HAY CREEK VALLEY

MDDP / PRELIMINARY DRAINAGE REPORT

Prepared for:

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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.

____________________________________ ______________

Jesse Sullivan Date
Registered Professional Engineer
State of Colorado
No. 55600

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.

View Homes, Inc.
Business Name

By: ____________________________________ ______________
Timothy Buschar Date

Title: Director of Land Acquisition and Development

Address: 555 Middle Creek Parkway Suite 500
Colorado Springs, CO 80921

El Paso County:

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

____________________________________ ________________________

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

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I. INTRODUCTION

The Hay Creek Valley site is comprised of approximately 214.6 acres of unplatted and mostly undeveloped land. The site is located on Smow Mountain Heights approximately 700 feet south of its intersection with Hay Creek Road. The site is currently comprised of six (6) parcels which are to be subdivided into 20 lots and three (3) tracts. The existing access road will be replaced with a private road having a 60-foot right of way that will terminate with a cul-de-sac in the southwestern section of the site.

a. PURPOSE AND SCOPE OF STUDY

The purpose of this Preliminary Drainage Report (FDR) is to evaluate the specific drainage infrastructure requirements which will provide compliance with the County Drainage Criteria Manual (DCM) and provide storm water conveyance for associated developments. 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 Beaver Creek Drainage Basin. No Drainage Basin Planning Study (DBPS) has been completed for this basin.

c. GENERAL PROJECT DESCRIPTION

The Hay Creek Valley Subdivision is located to the southwest of the intersection of Hay Creek Road and Smow Mountain Heights. The site is located as follows:

1. General Location: Southwest ¼ of Section 34 and the Southeast ¼ of Section 33, Township 11 South, Range 67 West of the 6th P.M. in the County of El Paso, State of Colorado.
2. Drainageway: The Hay Creek Subdivision is located on the southern edge of the Beaver Creek Drainage Basin. Most of the site drains north and into Hay Creek located approximately 200 feet north of the site. Hay Creek is a tributary to Beaver Creek which ultimately drains into Monument Creek. A small portion of the southeast corner of the site drains south into the Air Force Academy Major Drainage Basin.
3. Surrounding Developments: The site is bound Lots 1 through 8 Hay Creek Ranch Subdivision, and 4 unplatted parcels to the north, and by the Air Force Academy the south. The site is bound by Lot 2 Rush Subdivision and Lot 2 Block 1 Smiley Subdivision to the west, and an unplatted parcel to the east.
4. Lots to be Platted: The site is to be subdivided into 20 lots zoned RR-5 and 3 tracts.
5. Area of Disturbance: The Hay Creek Valley development is expected to disturb a total area of approximately 14.5 acres.
6. Streamside Zone: This project is not located within a streamside zone.
7. Vegetation: The Hay Creek Valley site contains a single-family residence, a barn and Smow Mountain Heights, a private road that provided access to the site from hay Creek Road. The vegetation of the site consists of sparse, natural vegetative land cover in the form of grasses and shrubs with sparse trees throughout.

Refer to Appendix D for the Vicinity Map.

d. SOILS CONDITIONS

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

Table 1.1 – NRCS Soil Survey for El Paso County – Hay Creek Valley

Soil ID Number	*Soil*	*Hydrologic Classification*	*Drainage Class*	*Percent of Site*
38	Jarre-Tecolote Complex, 8 to 65 percent slopes	B	Well Drained	50.8%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	Well Drained	14.5%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	Well Drained	34.7%

DATA SOURCES

Topographical information for the district 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 district. Offsite contours are 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 to 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.

II. Hydrologic Methodology

a. MAJOR BASINS AND SUBBASINS

The majority of the Hay Creek Valley site is located within the Beaver Creek Drainage Basin with a small portion of the site tributary to the Air Force Academy Major Drainage Basin. Runoff presently flows overland until reaching an existing natural drainage swale located within the site. This drainage swale directs flows internally until discharging from near the northeastern corner of the site. 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. METHODOLOGY

i. UD Methods

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

Time of Concentration

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

Rainfall Intensity

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

Table 2.1 – Project Area 1-Hour Rainfall Depth

Storm Recurrence Interval	Rainfall Depth (inches)
5-year	1.50
100-year	2.52

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. Proposed single family residential is considered as the Single Family – 5 acres category. Areas which will be future open spaces or detention facilities are modeled under the Parks and Cemeteries category. Undeveloped or predevelopment areas are model under Undeveloped Areas-Historic Flow Analysis—Greenbelts, Agriculture category.

ii.HEC-HMS Methods

The DCM requires the use of the SCS Hydrograph Procedure to compute storm water runoff quantities when the drainage area is greater than 100 acres. This report uses HEC-HMS for the routing and analysis of the site conditions.

SCS Lag

The SCS lag calculations are completed as part of this report. Proposed development areas within the Hay Creek area are calculated based on the methodology indicated in the DCM Equations:

The Time of Concentration is the sum of overland flow time and the t_t values for the various consecutive flow segments:

$$t_c = t_i + t_{t1} + t_{t2} + t_{t3} \ldots t_{tm} \qquad \text{(Eq. 6-14)}$$

Where:

t_c = time of concentration (hr)

t_i = overland (initial) flow time (hr)

t_{tm} = travel time for each flow segment (hr)

m = number of flow segments

Overland Flow:

$$T_i = 0.007(n \cdot L)^{0.8} / \; (P_2)^{0.5} \, S^{0.4} \qquad \text{(Eq. 6-15)}$$

Where:

T_i = overland flow time (hr)

n = Manning's roughness coefficient L

= flow length (ft)

P_2 = 2-year, 24-hour rainfall (in)

S = slope of hydraulic grade line (ft/ft)

Concentrated Flow:

$$T_t = L / (3600 \cdot V) \qquad \text{(Eq. 6-16)}$$

Where:

T_t = travel time (hr)

L = flow length (ft)

V = velocity (ft/s)

3,600 = conversion factor from seconds to hours

Runoff Analysis
The site has been analyzed using HEC-HMS and the NRCS SCS method. The model indicates approximately 0.1 cfs decrease for Q100 event post development of the Hay Creek site. (**EX-Q5, EX-Q100, PR-Q5, and PR-Q100)** These models look at the 5, and 100-year events for onsite detention within the Hay Creek Site and demonstrate a slight reduction for the 100-year event. Print outs from each model can be found in Appendix A.

Hydrographs for the proposed pond 1 are taken from MHFD-Detention, where appropriate, and input to the model to represent the detention required within the development to maintain the historic flow discharge downstream of the site and provide water quality for the development in accordance with the DCM.

NRCS SCS curve numbers (CN) are taken from Table 6-10 of the DCM and weighted for each basin based on the soil and development types. As recommended in the DCM storms of 2-hour duration are used for the 5-year event. A 24-hour storm is used for the 100-year event. Lag times are calculated for the basins using the formulas from the DCM shown above.

iii. HGL Profile Methods

Preliminary sizing of storm sewer has been completed using the Manning's channel flow calculation.

Each future phase of development will be required to analyze the storm sewer to confirm DCM compliant capacity and velocity values. These future FDRs will provide HGL profiles modeled in Storm CAD using the Standard head loss method and head loss values taken from Table 9-4 of the DCM or via other methodology allowed by the DCM. HGL profiles may alternately be submitted with construction drawings as addenda to the appropriate Final Drainage Report as the project area is developed.

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. BASIN LOCATION AND FLOWS

The Hay Creek Valley site is found on the southern border of the Beaver Creek Drainage Basin. In addition to the 214.6-acre site, there are off-site basins east, west, and south of the site that contribute a total tributary area of 98.5 acres. The Hay Creek Valley Road & Storm improvements are anticipated to disturb approximately 14.5 acres.

b. MAJOR DRAINAGEWAYS

Beaver Creek
The majority of the Hay Creek Valley site is located within the Beaver 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.

Air Force Academy
The area along the southeastern border of the site drains southeast into the Air Force Academy Major Drainage Basin. Runoff generated within this basin presently flows overland with slopes ranging from 15 to 45% until exiting the site to the southeast into the adjacent property.

c. LAND USES

Presently, the site is unplatted and consists mostly of undeveloped land. The 214.6-acre area is entirely zoned RR-5. The site will consist of residential lots containing 5-acres or more and three tracts, one containing the proposed pond 1, one containing the proposed roadway, and the other containing the Preble's mouse habitat which is undevelopable.

IV. BASIN HYDROLOGY

a. The ***Pre-development conditions*** for the Hay Creek Valley site have been analyzed and are presented by design points and are described as follows:

Predevelopment conditions have been analyzed using both the SCS Hydrograph Procedure and the routed Rational Method. The existing conditions will discuss the entry of runoff from off-site basins as it relates to the respective design point. Runoff generated, either on-site or off-site, drains overland towards the northeastern corner of the site where it is captured by the existing natural swale that runs northeast, exiting the site and releasing flows to be collected in Hay 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 and DR-02. Runoff calculations can be found in Appendix A. The existing runoff design points are described below:

Design Point 1 (Rational (Q_5 = 3.5 cfs, Q_{100} = 18.9 cfs) HEC-HMS (Q_5 = 0.8 cfs, Q_{100} = 4.1 cfs)) (sub-basin: EX-OS1a; Area: 9.4 Ac.) (Slopes: 5 to 15%) This point represents the discharge from offsite sub-basin EX-OS1a into the site. Stormwater runoff will sheet flow to the east and into sub-basin EX-1.

Design Point 2 (Rational (Q_5 = 12.3 cfs, Q_{100} = 74.6 cfs) HEC-HMS (Q_5 = 2.6 cfs, Q_{100} = 15.7 cfs)) (sub-basin: EX-OS1b; Area: 59.2 Ac.) (Slopes: 5 to 10%) This point represents the discharge from offsite sub-basin EX-OS1b into the site. Stormwater runoff will sheet flow to the east and into sub-basin EX-2.

Design Point 3 (Rational (Q_5 = 7.8 cfs, Q_{100} = 42.0 cfs) HEC-HMS (Q_5 = 1.5 cfs, Q_{100} = 8.0 cfs)) (sub-basin: EX-OS2a; Area: 15.9 Ac.) (Slopes: 20 to 50%) This point represents the discharge from offsite sub-basin EX-OS2a into the site. Stormwater runoff will sheet flow to the north and into sub-basin EX-2.

Design Point 4 (Rational (Q_5 = 1.3 cfs, Q_{100} = 6.7 cfs) HEC-HMS (Q_5 = 0.3 cfs, Q_{100} = 1.4 cfs)) (sub-basin: EX-OS2b; Area: 2.8 Ac.) (Slopes: 10 to 40%) This point represents the discharge from offsite sub-basin EX-OS2b into the site. Stormwater runoff will sheet flow to the north and into sub-basin EX-3.

Design Point 5 (Rational (Q_5 = 1.6 cfs, Q_{100} = 8.2 cfs) HEC-HMS (Q_5 = 0.3 cfs, Q_{100} = 1.6 cfs)) (sub-basin: EX-OS2c; Area: 3.2 Ac.) (Slopes: 10 to 50%) This point represents the discharge from offsite sub-basin EX-OS2c into the site. Stormwater runoff will sheet flow to the north and into sub-basin EX-3.

Design Point 6 (Rational (Q_5 = 2.7 cfs, Q_{100} = 17.7 cfs) HEC-HMS (Q_5 = 0.2 cfs, Q_{100} = 2.0 cfs)) (sub-basin: EX-OS3; Area: 8.2 Ac.) (Slopes: 10 to 45%) This point represents the discharge from offsite sub-basin EX-OS3 into the site. Stormwater runoff will sheet flow to the west and into sub-basin EX-5.

Design Point 7 (Rational (Q_5 = 2.3 cfs, Q_{100} = 15.6 cfs) HEC-HMS (Q_5 = 2.3 cfs, Q_{100} = 15.6 cfs)) (sub-basin: EX-4; Area: 5.9 Ac.) (Slopes: 10 to 50%) This point represents the discharge from sub-basin EX-4 into the adjacent property. Stormwater runoff will sheet flow to the south and into the adjacent property then continue south along historic paths.

Design Point 8 (Rational (Q_5 = 26.1 cfs, Q_{100} = 153.1 cfs) HEC-HMS (Q_5 = 5.4 cfs, Q_{100} = 30.9 cfs)) (sub-basins: EX-OS1b, EX-OS2a, EX-2; Area: 123.3 Ac.) (Slopes: 5 to 30%) This point represents the combined discharge from sub-basins EX-OS1b, EX-OS2a, and EX-2 into sub-basin EX-1. Stormwater runoff will sheet flow to the north to combine with the flows from sub-basin EX-1 before continuing along historic paths.

Design Point 9 (Rational (Q_5 = 17.6 cfs, Q_{100} = 106.5 cfs) HEC-HMS (Q_5 = 2.9 cfs, Q_{100} = 17.4 cfs)) (sub-basins: EX-OS2b, EX-OS2c, EX-3; Area: 67.6 Ac.) (Slopes: 5 to 60%) This point represents the combined discharge from sub-basins EX-OS2b, EX-OS2c, and EX-3 into sub-basin EX-1. Stormwater runoff will sheet flow to the north to combine with the flows from sub-basin EX-1 before continuing along historic paths.

Design Point 10 (Rational (Q_5 = 13.5 cfs, Q_{100} = 85.3 cfs) HEC-HMS (Q_5 = 1.8 cfs, Q_{100} = 11.9 cfs)) (sub-basins: EX-OS3, EX-5; Area: 51.0 Ac.) (Slopes: 5 to 50%) This point represents the combined discharge from sub-basins EX-OS3, and EX-5 into sub-basin EX-1. Stormwater runoff will sheet flow to the north to combine with the flows from sub-basin EX-1 before continuing along historic paths.

Design Point 11 (Rational (Q_5 = 35.0 cfs, Q_{100} = 210.9 cfs) HEC-HMS (Q_5 = 11.2 cfs, Q_{100} = 69.9 cfs)) (sub-basins: EX-OS1a, EX-OS1b, EX-OS2a, EX-OS2b, EX-OS2c, EX-OS3, EX-1, EX-2, EX-3, EX-5; Area: 307.3 Ac.) (Slopes: 5 to 50%) This point represents the total discharge from the site. Stormwater runoff is collected in a natural swale and directed to the northeast. The channelized flow exits the site near the northeast corner of the site and continues north before draining into Hay Creek approximately 300 feet north of the site.

Design Point HC (Q_{100} = 127 cfs) This point represents the stormwater flows in Hay Creek at the existing private 24"x36" culvert to the north of the site. The existing private 24"x36" culvert conveys the flows in Hay Creek under the existing access road. The proposed flows in Hay Creek come from the HEC-2 analysis provided by the Regional Floodplain Administrator. The HEC-2 results are included in **appendix C**.

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

Post development conditions have been analyzed using rational routed flow. The proposed conditions will discuss the entry of runoff from off-site basins as it relates to the respective design point. Runoff generated, either on-site or off-site, drains overland towards the northeastern corner of the site where it is captured by the existing natural swale that runs northeast, exiting the site and releasing flows to be collected in Hay Creek. Generally, the developed lots are considered to be residential lots containing 5 acres or more, having an imperviousness of 7.0%. Sub-basin PR-8, which contains the proposed roadway and ditch, has an imperviousness of 62.0%. Sub basins PR-9, and PR-10, containing the proposed pond 1 and open space are considered to have an imperviousness of 2.0%. A delineation of the basin boundaries can be found in Appendix D in drawing DR-03. Runoff calculations can be found in Appendix A. The existing runoff design points are described below:

Design Point 1 (Rational (Q_5 = 3.5 cfs, Q_{100} = 18.9 cfs) HEC-HMS (Q_5 = 0.8 cfs, Q_{100} = 3.6 cfs)) (sub-basin: OS1a; Area: 9.4 Ac.) (Slopes: 5 to 15%) This point represents the discharge from offsite sub-basin OS1a into the site. Stormwater runoff will sheet flow to the east and into sub-basin PR-1.

Design Point 2 (Rational (Q_5 = 12.3 cfs, Q_{100} = 74.6 cfs) HEC-HMS (Q_5 = 2.6 cfs, Q_{100} = 14.2 cfs)) (sub-basin: OS1b; Area: 59.2 Ac.) (Slopes: 5 to 10%) This point represents the discharge from offsite sub-basin OS1b into the site. Stormwater runoff will sheet flow to the east and into sub-basin PR-1.

Design Point 3 (Rational (Q_5 = 2.2 cfs, Q_{100} = 12.4 cfs) HEC-HMS (Q_5 = 0.4 cfs, Q_{100} = 1.8 cfs)) (sub-basin: OS2a; Area: 5.0 Ac.) (Slopes: 20 to 50%) This point represents the discharge from offsite sub-basin OS2a into the site. Stormwater runoff will sheet flow to the north and into sub-basin PR-1.

Design Point 4 (Rational (Q_5 = 4.0 cfs, Q_{100} = 21.6 cfs) HEC-HMS (Q_5 = 0.7 cfs, Q_{100} = 3.2 cfs)) (sub-basin: OS2b; Area: 8.6 Ac.) (Slopes: 20 to 50%) This point represents the discharge from offsite sub-basin OS2b into the site. Stormwater runoff will sheet flow to the north and into sub-basin PR-2.

Design Point 5 (Rational (Q_5 = 1.3 cfs, Q_{100} = 6.5 cfs) HEC-HMS (Q_5 = 0.3 cfs, Q_{100} = 1.2 cfs)) (sub-basin: OS2c; Area: 2.3 Ac.) (Slopes: 20 to 50%) This point represents the discharge from offsite sub-basin OS2c into the site. Stormwater runoff will sheet flow to the north and into sub-basin PR-3.

Design Point 6 (Rational (Q_5 = 2.9 cfs, Q_{100} = 14.4 cfs) HEC-HMS (Q_5 = 0.5 cfs, Q_{100} = 2.3 cfs)) (sub-basin: OS2d, OS2e; Area: 5.9 Ac.) (Slopes: 10 to 50%) This point represents the combined discharge from offsite sub-basins OS2d and OS2e into the site. Stormwater runoff will sheet flow to the north and into sub-basin PR-4.

Design Point 7 (Rational (Q_5 = 1.5 cfs, Q_{100} = 10.1 cfs) HEC-HMS (Q_5 = 0.1 cfs, Q_{100} = 0.9 cfs)) (sub-basin: OS3a; Area: 4.9 Ac.) (Slopes: 5 to 40%) This point represents the discharge from sub-basin OS2f into the site. Stormwater runoff will sheet flow to the north and into sub-basin PR-6.

Design Point 8 (Rational (Q_5 = 1.1 cfs, Q_{100} = 7.6 cfs) HEC-HMS (Q_5 = 0.1 cfs, Q_{100} = 0.8 cfs)) (sub-basins: OS3b; Area: 3.3 Ac.) (Slopes: 10 to 45%) This point represents the discharge from sub-basin OS3b into the site. Stormwater runoff will sheet flow to the west and into sub-basin PR-10.

Design Point 9 (Rational (Q_5 = 3.1 cfs, Q_{100} = 17.0 cfs)) (sub-basins: PR-5; Area: 5.9 Ac.) (Slopes: 10 to 50%) This point represents the discharge from sub-basin PR-5 into the adjacent property. Stormwater runoff will sheet flow to the south and into the adjacent property then continue south along historic paths.

Design Point 10 (Rational (Q_5 = 9.0 cfs, Q_{100} = 48.8 cfs) HEC-HMS (Q_5 = 2.1 cfs, Q_{100} = 9.6 cfs)) (sub-basins: OS2b, PR-2; Area: 24.7 Ac.) (Slopes: 5 to 30%) This point represents the flows from sub-basins OS2b and PR-2 that have been collected in the roadside ditch that runs along the south side of the proposed roadway. The roadside ditch located upstream of Design Point 10 will be lined with Type M Rip Rap. These flows travel northeast in the ditch before being collected in the proposed private 36-inch Flared End Section (FES) at Design Point 10 (DP-10). These flows are conveyed under the proposed roadway to the north, discharging via a proposed private 36-inch FES before continuing along historic paths.

Design Point 11 (Rational (Q_5 = 4.5 cfs, Q_{100} = 24.0 cfs) HEC-HMS (Q_5 = 1.0 cfs, Q_{100} = 4.6 cfs)) (sub-basins: OS2c, PR-3; Area: 12.1 Ac.) (Slopes: 5 to 30%) This point represents the flows from sub-basins OS2c and PR-3 that have been collected in the roadside ditch that runs along the south side of the proposed roadway. The roadside ditch along this stretch will be protected with Type L Rip Rap. These flows travel northeast in the ditch before being collected in the proposed private 30-inch FES at Design Point 11 (DP-11). These flows are conveyed under the proposed roadway to the north, discharging via a proposed private 30-inch FES before continuing along historic paths.

Design Point 12 (Rational (Q_5 = 8.7 cfs, Q_{100} = 46.8 cfs) HEC-HMS (Q_5 = 2.7 cfs, Q_{100} = 12.3 cfs)) (sub-basins: OS2d, OS2e, PR-4; Area: 34.3 Ac.) (Slopes: 5 to 60%) This point represents the flows from sub-basins OS2d, OS2e and PR-4 that have been collected in the roadside ditch that runs along the south side of the proposed roadway. The roadside ditch along this stretch will be protected with Type L Rip Rap. These flows travel northeast in the ditch before being collected in the proposed private 36-inch FES at Design Point 12 (DP-12). These flows are conveyed under the proposed roadway to the north, discharging via a proposed private 36-inch FES before continuing along historic paths.

Design Point 13 (Rational (Q_5 = 14.4 cfs, Q_{100} = 78.4 cfs) HEC-HMS (Q_5 = 3.7 cfs, Q_{100} = 17.0 cfs)) (sub-basin: PR-6; Area: 44.7 Ac.) (Slopes: 5 to 60%) This point represents the flows from sub-basin PR-6a that has been collected in the roadside ditch that runs along the south side of the proposed roadway. The roadside ditch along this stretch will be protected with Type L Rip Rap. These flows travel northeast in the ditch before being collected in the proposed private Type C Inlet at Design Point 13 (DP-13). These flows are conveyed under the proposed roadway to the north via proposed private 30" RCP, to be combined with the flows collected at Design Point 17 (DP-17).

Design Point 14 (Rational (Q_5 = 5.6 cfs, Q_{100} = 31.9 cfs) HEC-HMS (Q_5 = 1.2 cfs, Q_{100} = 6.1 cfs)) (sub-basin: OS3a, PR-6b; Area: 18.3 Ac.) (Slopes: 5 to 10%) This point represents the flows from sub-basins OS3a, and PR-6b that have been collected in the roadside ditch that runs along the south side of the proposed roadway downstream of DP-13. The roadside ditch along this stretch will be protected with Type L Rip Rap. These flows travel northeast in the ditch before being collected in the proposed private 30" FES at Design Point 14 (DP-14). These flows are conveyed under the proposed roadway to the west via proposed private 30" RCP.

Design Point 15 (Rational (Q_5 = 27.5 cfs, Q_{100} = 153.8 cfs) HEC-HMS (Q_5 = 11.8 cfs, Q_{100} = 58.5 cfs)) (sub-basins: OS1a, OS1b, OS2a, OS2b, OS2c, OS2d, OS2e, PR-1, PR-2, PR-3, PR-4; Area: 216.5 Ac.) (Slopes: 5 to 50%) This point represents the outfall from the proposed private swale located along the northwestern border of the proposed private pond (pond 1). The combined flows from sub-basins OS1a, OS1b, OS2a, OS2b, OS2c, OS2d, OS2e, PR-1, PR-2, PR-3, and PR-4 are collected in the proposed swale and diverted around pond 1 toward the proposed stilling basin at Design Point 17. The proposed swale will be lined with Type L Rip Rap.

Design Point 16a (Rational (Q_5 = 5.3 cfs, Q_{100} = 11.2 cfs) HEC-HMS (Q_5 = 1.5 cfs, Q_{100} = 5.6 cfs)) (sub-basins: PR-8a; Area: 5.2 Ac.) (Slopes: 2.8 to 6%) This point represents the Proposed Private Type-C inlet located on the north side of the proposed roadway southwest of the proposed pond (pond 1). All flows from the proposed roadway will drain to the north and into the northern roadside ditch. All runoff from the proposed roadway will drain to the Type C inlet at Design Point 16a. The flows collected in the inlet will be conveyed downstream towards Design Point EDB-IN via proposed private 18-inch RCP pipe.

Design Point 16b (Rational (Q_5 = 13.8 cfs, Q_{100} = 59.2 cfs) HEC-HMS (Q_5 = 4.9 cfs, Q_{100} = 22.0 cfs)) (sub-basins: PR-6, PR-8a; Area: 49.96 Ac.) (Slopes: 2.8 to 6%) This point represents the combination of flows from design points 13 and 16a. The combined flows will be conveyed downstream towards Design Point EDB-IN via proposed private 18-inch RCP pipe.

Design Point EDB-IN (Rational (Q_5 = 14.8 cfs, Q_{100} = 63.4 cfs) HEC-HMS (Q_5 = 5.1 cfs, Q_{100} = 22.4 cfs)) (sub-basin: PR-6, PR-8a, PR-8b, PR-9; Area: 52.78 Ac.) (Slopes: 2.8 to 50%) This point represents the total discharge into the Proposed Private Extended Detention Basin (EDB). Flows will be treated for water quality and released at such a rate that the overall discharge from the site does not increase under proposed conditions.

Design Point EDB-OUT (Q_5 = 0.8 cfs, Q_{100} = 3.5 cfs) (sub-basins: PR-6, PR-8a, PR-8b, PR-9; Area: 52.78 Ac.) (Slopes: 2.8 to 50%) This point represents the discharge from the EDB. The discharge from pond 1 will be routed downstream via proposed private 18-inch RCP pipe that will convey the flows to the proposed private stilling basin located at Design Point 17.

Design Point 17 (Q_5 = 31.7 cfs, Q_{100} 176.3 = cfs) (design points: DP-EDB-OUT, DP-14, DP-15; Area: 287.6 Ac.) (Slopes: 2.8 to 50%) This point represents the proposed private stilling basin located north of proposed pond 1. Flows from Design Points 13, 14, and EDB-OUT all discharge to the stilling basin which will release the flows at a velocity of 4.02 ft/sec.

Design Point 18 (Rational (Q_5 = 37.5 cfs, Q_{100} = 212.1 cfs) HEC-HMS (Q_5 = 13.3 cfs, Q_{100} = 66.3 cfs)) (sub-basins: DP-18, OS3b, PR-10; Area: 307.3 Ac.) (Slopes: 2.8 to 60%) This point represents the total discharge from the site. Stormwater runoff from the site will continue north in the existing channel before draining into Hay Creek, a tributary of Beaver Creek.

Design Point HC (Q_{100} = 127 cfs) This point represents the stormwater flows in Hay Creek at the proposed private dual 42" culverts to the north of the site. The proposed private dual 42" culverts convey the flows in Hay Creek under the proposed access road. Culvert calculations for the existing and proposed culvert at DP-HC can be found in Appendix A. The proposed flows in Hay Creek come from the HEC-2 analysis provided by the Regional Floodplain Administrator. The HEC-2 results are included in **appendix C**.

Notes:

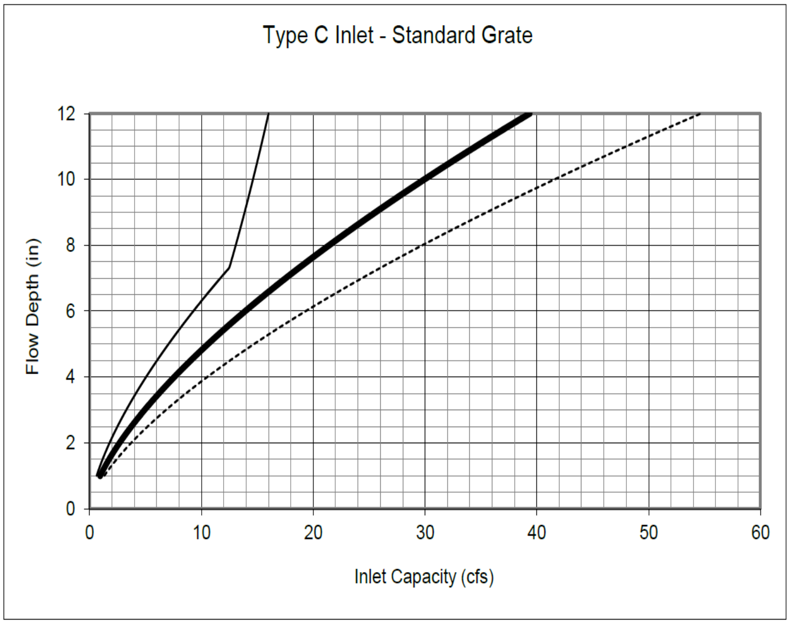
- **MHFD-Detention Analysis for the proposed detention pond (pond 1) which will be constructed as part of the Improvements associated with Hay Creek Valley can be found in Appendix A of this report.**
- **Tables summarizing inlet sizes and capacities, storm pipe sizes and capacities and swale capacities for the proposed improvements can be found in Appendix A and/or in the following section.**
- **All ponds and associated infrastructure are to be owned and maintained by the HOA.**
- **The ratio of the total site discharge in proposed conditions vs existing conditions is 1.0, representing no significant increase in flows in the proposed condition.**
- **The hydraulic model for Beaver Creek indicated approximately 127 cfs from the entire Hay Creek tributary basin which contains the development. We therefore believe the above hydrological analysis with the Rational Method to be quite conservative.**

V. Hydraulic Analysis

a. *Proposed Inlets*

INLET SUMMARY HAY CREEK VALLEY										
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**					
16	**PR-7, PR-8a**	6.32	3	C	**SUMP**	5.4	**5.4**	**0.0**	12.3	**12.3**

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



Inlet Overflow Routing	
Inlet	***Overflow Routing Under Sump Inlet Blockage Conditions***
16	Blockage of this inlet will cause runoff to surcharge the sump and direct runoff into the proposed Extended Detention Basin.

b. Swales

The initial swale analysis was performed using Hydraflow Express to determine flow depths and velocities. Per the El Paso County DCM Volume 1, Chapter 6, section 6.5.2. Channel Velocity, "***Concrete, riprap, or soil cement linings as approved by the City/County shall be used where channel bottom velocities exceed 6.0 ft/sec.***" Table 10-4 is included in Appendix B for reference. Further analysis was performed using the Federal Highway Administration (FHWA) Hydraulic Toolbox for those sections having flow velocities initially calculated to be greater than 6 ft/sec. This tool helps determine the stability of each proposed swale cross section based on the flows, cross section, and type of material used for the swale. Concentrated stormwater flows that drain along the existing drainage path through sub-basin PR-1 will be collected in a proposed swale north of the proposed roadside ditch. A 25-foot drainage easement will extend from proposed lot 1 to lot 9 along the existing drainage path to ensure that future developments do not impede the flow of stormwater through the site. The swale calculations have been applied to the most critical swale scenarios for the Site. The table below summarizes the various swales included as part of these improvements.

Swale Capacities HAY CREEK VALLEY						
Design Point	***Armoring Type***	***Anticipated Slope %***	***CHANNEL CAPACITY MAJOR STORM (cfs)***	***Q(100) TOTAL FLOW (cfs)***	***Q(100) VELOCTIY (FT/S)***	***Q100 Flow Depth (ft)***
10	Type L Rip Rap*	6.0%	**9.6**	9.6	2.92	**0.97**
11	Vegetation	2.8%	**4.6**	4.6	1.78	**0.86**
12	Type L Rip Rap*	4.8%	**12.3**	12.3	2.85	**1.11**
13	Type L Rip Rap*	3.6%	**17.0**	17.0	2.79	**1.32**
14	Type L Rip Rap*	2.8%	**6.1**	6.1	2.65	**0.87**
15	Type L Rip Rap*	4.5%	**58.5**	58.1	4.06	**1.14**
16 (2.8%)	Type L Rip Rap*	2.8%	**5.6**	5.6	1.93	**0.91**
16 (3.6%)	Type L Rip Rap*	3.6%	**5.6**	5.6	2.59	**0.86**
16 (4.8%)	Type L Rip Rap*	4.8%	**5.6**	5.6	2.24	**0.80**
16 (6.0%)	Type L Rip Rap*	6.0%	**5.6**	5.6	2.02	**0.76**

* Turf Reinforcement Mat (TRM) may be used in place of Rip Rap.

c. Driveway Culverts

Upon the development of the proposed lots, it will be necessary to place culverts along the roadside ditches to convey flows through driveways. Initial calculations for driveway culvert sizing at each lot is summarized in the table below:

Driveway Culvert Sizes HAY CREEK VALLEY			
Lot	***Q(100) TOTAL FLOW IN DITCH (cfs)***	***Anticipated Slope %***	***Minimum Culvert Inside Diameter (in)***
1-10	12.3	2.8%	**24**
11-12	9.6	6.0%	**18**
13	4.6	2.8%	**18**
14-16	12.3	4.8%	**24**
17-19	17.0	2.8%	**24**
20	6.1	2.8%	**18**

d. Detention

Due to the development of the site and the resulting increase in imperviousness, detention will be required to limit the 100-year discharge to historic rates. Pond 1 has been designed to over detain stormwater flows to reduce the total site discharge to predevelopment levels. The proposed private Extended Detention Basin (EDB) will provide detention and water quality treatment for stormwater runoff generated within the Hay Creek Valley site. Pond 1 will outfall to a stilling basin to the north. Flows from the pond will combine with flows from Design Points 14 and 15 in the stilling basin which will release the flows with a velocity of 4.02 ft/sec during the 100-year storm event which is considered by the DCM to be stable for the major storm event in the context of open channel flows. The stilling basin will provide a suitable outfall for the concentrated flows into the existing natural swale. The proposed stilling basin has a depth of 24-inches and, when at max capacity, will infiltrate within 40 hours. Infiltration rates have been determined using the f_0 value for type B soils in Table 6-7 of the MHFD Drainage Criteria Manual Volume 1 (below). Initial design information including calculations are included in Appendix A. Calculations will be finalized with the Final Drainage Report. The table below summarizes the detention provided for this development.

Proposed Pond Summary HAY CREEK VALLEY								
Pond	Tributary Area	% Impervious	Pre-Development Peak		Pond Outflow		Pre vs. Post Ratio	
			Q5	Q100	Q5	Q100	Q5	Q100
Pond 1	52.78	12.53	11.4	52.2	0.8	3.5	0.1	0.1

Table 6-7. Recommended Horton's equation parameters

NRCS Hydrologic Soil Group	Infiltration (inches per hour)		Decay Coefficient—*a*
	Initial—f_i	Final—f_o	
A	5.0	1.0	0.0007
B	4.5	0.6	0.0018
C	3.0	0.5	0.0018
D	3.0	0.5	0.0018

Emergency Overflow

Pond 1: If the emergency overflow weir receives flows, these flows will continue downstream along the existing natural swale and drain into Hay Creek.

VI. Storm Water Quality

Per the DCM Volume 1, Chapter 7, Section 2, El Paso County recommends the MHFD Four Step Process for receiving water protection that focuses on reducing runoff by disconnecting impervious area, eliminating "unnecessary" impervious area and encouraging infiltration into soils that are suitable, treat and slowly release the WQCV, stabilize stream channels, and implement source controls. The four-step process has been completed below.

Step 1: **Employ Runoff Reduction Practices.**

- The low-density nature of this development and the fact that none of the streets will have curb and gutter, means that most, if not all, runoff from impervious surfaces will sheet flow across pervious areas to grass lined swales.

Step 2: **Stabilize Drainageways.**

- The site is in the Beaver Creek Drainage Fee Basin. Drainage fees, to be paid by the relevant Hay Creek Valley developers at the time of platting, will help fund proposed channel improvements. Information on planned future improvements to the Beaver 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). 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. The lots containing large lot residential sites are excluded from WQ treatment per section I.7.1.b.5 of the ECM.

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 separate submittals by the various developments. These 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 Map (FIRM) 08041CO267 G***, effective date December 7, 2018, published by the Federal Emergency Management Agency (FEMA), Hay Creek, a Tributary to Beaver Creek runs along the northern bound of the Hay Creek Valley area and has designated 100-year floodplain. The developed portion of the site is generally not touched by the 100 year floodplain, however the road improvements associated with this site will cross the FEMA floodplain at the location where the site access easement crosses Hay Creek. Draft model backed BFEs for this area have been developed as part of Phase 1 for the ongoing El Paso County, CO, Risk MAP Project. The data have been reviewed and approved through FEMA’s QA/QC process (May 11, 2022) and are currently in the MIP (Case No. 19-08-0037s). This data is considered "FEMA APPROVED BFEs" This will need to be shown on the prelim plan and plat. Refer to the map in Appendix C.

IX. Fee Development

a. UNDEVELOPED PLATTABLE LAND

The Hay Creek Valley site is located within the Beaver Creek Drainage Fee Basin and within previously unplatted land. The 2023 Drainage Basin Fees for the Beaver Creek Drainage Fee Basin are: $13,797/impervious acre for the Drainage Fee and $0.00/impervious acre for the Bridge Fee. Per the ***El Paso County Engineering Criteria Manual,*** Appendix L, Section 3.10.1a Fee Reductions for Low Density Lots, with the site being developed into 5-acre lots, drainage fees may be reduced by 25%.

Hay Creek
Final Drainage Report
2023 Drainage and Bridge Fees

	Platted Area (Acres)	Imperviousness (%)	Platted Area (Imp. ac.)	Fee/ Imp. Acre	Fee Due	Drainage Fee Reduction	Fee Due at Platting
Drainage Fee	214.63	8.11	17.406	$13,797.00	$240,150.58	$60,037.65	$180,112.93
Bridge Fee	214.63	8.11	17.406	$0.00	$0.00	$0.00	$0.00
TOTAL							$180,112.93

Cost Estimate

Table 12.1

Engineer's Estimate of Probable Construction Costs				
BEAVER CREEK				
HAY CREEK VALLEY				
Private Non-Reimbursable				
Item	Unit	Quantity	Unit Cost	Extension
18" RCP/HP	LF	185	$76.00	$14,060.00
30" RCP/HP	LF	575	$114.00	$65,550.00
36" RCP/HP	LF	385	$140.00	$53,900.00
18" FES	EA	1	$456.00	$456.00
30" FES	EA	6	$684.00	$4,104.00
36" FES	EA	4	$840.00	$3,360.00
Type C Inlet	EA	1	$5,611.00	$5,611.00
STM MH	EA	3	$7,734.00	$23,202.00
RIPRAP	CY	2,740	$135.00	$369,900.00
			Sub Total	$540,143.00
			10% Contingency	$54,014.30
			TOTAL:	**$594,157.30**

Engineer's Estimate of Probable Construction Costs				
BEAVER CREEK				
HAY CREEK VALLEY				
Permanent BMP (EDB): Private Non-reimbursable				
Item	Unit	Quantity	Unit Cost	Extension
DETENTION POND GRADING	EA	1	$35,000.00	$35,000.00
2' TRICKLE CHANNEL	LF	316	$200.00	$63,200.00
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
STILLING BASIN	EA	1	$30,000.00	$30,000.00
			Sub Total	$213,200.00
			10% Contingency	$21,320.00
			TOTAL:	**$234,520.00**
			Overall Total	**$828,677.30**

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.

