



## **COTTAGES AT KETTLE CREEK**

### **FINAL DRAINAGE REPORT**

ALL TERRAIN ENGINEERING PROJECT NO: 24026

March 2025

PREPARED FOR:

GOODWIN KNIGHT

CONTACT: DAVE MORRISON

8605 EXPLORER DRIVE, SUITE 250

COLORADO SPRINGS, CO 80920

PREPARED BY:

ALL TERRAIN ENGINEERING LLC

CONTACT: NICHOLAS Q. JOKERST

NJOKERST@ALLTERRAINENG.COM

(530) 391-7635

---

## ENGINEER'S STATEMENT

This report and plan for the drainage design of the development, COTTAGES AT KETTLE CREEK, was prepared by me (or under my direct supervision) and is correct to the best of my knowledge and belief. Said report and plan has been prepared in accordance with the *City of Colorado Springs Drainage Criteria* Manual and is in conformity with the master plan of the drainage basin. I understand that the City of Colorado Springs does not and will not assume liability for drainage facilities designed by others. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

---

Nicholas Q. Jokerst, PE

Date

State of Colorado No. 59273

For and on behalf of All Terrain Engineering LLC

## DEVELOPER'S STATEMENT

GOODWIN KNIGHT hereby certifies that the drainage facilities for COTTAGES AT KETTLE CREEK shall be constructed according to the design presented in this report. I understand that the City of Colorado Springs does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that are submitted to the City of Colorado Springs pursuant to section 7.4.701 of the City Code; and cannot, on behalf of COTTAGES AT KETTLE CREEK, guarantee that final drainage design will absolve GOODWIN KNIGHT and/or their successors and/or assigns of future liability for improper design. I further understand that approval of the final plat does not imply approval of my engineer's drainage design.

---

Developer Name

Authorized Signature

Date

---

Printed Name

---

Title

---

Address

## CITY OF COLORADO SPRINGS STATEMENT

Filed in accordance with 7.4.701 of the Code of the City of Colorado Springs, 2023, as amended.

---

For SWENT Manager

Date

Conditions:

## ENGINEER'S STATEMENT

The attached drainage plan and report were prepared under my direction and supervision and are correct to the best of my knowledge and belief. Said drainage report has been prepared according to the criteria established by the County for drainage reports and said report is in conformity with the applicable master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors or omissions on my part in preparing this report.

Nicholas Q. Jokerst, PE

Date

State of Colorado No. 59273

For and on behalf of All Terrain Engineering LLC

## DEVELOPER'S STATEMENT

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

Dave Morrison

Date

## Goodwin Knight

8605 Explorer Drive, Suite 250, Colorado Springs, CO 80920

**EL PASO COUNTY ONLY**

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, PE

Date \_\_\_\_\_

County Engineer/ECM Administrator

Conditions:



## Table of Contents

I.	General Purpose, Location & Description .....	2
II.	Drainage Basins .....	2
III.	Drainage Design Criteria .....	5
IV.	Drainage Facility Design .....	6
V.	Summary .....	9
VI.	References .....	10

## Appendices

- A. Vicinity Map, FEMA Map & NRCS Soil Survey
- B. Hydrologic Analysis
- C. Hydraulic Analysis
- D. Water Quality & Detention
- E. Reference Material
- F. Drainage Maps



## I. General Purpose, Location & Description

### a. Purpose

The purpose of this Final Drainage Report (FDR) for COTTAGES AT KETTLE CREEK is to describe the site's onsite and offsite drainage patterns, existing and proposed storm infrastructure, and to safely route developed stormwater to adequate outfalls.

### b. Location

COTTAGES AT KETTLE CREEK, referred to as 'the site' herein, is in Section 28, Township 12 South and Range 66 West of the 6th P.M., Colorado Springs, El Paso County, Colorado. The site is bound by Old Ranch Road to the south and undeveloped parcels to the east, west and north. Surrounding platted developments include Kettle Creek Estates to the south, Fairlane Technology Park No. 4A and 4B to the west and Pendleton Subdivision to the north.

### c. Description of Property

The site is approximately 11.11 acres with existing vegetation consisting of native grasses and trees. The approximate disturbed area is 9.31 acres. The site is currently unplatted. The development will plat a single lot with 85 duplex units. In general, the site slopes southeasterly towards Old Ranch Road and Kettle Creek. Onsite elevations range from 6,700' – 6,726' with slopes ranging 1 – 50%. Per an NRCS soil survey, the site is made up of Type A Columbine gravelly sandy loam and Type B Stapleton-Bernal sandy loams. The soil survey is presented in Appendix A.

The existing site is partially developed with a single family residential buildings and associated structures. The site is zoned RR-2.5 (Rural Residential 2.5 acres). The Kettle Creek major drainageway traverses the eastern property line, however; the site is not within a Streamside Overlay Zone. The site is partially encumbered by a Preble's Jumping Mouse habitat.

There are no irrigation facilities on the site. Onsite, existing utilities include water, sewer, fiberoptic, communications, gas and overhead electric.

### d. Floodplain Statement

Based on FEMA Firm map 08041C0506G dated December 7, 2018, the site is Zone X and Zone AE. Zone X are areas determined to be outside the 0.2% annual chance flood. Zone AE areas are within the 1% annual chance of flooding. All development is located within Zone X.

## II. Drainage Basins

### a. Major Basin Description

The site is located within the Kettle Creek Drainage Basin. The site's drainage characteristics were previously studied in the following reports:

1. "Drainage Basin Planning Study for Kettle Creek Basin" prepared by JR Engineering, May 2015.

Per the DBPS, the site is located within Basin B32 and flows from Basin B32 outfall to Kettle Creek at J24. Per the DBPS, improvements are needed to stabilize the creek adjacent to the site. See Step 3 of the 4-Step Process, detailed later in this report, for channel stabilization details.

#### b. Existing Subbasin Description

The existing site's drainage patterns are relatively uniform to the southeast. Existing stormwater drains towards Old Ranch Road and Kettle Creek. There is no existing storm sewer located on-site. See below for existing basin descriptions:

Basin EX1 is 15.11 acres of undeveloped land, existing residential buildings and Kettle Creek Road. Existing stormwater from this basin ( $Q_5 = 3.7$  cfs  $Q_{100} = 19.6$  cfs) flows to DP1. Stormwater at DP1 is collected in an existing low point along Old Ranch Road.

Basin EX2 is 6.56 acres of undeveloped land and existing residential buildings. Existing stormwater from this basin ( $Q_5 = 1.8$  cfs  $Q_{100} = 9.6$  cfs) flows to an existing swale along the north side of Old Ranch Road at DP2. From here, stormwater drains east into Kettle Creek.

Basin EX3 is 10.41 acres of undeveloped land and Kettle Creek. Existing stormwater from this basin ( $Q_5 = 2.2$  cfs  $Q_{100} = 14.9$  cfs) drains directly into Kettle Creek at DP3. Stormwater at DP3 is conveyed under Old Ranch Road in an existing, private culvert. The size and material of the culvert are not known.

#### c. Proposed Subbasin Description

The proposed site has been divided into 12 subbasins for analysis. All proposed storm sewer will be privately owned and maintained, unless otherwise noted. All storm sewer discussed in the proposed subbasin descriptions is proposed, unless otherwise noted. See below for proposed basin descriptions.

Basin A is 2.08 acres of roadway, duplex units and landscaping. Stormwater from this basin ( $Q_5 = 5.1$  cfs,  $Q_{100} = 10.5$  cfs) is conveyed in curb and gutter to DP1. Stormwater at DP1 is captured in a 15' Type R inlet (private, on-grade). Captured flows at DP1 are piped to DP4.1 ( $Q_5 = 10.4$  cfs,  $Q_{100} = 28.8$  cfs) and continue to Pond 1. DP1 bypass flows ( $Q_5 = 0$  cfs,  $Q_{100} = 1.4$  cfs) continue in curb and gutter to DP4. A berm will be constructed along the northern property line of Basin A to direct offsite stormwater around the site to the west.

Basin B is 2.16 acres of roadway, duplex units and landscaping. Stormwater from this basin ( $Q_5 = 5.0$  cfs,  $Q_{100} = 10.5$  cfs) is conveyed in curb and gutter to DP2. Stormwater at DP2 is captured in a 15' Type R inlet (private, on-grade). Captured flows at DP2 are piped to DP4.1 ( $Q_5 = 10.4$  cfs,  $Q_{100} = 28.8$  cfs) and continue to Pond 1. DP2 bypass flows ( $Q_5 = 0$  cfs,  $Q_{100} = 1.3$  cfs) continue in curb and gutter to DP3. A berm will be constructed along the northern property line of Basin B to direct offsite stormwater around the site to the east.

Basin C is 0.53 acres of roadway, duplex units and landscaping. Stormwater from this basin ( $Q_5 = 1.4$  cfs,  $Q_{100} = 2.9$  cfs) is conveyed in curb and gutter to DP4 ( $Q_5 = 1.4$  cfs,  $Q_{100} = 3.9$  cfs). Stormwater at DP4 is captured in a 10' Type R inlet (private, on-grade). Captured flows at DP4 are piped to DP4.1 ( $Q_5 = 10.4$  cfs,  $Q_{100} = 28.8$  cfs) and continue to Pond 1.

Basin D is 1.57 acres of roadway, duplex units and landscaping. Stormwater from this basin ( $Q_5 = 4.8$  cfs,  $Q_{100} = 9.3$  cfs) is conveyed in curb and gutter to DP3. Stormwater at DP3 ( $Q_5 = 4.8$  cfs,  $Q_{100} = 8.9$  cfs) is captured in a 15' Type R inlet (private, on-grade). Captured flows at DP3 are piped to DP4.1 ( $Q_5 = 10.4$  cfs,  $Q_{100} = 28.8$  cfs) and continue to Pond 1.

Basin E is 0.50 acres of landscaping area and Pond 1. Stormwater from this basin ( $Q_5 = 0.4$  cfs,  $Q_{100} = 1.8$  cfs) flows directly into Pond 1 at DP5 ( $Q_5 = 10.7$  cfs,  $Q_{100} = 30.0$  cfs). See Water Quality and Detention section for Pond 1 details.

Basin F is 0.22 acres of roadway and landscaping. Stormwater from this basin ( $Q_5 = 0.5$  cfs,  $Q_{100} = 1.2$  cfs) is not captured on site. See Step 2 section for water quality exclusion explanation. Basin F stormwater is conveyed in curb and gutter to Old Ranch Road at DP7 and is captured in Swale #2. Swale #2 follows historic drainage patterns and discharges into an existing, public 24" RCP culvert at DP8. The total flow at DP8 is reduced in the proposed condition (Existing  $Q_{100} = 9.6$  cfs, Proposed  $Q_{100} = 5.2$  cfs). Swale capacity and stability calculations are presented in Appendix C.

Basin G1 is 0.79 acres. Basin G1 includes offsite, undeveloped area, Old Ranch Road improvements and Swale #1. The addition of turn lanes along Old Ranch Road expands the existing pavement edge approximately 12' north. These improvements are downstream of the pond and cannot be detained. Basin G1 stormwater ( $Q_5 = 0.8$  cfs,  $Q_{100} = 2.7$  cfs) is captured in Swale #1 and conveyed to DP6 ( $Q_5 = 0.8$  cfs,  $Q_{100} = 2.7$  cfs). Swale #1 replaces the existing roadside ditch. The total flow in the swale is reduced in the proposed condition (Existing  $Q_{100} = 9.6$  cfs, Proposed  $Q_{100} = 2.7$  cfs). In the existing condition, the swale was over capacity. Swale #1 provides 100-year capacity but is limited to 0.51' freeboard due to Old Ranch Road improvements and existing property boundaries. A cross section is provided in Appendix C. Stormwater at DP6 is conveyed under Jumping Heights in an 18" RCP culvert (public) to DP7. Culvert capacity and swale hydraulic calculations are presented in Appendix C.

Basin G2 is 0.42 acres. Basin G2 includes offsite, undeveloped area, Old Ranch Road improvements and Swale #2. The addition of turn lanes along Old Ranch Road expands the existing pavement edge approximately 12' north. These improvements are downstream of the pond and cannot be detained. Basin G2 stormwater ( $Q_5 = 0.9$  cfs,  $Q_{100} = 2.2$  cfs) combines with DP6 flow at DP7 and is conveyed in Swale #2 to DP8 ( $Q_5 = 1.9$  cfs,  $Q_{100} = 5.2$  cfs). Swale #2 replaces the existing roadside ditch. The total flow in the swale is reduced in the proposed condition (Existing  $Q_{100} = 9.6$  cfs, Proposed  $Q_{100} = 5.2$  cfs). In the existing condition, the swale was over capacity. Swale #2 provides 100-year capacity but is limited to 0.39' freeboard due to Old Ranch Road improvements and existing property boundaries. Swale capacity and stability calculations are presented in Appendix C.

Basin G3 is 0.14 acres. Basin G3 includes offsite, undeveloped area, Old Ranch Road improvements and Swale #3. The addition of turn lanes along Old Ranch Road expands the existing pavement edge approximately 8' north. These improvements are downstream of the pond and cannot be detained. Basin G3 stormwater ( $Q_5 = 0.3$  cfs,  $Q_{100} = 0.7$  cfs) is conveyed in Swale #3 to DP9 ( $Q_5 = 2.9$  cfs,  $Q_{100} = 15.6$  cfs). Swale #3 replaces the existing roadside ditch. The existing flow in the swale is maintained in the proposed condition (Existing  $Q_{100} = 0.7$  cfs, Proposed  $Q_{100} = 0.7$  cfs). Swale #3 provides 100-year capacity but is limited to 0.56' freeboard due to Old Ranch Road improvements and existing property boundaries. Stormwater at DP9 is

collected in an existing low point along Old Ranch Road, see Basin EX1 description for reference. Swale capacity and stability calculations are presented in Appendix C.

Basin OS1 is 1.99 acres of offsite, undeveloped area and Kettle Creek Road. Stormwater from this basin ( $Q_5 = 1.1$  cfs,  $Q_{100} = 4.6$  cfs) follows historic drainage patterns southerly along Kettle Creek Road to Old Ranch Road at DP10 ( $Q_5 = 1.1$  cfs,  $Q_{100} = 4.6$  cfs). DP10 continues along existing drainage patterns to the west. Basin OS1 is not detained in Pond 1.

Basin OS2 is 12.08 acres of offsite, undeveloped area and Kettle Creek Road. Stormwater from this basin ( $Q_5 = 2.7$  cfs,  $Q_{100} = 15.3$  cfs) follows the historic drainage patterns of Basin EX1 to DP9 ( $Q_5 = 2.9$  cfs,  $Q_{100} = 15.6$  cfs). A berm along the site's northern boundary will ensure offsite flows from Basin OS2 do not enter the site. Basin OS2 is not detained in Pond 1.

Basin OS3 is 10.37 acres of offsite, undeveloped area and Kettle Creek. Stormwater from this basin ( $Q_5 = 2.2$  cfs,  $Q_{100} = 14.8$  cfs) follows the historic drainage patterns of Basin EX2 to DP11. A berm along the site's northern boundary will ensure offsite flows from Basin OS3 do not enter the site. Basin OS3 drains directly to Kettle Creek and is not detained in Pond 1.

### III. Drainage Design Criteria

#### a. Development Criteria Reference

The drainage analysis, proposed storm sewer system, and proposed private, full spectrum water quality and detention pond follow the criteria from the "City of Colorado Springs Drainage Criteria Manual" Volumes 1 and 2" (CCSDCM, latest revision).

#### b. Hydrologic Criteria

Hydrologic data was obtained from the "City of Colorado Springs Drainage Criteria Manual – Chapter 6 Hydrology". Onsite drainage improvements are designed for the 5-year storm (minor event) and 100-year storm (major event). Runoff was calculated per CCSDCM Section 6.3.0 - Rational Method. Private, full spectrum pond design was completed using the latest version of Mile High Flood District's (MHFD) UD-Detention per CCSDCM Section 13.3.2.1 – Full Spectrum Detention. The detention pond allowable release rate will be limited to historic rates.

#### d. Hydraulic Criteria

Hydraulic criteria for inlet sizing were obtained from the "City of Colorado Springs Drainage Criteria Manual – Chapter 8 Inlets". Hydraulic criteria for storm sewer sizing were obtained from the "City of Colorado Springs Drainage Criteria Manual – Chapter 9 Storm Sewer". Hydraulic criteria for channel sizing were obtained from the "City of Colorado Springs Drainage Criteria Manual – Chapter 12 Open Channels".

Outfall tailwater conditions into detention facilities are based on the hydraulic grade line in the pond at the time of concentration of the tributary basin. The hydraulic grade line is adapted from the UD-Detention Drain Time v. Ponding Depth graph presented in Appendix D.

## IV. Drainage Facility Design

### a. General Concept

Onsite stormwater will be conveyed via curb and gutter to Type R inlets (on-grade, private). Captured stormwater will be piped to and detained in a proposed, private, full spectrum detention pond (Pond 1). Pond 1 will outfall at less than historic values to Kettle Creek. Kettle Creek is the historic outfall for the site.

### b. Water Quality & Detention

Water quality and detention for Basins A – E is provided in a Pond 1, a private, full spectrum detention pond located along Old Ranch Road. A total of 6.84 acres at 62.7% composite imperviousness will be detained in Pond 1. The WQCV is 0.140 ac-ft, the EURV is 0.387 ac-ft, and the 100-year volume is 0.265 ac-ft. The WQCV, EURV and 100-year storms are released in 40, 72 and 79 hours, respectively. A private, concrete forebay is located at the outfall into the pond and a 2.0' concrete trickle channel conveys flow towards the private outlet structure. An 11' access and maintenance road is provided to the bottom of the pond to facilitate future maintenance of the pond facilities. A 10' emergency overflow spillway is provided that conveys the developed, peak 100-yr flow rate with 1.0' of freeboard towards Old Ranch Road. The spillway and downstream outfall will be lined with Type L riprap. The pond outlet structure discharges into proposed, private 18" RCP storm sewer and ultimately to Kettle Creek. The outfall at Kettle Creek is reinforced with a Type L riprap low tailwater basin. Pond design calculations are presented in Appendix D.

### c. Operations & Maintenance

An Operations and Maintenance Manual has been submitted concurrently with this FDR. The manual will specify maintenance activities and intervals for stormwater facilities.

### d. Grading & Erosion Control Plan

Due to the project disturbance area, a separate Grading and Erosion Control plan is required. The Grading and Erosion Control Plan has been submitted concurrently with this FDR.

### e. Four Step Method

*Step 1 – Reducing Runoff Volumes:* Cottages at Kettle Creek consists of duplex units with associated parking, sidewalks and landscape areas. The landscaped areas disconnect impervious areas and reduce runoff volumes. Where possible, roof drains will route across landscape areas to promote infiltration. MHFD UD-BMP was used to calculate runoff reductions. The WQCV reduction for the site is 11%. The runoff reduction calculation and map are presented in Appendix B and F, respectively.

*Step 2 – Treat and slowly release the WQCV:* A proposed, private, full spectrum detention pond (Pond 1) provides water quality treatment for the site. The WQCV is released over a period of 40 hours. A total of 9.31 acres are disturbed by the development. 6.84 acres receive water quality treatment in Pond 1. The total area excluded from water quality per the City's 4-step process exclusions is 2.14 acres. Therefore, the applicable disturbance area is 7.17 acres. The remaining 0.33 acres of disturbed area that does not meet a 4-step exclusion and is not captured by Pond 1 is 4.8% of the applicable disturbance area. Therefore, 95.2% of the

applicable disturbance area is provided water quality. See below for 4-step process exclusions and a summary table at the end.

4-Step Process Exclusion Areas:

Basin F includes 0.10 acres of disturbed area that will remain pervious and will not be captured by Pond 1. Per the City's 4-step process exclusions, this area can be excluded from water quality treatment per Exclusion 2.1.1 - Utility Installation and Exclusion 2.1.2 – Areas to Remain Pervious. Stormwater from this area ( $Q_5 = 0.5$  cfs,  $Q_{100} = 1.2$  cfs) will follow historic drainage patterns towards Old Ranch Road.

Basin G1 includes 0.11 acres of disturbed area that will remain pervious and will not be captured by Pond 1. Per the City's 4-step process exclusions, these areas can be excluded from water quality treatment per Exclusion 2.1.2 – Areas to Remain Pervious. Stormwater from this area ( $Q_5 = 0.8$  cfs,  $Q_{100} = 2.7$  cfs) will follow historic drainage patterns towards Old Ranch Road.

Basin G2 includes 0.14 acres of disturbed area that will remain pervious and will not be captured by Pond 1. Per the City's 4-step process exclusions, these areas can be excluded from water quality treatment per Exclusion 2.1.2 – Areas to Remain Pervious. Stormwater from this area ( $Q_5 = 0.9$  cfs,  $Q_{100} = 2.2$  cfs) will follow historic drainage patterns towards Old Ranch Road.

Basin G3 includes 0.02 acres of disturbed area that will remain pervious and will not be captured by Pond 1. Per the City's 4-step process exclusions, these areas can be excluded from water quality treatment per Exclusion 2.1.2 – Areas to Remain Pervious. Stormwater from this area ( $Q_5 = 0.3$  cfs,  $Q_{100} = 0.7$  cfs) will follow historic drainage patterns towards Old Ranch Road.

Basin OS1 and OS2 include 0.70 acres of disturbed area that will remain pervious and will not be captured by Pond 1. Per the City's 4-step process exclusions, this area can be excluded from water quality treatment per Exclusion 2.1.2 – Areas to Remain Pervious. Stormwater from this area ( $Q_5 = 3.8$  cfs,  $Q_{100} = 19.8$  cfs) will follow historic drainage patterns towards Old Ranch Road.

Basin OS3 includes 1.03 acres of disturbed area (0.16 ac & 0.87 ac) that will remain pervious and will not be captured by Pond 1. Per the City's 4-step process exclusions, these areas can be excluded from water quality treatment per Exclusion 2.1.1 - Utility Installation and Exclusion 2.1.2 – Areas to Remain Pervious. Stormwater from this area ( $Q_5 = 2.2$  cfs,  $Q_{100} = 14.8$  cfs) will follow historic drainage patterns towards Kettle Creek.

Non Exclusion Areas:

Basin F includes 0.12 acres of disturbed area that will not be captured by Pond 1 and does not qualify for any water quality exclusions. This area is located downstream of Pond 1 and is impractical to capture. Therefore, this area will be allowed to drain to Old Ranch Road. The 0.12 acres contributes to the site total of 0.33 acres of disturbed area not receiving water quality treatment nor meeting an exclusion.

Basin G1 includes 0.08 acres of disturbed area that will not be captured by Pond 1 and does not qualify for any water quality exclusions. This area is located downstream of Pond 1 and is impractical to capture. Therefore, this area will be allowed to drain along Old Ranch Road. The 0.08 acres contributes to the site total of 0.33 acres of disturbed area not receiving water quality treatment nor meeting an exclusion.

Basin G2 includes 0.09 acres of disturbed area that will not be captured by Pond 1 and does not qualify for any water quality exclusions. This area is located downstream of Pond 1 and is impractical to capture. Therefore, this area will be allowed to drain along Old Ranch Road. The 0.09 acres contributes to the site total of 0.33 acres of disturbed area not receiving water quality treatment nor meeting an exclusion.

Basin G3 includes 0.02 acres of disturbed area that will not be captured by Pond 1 and does not qualify for any water quality exclusions. This area is located downstream of Pond 1 and is impractical to capture. Therefore, this area will be allowed to drain along Old Ranch Road. The 0.02 acres contributes to the site total of 0.33 acres of disturbed area not receiving water quality treatment nor meeting an exclusion.

Basin OS3 includes 0.02 acres of disturbed area that will not be captured by Pond 1 and does not qualify for any water quality exclusions. This area is located downstream of Pond 1 and is impractical to capture. Therefore, this area will be allowed to drain towards Kettle Creek. The 0.02 acres contributes to the site total of 0.33 acres of disturbed area not receiving water quality treatment nor meeting an exclusion.

APPLICABLE DISTURBANCE AREA CALCULATION		
Total Disturbed Area (TDA, ac)		9.31
Total Exclusion Areas (TEA, ac)	BASIN F	0.11
	BASIN G1-G3	0.29
	BASIN OS1 & OS2	0.70
	BASIN OS3	1.03
Applicable Disturbance Area (ADA, ac) ADA = TDA - TEA		<b>7.17</b>
Applicable Disturbance Area captured by Pond 1		6.84 ac (95.5% of ADA)
Applicable Disturbance Area <u>NOT</u> captured by Pond 1		0.33 ac (4.8% of ADA)

Per the above tables, a total of 6.84 ac, or 95.2% of the applicable disturbed area, will receive water quality treatment in Pond 1. 0.33 acres of applicable disturbance area will not be captured. 0.33 acres is equal to 4.8% of the applicable disturbance area.

*Step 3 – Stabilize stream channels:* All new and re-development projects are required to construct or participate in the funding of channel stabilization measures. Drainage basin fees paid, at the time of platting,

go towards channel stabilization within the drainage basin. The site lies adjacent to Kettle Creek along its eastern edge. Kettle Creek crosses onto the property at the southeast corner of the site. This development will participate in the funding of channel stabilization measures by paying a channel fee in lieu of construction channel stabilization measures. The Stormwater Enterprise (SWENT) has indicated that based on the flow rate in Kettle Creek above Old Ranch Road, the cost per linear foot of channel in 2025 dollars is \$676. This is the fee in lieu amount based on development on one side of the creek. Therefore, the total channel fee in lieu amount which must be paid to satisfy the Step 3 obligation for this development is \$353,548 (\$676/LF x 523 LF).

*Step 4 – Consider the need for source controls:* No industrial or commercial uses are proposed within this development. However, permanent erosion control measures will be provided in the form of asphalt drives, curb and gutter, storm inlets and storm sewer. Per MHFD guidance, the following permanent source controls may be necessary for residential development: S-3 Disposal of Household Waste, S-4 Illicit Discharge Controls, S-5 Good Housekeeping, S-8 Use of Pesticides, Herbicides and Fertilizers, S-9 Landscape Maintenance, and S-10 Snow and Ice Management.

#### f. Drainage Basin & Bridge Fees

Kettle Creek is a closed basin and therefore no fees are due. Building permits cannot be released for the site until the channel improvements are installed or channel improvement assurances have been paid. At the request of the City of Colorado Springs, fees will be paid in lieu of completing improvements. The fee in lieu is \$323,128 and is detailed in Step 3 above.

#### g. Storm Sewer HGL Analysis

An HGL analysis of the proposed storm sewer system is presented in Appendix C.

## V. Summary

COTTAGES AT KETTLE CREEK remains consistent with pre-development drainage conditions with the construction of the recommended drainage improvements. The proposed development will not adversely affect downstream stormwater infrastructure or surrounding developments. This report meets the latest City of Colorado Springs Drainage criteria and is in accordance with the Kettle Creek DBPS. See table below for comparison of existing and proposed stormwater flows leaving the site.

EXISTING V. PROPOSED FLOW COMPARISON				
LOCATION	Ex Q <sub>5-YR</sub>	Ex Q <sub>100-YR</sub>	Pr Q <sub>5-YR</sub>	Pr Q <sub>100-YR</sub>
EX DP2/ PR DP8	1.8	9.6	1.9	5.2
EX DP3/ PR DP11	3.9	23.9	2.2	14.8



## VI. References

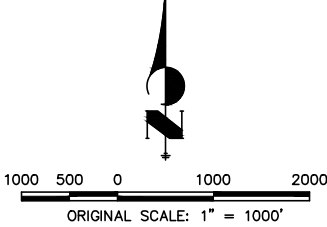
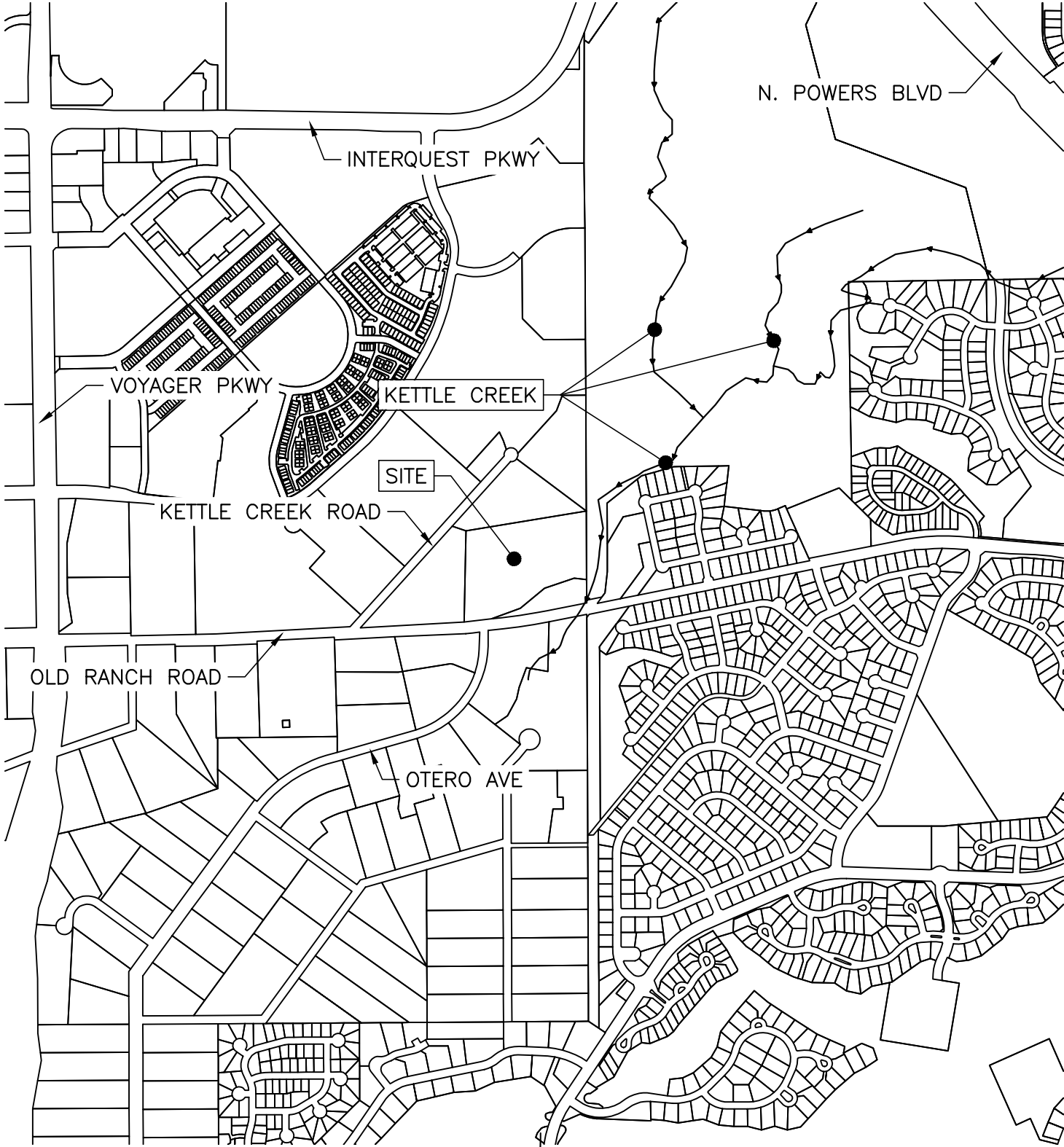
1. City of Colorado Springs – Drainage Criteria Manual, Vol 1 revised – 2021, Vol 2 revised – 2020.
2. Drainage Basin Planning Study for Kettle Creek Basin, prepared by JR Engineering, May 2015.
3. Federal Emergency Management Agency, Flood Map Service Center - <https://msc.fema.gov/portal/home>
4. Urban Storm Drainage Criteria Manual, Mile High Flood District, January 2018.
5. Web Soil Survey, Natural Resources Conservation Service, September 2024.



