CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1

FINAL DRAINAGE REPORT

Prepared for:

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November 2026

Project No. 24.1382.003

PCD File SF2420

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.

8-13-26
Date

William Griffin
Registered Professional Engineer
State of Colorado
No. 67648



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

Dean Venezia

Title: Owner, Manager

Address: _____

Marathon Holdings, LLP
Business Name

By: Dean Venezia — 8.13.2026 Date

Dean Venezia

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 Date

Conditions:

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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.

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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. This section of East Fork Sand Creek appears to be stable with no improvements recommended in the DBPS. Stormwater runoff from the proposed site generally drains to the south with a small portion draining directly into East Fork Sand Creek. Discharge into East Fork Sand Creek from the proposed site will not be increased due to changes made with this development, therefore, no improvements to East Fork Sand Creek will be required at this time.

A no rise certification has been prepared and an excerpt of relevant information from this certification is included in the appendices. The certification utilized the effective HEC-RAS model for this reach of East Fork Sand Creek updated with GIS topography for the development area to model existing conditions for the channel adjacent to the site. Effective model information was used for the channel downstream of the site. A proposed conditions model was created by modifying the existing conditions model to include topographic information for the proposed Meadowbrook Parkway extension and the proposed detention pond at the south end of the development to provide a means of comparing existing and proposed conditions. Comparison of the results indicates no change to the effective BFEs or the regulatory floodplain are caused by the proposed roadway extension.

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The FIRM shows flows surcharging the East Fork Sand Creek channel banks and flowing across the west portion of the site parallel to Peterson Road. Based on comparison of the annotated Base Flood Elevations taken from FIRM number 08041C0754G and the topography of the region conveying these flows (both in the NAVD 1988 vertical datum) the flooding depth is estimated to be between 6 inches and one foot at its crossing of the proposed Meadowbrook Parkway extension and therefore the road should not be in violation of the requirements set forth in DCM V1, Table 6-1 for major storm events. The minor (Q10) storm modeled in the HEC-RAS used for the "no-rise" certification does not exceed the elevation of the top of bank for the East Fork Sand Creek art any point adjacent to or upstream of Cimarron Hills Southeast Mixed Use Filing No. 1 (see HEC-RAS profile of minor event vs left and right overbank elevations included in appendix C) and we therefore believe that it is reasonable to infer that the minor event has no impact on the proposed extension of Meadowbrook Parkway and the road extension is in compliance with the DCM V1, Table 6-1 requirements for minor storm events.

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

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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.

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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

a. 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.

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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

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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

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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.

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INLET SUMMARY										
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DESIGN POINT or SUB-BASIN	***SUB-BASINS/ DESCRIPTION***	***TOTAL AREA (AC)***	***INLET***			***Q(5) TOTAL INFLOW***	***Q5 INLET CAPACTIY***	***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.

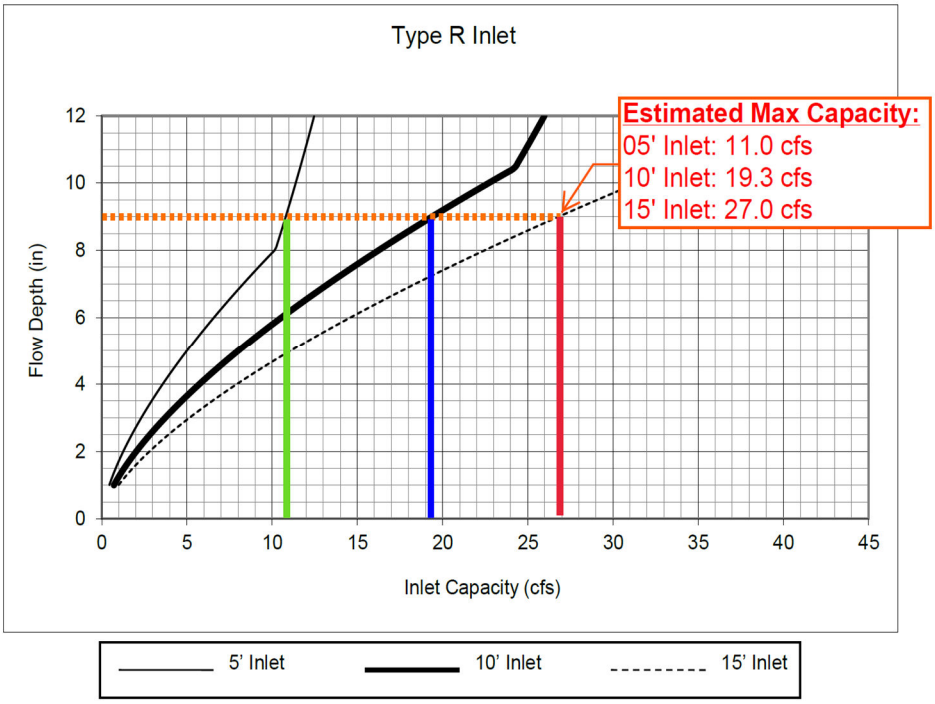

Figure 1

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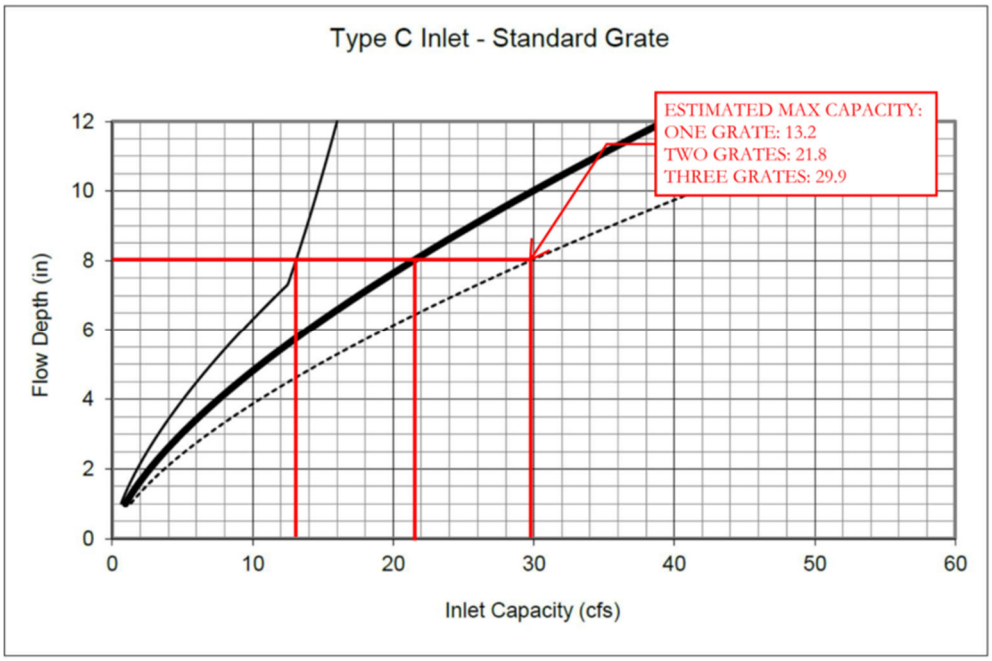

Figure 2

Inlet Overflow Routing	
Inlet	***Overflow Routing Under Sump Inlet Blockage Conditions***
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

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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.

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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) 08041CO752 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.

IX. No-Rise Certification

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

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floodplain. Both instances of construction in the floodplain have been 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.

X. Fee Development

a. Previously Platted Land

The Proposed development is located within the Sand Creek Drainage Fee Basin and within previously platted land. The 2026 Drainage Basin Fees for the Sand Creek Drainage Fee Basin are: $28,160/impervious acre for the Drainage Fee and $11,518.00/impervious acre for the Bridge Fee. The impervious area for the site has increased from 2.00% in existing conditions to 9.59% in proposed conditions for an increase of 7.59%. Calculations for the existing and proposed site imperviousness can be found in the rational calculations spreadsheets in Appendix A. Existing conditions are labeled Existing site Imperviousness, and the proposed conditions are labeled Site Discharge. 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) associated with the improvements described in this report. Drainage fees for developments in Lot 1 are calculated based on an increase in imperviousness from 2% in existing conditions to 72.1% in proposed conditions that is listed in the Final Drainage Report for Hillpointe Apartments at Peterson, by HR Green (PCD File No. PPR2613) (Hillpointe FDR). This 70.1% increase in imperviousness creates 10.438 acres of new impervious acres. Drainage fees for developments in Tracts A and B will be paid at the time of development. The total increase in impervious acres provided by the improvements described in this report and the Lot 1 improvements described in the Hillpointe FDR total 12.918 acres. Drainage and bridge fees have been based on this increase and are shown in the table below.

CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1
Final Drainage Report
2026 Drainage and Bridge Fees

	Increase in impervious acres	Fee/ Imp. Acre	Fee Due
Drainage Fee	12.918	$28,160.00	$363,767.78
Bridge Fee	12.918	$11,518.00	$148,788.26
TOTAL			$512,556.04

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Cost Estimate

Engineer's Estimate of Probable Construction Costs				
SAND CREEK				
CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1				
Public Non-Reimbursable				
Item	Unit	Quantity	Unit Cost	Extension
18" RCP/HP	LF	57	$111.00	$6,327.00
24" RCP/HP	LF	58	$161.00	$9,338.00
30" RCP/HP	LF	48	$167.00	$8,016.00
36" RCP/HP	LF	500	$191.00	$95,500.00
42" RCP/HP	LF	634	$275.00	$174,350.00
38" X 60" RCP	LF	74	$250.00	$18,500.00
30" FES	EA	1	$1,002.00	$1,002.00
5’ Type R Inlet	EA	4	$8,814.00	$35,256.00
Box Base MH	EA	6	$18,950.00	$113,700.00
RIPRAP	Tons	122	$102.00	$12,444.00
			Sub Total	$474,433.00
			10% Contingency	$47,443.30
			TOTAL:	**$521,876.30**

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
36" RCP/HP	LF	32	$191.00	$6,112.00
38" x 60" RCP/HP	LF	12	$166.00	$1,992.00
Type C Inlet	EA	1	$8,156.00	$8,156.00
			Sub Total	$16,260.00
			10% Contingency	$1,626.00
			TOTAL:	**$17,886.00**

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Engineer's Estimate of Probable Construction Costs				
SAND CREEK				
CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1				
Permanent BMP (EDB): Private Non-reimbursable				
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**
			Overall Total	**$743,262.30**

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.

XI. 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.

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XII. 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

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Appendices

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APPENDIX A

HYDROLOGIC AND HYDRAULIC CALCULATIONS

Rational Method - Existing Conditions

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

Average Channel Velocity	4.00	ft/s	(If specific channel vel is used, this will be ignored)
Average Slope for Initial Flow	0.04	ft/ft	(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										Tc	Rainfall Intensity & Rational Flow Rate						
					95%			100%			2%																								
					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	**Comments**			Soil Group	C5	C100		C5	C100	Area (SF)	C5	C100	Area	C5	C100		ft	Length ft	ft	Length ft	Slope	Tc (min)	Slope	Ground Type	(ft/s)	Tc (min)	(min)	in/hr	cfs	in/hr	cfs	in/hr	cfs	**Sub-basin**
		sf	acres																															
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 Velocity 4.00 ft/s (If specific channel vel is used, this will be ignored)
Average Slope for Initial Flow 0.04 ft/ft (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										Tc	Rainfall Intensity & Rational Flow Rate				
					95%			100%			70%			2%																					
Sub-basin	**Comments**			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	Channel	Total	i5	Q5	i100	Q100	**Sub-basin**
		sf	acres		C5	C100		C5	C100	Area (SF)	C5	C100	Area	C5	C100	Area	C5	C100		ft	Length ft	ft	Length ft	Slope	Tc (min)	Slope	Ground Type	(ft/s)	Tc (min)	(min)	in/hr	cfs	in/hr	cfs	
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 (FURTURE)	***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 (FURTURE)***
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 (l

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

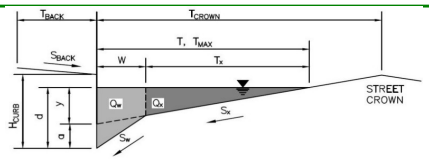
MHFD-Inlet, Version 5.03 (August 2023)

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	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.013	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	26.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.020	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.010	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.013	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	21.0	26.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	9.0	inches
Allow Flow Depth at Street Crown (check box for yes, leave blank for no)		☐	☐	

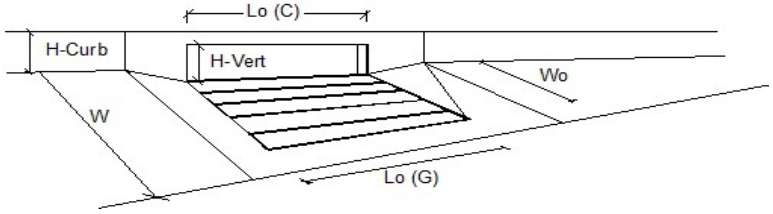
		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Spread Criterion	Q_{allow} =	**17.0**	**39.3**	**cfs**

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	inches
Total Number of Units in the Inlet (Grate or Curb Opening)	No =	2	2	
Length of a Single Unit Inlet (Grate or Curb Opening)	L_o =	5.00	5.00	ft
Width of a Unit Grate (cannot be greater than W, Gutter Width)	W_o =	N/A	N/A	ft
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 < Allowable Street Capacity'		MINOR	MAJOR	
Total Inlet Interception Capacity	**Q =**	**1.4**	**2.6**	**cfs**
Total Inlet Carry-Over Flow (flow bypassing inlet)	**Q_b =**	**0.0**	**0.0**	**cfs**
Capture Percentage = Q_a/Q_o	**C% =**	**100**	**100**	**%**

SUMP INLET CALCULATIONS

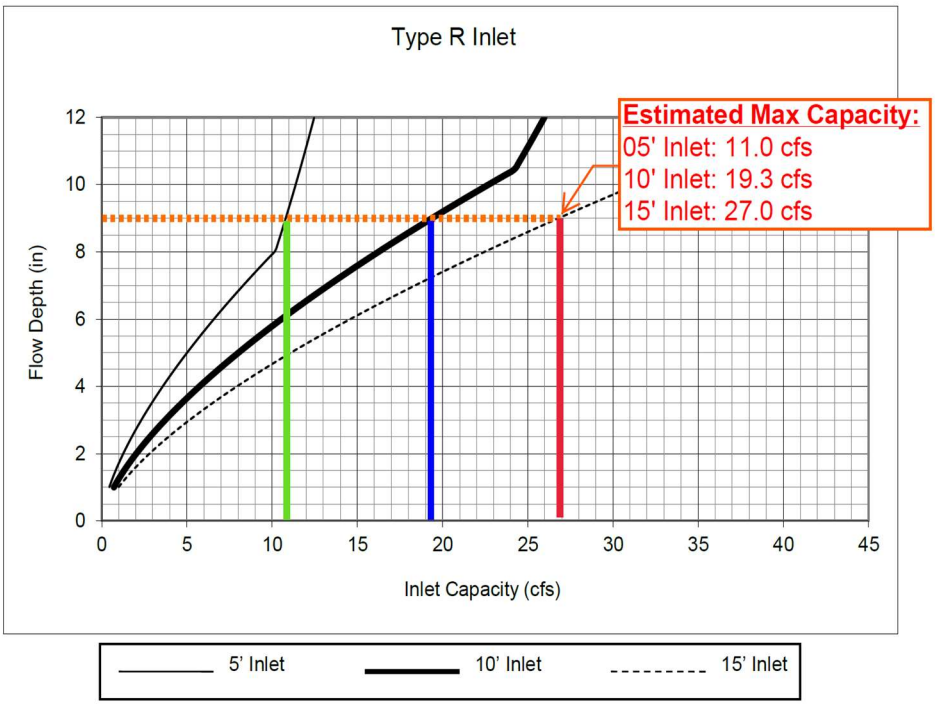


Figure 1

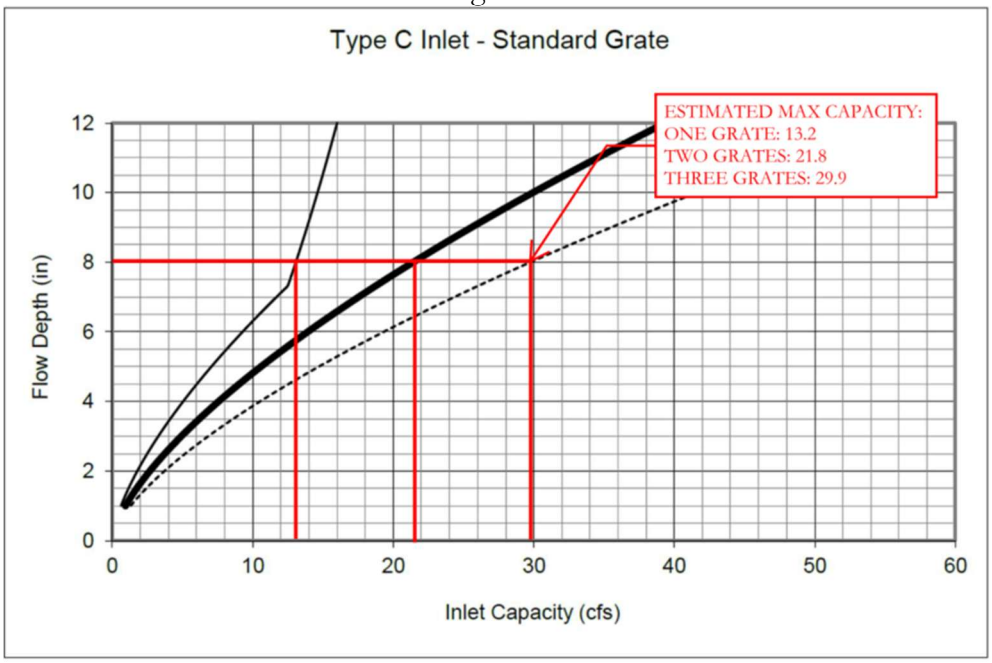


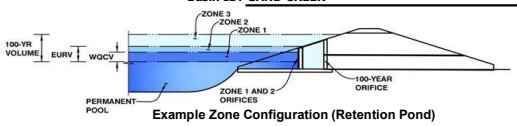
Figure 2

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: PETERSON AND MEADOWBROOK INTERIM CONDITION

Basin ID: SAND CREEK



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	31.71	acres
Watershed Length =	1,750	ft
Watershed Length to Centroid =	800	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	7.18%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	0.133	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.208	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.356	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.848	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.348	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	2.269	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	2.883	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	3.780	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	5.398	acre-feet	inches
Approximate 2-yr Detention Volume =	0.128	acre-feet	
Approximate 5-yr Detention Volume =	0.207	acre-feet	
Approximate 10-yr Detention Volume =	0.504	acre-feet	
Approximate 25-yr Detention Volume =	0.739	acre-feet	
Approximate 50-yr Detention Volume =	0.765	acre-feet	
Approximate 100-yr Detention Volume =	1.006	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.133	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.076	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.797	acre-feet
Total Detention Basin Volume =	1.006	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

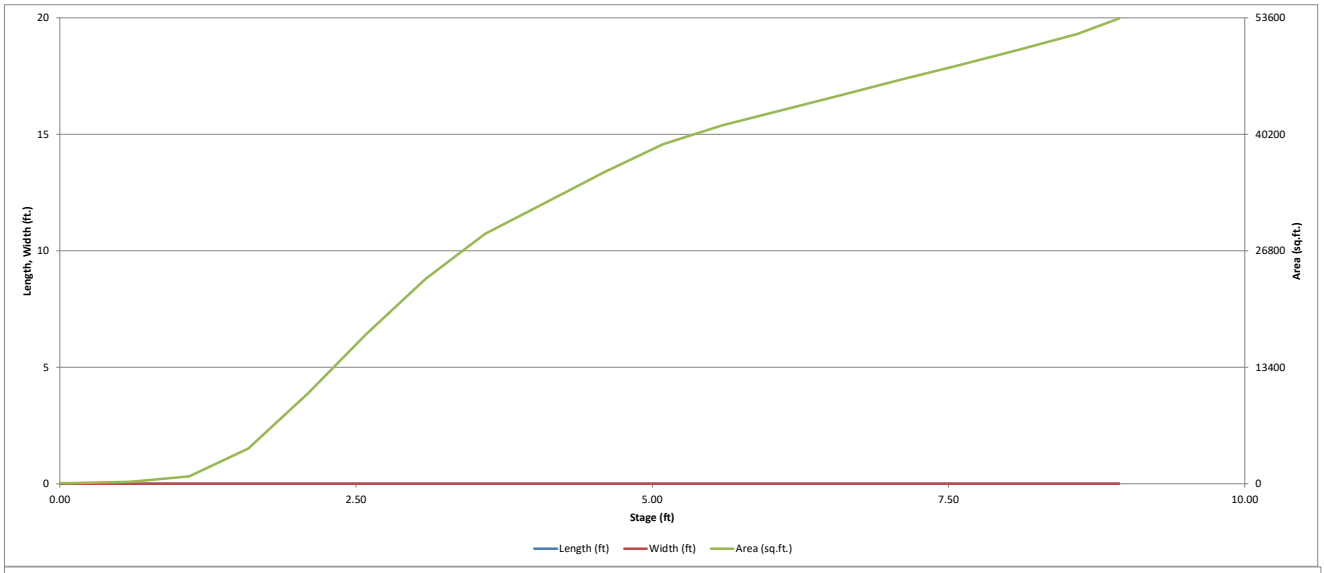
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	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

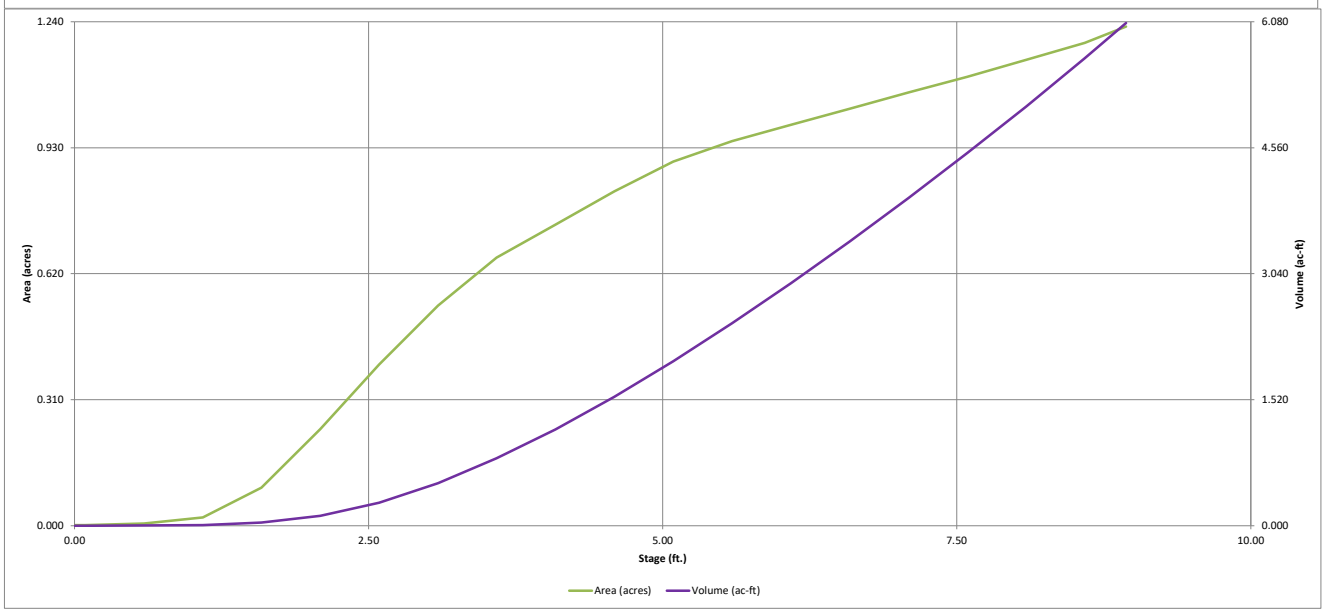
Depth Increment = 0.50 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	76	0.002		
6279.5	--	0.09	--	--	--	76	0.002	7	0.000
6280	--	0.59	--	--	--	219	0.005	81	0.002
	--	1.09	--	--	--	863	0.020	351	0.008
	--	1.59	--	--	--	4,074	0.094	1,585	0.036
	--	2.09	--	--	--	10,349	0.238	5,191	0.119
	--	2.59	--	--	--	17,287	0.397	12,100	0.278
	--	3.09	--	--	--	23,596	0.542	22,321	0.512
	--	3.59	--	--	--	28,748	0.660	35,407	0.813
	--	4.09	--	--	--	32,277	0.741	50,663	1.163
	--	4.59	--	--	--	35,822	0.822	67,688	1.554
	--	5.09	--	--	--	39,046	0.896	86,405	1.984
	--	5.59	--	--	--	41,212	0.946	106,469	2.444
	--	6.09	--	--	--	42,963	0.986	127,513	2.927
	--	6.59	--	--	--	44,690	1.026	149,426	3.430
	--	7.09	--	--	--	46,440	1.066	172,209	3.953
	--	7.59	--	--	--	48,134	1.105	195,852	4.496
	--	8.09	--	--	--	49,925	1.146	220,367	5.059
6288	--	8.59	--	--	--	51,750	1.188	245,786	5.642
	--	8.94	--	--	--	53,496	1.228	264,204	6.065

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



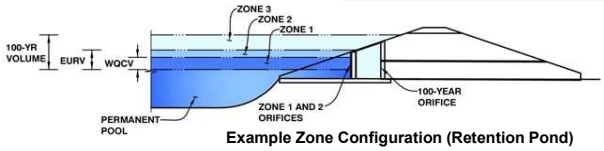


DETENTION BASIN OUTLET STRUCTURE DESIGN

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 =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	2.11	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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			Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	2.20	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	2.16	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	2.36	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	1.08	N/A	feet
Vertical Orifice Height =	25.92	N/A	inches				
Vertical Orifice Width =	12.00		inches				

Calculated Parameters for Vertical Orifice

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			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.63	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	5.63	N/A	feet
Overflow Weir Front Edge Length =	5.00	N/A	feet	Overflow Weir Slope Length =	5.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	5.66	N/A	
Horiz. Length of Weir Sides =	5.00	N/A	feet	Overflow Grate Open Area w/o Debris =	17.40	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	8.70	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	3.08	N/A	ft^2
Outlet Pipe Diameter =	30.00	N/A	inches	Outlet Orifice Centroid =	0.85	N/A	feet
Restrictor Plate Height Above Pipe Invert =	18.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.77	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	7.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.95 feet
Spillway Crest Length =	38.00	feet	Stage at Top of Freeboard =	8.95 feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.23 acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	6.07 acre-ft

Calculated Parameters for Spillway

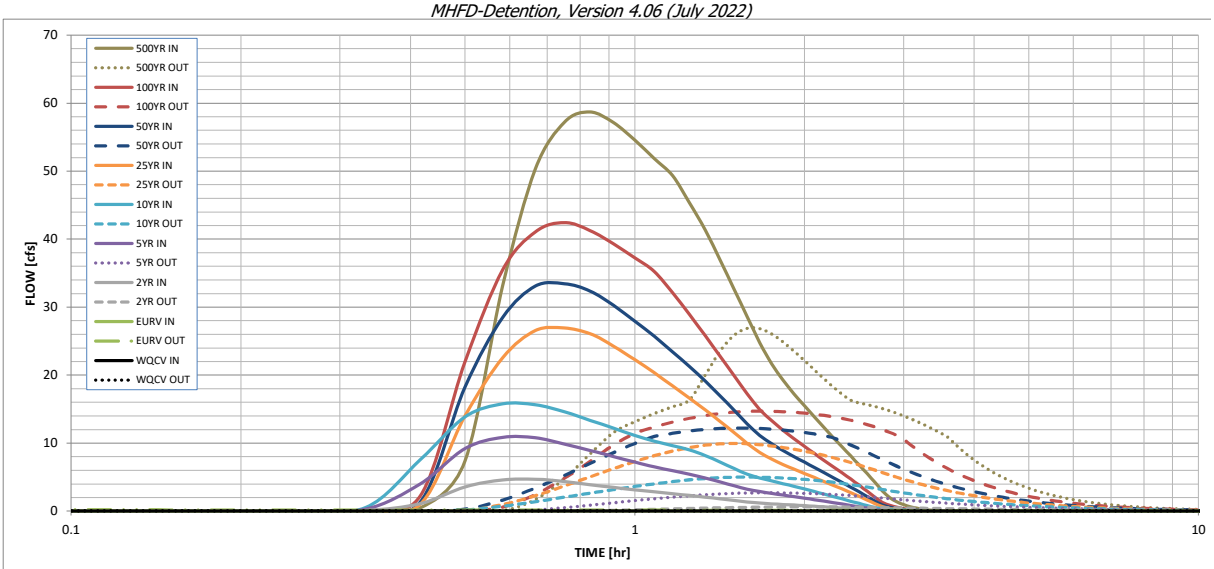
Routed Hydrograph Results

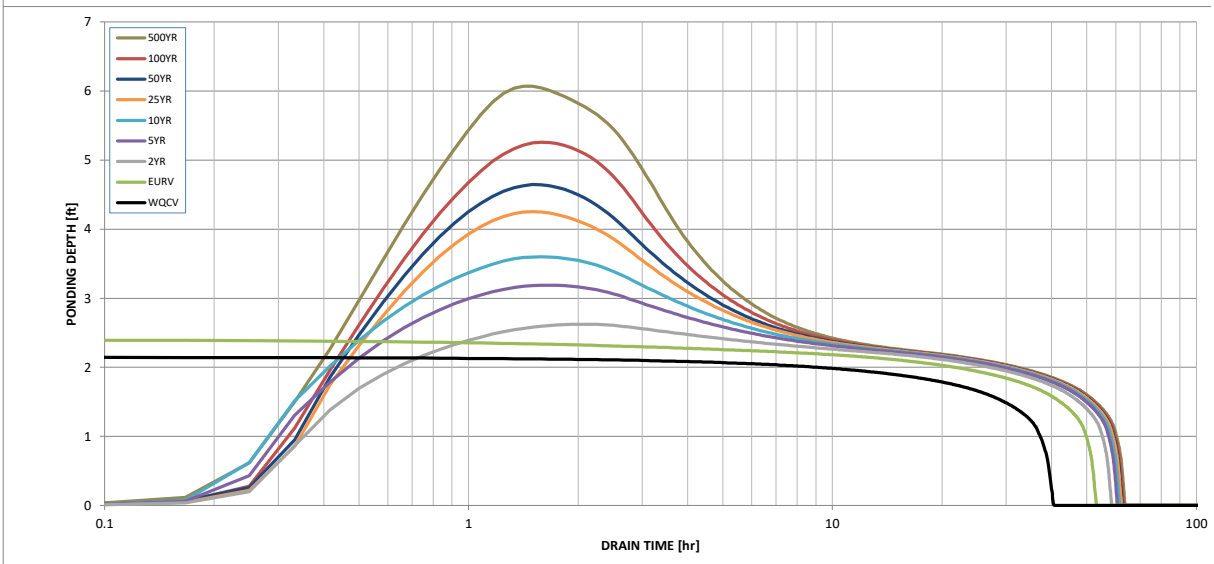
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

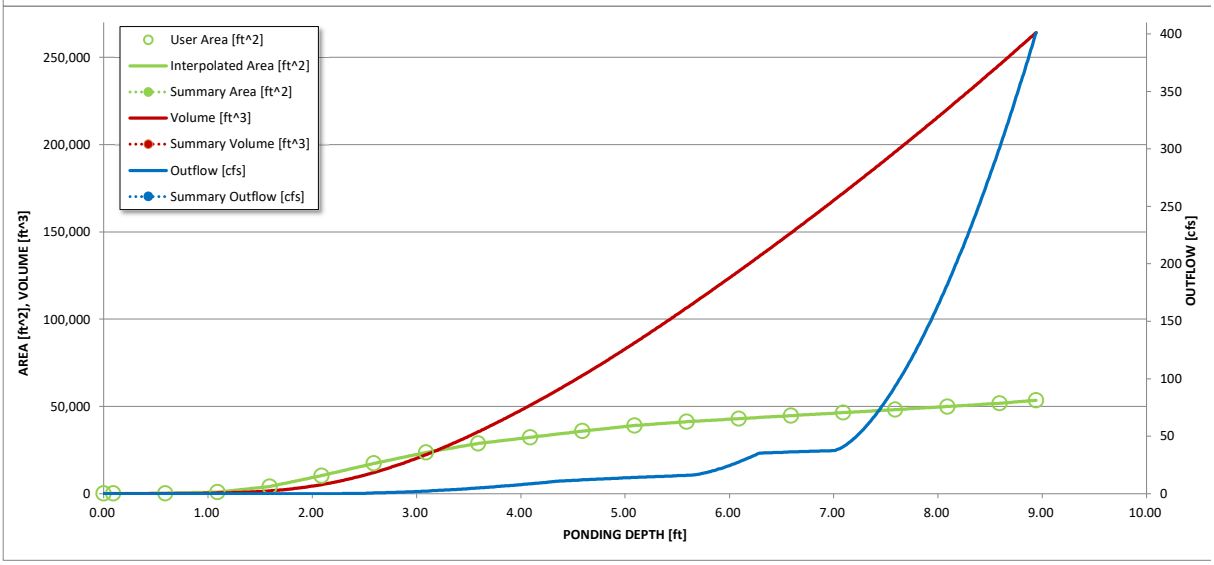
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.133	0.208	0.356	0.848	1.348	2.269	2.883	3.780	5.398
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.356	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)







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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.

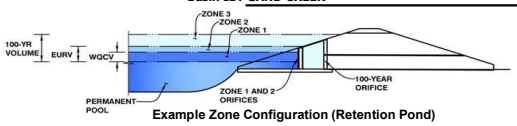
Time Interval	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	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

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: PETERSON AND MEADOWBROOK FUTURE CONDITIONS

Basin ID: SAND CREEK



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	31.71	acres
Watershed Length =	1,750	ft
Watershed Length to Centroid =	800	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	73.22%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	0.767	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	2.559	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	2.302	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	3.083	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	3.737	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	4.495	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	5.177	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	5.977	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	7.703	acre-feet	inches
Approximate 2-yr Detention Volume =	2.009	acre-feet	
Approximate 5-yr Detention Volume =	2.667	acre-feet	
Approximate 10-yr Detention Volume =	3.347	acre-feet	
Approximate 25-yr Detention Volume =	3.592	acre-feet	
Approximate 50-yr Detention Volume =	3.735	acre-feet	
Approximate 100-yr Detention Volume =	3.979	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.767	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.792	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.420	acre-feet
Total Detention Basin Volume =	3.979	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

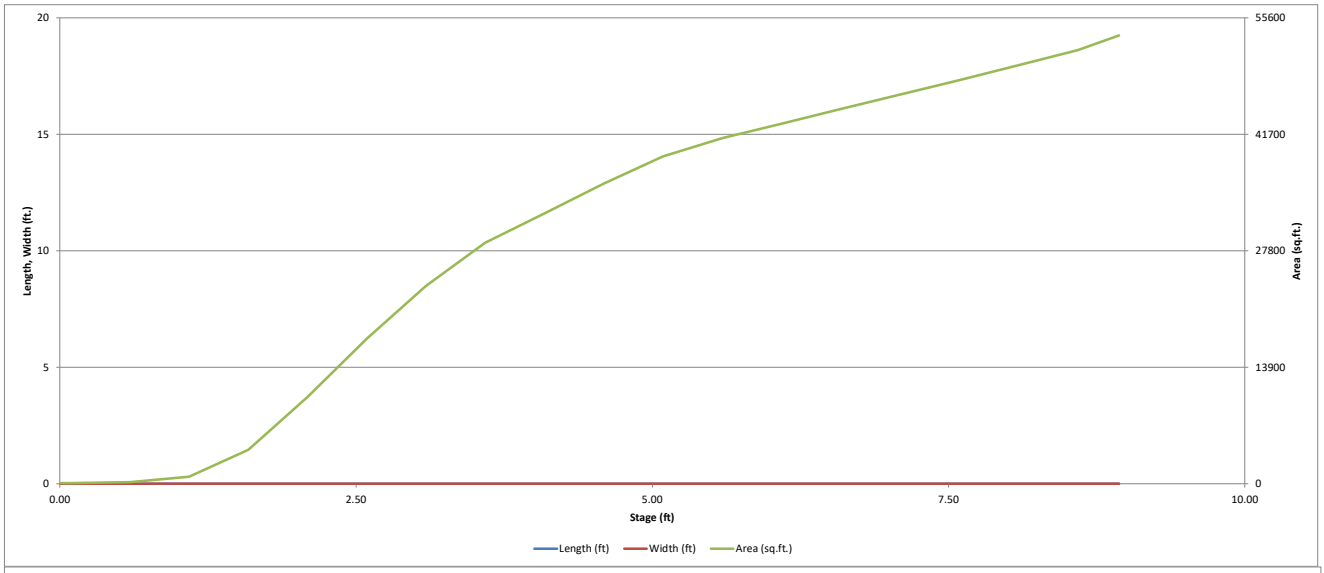
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	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

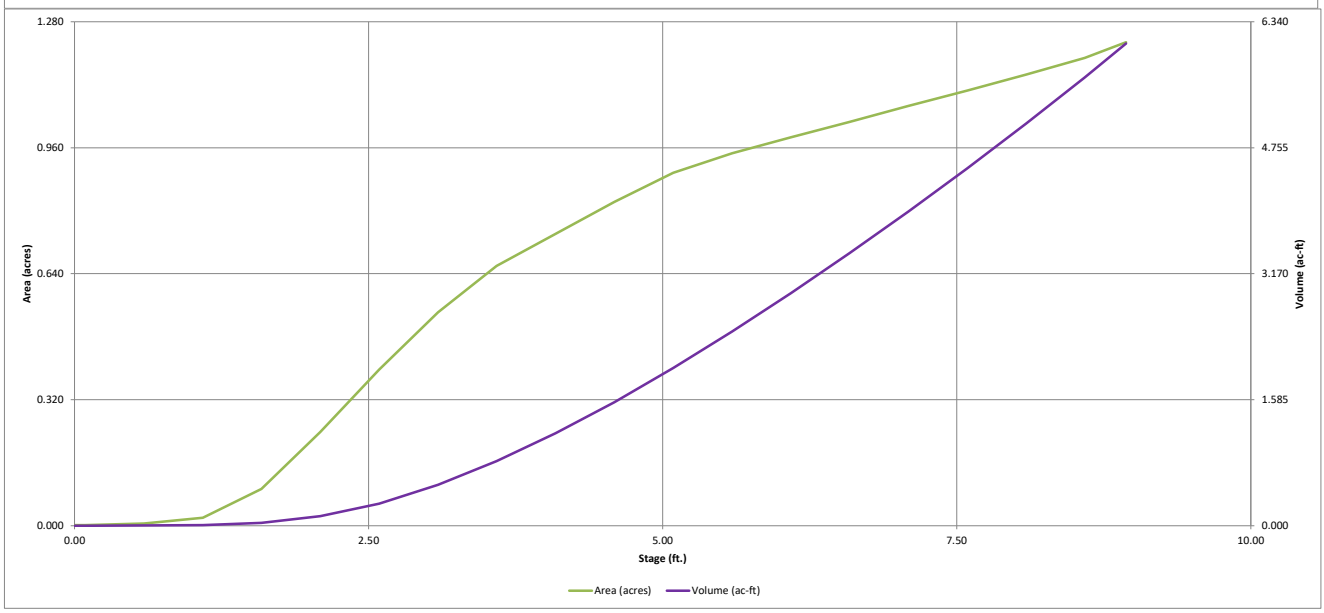
Depth Increment = 0.50 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	76	0.002		
6279.5	--	0.09	--	--	--	76	0.002	7	0.000
6280	--	0.59	--	--	--	219	0.005	81	0.002
	--	1.09	--	--	--	863	0.020	351	0.008
	--	1.59	--	--	--	4,074	0.094	1,585	0.036
	--	2.09	--	--	--	10,349	0.238	5,191	0.119
	--	2.59	--	--	--	17,287	0.397	12,100	0.278
	--	3.09	--	--	--	23,596	0.542	22,321	0.512
	--	3.59	--	--	--	28,748	0.660	35,407	0.813
	--	4.09	--	--	--	32,277	0.741	50,663	1.163
	--	4.59	--	--	--	35,822	0.822	67,688	1.554
	--	5.09	--	--	--	39,046	0.896	86,405	1.984
	--	5.59	--	--	--	41,212	0.946	106,469	2.444
	--	6.09	--	--	--	42,963	0.986	127,513	2.927
	--	6.59	--	--	--	44,690	1.026	149,426	3.430
	--	7.09	--	--	--	46,440	1.066	172,209	3.953
	--	7.59	--	--	--	48,134	1.105	195,852	4.496
	--	8.09	--	--	--	49,925	1.146	220,367	5.059
6288	--	8.59	--	--	--	51,750	1.188	245,786	5.642
	--	8.94	--	--	--	53,496	1.228	264,204	6.065

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



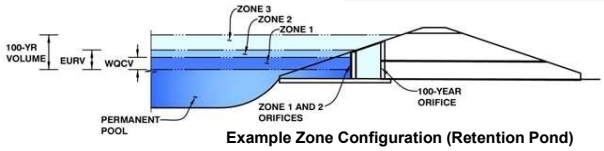


DETENTION BASIN OUTLET STRUCTURE DESIGN

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 Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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)	WQ Orifice Area per Row =	1.764E-02	ft^2
Depth at top of Zone using Orifice Plate =	3.45	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	2.54	sq. inches (diameter = 1-13/16 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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)

	Zone 2 Circular	Not Selected			Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	3.53	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	0.05	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	5.57	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	0.13	N/A	feet
Vertical Orifice Diameter =	3.00	N/A	inches				

