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Final Drainage Report

High Forest Estates Subdivision Filing No. 1

Project No. 61188

PCD File No. VR2311

January 17, 2024

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For

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Prepared for

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Prepared by

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Statements and Acknowledgments

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.

David R. Gorman, P.E. Colorado No. 31672
For and on Behalf of M.V.E., Inc.

Developer's Statement

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

____ __________________

Paula Donohoo Date
8855 Walker Road
Colorado Springs, CO 80908

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. Date
County Engineer / ECM Administrator

Conditions:

Contents

Final Drainage Report

The purpose of this Final Drainage Report is to identify drainage patterns and quantities within and affecting the proposed High Forest Estates Subdivision Filing No. 1 site. The development project is a large-lot rural residential subdivision zoned RR-5. The report will examine existing and proposed developed drainage conditions of the site and contributing off-site areas. The report and included maps present results of hydrologic and drainage facilities analyses. The report will discuss any recommended drainage improvements to the site and identify drainage requirements relative to the proposed project. This report has been prepared and submitted in accordance with the requirements of the El Paso County development approval process. An Appendix is included with this report with pertinent calculations and graphs used in the drainage analyses and design.

1. General Location and Description

1.1. Location

The proposed High Forest Estates Subdivision Filing No. 1 site is located within the southwest one-quarter of Section 10, Township 11 South, Range 65 West of the 6th principal meridian in El Paso County, Colorado. The property consists of Lot 1, Block 7, Willow Springs Estates having El Paso County Tax Schedule No. 5110001009. The current address of the site is 8855 Walker Road, Colorado Springs. The eastern portion of the site currently contains a residence, outbuilding, well and septic systems, and a gravel drive in the northern portion of the site connected to Walker Road. The site is 13.81± acres in area and is zoned RR-5 (Residential Rural – 5 Acre).

The site is situated on the east side of Walker Road, north of Lot 1, Block 6, Willow Springs Estates (Zoned RR-5) with existing single-family residential development and Barn. The site is south of Lot 2, Block 7, Willow Springs Estates (Zoned RR-5) with existing single-family residential development. Walker Road, a public road with 60 ft right-of-way, is adjacent to the western edge of the site on the east and an unplatted 200-acre agricultural property (Zoned RR-5) on the west. Lot 3, Block 7, Willow Springs Estates (Zone RR-5) is east of the site with existing single-family residential development.

A **Vicinity Map** is included in the **Appendix**. The site is located within the East Cherry Creek Drainage Basin.

1.2. Description of Property

The High Forest Estates Subdivision Filing No. 1 site is 13.81± acres and is zoned RR-5 (Residential Rural (5 Acres)). Proposed High Forest Estates Subdivision Filing No. 1 will create a total of two (2) rural residential lots. Lot 1, on the west portion of the site, will be 5.21± acres. Lot 2 will be 8.59± acres and located on the eastern portion of the site. The site is covered with native prairie grasses and weeds in good condition having approximately 90% ground coverage with sparse trees and shrubs scattered.

Natural drainage routes exist on the site, located in the southeastern, southcentral, and northwestern portions. The aforementioned natural drainage routes on-site comprise a drainageway, crossing the site from southeast to northwest with a stock pond located in the west-central portion of the site where seasonal ponding of water occurs. The existing pond embankment contains a 12" Corrugated Metal Pipe (CMP) and 18" grated inlet that are intended to drain ponded water in the drainageway following minor storms. Due to the location and size of the outlet pipe, and the magnitude of a 100 year storm, the inlet and pipe are largely ineffectual in draining flows from the pond in the 100 year storm conditions and can be ignored for hydrologic or hydraulic purposes. When the pond reaches capacity, overflows exit the pond at the opening provided at the south side of the embankment and continue west in the drainageway.

The existing site topography varies throughout the site. The northeastern portion of the site slopes southwesterly with grades that range from 3% to 8% with regions that reach 16% along the edge of the existing drainageway. The southeastern portion of the site slopes towards the existing drainageway, with the northerly portion sloping south and the southerly portion sloping north. The western portion of the site slopes northwesterly towards the existing 60" double CMP located approximately 120 feet south of the northwestern corner of the site, with grades that range from 2% to 10% with areas of extreme slope along the existing drainageway that reach 60%.

According to the National Resource Conservation Service, there is one (1) soil type in the High Forest Estates Subdivision Filing No. 1 site. Peyton-Pring complex (map unit 68) makes up the entirety of the site. Both major components of this complex (typically 40% Peyton and 30% Pring) are typically Deep and Well Drained, with Medium surface runoff and a Moderate hazard of erosion. Permeability for the Peyton component is moderate and the permeability of the Pring component is rapid. A portion of the Soil Map and data tables from the National Cooperative Soil Survey and relevant Soil Descriptions from the Soil Survey of El Paso County Area, Colorado are included in the **Appendix**.[1] [2]

The current Flood Insurance Study of the region includes Flood Insurance Rate Maps (FIRM), effective on December 7, 2018.[3] The proposed subdivision is included in the Community Panels Numbered 08041C0310G of the Flood Insurance Rate Maps for the El Paso County. No part of the site is shown to be included in a 100-year flood hazard area as determined by FEMA. A portion of the current FEMA Flood Insurance Rate Maps with the site delineated is included in the **Appendix**.

2. Drainage Basins and Sub-Basins

2.1. Major Basin Description

The site for the proposed High Forest Estates Subdivision Filing No. 1 is located in the unstudied East Cherry Creek Drainage Basin (CYCY0200). A portion of the El Paso County Drainage Basins Map is provided in the **Appendix**.

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[1] WSS
[2] OSD
[3] FIRM

2.2. Sub-Basin Description

The existing drainage patterns of the High Forest Estates Subdivision Filing No. 1 site are described by five (5) on-site drainage basins. All of these basins are previously undisturbed or developed to a degree as described below. The **Drainage Map (Existing)** depicts the existing topographic mapping, drainage basin delineations, drainage patterns, existing drives, drainage facilities, and runoff quantities with a data table including drainage areas and flow rates is included in the **Appendix**.

2.2.1. Existing Drainage Patterns (Offsite)

The High Forest Estates Subdivision Filing No. 1 site receives drainage flows from approximately 1.5 square miles of area to the south and east of the site that enters from drainage routes along the southern and eastern edges of the site. There are also three off-site basins that deposit flows onto the site at the northern edge of the site at design points DP-OS4 and DP-OS5 and the southwestern corner of the site at design point DP-OS1.

2.2.2. Existing Drainage Patterns (Onsite)

Existing Sub-basin EX-A1, located in the southwestern portion of the site, contains portions of existing Table Rock Road, an undeveloped grassed area on-site, portions of the existing drainageway, and stock pond. Offsite flows enter sub-basin EX-A1 at Design Point OS1 (DP-OS1) from the south through an 18" CMP culvert under Table Rock Road and combine with flows exiting the stock pond spillway to drain into sub-basin EX-A5.

Existing Sub-basin EX-A2, located in the south central portion of the site, contains an undeveloped grassed area and portions of the aforementioned drainageway and stock pond. Offsite flows enter sub-basin EX-A2 at Design Point OS2 (DP-OS2) from the south and combine with the runoff from the sub-basin in the stock pond.

Existing Sub-basin EX-A3, located in the southeastern portion of the site, contains the existing single-family residence and associated sheds, portions of the existing gravel drive, and portions of the aforementioned drainage way. Offsite flows enter sub-basin EX-A3 at Design Point OS3 (DP-OS3) from the east and combine with flows from the sub-basin in the aforementioned drainageway to enter sub-basin EX-A4.

Existing Sub-basin EX-A4, located in the northeastern portion of the site, contains portions of the existing gravel drive, and portions of the aforementioned stock pond. Offsite flows enter sub-basin EX-A4 at Design Point OS4 (DP-OS4) from the east and combine with flows from the sub-basin in the stock pond.

Existing Sub-basin EX-A5, located in the northwestern portion of the site, contains portions of the existing gravel drive, portions of existing Walker Road, and portions of the aforementioned drainageway. Flows from sub-basin EX-A5 combine with flows entering the sub-basin from the south through the stock pond spillway and flow northerly towards the site outfall at Design Point 2 (DP2). Offsite flows enter sub-basin EX-A5 at Design Point OS5 (DP-OS5) from the north and flow through 36" CMP culverts under the private gravel road on site, and flow onsite for approximately 100'± before exiting the site at Design Point 2 (DP2).

Design Point 2 (DP2), located at the northwestern portion of the site as shown on the Drainage Map (Existing), is the site outfall. All flows from the site and exit the site into the western adjacent site through the two (2) 60" CMP culverts with Flared End Sections (FES) under Walker Road located at Design Point 2 (DP2). Currently, these culverts have a minor amount of silt build-up within the pipe and at the flared end sections as a result of erosion of the east side slope of Walker Road. These flows continue east through adjacent properties and eventually enter East Cherry Creek approximately 2 miles downstream of the site outfall.

3. Drainage Design Criteria

3.1. Development Criteria Reference

This Final Drainage Report for High Forest Estates Subdivision Filing No. 1 has been prepared according to the report guidelines presented in the latest edition of *El Paso County Drainage Criteria Manual* (DCM)[4]. The County has also adopted portions of the *City of Colorado Springs Drainage Criteria Manual* Volumes 1 and 2, especially concerning the calculation of rainfall runoff flow rates.[5] [6] The hydrologic analysis is based on a collection of data from the DCM, the NRCS Web Soil Survey[7], and existing topographic data by Polaris Surveying, Inc.

3.2. Previous Drainage Studies

East Cherry Creek (CYCY0200) is not a studied Drainage Basin. The plat submittal for Willow Springs Estates does not list drainage plans or reports. No previous drainage report was found to address flows relevant to the project site, and so none were used in the drainage design for this site.

3.3. Hydrologic Criteria

For the on-site and local sub-basins in this Final Drainage Report, the Rational Method as described in the Drainage Criteria Manual has been used for all Storm Runoff calculations, as the development and all sub-basins are less than 130 acres in area. “Colorado Springs Rainfall Intensity Duration Frequency” curves, Figure 6-5 in the DCM, was used to obtain the design rainfall values; a copy is included in the Appendix. The “Overland (Initial) Flow Equation” (Eq. 6-8) in the DCM, and Manning's equation with estimated depths were used in time of concentration calculations. “Runoff Coefficients for Rational Method”, Table 6-6 in the DCM, was utilized as a guide in estimating runoff coefficient and Percent Impervious values; a copy is included in the Appendix. Peak runoff discharges were calculated for each drainage sub-basin for both the 5-year storm event and the 100-year storm event with the Rational Method formula, (Eq. 6-5) in the DCM.[8]

For the overall site and large upstream basins flowing through the site in the drainage way, the NRCS Curve Number Loss and Dimensionless Unit Hydrograph Method as described in the (DCM) was applied to calculate the 5-year and 100-year peak storm runoff rates for each drainage sub-basin using the “Hydrologic Engineering Center - Hydrologic Modeling System” (HEC-HMS) Version 4.3 computer program by U.S. Army Corps of Engineers.[9]

Point Precipitation Frequency Estimates for the 2-year, 5-year, 10-year, and 100-year storm events were obtained for the site using the National Oceanic and Atmospheric Administration,

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[4] County DCM Sections 4.3, 4.4
[5] City DCM Volume 1
[6] City DCM Volume 2
[7] WSS
[8] County DCM, Volume 1 Update, Chapter 6
[9] HEC-HMS

Atlas 14 website.[10] The rainfall depth is applied to the NRCS 24-Hour Type II Rainfall Distribution to produce a design storm with Depth-Area Reduction Factors (DARF) correction factors determined by the HEC-HMS program based on the return period of the storm and basin area.

The NRCS Curve Numbers used to calculate the volume of runoff from the 5-year and 100-year storm events in each sub-basin are estimated using the predominate Hydrologic Soil Group, discussed in the section above, the land cover, land use condition and the Antecedent Runoff Condition (ARC) of each basin. ARC II is used for all sub-basin Curve Numbers in this analysis. The NRCS Curve numbers for the individual sub-basins range from 69.5 to 73.6. The **Appendix** contains the NRCS Curve number calculations and summary.

Times of Concentration for sub-basin runoff is calculated using three flow components: Overland Flow Time, Shallow Concentrate Flow Time, and Concentrated Flow Time. The Overland Flow Component is calculated using the Overland Flow Equation as required (DCM Eq 6-15) with maximum overland flow length of 300 feet and the appropriate Manning's Roughness Coefficient according to the surface description (DCM Table 6-11). Shallow Concentrated Flow times are determined based on watercourse slope, ground cover and flow velocity using DCM Table 6-25. Concentrated flow velocities and times are estimated using the Manning' Equation with channel waterway characteristics taken from the basin mapping. The referenced equations, coefficients and tables are included in the appendix. Calculations for Times of Concentration and Lag Times are also included in the **Appendix**.

The Muskingum-Cunge method was utilized for hydrograph channel routing as applied in the HEC-HMS program using waterway course length, slope, channel shape, bottom width and side slopes as determined from the basin mapping.

4. Drainage Facility Design

4.1. General Concept

The intent of the drainage concept presented in this Final Drainage Report is to allow for the subdivision and future development of two (2) rural residential lots while maintaining the existing drainage patterns on the site. There will be no significant grading on the site and no public facilities constructed. The site will be in compliance with the County's Stormwater Management regulations without the need for permanent water quality treatment facilities due to the site being entirely large lot rural residential lots, which are excluded from water quality requirements. No roadways are being constructed and disturbance will be less than 1 acre. Major and minor storm flows will continue to be safely conveyed through the site and downstream.

The existing and proposed drainage hydrologic conditions are described in more detail below. Input data and results for all calculations are included in the Appendix. Drainage maps for hydrology are also included in the **Appendix**.

4.2. Specific Details

4.2.1. Existing Main Stem Drainageway Hydrologic Conditions

The existing drainageway on-site flows from the southeastern portion of the site, through a stock pond located in the west-central portion of the site and continuing across to the northwestern

[10] NOAA

portion of the site. The drainageway is comprised of natural drainage routes located in the southeastern, southcentral, and northwestern portions of the site. The site receives drainage flows from approximately 1.5 square miles of area south and east of the site that enters from drainage routes located along the southern and eastern edges of the site.

The existing pond embankment contains a 12" Corrugated Metal Pipe (CMP) and 18" grated inlet that are intended to drain ponded water in the drainageway following minor storms. Due to the location and size of the outlet pipe, and the magnitude of a 100 year storm, the inlet and pipe are largely ineffectual in draining flows from the pond in the 100 year storm conditions and can be ignored for hydrologic or hydraulic purposes. When the pond reaches capacity, overflows exit the pond at the opening provided at the south side of the embankment and continue west in the drainageway. The spillway's elevation is approximately 8± feet from the bottom elevation of the pond. Following major storms, when the stock pond contains pond water, flows exit the pond through the spillway.

Offsite flows entering the site from the southern edge at Design Point OS-2 (DP-OS2) have peak storm runoff discharges of Q_5 = 120.2 cfs and Q_{100} = 597.1 cfs (existing flows). These flows include flows from offsite sub-basins OS-1, OS-2, OS-3, OS-4, OS-5, OS-6, and OS-7.

Offsite flows entering the site from the eastern edge at Design Point OS-3 (DP-OS3) have peak storm runoff discharges of Q_5 = 74.8 cfs and Q_{100} = 391.9 cfs (existing flows). These flows include flows from offsite sub-basins OS-8, OS-9, OS-10, OS-11, OS-12, and OS-13.

These flows combine with flows from OS-14, entering the site at the northeastern corner at Design Point OS4 (DP-OS4) and having peak storm runoff discharges of Q_5 = 6.1 cfs and Q_{100} = 40.6 cfs (existing flows) and flows from OS-15, entering the site at the southwestern corner at Design Point OS1 (DP-OS1) and having peak storm runoff discharges of Q_5 = 19.8 cfs and Q_{100} = 132.1 cfs (existing flows) and drain to the stock pond located in the west-central portion of the site at Design Point 1 (DP1). DP1 has peak storm runoff discharges of Q_5 = 212.3 cfs and Q_{100} = 1104.4 cfs (existing flows).

Flows leave the stock pond to combine with flows from OS-16, entering the site at the northwestern corner at Design Point OS5 (DP-OS5) having peak storm runoff discharges of Q_5 = 6.6 cfs and Q_{100} = 44.5 cfs (existing flows), and exist the site at Design Point 2 (DP2), the site outfall. DP2 has peak storm runoff discharges of Q_5 = 215.6 cfs and Q_{100} = 1126.0 cfs (existing flows).

4.2.2. Existing On-Site Hydrologic Conditions

The High Forest Estates Subdivision Filing No. 1 site includes five (5) sub-basins. Runoff drains into a drainageway onsite that conveys the flows to an onsite stock pond. Flows leave the stock pond, combine with flows from offsite basin OS-16 and exit the site at the site outfall. These flows continue east through adjacent properties and eventually enter East Cherry Creek approximately 2 miles downstream of the site outfall.

Existing Sub-basin EX-A1 (1.16 acres) is located in the southwestern portion of the site and contains portions of existing Table Rock Road, an undeveloped grassed area on-site, and portions of the existing drainageway located in the southwestern portion of the site and stock pond. Located in the southwestern portion of the sub-basin is the spillway to the stock pond with elevation at approximately 8± feet from the bottom elevation. Runoff from the northern portion of the sub-basin drains southerly and combines with flows in the southern portion of the sub-basin to drain northwesterly and enter sub-basin EX-A5. Sub-basin EX-A1 produces peak discharges of Q_5 = 0.5 cfs and Q_{100} = 2.8 cfs (existing flows). Offsite flows enter this basin through an 18" CMP culvert under Table Rock Road and combine with flows from the northern portion of the sub-basin to drain into sub-basin EX-A5.

Existing Sub-basin EX-A2 (1.11 acres) is located in the south central portion of the site and contains an undeveloped grassed area and portions of the aforementioned drainageway and stock pond. Runoff in the western portion of this basin drain northeasterly into the drainage way and runoff in the eastern portion of the sub-basin drains westerly into the drainageway. Sub-basin EX-A2 produces peak discharges of Q_5 = 0.3 cfs and Q_{100} = 2.5 cfs (existing flows). Offsite flows enter this sub-basin at Design Point OS2 (DP-OS2) located south of the sub-basin as shown on the Drainage Map (Existing).

Existing Sub-basin EX-A3 (4.45 acres) is located in the southeastern portion of the site and contains the existing single-family residence and associated sheds, portions of the existing gravel drive, and portions of the aforementioned drainage way. Runoff in the southern portion of this basin drains northerly into the drainage way and runoff in the northern portion of this basin drains southerly into the drainage way. These flows exit the sub-basin through the aforementioned drainageway to enter sub-basin EX-A4. Sub-basin EX-A3 produces peak discharges of Q_5 = 1.5 cfs and Q_{100} = 9.5 cfs (existing flows). Offsite flows enter this sub-basin at Design Point OS3 (DP-OS3) located east of the sub-basin as shown on the Drainage Map (Existing).

Existing Sub-basin EX-A4 (4.08 acres) is located in the northeastern portion of the site and contains portions of the existing gravel drive, and portions of the aforementioned stock pond. Runoff in this basin drains southwesterly into the stock pond. Sub-basin EX-A4 produces peak discharges of Q_5 = 1.5 cfs and Q_{100} = 9.0 cfs (existing flows). Located at Design Point 1 (DP1) is a 18" grated inlet located with rim elevation at approximately 7± feet from the bottom elevation of the stock pond. Offsite flows enter this sub-basin at Design Point OS4 (DP-OS4) located north of the sub-basin as shown on the Drainage Map (Existing).

Design Point 1 (DP1) produces peak discharges of Q_5 = 212.3 cfs and Q_{100} = 1104.4 cfs (existing flows). Located in the southwestern portion of the site is the spillway to the stock pond with elevation at approximately 8± feet from the bottom elevation. Following major storms, when the stock pond contains ponded water, flows exit the spillway to enter sub-basin EX-A5.

Existing Sub-basin EX-A5 (3.56 acres) is located in the northwestern portion of the site and contains portions of the existing gravel drive, portions of existing Walker Road, and portions of the aforementioned drainage way. Runoff in the southern portion of this basin drains northerly into the drainage way and runoff in the northern portion of this basin drains southerly into the drainage way. Offsite flows enter sub-basin EX-A5 at Design Point OS5 (DP-OS5) from the north, flow through 36" CMP culverts under the private gravel road on site, flow onsite for approximately 100'±, and exit the site at Design Point 2 (DP2). Offsite flows combine with all flows from the site at Design Point 2 (DP2) and exit the site to the west via the drainage way into the western adjacent site through two (2) 60" CMP culverts under Walker Road located at Design Point 2 (DP2). Sub-basin EX-A5 produces peak discharges of Q_5 = 1.7 cfs and Q_{100} = 8.3 cfs (existing flows).

Design Point 2 (DP2) produces peak discharges of Q_5 = 215.6 cfs and Q_{100} = 1126.0 cfs (existing flows). Calculations show overtoping of the road in the existing condition for the 100 year rainfall event. The outfall is stable and contains significant vegetation and does not show signs of significant erosion. These flows continue west through adjacent properties and eventually enter East Cherry Creek approximately 2 miles downstream of the site outfall.

4.2.3. Proposed On-Site Hydrologic Conditions

The proposed drainage hydrologic conditions are described in more detail below. Input data and results for all calculations are included in the **Appendix**. The **Drainage Map (Proposed)** depicts the existing topographic mapping together with proposed contours, proposed drainage basin delineations, proposed drainage patterns, drainage facilities, and runoff quantities with a data table including drainage areas and flow rates is included in the **Appendix**.

The proposed drainage basins for High Forest Estates Subdivision Filing No. 1 site mirror the existing basins as no changes will be made to the site that affect the layout of the basins. Five (5) sub-basins have been identified in the High Forest Estates Subdivision Filing No. 1 site for analysis of the developed drainage conditions. The site is to contain two (2) rural residential lots. Lot 1, on the west portion of the site, will be 5.21± acres. Lot 2 will be 8.59± acres and located on the eastern portion of the site. Access to all lots will be from the existing gravel road which extends from Walker Road along the northern edge of the site. Each of the lots are assumed to contain a 5,100 SF house footprint, 1,000 SF of exterior hardscape, and 200 foot long 12' wide gravel driveway. The resulting percent imperviousness was used in the hydrologic calculations. The sub-basins are described in more detail below.

Proposed Sub-basin A1 (1.16 acres), located in the southwestern portion of the site and containing portions of existing Table Rock Road, an undeveloped grassed area on-site. This basin contains portions of the existing drainageway and stock pond onsite; located in the southwestern portion of the sub-basin is the spillway to the stock pond with elevation at approximately 8± feet from the bottom elevation. Runoff from the northern portion of the sub-basin will continue to drain southerly and combine with flows in the southern portion of the sub-basin to drain northwesterly and enter sub-basin A5. Sub-basin A1 produces peak discharges of Q_5 = 0.5 cfs and Q_{100} = 2.8 cfs (proposed flows). Offsite flows will continue to enter this sub-basin through an 18" CMP culvert under Table Rock Road and combine with flows from the northern portion of the sub-basin to drain into sub-basin A5. This sub-basin is not expected to contain any further improvements.

Proposed Sub-basin A2 (1.11 acres), located in the south central portion of the site and containing an undeveloped grassed area and portions of the aforementioned drainageway and stock pond. Runoff in the western portion of this basin drain northeasterly into the drainage way and runoff in the eastern portion of the sub-basin drains westerly into the drainageway. Sub-basin EX-A2 produces peak discharges of Q_5 = 0.3 cfs and Q_{100} = 2.5 cfs (proposed flows). Offsite flows will continue to enter this sub-basin at Design Point OS2 (DP-OS2) located south of the sub-basin as shown on the Drainage Map (Proposed). This sub-basin is not expected to contain any further improvements.

Proposed Sub-basin A3 (4.45 acres), located in the southeastern portion of the site, contains the existing single-family residence and associated sheds, portions of the existing gravel drive, and portions of the aforementioned drainage way. Runoff in the southern portion of this basin will continue to drain northerly into the drainage way and runoff in the northern portion of this basin will continue to drain southerly into the drainage way. These flows exit the sub-basin through the aforementioned drainageway to enter sub-basin A4. Sub-basin A3 produces peak discharges of Q_5 = 1.5 cfs and Q_{100} = 9.5 cfs (proposed flows). Offsite flows will continue to enter this sub-basin at Design Point OS3 (DP-OS3) located east of the sub-basin as shown on the Drainage Map (Proposed). This sub-basin is not expected to contain any further improvements.

Proposed Sub-basin A4 (4.08 acres), located in the northeastern portion of the site, contains portions of the existing gravel drive, and portions of the aforementioned stock pond. Runoff in this basin will continue to drain southwesterly into the stock pond. Sub-basin A4 produces peak discharges of Q_5 = 1.5 cfs and Q_{100} = 9.0 cfs (proposed flows). Located at Design Point 1 (DP1), in the existing pond embankment, is a 12” grated inlet located with rim elevation at approximately 7± feet from the bottom elevation of the stock pond. Due to the location and size of the outlet pipe, and the magnitude of a 100 year storm, the inlet and pipe are largely ineffectual in draining flows from the pond in the 100 year storm conditions and can be ignored for hydrologic or hydraulic purposes. When the pond reaches capacity, overflows exit the pond at the opening provided at the south side of the embankment and continue west in the drainageway. The spillway’s elevation is approximately 8± feet from the bottom elevation of the pond. Following major storms, when the stock pond contains pond water, flows exit the pond through the spillway. Offsite flows will continue to enter this sub-basin at Design Point OS4 (DP-OS4) located north of the sub-basin as shown on the Drainage Map (Proposed). This sub-basin is not expected to contain any further improvements.

Design Point 1 (DP1) produces peak discharges of Q_5 = 212.5 cfs and Q_{100} = 1105.1 cfs (proposed flows). Located in the southwestern portion of the site is the spillway to the stock pond with elevation at approximately 8± feet from the bottom elevation. Following major storms, when the stock pond contains ponded water, flows exit the spillway to enter sub-basin A5.

Proposed Sub-basin A5 (3.56 acres), located in the northwestern portion of the site, contains portions of the existing gravel drive, portions of existing Walker Road, and portions of the aforementioned drainage way. This basin is expected to be further developed to contain one (1) single family residence and driveway. Runoff in the southern portion of this basin will continue to drain northerly into the drainage way and runoff in the northern portion of this basin will continue to drain southerly into the drainage way. Offsite flows will continue to enter sub-basin A5 at Design Point OS5 (DP-OS5) from the north, flow through 36” CMP culverts under the private gravel road onsite, flow onsite for approximately 100’±, and exit the site at Design Point 2 (DP2). Offsite flows combine with all flows from the site at Design Point 2 (DP2) and exit the site to the west via the drainage way into the western adjacent site through two (2) 60” CMP culverts under Walker Road located at Design Point 2 (DP2). Sub-basin A5 produces peak discharges of Q_5 = 2.1 cfs and Q_{100} = 8.9 cfs (proposed flows).

Design Point 2 (DP2) produces peak discharges of Q_5 = 216.0 cfs and Q_{100} = 1127.2 cfs (proposed flows). The increase in flow due to this development are Q_5 = 0.4 cfs and Q_{100} = 1.2 cfs. This amounts to a 0.1% increase in flows. No change to the existing conditions downstream of the site occur as a result of this development and the outfall will remain stable and suitable. These flows continue east through adjacent properties and eventually enter East Cherry Creek approximately 2 miles downstream of the site outfall.

4.2.4. Proposed Main Stem Drainageway Hydrologic and Hydraulic Conditions

A natural drainageway crosses the site from the southeastern portion of the site, through a stock pond located in the west-central portion of the site, to the northwestern portion of the site. The drainageway is comprised of natural drainage routes located in the southeastern, southcentral, and northwestern portions of the site. The site receives drainage flows from approximately 1.5 square miles of area south and east of the site that enters from drainage routes located along the southern and eastern edges of the site.

Offsite flows entering the site from the southern edge at Design Point OS-2 (DP-OS2) have peak storm runoff discharges of Q_5 = 120.3 cfs and Q_{100} = 597.2 cfs (proposed flows). These flows include flows from offsite sub-basins OS-1, OS-2, OS-3, OS-4, OS-5, OS-6, and OS-7.

Offsite flows entering the site from the eastern edge at Design Point OS-3 (DP-OS3) have peak storm runoff discharges of Q_5 = 74.8 cfs and Q_{100} = 391.9 cfs (proposed flows). These flows include flows from offsite sub-basins OS-8, OS-9, OS-10, OS-11, OS-12, and OS-13.

These flows combine with flows from OS-14, entering the site at the northeastern corner at Design Point OS4 (DP-OS4) and having peak storm runoff discharges of Q_5 = 6.1 cfs and Q_{100} = 40.6 cfs (proposed flows) and flows from OS-15, entering the site at the southwestern corner at Design Point OS1 (DP-OS1) and having peak storm runoff discharges of Q_5 = 19.8 cfs and Q_{100} = 132.1 cfs (proposed flows) and drain to the stock pond located in the west-central portion of the site at Design Point 1 (DP1). DP1 has peak storm runoff discharges of Q_5 = 212.5 cfs and Q_{100} = 1105.1 cfs (proposed flows).

Flows leave the stock pond to combine with flows from OS-16, entering the site at the northwestern corner at Design Point OS5 (DP-OS5) having peak storm runoff discharges of Q_5 = 6.6 cfs and Q_{100} = 44.5 cfs (proposed flows), and exits the site at Design Point 2 (DP2), the site outfall. DP2 has peak storm runoff discharges of Q_5 = 216.0 cfs and Q_{100} = 1127.2 cfs (proposed flows).

Drainage easements and no-build areas are established in the final plat to contain this drainage way, existing ponds and the seasonably high ground water areas of the site. The boundary of the drainage easement was determined by a hydraulic analysis of the drainage way. Calculations and results of the analysis are included in the **Appendix**.

4.2.5. Detention Facilities

The existing pond has an east-west facing embankment that is well vegetated and stable. The Livestock Water Tank (pond) was approved by the Colorado Division of Water Resources in May of 1964. The capacity of the tank is listed as 6.8 acre feet of and per the correspondence with the State, the embankment is defined as a non-jurisdicational dam.

The Pond overflows at the spillway opening provided at the south side of the embankment. No detention is required for this site and the pond is not designed to provide detention. The owners of the High Forest Estates Subdivision Filing No. 1 property, own the pond and are responsible for maintenance. In the developed and platted condition, ownership, access and maintenance of the pond will be according to the covenants signed with the subdivision plat. No additional access easements will be needed to access the pond. Correspondence with the State and the approved application for Livestock Water Tank are included in the **Appendix.**

A permanent detention facility is not required for this site. The proposed lots onsite are classified as large rural residential lots by both zoning and plat implementation. All proposed lots are at least 5 acres in size. No public or private roadways will be constructed. The development's effect on peak runoff discharges is negligible with an increase of 1.2 cfs in the 100-year rainfall event.

4.2.6. Drainageway Hydraulic Analysis

A hydraulic analysis of the significant drainageway flowing southeast to northwest through the site was conducted utilizing HEC-RAS computer modeling. Cross sections were sampled through the project site in approximately 50' intervals as well as a short distance upstream and downstream of the site. The drainageway exhibits minor winding and is vegetated by long and dense native grasses in the channel and overbanks. Manning's roughness coefficient of 0.037 is selected due to the channel characteristics, vegetation and flow depths. Channel velocities for the 100-year flow range from 0.4 fps to 9.8 fps with a mean average of 3.9 fps. All onsite cross sections exhibit velocities of less than 6 fps excluding three cross sections near the pond spillway and four cross sections located in the southeastern portion of the site. Several gathered sources note permissible flow velocities of up to 6 fps for channels lined with long native grasses for channel stability. The source is included in the **Appendix** of this report.

The drainageway was examined for signs of sedimentation or erosion by visual inspection of site photographs and aerial photography. It is found that the flow path is vegetated with thick natural grasses without signs of erosion within the site boundaries. One cross section near the pond spillway exhibited a velocity exceeding 6 fps, however, the pond spillway was verified by visual inspection to be vegetated and showing no indication of erosive damage. We, therefore, do not recommend any further improvement of the spillway or disturbance of the existing conditions in that portion of the site. Four onsite cross sections in the southeast portion of the site exhibit velocities that exceed 6 fps, however, the drainage routes at these cross sections were verified by visual inspection and observed to be vegetated with deep, thick native grasses and brush, showing no indication of erosion or sediment transport. The existing drainageway is in a stable condition and flows are only negligibly increased as a result of the development. No stabilization measure are needed to the drainageway.

4.3. Erosion Control

There is no public infrastructure construction associated with this subdivision. Any required best management practices (BMP's) for the individual lot home construction will be handled on the BESQCP for each lot at time of building permit.

4.4. Four Step Process

El Paso County Engineering Criteria Manual, Appendix I, contains the policies and procedures for Stormwater Quality. Section I.7.1.B provides for exclusions to the requirements to provide Post Construction Stormwater Quality facilities. According to Section I.7.1.B.5, “A single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling and having a total lot impervious area of less than 10 percent” is excluded. The total area of the site is 13.80± acres. All 13.80± acres is comprised of large lot single-family rural residential units. The total lot imperviousness for rural residential lots is less than 10%. This site is eligible for an exclusion to permanent stormwater quality management requirements by the Post-Construction Stormwater Management exclusion criteria for “Large Lot Single-Family Site” corresponding to MS4 permit Part I.E.4.a.i (E) as the subdivision will contain single-family residential lots, of more 2.5 acres/dwelling and having a total lot impervious area of less than 10 percent. No public roadway improvements are proposed. There are no activities or improvements that require permanent water quality facilities for this project.

The El Paso County Engineering Criteria Manual (Appendix I, Section I.7.2) requires the consideration of a “Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long term source controls”. It is determined in the section above that this project is exempt from the requirements of Section I.7.1 to provide Post Construction Stormwater Management Facilities with Water Quality Capture Volume (WQCV). However, aspects of the

Four Step Process are considered and implemented in the High Forest Estates Subdivision Filing No. 1 project.

1) Runoff Reduction Practices are employed in this project. Impervious surfaces have been reduced as much as practically possible. There is only minimal concrete or other hard surfaces proposed. Minimized Directly Connected Impervious Areas (MDCIA) is employed on the project because runoff passes through open space grassed areas before leaving the site.
2) All existing swales will remain covered with the existing natural grasses. All of the onsite swales are trapezoidal in shape with wide bottoms widths and flat side slopes. The vegetation for each swale includes medium height prairie grasses that are periodically mowed. It is not anticipated that any of the swales will be modified in the future. It can be safely assumed that the negligible increase in flow as a result of development will have minimal negative impacts on the existing onsite swales.
3) The project contains no potentially hazardous uses. The site is exempted from the use of WQCV BMPs by ECM 1.7.1.B.5 corresponding to MS4 permit Part I.E.4.a.i (E) by virtue of the large lot rural residential nature of the site having percent imperviousness of less than 10%.
4) The rural residential site is not anticipated to contain storage of potentially harmful substances or use of potentially harmful substances. No site specific or other source control BMPs are required.

5. Drainage and Bridge Fees

The site is located within the East Cherry Creek Drainage Basin which is a no fee basin.

6. Conclusion

This Final Drainage Report presents existing and proposed drainage conditions for the proposed High Forest Estates Subdivision Filing No. 1. The development will have negligible and inconsequential effects on the existing site drainage and drainage conditions downstream. The proposed project will not, with respect to stormwater runoff, negatively impact the adjacent properties and downstream properties.