X. Summary

This report demonstrates that the proposed infrastructure associated with Hay Creek Valley 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 generally remain the same in post-development conditions (Rational (Q_5 = 37.5 cfs, Q_{100} = 212.1 cfs) HEC-HMS (Q_5 = 13.8 cfs, Q_{100} = 69.8 cfs)) as in pre-development conditions (Rational (Q_5 = 35.0 cfs, Q_{100} = 210.9 cfs) HEC-HMS (Q_5 = 11.2 cfs, Q_{100} = 69.9 cfs)). These proposed improvements should not adversely affect downstream or surrounding developments and are in conformance with the pertinent studies for the area.

XI. References

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

6. Appendices

APPENDIX A

HYDROLOGIC AND HYDRAULIC CALCULATIONS

Rational Method - Existing Conditions

Project Name:	Hay Creek
Project Location:	El Paso County, Colorado
Designer	WCG
Notes:	EXISTING CONDITIONS

Avg. Channel Velocity 4 ft/s (If specific channel vel is used, this will be ignored)

Avg. 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: 5-Acre Lots (7% Impervious)			Pavement (100% Impervious)			Undeveloped/Pervious Areas (2% Impervious)			Composite			Flow Lengths										Tc	Rainfall Intensity & Rational Flow Rate						
Sub-basin	**Comments**	sf	acres	Sq. Mi.	Soil Group	C5	C100	Area (SF)	C5	C100	Area (SF)	C5	C100	Area	C5	C100	Percent Impervious	Initial ft	True Initial Length ft	Channel ft	True Channel Length ft	Average (decimal) Slope	Initial Tc (min)	Average (%) Slope	Channel Flow Type (See Key above) Ground Type	Velocity (ft/s)	Channel Tc (min)	Total (min)	i5 in/hr	Q5 cfs	HEC-HMS Q5 cfs	i100 in/hr	Q100 cfs	HEC-HMS Q100 cfs	**Sub-basin**
EX-OS1a		407292	9.35	0.0146	B	0.12	0.39	407292	0.90	0.96		0.09	0.36		0.12	0.39	7.00%	300	300	672	672	0.10	14.23	9.9	4	2.20	5.09	19.31	3.07	**3.5**	**0.8**	5.15	**18.9**	**4.1**	*EX-OS1a*
EX-OS1b		2579029	59.21	0.0925	B	0.12	0.39	1173596	0.90	0.96		0.09	0.36	1405433	0.10	0.37	4.28%	300	300	2754	2754	0.07	16.48	6.7	4	1.81	25.33	41.80	1.99	**12.3**	**2.6**	3.34	**74.6**	**15.7**	*EX-OS1b*
EX-OS2a		692771	15.90	0.0248	B	0.12	0.39		0.90	0.96	25423	0.09	0.36	667348	0.12	0.38	5.60%	300	300	84	84	0.31	9.70	31.3	4	3.50	0.40	10.10	4.09	**7.8**	**1.5**	6.87	**42.0**	**8.0**	*EX-OS2a*
EX-OS2b		120503	2.77	0.0043	B				0.90	0.96	6033	0.09	0.36	114470	0.13	0.39	6.91%	300	300	113	113	0.15	12.31	14.8	4	2.69	0.70	13.00	3.69	**1.3**	**0.3**	6.20	**6.7**	**1.4**	*EX-OS2b*
EX-OS2c		137929	3.17	0.0049	B	0.12	0.39		0.90	0.96	6548	0.09	0.36	131381	0.13	0.39	6.65%	268	268	0	0	0.17	11.09	17.2	4	2.90	0.00	11.09	3.94	**1.6**	**0.3**	6.62	**8.2**	**1.6**	*EX-OS2c*
EX-OS3		354850	8.15	0.0127	B	0.12	0.39		0.90	0.96	475	0.09	0.36	354375	0.09	0.36	2.13%	300	300	265	265	0.16	12.54	15.8	4	2.78	1.59	14.12	3.56	**2.7**	**0.2**	5.98	**17.7**	**2.0**	*EX-OS3*
EX-1		2441168	56.04	0.0876	B	0.12	0.39		0.90	0.96	30061	0.09	0.36	2411107	0.10	0.37	3.21%	300	300	4763	4763	0.05	18.23	5.0	4	1.57	50.72	68.94	1.44	**8.2**	**1.6**	2.43	**50.4**	**9.9**	*EX-1*
EX-2		2100638	48.22	0.0754	B	0.12	0.39		0.90	0.96	46438	0.09	0.36	2054200	0.11	0.37	4.17%	300	300	2795	2795	0.06	16.66	6.4	4	1.77	26.31	42.96	1.96	**10.3**	**2.0**	3.29	**59.7**	**11.2**	*EX-2*
EX-3		2684942	61.64	0.0963	B	0.12	0.39		0.90	0.96	31890	0.09	0.36	2653052	0.10	0.37	3.16%	300	300	2002	2002	0.11	13.86	11.4	4	2.36	14.12	27.97	2.52	**15.6**	**2.3**	4.23	**96.6**	**14.7**	*EX-3*
EX-4		256265	5.88	0.0092	B	0.12	0.39		0.90	0.96	0	0.09	0.36	256265	0.09	0.36	2.00%	206	206	0	0	0.29	8.53	28.6	4	3.50	0.00	8.53	4.35	**2.3**		7.30	**15.6**		*EX-4*
EX-5		1865454	42.82	0.0669	B	0.12	0.39		0.90	0.96	18117	0.09	0.36	1847337	0.10	0.37	2.95%	300	300	1427	1427	0.11	14.18	10.7	4	2.29	10.39	24.56	2.71	**11.4**	**1.5**	4.55	**71.8**	**10.0**	*EX-5*
DESIGN POINTS	*Sub-basins*																																		*DESIGN POINTS*
1	*EX-OS1a*	407292	9.35	0.0146	B	0.12	0.39	407292	0.90	0.96	0	0.09	0.36	0	0.12	0.39	7.0%	300	300	672	672	0.10	14.23	9.9	4	2.20	5.09	19.31	3.07	**3.5**	**0.8**	5.15	**18.9**	**4.1**	*1*
2	*EX-OS1b*	2579029	59.21	0.0925	B	0.12	0.39	1173596	0.90	0.96	0	0.09	0.36	1405433	0.10	0.37	4.3%	300	300	2754	2754	0.07	16.48	6.7	4	1.81	25.33	41.80	1.99	**12.3**	**2.6**	3.34	**74.6**	**15.7**	*2*
3	*EX-OS2a*	692771	15.90	0.0248	B	0.12	0.39		0.90	0.96	25423	0.09	0.36	667348	0.12	0.38	5.6%	300	300	84	84	0.31	9.70	31.3	4	3.50	0.40	10.10	4.09	**7.8**	**1.5**	6.87	**42.0**	**8.0**	*3*
4	*EX-OS2b*	120503	2.77	0.0043	B	0.12	0.39		0.90	0.96	6033	0.09	0.36	114470	0.13	0.39	6.9%	300	300	113	113	0.15	12.31	14.8	4	2.69	0.70	13.00	3.69	**1.3**	**0.3**	6.20	**6.7**	**1.4**	*4*
5	*EX-OS2c*	137929	3.17	0.0049	B	0.12	0.39		0.90	0.96	6548	0.09	0.36	131381	0.13	0.39	6.7%	268	268	0	0	0.17	11.09	17.2	4	2.90	0.00	11.09	3.94	**1.6**	**0.3**	6.62	**8.2**	**1.6**	*5*
6	*EX-OS3*	354850	8.15	0.0127	B	0.12	0.39		0.90	0.96	475	0.09	0.36	354375	0.09	0.36	2.1%	300	300	265	265	0.16	12.54	15.8	4	2.78	1.59	14.12	3.56	**2.7**	**0.2**	5.98	**17.7**	**2.0**	*6*
7	*EX-4*	256265	5.88	0.0092	B	0.12	0.39		0.90	0.96	0	0.09	0.36	256265	0.09	0.36	2.0%	206	206	0	0	0.29	8.53	28.6	4	3.50	0.00	8.53	4.35	**2.3**		7.30	**15.6**		*7*
8	*EX-OS1b, EX-OS2a, EX-2*	5372438	123.33	0.1927	B	0.12	0.39	1173596	0.90	0.96	71861	0.09	0.36	4126981	0.11	0.37	4.4%	300	300	2795	2795	0.06	16.67	6.4	4	1.77	26.31	42.97	1.96	**26.1**	**5.4**	3.29	**153.1**	**30.9**	*8*
9	*EX-OS2b, EX-OS2c, EX-3*	2943374	67.57	0.1056	B	0.12	0.39		0.90	0.96	44471	0.09	0.36	2898903	0.10	0.37	3.5%	300	300	2002	2002	0.11	13.82	11.4	4	2.36	14.12	27.93	2.52	**17.6**	**2.9**	4.24	**106.5**	**17.4**	*9*
10	*EX-OS3, EX-5*	2220304	50.97	0.0796	B	0.12	0.39		0.90	0.96	18592	0.09	0.36	2201712	0.10	0.37	2.8%	300	300	1427	1427	0.11	14.19	10.7	4	2.29	10.39	24.58	2.71	**13.5**	**1.8**	4.55	**85.3**	**11.9**	*10*
11	*DP-8, DP-9, DP-10, EX-OS1a, EX-1*	13384576	307.27	0.4801	B	0.12	0.39	1580888	0.90	0.96	164985	0.09	0.36	11638703	0.10	0.37	3.8%	300	300	8062	8062	0.05	18.17	5.0	4	1.57	85.84	104.01	1.09	**35.0**	**11.2**	1.84	**210.9**	**69.9**	*11*

Rational Method - Proposed Conditions

Project Name:	Hay Creek
Project Location:	El Paso County, Colorado
Designer	WCG
Notes:	Proposed Condition

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

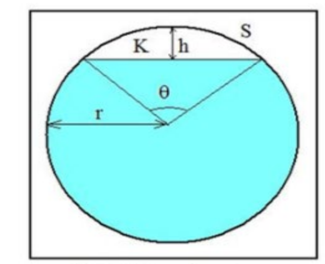
Heavy Meadow	2
Tillage/Field	3
Short Pasture and Lawns	4
Nearly Bare Ground	5
Grassed Waterway	6
Paved Areas	7

		Area				Rational 'C' Values											
						7%			100%			2%					
Sub-basin	**Comments**				Soil Group	5-Acre Lots (7% Impervious)			Pavement (100% Impervious)			Undeveloped/Pervious Areas (2% Impervious)			Composite		Percent Impervious
		sf	acres	Sq. Mi.		C5	C100		C5	C100	Area (SF)	C5	C100	Area	C5	C100	
OS1a		407292	9.35	0.0146	B	0.12	0.39	407292	0.90	0.96		0.09	0.36		0.12	0.39	7.00%
OS1b		2579029	59.21	0.0925	B	0.12	0.39	1173596	0.90	0.96		0.09	0.36	1405433	0.10	0.37	4.28%
OS2a		218316	5.01	0.0078	B	0.12	0.39		0.90	0.96	6435	0.09	0.36	211881	0.11	0.38	4.89%
OS2b		373332	8.57	0.0134	B	0.12	0.39		0.90	0.96	13773	0.09	0.36	359559	0.12	0.38	5.62%
OS2c		99203	2.28	0.0036	B	0.12	0.39		0.90	0.96	5222	0.09	0.36	93981	0.13	0.39	7.16%
OS2d		120503	2.77	0.0043	B	0.12	0.39		0.90	0.96	6033	0.09	0.36	114470	0.13	0.39	6.91%
OS2e		137929	3.17	0.0049	B	0.12	0.39		0.90	0.96	6548	0.09	0.36	131381	0.13	0.39	6.65%
OS3a		212463	4.88	0.0076	B	0.12	0.39		0.90	0.96		0.09	0.36	212463	0.09	0.36	2.00%
OS3b		143157	3.29	0.0051	B	0.12	0.39		0.90	0.96		0.09	0.36	143157	0.09	0.36	2.00%
PR-1		3135061	71.97	0.1125	B	0.12	0.39	3135061	0.90	0.96		0.09	0.36		0.12	0.39	7.00%
PR-2		700274	16.08	0.0251	B	0.12	0.39	700274	0.90	0.96		0.09	0.36		0.12	0.39	7.00%
PR-3		425946	9.78	0.0153	B	0.12	0.39	425946	0.90	0.96		0.09	0.36		0.12	0.39	7.00%
PR-4		1235031	28.35	0.0443	B	0.12	0.39	1235031	0.90	0.96		0.09	0.36		0.12	0.39	7.00%
PR-5		255265	5.86	0.0092	B	0.12	0.39	255265	0.90	0.96		0.09	0.36		0.12	0.39	7.00%
PR-6		1949910	44.76	0.0699	B	0.12	0.39	1949910	0.90	0.96		0.09	0.36	0	0.12	0.39	7.00%
PR-7		585132	13.43	0.0210	B	0.12	0.39	585132	0.90	0.96		0.09	0.36		0.12	0.39	7.00%
PR-8a		226357	5.20	0.0081	B	0.12	0.39		0.90	0.96	129912	0.09	0.36	96445	0.55	0.70	58.24%
PR-8b		17696	0.41	0.0006	B	0.12	0.39		0.90	0.96	17173	0.09	0.36	523	0.88	0.94	97.10%
PR-9		105045	2.41	0.0038	B	0.12	0.39		0.90	0.96		0.09	0.36	130492	0.11	0.45	2.48%
PR-10		713346	16.38	0.0256	B	0.12	0.39		0.90	0.96	11977	0.09	0.36	701369	0.10	0.37	3.65%
DESIGN POINTS	*Sub-Basins*																
1	*OS1a*	407292	9.35	0.0146	B	0.12	0.39	407292	0.90	0.96	0	0.09	0.36	0	0.12	0.39	7.00%
2	*OS1b*	2579029	59.21	0.0925	B	0.12	0.39	1173596	0.90	0.96	0	0.09	0.36	1405433	0.10	0.37	4.28%
3	*OS2a*	218316	5.01	0.0078	B	0.12	0.39	0	0.90	0.96	6435	0.09	0.36	211881	0.11	0.38	4.89%
4	*OS2b*	373332	8.57	0.0134	B	0.12	0.39	0	0.90	0.96	13773	0.09	0.36	359559	0.12	0.38	5.62%
5	*OS2c*	99203	2.28	0.0036	B	0.12	0.39	0	0.90	0.96	5222	0.09	0.36	93981	0.13	0.39	7.16%
6	*OS2d, OS2e*	258432	5.93	0.0093	B	0.12	0.39	0	0.90	0.96	12581	0.09	0.36	245851	0.13	0.39	6.77%
7	*OS3a*	212463	4.88	0.0076	B	0.12	0.39	0	0.90	0.96	0	0.09	0.36	212463	0.09	0.36	2.00%
8	*OS3b*	143157	3.29	0.0051	B	0.12	0.39	0	0.90	0.96	0	0.09	0.36	143157	0.09	0.36	2.00%
9	*PR-5*	255265	5.86	0.0092	B	0.12	0.39	255265	0.90	0.96	0	0.09	0.36	0	0.12	0.39	7.00%
10	*OS2b, PR-2*	1073606	24.65	0.0385	B	0.12	0.39	700274	0.90	0.96	13773	0.09	0.36	359559	0.12	0.39	6.52%
11	*OS2c, PR-3*	525149	12.06	0.0188	B	0.12	0.39	425946	0.90	0.96	5222	0.09	0.36	93981	0.12	0.39	7.03%
12	*OS2d, OS2e, PR-4*	1493463	34.29	0.0536	B	0.12	0.39	1235031	0.90	0.96	12581	0.09	0.36	245851	0.12	0.39	6.96%
13	*PR-6*	1949910	44.76	0.0699	B	0.12	0.39	1949910	0.90	0.96	0	0.09	0.36	0	0.12	0.39	7.00%
14	*OS3a, PR-7*	797595	18.31	0.0286	B	0.12	0.39	585132	0.90	0.96	0	0.09	0.36	212463	0.11	0.38	5.67%
15	*OS1a, OS1b, OS2a, PR-1, DP-10, DP-11, DP-12*	9431916	216.53	0.3383	B	0.12	0.39	7077200	0.90	0.96	38011	0.09	0.36	2316705	0.12	0.38	6.15%
16a	*PR-8a*	226357	5.20	0.0081	B	0.12	0.39	0	0.90	0.96	129912	0.09	0.36	96445	0.55	0.70	58.24%
16b	*PR-6, PR-8a*	2176267	49.96	0.0781	B	0.12	0.39	1949910	0.90	0.96	129912	0.09	0.36	96445	0.17	0.42	12.33%
EDB-IN	*PR-6, PR-8a, PR-8b, PR-9*	2299008	52.78	0.0825	B	0.12	0.39	1949910	0.90	0.96	147085	0.09	0.36	227460	0.17	0.43	12.53%
EDB-OUT	*PR-6, PR-8a, PR-8b, PR-9*	2299008	52.78	0.0825	B	0.12	0.39	1949910	0.90	0.96	147085	0.09	0.36	227460	0.17	0.43	12.53%
17	*EDB-OUT, DP-14, DP-15*	12528519	287.62	0.4494	B	0.12	0.39	9612242	0.90	0.96	185096	0.09	0.36	2756628	0.13	0.39	7.29%
18	*DP-8, DP-18, PR-10*	13385022	307.28	0.4801	B	0.12	0.39	9612242	0.90	0.96	197073	0.09	0.36	3601154	0.12	0.39	7.04%
HC	*From PPRBD Regional floodplane Administrator*																

	Flow Lengths										Tc	Rainfall Intensity & Rational Flow Rate					
Sub-basin	Initial	True Initial	Channel	True Channel	Average (decimal)	Initial	Average (%)	Channel Flow Type (See Key above)	Velocity	Channel	Total	i5	Q5	HEC-HMS Q5	i100	Q100	HEC-HMS Q100
	ft	Length ft	ft	Length ft	Slope	Tc (min)	Slope	Ground Type	(ft/s)	Tc (min)	(min)	in/hr	cfs	cfs	in/hr	cfs	cfs
OS1a	300	300	672	672	0.10	14.23	9.9	4	2.20	5.09	19.31	3.07	**3.5**	**0.8**	5.15	**18.9**	**3.6**
OS1b	300	300	2754	2754	0.07	16.48	6.7	4	1.81	25.33	41.80	1.99	**12.3**	**2.6**	3.34	**74.6**	**14.2**
OS2a	300	300	203	203	0.25	10.54	24.8	4	3.49	0.97	11.51	3.88	**2.2**	**0.4**	6.52	**12.4**	**1.8**
OS2b	300	300	33	33	0.20	11.18	20.4	4	3.16	0.17	11.35	3.90	**4.0**	**0.7**	6.56	**21.6**	**3.2**
OS2c	280	280	0	0	0.35	8.91	35.0	4	3.50	0.00	8.90	4.28	**1.3**	**0.3**	7.19	**6.5**	**1.2**
OS2d	300	300	44	44	0.13	12.72	13.4	4	2.56	0.29	13.01	3.69	**1.3**	**0.3**	6.19	**6.7**	**1.1**
OS2e	285	285	0	0	0.15	11.87	15.4	4	2.75	0.00	11.86	3.83	**1.6**	**0.3**	6.44	**8.0**	**1.3**
OS3a	300	300	27	27	0.09	15.39	8.6	4	2.05	0.22	15.61	3.40	**1.5**	**0.1**	5.71	**10.1**	**0.9**
OS3b	300	300	195	195	0.22	11.24	22.0	4	3.28	0.99	12.22	3.79	**1.1**	**0.1**	6.36	**7.6**	**0.8**
PR-1	300	300	5455	5455	0.05	17.64	5.2	4	1.60	56.96	74.59	1.37	**11.9**	**4.4**	2.30	**65.2**	**20.2**
PR-2	300	300	576	576	0.12	13.54	11.5	4	2.37	4.04	17.58	3.21	**6.2**	**1.4**	5.40	**34.1**	**6.5**
PR-3	300	300	764	764	0.10	14.28	9.8	4	2.19	5.81	20.08	3.01	**3.6**	**0.8**	5.05	**19.4**	**3.8**
PR-4	300	300	1015	1015	0.10	14.09	1.0	4	0.70	24.17	38.25	2.10	**7.2**	**2.2**	3.53	**39.3**	**10.3**
PR-5	206	206	0	0	0.29	8.28	28.6	4	3.50	0.00	8.27	4.39	**3.1**		7.38	**17.0**	
PR-6	300	300	1504	1504	0.10	14.18	10.0	4	2.21	11.32	25.50	2.65	**14.4**	**3.7**	4.46	**78.4**	**17.0**
PR-7	300	300	1400	1400	0.10	14.18	10.0	4	2.21	10.54	24.72	2.70	**4.4**	**1.1**	4.53	**23.9**	**5.1**
PR-8a	300	300	3558	3558	0.05	10.08	4.8	4	1.53	38.67	48.74	1.81	**5.3**	**3.5**	3.04	**11.2**	**8.3**
PR-8b	50	50	0	0	0.03	1.98	3.0	4	1.21	0.00	5.00	5.10	**1.8**	**0.8**	8.58	**3.3**	**1.7**
PR-9	260	260	0	0	0.01	36.14	0.5	4	0.49	0.00	36.13	2.17	**0.6**		3.65	**4.0**	
PR-10	300	300	395	395	0.04	19.25	4.2	4	1.43	4.59	23.84	2.75	**4.7**	**0.6**	4.62	**28.2**	**3.4**
DESIGN POINTS		0		0													
1	300	300	672	672	0.10	14.23	9.9	4	2.20	5.09	19.31	3.07	**3.5**	**0.8**	5.15	**18.9**	**3.6**
2	300	300	2754	2754	0.07	16.48	6.7	4	1.81	25.33	41.80	1.99	**12.3**	**2.6**	3.34	**74.6**	**14.2**
3	300	300	203	203	0.25	10.54	24.8	4	3.49	0.97	11.51	3.88	**2.2**	**0.4**	6.52	**12.4**	**1.8**
4	300	300	33	33	0.20	11.18	20.4	4	3.16	0.17	11.35	3.90	**4.0**	**0.7**	6.56	**21.6**	**3.2**
5	280	280	0	0	0.35	8.91	35.0	4	3.50	0.00	8.90	4.28	**1.3**	**0.3**	7.19	**6.5**	**1.2**
6	300	300	44	44	0.13	12.74	13.4	4	2.56	0.29	13.02	3.69	**2.9**	**0.5**	6.19	**14.4**	**2.3**
7	300	300	27	27	0.09	15.39	8.6	4	2.05	0.22	15.61	3.40	**1.5**	**0.1**	5.71	**10.1**	**0.9**
8	300	300	195	195	0.22	11.24	22.0	4	3.28	0.99	12.22	3.79	**1.1**	**0.1**	6.36	**7.6**	**0.8**
9	206	206	0	0	0.29	8.28	28.6	4	3.50	0.00	8.27	4.39	**3.1**		7.38	**17.0**	
10	300	300	908	908	0.12	13.54	11.5	4	2.37	6.38	19.91	3.02	**9.0**	**2.1**	5.08	**48.8**	**9.6**
11	300	300	764	764	0.10	14.24	9.8	4	2.19	5.81	20.05	3.01	**4.5**	**1.0**	5.06	**24.0**	**4.6**
12	300	300	1059	1059	0.10	14.06	1.0	4	0.70	25.21	39.27	2.07	**8.7**	**2.7**	3.47	**46.8**	**12.3**
13	300	300	1504	1504	0.10	14.18	10.0	4	2.21	11.32	25.50	2.65	**14.4**	**3.7**	4.46	**78.4**	**17.0**
14	300	300	1400	1400	0.10	14.30	10.0	4	2.21	10.54	24.83	2.69	**5.6**	**1.2**	4.52	**31.9**	**6.1**
15	300	300	8302	8302	0.05	17.71	5.2	4	1.60	86.68	104.39	1.09	**27.5**	**11.8**	1.83	**153.8**	**58.5**
16a	300	300	3558	3558	0.05	10.08	4.8	4	1.53	38.67	48.74	1.81	**5.3**	**1.5**	3.04	**11.2**	**5.6**
16b	300	300	3558	3558	0.05	17.28	4.8	4	1.53	38.67	55.94	1.66	**13.8**	**4.9**	2.78	**59.2**	**22.0**
EDB-IN	300	300	3558	3558	0.05	17.22	4.8	4	1.53	38.67	55.88	1.66	**14.8**	**5.1**	2.79	**63.4**	**22.4**
EDB-OUT													**0.8**	**0.8**		**3.5**	**3.5**
17													**31.7**	**13.2**		**176.3**	**66.0**
18													**37.5**	**13.3**		**212.1**	**66.3**
HC																	**127.0**

INITIAL STORM SEWER CAPACITY CALCULATIONS - MANNINGS CHANNEL FLOW METHOD

Design Point	Notes	Max Q (Q100) Proposed	Flow Type / Capacity Analysis	Storm Pipe Calculated Max Q for Pipe (CFS)	Percent of Pipe Channel Capacity Used	n(full)	Slope (ft/ft)	n	Pipe Diameter (ft)	Width (ft) Box Culvert Only	Pipe Depth (inches)	Optimum Flow Depth (+/- 0.94 x D)	Θ (Radians)	A (Sq. Ft.)	Wetted Perimeter (ft)	Velocity at Max Pipe Capacity
10		9.6	Channel/Adequate	12.0	80%	0.013	0.012	0.013	1.5		18	1.41	0.990	1.724	3.970	6.99
11		4.6	Channel/Adequate	12.5	37%	0.013	0.013	0.013	1.5		18	1.41	0.990	1.724	3.970	7.28
12		12.3	Channel/Adequate	16.8	73%	0.013	0.005	0.013	2		24	1.88	0.990	3.065	5.293	5.47
13		17.0	Channel/Adequate	22.0	77%	0.013	0.040	0.013	1.5		18	1.41	0.990	1.724	3.970	12.76
14		6.1	Channel/Adequate	9.6	63%	0.013	0.008	0.013	1.5		18	1.41	0.990	1.724	3.970	5.59
16b		22.0	Channel/Adequate	47.4	46%	0.013	0.040	0.013	2		24	1.88	0.990	3.065	5.293	15.46



Partially Full Pipe Flow Parameters
(More Than Half Full)

$r = D/2$

$h = 2r - y$

(hydraulic radius)

$R = A/P$

(Manning Equation)

$Q = (1.49/n)(A)(R^{2/3})(S^{1/2})$

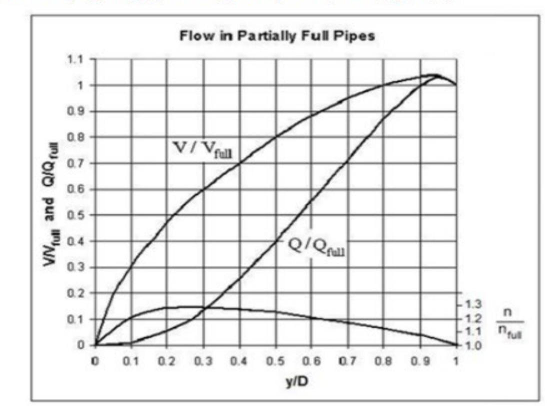
$V = Q/A$ P

$$\theta = 2 \arccos \left(\frac{r - h}{r}\right)$$

$$A = \pi r^2 - \frac{r^2(\theta - \sin\theta)}{2}$$

$$P = 2\pi r - r * \theta$$

Equation used for n/n_{full}: $\mathbf{n/n_{full} = 1.25 - (y/D - 0.5)*0.5}$ (for $0.5 \le y/D \le 1$)

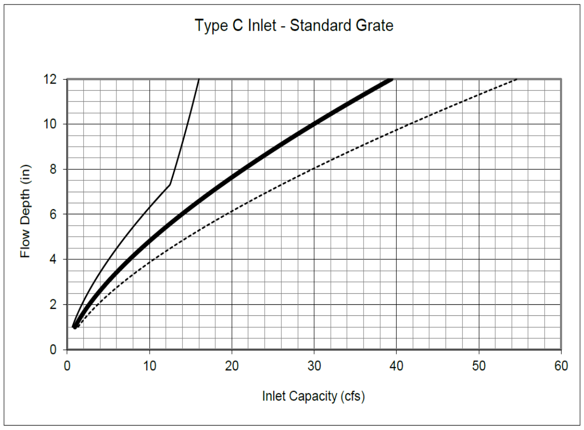


Flow In Partially Full Pipes

INLET SUMMARY

Hay Creek

DESIGN POINT or SUB-BASIN	SUB-BASINS	TOTAL AREA (AC)	INLET			Q(5) BYPASS FLOWS (cfs)	Q(5) TOTAL INFLOW	Q5 INLET CAPACTIY	Q(100) BYPASS FLOWS (cfs)	Q(100) TOTAL INFLOW (cfs)	MAX INLET CAPACITY	NOTES:
			SIZE (Ft.)	TYPE	CONDITION							
13	PR-6	44.76	3x3	C	SUMP	0.0	3.70	3.7	0.0	17.00	17.0	
16a	PR-8a	5.11	3x3	C	SUMP	0.0	1.50	1.5	0.0	5.60	5.6	



Culvert Report

DP-10 Culvert

Invert Elev Dn (ft)	=	7030.00
Pipe Length (ft)	=	40.00
Slope (%)	=	6.00
Invert Elev Up (ft)	=	7032.40
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

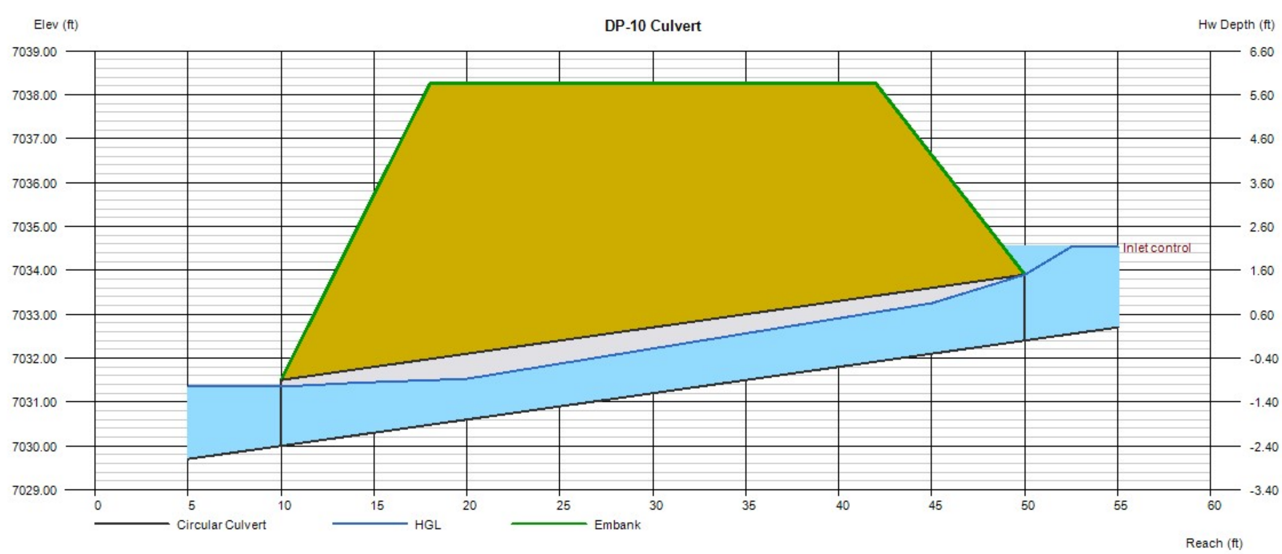
Top Elevation (ft)	=	7038.25
Top Width (ft)	=	24.00
Crest Width (ft)	=	30.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	9.60
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	9.60
Qpipe (cfs)	=	9.60
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	5.74
Veloc Up (ft/s)	=	6.36
HGL Dn (ft)	=	7031.35
HGL Up (ft)	=	7033.60
Hw Elev (ft)	=	7034.54
Hw/D (ft)	=	1.42
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Friday, Mar 24 2023

DP-11 Culvert

Invert Elev Dn (ft)	=	7000.00
Pipe Length (ft)	=	40.00
Slope (%)	=	2.80
Invert Elev Up (ft)	=	7001.12
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

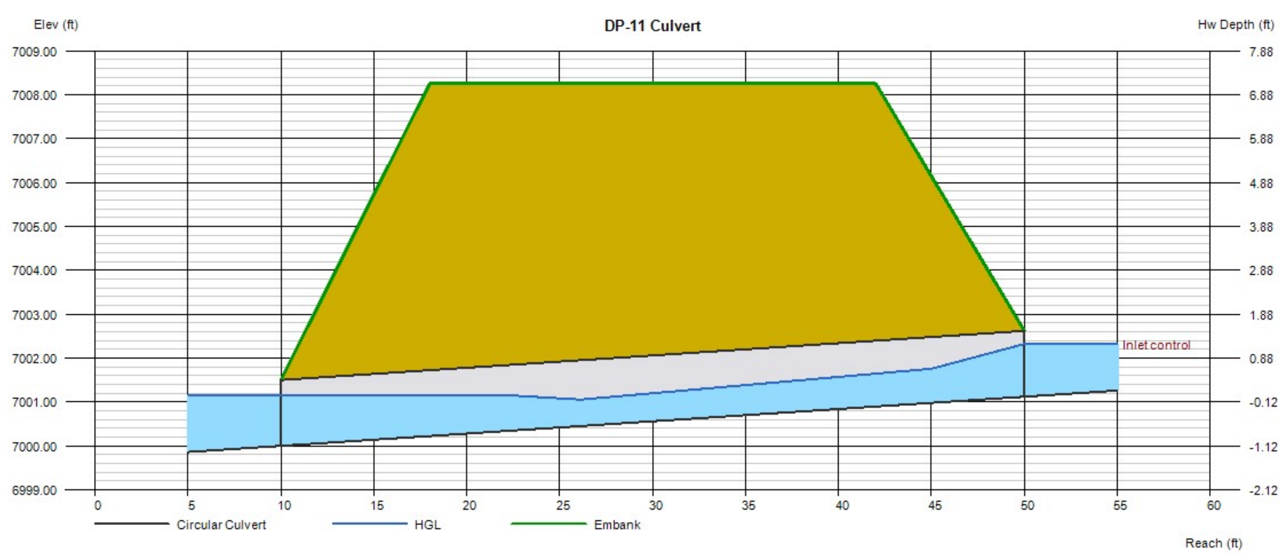
Top Elevation (ft)	=	7008.25
Top Width (ft)	=	24.00
Crest Width (ft)	=	30.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	4.60
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	4.60
Qpipe (cfs)	=	4.60
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.13
Veloc Up (ft/s)	=	4.63
HGL Dn (ft)	=	7001.16
HGL Up (ft)	=	7001.94
Hw Elev (ft)	=	7002.32
Hw/D (ft)	=	0.80
Flow Regime	=	Inlet Control



Culvert Report

DP-12 Culvert

Invert Elev Dn (ft)	=	6950.00
Pipe Length (ft)	=	40.00
Slope (%)	=	4.80
Invert Elev Up (ft)	=	6951.92
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

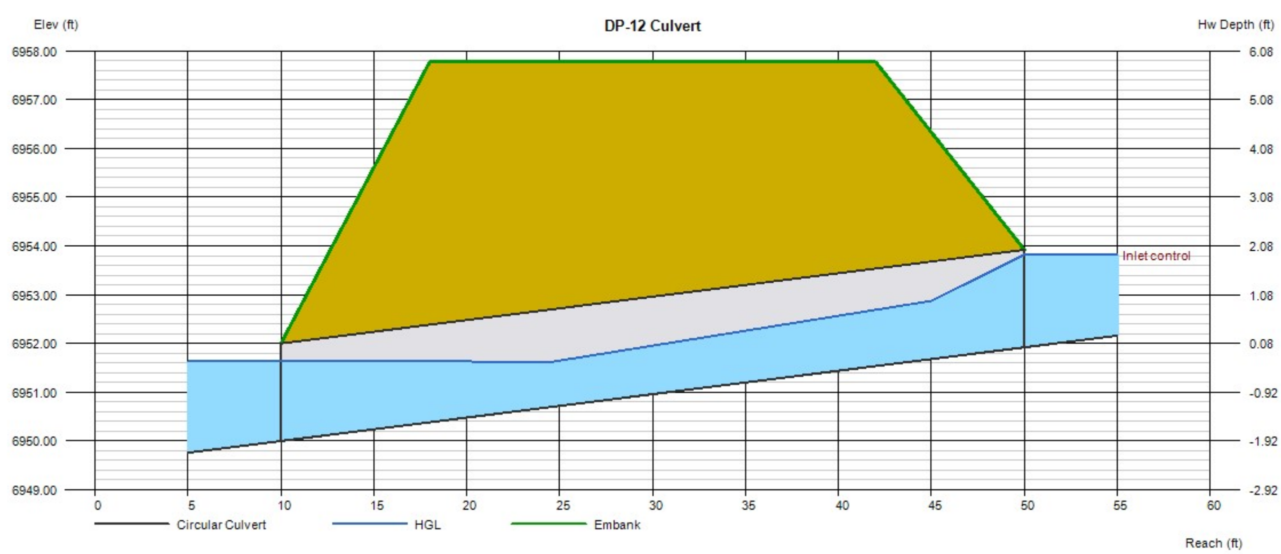
Top Elevation (ft)	=	6957.77
Top Width (ft)	=	24.00
Crest Width (ft)	=	30.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	12.30
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	12.30
Qpipe (cfs)	=	12.30
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	4.49
Veloc Up (ft/s)	=	5.90
HGL Dn (ft)	=	6951.63
HGL Up (ft)	=	6953.18
Hw Elev (ft)	=	6953.82
Hw/D (ft)	=	0.95
Flow Regime	=	Inlet Control