Calculated Parameters for Vertical Orifice

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			Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	5.63	N/A	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	5.63	N/A	feet
Overflow Weir Front Edge Length =	5.00	N/A	feet	Overflow Weir Slope Length =	5.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V	Grate Open Area / 100-yr Orifice Area =	6.06	N/A	
Horiz. Length of Weir Sides =	5.00	N/A	feet	Overflow Grate Open Area w/o Debris =	17.40	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	8.70	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 3 Restrictor	Not Selected			Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.25	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	2.87	N/A	ft^2
Outlet Pipe Diameter =	30.00	N/A	inches	Outlet Orifice Centroid =	0.81	N/A	feet
Restrictor Plate Height Above Pipe Invert =	17.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	1.70	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	7.00	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.95 feet
Spillway Crest Length =	38.00	feet	Stage at Top of Freeboard =	8.95 feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	1.23 acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	6.07 acre-ft

Calculated Parameters for Spillway

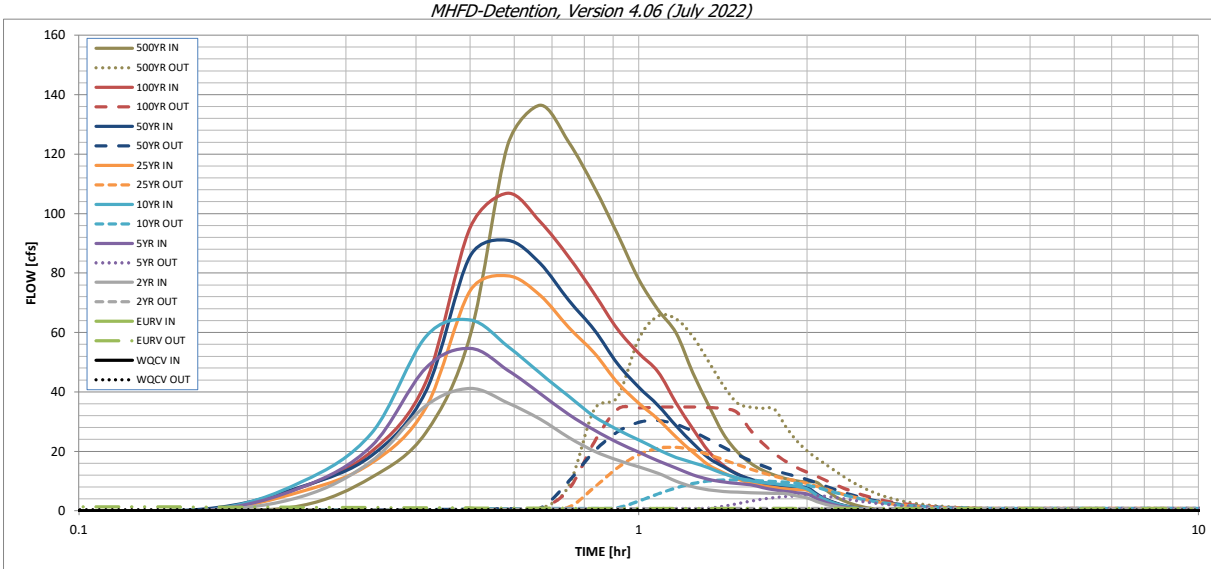
Routed Hydrograph Results

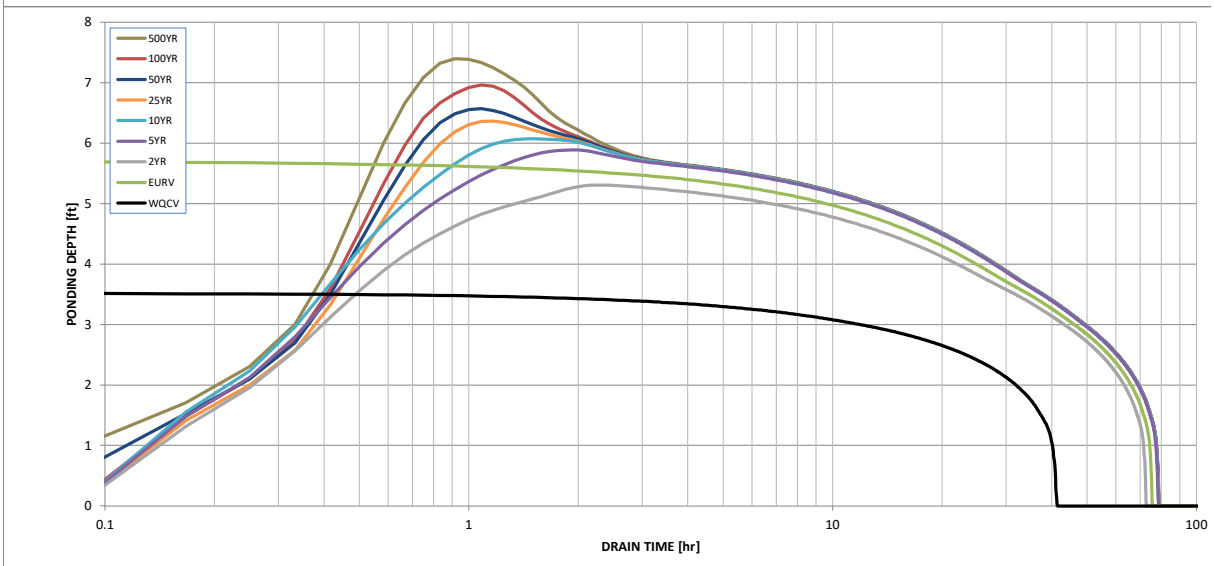
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

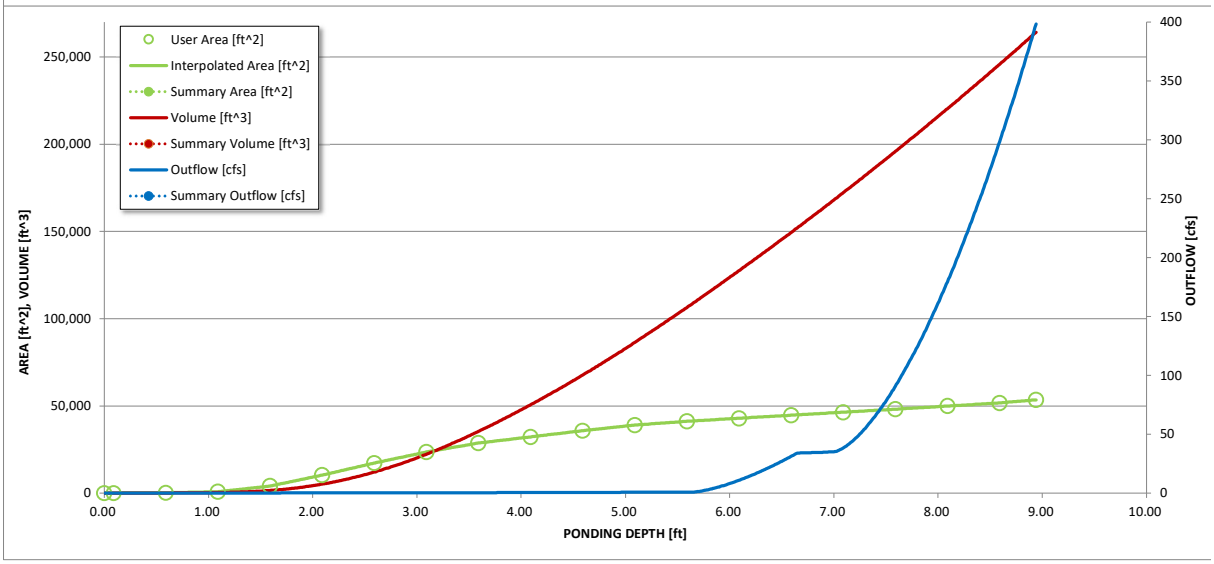
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.767	2.559	2.302	3.083	3.737	4.495	5.177	5.977	7.703
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.302	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)







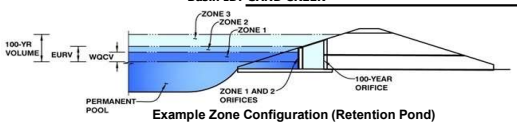
S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: PETERSON AND MEADOWBROOK TSB

Basin ID: SAND CREEK



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	33.23	acres
Watershed Length =	1,750	ft
Watershed Length to Centroid =	800	ft
Watershed Slope =	0.020	ft/ft
Watershed Imperviousness =	3.88%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	0.079	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.112	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.295	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.786	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.297	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	2.275	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	2.911	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	3.858	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	5.541	acre-feet	inches
Approximate 2-yr Detention Volume =	0.065	acre-feet	
Approximate 5-yr Detention Volume =	0.110	acre-feet	
Approximate 10-yr Detention Volume =	0.387	acre-feet	
Approximate 25-yr Detention Volume =	0.600	acre-feet	
Approximate 50-yr Detention Volume =	0.602	acre-feet	
Approximate 100-yr Detention Volume =	0.811	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.079	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	0.079	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

Total detention volume is less than 100-year volume.

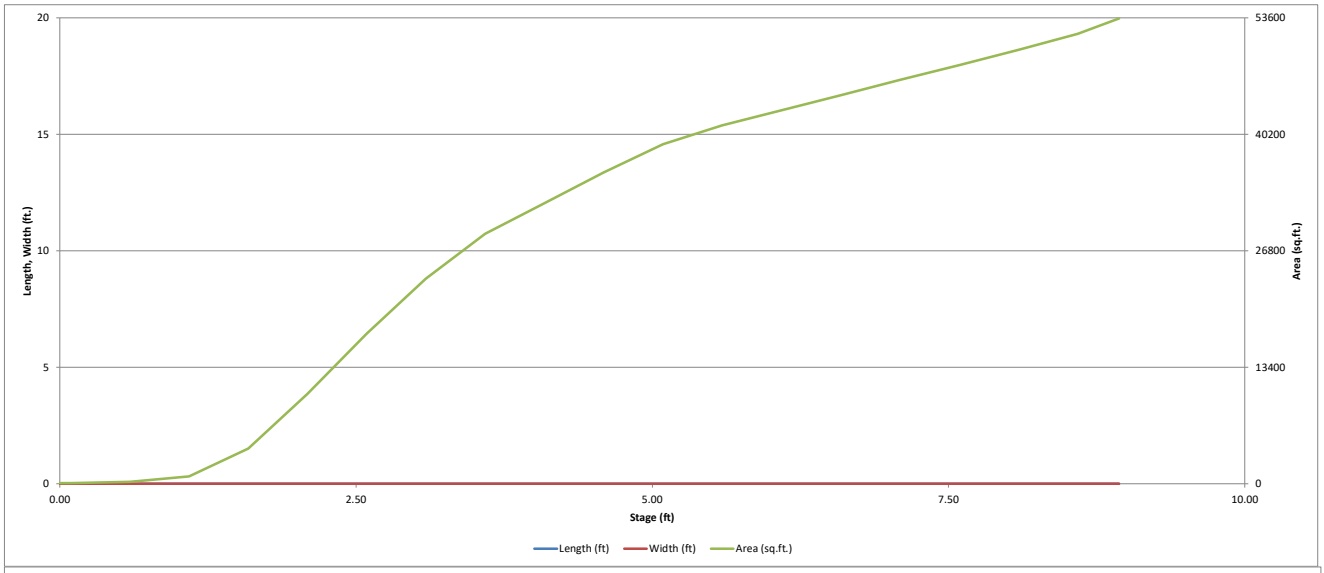
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	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

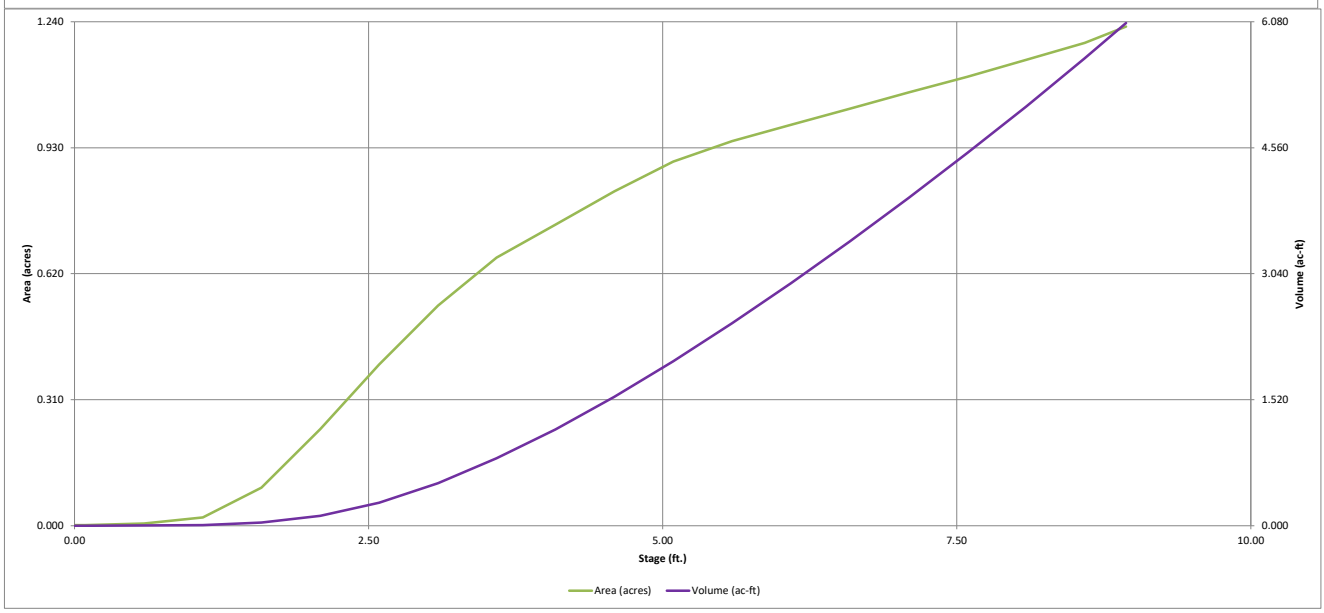
Depth Increment = 0.50 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	76	0.002		
6279.5	--	0.09	--	--	--	76	0.002	7	0.000
6280	--	0.59	--	--	--	219	0.005	81	0.002
	--	1.09	--	--	--	863	0.020	351	0.008
	--	1.59	--	--	--	4,074	0.094	1,585	0.036
	--	2.09	--	--	--	10,349	0.238	5,191	0.119
	--	2.59	--	--	--	17,287	0.397	12,100	0.278
	--	3.09	--	--	--	23,596	0.542	22,321	0.512
	--	3.59	--	--	--	28,748	0.660	35,407	0.813
	--	4.09	--	--	--	32,277	0.741	50,663	1.163
	--	4.59	--	--	--	35,822	0.822	67,688	1.554
	--	5.09	--	--	--	39,046	0.896	86,405	1.984
	--	5.59	--	--	--	41,212	0.946	106,469	2.444
	--	6.09	--	--	--	42,963	0.986	127,513	2.927
	--	6.59	--	--	--	44,690	1.026	149,426	3.430
	--	7.09	--	--	--	46,440	1.066	172,209	3.953
	--	7.59	--	--	--	48,134	1.105	195,852	4.496
	--	8.09	--	--	--	49,925	1.146	220,367	5.059
6288	--	8.59	--	--	--	51,750	1.188	245,786	5.642
	--	8.94	--	--	--	53,496	1.228	264,204	6.065

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



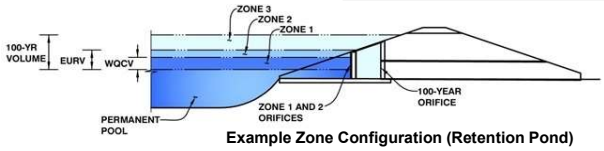


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **PETERSON AND MEADOWBROOK 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 = ft^2

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)	WQ Orifice Area per Row =	1.917E-02	ft^2
Depth at top of Zone using Orifice Plate =	3.00	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	2.76	sq. inches (diameter = 1-7/8 inches)	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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)

	Not Selected	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 Diameter =			inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =			ft^2
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)

	Not Selected	Not Selected	
Overflow Weir Front Edge Height, Ho =			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

	Not Selected	Not Selected	
Height of Grate Upper Edge, H_t =			feet
Overflow Weir Slope Length =			feet
Grate Open Area / 100-yr Orifice Area =			
Overflow Grate Open Area w/o Debris =			ft^2
Overflow Grate Open Area w/ Debris =			ft^2

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

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Not Selected	Not Selected	
Outlet Orifice Area =			ft^2
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

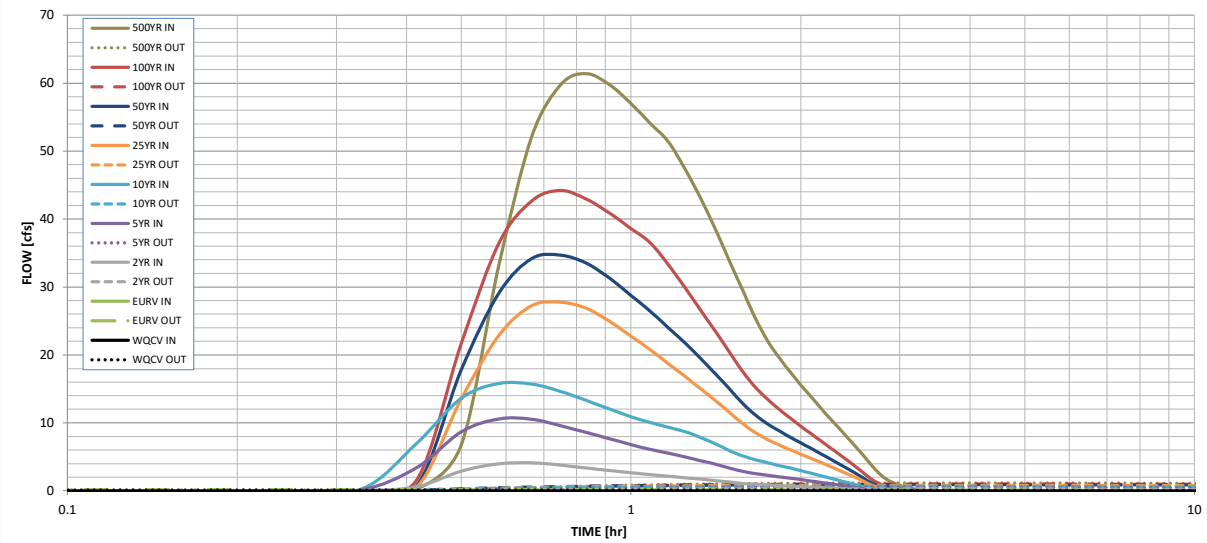
Routed Hydrograph Results

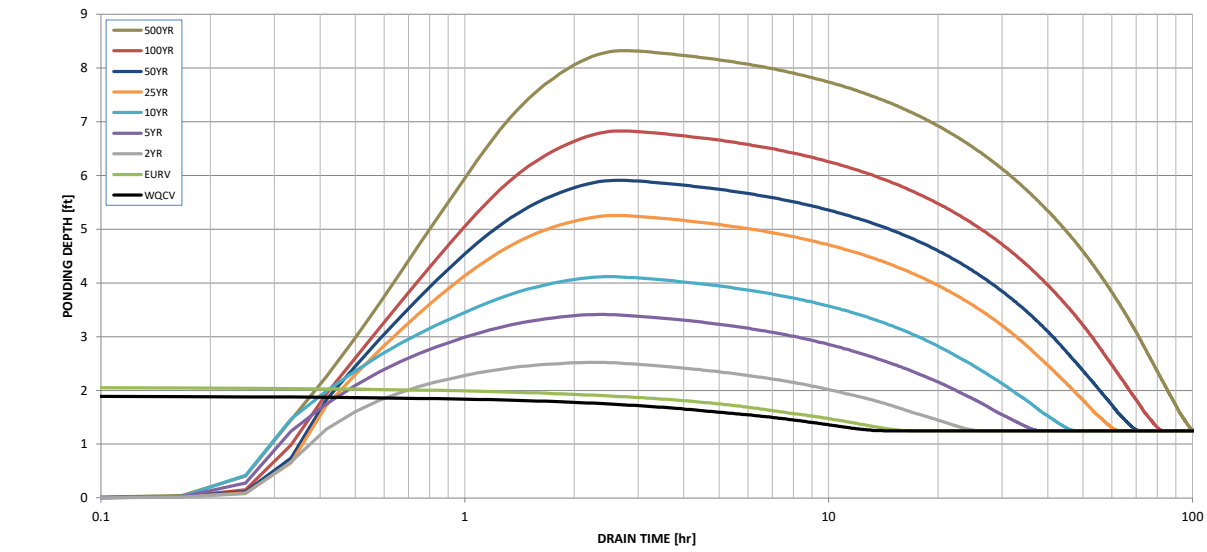
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

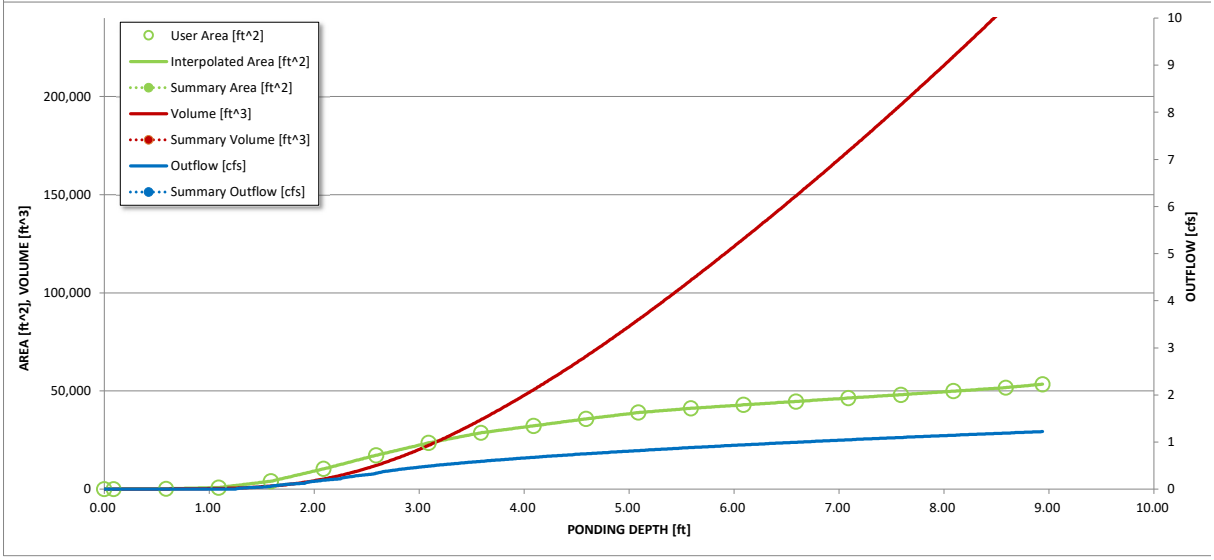
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.079	0.112	0.295	0.786	1.297	2.275	2.911	3.858	5.541
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.295	0.786	1.297	2.275	2.911	3.858	5.541
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	3.6	10.0	15.2	27.3	34.2	43.7	60.9
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

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.

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

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]

Figure 13-12b. Emergency Spillway Profile at Embankment

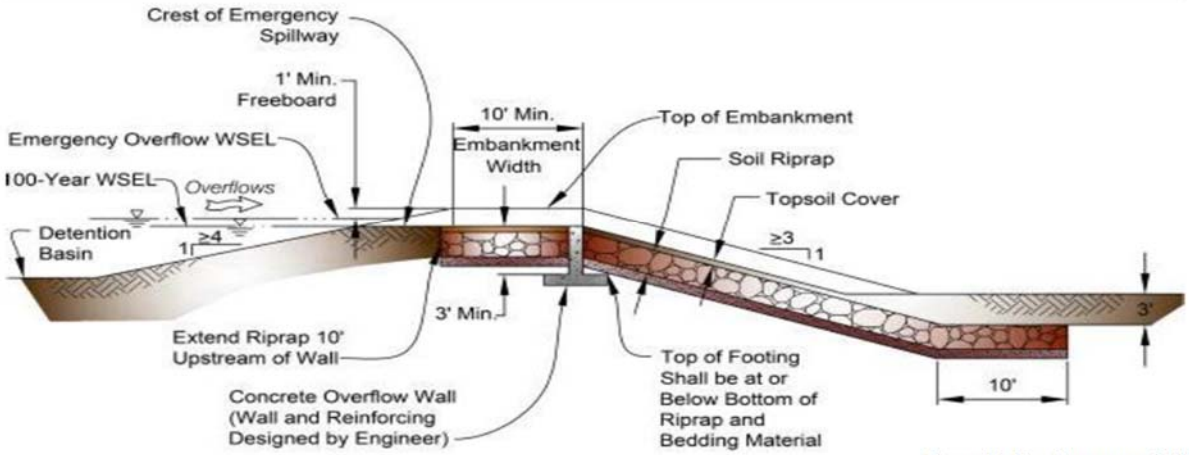
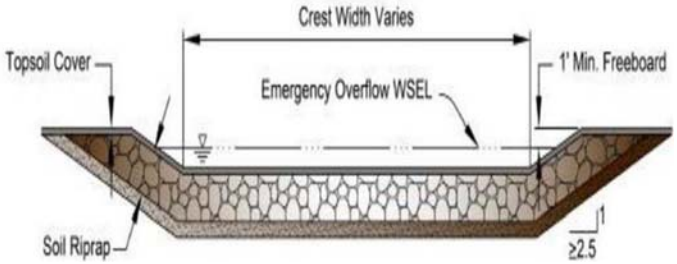


Figure 13-12c. Emergency Spillway Protection

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

=> TYPE L RIP RAP



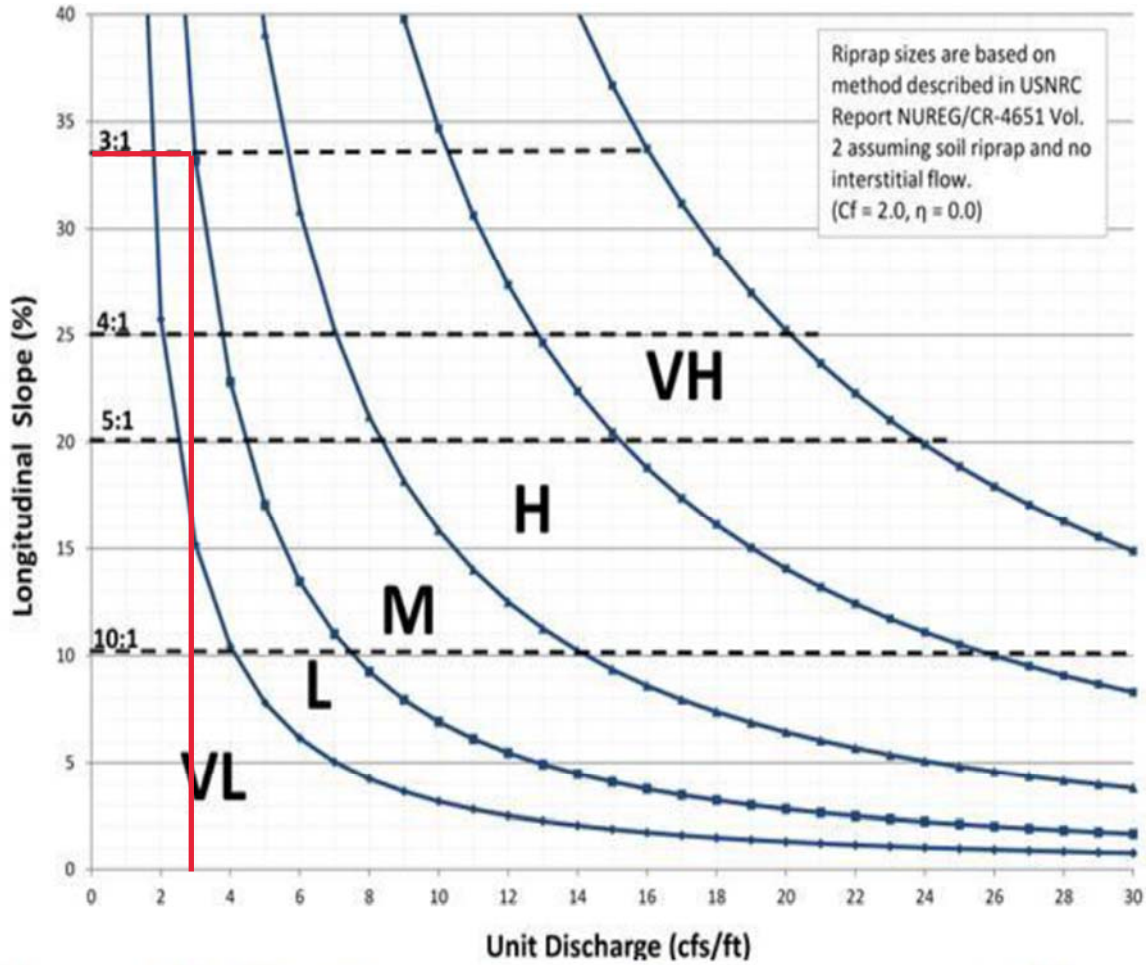


Figure 13-12d. Riprap Types for Emergency Spillway Protection

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Nov 7 2025

Trickle Channel

Rectangular

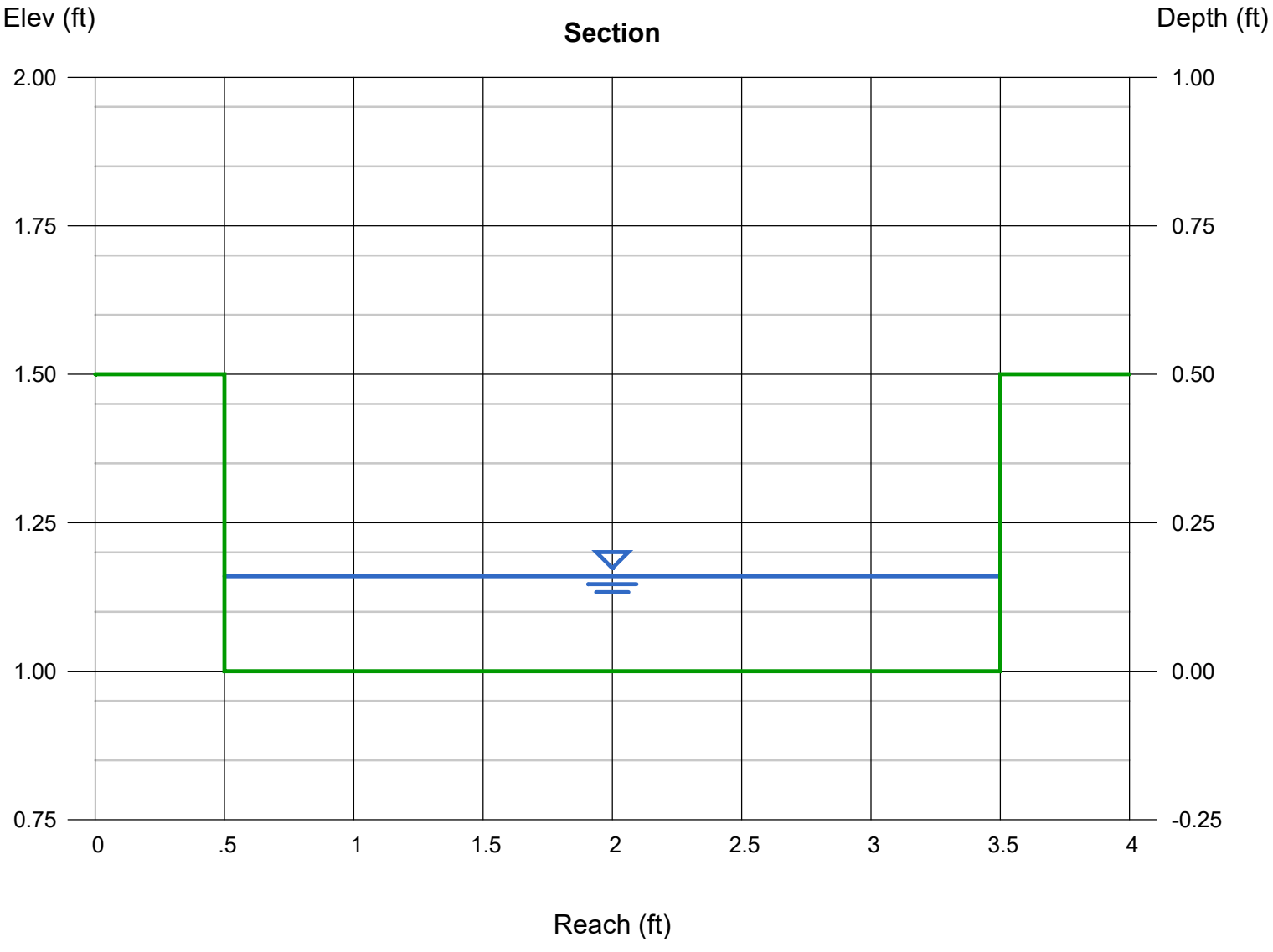
Bottom Width (ft)	= 3.00
Total Depth (ft)	= 0.50
Invert Elev (ft)	= 1.00
Slope (%)	= 0.50
N-Value	= 0.013

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

	WQCV		Pond Footprint	
EDB Pond	0.780	Acre-Ft	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

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

where

q = flow rate (ft^3/s)

h = head on the weir (ft)

b = width of the weir (ft)

MINIMUM SLOT WIDTH = 3"

Table EDB-4. EDB component criteria

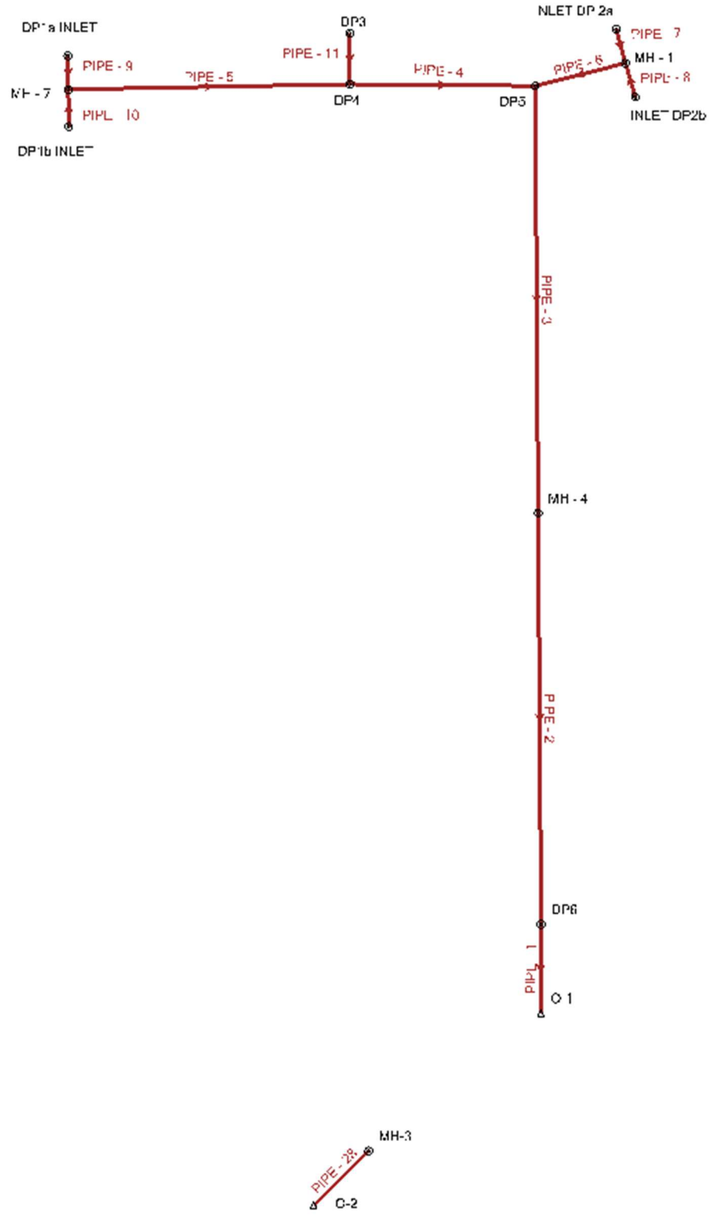
	On-Site EDBs for Watersheds up to 1 Impervious Acre[1]	EDBs with Watersheds between 1 and 2 Impervious Acres[1]	EDBs with Watersheds up to 5 Impervious Acres	EDBs with Watersheds over 5 Impervious Acres	EDBs with Watersheds over 20 Impervious Acres
Forebay Release and Configuration	EDBs should not be used for watersheds with less than 1 impervious acre.	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		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 Surcharge 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).

