HAY CREEK VALLEY

MDDP / ~~FINAL~~ DRAINAGE REPORT

Preliminary Drainage Report

Prepared for:

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January 2023

Project No. 22.886.076

PCD # SF-23-XXXX

Please update to PCD File SP-23-01

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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revise to preliminary drainage report. Typical for all.

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 ~~Final~~ 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 a detention pond, 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 **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 El Paso County 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 Tables 3-1 and 6-6 of the DCM. Anticipated single-family areas are considered under the single family – 5 acre lots category in table 3-1 with a percent imperviousness of 7%, which corresponds to the Parks and Cemeteries category in table 6-6. The paved road is considered under the Paved Areas 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. 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 a detention pond, 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 detention pond, 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 rational routed flow. 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 (Q_5 = 3.5 cfs, Q_{100} = 18.9 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 (Q_5 = 12.3 cfs, Q_{100} = 74.6 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 (Q_5 = 7.8 cfs, Q_{100} = 42.0 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 (Q_5 = 1.3 cfs, Q_{100} = 6.7 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 (Q_5 = 1.6 cfs, Q_{100} = 8.2 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 (Q_5 = 2.7 cfs, Q_{100} = 17.7 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 (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.

Provide Design point and analysis for the Hay Creek Road intersection to include existing/upgraded culvert analysis. Show on drainage maps.

Design Point 8 (Q_5 = 26.1 cfs, Q_{100} = 153.1 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 (Q_5 = 17.6 cfs, Q_{100} = 106.5 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 (Q_5 = 13.5 cfs, Q_{100} = 85.3 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 (Q_5 = 35.0 cfs, Q_{100} = 210.9 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.

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 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 (Q_5 = 3.5 cfs, Q_{100} = 18.9 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 (Q_5 = 12.3 cfs, Q_{100} = 74.6 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 (Q_5 = 2.2 cfs, Q_{100} = 12.4 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 (Q_5 = 4.0 cfs, Q_{100} = 21.6 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 (Q_5 = 1.3 cfs, Q_{100} = 6.5 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 (Q_5 = 2.9 cfs, Q_{100} = 14.4 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 (Q_5 = 1.5 cfs, Q_{100} = 10.1 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 (Q_5 = 1.1 cfs, Q_{100} 7.6 = 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 (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 (Q_5 = 9.0 cfs, Q_{100} = 48.8 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 (Q_5 = 4.5 cfs, Q_{100} = 24.0 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 (Q_5 = 8.7 cfs, Q_{100} = 46.8 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).

Clarify that all runoff from the roadway is conveyed to this point via the road itself and/or the northern roadside ditch. Thus all runoff from the roadway is conveyed to the pond.

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 (Q_5 = 18.1 cfs, Q_{100} = 100.1 cfs) (sub-basins: OS3a, PR-6; Area: 63.1 Ac.) (Slopes: 5 to 60%) This point represents the flows from sub-basins OS3a and PR-6 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 two proposed private 30-inch FES at Design Point 13 (DP-13). These flows are conveyed under the proposed roadway to the west, discharging via two proposed private 30-inch FES into the proposed stilling basin at Design Point 17 (DP-17).

Design Point 14 (Q_5 = 27.4 cfs, Q_{100} = 153.0 cfs) (sub-basins: OS1a, OS1b, OS2a, OS2b, OS2c, OS2d, OS2e, PR-1, PR-2, PR-3, PR-4; Area: 215.4 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. 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 the pond toward the proposed stilling basin at Design Point 17. The proposed swale will be lined with Type L Rip Rap.

Design Point 15 (Q_5 = 0.4 cfs, Q_{100} = 2.5 cfs) (sub-basin: PR-7; Area: 1.2 Ac.) (Slopes: 5 to 10%) This point represents the discharge from sub-basin PR-7 into the proposed roadside ditch that runs along the north side of the proposed roadway. The collected runoff will combine with flows from sub-basin PR-8 and continue north in the ditch toward design point 17.

Design Point 16 (Q_5 = 5.4 cfs, Q_{100} = 12.3 cfs) (sub-basins: PR-7, PR-8a; Area: 6.32 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. The flows collected in the inlet will be conveyed downstream towards Design Point EDB-IN via proposed private 18-inch RCP pipe.

Design Point EDB-IN (Q_5 = 6.4 cfs, Q_{100} = 16.4 cfs) (sub-basin: PR-7, PR-8a, PR-8b, PR-9; Area: 9.2 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 = 0.2 cfs, Q_{100} = 1.8 cfs) (sub-basins: PR-7, PR-8a, PR-8b, PR-9; Area: 9.2 Ac.) (Slopes: 2.8 to 50%) This point represents the discharge from the EDB. The discharge from the pond 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 = 38.1 cfs, Q_{100} 207.8 = cfs) (design points: DP-EDB-OUT, DP-13, DP-14; Area: 287.6 Ac.) (Slopes: 2.8 to 50%) This point represents the proposed private stilling basin located north of the proposed pond. 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 (Q_5 = 37.6 cfs, Q_{100} = 211.9 cfs) (sub-basins: DP-17, 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.

Notes:

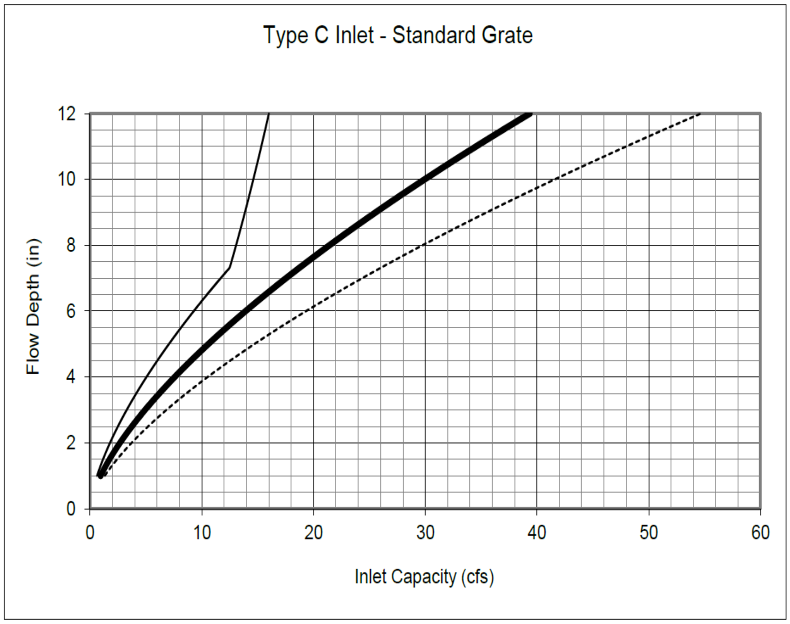
- **MHFD-Detention Analysis for the proposed detention pond which will be constructed as part of the Improvements associated with Hay Creek Valley can be found in Appendix A of this report.**
- **Tables summarizing inlet sizes and capacities, storm pipe sizes and capacities and swale capacities for the 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. 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 M Rip Rap*	6.0%	**48.8**	48.8	4.71	**1.72**
11	Vegetation	2.8%	**24.0**	24.0	4.39	**1.25**
12	Type L Rip Rap*	4.8%	**46.8**	46.8	4.63	**1.70**
13 (2.8%)	Type L Rip Rap*	2.8%	**100.1**	100.1	4.36	**2.56**
13 (3.6%)	Type M Rip Rap*	3.6%	**100.1**	100.1	4.80	**2.44**
14	Type L Rip Rap*	4.5%	**153.0**	153.0	4.78	**2.00**
16 (2.8%)	Vegetation	2.8%	**12.3**	12.3	3.74	**0.97**
16 (3.6%)	Vegetation	3.6%	**12.3**	12.3	4.06	**0.93**
16 (4.8%)	Vegetation	4.8%	**12.3**	12.3	4.54	**0.88**
16 (6.0%)	Vegetation	6.0%	**12.3**	12.3	4.86	**0.85**

* 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%	**18**
11-12	48.8	6.0%	**30**
13	14.4	2.8%	**24**
14-16	46.8	4.8%	**24**
17-20	100.1	2.8%	**30 x 2**

Given the anticipated culvert size is a v-ditch the appropriate design for the road side ditch along Lots 17-20? It seems the road side ditch should be transitioned to a trapezoidal channel at this section to accommodate the 2x30" culverts.

Discuss the reason for needing detention. Is the increase in imperviousness from the road and homes enough to warrant needing detention?

d. Detention

The proposed private Extended Detention Basin (EDB) will provide detention and water quality treatment for stormwater runoff generated within the Hay Creek Valley site. The pond will outfall to a stilling basin to the north. Flows from the pond will combine with flows from Design Points 13 and 14 in the stilling basin which will release the flows with a velocity of 4.02 ft/sec which is considered by the DCM to be stable for open channel flows. The stilling basin will provide a suitable outfall for the concentrated flows into the existing natural swale. Design information including calculations are included in Appendix A. 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		NOTES
			Q5	Q100	Q5	Q100	Q5	Q100	
EDB	9.15	38.93	1.2	6.0	0.3	2.1	0.2	0.4	

Emergency Overflow

EDB: 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.

and all of the other storm events listed in the MHFD-Detention spreadsheet.

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. The pond has been designed to meet the DCM standards for the release rates of Full Spectrum Detention Ponds for Water Quality Capture Volumes.

Step 4: **Consider Need for Industrial and Commercial BMPs.**

- There are no commercial or industrial componer
no BMPs of this nature are required.

VII. Erosion Control Plan

A grading and erosion control plan (GEC) for the proposed i
review as separate submittals by the various developments. These
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, however, no portion of the Improvements associated with Hay Creek Valley is located within the designated 100-year regulatory floodplain. Refer to the map in Appendix C.

Correct the statement. A portion of the property and road are contained in the FEMA floodplain. Discuss the FEMA approved BFEs. 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.

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%.

Provide breakout of this computed value

Hay Creek Final Drainage Report 2023 Drainage and Bridge Fees					
	Platted Area (Imp. ac.)	Fee/ Imp. Acre	Total Fee	Drainage Fee Reduction	Fee Due at Platting
Drainage Fee	17.085	$13,797.00	$235,715.51	$58,928.88	$176,786.63
Bridge Fee	17.085	$0.00	$0.00	$0.00	$0.00
TOTAL					$176,786.63

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. 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											
						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	Area (SF)	C5	C100	Area (SF)	C5	C100	Area	C5	C100	
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%
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%
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%
EX-OS2b		120503	2.77	0.0043	B				0.90	0.96	6033	0.09	0.36	114470	0.13	0.39	6.91%
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%
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%
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%
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%
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%
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%
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%
DESIGN POINTS	*Sub-basins*																
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%
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%
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%
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%
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%
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%
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%
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%
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%
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%
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%

	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	i100	Q100	**Sub-basin**
	ft	Length ft	ft	Length ft	Slope	Tc (min)	Slope	Ground Typ	(ft/s)	Tc (min)	(min)	in/hr	cfs	in/hr	cfs	
EX-OS1a	300	300	672	672	0.10	14.23	9.9	4	2.20	5.09	19.31	3.07	**3.5**	5.15	**18.9**	*EX-OS1a*
EX-OS1b	300	300	2754	2754	0.07	16.48	6.7	4	1.81	25.33	41.80	1.99	**12.3**	3.34	**74.6**	*EX-OS1b*
EX-OS2a	300	300	84	84	0.31	9.70	31.3	4	3.50	0.40	10.10	4.09	**7.8**	6.87	**42.0**	*EX-OS2a*
EX-OS2b	300	300	113	113	0.15	12.31	14.8	4	2.69	0.70	13.00	3.69	**1.3**	6.20	**6.7**	*EX-OS2b*
EX-OS2c	268	268	0	0	0.17	11.09	17.2	4	2.90	0.00	11.09	3.94	**1.6**	6.62	**8.2**	*EX-OS2c*
EX-OS3	300	300	265	265	0.16	12.54	15.8	4	2.78	1.59	14.12	3.56	**2.7**	5.98	**17.7**	*EX-OS3*
EX-1	300	300	4763	4763	0.05	18.23	5.0	4	1.57	50.72	68.94	1.44	**8.2**	2.43	**50.4**	*EX-1*
EX-2	300	300	2795	2795	0.06	16.66	6.4	4	1.77	26.31	42.96	1.96	**10.3**	3.29	**59.7**	*EX-2*
EX-3	300	300	2002	2002	0.11	13.86	11.4	4	2.36	14.12	27.97	2.52	**15.6**	4.23	**96.6**	*EX-3*
EX-4	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	300	300	1427	1427	0.11	14.18	10.7	4	2.29	10.39	24.56	2.71	**11.4**	4.55	**71.8**	*EX-5*
DESIGN POINTS																*DESIGN POINTS*
1	300	300	672	672	0.10	14.23	9.9	4	2.20	5.09	19.31	3.07	**3.5**	5.15	**18.9**	*1*
2	300	300	2754	2754	0.07	16.48	6.7	4	1.81	25.33	41.80	1.99	**12.3**	3.34	**74.6**	*2*
3	300	300	84	84	0.31	9.70	31.3	4	3.50	0.40	10.10	4.09	**7.8**	6.87	**42.0**	*3*
4	300	300	113	113	0.15	12.31	14.8	4	2.69	0.70	13.00	3.69	**1.3**	6.20	**6.7**	*4*
5	268	268	0	0	0.17	11.09	17.2	4	2.90	0.00	11.09	3.94	**1.6**	6.62	**8.2**	*5*
6	300	300	265	265	0.16	12.54	15.8	4	2.78	1.59	14.12	3.56	**2.7**	5.98	**17.7**	*6*
7	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	300	300	2795	2795	0.06	16.67	6.4	4	1.77	26.31	42.97	1.96	**26.1**	3.29	**153.1**	*8*
9	300	300	2002	2002	0.11	13.82	11.4	4	2.36	14.12	27.93	2.52	**17.6**	4.24	**106.5**	*9*
10	300	300	1427	1427	0.11	14.19	10.7	4	2.29	10.39	24.58	2.71	**13.5**	4.55	**85.3**	*10*
11	300	300	8062	8062	0.05	18.17	5.0	4	1.57	85.84	104.01	1.09	**35.0**	1.84	**210.9**	*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)

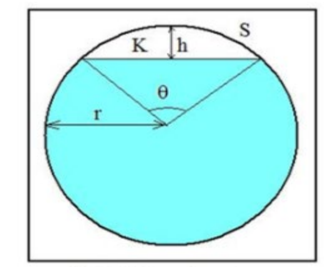
Channel Flow Type Key

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%						Flow Lengths										Tc	Rainfall Intensity & Rational Flow Rate				
Sub-basin	**Comments**				Soil Group	5-Acre Lots (7% Impervious)			Pavement (100% Impervious)			Undeveloped/Pervious Areas (2% Impervious)			Composite		Percent Impervious	Initial	True Initial	Channel	True Channel	Average (decimal)	Initial	Average (%)	Channel Flow Type (See Key above)	Velocity	Channel	Total	i5	Q5	i100	Q100	**Sub-basin**
		sf	acres	Sq. Mi.		C5	C100		C5	C100	Area (SF)	C5	C100	Area	C5	C100		ft	Length ft	ft	Length ft	Slope	Tc (min)	Slope	Ground Type	(ft/s)	Tc (min)	(min)	in/hr	cfs	in/hr	cfs	
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**	5.15	**18.9**	*OS1a*
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**	3.34	**74.6**	*OS1b*
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%	300	300	203	203	0.25	10.54	24.8	4	3.49	0.97	11.51	3.88	**2.2**	6.52	**12.4**	*OS2a*
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%	300	300	33	33	0.20	11.18	20.4	4	3.16	0.17	11.35	3.90	**4.0**	6.56	**21.6**	*OS2b*
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%	280	280	0	0	0.35	8.91	35.0	4	3.50	0.00	8.90	4.28	**1.3**	7.19	**6.5**	*OS2c*
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%	300	300	44	44	0.13	12.72	13.4	4	2.56	0.29	13.01	3.69	**1.3**	6.19	**6.7**	*OS2d*
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%	285	285	0	0	0.15	11.87	15.4	4	2.75	0.00	11.86	3.83	**1.6**	6.44	**8.0**	*OS2e*
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%	300	300	27	27	0.09	15.39	8.6	4	2.05	0.22	15.61	3.40	**1.5**	5.71	**10.1**	*OS3a*
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%	300	300	195	195	0.22	11.24	22.0	4	3.28	0.99	12.22	3.79	**1.1**	6.36	**7.6**	*OS3b*
PR-1		3086319	70.85	0.1107	B	0.12	0.39	3086319	0.90	0.96		0.09	0.36		0.12	0.39	7.00%	300	300	5455	5455	0.05	17.64	5.2	4	1.60	56.96	74.59	1.37	**11.7**	2.30	**64.2**	*PR-1*
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%	300	300	576	576	0.12	13.54	11.5	4	2.37	4.04	17.58	3.21	**6.2**	5.40	**34.1**	*PR-2*
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%	300	300	764	764	0.10	14.28	9.8	4	2.19	5.81	20.08	3.01	**3.6**	5.05	**19.4**	*PR-3*
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%	300	300	1015	1015	0.10	14.09	1.0	4	0.70	24.17	38.25	2.10	**7.2**	3.53	**39.3**	*PR-4*
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%	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-5*
PR-6		2535041	58.20	0.0909	B	0.12	0.39	2535041	0.90	0.96		0.09	0.36	0	0.12	0.39	7.00%	300	300	2112	2112	0.10	14.18	10.0	4	2.21	15.90	30.08	2.42	**17.0**	4.06	**93.0**	*PR-6*
PR-7		52400	1.20	0.0019	B	0.12	0.39	52400	0.90	0.96		0.09	0.36		0.12	0.39	7.00%	300	300	163	163	0.05	17.42	5.4	4	1.63	1.67	19.08	3.09	**0.4**	5.19	**2.5**	*PR-7*
PR-8a		222700	5.11	0.0080	B	0.12	0.39		0.90	0.96	129912	0.09	0.36	92788	0.56	0.71	59.17%	300	300	3558	3558	0.05	9.93	4.8	4	1.53	38.67	48.60	1.81	**5.3**	3.04	**11.1**	*PR-8a*
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%	50	50	0	0	0.03	1.98	3.0	4	1.21	0.00	5.00	5.10	**1.8**	8.58	**3.3**	*PR-8b*
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%	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-9*
PR-10		713346	16.38	0.0256	B	0.12	0.39		0.90	0.96		0.09	0.36	713346	0.09	0.36	2.00%	300	300	395	395	0.04	19.52	4.2	4	1.43	4.59	24.10	2.73	**4.1**	4.59	**27.3**	*PR-10*
DESIGN POINTS	*Sub-Basins*																		0		0												*DESIGN POINTS*
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%	300	300	672	672	0.10	14.23	9.9	4	2.20	5.09	19.31	3.07	**3.5**	5.15	**18.9**	*1*
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%	300	300	2754	2754	0.07	16.48	6.7	4	1.81	25.33	41.80	1.99	**12.3**	3.34	**74.6**	*2*
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%	300	300	203	203	0.25	10.54	24.8	4	3.49	0.97	11.51	3.88	**2.2**	6.52	**12.4**	*3*
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%	300	300	33	33	0.20	11.18	20.4	4	3.16	0.17	11.35	3.90	**4.0**	6.56	**21.6**	*4*
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%	280	280	0	0	0.35	8.91	35.0	4	3.50	0.00	8.90	4.28	**1.3**	7.19	**6.5**	*5*
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%	300	300	44	44	0.13	12.74	13.4	4	2.56	0.29	13.02	3.69	**2.9**	6.19	**14.4**	*6*
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%	300	300	27	27	0.09	15.39	8.6	4	2.05	0.22	15.61	3.40	**1.5**	5.71	**10.1**	*7*
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%	300	300	195	195	0.22	11.24	22.0	4	3.28	0.99	12.22	3.79	**1.1**	6.36	**7.6**	*8*
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%	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**	*9*
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%	300	300	908	908	0.12	13.54	11.5	4	2.37	6.38	19.91	3.02	**9.0**	5.08	**48.8**	*10*
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%	300	300	764	764	0.10	14.24	9.8	4	2.19	5.81	20.05	3.01	**4.5**	5.06	**24.0**	*11*
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%	300	300	1059	1059	0.10	14.06	1.0	4	0.70	25.21	39.27	2.07	**8.7**	3.47	**46.8**	*12*
13	*OS3a, PR-6*	2747504	63.07	0.0986	B	0.12	0.39	2535041	0.90	0.96	0	0.09	0.36	212463	0.12	0.39	6.61%	300	300	2112	2112	0.10	14.22	10.0	4	2.21	15.90	30.11	2.42	**18.1**	4.06	**100.1**	*13*
14	*OS1a, OS1b, OS2a, PR-1, DP-10, DP-11, DP-12*	9383174	215.41	0.3366	B	0.12	0.39	7028458	0.90	0.96	38011	0.09	0.36	2316705	0.12	0.38	6.14%	300	300	8302	8302	0.05	17.71	5.2	4	1.60	86.68	104.39	1.09	**27.4**	1.83	**153.0**	*14*
15	*PR-7*	52400	1.20	0.0019	B	0.12	0.39	52400	0.90	0.96	0	0.09	0.36	0	0.12	0.39	7.00%	300	300	163	163	0.05	17.42	5.4	4	1.63	1.67	19.08	3.09	**0.4**	5.19	**2.5**	*15*
16	*PR-7, PR-8a*	275100	6.32	0.0099	B	0.12	0.39	52400	0.90	0.96	129912	0.09	0.36	92788	0.48	0.65	49.23%	300	300	3558	3558	0.05	11.49	4.8	4	1.53	38.67	50.15	1.78	**5.4**	2.98	**12.3**	*16*
EDB-IN	*PR-7, PR-8a, PR-8b, PR-9*	397841	9.13	0.0143	B	0.12	0.39	52400	0.90	0.96	147085	0.09	0.36	223803	0.40	0.61	39.02%	300	300	3558	3558	0.05	12.95	4.8	4	1.53	38.67	51.61	1.74	**6.4**	2.93	**16.4**	*EDB-IN*
EDB-OUT	*PR-7, PR-8a, PR-8b, PR-9*	397841	9.13	0.0143	B	0.12	0.39	52400	0.90	0.96	147085	0.09	0.36	223803	0.40	0.61	39.02%													**0.2**		**1.8**	*EDB-OUT*
17	*EDB-OUT, DP-13, DP-14*	12528519	287.62	0.4494	B	0.12	0.39	9615899	0.90	0.96	185096	0.09	0.36	2752971	0.13	0.39	7.29%													**38.1**		**207.8**	*17*
18	*DP-8, DP-17, PR-10*	13385022	307.28	0.4801	B	0.12	0.39	9615899	0.90	0.96	185096	0.09	0.36	3609474	0.12	0.39	6.95%													**37.6**		**211.9**	*18*