Culvert Report

DP-13 Culvert

Invert Elev Dn (ft)	=	6870.00
Pipe Length (ft)	=	40.00
Slope (%)	=	2.80
Invert Elev Up (ft)	=	6871.12
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

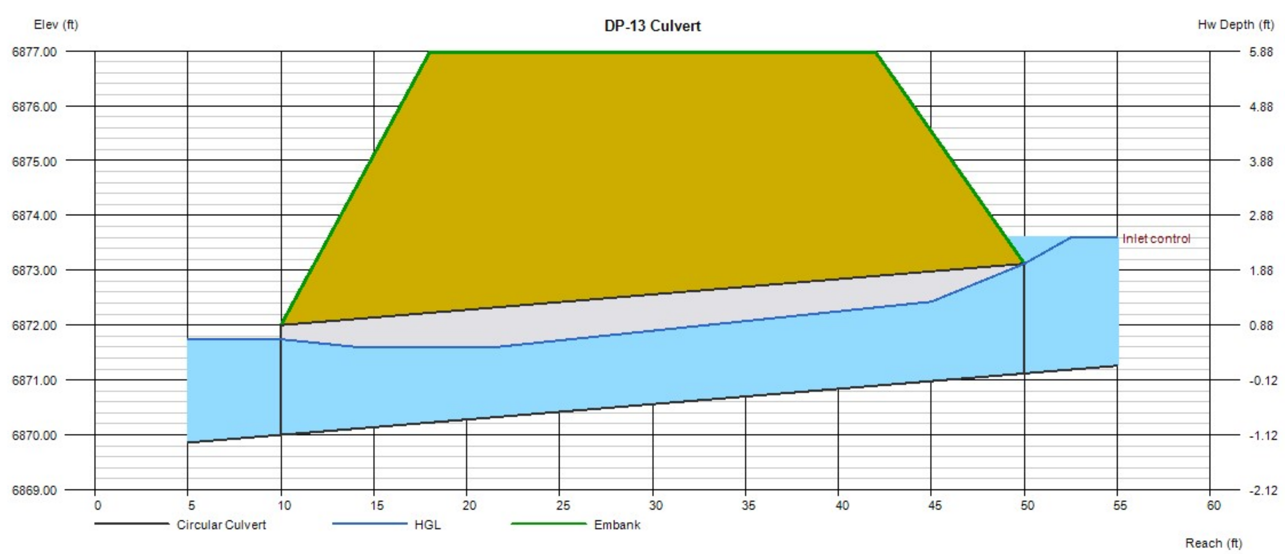
Top Elevation (ft)	=	6876.97
Top Width (ft)	=	24.00
Crest Width (ft)	=	30.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	17.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	17.00
Qpipe (cfs)	=	17.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	5.85
Veloc Up (ft/s)	=	6.80
HGL Dn (ft)	=	6871.74
HGL Up (ft)	=	6872.61
Hw Elev (ft)	=	6873.60
Hw/D (ft)	=	1.24
Flow Regime	=	Inlet Control



Culvert Report

DP-14 Culvert

Invert Elev Dn (ft)	=	6870.00
Pipe Length (ft)	=	40.00
Slope (%)	=	2.80
Invert Elev Up (ft)	=	6871.12
Rise (in)	=	18.0
Shape	=	Circular
Span (in)	=	18.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

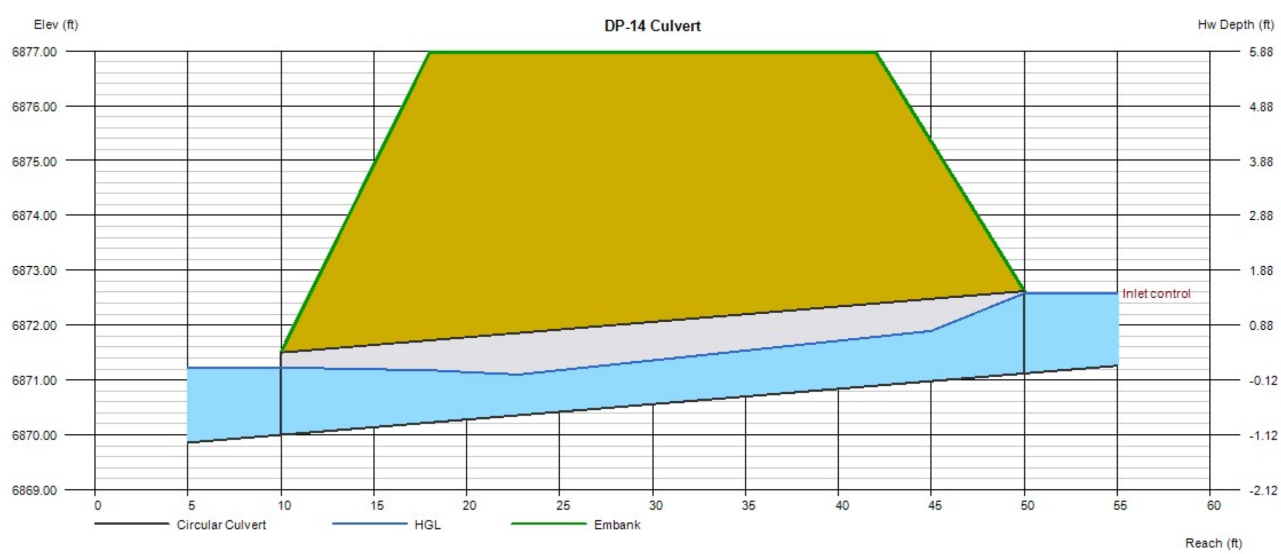
Top Elevation (ft)	=	6876.97
Top Width (ft)	=	24.00
Crest Width (ft)	=	30.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	6.10
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	6.10
Qpipe (cfs)	=	6.10
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	3.94
Veloc Up (ft/s)	=	5.15
HGL Dn (ft)	=	6871.23
HGL Up (ft)	=	6872.07
Hw Elev (ft)	=	6872.58
Hw/D (ft)	=	0.97
Flow Regime	=	Inlet Control



Culvert Report

DP-16 Culvert

Invert Elev Dn (ft)	=	6870.00
Pipe Length (ft)	=	40.00
Slope (%)	=	2.80
Invert Elev Up (ft)	=	6871.12
Rise (in)	=	24.0
Shape	=	Circular
Span (in)	=	24.0
No. Barrels	=	1
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

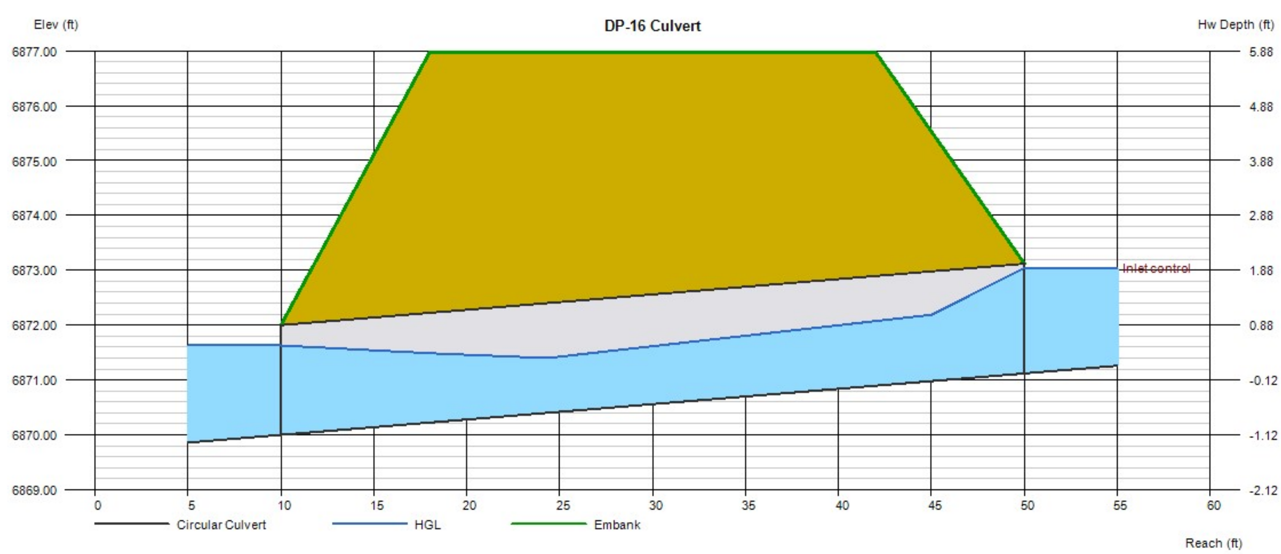
Top Elevation (ft)	=	6876.97
Top Width (ft)	=	24.00
Crest Width (ft)	=	30.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	12.30
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	12.30
Qpipe (cfs)	=	12.30
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	4.49
Veloc Up (ft/s)	=	5.90
HGL Dn (ft)	=	6871.63
HGL Up (ft)	=	6872.38
Hw Elev (ft)	=	6873.04
Hw/D (ft)	=	0.96
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Mar 29 2023

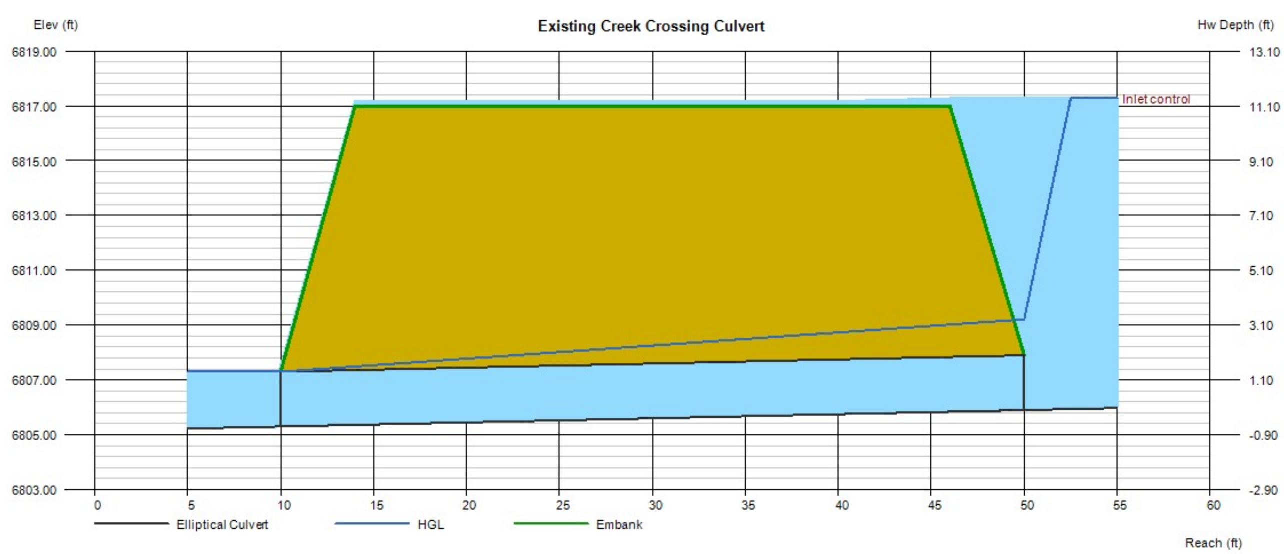
Existing Creek Crossing Culvert

Invert Elev Dn (ft) = 6805.30
Pipe Length (ft) = 40.00
Slope (%) = 1.50
Invert Elev Up (ft) = 6805.90
Rise (in) = 24.0
Shape = Elliptical
Span (in) = 36.0
No. Barrels = 1
n-Value = 0.013
Culvert Type = Horizontal Ellipse Concrete
Culvert Entrance = Groove end projecting (H)
Coeff. K,M,c,Y,k = 0.0045, 2, 0.0317, 0.69, 0.2

Embankment
Top Elevation (ft) = 6817.00
Top Width (ft) = 32.00
Crest Width (ft) = 100.00

Calculations
Qmin (cfs) = 127.00
Qmax (cfs) = 127.00
Tailwater Elev (ft) = (dc+D)/2

Highlighted
Qtotal (cfs) = 127.00
Qpipe (cfs) = 83.74
Qovertop (cfs) = 43.26
Veloc Dn (ft/s) = 17.77
Veloc Up (ft/s) = 17.77
HGL Dn (ft) = 6807.30
HGL Up (ft) = 6809.21
Hw Elev (ft) = 6817.28
Hw/D (ft) = 5.69
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Mar 29 2023

CREEK CROSSING CULVERT

Invert Elev Dn (ft)	=	6805.30
Pipe Length (ft)	=	40.00
Slope (%)	=	1.50
Invert Elev Up (ft)	=	6805.90
Rise (in)	=	42.0
Shape	=	Circular
Span (in)	=	42.0
No. Barrels	=	2
n-Value	=	0.013
Culvert Type	=	Circular Concrete
Culvert Entrance	=	Square edge w/headwall (C)
Coeff. K,M,c,Y,k	=	0.0098, 2, 0.0398, 0.67, 0.5

Embankment

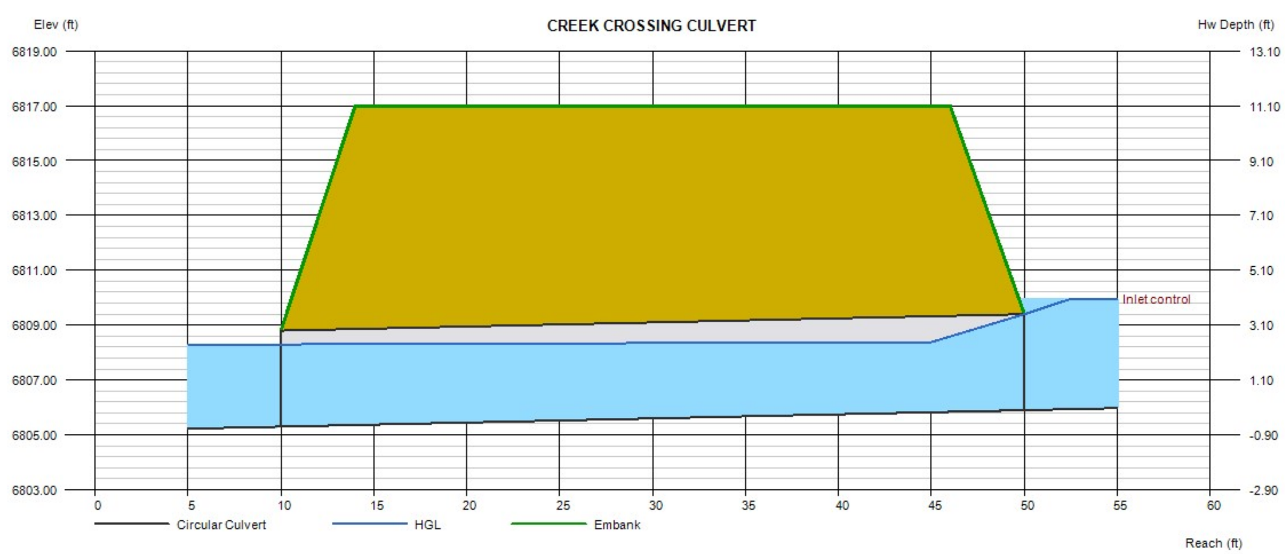
Top Elevation (ft)	=	6817.00
Top Width (ft)	=	32.00
Crest Width (ft)	=	100.00

Calculations

Qmin (cfs)	=	127.00
Qmax (cfs)	=	127.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	127.00
Qpipe (cfs)	=	127.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	7.24
Veloc Up (ft/s)	=	8.65
HGL Dn (ft)	=	6808.30
HGL Up (ft)	=	6808.40
Hw Elev (ft)	=	6809.96
Hw/D (ft)	=	1.16
Flow Regime	=	Inlet Control

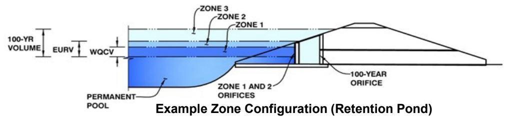


DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)

Project: Hay Creek Valley

Basin ID: Beaver Creek



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	52.78	acres
Watershed Length =	3,860	ft
Watershed Length to Centroid =	1,930	ft
Watershed Slope =	0.048	ft/ft
Watershed Imperviousness =	12.53%	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) =	0.356	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.633	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.816	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.697	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	2.563	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	4.070	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	5.111	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	6.595	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.55 in.) =	11.170	acre-feet	3.55	inches
Approximate 2-yr Detention Volume =	0.414	acre-feet		
Approximate 5-yr Detention Volume =	0.637	acre-feet		
Approximate 10-yr Detention Volume =	1.204	acre-feet		
Approximate 25-yr Detention Volume =	1.619	acre-feet		
Approximate 50-yr Detention Volume =	1.703	acre-feet		
Approximate 100-yr Detention Volume =	2.170	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.356	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.277	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.537	acre-feet
Total Detention Basin Volume =	2.170	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 = 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	--	--	--	150	0.003		
	--	0.33	--	--	--	150	0.003	50	0.001
	--	0.83	--	--	--	46,720	1.073	11,765	0.270
	--	1.33	--	--	--	48,480	1.113	35,565	0.816
	--	1.83	--	--	--	50,240	1.153	60,245	1.383
	--	2.33	--	--	--	52,051	1.195	85,818	1.970
	--	2.83	--	--	--	53,861	1.236	112,296	2.578
	--	3.33	--	--	--	55,722	1.279	139,691	3.207
	--	3.83	--	--	--	57,582	1.322	168,017	3.857
	--	4.33	--	--	--	59,493	1.366	197,286	4.529
	--	4.83	--	--	--	61,404	1.410	227,510	5.223
	--	5.33	--	--	--	63,365	1.455	258,703	5.939
	--	5.83	--	--	--	65,326	1.500	290,875	6.678
	--	6.33	--	--	--	67,338	1.546	324,041	7.439
	--	6.83	--	--	--	69,349	1.592	358,213	8.223
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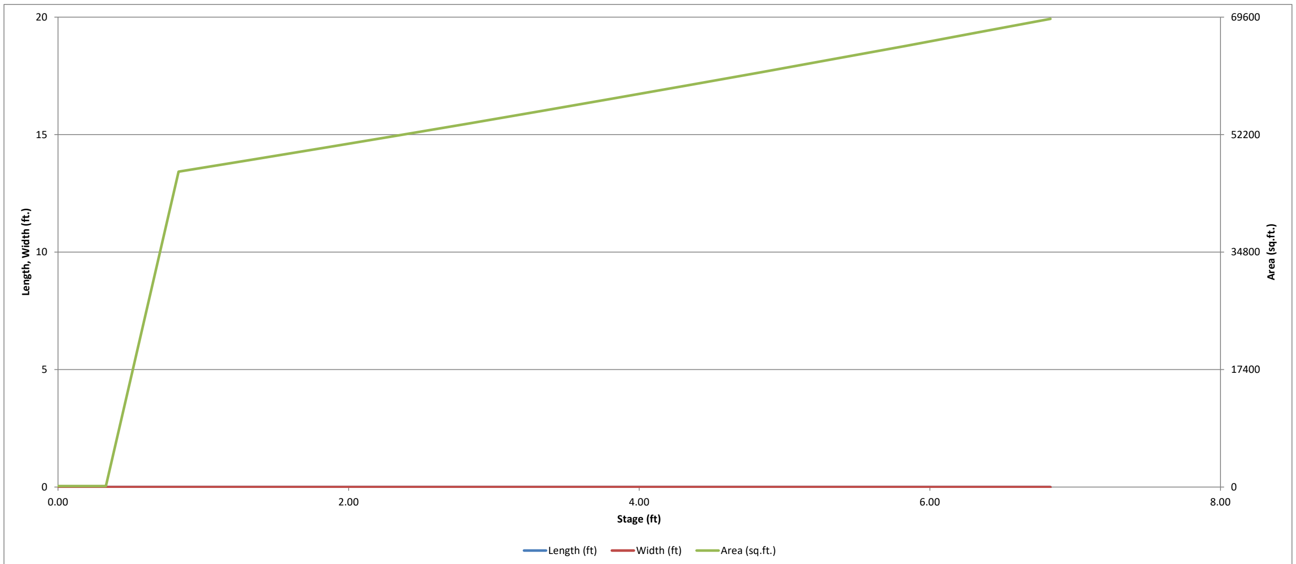
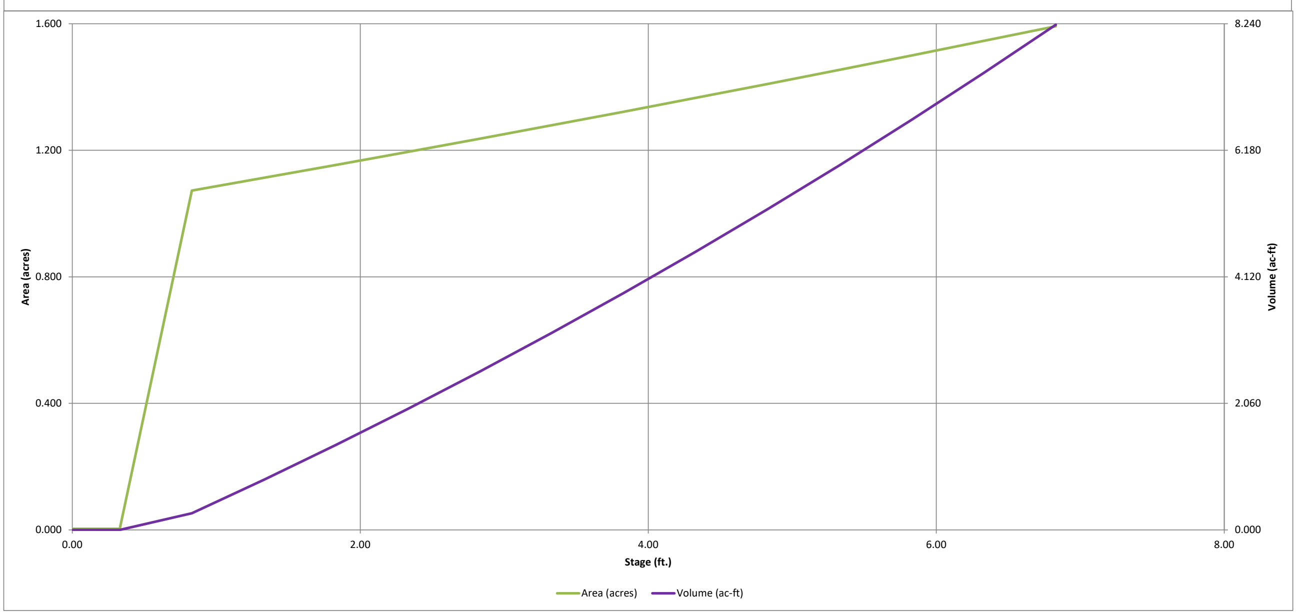
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)



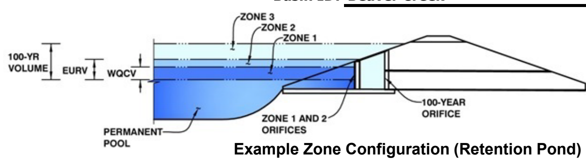


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: **Hay Creek Valley**

Basin ID: **Beaver Creek**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.91	0.356	Orifice Plate
Zone 2 (EURV)	1.17	0.277	Circular Orifice
Zone 3 (100-year)	2.50	1.537	Weir&Pipe (Restrict)
Total (all zones)		2.170	

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

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

Calculated Parameters for Underdrain

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

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	0.92	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	2.52	sq. inches (diameter = 1-3/4 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.750E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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	0.50	0.75					
Orifice Area (sq. inches)	2.52	2.52	2.52					

	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	
Invert of Vertical Orifice =	1.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	1.18	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	4.50	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.11	N/A	ft^2
Vertical Orifice Centroid =	0.19	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	6.00	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.00	N/A	feet
Overflow Weir Slope Length =	6.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	57.13	N/A	
Overflow Grate Open Area w/o Debris =	16.70	N/A	ft^2
Overflow Grate Open Area w/ Debris =	8.35	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	1.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	4.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.29	N/A	ft^2
Outlet Orifice Centroid =	0.20	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	0.98	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	50.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.52	feet
Stage at Top of Freeboard =	7.02	feet
Basin Area at Top of Freeboard =	1.59	acres
Basin Volume at Top of Freeboard =	8.22	acre-ft

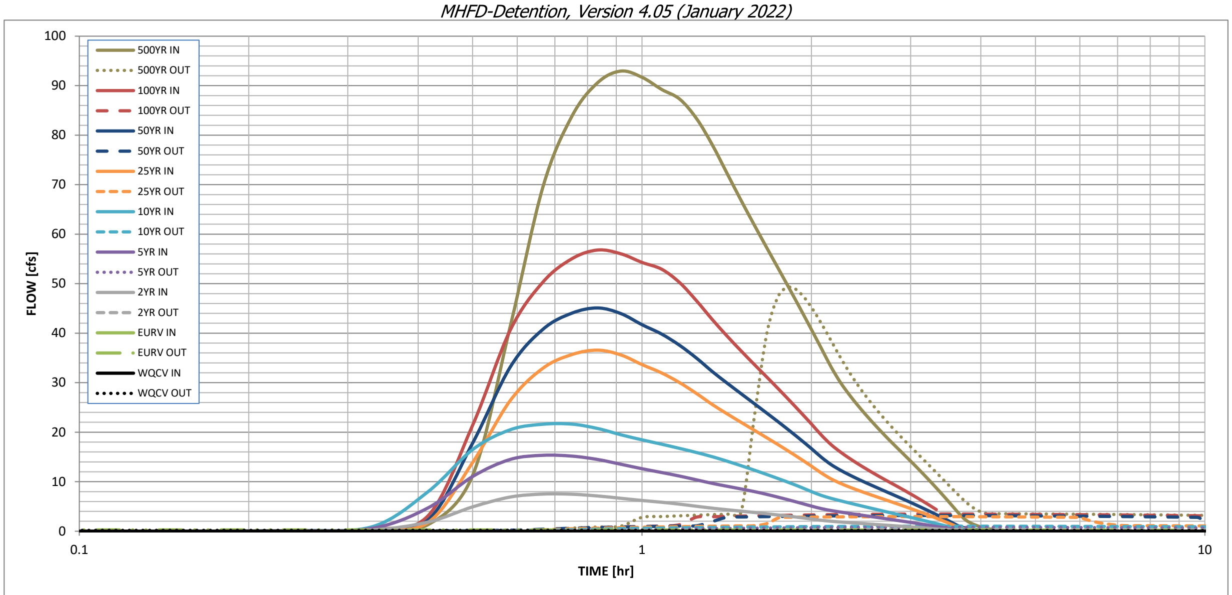
Routed Hydrograph Results

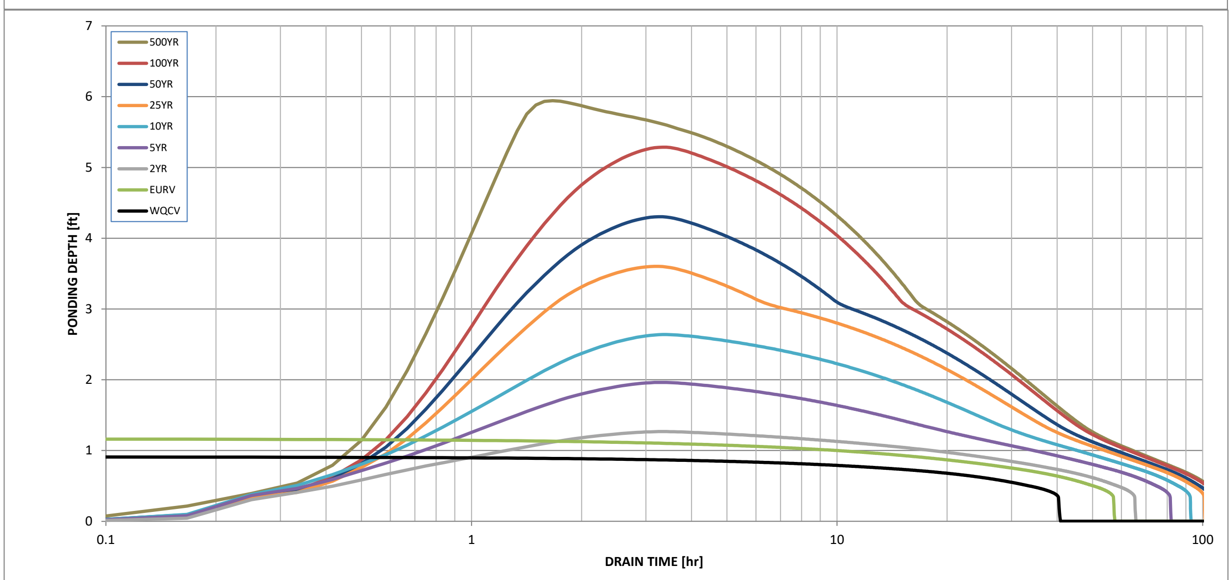
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

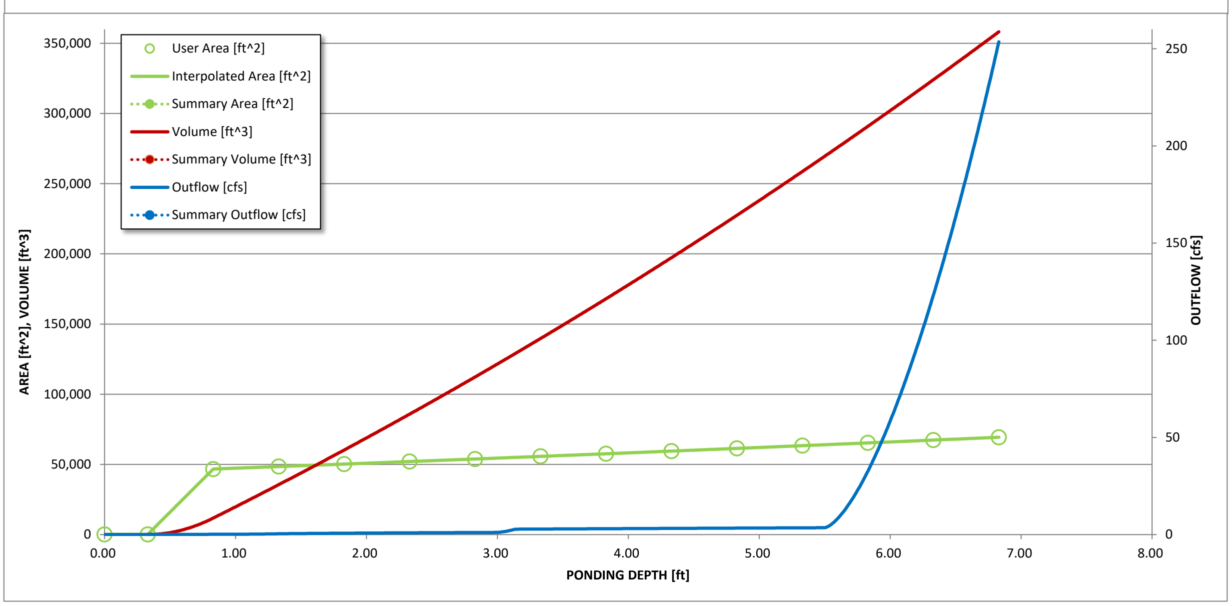
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.55
CUHP Runoff Volume (acre-ft) =	0.356	0.633	0.816	1.697	2.563	4.070	5.111	6.595	11.170
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.816	1.697	2.563	4.070	5.111	6.595	11.170
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	4.1	11.4	17.7	32.4	40.7	52.2	87.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.08	0.22	0.33	0.61	0.77	0.99	1.66
Peak Inflow Q (cfs) =	N/A	N/A	7.5	15.3	21.6	36.6	45.1	56.8	92.9
Peak Outflow Q (cfs) =	0.2	0.3	0.4	0.8	1.0	3.0	3.2	3.5	49.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.1	0.1	0.1	0.1	0.1	0.6
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.1	0.1	0.1	0.1
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	53	60	72	79	82	82	83	73
Time to Drain 99% of Inflow Volume (hours) =	**40**	56	64	78	87	93	95	98	94
Maximum Ponding Depth (ft) =	0.91	1.17	1.27	1.96	2.64	3.60	4.30	5.29	5.94
Area at Maximum Ponding Depth (acres) =	1.08	1.10	1.11	1.16	1.22	1.30	1.36	1.45	1.51
Maximum Volume Stored (acre-ft) =	0.356	0.639	0.739	1.534	2.332	3.555	4.488	5.866	6.843

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 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: *.\Outflow Hydrographs - UPDATED BASINS.xlsx*

Inflow Hydrographs

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

Time Interval: 5.00 min

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]
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	0.01	0.00	0.04
0:15:00	0.00	0.00	0.06	0.10	0.12	0.08	0.11	0.10	0.20
0:20:00	0.00	0.00	0.26	0.64	0.99	0.28	0.33	0.43	1.33
0:25:00	0.00	0.00	1.85	4.72	7.99	1.78	2.27	3.13	11.29
0:30:00	0.00	0.00	4.92	11.05	16.49	13.89	17.81	21.42	41.46
0:35:00	0.00	0.00	6.91	14.50	20.50	26.42	33.20	40.65	69.57
0:40:00	0.00	0.00	7.50	15.33	21.61	32.92	40.79	50.33	83.76
0:45:00	0.00	0.00	7.47	15.17	21.63	35.67	44.03	55.02	90.57
0:50:00	0.00	0.00	7.12	14.49	20.75	36.57	45.10	56.79	92.94
0:55:00	0.00	0.00	6.65	13.53	19.49	35.61	43.96	56.04	91.68
1:00:00	0.00	0.00	6.20	12.62	18.45	33.65	41.71	54.29	89.24
1:05:00	0.00	0.00	5.85	11.86	17.57	31.97	39.82	52.92	87.27
1:10:00	0.00	0.00	5.46	11.13	16.72	29.99	37.53	50.20	83.33
1:15:00	0.00	0.00	5.03	10.37	15.89	27.80	34.94	46.52	78.02
1:20:00	0.00	0.00	4.65	9.66	15.04	25.58	32.24	42.74	72.23
1:25:00	0.00	0.00	4.33	9.07	14.14	23.70	29.90	39.39	66.79
1:30:00	0.00	0.00	4.05	8.53	13.23	21.99	27.76	36.40	61.82
1:35:00	0.00	0.00	3.78	8.00	12.33	20.38	25.75	33.66	57.20
1:40:00	0.00	0.00	3.52	7.43	11.44	18.86	23.84	31.11	52.86
1:45:00	0.00	0.00	3.26	6.84	10.58	17.39	22.00	28.65	48.70
1:50:00	0.00	0.00	3.00	6.24	9.73	15.95	20.19	26.26	44.66
1:55:00	0.00	0.00	2.73	5.65	8.87	14.53	18.42	23.92	40.72
2:00:00	0.00	0.00	2.46	5.07	7.99	13.14	16.68	21.65	36.90
2:05:00	0.00	0.00	2.21	4.56	7.22	11.74	14.92	19.39	33.20
2:10:00	0.00	0.00	2.01	4.17	6.64	10.57	13.46	17.50	30.11
2:15:00	0.00	0.00	1.86	3.88	6.15	9.68	12.35	16.02	27.61
2:20:00	0.00	0.00	1.73	3.61	5.71	8.95	11.40	14.76	25.44
2:25:00	0.00	0.00	1.61	3.35	5.29	8.29	10.56	13.64	23.47
2:30:00	0.00	0.00	1.50	3.11	4.89	7.69	9.78	12.61	21.67
2:35:00	0.00	0.00	1.39	2.87	4.51	7.13	9.06	11.66	19.99
2:40:00	0.00	0.00	1.28	2.64	4.14	6.59	8.37	10.76	18.42
2:45:00	0.00	0.00	1.17	2.42	3.78	6.07	7.71	9.93	16.95
2:50:00	0.00	0.00	1.07	2.20	3.44	5.57	7.06	9.12	15.54
2:55:00	0.00	0.00	0.97	1.99	3.11	5.07	6.43	8.32	14.17
3:00:00	0.00	0.00	0.87	1.78	2.79	4.58	5.81	7.53	12.80
3:05:00	0.00	0.00	0.77	1.57	2.47	4.09	5.19	6.74	11.45
3:10:00	0.00	0.00	0.67	1.36	2.16	3.60	4.58	5.95	10.09
3:15:00	0.00	0.00	0.57	1.16	1.85	3.12	3.96	5.16	8.74
3:20:00	0.00	0.00	0.47	0.96	1.54	2.63	3.35	4.37	7.40
3:25:00	0.00	0.00	0.37	0.76	1.23	2.15	2.74	3.59	6.06
3:30:00	0.00	0.00	0.28	0.56	0.93	1.67	2.14	2.80	4.73
3:35:00	0.00	0.00	0.19	0.37	0.64	1.19	1.53	2.03	3.44
3:40:00	0.00	0.00	0.12	0.24	0.46	0.74	0.97	1.32	2.36
3:45:00	0.00	0.00	0.08	0.18	0.37	0.49	0.66	0.89	1.68
3:50:00	0.00	0.00	0.06	0.14	0.30	0.33	0.47	0.62	1.21
3:55:00	0.00	0.00	0.05	0.11	0.24	0.23	0.33	0.42	0.87
4:00:00	0.00	0.00	0.04	0.09	0.19	0.16	0.24	0.28	0.61
4:05:00	0.00	0.00	0.03	0.07	0.15	0.11	0.17	0.18	0.41
4:10:00	0.00	0.00	0.03	0.06	0.12	0.08	0.12	0.11	0.27
4:15:00	0.00	0.00	0.02	0.04	0.09	0.06	0.09	0.07	0.18
4:20:00	0.00	0.00	0.02	0.03	0.06	0.04	0.07	0.05	0.13
4:25:00	0.00	0.00	0.01	0.02	0.05	0.03	0.05	0.04	0.10
4:30:00	0.00	0.00	0.01	0.02	0.04	0.02	0.04	0.03	0.08
4:35:00	0.00	0.00	0.01	0.01	0.03	0.02	0.03	0.03	0.06
4:40:00	0.00	0.00	0.01	0.01	0.02	0.01	0.02	0.02	0.05
4:45:00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.03
4:50:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Figure 13-12b. Emergency Spillway Profile at Embankment