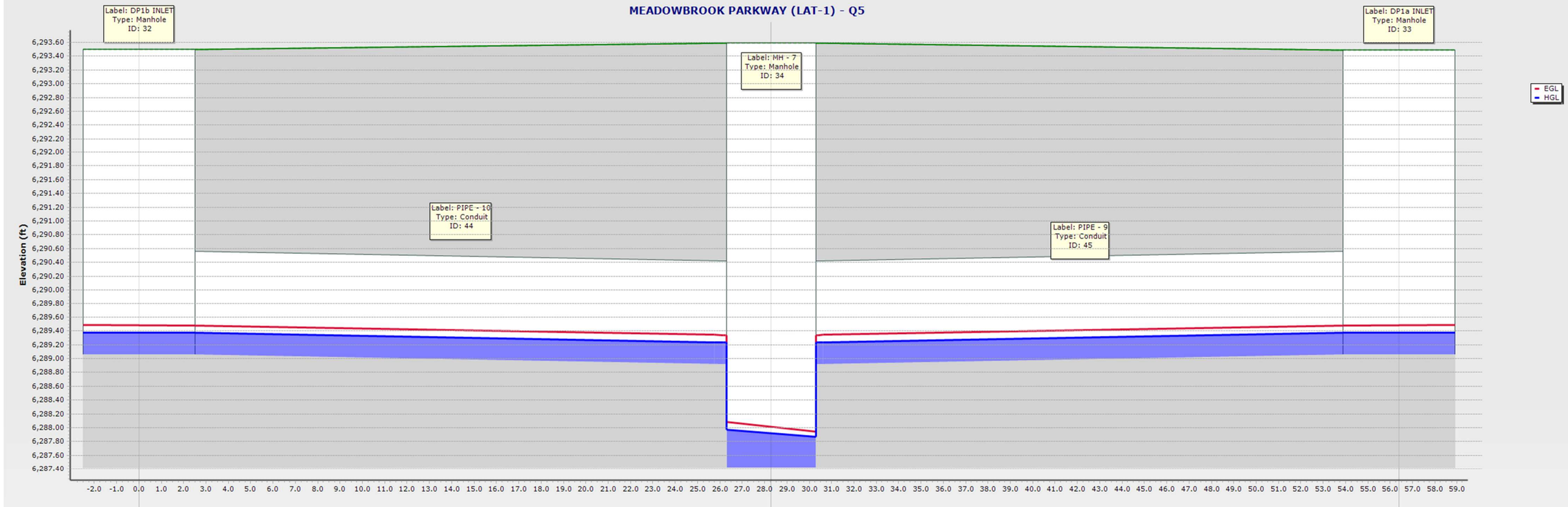
STORMCAD LAYOUT

NTS

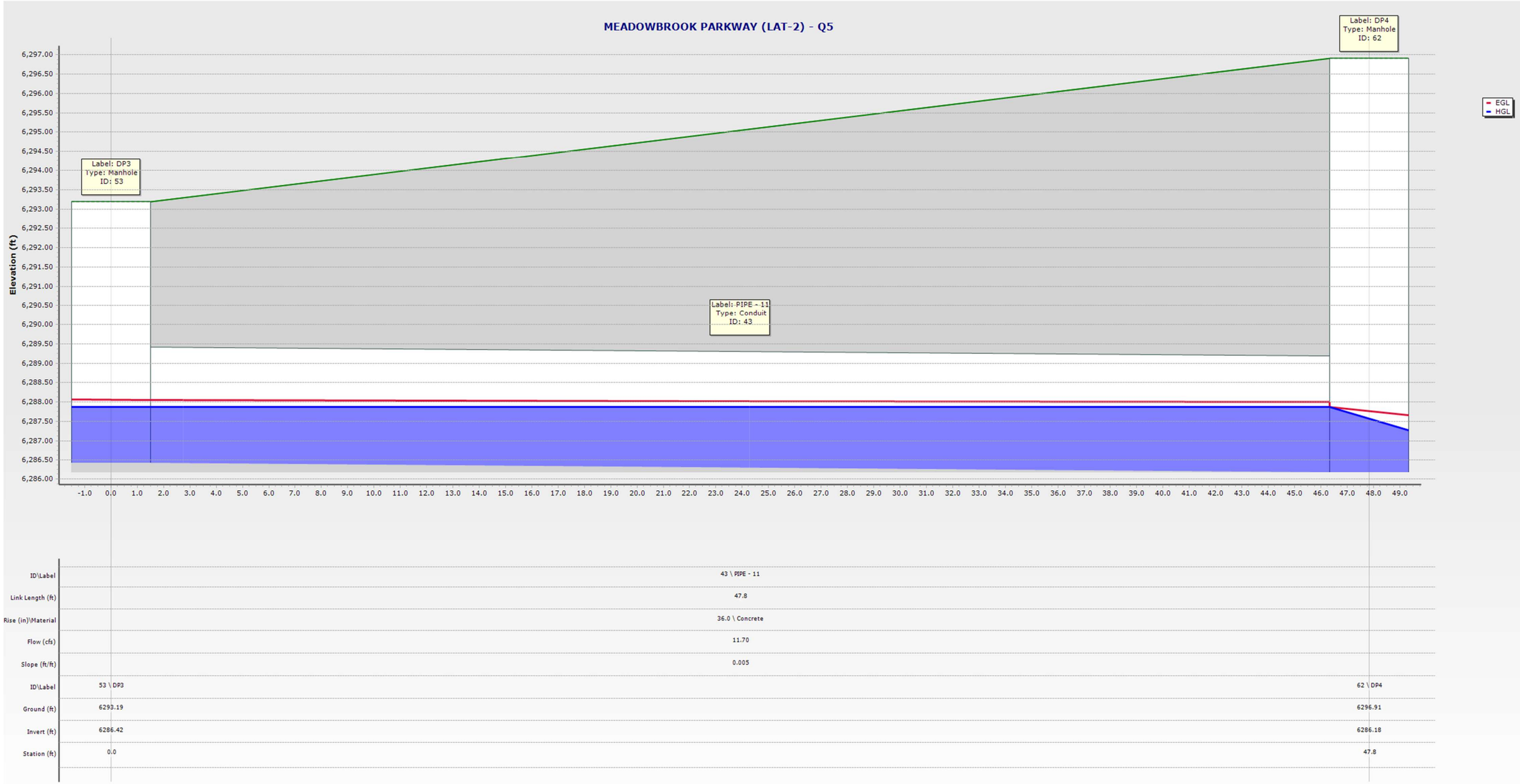


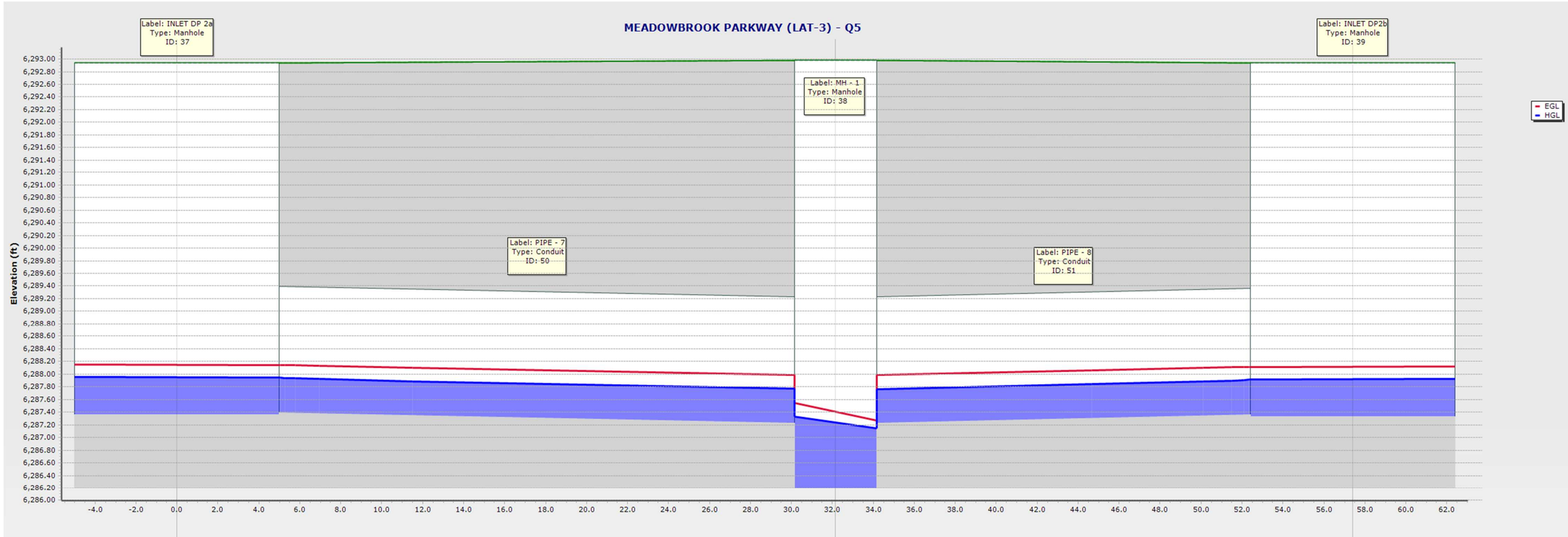
MEADOWBROOK PARKWAY (MAIN) - Q5

ID\Label	48 \ PIPE - 6	63 \ PIPE - 4	46 \ PIPE - 5	
Link Length (ft)	125.9	109.2	248.4	
Rise (in)\Material	36.0 \ Concrete	36.0 \ Concrete	36.0 \ Concrete	
Flow (cfs)	5.10	11.70	1.40	
Slope (ft/ft)	0.005	0.005	0.005	
ID\Label	38 \ MH - 1	35 \ DP5	62 \ DP4	34 \ MH - 7
Ground (ft)	6292.98	6294.37	6296.91	6293.59
Invert (ft)	6286.20	6285.10	6286.18	6287.42
Station (ft)	0.0	125.9	235.1	483.5



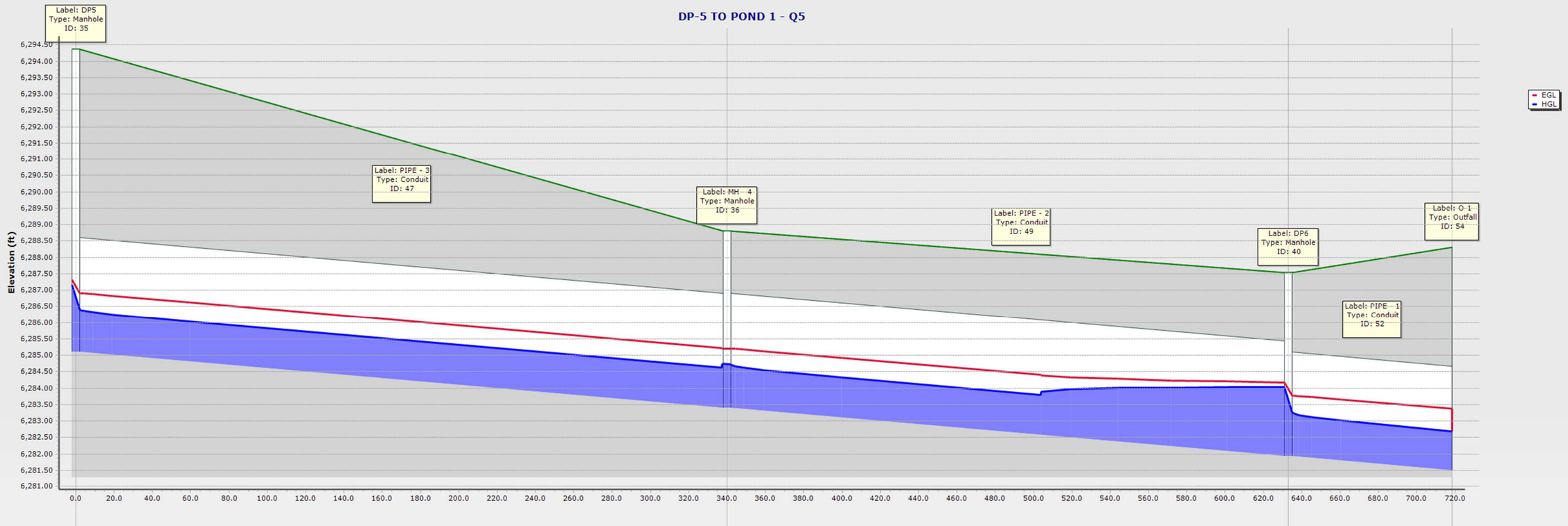
ID\Label		44 \ PIPE - 10		45 \ PIPE - 9	
Link Length (ft)		28.3		28.1	
Rise (in)\Material		18.0 \ Concrete		18.0 \ Concrete	
Flow (cfs)		0.70		0.70	
Slope (ft/ft)		0.005		0.005	
ID\Label	32 \ DP1b INLET		34 \ MH - 7		33 \ DP1a INLET
Ground (ft)	6293.50		6293.59		6293.49
Invert (ft)	6289.06		6287.42		6289.06
Station (ft)	0.0		28.3		56.4


MEADOWBROOK PARKWAY (LAT-2) - Q5
Label: DP4
Type: Manhole
ID: 62
Label: DP3
Type: Manhole
ID: 53
Label: PIPE - 11
Type: Conduit
ID: 43
EGL
HGL
Elevation (ft)
6,297.00
6,296.50
6,296.00
6,295.50
6,295.00
6,294.50
6,294.00
6,293.50
6,293.00
6,292.50
6,292.00
6,291.50
6,291.00
6,290.50
6,290.00
6,289.50
6,289.00
6,288.50
6,288.00
6,287.50
6,287.00
6,286.50
6,286.00
-1.0 0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0 30.0 31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0 45.0 46.0 47.0 48.0 49.0
ID\Label
43 \ PIPE - 11
Link Length (ft)
47.8
Rise (in)\Material
36.0 \ Concrete
Flow (cfs)
11.70
Slope (ft/ft)
0.005
ID\Label
53 \ DP3
62 \ DP4
Ground (ft)
6293.19
6296.91
Invert (ft)
6286.42
6286.18
Station (ft)
0.0
47.8

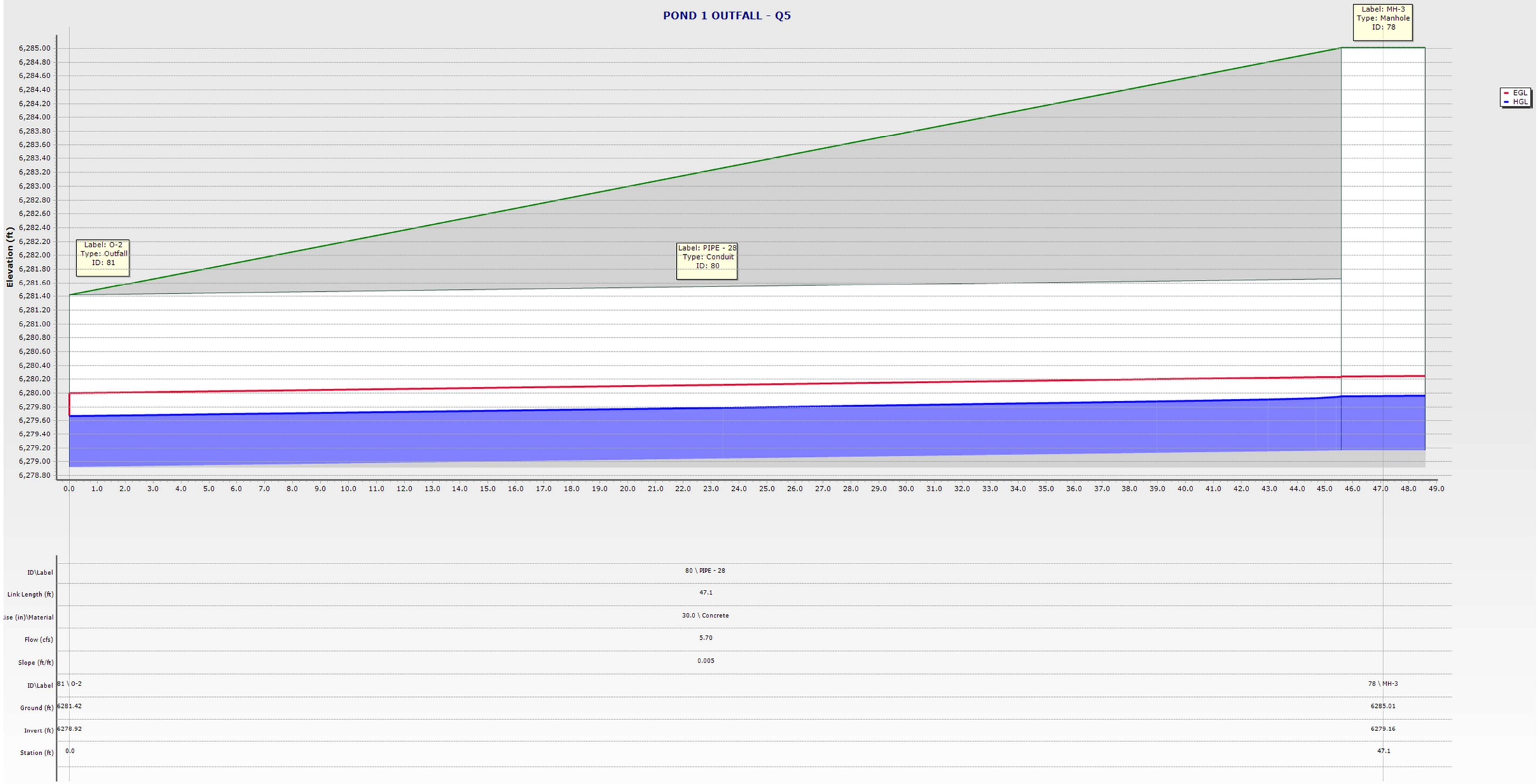


ID\Label		50 \ PIPE - 7	51 \ PIPE - 8
Link Length (ft)		32.2	25.2
Rise (in)\Material		24.0 \ Concrete	24.0 \ Concrete
Flow (cfs)		2.55	2.55
Slope (ft/ft)		0.005	0.005
ID\Label	37 \ INLET DP 2a	38 \ MH - 1	39 \ INLET DP2b
Ground (ft)	6292.94	6292.98	6292.94
Invert (ft)	6287.36	6286.20	6287.33
Station (ft)	0.0	32.2	57.4

DP-5 TO POND 1 - Q5



ID\Label		47 \ PIPE - 3		49 \ PIPE - 2		52 \ PIPE - 1	
Link Length (ft)		339.9		293.1		85.5	
Rise (in)\Material		42.0 \ Concrete		42.0 \ Concrete		38.0 \ Concrete	
Flow (cfs)		18.60		18.60		28.40	
Slope (ft/ft)		0.005		0.005		0.005	
ID\Label	35 \ DP5		36 \ MH - 4		40 \ DP6		54 \ O-1
Ground (ft)	6294.37		6288.81		6287.54		6288.31
Invert (ft)	6285.10		6283.40		6281.93		6281.30
Station (ft)	0.0		339.9		633.0		718.5


POND 1 OUTFALL - Q5
Label: MH-3
Type: Manhole
ID: 78
Label: O-2
Type: Outfall
ID: 81
Label: PIPE - 28
Type: Conduit
ID: 80
EGL
HGL
Elevation (ft)
6,285.00
6,284.80
6,284.60
6,284.40
6,284.20
6,284.00
6,283.80
6,283.60
6,283.40
6,283.20
6,283.00
6,282.80
6,282.60
6,282.40
6,282.20
6,282.00
6,281.80
6,281.60
6,281.40
6,281.20
6,281.00
6,280.80
6,280.60
6,280.40
6,280.20
6,280.00
6,279.80
6,279.60
6,279.40
6,279.20
6,279.00
6,278.80
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0 30.0 31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0 45.0 46.0 47.0 48.0 49.0
ID\Label
80 \ PIPE - 28
Link Length (ft)
47.1
ise (in)\Material
30.0 \ Concrete
Flow (cfs)
5.70
Slope (ft/ft)
0.005
ID\Label
81 \ O-2
78 \ MH-3
Ground (ft)
6281.42
6285.01
Invert (ft)
6278.92
6279.16
Station (ft)
0.0
47.1

	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

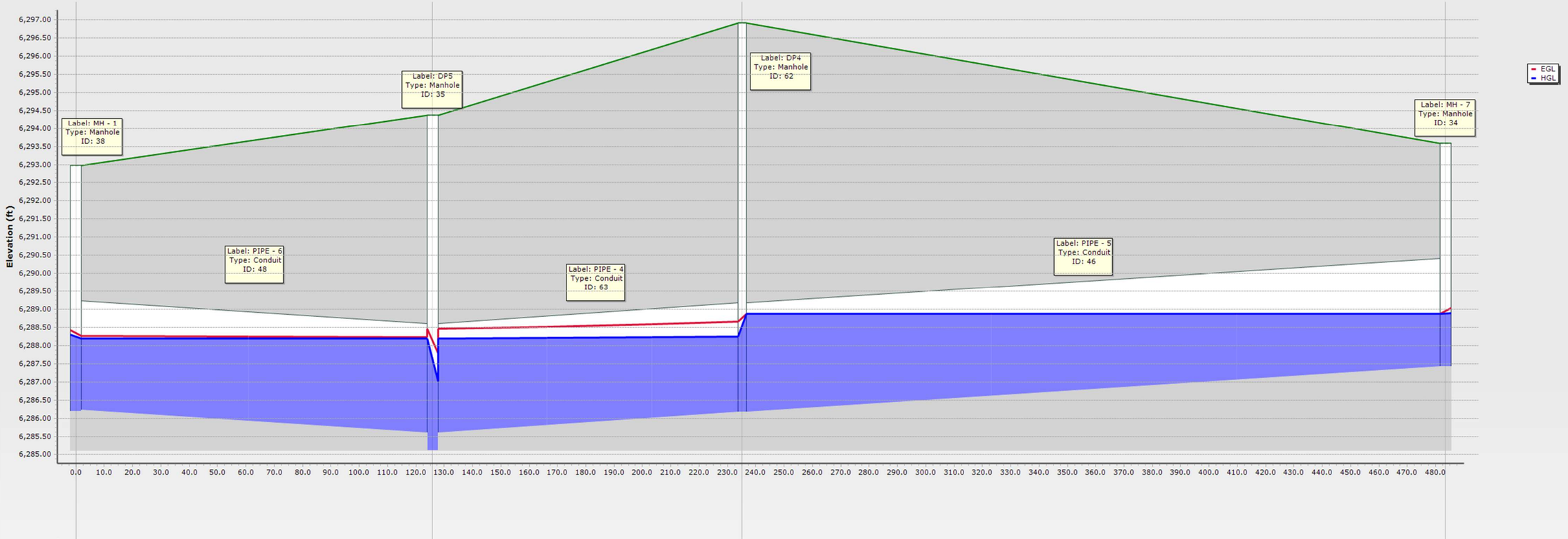
	Label	Elevation (Ground) (ft)	Elevation (Rim) (ft)	Elevation (Invert in 1) (ft)	Elevation (Invert in 2) (ft)	Elevation (Invert in 3) (ft)	Elevation (Invert Out) (ft)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Headloss Method	Headloss Coefficient (Standard)	Flow (Total Out) (cfs)	Headloss (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

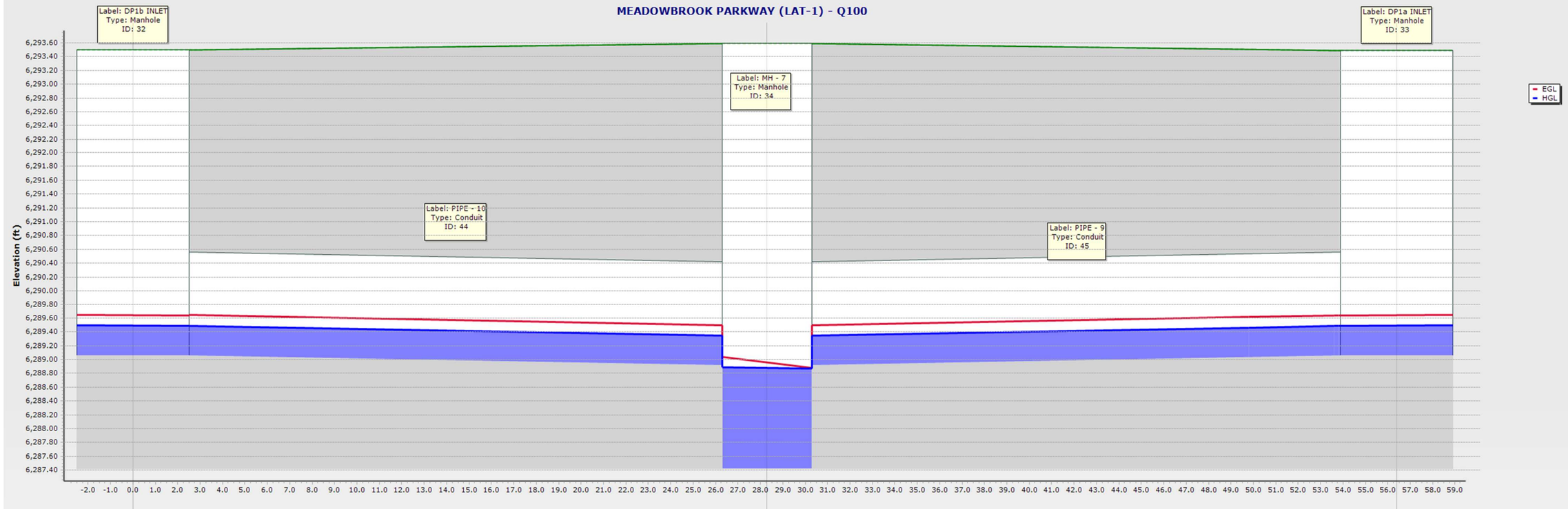
	Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
54: O-1	O-1	6,288.31	6,281.30	Free Outfall		6,282.69	28.40
81: O-2	O-2	6,281.42	6,278.92	Free Outfall		6,279.67	5.70

Figure 3- Q5 – Free Outfall OUTFALL SUMMARY

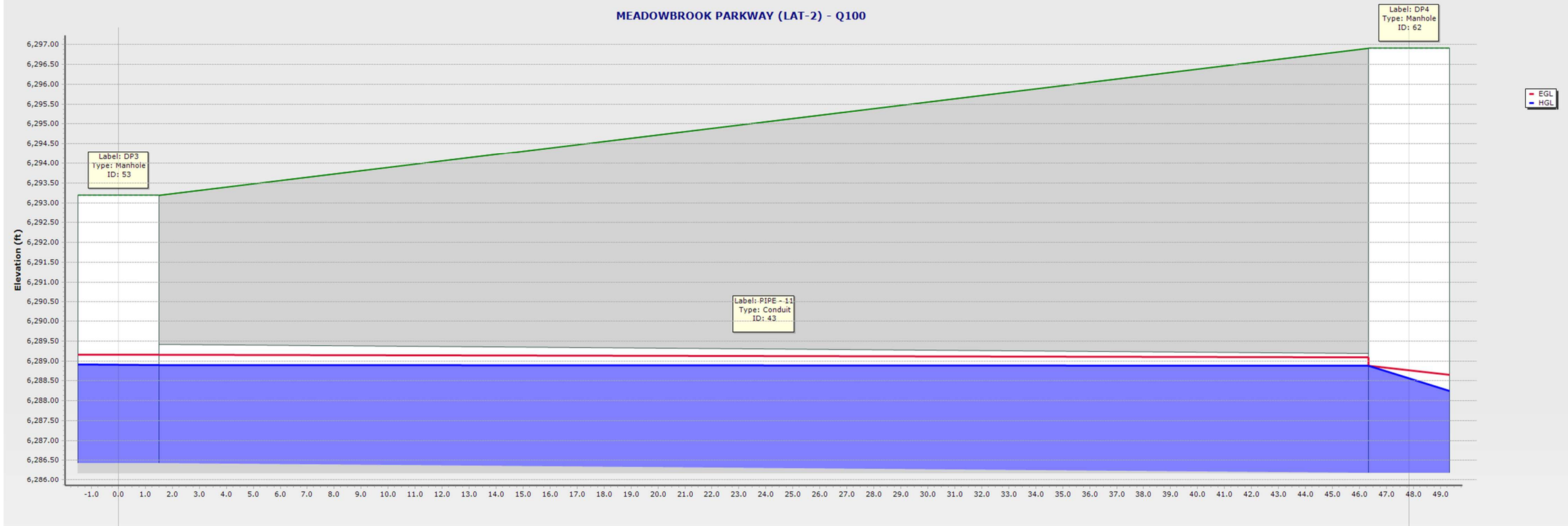
MEADOWBROOK PARKWAY (MAIN) - Q100



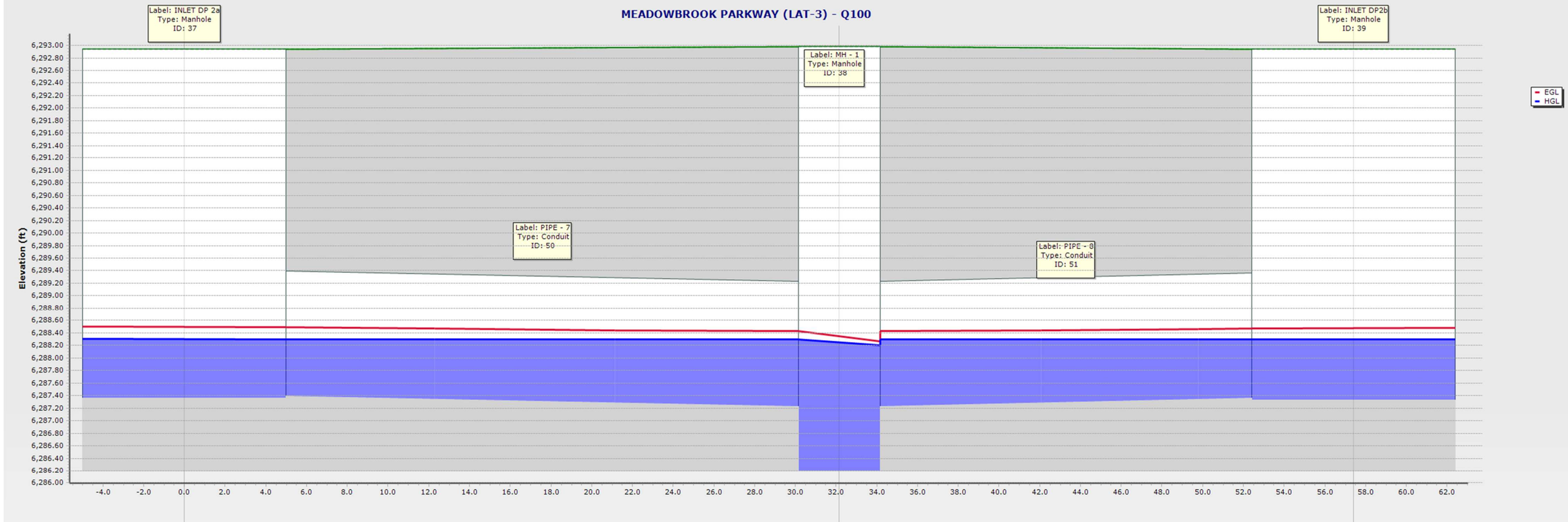
ID\Label	48 \ PIPE - 6	63 \ PIPE - 4	46 \ PIPE - 5	
Link Length (ft)	125.9	109.2	248.4	
Rise (in)\Material	36.0 \ Concrete	36.0 \ Concrete	36.0 \ Concrete	
Flow (cfs)	9.80	26.70	2.60	
Slope (ft/ft)	0.005	0.005	0.005	
ID\Label	38 \ MH - 1	35 \ DP5	62 \ DP4	34 \ MH - 7
Ground (ft)	6292.98	6294.37	6296.91	6293.59
Invert (ft)	6286.20	6285.10	6286.18	6287.42
Station (ft)	0.0	125.9	235.1	483.5



ID\Label	44 \ PIPE - 10	45 \ PIPE - 9	
Link Length (ft)	28.3	28.1	
Rise (in)\Material	18.0 \ Concrete	18.0 \ Concrete	
Flow (cfs)	1.30	1.30	
Slope (ft/ft)	0.005	0.005	
ID\Label	32 \ DP1b INLET	34 \ MH - 7	33 \ DP1a INLET
Ground (ft)	6293.50	6293.59	6293.49
Invert (ft)	6289.06	6287.42	6289.06
Station (ft)	0.0	28.3	56.4



ID\Label		43 \ PIPE - 11
Link Length (ft)		47.8
Rise (in)\Material		36.0 \ Concrete
Flow (cfs)		24.90
Slope (ft/ft)		0.005
ID\Label	53 \ DP3	62 \ DP4
Ground (ft)	6293.19	6296.91
Invert (ft)	6286.42	6286.18
Station (ft)	0.0	47.8

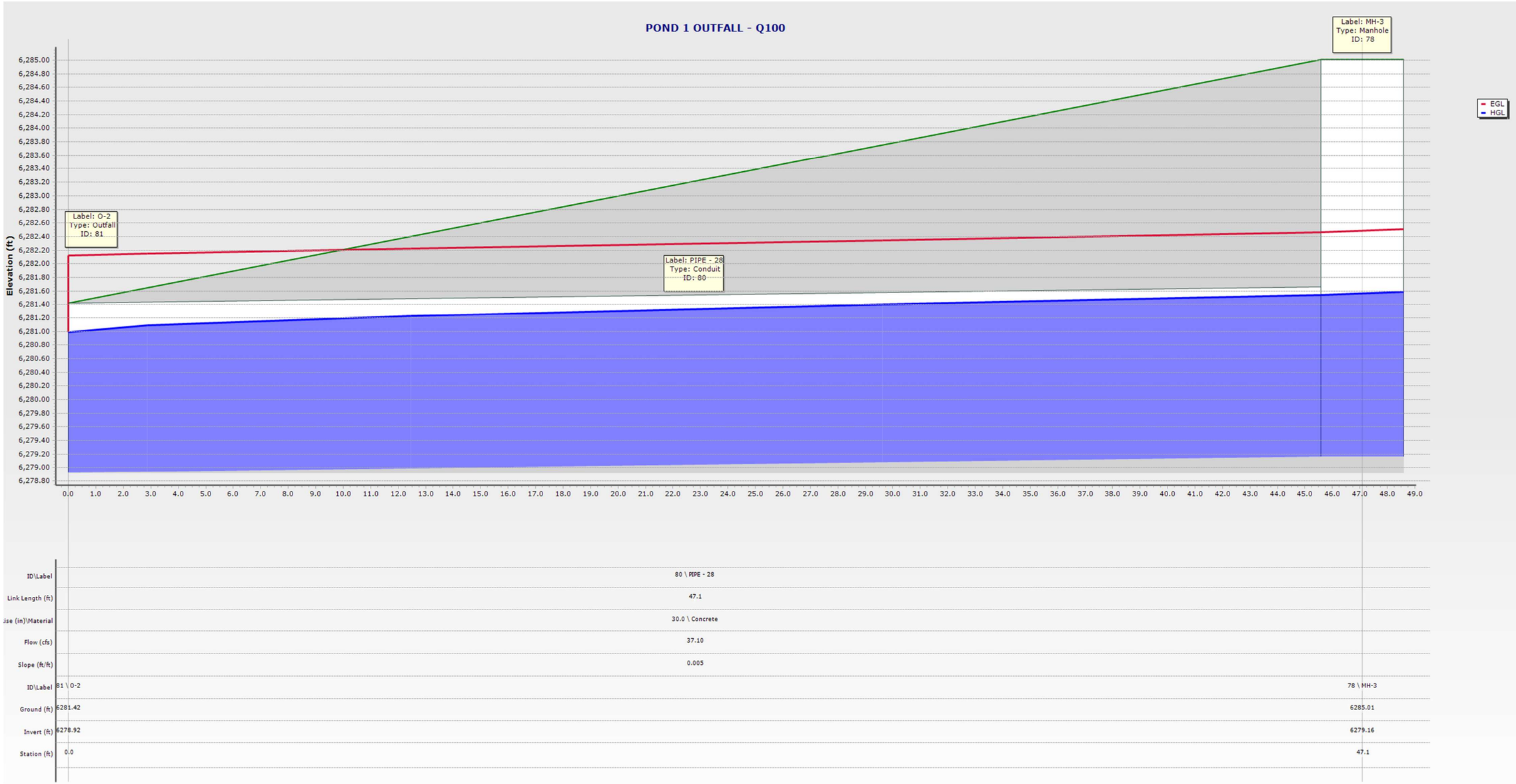


ID\Label		50 \ PIPE - 7		51 \ PIPE - 8	
Link Length (ft)		32.2		25.2	
Rise (in)\Material		24.0 \ Concrete		24.0 \ Concrete	
Flow (cfs)		4.90		4.90	
Slope (ft/ft)		0.005		0.005	
ID\Label	37 \ INLET DP 2a		38 \ MH - 1		39 \ INLET DP2b
Ground (ft)	6292.94		6292.98		6292.94
Invert (ft)	6287.36		6286.20		6287.33
Station (ft)	0.0		32.2		57.4

DP-5 TO POND 1 - Q100

ID\Label	47 \ PIPE - 3	49 \ PIPE - 2	52 \ PIPE - 1
Link Length (ft)	339.9	293.1	85.5
Rise (in)\Material	42.0 \ Concrete	42.0 \ Concrete	38.0 \ Concrete
Flow (cfs)	38.10	35.80	90.20
Slope (ft/ft)	0.005	0.005	0.005

ID\Label	35 \ DP5	36 \ MH - 4	40 \ DP6	54 \ O-1
Ground (ft)	6294.37	6288.81	6287.54	6288.31
Invert (ft)	6285.10	6283.40	6281.93	6281.30
Station (ft)	0.0	339.9	633.0	718.5


POND 1 OUTFALL - Q100
Label: MH-3
Type: Manhole
ID: 78
Label: O-2
Type: Outfall
ID: 81
Label: PIPE - 28
Type: Conduit
ID: 80
EGL
HGL
Elevation (ft)
6,285.00
6,284.80
6,284.60
6,284.40
6,284.20
6,284.00
6,283.80
6,283.60
6,283.40
6,283.20
6,283.00
6,282.80
6,282.60
6,282.40
6,282.20
6,282.00
6,281.80
6,281.60
6,281.40
6,281.20
6,281.00
6,280.80
6,280.60
6,280.40
6,280.20
6,280.00
6,279.80
6,279.60
6,279.40
6,279.20
6,279.00
6,278.80
0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0 11.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 19.0 20.0 21.0 22.0 23.0 24.0 25.0 26.0 27.0 28.0 29.0 30.0 31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0 45.0 46.0 47.0 48.0 49.0
ID\Label
80 \ PIPE - 28
Link Length (ft)
47.1
ise (in)\Material
30.0 \ Concrete
Flow (cfs)
37.10
Slope (ft/ft)
0.005
ID\Label
81 \ O-2
78 \ MH-3
Ground (ft)
6281.42
6285.01
Invert (ft)
6278.92
6279.16
Station (ft)
0.0
47.1

	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

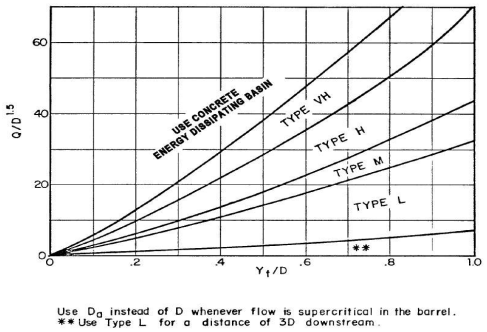
	Label	Elevation (Ground) (ft)	Elevation (Invert) (ft)	Boundary Condition Type	Elevation (User Defined Tailwater) (ft)	Hydraulic Grade (ft)	Flow (Total Out) (cfs)
54: O-1	O-1	6,288.31	6,281.30	Free Outfall		6,283.82	90.20
81: O-2	O-2	6,281.42	6,278.92	Free Outfall		6,280.98	37.10

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	
Yt/D	1.000	
Rip Rap	Type L for 3 x Pipe Dia Downstream	
Length of Rock	7.5	Feet
Width of Rock	7.5	Feet



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

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.

Inputs
calculations

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 $Q/WH^{1.5}$ of 8.0 or less. The parameters in these two figures are:

1. $Q/D^{1.5}$ or $Q/WH^{0.5}$ 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:

$$d_{50} = \frac{0.023Q}{Y_t^{1.2} D_c^{0.3}} \qquad \text{Equation 9-16}$$

Rectangular culvert:

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

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 ⅓ of the height of the storm drain, that is:

$$y_t \le \frac{D}{3} \quad \text{or} \quad y_t \le \frac{H}{3}$$

Where:

y_t = tailwater depth at design flow (feet)

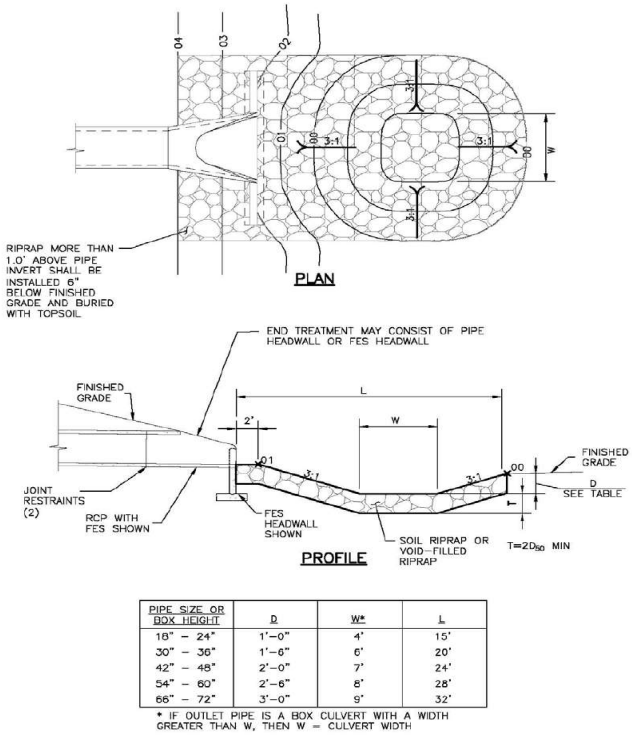
D = diameter of circular pipe (feet)

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:

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



PIPE SIZE OR BOX HEIGHT	D	W*	L
18" – 24"	1'–0"	4'	15'
30" – 36"	1'–6"	6'	20'
42" – 48"	2'–0"	7'	24'
54" – 60"	2'–6"	8'	28'
66" – 72"	3'–0"	9'	32'

* IF OUTLET PIPE IS A BOX CULVERT WITH A WIDTH GREATER THAN W, THEN W = CULVERT WIDTH

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)

User-defined

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

Calculations

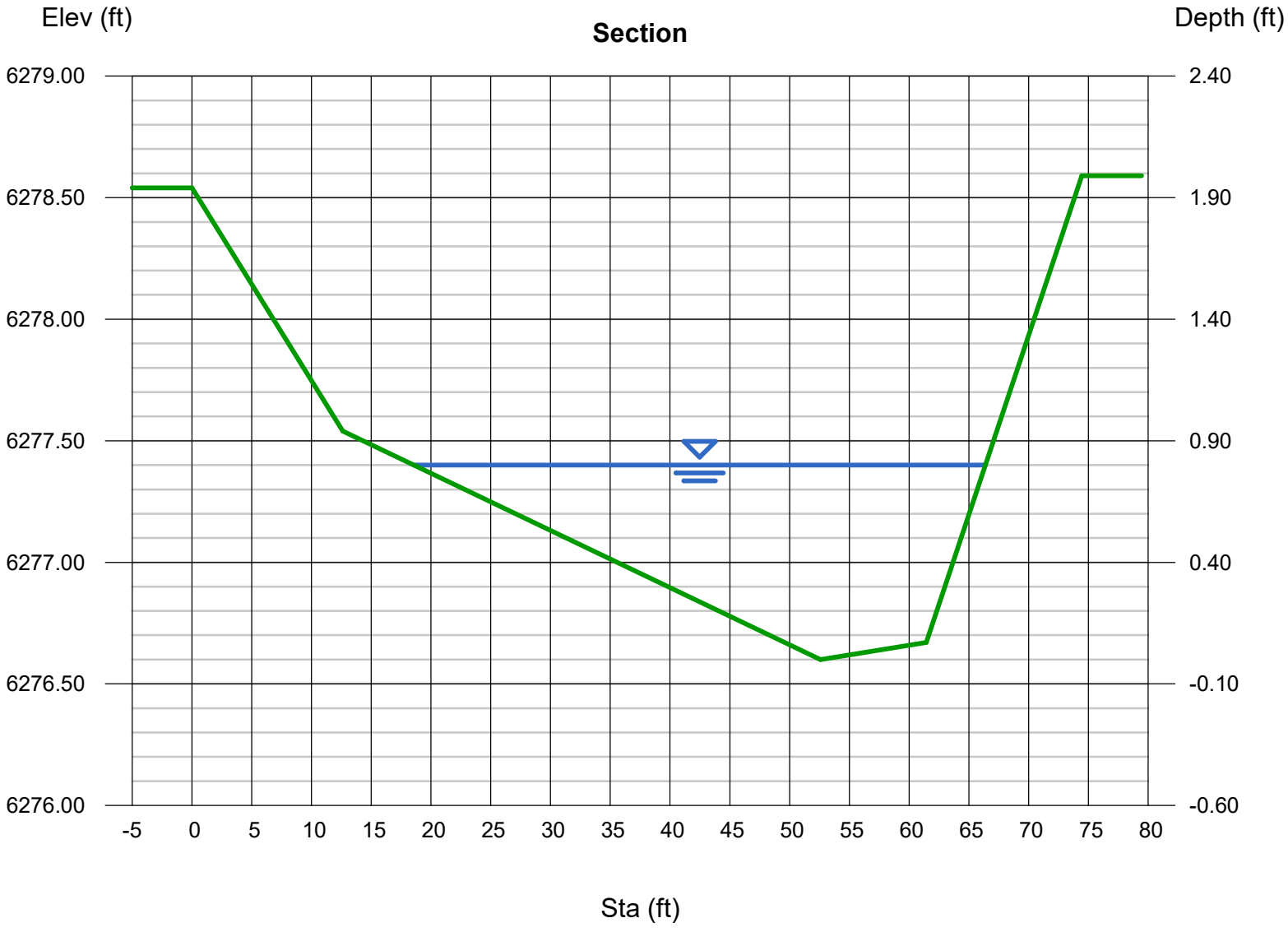
Compute by:	Known Q
Known Q (cfs)	= 71.80

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

(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

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Jun 24 2026

South Roadside Ditch (Proposed Flows)

