

HAY CREEK VALLEY

MDDP / PRELIMINARY DRAINAGE REPORT

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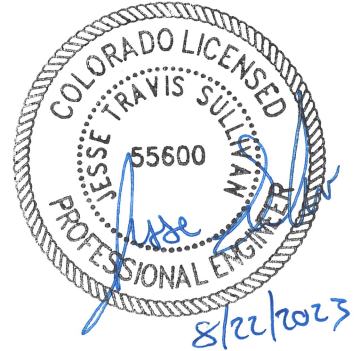
PCD File SP-23-01

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
Registered Professional Engineer
State of Colorado
No. 55600

Date



Owner/Developer's Statement:

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

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
Conditions: _____

Date

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I. INTRODUCTION

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

a. PURPOSE AND SCOPE OF STUDY

The purpose of this MDDP/Preliminary Drainage Report (MDDP/PDR) 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 MDDP/PDR.

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 $\frac{1}{4}$ of Section 34 and the Southeast $\frac{1}{4}$ 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

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

DATA SOURCES

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

e. APPLICABLE CRITERIA AND STANDARDS

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

II. Hydrologic Methodology

a. MAJOR BASINS AND SUBBASINS

The majority of the Hay Creek Valley site is located within the Beaver Creek Drainage Basin with a small portion of the site tributary to the Air Force Academy Major Drainage Basin. Runoff presently flows overland until reaching an existing natural drainage swale located within the site. This drainage swale directs flows internally until discharging from near the northeastern corner of the site. Drainage from the developed road will be directed to pond 1, where the runoff will be treated for water quality and detained to maintain the historic major event discharge rate from the site.

b. METHODOLOGY

i. UD Methods

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

$$Q=C*i*A$$

Where:

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

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

Time of Concentration

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

Rainfall Intensity

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

Table 2.1 – Project Area 1-Hour Rainfall Depth

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

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

C-Factors

C-factors for the Rational Method are based on anticipated land use and are taken from Table 6-6. Proposed single family residential is considered as the Single Family – 5 acres category. Areas which will be future open spaces or detention facilities are modeled under the Parks and Cemeteries

category. Undeveloped or predevelopment areas are model under Undeveloped Areas-Historic Flow Analysis—Greenbelts, Agriculture category.

ii. HEC-HMS Methods

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

SCS Lag

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

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

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

Where:

t_c = time of concentration (hr)

t_i = overland (initial) flow time (hr)

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

m = number of flow segments

Overland Flow:

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

Where:

T_i = overland flow time (hr)

n = Manning's roughness coefficient

L = flow length (ft)

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

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

Concentrated Flow:

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

Where:

T_t = travel time (hr)

L = flow length (ft)

V = velocity (ft/s)

3,600 = conversion factor from seconds to hours

Runoff Analysis

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

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

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

iii. HGL Profile Methods

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

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

Table 9-4. STORMCAD Standard Method Coefficients

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

III. Project Characteristics

a. BASIN LOCATION AND FLOWS

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

b. MAJOR DRAINAGEWAYS

Beaver Creek

The majority of the Hay Creek Valley site is located within the Beaver Creek Drainage Basin. Runoff generated within this basin presently flows overland with slopes ranging from 5 to 50% until reaching

an existing natural drainage swale located within the site. This drainage swale directs the sites flows internally until discharging from the site near the northeastern corner. Drainage from the developed road will be directed to pond 1, where the runoff will be treated for water quality and detained to maintain the historic major event discharge rate from the site.

Air Force Academy

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

c. LAND USES

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

IV. BASIN HYDROLOGY

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

Predevelopment conditions have been analyzed using both the SCS Hydrograph Procedure and the routed Rational Method. The existing conditions will discuss the entry of runoff from off-site basins as it relates to the respective design point. Runoff generated, either on-site or off-site, drains overland towards the northeastern corner of the site where it is captured by the existing natural swale that runs northeast, exiting the site and releasing flows to be collected in Hay Creek. Generally, all undeveloped basins are considered to be vegetated with sparse grasses. A delineation of the basin boundaries can be found in Appendix D in drawings DR-01 and DR-02. Runoff calculations can be found in Appendix A. The existing runoff design points are described below:

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

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

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

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

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

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

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

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

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

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

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

Design Point HC ($Q_{100} = 127$ cfs) This point represents the stormwater flows in Hay Creek at the existing private 24"x36" culvert to the north of the site. The existing private 24"x36" culvert

conveys the flows in Hay Creek under the existing access road. The proposed flows in Hay Creek come from the HEC-2 analysis provided by the Regional Floodplain Administrator. The HEC-2 results are included in **appendix C**.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Design Point 18 (Rational ($Q_5 = 37.5$ cfs, $Q_{100} = 212.1$ cfs) HEC-HMS ($Q_5 = 13.3$ cfs, $Q_{100} = 66.3$ cfs)) (sub-basins: DP-18, OS3b, PR-10; Area: 307.3 Ac.) (Slopes: 2.8 to 60%) This point represents

the total discharge from the site. Stormwater runoff from the site will continue north in the existing channel before draining into Hay Creek, a tributary of Beaver Creek.

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

Notes:

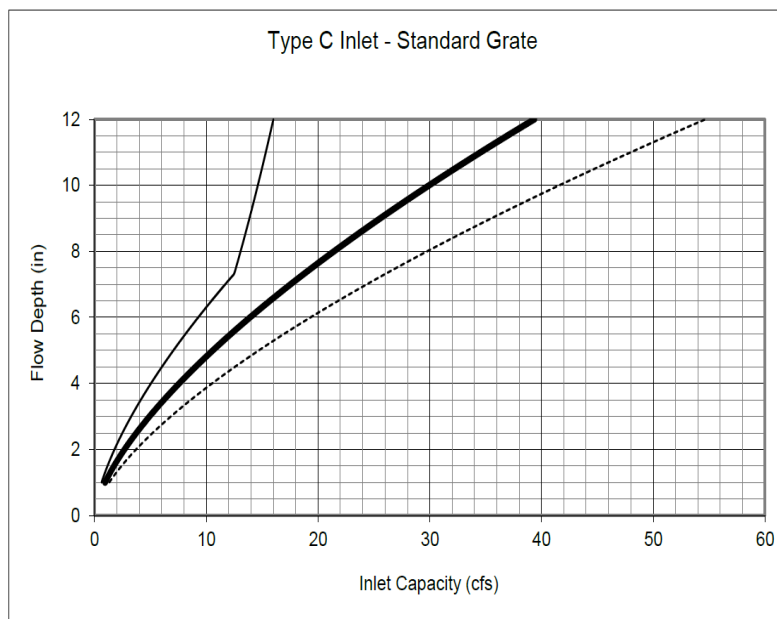
- **MHFD-Detention Analysis for the proposed detention pond (pond 1) which will be constructed as part of the Improvements associated with Hay Creek Valley can be found in Appendix A of this report.**
- **Tables summarizing inlet sizes and capacities, storm pipe sizes and capacities and swale capacities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

V. Hydraulic Analysis

a. Proposed Inlets

| INLET SUMMARY | | | | | | | | | | |
|---------------------------------|----------------------------|-----------------------|---------------|------|-----------|-------------------------|----------------------|------------------------------------|------------------------------------|-----------------------|
| HAY CREEK VALLEY | | | | | | | | | | |
| DESIGN POINT or SUB-BASIN | SUB-BASINS/ DESCRIPTION | TOTAL AREA (AC) | INLET | | | Q(5) TOTAL INFLOW | Q5 INLET CAPACITY | Q(100) BYPASS FLOWS (cfs) | Q(100) TOTAL INFLOW (cfs) | MAX INLET CAPACITY |
| | | | SIZE (Ft.) | TYPE | CONDITION | | | | | |
| 16 | PR-7, PR-8a | 6.32 | 3 | C | SUMP | 5.4 | 5.4 | 0.0 | 12.3 | 12.3 |

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



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

b. Swales

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

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

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

c. Driveway Culverts

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

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

d. Detention

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

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

Table 6-7. Recommended Horton's equation parameters

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

Emergency Overflow

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

VI. Storm Water Quality

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

Step 1: Employ Runoff Reduction Practices.

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

Step 2: Stabilize Drainageways.

- The site is in the Beaver Creek Drainage Fee Basin. Drainage fees, to be paid by the relevant Hay Creek Valley developers at the time of platting, will help fund proposed channel improvements. Information on planned future improvements to the Beaver Creek channel was unavailable for this report.

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

- As required by the DCM, runoff from the proposed streets which is feasible to detain, is directed into a proposed detention pond (pond 1). The pond has been designed to meet the DCM standards for the release rates of Full Spectrum Detention Ponds for Water Quality Capture Volumes, and all of the other storm events listed in the MHFD-Detention spreadsheet. Exclusions are listed below:
 - The lots containing large lot residential sites are excluded from WQ treatment per section I.7.1.b.5 of the ECM.
 - Disturbed areas that will return to an undeveloped state are excluded from WQ treatment per section I.7.1.B.7.
 - Disturbed areas that are not practicable to detain are excluded from WQ treatment per section I.7.1.C.1.a. so long as they are less than 1 acre and less than 20% of the development area. In this case 0.73 acres (0.3% of the overall development) are impracticable to detain which falls within these limits.

Step 4: Consider Need for Industrial and Commercial BMPs.

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

VII. Erosion Control Plan

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

VIII. Floodplains

Per the *Flood Insurance Rate Map (FIRM) 08041CO267 G*, effective date December 7, 2018, published by the Federal Emergency Management Agency (FEMA), Hay Creek, a Tributary to Beaver Creek runs along the northern bound of the Hay Creek Valley area and has designated 100-year

floodplain. The developed portion of the site is generally not touched by the 100 year floodplain, however the road improvements associated with this site will cross the FEMA floodplain at the location where the site access easement crosses Hay Creek. Draft model backed BFEs for this area have been developed as part of Phase 1 for the ongoing El Paso County, CO, Risk MAP Project. The data have been reviewed and approved through FEMA's QA/QC process (May 11, 2022) and are currently in the MIP (Case No. 19-08-0037s). This data is considered "FEMA APPROVED BFEs" This will need to be shown on the prelim plan and plat. Refer to the map in Appendix C.

IX. Fee Development

a. UNDEVELOPED PLATTABLE LAND

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

| Hay Creek Final Drainage Report 2023 Drainage and Bridge Fees | | | | | | | |
|---|----------------------------|-----------------------|-------------------------------|-------------------|--------------|------------------------------|----------------------------|
| | Platted Area (Acres) | Imperviousness (%) | Platted Area (Imp. ac.) | Fee/ Imp. Acre | Fee Due | Drainage Fee Reduction | Fee Due at Platting |
| Drainage Fee | 214.63 | 8.11 | 17.406 | \$13,797.00 | \$240,150.58 | \$60,037.65 | \$180,112.93 |
| Bridge Fee | 214.63 | 8.11 | 17.406 | \$0.00 | \$0.00 | \$0.00 | \$0.00 |
| TOTAL | | | | | | | <u><u>\$180,112.93</u></u> |

Cost Estimate

Table 12.1

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

| Engineer's Estimate of Probable Construction Costs | | | | |
|---|------|----------|-------------|---------------------|
| BEAVER CREEK | | | | |
| HAY CREEK VALLEY | | | | |
| Permanent BMP (EDB): Private Non-reimbursable | | | | |
| Item | Unit | Quantity | Unit Cost | Extension |
| DETENTION POND GRADING | EA | 1 | \$35,000.00 | \$35,000.00 |
| 2' TRICKLE CHANNEL | LF | 316 | \$200.00 | \$63,200.00 |
| FOREBAY | EA | 1 | \$40,000.00 | \$40,000.00 |
| OUTLET STRUCTURE | EA | 1 | \$40,000.00 | \$40,000.00 |
| EMERGENCY SPILLWAY | EA | 1 | \$5,000.00 | \$5,000.00 |
| STILLING BASIN | EA | 1 | \$30,000.00 | \$30,000.00 |
| Sub Total | | | | \$213,200.00 |
| 10% Contingency | | | | \$21,320.00 |
| TOTAL: | | | | \$234,520.00 |
| Overall Total | | | | \$828,677.30 |

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

X. Summary

This report demonstrates that the proposed infrastructure associated with Hay Creek Valley is in conformance with the El Paso County Drainage Criteria Manual, Volumes 1 and 2, October 2018 and all previously approved studies related to the project site. Stormwater flows will generally remain the same in post-development conditions (Rational ($Q_5 = 37.5$ cfs, $Q_{100} = 212.1$ cfs) HEC-HMS ($Q_5 = 13.8$ cfs, $Q_{100} = 69.8$ cfs)) as in pre-development conditions (Rational ($Q_5 = 35.0$ cfs, $Q_{100} = 210.9$ cfs) HEC-HMS ($Q_5 = 11.2$ cfs, $Q_{100} = 69.9$ cfs)). These proposed improvements should not adversely affect downstream or surrounding developments and are in conformance with the pertinent studies for the area.

XI. References

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

6. Appendices

APPENDIX A

HYDROLOGIC AND HYDRAULIC CALCULATIONS

Project Name:
Project Location:
Designer
Notes:

Hay Creek
El Paso County, Colorado
WCG
EXISTING CONDITIONS

Avg. Channel Velocity
Avg. Slope for Initial
Flow

4 ft/s
0.04 ft/ft

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

Channel Flow Type Key
Heavy Meadow 2

Tillage/Field 3
Short Pasture and Lawns 4
Nearly Bare Ground 5

Grassed Waterway 6
Paved Areas 7

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

Rational Method - Proposed Conditions

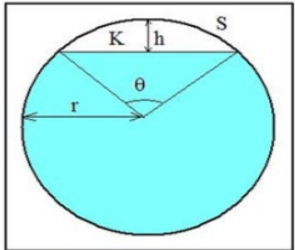
| | |
|-------------------|--------------------------|
| Project Name: | Hay Creek |
| Project Location: | El Paso County, Colorado |
| Designer | WCG |
| Notes: | Proposed Condition |

Average Channel Velocity 4.00 ft/s (If specific channel vel is used, this will be ignored)

Average Slope for Initial Flow 0.04 ft/ft (If Elevations are used, this will be ignored)

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

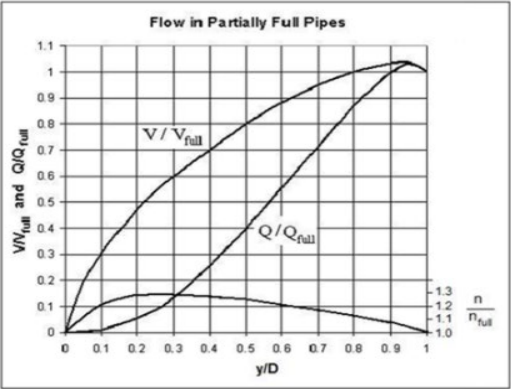
| | | Area | | | | Rational 'C' Values | | | | | | | | | | Flow Lengths | | | | | | Flow Lengths | | | | Tc | | | | Rainfall Intensity & Rational Flow Rate | | | | | | |
|---------------|------------------|---------|-------|---------|------------|-----------------------------|------|----------------------------|------|-----------|--|------|------|-----------|------|--------------------|---------|--------------|---------|--------------|-------------------|--------------|-------------|-----------------------------------|----------|---------|-------|-------|------|---|------|------|--------------|---------------|-------|-----------|
| Sub-basin | Comments | sf | acres | Sq. Mi. | 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 | HEC-HMS Q5 | i100 | Q100 | HEC-HMS Q100 | Sub-basin | | |
| | | | | | | C5 | C100 | C5 | C100 | Area (SF) | C5 | C100 | Area | C5 | C100 | | | | | | | | | | | | | | | | | | | | ft | Length ft |
| OS1a | | 407292 | 9.35 | 0.0146 | B | 0.12 | 0.39 | 407292 | 0.90 | 0.96 | | 0.09 | 0.36 | | 0.12 | 0.39 | 7.00% | 300 | 300 | 672 | 672 | 0.10 | 14.23 | 9.9 | 4 | 2.20 | 5.09 | 19.31 | 3.07 | 3.5 | 0.8 | 5.15 | 18.9 | 3.6 | 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 | 2.6 | 3.34 | 74.6 | 14.2 | 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 | 0.4 | 6.52 | 12.4 | 1.8 | 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 | 0.7 | 6.56 | 21.6 | 3.2 | 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 | 0.3 | 7.19 | 6.5 | 1.2 | 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 | 0.3 | 6.19 | 6.7 | 1.1 | 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 | 0.3 | 6.44 | 8.0 | 1.3 | 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 | 0.1 | 5.71 | 10.1 | 0.9 | 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 | 0.1 | 6.36 | 7.6 | 0.8 | OS3b | |
| PR-1 | | 3135061 | 71.97 | 0.1125 | B | 0.12 | 0.39 | 3135061 | 0.90 | 0.96 | | 0.09 | 0.36 | | 0.12 | 0.39 | 7.00% | 300 | 300 | 5455 | 5455 | 0.05 | 17.64 | 5.2 | 4 | 1.60 | 56.96 | 74.59 | 1.37 | 11.9 | 4.4 | 2.30 | 65.2 | 20.2 | PR-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 | 1.4 | 5.40 | 34.1 | 6.5 | 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 | 0.8 | 5.05 | 19.4 | 3.8 | 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 | 2.2 | 3.53 | 39.3 | 10.3 | 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 | | 1949910 | 44.76 | 0.0699 | B | 0.12 | 0.39 | 1949910 | 0.90 | 0.96 | | 0.09 | 0.36 | 0 | 0.12 | 0.39 | 7.00% | 300 | 300 | 1504 | 1504 | 0.10 | 14.18 | 10.0 | 4 | 2.21 | 11.32 | 25.50 | 2.65 | 14.4 | 3.7 | 4.46 | 78.4 | 17.0 | PR-6 | |
| PR-7 | | 585132 | 13.43 | 0.0210 | B | 0.12 | 0.39 | 585132 | 0.90 | 0.96 | | 0.09 | 0.36 | | 0.12 | 0.39 | 7.00% | 300 | 300 | 1400 | 1400 | 0.10 | 14.18 | 10.0 | 4 | 2.21 | 10.54 | 24.72 | 2.70 | 4.4 | 1.1 | 4.53 | 23.9 | 5.1 | PR-7 | |
| PR-8a | | 226357 | 5.20 | 0.0081 | B | 0.12 | 0.39 | | 0.90 | 0.96 | 129912 | 0.09 | 0.36 | 96445 | 0.55 | 0.70 | 58.24% | 300 | 300 | 3558 | 3558 | 0.05 | 10.08 | 4.8 | 4 | 1.53 | 38.67 | 48.74 | 1.81 | 5.3 | 3.5 | 3.04 | 11.2 | 8.3 | PR-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 | 0.8 | 8.58 | 3.3 | 1.7 | 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 | 11977 | 0.09 | 0.36 | 701369 | 0.10 | 0.37 | 3.65% | 300 | 300 | 395 | 395 | 0.04 | 19.25 | 4.2 | 4 | 1.43 | 4.59 | 23.84 | 2.75 | 4.7 | 0.6 | 4.62 | 28.2 | 3.4 | PR-10 | |
| DESIGN POINTS | Sub-Basins | | | | | | | | | | | | | | | | | 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 | 0.8 | 5.15 | 18.9 | 3.6 | 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 | 2.6 | 3.34 | 74.6 | 14.2 | 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 | 0.4 | 6.52 | 12.4 | 1.8 | 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 | 0.7 | 6.56 | 21.6 | 3.2 | 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 | 0.3 | 7.19 | 6.5 | 1.2 | 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 | 0.5 | 6.19 | 14.4 | 2.3 | 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 | 0.1 | 5.71 | 10.1 | 0.9 | 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 | 0.1 | 6.36 | 7.6 | 0.8 | 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 | 1075606 | 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 | 2.1 | 5.08 | 48.8 | 9.6 | 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 | 1.0 | 5.06 | 24.0 | 4.6 | 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 | 2.7 | 3.47 | 46.8 | 12.3 | 12 | |
| 13 | PR-6 | 1949910 | 44.76 | 0.0699 | B | 0.12 | 0.39 | 1949910 | 0.90 | 0.96 | 0 | 0.09 | 0.36 | 0 | 0.12 | 0.39 | 7.00% | 300 | 300 | 1504 | 1504 | 0.10 | 14.18 | 10.0 | 4 | 2.21 | 11.32 | 25.50 | 2.65 | 14.4 | 3.7 | 4.46 | 78.4 | 17.0 | 13 | |
| 14 | OS3a, PR-7 | 797595 | 18.31 | 0.0286 | B | 0.12 | 0.39 | 585132 | 0.90 | 0.96 | 0 | 0.09 | | | | | | | | | | | | | | | | | | | | | | | | |

[illegible]

Partially Full Pipe Flow Parameters (More Than Half Full)

$$\begin{aligned}r &= D/2 \\h &= 2r \cdot y \\(\text{hydraulic radius}) \\R &= A/P \\(\text{Manning Equation}) \\Q &= (1.49/n)(A)(R^{2/3})(S^{1/2}) \\V &= Q/A \\P & \\ \theta &= 2 \arccos \left(\frac{r-h}{r} \right) \\A &= \pi r^2 - \frac{r^2(\theta - \sin \theta)}{2} \\P &= 2\pi r - r \cdot \theta\end{aligned}$$

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

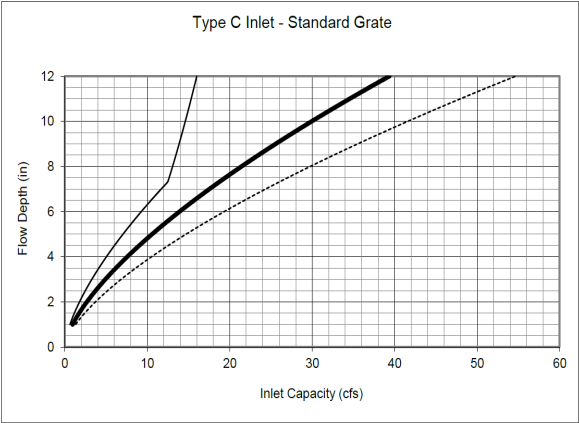


Flow In Partially Full Pipes

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 CAPACITY | Q(100) BYPASS FLOWS (cfs) | Q(100) TOTAL INFLOW (cfs) | MAX INLET CAPACITY | NOTES: |
|---------------------------------|------------|--------------------|---------------|------|-----------|-------------------------------|----------------------|----------------------|------------------------------------|------------------------------------|-----------------------|--------|
| | | | SIZE (Ft.) | TYPE | CONDITION | | | | | | | |
| 13 | PR-6 | 44.76 | 3x3 | C | SUMP | 0.0 | 3.70 | 3.7 | 0.0 | 17.00 | 17.0 | |
| 16a | PR-8a | 5.11 | 3x3 | C | SUMP | 0.0 | 1.50 | 1.5 | 0.0 | 5.60 | 5.6 | |



Culvert Report

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

Tuesday, Aug 22 2023

Lots 11 & 12 Driveway Culvert

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

Embankment

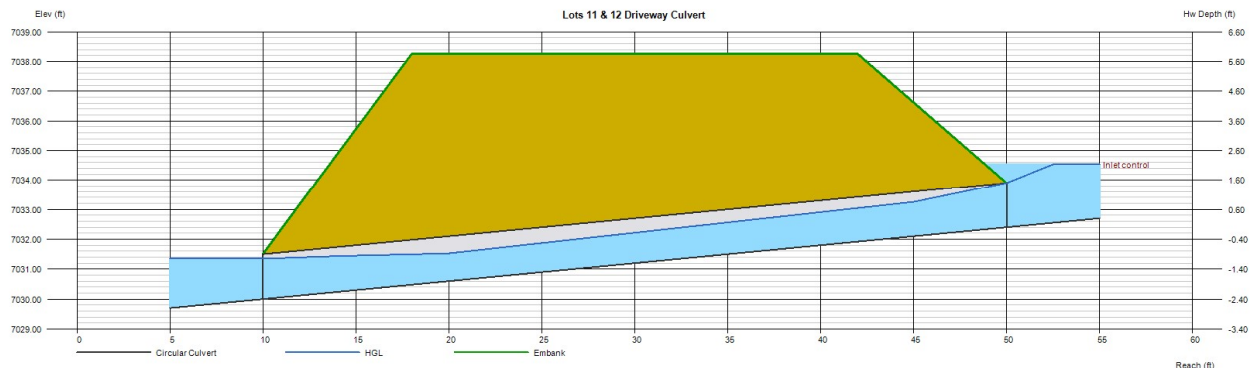
| | |
|--------------------|-----------|
| Top Elevation (ft) | = 7038.25 |
| Top Width (ft) | = 24.00 |
| Crest Width (ft) | = 30.00 |

Calculations

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

Highlighted

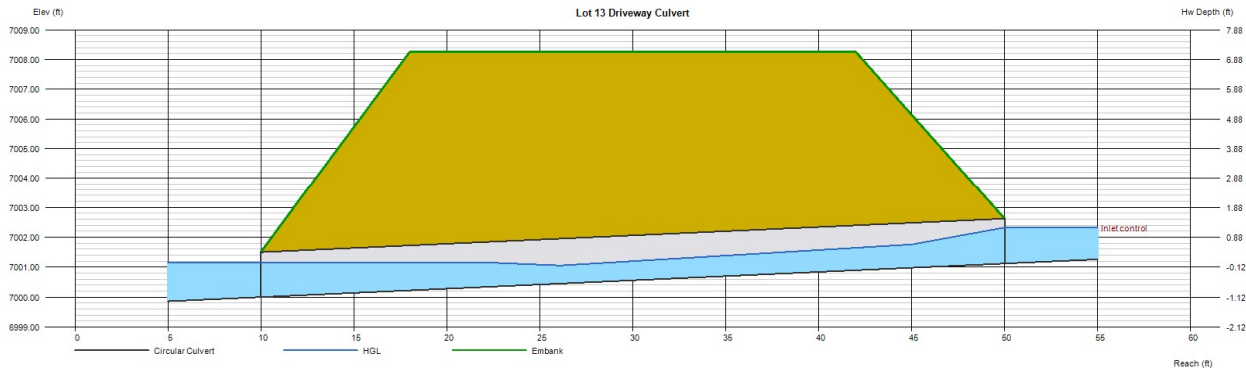
| | |
|-----------------|-----------------|
| Qtotal (cfs) | = 9.60 |
| Qpipe (cfs) | = 9.60 |
| Qovertop (cfs) | = 0.00 |
| Veloc Dn (ft/s) | = 5.74 |
| Veloc Up (ft/s) | = 6.36 |
| HGL Dn (ft) | = 7031.35 |
| HGL Up (ft) | = 7033.60 |
| Hw Elev (ft) | = 7034.54 |
| Hw/D (ft) | = 1.42 |
| Flow Regime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



Culvert Report

Lot 13 Driveway Culvert

| | | | |
|---------------------|--------------------------------|---------------------|-----------------|
| Invert Elev Dn (ft) | = 7000.00 | Calculations | |
| Pipe Length (ft) | = 40.00 | Qmin (cfs) | = 0.00 |
| Slope (%) | = 2.80 | Qmax (cfs) | = 4.60 |
| Invert Elev Up (ft) | = 7001.12 | Tailwater Elev (ft) | = (dc+D)/2 |
| Rise (in) | = 18.0 | | |
| Shape | = Circular | Highlighted | |
| Span (in) | = 18.0 | Qtotal (cfs) | = 4.60 |
| No. Barrels | = 1 | Qpipe (cfs) | = 4.60 |
| n-Value | = 0.013 | Qovertop (cfs) | = 0.00 |
| Culvert Type | = Circular Concrete | Veloc Dn (ft/s) | = 3.13 |
| Culvert Entrance | = Square edge w/headwall (C) | Veloc Up (ft/s) | = 4.63 |
| Coeff. K,M,c,Y,k | = 0.0098, 2, 0.0398, 0.67, 0.5 | HGL Dn (ft) | = 7001.16 |
| | | HGL Up (ft) | = 7001.94 |
| | | Hw Elev (ft) | = 7002.32 |
| | | Hw/D (ft) | = 0.80 |
| | | Flow Regime | = Inlet Control |
| Embankment | | | |
| Top Elevation (ft) | = 7008.25 | | |
| Top Width (ft) | = 24.00 | | |
| Crest Width (ft) | = 30.00 | | |



Culvert Report

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

Tuesday, Aug 22 2023

Lots 14 - 16 Driveway Culverts

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

Embankment

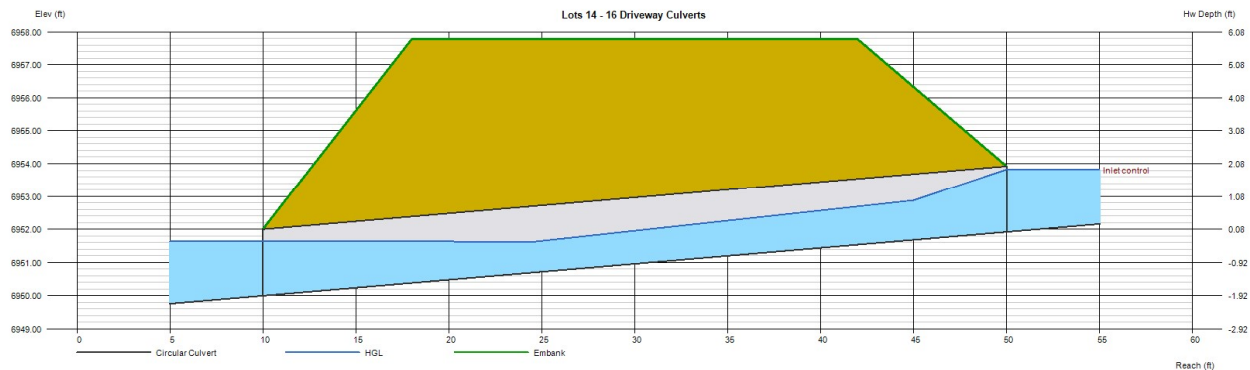
Top Elevation (ft) = 6957.77
Top Width (ft) = 24.00
Crest Width (ft) = 30.00

