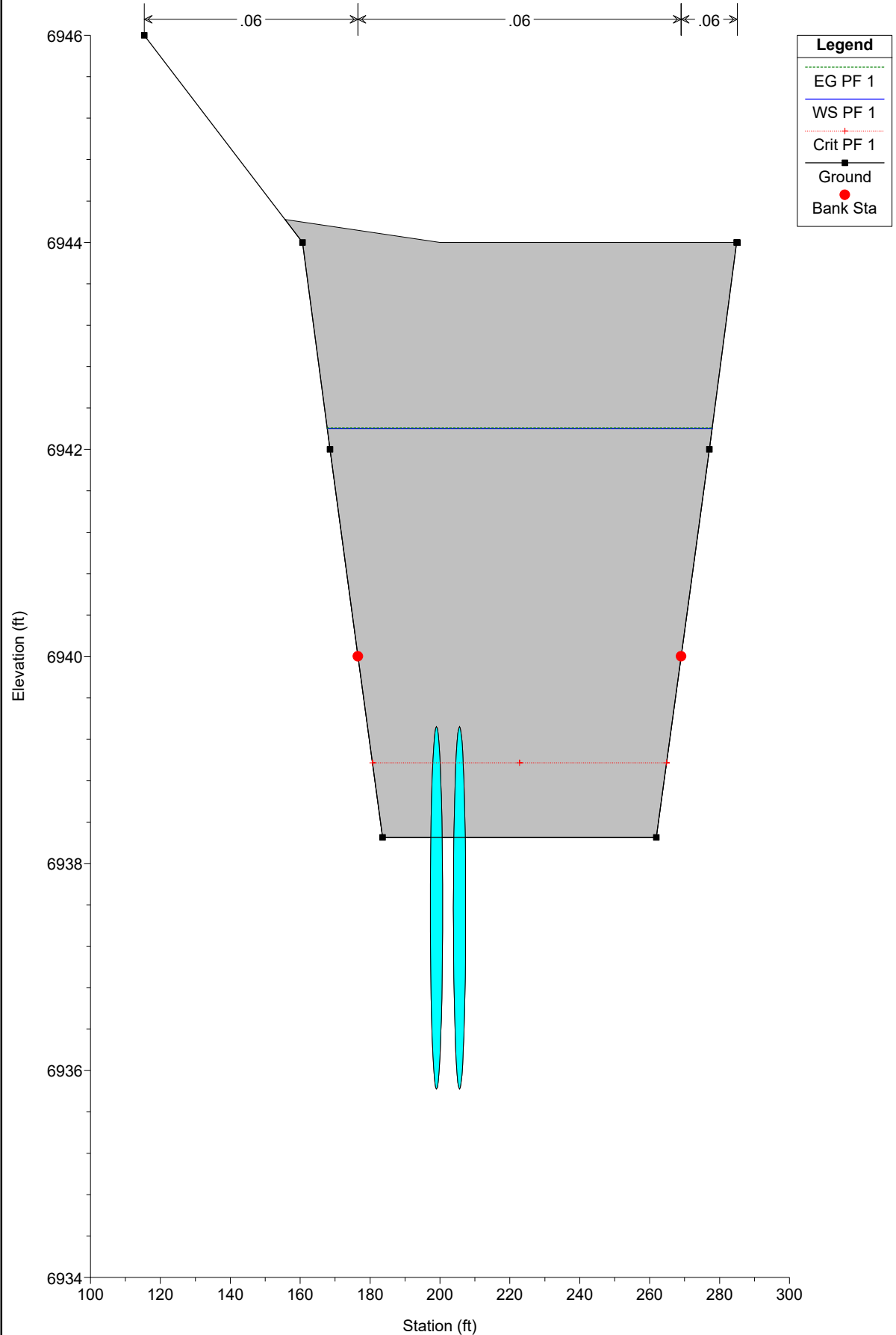
WEST CHAN PR NEW 100-Y    Plan: Plan 03    12/22/2024

River = WEST PR    Reach = chan-west-pr    RS = 1200    1200



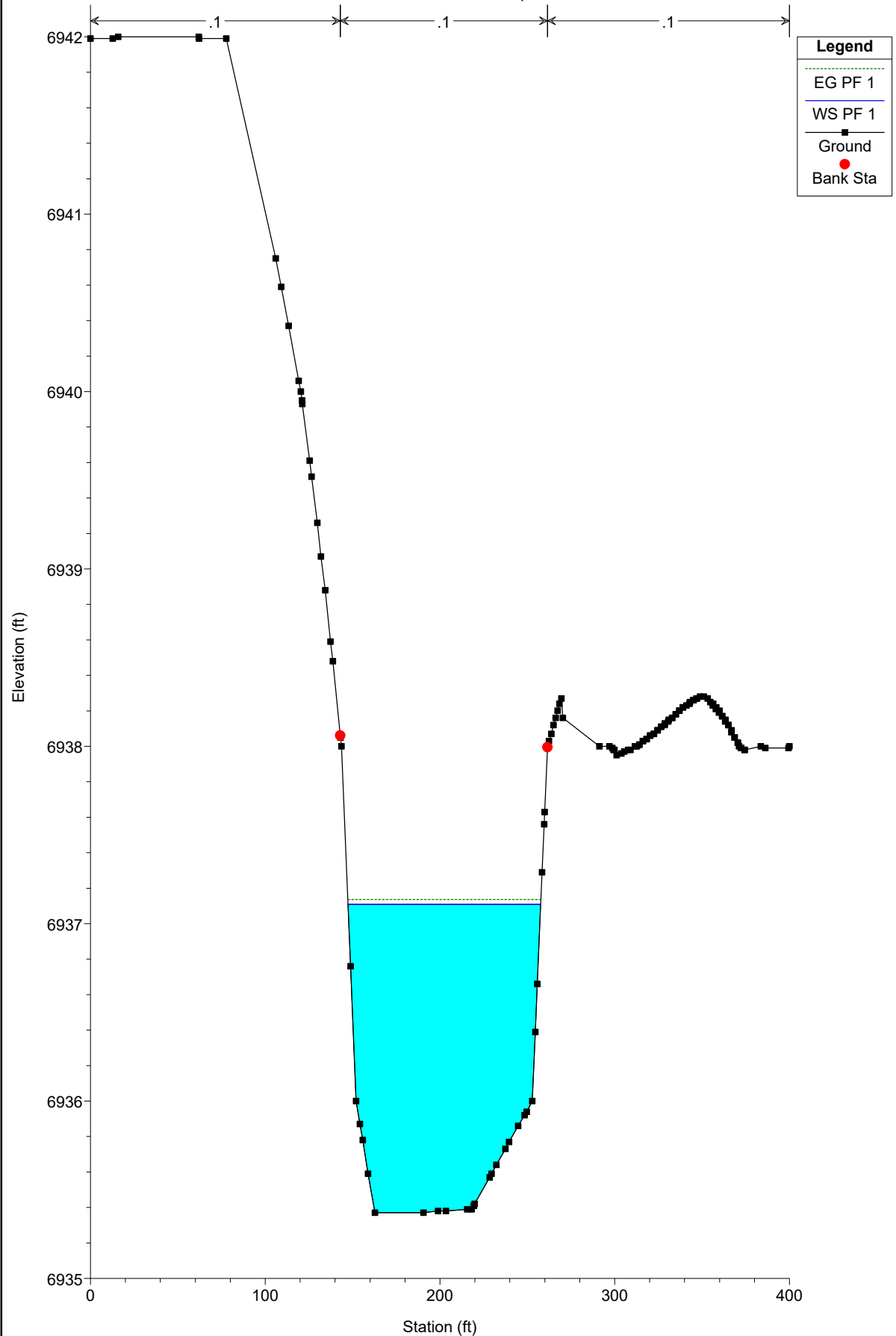
WEST CHAN PR NEW 100-Y    Plan: Plan 03    12/22/2024

River = WEST PR    Reach = chan-west-pr    RS = 1042.5    Culv    DUAL 42"



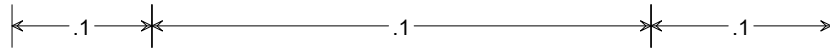
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 900 900

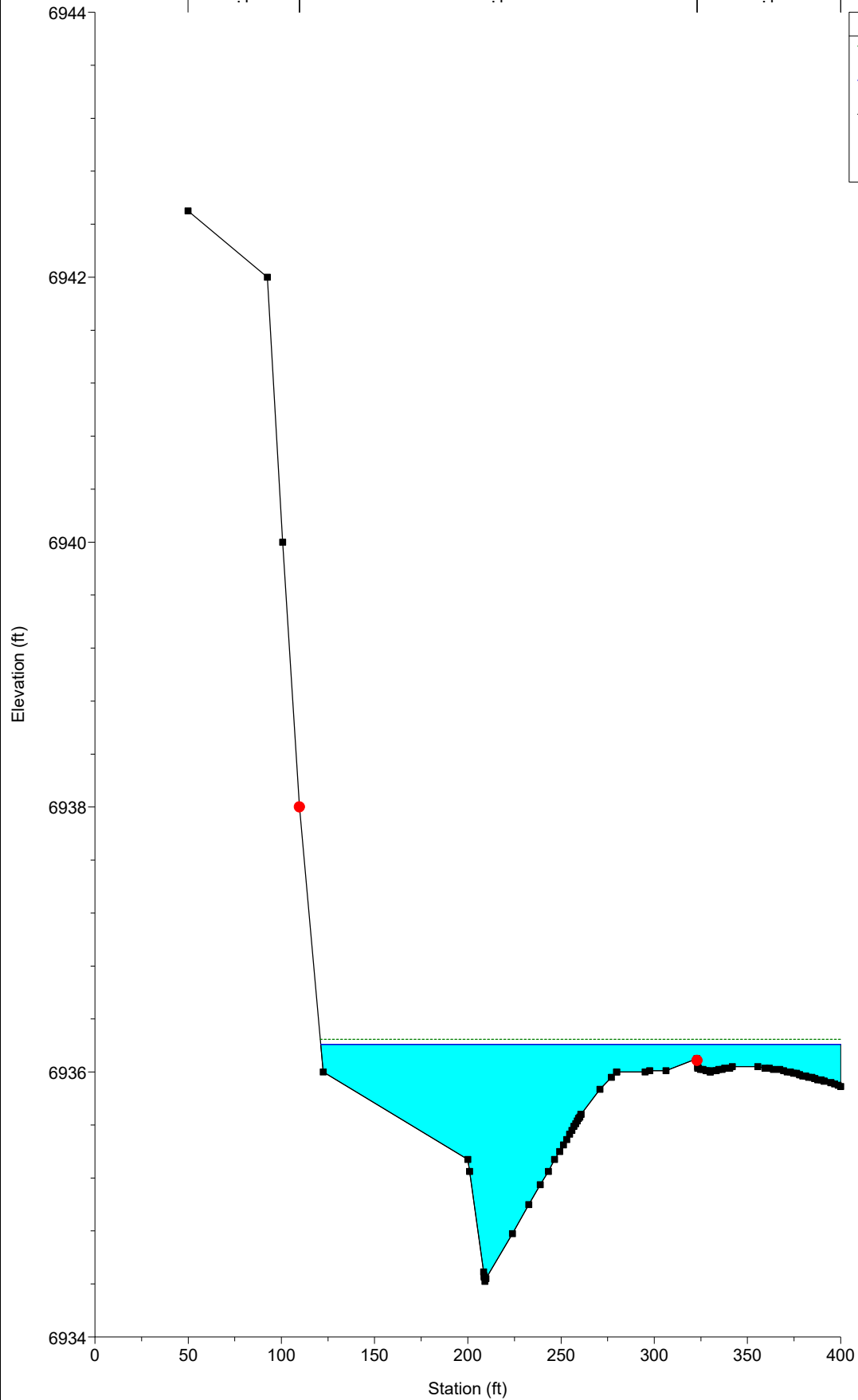


WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 800 800

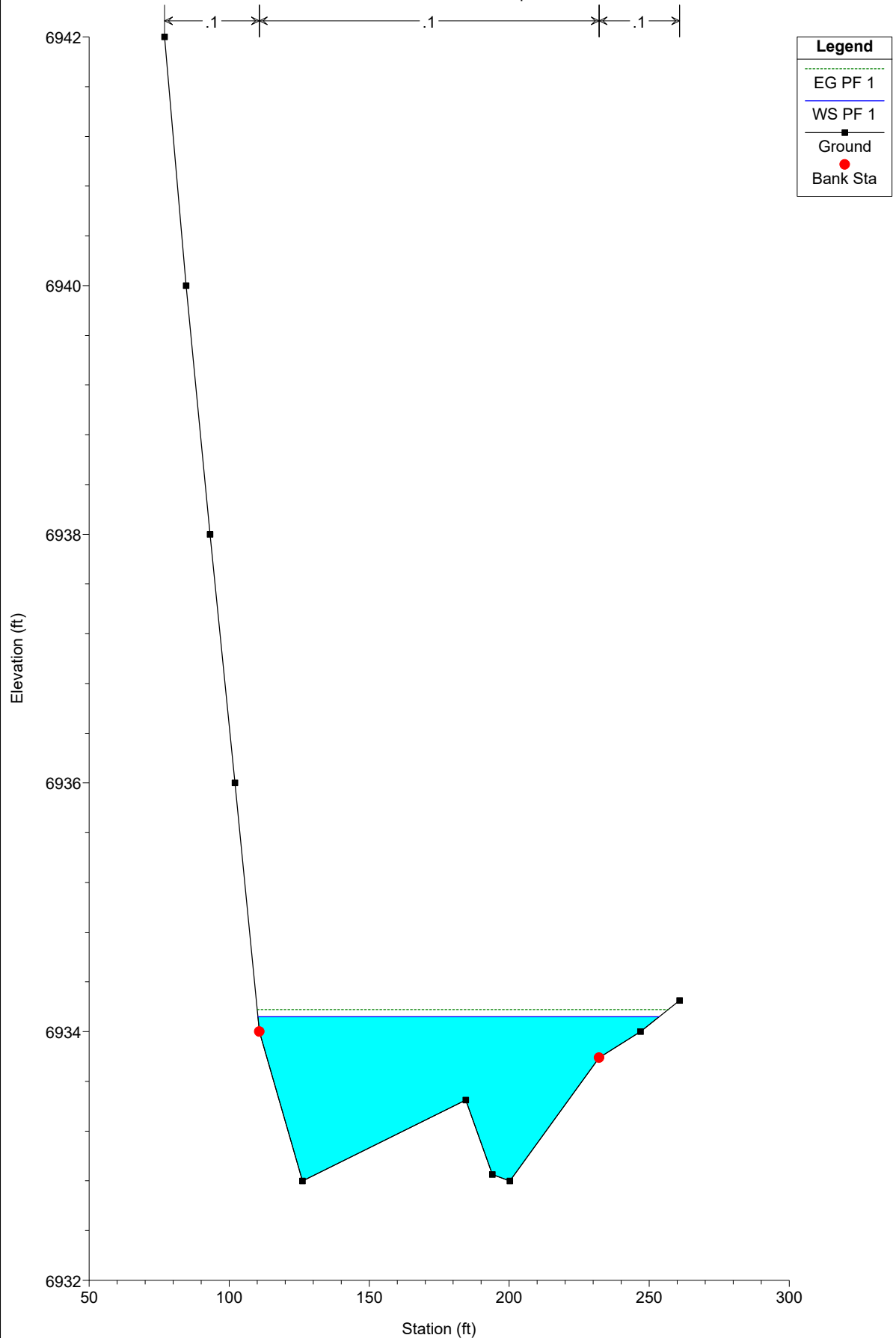


Legend	
EG PF 1	
WS PF 1	
Ground	
Bank Sta	



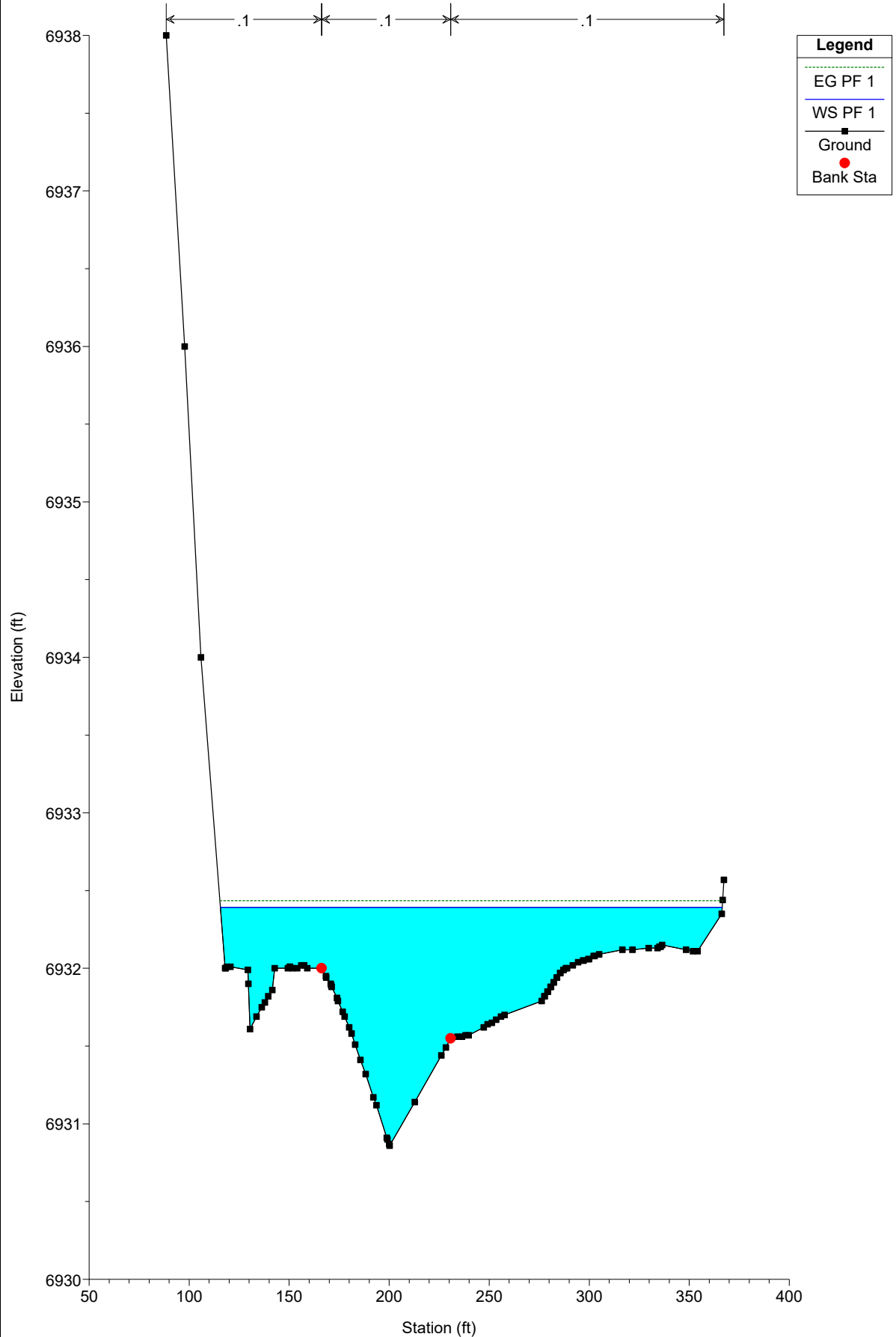
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 700 700



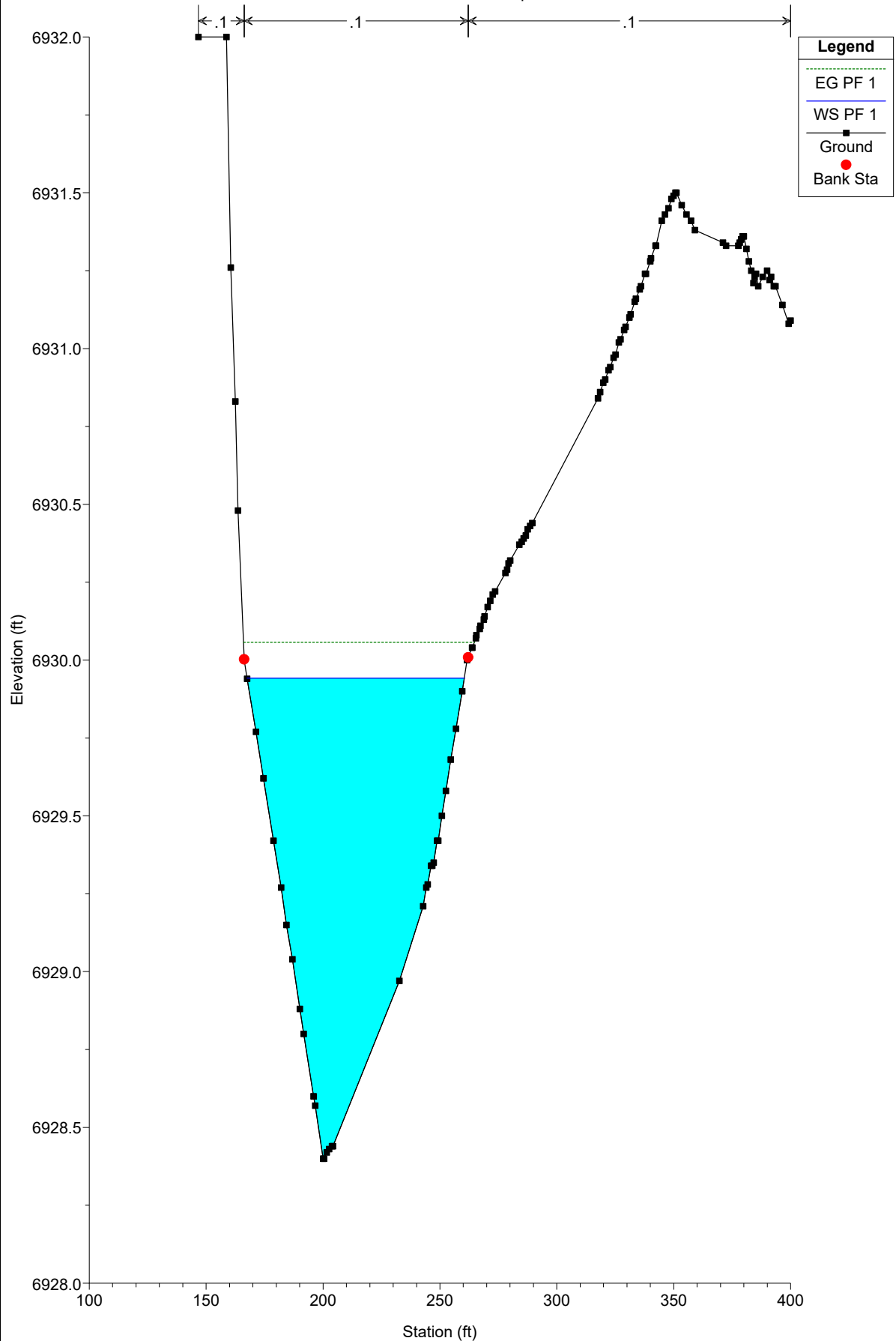
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 600 600



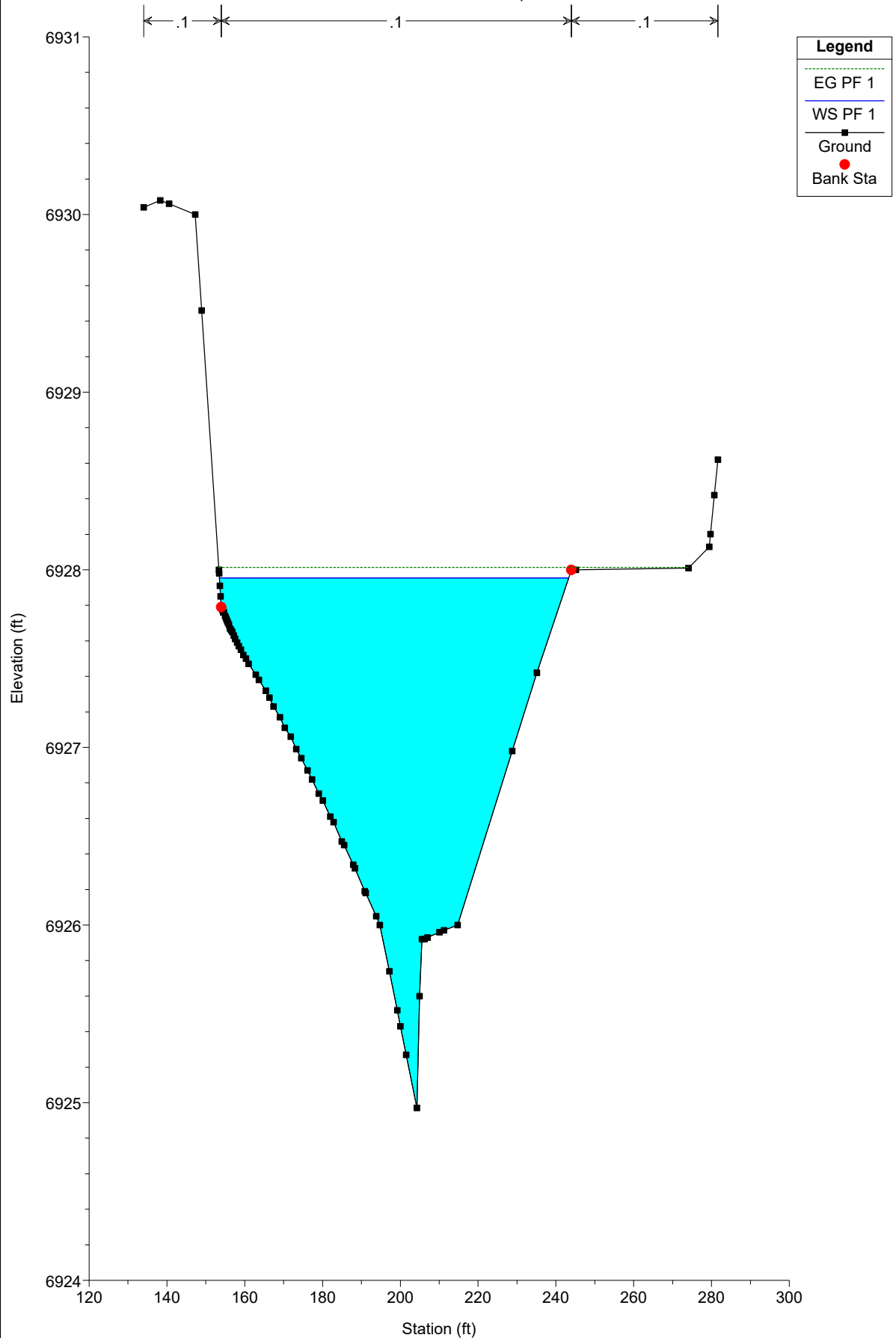
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 500 500