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		48.8	Channel/Adequate	76.5	64%	0.013	0.012	0.013	3		36	2.82	0.990	6.895	7.940	11.10
11		24.0	Channel/Adequate	27.0	89%	0.013	0.013	0.013	2		24	1.88	0.990	3.065	5.293	8.81
12		46.8	Channel/Adequate	49.4	95%	0.013	0.005	0.013	3		36	2.82	0.990	6.895	7.940	7.16
13		100.1	Channel/Adequate	106.4	94%	0.013	0.005	0.013	4		48	3.76	0.990	12.259	10.587	8.68
16		12.3	Channel/Adequate	25.6	48%	0.013	0.054	0.013	1.5		18	1.41	0.990	1.724	3.970	14.83



Partially Full Pipe Flow Parameters
(More Than Half Full)

$r = D/2$

$h = 2r - y$

(hydraulic radius)

$R = A/P$

(Manning Equation)

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

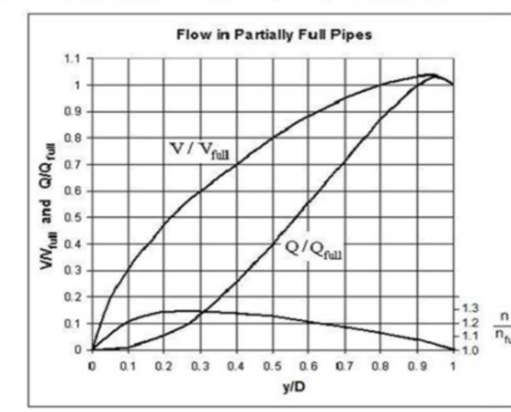
$V = Q/A$ P

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

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

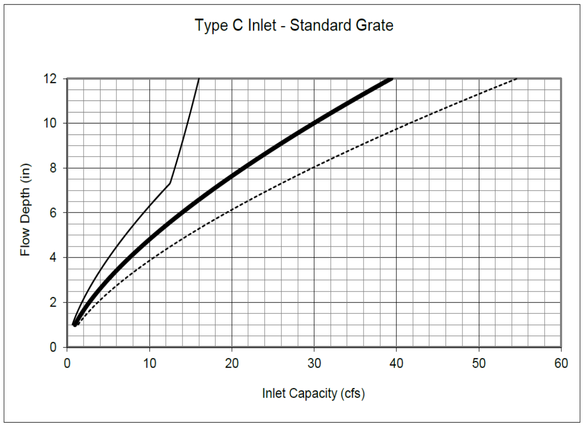
$$P = 2\pi r - r * \theta$$

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**							
16	**PR-7, PR-8a**	6.32	3x3	C	**SUMP**	**0.0**	5.41	**5.4**	**0.0**	12.33	**12.3**	



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)	=	30.0
Shape	=	Circular
Span (in)	=	30.0
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

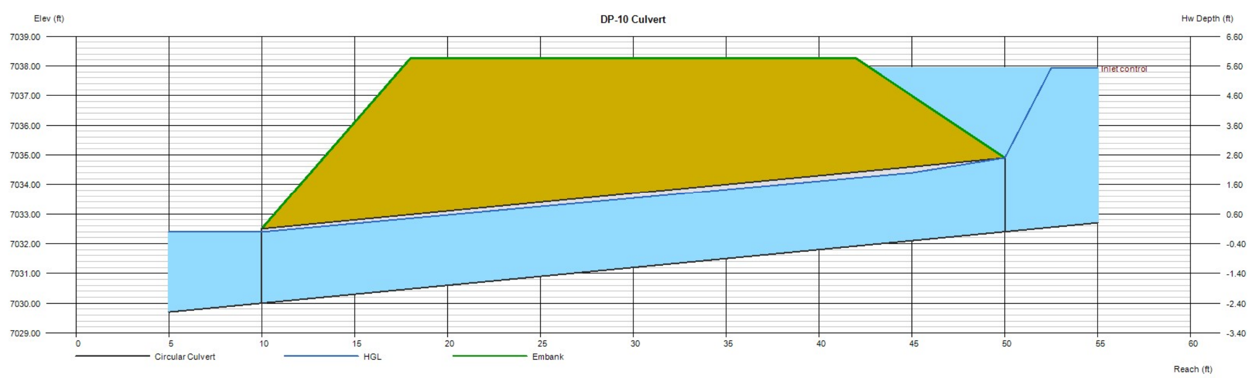
Top Elevation (ft)	=	7038.25
Top Width (ft)	=	24.00
Crest Width (ft)	=	30.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	48.81
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	48.80
Qpipe (cfs)	=	48.80
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	10.10
Veloc Up (ft/s)	=	10.38
HGL Dn (ft)	=	7032.39
HGL Up (ft)	=	7034.68
Hw Elev (ft)	=	7037.93
Hw/D (ft)	=	2.21
Flow Regime	=	Inlet Control



Update culvert design to maintain an Hw/D of 1.5 or less.

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Jan 16 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)	=	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

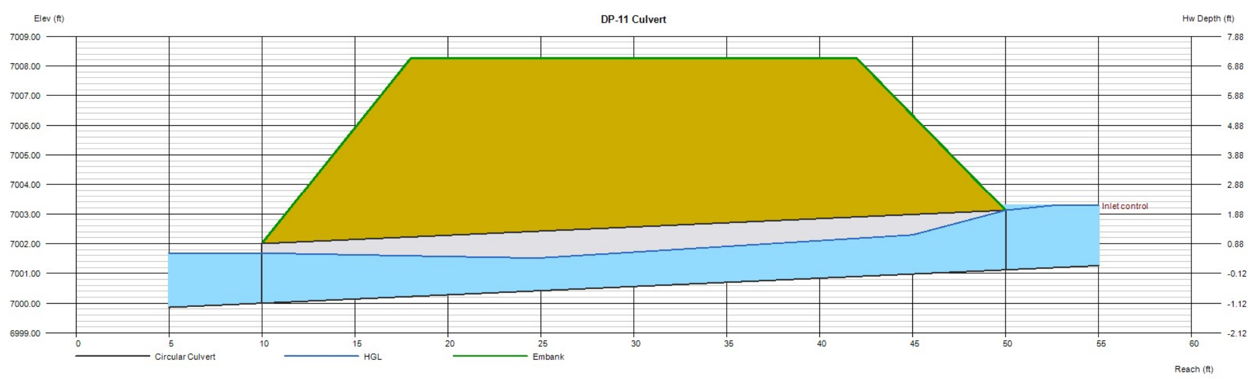
Top Elevation (ft)	=	7008.25
Top Width (ft)	=	24.00
Crest Width (ft)	=	30.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	24.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	14.40
Qpipe (cfs)	=	14.40
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	5.10
Veloc Up (ft/s)	=	6.30
HGL Dn (ft)	=	7001.68
HGL Up (ft)	=	7002.49
Hw Elev (ft)	=	7003.28
Hw/D (ft)	=	1.08
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Jan 16 2023

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	=	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

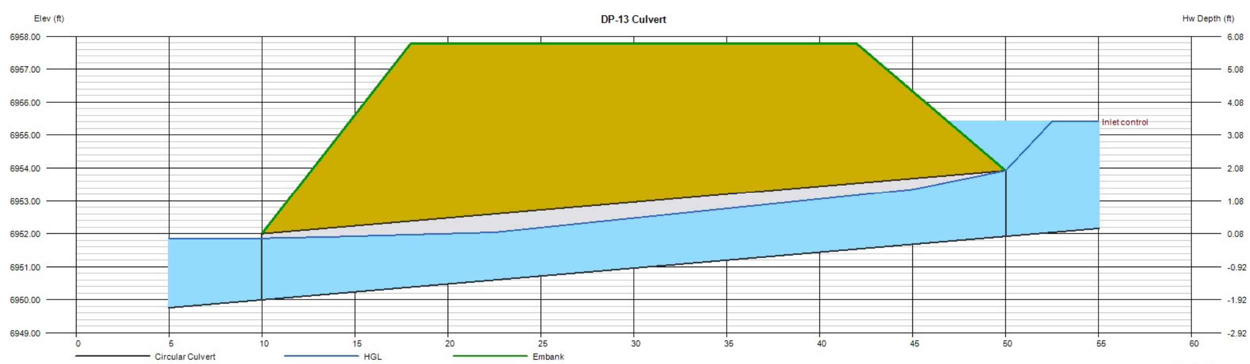
Top Elevation (ft)	=	6957.77
Top Width (ft)	=	24.00
Crest Width (ft)	=	30.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	46.80
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	46.80
Qpipe (cfs)	=	46.80
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	7.69
Veloc Up (ft/s)	=	8.15
HGL Dn (ft)	=	6951.86
HGL Up (ft)	=	6953.64
Hw Elev (ft)	=	6955.42
Hw/D (ft)	=	1.75
Flow Regime	=	Inlet Control



Update culvert design to maintain an Hw/D of 1.5 or less.

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. — Monday, Jan 16 2023

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)	= 30.0
Shape	= Circular
Span (in)	= 30.0
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

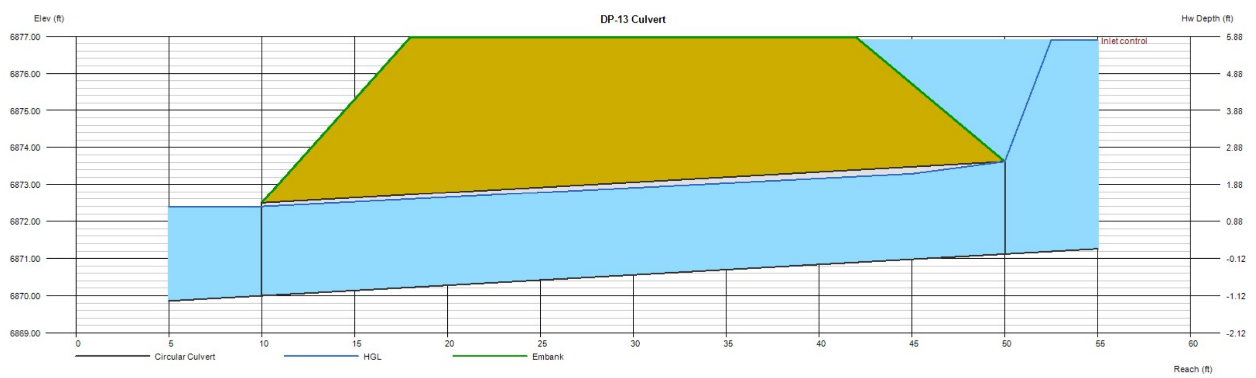
Top Elevation (ft)	= 6876.97
Top Width (ft)	= 24.00
Crest Width (ft)	= 30.00

Calculations

Qmin (cfs)	= 0.00
Qmax (cfs)	= 100.11
Tailwater Elev (ft)	= (dc+D)/2

Highlighted

Qtotal (cfs)	= 100.10
Qpipe (cfs)	= 100.10
Qovertop (cfs)	= 0.00
Veloc Dn (ft/s)	= 10.34
Veloc Up (ft/s)	= 10.60
HGL Dn (ft)	= 6872.40
HGL Up (ft)	= 6873.42
Hw Elev (ft)	= 6876.90
Hw/D (ft)	= 2.31
Flow Regime	= Inlet Control



Update culvert design to maintain an Hw/D of 1.5 or less.

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)	=	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

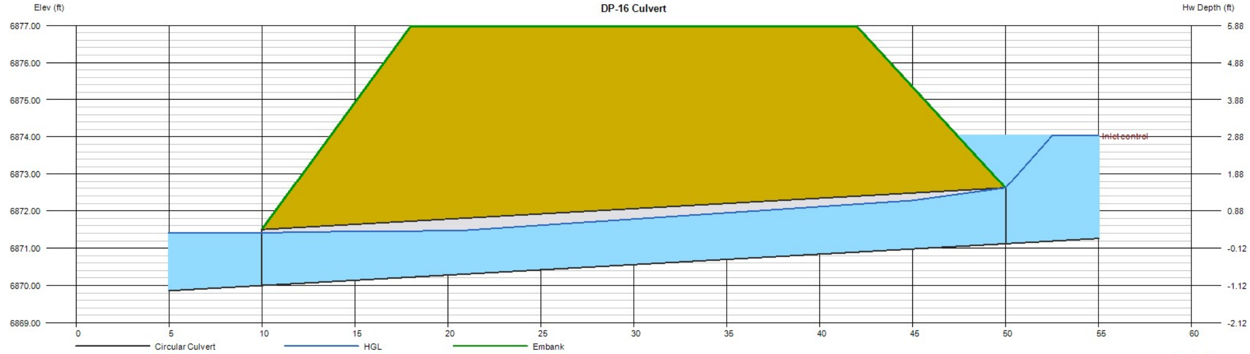
Top Elevation (ft)	=	6876.97
Top Width (ft)	=	24.00
Crest Width (ft)	=	30.00

Calculations

Qmin (cfs)	=	0.00
Qmax (cfs)	=	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)	=	7.13
Veloc Up (ft/s)	=	7.45
HGL Dn (ft)	=	6871.41
HGL Up (ft)	=	6872.45
Hw Elev (ft)	=	6874.03
Hw/D (ft)	=	1.94
Flow Regime	=	Inlet Control



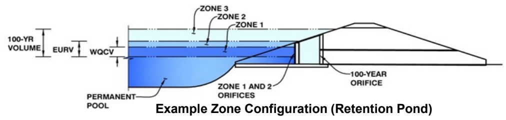
Update culvert design to maintain an Hw/D of 1.5 or less.

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**		**Note: L / W Ratio > 8**
Watershed Area =	9.13	acres	**L / W Ratio = 22.63**
Watershed Length =	3,000	ft	
Watershed Length to Centroid =	1,500	ft	
Watershed Slope =	0.048	ft/ft	
Watershed Imperviousness =	39.02%	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) =	0.135	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.373	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.369	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.555	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.724	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.966	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.155	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.400	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.55 in.) =	2.217	acre-feet	3.55	inches
Approximate 2-yr Detention Volume =	0.275	acre-feet		
Approximate 5-yr Detention Volume =	0.384	acre-feet		
Approximate 10-yr Detention Volume =	0.531	acre-feet		
Approximate 25-yr Detention Volume =	0.596	acre-feet		
Approximate 50-yr Detention Volume =	0.625	acre-feet		
Approximate 100-yr Detention Volume =	0.718	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.135	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.239	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.345	acre-feet
Total Detention Basin Volume =	0.718	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

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

Depth Increment = 0.20 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	--	--	--	500	0.011		
	--	0.50	--	--	--	53,856	1.236	13,587	0.312
	--	1.00	--	--	--	55,705	1.279	40,977	0.941
	--	1.50	--	--	--	57,577	1.322	69,298	1.591
	--	2.00	--	--	--	59,476	1.365	98,561	2.263
	--	2.50	--	--	--	61,399	1.410	128,780	2.956
	--	3.00	--	--	--	63,347	1.454	159,966	3.672
	--	3.50	--	--	--	65,320	1.500	192,133	4.411
	--	4.00	--	--	--	67,320	1.545	225,293	5.172
	--	4.50	--	--	--	69,343	1.592	259,459	5.956
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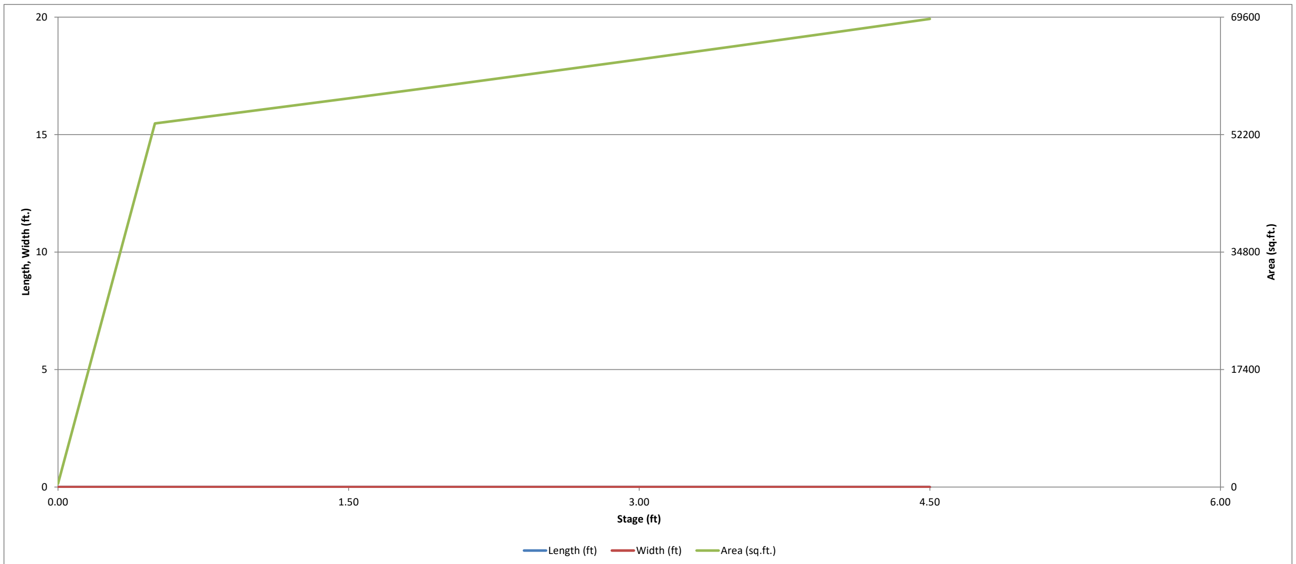
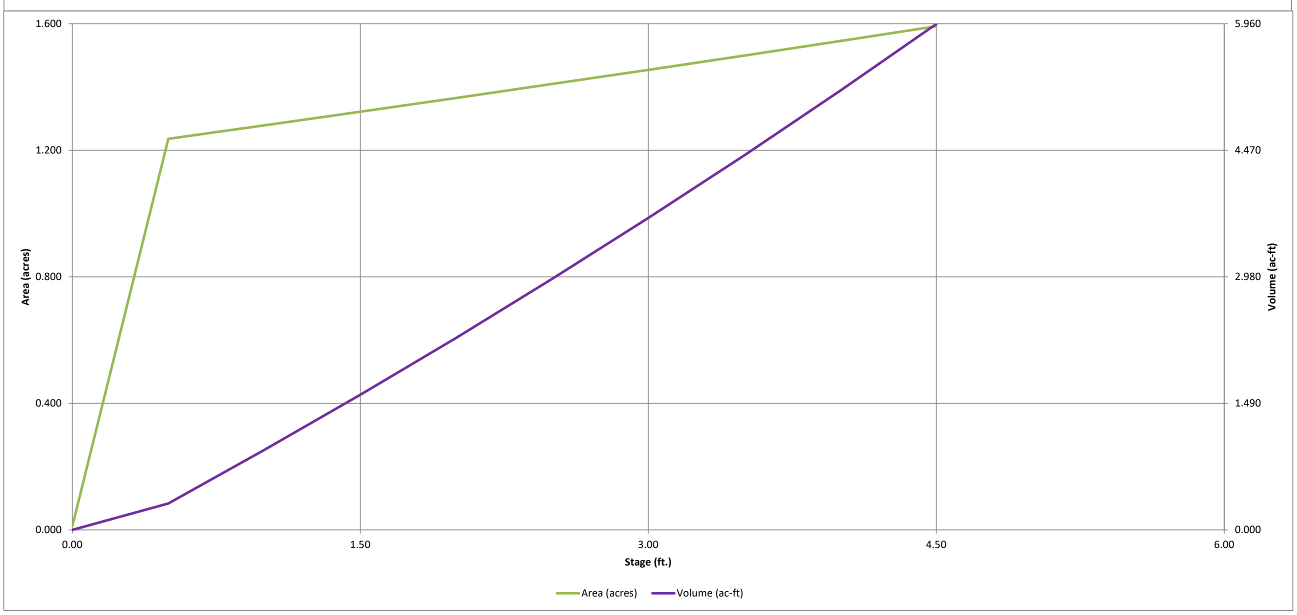
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.05 (January 2022)



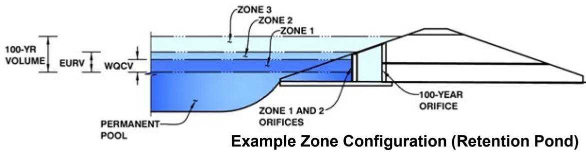


DETENTION BASIN OUTLET STRUCTURE DESIGN

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)	0.33	0.135	Orifice Plate
Zone 2 (EURV)	0.55	0.239	Circular Orifice
Zone 3 (100-year)	0.83	0.345	Weir&Pipe (Restrict)
Total (all zones)		0.718	

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 =	0.40	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	2.78	sq. inches (diameter = 1-7/8 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.931E-02	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

3 rows of holes are recommended.

