



Final Drainage Report

# Overlook at Homestead Filing No. 1 El Paso County, Colorado

Prepared for:

**PT Overlook LLC**

**1864 Woodmoor Drive, Suite 100**

**Monument, CO 80132**

Prepared by:

**Kimley-Horn and Associates, Inc.**

**2 North Nevada Avenue, Suite 900**

**Colorado Springs, Colorado 80903**

**(719) 453-0180**

**Contact: Kevin Kofford, P.E.**

Project #: 196239003

PCD Filing No.: SF2425

Prepared: February 21, 2025

**Kimley»Horn**

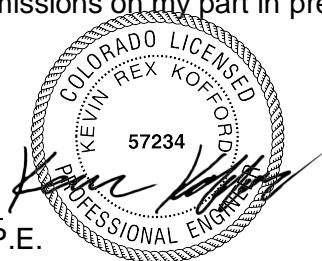
## CERTIFICATION

### DESIGN 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 master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparation of this report.

SIGNATURE (Affix Seal): \_\_\_\_\_

Kevin Kofford, P.E.



2/19/2025

Date

### OWNER/DEVELOPER'S STATEMENT

I, the developer, have read and will comply with all of the requirements specified in this Drainage Report and Plan.

PT Overlook LLC

Name of Developer

A handwritten signature in black ink, appearing to read "Steve Rossoll".

02/19/2025

Authorized Signature

Date

Steve Rossoll

Printed Name

Director of Entitlements

Title

1864 Woodmoor Drive Suite 100, Monument, CO 80132

Address

### EL PASO COUNTY

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

Joshua Palmer, P.E.

County Engineer/ ECM Administrator

Date

Conditions:

## TABLE OF CONTENTS

<b>CERTIFICATION .....</b>	<b>1</b>
DESIGN ENGINEER'S STATEMENT .....	1
OWNER/DEVELOPER'S STATEMENT .....	1
EL PASO COUNTY .....	1
<b>TABLE OF CONTENTS .....</b>	<b>2</b>
<b>INTRODUCTION .....</b>	<b>3</b>
PURPOSE AND SCOPE OF STUDY .....	3
LOCATION .....	3
DESCRIPTION OF PROPERTY .....	3
<b>FLOODPLAIN STATEMENT .....</b>	<b>4</b>
<b>DRAINAGE BASINS .....</b>	<b>4</b>
MAJOR BASIN DESCRIPTIONS .....	4
COMPLIANCE WITH PREVIOUS FINAL DRAINAGE REPORT .....	4
EXISTING SUB-BASIN DESCRIPTIONS .....	5
PROPOSED SUB-BASIN DESCRIPTIONS .....	6
<b>DRAINAGE DESIGN CRITERIA.....</b>	<b>11</b>
DEVELOPMENT CRITERIA REFERENCE .....	11
HYDROLOGIC CRITERIA .....	11
HYDRAULIC CRITERIA .....	11
DETENTION.....	12
<b>THE FOUR STEP PROCESS .....</b>	<b>13</b>
<b>DRAINAGE FACILITY DESIGN .....</b>	<b>14</b>
<b>DRAINAGE FEES .....</b>	<b>15</b>
FEES.....	15
<b>SUMMARY .....</b>	<b>15</b>
<b>REFERENCES .....</b>	<b>16</b>
<b>APPENDIX</b>	
APPENDIX A: VICINITY MAP	
APPENDIX B: FEMA MAP & SOILS REPORT	
APPENDIX C: HYDROLOGY	
APPENDIX D: HYDRUALICS	
APPENDIX E: EL PASO COUNTY DRAINAGE BASIN MAP	
APPENDIX F: APEX RANCH DRAINAGE REPORT	
APPENDIX G: DRAINAGE MAPS	
APPENDIX H: POND OPCC	

## **INTRODUCTION**

### ***PURPOSE AND SCOPE OF STUDY***

The purpose of this Final Drainage Report (FDR) is to document the drainage design in support of the proposed Overlook at Homestead Subdivision Filing No. 1 (“the Project”) on behalf of PT Overlook LLC. An early grading application (EGP241) with corresponding early grading final drainage report was approved by the County prior to this report. The Project is located within the jurisdictional limits of El Paso County (“the County”). Therefore, the hydrologic and hydraulic design is based on the County’s criteria which is described in further detail within the report.

### ***LOCATION***

The Project Site located east of Elbert Road within El Paso County, Colorado including parcels 4100000255 and 4100000256. More specifically, the site is a Portion of the North Half of Section 27, Township 11 South, Range 64 West of the 6<sup>th</sup> PM, County of El Paso, State of Colorado. North of the Project is agricultural and rural residential land, to the east is Homestead Ranch Park owned and maintained by El Paso County, and to the south and west is Homestead Ranch subdivisions. Filing No.1 consists of 36, five acre lots and is located just south the Apex Ranch Subdivision and the large butte. A vicinity map has been provided in the **Appendix** of this report.

The Site is currently owned by PT Overlook LLC and will be developed by PT Overlook LLC.

### ***DESCRIPTION OF PROPERTY***

The entire Overlook Project is approximately 350.8 acres consisting of mostly vacant, undeveloped land with native vegetation and a rural single-family residential home situated in the northwest corner of the Site and is classified as Agricultural Grazing Land to be subdivided into 62 total lots. Filing No. 1 consists of approximately 202.72 acres which will be subdivided into 36 5-acre parcels. Vegetation within the site is characterized primarily by prairie grasses along with some area of scrub brush and trees. The Site does not currently provide water quality or detention for the Project area.

The existing topography consists of slopes ranging from 1% to 33% with an existing butte covering much of the northern portion of the Site. Filing No. 1 includes a roadway and temporary cul-de-sac on the top of the existing butte, but the majority of the site is located south of the butte. Flows in the existing conditions run off site into one of four major drainage basins. Filing No. 1 only discharges into the Upper Black Squirrel Creek and La Vega Ranch drainage basins, to the south. Detailed descriptions of the existing major drainage basins can be found later in the report.

According to NRCS soil mapping data, USCS Type B soils are the primary soil type within the site. Type B soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained, or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission. Soils mapping information has been provided in the **Appendix**.

The Filing No. 1 development of this site will consist of 36, five-acre residential lots with roadway improvements, roadway grading, three full spectrum detention ponds, roadside ditches, culverts, and drainage swales.

## **FLOODPLAIN STATEMENT**

The Site is located outside the 100-year floodplain and within Zone X (an area of minimal flood hazard) as noted on the FEMA FIRM Map No. 08041C0350G revised on December 7, 2018 (See **Appendix**).

## **DRAINAGE BASINS**

### **MAJOR BASIN DESCRIPTIONS**

The Project Site is tributary to four major drainage basins in the El Paso County Drainage Basin Map. Bijou Creek, East Kiowa Creek, Upper Black Squirrel, and La Vega Ranch Drainage Basins. These drainage basins are located in the north central portion of El Paso County. The northeast portion of the site is tributary to Bijou Creek Drainage Basin, the northwest portion of the site is tributary to East Kiowa Creek Drainage Basin, the southwest portion of the site is tributary to Upper Black Squirrel Drainage Basin, and the southeast portion of the site is tributary to La Vega Ranch Drainage Basin. Filing No. 1 only discharges into the Upper Black Squirrel Creek and La Vega Ranch Drainage Basins, to the south. In an effort to simplify basin nomenclature, the following naming conventions have been used for both existing and proposed drainage sub-basins labeling. Proposed basin, culvert, and pond labels have been designed in effort to keep runoff within the same existing basins, as to not transfer runoff between basins.

- A - Upper Black Squirrel Drainage Basin (CHBS2000)
- B - La Vega Ranch Drainage Basin (CHBR0400)
- C - East Kiowa Creek Drainage Basin (KIKI0400)
- D - Bijou Creek Drainage Basin (BIBI0200)

El Paso County Drainage Basin map has been provided in the **Appendix**. A summary of flows in existing and proposed conditions has been added to the **Appendix**.

### **COMPLIANCE WITH PREVIOUS FINAL DRAINAGE REPORT**

A portion of the proposed Project Site falls within the existing approved “Final Drainage Report for Apex Ranch Estates” by Terra Nova Engineering, Inc. approval date September 3, 2008. Flows from these basins will be at or below history values. These flows are not included in the calculation for the existing detention facility for Filing No. 1. Excerpts from the previously approved FDR have been provided in the **Appendix**.

A Preliminary Drainage Report, “Preliminary Drainage Report for Apex Ranch Estates” by Terra Nova Engineering, Inc. approved on January 10, 2008, was submitted to the County as part of the SP238 Application prepared by Terra Nova Engineering, Inc. approved on March 18, 2008, for the Preliminary Plat.

In addition, an Early Grading Final Drainage Report (EGP 241), “Early Grading Permit – Final Drainage Report Overlook as Homestead Subdivision Filing No. 1” prepared by Kimley-Horn & Associates, approved on September 17, 2024, was prepared in support of the proposed early grading improvements associated with this development.

## **EXISTING SUB-BASIN DESCRIPTIONS**

Historically the runoff from the Site drains into one of two major drainage basins for Filing No. 1 as described above. Slopes vary from 2-33% throughout the site with various natural features. The Site has been divided into 8 onsite basins A1-A2, B1-B3, and B3A, and 2 offsite basins OS-A1 and OS-A2. The offsite basins are located west of the Site and generally flow west towards to existing stormwater infrastructure. Descriptions of each individual sub-basin can be found below.

In the existing conditions flows within the existing sub-basins are conveyed and collected into natural drainage channels. These channels can be found on the existing conditions drainage map, and hydraulic analysis of these channels in existing conditions have been completed. Both of these items can be found in the **Appendix**. Flows will generally follow historic drainage patterns with regards to the existing natural drainage channels.

### **Sub-Basin A1**

This on-site sub-basin consists of an area of 19.92 acres, located in the southwest corner of the Site. Drainage flows overland from the northeast to the southwest where it is captured by an existing 36" CMP culvert at DP 1 and outfalls west of Elbert Rd. The weighted imperviousness for this sub-basin is 8%. Runoff during the 5-year and 100-year events are 8.43 cfs and 38.41 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

### **Sub-Basin A2**

This on-site sub-basin consists of an area of 63.97 acres, located in the southwest corner of the Site. Drainage flows overland from the northeast to the southwest where it flows offsite at DP 2 into Reata subdivision south of the Site. The weighted imperviousness for this sub-basin is 1%. Runoff during the 5-year and 100-year events are 13.47 cfs and 91.03 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

### **Sub-Basin B1**

This on-site sub-basin consists of an area of 43.28 acres, located in the south-central portion of the Site. Drainage flows overland from the north to the south where it flows offsite at DP 3 into Reata subdivision south of the Site. The weighted imperviousness for this sub-basin is 0%. Runoff during the 5-year and 100-year events are 9.34 cfs and 68.56 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

### **Sub-Basin B2**

This on-site sub-basin consists of an area of 42.42 acres, located in the south-central portion of the Site. Drainage flows overland from the north to the south where it flows offsite at DP 4 into Reata subdivision south of the Site. The weighted imperviousness for this sub-basin is 0%. Runoff during the 5-year and 100-year events are 9.41 cfs and 69.09 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

### **Sub-Basin B3**

This on-site sub-basin consists of an area of 25.42 acres, located in the southeast portion of the Site. Drainage flows overland from the north to the south where it flows offsite at DP 5 into Reata subdivision south of the Site. The weighted imperviousness for this sub-basin is 0%. Runoff during the 5-year and 100-year events are 5.91 cfs and 43.40 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

### **Sub-Basin B3A**

This on-site sub-basin consists of an area of 24.23 acres, located in the southeast corner of the Site. Drainage flows overland from the north to the south where it flows offsite at DP 5A into Reata

subdivision south of the Site. The weighted imperviousness for this sub-basin is 0%. Runoff during the 5-year and 100-year events are 5.99 cfs and 43.98 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

#### **Sub-Basin OS-A1**

The off-site sub-basin consists of an area of 4.06 acres, located in the western central portion of the drainage study area. Drainage flows overland from the northeast to southwest where it is captured by an existing drainage culvert at DP 14 and directed west of Elbert Road. The weighted imperviousness for this sub-basin is 19%. Runoff during the 5-year and 100-year events are 3.62 cfs and 12.02 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

#### **Sub-Basin OS-A2**

The off-site sub-basin consists of an area of 4.45 acres, located in the central portion of the drainage study area. Drainage flows overland from the north to south where it enters sub-basin A2 at DP 15 and follows the patterns described in sub-basin A2. The weighted imperviousness for this sub-basin is 7%. Runoff during the 5-year and 100-year events are 2.10 cfs and 11.46 cfs respectively. Refer to the **Appendix** for the Existing Conditions Drainage Map.

### ***PROPOSED SUB-BASIN DESCRIPTIONS***

For the proposed condition, stormwater will generally maintain historic flow patterns. The proposed roadways will alter some of the existing flow paths. The roadway ditches will capture runoff from the roadways and direct flows via proposed culverts back to the existing flow paths, which will ultimately follow historic patterns or be captured by one of the three (3) proposed storm water ponds. The proposed Site has been divided into 10 onsite basins A1-A2, B1-B3, B6-B8, and three offsite basins OS-A1, OS-A2, and OS-A3. Descriptions of each individual sub-basin can be found below. The off-site basins are fully developed and no changes to the upstream basins are anticipated. Per Final Drainage Report for Apex Ranch Estates by Terra Nova Engineering, dated September 3, 2008, the existing extended detention basin, on the northwest corner of Apex Ranch Road and Fletcherville Lane was designed and sized to provide water quality for the entire basins A-J of the Apex Ranch Estates Final Drainage Report. This area includes all the proposed roadway extensions through the ROW preservation within the Apex Ranch Estates Subdivision. This Project does not rely on the water quality or detention volumes provided by the existing detention basin within Apex Ranch Estates.

In the proposed conditions flows within the proposed sub-basins are conveyed and collected into natural drainage channels. These channels can be found on the proposed conditions drainage map, and hydraulic analysis of these channels in proposed conditions have been completed. Both of these items can be found in the **Appendix**. Flows will generally follow historic drainage patterns with regards to the existing natural drainage channels. Due to the increase in site imperviousness some channels will see an increase in flows. All channels that have an increase of flows in proposed conditions currently have capacity to accept the additional flows. Hydraulic analysis was done to determine need for permanent stabilization. Any channel with a proposed velocity greater than 5.0 ft/s, based on soil parameters, has proposed channel stabilization measures. Public drainage easements as specially noted on the plat shall be maintained by the individual lot owners unless otherwise indicated. Details regarding channel velocity and other parameters can be found in the **Appendix**.

There are several drainage culverts proposed within Filing 1 of the Site. Locations of the proposed culverts were chosen to ensure historic drainage patterns are maintained. Culvert sizing and the outlet protection analysis was included with early grading FDR (EGP 241). Outlet protection will be installed with the culverts as part of the early grading portion of this development. Due to the

steep topography of the Site, instead of a traditional riprap pad for outlet protection, a low tailwater basin design is being proposed. Intended to prevent scour downstream by providing a stilling basin, the low tailwater basin acts as an additional energy dissipation mechanism by having a determined depth to the riprap pad that slows down the water prior to overtopping. The detail is provided in the **Appendix** of this report.

The three proposed full spectrum extended detention basins (EDB) will be designed to release developed flows from Filing No. 1 at less than or equal to historic rates prior to releasing to adjacent properties. The full design of these full spectrum extended detention basins are provided in this Final Drainage Report. A low tailwater stilling basin, based on the design provided by Mile High Flood District (MHFD), Urban Drainage and Flood Control District Drainage Criteria Manuals (UDFCDCM) Volume 2, Figure 9-37, will be installed at the outfall location of the proposed EDBs. The design helps prevent downstream scour and mitigates the concentrated flow, acting as a level spreader for concentrated flow in an existing drainageway. This is displayed and discussed in text and drainage maps. More detail regarding the proposed EDBs can be found in the detention basin section of this report.

### **Sub-Basin A1**

This on-site sub-basin consists of an area of 19.55 acres, located in the southwest corner of the Site. Drainage flows overland from the northeast to the southwest where it is captured by an existing 36" CMP culvert at DP 1 and outfalls west of Elbert Rd. There are no proposed improvements in sub-basin A1. The weighted imperviousness for this sub-basin is 15%. Runoff during the 5-year and 100-year events are 10.41 cfs and 41.24 cfs respectively. Due to the slight increase in sub-basin imperviousness, the 100-yr runoff increases from 38.41 to 41.24 cfs. The additional runoff will be accepted and mitigated through the nearly 1500 ft long, 50 ft wide existing drainage channel located within the sub-basin. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

### **Sub-Basin A2**

This on-site sub-basin consists of an area of 61.98 acres, located in the southwest corner of the Site. Improvements within this sub-basin include proposed roads, roadside ditches, culverts, and proposed private full spectrum detention basin A2. Drainage flows overland from the northeast to the southwest where it flows into proposed roadside ditches, is conveyed through proposed stormwater culverts, and is ultimately captured by proposed private full spectrum detention basin A2. Flows will be released at or below historic levels to the existing roadside ditch along Elbert Road located at DP 2. Flows will generally follow historic drainage patterns. The weighted imperviousness for this sub-basin is 10%. Runoff during the 5-year and 100-year events are 20.85 cfs and 97.07 cfs respectively. Due to the increase in sub-basin imperviousness, the 100-yr runoff for DP 2 is anticipated to increase from 91.03 cfs to 97.07 cfs. The additional runoff will be collected and released at less than historic rates via a proposed private full spectrum detention basin. Flows from this basin will not be released into the Reata subdivision south of the Site. They will be routed through an outfall pipe that will release into the roadside ditch within the County ROW. A downstream channel analysis of this roadside ditch has been provided in the **Appendix**. A more detailed analysis of the pond outfall and roadside ditch can be found in the Design Point 2 section of this report. The minor increase in flows will be mitigated by the proposed full spectrum detention basin A2 and released at less than historic rates. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

### **Sub-Basin B1**

This on-site sub-basin consists of an area of 38.38 acres, located in the south-central portion of the Site. Improvements within this sub-basin include proposed roads, roadside ditches, culverts, and proposed private full spectrum detention basin B1. Drainage flows overland from the north to the south where it flows into proposed roadside ditches, is conveyed through proposed stormwater culverts, and is ultimately captured by proposed private full spectrum detention basin B1 at DP 3. The weighted imperviousness for this sub-basin is 10%. Runoff during the 5-year and 100-year events are 16.38 cfs and 76.45 cfs respectively. Due to the increase in sub-basin imperviousness, the 100-yr runoff for DP 3 is anticipated to increase from 68.56 cfs to 76.45 cfs. The additional runoff will be collected and released at less than historic rates via a proposed private full spectrum detention basin with a proposed low tailwater basin. Flows from this basin will exit into the Reata subdivision south of the Site via existing, vegetated natural drainage channels and outfall to an existing stock pond within the adjacent property south of the Site. To mitigate erosion and downstream impacts, a low tailwater basin is proposed at the outfall prior to flows entering the Reata Subdivision. The minor increase in flows will be mitigated by the proposed full spectrum detention basin B1 and released at less than historic rates. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

### **Sub-Basin B2**

This on-site sub-basin consists of an area of 15.81 acres, located in the south-central portion of the Site. Drainage flows overland from the north to the south where it flows offsite at DP 4. Improvements within this sub-basin include proposed public roads. This sub-basin includes an approx. 14,351 sq ft improved area of roadway that will not be receiving water quality treatment. A detailed discussion regarding water quality treatment has been included in Step-2 of the Four Step Process. The weighted imperviousness for this sub-basin is 8%. Runoff during the 5-year and 100-year events are 7.46 cfs and 37.85 cfs respectively. It is anticipated in a 100-yr storm event the total runoff for DP 4 will reduce from 69.09 cfs to 37.85 cfs, as the proposed roadway will cut off much of the upstream portion of the existing drainage basin and route those flows to a proposed full spectrum detention basin. As such there are no anticipated downstream impacts. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

### **Sub-Basin B3**

This on-site sub-basin consists of an area of 19.11 acres, located in the southeastern portion of the Site. Drainage flows overland from the northwest to southeast where it flows off site at DP 5. There are no proposed public improvements within this sub-basin, but single-family homes will be constructed and excluded the large lot exclusion I.7.1.B.5 and discussed in step 2 of the four-step process. The weighted imperviousness for this sub-basin is 7%. Runoff during the 5-year and 100-year events are 7.83 cfs and 42.71 cfs respectively. In the proposed conditions, it is anticipated in a 100-yr storm event the total runoff for DP 5A (DP 5 in proposed conditions) will reduce from 43.98 to 42.71, as such there are no anticipated downstream impacts. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

### **Sub-Basin B6**

This on-site sub-basin consists of an area of 52.15 acres, located in the central portion of the Site. Improvements within this sub-basin include proposed roads, roadside ditches, and culverts. Drainage flows overland from the northeast to the southwest where it flows into proposed roadside ditches, is conveyed through a proposed stormwater culvert at DP 8, and into sub-basin B8. From there, flows will follow path as described in sub-basin B8 where it will ultimately be captured in proposed full spectrum detention basin B8. There is a natural channel, #17 as identified on the proposed drainage map that conveys flows directly to DP 8. The "Soils and Geology Study Overlook at Homestead – Filing No.1" Prepared by Entech Engineering, Inc., dated June 7, 2024, recommended that this ditch be riprap lined to help mitigate against bulk flows and debris. The

proposed drainage map identifies this channel as being riprap lined, with Type VL (D50= 6") riprap. The weighted imperviousness for this sub-basin is 11%. Runoff during the 5-year and 100-year events are 23.44 cfs and 106.32 cfs respectively. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

#### **Sub-Basin B7**

This on-site sub-basin consists of an area of 2.46 acres, located in the southern portion of the Site. Drainage flows overland from the north to south where it flows off site at DP 9. There are no proposed improvements within this sub-basin. The weighted imperviousness for this sub-basin is 7%. Runoff during the 5-year and 100-year events are 1.13 cfs and 6.17 cfs respectively. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

#### **Sub-Basin B8**

This on-site sub-basin consists of an area of 9.52 acres, located in the southern portion of the Site. Drainage flows overland from the north to south where it is captured by proposed private full spectrum extended detention basin B8 at DP 10. It should be noted that sub-basin B8 accepts flows from sub-basin B6 at DP 8. Refer to sub-basin B6 for information regarding the proposed flows from sub-basin B6. Aside from the proposed extended detention basin there are no proposed improvements within this sub-basin. The weighted imperviousness for this sub-basin is 7%. Runoff during the 5-year and 100-year events are 4.22 cfs and 23.05 cfs respectively. In addition to the increase of imperviousness, sub-basin B8 is also accepting flows from sub-basin B6 to the north. The combination of these factors results in a proposed increase of flows at DP 10 (DP 5 in existing conditions) from 43.40 cfs to 130.00 cfs. The additional runoff will be collected and released at less than historic rates via a proposed private full spectrum detention basin. To mitigate erosion and downstream impacts, a low tailwater basin is proposed at the outfall prior to flows entering the Reata Subdivision. Flows from this basin will exit into the Reata subdivision south of the Site via existing, vegetated natural drainage channel and outfall to an existing established vegetated area within the adjacent property south of the Site. The increase in flows will be mitigated by the proposed full spectrum detention basin B8 and released at less than historic rates. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

#### **Sub-Basin OS-A1**

The off-site sub-basin consists of an area of 4.06 acres, located in the western central portion of the drainage study area. Drainage flows overland from the northeast to southwest where it is captured by an existing drainage culvert at DP 18 and directed west of Elbert Road. The weighted imperviousness for this sub-basin is 25%. Runoff during the 5-year and 100-year events are 4.12 cfs and 12.86 cfs respectively. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

#### **Sub-Basin OS-A2**

The off-site sub-basin consists of an area of 3.14 acres, located in the central portion of the drainage study area. Drainage flows overland from the north to south where it enters sub-basin A2 at DP 19 and follows the patterns described in sub-basin A2. The weighted imperviousness for this sub-basin is 7%. Runoff during the 5-year and 100-year events are 1.48 cfs and 8.09 cfs respectively. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

#### **Sub-Basin OS-A3**

The off-site sub-basin consists of an area of 1.31 acres, located in the central portion of the drainage study area. Drainage flows overland from east to west where it enters into the proposed roadside ditch at DP 20 and follows the roadside ditches within Apex Ranch Subdivision, where is eventually routed into the existing detention basin. The weighted imperviousness for this sub-basin is 13%. Runoff during the 5-year and 100-year events are 0.87 cfs and 3.65 cfs respectively. Refer to the **Appendix** for the Proposed Conditions Drainage Map.

## DESIGN POINT COMPARISON ANALYSIS

### Design Point 2

Design Point 2 is located on the southwest corner of Sub-basin A2 and is at the outfall of proposed Full Spectrum Detention Pond A2 in the final condition. The outfall structure is designed to release flows from the EDB at less than or equal to historic rates. See **Appendix** for outlet structure design. In an effort to prevent erosion, a low tailwater stilling basin has been proposed to act as an energy dissipation mechanism. The low tailwater stilling basin will outfall to the existing roadside ditch within the Elbert Road ROW. Onsite observation and measurements show the existing roadside ditch has capacity with a minimum of 1 ft freeboard. A downstream analysis of this roadside ditch is provided in the **Appendix**. The roadside ditch travels approx. 1800 ft south along the east side of Elbert Rd where it enters an approximate 70 ft wide drainage channel. Due to the size of the downstream channel and the distance from the pond outfall, any change in flow into the drainage channel would be negligible. A table summarizing the existing historic flows and proposed flows in the final condition for the 100-year event, at Design Point 2 are presented here below.

Project Phase	Existing Rational Method Peak Inflow 100-YR (cfs)	Detained Outflow - 100 YR (cfs)	Notes
Final Condition	91.03	64.40	Outlet structure designed to regulate flows at less than historic

In the final conditions, the EDB will limit the peak flow at design point 2 to be less than the historic condition.

### Design Point 3

Design Point 3 is located on the southern property edge, near the center of the Site, in the center of Subbasin B1 and is at the outfall of proposed Full Spectrum Detention Pond B1 in the final condition. The outfall structure is designed to release flows from the EDB at less than or equal to historic rates. See **Appendix** for outlet structure design. In an effort to prevent erosion, a low tailwater stilling basin has been proposed to act as an energy dissipation mechanism. The low tailwater stilling basin will outfall to the existing historical drainageway. A table summarizing the existing historic flows and proposed flows in the interim and final condition for the 100-year event, at Design Point 3 are presented here.

Project Phase	Existing Rational Method Peak Inflow 100-YR (cfs)	Detained Outflow -100 YR (cfs)	Notes
Final Condition	68.56	42.40	Outlet structure will be constructed to regulate flows at less than

In the final conditions, the EDB will limit the peak flow at design point 3 to be less than the historic condition.

### Design Point 10

Design Point 10 is located on the southeast portion of the Site, in the center of Subbasin B8 and is at the outfall of proposed Full Spectrum Detention Pond B8 in the final condition. The outfall structure is designed to release flows from the EDB at less than or equal to historic rates. In an effort to prevent erosion, a low tailwater stilling basin has been proposed to act as an energy dissipation mechanism. The low tailwater stilling basin will outfall to the existing historical

drainageway. A table summarizing the existing historic flows and proposed flows in the interim and final condition for the 100-year event, at Design Point 10 are presented here.

Project Phase	Existing Rational Method Peak Inflow 100-YR (cfs)	Detained Outflow -100 YR (cfs)	Notes
Final Condition	43.40	39.40	Outlet structure will be constructed to regulate flows at less than

In the final conditions, the EDB will limit the peak flow at design point 3 to be less than the historic condition.

## **DRAINAGE DESIGN CRITERIA**

### ***DEVELOPMENT CRITERIA REFERENCE***

The proposed storm facilities are designed to be in compliance with El Paso County "Drainage Criteria Manual (DCM)" dated October 2018 ("the MANUAL"), El Paso County "Engineering Criteria Manual" ("the Engineering Manual"), Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs Drainage Criteria Manual dated May 2014 ("the Colorado Springs MANUAL"), and Mile High Flood District (MHFD), Urban Drainage and Flood Control District Drainage Criteria Manuals (UDFCDCM), (Volumes 1, 2 and 3), prepared by Wright-McLaughlin Engineers, June 2001, with latest revisions.

Site drainage is not significantly impacted by such constraints as utilities or existing development.

A Preliminary Drainage Report was completed for the overall Overlook Subdivision (SP238). This Final Drainage Report uses the Preliminary Drainage Report to assist with the drainage design for Filing No. 1.

### ***HYDROLOGIC CRITERIA***

The 5-year and 100-year design storm events were used in determining rainfall and runoff for the proposed drainage system per chapter 6 of the CRITERIA. Table 6-2 of the CRITERIA is the source for rainfall data for the 5-year and 100-year design storm events. Design runoff was calculated using the Rational Method for developed conditions as established in the CRITERIA and MANUAL. Runoff coefficients for the proposed development were determined using Table 6-6 of the CRITERIA by calculating weighted impervious values for each specific site basin as outlined and shown in the Preliminary Drainage Report.

### ***HYDRAULIC CRITERIA***

Applicable design methods were utilized to analyze & size the proposed ponds, culverts, and existing drainage channels which includes the use of the UD-Detention spreadsheet, rational calculations spreadsheet, and FlowMaster, and UD-Culvert.

Proposed Drainage features on-site have been analyzed and sized for the following design storm events:

- Major Storm: 100-year Storm Event

The existing natural drainage channels and proposed roadside ditches are designed to carry flows to the proposed EDBs. The natural channels have varying bottom widths, slopes, and side slopes. The Project intends on using existing natural drainage channels to convey flow where appropriate. Natural channels through Filing No. 1 have been labeled and identified on the Existing and Proposed Drainage Maps. Channel calculations and summary table have been provided in the **Appendix**. It is not anticipated channel upgrades or improvements will be required for this Project. Proposed drainage easements have been proposed in locations where the natural channels convey a substantial amount of flow between properties.

Roadside ditches are provided along the proposed roadways to route flows to the proposed culverts. The roadside ditches are sized to convey the major event flow. The proposed roadside ditches comply with Table 6-1 of the EPC DCM V1. The roadside ditches have been designed to have an average depth of 3 feet, a v-ditch, and side slopes of 4:1. Roadside ditch calculations and summary table has been provided in the **Appendix**.

Culverts were sized to convey flows from the ditches and channels, underneath the sites paved roads. The proposed culverts range from 18" to 36" and have been designed to convey the 100-year storm event. Culvert calculations and summary table has been provided in the **Appendix**. Due to the potential for sediment laden flows as identified in "Soils and Geology Study Overlook at Homestead – Filing No.1" Prepared by Entech Engineering, Inc., dated June 7, 2024, additional analysis was completed for Culvert B6-A. Considering the potential for bulked flows in the area, culvert analysis of a conservative 150% of flows was completed to ensure proper culvert capacity. The additional culvert analysis has been provided in the **Appendix** which shows that the 36 inch culverts have capacity to handle a sediment laden flow and additional headwater elevation without overtopping the road or adverse velocities or Headwater to diameter ratio.

## ***DETENTION***

Three full spectrum extended detention basins are proposed in order to maintain historic flows and water quality. Mile High Flood District UD-Detention Spreadsheet was utilized to design the pond outlet structures. The three full spectrum extended detention basins are to be owned and maintained by The Overlook at Homestead Metropolitan District. As most of the site is exempt from water quality per the large lot single family exclusion, the WQCV numbers provided represent the required volume to be treated from the proposed roadway improvements. The overridden WQCV value was determined using UD-Detention spreadsheets calculating from only the roadway improvements. The UD-Detention spreadsheets used to calculate WQCV have been included in the **Appendix**. Detailed information regarding the large lot single family exclusions and WQCV can be found in Step 2 of the Four-Step Process section below.

Detailed pond and outlet structure design can be found in the **Appendix**. A pond summary table can be found below.

Pond	Contributing Basins	Total Contributing Basin Area (Acre)	WQCV (Ac-ft)	Total Volume Required (Ac-ft)	Total Volume Provided (Ac-ft)	100-YR Pond Outfall (CFS)
A2	A2	61.98	0.093	2.287	4.610	64.40
B1	B1	38.38	0.048	1.503	2.868	42.45
B8	B6+B8	67.96	0.069	2.207	4.741	39.40

## THE FOUR STEP PROCESS

The Project was designed in accordance with the four-step process to minimize adverse impacts of urbanization, as outlined in the El Paso County Engineering Manual for BMP selection as noted below:

**Step 1. Employ Runoff Reduction Practices** – The Project is proposing a low-density residential development that will be designed to minimize the impact to the current existing terrain. Per Section I.7.1B of Appendix I of the ECM, the single-family residences fall under the large lot exemption as the total impervious area is less than 10% of the area. Homes are typically placed in the center of the lot and provide long distances for infiltration across natural terrain. The Site's proposed paved roadways will increase the Site's impervious area; however, roadside ditches and channels will be constructed to slow down the runoff velocity and reduce runoff peaks. The three proposed detention ponds will be used to capture stormwater, provide water quality treatment, and maintain flows discharging off site at or below historic levels.

**Step 2. Provide a Water Quality Capture Volume** – Permanent water quality measures and detention facilities will be necessary for the Project. Three (3) Full Spectrum Extended Detention Basins will treat the areas not excluded with either the Large Lot or 20% exclusion. Per ECM Appendix I Section I.7.B.5: Large Lot Single Family exclusion, most of the proposed site will be excluded from water quality, lot imperviousness shall be limited to 10 percent or less. Per ECM Appendix I Section 1.7.C.1.a., 20% of the development site or less than 1 acre can be excluded from providing water quality. As mentioned, 0.99 acres (43,197 sq ft) of impervious area will not be able to be treated which is less than 20% of the overall site.

**Step 3 Stabilize Drainageways**– Stabilizing proposed roadside ditches, and channels by designing them with slopes that control the flow rates. Placement of riprap upstream and downstream of culverts to help reduce erosion of the roadside ditches. Additionally, low tailwater stilling basins will be constructed in the place of traditional riprap outlet protection. The design helps prevent downstream scour and mitigates the concentrated flow, acting as a level spreader for concentrated flow in an existing drainageway. Existing drainage ways will be graded to reduce the velocity of the water to minimize erosion. The existing natural channels have been analyzed for width and velocity for the 100-yr storm event. Easements are proposed to accommodate the full width of the major storm event.

**Step 4. Implement Site Specific and Other Source Control BMPs** – The erosion control construction BMPs of the Project were designed to reduce contamination. Source control BMPs include the use of vehicle tracking control, culvert protection, stockpile management, and stabilized staging areas.

## DRAINAGE FACILITY DESIGN

### GENERAL CONCEPT

The proposed drainage patterns will match the historic patterns. To maintain historic flows, three full spectrum detention ponds are being proposed and will capture and control the flows from the proposed development at less than or equal to historic rates.

### WQCV EXCLUSION AREAS

Areas within the site do not have water quality provided. Under the ECM's Appendix I. Section 1.7.C.A, 20% of the development site or less than 1 acre can be excluded from providing water quality. The combined exclusion areas for Phase 1 sum to 0.99 acres. WQCV exclusion locations are provided in the **Appendix**.

### DRIVEWAY CULVERTS

Culverts were analyzed and sized for driveway crossings at each ditch crossing from the roadways. Refer to **Appendix** for the driveway culvert calculations. A culvert summary table has been provided below. In the event a driveway crosses a drainage easement or natural channel within the lot, culvert design and calculations have been provided in some instances.

DRIVEWAY CULVERT SIZING TABLE				
Lot	100 yr. Flow (cfs)	Culvert Size (in)	Anticipated Driveway Location	Notes
1	<10	18	Southeast side of lot	N/A
2	<10	18	East side of lot	N/A
3	<10	18	East side of lot	N/A
4	<10	18	Northeast side of lot	N/A
5	<10	18	Center of east side of lot	N/A
6	<10	18	Northeast side of lot	N/A
6 (Internal)	18	30	Interior Lot Driveway	Culvert for potention channel crossing within the lot
7	<10	18	North center of lot	N/A
8	<10	18	Northwest side of lot	N/A
9	<10	18	Northwest side of lot	N/A
9 (Internal)	25	30	Interior Lot Driveway	Culvert for potention channel crossing within the lot
10	<10	18	Northeast side of lot	N/A
11	<10	18	Northeast side of lot	N/A
12	<10	18	Northwest side of lot	N/A
13	<10	18	North side of lot	N/A
14	<10	18	Northwest side of lot	N/A
15	<10	18	Northeast side of lot	N/A
16	<10	18	North side of lot	N/A
17	<10	18	Northwest side of lot	N/A
18	<10	18	Southwest side of lot	N/A
19	14	18	Southeast side of lot	N/A
20	14	18	Southeast side of lot	N/A
21	91	48	Southwest side of lot	N/A
22	91	48	Southeast side of lot	N/A
23	24	24	Northwest side of lot	N/A
24	24	24	Northwest side of lot	N/A
25	<10	18	Northeast side of lot	N/A
26	<10	18	Northwest side of lot	N/A
27	<10	18	Northeast side of lot	N/A
28	<10	18	Northeast side of lot	Campout drive side
29	<10	18	Northeast side of lot	N/A
30	<10	18	Northeast side of lot	N/A
31	<10	18	Northeast side of lot	N/A
32	<10	18	Southeast side of lot	East of drainage channel connecting to hatband drive
33	26	24	Southwest side of lot	South of western drainage channel
34	26	24	West side of lot	N/A
34 (Internal)	58	42	Interior Lot Driveway	Culvert for potention channel crossing within the lot
35	<10	18	Southwest side of lot	N/A
35 (internal)	58	42	Interior Lot Driveway	Culvert for potention channel crossing within the lot
36	<10	18	Southwest side of lot	N/A

## **DRAINAGE FEES**

### ***FEES***

The Project is within the Upper Black Squirrel Drainage Basin (CHBS2000), La Vega Ranch Drainage Basin (CHBR0400), East Kiowa Creek Drainage Basin (KIKI0400), and Bijou Creek Drainage Basin (BIBI0200) all four of which are not part of the El Paso County Drainage Basin Fee Program. As such, no drainage fees are due with this Project.

## **SUMMARY**

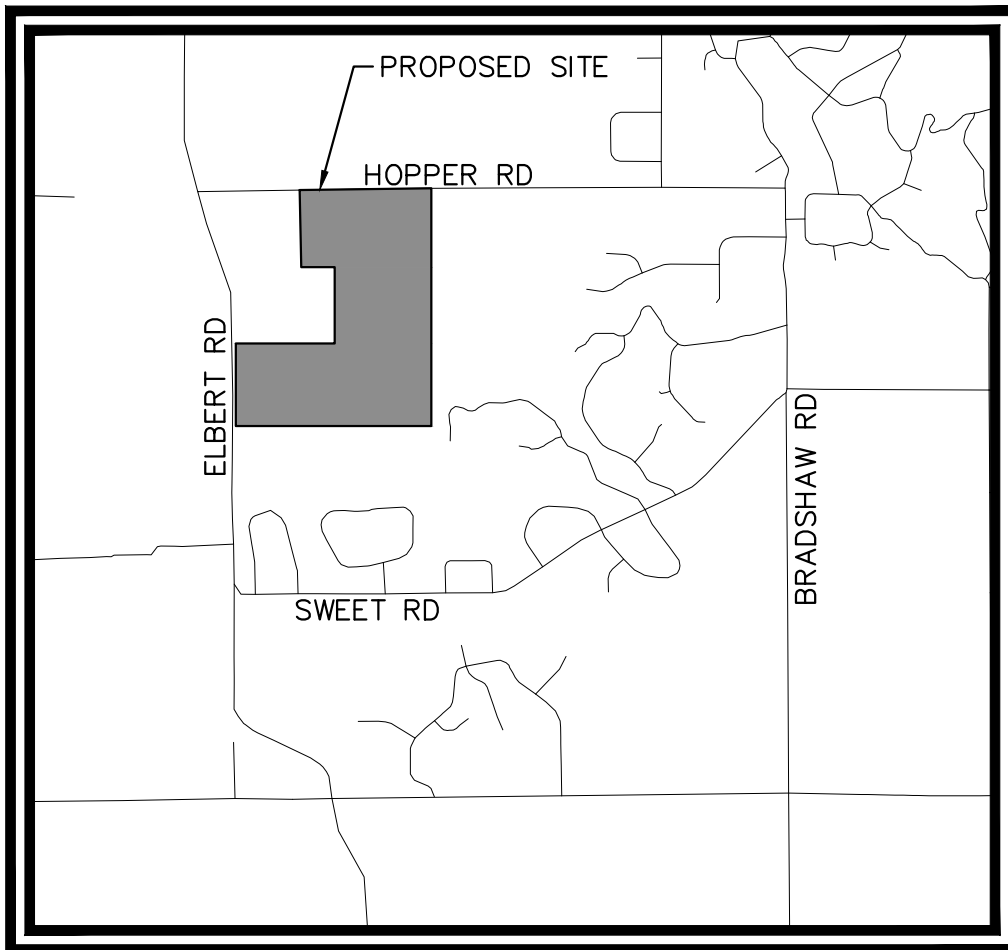
This report has been prepared in accordance with El Paso County stormwater criteria. It outlines the Site design for the 5-year and 100-year storm events drainage system. The drainage design presented within this report conforms to the criteria presented in the MANUAL. Additionally, as the proposed temporary sediment basin release rates are to be designed less than historic rates, the Site runoff and storm drain facilities will not adversely affect the downstream and surrounding developments.

## REFERENCES

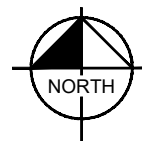
1. Final Drainage Report for Apex Ranch Estates by Terra Nova Engineering, Inc. dated September 3, 2008
2. El Paso County “Engineering Criteria Manual” Volumes 1 & 2, dated October 31, 2018
3. Natural Resources Conservation Service, Web Soil Survey, dated June 21, 2023.
4. Urban Drainage and Flood Control District Drainage Criteria Manuals (UDFCDCM), (Volumes 1, 2 and 3), prepared by Wright-McLaughlin Engineers, June 2001, with latest revisions.
5. Flood Insurance Rate Map, El Paso County, Colorado and Incorporated Areas, Map Number 08041C0350G, Effective Date December 7, 2018, prepared by the Federal Emergency Management Agency (FEMA).
6. Preliminary Drainage Report for Apex Ranch Estates by Terra Nova Engineering, Inc. dated January 10, 2008
7. Early Grading Permit – Final Drainage Report Overlook as Homestead Subdivision Filing No. 1 by Kimley-Horn & Associates, dated September 17, 2024
8. Soils and Geology Study Overlook at Homestead – Filing No.1 by Entech Engineering, Inc., dated November 13, 2024

## APPENDIX

***APPENDIX A: VICINITY MAP***



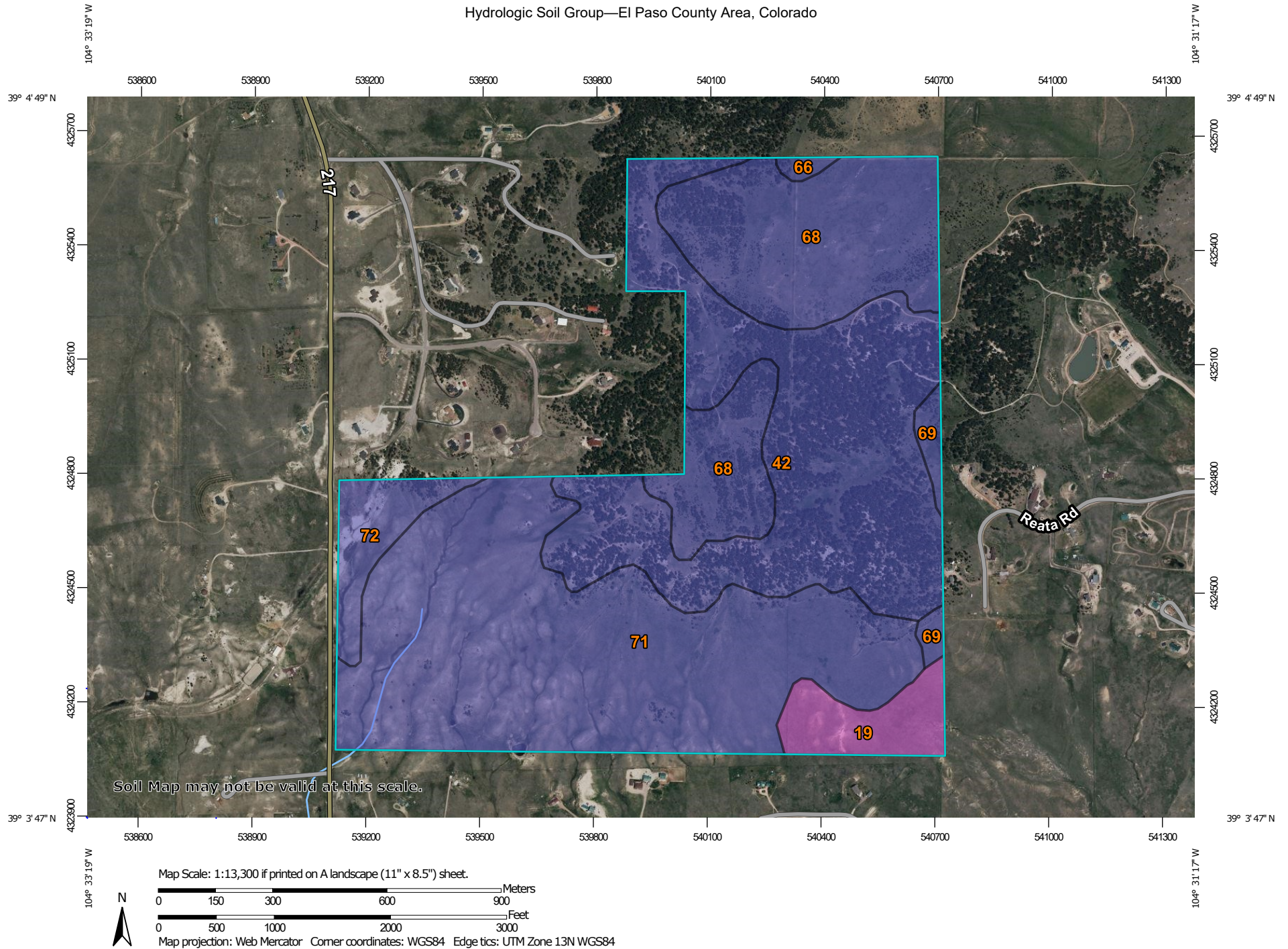
**VICINITY MAP**  
SCALE: 1":5000'




***APPENDIX B: FEMA MAP & SOILS REPORT***











# Hydrologic Soil Group—El Paso County Area, Colorado



**MAP LEGEND****Area of Interest (AOI)**
 Area of Interest (AOI)
**Soils****Soil Rating Polygons**





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


**Soil Rating Lines**






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


**Soil Rating Points**

-  A
-  A/D
-  B
-  B/D

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

**Water Features**
 Streams and Canals
**Transportation**

-  Rails
-  Interstate Highways
-  US Routes
-  Major Roads
-  Local Roads

**Background**
 Aerial Photography
**MAP INFORMATION**

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service  
Web Soil Survey URL:  
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: El Paso County Area, Colorado  
Survey Area Data: Version 20, Sep 2, 2022

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

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

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

## Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	A	18.1	4.1%
42	Kettle-Rock outcrop complex	B	135.4	30.8%
66	Peyton sandy loam, 1 to 5 percent slopes	B	1.7	0.4%
68	Peyton-Pring complex, 3 to 8 percent slopes	B	91.1	20.7%
69	Peyton-Pring complex, 8 to 15 percent slopes	B	5.6	1.3%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	171.8	39.0%
72	Pring coarse sandy loam, 8 to 15 percent slopes	B	16.2	3.7%
<b>Totals for Area of Interest</b>			<b>440.0</b>	<b>100.0%</b>

## Description

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

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

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

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

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

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

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

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff:* None Specified

*Tie-break Rule:* Higher

***APPENDIX C: HYDROLOGY***



# STANDARD FORM SF-1

## RUNOFF COEFFICIENTS - IMPERVIOUS CALCULATION

### EXISTING CONDITIONS

PROJECT NAME: Overlook  
PROJECT NUMBER: 196239003  
CALCULATED BY: GKS  
CHECKED BY: KRK

DATE: 9/16/2024

SOIL: B		RESIDENTIAL (>5AC)		PASTURE/MEADOW (SOIL GROUP A/B)	PAVEMENT						
	LAND USE:	AREA	AREA	AREA	AREA						
	2-YEAR COEFF.	0.05	0.02	0.89							
	5-YEAR COEFF.	0.12	0.08	0.90							
	10-YEAR COEFF.	0.20	0.15	0.92							
	100-YEAR COEFF.	0.39	0.35	0.96							
	IMPERVIOUS %	7%	0%	100%							
DESIGN BASIN	DESIGN POINT	RESIDENTIAL (>5AC)  AREA (AC)	PASTURE/MEADOW (SOIL GROUP A/B)  AREA (AC)	PAVEMENT  AREA (AC)	AREA (AC)	TOTAL AREA (AC)	C(2)	C(5)	C(10)	C(100)	Imp %
FDR Basins											
A1	1		18.28	1.64		19.92	0.09	0.15	0.21	0.40	8%
A2	2		63.31	0.66		63.97	0.03	0.09	0.16	0.36	1%
B1	3		43.28			43.28	0.02	0.08	0.15	0.35	0%
B2	4		42.42			42.42	0.02	0.08	0.15	0.35	0%
B3	5		25.42			25.42	0.02	0.08	0.15	0.35	0%
B3A	5A		24.23			24.23	0.02	0.08	0.15	0.35	0%
OS-A1	14		3.29	0.77		4.06	0.19	0.24	0.30	0.47	19%
OS-A2	15	4.45				4.45	0.05	0.12	0.20	0.39	7%
TOTAL - OVERALL		4.45	220.23	3.07	0.00	227.75	0.03	0.09	0.16	0.36	1%
		2%	97%	1%	0%	100%					

Note: Land use coefficients sourced from City of Colorado Springs Drainage Criteria Manual, Volume 1, Table 6-6.