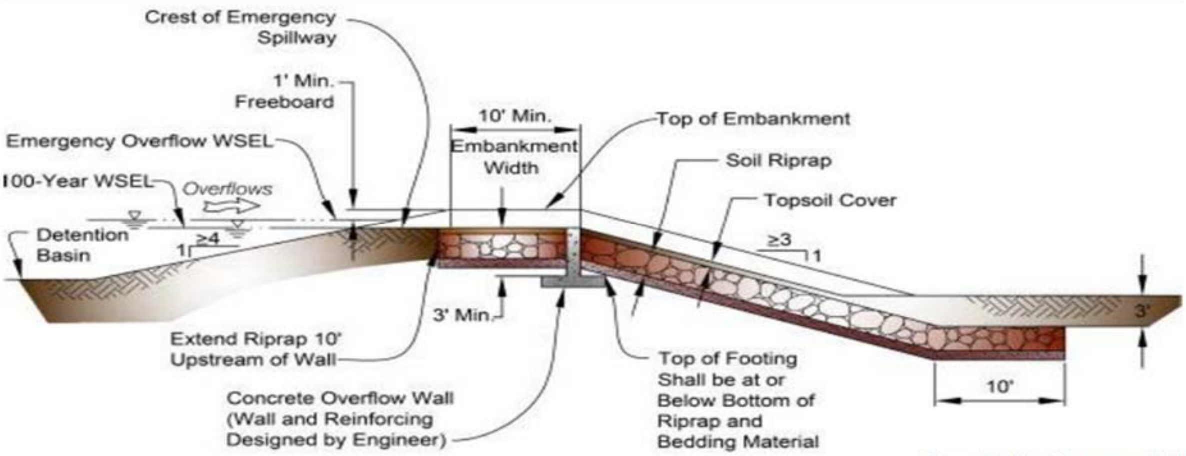
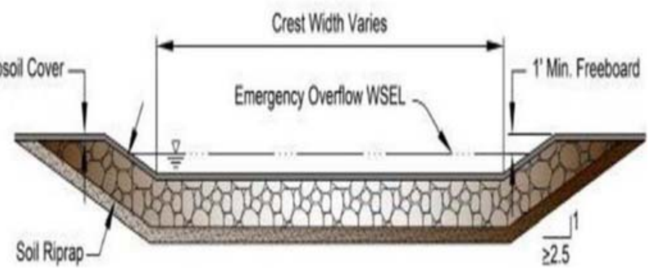


Figure 13-12c. Emergency Spillway Protection

Q=16.4 CFS
LENGTH=25 Feet
UNIT FLOW RATE: 0.66 CFS/FT

=> TYPE VL RIP RAP



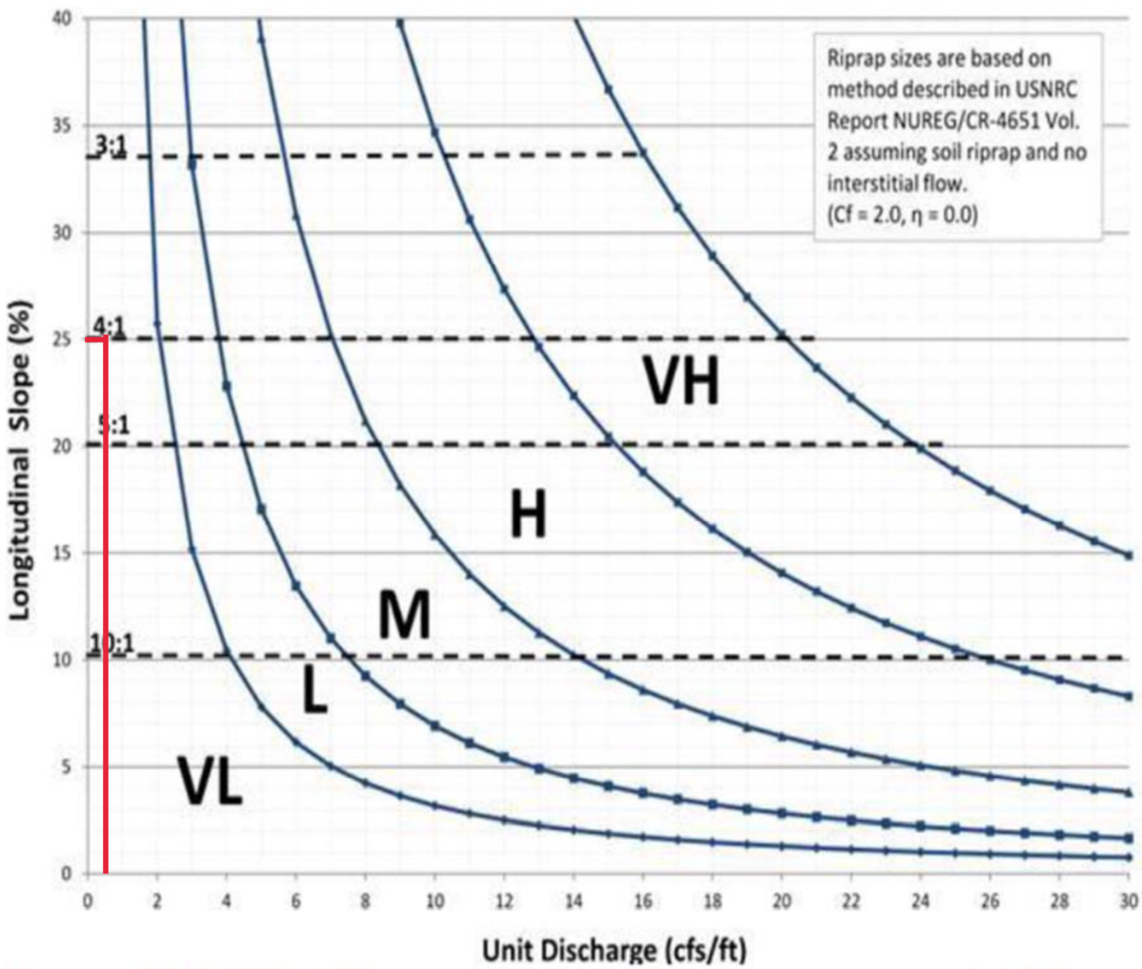


Figure 13-12d. Riprap Types for Emergency Spillway Protection

Weir Report

Stilling Basin Outfall

Trapezoidal Weir

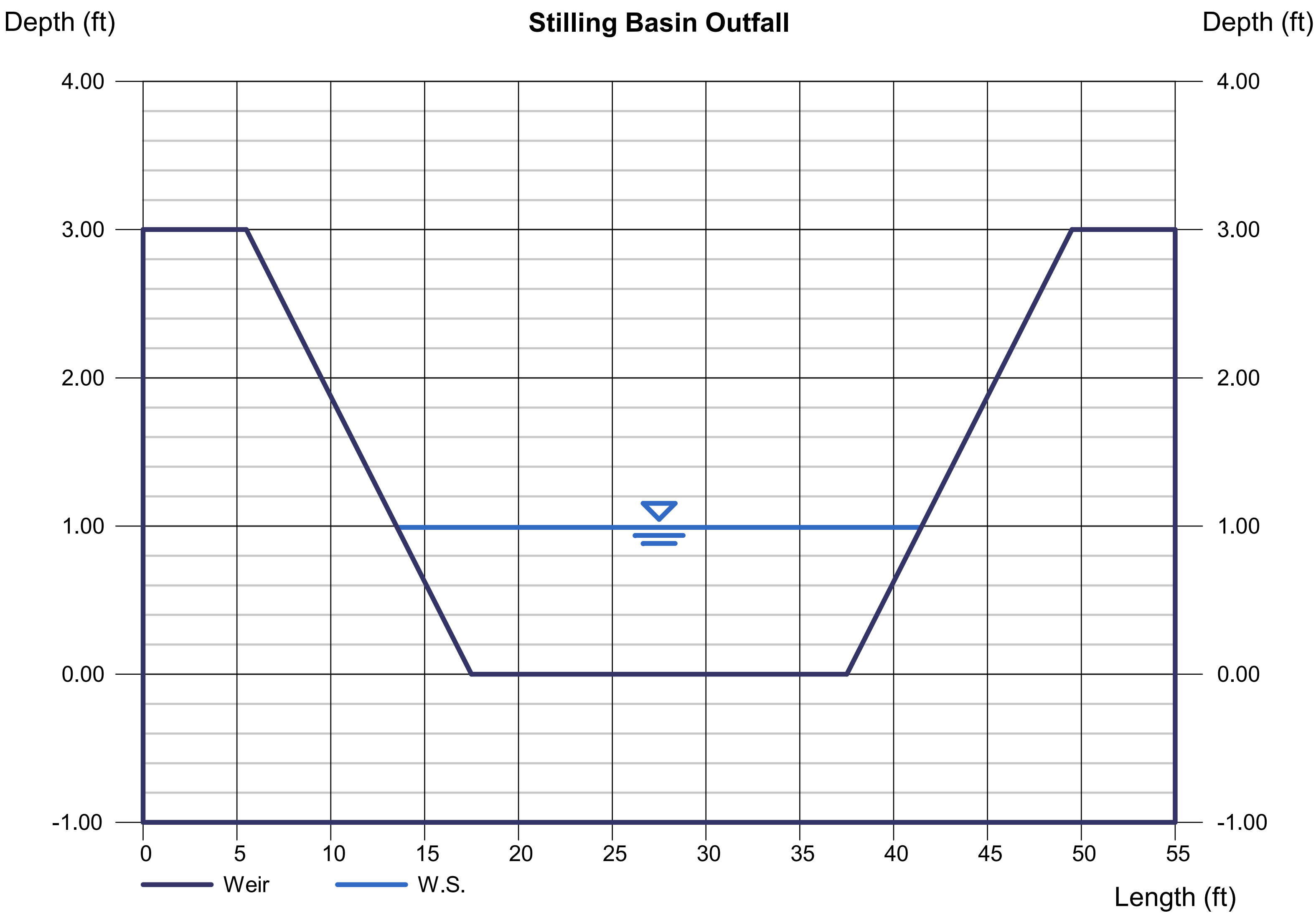
Crest	=	Sharp
Bottom Length (ft)	=	20.00
Total Depth (ft)	=	3.00
Side Slope (z:1)	=	4.00

Calculations

Weir Coeff. Cw	=	3.10
Compute by:		Known Q
Known Q (cfs)	=	69.80

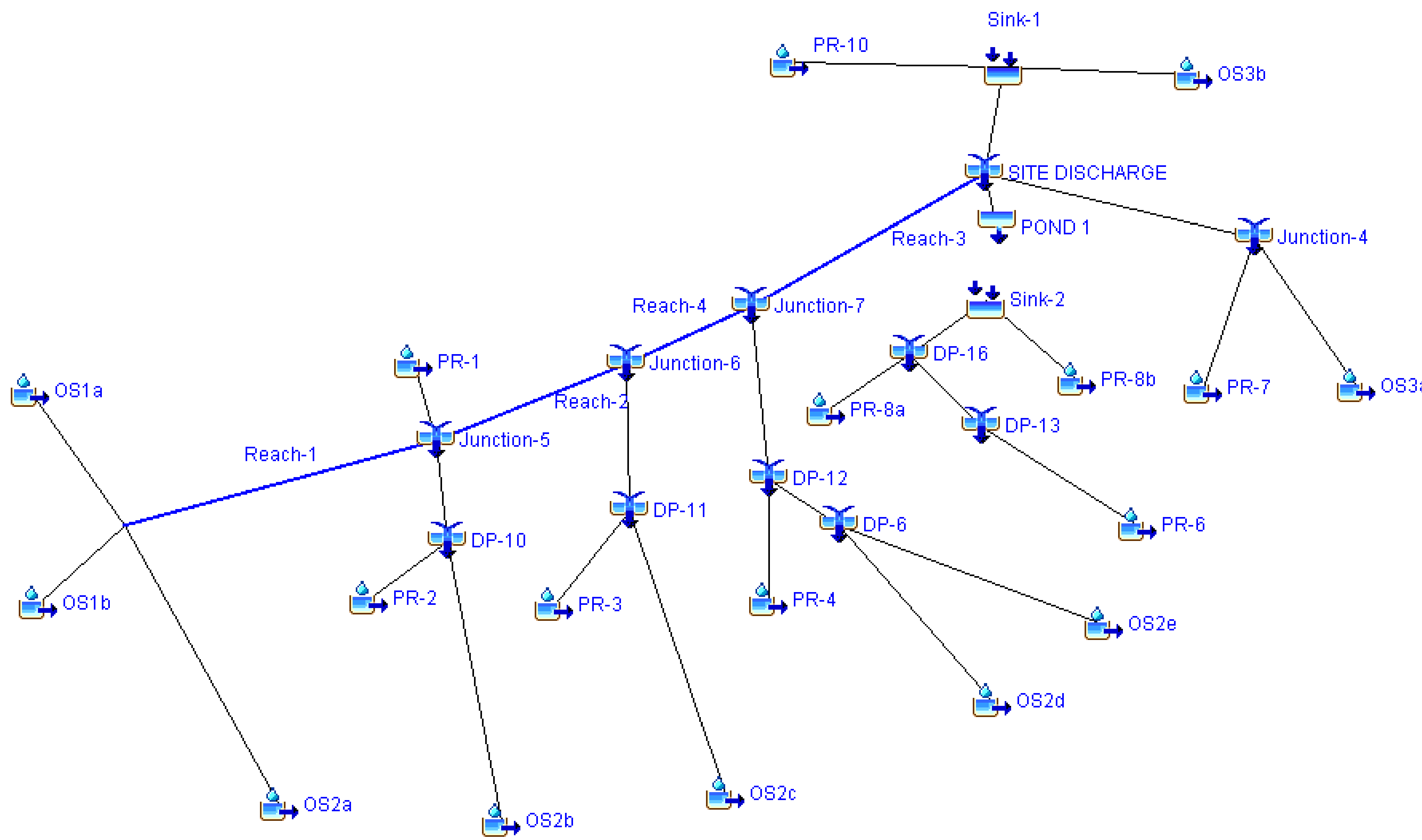
Highlighted

Depth (ft)	=	0.99
Q (cfs)	=	69.80
Area (sqft)	=	23.72
Velocity (ft/s)	=	2.94
Top Width (ft)	=	27.92



Model Name: **Hay_Creek_Forest_Manor**

These models reflect full development of the areas included in the Hay Creek development with full spectrum detention provided to maintain historic flows. Areas tributary to Pond 1 have been modeled to drain to "Sink 2" while the pond itself has been modeled using the outflow hydrographs from the MHFD-Detention Spreadsheet.

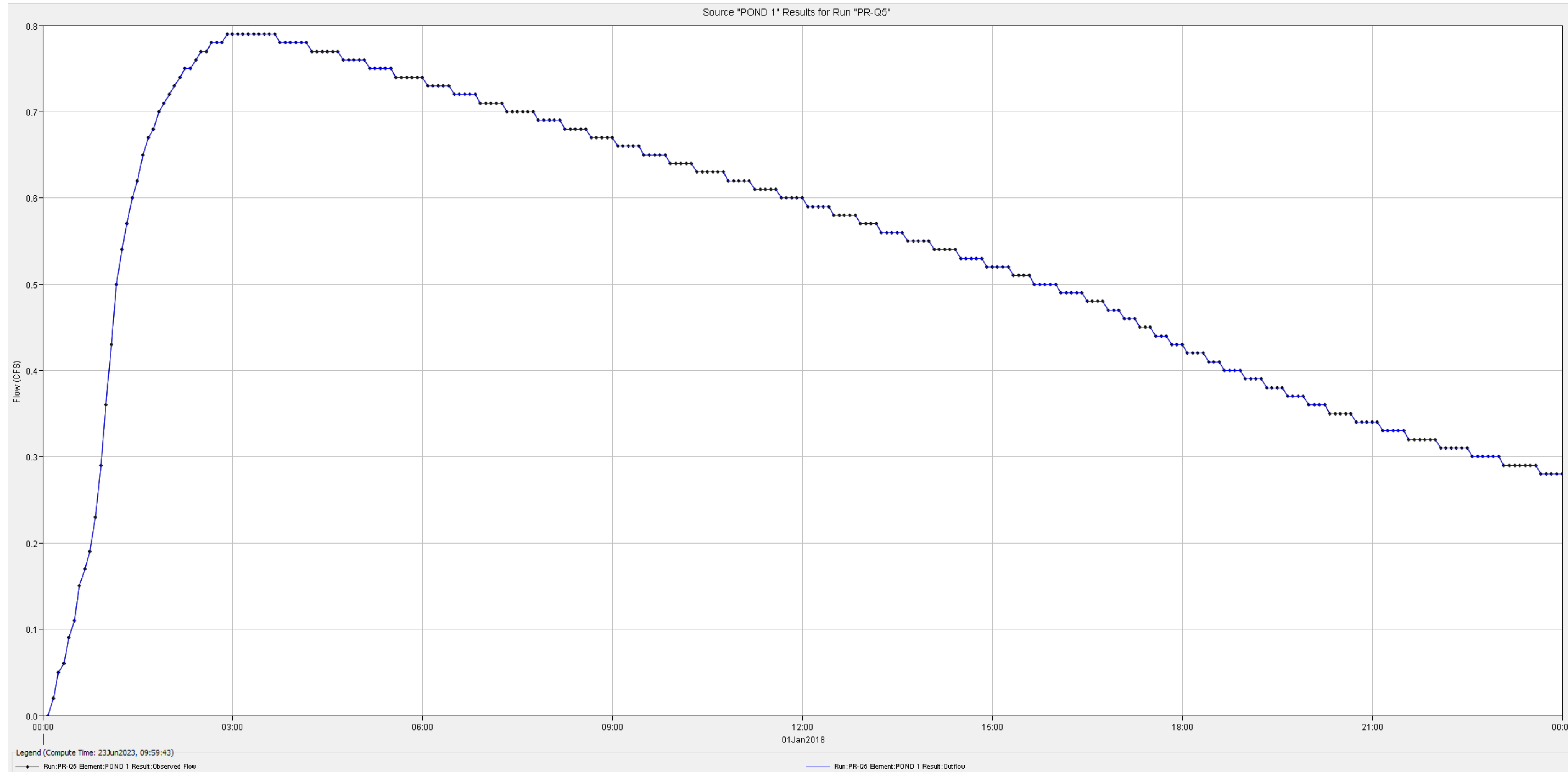


Project: HAY_CREEK_FOREST_MANOR - UP   Simulation Run: PR-Q5

Start of Run: 01Jan2018, 00:00   Basin Model: PR - HAY CREEK_FM
End of Run: 02Jan2018, 00:00   Meteorologic Model: 5 YEAR EVENT
Compute Time: 23Jun2023, 10:10:20   Control Specifications: 1 DAY

Volume Units: (•) IN ( ) AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
DP-10	0.0385	2.1	01Jan2018, 12:35	0.20
DP-11	0.0189	1.0	01Jan2018, 12:35	0.21
DP-12	0.0535	2.7	01Jan2018, 12:40	0.21
DP-13	0.0699	3.7	01Jan2018, 12:40	0.21
DP-16	0.0780	6.8	01Jan2018, 12:50	0.39
DP-6	0.0092	0.5	01Jan2018, 12:30	0.20
Junction-4	0.0286	1.2	01Jan2018, 12:40	0.17
Junction-5	0.2659	9.2	01Jan2018, 12:55	0.18
Junction-6	0.2848	9.9	01Jan2018, 13:00	0.18
Junction-7	0.3383	11.9	01Jan2018, 13:00	0.18
OS1a	0.0146	0.8	01Jan2018, 12:40	0.21
OS1b	0.0925	2.6	01Jan2018, 12:50	0.13
OS2a	0.0078	0.4	01Jan2018, 12:25	0.14
OS2b	0.0134	0.7	01Jan2018, 12:30	0.16
OS2c	0.0036	0.3	01Jan2018, 12:25	0.21
OS2d	0.0043	0.3	01Jan2018, 12:35	0.20
OS2e	0.0049	0.3	01Jan2018, 12:30	0.20
OS3a	0.0076	0.1	01Jan2018, 12:40	0.06
OS3b	0.0051	0.1	01Jan2018, 12:30	0.06
POND 1	0.0840	0.8	01Jan2018, 02:55	0.24
PR-1	0.1125	4.4	01Jan2018, 13:05	0.21
PR-10	0.0256	0.6	01Jan2018, 12:55	0.11
PR-2	0.0251	1.4	01Jan2018, 12:35	0.21
PR-3	0.0153	0.8	01Jan2018, 12:40	0.21
PR-4	0.0443	2.2	01Jan2018, 12:45	0.21
PR-6	0.0699	3.7	01Jan2018, 12:40	0.21
PR-7	0.0210	1.1	01Jan2018, 12:40	0.21
PR-8a	0.0081	3.5	01Jan2018, 13:00	1.94
PR-8b	0.0006	0.8	01Jan2018, 12:15	2.66
Reach-1	0.1149	3.5	01Jan2018, 12:55	0.14
Reach-2	0.2659	9.2	01Jan2018, 13:00	0.18
Reach-3	0.3383	11.9	01Jan2018, 13:05	0.18
Reach-4	0.2848	9.9	01Jan2018, 13:05	0.18
Sink-1	0.4816	13.9	01Jan2018, 13:05	0.19
Sink-2	0.0786	7.0	01Jan2018, 12:45	0.41
SITE DISCH...	0.4509	13.3	01Jan2018, 13:05	0.19

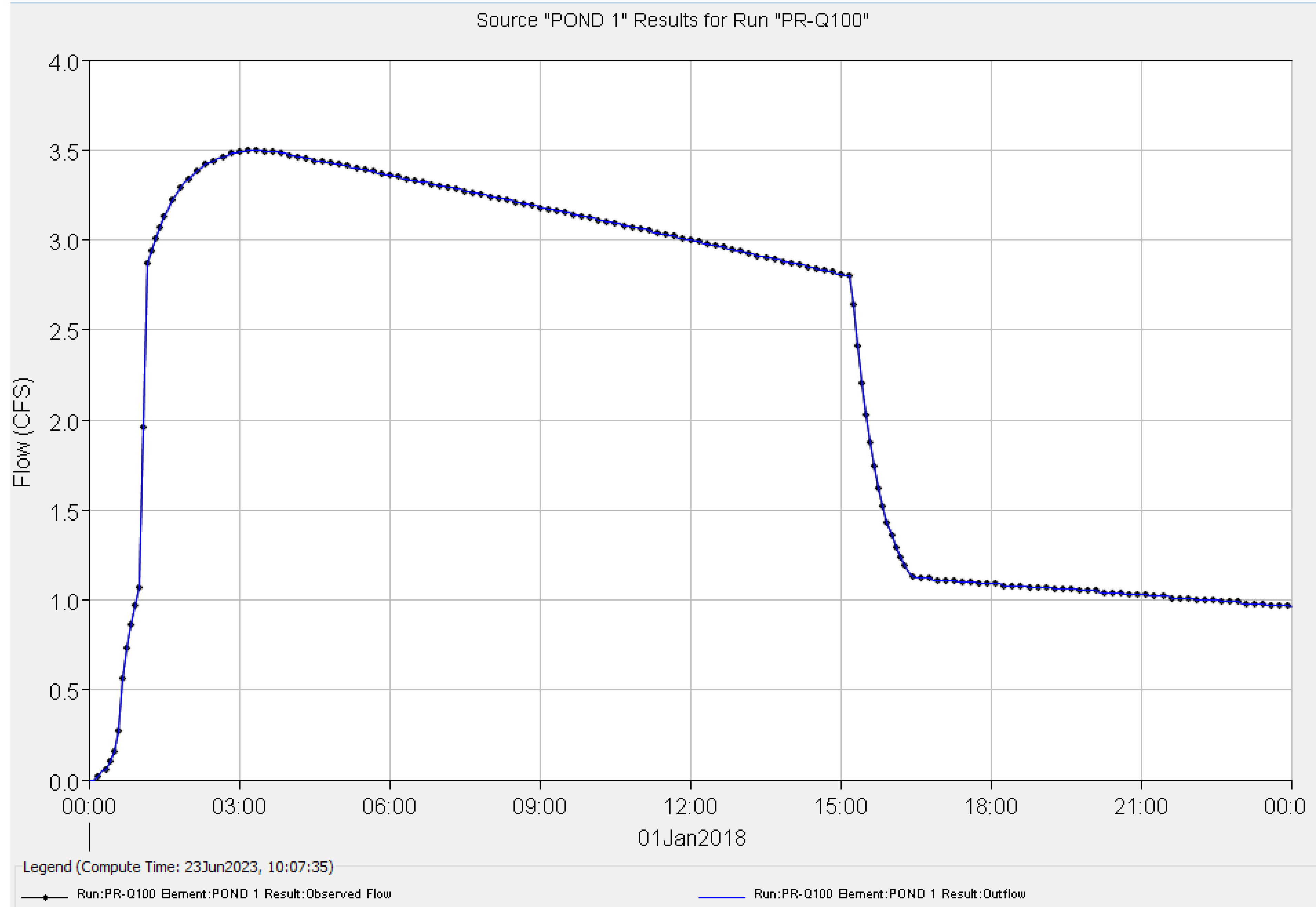


Project: HAY_CREEK_FOREST_MANOR - UP   Simulation Run: PR-Q100

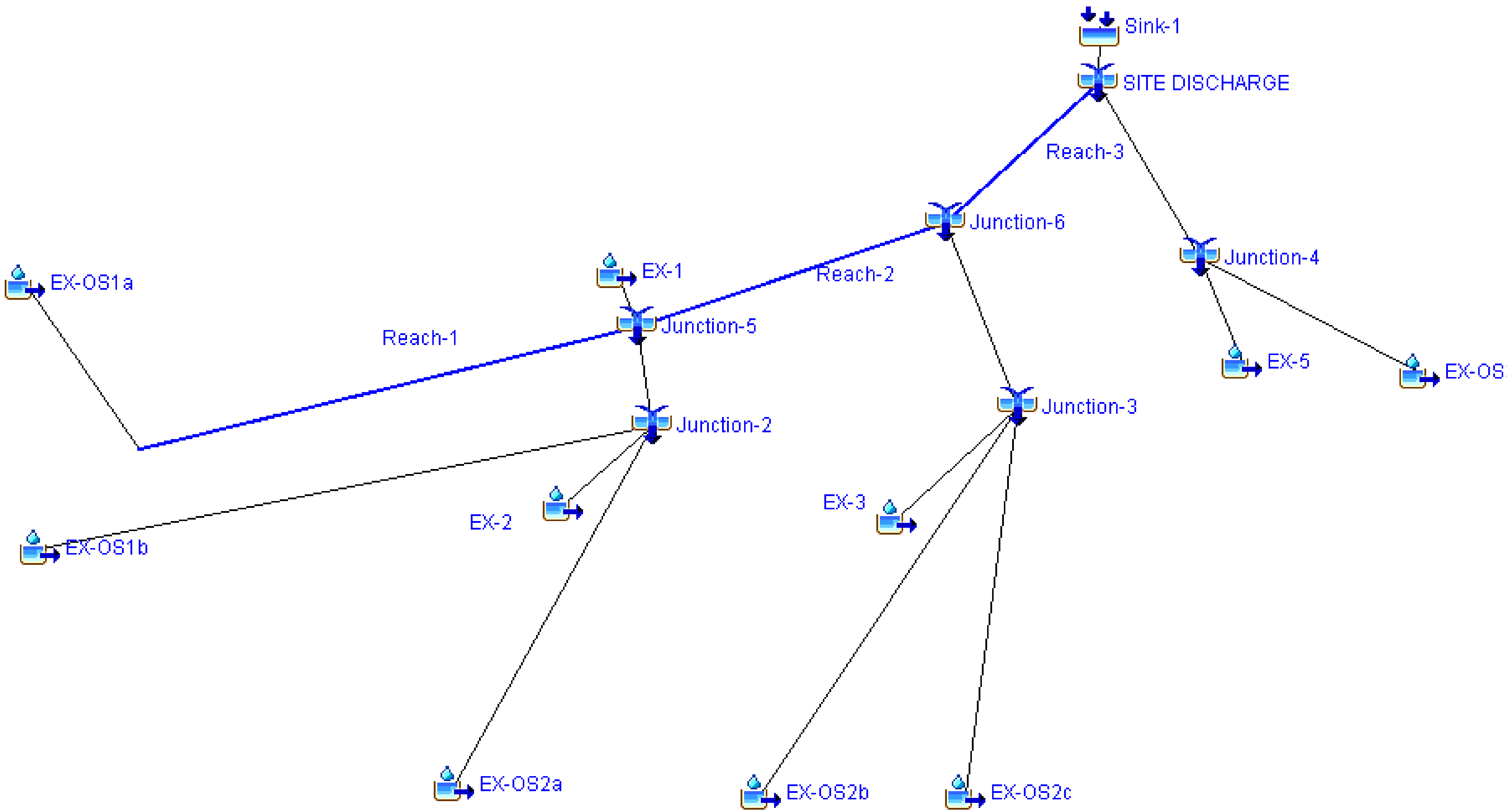
Start of Run: 01Jan2018, 00:00   Basin Model: PR - HAY CREEK_FM
End of Run: 02Jan2018, 00:00   Meteorologic Model: 100 YEAR EVENT
Compute Time: 23Jun2023, 10:05:14   Control Specifications: 1 DAY

Volume Units: (●) IN ( ) AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
DP-10	0.0385	9.6	01Jan2018, 12:40	0.87
DP-11	0.0189	4.6	01Jan2018, 12:40	0.91
DP-12	0.0535	12.3	01Jan2018, 12:45	0.91
DP-13	0.0699	17.0	01Jan2018, 12:45	0.92
DP-16	0.0780	24.7	01Jan2018, 12:50	1.28
DP-6	0.0092	2.3	01Jan2018, 12:35	0.85
Junction-4	0.0286	6.1	01Jan2018, 12:45	0.82
Junction-5	0.2659	44.8	01Jan2018, 13:00	0.82
Junction-6	0.2848	48.1	01Jan2018, 13:00	0.83
Junction-7	0.3383	58.5	01Jan2018, 13:05	0.84
OS1a	0.0146	3.6	01Jan2018, 12:45	0.92
OS1b	0.0925	14.2	01Jan2018, 13:00	0.70
OS2a	0.0078	1.8	01Jan2018, 12:30	0.71
OS2b	0.0134	3.2	01Jan2018, 12:35	0.76
OS2c	0.0036	1.2	01Jan2018, 12:25	0.89
OS2d	0.0043	1.1	01Jan2018, 12:40	0.86
OS2e	0.0049	1.3	01Jan2018, 12:35	0.84
OS3a	0.0076	0.9	01Jan2018, 12:50	0.53
OS3b	0.0051	0.8	01Jan2018, 12:35	0.53
POND 1	0.0840	3.5	01Jan2018, 03:10	1.02
PR-1	0.1125	20.2	01Jan2018, 13:10	0.91
PR-10	0.0256	3.4	01Jan2018, 13:05	0.65
PR-2	0.0251	6.5	01Jan2018, 12:40	0.92
PR-3	0.0153	3.8	01Jan2018, 12:45	0.92
PR-4	0.0443	10.3	01Jan2018, 12:50	0.92
PR-6	0.0699	17.0	01Jan2018, 12:45	0.92
PR-7	0.0210	5.1	01Jan2018, 12:45	0.92
PR-8a	0.0081	8.3	01Jan2018, 13:00	4.42
PR-8b	0.0006	1.7	01Jan2018, 12:15	5.49
Reach-1	0.1149	18.5	01Jan2018, 13:00	0.72
Reach-2	0.2659	44.7	01Jan2018, 13:05	0.82
Reach-3	0.3383	58.5	01Jan2018, 13:05	0.83
Reach-4	0.2848	48.1	01Jan2018, 13:05	0.82
Sink-1	0.4816	70.1	01Jan2018, 13:05	0.85
Sink-2	0.0786	25.1	01Jan2018, 12:50	1.32
SITE DISCH...	0.4509	66.3	01Jan2018, 13:05	0.87



Model Name: **Hay_Creek_Forest_Manor**
These models reflect the existing conditions on the Hay Creek development.



Project: HAY_CREEK_FOREST_MANOR - UP   Simulation Run: EX-Q5

Start of Run: 01Jan2018, 00:00   Basin Model: EX - HAY CREEK_FM
End of Run: 02Jan2018, 00:00   Meteorologic Model: 5 YEAR EVENT
Compute Time: 28Mar2023, 08:56:35   Control Specifications: 1 DAY

Volume Units: (•) IN ( ) AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
EX-1	0.0876	1.6	01Jan2018, 13:00	0.10
EX-2	0.0754	2.0	01Jan2018, 12:50	0.13
EX-3	0.0963	2.3	01Jan2018, 12:40	0.10
EX-5	0.0669	1.5	01Jan2018, 12:40	0.09
EX-OS1a	0.0146	0.8	01Jan2018, 12:40	0.23
EX-OS1b	0.0925	2.6	01Jan2018, 12:50	0.14
EX-OS2a	0.0248	1.5	01Jan2018, 12:25	0.18
EX-OS2b	0.0043	0.3	01Jan2018, 12:35	0.23
EX-OS2c	0.0049	0.3	01Jan2018, 12:30	0.22
EX-OS3	0.0127	0.2	01Jan2018, 12:30	0.07
Junction-2	0.1927	5.4	01Jan2018, 12:45	0.14
Junction-3	0.1055	2.9	01Jan2018, 12:35	0.11
Junction-4	0.0796	1.8	01Jan2018, 12:40	0.09
Junction-5	0.2949	7.5	01Jan2018, 12:50	0.13
Junction-6	0.4004	9.8	01Jan2018, 12:50	0.12
Reach-1	0.0146	0.8	01Jan2018, 13:00	0.23
Reach-2	0.2949	7.5	01Jan2018, 13:00	0.13
Reach-3	0.4004	9.8	01Jan2018, 12:55	0.12
Sink-1	0.4800	11.2	01Jan2018, 12:50	0.12
SITE DISCH...	0.4800	11.2	01Jan2018, 12:50	0.12

Project: HAY_CREEK_FOREST_MANOR - UP   Simulation Run: EX-Q100

Start of Run: 01Jan2018, 00:00   Basin Model: EX - HAY CREEK_FM
End of Run: 02Jan2018, 00:00   Meteorologic Model: 100 YEAR EVENT
Compute Time: 28Mar2023, 08:57:29   Control Specifications: 1 DAY

Volume Units: (•) IN ( ) AC-FT

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
EX-1	0.0876	9.9	01Jan2018, 13:15	0.62
EX-2	0.0754	11.2	01Jan2018, 13:00	0.69
EX-3	0.0963	14.7	01Jan2018, 12:45	0.62
EX-5	0.0669	10.0	01Jan2018, 12:45	0.61
EX-OS1a	0.0146	4.1	01Jan2018, 12:45	1.01
EX-OS1b	0.0925	15.7	01Jan2018, 13:00	0.76
EX-OS2a	0.0248	8.0	01Jan2018, 12:30	0.89
EX-OS2b	0.0043	1.4	01Jan2018, 12:35	1.01
EX-OS2c	0.0049	1.6	01Jan2018, 12:30	0.99
EX-OS3	0.0127	2.0	01Jan2018, 12:40	0.57
Junction-2	0.1927	30.9	01Jan2018, 12:55	0.75
Junction-3	0.1055	17.4	01Jan2018, 12:45	0.65
Junction-4	0.0796	11.9	01Jan2018, 12:45	0.60
Junction-5	0.2949	43.9	01Jan2018, 13:00	0.72
Junction-6	0.4004	59.2	01Jan2018, 12:55	0.70
Reach-1	0.0146	4.1	01Jan2018, 12:55	1.00
Reach-2	0.2949	43.8	01Jan2018, 13:00	0.72
Reach-3	0.4004	59.1	01Jan2018, 13:00	0.70
Sink-1	0.4800	69.9	01Jan2018, 12:55	0.68
SITE DISCH...	0.4800	69.9	01Jan2018, 12:55	0.68