User-defined

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

Calculations

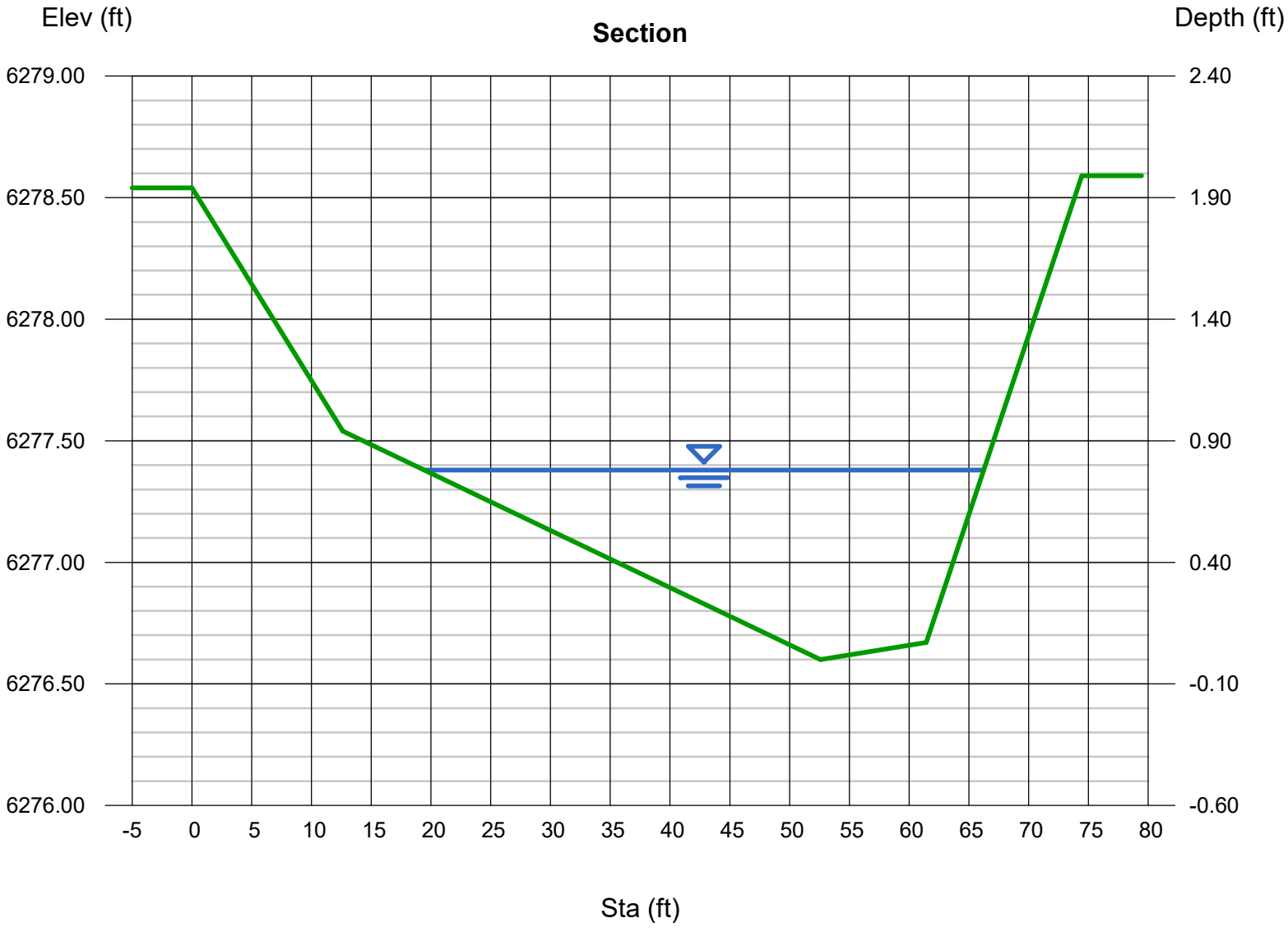
Compute by:	Known Q
Known Q (cfs)	= 68.10

Highlighted

Depth (ft)	= 0.78
Q (cfs)	= 68.10
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)



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Jun 24 2026

South Roadside Ditch (Undetained Emergency Spillway Flows)

User-defined

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

Calculations

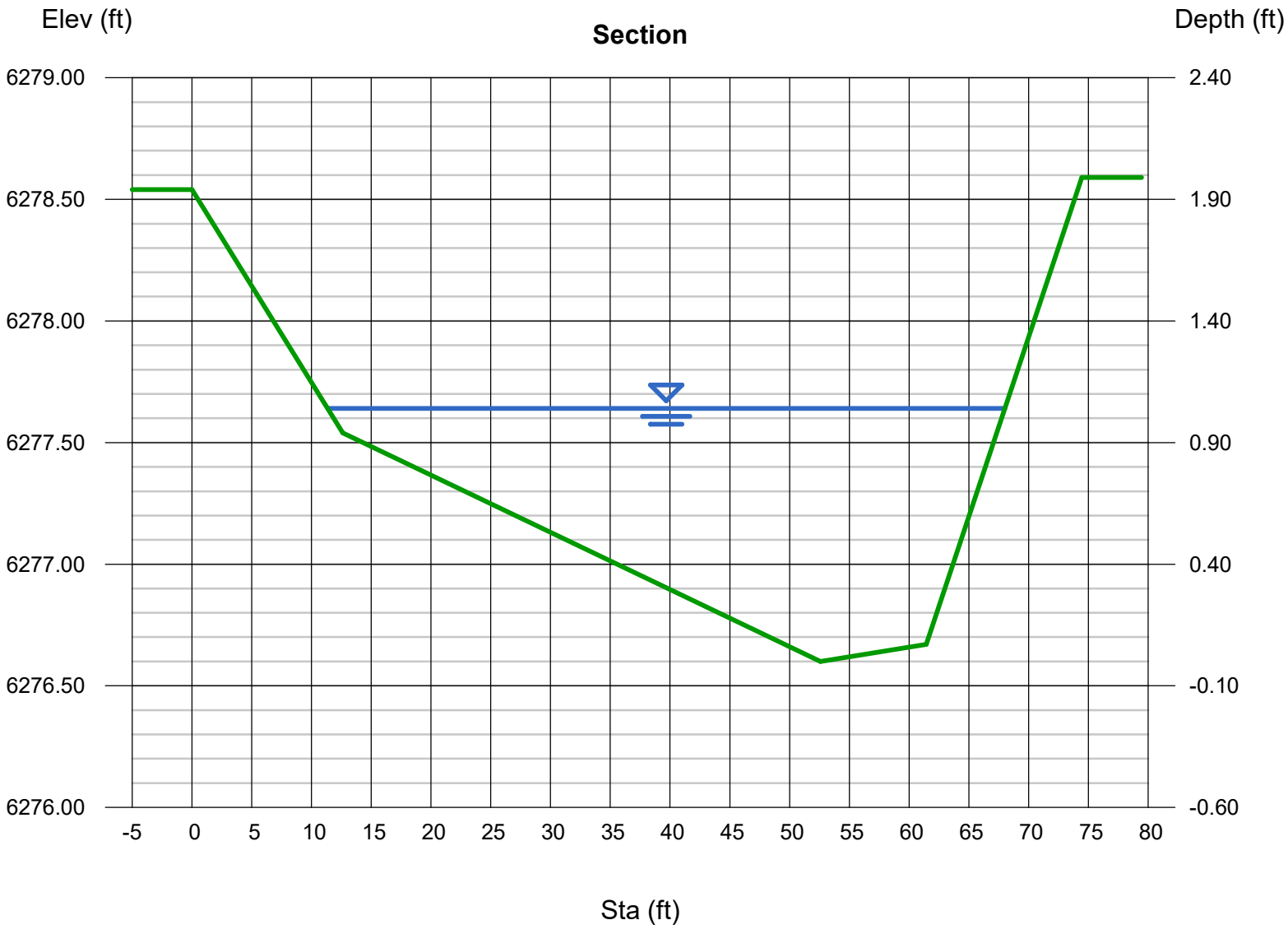
Compute by:	Known Q
Known Q (cfs)	= 137.80

Highlighted

Depth (ft)	= 1.04
Q (cfs)	= 137.80
Area (sqft)	= 34.94
Velocity (ft/s)	= 3.94
Wetted Perim (ft)	= 56.74
Crit Depth, Yc (ft)	= 0.99
Top Width (ft)	= 56.66
EGL (ft)	= 1.28

(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)



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

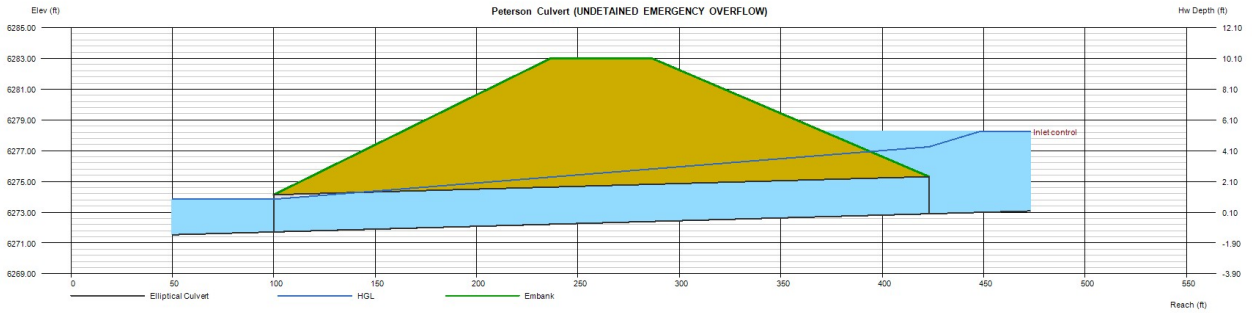
Top Elevation (ft)	=	6283.00
Top Width (ft)	=	50.00
Crest Width (ft)	=	10.00

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

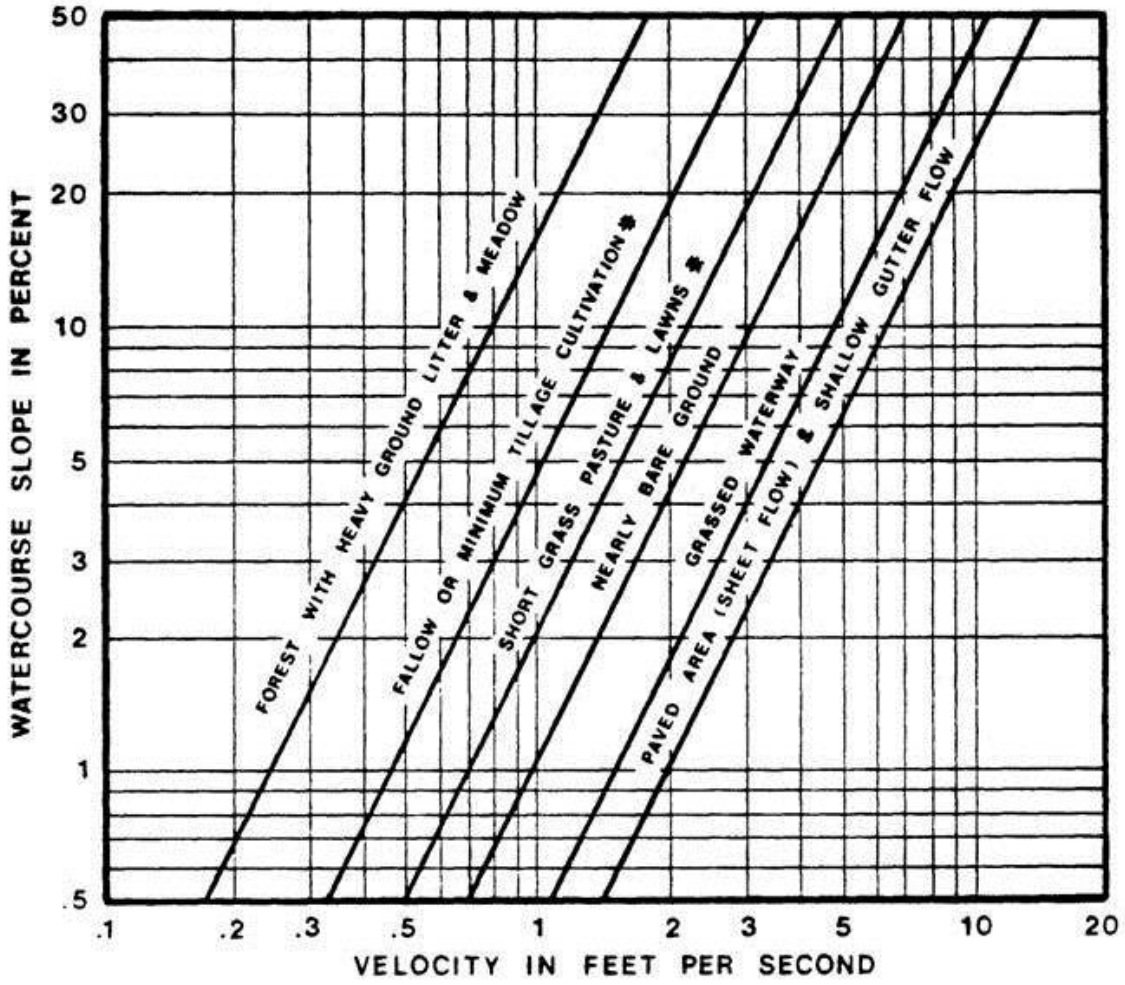
3.2 Time of Concentration

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

National Flood Hazard Layer FIRMette

FEMA

104°42'24"W 38°50'48"N



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

1:6,000

104°41'46"W 38°50'20"N

Basemap Imagery Source: USGS National Map 2023

Legend

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

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 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.

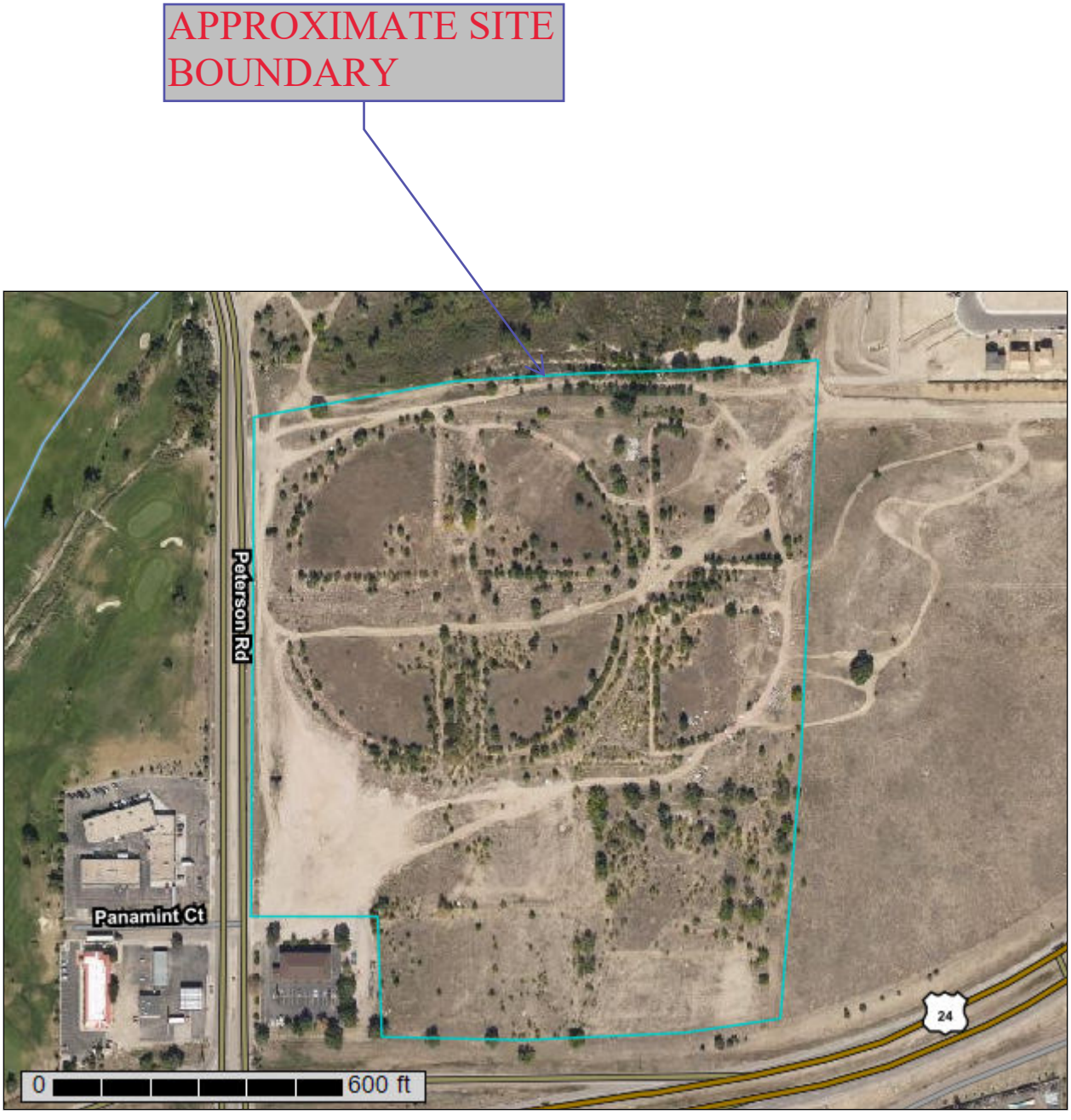
United States Department of Agriculture

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



July 17, 2024

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

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



Map Scale: 1:2,770 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 40 80 160 240

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

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, talf
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

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
Dallas, TX 75225
Phone: 970-819-9968

Prepared by:

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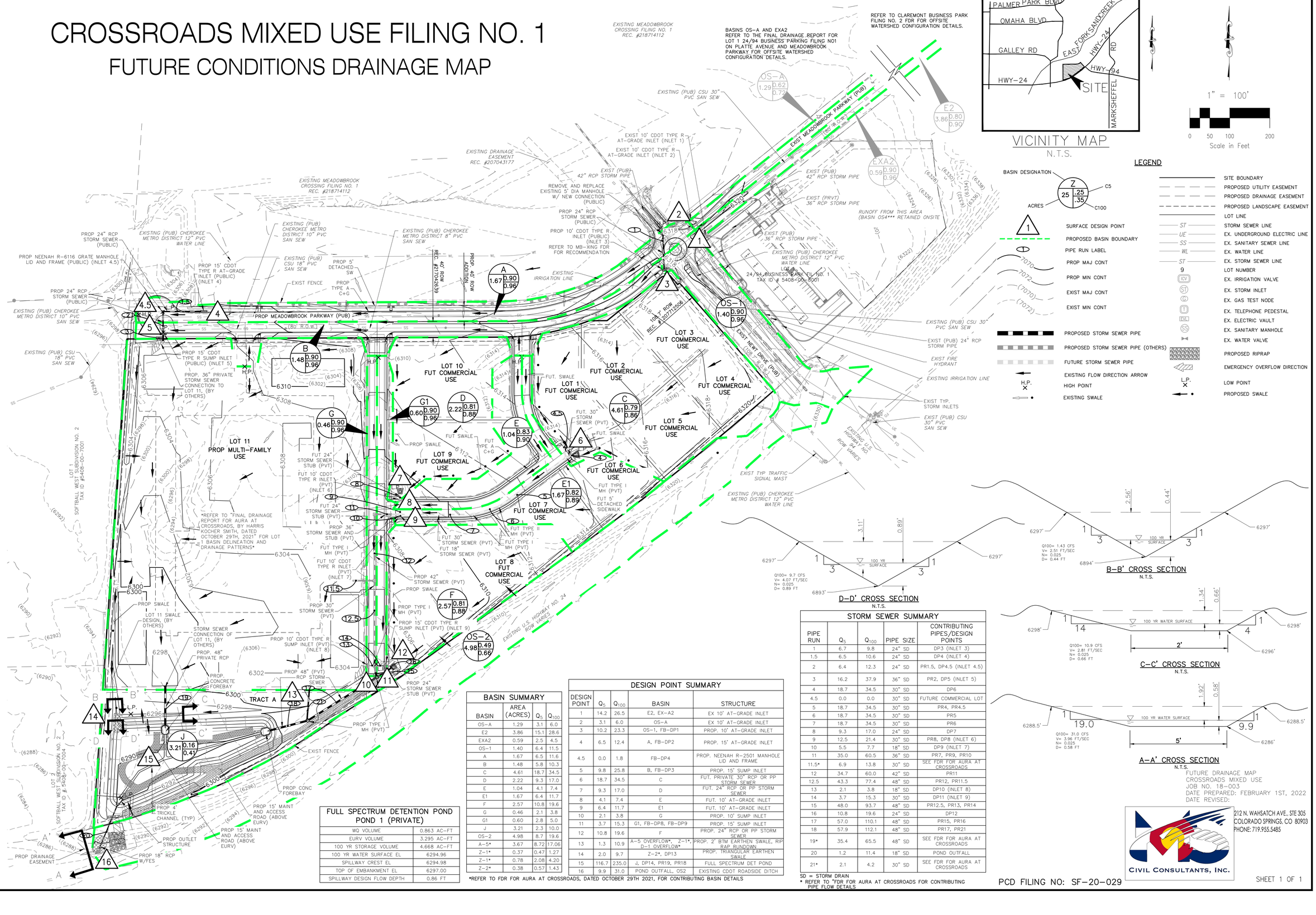
Harris Kocher Smith Project No.: 200823
PCD Project Number: PPR-21-041

CROSSROADS MIXED USE FILING NO. 1

FUTURE CONDITIONS DRAINAGE MAP



VICINITY MAP
N.T.S.

1" = 100'
0 50 100 200
Scale in Feet

LEGEND

BASIN DESIGNATION: Z / 25 / .25 / .35 / C5 / C100 / ACRES

- SURFACE DESIGN POINT
- PROPOSED BASIN BOUNDARY
- PIPE RUN LABEL
- PROP MAJ CONT
- PROP MIN CONT
- EXIST MAJ CONT
- EXIST MIN CONT
- PROPOSED STORM SEWER PIPE
- PROPOSED STORM SEWER PIPE (OTHERS)
- FUTURE STORM SEWER PIPE
- EXISTING FLOW DIRECTION ARROW
- HIGH POINT
- EXISTING SWALE
- SITE BOUNDARY
- PROPOSED UTILITY EASEMENT
- PROPOSED DRAINAGE EASEMENT
- PROPOSED LANDSCAPE EASEMENT
- LOT LINE
- ST STORM SEWER LINE
- UE EX. UNDERGROUND ELECTRIC LINE
- SS EX. SANITARY SEWER LINE
- WL EX. WATER LINE
- ST EX. STORM SEWER LINE
- LOT NUMBER
- CV EX. IRRIGATION VALVE
- ST EX. STORM INLET
- G EX. GAS TEST NODE
- T EX. TELEPHONE PEDESTAL
- EVL EX. ELECTRIC VAULT
- SS EX. SANITARY MANHOLE
- EX. WATER VALVE
- PROPOSED RIPRAP
- EMERGENCY OVERFLOW DIRECTION
- L.P. LOW POINT
- PROPOSED SWALE

BASIN SUMMARY

BASIN	AREA (ACRES)	Q_5	Q_{100}
OS-A	1.29	3.1	6.0
E2	3.86	15.1	28.6
EXA2	0.59	2.5	4.5
OS-1	1.40	6.4	11.5
A	1.67	6.5	11.6
B	1.48	5.8	10.3
C	4.61	18.7	34.5
D	2.22	9.3	17.0
E	1.04	4.1	7.4
E1	1.67	6.4	11.7
F	2.57	10.8	19.6
G	0.46	2.1	3.8
G1	0.60	2.8	5.0
J	3.21	2.3	10.0
OS-2	4.98	8.7	19.6
A-5*	3.67	8.72	17.06
Z-1*	0.37	0.47	1.27
Z-1*	0.78	2.08	4.20
Z-2*	0.38	0.57	1.43

*REFER TO FDR FOR AURA AT CROSSROADS, DATED OCTOBER 29TH 2021, FOR CONTRIBUTING BASIN DETAILS

FULL SPECTRUM DETENTION POND POND 1 (PRIVATE)

WQ VOLUME	0.863 AC-FT
EURV VOLUME	3.295 AC-FT
100 YR STORAGE VOLUME	4.668 AC-FT
100 YR WATER SURFACE EL	6294.96
SPILLWAY CREST EL	6294.98
TOP OF EMBANKMENT EL	6297.00
SPILLWAY DESIGN FLOW DEPTH	0.86 FT

DESIGN POINT SUMMARY

DESIGN POINT	Q_5	Q_{100}	BASIN	STRUCTURE
1	14.2	26.5	E2, EX-A2	EX 10' AT-GRADE INLET
2	3.1	6.0	OS-A	EX 10' AT-GRADE INLET
3	10.2	23.3	OS-1, FB-DP1	PROP. 10' AT-GRADE INLET
4	6.5	12.4	A, FB-DP2	PROP. 15' AT-GRADE INLET
4.5	0.0	1.8	FB-DP4	PROP. NEENAH R-2501 MANHOLE LID AND FRAME
5	9.8	25.8	B, FB-DP3	PROP. 15' SUMP INLET
6	18.7	34.5	C	FUT. PRIVATE 30" RCP OR PP STORM SEWER
7	9.3	17.0	D	FUT. 24" RCP OR PP STORM SEWER
8	4.1	7.4	E	FUT. 10' AT-GRADE INLET
9	6.4	11.7	E1	FUT. 10' AT-GRADE INLET
10	2.1	3.8	G	PROP. 10' SUMP INLET
11	3.7	15.3	G1, FB-DP8, FB-DP9	PROP. 15' SUMP INLET
12	10.8	19.6	F	PROP. 24" RCP OR PP STORM SEWER
13	1.3	10.9	A-5 OVERFLOW*, Z-1*, D-1 OVERFLOW*	PROP. 2' BTM EARTHEN SWALE, RIP RAP RUNDOWN
14	2.0	9.7	Z-2*, DP13	PROP. TRIANGULAR EARTHEN SWALE
15	116.7	235.0	J, DP14, PR19, PR18	FULL SPECTRUM DET POND
16	9.9	31.0	POND OUTFALL, OS2	EXISTING CDOT ROADSIDE DITCH

STORM SEWER SUMMARY

PIPE RUN	Q_5	Q_{100}	PIPE SIZE	CONTRIBUTING PIPES/DESIGN POINTS
1	6.7	9.8	24" SD	DP3 (INLET 3)
1.5	6.5	10.6	24" SD	DP4 (INLET 4)
2	6.4	12.3	24" SD	PR1.5, DP4.5 (INLET 4.5)
3	16.2	37.9	36" SD	PR2, DP5 (INLET 5)
4	18.7	34.5	30" SD	DP6
4.5	0.0	0.0	30" SD	FUTURE COMMERCIAL LOT
5	18.7	34.5	30" SD	PR4, PR4.5
6	18.7	34.5	30" SD	PR5
7	18.7	34.5	30" SD	PR6
8	9.3	17.0	24" SD	DP7
9	12.5	21.4	30" SD	PR8, DP8 (INLET 6)
10	5.5	7.7	18" SD	DP9 (INLET 7)
11	35.0	60.5	36" SD	PR7, PR9, PR10
11.5*	6.9	13.8	30" SD	SEE FDR FOR AURA AT CROSSROADS
12	34.7	60.0	42" SD	PR11
12.5	43.3	77.4	48" SD	PR12, PR11.5
13	2.1	3.8	18" SD	DP10 (INLET 8)
14	3.7	15.3	30" SD	DP11 (INLET 9)
15	48.0	93.7	48" SD	PR12.5, PR13, PR14
16	10.8	19.6	24" SD	DP12
17	57.0	110.1	48" SD	PR15, PR16
18	57.9	112.1	48" SD	PR17, PR21
19*	35.4	65.5	48" SD	SEE FDR FOR AURA AT CROSSROADS
20	1.2	11.4	18" SD	POND OUTFALL
21*	2.1	4.2	30" SD	SEE FDR FOR AURA AT CROSSROADS

SD = STORM DRAIN
* REFER TO "FDR FOR AURA AT CROSSROADS FOR CONTRIBUTING PIPE FLOW DETAILS

D-D' CROSS SECTION
N.T.S.

B-B' CROSS SECTION
N.T.S.

C-C' CROSS SECTION
N.T.S.

A-A' CROSS SECTION
N.T.S.

FUTURE DRAINAGE MAP
CROSSROADS MIXED USE
JOB NO. 18-003
DATE PREPARED: FEBRUARY 1ST, 2022
DATE REVISED:

CIVIL CONSULTANTS, INC.
212 N. WAHSATCH AVE., STE 305
COLORADO SPRINGS, CO 80903
PHONE: 719.955.5485

PCD FILING NO: SF-20-029

SHEET 1 OF 1

HEC RAS MODELING
EXCERPTED FROM "NO RISE"

EXISTING CONDITIONS HEC-RAS MODEL

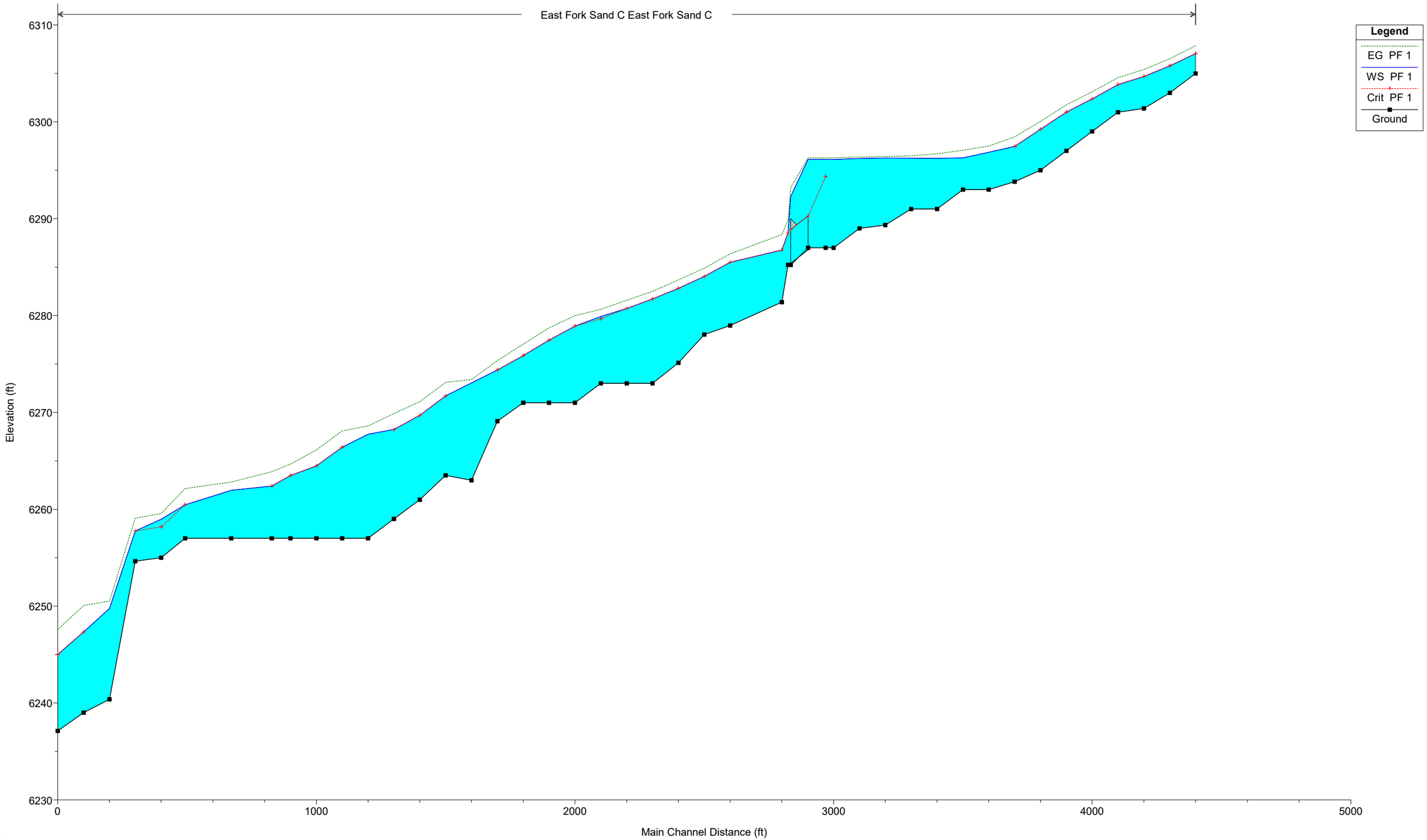
HEC-RAS Plan: Plan 2 River: East Fork Sand C Reach: East Fork Sand C Profile: PF 1

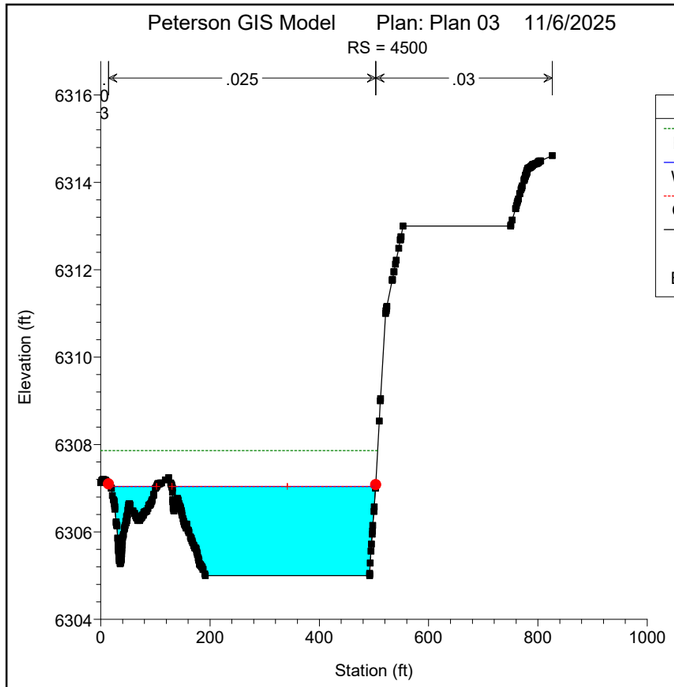
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
East Fork Sand C	4500	PF 1	5420.0	6305.0	6307.0	6307.0	6307.9	0.007868	7.3	744.2	457.7	1.01
East Fork Sand C	4400	PF 1	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
East Fork Sand C	3400	PF 1	5420.0	6291.0	6296.3		6296.5	0.000837	4.0	1348.7	1278.9	0.37
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
East Fork Sand C	3200	PF 1	5420.0	6289.0	6296.2		6296.4	0.000497	3.2	1706.7	1653.4	0.29
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
East Fork Sand C	2700	PF 1	5420.0	6279.0	6285.5	6285.5	6286.4	0.003942	8.1	781.2	427.0	0.80
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	0.008135	7.1	761.9	534.7	1.01
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	0.005288	6.9	784.5	386.4	0.85
East Fork Sand C	2100	PF 1	5420.0	6271.0	6278.9	6278.9	6280.0	0.007058	8.4	645.2	293.8	1.00
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	6273.1		6273.4	0.000974	4.8	1140.6	317.4	0.41
East Fork Sand C	1600	PF 1	5420.0	6263.5	6271.7	6271.7	6273.1	0.006804	9.5	572.5	233.1	1.01
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	0.006459	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

Peterson GIS Model Plan: Plan 03 11/6/2025

East Fork Sand C East Fork Sand C

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.03
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Legend
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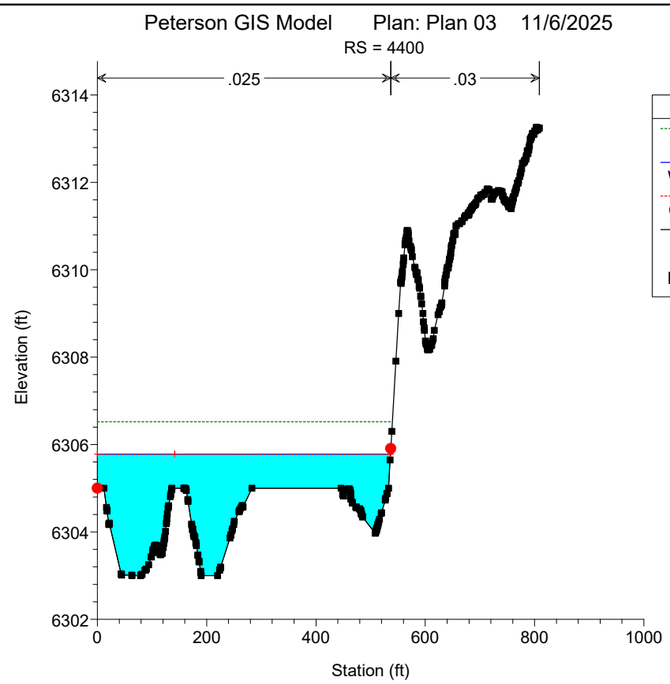
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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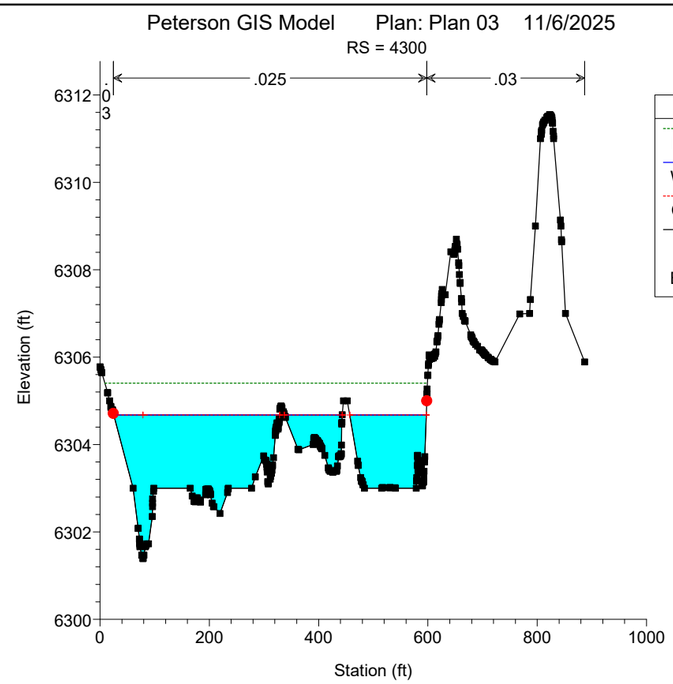
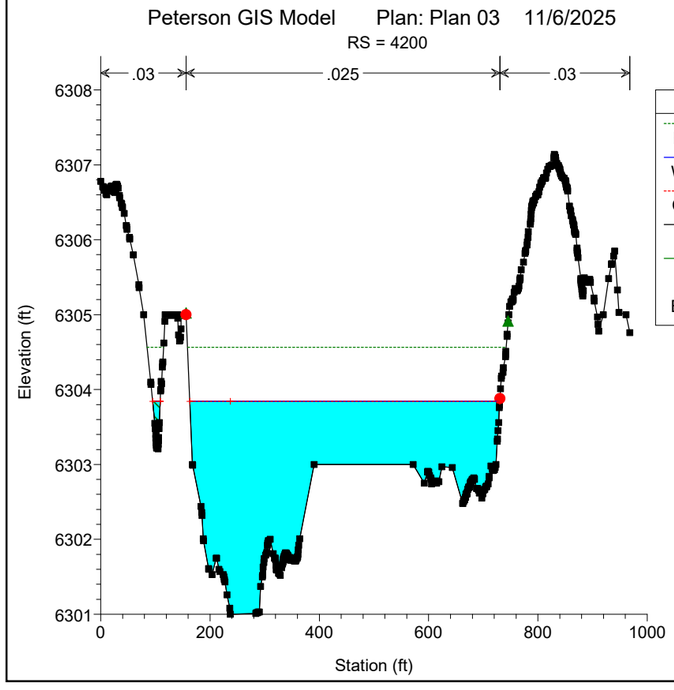
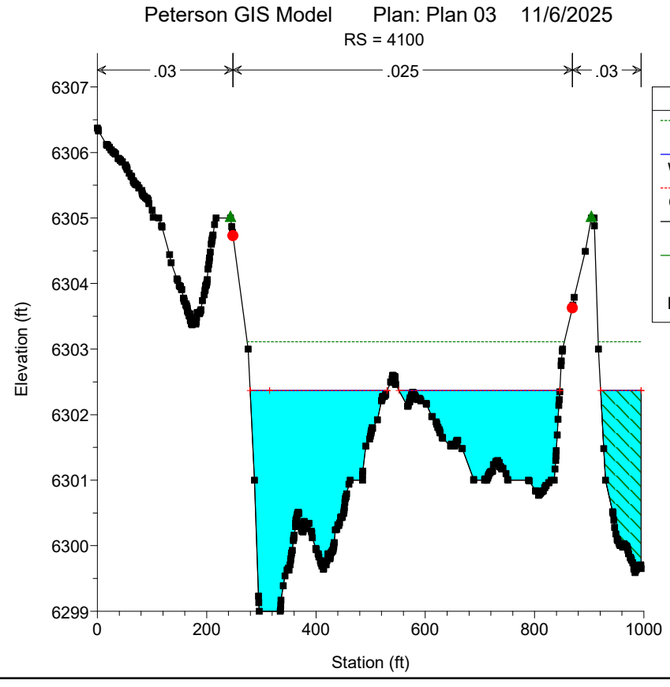
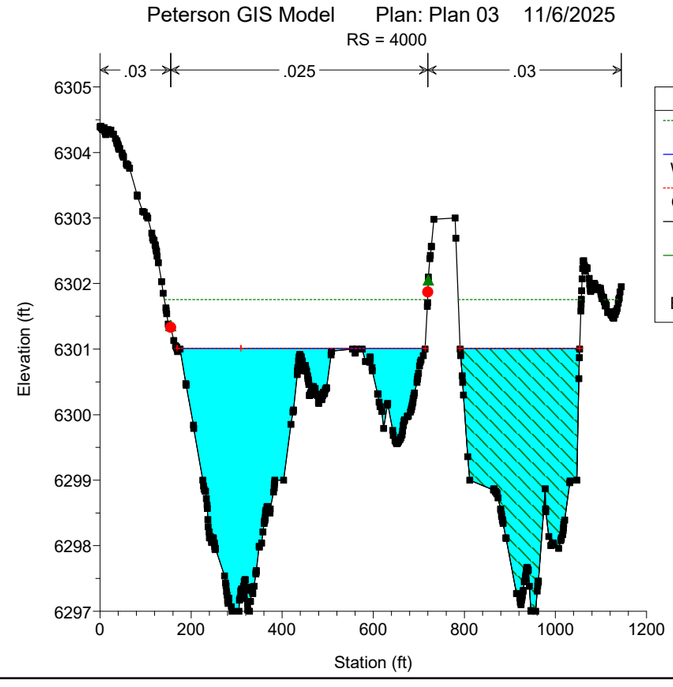
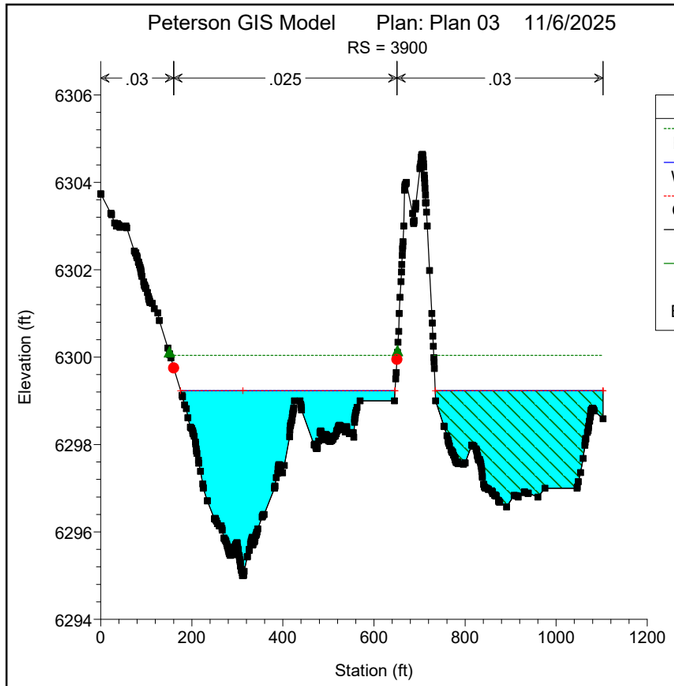
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