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00							
Orifice Area (sq. inches)	2.78							

	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 =	0.33	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	0.55	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	4.32	N/A	inches

Calculated Parameters for Vertical Orifice

	Zone 2 Circular	Not Selected	
Vertical Orifice Area =	0.10	N/A	ft^2
Vertical Orifice Centroid =	0.18	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 =	1.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	3.00	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 =	1.00	N/A	feet
Overflow Weir Slope Length =	3.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	12.15	N/A	
Overflow Grate Open Area w/o Debris =	6.26	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.13	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 =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	6.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.52	N/A	ft^2
Outlet Orifice Centroid =	0.29	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.23	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	1.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	25.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.23	feet
Stage at Top of Freeboard =	2.73	feet
Basin Area at Top of Freeboard =	1.43	acres
Basin Volume at Top of Freeboard =	3.28	acre-ft

Routed Hydrograph Results

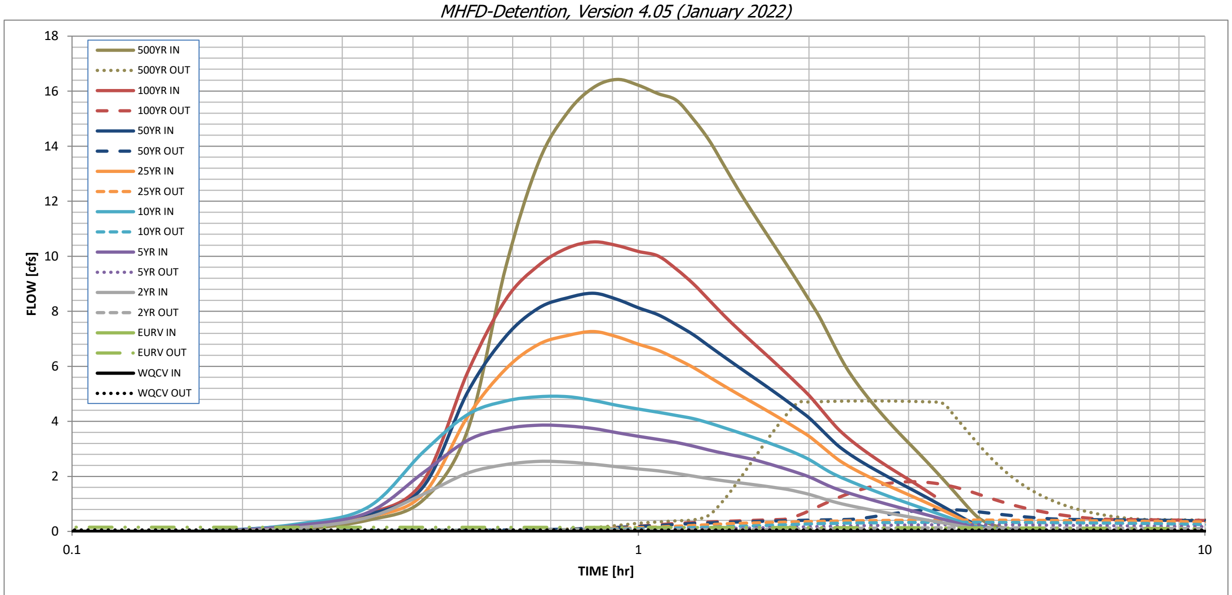
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

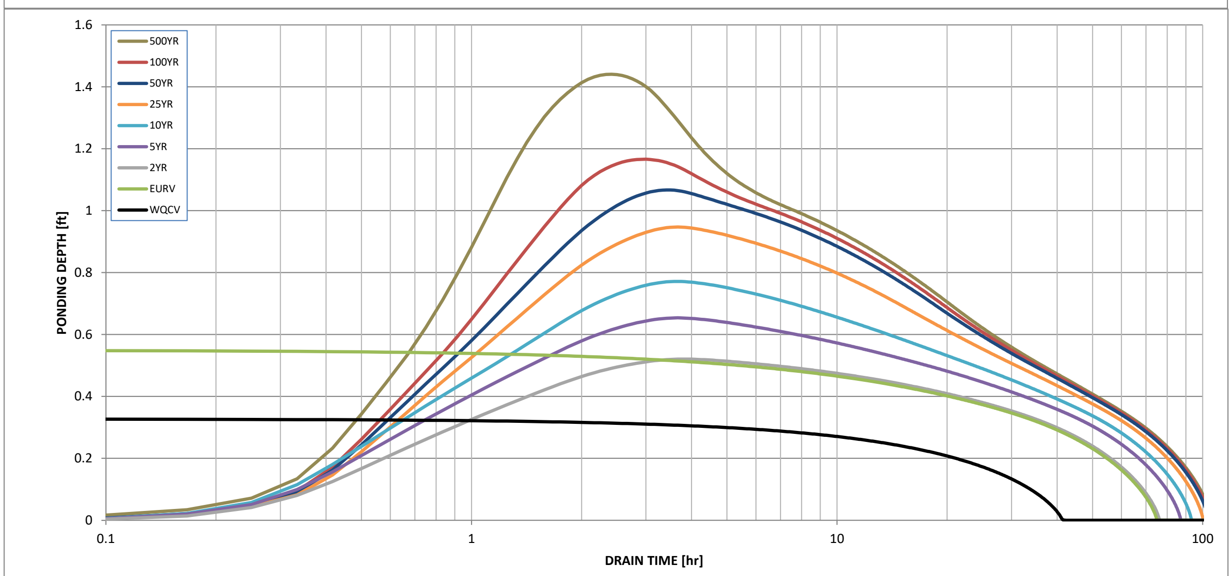
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.55
CUHP Runoff Volume (acre-ft) =	0.135	0.373	0.369	0.555	0.724	0.966	1.155	1.400	2.217
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.369	0.555	0.724	0.966	1.155	1.400	2.217
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.4	1.2	1.8	3.5	4.4	5.8	9.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.05	0.13	0.20	0.38	0.48	0.64	1.08
Peak Inflow Q (cfs) =	N/A	N/A	2.5	3.9	4.9	7.3	8.7	10.5	16.4
Peak Outflow Q (cfs) =	0.1	0.2	0.1	0.2	0.3	0.4	0.8	1.8	4.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.2	0.2	0.1	0.2	0.3	0.5
Structure Controlling Flow =	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	0.1	0.2	0.7
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	68	70	78	83	87	89	88	82
Time to Drain 99% of Inflow Volume (hours) =	**40**	72	73	83	89	95	97	97	95
		0.55	0.52	0.65	0.77	0.95	1.07	1.17	1.44
		1.24	1.24	1.25	1.26	1.27	1.28	1.29	1.32
		0.374	0.337	0.498	0.649	0.864	1.018	1.146	1.512

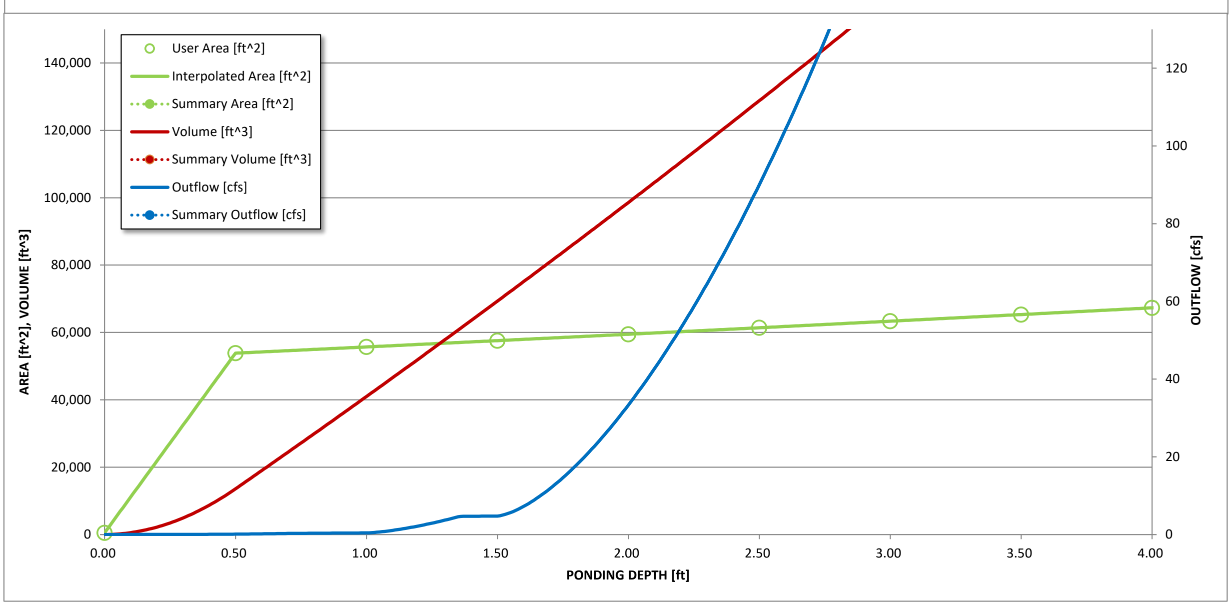
Update to meet criteria. Staff recommends the drainage report provide a statement that hydraulic computation will be finalized with the Final Drainage Report.

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:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.08
	0:15:00	0.00	0.00	0.13	0.22	0.27	0.18	0.23	0.22	0.41
	0:20:00	0.00	0.00	0.51	0.69	0.89	0.52	0.61	0.65	1.14
	0:25:00	0.00	0.00	1.35	2.13	2.88	1.35	1.62	1.82	3.71
	0:30:00	0.00	0.00	2.12	3.32	4.25	4.19	5.08	5.81	9.62
	0:35:00	0.00	0.00	2.43	3.74	4.74	5.91	7.09	8.43	13.42
	0:40:00	0.00	0.00	2.55	3.86	4.90	6.80	8.12	9.67	15.23
	0:45:00	0.00	0.00	2.52	3.83	4.90	7.12	8.49	10.30	16.14
	0:50:00	0.00	0.00	2.44	3.74	4.76	7.26	8.66	10.52	16.43
	0:55:00	0.00	0.00	2.35	3.59	4.58	7.07	8.43	10.39	16.22
	1:00:00	0.00	0.00	2.27	3.46	4.45	6.81	8.13	10.17	15.91
	1:05:00	0.00	0.00	2.20	3.34	4.33	6.58	7.87	10.01	15.67
	1:10:00	0.00	0.00	2.11	3.23	4.21	6.27	7.52	9.53	14.98
	1:15:00	0.00	0.00	2.01	3.10	4.10	5.96	7.15	9.00	14.21
	1:20:00	0.00	0.00	1.92	2.96	3.94	5.61	6.73	8.41	13.30
	1:25:00	0.00	0.00	1.84	2.84	3.77	5.29	6.35	7.84	12.43
	1:30:00	0.00	0.00	1.77	2.73	3.60	4.99	5.99	7.35	11.66
	1:35:00	0.00	0.00	1.71	2.63	3.44	4.71	5.65	6.91	10.95
	1:40:00	0.00	0.00	1.65	2.51	3.28	4.45	5.33	6.49	10.29
	1:45:00	0.00	0.00	1.59	2.38	3.12	4.20	5.02	6.09	9.65
	1:50:00	0.00	0.00	1.53	2.25	2.97	3.95	4.72	5.70	9.03
	1:55:00	0.00	0.00	1.44	2.12	2.80	3.71	4.43	5.32	8.42
	2:00:00	0.00	0.00	1.35	1.99	2.62	3.46	4.13	4.95	7.83
	2:05:00	0.00	0.00	1.24	1.82	2.40	3.17	3.79	4.53	7.15
	2:10:00	0.00	0.00	1.13	1.66	2.18	2.88	3.44	4.11	6.50
	2:15:00	0.00	0.00	1.04	1.53	2.02	2.62	3.12	3.73	5.92
	2:20:00	0.00	0.00	0.96	1.42	1.87	2.41	2.88	3.43	5.46
	2:25:00	0.00	0.00	0.90	1.32	1.74	2.23	2.67	3.18	5.05
	2:30:00	0.00	0.00	0.84	1.23	1.62	2.08	2.48	2.95	4.69
	2:35:00	0.00	0.00	0.78	1.15	1.51	1.93	2.31	2.74	4.35
	2:40:00	0.00	0.00	0.73	1.07	1.40	1.80	2.15	2.55	4.04
	2:45:00	0.00	0.00	0.67	0.99	1.30	1.68	2.00	2.37	3.75
	2:50:00	0.00	0.00	0.63	0.92	1.20	1.56	1.85	2.20	3.48
	2:55:00	0.00	0.00	0.58	0.85	1.11	1.44	1.72	2.04	3.22
	3:00:00	0.00	0.00	0.53	0.78	1.02	1.33	1.58	1.89	2.97
	3:05:00	0.00	0.00	0.49	0.71	0.93	1.22	1.46	1.73	2.72
	3:10:00	0.00	0.00	0.45	0.65	0.85	1.12	1.33	1.58	2.48
	3:15:00	0.00	0.00	0.41	0.59	0.77	1.01	1.20	1.43	2.23
	3:20:00	0.00	0.00	0.37	0.53	0.69	0.91	1.08	1.28	1.99
	3:25:00	0.00	0.00	0.33	0.47	0.61	0.81	0.96	1.14	1.76
	3:30:00	0.00	0.00	0.29	0.41	0.53	0.71	0.83	0.99	1.52
	3:35:00	0.00	0.00	0.25	0.35	0.46	0.61	0.71	0.85	1.29
	3:40:00	0.00	0.00	0.21	0.30	0.38	0.51	0.60	0.70	1.06
	3:45:00	0.00	0.00	0.18	0.24	0.31	0.41	0.48	0.56	0.84
	3:50:00	0.00	0.00	0.14	0.19	0.25	0.32	0.37	0.43	0.63
	3:55:00	0.00	0.00	0.11	0.15	0.20	0.24	0.27	0.31	0.47
	4:00:00	0.00	0.00	0.09	0.12	0.17	0.18	0.21	0.23	0.36
	4:05:00	0.00	0.00	0.08	0.10	0.14	0.14	0.16	0.18	0.28
	4:10:00	0.00	0.00	0.07	0.09	0.12	0.11	0.13	0.14	0.22
	4:15:00	0.00	0.00	0.06	0.08	0.10	0.09	0.11	0.10	0.17
	4:20:00	0.00	0.00	0.05	0.06	0.08	0.07	0.09	0.08	0.13
	4:25:00	0.00	0.00	0.04	0.05	0.07	0.06	0.07	0.06	0.10
	4:30:00	0.00	0.00	0.03	0.04	0.06	0.05	0.05	0.05	0.08
	4:35:00	0.00	0.00	0.03	0.04	0.05	0.04	0.04	0.04	0.06
	4:40:00	0.00	0.00	0.02	0.03	0.04	0.03	0.03	0.03	0.05
	4:45:00	0.00	0.00	0.02	0.02	0.03	0.02	0.03	0.02	0.04
	4:50:00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.03
	4:55:00	0.00	0.00	0.01	0.01	0.02	0.01	0.02	0.01	0.02
	5:00:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	5:05:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	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

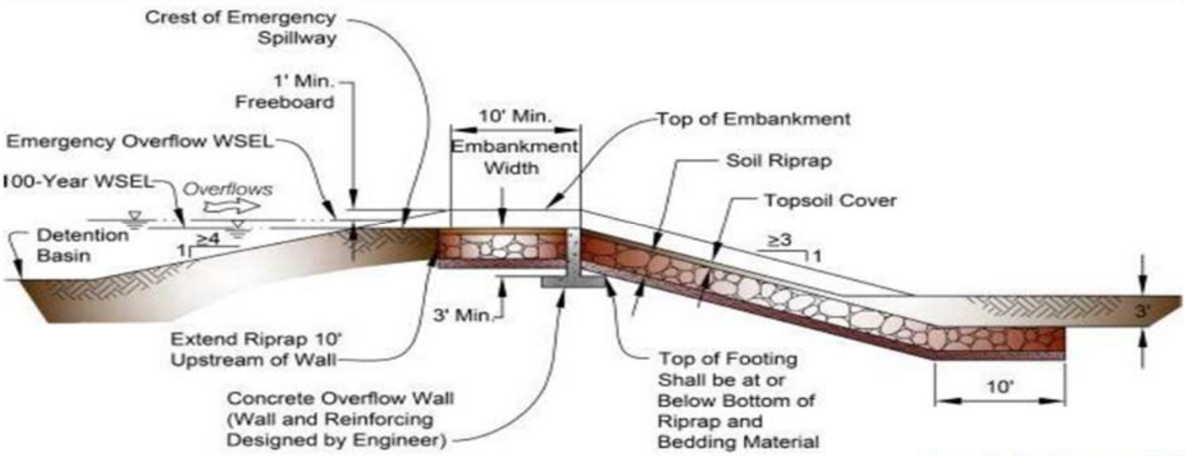
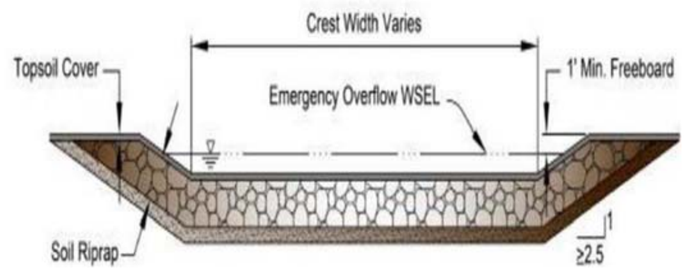