## **APPENDIX A – VICINITY MAP, FEMA MAP & NRCS WEB SOIL SURVEY**

# COTTAGES AT KETTLE CREEK

## VICINITY MAP

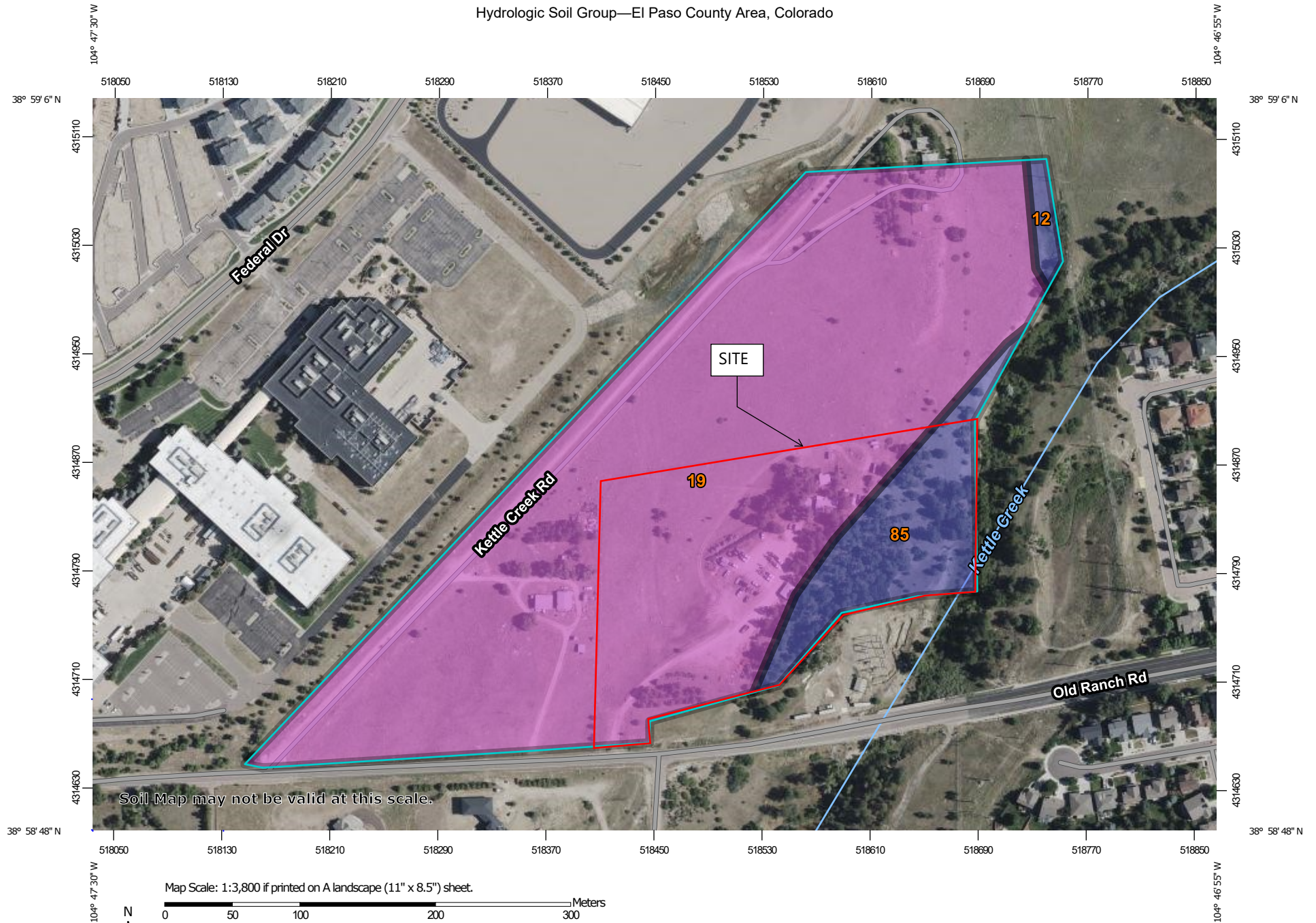


VICINITY MAP	
COTTAGES AT KETTLE CREEK	
JOB NO. 24026	
LOCATION: CS	SHEET
10/03/2024	
SHEET: 1	

**TALL  
TERRAIN**  
ENGINEERING

1004 WEST VAN BUREN STREET  
COLORADO SPRINGS, CO 80907

# Hydrologic Soil Group—El Paso County Area, Colorado



**Natural Resources  
Conservation Service**

Web Soil Survey  
National Cooperative Soil Survey

3/6/2025  
Page 1 of 4

## MAP LEGEND

### Area of Interest (AOI)









 Area of Interest (AOI)

### Soils


#### Soil Rating Polygons





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

#### Soil Rating Lines


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

#### Soil Rating Points






 A  
 A/D  
 B  
 B/D

 C  
 C/D  
 D  
 Not rated or not available

### Water Features

 Streams and Canals

### Transportation

 Rails  
 Interstate Highways  
 US Routes  
 Major Roads  
 Local Roads

### Background

 Aerial Photography

## MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado  
 Survey Area Data: Version 22, Sep 3, 2024

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

Date(s) aerial images were photographed: Jul 23, 2024—Aug 4, 2024

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
12	Bresser sandy loam, cool, 3 to 5 percent slopes	B	0.4	1.2%
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	A	28.9	88.1%
85	Stapleton-Bernal sandy loams, 3 to 20 percent slopes	B	3.5	10.7%
<b>Totals for Area of Interest</b>			<b>32.8</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

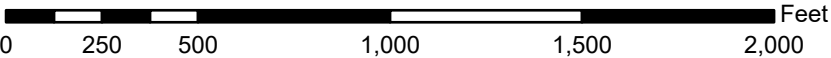
*Component Percent Cutoff:* None Specified

*Tie-break Rule:* Higher

# National Flood Hazard Layer FIRMette



104°47'35"W 38°59'8"N



1:6,000

104°46'57"W 38°58'40"N

Basemap Imagery Source: USGS National Map 2023

## Legend

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

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D
OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall
OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
MAP PANELS		Jurisdiction Boundary
		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
		Digital Data Available
		No Digital Data Available
		Unmapped



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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 9/12/2024 at 11:07 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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





**NOAA Atlas 14, Volume 8, Version 2**  
**Location name: Colorado Springs, Colorado, USA\***  
**Latitude: 38.9822°, Longitude: -104.7861°**  
**Elevation: 6724 ft\*\***

\* source: ESRI Maps  
 \*\* source: USGS



**POINT PRECIPITATION FREQUENCY ESTIMATES**

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

NOAA, National Weather Service, Silver Spring, Maryland

[PF tabular](#) | [PF graphical](#) | [Maps & aerals](#)

**PF tabular**

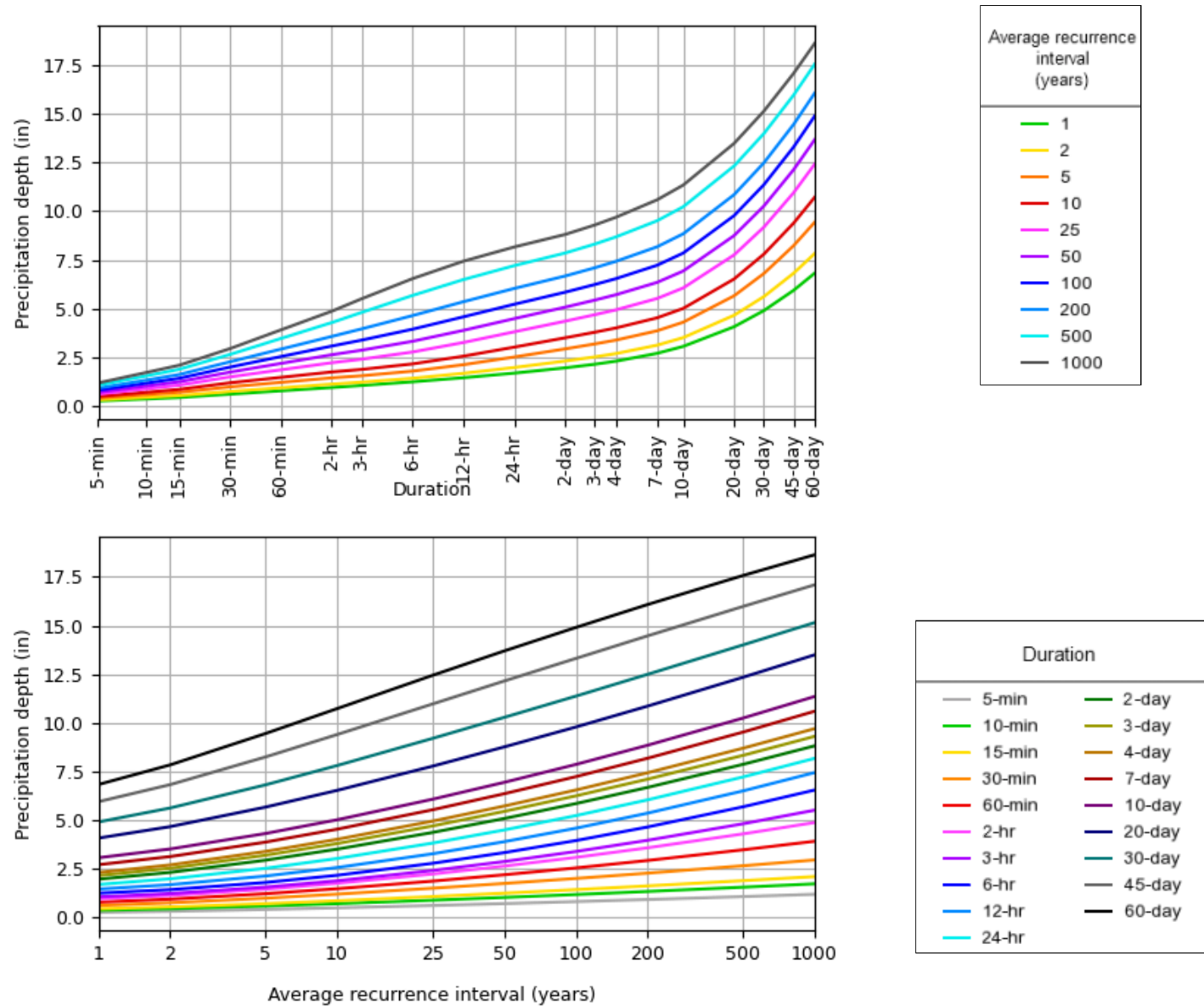
<b>PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)<sup>1</sup></b>										
<b>Duration</b>	<b>Average recurrence interval (years)</b>									
	<b>1</b>	<b>2</b>	<b>5</b>	<b>10</b>	<b>25</b>	<b>50</b>	<b>100</b>	<b>200</b>	<b>500</b>	<b>1000</b>
<b>5-min</b>	<b>0.231</b> (0.190-0.281)	<b>0.286</b> (0.235-0.349)	<b>0.381</b> (0.312-0.466)	<b>0.464</b> (0.378-0.570)	<b>0.584</b> (0.462-0.750)	<b>0.682</b> (0.525-0.886)	<b>0.785</b> (0.582-1.04)	<b>0.893</b> (0.633-1.22)	<b>1.04</b> (0.709-1.46)	<b>1.16</b> (0.767-1.65)
<b>10-min</b>	<b>0.338</b> (0.278-0.412)	<b>0.419</b> (0.345-0.511)	<b>0.558</b> (0.457-0.683)	<b>0.679</b> (0.554-0.835)	<b>0.856</b> (0.676-1.10)	<b>0.999</b> (0.768-1.30)	<b>1.15</b> (0.852-1.53)	<b>1.31</b> (0.927-1.78)	<b>1.53</b> (1.04-2.14)	<b>1.70</b> (1.12-2.41)
<b>15-min</b>	<b>0.412</b> (0.339-0.502)	<b>0.511</b> (0.420-0.623)	<b>0.680</b> (0.558-0.833)	<b>0.828</b> (0.675-1.02)	<b>1.04</b> (0.824-1.34)	<b>1.22</b> (0.937-1.58)	<b>1.40</b> (1.04-1.86)	<b>1.59</b> (1.13-2.18)	<b>1.86</b> (1.27-2.61)	<b>2.07</b> (1.37-2.94)
<b>30-min</b>	<b>0.583</b> (0.481-0.712)	<b>0.722</b> (0.594-0.882)	<b>0.960</b> (0.788-1.18)	<b>1.17</b> (0.953-1.44)	<b>1.47</b> (1.16-1.89)	<b>1.72</b> (1.32-2.23)	<b>1.98</b> (1.47-2.63)	<b>2.25</b> (1.60-3.07)	<b>2.63</b> (1.79-3.69)	<b>2.93</b> (1.93-4.16)
<b>60-min</b>	<b>0.755</b> (0.622-0.921)	<b>0.911</b> (0.750-1.11)	<b>1.19</b> (0.977-1.46)	<b>1.45</b> (1.18-1.78)	<b>1.84</b> (1.46-2.38)	<b>2.17</b> (1.67-2.83)	<b>2.52</b> (1.87-3.37)	<b>2.90</b> (2.06-3.98)	<b>3.45</b> (2.35-4.86)	<b>3.89</b> (2.57-5.52)
<b>2-hr</b>	<b>0.926</b> (0.768-1.12)	<b>1.10</b> (0.910-1.33)	<b>1.42</b> (1.17-1.73)	<b>1.73</b> (1.42-2.11)	<b>2.20</b> (1.77-2.84)	<b>2.61</b> (2.04-3.40)	<b>3.06</b> (2.30-4.08)	<b>3.56</b> (2.55-4.86)	<b>4.27</b> (2.94-5.99)	<b>4.86</b> (3.23-6.84)
<b>3-hr</b>	<b>1.03</b> (0.857-1.24)	<b>1.20</b> (0.997-1.45)	<b>1.53</b> (1.27-1.85)	<b>1.86</b> (1.53-2.26)	<b>2.38</b> (1.93-3.09)	<b>2.85</b> (2.23-3.71)	<b>3.36</b> (2.54-4.49)	<b>3.94</b> (2.85-5.39)	<b>4.79</b> (3.31-6.71)	<b>5.49</b> (3.67-7.71)
<b>6-hr</b>	<b>1.22</b> (1.02-1.46)	<b>1.40</b> (1.17-1.68)	<b>1.77</b> (1.47-2.12)	<b>2.14</b> (1.77-2.58)	<b>2.75</b> (2.25-3.56)	<b>3.30</b> (2.61-4.29)	<b>3.93</b> (2.99-5.21)	<b>4.63</b> (3.37-6.30)	<b>5.66</b> (3.95-7.90)	<b>6.53</b> (4.39-9.11)
<b>12-hr</b>	<b>1.43</b> (1.20-1.70)	<b>1.66</b> (1.39-1.97)	<b>2.10</b> (1.76-2.51)	<b>2.54</b> (2.11-3.04)	<b>3.24</b> (2.66-4.14)	<b>3.87</b> (3.07-4.97)	<b>4.56</b> (3.49-6.00)	<b>5.34</b> (3.91-7.21)	<b>6.48</b> (4.55-8.97)	<b>7.43</b> (5.03-10.3)
<b>24-hr</b>	<b>1.67</b> (1.41-1.97)	<b>1.96</b> (1.65-2.31)	<b>2.50</b> (2.10-2.96)	<b>3.00</b> (2.52-3.58)	<b>3.79</b> (3.11-4.77)	<b>4.47</b> (3.56-5.68)	<b>5.21</b> (4.00-6.78)	<b>6.03</b> (4.43-8.04)	<b>7.20</b> (5.07-9.86)	<b>8.16</b> (5.56-11.2)
<b>2-day</b>	<b>1.94</b> (1.65-2.27)	<b>2.29</b> (1.95-2.69)	<b>2.91</b> (2.47-3.43)	<b>3.48</b> (2.94-4.12)	<b>4.34</b> (3.57-5.39)	<b>5.06</b> (4.04-6.35)	<b>5.83</b> (4.50-7.50)	<b>6.67</b> (4.92-8.80)	<b>7.85</b> (5.56-10.6)	<b>8.81</b> (6.04-12.0)
<b>3-day</b>	<b>2.12</b> (1.82-2.48)	<b>2.50</b> (2.14-2.92)	<b>3.17</b> (2.70-3.72)	<b>3.77</b> (3.19-4.44)	<b>4.68</b> (3.85-5.77)	<b>5.43</b> (4.35-6.77)	<b>6.23</b> (4.82-7.97)	<b>7.09</b> (5.25-9.32)	<b>8.31</b> (5.91-11.2)	<b>9.30</b> (6.41-12.7)
<b>4-day</b>	<b>2.28</b> (1.95-2.66)	<b>2.67</b> (2.29-3.12)	<b>3.37</b> (2.87-3.94)	<b>3.99</b> (3.38-4.69)	<b>4.92</b> (4.07-6.06)	<b>5.70</b> (4.58-7.09)	<b>6.53</b> (5.06-8.32)	<b>7.42</b> (5.51-9.72)	<b>8.68</b> (6.19-11.7)	<b>9.69</b> (6.70-13.2)
<b>7-day</b>	<b>2.68</b> (2.31-3.11)	<b>3.10</b> (2.67-3.60)	<b>3.84</b> (3.30-4.47)	<b>4.51</b> (3.84-5.27)	<b>5.51</b> (4.57-6.73)	<b>6.34</b> (5.12-7.83)	<b>7.22</b> (5.63-9.14)	<b>8.17</b> (6.10-10.6)	<b>9.51</b> (6.82-12.7)	<b>10.6</b> (7.36-14.3)
<b>10-day</b>	<b>3.04</b> (2.63-3.51)	<b>3.49</b> (3.02-4.03)	<b>4.29</b> (3.69-4.96)	<b>5.00</b> (4.27-5.81)	<b>6.05</b> (5.03-7.35)	<b>6.92</b> (5.61-8.51)	<b>7.85</b> (6.14-9.89)	<b>8.84</b> (6.62-11.5)	<b>10.2</b> (7.36-13.6)	<b>11.3</b> (7.92-15.3)
<b>20-day</b>	<b>4.05</b> (3.52-4.64)	<b>4.64</b> (4.03-5.32)	<b>5.65</b> (4.89-6.49)	<b>6.51</b> (5.60-7.52)	<b>7.75</b> (6.46-9.29)	<b>8.75</b> (7.12-10.6)	<b>9.78</b> (7.68-12.2)	<b>10.9</b> (8.17-13.9)	<b>12.3</b> (8.92-16.3)	<b>13.5</b> (9.49-18.0)
<b>30-day</b>	<b>4.88</b> (4.26-5.57)	<b>5.60</b> (4.88-6.40)	<b>6.79</b> (5.90-7.77)	<b>7.79</b> (6.73-8.96)	<b>9.18</b> (7.66-10.9)	<b>10.3</b> (8.37-12.4)	<b>11.4</b> (8.94-14.1)	<b>12.5</b> (9.42-15.9)	<b>14.0</b> (10.2-18.3)	<b>15.2</b> (10.7-20.2)
<b>45-day</b>	<b>5.93</b> (5.19-6.73)	<b>6.81</b> (5.95-7.74)	<b>8.23</b> (7.17-9.38)	<b>9.39</b> (8.13-10.7)	<b>11.0</b> (9.14-12.9)	<b>12.1</b> (9.91-14.5)	<b>13.3</b> (10.5-16.3)	<b>14.5</b> (10.9-18.3)	<b>16.0</b> (11.6-20.8)	<b>17.1</b> (12.1-22.7)
<b>60-day</b>	<b>6.81</b> (5.98-7.71)	<b>7.82</b> (6.86-8.86)	<b>9.43</b> (8.24-10.7)	<b>10.7</b> (9.31-12.2)	<b>12.4</b> (10.4-14.5)	<b>13.7</b> (11.2-16.3)	<b>14.9</b> (11.8-18.2)	<b>16.1</b> (12.2-20.2)	<b>17.6</b> (12.8-22.7)	<b>18.6</b> (13.3-24.7)

<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).  
 Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.  
 Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

**PF graphical**

PDS-based depth-duration-frequency (DDF) curves  
Latitude: 38.9822°, Longitude: -104.7861°



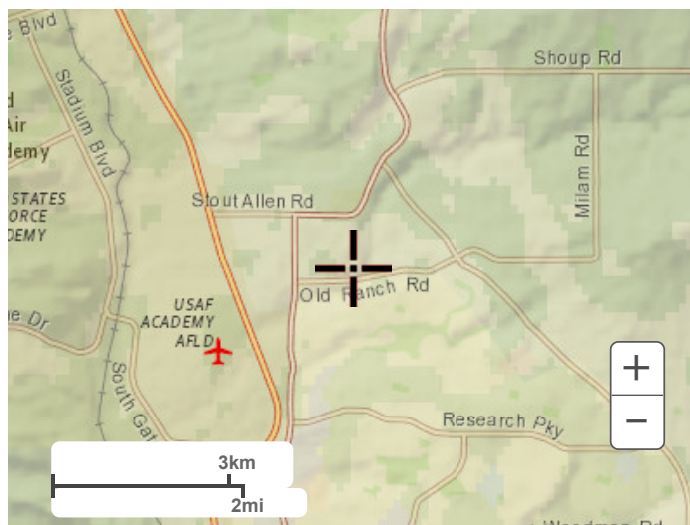
NOAA Atlas 14, Volume 8, Version 2

Created (GMT): Wed Sep 18 18:43:40 2024

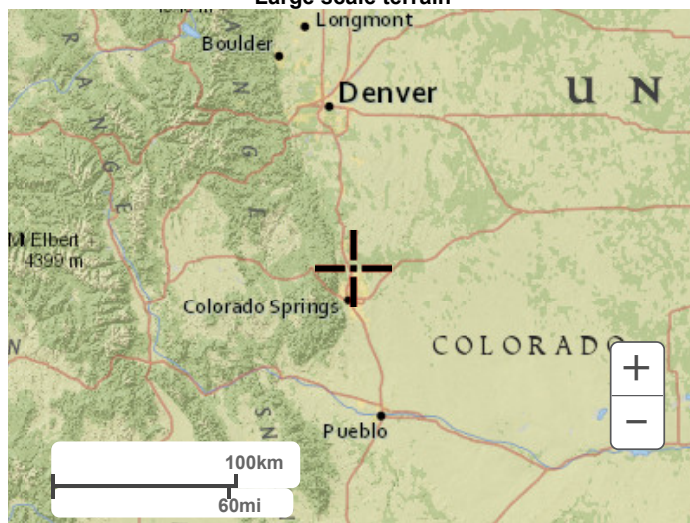
[Back to Top](#)

Maps & aerials

Small scale terrain



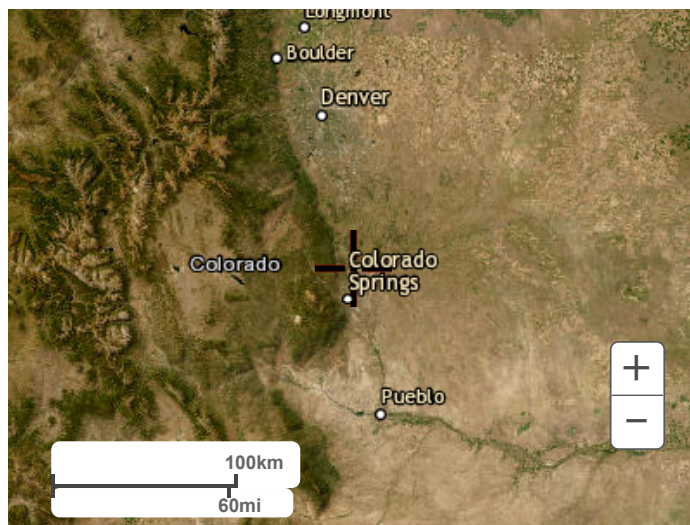
Large scale terrain



Large scale map



Large scale aerial



[Back to Top](#)

---

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

[Disclaimer](#)



## **APPENDIX B – HYDROLOGIC CALCULATIONS**

<b>Subdivision:</b>	Cottages at Kettle Creek
<b>Location:</b>	Colorado Springs
<b>Project Name:</b>	Cottages at Kettle Creek
<b>Project Number:</b>	24026
<b>Calculated By:</b>	NQJ
<b>Checked By:</b>	
<b>Date:</b>	9/30/2024

EX DRAINAGE CALCS - BASIN SUMMARY TABLE							
Tributary Sub-basin	Area (acres)	Percent Impervious	C <sub>5</sub>	C <sub>100</sub>	t <sub>c</sub> (min)	Q <sub>5</sub> (cfs)	Q <sub>100</sub> (cfs)
EX1	15.11	7%	0.09	0.36	40.5	3.7	19.6
EX2	6.56	6%	0.09	0.36	34.3	1.8	9.6
EX3	10.41	2%	0.09	0.36	32.3	2.2	14.9

DESIGN POINT SUMMARY TABLE		
DP#	Q <sub>5-YR</sub>	Q <sub>100-YR</sub>
1	3.7	19.6
2	1.8	9.6
3	3.9	23.9

COMPOSITE % IMPERVIOUS CALCULATIONS - EXISTING CONDITIONS

Subdivision: Cottages at Kettle Creek  
Location: Colorado Springs

Project Name: Cottages at Kettle Creek  
Project No.: 24026.00  
Calculated By: NQJ  
Checked By:  
Date: 9/30/24

		Gravel Drives				Paved				Roofs				Historic/Agriculture				Weighted C <sub>5</sub> & C <sub>100</sub>		Basins Total Weighted % Imp.
Basin ID	Total Area (ac)	C <sub>5</sub>	C <sub>100</sub>	Area (ac)	% Imp.	C <sub>5</sub>	C <sub>100</sub>	Area (ac)	% Imp.	C <sub>5</sub>	C <sub>100</sub>	Area (ac)	% Imp.	C <sub>5</sub>	C <sub>100</sub>	Area (ac)	% Imp.			
																		C <sub>5</sub>	C <sub>100</sub>	
EX1	15.11	0.59	0.70	0.83	80.0%	0.90	0.96	0.00	100.0%	0.73	0.81	0.06	90.0%	0.09	0.36	14.22	2.0%	0.12	0.38	6.6%
EX2	6.56	0.59	0.70	0.22	80.0%	0.90	0.96	0.05	100.0%	0.73	0.81	0.08	90.0%	0.09	0.36	6.21	2.0%	0.12	0.38	6.4%
EX3	10.41	0.59	0.70	0.00	80.0%	0.90	0.96	0.00	100.0%	0.73	0.81	0.00	90.0%	0.09	0.36	10.41	2.0%	0.09	0.36	2.0%
Total	32.08																			3.8%

STANDARD FORM SF-2 - EXISTING CONDITIONS  
TIME OF CONCENTRATION

Subdivision: Cottages at Kettle Creek  
Location: El Paso County

Project Name: Cottages at Kettle Creek  
Project No.: 24019.00  
Calculated By: NQJ  
Checked By:  
Date: 9/30/24

SUB-BASIN					INITIAL/OVERLAND			TRAVEL TIME					t <sub>c</sub> CHECK			FINAL
DATA					(T <sub>i</sub> )			(T <sub>t</sub> )					(URBANIZED BASINS)			
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Weighted C <sub>s</sub>	Impervious (%)	L (ft)	S <sub>o</sub> (%)	t <sub>i</sub> (min)	L <sub>t</sub> (ft)	S <sub>t</sub> (%)	K	VEL. (ft/s)	t <sub>t</sub> (min)	COMP. t <sub>c</sub> (min)	TOTAL LENGTH (ft)	Urbanized t <sub>c</sub> (min)	t <sub>c</sub> (min)
EX1	15.11	B	0.12	6.6%	300	2.7%	22.1	1280	1.9%	7.0	1.0	22.1	44.2	1580.0	40.5	40.5
EX2	6.56	B	0.12	6.4%	300	1.8%	25.2	920	2.7%	7.0	1.2	13.3	38.6	1220.0	34.3	34.3
EX3	10.41	B	0.09	2.0%	300	1.6%	27.0	1006	7.3%	7.0	1.9	8.9	35.9	1306.0	32.3	32.3

NOTES:

tc = ti + tt

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

Equation 6-3

Table 6-2. NRCS Conveyance factors, K

Type of Land Surface	Conveyance Factor, K
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

Where:

tc = computed time of concentration (minutes)

ti = overland (initial) flow time (minutes)

tt = channelized flow time (minutes).