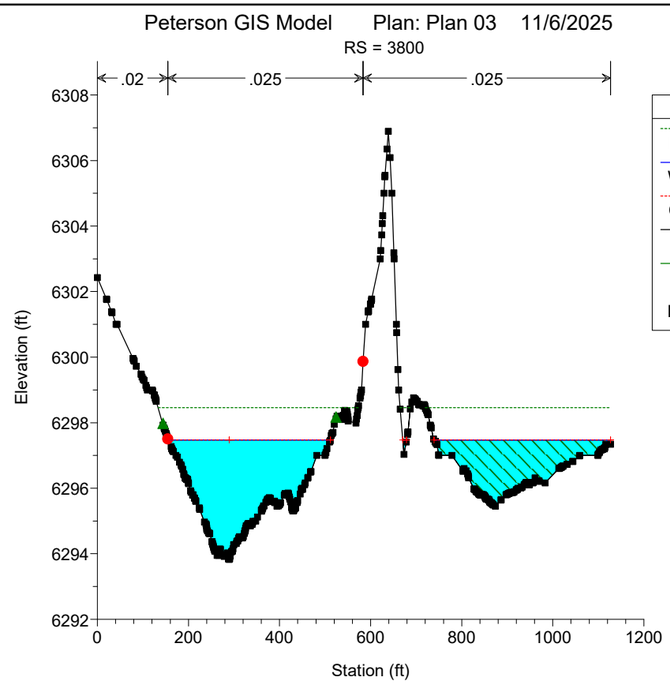

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 4300
.025
.03
0.3
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

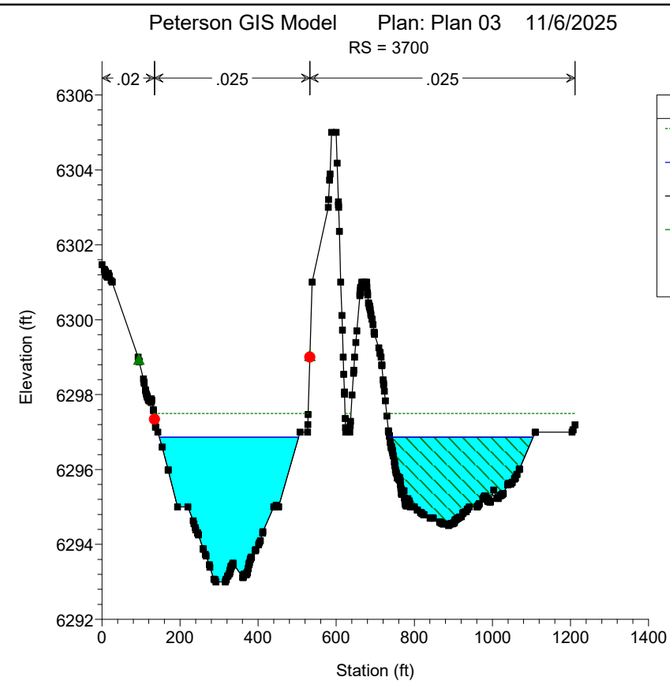

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 4200
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

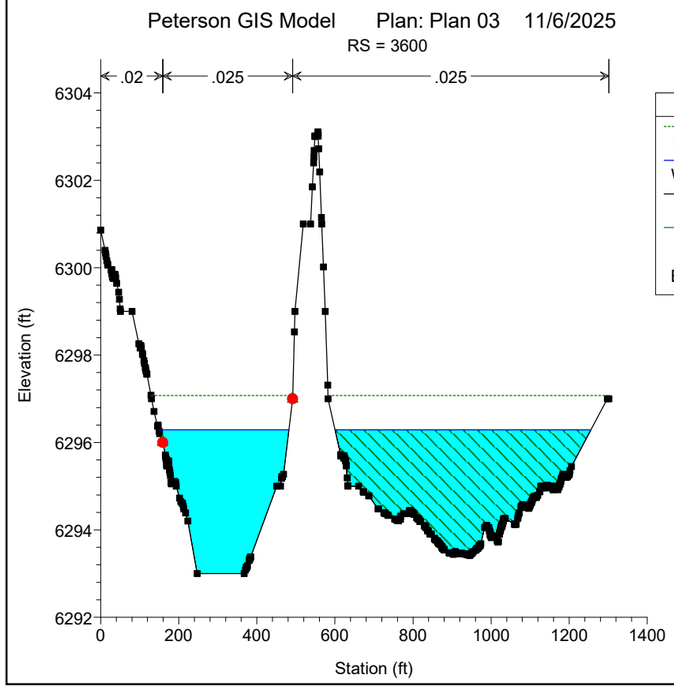

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 4100
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

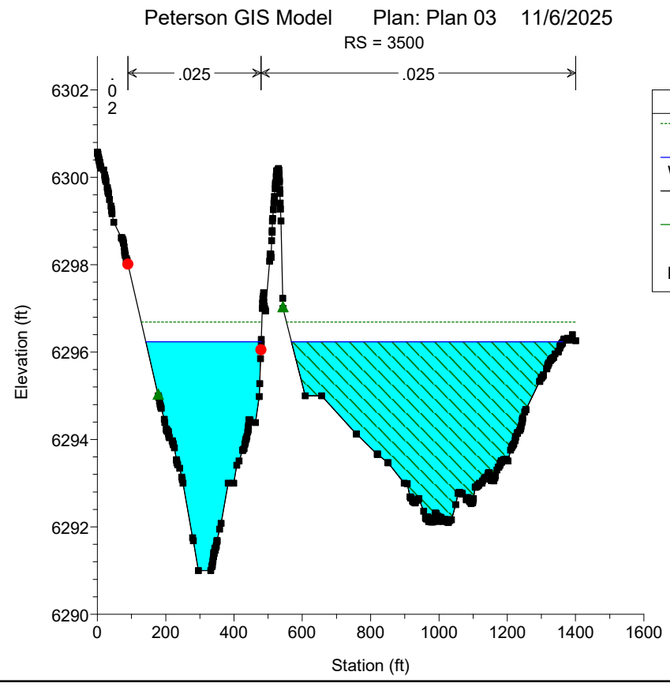

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 4000
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

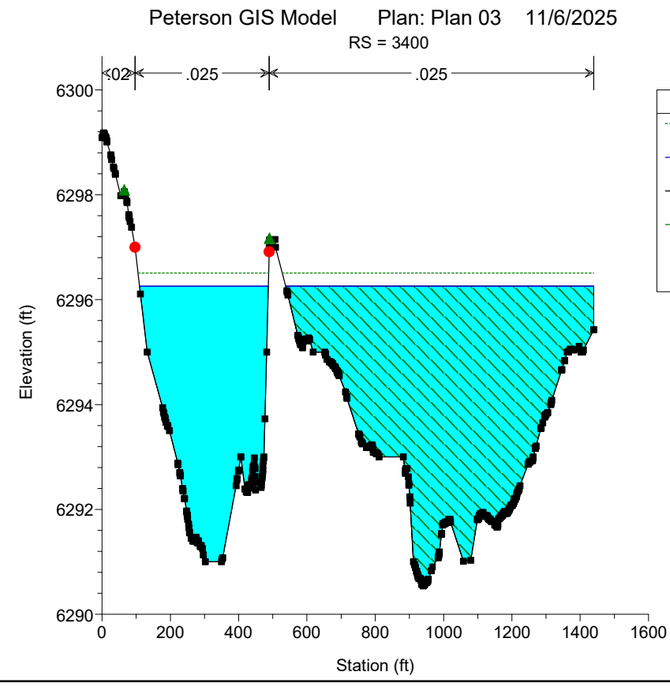

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 3900
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 3800
.02
.025
.025
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 3700
.02
.025
.025
Legend
EG PF 1
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

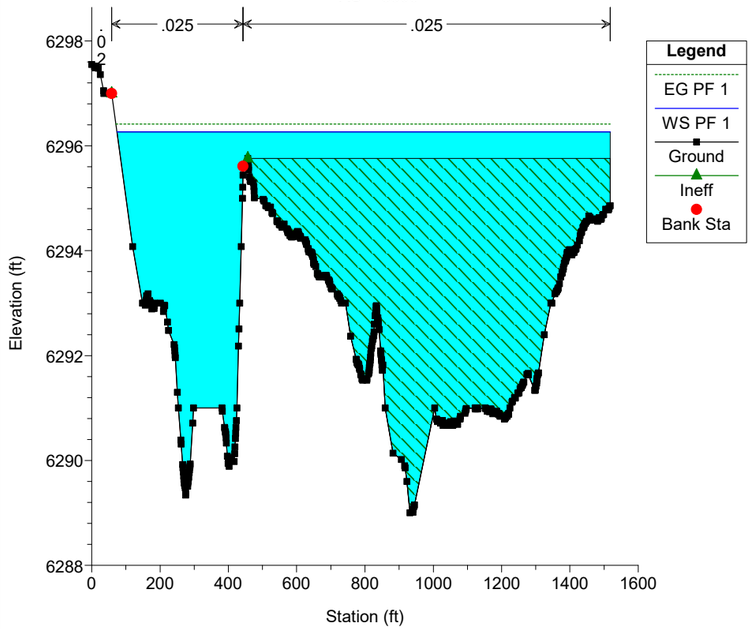

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 3600
.02
.025
.025
Legend
EG PF 1
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 3500
.025
.025
Legend
EG PF 1
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 3400
.02
.025
.025
Legend
EG PF 1
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

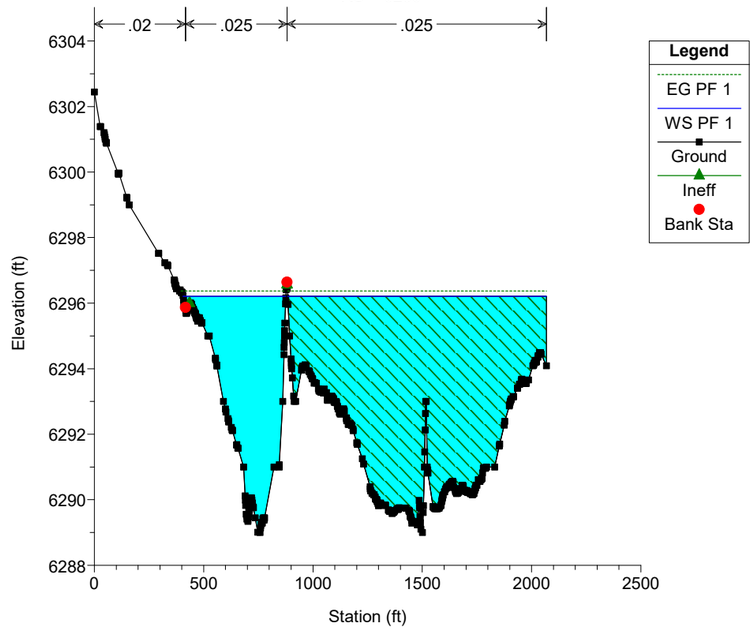
Peterson GIS Model Plan: Plan 03 11/6/2025

RS = 3300



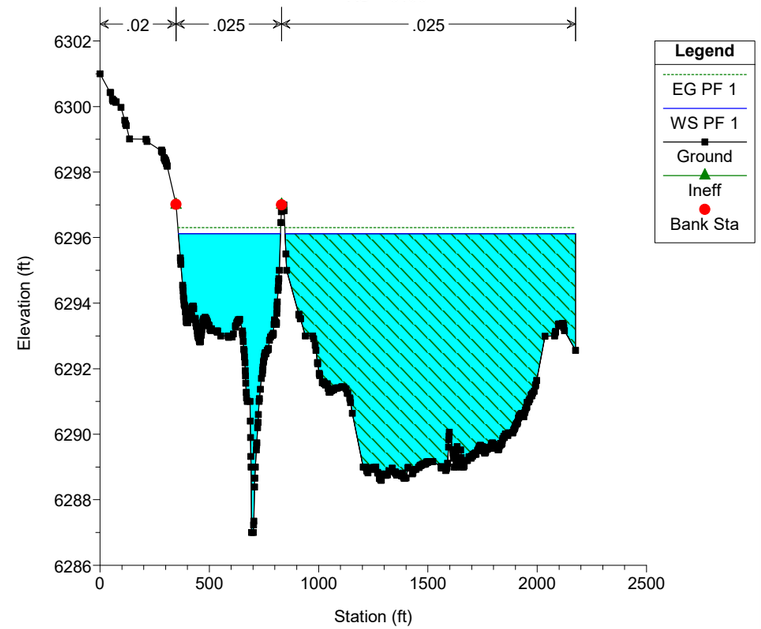
Peterson GIS Model Plan: Plan 03 11/6/2025

RS = 3200



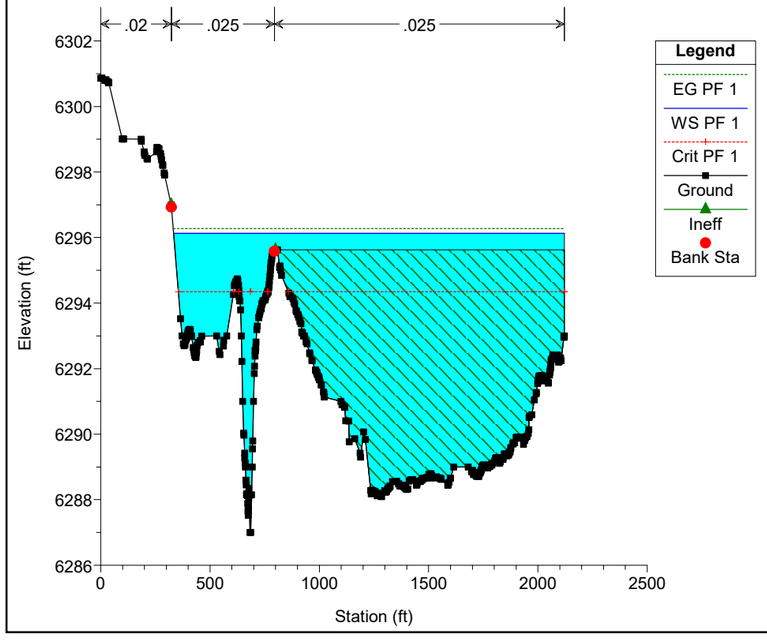
Peterson GIS Model Plan: Plan 03 11/6/2025

RS = 3100



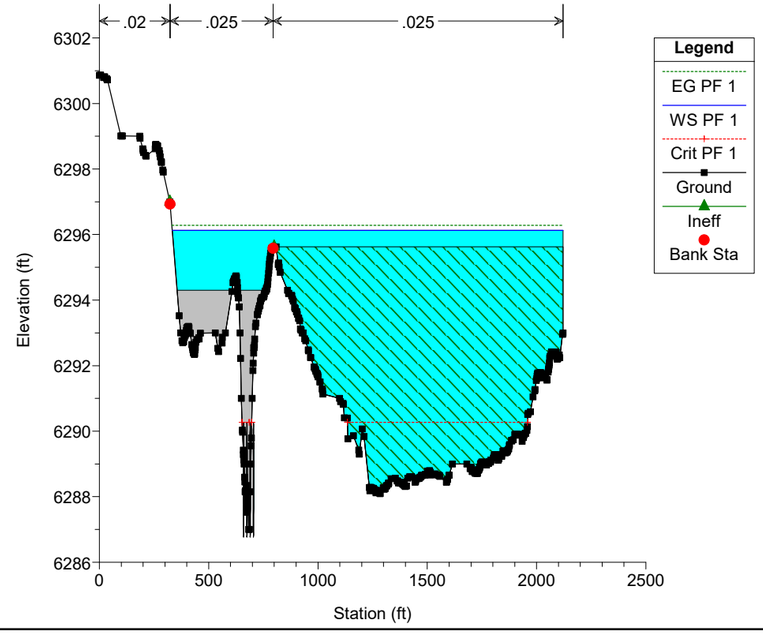
Peterson GIS Model Plan: Plan 03 11/6/2025

RS = 3069.1



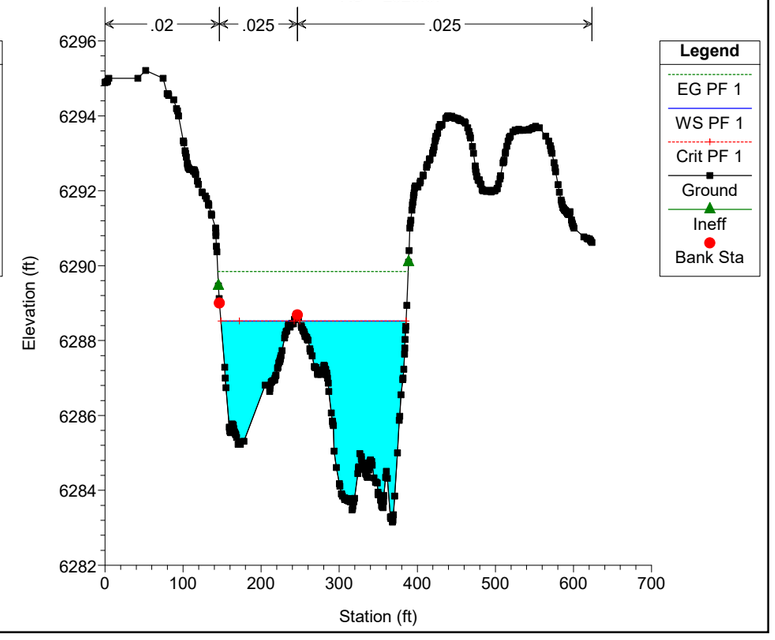
Peterson GIS Model Plan: Plan 03 11/6/2025

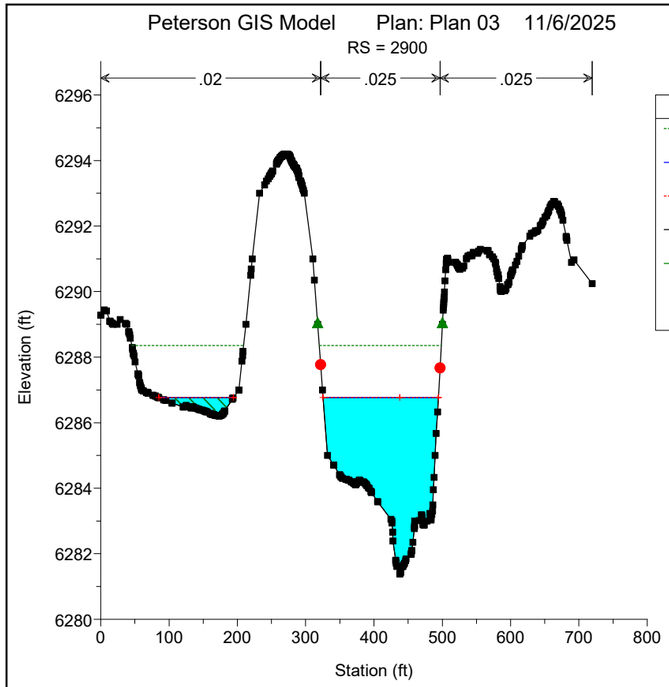
RS = 2991.67 Culv

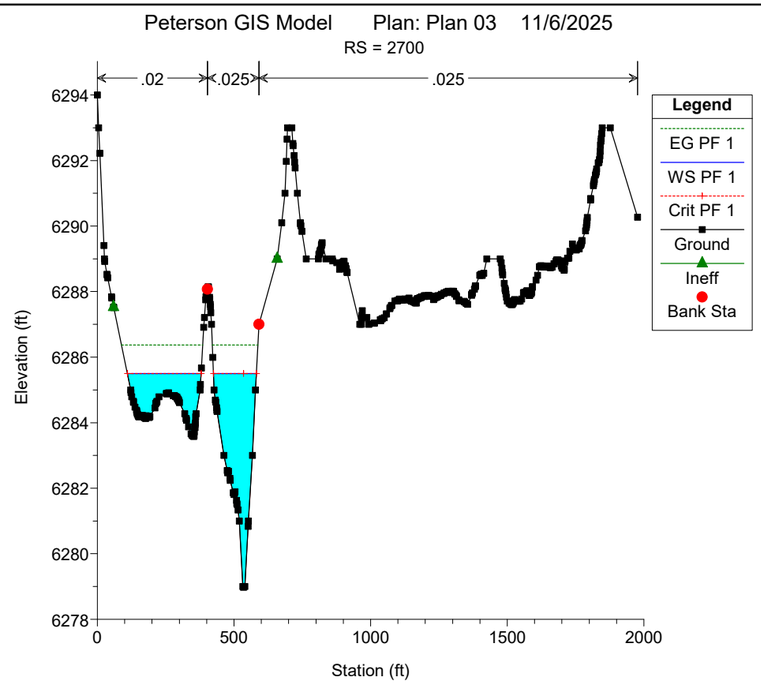


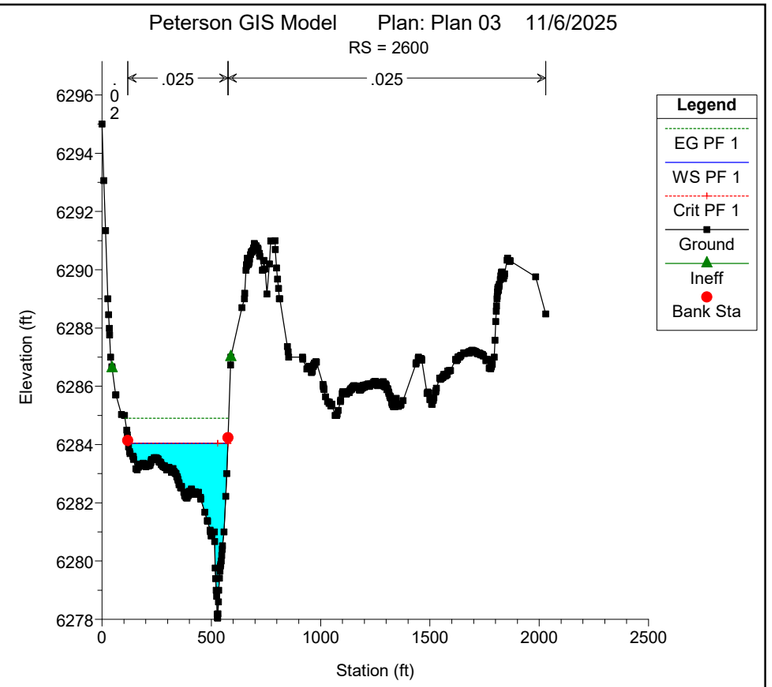
Peterson GIS Model Plan: Plan 03 11/6/2025

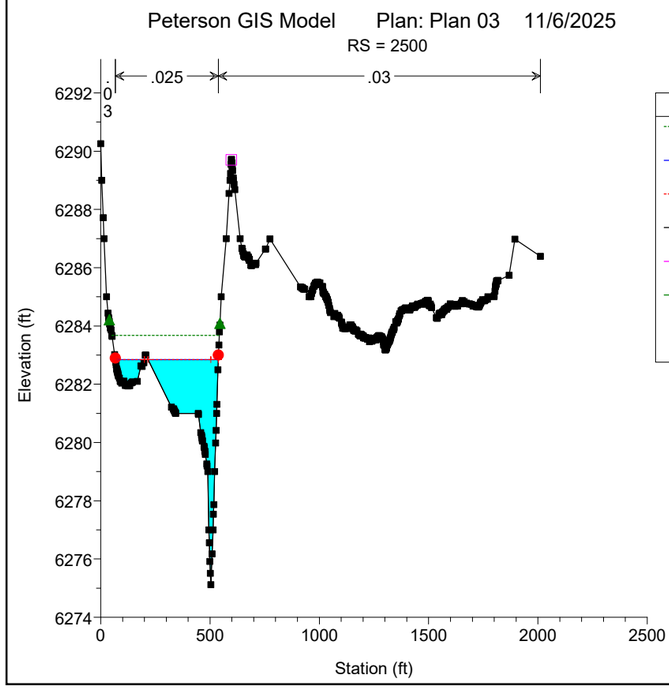
RS = 2923.67

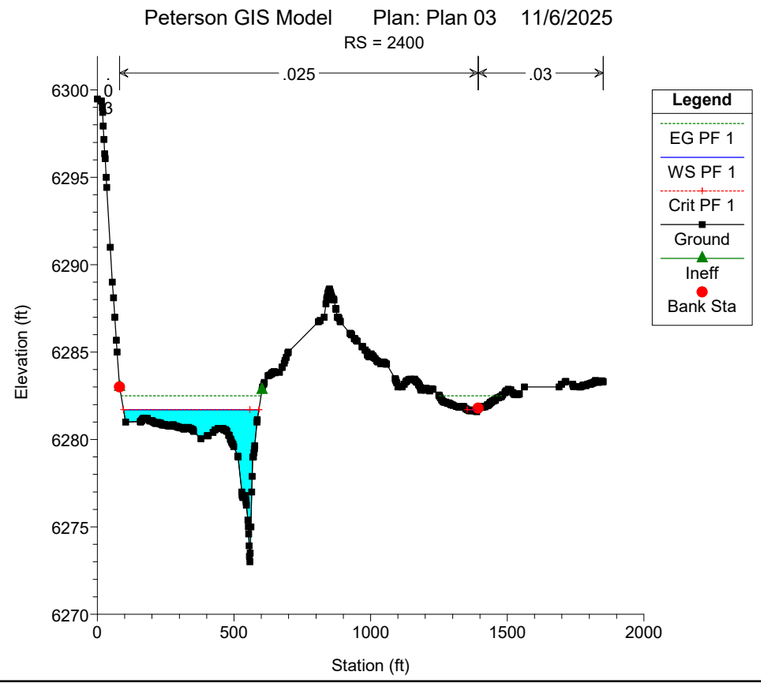


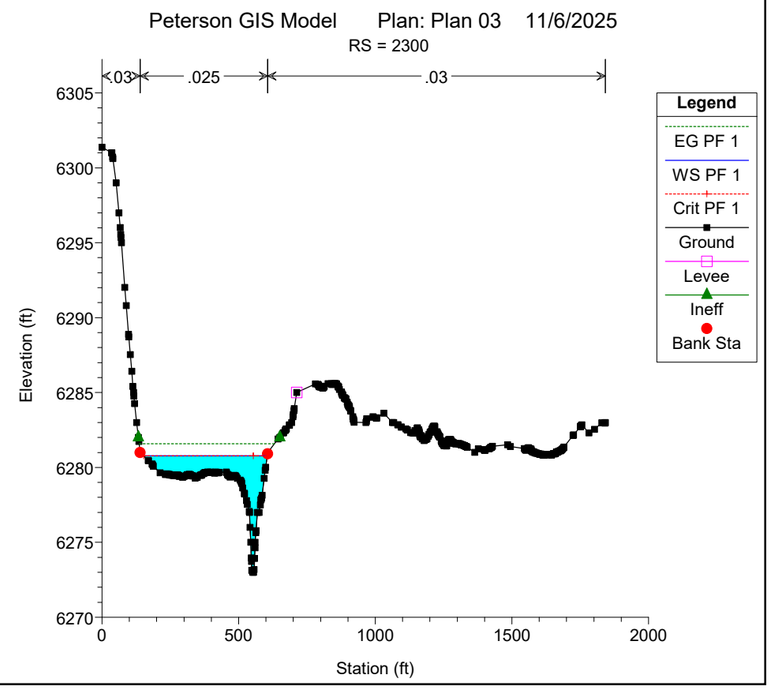

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 2900
.02
.025
.025
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

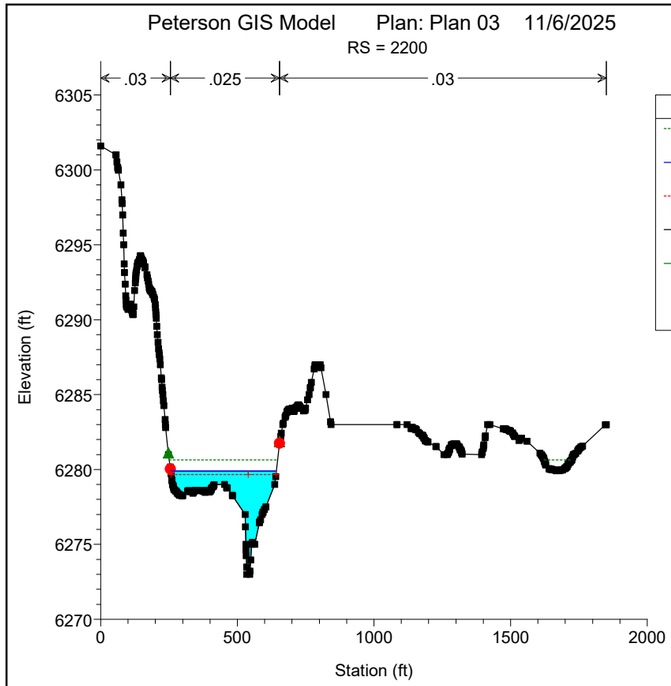

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 2700
.02
.025
.025
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

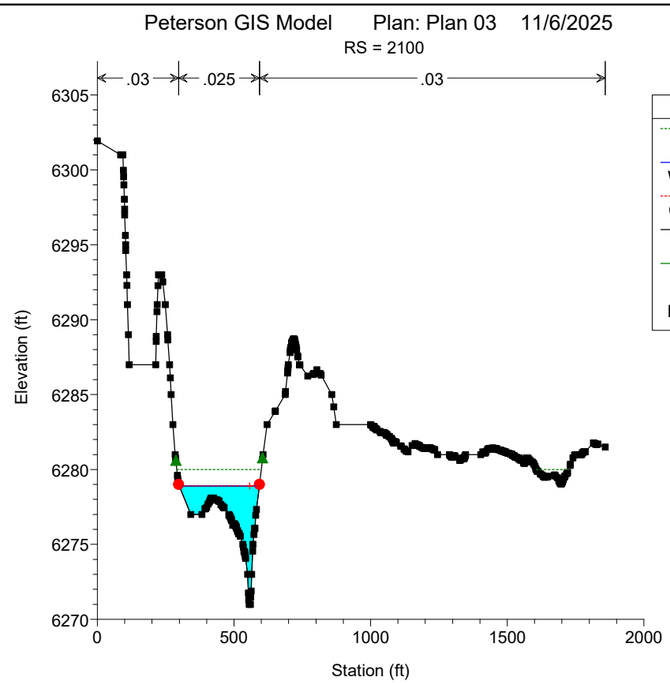

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 2600
.02
.025
.025
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

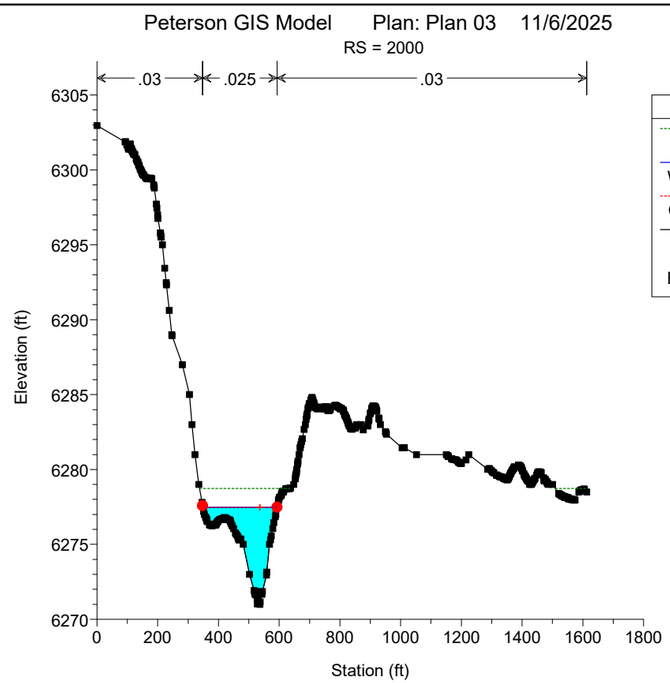

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 2500
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

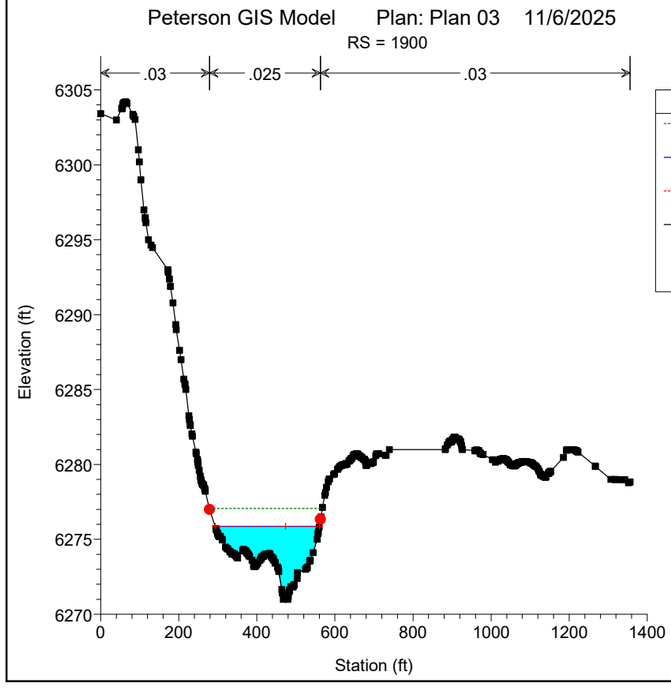

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 2400
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

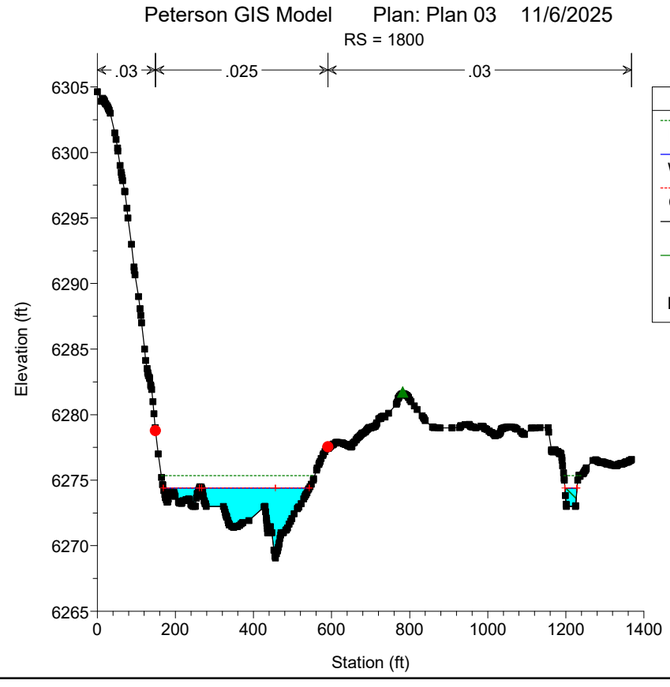

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 2300
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)

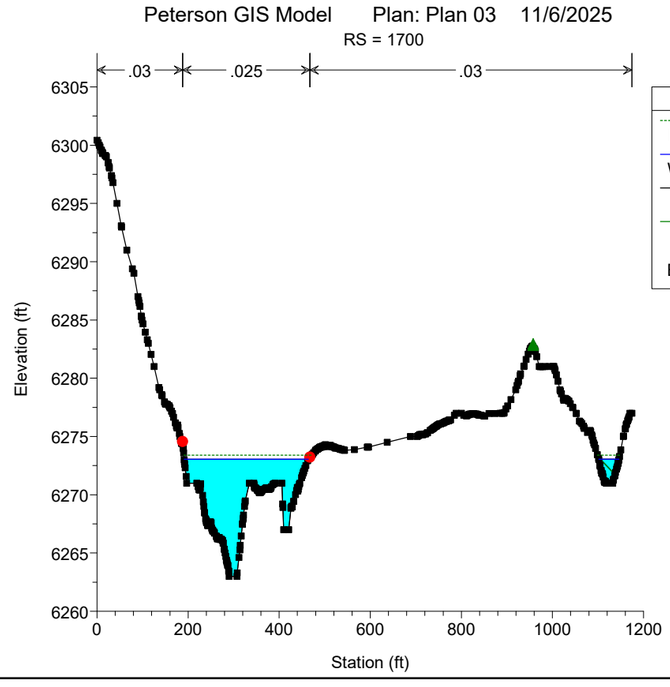

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 2200
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

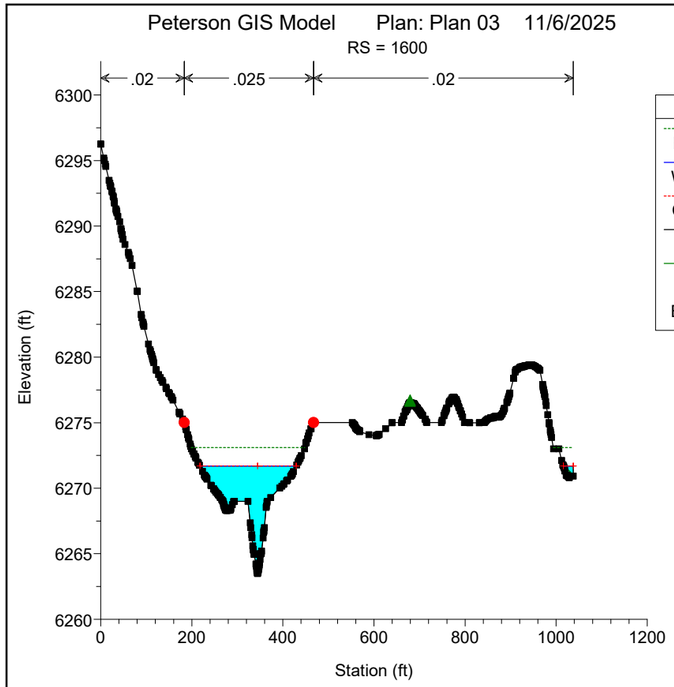

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 2100
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

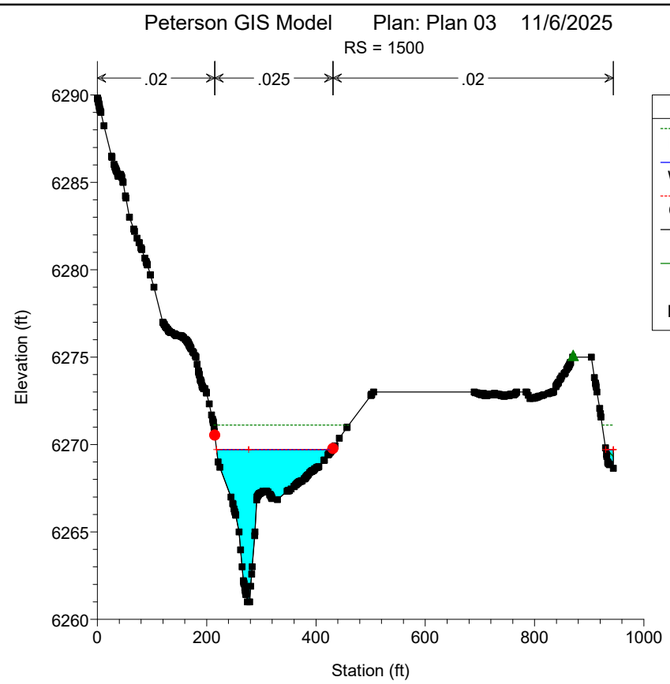

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 2000
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