STANDARD FORM SF-2  
Time of Concentration

PROJECT NAME: Overlook  
PROJECT NUMBER: 196239003  
CALCULATED BY: GKS  
CHECKED BY: KRK

EXISTING CONDITIONS

DATE: 9/16/2024

SUB-BASIN DATA			INITIAL TIME (T <sub>i</sub> )			TRAVEL TIME (T <sub>t</sub> )					T <sub>c</sub> CHECK (URBANIZED BASINS)					FINAL T <sub>c</sub>
DESIGN BASIN (1)	AREA Ac (2)	C5 (3)	LENGTH Ft (4)	SLOPE % (5)	T <sub>i</sub> Min. (6)	LENGTH Ft. (7)	SLOPE % (8)	C <sub>v</sub> (9)	VEL fps (11)	T <sub>t</sub> Min. (12)	COMP. t <sub>c</sub> (13)	TOTAL LENGTH (14)	TOTAL SLOPE (15)	TOTAL IMP. (16)	T <sub>c</sub> Min. (17)	Min.
FDR Basins																
A1	19.92	0.15	300	18.0%	11.5	2,066	5.7%	2.5	0.6	57.7	69.2	2366	7.3%	8%	23.1	23.1
A2	63.97	0.09	300	18.0%	12.3	3,677	5.7%	2.5	0.6	102.7	114.9	3977	6.6%	1%	32.1	32.1
B1	43.28	0.08	300	25.0%	11.1	2,577	6.5%	2.5	0.6	67.4	78.5	2877	8.4%		26.0	26.0
B2	42.42	0.08	300	6.9%	17.0	2,347	10.3%	2.5	0.8	48.8	65.8	2647	9.9%		24.7	24.7
B3	25.42	0.08	300	23.0%	11.4	1,968	9.9%	2.5	0.8	41.7	53.1	2268	11.6%		22.6	22.6
B3A	24.23	0.08	300	20.0%	11.9	1,500	10.0%	2.5	0.8	31.6	43.6	1800	11.7%		20.0	20.0
OS-A1	4.06	0.24	300	5.0%	16.1	161	5.0%	2.5	0.6	4.8	20.9	461	5.0%	19%	12.6	12.6
OS-A2	4.45	0.12	250	10.0%	13.2			2.5			13.2	250	10.0%	7%	11.4	11.4

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_0^{0.33}}$$

$$t_c = \frac{L}{180} + 10$$

$$V = C_v S_w^{0.5}$$

Note: Conveyance coefficient from Table 6-7 of DCM

Kimley»Horn

PROJECT NAME: Overlook  
PROJECT NUMBER: 196239003  
CALCULATED BY: GKS  
CHECKED BY: KRK

STANDARD FORM SF-3

STORM DRAINAGE DESIGN - RATIONAL METHOD 2 YEAR EVENT

EXISTING CONDITIONS

DATE: 9/16/2024

STORM LINE		DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS	
			DESIGN BASIN	AREA (AC)	RUNOFF COEFF	t <sub>c</sub> (min)	C*A(ac)	I (in/hr)	Q (cfs)	t <sub>c</sub> (max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY		t <sub>t</sub> (min)
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
		1	A1	19.92	0.09	23.14	1.83	2.30	4.19													
		2	A2	63.97	0.03	32.09	1.85	1.91	3.54													
		3	B1	43.28	0.02	25.98	0.87	2.16	1.87													
		4	B2	42.42	0.02	24.71	0.85	2.22	1.88													
		5	B3	25.42	0.02	22.60	0.51	2.32	1.18													
		5A	B3A	24.23	0.02	20.00	0.48	2.47	1.20													
		14	OS-A1	4.06	0.19	12.56	0.75	3.02	2.27													
		15	OS-A2	4.45	0.05	11.39	0.22	3.14	0.70													

Note: Rainfall intensity from Figure 6-5 IDF Equations

$$I_2 = -1.19 \ln(t_{c,min}) + 6.035$$

<div><div>Kimley»Horn</div><div>STANDARD FORM SF-3</div><div>STORM DRAINAGE DESIGN - RATIONAL METHOD 5 YEAR EVENT</div><div><div>PROJECT NAME: Overlook</div><div>PROJECT NUMBER: 196239003</div><div>CALCULATED BY: GKS</div><div>CHECKED BY: KRK</div></div><div>EXISTING CONDITIONS</div><div>DATE: 9/16/2024</div></div>																						
STORM LINE		DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS	
			DESIGN BASIN	AREA (AC)	RUNOFF COEFF	t <sub>c</sub> (min)	C*A (ac)	I (in/hr)	Q (cfs)	t <sub>c</sub> (max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY		t <sub>t</sub> (min)
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
		1	A1	19.92	0.15	23.14	2.94	2.87	8.43													
		2	A2	63.97	0.09	32.09	5.66	2.38	13.47													
		3	B1	43.28	0.08	25.98	3.46	2.70	9.34													
		4	B2	42.42	0.08	24.71	3.39	2.77	9.41													
		5	B3	25.42	0.08	22.60	2.03	2.91	5.91													
		5A	B3A	24.23	0.08	20.00	1.94	3.09	5.99													
		14	OS-A1	4.06	0.24	12.56	0.96	3.79	3.62													
		15	OS-A2	4.45	0.12	11.39	0.53	3.93	2.10													

Note: Rainfall intensity from Figure 6-5 IDF Equations

$I_5 = -1.5 \ln(t_{c,min}) + 7.583$

Kimley»Horn

PROJECT NAME: Overlook  
PROJECT NUMBER: 196239003  
CALCULATED BY: GKS  
CHECKED BY: KRK

STANDARD FORM SF-3

STORM DRAINAGE DESIGN - RATIONAL METHOD 100 YEAR EVENT

EXISTING CONDITIONS

DATE: 9/16/2024

STORM LINE		DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS	
			DESIGN BASIN	AREA (AC)	RUNOFF COEFF	t <sub>c</sub> (min)	C*A(ac)	I (in/hr)	Q (cfs)	t <sub>c</sub> (max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY	t <sub>t</sub> (min)	
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
		1	A1	19.92	0.40	23.14	7.97	4.82	38.41													
		2	A2	63.97	0.36	32.09	22.79	3.99	91.03													
		3	B1	43.28	0.35	25.98	15.15	4.53	68.56													
		4	B2	42.42	0.35	24.71	14.85	4.65	69.09													
		5	B3	25.42	0.35	22.60	8.90	4.88	43.40													
		5A	B3A	24.23	0.35	20.00	8.48	5.19	43.98													
		14	OS-A1	4.06	0.47	12.56	1.89	6.36	12.02													
		15	OS-A2	4.45	0.39	11.39	1.74	6.60	11.46													

Note: Rainfall intensity from Figure 6-5 IDF Equations

$I_{100} = -2.52 \ln(t_{c,min}) + 12.735$



PROJECT NAME: Overlook  
PROJECT NUMBER: 196239003  
CALCULATED BY: GKS  
CHECKED BY: KRK

9/16/2024

#### EXISTING CONDITIONS RATIONAL CALCULATIONS SUMMARY

DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	CFS			% IMPERVIOUS
			Q2	Q5	Q100	
FDR Basins						
1	A1	19.92	4.19	8.43	38.41	8%
2	A2	63.97	3.54	13.47	91.03	1%
3	B1	43.28	1.87	9.34	68.56	0%
4	B2	42.42	1.88	9.41	69.09	0%
5	B3	25.42	1.18	5.91	43.40	0%
5A	B3A	24.23	1.20	5.99	43.98	0%
14	OS-A1	4.06	2.27	3.62	12.02	19%
15	OS-A2	4.45	0.70	2.10	11.46	7%
ON-SITE BASIN TOTAL						
BASIN A TOTAL		83.89	7.73	21.90	129.44	3%
BASIN B TOTAL		135.35	6.13	30.64	225.03	0%
ON-SITE TOTAL		219.24	13.86	52.55	354.46	1%
OFF-SITE BASIN TOTAL						
OFF-SITE BASIN A		8.51	2.97	5.72	23.48	13%
OFF-SITE TOTAL		8.51	2.97	5.72	23.48	13%
SITE TOTAL		227.75	16.83	58.27	377.95	1%



STANDARD FORM SF-1

RUNOFF COEFFICIENTS - IMPERVIOUS CALCULATION

PROPOSED CONDITIONS

PROJECT NAME: Overlook  
PROJECT NUMBER: 196239003  
CALCULATED BY: GKS  
CHECKED BY: KRK

DATE: 9/16/2024

SOIL: B											
		RESIDENTIAL (>5AC)	PASTURE/MEADOW (SOIL GROUP A/B)	PAVEMENT							
LAND USE:		AREA	AREA	AREA	AREA						
2-YEAR COEFF.		0.05	0.02	0.89							
5-YEAR COEFF.		0.12	0.08	0.90							
10-YEAR COEFF.		0.20	0.15	0.92							
100-YEAR COEFF.		0.39	0.35	0.96							
IMPERVIOUS %		7%	0%	100%							
DESIGN BASIN	DESIGN POINT	RESIDENTIAL (>5AC) AREA (AC)	PASTURE/MEADOW (SOIL GROUP A/B) AREA (AC)	PAVEMENT AREA (AC)	AREA (AC)	TOTAL AREA (AC)	C(2)	C(5)	C(10)	C(100)	Imp %
FDR Basins											
A1	1	17.91		1.64		19.55	0.12	0.19	0.26	0.44	15%
A2	2	59.76		2.22		61.98	0.08	0.15	0.23	0.41	10%
B1	3	37.03		1.35		38.38	0.08	0.15	0.23	0.41	10%
B2	4	15.57		0.24		15.81	0.06	0.13	0.21	0.40	8%
B3	5	19.11				19.11	0.05	0.12	0.20	0.39	7%
B6	8	49.92		2.23		52.15	0.09	0.15	0.23	0.41	11%
B7	9	2.46				2.46	0.05	0.12	0.20	0.39	7%
B8	10	9.52				9.52	0.05	0.12	0.20	0.39	7%
OS-A1	18	3.29		0.77		4.06	0.21	0.27	0.34	0.50	25%
OS-A2	19	3.14				3.14	0.05	0.12	0.20	0.39	7%
OS-A3	20	1.22		0.09		1.31	0.11	0.17	0.25	0.43	13%
TOTAL - OVERALL		217.71	0.00	8.45	0.00	226.16	0.08	0.15	0.23	0.41	10%
		96%	0%	4%	0%	100%					

Note: Land use coefficients sourced from City of Colorado Springs Drainage Criteria Manual, Volume 1, Table 6-6.



STANDARD FORM SF-2  
Time of Concentration

PROJECT NAME: Overlook  
PROJECT NUMBER: 196239003  
CALCULATED BY: GKS  
CHECKED BY: KRK

PROPOSED CONDITIONS

DATE: 9/16/2024

SUB-BASIN DATA			INITIAL TIME (T <sub>i</sub> )			TRAVEL TIME (T <sub>t</sub> )					T <sub>c</sub> CHECK (URBANIZED BASINS)					FINAL T <sub>c</sub>
DESIGN BASIN (1)	AREA Ac (2)	C5 (3)	LENGTH Ft (4)	SLOPE % (5)	T <sub>i</sub> Min. (6)	LENGTH Ft. (7)	SLOPE % (8)	C <sub>v</sub> (9)	VEL fps (11)	T <sub>t</sub> Min. (12)	COMP. t <sub>c</sub> (13)	TOTAL LENGTH (14)	TOTAL SLOPE (15)	TOTAL IMP. (16)	T <sub>c</sub> Min. (17)	Min.
FDR Basins																
A1	19.55	0.19	300	18.0%	11.1	2,066	5.0%	2.5	0.6	61.6	72.7	2366	6.6%	15%	23.1	23.1
A2	61.98	0.15	300	18.0%	11.5	4,100	4.0%	2.5	0.5	136.7	148.2	4400	5.0%	10%	34.4	34.4
B1	38.38	0.15	300	8.0%	15.1	2,000	4.5%	2.5	0.5	62.9	78.0	2300	5.0%	10%	22.8	22.8
B2	15.81	0.13	300	7.0%	16.1	500	6.0%	2.5	0.6	13.6	29.7	800	6.4%	8%	14.4	14.4
B3	19.11	0.12	300	21.0%	11.3	800	8.0%	2.5	0.7	18.9	30.1	1100	11.5%	7%	16.1	16.1
B6	52.15	0.15	300	22.0%	10.7	1,900	3.0%	2.5	0.4	73.1	83.9	2200	5.6%	11%	22.2	22.2
B7	2.46	0.12	300	6.0%	17.1	100	6.0%	2.2	0.5	3.1	20.2	400	6.0%	7%	12.2	12.2
B8	9.52	0.12	300	6.0%	17.1	300	10.0%	2.5	0.8	6.3	23.5	600	8.0%	7%	13.3	13.3
OS-A1	4.06	0.27	300	5.0%	15.5	161	5.0%	2.5	0.6	4.8	20.3	461	5.0%	25%	12.6	12.6
OS-A2	3.14	0.12	250	10.0%	13.2			2.5			13.2	250	10.0%	7%	11.4	11.4
OS-A3	1.31	0.17	300	13.0%	12.5			2.5			12.5	300	13.0%	13%	11.7	11.7
<div><div><math display="block">t_i = \frac{0.395(1.1 - C_5)\sqrt{L_i}}{S_0^{0.33}}</math></div><div><math display="block">t_c = \frac{L}{180} + 10</math></div><div><math display="block">V = C_v S_w^{0.5}</math></div></div> <div>Note: Conveyance coefficient from Table 6-7 of DCM</div>																

Kimley»Horn

PROJECT NAME: Overlook  
PROJECT NUMBER: 196239003  
CALCULATED BY: GKS  
CHECKED BY: KRK

STANDARD FORM SF-3

STORM DRAINAGE DESIGN - RATIONAL METHOD 2 YEAR EVENT

PROPOSED CONDITIONS

DATE: 9/16/2024

STORM LINE		DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS	
			DESIGN BASIN	AREA (AC)	RUNOFF COEFF	t <sub>c</sub> (min)	C*A(ac)	I (in/hr)	Q (cfs)	t <sub>c</sub> (max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY	t <sub>t</sub> (min)	
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
		1	A1	19.55	0.12	23.14	2.36	2.30	5.41													
		2	A2	61.98	0.08	34.44	4.96	1.82	9.05													
		3	B1	38.38	0.08	22.78	3.05	2.32	7.07													
		4	B2	15.81	0.06	14.44	0.99	2.86	2.83													
		5	B3	19.11	0.05	16.11	0.96	2.73	2.61													
		8	B6	52.15	0.09	22.22	4.48	2.34	10.51													
		9	B7	2.46	0.05	12.22	0.12	3.06	0.38													
		10	B8	9.52	0.05	13.33	0.48	2.95	1.41													
		18	OS-A1	4.06	0.21	12.56	0.85	3.02	2.57													
		19	OS-A2	3.14	0.05	11.39	0.16	3.14	0.49													
		20	OS-A3	1.31	0.11	11.67	0.14	3.11	0.43													

Note: Rainfall intensity from Figure 6-5 IDF Equations

$I_2 = -1.19 \ln(t_{c,min}) + 6.035$

Kimley»Horn

PROJECT NAME: Overlook  
PROJECT NUMBER: 196239003  
CALCULATED BY: GKS  
CHECKED BY: KRK

STANDARD FORM SF-3

STORM DRAINAGE DESIGN - RATIONAL METHOD 5 YEAR EVENT

PROPOSED CONDITIONS

DATE: 9/16/2024

STORM LINE		DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				STREET		PIPE			TRAVEL TIME			REMARKS
			DESIGN BASIN	AREA (AC)	RUNOFF COEFF	t <sub>c</sub> (min)	C*A (ac)	I (in/hr)	Q (cfs)	t <sub>c</sub> (max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)	VELOCITY	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
	1	A1	19.55	0.19	23.14	3.63	2.87	10.41													
	2	A2	61.98	0.15	34.44	9.17	2.27	20.85													
	3	B1	38.38	0.15	22.78	5.66	2.89	16.38													
	4	B2	15.81	0.13	14.44	2.08	3.58	7.46													
	5	B3	19.11	0.12	16.11	2.29	3.41	7.83													
	8	B6	52.15	0.15	22.22	8.00	2.93	23.44													
	9	B7	2.46	0.12	12.22	0.30	3.83	1.13													
	10	B8	9.52	0.12	13.33	1.14	3.70	4.22													
	18	OS-A1	4.06	0.27	12.56	1.09	3.79	4.12													
	19	OS-A2	3.14	0.12	11.39	0.38	3.93	1.48													
	20	OS-A3	1.31	0.17	11.67	0.22	3.90	0.87													

Note: Rainfall intensity from Figure 6-5 IDF Equations

$$I_5 = -1.5 \ln(t_{c,min}) + 7.583$$

Kimley»Horn

PROJECT NAME: Overlook

PROJECT NUMBER: 196239003

CALCULATED BY: GKS

CHECKED BY: KRK

STANDARD FORM SF-3

STORM DRAINAGE DESIGN - RATIONAL METHOD 100 YEAR EVENT

PROPOSED CONDITIONS

DATE: 9/16/2024

STORM LINE		DESIGN POINT	DIRECT RUNOFF						TOTAL RUNOFF				STREET		PIPE		TRAVEL TIME			REMARKS		
			DESIGN BASIN	AREA (AC)	RUNOFF COEFF	t <sub>c</sub> (min)	C*A(ac)	I (in/hr)	Q (cfs)	t <sub>c</sub> (max)	S(C*A) (ac)	I (in/hr)	Q (cfs)	SLOPE (%)	STREET FLOW(cfs)	DESIGN FLOW(cfs)	SLOPE (%)	PIPE SIZE (in)	LENGTH (ft)		VELOCITY	t <sub>t</sub> (min)
(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)
		1	A1	19.55	0.44	23.14	8.56	4.82	41.24													
		2	A2	61.98	0.41	34.44	25.44	3.82	97.07													
		3	B1	38.38	0.41	22.78	15.74	4.86	76.45													
		4	B2	15.81	0.40	14.44	6.30	6.01	37.85													
		5	B3	19.11	0.39	16.11	7.45	5.73	42.71													
		8	B6	52.15	0.41	22.22	21.61	4.92	106.32													
		9	B7	2.46	0.39	12.22	0.96	6.43	6.17													
		10	B8	9.52	0.39	13.33	3.71	6.21	23.05													
		18	OS-A1	4.06	0.50	12.56	2.02	6.36	12.86													
		19	OS-A2	3.14	0.39	11.39	1.22	6.60	8.09													
		20	OS-A3	1.31	0.43	11.67	0.56	6.54	3.65													

Note: Rainfall intensity from Figure 6-5 IDF Equations

$I_{100} = -2.52 \ln(t_{c,min}) + 12.735$



PROJECT NAME: Overlook  
PROJECT NUMBER: 196239003  
CALCULATED BY: GKS  
CHECKED BY: KRK

9/16/2024

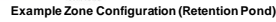
PROPOSED CONDITIONS RATIONAL CALCULATIONS SUMMARY

DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	CFS			% IMPERVIOUS	DETAINED 100 YR OUTFLOW (CFS)
			Q2	Q5	Q100		
Basins							
1	A1	19.55	5.41	10.41	41.24	15%	
2	A2	61.98	9.05	20.85	97.07	10%	
EDB A2	A2						64.40
3	B1	38.38	7.07	16.38	76.45	10%	
EDB B1	B1						42.45
4	B2	15.81	2.83	7.46	37.85	8%	
5	B3	19.11	2.61	7.83	42.71	7%	
8	B6	52.15	10.51	23.44	106.32	11%	
9	B7	2.46	0.38	1.13	6.17	7%	
10	B8	9.52	1.41	4.22	23.05	7%	
EDB B8	B6+B8						39.40
18	OS-A1	4.06	2.57	4.12	12.86	25%	
19	OS-A2	3.14	0.49	1.48	8.09	7%	
20	OS-A3	1.31	0.43	0.87	3.65	13%	
ON-SITE BASIN TOTAL							
BASIN A TOTAL		81.53	14.46	31.26	138.30	11%	
BASIN B TOTAL		137.43	24.80	60.46	292.55	10%	
ON-SITE TOTAL		218.96	39.25	91.72	430.86	10%	
OFF-SITE BASIN TOTAL							
OFF-SITE BASIN A		8.51	3.49	6.47	24.60	16%	
OFF-SITE TOTAL		8.51	3.49	6.47	24.60	16%	
SITE TOTAL		8.51	42.74	98.19	455.46	10%	

***APPENDIX D: HYDRUALICS***

MHFD-Detention, Version 4.06 (July 2022)

Basin ID: \_\_\_\_\_

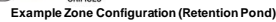


	acre-feet
	acre-feet
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

## VOLUME USED IN POND SIZING

MHFD-Detention, Version 4.06 (July 2022)

Basin ID: \_\_\_\_\_

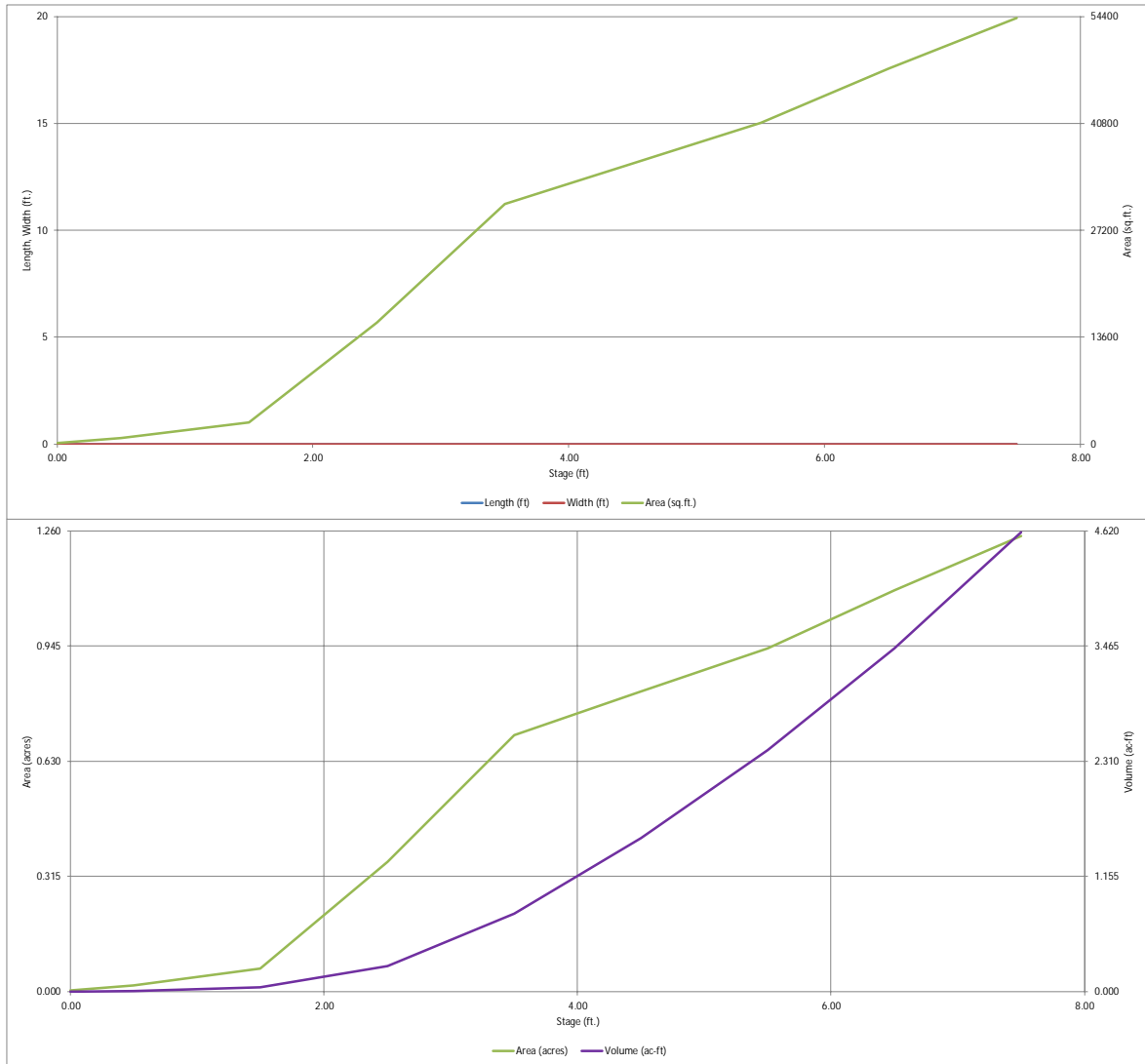


0.093	acre-feet
	acre-feet
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

7192.5

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

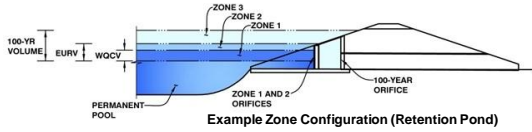


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Overlook Pond A2 Filling No. 1

Basin ID: \_\_\_\_\_



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WOCV)	1.91	0.093	Orifice Plate
Zone 2 (EURV)	3.20	0.490	Rectangular Orifice
Zone 3 (100-year)	5.36	1.704	Weir&Pipe (Restrict)
Total (all zones)	2.287		

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

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

Calculated Parameters for Underdrain  
Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

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

Centroid of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches

Calculated Parameters for Plate  
WO Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.25	1.00					
Orifice Area (sq. inches)	0.34	0.34	0.34					

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

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =   ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =   ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Height =   inches  
Vertical Orifice Width =   inches

Calculated Parameters for Vertical Orifice  
Zone 2 Rectangular =   ft<sup>2</sup>  
Vertical Orifice Area =   ft<sup>2</sup>  
Vertical Orifice Centroid =   feet

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

Zone 3 Weir =   ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =   feet  
Overflow Weir Gate Slope =   H:V  
Horiz. Length of Weir Sides =   feet  
Overflow Gate Type =    
Debris Clogging % =   %

Calculated Parameters for Overflow Weir  
Height of Gate Upper Edge, H<sub>1</sub> =   feet  
Overflow Weir Slope Length =   feet  
Gate Open Area / 100-yr Orifice Area =   ft<sup>2</sup>  
Overflow Gate Open Area w/o Debris =   ft<sup>2</sup>  
Overflow Gate Open Area w/ Debris =   ft<sup>2</sup>

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

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
Outlet Orifice Area =   ft<sup>2</sup>  
Outlet Orifice Centroid =   feet  
Half-Central Angle of Restrictor Plate on Pipe =   radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

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

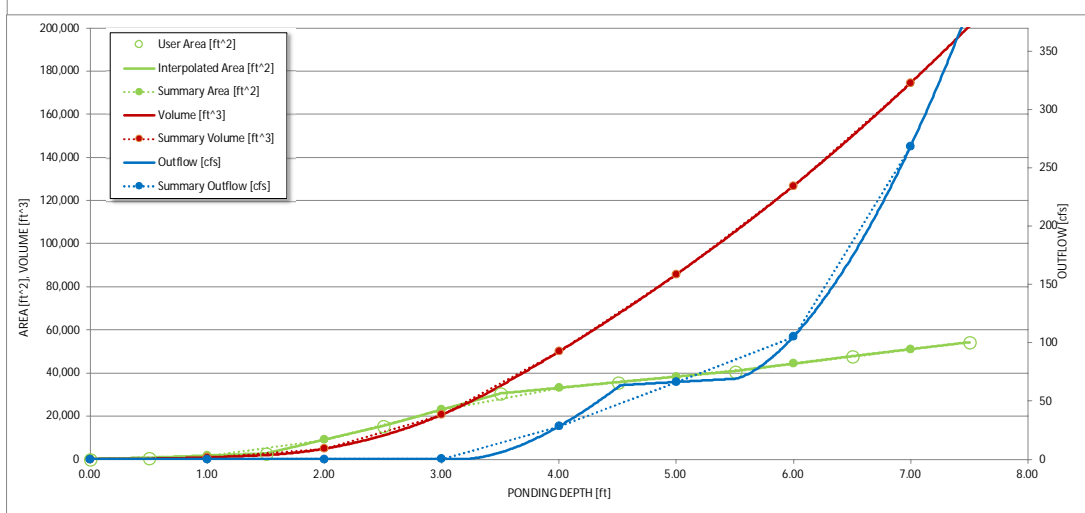
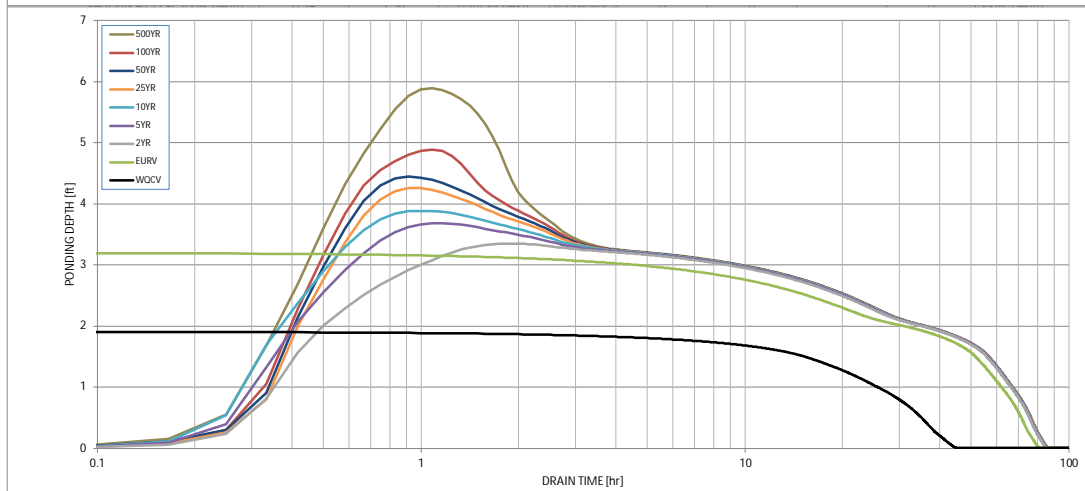
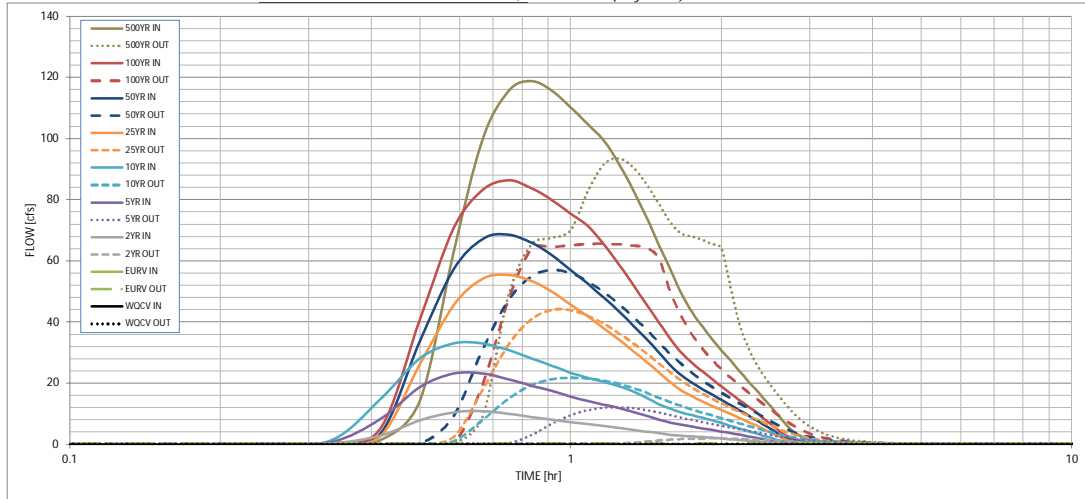
## Routed Hydrograph Results

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

	WOCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
One-Hour Rainfall Depth (in) =	0.093	0.583	0.827	1.827	2.824	4.601	5.814	7.559	10.741
CUHP Runoff Volume (acre-ft) =	N/A	N/A	0.827	1.827	2.824	4.601	5.814	7.559	10.741
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	6.8	18.9	28.6	51.3	64.4	81.9	114.1
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A							
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.11	0.30	0.46	0.83	1.04	1.32	1.84
Peak Inflow Q (cfs) =	N/A	N/A	10.8	23.2	33.0	55.4	68.5	86.3	118.8
Peak Outflow Q (cfs) =	0.0	0.3	1.9	12.1	21.8	43.9	57.0	65.6	93.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.8	0.9	0.9	0.8	0.8
Structure Controlling Flow =	Plate	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Gate 1 (fps) =	N/A	N/A	0.02	0.1	0.3	0.5	0.7	0.8	0.9
Max Velocity through Gate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	63	64	53	44	30	26	22	17
Time to Drain 99% of Inflow Volume (hours) =	41	71	73	67	63	56	52	47	37
Maximum Ponding Depth (ft) =	1.91	3.20	3.34	3.68	3.88	4.25	4.44	4.89	5.89
Area at Maximum Ponding Depth (acres) =	0.18	0.60	0.65	0.72	0.75	0.79	0.81	0.87	1.00
Maximum Volume Stored (acre-ft) =	0.095	0.586	0.673	0.902	1.056	1.340	1.485	1.862	2.789

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)



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

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: \_\_\_\_\_

## Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.03
	0:15:00	0.00	0.00	0.08	0.13	0.16	0.11	0.14	0.13	0.21
	0:20:00	0.00	0.00	0.32	0.78	1.38	0.33	0.39	0.41	1.32
	0:25:00	0.00	0.00	2.81	8.24	14.68	2.68	3.51	5.13	14.36
	0:30:00	0.00	0.00	7.86	18.77	28.11	26.22	33.92	40.85	62.27
	0:35:00	0.00	0.00	10.46	23.11	32.99	45.24	56.97	70.39	99.65
	0:40:00	0.00	0.00	10.84	23.20	32.96	54.09	67.15	83.11	115.36
	0:45:00	0.00	0.00	10.05	21.33	30.80	55.39	68.49	86.32	118.83
	0:50:00	0.00	0.00	8.97	19.26	28.17	53.50	66.07	83.88	115.59
	0:55:00	0.00	0.00	8.08	17.41	25.71	49.93	61.91	79.85	110.27
	1:00:00	0.00	0.00	7.26	15.60	23.43	45.70	56.98	75.42	104.47
	1:05:00	0.00	0.00	6.59	14.14	21.71	41.75	52.38	71.23	99.16
	1:10:00	0.00	0.00	5.98	12.98	20.34	37.85	47.82	65.25	91.57
	1:15:00	0.00	0.00	5.37	11.81	19.02	34.15	43.42	58.71	83.23
	1:20:00	0.00	0.00	4.78	10.57	17.27	30.51	38.89	52.13	74.21
	1:25:00	0.00	0.00	4.19	9.31	15.24	26.97	34.39	45.79	65.25
	1:30:00	0.00	0.00	3.62	8.08	13.18	23.50	30.00	39.85	56.80
	1:35:00	0.00	0.00	3.13	7.08	11.56	20.12	25.73	34.20	48.99
	1:40:00	0.00	0.00	2.80	6.35	10.41	17.52	22.50	29.86	42.99
	1:45:00	0.00	0.00	2.55	5.75	9.46	15.57	20.05	26.56	38.33
	1:50:00	0.00	0.00	2.34	5.20	8.61	13.95	18.01	23.74	34.32
	1:55:00	0.00	0.00	2.12	4.68	7.78	12.51	16.18	21.22	30.73
	2:00:00	0.00	0.00	1.90	4.18	6.94	11.21	14.51	18.92	27.43
	2:05:00	0.00	0.00	1.68	3.67	6.07	9.93	12.85	16.69	24.20
	2:10:00	0.00	0.00	1.45	3.16	5.23	8.68	11.23	14.58	21.10
	2:15:00	0.00	0.00	1.23	2.66	4.41	7.48	9.67	12.61	18.21
	2:20:00	0.00	0.00	1.01	2.18	3.63	6.29	8.15	10.69	15.40
	2:25:00	0.00	0.00	0.79	1.70	2.88	5.13	6.66	8.79	12.66
	2:30:00	0.00	0.00	0.58	1.23	2.16	3.98	5.19	6.89	9.94
	2:35:00	0.00	0.00	0.38	0.78	1.46	2.83	3.74	5.01	7.26
	2:40:00	0.00	0.00	0.22	0.48	1.02	1.74	2.35	3.23	4.85
	2:45:00	0.00	0.00	0.15	0.34	0.78	1.10	1.55	2.14	3.36
	2:50:00	0.00	0.00	0.11	0.26	0.61	0.71	1.05	1.45	2.37
	2:55:00	0.00	0.00	0.09	0.21	0.48	0.47	0.73	0.97	1.64
	3:00:00	0.00	0.00	0.07	0.16	0.38	0.30	0.49	0.62	1.11
	3:05:00	0.00	0.00	0.05	0.13	0.29	0.21	0.35	0.38	0.72
	3:10:00	0.00	0.00	0.04	0.10	0.22	0.14	0.23	0.21	0.44
	3:15:00	0.00	0.00	0.03	0.07	0.16	0.09	0.16	0.11	0.27
	3:20:00	0.00	0.00	0.03	0.05	0.11	0.06	0.12	0.08	0.19
	3:25:00	0.00	0.00	0.02	0.04	0.08	0.05	0.08	0.06	0.14
	3:30:00	0.00	0.00	0.02	0.03	0.06	0.03	0.06	0.05	0.11
	3:35:00	0.00	0.00	0.01	0.02	0.04	0.02	0.05	0.04	0.09
	3:40:00	0.00	0.00	0.01	0.01	0.03	0.02	0.04	0.03	0.07
	3:45:00	0.00	0.00	0.01	0.01	0.02	0.01	0.03	0.02	0.05
	3:50:00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.03
	3:55:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

### Summary Stage-Area-Volume-Discharge Relationships

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

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

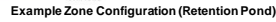
[illegible]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

MHFD-Detention, Version 4.06 (July 2022)

Basin ID: \_\_\_\_\_



Steep Slope > 0.06 ft/ft

### Optional User Overrides

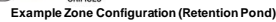
	acre-feet
	acre-feet
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

Initial Surcharge Area ( $A_{SIV}$ )	=	ft <sup>2</sup>
Surcharge Volume Length ( $L_{SIV}$ )	=	ft
Surcharge Volume Width ( $W_{SIV}$ )	=	ft
Depth of Basin Floor ( $H_{FLOOR}$ )	=	ft
Length of Basin Floor ( $L_{FLOOR}$ )	=	ft
Width of Basin Floor ( $W_{FLOOR}$ )	=	ft
Area of Basin Floor ( $A_{FLOOR}$ )	=	ft <sup>2</sup>
Volume of Basin Floor ( $V_{FLOOR}$ )	=	ft <sup>3</sup>
Depth of Main Basin ( $H_{MAIN}$ )	=	ft
Length of Main Basin ( $L_{MAIN}$ )	=	ft
Width of Main Basin ( $W_{MAIN}$ )	=	ft
Area of Main Basin ( $A_{MAIN}$ )	=	ft <sup>2</sup>
Volume of Main Basin ( $V_{MAIN}$ )	=	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TOTAL}$ )	=	acre-feet

## VOLUME USED IN POND SIZING

MHFD-Detention, Version 4.06 (July 2022)

Basin ID: \_\_\_\_\_

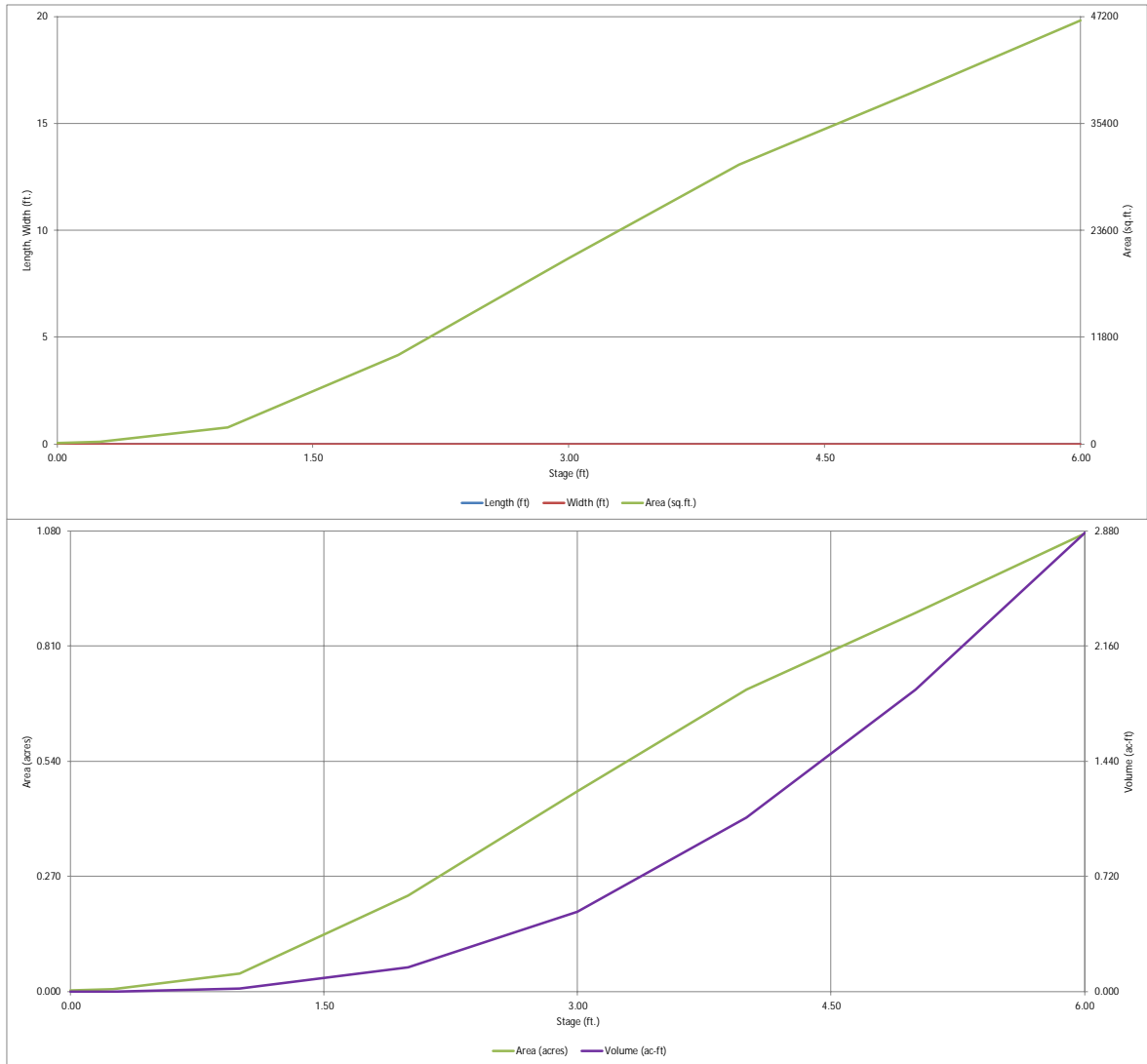


0.048	acre-feet
	acre-feet
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

7193

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

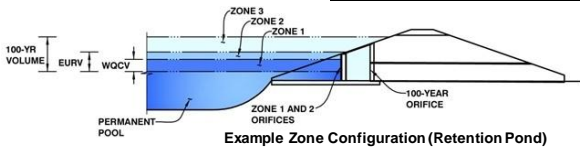


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Overlook Pond B1 Filling No. 1

Basin ID:



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.39	0.048	Orifice Plate
Zone 2 (EURV)	2.74	0.335	Rectangular Orifice
Zone 3 (100-year)	4.55	1.120	Weir&Pipe (Restrict)
Total (all zones)		1.503	

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

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

Calculated Parameters for Underdrain	
Underdrain Orifice Area =	N/A ft <sup>2</sup>
Underdrain Orifice Centroid =	N/A feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.39	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	5.60	inches
Orifice Plate: Orifice Area per Row =	0.25	sq. inches (diameter = 9/16 inch)

Calculated Parameters for Plate	
WO Orifice Area per Row =	1.736E-03 ft <sup>2</sup>
Elliptical Half-Width =	N/A feet
Elliptical Slot Centroid =	N/A feet
Elliptical Slot Area =	N/A ft <sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.46	0.93					
Orifice Area (sq. inches)	0.25	0.25	0.25					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	1.39	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	2.74	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	2.00	N/A	inches
Vertical Orifice Width =	2.25		inches

Calculated Parameters for Vertical Orifice		
	Zone 2 Rectangular	Not Selected
Vertical Orifice Area =	0.03	N/A
Vertical Orifice Centroid =	0.08	N/A

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.75	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	23.00	N/A	feet
Overflow Weir Gate Slope =	10.00	N/A	H:V
Horiz. Length of Weir Sides =	5.00	N/A	feet
Overflow Gate Type =	Type C Gate	N/A	
Debris Clogging % =	50%	N/A	%

		Calculated Parameters for Overflow Weir		
		Zone 3 Weir	Not Selected	
ft)	Height of Gate Upper Edge, H <sub>1</sub> =	3.25	N/A	feet
	Overflow Weir Slope Length =	5.02	N/A	feet
	Gate Open Area / 100-yr Orifice Area =	16.07	N/A	
	Overflow Gate Open Area w/o Debris =	80.44	N/A	ft <sup>2</sup>
	Overflow Gate Open Area w/ Debris =	40.22	N/A	ft <sup>2</sup>

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	1.58	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	36.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	24.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate				
		Zone 3 Restrictor	Not Selected	
at Stage = 0 ft)	Outlet Orifice Area =	5.01	N/A	ft <sup>2</sup>
	Outlet Orifice Centroid =	1.12	N/A	feet
	Half-Central Angle of Restrictor Plate on Pipe =	1.91	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	4.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	30.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway		
Spillway Design Flow Depth=	0.61	feet
Stage at Top of Freeboard =	5.61	feet
Basin Area at Top of Freeboard =	1.00	acres
Basin Volume at Top of Freeboard =	2.46	acre-ft