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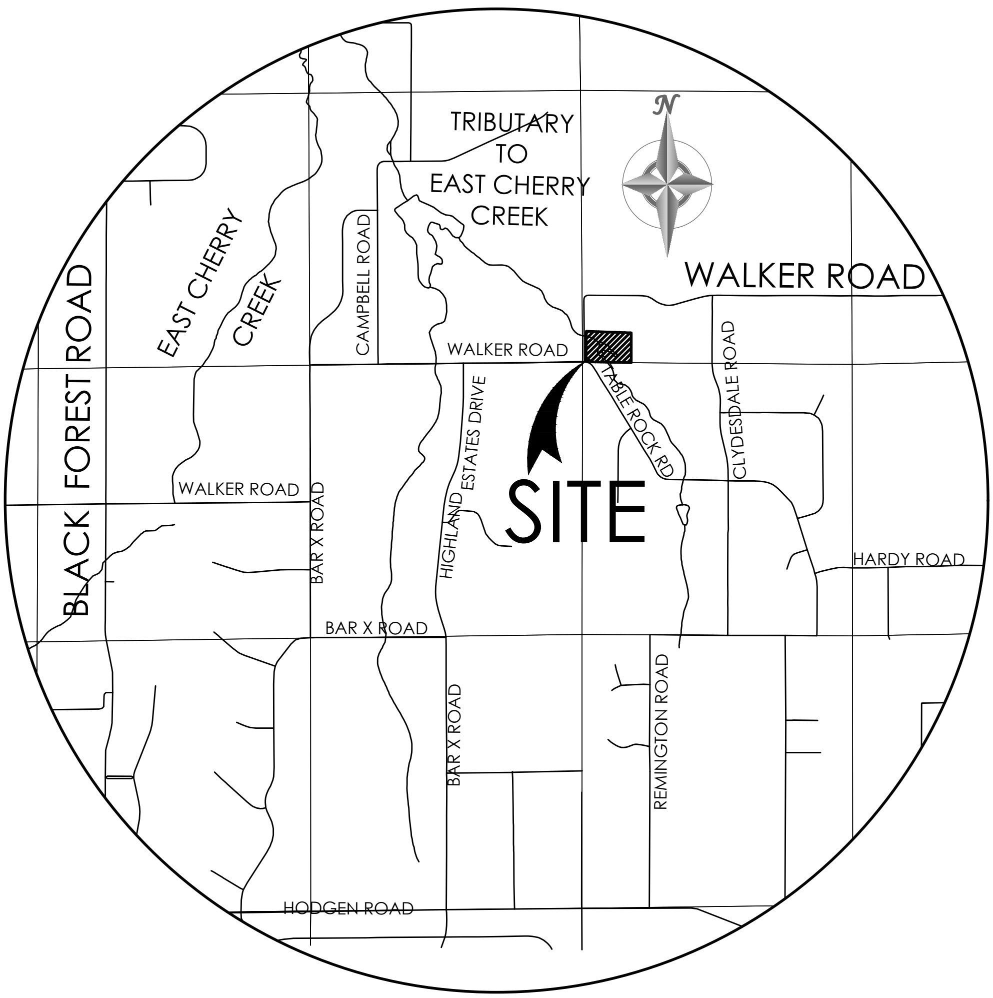
7. Appendices

A. General Maps and Supporting Data

I. Vicinity Map
II. Portions of Flood Insurance Rate Map
III. Portion of El Paso County Drainage Basins Map
IV. NRCS Soil Map and Tables
V. Soil Type Descriptions – Soil Survey of El Paso County
VI. NOAA Atlas Point Precipitation Frequency Estimates

I. Vicinity Map



VICINITY MAP

NOT TO SCALE

II. Portions of Flood Insurance Rate Map

National Flood Hazard Layer FIRMette

FEMA

104°39'58"W 39°6'17"N

104°39'20"W 39°5'49"N

Feet 1:6,000

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

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

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

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

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

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

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

OTHER FEATURES
- B 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

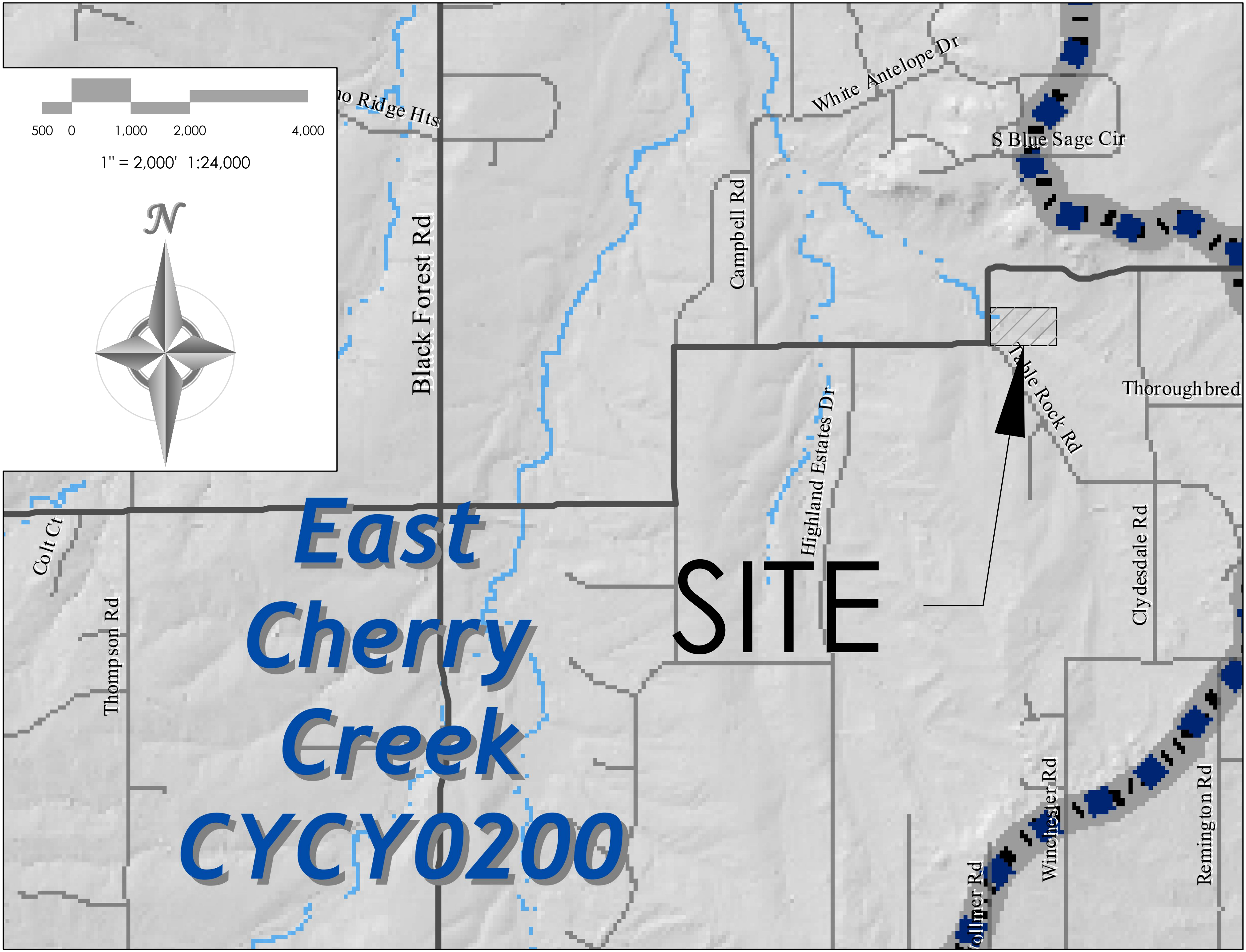
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/14/2022 at 12:49 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

III. Portion of El Paso County Drainage Basins Map


500 0 1,000 2,000 4,000
1" = 2,000' 1:24,000
N
Black Forest Rd
White Antelope Dr
S Blue Sage Cir
Campbell Rd
Highland Estates Dr
Table Rock Rd
Thoroughbred
Colt Ct
Thompson Rd
Clydesdale Rd
East Cherry Creek CYCY0200
SITE
Winchester Rd
Remington Rd

IV. NRCS Soil Map and Tables

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

September 6, 2022

Preface

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

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

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

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

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

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

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Contents

How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

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

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

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

Soil Map


104° 39' 46'' W
104° 39' 31'' W
39° 6' 7'' N
39° 6' 0'' N
529170
529200
529230
529260
529290
529320
529350
529380
529410
529440
529470
529500
4328160
4328130
4328100
4328070
4328040
4328010
4327980
4327950
Walker Rd
68
Soil Map may not be valid at this scale.
Map Scale: 1:1,610 if printed on A landscape (11" x 8.5") sheet.
Meters
0 20 40 80 120
Feet
0 50 100 200 300
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil 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 19, Aug 31, 2021

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
68	Peyton-Pring complex, 3 to 8 percent slopes	13.5	100.0%
Totals for Area of Interest		**13.5**	**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

68—Peyton-Pring complex, 3 to 8 percent slopes

Map Unit Setting

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

Map Unit Composition

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

Description of Peyton

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Arkosic alluvium derived from sedimentary rock and/or arkosic residuum weathered from sedimentary rock

Typical profile

A - 0 to 12 inches: sandy loam
Bt - 12 to 25 inches: sandy clay loam
BC - 25 to 35 inches: sandy loam
C - 35 to 60 inches: sandy loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (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: Moderate (about 7.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: R049XY216CO - Sandy Divide
Hydric soil rating: No

Description of Pring

Setting

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

Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

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

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 6.0 inches)

Interpretive groups

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

Minor Components

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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V. Soil Type Descriptions – Soil Survey of El Paso County

support a load and potential frost action on roads and streets. Roads and buildings can be designed to overcome these limitations. Capability subclass IVe.

67—Peyton sandy loam, 5 to 9 percent slopes. This deep, noncalcareous, well drained soil formed in alluvium and residuum derived from weathered arkosic sedimentary rock on uplands. Elevation ranges from 6,800 to 7,600 feet.

Typically, the surface layer is grayish brown sandy loam about 12 inches thick. The subsoil, about 23 inches thick, is pale brown sandy clay loam in the upper 13 inches and pale brown sandy loam in the lower 10 inches. The substratum is pale brown sandy loam to a depth of 60 inches.

Included with this soil in mapping are small areas of Holderness loam, 5 to 8 percent slopes; Pring coarse sandy loam, 3 to 8 percent slopes; and Tomah-Crowfoot loamy sands, 3 to 8 percent slopes.

Permeability of this soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, and the hazard of erosion is moderate. Gullies and rills are common.

Most of the acreage of this Peyton soil is used as rangeland. Some areas are used for wheat and oats. Stubble mulching or other crop residue management practices are needed to control water erosion. Wildlife habitat is also an important use.

This soil is well suited to the production of native vegetation suitable for grazing. The native vegetation is mainly mountain muhly, bluestem, mountain brome, needleandthread, and blue grama. This soil is subject to invasion by Kentucky bluegrass and Gambel oak. Minor amounts of forbs such as hairy goldenrod, geranium, milkvetch, low larkspur, fringed sage, and buckwheat are in the stand.

Proper location of livestock watering facilities helps to control grazing. Timely deferment of grazing is needed to protect the plant cover.

Windbreaks and environmental plantings generally are suited to this soil. Soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be necessary when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

This soil is suited to habitat for openland and rangeland wildlife. Rangeland wildife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

This soil has good potential for homesites. The main limitation is the limited ability to support a load and potential frost action. Buildings and roads can be designed to overcome these limitations. Capability subclass IVe.

68—Peyton-Pring complex, 3 to 8 percent slopes. These gently sloping to moderately sloping soils are on valley side slopes and on uplands. Elevation ranges from 6,800 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

The Peyton soil makes up about 40 percent of the complex, the Pring soil about 30 percent, and other soils about 30 percent.

Included with these soils in mapping are areas of Holderness loam, 1 to 5 percent slopes; Holderness loam, 5 to 8 percent slopes; and Tomah-Crowfoot loamy sands, 3 to 8 percent slopes. In some places arkosic beds of sandstone and shale are at a depth of 0 to 40 inches.

The Peyton soil is commonly on the less sloping part of the landscape. It is deep, noncalcareous, and well drained. It formed in alluvium and residuum derived from weathered arkosic sedimentary rock. Typically, the surface layer is grayish brown sandy loam about 12 inches thick. The subsoil, about 23 inches thick, is pale brown sandy clay loam in the upper 13 inches and pale brown sandy loam in the lower 10 inches. The substratum is pale brown sandy loam to a depth of 60 inches or more.

Permeability of the Peyton soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium, and the hazard of erosion is moderate.

The Pring soil is deep, noncalcareous, and well drained. It formed in sandy sediment derived from weathered arkosic sedimentary rock. Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The substratum is dark grayish brown coarse sandy loam about 10 inches thick over pale brown gravelly sandy loam that extends to a depth of 60 inches or more.

Permeability of the Pring soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium, and the hazard of erosion is moderate.

These soils are used as rangeland, for wildlife habitat, and for homesites.

These soils are well suited to the production of native vegetation suitable for grazing. The dominant native species are mountain muhly, bluestem, needleandthread, and blue grama. These soils are subject to invasion of Kentucky bluegrass and Gambel oak. Common forbs are hairy goldenrod, geranium, milkvetch, low larkspur, fringed sage, and buckwheat.

Properly locating livestock watering facilities helps to control grazing. Timely deferment of grazing is needed to protect the plant cover.

Windbreaks and environmental plantings generally are suited to these soils. Soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

These soils are suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

These soils have a good potential for homesites. The main limitations, especially on the Peyton soil, are low bearing strength and frost-action potential. Buildings and roads can be designed to overcome these limitations. Access roads should have adequate cut-slope grade and be provided with drains to control surface runoff and keep soil losses to a minimum. Capability subclass VIe.

69—Peyton-Pring complex, 8 to 15 percent slopes. These gently to moderately sloping soils are on valley side slopes and on uplands. Elevation ranges from 6,800 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

The Peyton soil makes up about 40 percent of the complex, the Pring soil about 30 percent, and other soils about 30 percent.

Included with these soils in mapping are areas of Holderness loam, 8 to 15 percent slopes; Tomah-Crowfoot loamy sands, 8 to 15 percent slopes; Kettle gravelly loamy sand, 8 to 40 percent slopes; and a few areas of Rock outcrop.

The Peyton soil is commonly on the less sloping part of the landscape. It is deep, noncalcareous, and well drained. It formed in alluvium and residuum derived from weathered, arkosic, sedimentary rock. Typically, the surface layer is grayish brown sandy loam about 12 inches thick. The subsoil, about 23 inches thick, is pale brown sandy clay loam in the upper 13 inches and pale brown sandy loam in the lower 10 inches. The substratum is pale brown sandy loam to a depth of 60 inches or more.

Permeability of the Peyton soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Surface runoff is medium to rapid, and the hazard of erosion is moderate to high. Some gullies have developed along drainageways and livestock trails.

The Pring soil is deep, noncalcareous, and well drained. It formed in sandy sediment derived from weathered, arkosic, sedimentary rock. Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The substratum is dark grayish brown coarse sandy loam about 10 inches thick over pale brown gravelly sandy loam that extends to a depth of 60 inches or more.

Permeability of the Pring soil is rapid. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Surface runoff is medium to rapid, and the hazard of erosion is moderate to high. Some gullies have developed along drainageways and livestock trails.

The soils in this complex are used as rangeland, for wildlife habitat, and for homesites.

These soils are well suited to the production of native vegetation suitable for grazing. The dominant native species are mountain muhly, bluestem grasses, needleandthread, and blue grama. These soils are subject to invasion of Kentucky bluegrass and Gambel oak. Common forbs are hairy goldenrod, geranium, milkvetch, low larkspur, fringed sage, and buckwheat.

Properly locating livestock watering facilities helps to control grazing. Timely deferment of grazing is needed to protect the plant cover.

Windbreaks and environmental plantings generally are suited to these soils. Soil blowing is the main limitation to the establishment of trees and shrubs. This limitation can be overcome by cultivating only in the tree rows and leaving a strip of vegetation between the rows. Supplemental irrigation may be needed when planting and during dry periods. Trees that are best suited and have good survival are Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry. Shrubs that are best suited are skunkbush sumac, lilac, and Siberian peashrub.

These soils are well suited to wildlife habitat. They are best suited to habitat for openland and rangeland wildlife. Rangeland wildlife, such as pronghorn antelope, can be encouraged by developing livestock watering facilities, properly managing livestock grazing, and reseeding range where needed.

These soils have good potential for use as homesites. The main limitations are steepness of slope, limited ability to support a load, and frost-action potential. Buildings and roads can be designed to overcome these limitations. These soils also require special site or building designs because of the slope. Access roads should have adequate cut-slope grade, and drains should be provided to control surface runoff and keep soil losses to a minimum. Capability subclass VIe.

70—Pits, gravel. Gravel pits are in nearly level to rolling areas. They are open excavations several feet deep and commonly 5 acres or less in size.

Gravel pits are very low in natural fertility and are highly susceptible to soil blowing. A cover of weeds or straw helps to control erosion.

Windbreaks and environmental plantings generally are not suited to these areas. Onsite investigation is needed to determine if plantings are feasible. Capability subclass VIIIs.

71—Pring coarse sandy loam, 3 to 8 percent slopes. This deep, noncalcareous, well drained soil formed in sandy sediment derived from arkosic sedimentary rock on valley side slopes and on uplands. Elevation ranges from 6,800 to 7,600 feet. The average annual precipitation is about 17 inches, the average annual air temperature is about 43 degrees F, and the average frost-free period is about 120 days.

Typically, the surface layer is dark grayish brown coarse sandy loam about 4 inches thick. The substratum is dark grayish brown coarse sandy loam about 10 inches thick over pale brown gravelly sandy loam that extends to a depth of 60 inches or more.

VI. NOAA Atlas 14 Point Precipitation Frequency Estimates

NOAA Atlas 14, Volume 8, Version 2
Location name: Colorado Springs, Colorado, USA*
Latitude: 39.1012°, Longitude: -104.6595°
Elevation: m/ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffrey Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.238 (0.190-0.301)	0.289 (0.230-0.366)	0.378 (0.299-0.478)	0.456 (0.359-0.579)	0.569 (0.437-0.755)	0.663 (0.495-0.887)	0.761 (0.549-1.04)	0.865 (0.598-1.21)	1.01 (0.672-1.45)	1.13 (0.727-1.64)
10-min	0.349 (0.278-0.441)	0.424 (0.337-0.535)	0.553 (0.439-0.700)	0.667 (0.526-0.848)	0.834 (0.639-1.11)	0.970 (0.725-1.30)	1.11 (0.804-1.53)	1.27 (0.876-1.78)	1.48 (0.984-2.13)	1.65 (1.07-2.40)
15-min	0.426 (0.339-0.537)	0.517 (0.411-0.653)	0.675 (0.535-0.854)	0.813 (0.641-1.03)	1.02 (0.780-1.35)	1.18 (0.884-1.58)	1.36 (0.980-1.86)	1.54 (1.07-2.17)	1.80 (1.20-2.60)	2.01 (1.30-2.92)
30-min	0.604 (0.481-0.762)	0.733 (0.583-0.926)	0.955 (0.757-1.21)	1.15 (0.907-1.46)	1.44 (1.10-1.90)	1.67 (1.25-2.23)	1.91 (1.38-2.62)	2.17 (1.50-3.05)	2.53 (1.69-3.65)	2.82 (1.82-4.10)
60-min	0.764 (0.609-0.965)	0.918 (0.730-1.16)	1.19 (0.945-1.51)	1.44 (1.13-1.83)	1.81 (1.39-2.41)	2.12 (1.59-2.85)	2.45 (1.77-3.37)	2.81 (1.95-3.95)	3.31 (2.21-4.78)	3.72 (2.40-5.41)
2-hr	0.925 (0.741-1.16)	1.10 (0.884-1.38)	1.43 (1.14-1.79)	1.73 (1.37-2.18)	2.18 (1.70-2.89)	2.57 (1.94-3.43)	2.99 (2.18-4.08)	3.44 (2.41-4.82)	4.09 (2.75-5.87)	4.61 (3.01-6.67)
3-hr	1.01 (0.812-1.26)	1.19 (0.960-1.49)	1.54 (1.23-1.92)	1.87 (1.49-2.34)	2.37 (1.86-3.14)	2.81 (2.14-3.75)	3.29 (2.41-4.49)	3.81 (2.69-5.34)	4.57 (3.10-6.56)	5.20 (3.40-7.48)
6-hr	1.17 (0.950-1.45)	1.37 (1.11-1.70)	1.76 (1.42-2.18)	2.13 (1.71-2.65)	2.72 (2.15-3.59)	3.24 (2.49-4.30)	3.81 (2.83-5.18)	4.45 (3.16-6.20)	5.38 (3.67-7.67)	6.14 (4.06-8.79)
12-hr	1.37 (1.12-1.68)	1.61 (1.31-1.97)	2.04 (1.66-2.51)	2.47 (1.99-3.04)	3.14 (2.50-4.10)	3.72 (2.88-4.90)	4.37 (3.26-5.88)	5.08 (3.64-7.02)	6.12 (4.22-8.67)	6.98 (4.65-9.91)
24-hr	1.61 (1.32-1.96)	1.89 (1.55-2.30)	2.40 (1.97-2.93)	2.88 (2.35-3.53)	3.63 (2.90-4.68)	4.26 (3.31-5.55)	4.95 (3.72-6.60)	5.71 (4.12-7.81)	6.81 (4.72-9.55)	7.70 (5.18-10.9)
2-day	1.88 (1.55-2.26)	2.22 (1.84-2.68)	2.83 (2.33-3.42)	3.38 (2.77-4.10)	4.20 (3.37-5.34)	4.89 (3.82-6.28)	5.62 (4.24-7.40)	6.41 (4.65-8.67)	7.52 (5.25-10.4)	8.41 (5.71-11.8)
3-day	2.05 (1.70-2.45)	2.44 (2.02-2.92)	3.11 (2.57-3.74)	3.71 (3.05-4.48)	4.60 (3.69-5.80)	5.32 (4.17-6.79)	6.09 (4.62-7.97)	6.91 (5.03-9.30)	8.06 (5.65-11.1)	8.98 (6.12-12.5)
4-day	2.20 (1.83-2.62)	2.61 (2.17-3.11)	3.32 (2.75-3.97)	3.95 (3.26-4.74)	4.87 (3.92-6.12)	5.63 (4.42-7.16)	6.43 (4.88-8.38)	7.28 (5.32-9.75)	8.47 (5.96-11.7)	9.41 (6.44-13.1)
7-day	2.60 (2.18-3.08)	3.03 (2.54-3.59)	3.78 (3.15-4.49)	4.44 (3.68-5.30)	5.42 (4.39-6.75)	6.22 (4.92-7.85)	7.07 (5.41-9.16)	7.98 (5.87-10.6)	9.25 (6.55-12.7)	10.3 (7.07-14.2)
10-day	2.97 (2.50-3.50)	3.42 (2.87-4.03)	4.21 (3.52-4.97)	4.91 (4.09-5.83)	5.93 (4.82-7.35)	6.77 (5.37-8.51)	7.66 (5.88-9.87)	8.61 (6.36-11.4)	9.93 (7.07-13.6)	11.0 (7.61-15.2)
20-day	3.99 (3.38-4.65)	4.58 (3.88-5.35)	5.59 (4.71-6.55)	6.45 (5.41-7.59)	7.67 (6.25-9.36)	8.64 (6.88-10.7)	9.63 (7.44-12.3)	10.7 (7.93-14.0)	12.1 (8.66-16.3)	13.2 (9.21-18.1)
30-day	4.80 (4.08-5.57)	5.53 (4.70-6.43)	6.73 (5.70-7.84)	7.72 (6.51-9.04)	9.10 (7.43-11.0)	10.2 (8.12-12.5)	11.2 (8.70-14.2)	12.3 (9.18-16.0)	13.8 (9.90-18.5)	14.9 (10.4-20.3)
45-day	5.80 (4.96-6.70)	6.69 (5.71-7.73)	8.10 (6.89-9.39)	9.25 (7.83-10.8)	10.8 (8.83-12.9)	12.0 (9.59-14.6)	13.1 (10.2-16.4)	14.2 (10.6-18.4)	15.7 (11.3-20.9)	16.8 (11.8-22.8)
60-day	6.64 (5.69-7.63)	7.64 (6.53-8.79)	9.22 (7.86-10.6)	10.5 (8.89-12.2)	12.1 (9.95-14.5)	13.4 (10.7-16.2)	14.6 (11.3-18.1)	15.7 (11.8-20.2)	17.1 (12.4-22.7)	18.2 (12.9-24.7)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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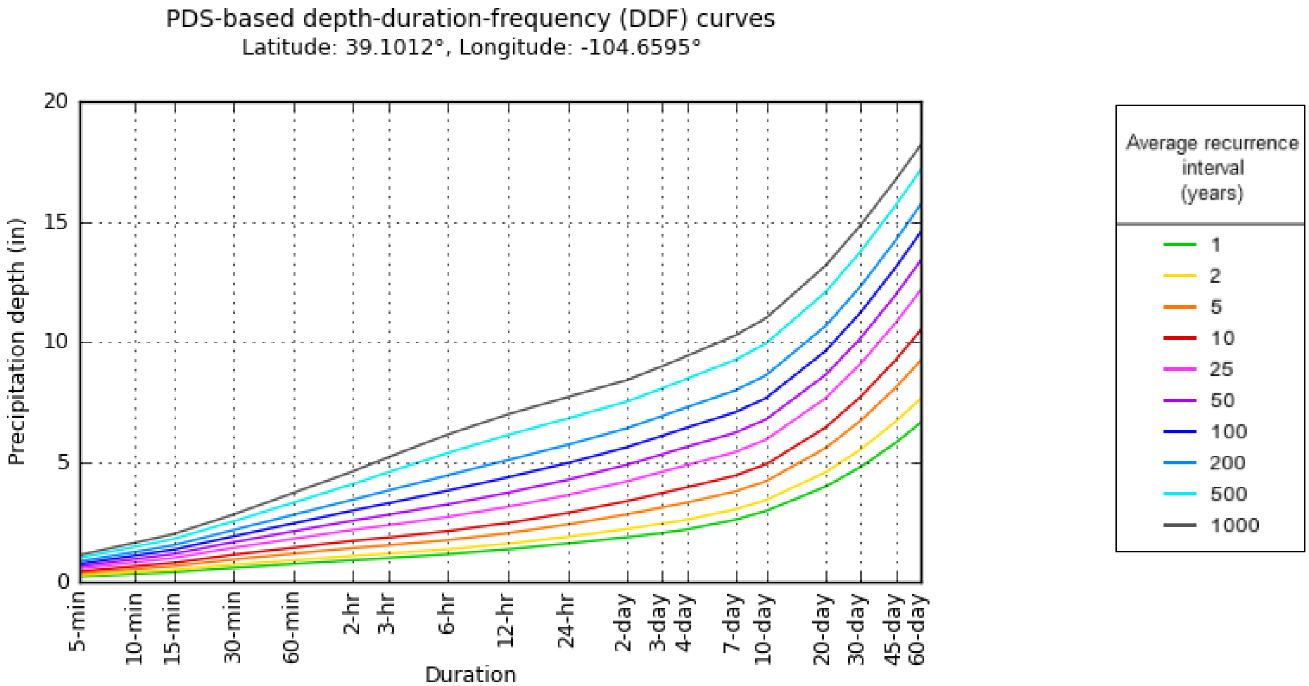
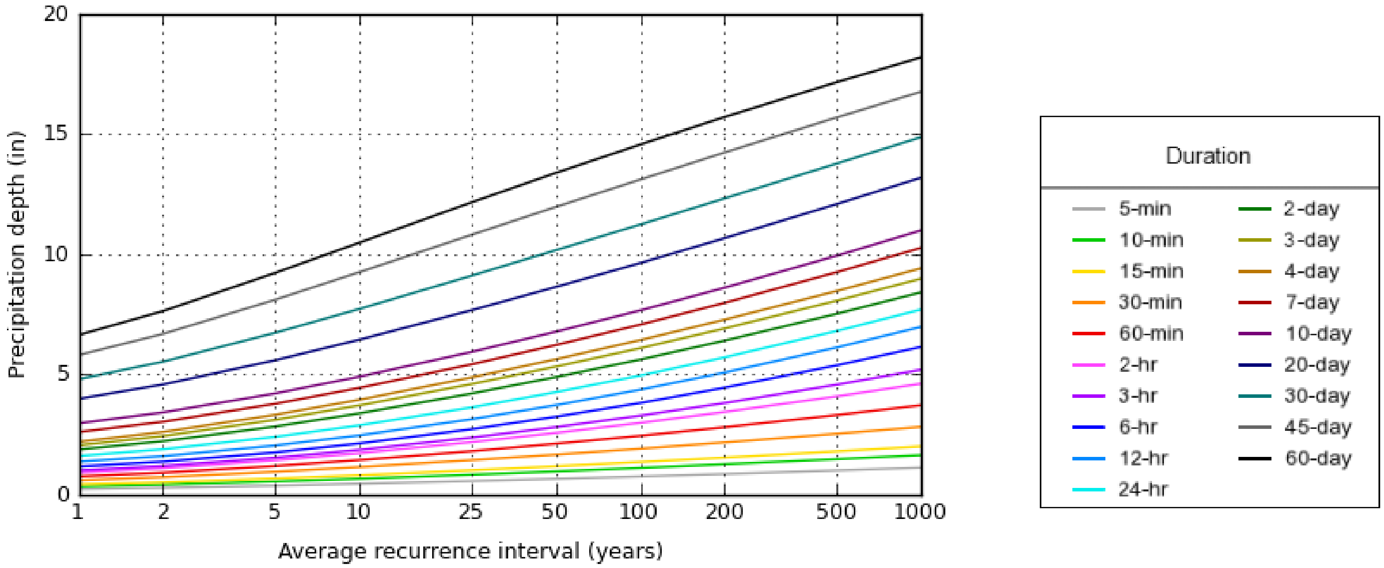
PF graphical





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Created (GMT): Tue Apr 18 21:08:18 2023

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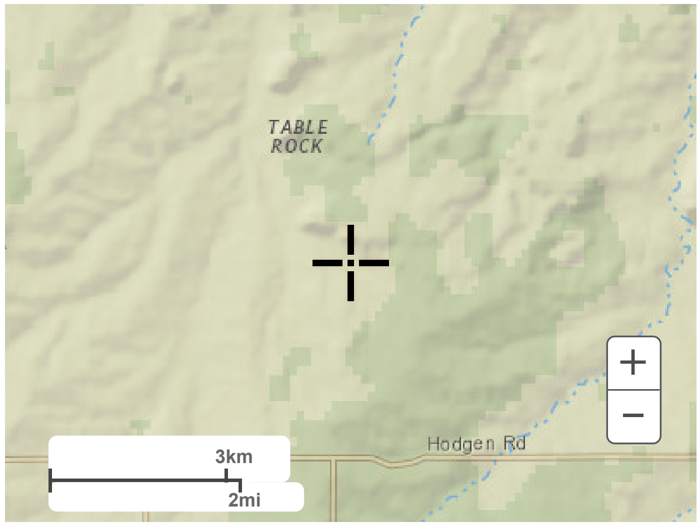
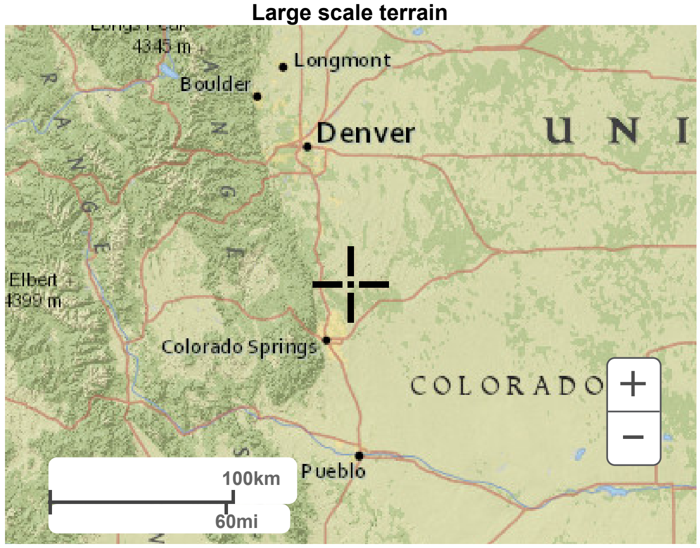
Maps & aerials

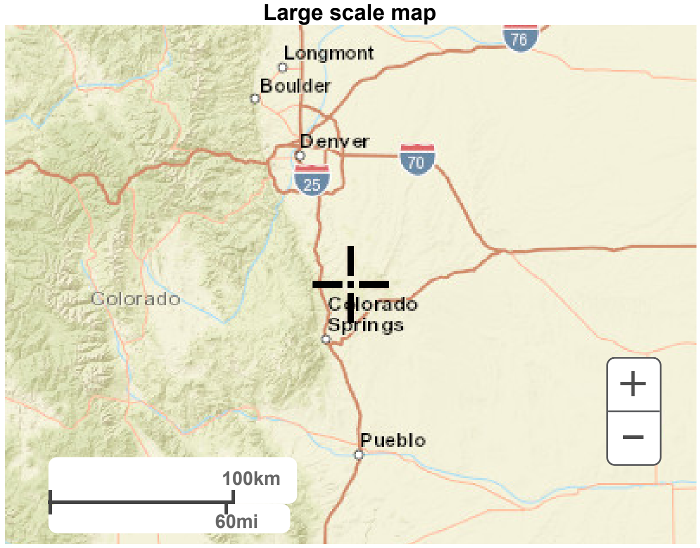
Small scale terrain



Large scale terrain



Large scale map



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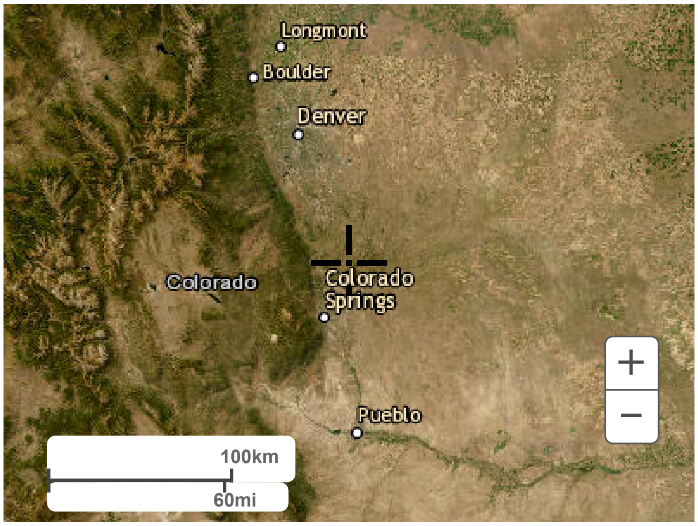

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US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

VII. Colorado Water Resources Jurisdictional Dam Correspondence

James Oakden

From:	McCormick - DNR, Brian <brian.c.mccormick@state.co.us>
Sent:	Friday, August 11, 2023 11:33
To:	James Oakden
Cc:	Batka - DNR, John; David Gorman; Paolo Clavijo - DNR
Subject:	Re: Dam/Embankment Determination: 61188-High Forest Estates Subdivision Filing No. 1
Attachments:	DWR_624495.pdf; NOI to Construct a Non-Jurisdictional Water Impoundment Structure.pdf; CO_DamSafetyRules_01JAN2020.pdf; 61188-Dam Determination-reduced.pdf

James,

Thanks for reaching out to Dam Safety with this question. This dam is in my region so I will be your primary Dam Safety point of contact. I've brought Paolo Clavijo, District 8 water commissioner, into the conversation as well. Paolo will be your point of contact related to reservoir administration, required augmentation, changes in water rights, etc.

The dam appears to have been constructed as a Livestock Water Tank (H.F. Vessels, 10260) in 1964. Jurisdictional height appears to be 9.5 ft from review of publicly available LiDAR data. Jurisdictional height is calculated from the spillway crest elevation, not the dam crest elevation. Based on height, and reservoir area and volume at full pool, this structure is of non-jurisdictional size. Per Rule 4.6.2, non-jurisdictional sized dams are regulated and subject to the authority of the State Engineer.

Please submit the attached NOI for a Non-Jurisdictional sized dam so that we can get this on the roster and assign accurate ownership in state records. Ownership of the dam will be tied to ownership of the underlying land - unless some type of ownership agreement and appropriate easement is recorded in County land records. CRS 37-87-104, clarifies the dam Owner's is liability for damages downstream.

If the dam is no longer needed and the Owner is wishes to minimize their liability, the dam can be breached in accordance with Rule 9.1.3.

Let me know if I can be of further assistance.

Brian McCormick, PE
Dam Safety Engineer
COLORADO
Division of Water Resources
Department of Natural Resources

719.248.3876
4255 Sinton Road, Colorado Springs, CO 80907
brian.c.mccormick@state.co.us
https://dwr.colorado.gov/services/dam-safety

---------- Forwarded message ---------
From: **James Oakden** <jameso@mvecivil.com>
Date: Wed, Aug 9, 2023 at 10:38 AM
Subject: Dam/Embankment Determination: 61188-High Forest Estates Subdivision Filing No. 1
To: John.Batka@state.co.us <John.Batka@state.co.us>
Cc: David Gorman <daveg@mvecivil.com>

EL PASO (21) 1-8 to 21 ✓

STATE OF COLORADO

DIVISION OF WATER RESOURCES

OFFICE OF STATE ENGINEER

10260

APPLICATION FOR LIVESTOCK WATER TANK: H.F. Vessels [redacted] #1-64
Title and Number

This application and statement is made in conformity with the provisions of the Livestock Water Tank Act of Colorado, Chap. 8-17-1, C.R.S. 1953.

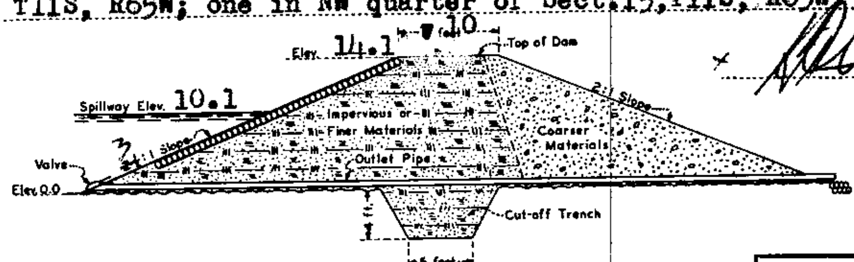
This application must be accompanied by a filing fee of one dollar, payable to the State Engineer of Colorado.

H.F. Vessels [redacted] — Name of Owner
Route #3, Colorado Springs, Colo. — P.O. Address

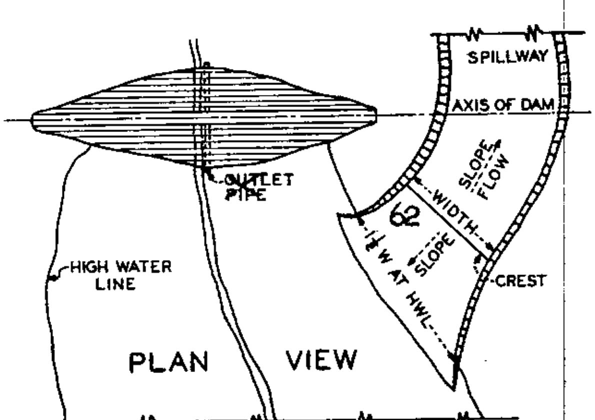
Tank located in the SW Quarter of Section 10, Township 11SO, Range 65W, 6th PM
Water course on which tank is located tributary to East Cherry Creek (16)
Is water course normally dry yes : Subject to floods no
Approximate area of drainage basin above tank 840 acres
Vegetative cover above tank: Cultivated ...., Pasture x, Forest ...., Brush x
Topography of drainage basin: Steep ...., Medium x, Flat ....
Character of surface formation of drainage basin: Rock ...., Rocky Soil ...., Soil x
Approximate elevation of drainage basin above sea level 7400 feet.
Height of top of dam above bottom of water course 14.1 feet.
Height of bottom of spillway above bottom of water course 10.1 feet.
Approximate capacity of tank 6.8 6.8 acre feet.
Location of spillway with respect to dam around the left end looking downstream
Bottom width of spillway at narrowest point 62 feet.
Distance of lower end of spillway below dam 500 feet.
Formations in which spillway is located: Rock ...., Shale ...., Clay ...., Earth x, or Mixture of Soil and Rock ....
Width of top of dam 10 feet. Length of dam 330 feet.
Slope of upstream face of dam 3:1 Slope of downstream face of dam 2:1
Kind and size of outlet pipe barrel 12" diameter - riser 18" diameter CMP
Nature of riprap or other protection to be placed over water face of dam none

Give location by section, township and range and size of every other stock tank now constructed in drainage basin in which this tank will be located one in SW Quarter of Sect. 15, T11S, R65W; one in NW quarter of Sect. 15, T11S, R65W.

