

**CIMARRON HILLS SOUTHEAST MIXED USE
FILING NO. 1
FINAL DRAINAGE REPORT**

Prepared for:

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Unresolved:
Please submit "no-rise" certification as
a stand alone document. Please
include documentation provided with
letter to PPRBD.

Prepared by:



Matrix

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August 2026

Project No. 24.1382.003

PCD File SF2420

Cimarron Hills Southeast Mixed Use Filing No. 1
Final Drainage Report

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.

William Griffin
Registered Professional Engineer
State of Colorado
No. 67648

8-13-26

Date



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.

Jovenchi-II, LLC

Business Name

By: _____

Dean Venezia

8-13-2026

Date

Title: _____

Owner, Manager

Address: _____

Marathon Holdings, LLP

Business Name

By: _____

Dean Venezia

8-13-2026

Date

Title: _____

Manager

Address: _____

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 J. Palmer, P.E.
County Engineer / ECM Administrator
Conditions:

Date

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I. INTRODUCTION

The proposed Cimarron Hills Southeast Mixed Use Filing No. 1 development is comprised of approximately 32.68 acres of land previously platted under the Softball West Subdivision No. 2 development. The site is currently not being used. It is located northeast of the intersection of Peterson Road and Highway 24. Improvements proposed by the developments will extend Meadowbrook Parkway through the site to an intersection with Peterson Road. The site is bounded to the north by the East Fork of Sand Creek. Currently, the site is comprised of three (3) parcels.

a. PURPOSE AND SCOPE OF STUDY

The purpose of this Final Drainage Report (FDR) is to evaluate the specific drainage infrastructure requirements which will provide compliance with the El Paso County Drainage Criteria Manual (DCM). This study will identify off-site, and on-site drainage patterns associated with respective land uses, provide hydrologic and hydraulic analysis of tributary basins and conveyance structures to a detention pond, and identify effective, safe routing to the downstream outfall. The improvements associated with this report maintain compliance with the DCM by providing full spectrum detention where necessary, which is to be constructed concurrently with the improvements associated with this FDR.

b. DBPS RELATED INVESTIGATIONS

The proposed development is located within the Sand Creek Drainage Basin. A Drainage Basin Planning Study (DBPS) was completed for this basin in 2021.

c. GENERAL PROJECT DESCRIPTION

The Cimarron Hills Southeast Mixed Use Filing No. 1 Subdivision is located to the northeast of the intersection of Peterson Road and Highway 24. The site is located as follows:

1. General Location: West ½ of the Southwest ¼ of Section 8, Range 65 West of the 6th P.M. in the County of El Paso, State of Colorado.
2. Drainageway: The proposed development is in the Sand Creek Drainage Basin. The site generally drains southwest eventually draining into East Fork Sand Creek at a point approximately 1,400 feet west of the site. East Fork Sand Creek is a tributary to Sand Creek which ultimately drains into Fountain Creek.
3. Surrounding Developments: The site is bounded on the east by Meadowbrook Crossing Filing No. 1 and Crossroads Mixed Use Filing No. 1, on the north by the East Fork of Sand Creek and Cimarron Southeast Filing No. 1, on the south by Highway 24 and on the west Peterson Road.
4. Lots to be Platted: The site is to be subdivided into 1 lot and 4 tracts.
5. Area of Disturbance: The proposed development is expected to disturb a total area of approximately 9.62 acres.
6. Streamside Zone: This project is not located within a streamside zone.
7. Vegetation: The site contains a small, paved area. The remainder of the site is sparsely vegetated, abandoned softball fields.

Refer to Appendix D for the Vicinity Map.

d. SOILS CONDITIONS

Soils can be classified in four different hydrologic groups, A, B, C, or D to help predict stormwater runoff rates. Hydrologic group “A” is characterized by deep, well-drained coarse-grained soils with a rapid infiltration rate when thoroughly wet and having a low runoff potential. Group “D” typically has a clay layer at or near to the surface, or a very shallow depth to impervious bedrock and has a very slow infiltration rate and a high runoff potential. See Soils Map, Appendix C. The following soil types are present at the site:

Table 1.1 – NRCS Soil Survey for El Paso County – Cimarron Hills Southeast Mixed Use Filing No. 1

Soil ID Number	Soil	Hydrologic Classification	Drainage Class	Percent of Site
8	Blakeland loamy sand, 1 to 9 percent slopes	A	Well Drained	49.2%
10	Blendon sandy loam, 0 to 3 percent slopes	B	Well Drained	50.8%

DATA SOURCES

Topographical information for the development area was found using a combination of **United States Geological Survey** (USGS) mapping as well as field surveying. The **Web Soil Survey**, created by the **Natural Resources Conservation Service**, was utilized to investigate the existing general soil types within the proposed development. Offsite contours may be taken from the **2018 El Paso County LIDAR** survey and/or USGS Quad Sheets.

e. APPLICABLE CRITERIA AND STANDARDS

This report has been prepared in accordance with the criteria set forth in the City of Colorado Springs and El Paso County DCM, El Paso County Engineering Criteria Manual (ECM) and El Paso County Resolutions 15-042 and 19-245. In addition to the DCM, the **Urban Storm Drainage Criteria Manuals, Volumes 1 through 3**, dated 2016 have been used to supplement the County’s Criteria Manual.

f. EAST FORK SAND CREEK

East Fork Sand Creek is adjacent to the northern boundary of the site. The Creek appears to be stable with no improvements recommended in the DCM. The Creek from the proposed site generally drains to the south with a small portion of the site discharging into East Fork Sand Creek. Discharge into East Fork Sand Creek from the proposed site due to changes made with this development, therefore, no improvements will be required at this time.

Unresolved:
-Provide analysis of the 100yr floodplain at the proposed meadowbrook parkway. Ensure cross flow in roadways for initial and major storms (DCMV1 table 6-1) is met. Include brief paragraph summarizing no-rise certification.

II. Hydrologic Methodology

a. MAJOR BASINS AND SUBBASINS

The proposed development is located within the Sand Creek Drainage Fee Basin. Runoff presently flows overland to the southwest until reaching the Highway 24 road ditch. Flows are conveyed west along Highway 24 until reaching the East Fork of Sand Creek.

b. METHODOLOGY

i. UD Methods

The hydrology for this project uses both the **SCS Hydrograph Procedure** and the **Rational Method** as recommended by the Drainage Criteria Manual (DCM) for the minor and major storms. The Rational Method is used for drainage basins less than 100-acres in size. The Rational Method uses the following equation:

$$Q=C*i*A$$

Where:

- Q = Maximum runoff rate in cubic feet per second (cfs)
- C = Runoff coefficient
- i = Average rainfall intensity (inches per hour)
- A = Area of drainage sub-basin (acres)

Rational Method coefficients from Table 6-6 of the Drainage Criteria Manual for developed land were utilized in the Rational Method calculations. This method will be used primarily for sizing of storm sewer infrastructure. See Appendix B for more information.

Time of Concentration

The time of concentration consists of the initial time of overland flow and the travel time in a channel to the inlet or point of interest. A minimum time of concentrations of 5 minutes is utilized for urban areas. The Rational Calculation spreadsheet included in Appendix A shows an initial overland flow length, a channel or street flow length for each sub-basin, and also demonstrates the time of concentration calculations for initial (overland) and channel (or street) conditions. A maximum “True Initial” Flow Length of 300 feet will be used for pre-developed sub-basins and a maximum length of 100 feet will be used for Developed sub-basins for time of concentration calculations in compliance with the DCM.

Rainfall Intensity

The hypothetical rainfall depths for the 1-hour storm duration were derived using Table 6-2 of the DCM (shown below).

Table 6-2. Rainfall Depths for Colorado Springs

Return Period	1-Hour Depth	6-Hour Depth	24-Hour Depth
2	1.19	1.70	2.10
5	1.50	2.10	2.70
10	1.75	2.40	3.20
25	2.00	2.90	3.60
50	2.25	3.20	4.20
100	2.52	3.50	4.60

Where Z= 6,840 ft/100

The rainfall intensity equation for the Rational Method was taken from Drainage Criteria Manual Volume 1 Figure 6-5.

C-Factors

C-factors for the Rational Method are based on anticipated land use and are taken from Table 6-6. The proposed Roadway, Meadowbrook Parkway, has been modeled under the paved category. The portion of Lot 1 that is to be developed has been modeled under the commercial areas category. Future Lots 2, and 3 have been modeled considering both the proposed and the future uses. In the proposed conditions these areas have been modeled under the Undeveloped Areas-Historic Flow Analysis—Greenbelts, Agriculture category. In the fully developed “Future” condition these areas have been modeled using the Neighborhood Areas category. Areas which will be open spaces or detention facilities are modeled under the Undeveloped Areas-Historic Flow Analysis—Greenbelts, Agriculture category.

ii. HGL Profile Methods

To confirm DCM compliant capacity and velocity values the site has been modeled in StormCAD using the Standard head loss method and head loss values taken from Table 9-4 of the DCM. The storm sewer has been designed to convey stormwater from the fully developed site. This includes future improvements to sub-basins PR-1, PR-4 and PR-5 that are not proposed with this FDR. HGL profiles modeled in StormCAD are included in Appendix C.

Table 9-4. STORMCAD Standard Method Coefficients

Bend Loss		
Bend Angle	K Coefficient	
0°	0.05	
22.5°	0.10	
45°	0.40	
60°	0.64	
90°	1.32	
LATERAL LOSS		
One Lateral K Coefficient		
Bend Angle	Non-surcharged	Surcharged
45°	0.27	0.47
60°	0.52	0.90
90°	1.02	1.77
Two Laterals K Coefficient		
45°	0.96	
60°	1.16	
90°	1.52	

III. Project Characteristics

a. MAJOR DRAINAGEWAYS

Sand Creek

The proposed development is located within the Sand Creek Drainage Basin. Runoff generated within this basin presently flows overland with slopes ranging from 5 to 50% until reaching an existing natural drainage swale located within the site. This drainage swale directs the sites flows internally until discharging from the site near the northeastern corner. Drainage from the developed road will be directed to Pond 1, where the runoff will be treated for water quality and detained to maintain the historic major event discharge rate from the site.

b. LAND USES

The proposed site was previously platted and contained softball fields. The 32.68-acre area is entirely zoned CR CAD-O. The site will consist of one lot, a dedicated ROW, and three tracts, one containing the proposed Pond 1, and the other two containing undeveloped land.

IV. BASIN HYDROLOGY

- The *Pre-development conditions* for the Proposed development have been analyzed and are presented by design points and are described as follows:

Predevelopment conditions have been analyzed using the Rational Method. Runoff generated, either on-site or off-site, drains overland towards the southwest where it is ultimately captured by the existing road ditch along Highway 24, exiting the site and releasing flows to be collected in the East Fork of Sand Creek. Generally, all undeveloped basins are considered to be vegetated with sparse grasses. A delineation of the basin boundaries can be found in Appendix D in drawings DR-01. Runoff calculations can be found in Appendix A. The existing runoff design points are described below:

Design Point EX-1 ($Q_5 = 6.3$ cfs, $Q_{100} = 37.6$ cfs) (sub-basins: OS1 and EX-1; Area: 33.23 Ac.) (Slopes: 2 to 25%) This point represents the discharge from sub-basins OS1 and EX-1 under predevelopment conditions. Under the predevelopment conditions Flows generated within sub-basins OS1 and EX-1 drain overland to the southwest. Flows are ultimately captured by the Highway 24 (Public) Road Ditch and conveyed westward toward an existing public 24" CMP culvert that conveys flows under Peterson Road. From there the stormwater continues along historic paths eventually reaching the East Fork of Sand Creek.

Design Point EX-2 ($Q_5 = 0.2$ cfs, $Q_{100} = 1.4$ cfs) (sub-basin: EX-2; Area: 0.45 Ac.) (Slopes: 2 to 25%) This point represents the discharge from sub-basin EX-2 under predevelopment conditions. Under the predevelopment conditions sub-basin EX-2 drains to the north into East Fork Sand Creek.

Design Point EX-3 ($Q_5 = 7.3$ cfs, $Q_{100} = 40.8$ cfs) (sub-basins: OS1, EX-1 and OS2; Area: 35.41 Ac.) (Slopes: 2 to 25%) This point represents the total discharge from the site under predevelopment conditions. Under the predevelopment conditions the general drainage direction is to the southwest except for sub-basin EX-2 which drains to the north and drains into East Fork Sand Creek. Flows from sub-basins OS1, OS2 and EX-1 are ultimately captured by the Highway 24 (Public) Road Ditch and conveyed westward, eventually reaching the East Fork of Sand Creek.

b. The **fully developed conditions** for the site are as follows:

Post development conditions have been analyzed using the rational method. Runoff drains overland and in proposed private storm sewer towards the southwestern corner of the site where developed flows will be treated in the proposed private full spectrum detention facility. Flows will be discharged into the Highway 24 road ditch which will convey the flows to the west, eventually reaching the East Fork of Sand Creek. All proposed storm is to be public unless otherwise indicated.

A delineation of the basin boundaries can be found in Appendix D in drawing DR-02. Runoff calculations can be found in Appendix A. The proposed runoff design points are described below:

Design Point 1 ($Q_5 = 1.4$ cfs, $Q_{100} = 2.6$ cfs) (sub-basin: PR-3; Area: 0.36 Ac.) (Slopes: 1 to 5%) This point represents the two at grade inlets capturing runoff in basin PR-3. The inlets are sized to capture the local flows. In the unlikely event of flooding from the East Fork of Sand Creek, the flows in excess of the designed capacity of the inlets will bypass to the west into the curb and gutter on the east side of Peterson Road. Stormwater collected in the inlets at DP1 is conveyed downstream toward the proposed full spectrum extended detention facility via 18-inch RCP.

Design Point 2 ($Q_5 = 5.1$ cfs, $Q_{100} = 9.8$ cfs) (sub-basin: PR-2; Area: 1.74 Ac.) (Slopes: 1 to 5%) This point represents the two sump inlets capturing runoff in basin PR-2. Stormwater runoff

generated within sub-basin PR-2 drains overland and in curb and gutter to the two inlets at DP-2. Stormwater collected in the inlets at DP2 is conveyed downstream toward the proposed full spectrum extended detention facility via 24-inch RCP.

Design Point 3 ($Q_5 = 1.9$ cfs, $Q_{100} = 12.6$ cfs) ($Q_5 = 11.7$ cfs, $Q_{100} = 24.9$ cfs (future)) (sub-basin: PR-1; Area: 5.79 Ac.) (Slopes: 1 to 5%) This point represents the stormwater runoff generated within sub-basin PR-1 collected in a temporary Type C inlet at DP3 that will capture offsite flows from the north until that parcel is developed. Development of sub-basin PR-1 is not proposed with this project. In fully developed (future) conditions flows generated within sub-basin PR-1 will be conveyed to DP3 via future storm sewer infrastructure to be designed with the FDR for Tract A. The temporary type C inlet collects flows from the undeveloped site which are then conveyed downstream toward the proposed detention facility via proposed 30-inch RCP.

Design Point 4 ($Q_5 = 2.9$ cfs, $Q_{100} = 15.0$ cfs) ($Q_5 = 12.7$ cfs, $Q_{100} = 26.7$ cfs (future)) (sub-basins: PR-1, PR-3; Area: 6.15 Ac.) (Slopes: 1 to 10%) This point represents the combination of flows from DP1, and DP3 in the proposed storm sewer. The combined flows will continue in the proposed public 36-inch RCP storm sewer to the east eventually discharging into the proposed detention facility.

Design Point 5 ($Q_5 = 7.9$ cfs, $Q_{100} = 24.6$ cfs) ($Q_5 = 18.6$ cfs, $Q_{100} = 38.1$ cfs (future)) (sub-basins: PR-1, PR-2, PR-3; Area: 7.89 Ac.) (Slopes: 1 to 10%) This point represents the combination of flows from DP1, DP2, and DP3 in the proposed storm sewer. The combined flows will continue in the proposed private 42-inch RCP storm sewer to the south eventually discharging into the proposed detention facility.

Design Point 6 ($Q_5 = 8.9$ cfs, $Q_{100} = 35.2$ cfs) ($Q_5 = 28.4$ cfs, $Q_{100} = 59.2$ cfs (future)) (sub-basins: PR-1, PR-2, PR-3, PR-4; Area: 14.90 Ac.) (Slopes: 1 to 10%) This point represents the discharge from sub-basins PR-1, PR-2, PR-3, and PR-4 into the proposed detention facility. Future flows at DP6 have been calculated assuming fully developed conditions even though the development of sub-basins PR-1, and PR-4 is not proposed at this time. In fully developed conditions stormwater runoff generated within sub-basins PR-4 will be directed to the proposed private manhole (MH-3) via future storm sewer infrastructure to be designed with the FDRs for the respectable tracts. In the interim condition, stormwater generated in sub-basin PR-4 drains overland to the southwest exiting the site into the existing curb and gutter along the east side of Peterson Road before continuing south in the existing curb and gutter along historic paths.

Design Point 7 ($Q_5 = 4.5$ cfs, $Q_{100} = 29.9$ cfs) ($Q_5 = 44.8$ cfs, $Q_{100} = 84.7$ cfs (future)) (sub-basin: PR-5; Area: 14.75 Ac.) (Slopes: 1 to 10%) This point represents the discharge from sub-basin PR-5 into the proposed detention facility. Future flows at DP7 have been calculated assuming fully developed conditions even though the development of sub-basin PR-5 is not proposed with this FDR. In fully developed conditions stormwater runoff generated within sub-basin PR-5 will be directed to the proposed detention facility via storm sewer infrastructure to be designed with the FDR for Lot 1 which is being reviewed concurrently under EPC project PPR2613. In the interim condition, stormwater generated in sub-basin PR-5 drains overland to the south exiting the site into the existing ditch along the north side of the Highway 24 off ramp before continuing along historic paths.

Design Point 8 ($Q_5 = 14.3$ cfs, $Q_{100} = 70.7$ cfs) ($Q_5 = 71.2$ cfs, $Q_{100} = 143.6$ cfs (future)) (sub-basins: PR-1, PR-2, PR-3, PR-4, PR-5, PR-6; Area: 31.71 Ac.) (Slopes: 1 to 10%) This point represents the discharge from the fully developed site into the proposed private Full Spectrum Extended Detention Basin located in the southwestern corner of the site (Pond 1). Stormwater is collected in Pond 1 which provides water quality treatment and detention for the site.

Design Point 9 ($Q_5 = 2.7$ cfs, $Q_{100} = 14.7$ cfs) ($Q_5 = 5.2$ cfs, $Q_{100} = 35.0$ cfs (future)) (sub-basins: PR-1, PR-2, PR-3, PR-4, PR-5, PR-6; Area: 31.71 Ac.) (Slopes: 1 to 10%) This point represents the discharge from Pond 1 in fully developed conditions. Stormwater collected in the proposed detention facility will be discharged to the Roadside ditch along the north side of the Highway 24 off-ramp before continuing to the west toward an existing public 36" RCP culvert crossing Peterson road and continuing along historic paths.

Design Point NC-1 ($Q_5 = 1.0$ cfs, $Q_{100} = 1.9$ cfs) (sub-basins: NC-1; Area: 0.26 Ac.) (Slopes: 1 to 10%) This point represents the discharge from sub-basin NC-1 into the curb and gutter along Peterson Road. Stormwater generated within sub-basin PR-1 drains undetained into Peterson Road before continuing along historic paths. Sub-basin NC-1 is excluded from water quality treatment per section I.7.1.C.1.a.

Design Point NC-2 ($Q_5 = 0.3$ cfs, $Q_{100} = 2.0$ cfs) (sub-basins: NC-2; Area: 0.70 Ac.) (Slopes: 1 to 10%) This point represents the discharge from sub-basin NC-2 in fully developed conditions. Stormwater generated in sub-basin NC-2 drains undetained to the north into East Fork Sand Creek. This sub-basin will be unchanged from existing conditions so water quality treatment and detention is not needed.

Notes:

- **MHFD-Detention Analysis for both the interim and final conditions have been included for the proposed detention pond (Pond 1) which will be constructed as part of the Improvements associated with Cimarron Hills Southeast Mixed Use Filing No. 1. It will be necessary to update the pond design in the final condition to meet criteria. Changes to the design will include updates to the orifice plate, and the addition of a forebay and trickle channel. Future developments upstream of the pond will be required to update the pond as necessary to maintain compliance with any applicable criteria. Design calculations can be found in Appendix A of this report.**
- **Tables summarizing inlet sizes and capacities, storm pipe sizes and capacities and swale capacities for the proposed improvements can be found in Appendix A and/or in the following section.**
- **All ponds and associated internal infrastructure are to be owned and maintained by the HOA.**
- **The ratio of the total site discharge in proposed conditions vs existing conditions is 0.9, representing no significant increase in flows in the proposed condition.**

V. Hydraulic Analysis

a. Proposed Inlets

This project will use Type R inlets in both sump and at grade conditions. Sump inlet capacities were determined utilizing the nomographs available from the El Paso County Drainage Criteria Manual Volume 1 (DCM). The Type R inlet has a total depth in sump conditions of 9-inches based on a flow depth of 6-inches in the curb and gutter and an additional 3-inches of depth in the throat of the inlet. The table below lists inlets by design point and corresponding capacity. Figure 1 shows the capacities for Type R inlets in sump conditions.

INLET SUMMARY										
CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1										
DESIGN POINT or SUB- BASIN	SUB-BASINS/ DESCRIPTION	TOTAL AREA (AC)	INLET			Q(5) TOTAL INFLOW	Q5 INLET CAPACITY	Q(100) BYPASS FLOWS (cfs)	Q(100) TOTAL INFLOW (cfs)	MAX INLET CAPACITY
			SIZE (Ft.)	TYPE	CONDITION					
1	PR-3	0.36	2 x 5'	R	AT GRADE	1.4	1.4	0.0	2.6	2.6
2	PR-2	1.74	2 x 5'	R	SUMP	5.1	22.0	0.0	9.8	22.0
3	PR-1	5.79	3' x 3'	C	SUMP	1.9	13.2	0.0	12.6	13.2

Note: Inlet sizes indicated are minimums. Larger sizes may be used in the construction plans for conservative design.

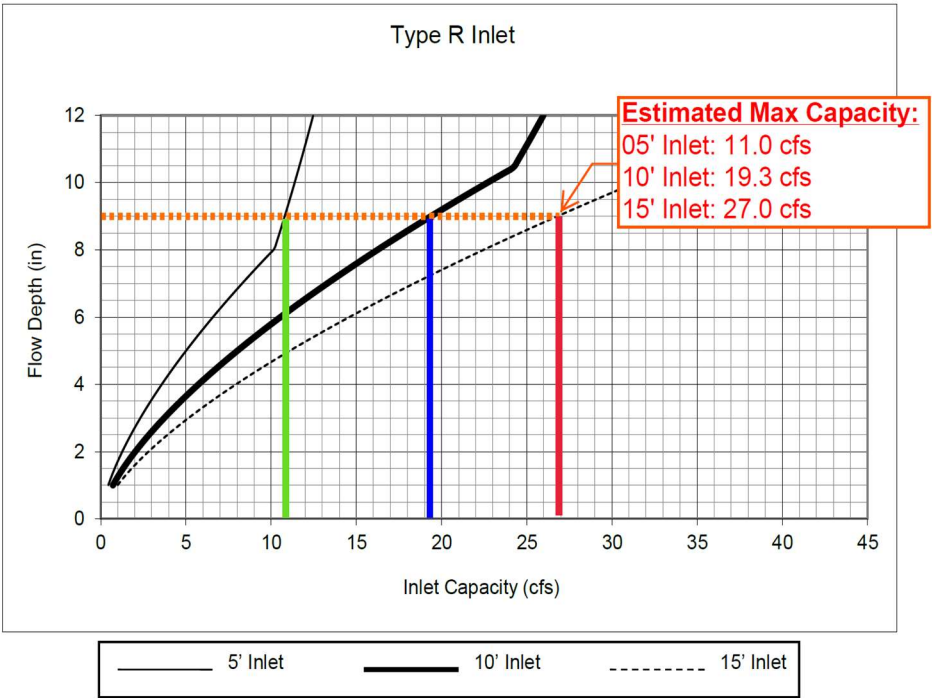


Figure 1

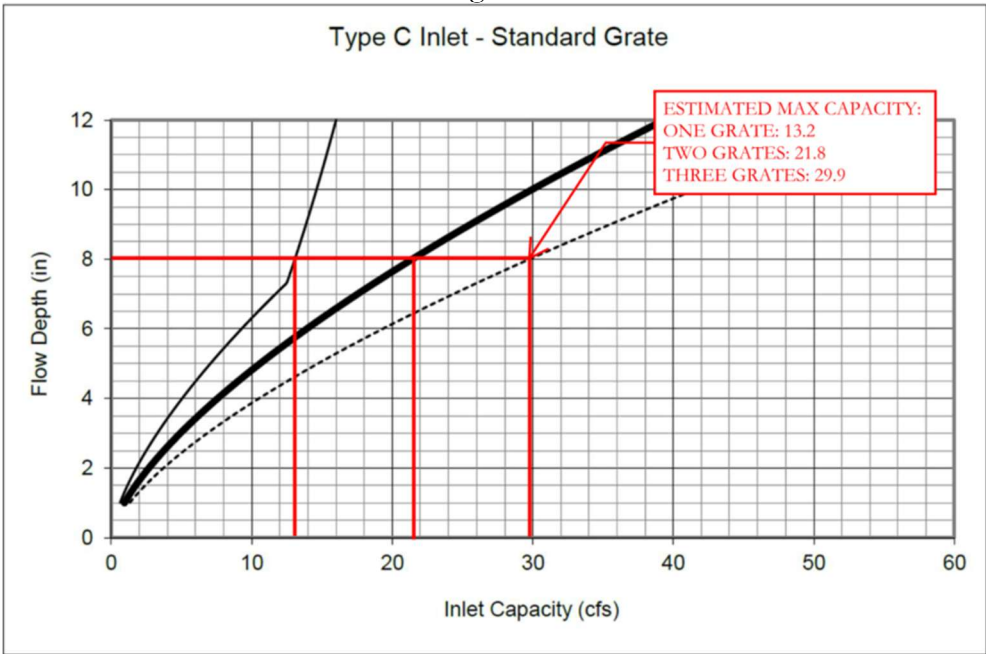


Figure 2

<i>Inlet Overflow Routing</i>	
<i>Inlet</i>	<i>Overflow Routing Under Sump Inlet Blockage Conditions</i>
2	Blockage of these inlets will force flows south along the nearby utility easement and into the proposed detention facility.

b. Storm Pipes

To confirm DCM compliant capacity and velocity values the site has been modeled in StormCAD using the Standard head loss method and head loss values taken from Table 9-4 of the DCM. HGL profiles modeled in StormCAD are included in Appendix A. Outfall protection has been provided at discharge points in accordance with DCM standards. Outfall protection calculations are included in Appendix A. All outfalls have been designed to provide flow velocities consistent with a stable and suitable outfall.

c. Detention

The proposed private Extended Detention Basin (Pond 1) has been designed to detain stormwater flows to reduce the total site discharge to predevelopment levels. The pond will provide detention and water quality treatment for stormwater runoff generated within the Proposed development. The proposed private Forebay at the north side of Pond 1 has been sized based on the untreated WQCV calculated in the MHFD-DETENTION worksheet. The forebay calculations and MHFD-DETENTION worksheet can be found in Appendix A. The proposed private trickle channel has been sized to accommodate the release from the proposed private forebay. Trickle channel calculations are included in Appendix A. Pond 1 will outfall to a riprap pad to the southwest. Design information including calculations are included in Appendix A. The table below summarizes the detention provided for this development.

Notes:

- The proposed forebay at DP-6 has been sized to handle fully developed flows from sub-basins PR-1, PR-2, PR-3, and PR-4. Future developments located within sub-basins PR-1, and PR-4 will be required to provide a connection to the proposed storm sewer system.
- The development located within sub-basin PR-5 will be required to provide an FDR and CDs for infrastructure providing conveyance to the proposed detention facility including an additional forebay and trickle channel connection. The FDR for this site is being reviewed under EPC project PPR2613.

Proposed Pond Summary CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1								
Pond	Tributary Area	% Impervious	Pre-Development Peak		Pond Outflow		Pre vs. Post Ratio	
			Q5	Q100	Q5	Q100	Q5	Q100
Pond 1	31.71	7.18	9.4	41.1	2.7	14.7	0.3	0.4

Emergency Overflow

Pond 1: If the emergency overflow weir receives flows, these flows will continue downstream and drain into the roadside ditch along the north side of the Highway 24 off-ramp. An analysis of the south roadside ditch and downstream culvert in the event that the emergency overflow weir receives flows is included in Appendix A. The analysis shows that both the ditch and culvert are adequate to convey the proposed flows.

d. Swale Capacity

The proposed private Extended Detention Basin (Pond 1) discharges into the existing public ditch (south roadside ditch) that runs along the north side of the Highway 24 off-ramp. The stormwater flows in the ditch have been calculated to be 71.8 cfs during the 100-yr storm event in existing conditions and 68.1 cfs during the 100-yr storm event in proposed conditions. The flows in the ditch have been determined by combining the flows exiting the development to the east (31.0 cfs at DP-16 of the Aura at Crossroads FDR) with the existing and proposed discharges from the site (40.8 cfs and 37.1 cfs respectively). Calculations for the south roadside ditch can be found in Appendix A and an excerpt from the Aura at Crossroads FDR can be found in Appendix C.

VI. Storm Water Quality

Per the DCM Volume 2, Section 4.1, El Paso County recommends the MHFD Four Step Process for receiving water protection that focuses on reducing runoff by disconnecting impervious area, eliminating “unnecessary” impervious area and encouraging infiltration into soils that are suitable, treat and slowly release the WQCV, stabilize stream channels, and implement source controls. The four-step process has been completed below.

Step 1: Employ Runoff Reduction Practices.

- Where possible runoff will be directed across and through grassed swales, however, please note that this report is for street infrastructure, which is difficult to drain across pervious areas and maintain compliance with the DCM and the County’s standard street sections.

Step 2: Stabilize Drainageways.

- The site is in the Sand Creek Drainage Fee Basin. Drainage fees paid at the time of initial platting help fund proposed channel improvements. Information on planned future improvements to the Sand Creek channel was unavailable for this report.

Step 3: Provide Water Quality Capture Volume (WQCV).

- As required by the DCM, runoff from the proposed streets which is feasible to detain, is directed into a proposed detention pond (Pond 1) via proposed storm sewer. The pond has been designed to meet the DCM standards for the release rates of Full Spectrum Detention Ponds for Water Quality Capture Volumes, and all of the other storm events listed in the MHFD- Detention spreadsheet. Exclusions are listed below:

- Disturbed areas that are not practicable to detain are excluded from WQ treatment per section I.7.1.C.1.a. This includes sub-basin NC-1 which contains 0.27 acres or 1.0% of the overall site.

Step 4: Consider Need for Industrial and Commercial BMPs.

- There are no commercial or industrial components of this development, therefore no BMPs of this nature are required.

VII. Erosion Control Plan

A grading and erosion control plan (GEC) for the proposed improvements will be submitted for review as a separate submittal. These plans will incorporate straw wattles, straw bale check dams, silt fence, vehicle tracking control, inlet & outlet control, sedimentation basins and other best management practices (CMs) identified in the DCM Volume 2.

VIII. Floodplains

Per the ***Flood Insurance Rate Maps (FIRM) 08041C0752 G & 08041C0754 G***, effective date December 7, 2018, published by the Federal Emergency Management Agency (FEMA), East Fork Sand Creek, a Tributary to Sand Creek runs along the northern bound of the Cimarron Hills Southeast Mixed Use Filing No. 1 area and has a designated 100-year floodplain. The developed portion of the site is generally not touched by the 100 year floodplain, however the road improvements associated with this site will cross the FEMA floodplain along the western portion of the proposed roadway. Additionally, a portion of proposed Pond 1 is to be constructed within the floodplain. Both instances of construction in the floodplain will be demonstrated to cause “no rise” in the associated base flood elevations and a “no rise” certification has been submitted to PPRBD with the floodplain development permit application. An excerpt from the "no rise" certification is included in Appendix C showing compliance with DCM Volume 1 Table 6-1.

IX. Fee Development

a. Previously Platted Land

The Proposed development is located within the Sand Creek Drainage Fee Basin and within previously platted land. The 2025 Drainage Basin Fees for the Sand Creek Drainage Fee Basin are: \$27,554/impervious acre for the Drainage Fee and \$11,270.00/impervious acre for the Bridge Fee. The impervious area for the site has increased from 2.00% to 9.59% for an increase of 7.59%. By multiplying the total area of the site (32.68 acres) by the increase in imperviousness (.0759) we get the increase in impervious acres (2.480 acres). Drainage fees for developments in Lot 1 and Tracts A and B will be paid at the time of development. Drainage and bridge fees have been based on this increase and are shown in the table below.

Unresolved:
Provide calculation for how the acreage was determined, as well as % impervious for this plat, as pond spreadsheet shows total impervious as 70%. Imperviousness for fees needs to be based on final conditions (Imperviousness based on Lot 1 being developed). Fees are due with platting, this plat creates Lot 1 and full bridge and drainage fees for it are due now.

CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1 Final Drainage Report 2025 Drainage and Bridge Fees			
	Increase in impervious acres	Fee/ Imp. Acre	Fee Due
Drainage Fee	2.480	\$27,554.00	\$68,333.92
Bridge Fee	2.480	\$11,270.00	\$27,949.60
TOTAL			\$96,283.52

Cost Estimate

Table 9.1

Engineer's Estimate of Probable Construction Costs				
SAND CREEK				
CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1				
Private Non-Reimbursable				
Item	Unit	Quantity	Unit Cost	Extension
18" RCP/HP	LF	56	\$88.00	\$4,928.00
24" RCP/HP	LF	57	\$105.00	\$5,985.00
30" RCP/HP	LF	45	\$132.00	\$5,940.00
36" RCP/HP	LF	531	\$162.00	\$86,022.00
42" RCP/HP	LF	633	\$216.00	\$136,728.00
38" X 60" RCP	LF	86	\$250.00	\$21,500.00
30" FES	EA	1	\$792.00	\$792.00
5' Type R Inlet	EA	4	\$10,800.00	\$43,200.00
Box Base MH	EA	6	\$16,265.00	\$97,590.00
Type C Inlet	EA	1	\$6,490.00	\$6,490.00
RIPRAP	CY	90	\$135.00	\$12,150.00
Sub Total				\$421,325.00
10% Contingency				\$42,132.50
TOTAL:				\$463,457.50

<i>Engineer's Estimate of Probable Construction Costs</i>				
SAND CREEK				
<u>CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1</u>				
<u>Permanent BMP (EDB): Private Non-reimbursable</u>				
Item	Unit	Quantity	Unit Cost	Extension
DETENTION POND GRADING	EA	1	\$35,000.00	\$35,000.00
3' TRICKLE CHANNEL	LF	260	\$250.00	\$65,000.00
FOREBAY	EA	1	\$40,000.00	\$40,000.00
OUTLET STRUCTURE	EA	1	\$40,000.00	\$40,000.00
EMERGENCY SPILLWAY	EA	1	\$5,000.00	\$5,000.00

Sub Total \$185,000.00

10% Contingency \$18,500.00

TOTAL:	\$203,500.00
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Overall Total	\$666,957.50
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Since the engineer has no control over the cost of labor, materials, equipment, or services furnished by others, or over the contractor's method of determining prices, or over the competitive bidding or market conditions, the opinion of probable construction costs provided herein are made on the basis of the engineer's experience and qualifications and represents the best judgment as an experienced and qualified professional familiar with the construction industry. The engineer cannot, and does not guarantee that proposals, bid or actual construction costs will not vary from the opinion of probable costs.

X. Summary

This report demonstrates that the proposed infrastructure associated with Cimarron Hills Southeast Mixed Use Filing No. 1 is in conformance with the El Paso County Drainage Criteria Manual, Volumes 1 and 2, October 2018 and all previously approved studies related to the project site. Stormwater flows will be reduced from $Q_5 = 6.5$ cfs, $Q_{100} = 39.0$ cfs, in existing conditions to $Q_5 = 4.0$ cfs, $Q_{100} = 18.7$ cfs in the interim condition and $Q_5 = 6.5$ cfs, $Q_{100} = 38.9$ cfs in fully developed (future) conditions. These proposed improvements should not adversely affect downstream or surrounding developments and are in conformance with the pertinent studies for the area.

XI. References

1. ***El Paso County and City of Colorado Springs Drainage Criteria Manual, Volume 1 & 2***, El Paso County, May 2014
2. ***El Paso County Engineering Criteria Manual***, El Paso County, Rev. December 2016
3. ***Web Soil Survey of El Paso County Area, Colorado. Unites States Department of Agriculture Soil Conservation Service.***
4. ***Flood Insurance Rate Maps for El Paso County, Colorado and Incorporated Areas, Panel 279 of 1275, Federal Emergency Management Agency***, Effective Date December 7, 2018.
5. ***Urban Storm Drainage Criteria Manual, Vol. 1-3*** by Urban Drainage and Flood Control District (UDFCD), January 2016

Appendices

APPENDIX A

HYDROLOGIC AND HYDRAULIC CALCULATIONS

Project Name:
Project Location:
Designer
Notes:

CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1
EL PASO COUNTY
WCG
EXISTING CONDITIONS

Average Channel Velocity
Average Slope for Initial Flow

4.00
0.04

ft/s
ft/ft

(If specific channel vel is used, this will be ignored)
(If Elevations are used, this will be ignored)

Channel Flow Type Key	
Heavy Meadow	2
Tillage/Field	3
Short Pasture and Lawns	4
Nearly Bare Ground	5
Grassed Waterway	6
Paved Areas	7

		Area			Rational 'C' Values												Flow Lengths								Rainfall Intensity & Rational Flow Rate									
Sub-basin	Comments	sf	acres	Soil Group	Commercial Areas (95% Impervious)			Pavement (100% Impervious)			Undeveloped/Pervious Areas (2% Impervious)			Composite		Percent Impervious	Initial	True Initial	Channel	True Channel	Average (decimal)	Initial	Average (%)	Channel Flow Type (See Key above)	Velocity	Channel	Total	i2	Q2	i5	Q5	i100	Q100	Sub-basin
					C5	C100	Area (SF)	C5	C100	Area	C5	C100	ft	Length ft	ft																			
OS-1	OFFSITE BASIN SOUTHWEST OF SITE. CONTAINS EXISTING HOTEL.	43567	1.00	B	0.81	0.88	29246	0.90	0.96		0.09	0.36	14321	0.57	0.71	64.43	25	25	350	350	0.10	2.20	2.0	7	2.83	2.06	5.00	4.12	2.38	5.17	3.0	8.68	6.2	OS-1
EX-1	UNDEVELOPED SITE AREA	1404112	32.23	B	0.81	0.88		0.90	0.96		0.09	0.36	1404112	0.09	0.36	2.00	300	100	1800	2000	0.25	10.77	1.7	4	0.89	37.65	48.41	1.42	4.15	1.76	5.2	2.96	34.6	EX-1
EX-2	UNDEVELOPED SITE AREA	19495	0.45	B	0.81	0.88		0.90	0.96		0.09	0.36	19495	0.09	0.36	2.00	50	50	0	0	0.17	5.04	0.5	4	0.49	0.00	5.03	4.11	0.17	5.16	0.2	8.66	1.4	EX-2
OS-2	South Roadside Ditch	94892	2.18	B	0.81	0.88		0.90	0.96	19435	0.09	0.36	75457	0.26	0.48	22.07	50	50	1073	1073	0.12	4.69	1.6	4	0.89	20.20	24.88	2.21	1.24	2.76	1.6	4.64	4.9	OS-2
DESIGN POINTS	Sub-basins																																	DESIGN POINTS
EX-1	EXISTING SITE DISCHARGE	1447679	33.23	B	0.81	0.88	29246	0.90	0.96		0.09	0.36	1418433	0.10	0.37	3.88	300	100	1800	2000	0.25	10.61	1.7	4	0.91	36.52	47.13	1.45	5.08	1.80	6.3	3.03	37.6	EX-1
EX-2	EXISTING SITE DISCHARGE	19495	0.45	B	0.81	0.88		0.90	0.96		0.09	0.36	19495	0.09	0.36	2.00	50	50	0	0	0.17	5.04	0.5	4	0.49	0.00	5.03	4.11	0.17	5.16	0.2	8.66	1.4	EX-2
EX-3	South Roadside Ditch	1542571	35.41	B	0.81	0.88	29246	0.90	0.96	19435	0.09	0.36	1493890	0.11	0.38	5.00	300	100	1800	2000	0.25	10.51	1.7	4	0.91	36.52	47.03	1.45	5.90	1.81	7.3	3.03	40.8	EX-3
	Existing site Imperviousness	1423606	32.68	B	0.81	0.88	0	0.90	0.96	0	0.09	0.36	1423606	0.09	0.36	2.00		0																

Rational Method - Proposed Conditions

Project Name:	CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1
Project Location:	EL PASO COUNTY
Designer	WCG
Notes:	PROPOSED CONDITIONS

Average Channel Velocity4.00 ft/s
Average Slope for Initial Flow0.04 ft/ft

(If specific channel vel is used, this will be ignored)
(If Elevations are used, this will be ignored)

Channel Flow Type Key	
Heavy Meadow	2
Tillage/Field	3
Short Pasture and Lawns	4
Nearly Bare Ground	5
Grassed Waterway	6
Paved Areas	7

		Area			Rational 'C' Values															Flow Lengths						Rainfall Intensity & Rational Flow Rate									
Sub-basin	Comments	sf	acres	Soil Group	Commercial Areas (95% Impervious)			Pavement (100% Impervious)			Neighborhoods/Multi-Family (70% Impervious)			Undeveloped/Pervious Areas (2% Impervious)			Composite		Percent Impervious	Initial	True Initial	Channel	True Channel	Average (decimal)	Initial	Average (%)	Channel Flow Type (See Key above)	Velocity (ft/s)	Channel	Total	Rainfall Intensity & Rational Flow Rate				Sub-basin
					C5	C100		C5	C100	Area (SF)	C5	C100	Area	C5	C100	Area	C5	C100													ft	Length ft	ft	Length ft	
PR-1	NORTH OF MEADOWBROOK PKWY UNDEVELOPED	252158	5.79	B	0.81	0.88		0.90	0.96		0.49	0.62		0.09	0.36	252158	0.09	0.36	2.00%	100	100	640	640	0.05	10.63	2.0	7	2.83	3.77	14.40	3.58	1.9	6.01	12.6	PR-1
PR-1 (FUTURE)	MULTI FAMILY	252158	5.79	B	0.81	0.88		0.90	0.96		0.49	0.62	252158	0.09	0.36		0.49	0.62	70.00%	100	100	640	640	0.05	6.42	2.0	7	2.83	3.77	10.19	4.10	11.7	6.89	24.9	PR-1 (FUTURE)
PR-2	MEADOWBROOK PKWY	75883	1.74	B	0.81	0.88		0.90	0.96	60512	0.49	0.62		0.09	0.36	15371	0.74	0.84	80.15%	50	50	1024	1024	0.03	3.18	1.1	7	2.10	8.14	11.31	3.94	5.1	6.62	9.8	PR-2
PR-3	MEADOWBROOK PKWY	15685	0.36	B	0.81	0.88		0.90	0.96	12508	0.49	0.62		0.09	0.36	3177	0.74	0.84	80.15%	50	50	136	136	0.02	3.68	1.1	7	2.10	1.08	5.00	5.17	1.4	8.68	2.6	PR-3
PR-4	UNDEVELOPED	305176	7.01	B	0.81	0.88		0.90	0.96		0.49	0.62		0.09	0.36	305176	0.09	0.36	2.00%	100	100	960	960	0.05	10.63	2.0	7	2.83	5.66	16.28	3.40	2.2	5.70	14.5	PR-4
PR-4 (FUTURE)	MULTI FAMILY (By others)	305176	7.01	B	0.81	0.88		0.90	0.96		0.49	0.62	305176	0.09	0.36		0.49	0.62	70.00%	100	100	960	960	0.05	6.42	2.0	7	2.83	5.66	12.07	3.85	13.3	6.46	28.3	PR-4 (FUTURE)
PR-5	UNDEVELOPED	642552	14.75	B	0.81	0.88		0.90	0.96		0.49	0.62		0.09	0.36	642552	0.09	0.36	2.00%	100	100	1460	1460	0.10	8.44	2.0	7	2.83	8.60	17.04	3.33	4.5	5.59	29.9	PR-5
PR-5 (Developed)	MULTI FAMILY (By others)	642552	14.75	B	0.81	0.88	573478	0.90	0.96		0.49	0.62		0.09	0.36	69074	0.73	0.82	85.00%	100	100	1460	1460	0.10	3.07	3.0	7	3.46	7.02	10.09	4.12	44.8	6.91	84.7	PR-5 (Developed)
PR-6	DETENTION TRACT	90049	2.07	B	0.81	0.88		0.90	0.96		0.49	0.62		0.09	0.36	90049	0.09	0.36	2.00%	25	25	330	330	0.25	3.11	0.5	4	0.49	11.11	14.22	3.60	0.7	6.05	4.5	PR-6
NC-1	PORTION OF MEADOWBROOK PKWY IMPRACTICABLE TO DETAIN	11541	0.26	B	0.81	0.88		0.90	0.96	9235	0.49	0.62		0.09	0.36	2306	0.74	0.84	80.42%	25	25	136	136	0.02	2.58	1.0	7	2.00	1.13	5.00	5.17	1.0	8.68	1.9	NC-1
NC-2	UNDEVELOPABLE AREA DRAINING TO THE NORTH.	30590	0.70	B	0.81	0.88		0.90	0.96		0.49	0.62		0.09	0.36	30590	0.09	0.36	2.00%	25	25	188	188	0.05	5.32	12.0	4	2.42	1.29	6.60	4.75	0.3	7.98	2.0	NC-2
OS-1	OFFSITE BASIN SOUTHWEST OF SITE. CONTAINS EXISTING HOTEL.	43567	1.00	B	0.81	0.88	29246	0.90	0.96		0.49	0.62		0.09	0.36	14321	0.57	0.71	64.43%	25	25	350	350	0.10	2.20	2.0	7	2.83	2.06	5.00	5.17	3.0	8.68	6.2	OS-1
OS-2	South Roadside Ditch	94892	2.18	B	0.81	0.88		0.90	0.96	19435	0.49	0.62		0.09	0.36	75457	0.26	0.48	22.07%	50	50	1073	1073	0.12	4.69	1.6	4	0.89	20.20	24.88	2.76	1.6	4.64	4.9	OS-2
DESIGN POINTS	Sub-basins																																		DESIGN POINTS
DP1	MEADOWBROOK PKWY- AT GRADE INLETS	15685	0.36	B	0.81	0.88	0	0.90	0.96	12508	0.49	0.62	0	0.09	0.36	3177	0.74	0.84	80.15%	50	50	136	136	0.02	3.68	1.1	7	2.10	1.08	5.00	5.17	1.4	8.68	2.6	DP1
DP2	MEADOWBROOK PKWY- SUMP INLETS	75883	1.74	B	0.81	0.88	0	0.90	0.96	60512	0.49	0.62	0	0.09	0.36	15371	0.74	0.84	80.15%	50	50	1024	1024	0.03	3.18	1.1	7	2.10	8.14	11.31	3.94	5.1	6.62	9.8	DP2
DP3	LOT 2	252158	5.79	B	0.81	0.88	0	0.90	0.96	0	0.49	0.62	0	0.09	0.36	252158	0.09	0.36	2.00%	100	100	640	640	0.05	10.63	2.0	7	2.83	3.77	14.40	3.58	1.9	6.01	12.6	DP3
DP3 (FUTURE)	LOT 2	252158	5.79	B	0.81	0.88	0	0.90	0.96	0	0.49	0.62	252158	0.09	0.36	0	0.49	0.62	70.00%	100	100	640	640	0.05	6.42	2.0	7	2.83	3.77	10.19	4.10	11.7	6.89	24.9	DP3 (FUTURE)
DP4	DP1, DP3	267842	6.15	B	0.81	0.88	0	0.90	0.96	12508	0.49	0.62	0	0.09	0.36	255335	0.13	0.39	6.58%	50	50	1024	1024	0.05	7.24	2.0	7	2.83	6.03	13.27	3.70	2.9	6.22	15.0	DP4
DP4 (FUTURE)	DP1, DP3	267842	6.15	B	0.81	0.88	0	0.90	0.96	12508	0.49	0.62	252158	0.09	0.36	3177	0.50	0.63	70.59%	50	50	1024	1024	0.05	4.43	2.0	7	2.83	6.03	10.46	4.06	12.7	6.82	26.7	DP4 (FUTURE)
DP5	DP 2, DP3, & DP 1	343725	7.89	B	0.81	0.88	0	0.90	0.96	73020	0.49	0.62	0	0.09	0.36	270705	0.26	0.49	22.82%	100	100	640	640	0.05	8.82	2.0	7	2.83	3.77	12.59	3.78	7.9	6.35	24.6	DP5
DP5 (FUTURE)	DP2, DP3, & DP1	343725	7.89	B	0.81	0.88	0	0.90	0.96	73020	0.49	0.62	252158	0.09	0.36	18547	0.56	0.68	72.70%	100	100	640	640	0.05	5.73	2.0	7	2.83	3.77	9.50	4.21	18.6	7.06	38.1	DP5 (FUTURE)
DP6	DP5 & LOT 3	648901	14.90	B	0.81	0.88	0	0.90	0.96	73020	0.49	0.62	0	0.09	0.36	575881	0.18	0.43	13.03%	100	100	1375	1375	0.05	9.67	2.0	7	2.83	8.10	17.77	3.27	8.9	5.48	35.2	DP6
DP6 (FUTURE)	DP5 & LOT 3	648901	14.90	B	0.81	0.88	0	0.90	0.96	73020	0.49	0.62	557334	0.09	0.36	18547	0.52	0.65	71.43%	100	100	1375	1375	0.05	6.06	2.0	7	2.83	8.10	14.15	3.61	28.4	6.06	59.2	DP6 (FUTURE)
DP7	PR-5	642552	14.75	B	0.81	0.88	0	0.90	0.96	0	0.49	0.62	0	0.09	0.36	642552	0.09	0.36	2.00%	100	100	1460	1460	0.10	8.44	2.0	7	2.83	8.60	17.04	3.33	4.5	5.59	29.9	DP7
DP7 (FUTURE)	PR-5 MULTI FAMILY (By others)	642552	14.75	B	0.81	0.88	573478	0.90	0.96	0	0.49	0.62	0	0.09	0.36	69074	0.73	0.82	85.00%	100	100	1460	1460	0.10	3.07	3.0	7	3.46	7.02	10.09	4.12	44.8	6.91	84.7	DP7 (FUTURE)
DP8	INTO DETENTION POND	1381503	31.71	B	0.81	0.88	0	0.90	0.96	73020	0.49	0.62	0	0.09	0.36	1308483	0.13	0.39	7.18%	100	100	1460	1460	0.10	8.08	2.0	7	2.83	8.60	16.68	3.36	14.3	5.64	70.7	DP8
DP9	OUT OF DETENTION POND	1381503	31.71	B	0.81	0.88	0	0.90	0.96	73020	0.49	0.62	0	0.09	0.36	1308483	0.13	0.39	7.18%	100	100	1460	1460	0.10	8.08	2.0	7	2.83	8.60	16.68	3.36	2.7	5.64	14.7	DP9
DP8 (FUTURE)	INTO DETENTION POND	1381503	31.71	B	0.81	0.88	573478	0.90	0.96	73020	0.49	0.62	557334	0.09	0.36	177671	0.59	0.71	73.22%	100	100	1460	1460	0.10	4.24	2.0	7	2.83	8.60	12.83	3.76	71.2	6.30	143.6	DP8 (FUTURE)
DP9 (FUTURE)	OUT OF DETENTION POND	1381503	31.71	B	0.81	0.88	573478	0.90	0.96	73020	0.49	0.62	557334	0.09	0.36	177671	0.59	0.71	73.22%	100	100	1460	1460	0.10	4.24	2.0	7	2.83	8.60	12.83	3.76	5.2	6.30	35.0	DP9 (FUTURE)
DSCH	SITE DISCHARGE	1423634	32.68	B	0.81	0.88	29246	0.90	0.96	82255	0.49	0.62	0	0.09	0.36	1325110	0.15	0.41	9.59%	100	100	1810	1810	0.10	7.92	2.0	7	2.83	10.67	18.58	3.20	4.0	5.37	18.7	DSCH
NC-1	UNDETAINED DISCHARGE INTO PETERSON ROAD	11541	0.26	B	0.81	0.88	0	0.90	0.96	9235	0.49	0.62	0	0.09	0.36	2306	0.74	0.84	80.42%	25	25	136	136	0.02	2.58	1.0	7	2.00	1.13	5.00	5.17	1.0	8.68	1.9	NC-1
NC-2	UNDETAINED DISCHARGE INTO EAST FORK SAND CREEK	30590	0.70	B	0.81	0.88	0	0.90	0.96	0	0.49	0.62	0	0.09	0.36	30590	0.09	0.36	2.00%	25	25	188	188	0.05	5.32	12.0	4	2.42	1.29	6.60	4.75	0.3	7.98	2.0	NC-2

Note: Sump inlet capacities are provided via the nomographs included in the narrative portion of this report.