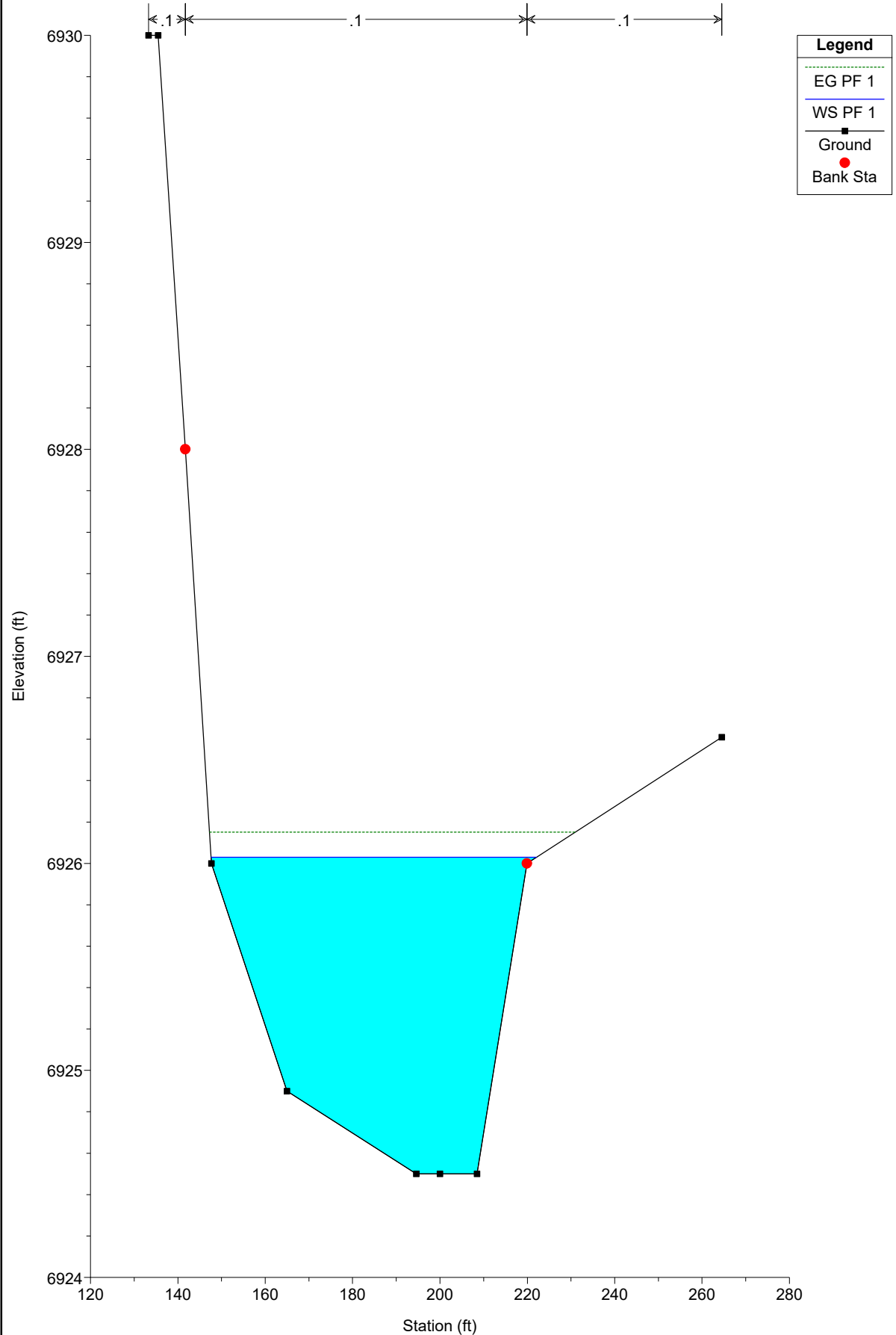
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 400 400



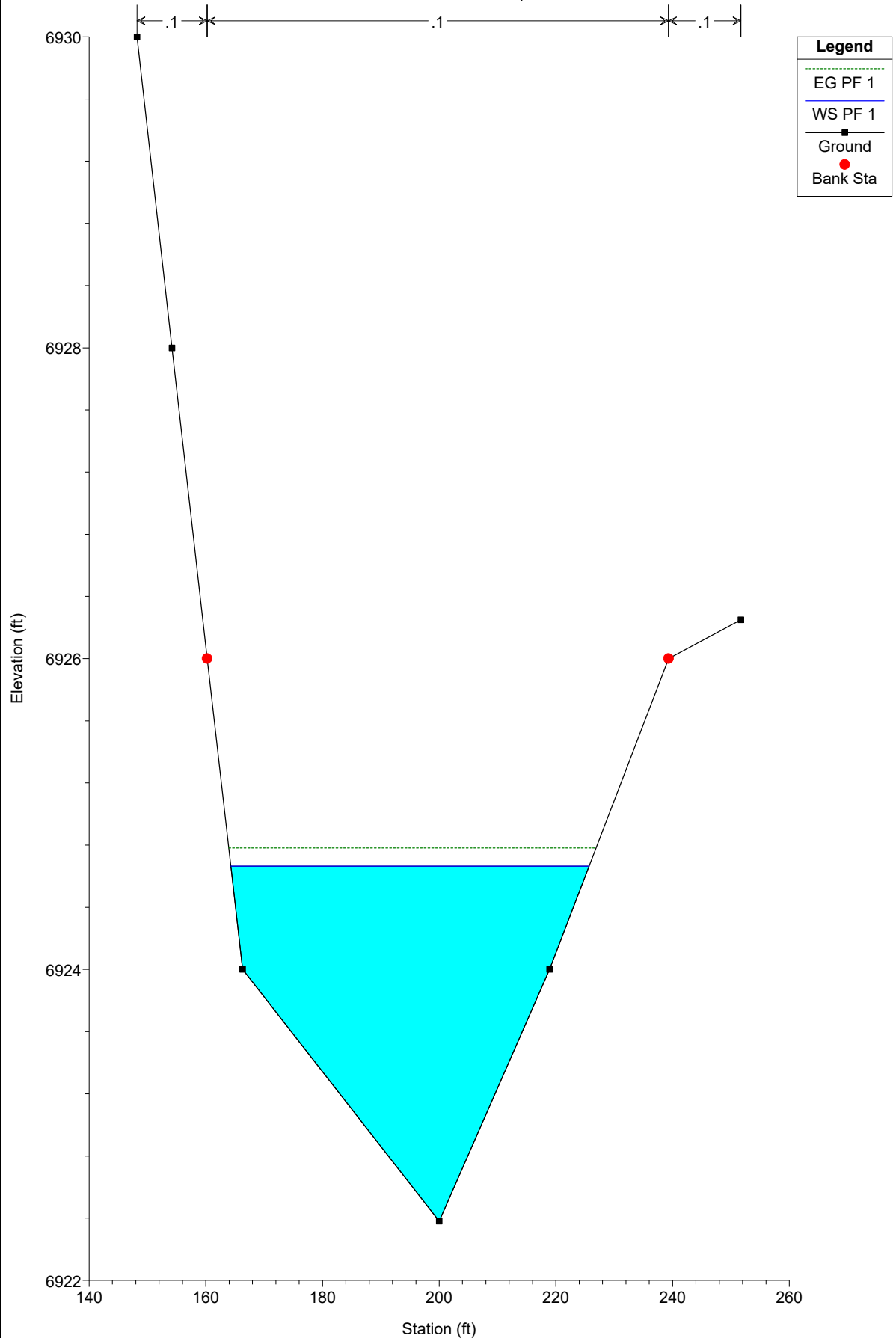
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 350



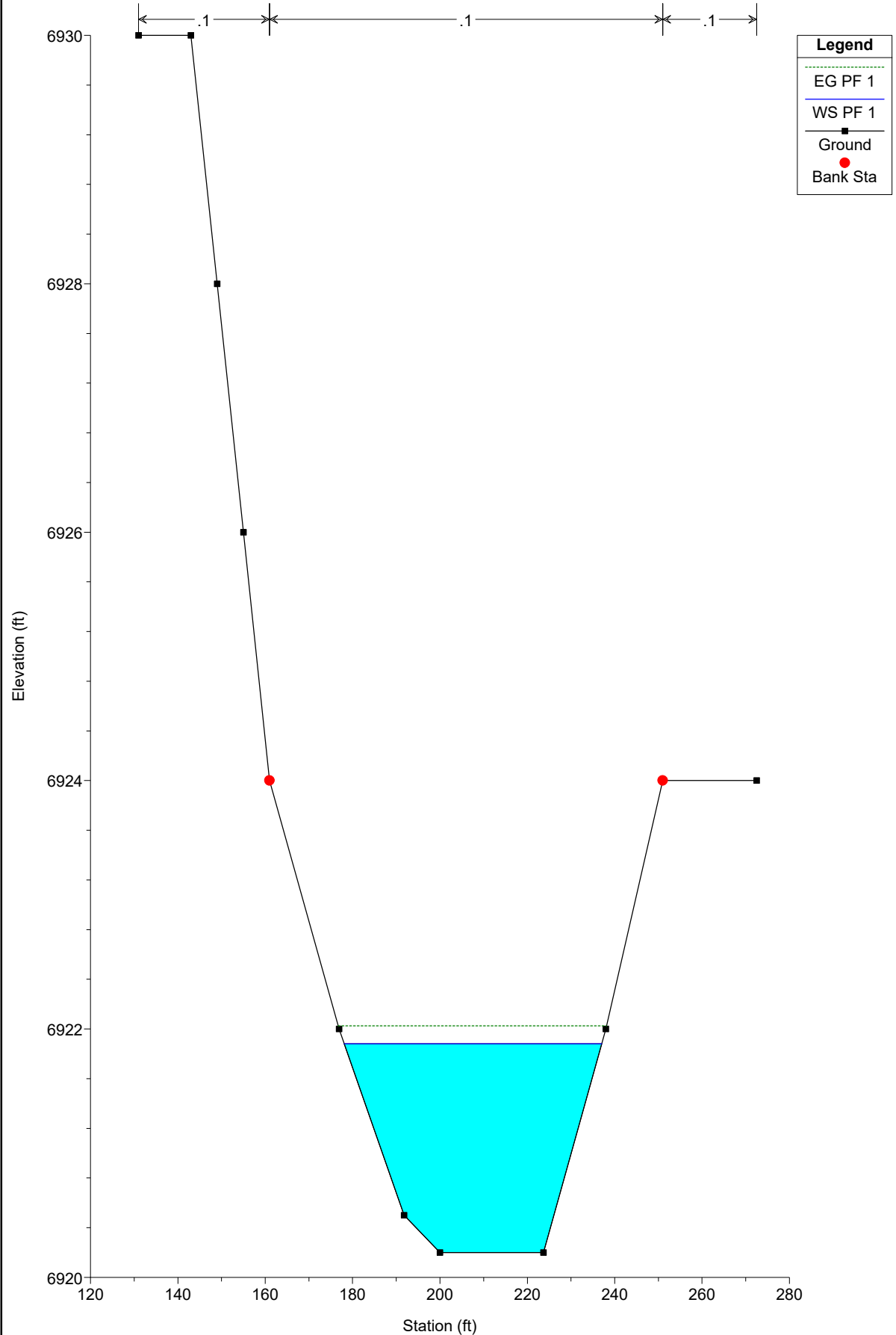
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 300 300



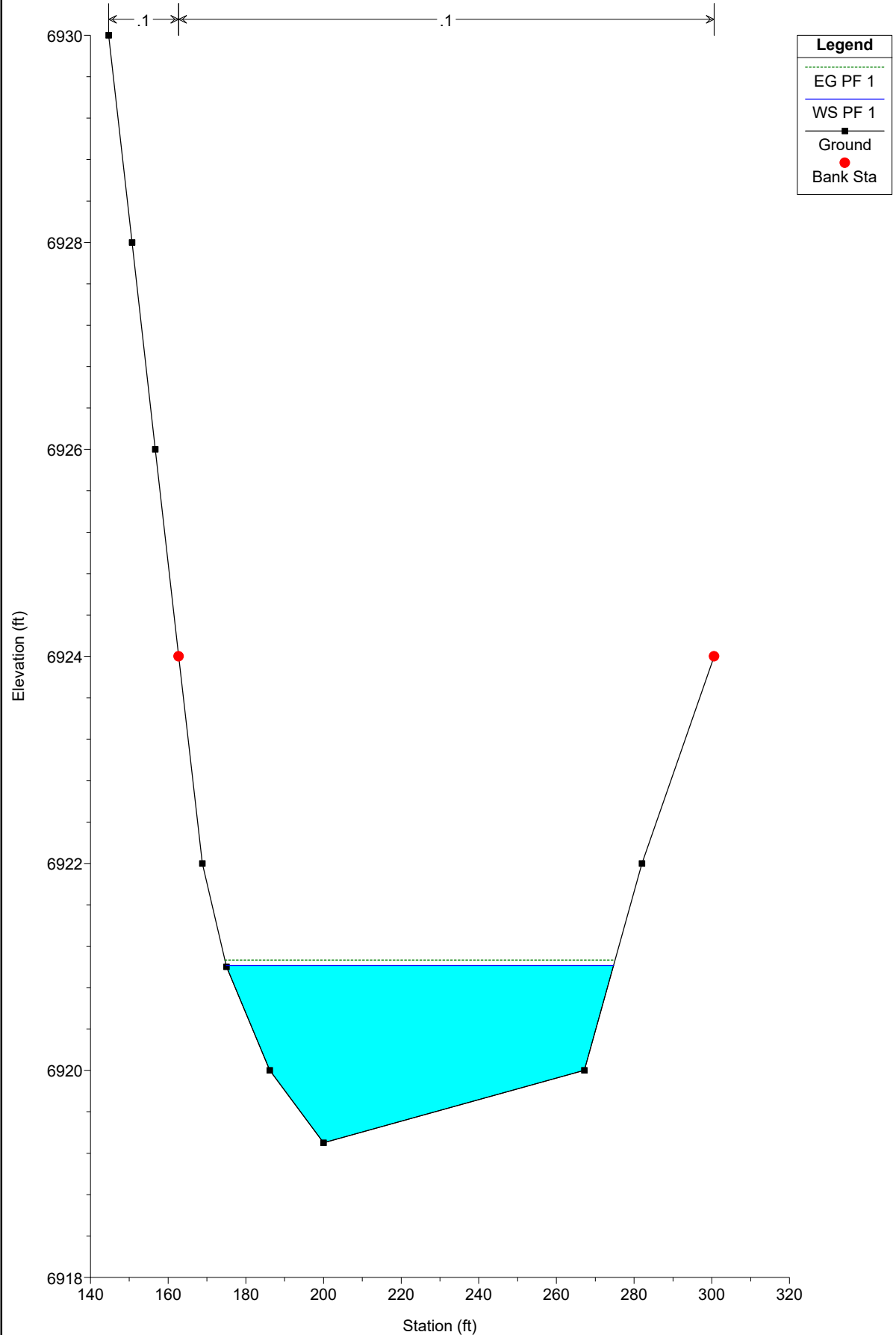
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 250



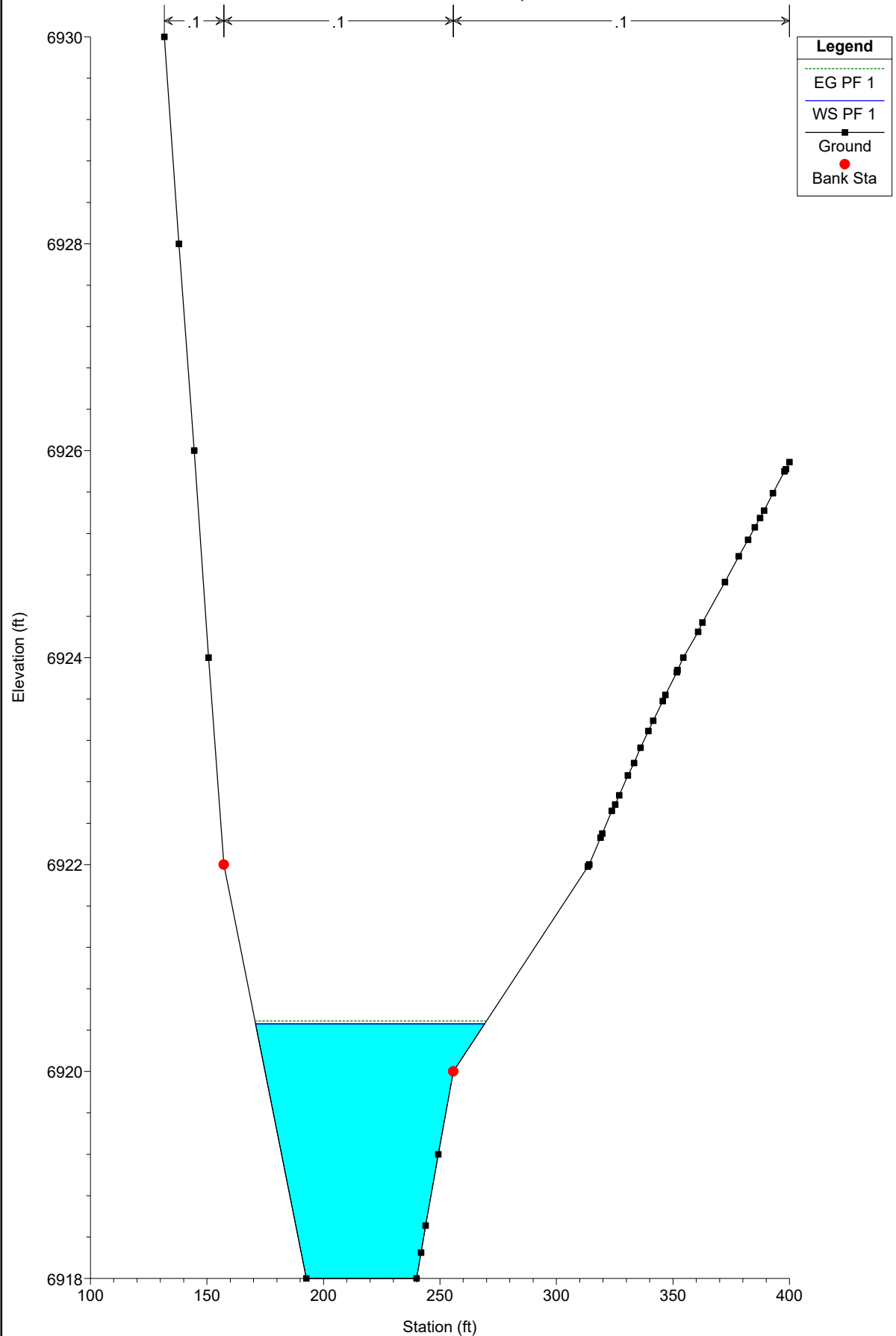
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 200 200



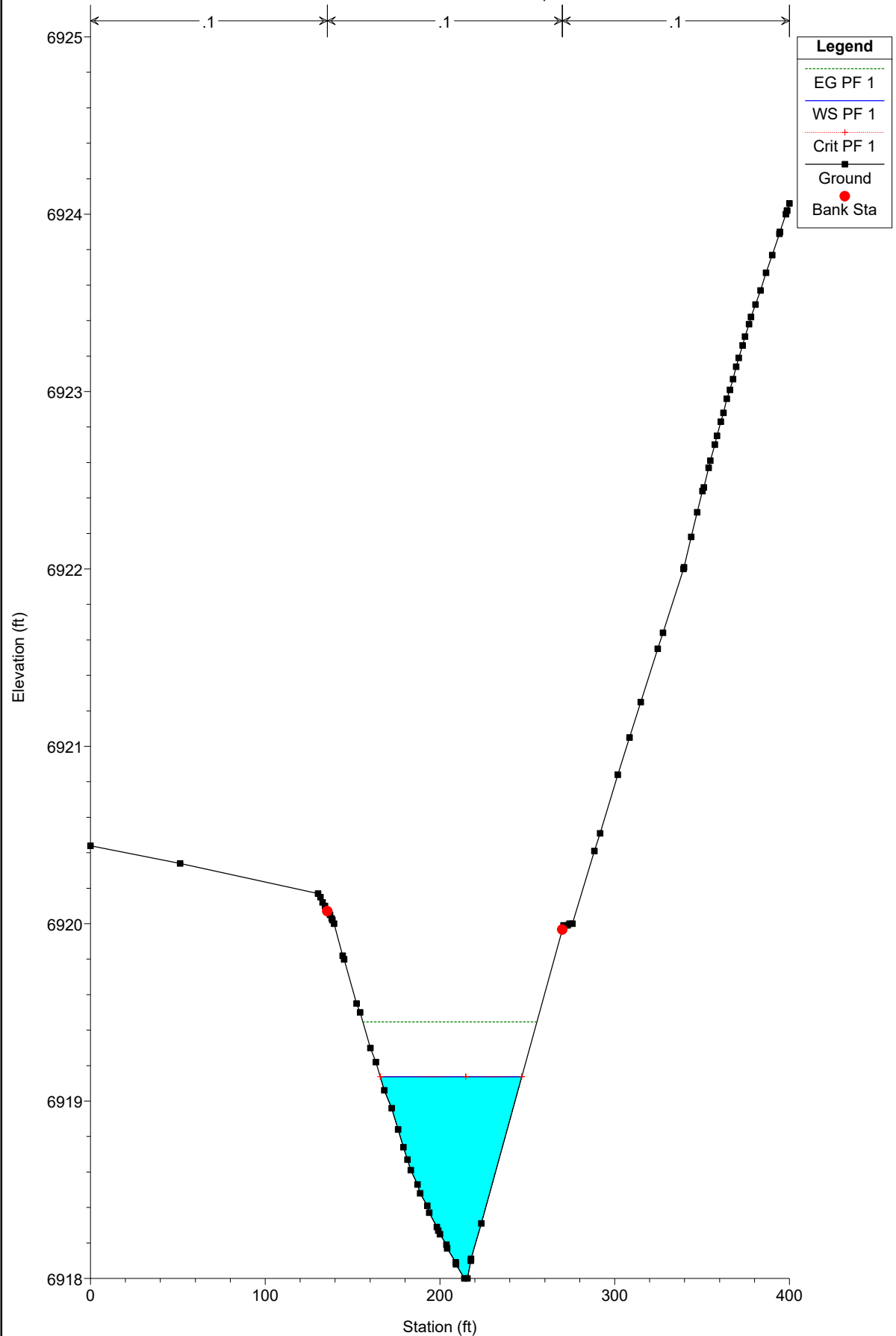
WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 100 100

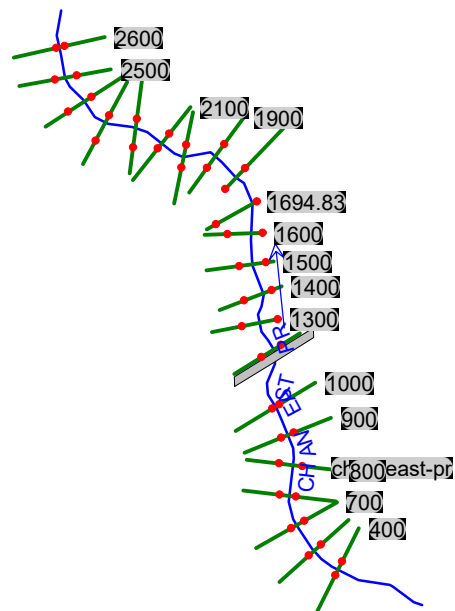


WEST CHAN PR NEW 100-Y Plan: Plan 03 12/22/2024

River = WEST PR Reach = chan-west-pr RS = 0



# EAST CHANNEL PROPOSED CONDITIONS



# PROPOSED EAST CHANNEL 100-Y

HEC-RAS Plan: Plan 01 River: CHAN EAST PR Reach: chan-east-pr 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)	
chan-east-pr	2600	PF 1	151.00	6942.53	6944.49		6944.60	0.020083	3.02	66.20	108.74	0.48
chan-east-pr	2500	PF 1	151.00	6941.18	6943.07		6943.13	0.010904	1.96	84.33	124.93	0.34
chan-east-pr	2400	PF 1	151.00	6939.95	6941.64		6941.73	0.018619	2.32	65.19	74.51	0.44
chan-east-pr	2300	PF 1	151.00	6938.19	6939.43		6939.53	0.026082	2.57	58.82	74.24	0.51
chan-east-pr	2200	PF 1	151.00	6936.58	6938.37		6938.40	0.006135	1.52	100.52	103.51	0.26
chan-east-pr	2100	PF 1	151.00	6935.13	6937.50		6937.58	0.011365	2.31	65.48	51.30	0.36
chan-east-pr	2010.45	PF 1	151.00	6933.88	6935.43		6935.63	0.056212	3.63	42.30	65.96	0.74
chan-east-pr	1900	PF 1	151.00	6931.88	6933.84		6933.88	0.007048	1.62	93.32	88.19	0.28
chan-east-pr	1801.17	PF 1	151.00	6931.01	6932.59		6932.66	0.027173	2.09	72.33	92.03	0.41
chan-east-pr	1694.83	PF 1	151.00	6929.94	6931.11		6931.13	0.008773	1.24	121.34	143.39	0.24
chan-east-pr	1600	PF 1	151.00	6928.36	6929.63		6929.71	0.030740	2.19	69.00	89.57	0.44
chan-east-pr	1500	PF 1	151.00	6924.52	6926.65		6926.76	0.028222	2.70	55.97	49.57	0.45
chan-east-pr	1400	PF 1	151.00	6922.11	6924.73		6924.81	0.014150	2.23	67.68	66.38	0.39
chan-east-pr	1300	PF 1	151.00	6921.11	6924.05		6924.08	0.004293	1.49	101.14	73.88	0.22
chan-east-pr	1200	PF 1	151.00	6919.19	6924.04	6920.52	6924.04	0.000109	0.47	355.73	125.84	0.04
chan-east-pr	1111.15		Culvert									
chan-east-pr	1000	PF 1	188.00	6916.11	6919.03		6919.16	0.011207	3.06	73.33	65.85	0.38
chan-east-pr	900	PF 1	188.00	6915.02	6917.87		6917.99	0.012344	2.79	67.32	42.09	0.39
chan-east-pr	800	PF 1	188.00	6913.85	6916.89		6916.97	0.008358	2.34	80.17	48.98	0.32
chan-east-pr	700	PF 1	188.00	6913.13	6916.11		6916.19	0.007279	2.18	86.53	55.48	0.30
chan-east-pr	600	PF 1	188.00	6912.13	6914.59		6914.84	0.031340	4.00	46.99	34.58	0.61
chan-east-pr	500	PF 1	188.00	6909.89	6913.37		6913.46	0.007372	2.36	79.71	43.67	0.31
chan-east-pr	400	PF 1	188.00	6908.81	6911.02	6911.02	6911.60	0.094950	6.11	30.76	27.24	1.01

# PROPOSED EAST CHANNEL 100-Y W/ 0.05 MANNING'S M

HEC-RAS Plan: Plan 01 River: CHAN EAST PR Reach: chan-east-pr 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)	
chan-east-pr	2600	PF 1	151.00	6942.53	6944.27	6944.27	6944.52	0.021288	4.37	44.51	90.76	0.76
chan-east-pr	2500	PF 1	151.00	6941.18	6942.83	6942.56	6942.94	0.011541	2.68	58.03	91.34	0.54
chan-east-pr	2400	PF 1	151.00	6939.95	6941.38	6941.15	6941.54	0.017390	3.21	46.98	63.16	0.66
chan-east-pr	2300	PF 1	151.00	6938.19	6939.19		6939.39	0.027034	3.62	41.76	65.53	0.80
chan-east-pr	2200	PF 1	151.00	6936.58	6938.07		6938.14	0.006824	2.10	71.82	91.84	0.42
chan-east-pr	2100	PF 1	151.00	6935.13	6937.14	6936.70	6937.29	0.010480	3.14	48.12	45.21	0.54
chan-east-pr	2010.45	PF 1	151.00	6933.88	6935.25	6935.25	6935.59	0.042851	4.69	32.18	48.66	1.01
chan-east-pr	1900	PF 1	151.00	6931.88	6933.57		6933.64	0.005686	2.12	71.17	77.16	0.39
chan-east-pr	1801.17	PF 1	151.00	6931.01	6932.23	6932.22	6932.44	0.040694	3.71	40.76	83.82	0.94
chan-east-pr	1694.83	PF 1	151.00	6929.94	6930.85		6930.90	0.007081	1.79	84.22	138.65	0.41
chan-east-pr	1600	PF 1	151.00	6928.36	6929.22	6929.22	6929.49	0.046505	4.16	36.28	69.30	1.01
chan-east-pr	1500	PF 1	151.00	6924.52	6926.23		6926.48	0.018898	4.00	37.71	38.64	0.71
chan-east-pr	1400	PF 1	151.00	6922.11	6924.34		6924.53	0.019741	3.49	43.32	56.50	0.70
chan-east-pr	1300	PF 1	151.00	6921.11	6924.03		6924.06	0.001745	1.52	99.63	73.31	0.23
chan-east-pr	1200	PF 1	151.00	6919.19	6924.04	6920.53	6924.04	0.000043	0.47	355.73	125.84	0.04
chan-east-pr	1111.15		Culvert									
chan-east-pr	1000	PF 1	188.00	6916.11	6918.61		6918.88	0.011828	4.27	48.70	49.94	0.61
chan-east-pr	900	PF 1	188.00	6915.02	6917.34		6917.59	0.013804	4.04	46.56	36.87	0.63
chan-east-pr	800	PF 1	188.00	6913.85	6916.39		6916.56	0.007704	3.25	57.93	41.39	0.48
chan-east-pr	700	PF 1	188.00	6913.13	6915.77		6915.89	0.005606	2.74	68.62	49.60	0.41
chan-east-pr	600	PF 1	188.00	6912.13	6914.13	6914.13	6914.67	0.037631	5.88	31.97	30.75	1.02
chan-east-pr	500	PF 1	188.00	6909.89	6912.81		6912.97	0.006783	3.29	57.14	36.09	0.46
chan-east-pr	400	PF 1	188.00	6908.81	6911.02	6911.02	6911.60	0.037090	6.11	30.76	27.24	1.01