[signature]
Owner



MAXIMUM CROSS-SECTION OF DAM



MAY 20 1964
Date of receipt of application

MAY 20 1964
Date of approval

10260
Number assigned tank

J. E. Whitten
STATE ENGINEER

Glen R. Rogers
DEPUTY

B. Hydrologic Calculations

I. Rational Method: Runoff Coefficients and Percent Imperviousness Table 6-6
II. Rational Method: Colorado Springs Rainfall Intensity Duration Frequency Figure 6-5
III. Rational Method: Rural Residential Imperviousness Assumptions
IV. SCS Method: Curve Number
V. SCS Method: Overland Flow n
VI. SCS Method: Shallow Flow n
VII. SCS Method: Concentrated Flow n
VIII. Hydrologic Calculations Summary Form SF-1 for Existing & Developed Conditions
IX. Hydrologic Calculations Summary 5-yr Form SF-2 for Existing & Developed Conditions
X. Hydrologic Calculations Summary 100-yr Form SF-2 for Existing & Developed Conditions
XI. CN Calculations
XII. Time of Concentration Calculations
XIII. HEC-HMS Calculations Summary 5-yr Existing & Developed Conditions
XIV. HEC-HMS Calculations Summary 100-yr Existing & Developed Conditions

I. Rational Method: Runoff Coefficients

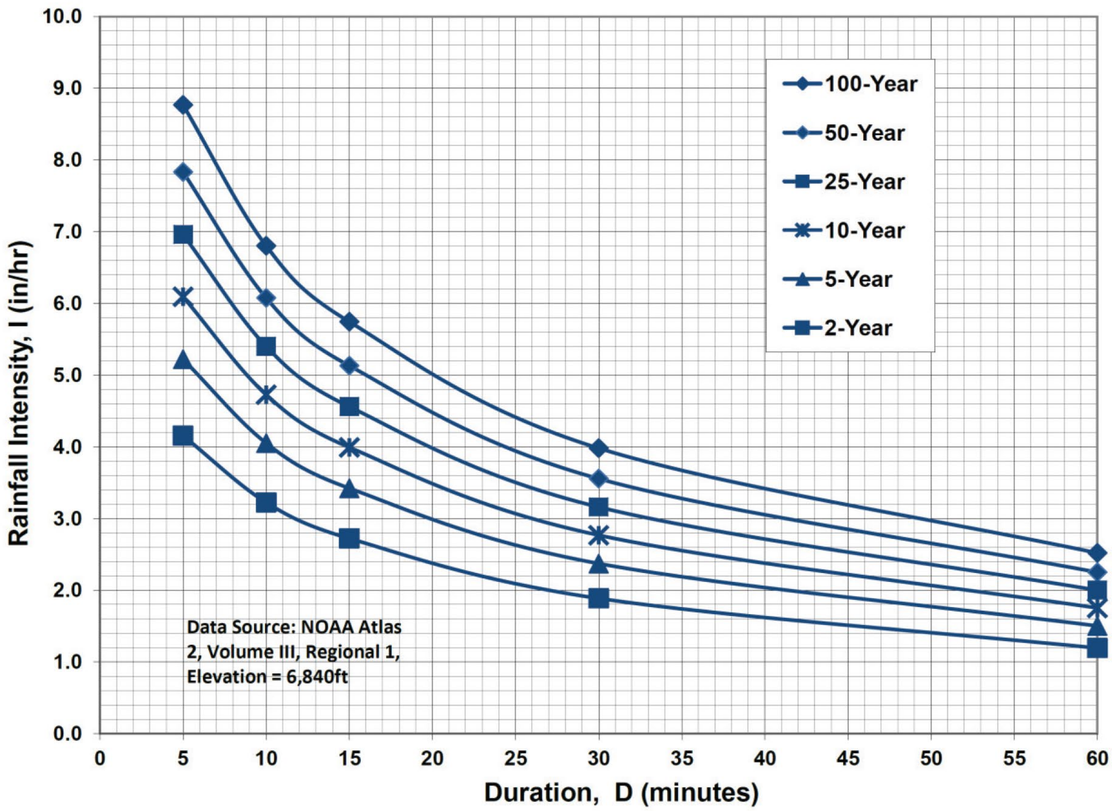
Runoff Coefficients and Percent Imperviousness Table 6-6, El Paso County DCM

II. Rational Method: Intensity Duration Frequency Curves

Rainfall Intensity Duration Frequency Figure 6-5, El Paso County DCM

III. Rational Method: Rural Residential Imperviousness Assumptions

Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency



IDF Equations

$$I_{100} = -2.52 \ln(D) + 12.735$$

$$I_{50} = -2.25 \ln(D) + 11.375$$

$$I_{25} = -2.00 \ln(D) + 10.111$$

$$I_{10} = -1.75 \ln(D) + 8.847$$

$$I_{5} = -1.50 \ln(D) + 7.583$$

$$I_{2} = -1.19 \ln(D) + 6.035$$

Note: Values calculated by equations may not precisely duplicate values read from figure.

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													
⅛ 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
¼ 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
⅓ 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
½ 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

Typical Rural Residential Imperviousness Assumptions (Rational Method)													
Lot Size	Impervious Percent	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
2-1/2 Acre	11.00%	0.08	0.12	0.12	0.21	0.22	0.3	0.31	0.41	0.36	0.48	0.4	0.53
5 Acre	7.00%	0.06	0.09	0.10	0.19	0.2	0.28	0.29	0.4	0.34	0.46	0.38	0.52
10+ Acre	2.00%	0.03	0.06	0.09	0.16	0.17	0.26	0.26	0.38	0.31	0.45	0.36	0.51

IV. SCS Method: Curve Number

NRCS Curve Numbers (Developed Conditions), Table 6-10, City of Colorado Springs DCM Volume 1

V. SCS Method: Overland Flow n

Roughness Coefficients (Manning's n) for NRCS Overland Flow, Table 6-11, City of Colorado Springs DCM Volume 1

VI. SCS Method: Shallow Flow n

Estimate of Average Concentrated Shallow Flow, Figure 6-13, City of Colorado Springs DCM Volume 1

VII. SCS Method: Concentrated Flow n

Roughness Coefficients, Table 12-2, City of Colorado Springs DCM Volume 1

Table 6-10. NRCS Curve Numbers for Frontal Storms & Thunderstorms for Developed Conditions (ARCII)

Fully Developed Urban Areas (vegetation established)[1]	Treatment	Hydrologic Condition	% I	Pre-Development CN			
				HSG A	HSG B	HSG C	HSG D
Open space (lawns, parks, golf courses, cemeteries, etc.):							
Poor condition (grass cover < 50%)	-----	-----	---	68	79	86	89
Fair condition (grass cover 50% to 75%)	-----	-----	---	49	69	79	84
Good condition (grass cover > 75%)	-----	-----	---	39	61	74	80
Impervious areas:							
Paved parking lots, roofs, driveways, etc. (excluding right-of-way	-----	-----	---	98	98	98	98
Streets and roads:							
Paved; curbs and storm sewers (excluding right-of-way)	-----	-----	---	98	98	98	98
Paved; open ditches (including right-of-way)	-----	-----	---	83	89	92	93
Gravel (including right-of-way)	-----	-----	---	76	85	89	91
Dirt (including right-of-way)	-----	-----	---	72	82	87	89
Western desert urban areas:							
Natural desert landscaping (pervious areas only)	-----	-----	---	63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)	-----	-----	---	96	96	96	96
Urban districts:							
Commercial and business	-----	-----	85	89	92	94	95
Industrial	-----	-----	72	81	88	91	93
Residential districts by average lot size:							
1/8 acre or less (town houses)	-----	-----	65	77	85	90	92
1/4 acre	-----	-----	38	61	75	83	87
1/3 acre	-----	-----	30	57	72	81	86
1/2 acre	-----	-----	25	54	70	80	85
1 acre	-----	-----	20	51	68	79	84
2 acres	-----	-----	12	46	65	77	82
Developing Urban Areas[1]	**Treatment[2]**	**Hydrologic Condition[3]**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Newly graded areas (pervious areas only, no vegetation)	-----	-----	---	77	86	91	94
Cultivated Agricultural Lands[1]	**Treatment**	**Hydrologic Condition**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Fallow	Bare soil	-----	---	77	86	91	94
	Crop residue cover (CR)	Poor	---	76	85	90	93
		Good	---	74	83	88	90
Row crops	Straight row (SR)	Poor	---	72	81	88	91
		Good	---	67	78	85	89
	SR + CR	Poor	---	71	80	87	90
		Good	---	64	75	82	85
	Contoured (C)	Poor	---	70	79	84	88
		Good	---	65	75	82	86
	C + CR	Poor	---	69	78	83	87
		Good	---	64	74	81	85
	Contoured & terraced (C&T)	Poor	---	66	74	80	82
		Good	---	62	71	78	81
	C&T+ CR	Poor	---	65	73	79	81
		Good	---	61	70	77	80
Small grain	SR	Poor	---	65	76	84	88
		Good	---	63	75	83	87
	SR + CR	Poor	---	64	75	83	86
		Good	---	60	72	80	84
	C	Poor	---	63	74	82	85
		Good	---	61	73	81	84
	C + CR Poor	Poor	---	62	73	81	84
		Good	---	60	72	80	83
	C&T	Poor	---	61	72	79	82
		Good	---	59	70	78	81
	C&T+ CR	Poor	---	60	71	78	81
		Good	---	58	69	77	80

Table 6-10. (continued)

Other Agricultural Lands[1]	**Treatment**	**Hydrologic Condition**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
	-----	Poor	---	68	79	86	89
Pasture, grassland, or range—continuous forage for grazing[4]	-----	Fair	---	49	69	79	84
	-----	Good	---	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay	-----	-----	---	30	58	71	78
	-----	Poor	---	48	67	77	83
Brush—brush-weed-grass mixture with brush the major element[5]	-----	Fair	---	35	56	70	77
	-----	Good	---	30	48	65	73
	-----	Poor	---	57	73	82	86
Woods—grass combination (orchard or tree farm)[6]	-----	Fair	---	43	65	76	82
	-----	Good	---	32	58	72	79
	-----	Poor	---	45	66	77	83
Woods[7]	-----	Fair	---	36	60	73	79
	-----	Good	---	30	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots	-----	-----	---	59	74	82	86
Arid and Semi-arid Rangelands[1]	**Treatment**	**Hydrologic Condition[8]**	**% I**	**HSG A**	**HSG B**	**HSG C**	**HSG D**
Herbaceous—mixture of grass, weeds, and low-growing brush, with brush the minor element	-----	Poor	---	-----	80	87	93
	-----	Fair	---	-----	71	81	89
	-----	Good	---	-----	62	74	85
Oak-aspen—mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	-----	Poor	---	-----	66	74	79
	-----	Fair	---	-----	48	57	63
	-----	Good	---	-----	30	41	48
	-----	Poor	---	-----	75	85	89
Pinyon-juniper—pinyon, juniper, or both; grass understory	-----	Fair	---	-----	58	73	80
	-----	Good	---	-----	41	61	71
	-----	Poor	---	-----	67	80	85
Sagebrush with grass understory	-----	Fair	---	-----	51	63	70
	-----	Good	---	-----	35	47	55
Desert shrub—major plants include saltbush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus	-----	Poor	---	63	77	85	88
	-----	Fair	---	55	72	81	86
	-----	Good	---	49	68	79	84

$I_a = 0.1\,S$

2. Crop residue cover applies only i f residue i s on at least 5% of the surface throughout the year.

3. Hydraulic condition i s based on combination factors that affect infiltration and runoff, including (a) density and canopy of vegetative areas, (b) amount of year- round cover, (c) amount of grass or close-seeded legumes, (d) percent of residue cover on the land surface (good ≥ 20%), and (e) degree of surface roughness. Poor: Factors impair infiltration and tend to increase runoff. Good: Factors encourage average and better than average infiltration and tend to decrease runoff.

4. Poor: <50%) ground cover or heavily grazed with no mulch. Fair: 50 to 75% ground cover and not heavily grazed. Good: > 75% ground cover and l ightly or only occasional

5. Poor: <50% ground cover. Fair: 50 to 75% ground cover. Good: >75% ground cover.

6. CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods

7. Poor: Forest l i tter, small trees, and brush are destroyed by heavy grazing or regular burning. Fair: Woods are grazed but not burned, and some forest l i tter covers the soil. Good: Woods are protected from grazing, and l i tter and brush adequately cover the soil.

8. Poor: <30% ground cover (l i tter, grass, and brush overstory). Fair: 30 to 70% ground cover. Good: > 70% ground cover.

4.6 Lag Time

While the NRCS curve numbers are used to calculate the volume of runoff and magnitude of losses, to transform the volume of runoff into a hydrograph using the NRCS dimensionless unit hydrograph, the lag time must be specified. The lag time is defined as the time from the centroid of the rainfall distribution of a storm to the peak discharge produced by the watershed. For this Manual, the lag time is defined as a fraction of the time of concentration (t_c) as shown in Equation 6-13.

$$t_{lag} = 0.6 \cdot t_c \qquad \text{(Eq. 6-13)}$$

4.6.1 Overland Flow Time for NRCS Method

The overland flow time represents the time for runoff to travel over the upper most portion of a drainage basin before there is enough flow to become concentrated into identifiable flow paths. This travel time can be estimated using the slope of the ground and the type of ground cover. Overland flow lengths should not exceed 100 feet for urban areas and 300 feet for undeveloped areas.

$T_i = 0.007(n \cdot L)^{0.8} / (P_2)^{0.5} S^{0.4}$ (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)

Typical roughness coefficients for the overland flow portion of the drainage basin are provided in Table 6-11. Be aware that Manning's roughness coefficients for overland flow are different from Manning's n values for open channels and conduits. Manning's n values for channels and conduits should not be used for overland flow.

Table 6-11. Roughness Coefficients (Manning's n) for NRCS Overland Flow

Surface description	n[1]
Smooth surfaces (concrete, asphalt, gravel, bare soil, etc.)	0.011
Fallow (no residue)	0.05
Cultivated Soils:	
Residue cover <20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermuda grass	0.41
Range (natural)	0.13
Woods [3]	
Light underbrush	0.40
Dense underbrush	0.80

4. [1]The values are a composite of information compiled by Engman (1986).

5. [2]Includes species such as weeping lovegrass, bluegrass, buffalograss, blue gramma grass, native grass mixtures.

6. [3]When selecting n, consider cover to a height of about 0.1 feet. This is the only part of the plant cover that will obstruct sheet flow.

Figure 6-13. Estimate of Average Concentrated Shallow Flow

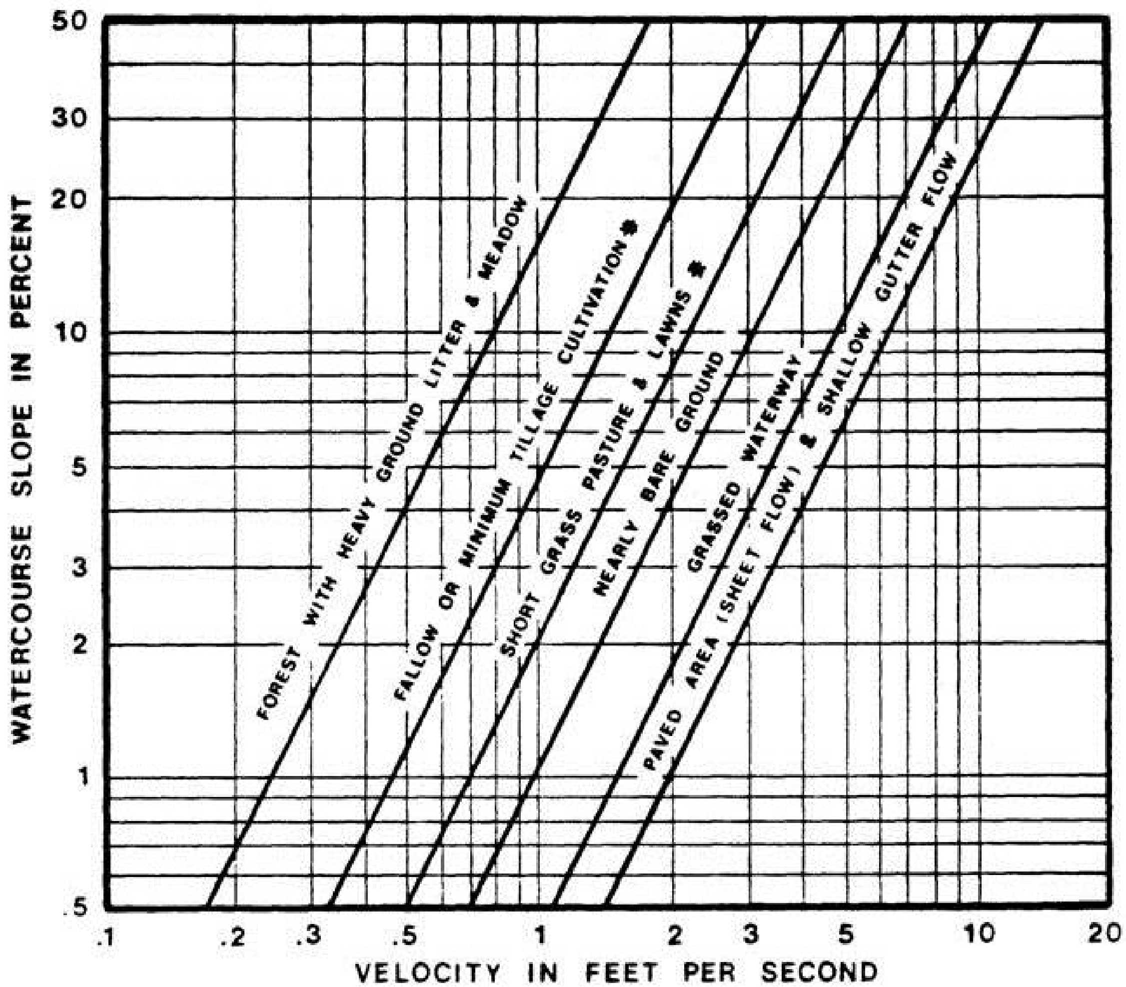


Table 12-2. Roughness Coefficients

Channel Description	Roughness Coefficient (n)		
	Minimum	Typical	Maximum
Natural Streams (top width at flood stage <100 feet			
1. Streams on Plain			
a. Clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
b. Same as above, but more stones and weeds	0.030	0.035	0.040
c. Clean, winding, some pools and shoals	0.033	0.040	0.045
d. Same as above, but some weeds and stones	0.035	0.045	0.050
e. Same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. Same as c, but more stones	0.045	0.050	0.060
g. Sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150
2. Mountain Streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
a. Bottom: gravels, cobbles, and few boulders	See Jarrett's equation*		
b. Bottom: cobbles with large boulders			
Major Streams (top width at flood stage > 100 feet)			
1. Regular section with no boulders or brush	0.025		0.060
2. Irregular and rough section	0.035		0.100
Grass Areas **	**Flow Depth =<u>0.1-1.5 ft</u>		Flow Depth > <u>3.0 ft</u>
1. Bermuda grass, buffalo grass, Kentucky bluegrass			
a. Mowed to 2 inches	0.035		0.030
b. Length = 4 to 6 inches	0.040		0.030
2. Good Stand, any grass			
a. Length = 12 inches	0.070		0.035
b. Length = 24 inches	0.100		0.035
3. Fair Stand, any grass			
a. Length = 12 inches	0.060		0.035
b. Length = 24 inches	0.070		0.035

*Jarrett's equation: $n = 0.39\ S_f^{0.38}\ R^{-0.16}$, where S_f equals friction slope and R equals the hydraulic radius.
** The n values shown for the grassed channel at the 0.1- to 1.5-ft depths represent average values for this depth range. Actual n values vary significantly within this depth range. For more information, see the *Handbook of Channel Design for Soil and Water Conservation* (SCS 1954).

2.2 HEC-RAS Analysis

Hydraulic analyses necessary to confirm that design criteria are satisfied can be complicated and often involve variable boundary conditions, various flow rates, a varying water surface profile, irregular channel geometry and crossing structures. Most project conditions require using the USACE's HEC-RAS computer software, which is available free from their website, to adequately assess project conditions. The application of the HEC-RAS computer software shall use model parameters described in this Manual or in the program documentation or justification shall be provided for values used that are not consistent with these documents.

VIII. Hydrologic Calculations Summary Form SF-1 for Existing & Developed Conditions

IX. Hydrologic Calculations Summary 5-yr Form SF-2 for Existing & Developed Conditions

X. Hydrologic Calculations Summary 100-yr Form SF-2 for Existing & Developed

Job No.:	61188	Date:	5/1/2023 13:56
Project:	High Forest Estates	Calcs By:	O. Ali
		Checked By:	

Time of Concentration (Modified from Standard Form SF-1)

Sub-Basin	Sub-Basin Data				Overland			Shallow Channel				Channelized				t_c Check		
	Area (Acres)	C_5	C_{100}/CN	% Imp.	L_0 (ft)	S_0 (%)	t_i (min)	L_{0t} (ft)	S_{0t} (ft/ft)	v_{0sc} (ft/s)	t_t (min)	L_{0c} (ft)	S_{0c} (ft/ft)	v_{0c} (ft/s)	t_c (min)	L (min)	$t_{c,alt}$ (min)	t_c (min)
OS-14	20.95	0.09	0.36	2%	100	3%	12.7	1422	0.082	2.0	11.8	0	0.000	0.0	0.0	1522	18.5	18.5
OS-15	82.59	0.09	0.36	2%	100	1%	18.2	2969	0.039	1.4	35.6	0	0.000	0.0	0.0	3069	27.1	27.1
OS-16	24.31	0.09	0.36	2%	100	1%	18.2	1843	0.075	1.9	16.0	0	0.000	0.0	0.0	1943	20.8	20.8
EX-A1	1.16	0.12	0.38	6%	100	3%	12.3	145	0.048	1.5	1.6	158	0.025	1.7	1.6	403	12.2	12.2
EX-A2	1.11	0.08	0.35	0%	100	10%	8.6	107	0.084	2.0	0.9	168	0.006	1.1	2.5	375	12.1	12.0
EX-A3	4.45	0.10	0.36	3%	100	7%	9.5	630	0.044	1.5	7.1	238	0.017	2.7	1.4	968	15.4	15.4
EX-A4	4.08	0.10	0.36	3%	100	5%	10.6	364	0.036	1.3	4.6	260	0.058	4.3	1.0	724	14.0	14.0
EX-A5	3.56	0.13	0.38	8%	100	5%	10.3	514	0.047	1.5	5.7	118	0.076	4.7	0.4	732	14.1	14.1
A1	1.16	0.12	0.38	6%	100	3%	12.3	145	0.048	1.5	1.6	158	0.025	1.7	1.6	403	12.2	12.2
A2	1.11	0.08	0.35	0%	100	10%	8.6	107	0.084	2.0	0.9	168	0.006	1.1	2.5	375	12.1	12.0
A3	4.45	0.10	0.36	3%	100	7%	9.5	630	0.044	1.5	7.1	238	0.017	2.7	1.4	968	15.4	15.4
A4	4.08	0.10	0.36	3%	100	5%	10.6	364	0.036	1.3	4.6	260	0.058	4.3	1.0	724	14.0	14.0
A5	3.56	0.17	0.41	13%	100	5%	9.9	514	0.047	1.5	5.7	118	0.076	4.8	0.4	732	14.1	14.1

Job No.: **61188**
Project: **High Forest Estates**
Design Storm: **5-Year Storm** *(20% Probability)*
Jurisdiction: **DCM**

Date: **5/1/2023 13:56**
Calcs By: **O. Ali**
Checked By:

Sub-Basin and Combined Flows (Modified from Standard Form SF-2)

				Direct Runoff				Combined Runoff				Streetflow			Pipe Flow					Travel Time		
DP	Sub-Basin	Area (Acres)	C5	t_c (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	t_c (min)	CA (Acres)	I5 (in/hr)	Q5 (cfs)	Slope (%)	Length (ft)	Q (cfs)	Q (cfs)	Slope (%)	Mnngs n	Length (ft)	D_{Pipe} (in)	Length (ft)	v_{0sc} (ft/s)	t_t (min)
	OS-14	20.95	0.09	18.5	1.89	3.21	6.05															
	OS-15	82.59	0.09	27.1	7.49	2.64	19.75															
	OS-16	24.31	0.09	20.8	2.19	3.03	6.63															
	EX-A1	1.16	0.12	12.2	0.14	3.83	0.53															
	EX-A2	1.11	0.08	12.0	0.09	3.85	0.34															
	EX-A3	4.45	0.10	15.4	0.44	3.48	1.53															
	EX-A4	4.08	0.10	14.0	0.40	3.62	1.47															
	EX-A5	3.56	0.13	14.1	0.47	3.62	1.68															
	A1	1.16	0.12	12.2	0.14	3.83	0.53															
	A2	1.11	0.08	12.0	0.09	3.85	0.34															
	A3	4.45	0.10	15.4	0.44	3.48	1.53															
	A4	4.08	0.10	14.0	0.40	3.62	1.47															
	A5	3.56	0.17	14.1	0.59	3.62	2.13															

DCM: I = C1 * ln (tc) + C2
C1: 1.5
C1: 7.583

Job No.: **61188**
Project: **High Forest Estates**
Design Storm: **100-Year Storm** *(1% Probability)*
Jurisdiction: **DCM**

Date: **5/1/2023 13:56**
Calcs By: **O. Ali**
Checked By:

Sub-Basin and Combined Flows (Modified from Standard Form SF-2)

				Direct Runoff				Combined Runoff				Streetflow			Pipe Flow					Travel Time		
	Sub-	Area		t_c	CA	I100	Q100	t_c	CA	I100	Q100	Slope	Length	Q	Q	Slope	Mnngs	Length	D_{Pipe}	Length	v_{0sc}	t_t
DP	Basin	(Acres)	C100	(min)	(Acres)	(in/hr)	(cfs)	(min)	(Acres)	(in/hr)	(cfs)	(%)	(ft)	(cfs)	(cfs)	(%)	n	(ft)	(in)	(ft)	(ft/s)	(min)
	OS-14	20.95	0.36	18.5	7.54	5.39	40.63															
	OS-15	82.59	0.36	27.1	29.85	4.42	132.08															
	OS-16	24.31	0.36	20.8	8.75	5.09	44.52															
	EX-A1	1.16	0.38	12.2	0.44	6.42	2.81															
	EX-A2	1.11	0.35	12.0	0.39	6.47	2.52															
	EX-A3	4.45	0.36	15.4	1.62	5.85	9.46															
	EX-A4	4.08	0.36	14.0	1.48	6.08	9.01															
	EX-A5	3.56	0.38	14.1	1.37	6.07	8.32															
	A1	1.16	0.38	12.2	0.44	6.42	2.81															
	A2	1.11	0.35	12.0	0.39	6.47	2.52															
	A3	4.45	0.36	15.4	1.62	5.85	9.46															
	A4	4.08	0.36	14.0	1.48	6.08	9.01															
	A5	3.56	0.41	14.1	1.46	6.07	8.85															

DCM: I = C1 * ln (tc) + C2
C1: 2.52
C1: 12.735

Sub-Basin OS-14 Runoff Calculations

Job No.:	**61188**	Date:	**5/1/2023 13:56**
Project:	**High Forest Estates**	Calcs by:	**O. Ali**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
5 Acre	-	0.00	0.06	0.1	0.2	0.29	0.34	0.38	7%
10+ Acre	912,380	20.95	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**912,380**	**20.95**	**0.03**	**0.09**	**0.17**	**0.26**	**0.31**	**0.36**	**2.0%**
	912,380								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	1,522	120	-	-	-	-	
Initial Time	100	3	0.030	-	12.7	18.5	DCM Eq. 6-8
Shallow Channel	1,422	117	0.082	2.0	11.8	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	Trap Ditch
				t_c	**18.5**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.57	3.21	3.75	4.28	4.82	5.39
Runoff (cfs)	1.6	**6.1**	13.3	23.3	31.3	**40.6**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.6	**6.1**	13.3	23.3	31.3	**40.6**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin OS-15 Runoff Calculations

Job No.:	**61188**	Date:	**5/1/2023 13:56**
Project:	**High Forest Estates**	Calcs by:	**O. Ali**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
5 Acre	252,685	5.80	0.06	0.1	0.2	0.29	0.34	0.38	7%
10+ Acre	3,345,087	76.79	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**3,597,772**	**82.59**	**0.03**	**0.09**	**0.17**	**0.26**	**0.31**	**0.36**	**2.4%**
	3,597,772								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft; C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	3,069	118	-	-	-	-	
Initial Time	100	1	0.010	-	18.2	27.1	DCM Eq. 6-8
Shallow Channel	2,969	117	0.039	1.4	35.6	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	Trap Ditch
				t_c	**27.1**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.11	2.64	3.08	3.52	3.96	4.42
Runoff (cfs)	5.6	**19.8**	43.7	76.1	102.0	**132.1**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	5.6	**19.8**	43.7	76.1	102.0	**132.1**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin OS-16 Runoff Calculations

Job No.:	**61188**	Date:	**5/1/2023 13:56**
Project:	**High Forest Estates**	Calcs by:	**O. Ali**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
5 Acre	-	0.00	0.06	0.1	0.2	0.29	0.34	0.38	7%
10+ Acre	1,058,946	24.31	0.03	0.09	0.17	0.26	0.31	0.36	2%
Combined	**1,058,946**	**24.31**	**0.03**	**0.09**	**0.17**	**0.26**	**0.31**	**0.36**	**2.0%**
	1,058,946								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	1,943	140	-	-	-	-	
Initial Time	100	1	0.010	-	18.2	20.8	DCM Eq. 6-8
Shallow Channel	1,843	139	0.075	1.9	16.0	-	DCM Eq. 6-9
Channelized			0.000	0.0	0.0	-	Trap Ditch
				t_c	**20.8**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.42	3.03	3.54	4.04	4.55	5.09
Runoff (cfs)	1.8	**6.6**	14.6	25.5	34.3	**44.5**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.8	**6.6**	14.6	25.5	34.3	**44.5**

DCM: $I = C1 * \ln(tc) + C2$

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin EX-A1 Runoff Calculations

Job No.:	**61188**	Date:	**5/1/2023 13:56**
Project:	**High Forest Estates**	Calcs by:	**O. Ali**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	46,789	1.07	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	3,862	0.09	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**50,651**	**1.16**	**0.06**	**0.12**	**0.19**	**0.28**	**0.33**	**0.38**	**6.1%**
	50,651								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	403	14	-	-	-	-	
Initial Time	100	3	0.030	-	12.3	12.2	DCM Eq. 6-8
Shallow Channel	145	7	0.048	1.5	1.6	-	DCM Eq. 6-9
Channelized	158	4	0.025	1.7	1.6	-	V-Ditch
				t_c	**12.2**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.05	3.83	4.46	5.10	5.74	6.42
Runoff (cfs)	0.2	**0.5**	1.0	1.7	2.2	**2.8**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.2	**0.5**	1.0	1.7	2.2	**2.8**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin EX-A2 Runoff Calculations

Job No.:	**61188**	Date:	**5/1/2023 13:56**
Project:	**High Forest Estates**	Calcs by:	**O. Ali**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	48,478	1.11	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**48,478**	**1.11**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	48,478								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	375	20	-	-	-	-	
Initial Time	100	10	0.100	-	8.6	12.1	DCM Eq. 6-8
Shallow Channel	107	9	0.084	2.0	0.9	-	DCM Eq. 6-9
Channelized	168	1	0.006	1.1	2.5	-	V-Ditch
				t_c	**12.0**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.08	3.85	4.50	5.14	5.78	6.47
Runoff (cfs)	0.1	**0.3**	0.8	1.4	1.9	**2.5**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	**0.3**	0.8	1.4	1.9	**2.5**
DCM: I = C1 * ln (tc) + C2						
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin EX-A3 Runoff Calculations

Job No.:	**61188**	Date:	**5/1/2023 13:56**
Project:	**High Forest Estates**	Calcs by:	**O. Ali**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	188,150	4.32	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	4,693	0.11	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	1,123	0.03	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**193,966**	**4.45**	**0.04**	**0.10**	**0.17**	**0.27**	**0.31**	**0.36**	**2.6%**
	193,966								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	968	39	-	-	-	-	
Initial Time	100	7	0.070	-	9.5	15.4	DCM Eq. 6-8
Shallow Channel	630	28	0.044	1.5	7.1	-	DCM Eq. 6-9
Channelized	238	4	0.017	2.7	1.4	-	V-Ditch
				t_c	**15.4**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.78	3.48	4.06	4.65	5.23	5.85
Runoff (cfs)	0.5	**1.5**	3.0	5.5	7.3	**9.5**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.5	**1.5**	3.0	5.5	7.3	**9.5**

DCM: I = C1 * ln (tc) + C2

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin EX-A4 Runoff Calculations

Job No.:	**61188**	Date:	**5/1/2023 13:56**
Project:	**High Forest Estates**	Calcs by:	**O. Ali**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	171,167	3.93	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	6,659	0.15	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**177,826**	**4.08**	**0.04**	**0.10**	**0.17**	**0.27**	**0.31**	**0.36**	**3.0%**
	177,826								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft　　C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	724	33	-	-	-	-	
Initial Time	100	5	0.050	-	10.6	14.0	DCM Eq. 6-8
Shallow Channel	364	13	0.036	1.3	4.6	-	DCM Eq. 6-9
Channelized	260	15	0.058	4.3	1.0	-	V-Ditch
				t_c	**14.0**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.89	3.62	4.23	4.83	5.43	6.08
Runoff (cfs)	0.5	**1.5**	2.9	5.2	7.0	**9.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.5	**1.5**	2.9	5.2	7.0	**9.0**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin EX-A5 Runoff Calculations

Job No.:	**61188**	Date:	**5/1/2023 13:56**
Project:	**High Forest Estates**	Calcs by:	**O. Ali**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	139,638	3.21	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	15,451	0.35	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**155,089**	**3.56**	**0.07**	**0.13**	**0.20**	**0.29**	**0.34**	**0.38**	**8.0%**
	155,089								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	732	38	-	-	-	-	
Initial Time	100	5	0.050	-	10.3	14.1	DCM Eq. 6-8
Shallow Channel	514	24	0.047	1.5	5.7	-	DCM Eq. 6-9
Channelized	118	9	0.076	4.7	0.4	-	V-Ditch
				t_c	**14.1**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.89	3.62	4.22	4.82	5.43	6.07
Runoff (cfs)	0.8	**1.7**	3.0	5.0	6.5	**8.3**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.8	**1.7**	3.0	5.0	6.5	**8.3**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Z:\61188\Documents\Drainage\Calcs\Hydrology\61188-Runoff Spreadsheet-20230420
EX-A5

Sub-Basin A1 Runoff Calculations

Job No.:	**61188**	Date:	**5/1/2023 13:56**
Project:	**High Forest Estates**	Calcs by:	**O. Ali**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	Runoff Coefficient C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	46,789	1.07	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	3,862	0.09	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**50,651**	**1.16**	**0.06**	**0.12**	**0.19**	**0.28**	**0.33**	**0.38**	**6.1%**
	50,651								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	403	14	-	-	-	-	
Initial Time	100	3	0.030	-	12.3	12.2	DCM Eq. 6-8
Shallow Channel	145	7	0.048	1.5	1.6	-	DCM Eq. 6-9
Channelized	158	4	0.025	1.7	1.6	-	V-Ditch

t_c **12.2 min.**

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	3.05	3.83	4.46	5.10	5.74	6.42
Runoff (cfs)	0.2	**0.5**	1.0	1.7	2.2	**2.8**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.2	**0.5**	1.0	1.7	2.2	**2.8**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin A2 Runoff Calculations

Job No.:	**61188**	Date:	**5/1/2023 13:56**
Project:	**High Forest Estates**	Calcs by:	**O. Ali**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	48,478	1.11	0.02	0.08	0.15	0.25	0.3	0.35	0%
Combined	**48,478**	**1.11**	**0.02**	**0.08**	**0.15**	**0.25**	**0.30**	**0.35**	**0.0%**
	48,478								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft; C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	375	20	-	-	-	-	
Initial Time	100	10	0.100	-	8.6	12.1	DCM Eq. 6-8
Shallow Channel	107	9	0.084	2.0	0.9	-	DCM Eq. 6-9
Channelized	168	1	0.006	1.1	2.5	-	V-Ditch
				t_c	**12.0**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	3.08	3.85	4.50	5.14	5.78	6.47
Runoff (cfs)	0.1	**0.3**	0.8	1.4	1.9	**2.5**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.1	**0.3**	0.8	1.4	1.9	**2.5**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin A3 Runoff Calculations

Job No.:	**61188**	Date:	**5/1/2023 13:56**
Project:	**High Forest Estates**	Calcs by:	**O. Ali**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

Surface	Area (SF)	Area (Acres)	C2	C5	C10	C25	C50	C100	% Imperv.
Pasture/Meadow	188,150	4.32	0.02	0.08	0.15	0.25	0.3	0.35	0%
Roofs	4,693	0.11	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	1,123	0.03	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**193,966**	**4.45**	**0.04**	**0.10**	**0.17**	**0.27**	**0.31**	**0.36**	**2.6%**
	193,966								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft; C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	968	39	-	-	-	-	
Initial Time	100	7	0.070	-	9.5	15.4	DCM Eq. 6-8
Shallow Channel	630	28	0.044	1.5	7.1	-	DCM Eq. 6-9
Channelized	238	4	0.017	2.7	1.4	-	V-Ditch
				t_c	**15.4**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
Intensity (in/hr)	2.78	3.48	4.06	4.65	5.23	5.85
Runoff (cfs)	0.5	**1.5**	3.0	5.5	7.3	**9.5**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.5	**1.5**	3.0	5.5	7.3	**9.5**

DCM: I = C1 * ln (tc) + C2

	2-Yr	5-Yr	10-Yr	25-Yr	50-Yr	100-Yr
C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin A4 Runoff Calculations

Job No.:	**61188**	Date:	**5/1/2023 13:56**
Project:	**High Forest Estates**	Calcs by:	**O. Ali**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	171,167	3.93	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	6,659	0.15	0.57	0.59	0.63	0.66	0.68	0.7	80%
Combined	**177,826**	**4.08**	**0.04**	**0.10**	**0.17**	**0.27**	**0.31**	**0.36**	**3.0%**
	177,826								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft; C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	724	33	-	-	-	-	
Initial Time	100	5	0.050	-	10.6	14.0	DCM Eq. 6-8
Shallow Channel	364	13	0.036	1.3	4.6	-	DCM Eq. 6-9
Channelized	260	15	0.058	4.3	1.0	-	V-Ditch
				t_c	**14.0**	**min.**	

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.89	3.62	4.23	4.83	5.43	6.08
Runoff (cfs)	0.5	**1.5**	2.9	5.2	7.0	**9.0**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	0.5	**1.5**	2.9	5.2	7.0	**9.0**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

Sub-Basin A5 Runoff Calculations

Job No.:	**61188**	Date:	**5/1/2023 13:56**
Project:	**High Forest Estates**	Calcs by:	**O. Ali**
		Checked by:	
Jurisdiction	**DCM**	Soil Type	**B**
Runoff Coefficient	**Surface Type**	Urbanization	**Urban**

Basin Land Use Characteristics

	Area		Runoff Coefficient						%
Surface	**(SF)**	**(Acres)**	**C2**	**C5**	**C10**	**C25**	**C50**	**C100**	**Imperv.**
Pasture/Meadow	131,138	3.01	0.02	0.08	0.15	0.25	0.3	0.35	0%
Gravel	15,451	0.35	0.57	0.59	0.63	0.66	0.68	0.7	80%
Roofs	5,100	0.12	0.71	0.73	0.75	0.78	0.8	0.81	90%
Gravel	2,400	0.06	0.57	0.59	0.63	0.66	0.68	0.7	80%
Paved	1,000	0.02	0.89	0.9	0.92	0.94	0.95	0.96	100%
Combined	**155,089**	**3.56**	**0.11**	**0.17**	**0.23**	**0.32**	**0.36**	**0.41**	**12.8%**
	155,089								

Basin Travel Time

Shallow Channel Ground Cover: Short Pasture/Lawns

$L_{max,Overland}$ 100 ft C_v 7

	L (ft)	ΔZ_0 (ft)	S_0 (ft/ft)	v (ft/s)	t (min)	t_{Alt} (min)	
Total	732	38	-	-	-	-	
Initial Time	100	5	0.050	-	9.9	14.1	DCM Eq. 6-8
Shallow Channel	514	24	0.047	1.5	5.7	-	DCM Eq. 6-9
Channelized	118	9	0.076	4.8	0.4	-	V-Ditch

t_c 14.1 min.