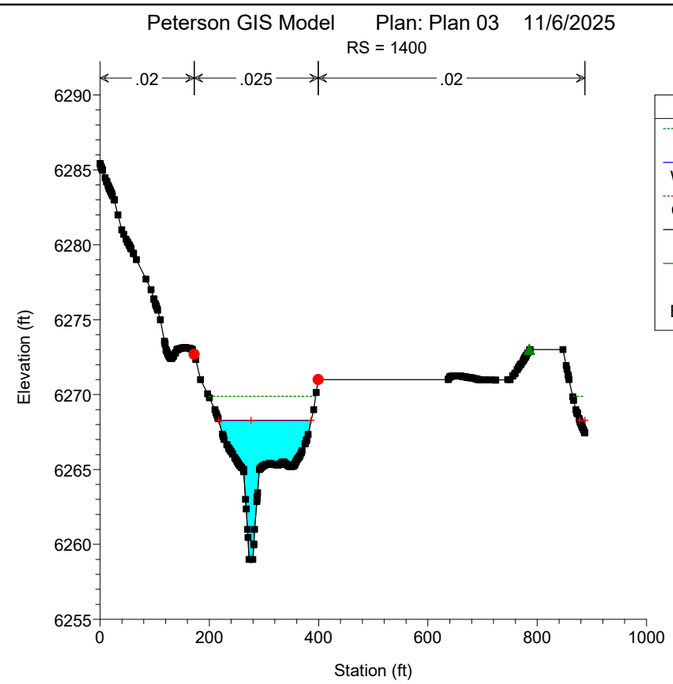

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 1900
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)

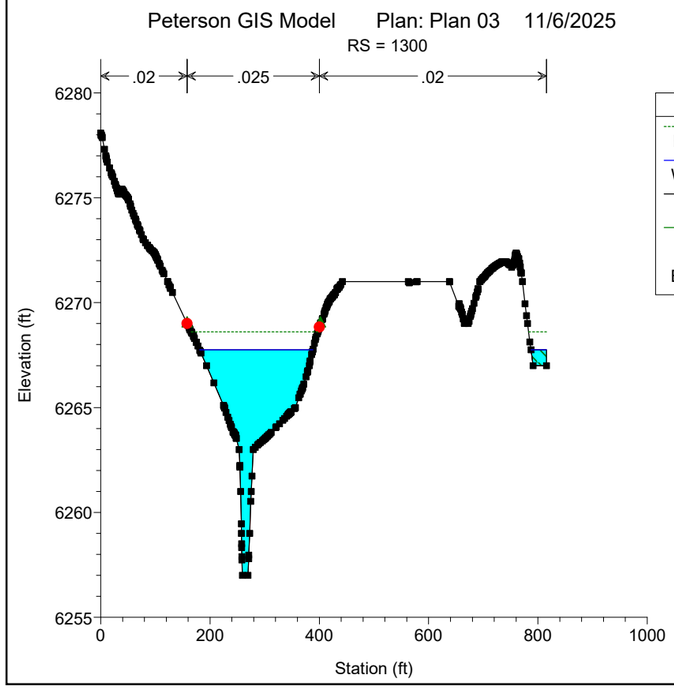

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 1800
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

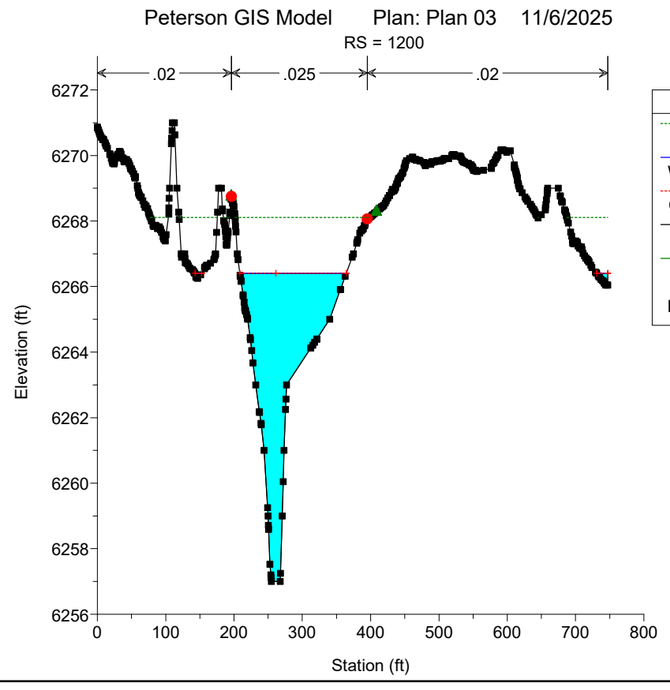

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 1700
.03
.025
.03
Legend
EG PF 1
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

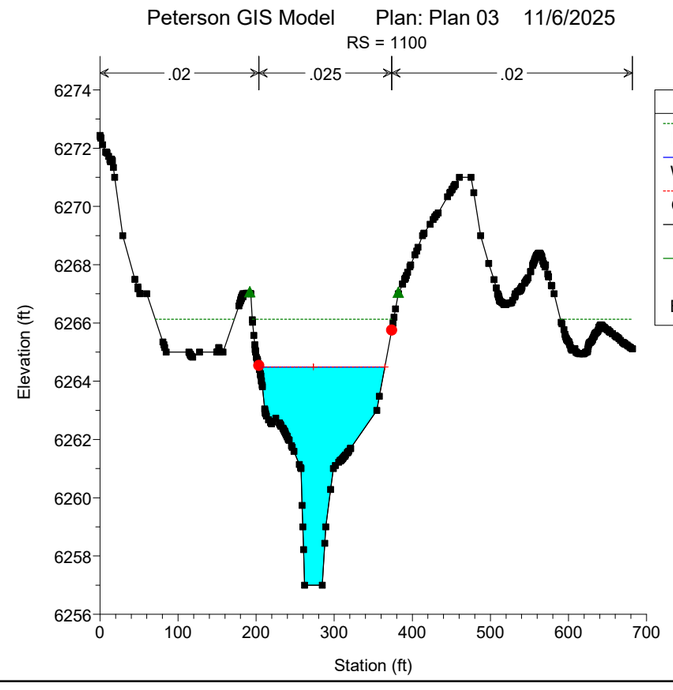

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 1600
.02
.025
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

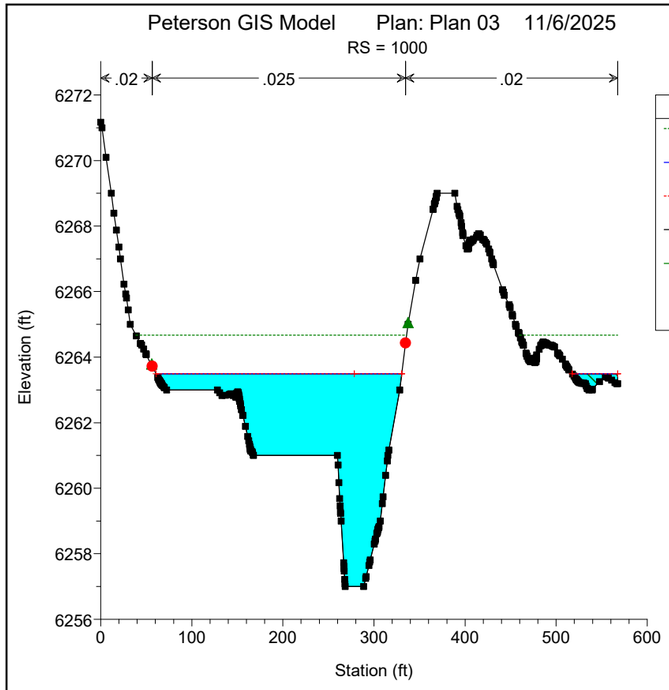

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 1500
.02
.025
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

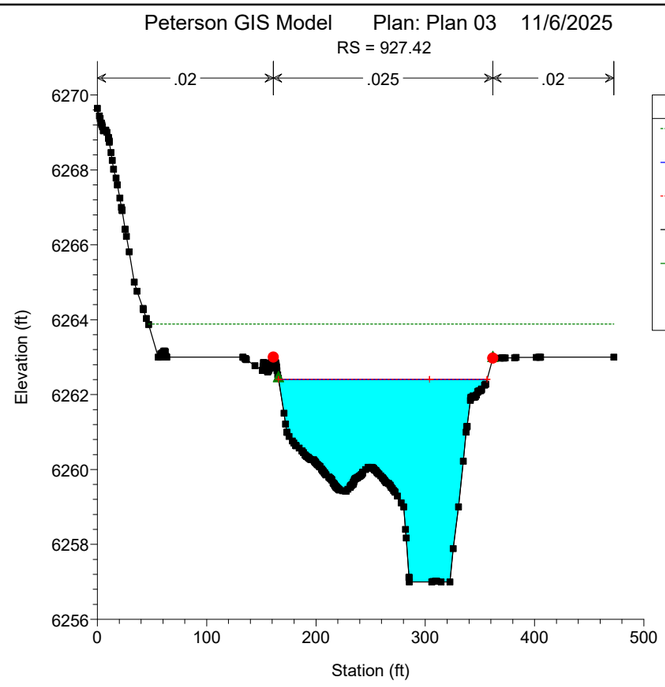

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 1400
.02
.025
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

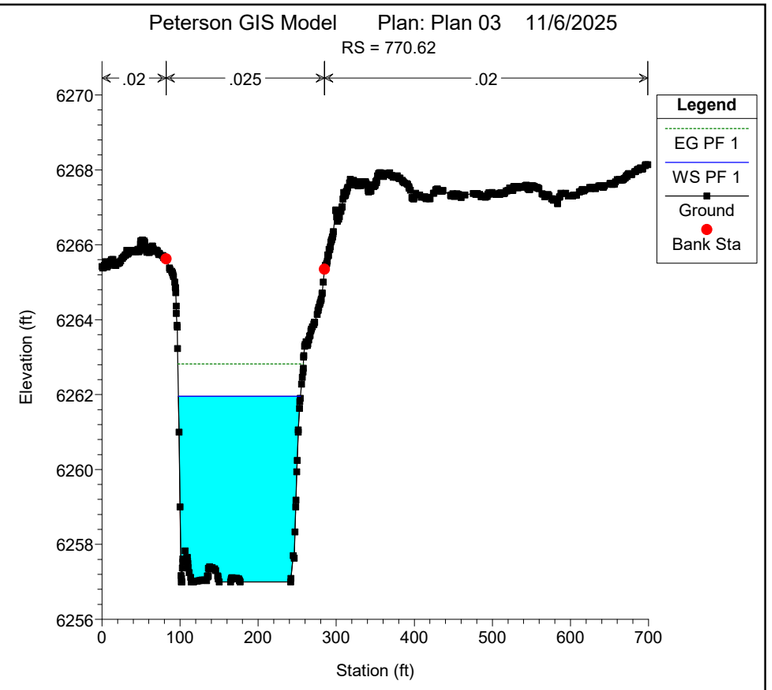

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 1300
.02
.025
.02
Legend
EG PF 1
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

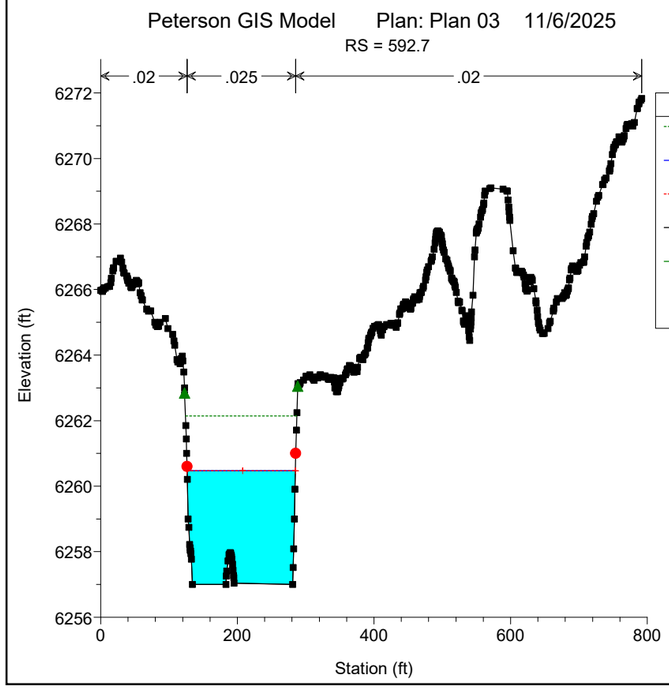

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 1200
.02
.025
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

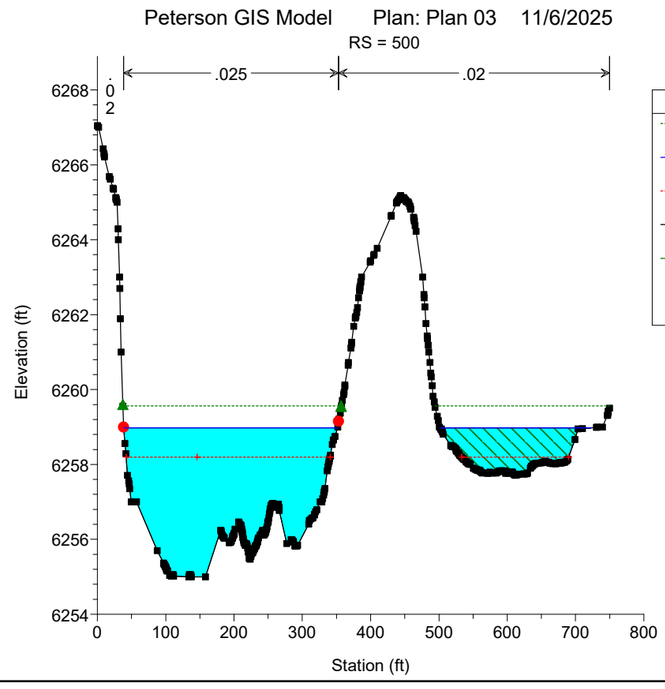

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 1100
.02
.025
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

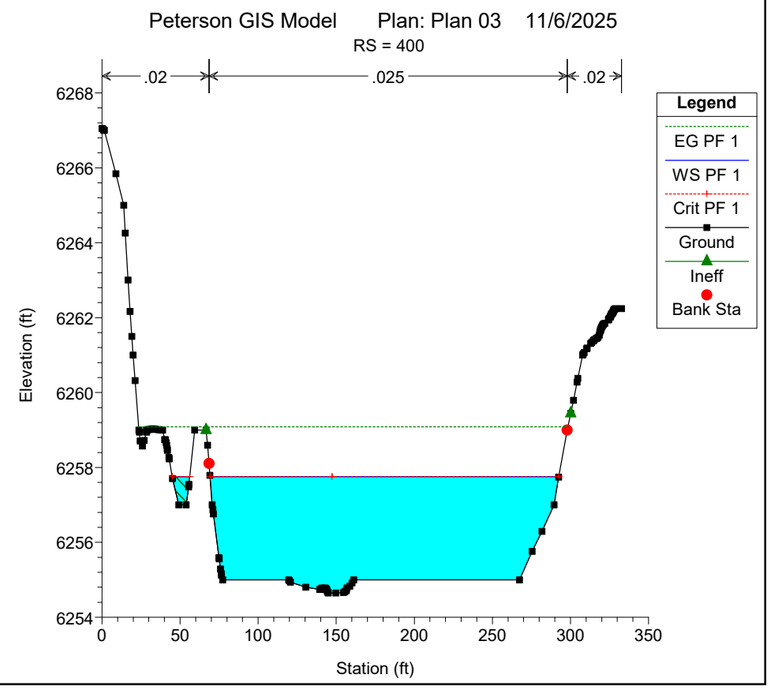

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 1000
.02
.025
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

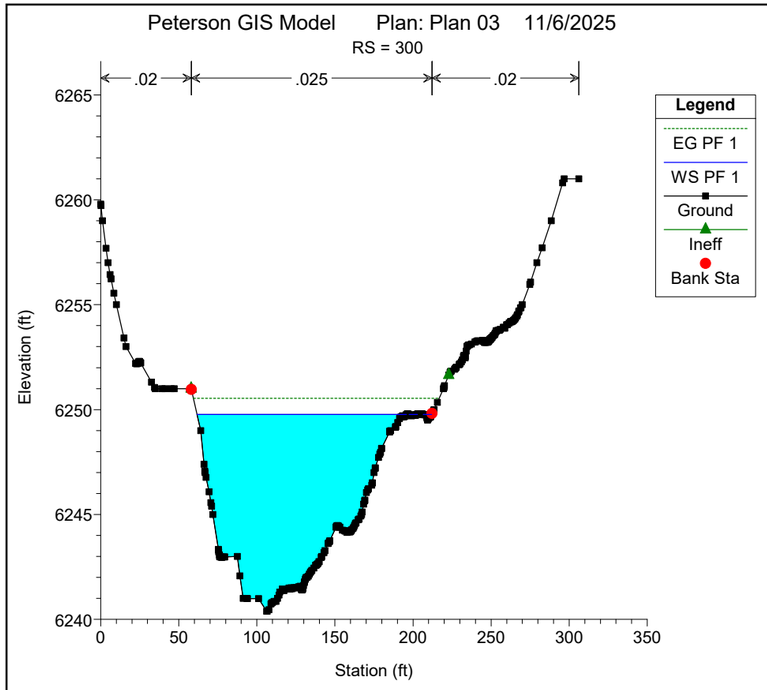

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 927.42
.02
.025
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

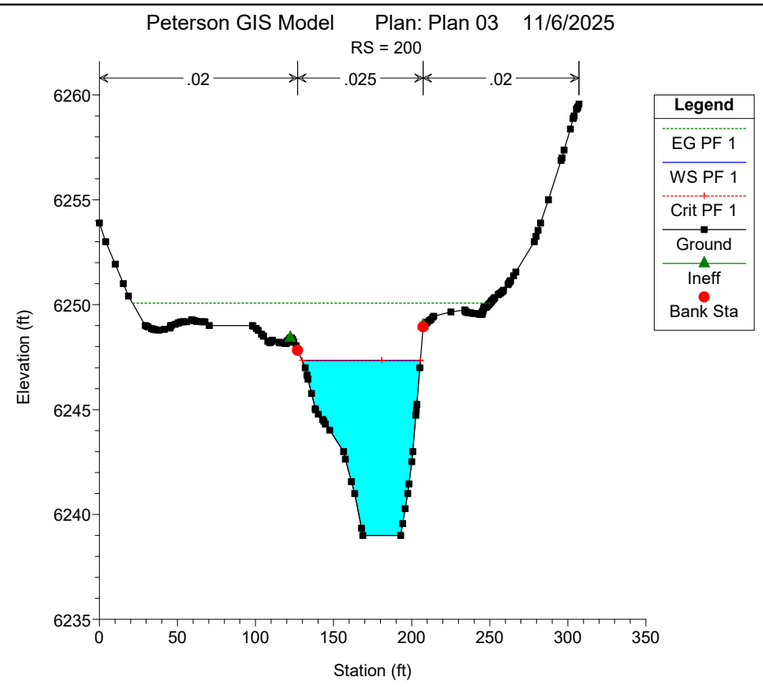

Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 770.62
.02
.025
.02
Legend
EG PF 1
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 592.7
.02
.025
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 500
.02
.025
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 400
.02
.025
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 300
.02
.025
.02
Legend
EG PF 1
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
6265
6260
6255
6250
6245
6240
0
50
100
150
200
250
300
350


Peterson GIS Model Plan: Plan 03 11/6/2025
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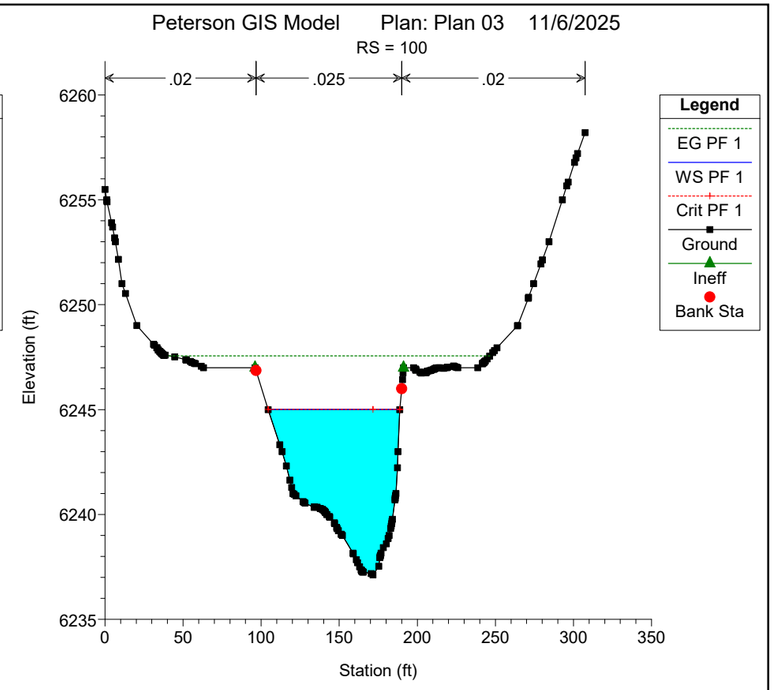
.02
.025
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
6260
6255
6250
6245
6240
6235
0
50
100
150
200
250
300
350


Peterson GIS Model Plan: Plan 03 11/6/2025
RS = 100
.02
.025
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
6260
6255
6250
6245
6240
6235
0
50
100
150
200
250
300
350

PROPOSED CONDITIONS HEC-RAS MODEL

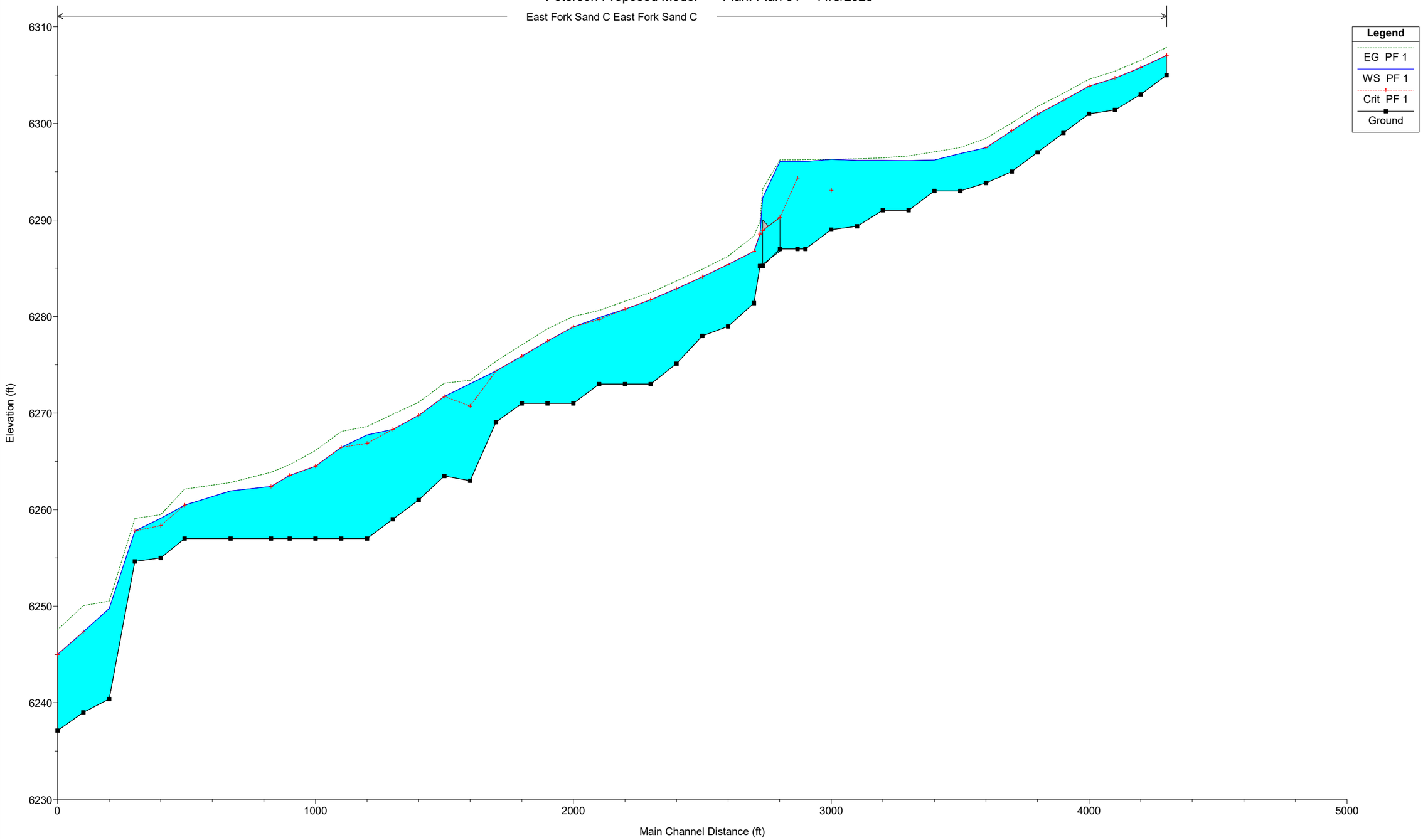
HEC-RAS Plan: Plan 01 River: East Fork Sand C Reach: East Fork Sand C Profile: PF 1

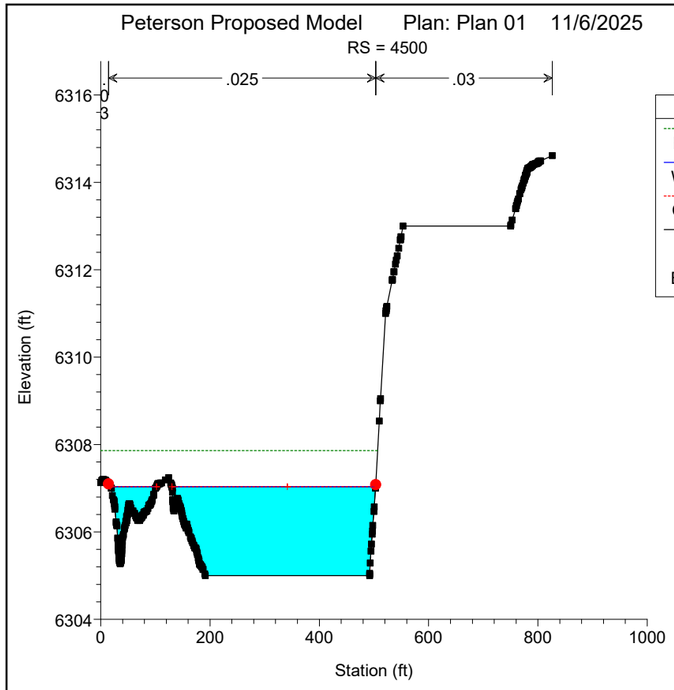
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
East Fork Sand C	4500	PF 1	5420.0	6305.0	6307.0	6307.0	6307.9	0.007923	7.3	742.4	457.3	1.01
East Fork Sand C	4400	PF 1	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

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

East Fork Sand C East Fork Sand C

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RS = 4500
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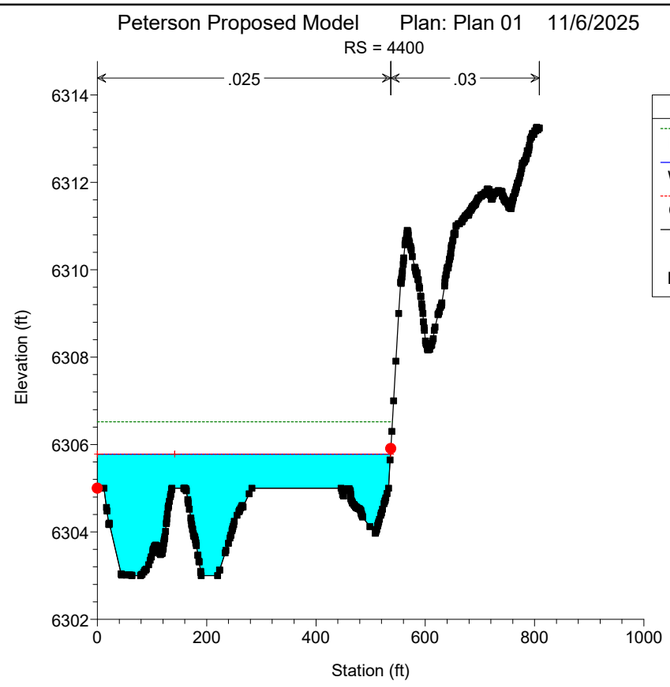
.03
0.3
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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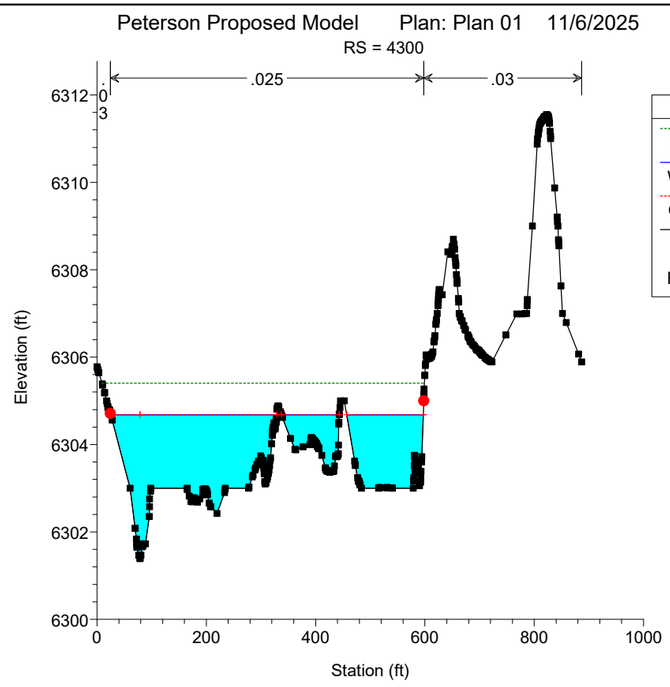
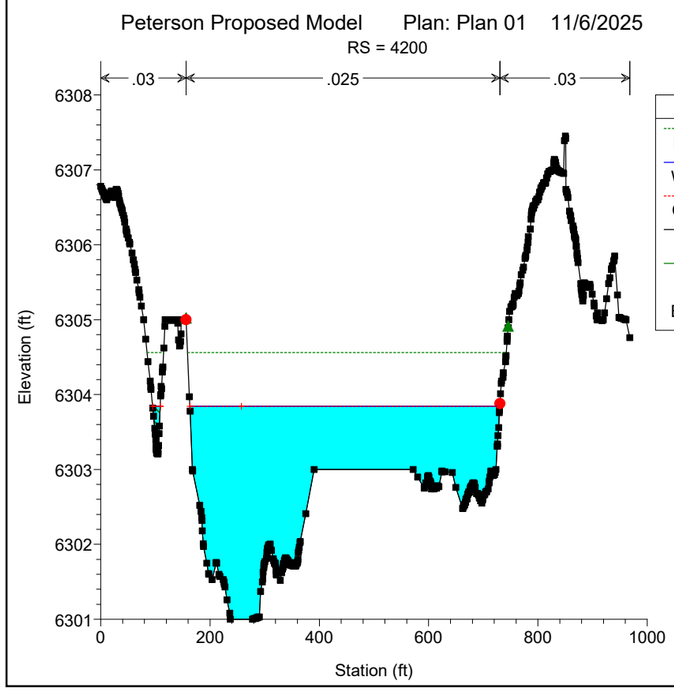
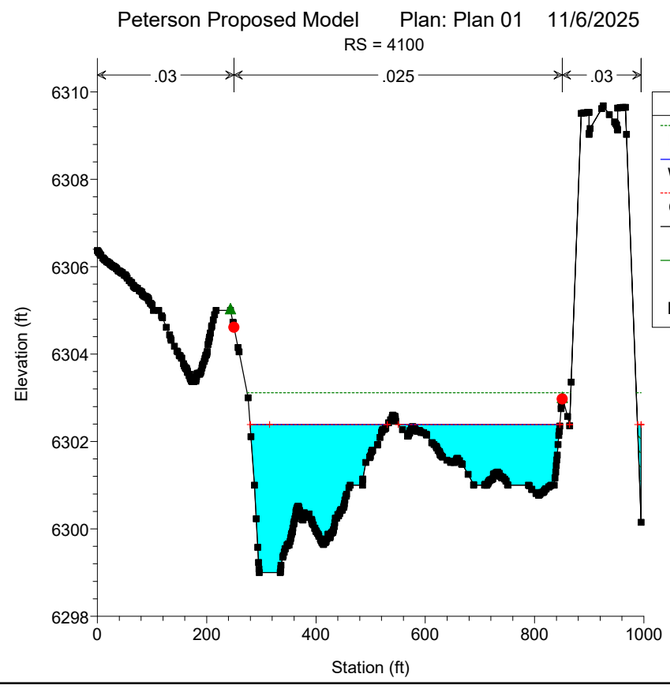
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 4300
.025
.03
0.3
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)


Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 4200
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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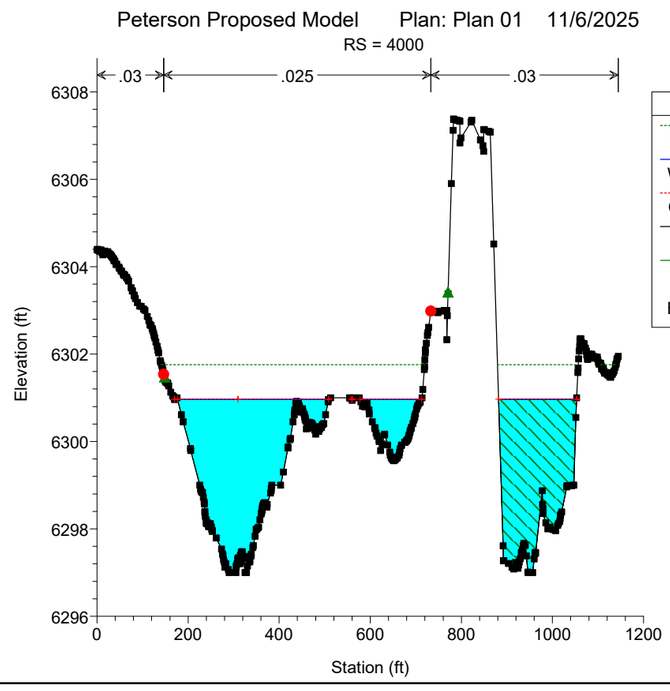
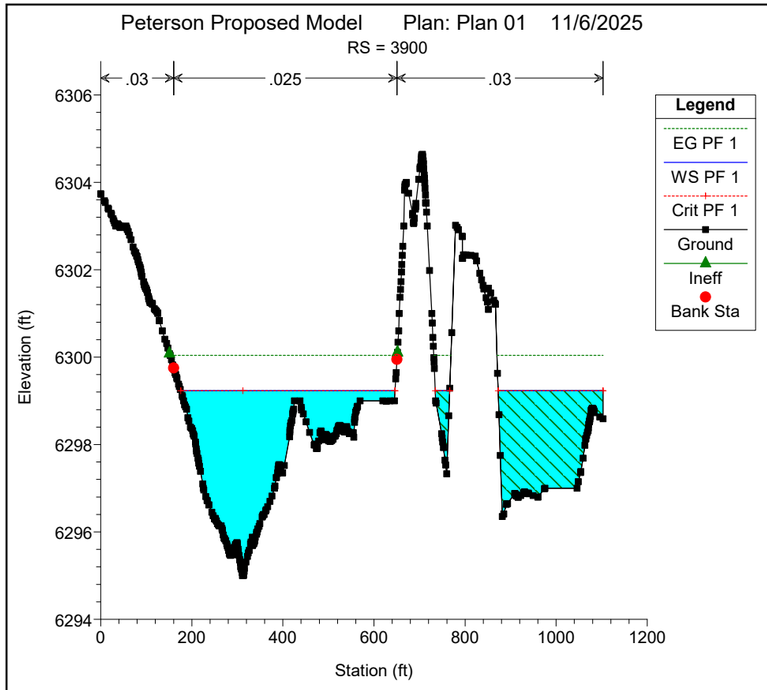
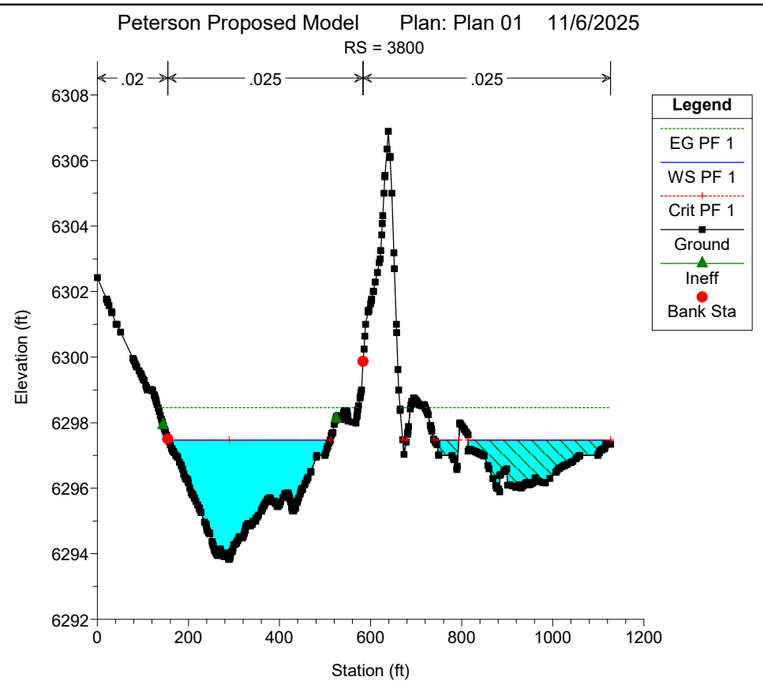
RS = 4100
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 4000
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 3900
.03
.025
.03
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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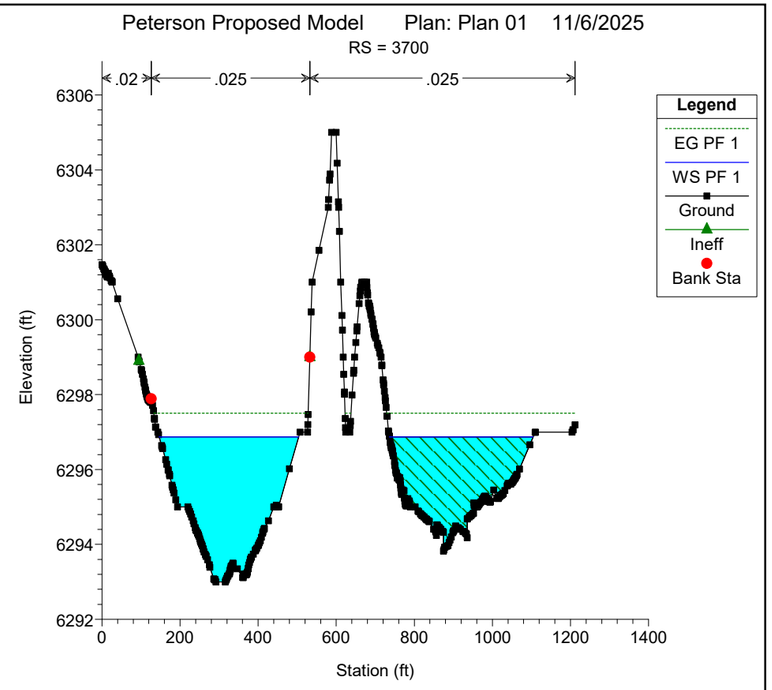
.02
.025
.025
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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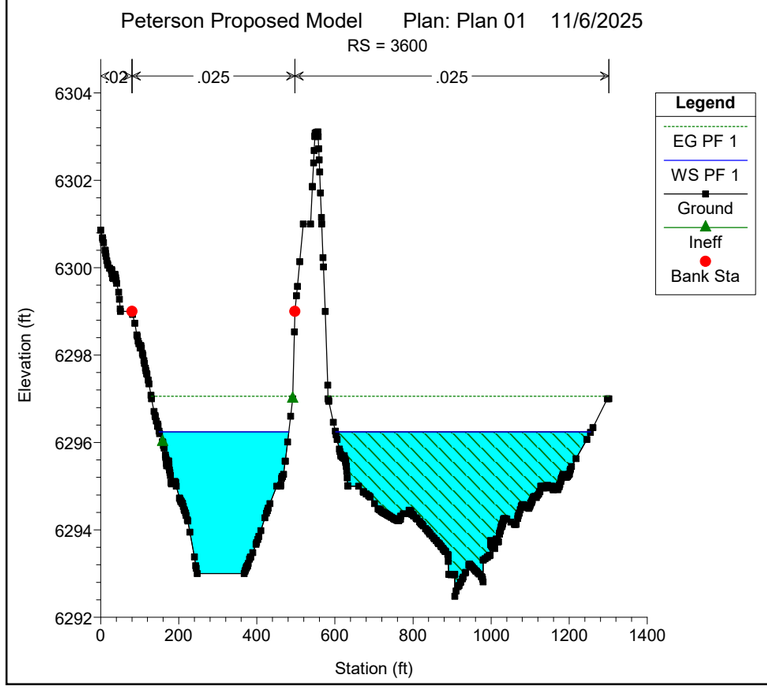
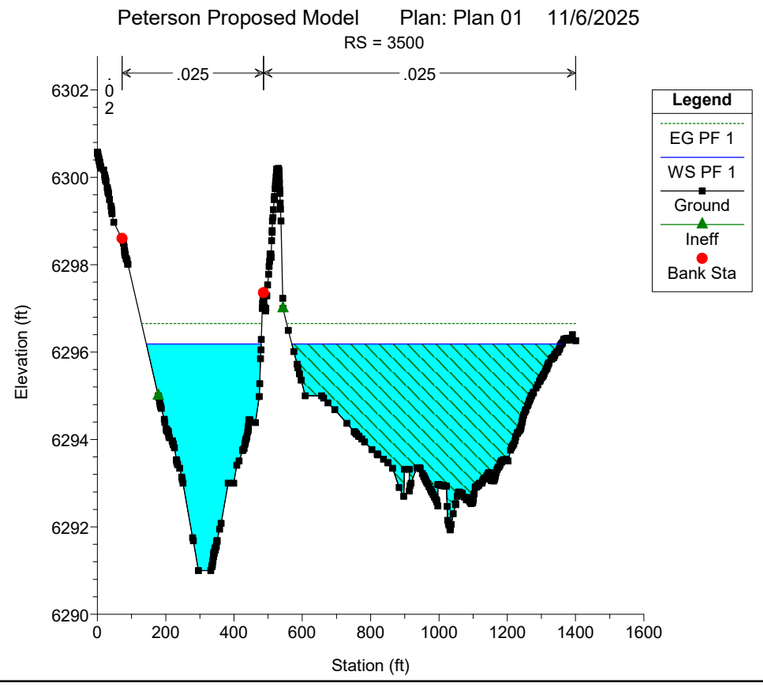
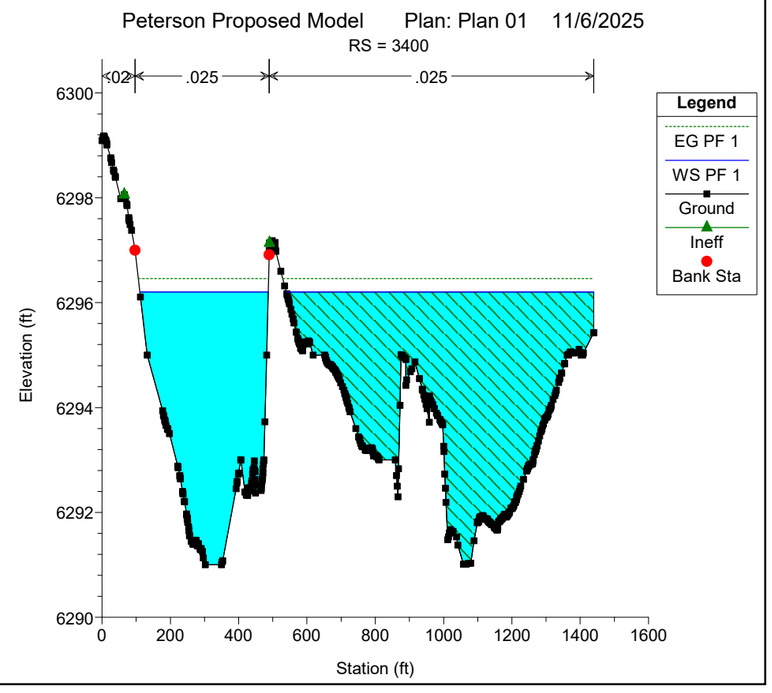
RS = 3700
.02
.025
.025
Legend
EG PF 1
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