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$

Where:

ti = overland (initial) flow time (minutes)  
C5 = runoff coefficient for 5-year frequency (from Table 6-4)  
Li = length of overland flow (ft)  
So = average slope along the overland flow path (ft/ft).

Equation 6-4 
$$t_t = \frac{L_t}{60(14i + 9)\sqrt{S_t}}$$

Equation 6-5

Where:

tt = channelized flow time (travel time, min)  
Lt = waterway length (ft)  
So = waterway slope (ft/ft)  
Vt = travel time velocity (ft/sec) = K√So  
K = NRCS conveyance factor (see Table 6-2).

tc =

tc = minimum time of concentration for first design point when less than tc from Equation 6-1.  
Lt = length of channelized flow path (ft)  
i = imperviousness (expressed as a decimal)  
St = slope of the channelized flow path (ft/ft).

Use a minimum tc value of 5 minutes for urbanized areas and a minimum tc value of 10 minutes for areas that are not considered urban. Use minimum values even when calculations result in a lesser time of concentration.



STANDARD FORM SF-3 - EXISTING CONDITIONS

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Cottages at Kettle Creek  
Location: Colorado Springs  
Design Storm: 5-Year

Project Name: Cottages at Kettle Creek  
Project No.: 24026.00  
Calculated By: NQJ  
Checked By:  
Date: 9/30/24

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	t <sub>c</sub> (min)	C*A (Ac)	I (in/hr)	Q (cfs)	t <sub>c</sub> (min)	C*A (ac)	I (in/hr)	Q (cfs)	Q <sub>cstreet</sub> (cfs)	C*A (ac)	Slope (%)	Q <sub>pipe</sub> (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	t <sub>t</sub> (min)	
	1	EX1	15.11	0.12	40.5	1.81	2.03	3.7															BASIN EX1 HISTORIC FLOW @ DP1, DRAINS WEST ALONG OLD RANCH ROAD
	2	EX2	6.56	0.12	34.3	0.79	2.28	1.8															BASIN EX2 HISTORIC FLOW @ DP2, DRAINS EAST ALONG OLD RANCH ROAD TO DP3
	3	EX3	10.41	0.09	32.3	0.94	2.37	2.2	34.3	1.73	2.28	3.9											BASIN EX3 HISTROIC FLOW & DP2 FLOW @ DP3, FLOWS SOUTH UNDER OLD RANCH ROAD IN EX CULVERT

Notes:  
Street and Pipe C\*A values are determined by Q/i using the catchment's intensity value.

STANDARD FORM SF-3 - EXISTING CONDITIONS

STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Subdivision: Cottages at Kettle Creek  
Location: Colorado Springs  
Design Storm: 100-Year

Project Name: Cottages at Kettle Creek  
Project No.: 24026.00  
Calculated By: NQJ  
Checked By:  
Date: 9/30/24

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	$t_c$ (min)	C*A (ac)	I (in/hr)	Q (cfs)	$t_c$ (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{street}$ (cfs)	C*A (ac)	Slope (%)	$Q_{pipe}$ (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	$t_t$ (min)	
	1	EX1	15.11	0.38	40.5	5.75	3.41	19.6															BASIN EX1 HISTORIC FLOW @ DP1, DRAINS WEST ALONG OLD RANCH ROAD
	2	EX2	6.56	0.38	34.3	2.50	3.82	9.6															BASIN EX2 HISTORIC FLOW @ DP2, DRAINS EAST ALONG OLD RANCH ROAD TO DP3
	3	EX3	10.41	0.36	32.3	3.75	3.97	14.9	34.3	6.25	3.82	23.9											BASIN EX3 HISTORIC FLOW & DP2 FLOW @ DP3, FLOWS SOUTH UNDER OLD RANCH ROAD IN EX CULVERT

Notes:  
Street and Pipe C\*A values are determined by Q/I using the catchment's intensity value.

**Subdivision:** Cottages at Kettle Creek  
**Location:** Colorado Springs  
**Project Name:** Cottages at Kettle Creek  
**Project Number:** 24026  
**Calculated By:** NQJ  
**Checked By:** REB  
**Date:** 3/21/2025

### PROPOSED CALCS - BASIN SUMMARY TABLE

Tributary Sub-basin	Area (acres)	Percent Impervious	C <sub>5</sub>	C <sub>100</sub>	t <sub>c</sub> (min)	Q <sub>5</sub> (cfs)	Q <sub>100</sub> (cfs)
A	2.08	64%	0.58	0.72	17.5	5.1	10.5
B	2.16	63%	0.57	0.71	18.5	5.0	10.5
C	0.53	65%	0.60	0.73	15.9	1.4	2.9
D	1.57	76%	0.69	0.80	15.4	4.8	9.3
E	0.50	12%	0.17	0.42	25.9	0.4	1.8
F	0.22	47%	0.46	0.63	19.7	0.5	1.2
G1	0.79	21%	0.25	0.47	25.1	0.8	2.7
G2	0.42	44%	0.43	0.61	18.9	0.9	2.2
G3	0.14	57%	0.53	0.68	17.7	0.3	0.7
OS1	1.99	14%	0.17	0.41	35.5	1.1	4.6
OS2	12.08	5%	0.11	0.38	40.9	2.7	15.3
OS3	10.37	2%	0.09	0.36	17.5	2.2	14.8

### DESIGN POINT SUMMARY TABLE

DP#	Q <sub>5-YR</sub>	Q <sub>100-YR</sub>
1	5.1	10.5
2	5.0	10.5
3	4.8	8.9
4	1.4	3.9
4.1	10.4	28.8
5	10.7	30.0
6	0.8	2.7
7	1.3	3.7
8	1.9	5.2
9	2.9	15.6
10	1.1	4.6
11	2.2	14.8

### EXISTING V. PROPOSED FLOW COMPARISON

LOCATION	Ex Q <sub>5-YR</sub>	Ex Q <sub>100-YR</sub>	Pr Q <sub>5-YR</sub>	Pr Q <sub>100-YR</sub>
EX DP2/ PR DP8	1.8	9.6	1.9	5.2
EX DP3/ PR DP11	3.9	23.9	2.2	14.8

COMPOSITE % IMPERVIOUS CALCULATIONS - PROPOSED CONDITIONS

Subdivision: Cottages at Kettle Creek

Location: Colorado Springs

Project Name: Cottages at Kettle Creek

Project No.: 24026.00

Calculated By: NOJ

Checked By:

Date: 3/21/25

Basin ID	Total Area (ac)	Paved				Gravel				Roofs				Landscaping/Undeveloped				Weighted C <sub>5</sub> & C <sub>100</sub>		Basins Total Weighted % Imp.
		C <sub>5</sub>	C <sub>100</sub>	Area (ac)	% Imp.	C <sub>5</sub>	C <sub>100</sub>	Area (ac)	% Imp.	C <sub>5</sub>	C <sub>100</sub>	Area (ac)	% Imp.	C <sub>5</sub>	C <sub>100</sub>	Area (ac)	% Imp.	C <sub>5</sub>	C <sub>100</sub>	
																		C <sub>5</sub>	C <sub>100</sub>	
A	2.08	0.90	0.96	0.92	100.0%	0.59	0.70	0.06	80.0%	0.73	0.81	0.39	90.0%	0.09	0.36	0.71	2.0%	0.58	0.72	64.1%
B	2.16	0.90	0.96	0.87	100.0%	0.59	0.70	0.00	80.0%	0.73	0.81	0.52	90.0%	0.09	0.36	0.77	2.0%	0.57	0.71	62.7%
C	0.53	0.90	0.96	0.27	100.0%	0.59	0.70	0.00	80.0%	0.73	0.81	0.08	90.0%	0.09	0.36	0.18	2.0%	0.60	0.73	65.2%
D	1.57	0.90	0.96	0.93	100.0%	0.59	0.70	0.00	80.0%	0.73	0.81	0.29	90.0%	0.09	0.36	0.35	2.0%	0.69	0.80	76.3%
E	0.50	0.90	0.96	0.05	100.0%	0.59	0.70	0.00	80.0%	0.73	0.81	0.00	90.0%	0.09	0.36	0.45	2.0%	0.17	0.42	11.8%
F	0.22	0.90	0.96	0.10	100.0%	0.59	0.70	0.00	80.0%	0.73	0.81	0.00	90.0%	0.09	0.36	0.12	2.0%	0.46	0.63	46.5%
G1	0.79	0.90	0.96	0.14	100.0%	0.59	0.70	0.02	80.0%	0.73	0.81	0.00	90.0%	0.09	0.36	0.63	2.0%	0.25	0.47	21.3%
G2	0.42	0.90	0.96	0.17	100.0%	0.59	0.70	0.01	80.0%	0.73	0.81	0.00	90.0%	0.09	0.36	0.24	2.0%	0.43	0.61	43.5%
G3	0.14	0.90	0.96	0.07	100.0%	0.59	0.70	0.01	80.0%	0.73	0.81	0.00	90.0%	0.09	0.36	0.06	2.0%	0.53	0.68	56.6%
OS1	1.99	0.90	0.96	0.00	100.0%	0.59	0.70	0.30	80.0%	0.73	0.81	0.00	90.0%	0.09	0.36	1.69	2.0%	0.17	0.41	13.8%
OS2	12.08	0.90	0.96	0.00	100.0%	0.59	0.70	0.46	80.0%	0.73	0.81	0.06	90.0%	0.09	0.36	11.56	2.0%	0.11	0.38	5.4%
OS3	10.37	0.90	0.96	0.00	100.0%	0.59	0.70	0.00	80.0%	0.73	0.81	0.00	90.0%	0.09	0.36	10.37	2.0%	0.09	0.36	2.0%
Total	32.85																			18.1%
Pond (A-E)	6.84																			62.7%

STANDARD FORM SF-2 - PROPOSED CONDITIONS  
TIME OF CONCENTRATION

Subdivision: Cottages at Kettle Creek  
Location: El Paso County

Project Name: Cottages at Kettle Creek  
Project No.: 24026.00  
Calculated By: NQJ  
Checked By:  
Date: 3/21/25

SUB-BASIN					INITIAL/OVERLAND			TRAVEL TIME					t <sub>c</sub> CHECK			FINAL
DATA					(T <sub>i</sub> )			(T <sub>t</sub> )					(URBANIZED BASINS)			
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Weighted C <sub>s</sub>	Impervious (%)	L (ft)	S <sub>o</sub> (%)	t <sub>i</sub> (min)	L <sub>t</sub> (ft)	S <sub>t</sub> (%)	K	VEL. (ft/s)	t <sub>t</sub> (min)	COMP. t <sub>c</sub> (min)	TOTAL LENGTH (ft)	Urbanized t <sub>c</sub> (min)	t <sub>c</sub> (min)
A	2.08	A	0.58	64.1%	100	2.0%	7.4	340	1.7%	20.0	2.6	2.2	9.6	440.0	17.5	9.6
B	2.16	A	0.57	62.7%	100	2.0%	7.6	420	1.6%	20.0	2.5	2.8	10.4	520.0	18.5	10.4
C	0.53	A	0.60	65.2%	100	2.0%	7.2	270	6.0%	20.0	4.9	0.9	8.1	370.0	15.9	8.1
D	1.57	A	0.69	76.3%	100	2.0%	5.9	400	2.0%	20.0	2.8	2.4	8.3	500.0	15.4	8.3
E	0.50	A	0.17	11.8%	65	33.0%	4.3	123	1.0%	20.0	2.0	1.0	5.3	188.0	25.9	5.3
F	0.22	A	0.46	46.5%	24	2.0%	4.5	310	4.4%	20.0	4.2	1.2	5.7	334.0	19.7	5.7
G1	0.79	A	0.25	21.3%	22	2.0%	5.8	390	4.0%	10.0	2.0	3.3	9.0	412.0	25.1	9.0
G2	0.42	A	0.43	43.5%	22	2.0%	4.5	181	50.0%	10.0	7.1	0.4	4.9	203.0	18.9	5.0
G3	0.14	A	0.53	56.6%	44	2.0%	5.4	264	3.7%	10.0	1.9	2.3	7.7	308.0	17.7	7.7
OS1	1.99	A	0.17	13.8%	10	2.0%	4.2	980	1.6%	10.0	1.3	12.9	17.2	990.0	35.5	17.2
OS2	12.08	A	0.11	5.4%	300	2.7%	22.3	1280	1.9%	7.0	1.0	22.1	44.4	1580.0	40.9	40.9
OS3	10.37	A/B	0.09	2.0%	300	1.6%	27.0	1006	7.3%	7.0	1.9	8.9	35.9	1306.0	32.3	32.3

NOTES:

$t_c = t_i + t_t$

Where:

$t_c$  = computed time of concentration (minutes)

$t_i$  = overland (initial) flow time (minutes)

$t_t$  = channelized flow time (minutes).

$$t_t = \frac{L_t}{60K\sqrt{S_o}} = \frac{L_t}{60V_t}$$

Where:

$t_t$  = channelized flow time (travel time, min)

$L_t$  = waterway length (ft)

$S_o$  = waterway slope (ft/ft)

$V_t$  = travel time velocity (ft/sec) =  $K\sqrt{S_o}$

$K$  = NRCS conveyance factor (see Table 6-2).

Eq

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

Where:

$t_i$  = overland (initial) flow time (minutes)

$C_s$  = runoff coefficient for 5-year frequency (from Table 6-4)

$L_i$  = length of overland flow (ft)

$S_o$  = average slope along the overland flow path (ft/ft).

Equation 6-4

$$t_i = \frac{16 - 17i}{60(14i + 9)\sqrt{S_i}}$$

Equation 6-5

∴

$t_c$  = minimum time of concentration for first design point when less than  $t_c$  from Equation 6-1.

$L_t$  = length of channelized flow path (ft)

$i$  = imperviousness (expressed as a decimal)

$S_i$  = slope of the channelized flow path (ft/ft).

Table 6-2. NRCS Conveyance factors, K	
Type of Land Surface	Conveyance Factor, K
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

Use a minimum  $t_c$  value of 5 minutes for urbanized areas and a minimum  $t_c$  value of 10 minutes for areas that are not urbanized.

STANDARD FORM SF-2 - PROPOSED CONDITIONS  
TIME OF CONCENTRATION

Subdivision: Cottages at Kettle Creek  
Location: El Paso County

Project Name: Cottages at Kettle Creek  
Project No.: 24026.00  
Calculated By: NQJ  
Checked By:  
Date: 3/21/25

SUB-BASIN					INITIAL/OVERLAND			TRAVEL TIME					tc CHECK			FINAL
DATA					(T <sub>i</sub> )			(T <sub>t</sub> )					(URBANIZED BASINS)			
BASIN ID	D.A. (ac)	Hydrologic Soils Group	Weighted C <sub>5</sub>	Impervious (%)	L (ft)	S <sub>o</sub> (%)	t <sub>i</sub> (min)	L <sub>t</sub> (ft)	S <sub>t</sub> (%)	K	VEL. (ft/s)	t <sub>t</sub> (min)	COMP. t <sub>c</sub> (min)	TOTAL LENGTH (ft)	Urbanized t <sub>c</sub> (min)	t <sub>c</sub> (min)

that are not considered urban. Use minimum values even when calculations result in a lesser time of concentration.

**STANDARD FORM SF-3 - PROPOSED CONDITIONS**  
**STORM DRAINAGE SYSTEM DESIGN**  
(RATIONAL METHOD PROCEDURE)

Subdivision: Cottages at Kettle Creek  
Location: Colorado Springs  
Design Storm: 5-Year

Project Name: Cottages at Kettle Creek  
Project No.: 24026.00  
Calculated By: NOJ  
Checked By: REB  
Date: 3/21/25

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (Ac)	Runoff Coeff.	$t_c$ (min)	C*A (Ac)	I (in/hr)	Q (cfs)	$t_c$ (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{street}$ (cfs)	C*A (ac)	Slope (%)	$Q_{pipe}$ (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	$t_t$ (min)	
	1	A	2.08	0.58	9.6	1.21	4.19	5.1								5.1	1.21	2.0	18	196	7.5	0.4	BASIN A FLOW @ DP1, CAPTURED IN 15' TYPE R, PIPE TO DP4.1
	2	B	2.16	0.57	10.4	1.23	4.07	5.0								5.0	1.23	2.0	18	360	7.6	0.8	BASIN B FLOW @ DP2, CAPTURED IN 15' TYPE R, PIPE TO DP4.1
		C	0.53	0.60	8.1	0.32	4.44	1.4															BASIN C FLOW @ DP4
	3	D	1.57	0.69	8.3	1.08	4.41	4.8								4.8	1.08	2.0	18	360	7.4	0.8	BASIN D FLOW @ DP3, CAPTURED IN 15' TYPE R INLET, PIPE TO DP4.1
	4								8.1	0.32	4.44	1.4				1.4	0.32	2.0	18	360	5.1	1.2	BASIN C FLOW @ DP4, CAPTURED IN 10' TYPE R, PIPE TO DP4.1
	4.1								11.2	2.63	3.96	10.4				10.4	2.63	2.0	24	50	9.0	0.1	COMBINED DP1-DP4 FLOW, PIPE TO DP5
	5	E	0.50	0.17	5.3	0.09	5.08	0.4	11.3	2.72	3.95	10.7											COMBINED DP4.1 & BASIN E FLOW, <b>TOTAL FLOW ENTERING WQ POND</b>
		F	0.22	0.46	5.7	0.10	4.96	0.5															BASIN F FLOW, ENTERS PR SWALE #2 @ DP7
	6	G1	0.79	0.25	9.0	0.19	4.29	0.8								0.8	0.19	2.5	18	50	4.9	0.2	BASIN G1 FLOW @ DP6, CULVERT FLOW TO DP7
	7								9.2	0.30	4.26	1.3	1.3	0.30	3.60					181	1.9	1.6	COMBINED BASIN F @ DP6 FLOW @DP7, PR SWALE #2 FLOW TO DP8
		G2	0.42	0.43	5.0	0.18	5.17	0.9															BASIN G2 FLOW @ DP8
	8								10.8	0.48	4.02	1.9											COMBINED DP7 & BASIN G2 FLOW @ DP8, CAPTURED BY EX 24" CULVERT, FOLLOWS EX TO KETTLE CREEK
		G3	0.14	0.53	7.7	0.07	4.52	0.3															BASIN G3 SWALE FLOW , FOLLOW HISTORIC PATTERNS TO DP9 ALONG OLD RANCH ROAD
		OS2	12.08	0.11	40.9	1.36	2.01	2.7															BASIN OS2 FLOW @ DP9
	9								40.9	1.43	2.01	2.9											COMBINED BASIN G3 & OS2 FLOW @ DP9 (HISTORIC OUTFALL)
	10	OS1	1.99	0.17	17.2	0.33	3.32	1.1															BASIN OS1 FLOW @ DP10, FOLLOW HISTORIC DRAINAGE PATTERNS WEST ALONG OLD RANCH ROAD
	11	OS3	10.37	0.09	32.3	0.93	2.37	2.2															BASIN OS3 FLOW @ DP10, FOLLOWS HISTORIC DRAINAGE PATTERNS UNDER OLD RANCH ROAD

**Notes:**  
Street and Pipe C\*A values are determined by Q/i using the catchment's intensity value.

## STANDARD FORM SF-3 - PROPOSED CONDITIONS

## STORM DRAINAGE SYSTEM DESIGN

(RATIONAL METHOD PROCEDURE)

Project Name: Cottages at Kettle Creek

Project No.: 24026.00

Calculated By: NQJ

Checked By: REB

Date: 3/21/25

Subdivision: Cottages at Kettle Creek

Location: Colorado Springs

Design Storm: 100-Year

STREET	Design Point	DIRECT RUNOFF							TOTAL RUNOFF				STREET			PIPE				TRAVEL TIME			REMARKS
		Basin ID	Area (ac)	Runoff Coeff.	$t_c$ (min)	C*A (ac)	I (in/hr)	Q (cfs)	$t_c$ (min)	C*A (ac)	I (in/hr)	Q (cfs)	$Q_{street}$ (cfs)	C*A (ac)	Slope (%)	$Q_{pipe}$ (cfs)	C*A (ac)	Slope (%)	Pipe Size (inches)	Length (ft)	Velocity (fps)	$t_t$ (min)	
	1	A	2.08	0.72	9.6	1.50	7.03	10.5					1.4	0.20	4.80	9.1	1.29	2.0	18	280	2.2	2.1	DP1 BYPASS, C&G FLOW TO DP4
																				196	8.8	0.4	BASIN A FLOW @ DP1, CAPTURED IN 15' TYPE R, PIPE TO DP4.1
	2	B	2.16	0.71	10.4	1.53	6.84	10.5					1.3	0.19	4.00	9.2	1.35	2.0	18	360	2.0	3.0	DP2 BYPASS, C&G FLOW TO DP3
																				360	8.8	0.7	BASIN B FLOW @ DP2, CAPTURED IN 15' TYPE R, PIPE TO DP4.1
		C	0.53	0.73	8.1	0.39	7.46	2.9															BASIN C FLOW @ DP4
	3	D	1.57	0.80	8.3	1.25	7.41	9.3	13.4	1.44	6.20	8.9	0.7	0.12	4.00	8.2	1.32	2.0	18	60	2.0	0.5	DP3 BYPASS FLOW, C&G FLOW TO DP6
																				360	8.6	0.7	COMBINED DP2 FLOWBY & BASIN D FLOW, CAPTURED IN 15' TYPE R INLET, PIPE TO DP4.1
	4								11.7	0.59	6.53	3.9	0.2	0.03	2.00	3.7	0.57	2.0	18	107	1.4	1.3	DP4 FLOW BY, C&G FLOW TO DP6
																				360	7.0	0.9	DP1 FLOWBY & BASIN C FLOW @ DP4, CAPTURED IN 10' TYPE R, PIPE TO DP4.1
	4.1								12.6	4.53	6.35	28.8				28.8	4.53	2.0	24	50	11.5	0.1	COMBINED DP1-DP4 FLOW, PIPE TO DP5
	5	E	0.50	0.42	5.3	0.21	8.54	1.8	12.7	4.74	6.34	30.0											COMBINED DP4.1 & BASIN E FLOW, TOTAL FLOW ENTERING WQ POND
		F	0.22	0.63	5.7	0.14	8.33	1.2															BASIN F FLOW, ENTERS PR SWALE #2 @ DP7
	6	G1	0.79	0.47	9.0	0.38	7.20	2.7								2.7	0.38	2.5	18	50	6.9	0.1	BASIN G1 FLOW @ DP6, CULVERT FLOW TO DP7
	7								9.1	0.51	7.16	3.7	3.7	0.51	3.60					181	1.9	1.6	COMBINED BASIN F @ DP6 FLOW @DP7, PR SWALE #2 FLOW TO DP8
		G2	0.42	0.61	5.0	0.26	8.68	2.2															BASIN G2 FLOW @ DP8
	8								10.7	0.77	6.76	5.2											COMBINED DP7 & BASIN G2 FLOW @ DP8, CAPTURED BY EX 24" CULVERT, FOLLOWS EX TO KETTLE CREEK
		G3	0.14	0.68	7.7	0.10	7.59	0.7															BASIN G3 SWALE FLOW , FOLLOW HISTORIC PATTERNS TO DP9 ALONG OLD RANCH ROAD
		OS2	12.08	0.38	40.9	4.53	3.38	15.3															BASIN OS2 FLOW @ DP9
	9								40.9	4.63	3.38	15.6											COMBINED BASIN G3 & OS2 FLOW @ DP9 (HISTORIC OUTFALL)
	10	OS1	1.99	0.41	17.2	0.82	5.57	4.6															BASIN OS1 FLOW @ DP10, FOLLOW HISTORIC DRAINAGE PATTERNS WEST ALONG OLD RANCH ROAD
	11	OS3	10.37	0.36	32.3	3.73	3.97	14.8															BASIN OS3 FLOW @ DP10, FOLLOWS HISTORIC DRAINAGE PATTERNS UNDER OLD RANCH ROAD

## Notes:

Street and Pipe C\*A values are determined by Q/i using the catchment's intensity value.



# Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 1

**Designer:** NQJ  
**Company:** ALL TERRAIN ENGINEERING  
**Date:** February 24, 2025  
**Project:** COTTAGES AT KETTLE CREEK  
**Location:** COLORADO SPRINGS

## SITE INFORMATION (User Input in Blue Cells)

WQCV Rainfall Depth 0.60 inches  
Depth of Average Runoff Producing Storm,  $d_6$  = 0.43 inches (for Watersheds Outside of the Denver Region, Figure 3-1 in USDCM Vol. 3)

Area Type	UIA:RPA	DCIA	SPA	UIA:RPA	DCIA	SPA							
Area ID	A:UIA-RPA	A:DCIA	A:SPA	B:UIA-RPA	B:DCIA	B:SPA							
Downstream Design Point ID	1	2	3	4	5	6							
Downstream BMP Type	EDB	EDB	EDB	EDB	EDB	EDB							
DCIA (ft <sup>2</sup> )	--	68,268	--	--	97,184	--							
UIA (ft <sup>2</sup> )	10,887	--	--	9,422	--	--							
RPA (ft <sup>2</sup> )	10,677	--	--	10,935	--	--							
SPA (ft <sup>2</sup> )	--	--	51,269	--	--	53,247							
HSG A (%)	100%	--	100%	100%	--	70%							
HSG B (%)	0%	--	0%	0%	--	30%							
HSG C/D (%)	0%	--	0%	0%	--	0%							
Average Slope of RPA (ft/ft)	0.020	--	--	0.020	--	--							
UIA:RPA Interface Width (ft)	133.00	--	--	15.00	--	--							

## CALCULATED RUNOFF RESULTS

Area ID	A:UIA-RPA	A:DCIA	A:SPA	B:UIA-RPA	B:DCIA	B:SPA							
UIA:RPA Area (ft <sup>2</sup> )	21,564	--	--	20,357	--	--							
L / W Ratio	1.22	--	--	16.00	--	--							
UIA / Area	0.5049	--	--	0.4628	--	--							
Runoff (in)	0.00	0.50	0.00	0.00	0.50	0.00							
Runoff (ft <sup>3</sup> )	0	2845	0	0	4049	0							
Runoff Reduction (ft <sup>3</sup> )	454	0	2563	393	0	2662							

## CALCULATED WQCV RESULTS

Area ID	A:UIA-RPA	A:DCIA	A:SPA	B:UIA-RPA	B:DCIA	B:SPA							
WQCV (ft <sup>3</sup> )	454	2845	0	393	4049	0							
WQCV Reduction (ft <sup>3</sup> )	454	0	0	393	0	0							
WQCV Reduction (%)	100%	0%	0%	100%	0%	0%							
Untreated WQCV (ft <sup>3</sup> )	0	2845	0	0	4049	0							

## CALCULATED DESIGN POINT RESULTS (sums results from all columns with the same Downstream Design Point ID)

Downstream Design Point ID	1	2	3	4	5	6							
DCIA (ft <sup>2</sup> )	0	68,268	0	0	97,184	0							
UIA (ft <sup>2</sup> )	10,887	0	0	9,422	0	0							
RPA (ft <sup>2</sup> )	10,677	0	0	10,935	0	0							
SPA (ft <sup>2</sup> )	0	0	51,269	0	0	53,247							
Total Area (ft <sup>2</sup> )	21,564	68,268	51,269	20,357	97,184	53,247							
Total Impervious Area (ft <sup>2</sup> )	10,887	68,268	0	9,422	97,184	0							
WQCV (ft <sup>3</sup> )	454	2,845	0	393	4,049	0							
WQCV Reduction (ft <sup>3</sup> )	454	0	0	393	0	0							
WQCV Reduction (%)	100%	0%	0%	100%	0%	0%							
Untreated WQCV (ft <sup>3</sup> )	0	2,845	0	0	4,049	0							

## CALCULATED SITE RESULTS (sums results from all columns in worksheet)

Total Area (ft <sup>2</sup> )	311,889
Total Impervious Area (ft <sup>2</sup> )	185,761
WQCV (ft <sup>3</sup> )	7,740
WQCV Reduction (ft <sup>3</sup> )	846
WQCV Reduction (%)	11%
Untreated WQCV (ft <sup>3</sup> )	6,894



## **APPENDIX C – HYDRAULIC CALCULATIONS**

**INLET MANAGEMENT**

Worksheet Protected

INLET NAME	DP1	DP2	DP3	DP4
Site Type (Urban or Rural)	URBAN	URBAN	URBAN	URBAN
Inlet Application (Street or Area)	STREET	STREET	STREET	STREET
Hydraulic Condition	On Grade	On Grade	On Grade	On Grade
Inlet Type	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening	CDOT Type R Curb Opening

**USER-DEFINED INPUT**

User-Defined Design Flows				
Minor $Q_{known}$ (cfs)	5.0	5.1	4.8	1.4
Major $Q_{known}$ (cfs)	10.5	10.6	9.0	3.8
<b>Bypass (Carry-Over) Flow from Upstream</b> <span style="color: blue;">Inlets must be organized from upstream (left) to downstream (right) in order for bypass flows to be linked.</span>				
Receive Bypass Flow from:	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received	No Bypass Flow Received
Minor Bypass Flow Received, $Q_b$ (cfs)	0.0	0.0	0.0	0.0
Major Bypass Flow Received, $Q_b$ (cfs)	0.0	0.0	0.0	0.0
<b>Watershed Characteristics</b>				
Subcatchment Area (acres)				
Percent Impervious				
NRCS Soil Type				
<b>Watershed Profile</b>				
Overland Slope (ft/ft)				
Overland Length (ft)				
Channel Slope (ft/ft)				
Channel Length (ft)				
<b>Minor Storm Rainfall Input</b>				
Design Storm Return Period, $T_r$ (years)				
One-Hour Precipitation, $P_1$ (inches)				
<b>Major Storm Rainfall Input</b>				
Design Storm Return Period, $T_r$ (years)				
One-Hour Precipitation, $P_1$ (inches)				