Calculations

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

Highlighted

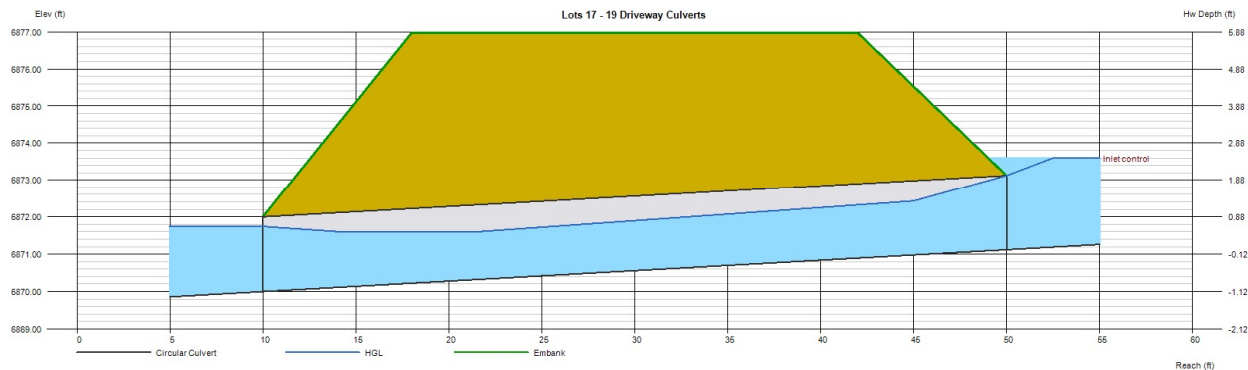
Qtotal (cfs) = 12.30
Qpipe (cfs) = 12.30
Qovertop (cfs) = 0.00
Veloc Dn (ft/s) = 4.49
Veloc Up (ft/s) = 5.90
HGL Dn (ft) = 6951.63
HGL Up (ft) = 6953.18
Hw Elev (ft) = 6953.82
Hw/D (ft) = 0.95
Flow Regime = Inlet Control



Culvert Report

Lots 17 - 19 Driveway Culverts

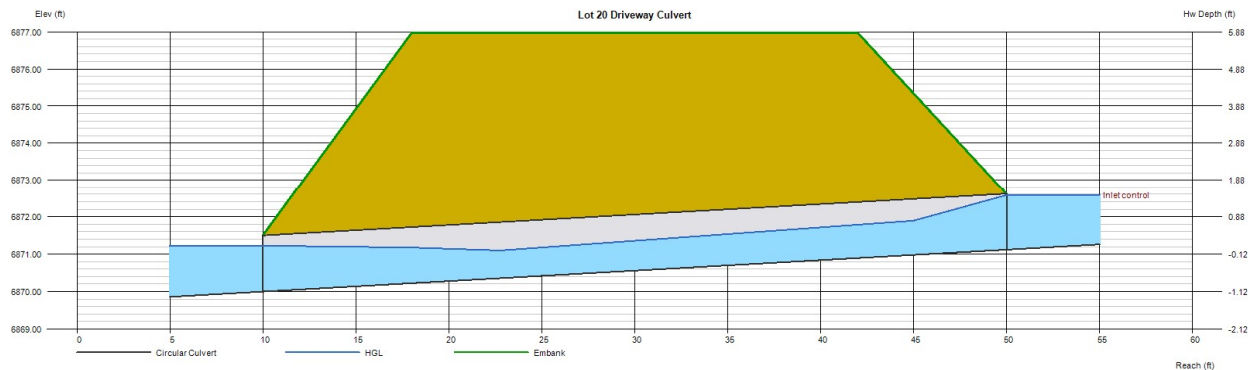
| | | | |
|---------------------|--------------------------------|---------------------|-----------------|
| Invert Elev Dn (ft) | = 6870.00 | Calculations | |
| Pipe Length (ft) | = 40.00 | Qmin (cfs) | = 0.00 |
| Slope (%) | = 2.80 | Qmax (cfs) | = 17.00 |
| Invert Elev Up (ft) | = 6871.12 | Tailwater Elev (ft) | = (dc+D)/2 |
| Rise (in) | = 24.0 | | |
| Shape | = Circular | Highlighted | |
| Span (in) | = 24.0 | Qtotal (cfs) | = 17.00 |
| No. Barrels | = 1 | Qpipe (cfs) | = 17.00 |
| n-Value | = 0.013 | Qovertop (cfs) | = 0.00 |
| Culvert Type | = Circular Concrete | Veloc Dn (ft/s) | = 5.85 |
| Culvert Entrance | = Square edge w/headwall (C) | Veloc Up (ft/s) | = 6.80 |
| Coeff. K,M,c,Y,k | = 0.0098, 2, 0.0398, 0.67, 0.5 | HGL Dn (ft) | = 6871.74 |
| | | HGL Up (ft) | = 6872.61 |
| | | Hw Elev (ft) | = 6873.60 |
| | | Hw/D (ft) | = 1.24 |
| | | Flow Regime | = Inlet Control |
| Embankment | | | |
| Top Elevation (ft) | = 6876.97 | | |
| Top Width (ft) | = 24.00 | | |
| Crest Width (ft) | = 30.00 | | |



Culvert Report

Lot 20 Driveway Culvert

| | | | |
|---------------------|--------------------------------|---------------------|-----------------|
| Invert Elev Dn (ft) | = 6870.00 | Calculations | |
| Pipe Length (ft) | = 40.00 | Qmin (cfs) | = 0.00 |
| Slope (%) | = 2.80 | Qmax (cfs) | = 6.10 |
| Invert Elev Up (ft) | = 6871.12 | Tailwater Elev (ft) | = (dc+D)/2 |
| Rise (in) | = 18.0 | | |
| Shape | = Circular | Highlighted | |
| Span (in) | = 18.0 | Qtotal (cfs) | = 6.10 |
| No. Barrels | = 1 | Qpipe (cfs) | = 6.10 |
| n-Value | = 0.013 | Qovertop (cfs) | = 0.00 |
| Culvert Type | = Circular Concrete | Veloc Dn (ft/s) | = 3.94 |
| Culvert Entrance | = Square edge w/headwall (C) | Veloc Up (ft/s) | = 5.15 |
| Coeff. K,M,c,Y,k | = 0.0098, 2, 0.0398, 0.67, 0.5 | HGL Dn (ft) | = 6871.23 |
| | | HGL Up (ft) | = 6872.07 |
| | | Hw Elev (ft) | = 6872.58 |
| | | Hw/D (ft) | = 0.97 |
| | | Flow Regime | = Inlet Control |
| Embankment | | | |
| Top Elevation (ft) | = 6876.97 | | |
| Top Width (ft) | = 24.00 | | |
| Crest Width (ft) | = 30.00 | | |



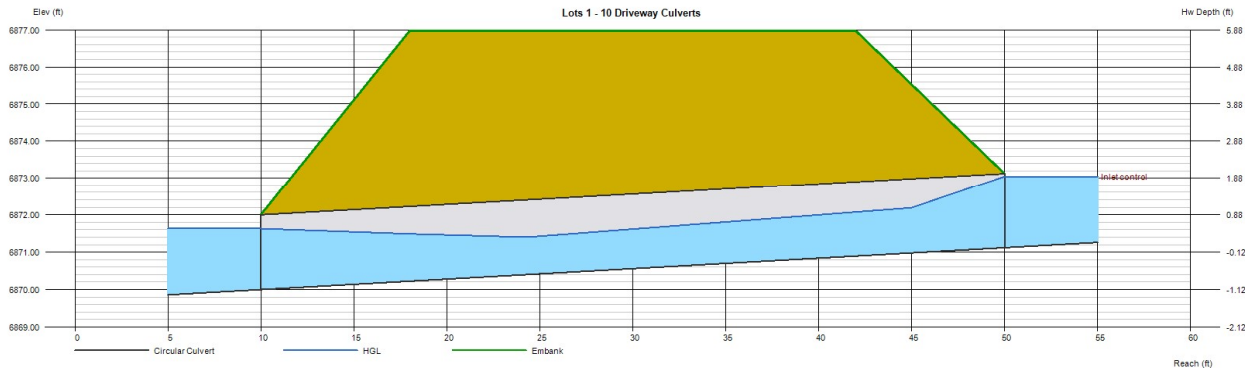
Culvert Report

Lots 1 - 10 Driveway Culverts

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

| | |
|--------------------|-----------|
| Embankment | |
| Top Elevation (ft) | = 6876.97 |
| Top Width (ft) | = 24.00 |
| Crest Width (ft) | = 30.00 |

| | |
|---------------------|-----------------|
| Calculations | |
| Qmin (cfs) | = 0.00 |
| Qmax (cfs) | = 12.30 |
| Tailwater Elev (ft) | = (dc+D)/2 |
| Highlighted | |
| Qtotal (cfs) | = 12.30 |
| Qpipe (cfs) | = 12.30 |
| Qovertop (cfs) | = 0.00 |
| Veloc Dn (ft/s) | = 4.49 |
| Veloc Up (ft/s) | = 5.90 |
| HGL Dn (ft) | = 6871.63 |
| HGL Up (ft) | = 6872.38 |
| Hw Elev (ft) | = 6873.04 |
| Hw/D (ft) | = 0.96 |
| Flow Regime | = Inlet Control |



Culvert Report

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

Wednesday, Mar 29 2023

Existing Creek Crossing Culvert

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

Embankment

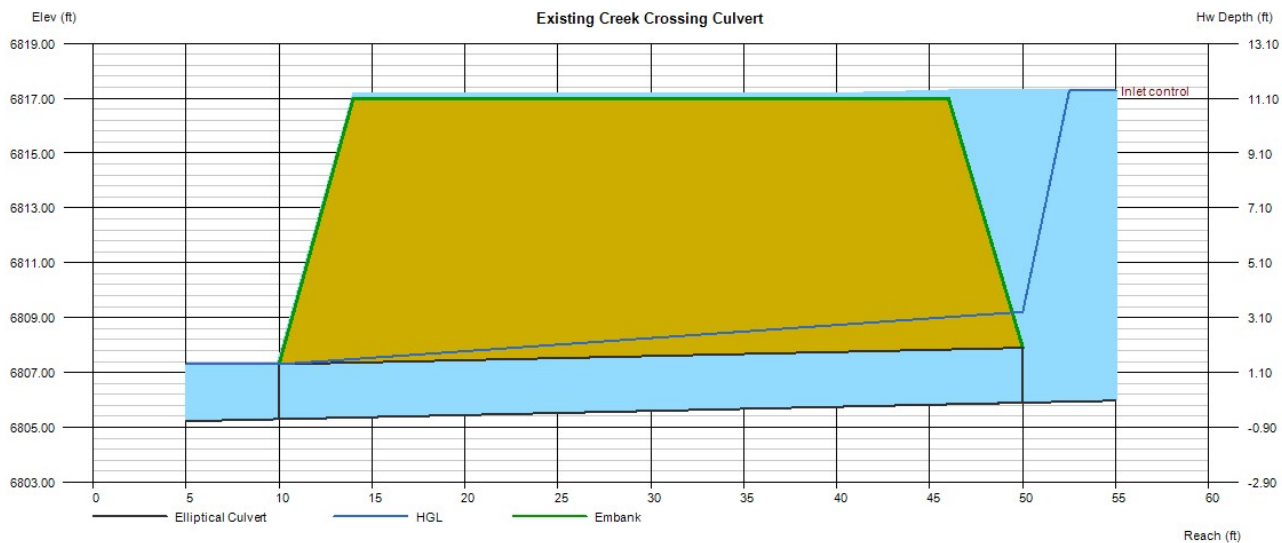
Top Elevation (ft) = 6817.00
Top Width (ft) = 32.00
Crest Width (ft) = 100.00

Calculations

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

Highlighted

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



Culvert Report

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

Wednesday, Mar 29 2023

CREEK CROSSING CULVERT

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

Embankment

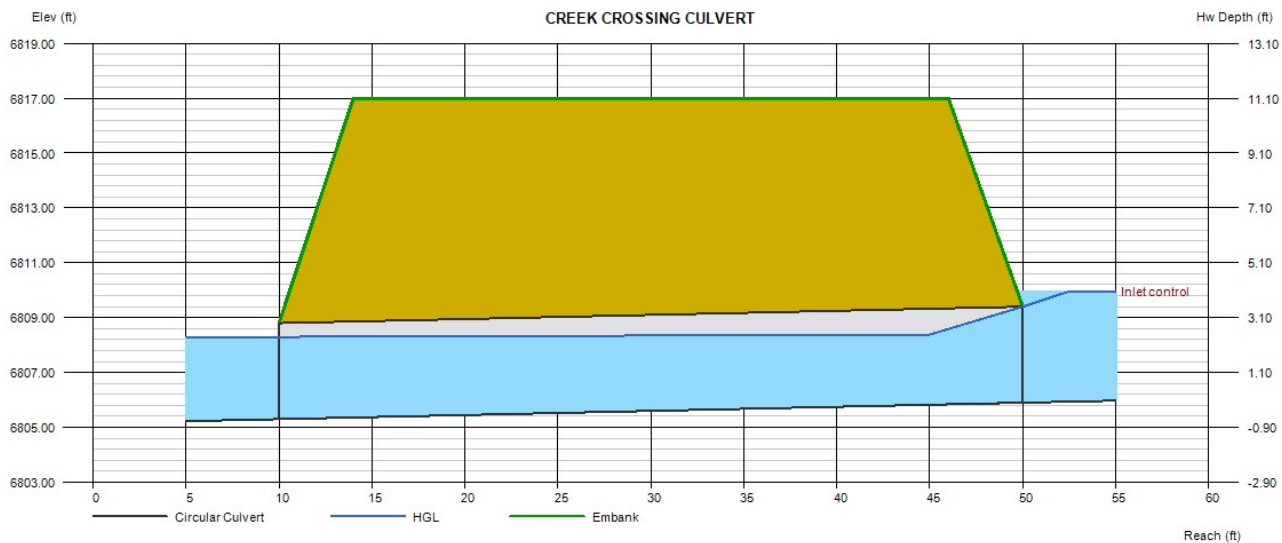
Top Elevation (ft) = 6817.00
Top Width (ft) = 32.00
Crest Width (ft) = 100.00

Calculations

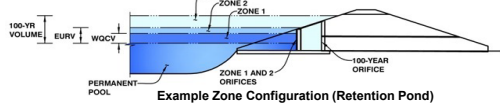
Qmin (cfs) = 127.00
Qmax (cfs) = 127.00
Tailwater Elev (ft) = (dc+D)/2

Highlighted

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



MHFD-Detention, Version 4.05 (January 2022)

Basin ID: Beaver Creek

Example Zone Configuration (Retention Pond)

| | | |
|--|------------|---------|
| Selected BMP Type = | EDB | |
| Watershed Area = | 52.78 | acres |
| Watershed Length = | 3,860 | ft |
| Watershed Length to Centroid = | 1,930 | ft |
| Watershed Slope = | 0.048 | ft/ft |
| Watershed Imperviousness = | 12.53% | percent |
| Percentage Hydrologic Soil Group A = | 0.0% | percent |
| Percentage Hydrologic Soil Group B = | 100% | percent |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent |
| Target WQCV Drain Time = | 40.0 | hours |
| Location for 1-hr Rainfall Depths = User Input | | |

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

Optional User Overrides

| | | | | |
|--|--------|-----------|------|-----------|
| Water Quality Capture Volume (WQCV) = | 0.356 | acre-feet | | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 0.633 | acre-feet | | acre-feet |
| 2-yr Runoff Volume (P1 = 1.19 in.) = | 0.816 | acre-feet | 1.19 | inches |
| 5-yr Runoff Volume (P1 = 1.5 in.) = | 1.697 | acre-feet | 1.50 | inches |
| 10-yr Runoff Volume (P1 = 1.75 in.) = | 2.563 | acre-feet | 1.75 | inches |
| 25-yr Runoff Volume (P1 = 2 in.) = | 4.070 | acre-feet | 2.00 | inches |
| 50-yr Runoff Volume (P1 = 2.25 in.) = | 5.111 | acre-feet | 2.25 | inches |
| 100-yr Runoff Volume (P1 = 2.52 in.) = | 6.595 | acre-feet | 2.52 | inches |
| 500-yr Runoff Volume (P1 = 3.55 in.) = | 11.170 | acre-feet | 3.55 | inches |
| Approximate 2-yr Detention Volume = | 0.414 | acre-feet | | |
| Approximate 5-yr Detention Volume = | 0.637 | acre-feet | | |
| Approximate 10-yr Detention Volume = | 1.204 | acre-feet | | |
| Approximate 25-yr Detention Volume = | 1.619 | acre-feet | | |
| Approximate 50-yr Detention Volume = | 1.703 | acre-feet | | |
| Approximate 100-yr Detention Volume = | 2.170 | acre-feet | | |

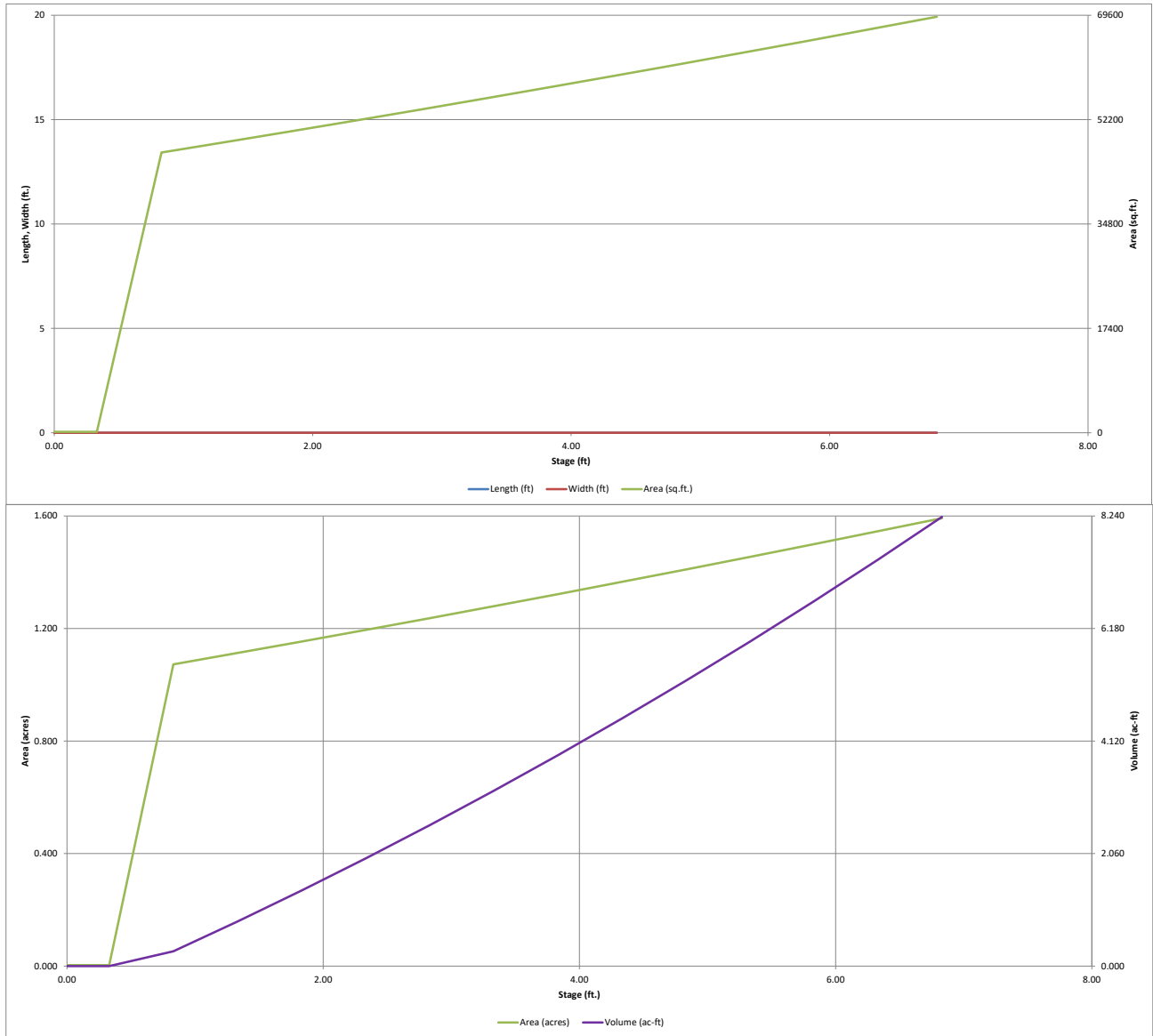
| | | |
|---|-------|------------------|
| Zone 1 Volume (WQCV) = | 0.356 | acre-feet |
| Zone 2 Volume (EURV - Zone 1) = | 0.277 | acre-feet |
| Zone 3 Volume (100-year - Zones 1 & 2) = | 1.537 | acre-feet |
| Total Detention Basin Volume = | 2.170 | acre-feet |
| Initial Surge Volume (ISV) = | user | ft. ³ |
| Initial Surge 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_{BW}) = | 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 |

[illegible]

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

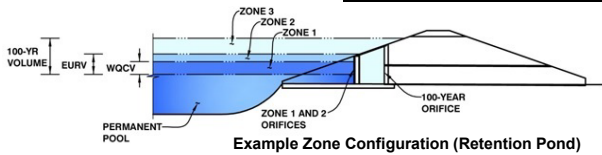
MHFD-Detention, Version 4.05 (January 2022)



DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Project: Hay Creek Valley
Basin ID: Beaver Creek



Example Zone Configuration (Retention Pond)

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

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

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

Calculated Parameters for Underdrain
Underdrain Orifice Area = N/A ft²
Underdrain Orifice Centroid = N/A feet

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

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

Calculated Parameters for Plate
WQ Orifice Area per Row = 1.750E-02 ft²
Elliptical Half-Width = N/A feet
Elliptical Slot Centroid = N/A feet
Elliptical Slot Area = N/A ft²

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

| | Row 1 (required) | Row 2 (optional) | Row 3 (optional) | Row 4 (optional) | Row 5 (optional) | Row 6 (optional) | Row 7 (optional) | Row 8 (optional) |
|--------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Stage of Orifice Centroid (ft) | 0.00 | 0.50 | 0.75 | | | | | |
| Orifice Area (sq. inches) | 2.52 | 2.52 | 2.52 | | | | | |

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice
Zone 2 Circular Not Selected
Vertical Orifice Area = 0.11 ft²
Vertical Orifice Centroid = 0.19 feet

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

Overflow Weir Front Edge Height, H_o = 3.00 ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length = 4.00 feet
Overflow Weir Grate Slope = 0.00 H:V
Horiz. Length of Weir Sides = 6.00 feet
Overflow Grate Type = Type C Grate
Debris Clogging % = 50%

Calculated Parameters for Overflow Weir
Zone 3 Weir Not Selected
Height of Grate Upper Edge, H_u = 3.00 feet
Overflow Weir Slope Length = 6.00 feet
Grate Open Area / 100-yr Orifice Area = 57.13
Overflow Grate Open Area w/o Debris = 16.70 ft²
Overflow Grate Open Area w/ Debris = 8.35 ft²

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

Depth to Invert of Outlet Pipe = 1.00 ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter = 18.00 inches
Restrictor Plate Height Above Pipe Invert = 4.00 inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate
Zone 3 Restrictor Not Selected
Outlet Orifice Area = 0.29 ft²
Outlet Orifice Centroid = 0.20 feet
Half-Central Angle of Restrictor Plate on Pipe = 0.98 radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

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

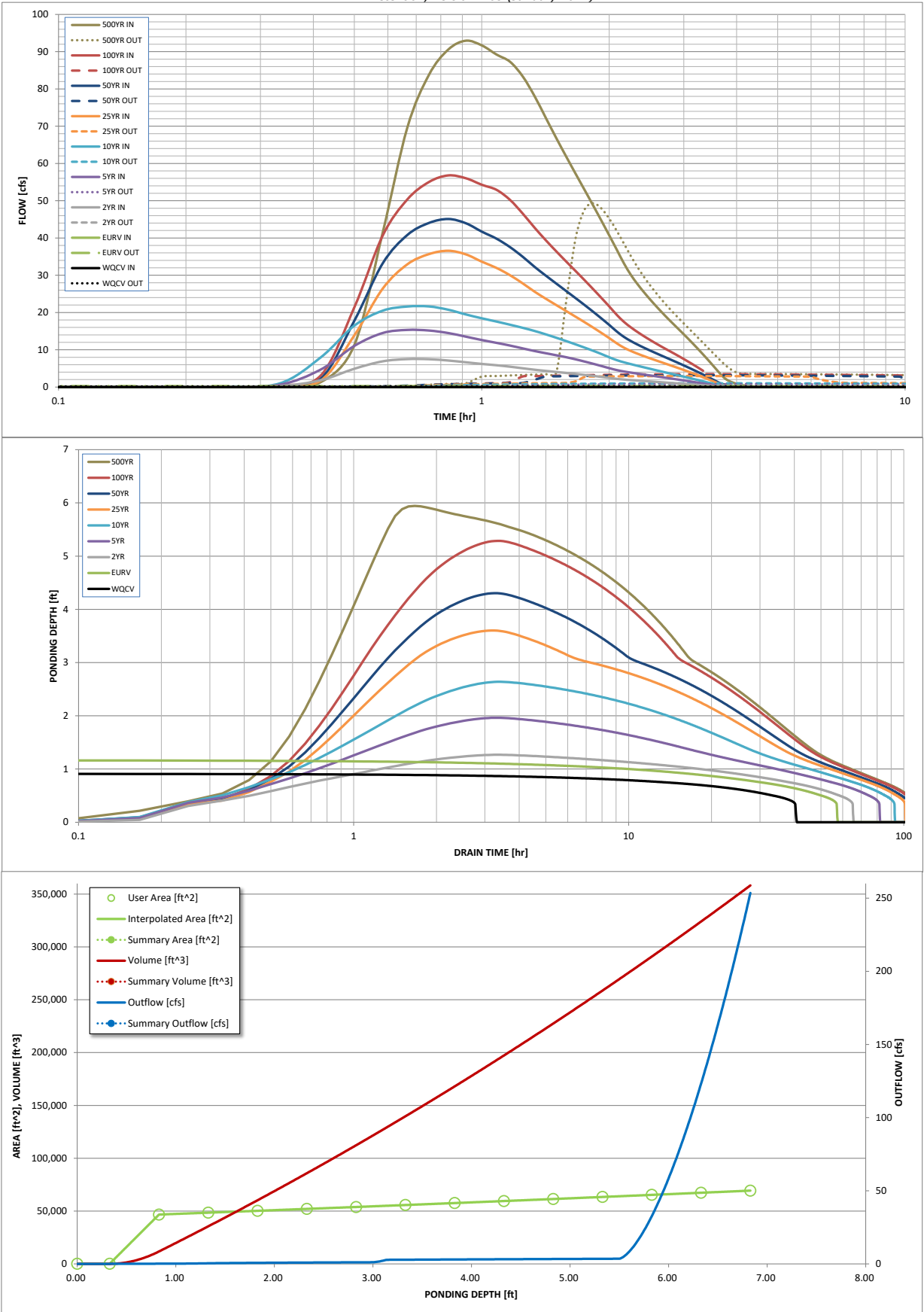
Routed Hydrograph Results

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

| | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|-------|--------------------|--------------------|--------------------|--------------------|----------------|----------------|----------------|----------|
| Design Storm Return Period = | N/A | N/A | 1.19 | 1.50 | 1.75 | 2.00 | 2.25 | 2.52 | 3.55 |
| One-Hour Rainfall Depth (in) = | 0.356 | 0.633 | 0.816 | 1.697 | 2.563 | 4.070 | 5.111 | 6.595 | 11.170 |
| CUHP Runoff Volume (acre-ft) = | N/A | N/A | 0.816 | 1.697 | 2.563 | 4.070 | 5.111 | 6.595 | 11.170 |
| Inflow Hydrograph Volume (acre-ft) = | N/A | N/A | 4.1 | 11.4 | 17.7 | 32.4 | 40.7 | 52.2 | 87.6 |
| CUHP Predevelopment Peak Q (cfs) = | N/A | N/A | | | | | | | |
| OPTIONAL Override Predevelopment Peak Q (cfs) = | N/A | N/A | | | | | | | |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | N/A | N/A | 0.08 | 0.22 | 0.33 | 0.61 | 0.77 | 0.99 | 1.66 |
| Peak Inflow Q (cfs) = | N/A | N/A | 7.5 | 15.3 | 21.6 | 36.6 | 45.1 | 56.8 | 92.9 |
| Peak Outflow Q (cfs) = | 0.2 | 0.3 | 0.4 | 0.8 | 1.0 | 3.0 | 3.2 | 3.5 | 49.3 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.6 |
| Structure Controlling Flow = | Plate | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Outlet Plate 1 | Outlet Plate 1 | Outlet Plate 1 | Spillway |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | N/A | N/A | 0.1 | 0.1 | 0.1 | 0.1 |
| Max Velocity through Grate 2 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Time to Drain 97% of Inflow Volume (hours) = | 38 | 53 | 60 | 72 | 79 | 82 | 82 | 83 | 73 |
| Time to Drain 99% of Inflow Volume (hours) = | 40 | 56 | 64 | 78 | 87 | 93 | 95 | 98 | 94 |
| Maximum Ponding Depth (ft) = | 0.91 | 1.17 | 1.27 | 1.96 | 2.64 | 3.60 | 4.30 | 5.29 | 5.94 |
| Area at Maximum Ponding Depth (acres) = | 1.08 | 1.10 | 1.11 | 1.16 | 1.22 | 1.30 | 1.36 | 1.45 | 1.51 |
| Maximum Volume Stored (acre-ft) = | 0.356 | 0.639 | 0.739 | 1.534 | 2.332 | 3.555 | 4.488 | 5.866 | 6.843 |

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)



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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: .\Outflow Hydrographs - UPDATED BASINS.xlsx

Inflow Hydrographs

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

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

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.05 (January 2022)