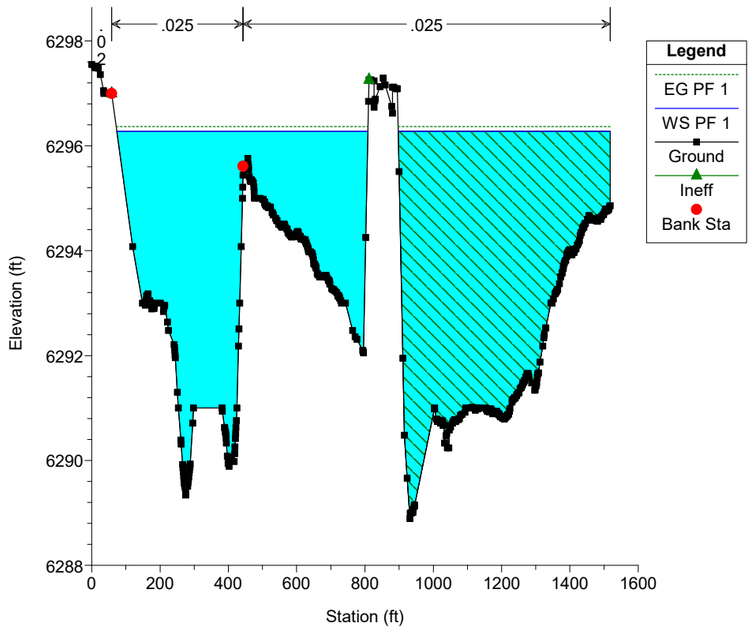

Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 3600
.02
.025
.025
Legend
EG PF 1
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 3500
.02
.025
.025
Legend
EG PF 1
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 3400
.02
.025
.025
Legend
EG PF 1
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

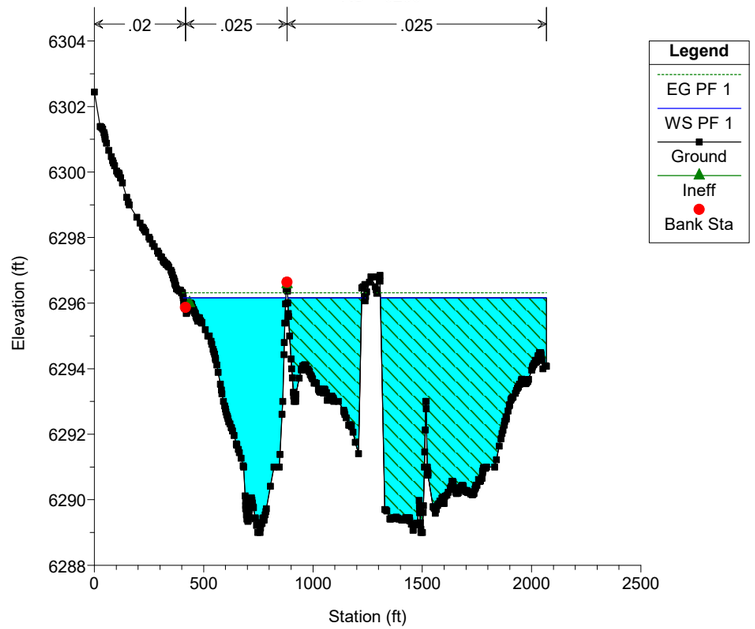
Peterson Proposed Model Plan: Plan 01 11/6/2025

RS = 3300



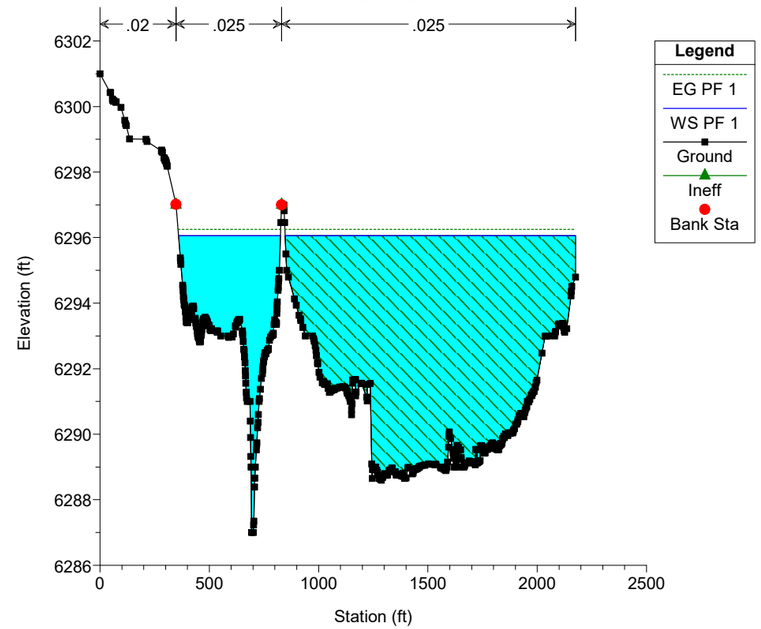
Peterson Proposed Model Plan: Plan 01 11/6/2025

RS = 3200



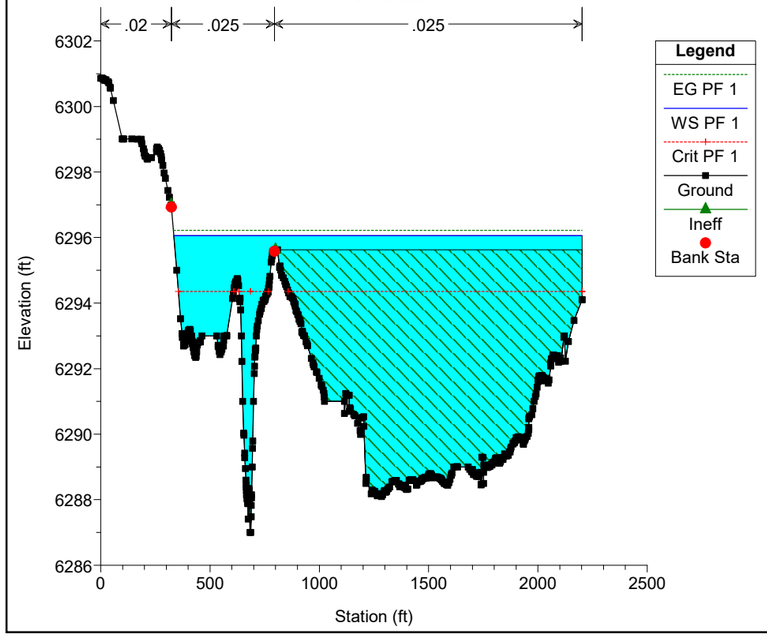
Peterson Proposed Model Plan: Plan 01 11/6/2025

RS = 3100



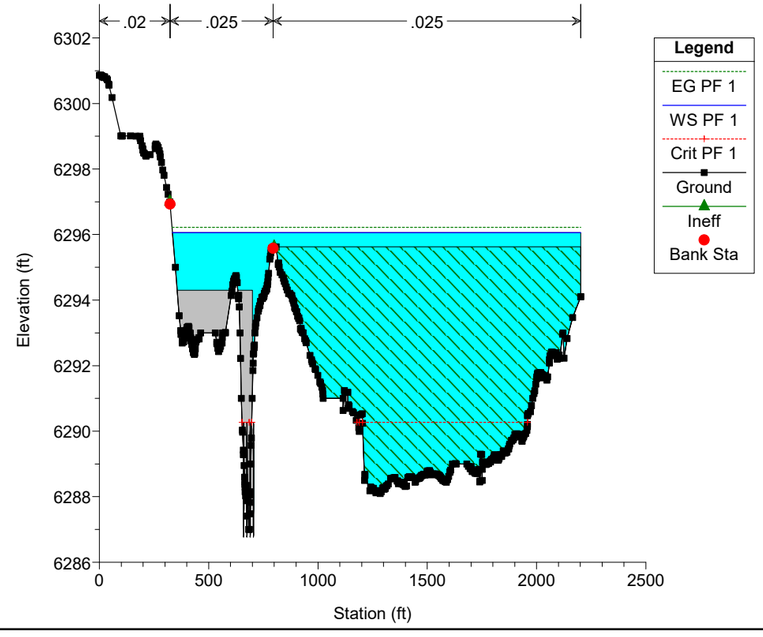
Peterson Proposed Model Plan: Plan 01 11/6/2025

RS = 3069.1



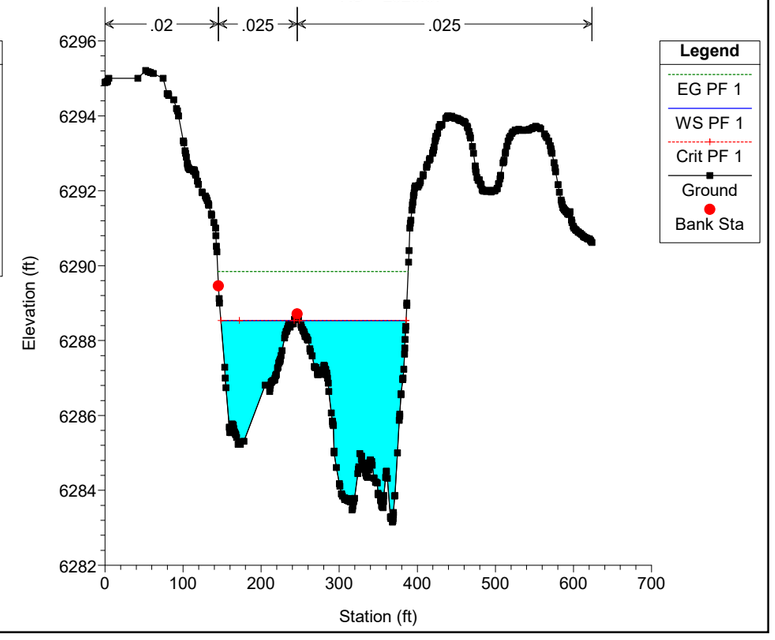
Peterson Proposed Model Plan: Plan 01 11/6/2025

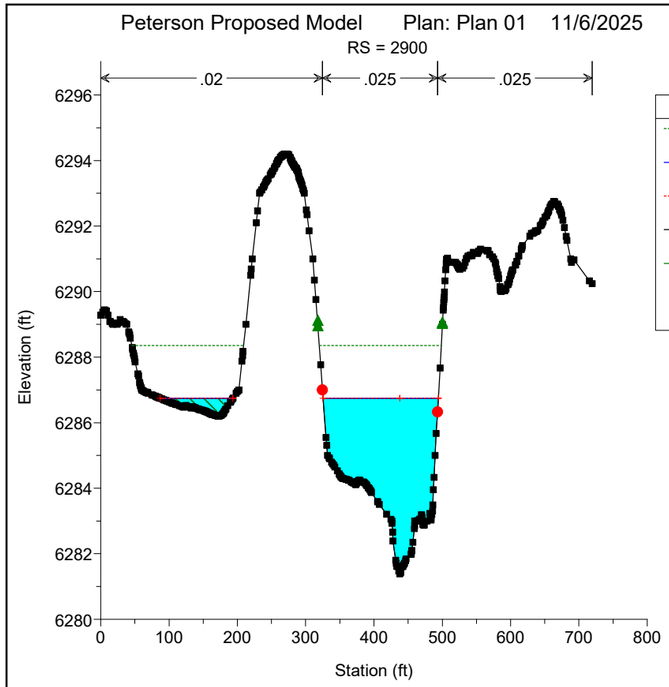
RS = 2991.67 Culv

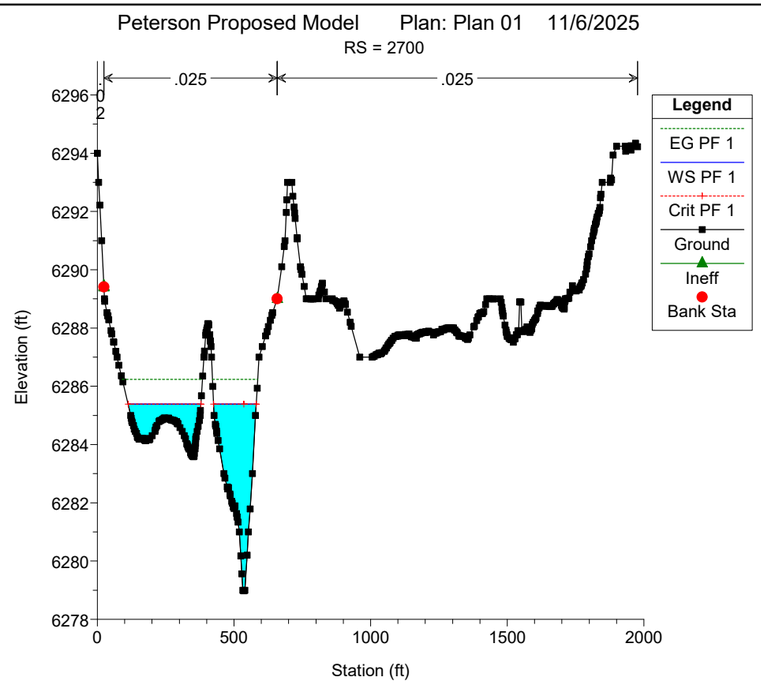


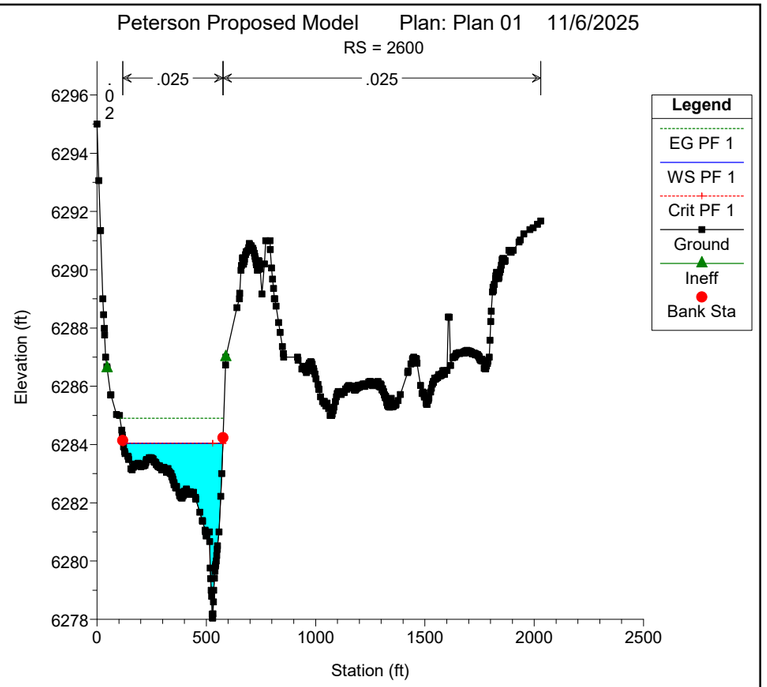
Peterson Proposed Model Plan: Plan 01 11/6/2025

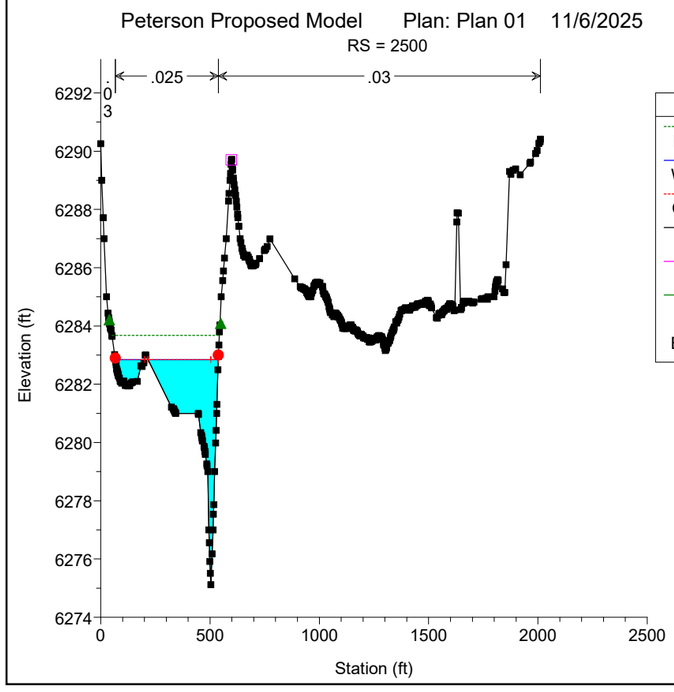
RS = 2923.67

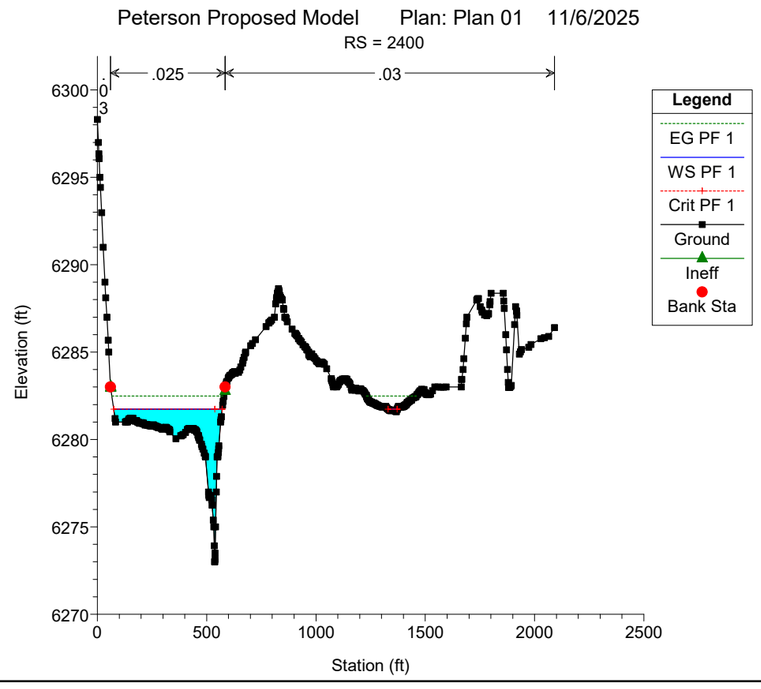


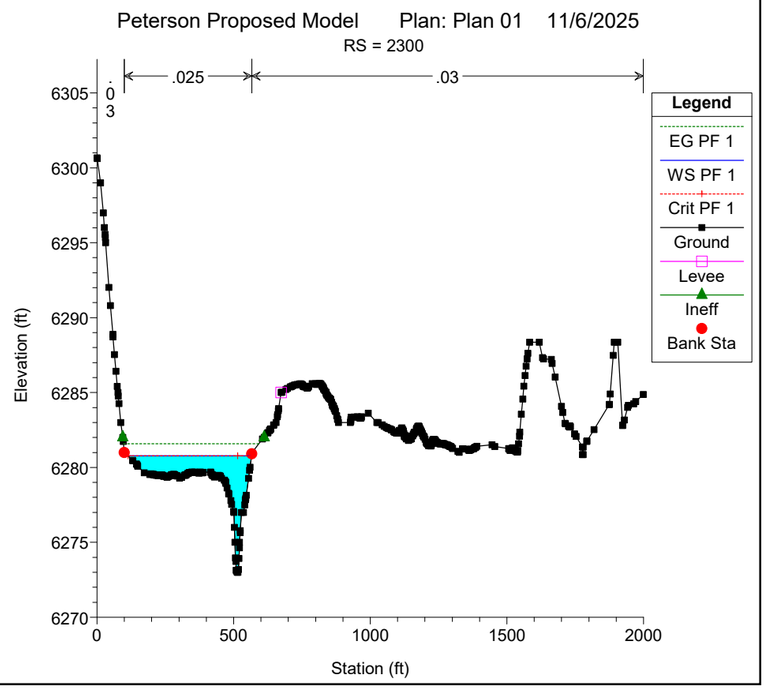

Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 2900
.02
.025
.025
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta


Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 2700
.025
.025
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta


Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 2600
.025
.025
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta


Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 2500
.025
.03
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Levee
Ineff
Bank Sta


Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 2400
.025
.03
Elevation (ft)
Station (ft)
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta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Station (ft)
Legend
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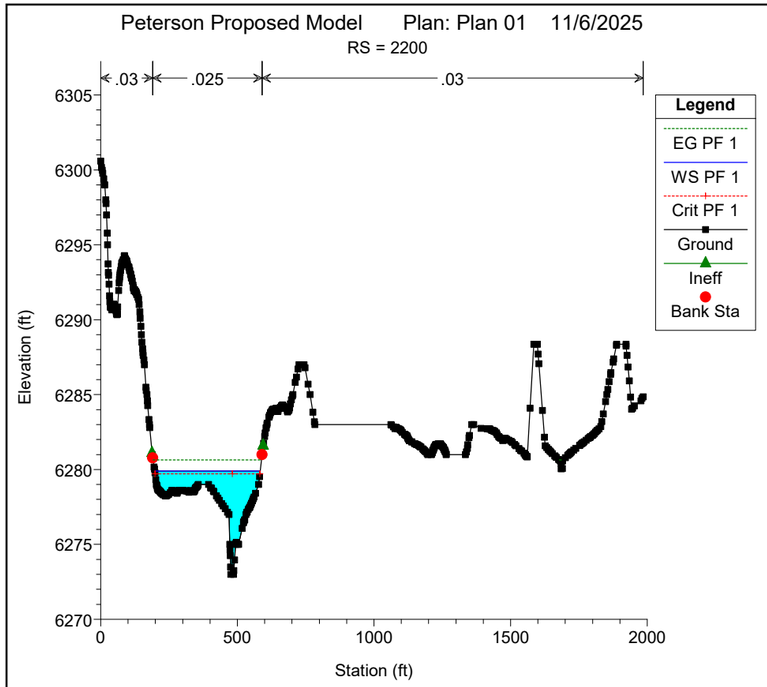
Crit PF 1
Ground
Levee
Ineff
Bank Sta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Ground
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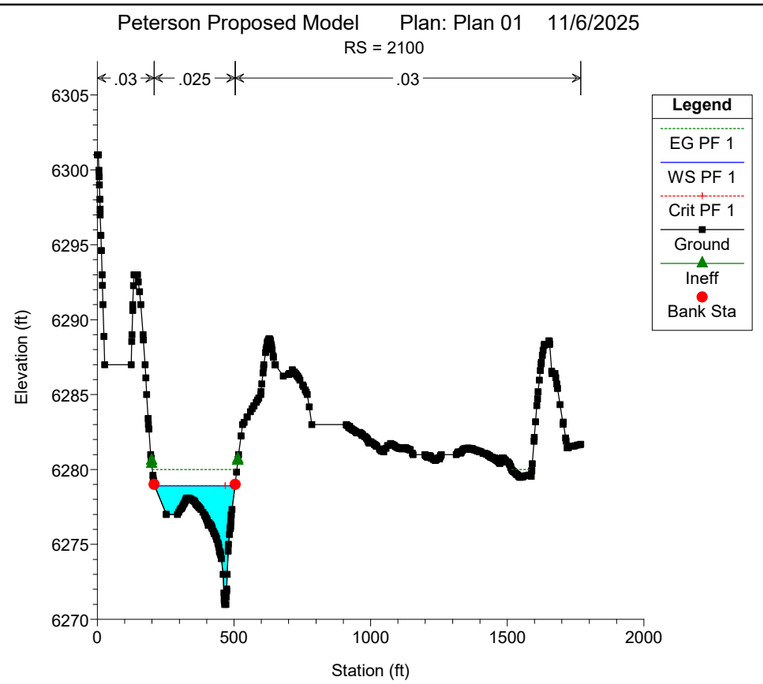
Elevation (ft)
Station (ft)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Bank Sta
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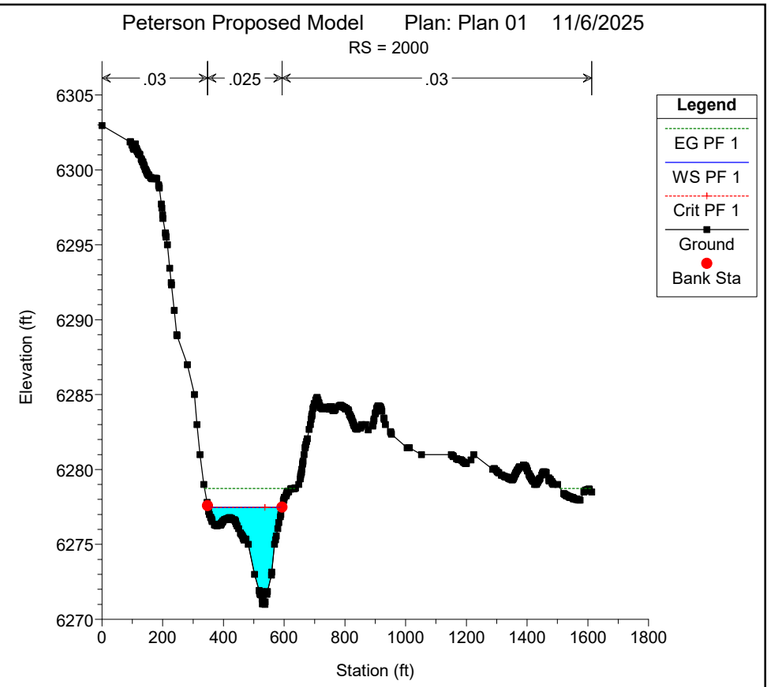
Station (ft)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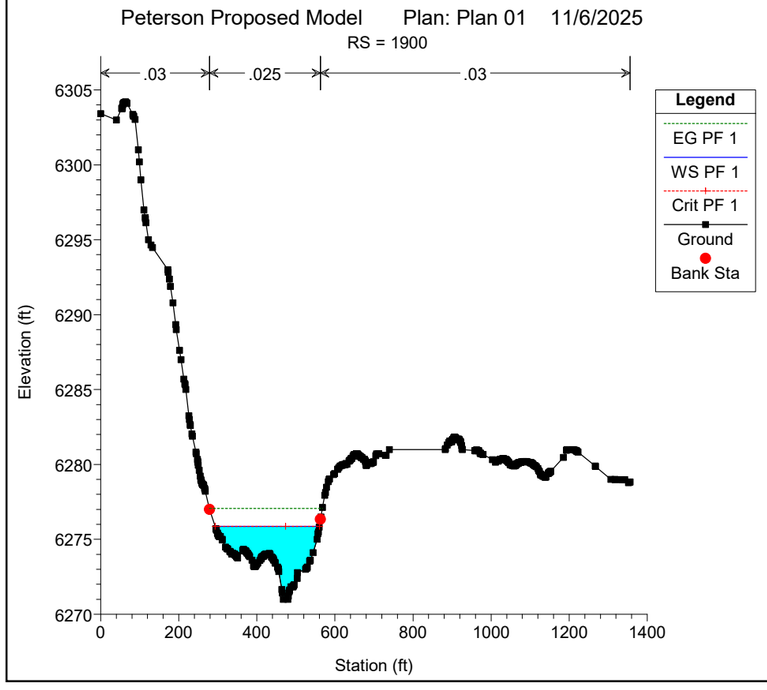
Bank Sta
Elevation (ft)
Station (ft)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Bank Sta
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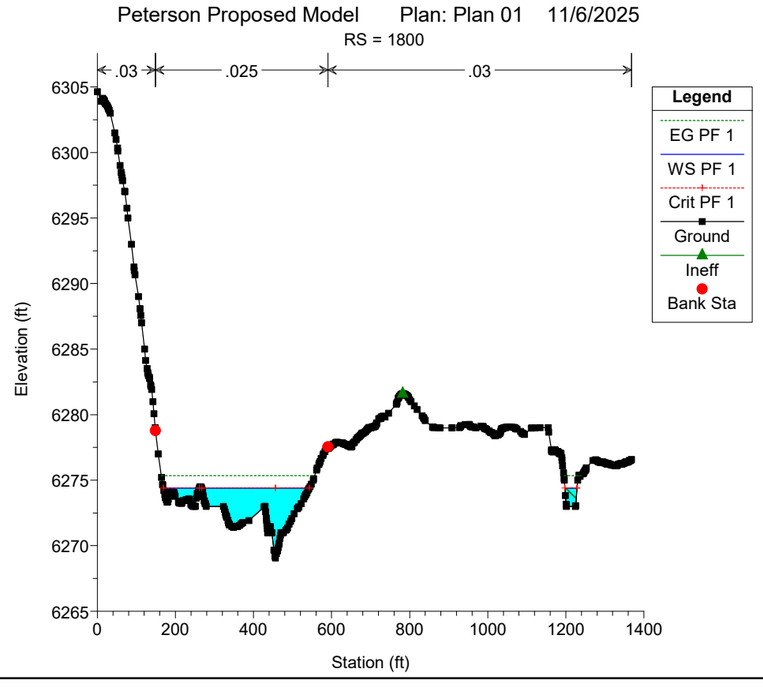
Station (ft)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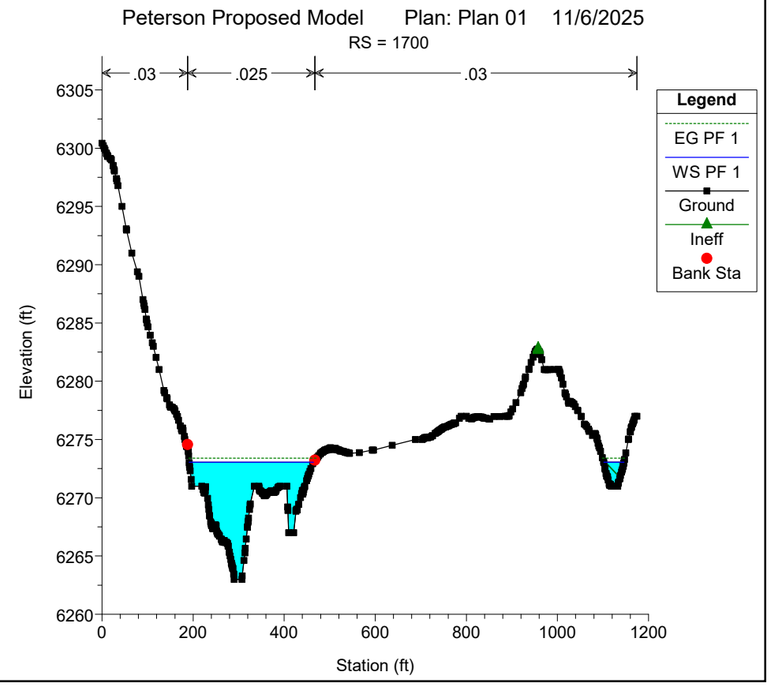
Bank Sta
Elevation (ft)
Station (ft)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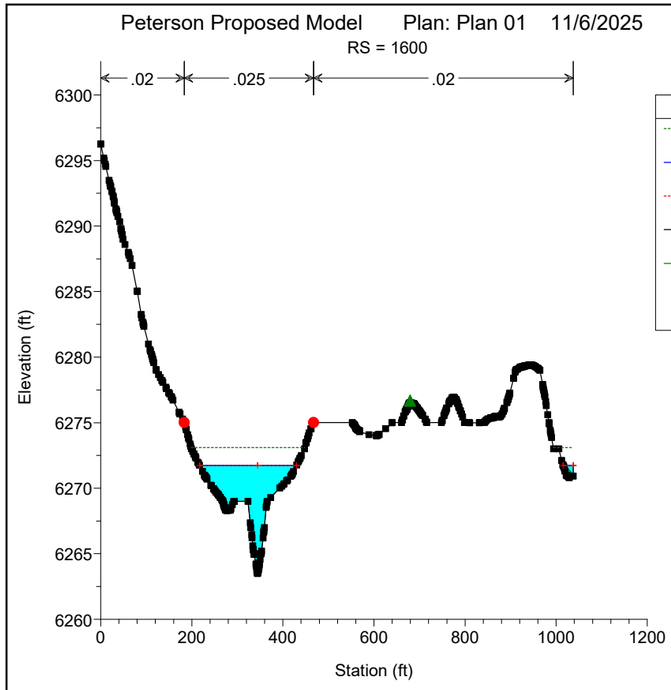
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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Crit PF 1
Ground
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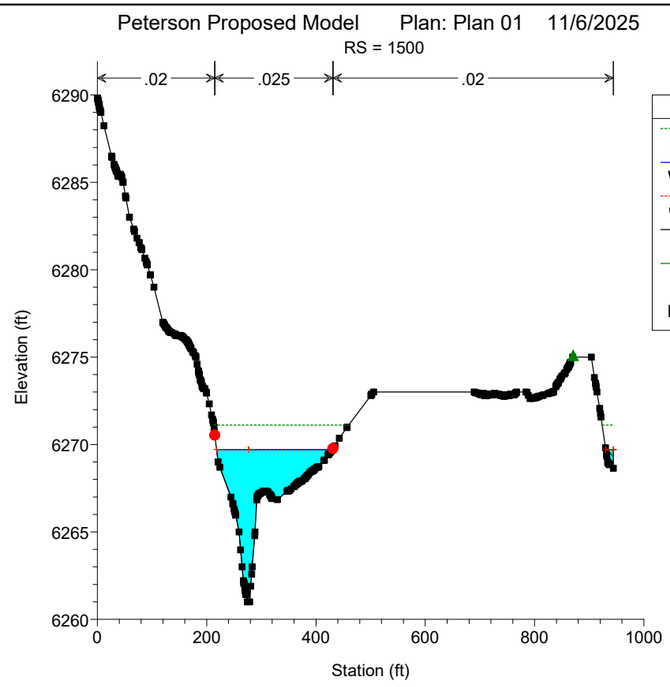
Bank Sta
Elevation (ft)
Station (ft)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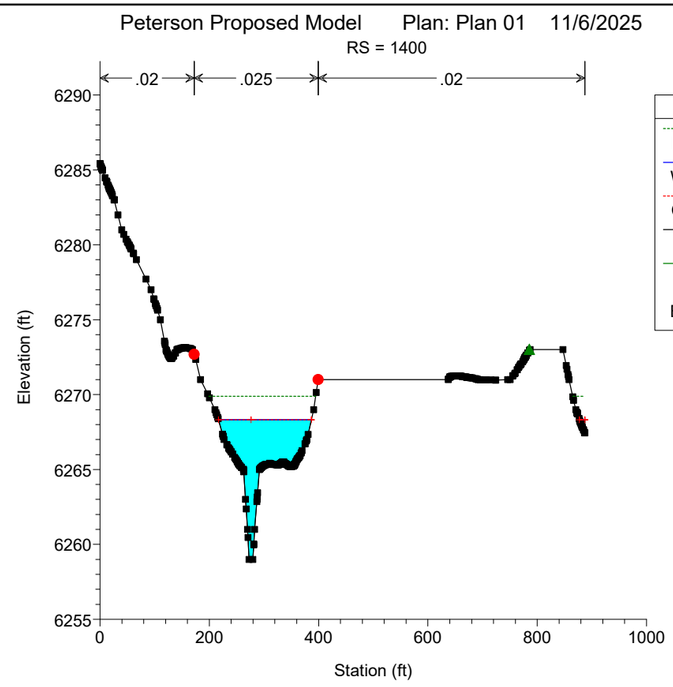
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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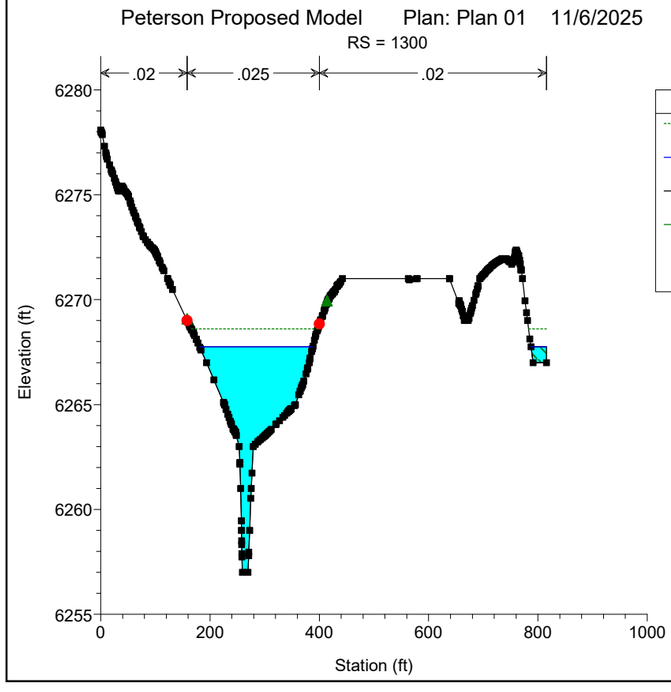
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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Legend
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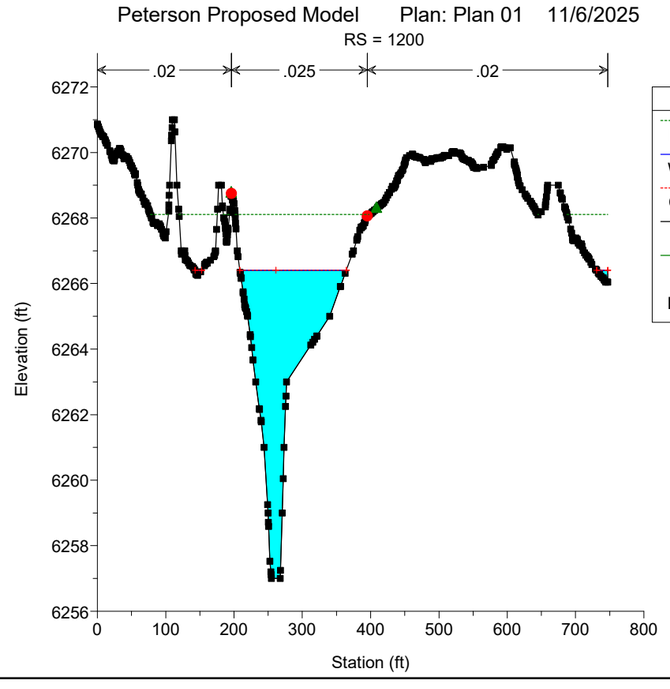
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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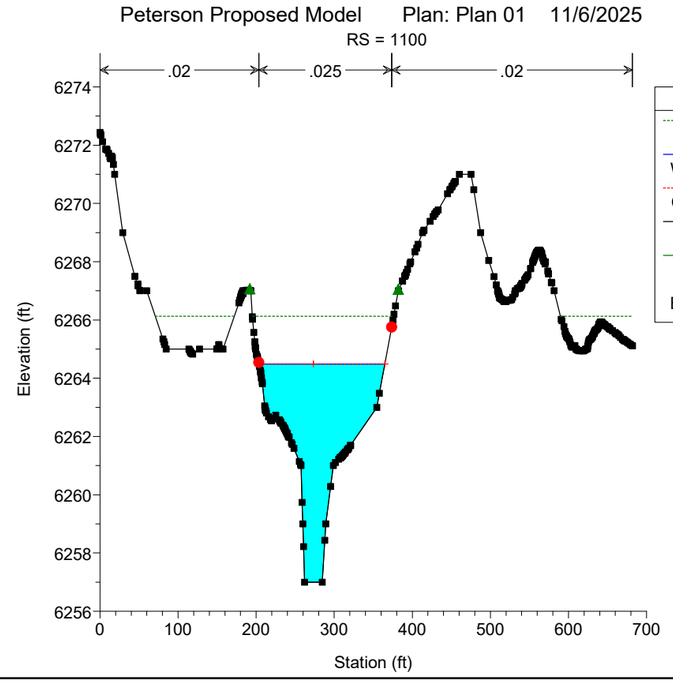
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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.02
Legend
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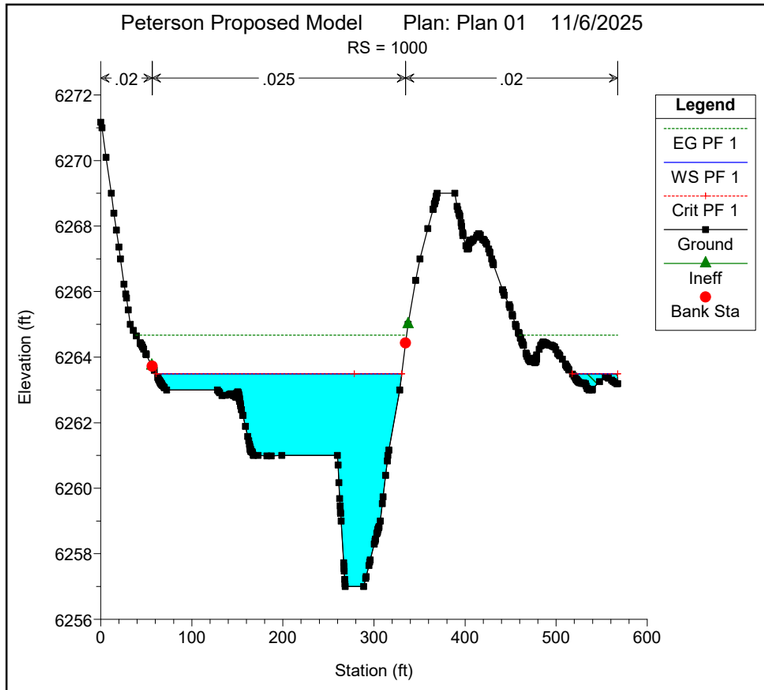
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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Legend
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Crit PF 1
Ground
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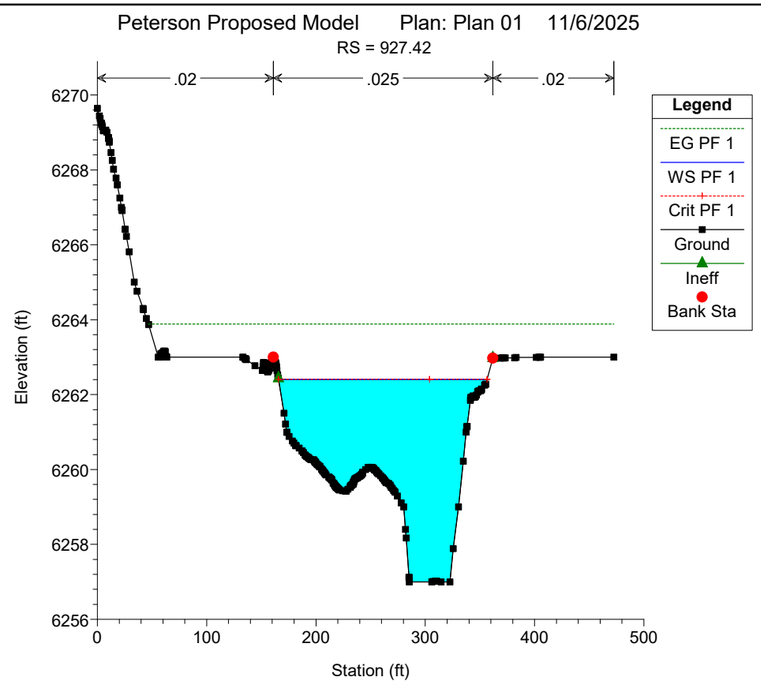
Bank Sta
Elevation (ft)
Station (ft)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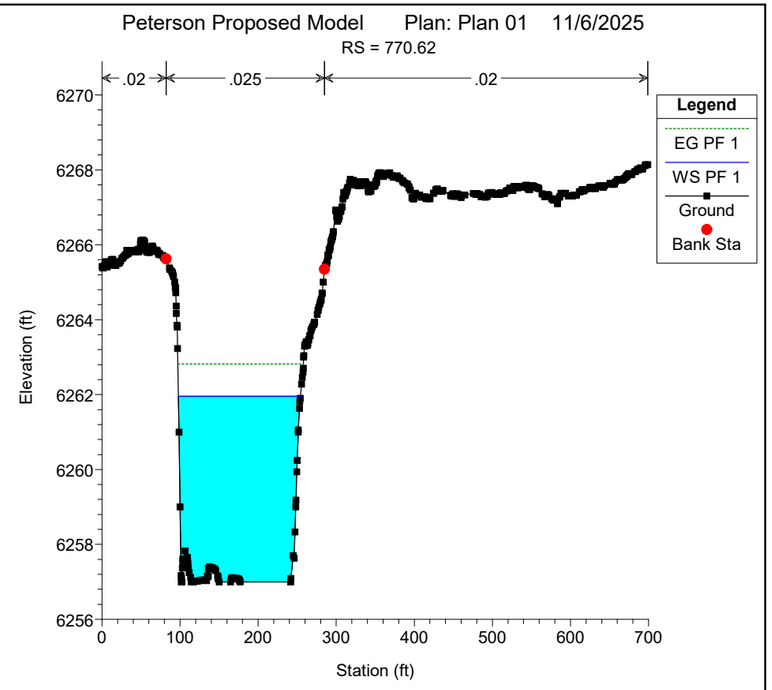
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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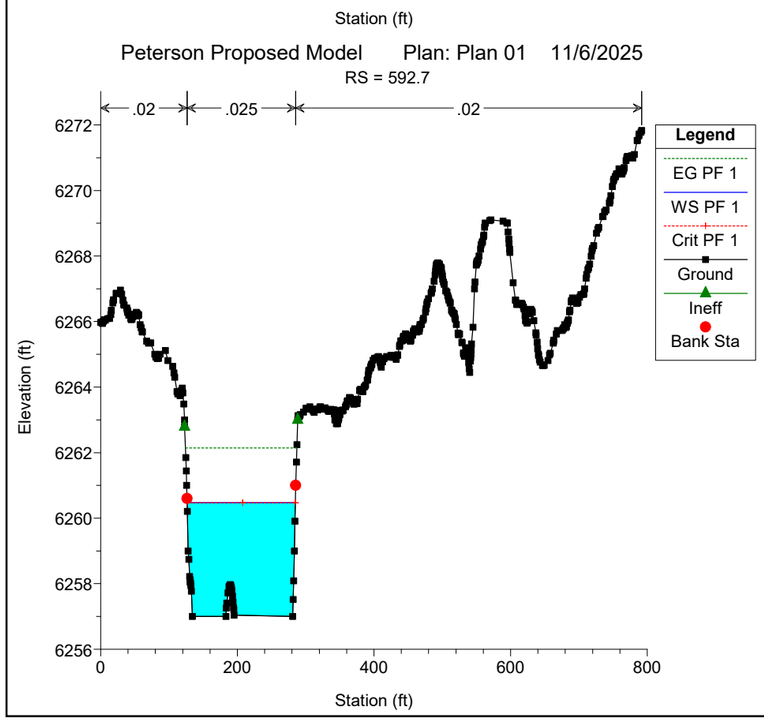
WS PF 1
Ground
Bank Sta
Elevation (ft)
Station (ft)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Legend
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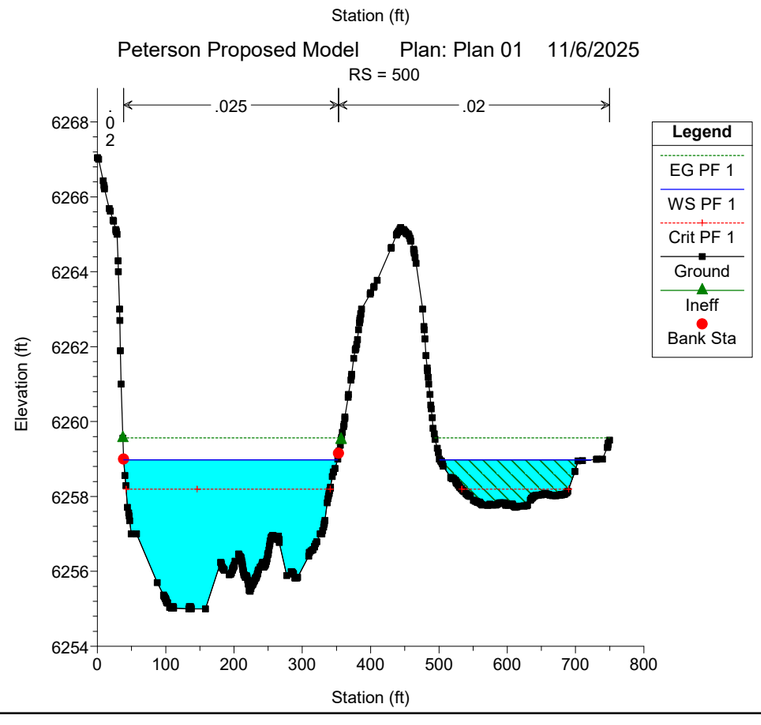
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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Legend
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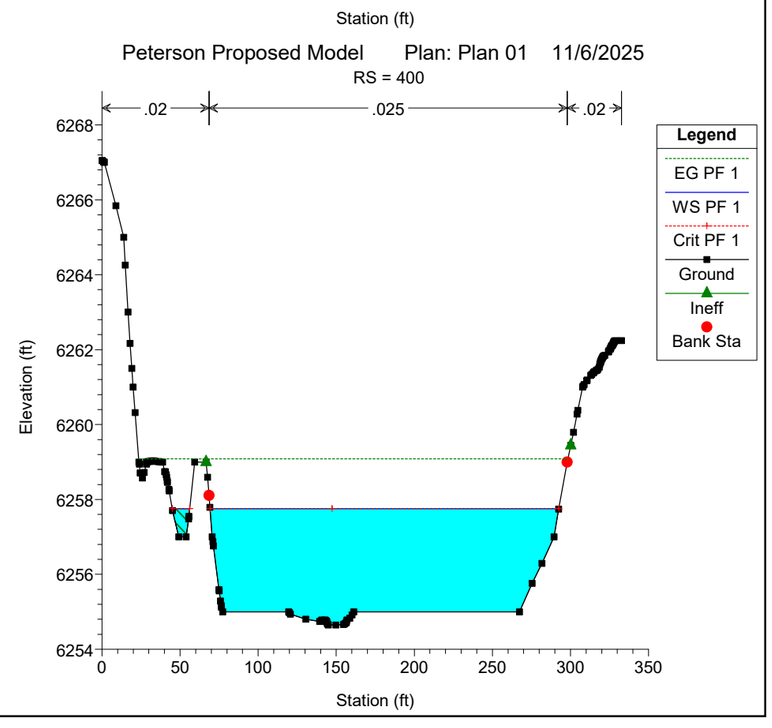
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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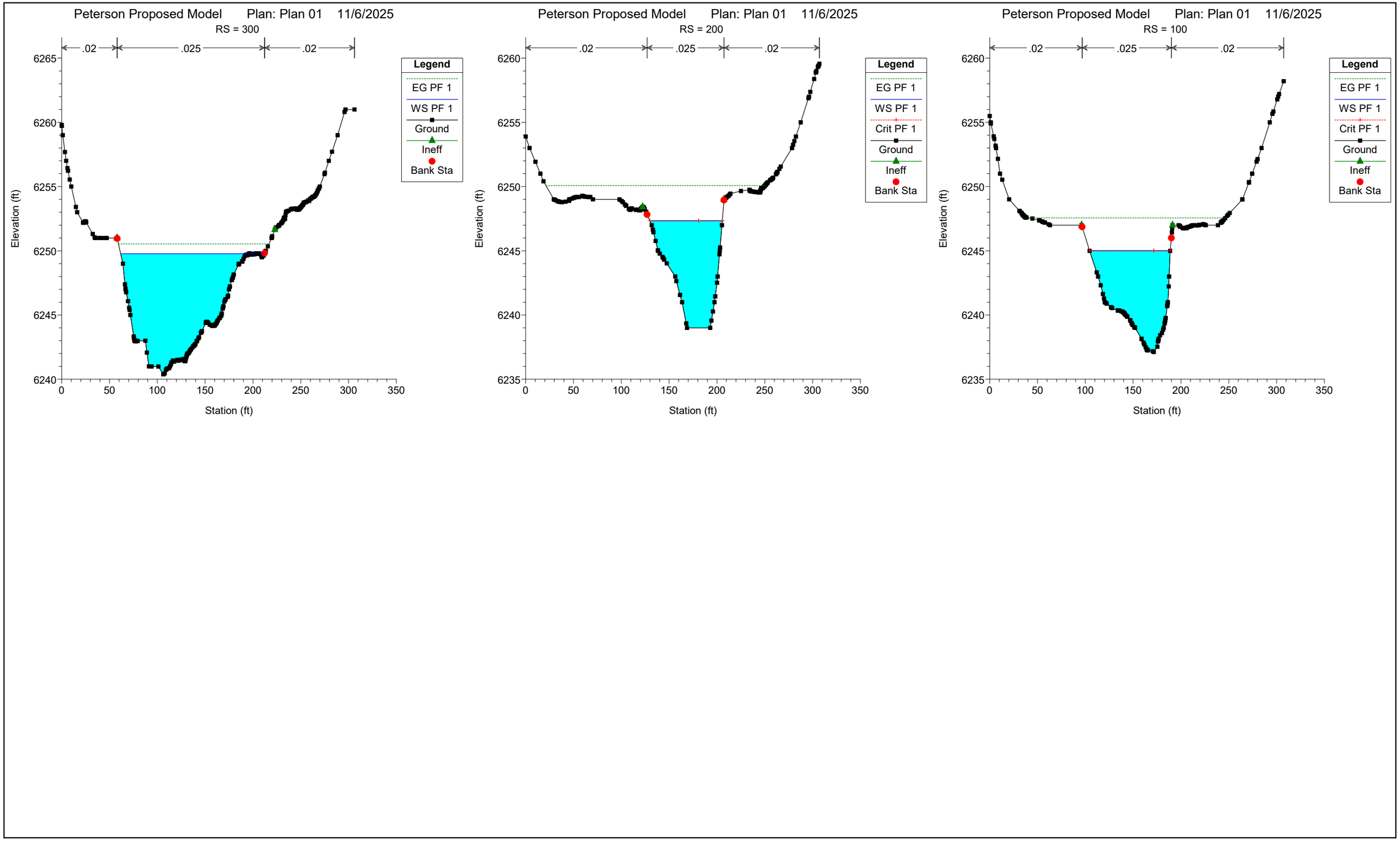
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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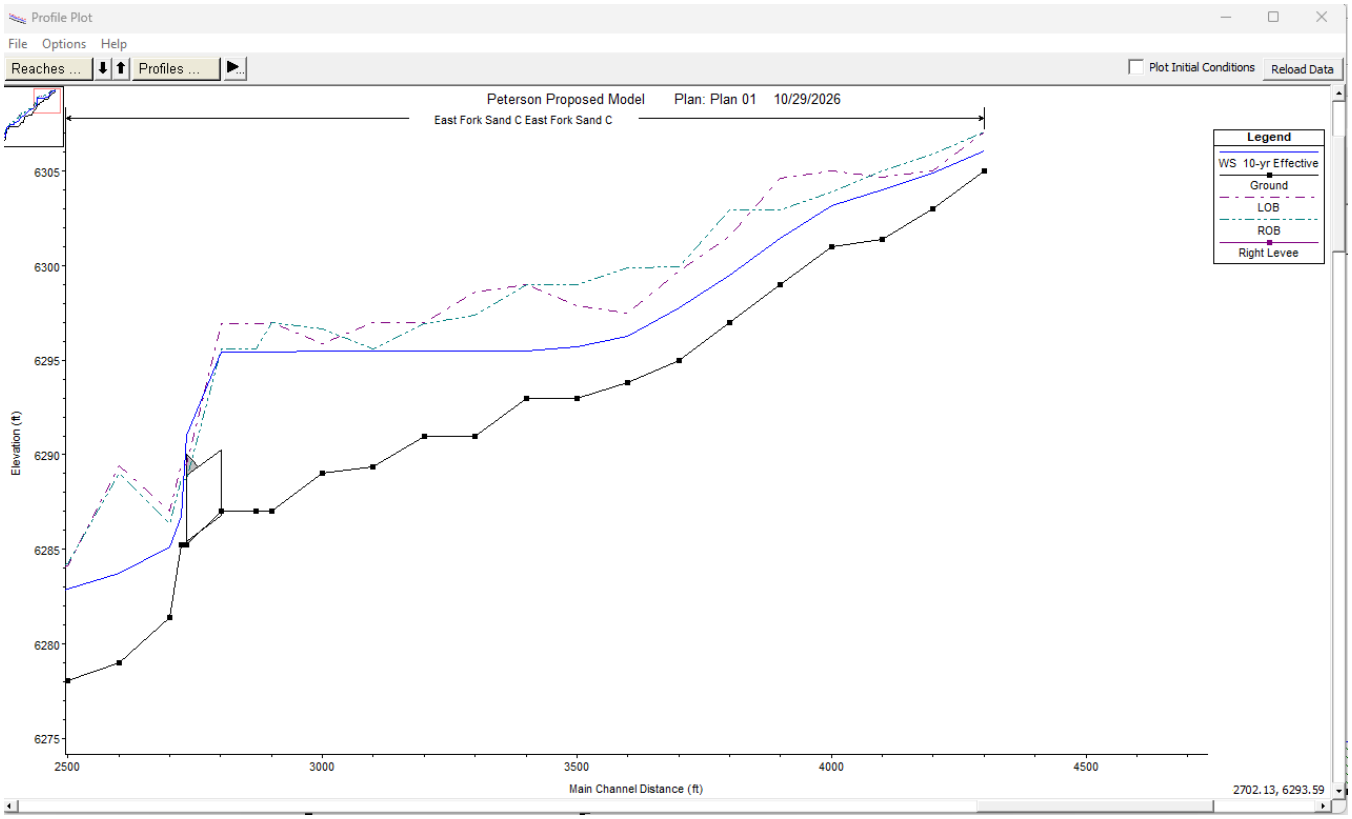
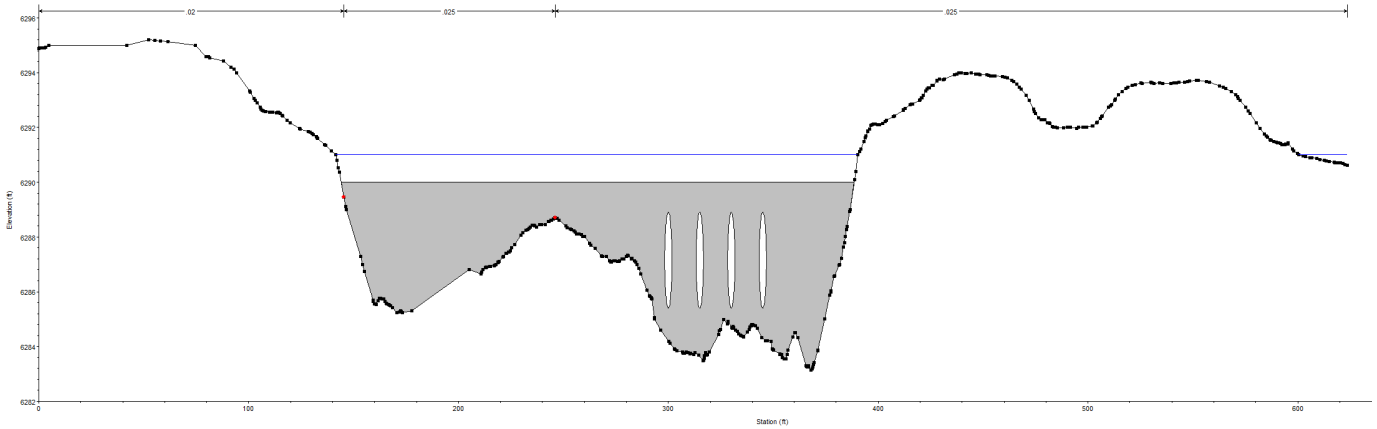
.025
.02
Legend
EG PF 1
WS PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 200
.02
.025
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Peterson Proposed Model Plan: Plan 01 11/6/2025
RS = 100
.02
.025
.02
Legend
EG PF 1
WS PF 1
Crit PF 1
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

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

HEC RAS MODELING EXCERPTS SHOWING MINOR (Q10) EVENT CONTAINMENT IN EAST FORK SAND CREEK CHANNEL



PROFILE OF MINOR EVENT IN EAST FORK SAND CREEK AS IT CROSSES PETERSON ROAD. PLEASE NOTE THAT THE DOWNSTREAM BANKS APPEAR LOWER BECAUSE THE OVERBANKS SLOPE UP QUITE A BIT MORE AND THE MODEL'S BANKS ARE INDICATED ON THE THE SMALLER LOW FLOW TYPE CHANNEL.



CROSS SECTION OF MINOR EVENT IN EAST FORK SAND CREEK AT PETERSON ROAD.

THE ABOVE PROFILE AND SECTION DEMONSTRATE THAT THE MINOR EVENT IN EAST FORK SAND CREEK IS BELOW THE ADJACENT BANKS ON BOTH SIDES OF THE DRAINAGEWAY AND, THEREFORE, ARE UNLIKELY TO INUNDATE THE EXTENSION OF MEADOWBROOK PARKWAY, THUS DEMONSTRATING COMPLIANCE WITH DCM V1, TABLE 6-1 FOR THE MINOR EVENT.

HRGreen

HRGREEN.COM

Final Drainage Report
for Hillpointe Apartments at Peterson

August 2026

HR Green Project No: 2502477

Prepared For:

Hillpointe, LLC.

3773 Cherry Creek Drive North, Suite 801 East Tower

Denver, CO 80209

Contact: Mark Foster

mfoster@hillpointe.com

Prepared By:

HR Green Development, LLC

1975 Research Parkway, Suite 160

Contact: Richie Lyon, PE

Richie.Lyon@hrgreen.com

(719) 318-0871

PCD File No. PPR2613

BR3	0.16	0.16	0.16		
BR4	0.17	0.17	0.17		
BR5	0.17	0.17	0.17		
BR6	0.17	0.17	0.17		
BR7	0.16	0.16	0.16		
BR8	0.33	0.33	0.33		
BR9	0.17	0.17	0.17		
BR10	0.33	0.33	0.33		
O1	0.18	0.18	0.00		0.18
O2	0.20	0.20	0.00		0.20
O3	0.15	0.15	0.00	0.15	
O4	0.47	0.47	0.47		
O5	0.27	0.27	0.00	0.27	
O6	0.28	0.28	0.00	0.28	
P1	0.20	0.20	0.20		
Total	14.89	14.89	13.81	0.70	0.38

Min Required Area to Receive WQ (ac)	Total Proposed Disturbed Area (ac)	Total Proposed Treated Area (ac)	Total Proposed Disturbed Area Excluded from WQ (ac)	Net Treatment (ac)
13.81	14.89	13.81	1.08	0.00

Step 3 – Stabilize stream channels: On-site stormwater is released by the existing off-site private full spectrum detention pond into the public roadside ditch at the south of the site at rates less than or equal to historical rates. The development decreases runoff released directly off-site into the public roadside ditch at the south of the site compared to historical rates, which helps to stabilize the channelized flow.

All new and redevelopment projects are required to construct or participate in the funding of channel stabilization measures. Drainage basin fees were paid at the time of platting to go towards channel stabilization within the drainage basin, therefore there are no public drainageway improvements required or proposed as a part of this development.

Step 4 – Consider the need for source controls: No industrial uses are proposed within this development and therefore no industrial source controls are proposed. The developed area is not anticipated to have uses that would require commercial source controls such as a grease trap/interceptor at this time. Should the uses of that building change, the appropriate source controls will be implemented to meet code requirements.

g. Drainage and Bridge Fees

For the Sand Creek Drainage Basin, the 2026 Drainage Fee is $28,160 per impervious acre and the 2026 Bridge Fee is $11,518 per impervious acre. The fees are to be paid at the time of final plat recording.

14.09 acres x 72.9% imperviousness = 10.24 Impervious Acres

$28,160 x 10.24 Impervious Acres = $288,358.40 (2026 Drainage Fee)

$11,518 x 10.24 Impervious Acres = $117,944.32 (2026 Bridge Fee)

h. Hydraulic Grade Line Calculations

Hydraulic Grade Line analysis for the storm network is presented in Appendix C.

V. Permanent Control Measure Cost Estimate

Pond 1 (SF2420) Improvements Cost Estimate				
Item	**Unit**	**Qty.**	**Unit Estimate**	**Total Estimate**
Orifice Plate	EA	1	$500.00	$500.00
Forebay	EA	1	$22,500.00	$22,500.00
Concrete Trickle Channel	LF	134	$105.00	$14,070.00
Handrail	LF	39	$100.50	$3,919.50
Stabilization Bedding	TN	50	$37.50	$1,875.00
Concrete Pump Truck	EA	3	$875.00	$2,625.00
Road Base	CY	169	$71.00	$11,999.00
36" RCP	LF	96	$191.00	$18,336.00
			Total	**$75,824.50**

VI. Summary

The Hillpointe Apartments at Peterson development remains consistent with drainage patterns and site area imperviousness used for calculations and design in the *Cimarron Hills Southeast Filing No. 1 Final Drainage Report* by Matrix Design Group. The proposed development will not adversely affect downstream stormwater infrastructure or surrounding developments. This report meets the latest El Paso County Drainage criteria and is in accordance with previous reports. This Final Drainage Report presents the amended site layout and the resultant drainage changes with design solutions for these revisions.

VII. Drawings

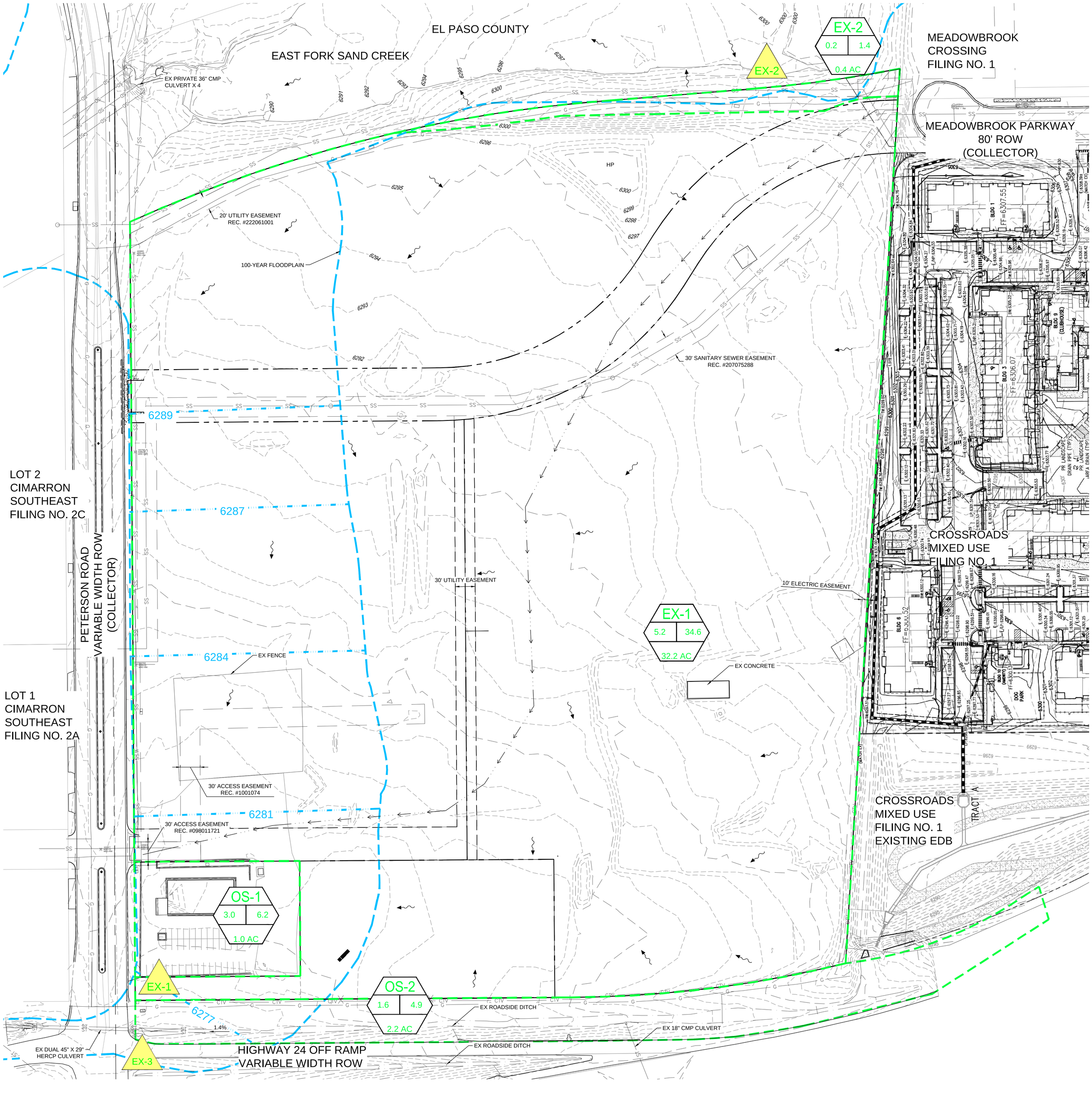
Please refer to the appendices for vicinity and drainage basin maps.

VIII. References

1. El Paso County – Drainage Criteria Manual Volume 1, Revised October 2018.
2. El Paso County – Drainage Criteria Manual Volume 2, Revised October 2018.
3. Urban Storm Drainage Criteria Manual, Urban Drainage Flood Control District, January 2018.
4. Cimmaron Hills Southeast Mixed Use Filing No. 1 Final Drainage Report, Matrix Design Group, September 2025 (SF2420)
5. Final Drainage Report for Crossroads Mixed Use Filing No. 1, MS Civil Consultants, Inc., April 2022 (SF21-029)
6. Sand Creek Drainage Basin Planning Study, Preliminary Design Report, Kiowa Engineering Corporation, January 1993, revised March 1996

APPENDIX D

MAPS



CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1			
Existing Conditions Sub-basin Summary			
Basin	Area	Q5	Q100
	acres	cfs	cfs
OS-1	1.00	3.0	6.2
EX-1	32.23	5.2	34.6
EX-2	0.45	0.2	1.4
OS-2	2.18	1.6	4.9

Existing Design Point Summary				
CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1				
Design Point	DESCRIPTION	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
EX-1	UNDEVELOPED SITE AREA	33.23	6.32	37.55
EX-2	UNDEVELOPED SITE AREA	0.45	0.21	1.41
EX-3	South Roadside Ditch	35.41	7.34	40.83

N

GRAPHIC SCALE

60' 0' 60' 120'

(IN FEET)
1 inch = 60 ft.

LEGEND

- BASIN BOUNDARY
- 5975 EXISTING CONTOUR
- EXISTING STORM DRAIN PIPE
- BASE FLOOD ELEVATION
- FLOW PATH
- 2 DESIGN POINT
- BASIN / Q5 / Q100 / AREA — SUB BASIN DESIGNATION; 5-YEAR STORM EVENT PEAK FLOW (CFS); 100-YEAR STORM EVENT PEAK FLOW (CFS); SUB BASIN AREA (AC.)

REFERENCE DRAWINGS
X-1382-PR-UTIL
X-1382-EX-SITE
X-1382-PR-SITE
X-1382-EX-MAP
X-1382-EX-UTIL
X-MDG30x42
X-1382-PR-MAP
X-1382-PR-SITE-LOT 1 (by others)

No.	DATE	DESCRIPTION	BY

REVISIONS

COMPUTER FILE MANAGEMENT
FILE NAME: S:\24.1382.003 Peterson Road and Meadowbrook Parkway Overall Development\200 Design\220 Drainage-WR\222 Reports\FDR\DWG\DR-Venezia.dwg
CTB FILE: ----
PLOT DATE: August 12, 2026 10:26:21 AM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.

SHEET KEY

PREPARED BY: Matrix Excellence by Design

SEAL

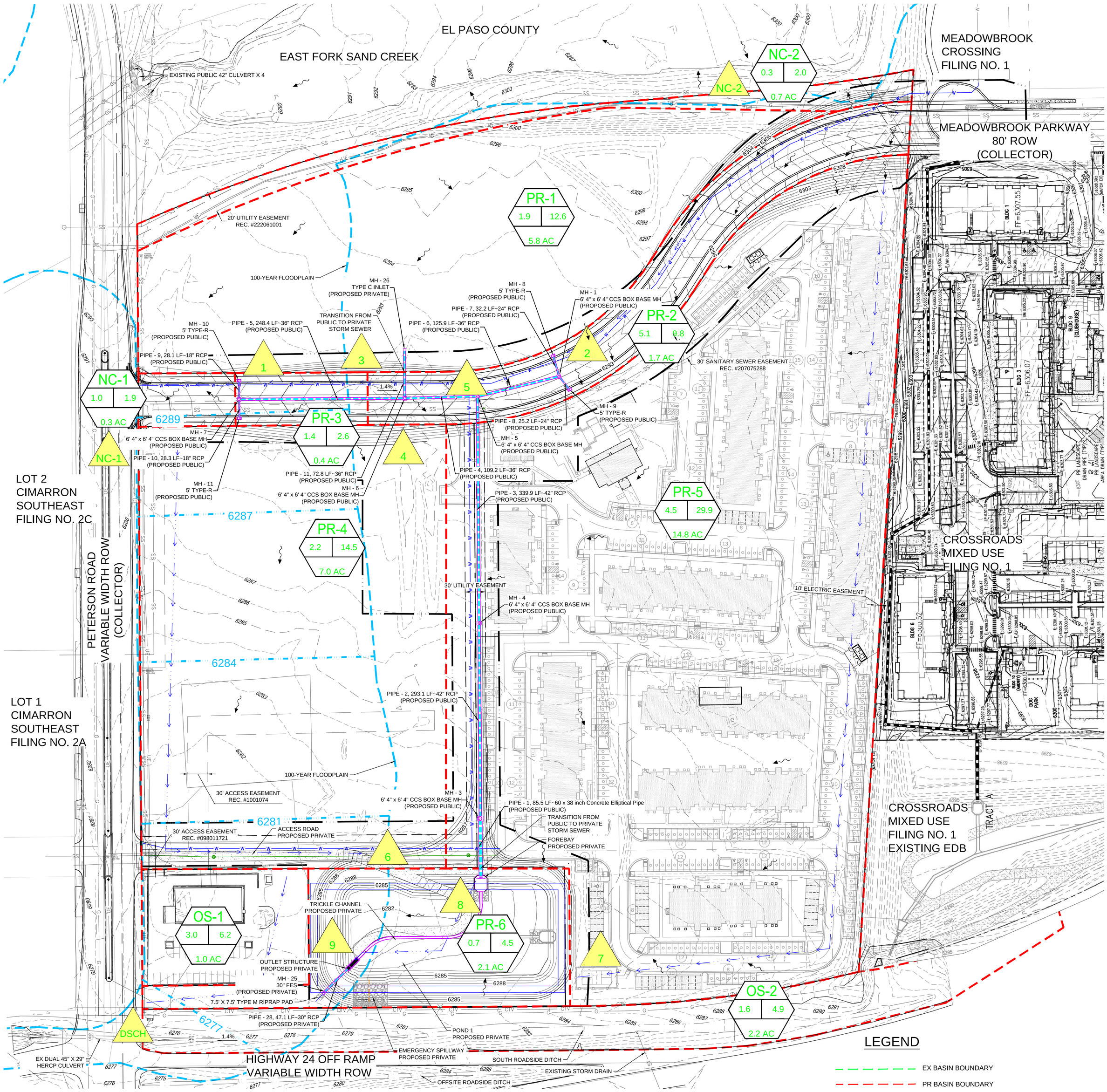
FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 24.1382.003

EL PASO COUNTY

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

EXISTING CONDITIONS DRAINAGE MAP

DESIGNED BY:	WCG	SCALE	DATE ISSUED:	AUGUST 2026	DRAWING No.
DRAWN BY:	WCG	HORIZ. 1" = 60'	SHEET	1 OF 2	DR01
CHECKED BY:	JTS	VERT. N/A			



CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1			
Proposed Conditions Sub-basin Summary			
Basin	Area	Q5	Q100
	acres	cfs	cfs
PR-1	5.79	1.9	12.6
PR-1 (FURTURE)	5.79	11.7	24.9
PR-2	1.74	5.1	9.8
PR-3	0.36	1.4	2.6
PR-4	7.01	2.2	14.5
PR-4 (FUTURE)	7.01	13.3	28.3
PR-5	14.75	4.5	29.9
PR-5 (Developed)	14.75	44.8	84.7
PR-6	2.07	0.7	4.5
NC-1	0.26	1.0	1.9
NC-2	0.70	0.3	2.0
OS-1	1.00	3.0	6.2
OS-2	2.18	1.6	4.9

NOTES:
1. 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.
2. CONCURRENT DEVELOPMENTS BY OTHERS LOCATED WITHIN SUB-BASIN PR-5 WILL BE REQUIRED TO PROVIDE CONVEYANCE TO THE PROPOSED DETENTION FACILITY INCLUDING AN ADDITIONAL FOREBAY AND TRICKLE CHANNEL CONNECTION.

Proposed Design Point Summary				
CIMARRON HILLS SOUTHEAST MIXED USE FILING NO. 1				
Design Point	DESCRIPTION	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
DP1	MEADOWBROOK PKWY- AT GRADE INLETS	0.36	1.4	2.6
DP2	MEADOWBROOK PKWY- SUMP INLETS	1.74	5.1	9.8
DP3	LOT 2	5.79	1.9	12.6
DP3 (FUTURE)	LOT 2	5.79	11.7	24.9
DP4	DP1, DP3	6.15	2.9	15.0
DP4 (FUTURE)	DP1, DP3	6.15	12.7	26.7
DP5	DP 2, DP3, & DP 1	7.89	7.9	24.6
DP5 (FUTURE)	DP2, DP3, & DP1	7.89	18.6	38.1
DP6	DP5 & LOT 3	14.90	8.9	35.2
DP6 (FUTURE)	DP5 & LOT 3	14.90	28.4	59.2
DP7	PR-5	14.75	4.5	29.9
DP7 (FUTURE)	PR-5 MULTI FAMILY (By others)	14.75	44.8	84.7
DP8	INTO DETENTION POND	31.71	14.3	70.7
DP9	OUT OF DETENTION POND	31.71	2.7	14.7
DP8 (FUTURE)	INTO DETENTION POND	31.71	71.2	143.6
DP9 (FUTURE)	OUT OF DETENTION POND	31.71	5.20	35.00
DSCH	SITE DISCHARGE	32.68	4.02	18.68
NC-1	PORTION OF MEADOWBROOK PKWY IMPRACTICABLE TO DETAIN	0.26	1.02	1.95
NC-2	UNDEVELOPABLE AREA DRAINING TO THE NORTH.	0.70	0.30	2.03

N

GRAPHIC SCALE

60' 0' 60' 120'

(IN FEET)
1 inch = 60 ft.

LEGEND

- EX BASIN BOUNDARY
- PR BASIN BOUNDARY
- 5975 EXISTING CONTOUR
- 7050 PROPOSED CONTOUR
- PROPOSED STORM DRAIN PIPE
- EXISTING STORM DRAIN PIPE
- PROPOSED PROPERTY LINE
- LIMITS OF DISTURBANCE
- PROPOSED FLOW DIRECTION
- FLOW PATH
- PROPOSED STORM STRUCTURES
- BASE FLOOD ELEVATION
- 2 DESIGN POINT
- PROPOSED MAINTENANCE ACCESS ROAD
- PROPOSED RIP RAP
- PW12 PROPOSED WATER LINE
- PROPOSED SANITARY SEWER
- EMERGENCY FLOW PATHS

BASIN (Q5 | Q100) AREA
- SUB BASIN DESIGNATION
- 5-YEAR STORM EVENT PEAK FLOW (CFS)
- 100-YEAR STORM EVENT PEAK FLOW (CFS)
- SUB BASIN AREA (AC.)

REFERENCE DRAWINGS
X-1382-PR-UTIL
X-1382-EX-SITE
X-1382-PR-SITE
X-1382-EX-MAP
X-1382-EX-UTIL
X-MDG30x42
X-1382-PR-MAP
X-1382-PR-SITE-LOT 1 (by others)

No.	DATE	DESCRIPTION	BY

REVISIONS

COMPUTER FILE MANAGEMENT
FILE NAME: S:\24.1382.003 Peterson Road and Meadowbrook Parkway Overall Development\200 Design\220 Drainage-WR\222 Reports\FDR\DWG\DR-Venezia.dwg
CTB FILE: Matrix.ctb
PLOT DATE: September 23, 2026 1:03:20 PM
THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.

SHEET KEY

PREPARED BY: Matrix Excellence by Design

SEAL

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 24.1382.003

EL PASO COUNTY

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

PROPOSED CONDITIONS DRAINAGE MAP

DESIGNED BY:	WCG	SCALE		DATE ISSUED: SEPTEMBER 2026	DRAWING No.
DRAWN BY:	WCG	HORIZ.	1" = 60'		
CHECKED BY:	JTS	VERT.	N/A	SHEET 2 OF 2	DR02