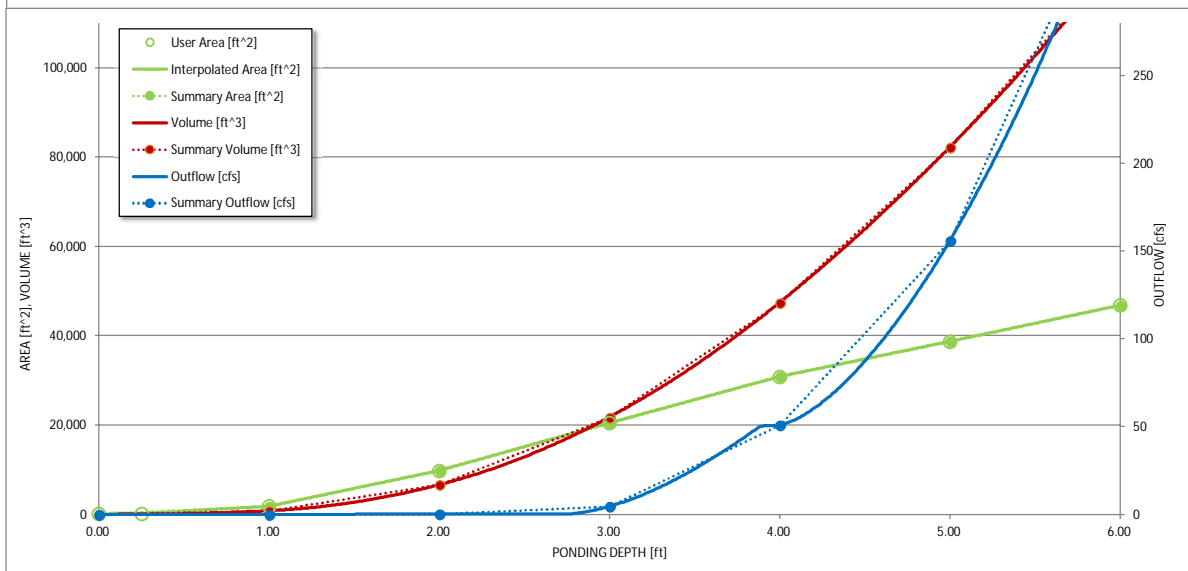
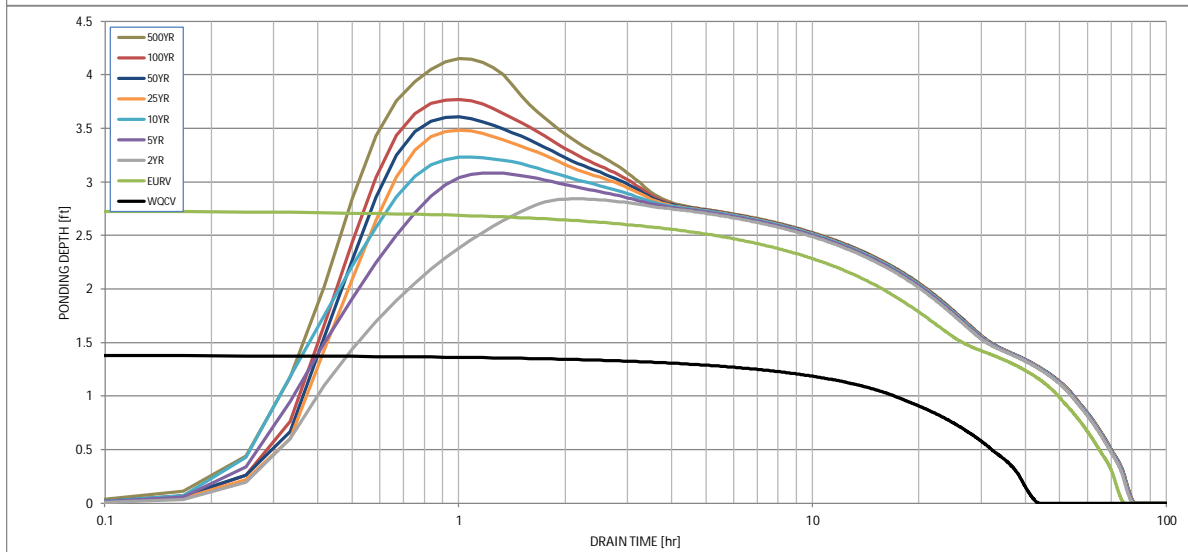
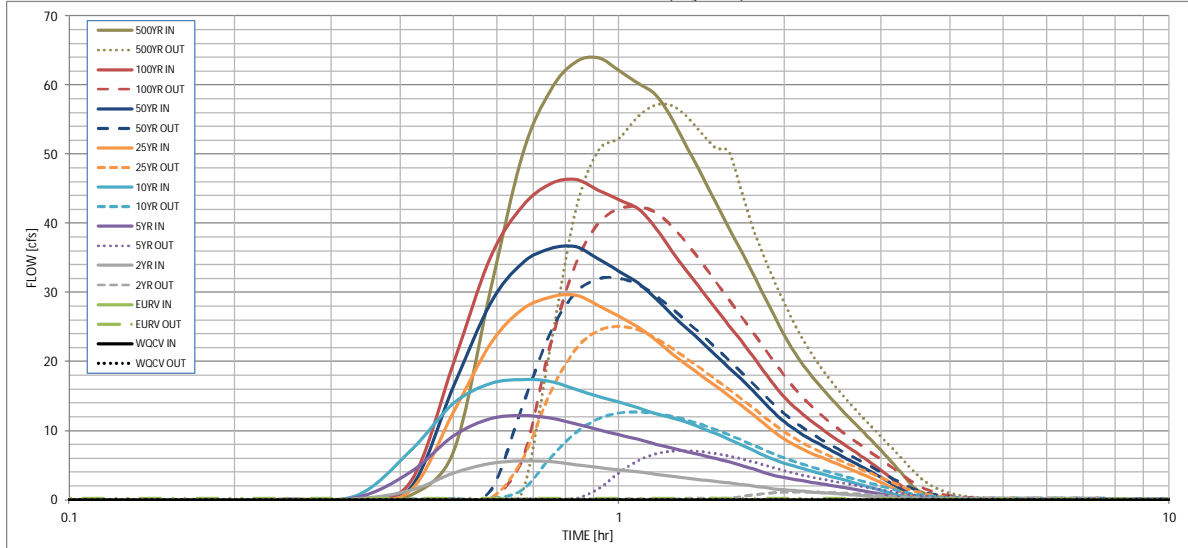
## Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
One-Hour Rainfall Depth (in)	N/A	N/A	0.383	0.544	0.758	1.027	1.382	1.973	3.14
CUHP Runoff Volume (acre-ft)	0.048	0.383	0.544	1.202	1.858	3.027	3.825	4.973	7.066
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	0.544	1.202	1.858	3.027	3.825	4.973	7.066
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	3.5	9.8	14.9	27.3	34.3	43.9	61.4
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.09	0.24	0.37	0.67	0.84	1.08	1.51
Peak Inflow Q (cfs)	N/A	N/A	5.7	12.2	17.4	29.6	36.6	46.3	64.0
Peak Outflow Q (cfs)	0.0	0.2	1.2	7.1	12.7	25.1	32.1	42.5	57.2
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.7	0.9	0.9	0.9	1.0	0.9
Structure Controlling Flow	Plate	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Spillway
Max Velocity through Gate 1 (fps)	N/A	N/A	0.01	0.1	0.2	0.3	0.4	0.5	0.6
Max Velocity through Gate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours)	37	56	56	44	34	27	24	21	16
Time to Drain 99% of Inflow Volume (hours)	40	65	67	60	55	47	43	37	30
Maximum Ponding Depth (ft)	1.39	2.74	2.84	3.09	3.23	3.49	3.61	3.77	4.15
Area at Maximum Ponding Depth (acres)	0.11	0.41	0.43	0.49	0.52	0.58	0.61	0.65	0.74
Maximum Volume Stored (acre-ft)	0.049	0.386	0.427	0.538	0.614	0.753	0.824	0.932	1.197

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)



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

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: \_\_\_\_\_

## Inflow Hydrographs

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

Time Interval	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:15:00	0.00	0.00	0.04	0.06	0.08	0.05	0.07	0.06	0.10
	0:20:00	0.00	0.00	0.16	0.38	0.67	0.16	0.19	0.20	0.64
	0:25:00	0.00	0.00	1.35	3.97	7.07	1.29	1.70	2.47	6.93
	0:30:00	0.00	0.00	3.86	9.27	13.97	12.65	16.36	19.74	30.33
	0:35:00	0.00	0.00	5.29	11.75	16.83	22.58	28.46	35.13	49.93
	0:40:00	0.00	0.00	5.65	12.20	17.45	27.58	34.29	42.45	59.26
	0:45:00	0.00	0.00	5.51	11.82	17.14	29.34	36.35	45.72	63.33
	0:50:00	0.00	0.00	5.12	11.02	16.04	29.61	36.63	46.35	63.97
	0:55:00	0.00	0.00	4.70	10.15	14.99	28.14	34.89	44.84	62.10
	1:00:00	0.00	0.00	4.37	9.44	14.13	26.53	33.07	43.41	60.28
	1:05:00	0.00	0.00	4.07	8.75	13.30	25.01	31.34	42.11	58.61
	1:10:00	0.00	0.00	3.73	8.08	12.49	23.15	29.15	39.33	55.06
	1:15:00	0.00	0.00	3.41	7.48	11.88	21.13	26.76	35.96	50.87
	1:20:00	0.00	0.00	3.15	6.97	11.20	19.44	24.69	32.97	46.87
	1:25:00	0.00	0.00	2.91	6.47	10.40	17.91	22.77	30.21	43.02
	1:30:00	0.00	0.00	2.69	6.00	9.59	16.45	20.93	27.65	39.40
	1:35:00	0.00	0.00	2.47	5.52	8.78	15.05	19.16	25.29	36.03
	1:40:00	0.00	0.00	2.25	5.02	7.98	13.71	17.46	23.00	32.78
	1:45:00	0.00	0.00	2.03	4.50	7.21	12.38	15.79	20.79	29.64
	1:50:00	0.00	0.00	1.81	3.99	6.45	11.08	14.15	18.62	26.59
	1:55:00	0.00	0.00	1.61	3.55	5.80	9.81	12.56	16.55	23.72
	2:00:00	0.00	0.00	1.46	3.23	5.30	8.75	11.25	14.81	21.35
	2:05:00	0.00	0.00	1.35	2.98	4.89	7.95	10.24	13.46	19.44
	2:10:00	0.00	0.00	1.25	2.76	4.50	7.29	9.39	12.31	17.77
	2:15:00	0.00	0.00	1.15	2.54	4.14	6.70	8.62	11.27	16.27
	2:20:00	0.00	0.00	1.06	2.34	3.79	6.16	7.92	10.34	14.90
	2:25:00	0.00	0.00	0.97	2.14	3.46	5.66	7.27	9.46	13.62
	2:30:00	0.00	0.00	0.89	1.95	3.14	5.18	6.65	8.64	12.42
	2:35:00	0.00	0.00	0.80	1.76	2.83	4.72	6.05	7.88	11.31
	2:40:00	0.00	0.00	0.72	1.57	2.53	4.27	5.47	7.15	10.24
	2:45:00	0.00	0.00	0.64	1.39	2.25	3.83	4.90	6.42	9.19
	2:50:00	0.00	0.00	0.56	1.21	1.97	3.38	4.34	5.70	8.15
	2:55:00	0.00	0.00	0.48	1.03	1.69	2.94	3.78	4.98	7.12
	3:00:00	0.00	0.00	0.40	0.86	1.42	2.51	3.22	4.25	6.08
	3:05:00	0.00	0.00	0.32	0.68	1.15	2.07	2.67	3.53	5.05
	3:10:00	0.00	0.00	0.24	0.51	0.87	1.63	2.11	2.82	4.03
	3:15:00	0.00	0.00	0.16	0.34	0.61	1.20	1.56	2.10	3.01
	3:20:00	0.00	0.00	0.10	0.21	0.42	0.78	1.03	1.41	2.07
	3:25:00	0.00	0.00	0.06	0.14	0.31	0.48	0.66	0.92	1.41
	3:30:00	0.00	0.00	0.04	0.11	0.25	0.31	0.45	0.62	0.99
	3:35:00	0.00	0.00	0.03	0.08	0.20	0.20	0.31	0.42	0.69
	3:40:00	0.00	0.00	0.03	0.07	0.16	0.13	0.21	0.27	0.47
	3:45:00	0.00	0.00	0.02	0.05	0.12	0.09	0.15	0.17	0.32
	3:50:00	0.00	0.00	0.02	0.04	0.09	0.06	0.10	0.10	0.20
	3:55:00	0.00	0.00	0.01	0.03	0.07	0.04	0.07	0.05	0.12
	4:00:00	0.00	0.00	0.01	0.02	0.05	0.03	0.05	0.03	0.08
	4:05:00	0.00	0.00	0.01	0.02	0.03	0.02	0.04	0.03	0.06
	4:10:00	0.00	0.00	0.01	0.01	0.02	0.01	0.03	0.02	0.05
	4:15:00	0.00	0.00	0.01	0.01	0.02	0.01	0.02	0.02	0.04
	4:20:00	0.00	0.00	0.00	0.01	0.01	0.01	0.02	0.01	0.03
	4:25:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	4:30:00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

### Summary Stage-Area-Volume-Discharge Relationships

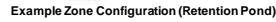
The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

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

[illegible]

MHFD-Detention, Version 4.06 (July 2022)

Basin ID: \_\_\_\_\_



Note:  $L / W$  Ratio  $>$   
 $L / W$  Ratio = 13.83

### Optional User Overrides

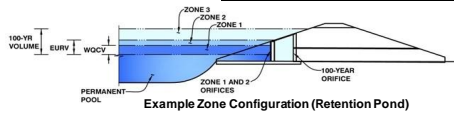
	acre-feet
	acre-feet
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

Initial Surcharge Area ( $A_{S1}$ )	=	ft <sup>2</sup>
Surcharge Volume Length ( $L_{S1}$ )	=	ft
Surcharge Volume Width ( $W_{S1}$ )	=	ft
Depth of Basin Floor ( $H_{1LOOR}$ )	=	ft
Length of Basin Floor ( $L_{1LOOR}$ )	=	ft
Width of Basin Floor ( $W_{1LOOR}$ )	=	ft
Area of Basin Floor ( $A_{1LOOR}$ )	=	ft <sup>2</sup>
Volume of Basin Floor ( $V_{1LOOR}$ )	=	ft <sup>3</sup>
Depth of Main Basin ( $H_{MAIN}$ )	=	ft
Length of Main Basin ( $L_{MAIN}$ )	=	ft
Width of Main Basin ( $W_{MAIN}$ )	=	ft
Area of Main Basin ( $A_{MAIN}$ )	=	ft <sup>2</sup>
Volume of Main Basin ( $V_{MAIN}$ )	=	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TBL}$ )	=	acre-feet

f

## VOLUME USED IN POND SIZING

MHFD-Detention, Version 4.06 (July 2022)

Basin ID: B6 & B8

### Example Zone Configuration (Retention Pond)

Selected BMP Type =	EDB	
Watershed Area =	62.83	acres
Watershed Length =	4,000	ft
Watershed Length to Centroid =	2,000	ft
Watershed Slope =	0.050	ft/ft
Watershed Imperviousness =	9.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WOCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

Water Quality Capture Volume (WQCV) =	<b>0.069</b>	acre-feet
Excess Urban Runoff Volume (EURV) =	<b>0.527</b>	acre-feet
2-yr Runoff Volume ( $P1 = 1.19$ in.) =	<b>0.793</b>	acre-feet
5-yr Runoff Volume ( $P1 = 1.5$ in.) =	<b>1.795</b>	acre-feet
10-yr Runoff Volume ( $P1 = 1.75$ in.) =	<b>2.801</b>	acre-feet
25-yr Runoff Volume ( $P1 = 2.1$ in.) =	<b>4.614</b>	acre-feet
50-yr Runoff Volume ( $P1 = 2.25$ in.) =	<b>5.843</b>	acre-feet
100-yr Runoff Volume ( $P1 = 2.52$ in.) =	<b>7.619</b>	acre-feet
500-yr Runoff Volume ( $P1 = 3.14$ in.) =	<b>10.846</b>	acre-feet
Approximate 2-yr Detention Volume =	<b>0.333</b>	acre-feet
Approximate 5-yr Detention Volume =	<b>0.527</b>	acre-feet
Approximate 10-yr Detention Volume =	<b>1.146</b>	acre-feet
Approximate 25-yr Detention Volume =	<b>1.628</b>	acre-feet
Approximate 50-yr Detention Volume =	<b>1.697</b>	acre-feet
Approximate 100-yr Detention Volume =	<b>2.207</b>	acre-feet

Zone 1 Volume (WOCV) =	0.069	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.458	acre-feet
Zone 3 Volume (100-year - Zone 1 & 2) =	1.680	acre-feet
Total Detention Basin Volume =	2.207	acre-feet
Initial Surcharge Volume (ISV) =	user	ft <sup>3</sup>
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth ( $H_{total}$ ) =	user	ft
Depth of Trickle Channel ( $H_{TC}$ ) =	user	ft
Slope of Trickle Channel ( $S_{TC}$ ) =	user	ft/ft
Slopes of Main Basin Sides ( $S_{main}$ ) =	user	H:V
Basin Length-to-Width Ratio ( $R_{L/W}$ ) =	user	

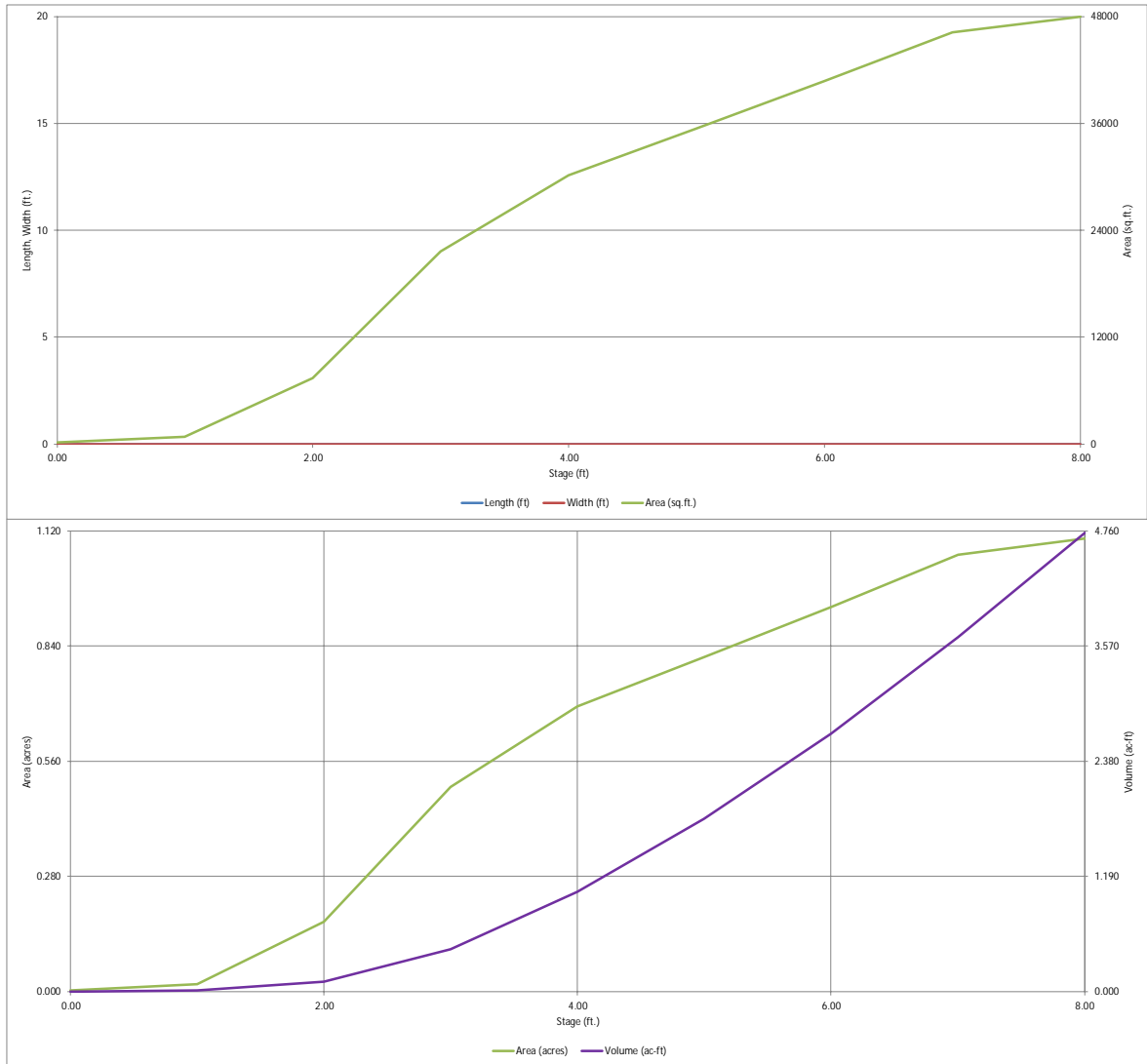
Initial Surcharge Area ( $A_{S1}$ )	=	user	ft <sup>2</sup>
Surcharge Volume Length ( $L_{S1}$ )	=	user	ft
Surcharge Volume Width ( $W_{S1}$ )	=	user	ft
Depth of Basin Floor ( $H_{1LOO}$ )	=	user	ft
Length of Basin Floor ( $L_{1LOO}$ )	=	user	ft
Width of Basin Floor ( $W_{1LOO}$ )	=	user	ft
Area of Basin Floor ( $A_{1LOO}$ )	=	user	ft <sup>2</sup>
Volume of Basin Floor ( $V_{1LOO}$ )	=	user	ft <sup>3</sup>
Depth of Main Basin ( $H_{MA}$ )	=	user	ft
Length of Main Basin ( $L_{MA}$ )	=	user	ft
Width of Main Basin ( $W_{MA}$ )	=	user	ft
Area of Main Basin ( $A_{MA}$ )	=	user	ft <sup>2</sup>
Volume of Main Basin ( $V_{MA}$ )	=	user	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TBA}$ )	=	USER	acre-feet

0.069	acre-feet
	acre-feet
1.19	inches
1.50	inches
1.75	inches
2.00	inches
2.25	inches
2.52	inches
	inches

7186	Depth Increment = 1.00		ft							
	Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft <sup>2</sup> )	Optional Override Area (ft <sup>2</sup> )	Area (acre)	Volume (ft <sup>3</sup> )	Volume (ac-ft)
	Top of Micropool	--	0.00	--	--	--	180	0.004		
	7187	--	1.00	--	--	--	812	0.019	496	0.011
	7188	--	2.00	--	--	--	7,385	0.170	4,594	0.105
	7189	--	3.00	--	--	--	21,644	0.497	19,109	0.439
	7190	--	4.00	--	--	--	30,169	0.693	45,015	1.033
	7191	--	5.00	--	--	--	35,429	0.813	77,814	1.786
	7192	--	6.00	--	--	--	40,734	0.935	115,896	2.661
	7193	--	7.00	--	--	--	46,264	1.062	159,395	3.659
7185	7194	--	8.00	--	--	--	48,000	1.102	206,526	4.741
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7184		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7183		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7182		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7181		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7180		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7179		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7178		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7177		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7176		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7175		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7174		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7173		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7172		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7171		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7170		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7169		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7168		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7167		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7166		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7165		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7164		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7163		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
7162		--		--	--	--				
		--		--	--	--				
		--		--	--	--				
		--		--	--	--				

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

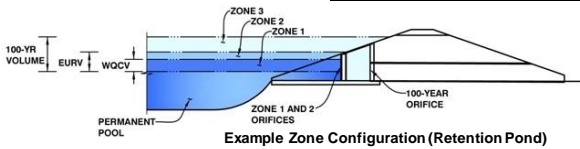


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Overlook Pond B8- Filing No. 1

Basin ID: B6 & B8



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.76	0.069	Orifice Plate
Zone 2 (EURV)	3.18	0.458	Rectangular Orifice
Zone 3 (100-year)	5.50	1.680	Weir&Pipe (Restrict)
Total (all zones)		2.207	

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

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

Calculated Parameters for Underdrain		
Underdrain Orifice Area =	N/A	ft <sup>2</sup>
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.76	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	12.70	inches
Orifice Plate: Orifice Area per Row =	0.31	sq. inches (diameter = 5/8 inch)

Calculated Parameters for Plate		
WQ Orifice Area per Row =	2.153E-03	ft <sup>2</sup>
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft <sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.59	1.17					
Orifice Area (sq. inches)	0.31	0.31	0.31					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	1.76	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	3.18	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	2.00	N/A	inches
Vertical Orifice Width =	3.00		inches

<u>Calculated Parameters for Vertical Orifice</u>			
	Zone 2 Rectangular	Not Selected	
Vertical Orifice Area =	0.04	N/A	ft <sup>2</sup>
Vertical Orifice Centroid =	0.08	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.20	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	23.00	N/A	feet
Overflow Weir Gate Slope =	10.00	N/A	H:V
Horiz. Length of Weir Sides =	5.00	N/A	feet
Overflow Gate Type =	Type C Gate	N/A	
Debris Clogging % =	50%	N/A	%

(e)		Calculated Parameters for Overflow Weir		
		Zone 3 Weir	Not Selected	
ft)	Height of Gate Upper Edge, $H_1$ =	3.70	N/A	feet
	Overflow Weir Slope Length =	5.02	N/A	feet
	Gate Open Area / 100-yr Orifice Area =	22.76	N/A	
	Overflow Gate Open Area w/o Debris =	80.44	N/A	ft <sup>2</sup>
	Overflow Gate Open Area w/ Debris =	40.22	N/A	ft <sup>2</sup>

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	36.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	18.00		inches

<u>Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate</u>			
	Zone 3 Restrictor	Not Selected	
Outlet Stage = 0 ft)			
Outlet Orifice Area =	3.53	N/A	ft <sup>2</sup>
Outlet Orifice Centroid =	0.86	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.57	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	5.80	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	30.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway		
Spillway Design Flow Depth=	0.78	feet
Stage at Top of Freeboard =	7.58	feet
Basin Area at Top of Freeboard =	1.09	acres
Basin Volume at Top of Freeboard =	4.28	acre-ft

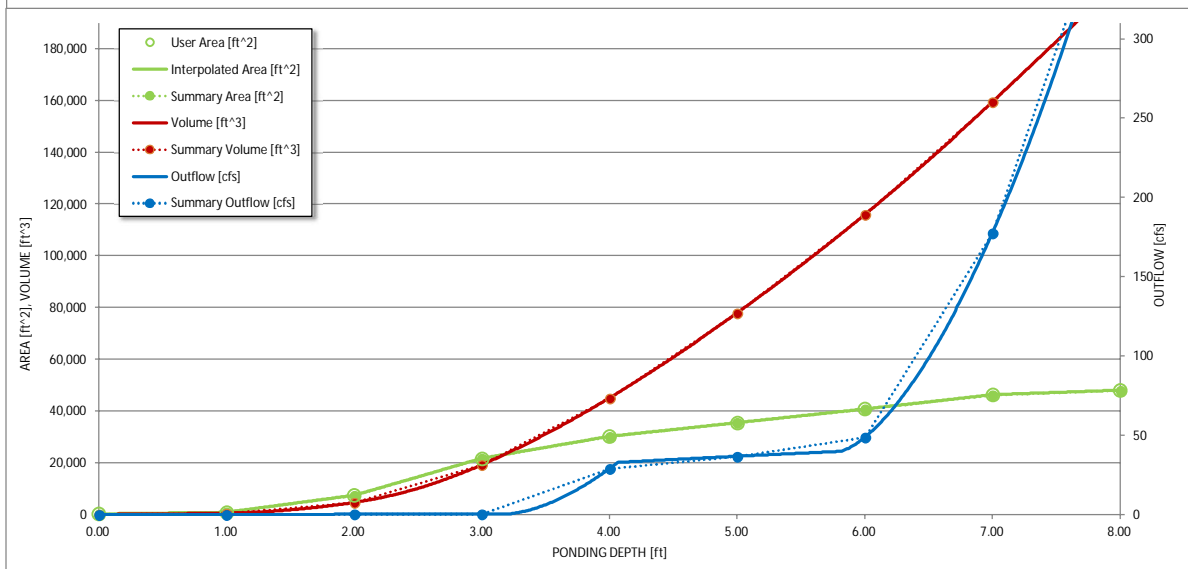
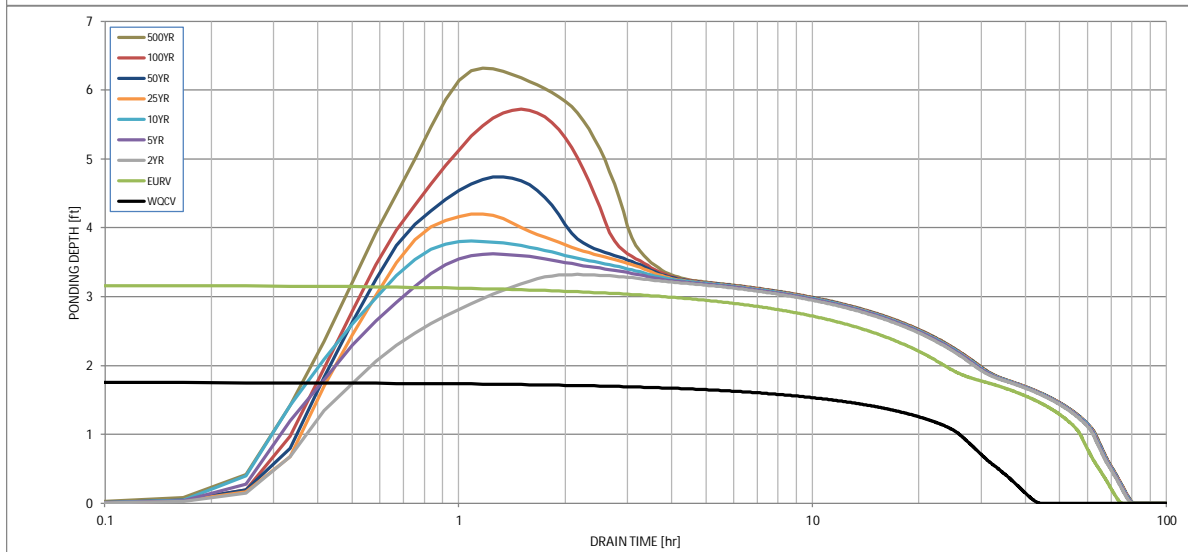
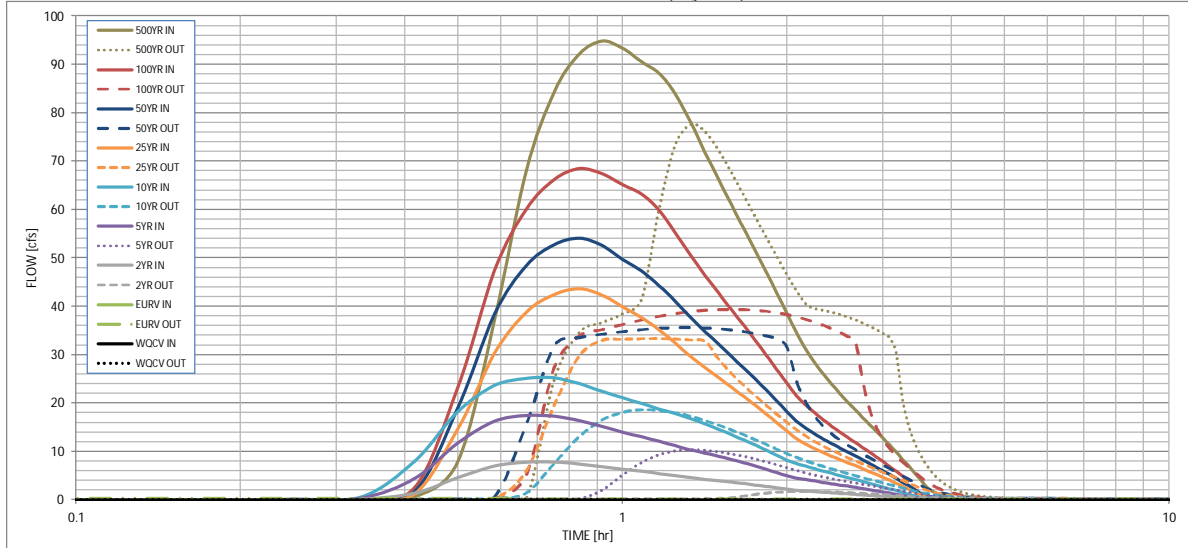
## Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
One-Hour Rainfall Depth (in)	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft)	0.069	0.527	0.793	1.795	2.801	4.614	5.843	7.619	10.846
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	0.793	1.795	2.801	4.614	5.843	7.619	10.846
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	5.1	14.3	22.1	40.5	50.8	65.0	91.2
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.08	0.23	0.35	0.64	0.81	1.04	1.45
Peak Inflow Q (cfs)	N/A	N/A	7.8	17.5	25.2	43.6	54.1	68.5	94.8
Peak Outflow Q (cfs)	0.0	0.3	1.8	10.4	18.6	33.3	35.6	39.40	77.6
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	0.7	0.8	0.8	0.7	0.6	0.9
Structure Controlling Flow	Plate	Vertical Orifice 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Gate 1 (fps)	N/A	N/A	0.02	0.1	0.2	0.4	0.4	0.5	0.5
Max Velocity through Gate 2 (fps)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours)	37	54	55	42	32	26	24	21	15
Time to Drain 99% of Inflow Volume (hours)	40	62	65	58	53	46	41	34	29
Maximum Ponding Depth (ft)	1.76	3.18	3.32	3.62	3.81	4.20	4.74	5.72	6.32
Area at Maximum Ponding Depth (acres)	0.13	0.53	0.56	0.62	0.66	0.72	0.78	0.90	0.98
Maximum Volume Stored (acre-ft)	0.069	0.531	0.608	0.784	0.905	1.174	1.579	2.404	2.966

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)



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

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: \_\_\_\_\_

## Inflow Hydrographs

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

Time Interval	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:15:00	0.00	0.00	0.04	0.06	0.07	0.05	0.06	0.06	0.10
	0:20:00	0.00	0.00	0.16	0.40	0.70	0.17	0.20	0.21	0.68
	0:25:00	0.00	0.00	1.43	4.45	8.08	1.37	1.80	2.69	7.93
	0:30:00	0.00	0.00	4.60	11.74	18.28	14.67	19.05	23.23	37.07
	0:35:00	0.00	0.00	7.05	16.27	23.62	30.26	38.40	47.29	67.96
	0:40:00	0.00	0.00	7.84	17.46	25.17	38.80	48.42	60.09	84.34
	0:45:00	0.00	0.00	7.84	17.28	25.20	42.49	52.77	66.23	92.14
	0:50:00	0.00	0.00	7.44	16.39	24.06	43.62	54.09	68.49	94.83
	0:55:00	0.00	0.00	6.87	15.17	22.44	42.38	52.61	67.42	93.38
	1:00:00	0.00	0.00	6.34	14.02	21.10	39.90	49.76	65.14	90.55
	1:05:00	0.00	0.00	5.92	13.05	19.95	37.71	47.28	63.28	88.21
	1:10:00	0.00	0.00	5.47	12.12	18.83	35.19	44.35	59.88	83.89
	1:15:00	0.00	0.00	5.01	11.19	17.78	32.38	41.03	55.20	78.00
	1:20:00	0.00	0.00	4.59	10.37	16.78	29.63	37.68	50.51	71.86
	1:25:00	0.00	0.00	4.26	9.68	15.70	27.34	34.82	46.41	66.18
	1:30:00	0.00	0.00	3.96	9.03	14.58	25.24	32.17	42.69	60.94
	1:35:00	0.00	0.00	3.67	8.39	13.48	23.26	29.67	39.26	56.07
	1:40:00	0.00	0.00	3.38	7.72	12.39	21.37	27.27	36.05	51.49
	1:45:00	0.00	0.00	3.09	7.03	11.32	19.55	24.96	32.96	47.07
	1:50:00	0.00	0.00	2.80	6.34	10.27	17.75	22.69	29.94	42.79
	1:55:00	0.00	0.00	2.51	5.65	9.23	15.98	20.47	27.00	38.62
	2:00:00	0.00	0.00	2.24	5.02	8.26	14.25	18.29	24.15	34.64
	2:05:00	0.00	0.00	2.01	4.54	7.53	12.68	16.31	21.57	31.10
	2:10:00	0.00	0.00	1.86	4.21	6.96	11.53	14.86	19.61	28.34
	2:15:00	0.00	0.00	1.72	3.91	6.44	10.59	13.66	18.00	26.01
	2:20:00	0.00	0.00	1.60	3.63	5.95	9.79	12.61	16.56	23.92
	2:25:00	0.00	0.00	1.49	3.36	5.49	9.05	11.64	15.26	22.01
	2:30:00	0.00	0.00	1.37	3.10	5.05	8.37	10.75	14.06	20.25
	2:35:00	0.00	0.00	1.26	2.84	4.62	7.71	9.90	12.93	18.60
	2:40:00	0.00	0.00	1.15	2.59	4.20	7.08	9.08	11.88	17.05
	2:45:00	0.00	0.00	1.05	2.34	3.80	6.47	8.30	10.88	15.59
	2:50:00	0.00	0.00	0.94	2.10	3.42	5.87	7.52	9.89	14.16
	2:55:00	0.00	0.00	0.84	1.86	3.04	5.27	6.76	8.90	12.74
	3:00:00	0.00	0.00	0.73	1.63	2.67	4.67	6.00	7.91	11.33
	3:05:00	0.00	0.00	0.63	1.39	2.30	4.08	5.24	6.93	9.92
	3:10:00	0.00	0.00	0.52	1.16	1.94	3.48	4.48	5.95	8.51
	3:15:00	0.00	0.00	0.42	0.93	1.57	2.89	3.73	4.97	7.11
	3:20:00	0.00	0.00	0.32	0.70	1.21	2.30	2.98	3.99	5.71
	3:25:00	0.00	0.00	0.22	0.47	0.86	1.71	2.23	3.01	4.32
	3:30:00	0.00	0.00	0.13	0.29	0.58	1.13	1.50	2.06	3.01
	3:35:00	0.00	0.00	0.07	0.18	0.42	0.69	0.95	1.33	2.03
	3:40:00	0.00	0.00	0.05	0.13	0.33	0.44	0.63	0.89	1.42
	3:45:00	0.00	0.00	0.04	0.10	0.26	0.28	0.43	0.60	0.99
	3:50:00	0.00	0.00	0.03	0.08	0.21	0.18	0.29	0.39	0.68
	3:55:00	0.00	0.00	0.03	0.07	0.16	0.12	0.20	0.24	0.45
	4:00:00	0.00	0.00	0.02	0.05	0.12	0.08	0.14	0.14	0.28
	4:05:00	0.00	0.00	0.02	0.04	0.09	0.05	0.09	0.07	0.17
	4:10:00	0.00	0.00	0.01	0.03	0.06	0.03	0.06	0.04	0.11
	4:15:00	0.00	0.00	0.01	0.02	0.04	0.02	0.05	0.03	0.08
	4:20:00	0.00	0.00	0.01	0.02	0.03	0.02	0.03	0.03	0.06
	4:25:00	0.00	0.00	0.01	0.01	0.02	0.01	0.03	0.02	0.05
	4:30:00	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.02	0.04
	4:35:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.03
	4:40:00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.02
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

### Summary Stage-Area-Volume-Discharge Relationships

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

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

[illegible]



Date11/13/2024

Prepared ByAJL

Checked ByEJG

FOREBAY DESIGN CALCULATIONS								
FOREBAY ID	FOREBAY LOCATION	CONTRIBUTING BASINS	Q <sub>100</sub> FLOW (CFS)	VOLUME REQUIRED (CF)	VOLUME PROVIDED (CF)	2% OF UNDETAINED 100-YR FLOW (CFS)	FOREBAY PIPE SIZE (IN)	NORMAL DEPTH (IN)*
A2-W	POND A2	A2	18	77.55	252	0.36	6	3.7
A2-W2	POND A2	A2	3	8.27	300	0.06	6	1.4
A2-C	POND A2	A2	3	8.27	224	0.06	6	1.4
A2-E	POND A2	A2	18	54.83	224	0.36	6	3.7
B1-W	POND B1	B1	52	65.34	867	1.04	8	6.1
B1-E	POND B1	B1	5	13.23	360	0.10	6	1.8
B8-W	POND B8	B6, B8	119	298.53	748	2.38	12	7.6
B8-E	POND B8	B8	23	20.14	288	0.46	6	4.4

\*ASSUMED 0.5% PIPE SLOPE

		Forebay A2-W		
Forebay Release and Configuration	<u>Required</u> Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration	Flow: $Q_{100}$ = (cfs)	<u>Release Rate</u>	<u>Release Type</u>
		17.93	0.36	Berm/ Pipe Configuration - 6" Pipe

Minimum Forebay Volume Required	1% of the WQCV (Per Table 4-12 Forebay Sizing Criteria USDCM Volume-3)	40hr drain time $a = 1$ $I = 0.15$ $A = 11.45$ AC	<u>Required (CF)</u>	<u>Provided (CF)</u>
			77.55	252.00



Forebay Sizing Calculations- Detention Basin Forebay  
Contributing Sub-Basins: A2

Date 11/13/2024  
Prepared By AJL  
Checked By KRK

		Forebay A2-W2		
		Flow: Q <sub>100</sub> = (cfs)	Release Rate	Release Type
Forebay Release and Configuration	<u>Required</u>			
	Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration	2.90	0.06	Berm/ Pipe Configuration - 6" Pipe

Minimum Forebay Volume Required	1% of the WQCV (Per Table 4-12 Forebay Sizing Criteria USDCM Volume-3)	40hr drain time $a = 1$ $I = 0.1$ $A = 1.74$ AC	<u>Required (CF)</u>	<u>Provided (CF)</u>
			8.27	300.00

		Forebay A2-C		
Forebay Release and Configuration	<u>Required</u> Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration	Flow: $Q_{100}$ = (cfs)	<u>Release Rate</u>	<u>Release Type</u>
		2.66	0.05	Berm/ Pipe Configuration - 6" Pipe

Minimum Forebay Volume Required	1% of the WQCV (Per Table 4-12 Forebay Sizing Criteria USDCM Volume-3)	40hr drain time $a = 1$ $I = 0.10$ $A = 1.74$ AC	<u>Required (CF)</u>	<u>Provided (CF)</u>
			8.27	224.00

		Forebay A2-E		
Forebay Release and Configuration	<u>Required</u> Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration	Flow: $Q_{100}$ = (cfs)	<u>Release Rate</u>	<u>Release Type</u>
		17.65	0.35	Berm/ Pipe Configuration - 6" Pipe

Minimum Forebay Volume Required	1% of the WQCV (Per Table 4-12 Forebay Sizing Criteria USDCM Volume-3)	40hr drain time $a = 1$ $I = 0.1$ $A = 11.27$ AC	<u>Required (CF)</u>	<u>Provided (CF)</u>
			54.83	224.00

		Forebay: B1-W		
Forebay Release and Configuration	<u>Required</u> Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration	Flow: $Q_{100}$ = (cfs)	<u>Release Rate</u>	<u>Release Type</u>
		52.00	1.04	Berm/ Pipe Configuration - 8" Pipe

Minimum Forebay Volume Required	1% of the WQCV (Per Table 4-12 Forebay Sizing Criteria USDCM Volume-3)	40hr drain time $a = 1$ $I = 0.10$ $A = 13.43$ AC	<u>Required (CF)</u>	<u>Provided (CF)</u>
			65.34	867.00

		Forebay: B1-E		
Forebay Release and Configuration	<u>Required</u> Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration	Flow: $Q_{100}$ = (cfs)	<u>Release Rate</u>	<u>Release Type</u>
		5.10	0.10	Berm/ Pipe Configuration - 6" Pipe

Minimum Forebay Volume Required	1% of the WQCV (Per Table 4-12 Forebay Sizing Criteria USDCM Volume-3)	40hr drain time $a = 1$ $I = 0.10$ $A = 2.72$ AC	<u>Required (CF)</u>	<u>Provided (CF)</u>
			13.23	360.00

		Forebay B8-W		
Forebay Release and Configuration	<u>Required</u> Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration	Flow: $Q_{100}$ = (cfs)	<u>Release Rate</u>	<u>Release Type</u>
		118.80	2.38	Berm/ Pipe Configuration - 12" Pipe

Minimum Forebay Volume Required	1% of the WQCV (Per Table 4-12 Forebay Sizing Criteria USDCM Volume-3)	40hr drain time $a = 1$ $I = 0.11$ $A = 56.63$ AC	<u>Required (CF)</u> 298.53	<u>Provided (CF)</u> 748.00
---------------------------------	--	---	--------------------------------	--------------------------------

		<u>Forebay: B8-E</u>		
Forebay Release and Configuration	<u>Required</u> Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration	Flow: $Q_{100}$ = (cfs)	<u>Release Rate</u>	<u>Release Type</u>
		23.00	0.46	Berm/ Pipe Configuration - 6" Pipe

Minimum Forebay Volume Required	2% of the WQCV	40hr drain time a = 1 I = 0.11 A = 3.82 AC	<u>Required (CF)</u>	<u>Provided (CF)</u>
			20.14	288.00

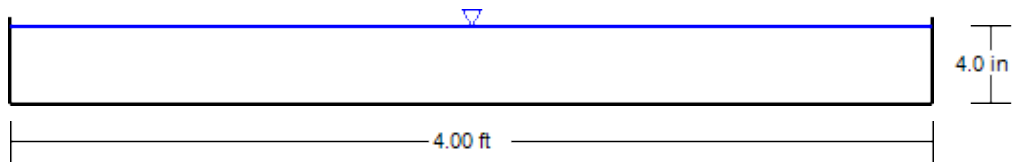
## Worksheet for Trickle Channel

Project Description	
Friction Method	Manning
	Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	0.005 ft/ft
Bottom Width	4.00 ft
Discharge	4.76 cfs
Results	
Normal Depth	4.0 in
Flow Area	1.3 ft <sup>2</sup>
Wetted Perimeter	4.7 ft
Hydraulic Radius	3.5 in
Top Width	4.00 ft
Critical Depth	4.2 in
Critical Slope	0.004 ft/ft
Velocity	3.53 ft/s
Velocity Head	0.19 ft
Specific Energy	0.53 ft
Froude Number	1.071
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	4.0 in
Critical Depth	4.2 in
Channel Slope	0.005 ft/ft
Critical Slope	0.004 ft/ft

Trickle Channel are same width throughout project for simplicity. Discharge is 2X highest forebay discharge (most conservative condition)

## Cross Section for Trickle Channel

Project Description	
Friction Method	Manning
	Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.013
Channel Slope	0.005 ft/ft
Normal Depth	4.0 in
Bottom Width	4.00 ft
Discharge	4.76 cfs



V: 1  
H: 1

Existing Conditions Natural Channels Flow Summary							
Channel ID	Contributing Basins	Tributary Area (ac)	Basin Area (ac)	Basin 100-yr Flow (cfs)	Channel 100-yr Flow (cfs)	Velocity (ft/s)	Normal Depth (ft)
A1-1	A1	19.92	19.92	38.41	38.41	2.56	0.47
A2-3	A2, OS-A2	48.30 (A2) + 4.45 (OS-A2)	63.97 (A2) + 4.45 (OS-A2)	91.03(A2) + 11.46 (OS-A2)	79.02	4.88	0.89
A2-4	A2	2.73	63.97	91.03	2.71	1.49	0.23
A2-5	A2, B1	7.38 (A2) + 2.81 (B1)	63.97 (A2) + 43.28 (B1)	91.03(A2) + 72.48 (B1)	15.53	1.99	0.26
B1-2	B1	16.60	43.28	72.48	27.80	3.66	0.23
B1-3	B1	6.15	43.28	72.48	10.30	2.52	0.27
B1-6	B1	13.08	43.28	72.48	21.90	2.96	0.36
B2-1	B2	4.52	42.42	69.09	7.36	2.25	0.19
B2-2	B2	36.7	42.42	69.09	59.77	4.90	0.49
B7-1	B3	2.20	25.42	43.40	3.76	1.73	0.20
B8-1	B3	17.57	25.42	43.40	30.00	3.41	0.29

## Worksheet for A1-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.015 ft/ft
Discharge	38.41 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	41.00
0+35	36.00
0+64	36.00
1+00	41.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 41.00)	(0+35, 36.00)	0.040
(0+35, 36.00)	(0+64, 36.00)	0.040
(0+64, 36.00)	(1+00, 41.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	5.6 in
Roughness Coefficient	0.040
Elevation	36.47 ft
Elevation Range	36.0 to 41.0 ft
Flow Area	15.0 ft <sup>2</sup>
Wetted Perimeter	35.7 ft
Hydraulic Radius	5.1 in
Top Width	35.61 ft
Normal Depth	5.6 in
Critical Depth	4.4 in
Critical Slope	0.033 ft/ft
Velocity	2.56 ft/s
Velocity Head	0.10 ft
Specific Energy	0.57 ft
Froude Number	0.694

## Worksheet for A1-1

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	5.6 in
Critical Depth	4.4 in
Channel Slope	0.015 ft/ft
Critical Slope	0.033 ft/ft

## Worksheet for A2-3

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.030 ft/ft
Discharge	79.02 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	11.00
0+51	4.00
0+63	4.00
0+98	9.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 11.00)	(0+51, 4.00)	0.040
(0+51, 4.00)	(0+63, 4.00)	0.040
(0+63, 4.00)	(0+98, 9.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	10.6 in
Roughness Coefficient	0.040
Elevation	4.89 ft
Elevation Range	4.0 to 11.0 ft
Flow Area	16.3 ft <sup>2</sup>
Wetted Perimeter	24.8 ft
Hydraulic Radius	7.9 in
Top Width	24.67 ft
Normal Depth	10.6 in
Critical Depth	11.0 in
Critical Slope	0.027 ft/ft
Velocity	4.86 ft/s
Velocity Head	0.37 ft
Specific Energy	1.25 ft
Froude Number	1.055
Flow Type	Supercritical

## Worksheet for A2-3

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	10.6 in
Critical Depth	11.0 in
Channel Slope	0.030 ft/ft
Critical Slope	0.027 ft/ft

---

## Worksheet for A2-4

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.029 ft/ft
Discharge	2.71 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+15	14.00
0+32	12.75
0+47	12.50
0+98	18.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+15, 14.00)	(0+32, 12.75)	0.040
(0+32, 12.75)	(0+47, 12.50)	0.040
(0+47, 12.50)	(0+98, 18.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	2.7 in
Roughness Coefficient	0.040
Elevation	12.73 ft
Elevation Range	12.5 to 18.0 ft
Flow Area	1.8 ft <sup>2</sup>
Wetted Perimeter	15.9 ft
Hydraulic Radius	1.4 in
Top Width	15.86 ft
Normal Depth	2.7 in
Critical Depth	2.5 in
Critical Slope	0.050 ft/ft
Velocity	1.49 ft/s
Velocity Head	0.03 ft
Specific Energy	0.26 ft
Froude Number	0.778

## Worksheet for A2-4

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	2.7 in
Critical Depth	2.5 in
Channel Slope	0.029 ft/ft
Critical Slope	0.050 ft/ft

## Worksheet for A2-5

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.020 ft/ft
Discharge	15.53 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	15.00
0+43	12.00
0+68	12.00
1+25	16.75