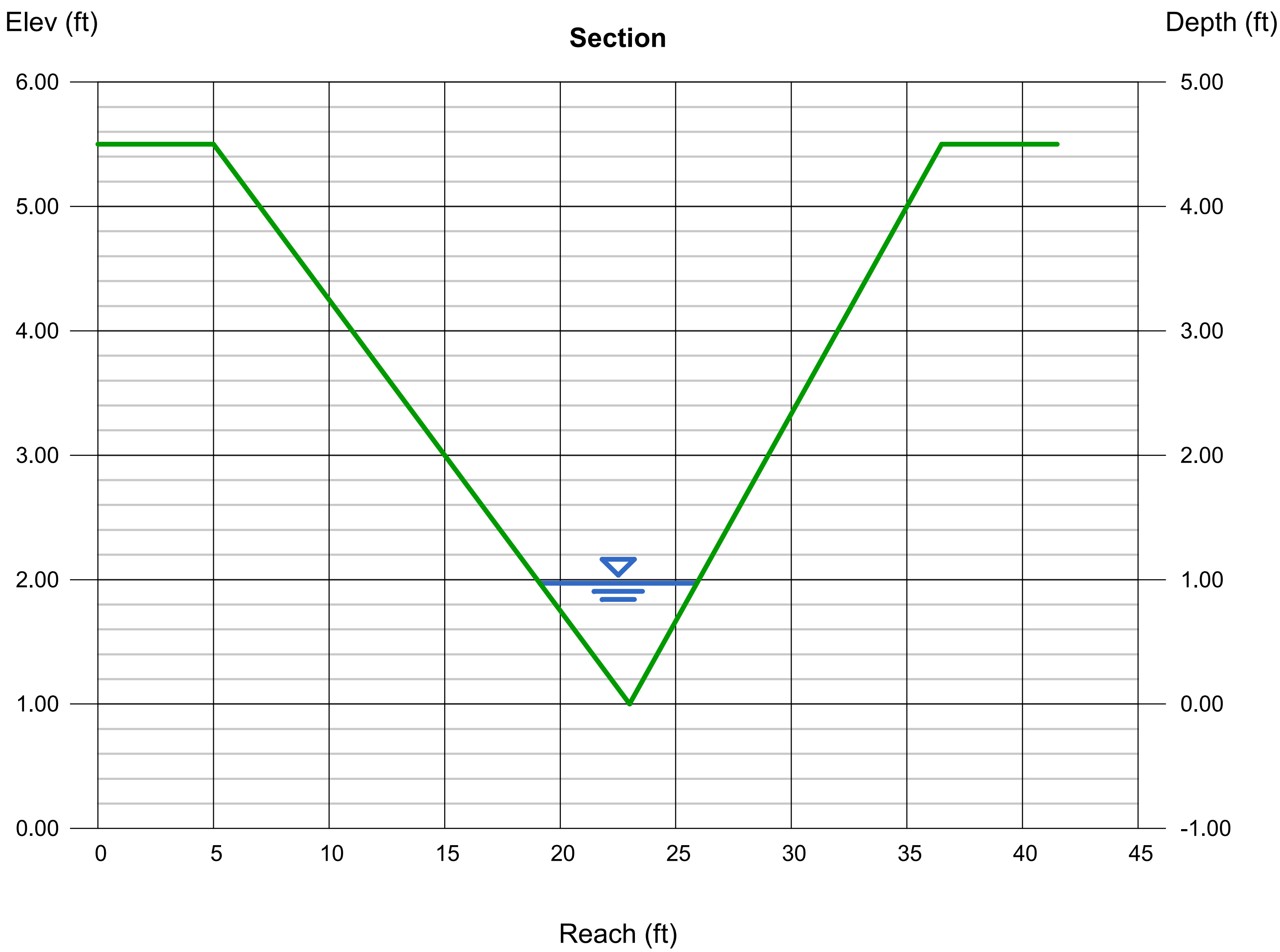
SWALE CALCULATIONS

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Mar 27 2023

DP-10

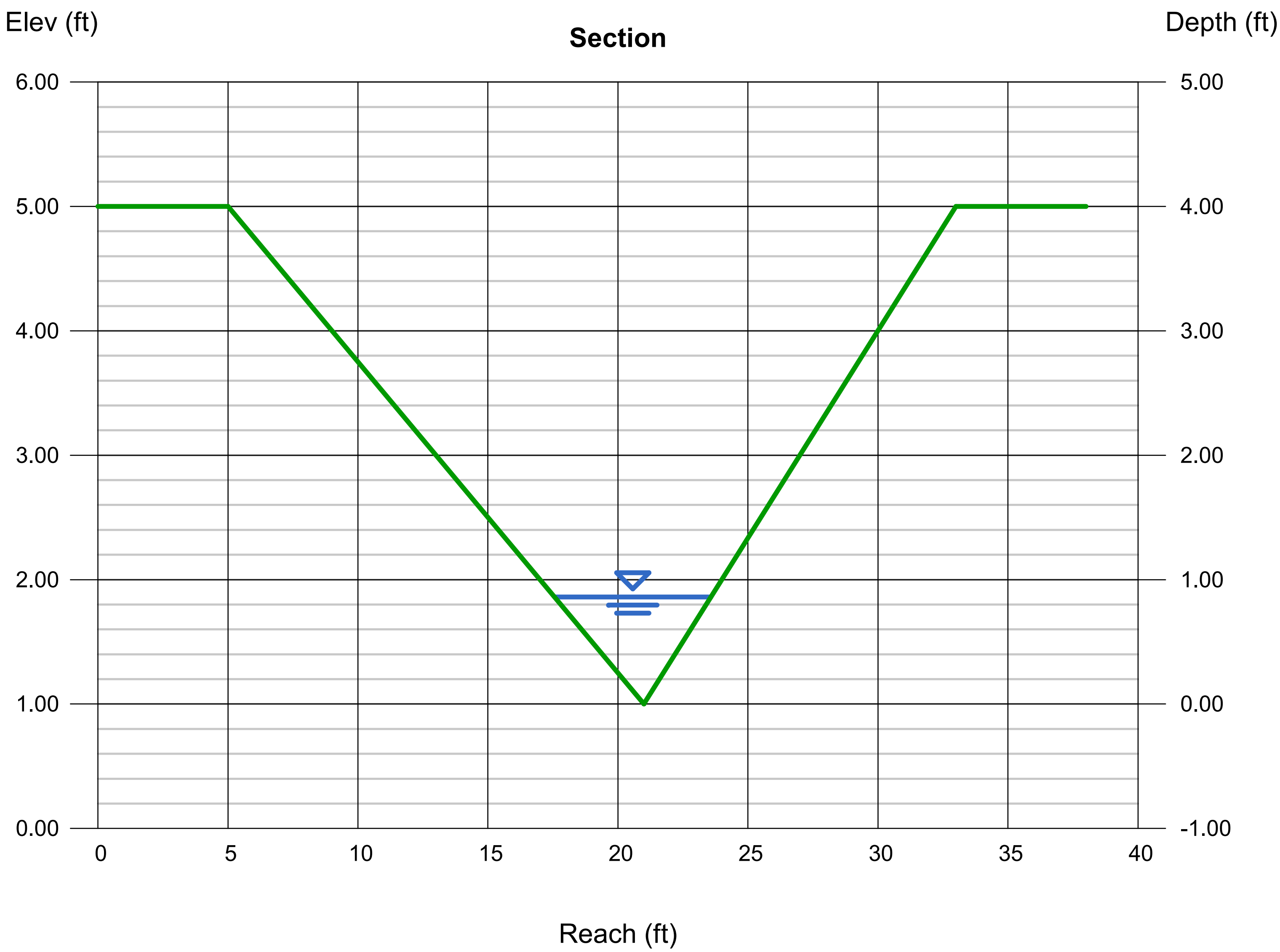
Triangular		Highlighted	
Side Slopes (z:1)	= 4.00, 3.00	Depth (ft)	= 0.97
Total Depth (ft)	= 4.50	Q (cfs)	= 9.600
		Area (sqft)	= 3.29
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 2.92
Slope (%)	= 6.00	Wetted Perim (ft)	= 7.07
N-Value	= 0.075	Crit Depth, Yc (ft)	= 0.86
		Top Width (ft)	= 6.79
Calculations		EGL (ft)	= 1.10
Compute by:	Known Q		
Known Q (cfs)	= 9.60		



Channel Report

DP-11

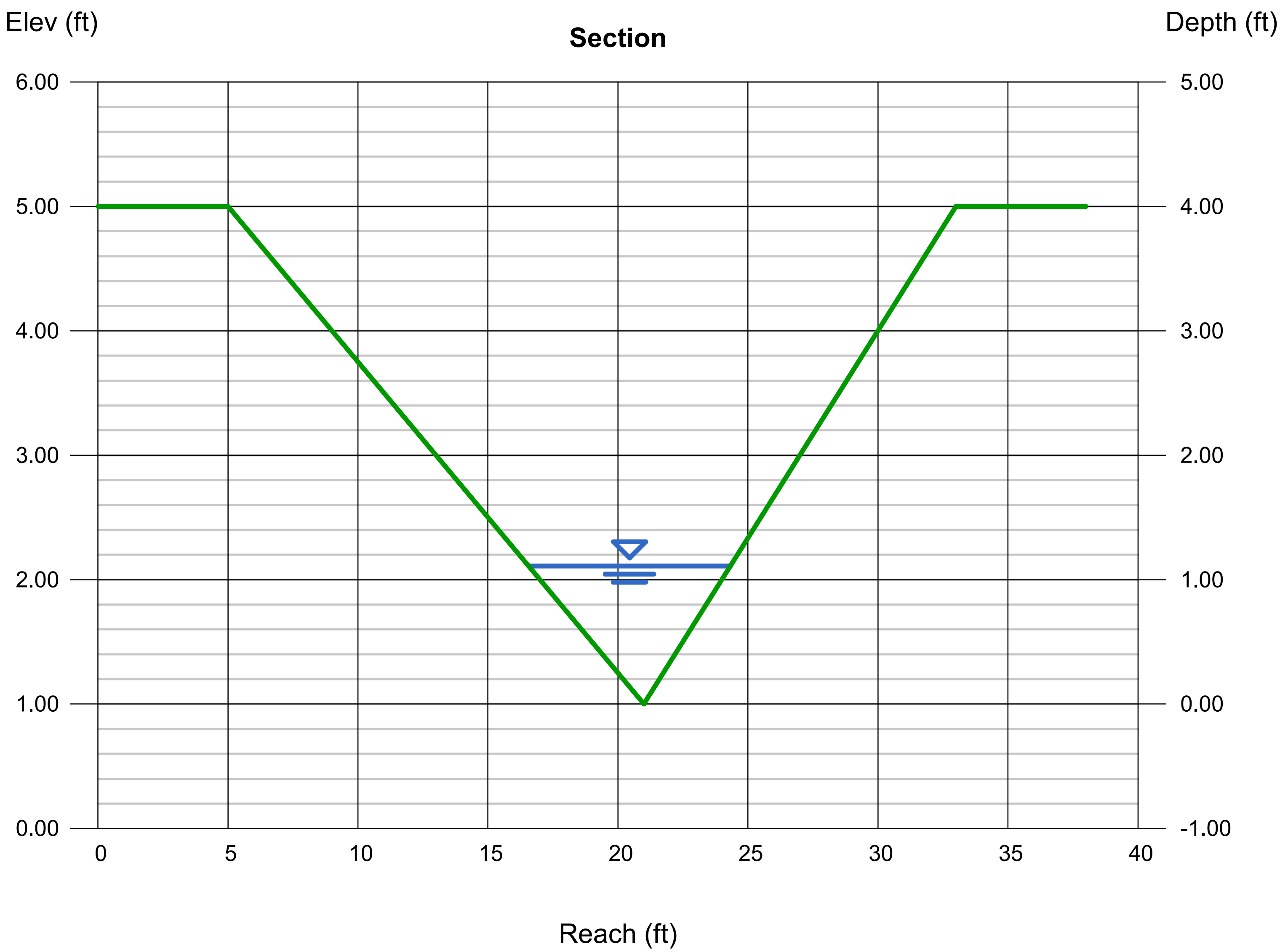
Triangular		**Highlighted**	
Side Slopes (z:1)	= 4.00, 3.00	Depth (ft)	= 0.86
Total Depth (ft)	= 4.00	Q (cfs)	= 4.600
		Area (sqft)	= 2.59
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 1.78
Slope (%)	= 2.80	Wetted Perim (ft)	= 6.27
N-Value	= 0.076	Crit Depth, Yc (ft)	= 0.65
		Top Width (ft)	= 6.02
Calculations		EGL (ft)	= 0.91
Compute by:	Known Q		
Known Q (cfs)	= 4.60		



Channel Report

DP-12

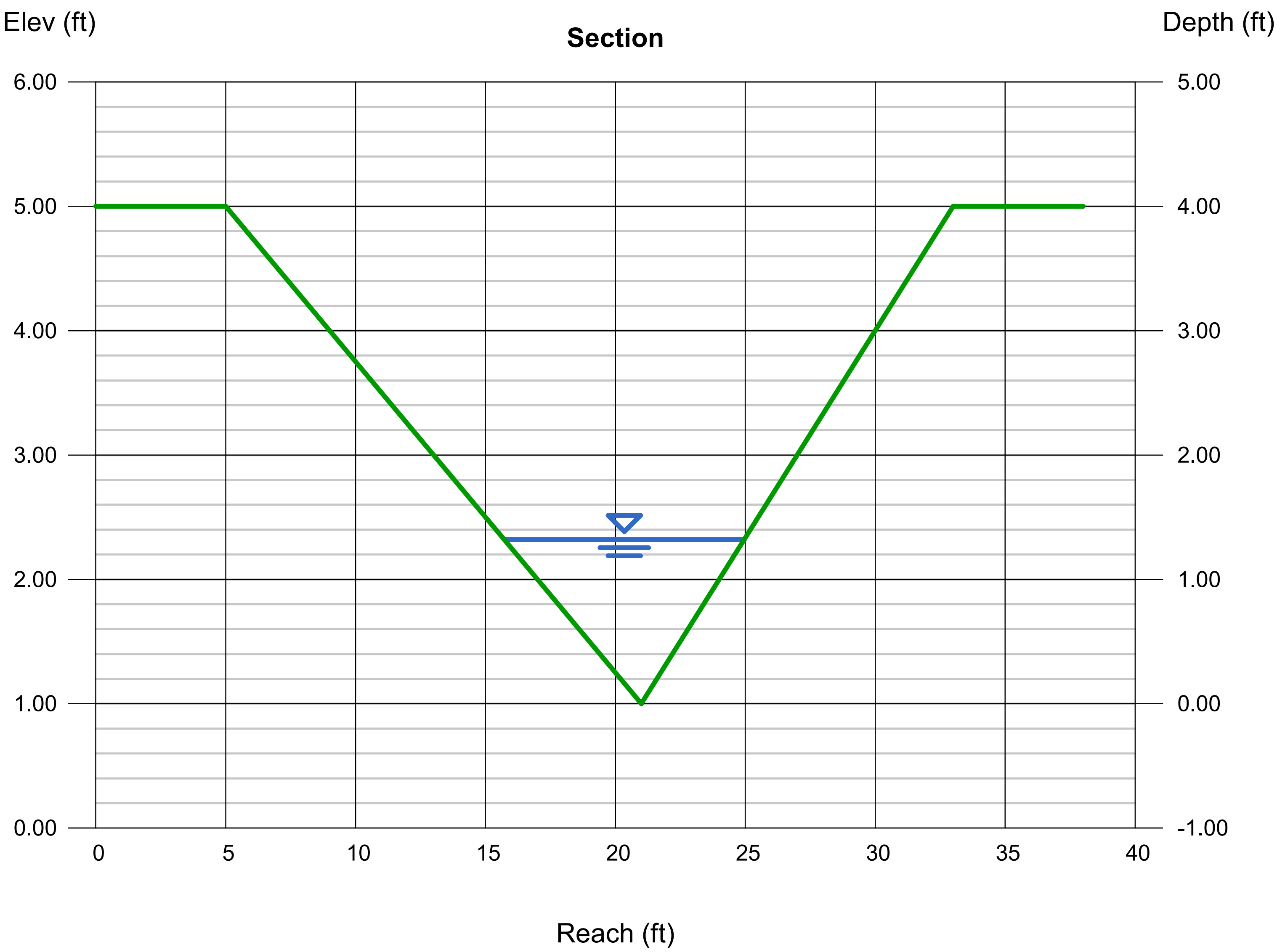
Triangular		**Highlighted**	
Side Slopes (z:1)	= 4.00, 3.00	Depth (ft)	= 1.11
Total Depth (ft)	= 4.00	Q (cfs)	= 12.30
		Area (sqft)	= 4.31
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 2.85
Slope (%)	= 4.80	Wetted Perim (ft)	= 8.09
N-Value	= 0.075	Crit Depth, Yc (ft)	= 0.95
		Top Width (ft)	= 7.77
Calculations		EGL (ft)	= 1.24
Compute by:	Known Q		
Known Q (cfs)	= 12.30		



Channel Report

DP-13 (3.6%)

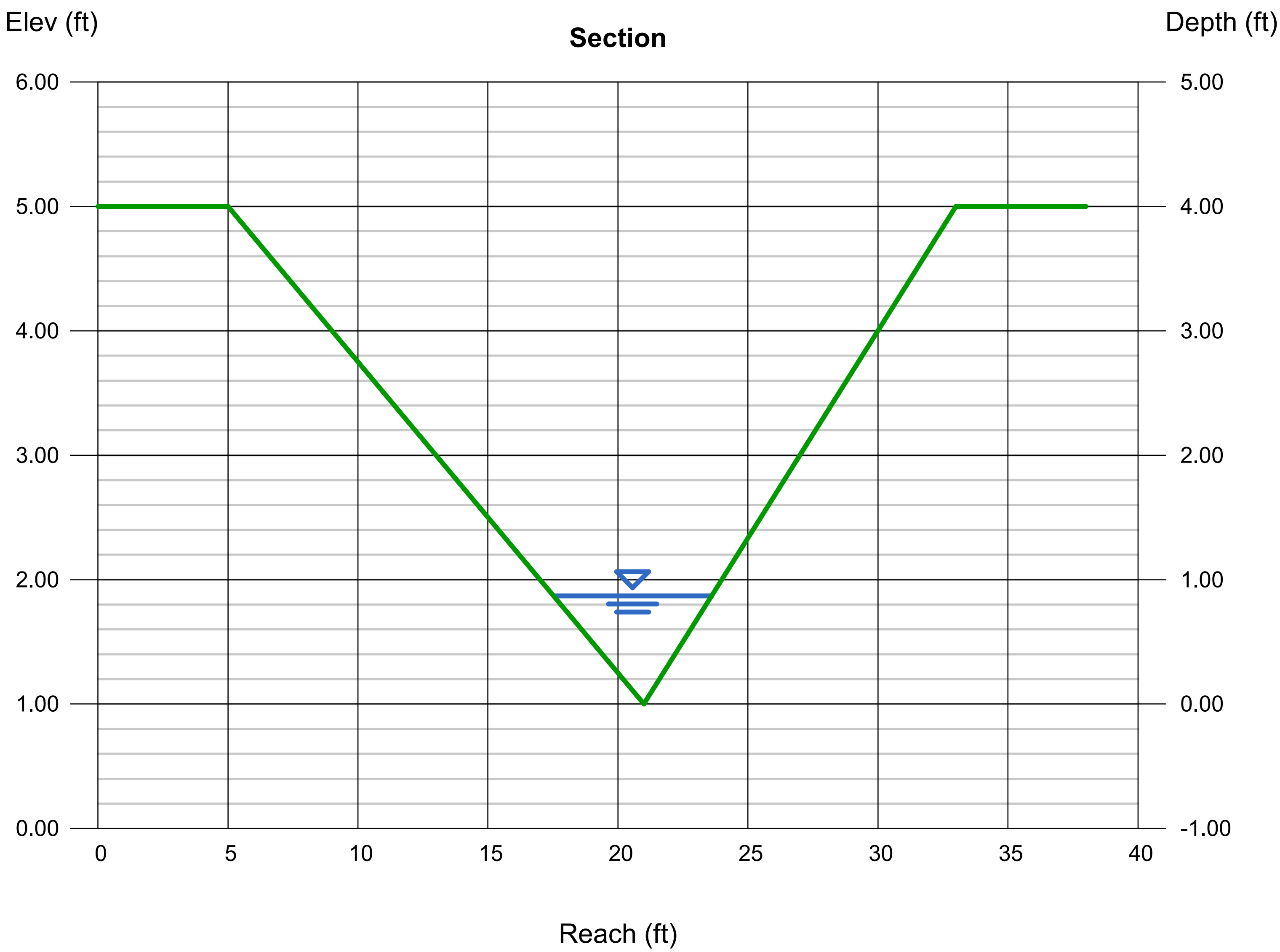
Triangular		**Highlighted**	
Side Slopes (z:1)	= 4.00, 3.00	Depth (ft)	= 1.32
Total Depth (ft)	= 4.00	Q (cfs)	= 17.00
		Area (sqft)	= 6.10
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 2.79
Slope (%)	= 3.60	Wetted Perim (ft)	= 9.62
N-Value	= 0.074	Crit Depth, Yc (ft)	= 1.08
		Top Width (ft)	= 9.24
Calculations		EGL (ft)	= 1.44
Compute by:	Known Q		
Known Q (cfs)	= 17.00		



Channel Report

DP-14

Triangular		**Highlighted**	
Side Slopes (z:1)	= 4.00, 3.00	Depth (ft)	= 0.87
Total Depth (ft)	= 4.00	Q (cfs)	= 6.100
		Area (sqft)	= 2.65
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 2.30
Slope (%)	= 2.80	Wetted Perim (ft)	= 6.34
N-Value	= 0.060	Crit Depth, Yc (ft)	= 0.72
		Top Width (ft)	= 6.09
Calculations		EGL (ft)	= 0.95
Compute by:	Known Q		
Known Q (cfs)	= 6.10		



Channel Report

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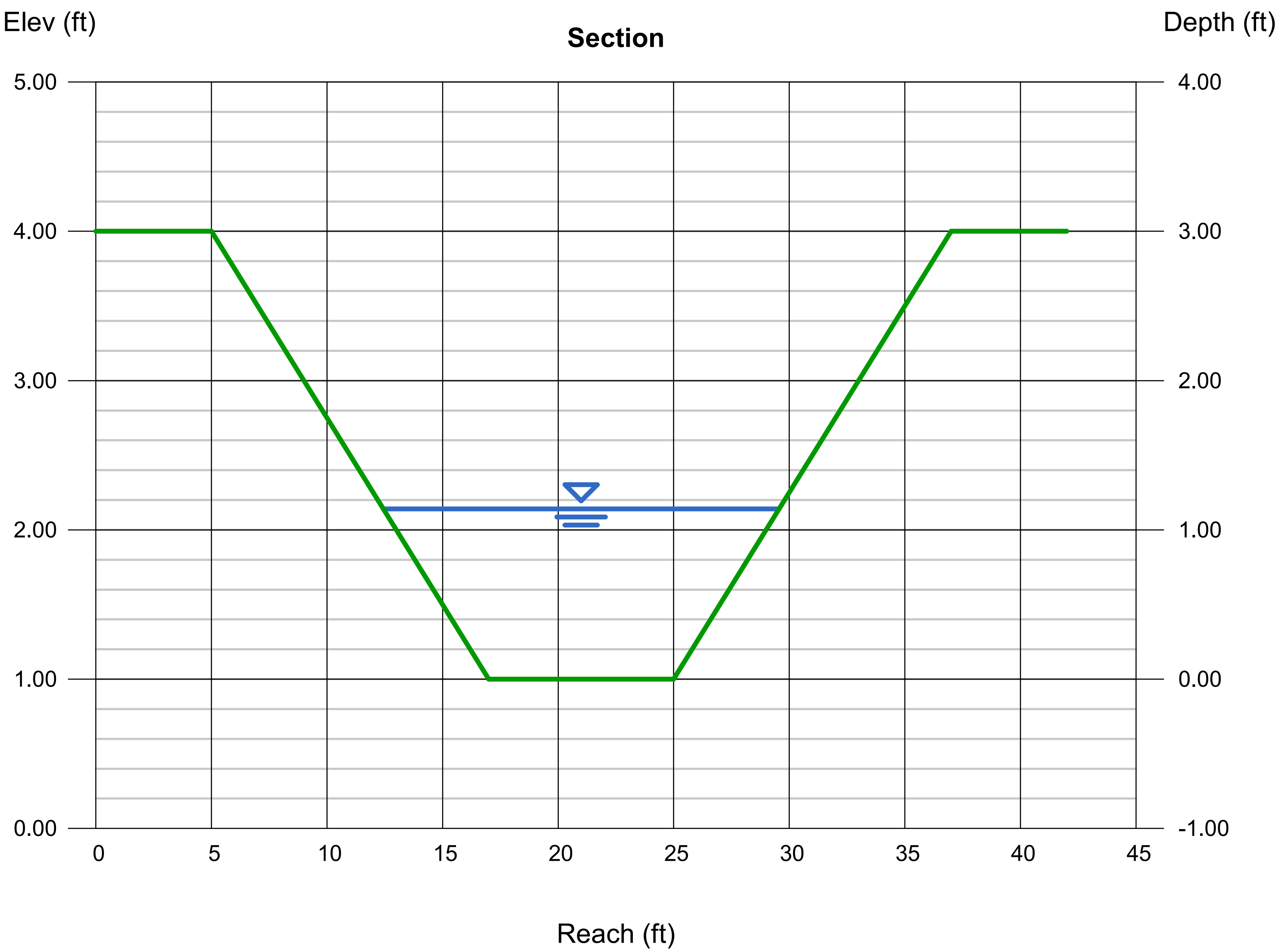
DP-15

Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 8.00	Depth (ft)	= 1.14
Side Slopes (z:1)	= 4.00, 4.00	Q (cfs)	= 58.10
Total Depth (ft)	= 3.00	Area (sqft)	= 14.32
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 4.06
Slope (%)	= 4.50	Wetted Perim (ft)	= 17.40
N-Value	= 0.068	Crit Depth, Yc (ft)	= 1.00
		Top Width (ft)	= 17.12
Calculations		EGL (ft)	= 1.40
Compute by:	Known Q		
Known Q (cfs)	= 58.10		

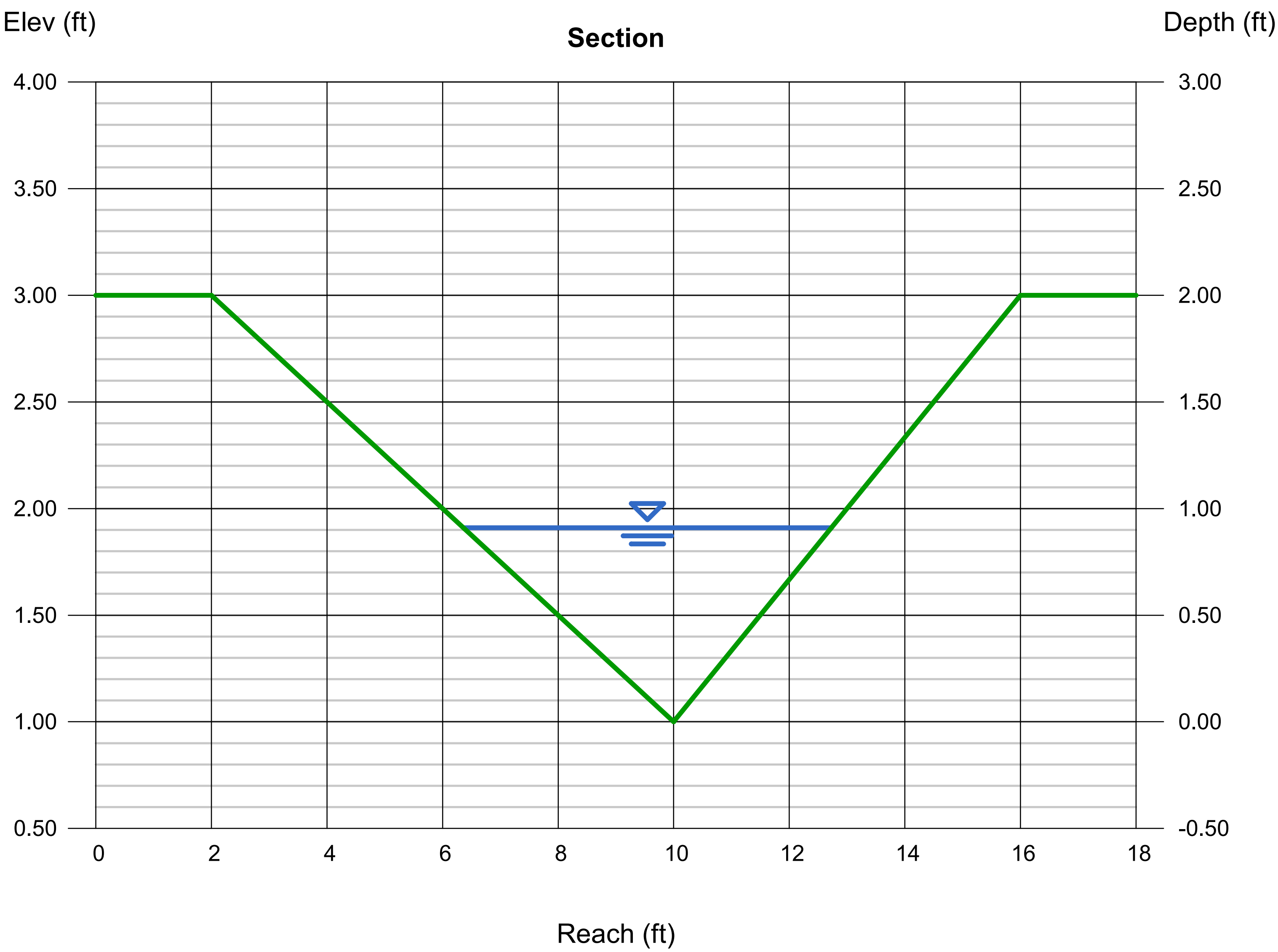


Channel Report

DP-16 (2.8%)

Triangular	
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 2.80
N-Value	= 0.074
Calculations	
Compute by:	Known Q
Known Q (cfs)	= 5.60

Highlighted	
Depth (ft)	= 0.91
Q (cfs)	= 5.600
Area (sqft)	= 2.90
Velocity (ft/s)	= 1.93
Wetted Perim (ft)	= 6.63
Crit Depth, Yc (ft)	= 0.70
Top Width (ft)	= 6.37
EGL (ft)	= 0.97



Channel Report

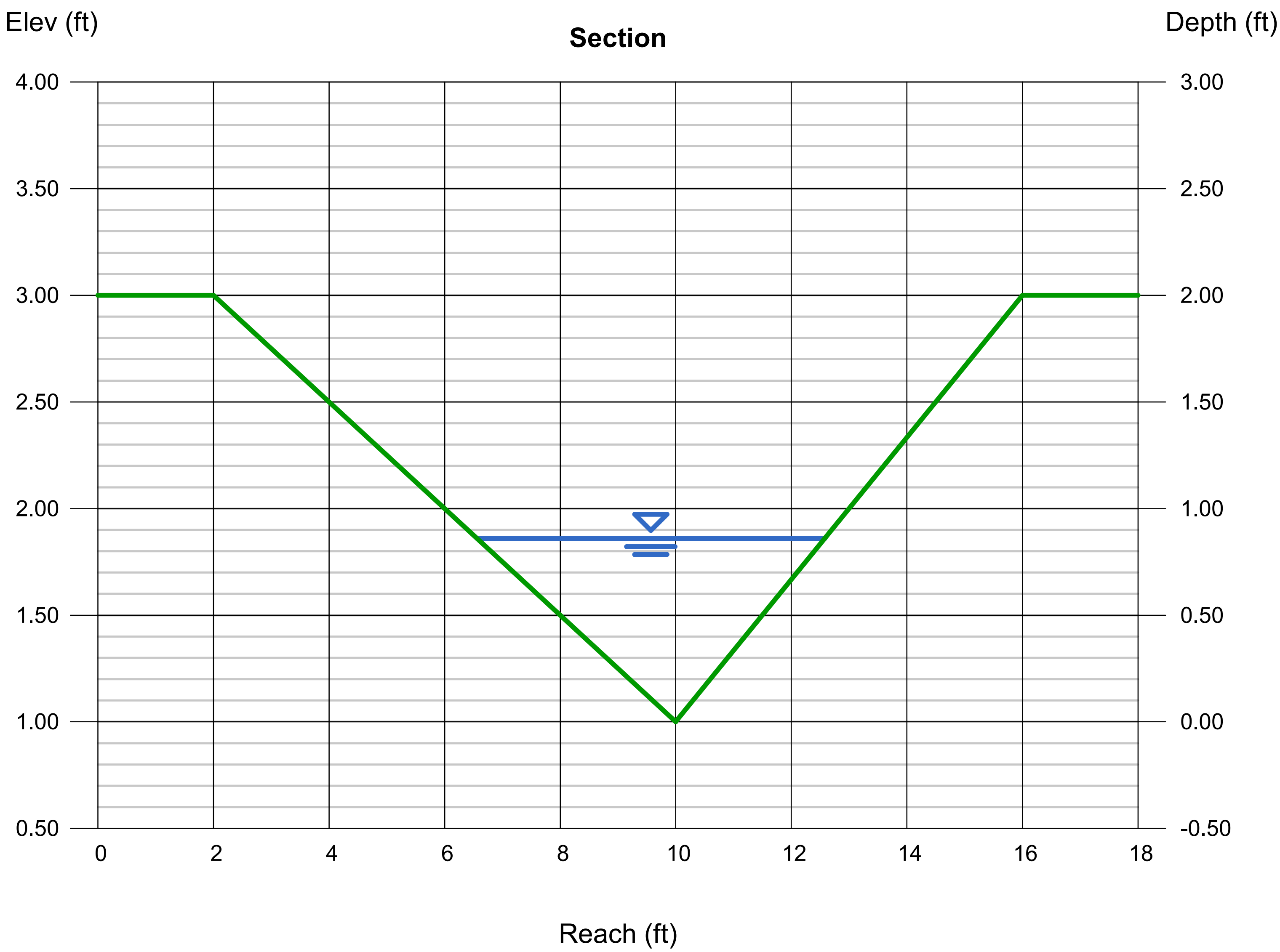
DP-16 (3.6%)

Triangular
Side Slopes (z:1) = 4.00, 3.00
Total Depth (ft) = 2.00

Invert Elev (ft) = 1.00
Slope (%) = 3.60
N-Value = 0.071

Calculations
Compute by: Known Q
Known Q (cfs) = 5.60

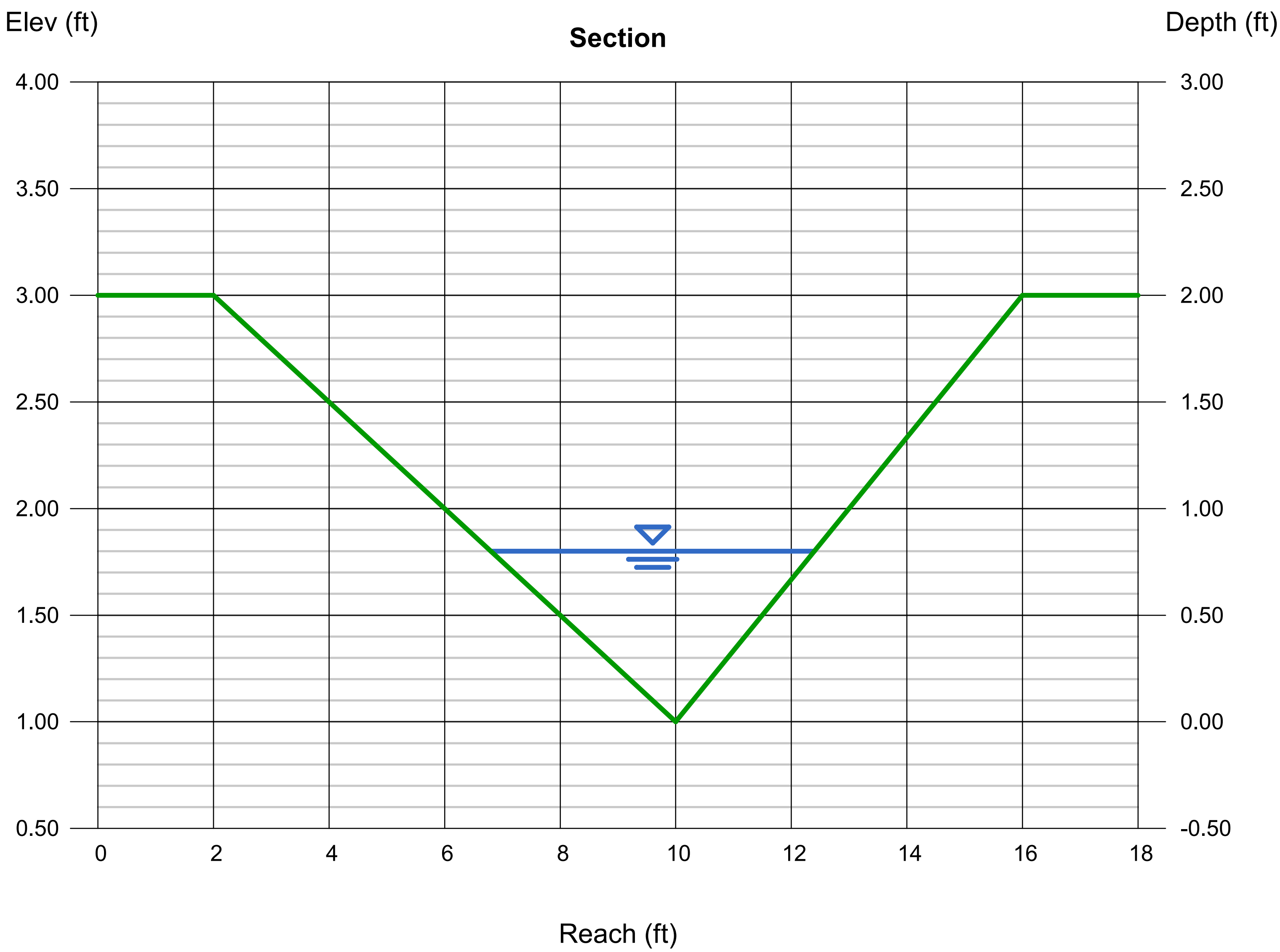
Highlighted
Depth (ft) = 0.86
Q (cfs) = 5.600
Area (sqft) = 2.59
Velocity (ft/s) = 2.16
Wetted Perim (ft) = 6.27
Crit Depth, Yc (ft) = 0.70
Top Width (ft) = 6.02
EGL (ft) = 0.93



Channel Report

DP-16 (4.8%)

Triangular		**Highlighted**	
Side Slopes (z:1)	= 4.00, 3.00	Depth (ft)	= 0.80
Total Depth (ft)	= 2.00	Q (cfs)	= 5.600
		Area (sqft)	= 2.24
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 2.50
Slope (%)	= 4.80	Wetted Perim (ft)	= 5.83
N-Value	= 0.068	Crit Depth, Yc (ft)	= 0.70
		Top Width (ft)	= 5.60
Calculations		EGL (ft)	= 0.90
Compute by:	Known Q		
Known Q (cfs)	= 5.60		



Channel Report

DP-16 (6.0%)