MHFD-Inlet, Version 5.03 (August 2023)

INLET MANAGEMENT

Worksheet Protected

INLET NAME	DP1
Site Type (Urban or Rural)	URBAN
Inlet Application (Street or Area)	STREET
Hydraulic Condition	On Grade
Inlet Type	CDOT Type R Curb Opening

USER-DEFINED INPUT

User-Defined Design Flows

Minor Q_{Known} (cfs)	1.4
Major Q_{Known} (cfs)	2.6

Bypass (Carry-Over) Flow from Upstream

Inlets must be organized from upstream (left) to downstream (right).

Receive Bypass Flow from:	No Bypass Flow Received
Minor Bypass Flow Received, Q_b (cfs)	0.0
Major Bypass Flow Received, Q_b (cfs)	0.0

Watershed Characteristics

Subcatchment Area (acres)	
Percent Impervious	
NRCS Soil Type	

Watershed Profile

Overland Slope (ft/ft)	
Overland Length (ft)	
Channel Slope (ft/ft)	
Channel Length (ft)	

Minor Storm Rainfall Input

Design Storm Return Period, T_r (years)	
One-Hour Precipitation, P_1 (inches)	

Major Storm Rainfall Input

Design Storm Return Period, T_r (years)	
One-Hour Precipitation, P_1 (inches)	

CALCULATED OUTPUT

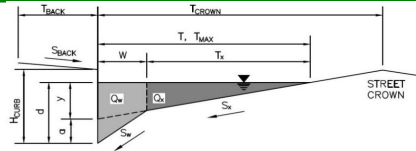
Minor Total Design Peak Flow, Q (cfs)	1.4
Major Total Design Peak Flow, Q (cfs)	2.6
Minor Flow Bypassed Downstream, Q_b (cfs)	0.0
Major Flow Bypassed Downstream, Q_b (cfs)	0.0

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

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

Project:

Inlet ID: DP1

**Gutter Geometry:**

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)

T_{BACK} =	0.0	ft
S_{BACK} =		ft/ft
n_{BACK} =	0.013	

H_{CURB} =	6.00	inches
T_{CROWN} =	26.0	ft
W =	2.00	ft
S_X =	0.020	ft/ft
S_W =	0.083	ft/ft
S_O =	0.010	ft/ft
n_{STREET} =	0.013	

Max. Allowable Spread for Minor & Major Storm

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

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
T_{MAX} =	21.0	26.0	ft
d_{MAX} =	6.0	9.0	inches
	☐	☐	

MINOR STORM Allowable Capacity is based on Depth Criterion

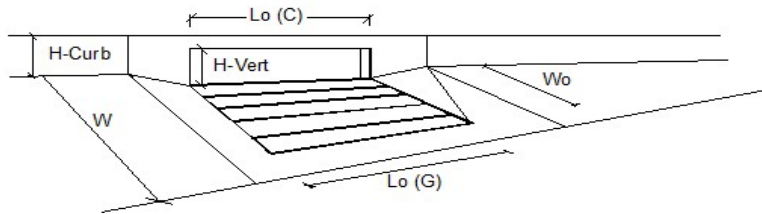
MAJOR STORM Allowable Capacity is based on Spread Criterion

	Minor Storm	Major Storm	
Q_{allow} =	17.0	39.3	cfs

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 1.40 cfs on sheet 'Inlet Management'**Major storm max. allowable capacity GOOD - greater than the design peak flow of 2.60 cfs on sheet 'Inlet Management'**

INLET ON A CONTINUOUS GRADE

MHFD-Inlet, Version 5.03 (August 2023)



CDOT Type R Curb Opening			
Design Information (Input)		MINOR	MAJOR
Type of Inlet	Type =	CDOT Type R Curb Opening	
Local Depression (additional to continuous gutter depression 'a')	$a_{LOCAL} =$	3.0	3.0
Total Number of Units in the Inlet (Grate or Curb Opening)	$N_o =$	2	2
Length of a Single Unit Inlet (Grate or Curb Opening)	$L_o =$	5.00	5.00
Width of a Unit Grate (cannot be greater than W, Gutter Width)	$W_o =$	N/A	N/A
Clogging Factor for a Single Unit Grate (typical min. value = 0.5)	$C_f (G) =$	N/A	N/A
Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)	$C_f (C) =$	0.10	0.10
Street Hydraulics: OK - $Q < \text{Allowable Street Capacity}$		MINOR	MAJOR
Total Inlet Interception Capacity	$Q =$	1.4	2.6
Total Inlet Carry-Over Flow (flow bypassing inlet)	$Q_o =$	0.0	0.0
Capture Percentage = Q_o/Q_o	$C\% =$	100	100

SUMP INLET CALCULATIONS

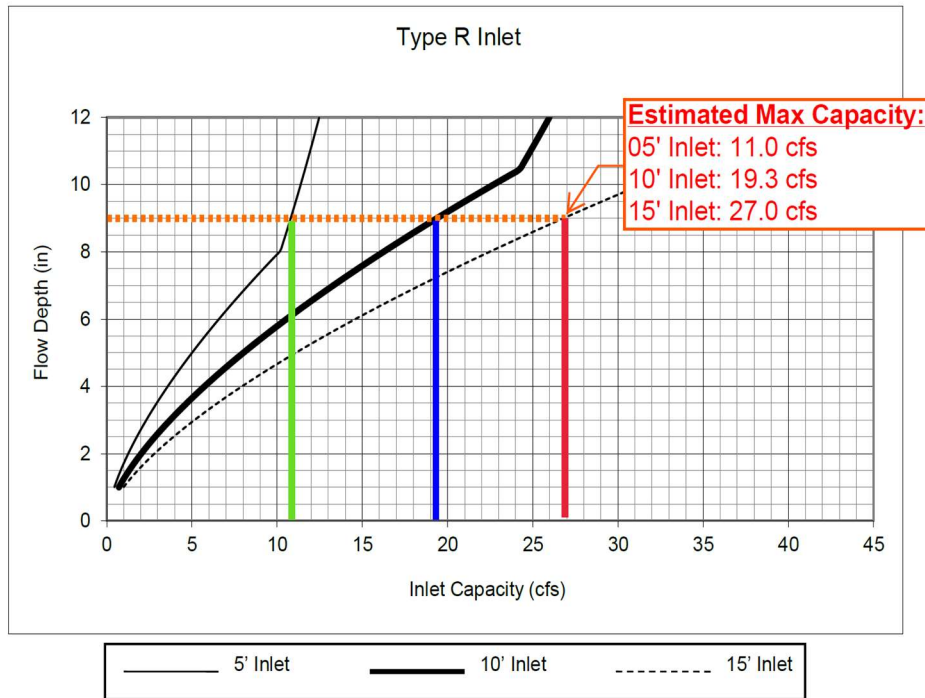


Figure 1

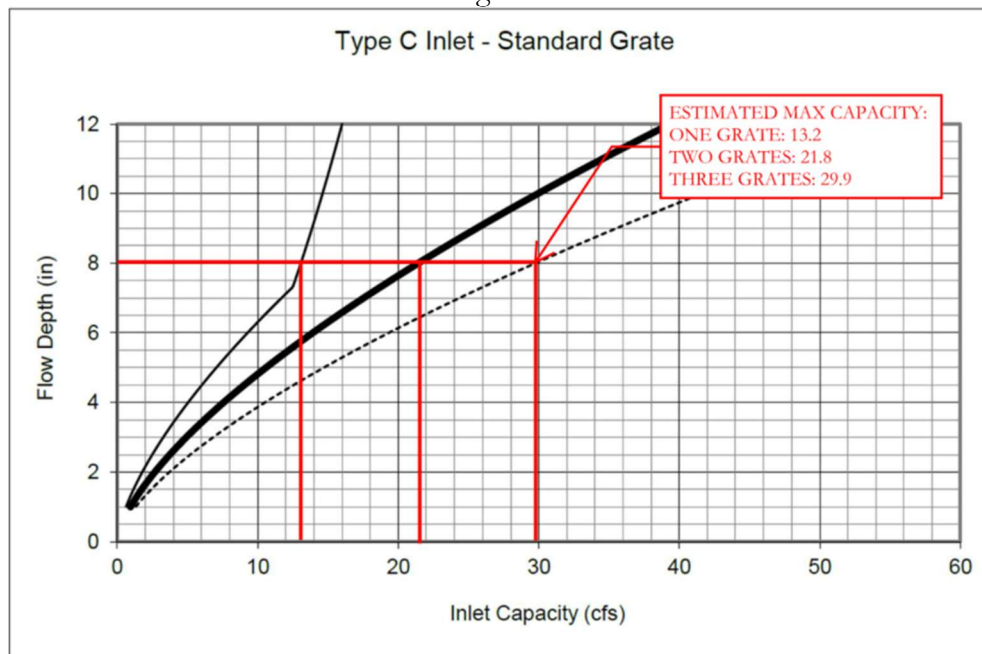
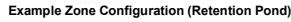


Figure 2

MHFD-Detention, Version 4.06 (July 2022)

Basin ID: SAND CREEK

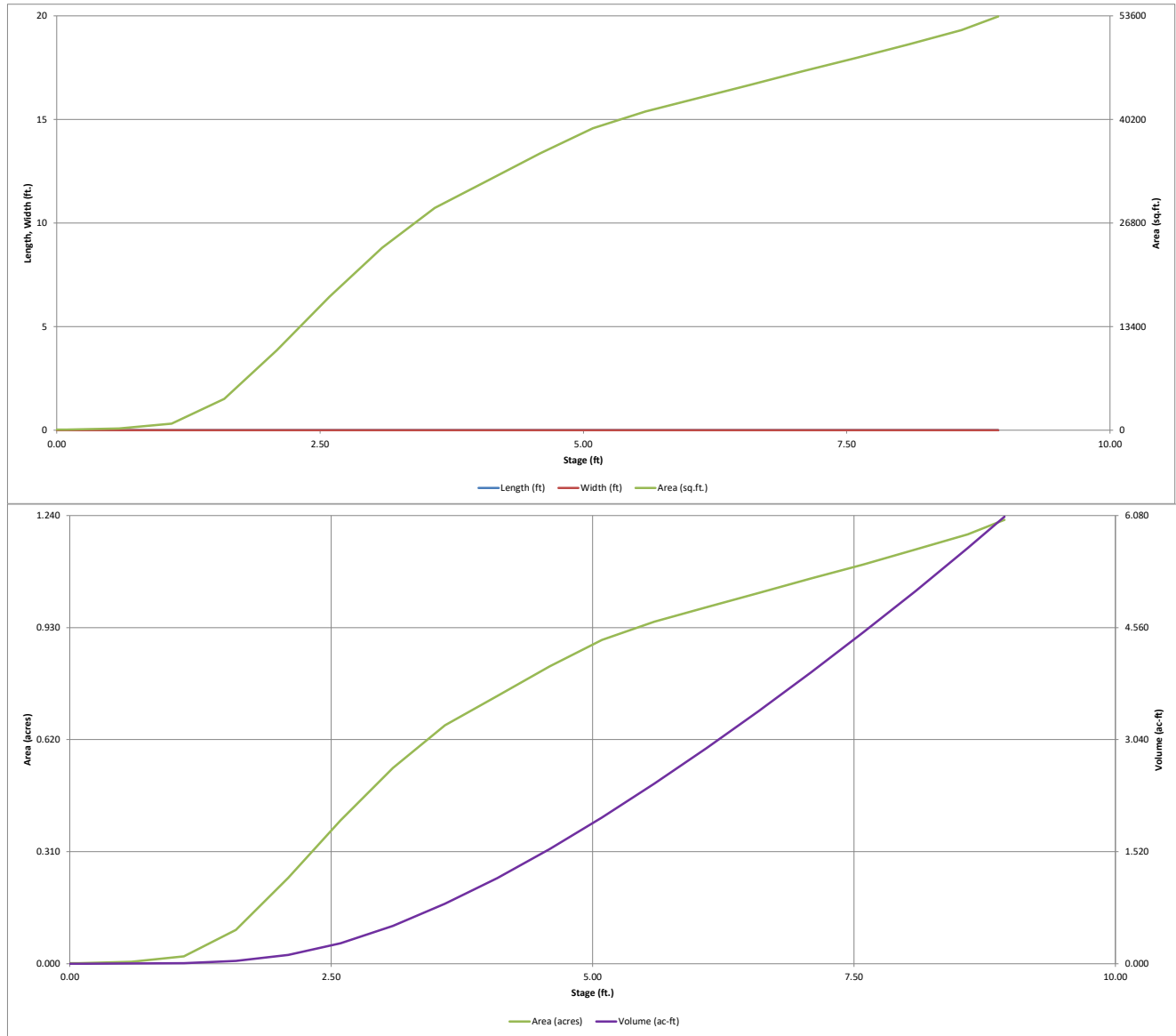
	acre-feet
	acre-feet
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

Initial Surcharge Area (A_{ISV})	=	user	ft ²
Surcharge Volume Length (L_{ISV})	=	user	ft
Surcharge Volume Width (W_{ISV})	=	user	ft
Depth of Basin Floor (H_{FLOOR})	=	user	ft
Length of Basin Floor (L_{FLOOR})	=	user	ft
Width of Basin Floor (W_{FLOOR})	=	user	ft
Area of Basin Floor (A_{FLOOR})	=	user	ft ²
Volume of Basin Floor (V_{FLOOR})	=	user	ft ³
Depth of Main Basin (H_{MAIN})	=	user	ft
Length of Main Basin (L_{MAIN})	=	user	ft
Width of Main Basin (W_{MAIN})	=	user	ft
Area of Main Basin (A_{MAIN})	=	user	ft ²
Volume of Main Basin (V_{MAIN})	=	user	ft ³
Calculated Total Basin Volume (V_{TOTAL})	=	user	acre-feet

[illegible]

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

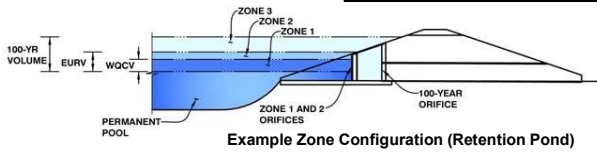


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **PETERSON AND MEADOWBROOK INTERIM CONDITION**

Basin ID: **SAND CREEK**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.15	0.133	Orifice Plate
Zone 2 (EURV)	2.41	0.076	Rectangular Orifice
Zone 3 (100-year)	3.88	0.797	Weir&Pipe (Restrict)
Total (all zones)		1.006	

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 = ft²
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)

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

Calculated Parameters for Plate

WQ Orifice Area per Row = ft²
Elliptical Half-Width = feet
Elliptical Slot Centroid = feet
Elliptical Slot Area = ft²

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							
Orifice Area (sq. inches)	0.93							

	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)

Zone 2 Rectangular ☐ Not Selected ☐
Invert of Vertical Orifice = ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice = ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height = inches
Vertical Orifice Width = inches

Calculated Parameters for Vertical Orifice

Zone 2 Rectangular Not Selected ft²
Vertical Orifice Area = ft²
Vertical Orifice Centroid = feet

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

Zone 3 Weir ☐ Not Selected ☐
Overflow Weir Front Edge Height, H_o = ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length = feet
Overflow Weir Grate Slope = H:V
Horiz. Length of Weir Sides = feet
Overflow Grate Type = ☐
Debris Clogging % = %

Calculated Parameters for Overflow Weir

Height of Grate Upper Edge, H_u = feet
Overflow Weir Slope Length = feet
Grate Open Area / 100-yr Orifice Area = ☐
Overflow Grate Open Area w/o Debris = ft²
Overflow Grate Open Area w/ Debris = ft²

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 = ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter = inches
Restrictor Plate Height Above Pipe Invert = inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Zone 3 Restrictor Not Selected ft²
Outlet Orifice Area = ft²
Outlet Orifice Centroid = feet
Half-Central Angle of Restrictor Plate on Pipe = radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage = ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length = feet
Spillway End Slopes = H:V
Freeboard above Max Water Surface = feet

Calculated Parameters for Spillway

Spillway Design Flow Depth = feet
Stage at Top of Freeboard = feet
Basin Area at Top of Freeboard = acres
Basin Volume at Top of Freeboard = acre-ft

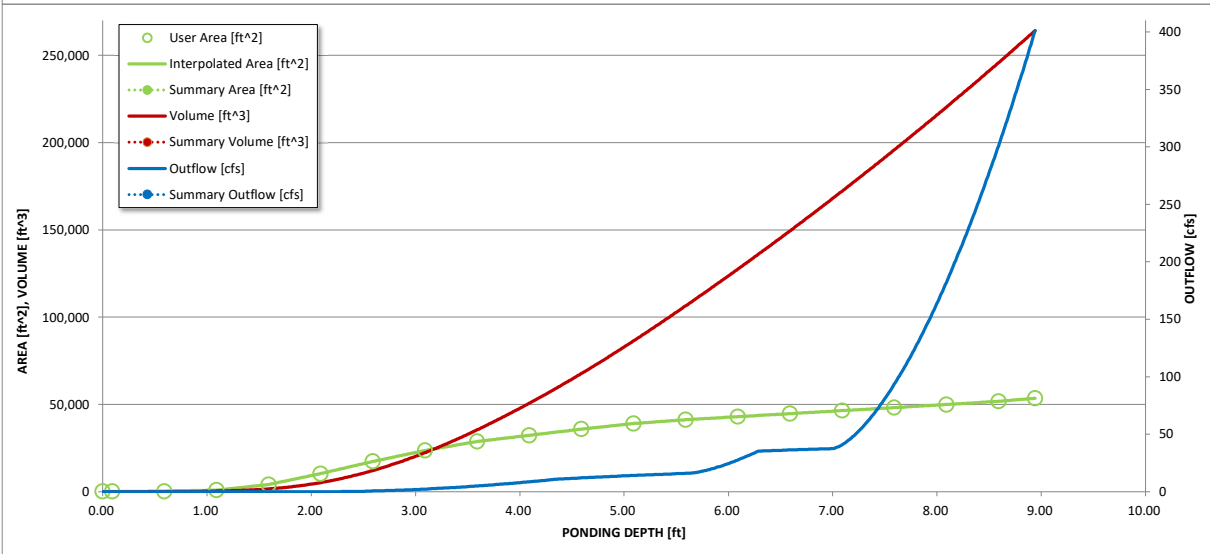
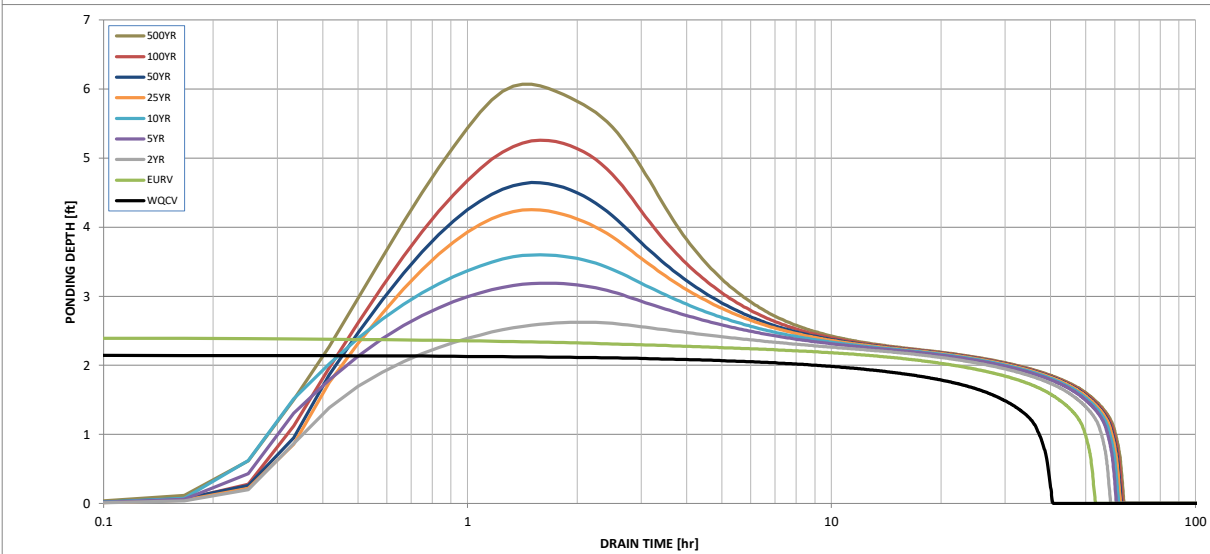
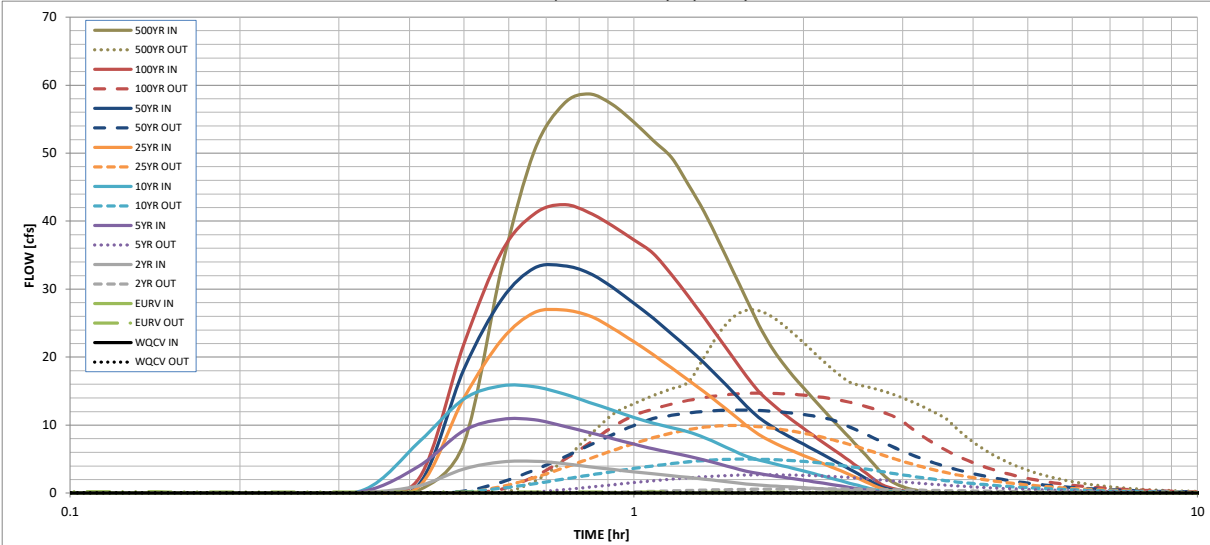
Routed Hydrograph Results

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	3.14
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.133	0.208	0.356	0.848	1.348	2.269	2.883	3.780	5.398
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.356	0.848	1.348	2.269	2.883	3.780	5.398
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	3.4	9.4	14.2	25.6	32.1	41.1	57.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.11	0.30	0.45	0.81	1.01	1.29	1.80
Peak Inflow Q (cfs) =	N/A	N/A	4.7	10.9	15.8	26.9	33.4	42.4	58.7
Peak Outflow Q (cfs) =	0.0	0.2	0.6	2.7	5.0	10.0	12.2	14.7	26.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.3	0.4	0.4	0.4	0.4	0.5
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.5
Max Velocity through Grate 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	50	54	51	47	40	35	28	16
Time to Drain 99% of Inflow Volume (hours) =	40	52	56	57	56	53	52	49	45
Maximum Ponding Depth (ft) =	2.15	2.40	2.63	3.19	3.60	4.26	4.65	5.26	6.07
Area at Maximum Ponding Depth (acres) =	0.26	0.34	0.41	0.57	0.66	0.77	0.83	0.91	0.98
Maximum Volume Stored (acre-ft) =	0.134	0.208	0.290	0.568	0.819	1.284	1.595	2.128	2.908

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

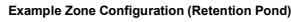
Outflow Hydrograph Workbook Filename:

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	0.00	0.00	0.01
	0:15:00	0.00	0.00	0.02	0.04	0.05	0.03	0.04	0.04	0.06
	0:20:00	0.00	0.00	0.09	0.29	0.54	0.09	0.11	0.13	0.50
	0:25:00	0.00	0.00	1.12	4.02	7.58	1.06	1.40	2.29	7.36
	0:30:00	0.00	0.00	3.57	9.19	13.87	13.99	18.21	21.97	33.20
	0:35:00	0.00	0.00	4.59	10.85	15.77	22.58	28.51	35.52	50.35
	0:40:00	0.00	0.00	4.70	10.79	15.64	26.55	33.09	41.08	57.22
	0:45:00	0.00	0.00	4.33	9.87	14.62	26.92	33.44	42.44	58.68
	0:50:00	0.00	0.00	3.86	8.91	13.36	26.09	32.37	41.27	57.14
	0:55:00	0.00	0.00	3.48	8.04	12.20	24.26	30.26	39.31	54.57
	1:00:00	0.00	0.00	3.13	7.20	11.12	22.26	27.93	37.24	51.85
	1:05:00	0.00	0.00	2.83	6.50	10.29	20.35	25.70	35.24	49.32
	1:10:00	0.00	0.00	2.56	5.96	9.64	18.41	23.43	32.14	45.40
	1:15:00	0.00	0.00	2.30	5.41	9.02	16.62	21.30	28.96	41.36
	1:20:00	0.00	0.00	2.06	4.85	8.17	14.88	19.11	25.79	36.96
	1:25:00	0.00	0.00	1.81	4.28	7.22	13.20	16.96	22.78	32.66
	1:30:00	0.00	0.00	1.57	3.73	6.26	11.57	14.87	19.95	28.59
	1:35:00	0.00	0.00	1.34	3.24	5.45	9.96	12.82	17.22	24.76
	1:40:00	0.00	0.00	1.18	2.87	4.87	8.62	11.13	14.96	21.63
	1:45:00	0.00	0.00	1.07	2.60	4.43	7.64	9.90	13.29	19.26
	1:50:00	0.00	0.00	0.98	2.36	4.03	6.85	8.89	11.89	17.26
	1:55:00	0.00	0.00	0.89	2.13	3.65	6.16	8.01	10.66	15.49
	2:00:00	0.00	0.00	0.80	1.91	3.27	5.54	7.20	9.54	13.87
	2:05:00	0.00	0.00	0.71	1.69	2.88	4.94	6.42	8.47	12.30
	2:10:00	0.00	0.00	0.62	1.47	2.50	4.36	5.66	7.46	10.82
	2:15:00	0.00	0.00	0.53	1.25	2.14	3.80	4.93	6.52	9.43
	2:20:00	0.00	0.00	0.45	1.04	1.79	3.25	4.22	5.61	8.10
	2:25:00	0.00	0.00	0.36	0.84	1.45	2.71	3.52	4.71	6.80
	2:30:00	0.00	0.00	0.28	0.63	1.13	2.17	2.84	3.82	5.52
	2:35:00	0.00	0.00	0.19	0.43	0.81	1.64	2.15	2.93	4.24
	2:40:00	0.00	0.00	0.11	0.25	0.53	1.11	1.48	2.05	3.00
	2:45:00	0.00	0.00	0.06	0.14	0.37	0.66	0.91	1.31	2.00
	2:50:00	0.00	0.00	0.04	0.10	0.28	0.41	0.59	0.86	1.37
	2:55:00	0.00	0.00	0.03	0.08	0.22	0.26	0.40	0.57	0.95
	3:00:00	0.00	0.00	0.02	0.06	0.17	0.16	0.27	0.37	0.65
	3:05:00	0.00	0.00	0.02	0.05	0.13	0.10	0.18	0.23	0.42
	3:10:00	0.00	0.00	0.01	0.04	0.10	0.07	0.12	0.13	0.26
	3:15:00	0.00	0.00	0.01	0.03	0.07	0.04	0.08	0.06	0.15
	3:20:00	0.00	0.00	0.01	0.02	0.05	0.03	0.05	0.03	0.09
	3:25:00	0.00	0.00	0.01	0.01	0.03	0.02	0.04	0.03	0.06
	3:30:00	0.00	0.00	0.00	0.01	0.02	0.01	0.03	0.02	0.05
	3:35:00	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.02	0.04
	3:40:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.03
	3:45:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	3:50:00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	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

MHFD-Detention, Version 4.06 (July 2022)

Basin ID: SAND CREEK

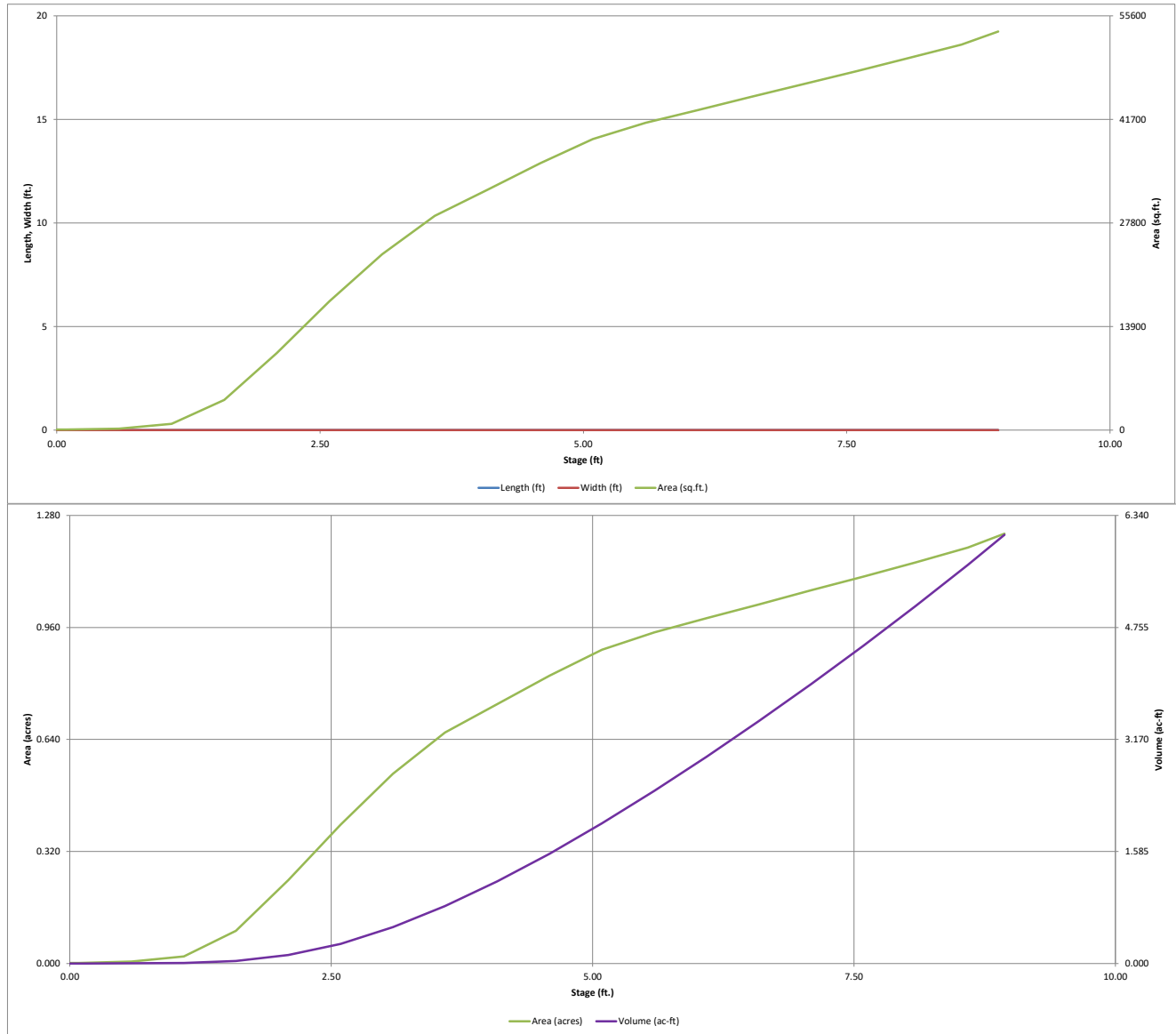
	acre-feet
	acre-feet
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

Initial Surcharge Area (A_{ISV})	=	user	ft ²
Surcharge Volume Length (L_{ISV})	=	user	ft
Surcharge Volume Width (W_{ISV})	=	user	ft
Depth of Basin Floor (H_{FLOOR})	=	user	ft
Length of Basin Floor (L_{FLOOR})	=	user	ft
Width of Basin Floor (W_{FLOOR})	=	user	ft
Area of Basin Floor (A_{FLOOR})	=	user	ft ²
Volume of Basin Floor (V_{FLOOR})	=	user	ft ³
Depth of Main Basin (H_{MAIN})	=	user	ft
Length of Main Basin (L_{MAIN})	=	user	ft
Width of Main Basin (W_{MAIN})	=	user	ft
Area of Main Basin (A_{MAIN})	=	user	ft ²
Volume of Main Basin (V_{MAIN})	=	user	ft ³
Calculated Total Basin Volume (V_{TOTAL})	=	user	acre-feet

[illegible]

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

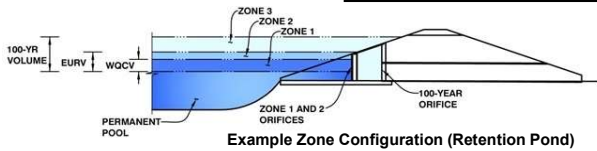


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **PETERSON AND MEADOWBROOK FUTURE CONDITIONS**

Basin ID: **SAND CREEK**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.53	0.767	Orifice Plate
Zone 2 (EURV)	5.72	1.792	Circular Orifice
Zone 3 (100-year)	7.12	1.420	Weir&Pipe (Restrict)
Total (all zones)		3.979	

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 ft²
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 = 3.45 ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing = N/A inches
Orifice Plate: Orifice Area per Row = 2.54 sq. inches (diameter = 1-13/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row = 1.764E-02 ft²
Elliptical Half-Width = N/A feet
Elliptical Slot Centroid = N/A feet
Elliptical Slot Area = N/A ft²

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	1.50	3.00					
Orifice Area (sq. inches)	2.54	2.54	2.54					

	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)

Invert of Vertical Orifice = 3.53 ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice = 5.57 ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter = 3.00 inches

Calculated Parameters for Vertical Orifice

Zone 2 Circular Not Selected
Vertical Orifice Area = 0.05 ft²
Vertical Orifice Centroid = 0.13 feet

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

Zone 3 Weir Not Selected
Overflow Weir Front Edge Height, H_o = 5.63 ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length = 5.00 feet
Overflow Weir Grate Slope = 0.00 H:V
Horiz. Length of Weir Sides = 5.00 feet
Overflow Grate Type = Type C Grate
Debris Clogging % = 50%

Calculated Parameters for Overflow Weir

Height of Grate Upper Edge, H_u = 5.63 feet
Overflow Weir Slope Length = 5.00 feet
Grate Open Area / 100-yr Orifice Area = 6.06
Overflow Grate Open Area w/o Debris = 17.40 ft²
Overflow Grate Open Area w/ Debris = 8.70 ft²

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

Depth to Invert of Outlet Pipe = 0.25 ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter = 30.00 inches
Restrictor Plate Height Above Pipe Invert = 17.00 inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Zone 3 Restrictor Not Selected
Outlet Orifice Area = 2.87 ft²
Outlet Orifice Centroid = 0.81 feet
Half-Central Angle of Restrictor Plate on Pipe = 1.70 radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage = 7.00 ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length = 38.00 feet
Spillway End Slopes = 4.00 H:V
Freeboard above Max Water Surface = 1.00 feet

Calculated Parameters for Spillway

Spillway Design Flow Depth = 0.95 feet
Stage at Top of Freeboard = 8.95 feet
Basin Area at Top of Freeboard = 1.23 acres
Basin Volume at Top of Freeboard = 6.07 acre-ft

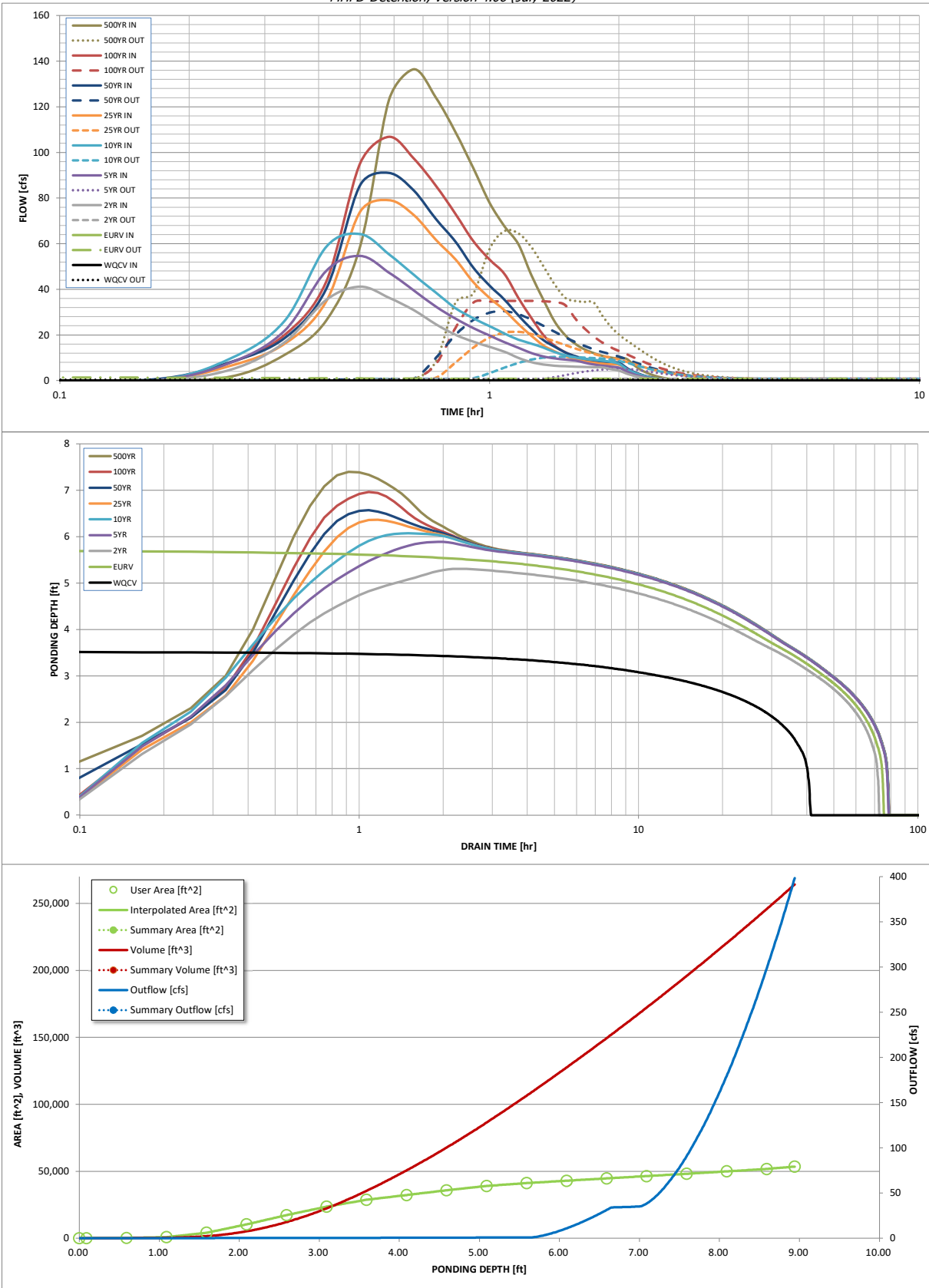
Routed Hydrograph Results

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	3.14
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.767	2.559	2.302	3.083	3.737	4.495	5.177	5.977	7.703
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.302	3.083	3.737	4.495	5.177	5.977	7.703
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	3.4	9.4	14.2	25.6	32.1	41.1	57.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.11	0.30	0.45	0.81	1.01	1.29	1.80
Peak Inflow Q (cfs) =	N/A	N/A	41.1	54.6	64.2	79.1	91.0	106.8	136.5
Peak Outflow Q (cfs) =	0.3	1.5	0.8	5.2	10.4	21.4	30.4	35.0	65.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.7	0.8	0.9	0.9	1.1
Structure Controlling Flow =	Plate	Overflow Weir 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.05	N/A	0.2	0.5	1.2	1.7	2.0	2.0
Max Velocity through Grate 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	68	65	70	68	67	66	64	62
Time to Drain 99% of Inflow Volume (hours) =	40	72	70	74	74	73	73	72	71
Maximum Ponding Depth (ft) =	3.52	5.72	5.31	5.89	6.07	6.37	6.57	6.96	7.40
Area at Maximum Ponding Depth (acres) =	0.64	0.96	0.92	0.97	0.98	1.01	1.02	1.06	1.09
Maximum Volume Stored (acre-ft) =	0.767	2.568	2.174	2.732	2.908	3.196	3.410	3.815	4.277

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)



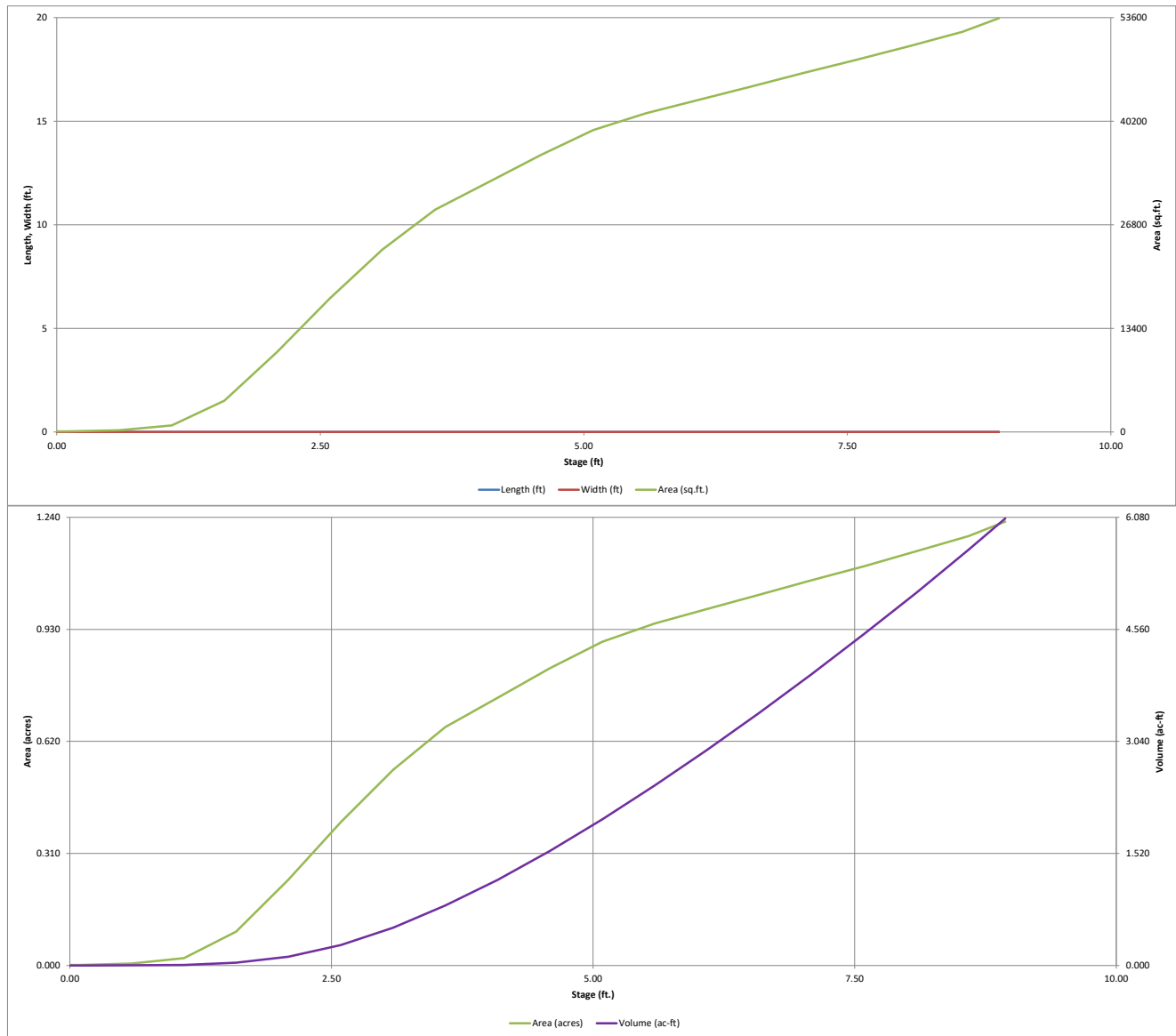
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