**CALCULATED OUTPUT**

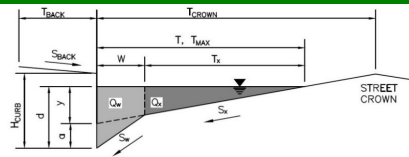
Minor Total Design Peak Flow, $Q$ (cfs)	5.0	5.1	4.8	1.4
Major Total Design Peak Flow, $Q$ (cfs)	10.5	10.6	9.0	3.8
Minor Flow Bypassed Downstream, $Q_b$ (cfs)	0.0	0.0	0.0	0.0
Major Flow Bypassed Downstream, $Q_b$ (cfs)	1.4	1.4	0.8	0.1

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: COTTAGES AT KETTLE CREEK

Inlet ID: DP1

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	5.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.016	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	24.0	ft
$W$	=	1.00	ft
$S_x$	=	0.020	ft/ft
$S_w$	=	0.083	ft/ft
$S_o$	=	0.048	ft/ft
$n_{STREET}$	=	0.016	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	=	24.0	ft
$d_{MAX}$	=	6.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

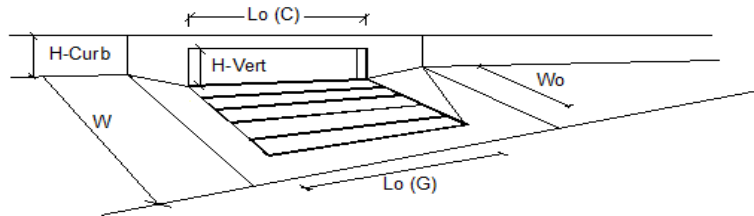
MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow}$	=	21.9	cfs

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 5.00 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 10.50 cfs on sheet 'Inlet Management'

**INLET ON A CONTINUOUS GRADE****Design Information (Input)**

Type of Inlet

Local Depression (additional to continuous gutter depression 'a')

Total Number of Units in the Inlet (Grate or Curb Opening)

Length of a Single Unit Inlet (Grate or Curb Opening)

Width of a Unit Grate (cannot be greater than W, Gutter Width)

Clogging Factor for a Single Unit Grate (typical min. value = 0.5)

Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)

Street Hydraulics: OK -  $Q < Q_{allow}$  Allowable Street Capacity

Total Inlet Interception Capacity

Total Inlet Carry-Over Flow (flow bypassing inlet)

Capture Percentage =  $Q_c/Q_a$ 

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
$a_{LOCAL}$	=	3.0	inches
$N_o$	=	3	
$L_o$	=	5.00	ft
$W_o$	=	N/A	ft
$C_f (G)$	=	N/A	
$C_f (C)$	=	0.10	

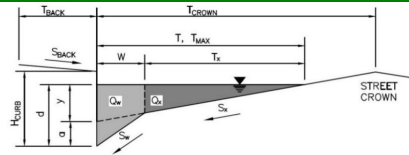
	MINOR	MAJOR	
$Q$	=	5.0	cfs
$Q_c$	=	0.0	cfs
$C\%$	=	100	%

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: COTTAGES AT KETTLE CREEK

Inlet ID: DP2

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	5.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.016	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	24.0	ft
$W$	=	1.00	ft
$S_x$	=	0.020	ft/ft
$S_w$	=	0.083	ft/ft
$S_0$	=	0.041	ft/ft
$n_{STREET}$	=	0.016	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	=	24.0	ft
$d_{MAX}$	=	6.0	inches
	<input type="checkbox"/>	<input checked="" type="checkbox"/>	

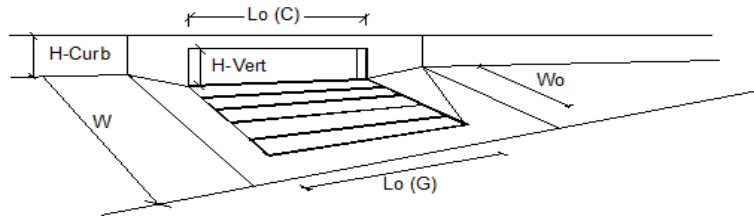
MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow}$	=	22.9	cfs

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 5.10 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 10.60 cfs on sheet 'Inlet Management'

**INLET ON A CONTINUOUS GRADE****Design Information (Input)**

Type of Inlet

Local Depression (additional to continuous gutter depression 'a')

Total Number of Units in the Inlet (Grate or Curb Opening)

Length of a Single Unit Inlet (Grate or Curb Opening)

Width of a Unit Grate (cannot be greater than W, Gutter Width)

Clogging Factor for a Single Unit Grate (typical min. value = 0.5)

Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)

Street Hydraulics: OK -  $Q < Q_{allow}$  Allowable Street Capacity

Total Inlet Interception Capacity

Total Inlet Carry-Over Flow (flow bypassing inlet)

Capture Percentage =  $Q_i/Q_a$ 

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
$a_{LOCAL}$	=	3.0	inches
$N_u$	=	3	
$L_u$	=	5.00	ft
$W_u$	=	N/A	ft
$C_f (G)$	=	N/A	
$C_f (C)$	=	0.10	

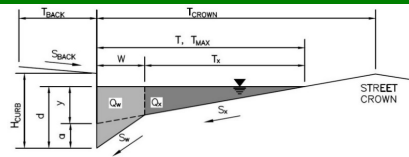
	MINOR	MAJOR	
$Q$	=	5.1	cfs
$Q_o$	=	0.0	cfs
$C\%$	=	100	%

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: COTTAGES AT KETTLE CREEK

Inlet ID: DP3

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	0.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.016	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	24.0	ft
$W$	=	1.00	ft
$S_X$	=	0.020	ft/ft
$S_W$	=	0.083	ft/ft
$S_O$	=	0.020	ft/ft
$n_{STREET}$	=	0.016	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	=	24.0	ft
$d_{MAX}$	=	6.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

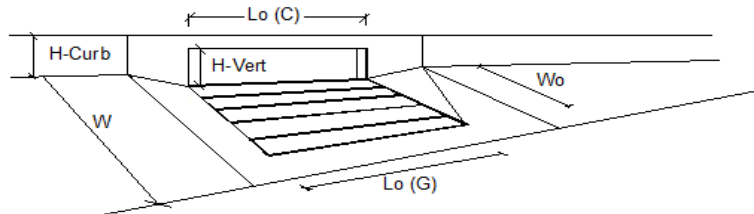
MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow}$	=	27.6	cfs

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 4.80 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 9.00 cfs on sheet 'Inlet Management'

**INLET ON A CONTINUOUS GRADE****Design Information (Input)**

Type of Inlet: CDOT Type R Curb Opening

Local Depression (additional to continuous gutter depression 'a')

Total Number of Units in the Inlet (Grate or Curb Opening)

Length of a Single Unit Inlet (Grate or Curb Opening)

Width of a Unit Grate (cannot be greater than W, Gutter Width)

Clogging Factor for a Single Unit Grate (typical min. value = 0.5)

Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)

Street Hydraulics: OK -  $Q < Q_{allow}$  Allowable Street Capacity

Total Inlet Interception Capacity

Total Inlet Carry-Over Flow (flow bypassing inlet)

Capture Percentage =  $Q_c/Q_a$ 

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
$a_{LOCAL}$	=	3.0	inches
$N_u$	=	3	
$L_u$	=	5.00	ft
$W_u$	=	N/A	ft
$C_f (G)$	=	N/A	
$C_f (C)$	=	0.10	

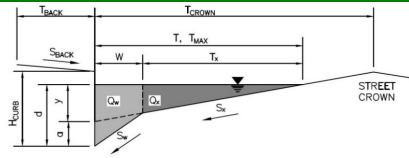
	MINOR	MAJOR	
$Q$	=	4.8	cfs
$Q_c$	=	0.0	cfs
$C\%$	=	100	%

**ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)**

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: COTTAGES AT KETTLE CREEK

Inlet ID: DP4

**Gutter Geometry:**

Maximum Allowable Width for Spread Behind Curb

Side Slope Behind Curb (leave blank for no conveyance credit behind curb)

Manning's Roughness Behind Curb (typically between 0.012 and 0.020)

Height of Curb at Gutter Flow Line

Distance from Curb Face to Street Crown

Gutter Width

Street Transverse Slope

Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)

Street Longitudinal Slope - Enter 0 for sump condition

Manning's Roughness for Street Section (typically between 0.012 and 0.020)

$T_{BACK}$	=	0.0	ft
$S_{BACK}$	=	0.020	ft/ft
$n_{BACK}$	=	0.016	

$H_{CURB}$	=	6.00	inches
$T_{CROWN}$	=	24.0	ft
$W$	=	1.00	ft
$S_X$	=	0.020	ft/ft
$S_W$	=	0.083	ft/ft
$S_O$	=	0.040	ft/ft
$n_{STREET}$	=	0.016	

Max. Allowable Spread for Minor &amp; Major Storm

Max. Allowable Depth at Gutter Flowline for Minor &amp; Major Storm

Allow Flow Depth at Street Crown (check box for yes, leave blank for no)

	Minor Storm	Major Storm	
$T_{MAX}$	=	24.0	ft
$d_{MAX}$	=	6.0	inches
	<input type="checkbox"/>	<input type="checkbox"/>	

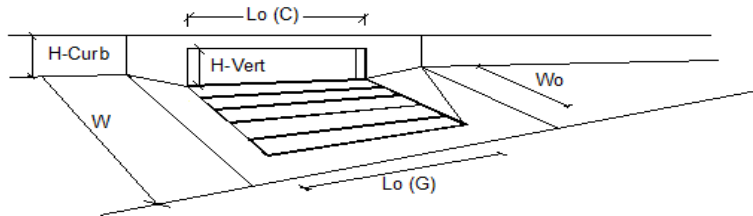
MINOR STORM Allowable Capacity is based on Depth Criterion

MAJOR STORM Allowable Capacity is based on Depth Criterion

	Minor Storm	Major Storm	
$Q_{allow}$	=	23.1	cfs

Minor storm max. allowable capacity GOOD - greater than the design peak flow of 1.40 cfs on sheet 'Inlet Management'

Major storm max. allowable capacity GOOD - greater than the design peak flow of 3.80 cfs on sheet 'Inlet Management'

**INLET ON A CONTINUOUS GRADE****Design Information (Input)**

Type of Inlet

Local Depression (additional to continuous gutter depression 'a')

Total Number of Units in the Inlet (Grate or Curb Opening)

Length of a Single Unit Inlet (Grate or Curb Opening)

Width of a Unit Grate (cannot be greater than W, Gutter Width)

Clogging Factor for a Single Unit Grate (typical min. value = 0.5)

Clogging Factor for a Single Unit Curb Opening (typical min. value = 0.1)

Street Hydraulics: OK -  $Q < Q_{allow}$  Allowable Street Capacity

Total Inlet Interception Capacity

Total Inlet Carry-Over Flow (flow bypassing inlet)

Capture Percentage =  $Q_c/Q_a$ 

	MINOR	MAJOR	
Type =	CDOT Type R Curb Opening		
$a_{LOCAL}$	=	3.0	inches
$N_o$	=	2	
$L_o$	=	5.00	ft
$W_o$	=	N/A	ft
$C_f (G)$	=	N/A	
$C_f (C)$	=	0.10	

	MINOR	MAJOR	
$Q$	=	1.4	cfs
$Q_o$	=	0.0	cfs
$C\%$	=	100	%

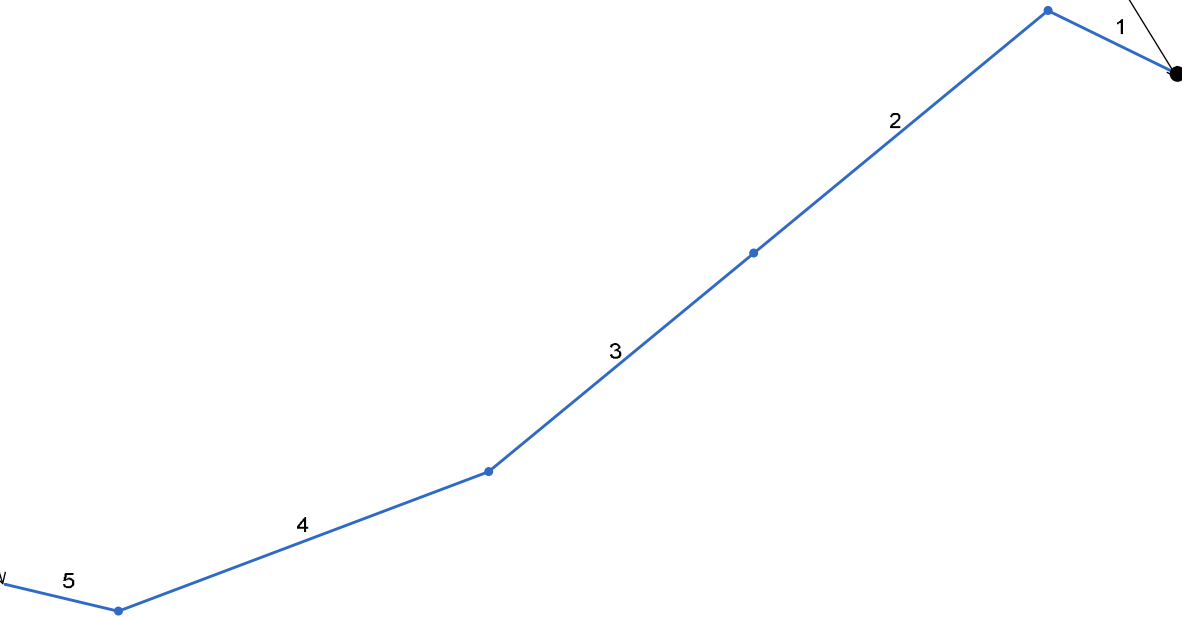
# Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan

POND OUTFALL - HGL ANALYSIS  
PLAN VIEW

LOW TAIL WATER BASIN  
OUTFALL

POND OUTLET STRUCTURE

Outfall





Line No.	Vel Ave  (ft/s)	Flow Rate  (cfs)	Line Size  (in)	Line Length  (ft)	Invert Up  (ft)	Invert Dn  (ft)	Line Slope  (%)	HGL Up  (ft)	HGL Dn  (ft)	n-val Pipe	J-Loss Coeff			
1	1.54	0.60	18	94.330	6672.10	6668.00	4.35	6672.39 j	6668.91	0.013	0.93 z			
2	3.63	0.60	18	250.000	6679.90	6672.40	3.00	6680.19	6672.59	0.013	0.15 z			
3	3.24	0.60	24	225.100	6687.77	6680.00	3.45	6688.04	6680.19	0.013	0.38 z			
4	3.34	0.60	18	259.020	6693.29	6687.97	2.05	6693.58	6688.18	0.013	0.61 z			
5	2.88	0.60	18	76.010	6694.25	6693.49	1.00	6694.54	6693.73	0.013	1.00 z			
Project File: Cottages_Outfall.stm												Number of lines: 5		Date: 3/18/2025
NOTES: ** Critical depth														



Project: Cottages at Kettle Creek  
Project No: 24026  
3/10/2025

**Forebay Sizing (Per USDCM Volume 3, Table 4-12)**

WQCV (ac-ft)	1% WQCV (ft <sup>3</sup> )	Forebay Area (ft <sup>2</sup> )	Forebay Depth (ft)	Forebay Volume (ft <sup>3</sup> )
0.14	61	46	1.5	69

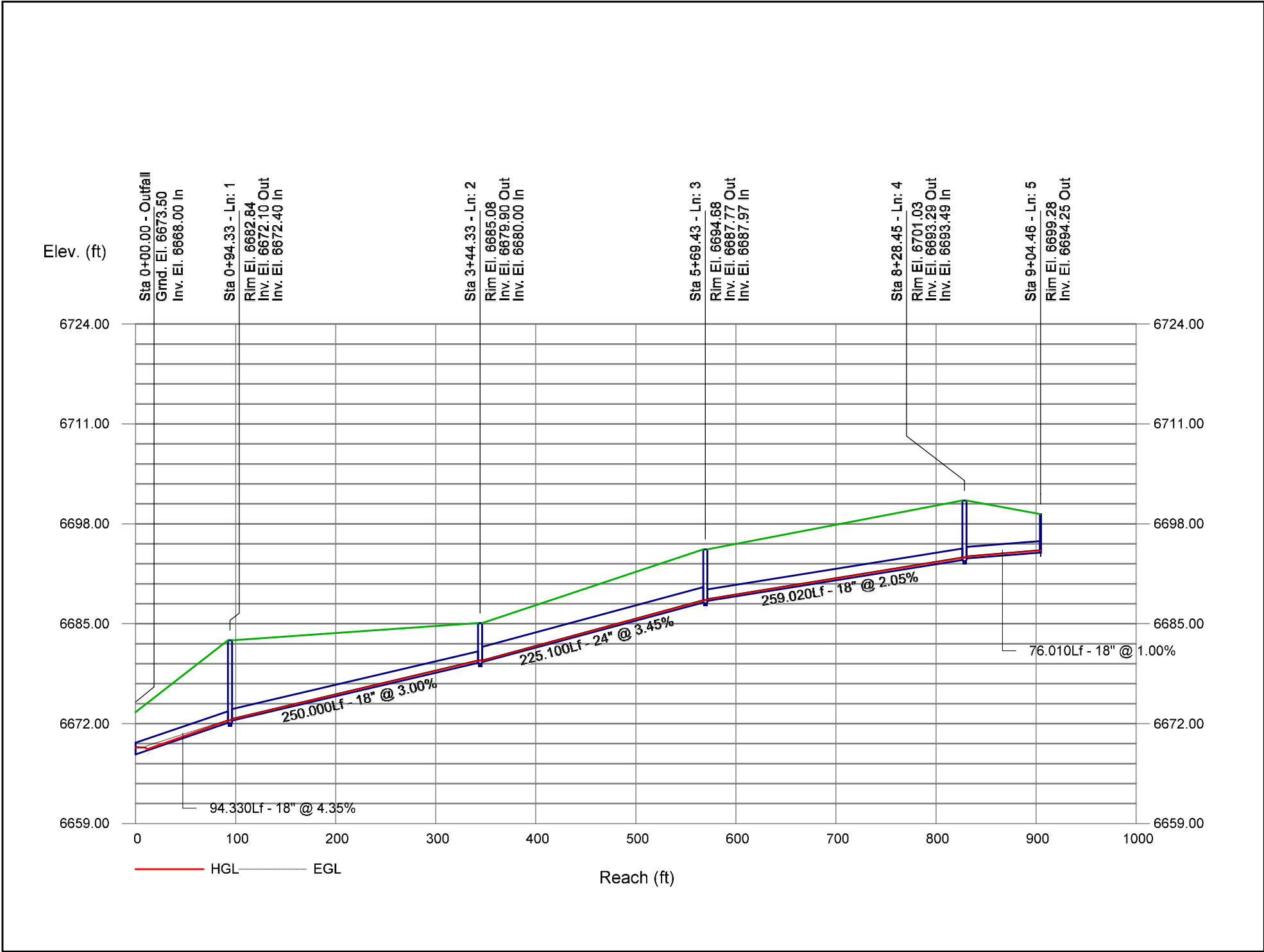
**Forebay Notch Sizing  
(Per USDCM Volume 3 Equation 4-1)**

$$w = 9.23(A_{FB}/t)(1/\sqrt{h_{max}})$$

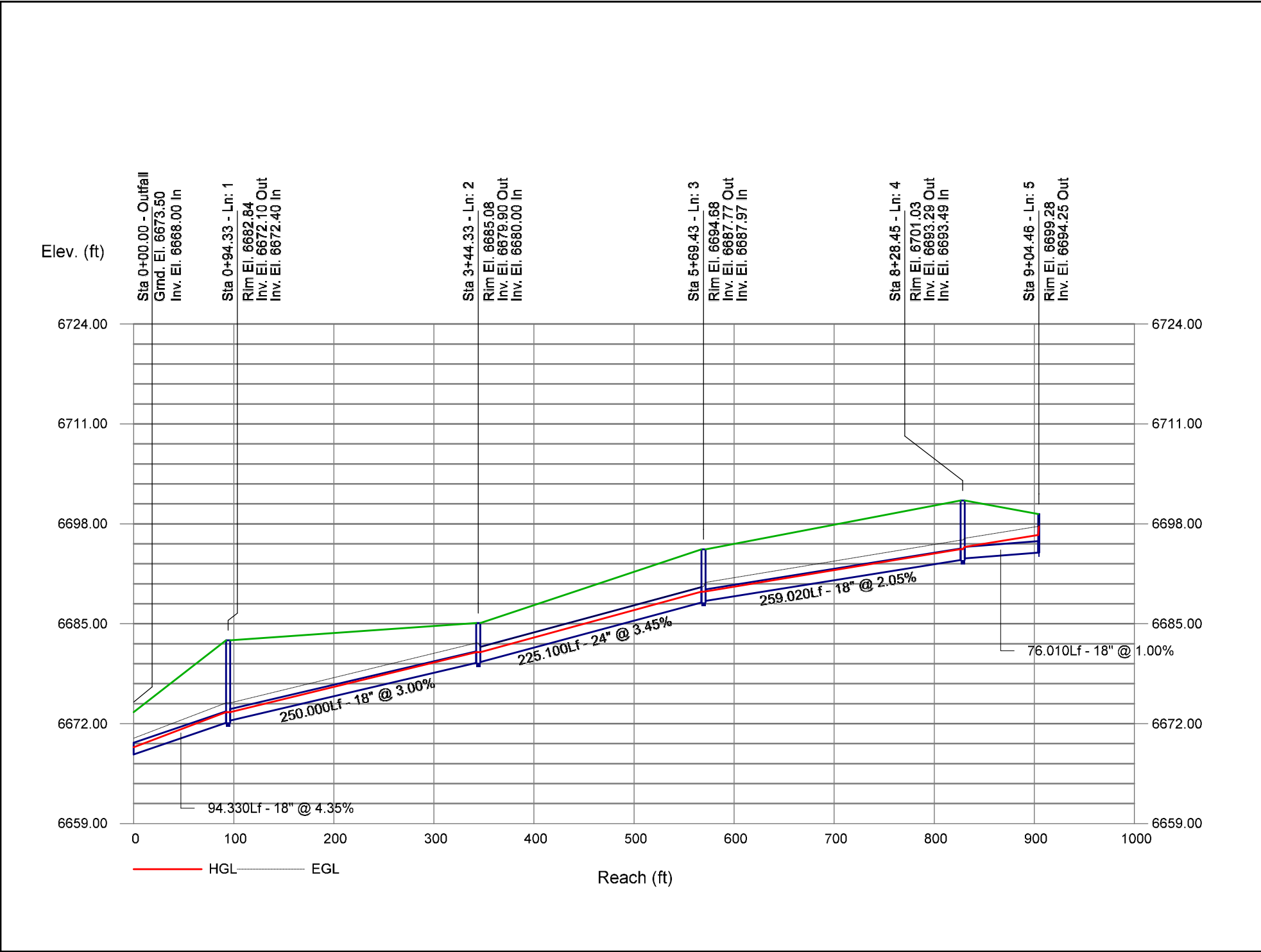
$A_{FB}$ (ft <sup>2</sup> )	t (s)	$h_{max}$ (ft)	w (in)
46	300	1.5	1.16

Line No.	Vel Ave  (ft/s)	Flow Rate  (cfs)	Line Size  (in)	Line Length  (ft)	Invert Up  (ft)	Invert Dn  (ft)	Line Slope  (%)	HGL Up  (ft)	HGL Dn  (ft)	n-val Pipe	J-Loss Coeff				
1	11.03	15.00	18	94.330	6672.10	6668.00	4.35	6673.51	6668.91	0.013	0.93 z				
2	9.73	15.00	18	250.000	6679.90	6672.40	3.00	6681.31	6673.51	0.013	0.15 z				
3	6.66	15.00	24	225.100	6687.77	6680.00	3.45	6689.17	6681.31	0.013	0.38 z				
4	9.21	15.00	18	259.020	6693.29	6687.97	2.05	6694.70	6689.20	0.013	0.61 z				
5	8.49	15.00	18	76.010	6694.25	6693.49	1.00	6696.54	6694.99	0.013	1.00				
Project File: Cottages_Outfall.stm												Number of lines: 5		Date: 3/18/2025	
NOTES: ** Critical depth															

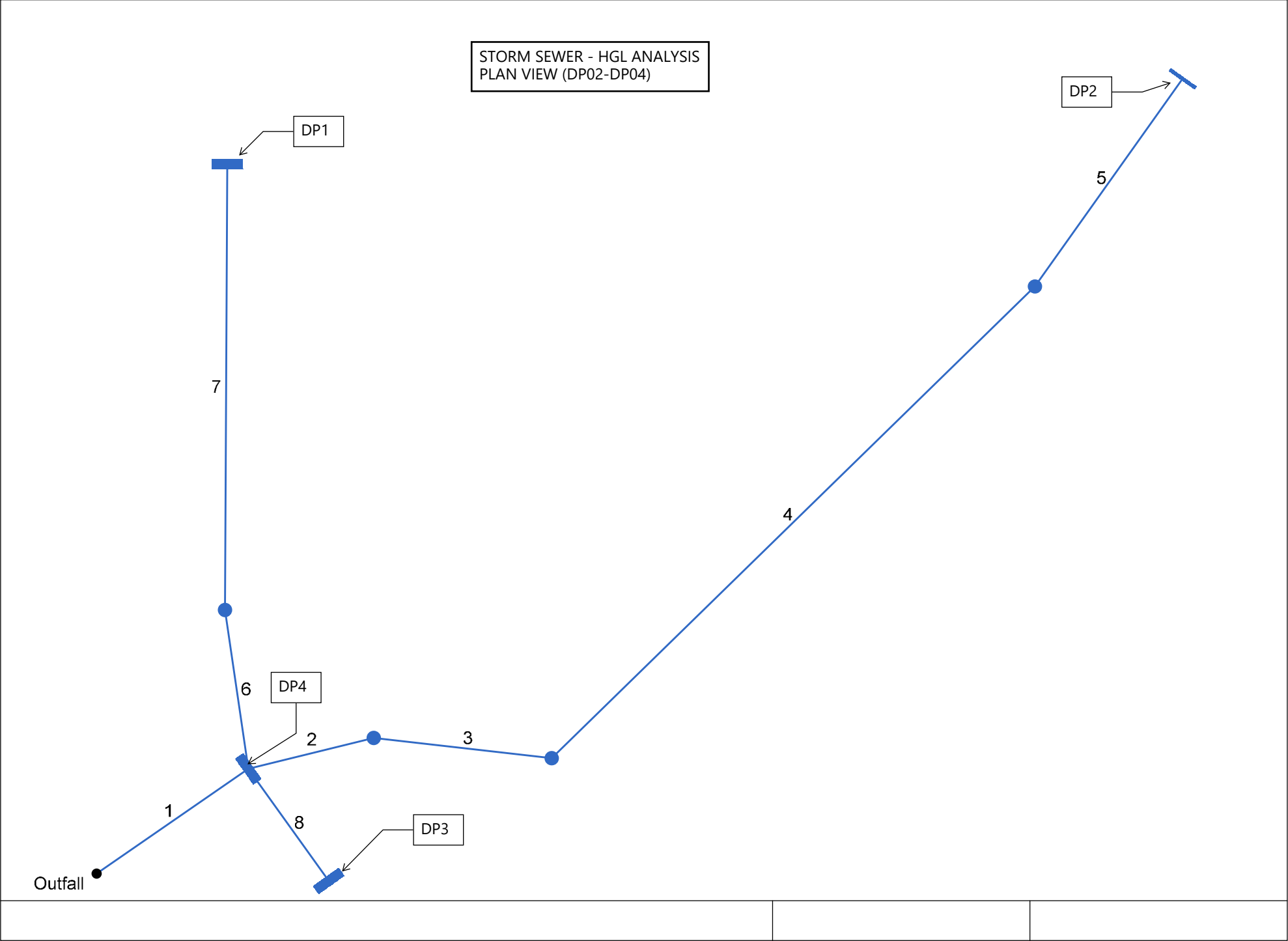
Storm Sewer Profile



Storm Sewer Profile



# Hydraflow Storm Sewers Extension for Autodesk® Civil 3D® Plan

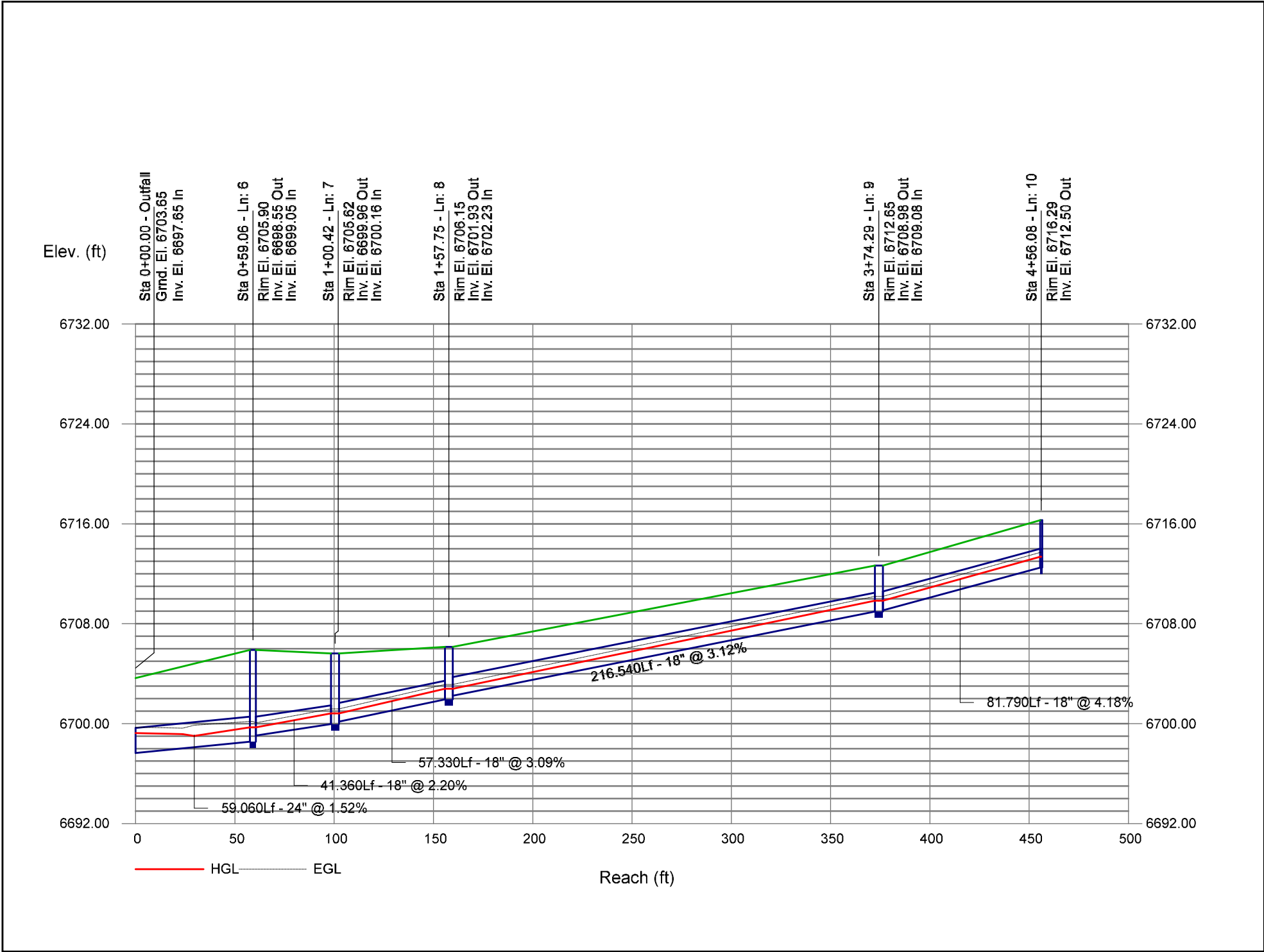


Line No.	Vel Ave (ft/s)	Flow Rate (cfs)	Line Size (in)	Line Length (ft)	Invert Up (ft)	Invert Dn (ft)	Line Slope (%)	HGL Up (ft)	HGL Dn (ft)	n-val Pipe	J-Loss Coeff		
1	4.60	10.40	24	59.060	6698.55	6697.65	1.52	6699.70 j	6699.35	0.013	1.50 z		
2	5.76	5.00	18	41.360	6699.96	6699.05	2.20	6700.82	6699.70	0.013	0.40 z		
3	5.73	5.00	18	57.330	6701.93	6700.16	3.09	6702.79	6700.82	0.013	0.81 z		
4	6.55	5.00	18	216.540	6708.98	6702.23	3.12	6709.84	6702.79	0.013	0.22 z		
5	5.17	5.00	18	81.790	6712.50	6709.08	4.18	6713.36	6709.84	0.013	1.00 z		
6	5.85	5.10	18	51.560	6702.74	6699.05	7.16	6703.61	6699.70	0.013	0.18 z		
7	5.20	5.10	18	143.180	6708.97	6702.84	4.28	6709.84	6703.61	0.013	1.00 z		
8	5.27	4.80	18	44.260	6699.50	6699.05	1.02	6700.34	6699.76	0.013	1.00 z		