Figure 13-12c. Emergency Spillway Protection

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

=> TYPE VL RIP RAP



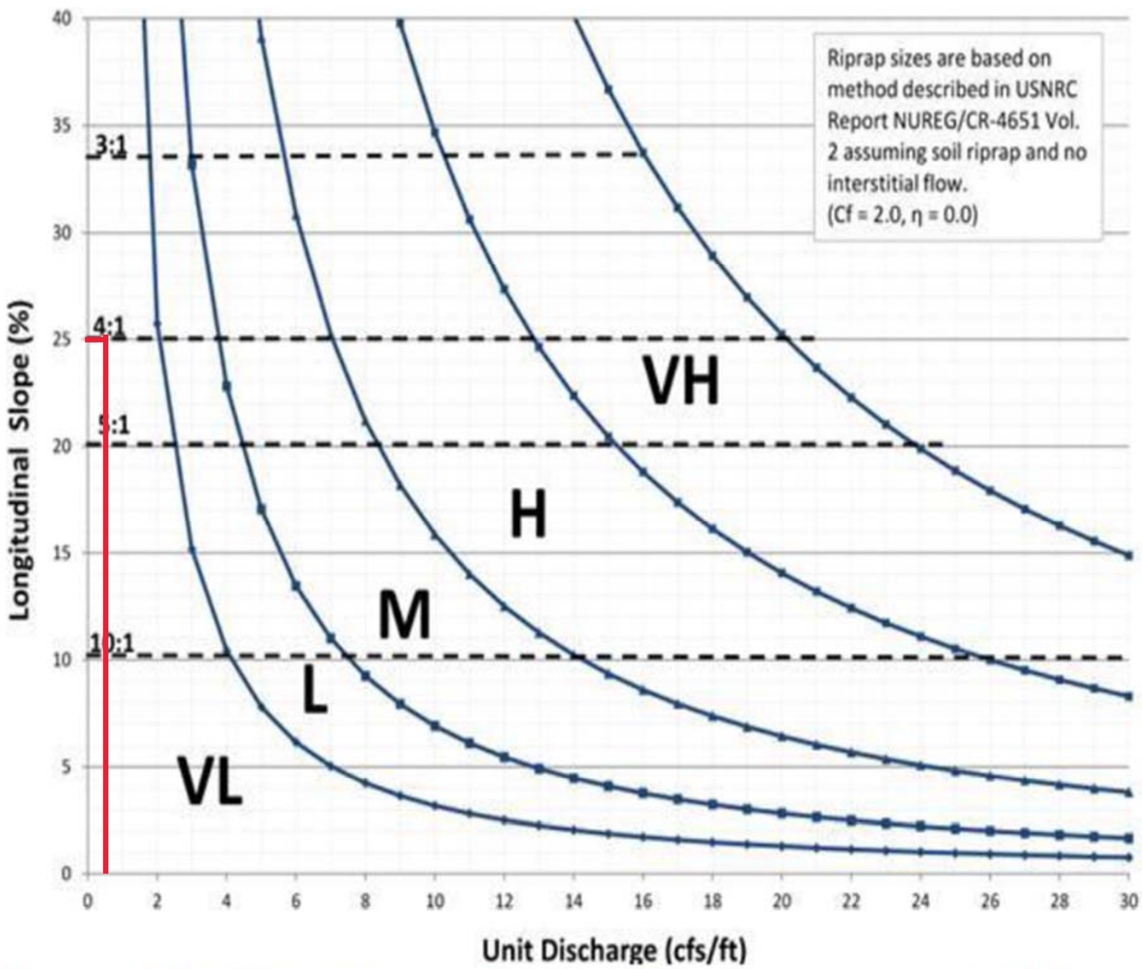


Figure 13-12d. Riprap Types for Emergency Spillway Protection

Weir Report

Stilling Basin Outfall

Trapezoidal Weir

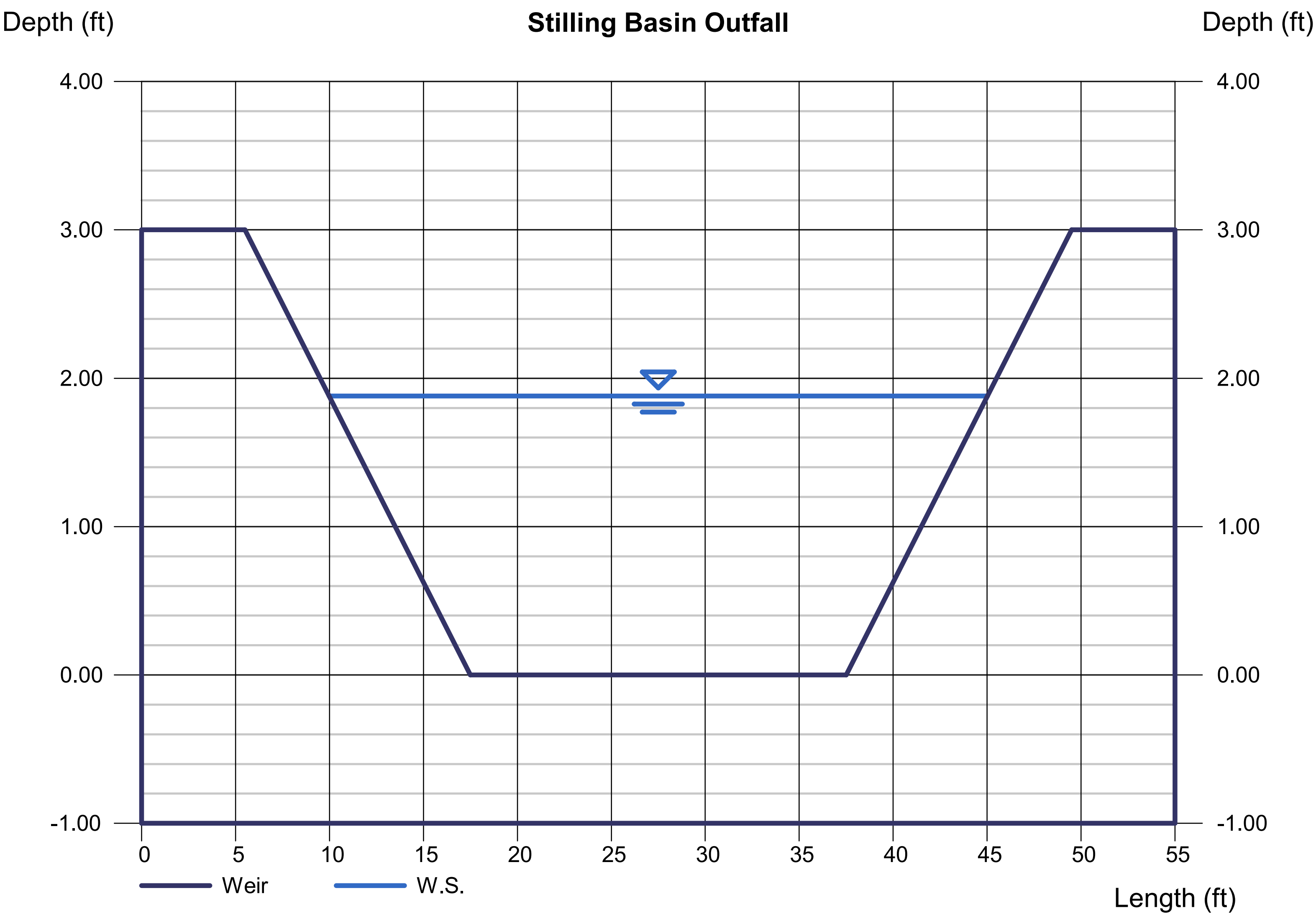
Crest	= Sharp
Bottom Length (ft)	= 20.00
Total Depth (ft)	= 3.00
Side Slope (z:1)	= 4.00

Calculations

Weir Coeff. Cw	= 3.10
Compute by:	Known Q
Known Q (cfs)	= 207.80

Highlighted

Depth (ft)	= 1.88
Q (cfs)	= 207.80
Area (sqft)	= 51.74
Velocity (ft/s)	= 4.02
Top Width (ft)	= 35.04



SWALE CALCULATIONS

Channel Report

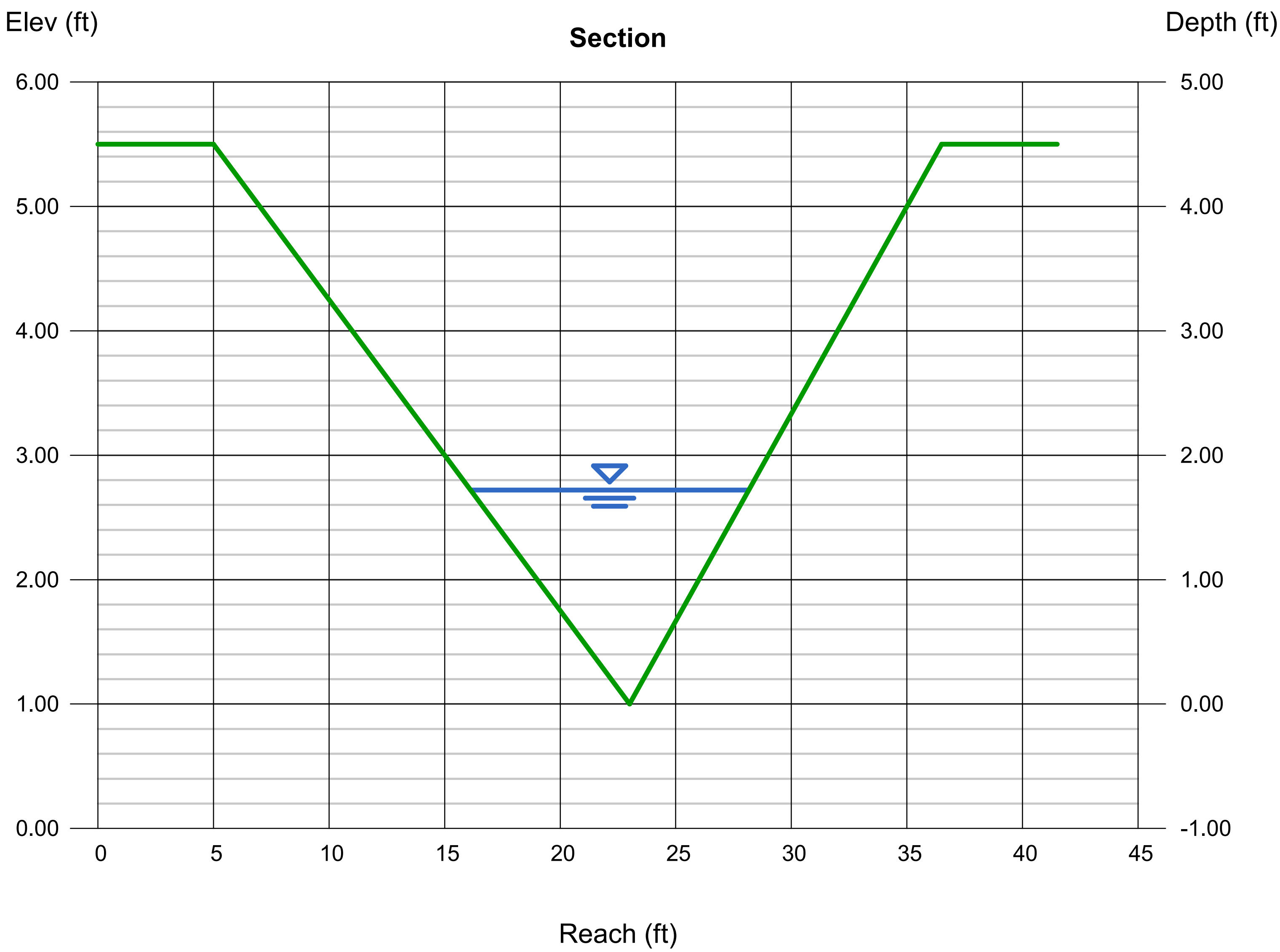
DP-10

Triangular
Side Slopes (z:1) = 4.00, 3.00
Total Depth (ft) = 4.50

Invert Elev (ft) = 1.00
Slope (%) = 6.00
N-Value = 0.068

Calculations
Compute by: Known Q
Known Q (cfs) = 48.80

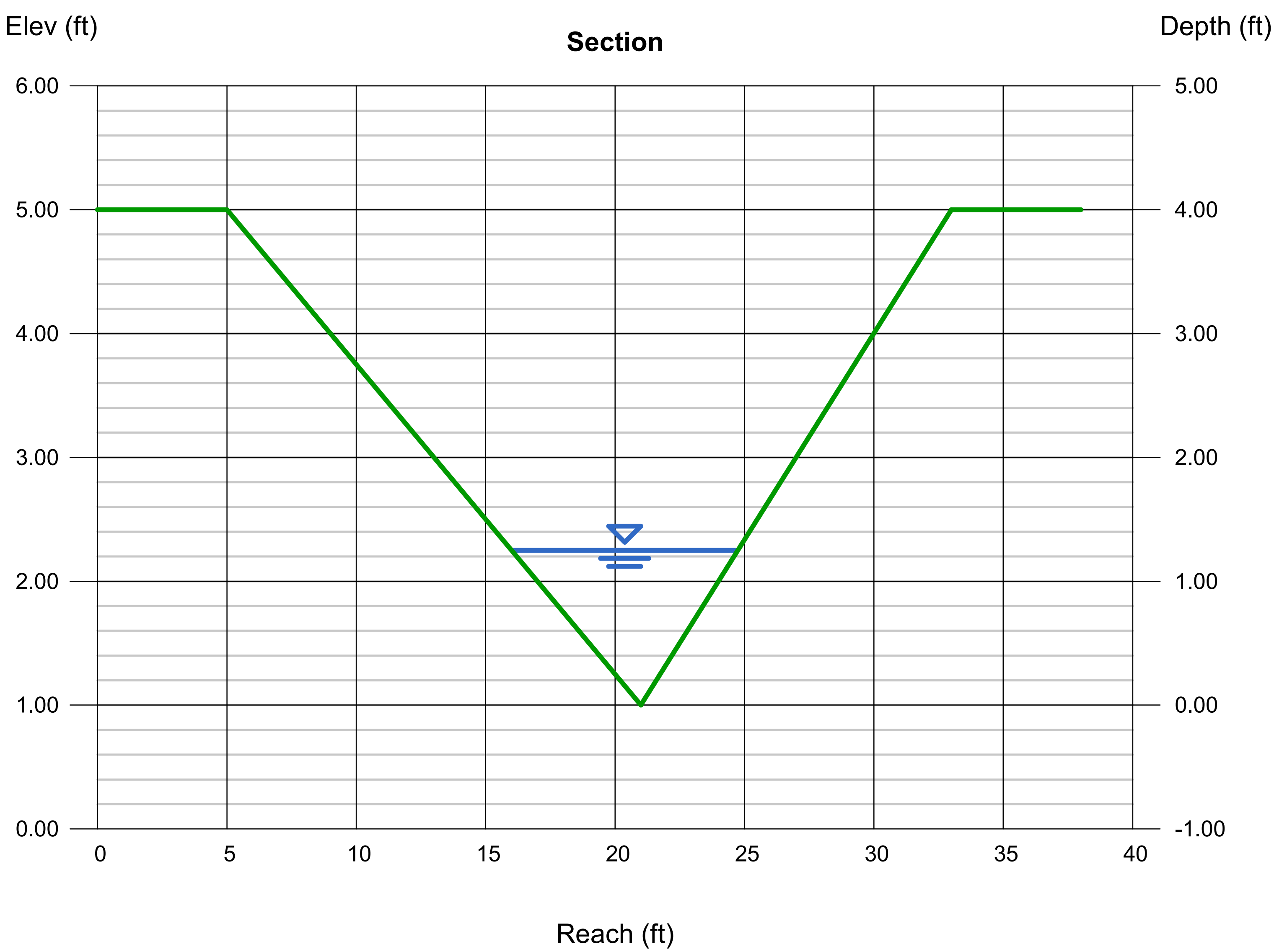
Highlighted
Depth (ft) = 1.72
Q (cfs) = 48.80
Area (sqft) = 10.35
Velocity (ft/s) = 4.71
Wetted Perim (ft) = 12.53
Crit Depth, Yc (ft) = 1.65
Top Width (ft) = 12.04
EGL (ft) = 2.07



Channel Report

DP-11

Triangular		**Highlighted**	
Side Slopes (z:1)	= 4.00, 3.00	Depth (ft)	= 1.25
Total Depth (ft)	= 4.00	Q (cfs)	= 24.00
		Area (sqft)	= 5.47
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 4.39
Slope (%)	= 2.80	Wetted Perim (ft)	= 9.11
N-Value	= 0.040	Crit Depth, Yc (ft)	= 1.24
		Top Width (ft)	= 8.75
Calculations		EGL (ft)	= 1.55
Compute by:	Known Q		
Known Q (cfs)	= 24.00		