Example Zone Configuration (Retention Pond)

8/11/2026, 2:05 PM

CALCULATIONS FOR TEMPORARY SEDIMENT BASIN



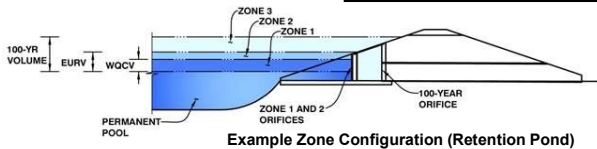
CALCULATIONS FOR TEMPORARY SEDIMENT BASIN

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **PETERSON AND MEADOWBROOK TSB**

Basin ID: **SAND CREEK**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.90	0.079	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		0.079	

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 = ft²
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)

Centroid of Lowest Orifice = 1.25 ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate = 3.00 ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing = N/A inches
Orifice Plate: Orifice Area per Row = 2.76 sq. inches (diameter = 1-7/8 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row = 1.917E-02 ft²
Elliptical Half-Width = N/A feet
Elliptical Slot Centroid = N/A feet
Elliptical Slot Area = N/A ft²

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)	1.25	1.58	1.91	2.25	2.58			
Orifice Area (sq. inches)	2.76	2.76	2.76	2.76	2.76			

	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)

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 = ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter = inches

Calculated Parameters for Vertical Orifice

Vertical Orifice Area = ft²
Vertical Orifice Centroid = feet

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

Overflow Weir Front Edge Height, H_o = Not Selected Not Selected ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length = feet
Overflow Weir Grate Slope = H:V
Horiz. Length of Weir Sides = feet
Overflow Grate Type =
Debris Clogging % = %

Calculated Parameters for Overflow Weir

Height of Grate Upper Edge, H_u = feet
Overflow Weir Slope Length = feet
Grate Open Area / 100-yr Orifice Area =
Overflow Grate Open Area w/o Debris = ft²
Overflow Grate Open Area w/ Debris = ft²

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

Depth to Invert of Outlet Pipe = Not Selected Not Selected ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter = inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Outlet Orifice Area = ft²
Outlet Orifice Centroid = feet
Half-Central Angle of Restrictor Plate on Pipe = N/A N/A radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage = ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length = feet
Spillway End Slopes = H:V
Freeboard above Max Water Surface = feet

Calculated Parameters for Spillway

Spillway Design Flow Depth = feet
Stage at Top of Freeboard = feet
Basin Area at Top of Freeboard = acres
Basin Volume at Top of Freeboard = acre-ft

Routed Hydrograph Results

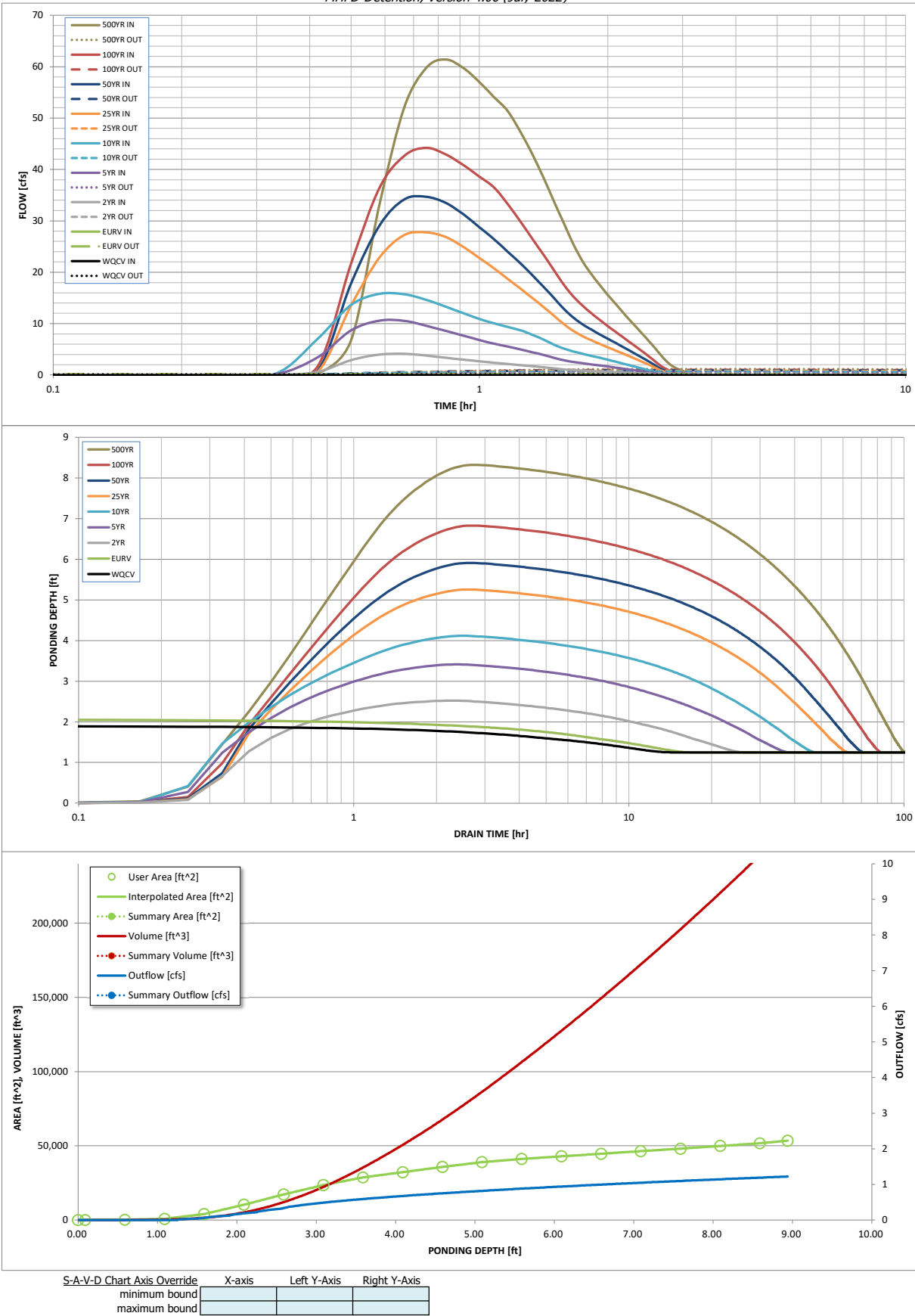
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	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	3.14
One-Hour Rainfall Depth (in) =	N/A	N/A	0.295	0.786	1.297	2.275	2.911	3.858	5.541
CUHP Runoff Volume (acre-ft) =	0.079	0.112	0.295	0.786	1.297	2.275	2.911	3.858	5.541
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	3.6	10.0	15.2	27.3	34.2	43.7	60.9
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	0.11	0.30	0.46	0.82	1.03	1.32	1.83
Peak Inflow Q (cfs) =	N/A	N/A	4.1	10.6	15.8	27.7	34.7	44.2	61.4
Peak Outflow Q (cfs) =	0.1	0.2	0.3	0.6	0.7	0.8	0.9	1.0	1.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.0	0.0	0.0	0.0	0.0
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 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) =	>120	>120	>120	33	38	50	57	66	81
Time to Drain 99% of Inflow Volume (hours) =	>120	>120	>120	>120	>120	57	64	74	90
Maximum Ponding Depth (ft) =	1.90	2.06	2.52	3.41	4.12	5.26	5.91	6.83	8.32
Area at Maximum Ponding Depth (acres) =	0.18	0.23	0.37	0.62	0.74	0.91	0.97	1.05	1.17
Maximum Volume Stored (acre-ft) =	0.079	0.112	0.251	0.698	1.178	2.128	2.751	3.679	5.325

CALCULATIONS FOR TEMPORARY SEDIMENT BASIN

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)



CALCULATIONS FOR TEMPORARY SEDIMENT BASIN

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.

Time Interval	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
	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	0.00	0.00	0.00
	0:15:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	0:20:00	0.00	0.00	0.03	0.15	0.29	0.03	0.03	0.06	0.26
	0:25:00	0.00	0.00	0.62	3.41	7.01	0.58	0.77	1.64	6.75
	0:30:00	0.00	0.00	2.91	8.69	13.63	13.55	17.81	21.67	33.32
	0:35:00	0.00	0.00	3.99	10.58	15.79	22.90	29.14	36.47	52.10
	0:40:00	0.00	0.00	4.12	10.55	15.69	27.26	34.18	42.67	59.75
	0:45:00	0.00	0.00	3.80	9.60	14.63	27.75	34.67	44.20	61.41
	0:50:00	0.00	0.00	3.35	8.58	13.29	26.85	33.50	42.94	59.75
	0:55:00	0.00	0.00	2.99	7.68	12.06	24.92	31.27	40.85	56.99
	1:00:00	0.00	0.00	2.66	6.81	10.91	22.77	28.76	38.61	54.04
	1:05:00	0.00	0.00	2.38	6.09	10.04	20.73	26.38	36.46	51.33
	1:10:00	0.00	0.00	2.14	5.53	9.35	18.68	23.97	33.21	47.21
	1:15:00	0.00	0.00	1.92	4.98	8.69	16.77	21.69	29.80	42.87
	1:20:00	0.00	0.00	1.70	4.43	7.82	14.94	19.37	26.45	38.19
	1:25:00	0.00	0.00	1.49	3.87	6.85	13.18	17.09	23.27	33.61
	1:30:00	0.00	0.00	1.28	3.32	5.88	11.48	14.90	20.28	29.27
	1:35:00	0.00	0.00	1.08	2.86	5.10	9.81	12.75	17.41	25.22
	1:40:00	0.00	0.00	0.95	2.54	4.55	8.50	11.08	15.13	22.02
	1:45:00	0.00	0.00	0.86	2.29	4.11	7.53	9.84	13.43	19.57
	1:50:00	0.00	0.00	0.78	2.08	3.72	6.74	8.81	11.99	17.48
	1:55:00	0.00	0.00	0.71	1.87	3.35	6.04	7.90	10.71	15.62
	2:00:00	0.00	0.00	0.63	1.66	2.98	5.41	7.07	9.54	13.92
	2:05:00	0.00	0.00	0.56	1.46	2.61	4.81	6.28	8.44	12.29
	2:10:00	0.00	0.00	0.48	1.26	2.25	4.22	5.51	7.40	10.76
	2:15:00	0.00	0.00	0.41	1.06	1.90	3.65	4.77	6.43	9.33
	2:20:00	0.00	0.00	0.34	0.87	1.57	3.10	4.04	5.49	7.95
	2:25:00	0.00	0.00	0.26	0.67	1.24	2.54	3.33	4.56	6.59
	2:30:00	0.00	0.00	0.19	0.48	0.92	1.99	2.62	3.62	5.24
	2:35:00	0.00	0.00	0.12	0.29	0.61	1.44	1.91	2.69	3.90
	2:40:00	0.00	0.00	0.06	0.15	0.39	0.90	1.22	1.77	2.65
	2:45:00	0.00	0.00	0.03	0.08	0.27	0.52	0.75	1.13	1.76
	2:50:00	0.00	0.00	0.01	0.05	0.20	0.31	0.48	0.74	1.20
	2:55:00	0.00	0.00	0.01	0.04	0.15	0.19	0.31	0.48	0.81
	3:00:00	0.00	0.00	0.01	0.03	0.12	0.11	0.19	0.29	0.53
	3:05:00	0.00	0.00	0.01	0.02	0.09	0.07	0.12	0.17	0.33
	3:10:00	0.00	0.00	0.00	0.02	0.06	0.04	0.07	0.08	0.18
	3:15:00	0.00	0.00	0.00	0.01	0.04	0.02	0.04	0.03	0.09
	3:20:00	0.00	0.00	0.00	0.01	0.03	0.01	0.03	0.02	0.05
	3:25:00	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.01	0.03
	3:30:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	3:35:00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.02
	3:40:00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	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

Figure 13-12b. Emergency Spillway Profile at Embankment

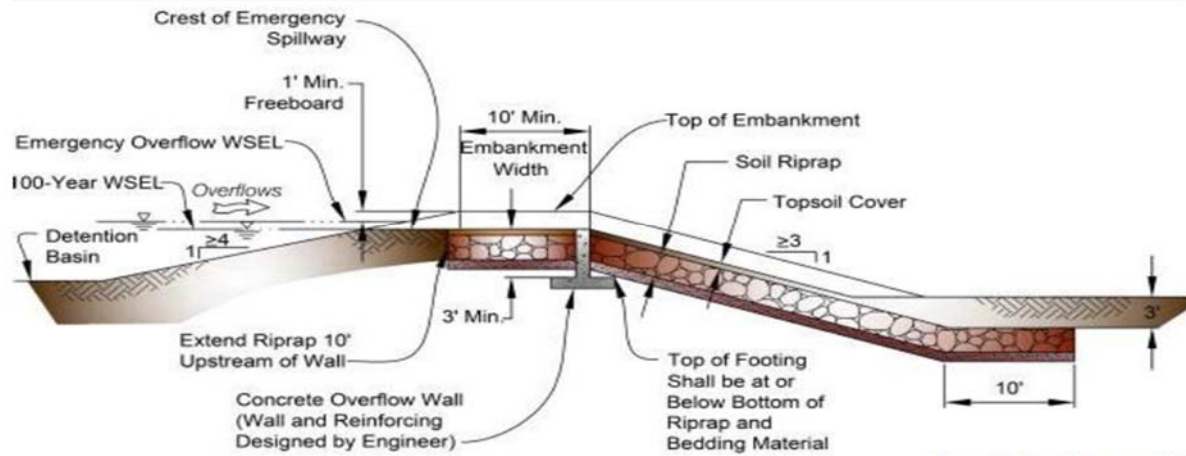
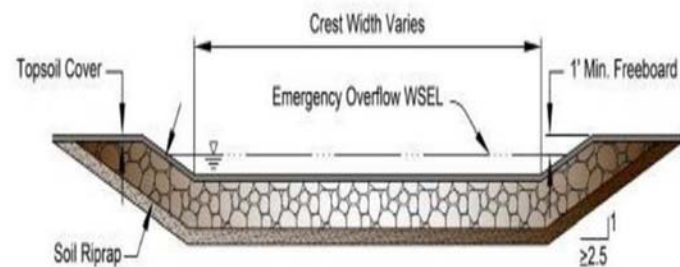


Figure 13-12c. Emergency Spillway Protection



Q=106.8 CFS
LENGTH=38 Feet
UNIT FLOW RATE: 2.81 CFS/FT

=> TYPE L RIP RAP

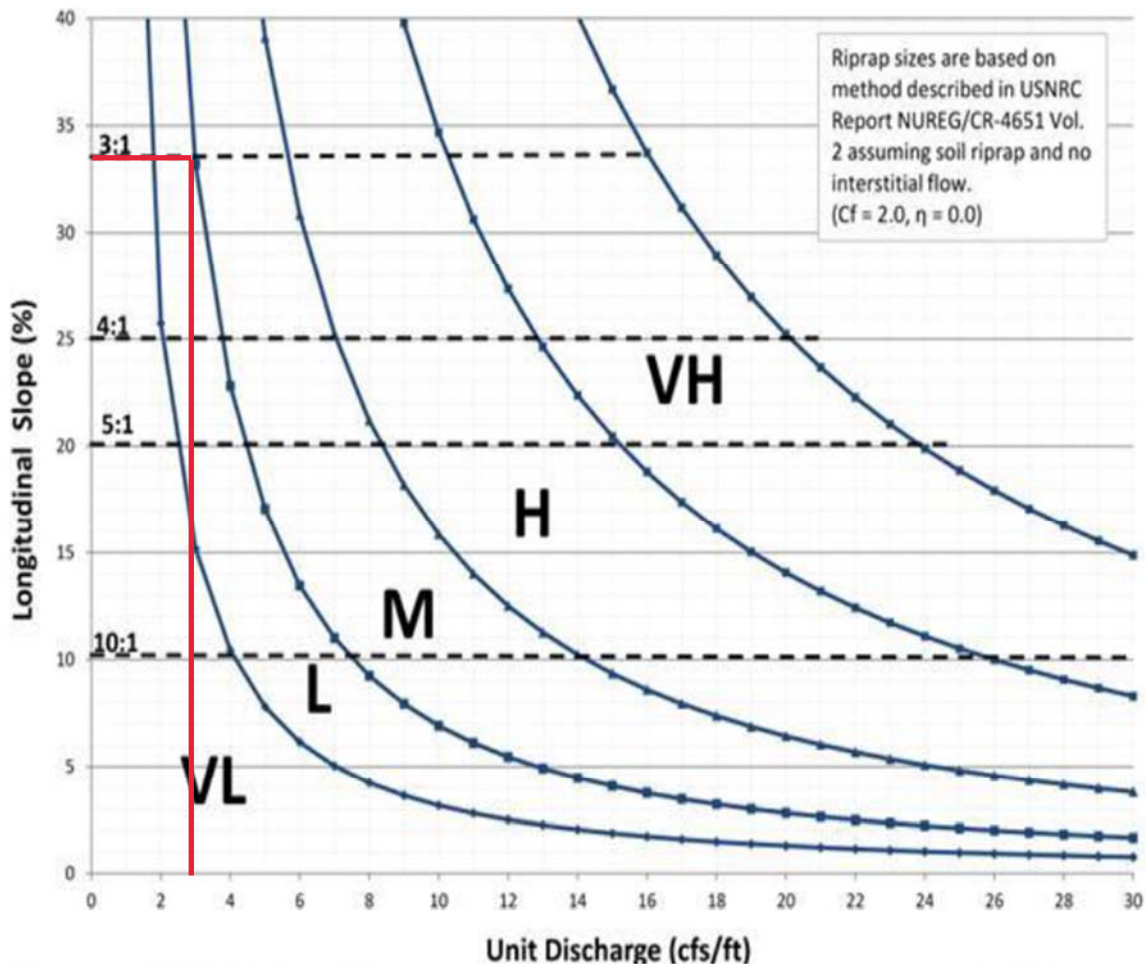


Figure 13-12d. Riprap Types for Emergency Spillway Protection

Channel Report

Trickle Channel

Rectangular

Bottom Width (ft) = 3.00
Total Depth (ft) = 0.50

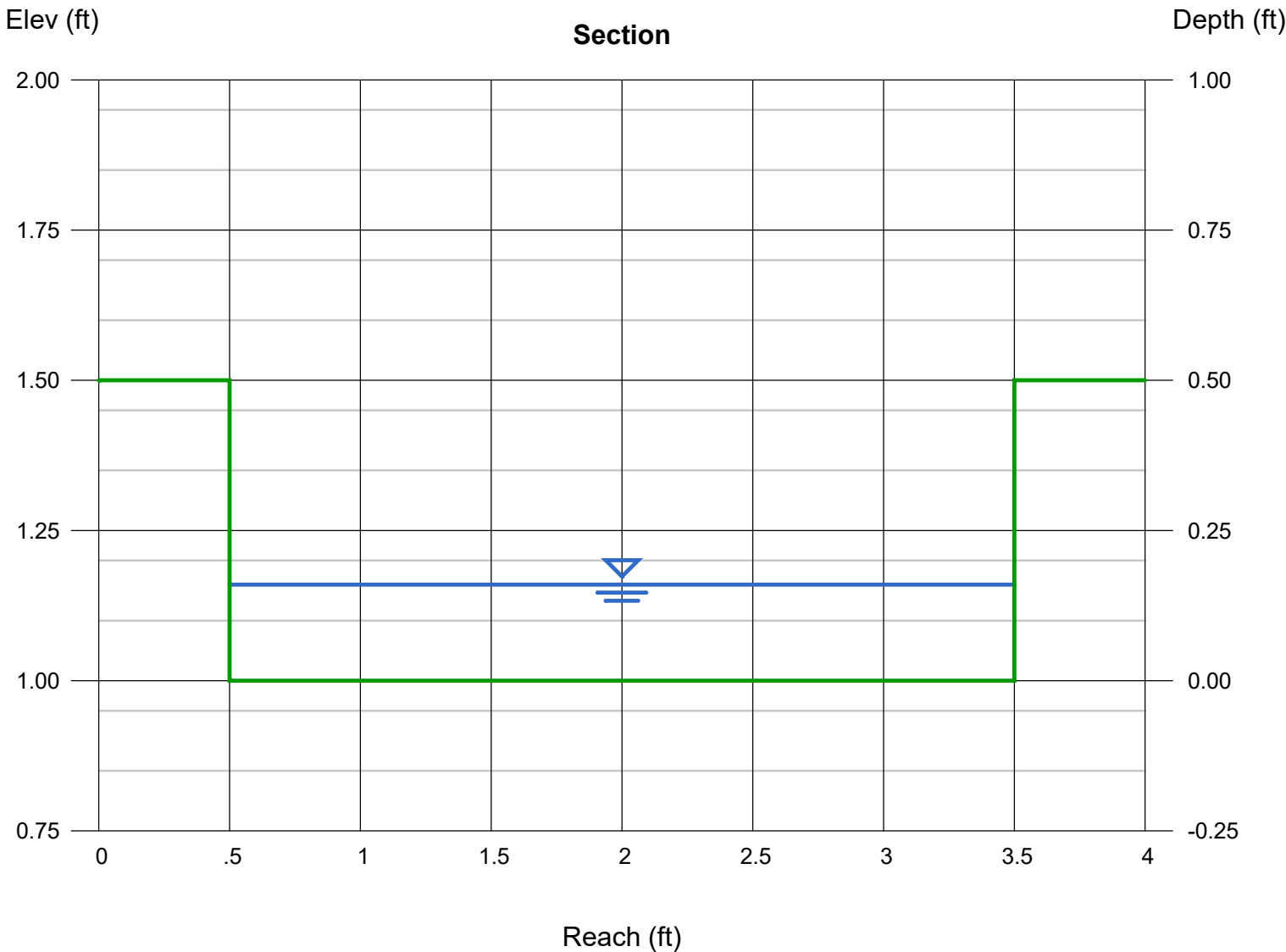
Invert Elev (ft) = 1.00
Slope (%) = 0.50
N-Value = 0.013

Calculations

Compute by: Known Q
Known Q (cfs) = 1.00

Highlighted

Depth (ft) = 0.16
Q (cfs) = 1.000
Area (sqft) = 0.48
Velocity (ft/s) = 2.08
Wetted Perim (ft) = 3.32
Crit Depth, Yc (ft) = 0.16
Top Width (ft) = 3.00
EGL (ft) = 0.23



Design Point	Total Water Quality Control Volume (Cu. Ft.)	Pond Name	Pond Drainage Area (Acres)	Pond Drainage Area Less Pond Footprint (Acres)	Forebay Location	Drainage area tributary to Forebay	Proportion of Total Drainage Area	Proportional WQCV Volume (Cu. Ft.)	Forebay Volume 3% of WQCV (Cu. Ft.)	Q100 to Forebay (cfs)	Forebay Outlet Sizing 2% of Q100 (cfs)	Forebay Slot Sizing (inches)	Forebay Depth (ft)
5	33976.8	Pond 1	31.71	29.88	SOUTH	14.90	0.50	16942.31	508	49.5	1.0	6.66	1.5

Table EDB-4. EDB component criteria

	On-Site EDBs for Watersheds up to 1 Impervious Acre ¹	EDBs with Watersheds between 1 and 2 Impervious Acres ¹	EDBs with Watersheds up to 5 Impervious Acres	EDBs with Watersheds over 5 Impervious Acres	EDBs with Watersheds over 20 Impervious Acres
Forebay Release and Configuration		Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe ² configuration
Minimum Forebay Volume	EDBs should not be used for watersheds with less than 1 impervious acre.	1% of the WQCV	2% of the WQCV	3% of the WQCV	3% of the WQCV
Maximum Forebay Depth		12 inches	18 inches	18 inches	30 inches
Trickle Channel Capacity		≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity	≥ the maximum possible forebay outlet capacity
Micropool		Area ≥ 10 ft ²	Area ≥ 10 ft ²	Area ≥ 10 ft ²	Area ≥ 10 ft ²
Initial Surge Volume		Depth ≥ 4 inches	Depth ≥ 4 inches	Depth ≥ 4 in. Volume ≥ 0.3% WQCV	Depth ≥ 4 in. Volume ≥ 0.3% WQCV

¹ EDBs are not recommended for sites with less than 2 impervious acres. Consider a sand filter or rain garden.

² Round up to the first standard pipe size (minimum 8 inches).

EDB Pond	WQCV 0.780	Acre-Ft	Pond Footprint 1.83	Acres
Percent of WQCV for Forebay	3%	Between 5 and 20 impervious acres		
Impervious Percentage	74.52%			
Impervious Acres	23.6	Acres		
ISV	102	SQ FT		

FOREBAY SLOT: WEIR SIZING EQUATION:

The Francis Formula - Imperial Units

Flow through a rectangular weir can be expressed in imperial units with the Francis formula

$$q = 3.33 (b - 0.2 h) h^{3/2} \quad (1b)$$

where

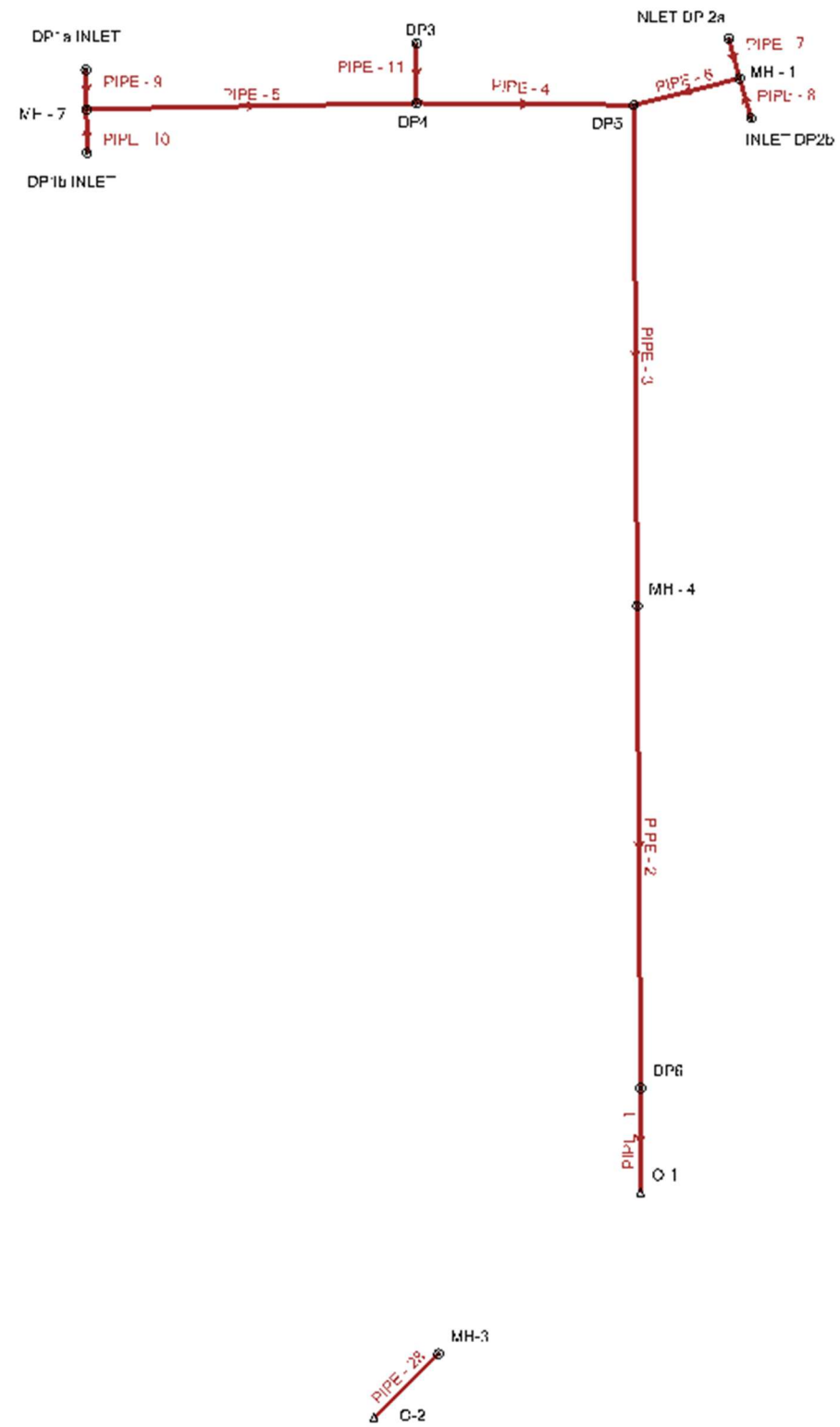
q = flow rate (ft³/s)

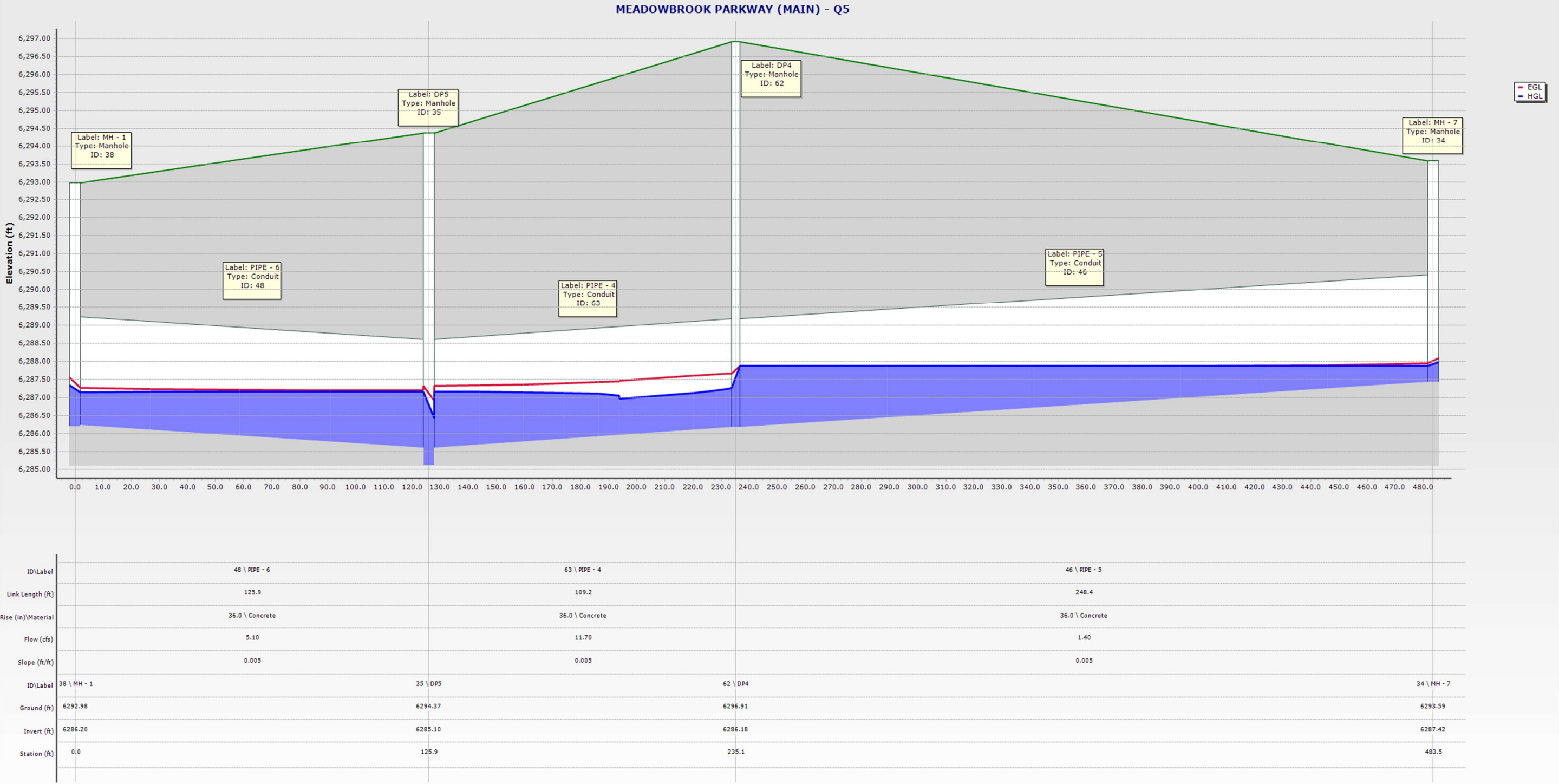
h = head on the weir (ft)

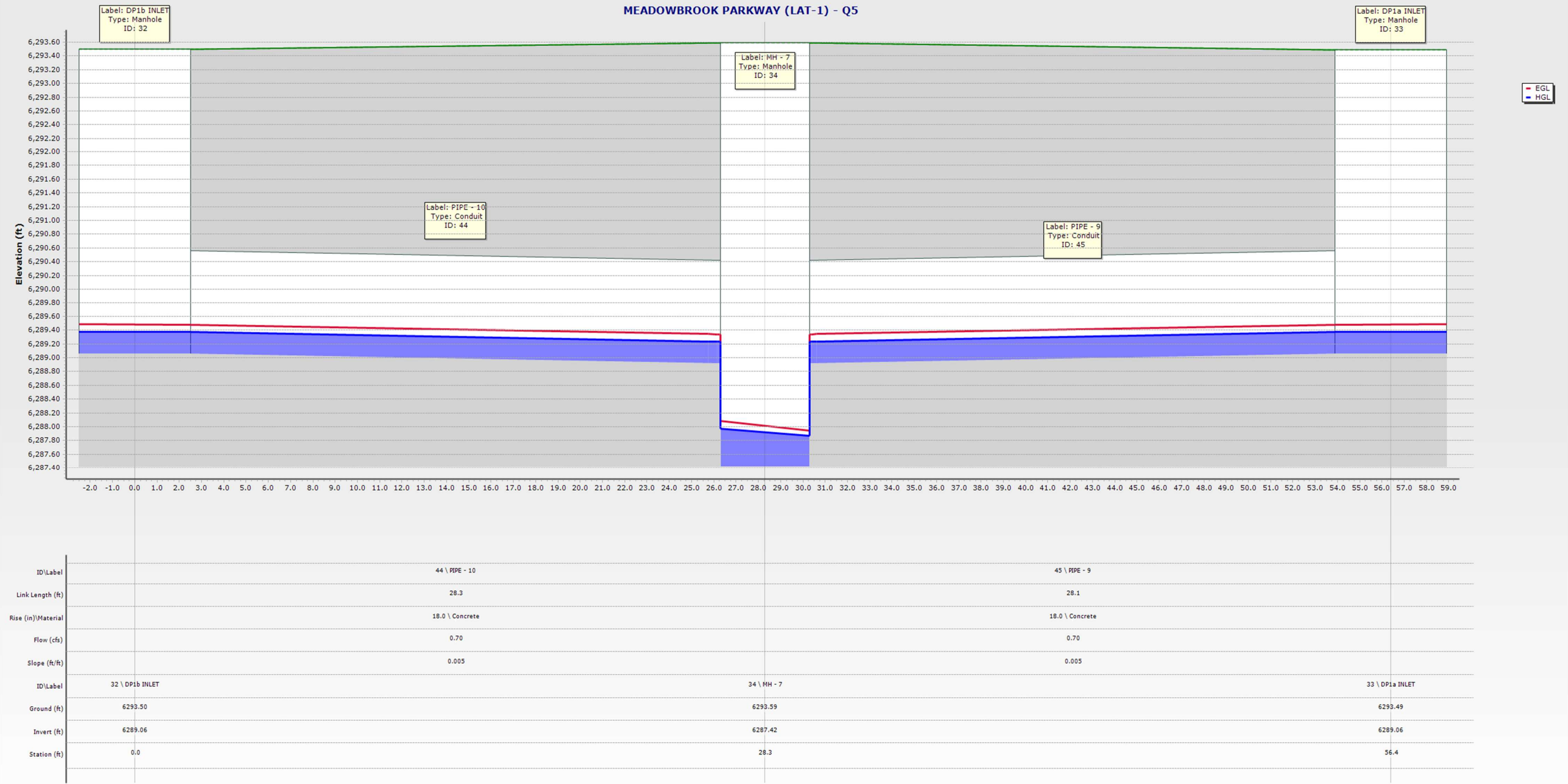
b = width of the weir (ft)

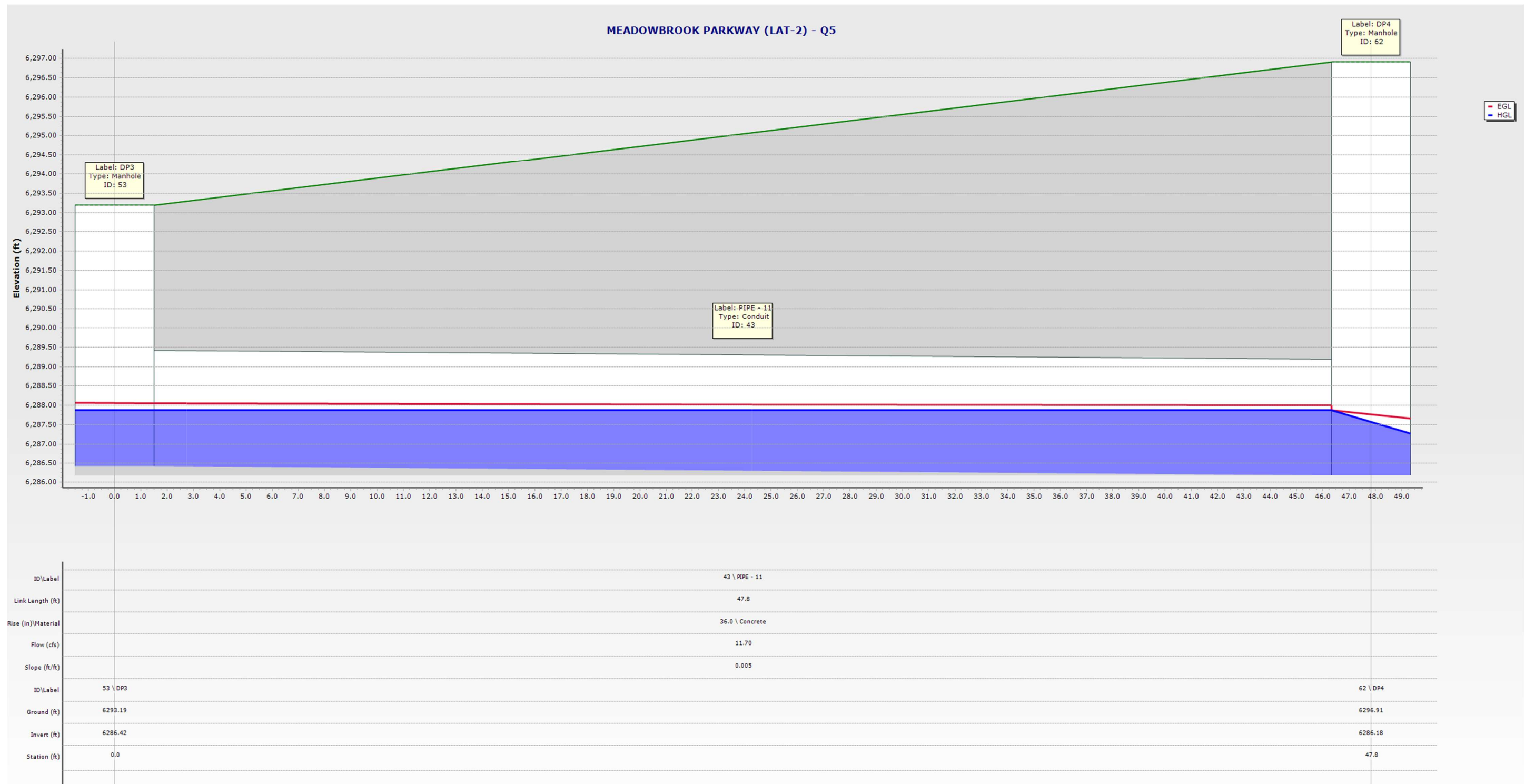
MINIMUM SLOT WIDTH = 3"

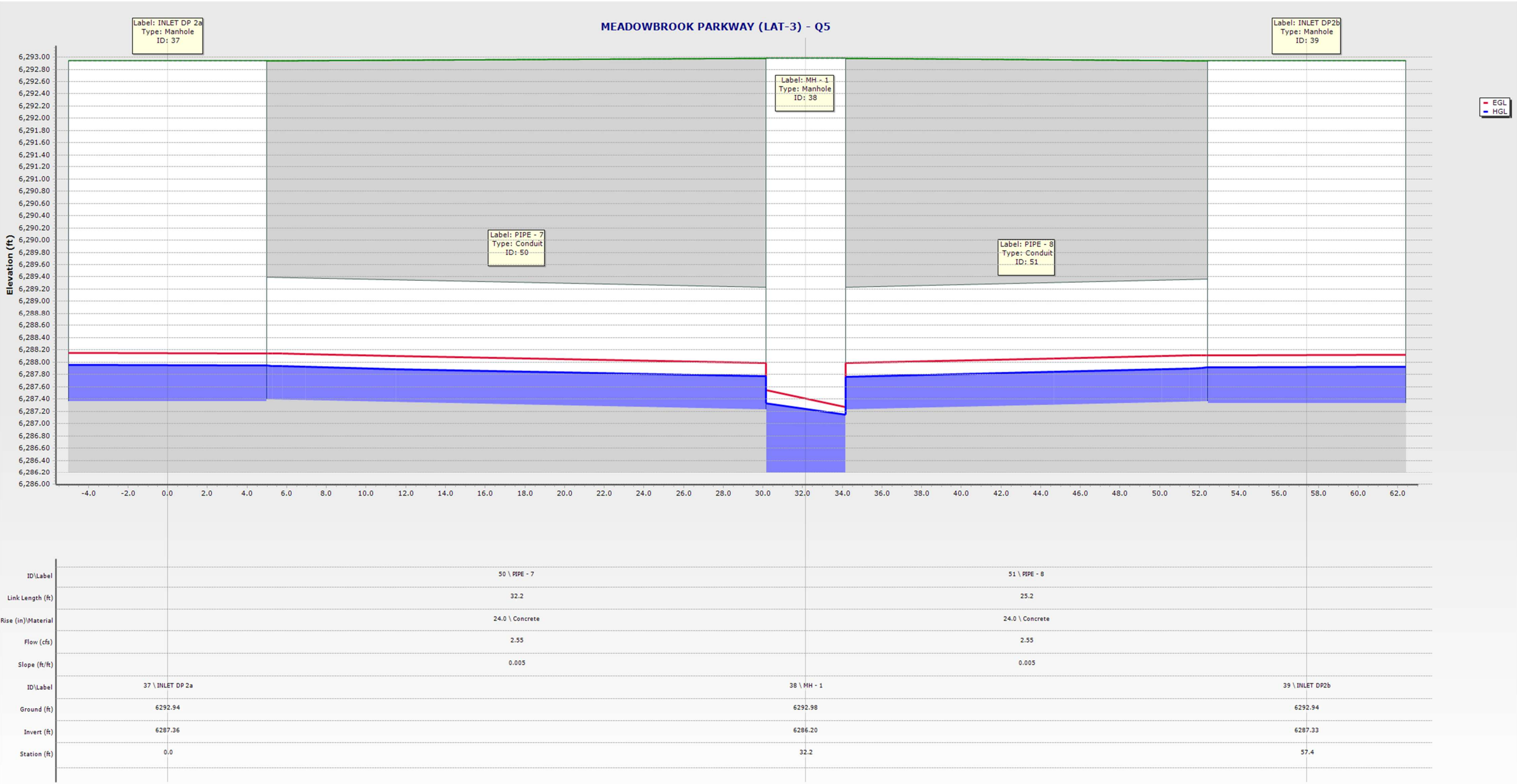
STORMCAD LAYOUT
NTS

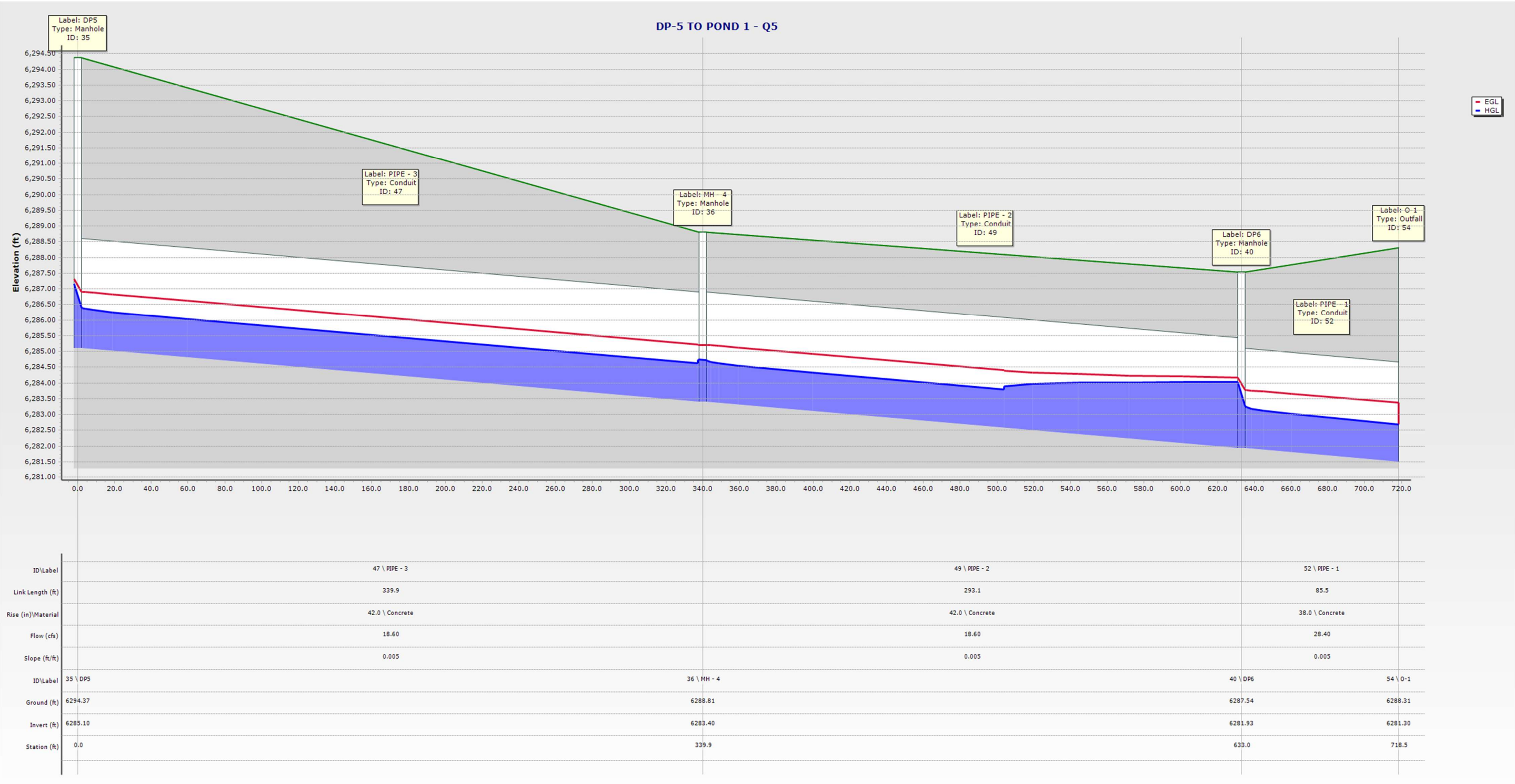


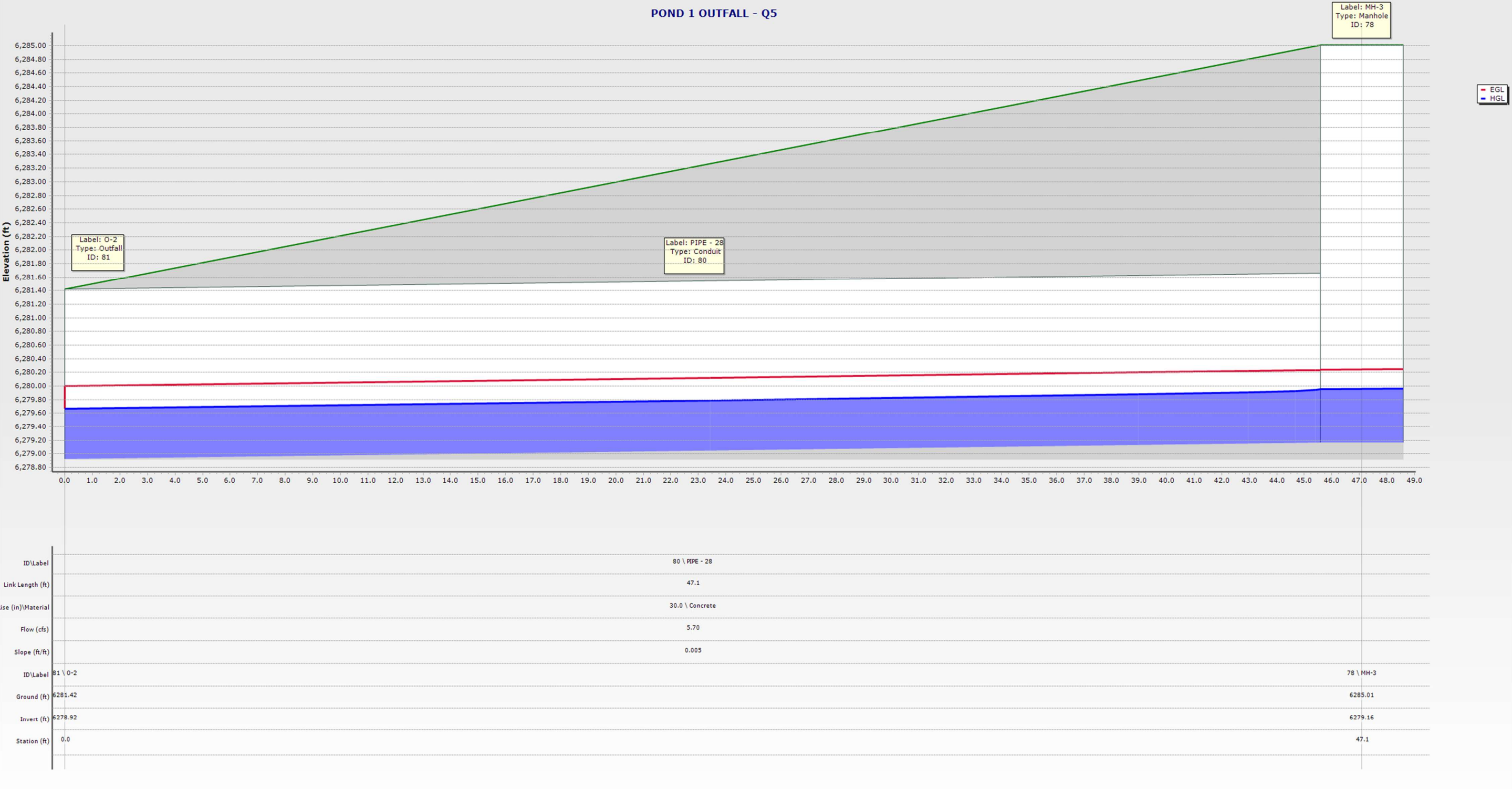












	Label ▲	Flow (cfs)	Velocity (ft/s)	Start Node	Invert (Start) (ft)	Elevation Ground (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Stop) (ft)	Elevation Ground (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Stop Node	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Manning's n	Diameter (in)	Flow / Capacity (Design) (%)	Material	Capacity (Full Flow) (cfs)
52: PIPE - 1	PIPE - 1	28.40	6.64	DP6	6,281.93	6,287.54	6,283.27	6,281.50	6,288.31	6,282.69	O-1	85.5	0.005	0.013		28.9	Concrete	98.23
49: PIPE - 2	PIPE - 2	18.60	6.23	MH - 4	6,283.40	6,288.81	6,284.72	6,281.93	6,287.54	6,284.03	DP6	293.1	0.005	0.013	42.0	26.1	Concrete	71.25
47: PIPE - 3	PIPE - 3	18.60	6.22	DP5	6,285.10	6,294.35	6,286.42	6,283.40	6,288.81	6,284.74	MH - 4	339.9	0.005	0.013	42.0	26.1	Concrete	71.15
63: PIPE - 4	PIPE - 4	11.70	5.66	DP4	6,286.18	6,296.91	6,287.27	6,285.60	6,294.35	6,287.16	DP5	109.2	0.005	0.013	36.0	24.1	Concrete	48.60
46: PIPE - 5	PIPE - 5	1.40	2.97	MH - 7	6,287.42	6,293.59	6,287.87	6,286.18	6,296.91	6,287.87	DP4	248.4	0.005	0.013	36.0	3.0	Concrete	47.13
48: PIPE - 6	PIPE - 6	5.10	4.37	MH - 1	6,286.23	6,293.30	6,287.14	6,285.60	6,294.35	6,287.16	DP5	125.9	0.005	0.013	36.0	10.8	Concrete	47.18
50: PIPE - 7	PIPE - 7	2.55	3.72	INLET DP 2a	6,287.39	6,293.30	6,287.95	6,287.23	6,293.30	6,287.77	MH - 1	32.2	0.005	0.013	24.0	16.0	Concrete	15.96
51: PIPE - 8	PIPE - 8	2.55	3.77	INLET DP2b	6,287.36	6,293.30	6,287.92	6,287.23	6,293.30	6,287.77	MH - 1	25.2	0.005	0.013	24.0	15.7	Concrete	16.23
45: PIPE - 9	PIPE - 9	0.70	2.64	DP1a INLET	6,289.06	6,293.49	6,289.37	6,288.92	6,293.59	6,289.23	MH - 7	28.1	0.005	0.013	18.0	9.4	Concrete	7.41
44: PIPE - 10	PIPE - 10	0.70	2.63	DP1b INLET	6,289.06	6,293.50	6,289.37	6,288.92	6,293.59	6,289.23	MH - 7	28.3	0.005	0.013	18.0	9.5	Concrete	7.39
43: PIPE - 11	PIPE - 11	11.70	5.54	DP3	6,286.42	6,293.19	6,287.86	6,286.18	6,296.91	6,287.87	DP4	47.8	0.005	0.013	36.0	24.8	Concrete	47.24
80: PIPE - 28	PIPE - 28	5.70	4.62	MH-3	6,279.16	6,285.01	6,279.95	6,278.92	6,281.42	6,279.67	O-2	47.1	0.005	0.013	30.0	19.5	Concrete	29.28