Summary Stage-Area-Volume-Discharge Relationships

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

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

[illegible]

Figure 13-12b. Emergency Spillway Profile at Embankment

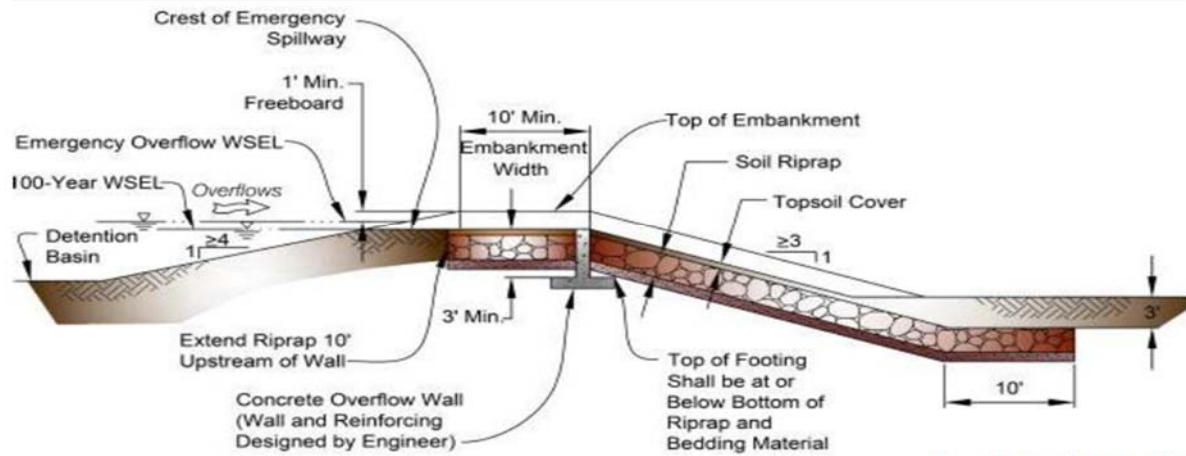
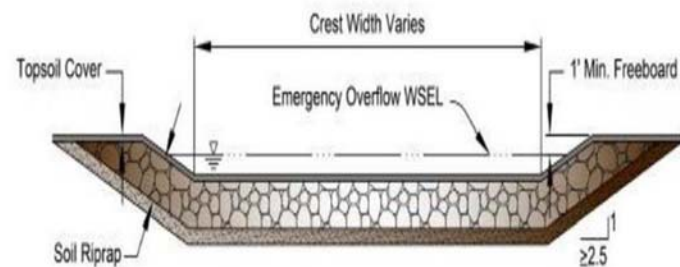


Figure 13-12c. Emergency Spillway Protection



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

=> TYPE VL RIP RAP

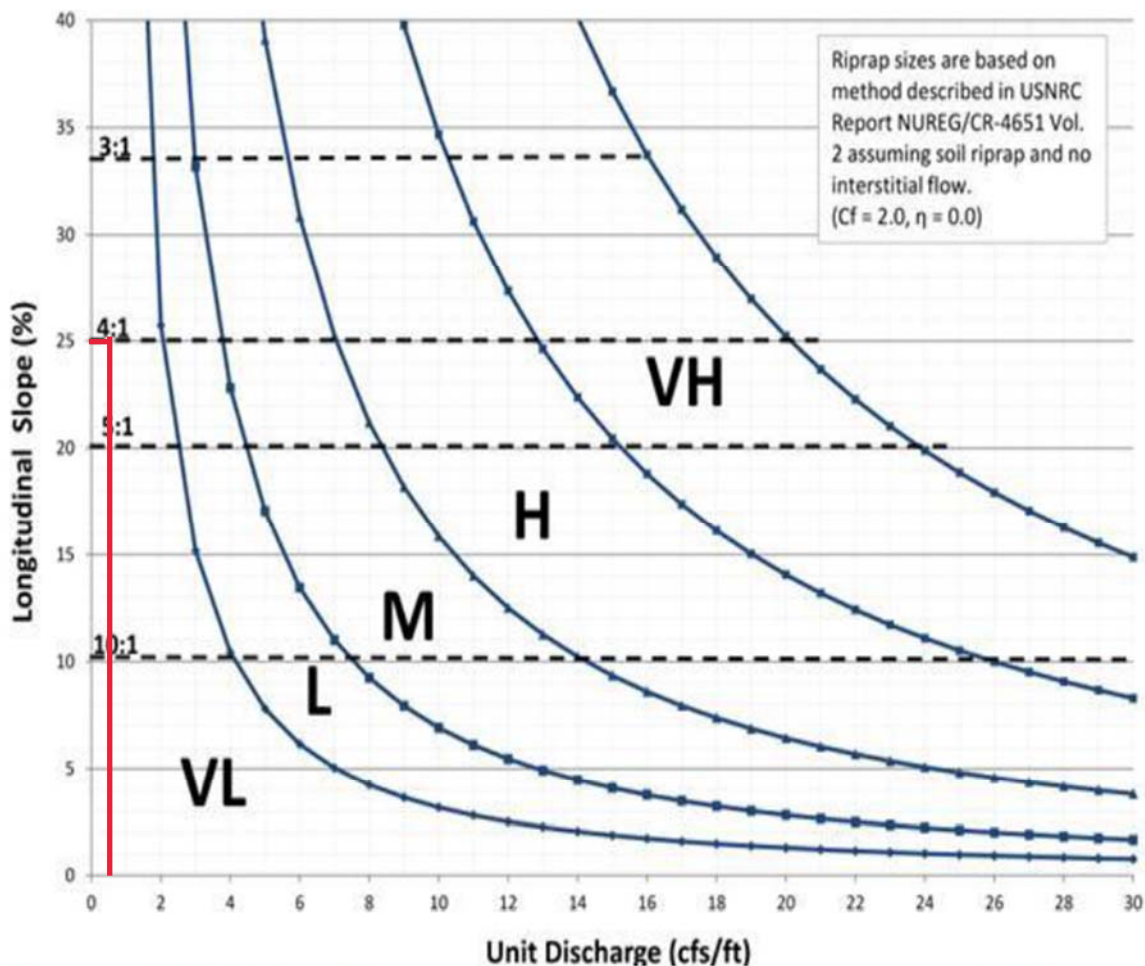


Figure 13-12d. Riprap Types for Emergency Spillway Protection

Weir Report

Stilling Basin Outfall

Trapezoidal Weir

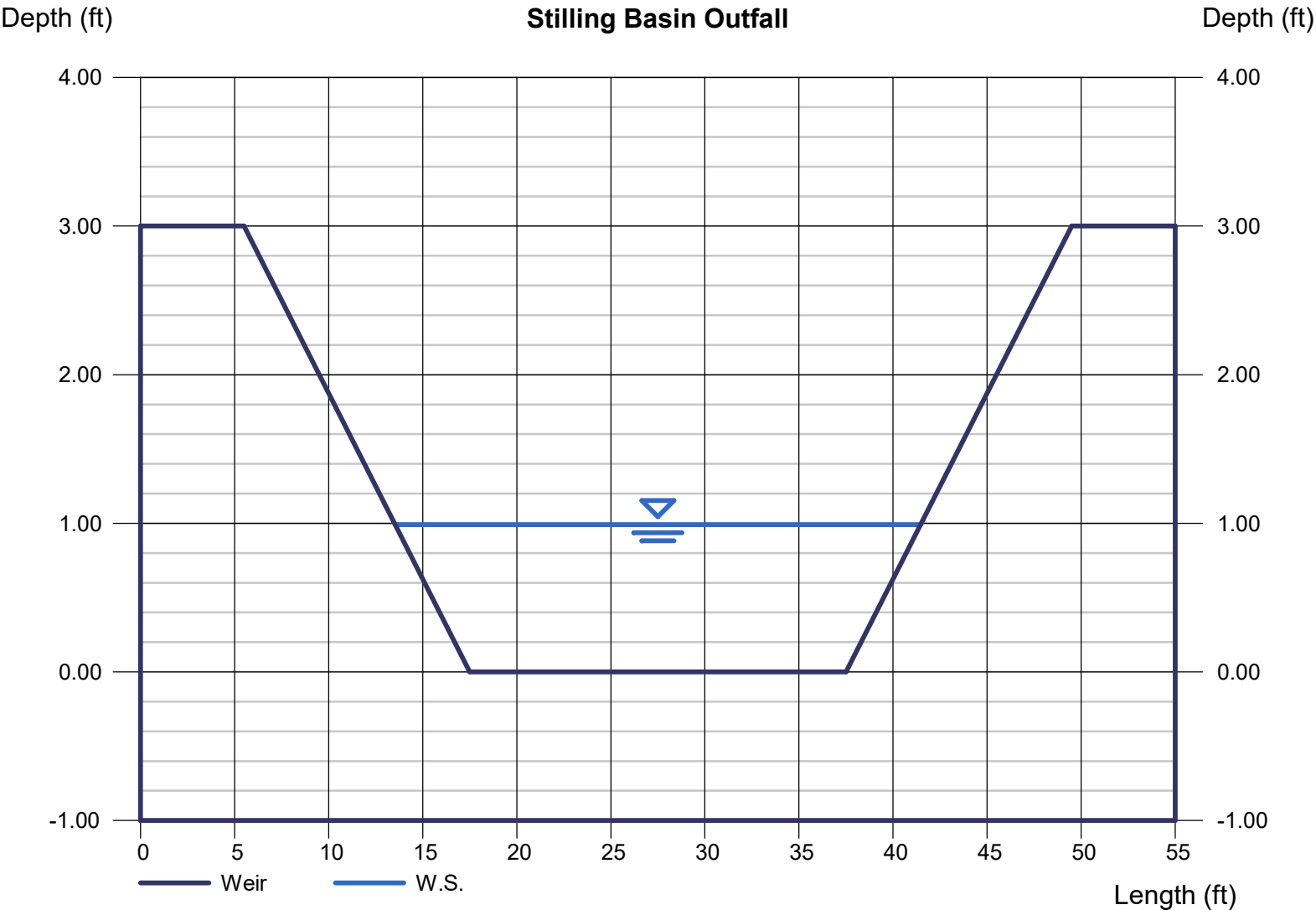
| | |
|--------------------|---------|
| Crest | = Sharp |
| Bottom Length (ft) | = 20.00 |
| Total Depth (ft) | = 3.00 |
| Side Slope (z:1) | = 4.00 |

Highlighted

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

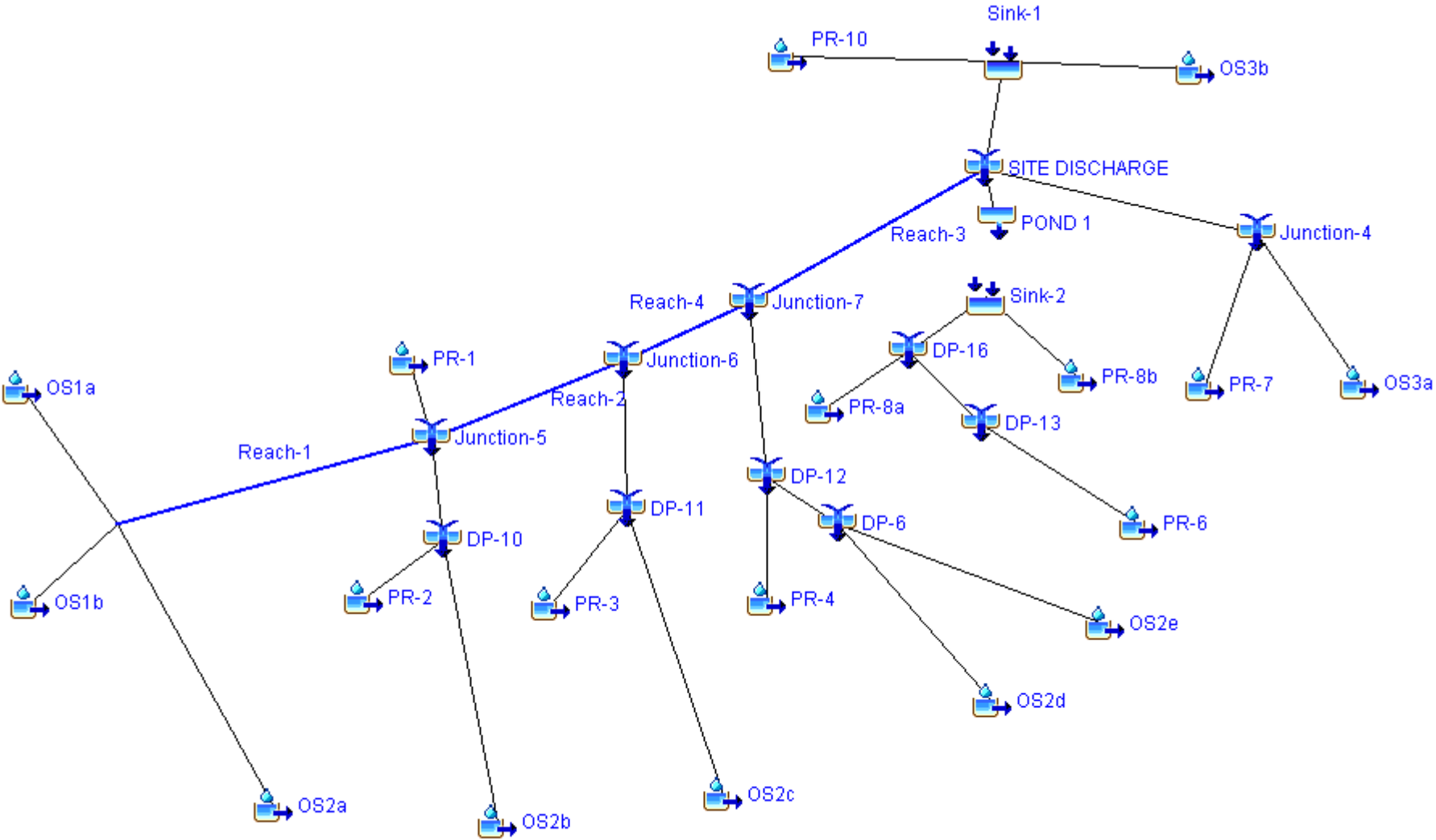
Calculations

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



Model Name: **Hay_Creek_Forest_Manor**

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

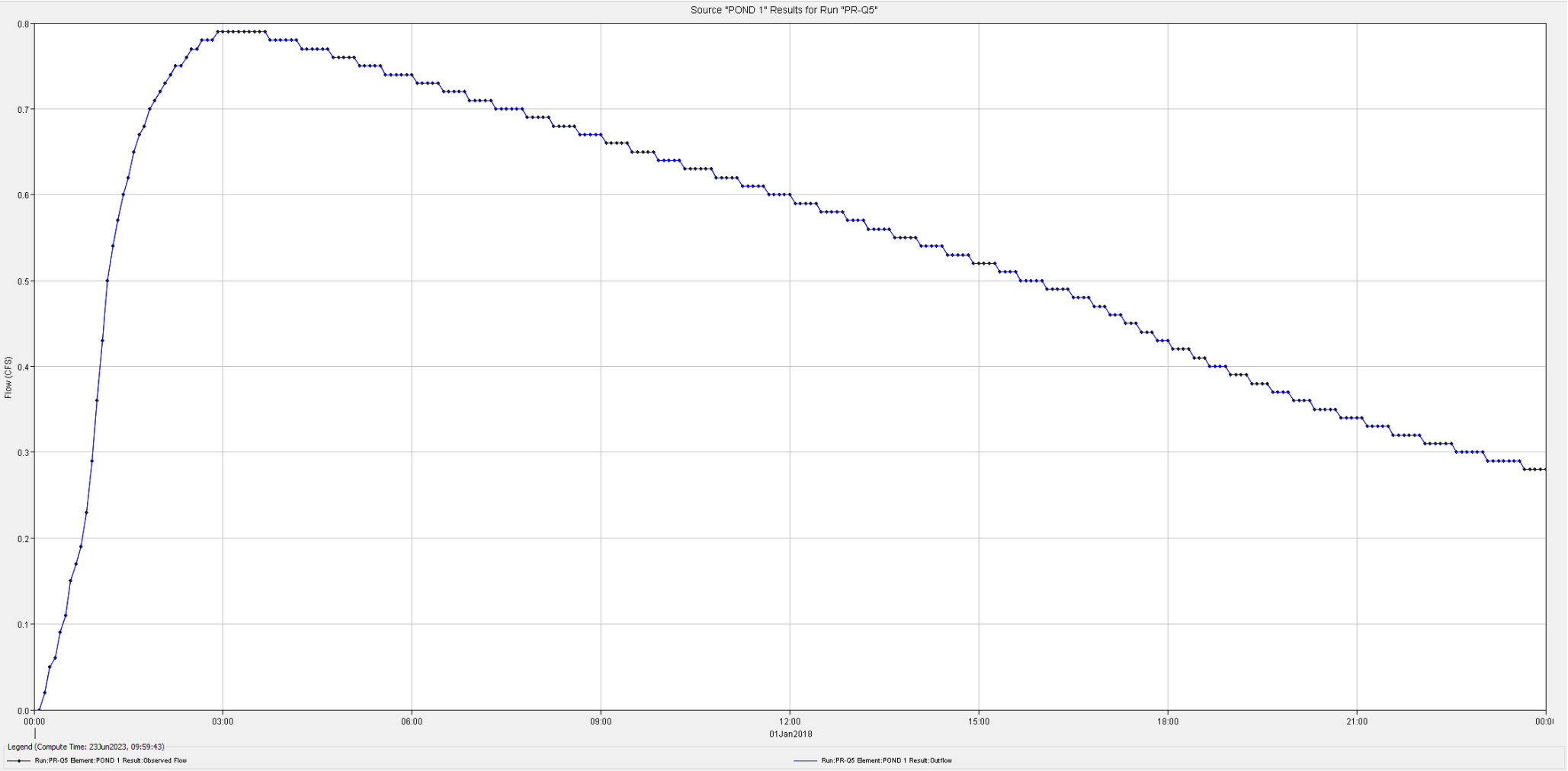


Project: HAY_CREEK_FOREST_MANOR - UP Simulation Run: PR-Q5

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

Volume Units: ☒ IN ☐ AC-FT

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



Project: HAY_CREEK_FOREST_MANOR - UPSimulation Run: PR-Q100

Start of Run: 01Jan2018, 00:00

End of Run: 02Jan2018, 00:00

Compute Time: 23Jun2023, 10:05:14

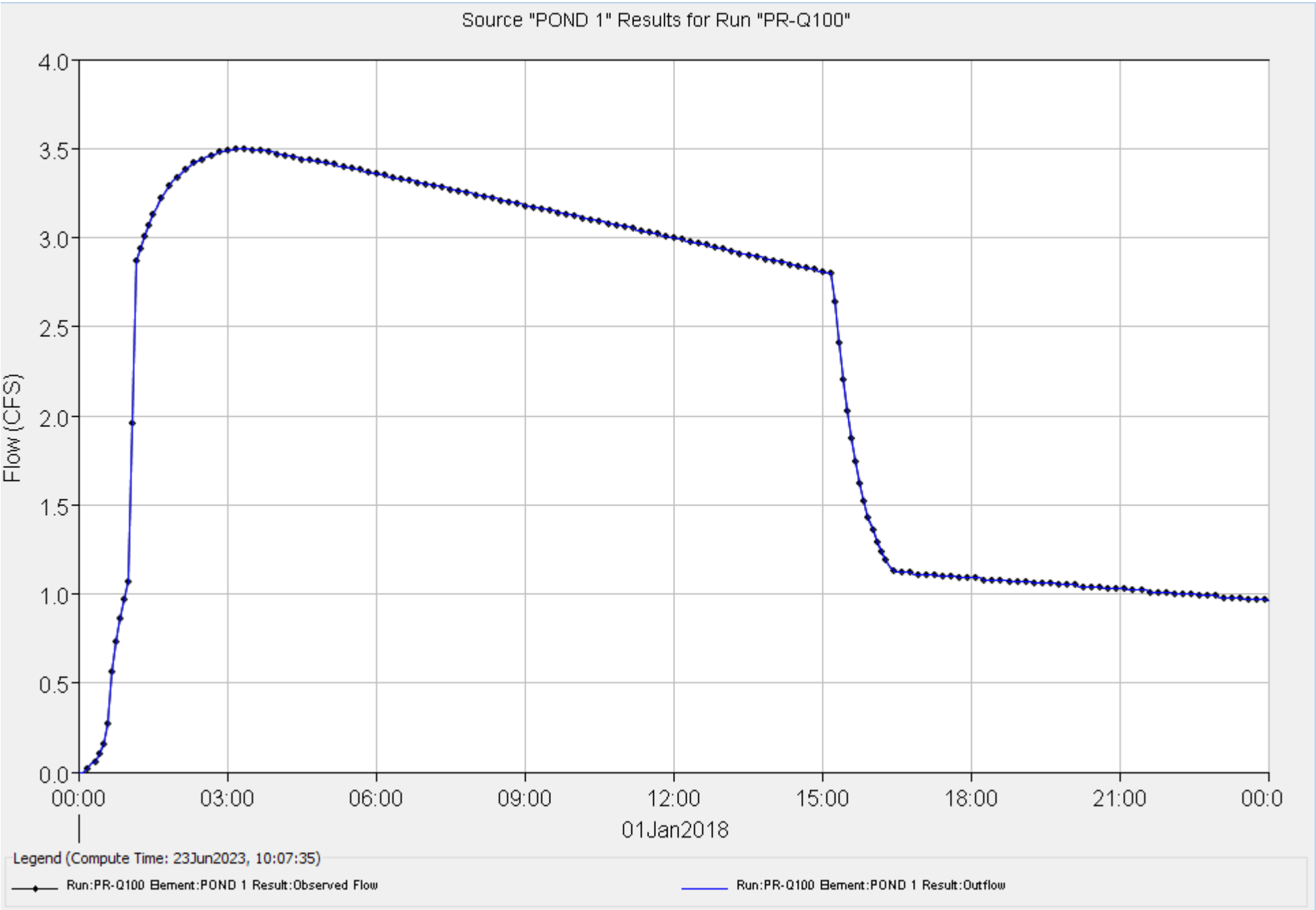
Basin Model: PR - HAY CREEK_FM

Meteorologic Model: 100 YEAR EVENT

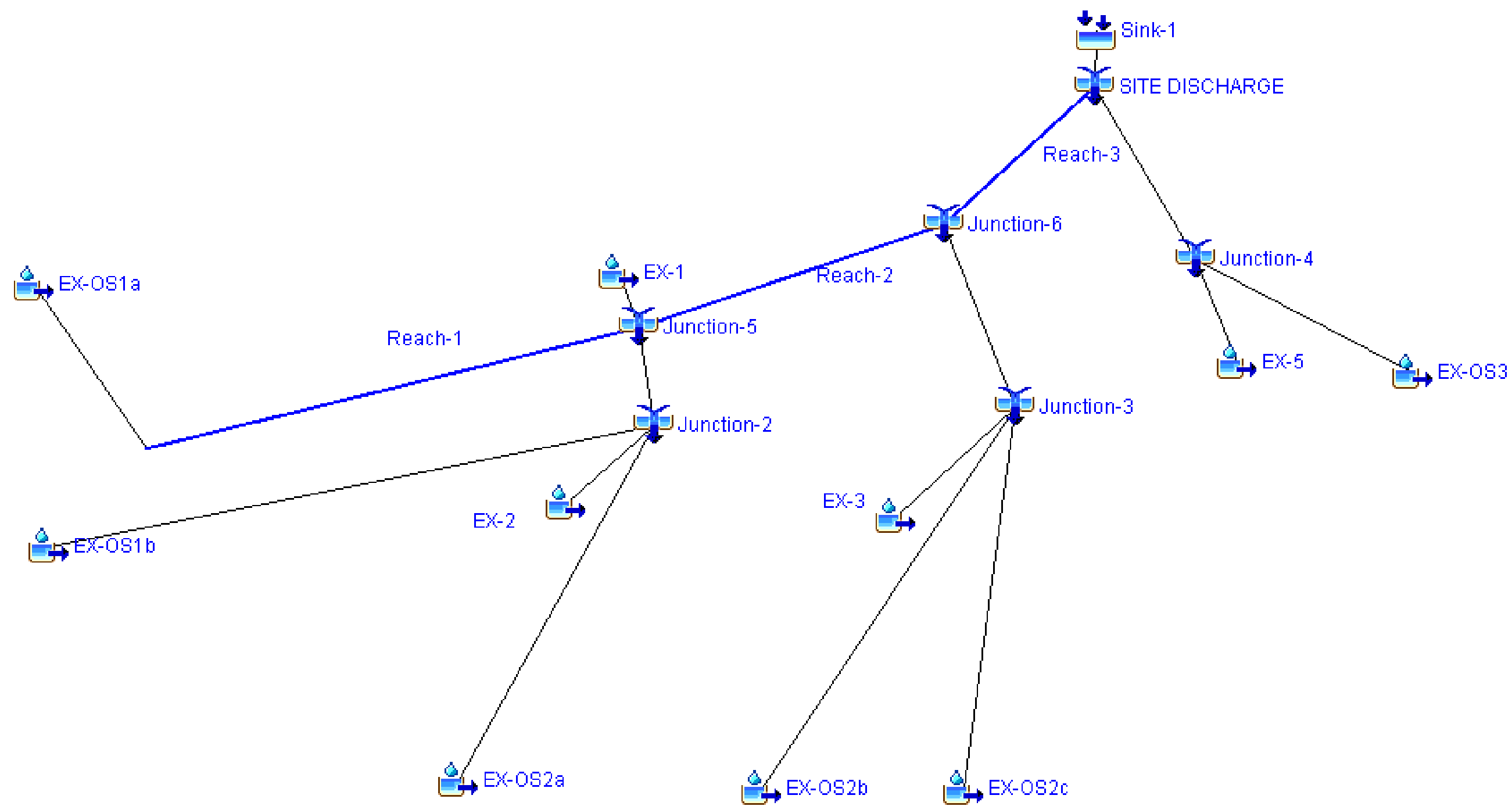
Control Specifications: 1 DAY

Volume Units: ☒ IN☐ AC-FT

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



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



Project: HAY_CREEK_FOREST_MANOR - UP Simulation Run: EX-Q5

Start of Run: 01Jan2018, 00:00 Basin Model: EX - HAY CREEK_FM

End of Run: 02Jan2018, 00:00 Meteorologic Model: 5 YEAR EVENT

Compute Time: 28Mar2023, 08:56:35 Control Specifications: 1 DAY

Volume Units: ☒ IN ☐ AC-FT

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

Project: HAY_CREEK_FOREST_MANOR - UP

Simulation Run: EX-Q100

Start of Run: 01Jan2018, 00:00

Basin Model: EX - HAY CREEK_FM

End of Run: 02Jan2018, 00:00

Meteorologic Model: 100 YEAR EVENT

Compute Time: 28Mar2023, 08:57:29

Control Specifications: 1 DAY

Volume Units: ☒ IN ☐ AC-FT

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

SWALE
CALCULATIONS

Channel Report

DP-10

Triangular

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

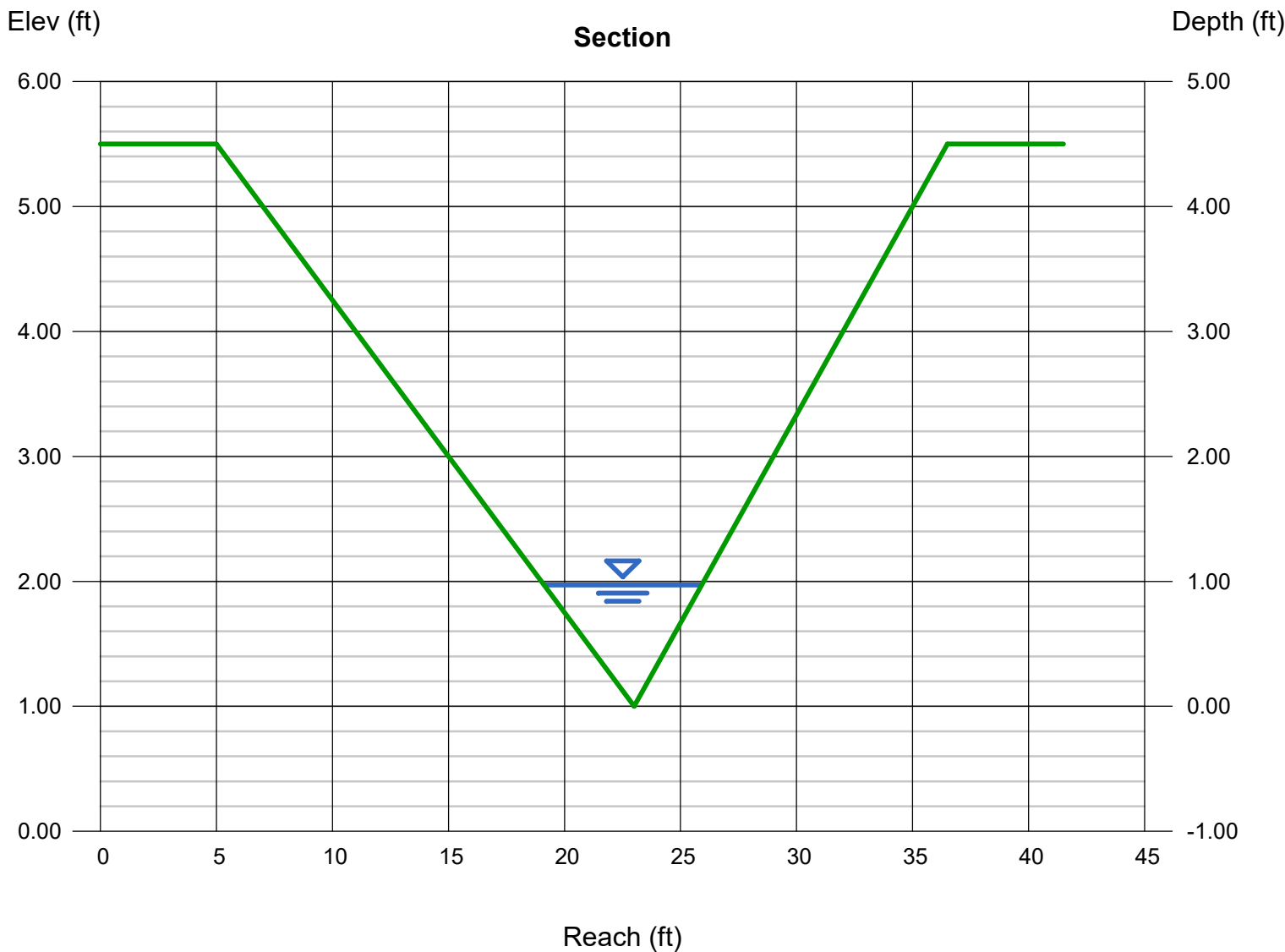
Invert Elev (ft) = 1.00
Slope (%) = 6.00
N-Value = 0.075