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 15.00)	(0+43, 12.00)	0.040
(0+43, 12.00)	(0+68, 12.00)	0.040
(0+68, 12.00)	(1+25, 16.75)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	3.2 in
Roughness Coefficient	0.040
Elevation	12.27 ft
Elevation Range	12.0 to 16.8 ft
Flow Area	7.7 ft <sup>2</sup>
Wetted Perimeter	32.3 ft
Hydraulic Radius	2.9 in
Top Width	32.30 ft
Normal Depth	3.2 in
Critical Depth	2.6 in
Critical Slope	0.040 ft/ft
Velocity	2.02 ft/s
Velocity Head	0.06 ft
Specific Energy	0.33 ft
Froude Number	0.729

## Worksheet for A2-5

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	3.2 in
Critical Depth	2.6 in
Channel Slope	0.020 ft/ft
Critical Slope	0.040 ft/ft

## Worksheet for B1-2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.075 ft/ft
Discharge	27.80 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	3.00
0+31	0.00
0+60	0.00
1+00	4.84

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 3.00)	(0+31, 0.00)	0.040
(0+31, 0.00)	(0+60, 0.00)	0.040
(0+60, 0.00)	(1+00, 4.84)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	2.9 in
Roughness Coefficient	0.040
Elevation	0.24 ft
Elevation Range	0.0 to 4.8 ft
Flow Area	7.4 ft <sup>2</sup>
Wetted Perimeter	33.3 ft
Hydraulic Radius	2.7 in
Top Width	33.30 ft
Normal Depth	2.9 in
Critical Depth	3.6 in
Critical Slope	0.036 ft/ft
Velocity	3.73 ft/s
Velocity Head	0.22 ft
Specific Energy	0.46 ft
Froude Number	1.393
Flow Type	Supercritical

## Worksheet for B1-2

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.9 in
Critical Depth	3.6 in
Channel Slope	0.075 ft/ft
Critical Slope	0.036 ft/ft

---

## Worksheet for B1-3

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.033 ft/ft
Discharge	10.30 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	19.00
0+45	14.00
0+56	14.00
0+98	18.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 19.00)	(0+45, 14.00)	0.040
(0+45, 14.00)	(0+56, 14.00)	0.040
(0+56, 14.00)	(0+98, 18.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	3.3 in
Roughness Coefficient	0.040
Elevation	14.28 ft
Elevation Range	14.0 to 19.0 ft
Flow Area	4.0 ft <sup>2</sup>
Wetted Perimeter	17.2 ft
Hydraulic Radius	2.8 in
Top Width	17.13 ft
Normal Depth	3.3 in
Critical Depth	3.2 in
Critical Slope	0.038 ft/ft
Velocity	2.56 ft/s
Velocity Head	0.10 ft
Specific Energy	0.38 ft
Froude Number	0.933

## Worksheet for B1-3

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.3 in
Critical Depth	3.2 in
Channel Slope	0.033 ft/ft
Critical Slope	0.038 ft/ft

## Worksheet for B1-6

Project Description	
Friction Method	Manning
Solve For	Formula
	Normal Depth
Input Data	
Channel Slope	0.030 ft/ft
Discharge	21.90 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	22.00
0+35	18.00
0+51	18.00
0+92	23.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 22.00)	(0+35, 18.00)	0.040
(0+35, 18.00)	(0+51, 18.00)	0.040
(0+51, 18.00)	(0+92, 23.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	4.5 in
Roughness Coefficient	0.040
Elevation	18.37 ft
Elevation Range	18.0 to 23.0 ft
Flow Area	7.3 ft <sup>2</sup>
Wetted Perimeter	22.6 ft
Hydraulic Radius	3.9 in
Top Width	22.57 ft
Normal Depth	4.5 in
Critical Depth	4.3 in
Critical Slope	0.035 ft/ft
Velocity	3.01 ft/s
Velocity Head	0.14 ft
Specific Energy	0.52 ft
Froude Number	0.937

## Worksheet for B1-6

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	4.5 in
Critical Depth	4.3 in
Channel Slope	0.030 ft/ft
Critical Slope	0.035 ft/ft

## Worksheet for B2-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.037 ft/ft
Discharge	7.36 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	5.00
0+42	0.00
0+58	0.00
0+75	4.50

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 5.00)	(0+42, 0.00)	0.040
(0+42, 0.00)	(0+58, 0.00)	0.040
(0+58, 0.00)	(0+75, 4.50)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	2.3 in
Roughness Coefficient	0.040
Elevation	0.19 ft
Elevation Range	0.0 to 5.0 ft
Flow Area	3.3 ft <sup>2</sup>
Wetted Perimeter	18.4 ft
Hydraulic Radius	2.1 in
Top Width	18.32 ft
Normal Depth	2.3 in
Critical Depth	2.2 in
Critical Slope	0.042 ft/ft
Velocity	2.25 ft/s
Velocity Head	0.08 ft
Specific Energy	0.27 ft
Froude Number	0.942
Flow Type	Subcritical

## Worksheet for B2-1

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	2.3 in
Critical Depth	2.2 in
Channel Slope	0.037 ft/ft
Critical Slope	0.042 ft/ft

---

## Worksheet for B2-2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.054 ft/ft
Discharge	59.77 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	13.00
0+38	8.00
0+59	8.00
0+96	13.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 13.00)	(0+38, 8.00)	0.040
(0+38, 8.00)	(0+59, 8.00)	0.040
(0+59, 8.00)	(0+96, 13.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	5.9 in
Roughness Coefficient	0.040
Elevation	8.49 ft
Elevation Range	8.0 to 13.0 ft
Flow Area	12.2 ft <sup>2</sup>
Wetted Perimeter	28.5 ft
Hydraulic Radius	5.1 in
Top Width	28.40 ft
Normal Depth	5.9 in
Critical Depth	7.0 in
Critical Slope	0.029 ft/ft
Velocity	4.90 ft/s
Velocity Head	0.37 ft
Specific Energy	0.87 ft
Froude Number	1.320
Flow Type	Supercritical

## Worksheet for B2-2

---

### GVF Input Data

---

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

---

---

### GVF Output Data

---

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	5.9 in
Critical Depth	7.0 in
Channel Slope	0.054 ft/ft
Critical Slope	0.029 ft/ft

---

## Worksheet for B7-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.046 ft/ft
Discharge	3.76 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	95.00
0+25	92.00
0+50	91.75
0+90	98.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 95.00)	(0+25, 92.00)	0.040
(0+25, 92.00)	(0+50, 91.75)	0.040
(0+50, 91.75)	(0+90, 98.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	2.4 in
Roughness Coefficient	0.040
Elevation	91.95 ft
Elevation Range	91.8 to 98.0 ft
Flow Area	2.2 ft <sup>2</sup>
Wetted Perimeter	21.5 ft
Hydraulic Radius	1.2 in
Top Width	21.51 ft
Normal Depth	2.4 in
Critical Depth	2.4 in
Critical Slope	0.050 ft/ft
Velocity	1.73 ft/s
Velocity Head	0.05 ft
Specific Energy	0.25 ft
Froude Number	0.959

## Worksheet for B7-1

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	2.4 in
Critical Depth	2.4 in
Channel Slope	0.046 ft/ft
Critical Slope	0.050 ft/ft

## Worksheet for B8-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.050 ft/ft
Discharge	30.00 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	202.00
0+52	198.00
0+79	198.00
1+06	201.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 202.00)	(0+52, 198.00)	0.040
(0+52, 198.00)	(0+79, 198.00)	0.040
(0+79, 198.00)	(1+06, 201.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	3.5 in
Roughness Coefficient	0.040
Elevation	198.29 ft
Elevation Range	198.0 to 202.0 ft
Flow Area	8.8 ft <sup>2</sup>
Wetted Perimeter	33.4 ft
Hydraulic Radius	3.2 in
Top Width	33.41 ft
Normal Depth	3.5 in
Critical Depth	3.9 in
Critical Slope	0.035 ft/ft
Velocity	3.41 ft/s
Velocity Head	0.18 ft
Specific Energy	0.47 ft
Froude Number	1.172

## Worksheet for B8-1

Results	
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.5 in
Critical Depth	3.9 in
Channel Slope	0.050 ft/ft
Critical Slope	0.035 ft/ft

Proposed Conditions Natural Channels Flow Summary								
Channel ID	Contributing Basins	Tributary Area (ac)	Basin Area (ac)	Basin 100-yr Flow (cfs)	Channel 100-yr Flow (cfs)	Velocity (ft/s)	Normal Depth (ft)	Lining
A1-1	A1	19.55	19.55	41.24	41.24	2.62	0.48	
A2-1	A2	34.06	61.98	97.07	53.34	3.67	0.55	
A2-2	A2	9.06	61.98	97.07	14.19	2.47	0.18	
A2-3	A2	11.45	61.98	97.07	17.93	3.07	0.39	
A2-4	A2	1.70	61.98	97.07	2.66	1.49	0.23	
A2-5	A2	11.27	61.98	97.07	17.65	2.18	0.30	
A2-6	A2	5.9	61.98	97.07	9.24	1.83	0.18	
A2-7	A2	1.74	58.27	97.07	2.90	0.97	0.10	
B1-1	B1	10.19	40.74	76.45	19.12	2.67	0.28	
B1-2	B1	14.29	40.74	76.45	26.82	3.69	0.23	
B1-3	B1	13.43	40.74	76.45	25.20	5.26	0.36	TRM
B1-4	B1	4.03	40.74	76.45	7.56	2.47	0.14	
B1-5	B1	2.54	40.74	76.45	4.77	1.65	0.11	
B1-6	B1	2.72	40.74	76.45	5.10	1.81	0.16	
B2-1	B2	4.92	16.00	37.85	11.64	2.67	0.25	
B2-2	B2	9.77	16.00	37.85	23.11	3.52	0.28	
B6-1	B6	11.58	53.31	106.32	23.09	6.66	0.29	RIPRAP
B7-1	B7	2.25	2.46	6.17	5.64	1.91	0.23	
B8-1	B8, B6	3.32 (B8) + 53.31 (B6)	9.52 (B8) + 52.15 (B6)	23.05 (B8) + 106.32 (B6)	118.80	5.44	0.64	TRM

## Worksheet for A1-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.015 ft/ft
Discharge	41.24 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	41.00
0+35	36.00
0+64	36.00
1+00	41.00

### Roughness Segment Definitions

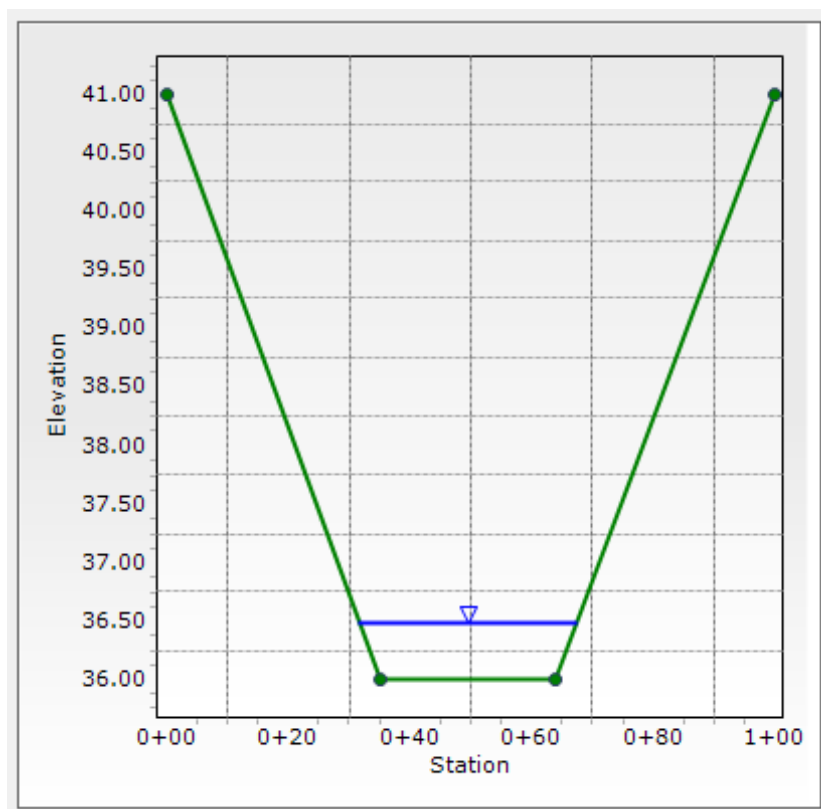
Start Station	Ending Station	Roughness Coefficient
(0+00, 41.00)	(0+35, 36.00)	0.040
(0+35, 36.00)	(0+64, 36.00)	0.040
(0+64, 36.00)	(1+00, 41.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	5.8 in
Roughness Coefficient	0.040
Elevation	36.48 ft
Elevation Range	36.0 to 41.0 ft
Flow Area	15.7 ft <sup>2</sup>
Wetted Perimeter	36.0 ft
Hydraulic Radius	5.3 in
Top Width	35.89 ft
Normal Depth	5.8 in
Critical Depth	4.6 in
Critical Slope	0.033 ft/ft
Velocity	2.62 ft/s
Velocity Head	0.11 ft
Specific Energy	0.59 ft
Froude Number	0.698

## Worksheet for A1-1

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	5.8 in
Critical Depth	4.6 in
Channel Slope	0.015 ft/ft
Critical Slope	0.033 ft/ft



## Worksheet for A2-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.028 ft/ft
Discharge	58.15 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	47.00
0+66	42.00
0+87	42.00
1+25	47.75

### Roughness Segment Definitions

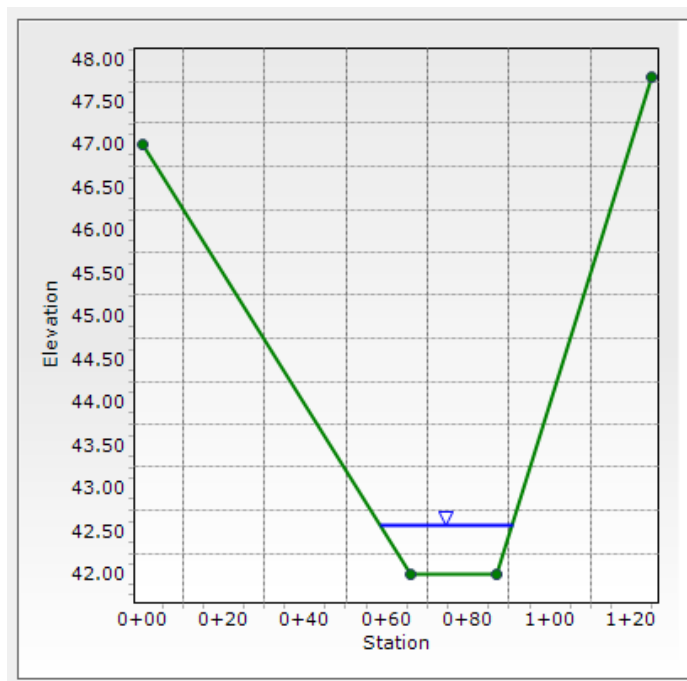
Start Station	Ending Station	Roughness Coefficient
(0+00, 47.00)	(0+66, 42.00)	0.040
(0+66, 42.00)	(0+87, 42.00)	0.040
(0+87, 42.00)	(1+25, 47.75)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	6.9 in
Roughness Coefficient	0.040
Elevation	42.58 ft
Elevation Range	42.0 to 47.8 ft
Flow Area	15.4 ft <sup>2</sup>
Wetted Perimeter	32.5 ft
Hydraulic Radius	5.7 in
Top Width	32.42 ft
Normal Depth	6.9 in
Critical Depth	6.8 in
Critical Slope	0.030 ft/ft
Velocity	3.78 ft/s
Velocity Head	0.22 ft
Specific Energy	0.80 ft
Froude Number	0.966

## Worksheet for A2-1

<b>Results</b>	
Flow Type	Subcritical
<b>GVF Input Data</b>	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
<b>GVF Output Data</b>	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	6.9 in
Critical Depth	6.8 in
Channel Slope	0.028 ft/ft
Critical Slope	0.030 ft/ft



## Worksheet for A2-2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.046 ft/ft
Discharge	14.19 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	23.00
0+43	16.00
0+72	16.00
1+25	20.00

### Roughness Segment Definitions

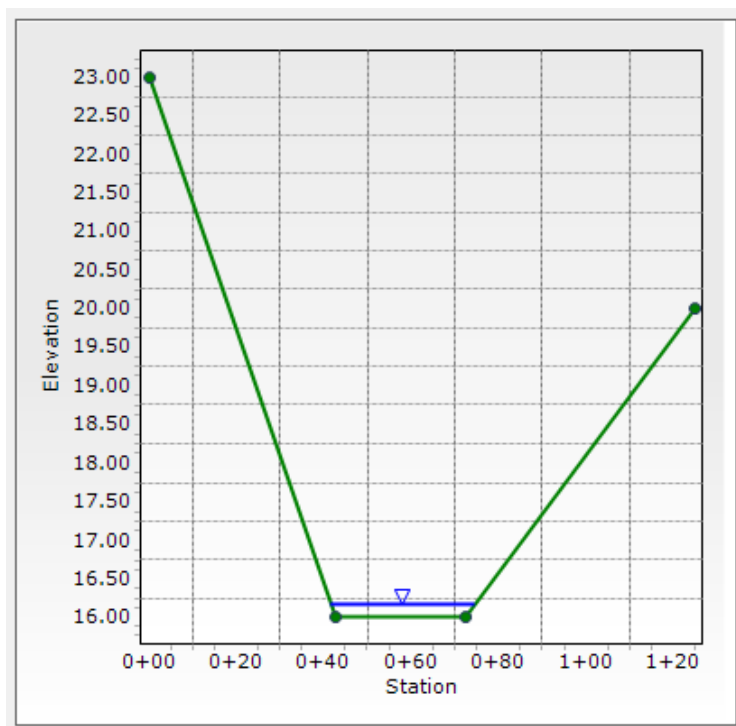
Start Station	Ending Station	Roughness Coefficient
(0+00, 23.00)	(0+43, 16.00)	0.040
(0+43, 16.00)	(0+72, 16.00)	0.040
(0+72, 16.00)	(1+25, 20.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	2.2 in
Roughness Coefficient	0.040
Elevation	16.18 ft
Elevation Range	16.0 to 23.0 ft
Flow Area	5.7 ft <sup>2</sup>
Wetted Perimeter	33.3 ft
Hydraulic Radius	2.1 in
Top Width	33.26 ft
Normal Depth	2.2 in
Critical Depth	2.3 in
Critical Slope	0.042 ft/ft
Velocity	2.47 ft/s
Velocity Head	0.09 ft
Specific Energy	0.28 ft
Froude Number	1.047

## Worksheet for A2-2

Results	
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.2 in
Critical Depth	2.3 in
Channel Slope	0.046 ft/ft
Critical Slope	0.042 ft/ft



## Worksheet for A2-3

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.030 ft/ft
Discharge	17.93 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	11.00
0+51	4.00
0+63	4.00
0+98	9.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 11.00)	(0+51, 4.00)	0.040
(0+51, 4.00)	(0+63, 4.00)	0.040
(0+63, 4.00)	(0+98, 9.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	4.7 in
Roughness Coefficient	0.040
Elevation	4.39 ft
Elevation Range	4.0 to 11.0 ft
Flow Area	5.8 ft <sup>2</sup>
Wetted Perimeter	17.7 ft
Hydraulic Radius	4.0 in
Top Width	17.63 ft
Normal Depth	4.7 in
Critical Depth	4.6 in
Critical Slope	0.034 ft/ft
Velocity	3.07 ft/s
Velocity Head	0.15 ft
Specific Energy	0.54 ft
Froude Number	0.941
Flow Type	Subcritical

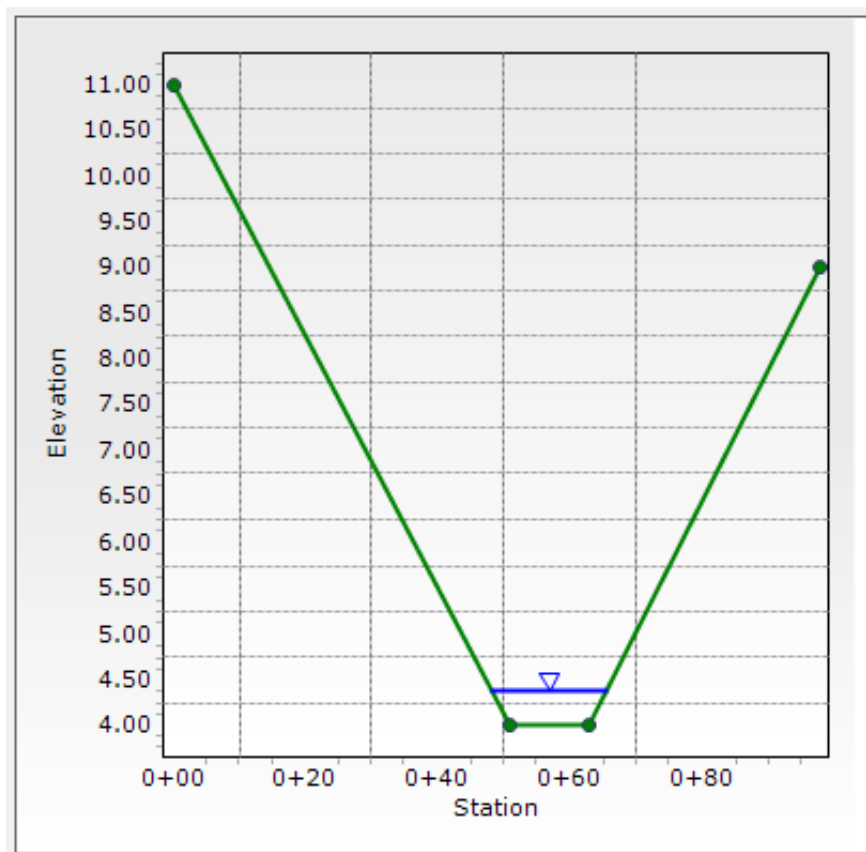
## Worksheet for A2-3

### GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

### GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	4.7 in
Critical Depth	4.6 in
Channel Slope	0.030 ft/ft
Critical Slope	0.034 ft/ft



## Worksheet for A2-4

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.029 ft/ft
Discharge	2.66 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+15	14.00
0+32	12.75
0+47	12.50
0+98	18.00

### Roughness Segment Definitions

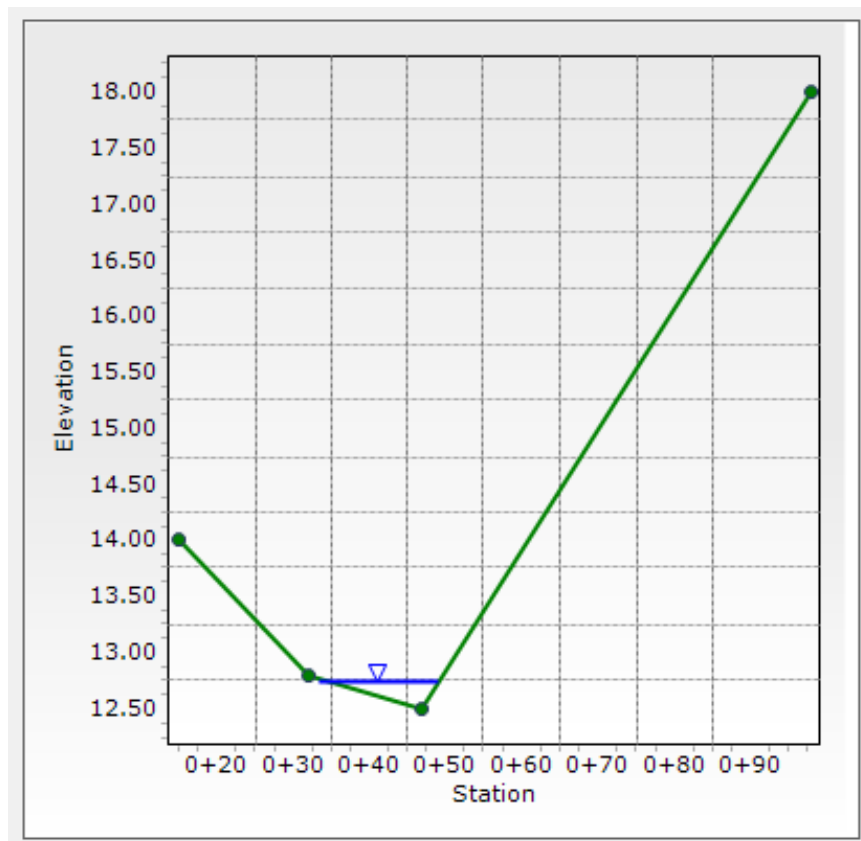
Start Station	Ending Station	Roughness Coefficient
(0+15, 14.00)	(0+32, 12.75)	0.040
(0+32, 12.75)	(0+47, 12.50)	0.040
(0+47, 12.50)	(0+98, 18.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	2.7 in
Roughness Coefficient	0.040
Elevation	12.73 ft
Elevation Range	12.5 to 18.0 ft
Flow Area	1.8 ft <sup>2</sup>
Wetted Perimeter	15.8 ft
Hydraulic Radius	1.4 in
Top Width	15.75 ft
Normal Depth	2.7 in
Critical Depth	2.5 in
Critical Slope	0.050 ft/ft
Velocity	1.49 ft/s
Velocity Head	0.03 ft
Specific Energy	0.26 ft
Froude Number	0.777

## Worksheet for A2-4

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	2.7 in
Critical Depth	2.5 in
Channel Slope	0.029 ft/ft
Critical Slope	0.050 ft/ft



## Worksheet for A2-5

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.020 ft/ft
Discharge	19.34 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	15.00
0+43	12.00
0+68	12.00
1+25	16.75

### Roughness Segment Definitions

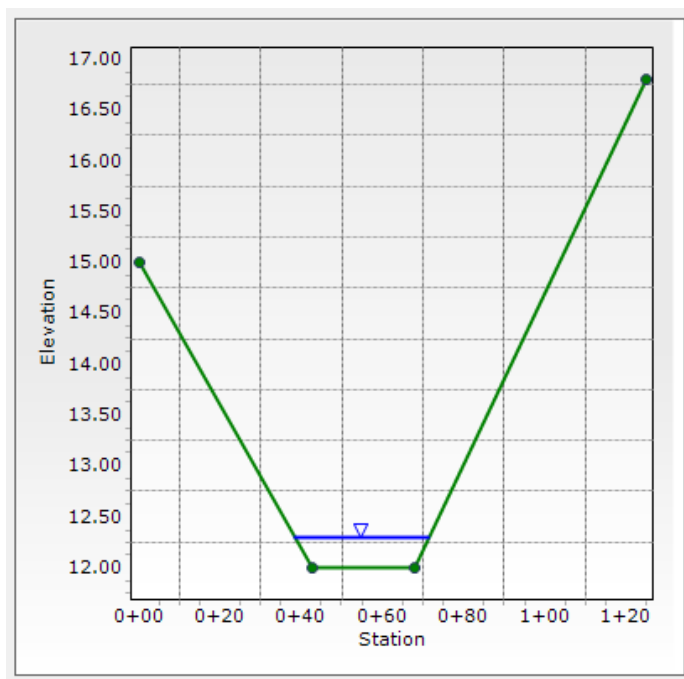
Start Station	Ending Station	Roughness Coefficient
(0+00, 15.00)	(0+43, 12.00)	0.040
(0+43, 12.00)	(0+68, 12.00)	0.040
(0+68, 12.00)	(1+25, 16.75)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	3.6 in
Roughness Coefficient	0.040
Elevation	12.30 ft
Elevation Range	12.0 to 16.8 ft
Flow Area	8.9 ft <sup>2</sup>
Wetted Perimeter	33.3 ft
Hydraulic Radius	3.2 in
Top Width	33.25 ft
Normal Depth	3.6 in
Critical Depth	3.0 in
Critical Slope	0.038 ft/ft
Velocity	2.18 ft/s
Velocity Head	0.07 ft
Specific Energy	0.38 ft
Froude Number	0.743

## Worksheet for A2-5

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	3.6 in
Critical Depth	3.0 in
Channel Slope	0.020 ft/ft
Critical Slope	0.038 ft/ft



## Worksheet for A2-6

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.027 ft/ft
Discharge	10.20 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	30.00
0+31	28.00
0+59	28.00
0+94	30.25

### Roughness Segment Definitions

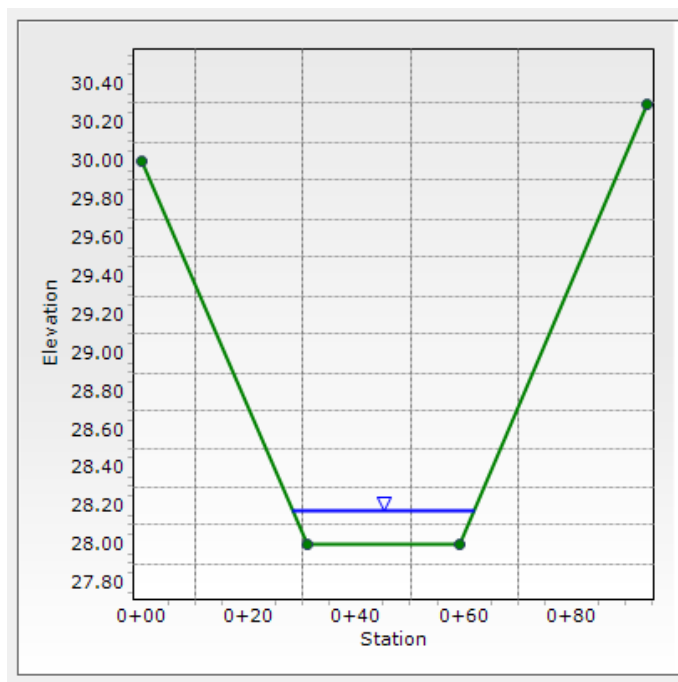
Start Station	Ending Station	Roughness Coefficient
(0+00, 30.00)	(0+31, 28.00)	0.040
(0+31, 28.00)	(0+59, 28.00)	0.040
(0+59, 28.00)	(0+94, 30.25)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	2.1 in
Roughness Coefficient	0.040
Elevation	28.18 ft
Elevation Range	28.0 to 30.3 ft
Flow Area	5.6 ft <sup>2</sup>
Wetted Perimeter	34.0 ft
Hydraulic Radius	2.0 in
Top Width	34.00 ft
Normal Depth	2.1 in
Critical Depth	1.8 in
Critical Slope	0.045 ft/ft
Velocity	1.83 ft/s
Velocity Head	0.05 ft
Specific Energy	0.23 ft
Froude Number	0.796

## Worksheet for A2-6

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	2.1 in
Critical Depth	1.8 in
Channel Slope	0.027 ft/ft
Critical Slope	0.045 ft/ft



## Worksheet for A2-7

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.015 ft/ft
Discharge	2.90 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	41.00
0+35	36.00
0+64	36.00
1+00	41.00

### Roughness Segment Definitions

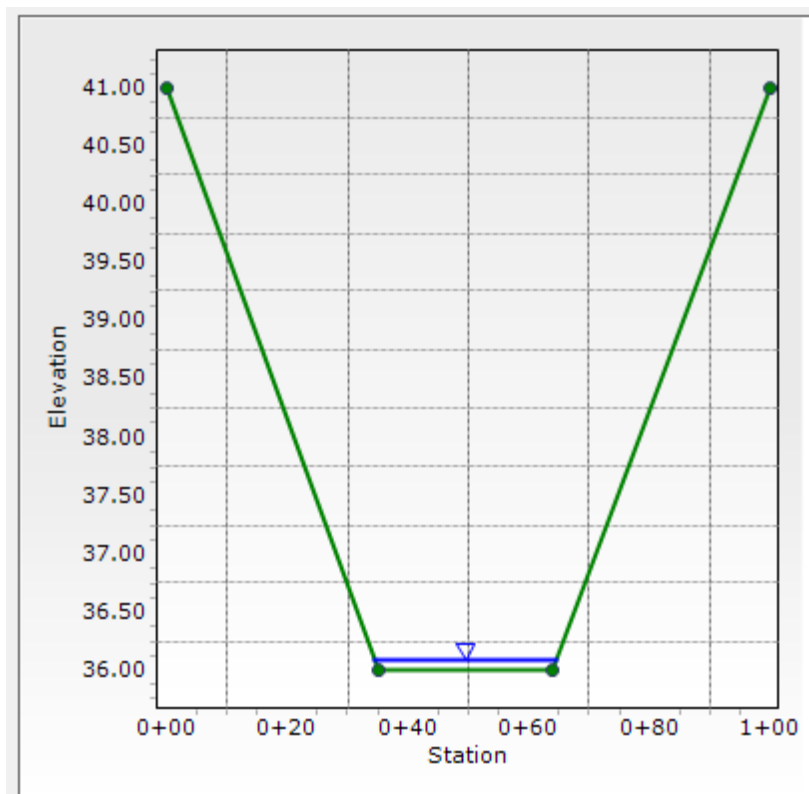
Start Station	Ending Station	Roughness Coefficient
(0+00, 41.00)	(0+35, 36.00)	0.040
(0+35, 36.00)	(0+64, 36.00)	0.040
(0+64, 36.00)	(1+00, 41.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	1.2 in
Roughness Coefficient	0.040
Elevation	36.10 ft
Elevation Range	36.0 to 41.0 ft
Flow Area	3.0 ft <sup>2</sup>
Wetted Perimeter	30.4 ft
Hydraulic Radius	1.2 in
Top Width	30.43 ft
Normal Depth	1.2 in
Critical Depth	0.8 in
Critical Slope	0.058 ft/ft
Velocity	0.97 ft/s
Velocity Head	0.01 ft
Specific Energy	0.12 ft
Froude Number	0.544

## Worksheet for A2-7

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	1.2 in
Critical Depth	0.8 in
Channel Slope	0.015 ft/ft
Critical Slope	0.058 ft/ft



## Worksheet for B1-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.034 ft/ft
Discharge	19.12 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	26.00
0+54	20.00
0+76	20.00
1+25	22.75

### Roughness Segment Definitions

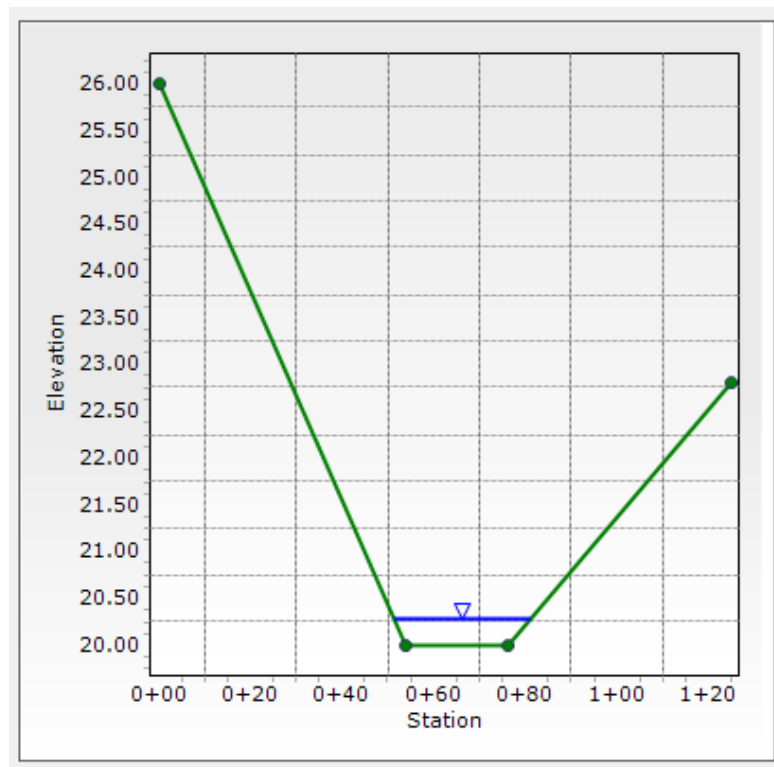
Start Station	Ending Station	Roughness Coefficient
(0+00, 26.00)	(0+54, 20.00)	0.040
(0+54, 20.00)	(0+76, 20.00)	0.040
(0+76, 20.00)	(1+25, 22.75)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	3.3 in
Roughness Coefficient	0.040
Elevation	20.28 ft
Elevation Range	20.0 to 26.0 ft
Flow Area	7.2 ft <sup>2</sup>
Wetted Perimeter	29.5 ft
Hydraulic Radius	2.9 in
Top Width	29.47 ft
Normal Depth	3.3 in
Critical Depth	3.2 in
Critical Slope	0.038 ft/ft
Velocity	2.67 ft/s
Velocity Head	0.11 ft
Specific Energy	0.39 ft
Froude Number	0.954

## Worksheet for B1-1

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	3.3 in
Critical Depth	3.2 in
Channel Slope	0.034 ft/ft
Critical Slope	0.038 ft/ft



## Worksheet for B1-2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.075 ft/ft
Discharge	26.82 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	3.00
0+31	0.00
0+60	0.00
1+00	4.84

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 3.00)	(0+31, 0.00)	0.040
(0+31, 0.00)	(0+60, 0.00)	0.040
(0+60, 0.00)	(1+00, 4.84)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	2.8 in
Roughness Coefficient	0.040
Elevation	0.23 ft
Elevation Range	0.0 to 4.8 ft
Flow Area	7.3 ft <sup>2</sup>
Wetted Perimeter	33.2 ft
Hydraulic Radius	2.6 in
Top Width	33.21 ft
Normal Depth	2.8 in
Critical Depth	3.5 in
Critical Slope	0.036 ft/ft
Velocity	3.69 ft/s
Velocity Head	0.21 ft
Specific Energy	0.45 ft
Froude Number	1.388
Flow Type	Supercritical

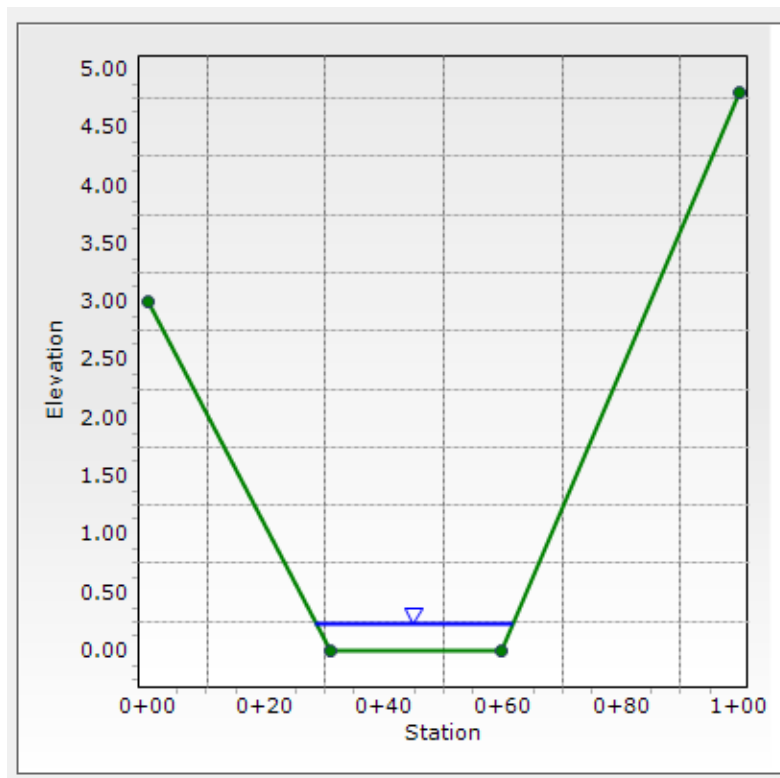
## Worksheet for B1-2

### GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

### GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.8 in
Critical Depth	3.5 in
Channel Slope	0.075 ft/ft
Critical Slope	0.036 ft/ft



## Worksheet for B1-3-Proposed

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Roughness Coefficient	0.035
Channel Slope	0.070 ft/ft
Left Side Slope	4.000 H:V
Right Side Slope	4.000 H:V
Bottom Width	12.00 ft
Discharge	25.20 cfs
Results	
Normal Depth	4.3 in
Flow Area	4.8 ft <sup>2</sup>
Wetted Perimeter	14.9 ft
Hydraulic Radius	3.8 in
Top Width	14.86 ft
Critical Depth	5.8 in
Critical Slope	0.024 ft/ft
Velocity	5.26 ft/s
Velocity Head	0.43 ft
Specific Energy	0.79 ft
Froude Number	1.632
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	4.3 in
Critical Depth	5.8 in
Channel Slope	0.070 ft/ft
Critical Slope	0.024 ft/ft

## Worksheet for B1-4

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.063 ft/ft
Discharge	7.56 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	34.00
0+26	30.00
0+47	30.00
0+75	35.00

### Roughness Segment Definitions

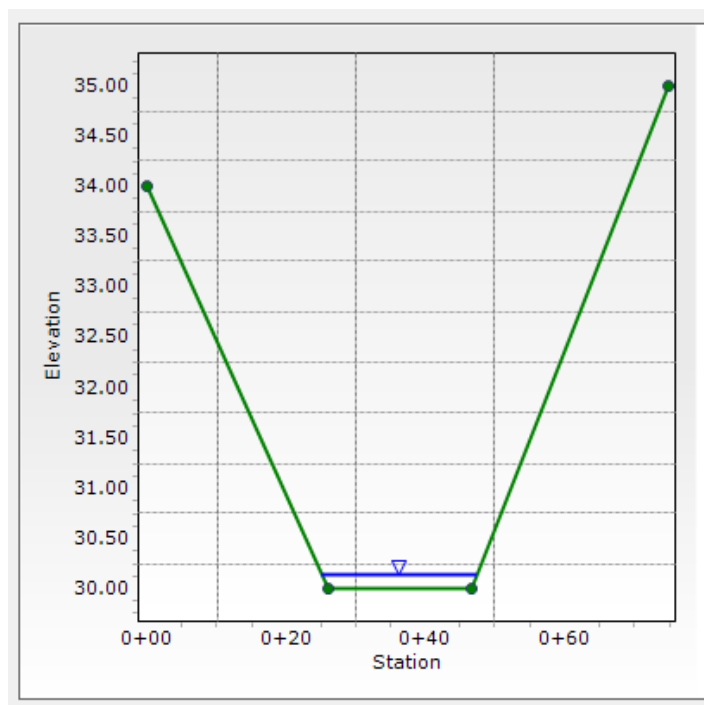
Start Station	Ending Station	Roughness Coefficient
(0+00, 34.00)	(0+26, 30.00)	0.040
(0+26, 30.00)	(0+47, 30.00)	0.040
(0+47, 30.00)	(0+75, 35.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	1.7 in
Roughness Coefficient	0.040
Elevation	30.14 ft
Elevation Range	30.0 to 35.0 ft
Flow Area	3.1 ft <sup>2</sup>
Wetted Perimeter	22.5 ft
Hydraulic Radius	1.6 in
Top Width	22.47 ft
Normal Depth	1.7 in
Critical Depth	1.9 in
Critical Slope	0.044 ft/ft
Velocity	2.47 ft/s
Velocity Head	0.09 ft
Specific Energy	0.24 ft
Froude Number	1.180

## Worksheet for B1-4

<b>Results</b>	
Flow Type	Supercritical
<b>GVF Input Data</b>	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
<b>GVF Output Data</b>	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	1.7 in
Critical Depth	1.9 in
Channel Slope	0.063 ft/ft
Critical Slope	0.044 ft/ft



## Worksheet for B1-5

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.039 ft/ft
Discharge	4.77 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	35.00
0+29	32.00
0+54	32.00
0+73	35.00

### Roughness Segment Definitions

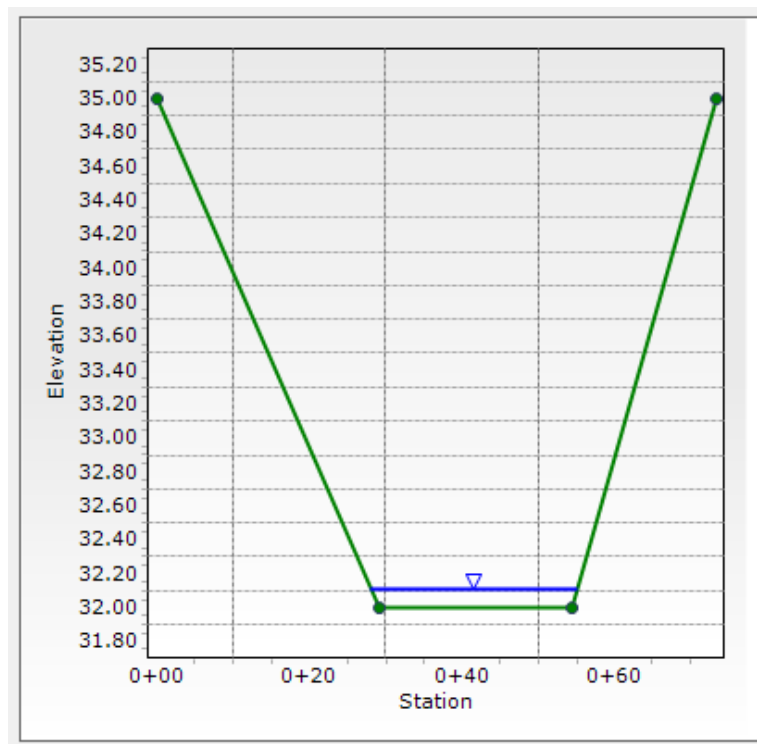
Start Station	Ending Station	Roughness Coefficient
(0+00, 35.00)	(0+29, 32.00)	0.040
(0+29, 32.00)	(0+54, 32.00)	0.040
(0+54, 32.00)	(0+73, 35.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	1.3 in
Roughness Coefficient	0.040
Elevation	32.11 ft
Elevation Range	32.0 to 35.0 ft
Flow Area	2.9 ft <sup>2</sup>
Wetted Perimeter	27.0 ft
Hydraulic Radius	1.3 in
Top Width	27.02 ft
Normal Depth	1.3 in
Critical Depth	1.2 in
Critical Slope	0.050 ft/ft
Velocity	1.65 ft/s
Velocity Head	0.04 ft
Specific Energy	0.15 ft
Froude Number	0.890

## Worksheet for B1-5

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	1.3 in
Critical Depth	1.2 in
Channel Slope	0.039 ft/ft
Critical Slope	0.050 ft/ft



## Worksheet for B1-6

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.030 ft/ft
Discharge	5.10 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	22.00
0+35	18.00
0+51	18.00
0+92	23.00

### Roughness Segment Definitions

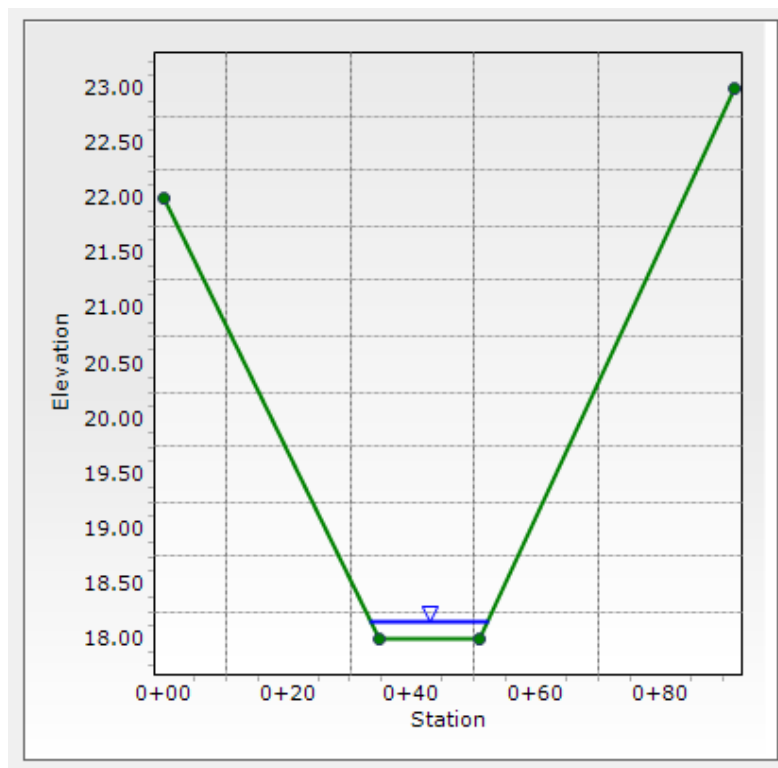
Start Station	Ending Station	Roughness Coefficient
(0+00, 22.00)	(0+35, 18.00)	0.040
(0+35, 18.00)	(0+51, 18.00)	0.040
(0+51, 18.00)	(0+92, 23.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	1.9 in
Roughness Coefficient	0.040
Elevation	18.16 ft
Elevation Range	18.0 to 23.0 ft
Flow Area	2.8 ft <sup>2</sup>
Wetted Perimeter	19.0 ft
Hydraulic Radius	1.8 in
Top Width	18.96 ft
Normal Depth	1.9 in
Critical Depth	1.7 in
Critical Slope	0.046 ft/ft
Velocity	1.81 ft/s
Velocity Head	0.05 ft
Specific Energy	0.21 ft
Froude Number	0.825

## Worksheet for B1-6

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	1.9 in
Critical Depth	1.7 in
Channel Slope	0.030 ft/ft
Critical Slope	0.046 ft/ft



## Worksheet for B2-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.037 ft/ft
Discharge	11.64 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	5.00
0+42	0.00
0+58	0.00
0+75	4.50