# PROPOSED EAST CHANNEL 5-Y

HEC-RAS Plan: Plan 01 River: CHAN EAST PR Reach: chan-east-pr 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)	
chan-east-pr	2600	PF 1	31.00	6942.53	6943.83		6943.89	0.019615	1.94	15.94	24.40	0.42
chan-east-pr	2500	PF 1	31.00	6941.18	6942.43		6942.45	0.010793	1.12	27.62	62.13	0.30
chan-east-pr	2400	PF 1	31.00	6939.95	6940.80		6940.85	0.025978	1.77	17.49	38.34	0.46
chan-east-pr	2300	PF 1	31.00	6938.19	6938.88		6938.90	0.014891	1.32	23.46	52.68	0.35
chan-east-pr	2200	PF 1	31.00	6936.58	6937.54		6937.56	0.012323	1.14	27.31	66.80	0.31
chan-east-pr	2100	PF 1	31.00	6935.13	6936.57	6936.11	6936.60	0.007728	1.24	24.90	36.77	0.27
chan-east-pr	2010.45	PF 1	31.00	6933.88	6934.63	6934.62	6934.80	0.125209	3.34	9.29	25.65	0.98
chan-east-pr	1900	PF 1	31.00	6931.88	6932.93		6932.95	0.006112	1.03	30.23	50.91	0.23
chan-east-pr	1801.17	PF 1	31.00	6931.01	6931.95		6931.99	0.018414	1.54	20.08	41.86	0.39
chan-east-pr	1694.83	PF 1	31.00	6929.94	6930.55		6930.55	0.010212	0.71	43.53	133.24	0.22
chan-east-pr	1600	PF 1	31.00	6928.36	6929.02		6929.05	0.028146	1.33	23.29	59.69	0.38
chan-east-pr	1500	PF 1	31.00	6924.52	6925.46		6925.54	0.044684	2.20	14.08	23.87	0.51
chan-east-pr	1400	PF 1	31.00	6922.11	6924.18		6924.19	0.006255	0.89	34.87	52.71	0.19
chan-east-pr	1300	PF 1	31.00	6921.11	6922.19	6922.19	6922.36	0.200434	3.34	9.28	25.68	0.98
chan-east-pr	1200	PF 1	31.00	6919.19	6921.57	6920.03	6921.58	0.000290	0.31	99.20	71.76	0.05
chan-east-pr	1111.15		Culvert									
chan-east-pr	1000	PF 1	32.00	6916.11	6917.92		6917.95	0.010581	1.38	23.12	26.69	0.26
chan-east-pr	900	PF 1	32.00	6915.02	6916.54		6916.58	0.018490	1.58	20.27	28.93	0.33
chan-east-pr	800	PF 1	32.00	6913.85	6915.51		6915.53	0.006648	1.17	27.31	28.48	0.21
chan-east-pr	700	PF 1	32.00	6913.13	6914.93		6914.94	0.005243	0.99	32.44	36.42	0.18
chan-east-pr	600	PF 1	32.00	6912.13	6913.12	6913.12	6913.38	0.189670	4.04	7.92	15.92	1.01
chan-east-pr	500	PF 1	32.00	6909.89	6911.81		6911.83	0.004944	1.15	27.75	23.54	0.19
chan-east-pr	400	PF 1	32.00	6908.81	6910.10	6910.10	6910.32	0.207973	3.71	8.63	20.97	1.02

# PROPOSED EAST CHANNEL 2-Y

HEC-RAS Plan: Plan 01 River: CHAN EAST PR Reach: chan-east-pr 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)	
chan-east-pr	2600	PF 1	21.00	6942.53	6943.67		6943.72	0.018097	1.71	12.27	21.41	0.40
chan-east-pr	2500	PF 1	21.00	6941.18	6942.31		6942.33	0.010976	1.03	20.48	53.39	0.29
chan-east-pr	2400	PF 1	21.00	6939.95	6940.68		6940.72	0.025717	1.60	13.12	33.26	0.45
chan-east-pr	2300	PF 1	21.00	6938.19	6938.77		6938.79	0.014820	1.17	17.90	47.90	0.34
chan-east-pr	2200	PF 1	21.00	6936.58	6937.39		6937.41	0.012863	1.11	18.89	49.25	0.32
chan-east-pr	2100	PF 1	21.00	6935.13	6936.42	6936.03	6936.43	0.007648	1.09	19.31	34.63	0.26
chan-east-pr	2010.45	PF 1	21.00	6933.88	6934.53	6934.51	6934.67	0.121395	3.00	7.01	22.18	0.94
chan-east-pr	1900	PF 1	21.00	6931.88	6932.77		6932.78	0.006323	0.94	22.37	44.10	0.23
chan-east-pr	1801.17	PF 1	21.00	6931.01	6931.87	6931.56	6931.89	0.013535	1.24	16.88	38.60	0.33
chan-east-pr	1694.83	PF 1	21.00	6929.94	6930.45		6930.46	0.013196	0.67	31.11	125.07	0.24
chan-east-pr	1600	PF 1	21.00	6928.36	6928.97		6928.99	0.018681	1.02	20.55	57.53	0.30
chan-east-pr	1500	PF 1	21.00	6924.52	6925.16		6925.28	0.105830	2.70	7.77	18.48	0.74
chan-east-pr	1400	PF 1	21.00	6922.11	6923.84		6923.85	0.005242	0.97	21.73	25.27	0.18
chan-east-pr	1300	PF 1	21.00	6921.11	6922.08	6922.08	6922.23	0.249263	3.19	6.58	22.91	1.05
chan-east-pr	1200	PF 1	21.00	6919.19	6921.28	6919.87	6921.28	0.000248	0.27	79.17	65.08	0.04
chan-east-pr	1111.15		Culvert									
chan-east-pr	1000	PF 1	22.00	6916.11	6917.74		6917.77	0.009297	1.19	18.51	24.19	0.24
chan-east-pr	900	PF 1	22.00	6915.02	6916.35		6916.38	0.022502	1.48	14.84	27.01	0.35
chan-east-pr	800	PF 1	22.00	6913.85	6915.28		6915.30	0.006315	1.04	21.10	25.25	0.20
chan-east-pr	700	PF 1	22.00	6913.13	6914.72		6914.74	0.005064	0.87	25.26	33.29	0.18
chan-east-pr	600	PF 1	22.00	6912.13	6912.98	6912.98	6913.20	0.198497	3.74	5.88	13.72	1.01
chan-east-pr	500	PF 1	22.00	6909.89	6911.55		6911.56	0.004425	1.00	21.96	21.17	0.17
chan-east-pr	400	PF 1	22.00	6908.81	6910.00	6910.00	6910.18	0.238618	3.40	6.47	19.84	1.05

# PROPOSED EAST CHANNEL 100-Y

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 2600 Profile: PF 1

E.G. Elev (ft)	6944.60	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.11	Wt. n-Val.	0.080	0.080	0.080
W.S. Elev (ft)	6944.49	Reach Len. (ft)	103.00	100.00	103.00
Crit W.S. (ft)		Flow Area (sq ft)	2.13	33.58	30.49
E.G. Slope (ft/ft)	0.020083	Area (sq ft)	2.13	33.58	30.49
Q Total (cfs)	151.00	Flow (cfs)	1.95	101.52	47.53
Top Width (ft)	108.74	Top Width (ft)	14.87	27.00	66.87
Vel Total (ft/s)	2.28	Avg. Vel. (ft/s)	0.91	3.02	1.56
Max Chl Dpth (ft)	1.96	Hydr. Depth (ft)	0.14	1.24	0.46
Conv. Total (cfs)	1065.5	Conv. (cfs)	13.8	716.4	335.4
Length Wtd. (ft)	100.57	Wetted Per. (ft)	14.99	27.28	66.88
Min Ch El (ft)	6942.53	Shear (lb/sq ft)	0.18	1.54	0.57
Alpha	1.33	Stream Power (lb/ft s)	0.16	4.67	0.89
Frctn Loss (ft)	1.45	Cum Volume (acre-ft)	0.05	3.69	0.14
C & E Loss (ft)	0.02	Cum SA (acres)	0.23	3.27	0.34

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 2500 Profile: PF 1

E.G. Elev (ft)	6943.13	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.06	Wt. n-Val.	0.080	0.080	0.080
W.S. Elev (ft)	6943.07	Reach Len. (ft)	83.00	100.00	112.00
Crit W.S. (ft)		Flow Area (sq ft)	6.97	73.09	4.26
E.G. Slope (ft/ft)	0.010904	Area (sq ft)	6.97	73.09	4.26
Q Total (cfs)	151.00	Flow (cfs)	4.66	143.00	3.34
Top Width (ft)	124.93	Top Width (ft)	36.36	72.00	16.56
Vel Total (ft/s)	1.79	Avg. Vel. (ft/s)	0.67	1.96	0.78
Max Chl Dpth (ft)	1.89	Hydr. Depth (ft)	0.19	1.02	0.26
Conv. Total (cfs)	1446.0	Conv. (cfs)	44.7	1369.4	32.0
Length Wtd. (ft)	99.87	Wetted Per. (ft)	36.61	72.15	16.57
Min Ch El (ft)	6941.18	Shear (lb/sq ft)	0.13	0.69	0.17
Alpha	1.14	Stream Power (lb/ft s)	0.09	1.35	0.14
Frctn Loss (ft)	1.40	Cum Volume (acre-ft)	0.04	3.56	0.10
C & E Loss (ft)	0.00	Cum SA (acres)	0.17	3.16	0.24

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 2400 Profile: PF 1

E.G. Elev (ft)	6941.73	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.08	Wt. n-Val.		0.080	
W.S. Elev (ft)	6941.64	Reach Len. (ft)	83.00	100.00	128.00
Crit W.S. (ft)		Flow Area (sq ft)		65.19	
E.G. Slope (ft/ft)	0.018619	Area (sq ft)		65.19	
Q Total (cfs)	151.00	Flow (cfs)		151.00	
Top Width (ft)	74.51	Top Width (ft)		74.51	
Vel Total (ft/s)	2.32	Avg. Vel. (ft/s)		2.32	
Max Chl Dpth (ft)	1.69	Hydr. Depth (ft)		0.87	
Conv. Total (cfs)	1106.6	Conv. (cfs)		1106.6	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		74.61	
Min Ch El (ft)	6939.95	Shear (lb/sq ft)		1.02	
Alpha	1.00	Stream Power (lb/ft s)		2.35	
Frctn Loss (ft)	2.19	Cum Volume (acre-ft)	0.03	3.40	0.09
C & E Loss (ft)	0.00	Cum SA (acres)	0.13	2.99	0.22

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 2300 Profile: PF 1

E.G. Elev (ft)	6939.53	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.10	Wt. n-Val.		0.080	
W.S. Elev (ft)	6939.43	Reach Len. (ft)	90.00	100.00	123.00
Crit W.S. (ft)		Flow Area (sq ft)		58.82	
E.G. Slope (ft/ft)	0.026082	Area (sq ft)		58.82	
Q Total (cfs)	151.00	Flow (cfs)		151.00	

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 2300 Profile: PF 1 (Continued)

Top Width (ft)	74.24	Top Width (ft)		74.24	
Vel Total (ft/s)	2.57	Avg. Vel. (ft/s)		2.57	
Max Chl Dpth (ft)	1.24	Hydr. Depth (ft)		0.79	
Conv. Total (cfs)	935.0	Conv. (cfs)		935.0	
Length Wtd. (ft)	99.97	Wetted Per. (ft)		74.31	
Min Ch El (ft)	6938.19	Shear (lb/sq ft)		1.29	
Alpha	1.00	Stream Power (lb/ft s)		3.31	
Frctn Loss (ft)	1.11	Cum Volume (acre-ft)	0.03	3.26	0.09
C & E Loss (ft)	0.02	Cum SA (acres)	0.13	2.82	0.22

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 2200 Profile: PF 1

E.G. Elev (ft)	6938.40	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.04	Wt. n-Val.	0.080	0.080	
W.S. Elev (ft)	6938.37	Reach Len. (ft)	115.00	100.00	80.00
Crit W.S. (ft)		Flow Area (sq ft)	1.97	98.55	
E.G. Slope (ft/ft)	0.006135	Area (sq ft)	1.97	98.55	
Q Total (cfs)	151.00	Flow (cfs)	0.87	150.13	
Top Width (ft)	103.51	Top Width (ft)	11.72	91.79	
Vel Total (ft/s)	1.50	Avg. Vel. (ft/s)	0.44	1.52	
Max Chl Dpth (ft)	1.79	Hydr. Depth (ft)	0.17	1.07	
Conv. Total (cfs)	1927.9	Conv. (cfs)	11.1	1916.7	
Length Wtd. (ft)	100.04	Wetted Per. (ft)	11.73	91.98	
Min Ch El (ft)	6936.58	Shear (lb/sq ft)	0.06	0.41	
Alpha	1.02	Stream Power (lb/ft s)	0.03	0.63	
Frctn Loss (ft)	0.82	Cum Volume (acre-ft)	0.03	3.08	0.09
C & E Loss (ft)	0.00	Cum SA (acres)	0.12	2.63	0.22

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 2100 Profile: PF 1

E.G. Elev (ft)	6937.58	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.08	Wt. n-Val.		0.080	
W.S. Elev (ft)	6937.50	Reach Len. (ft)	65.00	89.55	98.00
Crit W.S. (ft)		Flow Area (sq ft)		65.48	
E.G. Slope (ft/ft)	0.011365	Area (sq ft)		65.48	
Q Total (cfs)	151.00	Flow (cfs)		151.00	
Top Width (ft)	51.30	Top Width (ft)		51.30	
Vel Total (ft/s)	2.31	Avg. Vel. (ft/s)		2.31	
Max Chl Dpth (ft)	2.37	Hydr. Depth (ft)		1.28	
Conv. Total (cfs)	1416.4	Conv. (cfs)		1416.4	
Length Wtd. (ft)	89.57	Wetted Per. (ft)		52.10	
Min Ch El (ft)	6935.13	Shear (lb/sq ft)		0.89	
Alpha	1.00	Stream Power (lb/ft s)		2.06	
Frctn Loss (ft)	1.94	Cum Volume (acre-ft)	0.03	2.89	0.09
C & E Loss (ft)	0.01	Cum SA (acres)	0.10	2.46	0.22

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 2010.45 Profile: PF 1

E.G. Elev (ft)	6935.63	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.20	Wt. n-Val.		0.080	0.080
W.S. Elev (ft)	6935.43	Reach Len. (ft)	123.00	110.45	82.00
Crit W.S. (ft)		Flow Area (sq ft)		41.30	1.00
E.G. Slope (ft/ft)	0.056212	Area (sq ft)		41.30	1.00
Q Total (cfs)	151.00	Flow (cfs)		150.11	0.89
Top Width (ft)	65.96	Top Width (ft)		54.97	10.99
Vel Total (ft/s)	3.57	Avg. Vel. (ft/s)		3.63	0.89
Max Chl Dpth (ft)	1.55	Hydr. Depth (ft)		0.75	0.09
Conv. Total (cfs)	636.9	Conv. (cfs)		633.1	3.8
Length Wtd. (ft)	110.37	Wetted Per. (ft)		55.07	11.00
Min Ch El (ft)	6933.88	Shear (lb/sq ft)		2.63	0.32

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 2010.45 Profile: PF 1 (Continued)

Alpha	1.03	Stream Power (lb/ft s)		9.57	0.28
Frctn Loss (ft)	1.70	Cum Volume (acre-ft)	0.03	2.78	0.09
C & E Loss (ft)	0.05	Cum SA (acres)	0.10	2.35	0.20

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 1900 Profile: PF 1

E.G. Elev (ft)	6933.88	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.04	Wt. n-Val.		0.080	
W.S. Elev (ft)	6933.84	Reach Len. (ft)	102.00	98.83	89.00
Crit W.S. (ft)		Flow Area (sq ft)		93.32	
E.G. Slope (ft/ft)	0.007048	Area (sq ft)		93.32	
Q Total (cfs)	151.00	Flow (cfs)		151.00	
Top Width (ft)	88.19	Top Width (ft)		88.19	
Vel Total (ft/s)	1.62	Avg. Vel. (ft/s)		1.62	
Max Chl Dpth (ft)	1.96	Hydr. Depth (ft)		1.06	
Conv. Total (cfs)	1798.6	Conv. (cfs)		1798.6	
Length Wtd. (ft)	98.83	Wetted Per. (ft)		88.28	
Min Ch El (ft)	6931.88	Shear (lb/sq ft)		0.47	
Alpha	1.00	Stream Power (lb/ft s)		0.75	
Frctn Loss (ft)	1.22	Cum Volume (acre-ft)	0.03	2.61	0.09
C & E Loss (ft)	0.00	Cum SA (acres)	0.10	2.17	0.19

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 1801.17 Profile: PF 1

E.G. Elev (ft)	6932.66	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.07	Wt. n-Val.	0.000	0.100	
W.S. Elev (ft)	6932.59	Reach Len. (ft)	114.00	106.34	118.00
Crit W.S. (ft)		Flow Area (sq ft)	0.00	72.33	
E.G. Slope (ft/ft)	0.027173	Area (sq ft)	0.00	72.33	
Q Total (cfs)	151.00	Flow (cfs)	0.00	151.00	
Top Width (ft)	92.03	Top Width (ft)	0.21	91.82	
Vel Total (ft/s)	2.09	Avg. Vel. (ft/s)	0.09	2.09	
Max Chl Dpth (ft)	1.58	Hydr. Depth (ft)	0.01	0.79	
Conv. Total (cfs)	916.0	Conv. (cfs)	0.0	916.0	
Length Wtd. (ft)	106.34	Wetted Per. (ft)	0.21	91.92	
Min Ch El (ft)	6931.01	Shear (lb/sq ft)		1.33	
Alpha	1.00	Stream Power (lb/ft s)		2.79	
Frctn Loss (ft)	1.52	Cum Volume (acre-ft)	0.03	2.42	0.09
C & E Loss (ft)	0.01	Cum SA (acres)	0.10	1.97	0.19

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 1694.83 Profile: PF 1

E.G. Elev (ft)	6931.13	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.02	Wt. n-Val.		0.100	
W.S. Elev (ft)	6931.11	Reach Len. (ft)	103.00	94.83	49.00
Crit W.S. (ft)		Flow Area (sq ft)		121.34	
E.G. Slope (ft/ft)	0.008773	Area (sq ft)		121.34	
Q Total (cfs)	151.00	Flow (cfs)		151.00	
Top Width (ft)	143.39	Top Width (ft)		143.39	
Vel Total (ft/s)	1.24	Avg. Vel. (ft/s)		1.24	
Max Chl Dpth (ft)	1.17	Hydr. Depth (ft)		0.85	
Conv. Total (cfs)	1612.2	Conv. (cfs)		1612.2	
Length Wtd. (ft)	94.83	Wetted Per. (ft)		143.51	
Min Ch El (ft)	6929.94	Shear (lb/sq ft)		0.46	
Alpha	1.00	Stream Power (lb/ft s)		0.58	
Frctn Loss (ft)	1.41	Cum Volume (acre-ft)	0.03	2.19	0.09
C & E Loss (ft)	0.01	Cum SA (acres)	0.10	1.68	0.19

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 1600 Profile: PF 1

E.G. Elev (ft)	6929.71	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.07	Wt. n-Val.		0.100	
W.S. Elev (ft)	6929.63	Reach Len. (ft)	96.00	100.00	108.00
Crit W.S. (ft)		Flow Area (sq ft)		69.00	
E.G. Slope (ft/ft)	0.030740	Area (sq ft)		69.00	
Q Total (cfs)	151.00	Flow (cfs)		151.00	
Top Width (ft)	89.57	Top Width (ft)		89.57	
Vel Total (ft/s)	2.19	Avg. Vel. (ft/s)		2.19	
Max Chl Dpth (ft)	1.27	Hydr. Depth (ft)		0.77	
Conv. Total (cfs)	861.2	Conv. (cfs)		861.2	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		89.62	
Min Ch El (ft)	6928.36	Shear (lb/sq ft)		1.48	
Alpha	1.00	Stream Power (lb/ft s)		3.23	
Frctn Loss (ft)	2.94	Cum Volume (acre-ft)	0.03	1.98	0.09
C & E Loss (ft)	0.00	Cum SA (acres)	0.10	1.43	0.19

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 1500 Profile: PF 1

E.G. Elev (ft)	6926.76	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.11	Wt. n-Val.		0.100	
W.S. Elev (ft)	6926.65	Reach Len. (ft)	91.00	100.00	112.00
Crit W.S. (ft)		Flow Area (sq ft)		55.97	
E.G. Slope (ft/ft)	0.028222	Area (sq ft)		55.97	
Q Total (cfs)	151.00	Flow (cfs)		151.00	
Top Width (ft)	49.57	Top Width (ft)		49.57	
Vel Total (ft/s)	2.70	Avg. Vel. (ft/s)		2.70	
Max Chl Dpth (ft)	2.13	Hydr. Depth (ft)		1.13	
Conv. Total (cfs)	898.8	Conv. (cfs)		898.8	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		49.82	
Min Ch El (ft)	6924.52	Shear (lb/sq ft)		1.98	
Alpha	1.00	Stream Power (lb/ft s)		5.34	
Frctn Loss (ft)	1.94	Cum Volume (acre-ft)	0.03	1.84	0.09
C & E Loss (ft)	0.01	Cum SA (acres)	0.10	1.27	0.19

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 1400 Profile: PF 1

E.G. Elev (ft)	6924.81	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.08	Wt. n-Val.		0.080	
W.S. Elev (ft)	6924.73	Reach Len. (ft)	96.00	100.00	83.00
Crit W.S. (ft)		Flow Area (sq ft)		67.68	
E.G. Slope (ft/ft)	0.014150	Area (sq ft)		67.68	
Q Total (cfs)	151.00	Flow (cfs)		151.00	
Top Width (ft)	66.38	Top Width (ft)		66.38	
Vel Total (ft/s)	2.23	Avg. Vel. (ft/s)		2.23	
Max Chl Dpth (ft)	2.62	Hydr. Depth (ft)		1.02	
Conv. Total (cfs)	1269.4	Conv. (cfs)		1269.4	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		66.71	
Min Ch El (ft)	6922.11	Shear (lb/sq ft)		0.90	
Alpha	1.00	Stream Power (lb/ft s)		2.00	
Frctn Loss (ft)	0.71	Cum Volume (acre-ft)	0.03	1.70	0.09
C & E Loss (ft)	0.01	Cum SA (acres)	0.10	1.14	0.19

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 1300 Profile: PF 1

E.G. Elev (ft)	6924.08	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.03	Wt. n-Val.		0.080	
W.S. Elev (ft)	6924.05	Reach Len. (ft)	83.00	100.00	118.00
Crit W.S. (ft)		Flow Area (sq ft)		101.14	
E.G. Slope (ft/ft)	0.004293	Area (sq ft)		101.14	
Q Total (cfs)	151.00	Flow (cfs)		151.00	

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 1300 Profile: PF 1 (Continued)

Top Width (ft)	73.88	Top Width (ft)		73.88	
Vel Total (ft/s)	1.49	Avg. Vel. (ft/s)		1.49	
Max Chl Dpth (ft)	2.94	Hydr. Depth (ft)		1.37	
Conv. Total (cfs)	2304.7	Conv. (cfs)		2304.7	
Length Wtd. (ft)	100.66	Wetted Per. (ft)		74.43	
Min Ch El (ft)	6921.11	Shear (lb/sq ft)		0.36	
Alpha	1.00	Stream Power (lb/ft s)		0.54	
Frctn Loss (ft)	0.03	Cum Volume (acre-ft)	0.03	1.50	0.09
C & E Loss (ft)	0.01	Cum SA (acres)	0.10	0.97	0.19

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 1200 Profile: PF 1

E.G. Elev (ft)	6924.04	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.00	Wt. n-Val.	0.080	0.080	0.080
W.S. Elev (ft)	6924.04	Reach Len. (ft)	191.00	200.00	169.00
Crit W.S. (ft)	6920.52	Flow Area (sq ft)	20.32	281.35	54.07
E.G. Slope (ft/ft)	0.000109	Area (sq ft)	20.32	281.35	54.07
Q Total (cfs)	151.00	Flow (cfs)	3.99	132.19	14.82
Top Width (ft)	125.84	Top Width (ft)	19.84	74.00	32.00
Vel Total (ft/s)	0.42	Avg. Vel. (ft/s)	0.20	0.47	0.27
Max Chl Dpth (ft)	4.85	Hydr. Depth (ft)	1.02	3.80	1.69
Conv. Total (cfs)	14460.9	Conv. (cfs)	381.9	12659.9	1419.1
Length Wtd. (ft)	200.00	Wetted Per. (ft)	19.96	74.61	32.18
Min Ch El (ft)	6919.19	Shear (lb/sq ft)	0.01	0.03	0.01
Alpha	1.12	Stream Power (lb/ft s)	0.00	0.01	0.00
Frctn Loss (ft)		Cum Volume (acre-ft)	0.01	1.06	0.02
C & E Loss (ft)		Cum SA (acres)	0.08	0.80	0.15

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 1000 Profile: PF 1

E.G. Elev (ft)	6919.16	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.13	Wt. n-Val.	0.080	0.080	0.080
W.S. Elev (ft)	6919.03	Reach Len. (ft)	103.00	100.00	98.00
Crit W.S. (ft)		Flow Area (sq ft)	5.65	53.03	14.65
E.G. Slope (ft/ft)	0.011207	Area (sq ft)	5.65	53.03	14.65
Q Total (cfs)	188.00	Flow (cfs)	7.13	162.15	18.73
Top Width (ft)	65.85	Top Width (ft)	10.94	27.00	27.92
Vel Total (ft/s)	2.56	Avg. Vel. (ft/s)	1.26	3.06	1.28
Max Chl Dpth (ft)	2.92	Hydr. Depth (ft)	0.52	1.96	0.52
Conv. Total (cfs)	1775.8	Conv. (cfs)	67.3	1531.6	176.9
Length Wtd. (ft)	99.96	Wetted Per. (ft)	10.99	27.35	27.95
Min Ch El (ft)	6916.11	Shear (lb/sq ft)	0.36	1.36	0.37
Alpha	1.26	Stream Power (lb/ft s)	0.45	4.15	0.47
Frctn Loss (ft)	1.18	Cum Volume (acre-ft)	0.01	0.92	0.02
C & E Loss (ft)	0.00	Cum SA (acres)	0.02	0.57	0.03