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Tuesday, Jan 17 2023

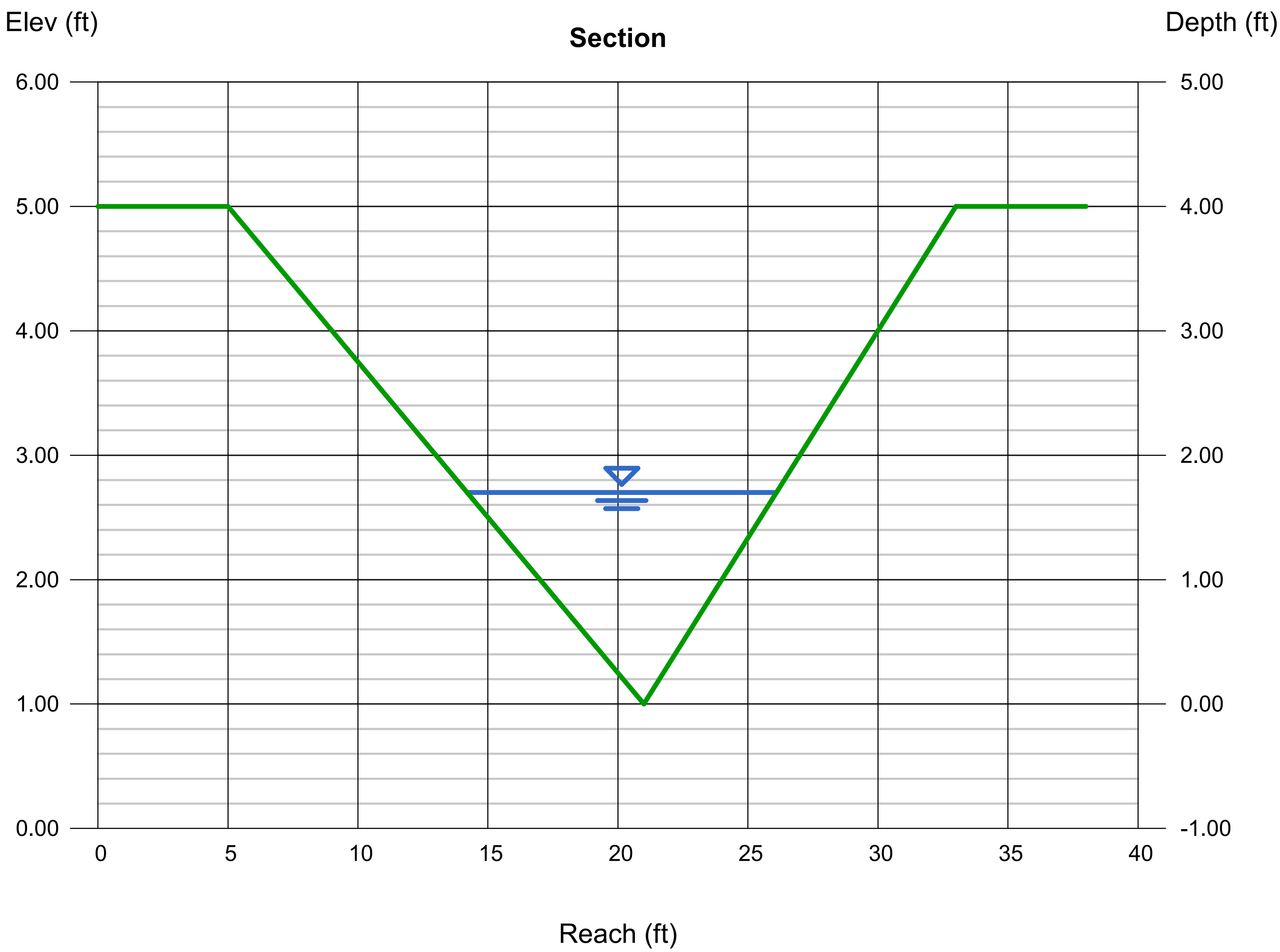
DP-12

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

Invert Elev (ft) = 1.00
Slope (%) = 4.80
N-Value = 0.061

Calculations
Compute by: Known Q
Known Q (cfs) = 46.80

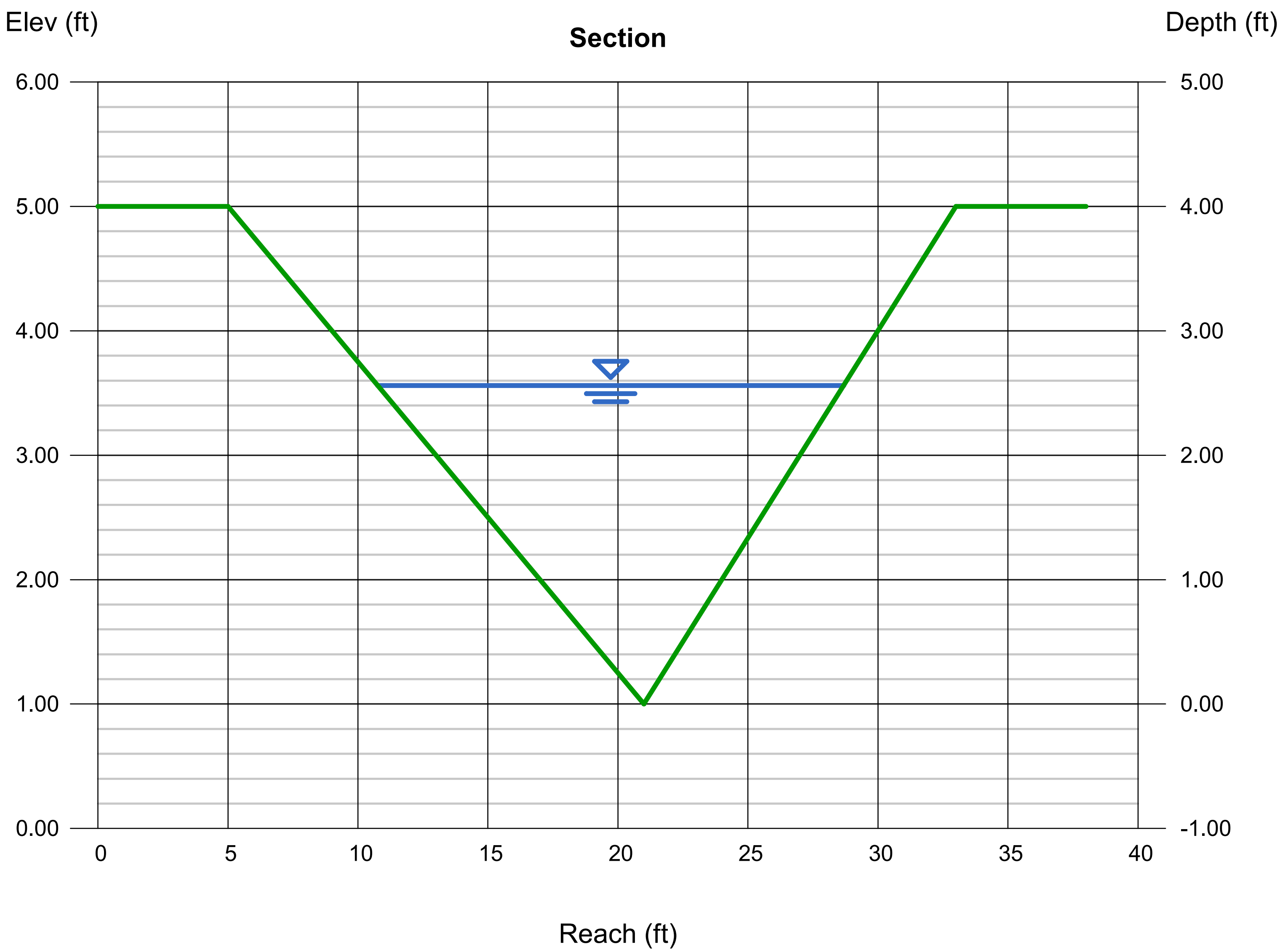
Highlighted
Depth (ft) = 1.70
Q (cfs) = 46.80
Area (sqft) = 10.11
Velocity (ft/s) = 4.63
Wetted Perim (ft) = 12.39
Crit Depth, Yc (ft) = 1.62
Top Width (ft) = 11.90
EGL (ft) = 2.03



Channel Report

DP-13 (2.8%)

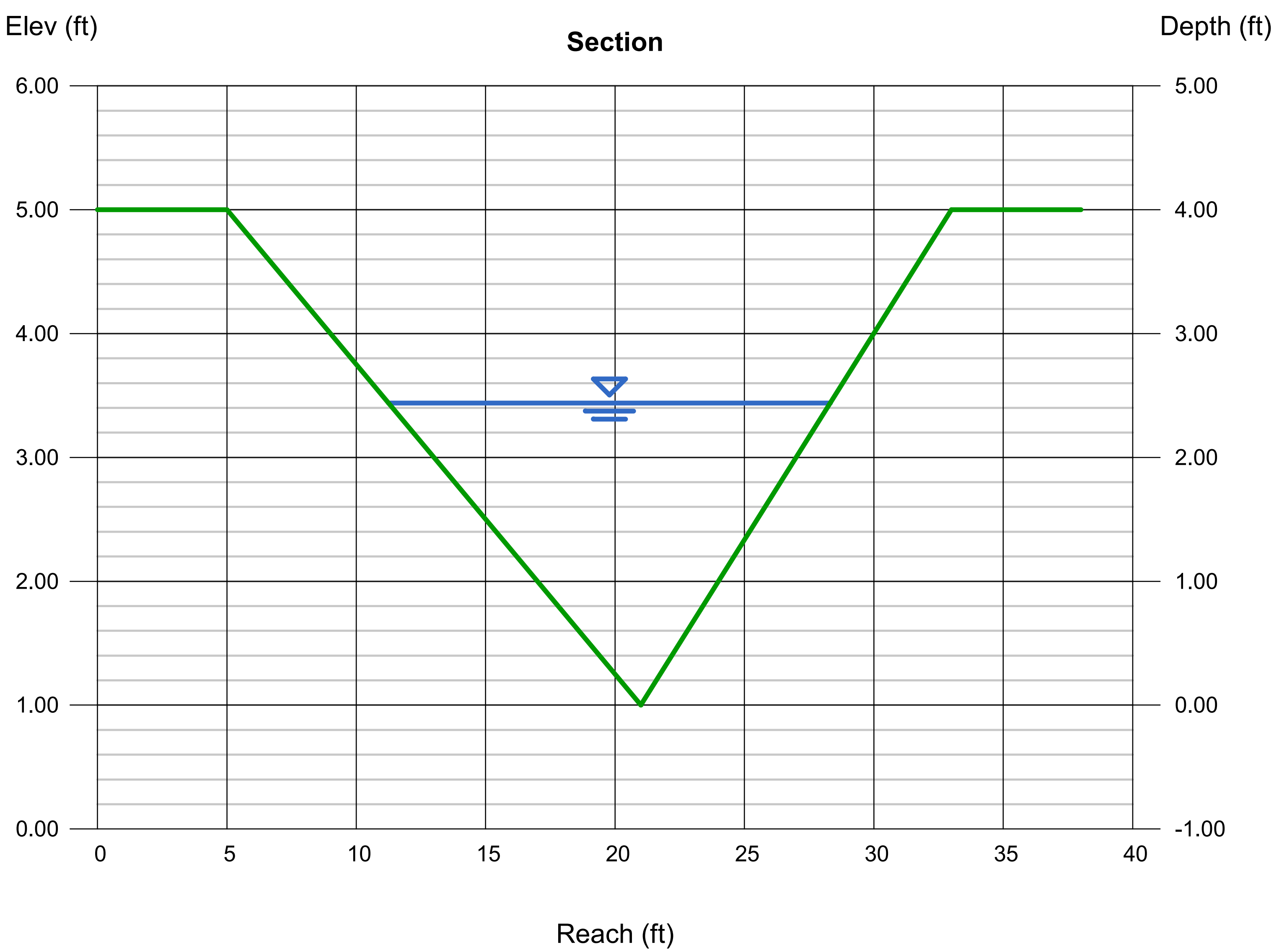
Triangular		**Highlighted**	
Side Slopes (z:1)	= 4.00, 3.00	Depth (ft)	= 2.56
Total Depth (ft)	= 4.00	Q (cfs)	= 100.10
		Area (sqft)	= 22.94
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 4.36
Slope (%)	= 2.80	Wetted Perim (ft)	= 18.65
N-Value	= 0.015	Crit Depth, Yc (ft)	= 2.20
		Top Width (ft)	= 17.92
Calculations		EGL (ft)	= 2.86
Compute by:	Known Q		
Known Q (cfs)	= 100.10		



Channel Report

DP-13 (3.6%)

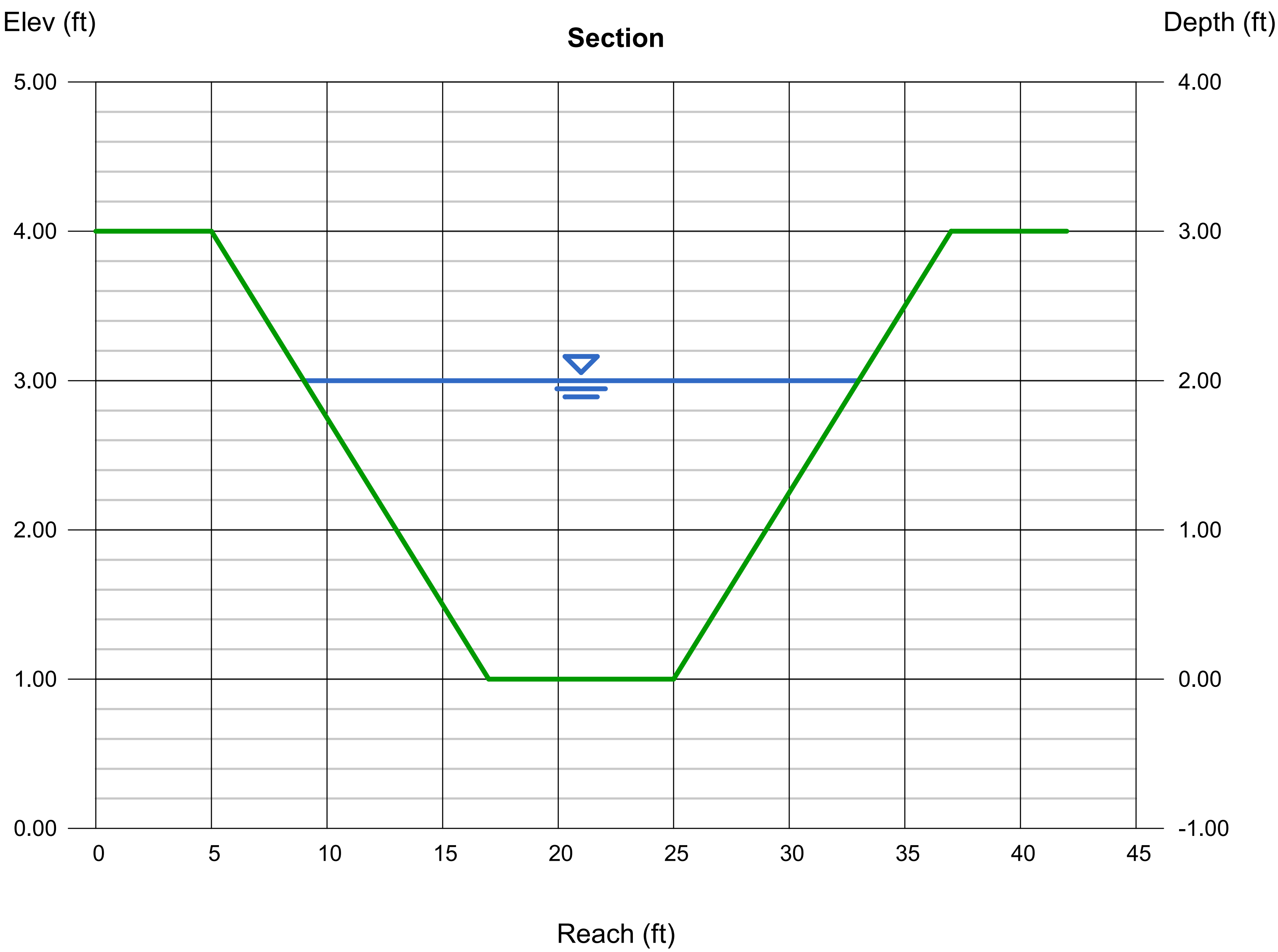
Triangular		**Highlighted**	
Side Slopes (z:1)	= 4.00, 3.00	Depth (ft)	= 2.44
Total Depth (ft)	= 4.00	Q (cfs)	= 100.10
		Area (sqft)	= 20.84
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 4.80
Slope (%)	= 3.60	Wetted Perim (ft)	= 17.78
N-Value	= 0.065	Crit Depth, Yc (ft)	= 2.20
		Top Width (ft)	= 17.08
Calculations		EGL (ft)	= 2.80
Compute by:	Known Q		
Known Q (cfs)	= 100.10		



Channel Report

DP-14

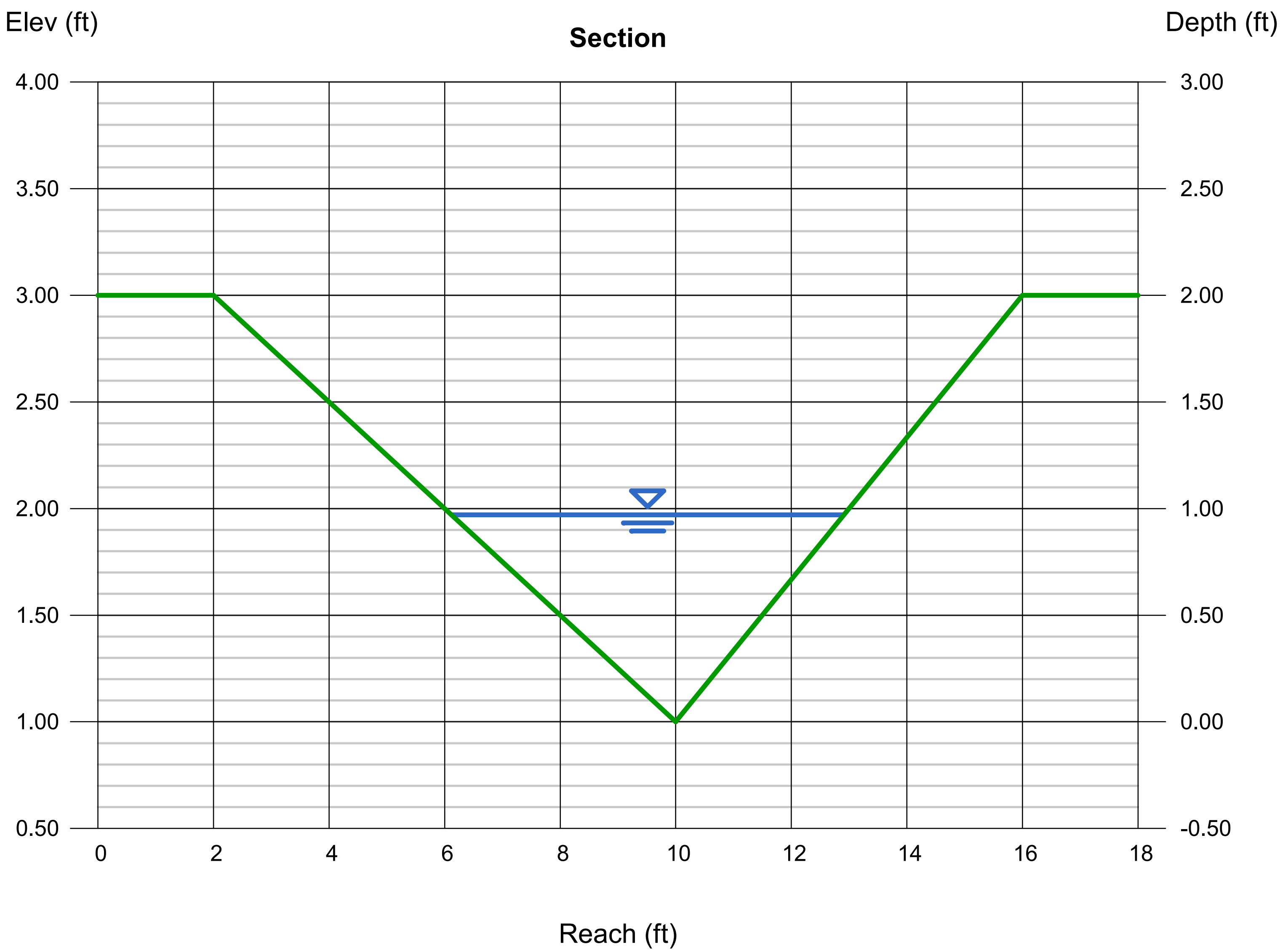
Trapezoidal		**Highlighted**	
Bottom Width (ft)	= 8.00	Depth (ft)	= 2.00
Side Slopes (z:1)	= 4.00, 4.00	Q (cfs)	= 153.00
Total Depth (ft)	= 3.00	Area (sqft)	= 32.00
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 4.78
Slope (%)	= 4.50	Wetted Perim (ft)	= 24.49
N-Value	= 0.078	Crit Depth, Yc (ft)	= 1.70
		Top Width (ft)	= 24.00
Calculations		EGL (ft)	= 2.36
Compute by:	Known Q		
Known Q (cfs)	= 153.00		



Channel Report

DP-16 (2.8%)

Triangular		**Highlighted**	
Side Slopes (z:1)	= 4.00, 3.00	Depth (ft)	= 0.97
Total Depth (ft)	= 2.00	Q (cfs)	= 12.30
		Area (sqft)	= 3.29
Invert Elev (ft)	= 1.00	Velocity (ft/s)	= 3.74
Slope (%)	= 2.80	Wetted Perim (ft)	= 7.07
N-Value	= 0.040	Crit Depth, Yc (ft)	= 0.95
		Top Width (ft)	= 6.79
Calculations		EGL (ft)	= 1.19
Compute by:	Known Q		
Known Q (cfs)	= 12.30		



Channel Report

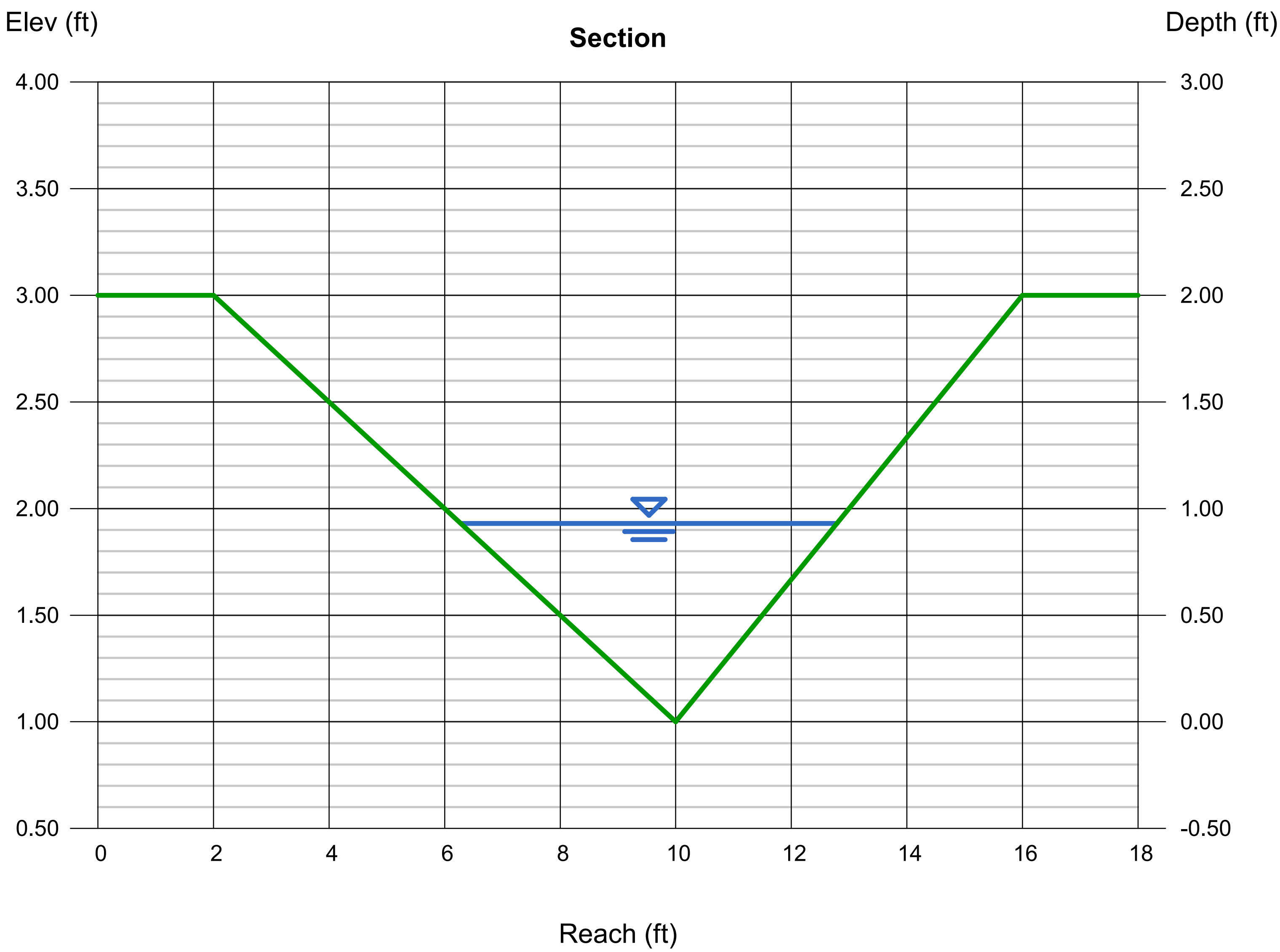
DP-16 (3.6%)