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 5.00)	(0+42, 0.00)	0.040
(0+42, 0.00)	(0+58, 0.00)	0.040
(0+58, 0.00)	(0+75, 4.50)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	3.0 in
Roughness Coefficient	0.040
Elevation	0.25 ft
Elevation Range	0.0 to 5.0 ft
Flow Area	4.4 ft <sup>2</sup>
Wetted Perimeter	19.1 ft
Hydraulic Radius	2.7 in
Top Width	19.03 ft
Normal Depth	3.0 in
Critical Depth	3.0 in
Critical Slope	0.038 ft/ft
Velocity	2.67 ft/s
Velocity Head	0.11 ft
Specific Energy	0.36 ft
Froude Number	0.982
Flow Type	Subcritical

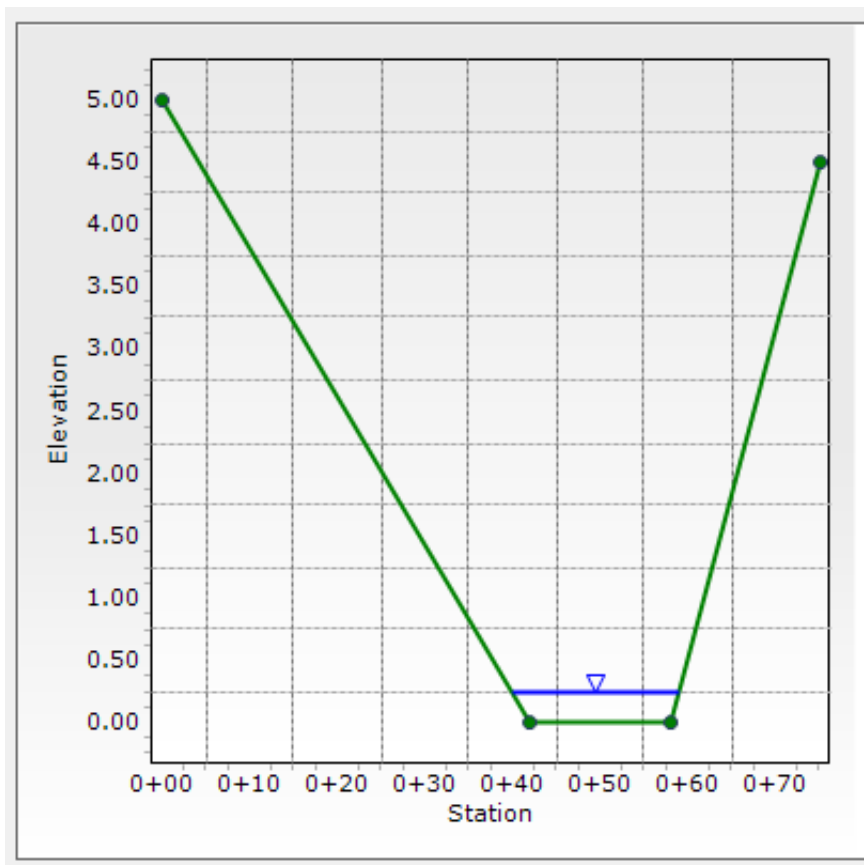
## Worksheet for B2-1

### GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

### GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	3.0 in
Critical Depth	3.0 in
Channel Slope	0.037 ft/ft
Critical Slope	0.038 ft/ft



## Worksheet for B2-2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.054 ft/ft
Discharge	23.11 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	13.00
0+38	8.00
0+59	8.00
0+96	13.00

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 13.00)	(0+38, 8.00)	0.040
(0+38, 8.00)	(0+59, 8.00)	0.040
(0+59, 8.00)	(0+96, 13.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	3.4 in
Roughness Coefficient	0.040
Elevation	8.28 ft
Elevation Range	8.0 to 13.0 ft
Flow Area	6.6 ft <sup>2</sup>
Wetted Perimeter	25.3 ft
Hydraulic Radius	3.1 in
Top Width	25.26 ft
Normal Depth	3.4 in
Critical Depth	3.9 in
Critical Slope	0.035 ft/ft
Velocity	3.52 ft/s
Velocity Head	0.19 ft
Specific Energy	0.48 ft
Froude Number	1.215
Flow Type	Supercritical

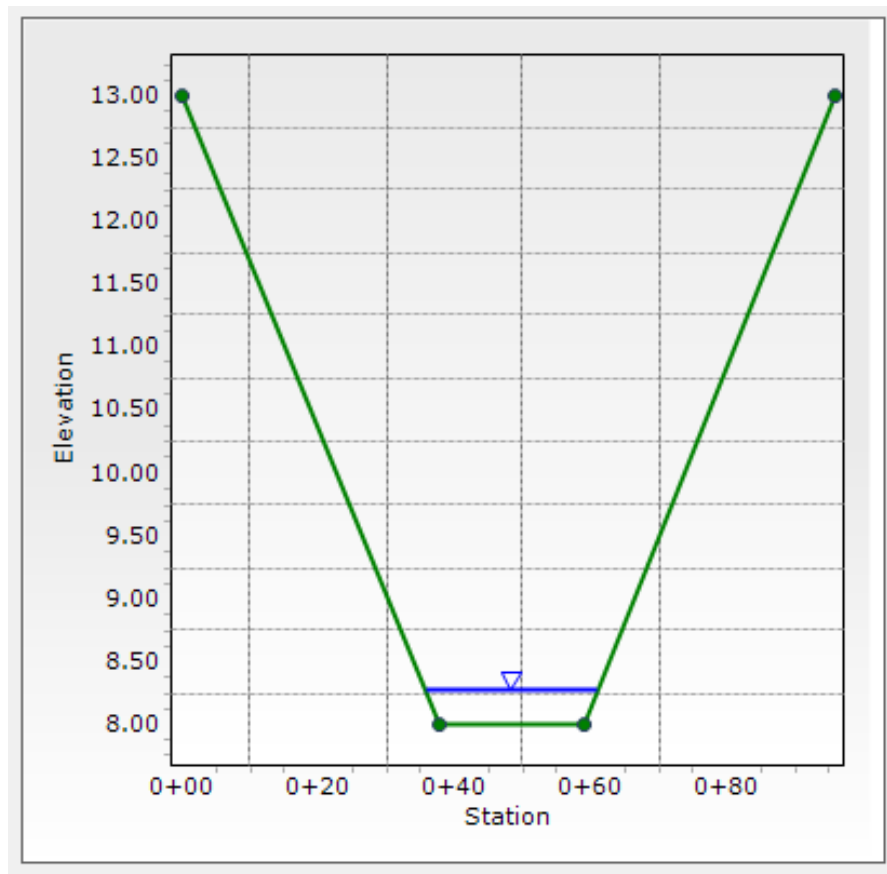
## Worksheet for B2-2

### GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

### GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.4 in
Critical Depth	3.9 in
Channel Slope	0.054 ft/ft
Critical Slope	0.035 ft/ft



## Worksheet for B6-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.190 ft/ft
Discharge	23.09 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	14.00
0+39	6.00
0+50	6.00
0+63	11.50

### Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 14.00)	(0+39, 6.00)	0.040
(0+39, 6.00)	(0+50, 6.00)	0.040
(0+50, 6.00)	(0+63, 11.50)	0.040

### Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

### Results

Normal Depth	3.5 in
Roughness Coefficient	0.040
Elevation	6.29 ft
Elevation Range	6.0 to 14.0 ft
Flow Area	3.5 ft <sup>2</sup>
Wetted Perimeter	13.2 ft
Hydraulic Radius	3.2 in
Top Width	13.09 ft
Normal Depth	3.5 in
Critical Depth	5.9 in
Critical Slope	0.031 ft/ft
Velocity	6.66 ft/s
Velocity Head	0.69 ft
Specific Energy	0.98 ft
Froude Number	2.279
Flow Type	Supercritical

RIPRAP LINED PER  
 GEOTECH  
 RECOMMENDATION.  
 SIZING CALCS NEXT  
 SHEET

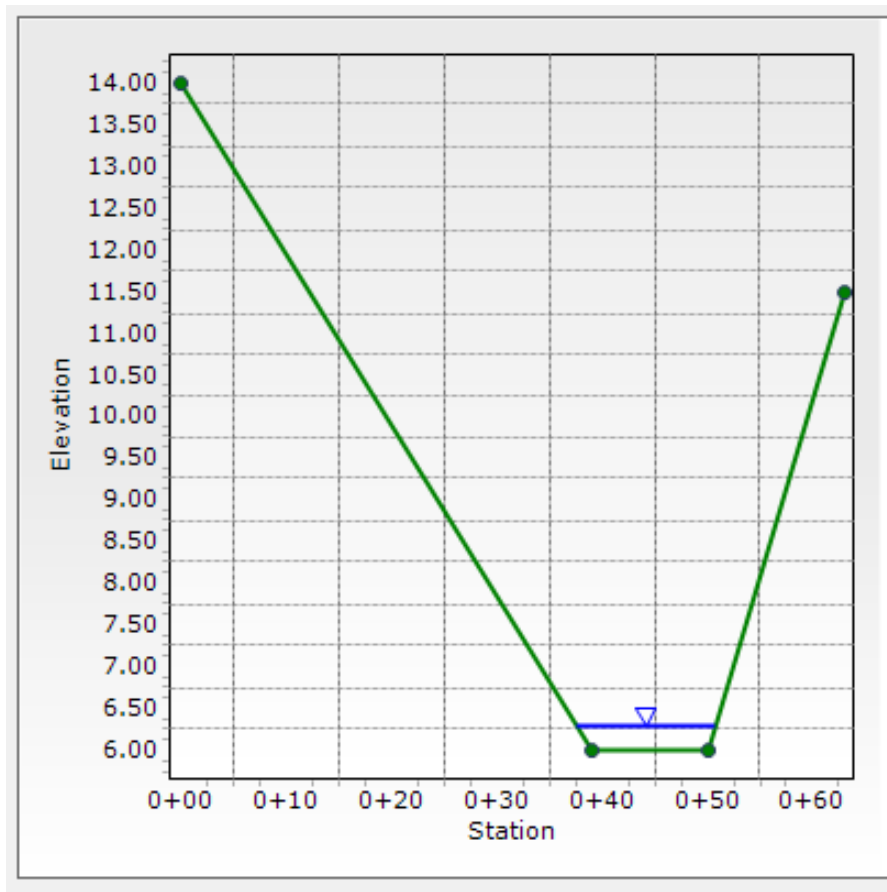
## Worksheet for B6-1

### GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

### GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	3.5 in
Critical Depth	5.9 in
Channel Slope	0.190 ft/ft
Critical Slope	0.031 ft/ft



## Steep Slope Channel-Riprap Lining and Sizing Calculations Existing Channel 17- Basin B6

### e. Steep slope riprap design.

In cases where unit discharge is low, riprap can be used on steep slopes ranging from 2 to 20 percent. A typical application is a rock-lined chute. The stone size equation is

$$D_{30} = \frac{1.95 S^{0.555} q^{2/3}}{g^{1/3}} \quad (3-5)$$

where

$S$  = slope of bed

$q$  = unit discharge

Equation 3-5 is applicable to thickness =  $1.5 D_{100}$ , angular rock, unit weight of 167 pcf,  $D_{85}/D_{15}$  from 1.7 to 2.7, slopes from 2 to 20 percent, and uniform flow on a down-slope with no tailwater. The following steps should be used in application of Equation 3-5:

- (1) Estimate  $q = Q/b$  where  $b$  = bottom width of chute.
- (2) Multiply  $q$  by flow concentration factor of 1.25. Use greater factor if approach flow is skewed.
- (3) Compute  $D_{30}$  using Equation 3-5.
- (4) Use uniform gradation having  $D_{85}/D_{15} \leq 2$  such as Table 3-1.
- (5) Restrict application to straight channels with side slope of 1V:2.5H or flatter.
- (6) Use filter fabric beneath rock.

The guidance for steep slope riprap generally results in large riprap sizes. Grouted riprap is often used instead of loose riprap in steep slope applications. \*

Inputs	Value	Units	Notes
Slope (S)	8.50%		
Q	23.09	cfs	From Proposed Ditch Analysis
Bottom Width (b)	10	feet	Estimate from existing topo
g	32	ft/sec <sup>2</sup>	

Output	Value	Units
q	2.31	cfs/ft
D30	0.27	feet
D30	3.28	inches

Use Type VL Riprap, D50= 6 Inches

## Worksheet for B7-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.046 ft/ft
Discharge	5.64 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	95.00
0+25	92.00
0+50	91.75
0+90	98.00

### Roughness Segment Definitions

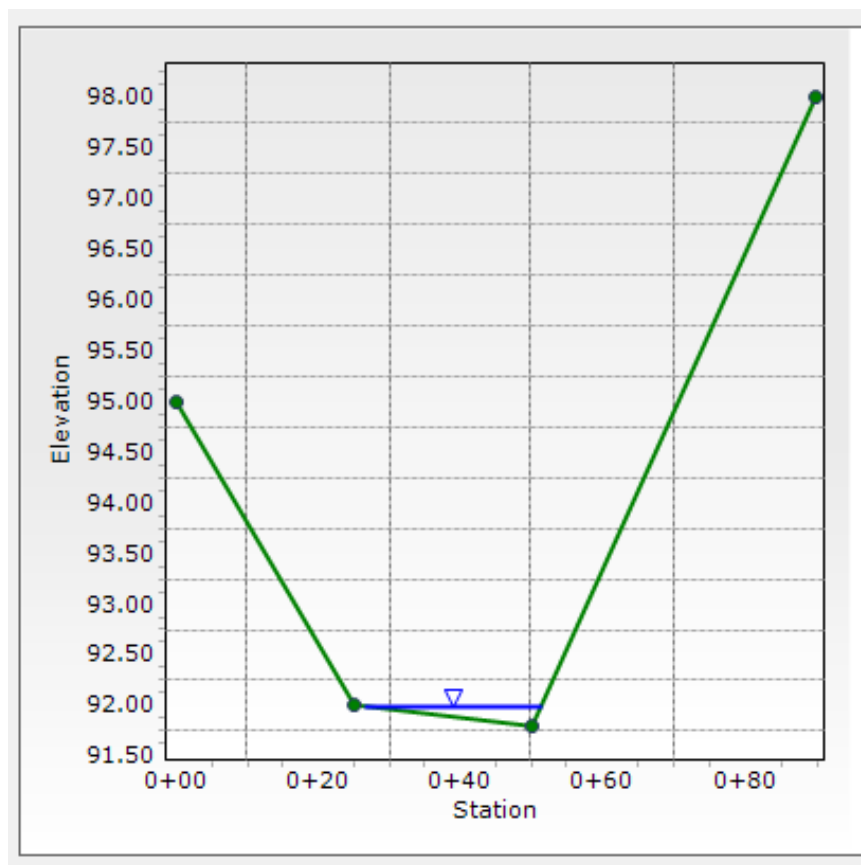
Start Station	Ending Station	Roughness Coefficient
(0+00, 95.00)	(0+25, 92.00)	0.040
(0+25, 92.00)	(0+50, 91.75)	0.040
(0+50, 91.75)	(0+90, 98.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	2.8 in
Roughness Coefficient	0.040
Elevation	91.99 ft
Elevation Range	91.8 to 98.0 ft
Flow Area	2.9 ft <sup>2</sup>
Wetted Perimeter	25.1 ft
Hydraulic Radius	1.4 in
Top Width	25.05 ft
Normal Depth	2.8 in
Critical Depth	2.8 in
Critical Slope	0.048 ft/ft
Velocity	1.91 ft/s
Velocity Head	0.06 ft
Specific Energy	0.29 ft
Froude Number	0.983

## Worksheet for B7-1

Results	
Flow Type	Subcritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	2.8 in
Critical Depth	2.8 in
Channel Slope	0.046 ft/ft
Critical Slope	0.048 ft/ft



## Worksheet for B8-1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.050 ft/ft
Discharge	118.80 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	202.00
0+52	198.00
0+79	198.00
1+06	201.00

### Roughness Segment Definitions

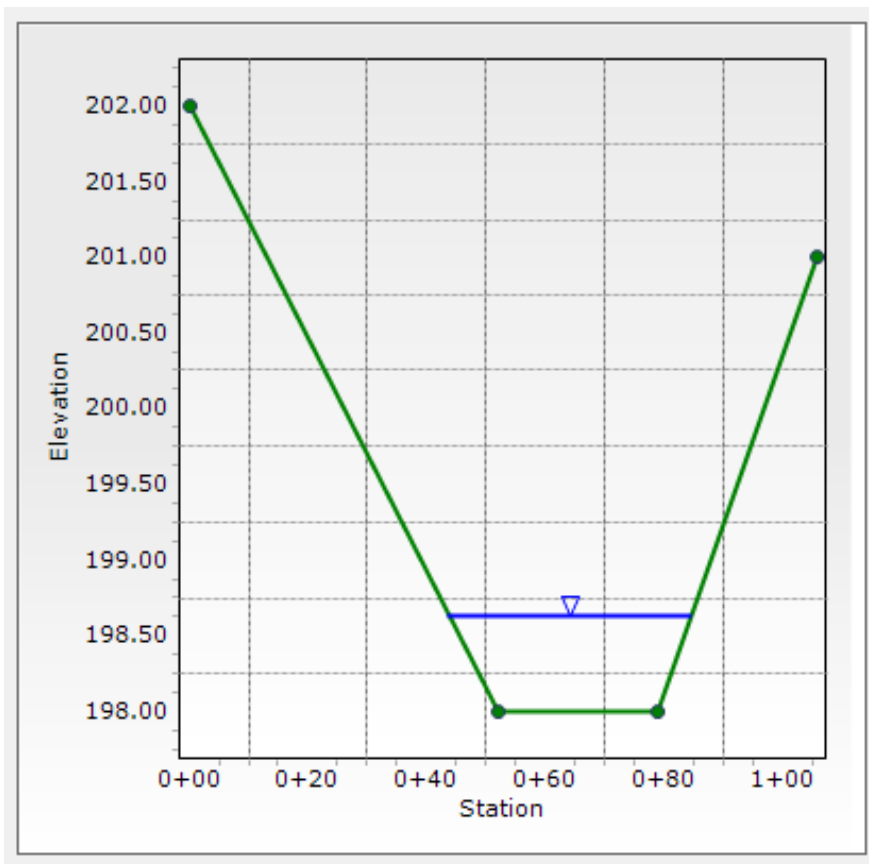
Start Station	Ending Station	Roughness Coefficient
(0+00, 202.00)	(0+52, 198.00)	0.040
(0+52, 198.00)	(0+79, 198.00)	0.040
(0+79, 198.00)	(1+06, 201.00)	0.040

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	7.7 in
Roughness Coefficient	0.040
Elevation	198.64 ft
Elevation Range	198.0 to 202.0 ft
Flow Area	21.8 ft <sup>2</sup>
Wetted Perimeter	41.2 ft
Hydraulic Radius	6.4 in
Top Width	41.10 ft
Normal Depth	7.7 in
Critical Depth	9.1 in
Critical Slope	0.028 ft/ft
Velocity	5.44 ft/s
Velocity Head	0.46 ft
Specific Energy	1.10 ft
Froude Number	1.317

## Worksheet for B8-1

Results	
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	7.7 in
Critical Depth	9.1 in
Channel Slope	0.050 ft/ft
Critical Slope	0.028 ft/ft



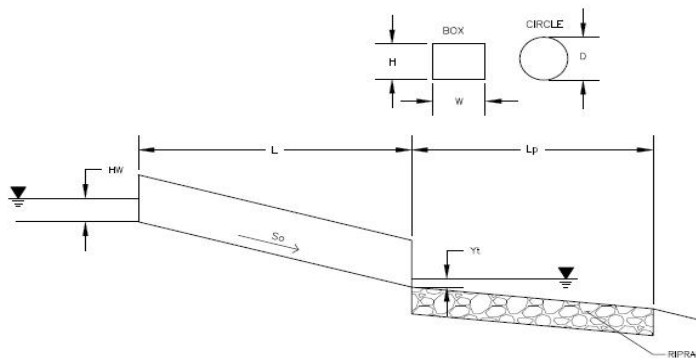
Culvert & Riprap Summary														
Culvert Details							Riprap Details (Low Tailwater Basin Design)							
Culvert ID	Basin	Q100 flow (cfs)	Flow % of Basin	Flows (cfs)	HW/D Ratio	Diameter (in)	Top Length (ft)	Bottom Width (ft)	Top Width (ft)	D50 Type	D50 Size (in)	D50 Thickness (D) (in)	Normal Depth in Pipe (ft)	Upstream Headwater Elevation (ft)
A2-A	A2	93.46	10.00%	9.35	1.39	18	15	4	10	VL	6	12	0.75	7211.99
A2-B	A2	93.46	8.00%	7.48	1.12	18	15	4	10	VL	6	12	0.56	7221.58
A2-C	A2	93.46	49.00%	45.80	1.21	36	20	6	15	L	9	18	1.17	7224.11
A2-D	A2	93.46	11.00%	10.28	1.52	18	15	4	10	VL	6	12	0.60	7320.27
B1-A	B1	80.40	28.00%	22.51	0.99	30	20	6	15	L	9	18	0.85	7218.48
B1-B	B1	80.40	34.00%	27.34	1.14	30	20	6	15	L	9	18	0.90	7224.85
B6-A	B6	104.60	100.00%	104.60	0.99	36 (3 Barrels)	24	7	27	M	12	24	1.91	7230.75
B6-A (BULK FLOWS)	B6	156.90	100.00%	156.90	1.39	36 (3 Barrels)	24	7	27	M	12	24	2.52	7231.94
B6-B	B6	104.60	2.00%	5.63	0.91	18	15	4	10	VL	6	12	0.47	7246.36
B6-C	B6	104.60	1.00%	3.26	1.28	12	15	4	10	VL	6	12	0.32	7340.58
EDB A2 OUTFALL	(Used pond outfall diameter sizing for final pond installation)					42	24	7	19	L	9	18		
EDB B1 OUTFALL	(Used pond outfall diameter sizing for final pond installation)					36	20	6	15	L	9	18		
EDB B6 OUTFALL	(Used pond outfall diameter sizing for final pond installation)					42	24	7	19	L	9	18		

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: OVERLOOK

ID: CULVERT A1



Soil Type:

Choose One:

☒ Sandy

☐ Non-Sandy

## Design Information:

Design Discharge

Q = 41.42 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 36 inches

Inlet Edge Type (Choose from pull-down list)

Square Edge with Headwall

OR:

Box Culvert:

Barrel Height (Rise) in Feet

H (Rise) = OR ft

Barrel Width (Span) in Feet

W (Span) = ft

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

# Barrels = 1

Inlet Elevation

Elev IN = 7204.67 ft

Outlet Elevation OR Slope

Elev OUT = 7204.42 ft

Culvert Length

L = 68.15 ft

Manning's Roughness

n = 0.012

Bend Loss Coefficient

k<sub>b</sub> = 0

Exit Loss Coefficient

k<sub>x</sub> = 1

Tailwater Surface Elevation

Y<sub>t</sub>, Elevation = ft

Max Allowable Channel Velocity

V = 5 ft/s

## Calculated Results:

Culvert Cross Sectional Area Available

A = 7.07 ft<sup>2</sup>

Culvert Normal Depth

Y<sub>n</sub> = 2.32 ft

Culvert Critical Depth

Y<sub>c</sub> = 2.10 ft

Froude Number

Fr = 0.81

Entrance Loss Coefficient

k<sub>e</sub> = 0.50

Friction Loss Coefficient

k<sub>f</sub> = 0.42

Sum of All Loss Coefficients

k<sub>s</sub> = 1.92 ft

Headwater:

Inlet Control Headwater

HW<sub>i</sub> = 3.39 ft

Outlet Control Headwater

HW<sub>o</sub> = 3.32 ft

Design Headwater Elevation

HW = 7208.06 ft

Headwater/Diameter OR Headwater/Rise Ratio

HW/D = 1.13

Outlet Protection:

Flow/(Diameter<sup>2.5</sup>)

Q/D<sup>2.5</sup> = 2.66 ft<sup>0.5</sup>/s

Tailwater Surface Height

Y<sub>t</sub> = 1.20 ft

Tailwater/Diameter

Y<sub>t</sub>/D = 0.40

Expansion Factor

1/(2\*tan(θ)) = 4.85

Flow Area at Max Channel Velocity

A<sub>t</sub> = 8.28 ft<sup>2</sup>

Width of Equivalent Conduit for Multiple Barrels

W<sub>eq</sub> = - ft

Length of Riprap Protection

L<sub>p</sub> = 19 ft

Width of Riprap Protection at Downstream End

T = 7 ft

Adjusted Diameter for Supercritical Flow

Da = - ft

Minimum Theoretical Riprap Size

d<sub>50 min</sub> = 7 in

Nominal Riprap Size

d<sub>50 nominal</sub> = 9 in

MHFD Riprap Type

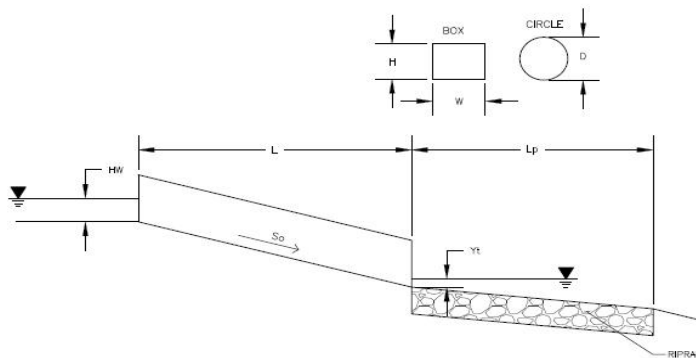
Type = L

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: OVERLOOK

ID: CULVERT A2-A



Soil Type:

Choose One:

- ☒ Sandy  
☐ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

## Design Information:

Design Discharge

Q = 9.3 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 18 inches

Inlet Edge Type (Choose from pull-down list)

Square Edge with Headwall

OR:

Box Culvert:

Barrel Height (Rise) in Feet

H (Rise) =

Barrel Width (Span) in Feet

W (Span) =

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

# Barrels = 1

Inlet Elevation

Elev IN = 7209.75 ft

Outlet Elevation OR Slope

Elev OUT = 7207.31 ft

Culvert Length

L = 93 ft

Manning's Roughness

n = 0.012

Bend Loss Coefficient

k<sub>b</sub> = 0

Exit Loss Coefficient

k<sub>x</sub> = 1

Tailwater Surface Elevation

Y<sub>t</sub>, Elevation =

Max Allowable Channel Velocity

V = 5 ft/s

## Calculated Results:

Culvert Cross Sectional Area Available

A = 1.77 ft<sup>2</sup>

Culvert Normal Depth

Y<sub>n</sub> = 0.75 ft

Culvert Critical Depth

Y<sub>c</sub> = 1.18 ft

Froude Number

Fr = 2.40 Supercritical!

Entrance Loss Coefficient

k<sub>e</sub> = 0.50

Friction Loss Coefficient

k<sub>f</sub> = 1.44

Sum of All Loss Coefficients

k<sub>s</sub> = 2.94

Headwater:

Inlet Control Headwater

HW<sub>i</sub> = 2.08 ft

Outlet Control Headwater

HW<sub>o</sub> = N/A

Design Headwater Elevation

HW = 7211.83 ft

Headwater/Diameter OR Headwater/Rise Ratio

HW/D = 1.39

Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

Outlet Protection:

Flow/(Diameter<sup>2.5</sup>)

Q/D<sup>2.5</sup> = 3.37 ft<sup>0.5</sup>/s

Tailwater Surface Height

Y<sub>t</sub> = 0.60 ft

Tailwater/Diameter

Y<sub>t</sub>/D = 0.40

Expansion Factor

1/(2\*tan(Θ)) = 4.05

Flow Area at Max Channel Velocity

A<sub>t</sub> = 1.86 ft<sup>2</sup>

Width of Equivalent Conduit for Multiple Barrels

W<sub>eq</sub> = - ft

Length of Riprap Protection

L<sub>p</sub> = 7 ft

Width of Riprap Protection at Downstream End

T = 4 ft

Adjusted Diameter for Supercritical Flow

Da = 1.13 ft

Minimum Theoretical Riprap Size

d<sub>50 min</sub> = 5 in

Nominal Riprap Size

d<sub>50 nominal</sub> = 6 in

MHFD Riprap Type

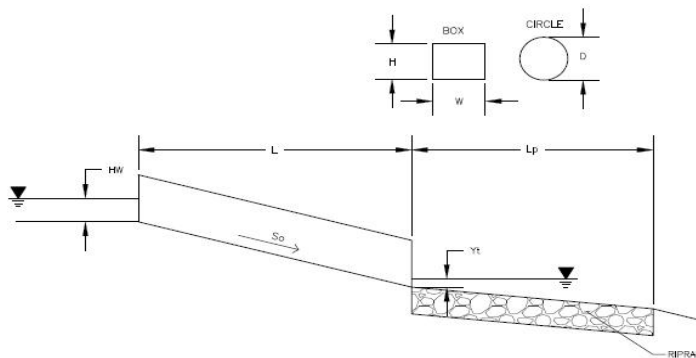
Type = VL

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: OVERLOOK

ID: CULVERT A2-B



Soil Type:

Choose One:

☒ Sandy

☐ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

## Design Information:

Design Discharge

Q = 7.44 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 18 inches

Inlet Edge Type (Choose from pull-down list)

Square Edge with Headwall

OR:

Box Culvert:

Barrel Height (Rise) in Feet

H (Rise) =

Barrel Width (Span) in Feet

W (Span) =

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

# Barrels = 1

Inlet Elevation

Elev IN = 7219.6 ft

Outlet Elevation OR Slope

Elev OUT = 7215.35 ft

Culvert Length

L = 87.8 ft

Manning's Roughness

n = 0.012

Bend Loss Coefficient

k<sub>b</sub> = 0

Exit Loss Coefficient

k<sub>x</sub> = 1

Tailwater Surface Elevation

Y<sub>t</sub>, Elevation =

Max Allowable Channel Velocity

V = 5 ft/s

## Calculated Results:

Culvert Cross Sectional Area Available

A = 1.77 ft<sup>2</sup>

Culvert Normal Depth

Y<sub>n</sub> = 0.56 ft

Culvert Critical Depth

Y<sub>c</sub> = 1.06 ft

Froude Number

Fr = 3.39 Supercritical!

Entrance Loss Coefficient

k<sub>e</sub> = 0.50

Friction Loss Coefficient

k<sub>f</sub> = 1.36

Sum of All Loss Coefficients

k<sub>s</sub> = 2.86 ft

Headwater:

Inlet Control Headwater

HW<sub>i</sub> = 1.68 ft

Outlet Control Headwater

HW<sub>o</sub> = N/A ft

Design Headwater Elevation

HW = 7221.28 ft

Headwater/Diameter OR Headwater/Rise Ratio

HW/D = 1.12

Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

Outlet Protection:

Flow/(Diameter<sup>2.5</sup>)

Q/D<sup>2.5</sup> = 2.70 ft<sup>0.5</sup>/s

Tailwater Surface Height

Y<sub>t</sub> = 0.60 ft

Tailwater/Diameter

Y<sub>t</sub>/D = 0.40

Expansion Factor

1/(2\*tan(θ)) = 4.79

Flow Area at Max Channel Velocity

A<sub>t</sub> = 1.49 ft<sup>2</sup>

Width of Equivalent Conduit for Multiple Barrels

W<sub>eq</sub> = - ft

Length of Riprap Protection

L<sub>p</sub> = 5 ft

Width of Riprap Protection at Downstream End

T = 3 ft

Adjusted Diameter for Supercritical Flow

Da = 1.03 ft

Minimum Theoretical Riprap Size

d<sub>50 min</sub> = 4 in

Nominal Riprap Size

d<sub>50 nominal</sub> = 6 in

MHFD Riprap Type

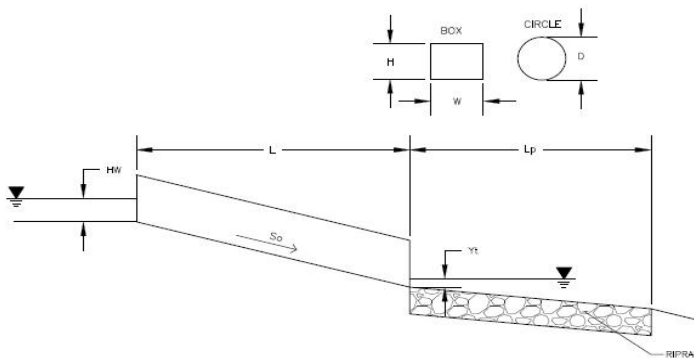
Type = VL

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: OVERLOOK

ID: CULVERT A2-C



Soil Type:

Choose One:

- ☒ Sandy  
☐ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

## Design Information:

Design Discharge

Q = 45.55 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 36 inches

Inlet Edge Type (Choose from pull-down list)

Square Edge with Headwall

OR:

Box Culvert:

Barrel Height (Rise) in Feet

H (Rise) =

Barrel Width (Span) in Feet

W (Span) =

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

# Barrels = 1

Inlet Elevation

Elev IN = 7220.18 ft

Outlet Elevation OR Slope

Elev OUT = 7216.35 ft

Culvert Length

L = 101.4 ft

Manning's Roughness

n = 0.012

Bend Loss Coefficient

k<sub>b</sub> = 0

Exit Loss Coefficient

k<sub>x</sub> = 1

Tailwater Surface Elevation

Y<sub>t</sub>, Elevation =

Max Allowable Channel Velocity

V = 5 ft/s

## Calculated Results:

Culvert Cross Sectional Area Available

A = 7.07 ft<sup>2</sup>

Culvert Normal Depth

Y<sub>n</sub> = 1.17 ft

Culvert Critical Depth

Y<sub>c</sub> = 2.20 ft

Froude Number

Fr = 3.35 Supercritical!

Entrance Loss Coefficient

k<sub>e</sub> = 0.50

Friction Loss Coefficient

k<sub>f</sub> = 0.62

Sum of All Loss Coefficients

k<sub>s</sub> = 2.12 ft

Headwater:

Inlet Control Headwater

HW<sub>i</sub> = 3.62 ft

Outlet Control Headwater

HW<sub>o</sub> = N/A

Design Headwater Elevation

HW = 7223.80 ft

Headwater/Diameter OR Headwater/Rise Ratio

HW/D = 1.21

Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

Outlet Protection:

Flow/(Diameter<sup>2.5</sup>)

Q/D<sup>2.5</sup> = 2.92 ft<sup>0.5</sup>/s

Tailwater Surface Height

Y<sub>t</sub> = 1.20 ft

Tailwater/Diameter

Y<sub>t</sub>/D = 0.40

Expansion Factor

1/(2\*tan(θ)) = 4.49

Flow Area at Max Channel Velocity

A<sub>t</sub> = 9.11 ft<sup>2</sup>

Width of Equivalent Conduit for Multiple Barrels

W<sub>eq</sub> = - ft

Length of Riprap Protection

L<sub>p</sub> = 21 ft

Width of Riprap Protection at Downstream End

T = 8 ft

Adjusted Diameter for Supercritical Flow

Da = 2.09 ft

Minimum Theoretical Riprap Size

d<sub>50</sub> min = 8 in

Nominal Riprap Size

d<sub>50</sub> nominal = 9 in

MHFD Riprap Type

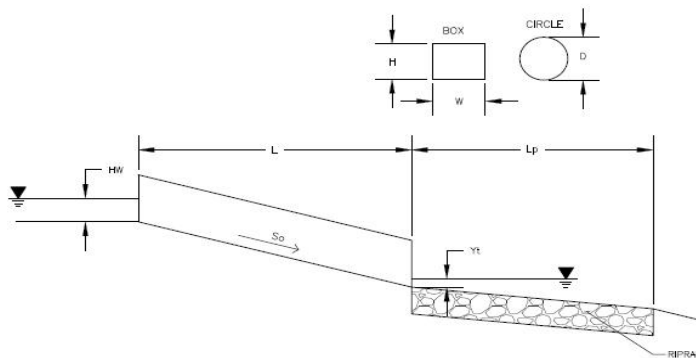
Type = L

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Overlook

ID: A2-D



Soil Type:

Choose One:

☒ Sandy  
☐ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

## Design Information:

Design Discharge

Q = 10.23 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 24 inches

Inlet Edge Type (Choose from pull-down list)

Square Edge with Headwall

OR:

Box Culvert:

Barrel Height (Rise) in Feet

H (Rise) = OR ft

Barrel Width (Span) in Feet

W (Span) = OR ft

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

# Barrels = 1

Inlet Elevation

Elev IN = 7313.3 ft

Outlet Elevation OR Slope

Elev OUT = 7312.4 ft

Culvert Length

L = 86.6 ft

Manning's Roughness

n = 0.012

Bend Loss Coefficient

k<sub>b</sub> = 0

Exit Loss Coefficient

k<sub>x</sub> = 1

Tailwater Surface Elevation

Y<sub>t</sub>, Elevation = OR ft

Max Allowable Channel Velocity

V = 5 ft/s

## Calculated Results:

Culvert Cross Sectional Area Available

A = 3.14 ft<sup>2</sup>

Culvert Normal Depth

Y<sub>n</sub> = 0.89 ft

Culvert Critical Depth

Y<sub>c</sub> = 1.14 ft

Froude Number

Fr = 1.62 Supercritical!

Entrance Loss Coefficient

k<sub>e</sub> = 0.50

Friction Loss Coefficient

k<sub>f</sub> = 0.91

Sum of All Loss Coefficients

k<sub>s</sub> = 2.41 ft

Headwater:

Inlet Control Headwater

HW<sub>i</sub> = 1.72 ft

Outlet Control Headwater

HW<sub>o</sub> = N/A ft

Design Headwater Elevation

HW = 7315.02 ft

Headwater/Diameter OR Headwater/Rise Ratio

HW/D = 0.86

Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

Outlet Protection:

Flow/(Diameter<sup>2.5</sup>)

Q/D<sup>2.5</sup> = 1.81 ft<sup>0.5</sup>/s

Tailwater Surface Height

Y<sub>t</sub> = 0.80 ft

Tailwater/Diameter

Y<sub>t</sub>/D = 0.40

Expansion Factor

1/(2\*tan(θ)) = 5.93

Flow Area at Max Channel Velocity

A<sub>t</sub> = 2.05 ft<sup>2</sup>

Width of Equivalent Conduit for Multiple Barrels

W<sub>eq</sub> = - ft

Length of Riprap Protection

L<sub>p</sub> = 6 ft

Width of Riprap Protection at Downstream End

T = 4 ft

Adjusted Diameter for Supercritical Flow

Da = 1.45 ft

Minimum Theoretical Riprap Size

d<sub>50 min</sub> = 3 in

Nominal Riprap Size

d<sub>50 nominal</sub> = 6 in

MHFD Riprap Type

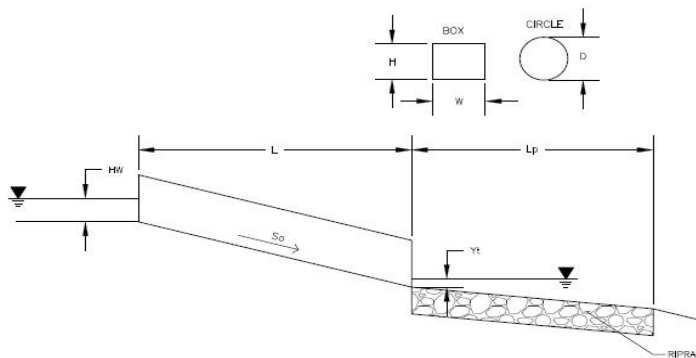
Type = VL

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: OVERLOOK

ID: CULVERT B1-A



Soil Type:

Choose One:

☒ Sandy

☐ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

## Design Information:

Design Discharge

Q = 22.51 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 30 inches

Inlet Edge Type (Choose from pull-down list)

Square Edge with Headwall

OR:

Box Culvert:

Barrel Height (Rise) in Feet

H (Rise) = OR

Barrel Width (Span) in Feet

W (Span) =

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

# Barrels = 1

Inlet Elevation

Elev IN = 7215.76 ft

Outlet Elevation OR Slope

Elev OUT = 7210.52 ft

Culvert Length

L = 125.2 ft

Manning's Roughness

n = 0.012

Bend Loss Coefficient

k<sub>b</sub> = 0

Exit Loss Coefficient

k<sub>x</sub> = 1

Tailwater Surface Elevation

Y<sub>t</sub>, Elevation =

Max Allowable Channel Velocity

V = 5 ft/s

## Calculated Results:

Culvert Cross Sectional Area Available

A = 4.91 ft<sup>2</sup>

Culvert Normal Depth

Y<sub>n</sub> = 0.85 ft

Culvert Critical Depth

Y<sub>c</sub> = 1.61 ft

Froude Number

Fr = 3.45 Supercritical!

Entrance Loss Coefficient

k<sub>e</sub> = 0.50

Friction Loss Coefficient

k<sub>f</sub> = 0.98

Sum of All Loss Coefficients

k<sub>s</sub> = 2.48

Headwater:

Inlet Control Headwater

HW<sub>i</sub> = 2.47 ft

Outlet Control Headwater

HW<sub>o</sub> = N/A

Design Headwater Elevation

HW = 7218.23 ft

Headwater/Diameter OR Headwater/Rise Ratio

HW/D = 0.99

Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

Outlet Protection:

Flow/(Diameter<sup>2.5</sup>)

Q/D<sup>2.5</sup> = 2.28 ft<sup>0.5</sup>/s

Tailwater Surface Height

Y<sub>t</sub> = 1.00 ft

Tailwater/Diameter

Y<sub>t</sub>/D = 0.40

Expansion Factor

1/(2\*tan(θ)) = 5.36

Flow Area at Max Channel Velocity

A<sub>t</sub> = 4.50 ft<sup>2</sup>

Width of Equivalent Conduit for Multiple Barrels

W<sub>eq</sub> = - ft

Length of Riprap Protection

L<sub>p</sub> = 11 ft

Width of Riprap Protection at Downstream End

T = 5 ft

Adjusted Diameter for Supercritical Flow

Da = 1.67 ft

Minimum Theoretical Riprap Size

d<sub>50 min</sub> = 5 in

Nominal Riprap Size

d<sub>50 nominal</sub> = 6 in

MHFD Riprap Type

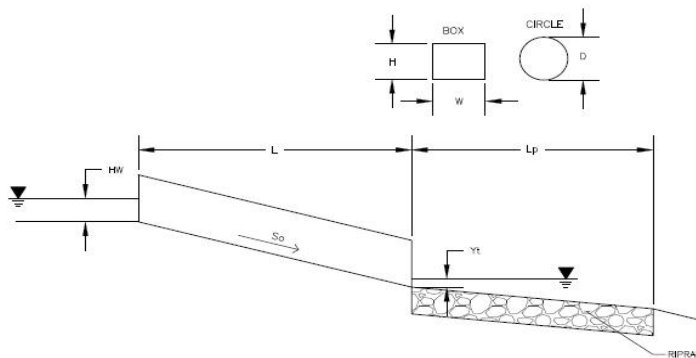
Type = VL

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: OVERLOOK

ID: CULVERT B1-B



Soil Type:

Choose One:

☒ Sandy

☐ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

## Design Information:

Design Discharge

Q = 27.34 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 30 inches

Inlet Edge Type (Choose from pull-down list)

Square Edge with Headwall

OR:

Box Culvert:

Barrel Height (Rise) in Feet

H (Rise) = OR ft

Barrel Width (Span) in Feet

W (Span) = ft

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

# Barrels = 1

Inlet Elevation

Elev IN = 7219.01 ft

Outlet Elevation OR Slope

Elev OUT = 7218.46 ft

Culvert Length

L = 68.26 ft

Manning's Roughness

n = 0.012

Bend Loss Coefficient

k<sub>b</sub> = 0

Exit Loss Coefficient

k<sub>x</sub> = 1

Tailwater Surface Elevation

Y<sub>t</sub>, Elevation = ft

Max Allowable Channel Velocity

V = 5 ft/s

## Calculated Results:

Culvert Cross Sectional Area Available

A = 4.91 ft<sup>2</sup>

Culvert Normal Depth

Y<sub>n</sub> = 1.52 ft

Culvert Critical Depth

Y<sub>c</sub> = 1.78 ft

Froude Number

Fr = 1.37 Supercritical!

Entrance Loss Coefficient

k<sub>e</sub> = 0.50

Friction Loss Coefficient

k<sub>f</sub> = 0.53

Sum of All Loss Coefficients

k<sub>s</sub> = 2.03 ft

Headwater:

Inlet Control Headwater

HW<sub>i</sub> = 2.91 ft

Outlet Control Headwater

HW<sub>o</sub> = 2.57 ft

Design Headwater Elevation

HW = 7221.92 ft

Headwater/Diameter OR Headwater/Rise Ratio

HW/D = 1.16

Outlet Protection:

Flow/(Diameter<sup>2.5</sup>)

Q/D<sup>2.5</sup> = 2.77 ft<sup>0.5</sup>/s

Tailwater Surface Height

Y<sub>t</sub> = 1.00 ft

Tailwater/Diameter

Y<sub>t</sub>/D = 0.40

Expansion Factor

1/(2\*tan(Θ)) = 4.70

Flow Area at Max Channel Velocity

A<sub>t</sub> = 5.47 ft<sup>2</sup>

Width of Equivalent Conduit for Multiple Barrels

W<sub>eq</sub> = - ft

Length of Riprap Protection

L<sub>p</sub> = 14 ft

Width of Riprap Protection at Downstream End

T = 6 ft

Adjusted Diameter for Supercritical Flow

Da = 2.01 ft

Minimum Theoretical Riprap Size

d<sub>50 min</sub> = 6 in

Nominal Riprap Size

d<sub>50 nominal</sub> = 9 in

MHFD Riprap Type

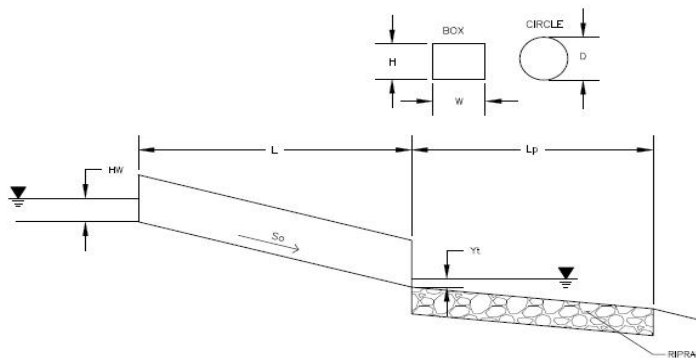
Type = L

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Overlook

ID: CULVERT B6-A



Soil Type:

Choose One:

☒ Sandy

☐ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

## Design Information:

Design Discharge

Q = 104.6 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 36 inches

Inlet Edge Type (Choose from pull-down list)

Square Edge with Headwall

OR:

Box Culvert:

Barrel Height (Rise) in Feet

H (Rise) = OR ft

Barrel Width (Span) in Feet

W (Span) = ft

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

# Barrels = 3

Inlet Elevation

Elev IN = 7227.77 ft

Outlet Elevation OR Slope

Elev OUT = 7227.51 ft

Culvert Length

L = 51.93 ft

Manning's Roughness

n = 0.012

Bend Loss Coefficient

k<sub>b</sub> = 0

Exit Loss Coefficient

k<sub>x</sub> = 1

Tailwater Surface Elevation

Y<sub>t</sub>, Elevation = ft

Max Allowable Channel Velocity

V = 5 ft/s

## Calculated Results:

Culvert Cross Sectional Area Available

A = 7.07 ft<sup>2</sup>

Culvert Normal Depth

Y<sub>n</sub> = 1.81 ft

Culvert Critical Depth

Y<sub>c</sub> = 1.92 ft

Froude Number

Fr = 1.11 Supercritical!