Rainfall Intensity & Runoff

	2-Yr	**5-Yr**	**10-Yr**	**25-Yr**	**50-Yr**	**100-Yr**
Intensity (in/hr)	2.89	3.62	4.22	4.82	5.43	6.07
Runoff (cfs)	1.1	**2.1**	3.5	5.5	7.0	**8.9**
Release Rates (cfs/ac)	-	-	-	-	-	-
Allowed Release (cfs)	1.1	**2.1**	3.5	5.5	7.0	**8.9**

DCM: I = C1 * ln (tc) + C2

C1	1.19	1.5	1.75	2	2.25	2.52
C2	6.035	7.583	8.847	10.111	11.375	12.735

Notes

XI. CN Calculations

XII. Time of Concentration Calculations

High Forest Estates Subdivision
Off-Site Basins
M.V.E., Inc.
April 19, 2023

NRCS Curve Number Calculations

Basin	Basin Area (Sq Mi)	Basin Area (Ac)	Predominant Soil Type	Land Use (Type)	Land Use (Ac)	Land Use (CN)	Land Use (Type)	Land Use (Ac)	Land Use (CN)	**Composite (CN)**	**Initial Abstraction (in)**
1	0.112	71.7	B	5 acre	20.34	74	10+ acre	51.40	69	**70.4**	**0.42**
2	0.225	143.8	B	5 acre	74.42	74	10+ acre	69.41	69	**71.6**	**0.40**
3	0.066	41.9	B	5 acre	22.30	74	10+ acre	19.64	69	**71.7**	**0.40**
4	0.226	144.6	B	5 acre	132.84	74	10+ acre	11.75	69	**73.6**	**0.36**
5	0.071	45.3	B	5 acre	12.89	74	10+ acre	32.36	69	**70.4**	**0.42**
6	0.043	27.7	B	5 acre	4.51	74	10+ acre	23.15	69	**69.8**	**0.43**
7	0.042	27.2	B	5 acre	5.77	74	10+ acre	21.39	69	**70.1**	**0.43**
8	0.076	48.6	B	5 acre	38.15	74	10+ acre	10.46	69	**72.9**	**0.37**
9	0.143	91.8	B	5 acre	59.26	74	10+ acre	32.57	69	**72.2**	**0.38**
10	0.091	58.2	B	5 acre	17.02	74	10+ acre	41.13	69	**70.5**	**0.42**
11	0.141	90.1	B	5 acre	26.26	74	10+ acre	63.81	69	**70.5**	**0.42**
12	0.035	22.7	B	5 acre	2.32	74	10+ acre	20.36	69	**69.5**	**0.44**
13	0.077	49.5	B	5 acre	18.11	74	10+ acre	31.34	69	**70.8**	**0.41**
14	0.039	25.0	B	5 acre	0.00	74	10+ acre	25.03	69	**69.0**	**0.45**
15	0.131	83.8	B	5 acre	5.80	74	10+ acre	77.96	69	**69.3**	**0.44**
16	0.044	27.9	B	5 acre	0.00	74	10+ acre	27.87	69	**69.0**	**0.45**

999.6 Total AC.

Weighted Average CN = 71.2

High Forest Estates Subdivision
Off-Site Basins
M.V.E., Inc.
April 19, 2023

NRCS Curve Number Calculations

DEVELOPED

Basin	Basin Area (Sq Mi)	Basin Area (Ac)	Predominant Soil Type	Land Use (Type)	Land Use (Ac)	Land Use (CN)	Land Use (Type)	Land Use (Ac)	Land Use (CN)	**Composite (CN)**	**Initial Abstraction (in)**
1	0.112	71.7	B	5 acre	20.34	74	10+ acre	51.40	69	**70.4**	**0.42**
2	0.225	143.8	B	5 acre	74.42	74	10+ acre	69.41	69	**71.6**	**0.40**
3	0.066	41.9	B	5 acre	22.30	74	10+ acre	19.64	69	**71.7**	**0.40**
4	0.226	144.6	B	5 acre	132.84	74	10+ acre	11.75	69	**73.6**	**0.36**
5	0.071	45.3	B	5 acre	12.89	74	10+ acre	32.36	69	**70.4**	**0.42**
6	0.043	27.7	B	5 acre	4.98	74	10+ acre	22.68	69	**69.9**	**0.43**
7	0.042	27.2	B	5 acre	6.15	74	10+ acre	21.01	69	**70.1**	**0.43**
8	0.076	48.6	B	5 acre	38.15	74	10+ acre	10.46	69	**72.9**	**0.37**
9	0.143	91.8	B	5 acre	59.26	74	10+ acre	32.57	69	**72.2**	**0.38**
10	0.091	58.2	B	5 acre	17.02	74	10+ acre	41.13	69	**70.5**	**0.42**
11	0.141	90.1	B	5 acre	26.26	74	10+ acre	63.81	69	**70.5**	**0.42**
12	0.035	22.7	B	5 acre	2.32	74	10+ acre	20.36	69	**69.5**	**0.44**
13	0.077	49.5	B	5 acre	18.11	74	10+ acre	31.34	69	**70.8**	**0.41**
14	0.039	25.0	B	5 acre	1.07	74	10+ acre	23.95	69	**69.2**	**0.44**
15	0.131	83.8	B	5 acre	6.95	74	10+ acre	76.81	69	**69.4**	**0.44**
16	0.044	27.9	B	5 acre	3.34	74	10+ acre	24.53	69	**69.6**	**0.44**

999.6	Total AC.

Weighted Average CN =	71.2

High Forest Estates Subdivision
Offsite Basins
M.V.E., Inc.
April 24, 2023

Time of Concentration/Lag Time Calculations

				Overland Flow					Shallow Concentrated Flow				
Basin	Basin Area (Sq Mi)	Basin Area (Ac)		Manning's n	Length (ft)	P2 (in)	Slope (ft/ft)	**Ti (hr)**	Cover Type	Length (ft)	Slope (%)	V (fps)	**Tsc (hr)**
1	0.112	71.7		0.200	300	2.1	0.063	**0.39**	Woodlands	1745	4.4	1.0	**0.48**
2	0.225	143.8		0.200	300	2.1	0.057	**0.40**	Woodlands	1711	5.2	1.2	**0.41**
3	0.065	41.9		0.200	300	2.1	0.023	**0.58**	Woodlands	1023	2.8	0.8	**0.34**
4	0.226	144.6		0.200	300	2.1	0.093	**0.33**	Woodlands	1475	3.5	0.9	**0.45**
5	0.071	45.2		0.150	214	2.1	0.093	**0.20**	Pasture	1334	4.3	1.5	**0.25**
6	0.043	27.7		0.150	235	2.1	0.094	**0.22**	Pasture	1063	5.6	1.7	**0.17**
7	0.043	27.2		0.150	255	2.1	0.118	**0.21**	Pasture	828	5.2	1.6	**0.14**
8	0.076	48.6		0.200	300	2.1	0.037	**0.48**	Woodlands	1957	4.1	0.9	**0.60**
9	0.143	91.8		0.200	300	2.1	0.020	**0.61**	Woodlands	1941	3.4	0.9	**0.60**
10	0.091	58.1		0.200	300	2.1	0.027	**0.54**	Woodlands	1632	3.6	1.0	**0.48**
11	0.141	90.1		0.150	300	2.1	0.027	**0.43**	Pasture	1702	3.3	1.4	**0.35**
12	0.035	22.7		0.150	300	2.1	0.067	**0.30**	Pasture	354	8.8	2.1	**0.05**
13	0.077	49.4		0.200	300	2.1	0.153	**0.27**	Woodlands	1904	5.7	1.0	**0.53**
14	0.039	25.0		0.200	300	2.1	0.133	**0.29**	Woodlands	1291	6.5	1.1	**0.33**
15	0.131	83.8		0.150	300	2.1	0.057	**0.32**	Pasture	1680	3.6	1.4	**0.34**
16	0.044	27.9		0.200	300	2.1	0.120	**0.30**	Pasture	1263	7.1	1.8	**0.19**

High Forest Estates Subdivision
Offsite Basins
M.V.E., Inc.
April 24, 2023

Time of Concentration/Lag Time Calculations

Basin	Concentrated Flow												Total Time of Conc Tc (hr)	Lag Time (Min)
	Length (ft)	Slope (%)	Manning's n	Bot Width (ft)	Side Slopes	Est Flow (cfs)	Est d (ft)	Calc Q (cfs)	Calc A (ft)	Calc P (ft)	V (fps)	**Tcf (hr)**		
1	1307	2.5	0.033	25	13	112	0.95	150	23.8	26.9	6.6	**0.06**	**0.93**	**33**
2	2280	2.0	0.060	25	13	205	1.40	154	34.9	27.8	4.1	**0.16**	**0.97**	**35**
3	2172	1.5	0.033	25	13	66	0.83	89	20.8	26.7	4.7	**0.13**	**1.05**	**38**
4	3235	2.1	0.060	25	13	196	1.34	145	33.4	27.7	4.1	**0.22**	**1.00**	**36**
5	1333	2.6	0.033	25	6	75	0.77	102	19.3	26.5	5.9	**0.06**	**0.51**	**18**
6	1459	2.2	0.040	25	6	47	0.63	52	15.8	26.3	3.9	**0.10**	**0.49**	**18**
7	2096	2.0	0.040	25	6	43	0.62	47	15.4	26.2	3.7	**0.16**	**0.51**	**18**
8	861	2.3	0.033	25	10	80	0.82	107	20.4	26.6	5.7	**0.04**	**1.12**	**40**
9	1725	2.8	0.033	25	10	137	1.03	185	25.8	27.1	7.3	**0.07**	**1.28**	**46**
10	1369	3.2	0.033	25	10	92	0.81	123	20.1	26.6	6.7	**0.06**	**1.08**	**39**
11	1919	3.0	0.040	25	10	135	1.00	149	25.0	27.0	6.1	**0.09**	**0.87**	**31**
12	1713	2.3	0.040	20	7	40	0.58	35	11.5	21.2	3.8	**0.13**	**0.47**	**17**
13	1059	1.7	0.040	20	7	80	0.89	70	17.7	21.8	4.2	**0.07**	**0.87**	**31**
14	558	5.7	0.040	20	7	46	0.60	59	11.9	21.2	6.1	**0.03**	**0.64**	**23**
15	1494	3.6	0.033	20	7	131	0.94	138	18.8	21.9	7.8	**0.05**	**0.71**	**26**
16	488	3.7	0.040	20	7	52	0.54	39	10.7	21.1	4.6	**0.03**	**0.52**	**19**

XIII. HEC-HMS Global Summary Results for 5-yr Storm (Existing & Developed Condition)

XIV. HEC-HMS Global Summary Results for 100-yr Storm (Existing & Developed Condition)

Project: 8855 Walker Road   Simulation Run: 5yr_Existing

Start of Run: 01Jan2000, 00:00   Basin Model: High-Forest-Existing
End of Run: 02Jan2000, 00:00   Meteorologic Model: 5-yr
Compute Time: 01May2023, 14:56:57   Control Specifications: 24-hr

Show Elements: All Elements   Volume Units: (•) IN ( ) ACRE-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
OS-9	0.143	20.3	01Jan2000, 12:45	0.57
OS-10	0.091	11.6	01Jan2000, 12:38	0.48
OS-8	0.076	13.0	01Jan2000, 12:37	0.61
Junction-4	0.310	44.5	01Jan2000, 12:41	0.55
Reach-4	0.310	44.5	01Jan2000, 12:45	0.55
OS-11	0.141	21.2	01Jan2000, 12:28	0.49
Junction-5	0.451	62.1	01Jan2000, 12:39	0.53
Reach-5	0.451	62.1	01Jan2000, 12:43	0.53
OS-13	0.077	12.1	01Jan2000, 12:28	0.50
OS-12	0.035	6.8	01Jan2000, 12:13	0.44
Junction-6	0.563	74.8	01Jan2000, 12:39	0.52
OS-2	0.225	36.1	01Jan2000, 12:32	0.54
OS-1	0.112	15.9	01Jan2000, 12:31	0.48
Junction-1	0.337	51.9	01Jan2000, 12:32	0.52
Reach-1	0.337	51.9	01Jan2000, 12:39	0.52
OS-4	0.226	44.9	01Jan2000, 12:32	0.65
OS-5	0.071	15.4	01Jan2000, 12:13	0.48
OS-3	0.066	10.1	01Jan2000, 12:36	0.55
Junction-2	0.700	113.0	01Jan2000, 12:35	0.56
Reach-2	0.700	113.0	01Jan2000, 12:39	0.56
OS-6	0.043	8.5	01Jan2000, 12:13	0.45
OS-7	0.042	8.7	01Jan2000, 12:13	0.47
Junction-3	0.785	120.2	01Jan2000, 12:38	0.55
Reach-3	0.785	120.2	01Jan2000, 12:38	0.55
Reach-6	0.563	74.8	01Jan2000, 12:40	0.52
OS-15	0.131	18.4	01Jan2000, 12:23	0.43
OS-14	0.039	5.7	01Jan2000, 12:20	0.41
Junction-7	1.518	212.3	01Jan2000, 12:37	0.52
Reach-7	1.518	212.1	01Jan2000, 12:40	0.52
OS-16	0.044	7.3	01Jan2000, 12:15	0.41
Junction-8	1.562	215.6	01Jan2000, 12:39	0.52

Project: 8855 Walker Road   Simulation Run: 5yr_Developed

Start of Run: 01Jan2000, 00:00   Basin Model: High-Forest-Developed
End of Run: 02Jan2000, 00:00   Meteorologic Model: 5-yr
Compute Time: 01May2023, 14:57:50   Control Specifications: 24-hr

Show Elements: All Elements   Volume Units: (•) IN ( ) ACRE-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
OS-2	0.225	36.1	01Jan2000, 12:32	0.54
OS-1	0.112	15.9	01Jan2000, 12:31	0.48
Junction-1	0.337	51.9	01Jan2000, 12:32	0.52
Reach-1	0.337	51.9	01Jan2000, 12:39	0.52
OS-4	0.226	44.9	01Jan2000, 12:32	0.65
OS-5	0.071	15.4	01Jan2000, 12:13	0.48
OS-3	0.066	10.1	01Jan2000, 12:36	0.55
Junction-2	0.700	113.0	01Jan2000, 12:35	0.56
Reach-2	0.700	113.0	01Jan2000, 12:39	0.56
OS-6	0.043	8.6	01Jan2000, 12:13	0.46
OS-7	0.042	8.7	01Jan2000, 12:13	0.47
Junction-3	0.785	120.3	01Jan2000, 12:38	0.55
Reach-3	0.785	120.2	01Jan2000, 12:38	0.55
OS-9	0.143	20.3	01Jan2000, 12:45	0.57
OS-10	0.091	11.6	01Jan2000, 12:38	0.48
OS-8	0.076	13.0	01Jan2000, 12:37	0.61
Junction-4	0.310	44.5	01Jan2000, 12:41	0.55
Reach-4	0.310	44.5	01Jan2000, 12:45	0.55
OS-11	0.141	21.2	01Jan2000, 12:28	0.49
Junction-5	0.451	62.1	01Jan2000, 12:39	0.53
Reach-5	0.451	62.1	01Jan2000, 12:43	0.53
OS-13	0.077	12.1	01Jan2000, 12:28	0.50
OS-12	0.035	6.8	01Jan2000, 12:13	0.44
Junction-6	0.563	74.8	01Jan2000, 12:39	0.52
Reach-6	0.563	74.8	01Jan2000, 12:40	0.52
OS-15	0.131	18.7	01Jan2000, 12:23	0.43
OS-14	0.039	5.8	01Jan2000, 12:20	0.42
Junction-7	1.518	212.5	01Jan2000, 12:37	0.52
Reach-7	1.518	212.4	01Jan2000, 12:40	0.52
OS-16	0.044	7.9	01Jan2000, 12:15	0.43
Junction-8	1.562	216.0	01Jan2000, 12:39	0.52

Project: 8855 Walker Road   Simulation Run: 100yr_Existing

Start of Run: 01Jan2000, 00:00   Basin Model: High-Forest-Existing
End of Run: 02Jan2000, 00:00   Meteorologic Model: 100-yr
Compute Time: 01May2023, 14:58:33   Control Specifications: 24-hr

Show Elements: All Elements   Volume Units: (•) IN ( ) ACRE-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
OS-9	0.143	98.2	01Jan2000, 12:41	2.28
OS-10	0.091	64.7	01Jan2000, 12:33	2.11
OS-8	0.076	59.8	01Jan2000, 12:34	2.36
Junction-4	0.310	220.7	01Jan2000, 12:36	2.25
Reach-4	0.310	220.7	01Jan2000, 12:41	2.24
OS-11	0.141	118.3	01Jan2000, 12:25	2.11
Junction-5	0.451	320.1	01Jan2000, 12:35	2.20
Reach-5	0.451	320.0	01Jan2000, 12:37	2.20
OS-13	0.077	65.6	01Jan2000, 12:25	2.14
OS-12	0.035	41.7	01Jan2000, 12:10	2.02
Junction-6	0.563	391.9	01Jan2000, 12:34	2.18
OS-2	0.225	183.2	01Jan2000, 12:29	2.22
OS-1	0.112	89.4	01Jan2000, 12:27	2.10
Junction-1	0.337	272.3	01Jan2000, 12:28	2.18
Reach-1	0.337	272.1	01Jan2000, 12:34	2.18
OS-4	0.226	198.2	01Jan2000, 12:30	2.43
OS-5	0.071	85.7	01Jan2000, 12:11	2.11
OS-3	0.066	50.9	01Jan2000, 12:32	2.23
Junction-2	0.700	556.6	01Jan2000, 12:31	2.26
Reach-2	0.700	556.5	01Jan2000, 12:34	2.25
OS-6	0.043	50.3	01Jan2000, 12:11	2.05
OS-7	0.042	49.9	01Jan2000, 12:11	2.08
Junction-3	0.785	597.1	01Jan2000, 12:33	2.23
Reach-3	0.785	597.1	01Jan2000, 12:33	2.23
Reach-6	0.563	391.7	01Jan2000, 12:34	2.18
OS-15	0.131	116.4	01Jan2000, 12:19	1.99
OS-14	0.039	37.1	01Jan2000, 12:16	1.96
Junction-7	1.518	1104.4	01Jan2000, 12:31	2.19
Reach-7	1.518	1103.3	01Jan2000, 12:32	2.18
OS-16	0.044	47.5	01Jan2000, 12:12	1.97
Junction-8	1.562	1126.0	01Jan2000, 12:32	2.18

Project: 8855 Walker Road   Simulation Run: 100yr_Developed

Start of Run: 01Jan2000, 00:00   Basin Model: High-Forest-Developed
End of Run: 02Jan2000, 00:00   Meteorologic Model: 100-yr
Compute Time: 01May2023, 14:59:15   Control Specifications: 24-hr

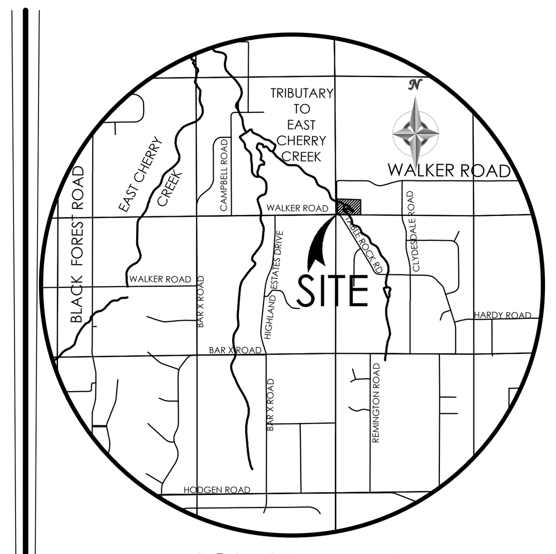
Show Elements: All Elements   Volume Units: (•) IN ( ) ACRE-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
OS-2	0.225	183.2	01Jan2000, 12:29	2.22
OS-1	0.112	89.4	01Jan2000, 12:27	2.10
Junction-1	0.337	272.3	01Jan2000, 12:28	2.18
Reach-1	0.337	272.1	01Jan2000, 12:34	2.18
OS-4	0.226	198.2	01Jan2000, 12:30	2.43
OS-5	0.071	85.7	01Jan2000, 12:11	2.11
OS-3	0.066	50.9	01Jan2000, 12:32	2.23
Junction-2	0.700	556.6	01Jan2000, 12:31	2.26
Reach-2	0.700	556.5	01Jan2000, 12:34	2.25
OS-6	0.043	50.5	01Jan2000, 12:11	2.06
OS-7	0.042	49.9	01Jan2000, 12:11	2.08
Junction-3	0.785	597.2	01Jan2000, 12:33	2.23
Reach-3	0.785	597.2	01Jan2000, 12:33	2.23
OS-9	0.143	98.2	01Jan2000, 12:41	2.28
OS-10	0.091	64.7	01Jan2000, 12:33	2.11
OS-8	0.076	59.8	01Jan2000, 12:34	2.36
Junction-4	0.310	220.7	01Jan2000, 12:36	2.25
Reach-4	0.310	220.7	01Jan2000, 12:41	2.24
OS-11	0.141	118.3	01Jan2000, 12:25	2.11
Junction-5	0.451	320.1	01Jan2000, 12:35	2.20
Reach-5	0.451	320.0	01Jan2000, 12:37	2.20
OS-13	0.077	65.6	01Jan2000, 12:25	2.14
OS-12	0.035	41.7	01Jan2000, 12:10	2.02
Junction-6	0.563	391.9	01Jan2000, 12:34	2.18
Reach-6	0.563	391.7	01Jan2000, 12:34	2.18
OS-15	0.131	116.9	01Jan2000, 12:19	2.00
OS-14	0.039	37.4	01Jan2000, 12:16	1.98
Junction-7	1.518	1105.1	01Jan2000, 12:31	2.19
Reach-7	1.518	1103.9	01Jan2000, 12:32	2.18
OS-16	0.044	48.8	01Jan2000, 12:12	2.01
Junction-8	1.562	1127.2	01Jan2000, 12:32	2.18

C. Hydraulic Calculations

I. HEC-RAS Cross Sections Map
II. HEC-RAS Profile
III. HEC-RAS Summary Table
IV. HEC-RAS Cross Sections
V. HEC-RAS Detailed Report
VI. Permissible Shear and Velocity for Selected Lining Materials
VII. Design Point 2 Culvert Calculation

I. HEC-RAS Cross Sections Map



VICINITY MAP

NOT TO SCALE

BENCHMARK

N

10 0 20 50 100

1" = 50' 1:600

MVE INC.
ENGINEERS, SURVEYORS
1903 lelaray street, suite 200 colorado springs co 80909 719.635.5736

REVISIONS

DESIGNED BY
DRAWN BY
CHECKED BY ____ ________
AS-BUILTS BY
CHECKED BY ____ ________

HIGH FOREST ESTATES
SUBDIVISION FILING NO. 1

HEC-RAS
CROSS SECTIONS

MVE PROJECT 61188

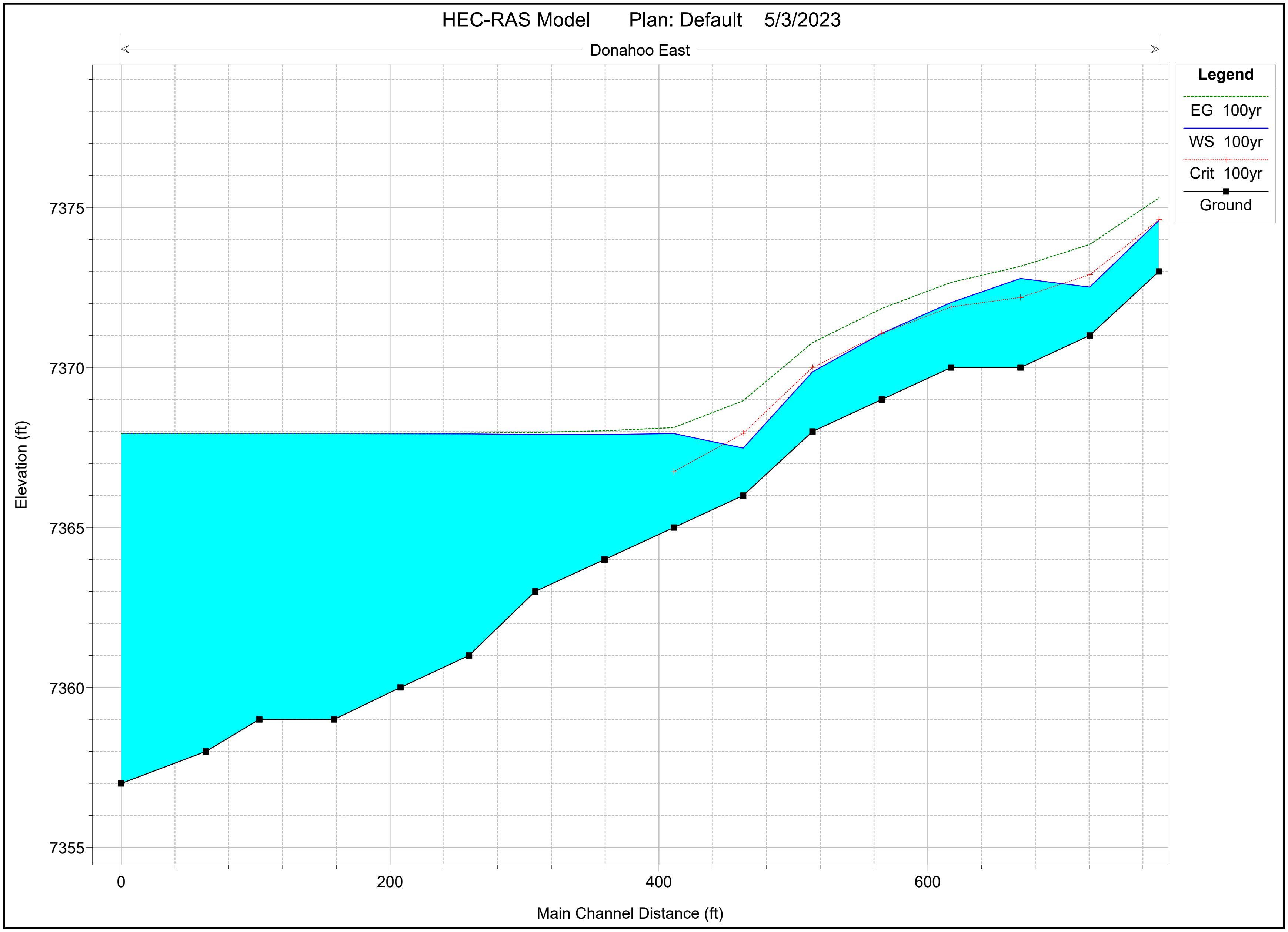
MVE DRAWING DRAIN-HEC-RAS

MAY 3, 2023
SHEET 1 OF 1

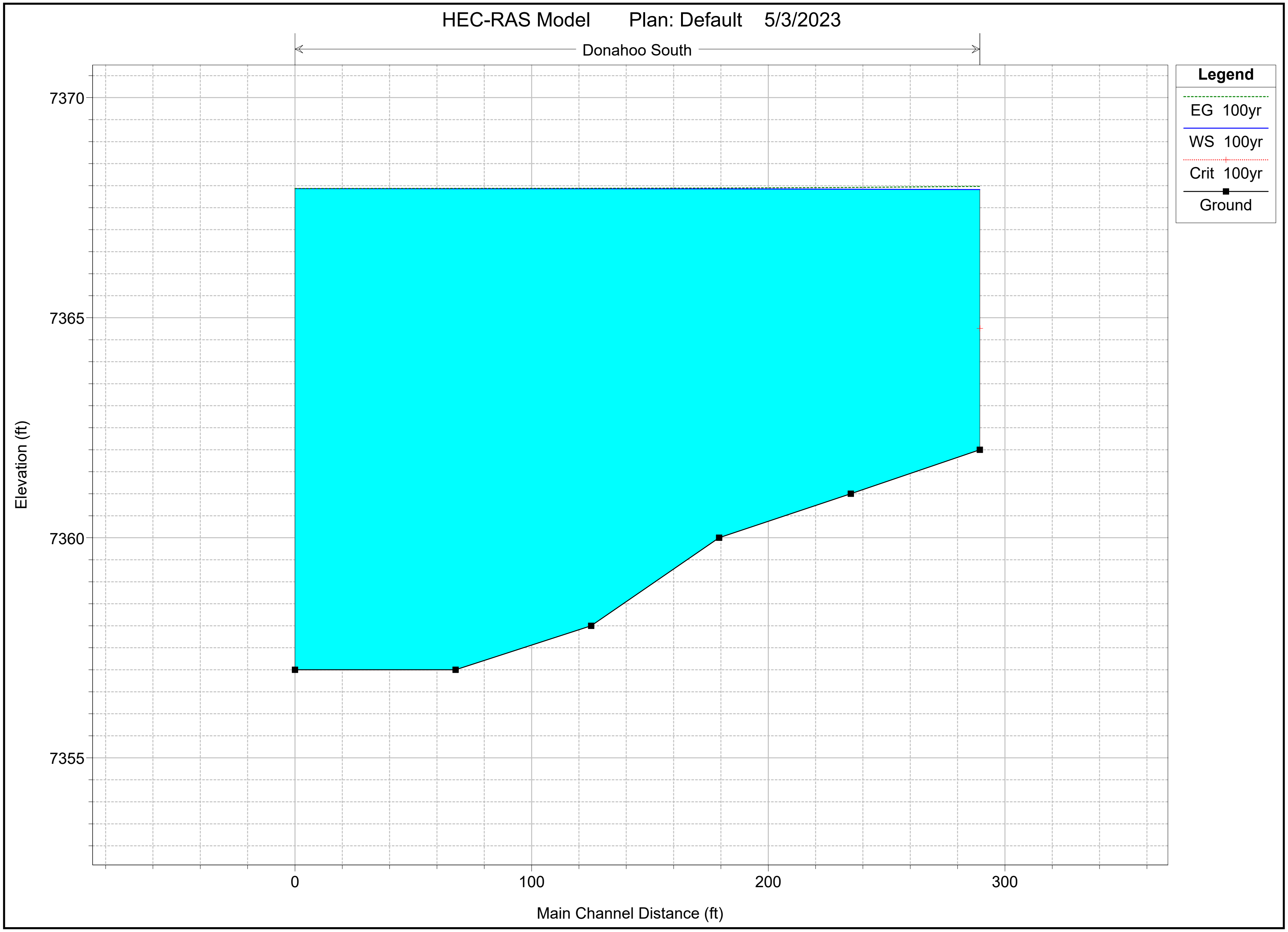
FLOODPLAIN STATEMENT

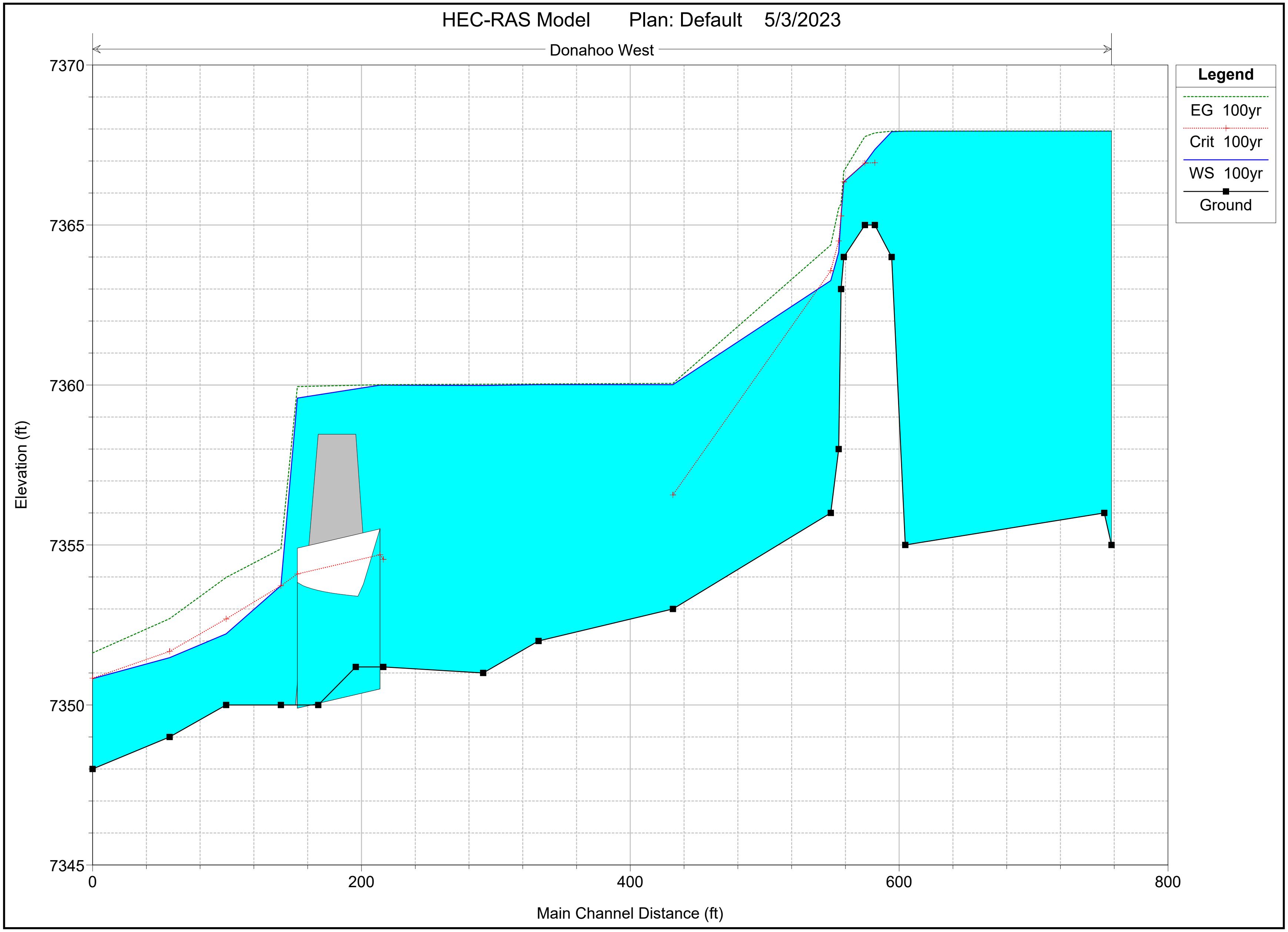
NO PORTION OF THE SUBJECT PROPERTY IS LOCATED WITHIN A FEMA DESIGNATED SPECIAL FLOOD HAZARD AREA (SFHA) AS INDICATED ON THE FLOOD INSURANCE RATE MAPS (FIRM) FOR EL PASO COUNTY, COLORADO AND INCORPORATED AREAS - MAP NUMBERS 08041C0310 G, EFFECTIVE DECEMBER 7, 2018.