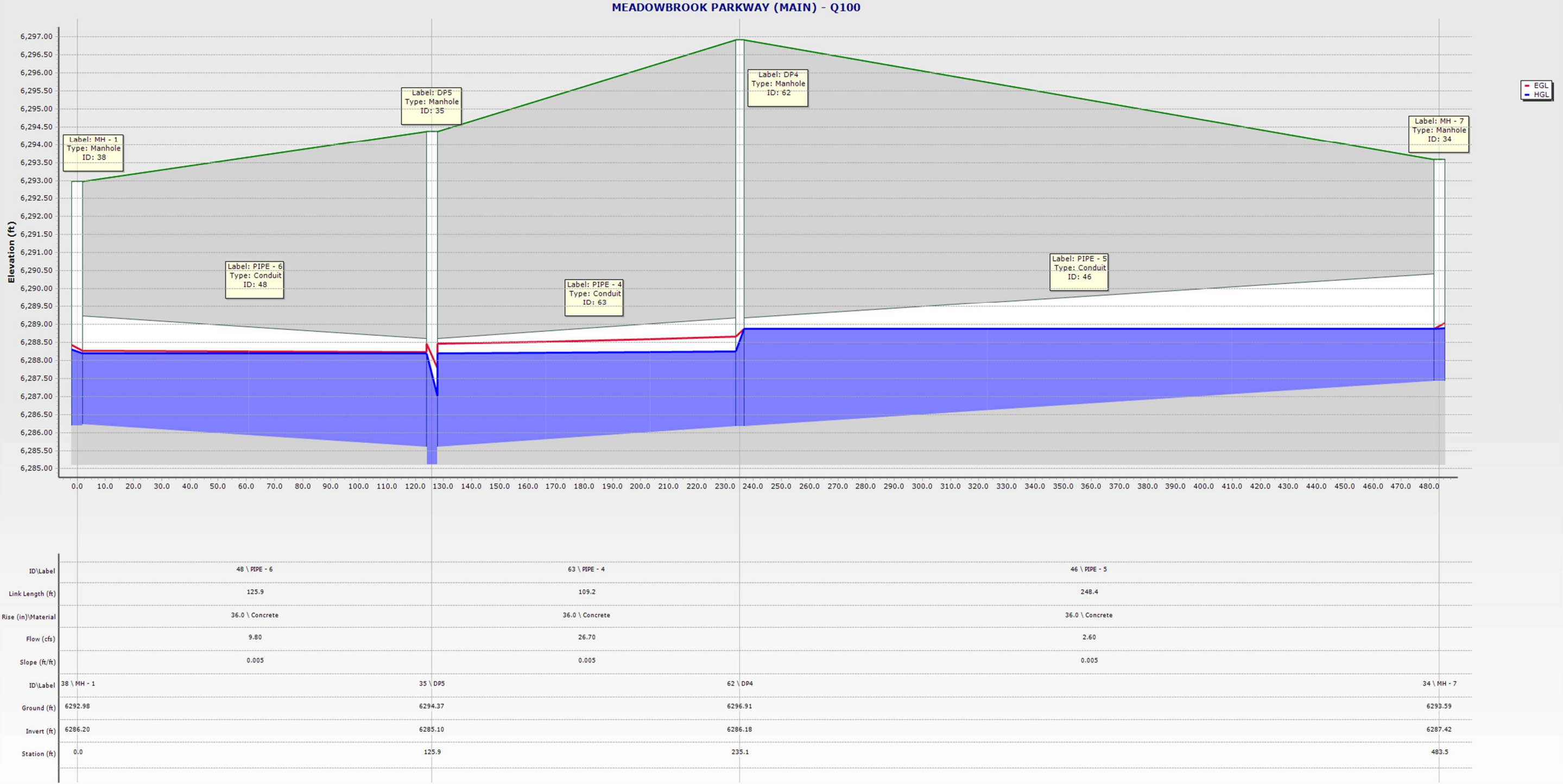
Figure 1- Q5 – Free Outfall CONDUIT SUMMARY

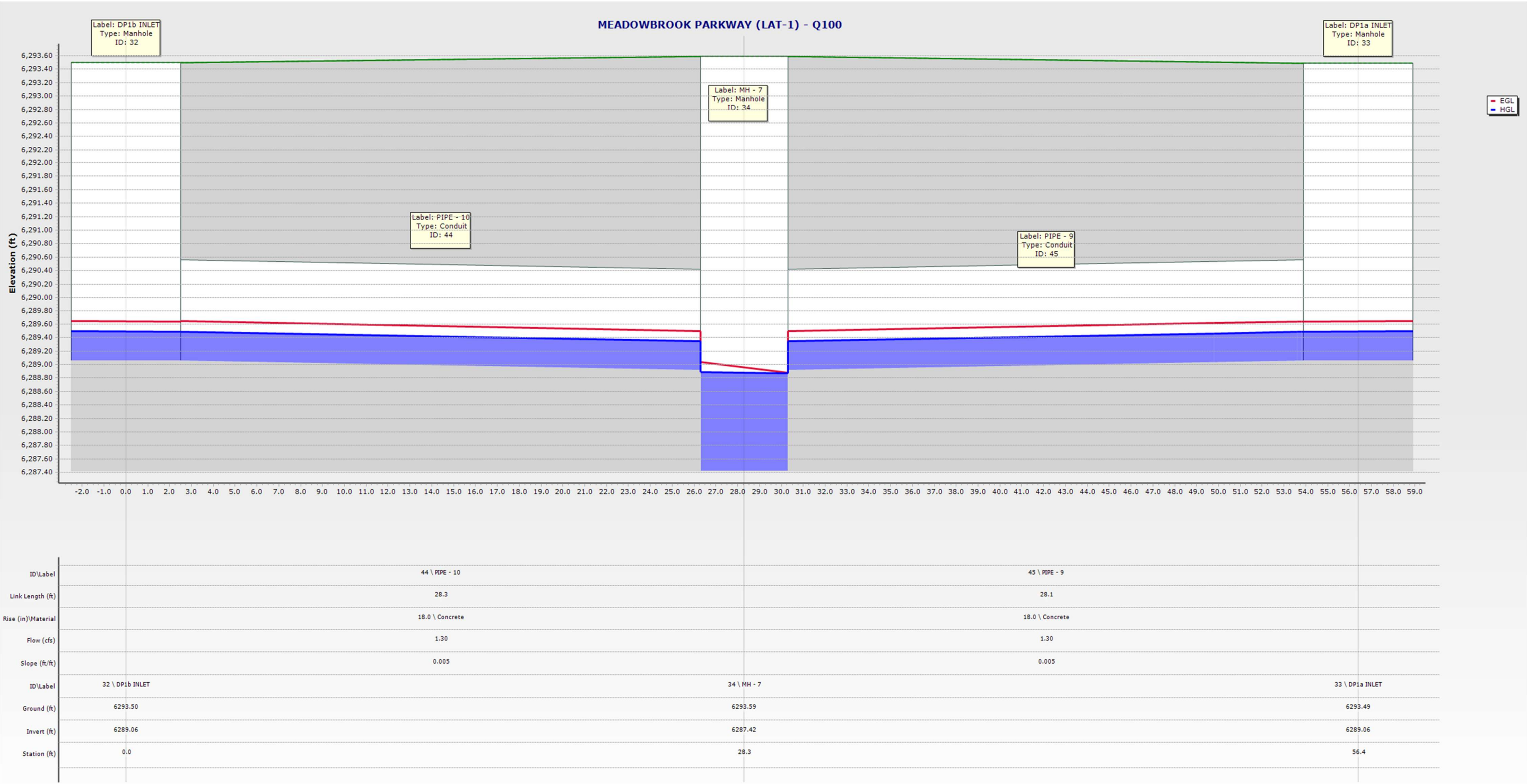
	Label ▲	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert in 1) (ft)	Elevation (Invert in 2) (ft)	Elevation (Invert in 3) (ft)	Elevation (Invert Out) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Headloss Coefficient (Standard)	Flow (Total Out) (cfs)	Headloss (ft)	Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)
33: DP1a INLET	DP1a INLET	6,293.49	6,293.49	(N/A)	(N/A)	(N/A)	6,289.06	6,289.38	6,289.37	Standard	0.050	0.70	0.01	6,289.49	6,289.48
32: DP1b INLET	DP1b INLET	6,293.50	6,293.50	(N/A)	(N/A)	(N/A)	6,289.06	6,289.38	6,289.37	Standard	0.050	0.70	0.01	6,289.49	6,289.48
53: DP3	DP3	6,293.19	6,293.19	(N/A)	(N/A)	(N/A)	6,286.42	6,287.87	6,287.86	Standard	0.050	11.70	0.01	6,288.06	6,288.05
62: DP4	DP4	6,296.91	6,296.91	6,286.18	6,286.18	(N/A)	6,286.18	6,287.87	6,287.27	Standard	1.520	11.70	0.61	6,287.87	6,287.67
35: DP5	DP5	6,294.35	6,294.35	6,285.60	6,285.60	(N/A)	6,285.10	6,287.16	6,286.42	Standard	1.520	18.60	0.74	6,287.32	6,286.91
40: DP6	DP6	6,287.54	6,287.54	6,281.93	(N/A)	(N/A)	6,281.93	6,284.03	6,283.27	Standard	1.520	28.40	0.77	6,284.18	6,283.77
37: INLET DP 2a	INLET DP 2a	6,293.30	6,293.30	(N/A)	(N/A)	(N/A)	6,287.39	6,287.96	6,287.95	Standard	0.050	2.55	0.01	6,288.15	6,288.14
39: INLET DP2b	INLET DP2b	6,293.30	6,293.30	(N/A)	(N/A)	(N/A)	6,287.36	6,287.93	6,287.92	Standard	0.050	2.55	0.01	6,288.12	6,288.11
38: MH - 1	MH - 1	6,293.30	6,293.30	6,287.23	6,287.23	(N/A)	6,286.23	6,287.33	6,287.14	Standard	1.520	5.10	0.19	6,287.55	6,287.26
36: MH - 4	MH - 4	6,288.81	6,288.81	6,283.40	(N/A)	(N/A)	6,283.40	6,284.74	6,284.72	Standard	0.050	18.60	0.02	6,285.21	6,285.21
34: MH - 7	MH - 7	6,293.59	6,293.59	6,288.92	6,288.92	(N/A)	6,287.42	6,287.98	6,287.87	Standard	1.520	1.40	0.10	6,288.08	6,287.94
78: MH-3	MH-3	6,285.01	6,285.01	(N/A)	(N/A)	(N/A)	6,279.16	6,279.96	6,279.95	Standard	0.050	5.70	0.01	6,280.25	6,280.24

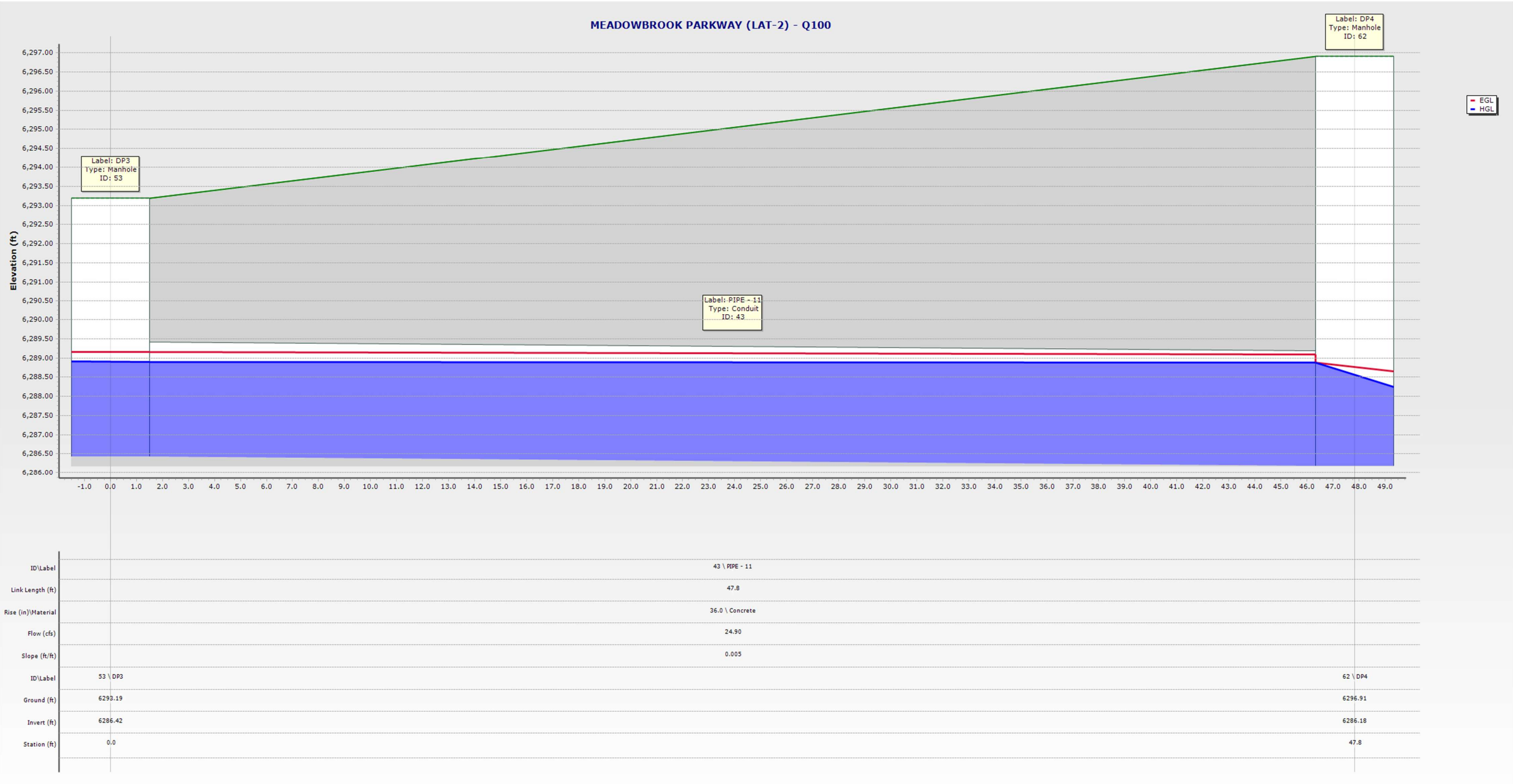
Figure 2- Q5 – Free Outfall NODE SUMMARY

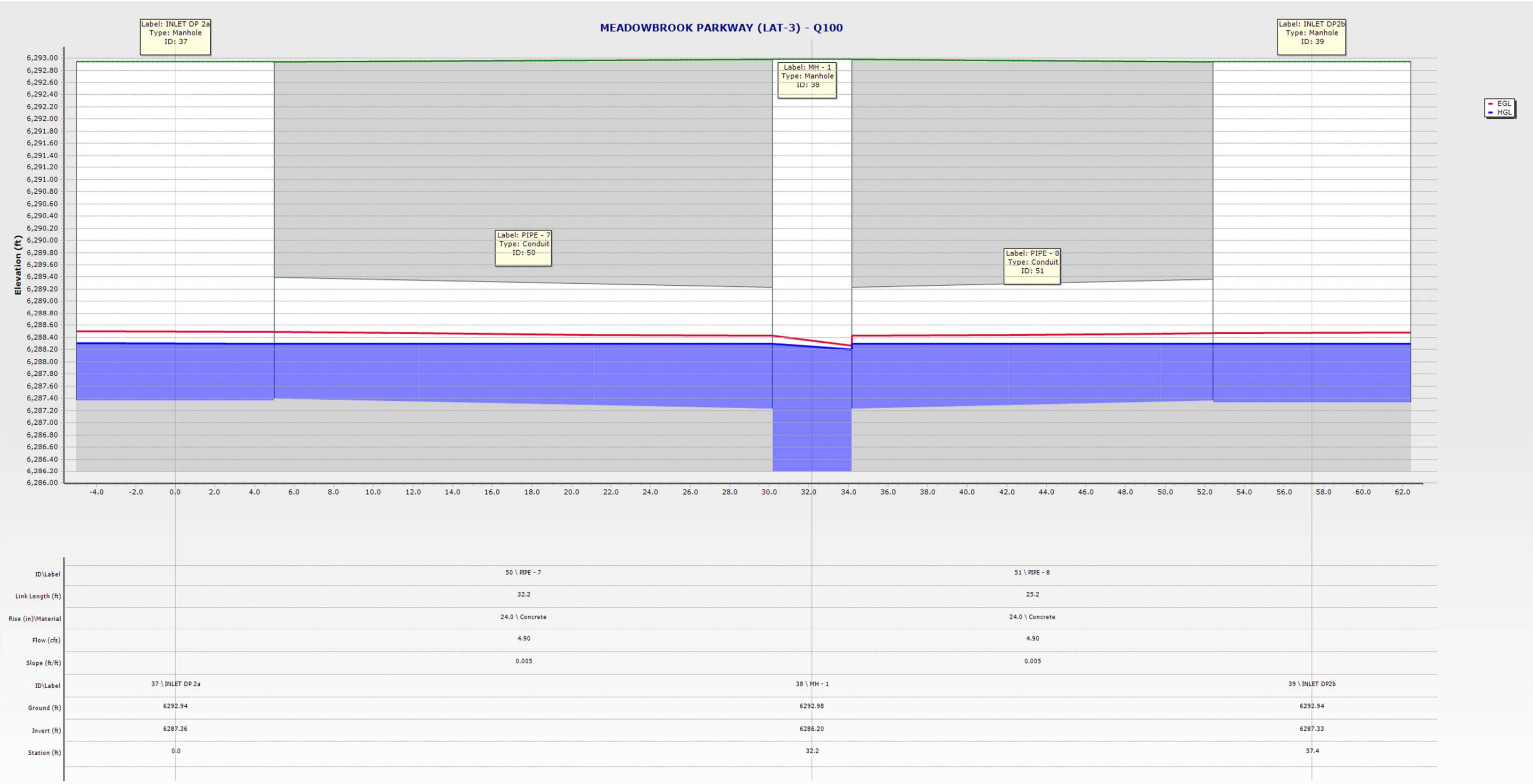
	Label ▲	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
54: O-1	O-1	6,288.31	6,281.30	Free Outfall		6,282.69	28.40
81: O-2	O-2	6,281.42	6,278.92	Free Outfall		6,279.67	5.70

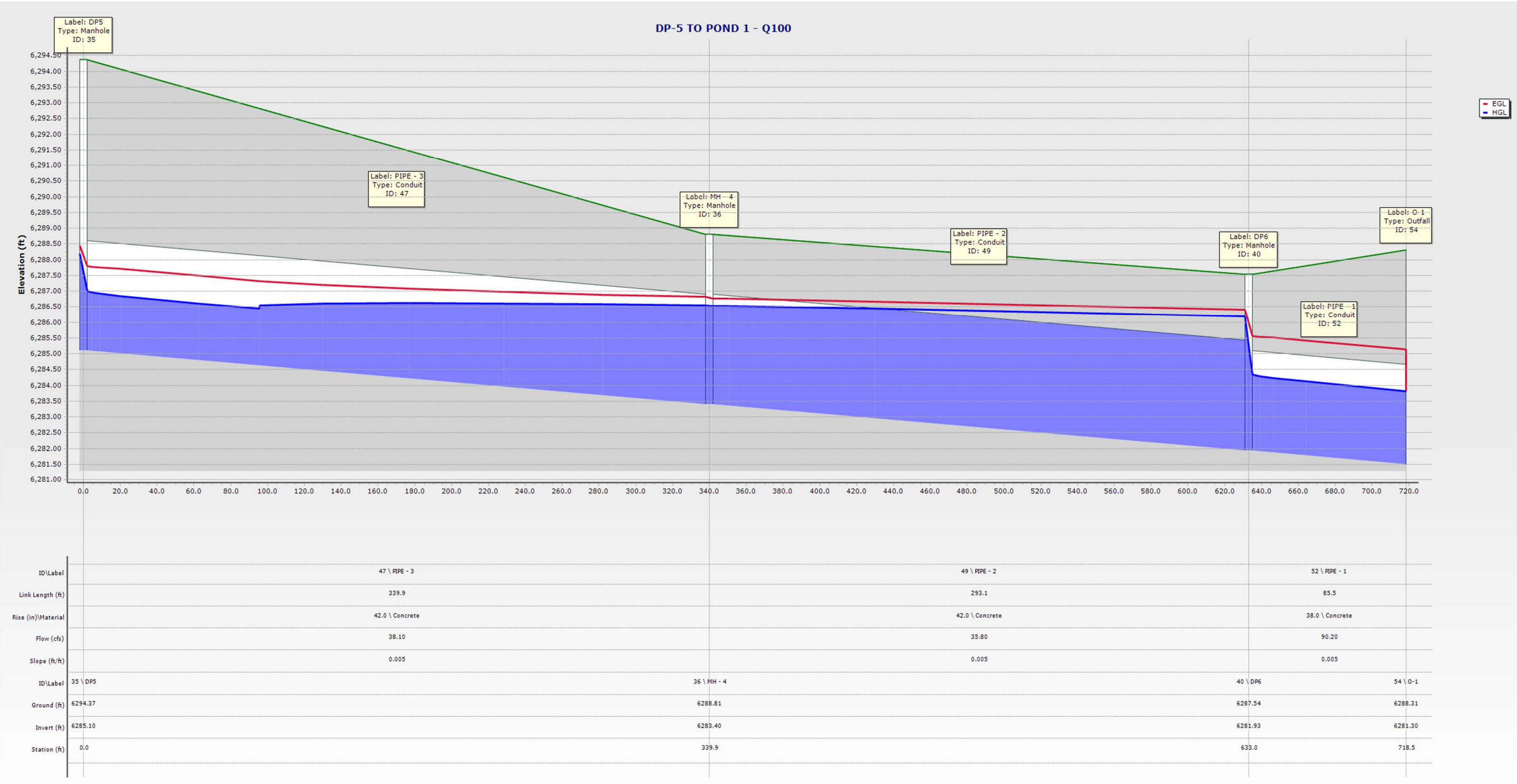
Figure 3- Q5 – Free Outfall OUTFALL SUMMARY

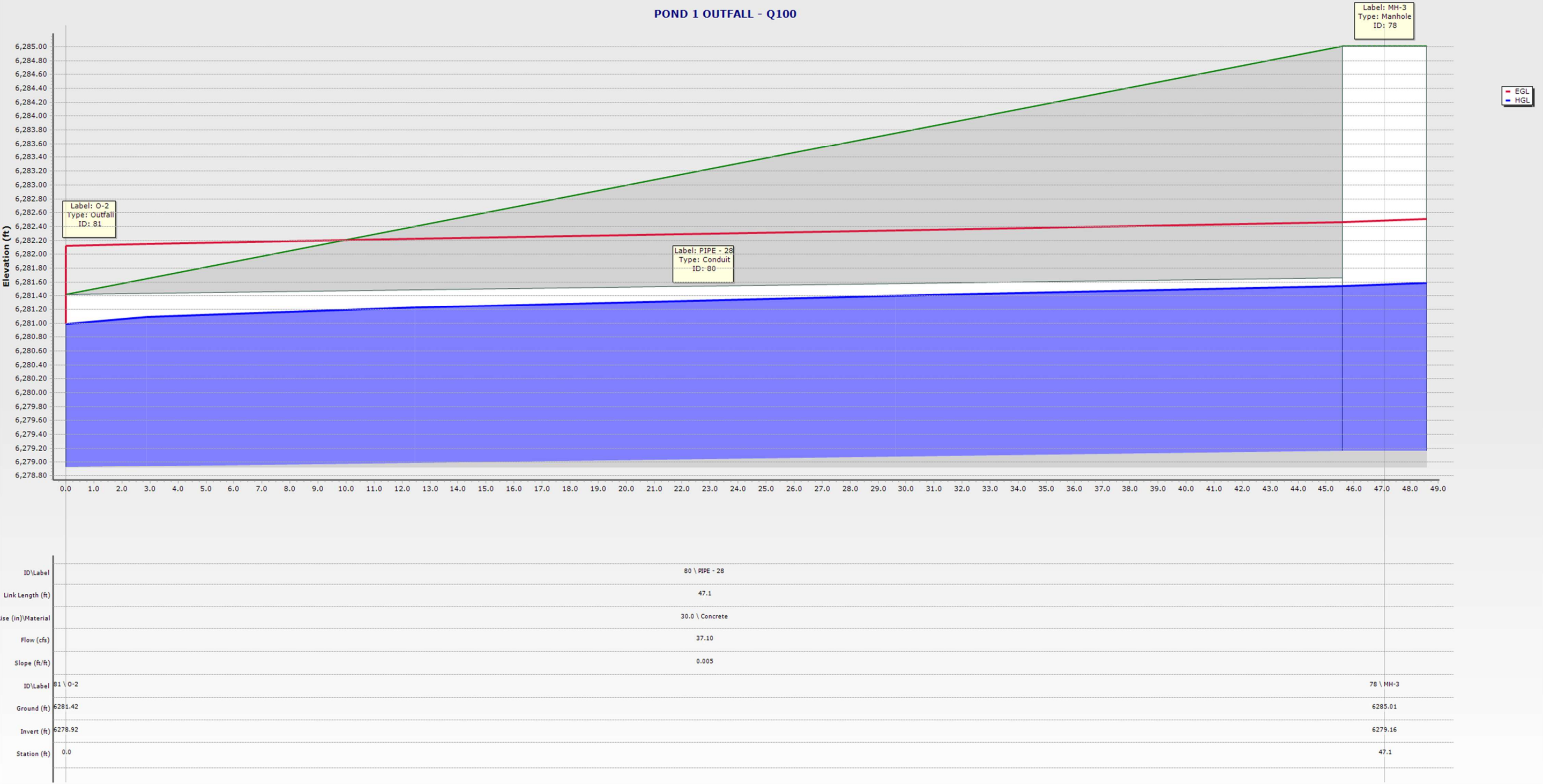












	Label ▲	Flow (cfs)	Velocity (ft/s)	Start Node	Invert (Start) (ft)	Elevation Ground (Start) (ft)	Hydraulic Grade Line (In) (ft)	Invert (Stop) (ft)	Elevation Ground (Stop) (ft)	Hydraulic Grade Line (Out) (ft)	Stop Node	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Manning's n	Diameter (in)	Flow / Capacity (Design) (%)	Material	Capacity (Full Flow) (cfs)
52: PIPE - 1	PIPE - 1	90.20	9.23	DP6	6,281.93	6,287.54	6,284.36	6,281.50	6,288.31	6,283.82	O-1	85.5	0.005	0.013		91.8	Concrete	98.23
49: PIPE - 2	PIPE - 2	35.80	7.41	MH - 4	6,283.40	6,288.81	6,286.53	6,281.93	6,287.54	6,286.19	DP6	293.1	0.005	0.013	42.0	50.2	Concrete	71.25
47: PIPE - 3	PIPE - 3	38.10	7.52	DP5	6,285.10	6,294.35	6,287.02	6,283.40	6,288.81	6,286.54	MH - 4	339.9	0.005	0.013	42.0	53.6	Concrete	71.15
63: PIPE - 4	PIPE - 4	26.70	7.04	DP4	6,286.18	6,296.91	6,288.25	6,285.60	6,294.35	6,288.19	DP5	109.2	0.005	0.013	36.0	54.9	Concrete	48.60
46: PIPE - 5	PIPE - 5	2.60	3.58	MH - 7	6,287.42	6,293.59	6,288.87	6,286.18	6,296.91	6,288.87	DP4	248.4	0.005	0.013	36.0	5.5	Concrete	47.13
48: PIPE - 6	PIPE - 6	9.80	5.27	MH - 1	6,286.23	6,293.30	6,288.20	6,285.60	6,294.35	6,288.19	DP5	125.9	0.005	0.013	36.0	20.8	Concrete	47.18
50: PIPE - 7	PIPE - 7	4.90	4.47	INLET DP 2a	6,287.39	6,293.30	6,288.29	6,287.23	6,293.30	6,288.30	MH - 1	32.2	0.005	0.013	24.0	30.7	Concrete	15.96
51: PIPE - 8	PIPE - 8	4.90	4.53	INLET DP2b	6,287.36	6,293.30	6,288.29	6,287.23	6,293.30	6,288.30	MH - 1	25.2	0.005	0.013	24.0	30.2	Concrete	16.23
45: PIPE - 9	PIPE - 9	1.30	3.16	DP1a INLET	6,289.06	6,293.49	6,289.49	6,288.92	6,293.59	6,289.34	MH - 7	28.1	0.005	0.013	18.0	17.5	Concrete	7.41
44: PIPE - 10	PIPE - 10	1.30	3.15	DP1b INLET	6,289.06	6,293.50	6,289.49	6,288.92	6,293.59	6,289.35	MH - 7	28.3	0.005	0.013	18.0	17.6	Concrete	7.39
43: PIPE - 11	PIPE - 11	24.90	6.77	DP3	6,286.42	6,293.19	6,288.90	6,286.18	6,296.91	6,288.87	DP4	47.8	0.005	0.013	36.0	52.7	Concrete	47.24
80: PIPE - 28	PIPE - 28	37.10	7.56	MH-3	6,279.16	6,285.01	6,281.54	6,278.92	6,281.42	6,280.98	O-2	47.1	0.005	0.013	30.0	126.7	Concrete	29.28

Figure 4- Q100 – Free Outfall CONDUIT SUMMARY

	Label ▲	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert in 1) (ft)	Elevation (Invert in 2) (ft)	Elevation (Invert in 3) (ft)	Elevation (Invert Out) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Headloss Coefficient (Standard)	Flow (Total Out) (cfs)	Headloss (ft)	Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)
33: DP1a INLET	DP1a INLET	6,293.49	6,293.49	(N/A)	(N/A)	(N/A)	6,289.06	6,289.49	6,289.49	Standard	0.050	1.30	0.01	6,289.65	6,289.64
32: DP1b INLET	DP1b INLET	6,293.50	6,293.50	(N/A)	(N/A)	(N/A)	6,289.06	6,289.49	6,289.49	Standard	0.050	1.30	0.01	6,289.65	6,289.64
53: DP3	DP3	6,293.19	6,293.19	(N/A)	(N/A)	(N/A)	6,286.42	6,288.92	6,288.90	Standard	0.050	24.90	0.01	6,289.16	6,289.15
62: DP4	DP4	6,296.91	6,296.91	6,286.18	6,286.18	(N/A)	6,286.18	6,288.87	6,288.25	Standard	1.520	26.70	0.62	6,288.87	6,288.66
35: DP5	DP5	6,294.35	6,294.35	6,285.60	6,285.60	(N/A)	6,285.10	6,288.19	6,287.02	Standard	1.520	38.10	1.18	6,288.46	6,287.79
40: DP6	DP6	6,287.54	6,287.54	6,281.93	(N/A)	(N/A)	6,281.93	6,286.19	6,284.36	Standard	1.520	90.20	1.84	6,286.41	6,285.57
37: INLET DP 2a	INLET DP 2a	6,293.30	6,293.30	(N/A)	(N/A)	(N/A)	6,287.39	6,288.30	6,288.29	Standard	0.050	4.90	0.01	6,288.50	6,288.49
39: INLET DP2b	INLET DP2b	6,293.30	6,293.30	(N/A)	(N/A)	(N/A)	6,287.36	6,288.30	6,288.29	Standard	0.050	4.90	0.01	6,288.48	6,288.47
38: MH - 1	MH - 1	6,293.30	6,293.30	6,287.23	6,287.23	(N/A)	6,286.23	6,288.30	6,288.20	Standard	1.520	9.80	0.09	6,288.42	6,288.26
36: MH - 4	MH - 4	6,288.81	6,288.81	6,283.40	(N/A)	(N/A)	6,283.40	6,286.54	6,286.53	Standard	0.050	35.80	0.01	6,286.82	6,286.77
34: MH - 7	MH - 7	6,293.59	6,293.59	6,288.92	6,288.92	(N/A)	6,287.42	6,288.89	6,288.87	Standard	1.520	2.60	0.01	6,289.04	6,288.88
78: MH-3	MH-3	6,285.01	6,285.01	(N/A)	(N/A)	(N/A)	6,279.16	6,281.59	6,281.54	Standard	0.050	37.10	0.05	6,282.51	6,282.46

Figure 5- Q100 – Free Outfall NODE SUMMARY

	Label ▲	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
54: O-1	O-1	6,288.31	6,281.30	Free Outfall		6,283.82	90.20
81: O-2	O-2	6,281.42	6,278.92	Free Outfall		6,280.98	37.10

Figure 6- Q100 Free Outfall OUTFALL SUMMARY

OUTFALL PROTECTION CALCULATIONS

POND OUTFALL		
Pipe Size (D)	30	Inches
Q	34.9	cfs
L	7.5	Feet
W	7.5	Feet
D	0	Feet
d50	0.20	Feet
	2.44	Inches
Depth of Flow	2.50	Feet
$Q/D^{1.5}$	8.83	
Y_t/D	1.000	
Rip Rap	Type L for 3 x Pipe Dia Downstream m	
Length of Rock	7.5	Feet
Width of Rock	7.5	Feet

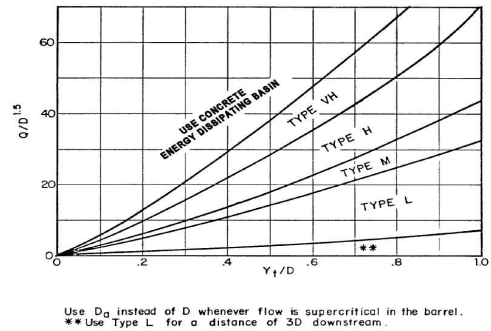


Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for $Q/D^{1.5} \leq 6.0$)

	Inputs
	calculations

CLASSIFICATION AND GRADATION OF ORDINARY RIP RAP			
Rip Rap Designation by Weight	% Smaller Than Given Size (inches)	Intermediate Rock Dimension	d50* (inches)
Type VL	70 – 100	12	6**
	50 – 70	9	
	35 – 50	6	
	2 – 10	2	
Type L	70 – 100	15	9**
	50 – 70	12	
	35 – 50	9	
	2 – 10	3	
Type M	70 – 100	21	12
	50 – 70	18	
	35 – 50	12	
	2 – 10	4	
Type H	70 – 100	30	18
	50 – 70	24	
	35 – 50	18	
	2 – 10	6	
Type VH	70 – 100	42	24
	50 – 70	33	
	35 – 50	24	
	2 – 10	9	

* d50 = Mean particle size
** Bury types VL and L with native top soil and revegetate to protect from vandalism.

3.2.3 Rock Sizing for Riprap Apron and Low Tailwater Basin

Scour resulting from highly turbulent, rapidly decelerating flow is a common problem at conduit outlets. The following section summarizes the method for sizing riprap protection for both riprap aprons (Section 3.2.1) and low tailwater basins (Section 3.2.2).

Use Figure 9-38 to determine the required rock size for circular conduits and Figure 9-39 for rectangular conduits. Figure 9-38 is valid for $Q/D_c^{2.5}$ of 6.0 or less and Figure 9-39 is valid for $Q/WH^{2.5}$ of 8.0 or less. The parameters in these two figures are:

1. $Q/D_c^{2.5}$ or $Q/WH^{2.5}$ in which Q is the design discharge in cfs, D_c is the diameter of a circular conduit in feet, and W and H are the width and height of a rectangular conduit in feet.
2. Y_t/D_c or Y_t/H in which Y_t is the tailwater depth in feet, D_c is the diameter of a circular conduit in feet, and H is the height of a rectangular conduit in feet. In cases where Y_t is unknown or a hydraulic jump is suspected downstream of the outlet, use $Y_t/D_c = Y_t/H = 0.40$ when using Figures 9-38 and 9-39.
3. The riprap size requirements in Figures 9-38 and 9-39 are based on the non-dimensional parametric Equations 9-16 and 9-17 (Steven, Simons, and Watts 1971 and Smith 1975).

Circular culvert:

$$d_{50} = \frac{0.023Q}{Y_t^{1.5} D_c^{0.5}} \quad \text{Equation 9-16}$$

Rectangular culvert:

$$d_{50} = \frac{0.014H^{0.5}Q}{Y_t W} \quad \text{Equation 9-17}$$

3.2.2 Low Tailwater Basin

The design of low tailwater riprap basins is necessary when the receiving channel may have little or no flow or tailwater at time when the pipe or culvert is in operation. Figure 9-37 provides a plan and profile view of a typical low tailwater riprap basin.

By providing a low tailwater basin at the end of a storm drain conduit or culvert, the kinetic energy of the discharge dissipates under controlled conditions without causing scour at the channel bottom.

Low tailwater is defined as being equal to or less than $\frac{1}{3}$ of the height of the storm drain, that is:

$$Y_t \leq \frac{D}{3} \quad \text{or} \quad Y_t \leq \frac{H}{3}$$

Where:

Y_t = tailwater depth at design flow (feet)

D = diameter of circular pipe (feet)

H = height of rectangular pipe (feet)

Rock Size

The procedure for determining the required riprap size downstream of a conduit outlet is in Section 3.2.3.

After selecting the riprap size, the minimum thickness of the riprap layer, T , in feet, in the basin is defined as:

$$T = 2D_{50} \quad \text{Equation 9-15}$$

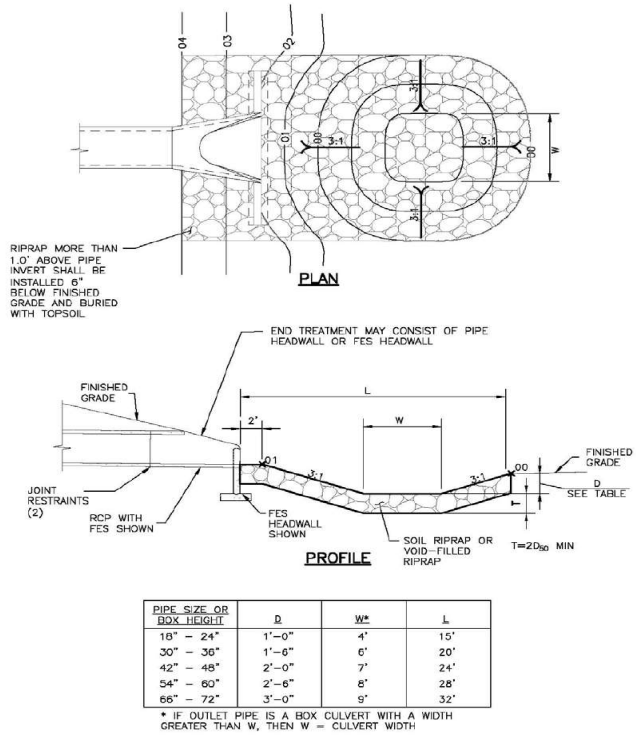


Figure 9-37. Low tailwater riprap basin

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc.

Wednesday, Jun 24 2026

South Roadside Ditch (Existing Flows)

Unresolved:
Is this south of Highway 24 or south
of property? Please clearly state
which ditch it is.

User-defined

Invert Elev (ft) = 6276.60
Slope (%) = 1.40
N-Value = 0.032

Highlighted

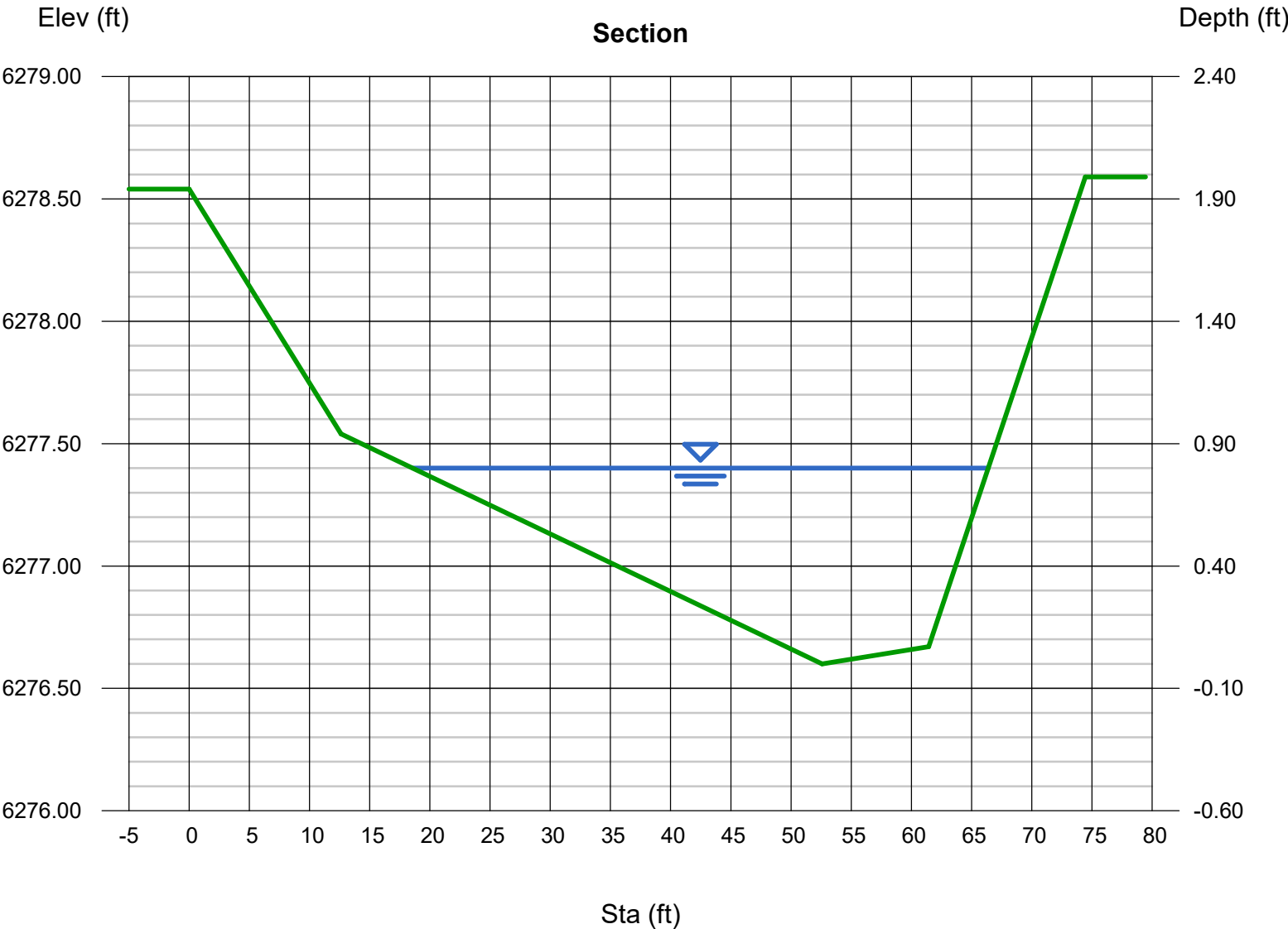
Depth (ft) = 0.80
Q (cfs) = 71.80
Area (sqft) = 22.18
Velocity (ft/s) = 3.24
Wetted Perim (ft) = 47.87
Crit Depth, Yc (ft) = 0.74
Top Width (ft) = 47.81
EGL (ft) = 0.96

Calculations

Compute by: Known Q
Known Q (cfs) = 71.80

(Sta, El, n)-(Sta, El, n)...