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 900 Profile: PF 1

E.G. Elev (ft)	6917.99	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.12	Wt. n-Val.		0.080	
W.S. Elev (ft)	6917.87	Reach Len. (ft)	111.00	100.00	84.00
Crit W.S. (ft)		Flow Area (sq ft)		67.32	
E.G. Slope (ft/ft)	0.012344	Area (sq ft)		67.32	
Q Total (cfs)	188.00	Flow (cfs)		188.00	
Top Width (ft)	42.09	Top Width (ft)		42.09	
Vel Total (ft/s)	2.79	Avg. Vel. (ft/s)		2.79	
Max Chl Dpth (ft)	2.84	Hydr. Depth (ft)		1.60	
Conv. Total (cfs)	1692.1	Conv. (cfs)		1692.1	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		42.77	
Min Ch El (ft)	6915.02	Shear (lb/sq ft)		1.21	

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 900 Profile: PF 1 (Continued)

Alpha	1.00	Stream Power (lb/ft s)		3.39	
Frctn Loss (ft)	1.01	Cum Volume (acre-ft)	0.00	0.79	0.00
C & E Loss (ft)	0.01	Cum SA (acres)	0.00	0.49	0.00

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 800 Profile: PF 1

E.G. Elev (ft)	6916.97	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.09	Wt. n-Val.		0.080	
W.S. Elev (ft)	6916.89	Reach Len. (ft)	100.50	100.00	100.00
Crit W.S. (ft)		Flow Area (sq ft)		80.17	
E.G. Slope (ft/ft)	0.008358	Area (sq ft)		80.17	
Q Total (cfs)	188.00	Flow (cfs)		188.00	
Top Width (ft)	48.98	Top Width (ft)		48.98	
Vel Total (ft/s)	2.34	Avg. Vel. (ft/s)		2.34	
Max Chl Dpth (ft)	3.03	Hydr. Depth (ft)		1.64	
Conv. Total (cfs)	2056.3	Conv. (cfs)		2056.3	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		49.40	
Min Ch El (ft)	6913.85	Shear (lb/sq ft)		0.85	
Alpha	1.00	Stream Power (lb/ft s)		1.99	
Frctn Loss (ft)	0.78	Cum Volume (acre-ft)	0.00	0.62	0.00
C & E Loss (ft)	0.00	Cum SA (acres)	0.00	0.39	0.00

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 700 Profile: PF 1

E.G. Elev (ft)	6916.19	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.07	Wt. n-Val.	0.080	0.080	0.080
W.S. Elev (ft)	6916.11	Reach Len. (ft)	82.00	100.00	114.00
Crit W.S. (ft)		Flow Area (sq ft)	0.06	86.37	0.10
E.G. Slope (ft/ft)	0.007279	Area (sq ft)	0.06	86.37	0.10
Q Total (cfs)	188.00	Flow (cfs)	0.01	187.95	0.04
Top Width (ft)	55.48	Top Width (ft)	1.42	53.00	1.06
Vel Total (ft/s)	2.17	Avg. Vel. (ft/s)	0.20	2.18	0.34
Max Chl Dpth (ft)	2.98	Hydr. Depth (ft)	0.04	1.63	0.10
Conv. Total (cfs)	2203.6	Conv. (cfs)	0.1	2203.0	0.4
Length Wtd. (ft)	100.00	Wetted Per. (ft)	1.43	53.67	1.07
Min Ch El (ft)	6913.13	Shear (lb/sq ft)	0.02	0.73	0.04
Alpha	1.00	Stream Power (lb/ft s)	0.00	1.59	0.01
Frctn Loss (ft)	1.33	Cum Volume (acre-ft)	0.00	0.43	0.00
C & E Loss (ft)	0.02	Cum SA (acres)	0.00	0.27	0.00

Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 600 Profile: PF 1

E.G. Elev (ft)	6914.84	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.25	Wt. n-Val.		0.080	
W.S. Elev (ft)	6914.59	Reach Len. (ft)	94.00	100.00	104.00
Crit W.S. (ft)		Flow Area (sq ft)		46.99	
E.G. Slope (ft/ft)	0.031340	Area (sq ft)		46.99	
Q Total (cfs)	188.00	Flow (cfs)		188.00	
Top Width (ft)	34.58	Top Width (ft)		34.58	
Vel Total (ft/s)	4.00	Avg. Vel. (ft/s)		4.00	
Max Chl Dpth (ft)	2.46	Hydr. Depth (ft)		1.36	
Conv. Total (cfs)	1062.0	Conv. (cfs)		1062.0	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		35.02	
Min Ch El (ft)	6912.13	Shear (lb/sq ft)		2.63	
Alpha	1.00	Stream Power (lb/ft s)		10.50	
Frctn Loss (ft)	1.34	Cum Volume (acre-ft)		0.27	
C & E Loss (ft)	0.05	Cum SA (acres)		0.17	

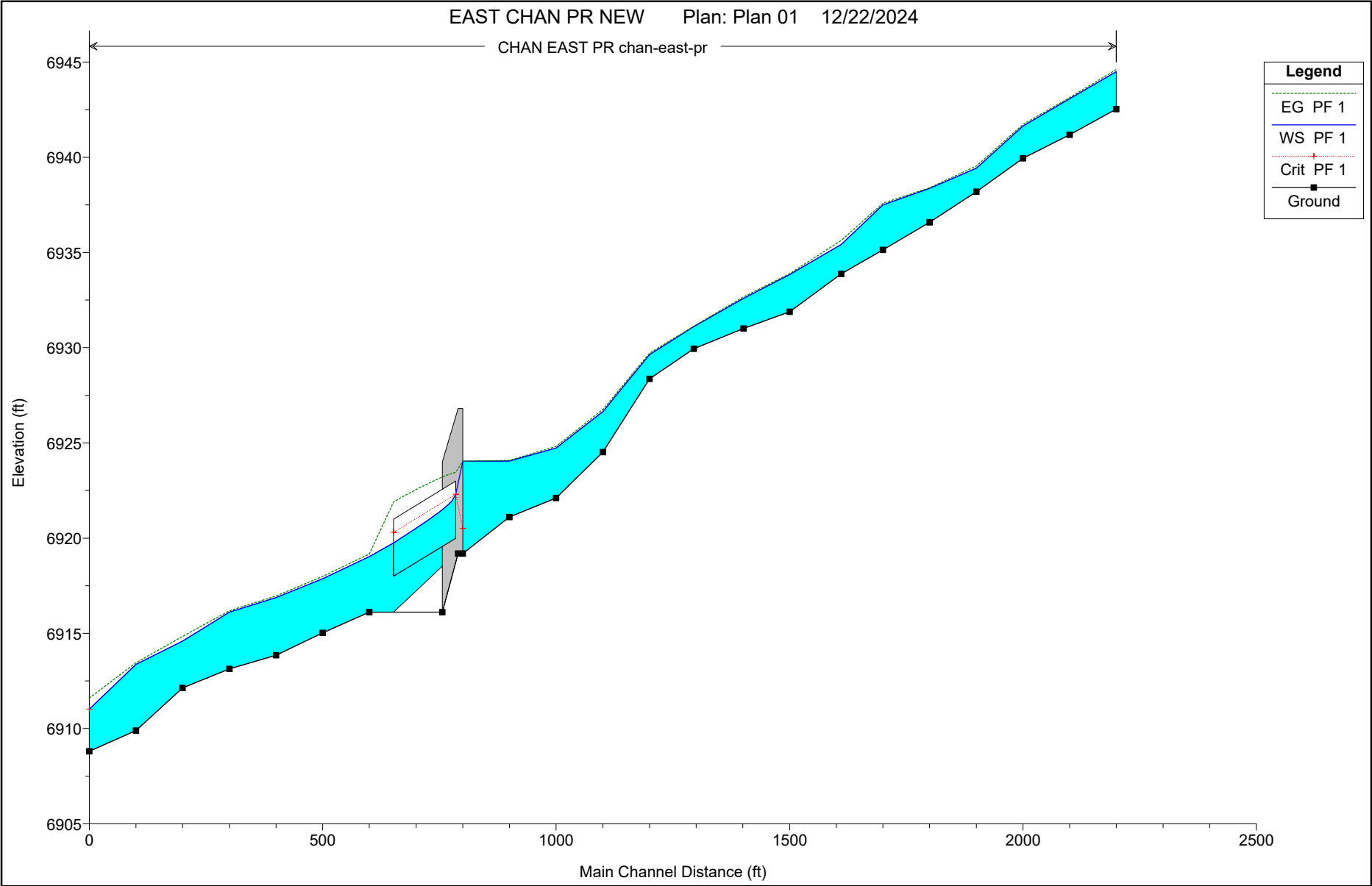
Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 500 Profile: PF 1

E.G. Elev (ft)	6913.46	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.09	Wt. n-Val.		0.080	
W.S. Elev (ft)	6913.37	Reach Len. (ft)	87.00	100.00	107.00
Crit W.S. (ft)		Flow Area (sq ft)		79.71	
E.G. Slope (ft/ft)	0.007372	Area (sq ft)		79.71	
Q Total (cfs)	188.00	Flow (cfs)		188.00	
Top Width (ft)	43.67	Top Width (ft)		43.67	
Vel Total (ft/s)	2.36	Avg. Vel. (ft/s)		2.36	
Max Chl Dpth (ft)	3.48	Hydr. Depth (ft)		1.83	
Conv. Total (cfs)	2189.6	Conv. (cfs)		2189.6	
Length Wtd. (ft)	100.00	Wetted Per. (ft)		44.32	
Min Ch El (ft)	6909.89	Shear (lb/sq ft)		0.83	
Alpha	1.00	Stream Power (lb/ft s)		1.95	
Frctn Loss (ft)	1.80	Cum Volume (acre-ft)		0.13	
C & E Loss (ft)	0.05	Cum SA (acres)		0.08	

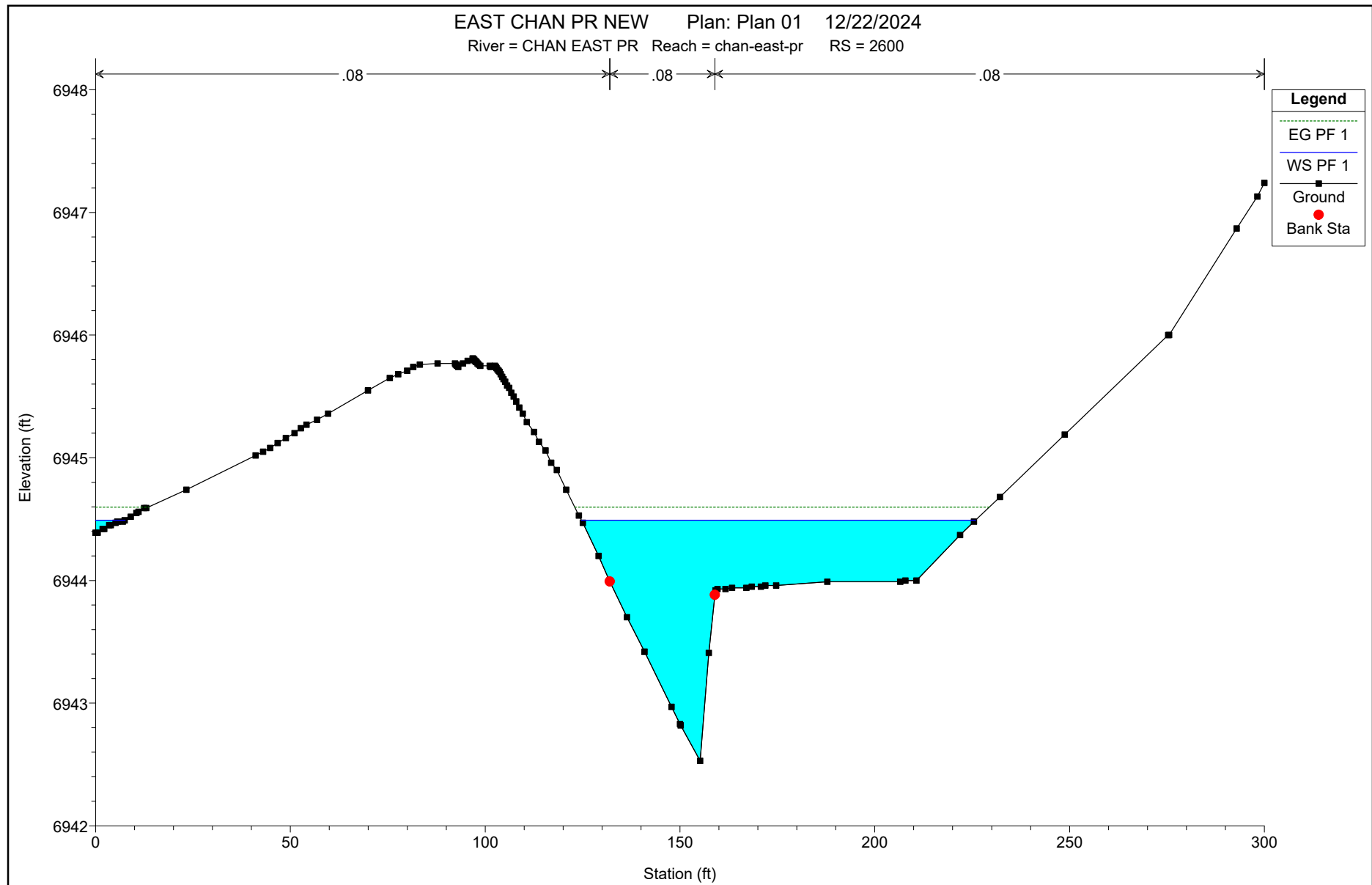
Plan: Plan 01 CHAN EAST PR chan-east-pr RS: 400 Profile: PF 1

E.G. Elev (ft)	6911.60	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.58	Wt. n-Val.		0.080	
W.S. Elev (ft)	6911.02	Reach Len. (ft)			
Crit W.S. (ft)	6911.02	Flow Area (sq ft)		30.76	
E.G. Slope (ft/ft)	0.094950	Area (sq ft)		30.76	
Q Total (cfs)	188.00	Flow (cfs)		188.00	
Top Width (ft)	27.24	Top Width (ft)		27.24	
Vel Total (ft/s)	6.11	Avg. Vel. (ft/s)		6.11	
Max Chl Dpth (ft)	2.21	Hydr. Depth (ft)		1.13	
Conv. Total (cfs)	610.1	Conv. (cfs)		610.1	
Length Wtd. (ft)		Wetted Per. (ft)		27.87	
Min Ch El (ft)	6908.81	Shear (lb/sq ft)		6.54	
Alpha	1.00	Stream Power (lb/ft s)		39.99	
Frctn Loss (ft)		Cum Volume (acre-ft)			
C & E Loss (ft)		Cum SA (acres)			

# PROPOSED EAST CHANNEL 100-Y

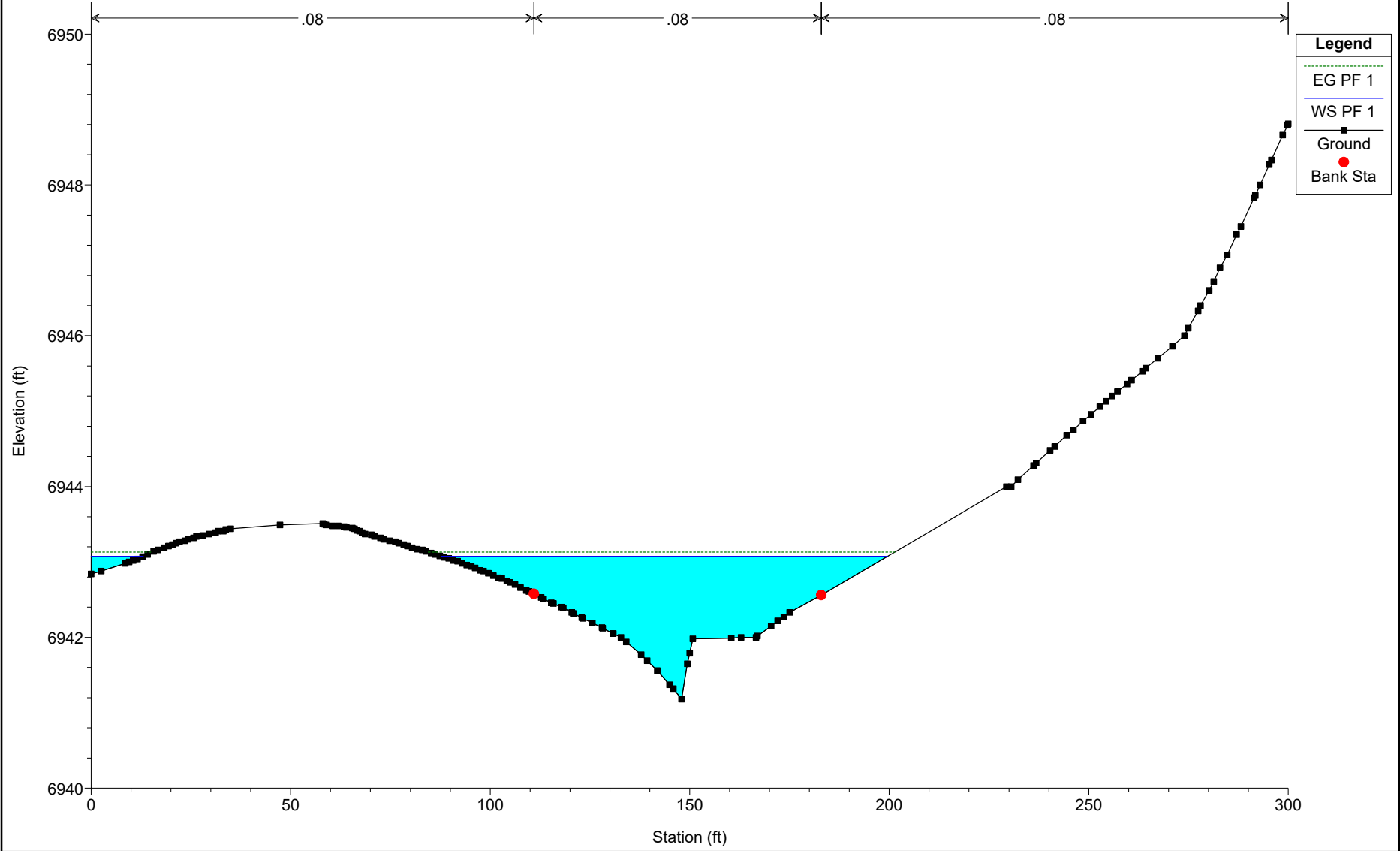


## PROPOSED EAST CHANNEL 100-Y

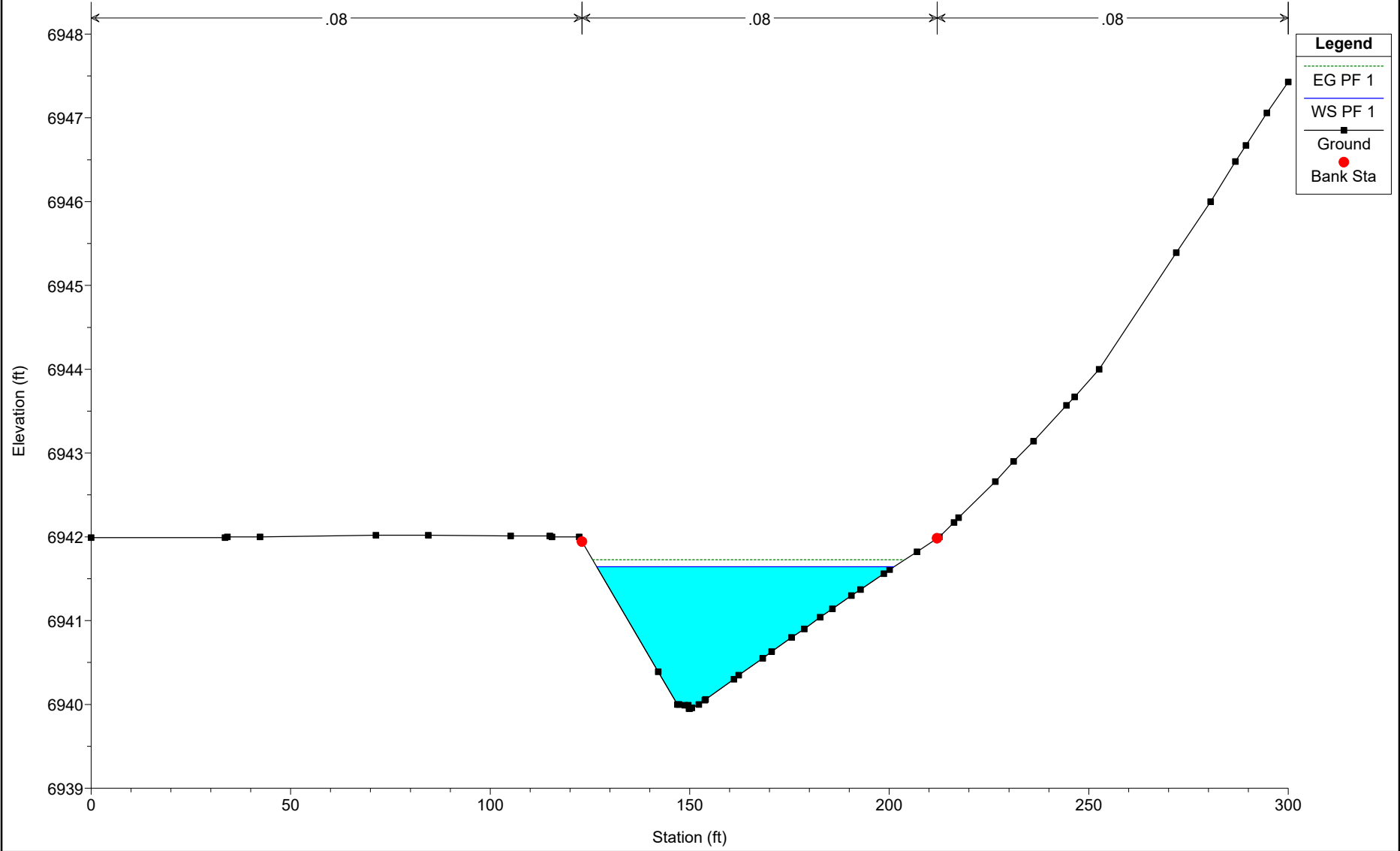


EAST CHAN PR NEW    Plan: Plan 01    12/22/2024

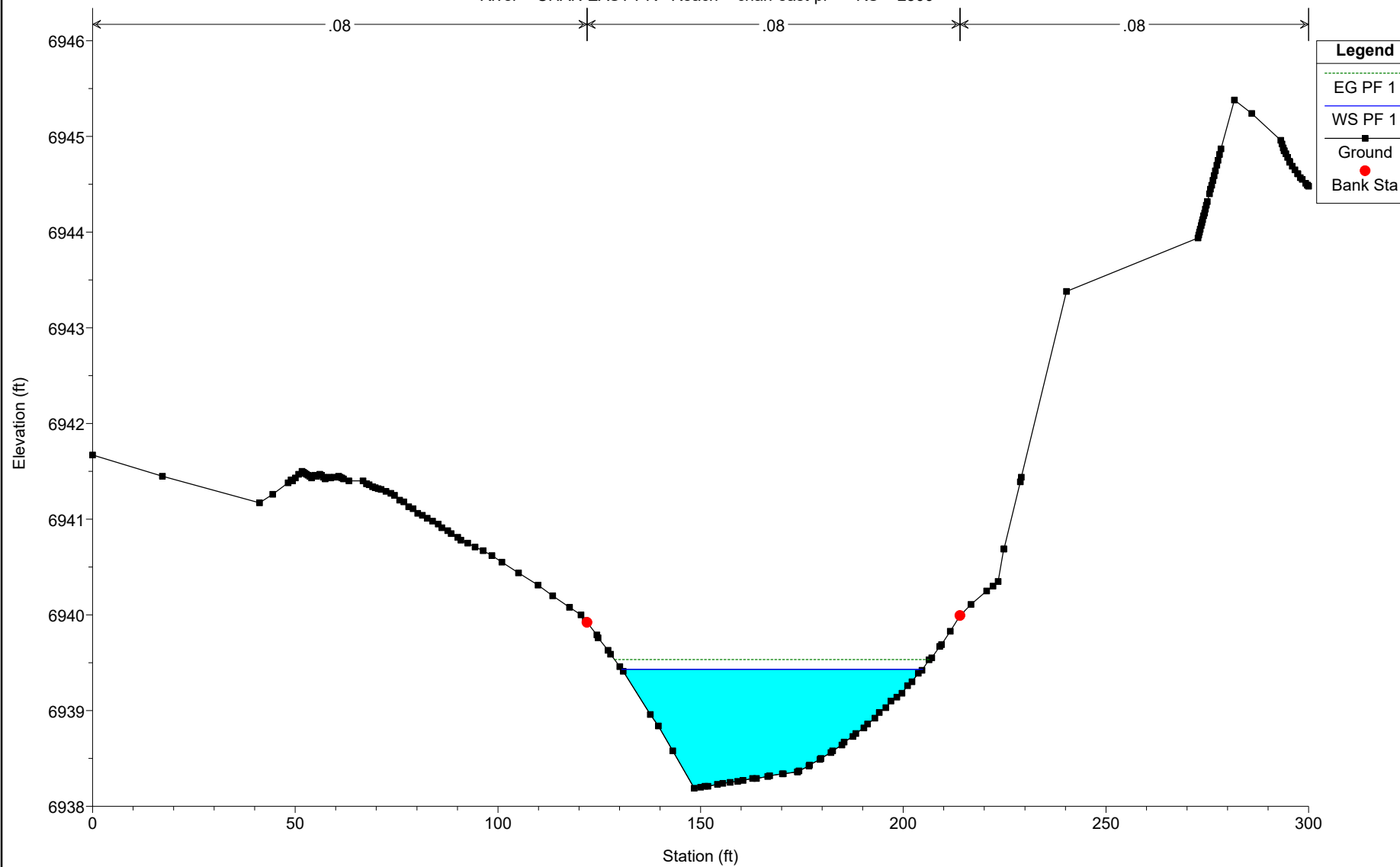
River = CHAN EAST PR    Reach = chan-east-pr    RS = 2500