Triangular

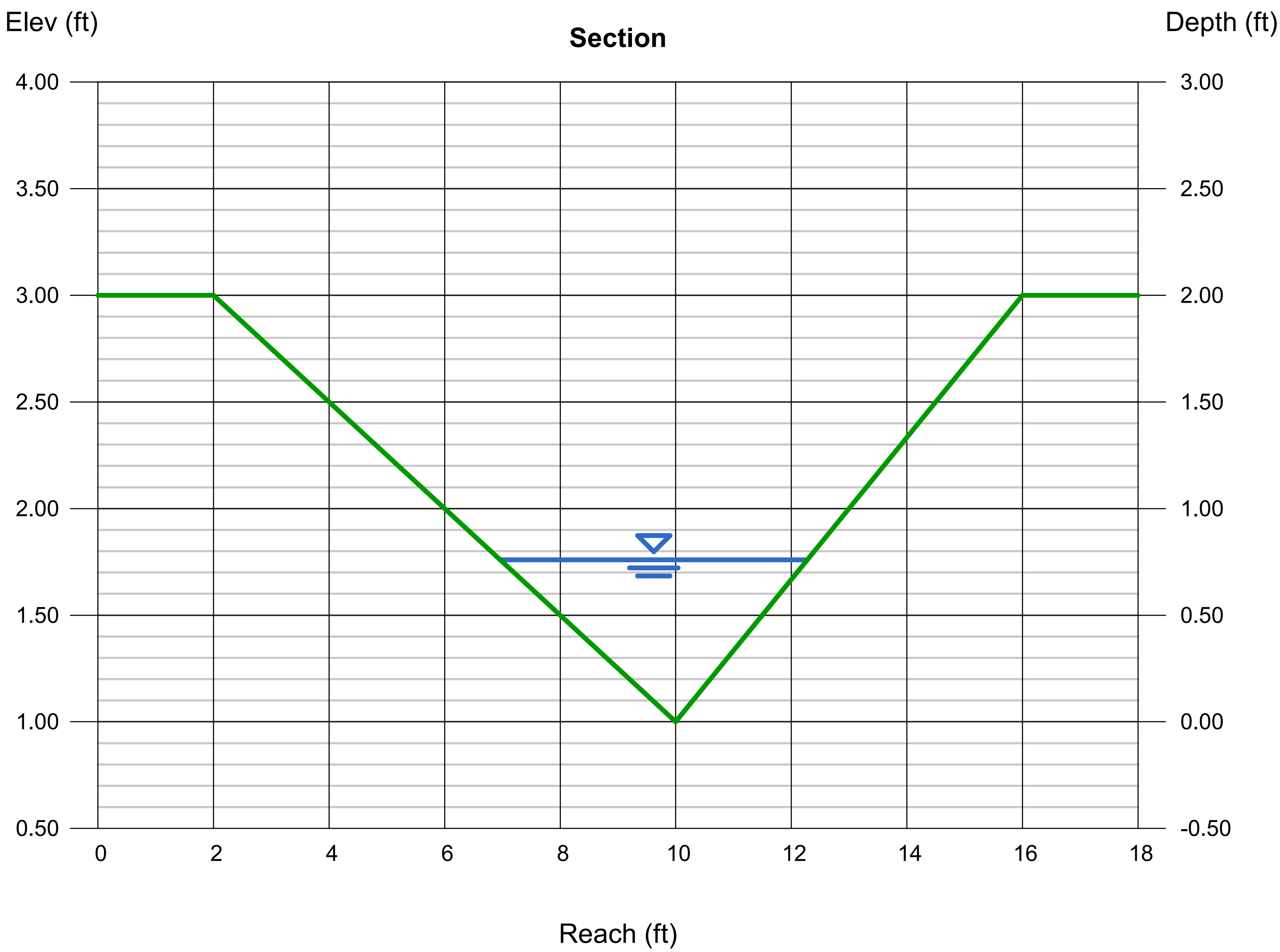
Side Slopes (z:1)	= 4.00, 3.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 1.00
Slope (%)	= 6.00
N-Value	= 0.066

Calculations

Compute by:	Known Q
Known Q (cfs)	= 5.60

Highlighted

Depth (ft)	= 0.76
Q (cfs)	= 5.600
Area (sqft)	= 2.02
Velocity (ft/s)	= 2.77
Wetted Perim (ft)	= 5.54
Crit Depth, Yc (ft)	= 0.70
Top Width (ft)	= 5.32
EGL (ft)	= 0.88



Channel Report

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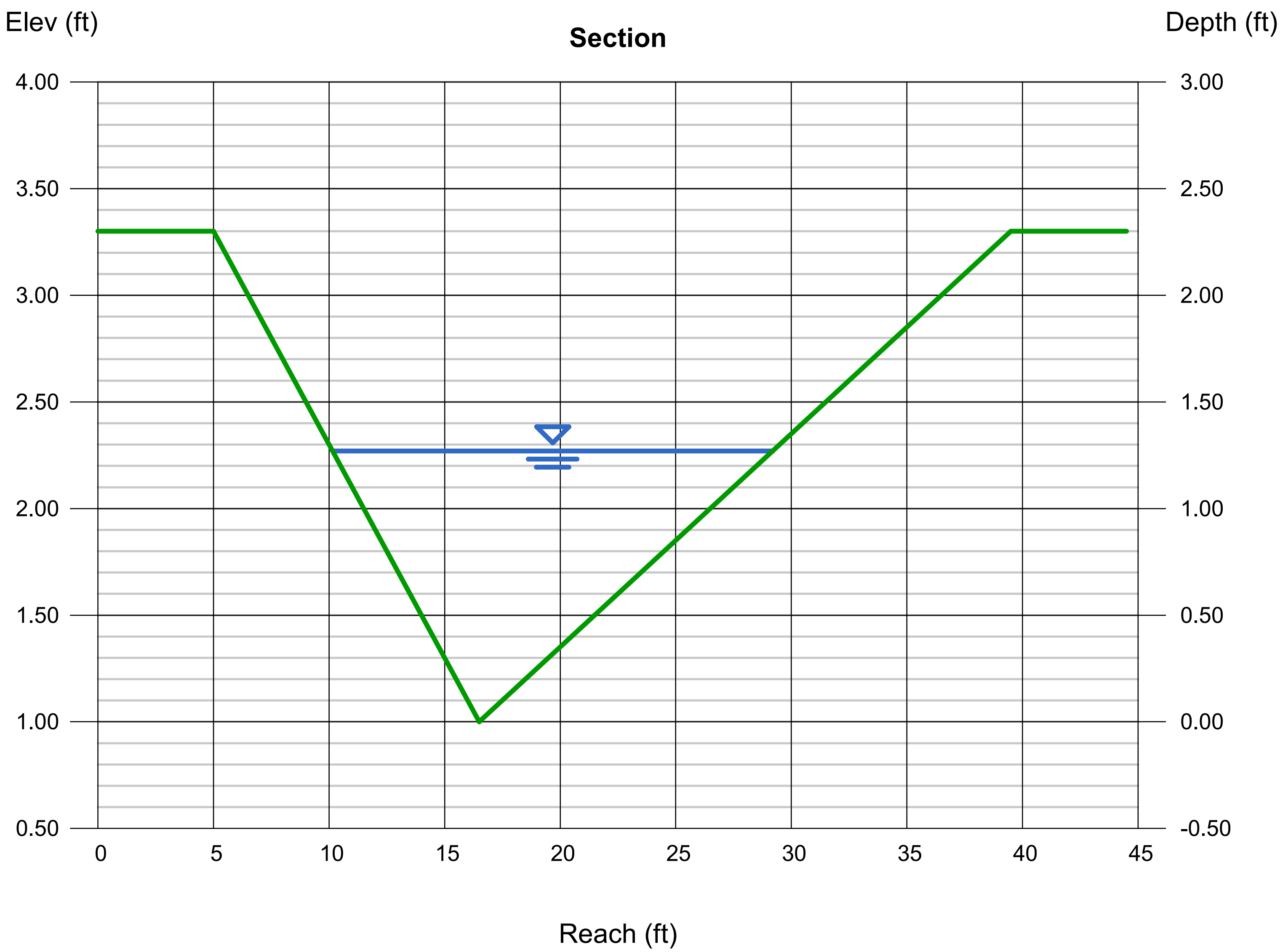
Roadside Embankment

Triangular
Side Slopes (z:1) = 5.00, 10.00
Total Depth (ft) = 2.30

Invert Elev (ft) = 1.00
Slope (%) = 2.00
N-Value = 0.032

Calculations
Compute by: Known Q
Known Q (cfs) = 58.10

Highlighted
Depth (ft) = 1.27
Q (cfs) = 58.10
Area (sqft) = 12.10
Velocity (ft/s) = 4.80
Wetted Perim (ft) = 19.24
Crit Depth, Yc (ft) = 1.31
Top Width (ft) = 19.05
EGL (ft) = 1.63



Hydraulic Analysis Report

Project Data

Project Title: Hay Creek

Designer:

Project Date: Thursday, January 12, 2023

Project Units: U.S. Customary Units

Notes:

Channel Analysis: DP-10

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0600 ft/ft

Manning's n: 0.0748

Flow: 9.6000 cfs

Result Parameters

Depth: 0.9687 ft

Area of Flow: 3.2840 ft^2

Wetted Perimeter: 7.0570 ft

Hydraulic Radius: 0.4654 ft

Average Velocity: 2.9233 ft/s

Top Width: 6.7806 ft

Froude Number: 0.7402

Critical Depth: 0.8624 ft

Critical Velocity: 3.6880 ft/s

Critical Slope: 0.1115 ft/ft

Critical Top Width: 6.16 ft

Calculated Max Shear Stress: 3.6266 lb/ft^2

Calculated Avg Shear Stress: 1.7423 lb/ft^2

Channel Lining Analysis: Channel Lining Design Analysis DP-10

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft^3

Water Specific Weight: 62.4 lb/ft^3

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.13865

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.645971

Manning's n method: Bathurst

Manning's n: 0.0747751

Channel Bottom Shear Results

V*: 1.36822

Reynold's Number: 84319.2

Shield's Parameter: 0.0755305

shear stress on channel bottom: 3.62777 lb/ft^2

Permissible shear stress for channel bottom: 5.34519 lb/ft^2

channel bottom is stable

Stable D50: 0.579601 ft

Channel Side Shear Results

K1: 0.934

K2: 1

Kb: 0

shear stress on side of channel: 3.62777 lb/ft^2

Permissible shear stress for side of channel: 5.34519 lb/ft^2

Stable Side D50: 0.541347 lb/ft^2

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-10

Channel Analysis: DP-12

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0480 ft/ft

Manning's n: 0.0749

Flow: 12.3000 cfs

Result Parameters

Depth: 1.1092 ft

Area of Flow: 4.3061 ft^2

Wetted Perimeter: 8.0809 ft

Hydraulic Radius: 0.5329 ft

Average Velocity: 2.8564 ft/s

Top Width: 7.7644 ft

Froude Number: 0.6759

Critical Depth: 0.9523 ft

Critical Velocity: 3.8754 ft/s

Critical Slope: 0.1083 ft/ft

Critical Top Width: 6.80 ft

Calculated Max Shear Stress: 3.3223 lb/ft^2

Calculated Avg Shear Stress: 1.5961 lb/ft^2

Channel Lining Analysis: Channel Lining Design Analysis DP-12

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft^3

Water Specific Weight: 62.4 lb/ft^3

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.12738

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.739882

Manning's n method: Bathurst

Manning's n: 0.0749154

Channel Bottom Shear Results

V*: 1.30971

Reynold's Number: 80713.5

Shield's Parameter: 0.0732093

shear stress on channel bottom: 3.32414 lb/ft^2

Permissible shear stress for channel bottom: 5.63346 lb/ft^2

channel bottom is stable

Stable D50: 0.498928 ft

Channel Side Shear Results

K1: 0.934

K2: 0.931169

Kb: 0

shear stress on side of channel: 3.32414 lb/ft^2

Permissible shear stress for side of channel: 5.2457 lb/ft^2

Stable Side D50: 0.500445 lb/ft^2

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-12

Channel Analysis: DP-13 (3.6%)

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0360 ft/ft

Manning's n: 0.0742

Flow: 17.0000 cfs

Result Parameters

Depth: 1.3169 ft

Area of Flow: 6.0700 ft^2

Wetted Perimeter: 9.5942 ft

Hydraulic Radius: 0.6327 ft

Average Velocity: 2.8007 ft/s

Top Width: 9.2184 ft

Froude Number: 0.6082

Critical Depth: 1.0839 ft

Critical Velocity: 4.1345 ft/s

Critical Slope: 0.1017 ft/ft

Critical Top Width: 7.75 ft

Calculated Max Shear Stress: 2.9583 lb/ft^2

Calculated Avg Shear Stress: 1.4212 lb/ft^2

Channel Lining Analysis: Channel Lining Design Analysis DP-13 (3.6%)

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft^3

Water Specific Weight: 62.4 lb/ft^3

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.11313

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.87817

Manning's n method: Bathurst

Manning's n: 0.074193

Channel Bottom Shear Results

V*: 1.2357

Reynold's Number: 76152.6

Shield's Parameter: 0.0702732

shear stress on channel bottom: 2.95908 lb/ft^2

Permissible shear stress for channel bottom: 5.40753 lb/ft^2

channel bottom is stable

Stable D50: 0.456842 ft

Channel Side Shear Results

K1: 0.934

K2: 0.931169

Kb: 0

shear stress on side of channel: 2.95908 lb/ft^2

Permissible shear stress for side of channel: 5.03532 lb/ft^2

Stable Side D50: 0.458231 lb/ft^2

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-13 (3.6%)

Channel Analysis: DP-14 (2.8%)

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0280 ft/ft

Manning's n: 0.0719

Flow: 6.1000 cfs

Result Parameters

Depth: 0.9292 ft

Area of Flow: 3.0218 ft^2

Wetted Perimeter: 6.7694 ft

Hydraulic Radius: 0.4464 ft

Average Velocity: 2.0187 ft/s

Top Width: 6.5042 ft

Froude Number: 0.5219

Critical Depth: 0.7193 ft

Critical Velocity: 3.3682 ft/s

Critical Slope: 0.1097 ft/ft

Critical Top Width: 5.14 ft

Calculated Max Shear Stress: 1.6235 lb/ft^2

Calculated Avg Shear Stress: 0.7799 lb/ft^2

Channel Lining Analysis: Channel Lining Design Analysis DP-14 (2.8%)

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft^3

Water Specific Weight: 62.4 lb/ft^3

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.00016

Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.929871

Manning's n method: Bathurst

Manning's n: 0.0719463

Channel Bottom Shear Results

V*: 0.915626

Reynold's Number: 37618.2

Shield's Parameter: 0.047

shear stress on channel bottom: 1.62467 lb/ft^2

Permissible shear stress for channel bottom: 2.4111 lb/ft^2

channel bottom is stable

Stable D50: 0.336967 ft

Channel Side Shear Results

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 1.62467 lb/ft^2

Permissible shear stress for side of channel: 2.24135 lb/ft^2

Stable Side D50: 0.338563 lb/ft^2

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-14 (2.8%)

Channel Analysis: DP-15

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0450 ft/ft

Manning's n: 0.0679

Flow: 58.1000 cfs

Result Parameters

Depth: 1.1374 ft

Area of Flow: 14.2731 ft^2

Wetted Perimeter: 17.3789 ft

Hydraulic Radius: 0.8213 ft

Average Velocity: 4.0706 ft/s

Top Width: 17.0988 ft

Froude Number: 0.7852

Critical Depth: 0.9917 ft

Critical Velocity: 4.8956 ft/s

Critical Slope: 0.0756 ft/ft

Critical Top Width: 15.93 ft

Calculated Max Shear Stress: 3.1937 lb/ft^2

Calculated Avg Shear Stress: 2.3062 lb/ft^2

Channel Lining Analysis: Channel Lining Design Analysis DP-15

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft^3

Water Specific Weight: 62.4 lb/ft^3

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.12239

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 1.11299

Manning's n method: Bathurst

Manning's n: 0.0678818

Channel Bottom Shear Results

V*: 1.28375

Reynold's Number: 79113.9

Shield's Parameter: 0.0721795

shear stress on channel bottom: 3.19369 lb/ft^2

Permissible shear stress for channel bottom: 5.55422 lb/ft^2

channel bottom is stable

Stable D50: 0.484031 ft

Channel Side Shear Results

K1: 0.934

K2: 0.931169

Kb: 0

shear stress on side of channel: 3.19369 lb/ft^2

Permissible shear stress for side of channel: 5.17191 lb/ft^2

Stable Side D50: 0.485503 lb/ft^2

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-15

Channel Analysis: DP-11

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0280 ft/ft

Manning's n: 0.0758

Flow: 4.6000 cfs

Result Parameters

Depth: 0.8526 ft

Area of Flow: 2.5441 ft^2

Wetted Perimeter: 6.2113 ft

Hydraulic Radius: 0.4096 ft

Average Velocity: 1.8081 ft/s

Top Width: 5.9680 ft

Froude Number: 0.4880

Critical Depth: 0.6425 ft

Critical Velocity: 3.1834 ft/s

Critical Slope: 0.1265 ft/ft

Critical Top Width: 4.59 ft

Calculated Max Shear Stress: 1.4896 lb/ft^2

Calculated Avg Shear Stress: 0.7156 lb/ft^2

Channel Lining Analysis: Channel Lining Design Analysis DP-11

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft^3

Water Specific Weight: 62.4 lb/ft^3

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.00016

Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.853239

Manning's n method: Bathurst

Manning's n: 0.0758392

Channel Bottom Shear Results

V*: 0.877086

Reynold's Number: 36034.8

Shield's Parameter: 0.047

shear stress on channel bottom: 1.49078 lb/ft^2

Permissible shear stress for channel bottom: 2.4111 lb/ft^2

channel bottom is stable

Stable D50: 0.309197 ft

Channel Side Shear Results

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 1.49078 lb/ft^2

Permissible shear stress for side of channel: 2.24135 lb/ft^2

Stable Side D50: 0.310662 lb/ft^2

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-11

Channel Analysis: DP-16 2.8%

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0280 ft/ft

Manning's n: 0.0731

Flow: 5.6000 cfs

Result Parameters

Depth: 0.9050 ft

Area of Flow: 2.8667 ft^2

Wetted Perimeter: 6.5934 ft

Hydraulic Radius: 0.4348 ft

Average Velocity: 1.9535 ft/s

Top Width: 6.3351 ft

Froude Number: 0.5118

Critical Depth: 0.6951 ft

Critical Velocity: 3.3111 ft/s

Critical Slope: 0.1144 ft/ft

Critical Top Width: 4.97 ft

Calculated Max Shear Stress: 1.5813 lb/ft^2

Calculated Avg Shear Stress: 0.7597 lb/ft^2

Channel Lining Analysis: Channel Lining Design Analysis DP-16 2.8%

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft^3

Water Specific Weight: 62.4 lb/ft^3

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.00016

Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.905928

Manning's n method: Bathurst

Manning's n: 0.0730949

Channel Bottom Shear Results

V*: 0.903762

Reynold's Number: 37130.7

Shield's Parameter: 0.047

shear stress on channel bottom: 1.58284 lb/ft^2

Permissible shear stress for channel bottom: 2.4111 lb/ft^2

channel bottom is stable

Stable D50: 0.328291 ft

Channel Side Shear Results

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 1.58284 lb/ft^2

Permissible shear stress for side of channel: 2.24135 lb/ft^2

Stable Side D50: 0.329846 lb/ft^2

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-16 2.8%

Channel Analysis: DP-16 3.6%

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0360 ft/ft

Manning's n: 0.0705

Flow: 5.6000 cfs

Result Parameters

Depth: 0.8520 ft

Area of Flow: 2.5408 ft^2

Wetted Perimeter: 6.2073 ft

Hydraulic Radius: 0.4093 ft

Average Velocity: 2.2041 ft/s

Top Width: 5.9641 ft

Froude Number: 0.5951

Critical Depth: 0.6951 ft

Critical Velocity: 3.3111 ft/s

Critical Slope: 0.1066 ft/ft

Critical Top Width: 4.97 ft

Calculated Max Shear Stress: 1.9140 lb/ft^2

Calculated Avg Shear Stress: 0.9195 lb/ft^2

Channel Lining Analysis: Channel Lining Design Analysis DP-16 3.6%

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft^3

Water Specific Weight: 62.4 lb/ft^3

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.00277

Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.852316

Manning's n method: Bathurst

Manning's n: 0.0705366

Channel Bottom Shear Results

V*: 0.993984

Reynold's Number: 40837.5

Shield's Parameter: 0.0475391

shear stress on channel bottom: 1.91464 lb/ft^2

Permissible shear stress for channel bottom: 2.43876 lb/ft^2

channel bottom is stable

Stable D50: 0.393633 ft

Channel Side Shear Results

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 1.91464 lb/ft^2

Permissible shear stress for side of channel: 2.26706 lb/ft^2

Stable Side D50: 0.395497 lb/ft^2

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-16 3.6%

Channel Analysis: DP-16 4.8%

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0480 ft/ft

Manning's n: 0.0674

Flow: 5.6000 cfs

Result Parameters

Depth: 0.7936 ft

Area of Flow: 2.2041 ft^2

Wetted Perimeter: 5.7815 ft

Hydraulic Radius: 0.3812 ft

Average Velocity: 2.5407 ft/s

Top Width: 5.5550 ft

Froude Number: 0.7108

Critical Depth: 0.6951 ft

Critical Velocity: 3.3111 ft/s

Critical Slope: 0.0973 ft/ft

Critical Top Width: 4.97 ft

Calculated Max Shear Stress: 2.3769 lb/ft^2

Calculated Avg Shear Stress: 1.1419 lb/ft^2

Channel Lining Analysis: Channel Lining Design Analysis DP-16 4.8%

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft^3

Water Specific Weight: 62.4 lb/ft^3

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.01739

Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.79406

Manning's n method: Bathurst

Manning's n: 0.067402

Channel Bottom Shear Results

V*: 1.10784

Reynold's Number: 45515

Shield's Parameter: 0.0505503

shear stress on channel bottom: 2.37837 lb/ft^2

Permissible shear stress for channel bottom: 2.59323 lb/ft^2

channel bottom is stable

Stable D50: 0.466547 ft

Channel Side Shear Results

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 2.37837 lb/ft^2

Permissible shear stress for side of channel: 2.41066 lb/ft^2

Stable Side D50: 0.468757 lb/ft^2

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-16 4.8%

Channel Analysis: DP-16 6.0%

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0600 ft/ft

Manning's n: 0.0818

Flow: 5.6000 cfs

Result Parameters

Depth: 0.8186 ft

Area of Flow: 2.3455 ft^2

Wetted Perimeter: 5.9639 ft

Hydraulic Radius: 0.3933 ft

Average Velocity: 2.3876 ft/s

Top Width: 5.7303 ft

Froude Number: 0.6577

Critical Depth: 0.6951 ft

Critical Velocity: 3.3111 ft/s

Critical Slope: 0.1435 ft/ft

Critical Top Width: 4.97 ft

Calculated Max Shear Stress: 3.0649 lb/ft^2

Calculated Avg Shear Stress: 1.4724 lb/ft^2

Channel Lining Analysis: Channel Lining Design Analysis DP-16 6.0%

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft^3

Water Specific Weight: 62.4 lb/ft^3

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.11741

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.546015

Manning's n method: Bathurst

Manning's n: 0.0818682

Channel Bottom Shear Results

V*: 1.25792

Reynold's Number: 77521.5

Shield's Parameter: 0.0711545

shear stress on channel bottom: 3.06642 lb/ft^2

Permissible shear stress for channel bottom: 5.09212 lb/ft^2

channel bottom is stable

Stable D50: 0.504669 ft

Channel Side Shear Results

K1: 0.934

K2: 1

Kb: 0

shear stress on side of channel: 3.06642 lb/ft^2

Permissible shear stress for side of channel: 5.09212 lb/ft^2

Stable Side D50: 0.471361 lb/ft^2

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-16 6.0%

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

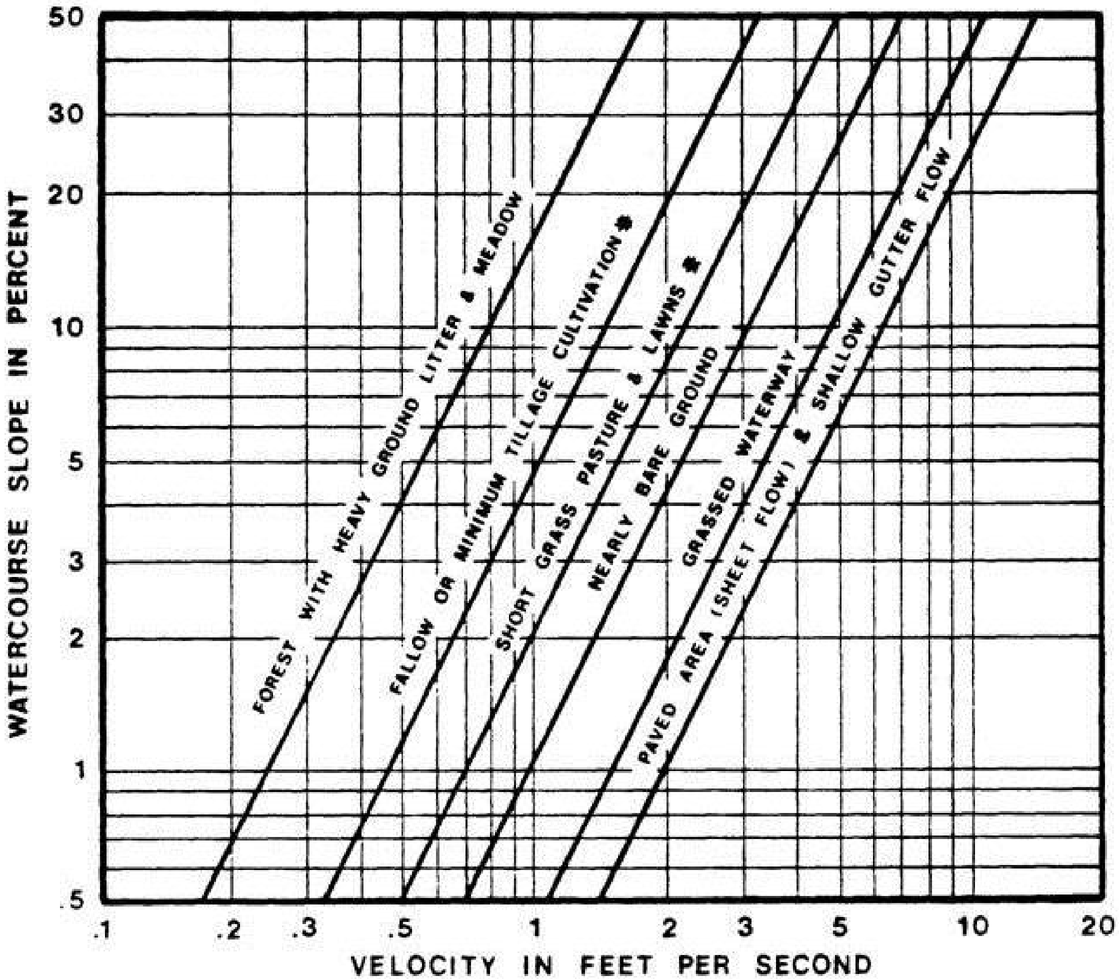
3.2 Time of Concentration

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



El Paso County Drainage Basin Fees

Resolution No. 22-442

Basin Number	Receiving Waters	Year Studied	Drainage Basin Name	2023 Drainage Fee (per Impervious Acre)	2023 Bridge Fee (per Impervious Acre)
Drainage Basins with DBPS's:					
CHMS0200	Chico Creek	2013	Haegler Ranch	$12,985	$1,916
CHWS1200	Chico Creek	2001	Bennett Ranch	$14,536	$5,576
CHWS1400	Chico Creek	2013	Falcon	$37,256	$5,118
FOFO2000	Fountain Creek	2001	West Fork Jimmy Camp Creek	$15,802	$4,675
FOFO2600	Fountain Creek	1991*	Big Johnson / Crews Gulch	$23,078	$2,980
FOFO2800	Fountain Creek	1988*	Widefield	$23,078	$0
FOFO2900	Fountain Creek	1988*	Security	$23,078	$0
FOFO3000	Fountain Creek	1991*	Windmill Gulch	$23,078	$346
FOFO3100 / FOFO3200	Fountain Creek	1988*	Carson Street / Little Johnson	$14,077	$0
FOFO3400	Fountain Creek	1984*	Peterson Field	$16,646	$1,262
FOFO3600	Fountain Creek	1991*	Fisher's Canyon	$23,078	$0
FOFO4000	Fountain Creek	1996	Sand Creek	$23,821	$9,743
FOFO4200	Fountain Creek	1977	Spring Creek	$11,969	$0
FOFO4600	Fountain Creek	1984*	Southwest Area	$23,078	$0
FOFO4800	Fountain Creek	1991	Bear Creek	$23,078	$1,262
FOFO5800	Fountain Creek	1964	Camp Creek	$2,557	$0
FOMO1000	Monument Creek	1981	Douglas Creek	$14,514	$321
FOMO1200	Monument Creek	1977	Templeton Gap	$14,900	$346
FOMO2000	Monument Creek	1971	Pulpit Rock	$7,653	$0
FOMO2200	Monument Creek	1994	Cottonwood Creek / S. Pine	$23,078	$1,262
FOMO2400	Monument Creek	1966	Dry Creek	$18,219	$660
FOMO3600	Monument Creek	1989*	Black Squirrel Creek	$10,478	$660
FOMO3700	Monument Creek	1987*	Middle Tributary	$19,259	$0
FOMO3800	Monument Creek	1987*	Monument Branch	$23,078	$0
FOMO4000	Monument Creek	1996	Smith Creek	$9,409	$1,262
FOMO4200	Monument Creek	1989*	Black Forest	$23,078	$628
FOMO5200	Monument Creek	1993*	Dirty Woman Creek	$23,078	$1,262
FOMO5300	Fountain Creek	1993*	Crystal Creek	$23,078	$1,262
Miscellaneous Drainage Basins: [1]					
CHBS0800	Chico Creek		Book Ranch	$21,654	$3,135
CHEC0400	Chico Creek		Upper East Chico	$11,797	$342
CHWS0200	Chico Creek		Telephone Exchange	$12,962	$304
CHWS0400	Chico Creek		Livestock Company	$21,351	$254
CHWS0600	Chico Creek		West Squirrel	$11,129	$4,619
CHWS0800	Chico Creek		Solberg Ranch	$23,078	$0
FOFO1200	Fountain Creek		Crooked Canyon	$6,968	$0
FOFO1400	Fountain Creek		Calhan Reservoir	$5,817	$339
FOFO1600	Fountain Creek		Sand Canyon	$4,203	$0
FOFO2000	Fountain Creek		Jimmy Camp Creek[3]	$23,078	$1,079
FOFO2200	Fountain Creek		Fort Carson	$18,219	$660
FOFO2700	Fountain Creek		West Little Johnson	$1,521	$0
FOFO3800	Fountain Creek		Stratton	$11,070	$495
FOFO5000	Fountain Creek		Midland	$18,219	$660
FOFO6000	Fountain Creek		Palmer Trail	$18,219	$660
FOFO6800	Fountain Creek		Black Canyon	$18,219	$660
FOMO4600	Monument Creek		Beaver Creek	$13,797	$0
FOMO3000	Monument Creek		Kettle Creek	$12,463	$0
FOMO3400	Monument Creek		Elkhorn	$2,094	$0
FOMO5000	Monument Creek		Monument Rock	$10,003	$0
FOMO5400	Monument Creek		Palmer Lake	$15,995	$0
FOMO5600	Monument Creek		Raspberry Mountain	$5,380	$0
PLPL0200	Monument Creek		Bald Mountain	$11,465	$0
Interim Drainage Basins: [2]					
FOFO1800	Fountain Creek		Little Fountain Creek	$2,950	$0
FOMO4400	Monument Creek		Jackson Creek	$9,135	$0
FOMO4800	Monument Creek		Teachout Creek	$6,343	$953

1. The miscellaneous drainage fee previous to September 1999 resolution was the average of all drainage fees for basins with Basin Planning Studies performed within the last 14 years.

2. Interim Drainage Fees are based upon draft Drainage Basin Planning Studies or the Drainage Basin Identification and Fee Estimation Report. (Best available information suitable for setting a fee.)

3. This is an interim fee and will be adjusted when a DBPS is completed. In addition to the Drainage Fee a surety in the amount of $7,285 per impervious acre shall be provided to secure payment of additional fees in the event that the DBPS results in a fee greater than the current fee. Fees paid in excess of the future revised fee will be reimbursed. See Resolution 06-326 (9/14/06) and Resolution 16-320 (9/07/16).

EPC Stormwater Management *Joshua Palmer, P.E.*

Channel Slope	Lining	Permissible Mean Channel Velocity* (ft/sec)
0 - 5%	Sodded grass	7
	Bermudagrass	6
	Reed canarygrass	5
	Tall fescue	5
	Kentucky bluegrass	5
	Grass-legume mixture	4
	Red fescue	2.5
	Redtop	2.5
	Sericea lespedeza	2.5
	Annual lespedeza	2.5
	Small grains (temporary)	2.5
5 - 10%	Sodded grass	6

Channel Slope	Lining	Permissible Mean Channel Velocity* (ft/sec)
	Bermudagrass	5
	Reed canarygrass	4
	Tall fescue	4
	Kentucky bluegrass	4
	Grass-legume mixture	3
Greater than 10%	Sodded grass	5
	Bermudagrass	4
	Reed canarygrass	3
	Tall fescue	3
	Kentucky bluegrass	3
*For highly erodible soils, decrease permissible velocities by 25%.		
*Grass lined channels are dependent upon assurances of continuous growth and maintenance of grass.		

APPENDIX C

REPORT REFERENCES

```
1*****************************************************
          **************************************
 *  WATER SURFACE PROFILES                          *
          *  U.S. ARMY CORPS OF ENGINEERS      *
 *  VERSION OF SEPTEMBER 1988                       *
          *  THE HYDROLOGIC ENGINEERING CENTER  *
 *  ERROR: 01,02                                    *
          *  609 SECOND STREET, SUITE D         *
 *  UPDATED:  4 APRIL    1989                       *
          *  DAVIS, CALIFORNIA 95616-4687       *
 *  RUN DATE    11/ 3/ 3   TIME   12:40:22          *
          *  (916) 756-1104, (916) 551-1748     *
 *****************************************************
          **************************************
```

THIS DOCUMENT IS THE HEC-2 MODEL PRINT OUT FOR THE 2003 LOMR FOR BEAVER CREEK. IT WAS SOURCED FROM THE REGIONAL FLOODPLAIN ADMINISTRATOR AT PIKES PEAK REGIONAL BUILDING DEPARTMENT (PPRBD).

```
                                            X     X  XXXXXXX   XXXXX
XXXXX
                                            X     X  X        X     X            X
    X
                                            X     X  X        X
    X
                                            XXXXXXX  XXXX     X          XXXXX
XXXXX
                                            X     X  X        X                  X

                                            X     X  X        X     X            X

                                            X     X  XXXXXXX   XXXXX
XXXXXXX
 END OF BANNER
1
    11/ 3/ 3      12:40:22
                                         PAGE    1



 THIS RUN EXECUTED 11/ 3/ 3    12:40:22
 **************************************************
   HEC2 RELEASE DATED SEP 88 UPDATED APR  1989


   ERROR CORR -  01,02
   MODIFICATION -
 **************************************************


 T1      BEAVER CREEK LOMR PROJECT NO. 03012
 T2      BEAVER CREEK FROM MONUMENT CREEK CONFLUENCE THROUGH SOUTH FORK
```

```
 T3       FILE NAME BVREFF.DAT
 T3       100-YEAR FREQUENCY CROSS-SECTIONS L TO R FACING UPSTREAM

 J1   ICHECK     INQ        NINV       IDIR       STRT       METRIC     HVINS      Q
 WSEL       FQ

        0          3          0          0          0          0          0          0
6733.2

 J2   NPROF      IPLOT      PRFVS      XSECV      XSECH      FN         ALLDC      IBW
CHNIM       ITRACE

       1          0         -1
```

THE QT ROW/CARD REPRESENTS THE FLOW VALUES USED IN THE HEC-2 MODELS. THIS QT CARD IS AT THE CONFLUENCE OF BEAVER AND MONUMENT CREEK WHICH IS LOCATED JUST DOWNSTREAM OF THE HAY AND BEAVER CREEK CONFLUENCE.

```
 QT          2        6317       20974

 NC       .07         .07         .05         .2          .4

          CONFLUENCE WITH MONUMENT CREEK
 X1         60          15        1280        1360           0           0           0

 GR       6752        1000        6750        1085        6740        1170        6735
     1235        6730        1250
 GR       6725        1280        6720        1295        6718        1305        6720
     1310        6725        1360
 GR       6730        1445        6735        1525        6740        1560        6745
     1670        6750        1810
```

THIS QT CARD IS APPROXIMATELY AT THE HAY CREEK CONFLUENCE WITH BEAVER CREEK AND DEMONSTRATES A 127 CFS INCREASE OVER THE UPSTREAM QT CARD. (6915 CFS -6788 CFS=127 CFS). WE THEREFORE BELIEVE 127 CFS TO BE A REASONABLE FLOW TO USE FOR HAY CREEK.

```
 QT          2        3507        6915

 NC       .07         .07         .05

 X1          1          14        1507        1545        1047        1047        1047

 GR       6748        1000        6744        1163        6742        1193        6740
     1313        6740        1358
 GR       6738        1386        6736        1507        6734        1520        6732
     1526        6732        1541
 GR       6740        1548        6746        1563        6746        1748        6748
     1798

 NC       .07         .07         .05         .1          .3

 X1          2          11        1136        1195         759         759         759

 GR       6758        1034        6756        1049        6750        1064        6748
     1076        6748        1136
 GR       6746        1147        6746        1184        6748        1195        6750
     1227        6756        1254
 GR       6758        1274


 QT          2        1847        5128
```

```
NC     .013       .013       .015         .1          .3

        HAY CREEK ROAD 2-72", 1-78" AND 1-84" CMP'S
        CROSS SECTION MODELED FOR ROAD PROFILE
        FLOW OVER ROAD REDUCED FOR CULVERTS CAPACITY
        CULVERTS CALCULATED CAPACITY = 1660 cfs
X1        3          6       1130       1250         845         845         845

GR     6778       1000       6772       1130        6772        1250        6774
    1390        6776        1500
GR     6778       1720

1
   11/ 3/ 3      12:40:22
                                        PAGE     2

NC     .025       .025       .025         .1          .3

QT        2       3107       6788

        DELACROCE RANCH ROAD CROSSING 1-84" AND 1-72" CMP
        CROSS SECTION MODELED FOR ROAD PROFILE
        FLOW OVER ROAD REDUCED FOR CULVERTS CAPACITY
        CULVERTS CALCULATED CAPACITY = 400 cfs
X1        4          5       1070       1280         984         984         984

X4        1       6786       1000

GR     6790        900       6784       1070        6784        1280        6790
    1420        6796        1520

NC      .07        .07        .08

X1        5         14       1243       1314         722         722         722

GR     6806       1188       6804       1198        6800        1211        6798
    1221        6786        1246
GR     6786       1272       6788       1314        6790        1344        6796
    1391        6796        1427
GR     6798       1428       6800       1435        6804        1475        6806
    1512

NC     .013       .013       .013         .1          .3

QT        2       3216       6154

NC     .013       .013       .015         .1          .3

X1      6.1          9       1209       1230        1160        1160        1160

GR     6840       1000       6828       1091        6828        1209      6806.6
    1209      6806.6        1230
GR     6828       1230       6828       1316        6830        1457        6840
    1619
```