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

Invert Elev (ft) = 1.00
Slope (%) = 3.60
N-Value = 0.040

Calculations
Compute by: Known Q
Known Q (cfs) = 12.30

Highlighted
Depth (ft) = 0.93
Q (cfs) = 12.30
Area (sqft) = 3.03
Velocity (ft/s) = 4.06
Wetted Perim (ft) = 6.78
Crit Depth, Yc (ft) = 0.95
Top Width (ft) = 6.51
EGL (ft) = 1.19



Channel Report

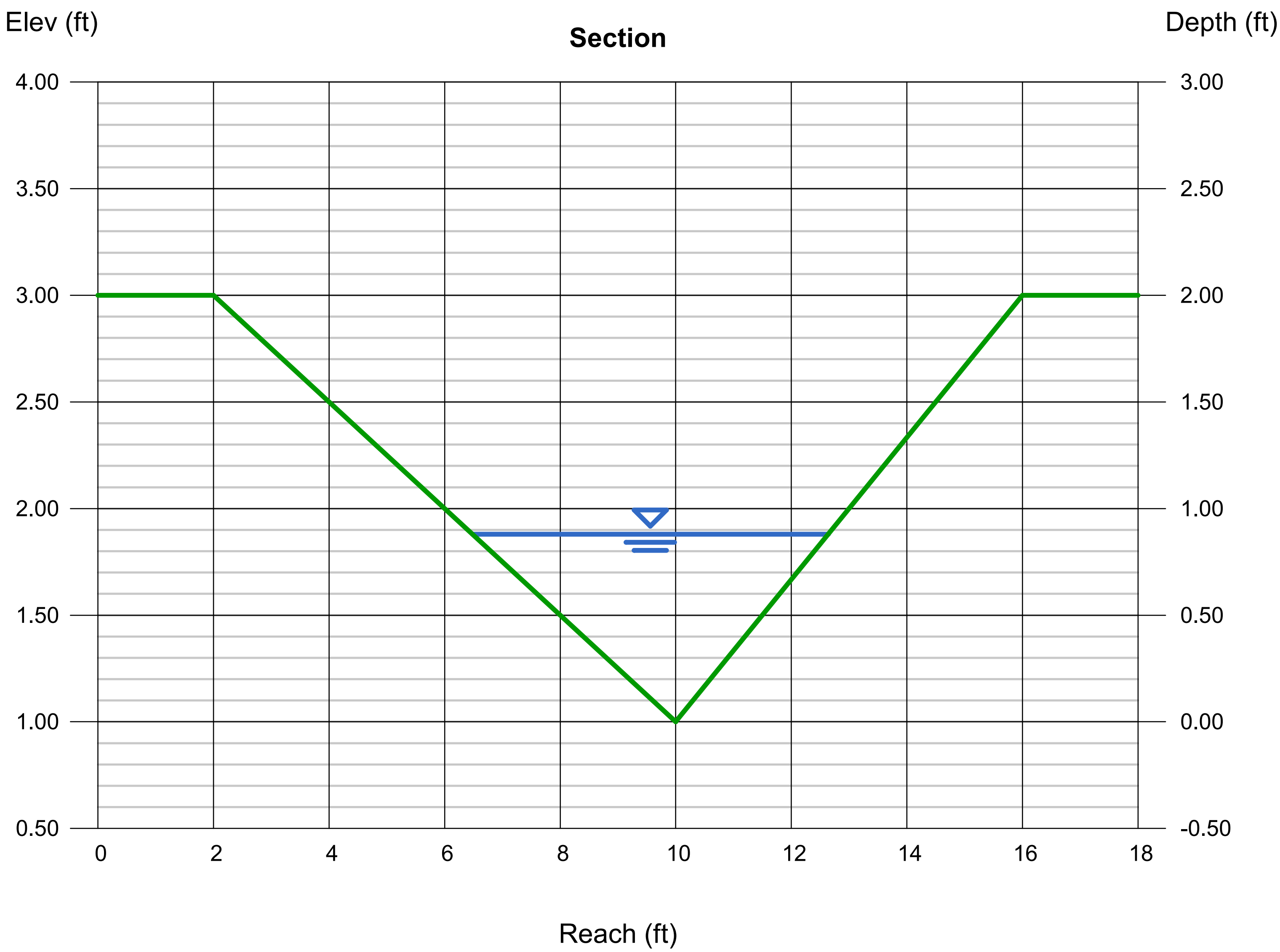
DP-16 (4.8%)

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

Invert Elev (ft) = 1.00
Slope (%) = 4.80
N-Value = 0.040

Calculations
Compute by: Known Q
Known Q (cfs) = 12.30

Highlighted
Depth (ft) = 0.88
Q (cfs) = 12.30
Area (sqft) = 2.71
Velocity (ft/s) = 4.54
Wetted Perim (ft) = 6.41
Crit Depth, Yc (ft) = 0.95
Top Width (ft) = 6.16
EGL (ft) = 1.20

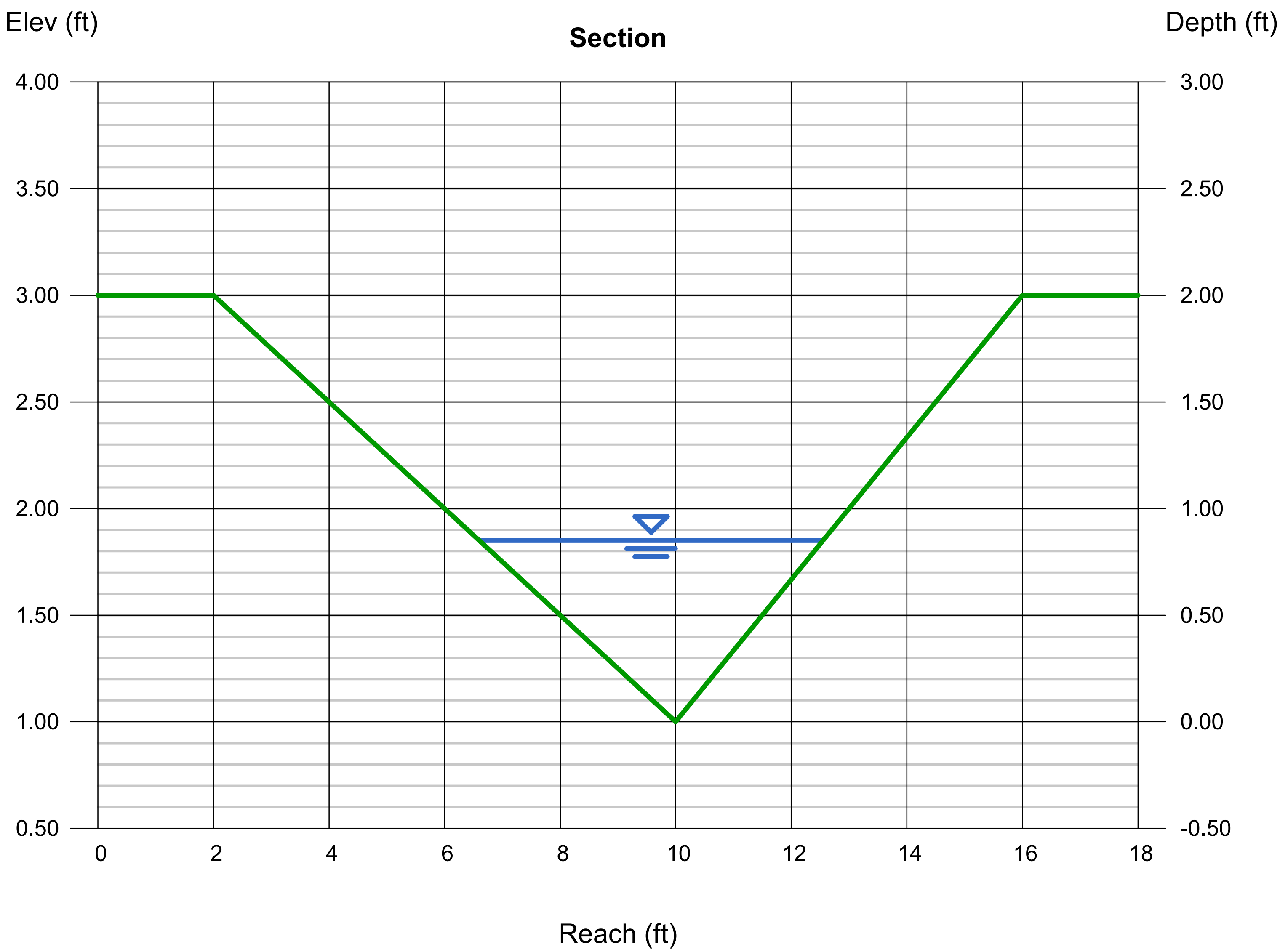


Channel Report

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	= 0.040
Calculations	
Compute by:	Known Q
Known Q (cfs)	= 12.30

Highlighted	
Depth (ft)	= 0.85
Q (cfs)	= 12.30
Area (sqft)	= 2.53
Velocity (ft/s)	= 4.86
Wetted Perim (ft)	= 6.19
Crit Depth, Yc (ft)	= 0.95
Top Width (ft)	= 5.95
EGL (ft)	= 1.22



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: 0.0681

Flow: 48.8000 cfs

Result Parameters

Depth: 1.7205 ft

Area of Flow: 10.3602 ft^2

Wetted Perimeter: 12.5344 ft

Hydraulic Radius: 0.8265 ft

Average Velocity: 4.7103 ft/s

Top Width: 12.0434 ft

Froude Number: 0.8950

Critical Depth: 1.6526 ft

Critical Velocity: 5.1053 ft/s

Critical Slope: 0.0744 ft/ft

Critical Top Width: 11.81 ft

Calculated Max Shear Stress: 6.4415 lb/ft^2

Calculated Avg Shear Stress: 3.0946 lb/ft^2

Channel Lining Analysis: Channel Lining Design Analysis DP-10

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 1 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: 1.34342

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.860654

Manning's n method: Bathurst

Manning's n: 0.0680594

Channel Bottom Shear Results

V*: 1.82361

Reynold's Number: 149845

Shield's Parameter: 0.117713

shear stress on channel bottom: 6.44458 lb/ft^2

Permissible shear stress for channel bottom: 10.5606 lb/ft^2

channel bottom is stable

Stable D50: 0.819817 ft

Channel Side Shear Results

K1: 0.934

K2: 1

Kb: 0

shear stress on side of channel: 6.44458 lb/ft^2

Permissible shear stress for side of channel: 10.5606 lb/ft^2

Stable Side D50: 0.765709 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: 0.0605

Flow: 46.8000 cfs

Result Parameters

Depth: 1.6903 ft

Area of Flow: 9.9996 ft^2

Wetted Perimeter: 12.3143 ft

Hydraulic Radius: 0.8120 ft

Average Velocity: 4.6802 ft/s

Top Width: 11.8319 ft

Froude Number: 0.8972

Critical Depth: 1.6252 ft

Critical Velocity: 5.0627 ft/s

Critical Slope: 0.0592 ft/ft

Critical Top Width: 11.61 ft

Calculated Max Shear Stress: 5.0627 lb/ft^2

Calculated Avg Shear Stress: 2.4322 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: 1.18646

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 1.12705

Manning's n method: Bathurst

Manning's n: 0.0605469

Channel Bottom Shear Results

V*: 1.61646

Reynold's Number: 99617.6

Shield's Parameter: 0.0853788

shear stress on channel bottom: 5.0636 lb/ft^2

Permissible shear stress for channel bottom: 6.5699 lb/ft^2

channel bottom is stable

Stable D50: 0.685828 ft

Channel Side Shear Results

K1: 0.934

K2: 0.931169

Kb: 0

shear stress on side of channel: 5.0636 lb/ft^2

Permissible shear stress for side of channel: 6.11768 lb/ft^2

Stable Side D50: 0.687913 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: 0.0653

Flow: 100.1000 cfs

Result Parameters

Depth: 2.4405 ft

Area of Flow: 20.8462 ft^2

Wetted Perimeter: 17.7800 ft

Hydraulic Radius: 1.1725 ft

Average Velocity: 4.8018 ft/s

Top Width: 17.0835 ft

Froude Number: 0.7660

Critical Depth: 2.2028 ft

Critical Velocity: 5.8942 ft/s

Critical Slope: 0.0622 ft/ft

Critical Top Width: 15.74 ft

Calculated Max Shear Stress: 5.4823 lb/ft^2

Calculated Avg Shear Stress: 2.6338 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: 1 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: 1.30708

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 1.22039

Manning's n method: Bathurst

Manning's n: 0.0652905

Channel Bottom Shear Results

V*: 1.68207

Reynold's Number: 138214

Shield's Parameter: 0.110225

shear stress on channel bottom: 5.48297 lb/ft^2

Permissible shear stress for channel bottom: 11.3091 lb/ft^2

channel bottom is stable

Stable D50: 0.633705 ft

Channel Side Shear Results

K1: 0.934

K2: 0.931169

Kb: 0

shear stress on side of channel: 5.48297 lb/ft^2

Permissible shear stress for side of channel: 10.5307 lb/ft^2

Stable Side D50: 0.635632 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-13 (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: 0.0766

Flow: 100.1000 cfs

Result Parameters

Depth: 2.7164 ft

Area of Flow: 25.8262 ft^2

Wetted Perimeter: 19.7901 ft

Hydraulic Radius: 1.3050 ft

Average Velocity: 3.8759 ft/s

Top Width: 19.0149 ft

Froude Number: 0.5861

Critical Depth: 2.2028 ft

Critical Velocity: 5.8942 ft/s

Critical Slope: 0.0856 ft/ft

Critical Top Width: 15.74 ft

Calculated Max Shear Stress: 4.7461 lb/ft^2

Calculated Avg Shear Stress: 2.2801 lb/ft^2

Channel Lining Analysis: Channel Lining Design Analysis DP-13 (2.8%)

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: 1.17654

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 1.81094

Manning's n method: Blodgett

Manning's n: 0.0766124

Channel Bottom Shear Results

V*: 1.56497

Reynold's Number: 96444.1

Shield's Parameter: 0.0833359

shear stress on channel bottom: 4.74612 lb/ft^2

Permissible shear stress for channel bottom: 6.4127 lb/ft^2

channel bottom is stable

Stable D50: 0.653081 ft

Channel Side Shear Results

K1: 0.934

K2: 0.931169

Kb: 0

shear stress on side of channel: 4.74612 lb/ft^2

Permissible shear stress for side of channel: 5.9713 lb/ft^2

Stable Side D50: 0.655067 lb/ft^2

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-13 (2.8%)

Channel Analysis: DP-14

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: 0.0775

Flow: 153.0000 cfs

Result Parameters

Depth: 1.9839 ft

Area of Flow: 31.6139 ft^2

Wetted Perimeter: 24.3594 ft

Hydraulic Radius: 1.2978 ft

Average Velocity: 4.8396 ft/s

Top Width: 23.8709 ft

Froude Number: 0.7411

Critical Depth: 1.6940 ft

Critical Velocity: 6.1127 ft/s

Critical Slope: 0.0854 ft/ft

Critical Top Width: 21.55 ft

Calculated Max Shear Stress: 5.5707 lb/ft^2

Calculated Avg Shear Stress: 3.6443 lb/ft^2

Channel Lining Analysis: Channel Lining Design Analysis DP-14

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: 1.20173

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 1.76635

Manning's n method: Blodgett

Manning's n: 0.0775146

Channel Bottom Shear Results

V*: 1.69577

Reynold's Number: 104505

Shield's Parameter: 0.0885253

shear stress on channel bottom: 5.57269 lb/ft^2

Permissible shear stress for channel bottom: 6.81202 lb/ft^2

channel bottom is stable

Stable D50: 0.737324 ft

Channel Side Shear Results

K1: 0.934

K2: 0.931169

Kb: 0

shear stress on side of channel: 5.57269 lb/ft^2

Permissible shear stress for side of channel: 6.34314 lb/ft^2

Stable Side D50: 0.739566 lb/ft^2

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-14

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

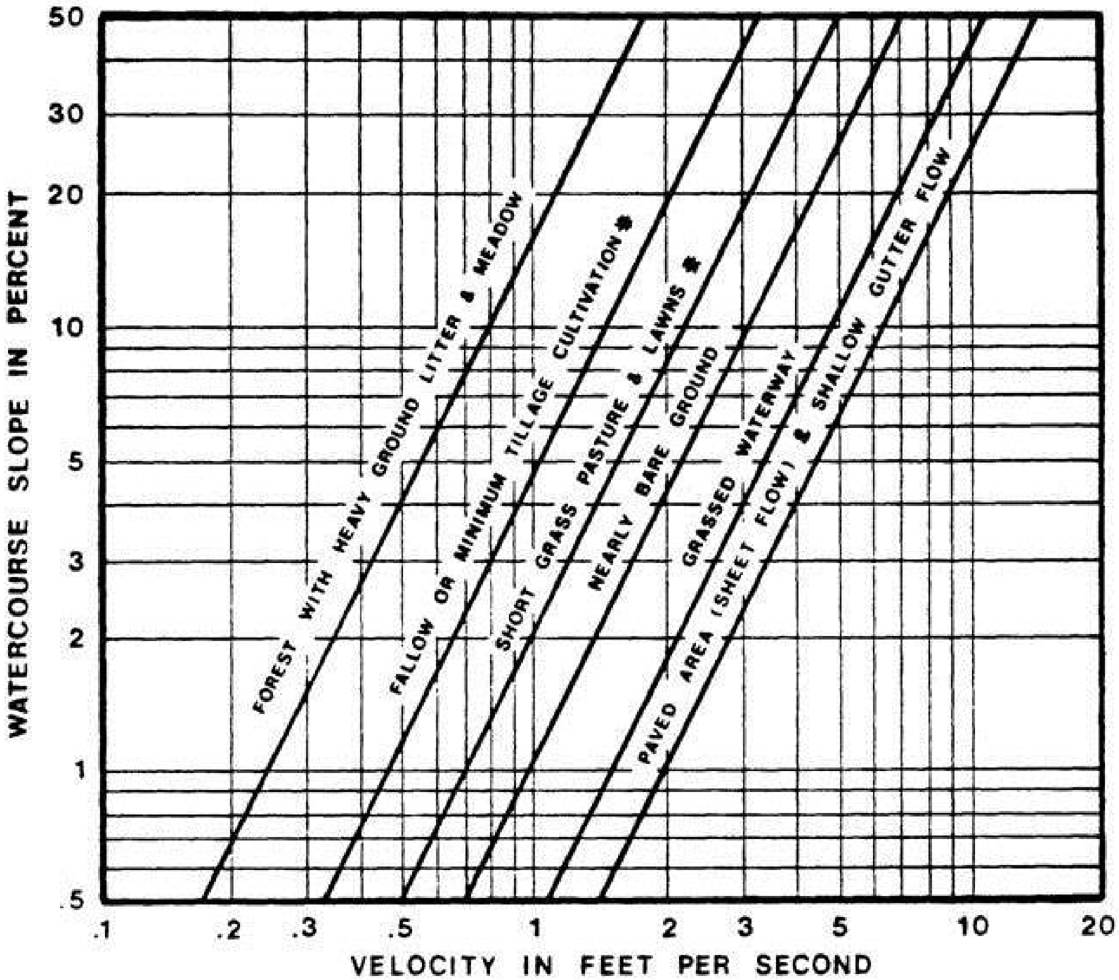
3.2 Time of Concentration

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

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.