II. HEC-RAS Profiles



HEC-RAS Model Plan: Default 5/3/2023
Donahoo East
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
7375
7370
7365
7360
7355
Elevation (ft)
0
200
400
600
Main Channel Distance (ft)


HEC-RAS Model Plan: Default 5/3/2023
Donahoo South
Legend
EG 100yr
WS 100yr
Crit 100yr
Ground
7370
7365
7360
7355
Elevation (ft)
0
100
200
300
Main Channel Distance (ft)


HEC-RAS Model Plan: Default 5/3/2023
Donahoo West
Legend
EG 100yr
Crit 100yr
WS 100yr
Ground
Elevation (ft)
7370
7365
7360
7355
7350
7345
0
200
400
600
800
Main Channel Distance (ft)

III. HEC-RAS Summary Table

HEC-RAS Plan: Default River: Donahoo Reach: East

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Flow Area	Top Width	Vel Chnl	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(sq ft)	(ft)	(ft/s)		(lb/sq ft)
East	728	100yr	391.90	7373.00	7374.60	7374.62	7375.30	0.019389	1.60	1.33	58.18	43.65	6.74	1.03	1.60
East	728	5yr	74.80	7373.00	7373.56	7373.56	7373.84	0.026162	0.56	0.52	17.85	34.33	4.19	1.02	0.85
East	676	100yr	391.90	7371.00	7372.51	7372.90	7373.85	0.040244	1.51	1.25	42.28	33.88	9.27	1.46	3.10
East	676	5yr	74.80	7371.00	7371.56	7371.68	7372.04	0.047445	0.56	0.51	13.46	26.43	5.56	1.37	1.50
East	624	100yr	391.90	7370.00	7372.78	7372.19	7373.16	0.006551	2.78	1.90	79.40	41.89	4.94	0.63	0.77
East	624	5yr	74.80	7370.00	7371.35	7370.99	7371.46	0.005582	1.34	0.88	27.19	30.78	2.75	0.52	0.31
East	572	100yr	391.90	7370.00	7372.03	7371.89	7372.66	0.013720	2.03	1.60	61.46	40.14	6.38	0.89	1.35
East	572	5yr	74.80	7370.00	7370.80		7371.02	0.014274	0.80	0.70	19.94	28.67	3.75	0.79	0.62
East	520	100yr	391.90	7369.00	7371.07	7371.07	7371.84	0.017753	2.07	1.54	55.38	36.59	7.08	1.00	1.69
East	520	5yr	74.80	7369.00	7369.89	7369.84	7370.17	0.019173	0.89	0.66	17.79	26.86	4.20	0.91	0.79
East	468	100yr	391.90	7368.00	7369.86	7370.00	7370.78	0.023807	1.86	1.39	51.09	36.71	7.67	1.15	2.05
East	468	5yr	74.80	7368.00	7368.75	7368.75	7369.08	0.023466	0.75	0.64	16.43	25.65	4.55	1.00	0.93
East	416	100yr	391.90	7366.00	7367.48	7367.94	7368.96	0.052396	1.48	1.10	40.14	36.39	9.76	1.64	3.58
East	416	5yr	74.80	7366.00	7366.57	7366.75	7367.17	0.064055	0.57	0.48	12.01	24.94	6.23	1.58	1.92
East	364	100yr	391.90	7365.00	7367.94	7366.74	7368.12	0.002511	2.94	2.26	114.33	50.66	3.43	0.40	0.35
East	364	5yr	74.80	7365.00	7366.13	7365.67	7366.20	0.003554	1.13	0.89	33.86	38.03	2.21	0.41	0.20
East	312	100yr	391.90	7364.00	7367.90		7368.02	0.001035	3.90	3.23	142.41	48.59	2.79	0.27	0.20
East	312	5yr	74.80	7364.00	7366.12		7366.14	0.000413	2.12	1.70	64.97	38.21	1.15	0.16	0.04
East	260	100yr	391.90	7363.00	7367.91		7367.98	0.000425	4.90	4.50	197.94	62.93	2.23	0.19	0.12
East	260	5yr	74.80	7363.00	7366.12		7366.13	0.000102	3.12	2.71	100.39	46.68	0.78	0.08	0.02
East	210	100yr	391.90	7361.00	7367.93		7367.95	0.000115	6.93	5.34	332.96	95.48	1.30	0.10	0.04
East	210	5yr	74.80	7361.00	7366.12		7366.12	0.000019	5.12	3.54	189.09	56.92	0.40	0.04	0.00
East	159	100yr	391.90	7360.00	7367.93		7367.94	0.000051	7.93	6.69	481.58	112.94	1.01	0.07	0.02
East	159	5yr	74.80	7360.00	7366.12		7366.12	0.000007	6.12	4.87	294.38	94.87	0.31	0.02	0.00
East	109	100yr	391.90	7359.00	7367.93		7367.94	0.000025	8.93	7.64	632.15	128.16	0.77	0.05	0.01
East	109	5yr	74.80	7359.00	7366.12		7366.12	0.000003	7.12	5.83	415.34	110.86	0.22	0.02	0.00
East	53	100yr	391.90	7359.00	7367.93		7367.94	0.000019	8.93	6.81	695.40	137.40	0.63	0.04	0.01
East	53	5yr	74.80	7359.00	7366.12		7366.12	0.000002	7.12	5.00	463.95	117.97	0.17	0.01	0.00
East	14	100yr	391.90	7358.00	7367.93		7367.94	0.000014	9.93	8.32	802.08	162.67	0.60	0.04	0.01
East	14	5yr	74.80	7358.00	7366.12		7366.12	0.000001	8.12	6.50	521.49	146.94	0.17	0.01	0.00
East	-49	100yr	391.90	7357.00	7367.94		7367.94	0.000006	10.93	9.54	1047.48	165.13	0.45	0.03	0.00
East	-49	5yr	74.80	7357.00	7366.12		7366.12	0.000001	9.12	7.73	761.66	149.42	0.12	0.01	0.00

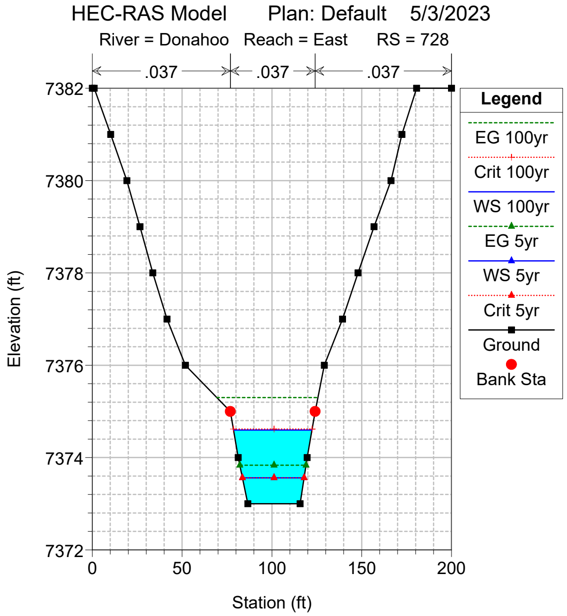
HEC-RAS Plan: Default River: Donahoo Reach: South

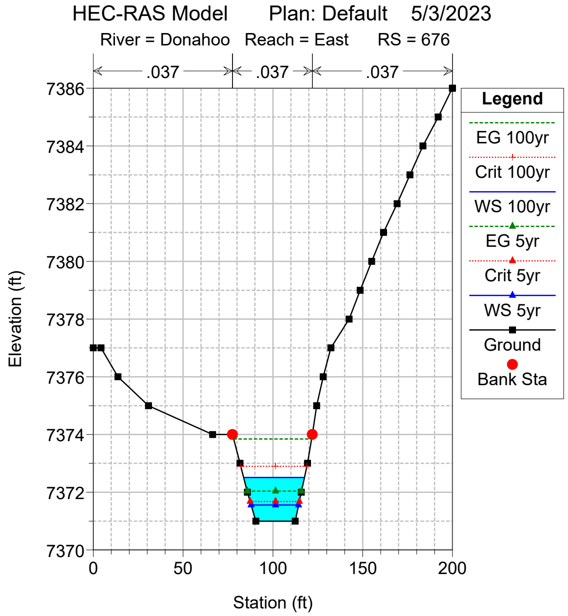
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Flow Area	Top Width	Vel Chnl	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(sq ft)	(ft)	(ft/s)		(lb/sq ft)
South	220	100yr	597.20	7362.00	7367.91	7364.76	7367.98	0.000407	5.91	4.79	299.89	95.56	2.28	0.18	0.12
South	220	5yr	120.30	7362.00	7366.12	7363.10	7366.13	0.000098	4.12	3.00	153.56	66.79	0.82	0.08	0.02
South	166	100yr	597.20	7361.00	7367.92		7367.96	0.000181	6.92	5.91	442.10	155.28	1.75	0.13	0.07
South	166	5yr	120.30	7361.00	7366.12		7366.13	0.000035	5.12	4.11	223.61	86.72	0.60	0.05	0.01
South	111	100yr	597.20	7360.00	7367.93		7367.95	0.000081	7.93	6.16	642.74	209.56	1.20	0.09	0.03
South	111	5yr	120.30	7360.00	7366.12		7366.12	0.000014	6.12	4.35	347.93	131.84	0.40	0.03	0.00
South	57	100yr	597.20	7358.00	7367.93		7367.94	0.000042	9.93	6.18	862.35	277.09	0.87	0.06	0.02
South	57	5yr	120.30	7358.00	7366.12		7366.12	0.000008	8.12	4.37	433.38	151.86	0.29	0.02	0.00
South	0	100yr	597.20	7357.00	7367.93		7367.94	0.000027	10.93	8.26	1028.47	301.55	0.83	0.05	0.01
South	0	5yr	120.30	7357.00	7366.12		7366.12	0.000004	9.12	6.45	546.81	198.54	0.28	0.02	0.00
South	-68	100yr	597.20	7357.00	7367.93		7367.94	0.000010	10.93	7.39	1548.16	361.83	0.49	0.03	0.00
South	-68	5yr	120.30	7357.00	7366.12		7366.12	0.000002	9.12	5.58	934.05	293.37	0.16	0.01	0.00

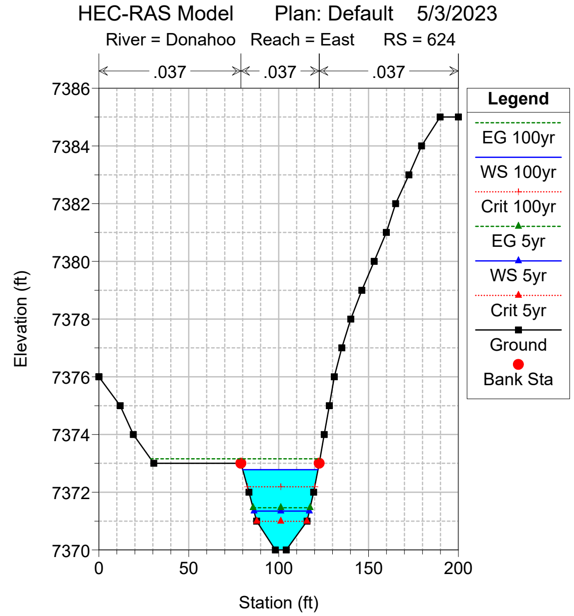
HEC-RAS Plan: Default River: Donahoo Reach: West

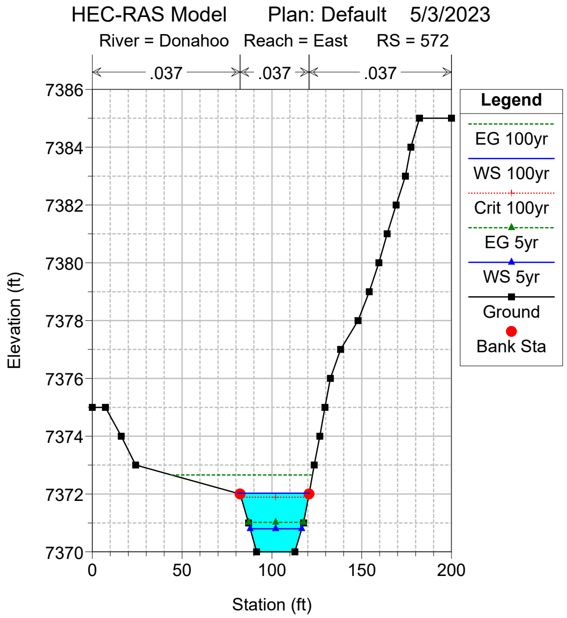
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Max Chl Dpth	Hydr Depth C	Flow Area	Top Width	Vel Chnl	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)	(ft)	(sq ft)	(ft)	(ft/s)		(lb/sq ft)
West	980	100yr	1105.10	7355.00	7367.94		7367.94	0.000004	12.93	10.16	3393.73	495.10	0.37	0.02	0.00
West	980	5yr	212.50	7355.00	7366.12		7366.12	0.000000	11.12	8.34	2553.62	429.51	0.09	0.01	0.00
West	975	100yr	1105.10	7355.00	7367.94		7367.94	0.000004	12.94	10.39	3649.52	529.78	0.36	0.02	0.00
West	975	5yr	212.50	7355.00	7366.12		7366.12	0.000000	11.12	8.57	2751.16	457.13	0.09	0.01	0.00
West	965	100yr	1105.10	7356.00	7367.94		7367.94	0.000004	11.93	10.45	3290.98	427.84	0.38	0.02	0.00
West	965	5yr	212.50	7356.00	7366.12		7366.12	0.000000	10.12	8.64	2558.33	376.15	0.09	0.01	0.00
West	708	100yr	1105.10	7364.00	7367.92		7367.93	0.000174	3.92	3.70	1071.56	408.36	1.26	0.12	0.04
West	708	5yr	212.50	7364.00	7366.11		7366.12	0.000179	2.11	1.90	364.94	380.19	0.82	0.11	0.02
West	696	100yr	1105.10	7365.00	7367.36	7366.95	7367.88	0.008056	2.36	2.03	193.16	106.69	5.78	0.71	1.02
West	696	5yr	212.50	7365.00	7365.94		7366.10	0.007836	0.94	0.86	66.34	77.43	3.20	0.61	0.42
West	691	100yr	1105.10	7365.00	7366.94	7366.94	7367.76	0.017131	1.94	1.64	151.52	92.40	7.29	1.00	1.75
West	691	5yr	212.50	7365.00	7365.67	7365.67	7365.99	0.023282	0.67	0.64	46.96	73.90	4.52	1.00	0.92
West	674	100yr	1105.10	7364.00	7366.35	7366.35	7366.68	0.007677	8.35	1.76	293.20	413.43	5.12	0.68	0.84
West	674	5yr	212.50	7364.00	7365.00	7365.00	7365.30	0.024109	7.00	0.60	48.09	365.12	4.42	1.01	0.90
West	603	100yr	1105.10	7363.00	7365.30	7365.28	7365.66	0.008398	7.29	1.66	269.74	386.95	5.16	0.71	0.87
West	603	5yr	212.50	7363.00	7363.93	7363.93	7364.23	0.024188	5.93	0.59	48.43	328.41	4.39	1.01	0.89
West	577	100yr	1105.10	7358.00	7364.15	7364.50	7365.52	0.228423	6.15	0.34	117.58	343.92	9.41	2.83	4.90
West	577	5yr	212.50	7358.00	7363.60	7363.76	7364.14	0.056161	5.60	0.49	36.08	313.10	5.89	1.49	1.71
West	551	100yr	1105.10	7356.00	7363.26	7363.57	7364.38	0.148661	7.26	0.41	131.53	331.19	8.55	2.35	3.80
West	551	5yr	212.50	7356.00	7362.79	7363.09	7363.70	0.085443	6.79	0.53	27.80	284.37	7.65	1.86	2.80
West	434	100yr	1105.10	7353.00	7360.01	7356.57	7360.05	0.000223	7.01	5.94	779.60	250.56	1.95	0.14	0.08
West	434	5yr	212.50	7353.00	7355.42	7354.41	7355.55	0.002653	2.42	1.66	73.74	44.38	2.88	0.39	0.27
West	334	100yr	1105.10	7352.00	7360.01		7360.03	0.000080	8.01	7.34	1017.00	234.31	1.35	0.09	0.04
West	334	5yr	212.50	7352.00	7355.47		7355.48	0.000130	3.47	2.80	237.59	99.81	0.91	0.10	0.02
West	293	100yr	1105.10	7351.00	7359.98		7360.03	0.000152	8.98	7.75	790.94	206.51	1.92	0.12	0.07
West	293	5yr	212.50	7351.00	7355.44		7355.47	0.000258	4.44	3.21	158.37	64.11	1.39	0.14	0.05
West	219	100yr	1127.20	7351.19	7359.99	7354.55	7360.01	0.000070	8.80	7.10	1305.19	418.86	1.23	0.08	0.03
West	219	5yr	216.00	7351.19	7355.44	7352.70	7355.45	0.000181	4.25	2.54	217.06	95.59	1.00	0.11	0.03
West	183		Culvert												
West	142	100yr	1127.20	7350.00	7353.73	7353.73	7354.88	0.013976	3.73	2.48	133.08	62.13	8.64	0.97	2.14
West	142	5yr	216.00	7350.00	7351.81	7351.75	7352.29	0.017121	1.81	1.09	38.97	35.64	5.54	0.93	1.16
West	102	100yr	1127.20	7350.00	7352.22	7352.69	7353.99	0.032702	2.22	1.79	105.90	59.11	10.64	1.40	3.62
West	102	5yr	216.00	7350.00	7351.07	7351.07	7351.48	0.021961	1.07	0.81	41.83	51.55	5.16	1.01	1.11
West	60	100yr	1127.20	7349.00	7351.48	7351.67	7352.70	0.022508	2.48	1.80	127.13	70.79	8.87	1.17	2.51
West	60	5yr	216.00	7349.00	7350.45	7350.19	7350.66	0.008714	1.45	0.97	58.80	60.47	3.67	0.66	0.53
West	2	100yr	1127.20	7348.00	7350.82	7350.84	7351.63	0.017727	2.82	1.56	156.92	100.27	7.18	1.01	1.72
West	2	5yr	216.00	7348.00	7349.65	7349.58	7349.95	0.018718	1.65	0.71	49.47	69.57	4.37	0.91	0.83

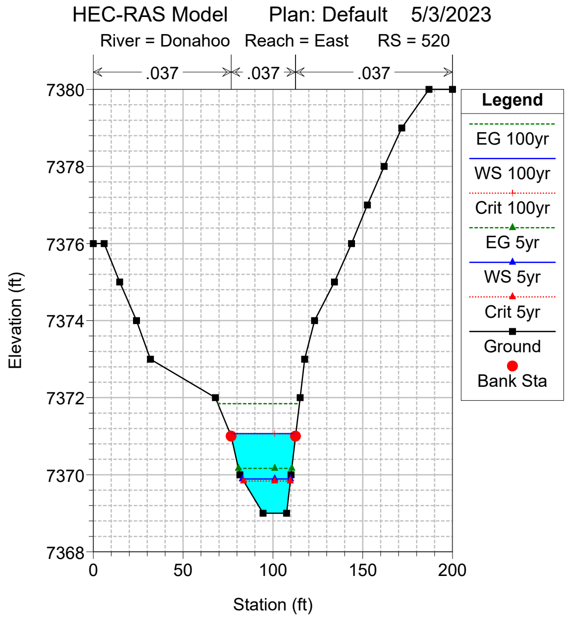
IV. HEC-RAS Cross Sections

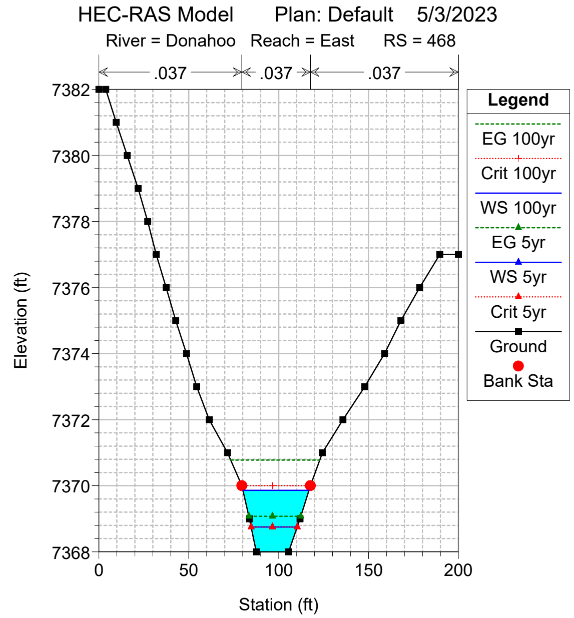

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 728
.037
.037
.037
Elevation (ft)
Station (ft)
Legend
EG 100yr
Crit 100yr
WS 100yr
EG 5yr
WS 5yr
Crit 5yr
Ground
Bank Sta

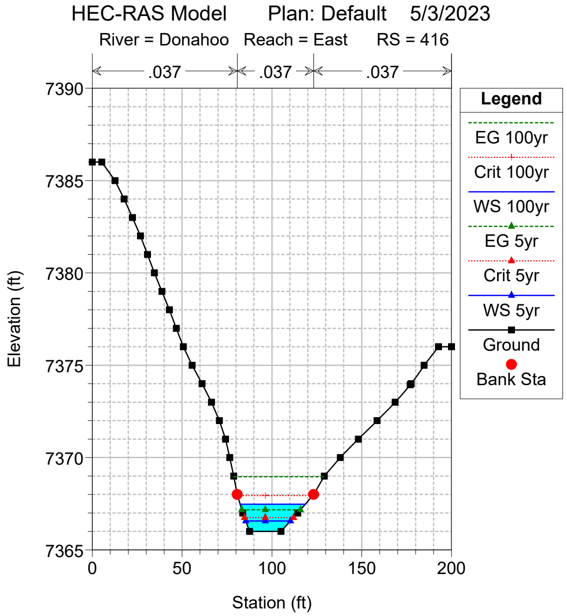

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 676
.037
.037
.037
Elevation (ft)
Station (ft)
Legend
EG 100yr
Crit 100yr
WS 100yr
EG 5yr
Crit 5yr
WS 5yr
Ground
Bank Sta

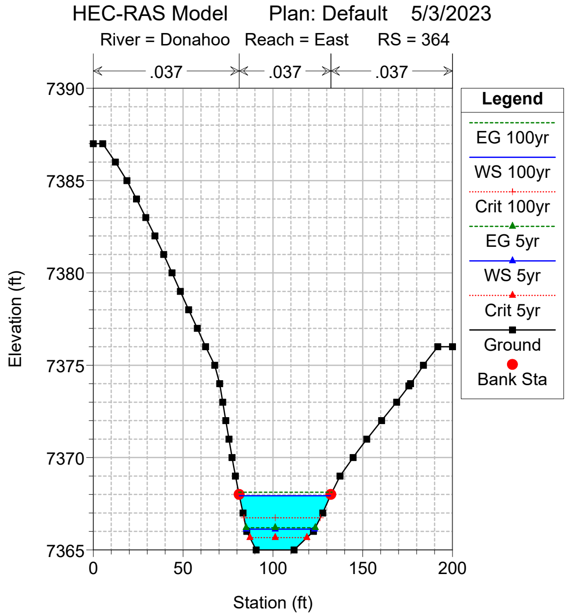

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 624
.037
.037
.037
Elevation (ft)
Station (ft)
Legend
EG 100yr
WS 100yr
Crit 100yr
EG 5yr
WS 5yr
Crit 5yr
Ground
Bank Sta

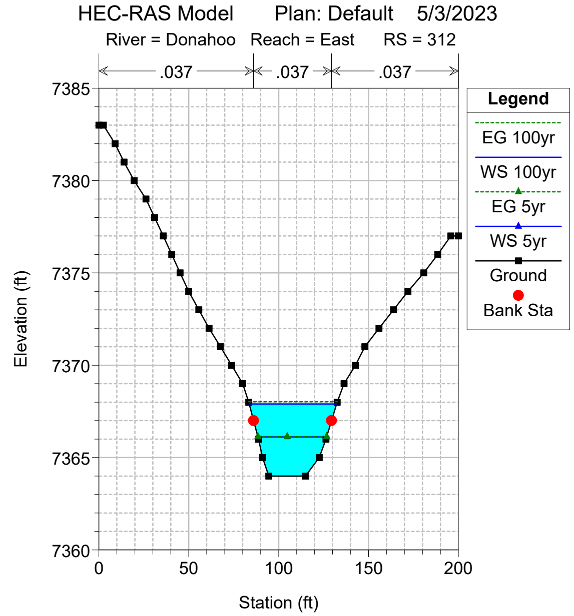

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 572
.037
.037
.037
Elevation (ft)
Station (ft)
Legend
EG 100yr
WS 100yr
Crit 100yr
EG 5yr
WS 5yr
Ground
Bank Sta

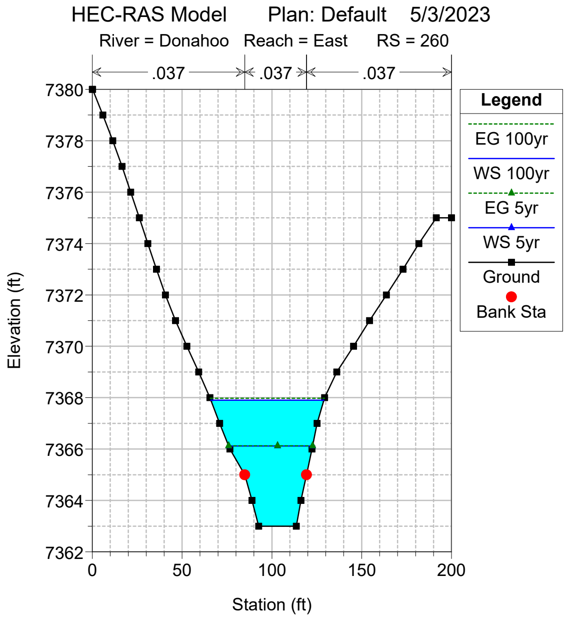

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 520
.037
.037
.037
Elevation (ft)
Station (ft)
Legend
EG 100yr
WS 100yr
Crit 100yr
EG 5yr
WS 5yr
Crit 5yr
Ground
Bank Sta

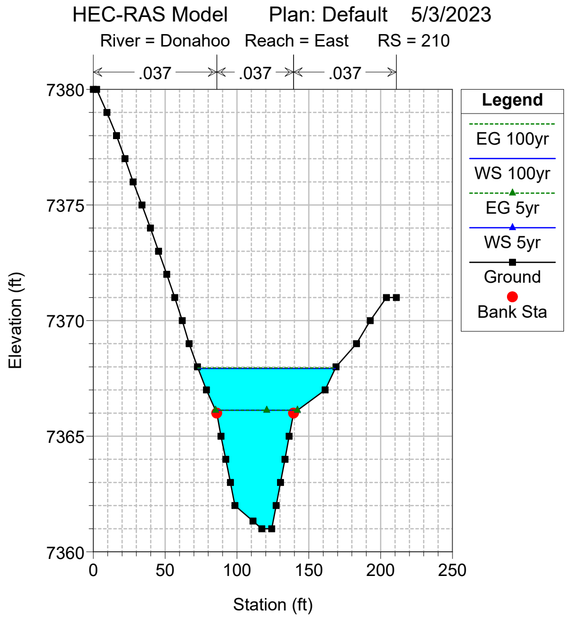

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 468
.037
.037
.037
Elevation (ft)
Station (ft)
Legend
EG 100yr
Crit 100yr
WS 100yr
EG 5yr
WS 5yr
Crit 5yr
Ground
Bank Sta

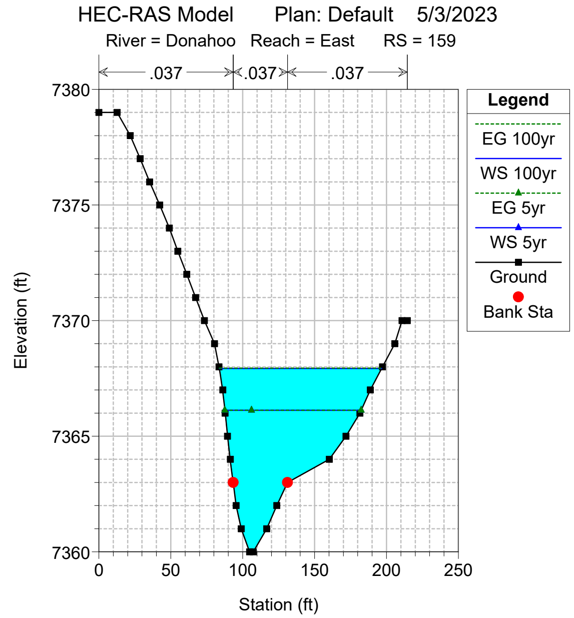

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 416
.037 .037 .037
Legend
EG 100yr
Crit 100yr
WS 100yr
EG 5yr
Crit 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

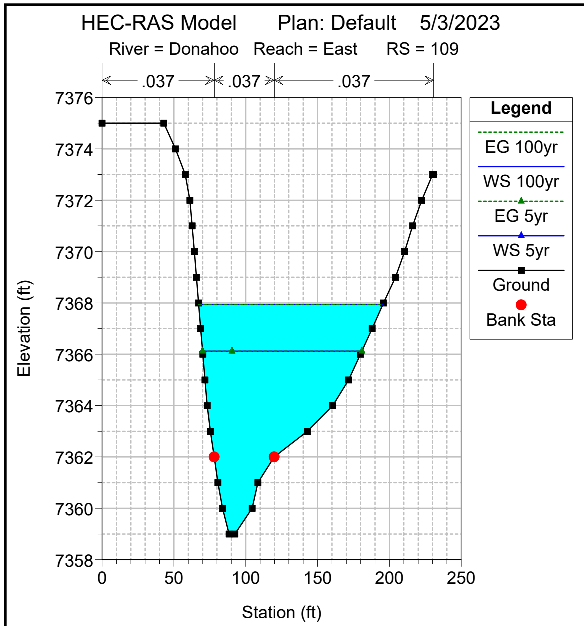

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 364
.037 .037 .037
Legend
EG 100yr
WS 100yr
Crit 100yr
EG 5yr
WS 5yr
Crit 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

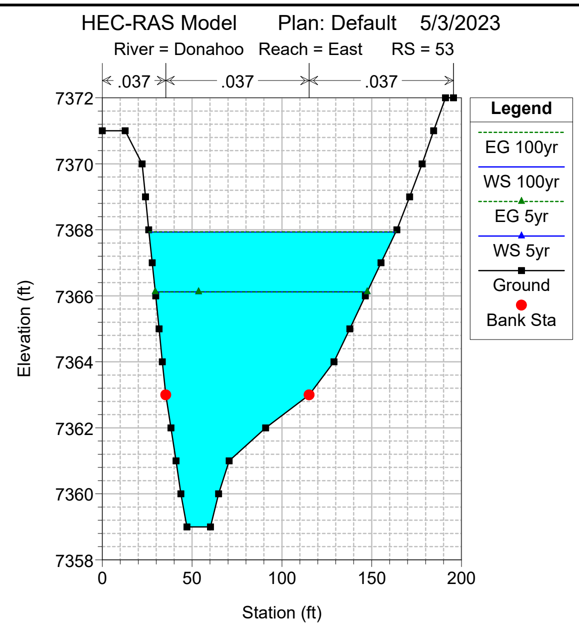

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 312
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

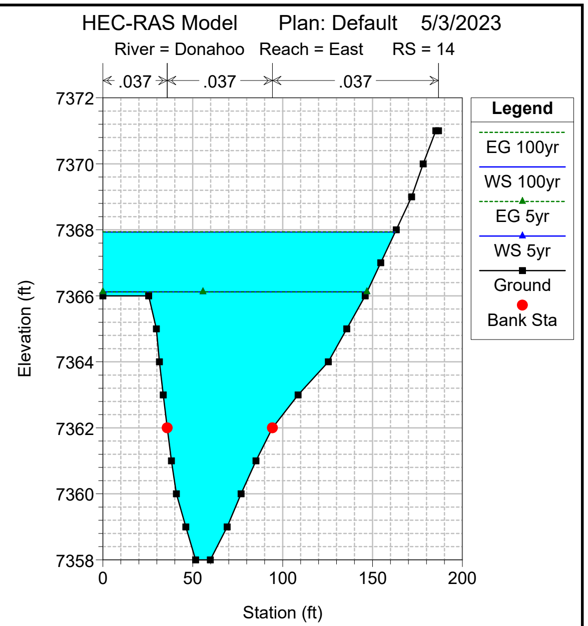

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 260
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

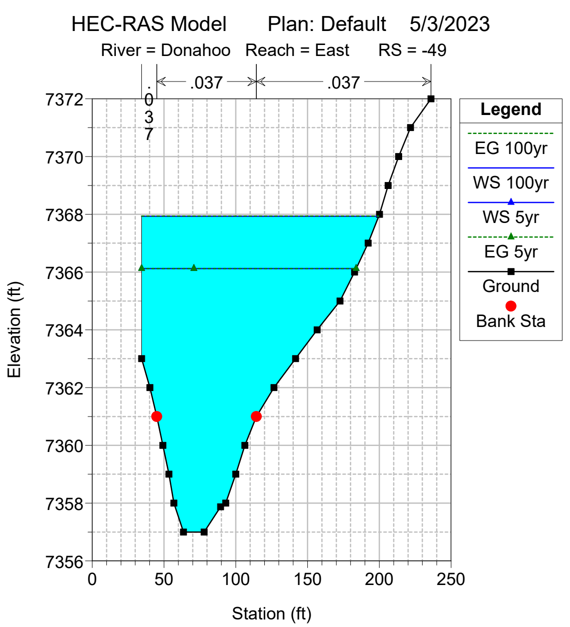

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 210
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

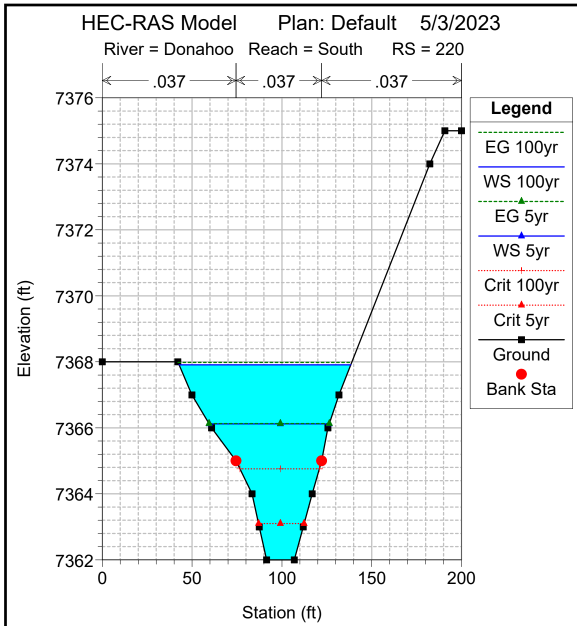

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 159
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

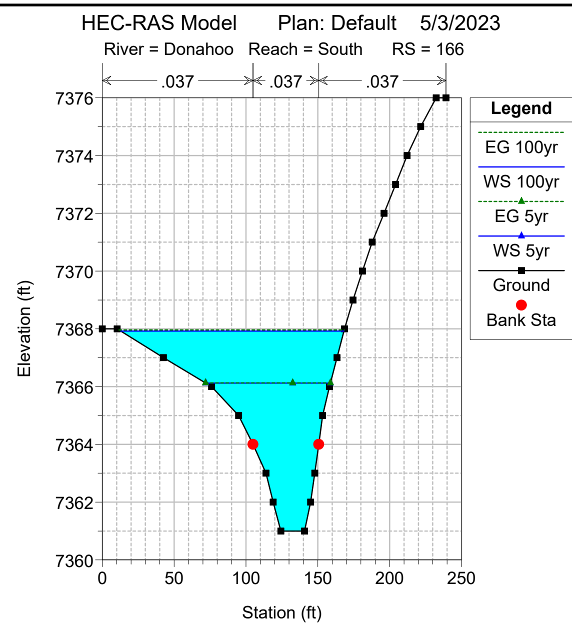

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 109
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
7376
7374
7372
7370
7368
7366
7364
7362
7360
7358
Station (ft)
0 50 100 150 200 250

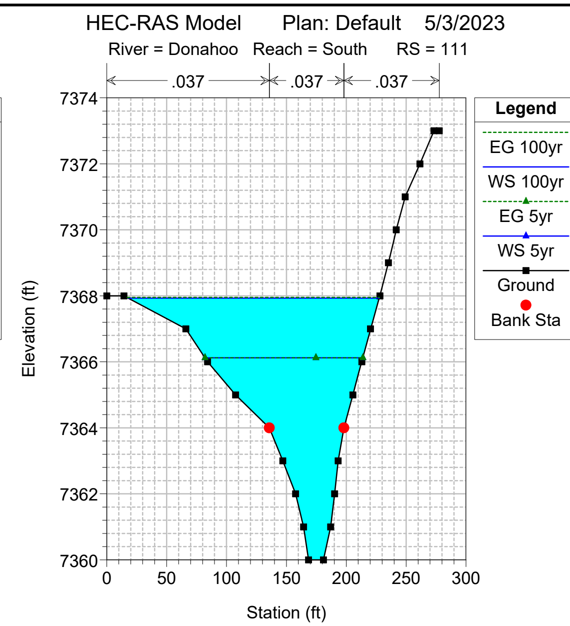

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 53
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
7372
7370
7368
7366
7364
7362
7360
7358
Station (ft)
0 50 100 150 200

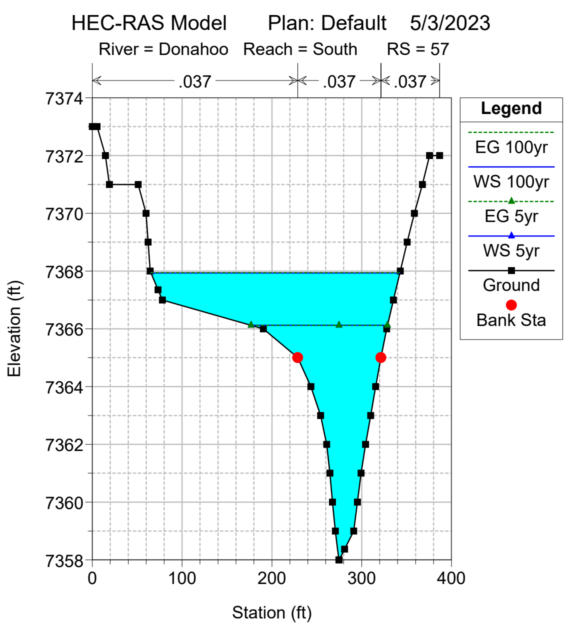

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = 14
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
7372
7370
7368
7366
7364
7362
7360
7358
Station (ft)
0 50 100 150 200