(0.00, 6278.54)-(12.62, 6277.54, 0.032)-(52.58, 6276.60, 0.032)-(61.44, 6276.67, 0.032)-(74.45, 6278.59, 0.032)



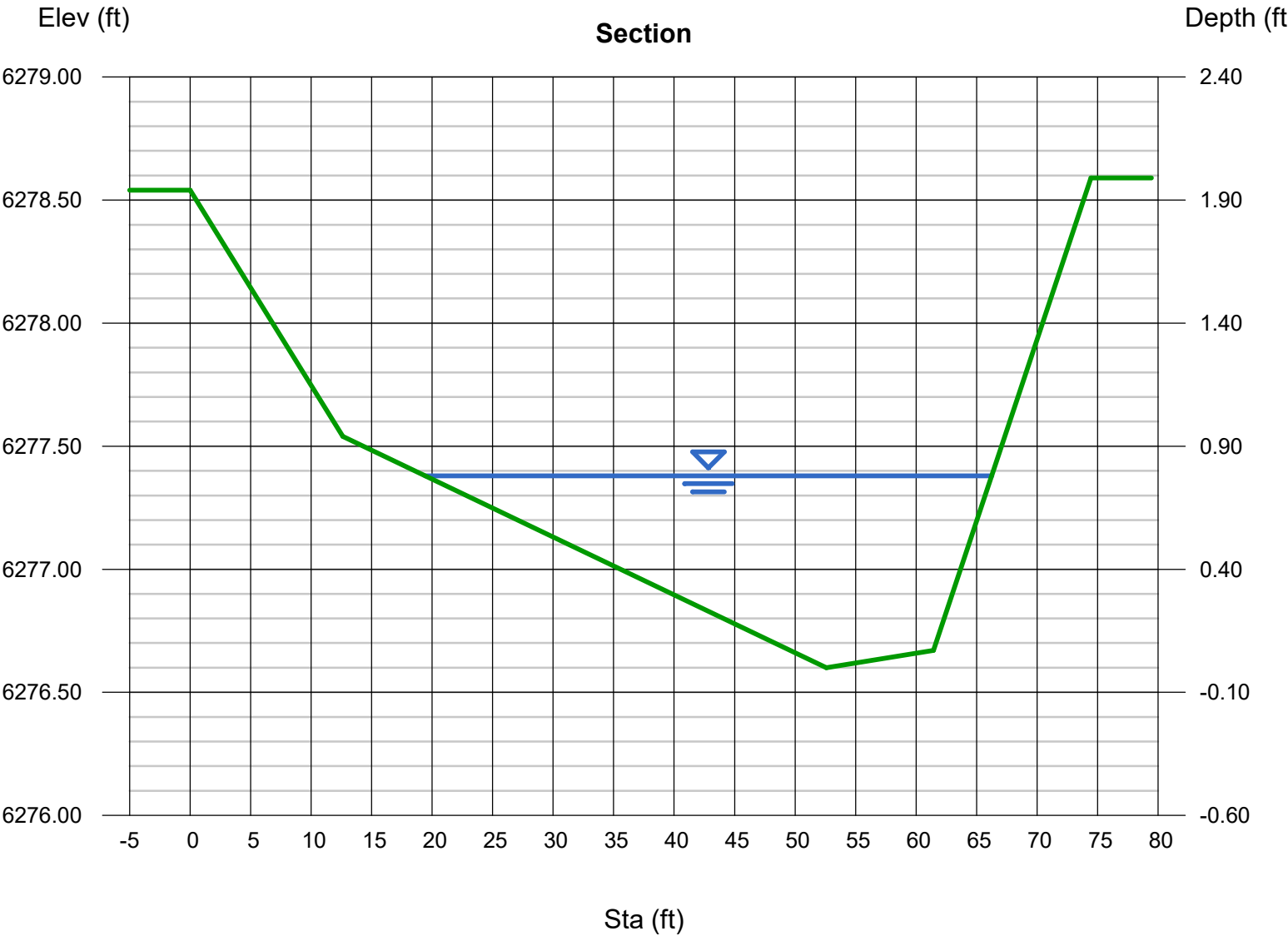
Channel Report

South Roadside Ditch (Proposed Flows)

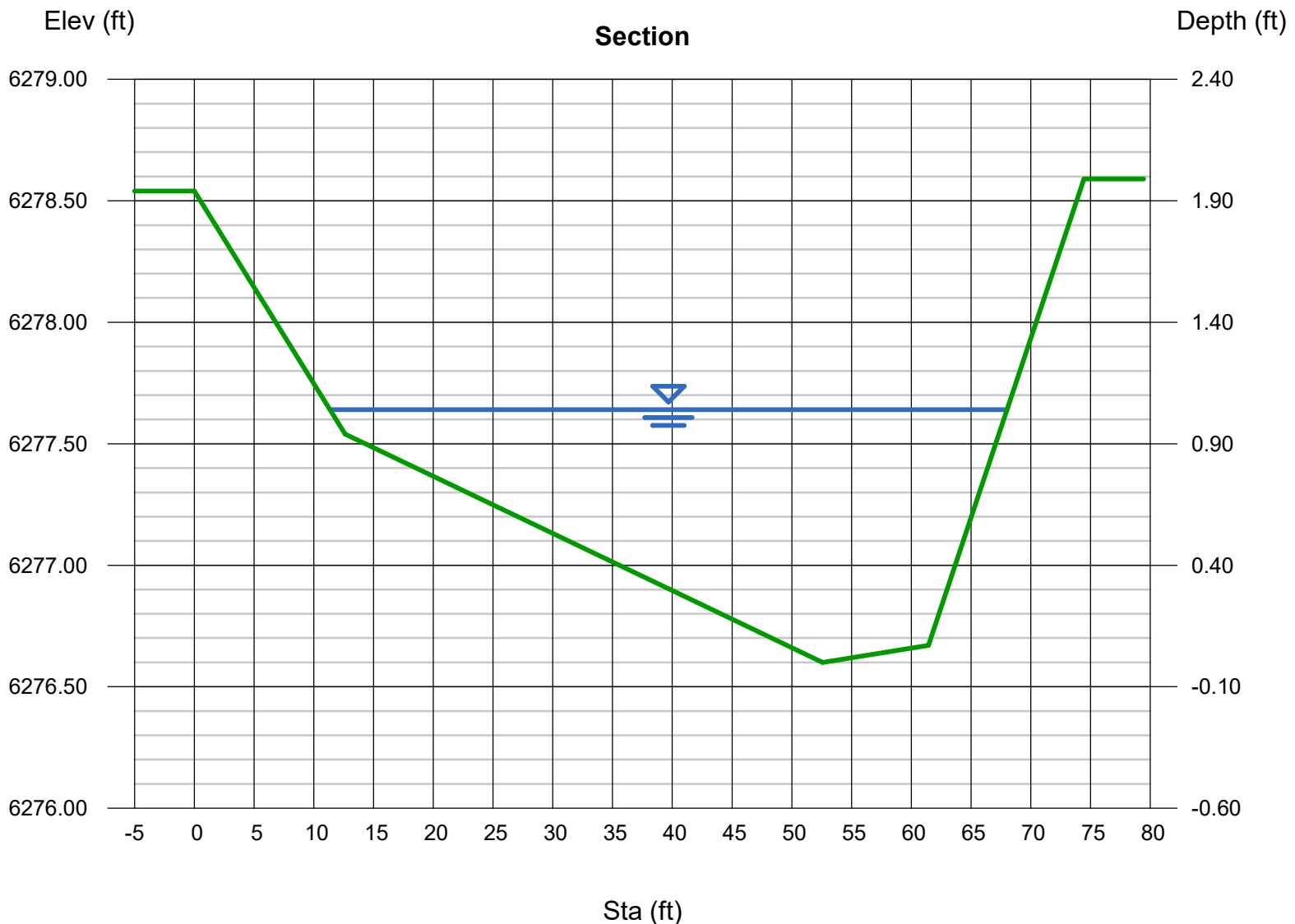
User-defined		Highlighted	
Invert Elev (ft)	= 6276.60	Depth (ft)	= 0.78
Slope (%)	= 1.40	Q (cfs)	= 68.10
N-Value	= 0.032	Area (sqft)	= 21.23
		Velocity (ft/s)	= 3.21
		Wetted Perim (ft)	= 46.88
		Crit Depth, Yc (ft)	= 0.72
		Top Width (ft)	= 46.82
		EGL (ft)	= 0.94

(Sta, El, n)-(Sta, El, n)...

(0.00, 6278.54)-(12.62, 6277.54, 0.032)-(52.58, 6276.60, 0.032)-(61.44, 6276.67, 0.032)-(74.45, 6278.59, 0.032)



Wednesday, Jun 24 2026



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc.

Wednesday, Jun 24 2026

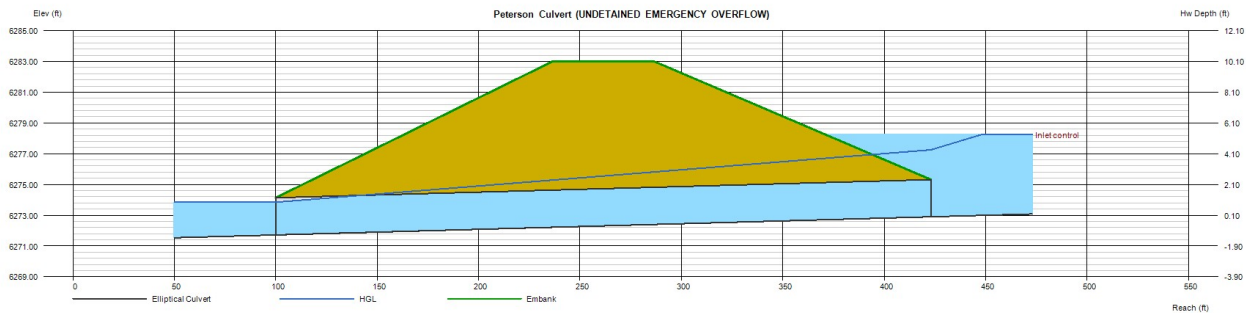
Peterson Culvert (UNDETAINED EMERGENCY OVERFLOW)

Invert Elev Dn (ft) = 6271.72
Pipe Length (ft) = 323.00
Slope (%) = 0.37
Invert Elev Up (ft) = 6272.90
Rise (in) = 29.0
Shape = Elliptical
Span (in) = 45.0
No. Barrels = 2
n-Value = 0.013
Culvert Type = Horizontal Ellipse Concrete
Culvert Entrance = Square edge w/headwall (H)
Coeff. K,M,c,Y,k = 0.01, 2, 0.0398, 0.67, 0.5

Embankment
Top Elevation (ft) = 6283.00
Top Width (ft) = 50.00
Crest Width (ft) = 10.00

Calculations
Qmin (cfs) = 137.80
Qmax (cfs) = 137.80
Tailwater Elev (ft) = (dc+D)/2

Highlighted
Qtotal (cfs) = 137.80
Qpipe (cfs) = 137.80
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 10.35
Veloc Up (ft/s) = 9.68
HGL Dn (ft) = 6273.85
HGL Up (ft) = 6277.25
Hw Elev (ft) = 6278.24
Hw/D (ft) = 2.21
Flow Regime = Inlet Control



APPENDIX B

STANDARD DESIGN CHARTS AND TABLES

Table 6-6. Runoff Coefficients for Rational Method

(Source: UDFCD 2001)

Land Use or Surface Characteristics	Percent Impervious	Runoff Coefficients											
		2-year		5-year		10-year		25-year		50-year		100-year	
		HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D	HSG A&B	HSG C&D
Business													
Commercial Areas	95	0.79	0.80	0.81	0.82	0.83	0.84	0.85	0.87	0.87	0.88	0.88	0.89
Neighborhood Areas	70	0.45	0.49	0.49	0.53	0.53	0.57	0.58	0.62	0.60	0.65	0.62	0.68
Residential													
1/8 Acre or less	65	0.41	0.45	0.45	0.49	0.49	0.54	0.54	0.59	0.57	0.62	0.59	0.65
1/4 Acre	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
1/3 Acre	30	0.18	0.22	0.25	0.30	0.32	0.38	0.39	0.47	0.43	0.52	0.47	0.57
1/2 Acre	25	0.15	0.20	0.22	0.28	0.30	0.36	0.37	0.46	0.41	0.51	0.46	0.56
1 Acre	20	0.12	0.17	0.20	0.26	0.27	0.34	0.35	0.44	0.40	0.50	0.44	0.55
Industrial													
Light Areas	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Heavy Areas	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Parks and Cemeteries	7	0.05	0.09	0.12	0.19	0.20	0.29	0.30	0.40	0.34	0.46	0.39	0.52
Playgrounds	13	0.07	0.13	0.16	0.23	0.24	0.31	0.32	0.42	0.37	0.48	0.41	0.54
Railroad Yard Areas	40	0.23	0.28	0.30	0.35	0.36	0.42	0.42	0.50	0.46	0.54	0.50	0.58
Undeveloped Areas													
Historic Flow Analysis-- Greenbelts, Agriculture	2	0.03	0.05	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51
Pasture/Meadow	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Forest	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50
Exposed Rock	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Offsite Flow Analysis (when landuse is undefined)	45	0.26	0.31	0.32	0.37	0.38	0.44	0.44	0.51	0.48	0.55	0.51	0.59
Streets													
Paved	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Gravel	80	0.57	0.60	0.59	0.63	0.63	0.66	0.66	0.70	0.68	0.72	0.70	0.74
Drive and Walks	100	0.89	0.89	0.90	0.90	0.92	0.92	0.94	0.94	0.95	0.95	0.96	0.96
Roofs	90	0.71	0.73	0.73	0.75	0.75	0.77	0.78	0.80	0.80	0.82	0.81	0.83
Lawns	0	0.02	0.04	0.08	0.15	0.15	0.25	0.25	0.37	0.30	0.44	0.35	0.50

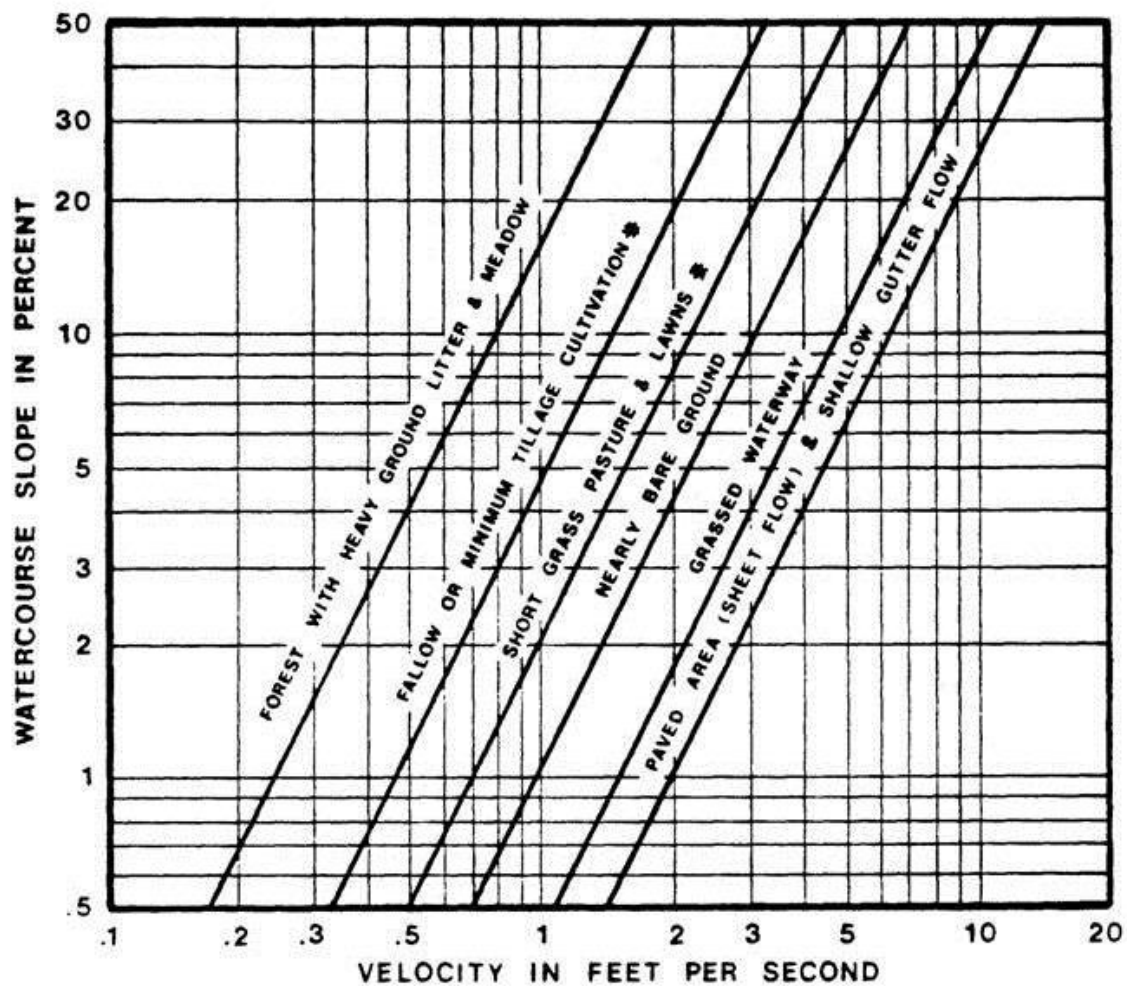
3.2 Time of Concentration

One of the basic assumptions underlying the Rational Method is that runoff is a function of the average rainfall rate during the time required for water to flow from the hydraulically most remote part of the drainage area under consideration to the design point. However, in practice, the time of concentration can be an empirical value that results in reasonable and acceptable peak flow calculations.

For urban areas, the time of concentration (t_c) consists of an initial time or overland flow time (t_i) plus the travel time (t_t) in the storm sewer, paved gutter, roadside drainage ditch, or drainage channel. For non-urban areas, the time of concentration consists of an overland flow time (t_i) plus the time of travel in a concentrated form, such as a swale or drainageway. The travel portion (t_t) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

Type of Development	Percent Impervious
Commercial	95%
Industrial	85%
Multi-Family	65%
Single Family - 0.1377 acre lots (6,000 SF)	53%
Single-Family - 0.20 acre lots	43%
Single-Family - 0.25 acre lots	40%
Single-Family - 0.33 acre lots	30%
Single-Family - 0.5 acre lots	25%
Single-Family - 1.0 acre lots	20%
Single-Family - 2.5 acre lots	11%
Single-Family - 5 acre lots	7%

Figure 6-25. Estimate of Average Concentrated Shallow Flow



APPENDIX C

REPORT REFERENCES

An aerial photograph overlaid with technical floodway information. The map shows a river or stream flowing from the top left towards the bottom left. Floodway areas are shaded in green with red diagonal hatching and labeled "FLOODWAY Zone AE". Specific elevation points along the floodway boundaries are marked with black dots and labels such as "6295 FEET", "6285 FEET", "6277 FEET", "6272.3 FEET", "6268 FEET", "6258 FEET", "6263.5 FEET", "6271 FEET", "6277 FEET", "6281 FEET", "6284 FEET", "6287 FEET", "6289 FEET", "6293 FEET", "6290 FEET", and "6306 FEET". A blue-outlined polygon indicates the "APPROXIMATE SITE BOUNDARY". Two parcels are identified by their assessor's numbers and effective dates: "08041C0752G eff. 12/7/2018" and "08041C0754G eff. 12/7/2018". The map also includes section identifiers like "T14S R6E W S008" and "T14S R6E W S018", and a label "AREA OF MINIMAL FLOOD HAZARD Zone X" at the top. Section corner markers "S", "R", and "Z" are visible. At the bottom, there is a red box containing the text "APPROXIMATE SITE BOUNDARY" in white capital letters.

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

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) <i>Zone A, V, A99</i>
		With BFE or Depth <i>Zone AE, AO, AH, VE, AR</i>
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 <i>Zone X</i>
		Future Conditions 1% Annual Chance Flood Hazard <i>Zone X</i>
		Area with Reduced Flood Risk due to Levee. See Notes, <i>Zone X</i>
		Area with Flood Risk due to Levee <i>Zone D</i>
		NO SCREEN Area of Minimal Flood Hazard <i>Zone X</i>
OTHER AREAS		Effective LOMRs
		Area of Undetermined Flood Hazard <i>Zone D</i>
GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped
		
 The pin displayed on the map is an approximate		

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 **6/28/2024 at 4:59 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.



United States
Department of
Agriculture

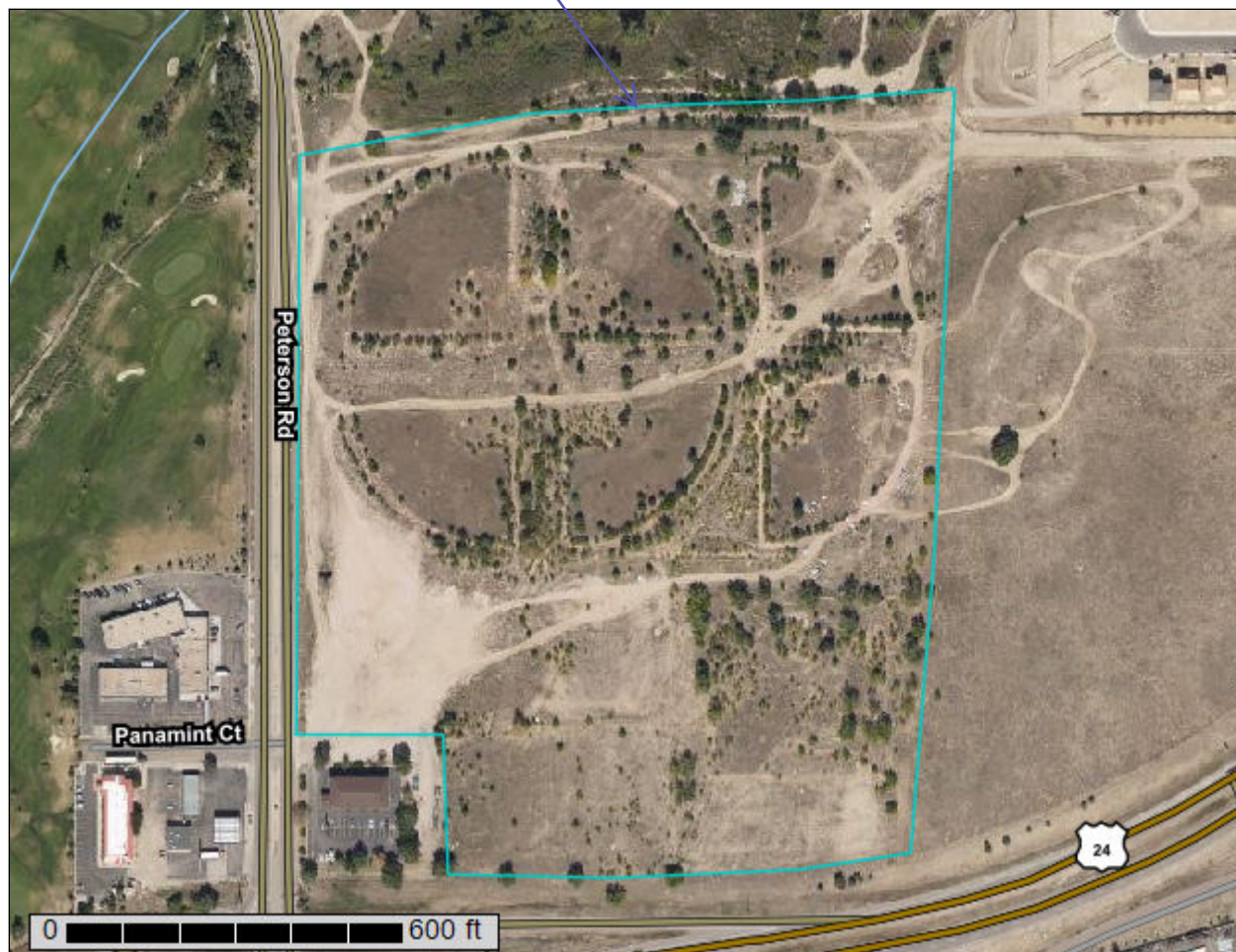
NRCS

Natural
Resources
Conservation
Service

A product of the National
Cooperative Soil Survey,
a joint effort of the United
States Department of
Agriculture and other
Federal agencies, State
agencies including the
Agricultural Experiment
Stations, and local
participants

Custom Soil Resource Report for **El Paso County Area, Colorado**

**APPROXIMATE SITE
BOUNDARY**



Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

Custom Soil Resource Report

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



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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 21, Aug 24, 2023

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 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
8	Blakeland loamy sand, 1 to 9 percent slopes	16.6	49.2%
10	Blendon sandy loam, 0 to 3 percent slopes	17.2	50.8%
Totals for Area of Interest		33.8	100.0%

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

El Paso County Area, Colorado

8—Blakeland loamy sand, 1 to 9 percent slopes

Map Unit Setting

National map unit symbol: 369v
Elevation: 4,600 to 5,800 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Blakeland and similar soils: 98 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blakeland

Setting

Landform: Hills, flats
Landform position (three-dimensional): Side slope, talus
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock and/or eolian deposits
derived from sedimentary rock

Typical profile

A - 0 to 11 inches: loamy sand
AC - 11 to 27 inches: loamy sand
C - 27 to 60 inches: sand

Properties and qualities

Slope: 1 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: 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
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Minor Components

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

10—Blendon sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 3671

Elevation: 6,000 to 6,800 feet

Mean annual precipitation: 14 to 16 inches

Mean annual air temperature: 46 to 48 degrees F

Frost-free period: 125 to 145 days

Farmland classification: Not prime farmland

Map Unit Composition

Blendon and similar soils: 98 percent

Minor components: 2 percent

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

Description of Blendon

Setting

Landform: Terraces, alluvial fans

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Sandy alluvium derived from arkose

Typical profile

A - 0 to 10 inches: sandy loam

Bw - 10 to 36 inches: sandy loam

C - 36 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 0 to 3 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Runoff class: Low

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high
(0.60 to 2.00 in/hr)

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Calcium carbonate, maximum content: 2 percent

Available water supply, 0 to 60 inches: Moderate (about 6.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3e

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Hydrologic Soil Group: B

Ecological site: R049XB210CO - Sandy Foothill

Hydric soil rating: No

Minor Components

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

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FINAL DRAINAGE REPORT

FOR

Aura at Crossroads

Date: April 4, 2022

Prepared for:

Trinsic Acquisition Company, LLC

8235 Douglas Avenue, Suite 950

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Prepared by:



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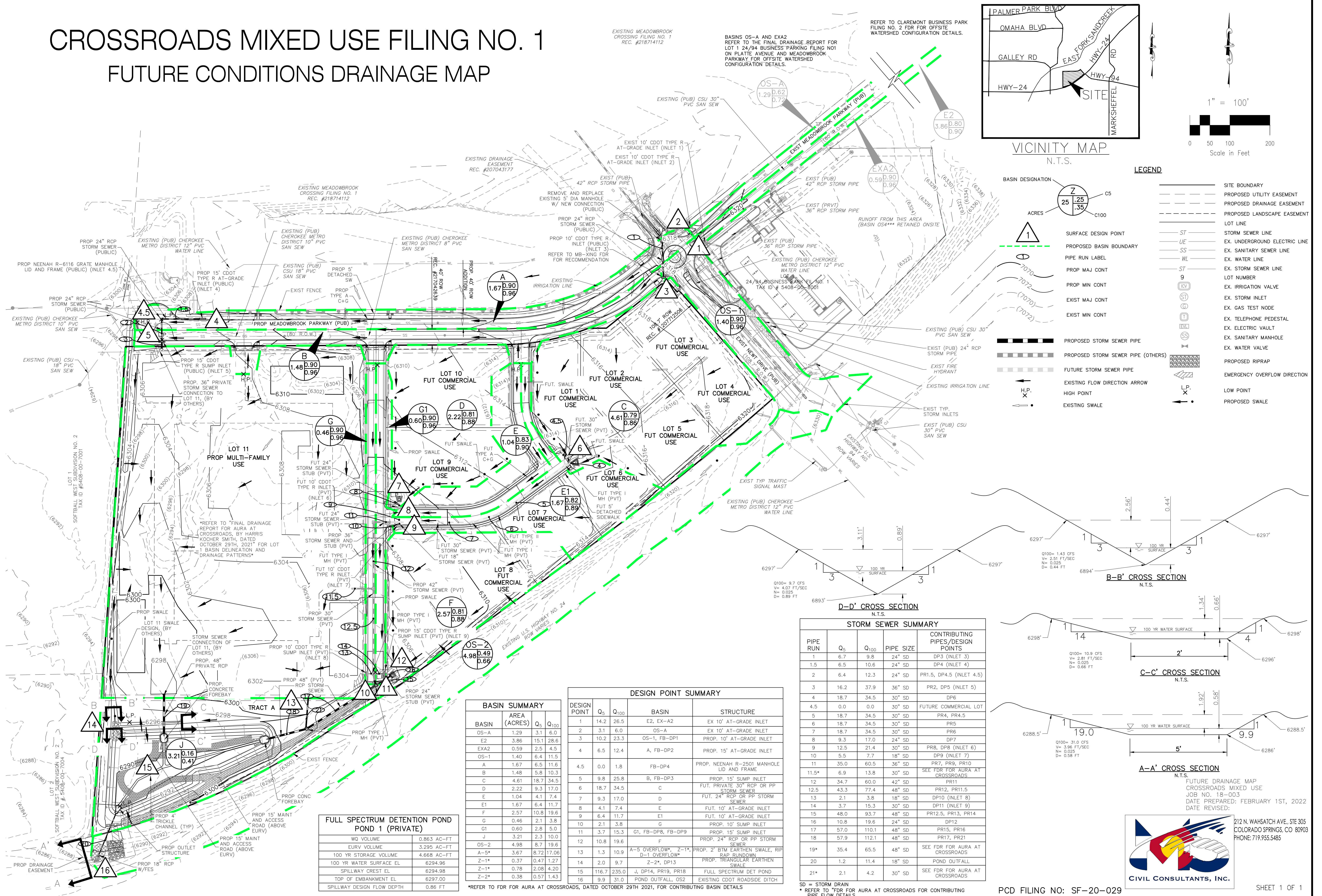
Ph.: 303-623-6300, Fax: 303-623-6311

Harris Kocher Smith Project No.: 200823

PCD Project Number: PPR-21-041

CROSSROADS MIXED USE FILING NO. 1

FUTURE CONDITIONS DRAINAGE MAP

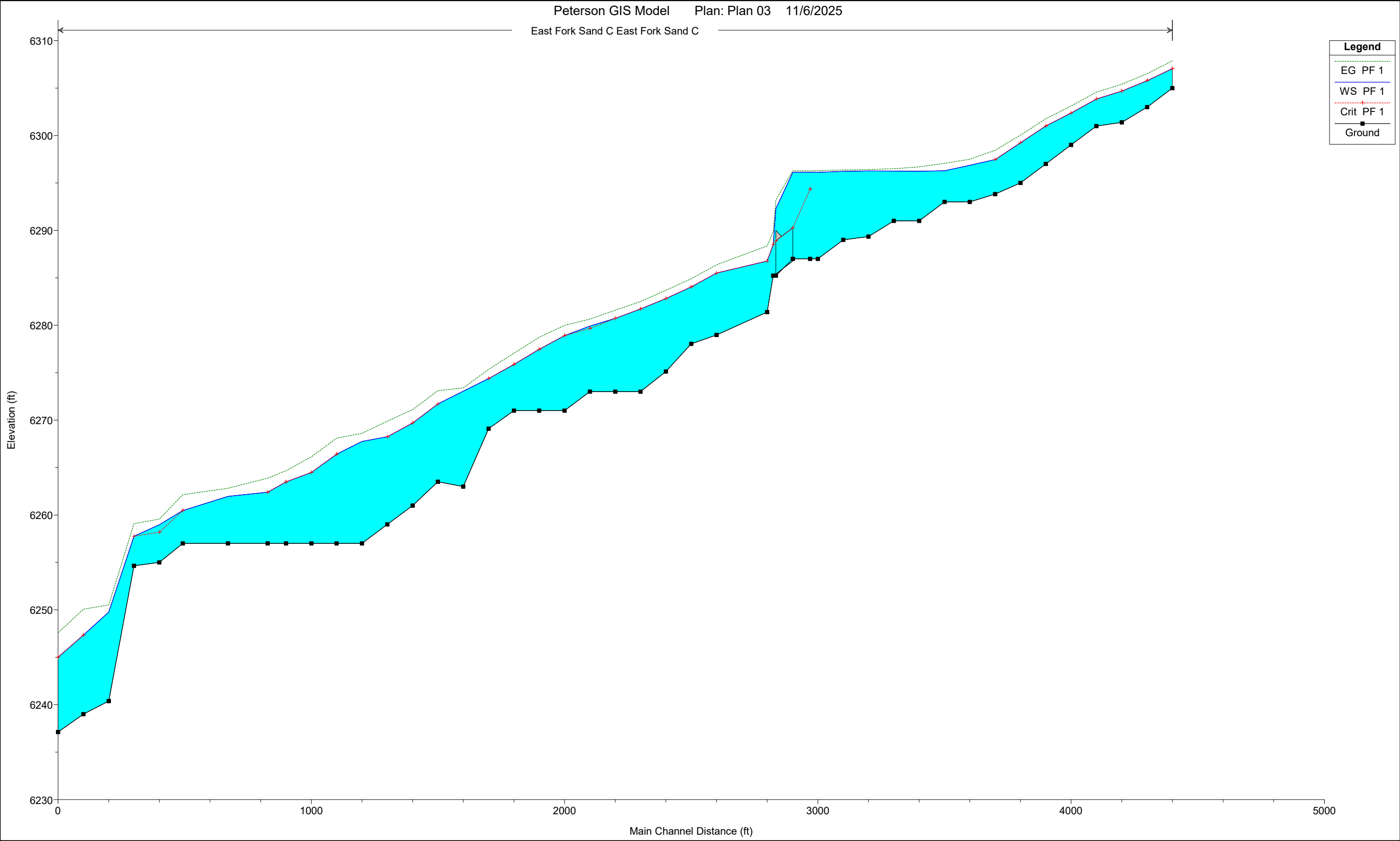


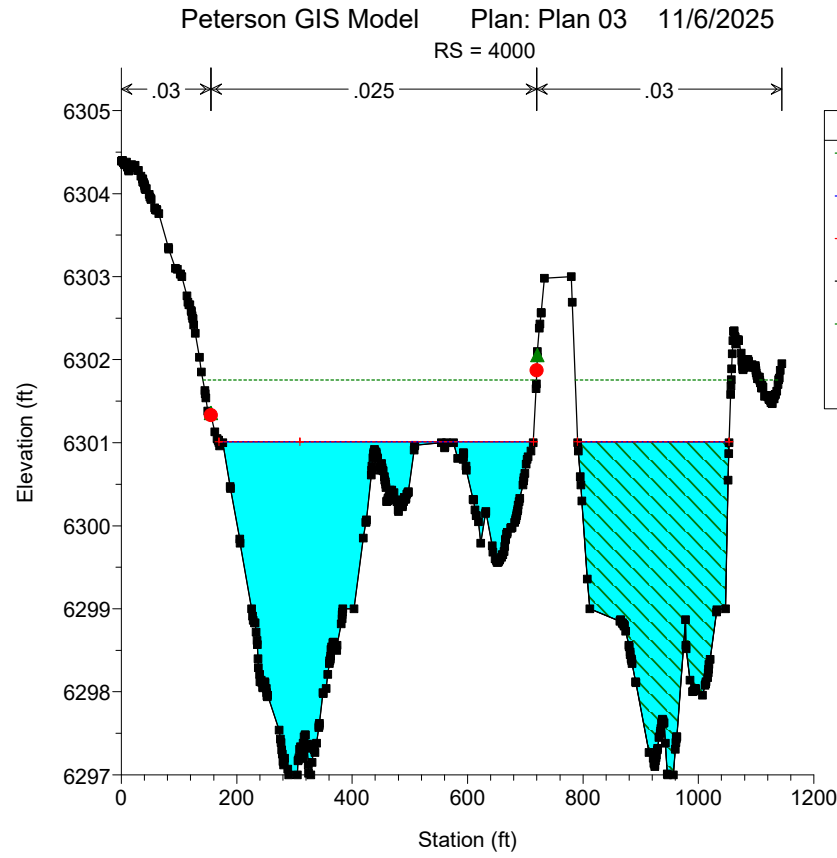
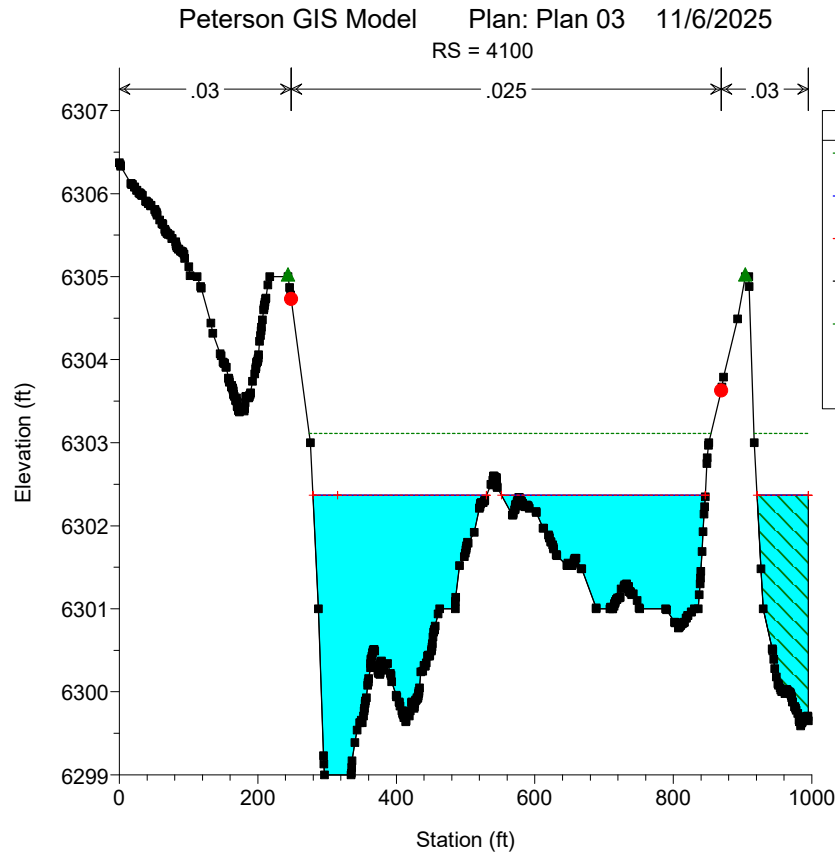
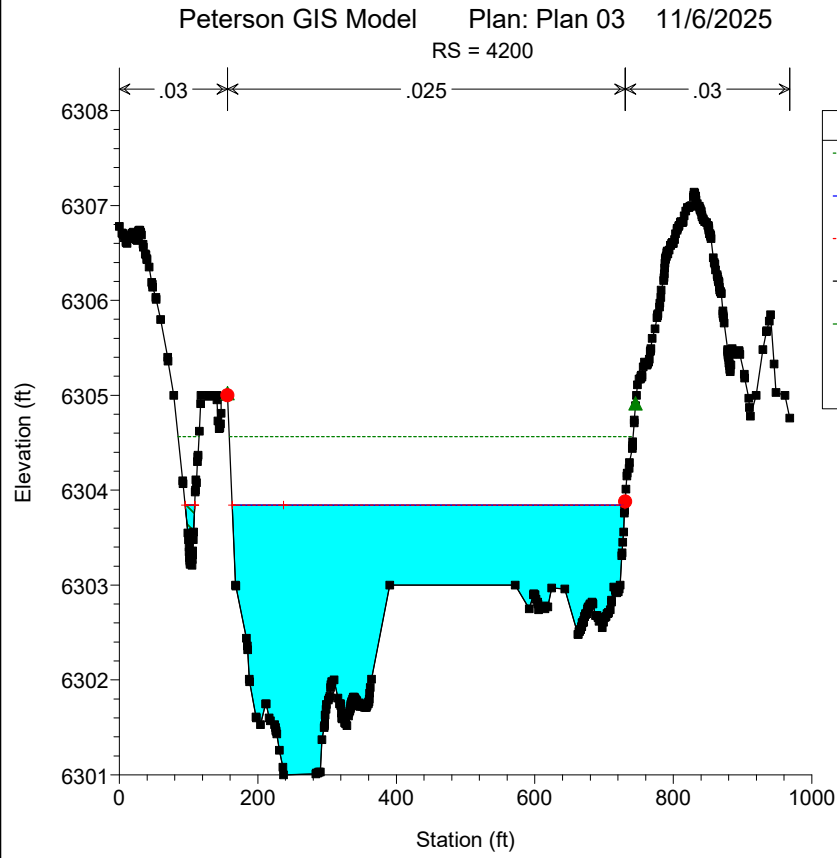
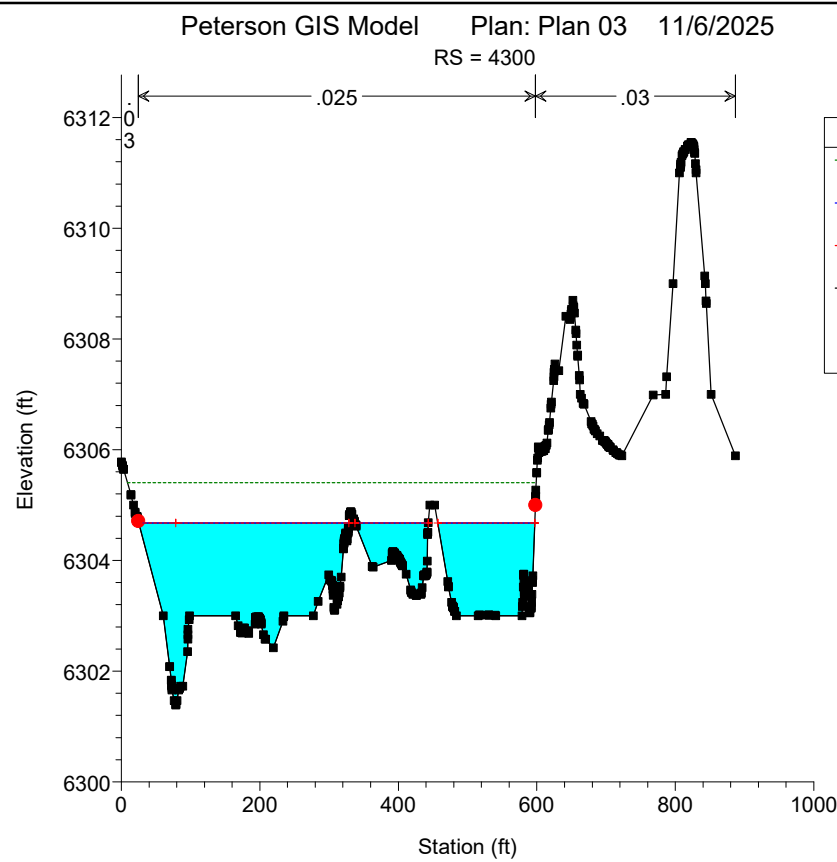
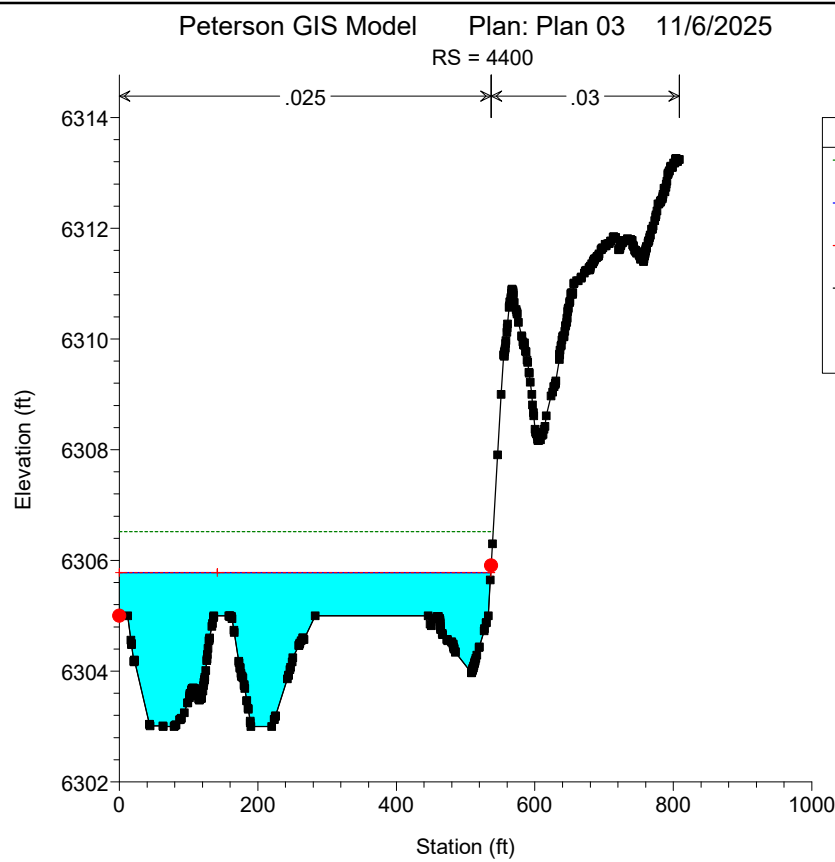
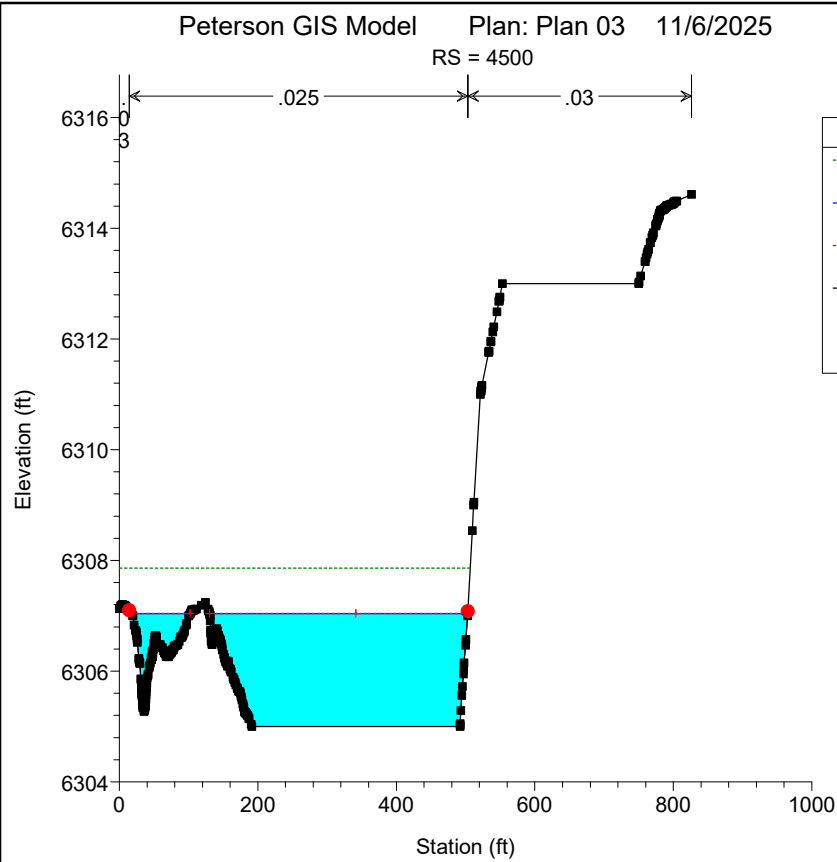
EXISTING CONDITIONS HEC-RAS MODEL