Calculations

Compute by: Known Q
Known Q (cfs) = 9.60

Highlighted

Depth (ft) = 0.97
Q (cfs) = 9.600
Area (sqft) = 3.29
Velocity (ft/s) = 2.92
Wetted Perim (ft) = 7.07
Crit Depth, Yc (ft) = 0.86
Top Width (ft) = 6.79
EGL (ft) = 1.10



Channel Report

DP-11

Triangular

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

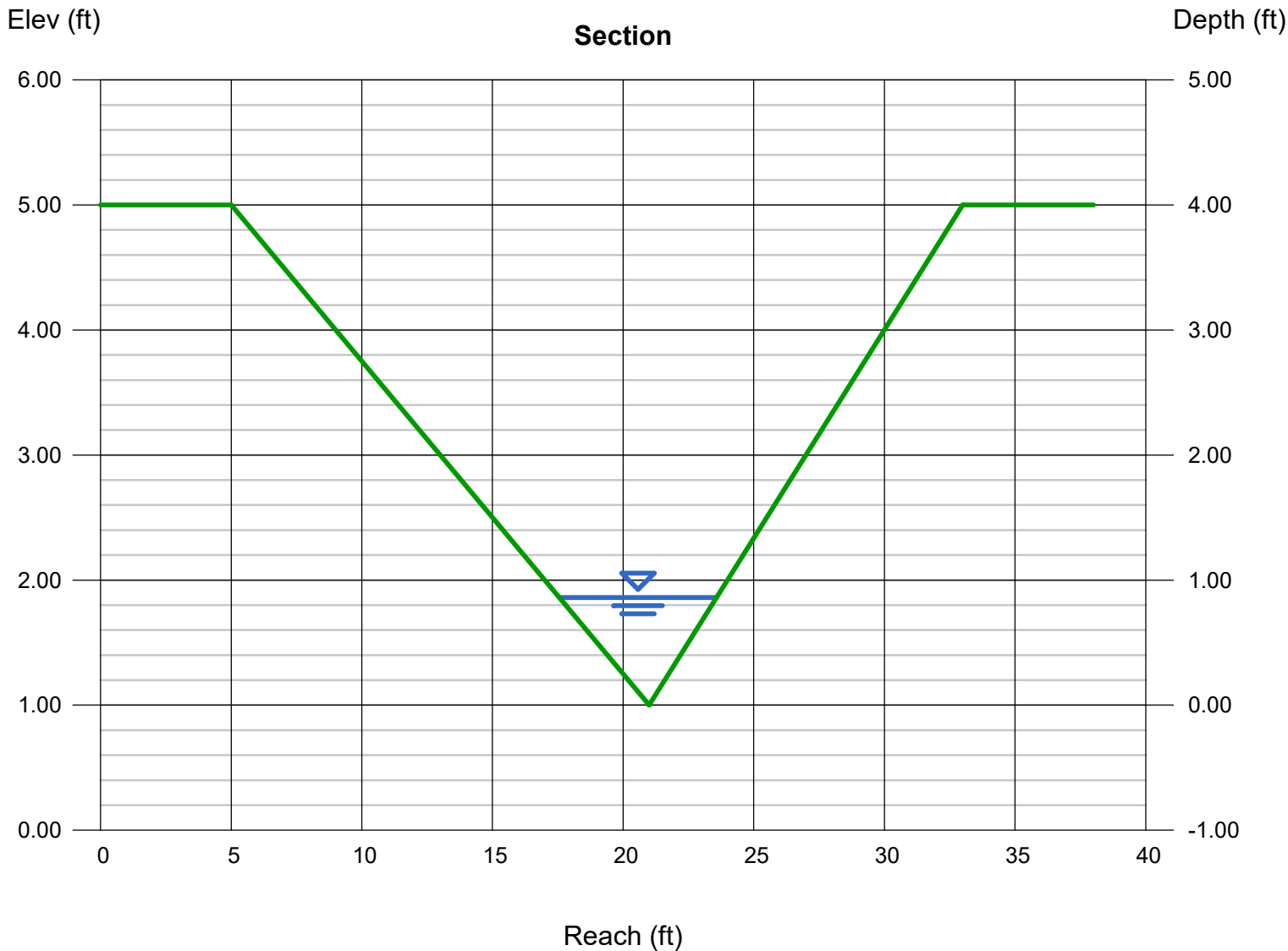
Invert Elev (ft) = 1.00
Slope (%) = 2.80
N-Value = 0.076

Calculations

Compute by: Known Q
Known Q (cfs) = 4.60

Highlighted

Depth (ft) = 0.86
Q (cfs) = 4.600
Area (sqft) = 2.59
Velocity (ft/s) = 1.78
Wetted Perim (ft) = 6.27
Crit Depth, Yc (ft) = 0.65
Top Width (ft) = 6.02
EGL (ft) = 0.91



Channel Report

DP-12

Triangular

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

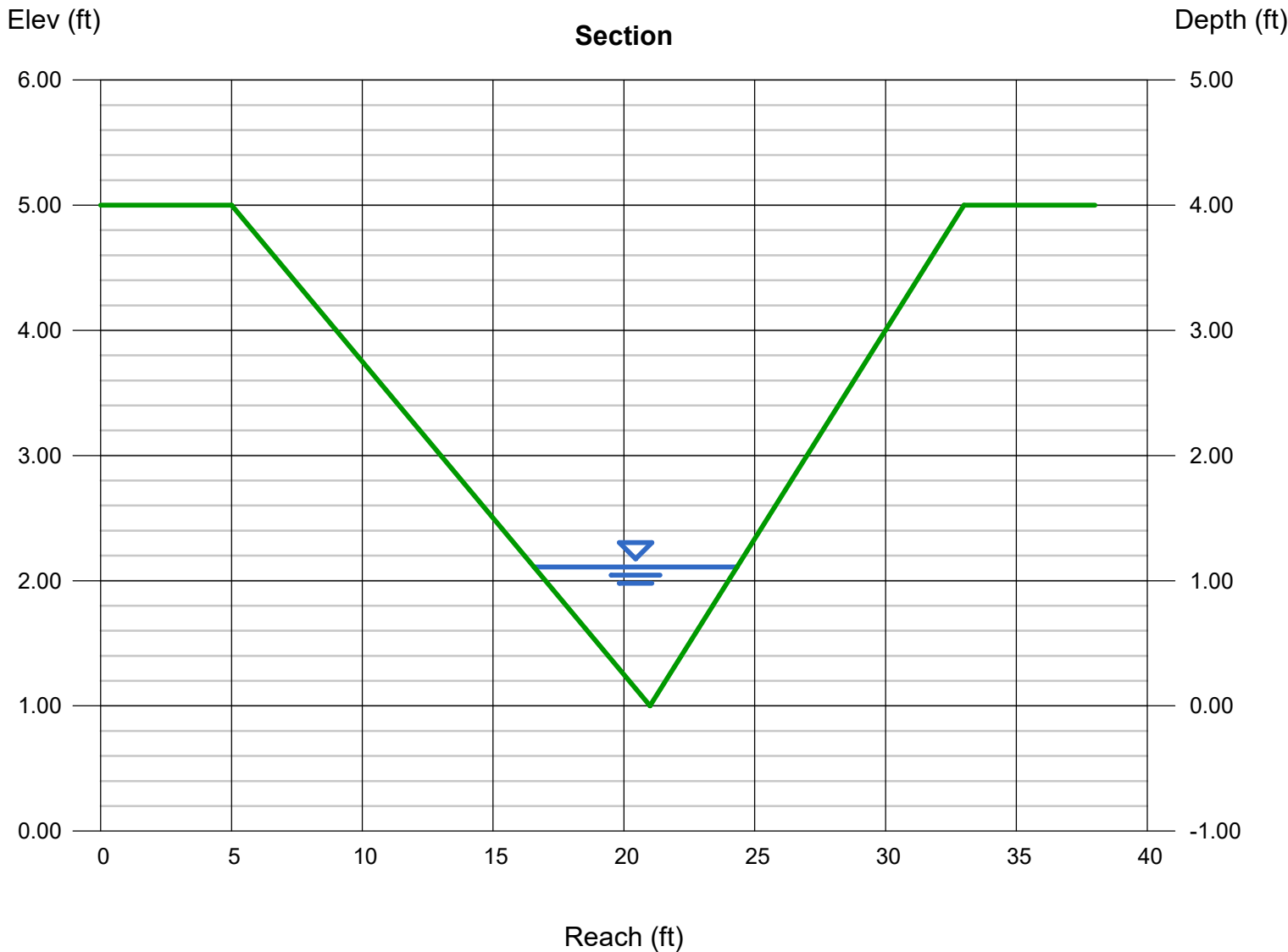
Invert Elev (ft) = 1.00
Slope (%) = 4.80
N-Value = 0.075

Calculations

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

Highlighted

Depth (ft) = 1.11
Q (cfs) = 12.30
Area (sqft) = 4.31
Velocity (ft/s) = 2.85
Wetted Perim (ft) = 8.09
Crit Depth, Yc (ft) = 0.95
Top Width (ft) = 7.77
EGL (ft) = 1.24



Channel Report

DP-13 (3.6%)

Triangular

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

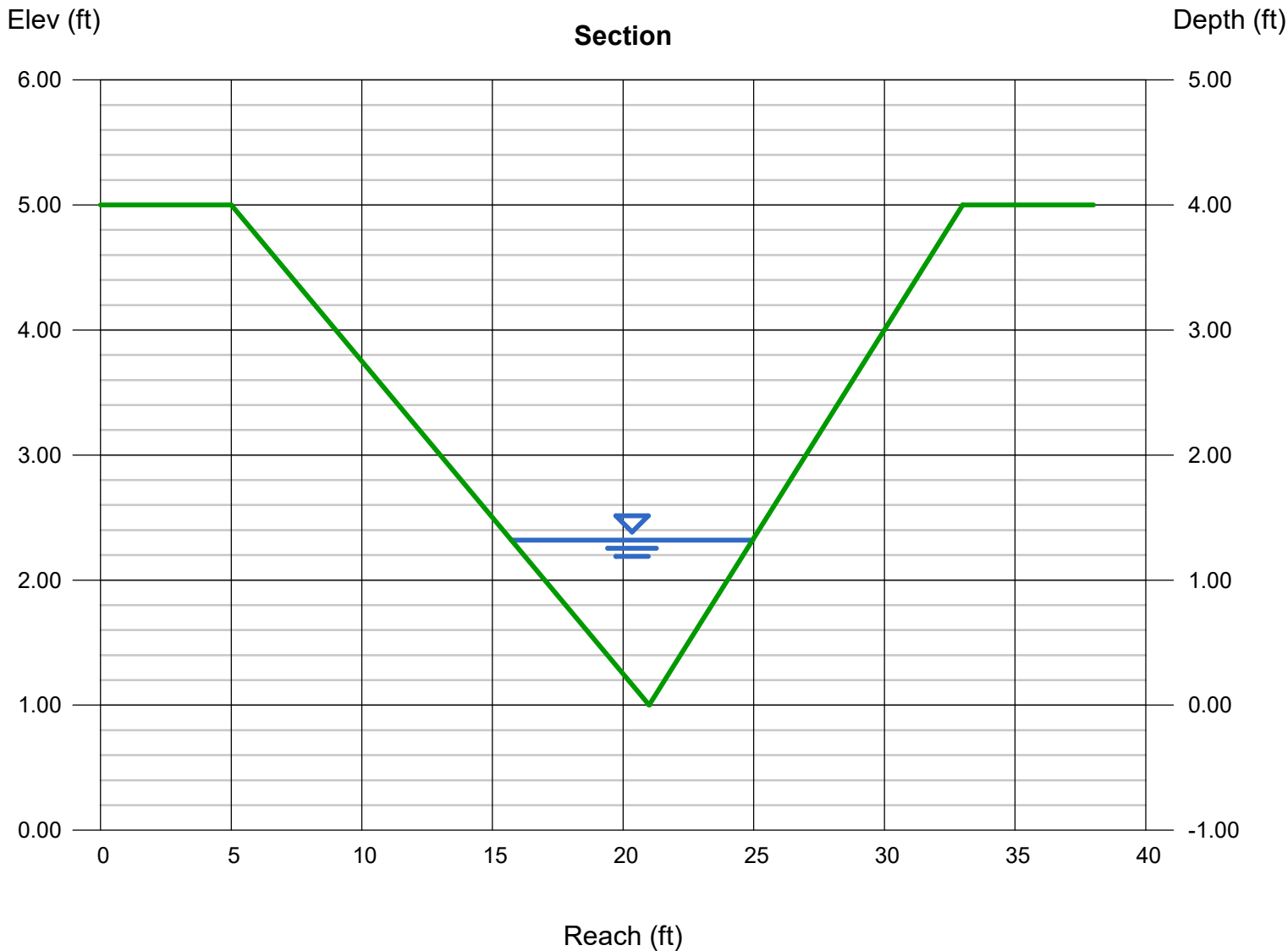
Invert Elev (ft) = 1.00
Slope (%) = 3.60
N-Value = 0.074

Calculations

Compute by: Known Q
Known Q (cfs) = 17.00

Highlighted

Depth (ft) = 1.32
Q (cfs) = 17.00
Area (sqft) = 6.10
Velocity (ft/s) = 2.79
Wetted Perim (ft) = 9.62
Crit Depth, Yc (ft) = 1.08
Top Width (ft) = 9.24
EGL (ft) = 1.44



Channel Report

DP-14

Triangular

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

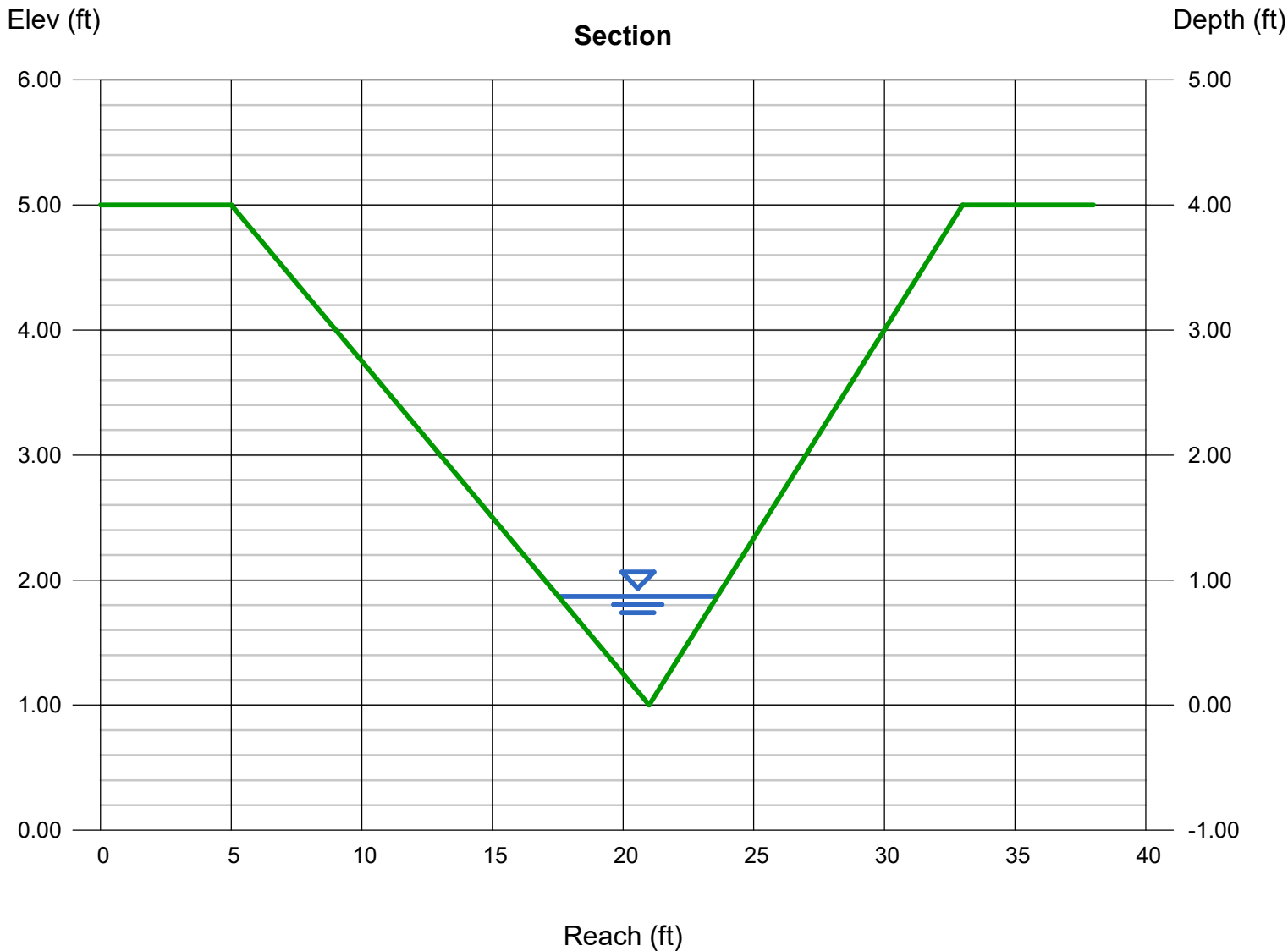
Invert Elev (ft) = 1.00
Slope (%) = 2.80
N-Value = 0.060

Calculations

Compute by: Known Q
Known Q (cfs) = 6.10

Highlighted

Depth (ft) = 0.87
Q (cfs) = 6.100
Area (sqft) = 2.65
Velocity (ft/s) = 2.30
Wetted Perim (ft) = 6.34
Crit Depth, Yc (ft) = 0.72
Top Width (ft) = 6.09
EGL (ft) = 0.95



Channel Report

DP-15

Trapezoidal

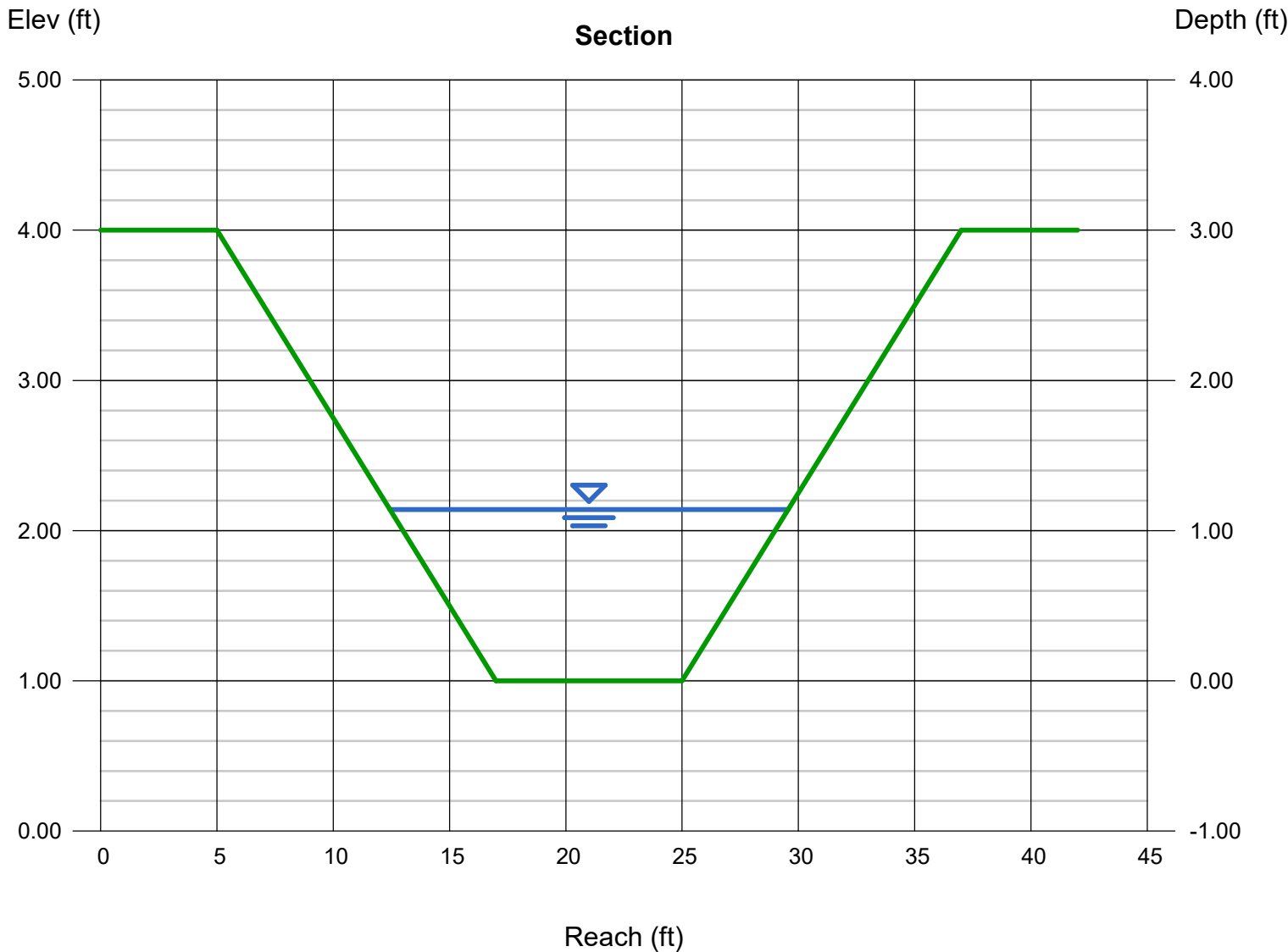
| | |
|-------------------|--------------|
| Bottom Width (ft) | = 8.00 |
| Side Slopes (z:1) | = 4.00, 4.00 |
| Total Depth (ft) | = 3.00 |
| Invert Elev (ft) | = 1.00 |
| Slope (%) | = 4.50 |
| N-Value | = 0.068 |

Highlighted

| | |
|---------------------|---------|
| Depth (ft) | = 1.14 |
| Q (cfs) | = 58.10 |
| Area (sqft) | = 14.32 |
| Velocity (ft/s) | = 4.06 |
| Wetted Perim (ft) | = 17.40 |
| Crit Depth, Yc (ft) | = 1.00 |
| Top Width (ft) | = 17.12 |
| EGL (ft) | = 1.40 |

Calculations

| | |
|---------------|---------|
| Compute by: | Known Q |
| Known Q (cfs) | = 58.10 |



Channel Report

DP-16 (2.8%)

Triangular

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

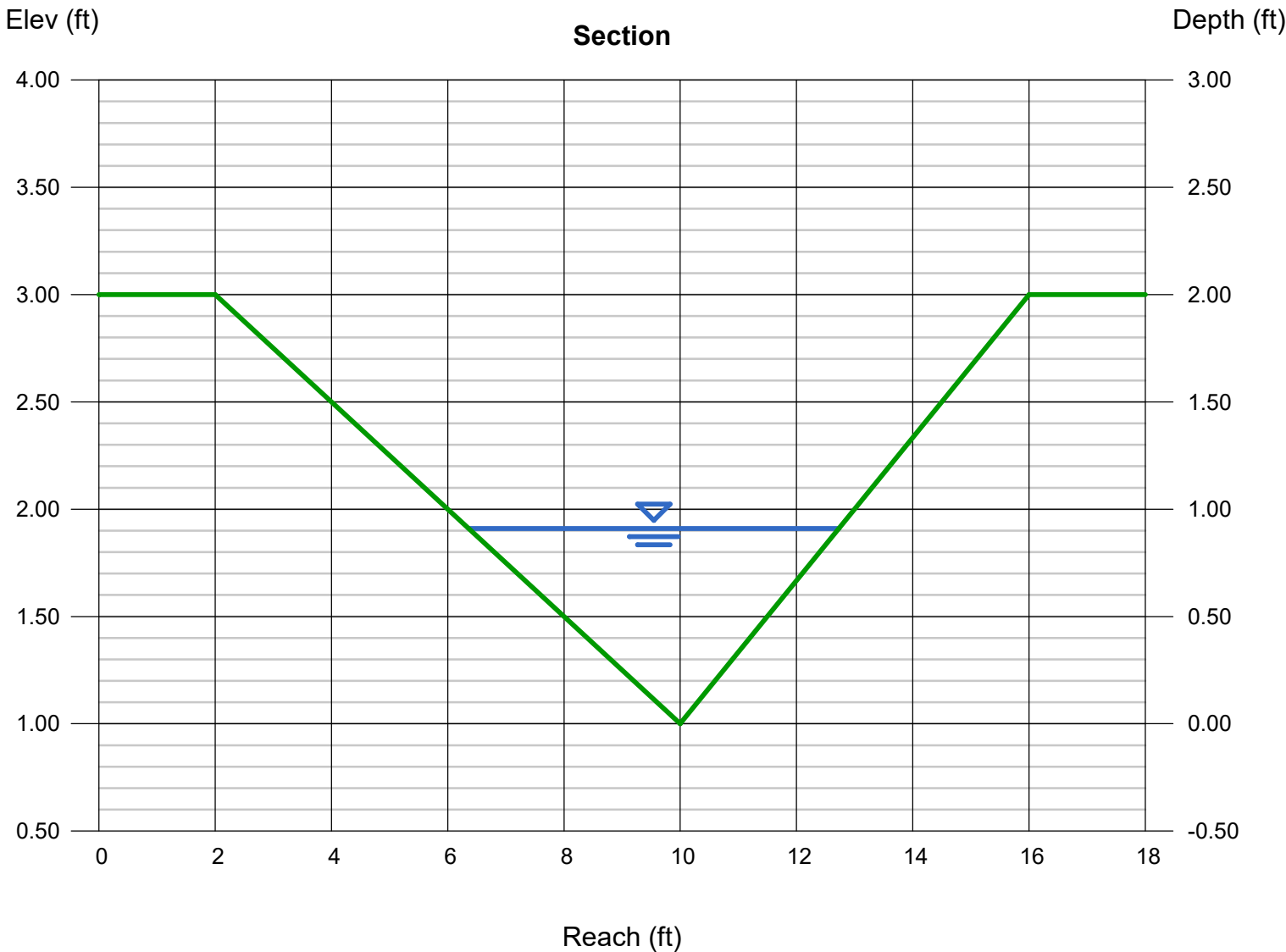
Invert Elev (ft) = 1.00
Slope (%) = 2.80
N-Value = 0.074

Calculations

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

Highlighted

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



Channel Report

DP-16 (3.6%)

Triangular

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

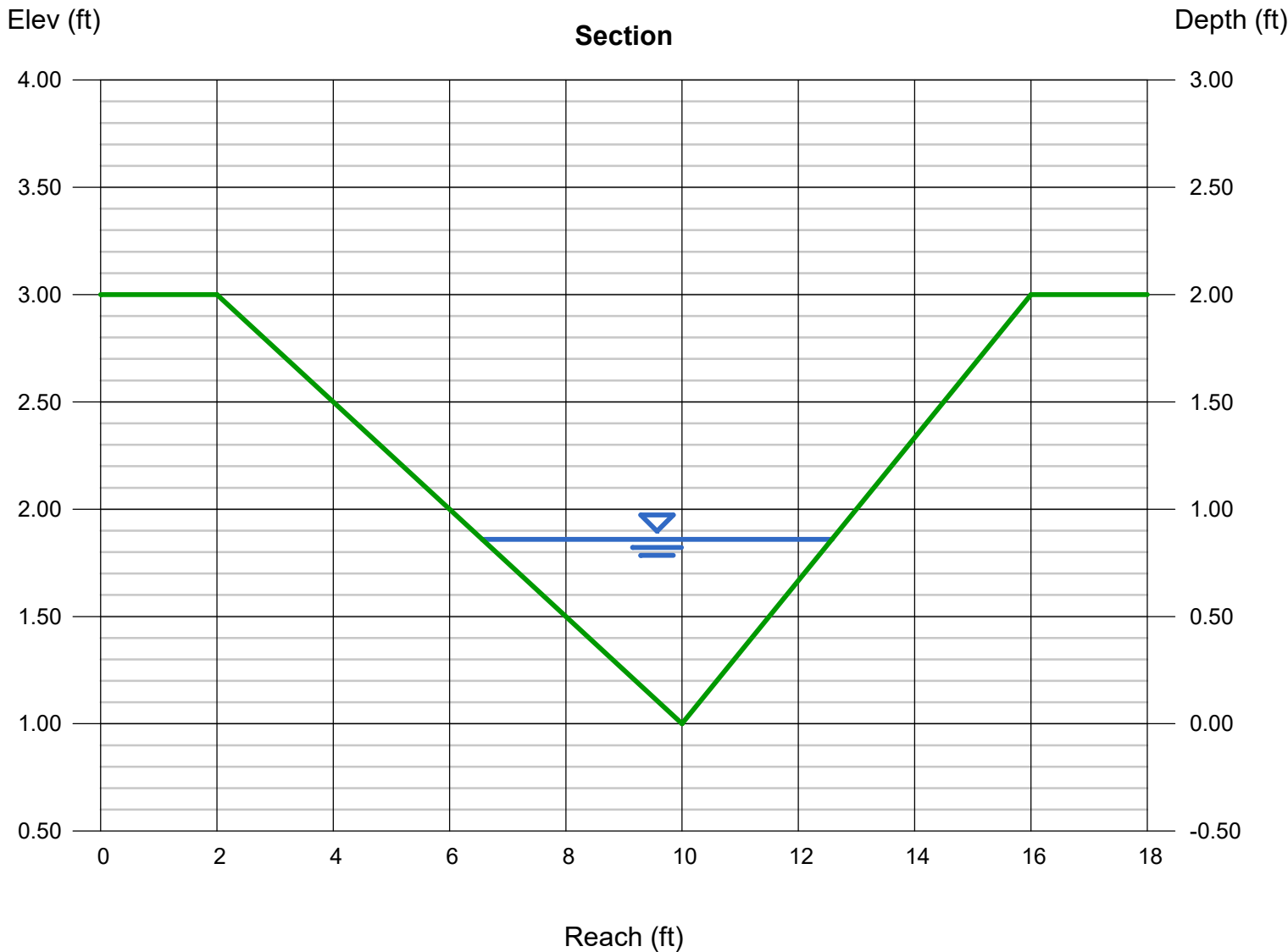
Invert Elev (ft) = 1.00
Slope (%) = 3.60
N-Value = 0.071