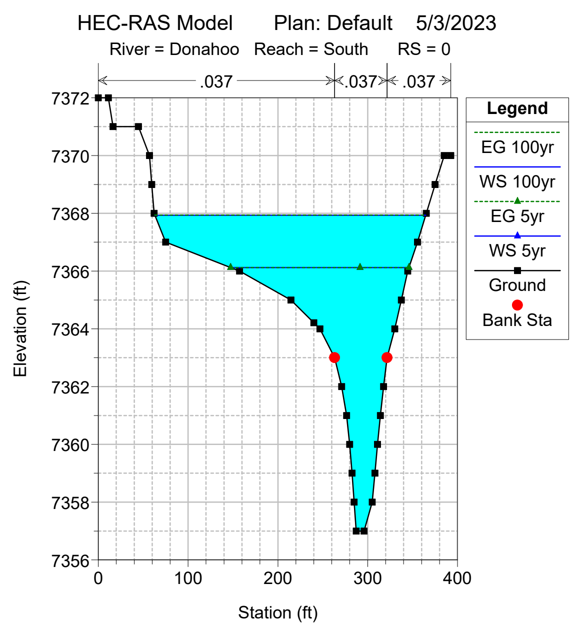

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = East RS = -49
.037 .037
.037
Legend
EG 100yr
WS 100yr
WS 5yr
EG 5yr
Ground
Bank Sta
Elevation (ft)
7372
7370
7368
7366
7364
7362
7360
7358
7356
Station (ft)
0 50 100 150 200 250

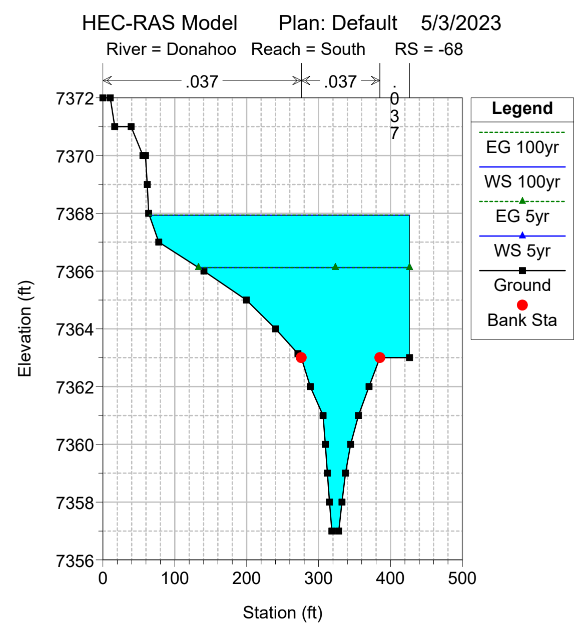

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = South RS = 220
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Crit 100yr
Crit 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

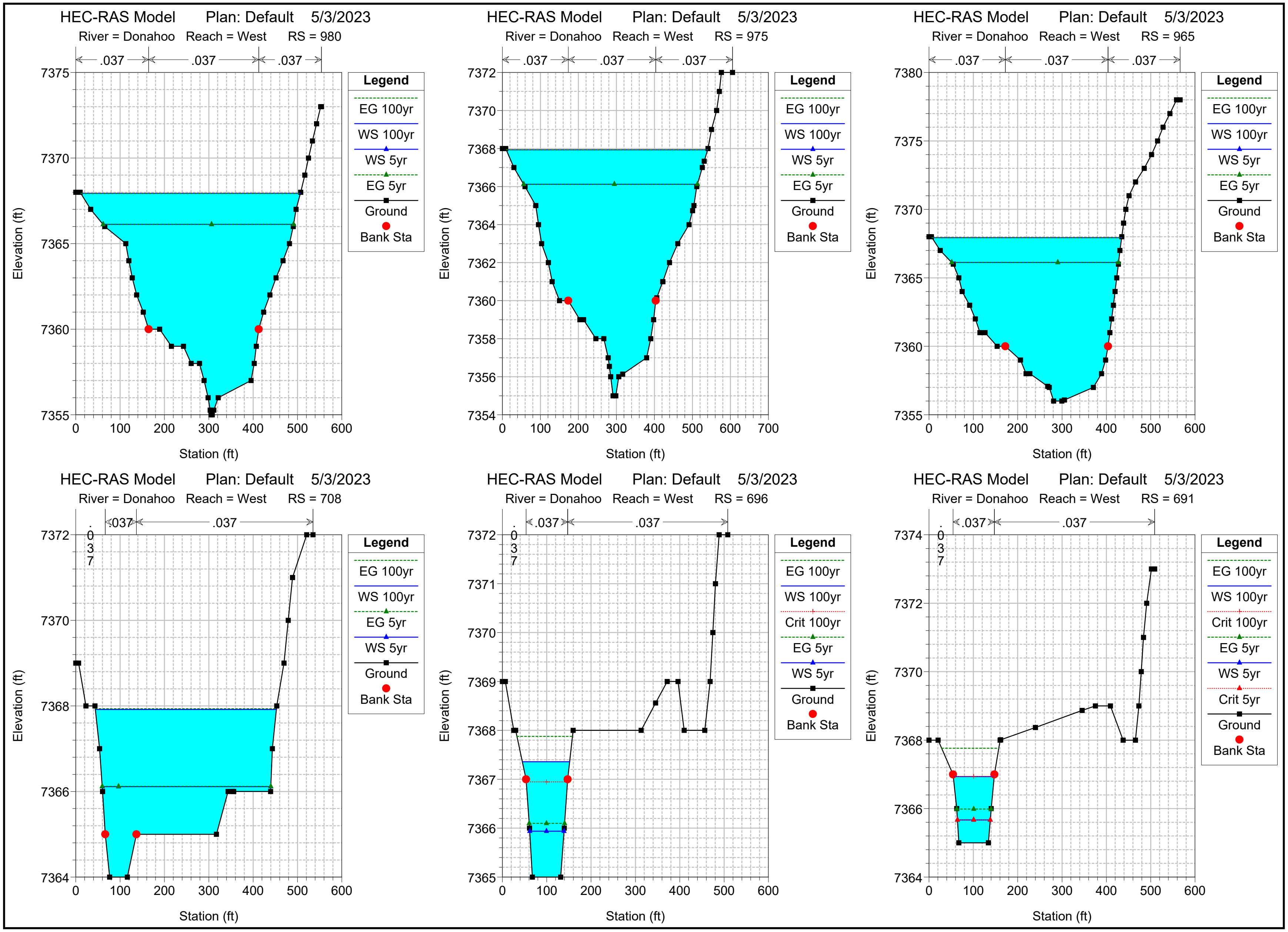

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = South RS = 166
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

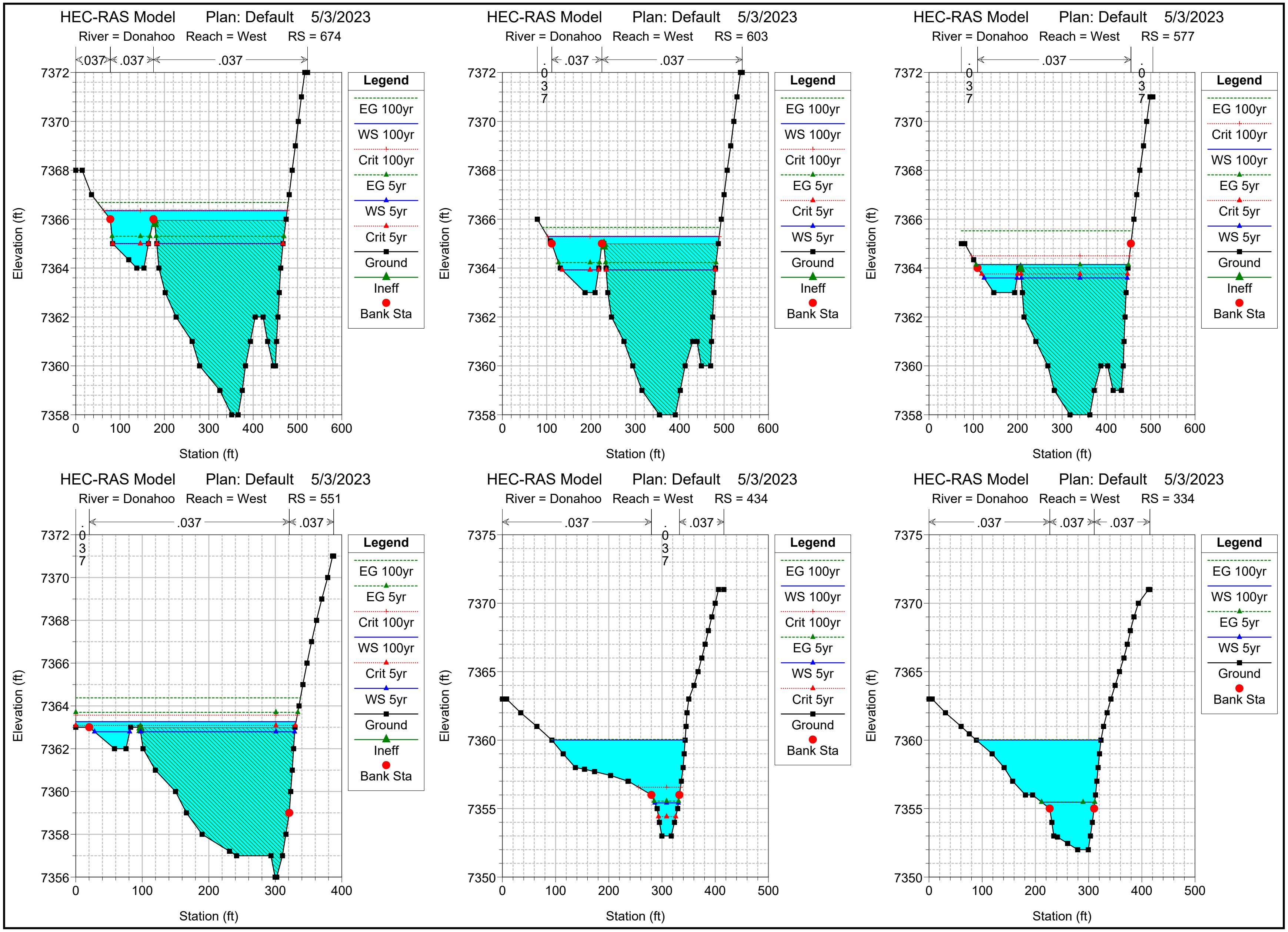

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = South RS = 111
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = South RS = 57
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

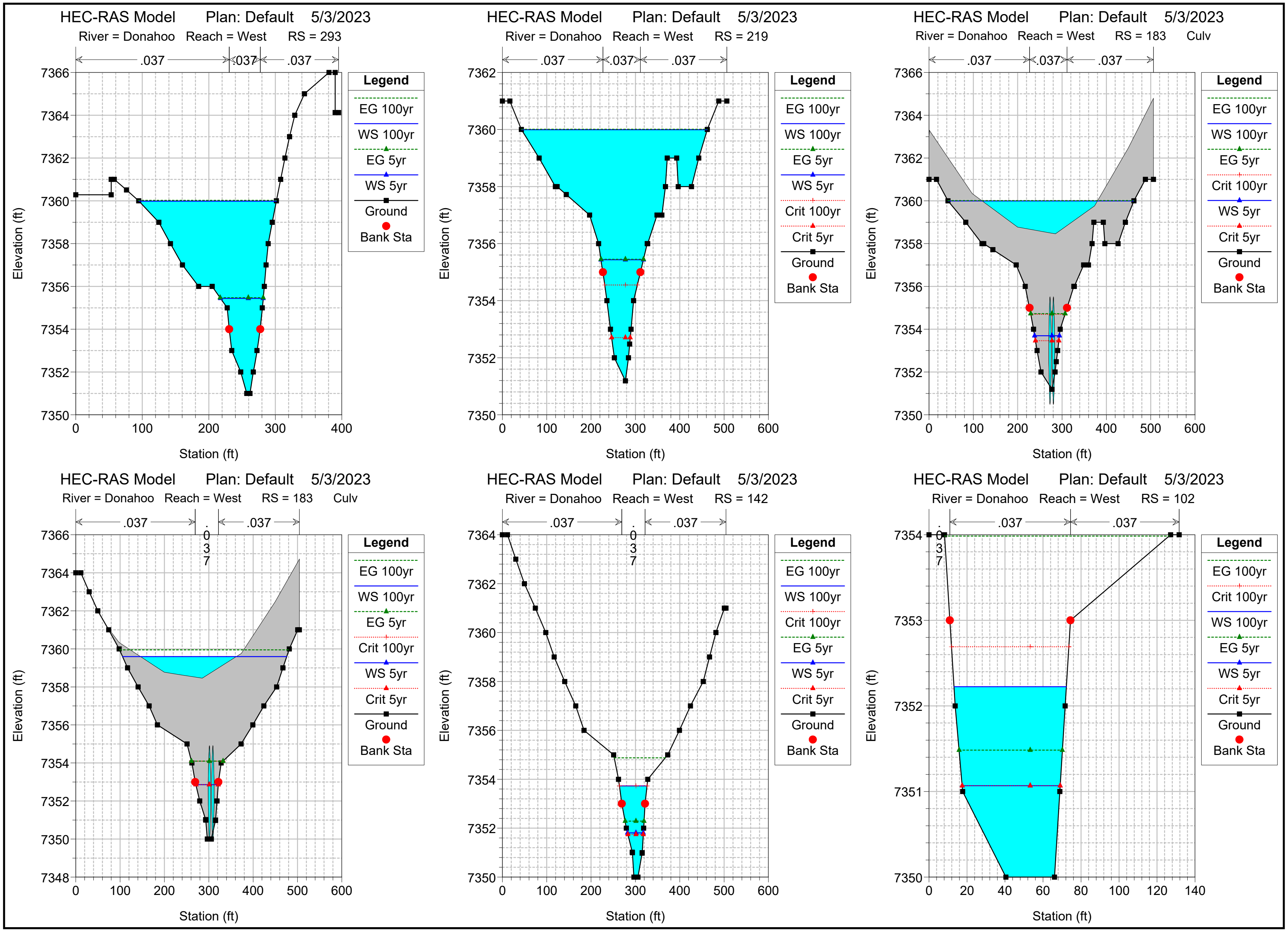

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = South RS = 0
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

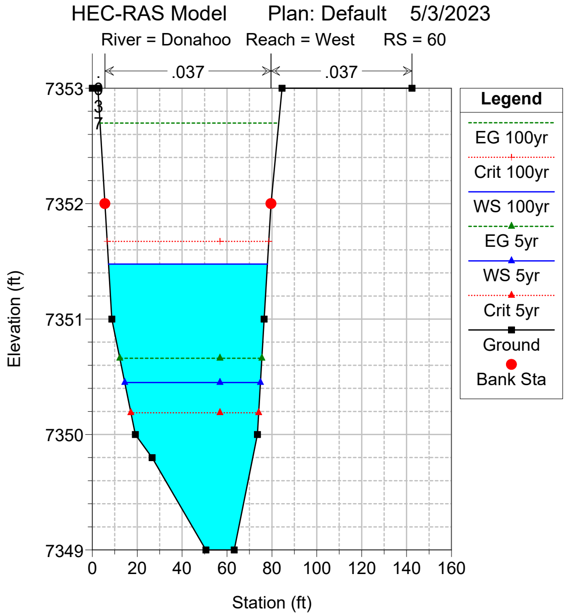

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = South RS = -68
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

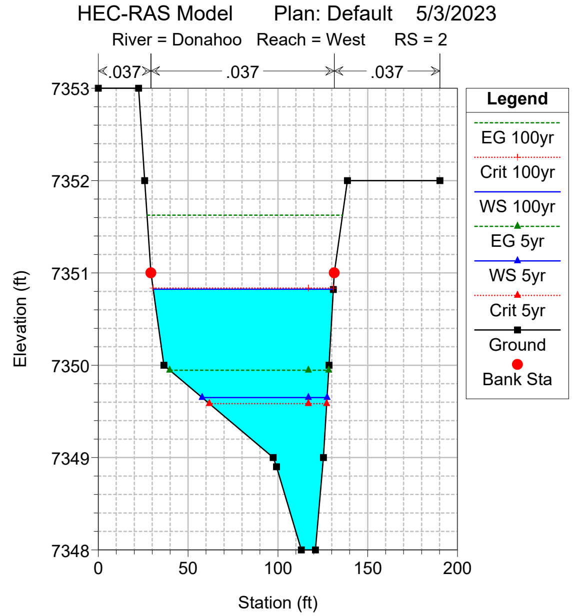

HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 980
.037 .037 .037
Legend
EG 100yr
WS 100yr
WS 5yr
EG 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 975
.037 .037 .037
Legend
EG 100yr
WS 100yr
WS 5yr
EG 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 965
.037 .037 .037
Legend
EG 100yr
WS 100yr
WS 5yr
EG 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 708
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 696
.037 .037 .037
Legend
EG 100yr
WS 100yr
Crit 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 691
.037 .037 .037
Legend
EG 100yr
WS 100yr
Crit 100yr
EG 5yr
WS 5yr
Crit 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)



HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 674
.037 .037 .037
Legend
EG 100yr
WS 100yr
Crit 100yr
EG 5yr
WS 5yr
Crit 5yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 603
.037 .037 .037
Legend
EG 100yr
WS 100yr
Crit 100yr
EG 5yr
Crit 5yr
WS 5yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 577
.037 .037 .037
Legend
EG 100yr
Crit 100yr
WS 100yr
EG 5yr
Crit 5yr
WS 5yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 551
.037 .037 .037
Legend
EG 100yr
EG 5yr
Crit 100yr
WS 100yr
Crit 5yr
WS 5yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 434
.037 .037 .037
Legend
EG 100yr
WS 100yr
Crit 100yr
EG 5yr
WS 5yr
Crit 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 334
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 293
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 219
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
WS 5yr
Crit 100yr
Crit 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 183 Culv
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
Crit 100yr
WS 5yr
Crit 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 183 Culv
.037 .037 .037
Legend
EG 100yr
WS 100yr
EG 5yr
Crit 100yr
WS 5yr
Crit 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 142
.037 .037 .037
Legend
EG 100yr
WS 100yr
Crit 100yr
EG 5yr
WS 5yr
Crit 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 102
.037 .037 .037
Legend
EG 100yr
Crit 100yr
WS 100yr
EG 5yr
WS 5yr
Crit 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 60
.037
.037
Legend
EG 100yr
Crit 100yr
WS 100yr
EG 5yr
WS 5yr
Crit 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
7353
7352
7351
7350
7349
0 20 40 60 80 100 120 140 160


HEC-RAS Model Plan: Default 5/3/2023
River = Donahoo Reach = West RS = 2
.037
.037
.037
Legend
EG 100yr
Crit 100yr
WS 100yr
EG 5yr
WS 5yr
Crit 5yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
7353
7352
7351
7350
7349
7348
0 50 100 150 200

V. HEC-RAS Detailed Report

```
HEC-RAS HEC-RAS 5.0.7 March 2019
 U.S. Army Corps of Engineers
Hydrologic Engineering Center
      609 Second Street
      Davis, California

X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X       X   X     X  X    X
X     X  X        X            X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X       X
X     X  X        X    X       X   X    X    X       X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: HEC-RAS Model
Project File : Donohoo-Updated.prj
Run Date and Time: 5/3/2023 3:18:20 PM

Project in English units

PLAN DATA

Plan Title: Default
Plan File : C:\Users\tomw\Desktop\Donohoo-Updated.p02

```
           Geometry Title: Default Geometry
           Geometry File : C:\Users\tomw\Desktop\Donohoo-Updated.g01

           Flow Title    : Default Steady Flow
           Flow File     : C:\Users\tomw\Desktop\Donohoo-Updated.f01
```

Plan Description:
Default Scenario

```
Plan Summary Information:
Number of:  Cross Sections =   40    Multiple Openings  =    0
            Culverts       =    1    Inline Structures  =    0
            Bridges        =    0    Lateral Structures =    0

Computational Information
    Water surface calculation tolerance  =  0.01
    Critical depth calculation tolerance =  0.01
    Maximum number of iterations         =  20
    Maximum difference tolerance         =  0.33
    Flow tolerance factor                =  0.001

Computation Options
    Critical depth computed only where necessary
    Conveyance Calculation Method: At breaks in n values only
    Friction Slope Method:         Average Conveyance
    Computational Flow Regime:     Mixed Flow
```

FLOW DATA

Flow Title: Default Steady Flow
Flow File : C:\Users\tomw\Desktop\Donohoo-Updated.f01

Flow Data (cfs)

River	Reach	RS	100yr	5yr
Donahoo	East	728	391.9	74.8
Donahoo	South	220	597.2	120.3
Donahoo	West	980	1105.1	212.5
Donahoo	West	219	1127.2	216

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Donahoo	East	100yr	Normal S = 0.019395	
Donahoo	East	5yr	Normal S = 0.019395	
Donahoo	South	100yr	Normal S = 0.022568	
Donahoo	South	5yr	Normal S = 0.022568	
Donahoo	West	100yr		Normal S = 0.018699
Donahoo	West	5yr		Normal S = 0.018699

GEOMETRY DATA

Geometry Title: Default Geometry
Geometry File : C:\Users\tomw\Desktop\Donohoo-Updated.g01

Reach Connection Table

River	Reach	Upstream Boundary	Downstream Boundary
Donahoo	East		Junction 1
Donahoo	South		Junction 1
Donahoo	West	Junction 1	

JUNCTION INFORMATION

Name: Junction 1
Description:
Energy computation Method

Length across Junction River	Reach	Tributary River	Reach	Length	Angle
Donahoo	East	to Donahoo	West	101.05	0
Donahoo	South	to Donahoo	West	83.49	0

CROSS SECTION

RIVER: Donahoo
REACH: East RS: 728

INPUT
Description:
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7382	1.06	7382	10.25	7381	19.24	7380	26.56	7379
33.69	7378	41.64	7377	51.84	7376	76.87	7375	81.28	7374
86.59	7373	115.73	7373	119.64	7374	124.11	7375	129.14	7376
139.31	7377	147.95	7378	156.86	7379	166.3	7380	172.4	7381
180.61	7382	200	7382						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	76.87	.037	124.11	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
76.87	124.11	51.56	51.56	51.56	.1	.3

CROSS SECTION

```
RIVER: Donahoo
REACH: East              RS: 676

INPUT
Description:
Station Elevation Data    num=      26
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0    7377    4.24    7377   13.74    7376   30.72    7375   66.42    7374
   77.55    7374   81.73    7373   85.81    7372   90.47    7371  112.39    7371
  115.84    7372   119.3    7373  121.95    7374   124.4    7375  128.03    7376
  132.32    7377  142.43    7378  148.57    7379     155    7380  161.57    7381
  169.18    7382  176.33    7383  183.56    7384  192.03    7385  199.88    7386
     200    7386

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .037   77.55    .037  121.95    .037

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         77.55  121.95            51.56   51.56   51.56             .1       .3

CROSS SECTION


RIVER: Donahoo
REACH: East              RS: 624

INPUT
Description:
Station Elevation Data    num=      26
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0    7376     .03    7376   11.83    7375   19.11    7374   30.54    7373
      79    7373   83.51    7372   87.76    7371    98.2    7370  104.24    7370
  115.81    7371  119.49    7372  122.56    7373  125.37    7374  128.17    7375
  130.98    7376  135.13    7377  140.09    7378  146.27    7379  153.13    7380
  159.95    7381  165.11    7382  172.44    7383  179.54    7384  189.87    7385
     200    7385

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .037      79    .037  122.56    .037

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
            79  122.56            51.56   51.56   51.56             .1       .3

CROSS SECTION


RIVER: Donahoo
REACH: East              RS: 572

INPUT
Description:
Station Elevation Data    num=      24
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0    7375    7.27    7375   16.14    7374   24.13    7373    82.3    7372
   87.08    7371   91.52    7370  112.74    7370  117.62    7371  120.74    7372
  123.54    7373  126.64    7374  129.55    7375  132.59    7376  138.22    7377
  147.93    7378  154.17    7379  159.55    7380  164.19    7381  169.22    7382
  174.38    7383  177.38    7384  182.17    7385     200    7385

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .037    82.3    .037  120.74    .037

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          82.3  120.74            51.56   51.56   51.56             .1       .3

CROSS SECTION
```

RIVER: Donahoo
REACH: East RS: 520

INPUT
Description:
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7376	6.04	7376	14.73	7375	24.07	7374	31.76	7373
67.95	7372	76.77	7371	81.56	7370	94.52	7369	107.59	7369
110.11	7370	112.62	7371	115.16	7372	117.71	7373	123.25	7374
134.23	7375	143.81	7376	152.59	7377	161.97	7378	171.75	7379
186.9	7380	200	7380						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	76.77	.037	112.62	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
76.77	112.62	51.56	51.56	51.56	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: East RS: 468

INPUT
Description:
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7382	3.82	7382	9.58	7381	15.73	7380	21.86	7379
27.16	7378	31.92	7377	37.44	7376	42.77	7375	48.75	7374
54.41	7373	61.35	7372	71.57	7371	79.58	7370	83.77	7369
87.55	7368	105.57	7368	111.93	7369	117.64	7370	124.39	7371
135.79	7372	147.88	7373	158.96	7374	168	7375	178.42	7376
189.64	7377	200	7377						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	79.58	.037	117.64	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
79.58	117.64	51.56	51.56	51.56	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: East RS: 416

INPUT
Description:
Station Elevation Data num= 35

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7386	5.3	7386	12.61	7385	17.73	7384	22.36	7383
26.84	7382	30.72	7381	34.61	7380	38.76	7379	42.93	7378
46.74	7377	50.68	7376	55.57	7375	61.13	7374	66.41	7373
70.74	7372	74.24	7371	76.55	7370	78.71	7369	80.69	7368
83.72	7367	87.58	7366	105.05	7366	114.38	7367	123.29	7368
129.19	7369	138.06	7370	148.12	7371	158.58	7372	168.66	7373
177	7373.94	177.54	7374	184.81	7375	192.77	7376	200	7376

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	80.69	.037	123.29	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
80.69	123.29	51.56	51.56	51.56	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: East RS: 364

INPUT
Description:
Station Elevation Data num= 38

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7387	5.26	7387	12.29	7386	18.71	7385	24.01	7384
29.25	7383	34.29	7382	39.16	7381	43.81	7380	48.45	7379
53.12	7378	57.9	7377	62.54	7376	67.59	7375	70.37	7374
72.09	7373	73.79	7372	75.51	7371	77.24	7370	79.07	7369
81.24	7368	83.42	7367	85.46	7366	90.73	7365	111.77	7365
122.57	7366	127.71	7367	132.32	7368	137.4	7369	144.71	7370
152.24	7371	160.53	7372	168.92	7373	175.64	7373.88	176.62	7374
183.81	7375	191.82	7376	200	7376				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	81.24	.037	132.32	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
81.24	132.32	51.56	51.56	51.56	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: East RS: 312

INPUT
Description:
Station Elevation Data num= 36

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7383	2.47	7383	8.96	7382	14	7381	19.64	7380
26.15	7379	31.03	7378	35.79	7377	40.55	7376	45.2	7375
49.95	7374	55.6	7373	61.31	7372	67.66	7371	73.81	7370
79.99	7369	83.38	7368	86.07	7367	88.83	7366	91.07	7365
94.5	7364	114.95	7364	122.56	7365	126.35	7366	129.42	7367
132.53	7368	136.4	7369	142.76	7370	147.98	7371	155.77	7372
163.92	7373	171.91	7374	180.8	7375	188.48	7376	195.79	7377
200	7377								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	86.07	.037	129.42	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
86.07	129.42	51.56	51.56	51.56	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: East RS: 260

INPUT
Description:
Station Elevation Data num= 33

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7380	.19	7380	5.89	7379	11.41	7378	16.58	7377
21.37	7376	26.18	7375	30.94	7374	35.69	7373	40.72	7372
46.3	7371	52.67	7370	59.28	7369	65.49	7368	70.95	7367
76.62	7366	84.86	7365	88.89	7364	92.69	7363	113.59	7363
116.17	7364	119.27	7365	122.29	7366	125.2	7367	129.33	7368
136.13	7369	145.49	7370	154.4	7371	163.76	7372	172.99	7373
181.85	7374	191.51	7375	200	7375				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val

0	.037	84.86	.037	119.27	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
84.86	119.27	49.2	49.2	49.2	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: East RS: 210

INPUT
Description:
Station Elevation Data num= 34

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7380	2.38	7380	9.48	7379	16.1	7378	22.09	7377
27.72	7376	33.89	7375	39.78	7374	45.41	7373	51.07	7372
56.69	7371	61.93	7370	66.74	7369	72.45	7368	78.7	7367
86.01	7366	88.88	7365	92.15	7364	95.48	7363	98.54	7362
111.11	7361.33	117.21	7361	124.2	7361	127.31	7362	130.3	7363
133.42	7364	136.32	7365	139.42	7366	161.31	7367	168.95	7368
183.23	7369	192.81	7370	204.05	7371	210.86	7371		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	86.01	.037	139.42	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
86.01	139.42	51.1	51.1	51.1	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: East RS: 159

INPUT
Description:
Station Elevation Data num= 33

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7379	12.66	7379	21.87	7378	28.78	7377	35.32	7376
42.32	7375	49.01	7374	54.89	7373	61.1	7372	67.24	7371
73.36	7370	80.44	7369	83.55	7368	86.18	7367	87.74	7366
89.44	7365	91.47	7364	93.45	7363	95.39	7362	99.01	7361
104.82	7360	107.39	7360	116.65	7361	123.73	7362	131.14	7363
160.24	7364	171.81	7365	181.56	7366	188.74	7367	197.25	7368
205.81	7369	210.84	7370	214.49	7370				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	93.45	.037	131.14	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
93.45	131.14	49.3	49.3	49.3	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: East RS: 109

INPUT
Description:
Station Elevation Data num= 34

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7375	43.02	7375	51.1	7374	57.87	7373	61.19	7372
62.73	7371	64.23	7370	65.66	7369	67.13	7368	68.61	7367
70.13	7366	71.65	7365	73.19	7364	75.36	7363	78.06	7362
80.61	7361	83.87	7360	88.37	7359	92.47	7359	104.49	7360
108.42	7361	119.87	7362	142.86	7363	160.62	7364	171.63	7365
179.82	7366	188.01	7367	195.91	7368	204.22	7369	210.61	7370

216.12	7371	222.5	7372	230.09	7373	230.81	7373		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	78.06	.037	119.87	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
78.06	119.87	55.64	55.64	55.64	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: East RS: 53

INPUT
Description:
Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7371	12.75	7371	22.14	7370	24.08	7369	25.86	7368
27.81	7367	29.76	7366	31.65	7365	33.41	7364	35.37	7363
38.24	7362	41.06	7361	43.77	7360	47.09	7359	60.24	7359
64.77	7360	70.66	7361	90.92	7362	115.21	7363	128.99	7364
137.84	7365	146.44	7366	155.15	7367	163.98	7368	171.15	7369
178.06	7370	184.49	7371	191.1	7372	195.51	7372		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	35.37	.037	115.21	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
35.37	115.21	39.8	39.8	39.8	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: East RS: 14

INPUT
Description:
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7366	25.46	7366	29.75	7365	31.45	7364	33.56	7363
35.81	7362	38.15	7361	40.86	7360	46.11	7359	51.54	7358
59.75	7358	69.17	7359	76.85	7360	85.14	7361	94.3	7362
108.6	7363	125.43	7364	135.71	7365	145.89	7366	154.58	7367
163.25	7368	171.72	7369	178.21	7370	185.21	7371	186.69	7371

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	35.81	.037	94.3	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
35.81	94.3	62.95	62.95	62.95	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: East RS: -49

INPUT
Description:
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
34.45	7363	40.19	7362	44.99	7361	49.27	7360	53.43	7359
56.86	7358	63.58	7357	78	7357	89.44	7357.87	92.97	7358
100.01	7359	106.3	7360	114.36	7361	126.57	7362	141.64	7363
156.66	7364	172.66	7365	182.73	7366	192.15	7367	200.1	7368
206.07	7369	213.47	7370	221.74	7371	235.98	7372		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
34.45	.037	44.99	.037	114.36	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
44.99	114.36	0	0	0	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: South RS: 220

INPUT
Description:
Station Elevation Data num= 17

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7368	42.06	7368	49.88	7367	60.89	7366	74.49	7365
83.35	7364	87.43	7363	91.46	7362	106.89	7362	111.87	7363
116.91	7364	122.12	7365	125.65	7366	131.72	7367	182.34	7374
190.73	7375	200	7375						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	74.49	.037	122.12	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
74.49	122.12	54.51	54.51	54.51	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: South RS: 166

INPUT
Description:
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7368	10.34	7368	42.55	7367	76.04	7366	94.83	7365
104.93	7364	113.94	7363	118.98	7362	124.29	7361	140.74	7361
144.96	7362	147.89	7363	150.68	7364	153.39	7365	158.13	7366
163.31	7367	168.56	7368	174.47	7369	181.11	7370	187.84	7371
196.06	7372	204.09	7373	212.12	7374	221.58	7375	232.37	7376
239.16	7376								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	104.93	.037	150.68	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
104.93	150.68	55.66	55.66	55.66	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: South RS: 111

INPUT
Description:
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7368	14.36	7368	65.95	7367	84.24	7366	107.56	7365
135.8	7364	147.04	7363	157.63	7362	164.37	7361	168.49	7360
180.87	7360	186.93	7361	190.31	7362	193.29	7363	198.02	7364
205.49	7365	213.01	7366	220.19	7367	228.13	7368	235.14	7369
241.75	7370	249.21	7371	261.55	7372	273.23	7373	277.73	7373

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	135.8	.037	198.02	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
135.8	198.02	54.05	54.05	54.05	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: South RS: 57

INPUT
Description:
Station Elevation Data num= 36

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7373	5.32	7373	14.62	7372	19.03	7371	51.22	7371
59.89	7370	62.22	7369	64.49	7368	73.31	7367.35	77.97	7367
190.51	7366	228.78	7365	243.38	7364	254.24	7363	261.08	7362
264.67	7361	267.4	7360	270.65	7359	274.58	7358	274.97	7358
281.02	7358.37	291.22	7359	295.26	7360	299.4	7361	304.29	7362
310.04	7363	315.53	7364	321.49	7365	327.9	7366	335.3	7367
343.03	7368	350.62	7369	358.73	7370	367.63	7371	375.61	7372
386.77	7372								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	228.78	.037	321.49	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
228.78	321.49	57.33	57.33	57.33	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: South RS: 0

INPUT
Description:
Station Elevation Data num= 34

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7372	11.31	7372	16.35	7371	44.64	7371	56.99	7370
59.44	7369	62.15	7368	75.09	7367	157.34	7366	214.53	7365
240.08	7364.21	246.85	7364	263.25	7363	271.08	7362	276.58	7361
279.84	7360	282.52	7359	284.91	7358	287.22	7357	295.87	7357
305.08	7358	308.09	7359	310.96	7360	314.12	7361	317.63	7362
321.63	7363	330.11	7364	337.51	7365	344.65	7366	355.48	7367
365.25	7368	375.06	7369	385.24	7370	392.43	7370		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	263.25	.037	321.63	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
263.25	321.63	67.85	67.85	67.85	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: South RS: -68

INPUT
Description:
Station Elevation Data num= 28

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7372	10.27	7372	16.57	7371	39.23	7371	55.65	7370
59.35	7370	61.64	7369	63.66	7368	77.78	7367	140.63	7366
199.52	7365	240.15	7364	271.25	7363.14	276.04	7363	288.48	7362
306.18	7361	309.4	7360	312.21	7359	315.17	7358	318.58	7357

328.13	7357	332.46	7358	337.46	7359	344.44	7360	355.47	7361
370.25	7362	385.19	7363	426.42	7363				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	276.04	.037	385.19	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
276.04	385.19	0	0	0	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: West RS: 980

INPUT
Description:
Station Elevation Data num= 40

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7368	9.88	7368	33.61	7367	65.56	7366	112.68	7365
119.66	7364	127.47	7363	137.38	7362	152.4	7361	164.29	7360
189.33	7360	215.55	7359	243.07	7359	260.42	7358	279.04	7358
289.41	7357	298.59	7356	303.19	7355.27	304.85	7355	307.91	7355
311.43	7355.27	321.29	7356	395.22	7357	402.51	7358	407.16	7359
412.74	7360	423.73	7361	437.76	7362	451.64	7363	467.42	7364
481.96	7365	490.43	7366	496.81	7367	507.21	7368	516.61	7369
524.91	7370	533.83	7371	543.14	7372	552.45	7373	553.94	7373

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	164.29	.037	412.74	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
164.29	412.74	5.44	5.44	5.44	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: West RS: 975

INPUT
Description:
Station Elevation Data num= 43

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7368	8.76	7368	30.19	7367	59.56	7366	87.84	7365
95.25	7364	103.27	7363	121.05	7362	130.93	7361	150.38	7360
173.48	7360	204.03	7359	213.55	7359	246.09	7358	266.91	7358
278.37	7357	281.44	7356.54	284.98	7356	291.13	7355	298.39	7355
306.3	7356	316.62	7356.14	379.41	7357	390.5	7358	397.84	7359
403.41	7360	406.13	7360.15	421.74	7361	422.15	7361	439.5	7362
461.53	7363	491.23	7364	500.39	7364.73	503.88	7365	511.35	7366
526.09	7367	530.99	7367.33	540.89	7368	550.48	7369	563.65	7370
570.85	7371	576.3	7372	605.56	7372				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	173.48	.037	403.41	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
173.48	403.41	10.13	10.13	10.13	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: West RS: 965

INPUT
Description:

Station Elevation Data num= 43

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7368	5.43	7368	25.38	7367	54.81	7366	67.47	7365
74.83	7364	91.64	7363	104.62	7362	114.99	7361	126.37	7361
153.59	7360	172.11	7360	206.3	7359	218.91	7358	227.31	7358
267.83	7357.08	271.31	7357	281.26	7356	299.68	7356	305.59	7356.08
370.58	7357	389.14	7358	398.34	7359	403.79	7360	407.96	7361
411.9	7362	415.79	7363	419.63	7364	423.33	7365	426.95	7366
430.6	7367	434.85	7368	438.85	7369	443.86	7370	451.15	7371
465.71	7372	485.31	7373	501.84	7374	515.58	7375	527.74	7376
543.23	7377	558.44	7378	566.22	7378				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	172.11	.037	403.79	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
172.11	403.79	148	148	148	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: West RS: 708

INPUT
Description:
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7369	6.5	7369	22.93	7368	43.2	7368	53.71	7367
60.52	7366	66.57	7365	76.39	7364	116.32	7364	136.83	7365
317.26	7365	343.53	7366	353.71	7366	356.36	7366	439.5	7366
443.36	7367	453.29	7368	469.51	7369	479.22	7370	488.9	7371
520.82	7372	535.14	7372						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	66.57	.037	136.83	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
66.57	136.83	12.49	12.49	12.49	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: West RS: 696

INPUT
Description:
Station Elevation Data num= 22

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7369	6.58	7369	25.78	7368	29.89	7368	53.51	7367
61.23	7366	67.5	7365	131.45	7365	139.54	7366	147.3	7367
159.63	7368	312.83	7368	345.47	7368.56	371.75	7369	396.11	7369
410.09	7368	456.38	7368	468.47	7369	474.74	7370	480.61	7371
488.95	7372	508.39	7372						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	53.51	.037	147.3	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
53.51	147.3	7.45	7.45	7.45	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: West RS: 691