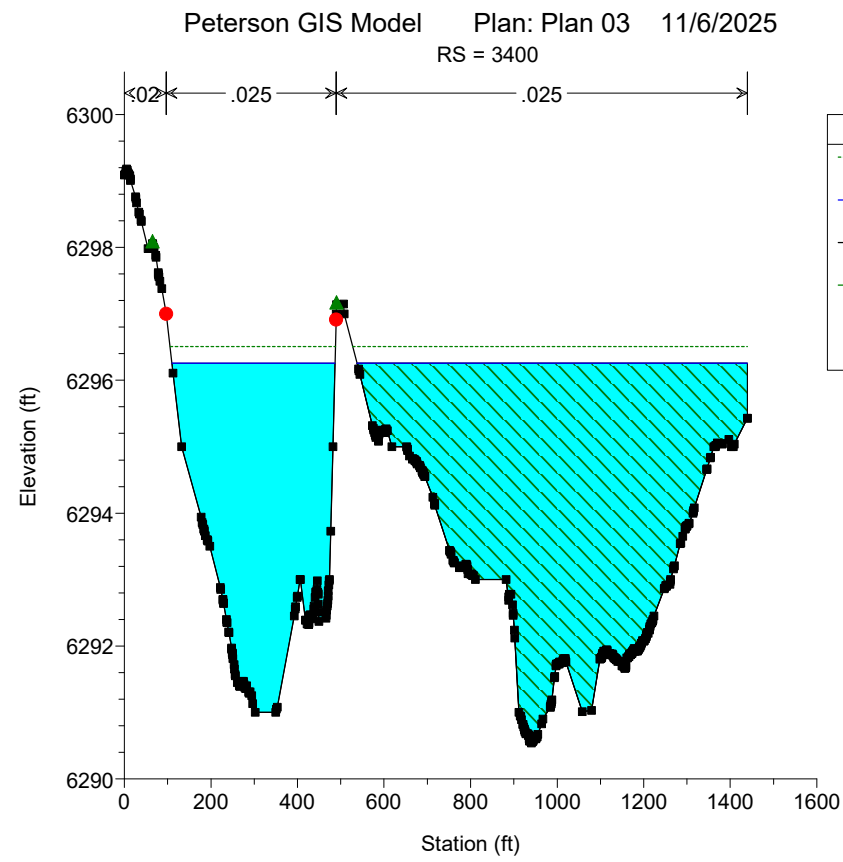
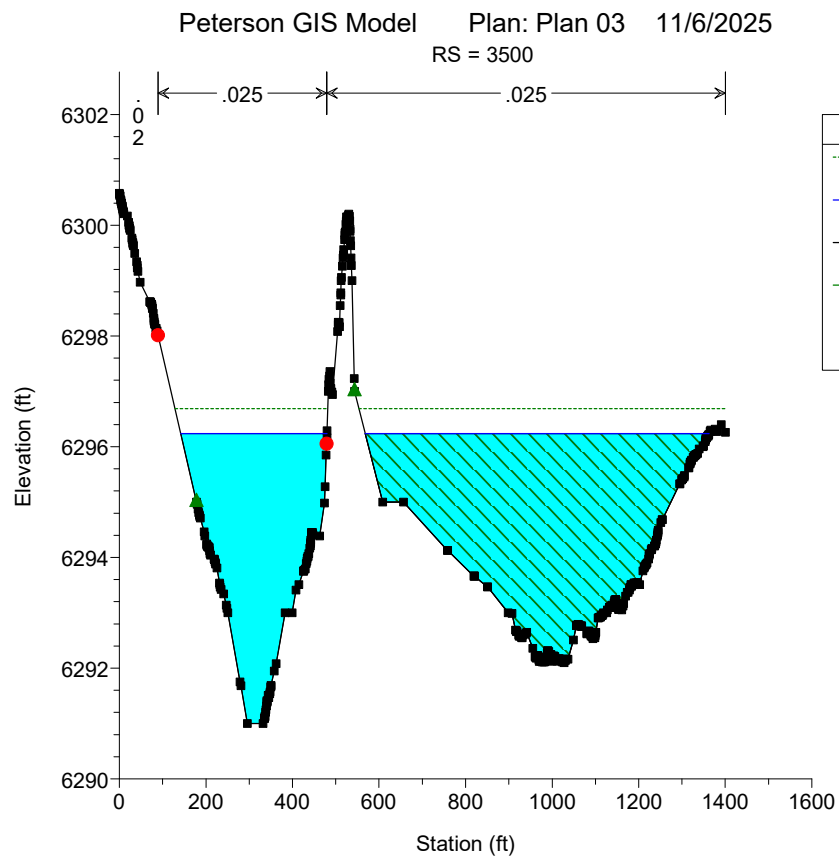
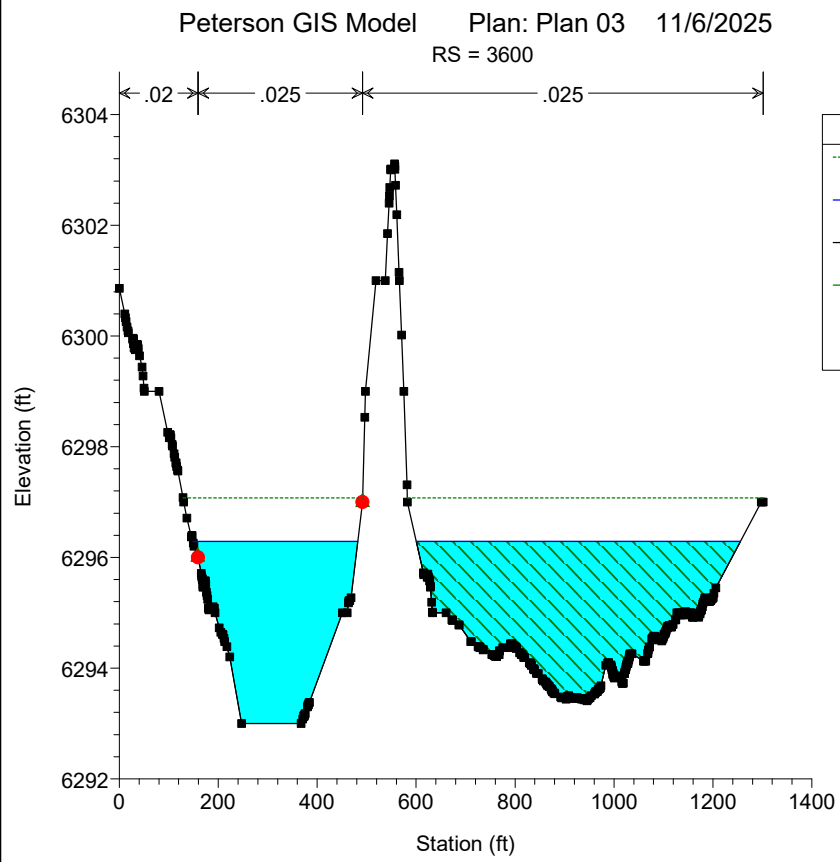
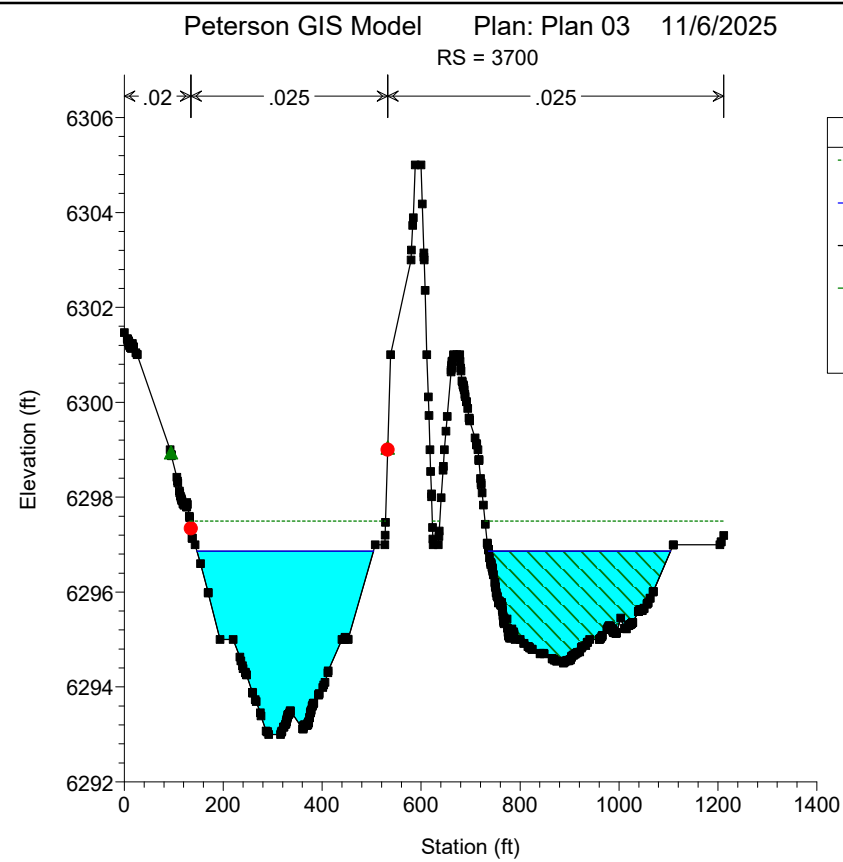
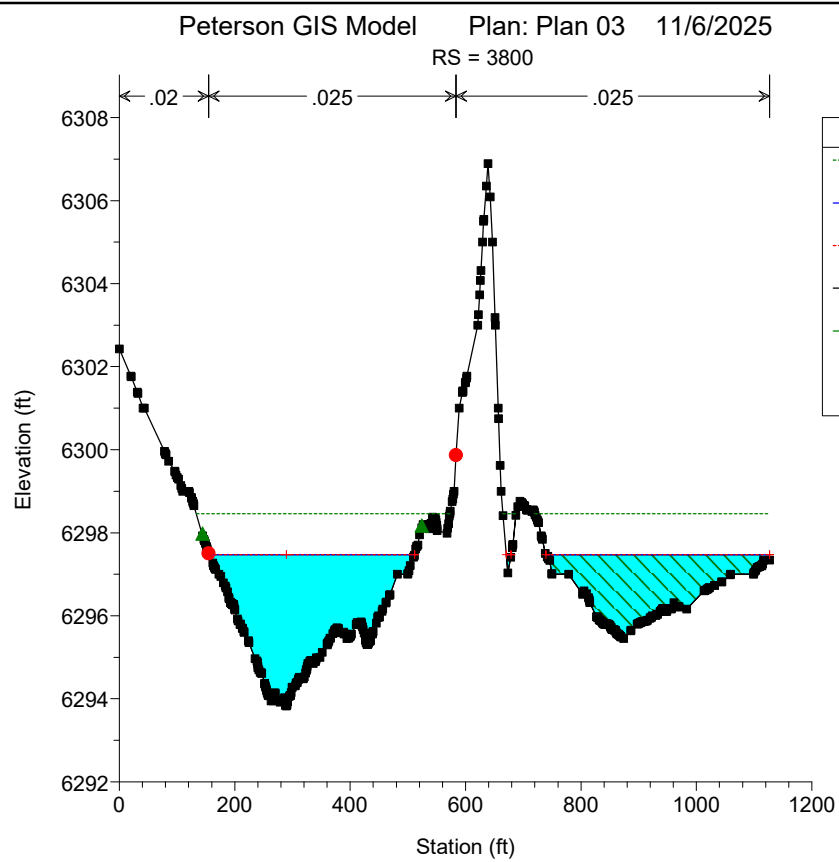
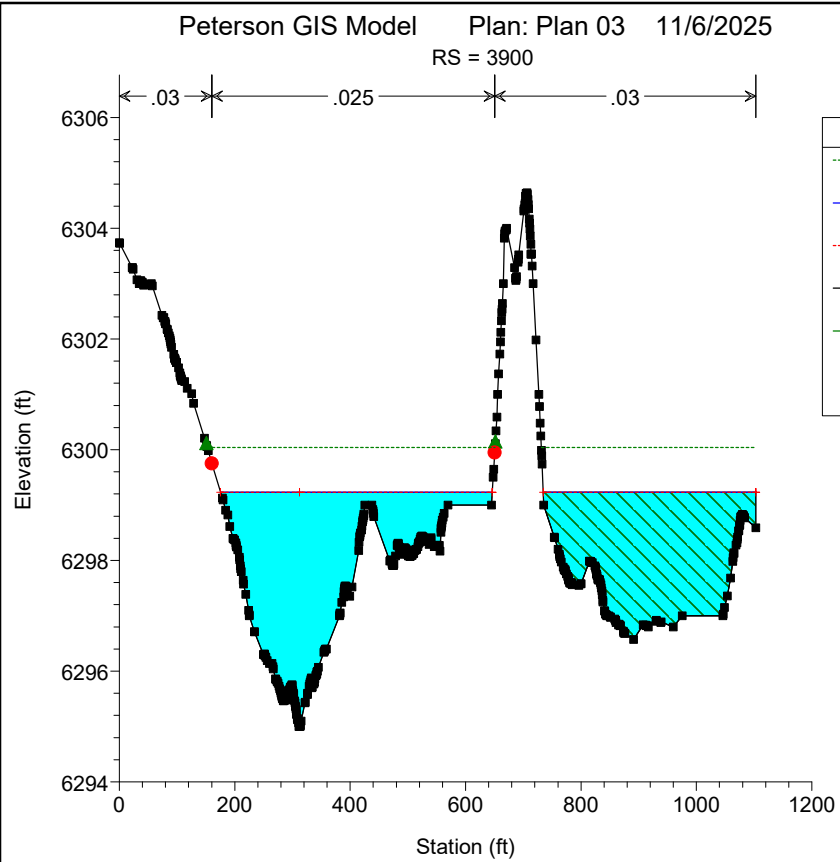
HEC-RAS Plan: Plan 2 River: East Fork Sand C Reach: East Fork Sand C Profile: PF 1

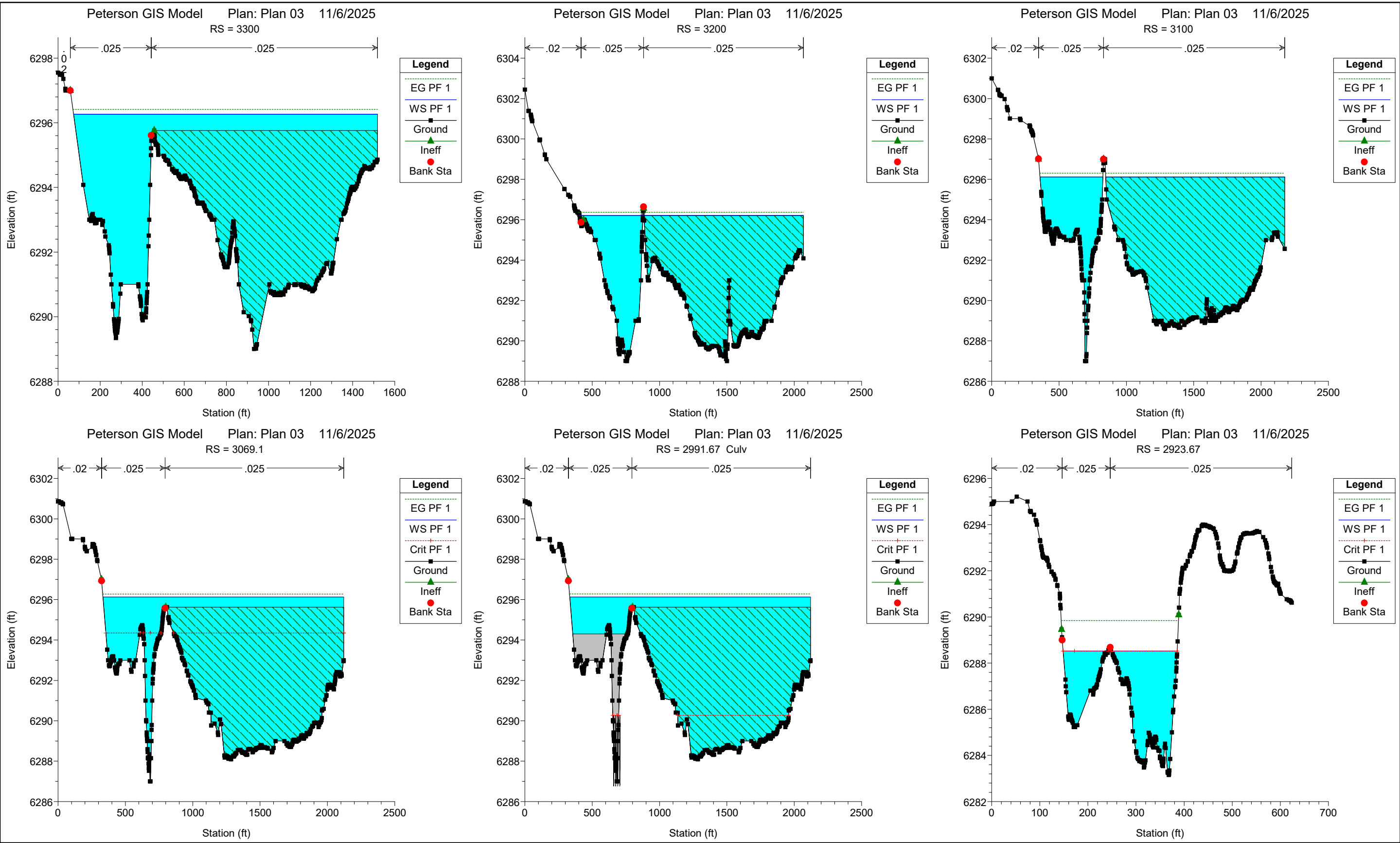
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East Fork Sand C	4500	PF 1	5420.0	6305.0	6307.0	6307.0	6307.9	0.007868	7.3	744.2	457.7	1.01
East Fork Sand C	4400	PF 1	5420.0	6303.0	6305.8	6305.8	6306.5	0.008097	6.9	786.4	536.4	1.00
East Fork Sand C	4300	PF 1	5420.0	6301.4	6304.7	6304.7	6305.4	0.008168	6.8	792.0	549.2	1.00
East Fork Sand C	4200	PF 1	5420.0	6301.0	6303.8	6303.8	6304.6	0.008368	6.8	795.8	581.1	1.01
East Fork Sand C	4100	PF 1	5420.0	6299.0	6302.4	6302.4	6303.1	0.008404	6.9	782.2	619.0	1.02
East Fork Sand C	4000	PF 1	5420.0	6297.0	6301.0	6301.0	6301.8	0.008342	6.9	783.9	807.6	1.02
East Fork Sand C	3900	PF 1	5420.0	6295.0	6299.2	6299.2	6300.0	0.007878	7.2	752.1	839.2	1.01
East Fork Sand C	3800	PF 1	5420.0	6293.8	6297.5	6297.5	6298.5	0.007543	8.0	681.6	752.3	1.01
East Fork Sand C	3700	PF 1	5420.0	6293.0	6296.9		6297.5	0.003648	6.4	848.2	724.6	0.73
East Fork Sand C	3600	PF 1	5420.0	6293.0	6296.3		6297.1	0.004584	7.1	762.3	988.6	0.82
East Fork Sand C	3500	PF 1	5420.0	6291.0	6296.2		6296.7	0.001914	5.4	1006.4	1132.6	0.55
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East Fork Sand C	3300	PF 1	5420.0	6289.3	6296.3		6296.4	0.000449	3.2	2078.4	1443.9	0.28
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East Fork Sand C	3100	PF 1	5420.0	6287.0	6296.1		6296.3	0.000700	3.5	1552.6	1795.5	0.34
East Fork Sand C	3069.1	PF 1	5420.0	6287.0	6296.1	6294.4	6296.3	0.000654	3.3	2121.3	1787.6	0.32
East Fork Sand C	2991.67		Culvert									
East Fork Sand C	2923.67	PF 1	5420.0	6285.2	6288.5	6288.5	6289.8	0.006020	7.0	603.6	229.9	0.90
East Fork Sand C	2900	PF 1	5420.0	6281.4	6286.8	6286.8	6288.4	0.006275	10.1	536.0	278.0	1.00
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East Fork Sand C	1400	PF 1	5420.0	6259.0	6268.3	6268.3	6269.9	0.006459	10.1	534.8	179.1	1.01
East Fork Sand C	1300	PF 1	5420.0	6257.0	6267.8		6268.6	0.003034	7.4	727.6	235.5	0.70
East Fork Sand C	1200	PF 1	5420.0	6257.0	6266.4	6266.4	6268.1	0.006394	10.5	518.4	181.8	1.01
East Fork Sand C	1100	PF 1	5420.0	6257.0	6264.5	6264.5	6266.1	0.006246	10.3	528.1	161.1	1.00
East Fork Sand C	1000	PF 1	5420.0	6257.0	6263.5	6263.5	6264.7	0.007111	8.7	622.1	319.8	1.01
East Fork Sand C	927.42	PF 1	5420.0	6257.0	6262.4	6262.4	6263.9	0.006555	9.8	555.1	190.8	1.01
East Fork Sand C	770.62	PF 1	5420.0	6257.0	6262.0		6262.8	0.002101	7.5	726.9	156.4	0.61
East Fork Sand C	592.7	PF 1	5420.0	6257.0	6260.5	6260.5	6262.1	0.006317	10.4	523.0	158.5	1.01
East Fork Sand C	500	PF 1	5420.0	6255.0	6259.0	6258.2	6259.6	0.002684	6.1	882.8	534.3	0.64
East Fork Sand C	400	PF 1	5420.0	6254.7	6257.8	6257.8	6259.1	0.006733	9.3	585.6	234.6	1.01
East Fork Sand C	300	PF 1	5420.0	6240.4	6249.8		6250.5	0.001540	7.0	771.9	144.6	0.54
East Fork Sand C	200	PF 1	5420.0	6239.0	6247.3	6247.3	6250.1	0.005577	13.2	409.5	75.8	1.00
East Fork Sand C	100	PF 1	5420.0	6237.1	6245.0	6245.0	6247.6	0.005723	12.8	423.0	84.2	1.01

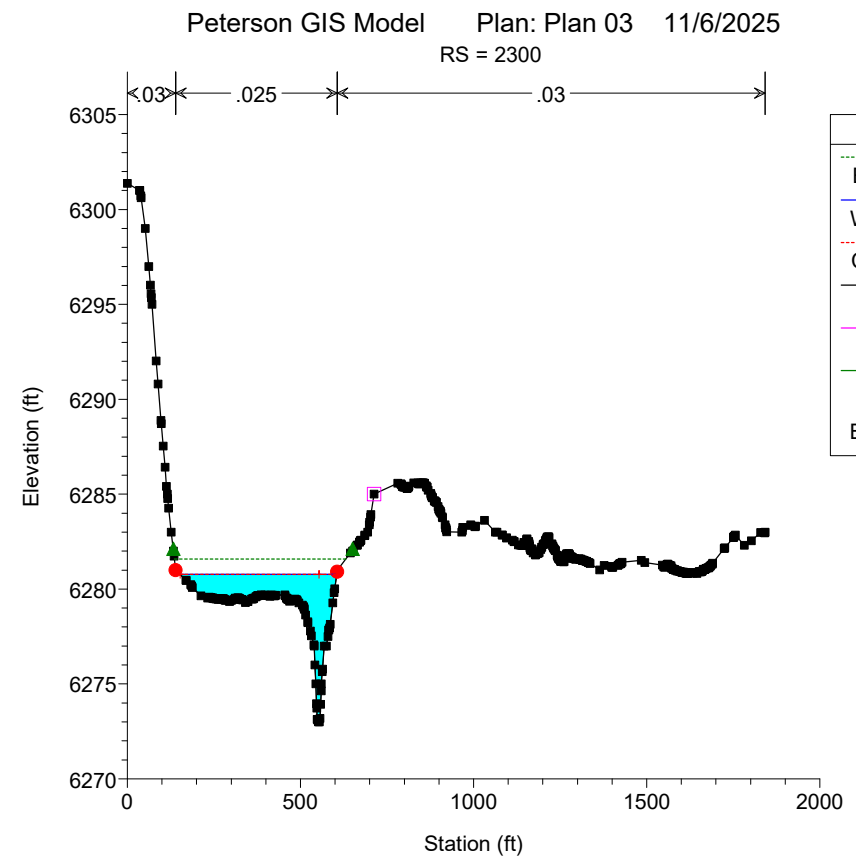
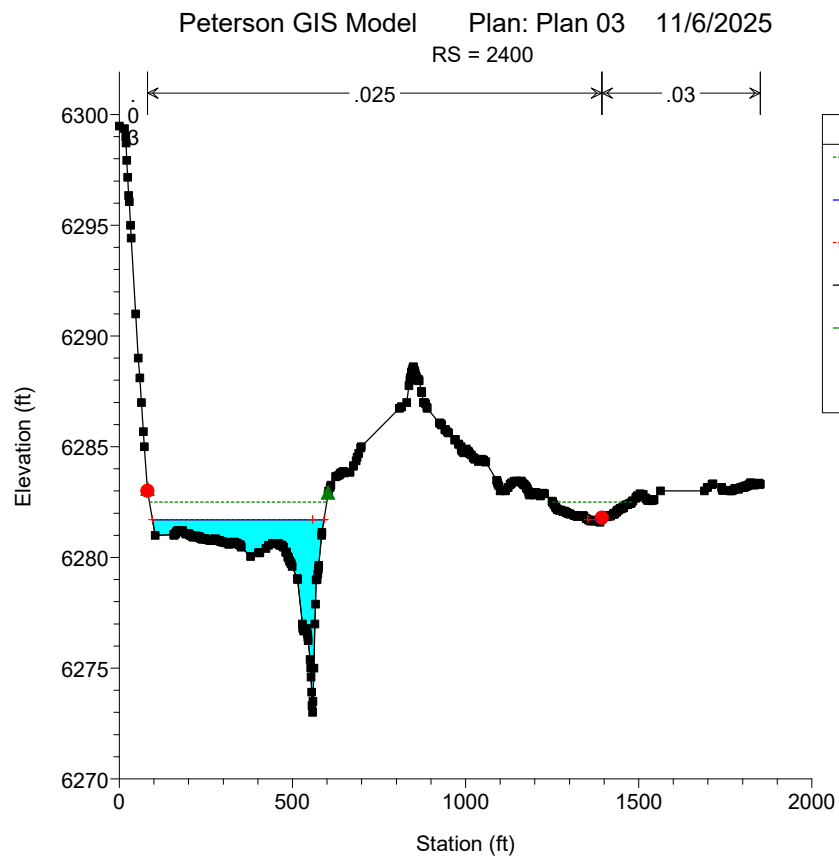
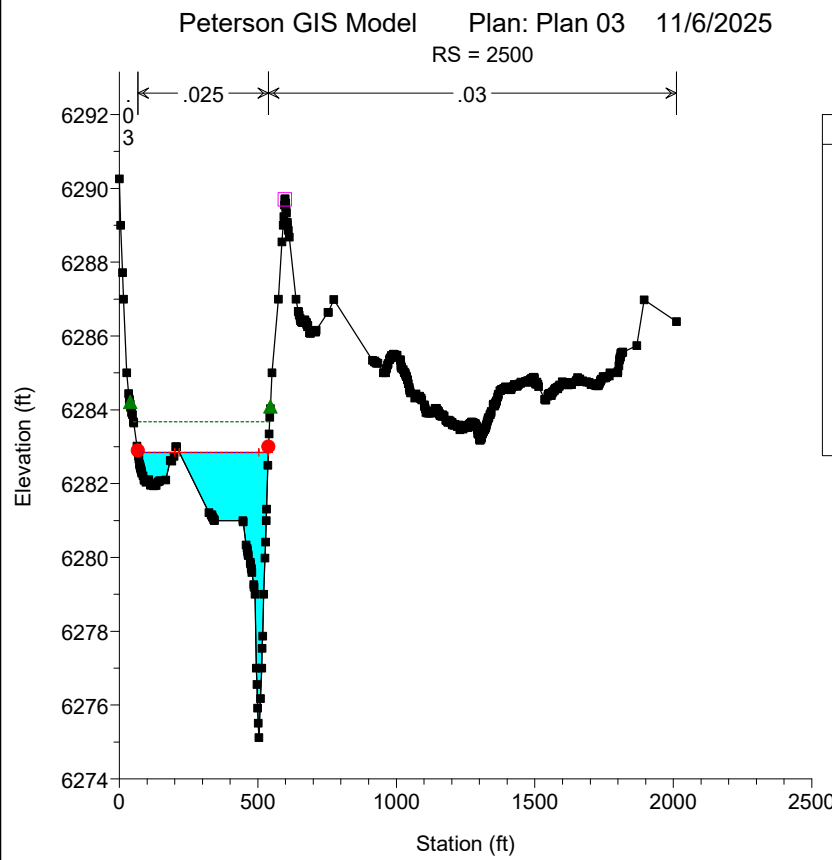
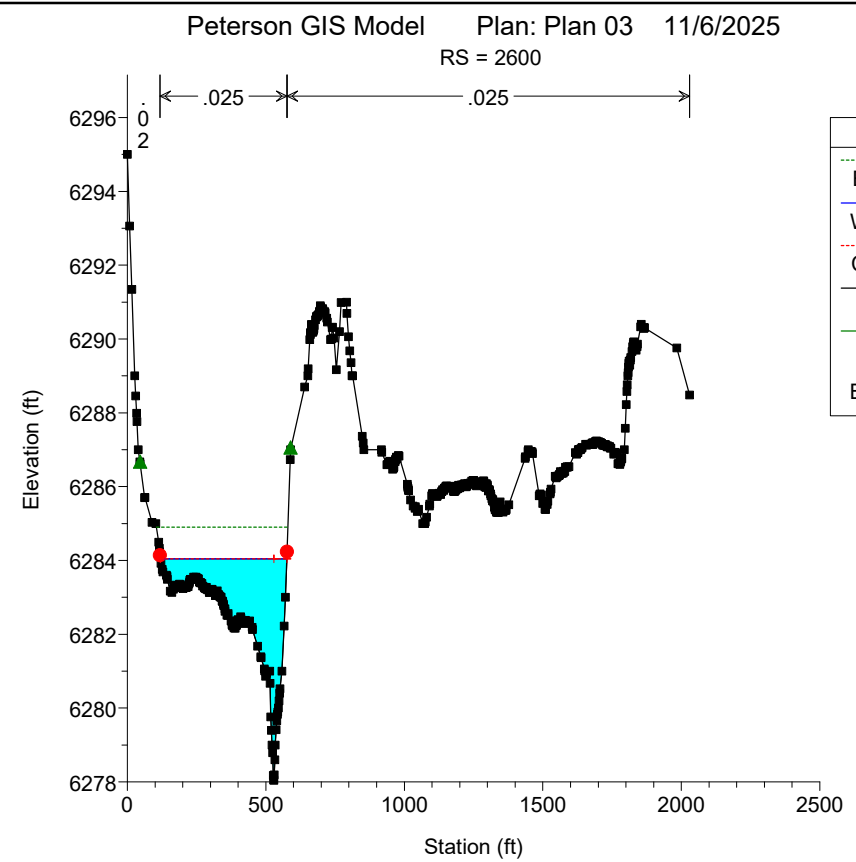
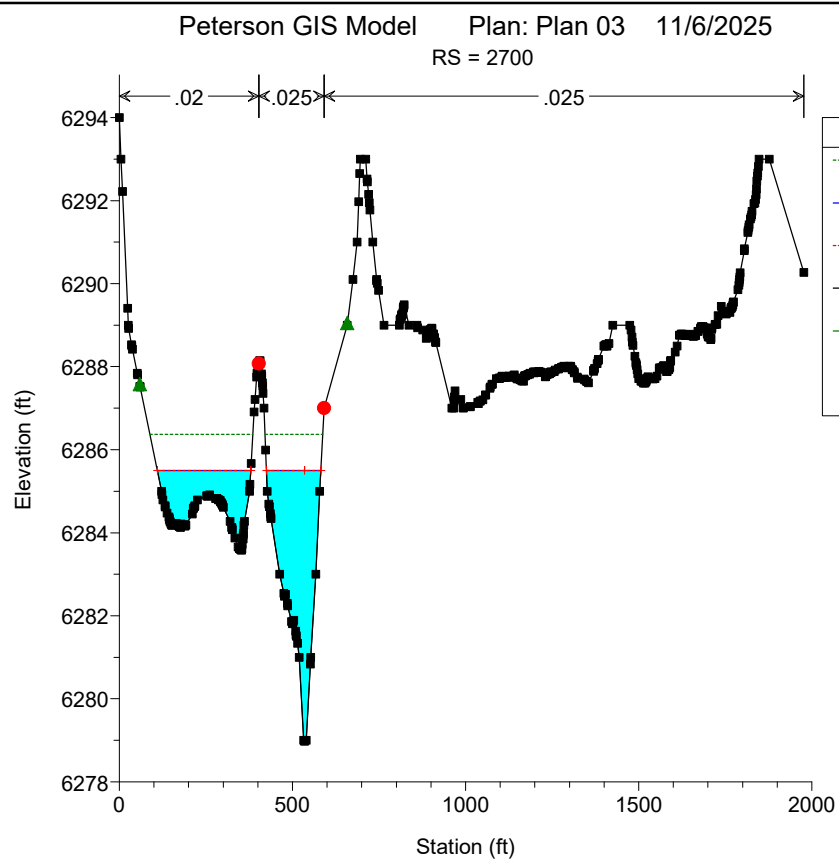
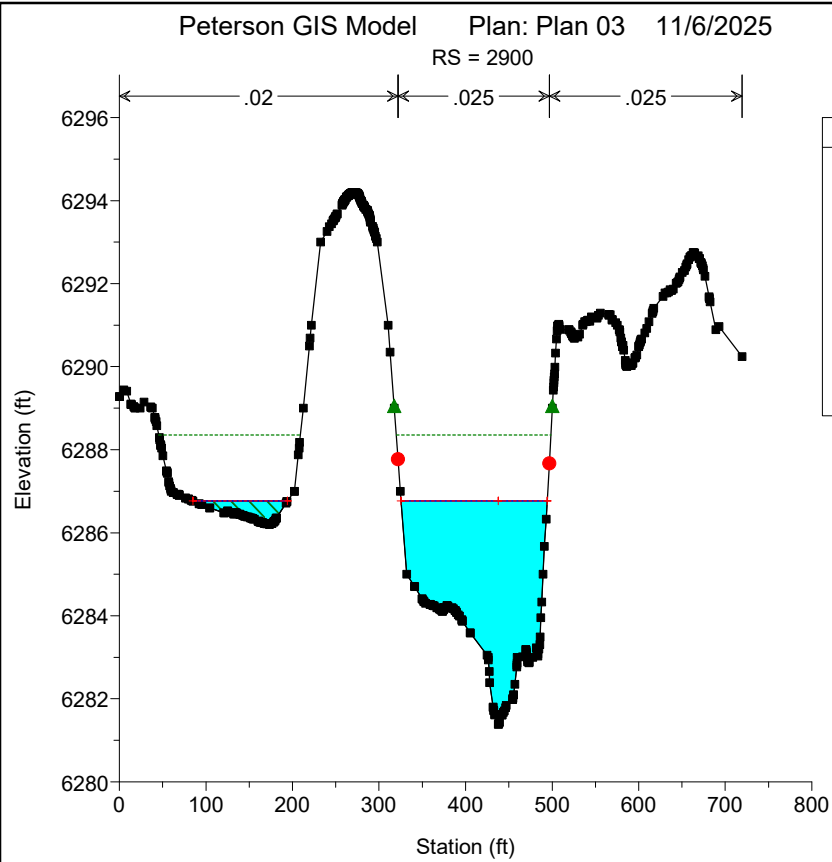
SECTIONS CONTAINING
IMPROVEMENTS WITHIN THE
FLOODPLAIN BEEN HIGHLIGHTED

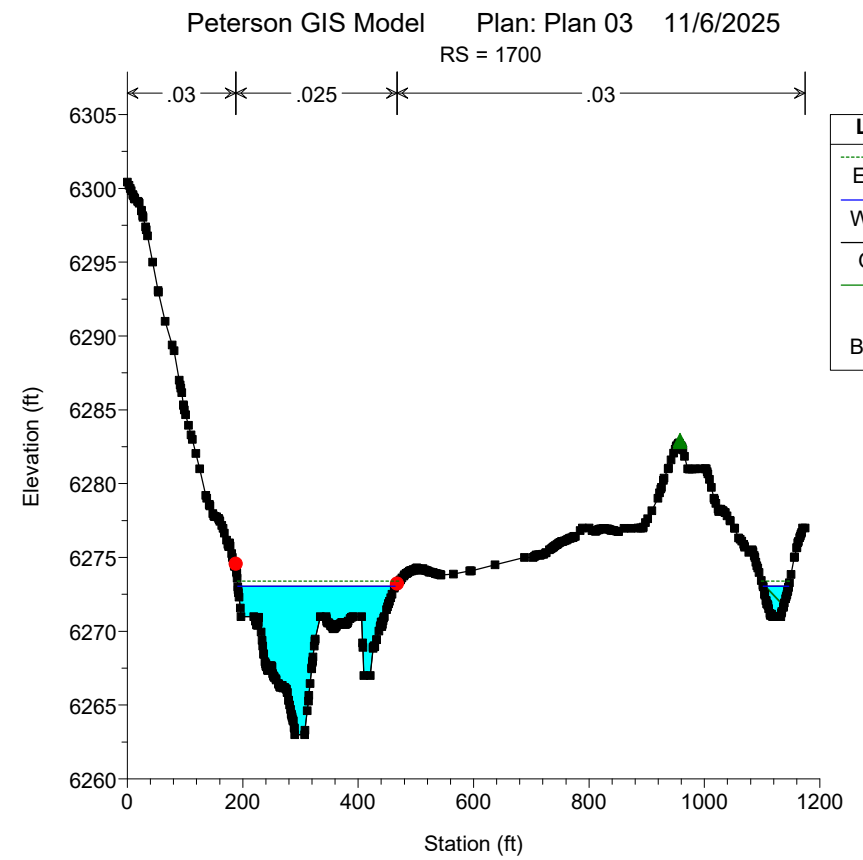
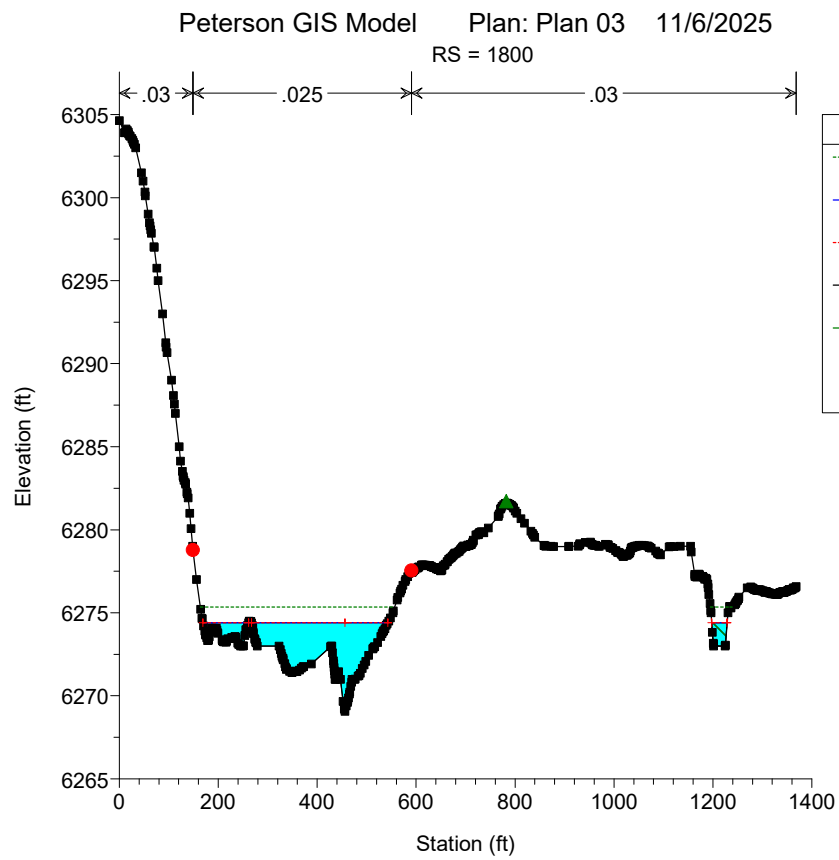
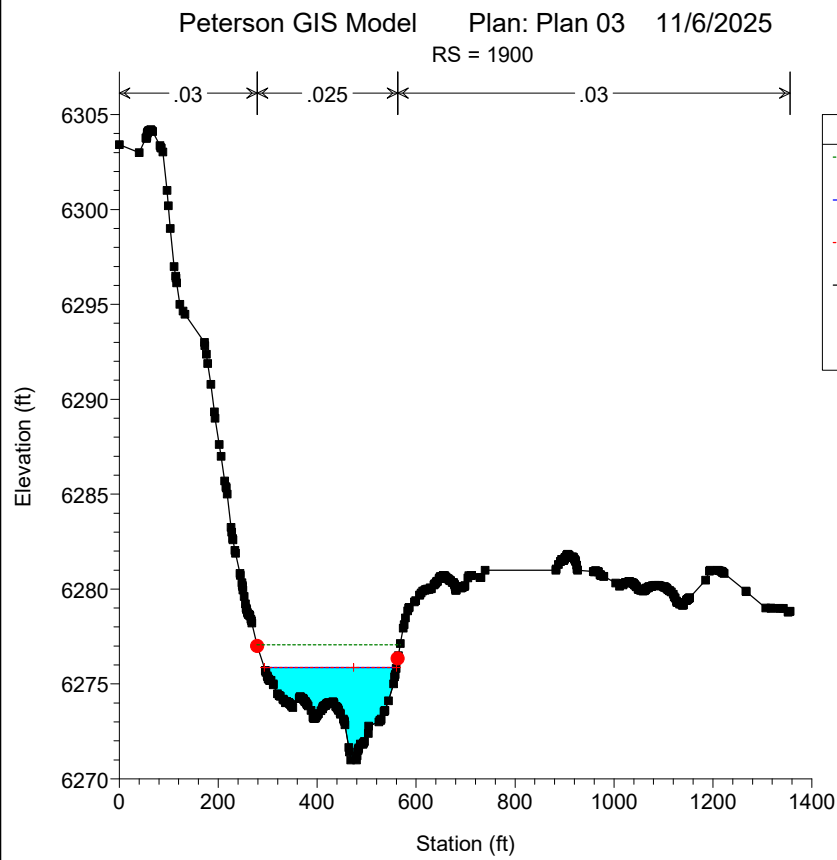
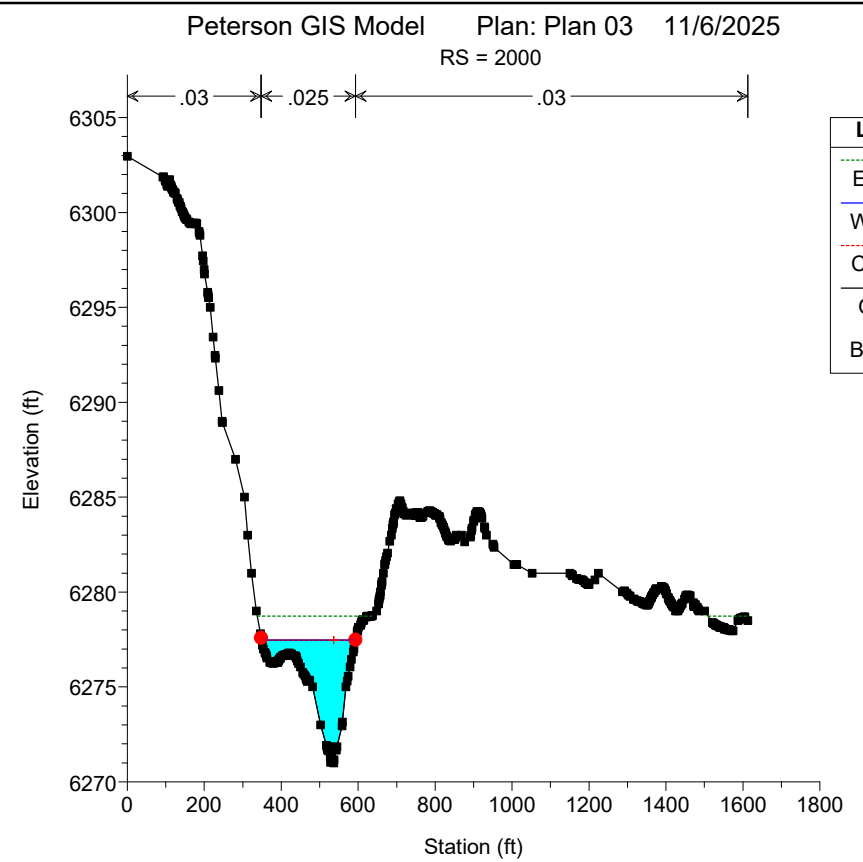
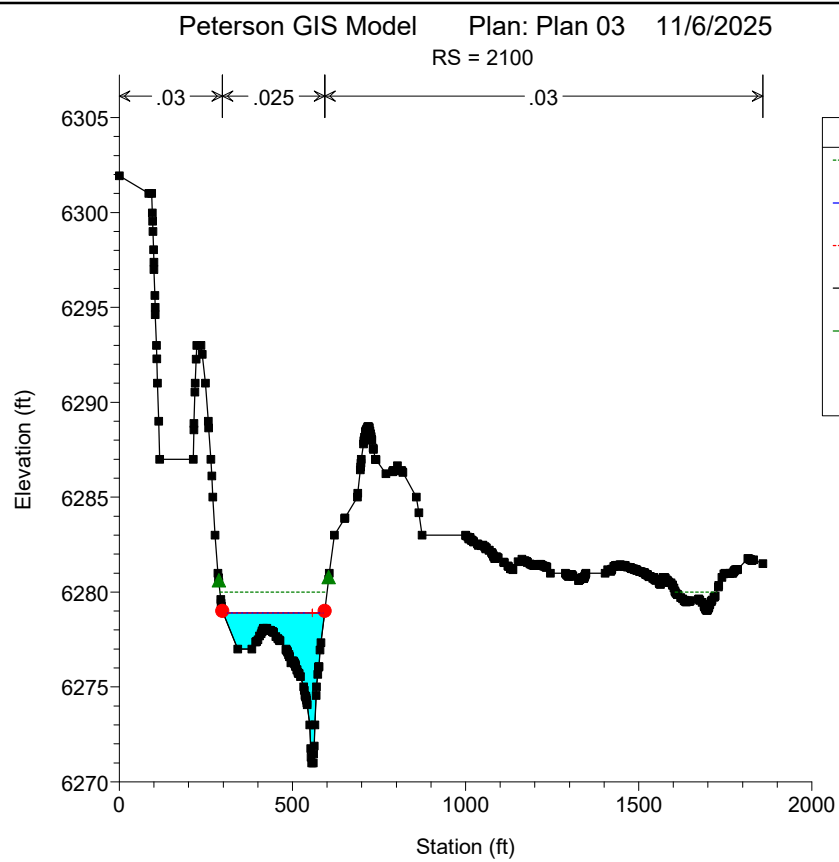
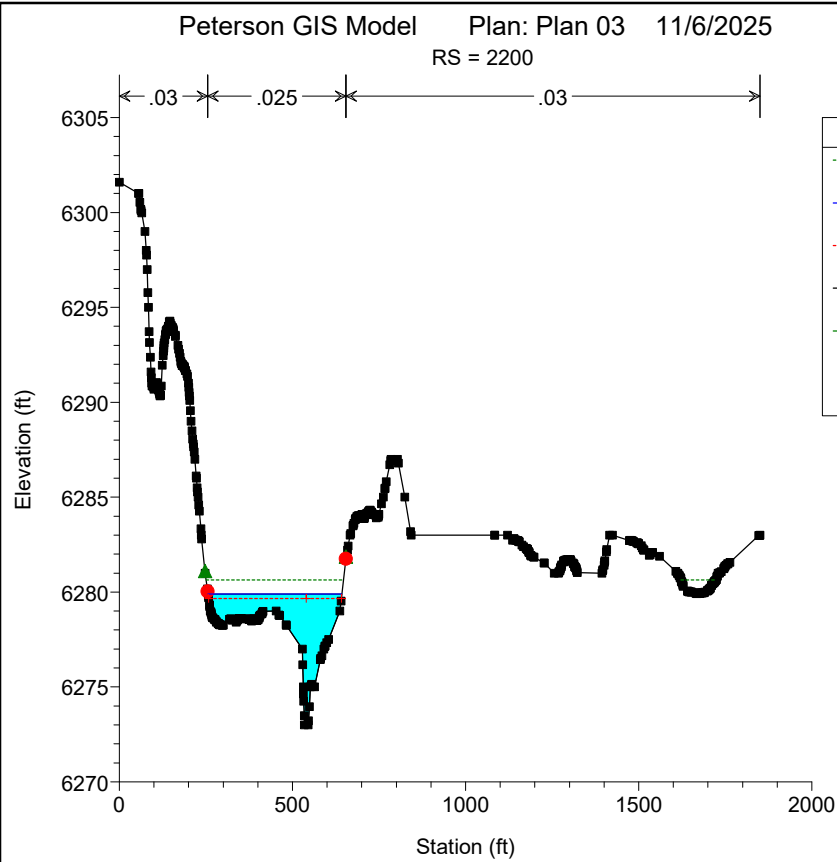