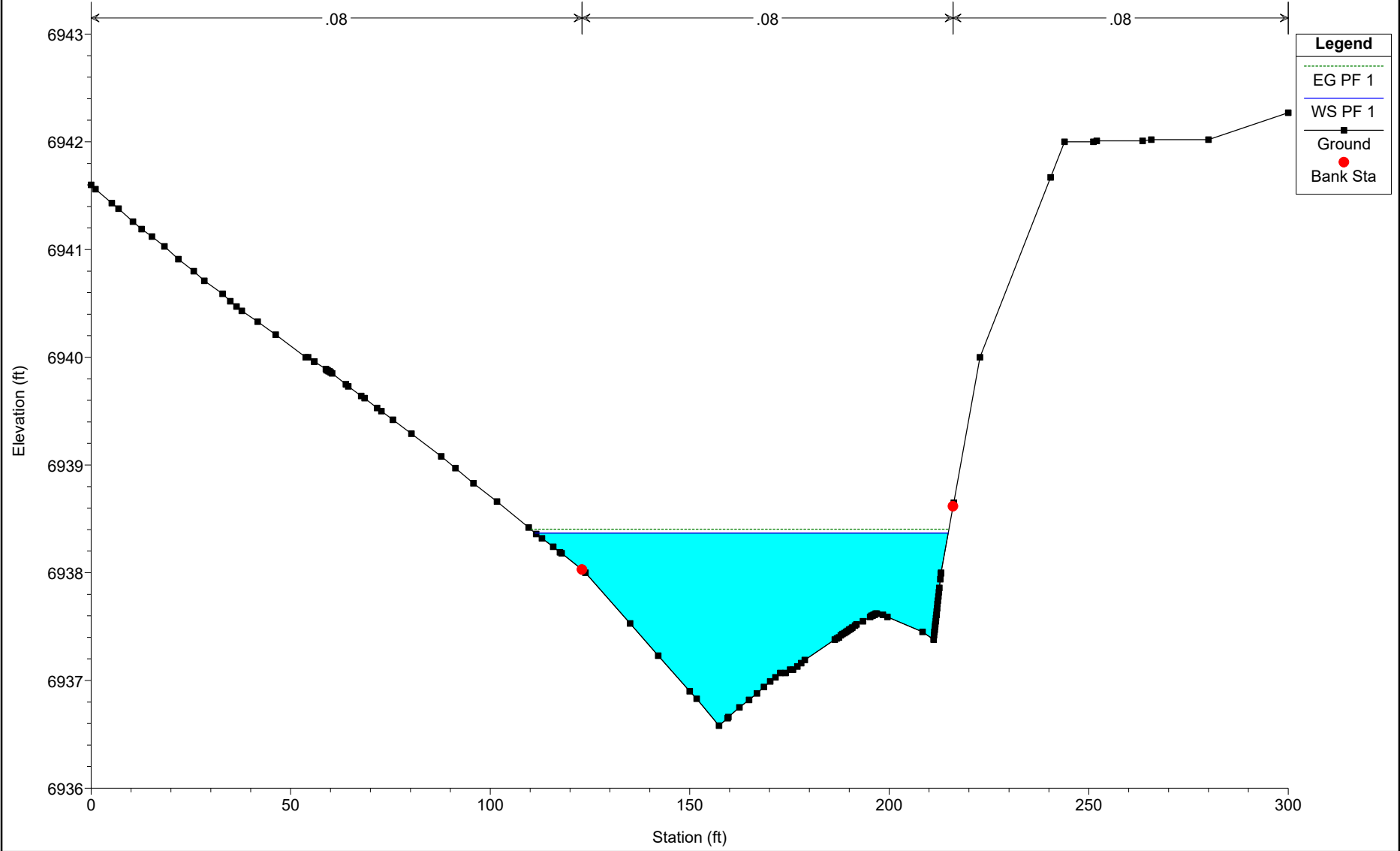
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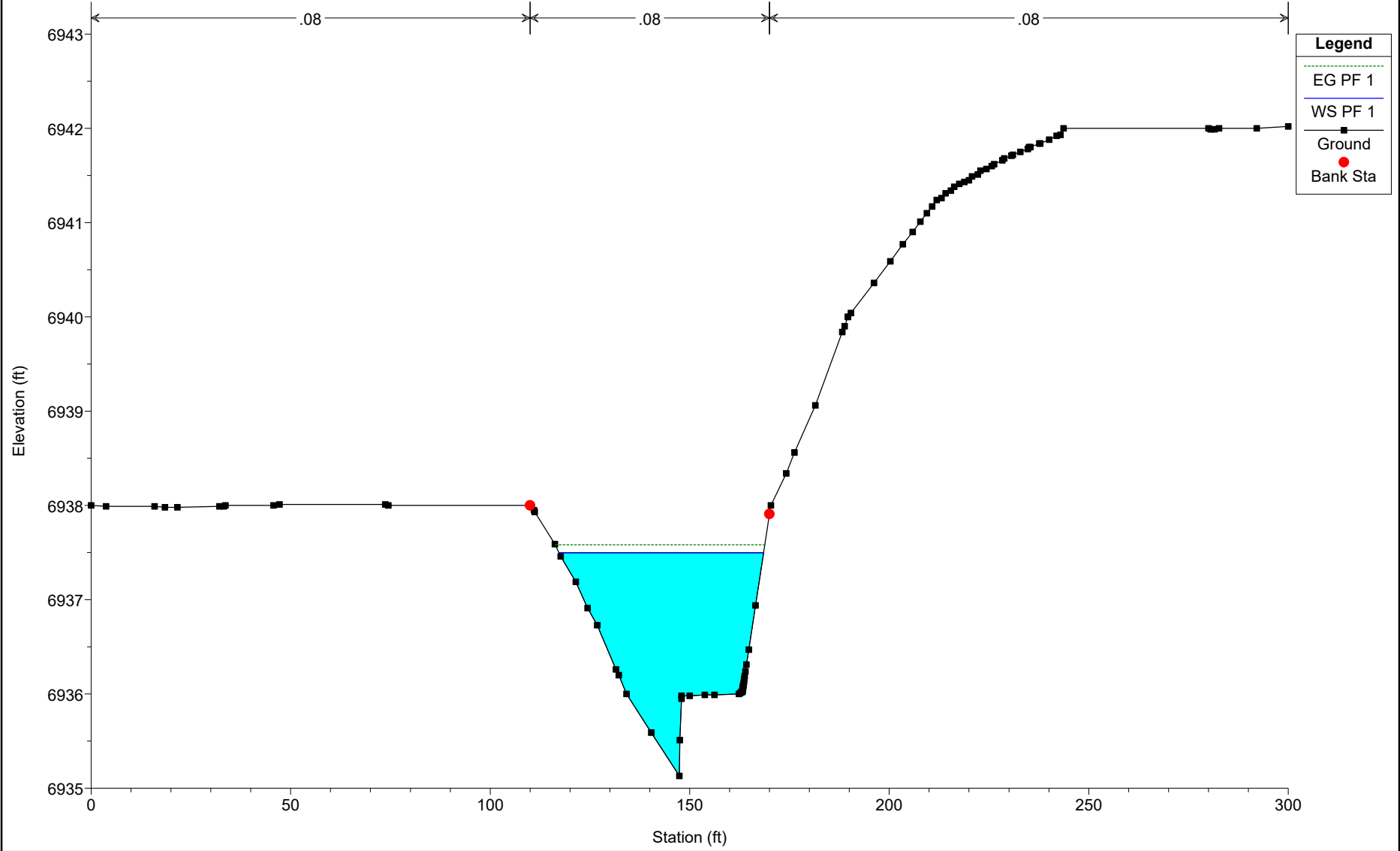
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River = CHAN EAST PR    Reach = chan-east-pr    RS = 2300



EAST CHAN PR NEW    Plan: Plan 01    12/22/2024  
River = CHAN EAST PR    Reach = chan-east-pr    RS = 2200

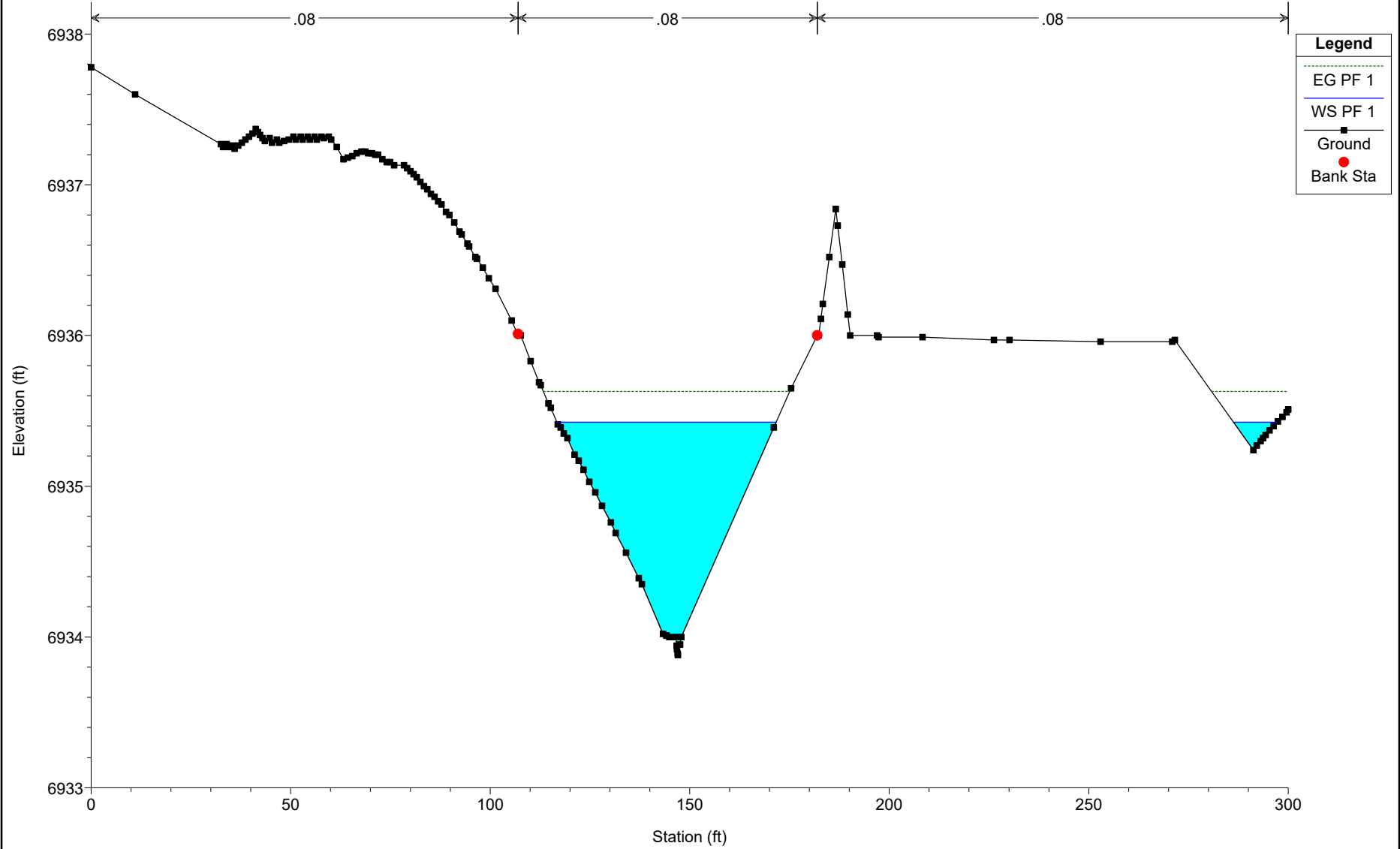


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River = CHAN EAST PR    Reach = chan-east-pr    RS = 2100



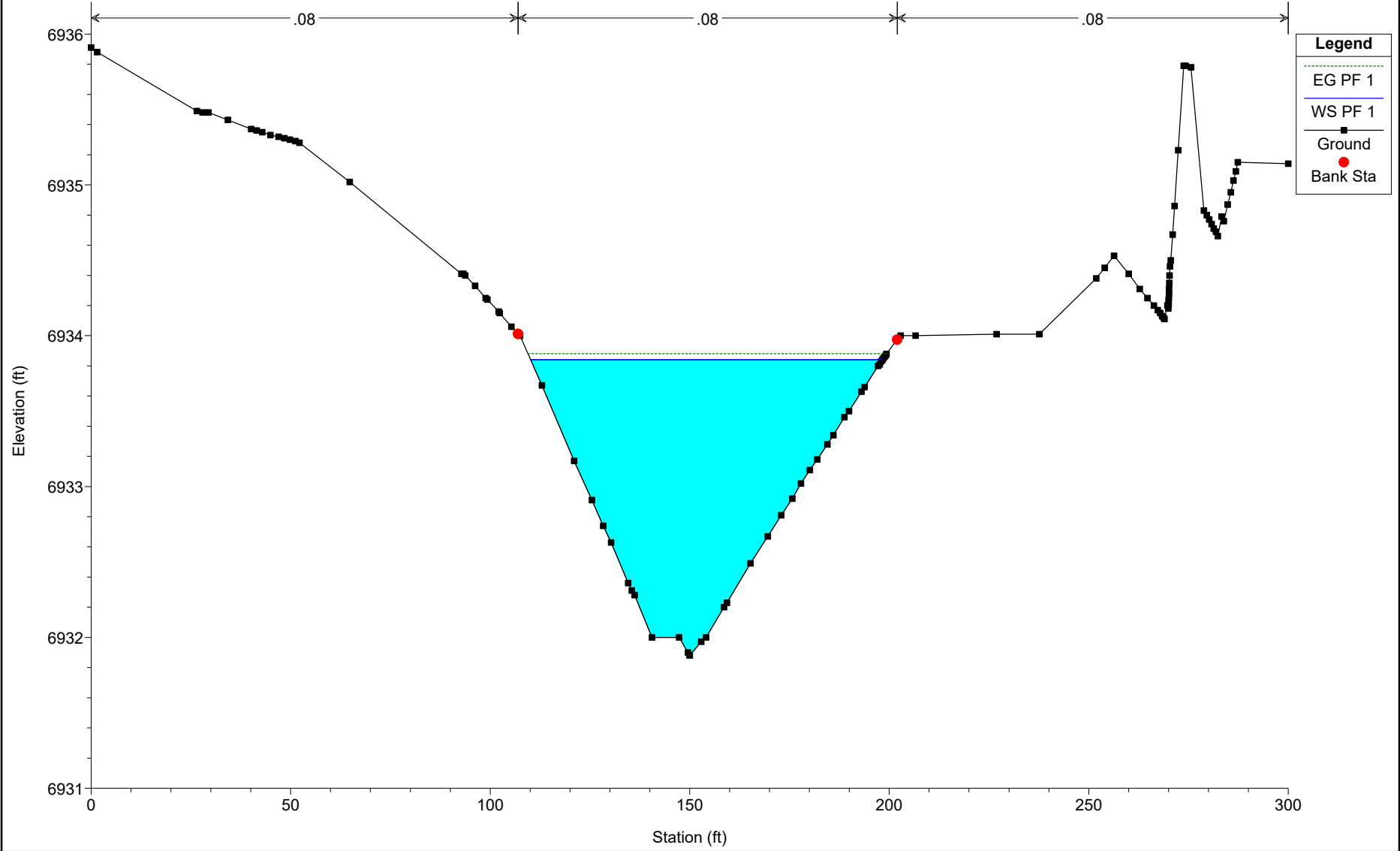
EAST CHAN PR NEW Plan: Plan 01 12/22/2024

River = CHAN EAST PR Reach = chan-east-pr RS = 2010.45



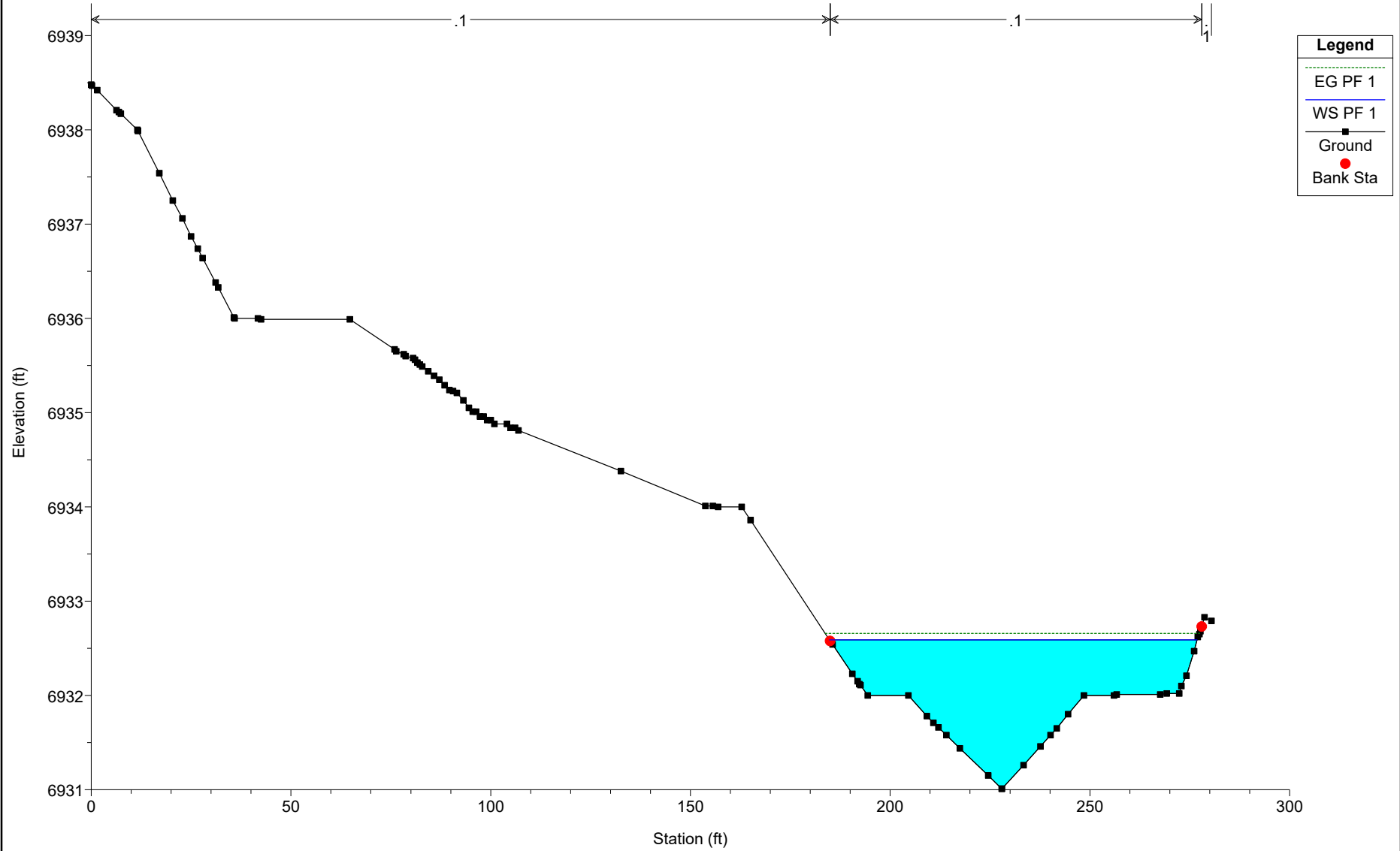
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River = CHAN EAST PR    Reach = chan-east-pr    RS = 1900

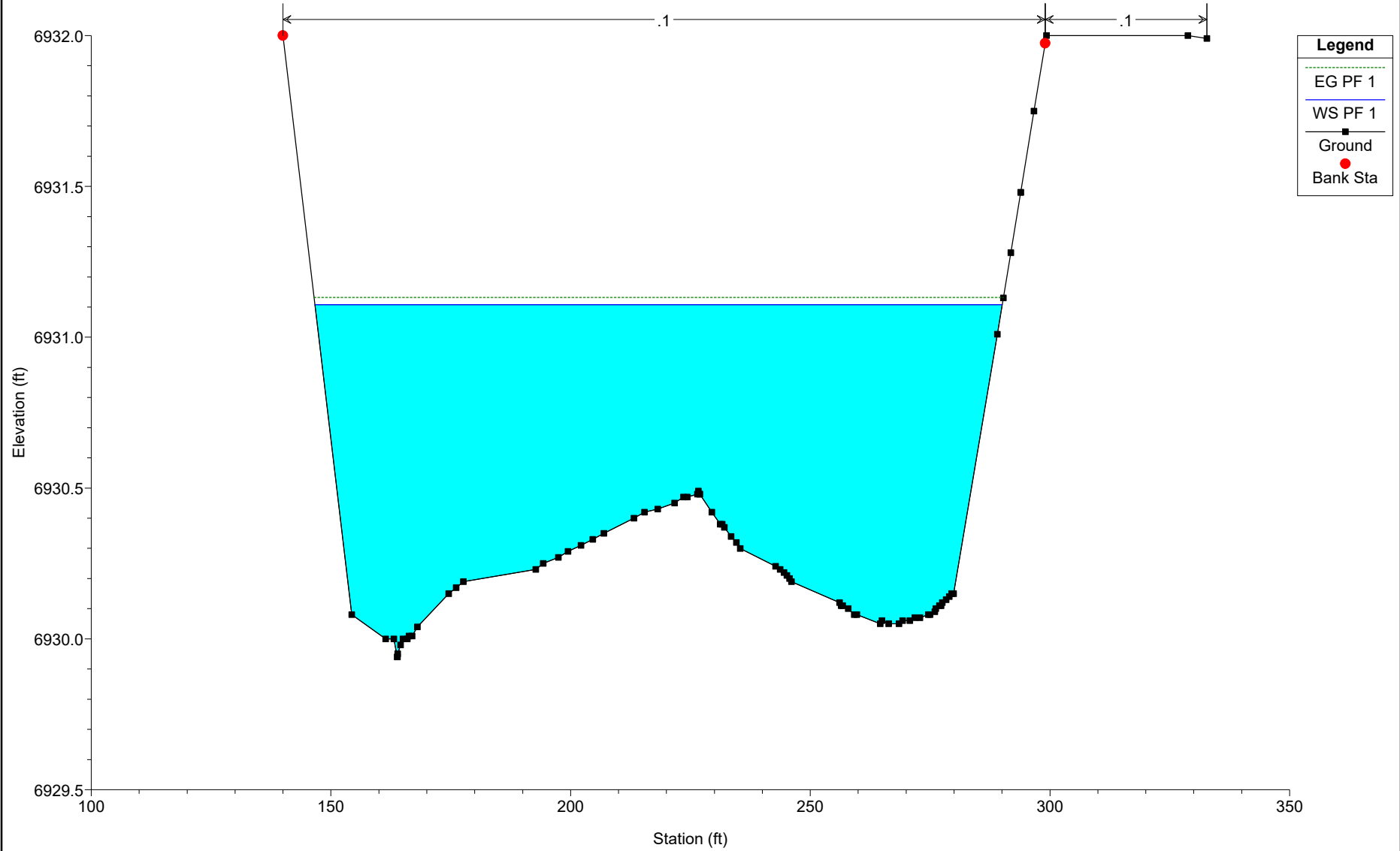


EAST CHAN PR NEW Plan: Plan 01 12/22/2024

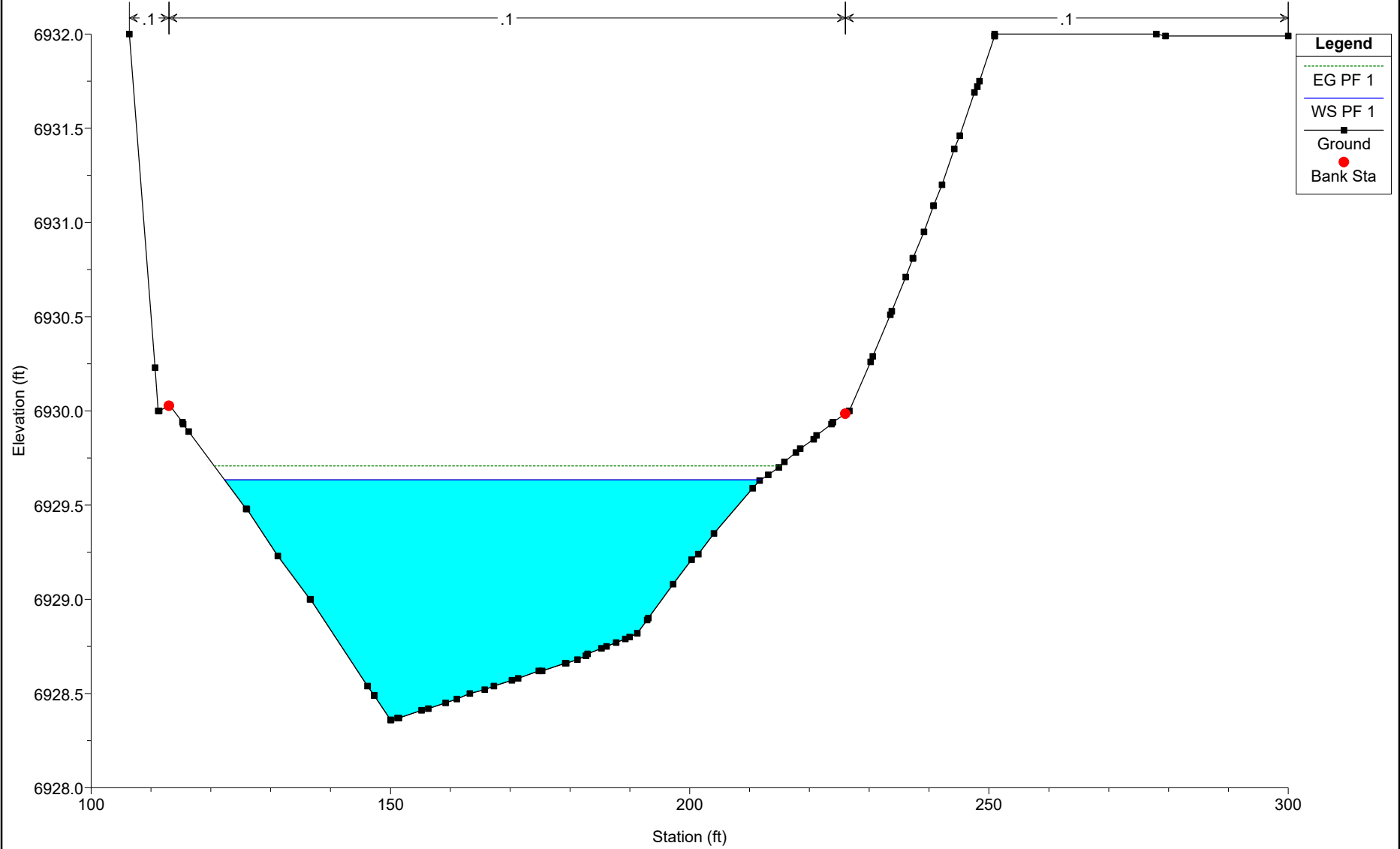
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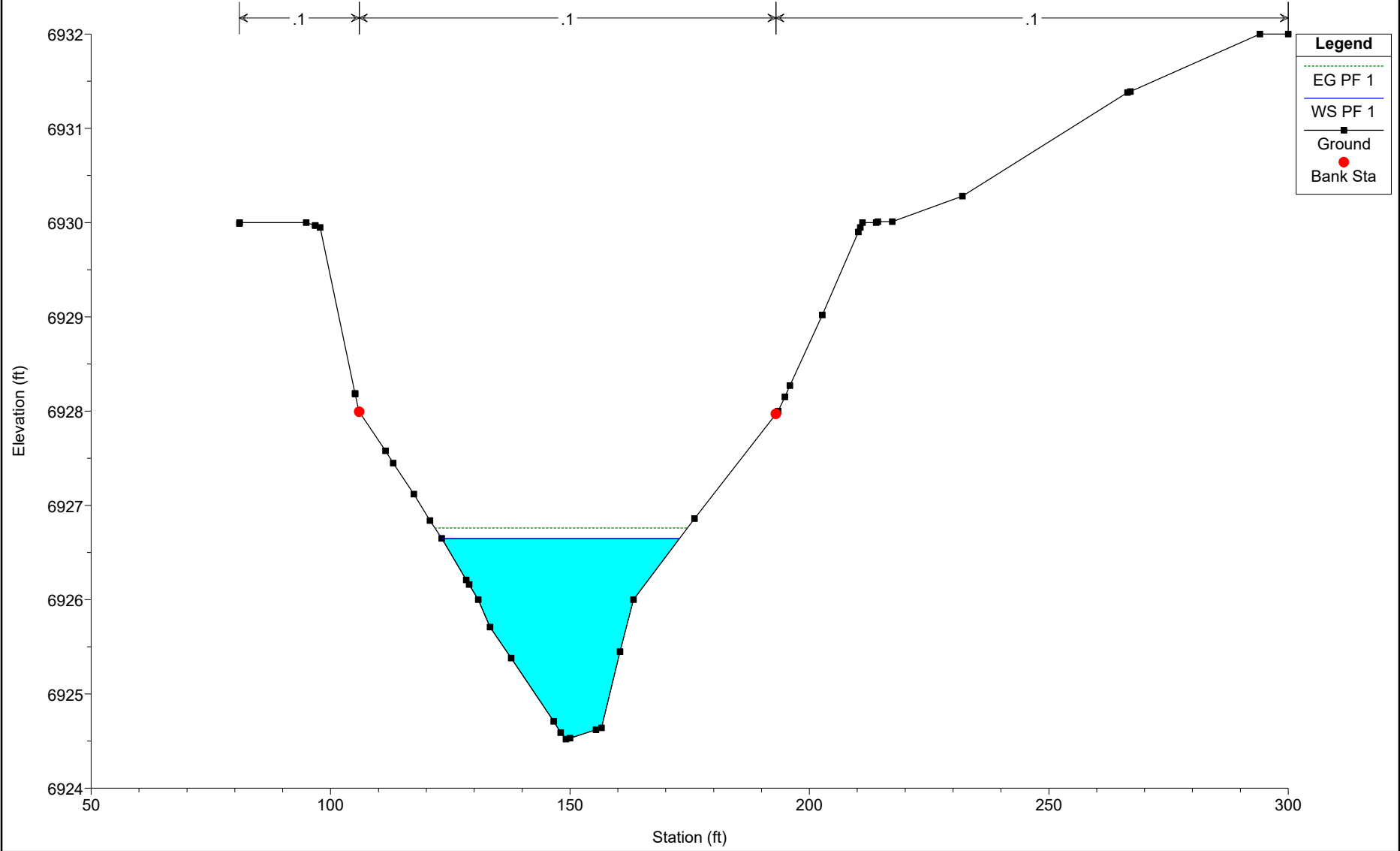
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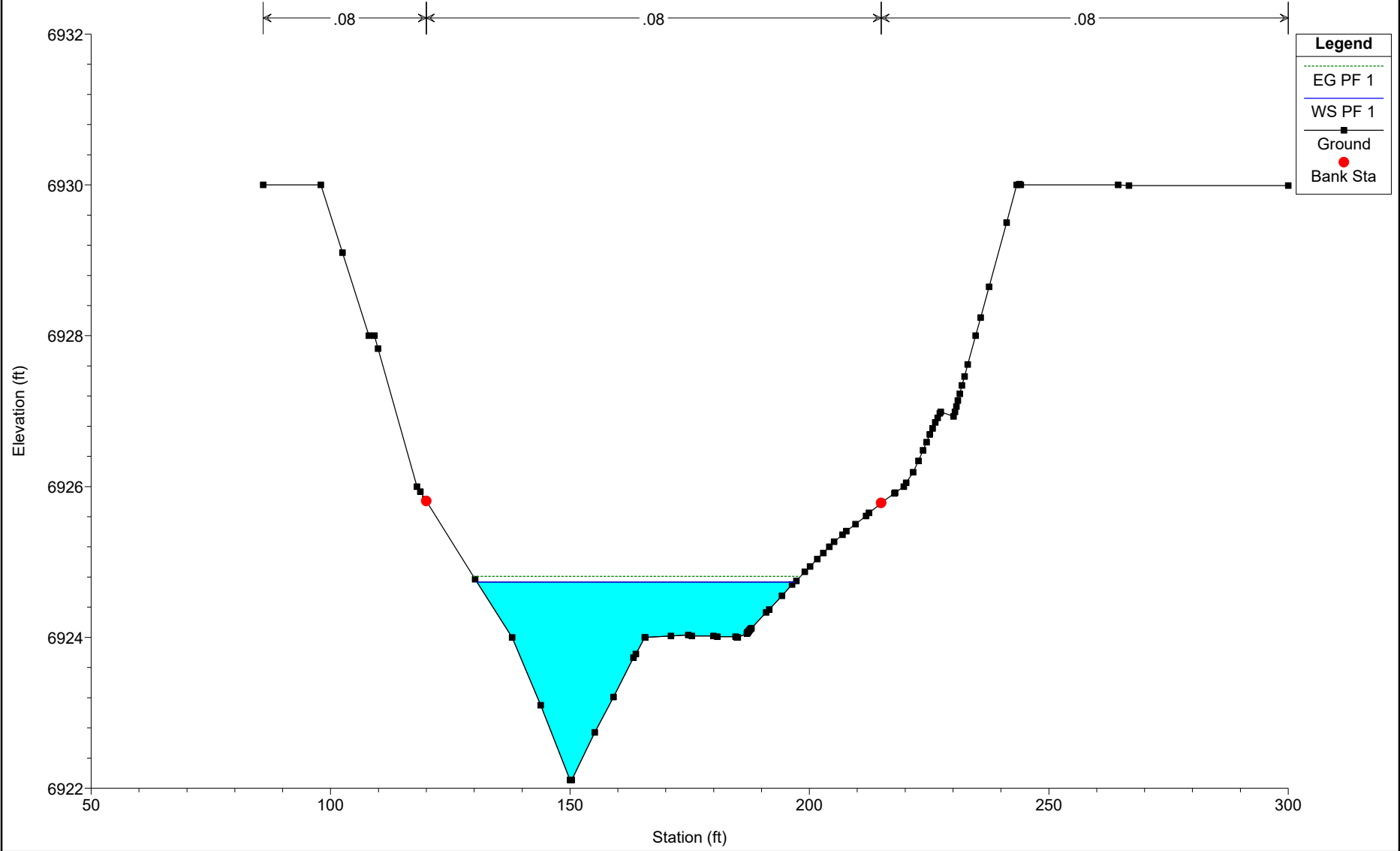
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River = CHAN EAST PR    Reach = chan-east-pr    RS = 1600