```
INPUT
Description:
Station Elevation Data    num=      22
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0    7368   20.49    7368   54.15    7367   62.59    7366   67.48    7365
  133.79    7365  140.23    7366  147.57    7367  160.37    7368  161.73 7368.01
  239.89 7368.37  345.31 7368.87  375.24    7369   409.1    7369  437.68    7368
   465.7    7368  473.24    7369  478.69    7370  483.62    7371   490.9    7372
  501.76    7373  508.98    7373

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .037   54.15    .037  147.57    .037

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         54.15  147.57            15.64   15.64   15.64             .1       .3

CROSS SECTION


RIVER: Donahoo
REACH: West              RS: 674

INPUT
Description:
Station Elevation Data    num=      41
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0    7368   14.49    7368   35.65    7367   78.08    7366   83.22    7365
  119.35 7364.34  137.63    7364   153.6    7364  163.88    7365  175.45    7366
  177.41    7366  182.91    7365  187.61    7364  201.73    7363  226.25    7362
  262.34    7361  279.21    7360  324.95    7359  351.59    7358  366.18    7358
  375.37    7359  382.64    7360  393.69    7361  404.58    7362   422.5    7362
  432.75    7361  445.59    7360  450.24    7360  452.76    7361  455.85    7362
  458.89    7363  461.98    7364  467.48    7365  474.29    7366  481.25    7367
  488.05    7368  495.17    7369  502.02    7370  508.87    7371  516.62    7372
  522.65    7372

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .037   78.08    .037  175.45    .037

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
         78.08  175.45             2.03    2.03    2.03             .1       .3
Ineffective Flow     num=       1
   Sta L   Sta R    Elev  Permanent
  178.57  522.65 7365.95       T

CROSS SECTION


RIVER: Donahoo
REACH: West              RS: 603

INPUT
Description:
Station Elevation Data    num=      36
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
   78.86    7366  107.97 7365.11  111.35    7365   130.7    7364  186.43    7363
  208.87    7363  217.67    7364  224.52    7365  228.71    7365  233.73    7364
  237.76    7363  246.18    7362  274.08    7361  293.93    7360  314.94    7359
  354.16    7358  389.85    7358  401.26    7359  412.22    7360   429.3    7361
  439.08    7361   448.6    7360  469.69    7360  471.64    7361  474.08    7362
  477.09    7363  480.51    7364  486.87    7365  493.65    7366  500.17    7367
  507.07    7368  515.14    7369  521.97    7370  529.13    7371     537    7372
  540.86    7372

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
   78.86    .037  111.35    .037  224.52    .037

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
```

111.35	224.52	1.76	1.76	1.76	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
229.34	540.86	7364.99	T

CROSS SECTION

RIVER: Donahoo
REACH: West RS: 577

INPUT
Description:
Station Elevation Data num= 33

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
73	7365	80.64	7365	100.8	7364.34	109.67	7364	146.29	7363
192.85	7363	202.26	7364	206.43	7364	210.52	7363	214.29	7362
241.2	7361	267.98	7360	282.41	7359	318.14	7358	362.71	7358
372.65	7359	387.53	7360	403.09	7360	415.32	7359	433.67	7359
437.96	7360	439.95	7361	441.94	7362	444.57	7363	448.76	7364
455.39	7365	461.96	7366	468.49	7367	475.4	7368	483.81	7369
490.93	7370	498.33	7371	504.84	7371				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
73	.037	109.67	.037	455.39	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
109.67	455.39	5.9	5.9	5.9	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
206.68	504.84	7364.01	T

CROSS SECTION

RIVER: Donahoo
REACH: West RS: 551

INPUT
Description:
Station Elevation Data num= 32

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7363	20.3	7363	58.2	7362	75.53	7362	82.41	7363
96.61	7363	101.29	7362	119.76	7361	150.04	7360	166.34	7359
189.99	7358	231.07	7357.21	241.79	7357	293.41	7357	299.71	7356
302.21	7356	310.71	7357	315.9	7358	321.02	7359	323.24	7360
325.46	7361	327.53	7362	329.56	7363	335.74	7364	341.59	7365
347.6	7366	354.58	7367	362.04	7368	369.92	7369	378.71	7370
386.19	7371	387.66	7371						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	20.3	.037	321.02	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
20.3	321.02	117.49	117.49	117.49	.1	.3

Ineffective Flow num= 1

Sta L	Sta R	Elev	Permanent
97.27	387.66	7362.98	T

CROSS SECTION

RIVER: Donahoo
REACH: West RS: 434

INPUT
Description:
Station Elevation Data num= 36

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev

0	7363	7.97	7363	34.61	7362	64.74	7361	93.01	7360
114.23	7359	137.27	7358	154.37	7357.88	173.29	7357.7	203.33	7357.42
236.01	7357	236.83	7357	280.24	7356	290.93	7355	295.09	7354
299.84	7353	317.36	7353	323.42	7354	329.34	7355	332.81	7356
336.31	7357	339.65	7358	341.59	7359	343.32	7360	345.12	7361
346.94	7362	350.28	7363	360.03	7364	367.67	7365	374.92	7366
381.17	7367	387.19	7368	393.77	7369	400.02	7370	406.13	7371
416.33	7371								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	280.24	.037	332.81	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
280.24	332.81	99.9	99.9	99.9	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: West RS: 334

INPUT
Description:
Station Elevation Data num= 38

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7363	6.11	7363	30.86	7362	60.38	7361	75.78	7360.46
89.03	7360	118.76	7359	141.12	7358	157.3	7357	181.32	7356
194.55	7356	226.89	7355	230.87	7354	234.6	7353	241.49	7352.93
260.49	7352.46	279.57	7352	299.37	7352	303.3	7353	307	7354
310.39	7355	312.91	7356	315.36	7357	317.91	7358	320.5	7359
323.06	7360	328.09	7361	334.68	7362	341.93	7363	349.95	7364
357.98	7365	366.3	7366	372.63	7367	378.43	7368	385.35	7369
393.5	7370	412.42	7371	415.14	7371				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	226.89	.037	310.39	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
226.89	310.39	41.18	41.18	41.18	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: West RS: 293

INPUT
Description:
Station Elevation Data num= 35

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7360.28	53.27	7360.28	53.27	7361	57.91	7361	76.23	7360.51
94.57	7360	124.82	7359	142.44	7358	160.36	7357	184.78	7356
205	7356	227.64	7355	230.69	7354	234.42	7353	247.93	7352
257.18	7351	261.84	7351	266.98	7352	272.41	7353	277.47	7354
280.46	7355	283.4	7356	286.19	7357	289.28	7358	295.48	7359
301.69	7360	308.11	7361	314.56	7362	321.37	7363	329.19	7364
343.81	7365	380.75	7366	390	7366	390	7364.13	395.26	7364.13

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	230.69	.037	277.47	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
230.69	277.47	74.34	74.34	74.34	.1	.3

CROSS SECTION

RIVER: Donahoo

REACH: West RS: 219

INPUT

Description:

Station Elevation Data num= 33

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7361	16.73	7361	42.79	7360	82.74	7359	119.54	7358
123.52	7358	143.97	7357.72	196.79	7357	217.14	7356	226.5	7355
227.01	7355	235.62	7354	243.69	7353	252.5	7352	277.45	7351.19
284.31	7352	287.14	7352.48	290.24	7353	295.89	7354	311.34	7355
326.67	7356	327.75	7356	348.75	7357	359.81	7357	367.65	7358
371.75	7359	393.03	7359	396.55	7358	426.48	7358	442.95	7359
462.05	7360	487.93	7361	506.06	7361				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	227.01	.037	311.34	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
227.01	311.34	76.13	76.13	76.13	.1	.3

CULVERT

RIVER: Donahoo

REACH: West RS: 183

INPUT

Description:

Distance from Upstream XS = 20.44

Deck/Roadway Width = 27.92

Weir Coefficient = 2.6

Upstream Deck/Roadway Coordinates

num= 28

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-177.92	7363.3	0	-176.64	7363	0	-145.12	7362	0
-110.69	7361	0	-68.83	7358.6	0	-9.45	7359	0
0	7363.32	0	0	7363.05	0	1.13	7363.29	0
45.21	7361.94	0	97.44	7360.34	0	98.79	7360.32	0
99.47	7360.31	0	175.65	7359.14	0	199.85	7358.77	0
200.52	7358.77	0	234.94	7358.64	0	273.32	7358.5	0
276.48	7358.49	0	277.01	7358.49	0	285.3	7358.46	0
288.69	7358.51	0	373.47	7359.76	0	400.59	7360.73	0
449.42	7362.47	0	505.72	7364.77	0	507.07	7364.83	0
507.75	7362.23	0						

Upstream Bridge Cross Section Data

Station Elevation Data num= 33

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7361	16.73	7361	42.79	7360	82.74	7359	119.54	7358
123.52	7358	143.97	7357.72	196.79	7357	217.14	7356	226.5	7355
227.01	7355	235.62	7354	243.69	7353	252.5	7352	277.45	7351.19
284.31	7352	287.14	7352.48	290.24	7353	295.89	7354	311.34	7355
326.67	7356	327.75	7356	348.75	7357	359.81	7357	367.65	7358
371.75	7359	393.03	7359	396.55	7358	426.48	7358	442.95	7359
462.05	7360	487.93	7361	506.06	7361				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	227.01	.037	311.34	.037

Bank Sta: Left	Right	Coeff Contr.	Expan.
227.01	311.34	.1	.3

Downstream Deck/Roadway Coordinates

num= 28

Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord	Sta	Hi Cord	Lo Cord
-177.92	7363.3	0	-176.64	7363	0	-145.12	7362	0
-110.69	7361	0	-68.83	7358.6	0	-9.45	7359	0
0	7363.32	0	0	7363.05	0	1.13	7363.29	0
45.21	7361.94	0	97.44	7360.34	0	98.79	7360.32	0

```
   99.47 7360.31       0  175.65 7359.14       0  199.85 7358.77       0
  200.52 7358.77       0  234.94 7358.64       0  273.32  7358.5       0
  276.48 7358.49       0  277.01 7358.49       0   285.3 7358.46       0
  288.69 7358.51       0  373.47 7359.76       0  400.59 7360.73       0
  449.42 7362.47       0  505.72 7364.77       0  507.07 7364.83       0
  507.75 7362.23       0

Downstream Bridge Cross Section Data
Station Elevation Data    num=      31
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0    7364   11.36    7364   30.29    7363   49.58    7362   74.37    7361
   97.87    7360  116.86    7359  140.68    7358  165.55    7357  184.12    7356
  250.96    7355  262.04    7354  269.53    7353  279.68    7352   292.9 7351.02
  293.13    7351  296.65    7350  305.63    7350  315.12 7350.98  315.32    7351
  318.49    7352  321.67    7353  327.92    7354   372.9    7355  399.41    7356
  424.04    7357  452.89    7358  467.24    7359   481.6    7360  500.57    7361
  504.34    7361

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0    .037  269.53    .037  321.67    .037

Bank Sta: Left   Right    Coeff Contr.   Expan.
        269.53  321.67             .1       .3

Upstream Embankment side slope              =     1.7 horiz. to 1.0 vertical
Downstream Embankment side slope            =       2 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .98
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Culverts =  1

Culvert Name     Shape      Rise    Span
Culvert #1      Circular       5
FHWA Chart # 2 - Corrugated Metal Pipe Culvert
FHWA Scale # 2 - Mitered to conform to slope
Solution Criteria = Highest U.S. EG
Culvert Upstrm Dist  Length    Top n  Bottom n  Depth Blocked  Entrance Loss Coef   Exit Loss Coef
               2.49   61.42     .023     .023        0                   .7                1
Number of Barrels =  2
Upstream   Elevation =  7350.5
Centerline Stations
    Sta.    Sta.
  272.91  280.64
Downstream Elevation =  7349.9
Centerline Stations
    Sta.    Sta.
   301.4   309.2

CROSS SECTION


RIVER: Donahoo
REACH: West               RS: 142

INPUT
Description:
Station Elevation Data    num=      31
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0    7364   11.36    7364   30.29    7363   49.58    7362   74.37    7361
   97.87    7360  116.86    7359  140.68    7358  165.55    7357  184.12    7356
  250.96    7355  262.04    7354  269.53    7353  279.68    7352   292.9 7351.02
  293.13    7351  296.65    7350  305.63    7350  315.12 7350.98  315.32    7351
  318.49    7352  321.67    7353  327.92    7354   372.9    7355  399.41    7356
  424.04    7357  452.89    7358  467.24    7359   481.6    7360  500.57    7361
  504.34    7361

Manning's n Values        num=       3
```

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	269.53	.037	321.67	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
269.53	321.67	40.73	40.73	40.73	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: West RS: 102

INPUT
Description:
Station Elevation Data num= 12

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7354	8.14	7354	10.96	7353	13.8	7352	17.74	7351
40.46	7350	66.02	7350	68.83	7351	71.64	7352	74.46	7353
127.15	7354	131.66	7354						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	10.96	.037	74.46	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
10.96	74.46	42.06	42.06	42.06	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: West RS: 60

INPUT
Description:
Station Elevation Data num= 13

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7353	2.46	7353	5.62	7352	8.69	7351	19.17	7350
26.62	7349.8	50.6	7349	63.21	7349	73.56	7350	76.57	7351
79.6	7352	84.49	7353	142.41	7353				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	5.62	.037	79.6	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
5.62	79.6	57.32	57.32	57.32	.1	.3

CROSS SECTION

RIVER: Donahoo
REACH: West RS: 2

INPUT
Description:
Station Elevation Data num= 15

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	7353	22.44	7353	25.86	7352	29.31	7351	36.51	7350
97.41	7349	99.26	7348.9	113.03	7348	120.89	7348	125.35	7349
128.46	7350	130.83	7350.82	131.38	7351	138.75	7352	190.16	7352

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.037	29.31	.037	131.38	.037

Bank Sta: Left	Right	Lengths: Left	Channel	Right	Coeff Contr.	Expan.
29.31	131.38	0	0	0	.1	.3

SUMMARY OF MANNING'S N VALUES

River:Donahoo

Reach	River Sta.	n1	n2	n3
East	728	.037	.037	.037
East	676	.037	.037	.037
East	624	.037	.037	.037
East	572	.037	.037	.037
East	520	.037	.037	.037
East	468	.037	.037	.037
East	416	.037	.037	.037
East	364	.037	.037	.037
East	312	.037	.037	.037
East	260	.037	.037	.037
East	210	.037	.037	.037
East	159	.037	.037	.037
East	109	.037	.037	.037
East	53	.037	.037	.037
East	14	.037	.037	.037
East	-49	.037	.037	.037
South	220	.037	.037	.037
South	166	.037	.037	.037
South	111	.037	.037	.037
South	57	.037	.037	.037
South	0	.037	.037	.037
South	-68	.037	.037	.037
West	980	.037	.037	.037
West	975	.037	.037	.037
West	965	.037	.037	.037
West	708	.037	.037	.037
West	696	.037	.037	.037
West	691	.037	.037	.037
West	674	.037	.037	.037
West	603	.037	.037	.037
West	577	.037	.037	.037
West	551	.037	.037	.037
West	434	.037	.037	.037
West	334	.037	.037	.037
West	293	.037	.037	.037
West	219	.037	.037	.037
West	183	Culvert		
West	142	.037	.037	.037
West	102	.037	.037	.037
West	60	.037	.037	.037
West	2	.037	.037	.037

SUMMARY OF REACH LENGTHS

River: Donahoo

Reach	River Sta.	Left	Channel	Right
East	728	51.56	51.56	51.56
East	676	51.56	51.56	51.56
East	624	51.56	51.56	51.56
East	572	51.56	51.56	51.56
East	520	51.56	51.56	51.56
East	468	51.56	51.56	51.56
East	416	51.56	51.56	51.56
East	364	51.56	51.56	51.56
East	312	51.56	51.56	51.56
East	260	49.2	49.2	49.2
East	210	51.1	51.1	51.1
East	159	49.3	49.3	49.3
East	109	55.64	55.64	55.64
East	53	39.8	39.8	39.8

East	14	62.95	62.95	62.95
East	-49	0	0	0
South	220	54.51	54.51	54.51
South	166	55.66	55.66	55.66
South	111	54.05	54.05	54.05
South	57	57.33	57.33	57.33
South	0	67.85	67.85	67.85
South	-68	0	0	0
West	980	5.44	5.44	5.44
West	975	10.13	10.13	10.13
West	965	148	148	148
West	708	12.49	12.49	12.49
West	696	7.45	7.45	7.45
West	691	15.64	15.64	15.64
West	674	2.03	2.03	2.03
West	603	1.76	1.76	1.76
West	577	5.9	5.9	5.9
West	551	117.49	117.49	117.49
West	434	99.9	99.9	99.9
West	334	41.18	41.18	41.18
West	293	74.34	74.34	74.34
West	219	76.13	76.13	76.13
West	183	Culvert		
West	142	40.73	40.73	40.73
West	102	42.06	42.06	42.06
West	60	57.32	57.32	57.32
West	2	0	0	0

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Donahoo

Reach	River Sta.	Contr.	Expan.
East	728	.1	.3
East	676	.1	.3
East	624	.1	.3
East	572	.1	.3
East	520	.1	.3
East	468	.1	.3
East	416	.1	.3
East	364	.1	.3
East	312	.1	.3
East	260	.1	.3
East	210	.1	.3
East	159	.1	.3
East	109	.1	.3
East	53	.1	.3
East	14	.1	.3
East	-49	.1	.3
South	220	.1	.3
South	166	.1	.3
South	111	.1	.3
South	57	.1	.3
South	0	.1	.3
South	-68	.1	.3
West	980	.1	.3
West	975	.1	.3
West	965	.1	.3
West	708	.1	.3
West	696	.1	.3
West	691	.1	.3
West	674	.1	.3
West	603	.1	.3
West	577	.1	.3
West	551	.1	.3
West	434	.1	.3
West	334	.1	.3

West	293		.1	.3
West	219		.1	.3
West	183	Culvert		
West	142		.1	.3
West	102		.1	.3
West	60		.1	.3
West	2		.1	.3

Profile Output Table - MVE Standard Table

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Max Chl Dpth (ft)	Hydr Depth C (ft)	Flow Area (sq ft)	Top Width (ft)	Vel Chnl (ft/s)	Froude # Chl	Shear Chan (lb/sq ft)
East	728	100yr	391.90	7373.00	7374.60	7374.62	7375.30	0.019389	1.60	1.33	58.18	43.65	6.74	1.03	1.60
East	728	5yr	74.80	7373.00	7373.56	7373.56	7373.84	0.026162	0.56	0.52	17.85	34.33	4.19	1.02	0.85
East	676	100yr	391.90	7371.00	7372.51	7372.90	7373.85	0.040244	1.51	1.25	42.28	33.88	9.27	1.46	3.10
East	676	5yr	74.80	7371.00	7371.56	7371.68	7372.04	0.047445	0.56	0.51	13.46	26.43	5.56	1.37	1.50
East	624	100yr	391.90	7370.00	7372.78	7372.19	7373.16	0.006551	2.78	1.90	79.40	41.89	4.94	0.63	0.77
East	624	5yr	74.80	7370.00	7371.35	7370.99	7371.46	0.005582	1.34	0.88	27.19	30.78	2.75	0.52	0.31
East	572	100yr	391.90	7370.00	7372.03	7371.89	7372.66	0.013720	2.03	1.60	61.46	40.14	6.38	0.89	1.35
East	572	5yr	74.80	7370.00	7370.80		7371.02	0.014274	0.80	0.70	19.94	28.67	3.75	0.79	0.62
East	520	100yr	391.90	7369.00	7371.07	7371.07	7371.84	0.017753	2.07	1.54	55.38	36.59	7.08	1.00	1.69
East	520	5yr	74.80	7369.00	7369.89	7369.84	7370.17	0.019173	0.89	0.66	17.79	26.86	4.20	0.91	0.79
East	468	100yr	391.90	7368.00	7369.86	7370.00	7370.78	0.023807	1.86	1.39	51.09	36.71	7.67	1.15	2.05
East	468	5yr	74.80	7368.00	7368.75	7368.75	7369.08	0.023466	0.75	0.64	16.43	25.65	4.55	1.00	0.93
East	416	100yr	391.90	7366.00	7367.48	7367.94	7368.96	0.052396	1.48	1.10	40.14	36.39	9.76	1.64	3.58
East	416	5yr	74.80	7366.00	7366.57	7366.75	7367.17	0.064055	0.57	0.48	12.01	24.94	6.23	1.58	1.92
East	364	100yr	391.90	7365.00	7367.94	7366.74	7368.12	0.002511	2.94	2.26	114.33	50.66	3.43	0.40	0.35
East	364	5yr	74.80	7365.00	7366.13	7365.67	7366.20	0.003554	1.13	0.89	33.86	38.03	2.21	0.41	0.20
East	312	100yr	391.90	7364.00	7367.90		7368.02	0.001035	3.90	3.23	142.41	48.59	2.79	0.27	0.20
East	312	5yr	74.80	7364.00	7366.12		7366.14	0.000413	2.12	1.70	64.97	38.21	1.15	0.16	0.04
East	260	100yr	391.90	7363.00	7367.91		7367.98	0.000425	4.90	4.50	197.94	62.93	2.23	0.19	0.12
East	260	5yr	74.80	7363.00	7366.12		7366.13	0.000102	3.12	2.71	100.39	46.68	0.78	0.08	0.02
East	210	100yr	391.90	7361.00	7367.93		7367.95	0.000115	6.93	5.34	332.96	95.48	1.30	0.10	0.04
East	210	5yr	74.80	7361.00	7366.12		7366.12	0.000019	5.12	3.54	189.09	56.92	0.40	0.04	0.00
East	159	100yr	391.90	7360.00	7367.93		7367.94	0.000051	7.93	6.69	481.58	112.94	1.01	0.07	0.02
East	159	5yr	74.80	7360.00	7366.12		7366.12	0.000007	6.12	4.87	294.38	94.87	0.31	0.02	0.00
East	109	100yr	391.90	7359.00	7367.93		7367.94	0.000025	8.93	7.64	632.15	128.16	0.77	0.05	0.01
East	109	5yr	74.80	7359.00	7366.12		7366.12	0.000003	7.12	5.83	415.34	110.86	0.22	0.02	0.00
East	53	100yr	391.90	7359.00	7367.93		7367.94	0.000019	8.93	6.81	695.40	137.40	0.63	0.04	0.01
East	53	5yr	74.80	7359.00	7366.12		7366.12	0.000002	7.12	5.00	463.95	117.97	0.17	0.01	0.00
East	14	100yr	391.90	7358.00	7367.93		7367.94	0.000014	9.93	8.32	802.08	162.67	0.60	0.04	0.01
East	14	5yr	74.80	7358.00	7366.12		7366.12	0.000001	8.12	6.50	521.49	146.94	0.17	0.01	0.00
East	-49	100yr	391.90	7357.00	7367.94		7367.94	0.000006	10.93	9.54	1047.48	165.13	0.45	0.03	0.00
East	-49	5yr	74.80	7357.00	7366.12		7366.12	0.000001	9.12	7.73	761.66	149.42	0.12	0.01	0.00
South	220	100yr	597.20	7362.00	7367.91	7364.76	7367.98	0.000407	5.91	4.79	299.89	95.56	2.28	0.18	0.12
South	220	5yr	120.30	7362.00	7366.12	7363.10	7366.13	0.000098	4.12	3.00	153.56	66.79	0.82	0.08	0.02
South	166	100yr	597.20	7361.00	7367.92		7367.96	0.000181	6.92	5.91	442.10	155.28	1.75	0.13	0.07
South	166	5yr	120.30	7361.00	7366.12		7366.13	0.000035	5.12	4.11	223.61	86.72	0.60	0.05	0.01
South	111	100yr	597.20	7360.00	7367.93		7367.95	0.000081	7.93	6.16	642.74	209.56	1.20	0.09	0.03
South	111	5yr	120.30	7360.00	7366.12		7366.12	0.000014	6.12	4.35	347.93	131.84	0.40	0.03	0.00

South	57	100yr	597.20	7358.00	7367.93		7367.94	0.000042	9.93	6.18	862.35	277.09	0.87	0.06	0.02
South	57	5yr	120.30	7358.00	7366.12		7366.12	0.000008	8.12	4.37	433.38	151.86	0.29	0.02	0.00
South	0	100yr	597.20	7357.00	7367.93		7367.94	0.000027	10.93	8.26	1028.47	301.55	0.83	0.05	0.01
South	0	5yr	120.30	7357.00	7366.12		7366.12	0.000004	9.12	6.45	546.81	198.54	0.28	0.02	0.00
South	-68	100yr	597.20	7357.00	7367.93		7367.94	0.000010	10.93	7.39	1548.16	361.83	0.49	0.03	0.00
South	-68	5yr	120.30	7357.00	7366.12		7366.12	0.000002	9.12	5.58	934.05	293.37	0.16	0.01	0.00
West	980	100yr	1105.10	7355.00	7367.94		7367.94	0.000004	12.93	10.16	3393.73	495.10	0.37	0.02	0.00
West	980	5yr	212.50	7355.00	7366.12		7366.12	0.000000	11.12	8.34	2553.62	429.51	0.09	0.01	0.00
West	975	100yr	1105.10	7355.00	7367.94		7367.94	0.000004	12.94	10.39	3649.52	529.78	0.36	0.02	0.00
West	975	5yr	212.50	7355.00	7366.12		7366.12	0.000000	11.12	8.57	2751.16	457.13	0.09	0.01	0.00
West	965	100yr	1105.10	7356.00	7367.94		7367.94	0.000004	11.93	10.45	3290.98	427.84	0.38	0.02	0.00
West	965	5yr	212.50	7356.00	7366.12		7366.12	0.000000	10.12	8.64	2558.33	376.15	0.09	0.01	0.00
West	708	100yr	1105.10	7364.00	7367.92		7367.93	0.000174	3.92	3.70	1071.56	408.36	1.26	0.12	0.04
West	708	5yr	212.50	7364.00	7366.11		7366.12	0.000179	2.11	1.90	364.94	380.19	0.82	0.11	0.02
West	696	100yr	1105.10	7365.00	7367.36	7366.95	7367.88	0.008056	2.36	2.03	193.16	106.69	5.78	0.71	1.02
West	696	5yr	212.50	7365.00	7365.94		7366.10	0.007836	0.94	0.86	66.34	77.43	3.20	0.61	0.42
West	691	100yr	1105.10	7365.00	7366.94	7366.94	7367.76	0.017131	1.94	1.64	151.52	92.40	7.29	1.00	1.75
West	691	5yr	212.50	7365.00	7365.67	7365.67	7365.99	0.023282	0.67	0.64	46.96	73.90	4.52	1.00	0.92
West	674	100yr	1105.10	7364.00	7366.35	7366.35	7366.68	0.007677	8.35	1.76	293.20	413.43	5.12	0.68	0.84
West	674	5yr	212.50	7364.00	7365.00	7365.00	7365.30	0.024109	7.00	0.60	48.09	365.12	4.42	1.01	0.90
West	603	100yr	1105.10	7363.00	7365.30	7365.28	7365.66	0.008398	7.29	1.66	269.74	386.95	5.16	0.71	0.87
West	603	5yr	212.50	7363.00	7363.93	7363.93	7364.23	0.024188	5.93	0.59	48.43	328.41	4.39	1.01	0.89
West	577	100yr	1105.10	7358.00	7364.15	7364.50	7365.52	0.228423	6.15	0.34	117.58	343.92	9.41	2.83	4.90
West	577	5yr	212.50	7358.00	7363.60	7363.76	7364.14	0.056161	5.60	0.49	36.08	313.10	5.89	1.49	1.71
West	551	100yr	1105.10	7356.00	7363.26	7363.57	7364.38	0.148661	7.26	0.41	131.53	331.19	8.55	2.35	3.80
West	551	5yr	212.50	7356.00	7362.79	7363.09	7363.70	0.085443	6.79	0.53	27.80	284.37	7.65	1.86	2.80
West	434	100yr	1105.10	7353.00	7360.01	7356.57	7360.05	0.000223	7.01	5.94	779.60	250.56	1.95	0.14	0.08
West	434	5yr	212.50	7353.00	7355.42	7354.41	7355.55	0.002653	2.42	1.66	73.74	44.38	2.88	0.39	0.27
West	334	100yr	1105.10	7352.00	7360.01		7360.03	0.000080	8.01	7.34	1017.00	234.31	1.35	0.09	0.04
West	334	5yr	212.50	7352.00	7355.47		7355.48	0.000130	3.47	2.80	237.59	99.81	0.91	0.10	0.02
West	293	100yr	1105.10	7351.00	7359.98		7360.03	0.000152	8.98	7.75	790.94	206.51	1.92	0.12	0.07
West	293	5yr	212.50	7351.00	7355.44		7355.47	0.000258	4.44	3.21	158.37	64.11	1.39	0.14	0.05
West	219	100yr	1127.20	7351.19	7359.99	7354.55	7360.01	0.000070	8.80	7.10	1305.19	418.86	1.23	0.08	0.03
West	219	5yr	216.00	7351.19	7355.44	7352.70	7355.45	0.000181	4.25	2.54	217.06	95.59	1.00	0.11	0.03
West	183		Culvert												
West	142	100yr	1127.20	7350.00	7353.73	7353.73	7354.88	0.013976	3.73	2.48	133.08	62.13	8.64	0.97	2.14
West	142	5yr	216.00	7350.00	7351.81	7351.75	7352.29	0.017121	1.81	1.09	38.97	35.64	5.54	0.93	1.16
West	102	100yr	1127.20	7350.00	7352.22	7352.69	7353.99	0.032702	2.22	1.79	105.90	59.11	10.64	1.40	3.62
West	102	5yr	216.00	7350.00	7351.07	7351.07	7351.48	0.021961	1.07	0.81	41.83	51.55	5.16	1.01	1.11
West	60	100yr	1127.20	7349.00	7351.48	7351.67	7352.70	0.022508	2.48	1.80	127.13	70.79	8.87	1.17	2.51
West	60	5yr	216.00	7349.00	7350.45	7350.19	7350.66	0.008714	1.45	0.97	58.80	60.47	3.67	0.66	0.53
West	2	100yr	1127.20	7348.00	7350.82	7350.84	7351.63	0.017727	2.82	1.56	156.92	100.27	7.18	1.01	1.72
West	2	5yr	216.00	7348.00	7349.65	7349.58	7349.95	0.018718	1.65	0.71	49.47	69.57	4.37	0.91	0.83

ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : Default

```
River: Donahoo  Reach: East     RS: 728     Profile: 5yr
     Warning:The energy equation could not be balanced within the specified number of iterations.  The program used critical depth
             for the water surface and continued on with the calculations.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
             the need for additional cross sections.
     Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
             water surface came back below critical depth.  This indicates that there is not a valid subcritical answer.  The
             program defaulted to critical depth.
River: Donahoo  Reach: East     RS: 676     Profile: 100yr
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m).  This may indicate the need for additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Donahoo  Reach: East     RS: 676     Profile: 5yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Donahoo  Reach: East     RS: 624     Profile: 100yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Note:   Hydraulic jump has occurred between this cross section and the previous upstream section.
River: Donahoo  Reach: East     RS: 624     Profile: 5yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Note:   Hydraulic jump has occurred between this cross section and the previous upstream section.
River: Donahoo  Reach: East     RS: 520     Profile: 100yr
     Warning:The energy equation could not be balanced within the specified number of iterations.  The program used critical depth
             for the water surface and continued on with the calculations.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
             the need for additional cross sections.
     Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
             water surface came back below critical depth.  This indicates that there is not a valid subcritical answer.  The
             program defaulted to critical depth.
River: Donahoo  Reach: East     RS: 520     Profile: 5yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Donahoo  Reach: East     RS: 468     Profile: 100yr
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
             the need for additional cross sections.
     Note:   Program found supercritical flow starting at this cross section.
River: Donahoo  Reach: East     RS: 468     Profile: 5yr
     Warning:The energy equation could not be balanced within the specified number of iterations.  The program used critical depth
             for the water surface and continued on with the calculations.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
             the need for additional cross sections.
     Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
             water surface came back below critical depth.  This indicates that there is not a valid subcritical answer.  The
             program defaulted to critical depth.
River: Donahoo  Reach: East     RS: 416     Profile: 100yr
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m).  This may indicate the need for additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Donahoo  Reach: East     RS: 416     Profile: 5yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
             the need for additional cross sections.
     Note:   Program found supercritical flow starting at this cross section.
River: Donahoo  Reach: East     RS: 364     Profile: 100yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Note:   Hydraulic jump has occurred between this cross section and the previous upstream section.
River: Donahoo  Reach: East     RS: 364     Profile: 5yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Note:   Hydraulic jump has occurred between this cross section and the previous upstream section.
River: Donahoo  Reach: East     RS: 312     Profile: 100yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
```

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River: Donahoo  Reach: East     RS: 312     Profile: 5yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: East     RS: 260     Profile: 100yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: East     RS: 260     Profile: 5yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: East     RS: 210     Profile: 100yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: East     RS: 210     Profile: 5yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: East     RS: 159     Profile: 100yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: East     RS: 159     Profile: 5yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: East     RS: 14     Profile: 100yr
     Warning:The cross-section end points had to be extended vertically for the computed water surface.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: East     RS: 14     Profile: 5yr
     Warning:The cross-section end points had to be extended vertically for the computed water surface.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: East     RS: -49     Profile: 100yr
     Warning:The cross-section end points had to be extended vertically for the computed water surface.
River: Donahoo  Reach: East     RS: -49     Profile: 5yr
     Warning:The cross-section end points had to be extended vertically for the computed water surface.
River: Donahoo  Reach: South     RS: 220     Profile: 100yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: South     RS: 220     Profile: 5yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: South     RS: 166     Profile: 100yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: South     RS: 166     Profile: 5yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: South     RS: 0     Profile: 100yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: South     RS: 0     Profile: 5yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: South     RS: -68     Profile: 100yr
     Warning:The cross-section end points had to be extended vertically for the computed water surface.
River: Donahoo  Reach: South     RS: -68     Profile: 5yr
     Warning:The cross-section end points had to be extended vertically for the computed water surface.
River: Donahoo  Reach: West     RS: 965     Profile: 100yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: West     RS: 965     Profile: 5yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: West     RS: 708     Profile: 100yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: West     RS: 708     Profile: 5yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: West     RS: 696     Profile: 100yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: West     RS: 696     Profile: 5yr
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Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

River: Donahoo Reach: West RS: 691 Profile: 100yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

River: Donahoo Reach: West RS: 691 Profile: 5yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

River: Donahoo Reach: West RS: 674 Profile: 100yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Note: Program found supercritical flow starting at this cross section.

River: Donahoo Reach: West RS: 674 Profile: 5yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

Warning:Divided flow computed for this cross-section.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

River: Donahoo Reach: West RS: 603 Profile: 100yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

River: Donahoo Reach: West RS: 603 Profile: 5yr

Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth for the water surface and continued on with the calculations.

Warning:Divided flow computed for this cross-section.

Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The program defaulted to critical depth.

River: Donahoo Reach: West RS: 577 Profile: 100yr

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

River: Donahoo Reach: West RS: 577 Profile: 5yr

Warning:Divided flow computed for this cross-section.

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

River: Donahoo Reach: West RS: 551 Profile: 100yr

Warning:The cross-section end points had to be extended vertically for the computed water surface.

Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate the need for additional cross sections.

River: Donahoo Reach: West RS: 551 Profile: 5yr

Warning:Divided flow computed for this cross-section.

River: Donahoo Reach: West RS: 434 Profile: 100yr

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

Note: Hydraulic jump has occurred between this cross section and the previous upstream section.

River: Donahoo Reach: West RS: 434 Profile: 5yr

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.