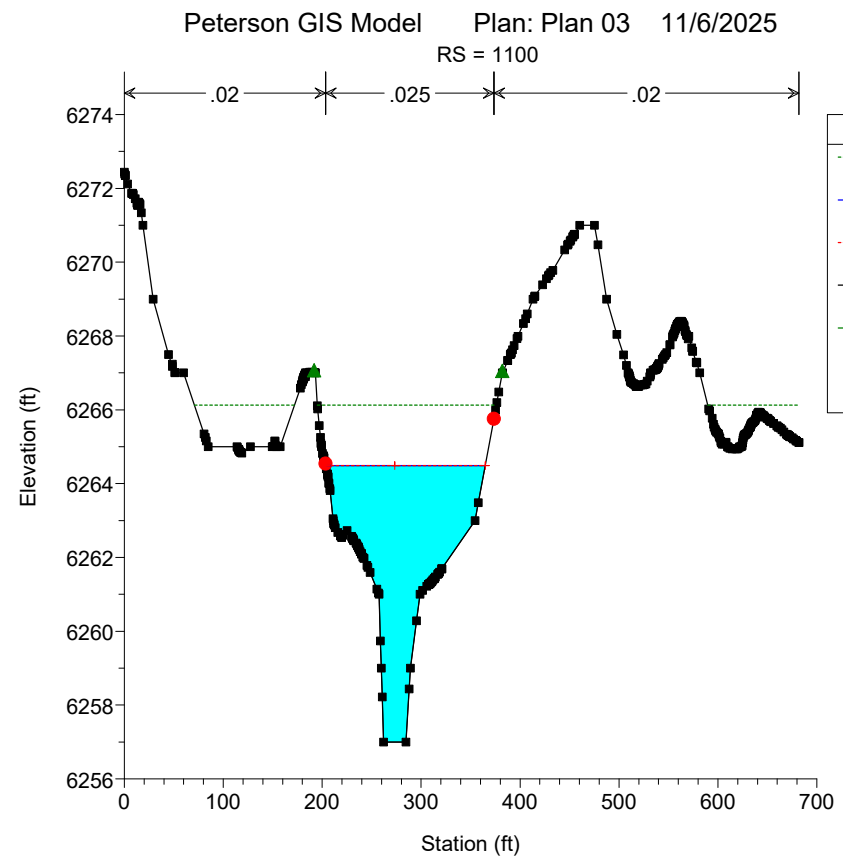
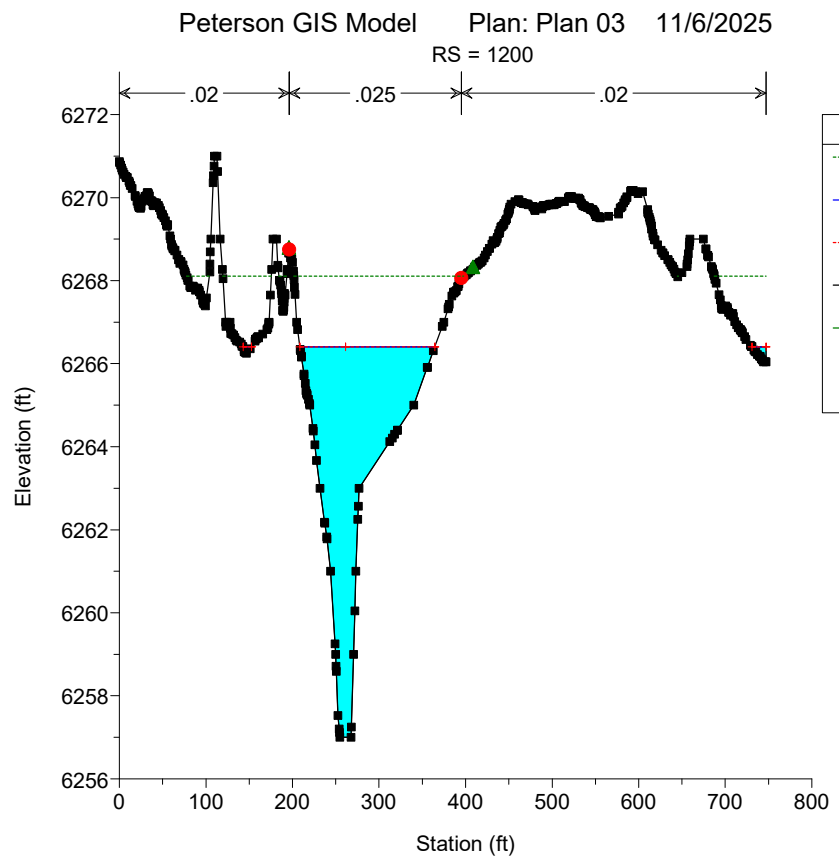
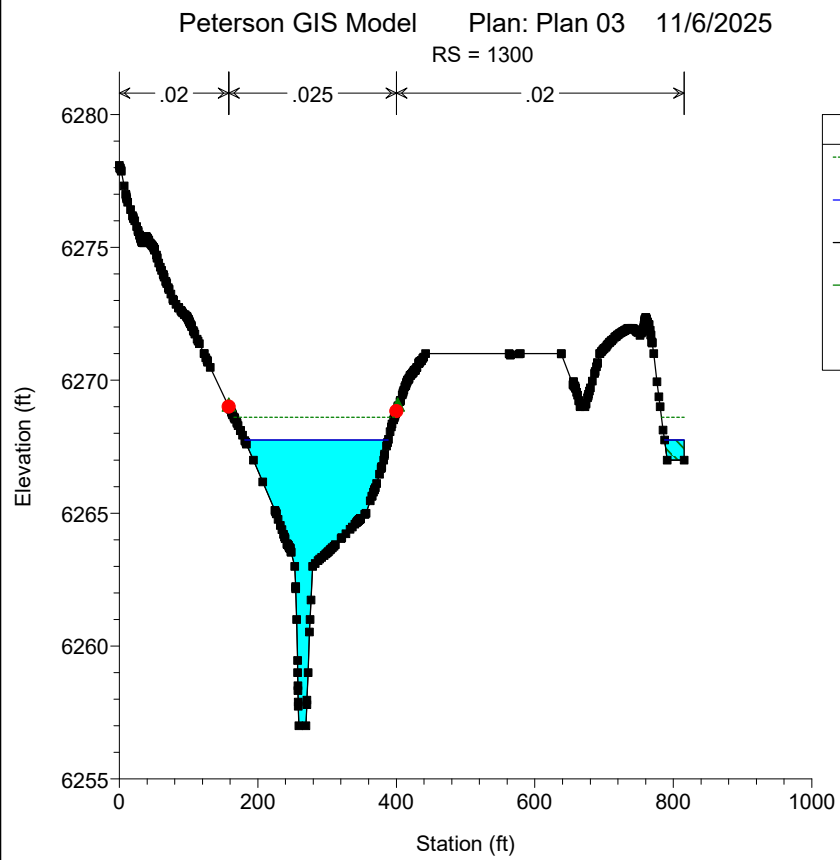
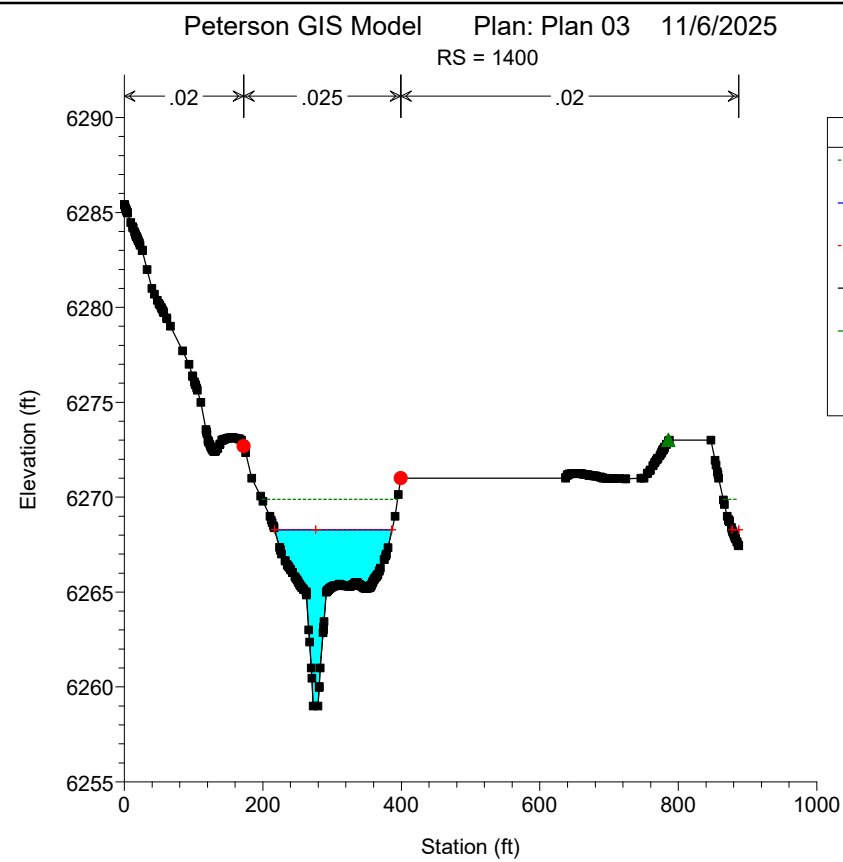
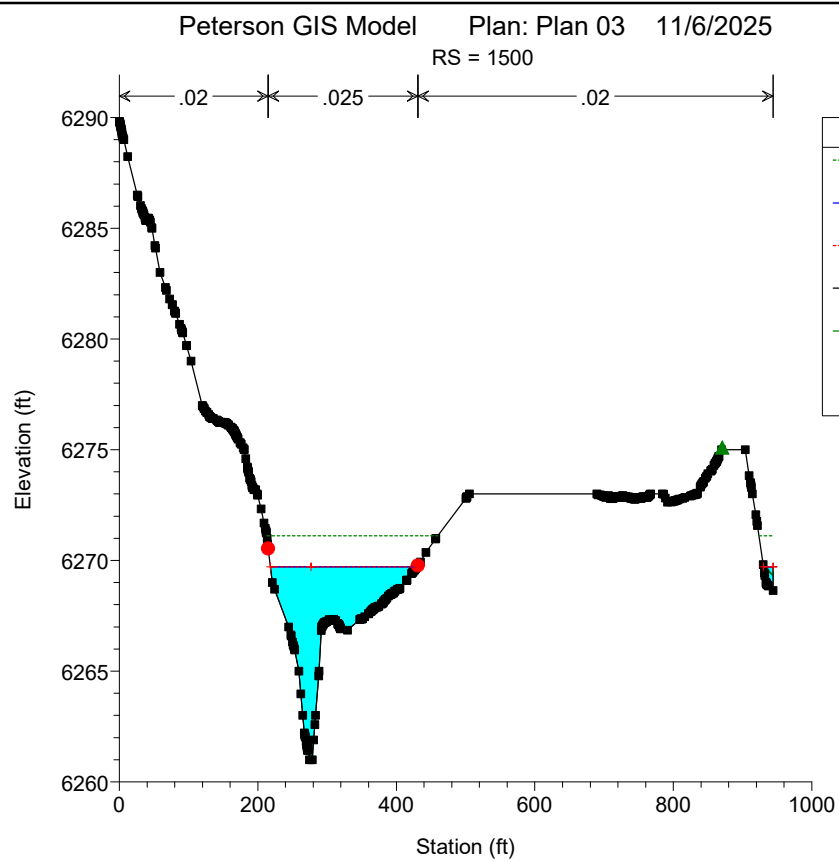
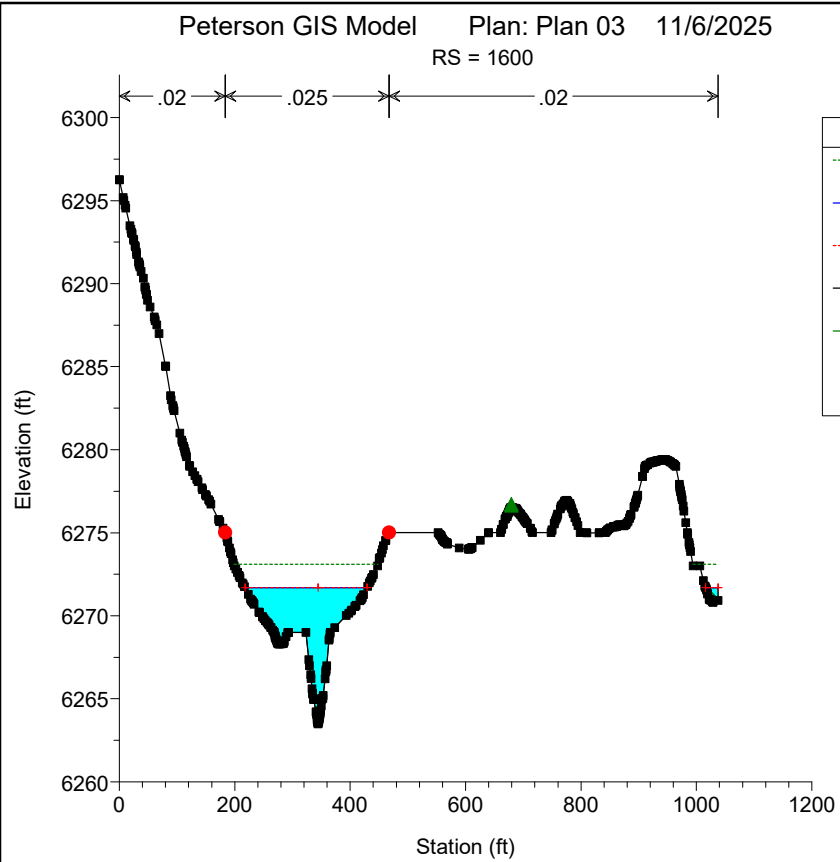


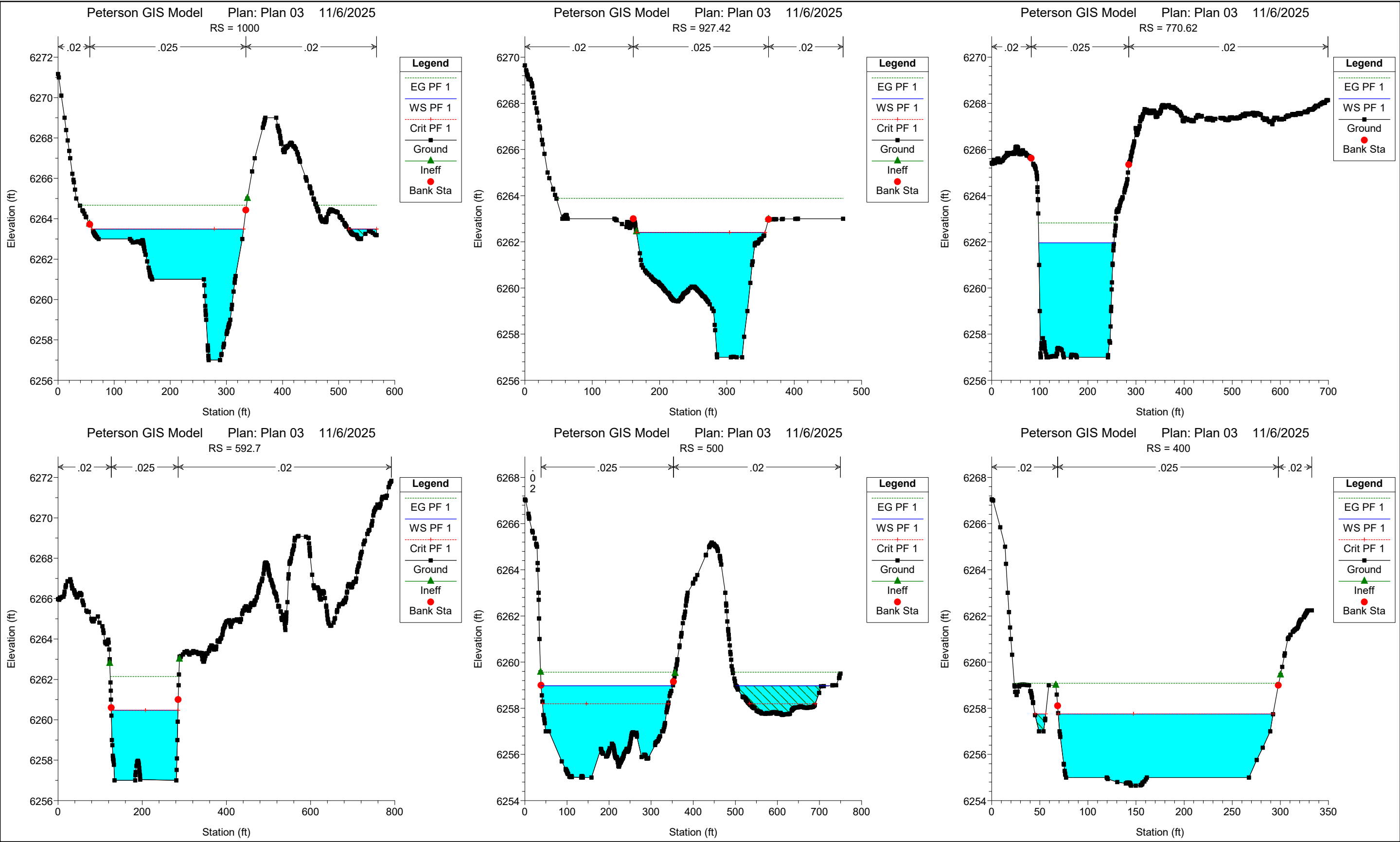


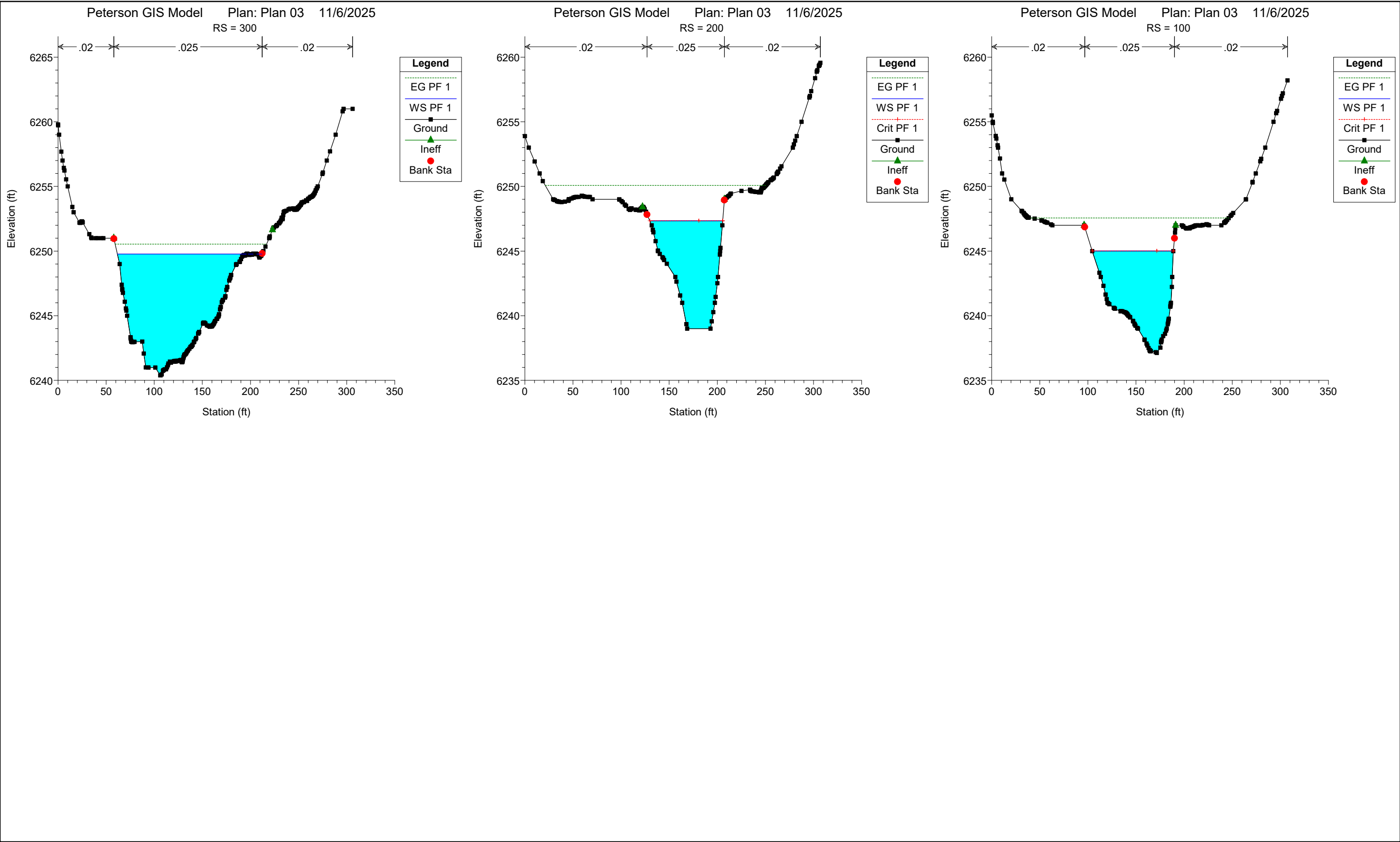










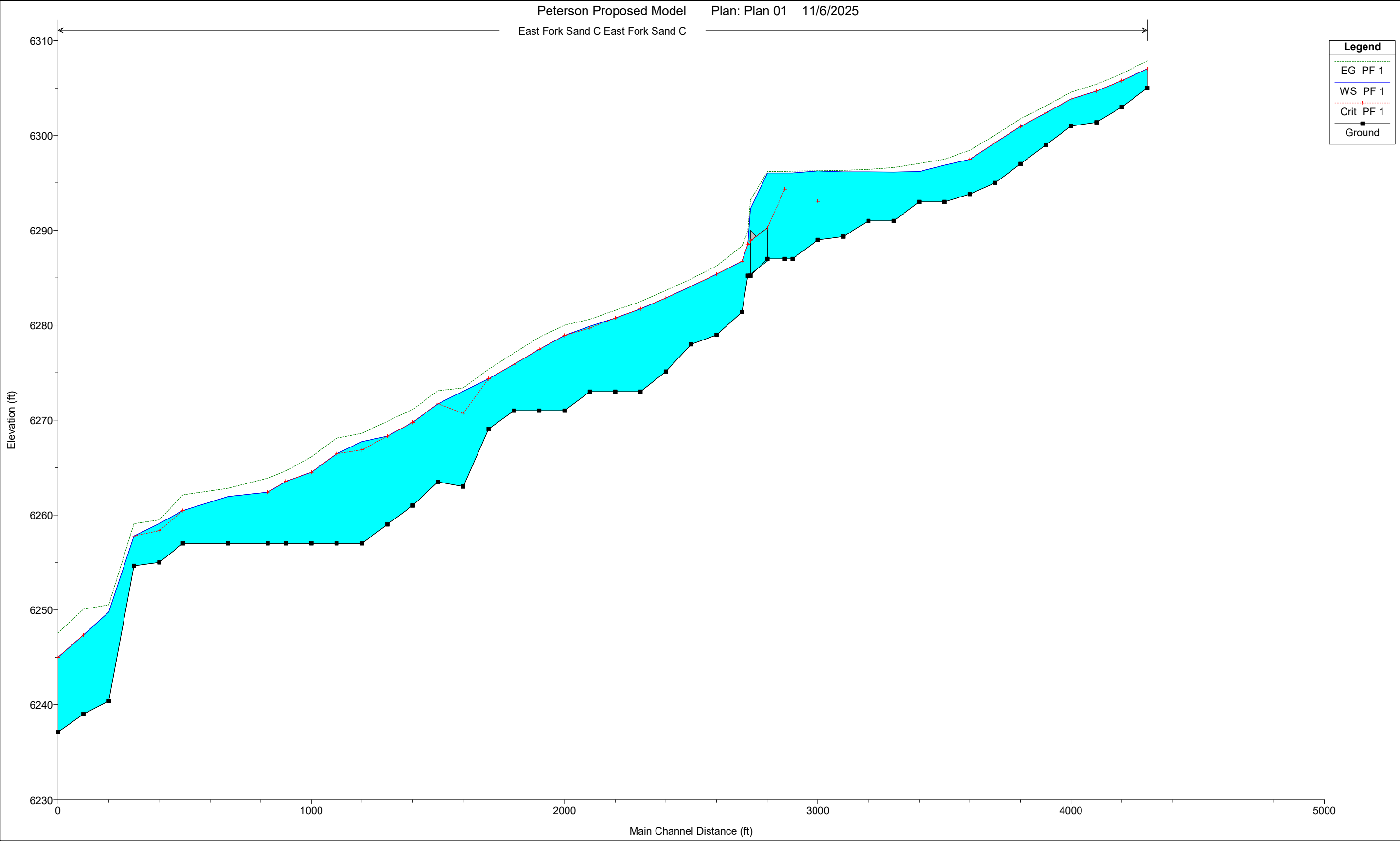


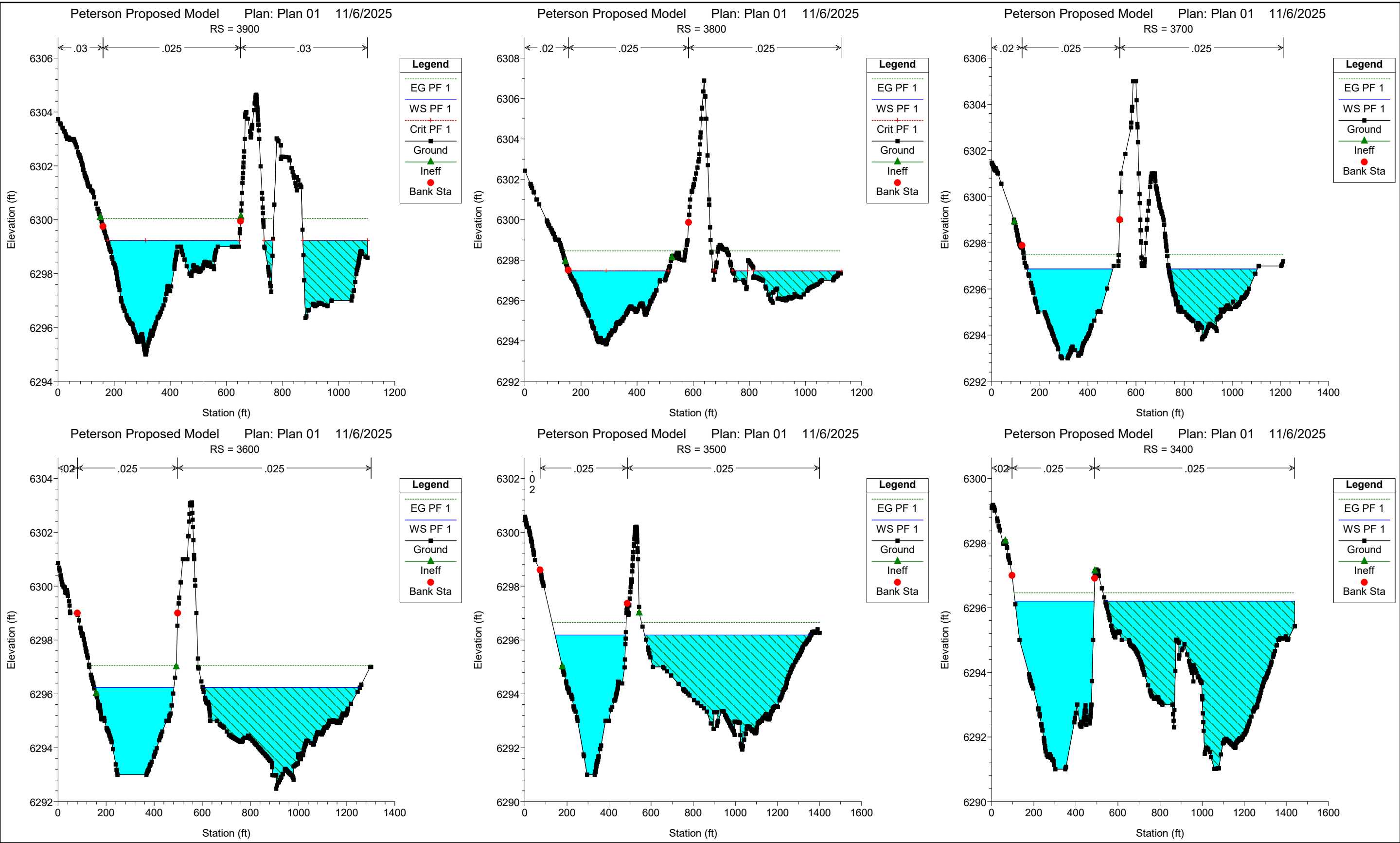
PROPOSED CONDITIONS HEC-RAS MODEL

HEC-RAS Plan: Plan 01 River: East Fork Sand C Reach: East Fork Sand C Profile: PF 1

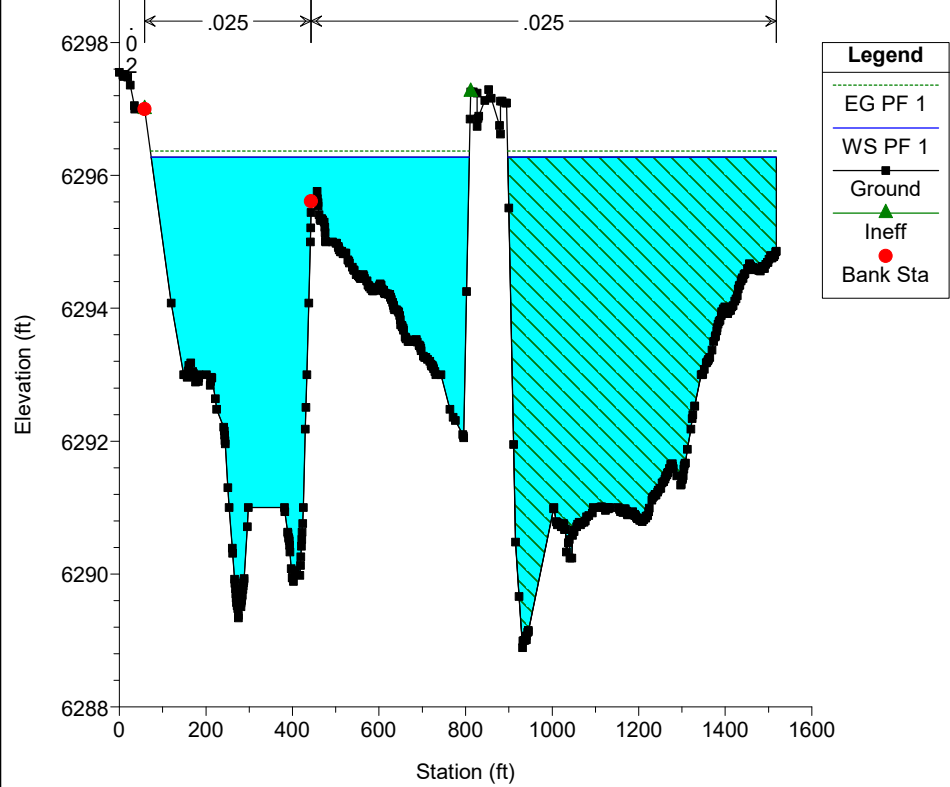
Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
East Fork Sand C	4500	PF 1	5420.0	6305.0	6307.0	6307.0	6307.9	0.007923	7.3	742.4	457.3	1.01
East Fork Sand C	4400	PF 1	5420.0	6303.0	6305.8	6305.8	6306.5	0.008091	6.9	786.6	536.4	1.00
East Fork Sand C	4300	PF 1	5420.0	6301.4	6304.7	6304.7	6305.4	0.008159	6.8	792.4	549.3	1.00
East Fork Sand C	4200	PF 1	5420.0	6301.0	6303.8	6303.8	6304.6	0.008342	6.8	796.5	581.1	1.01
East Fork Sand C	4100	PF 1	5420.0	6299.0	6302.4	6302.4	6303.1	0.008103	6.8	792.1	554.2	1.00
East Fork Sand C	4000	PF 1	5420.0	6297.0	6301.0	6301.0	6301.8	0.007627	7.1	759.5	641.9	0.99
East Fork Sand C	3900	PF 1	5420.0	6295.0	6299.2	6299.2	6300.0	0.007877	7.2	752.1	732.6	1.00
East Fork Sand C	3800	PF 1	5420.0	6293.8	6297.5	6297.5	6298.5	0.007535	8.0	681.7	732.0	1.01
East Fork Sand C	3700	PF 1	5420.0	6293.0	6296.9		6297.5	0.003611	6.4	851.2	725.3	0.73
East Fork Sand C	3600	PF 1	5420.0	6293.0	6296.2		6297.1	0.005046	7.3	747.5	985.3	0.85
East Fork Sand C	3500	PF 1	5420.0	6291.0	6296.2		6296.7	0.002024	5.5	988.4	1125.4	0.56
East Fork Sand C	3400	PF 1	5420.0	6291.0	6296.2		6296.5	0.000875	4.1	1329.2	1275.8	0.38
East Fork Sand C	3300	PF 1	5420.0	6289.3	6296.3		6296.4	0.000283	2.6	2374.6	1355.7	0.22
East Fork Sand C	3200	PF 1	5420.0	6289.0	6296.2		6296.3	0.000521	3.2	1682.2	1568.4	0.30
East Fork Sand C	3100	PF 1	5420.0	6287.0	6296.1		6296.3	0.000741	3.6	1525.0	1794.2	0.35
East Fork Sand C	3069.1	PF 1	5420.0	6287.0	6296.1	6294.4	6296.2	0.000725	3.4	2036.2	1867.7	0.34
East Fork Sand C	2991.67		Culvert									
East Fork Sand C	2923.67	PF 1	5420.0	6285.2	6288.5	6288.5	6289.8	0.005925	6.9	607.2	230.4	0.89
East Fork Sand C	2900	PF 1	5420.0	6281.4	6286.7	6286.7	6288.4	0.006336	10.2	532.9	275.4	1.01
East Fork Sand C	2700	PF 1	5420.0	6279.0	6285.4	6285.4	6286.2	0.007448	7.4	732.8	422.2	0.99
East Fork Sand C	2600	PF 1	5420.0	6278.0	6284.0	6284.0	6284.9	0.008351	7.4	730.8	457.1	1.03
East Fork Sand C	2500	PF 1	5420.0	6275.1	6282.8	6282.8	6283.7	0.007931	7.3	740.3	453.5	1.01
East Fork Sand C	2400	PF 1	5420.0	6273.0	6281.7	6281.7	6282.5	0.007703	7.0	774.8	538.0	0.99
East Fork Sand C	2300	PF 1	5420.0	6273.0	6280.8	6280.8	6281.6	0.007609	7.2	749.1	452.4	0.99
East Fork Sand C	2200	PF 1	5420.0	6273.0	6279.9	6279.7	6280.6	0.005363	6.9	781.1	386.2	0.86
East Fork Sand C	2100	PF 1	5420.0	6271.0	6278.9	6278.9	6280.0	0.006849	8.3	651.5	294.4	0.99
East Fork Sand C	2000	PF 1	5420.0	6271.0	6277.5	6277.5	6278.7	0.006972	9.0	601.0	244.5	1.01
East Fork Sand C	1900	PF 1	5420.0	6271.0	6275.9	6275.9	6277.1	0.007014	8.7	621.4	267.1	1.01
East Fork Sand C	1800	PF 1	5420.0	6269.1	6274.4	6274.4	6275.4	0.007539	7.8	691.4	398.8	1.01
East Fork Sand C	1700	PF 1	5420.0	6263.0	6273.0		6273.4	0.000978	4.8	1139.0	317.2	0.41
East Fork Sand C	1600	PF 1	5420.0	6263.5	6271.7	6271.7	6273.1	0.006611	9.4	578.3	234.2	1.00
East Fork Sand C	1500	PF 1	5420.0	6261.0	6269.7	6269.7	6271.1	0.006972	9.5	568.7	225.2	1.02
East Fork Sand C	1400	PF 1	5420.0	6259.0	6268.3	6268.3	6269.9	0.006254	10.0	540.6	179.9	0.99
East Fork Sand C	1300	PF 1	5420.0	6257.0	6267.8		6268.6	0.003034	7.4	727.6	235.5	0.70
East Fork Sand C	1200	PF 1	5420.0	6257.0	6266.4	6266.4	6268.1	0.006394	10.5	518.4	181.8	1.01
East Fork Sand C	1100	PF 1	5420.0	6257.0	6264.5	6264.5	6266.1	0.006246	10.3	528.1	161.1	1.00
East Fork Sand C	1000	PF 1	5420.0	6257.0	6263.5	6263.5	6264.7	0.007106	8.7	622.3	319.8	1.01
East Fork Sand C	927.42	PF 1	5420.0	6257.0	6262.4	6262.4	6263.9	0.006555	9.8	555.1	190.8	1.01
East Fork Sand C	770.62	PF 1	5420.0	6257.0	6262.0		6262.8	0.002101	7.5	726.9	156.4	0.61
East Fork Sand C	592.7	PF 1	5420.0	6257.0	6260.5	6260.5	6262.1	0.006317	10.4	523.0	158.5	1.01
East Fork Sand C	500	PF 1	5420.0	6255.0	6259.0	6258.2	6259.6	0.002684	6.1	882.8	534.3	0.64
East Fork Sand C	400	PF 1	5420.0	6254.7	6257.8	6257.8	6259.1	0.006733	9.3	585.6	234.6	1.01
East Fork Sand C	300	PF 1	5420.0	6240.4	6249.8		6250.5	0.001540	7.0	771.9	144.6	0.54
East Fork Sand C	200	PF 1	5420.0	6239.0	6247.3	6247.3	6250.1	0.005577	13.2	409.5	75.8	1.00
East Fork Sand C	100	PF 1	5420.0	6237.1	6245.0	6245.0	6247.6	0.005723	12.8	423.0	84.2	1.01

SECTIONS CONTAINING
IMPROVEMENTS WITHIN THE
FLOODPLAIN BEEN HIGHLIGHTED

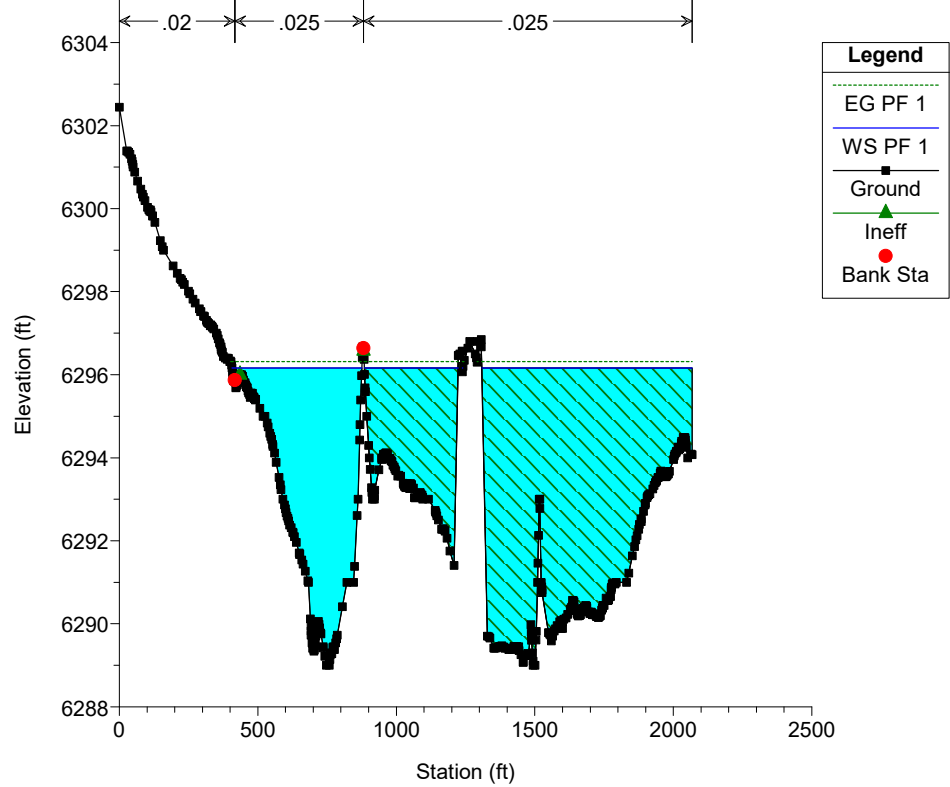




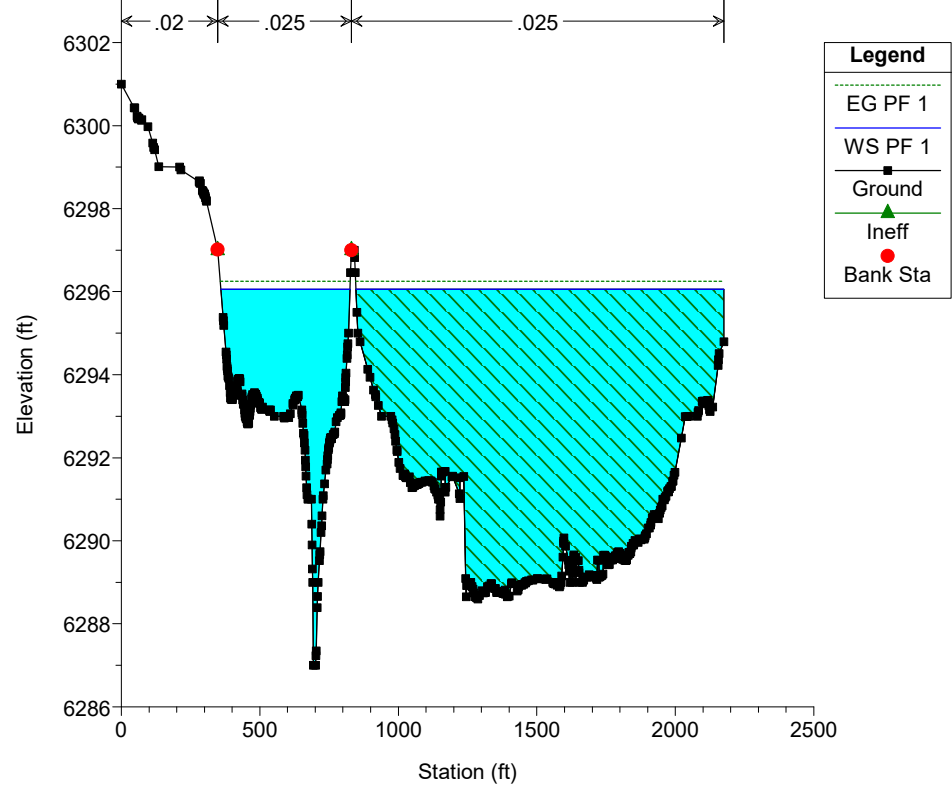
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RS = 3300



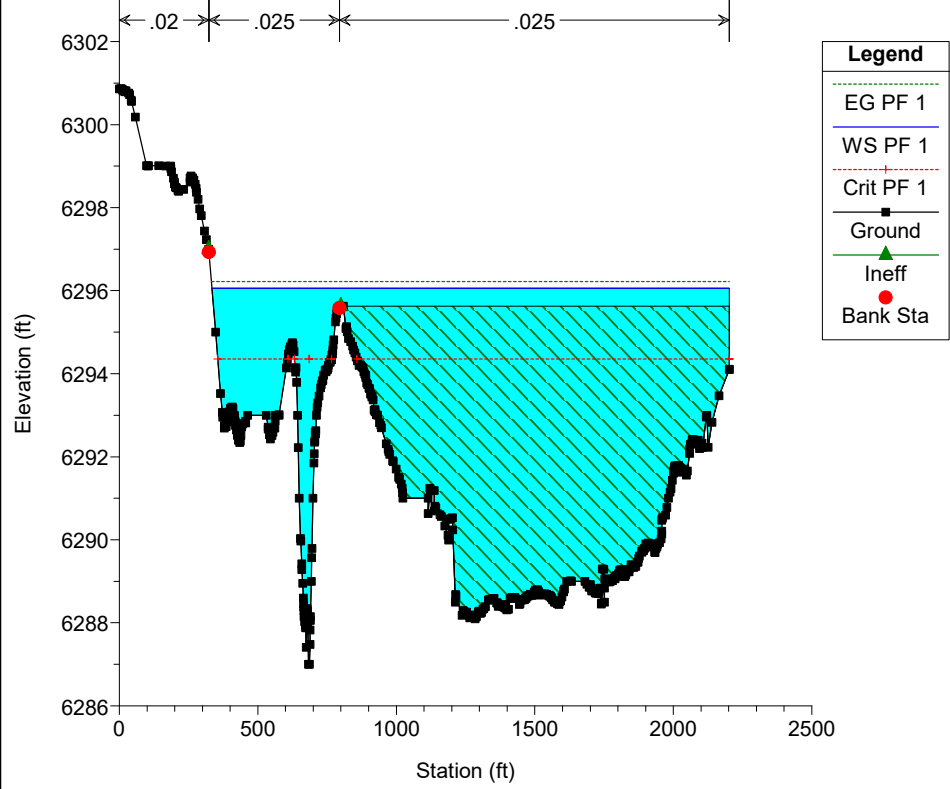
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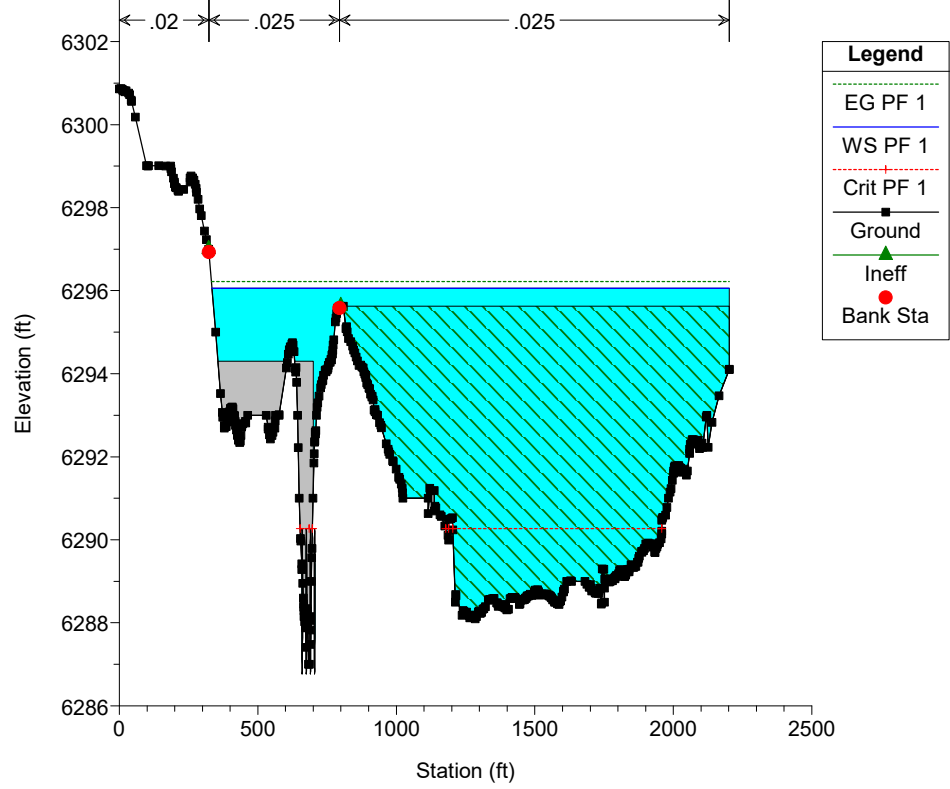
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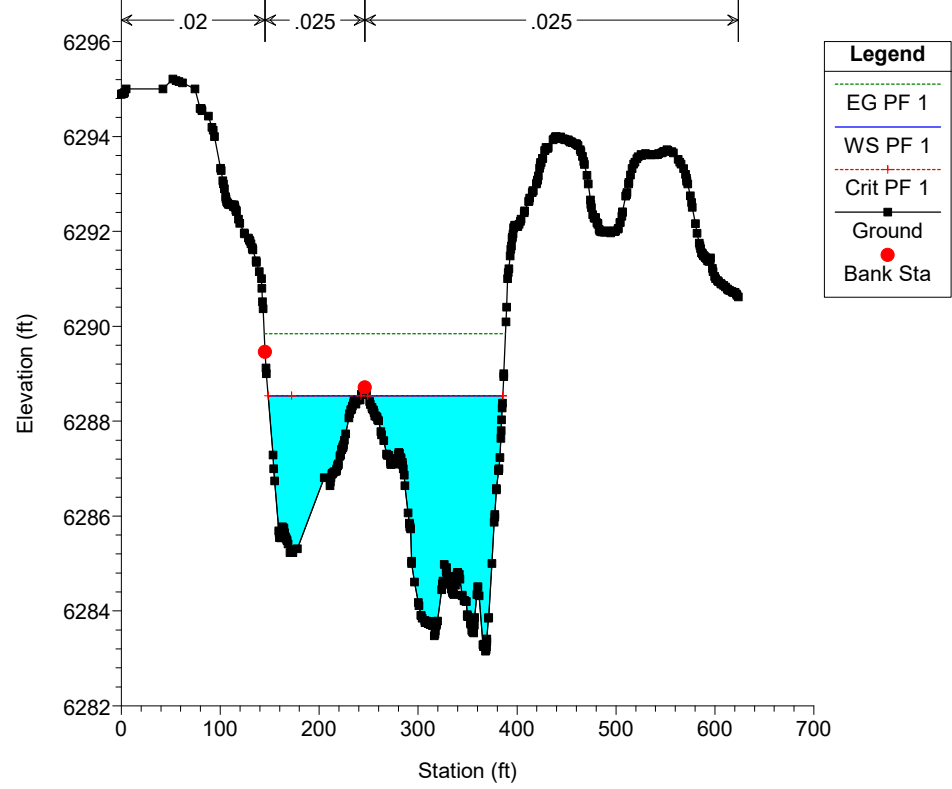
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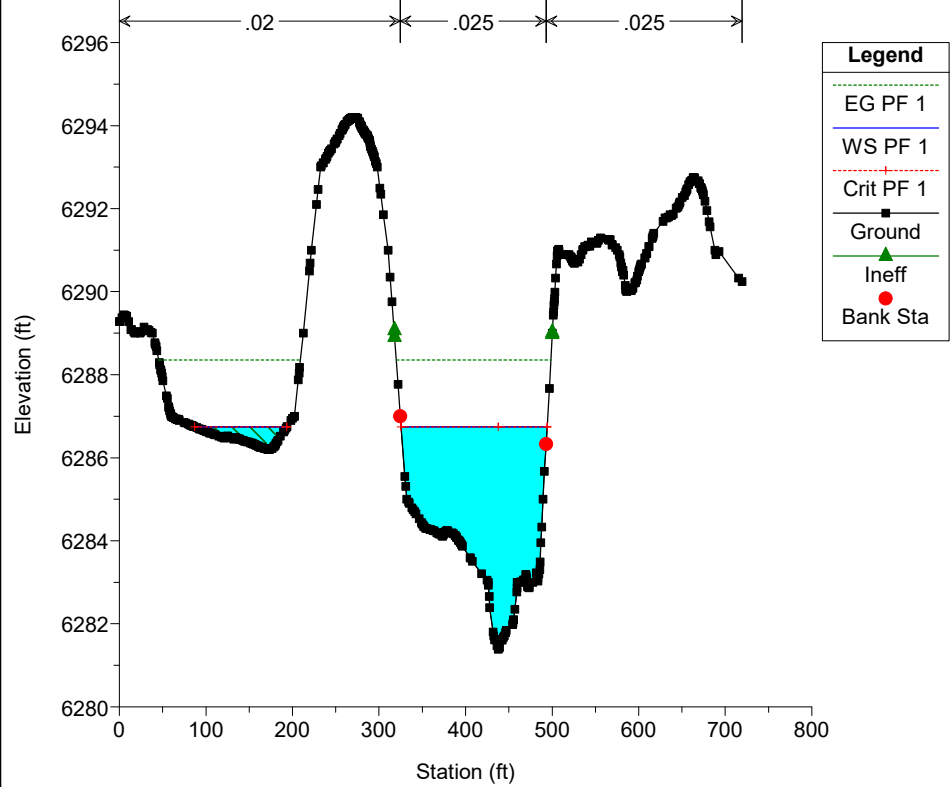
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RS = 2991.67 Culv