NOTE THAT, ONCE THE FLOW THROUGH THE CULVERTS IS ACCOUNTED FOR, THE QT CARD MATCHES THE UPSTREAM QT CARD AT 6788 CFS. (5128 CFS + 1660 CFS = 6788 CFS)

THIS QT CARD IS AT THE HAY CREEK ROAD CULVERT JUST UPSTREAM OF THE CONFLUENCE WITH HAY CREEK.

```
SB     1.05       1.25        2.6          0          20         1.0         210
         0      6807.3      6806.6
NC     .013       .013       .015         .3          .5

         LONG VALLEY DRIVE, EXISITNG 2-10' x 10' CBC FACE
X1      6.2          9       1209       1230          48          48          48

X2        0          0          1     6817.3        6828

BT        9       1000       6840       6840        1091        6828        6828
     1209        6828        6828
BT     1209       6828     6817.3       1230        6828      6817.3        1230
     6828        6828        1316
BT     6828       6828       1457       6830        6830        1619        6840
     6840
GR     6840       1000       6828       1091        6828        1209      6807.3
     1209      6807.3        1230
GR     6828       1230       6828       1316        6830        1457        6840
     1619

NC      .07        .07        .08         .1          .3

X1        7          9       1146       1193         856         856         856

GR     6862       1033       6858       1042        6856        1071        6854
     1146        6854        1193
GR     6856       1279       6858       1312        6860        1326        6862
     1354

NC     .015       .015        .02

         BRISTLECONE LAKE CONCRETE SPILLWAY
X1        8          8       1080       1520        1026        1026        1026

GR     6910       1000       6908       1020        6900        1050        6890
     1080        6889        1090
GR     6889       1500       6890       1520        6908        1580


QT        2       4860       8624

NC      .07        .07        .05

         FLOW INTO BRISTLECONE LAKE
X1        9         13       1484       1817        2638        2638        2638

GR     6910       1000       6908       1050        6906        1135        6900
     1173        6894        1260
GR     6890       1484       6890       1817        6894        1824        6894
     1845        6900        1871
GR     6902       1905       6908       1982        6910        1991
```

```
X1        10        15      1169      1529       590       590       590

GR      6916      1000      6910      1044      6908      1064      6904
    1112      6900      1230
GR      6898      1270      6898      1334      6896      1349      6896
    1361      6898      1379
GR      6900      1392      6902      1530      6910      1614      6912
    1645      6916      1662

NC        .1        .1       .08

X1        11        13      1149      1363       701       701       701

GR      6924      1000      6920      1041      6918      1069      6916
    1077      6910      1149
GR      6908      1165      6904      1177      6904      1216      6906
    1226      6906      1346
GR      6916      1381      6918      1392      6924      1456


X1        12        14      1213      1240       643       643       643

GR      6936      1000      6928      1110      6926      1162      6922
    1176      6922      1213
GR      6916      1226      6916      1228      6922      1240      6922
    1246      6918      1256
GR      6916      1317      6916      1447      6930      1486      6936
    1566

X1        13        10      1139      1345       689       689       689

GR      6948      1000      6944      1053      6940      1139      6938
    1152      6928      1195
GR      6928      1221      6930      1230      6932      1274      6934
    1321      6948      1429

X1        14        11      1184      1401       834       834       834

GR      6964      1000      6956      1071      6954      1119      6948
    1234      6946      1305
GR      6944      1316      6944      1342      6946      1392      6956
    1414      6958      1435
GR      6964      1527


X1        15        17      1091      1278       764       764       764

GR      6978      1000      6970      1047      6966      1081      6962
    1091      6962      1133
GR      6960      1145      6958      1161      6958      1177      6960
    1219      6962      1278
GR      6962      1312      6960      1319      6960      1333      6962
    1336      6970      1371
```

```
GR     6974       1430       6978       1448


X1       16         15       1266       1400          718          718          718

GR     6994       1000       6992       1025         6986         1193         6984
    1205         6980         1266
GR     6974       1321       6974       1331         6976         1364         6980
    1400         6982         1505
GR     6986       1572       6988       1584         6990         1609         6992
    1615         6994         1618

QT        2       4772       8270

        CONFLUENCE OF NORTH AND SOUTH BEAVER CREEK
X1       17         16       1101       1378          547          547          547

GR     7008       1000       7002       1072         6998         1101         6994
    1117         6992         1121
GR     6988       1139       6988       1169         6990         1196         6992
    1213         6996         1277
GR     6996       1324       6998       1378         7000         1410         7002
    1427         7004         1489
GR     7008       1552


QT        2       3757       6754

        BEAVER CREEK SOUTH FORK
X1       18         10       1075       1269          598          598          598

GR     7022       1000       7018       1075         7016         1088         7004
    1122         7002         1128
GR     7002       1151       7008       1187         7012         1237         7020
    1269         7022         1285
1
   11/ 3/ 3      12:40:22
                                   PAGE    4



X1       19         16       1115       1341          800          800          800

GR     7046       1000       7044       1021         7038         1072         7034
    1115         7032         1129
GR     7030       1177       7028       1198         7026         1207         7026
    1228         7030         1242
GR     7032       1259       7034       1341         7038         1412         7040
    1473         7042         1536
GR     7046       1578


X1       20         14       1046       1295          625          625          625

GR     7068       1000       7062       1031         7058         1046         7056
    1061         7052         1072
```

```
 GR     7050       1099       7048       1122        7048        1178        7050
     1185        7052        1201
 GR     7058       1264       7060       1295        7062        1384        7068
     1656

 X1       21         17       1066       1246         879         879         879

 GR     7092       1000       7084       1032        7080        1066        7078
     1109        7074        1133
 GR     7072       1139       7072       1171        7074        1180        7076
     1200        7076        1229
 GR     7078       1239       7080       1246        7084        1271        7086
     1306        7086        1328
 GR     7088       1368       7092       1445


 X1       22          8       1032       1179         554         554         554

 GR     7104       1000       7096       1032        7094        1079        7092
     1085        7092        1094
 GR     7094       1108       7096       1179        7104        1252


 X1       23          7       1119       1165         514         514         514

 GR     7124       1000       7110       1119        7108        1145        7108
     1158        7110        1165
 GR     7120       1189       7124       1205




1
    11/ 3/ 3      12:40:22
                                  PAGE     5


    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS
BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA
LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN
   SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID
   ENDST


 *PROF 1
0

 CCHV=     .200 CEHV=     .400
 *SECNO 60.000
 3720 CRITICAL DEPTH ASSUMED
         CONFLUENCE WITH MONUMENT CREEK
     60.00    15.36  6733.36  6733.36  6733.20  6736.77     3.41      .00      .00
6725.00
```

```
    20974.    1400.   15429.    4145.     193.     921.     588.       0.       0.
 6725.00
       .00     7.27    16.75     7.05     .070     .050     .070     .000  6718.00
1239.93
   .012557       0.       0.       0.        0        4        0      .00   258.76
1498.70
0
 CCHV=     .100 CEHV=     .300
 *SECNO 1.000

 3301 HV CHANGED MORE THAN HVINS

      1.00    11.87  6743.87      .00      .00  6744.18      .30     7.10      .31
6736.00
     6915.    4409.    2319.     187.    1514.     359.      74.      44.       8.
 6732.00
       .07     2.91     6.46     2.53     .070     .050     .070     .000  6732.00
1164.88
   .002082    1047.    1047.    1047.        3        0        0      .00   392.81
1557.69
0
 CCHV=     .100 CEHV=     .300
 *SECNO 2.000

 3301 HV CHANGED MORE THAN HVINS

 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
      2.00     5.95  6751.95  6751.95      .00  6753.89     1.94     3.60      .49
6748.00
     6915.    1999.    4311.     605.     277.     329.     103.      67.      13.
 6748.00
       .09     7.21    13.09     5.87     .070     .050     .070     .000  6746.00
1059.12
   .019770     759.     759.     759.       20        8        0      .00   176.67
1235.79
0
 CCHV=     .100 CEHV=     .300
 *SECNO 3.000

 3301 HV CHANGED MORE THAN HVINS

1
    11/ 3/ 3      12:40:22
                                PAGE    6


    SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS
BANK ELEV
    Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA
LEFT/RIGHT
    TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN
   SSTA
    SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID
   ENDST
```

```
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
         HAY CREEK ROAD 2-72", 1-78" AND 1-84" CMP'S
         CROSS SECTION MODELED FOR ROAD PROFILE
         FLOW OVER ROAD REDUCED FOR CULVERTS CAPACITY
         CULVERTS CALCULATED CAPACITY = 1660 cfs
      3.00     2.75  6774.75  6774.75      .00  6775.69      .94     4.43      .10
6772.00
     5128.     506.    2806.    1817.      82.     330.     260.      80.      18.
 6772.00
       .12     6.18     8.51     6.99     .013     .015     .013     .000  6772.00
1070.47
   .001918     845.     845.     845.       20       14        0      .00   360.65
1431.12
0
 CCHV=     .100 CEHV=     .300
 *SECNO 4.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
         DELACROCE RANCH ROAD CROSSING 1-84" AND 1-72" CMP
         CROSS SECTION MODELED FOR ROAD PROFILE
         FLOW OVER ROAD REDUCED FOR CULVERTS CAPACITY
         CULVERTS CALCULATED CAPACITY = 400 cfs
      4.00     2.82  6786.82  6786.82      .00  6787.96     1.14     3.30      .06
6784.00
     6788.     884.    5375.     530.     136.     592.      93.      97.      26.
 6784.00
       .15     6.52     9.08     5.72     .025     .025     .025     .000  6784.00
 979.55
   .005866     984.     984.     984.       20        8        0      .00   366.20
1345.75
0
 *SECNO 5.000

 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =   .54

      5.00     7.93  6793.93      .00      .00  6795.16     1.23     7.17      .03
6798.00
     6788.       0.    5205.    1583.       0.     563.     208.     110.      30.
 6788.00
       .18      .00     9.25     7.59     .000     .080     .070     .000  6786.00
1229.48
   .020365     722.     722.     722.        3        0        0      .00   145.32
1374.79
0
 CCHV=     .100 CEHV=     .300
 CCHV=     .100 CEHV=     .300
 *SECNO 6.100
1
```

```
    SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS
BANK ELEV
    Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA
LEFT/RIGHT
    TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN
   SSTA
    SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID
   ENDST



 3301 HV CHANGED MORE THAN HVINS

 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
      6.10    13.82  6820.42  6820.42      .00  6827.40     6.98     9.61     1.73
6828.00
     6154.       0.    6154.       0.       0.     290.       0.     125.      33.
 6828.00
       .19      .00    21.20      .00     .000     .015     .000     .000  6806.60
1209.00
   .004232    1160.    1160.    1160.       20       14        0      .00    21.00
1230.00
0

 SPECIAL BRIDGE

 5227 DOWNSTREAM ELEV IS    6818.62 , NOT    6820.42 HYDRAULIC JUMP OCCURS
DOWNSTREAM (IF LOW FLOW CONTROLS)

 SB  XK        XKOR      COFQ      RDLEN     BWC       BWP       BAREA     SS
 ELCHU     ELCHD
      1.05      1.25      2.60       .00     20.00      1.00    210.00       .00
6807.30   6806.60

 CCHV=     .300 CEHV=     .500
 *SECNO 6.200

 3301 HV CHANGED MORE THAN HVINS


 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.45

 PRESSURE AND WEIR FLOW,  Weir Submergence Based on TRAPEZOIDAL Shape


  EGPRS      EGLWC       H3       QWEIR      QPR       BAREA   TRAPEZOID      ELLC
   ELTRD     WEIRLN
                                                                AREA
    6837.09   6829.67       .00     1566.     4591.      210.      190.     6817.30
  6828.00      358.


        LONG VALLEY DRIVE, EXISITNG 2-10' x 10' CBC FACE
```

```
      6.20    18.51  6825.81      .00      .00  6829.70     3.89     2.30      .00
6828.00
     6154.       0.    6154.       0.       0.     389.       0.     125.      33.
 6828.00
       .19      .00    15.84      .00     .000     .015     .000     .000  6807.30
1209.00
   .002023      48.      48.      48.        6        0        5      .00    21.00
1230.00
0
 CCHV=     .100 CEHV=     .300
1
    11/ 3/ 3      12:40:22
                                PAGE    8


    SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS
BANK ELEV
    Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA
LEFT/RIGHT
    TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN
   SSTA
    SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID
   ENDST


 *SECNO 7.000

 3301 HV CHANGED MORE THAN HVINS

 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
      7.00     3.79  6857.79  6857.79      .00  6859.09     1.29     4.78      .26
6854.00
     6154.    2041.    1773.    2340.     233.     178.     267.     135.      35.
 6854.00
       .22     8.77     9.94     8.78     .070     .080     .070     .000  6854.00
1045.01
   .048456     856.     856.     856.       20       21        0      .00   263.57
1308.58
0
 *SECNO 8.000
 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
         BRISTLECONE LAKE CONCRETE SPILLWAY
      8.00     1.86  6890.86  6890.86      .00  6891.77      .91    11.36      .04
6890.00
     6154.       4.    6145.       5.       1.     802.       1.     153.      44.
 6890.00
       .26     3.76     7.66     3.78     .015     .020     .015     .000  6889.00
1077.43
   .004781    1026.    1026.    1026.       20       11        0      .00   445.42
1522.85
0
 *SECNO 9.000
```

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 3301 HV CHANGED MORE THAN HVINS


 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  3.00

         FLOW INTO BRISTLECONE LAKE
      9.00     6.25  6896.25      .00      .00  6896.39      .14     4.54      .08
6890.00
     8624.    1738.    6774.     112.     988.    2081.      88.     273.      76.
 6890.00
       .51     1.76     3.26     1.28     .070     .050     .070     .000  6890.00
1227.40
   .001042    2638.    2638.    2638.        6        0        0      .00   627.35
1854.74
0
 *SECNO 10.000

 3301 HV CHANGED MORE THAN HVINS

 3685 20 TRIALS ATTEMPTED WSEL,CWSEL
1
    11/ 3/ 3      12:40:22
                                PAGE    9


    SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS
BANK ELEV
    Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA
LEFT/RIGHT
    TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN
   SSTA
    SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID
   ENDST


 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED
     10.00     6.42  6902.42  6902.42      .00  6903.79     1.37     1.64      .37
6904.00
     8624.       0.    7868.     756.       0.     806.     197.     301.      83.
 6900.00
       .52      .00     9.76     3.84     .000     .050     .070     .000  6896.00
1158.67
   .020723     590.     590.     590.       20        8        0      .00   375.72
1534.39
0
 *SECNO 11.000

 3301 HV CHANGED MORE THAN HVINS


 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.51

     11.00     8.51  6912.51      .00      .00  6913.11      .60     9.25      .08
6910.00
```

```
     8624.      63.    8336.     226.      38.    1323.      74.     321.      88.
 6906.00
       .55     1.65     6.30     3.04     .100     .080     .100     .000  6904.00
1118.82
   .009130     701.     701.     701.        5        0        0      .00   249.98
1368.80
0
 *SECNO 12.000

 3265 DIVIDED FLOW


 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =   .58

     12.00     5.74  6921.74      .00      .00  6922.57      .83     9.39      .07
6922.00
     8624.       0.     489.    8135.       0.      80.    1101.     340.      92.
 6922.00
       .58      .00     6.08     7.39     .000     .080     .100     .000  6916.00
1213.54
   .027002     643.     643.     643.        2        0        0      .00   242.34
1463.02
0
 *SECNO 13.000
     13.00     9.37  6937.37      .00      .00  6938.49     1.12    15.83      .09
6940.00
     8624.       0.    8495.     129.       0.     993.      44.     357.      95.
 6934.00
       .60      .00     8.55     2.94     .000     .080     .100     .000  6928.00
1154.72
   .019789     689.     689.     689.        3        0        0      .00   192.27
1346.98
0
 *SECNO 14.000
     14.00     8.38  6952.38      .00      .00  6953.10      .72    14.57      .04
6954.00
     8624.       0.    8455.     169.       0.    1234.      45.     380.     100.
 6946.00
       .64      .00     6.85     3.77     .000     .080     .100     .000  6944.00
1150.04
   .015530     834.     834.     834.        5        0        0      .00   255.99
1406.04
0
1
```



```
    SECNO    DEPTH    CWSEL    CRIWS    WSELK    EG       HV       HL       OLOSS
BANK ELEV
    Q        QLOB     QCH      QROB     ALOB     ACH      AROB     VOL      TWA
LEFT/RIGHT
    TIME     VLOB     VCH      VROB     XNL      XNCH     XNR      WTN      ELMIN
   SSTA
    SLOPE    XLOBL    XLCH     XLOBR    ITRIAL   IDC      ICONT    CORAR    TOPWID
   ENDST
```

```
 *SECNO 15.000
     15.00     7.44  6965.44      .00       .00  6966.26       .82    13.13       .03
6962.00
     8624.      42.    7240.    1342.       15.     953.      264.     402.      104.
 6962.00
       .67     2.81     7.60     5.09      .100      .080      .100     .000  6958.00
1082.39
   .019128     764.     764.     764.         4         0         0      .00   268.67
1351.06
0
 *SECNO 16.000

 3301 HV CHANGED MORE THAN HVINS

     16.00     8.28  6982.28  6981.98       .00  6983.91      1.63    17.41       .24
6980.00
     8624.     114.    8093.     417.       39.     767.      134.     420.      109.
 6980.00
       .69     2.88    10.55     3.10      .100      .080      .100     .000  6974.00
1231.31
   .031727     718.     718.     718.         7         8         0      .00   278.30
1509.60
0
 *SECNO 17.000

 3301 HV CHANGED MORE THAN HVINS

         CONFLUENCE OF NORTH AND SOUTH BEAVER CREEK
     17.00     9.53  6997.53      .00       .00  6998.36       .82    14.36       .08
6998.00
     8270.       0.    8270.       0.        0.    1137.        0.     433.      112.
 6998.00
       .71      .00     7.28      .00      .000      .080      .000     .000  6988.00
1102.86
   .021938     547.     547.     547.         5         0         0      .00   262.59
1365.45
0
 *SECNO 18.000

 3301 HV CHANGED MORE THAN HVINS

         BEAVER CREEK SOUTH FORK
     18.00     9.92  7011.92      .00       .00  7013.30      1.38    14.78       .17
7018.00
     6754.       0.    6754.       0.        0.     716.        0.     445.      115.
 7020.00
       .72      .00     9.43      .00      .000      .080      .000     .000  7002.00
1099.55
   .028896     598.     598.     598.         3         0         0      .00   136.51
1236.06
0
 *SECNO 19.000
     19.00     8.79  7034.79      .00       .00  7035.68       .89    22.33       .05
7034.00
```

```
     6754.        4.    6742.        7.        3.      890.        6.      460.      118.
 7034.00
       .75      1.31      7.58      1.31      .100      .080      .100      .000   7026.00
1106.50
   .026968      800.      800.      800.         4         0         0       .00    248.53
1355.03
0
1
    11/ 3/ 3      12:40:22
                                PAGE   11


    SECNO     DEPTH     CWSEL     CRIWS     WSELK     EG        HV        HL        OLOSS
BANK ELEV
    Q         QLOB      QCH       QROB      ALOB      ACH       AROB      VOL       TWA
LEFT/RIGHT
    TIME      VLOB      VCH       VROB      XNL       XNCH      XNR       WTN       ELMIN
   SSTA
    SLOPE     XLOBL     XLCH      XLOBR     ITRIAL    IDC       ICONT     CORAR     TOPWID
   ENDST


 *SECNO 20.000

 3301 HV CHANGED MORE THAN HVINS

     20.00      6.36   7054.36       .00       .00   7055.81      1.45     19.96       .17
7058.00
     6754.        0.    6754.        0.        0.      698.        0.      472.      121.
 7060.00
       .77       .00      9.67       .00      .000      .080      .000      .000   7048.00
1065.51
   .038415      625.      625.      625.         2         0         0       .00    160.28
1225.79
0
 *SECNO 21.000
     21.00      8.56   7080.56       .00       .00   7081.53       .97     25.68       .05
7080.00
     6754.        1.    6752.        1.        1.      854.        1.      487.      125.
 7080.00
       .80       .96      7.90       .96      .100      .080      .100      .000   7072.00
1061.22
   .022960      879.      879.      879.         5         0         0       .00    188.29
1249.51
0
 *SECNO 22.000

 3301 HV CHANGED MORE THAN HVINS


 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =   .65

     22.00      6.61   7098.61   7098.55       .00   7100.44      1.83     18.65       .26
7096.00
     6754.       55.    6570.      128.       14.      598.       31.      497.      127.
 7096.00
```

```
       .82     4.05    10.98     4.11     .100     .080     .100     .000  7092.00
1021.54
   .054047     554.     554.     554.        6       19        0      .00   181.31
1202.86
0
 *SECNO 23.000

 3302 WARNING:  CONVEYANCE CHANGE OUTSIDE OF ACCEPTABLE RANGE,  KRATIO =  1.42

     23.00     9.38  7117.38      .00      .00  7119.39     2.01    18.90      .05
7110.00
     6754.    1332.    5064.     358.     231.     398.      65.     505.     129.
 7110.00
       .83     5.76    12.71     5.49     .100     .080     .100     .000  7108.00
1056.30
   .026617     514.     514.     514.        4        0        0      .00   126.40
1182.70
0
1
    11/ 3/ 3      12:40:22
                                PAGE   12
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 THIS RUN EXECUTED 11/ 3/ 3    12:40:22
 **************************************************
   HEC2 RELEASE DATED SEP 88 UPDATED APR  1989


   ERROR CORR -  01,02
   MODIFICATION -
 **************************************************


 NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF
ERRORS LIST


 100-YEAR FREQUENCY CROSS

 SUMMARY PRINTOUT TABLE  150


       SECNO     XLCH      ELTRD     ELLC      ELMIN       Q       CWSEL     CRIWS
    EG       10*KS      VCH      AREA      .01K

 *     60.000       .00       .00       .00   6718.00  20974.00   6733.36   6733.36
  6736.77    125.57     16.75   1701.40  1871.69

        1.000   1047.00       .00       .00   6732.00   6915.00   6743.87       .00
  6744.18     20.82      6.46   1946.76  1515.58