```
     Note:   Hydraulic jump has occurred between this cross section and the previous upstream section.
River: Donahoo  Reach: West     RS: 334     Profile: 5yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: West     RS: 293     Profile: 100yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: West     RS: 183     Profile: 100yr
     Warning:The flow through the culvert is supercritical.  However, since there is flow over the road (weir flow), the program
             cannot determine if the downstream cross section should be subcritical or supercritical.  The program used the
             downstream subcritical answer, even though it may not be valid.
River: Donahoo  Reach: West     RS: 183     Profile: 100yr     Culv: Culvert #1
     Warning:During the supercritical analysis, the program could not converge on a supercritical answer in the downstream cross
             section.  The program used the solution with the least error.
     Note:   The normal depth exceeds the height of the culvert.  The program assumes that the normal depth is equal to the height
             of the culvert.
     Note:   The flow in the culvert is entirely supercritical.
River: Donahoo  Reach: West     RS: 142     Profile: 100yr
     Warning:The energy equation could not be balanced within the specified number of iterations.  The program used critical depth
             for the water surface and continued on with the calculations.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
             the need for additional cross sections.
     Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
             water surface came back below critical depth.  This indicates that there is not a valid subcritical answer.  The
             program defaulted to critical depth.
River: Donahoo  Reach: West     RS: 102     Profile: 100yr
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m).  This may indicate the need for additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Donahoo  Reach: West     RS: 102     Profile: 5yr
     Warning:The energy equation could not be balanced within the specified number of iterations.  The program used critical depth
             for the water surface and continued on with the calculations.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
             water surface came back below critical depth.  This indicates that there is not a valid subcritical answer.  The
             program defaulted to critical depth.
River: Donahoo  Reach: West     RS: 60     Profile: 100yr
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m).  This may indicate the need for additional cross sections.
     Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section.  This may indicate
             the need for additional cross sections.
River: Donahoo  Reach: West     RS: 60     Profile: 5yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Note:   Hydraulic jump has occurred between this cross section and the previous upstream section.
River: Donahoo  Reach: West     RS: 2     Profile: 100yr
     Warning:Slope too steep for slope area to converge during supercritical flow calculations (normal depth is below critical
             depth). Water surface set to critical depth.
```

VI. Permissible Shear and Velocity for Selected Lining Materials

Table 2. Permissible Shear and Velocity for Selected Lining Materials[1]

Boundary Category	Boundary Type	Permissible Shear Stress (lb/sq ft)	Permissible Velocity (ft/sec)	Citation(s)
Soils	Fine colloidal sand	0.02 - 0.03	1.5	A
	Sandy loam (noncolloidal)	0.03 - 0.04	1.75	A
	Alluvial silt (noncolloidal)	0.045 - 0.05	2	A
	Silty loam (noncolloidal)	0.045 - 0.05	1.75 – 2.25	A
	Firm loam	0.075	2.5	A
	Fine gravels	0.075	2.5	A
	Stiff clay	0.26	3 – 4.5	A, F
	Alluvial silt (colloidal)	0.26	3.75	A
	Graded loam to cobbles	0.38	3.75	A
	Graded silts to cobbles	0.43	4	A
	Shales and hardpan	0.67	6	A
Gravel/Cobble	1-in.	0.33	2.5 – 5	A
	2-in.	0.67	3 – 6	A
	6-in.	2.0	4 – 7.5	A
	12-in.	4.0	5.5 – 12	A
Vegetation	Class A turf	3.7	6 – 8	E, N
	Class B turf	2.1	4 - 7	E, N
	Class C turf	1.0	3.5	E, N
	Long native grasses	1.2 – 1.7	4 – 6	G, H, L, N
	Short native and bunch grass	0.7 - 0.95	3 – 4	G, H, L, N
	Reed plantings	0.1-0.6	N/A	E, N
	Hardwood tree plantings	0.41-2.5	N/A	E, N
Temporary Degradable RECPs	Jute net	0.45	1 – 2.5	E, H, M
	Straw with net	1.5 – 1.65	1 – 3	E, H, M
	Coconut fiber with net	2.25	3 – 4	E, M
	Fiberglass roving	2.00	2.5 – 7	E, H, M
Non-Degradable RECPs	Unvegetated	3.00	5 – 7	E, G, M
	Partially established	4.0-6.0	7.5 – 15	E, G, M
	Fully vegetated	8.00	8 – 21	F, L, M
Riprap	6 – in. d_{50}	2.5	5 – 10	H
	9 – in. d_{50}	3.8	7 – 11	H
	12 – in. d_{50}	5.1	10 – 13	H
	18 – in. d_{50}	7.6	12 – 16	H
	24 – in. d_{50}	10.1	14 – 18	E
Soil Bioengineering	Wattles	0.2 – 1.0	3	C, I, J, N
	Reed fascine	0.6-1.25	5	E
	Coir roll	3 - 5	8	E, M, N
	Vegetated coir mat	4 - 8	9.5	E, M, N
	Live brush mattress (initial)	0.4 – 4.1	4	B, E, I
	Live brush mattress (grown)	3.90-8.2	12	B, C, E, I, N
	Brush layering (initial/grown)	0.4 – 6.25	12	E, I, N
	Live fascine	1.25-3.10	6 – 8	C, E, I, J
	Live willow stakes	2.10-3.10	3 – 10	E, N, O
Hard Surfacing	Gabions	10	14 – 19	D
	Concrete	12.5	>18	H

[1] Ranges of values generally reflect multiple sources of data or different testing conditions.

A. Chang, H.H. (1988).
B. Florineth. (1982)
C. Gerstgraser, C. (1998).
D. Goff, K. (1999).
E. Gray, D.H., and Sotir, R.B. (1996).
F. Julien, P.Y. (1995).
G. Kouwen, N.; Li, R. M.; and Simons, D.B., (1980).
H. Norman, J. N. (1975).
I. Schiechtl, H. M. and R. Stern. (1996).
J. Schoklitsch, A. (1937).
K. Sprague, C.J. (1999).
L. Temple, D.M. (1980).
M. TXDOT (1999)
N. Data from Author (2001)
O. USACE (1997).

VII. Design Point 2 Culvert Calculation

Culvert Report

61188 - Existing Design Point 2: 2-60 inch CMPs (5-yr)

Invert Elev Dn (ft)	=	7349.89
Pipe Length (ft)	=	61.00
Slope (%)	=	1.07
Invert Elev Up (ft)	=	7350.54
Rise (in)	=	60.0
Shape	=	Circular
Span (in)	=	60.0
No. Barrels	=	2
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Mitered to slope (C)
Coeff. K,M,c,Y,k	=	0.021, 1.33, 0.0463, 0.75, 0.7

Embankment

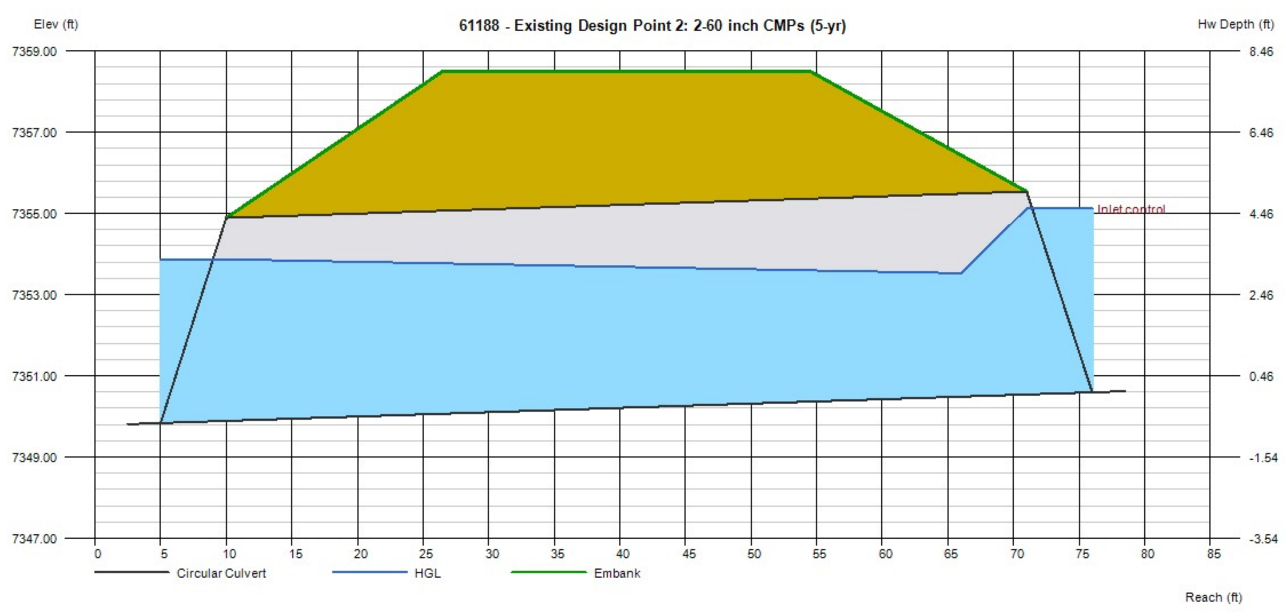
Top Elevation (ft)	=	7358.50
Top Width (ft)	=	28.00
Crest Width (ft)	=	64.00

Calculations

Qmin (cfs)	=	215.60
Qmax (cfs)	=	215.60
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	215.60
Qpipe (cfs)	=	215.60
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.43
Veloc Up (ft/s)	=	8.91
HGL Dn (ft)	=	7353.87
HGL Up (ft)	=	7353.50
Hw Elev (ft)	=	7355.12
Hw/D (ft)	=	0.92
Flow Regime	=	Inlet Control



Culvert Report

61188 - Existing Design Point 2: 2-60 inch CMPs (100-yr)

Invert Elev Dn (ft)	=	7349.89
Pipe Length (ft)	=	61.00
Slope (%)	=	1.07
Invert Elev Up (ft)	=	7350.54
Rise (in)	=	60.0
Shape	=	Circular
Span (in)	=	60.0
No. Barrels	=	2
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Mitered to slope (C)
Coeff. K,M,c,Y,k	=	0.021, 1.33, 0.0463, 0.75, 0.7

Embankment

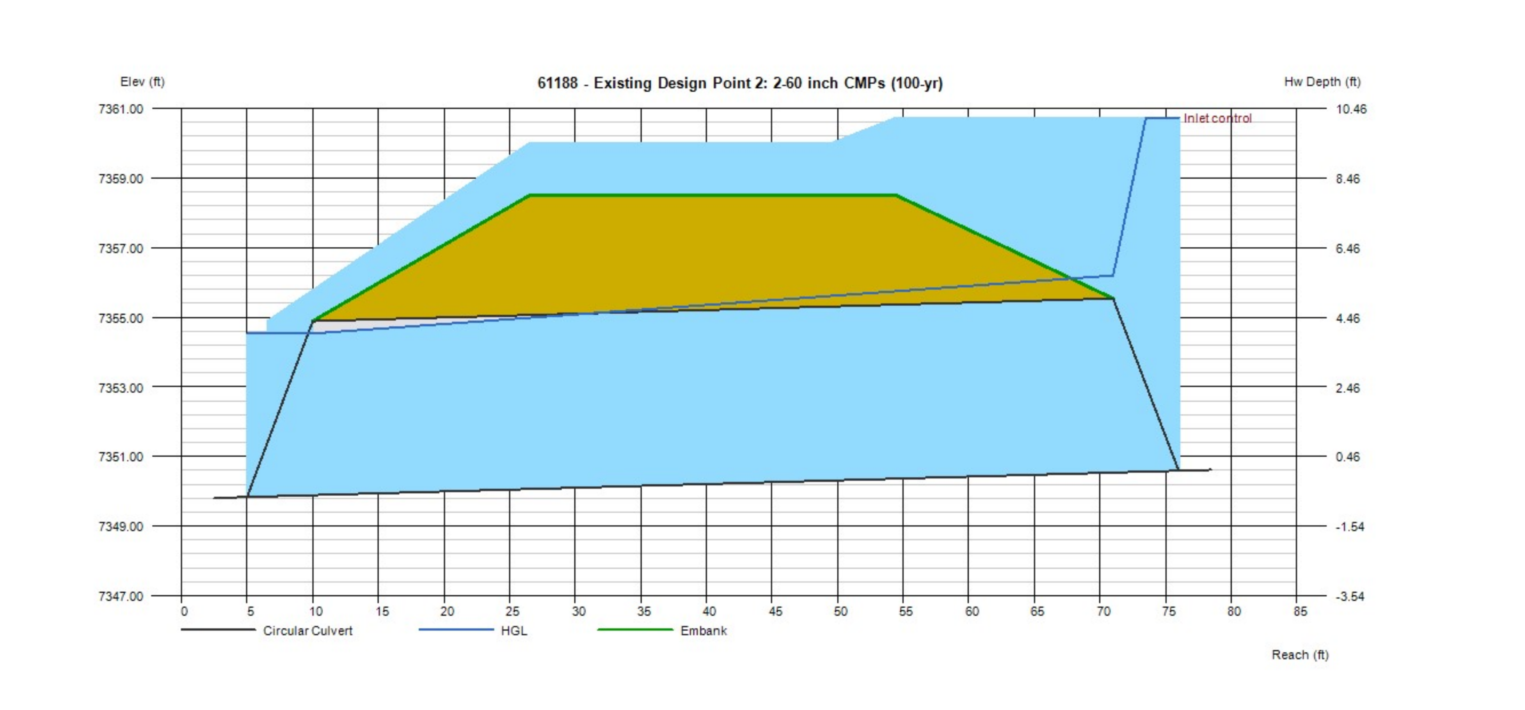
Top Elevation (ft)	=	7358.50
Top Width (ft)	=	28.00
Crest Width (ft)	=	64.00

Calculations

Qmin (cfs)	=	1126.00
Qmax (cfs)	=	1126.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	1126.00
Qpipe (cfs)	=	462.12
Qovertop (cfs)	=	663.88
Veloc Dn (ft/s)	=	12.15
Veloc Up (ft/s)	=	11.77
HGL Dn (ft)	=	7354.54
HGL Up (ft)	=	7356.20
Hw Elev (ft)	=	7360.74
Hw/D (ft)	=	2.04
Flow Regime	=	Inlet Control



Culvert Report

61188 - Proposed Design Point 2: Existing 2-60 inch CMPs (5-yr)

Invert Elev Dn (ft)	=	7349.89
Pipe Length (ft)	=	61.00
Slope (%)	=	1.07
Invert Elev Up (ft)	=	7350.54
Rise (in)	=	60.0
Shape	=	Circular
Span (in)	=	60.0
No. Barrels	=	2
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Mitered to slope (C)
Coeff. K,M,c,Y,k	=	0.021, 1.33, 0.0463, 0.75, 0.7

Embankment

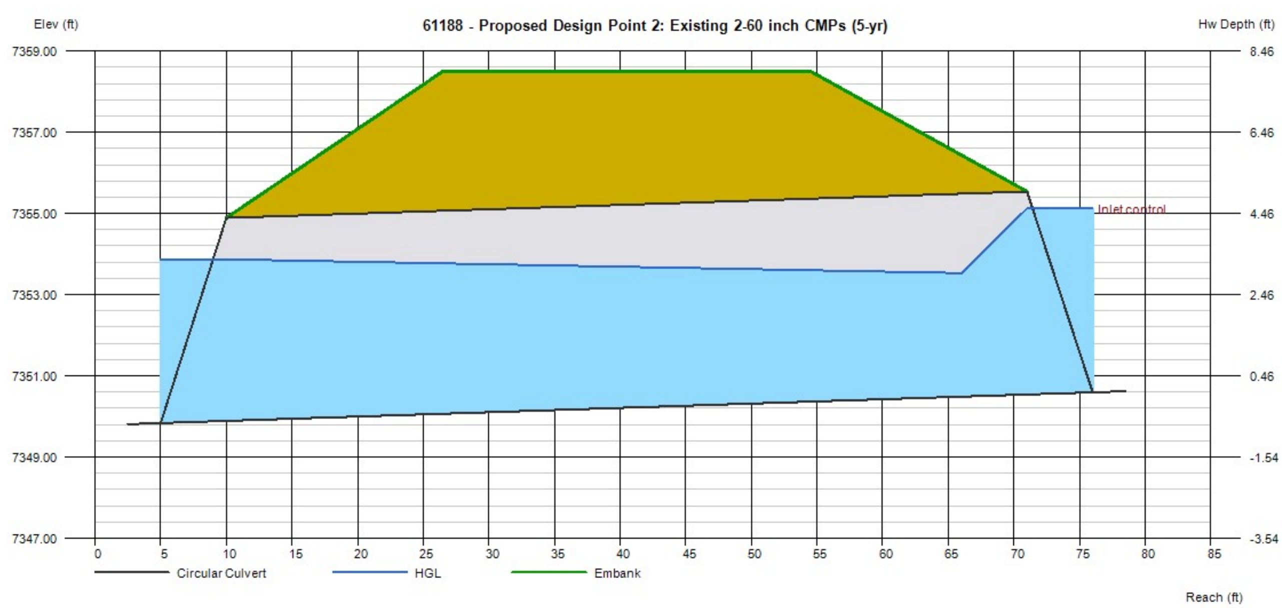
Top Elevation (ft)	=	7358.50
Top Width (ft)	=	28.00
Crest Width (ft)	=	64.00

Calculations

Qmin (cfs)	=	216.00
Qmax (cfs)	=	216.00
Tailwater Elev (ft)	=	(dc+D)/2

Highlighted

Qtotal (cfs)	=	216.00
Qpipe (cfs)	=	216.00
Qovertop (cfs)	=	0.00
Veloc Dn (ft/s)	=	6.44
Veloc Up (ft/s)	=	8.92
HGL Dn (ft)	=	7353.87
HGL Up (ft)	=	7353.50
Hw Elev (ft)	=	7355.12
Hw/D (ft)	=	0.92
Flow Regime	=	Inlet Control



Culvert Report

61188 - Proposed Design Point 2: Existing 2-60 inch CMPs (100-yr)

Invert Elev Dn (ft)	= 7349.89
Pipe Length (ft)	= 61.00
Slope (%)	= 1.07
Invert Elev Up (ft)	= 7350.54
Rise (in)	= 60.0
Shape	= Circular
Span (in)	= 60.0
No. Barrels	= 2
n-Value	= 0.024
Culvert Type	= Circular Corrugate Metal Pipe
Culvert Entrance	= Mitered to slope (C)
Coeff. K,M,c,Y,k	= 0.021, 1.33, 0.0463, 0.75, 0.7

Embankment

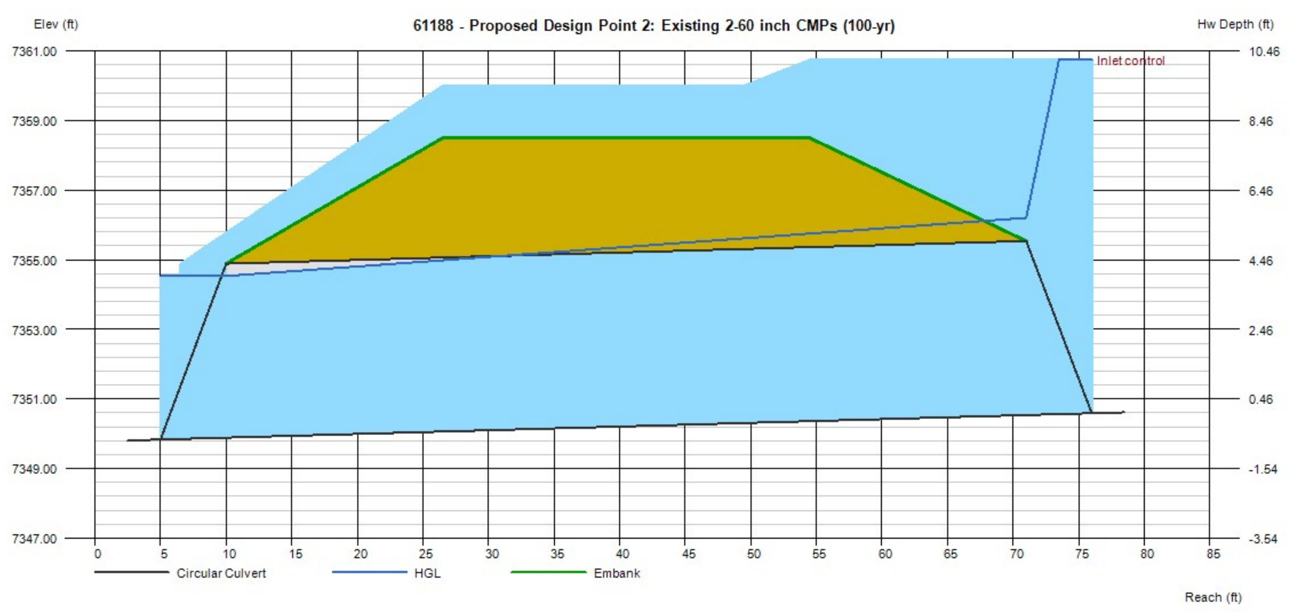
Top Elevation (ft)	= 7358.50
Top Width (ft)	= 28.00
Crest Width (ft)	= 64.00

Calculations

Qmin (cfs)	= 1127.20
Qmax (cfs)	= 1127.20
Tailwater Elev (ft)	= (dc+D)/2

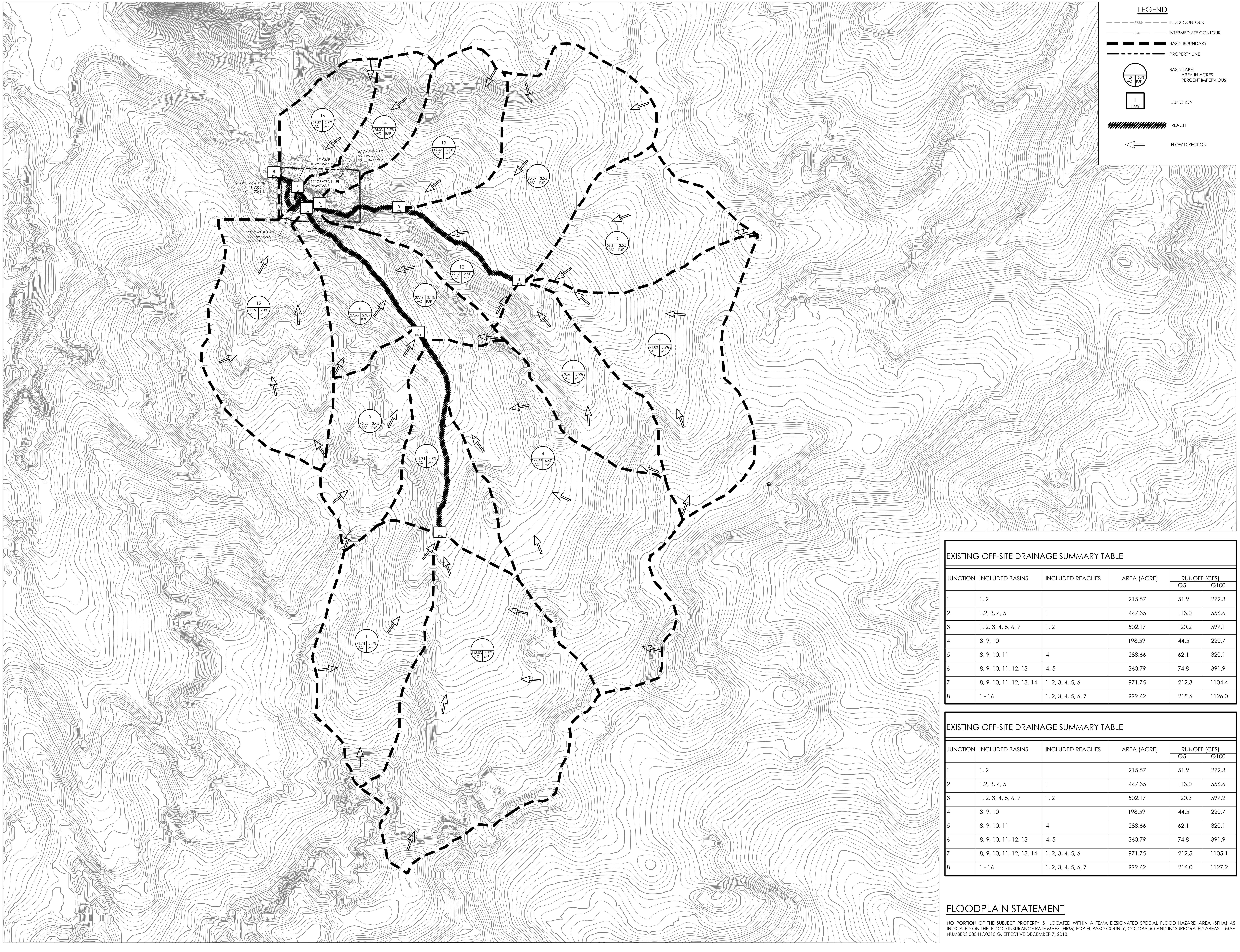
Highlighted

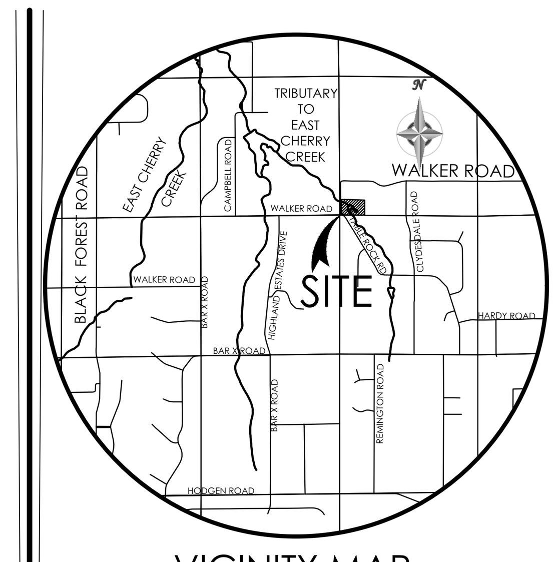
Qtotal (cfs)	= 1127.20
Qpipe (cfs)	= 462.43
Qovertop (cfs)	= 664.77
Veloc Dn (ft/s)	= 12.16
Veloc Up (ft/s)	= 11.78
HGL Dn (ft)	= 7354.54
HGL Up (ft)	= 7356.21
Hw Elev (ft)	= 7360.75
Hw/D (ft)	= 2.04
Flow Regime	= Inlet Control



D. Report Maps

I. Drainage Map (Off-Site)
II. Drainage Map (Existing)
III. Drainage Map (Proposed)





VICINITY MAP
NOT TO SCALE

BENCHMARK

N

1" = 500' 1:6,000

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ENGINEERS, SURVEYORS
1903 lelaray street, suite 200 colorado springs co 80909 719.635.5736

REVISIONS

EXISTING OFF-SITE DRAINAGE SUMMARY TABLE

JUNCTION	INCLUDED BASINS	INCLUDED REACHES	AREA (ACRE)	RUNOFF (CFS)	
				Q5	Q100
1	1, 2		215.57	51.9	272.3
2	1,2, 3, 4, 5	1	447.35	113.0	556.6
3	1, 2, 3, 4, 5, 6, 7	1, 2	502.17	120.2	597.1
4	8, 9, 10		198.59	44.5	220.7
5	8, 9, 10, 11	4	288.66	62.1	320.1
6	8, 9, 10, 11, 12, 13	4, 5	360.79	74.8	391.9
7	8, 9, 10, 11, 12, 13, 14	1, 2, 3, 4, 5, 6	971.75	212.3	1104.4
8	1 - 16	1, 2, 3, 4, 5, 6, 7	999.62	215.6	1126.0

EXISTING OFF-SITE DRAINAGE SUMMARY TABLE

JUNCTION	INCLUDED BASINS	INCLUDED REACHES	AREA (ACRE)	RUNOFF (CFS)	
				Q5	Q100
1	1, 2		215.57	51.9	272.3
2	1,2, 3, 4, 5	1	447.35	113.0	556.6
3	1, 2, 3, 4, 5, 6, 7	1, 2	502.17	120.3	597.2
4	8, 9, 10		198.59	44.5	220.7
5	8, 9, 10, 11	4	288.66	62.1	320.1
6	8, 9, 10, 11, 12, 13	4, 5	360.79	74.8	391.9
7	8, 9, 10, 11, 12, 13, 14	1, 2, 3, 4, 5, 6	971.75	212.5	1105.1
8	1 - 16	1, 2, 3, 4, 5, 6, 7	999.62	216.0	1127.2

FLOODPLAIN STATEMENT

NO PORTION OF THE SUBJECT PROPERTY IS LOCATED WITHIN A FEMA DESIGNATED SPECIAL FLOOD HAZARD AREA (SFHA) AS INDICATED ON THE FLOOD INSURANCE RATE MAPS (FIRM) FOR EL PASO COUNTY, COLORADO AND INCORPORATED AREAS - MAP NUMBERS 08041C0310 G, EFFECTIVE DECEMBER 7, 2018.

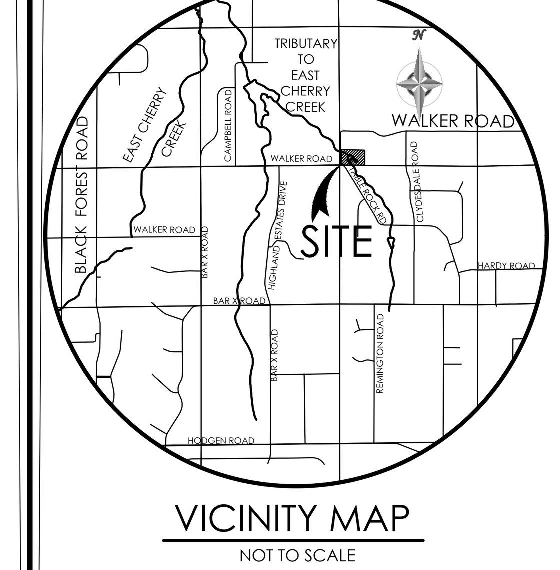
DESIGNED BY
DRAWN BY
CHECKED BY
AS-BUILTS BY
CHECKED BY

HIGH FOREST ESTATES
SUBDIVISION FILING NO. 1

DRAINAGE MAP
(OFF-SITE)

MVE PROJECT 61188
MVE DRAWING DRAIN-OS

APRIL 18, 2023
SHEET 1 OF 1



VICINITY MAP
NOT TO SCALE

BENCHMARK

1" = 50' 1:600

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REVISIONS

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CHECKED BY

DESIGN POINTS SUMMARY TABLE

DESIGN POINTS	INCLUDED BASINS AND DESIGN POINTS	AREA (AC)	Tc (RATIONAL) (MIN.)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)	RUNOFF METHOD
DPOS1	OS-15	82.59	27.1	19.8	132.1	RATIONAL
DPOS2	OS-1, OS-2, OS-3, OS-4, OS-5, OS-6, OS-7	502.17		120.2	597.1	HEC-HMS
DPOS3	OS-8, OS-9, OS-10, OS-11, OS-12, OS-13	360.79		74.8	391.9	HEC-HMS
DPOS4	OS-14	20.95	18.5	6.1	40.6	RATIONAL
DPOS5	OS-16	24.31	20.8	6.6	44.5	RATIONAL
DP1	A1, A2, A3, A4, DPOS1, DPOS2, DPOS3, DPOS4	971.75		212.3	1104.4	HEC-HMS
DP2	A5, DP1, DPOS5	999.62		215.6	1126.0	HEC-HMS

ON-SITE BASIN SUMMARY TABLE

INCLUDED BASINS	AREA (AC)	Tc (MIN.)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)
EX-A1	1.16	12.2	0.5	2.8
EX-A2	1.11	12.0	0.3	2.5
EX-A3	4.45	15.4	1.5	9.5
EX-A4	4.08	14.0	1.5	9.0
EX-A5	3.56	14.1	1.7	8.3

FLOODPLAIN STATEMENT

NO PORTION OF THE SUBJECT PROPERTY IS LOCATED WITHIN A FEMA DESIGNATED SPECIAL FLOOD HAZARD AREA (SFHA) AS INDICATED ON THE FLOOD INSURANCE RATE MAPS (FIRM) FOR EL PASO COUNTY, COLORADO AND INCORPORATED AREAS - MAP NUMBERS 08041C0310 G, EFFECTIVE DECEMBER 7, 2018.

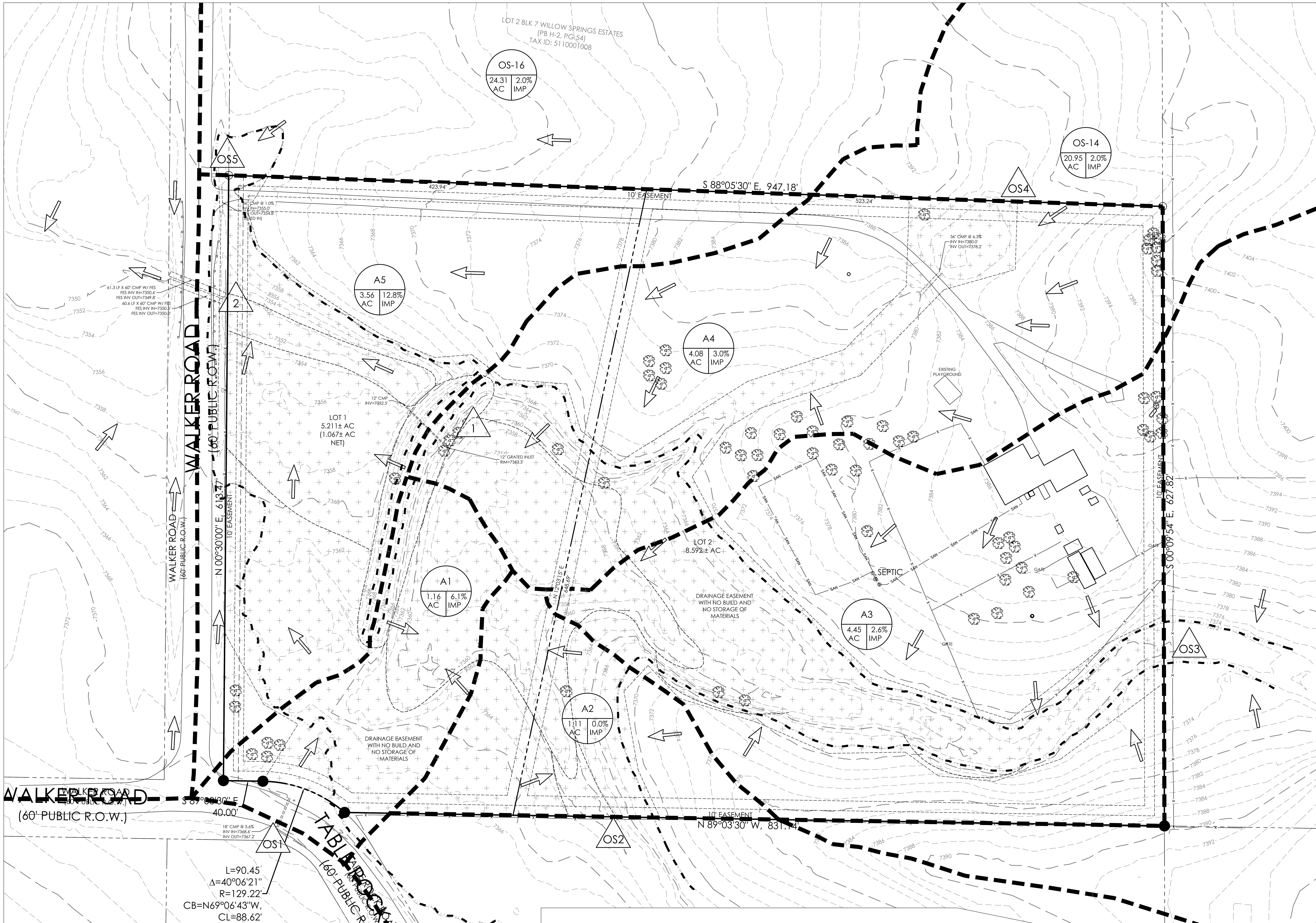
NOTE: SEE BASIN MAP FOR OFFSITE BASIN DETAILS

HIGH FOREST ESTATES
SUBDIVISION FILING NO. 1

DRAINAGE MAP
(EXISTING)

MVE PROJECT 61188
MVE DRAWING DRAIN-EX

MAY 3, 2023
SHEET 1 OF 1



LEGEND

- PROPERTY LINE
- EASEMENT LINE
- LOT LINE

EXISTING

- 5985 INDEX CONTOUR
- 84 INTERMEDIATE CONTOUR

PROPOSED

- 5985 INDEX CONTOUR
- 84 INTERMEDIATE CONTOUR
- BASIN BOUNDARY
- FLOW DIRECTION
- BASIN LABEL (A1, 1.0 AC, 50% IMP): AREA IN ACRES, PERCENT IMPERVIOUS
- DESIGN POINT
- 100 YEAR STORM WATER FLOOD LEVEL
- DRAINAGE EASEMENT NO BUILD / NO STORAGE

VICINITY MAP
NOT TO SCALE

BENCHMARK

1" = 50' 1:600

DESIGN POINTS SUMMARY TABLE

DESIGN POINTS	INCLUDED BASINS AND DESIGN POINTS	AREA (AC)	Tc (RATIONAL) (MIN.)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)	RUNOFF METHOD
DPOS1	OS-15	82.59	27.1	19.8	132.1	RATIONAL
DPOS2	OS-1, OS-2, OS-3, OS-4, OS-5, OS-6, OS-7	502.17		120.3	597.2	HEC-HMS
DPOS3	OS-8, OS-9, OS-10, OS-11, OS-12, OS-13	360.79		74.8	391.9	HEC-HMS
DPOS4	OS-14	20.95	18.5	6.1	40.6	RATIONAL
DPOS5	OS-16	24.31	20.8	6.6	44.5	RATIONAL
DP1	A1, A2, A3, A4, DPOS1, DPOS2, DPOS3, DPOS4	971.75		212.5	1105.1	HEC-HMS
DP2	A5, DP1, DPOS5	999.62		216.0	1127.2	HEC-HMS

ON-SITE BASIN SUMMARY TABLE

INCLUDED BASINS	AREA (AC)	Tc (MIN.)	RUNOFF Q5 (CFS)	RUNOFF Q100 (CFS)
A1	1.16	12.2	0.5	2.8
A2	1.11	12.0	0.3	2.5
A3	4.45	15.4	1.5	9.5
A4	4.08	14.0	1.5	9.0
A5	3.56	14.1	2.1	8.9

FLOODPLAIN STATEMENT

NO PORTION OF THE SUBJECT PROPERTY IS LOCATED WITHIN A FEMA DESIGNATED SPECIAL FLOOD HAZARD AREA (SFHA) AS INDICATED ON THE FLOOD INSURANCE RATE MAPS (FIRM) FOR EL PASO COUNTY, COLORADO AND INCORPORATED AREAS - MAP NUMBERS 08041C0310 G, EFFECTIVE DECEMBER 7, 2018.

NOTE: SEE BASIN MAP FOR OFFSITE BASIN DETAILS

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SUBDIVISION FILING NO. 1

DRAINAGE MAP (PROPOSED)

MVE PROJECT 61188
MVE DRAWING DRAIN-PP

MAY 3, 2023