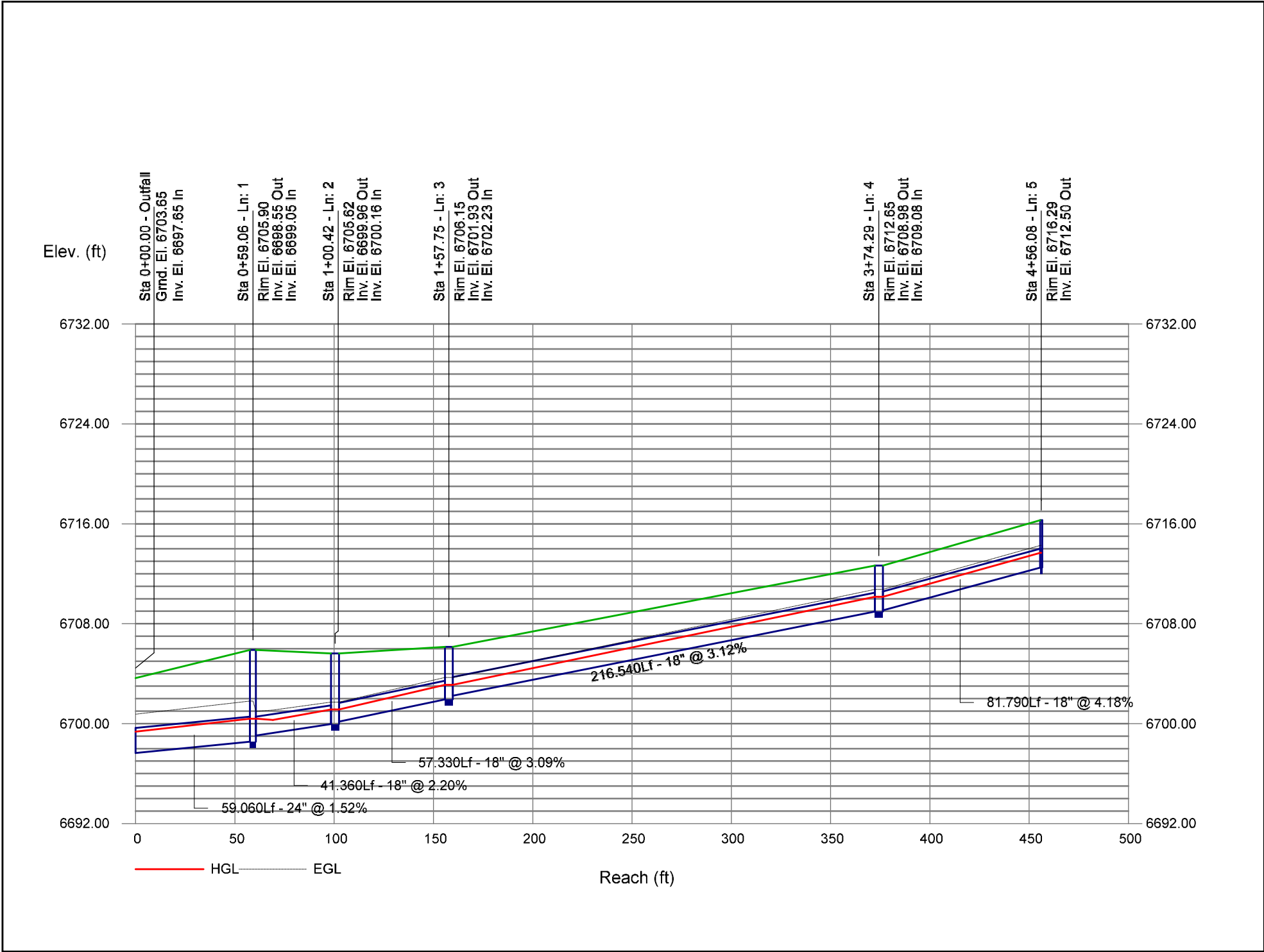
Line No.	Vel Ave  (ft/s)	Flow Rate  (cfs)	Line Size  (in)	Line Length  (ft)	Invert Up  (ft)	Invert Dn  (ft)	Line Slope  (%)	HGL Up  (ft)	HGL Dn  (ft)	n-val Pipe	J-Loss Coeff						
1	9.81	28.80	24	59.060	6698.55	6697.65	1.52	6700.39	6699.35	0.013	1.50 z	<div>FLOW RATES ARE CAPTURED FLOWS AT CORRESPONDING DESIGN POINT. SEE INLET CALCS FOR CAPTURED FLOW QUANTITIES.</div>					
2	5.86	9.20	18	41.360	6699.96	6699.05	2.20	6701.13 j	6700.39	0.013	0.40 z						
3	6.90	9.20	18	57.330	6701.93	6700.16	3.09	6703.10	6701.13	0.013	0.81 z						
4	7.42	9.20	18	216.540	6708.98	6702.23	3.12	6710.15	6703.10	0.013	0.22 z						
5	6.51	9.20	18	81.790	6712.50	6709.08	4.18	6713.67	6710.15	0.013	1.00 z						
6	5.81	9.10	18	51.560	6702.74	6699.05	7.16	6703.91 j	6700.39	0.013	0.18 z						
7	6.47	9.10	18	143.180	6708.97	6702.84	4.28	6710.14	6703.91	0.013	1.00 z						
8	5.39	8.20	18	44.260	6699.50	6699.05	1.02	6700.61 j	6700.39	0.013	1.00 z						
												Project File: Cottages.stm		Number of lines: 8		Date: 3/6/2025	
NOTES: ** Critical depth																	



Storm Sewer Profile

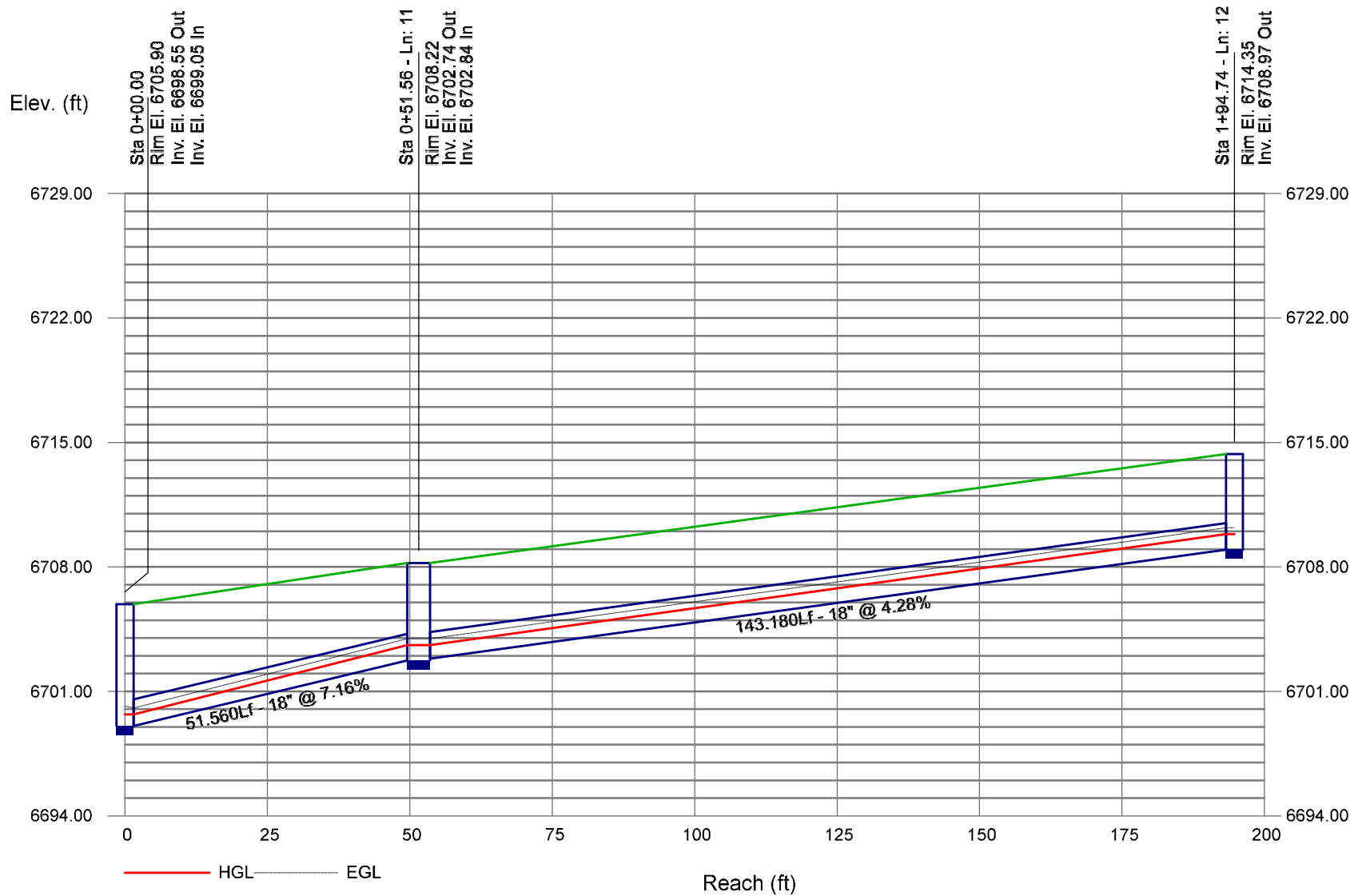


Storm Sewer Profile

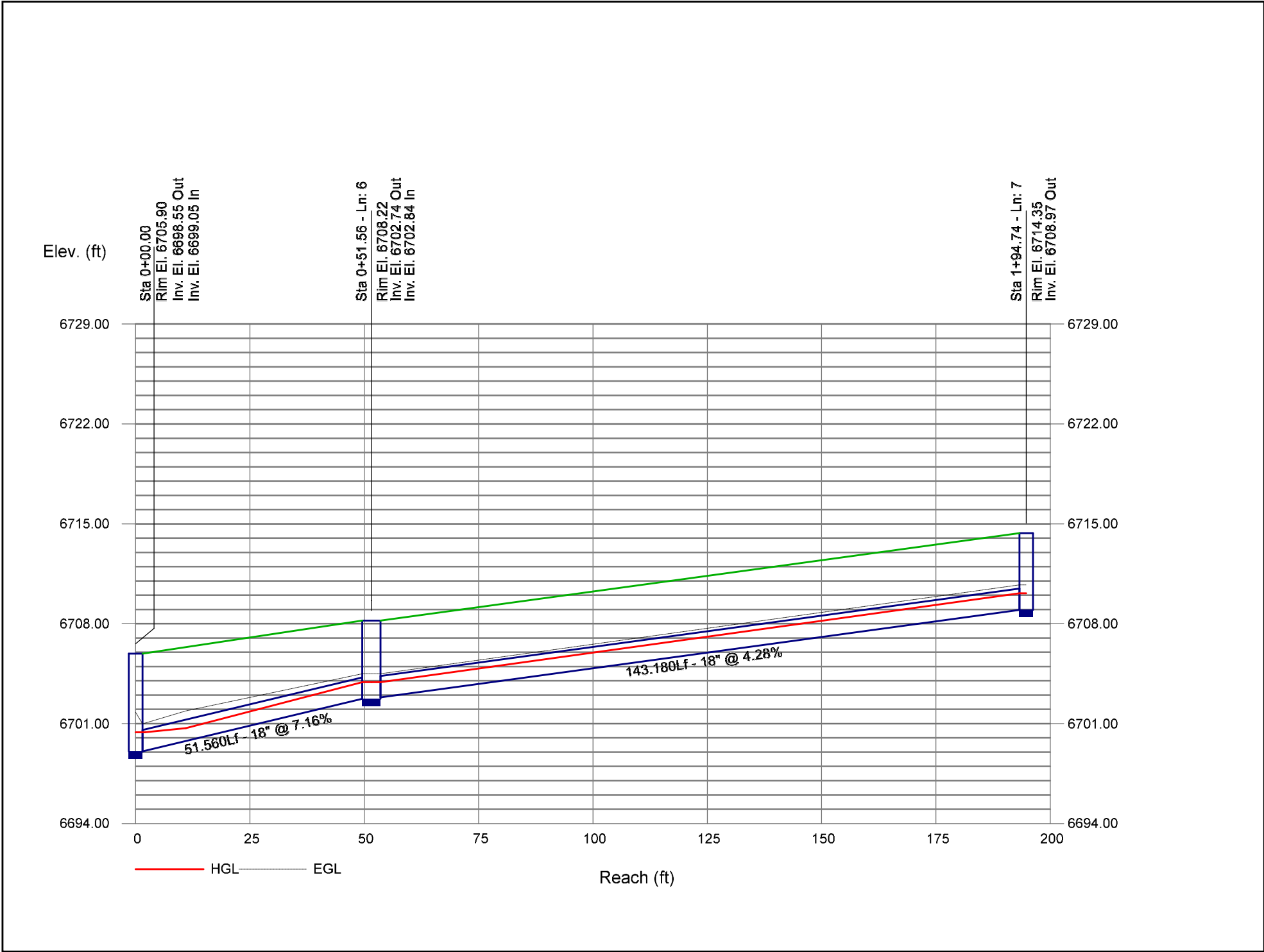


# Storm Sewer Profile

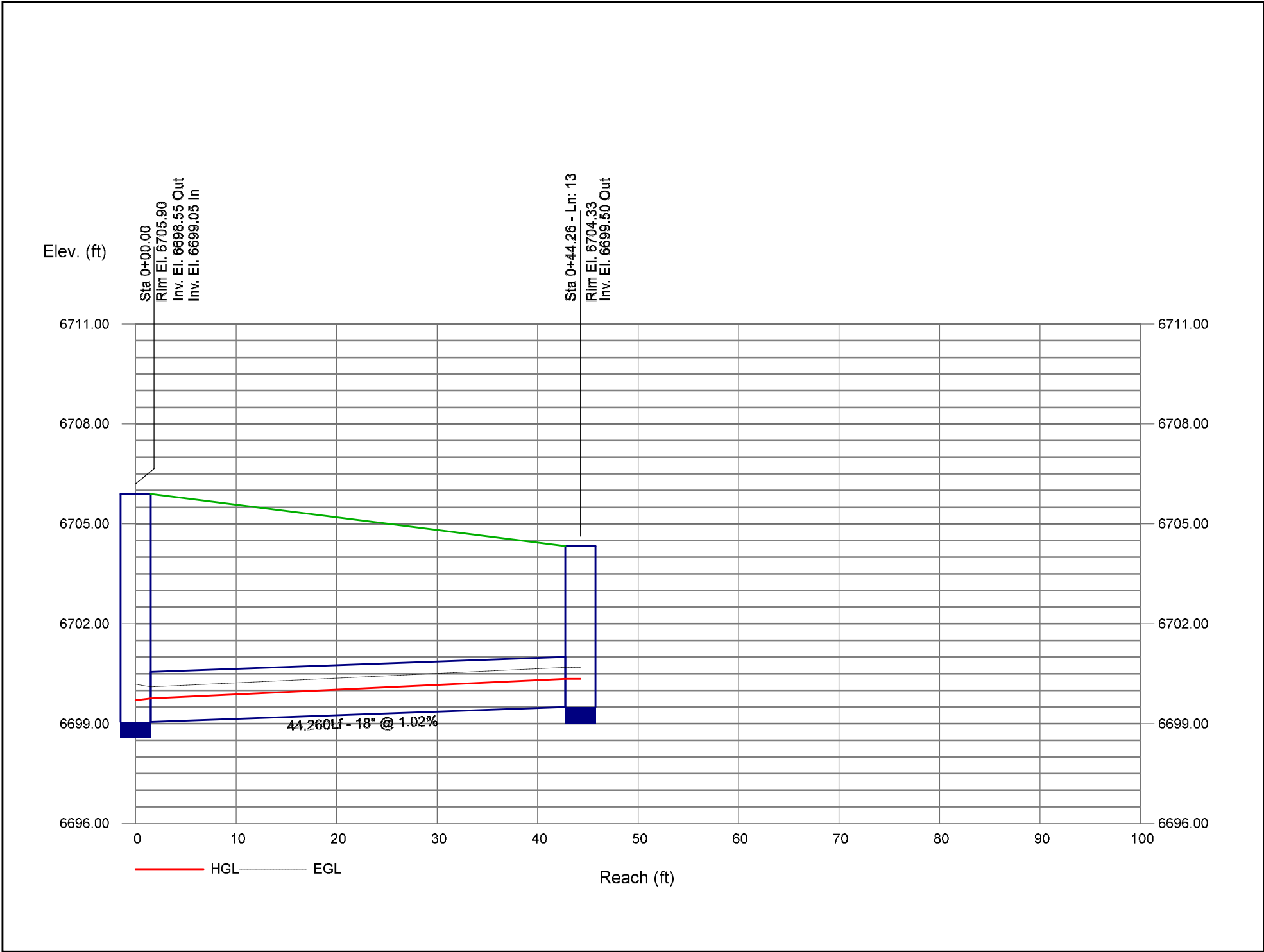
Proj. file: Cottages.stm



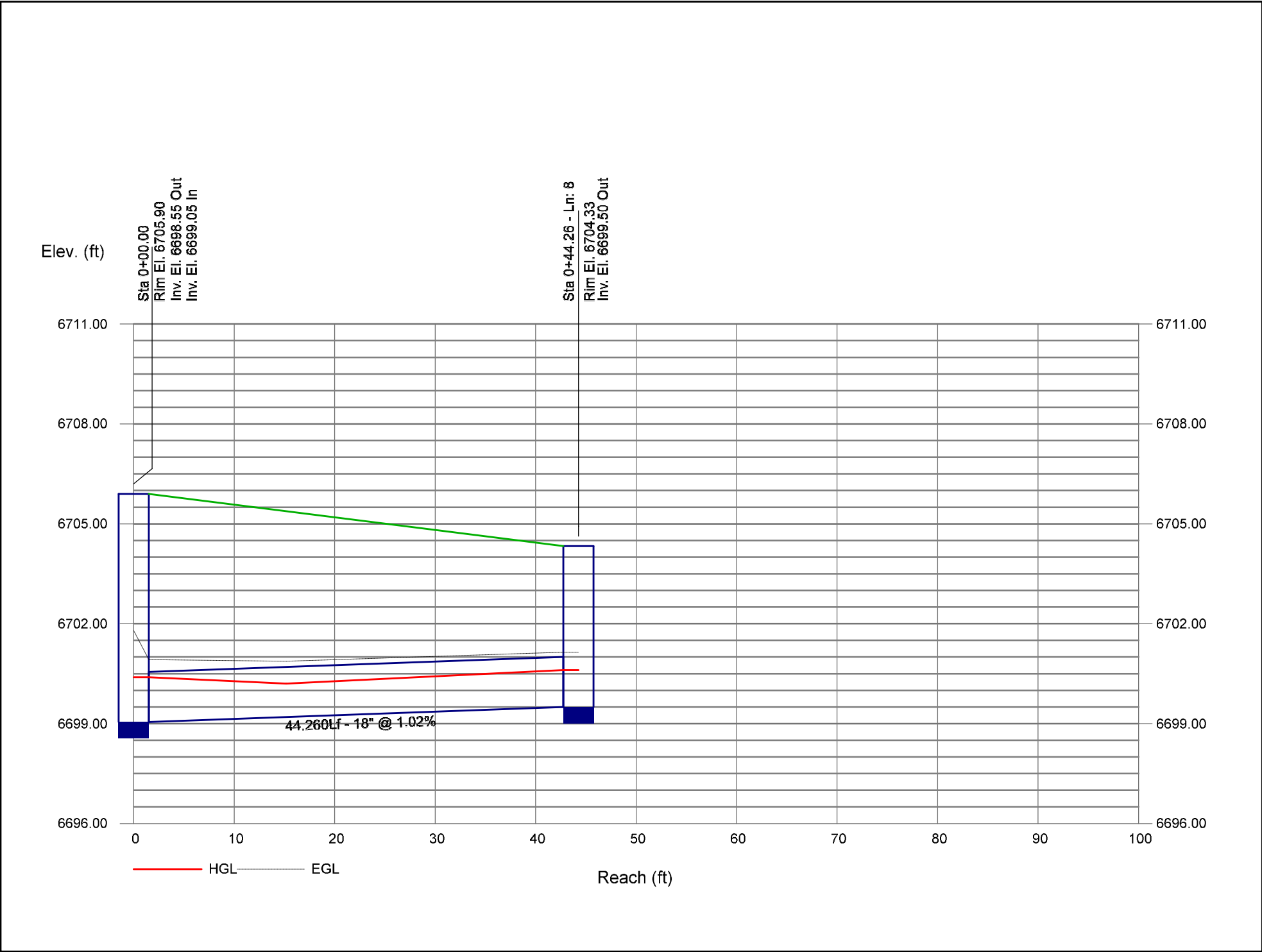
Storm Sewer Profile



Storm Sewer Profile



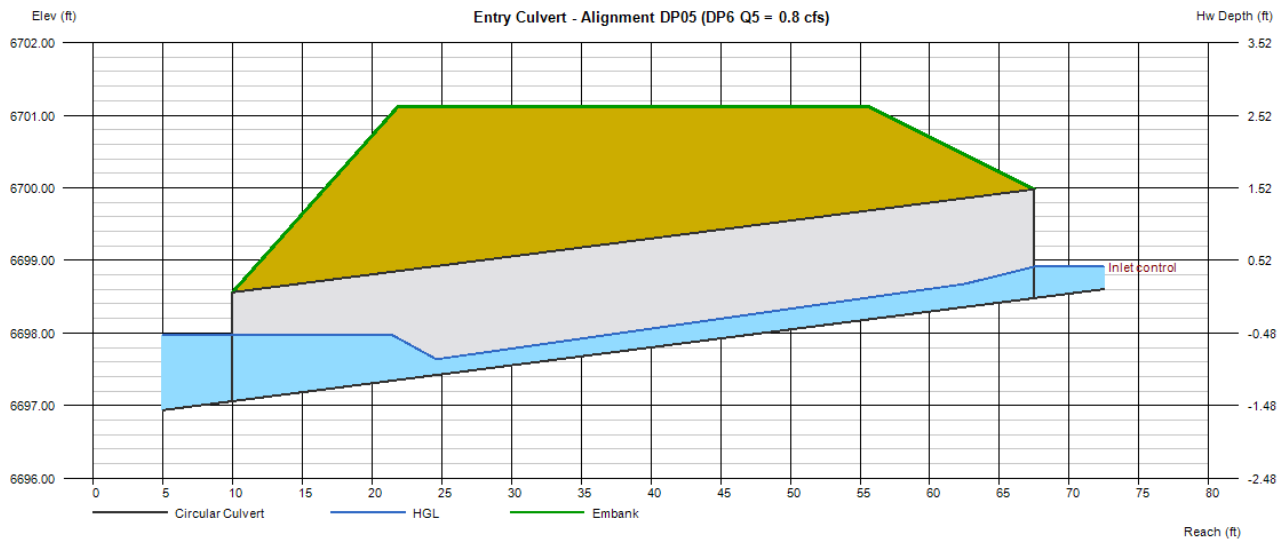
Storm Sewer Profile



# Culvert Report

## Entry Culvert - Alignment DP05 (DP6 Q5 = 0.8 cfs)

Invert Elev Dn (ft)	= 6697.06	<b>Calculations</b>	
Pipe Length (ft)	= 57.48	Qmin (cfs)	= 0.80
Slope (%)	= 2.47	Qmax (cfs)	= 0.80
Invert Elev Up (ft)	= 6698.48	Tailwater Elev (ft)	= (dc+D)/2
Rise (in)	= 18.0		
Shape	= Circular	<b>Highlighted</b>	
Span (in)	= 18.0	Qtotat (cfs)	= 0.80
No. Barrels	= 1	Qpipe (cfs)	= 0.80
n-Value	= 0.012	Qovertop (cfs)	= 0.00
Culvert Type	= Circular Concrete	Veloc Dn (ft/s)	= 0.71
Culvert Entrance	= Groove end projecting (C)	Veloc Up (ft/s)	= 2.75
Coeff. K,M,c,Y,k	= 0.0045, 2, 0.0317, 0.69, 0.2	HGL Dn (ft)	= 6697.98
		HGL Up (ft)	= 6698.81
		Hw Elev (ft)	= 6698.91
		Hw/D (ft)	= 0.29
		Flow Regime	= Inlet Control
<b>Embankment</b>			
Top Elevation (ft)	= 6701.12		
Top Width (ft)	= 33.75		
Crest Width (ft)	= 30.00		



# Culvert Report

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

Thursday, Mar 20 2025

## Entry Culvert - Alignment DP05 (DP6 Q100 = 2.7 cfs)

Invert Elev Dn (ft) = 6697.06  
Pipe Length (ft) = 57.48  
Slope (%) = 2.47  
Invert Elev Up (ft) = 6698.48  
Rise (in) = 18.0  
Shape = Circular  
Span (in) = 18.0  
No. Barrels = 1  
n-Value = 0.012  
Culvert Type = Circular Concrete  
Culvert Entrance = Groove end projecting (C)  
Coeff. K,M,c,Y,k = 0.0045, 2, 0.0317, 0.69, 0.2

### Embankment

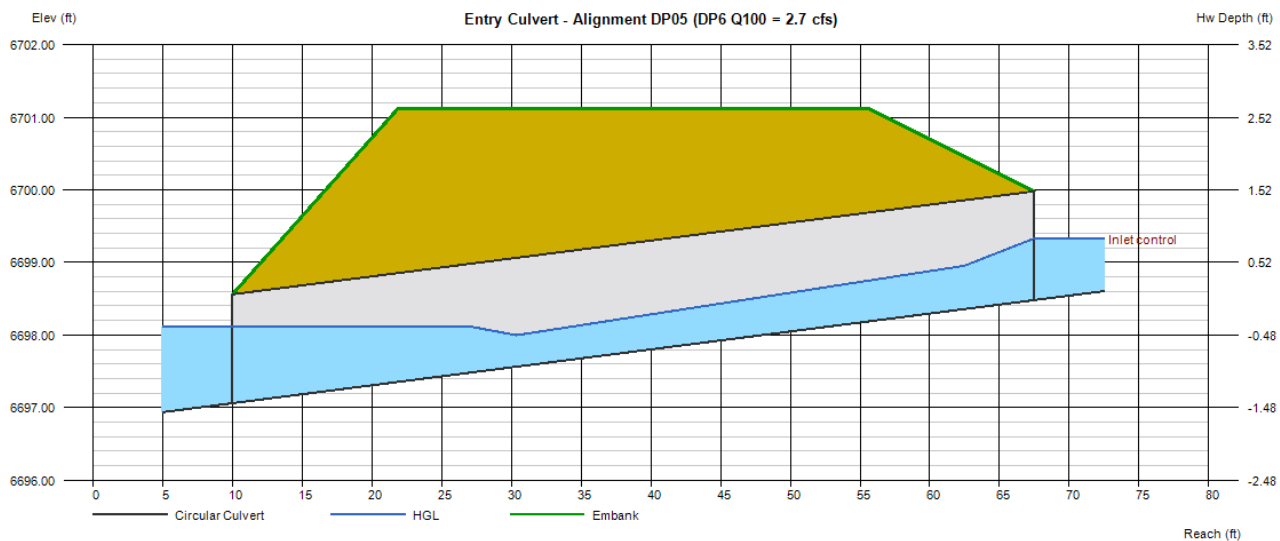
Top Elevation (ft) = 6701.12  
Top Width (ft) = 33.75  
Crest Width (ft) = 30.00