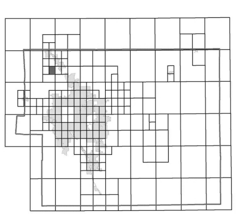
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this 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

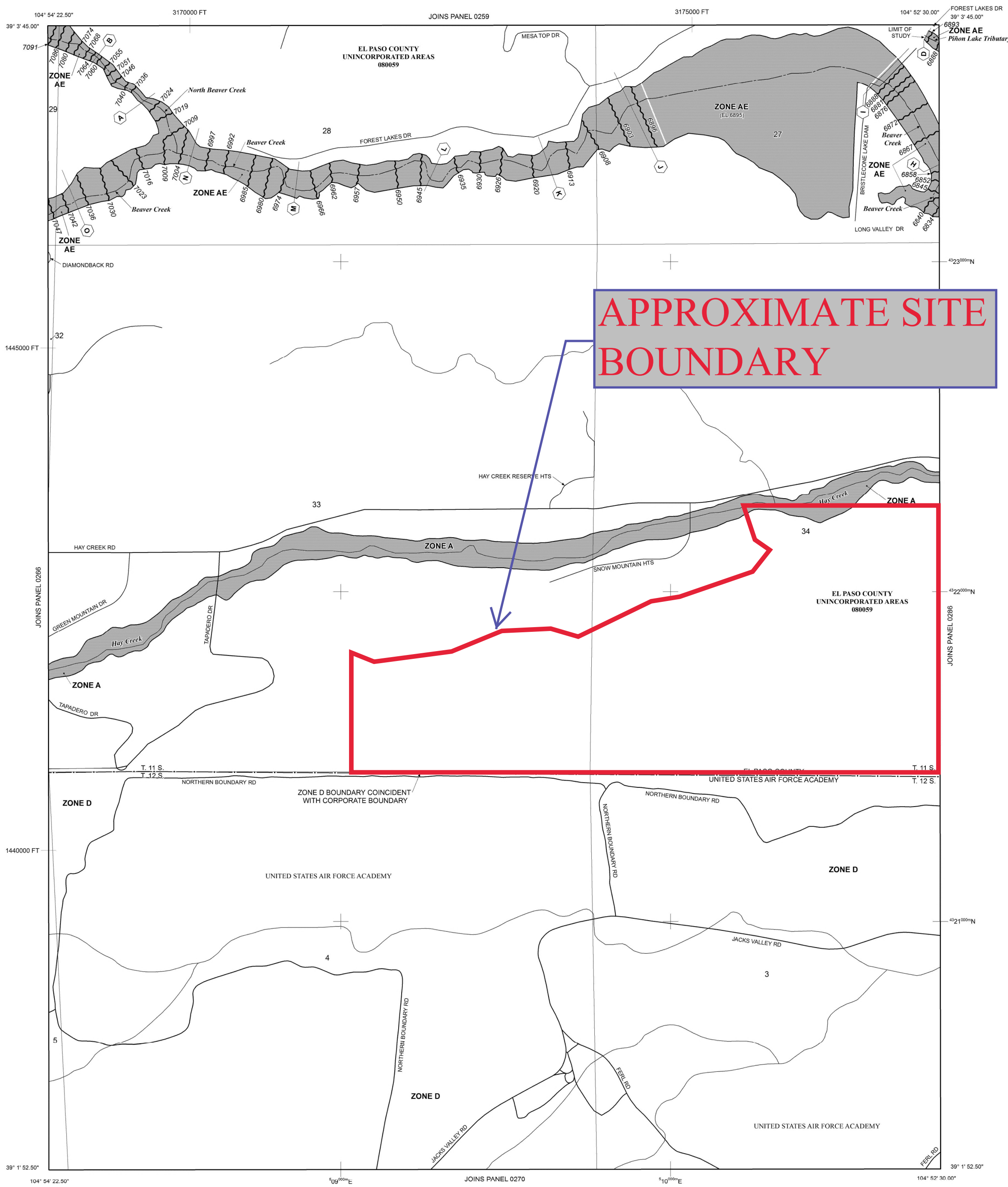
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

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

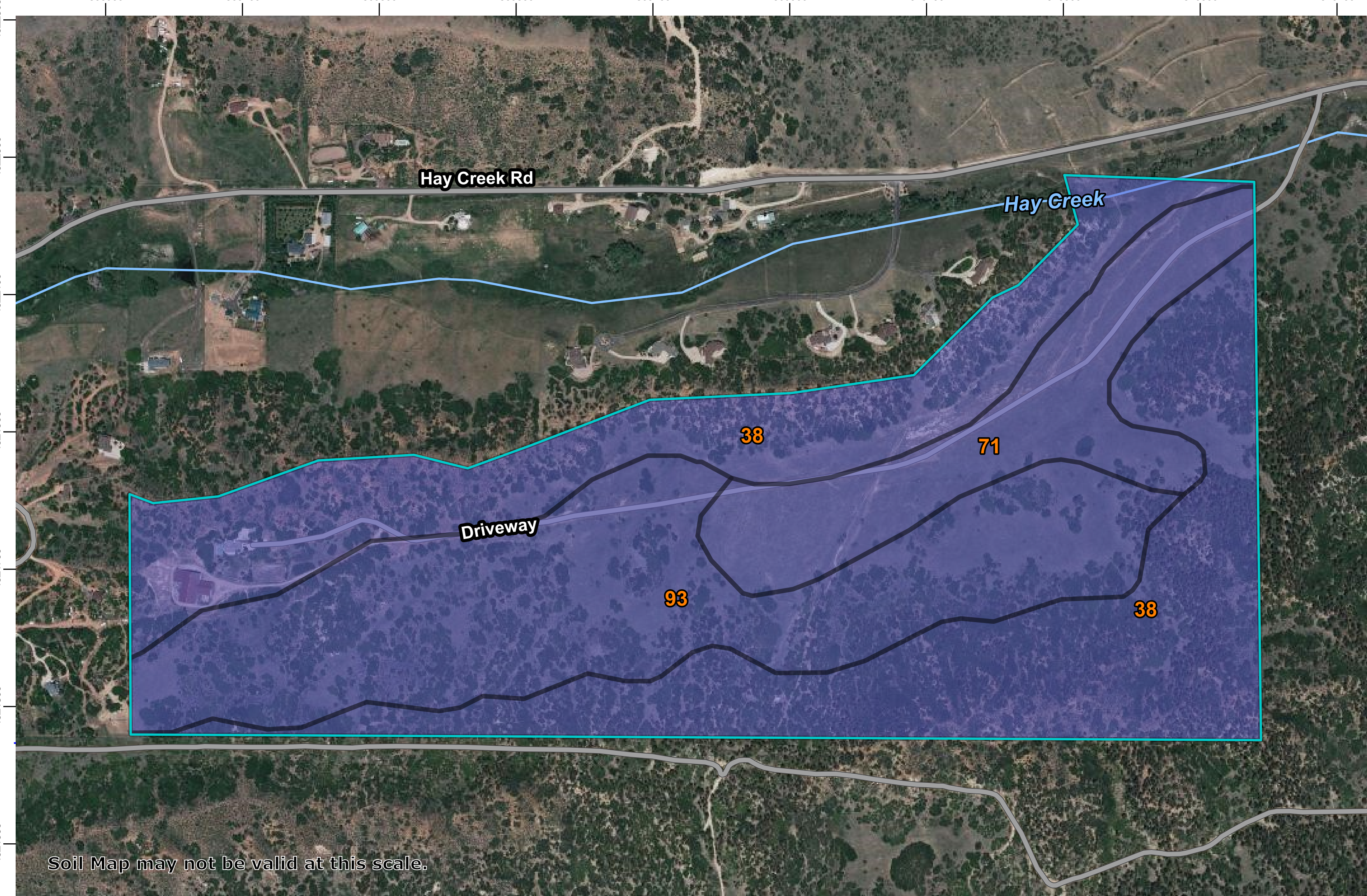
Federal Emergency Management Agency

104° 53' 55" W | 104° 52' 32" W

39° 3' 5" N

508900 509100 509300 509500 509700 509900 510100 510300 510500 510700

4322500 4322300 4322100 4321900 4321700 4321500 4321300



39° 2' 23" N

508900 509100 509300 509500 509700 509900 510100 510300 510500 510700

104° 53' 55" W | 104° 52' 32" W

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 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

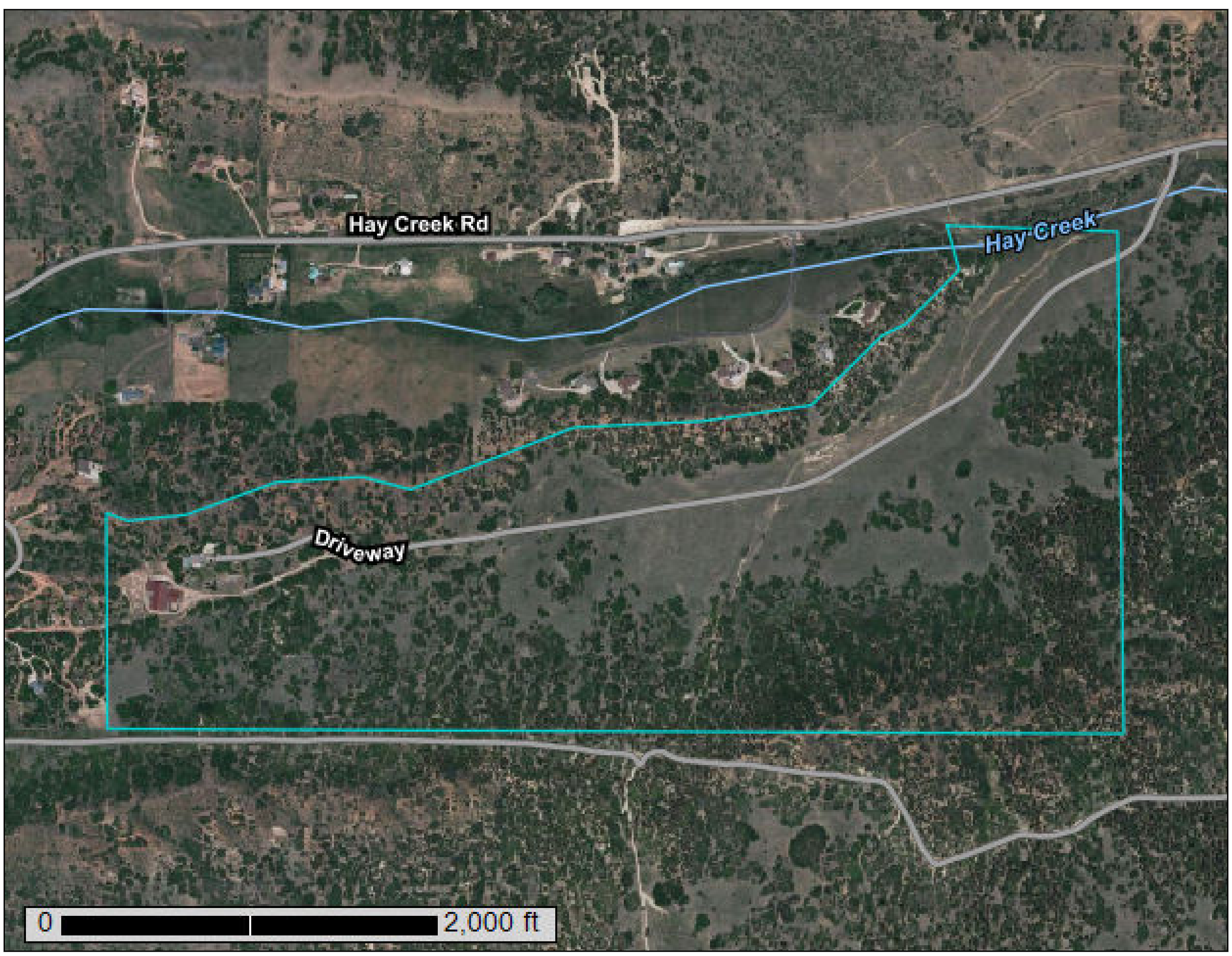
NRCS

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.

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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.

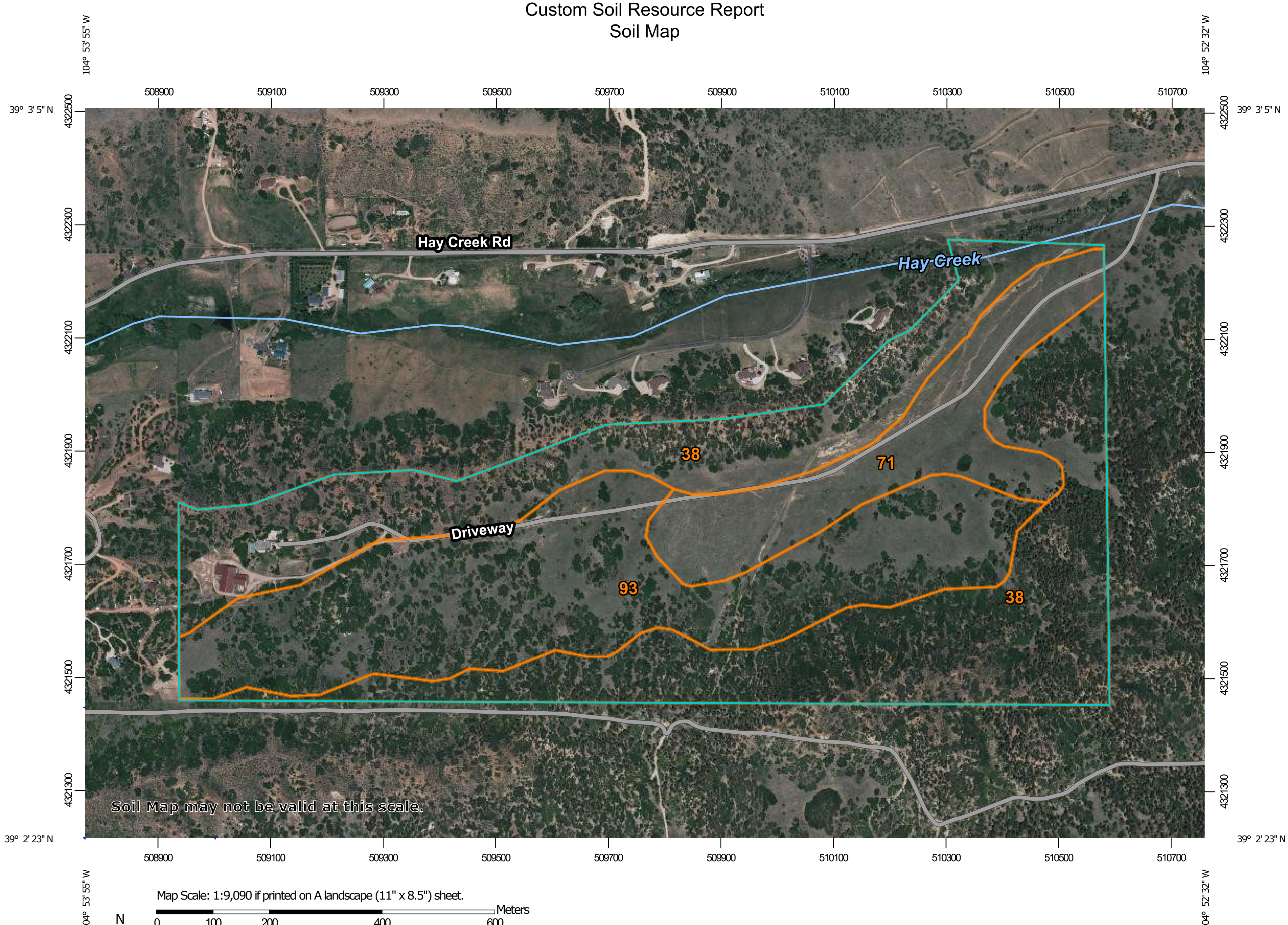
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree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

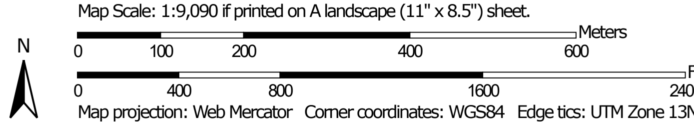
Soil Map

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.

Custom Soil Resource Report
Soil Map



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



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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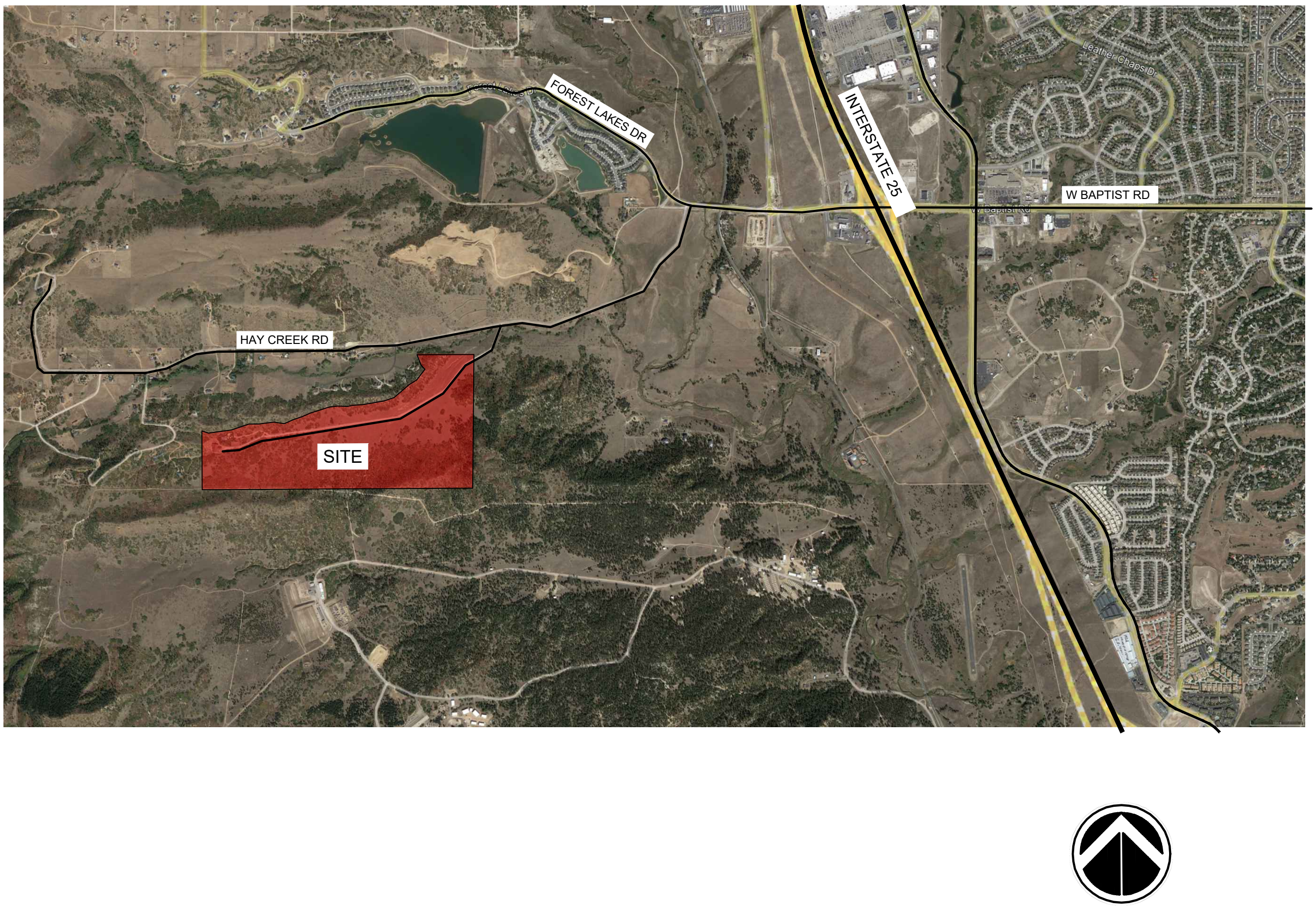
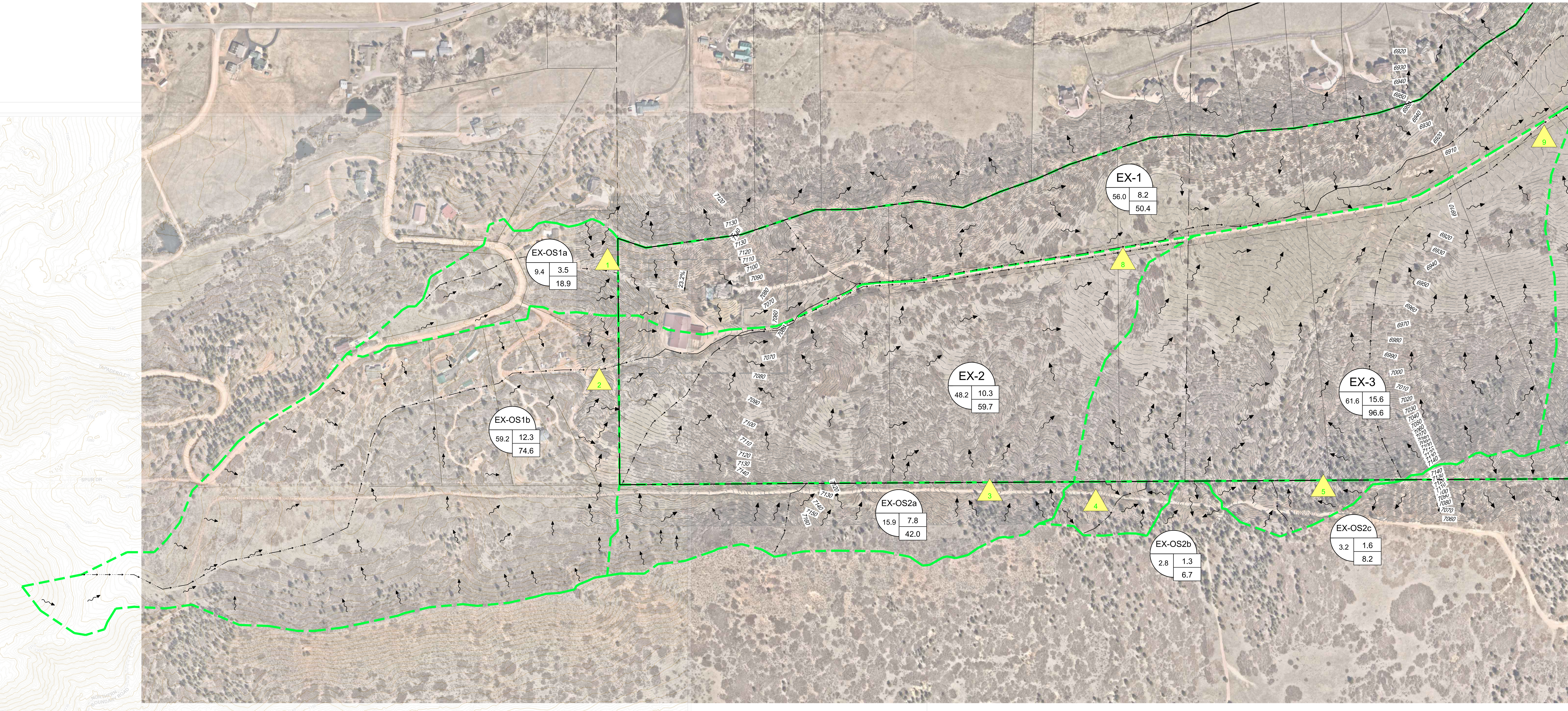
APPENDIX D