Calculations

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

Highlighted

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



Channel Report

DP-16 (4.8%)

Triangular

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

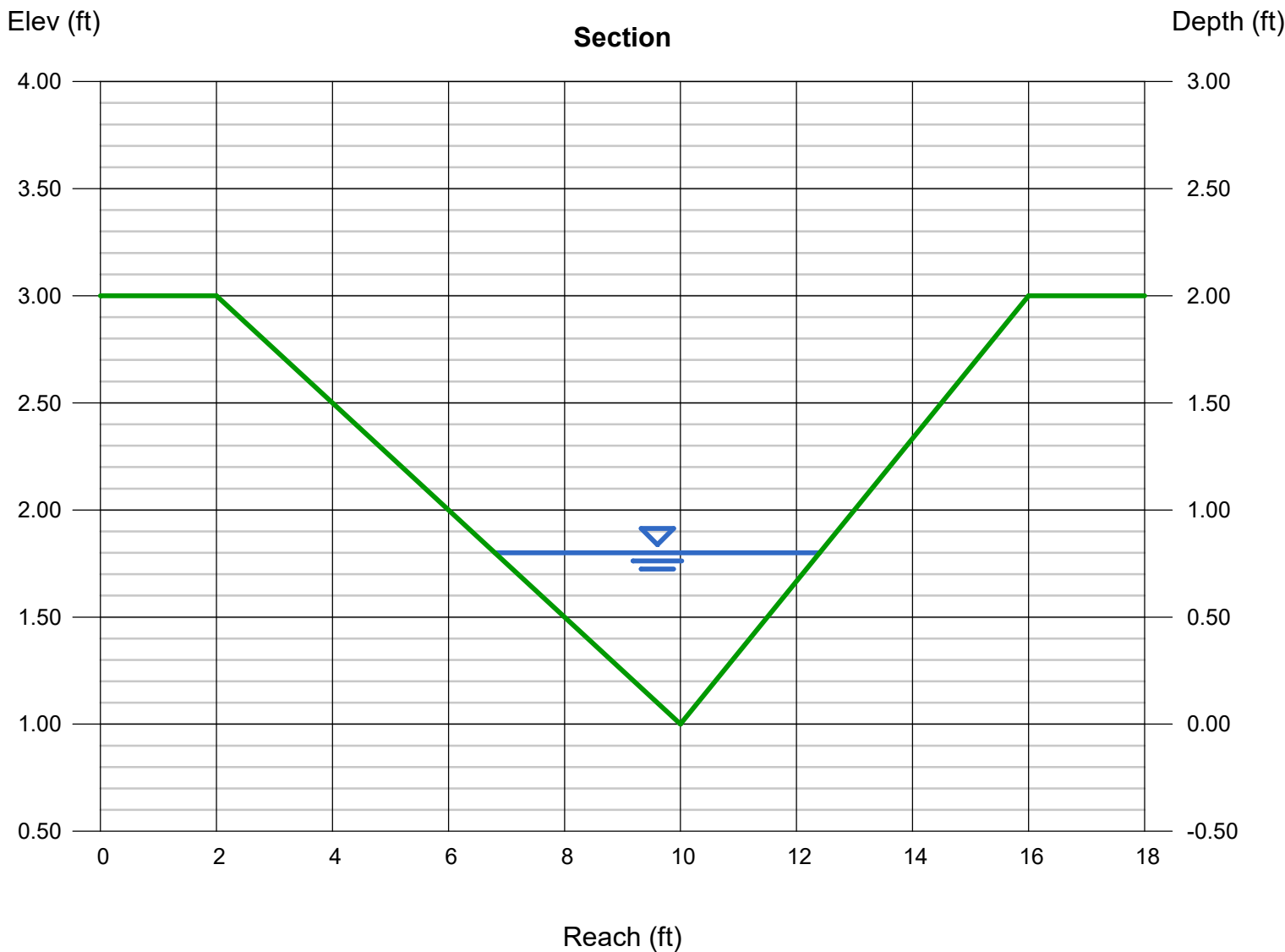
Invert Elev (ft) = 1.00
Slope (%) = 4.80
N-Value = 0.068

Calculations

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

Highlighted

Depth (ft) = 0.80
Q (cfs) = 5.600
Area (sqft) = 2.24
Velocity (ft/s) = 2.50
Wetted Perim (ft) = 5.83
Crit Depth, Yc (ft) = 0.70
Top Width (ft) = 5.60
EGL (ft) = 0.90



Channel Report

DP-16 (6.0%)

Triangular

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

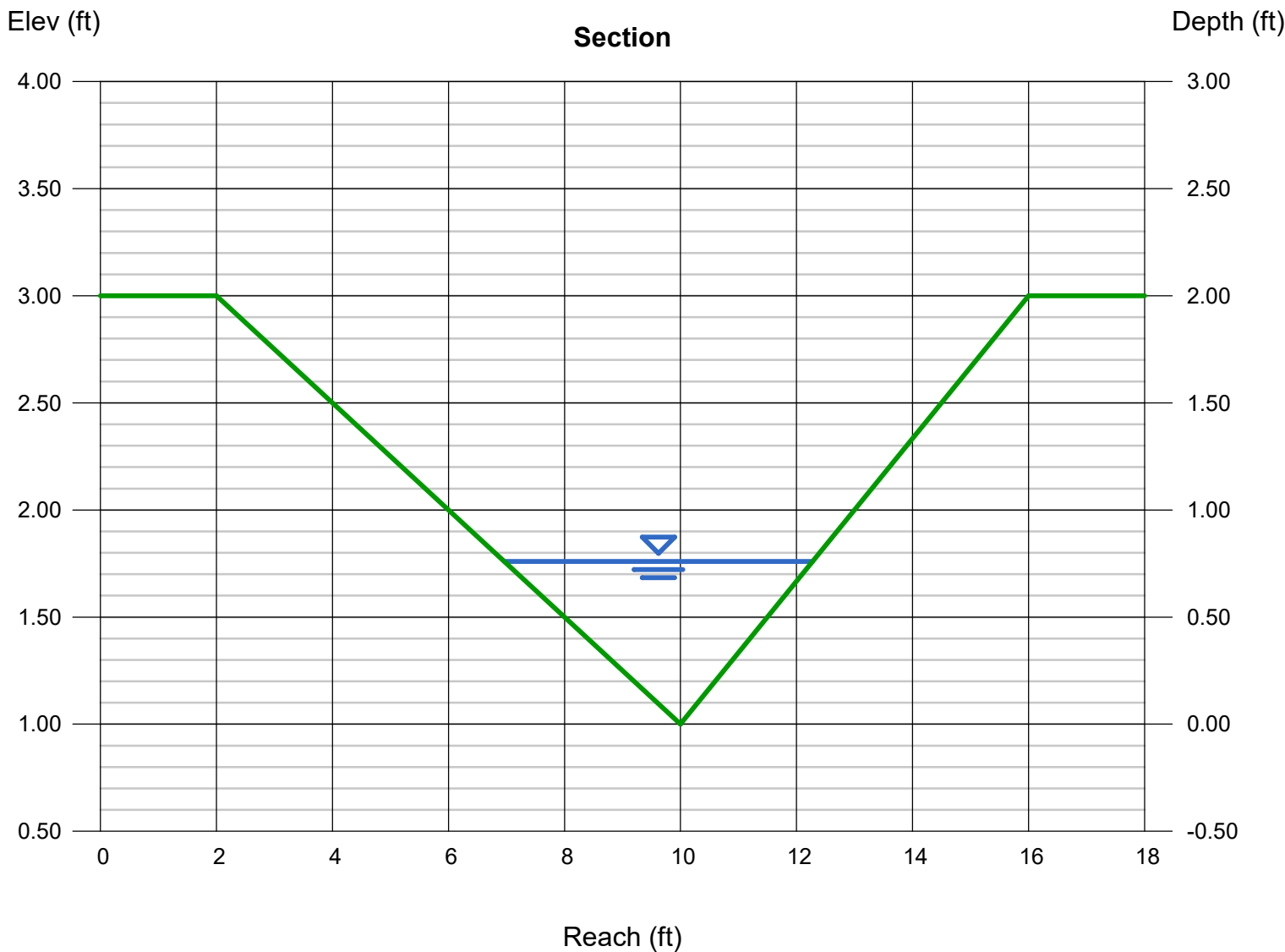
Invert Elev (ft) = 1.00
Slope (%) = 6.00
N-Value = 0.066

Calculations

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

Highlighted

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



Channel Report

Roadside Embankment

Triangular

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

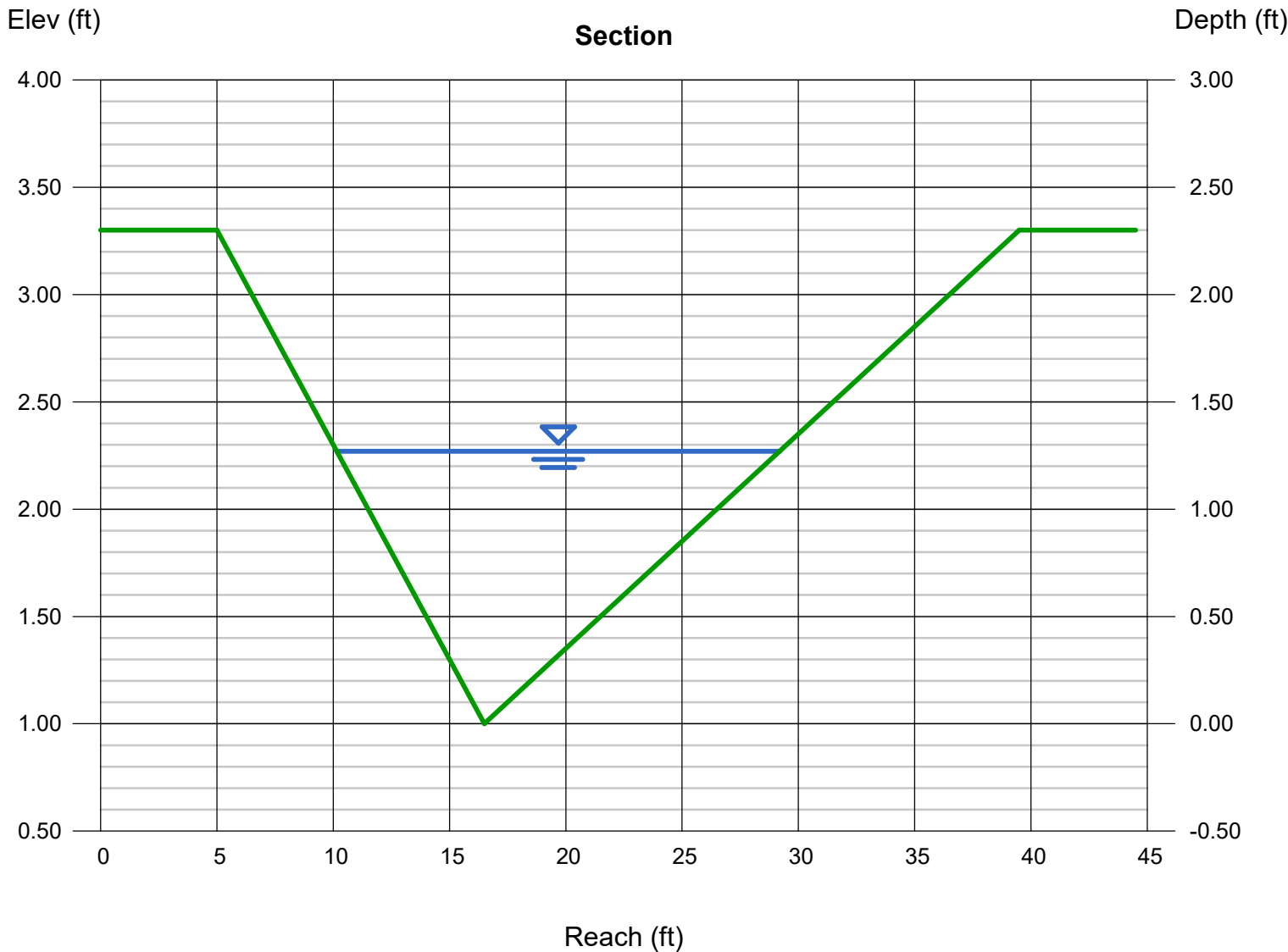
Invert Elev (ft) = 1.00
Slope (%) = 2.00
N-Value = 0.032

Calculations

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

Highlighted

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



Hydraulic Analysis Report

Project Data

Project Title: Hay Creek

Designer:

Project Date: Thursday, January 12, 2023

Project Units: U.S. Customary Units

Notes:

Channel Analysis: DP-10

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0600 ft/ft

Manning's n: 0.0748

Flow: 9.6000 cfs

Result Parameters

Depth: 0.9687 ft

Area of Flow: 3.2840 ft²

Wetted Perimeter: 7.0570 ft

Hydraulic Radius: 0.4654 ft

Average Velocity: 2.9233 ft/s

Top Width: 6.7806 ft

Froude Number: 0.7402

Critical Depth: 0.8624 ft

Critical Velocity: 3.6880 ft/s

Critical Slope: 0.1115 ft/ft

Critical Top Width: 6.16 ft

Calculated Max Shear Stress: 3.6266 lb/ft²

Calculated Avg Shear Stress: 1.7423 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis DP-10

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft³

Water Specific Weight: 62.4 lb/ft³

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.13865

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.645971

Manning's n method: Bathurst

Manning's n: 0.0747751

Channel Bottom Shear Results

V*: 1.36822

Reynold's Number: 84319.2

Shield's Parameter: 0.0755305

shear stress on channel bottom: 3.62777 lb/ft²

Permissible shear stress for channel bottom: 5.34519 lb/ft²

channel bottom is stable

Stable D50: 0.579601 ft

Channel Side Shear Results

K1: 0.934

K2: 1

Kb: 0

shear stress on side of channel: 3.62777 lb/ft²

Permissible shear stress for side of channel: 5.34519 lb/ft²

Stable Side D50: 0.541347 lb/ft²

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-10

Channel Analysis: DP-12

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0480 ft/ft

Manning's n: 0.0749

Flow: 12.3000 cfs

Result Parameters

Depth: 1.1092 ft

Area of Flow: 4.3061 ft²

Wetted Perimeter: 8.0809 ft

Hydraulic Radius: 0.5329 ft

Average Velocity: 2.8564 ft/s

Top Width: 7.7644 ft

Froude Number: 0.6759

Critical Depth: 0.9523 ft

Critical Velocity: 3.8754 ft/s

Critical Slope: 0.1083 ft/ft

Critical Top Width: 6.80 ft

Calculated Max Shear Stress: 3.3223 lb/ft²

Calculated Avg Shear Stress: 1.5961 lb/ft²

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/ft³

Water Specific Weight: 62.4 lb/ft³

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.12738

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.739882

Manning's n method: Bathurst

Manning's n: 0.0749154

Channel Bottom Shear Results

V*: 1.30971

Reynold's Number: 80713.5

Shield's Parameter: 0.0732093

shear stress on channel bottom: 3.32414 lb/ft²

Permissible shear stress for channel bottom: 5.63346 lb/ft²

channel bottom is stable

Stable D50: 0.498928 ft

Channel Side Shear Results

K1: 0.934

K2: 0.931169

Kb: 0

shear stress on side of channel: 3.32414 lb/ft²

Permissible shear stress for side of channel: 5.2457 lb/ft²

Stable Side D50: 0.500445 lb/ft²

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-12

Channel Analysis: DP-13 (3.6%)

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0360 ft/ft

Manning's n: 0.0742

Flow: 17.0000 cfs

Result Parameters

Depth: 1.3169 ft

Area of Flow: 6.0700 ft²

Wetted Perimeter: 9.5942 ft

Hydraulic Radius: 0.6327 ft

Average Velocity: 2.8007 ft/s

Top Width: 9.2184 ft

Froude Number: 0.6082

Critical Depth: 1.0839 ft

Critical Velocity: 4.1345 ft/s

Critical Slope: 0.1017 ft/ft

Critical Top Width: 7.75 ft

Calculated Max Shear Stress: 2.9583 lb/ft²

Calculated Avg Shear Stress: 1.4212 lb/ft²

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

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft³

Water Specific Weight: 62.4 lb/ft³

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.11313

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.87817

Manning's n method: Bathurst

Manning's n: 0.074193

Channel Bottom Shear Results

V*: 1.2357

Reynold's Number: 76152.6

Shield's Parameter: 0.0702732

shear stress on channel bottom: 2.95908 lb/ft²

Permissible shear stress for channel bottom: 5.40753 lb/ft²

channel bottom is stable

Stable D50: 0.456842 ft

Channel Side Shear Results

K1: 0.934

K2: 0.931169

Kb: 0

shear stress on side of channel: 2.95908 lb/ft²

Permissible shear stress for side of channel: 5.03532 lb/ft²

Stable Side D50: 0.458231 lb/ft²

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

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

Channel Analysis: DP-14 (2.8%)

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0280 ft/ft

Manning's n: 0.0719

Flow: 6.1000 cfs

Result Parameters

Depth: 0.9292 ft

Area of Flow: 3.0218 ft²

Wetted Perimeter: 6.7694 ft

Hydraulic Radius: 0.4464 ft

Average Velocity: 2.0187 ft/s

Top Width: 6.5042 ft

Froude Number: 0.5219

Critical Depth: 0.7193 ft

Critical Velocity: 3.3682 ft/s

Critical Slope: 0.1097 ft/ft

Critical Top Width: 5.14 ft

Calculated Max Shear Stress: 1.6235 lb/ft²

Calculated Avg Shear Stress: 0.7799 lb/ft²

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

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft³

Water Specific Weight: 62.4 lb/ft³

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.00016

Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.929871

Manning's n method: Bathurst

Manning's n: 0.0719463

Channel Bottom Shear Results

V*: 0.915626

Reynold's Number: 37618.2

Shield's Parameter: 0.047

shear stress on channel bottom: 1.62467 lb/ft²

Permissible shear stress for channel bottom: 2.4111 lb/ft²

channel bottom is stable

Stable D50: 0.336967 ft

Channel Side Shear Results

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 1.62467 lb/ft²

Permissible shear stress for side of channel: 2.24135 lb/ft²

Stable Side D50: 0.338563 lb/ft²

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

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

Channel Analysis: DP-15

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0450 ft/ft

Manning's n: 0.0679

Flow: 58.1000 cfs

Result Parameters

Depth: 1.1374 ft

Area of Flow: 14.2731 ft²

Wetted Perimeter: 17.3789 ft

Hydraulic Radius: 0.8213 ft

Average Velocity: 4.0706 ft/s

Top Width: 17.0988 ft

Froude Number: 0.7852

Critical Depth: 0.9917 ft

Critical Velocity: 4.8956 ft/s

Critical Slope: 0.0756 ft/ft

Critical Top Width: 15.93 ft

Calculated Max Shear Stress: 3.1937 lb/ft²

Calculated Avg Shear Stress: 2.3062 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis DP-15

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft³

Water Specific Weight: 62.4 lb/ft³

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.12239

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 1.11299

Manning's n method: Bathurst

Manning's n: 0.0678818

Channel Bottom Shear Results

V*: 1.28375

Reynold's Number: 79113.9

Shield's Parameter: 0.0721795

shear stress on channel bottom: 3.19369 lb/ft²

Permissible shear stress for channel bottom: 5.55422 lb/ft²

channel bottom is stable

Stable D50: 0.484031 ft

Channel Side Shear Results

K1: 0.934

K2: 0.931169

Kb: 0

shear stress on side of channel: 3.19369 lb/ft²

Permissible shear stress for side of channel: 5.17191 lb/ft²

Stable Side D50: 0.485503 lb/ft²

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-15

Channel Analysis: DP-11

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0280 ft/ft

Manning's n: 0.0758

Flow: 4.6000 cfs

Result Parameters

Depth: 0.8526 ft

Area of Flow: 2.5441 ft²

Wetted Perimeter: 6.2113 ft

Hydraulic Radius: 0.4096 ft

Average Velocity: 1.8081 ft/s

Top Width: 5.9680 ft

Froude Number: 0.4880

Critical Depth: 0.6425 ft

Critical Velocity: 3.1834 ft/s

Critical Slope: 0.1265 ft/ft

Critical Top Width: 4.59 ft

Calculated Max Shear Stress: 1.4896 lb/ft²

Calculated Avg Shear Stress: 0.7156 lb/ft²

Channel Lining Analysis: Channel Lining Design Analysis DP-11

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft³

Water Specific Weight: 62.4 lb/ft³

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.00016

Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.853239

Manning's n method: Bathurst

Manning's n: 0.0758392

Channel Bottom Shear Results

V*: 0.877086

Reynold's Number: 36034.8

Shield's Parameter: 0.047

shear stress on channel bottom: 1.49078 lb/ft²

Permissible shear stress for channel bottom: 2.4111 lb/ft²

channel bottom is stable

Stable D50: 0.309197 ft

Channel Side Shear Results

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 1.49078 lb/ft²

Permissible shear stress for side of channel: 2.24135 lb/ft²

Stable Side D50: 0.310662 lb/ft²

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-11

Channel Analysis: DP-16 2.8%

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Longitudinal Slope: 0.0280 ft/ft

Manning's n: 0.0731

Flow: 5.6000 cfs

Result Parameters

Depth: 0.9050 ft

Area of Flow: 2.8667 ft²

Wetted Perimeter: 6.5934 ft

Hydraulic Radius: 0.4348 ft

Average Velocity: 1.9535 ft/s

Top Width: 6.3351 ft

Froude Number: 0.5118

Critical Depth: 0.6951 ft

Critical Velocity: 3.3111 ft/s

Critical Slope: 0.1144 ft/ft

Critical Top Width: 4.97 ft

Calculated Max Shear Stress: 1.5813 lb/ft²

Calculated Avg Shear Stress: 0.7597 lb/ft²

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

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft³

Water Specific Weight: 62.4 lb/ft³

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.00016

Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.905928

Manning's n method: Bathurst

Manning's n: 0.0730949

Channel Bottom Shear Results

V*: 0.903762

Reynold's Number: 37130.7

Shield's Parameter: 0.047

shear stress on channel bottom: 1.58284 lb/ft²

Permissible shear stress for channel bottom: 2.4111 lb/ft²

channel bottom is stable

Stable D50: 0.328291 ft

Channel Side Shear Results

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 1.58284 lb/ft²

Permissible shear stress for side of channel: 2.24135 lb/ft²

Stable Side D50: 0.329846 lb/ft²

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-16 2.8%

Channel Analysis: DP-16 3.6%

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0360 ft/ft

Manning's n: 0.0705

Flow: 5.6000 cfs

Result Parameters

Depth: 0.8520 ft

Area of Flow: 2.5408 ft²

Wetted Perimeter: 6.2073 ft

Hydraulic Radius: 0.4093 ft

Average Velocity: 2.2041 ft/s

Top Width: 5.9641 ft

Froude Number: 0.5951

Critical Depth: 0.6951 ft

Critical Velocity: 3.3111 ft/s

Critical Slope: 0.1066 ft/ft

Critical Top Width: 4.97 ft

Calculated Max Shear Stress: 1.9140 lb/ft²

Calculated Avg Shear Stress: 0.9195 lb/ft²

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

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft³

Water Specific Weight: 62.4 lb/ft³

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.00277

Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.852316

Manning's n method: Bathurst

Manning's n: 0.0705366

Channel Bottom Shear Results

V*: 0.993984

Reynold's Number: 40837.5

Shield's Parameter: 0.0475391

shear stress on channel bottom: 1.91464 lb/ft²

Permissible shear stress for channel bottom: 2.43876 lb/ft²

channel bottom is stable

Stable D50: 0.393633 ft

Channel Side Shear Results

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 1.91464 lb/ft²

Permissible shear stress for side of channel: 2.26706 lb/ft²

Stable Side D50: 0.395497 lb/ft²

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-16 3.6%

Channel Analysis: DP-16 4.8%

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0480 ft/ft

Manning's n: 0.0674

Flow: 5.6000 cfs

Result Parameters

Depth: 0.7936 ft

Area of Flow: 2.2041 ft²

Wetted Perimeter: 5.7815 ft

Hydraulic Radius: 0.3812 ft

Average Velocity: 2.5407 ft/s

Top Width: 5.5550 ft

Froude Number: 0.7108

Critical Depth: 0.6951 ft

Critical Velocity: 3.3111 ft/s

Critical Slope: 0.0973 ft/ft

Critical Top Width: 4.97 ft

Calculated Max Shear Stress: 2.3769 lb/ft²

Calculated Avg Shear Stress: 1.1419 lb/ft²

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

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.5 ft

Riprap Specific Weight: 165 lb/ft³

Water Specific Weight: 62.4 lb/ft³

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.01739

Lining Results

Angle of Repose: 41.15 degrees

Relative Flow Depth: 0.79406

Manning's n method: Bathurst

Manning's n: 0.067402

Channel Bottom Shear Results

V*: 1.10784

Reynold's Number: 45515

Shield's Parameter: 0.0505503

shear stress on channel bottom: 2.37837 lb/ft²

Permissible shear stress for channel bottom: 2.59323 lb/ft²

channel bottom is stable

Stable D50: 0.466547 ft

Channel Side Shear Results

K1: 0.934

K2: 0.929597

Kb: 0

shear stress on side of channel: 2.37837 lb/ft²

Permissible shear stress for side of channel: 2.41066 lb/ft²

Stable Side D50: 0.468757 lb/ft²

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-16 4.8%

Channel Analysis: DP-16 6.0%

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0600 ft/ft

Manning's n: 0.0818

Flow: 5.6000 cfs

Result Parameters

Depth: 0.8186 ft

Area of Flow: 2.3455 ft²

Wetted Perimeter: 5.9639 ft

Hydraulic Radius: 0.3933 ft

Average Velocity: 2.3876 ft/s

Top Width: 5.7303 ft

Froude Number: 0.6577

Critical Depth: 0.6951 ft

Critical Velocity: 3.3111 ft/s

Critical Slope: 0.1435 ft/ft

Critical Top Width: 4.97 ft

Calculated Max Shear Stress: 3.0649 lb/ft²

Calculated Avg Shear Stress: 1.4724 lb/ft²

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

Notes:

Lining Input Parameters

Channel Lining Type: Riprap, Cobble, or Gravel

D50: 0.75 ft

Riprap Specific Weight: 165 lb/ft³

Water Specific Weight: 62.4 lb/ft³

Riprap Shape is Angular

Safety Factor: 1

Calculated Safety Factor: 1.11741

Lining Results

Angle of Repose: 41.7 degrees

Relative Flow Depth: 0.546015

Manning's n method: Bathurst

Manning's n: 0.0818682

Channel Bottom Shear Results

V*: 1.25792

Reynold's Number: 77521.5

Shield's Parameter: 0.0711545

shear stress on channel bottom: 3.06642 lb/ft²

Permissible shear stress for channel bottom: 5.09212 lb/ft²

channel bottom is stable

Stable D50: 0.504669 ft

Channel Side Shear Results

K1: 0.934

K2: 1

Kb: 0

shear stress on side of channel: 3.06642 lb/ft²

Permissible shear stress for side of channel: 5.09212 lb/ft²

Stable Side D50: 0.471361 lb/ft²

side of channel is stable

Channel Lining Stability Results

the channel is stable

Channel Summary

Name of Selected Channel: DP-16 6.0%

APPENDIX B

STANDARD DESIGN CHARTS AND TABLES

Table 6-6. Runoff Coefficients for Rational Method

(Source: UDFCD 2001)