### Calculations

Qmin (cfs) = 2.70  
Qmax (cfs) = 2.70  
Tailwater Elev (ft) = (dc+D)/2

### Highlighted

Qtotal (cfs) = 2.70  
Qpipe (cfs) = 2.70  
Qovertop (cfs) = 0.00  
Veloc Dn (ft/s) = 2.02  
Veloc Up (ft/s) = 3.89  
HGL Dn (ft) = 6698.12  
HGL Up (ft) = 6699.10  
Hw Elev (ft) = 6699.33  
Hw/D (ft) = 0.57  
Flow Regime = Inlet Control





# Channel Report

## Pr Swale #1 (Q100 = DP6 = 2.7 cfs)

### Triangular

Side Slopes (z:1) = 4.00, 3.00  
Total Depth (ft) = 1.00  
  
Invert Elev (ft) = 1.00  
Slope (%) = 3.20  
N-Value = 0.030

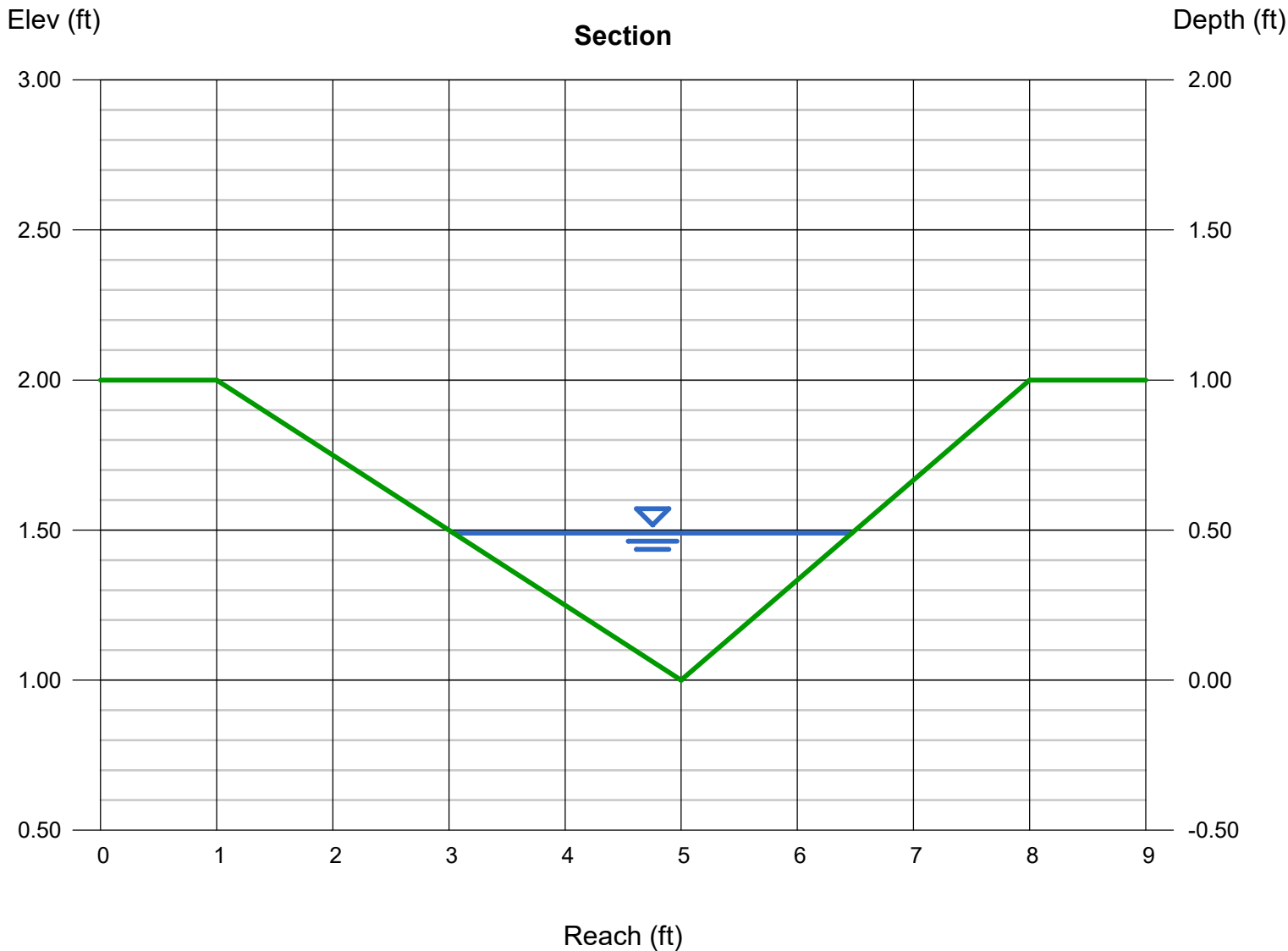
### Calculations

Compute by: Known Q  
Known Q (cfs) = 2.70

### Highlighted

Depth (ft) = 0.49  
Q (cfs) = 2.700  
Area (sqft) = 0.84  
Velocity (ft/s) = 3.21  
Wetted Perim (ft) = 3.57  
Crit Depth, Yc (ft) = 0.52  
Top Width (ft) = 3.43  
EGL (ft) = 0.65

FROUDE =  $v/\sqrt{g \cdot h}$  = 0.78



# Channel Report

## Pr Swale #2 (Q100 = DP8 = 5.2 cfs)

### Triangular

Side Slopes (z:1) = 4.00, 3.00  
Total Depth (ft) = 1.00

Invert Elev (ft) = 1.00  
Slope (%) = 3.62  
N-Value = 0.030

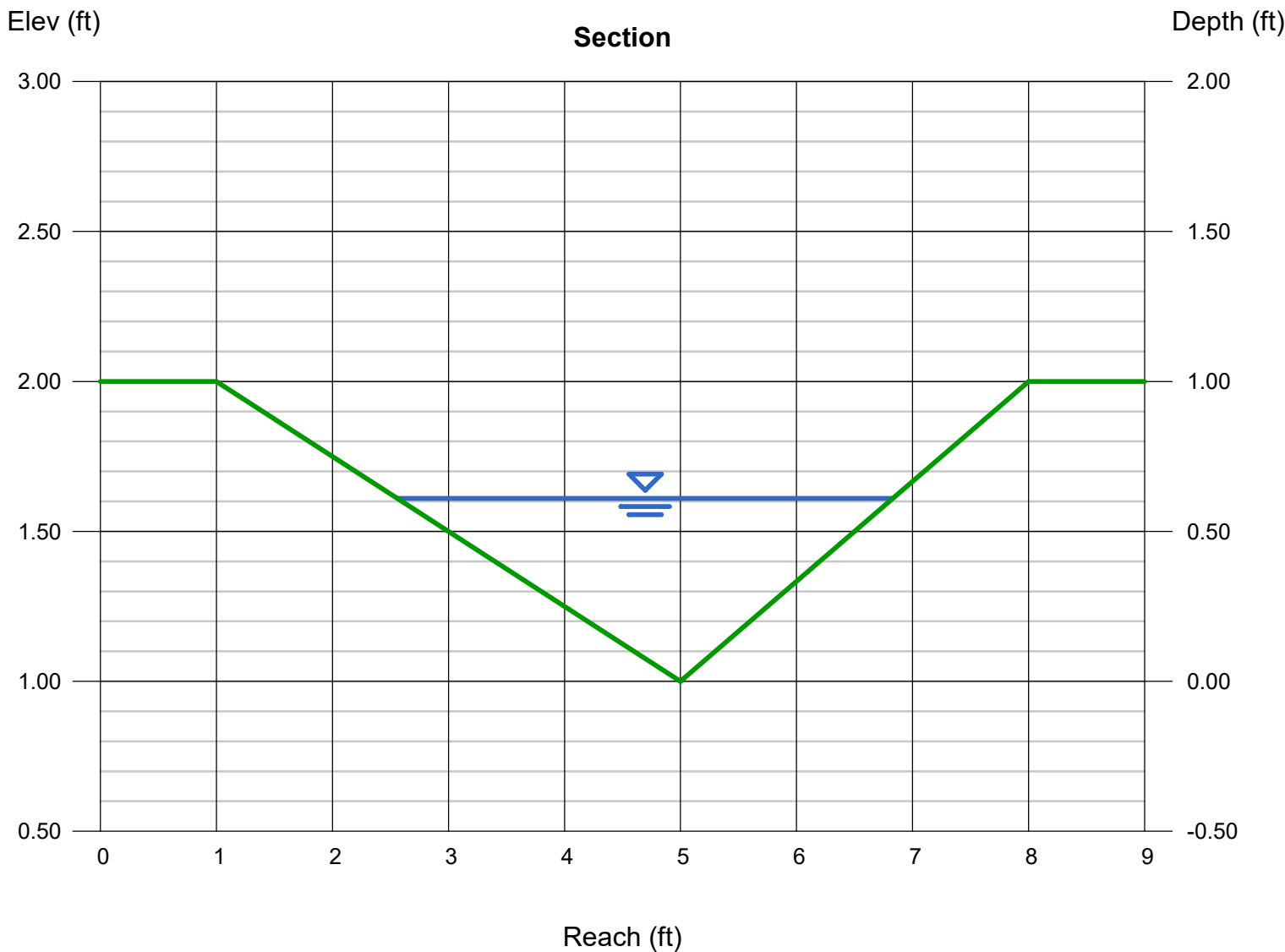
### Calculations

Compute by: Known Q  
Known Q (cfs) = 5.20

### Highlighted

Depth (ft) = 0.61  
Q (cfs) = 5.200  
Area (sqft) = 1.30  
Velocity (ft/s) = 3.99  
Wetted Perim (ft) = 4.44  
Crit Depth, Yc (ft) = 0.68  
Top Width (ft) = 4.27  
EGL (ft) = 0.86

FROUDE =  $v/\sqrt{g \cdot h}$  = 0.85



# Channel Report

## Pr Swale #3 (Q100 = Basin G3 = 0.7 cfs)

### Triangular

Side Slopes (z:1) = 3.00, 3.00  
Total Depth (ft) = 0.50

Invert Elev (ft) = 1.00  
Slope (%) = 0.50  
N-Value = 0.030

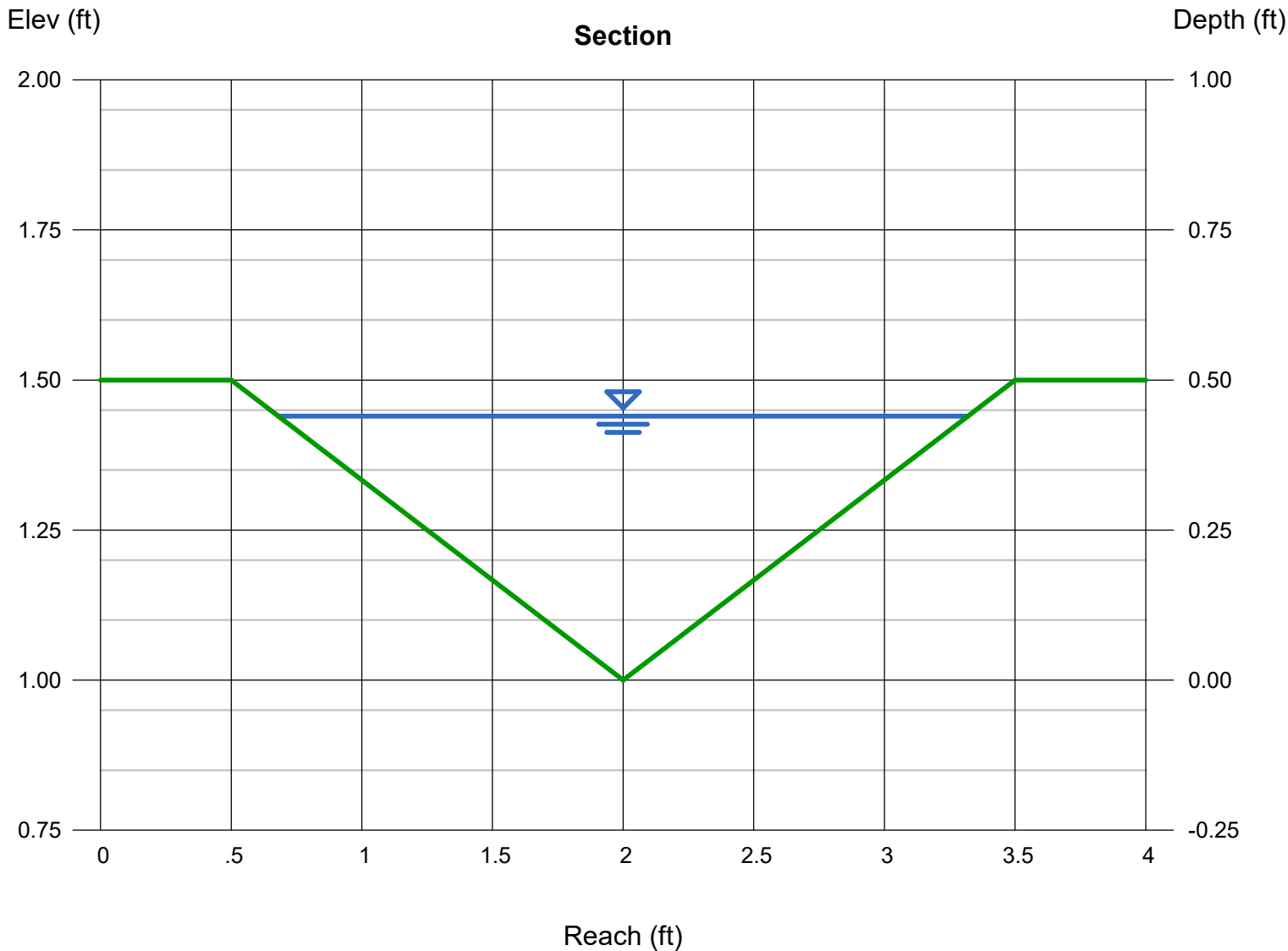
### Calculations

Compute by: Known Q  
Known Q (cfs) = 0.70

### Highlighted

Depth (ft) = 0.44  
Q (cfs) = 0.700  
Area (sqft) = 0.58  
Velocity (ft/s) = 1.21  
Wetted Perim (ft) = 2.78  
Crit Depth, Yc (ft) = 0.33  
Top Width (ft) = 2.64  
EGL (ft) = 0.46

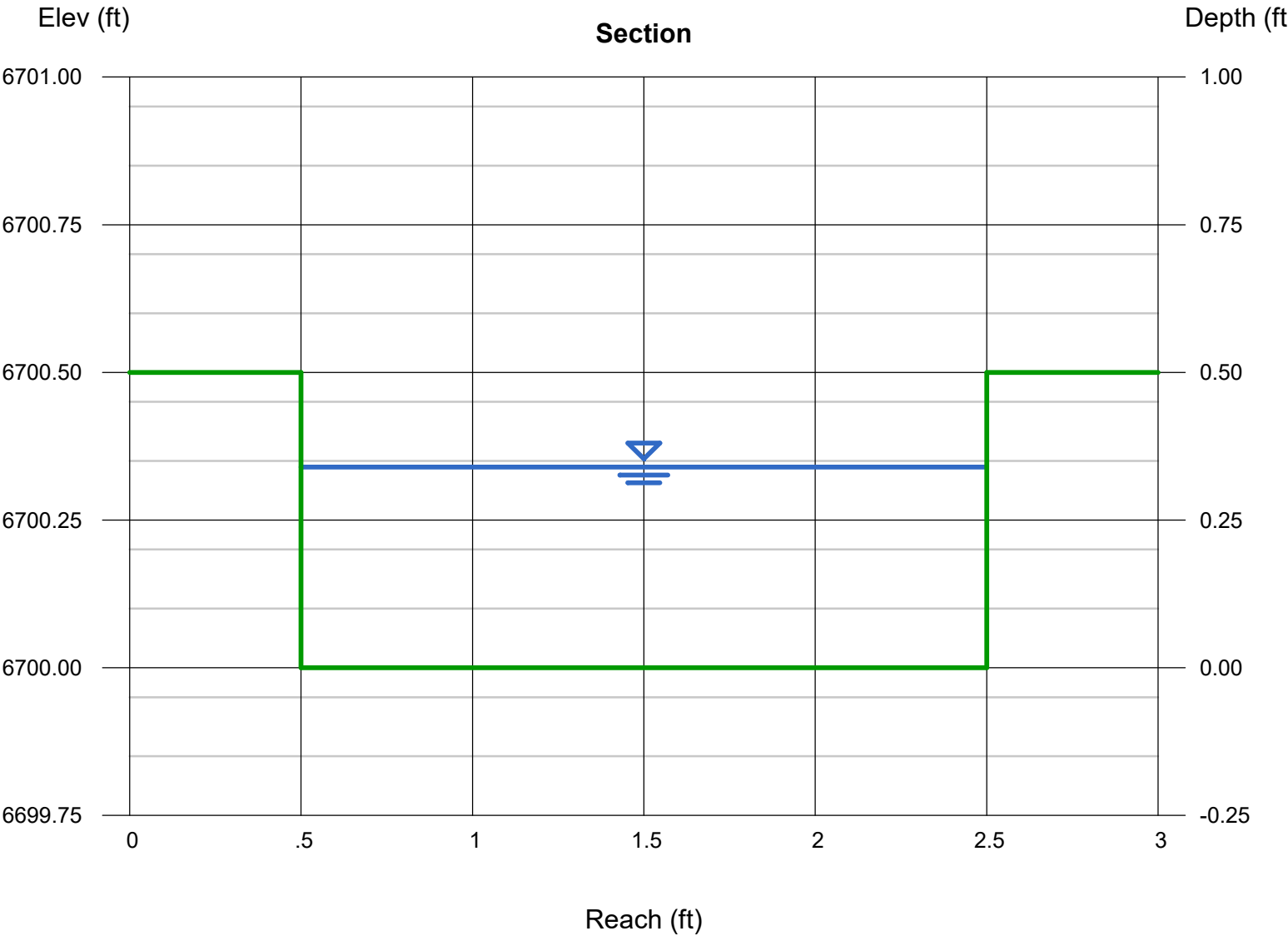
FROUDE =  $v/\sqrt{g \cdot h}$  = 0.37



# Channel Report

## Trickle Channel Sizing (1% OF 100yr Peak Inflow per UD-Det. = 1.72 cfs)

<b>Rectangular</b>		<b>Highlighted</b>	
Bottom Width (ft)	= 2.00	Depth (ft)	= 0.34
Total Depth (ft)	= 0.50	Q (cfs)	= 1.720
		Area (sqft)	= 0.68
Invert Elev (ft)	= 6700.00	Velocity (ft/s)	= 2.53
Slope (%)	= 0.50	Wetted Perim (ft)	= 2.68
N-Value	= 0.016	Crit Depth, Yc (ft)	= 0.29
		Top Width (ft)	= 2.00
		EGL (ft)	= 0.44
<b>Calculations</b>			
Compute by:	Known Q		
Known Q (cfs)	= 1.72		



### 3.2.1 Riprap Apron

This section addresses the use of riprap for erosion protection downstream of conduit and culvert outlets. Refer to the *Open Channels* chapter for additional information on applications for and placement of riprap. Those criteria will be useful in design of erosion protection for conduit outlets. When incorporating a drop into the outfall use Figure 9-40 or 9-41.

#### Rock Size

The procedure for determining the required riprap size downstream of a conduit outlet is in Section 3.2.3.

#### Configuration of Riprap Apron

Figure 9-34 illustrates typical riprap protection of culverts at conduit outlets.

#### Extent of Protection

The length of the riprap protection downstream from the outlet depends on the degree of protection desired. If it is necessary to prevent all erosion, the riprap must extend until the velocity decreases to an acceptable value. The acceptable major event velocity is set at 5 ft/sec for non-cohesive soils and at 7 ft/sec for erosion resistant soils. The rate at which the velocity of a jet from a conduit outlet decreases is not well known. The procedure recommended here assumes the rate of decrease in velocity is related to the angle of lateral expansion,  $\theta$ , of the jet. The velocity is related to the expansion factor,  $(1/(2\tan\theta))$ , which can be determined directly using Figure 9-35 or Figure 9-36, by assuming that the expanding jet has a rectangular shape:

$$L_p = \left( \frac{1}{2 \tan \theta} \right) \left( \frac{A_t}{Y_t} - W \right) \quad \text{Equation 9-11}$$

Where:

$L_p$  = length of protection (ft)

$W$  = width of the conduit (ft, use diameter for circular conduits)

$Y_t$  = tailwater depth (ft)

$\theta$  = the expansion angle of the culvert flow

and:

$$A_t = \frac{Q}{V} \quad \text{Equation 9-12}$$

Where:

$Q$  = design discharge (cfs)

$V$  = the allowable non-eroding velocity in the downstream channel (ft/sec)

$A_t$  = required area of flow at allowable velocity (ft<sup>2</sup>)

In certain circumstances, Equation 9-11 may yield unreasonable results. Therefore, in no case should  $L_p$  be less than  $3H$  or  $3D$ , nor does  $L_p$  need to be greater than  $10H$  or  $10D$  whenever the Froude parameter,  $Q/WH^{1.5}$  or  $Q/D^{2.5}$ , is less than 8.0 or 6.0, respectively. Whenever the Froude parameter is greater than these maximums, increase the maximum  $L_p$  required by  $\frac{1}{4} D_c$  or  $\frac{1}{4} H$  for circular or rectangular (box) culverts, respectively, for each whole number by which the Froude parameter is greater than 8.0 or 6.0, respectively.

Once  $L_p$  has been determined, the width of the riprap protection at the furthest downstream point should be verified. This dimension is labeled “T” on Figure 9-34. The first step is to solve for  $\theta$  using the results from Figure 9-35 or 9-36:

$$\theta = \tan^{-1} \left( \frac{1}{2(\text{ExpansionFactor})} \right) \quad \text{Equation 9-13}$$

Where:

Expansion Factor = determined using Figure 9-35 or 9-36

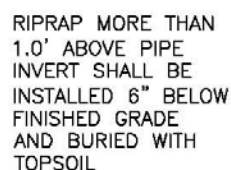
T is then calculated using the following equation:

$$T = 2(L_p \tan \theta) + W \quad \text{Equation 9-14}$$

### Multiple Conduit Installations

The procedures outlined in this section can be used to design outlet erosion protection for multi-barrel culvert installations by replacing the multiple barrels with a single hydraulically equivalent hypothetical rectangular conduit. The dimensions of the equivalent conduit may be established as follows:

1. Distribute the total discharge,  $Q$ , among the individual conduits. Where all the conduits are hydraulically similar and identically situated, the flow can be assumed to be equally distributed; otherwise, the flow through each barrel must be computed.
2. Compute the Froude parameter  $Q_i/D_{ci}^{2.5}$  (circular conduit) or  $Q_i/W_i H_i^{1.5}$  (rectangular conduit), where the subscript  $i$  indicates the discharge and dimensions associated with an individual conduit.
3. If the installation includes dissimilar conduits, select the conduit with the largest value of the Froude parameter to determine the dimensions of the equivalent conduit.
4. Make the height of the equivalent conduit,  $H_{eq}$ , equal to the height, or diameter, of the selected individual conduit.
5. The width of the equivalent conduit,  $W_{eq}$ , is determined by equating the Froude parameter from the selected individual conduit with the Froude parameter associated with the equivalent conduit,  $Q/W_i H_{eq}^{1.5}$ .



September 2017

## DP05 (Entry Road Culvert) Riprap Sizing

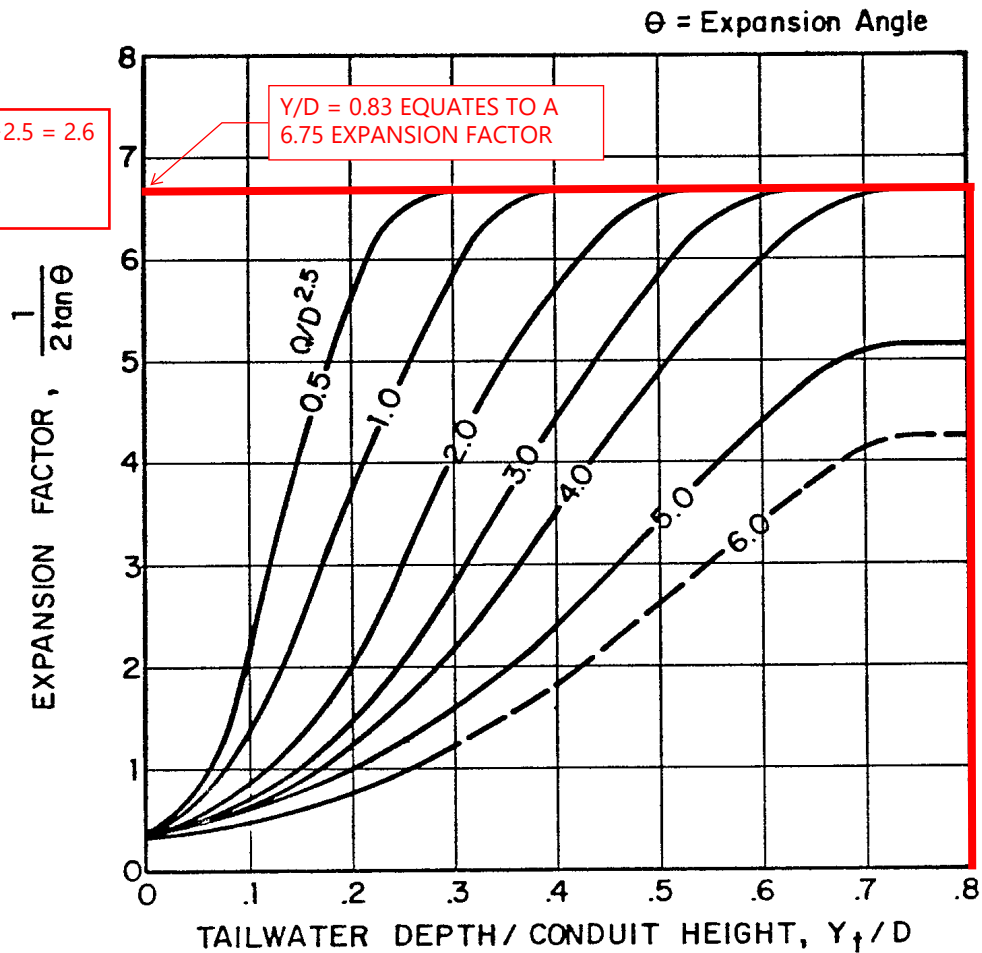


Figure 9-35. Expansion factor for circular conduits

$$\text{Length} = (\text{Expansion Factor}) \cdot (A/Y - W)$$

$$\text{Length} = (6.75) \cdot (0.71 - 1) = \text{UNREASONABLE RESULT, THEREFORE LENGTH OF RIPRAP} = 3 \cdot D = 3 \text{ FT}$$