Entrance Loss Coefficient

k<sub>e</sub> = 0.50

Friction Loss Coefficient

k<sub>f</sub> = 0.32

Sum of All Loss Coefficients

k<sub>s</sub> = 1.82 ft

Headwater:

Inlet Control Headwater

HW<sub>i</sub> = 2.98 ft

Outlet Control Headwater

HW<sub>o</sub> = 2.89 ft

Design Headwater Elevation

HW = 7230.75 ft

Headwater/Diameter OR Headwater/Rise Ratio

HW/D = 0.99

Outlet Protection:

Flow/(Diameter<sup>2.5</sup>)

Q/D<sup>2.5</sup> = 2.24 ft<sup>0.5</sup>/s

Tailwater Surface Height

Y<sub>t</sub> = 1.20 ft

Tailwater/Diameter

Y<sub>t</sub>/D = 0.40

Expansion Factor

1/(2\*tan(θ)) = 5.42

Flow Area at Max Channel Velocity

A<sub>t</sub> = 20.92 ft<sup>2</sup>

Width of Equivalent Conduit for Multiple Barrels

W<sub>eq</sub> = 9.00 ft

Length of Riprap Protection

L<sub>p</sub> = 30 ft

Width of Riprap Protection at Downstream End

T = 15 ft

Adjusted Diameter for Supercritical Flow

Da = 2.41 ft

Minimum Theoretical Riprap Size

d<sub>50 min</sub> = 6 in

Nominal Riprap Size

d<sub>50 nominal</sub> = 6 in

MHFD Riprap Type

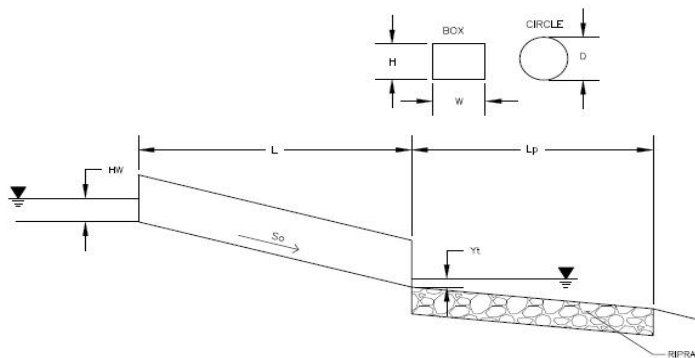
Type = VL

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Overlook

ID: CULVERT B6-A (Bulk Flows)



Soil Type:

Choose One:

☒ Sandy

☐ Non-Sandy

## Design Information:

Design Discharge

Q = 156.9 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 36 inches

Inlet Edge Type (Choose from pull-down list)

Square Edge with Headwall

OR:

Box Culvert:

Barrel Height (Rise) in Feet

H (Rise) = OR ft

Barrel Width (Span) in Feet

W (Span) = OR ft

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

# Barrels = 3

Inlet Elevation

Elev IN = 7227.77 ft

Outlet Elevation OR Slope

Elev OUT = 7227.51 ft

Culvert Length

L = 51.93 ft

Manning's Roughness

n = 0.012

Bend Loss Coefficient

k<sub>b</sub> = 0

Exit Loss Coefficient

k<sub>x</sub> = 1

Tailwater Surface Elevation

Y<sub>t</sub>, Elevation = OR ft

Max Allowable Channel Velocity

V = 5 ft/s

## Calculated Results:

Culvert Cross Sectional Area Available

A = 7.07 ft<sup>2</sup>

Culvert Normal Depth

Y<sub>n</sub> = 2.52 ft

Culvert Critical Depth

Y<sub>c</sub> = 2.35 ft

Froude Number

Fr = 0.86

Entrance Loss Coefficient

k<sub>e</sub> = 0.50

Friction Loss Coefficient

k<sub>f</sub> = 0.32

Sum of All Loss Coefficients

k<sub>s</sub> = 1.82 ft

Headwater:

Inlet Control Headwater

HW<sub>i</sub> = 4.17 ft

Outlet Control Headwater

HW<sub>o</sub> = 3.96 ft

Design Headwater Elevation

HW = 7231.94 ft

Headwater/Diameter OR Headwater/Rise Ratio

HW/D = 1.39

Outlet Protection:

Flow/(Diameter<sup>2.5</sup>)

Q/D<sup>2.5</sup> = 3.36 ft<sup>0.5</sup>/s

Tailwater Surface Height

Y<sub>t</sub> = 1.20 ft

Tailwater/Diameter

Y<sub>t</sub>/D = 0.40

Expansion Factor

1/(2\*tan(Θ)) = 4.07

Flow Area at Max Channel Velocity

A<sub>t</sub> = 31.38 ft<sup>2</sup>

Width of Equivalent Conduit for Multiple Barrels

W<sub>eq</sub> = 9.00 ft

Length of Riprap Protection

L<sub>p</sub> = 30 ft

Width of Riprap Protection at Downstream End

T = 17 ft

Adjusted Diameter for Supercritical Flow

Da = - ft

Minimum Theoretical Riprap Size

d<sub>50</sub> min = 8 in

Nominal Riprap Size

d<sub>50</sub> nominal = 9 in

MHFD Riprap Type

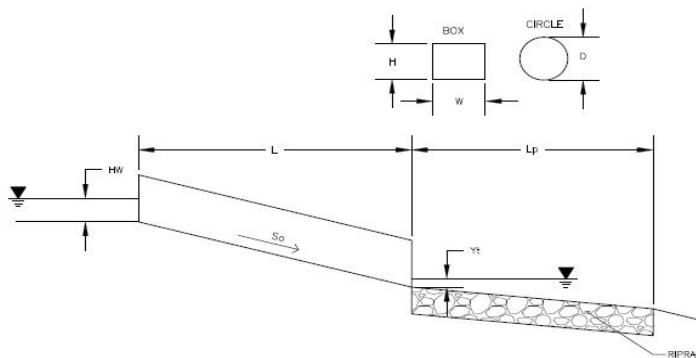
Type = L

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project:

ID: B6-B



Soil Type:

Choose One:

☐ Sandy

☐ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

## Design Information:

Design Discharge

Q = 5.63 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 18 inches

Inlet Edge Type (Choose from pull-down list)

Square Edge with Headwall

OR:

Box Culvert:

Barrel Height (Rise) in Feet

H (Rise) = OR ft

Barrel Width (Span) in Feet

W (Span) = ft

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

# Barrels = 1

Inlet Elevation

Elev IN = 7245 ft

Outlet Elevation OR Slope

Elev OUT = 7244 ft

Culvert Length

L = 18 ft

Manning's Roughness

n = 0.012

Bend Loss Coefficient

k<sub>b</sub> = 0

Exit Loss Coefficient

k<sub>x</sub> = 1

Tailwater Surface Elevation

Y<sub>t</sub>, Elevation = ft

Max Allowable Channel Velocity

V = 5 ft/s

## Calculated Results:

Culvert Cross Sectional Area Available

A = 1.77 ft<sup>2</sup>

Culvert Normal Depth

Y<sub>n</sub> = 0.47 ft

Culvert Critical Depth

Y<sub>c</sub> = 0.92 ft

Froude Number

Fr = 3.65 Supercritical!

Entrance Loss Coefficient

k<sub>e</sub> = 0.50

Friction Loss Coefficient

k<sub>f</sub> = 0.28

Sum of All Loss Coefficients

k<sub>s</sub> = 1.78 ft

Headwater:

Inlet Control Headwater

HW<sub>i</sub> = 1.36 ft

Outlet Control Headwater

HW<sub>o</sub> = N/A ft

Design Headwater Elevation

HW = 7246.36 ft

Headwater/Diameter OR Headwater/Rise Ratio

HW/D = 0.91

Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

Outlet Protection:

Flow/(Diameter<sup>2.5</sup>)

Q/D<sup>2.5</sup> = 2.04 ft<sup>0.5</sup>/s

Tailwater Surface Height

Y<sub>t</sub> = 0.60 ft

Tailwater/Diameter

Y<sub>t</sub>/D = 0.40

Expansion Factor

1/(2\*tan(θ)) = 5.68

Flow Area at Max Channel Velocity

A<sub>t</sub> = 1.13 ft<sup>2</sup>

Width of Equivalent Conduit for Multiple Barrels

W<sub>eq</sub> = - ft

Length of Riprap Protection

L<sub>p</sub> = 5 ft

Width of Riprap Protection at Downstream End

T = 3 ft

Adjusted Diameter for Supercritical Flow

Da = 0.98 ft

Minimum Theoretical Riprap Size

d<sub>50 min</sub> = 3 in

Nominal Riprap Size

d<sub>50 nominal</sub> = 6 in

MHFD Riprap Type

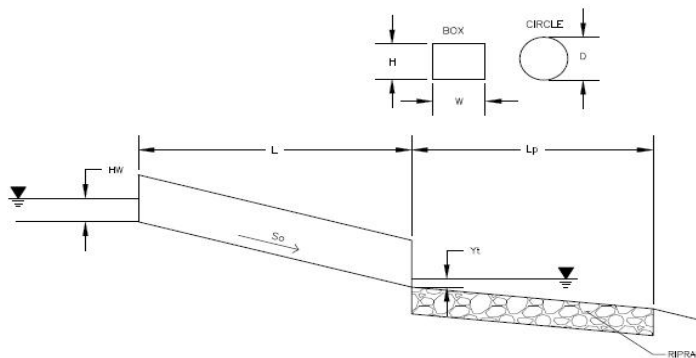
Type = VL

# DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project:

ID: B6-C



Soil Type:

Choose One:

☒ Sandy  
☐ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

## Design Information:

Design Discharge

Q = 3.26 cfs

Circular Culvert:

Barrel Diameter in Inches

D = 12 inches

Inlet Edge Type (Choose from pull-down list)

Square Edge with Headwall

OR:

Box Culvert:

Barrel Height (Rise) in Feet

H (Rise) =

Barrel Width (Span) in Feet

W (Span) =

Inlet Edge Type (Choose from pull-down list)

Number of Barrels

# Barrels = 1

Inlet Elevation

Elev IN = 7339.3 ft

Outlet Elevation OR Slope

Elev OUT = 7329.5 ft

Culvert Length

L = 68 ft

Manning's Roughness

n = 0.012

Bend Loss Coefficient

k<sub>b</sub> = 0

Exit Loss Coefficient

k<sub>x</sub> = 1

Tailwater Surface Elevation

Y<sub>t</sub>, Elevation =

Max Allowable Channel Velocity

V = 5 ft/s

## Calculated Results:

Culvert Cross Sectional Area Available

A = 0.79 ft<sup>2</sup>

Culvert Normal Depth

Y<sub>n</sub> = 0.32 ft

Culvert Critical Depth

Y<sub>c</sub> = 0.77 ft

Froude Number

Fr = 5.50 Supercritical!

Entrance Loss Coefficient

k<sub>e</sub> = 0.50

Friction Loss Coefficient

k<sub>f</sub> = 1.80

Sum of All Loss Coefficients

k<sub>s</sub> = 3.30 ft

Headwater:

Inlet Control Headwater

HW<sub>i</sub> = 1.28 ft

Outlet Control Headwater

HW<sub>o</sub> = N/A

Design Headwater Elevation

HW = 7340.58 ft

Headwater/Diameter OR Headwater/Rise Ratio

HW/D = 1.28

Outlet Control Headwater Approximation Method Inaccurate for Low Flow - Backwater Calculations Required

Outlet Protection:

Flow/(Diameter<sup>2.5</sup>)

Q/D<sup>2.5</sup> = 3.26 ft<sup>0.5</sup>/s

Tailwater Surface Height

Y<sub>t</sub> = 0.40 ft

Tailwater/Diameter

Y<sub>t</sub>/D = 0.40

Expansion Factor

1/(2\*tan(θ)) = 4.15

Flow Area at Max Channel Velocity

A<sub>t</sub> = 0.65 ft<sup>2</sup>

Width of Equivalent Conduit for Multiple Barrels

W<sub>eq</sub> = - ft

Length of Riprap Protection

L<sub>p</sub> = 3 ft

Width of Riprap Protection at Downstream End

T = 2 ft

Adjusted Diameter for Supercritical Flow

Da = 0.66 ft

Minimum Theoretical Riprap Size

d<sub>50 min</sub> = 3 in

Nominal Riprap Size

d<sub>50 nominal</sub> = 6 in

MHFD Riprap Type

Type = VL

## Active Scenario: 5 Year

FlexTable: Conduit Table

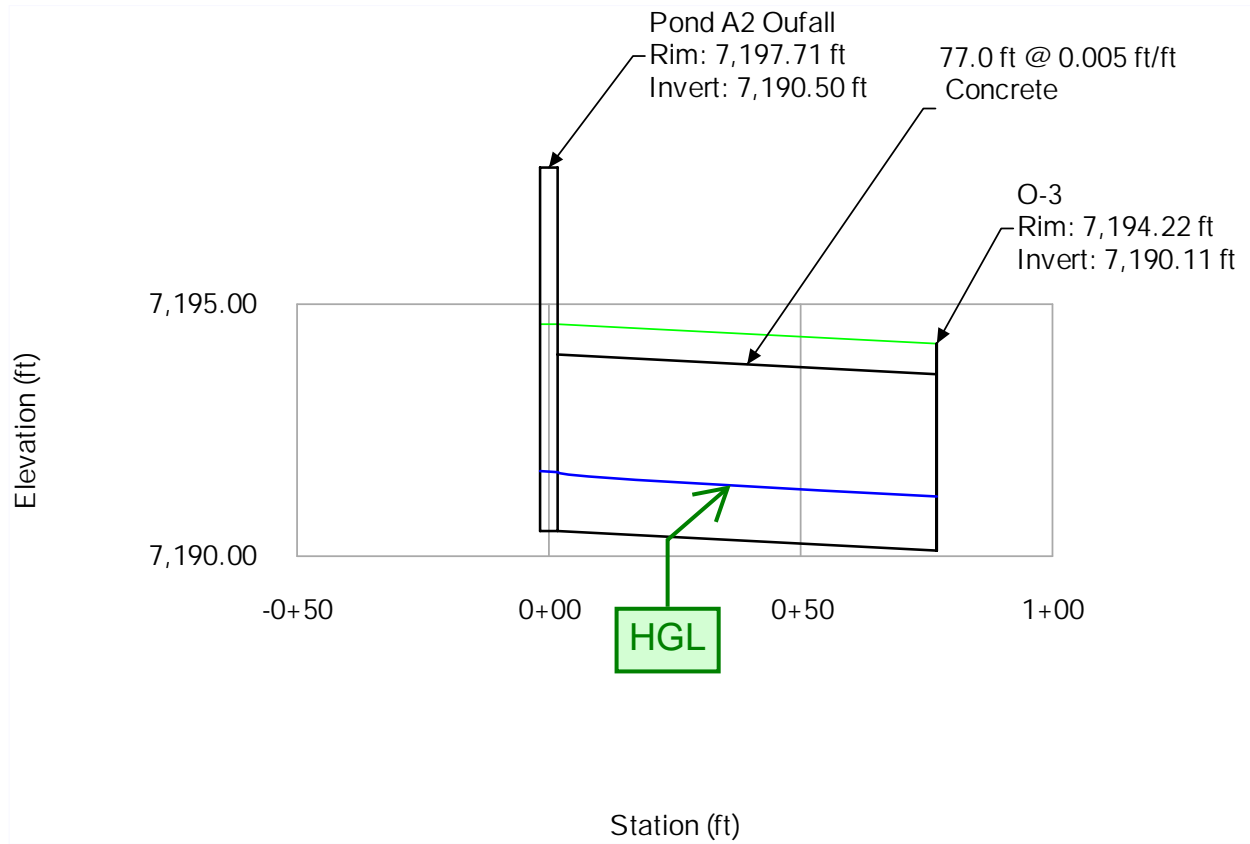
Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Flow (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
PIPE -21 (STORM)	Pond B1 Outfall	O-2	7,191.42	7,190.00	59.2	0.024	36.0	7.10	8.37	7,192.26	7,190.54
PIPE -23 (STORM)	Pond A2 Oufall	O-3	7,190.50	7,190.11	77.0	0.005	42.0	14.70	5.85	7,191.67	7,191.19
PIPE -15 (STORM)	Pond B8 Outfall	O-1	7,185.50	7,184.08	68.1	0.021	36.0	10.40	8.91	7,186.52	7,184.76

# Active Scenario: 100 year

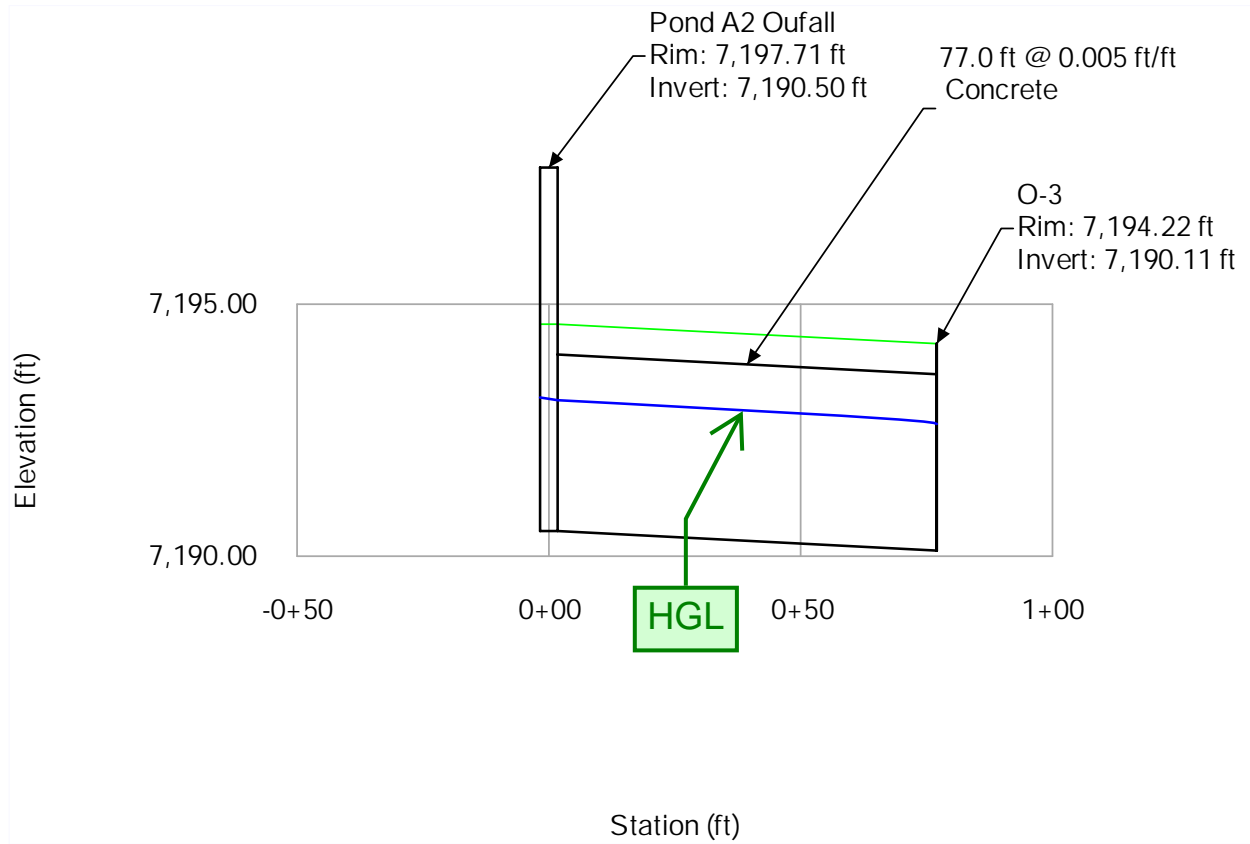
## FlexTable: Conduit Table

Label	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Diameter (in)	Flow (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)
PIPE -21 (STORM)	Pond B1 Outfall	O-2	7,191.42	7,190.00	59.2	0.024	36.0	42.50	13.90	7,193.54	7,191.49
PIPE -23 (STORM)	Pond A2 Outfall	O-3	7,190.50	7,190.11	77.0	0.005	42.0	64.40	8.42	7,193.09	7,192.63
PIPE -15 (STORM)	Pond B8 Outfall	O-1	7,185.50	7,184.08	68.1	0.021	36.0	39.40	12.94	7,187.54	7,185.53

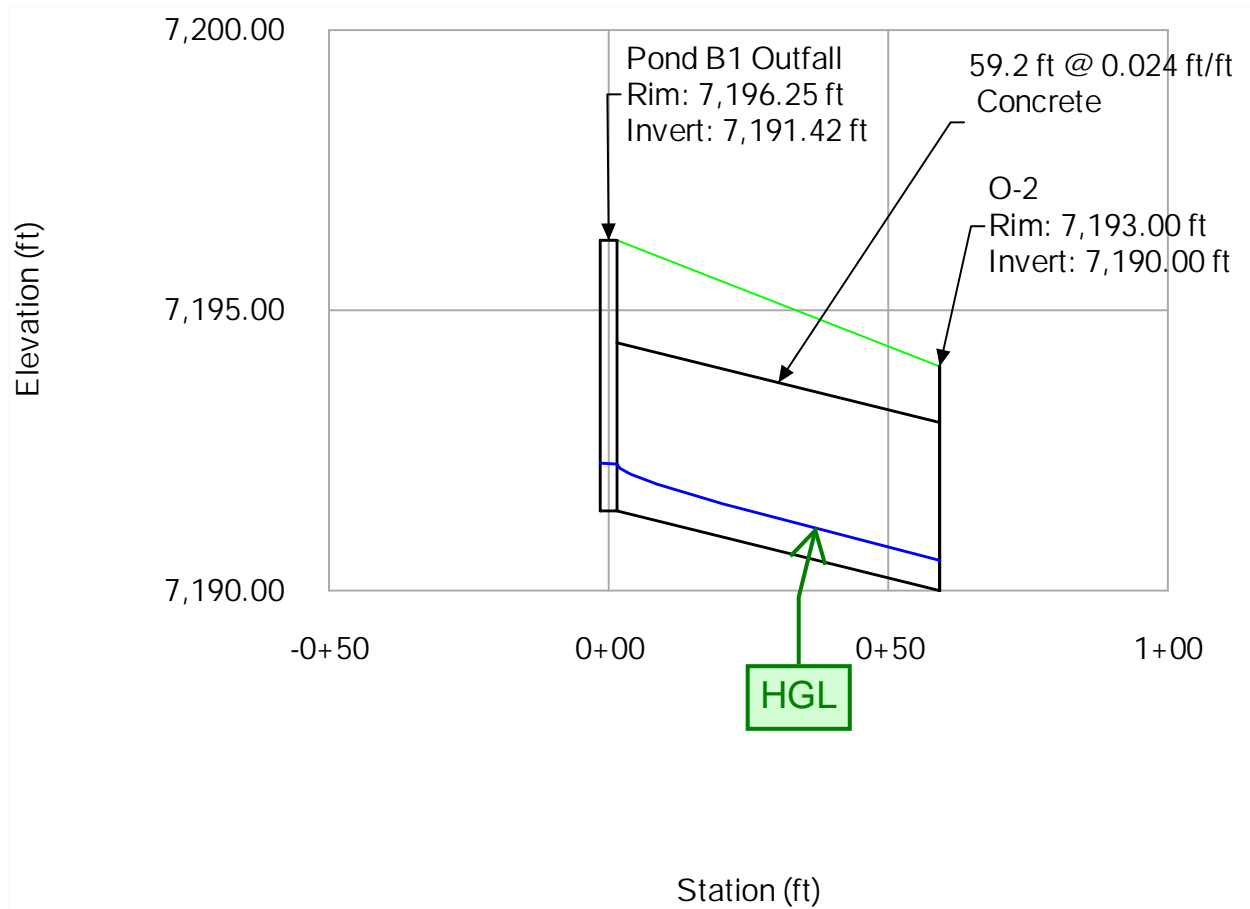
Active Scenario: 5 Year  
Profile Report  
Engineering Profile - Pond A2 (Untitled1.stsw)



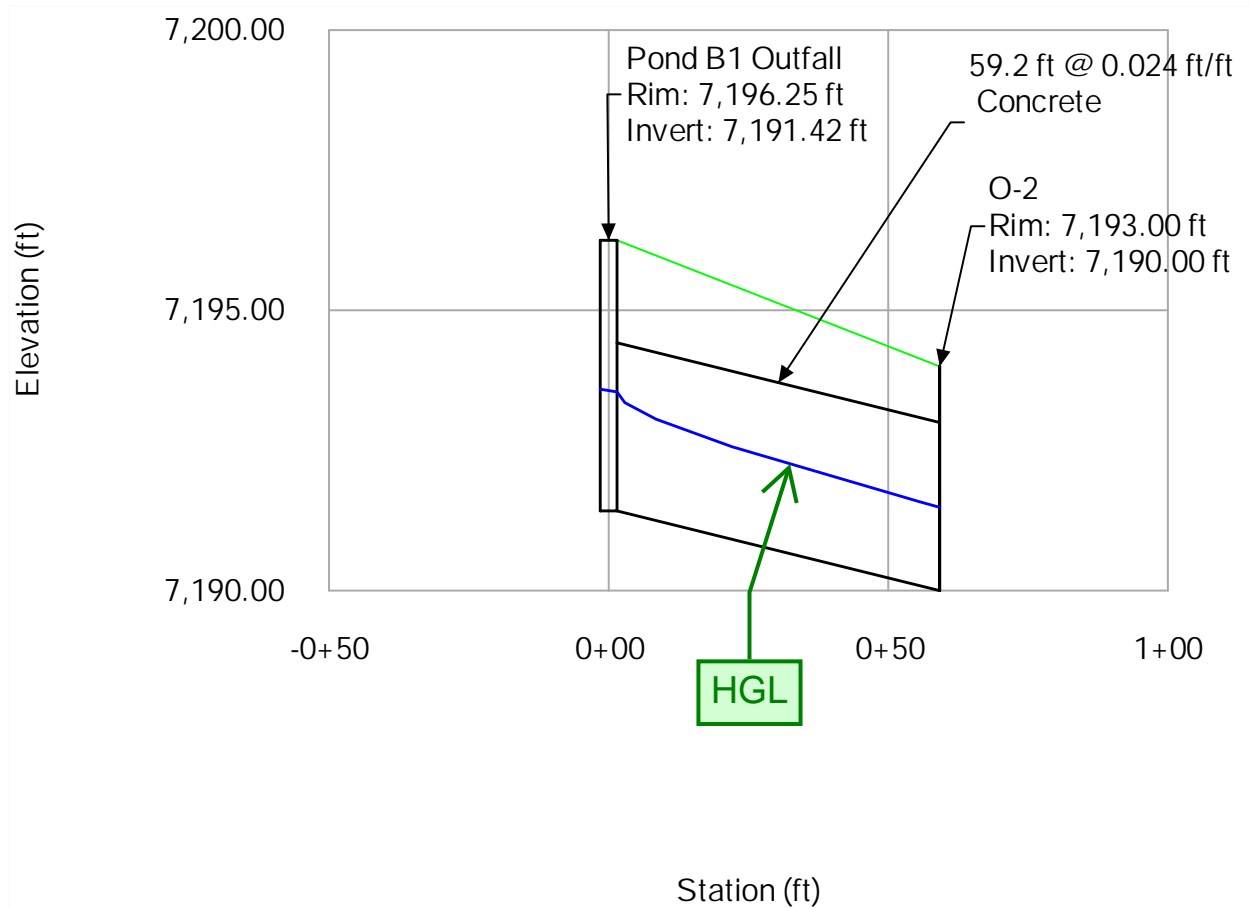
Active Scenario: 100 year  
Profile Report  
Engineering Profile - Pond A2 (Untitled1.stsw)



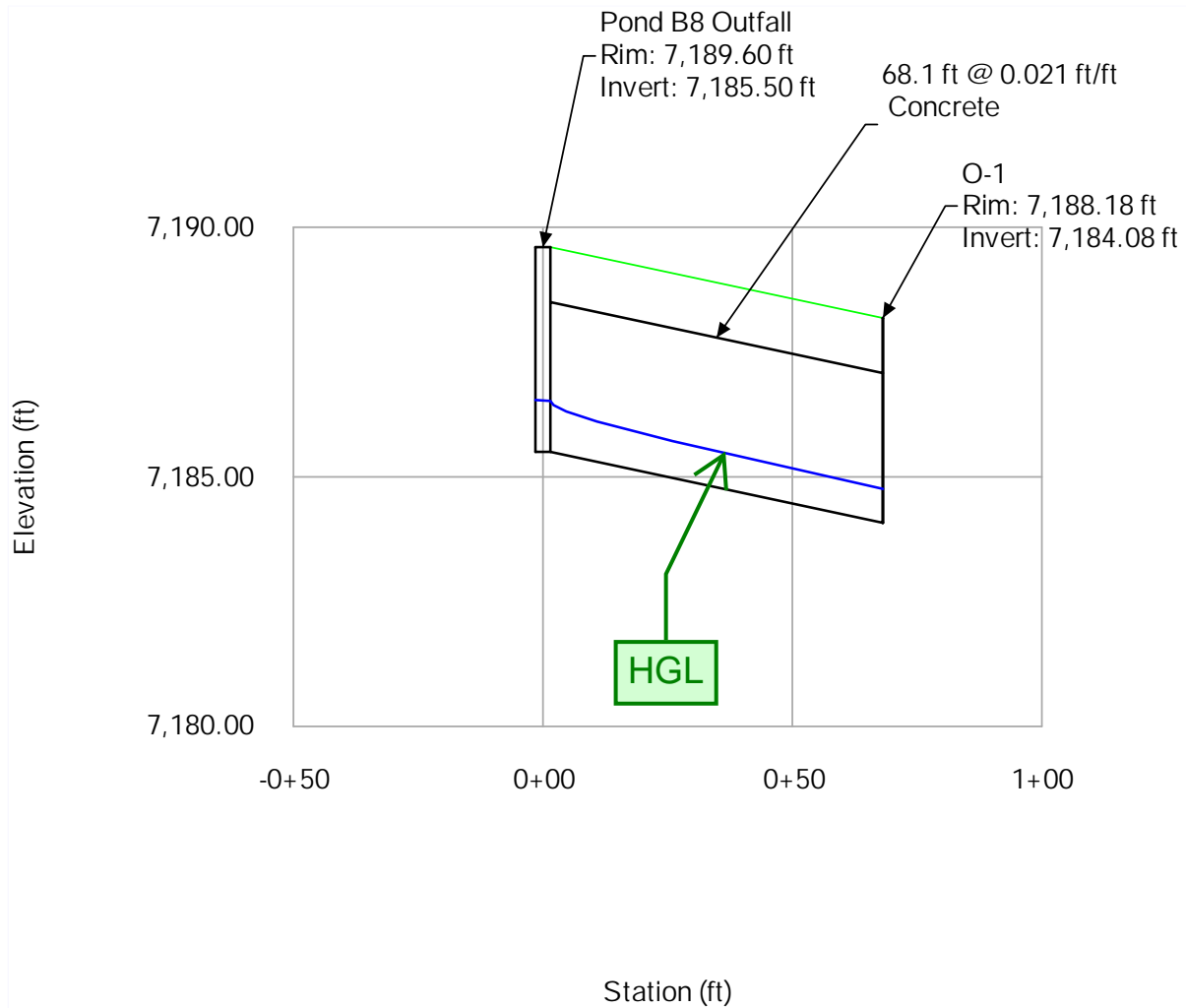
Active Scenario: 5 Year  
Profile Report  
Engineering Profile - Pond B1 (Untitled1.stsw)



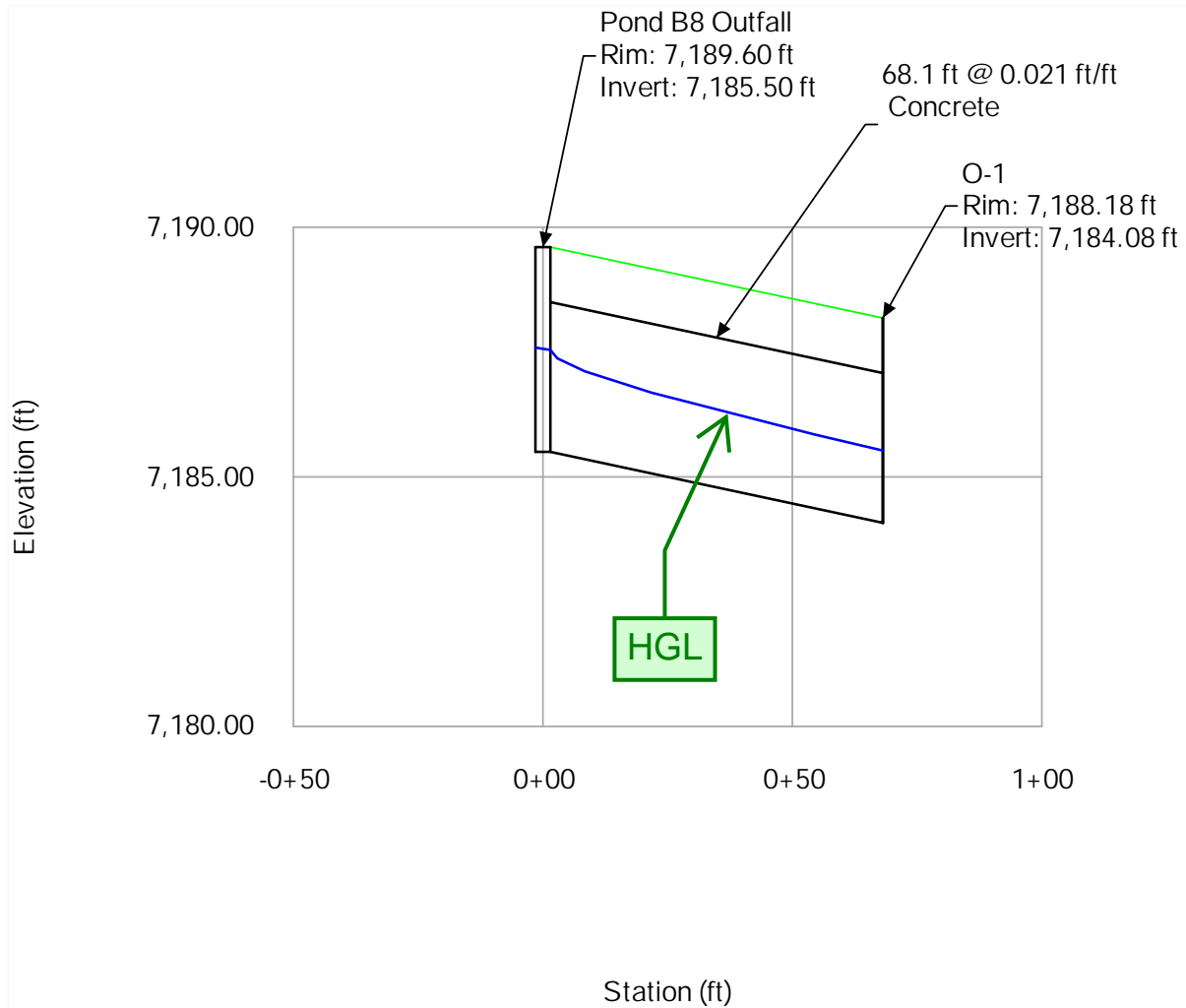
Active Scenario: 100 year  
Profile Report  
Engineering Profile - Pond B1 (Untitled1.stsw)



Active Scenario: 5 Year  
Profile Report  
Engineering Profile - Pond B8 (Untitled1.stsw)

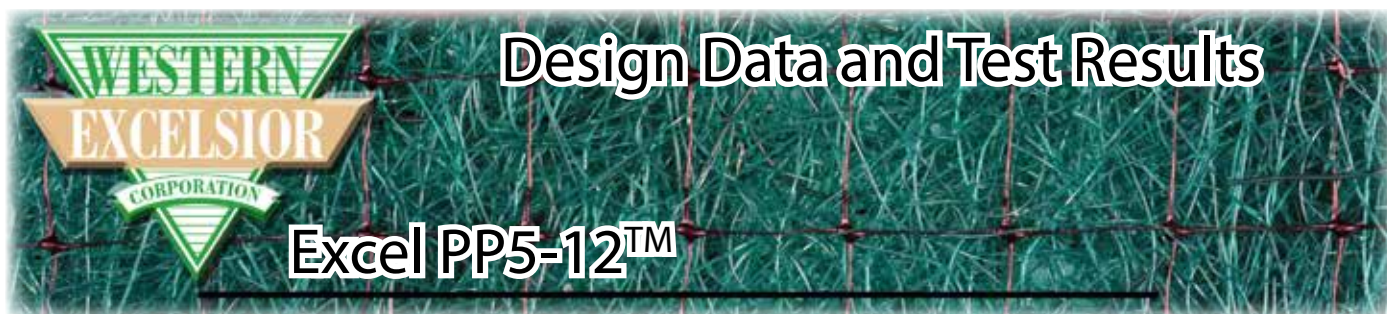


Active Scenario: 100 year  
Profile Report  
Engineering Profile - Pond B8 (Untitled1.stsw)



ROADSIDE DITCH SUMMARY TABLE

ROADWAY	FROM STA	TO STA	PROPOSED SLOPE (%)	SIDE	SIDE SLOPE	CHANNEL DEPTH (FT)	FRICTION FACTOR	BASIN	Q100 FLOW (CFS)	DITCH FLOW % OF BASIN	DITCH FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	FROUDE NUMBER	DITCH LINING	NOTES
HATBAND DRIVE	1+30	2+80	2.75%	LEFT	4:1/4:1	2.5	0.04	A1	41.24	0.9%	0.37	0.25	1.50	0.750	GRASS	
HATBAND DRIVE	1+30	3+40	2.75%	RIGHT	4:1/4:1	2.5	0.04	A2	97.07	0.4%	0.37	0.24	1.48	0.749	GRASS	
HATBAND DRIVE	2+80	3+80	2.75%	LEFT	4:1/4:1	2.5	0.04	A2	97.07	0.5%	0.49	0.27	1.59	0.762	GRASS	
HATBAND DRIVE	4+90	7+20	2.75%	LEFT	4:1/4:1	2.5	0.04	A2	97.07	1.1%	1.06	0.36	1.93	0.800	GRASS	
HATBAND DRIVE	6+13	7+20	2.75%	RIGHT	4:1/4:1	2.5	0.04	A2	97.07	0.2%	0.19	0.19	1.26	0.719	GRASS	
HATBAND DRIVE	12+60	15+00	1.00%	LEFT	4:1/4:1	2.5	0.04	B1	76.45	0.7%	0.50	0.34	1.12	0.479	GRASS	
HATBAND DRIVE	12+60	15+00	1.00%	RIGHT	4:1/4:1	2.5	0.04	B1	76.45	0.6%	0.45	0.33	1.09	0.475	GRASS	
HATBAND DRIVE	15+00	18+00	2.00%	LEFT	4:1/4:1	2.5	0.04	B1	76.45	24.4%	18.65	1.17	3.60	0.830	GRASS	
HATBAND DRIVE	15+00	18+00	2.00%	RIGHT	4:1/4:1	2.5	0.04	B1	76.45	0.7%	0.57	0.32	1.50	0.667	GRASS	
HATBAND DRIVE	19+75	20+45	3.00%	RIGHT	4:1/4:1	2.5	0.04	B1	76.45	0.1%	0.08	0.29	1.74	0.806	GRASS	
HATBAND DRIVE	20+45	22+00	2.00%	RIGHT	4:1/4:1	2.5	0.04	B2	37.85	1.1%	0.43	0.28	1.39	0.655	GRASS	
HATBAND DRIVE	20+20	22+75	2.40%	LEFT	4:1/4:1	2.5	0.04	B1	76.45	1.3%	0.99	0.38	1.85	0.753	GRASS	
SALOON DRIVE	3+30	5+90	1.25%	LEFT	4:1/4:1	2.5	0.04	A2	97.07	0.28%	0.27	0.25	1.02	0.507	GRASS	
SALOON DRIVE	3+30	6+10	1.50%	RIGHT	4:1/4:1	2.5	0.04	A2	97.07	27.8%	26.98	1.37	3.46	0.738	GRASS	
SALOON DRIVE	7+00	10+80	6.00%	LEFT	4:1/4:1	2.5	0.04	A2	97.07	1.1%	1.07	0.32	2.62	1.158	TRM	
SALOON DRIVE	10+80	END	1.30%	LEFT	4:1/4:1	2.5	0.04	A2	97.07	0.7%	0.68	0.35	1.30	0.547	GRASS	
CAMPOUT DRIVE	7+45	8+20	9.50%	RIGHT	4:1/4:1	1.75	0.04	B1	76.45	0.2%	0.15	0.14	1.94	1.277	TRM	
CAMPOUT DRIVE	2+50	13+92	5.15%	LEFT	4:1/3:1	2.5	0.04	B6	106.32	21.8%	23.23	1.10	5.51	1.310	TRM	
CAMPOUT DRIVE	16+80	25+80	1.00%	LEFT	4:1/4:1	2.5	0.04	B6	106.32	84.9%	90.27	2.36	4.07	0.660	GRASS	
CAMPOUT DRIVE	25+80	END	1.00%	LEFT	4:1/4:1	2.5	0.04	B6	106.32	13.2%	14.03	1.18	2.55	0.587	GRASS	
CAMPOUT DRIVE	27+80	29+60	1.00%	RIGHT	4:1/4:1	2.5	0.04	B6	106.32	0.3%	0.28	0.27	0.96	0.460	GRASS	
APEX RANCH ROAD	START	4+80	3.00%	LEFT	4:1/4:1	2.5	0.04	OS-C1/OS-A3	63.55*	4.1%*	3.96*	0.64	2.81	0.908	GRASS	* INLCUDES FLOW FROM SUB-BASINS OS-C1, AND OS-A3
APEX RANCH ROAD	START	4+30	2.93%	RIGHT	4:1/4:1	2.5	0.04	OS-C1/OS-A2	68.02*	2.8%*	0.69	0.31	1.80	0.805	GRASS	* INLCUDES FLOW FROM SUB-BASINS OS-C1, AND OS-A2
APEX RANCH ROAD	12+30	16+60	10.00%	LEFT	4:1/2:1	2.5	0.04	A2	97.07	2.0%	1.94	0.40	3.87	1.523	TRM	
APEX RANCH ROAD	16+60	18+30	5.15%	LEFT	4:1/2:1	2.5	0.04	A2	97.07	0.7%	0.68	0.31	2.32	1.045	TRM	
APEX RANCH ROAD	12+65	20+00	10.00%	RIGHT	3:1/3:1	0.667	0.04	B6	106.32	2.0%	2.13	0.43	3.96	1.518	TRM	



# Design Data and Test Results

## Excel PP5-12™



## Specifications

A variety of test methods are utilized to determine performance and conformance values for Rolled Erosion Control Products (RECPs). Information within this document is presented to provide conformance values and recommended design values. Test results obtained for the Excel PP5-12 Turf Reinforcement Mat (TRM) and general design values are presented in Tables 1-4. For specific information detailing testing protocols, results and application of design values, refer to document number WE\_EXCEL\_PERF\_GEN.

Table 1 - Bench Scale Testing / NTPEP

Test Method	Condition	Result
ASTM D7101 Bench Scale Rainfall and Rainsplash Test	2 in per hour	14.53
	4 in per hour	5.59
	6 in per hour	4.82
ASTM D7207 Bench Scale Shear Resistance Test	3.0 psf (145 PA)	0.5 in (12 mm)
ASTM D7322 Bench Scale Vegetation Establishment Test	Top Soil, Fescue, 21 Day Incubation	661 %
NTPEP Report Number	ECP-2016-03-008	

Table 3 - Recommended Design Values\*

Design Value	Unvegetated	Vegetated
Typical RUSLE Cover Factor (C Factor)**	0.03	N/A
Maximum Slope Gradient (RUSLE)	1H : 1V	N/A
Max Allowable Velocity (0.5 in (12mm) soil loss)***	9.0 ft/s (2.7 m/s)	15.0 ft/s (4.6 m/s)
Max Allowable Shear Stress (0.5 in (12mm) soil loss)***	2.8 psf (134 PA)	12.0 psf (575 PA)
CF <sub>veg</sub> /CF <sub>TRM</sub>	N/A	0.26
**C Factor value compliant with ASTM D6459. *** Shear Stress and Velocity values compliant with ASTM D6460.		

Table 2 - Texas Transportation Institute (TTI) Results

Class	Test Condition	Result
A	< 3H:1 Clay Slope Test	N/A
B	< 3H:1 Sand Slope Test	N/A
C	> 3H:1 Clay Slope Test	N/A
D	> 3H:1 Sand Slope Test	N/A
E	2 psf Partially Vegetated Channel Test	Approved
F	4 psf Partially Vegetated Channel Test	Approved
G	6 psf Partially Vegetated Channel Test	Approved
H	8 psf Partially Vegetated Channel Test	Approved

Table 4 - HEC-15 Resistance to Flow Values

Design Value	Unvegetated
Manning's n @ Tau lower (0.7 psf (34 PA))	0.027
Manning's n @ Tau mid (1.4 psf (67 PA))	0.027
Manning's n @ Tau upper (2.8 psf (134 PA))	0.027

\*Recommended Design Values are based on results of standardized industry full-scale testing and may not be applicable for all field conditions. For most accurate computation of field performance, consult Excel Erosion Design (EED) at [www.westernexcelsior.com](http://www.westernexcelsior.com).

The information contained herein may represent product index data, performance ratings, bench scale testing or other material utility quantifications. Each representation may have unique utility and limitations. Every effort has been made to ensure accuracy, however, no warranty is claimed and no liability shall be assumed by Western Excelsior Corporation (WEC) or its affiliates regarding the completeness, accuracy or fitness of these values for any particular application or interpretation. While testing methods are provided for reference, values shown may be derived from interpolation or adjustment to be representative of intended use. For further information, please feel free to contact WEC.

## Elbert Rd Roadside Ditch

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth
Input Data	
Channel Slope	0.020 ft/ft
Discharge	64.40 cfs

### Section Definitions

Station (ft)	Elevation (ft)
0+00	88.75
0+05	86.30
0+15	86.30
0+20	88.75

### Roughness Segment Definitions

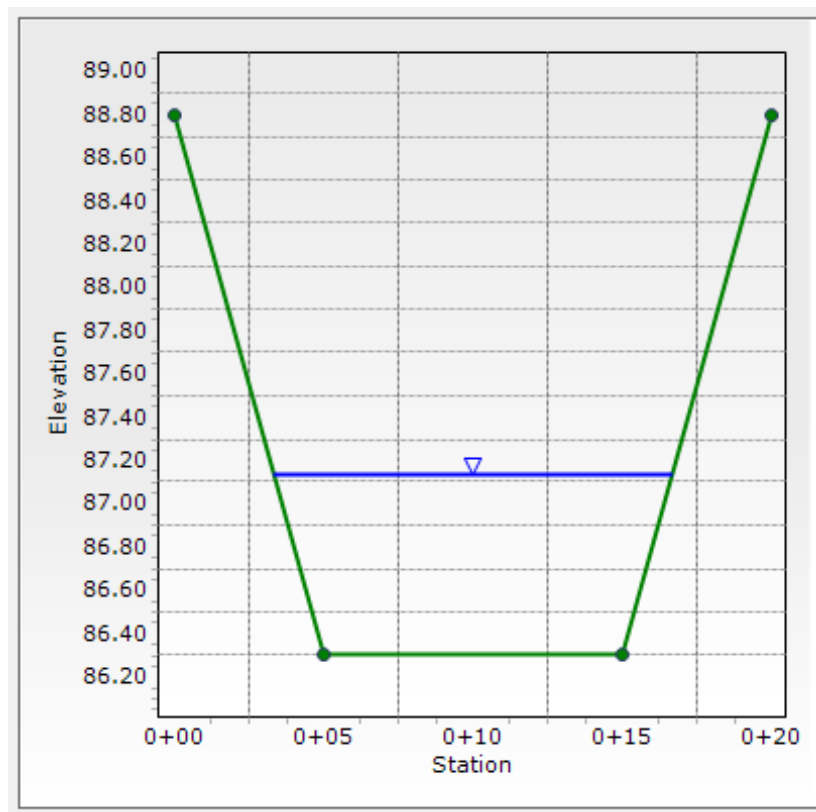
Start Station	Ending Station	Roughness Coefficient
(0+00, 88.75)	(0+05, 86.30)	0.025
(0+05, 86.30)	(0+15, 86.30)	0.025
(0+15, 86.30)	(0+20, 88.75)	0.025

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	9.9 in
Roughness Coefficient	0.025
Elevation	87.13 ft
Elevation Range	86.3 to 88.8 ft
Flow Area	9.7 ft <sup>2</sup>
Wetted Perimeter	13.8 ft
Hydraulic Radius	8.4 in
Top Width	13.38 ft
Normal Depth	9.9 in
Critical Depth	12.1 in
Critical Slope	0.010 ft/ft
Velocity	6.65 ft/s
Velocity Head	0.69 ft
Specific Energy	1.52 ft
Froude Number	1.378

## Elbert Rd Roadside Ditch

Results	
Flow Type	Supercritical
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0
GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	9.9 in
Critical Depth	12.1 in
Channel Slope	0.020 ft/ft
Critical Slope	0.010 ft/ft



Rock Chute ID	Forebay ID	Rock Chute Location	Contributing Basins	Q100 Flow (cfs)	Upstream Inlet Apron Length (ft)	Drop (ft) (Inlet Apron to Outlet Apron)	Chute Length (ft)	Chute Slope (%)	Downstream Outlet Apron Length (ft)	Chute Width (ft)	D50 (in)	Rock Chute Thickness (in)	Rock Chute Depth* (ft)	Top Width (ft)	Berm Length	Berm Height (ft)	Berm Side Slopes	Total Berm Depth (ft)
A2-W	A2-W	Pond A2	A2	18	10	3	16	25	7	10	6	12	2.0	26.0	26.0	1	2.5:1	7.5
A2-W2	A2-W2	Pond A2	A2	3			20			15	6	12			15.0	1	2.5	7.5
A2-C	A2-C	Pond A2	A2	3	10	8	36	25	7	10	6	12	1.5	22.0	22.0	1	2.5:1	7.5
A2-E	A2-E	Pond A2	A2	18	10	9	40	25	7	10	6	12	1.5	22.0	22.0	1	2.5:1	7.5
B1-W	B1-W	Pond B1	B1	25	12	0.8	25	3	23	12	6	12	1.5	24.0	24.0	1	2.5:1	7.5
B1-E	B1-E	Pond B1	B1	5	10	3.75	19	25	10	10	6	12	2.0	26.0	38.0	1	2.5:1	7.5
B8-W	B8-W	Pond B8	B6, B8	119	13	8	36	25	17	10	18	36	3.0	34.0	34.0	1	2.5:1	7.5
B8-E	B8-E	Pond B8	B8	23	10	9	36	25	8	10	6	12	2.0	26.0	26.0	1	2.5:1	7.5

NOTES:

\*: Rock Chute Depth accounts for 0.5' of freeboard.

# Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Pond A2- East Chute  
 Designer: KRK  
 Date: April 30, 2024

County: El Paso County  
 Checked by: \_\_\_\_\_  
 Date: \_\_\_\_\_

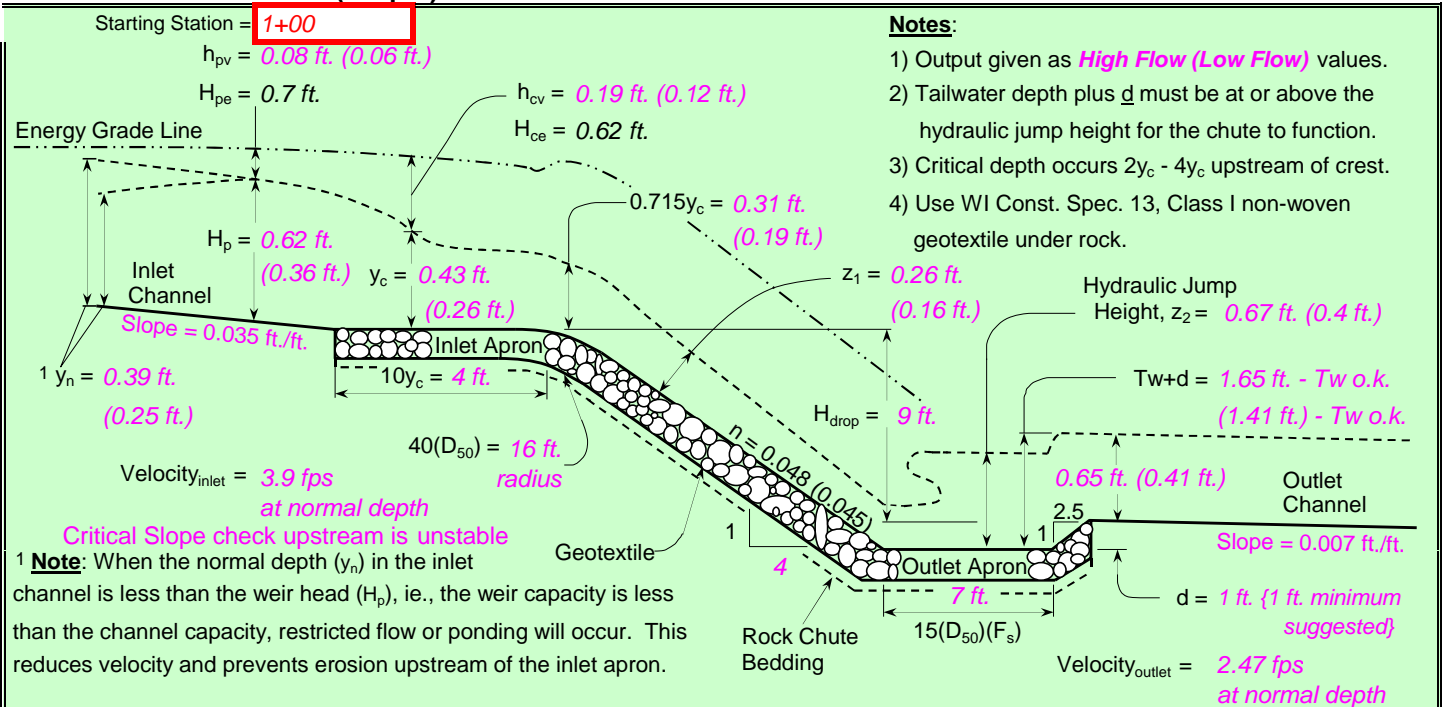
## Input Geometry:

Upstream Channel	Chute	Downstream Channel
Bw = 10.0 ft.	Bw = 10.0 ft.	Bw = 10.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 ( $F_s$ )	Side slopes = 1.5 (m:1)
Velocity n-value = 0.035	Side slopes = 4.0 (m:1) → 2.0:1 max.	Velocity n-value = 0.035
Bed slope = 0.0350 ft./ft.	Bed slope (4:1) = 0.250 ft./ft. → 3.0:1 max.	Bed slope = 0.0070 ft./ft.
Note: n value = a) velocity n from waterway program or b) computed mannings n for channel	Freeboard = 0.5 ft. → Outlet apron depth, d = 1.0 ft.	Base flow = 0.0 cfs

## Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):

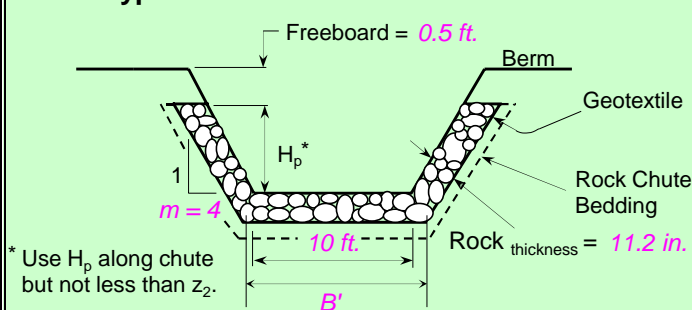
Apron elev. --- Inlet = 205.0 ft. ----- Outlet 195.0 ft. --- ( $H_{drop} = 9$ ft.)	Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.
$Q_{high}$ = Runoff from design storm capacity from Table 2, FOTG Standard 410	Input tailwater ( $T_w$ ): 0.25 1.20
$Q_5$ = Runoff from a 5-year, 24-hour storm.	
$Q_{high} = 17.7$ cfs High flow storm through chute	→ $T_w$ (ft.) = Program
$Q_5 = 8.0$ cfs Low flow storm through chute	→ $T_w$ (ft.) = Program

## Profile and Cross Section (Output):



## Profile Along Centerline of Chute

### Typical Cross Section



$F_s = 1.20$	Factor of safety (multiplier)
$z_1 = 0.26$ ft.	Normal depth in chute
n-value = 0.048	Manning's roughness coefficient
$D_{50}(F_s) = 5.6$ in.	Minimum Design $D_{50}^*$
$2(D_{50})(F_s) = 11.2$ in.	Rock chute thickness
$T_w + d = 1.65$ ft.	Tailwater above outlet apron
$z_2 = 0.67$ ft.	Hydraulic jump height
*** The outlet will	function adequately

## High Flow Storm Information

# Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Pond A2- West Chute  
 Designer: KRK  
 Date: April 30, 2024

County: El Paso County  
 Checked by: \_\_\_\_\_  
 Date: \_\_\_\_\_

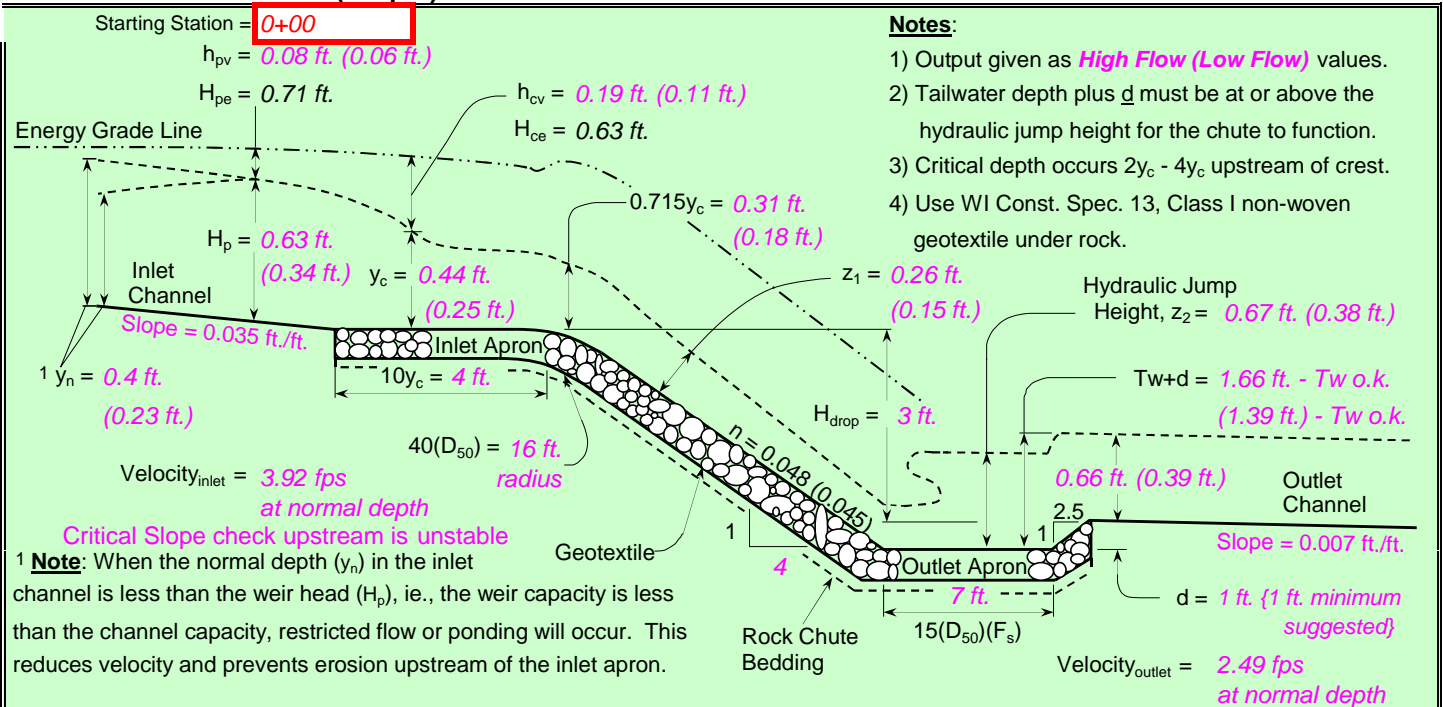
## Input Geometry:

Upstream Channel	Chute	Downstream Channel
Bw = 10.0 ft.	Bw = 10.0 ft.	Bw = 10.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 ( $F_s$ )	Side slopes = 1.5 (m:1)
Velocity n-value = 0.035	Side slopes = 4.0 (m:1) → 2.0:1 max.	Velocity n-value = 0.035
Bed slope = 0.0350 ft./ft.	Bed slope (4:1) = 0.250 ft./ft → 3.0:1 max.	Bed slope = 0.0070 ft./ft.
Note: n value = a) velocity n from waterway program or b) computed mannings n for channel	Freeboard = 0.5 ft. → Outlet apron depth, d = 1.0 ft.	Base flow = 0.0 cfs

## Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):

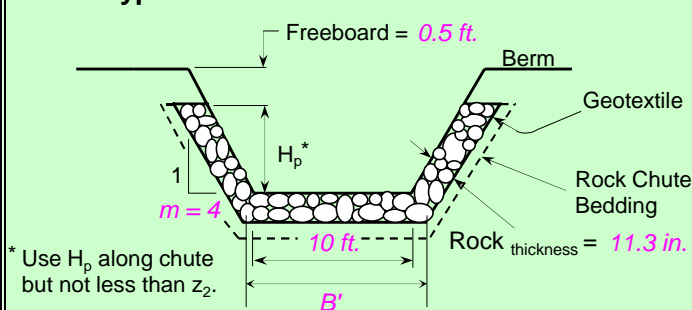
Apron elev. --- Inlet = 199.0 ft. ----- Outlet 195.0 ft. --- ( $H_{drop} = 3$ ft.)	Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.
$Q_{high}$ = Runoff from design storm capacity from Table 2, FOTG Standard 410	Input tailwater ( $T_w$ ): 0.25 1.20
$Q_5$ = Runoff from a 5-year, 24-hour storm.	
$Q_{high} = 17.9$ cfs High flow storm through chute	$T_w$ (ft.) = Program
$Q_5 = 7.3$ cfs Low flow storm through chute	$T_w$ (ft.) = Program

## Profile and Cross Section (Output):



## Profile Along Centerline of Chute

### Typical Cross Section



Equivalent unit discharge	$1.64$ cfs/ft.
Factor of safety (multiplier)	$F_s = 1.20$
Normal depth in chute	$z_1 = 0.26$ ft.
Manning's roughness coefficient	n-value = 0.048
Minimum Design D50*	$D_{50}(F_s) = 5.6$ in.
Rock chute thickness	$2(D_{50})(F_s) = 11.3$ in.
Tailwater above outlet apron	$T_w + d = 1.66$ ft.
Hydraulic jump height	$z_2 = 0.67$ ft.
*** The outlet will function adequately	

## High Flow Storm Information

# Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Pond A2- Center Chute  
 Designer: KRK  
 Date: April 30, 2024

County: El Paso County  
 Checked by: \_\_\_\_\_  
 Date: \_\_\_\_\_

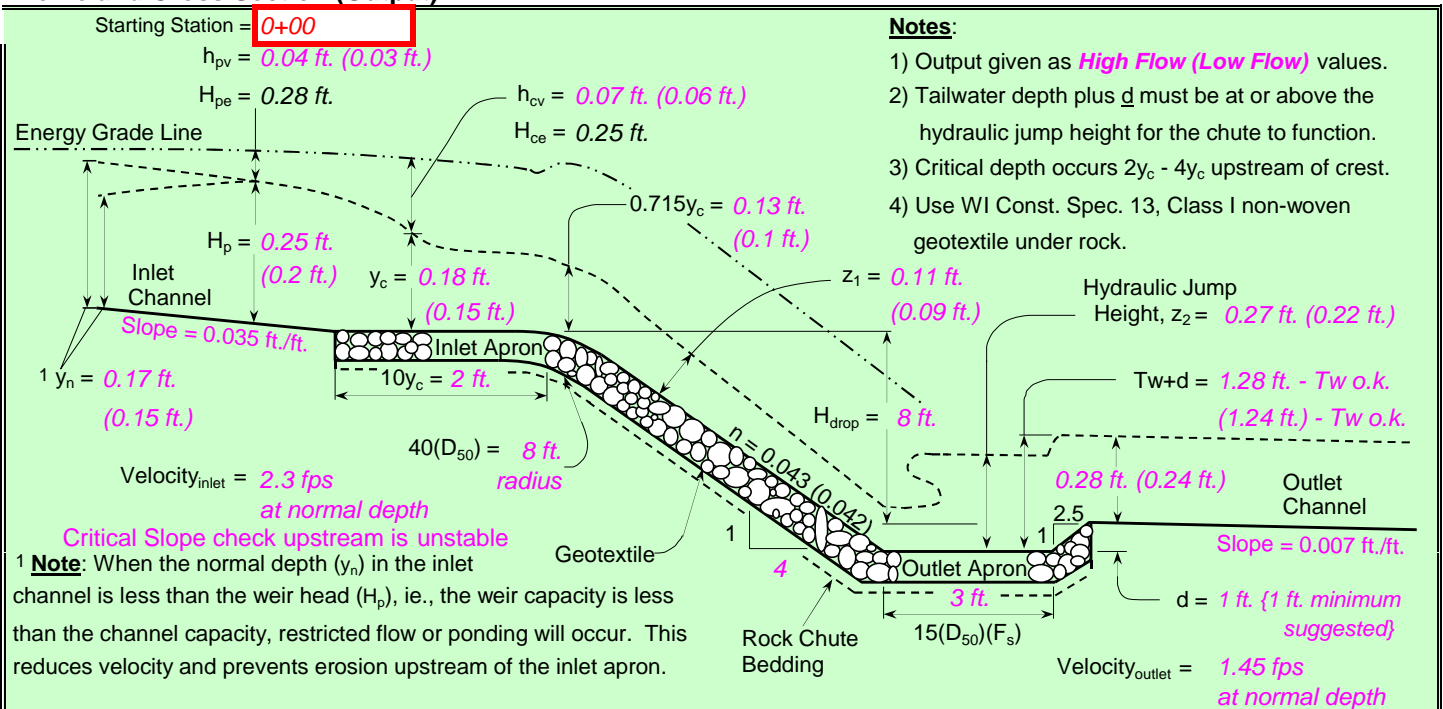
## Input Geometry:

Upstream Channel	Chute	Downstream Channel
Bw = 6.0 ft.	Bw = 6.0 ft.	Bw = 6.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 ( $F_s$ )	Side slopes = 1.5 (m:1)
Velocity n-value = 0.035	Side slopes = 4.0 (m:1) → 2.0:1 max.	Velocity n-value = 0.035
Bed slope = 0.0350 ft./ft.	Bed slope (4:1) = 0.250 ft./ft. → 3.0:1 max.	Bed slope = 0.0070 ft./ft.
Note: n value = a) velocity n from waterway program or b) computed manning's n for channel	Freeboard = 0.5 ft.	Base flow = 0.0 cfs
	Outlet apron depth, d = 1.0 ft.	

## Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):

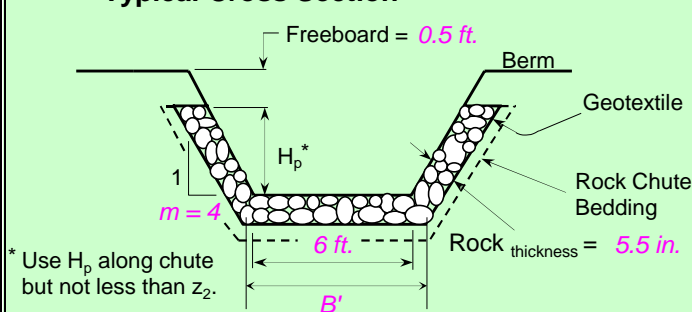
Apron elev. --- Inlet = 204.0 ft. ----- Outlet 195.0 ft. --- ( $H_{drop} = 8$ ft.)	Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.
$Q_{high}$ = Runoff from design storm capacity from Table 2, FOTG Standard 410	Input tailwater ( $T_w$ ): 0.25 1.20
$Q_5$ = Runoff from a 5-year, 24-hour storm.	
$Q_{high} = 2.7$ cfs High flow storm through chute	→ $T_w$ (ft.) = Program
$Q_5 = 2.0$ cfs Low flow storm through chute	→ $T_w$ (ft.) = Program

## Profile and Cross Section (Output):



## Profile Along Centerline of Chute

### Typical Cross Section



$F_s = 1.20$	Factor of safety (multiplier)
$z_1 = 0.11$ ft.	Normal depth in chute
n-value = 0.043	Manning's roughness coefficient
$D_{50}(F_s) = 2.7$ in.	Minimum Design $D_{50}$ *
$2(D_{50})(F_s) = 5.5$ in.	Rock chute thickness
$T_w + d = 1.28$ ft.	Tailwater above outlet apron
$z_2 = 0.27$ ft.	Hydraulic jump height
*** The outlet will	function adequately

## High Flow Storm Information

# Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Pond B1- East Chute  
 Designer: KRK  
 Date: April 30, 2024

County: El Paso County  
 Checked by: \_\_\_\_\_  
 Date: \_\_\_\_\_

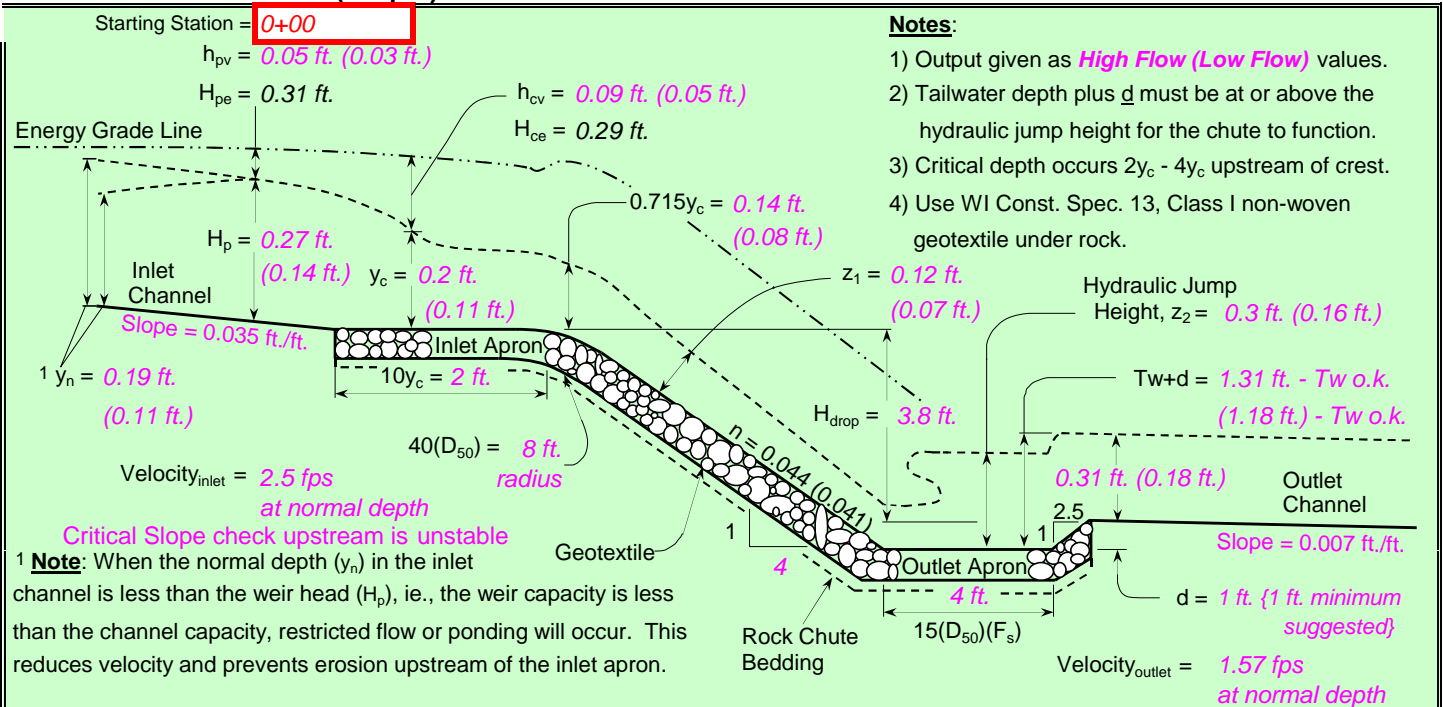
## Input Geometry:

Upstream Channel	Chute	Downstream Channel
Bw = 10.0 ft.	Bw = 10.0 ft.	Bw = 10.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 ( $F_s$ )	Side slopes = 1.5 (m:1)
Velocity n-value = 0.035	Side slopes = 4.0 (m:1) → 2.0:1 max.	Velocity n-value = 0.035
Bed slope = 0.0350 ft./ft.	Bed slope (4:1) = 0.250 ft./ft → 3.0:1 max.	Bed slope = 0.0070 ft./ft.
Note: n value = a) velocity n from waterway program or b) computed mannings n for channel	Freeboard = 0.5 ft. → Outlet apron depth, d = 1.0 ft.	Base flow = 0.0 cfs

## Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):

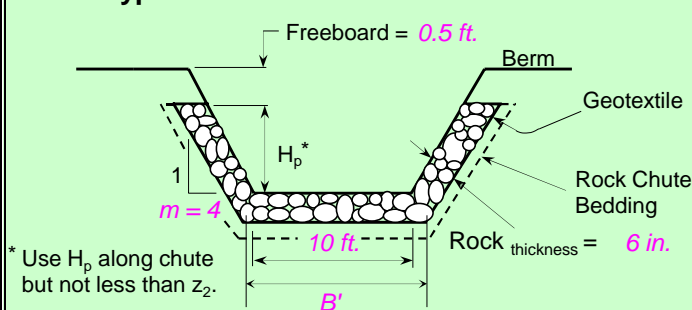
Apron elev. --- Inlet = 199.0 ft. ----- Outlet 194.3 ft. --- ( $H_{drop}$ = 3.8 ft.)	Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.
$Q_{high}$ = Runoff from design storm capacity from Table 2, FOTG Standard 410	Input tailwater ( $T_w$ ): 0.25 1.20
$Q_5$ = Runoff from a 5-year, 24-hour storm.	
$Q_{high}$ = 5.1 cfs High flow storm through chute	$T_w$ (ft.) = Program
$Q_5$ = 2.0 cfs Low flow storm through chute	$T_w$ (ft.) = Program

## Profile and Cross Section (Output):



## Profile Along Centerline of Chute

### Typical Cross Section



$F_s$ = 1.20	Equivalent unit discharge
$z_1$ = 0.12 ft.	Factor of safety (multiplier)
n-value = 0.044	Normal depth in chute
$D_{50}(F_s)$ = 3 in.	Manning's roughness coefficient
$2(D_{50})(F_s)$ = 6 in.	Minimum Design $D_{50}$ *
$T_w + d$ = 1.31 ft.	Rock chute thickness
$z_2$ = 0.3 ft.	Tailwater above outlet apron
*** The outlet will	Hydraulic jump height
function adequately	

## High Flow Storm Information

# Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Pond B1- West Chute  
 Designer: KRK  
 Date: November 13, 2024

County: El Paso County  
 Checked by: \_\_\_\_\_  
 Date: \_\_\_\_\_

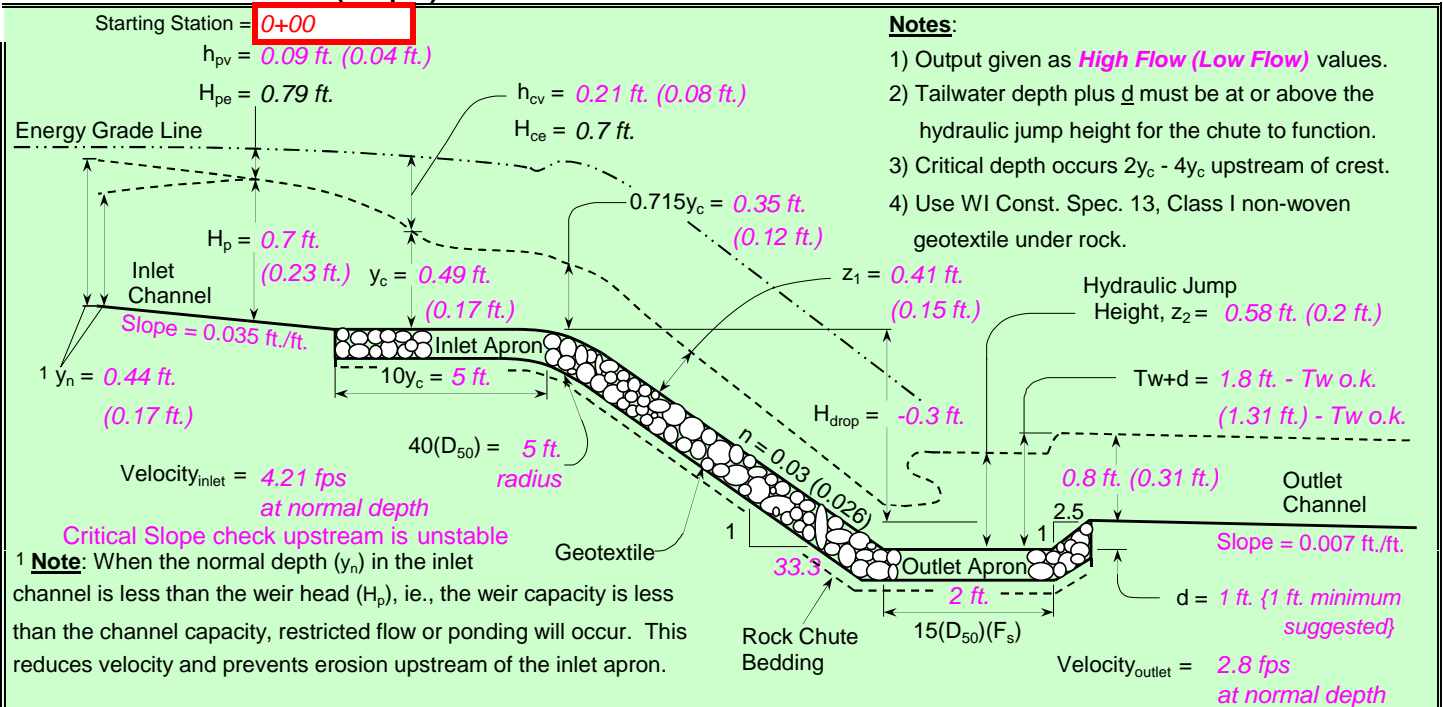
## Input Geometry:

Upstream Channel	Chute	Downstream Channel
Bw = 12.0 ft.	Bw = 12.0 ft.	Bw = 10.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 ( $F_s$ )	Side slopes = 1.5 (m:1)
Velocity n-value = 0.035	Side slopes = 4.0 (m:1) → 2.0:1 max.	Velocity n-value = 0.035
Bed slope = 0.0350 ft./ft.	Bed slope (33.3:1) = 0.030 ft./ft. → 3.0:1 max.	Bed slope = 0.0070 ft./ft.
Note: n value = a) velocity n from waterway program or b) computed manning's n for channel	Freeboard = 0.5 ft. → Outlet apron depth, d = 1.0 ft.	Base flow = 0.0 cfs

## Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):

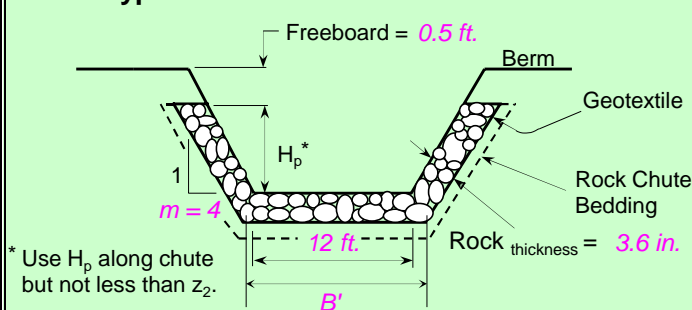
Apron elev. --- Inlet = 196.2 ft. ----- Outlet 195.4 ft. --- ( $H_{drop} = -0.3$ ft.)	Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.
$Q_{high}$ = Runoff from design storm capacity from Table 2, FOTG Standard 410	Input tailwater ( $T_w$ ): 0.03 1.20
$Q_5$ = Runoff from a 5-year, 24-hour storm.	
$Q_{high} = 25.2$ cfs High flow storm through chute	→ $T_w$ (ft.) = Program
$Q_5 = 5.0$ cfs Low flow storm through chute	→ $T_w$ (ft.) = Program

## Profile and Cross Section (Output):



## Profile Along Centerline of Chute

### Typical Cross Section



$F_s = 1.20$	Factor of safety (multiplier)
$z_1 = 0.41$ ft.	Normal depth in chute
n-value = 0.03	Manning's roughness coefficient
$D_{50}(F_s) = 1.8$ in.	Minimum Design $D_{50}$ *
$2(D_{50})(F_s) = 3.6$ in.	Rock chute thickness
$T_w + d = 1.8$ ft.	Tailwater above outlet apron
$z_2 = 0.58$ ft.	Hydraulic jump height
*** The outlet will	function adequately

## High Flow Storm Information

# Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Pond B8- East Chute  
 Designer: KRK  
 Date: April 30, 2024

County: El Paso County  
 Checked by: \_\_\_\_\_  
 Date: \_\_\_\_\_

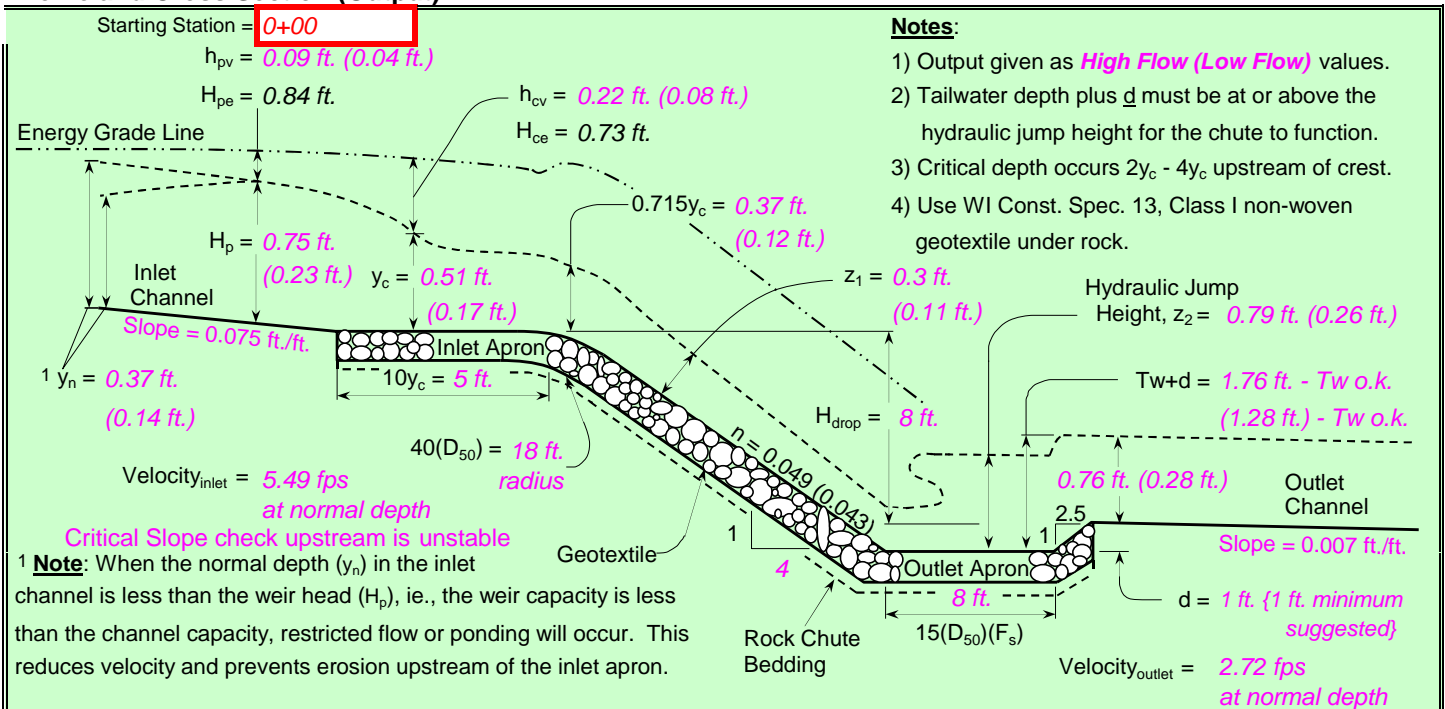
## Input Geometry:

Upstream Channel	Chute	Downstream Channel
Bw = 10.0 ft.	Bw = 10.0 ft.	Bw = 10.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 ( $F_s$ )	Side slopes = 1.5 (m:1)
Velocity n-value = 0.035	Side slopes = 4.0 (m:1) → 2.0:1 max.	Velocity n-value = 0.035
Bed slope = 0.0750 ft./ft.	Bed slope (4:1) = 0.250 ft./ft → 3.0:1 max.	Bed slope = 0.0070 ft./ft.
Note: n value = a) velocity n from waterway program or b) computed manning's n for channel	Freeboard = 0.5 ft. → Outlet apron depth, d = 1.0 ft.	Base flow = 0.0 cfs

## Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):

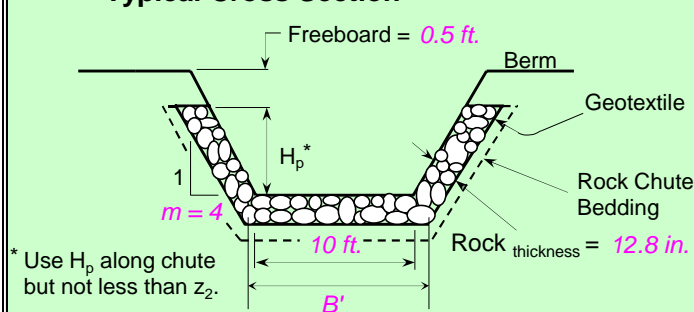
Apron elev. --- Inlet = 197.0 ft. ----- Outlet 188.0 ft. --- ( $H_{drop} = 8$ ft.)	Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.
$Q_{high}$ = Runoff from design storm capacity from Table 2, FOTG Standard 410	Input tailwater ( $T_w$ ): 0.25 1.20
$Q_5$ = Runoff from a 5-year, 24-hour storm.	
$Q_{high} = 23.1$ cfs High flow storm through chute	→ $T_w$ (ft.) = Program
$Q_5 = 4.2$ cfs Low flow storm through chute	→ $T_w$ (ft.) = Program

## Profile and Cross Section (Output):



## Profile Along Centerline of Chute

### Typical Cross Section



Equivalent unit discharge	$2.07$ cfs/ft.
Factor of safety (multiplier)	$F_s = 1.20$
Normal depth in chute	$z_1 = 0.3$ ft.
Manning's roughness coefficient	n-value = 0.049
Minimum Design D50*	$D_{50}(F_s) = 6.4$ in.
Rock chute thickness	$2(D_{50})(F_s) = 12.8$ in.
Tailwater above outlet apron	$T_w + d = 1.76$ ft.
Hydraulic jump height	$z_2 = 0.79$ ft.
*** The outlet will function adequately	

## High Flow Storm Information

# Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Pond B8- West Chute  
 Designer: KRK  
 Date: April 30, 2024

County: El Paso County  
 Checked by: \_\_\_\_\_  
 Date: \_\_\_\_\_

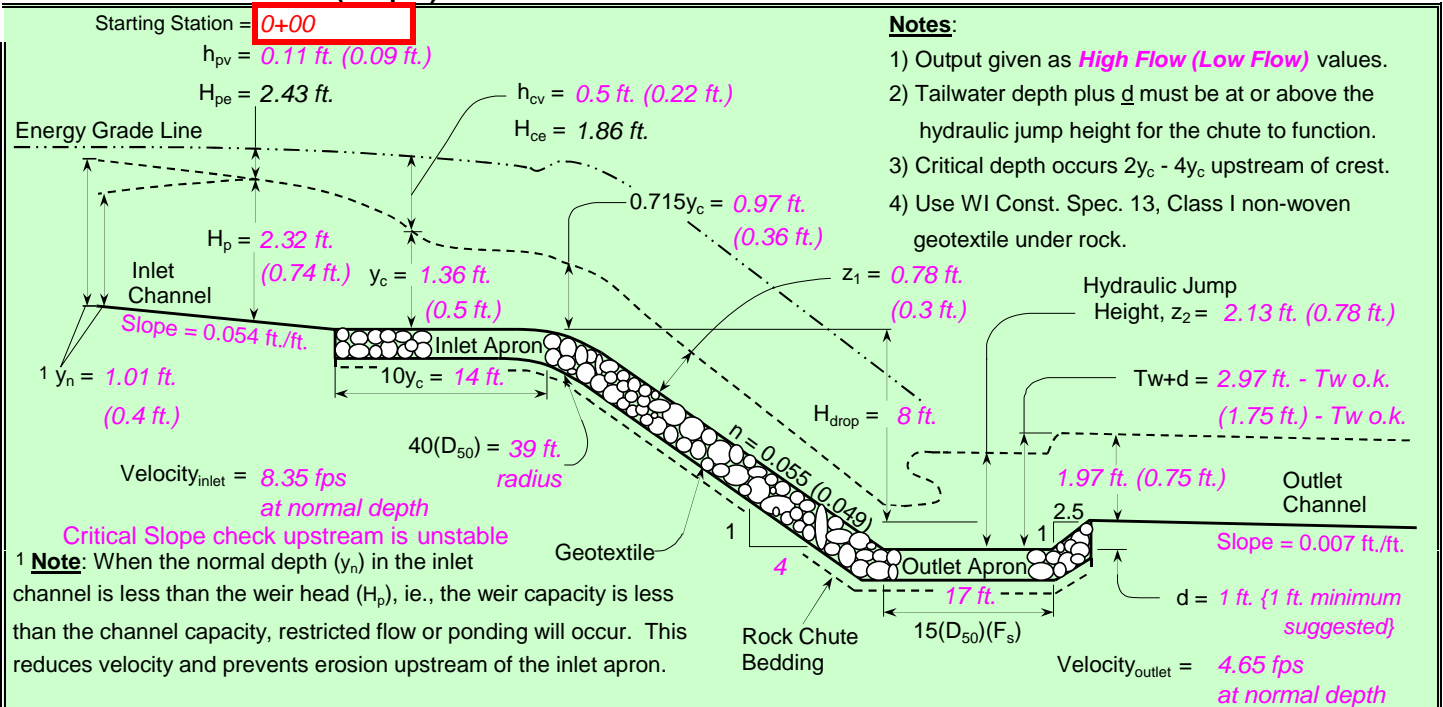
## Input Geometry:

Upstream Channel	Chute	Downstream Channel
Bw = 10.0 ft.	Bw = 10.0 ft.	Bw = 10.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 ( $F_s$ )	Side slopes = 1.5 (m:1)
Velocity n-value = 0.035	Side slopes = 4.0 (m:1) → 2.0:1 max.	Velocity n-value = 0.035
Bed slope = 0.0540 ft./ft.	Bed slope (4:1) = 0.250 ft./ft. → 3.0:1 max.	Bed slope = 0.0070 ft./ft.
Note: n value = a) velocity n from waterway program or b) computed manning's n for channel	Freeboard = 0.5 ft. → Outlet apron depth, d = 1.0 ft.	Base flow = 0.0 cfs

## Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):

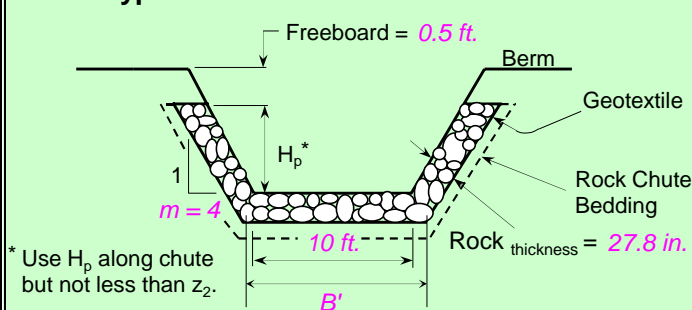
Apron elev. --- Inlet = 197.0 ft. ----- Outlet 188.0 ft. --- ( $H_{drop} = 8$ ft.)	Note: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.
$Q_{high}$ = Runoff from design storm capacity from Table 2, FOTG Standard 410	Input tailwater ( $T_w$ ): 0.25 1.20
$Q_5$ = Runoff from a 5-year, 24-hour storm.	
$Q_{high} = 119.0$ cfs High flow storm through chute	→ $T_w$ (ft.) = Program
$Q_5 = 22.6$ cfs Low flow storm through chute	→ $T_w$ (ft.) = Program

## Profile and Cross Section (Output):



## Profile Along Centerline of Chute

### Typical Cross Section



$F_s = 1.20$	Factor of safety (multiplier)
$z_1 = 0.78$ ft.	Normal depth in chute
n-value = 0.055	Manning's roughness coefficient
$D_{50}(F_s) = 13.9$ in.	Minimum Design $D_{50}$ *
$2(D_{50})(F_s) = 27.8$ in.	Rock chute thickness
$T_w + d = 2.97$ ft.	Tailwater above outlet apron
$z_2 = 2.13$ ft.	Hydraulic jump height
*** The outlet will	function adequately

## High Flow Storm Information

DRIVEWAY CULVERT SIZING TABLE				
Lot	100 yr. Flow (cfs)	Culvert Size (in)	Anticipated Driveway Location	Notes
1	<10	18	Southeast side of lot	N/A
2	<10	18	East side of lot	N/A
3	<10	18	East side of lot	N/A
4	<10	18	Northeast side of lot	N/A
5	<10	18	Center of east side of lot	N/A
6	<10	18	Northeast side of lot	N/A
6 (Internal)	18	30	Interior Lot Driveway	Culvert for potention channel crossing within the lot
7	<10	18	North center of lot	N/A
8	<10	18	Northwest side of lot	N/A
9	<10	18	Northwest side of lot	N/A
9 (Internal)	25	30	Interior Lot Driveway	Culvert for potention channel crossing within the lot
10	<10	18	Northeast side of lot	N/A
11	<10	18	Northeast side of lot	N/A
12	<10	18	Northwest side of lot	N/A
13	<10	18	North side of lot	N/A
14	<10	18	Northwest side of lot	N/A
15	<10	18	Northeast side of lot	N/A
16	<10	18	North side of lot	N/A
17	<10	18	Northwest side of lot	N/A
18	<10	18	Southwest side of lot	N/A
19	14	18	Southeast side of lot	N/A
20	14	18	Southeast side of lot	N/A
21	91	48	Southwest side of lot	N/A
22	91	48	Southeast side of lot	N/A
23	24	24	Northwest side of lot	N/A
24	24	24	Northwest side of lot	N/A
25	<10	18	Northeast side of lot	N/A
26	<10	18	Northwest side of lot	N/A
27	<10	18	Northeast side of lot	N/A
28	<10	18	Northeast side of lot	Campout drive side
29	<10	18	Northeast side of lot	N/A
30	<10	18	Northeast side of lot	N/A
31	<10	18	Northeast side of lot	N/A
32	<10	18	Southeast side of lot	East of drainage channel connecting to hatband drive
33	26	24	Southwest side of lot	South of western drainage channel
34	26	24	West side of lot	N/A
34 (Internal)	58	42	Interior Lot Driveway	Culvert for potention channel crossing within the lot
35	<10	18	Southwest side of lot	N/A
35 (internal)	58	42	Interior Lot Driveway	Culvert for potention channel crossing within the lot
36	<10	18	Southwest side of lot	N/A

***APPENDIX E: EL PASO COUNTY DRAINAGE BASIN MAP***

Douglas County

Elbert County

Elbert County

Lincoln County

Pueblo County

## Drainage Basins

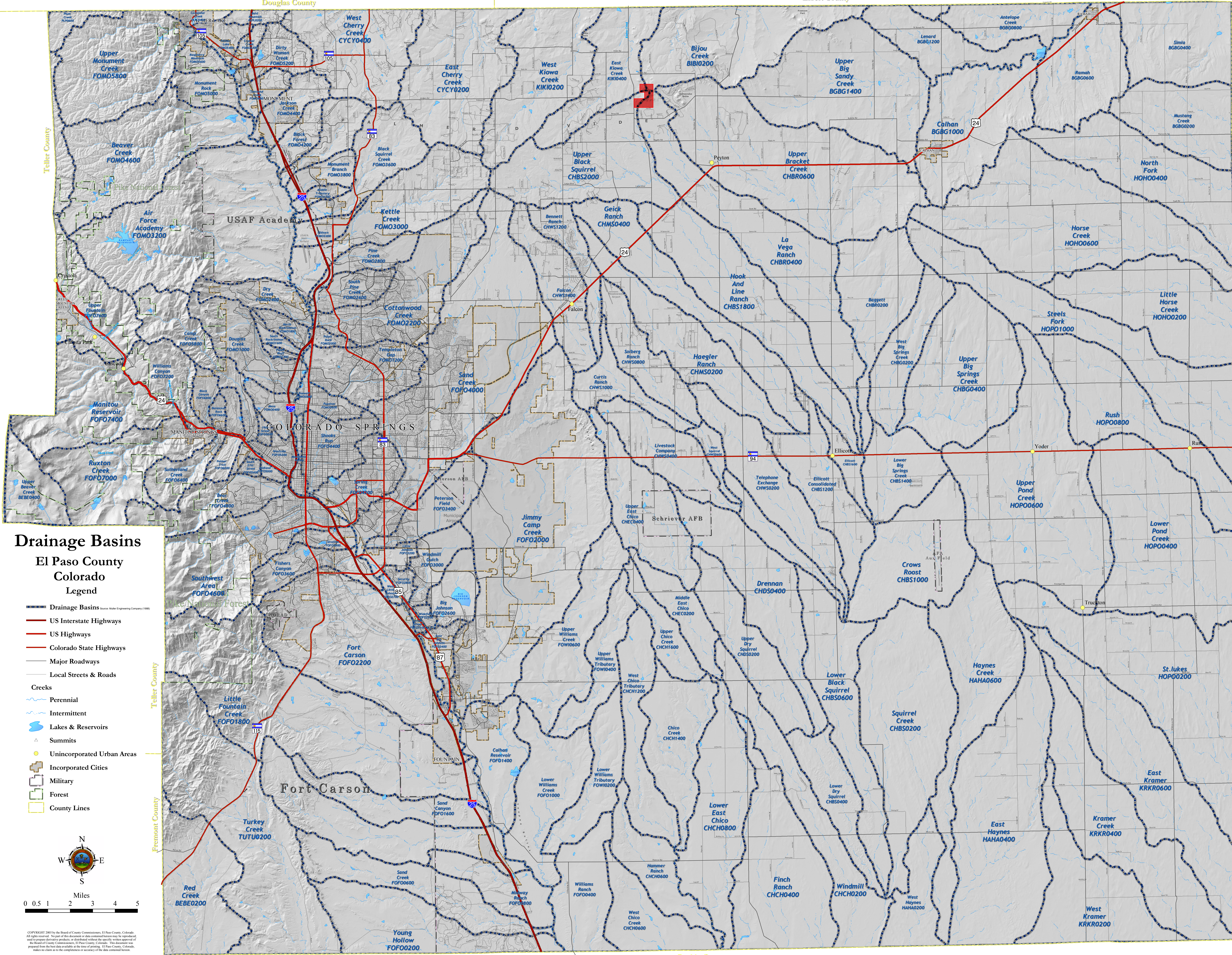
### El Paso County Colorado Legend

- Drainage Basins (Source: Muter Engineering Company 1988)
- US Interstate Highways
- US Highways
- Colorado State Highways
- Major Roadways
- Local Streets & Roads
- Creeks
  - Perennial
  - Intermittent
- Lakes & Reservoirs
- Summits
- Unincorporated Urban Areas
- Incorporated Cities
- Military
- Forest
- County Lines



0 0.5 1 2 3 4 5  
Miles

COPYRIGHT 2007 by the Board of County Commissioners, El Paso County, Colorado. All rights reserved. No part of this document or data contained herein may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or by any information storage and retrieval system, without the prior written permission of the Board of County Commissioners, El Paso County, Colorado. This document was prepared from the best data available at the time of printing. El Paso County, Colorado, makes no claim as to the completeness or accuracy of the data contained herein.