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

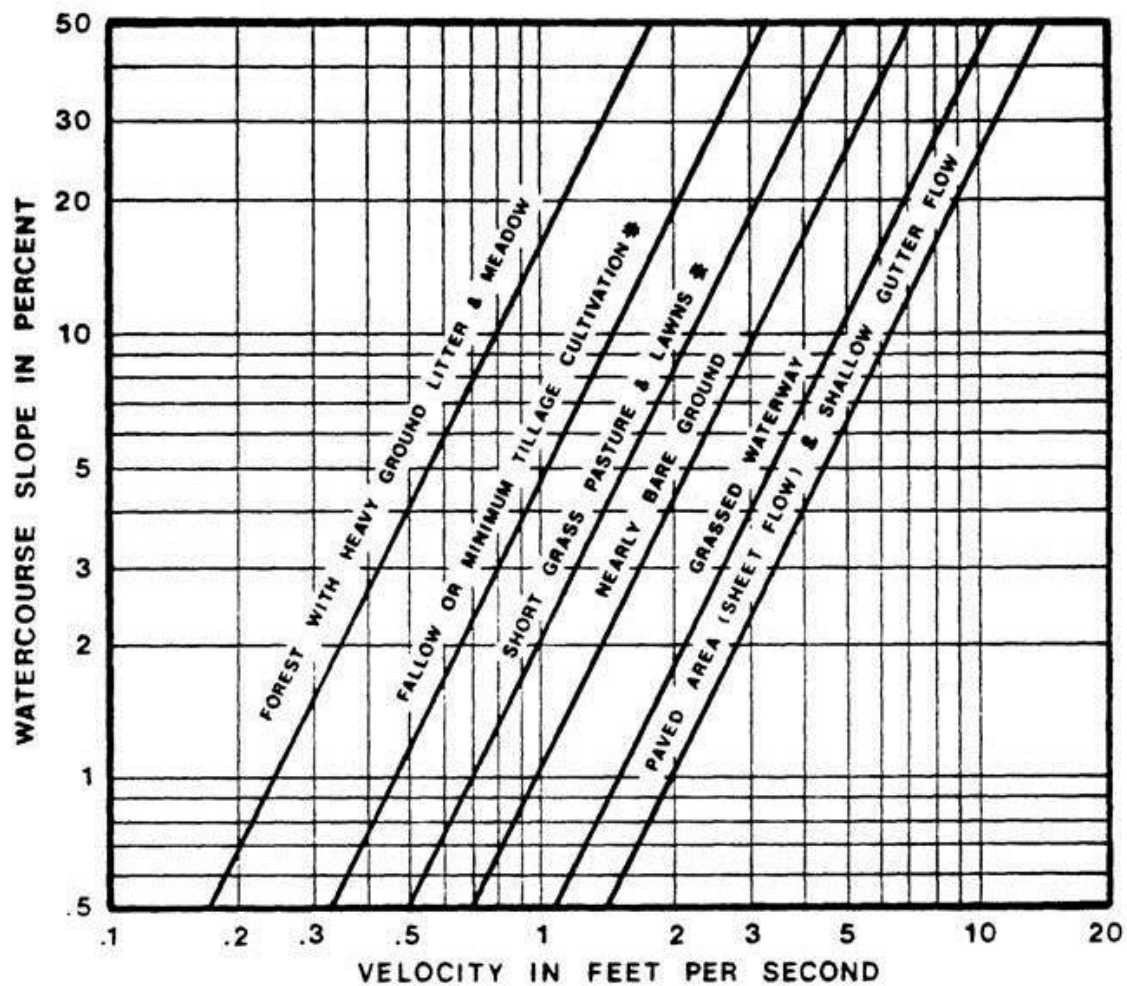
3.2 Time of Concentration

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

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

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

Figure 6-25. Estimate of Average Concentrated Shallow Flow



El Paso County Drainage Basin Fees

Resolution No. 22-442

| Basin Number | Receiving Waters | Year Studied | Drainage Basin Name | 2023 Drainage Fee (per Impervious Acre) | 2023 Bridge Fee (per Impervious Acre) |
|--------------|------------------|--------------|---------------------|---|---------------------------------------|
|--------------|------------------|--------------|---------------------|---|---------------------------------------|

Drainage Basins with DBPS's:

| | | | | | |
|---------------------|----------------|-------|--------------------------------|----------|---------|
| CHMS0200 | Chico Creek | 2013 | Haegler Ranch | \$12,985 | \$1,916 |
| CHWS1200 | Chico Creek | 2001 | Bennett Ranch | \$14,536 | \$5,576 |
| CHWS1400 | Chico Creek | 2013 | Falcon | \$37,256 | \$5,118 |
| FOFO2000 | Fountain Creek | 2001 | West Fork Jimmy Camp Creek | \$15,802 | \$4,675 |
| FOFO2600 | Fountain Creek | 1991* | Big Johnson / Crews Gulch | \$23,078 | \$2,980 |
| FOFO2800 | Fountain Creek | 1988* | Widefield | \$23,078 | \$0 |
| FOFO2900 | Fountain Creek | 1988* | Security | \$23,078 | \$0 |
| FOFO3000 | Fountain Creek | 1991* | Windmill Gulch | \$23,078 | \$346 |
| FOFO3100 / FOFO3200 | Fountain Creek | 1988* | Carson Street / Little Johnson | \$14,077 | \$0 |
| FOFO3400 | Fountain Creek | 1984* | Peterson Field | \$16,646 | \$1,262 |
| FOFO3600 | Fountain Creek | 1991* | Fisher's Canyon | \$23,078 | \$0 |
| FOFO4000 | Fountain Creek | 1996 | Sand Creek | \$23,821 | \$9,743 |
| FOFO4200 | Fountain Creek | 1977 | Spring Creek | \$11,969 | \$0 |
| FOFO4600 | Fountain Creek | 1984* | Southwest Area | \$23,078 | \$0 |
| FOFO4800 | Fountain Creek | 1991 | Bear Creek | \$23,078 | \$1,262 |
| FOFO5800 | Fountain Creek | 1964 | Camp Creek | \$2,557 | \$0 |
| FOMO1000 | Monument Creek | 1981 | Douglas Creek | \$14,514 | \$321 |
| FOMO1200 | Monument Creek | 1977 | Templeton Gap | \$14,900 | \$346 |
| FOMO2000 | Monument Creek | 1971 | Pulpit Rock | \$7,653 | \$0 |
| FOMO2200 | Monument Creek | 1994 | Cottonwood Creek / S. Pine | \$23,078 | \$1,262 |
| FOMO2400 | Monument Creek | 1966 | Dry Creek | \$18,219 | \$660 |
| FOMO3600 | Monument Creek | 1989* | Black Squirrel Creek | \$10,478 | \$660 |
| FOMO3700 | Monument Creek | 1987* | Middle Tributary | \$19,259 | \$0 |
| FOMO3800 | Monument Creek | 1987* | Monument Branch | \$23,078 | \$0 |
| FOMO4000 | Monument Creek | 1996 | Smith Creek | \$9,409 | \$1,262 |
| FOMO4200 | Monument Creek | 1989* | Black Forest | \$23,078 | \$628 |
| FOMO5200 | Monument Creek | 1993* | Dirty Woman Creek | \$23,078 | \$1,262 |
| FOMO5300 | Fountain Creek | 1993* | Crystal Creek | \$23,078 | \$1,262 |

Miscellaneous Drainage Basins: ¹

| | | | | | |
|----------|----------------|--|-------------------------------|----------|---------|
| CHBS0800 | Chico Creek | | Book Ranch | \$21,654 | \$3,135 |
| CHEC0400 | Chico Creek | | Upper East Chico | \$11,797 | \$342 |
| CHWS0200 | Chico Creek | | Telephone Exchange | \$12,962 | \$304 |
| CHWS0400 | Chico Creek | | Livestock Company | \$21,351 | \$254 |
| CHWS0600 | Chico Creek | | West Squirrel | \$11,129 | \$4,619 |
| CHWS0800 | Chico Creek | | Solberg Ranch | \$23,078 | \$0 |
| FOFO1200 | Fountain Creek | | Crooked Canyon | \$6,968 | \$0 |
| FOFO1400 | Fountain Creek | | Calhan Reservoir | \$5,817 | \$339 |
| FOFO1600 | Fountain Creek | | Sand Canyon | \$4,203 | \$0 |
| FOFO2000 | Fountain Creek | | Jimmy Camp Creek ³ | \$23,078 | \$1,079 |
| FOFO2200 | Fountain Creek | | Fort Carson | \$18,219 | \$660 |
| FOFO2700 | Fountain Creek | | West Little Johnson | \$1,521 | \$0 |
| FOFO3800 | Fountain Creek | | Stratton | \$11,070 | \$495 |
| FOFO5000 | Fountain Creek | | Midland | \$18,219 | \$660 |
| FOFO6000 | Fountain Creek | | Palmer Trail | \$18,219 | \$660 |
| FOFO6800 | Fountain Creek | | Black Canyon | \$18,219 | \$660 |
| FOMO4600 | Monument Creek | | Beaver Creek | \$13,797 | \$0 |
| FOMO3000 | Monument Creek | | Kettle Creek | \$12,463 | \$0 |
| FOMO3400 | Monument Creek | | Elkhorn | \$2,094 | \$0 |
| FOMO5000 | Monument Creek | | Monument Rock | \$10,003 | \$0 |
| FOMO5400 | Monument Creek | | Palmer Lake | \$15,995 | \$0 |
| FOMO5600 | Monument Creek | | Raspberry Mountain | \$5,380 | \$0 |
| PLPL0200 | Monument Creek | | Bald Mountain | \$11,465 | \$0 |

Interim Drainage Basins: ²

| | | | | | |
|----------|----------------|--|-----------------------|---------|-------|
| FOFO1800 | Fountain Creek | | Little Fountain Creek | \$2,950 | \$0 |
| FOMO4400 | Monument Creek | | Jackson Creek | \$9,135 | \$0 |
| FOMO4800 | Monument Creek | | Teachout Creek | \$6,343 | \$953 |

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

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

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

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

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

APPENDIX C

REPORT REFERENCES

```

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

```

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

```

XXXXXXXXX
X          X  XXXXXXXX  XXXXX
X          X  X          X    X          X
X          X  X          X
X          XXXXXXXX  XXXX  X          XXXXX
XXXXXXXXX
X          X  X          X          X
X          X  X          X    X          X
X          X  XXXXXXXX  XXXXX
XXXXXXXXX
END OF BANNER
1
11/ 3/ 3      12:40:22
PAGE      1

```

THIS RUN EXECUTED 11/ 3/ 3 12:40:22

 HEC2 RELEASE DATED SEP 88 UPDATED APR 1989

ERROR CORR - 01,02
 MODIFICATION -

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

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

| J1 | ICHECK | INQ | NINV | IDIR | STRT | METRIC | HVINS | Q |
|------|--------|-----|------|------|------|--------|-------|---|
| WSEL | FQ | | | | | | | |
| | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |

6733.2

| J2 | NPROF | IPLOT | PRFVS | XSECV | XSECH | FN | ALLDC | IBW |
|-------|--------|-------|-------|-------|-------|----|-------|-----|
| CHNIM | ITRACE | | | | | | | |

| | | | | | | | | |
|---|---|----|--|--|--|--|--|--|
| 1 | 0 | -1 | | | | | | |
|---|---|----|--|--|--|--|--|--|

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

| | | | | | | | | |
|----|---|------|-------|--|--|--|--|--|
| QT | 2 | 6317 | 20974 | | | | | |
|----|---|------|-------|--|--|--|--|--|

| | | | | | | | | |
|----|-----|-----|-----|----|----|--|--|--|
| NC | .07 | .07 | .05 | .2 | .4 | | | |
|----|-----|-----|-----|----|----|--|--|--|

CONFLUENCE WITH MONUMENT CREEK

| | | | | | | | |
|----|----|----|------|------|---|---|---|
| X1 | 60 | 15 | 1280 | 1360 | 0 | 0 | 0 |
|----|----|----|------|------|---|---|---|

| | | | | | | | |
|----|------|------|------|------|------|------|------|
| GR | 6752 | 1000 | 6750 | 1085 | 6740 | 1170 | 6735 |
|----|------|------|------|------|------|------|------|

| | | | | | | | |
|------|------|------|--|--|--|--|--|
| 1235 | 6730 | 1250 | | | | | |
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|----|------|------|------|------|------|------|------|
| GR | 6725 | 1280 | 6720 | 1295 | 6718 | 1305 | 6720 |
|----|------|------|------|------|------|------|------|

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| 1310 | 6725 | 1360 | | | | | |
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|----|------|------|------|------|------|------|------|
| GR | 6730 | 1445 | 6735 | 1525 | 6740 | 1560 | 6745 |
|----|------|------|------|------|------|------|------|

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|------|------|------|--|--|--|--|--|
| 1670 | 6750 | 1810 | | | | | |
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THIS QT CARD IS APPROXIMATELY AT THE HAY CREEK CONFLUENCE WITH BEAVER CREEK AND DEMONSTRATES A 127 CFS INCREASE OVER THE UPSTREAM QT CARD. (6915 CFS -6788 CFS=127 CFS). WE THEREFORE BELIEVE 127 CFS TO BE A REASONABLE FLOW TO USE FOR HAY CREEK.

| | | | | | | | |
|----|---|------|------|--|--|--|--|
| QT | 2 | 3507 | 6915 | | | | |
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| NC | .07 | .07 | .05 | | | | |
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|----|---|----|------|------|------|------|------|
| X1 | 1 | 14 | 1507 | 1545 | 1047 | 1047 | 1047 |
|----|---|----|------|------|------|------|------|

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|----|------|------|------|------|------|------|------|
| GR | 6748 | 1000 | 6744 | 1163 | 6742 | 1193 | 6740 |
|----|------|------|------|------|------|------|------|

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| 1313 | 6740 | 1358 | | | | | |
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|----|------|------|------|------|------|------|------|
| GR | 6738 | 1386 | 6736 | 1507 | 6734 | 1520 | 6732 |
|----|------|------|------|------|------|------|------|

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| 1526 | 6732 | 1541 | | | | | |
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|----|------|------|------|------|------|------|------|
| GR | 6740 | 1548 | 6746 | 1563 | 6746 | 1748 | 6748 |
|----|------|------|------|------|------|------|------|

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| 1798 | | | | | | | |
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| NC | .07 | .07 | .05 | .1 | .3 | | |
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| X1 | 2 | 11 | 1136 | 1195 | 759 | 759 | 759 |
|----|---|----|------|------|-----|-----|-----|

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| GR | 6758 | 1034 | 6756 | 1049 | 6750 | 1064 | 6748 |
|----|------|------|------|------|------|------|------|

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| 1076 | 6748 | 1136 | | | | | |
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|----|------|------|------|------|------|------|------|
| GR | 6746 | 1147 | 6746 | 1184 | 6748 | 1195 | 6750 |
|----|------|------|------|------|------|------|------|

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| 1227 | 6756 | 1254 | | | | | |
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| GR | 6758 | 1274 | | | | | |
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|----|---|------|------|--|--|--|--|
| QT | 2 | 1847 | 5128 | | | | |
|----|---|------|------|--|--|--|--|

NC .013 .013 .015 .1 .3

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

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

X1 3 6 1130 1250 845 845 845

GR 6778 1000 6772 1130 6772 1250 6774

1390 6776 1500

GR 6778 1720

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PAGE 2

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

NC .025 .025 .025 .1 .3

QT 2 3107 6788

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

X1 4 5 1070 1280 984 984 984

X4 1 6786 1000

GR 6790 900 6784 1070 6784 1280 6790

1420 6796 1520

NC .07 .07 .08

X1 5 14 1243 1314 722 722 722

GR 6806 1188 6804 1198 6800 1211 6798

1221 6786 1246

GR 6786 1272 6788 1314 6790 1344 6796

1391 6796 1427

GR 6798 1428 6800 1435 6804 1475 6806

1512

NC .013 .013 .013 .1 .3

QT 2 3216 6154

NC .013 .013 .015 .1 .3

X1 6.1 9 1209 1230 1160 1160 1160

GR 6840 1000 6828 1091 6828 1209 6806.6

1209 6806.6 1230

GR 6828 1230 6828 1316 6830 1457 6840

1619

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|--|--------------|----------------|----------------|--------|------|--------|--------|
| SB | 1.05 0 | 1.25 6807.3 | 2.6 6806.6 | 0 | 20 | 1.0 | 210 |
| NC | .013 | .013 | .015 | .3 | .5 | | |
| LONG VALLEY DRIVE, EXISITNG 2-10' x 10' CBC FACE | | | | | | | |
| X1 | 6.2 | 9 | 1209 | 1230 | 48 | 48 | 48 |
| X2 | 0 | 0 | 1 | 6817.3 | 6828 | | |
| BT | 9 1209 | 1000 6828 | 6840 6828 | 6840 | 1091 | 6828 | 6828 |
| BT | 1209 6828 | 6828 6828 | 6817.3 1316 | 1230 | 6828 | 6817.3 | 1230 |
| BT | 6828 6840 | 6828 | 1457 | 6830 | 6830 | 1619 | 6840 |
| GR | 6840 1209 | 1000 6807.3 | 6828 1230 | 1091 | 6828 | 1209 | 6807.3 |
| GR | 6828 1619 | 1230 | 6828 | 1316 | 6830 | 1457 | 6840 |
| NC | .07 | .07 | .08 | .1 | .3 | | |
| X1 | 7 | 9 | 1146 | 1193 | 856 | 856 | 856 |
| GR | 6862 1146 | 1033 6854 | 6858 1193 | 1042 | 6856 | 1071 | 6854 |
| GR | 6856 1354 | 1279 | 6858 | 1312 | 6860 | 1326 | 6862 |
| NC | .015 | .015 | .02 | | | | |
| BRISTLECONE LAKE CONCRETE SPILLWAY | | | | | | | |
| X1 | 8 | 8 | 1080 | 1520 | 1026 | 1026 | 1026 |
| GR | 6910 1080 | 1000 6889 | 6908 1090 | 1020 | 6900 | 1050 | 6890 |
| GR | 6889 | 1500 | 6890 | 1520 | 6908 | 1580 | |
| QT | 2 | 4860 | 8624 | | | | |
| NC | .07 | .07 | .05 | | | | |
| FLOW INTO BRISTLECONE LAKE | | | | | | | |
| X1 | 9 | 13 | 1484 | 1817 | 2638 | 2638 | 2638 |
| GR | 6910 1173 | 1000 6894 | 6908 1260 | 1050 | 6906 | 1135 | 6900 |
| GR | 6890 1845 | 1484 6900 | 6890 1871 | 1817 | 6894 | 1824 | 6894 |
| GR | 6902 | 1905 | 6908 | 1982 | 6910 | 1991 | |

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|----|------|------|------|------|------|------|------|
| X1 | 10 | 15 | 1169 | 1529 | 590 | 590 | 590 |
| GR | 6916 | 1000 | 6910 | 1044 | 6908 | 1064 | 6904 |
| | 1112 | 6900 | 1230 | | | | |
| GR | 6898 | 1270 | 6898 | 1334 | 6896 | 1349 | 6896 |
| | 1361 | 6898 | 1379 | | | | |
| GR | 6900 | 1392 | 6902 | 1530 | 6910 | 1614 | 6912 |
| | 1645 | 6916 | 1662 | | | | |
| NC | .1 | .1 | .08 | | | | |
| X1 | 11 | 13 | 1149 | 1363 | 701 | 701 | 701 |
| GR | 6924 | 1000 | 6920 | 1041 | 6918 | 1069 | 6916 |
| | 1077 | 6910 | 1149 | | | | |
| GR | 6908 | 1165 | 6904 | 1177 | 6904 | 1216 | 6906 |
| | 1226 | 6906 | 1346 | | | | |
| GR | 6916 | 1381 | 6918 | 1392 | 6924 | 1456 | |
| X1 | 12 | 14 | 1213 | 1240 | 643 | 643 | 643 |
| GR | 6936 | 1000 | 6928 | 1110 | 6926 | 1162 | 6922 |
| | 1176 | 6922 | 1213 | | | | |
| GR | 6916 | 1226 | 6916 | 1228 | 6922 | 1240 | 6922 |
| | 1246 | 6918 | 1256 | | | | |
| GR | 6916 | 1317 | 6916 | 1447 | 6930 | 1486 | 6936 |
| | 1566 | | | | | | |
| X1 | 13 | 10 | 1139 | 1345 | 689 | 689 | 689 |
| GR | 6948 | 1000 | 6944 | 1053 | 6940 | 1139 | 6938 |
| | 1152 | 6928 | 1195 | | | | |
| GR | 6928 | 1221 | 6930 | 1230 | 6932 | 1274 | 6934 |
| | 1321 | 6948 | 1429 | | | | |
| X1 | 14 | 11 | 1184 | 1401 | 834 | 834 | 834 |
| GR | 6964 | 1000 | 6956 | 1071 | 6954 | 1119 | 6948 |
| | 1234 | 6946 | 1305 | | | | |
| GR | 6944 | 1316 | 6944 | 1342 | 6946 | 1392 | 6956 |
| | 1414 | 6958 | 1435 | | | | |
| GR | 6964 | 1527 | | | | | |
| X1 | 15 | 17 | 1091 | 1278 | 764 | 764 | 764 |
| GR | 6978 | 1000 | 6970 | 1047 | 6966 | 1081 | 6962 |
| | 1091 | 6962 | 1133 | | | | |
| GR | 6960 | 1145 | 6958 | 1161 | 6958 | 1177 | 6960 |
| | 1219 | 6962 | 1278 | | | | |
| GR | 6962 | 1312 | 6960 | 1319 | 6960 | 1333 | 6962 |
| | 1336 | 6970 | 1371 | | | | |

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|----|------|------|------|------|--|--|--|
| GR | 6974 | 1430 | 6978 | 1448 | | | |
|----|------|------|------|------|--|--|--|

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| X1 | 16 | 15 | 1266 | 1400 | 718 | 718 | 718 |
|----|----|----|------|------|-----|-----|-----|

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|----|------|------|------|------|------|------|------|
| GR | 6994 | 1000 | 6992 | 1025 | 6986 | 1193 | 6984 |
| | 1205 | 6980 | 1266 | | | | |

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|----|------|------|------|------|------|------|------|
| GR | 6974 | 1321 | 6974 | 1331 | 6976 | 1364 | 6980 |
| | 1400 | 6982 | 1505 | | | | |

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|----|------|------|------|------|------|------|------|
| GR | 6986 | 1572 | 6988 | 1584 | 6990 | 1609 | 6992 |
| | 1615 | 6994 | 1618 | | | | |

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|----|---|------|------|--|--|--|--|
| QT | 2 | 4772 | 8270 | | | | |
|----|---|------|------|--|--|--|--|

CONFLUENCE OF NORTH AND SOUTH BEAVER CREEK

| | | | | | | | |
|----|----|----|------|------|-----|-----|-----|
| X1 | 17 | 16 | 1101 | 1378 | 547 | 547 | 547 |
|----|----|----|------|------|-----|-----|-----|

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|----|------|------|------|------|------|------|------|
| GR | 7008 | 1000 | 7002 | 1072 | 6998 | 1101 | 6994 |
| | 1117 | 6992 | 1121 | | | | |

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|----|------|------|------|------|------|------|------|
| GR | 6988 | 1139 | 6988 | 1169 | 6990 | 1196 | 6992 |
| | 1213 | 6996 | 1277 | | | | |

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|----|------|------|------|------|------|------|------|
| GR | 6996 | 1324 | 6998 | 1378 | 7000 | 1410 | 7002 |
| | 1427 | 7004 | 1489 | | | | |

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|----|------|------|--|--|--|--|--|
| GR | 7008 | 1552 | | | | | |
|----|------|------|--|--|--|--|--|

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|----|---|------|------|--|--|--|--|
| QT | 2 | 3757 | 6754 | | | | |
|----|---|------|------|--|--|--|--|

BEAVER CREEK SOUTH FORK

| | | | | | | | |
|----|----|----|------|------|-----|-----|-----|
| X1 | 18 | 10 | 1075 | 1269 | 598 | 598 | 598 |
|----|----|----|------|------|-----|-----|-----|

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|----|------|------|------|------|------|------|------|
| GR | 7022 | 1000 | 7018 | 1075 | 7016 | 1088 | 7004 |
| | 1122 | 7002 | 1128 | | | | |

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|----|------|------|------|------|------|------|------|
| GR | 7002 | 1151 | 7008 | 1187 | 7012 | 1237 | 7020 |
| | 1269 | 7022 | 1285 | | | | |

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|----|----|----|------|------|-----|-----|-----|
| X1 | 19 | 16 | 1115 | 1341 | 800 | 800 | 800 |
|----|----|----|------|------|-----|-----|-----|

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|----|------|------|------|------|------|------|------|
| GR | 7046 | 1000 | 7044 | 1021 | 7038 | 1072 | 7034 |
| | 1115 | 7032 | 1129 | | | | |

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|----|------|------|------|------|------|------|------|
| GR | 7030 | 1177 | 7028 | 1198 | 7026 | 1207 | 7026 |
| | 1228 | 7030 | 1242 | | | | |

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|----|------|------|------|------|------|------|------|
| GR | 7032 | 1259 | 7034 | 1341 | 7038 | 1412 | 7040 |
| | 1473 | 7042 | 1536 | | | | |

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|----|------|------|--|--|--|--|--|
| GR | 7046 | 1578 | | | | | |
|----|------|------|--|--|--|--|--|

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| X1 | 20 | 14 | 1046 | 1295 | 625 | 625 | 625 |
|----|----|----|------|------|-----|-----|-----|

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|----|------|------|------|------|------|------|------|
| GR | 7068 | 1000 | 7062 | 1031 | 7058 | 1046 | 7056 |
| | 1061 | 7052 | 1072 | | | | |

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|----|------|------|------|------|------|------|------|
| GR | 7050 | 1099 | 7048 | 1122 | 7048 | 1178 | 7050 |
| | 1185 | 7052 | 1201 | | | | |
| GR | 7058 | 1264 | 7060 | 1295 | 7062 | 1384 | 7068 |
| | 1656 | | | | | | |
| | | | | | | | |
| X1 | 21 | 17 | 1066 | 1246 | 879 | 879 | 879 |
| | | | | | | | |
| GR | 7092 | 1000 | 7084 | 1032 | 7080 | 1066 | 7078 |
| | 1109 | 7074 | 1133 | | | | |
| GR | 7072 | 1139 | 7072 | 1171 | 7074 | 1180 | 7076 |
| | 1200 | 7076 | 1229 | | | | |
| GR | 7078 | 1239 | 7080 | 1246 | 7084 | 1271 | 7086 |
| | 1306 | 7086 | 1328 | | | | |
| GR | 7088 | 1368 | 7092 | 1445 | | | |
| | | | | | | | |
| | | | | | | | |
| X1 | 22 | 8 | 1032 | 1179 | 554 | 554 | 554 |
| | | | | | | | |
| GR | 7104 | 1000 | 7096 | 1032 | 7094 | 1079 | 7092 |
| | 1085 | 7092 | 1094 | | | | |
| GR | 7094 | 1108 | 7096 | 1179 | 7104 | 1252 | |
| | | | | | | | |
| | | | | | | | |
| X1 | 23 | 7 | 1119 | 1165 | 514 | 514 | 514 |
| | | | | | | | |
| GR | 7124 | 1000 | 7110 | 1119 | 7108 | 1145 | 7108 |
| | 1158 | 7110 | 1165 | | | | |
| GR | 7120 | 1189 | 7124 | 1205 | | | |

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PAGE 5

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

*PROF 1
0

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

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

3301 HV CHANGED MORE THAN HVINS

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

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

| | | | | | | | | |
|---------|-------|---------|---------|------|---------|------|------|---------|
| 2.00 | 5.95 | 6751.95 | 6751.95 | .00 | 6753.89 | 1.94 | 3.60 | .49 |
| 6748.00 | | | | | | | | |
| 6915. | 1999. | 4311. | 605. | 277. | 329. | 103. | 67. | 13. |
| 6748.00 | | | | | | | | |
| .09 | 7.21 | 13.09 | 5.87 | .070 | .050 | .070 | .000 | 6746.00 |
| 1059.12 | | | | | | | | |
| .019770 | 759. | 759. | 759. | 20 | 8 | 0 | .00 | 176.67 |
| 1235.79 | | | | | | | | |
| 0 | | | | | | | | |
| CCHV= | .100 | CEHV= | .300 | | | | | |
| *SECNO | 3.000 | | | | | | | |

3301 HV CHANGED MORE THAN HVINS

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

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

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

| | | | | | | | | |
|---------|------|---------|---------|------|---------|------|------|---------|
| 3.00 | 2.75 | 6774.75 | 6774.75 | .00 | 6775.69 | .94 | 4.43 | .10 |
| 6772.00 | | | | | | | | |
| 5128. | 506. | 2806. | 1817. | 82. | 330. | 260. | 80. | 18. |
| 6772.00 | | | | | | | | |
| .12 | 6.18 | 8.51 | 6.99 | .013 | .015 | .013 | .000 | 6772.00 |
| 1070.47 | | | | | | | | |
| .001918 | 845. | 845. | 845. | 20 | 14 | 0 | .00 | 360.65 |
| 1431.12 | | | | | | | | |
| 0 | | | | | | | | |

CCHV= .100 CEHV= .300

*SECNO 4.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

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

| | | | | | | | | |
|---------|------|---------|---------|------|---------|------|------|---------|
| 4.00 | 2.82 | 6786.82 | 6786.82 | .00 | 6787.96 | 1.14 | 3.30 | .06 |
| 6784.00 | | | | | | | | |
| 6788. | 884. | 5375. | 530. | 136. | 592. | 93. | 97. | 26. |
| 6784.00 | | | | | | | | |
| .15 | 6.52 | 9.08 | 5.72 | .025 | .025 | .025 | .000 | 6784.00 |
| 979.55 | | | | | | | | |
| .005866 | 984. | 984. | 984. | 20 | 8 | 0 | .00 | 366.20 |
| 1345.75 | | | | | | | | |
| 0 | | | | | | | | |

*SECNO 5.000

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

| | | | | | | | | |
|---------|------|---------|-------|------|---------|------|------|---------|
| 5.00 | 7.93 | 6793.93 | .00 | .00 | 6795.16 | 1.23 | 7.17 | .03 |
| 6798.00 | | | | | | | | |
| 6788. | 0. | 5205. | 1583. | 0. | 563. | 208. | 110. | 30. |
| 6788.00 | | | | | | | | |
| .18 | .00 | 9.25 | 7.59 | .000 | .080 | .070 | .000 | 6786.00 |
| 1229.48 | | | | | | | | |
| .020365 | 722. | 722. | 722. | 3 | 0 | 0 | .00 | 145.32 |
| 1374.79 | | | | | | | | |
| 0 | | | | | | | | |

CCHV= .100 CEHV= .300

CCHV= .100 CEHV= .300

*SECNO 6.100

1

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

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
 3693 PROBABLE MINIMUM SPECIFIC ENERGY
 3720 CRITICAL DEPTH ASSUMED

| | | | | | | | | |
|---------|-------|---------|---------|------|---------|------|------|---------|
| 6.10 | 13.82 | 6820.42 | 6820.42 | .00 | 6827.40 | 6.98 | 9.61 | 1.73 |
| 6828.00 | | | | | | | | |
| 6154. | 0. | 6154. | 0. | 0. | 290. | 0. | 125. | 33. |
| 6828.00 | | | | | | | | |
| .19 | .00 | 21.20 | .00 | .000 | .015 | .000 | .000 | 6806.60 |
| 1209.00 | | | | | | | | |
| .004232 | 1160. | 1160. | 1160. | 20 | 14 | 0 | .00 | 21.00 |
| 1230.00 | | | | | | | | |
| 0 | | | | | | | | |