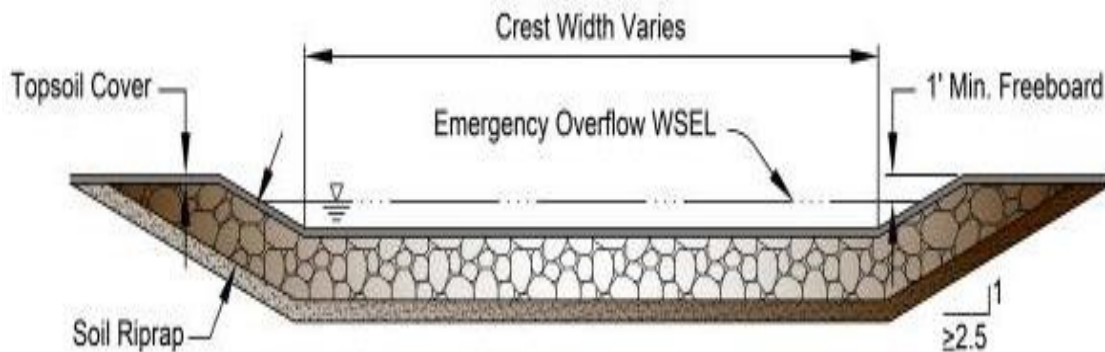
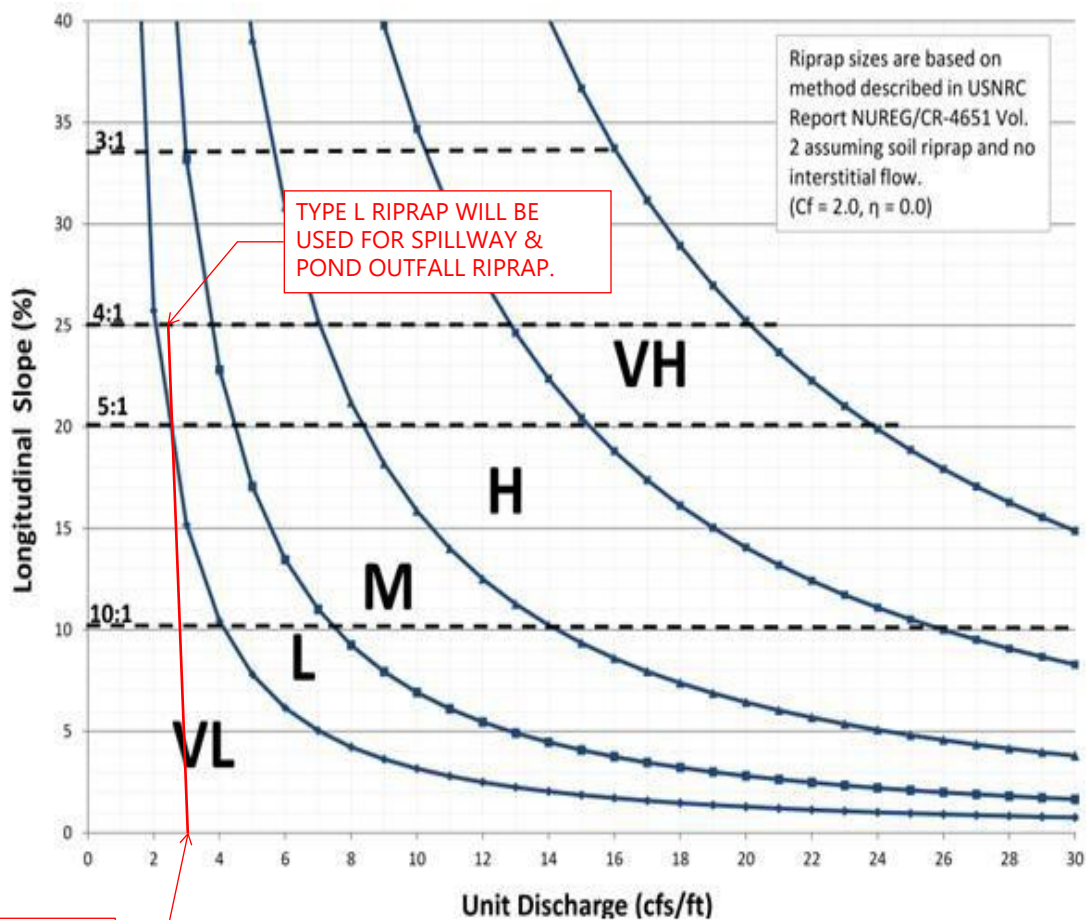
$$\text{Width} = 2 \cdot (L \cdot \tan(\text{expansion angle})) + W$$

$$\text{Expansion Angle} = \tan^{-1}(1/(2 \cdot \text{Expansion Factor}))$$

$$\text{Expansion Angle} = \tan^{-1}(1/(2 \cdot 6.75)) = 4.23$$

$$\text{Width} = 2 \cdot (3 \text{ ft} \cdot \tan(4.23)) + 1 = 1.44 \text{ FT} \rightarrow \text{INCREASED TO 4 FT FOR CONSTRUCTABILITY}$$



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

SPILLWAY 100-YR FLOW =  
17.2 CFS / 6 FT = 2.9 CFS/FT

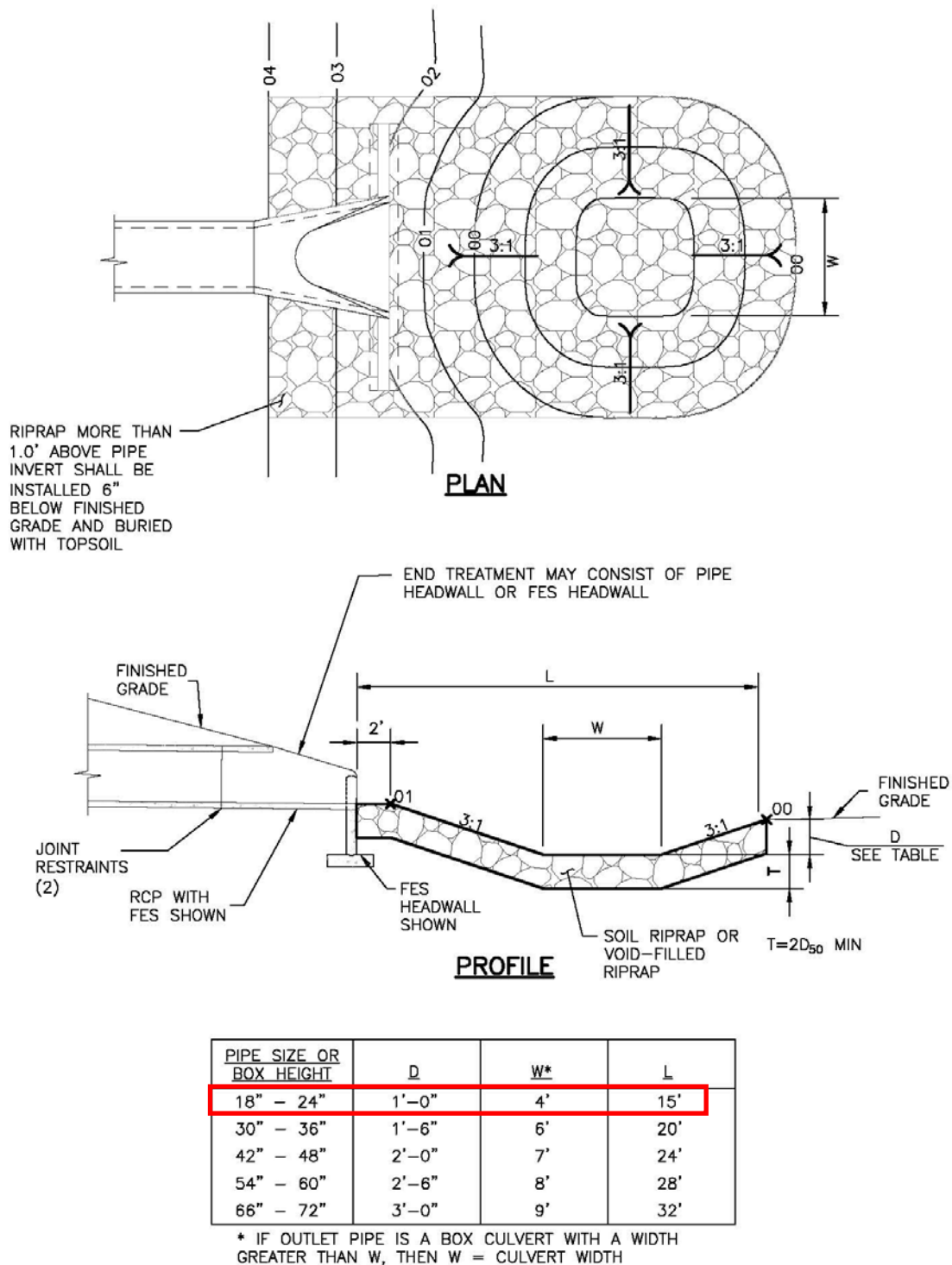


Figure 9-37. Low tailwater riprap basin

### 3.2.3 Rock Sizing for Riprap Apron and Low Tailwater Basin

Scour resulting from highly turbulent, rapidly decelerating flow is a common problem at conduit outlets. The following section summarizes the method for sizing riprap protection for both riprap aprons (Section 3.2.1) and low tailwater basins (Section 3.2.2).

Use Figure 9-38 to determine the required rock size for circular conduits and Figure 9-39 for rectangular conduits. Figure 9-38 is valid for  $Q/D_c^{2.5}$  of 6.0 or less and Figure 9-39 is valid for  $Q/WH^{1.5}$  of 8.0 or less. The parameters in these two figures are:

1.  $Q/D^{1.5}$  or  $Q/WH^{0.5}$  in which  $Q$  is the design discharge in cfs,  $D_c$  is the diameter of a circular conduit in feet, and  $W$  and  $H$  are the width and height of a rectangular conduit in feet.
2.  $Y_t/D_c$  or  $Y_t/H$  in which  $Y_t$  is the tailwater depth in feet,  $D_c$  is the diameter of a circular conduit in feet, and  $H$  is the height of a rectangular conduit in feet. In cases where  $Y_t$  is unknown or a hydraulic jump is suspected downstream of the outlet, use  $Y_t/D_t = Y_t/H = 0.40$  when using Figures 9-38 and 9-39.
3. The riprap size requirements in Figures 9-38 and 9-39 are based on the non-dimensional parametric Equations 9-16 and 9-17 (Steven, Simons, and Watts 1971 and Smith 1975).

Circular culvert:

$$d_{50} = \frac{0.023Q}{Y_t^{1.2} D_c^{0.3}} \quad \text{Equation 9-16}$$

Rectangular culvert:

$$d_{50} = \frac{0.014H^{0.5}Q}{Y_t W} \quad \text{Equation 9-17}$$

These rock size requirements assume that the flow in the culvert is subcritical. It is possible to use Equations 9-16 and 9-17 when the flow in the culvert is supercritical (and less than full) if the value of  $D_c$  or  $H$  is modified for use in Figures 9-38 and 9-39. Note that rock sizes referenced in these figures are defined in the *Open Channels* chapter. Whenever the flow is supercritical in the culvert, substitute  $D_a$  for  $D_c$  and  $H_a$  for  $H$ , in which  $D_a$  is defined as:

$$D_a = \frac{(D_c + Y_n)}{2} \quad \text{Equation 9-18}$$

Where the maximum value of  $D_a$  shall not exceed  $D_c$ , and

$$H_a = \frac{(H + Y_n)}{2}$$

Equation 9-19

Where the maximum value of  $H_a$  shall not exceed  $H$ , and:

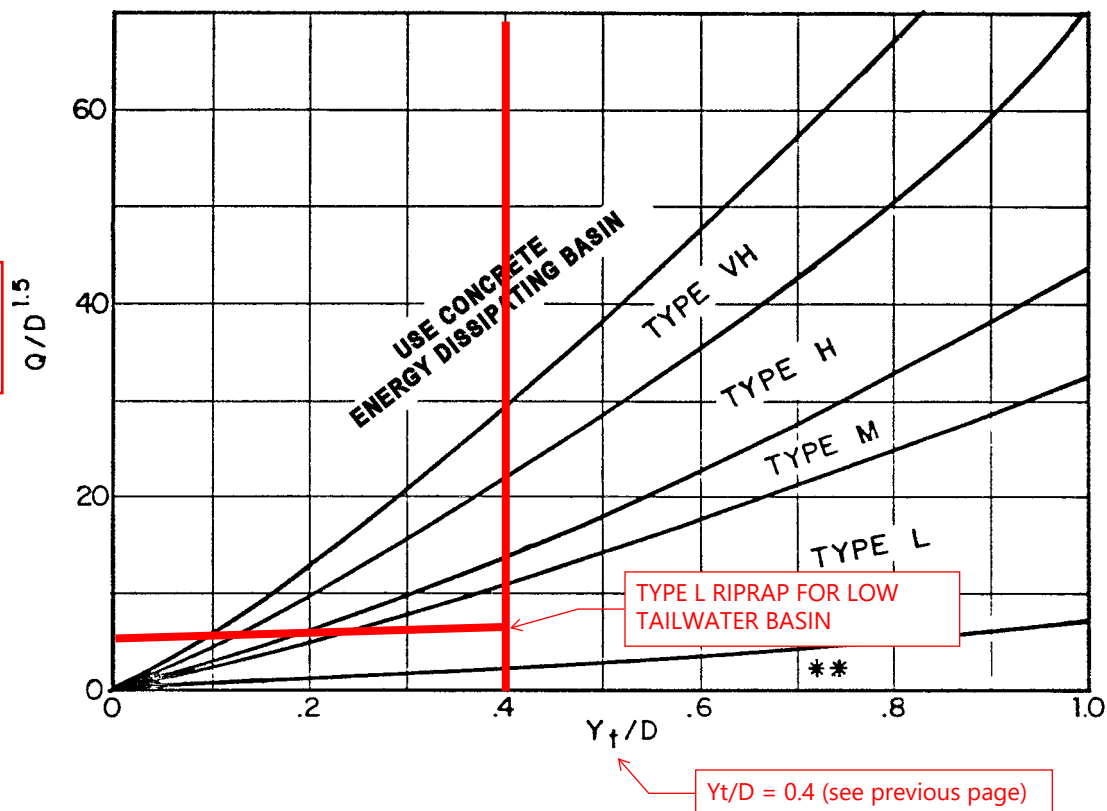
$D_a$  = parameter to use in place of  $D$  in Figure 9-38 when flow is supercritical (ft)

$D_c$  = diameter of circular culvert (ft)

$H_a$  = parameter to use in place of  $H$  in Figure 9-39 when flow is supercritical (ft)

$H$  = height of rectangular culvert (ft)

$Y_n$  = normal depth of supercritical flow in the culvert (ft)



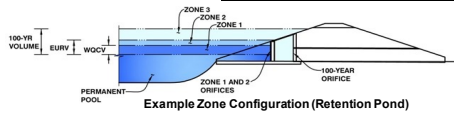
Use  $D_a$  instead of  $D$  whenever flow is supercritical in the barrel.  
 \*\* Use Type L for a distance of  $3D$  downstream.

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for  $Q/D^{2.5} \leq 6.0$ )



## **APPENDIX D – WATER QUALITY & DETENTION**

MHFD-Detention, Version 4.06 (July 2022)

Basin ID: POND 1

### Example Zone Configuration (Retention Pond)

Selected BMP Type =	<b>EDB</b>	
Watershed Area =	6.84	acres
Watershed Length =	935	ft
Watershed Length to Centroid =	387	ft
Watershed Slope =	0.023	ft/ft
Watershed Imperviousness =	62.70%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Group C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths = User Input		

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

Water Quality Capture Volume (WQCV) =	0.140	acre-feet
Excess Urban Runoff Volume (EURV) =	0.527	acre-feet
2-yr Runoff Volume ( $P1 = 0.91$ in.) =	0.282	acre-feet
5-yr Runoff Volume ( $P1 = 1.19$ in.) =	0.377	acre-feet
10-yr Runoff Volume ( $P1 = 1.45$ in.) =	0.475	acre-feet
25-yr Runoff Volume ( $P1 = 1.84$ in.) =	0.640	acre-feet
50-yr Runoff Volume ( $P1 = 2.17$ in.) =	0.803	acre-feet
100-yr Runoff Volume ( $P1 = 2.52$ in.) =	0.995	acre-feet
500-yr Runoff Volume ( $P1 = 3.14$ in.) =	1.328	acre-feet
Approximate 2-yr Detention Volume =	0.262	acre-feet
Approximate 5-yr Detention Volume =	0.355	acre-feet
Approximate 10-yr Detention Volume =	0.448	acre-feet
Approximate 25-yr Detention Volume =	0.600	acre-feet
Approximate 50-yr Detention Volume =	0.694	acre-feet
Approximate 100-yr Detention Volume =	0.792	acre-feet

Zone 1 Volume ( $WQV_1$ )	=	0.140	acre-feet
Zone 2 Volume ( $EURV - Zone1$ )	=	0.387	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2)	=	0.265	acre-feet
Total Detention Basin Volume	=	0.792	acre-feet
Initial Surcharge Volume ( $ISV$ )	=	user	ft <sup>3</sup>
Initial Surcharge Depth ( $H_{SD}$ )	=	user	ft
Total Available Detention Depth ( $H_{TAD}$ )	=	user	ft
Depth of Trickle Channel ( $H_{TC}$ )	=	user	ft
Slope of Trickle Channel ( $S_{TC}$ )	=	user	ft/ft
Slopes of Main Basin Sides ( $S_{Main}$ )	=	user	H:V
Basin Length-to-Width Ratio ( $R_{L/W}$ )	=	user	
Initial Surcharge Area ( $A_{ISV}$ )	=	user	ft <sup>2</sup>
Surcharge Volume Length ( $LSV$ )	=	user	ft
Surcharge Volume Width ( $WSV$ )	=	user	ft
Depth of Basin Floor ( $H_{FLLOOR}$ )	=	user	ft
Length of Basin Floor ( $W_{FLLOOR}$ )	=	user	ft
Width of Basin Floor ( $W_{FLLOOR}$ )	=	user	ft
Area of Basin Floor ( $A_{FLLOOR}$ )	=	user	ft <sup>2</sup>
Volume of Basin Floor ( $V_{FLLOOR}$ )	=	user	ft <sup>3</sup>
Depth of Main Basin ( $H_{MAIN}$ )	=	user	ft
Length of Main Basin ( $L_{MAIN}$ )	=	user	ft
Width of Main Basin ( $W_{MAIN}$ )	=	user	ft
Area of Main Basin ( $A_{MAIN}$ )	=	user	ft <sup>2</sup>
Volume of Main Basin ( $V_{MAIN}$ )	=	user	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TOTAL}$ )	=	user	acre-feet

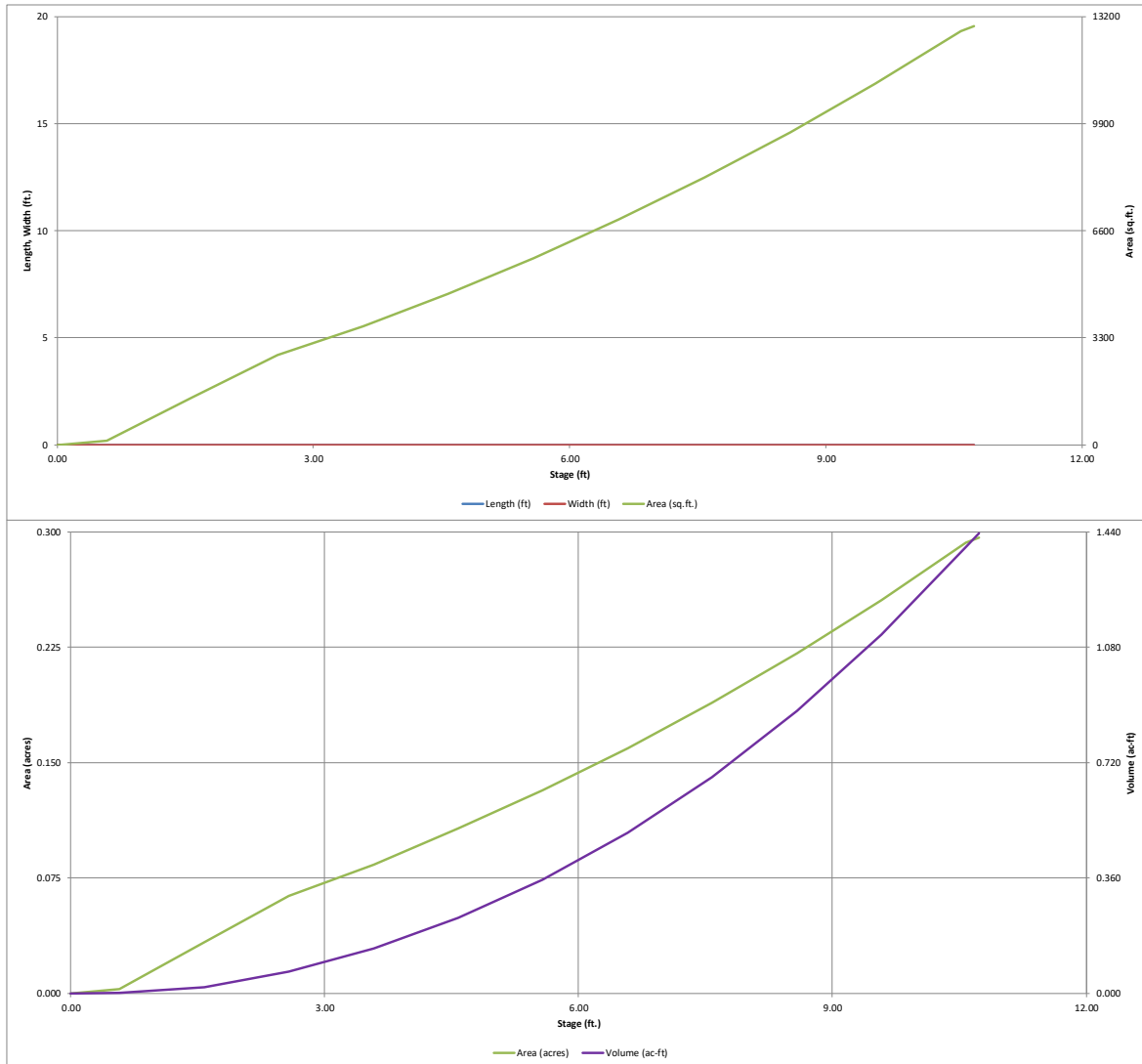
	acre-feet
	acre-feet
0.91	inches
1.19	inches
1.45	inches
1.84	inches
2.17	inches
2.52	inches
	inches

6696.42

[illegible]

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

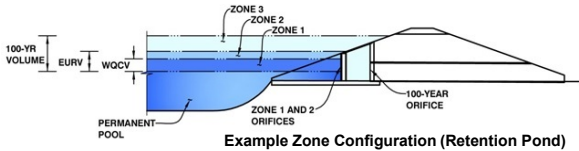


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: COTTAGES AT KETTLE CREEK

Basin ID: POND 1



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.58	0.140	Orifice Plate
Zone 2 (EURV)	6.74	0.387	Rectangular Orifice
Zone 3 (100-year)	8.17	0.265	Weir&Pipe (Restrict)
Total (all zones)		0.792	

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)

Calculated Parameters for Plate

Centroid of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate = 3.58 ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing = N/A inches  
Orifice Plate: Orifice Area per Row = N/A sq. inches

WQ Orifice Area per Row = N/A 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	1.25	2.50					
Orifice Area (sq. inches)	0.48	0.48	0.48					

	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)

Calculated Parameters for Vertical Orifice

Invert of Vertical Orifice = 3.58 N/A ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice = 6.74 N/A ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Height = 2.00 N/A inches  
Vertical Orifice Width = 0.55 inches

Zone 2 Rectangular Not Selected  
Vertical Orifice Area = 0.01 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)

Calculated Parameters for Overflow Weir

Overflow Weir Front Edge Height, H<sub>o</sub> = 7.33 N/A ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length = 3.00 N/A feet  
Overflow Weir Gate Slope = 0.00 N/A H:V  
Horiz. Length of Weir Sides = 3.00 N/A feet  
Overflow Gate Type = Type C Gate  
Debris Clogging % = 50% N/A %

Height of Gate Upper Edge, H<sub>g</sub> = 7.33 N/A feet  
Overflow Weir Slope Length = 3.00 N/A feet  
Gate Open Area / 100-yr Orifice Area = 27.02 N/A  
Overflow Gate Open Area w/o Debris = 6.26 N/A ft<sup>2</sup>  
Overflow Gate Open Area w/ Debris = 3.13 N/A ft<sup>2</sup>

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Depth to Invert of Outlet Pipe = 2.00 N/A ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter = 18.00 N/A inches  
Restrictor Plate Height Above Pipe Invert = 3.40 inches

Zone 3 Restrictor Not Selected  
Outlet Orifice Area = 0.23 N/A ft<sup>2</sup>  
Outlet Orifice Centroid = 0.17 N/A feet  
Half-Central Angle of Restrictor Plate on Pipe = 0.90 N/A radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage = 8.23 ft (relative to basin bottom at Stage = 0 ft)  
Spillway Crest Length = 10.00 feet  
Spillway End Slopes = 4.00 H:V  
Freeboard above Max Water Surface = 1.00 feet

Spillway Design Flow Depth = 0.61 feet  
Stage at Top of Freeboard = 9.84 feet  
Basin Area at Top of Freeboard = 0.27 acres  
Basin Volume at Top of Freeboard = 1.19 acre-ft

## Routed Hydrograph Results

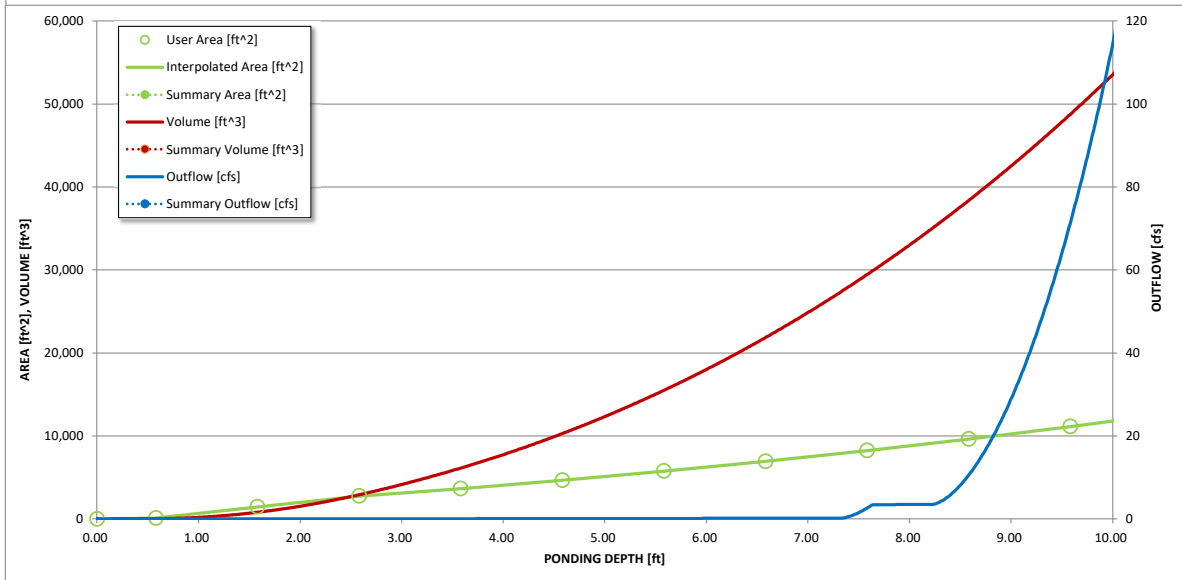
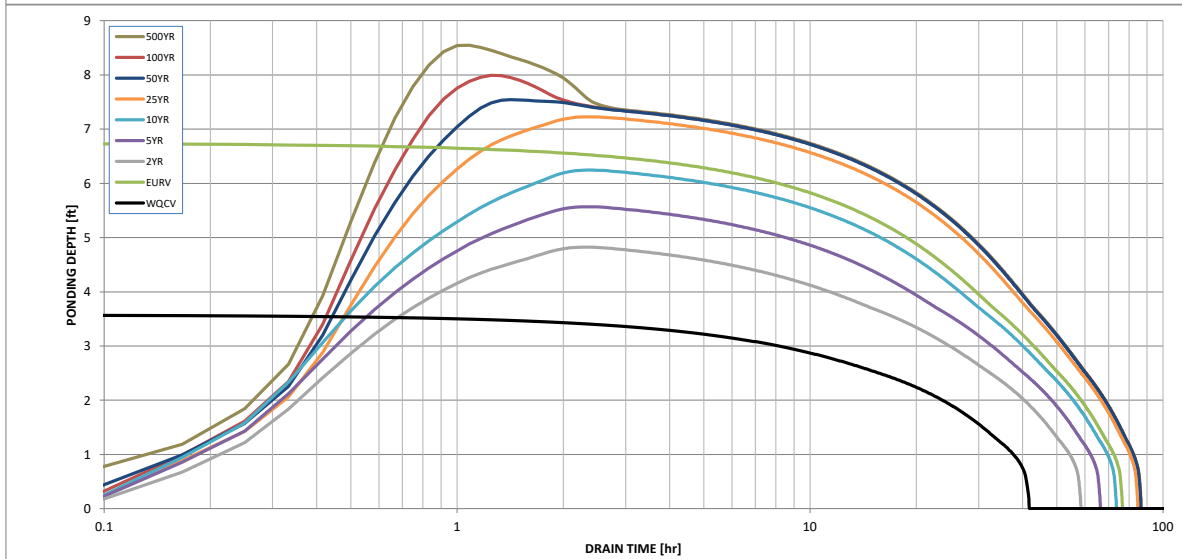
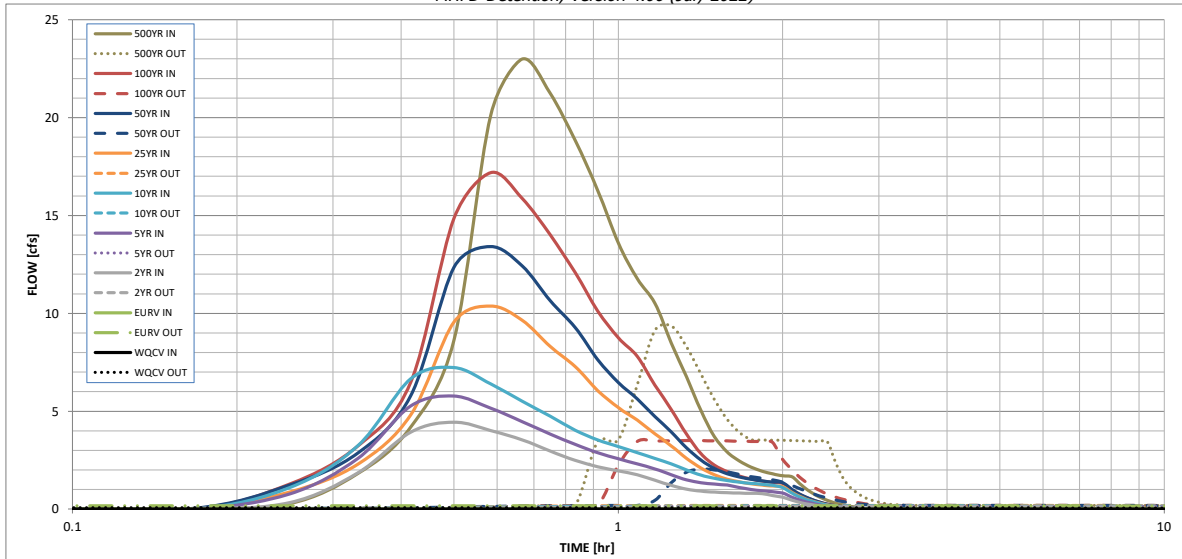
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.91	1.19	1.45	1.84	2.17	2.52	3.14
One-Hour Rainfall Depth (in) =	0.140	0.527	0.282	0.377	0.475	0.640	0.803	0.995	1.328
CUHP Runoff Volume (acre-ft) =	N/A	N/A	0.282	0.377	0.475	0.640	0.803	0.995	1.328
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.0	0.0	0.1	0.5	2.0	4.0	7.1
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.0	0.1	0.5	2.0	4.0	7.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.0	0.1	0.5	2.0	4.0	7.1
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.01	0.07	0.30	0.58	1.04
Peak Inflow Q (cfs) =	N/A	N/A	4.4	5.8	7.2	10.4	13.4	17.2	23.0
Peak Outflow Q (cfs) =	0.1	0.2	0.1	0.2	0.2	0.2	2.0	3.5	9.4
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	3.6	2.0	0.4	1.0	0.9	1.3
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Gate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	0.3	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) =	38	66	52	58	64	73	72	70	67
Time to Drain 99% of Inflow Volume (hours) =	40	72	56	63	70	79	80	79	77
Maximum Ponding Depth (ft) =	3.58	6.74	4.82	5.57	6.24	7.22	7.54	7.99	8.54
Area at Maximum Ponding Depth (acres) =	0.08	0.16	0.11	0.13	0.15	0.18	0.19	0.20	0.22
Maximum Volume Stored (acre-ft) =	0.141	0.527	0.262	0.353	0.449	0.610	0.666	0.754	0.872