EAST CHAN PR NEW    Plan: Plan 01    12/22/2024  
River = CHAN EAST PR    Reach = chan-east-pr    RS = 1500

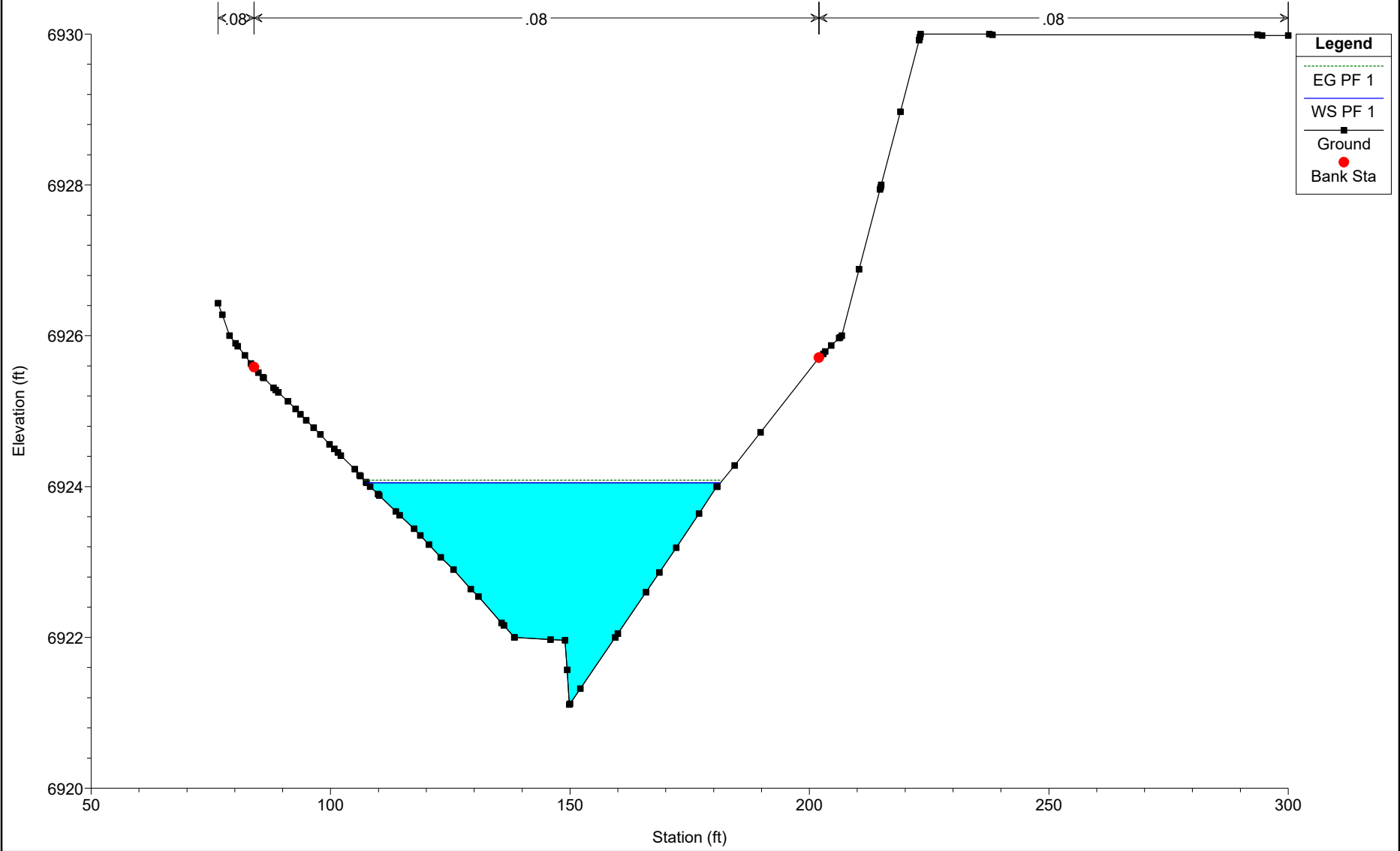


EAST CHAN PR NEW    Plan: Plan 01    12/22/2024  
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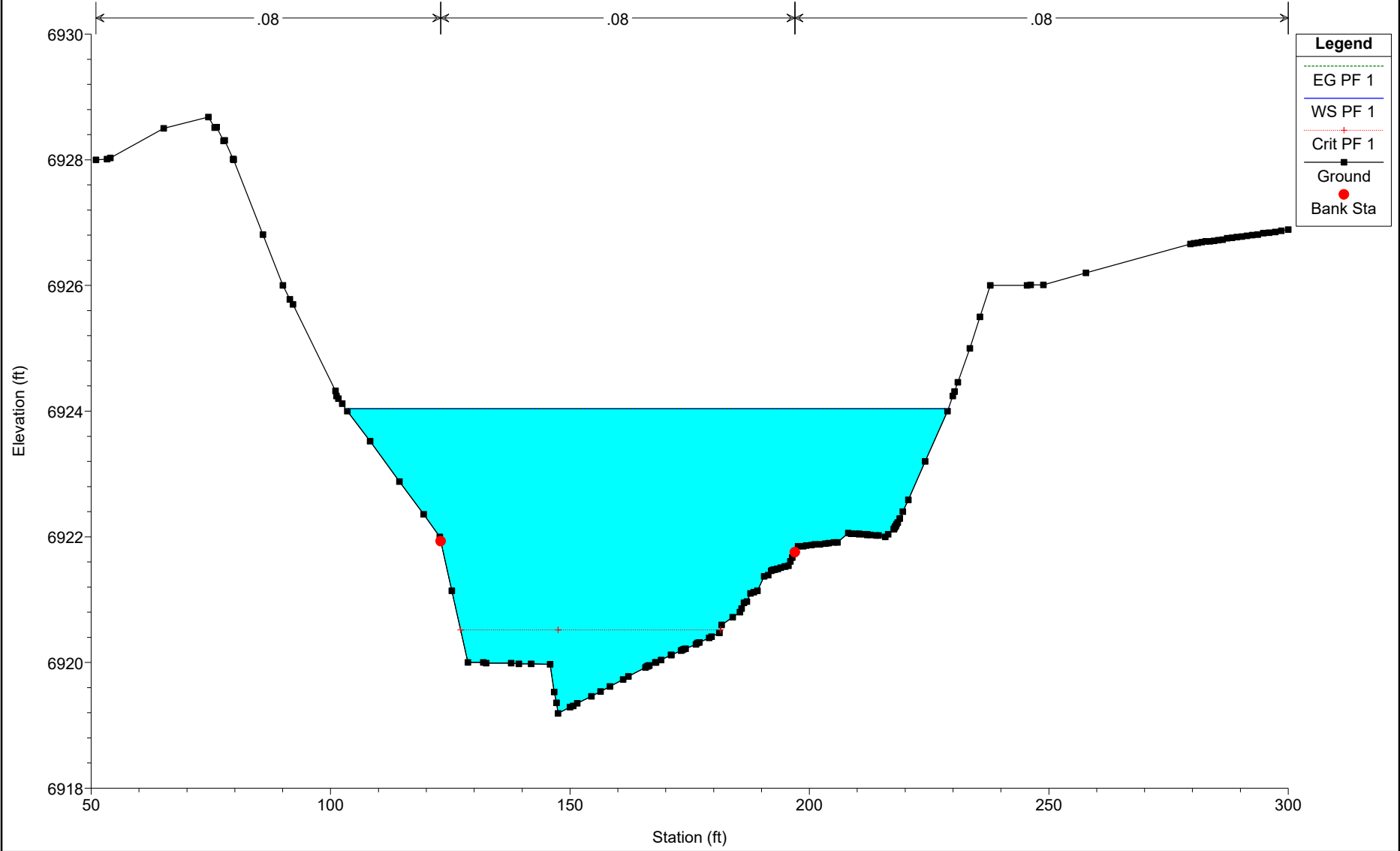
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River = CHAN EAST PR    Reach = chan-east-pr    RS = 1300



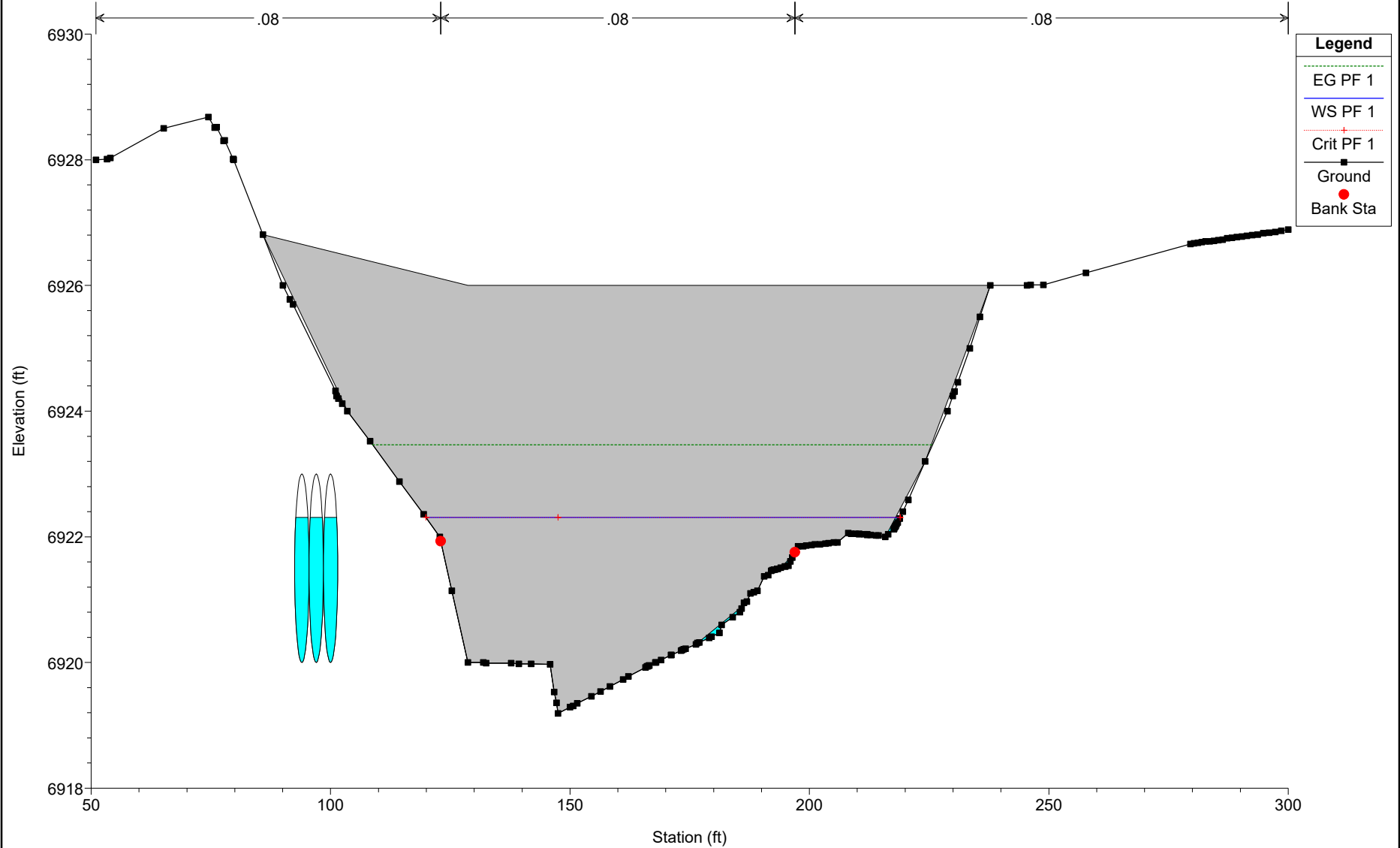
EAST CHAN PR NEW Plan: Plan 01 12/22/2024

River = CHAN EAST PR Reach = chan-east-pr RS = 1200

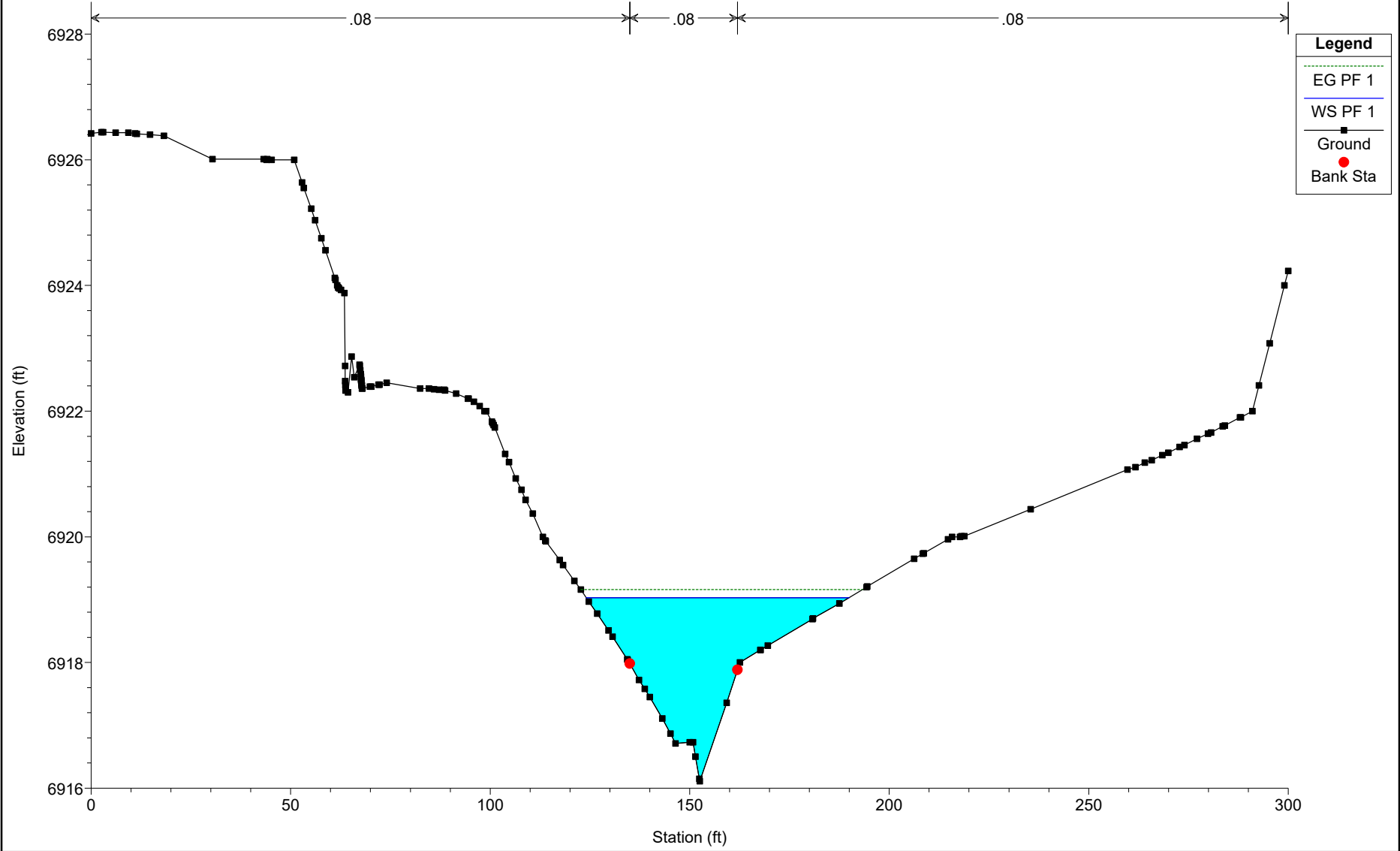


EAST CHAN PR NEW    Plan: Plan 01    12/22/2024

River = CHAN EAST PR    Reach = chan-east-pr    RS = 1111.15    Culv

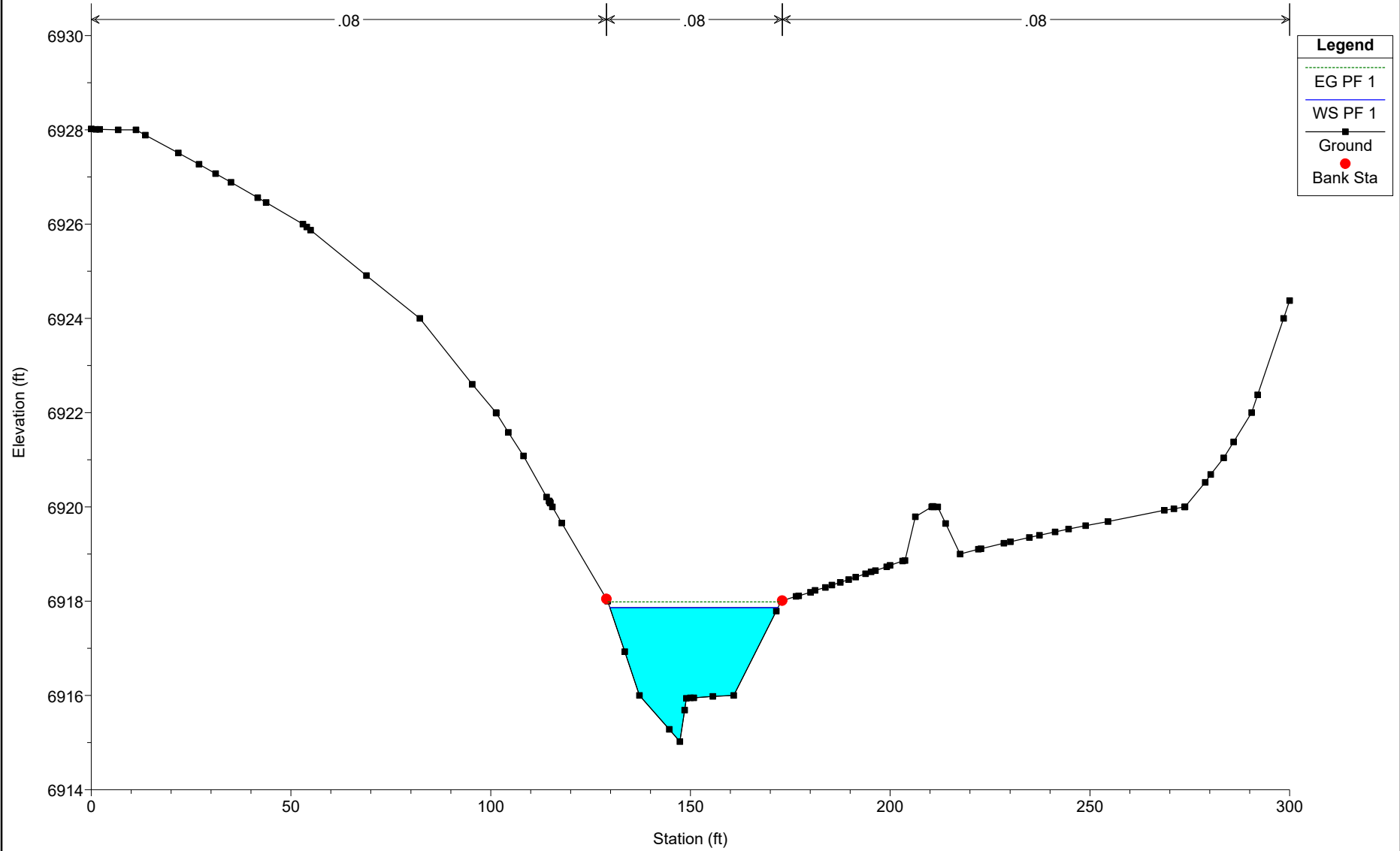


EAST CHAN PR NEW    Plan: Plan 01    12/22/2024  
River = CHAN EAST PR    Reach = chan-east-pr    RS = 1000