SPECIAL BRIDGE

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

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

CCHV= .300 CEHV= .500
 *SECNO 6.200

3301 HV CHANGED MORE THAN HVINS

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

PRESSURE AND WEIR FLOW, Weir Submergence Based on TRAPEZOIDAL Shape

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

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

| | | | | | | | | |
|---------|-------|---------|-----|------|---------|------|------|---------|
| 6.20 | 18.51 | 6825.81 | .00 | .00 | 6829.70 | 3.89 | 2.30 | .00 |
| 6828.00 | | | | | | | | |
| 6154. | 0. | 6154. | 0. | 0. | 389. | 0. | 125. | 33. |
| 6828.00 | | | | | | | | |
| .19 | .00 | 15.84 | .00 | .000 | .015 | .000 | .000 | 6807.30 |
| 1209.00 | | | | | | | | |
| .002023 | 48. | 48. | 48. | 6 | 0 | 5 | .00 | 21.00 |
| 1230.00 | | | | | | | | |
| 0 | | | | | | | | |

CCHV= .100 CEHV= .300

1

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

*SECNO 7.000

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

| | | | | | | | | |
|---------|-------|---------|---------|------|---------|------|------|---------|
| 7.00 | 3.79 | 6857.79 | 6857.79 | .00 | 6859.09 | 1.29 | 4.78 | .26 |
| 6854.00 | | | | | | | | |
| 6154. | 2041. | 1773. | 2340. | 233. | 178. | 267. | 135. | 35. |
| 6854.00 | | | | | | | | |
| .22 | 8.77 | 9.94 | 8.78 | .070 | .080 | .070 | .000 | 6854.00 |
| 1045.01 | | | | | | | | |
| .048456 | 856. | 856. | 856. | 20 | 21 | 0 | .00 | 263.57 |
| 1308.58 | | | | | | | | |
| 0 | | | | | | | | |

*SECNO 8.000

3685 20 TRIALS ATTEMPTED WSEL,CWSEL
3693 PROBABLE MINIMUM SPECIFIC ENERGY
3720 CRITICAL DEPTH ASSUMED

BRISTLECONE LAKE CONCRETE SPILLWAY

| | | | | | | | | |
|---------|-------|---------|---------|------|---------|------|-------|---------|
| 8.00 | 1.86 | 6890.86 | 6890.86 | .00 | 6891.77 | .91 | 11.36 | .04 |
| 6890.00 | | | | | | | | |
| 6154. | 4. | 6145. | 5. | 1. | 802. | 1. | 153. | 44. |
| 6890.00 | | | | | | | | |
| .26 | 3.76 | 7.66 | 3.78 | .015 | .020 | .015 | .000 | 6889.00 |
| 1077.43 | | | | | | | | |
| .004781 | 1026. | 1026. | 1026. | 20 | 11 | 0 | .00 | 445.42 |
| 1522.85 | | | | | | | | |
| 0 | | | | | | | | |

*SECNO 9.000

3301 HV CHANGED MORE THAN HVINS

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

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

3301 HV CHANGED MORE THAN HVINS

3685 20 TRIALS ATTEMPTED WSEL,CWSEL

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

3693 PROBABLE MINIMUM SPECIFIC ENERGY

3720 CRITICAL DEPTH ASSUMED

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

3301 HV CHANGED MORE THAN HVINS

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

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

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

*SECNO 12.000

3265 DIVIDED FLOW

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

| | | | | | | | | |
|---------|------|---------|-------|------|---------|-------|------|---------|
| 12.00 | 5.74 | 6921.74 | .00 | .00 | 6922.57 | .83 | 9.39 | .07 |
| 6922.00 | | | | | | | | |
| 8624. | 0. | 489. | 8135. | 0. | 80. | 1101. | 340. | 92. |
| 6922.00 | | | | | | | | |
| .58 | .00 | 6.08 | 7.39 | .000 | .080 | .100 | .000 | 6916.00 |
| 1213.54 | | | | | | | | |
| .027002 | 643. | 643. | 643. | 2 | 0 | 0 | .00 | 242.34 |
| 1463.02 | | | | | | | | |
| 0 | | | | | | | | |

*SECNO 13.000

| | | | | | | | | |
|---------|------|---------|------|------|---------|------|-------|---------|
| 13.00 | 9.37 | 6937.37 | .00 | .00 | 6938.49 | 1.12 | 15.83 | .09 |
| 6940.00 | | | | | | | | |
| 8624. | 0. | 8495. | 129. | 0. | 993. | 44. | 357. | 95. |
| 6934.00 | | | | | | | | |
| .60 | .00 | 8.55 | 2.94 | .000 | .080 | .100 | .000 | 6928.00 |
| 1154.72 | | | | | | | | |
| .019789 | 689. | 689. | 689. | 3 | 0 | 0 | .00 | 192.27 |
| 1346.98 | | | | | | | | |
| 0 | | | | | | | | |

*SECNO 14.000

| | | | | | | | | |
|---------|------|---------|------|------|---------|------|-------|---------|
| 14.00 | 8.38 | 6952.38 | .00 | .00 | 6953.10 | .72 | 14.57 | .04 |
| 6954.00 | | | | | | | | |
| 8624. | 0. | 8455. | 169. | 0. | 1234. | 45. | 380. | 100. |
| 6946.00 | | | | | | | | |
| .64 | .00 | 6.85 | 3.77 | .000 | .080 | .100 | .000 | 6944.00 |
| 1150.04 | | | | | | | | |
| .015530 | 834. | 834. | 834. | 5 | 0 | 0 | .00 | 255.99 |
| 1406.04 | | | | | | | | |
| 0 | | | | | | | | |

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

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

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

| | | | | | | | | |
|---------|------|---------|------|------|---------|------|-------|---------|
| 17.00 | 9.53 | 6997.53 | .00 | .00 | 6998.36 | .82 | 14.36 | .08 |
| 6998.00 | | | | | | | | |
| 8270. | 0. | 8270. | 0. | 0. | 1137. | 0. | 433. | 112. |
| 6998.00 | | | | | | | | |
| .71 | .00 | 7.28 | .00 | .000 | .080 | .000 | .000 | 6988.00 |
| 1102.86 | | | | | | | | |
| .021938 | 547. | 547. | 547. | 5 | 0 | 0 | .00 | 262.59 |
| 1365.45 | | | | | | | | |

| | | | | | | | | |
|---------|------|---------|------|------|---------|------|-------|---------|
| 18.00 | 9.92 | 7011.92 | .00 | .00 | 7013.30 | 1.38 | 14.78 | .17 |
| 7018.00 | | | | | | | | |
| 6754. | 0. | 6754. | 0. | 0. | 716. | 0. | 445. | 115. |
| 7020.00 | | | | | | | | |
| .72 | .00 | 9.43 | .00 | .000 | .080 | .000 | .000 | 7002.00 |
| 1099.55 | | | | | | | | |
| .028896 | 598. | 598. | 598. | 3 | 0 | 0 | .00 | 136.51 |
| 1236.06 | | | | | | | | |

| | | | | | | | | |
|---------|------|---------|-----|-----|---------|-----|-------|-----|
| 19.00 | 8.79 | 7034.79 | .00 | .00 | 7035.68 | .89 | 22.33 | .05 |
| 7034.00 | | | | | | | | |

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

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

| | | | | | | | | |
|---------|-------|---------|------|------|---------|------|-------|---------|
| 23.00 | 9.38 | 7117.38 | .00 | .00 | 7119.39 | 2.01 | 18.90 | .05 |
| 7110.00 | | | | | | | | |
| 6754. | 1332. | 5064. | 358. | 231. | 398. | 65. | 505. | 129. |
| 7110.00 | | | | | | | | |
| .83 | 5.76 | 12.71 | 5.49 | .100 | .080 | .100 | .000 | 7108.00 |
| 1056.30 | | | | | | | | |
| .026617 | 514. | 514. | 514. | 4 | 0 | 0 | .00 | 126.40 |
| 1182.70 | | | | | | | | |
| 0 | | | | | | | | |
| 1 | | | | | | | | |

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THIS RUN EXECUTED 11/ 3/ 3 12:40:22

HEC2 RELEASE DATED SEP 88 UPDATED APR 1989

ERROR CORR - 01,02

MODIFICATION -

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

100-YEAR FREQUENCY CROSS

SUMMARY PRINTOUT TABLE 150

| SECNO | XLCH | ELTRD | ELLC | ELMIN | Q | CWSEL | CRIWS |
|----------|---------|-------|---------|---------|----------|---------|---------|
| EG | 10*KS | VCH | AREA | .01K | | | |
| * 60.000 | .00 | .00 | .00 | 6718.00 | 20974.00 | 6733.36 | 6733.36 |
| 6736.77 | 125.57 | 16.75 | 1701.40 | 1871.69 | | | |
| 1.000 | 1047.00 | .00 | .00 | 6732.00 | 6915.00 | 6743.87 | .00 |
| 6744.18 | 20.82 | 6.46 | 1946.76 | 1515.58 | | | |
| * 2.000 | 759.00 | .00 | .00 | 6746.00 | 6915.00 | 6751.95 | 6751.95 |
| 6753.89 | 197.70 | 13.09 | 709.71 | 491.80 | | | |

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

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

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

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100-YEAR FREQUENCY CROSS

SUMMARY PRINTOUT TABLE 150

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

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

1

11/ 3/ 3 12:40:22

PAGE 15

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

1

11/ 3/ 3 12:40:22

PAGE 16

SUMMARY OF ERRORS AND SPECIAL NOTES

| | | | | |
|----------------|--------|----------|---|-------------------------------------|
| CAUTION SECNO= | 60.000 | PROFILE= | 1 | CRITICAL DEPTH ASSUMED |
| CAUTION SECNO= | 2.000 | PROFILE= | 1 | CRITICAL DEPTH ASSUMED |
| CAUTION SECNO= | 2.000 | PROFILE= | 1 | PROBABLE MINIMUM SPECIFIC ENERGY |
| CAUTION SECNO= | 2.000 | PROFILE= | 1 | 20 TRIALS ATTEMPTED TO BALANCE WSEL |
| CAUTION SECNO= | 3.000 | PROFILE= | 1 | CRITICAL DEPTH ASSUMED |
| CAUTION SECNO= | 3.000 | PROFILE= | 1 | PROBABLE MINIMUM SPECIFIC ENERGY |
| CAUTION SECNO= | 3.000 | PROFILE= | 1 | 20 TRIALS ATTEMPTED TO BALANCE WSEL |
| CAUTION SECNO= | 4.000 | PROFILE= | 1 | CRITICAL DEPTH ASSUMED |
| CAUTION SECNO= | 4.000 | PROFILE= | 1 | PROBABLE MINIMUM SPECIFIC ENERGY |
| CAUTION SECNO= | 4.000 | PROFILE= | 1 | 20 TRIALS ATTEMPTED TO BALANCE WSEL |

| | | | | |
|----------------|--------|----------|---|--|
| WARNING SECNO= | 5.000 | PROFILE= | 1 | CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE |
| CAUTION SECNO= | 6.100 | PROFILE= | 1 | CRITICAL DEPTH ASSUMED |
| CAUTION SECNO= | 6.100 | PROFILE= | 1 | PROBABLE MINIMUM SPECIFIC ENERGY |
| CAUTION SECNO= | 6.100 | PROFILE= | 1 | 20 TRIALS ATTEMPTED TO BALANCE WSEL |
| CAUTION SECNO= | 6.200 | PROFILE= | 1 | HYDRAULIC JUMP D.S. |
| WARNING SECNO= | 6.200 | PROFILE= | 1 | CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE |
| CAUTION SECNO= | 7.000 | PROFILE= | 1 | CRITICAL DEPTH ASSUMED |
| CAUTION SECNO= | 7.000 | PROFILE= | 1 | PROBABLE MINIMUM SPECIFIC ENERGY |
| CAUTION SECNO= | 7.000 | PROFILE= | 1 | 20 TRIALS ATTEMPTED TO BALANCE WSEL |
| CAUTION SECNO= | 8.000 | PROFILE= | 1 | CRITICAL DEPTH ASSUMED |
| CAUTION SECNO= | 8.000 | PROFILE= | 1 | PROBABLE MINIMUM SPECIFIC ENERGY |
| CAUTION SECNO= | 8.000 | PROFILE= | 1 | 20 TRIALS ATTEMPTED TO BALANCE WSEL |
| WARNING SECNO= | 9.000 | PROFILE= | 1 | CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE |
| CAUTION SECNO= | 10.000 | PROFILE= | 1 | CRITICAL DEPTH ASSUMED |
| CAUTION SECNO= | 10.000 | PROFILE= | 1 | PROBABLE MINIMUM SPECIFIC ENERGY |
| CAUTION SECNO= | 10.000 | PROFILE= | 1 | 20 TRIALS ATTEMPTED TO BALANCE WSEL |
| WARNING SECNO= | 11.000 | PROFILE= | 1 | CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE |
| WARNING SECNO= | 12.000 | PROFILE= | 1 | CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE |
| WARNING SECNO= | 22.000 | PROFILE= | 1 | CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE |
| WARNING SECNO= | 23.000 | PROFILE= | 1 | CONVEYANCE CHANGE OUTSIDE ACCEPTABLE RANGE |

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 **Floodway** 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, projection or UTM zone 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, NGS12
National Geodetic Survey
SSMC-3, #5022
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) 713-3322 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.

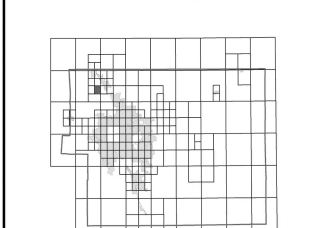
Contact **FEMA Map Service Center (MSC)** via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-338-9620 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/businessinfo>.

Flood Source Vertical Datum Offset Table

| Flood 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, AV, and VE.

- ZONE A** No Base Flood Elevations determined. Base Flood Elevations determined.
- ZONE AE** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of sheet flow flooding, vehicles also determined.
- ZONE AO** Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that is no longer operational. Zone AO indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE AR** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE AV** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); no 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 encroachments so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

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

OTHER AREAS

Areas determined to be outside the 0.2% annual chance floodplain. 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
Base Flood Elevation line and value; elevation in feet*
Base Flood Elevation value where uniform within zone; elevation in feet*

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

Cross section line
Transsect line

Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
1000-meter Universal Transverse Mercator grid ticks, zone 13

5000-foot grid ticks: Colorado State Plane coordinate system, central zone (SPROCK 0901)
 Lambert Conformal Conic Projection

Bench mark (see explanation in Notes to Users section of this FIS report)

1.5 River Mile

MAP REPOSITORIES
Refer to Map Repository 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 17, 2018 to update corporate limits, to update 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 included 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 1-800-638-9620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFP PANEL 0267G

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 0800 0267 G

Notes to User: The Map Number shown below should be used when doing 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

NATIONAL FLOOD INSURANCE PROGRAM

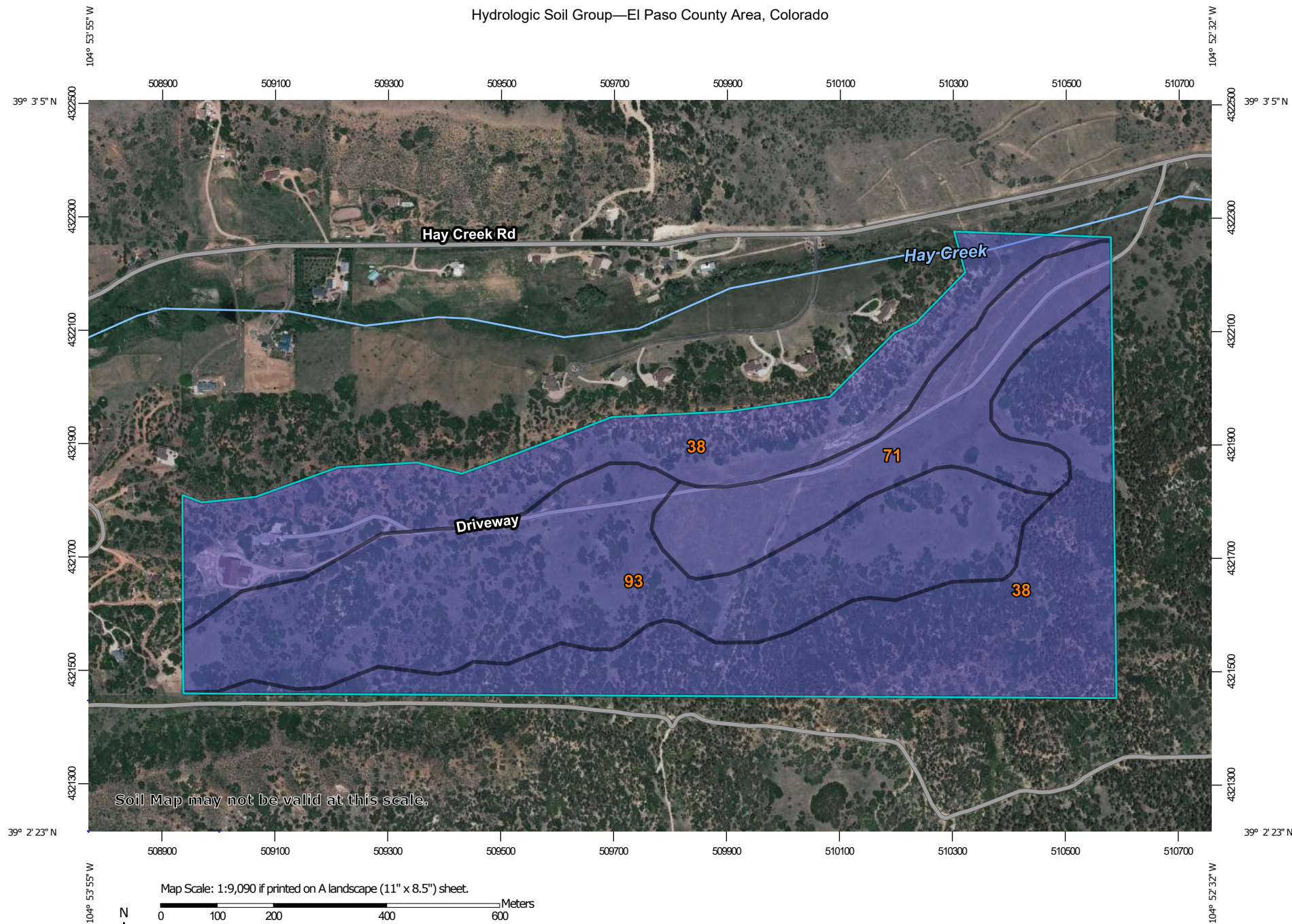
EL PASO COUNTY

08041C0267G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

Hydrologic Soil Group—El Paso County Area, Colorado



Soil Map may not be valid at this scale.

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

0 100 200 400 600 Meters

0 400 800 1600 2400 Feet

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



**Natural Resources
Conservation Service**

Web Soil Survey
National Cooperative Soil Survey

12/27/2022
Page 1 of 4

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



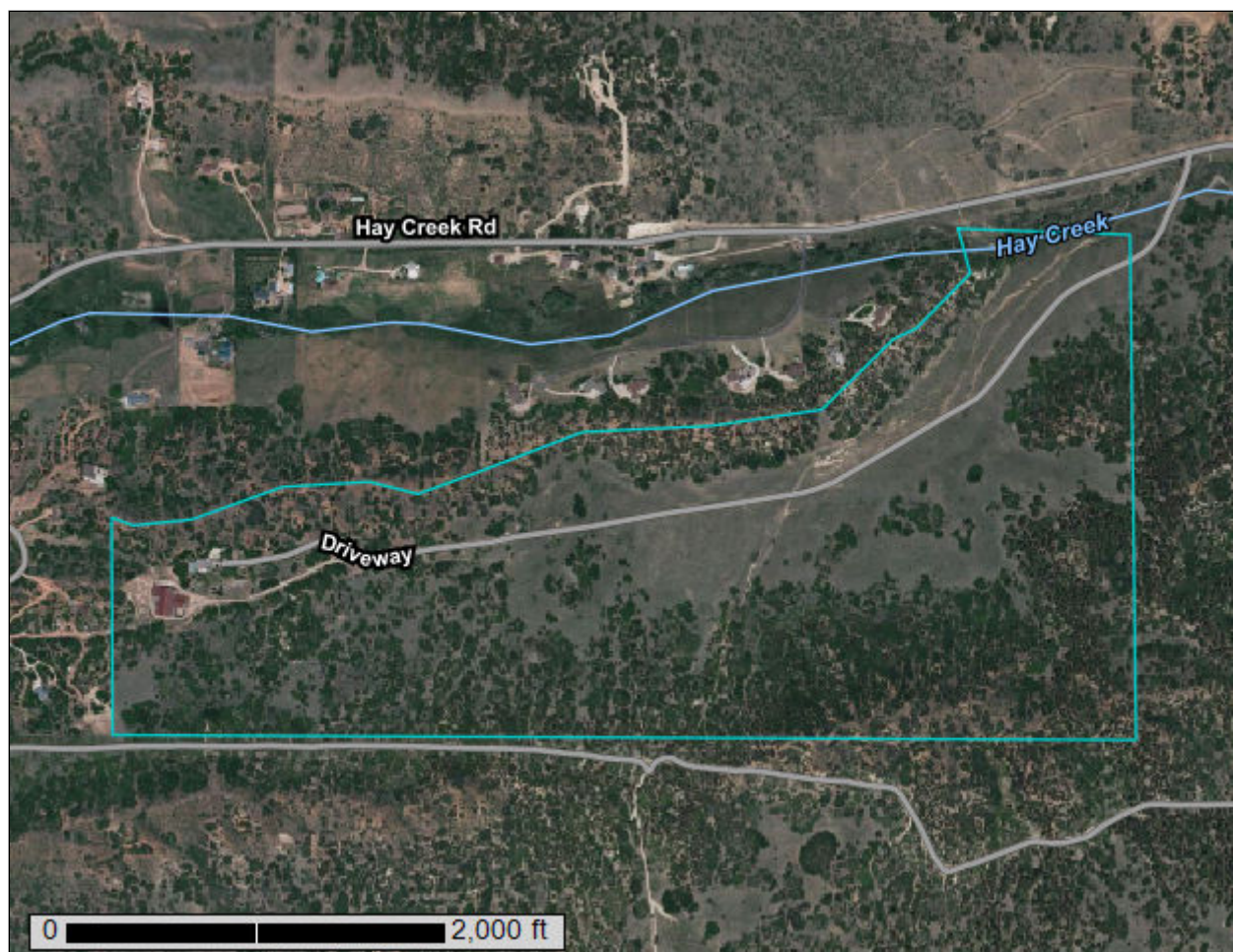
United States
Department of
Agriculture

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**



Preface

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

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

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

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

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

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

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How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

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

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

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

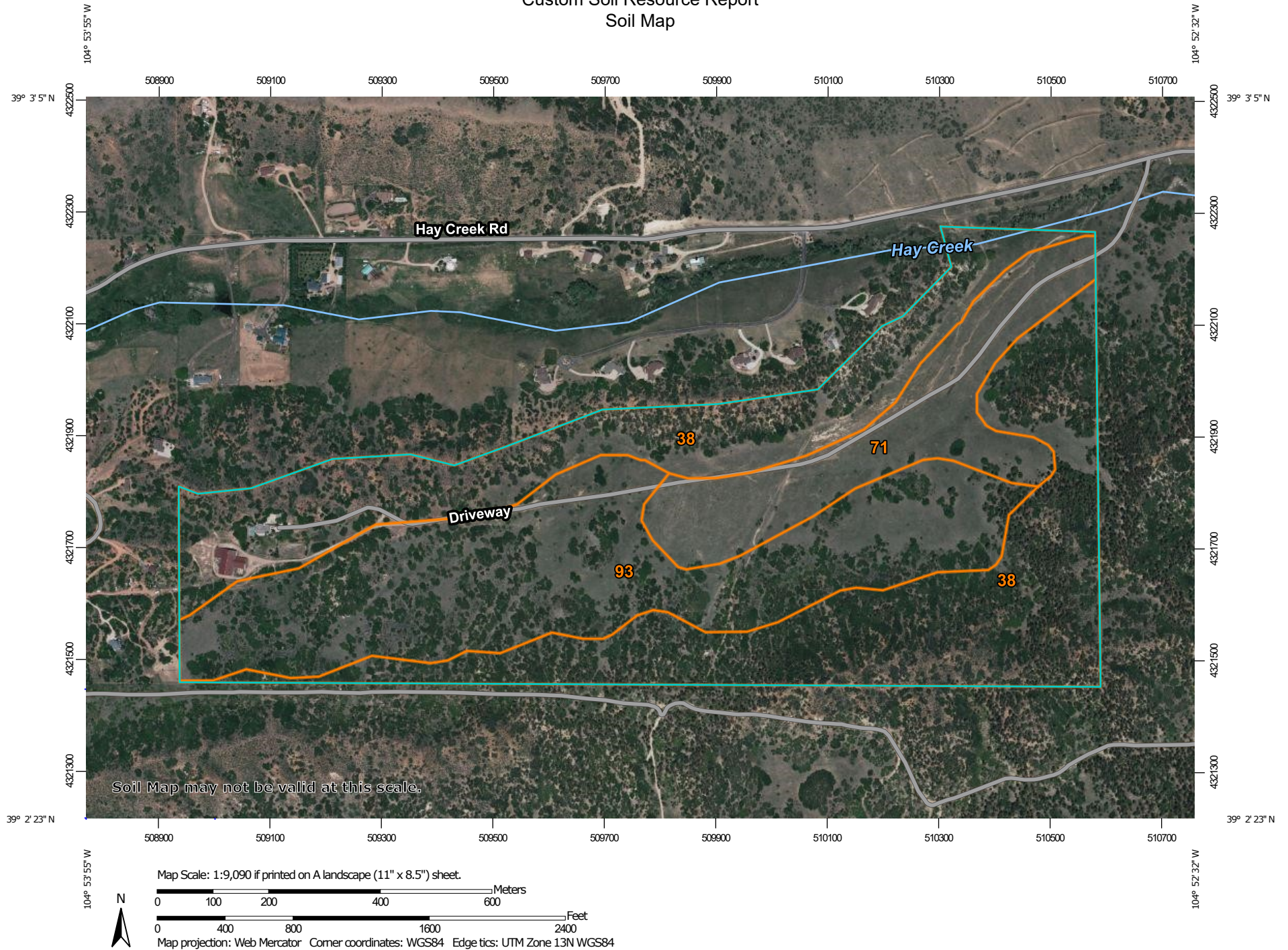
Custom Soil Resource Report

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

Soil Map

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

Custom Soil Resource Report Soil Map



Custom Soil Resource Report


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

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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

Custom Soil Resource Report

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

Custom Soil Resource Report

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)

Custom Soil Resource Report

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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Custom Soil Resource Report