***APPENDIX F: APEX RANCH DRAINAGE REPORT***

## Design Procedure Form: Extended Detention Basin (EDB) - Sedimentation Facility

Sheet 1 of 3

Designer: QUENTIN ARMIJO  
 Company: TERRA NOVA ENG.  
 Date: April 2, 2008  
 Project: APEX RANCH ESTATES  
 Location: PEYTON, CO

<p>1. Basin Storage Volume</p> <p>A) Tributary Area's Imperviousness Ratio (<math>i = I_a / 100</math>)</p> <p>B) Contributing Watershed Area (Area)</p> <p>C) Water Quality Capture Volume (WQCV)  <math>(WQCV = 1.0 * (0.91 * I^3 - 1.19 * I^2 + 0.78 * I))</math></p> <p>D) Design Volume: <math>Vol = (WQCV / 12) * Area * 1.2</math></p>	<p><math>I_a =</math> <u>10.00</u> %</p> <p><math>i =</math> <u>0.10</u></p> <p>Area = <u>76.80</u> acres</p> <p>WQCV = <u>0.07</u> watershed inches</p> <p>Vol = <u>0.515</u> acre-feet</p>
<p>2. Outlet Works</p> <p>A) Outlet Type (Check One)</p> <p>B) Depth at Outlet Above Lowest Perforation (H)</p> <p>C) Required Maximum Outlet Area per Row, (<math>A_o</math>)</p> <p>D) Perforation Dimensions (<b>enter one only</b>):        i) Circular Perforation Diameter <b>OR</b>        ii) 2" Height Rectangular Perforation Width</p> <p>E) Number of Columns (<math>nc</math>, See Table 6a-1 For Maximum)</p> <p>F) Actual Design Outlet Area per Row (<math>A_o</math>)</p> <p>G) Number of Rows (<math>nr</math>)</p> <p>H) Total Outlet Area (<math>A_{ot}</math>)</p>	<p><input checked="" type="checkbox"/> Orifice Plate  <input type="checkbox"/> Perforated Riser Pipe  <input type="checkbox"/> Other: _____</p> <p>H = <u>2.50</u> feet</p> <p><math>A_o =</math> <u>0.81</u> square inches</p> <p>D = <u>1.0000</u> inches, <b>OR</b>        W = _____ inches</p> <p><math>nc =</math> <u>1</u> number</p> <p><math>A_o =</math> <u>0.79</u> square inches</p> <p><math>nr =</math> <u>8</u> number</p> <p><math>A_{ot} =</math> <u>5.89</u> square inches</p>
<p>3. Trash Rack</p> <p>A) Needed Open Area: <math>A_t = 0.5 * (\text{Figure 7 Value}) * A_{ot}</math></p> <p>B) Type of Outlet Opening (Check One)</p> <p>C) For 2", or Smaller, <b>Round Opening</b> (Ref.: Figure 6a):        i) Width of Trash Rack and Concrete Opening (<math>W_{conc}</math>)        from Table 6a-1        ii) Height of Trash Rack Screen (<math>H_{TR}</math>)</p>	<p><math>A_t =</math> <u>200</u> square inches</p> <p><input checked="" type="checkbox"/> <b>&lt; 2" Diameter Round</b>  <input type="checkbox"/> <b>2" High Rectangular</b>  <input type="checkbox"/> Other: _____</p> <p><math>W_{conc} =</math> <u>9</u> inches</p> <p><math>H_{TR} =</math> <u>54</u> inches</p>

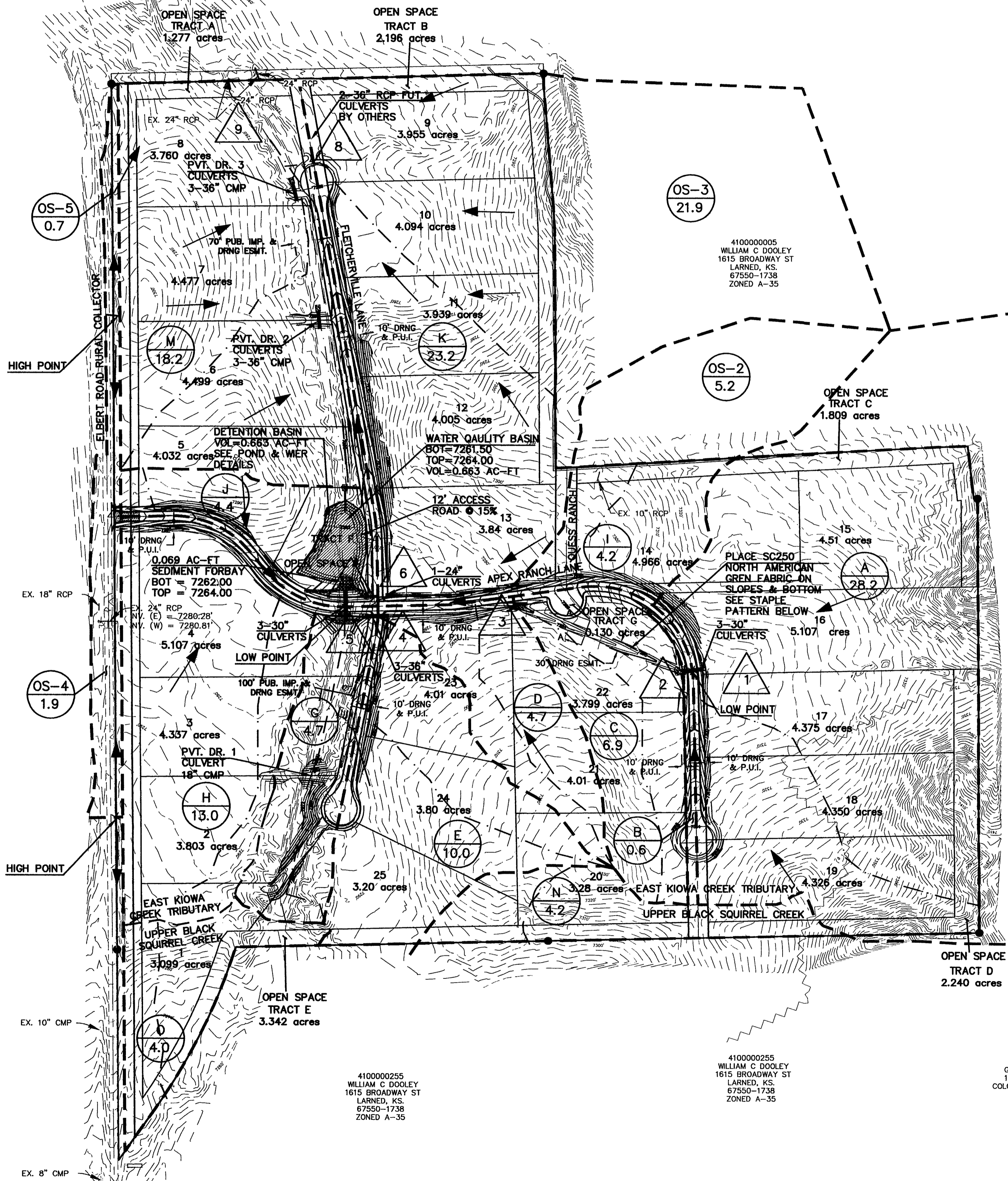
# APEX RANCH ESTATES

## EL PASO COUNTY, COLORADO

### FINAL DRAINAGE MAP

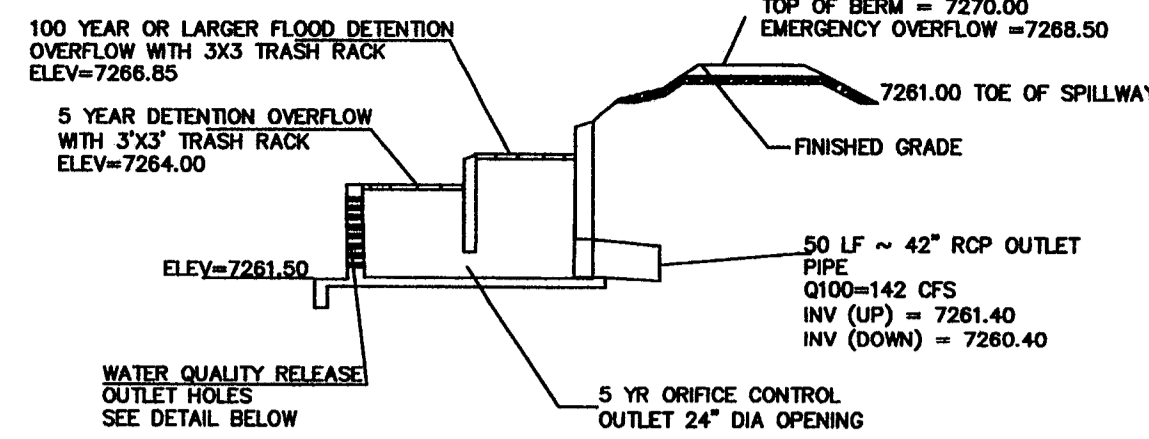
AUGUST 2008

4122000008  
COLLEEN KRASOVICH  
3650 GARRISON ST  
WHEAT RIDGE, CO.  
ZONED A-35

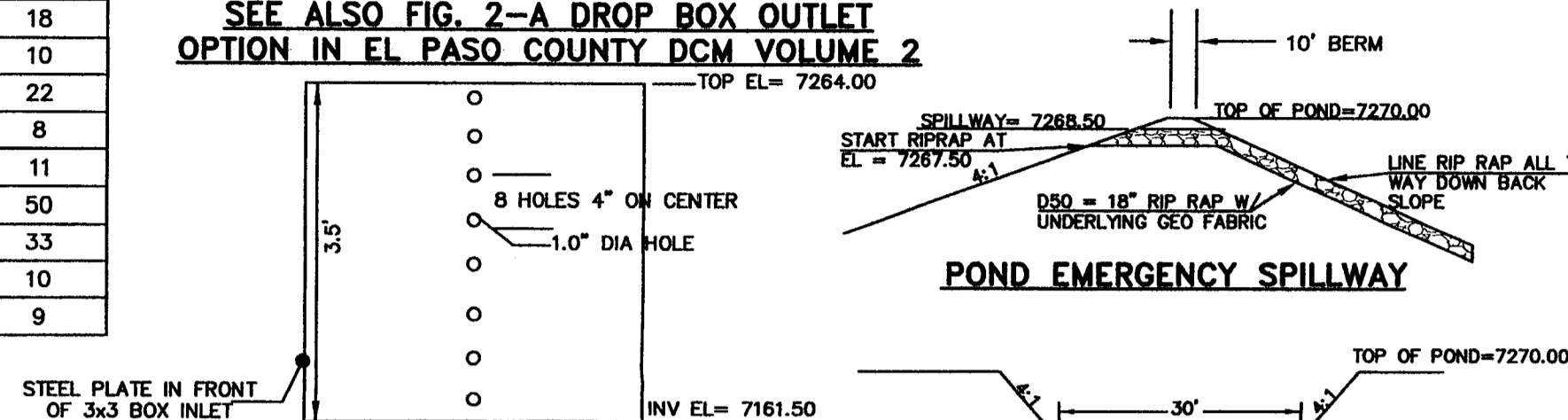


#### DEVELOPED CONDITIONS

BASIN	ACRES	Q5 CFS	Q100 CFS
OS-1	72.1	45	102
OS-2	5.2	4	9
OS-3	21.9	13	29
OS-4	1.9	4	8
OS-5	0.7	1	3
A	28.2	29	64
B	0.6	2	3
C	6.9	6	12
D	4.7	4	9
E	10.0	8	18
G	4.7	5	10
H	13.0	10	22
I	4.2	4	8
J	4.4	5	11
K	23.2	22	50
M	18.2	15	33
N	4.2	5	10
O	4.0	4	9



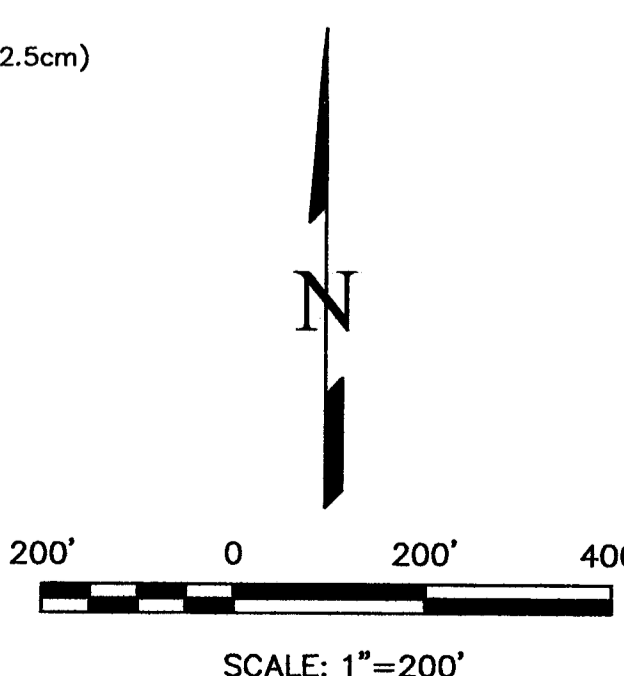
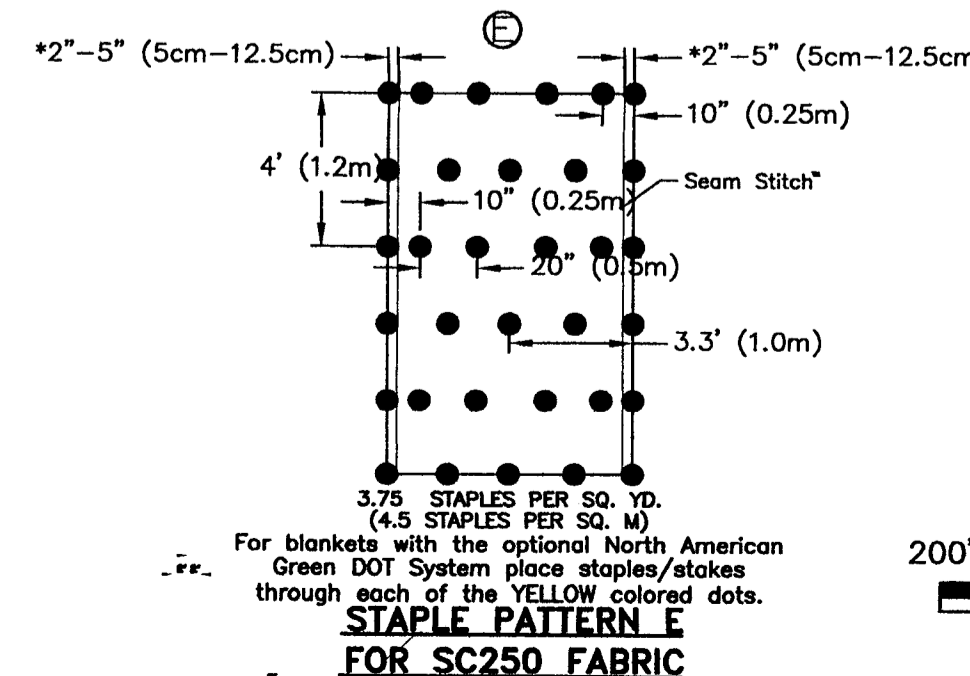
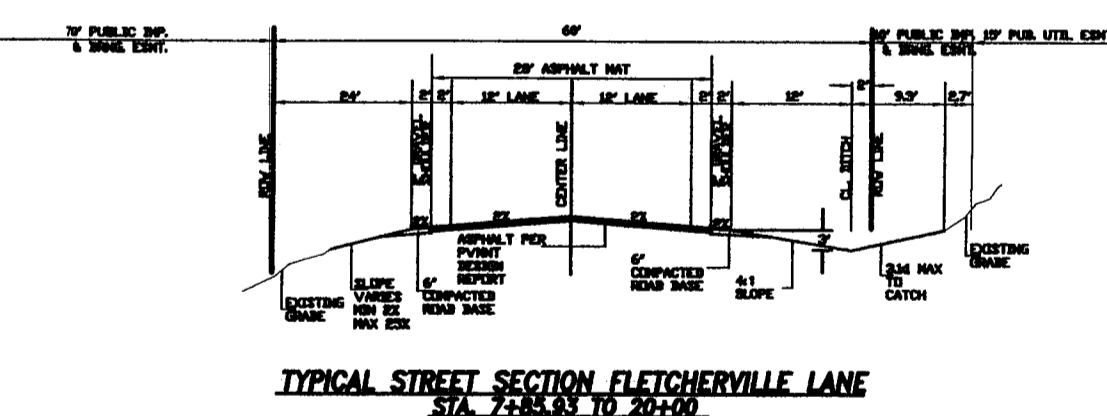
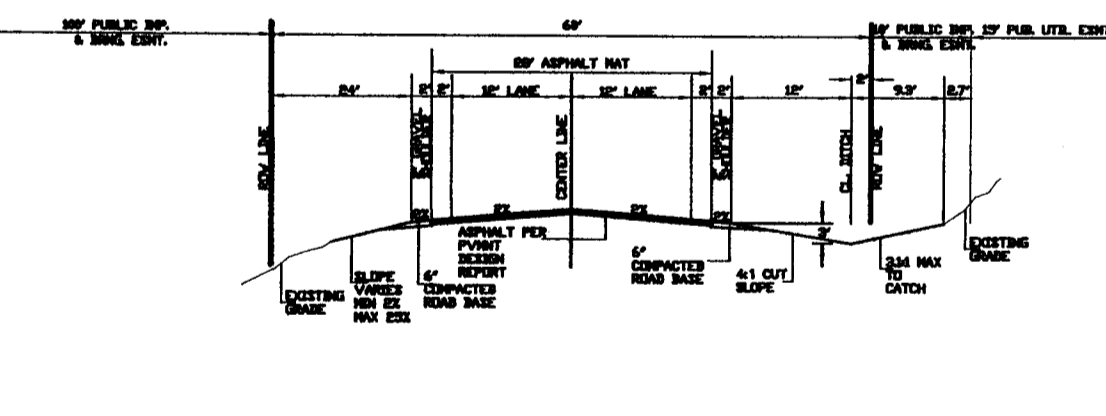
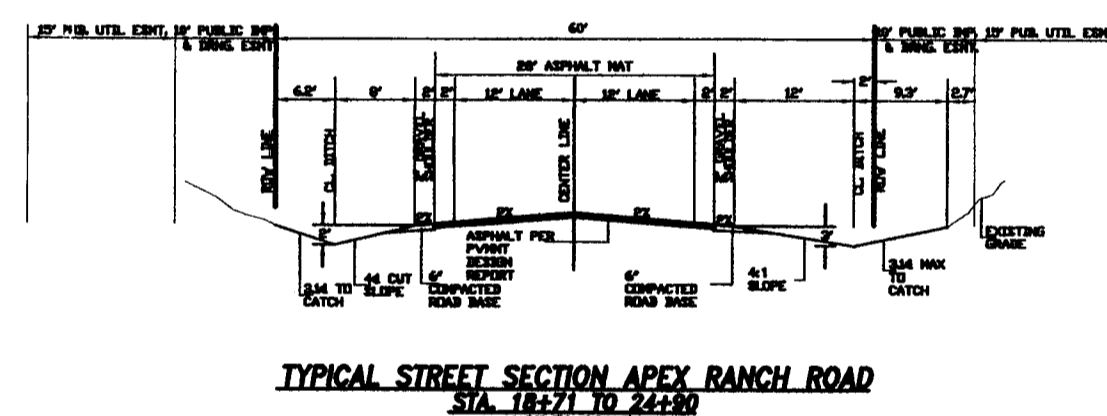
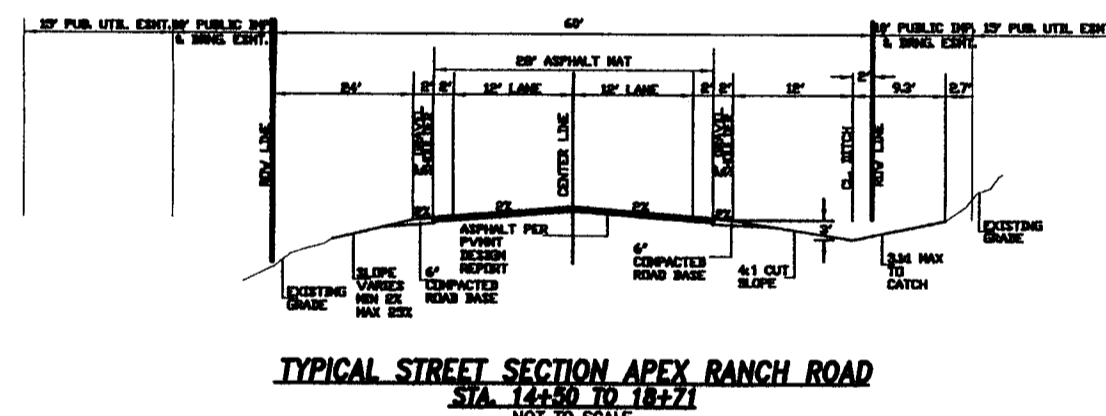
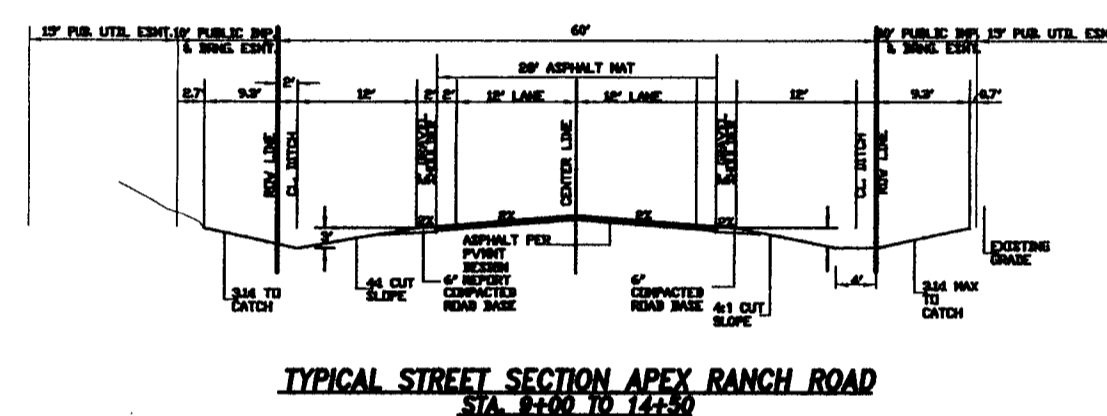
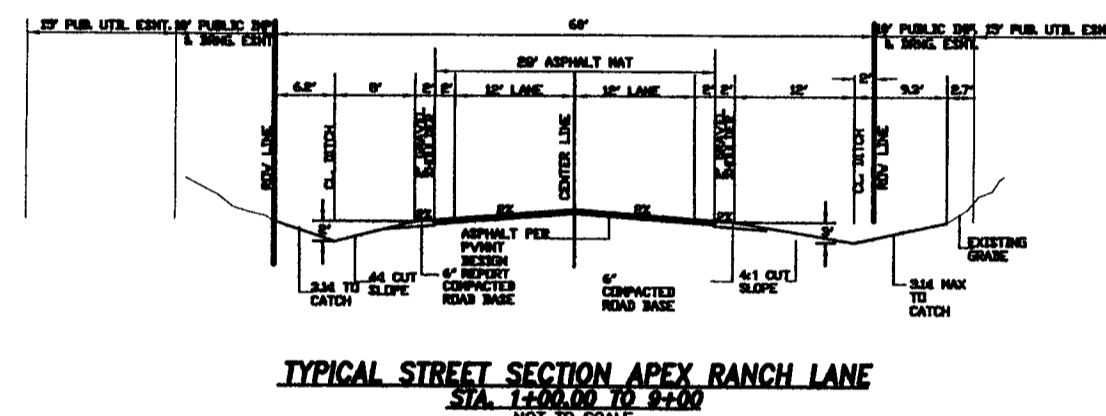
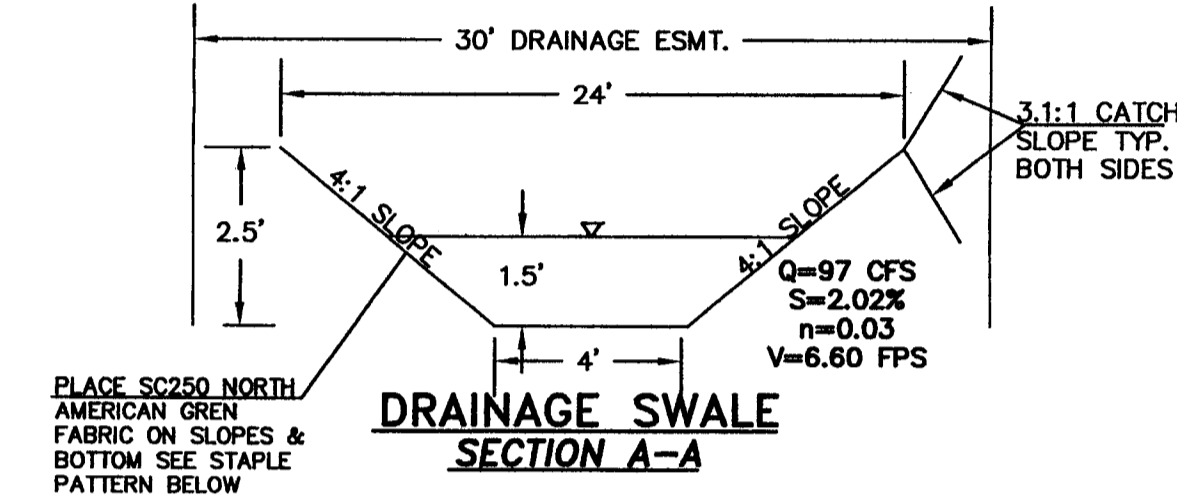
#### POND 2 OUTLET DETAIL SEE ALSO FIG. 2-A DROP BOX OUTLET OPTION IN EL PASO COUNTY DCM VOLUME 2



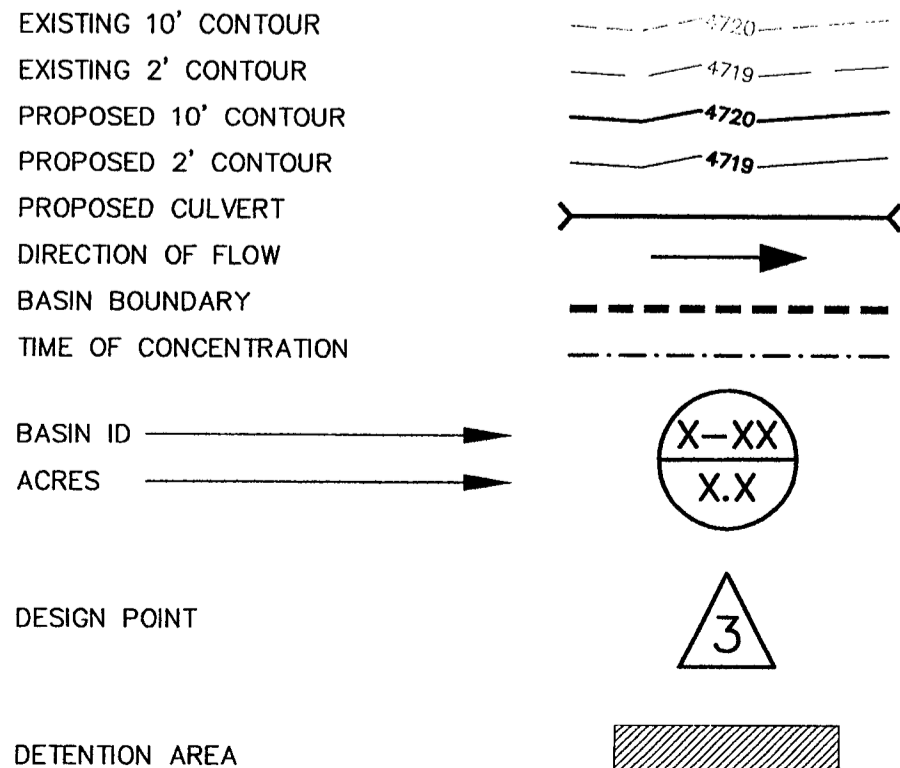
#### DESIGN POINT SUMMARY

DP	CONTRIBUTING BASINS	Q5 CFS	Q100 CFS
1	OS-1 & A	58	130
2	DP-1 & B	59	131
3	DP-2 & C	61	134
4	DP-3, D & E	68	148
5	DP-4, G & H	78	170
6	OS-2 & I	8	18
7	DP-5, DP-6, J & OS-4	87	188
8	OS-3 & K	29	64
9	DP-8, L, M, OS-5 & POND RELEASE	102	227
10	N & O	8	19

#### POND PERFORATED HOLE PATTERN



#### LEGEND



DATE: 11/9/07  
REVISIONS: 1.  
DESCRIPTION: REVISED PER COUNTY COMMENTS

UNTIL SUCH TIME AS THESE DRAWINGS ARE APPROVED BY THE APPROPRIATE TERRA NOVA ENGINEERING, INC. APPROVES THEIR USE ONLY FOR THE PURPOSES DESIGNATED BY WRITTEN AUTHORIZATION.

PREPARED FOR:  
APEX RANCH ESTATES, LLC  
ATTN: CRAIG MCCONNELL  
P.O. BOX 267  
PEYTON, COLORADO 80831

4122000008  
COLLEEN KRASOVICH  
3650 GARRISON ST  
WHEAT RIDGE, CO.  
ZONED A-35

DESIGNED BY QNA  
DRAWN BY LAE  
CHECKED BY LDR

1\"/>

DATE ISSUED 8/26/08  
SHEET NO. 1 OF 1

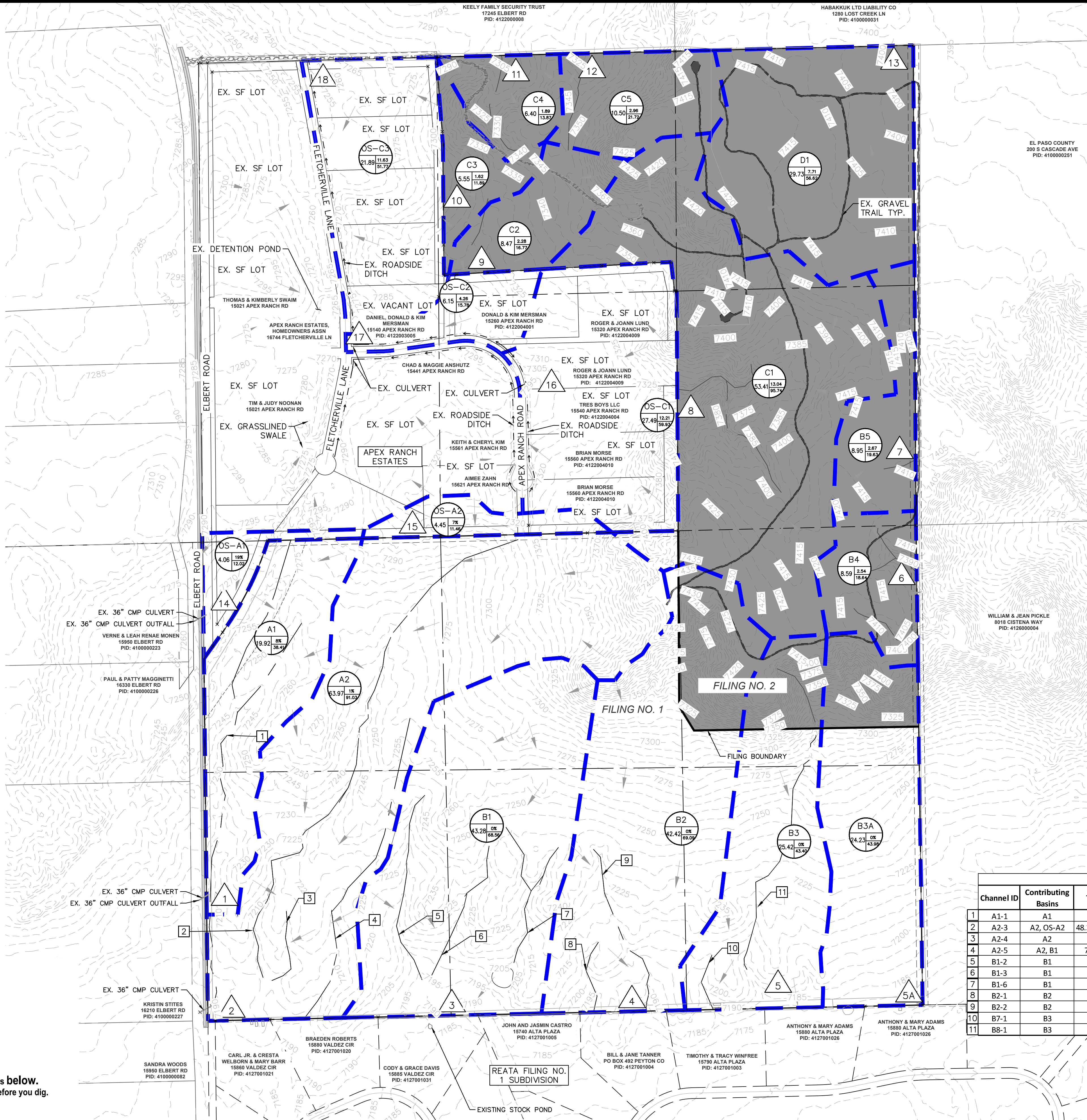
4122000008  
COLLEEN KRASOVICH  
3650 GARRISON ST  
WHEAT RIDGE, CO.  
ZONED A-35

***APPENDIX G: DRAINAGE MAPS***

THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.



Know what's below.  
Call before you dig.



### LEGEND

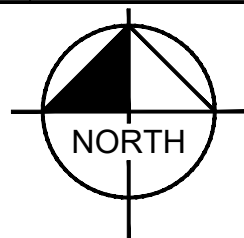
- A = BASIN DESIGNATION
  - B = AREA (ACRES)
  - C = BASIN IMPERVIOUSNESS
  - D = 100YR DESIGN STORM RUNOFF (CFS)
- # = DESIGN POINT
- EXISTING FLOW DIRECTION
  - PROPOSED PROPERTY LINE
  - EXISTING PROPERTY LINE
  - PROPOSED EASEMENT LINE
  - DRAINAGE BASIN BOUNDARY
  - EXISTING MAJOR CONTOUR
  - EXISTING MINOR CONTOUR
- FILING NO. 2

- A - Upper Black Squirrel Drainage Basin (CHBS2000)
- B - La Vega Ranch Drainage Basin (CHBR0400)
- C - East Kiowa Creek Drainage Basin (KIKI0400)
- D - Bijou Creek Drainage Basin (BIBI0200)

EXISTING CONDITIONS RATIONAL CALCULATIONS SUMMARY						
DESIGN POINT	TRIBUTARY BASINS	TRIBUTARY AREA (AC)	CFS			% IMPERVIOUS
			Q2	Q5	Q100	
FDR Basins						
1	A1	19.92	4.19	8.43	38.41	8%
2	A2	63.97	3.54	13.47	91.03	1%
3	B1	43.28	1.87	9.34	68.56	0%
4	B2	42.42	1.88	9.41	69.09	0%
5	B3	25.42	1.18	5.91	43.40	0%
5A	B3A	24.23	1.20	5.99	43.98	0%
14	OS-A1	4.06	2.27	3.62	12.02	19%
15	OS-A2	4.45	0.70	2.10	11.46	7%
ON-SITE BASIN TOTAL						
BASIN A TOTAL		83.89	7.73	21.90	129.44	3%
BASIN B TOTAL		135.35	6.13	30.64	225.03	0%
ON-SITE TOTAL		219.24	13.86	52.55	354.46	1%
OFF-SITE BASIN TOTAL						
OFF-SITE BASIN A		8.51	2.97	5.72	23.48	13%
OFF-SITE TOTAL		8.51	2.97	5.72	23.48	13%
SITE TOTAL		227.75	16.83	58.27	377.95	1%

Existing Conditions Natural Channels Flow Summary								
Channel ID	Contributing Basins	Tributary Area (ac)	Basin Area (ac)	Basin 100-yr Flow (cfs)	Channel 100-yr Flow (cfs)	Velocity (ft/s)	Normal Depth (ft)	
1	A1-1	A1	19.92	19.92	38.41	38.41	2.56	0.47
2	A2-3	A2, OS-A2	48.30 (A2) + 4.45 (OS-A2)	63.97 (A2) + 4.45 (OS-A2)	91.03(A2) + 11.46 (OS-A2)	79.02	4.86	0.88
3	A2-4	A2	2.73	63.97	91.03	2.71	1.49	0.23
4	A2-5	A2, B1	7.38 (A2) + 2.81 (B1)	63.97 (A2) + 43.28 (B1)	91.03(A2) + 72.48 (B1)	15.53	2.02	0.27
5	B1-2	B1	16.60	43.28	72.48	27.80	3.73	0.30
6	B1-3	B1	6.15	43.28	72.48	10.30	2.56	0.27
7	B1-6	B1	13.08	43.28	72.48	21.90	3.01	0.36
8	B2-1	B2	4.52	42.42	69.09	7.36	2.25	0.19
9	B2-2	B2	36.7	42.42	69.09	59.77	4.90	0.49
10	B7-1	B3	2.20	25.42	43.40	3.76	1.73	0.20
11	B8-1	B3	17.57	25.42	43.40	30.00	3.41	0.29

GRAPHIC SCALE IN FEET  
0 150 300 600



**Kimley»Horn**

2024 KIMLEY-HORN AND ASSOCIATES, INC.  
2 N NEVADA ST, SUITE 900  
COLORADO SPRINGS, CO 80903 719-453-0180

DESIGNED BY: KRK  
DRAWN BY: AJL  
CHECKED BY: KRK  
DATE: 09/10/24

OVERLOOK FILING NO. 1  
EL PASO COUNTY, COLORADO  
CONSTRUCTION DOCUMENTS  
EXISTING DRAINAGE MAP

PRELIMINARY  
FOR REVIEW ONLY  
NOT FOR  
CONSTRUCTION  
**Kimley»Horn**  
Kimley-Horn and Associates, Inc.

PROJECT NO.  
196239003

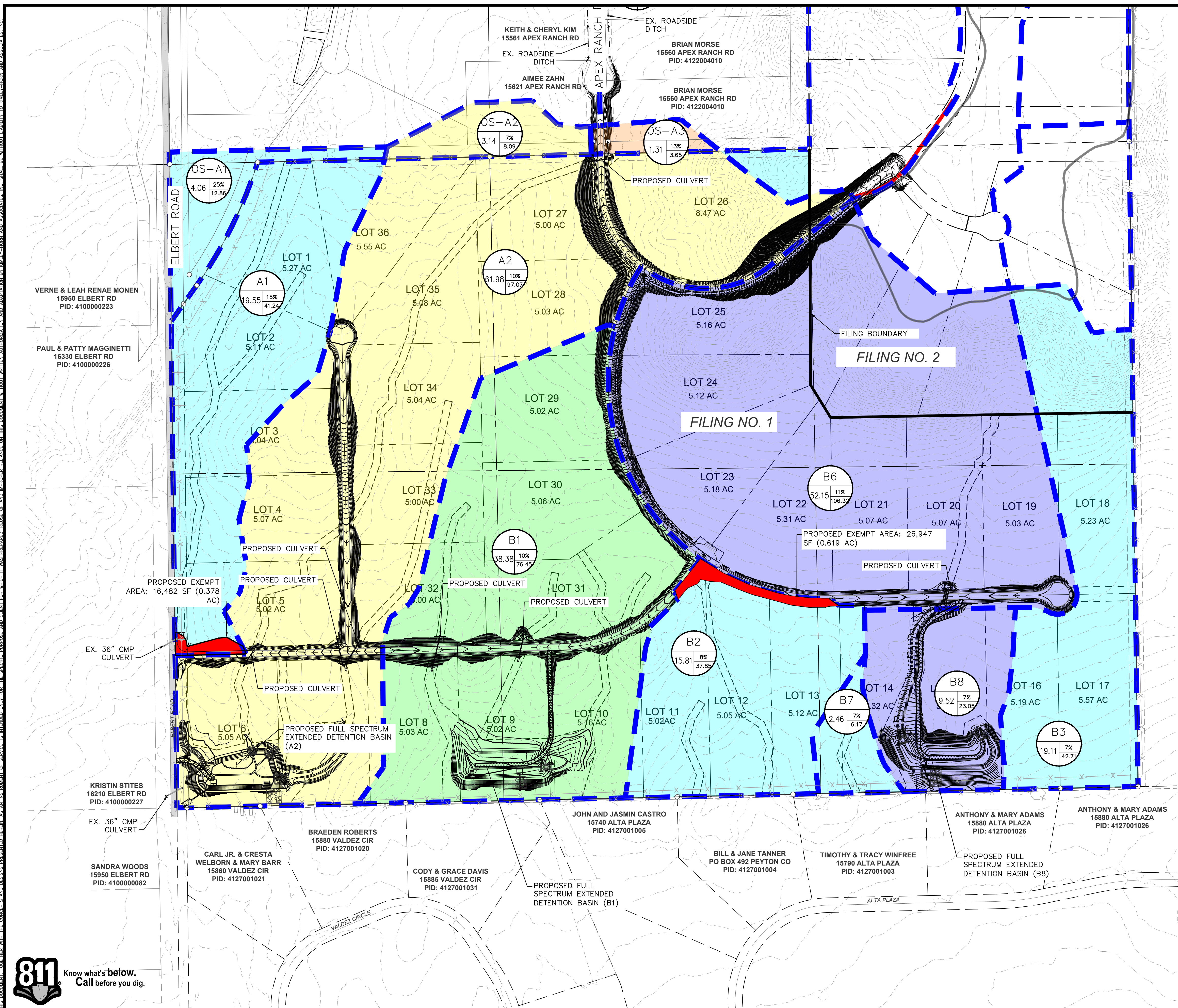
SHEET

EX-1

NO. REVISION BY DATE APPR



THIS DOCUMENT, TOGETHER WITH THE CONCEPTS AND DESIGNS PRESENTED HEREIN, AS AN INSTRUMENT OF SERVICE, IS INTENDED ONLY FOR THE SPECIFIC PURPOSE AND CLIENT FOR WHICH IT WAS PREPARED. REUSE OF AND IMPROPER RELIANCE ON THIS DOCUMENT WITHOUT WRITTEN AUTHORIZATION AND ADAPTATION BY KIMLEY-HORN AND ASSOCIATES, INC. SHALL BE WITHOUT LIABILITY TO KIMLEY-HORN AND ASSOCIATES, INC.

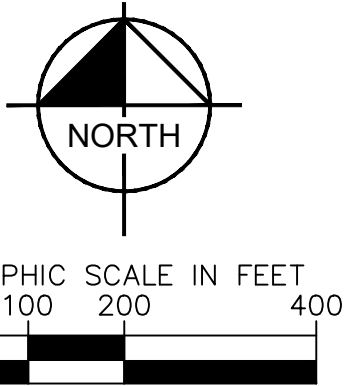


LEGEND

- A = BASIN DESIGNATION  
B = AREA (ACRES)  
C = BASIN IMPERVIOUSNESS  
D = 100YR DESIGN STORM RUNOFF (CFS)
- PROPOSED PROPERTY LINE  
EXISTING PROPERTY LINE  
PROPOSED EASEMENT LINE  
DRAINAGE BASIN BOUNDARY
- THE LARGE LOT EXCLUSION I.7.1.B.5  
TRIBUTARY TO POND A2  
TRIBUTARY TO POND B1  
TRIBUTARY TO POND B8  
TRIBUTARY TO APEX RANCH POND  
PROPOSED EXEMPT AREA

EXEMPT AREAS (ECM I.7.1.C.1)

BASIN A1	= ±16,482 SF
BASIN B2	= ±26,947 SF
TOTAL	= ±43,429 SF (0.99 ACRES)



Kimley»Horn

2023 KIMLEY-HORN AND ASSOCIATES, INC.  
2 N NEVADA ST., SUITE 900  
COLORADO SPRINGS, CO 80903 719-453-0180

DESIGNED BY: KRK  
DRAWN BY: AJL  
CHECKED BY: KRK  
DATE: 11/27/23

OVERLOOK FILING NO. 1  
EL PASO COUNTY, COLORADO  
PRELIMINARY DESIGN PLANS  
EXCLUSION EXHIBIT DRAINAGE MAP-FILING NO. 1

PRELIMINARY  
FOR REVIEW ONLY  
NOT FOR  
CONSTRUCTION  
Kimley»Horn  
Kimley-Horn and Associates, Inc.

PROJECT NO.  
196239003  
SHEET  
EX-3

***APPENDIX H: POND OPCC***



2 North Nevada, Suite 900  
Colorado Springs, Colorado 80903

Project: Overlook Filing No. 1

Project Number:

Date:

November 13, 2024

Prepared By: KRK

Checked By: KRK

Pond A2					
Item		Unit	Quantity	Unit Cost	Cost
Rip Rap Chute #1 / Forebay		CY	36	\$ 210.00	\$7,560.00
Rip Rap Chute #2/ Forebay		CY	45	\$ 210.00	\$9,450.00
Rip Rap Chute #3/ Forebay		CY	48	\$ 210.00	\$10,080.00
Riprap Forebay- West Channel		CY	15	\$ 210.00	\$3,150.00
Concrete Trickle Channel		LF	445	\$ 64.00	\$28,480.00
Concrete Micropool		EA	1	\$ 12,000.00	\$12,000.00
Concrete Outlet Structure		EA	1	\$ 8,500.00	\$8,500.00
42" RCP Outfall Pipe		LF	74	\$ 201.00	\$14,874.00
42" RCP FES		EA	1	\$ 1,206.00	\$1,206.00
Toe Wall		EA	1	\$ 2,000.00	\$2,000.00
Outfall Riprap Protection		CY	34	\$ 210.00	\$7,140.00
Concrete Cut Off Wall		EA	1	\$ 8,000.00	\$8,000.00
Rip Rap Emergency Spillway		CY	197	\$ 210.00	\$41,370.00
Maintenance Road (6" Thick)		CY	71	\$ 56.00	\$3,976.00
Total					\$157,786.00
Pond B1					
Item		Unit	Quantity	Unit Cost	Cost
Rip Rap Chute #1 / Forebay		CY	42	\$ 210.00	\$8,820.00
Rip Rap Chute #2 / Forebay		CY	208	\$ 210.00	\$43,680.00
Concrete Trickle Channel		LF	345	\$ 64.00	\$22,080.00
Concrete Micropool		EA	1	\$ 12,000.00	\$12,000.00
Concrete Outlet Structure		EA	1	\$ 8,500.00	\$8,500.00
36" RCP Outfall Pipe		LF	59	\$ 151.00	\$8,909.00
36" RCP FES		EA	1	\$ 906.00	\$906.00
Toe Wall		EA	1	\$ 2,000.00	\$2,000.00
Outfall Riprap Protection		CY	17	\$ 210.00	\$3,570.00
Concrete Cut Off Wall		EA	1	\$ 8,000.00	\$8,000.00
Rip Rap Emergency Spillway		CY	178	\$ 210.00	\$37,380.00
Maintenance Road (6" Thick)		CY	198	\$ 56.00	\$11,088.00
Total					\$166,933.00
Pond B8					
Item		Unit	Quantity	Unit Cost	Cost
Rip Rap Chute #1 / Forebay		CY	174	\$ 210.00	\$36,540.00
Rip Rap Chute #2/ Forebay		CY	54	\$ 210.00	\$11,340.00
Concrete Trickle Channel		LF	428	\$ 64.00	\$27,392.00
Concrete Micropool		EA	1	\$ 12,000.00	\$12,000.00
Concrete Outlet Structure		EA	1	\$ 8,500.00	\$8,500.00
36" RCP Outfall Pipe		LF	68	\$ 151.00	\$10,268.00
36" RCP FES		EA	1	\$ 906.00	\$906.00
Toe Wall		EA	1	\$ 2,000.00	\$2,000.00
Outfall Riprap Protection		CY	25	\$ 210.00	\$5,250.00
Concrete Cut Off Wall		EA	1	\$ 8,000.00	\$8,000.00
Rip Rap Emergency Spillway		CY	268	\$ 210.00	\$56,280.00
Maintenance Road (6" Thick)		CY	98	\$ 56.00	\$5,488.00
Total					\$183,964.00
TOTAL COST =					\$508,683.00

#### Conceptual Opinion of Probable Construction Cost

The Engineer has no control over the cost of labor, materials, equipment, or over the Contractor's methods of determining prices or over competitive bidding or market conditions. Opinions of probable costs provided herein are based on the information known to Engineer at this time and represent only the Engineer's judgment as a design professional familiar with the construction industry. The Engineer cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from its opinions of probable costs.