EAST CHAN PR NEW Plan: Plan 01 12/22/2024

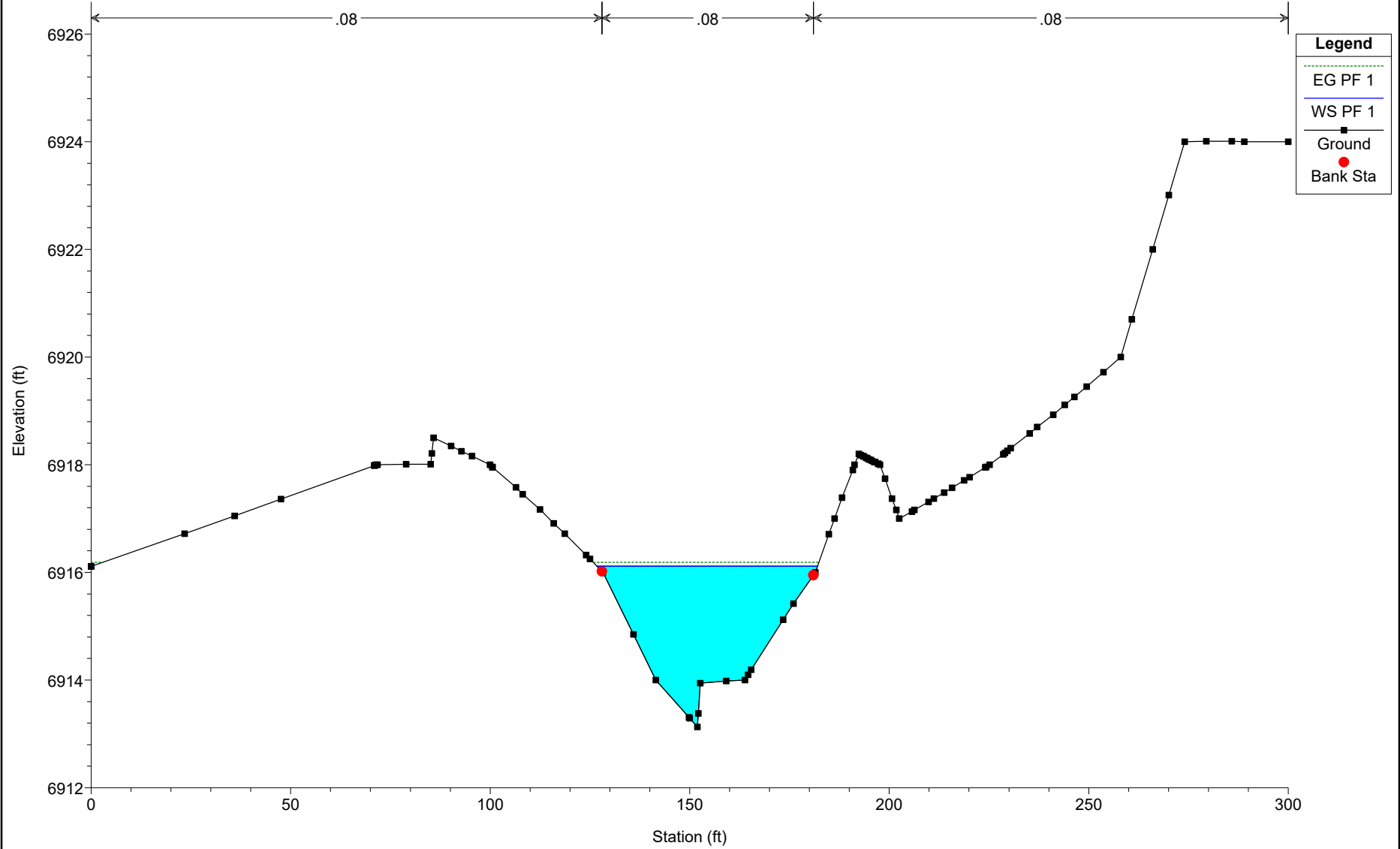
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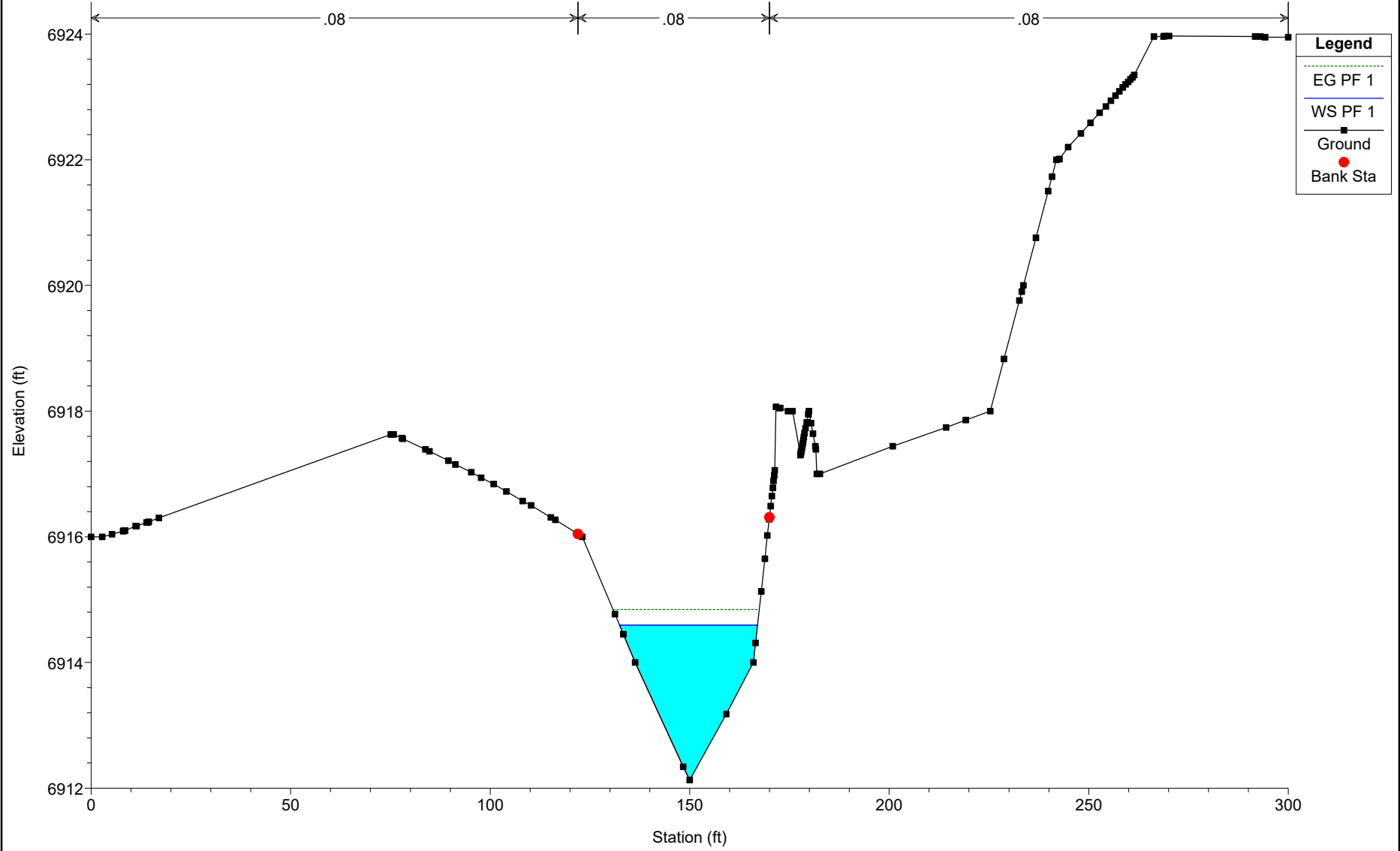
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River = CHAN EAST PR Reach = chan-east-pr RS = 700



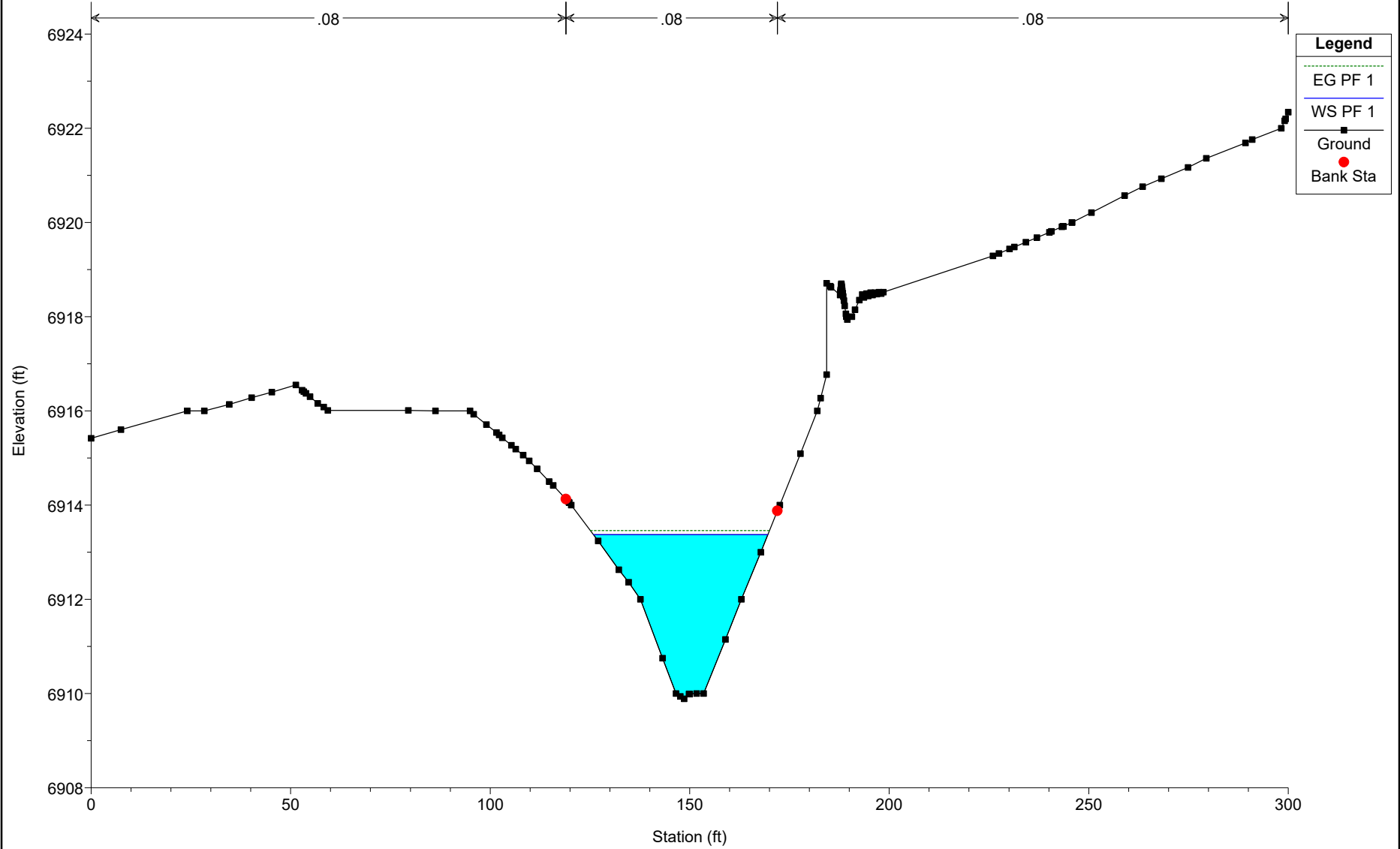
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River = CHAN EAST PR    Reach = chan-east-pr    RS = 600



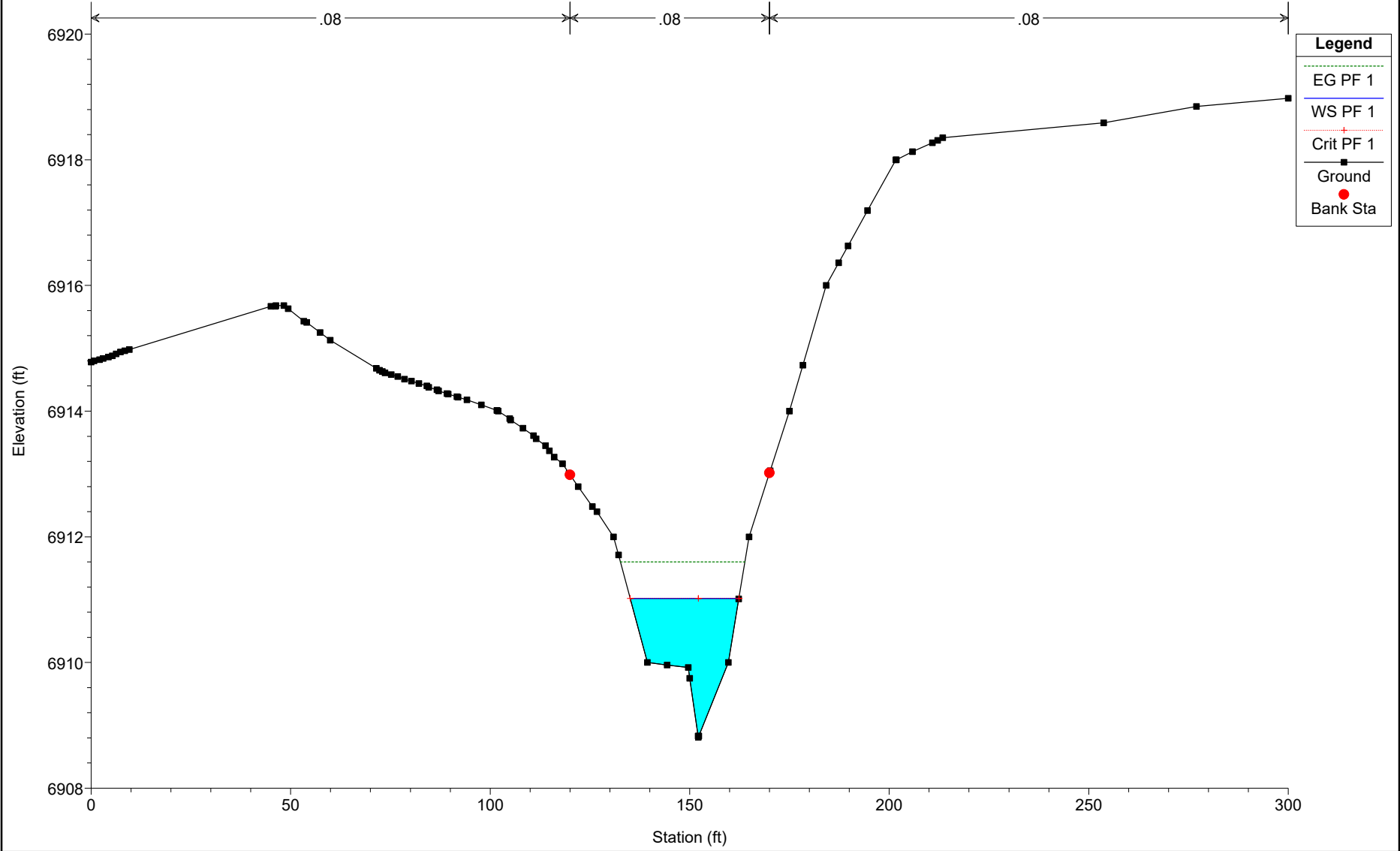
EAST CHAN PR NEW    Plan: Plan 01    12/22/2024

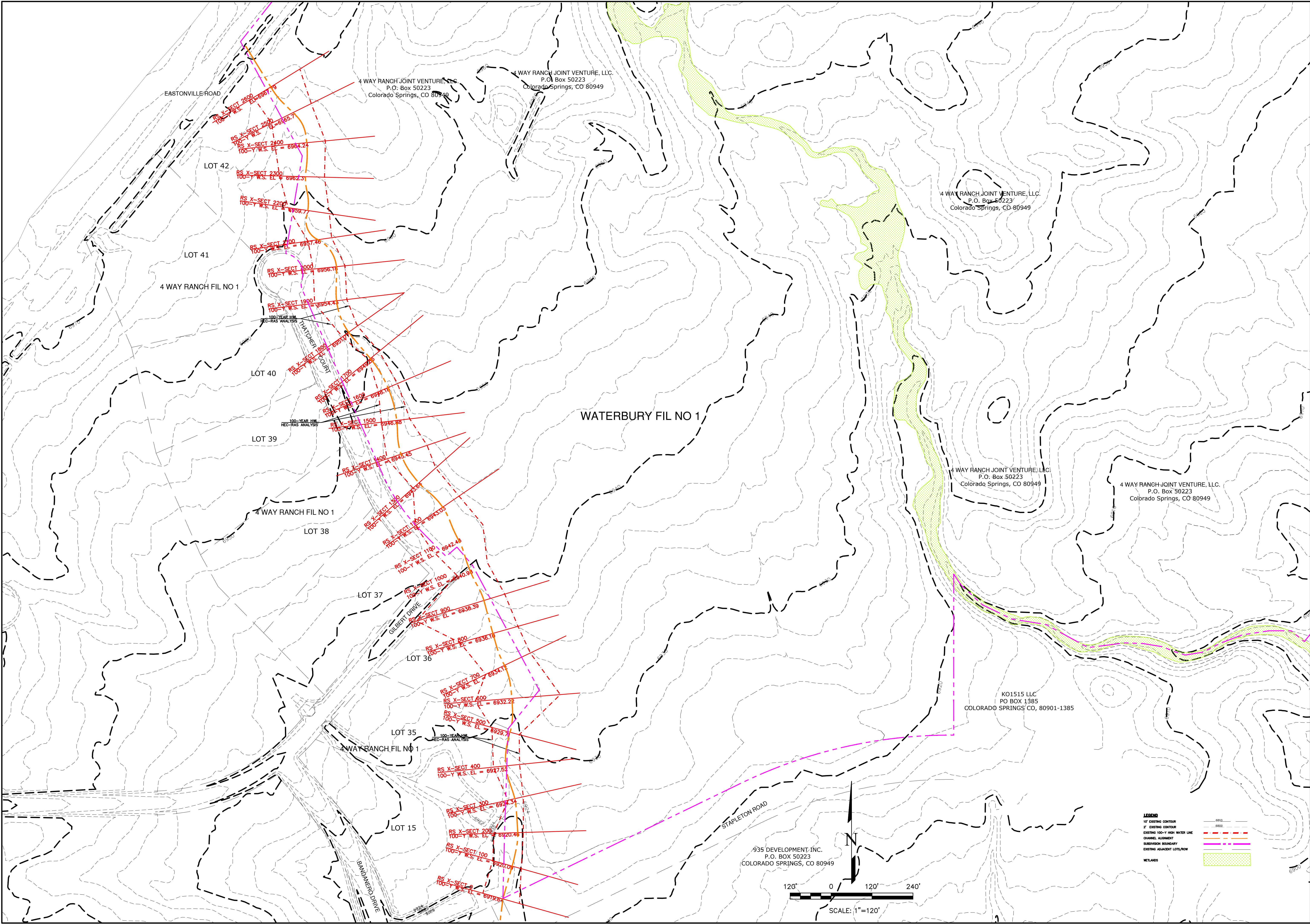
River = CHAN EAST PR    Reach = chan-east-pr    RS = 500



EAST CHAN PR NEW    Plan: Plan 01    12/22/2024

River = CHAN EAST PR    Reach = chan-east-pr    RS = 400





REVISIONS

NO.	DESCRIPTION	DATE

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, TERRA NOVA ENGINEERING, INC. APPROVES THEIR USE ONLY FOR THE PROJECTS SPECIFIED BY WRITTEN AUTHORIZATION.

PREPARED FOR:

4-WAY RANCH JOINT VENTURE  
ATTN: PETER MARIZ  
P.O. BOX 50223  
COLORADO SPRINGS, CO 80949  
719-491-3150

Terra Nova

Engineering, Inc.

721 S. 23RD STREET  
COLORADO SPRINGS, CO 80904  
OFFICE: 719-635-6422  
FAX: 719-635-6426  
www.tnainc.com

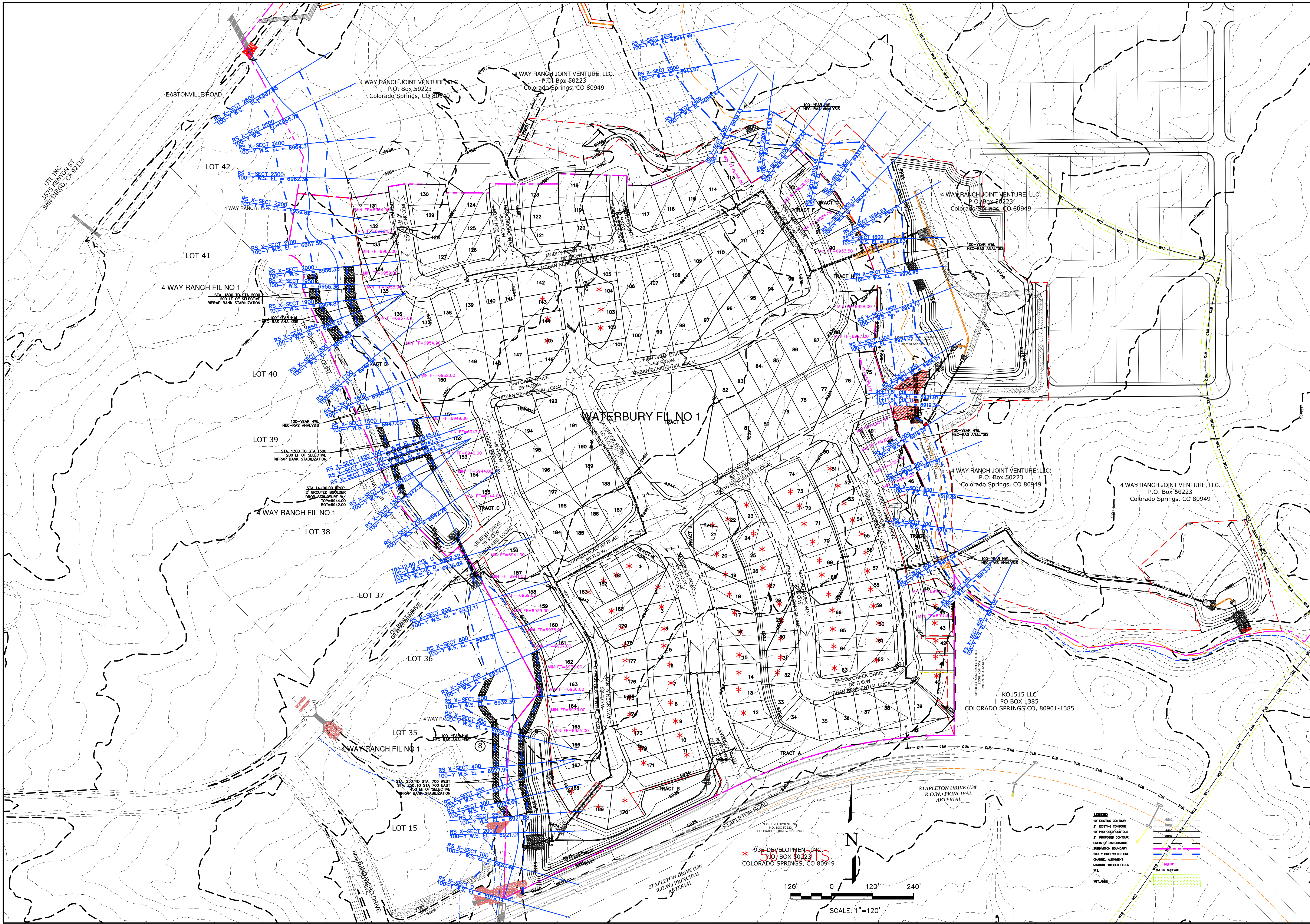
WATERBURY FILING NO. 1 & 2

EXISTING 100-Y FLOODPLAIN EXHIBIT  
WEST CHANNEL ONLY

DESIGNED BY DLF  
DRAWN BY QNA  
CHECKED BY QNA

H-SCALE 1" = 120'  
V-SCALE N/A

JOB NO. 1715.00  
DATE ISSUED 10/4/24  
SHEET NO. 1 OF 2



REVISIONS

NO.	DESCRIPTION	DATE

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE REVIEWING AGENCIES, TERRA NOVA ENGINEERING, INC. APPROVES THEIR USE ONLY FOR THE PROJECTS SPECIFICALLY AUTHORIZED BY WRITTEN AUTHORIZATION.

PREPARED FOR:  
**4-WAY RANCH JOINT VENTURE**  
ATTN: PETER MARIZ  
P.O. BOX 50223  
COLORADO SPRINGS, CO 80949  
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721 S. 23RD STREET  
COLORADO SPRINGS, CO 80904

OFFICE: 719-635-6422  
FAX: 719-635-6426  
www.tnainc.com

**WATERBURY FILING NO. 1 & 2**

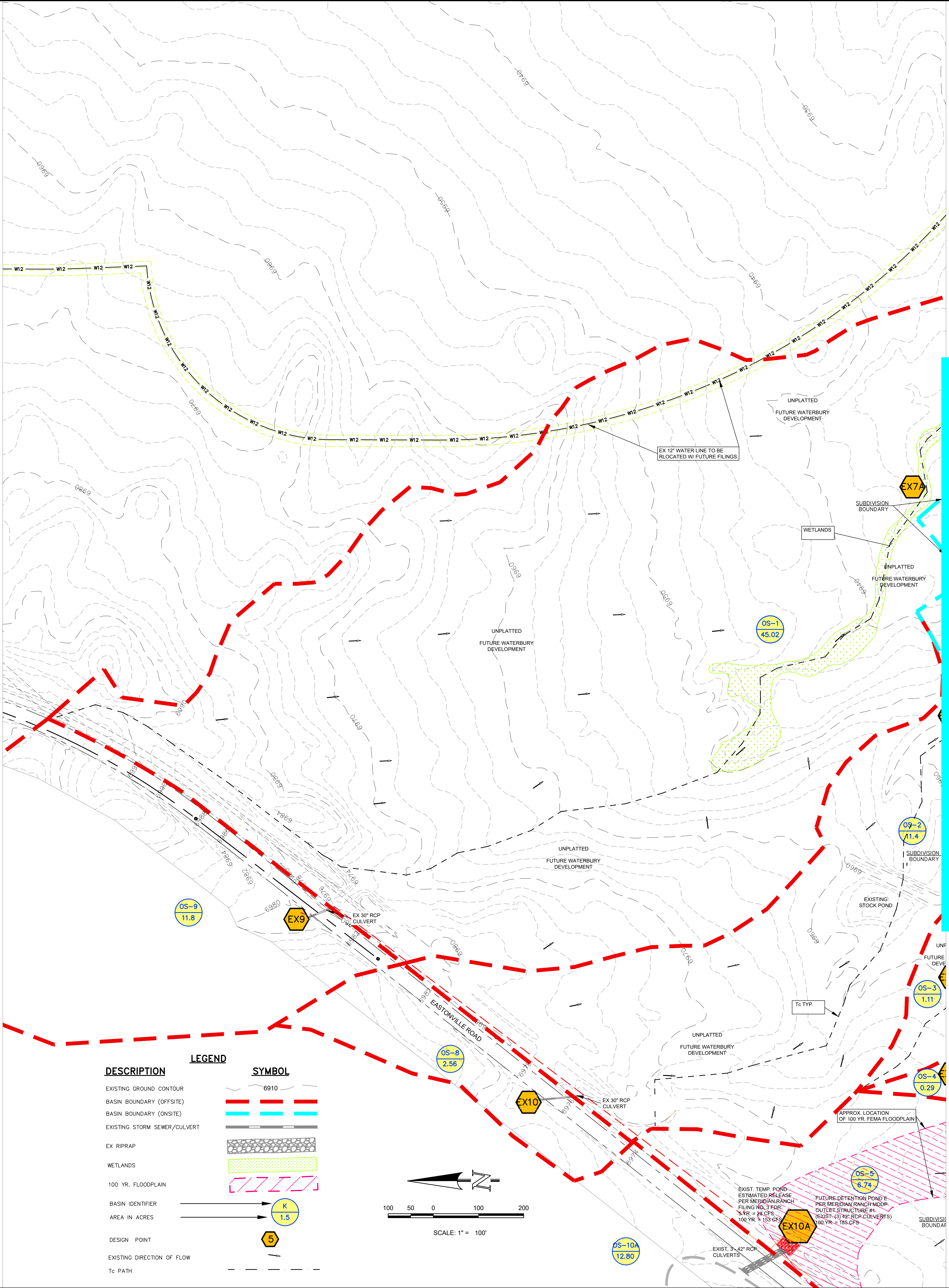
PROPOSED 100-Y FLOODPLAIN EXHIBIT

DESIGNED BY DLF  
DRAWN BY QNA  
CHECKED BY QNA  
H-SCALE 1" = 100'  
V-SCALE N/A  
JOB NO. 1715.00  
DATE ISSUED 10/4/24  
SHEET NO. 2 OF 2

**APPENDIX I**  
**DRAINAGE MAPS**

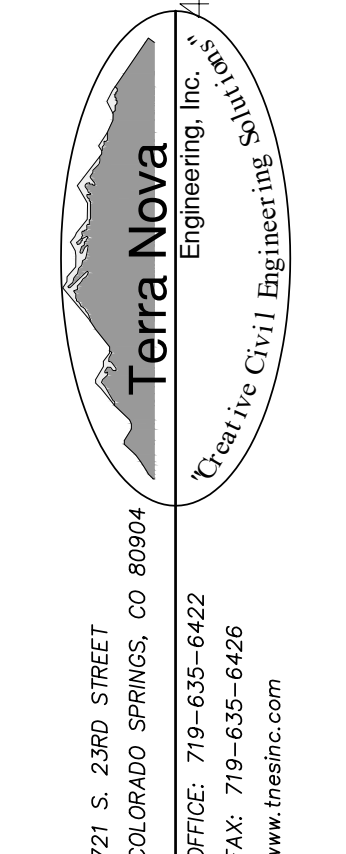
FDR - EXISTING BASIN RUNOFF SUMMARY															
BASIN	WEIGHTED		OVERLAND				STREET / CHANNEL FLOW			Tc	INTENSITY		TOTAL FLOWS		
	CA(5)	CA(100)	C(5)	Length (ft)	Height (ft)	Tc (min)	Length (ft)	Sto Velocity (ft/s)	Tc (min)		I(5) (in/hr)	I(100) (in/hr)	Q(5) (cfs)	Q(100) (cfs)	
EXA	0.87	3.46	0.25	100	3	11.1	1193	1.7%	4.5	4.4	15.4	3.43	5.81	3	20
EXB	0.37	1.47	0.25	100	2	12.6	623	2.2%	5.2	2.0	14.6	3.51	5.96	1	9
EXC	2.23	8.63	0.25	100	2.5	11.7	2420	1.7%	4.6	8.9	20.6	3.01	5.01	7	45
EXD	1.43	5.71	0.25	100	2	12.6	1616	5.6%	5.6	4.8	17.4	3.25	5.47	5	31
EXE	0.52	2.10	0.25	100	8	8.0	1063	2.1%	5.0	3.5	11.5	3.86	6.66	2	14
EXF	0.15	0.58	0.25	100	6	8.8	400	2.5%	5.5	1.2	10.0	4.06	7.07	1	8
OS-1	4.05	16.21	0.25	100	6	8.8	3219	2.3%	5.3	10.1	18.9	3.13	5.24	14	85
OS-2	1.03	4.11	0.25	100	2	12.6	1203	1.0%	3.5	5.7	18.4	3.17	5.32	3	22
OS-3	0.10	0.40	0.25	100	2	12.6	330	2.6%	5.6	1.0	13.8	3.61	6.17	0	2
OS-4	0.03	0.11	0.25	100	2	12.6	230	2.6%	5.7	0.7	13.3	3.64	6.23	0	1
OS-5	0.81	2.43	0.25	80	5	7.8	1000	2.5%	5.5	3.0	10.8	3.96	6.85	2	17
OS-8	FLOW TAKEN FROM MERIDIAN RANCH MDDP													5	11
OS-9	FLOW TAKEN FROM MERIDIAN RANCH MDDP													8	19
OS-10A	FLOW TAKEN FROM MERIDIAN RANCH MDDP													28	185

FDR ~ EXISTING SURFACE ROUTING SUMMARY										
Design Point(s)	Contributing Basins	Area (AC)	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Facility Size
						I(5)	I(100)	Q(5)	Q(100)	
EX1A	OS-5, & DP-EX10A	19.54	0.61	2.43	10.8	3.96	6.85	30	202	NORTH BOUNDARY
EX1	EXA, OS-5, & DP-EX10A	29.16	1.47	5.89	15.4	3.43	5.81	33	219	3-42" CULVERTS
EX2	EXB	4.09	0.37	1.47	14.6	3.51	5.96	1	9	STAPLETON ROAD
EX3A	OS-4	1.11	0.03	0.11	13.3	3.64	6.23	0	1	NORTH BOUNDARY
EX3	EXC & OS-4	25.10	2.26	9.03	20.6	3.01	5.01	7	45	EAST BOUNDARY
EX4A	OS-3	1.11	0.10	0.40	13.6	3.61	6.17	0	2	NORTH BOUNDARY
EX4	EXD & OS-3	16.98	1.53	6.11	17.4	3.25	5.47	5	33	EAST BOUNDARY
EX5A	OS-2 & OS-8	13.96	1.03	4.11	18.4	3.17	5.32	8	33	NORTH BOUNDARY
EX5	EXE, OS-2 & OS-8	17.23	1.55	6.20	18.4	3.17	5.32	10	44	EAST BOUNDARY
EX6	EXF	1.62	0.15	0.58	13.8	3.59	6.12	1	4	EAST BOUNDARY
EX7A	OS-1 & OS-9	56.82	4.05	16.21	18.9	3.13	5.24	21	104	POINT ALONG CHANNEL
EX7	EXE, EXF, OS-1, OS-2, OS-8 & OS-9	78.24	5.75	23.00	18.9	3.13	5.24	31	151	DP 30"PROP. CONDITION
EX9	OS-9	11.80						8	19	EX 36" RCP Culvert
EX10	OS-8	2.56						5	11	EX 36" RCP Culvert
EX10A	MERIDIAN POND E RELEASE	Meridian Ranch Flng 3 FDR Calculated Flows						28	185	EX 3-42" RCP Culverts
13	TOTAL OFFSITE EX. STOCK POND INFLOW	Per "Final Drainage Report for Waterbury Flng No. 1," dated September 2016, by Classic Consulting						69	396	EX STOCK POND



UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED FOR THE PURPOSES OF REMEDIAL INVESTIGATION AND SURVEYING, INC. APPROVES THEIR USE ONLY FOR THE PURPOSES SPECIFICALLY WRITTEN AUTHORIZATION.	REVISIONS	DESCRIPTION	DATE
	NO.		