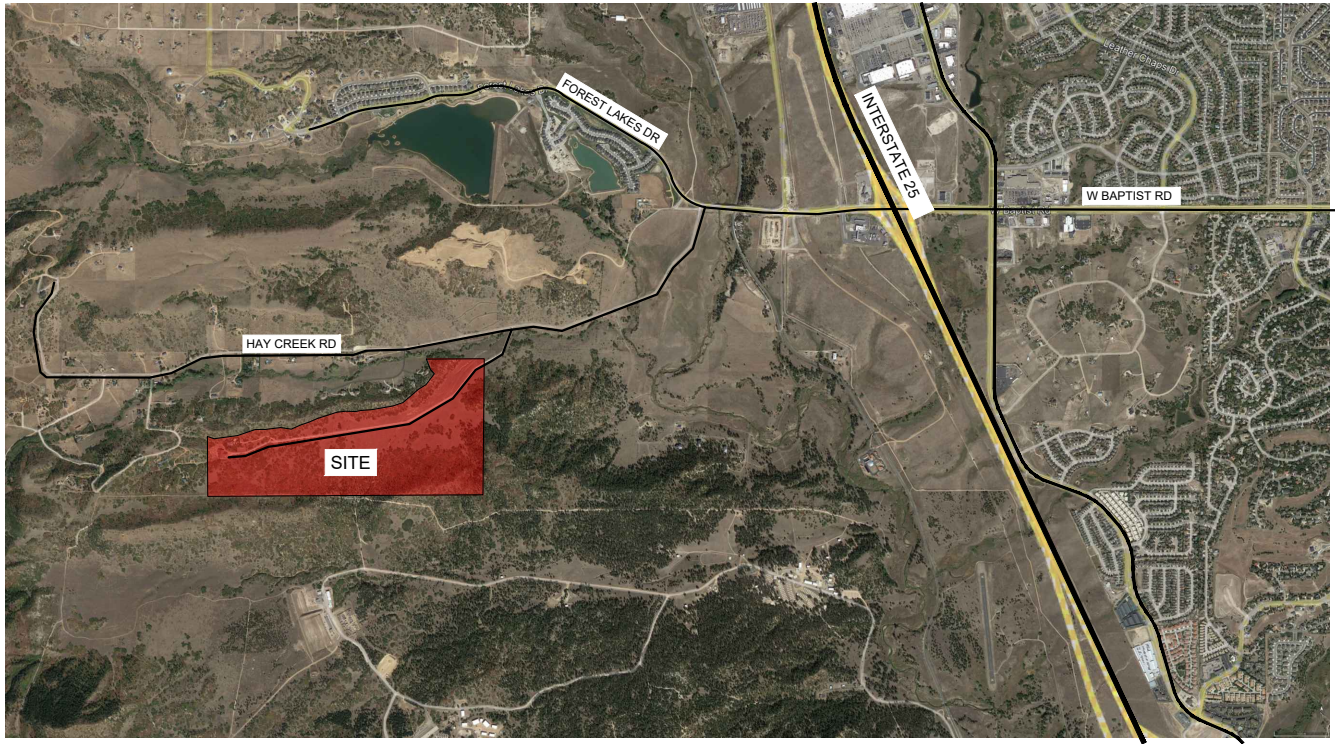
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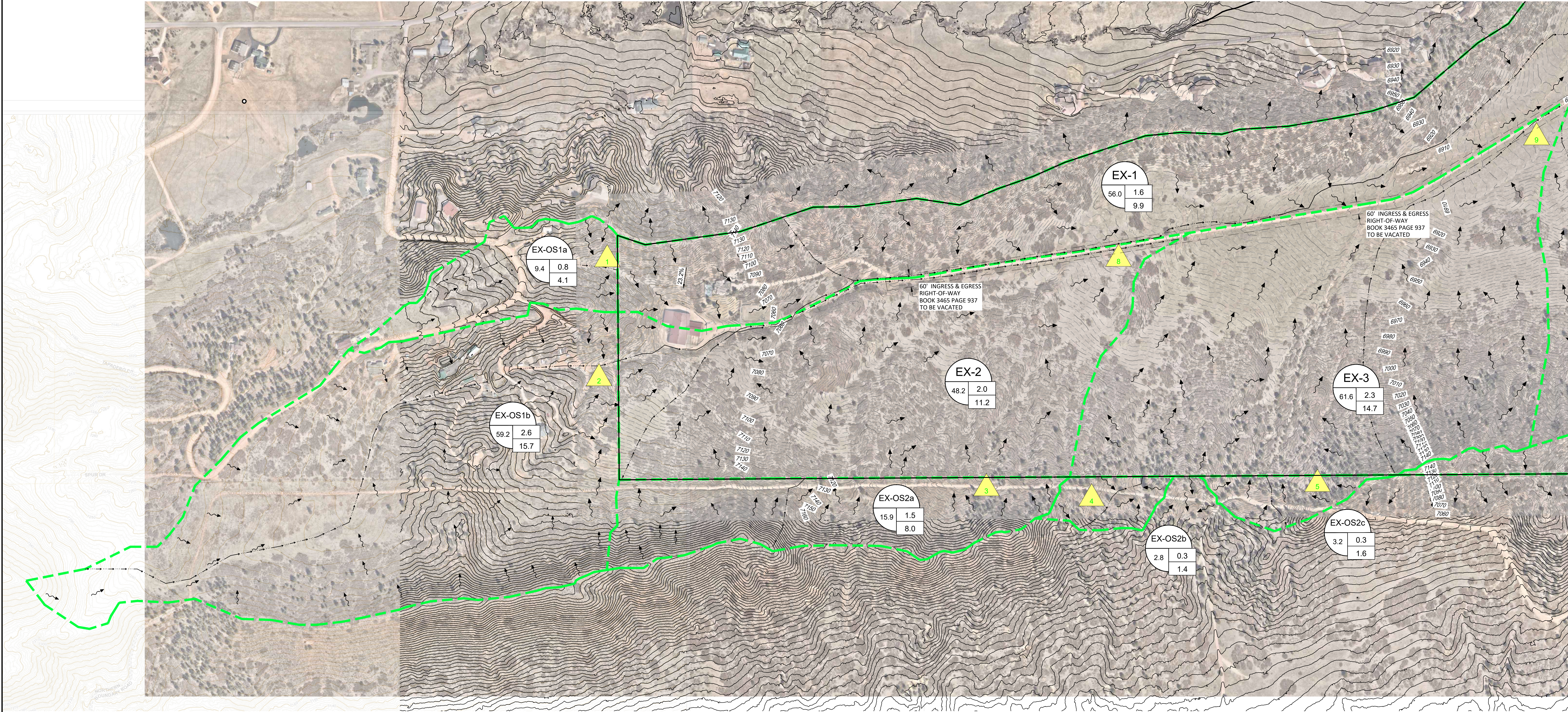
United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf

APPENDIX D

MAPS



VICINITY MAP
HAY CREEK VALLEY
(NTS)



LEGEND

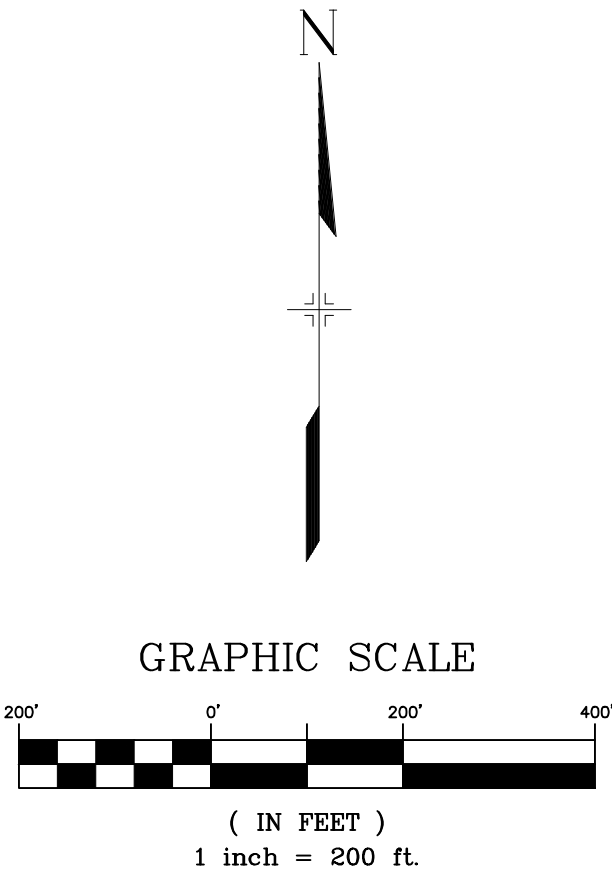
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- EXISTING PROPERTY LINE
- EXISTING CONTOUR
- FLOW DIRECTION
- DESIGN POINT
- | | |
|------|-----|
| 59.2 | 2.6 |
| 15.7 | |

 SUB BASIN DESIGNATION
- | | |
|------|-----|
| 59.2 | 2.6 |
|------|-----|

 5-YEAR STORM EVENT PEAK FLOW (CFS)
- | | |
|------|-----|
| 15.7 | 4.1 |
|------|-----|

 100-YEAR STORM EVENT PEAK FLOW (CFS)
- | | |
|-----|-----|
| 9.4 | 0.8 |
|-----|-----|

 SUB BASIN AREA (AC.)



| REFERENCE DRAWINGS | SHEET KEY | | | |
|--------------------|-----------|------|-------------|-----|
| | NO. | DATE | DESCRIPTION | BY |
| | ### | ### | ### | ### |
| | ### | ### | ### | ### |
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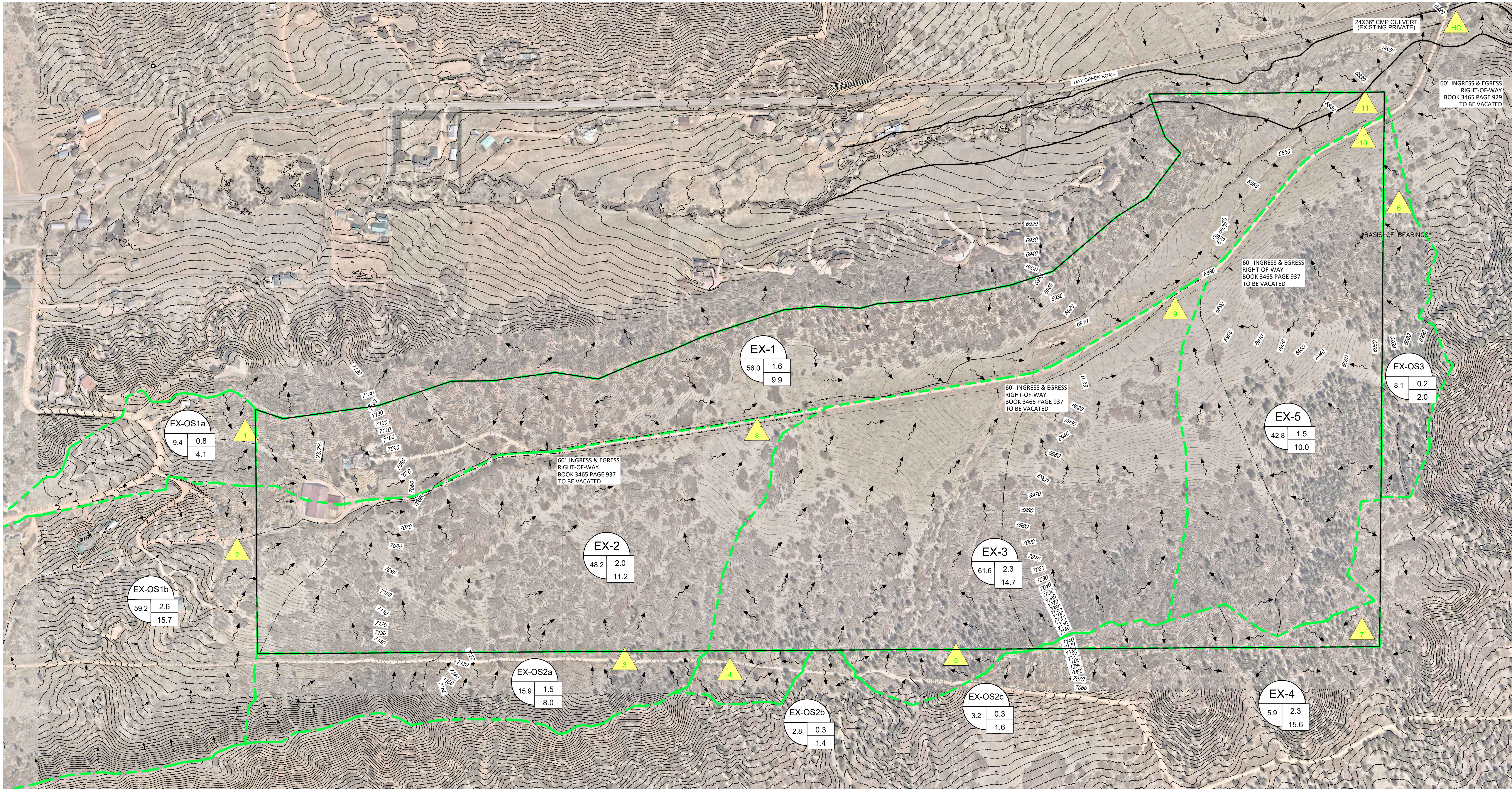
PRELIMINARY
DESIGN
FOR REVIEW ONLY
BEING APPROVED BY
GOVERNING AGENCIES AND
IS SUBJECT TO CHANGE

PREPARED BY:
Matrix
Excellence by Design

EL PASO COUNTY
HAY CREEK
PRELIMINARY DRAINAGE REPORT
OFFSITE DRAINAGE BASINS

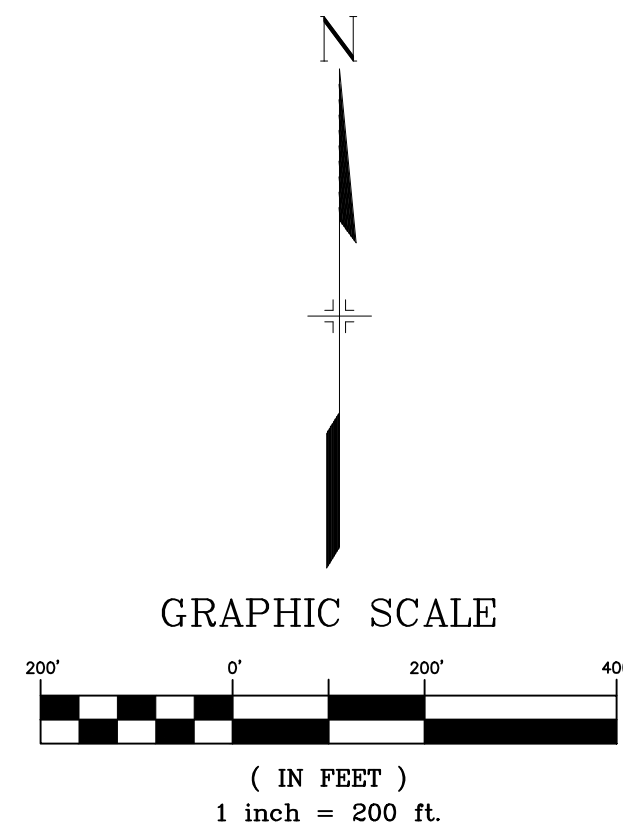
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DRAWN BY: WCC
CHECKED BY: JTS
PROJECT NO. 22-886.076

DATE ISSUED: MARCH 2023
SCALE: 1/4" = 100'
SHEET: 1 OF 3
DRAWING NO.: DR01



LEGEND

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



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

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

SEAL

PRELIMINARY
DESIGN
FOR REVIEW ONLY
FOR AND ON BEHALF OF
MATRIX DESIGN GROUP, INC.
PROJECT No. 22-886.076

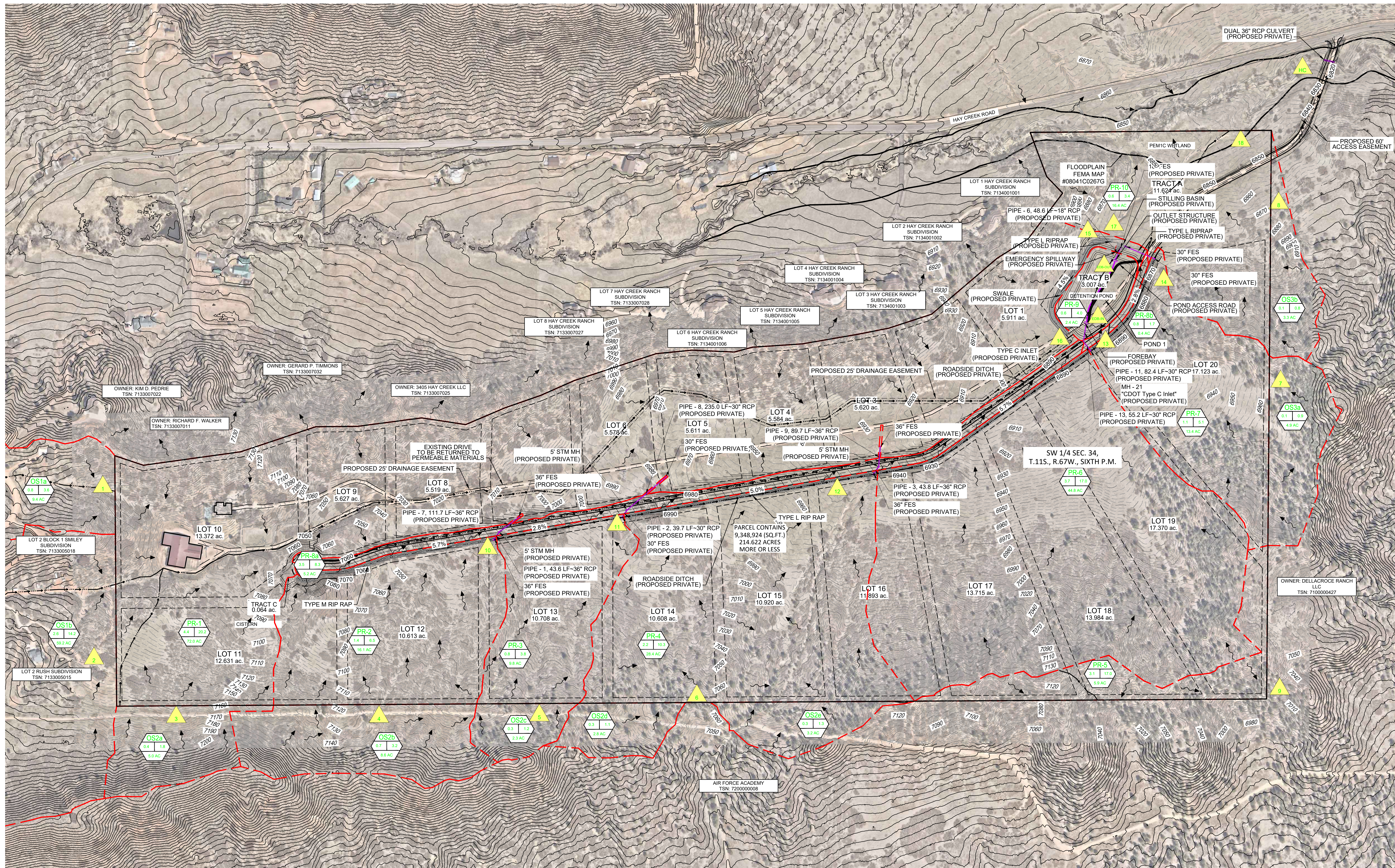
EL PASO COUNTY
HAY CREEK
PRELIMINARY DRAINAGE REPORT
PRE DEVELOPMENT DRAINAGE CONDITIONS

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DRAWN BY: WCC
CHECKED BY: JTS
SCALE: HORIZ
VERT
DATE ISSUED: MARCH 2023
SHEET 2 OF 3
DRAWING NO. DR02

SHEET KEY

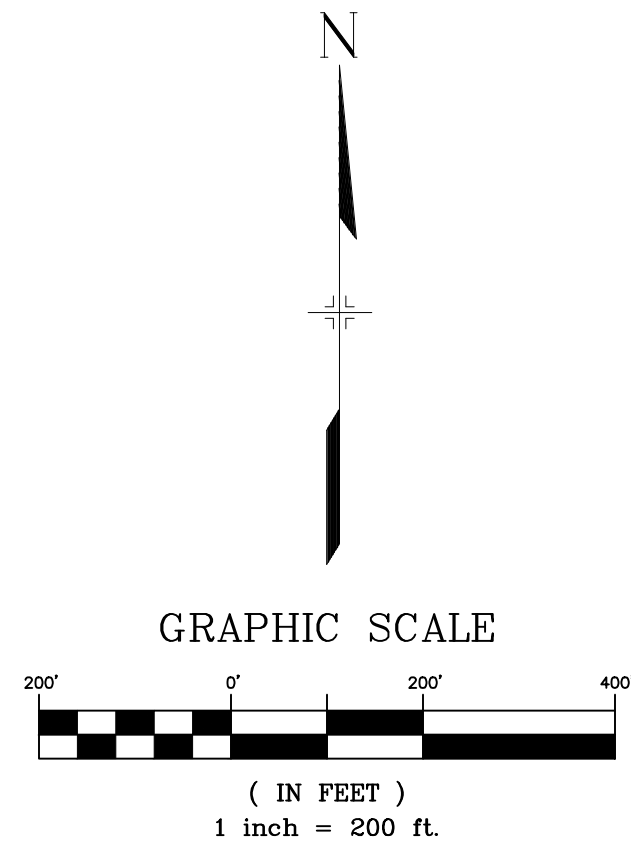
REVISIONS

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



LEGEND

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



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

| Proposed Design Point Summary - Central Basin | | | | |
|---|---|---------------------|---------------|-----------------|
| Hay Creek | | | | |
| Design Point | Sub-Basins | Total Area (ac.) | Q(5) (cfs) | Q(100) (cfs) |
| 1 | OS1a | 9.35 | 0.80 | 3.60 |
| 2 | OS1b | 59.21 | 2.60 | 14.20 |
| 3 | OS2a | 5.01 | 0.40 | 1.80 |
| 4 | OS2b | 8.57 | 0.70 | 3.20 |
| 5 | OS2c | 2.28 | 0.30 | 1.20 |
| 6 | OS2d, OS2e | 5.93 | 0.50 | 2.30 |
| 7 | OS3a | 4.88 | 0.10 | 0.90 |
| 8 | OS3b | 3.29 | 0.10 | 0.80 |
| 9 | PR-5 | 5.86 | 0.00 | 0.00 |
| 10 | OS2b, PR-2 | 24.65 | 2.10 | 9.60 |
| 11 | OS2c, PR-3 | 12.06 | 1.00 | 4.60 |
| 12 | OS2d, OS2e, PR-4 | 34.20 | 2.70 | 12.30 |
| 13 | PR-6 | 44.76 | 3.70 | 17.00 |
| 14 | OS3a, PR-7 | 18.31 | 1.20 | 6.10 |
| 15 | OS1a, OS1b, OS2a, PR-1, DP-10, DP-11, DP-12 | 216.53 | 11.80 | 58.50 |
| 16a | PR-8a | 5.20 | 1.50 | 5.60 |
| 16b | PR-6, PR-8a | 49.96 | 4.90 | 22.00 |
| EDB-IN | PR-6, PR-8a, PR-8b, PR-9 | 52.78 | 5.10 | 22.40 |
| EDB-OUT | PR-6, PR-8a, PR-8b, PR-9 | 52.78 | 0.80 | 3.50 |
| 17 | EDB-OUT, DP-14, DP-15 | 287.62 | 13.20 | 66.00 |
| 18 | DP-8, DP-18, PR-10 | 307.28 | 13.30 | 66.30 |
| HC | From PRRD Regional floodplain Administrator | | | 127.00 |

EL PASO COUNTY

HAY CREEK

PRELIMINARY DRAINAGE REPORT

POST DEVELOPMENT DRAINAGE CONDITIONS

PRELIMINARY

FOR AND ON BEHALF OF

MATRIX DESIGN GROUP, INC.

PROJECT No. 22-886-076

DESIGNED BY

DRAWN BY

CHECKED BY

SCALE

DATE ISSUED

SHEET

NO.

DATE

DESCRIPTION

REVISIONS

FOR AND ON BEHALF OF

MATRIX DESIGN GROUP, INC.

PROJECT No. 22-886-076

DATE: August 22, 2023 5:15:59 PM

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

EL PASO COUNTY

HAY CREEK

PRELIMINARY DRAINAGE REPORT

POST DEVELOPMENT DRAINAGE CONDITIONS

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HAY CREEK

PRELIMINARY DRAINAGE REPORT

POST DEVELOPMENT DRAINAGE CONDITIONS

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REVISIONS

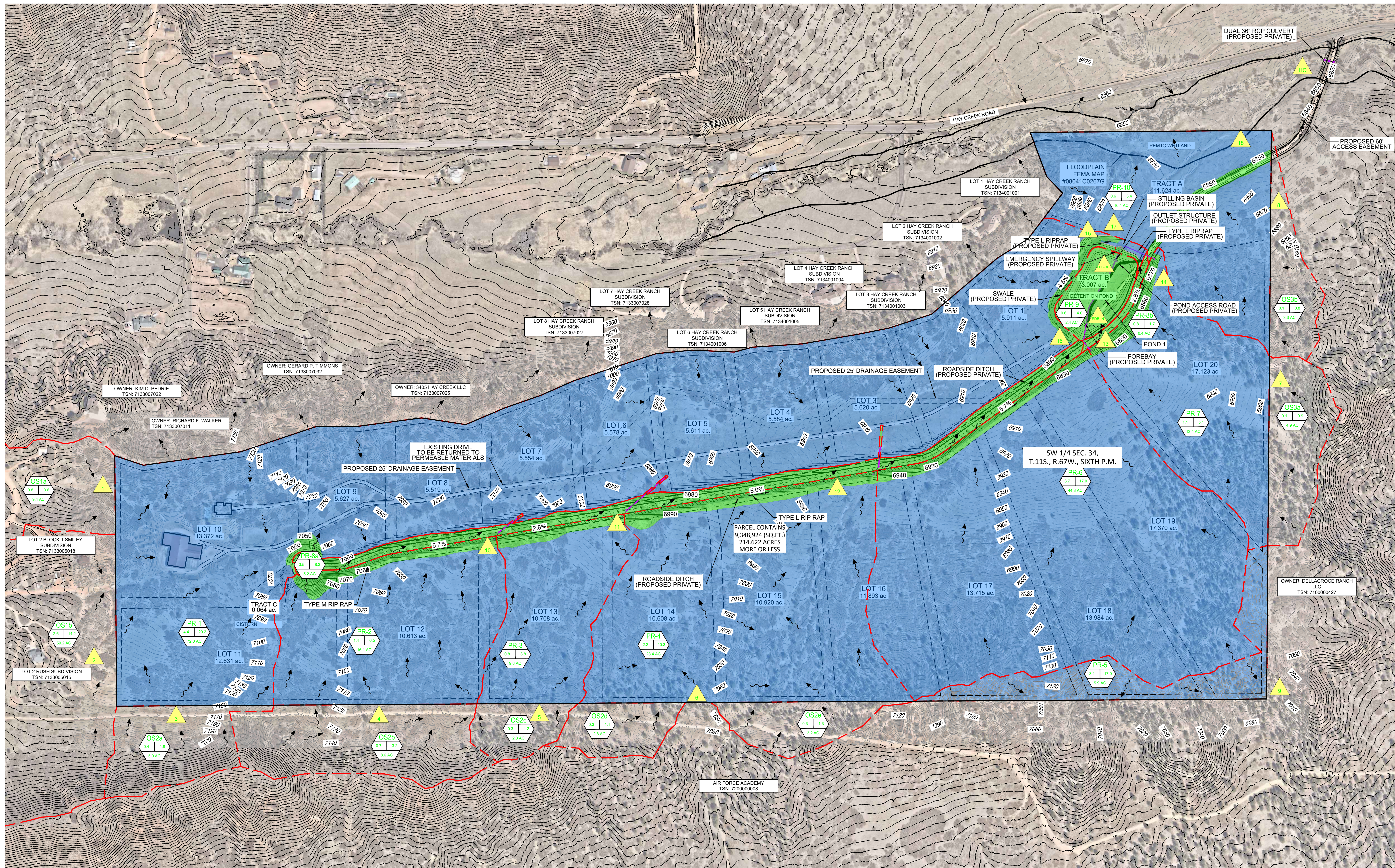
FOR AND ON BEHALF OF

MATRIX DESIGN GROUP, INC.

PROJECT No. 22-886-076

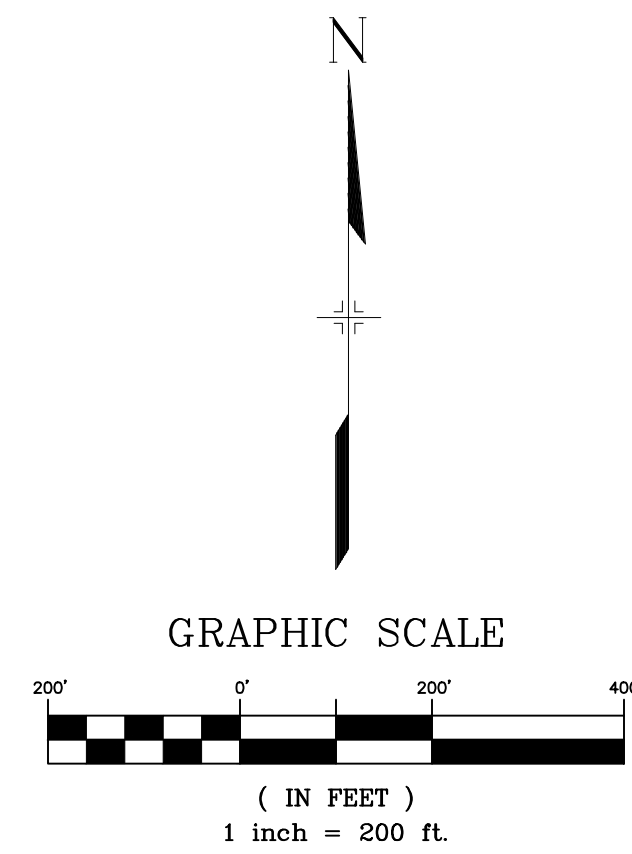
DATE: August 22, 2023 5:15:59 PM

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LEGEND

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



| Hay Creek Disturbed Area | | | | | |
|-----------------------------|--------------------|--|--|--|---|
| Basin ID | Total Area (ac) | Total Proposed Disturbed Area (ac) | Disturbed Area Tributary to Pond 1 (ac) | Disturbed Area which will be returned to permeable/undeveloped (Excl. L7.1.B.7) (ac) | Impervious areas which are not practicable to detain (Excl. L7.1.C.1.a) (ac) |
| PR-1 | 71.97 | 1.02 | 0 | 1.02 | 0 |
| PR-2 | 16.08 | 1.27 | 0 | 1.27 | 0 |
| PR-3 | 9.78 | 0.75 | 0 | 0.75 | 0 |
| PR-4 | 28.35 | 1.53 | 0 | 1.53 | 0 |
| PR-5 | 5.86 | 0 | 0 | 0 | 0 |
| PR-6 | 44.76 | 1.15 | 1.15 | 0 | 0 |
| PR-7 | 13.43 | 0.87 | 0 | 0.87 | 0 |
| PR-8a | 5.20 | 5.2 | 5.2 | 0 | 0 |
| PR-8b | 0.40 | 0.4 | 0.4 | 0 | 0 |
| PR-9 | 2.41 | 2.41 | 2.41 | 0 | 0 |
| PR-10 | 16.38 | 0.73 | 0 | | 0.73 |
| Total | 214.62 | 15.33 | 9.16 | 5.44 | 0.73 |

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

EL PASO COUNTY

HAY CREEK

PRELIMINARY DRAINAGE REPORT

POST DEVELOPMENT DISTURBED AREAS

PRELIMINARY DRAINAGE REPORT

FOR AND ON BEHALF OF
MATRIX DESIGN GROUP, INC.
PROJECT No. 22-886-076

DESIGNED BY: WJC
DRAWN BY: WJC
CHECKED BY: JTS

DATE ISSUED: JUNE 2023
SHEET 4 OF 4

SCALE: 1"=200'
VERT: 1"=20'

DR04

SEAL

PREPARED BY: Matrix
Excellence by Design

Matrix
Excellence by Design

SHEET KEY

NO. DATE BY DESCRIPTION REVISIONS

1 11/15/23 WJC Initial Design

2 12/15/23 WJC Update Basins

3 1/15/24 WJC Update Basins

4 6/15/23 WJC Update Basins

REFERENCE DRAWINGS

COMPUTER FILE MANAGEMENT

FILE NAME: S:\22-886-076 Hay Creek\Forest\220 Drainage\WRC22 Reports\PR-ANDP\DWG\DR02 - HAY CREEK

PLOT DATE: August 22, 2023 5:11:54 PM

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