 *      2.000    759.00       .00       .00   6746.00   6915.00   6751.95   6751.95
  6753.89    197.70     13.09    709.71   491.80
```

*	3.000	845.00	.00	.00	6772.00	5128.00	6774.75	6774.75	6775.69	19.18	8.51	671.52	1171.06
*	4.000	984.00	.00	.00	6784.00	6788.00	6786.82	6786.82	6787.96	58.66	9.08	820.00	886.28
*	5.000	722.00	.00	.00	6786.00	6788.00	6793.93	.00	6795.16	203.65	9.25	771.30	475.67
*	6.100	1160.00	.00	.00	6806.60	6154.00	6820.42	6820.42	6827.40	42.32	21.20	290.26	946.04
*	6.200	48.00	6828.00	6817.30	6807.30	6154.00	6825.81	.00	6829.70	20.23	15.84	388.61	1368.18
*	7.000	856.00	.00	.00	6854.00	6154.00	6857.79	6857.79	6859.09	484.56	9.94	677.64	279.57
*	8.000	1026.00	.00	.00	6889.00	6154.00	6890.86	6890.86	6891.77	47.81	7.66	804.16	890.04
*	9.000	2638.00	.00	.00	6890.00	8624.00	6896.25	.00	6896.39	10.42	3.26	3157.00	2671.12
*	10.000	590.00	.00	.00	6896.00	8624.00	6902.42	6902.42	6903.79	207.23	9.76	1002.54	599.08
*	11.000	701.00	.00	.00	6904.00	8624.00	6912.51	.00	6913.11	91.30	6.30	1435.60	902.54
*	12.000	643.00	.00	.00	6916.00	8624.00	6921.74	.00	6922.57	270.02	6.08	1181.02	524.82
	13.000	689.00	.00	.00	6928.00	8624.00	6937.37	.00	6938.49	197.89	8.55	1036.84	613.05
	14.000	834.00	.00	.00	6944.00	8624.00	6952.38	.00	6953.10	155.30	6.85	1278.76	692.03
	15.000	764.00	.00	.00	6958.00	8624.00	6965.44	.00	6966.26	191.28	7.60	1231.38	623.56

SECNO	XLCH	ELTRD	ELLC	ELMIN	Q	CWSEL	CRIWS	EG	10*KS	VCH	AREA	.01K
16.000	718.00	.00	.00	6974.00	8624.00	6982.28	6981.98	6983.91	317.27	10.55	940.80	484.16
17.000	547.00	.00	.00	6988.00	8270.00	6997.53	.00	6998.36	219.38	7.28	1136.59	558.36

	18.000	598.00	.00	.00	7002.00	6754.00	7011.92	.00
	7013.30	288.96	9.43	716.36	397.32			
	19.000	800.00	.00	.00	7026.00	6754.00	7034.79	.00
	7035.68	269.68	7.58	898.56	411.28			
	20.000	625.00	.00	.00	7048.00	6754.00	7054.36	.00
	7055.81	384.15	9.67	698.47	344.60			
	21.000	879.00	.00	.00	7072.00	6754.00	7080.56	.00
	7081.53	229.60	7.90	856.49	445.74			
*	22.000	554.00	.00	.00	7092.00	6754.00	7098.61	7098.55
	7100.44	540.47	10.98	643.15	290.52			
*	23.000	514.00	.00	.00	7108.00	6754.00	7117.38	.00
	7119.39	266.17	12.71	694.80	413.98			

100-YEAR FREQUENCY CROSS

SUMMARY PRINTOUT TABLE 150

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	60.000	20974.00	6733.36	.00	.00	.16	258.76	.00
	1.000	6915.00	6743.87	.00	10.52	.00	392.81	1047.00
*	2.000	6915.00	6751.95	.00	8.08	.00	176.67	759.00
*	3.000	5128.00	6774.75	.00	22.79	.00	360.65	845.00
*	4.000	6788.00	6786.82	.00	12.07	.00	366.20	984.00
*	5.000	6788.00	6793.93	.00	7.11	.00	145.32	722.00
*	6.100	6154.00	6820.42	.00	26.49	.00	21.00	1160.00
*	6.200	6154.00	6825.81	.00	5.38	.00	21.00	48.00
*	7.000	6154.00	6857.79	.00	31.99	.00	263.57	856.00
*	8.000	6154.00	6890.86	.00	33.06	.00	445.42	1026.00
*	9.000	8624.00	6896.25	.00	5.39	.00	627.35	2638.00
*	10.000	8624.00	6902.42	.00	6.17	.00	375.72	590.00
*	11.000	8624.00	6912.51	.00	10.10	.00	249.98	701.00

*	12.000	8624.00	6921.74	.00	9.23	.00	242.34	643.00
	13.000	8624.00	6937.37	.00	15.63	.00	192.27	689.00
	14.000	8624.00	6952.38	.00	15.01	.00	255.99	834.00
	15.000	8624.00	6965.44	.00	13.06	.00	268.67	764.00
	16.000	8624.00	6982.28	.00	16.84	.00	278.30	718.00
	17.000	8270.00	6997.53	.00	15.26	.00	262.59	547.00
	18.000	6754.00	7011.92	.00	14.39	.00	136.51	598.00
	19.000	6754.00	7034.79	.00	22.87	.00	248.53	800.00
	20.000	6754.00	7054.36	.00	19.57	.00	160.28	625.00
	21.000	6754.00	7080.56	.00	26.21	.00	188.29	879.00
*	22.000	6754.00	7098.61	.00	18.05	.00	181.31	554.00

	SECNO	Q	CWSEL	DIFWSP	DIFWSX	DIFKWS	TOPWID	XLCH
*	23.000	6754.00	7117.38	.00	18.77	.00	126.40	514.00

SUMMARY OF ERRORS AND SPECIAL NOTES

CAUTION SECNO= 60.000 PROFILE= 1 CRITICAL DEPTH ASSUMED

CAUTION SECNO= 2.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 2.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 2.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO= 3.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 3.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 3.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO= 4.000 PROFILE= 1 CRITICAL DEPTH ASSUMED
CAUTION SECNO= 4.000 PROFILE= 1 PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO= 4.000 PROFILE= 1 20 TRIALS ATTEMPTED TO BALANCE WSEL

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WARNING SECNO=      5.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=      6.100  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=      6.100  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=      6.100  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=      6.200  PROFILE=  1  HYDRAULIC JUMP D.S.
WARNING SECNO=      6.200  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=      7.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=      7.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=      7.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

CAUTION SECNO=      8.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=      8.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=      8.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

WARNING SECNO=      9.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

CAUTION SECNO=     10.000  PROFILE=  1  CRITICAL DEPTH ASSUMED
CAUTION SECNO=     10.000  PROFILE=  1  PROBABLE MINIMUM SPECIFIC ENERGY
CAUTION SECNO=     10.000  PROFILE=  1  20 TRIALS ATTEMPTED TO BALANCE WSEL

WARNING SECNO=     11.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=     12.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=     22.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE

WARNING SECNO=     23.000  PROFILE=  1  CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE
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NOTES TO USERS

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

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

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

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

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, City of Fountain, Bureau of Land Management, National Oceanic and Atmospheric Administration, United States Geological Survey, and Anderson Consulting Engineers, Inc. These data are current as of 2006.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

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

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

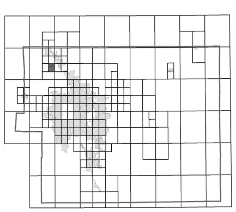
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

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

El Paso County Vertical Datum Offset Table

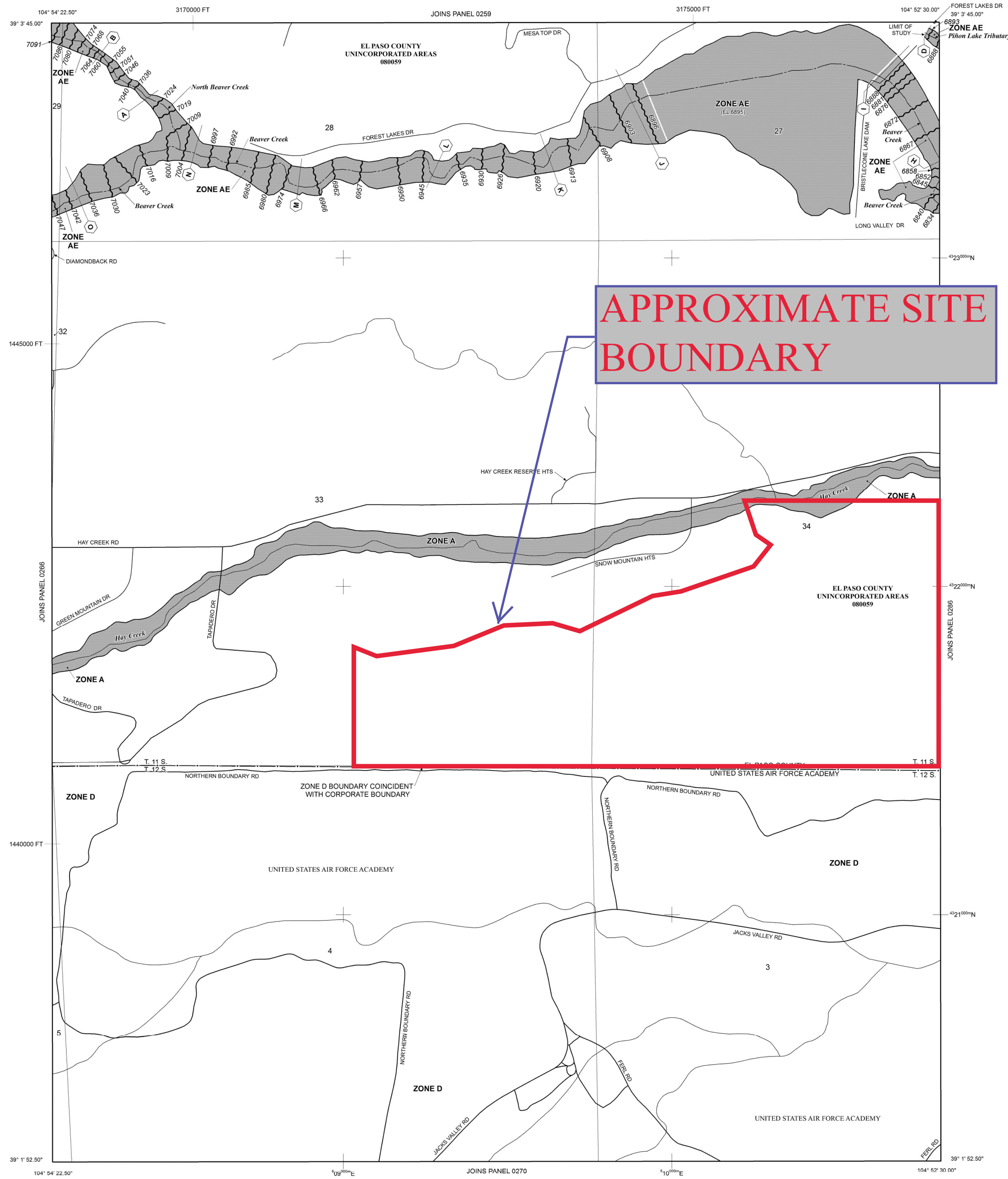
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 11 SOUTH, RANGE 67 WEST, AND TOWNSHIP 12 SOUTH, RANGE 67 WEST.

LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

- Floodplain boundary
- Floodway boundary
- Zone D Boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
- ~~ 513 ~~ Base Flood Elevation line and value; elevation in feet*
- (EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

- (A)—(A) Cross section line
- (23)- - - -(23) Transect line
- 97° 07' 30.00" 32° 22' 30.00" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
- 4275000mN 1000-meter Universal Transverse Mercator grid ticks, zone 13
- 6000000 FT 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
- DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel)
- • M1.5 River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

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

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

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

PANEL 0267G

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 267 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

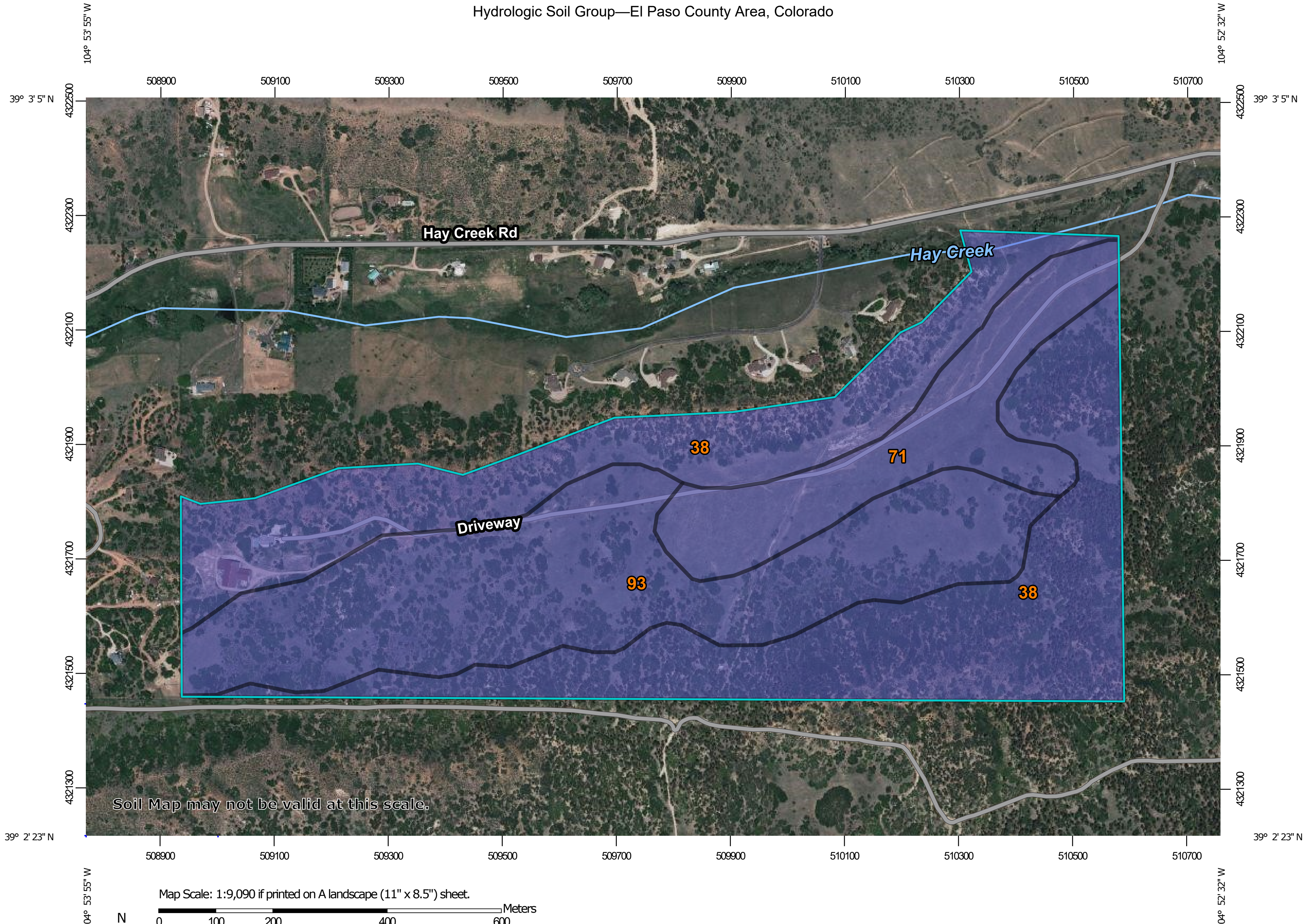
COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0267	G

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

MAP NUMBER
08041C0267G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency



Map Scale: 1:9,090 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 100, 200, 400, 600

Feet: 0, 400, 800, 1600, 2400

N

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 Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

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 20, Sep 2, 2022

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

Date(s) aerial images were photographed: Jun 9, 2021—Jun 12, 2021

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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
38	Jarre-Tecolote complex, 8 to 65 percent slopes	B	109.5	50.8%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	31.1	14.5%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	B	74.8	34.7%
Totals for Area of Interest			**215.4**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

United States Department of Agriculture

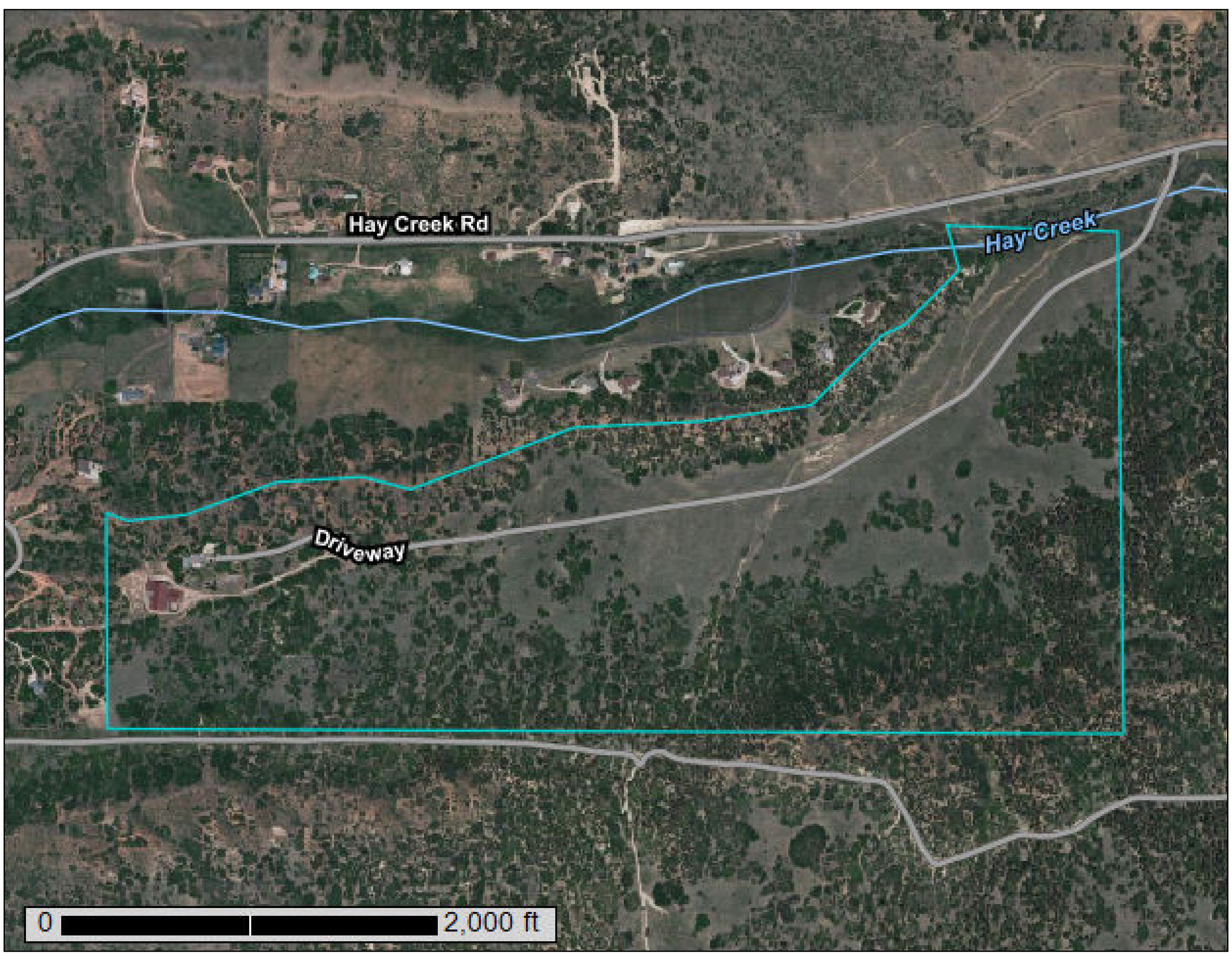
NRCS

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



December 27, 2022

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.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

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.

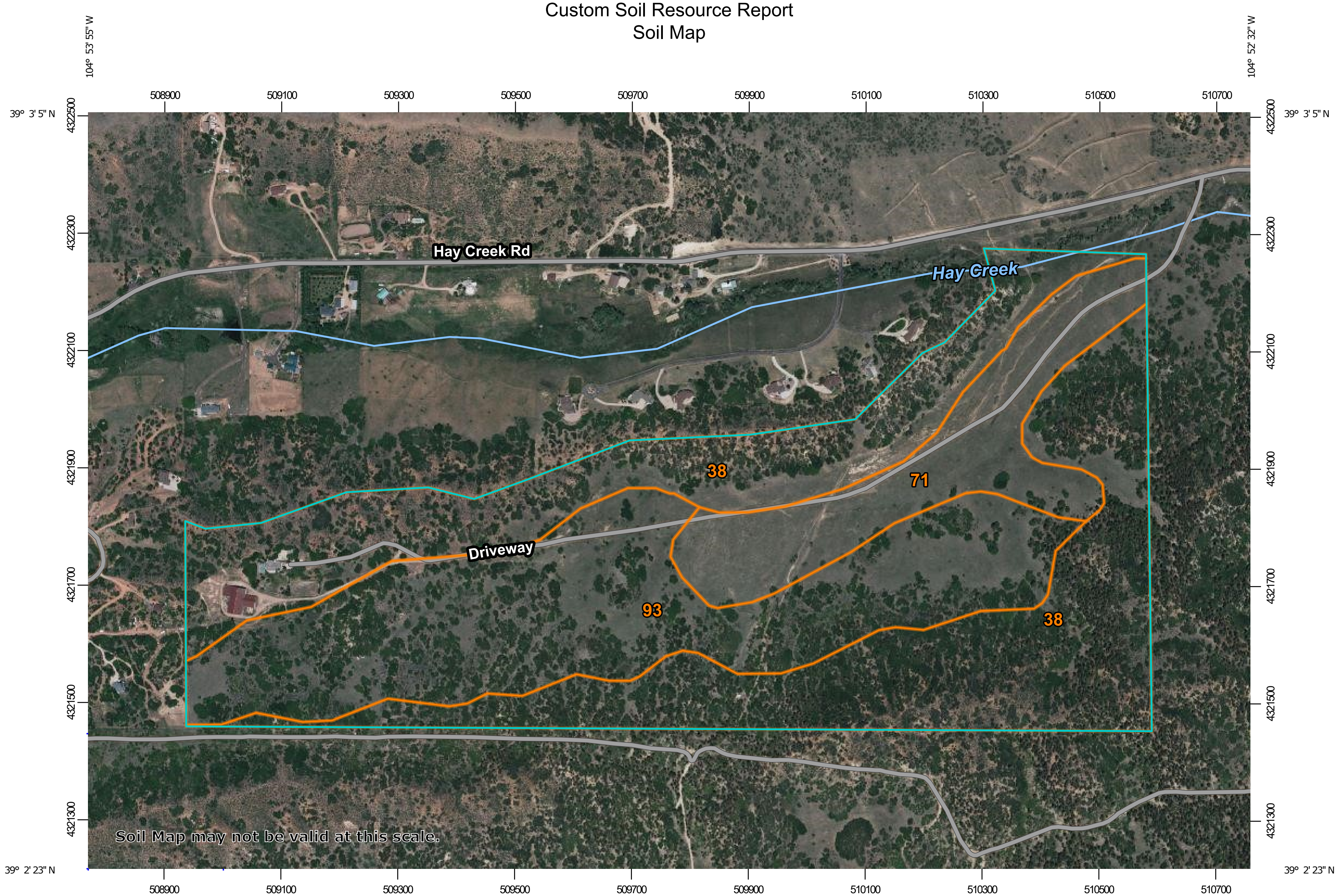
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree 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.

Soil Map



Map Scale: 1:9,090 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 100, 200, 400, 600

Feet: 0, 400, 800, 1600, 2400

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 20, Sep 2, 2022

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

Date(s) aerial images were photographed: Jun 9, 2021—Jun 12, 2021

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
38	Jarre-Tecolote complex, 8 to 65 percent slopes	109.5	50.8%
71	Pring coarse sandy loam, 3 to 8 percent slopes	31.1	14.5%
93	Tomah-Crowfoot complex, 8 to 15 percent slopes	74.8	34.7%
Totals for Area of Interest		**215.4**	**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

38—Jarre-Tecolote complex, 8 to 65 percent slopes

Map Unit Setting

National map unit symbol: 368c
Elevation: 6,700 to 7,500 feet
Frost-free period: 90 to 125 days
Farmland classification: Not prime farmland

Map Unit Composition

Jarre and similar soils: 40 percent
Tecolote and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Jarre

Setting

Landform: Alluvial fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 5 inches: gravelly sandy loam
Bt - 5 to 22 inches: gravelly sandy clay loam
2C - 22 to 60 inches: very gravelly sandy loam

Properties and qualities

Slope: 8 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: R048AY222CO - Loamy Park
Hydric soil rating: No

Description of Tecolote

Setting

Landform: Alluvial fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 3 inches: very stony loam
E - 3 to 12 inches: very gravelly loamy sand
Bt - 12 to 45 inches: extremely gravelly sandy clay loam
C - 45 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 8 to 65 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: R048AY255CO - Pine Grasslands
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

71—Pring coarse sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369k
Elevation: 6,800 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Pring and similar soils: 85 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Pring

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear

Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam
C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 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): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R048AY222CO - Loamy Park
Hydric soil rating: No

Minor Components

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

Other soils

Percent of map unit:
Hydric soil rating: No

93—Tomah-Crowfoot complex, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 36bb
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Tomah and similar soils: 50 percent
Crowfoot and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tomah

Setting

Landform: Hills, alluvial fans

Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose and/or residuum weathered from arkose

Typical profile

A - 0 to 10 inches: loamy sand
E - 10 to 22 inches: coarse sand
Bt - 22 to 48 inches: stratified coarse sand to sandy clay loam
C - 48 to 60 inches: coarse sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
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
Available water supply, 0 to 60 inches: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: R049XY216CO - Sandy Divide
Hydric soil rating: No

Description of Crowfoot

Setting

Landform: Hills, alluvial fans
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 12 inches: loamy sand
E - 12 to 23 inches: sand
Bt - 23 to 36 inches: sandy clay loam
C - 36 to 60 inches: coarse sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
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
Available water supply, 0 to 60 inches: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: R049XY216CO - Sandy Divide
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

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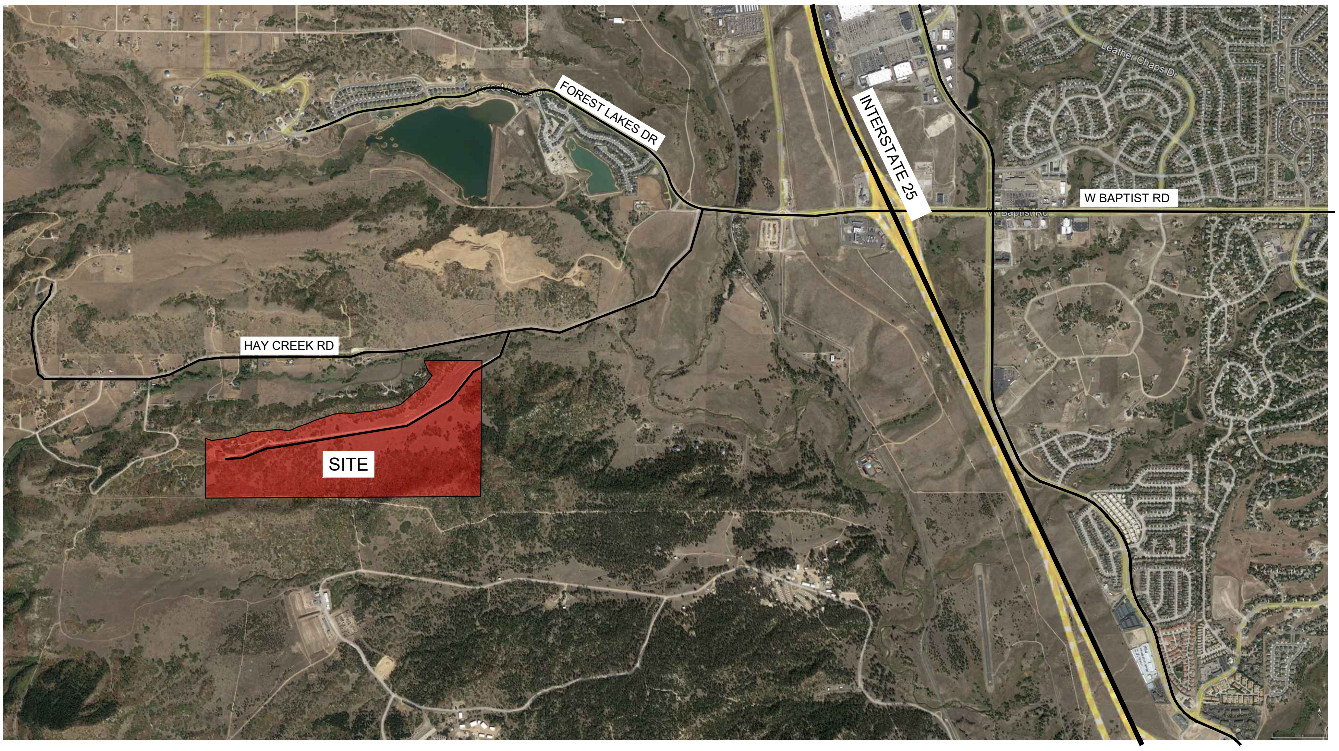
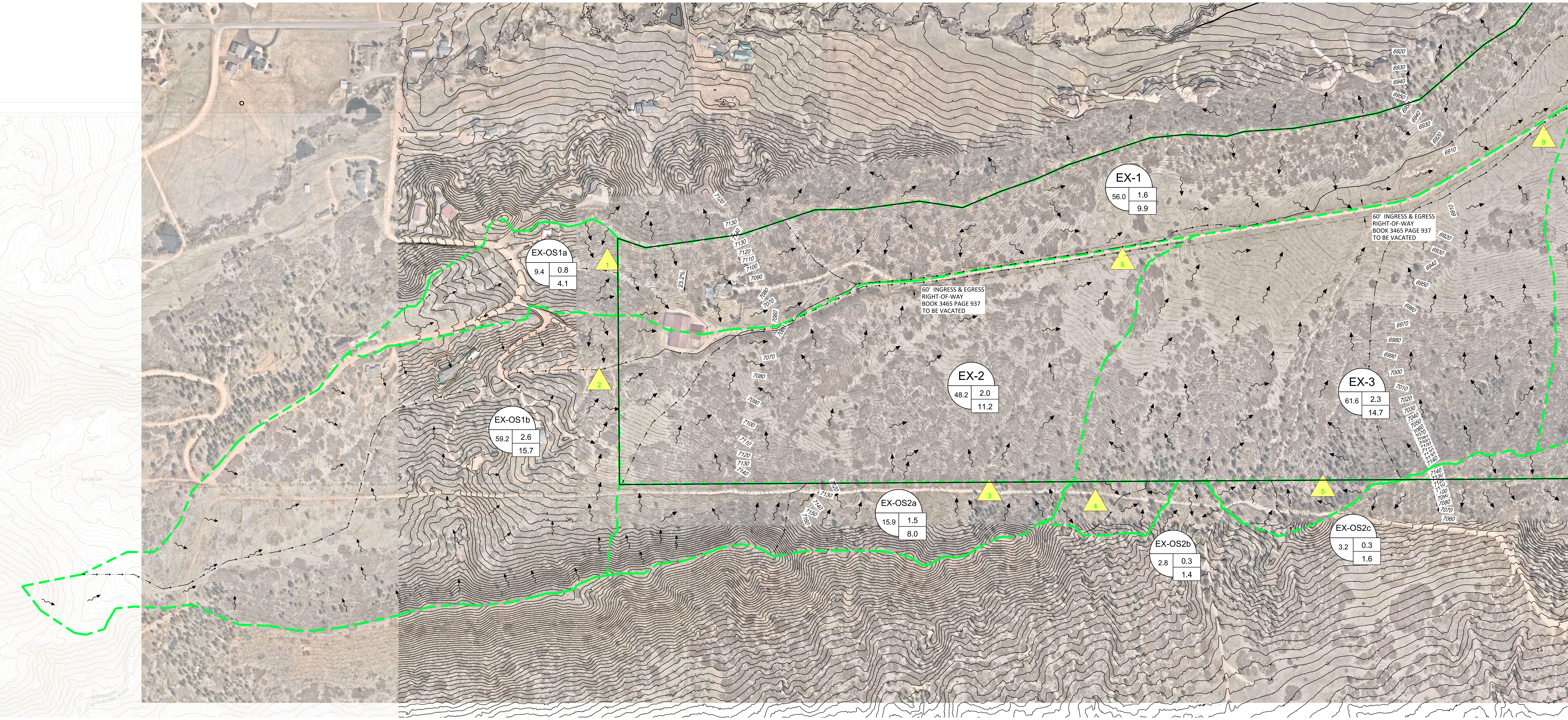
APPENDIX D

MAPS



VICINITY MAP
HAY CREEK VALLEY
(NTS)



LEGEND

- BASIN BOUNDARY
- EXISTING PROPERTY LINE
- EXISTING CONTOUR
- FLOW DIRECTION
- DESIGN POINT
- SUB BASIN DESIGNATION
- 5-YEAR STORM EVENT PEAK FLOW (CFS)
- 100-YEAR STORM EVENT PEAK FLOW (CFS)
- SUB BASIN AREA (AC.)

GRAPHIC SCALE

200' 0 200' 400'

(IN FEET)
1 inch = 200 ft.

EL PASO COUNTY

HAY CREEK
PRELIMINARY DRAINAGE REPORT

OFFSITE DRAINAGE BASINS

PRELIMINARY
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SEAL

PREPARED BY:
Matrix
Excellence by Design

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.
PROJECT No. 22.886.076

DESIGNED BY:	WCG	SCALE		DATE ISSUED:	MARCH 2023	DRAWING No.
DRAWN BY:	WCG	HORIZ.		SHEET	1 OF 3	DR01
CHECKED BY:	JTS	VERT.				

SHEET KEY

No.	DATE	DESCRIPTION	BY
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####	####		####
####	####		####
####	####		####
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REVISIONS

COMPUTER FILE MANAGEMENT
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PLOT DATE: March 29, 2023 3:43:41 PM
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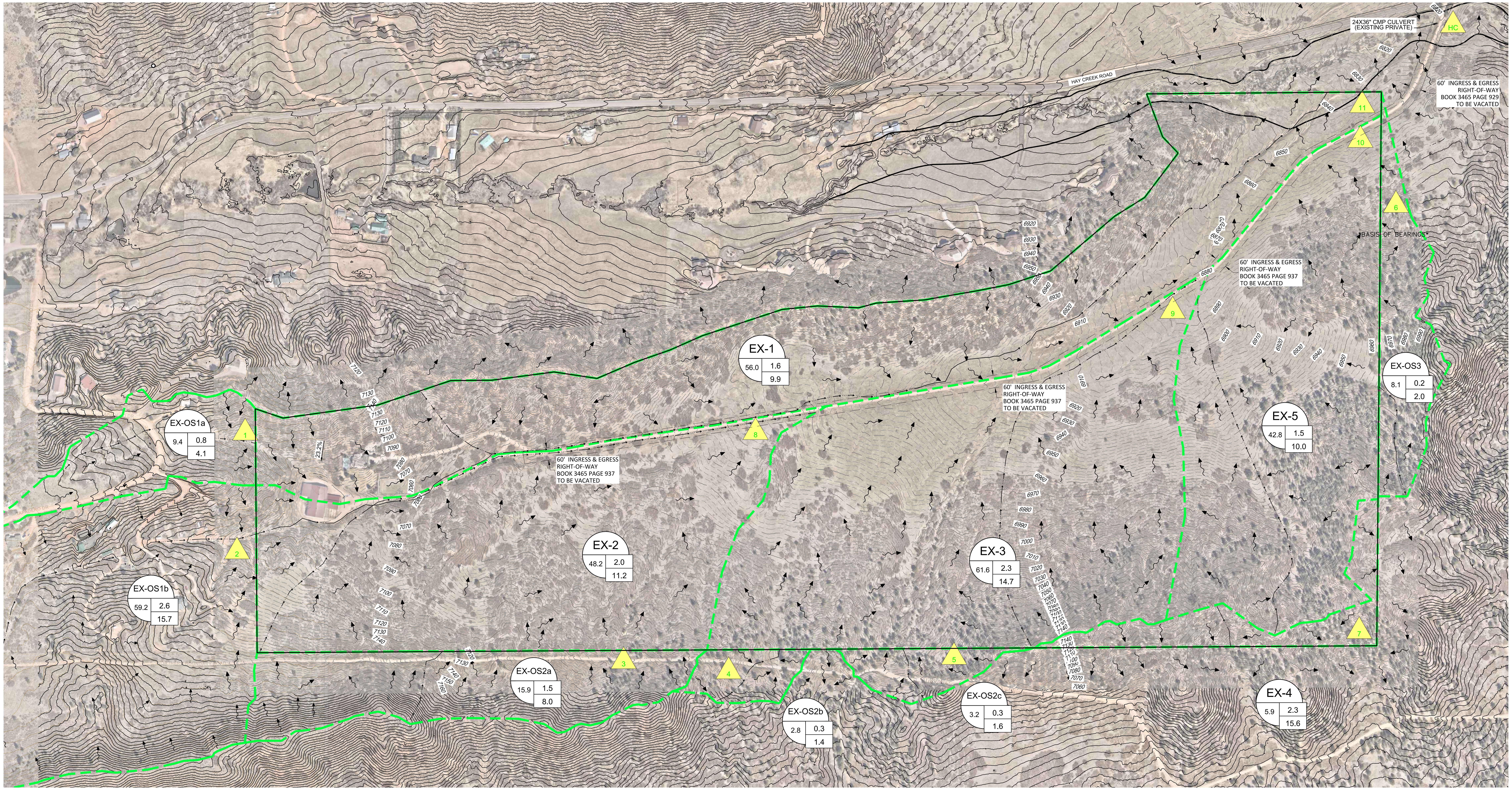
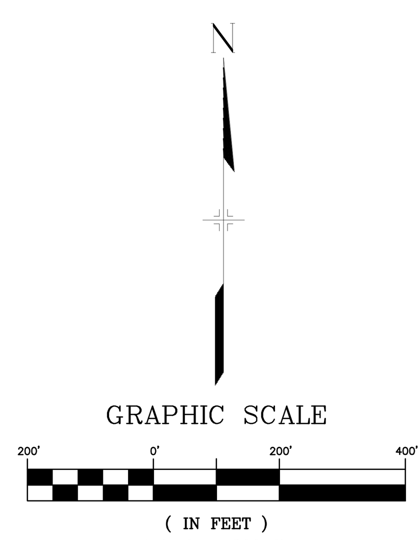
REFERENCE DRAWINGS



LEGEND

- BASIN BOUNDARY
- EXISTING CONTOUR
- FLOW DIRECTION
- DESIGN POINT
- SUB BASIN DESIGNATION
- 5-YEAR STORM EVENT PEAK FLOW (CFS)
- 100-YEAR STORM EVENT PEAK FLOW (CFS)
- SUB BASIN AREA (AC.)



Hay Creek Existing Conditions Sub-basin Summary			
Basin	**Area**	Q5	Q100
	acres	cfs	cfs
EX-OS1a	9.4	0.8	4.1
EX-OS1b	59.2	2.6	15.7
EX-OS2a	15.9	1.5	8.0
EX-OS2b	2.8	0.3	1.4
EX-OS2c	3.2	0.3	1.6
EX-OS3	8.1	0.2	2.0
EX-1	56.0	1.6	9.9
EX-2	48.2	2.0	11.2
EX-3	61.6	2.3	14.7
EX-4	5.9	2.3	15.6
EX-5	42.8	1.5	10.0

Existing Design Point Summary				
Hay Creek				
Design Point	**Sub-Basins**	**Total Area (ac.)**	**Q(5) (cfs)**	**Q(100) (cfs)**
1	EX-OS1a	9.35	0.80	4.10
2	EX-OS1b	59.21	2.60	15.70
3	EX-OS2a	15.90	1.50	8.00
4	EX-OS2b	2.77	0.30	1.40
5	EX-OS2c	3.17	0.30	1.60
6	EX-OS3	8.15	0.20	2.00
7	EX-4	5.88	2.30	15.60
8	EX-OS1b, EX-OS2a, EX-2	123.33	5.40	30.90
9	EX-OS2b, EX-OS2c, EX-3	67.57	2.90	17.40
10	EX-OS3, EX-5	50.97	1.80	11.90
11	DP-8, DP-9, DP-10, EX-OS1a, EX-1	307.27	11.20	69.90
HC	From PPRBD Regional floodplane Administrator			127.00

EL PASO COUNTY

HAY CREEK
PRELIMINARY DRAINAGE REPORT

PRE DEVELOPMENT DRAINAGE CONDITIONS

DESIGNED BY: WCG
DRAWN BY: WCG
CHECKED BY: JTS

SCALE
HORIZ.
VERT.

DATE ISSUED: MARCH 2023
SHEET 2 OF 3
DRAWING No. DR02

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PROJECT No. 22.886.076

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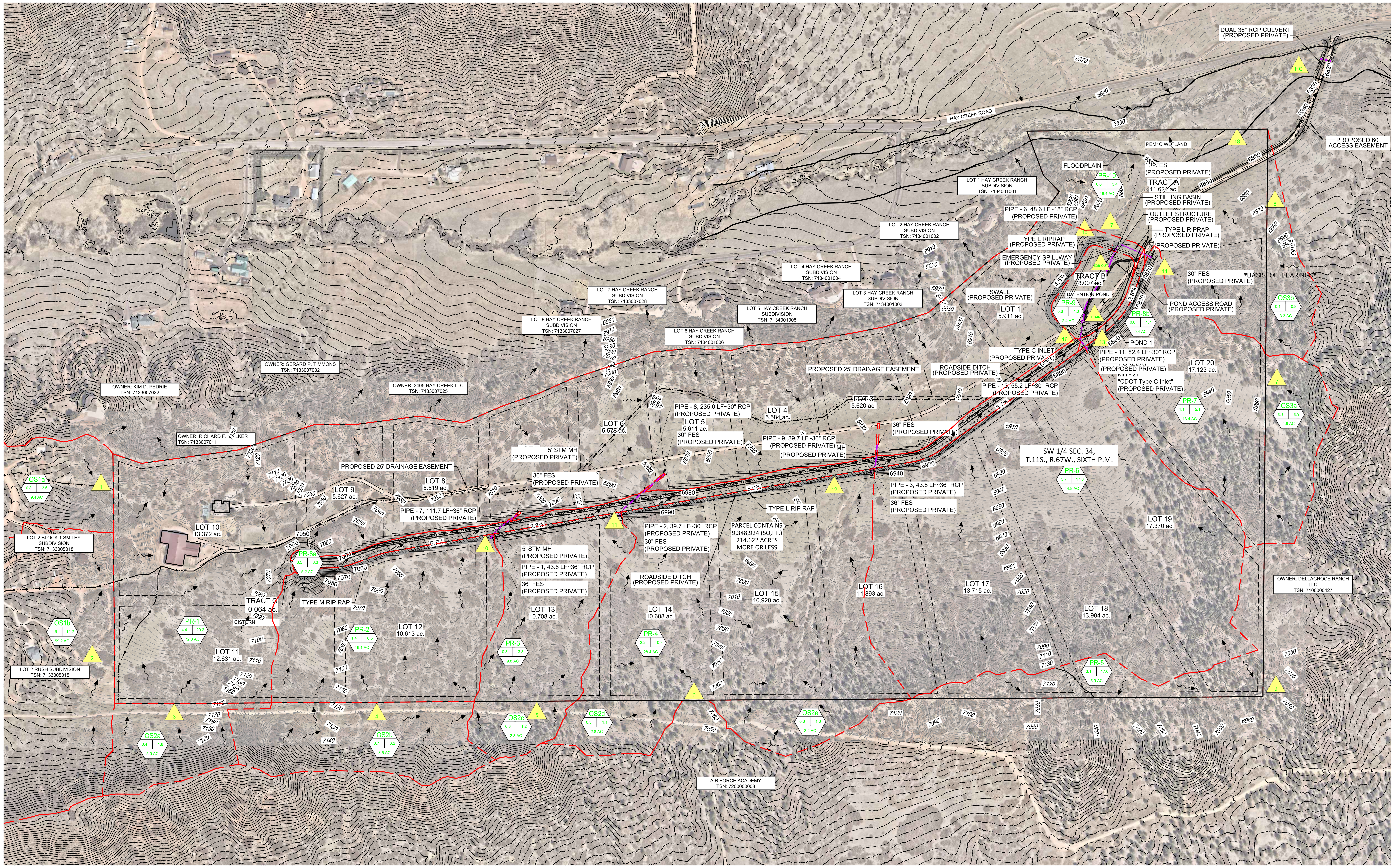

LEGEND

- PR BASIN BOUNDARY
- EXISTING CONTOUR
- PROPOSED CONTOUR
- PROPOSED STORM DRAIN PIPE
- EXISTING EDGE OF ROAD
- PROPOSED PROPERTY LINE
- PROPOSED FLOW DIRECTION
- DESIGN POINT
- PROPOSED MAINTENANCE ACCESS ROAD
- PROPOSED RIP RAP
- EMERGENCY FLOW PATHS
- SUB BASIN DESIGNATION
- 5-YEAR STORM EVENT PEAK FLOW (CFS)
- 100-YEAR STORM EVENT PEAK FLOW (CFS)
- SUB BASIN AREA (AC.)

BASIN / Q5 / Q100 / AREA

GRAPHIC SCALE

(IN FEET)
1 inch = 200 ft.

Hay Creek

Proposed Conditions
Sub-basin Summary

Basin	Area	Q5	Q100
	acres	cfs	cfs
OS1a	9.4	0.8	3.6
OS1b	59.2	2.6	14.2
OS2a	5.0	0.4	1.8
OS2b	8.6	0.7	3.2
OS2c	2.3	0.3	1.2
OS2d	2.8	0.3	1.1
OS2e	3.2	0.3	1.3
OS3a	4.9	0.1	0.9
OS3b	3.3	0.1	0.8
PR-1	72.0	4.4	20.2
PR-2	16.1	1.4	6.5
PR-3	9.8	0.8	3.8
PR-4	28.4	2.2	10.3
PR-5	5.9	3.1	17.0
PR-6	44.8	3.7	17.0
PR-7	13.4	1.1	5.1
PR-8a	5.2	3.5	8.3
PR-8b	0.4	0.8	1.7
PR-9	2.4	0.6	4.0
PR-10	16.4	0.6	3.4

Proposed Design Point Summary - Central Basin

Hay Creek

Design Point	Sub-Basins	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
1	OS1a	9.35	0.80	3.60
2	OS1b	59.21	2.60	14.20
3	OS2a	5.01	0.40	1.80
4	OS2b	8.57	0.70	3.20
5	OS2c	2.28	0.30	1.20
6	OS2d, OS2e	5.93	0.50	2.30
7	OS3a	4.88	0.10	0.90
8	OS3b	3.29	0.10	0.80
9	PR-5	5.86	0.00	0.00
10	OS2b, PR-2	24.65	2.10	9.60
11	OS2c, PR-3	12.06	1.00	4.60
12	OS2d, OS2e, PR-4	34.29	2.70	12.30
13	PR-6	44.76	3.70	17.00
14	OS3a, PR-7	18.31	1.20	6.10
15	OS1a, OS1b, OS2a, PR-1, DP-10, DP-11, DP-12	216.53	11.80	58.50
16a	PR-8a	5.20	1.50	5.60
16b	PR-6, PR-8a	49.96	4.90	22.00
EDB-IN	PR-6, PR-8a, PR-8b, PR-9	52.78	5.10	22.40
EDB-OUT	PR-6, PR-8a, PR-8b, PR-9	52.78	0.80	3.50
17	EDB-OUT, DP-14, DP-15	287.62	13.20	66.00
18	DP-8, DP-18, PR-10	307.28	13.30	66.30
HC	From PPRBD Regional floodplane Administrator			127.00

EL PASO COUNTY

HAY CREEK
PRELIMINARY DRAINAGE REPORT

POST DEVELOPMENT DRAINAGE CONDITIONS

DRAWING No. DR03

DATE ISSUED: JUNE 2023
SHEET 3 OF 4

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PROJECT No. 22.886.076

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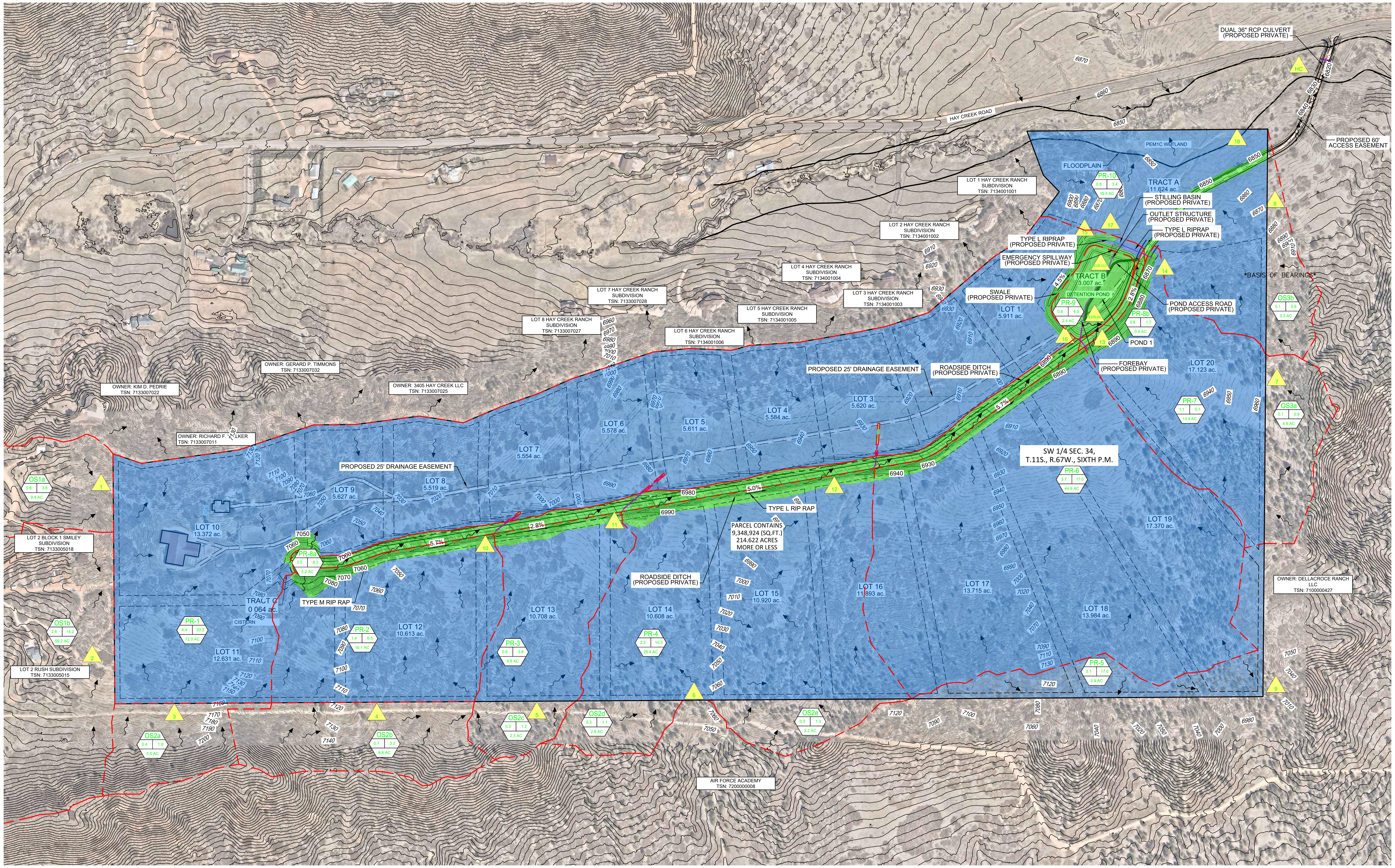

LEGEND

- PR BASIN BOUNDARY
- EXISTING CONTOUR
- PROPOSED CONTOUR
- PROPOSED STORM DRAIN PIPE
- EXISTING EDGE OF ROAD
- PROPOSED PROPERTY LINE
- PROPOSED FLOW DIRECTION
- DESIGN POINT
- PROPOSED MAINTENANCE ACCESS ROAD
- PROPOSED RIP RAP
- DISTURBED AREA
- UNDISTURBED AREA
- EMERGENCY FLOW PATHS
- SUB BASIN DESIGNATION
- 5-YEAR STORM EVENT PEAK FLOW (CFS)
- 100-YEAR STORM EVENT PEAK FLOW (CFS)
- SUB BASIN AREA (AC.)

GRAPHIC SCALE

(IN FEET)
1 inch = 200 ft.

Hay Creek Disturbed Area				
Basin ID	Total Area (ac)	Total Proposed Disturbed Area (ac)	Disturbed Area Tributary to Pond 1 (ac)	Disturbed Area Excluded from WQ per ECM App I.7.1. b.5 (ac)
PR-1	71.97	1.02	0	1.02
PR-2	16.08	1.27	0	1.27
PR-3	9.78	0.75	0	0.75
PR-4	28.35	1.53	0	1.53
PR-5	5.86	0	0	0
PR-6	44.76	1.15	1.15	0
PR-7	13.43	0.87	0	0.87
PR-8a	5.20	5.2	5.2	0
PR-8b	0.40	0.4	0.4	0
PR-9	2.41	2.41	0	2.41
PR-10	16.38	0.73	0	0.73
Total	214.62	15.33	6.75	8.58

NOTE: FUTURE RESIDENTIAL CONSTRUCTION FALLS UNDER THE LARGE LOT EXCLUSION FROM WQ TREATMENT, HOWEVER MUCH, IF NOT ALL, OF THE IMPROVEMENTS ASSOCIATED WITH THE RESIDENCES WILL DRAIN ACROSS VEGETATED AREAS AND UNDER THE RUNOFF REDUCTION METHODOLOGY WILL HAVE THE REQUIRED WQ TREATMENT VOLUME REDUCED TO ZERO.

EL PASO COUNTY

HAY CREEK
PRELIMINARY DRAINAGE REPORT

POST DEVELOPMENT DISTURBED AREAS

DESIGNED BY: WCG
DRAWN BY: WCG
CHECKED BY: JTS
SCALE HORIZ. VERT.
DATE ISSUED: JUNE 2023
SHEET 4 OF 4
DRAWING No. DR04

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PROJECT No. 22.886.076

PREPARED BY: Matrix Excellence by Design

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