MAPS



VICINITY MAP
HAY CREEK VALLEY
(NTS)



LEGEND

BASIN BOUNDARY

EXISTING PROPERTY LINE

EXISTING CONTOUR

FLOW DIRECTION

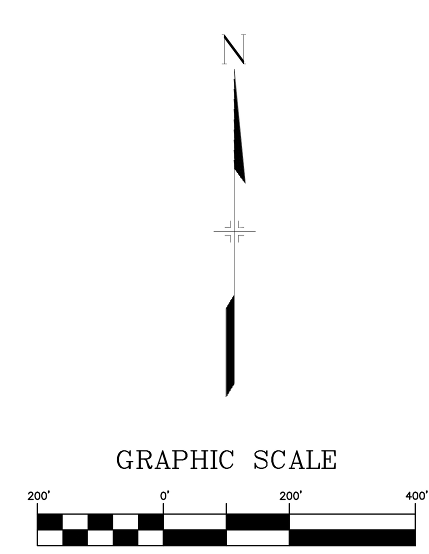
DESIGN POINT

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

FINAL DRAINAGE REPORT

OFFSITE DRAINAGE BASINS

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

SEAL

PRELIMINARY

THIS DRAWING HAS NOT BEEN APPROVED BY GOVERNING AGENCIES AND IS SUBJECT TO CHANGE

FOR AND ON BEHALF OF MATRIX DESIGN GROUP, INC.

PROJECT No. 22.886.076

PREPARED BY:

Matrix

Excellence by Design

SHEET KEY

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

REFERENCE DRAWINGS

COMPUTER FILE MANAGEMENT

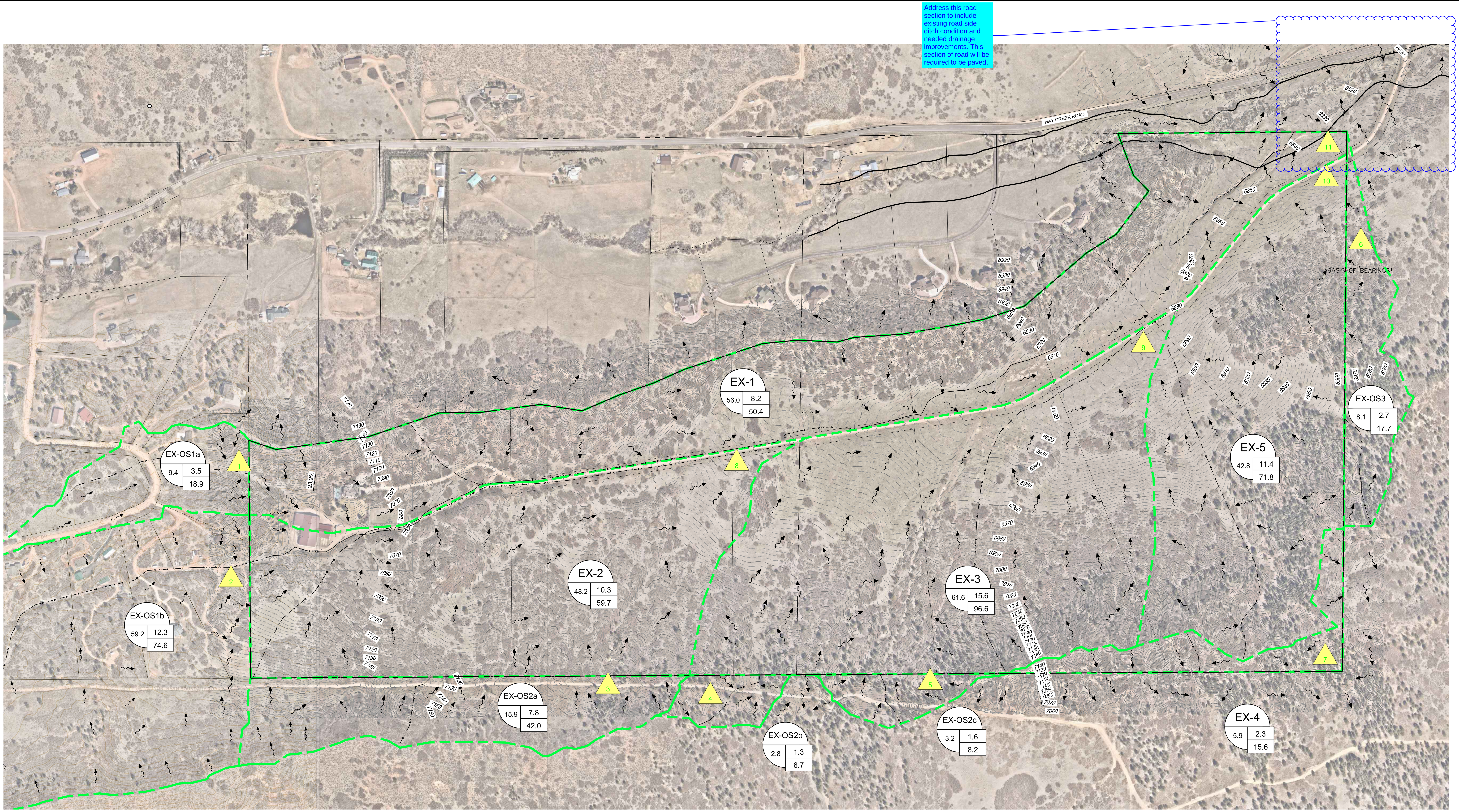
FILE NAME: S:\22.886.076 Hay Creek-Forest Manor-O'Leary Properties\200 Design\220 Drainage-WR\222 Reports\FDR\DWG\DR01 - HAY CREEK.dwg

CTB FILE: ---

PLOT DATE: January 18, 2023 1:46:38 PM

THIS DRAWING IS CURRENT AS OF PLOT DATE AND MAY BE SUBJECT TO CHANGE.

Address this road section to include existing road side ditch condition and needed drainage improvements. This section of road will be required to be paved.



LEGEND

BASIN BOUNDARY

EXISTING CONTOUR

FLOW DIRECTION

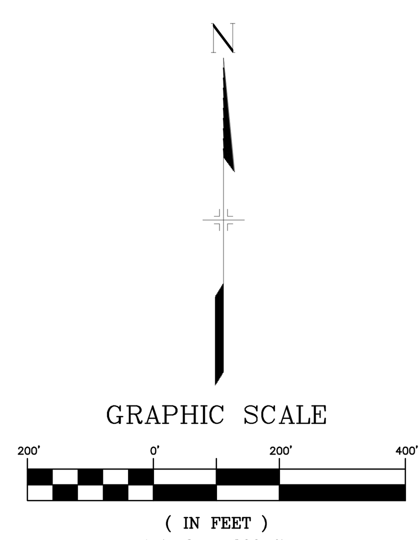
DESIGN POINT

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	3.5	18.9
EX-OS1b	59.2	12.3	74.6
EX-OS2a	15.9	7.8	42.0
EX-OS2b	2.8	1.3	6.7
EX-OS2c	3.2	1.6	8.2
EX-OS3	8.1	2.7	17.7
EX-1	56.0	8.2	50.4
EX-2	48.2	10.3	59.7
EX-3	61.6	15.6	96.6
EX-4	5.9	2.3	15.6
EX-5	42.8	11.4	71.8

Existing Design Point Summary

Hay Creek

Design Point	Sub-Basins	Total Area (ac.)	Q(5) (cfs)	Q(100) (cfs)
1	EX-OS1a	9.35	3.47	18.95
2	EX-OS1b	59.21	12.31	74.56
3	EX-OS2a	15.90	7.84	42.05
4	EX-OS2b	2.77	1.34	6.74
5	EX-OS2c	3.17	1.62	8.21
6	EX-OS3	8.15	2.66	17.71
7	EX-4	5.88	2.32	15.59
8	EX-OS1b, EX-OS2a, EX-2	123.33	26.12	153.08
9	EX-OS2b, EX-OS2c, EX-3	67.57	17.56	106.51
10	EX-OS3, EX-5	50.97	13.45	85.25
11	DP-8, DP-9, DP-10, EX-OS1a, EX-1	307.27	35.04	210.91

EL PASO COUNTY

HAY CREEK
FINAL DRAINAGE REPORT

PRE DEVELOPMENT DRAINAGE CONDITIONS

DRAWING No. DR02

DATE ISSUED: JANUARY 2023

SHEET 2 OF 3

SCALE HORIZ. VERT.

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

SEAL

PRELIMINARY
THIS DRAWING HAS NOT BEEN APPROVED BY GOVERNING AGENCIES AND IS SUBJECT TO CHANGE

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

PREPARED BY:
Matrix
Excellence by Design

SHEET KEY

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

REFERENCE DRAWINGS

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FILE NAME: S:\22.886.076 Hay Creek-Forest Manor-O'Leary Properties\200 Design\220 Drainage-WR\222 Reports\FDR\DWG\DR01 - HAY CREEK.dwg
CTB FILE: ---
PLOT DATE: January 18, 2023 1:43:40 PM
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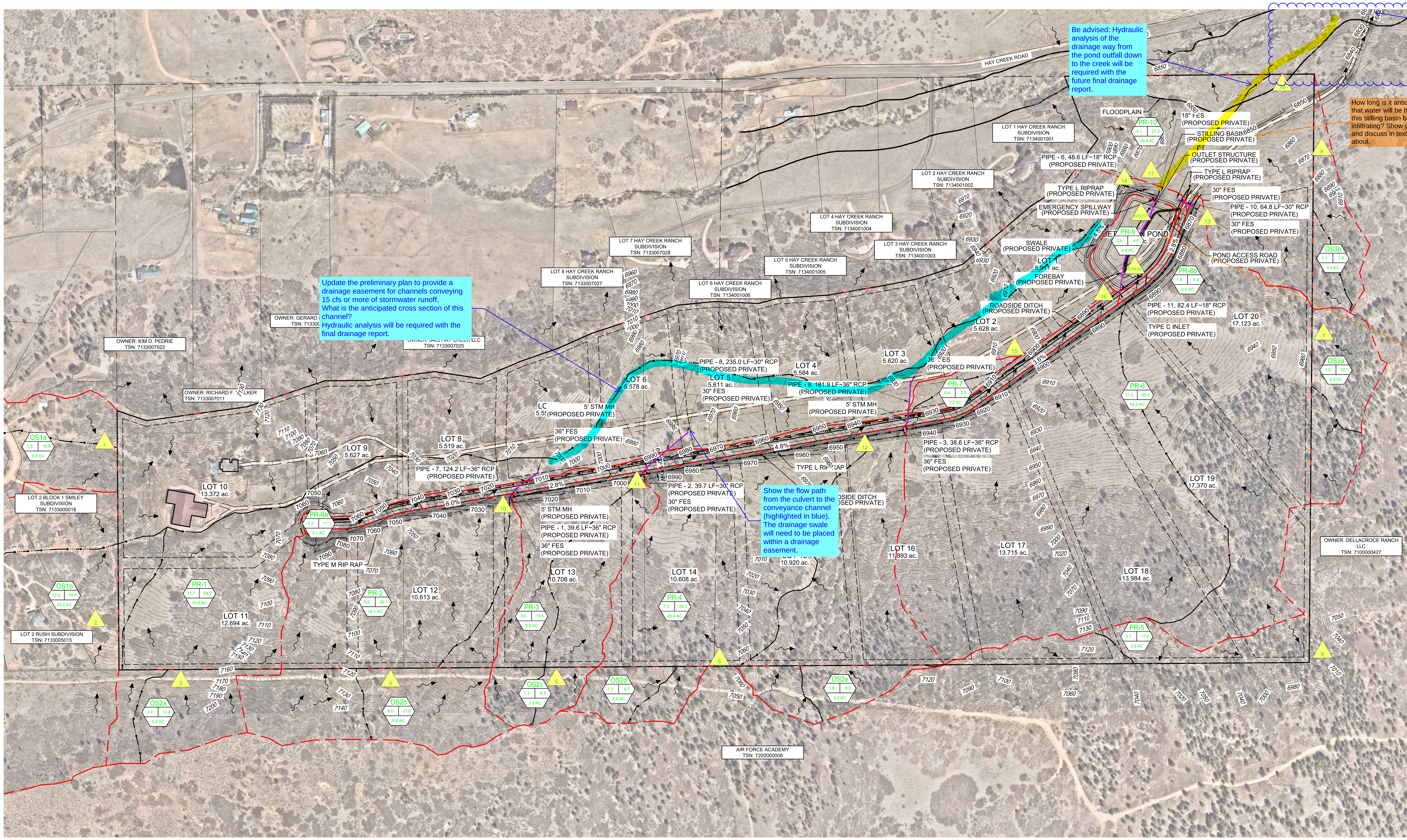

Provide analysis of the creek crossing. Is there an existing culvert and does it meet criteria for Hw/D and overtopping? If not then the crossing will need to be modified.

Show Hay Creek Rd Intersection to include culverts.

Assign a name/number to all PBMPs and then update all submitted text and drawings accordingly with consistent labeling throughout (example: "Pond A" or "Pond 1").

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

We need to know how much disturbed area is untreated and if there are any exclusions that apply to those areas. So please create a basic overview map (or modify an existing drainage map) with color shading/hatching that shows areas tributary to each PBMP (pond, runoff reduction, etc) and those disturbed areas that are not treated by a PBMP, with the applicable exclusion labeled (ex: 20% up to 1ac of development can be excluded per ECM App I.7.1.C.1 and exclusions listed in ECM App I.7.1.B.#). An accompanying summary table on this map would also be very helpful (example provided):

GRAPHIC SCALE

200' 0' 200' 400'

Basin ID	Total Area (ac)	Total Proposed Disturbed Area (ac)	Area Trib to Pond A (ac)	Disturbed Area Treated via Runoff Reduction (ac)	Area Excluded from WQ per ECM App I.7.1.C.1 (ac)	Area Excluded from WQ per ECM App I.7.1.B.# (ac)	Applicable WQ Exclusions (App I.7.1.B.#)
A	4.50	4.50	4.50	-	-	-	
B	1.25	1.25	-	1.00	0.25	-	
C	6.00	4.00	-	-	-	4.00	ECM App I.7.1.B.5
D	2.50	2.50	1.00	-	0.50	1.00	ECM App I.7.1.B.7
E	3.00	-	3.00	-	-	-	
F	8.25	-	-	-	-	-	
Total	25.50	12.25	8.50	1.00	0.75	5.00	
Comments		[For each row, the sum of the values in Columns 4-7 must be greater than or equal to the value in Column 3 above.]	[Values in this column can be more than Column 3 if over-treating non-disturbed areas.]	See RR calc spreadsheet.	[Total must be <20% of site and <1ac.]		

Hay Creek

Proposed Conditions
Sub-basin Summary

Basin	Area	Q5	Q100
	acres	cfs	cfs
OS1a	9.4	3.5	18.9
OS1b	59.2	12.3	74.6
OS2a	5.0	2.2	12.4
OS2b	8.6	4.0	21.6
OS2c	2.3	1.3	6.5
OS2d	2.8	1.3	6.7
OS2e	3.2	1.6	8.0
OS3a	4.9	1.5	10.1
OS3b	3.3	1.1	7.6
PR-1	70.9	11.7	64.2
PR-2	16.1	6.2	34.1
PR-3	9.8	3.6	19.4
PR-4	28.4	7.2	39.3
PR-5	5.9	3.1	17.0
PR-6	58.2	17.0	93.0
PR-7	1.2	0.4	2.5
PR-8a	5.1	5.3	11.1
PR-8b	0.4	1.8	3.3
PR-9	2.4	0.6	4.0
PR-10	16.4	4.1	27.3

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	3.47	18.95
2	OS1b	59.21	12.31	74.56
3	OS2a	5.01	2.23	12.44
4	OS2b	8.57	4.04	21.65
5	OS2c	2.28	1.30	6.47
6	OS2d, OS2e	5.93	2.85	14.41
7	OS3a	4.88	1.50	10.11
8	OS3b	3.29	1.13	7.59
9	PR-5	5.86	3.11	17.01
10	OS2b, PR-2	24.65	9.00	48.83
11	OS2c, PR-3	12.06	4.48	23.99
12	OS2d, OS2e, PR-4	34.29	8.69	46.80
13	OS3a, PR-6	63.07	18.09	100.09
14	OS1a, OS1b, OS2a, PR-1, DP-10, DP-11, DP-12	215.41	27.39	153.04
15	PR-7	1.20	0.45	2.45
16	PR-7, PR-8a	6.32	5.41	12.33
EDB-IN	PR-7, PR-8a, PR-8b, PR-9	9.13	6.41	16.43
EDB-OUT	PR-7, PR-8a, PR-8b, PR-9	9.13	0.20	1.80
17	EDB-OUT, DP-13, DP-14	287.62	38.10	207.80
18	DP-8, DP-17, PR-10	307.28	37.60	211.90

EL PASO COUNTY

HAY CREEK
FINAL DRAINAGE REPORT

POST DEVELOPMENT DRAINAGE CONDITIONS

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

SCALE
HORIZ.
VERT.

DATE ISSUED: JANUARY 2023
SHEET 3 OF 3

DRAWING No. DR03

SEAL

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

PREPARED BY:
Matrix
Excellence by Design

SHEET KEY

REFERENCE DRAWINGS

No.	DATE	DESCRIPTION	BY
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REVISIONS

COMPUTER FILE MANAGEMENT
FILE NAME: S:\22.886.076 Hay Creek-Forest Manor-O'Leary Properties\200 Design\220 Drainage-WR\222 Reports\FDR\DWG\DR02 - HAY CREEK.dwg
CTB FILE: ----
PLOT DATE: January 18, 2023 2:07:13 PM
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