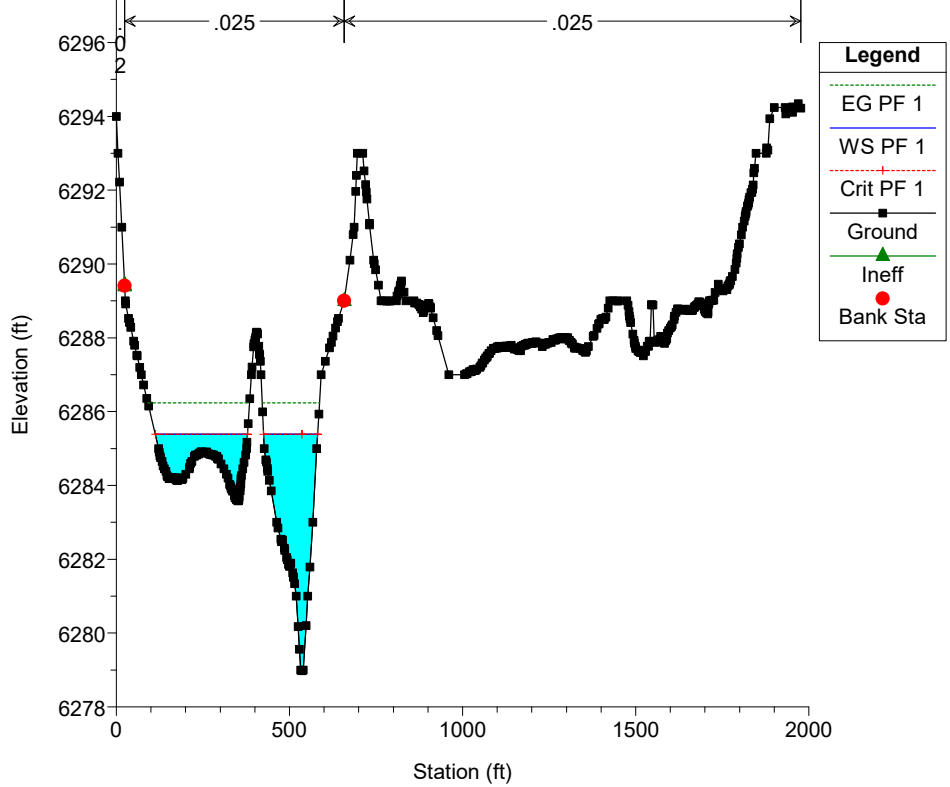
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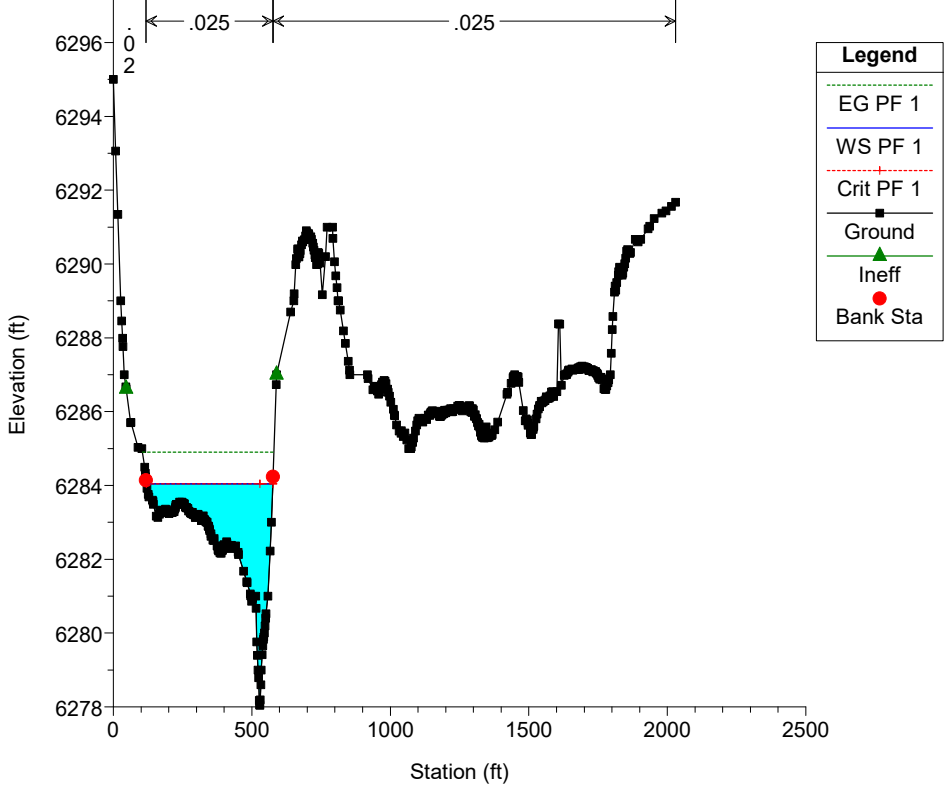
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RS = 2900



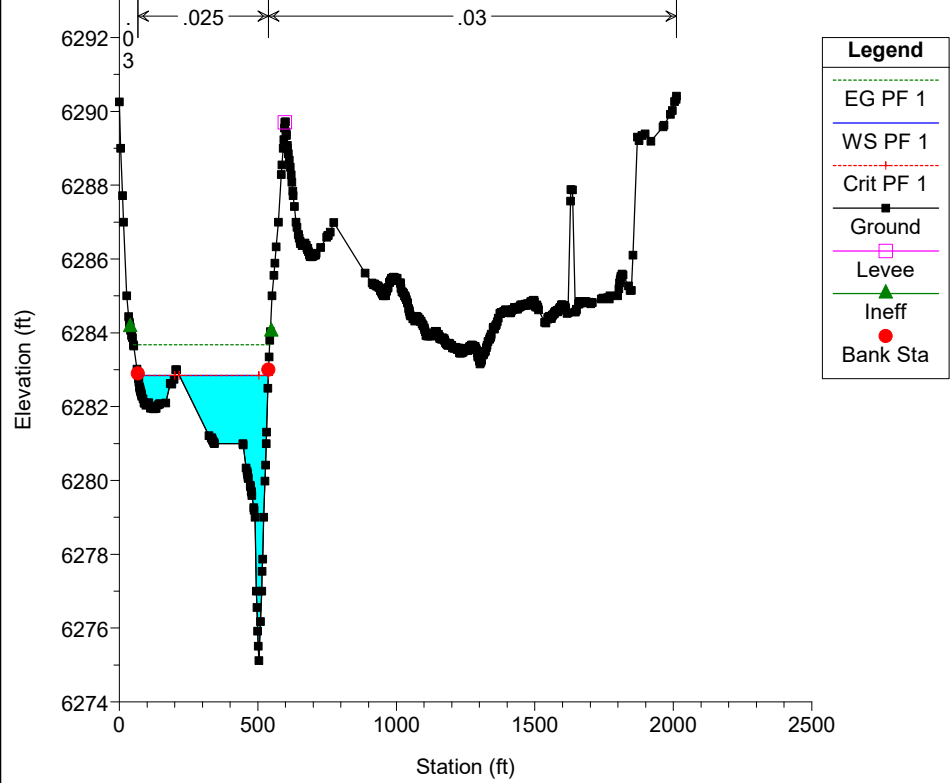
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RS = 2700



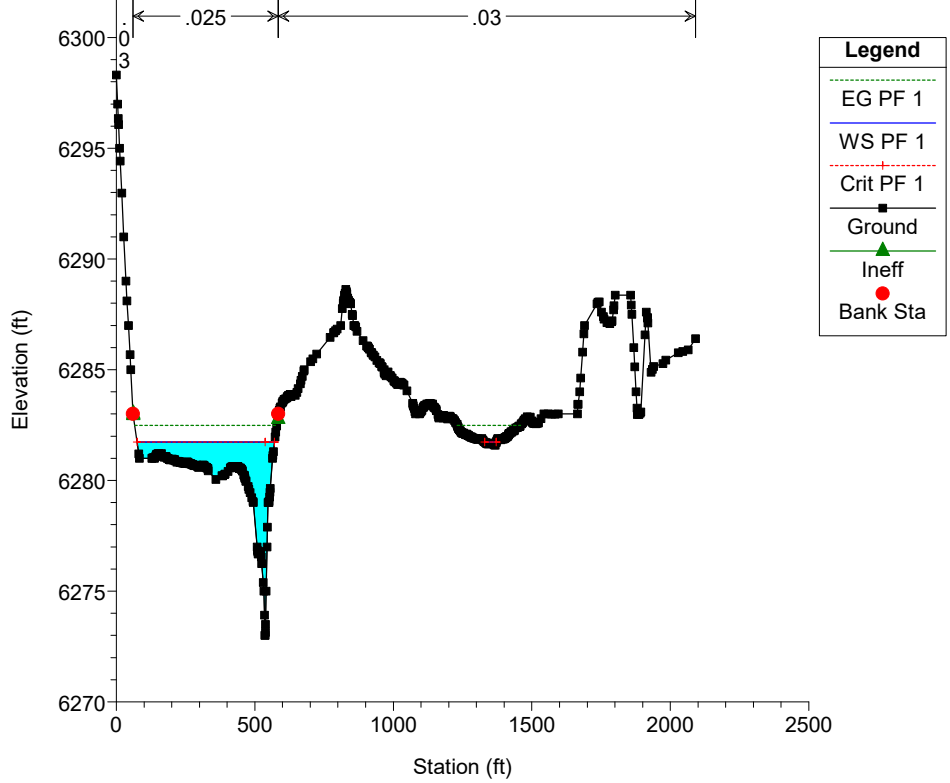
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RS = 2600



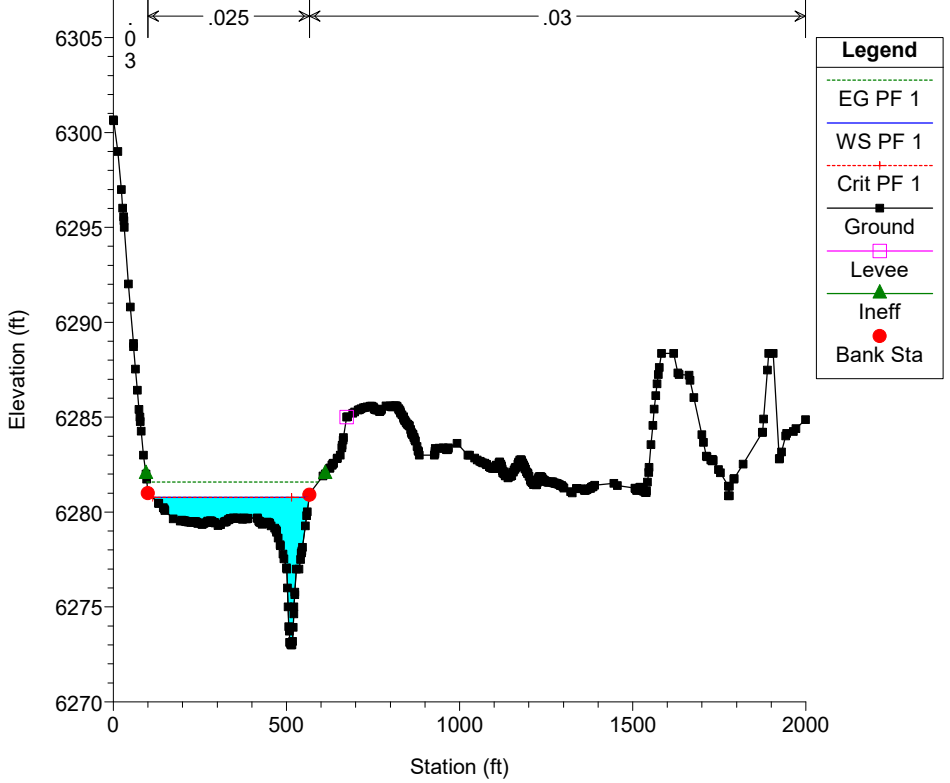
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RS = 2500



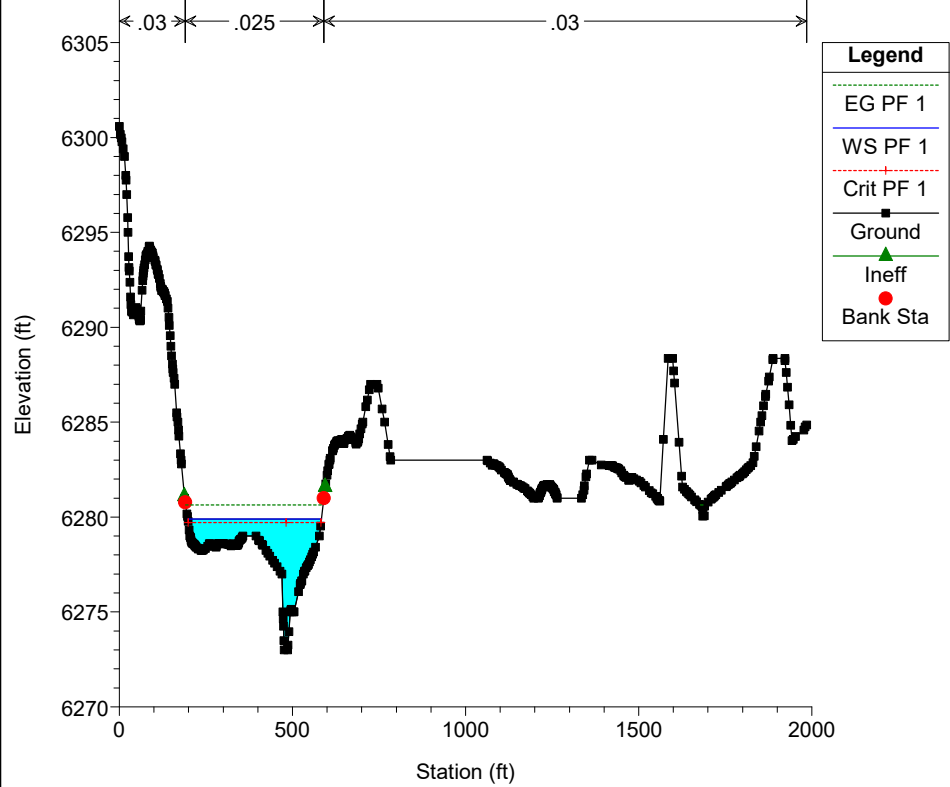
Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 2400



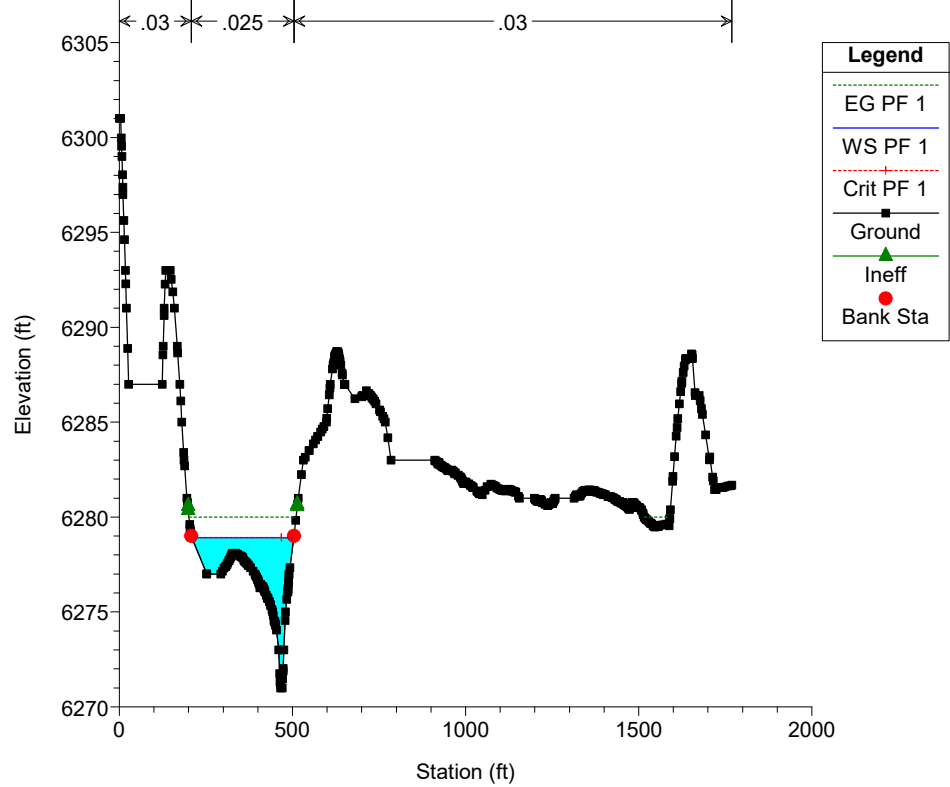
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RS = 2300



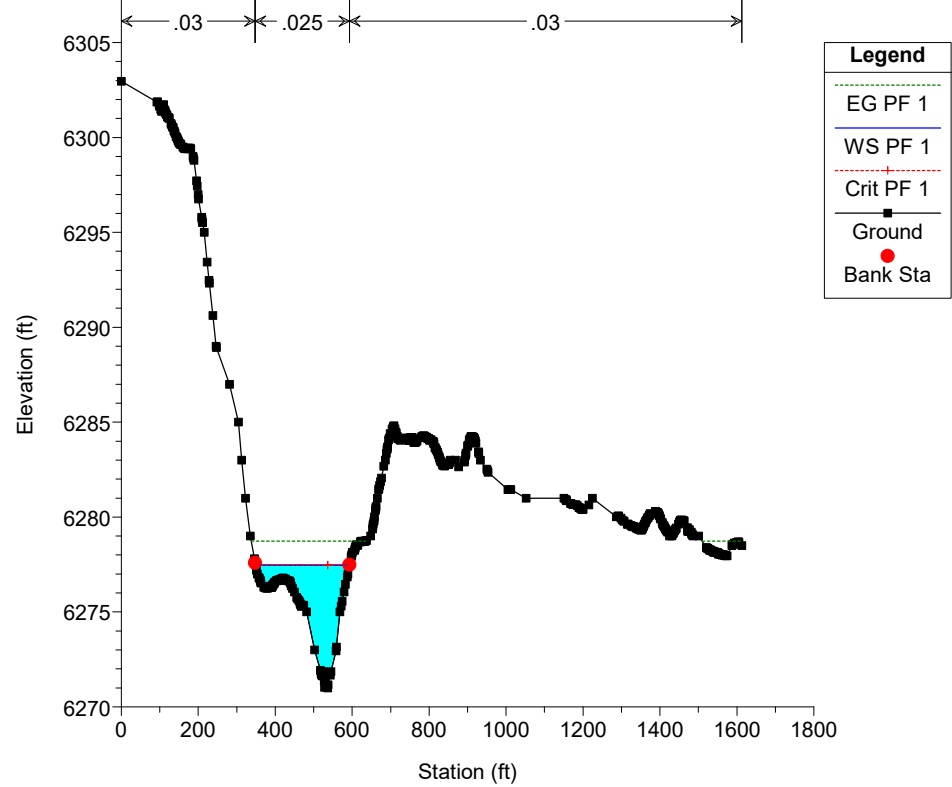
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RS = 2200



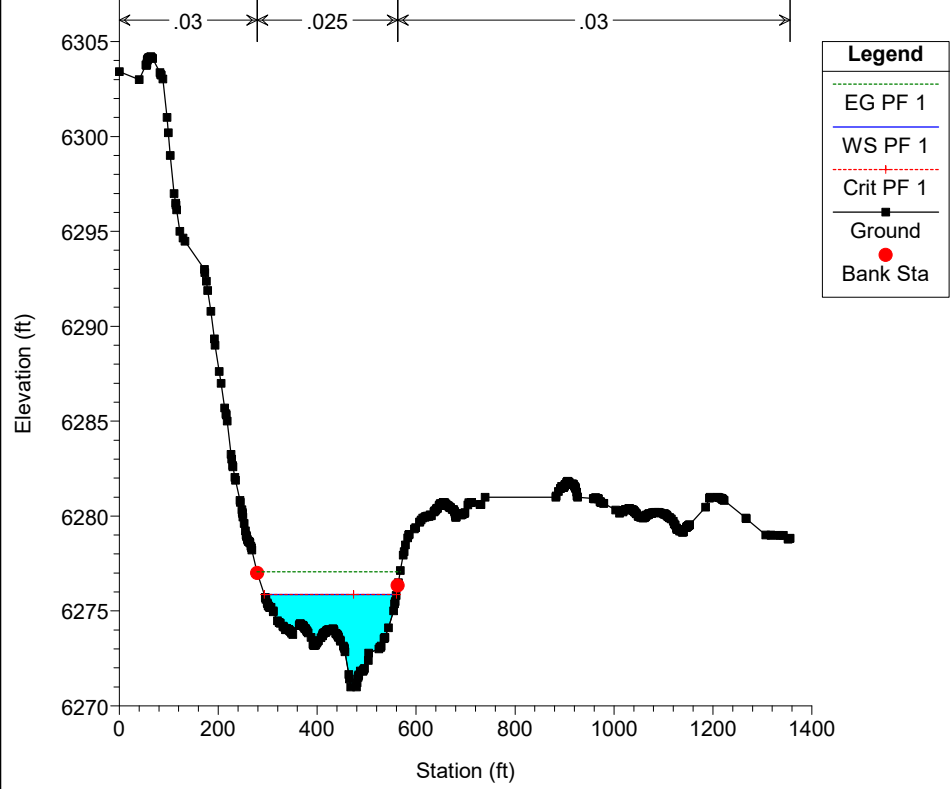
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RS = 2100



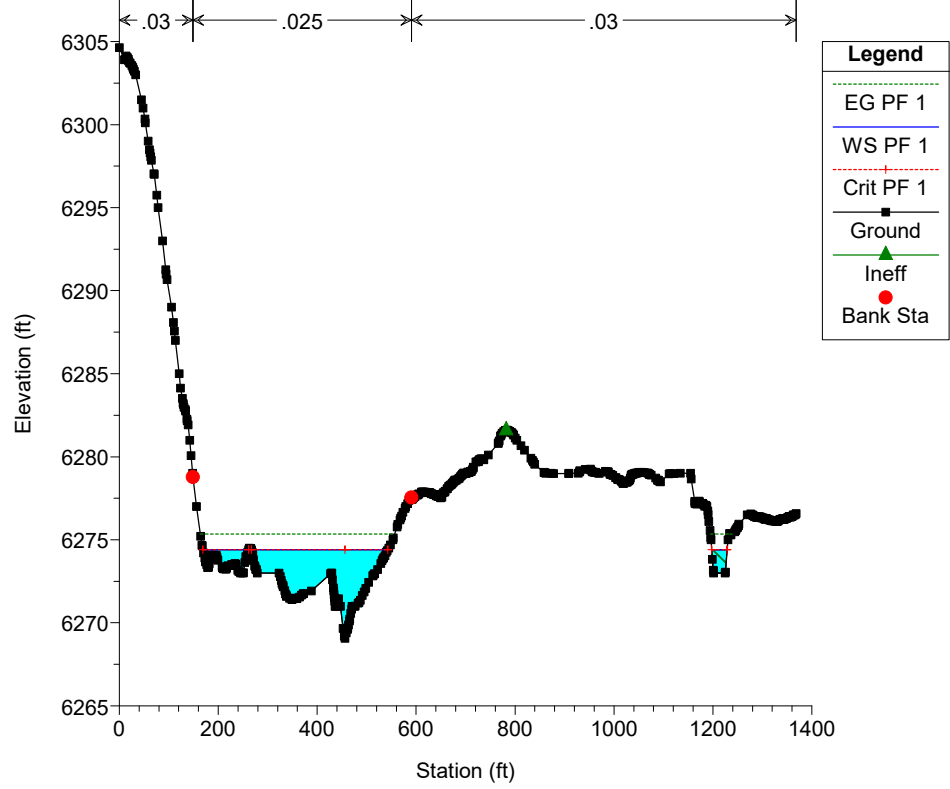
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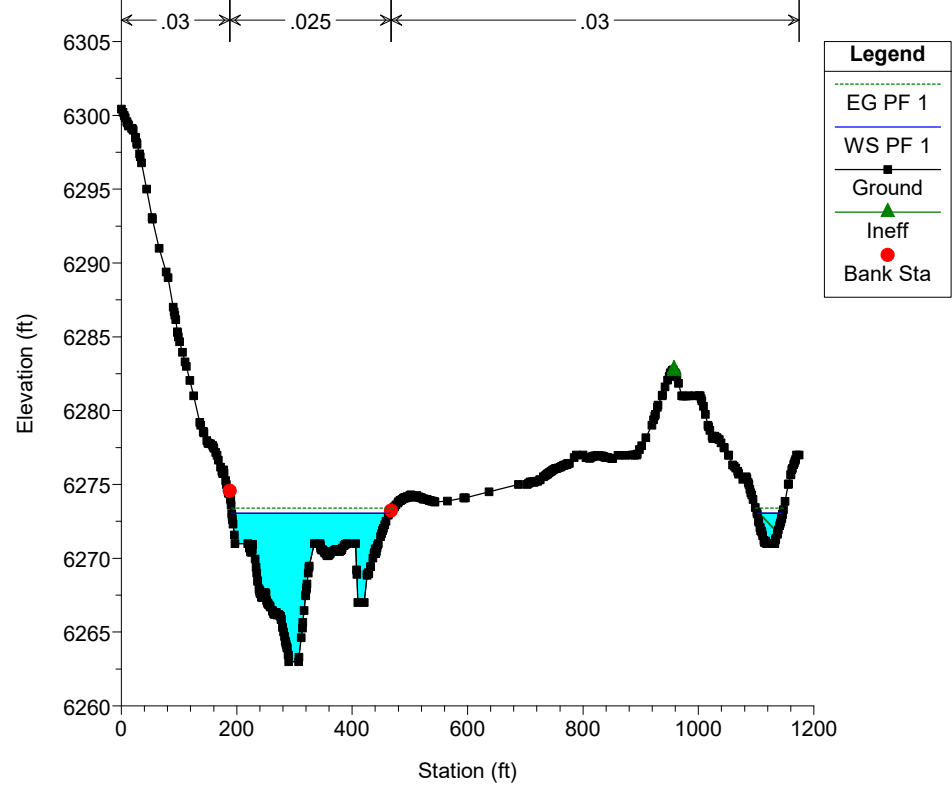
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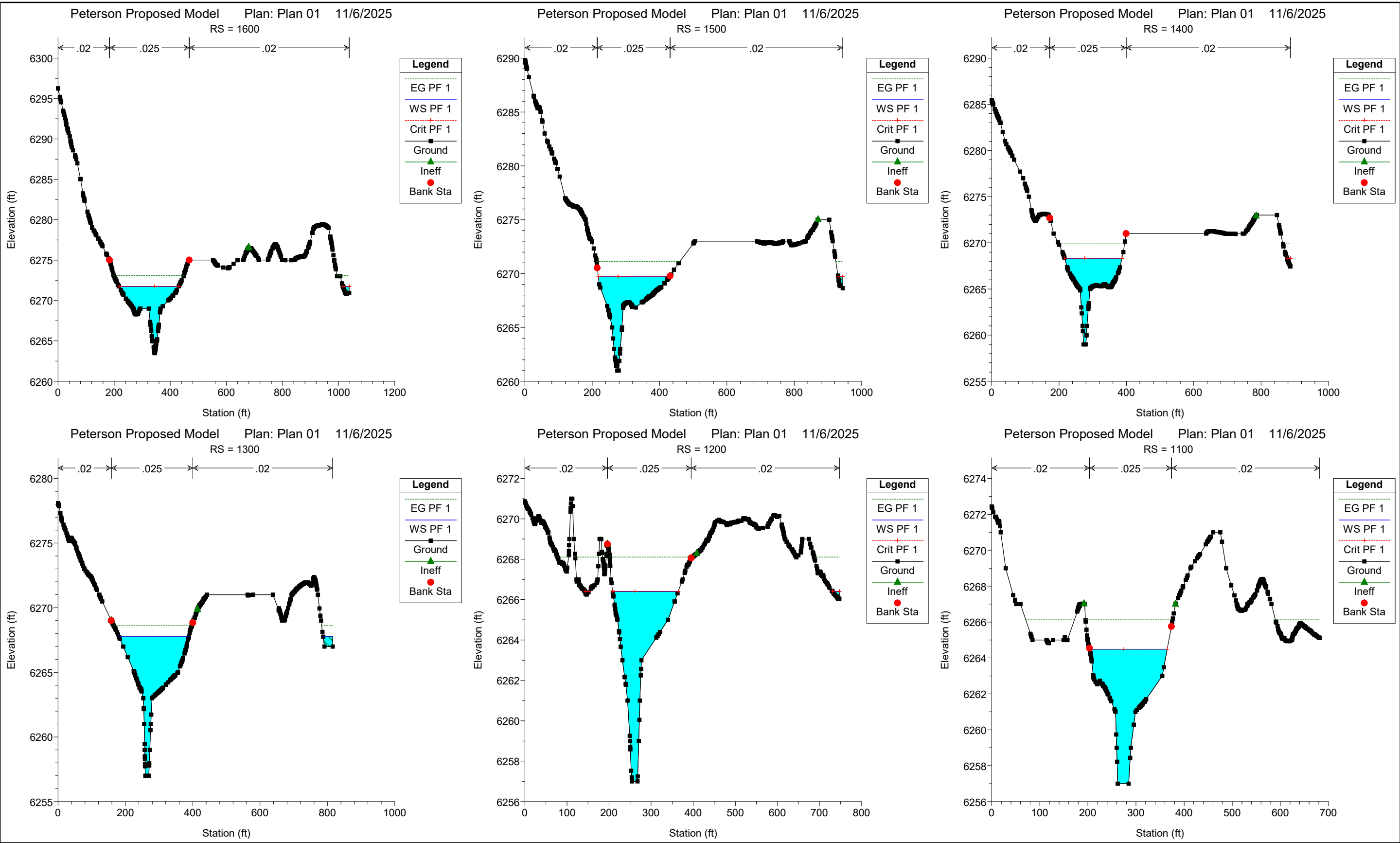


Peterson Proposed Model Plan: Plan 01 11/6/2025
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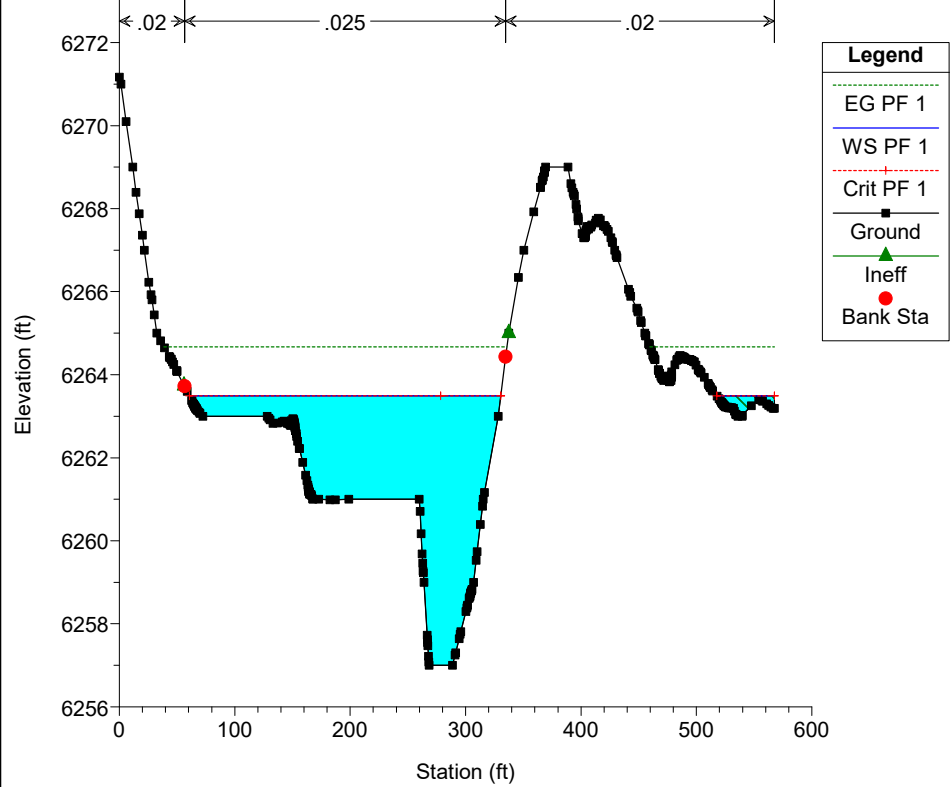


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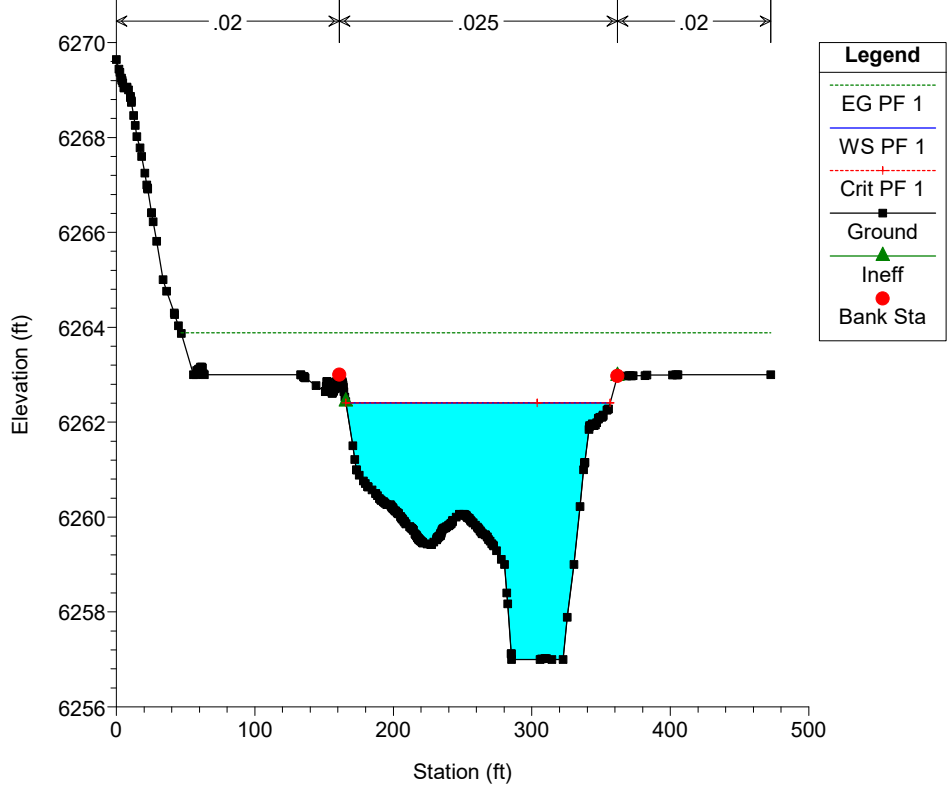




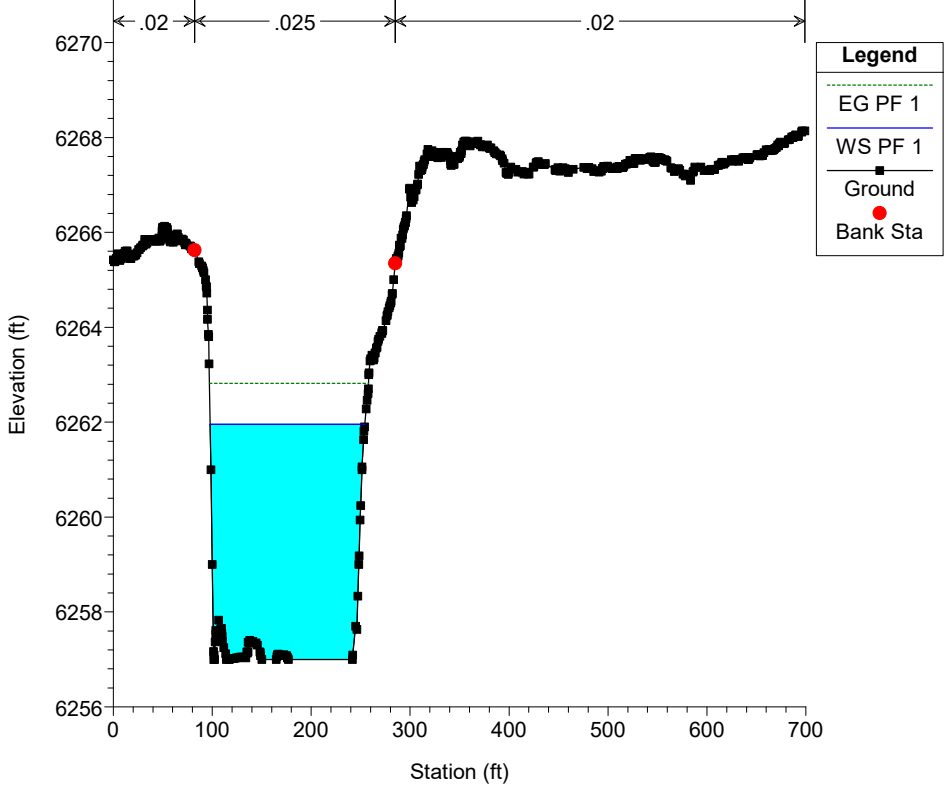
Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 1000



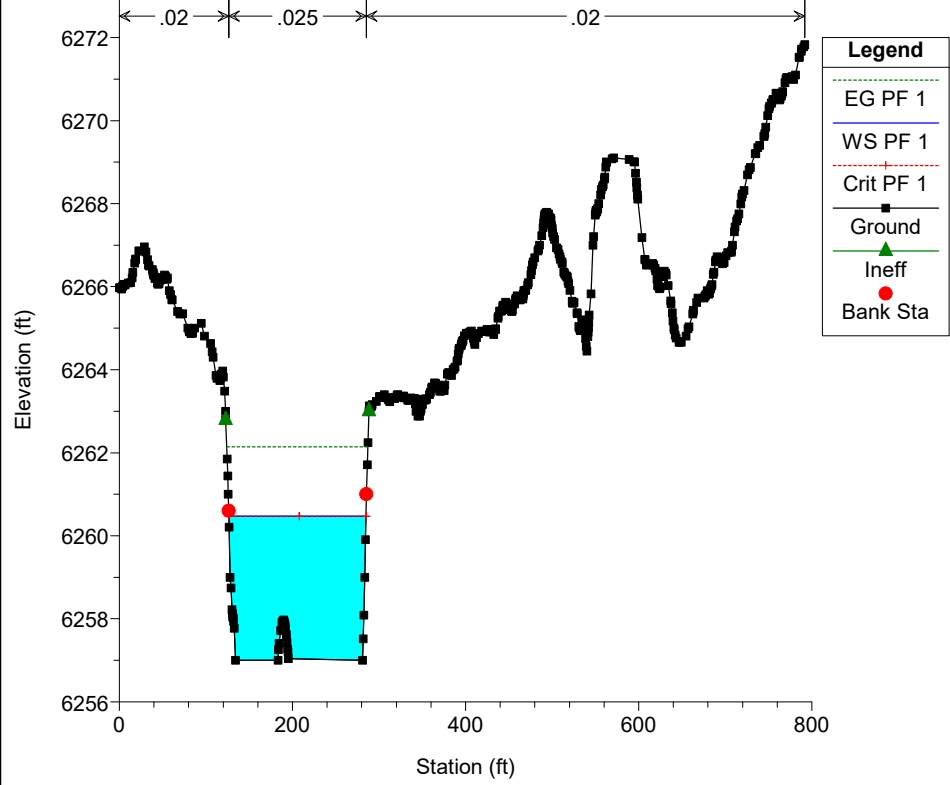
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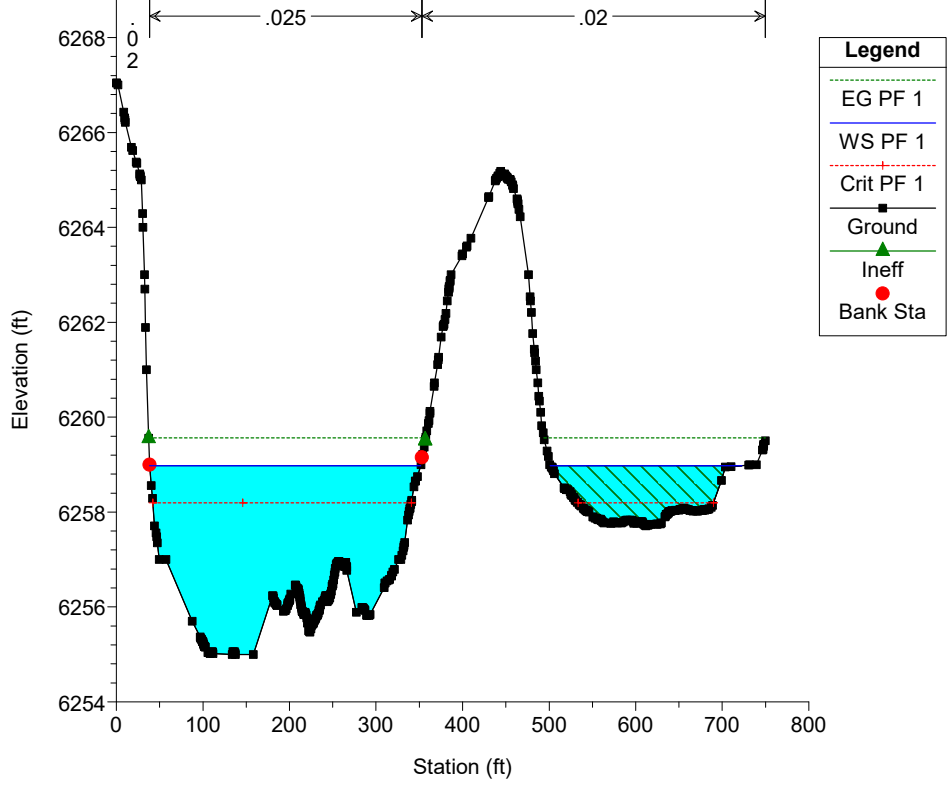
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RS = 770.62



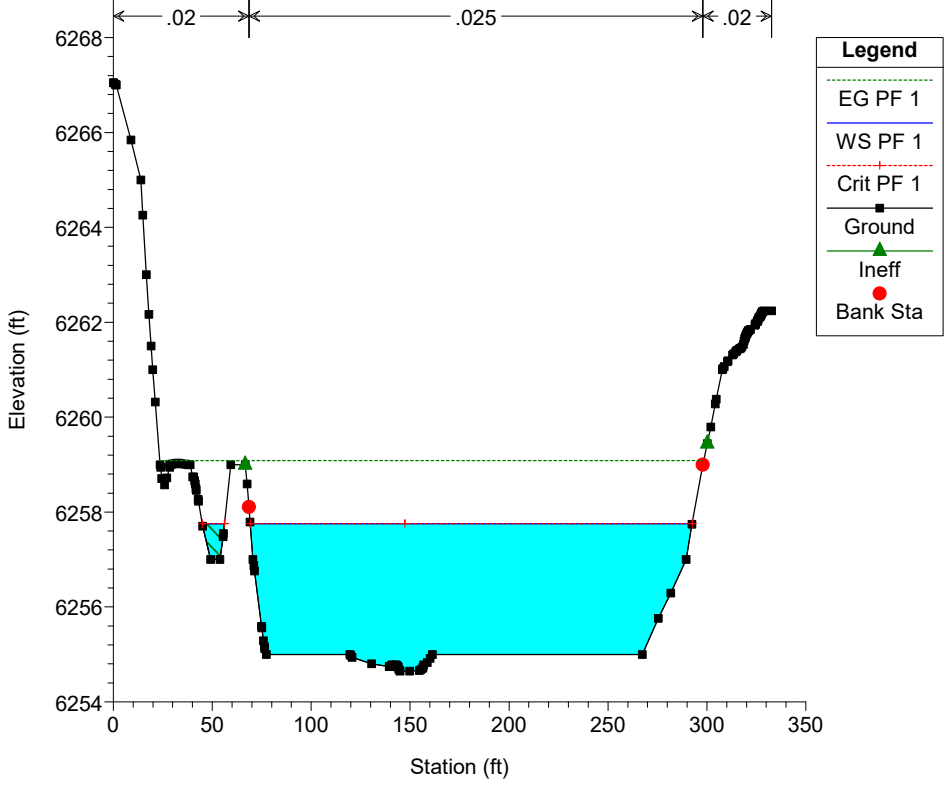
Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 592.7



Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 500



Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 400



**CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1
HEC-RAS COMPARISON TABLE**

STATION	EXISTING CONDITIONS WSE	PROPOSED CONDITIONS WSE	DIFFERENCE
2100	6278.9	6278.9	0
2200	6279.9	6279.9	0
2300	6280.8	6280.8	0
2400	6281.7	6281.7	0
2500	6282.8	6282.8	0
2600	6284	6284	0
2700	6285.5	6285.4	0.1
2900	6286.8	6286.7	0.1
2923.67	6288.5	6288.5	0
3069.1	6296.1	6296.1	0
3100	6296.1	6296.1	0
3200	6296.2	6296.2	0

APPENDIX D

MAPS