PREPARED FOR:  
ACM ALF VIII JV SUB II LLC  
ATTN: JASON POCK  
100 E. MISSISSIPPI AVE., STE 500  
DENVER, CO 80246  
303-984-9800

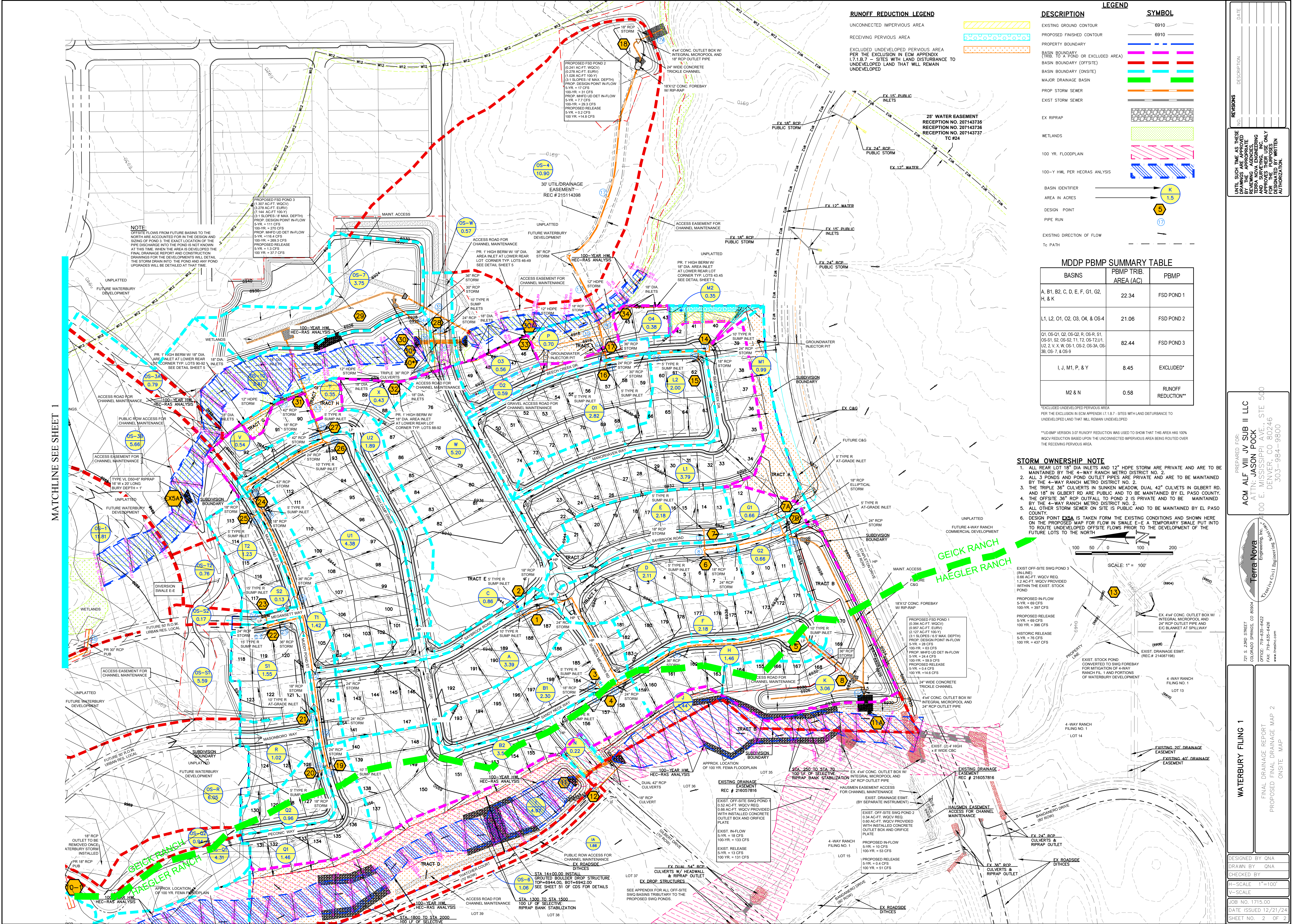


<p><b>WATERBURY FILING 1</b></p>	<p>FINAL DRAINAGE REPORT EXISTING FINAL DRAINAGE MAP 1 OFFSITE MAP</p>
	<p>DESIGNED BY QNA DRAWN BY QNA CHECKED BY H-SCALE 1"=100' V-SCALE JOB NO. 1715.00 DATE ISSUED 12/20/24 SHEET NO. 1 OF 2</p>



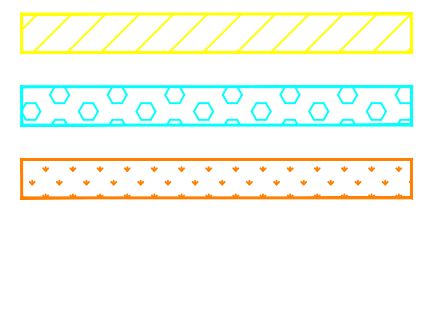
FDR ~ PROPOSED BASIN RUNOFF SUMMARY														
WEIGHTED CA(5)	CA(100)	Q(5)	Length (ft)	Height (ft)	Tc (min)	STREET / CHANNEL FLOW	Length (ft)	Slope	Velocity (ft/s)	Tc (min)	Intensity (in/hr)	TOTAL FLOW	Q(5)	Q(100)
OVERLAND														
TOTAL (15) (100)														
Q(5) Q(100)														
152	2.00	0.25	100	2	12.8	460	1.0%	4.3	1.6	14.3	3.54	6.05	4	8
103	1.36	0.25	100	2	12.8	460	1.0%	4.3	1.6	14.3	3.54	6.05	4	8
161	2.11	0.25	100	2	12.8	550	1.0%	4.3	2.1	14.8	3.40	5.93	6	13
0.39	0.51	0.25	20	0.5	5.3	500	2.0%	4.9	1.7	6.9	4.08	8.14	2	4
0.95	1.34	0.25	80	2	16.5	380	2.0%	5.5	0.9	11.4	3.87	6.69	4	8
0.98	1.29	0.25	100	2	12.8	460	2.0%	5.5	1.2	13.8	3.59	6.12	4	8
0.98	1.29	0.25	90	2	11	620	1.0%	4.3	2.4	9.5	4.14	7.22	4	9
0.24	0.31	0.25								5.9	5.00	9.06	1	3
0.31	0.41	0.25								5.9	5.00	9.06	2	4
0.66	0.86	0.25	90	2	11	520	1.0%	4.3	2.0	9.2	4.19	7.33	3	6
0.97	2.12	0.25	80	4	8.4	250	2.0%	4.9	0.9	9.2	4.19	7.32	4	16
0.85	0.85	0.25	80	4	8.7	880	2.0%	4.9	0.9	8.9	3.98	6.81	3	6
0.69	1.37	0.25	100	10	6.1	30	1.0%	3.3	0.4	6.5	4.40	8.03	2	11
1.71	2.34	0.25	100	2	12.8	860	1.0%	4.1	3.5	16.1	3.36	5.69	3	13
0.90	1.18	0.25	55	1.1	9.4	880	3.0%	4.1	3.5	12.8	3.70	6.34	3	7
0.44	0.58	0.25	70	15	10.3	280	2.0%	4.9	0.7	11.0	3.30	6.79	2	4
0.16	0.21	0.25	65	3	7.7	6	0.0%	0.6	0.0	7.7	4.43	7.83	1	2
0.10	0.13	0.25								5.9	5.00	9.06	1	1
1.27	1.66	0.25	100	2.5	11.7	460	1.0%	4.3	1.8	13.5	3.62	6.19	5	10
0.27	0.35	0.25	100	2	12.8	650	2.0%	4.9	2.9	15.5	3.42	5.80	1	2
0.25	0.33	0.25								5.9	5.00	9.06	1	3
0.17	0.23	0.25								5.9	5.00	9.06	1	2
0.06	0.25	0.25								5.9	5.00	9.06	0	2
0.06	0.07	0.25	55	1.3	6.9	445	2.0%	5.1	1.5	16.4	4.01	6.97	3	6
0.43	0.56	0.25	55	1.3	6.9	445	2.0%	5.1	1.5	16.4	4.01	6.97	2	4
0.46	0.60	0.25	100	4	16.1	700	2.0%	4.9	2.4	12.4	3.75	6.44	2	4
0.70	0.91	0.25	100	6	8.8	175	2.0%	4.9	0.6	9.4	4.16	7.26	3	7
0.86	0.98	0.25								5.9	5.00	9.06	0	1
0.44	0.58	0.25	55	1.1	9.4	380	2.0%	4.9	1.3	10.7	3.37	6.96	3	6
0.55	0.73	0.25	100	2	12.8	345	2.0%	5.0	0.8	13.5	3.63	6.20	3	5
1.97	2.58	0.25	100	2	12.8	520	2.0%	5.3	1.6	14.3	3.54	6.03	7	16
0.85	1.11	0.25	100	2	12.8	385	2.0%	5.4	1.2	13.8	3.36	6.12	3	7
0.24	0.32	0.25								5.9	5.00	9.06	1	3
2.34	3.07	0.25	100	2	12.8	630	1.0%	4.4	2.4	15.0	3.47	5.99	9	18
0.19	0.25	0.25								5.9	5.00	9.06	1	2
0.16	0.21	0.25								5.9	5.00	9.06	1	2
5.31	6.97	0.25	100	2	12.8	680	2.0%	5.1	3.3	15.0	3.47	5.90	18	41
5.19	6.80	0.25	100	2	12.8	1700	1.0%	4.4	4.1	16.7	3.14	5.27	18	36
0.35	0.47	0.25	55	1.1	9.4	480	1.0%	3.9	1.0	11.4	3.87	6.68	1	3
2.55	3.34	0.25	100	2	12.8	480	1.0%	3.9	2.0	14.7	3.50	5.65	9	20
0.06	0.10	0.25	880	26	36.5					36.5	2.46	4.01	2	16
0.51	2.03	0.25	80	5	7.8					7.8	4.42	7.82	2	16
0.48	0.63	0.25	30	6.6	6.9	860	1.0%	4.7	5.2	16.1	4.05	7.84	2	12
0.34	1.35									5.9	5.00	9.06	2	12
INFO TAKEN FROM EASTONVILLE ROAD LONDCORRIDRY DR. TO REX RD. FOR														
INFO TAKEN FROM EASTONVILLE ROAD CORRIDOR PH 1 FOR														
0.31	1.23	0.25	100	2	12.8	385	2.1%	5.7	0.9	13.5	3.62	6.19	1	8
1.94	2.54	0.25	200	5	16.8	1000	1.0%	4.3	5.8	22.4	2.88	4.78	6	12
0.42	0.55	0.25	50	1	8.9	660	1.0%	4.3	3.5	12.4	3.75	6.43	2	4
2.72	3.57	0.25	90	1	8.9	660	2.1%	5.8	2.5	11.4	3.87	6.69	18	24
2.51	3.30	0.25	100	2	12.8	630	1.2%	3.6	4.0	16.7	3.32	5.60	9	18
0.08	0.10	0.25	100	2	12.8					12.8	3.72	6.39	0	1
0.34	0.45	0.25	100	2	12.8					12.8	3.72	6.39	1	3
0.51	0.54	0.25	10	1	2.4					5.9	5.00	9.06	3	5

FDR ~ PROPOSED SURFACE ROUTING SUMMARY										
Design Points	Contributing Basins	Area (AC)	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity		Flow		Facility Size
						I(5)	I(100)	Q(5)	Q(100)	
1	A	3.39	1.52	2.30	14.3	3.54	6.03	5	12	10" Type R Sump Inlet
2	C	0.86	0.39	0.51	6.9	4.06	8.14	2	4	5" Type R Sump Inlet
3	B1	2.30	1.03	1.36	14.2	3.55	6.05	4	8	5" Type R Sump Inlet
4	B2	3.58	1.61	2.11	14.8	3.49	5.93	6	13	10" Type R Sump Inlet
5	F & H	3.65	1.64	2.15	9.5	4.14	7.22	7	16	10" Type R Sump Inlet
6	D	2.11	0.95	1.24	11.4	3.87	6.68	4	8	5" Type R Sump Inlets
7	E	2.18	0.98	1.29	13.8	3.59	6.12	4	8	5" Type R Sump Inlet
7A	G1	0.53	0.24	0.31	5.0	5.90	9.06	1	3	5" Type R At-grade Inlet
7B	G2	0.69	0.31	0.41	5.0	5.90	9.06	2	4	5" Type R At-grade Inlet
8	DESIGN POINTS 1-7B & K	22.34	8.13	10.66	14.8	3.49	5.93	28	63	FSD Pond 1
9	OS-9	12.30	INFO TAKEN FROM EASTONVILLE ROAD CORRIDOR PH 1 FDR					4	24	EX 30" RCP Culvert
9A	EAS, EAM & EAS	1.43	INFO TAKEN FROM EASTONVILLE ROAD CORRIDOR PH 1 FDR					4	6	WQ POND
9B	POND RELEASE & DP9	13.73	INFO TAKEN FROM EASTONVILLE ROAD CORRIDOR PH 1 FDR					4	25	PR 24" RCP
10	OS-8	8.43	INFO TAKEN FROM EASTONVILLE ROAD LONDONERRY DR. TO REX RD. FDR					5	12	EX FSD Pond
10-1	POND RELEASE & DP10	12.30	INFO TAKEN FROM EASTONVILLE ROAD LONDONERRY DR. TO REX RD. FDR					0.3	5	PR 18" RCP
10A	MERIDIAN POND E RELEASE		Meridian Ranch Flap 3 FDR Calculated Flows					28	185	EX 3-42" RCP Culverts
11	OS-5, L, DP10A (MERIDIAN POND E RELEASE)		Sum of Basins					34	216	PR 2-42" RCP Culverts
11A	DP 11 & BASIN J		Sum of Basins					37	222	EX Channel
12	OS-6	1.06	0.48	0.83	10.1	4.05	7.94	2	4	18" RCP Culvert
13	TOTAL OFFSITE EX STOCK POND FLOW		Ph "Final Drainage Report for Waterbury Flap No. 1" dated September 2016, by Classis Consulting					69	396	EX STOCK POND
14	L1	3.79	1.71	2.24	16.1	3.36	5.89	6	13	10" Type R Sump Inlet
15	L2	2.00	0.90	1.18	12.8	3.70	6.34	3	7	5" Type R Sump Inlet
16	O1	2.82	1.27	1.66	13.5	3.42	6.19	5	10	10" Type R Sump Inlet
17	O2	0.59	0.27	0.35	15.5	3.48	5.80	1	2	5" Type R Sump Inlet
18	DESIGN POINTS 14-17 & 33-34 AND BASIN OS-4	21.05	5.12	5.43	16.1	3.36	5.89	17	31	Interim FSD Pond 2
19	O1 & OS-O1	5.78	2.80	3.41	22.4	2.89	4.78	8	16	10" Type R Sump Inlet
20	O2 & OS-O2	1.89	0.85	1.12	12.4	3.75	6.43	3	7	5" Type R Sump Inlet
21	R & OS-R	7.06	3.18	4.17	11.4	3.87	6.68	12	28	10" Type R At-grade Inlet
22	S1 & OS-S1 & DP 21 FLOW BY	7.14	4.46	6.76	16.7	3.32	5.80	15	38	15" Type R Sump Inlet
23	S2 & OS-S2	0.31	0.14	0.18	12.6	3.72	6.39	1	1	15" Type R Sump Inlet
22 & 23 SPLIT	S1, OS-S1, S2, OS-S2, & DP 21 FLOW BY	7.44	4.59	6.95	16.7	3.32	5.80	8	19	2-10" Type R Sump Inlets
24	T1	1.42	0.64	0.84	10.7	3.97	6.88	3	6	5" Type R Sump Inlets
25	T2 & OS-T2	1.99	0.90	1.18	13.5	3.43	6.20	3	7	5" Type R Sump Inlets
26	U1	4.38	1.97	2.58	14.3	3.54	6.03	7	16	10" Type R Sump Inlets
27	U2	1.89	0.85	1.11	13.8	3.59	6.12	3	7	5" Type R Sump Inlets
28	W & OS-W	5.76	2.85	3.61	15.0	3.47	5.89	10	21	2-10" Type R Sump Inlets
29	BASIN O1, O2, R, S1, S2, T1, T2, U1, U2, W & OS, OS-1, OS-2, OS-3A, OS-3B, OS-4, OS-5, OS-6, OS-7, OS-8, OS-9, OS-10, OS-11, OS-12, OS-13, OS-14, OS-15, OS-16, OS-17, OS-18, OS-19, OS-20, OS-21, OS-22, OS-23, OS-24, OS-25, OS-26, OS-27, OS-28, OS-29, OS-30, OS-31, OS-32, OS-33, OS-34, OS-35, OS-36, OS-37, OS-38, OS-39, OS-40, OS-41, OS-42, OS-43, OS-44, OS-45, OS-46, OS-47, OS-48, OS-49, OS-50, OS-51, OS-52, OS-53, OS-54, OS-55, OS-56, OS-57, OS-58, OS-59, OS-60, OS-61, OS-62, OS-63, OS-64, OS-65, OS-66, OS-67, OS-68, OS-69, OS-70, OS-71, OS-72, OS-73, OS-74, OS-75, OS-76, OS-77, OS-78, OS-79, OS-80, OS-81, OS-82, OS-83, OS-84, OS-85, OS-86, OS-87, OS-88, OS-89, OS-90, OS-91, OS-92, OS-93, OS-94, OS-95, OS-96, OS-97, OS-98, OS-99, OS-100, OS-101, OS-102, OS-103, OS-104, OS-105, OS-106, OS-107, OS-108, OS-109, OS-110, OS-111, OS-112, OS-113, OS-114, OS-115, OS-116, OS-117, OS-118, OS-119, OS-120, OS-121, OS-122, OS-123, OS-124, OS-125, OS-126, OS-127, OS-128, OS-129, OS-130, OS-131, 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**RUNOFF REDUCTION LEGEND**

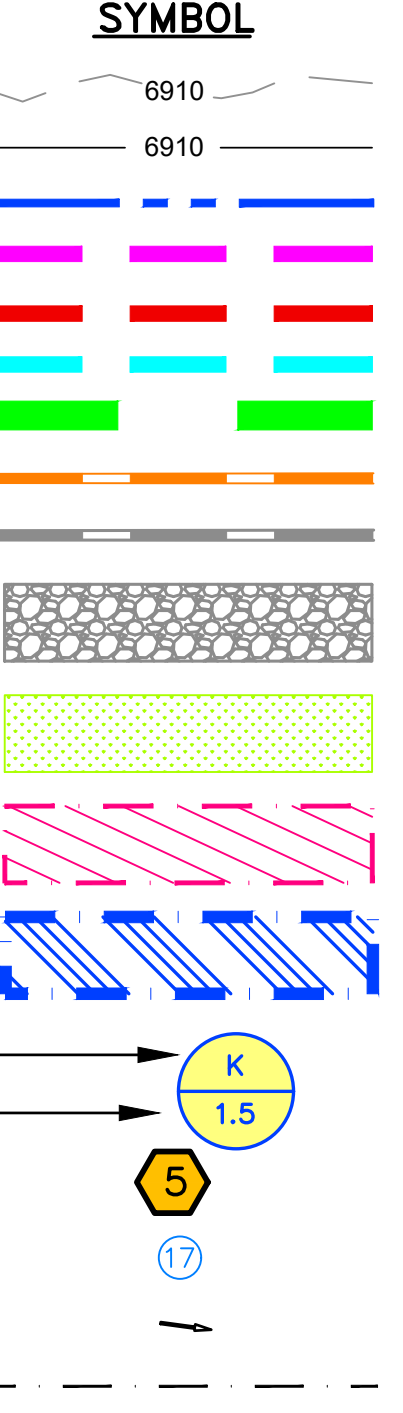
UNCONNECTED IMPERVIOUS AREA  
RECEIVING PERVIOUS AREA  
EXCLUDED UNDEVELOPED PERVIOUS AREA PER THE EXCLUSION IN EGM APPENDIX 17.1.B.7 - SITES WITH LAND DISTURBANCE TO UNDEVELOPED LAND THAT WILL REMAIN UNDEVELOPED



**DESCRIPTION**

EXISTING GROUND CONTOUR  
PROPOSED FINISHED CONTOUR  
PROPERTY BOUNDARY  
BASIN BOUNDARY (TRIBUTARY POND OR EXCLUDED AREA)  
BASIN BOUNDARY (OFFSITE)  
BASIN BOUNDARY (ONSITE)  
MAJOR DRAINAGE BASIN  
PROP. STORM SEWER  
EXIST. STORM SEWER  
EX. RIPRAP  
WETLANDS  
100 YR. FLOODPLAIN  
100-YR. HWL PER HEC-RAS ANALYSIS  
BASIN IDENTIFIER  
AREA IN ACRES  
DESIGN POINT  
PIPE RUN  
EXISTING DIRECTION OF FLOW  
TO PATH

**LEGEND**



**MDDP PBMP SUMMARY TABLE**

BASINS	PBMP TRIB. AREA (AC)	PBMP
A, B1, B2, C, D, E, F, G1, G2, H & K	22.34	FSD POND 1
L1, L2, O1, O2, O3, O4, & OS-4	21.06	FSD POND 2
Q1, OS-Q1, Q2, OS-Q2, R, OS-R, S1, OS-S1, S2, OS-S2, T1, T2, OS-T2, U1, U2, V, X, W, OS-1, OS-2, OS-3A, OS-3B, OS-7, & OS-9	82.44	FSD POND 3
I, J, M1, P, & Y	8.45	EXCLUDED*
M2 & N	0.58	RUNOFF REDUCTION**

\*EXCLUDED UNDEVELOPED PERVIOUS AREA PER THE EXCLUSION IN EGM APPENDIX 17.1.B.7 - SITES WITH LAND DISTURBANCE TO UNDEVELOPED LAND THAT WILL REMAIN UNDEVELOPED  
\*\*PBMP VERSION 3.07 RUNOFF REDUCTION WAS USED TO SHOW THAT THE AREA WAS 100% WOVCY REDUCTION BASED UPON THE UNCONNECTED IMPERVIOUS AREA BEING ROUTED OVER THE RECEIVING PERVIOUS AREA.

**STORM OWNERSHIP NOTE**

- ALL REAR LOT 18" DIA INLETS AND 12" HDPE STORM ARE PRIVATE AND ARE TO BE MAINTAINED BY THE 4-WAY RANCH METRO DISTRICT NO. 2.
- ALL 3 POND AND POND OUTLET PIPES ARE PRIVATE AND ARE TO BE MAINTAINED BY THE 4-WAY RANCH METRO DISTRICT NO. 2.
- THE TRIPLE 36" CULVERTS IN SUNKEN MEADOW, DUAL 42" STORM IN GILBERT RD. AND 18" IN GILBERT RD ARE PUBLIC AND TO BE MAINTAINED BY EL PASO COUNTY.
- THE OFFSITE 36" RCP OUTFALL TO POND 2 IS PRIVATE AND TO BE MAINTAINED BY THE 4-WAY RANCH METRO DISTRICT NO. 2.
- ALL OTHER STORM SEWER ON SITE IS PUBLIC AND TO BE MAINTAINED BY EL PASO COUNTY.
- DESIGN POINT EX-5A IS TAKEN FROM THE EXISTING CONDITIONS AND SHOWN HERE ON THE PROPOSED MAP FOR FLOW IN SWALE E-E A TEMPORARY SWALE PUT INTO TO ROUTE UNDEVELOPED OFFSITE FLOWS PRIOR TO THE DEVELOPMENT OF THE FUTURE LOTS TO THE NORTH



GEICK RANCH  
HAEGLER RANCH

DATE: \_\_\_\_\_

DESCRIPTION: \_\_\_\_\_

REVISIONS: \_\_\_\_\_

NO. \_\_\_\_\_

UNTIL SUCH TIME AS THESE PLANS ARE REVISED BY THE REVIEWING AGENCIES AND SURVEYING, INC. APPROVES THEIR USE ONLY DESIGNED BY: \_\_\_\_\_ AUTHORIZED BY: \_\_\_\_\_

PREPARED FOR: **ACM ALF VII JV SUB II LLC**  
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www.terrano.com

**WATERBURY FILING 1**  
FINAL DRAINAGE REPORT  
PROPOSED FINAL DRAINAGE MAP 2  
ONSITE MAP

DESIGNED BY: QNA  
DRAWN BY: QNA  
CHECKED BY: \_\_\_\_\_  
H-SCALE: 1"=100'  
V-SCALE: \_\_\_\_\_  
JOB NO.: 1715.00  
DATE ISSUED: 12/21/24  
SHEET NO.: 2 OF 2