# 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	0.05	0.01	0.28
	0:15:00	0.00	0.00	0.34	0.78	1.10	0.88	1.22	1.28	1.81
	0:20:00	0.00	0.00	1.85	2.59	3.24	2.30	2.87	3.22	4.19
	0:25:00	0.00	0.00	3.93	5.26	6.65	4.80	5.79	6.48	8.63
	0:30:00	0.00	0.00	4.44	5.77	7.23	9.55	12.35	14.85	20.12
	0:35:00	0.00	0.00	4.02	5.15	6.40	10.38	13.42	17.19	22.99
	0:40:00	0.00	0.00	3.54	4.47	5.51	9.65	12.43	15.88	21.24
	0:45:00	0.00	0.00	2.96	3.83	4.75	8.31	10.65	14.02	18.83
	0:50:00	0.00	0.00	2.49	3.31	4.03	7.28	9.28	12.08	16.29
	0:55:00	0.00	0.00	2.17	2.88	3.53	6.06	7.63	10.12	13.60
	1:00:00	0.00	0.00	1.95	2.58	3.19	5.18	6.47	8.75	11.77
	1:05:00	0.00	0.00	1.76	2.31	2.89	4.54	5.63	7.80	10.53
	1:10:00	0.00	0.00	1.47	2.06	2.59	3.85	4.73	6.34	8.49
	1:15:00	0.00	0.00	1.21	1.76	2.31	3.23	3.94	5.09	6.75
	1:20:00	0.00	0.00	1.02	1.49	2.00	2.59	3.13	3.83	5.04
	1:25:00	0.00	0.00	0.92	1.35	1.73	2.10	2.51	2.84	3.70
	1:30:00	0.00	0.00	0.86	1.28	1.57	1.75	2.07	2.25	2.91
	1:35:00	0.00	0.00	0.83	1.22	1.46	1.53	1.81	1.91	2.46
	1:40:00	0.00	0.00	0.82	1.10	1.37	1.39	1.64	1.69	2.15
	1:45:00	0.00	0.00	0.80	1.00	1.31	1.29	1.52	1.54	1.94
	1:50:00	0.00	0.00	0.79	0.93	1.27	1.22	1.44	1.44	1.80
	1:55:00	0.00	0.00	0.69	0.88	1.21	1.18	1.39	1.36	1.70
	2:00:00	0.00	0.00	0.60	0.82	1.09	1.14	1.35	1.32	1.64
	2:05:00	0.00	0.00	0.45	0.60	0.80	0.84	0.99	0.97	1.21
	2:10:00	0.00	0.00	0.32	0.43	0.58	0.61	0.72	0.70	0.87
	2:15:00	0.00	0.00	0.23	0.31	0.41	0.44	0.51	0.51	0.63
	2:20:00	0.00	0.00	0.16	0.22	0.29	0.31	0.36	0.36	0.44
	2:25:00	0.00	0.00	0.11	0.15	0.20	0.21	0.25	0.25	0.31
	2:30:00	0.00	0.00	0.07	0.10	0.14	0.15	0.17	0.17	0.21
	2:35:00	0.00	0.00	0.05	0.07	0.09	0.10	0.11	0.11	0.14
	2:40:00	0.00	0.00	0.02	0.04	0.05	0.06	0.07	0.07	0.08
	2:45:00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.04
	2:50:00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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]



## **APPENDIX E – REFERENCE MATERIAL**

Attn: Jonathan Scherer  
Stormwater Enterprise  
30 S. Nevada Avenue, Suite 401  
Colorado Springs, CO 80903  
O: (719) 385-5980



---

VARIANCE REQUEST FOR **COTTAGES AT KETTLE CREEK (DEPN-24-0160)**

---

Dear Mr. Scherer,

We respectfully submit this request for a variance from the Colorado Springs Drainage Criteria Manual, Volume 1, Section 10.2.4 that states, "Storm sewer outlets shall be set with their inverts 1 to 2 feet (2 feet for wetland channels) above the natural channel bottom and provided with appropriate erosion protection measures."

In accordance with Variance Requests Policy Clarification, January 13, 2017, a variance may be considered when the, " ...implementation of the requirements will impose undue financial burdens or cause undue time delays, or that superior approach is available."

The Cottages at Kettle Creek storm sewer outfall location was chosen based upon a balance of multiple factors. While channel stability within Kettle Creek is of upmost concern, the preservation of U.S. Army Corps of Engineer (USACE) regulated wetlands and endangered species' habitat is of equal, if not of greater, concern. The channel bottom is located approximately 48' beyond the limits of the wetlands. To follow Section 10.2.4 guidance, approximately 600 square feet of wetland area would be severely impacted. Disturbing the wetlands would trigger the USACE federal permitting process which would impose undue time delays to the project.

Furthermore, US Fish & Wildlife Service (USFWS) has provided a concurrence letter for the project, regarding the impacts to federally protected endangered species Preble's meadow jumping mouse habitat. The USFW service has provided their support for the proposed location of the outfall as it preserves the wetland area, which is the most critical habitat of the Preble's mouse. Please review the attached USFWS concurrence letter and Outfall Justification Letter by Bristlecone Ecology.

The outfall is proposed with a low tailwater basin to be located at the base of the channel bank and within the floodplain terrace. The low tailwater basin will be privately owned and maintained. Per Mile High Flood District (MHFD) guidance in Volume 2, Section 9.3.2.2 a low tailwater basin dissipates the kinetic energy under controlled conditions without causing scouring at the channel bottom. Please see the attached exhibit detailing the outfall location and mitigation measures.

The approval of this variance will not result in a change in peak flows to Fountain Creek or water quality in Fountain Creek.

Attached exhibits are as follows:

1. Vicinity Map
2. Outfall Exhibit
3. Kettle Creek Floodplain Terrace Stability Calculation
4. Bristlecone Letter

5. USFW Letter
6. MHFD Low Tailwater Basin Guidance
7. Cottages at Kettle Creek Pond Discharge
8. Challenger Pond Discharge

Respectfully submitted,

A handwritten signature in black ink, appearing to read 'Nick Jokerst', written in a cursive style.

**NICHOLAS JOKERST, PE**

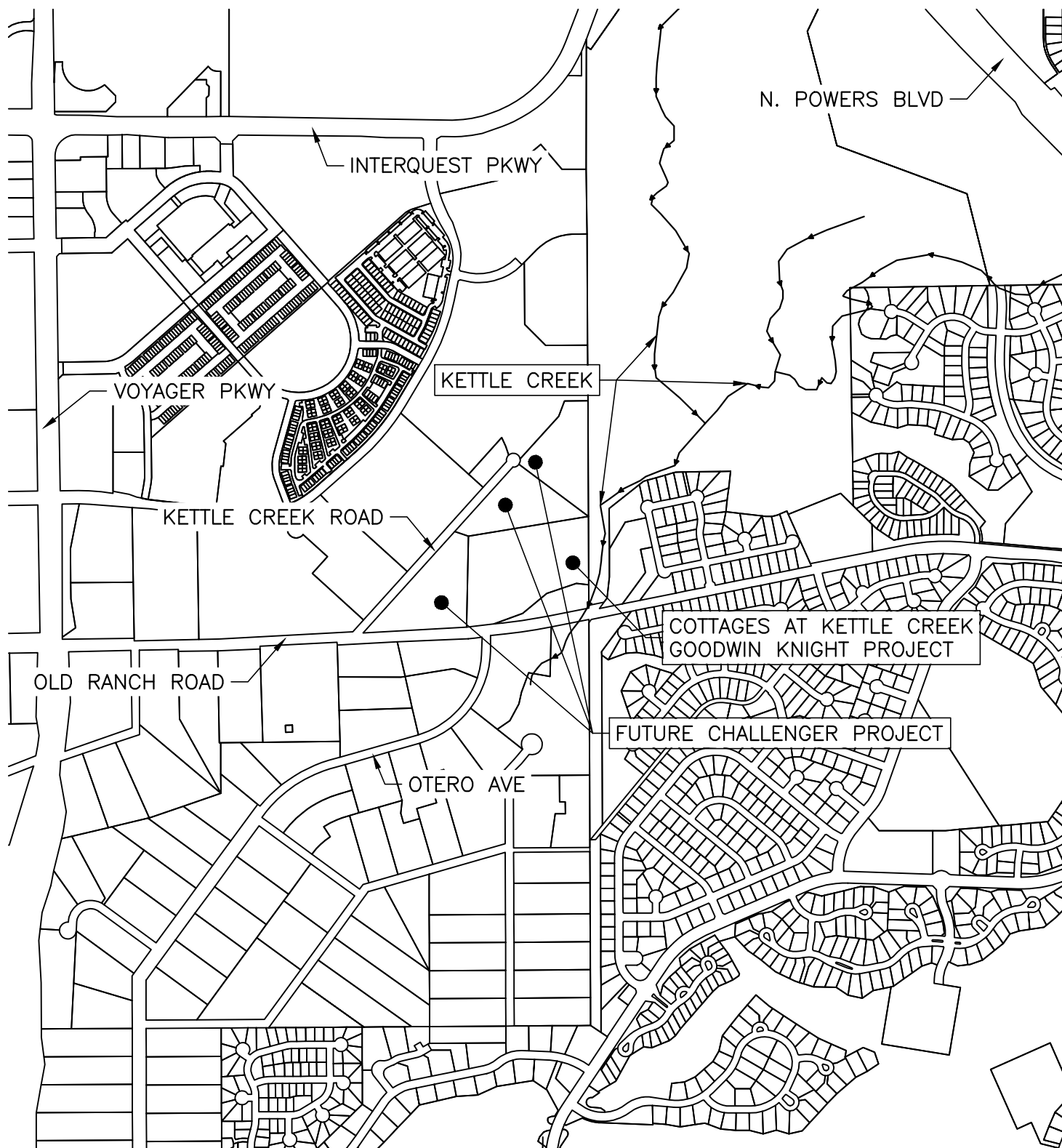
**All Terrain Engineering LLC**

njokerst@allterraineng.com

530.391.7635

# COTTAGES AT KETTLE CREEK

## VICINITY MAP



1000 500 0 1000 2000  
ORIGINAL SCALE: 1" = 1000'

VICINITY MAP

COTTAGES AT KETTLE CREEK  
JOB NO. 24026  
LOCATION: CS  
10/03/2024  
SHEET: 1

SHEET



ENGINEERING  
1004 WEST VAN BUREN STREET  
COLORADO SPRINGS, CO 80907

PR 24" RCP STM SWR  
 FLOW (5YR/100YR) = 0.1 CFS/3.8 CFS  
 VELOCITY (5YR/100YR) = 0.82 FT/S/4.02 FT/S

PR LOW TAILWATER BASIN  
 W/ TYPE L SOIL RIPRAP  
 DEPTH = 18"

EX 100-YR FLOODPLAIN

EX PROP. BNDY

PR 24" FES W/ HEADWALL

EX WETLAND LIMITS

WETLAND 48.22' - FLOWLINE

EX BOTTOM OF BANK

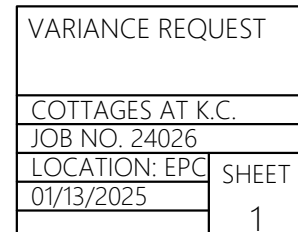
EX TOP OF BANK

EX CHANNEL FLOWLINE

KETTLE CREEK

Elevations: 6667, 6668, 6669, 6674, 6678, 6682

Slopes: -2.1, -2.20%, -3.7

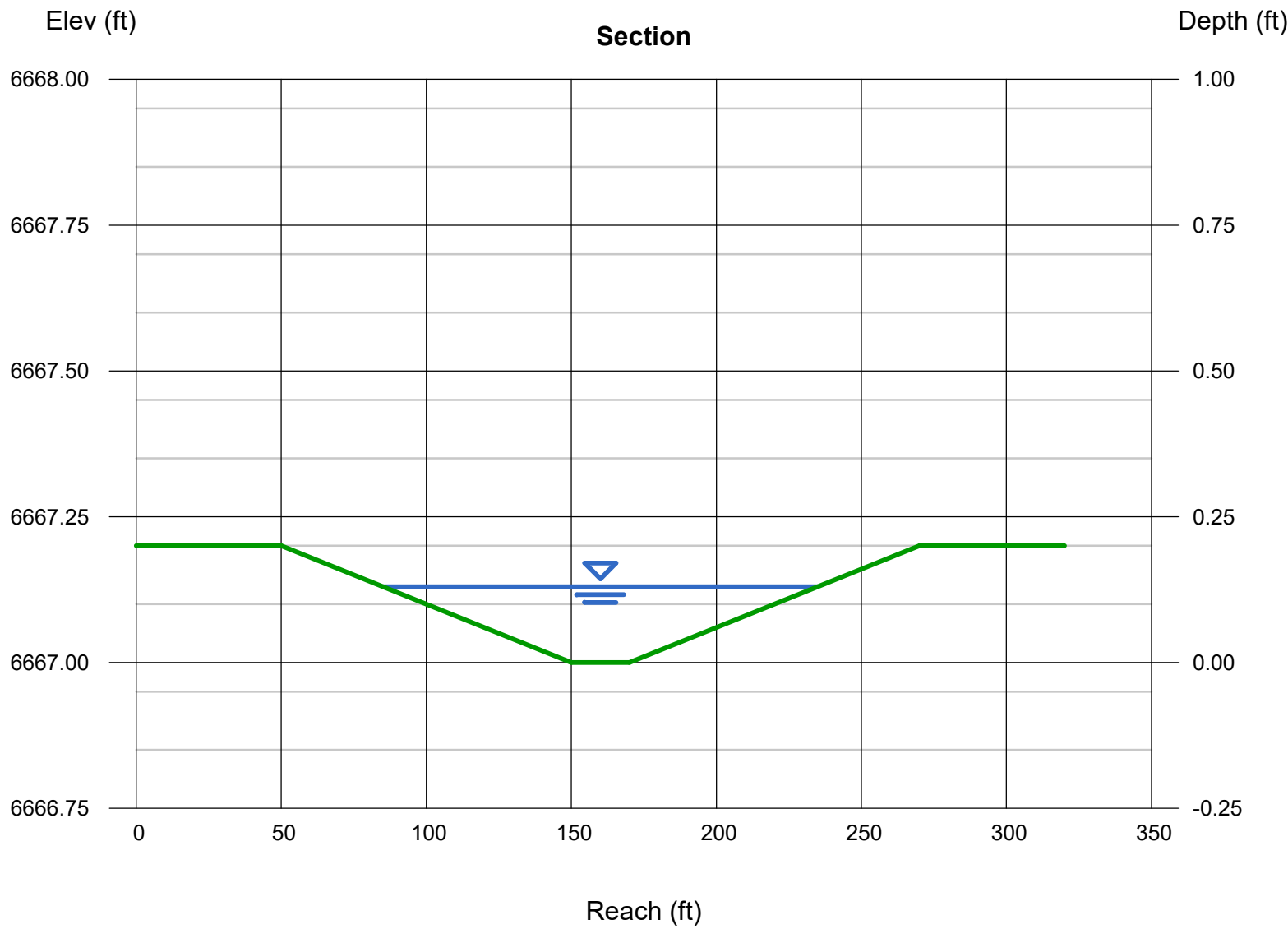




# Channel Report

## KETTLE CREEK STABILITY - LOW TAILWATER BASIN DISCHARGE (Q100 = 12 CFS)

<b>Trapezoidal</b>		<b>Highlighted</b>	
Bottom Width (ft)	= 20.00	Depth (ft)	= 0.13
Side Slopes (z:1)	= 500.00, 500.00	Q (cfs)	= 12.00
Total Depth (ft)	= 0.20	Area (sqft)	= 11.05
Invert Elev (ft)	= 6667.00	Velocity (ft/s)	= 1.09
Slope (%)	= 2.20	Wetted Perim (ft)	= 150.00
N-Value	= 0.030	Crit Depth, Yc (ft)	= 0.12
<b>Calculations</b>		Top Width (ft)	= 150.00
Compute by:	Known Q	EGL (ft)	= 0.15
Known Q (cfs)	= 12.00		





January 8, 2025

Jonathan Scherer & Erin Powers  
Stormwater Enterprise  
30 S. Nevada Ave., Suite 401  
Colorado Springs, CO 80903

**RE: Outfall Location Justification Letter  
Cottages at Kettle Creek Development  
El Paso County, Colorado**

Dear Mr. Scherer,

Thank you for your feedback regarding concerns for potential erosion from the proposed location of the Cottages at Kettle Creek's storm sewer outfall. To address your concerns, All Terrain Engineering and Goodwin Knight, on advice from Bristlecone Ecology, have carefully designed the outfall location to effectively minimize the risk of erosion. The current design allows stormwater to first flow into the heavily vegetated floodplain, where both woody and herbaceous vegetation will dissipate velocities significantly before they reach the creek. The existing vegetation serves as a natural buffer, minimizing the likelihood of erosion. Relocating the outfall closer to the creek may increase the risk of erosion by concentrating point-source water flows, increasing velocity and energy. This concentrated flow could contribute to overwhelming the natural sediment transport processes, potentially scouring the channel bed and banks, altering the channel form, and destabilizing the stream over time. Furthermore, the lack of groundwater infiltration and sediment deposition in the floodplain would deprive riparian vegetation of essential nutrients and moisture, reducing its ability to stabilize the soil. In contrast, the current design allows stormwater to dissipate into the floodplain terrace, benefiting vegetation, supporting sediment transport, promoting groundwater recharge, and ensuring that the stream can sustain its natural form and function over the long term.

Additionally, relocating the stormwater outfall would negatively impact habitat for federally protected endangered species, Preble's meadow jumping mouse (*Zapus hudsonius preblei*), which has Designated Critical Habitat on the project site. Moving the outfall structure into wetlands would trigger federal permitting with the U.S. Army Corps of Engineers (USACE), necessitating the preparation of a Biological Assessment, formal consultation with the U.S. Fish and Wildlife Service (USFWS), and issuance of a Biological Opinion. The USFWS has already reviewed and approved the current design and agreed with our assessment that the current location of the outfall structure would not degrade Critical Preble's habitat in the flood terrace. Furthermore, they agreed that Kettle Creek's global functioning, particularly regarding Preble's mice using the larger stream corridor, could decline with more concentrated flow points entering the stream channel. Moving the outfall and triggering additional permitting and consultations would nullify the concurrence we have already received from USFWS.



January 8, 2025

Our team has worked diligently to balance erosion mitigation with habitat preservation, and we believe the current design represents the most sustainable solution. Moving the outfall closer to the creek would increase environmental disturbance to both wetlands and federally listed species, would significantly delay the project, and would incur significant costs. We request your concurrence with our rationale for maintaining the current design, as we believe it offers the best approach to protecting wetlands, sensitive species and their habitats, and mitigating erosion concerns. Please let us know if additional information or discussion would be helpful.

Sincerely,

**Bristlecone Ecology, LLC**

**Daniel Maynard**

Ecologist



United States Department of the Interior

FISH AND WILDLIFE SERVICE  
Mountain-Prairie Region



IN REPLY REFER TO:

FWS/R6/

MAILING ADDRESS: STREET LOCATION:

Post Office Box 25486

1 Denver Federal Center

Denver Federal Center

Building 53, Room FW-192

Denver, Colorado 80225

Denver, Colorado 80225

ECOSphere: 2024-0150467

December 26, 2024

Daniel Maynard  
Owner/Ecologist  
Bristlecone Ecology, LLC  
2023 W. Scott Place  
Denver, CO 80211

Subject: Endangered Species Act section 7 consultation regarding Cottages at Kettle Creek property development at 2210 Old Ranch Road in Colorado Springs, Colorado

Dear Daniel Maynard:

Thank you for your communications requesting technical assistance from the U.S. Fish and Wildlife Service (Service) regarding the proposed Cottages at Kettle Creek development (project), located originally on approximately 11.1 acres at 2210 Old Ranch Road in Colorado Springs, El Paso County, Colorado. Discussions regarding the project were initiated between the Service and Mark Gilliland of Cornerstone Design Build, LTD and Highlander Development, LLC on November 12, 2020. At that stage, the project was proposed as a 6.0-acre residential parcel with 24 4-plex buildings and parking, and a 5.1-acre church parcel for a 250-300 seat church, an amphitheater, and a total parking capacity of 272 spaces, and attendant infrastructure and facilities.

Per your Request for Technical Assistance/Effects Determination Concurrence letter of September 26, 2024, the project has been redesigned as follows:

*"The Project will be constructed on approximately 11.88 acres in El Paso County Parcel No. 6228001007. The Project will consist of up to 174 cottage-style housing units, as well as other attendant features such as parking, stormwater detention facilities, utilities, open spaces, and trails. The Project is located just west of Kettle Creek, which has Designated Critical Habitat (DCH) for the federally threatened Preble's meadow jumping mouse (*Zapus hudsonius preblei* or Preble's mouse). A portion of the site (approximately 4.70 acres) is within Preble's DCH. Because the Project does not have a federal nexus, thus the Critical Habitat designation is not a factor; however, there is suitable habitat for Preble's along Kettle Creek that overlaps the site*

*which will be affected by site development. The site was previously assessed in 2021 and received concurrence from USFWS for a determination of “Unlikely to Affect” under TAILS number 06E24000-2021-TA-0170. The Project is under new ownership and has a modified site plan; therefore, B.E. [Bristlecone Ecology] is reinitiating consultation with USFWS with an updated effects determination request.”*

The redesigned project will now permanently affect 350 square feet of upland Preble’s mouse habitat. A stormwater detention pond will also be constructed at the southwest corner of the development to regulate the runoff flows from the newly created impervious surfaces. The detention pond will be sized per city standard practices and will provide for full spectrum detention. Stormwater outfall will be designed to meet the city's drainage criteria manual which includes not creating downstream erosion potential. The project will include an 18” pipe outfall and flared end section (FES, also 18”), along with a Type L riprap pad to dissipate flows coming through the pipe. The riprap pad will extend 6’ beyond the FES and will encompass it entirely; at the downstream end, the pad will be 6x the size of the pipe to allow the storm flows to dissipate before entering Kettle Creek. Because the outfall is set back from the creek, flows will make their way through the heavily vegetated floodplain, allowing further dissipation and reduction in velocities owing to the presence of woody vegetation. As you mentioned, the project site is located close to suitable habitat along Kettle Creek that may support the Preble's mouse, which is listed as threatened under the Endangered Species Act (ESA), as amended (16 U.S.C. 1531 *et seq.*). As determined by consultation with U.S. Army Corp of Engineers, there is no federal nexus to this project; thus, the critical habitat designation for Kettle Creek is not a factor in this consultation because critical habitat protections are limited to federal actions. The comments here are provided in accordance with the ESA. For any action not involving a federal agency, the project proponent must avoid any actions that would be likely to result in the take (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct) of listed fish or wildlife (ESA, Section 9). We appreciate the inclusion of an assessment of the proposed Project, and we interpret your request to be for technical assistance from the U.S. Fish and Wildlife Service (Service) regarding the likelihood of the described Project resulting in take of listed fish or wildlife.

The original evaluation from the Service expressed the primary concern regarding conservation of the Preble’s mouse as the direct actions in proximity to Kettle Creek and indirect consequences from stormwater discharges into Kettle Creek. Through your communications then, and recently via emails, the project has agreed to uphold additional conservation measures.

The proponent has committed to the following conservation measures to ensure that take of the Preble’s mouse is not reasonably certain to occur:

- The project will minimize impacts to Preble’s habitat by limiting disturbance to habitat within 300 ft of Kettle Creek, developing upland areas that generally are less frequently used by Preble’s mice based on distance from or elevation above Kettle Creek, and avoiding impacts to riparian vegetation and habitat that connects Preble’s mouse populations along Kettle Creek.

- Work is not proposed in riparian areas; therefore no riparian vegetation will be affected.
- Potential impacts to Preble's mice hibernation habitat would be minimized within the Ponderosa pine stand of Preble's mouse habitat to be impacted. Hand-clearing of vegetation will occur one-two weeks prior to any ground-disturbing activities, to reduce the availability of hibernacula within the area to be disturbed.
- To further avoid take, construction will occur during the late summer (before Preble's hibernation period) and any shrub vegetation within Preble's mouse upland habitat ( $\leq 300$  ft from creek) will be trimmed to less than 1 foot tall to deter mice from selecting the location for hibernation. Trimming will occur a week or two in advance of any ground-disturbing activities.
- To regulate the release of stormwaters, the detention pond's design will be certified to meet City of Colorado Springs Drainage Criteria Manual (Volume 2) stormwater management standards so that downstream impacts to the stream channel, banks, and riparian vegetation are minimized.
- Sediment will be captured at the full-spectrum detention pond at the other end of the property before being piped ~850 feet to the outfall discussed below, which will fully treat and dissipate flows by the time they hit Kettle Creek. This is important to ensure the habitat along Kettle Creek is not impacted by increased sedimentation and erosion from stormwater runoff caused by the project.

You indicated that implementing the conservation measures before, during, and after implementation of the project as described in the original correspondence from 2021, the email message of November 1, 2024, addressing reduction of outfall and stormwater flows, and previous communications will decrease the potential for injuring the Preble's mouse or its habitat. Thus, you concluded the project is not likely to result in "take" of a listed species (take is defined by the ESA as to harass, harm, pursue, hunt, shoot, wound kill, trap, capture, or collect or attempt to engage in any such conduct of a listed species).

As of the date of this letter, the Colorado Field Office concludes that the Project is not reasonably certain to result in the take of the Preble's meadow jumping mouse. The Service reached this conclusion through coordination and ongoing discussions with Goodwin Knight, LLC, including Goodwin Knight LLC's commitment, in writing to the USFWS, that the above conservation measures will be implemented.

This office is not authorized to provide guidance in regard to the Service's Office of Law Enforcement (OLE) investigative priorities involving federally listed species. However, we understand that OLE carries out its mission to protect listed species through investigation and enforcement, as well as by fostering relationships with individuals, companies, and industries that have taken effective steps to minimize the likelihood of take such that it is not reasonably certain

to occur. It is not possible to absolve individuals or companies from liability for unpermitted take of listed species, even if such take occurs despite the implementation of appropriate minimization strategies. However, the OLE focuses its enforcement resources on individuals and companies that take listed species without identifying and implementing all reasonable, prudent, and effective measures to minimize the likelihood of take such that it is not reasonably certain to occur. This office concludes that, if Goodwin Knight, LLC follows the measures above, the Cottages at Kettle Creek Development project is not reasonably certain to take ESA listed species.

Given the scope of the property development in Preble's mouse habitat and the conservation measures to which you have agreed, the Service concurs that the impacts resulting from the project next to Kettle Creek is unlikely to result in take of a listed species.

We appreciate your request for assistance and encourage you to contact us again if the scope of the project changes or new information indicates that the project may result in take of listed species. Please reference TAILS project code 06E24000-2021-TA-0170 when contacting our office about this letter. If we can be of any additional assistance, please contact Robert Schorr of the Colorado Field Office by telephone at 720.322.2430 or by email to [Robert\\_schorr@fws.gov](mailto:Robert_schorr@fws.gov).

Sincerely,

LAUREL HILL

Digitally signed by LAUREL  
HILL  
Date: 2024.12.26 10:26:17  
-07'00'

Laurel Hill  
Eastern Colorado Supervisor  
Colorado Ecological Services Field Office

CC:

David Morrison, Goodwin Knight  
Brandon Loveridge, Goodwin Knight  
Nicholas Jokerst, All Terrain Engineering

### 3.2.2 Low Tailwater Basin

The design of low tailwater riprap basins is necessary when the receiving channel may have little or no flow or tailwater at time when the pipe or culvert is in operation. Figure 9-37 provides a plan and profile view of a typical low tailwater riprap basin.

By providing a low tailwater basin at the end of a storm drain conduit or culvert, the kinetic energy of the discharge dissipates under controlled conditions without causing scour at the channel bottom.

Low tailwater is defined as being equal to or less than  $\frac{1}{3}$  of the height of the storm drain, that is:

$$y_t \leq \frac{D}{3} \quad \text{or} \quad y_t \leq \frac{H}{3}$$

Where:

$y_t$  = tailwater depth at design flow (feet)

$D$  = diameter of circular pipe (feet)

$H$  = height of rectangular pipe (feet)

#### Rock Size

The procedure for determining the required riprap size downstream of a conduit outlet is in Section 3.2.3.

After selecting the riprap size, the minimum thickness of the riprap layer,  $T$ , in feet, in the basin is defined as:

$$T = 2D_{50} \quad \text{Equation 9-15}$$

#### Basin Geometry

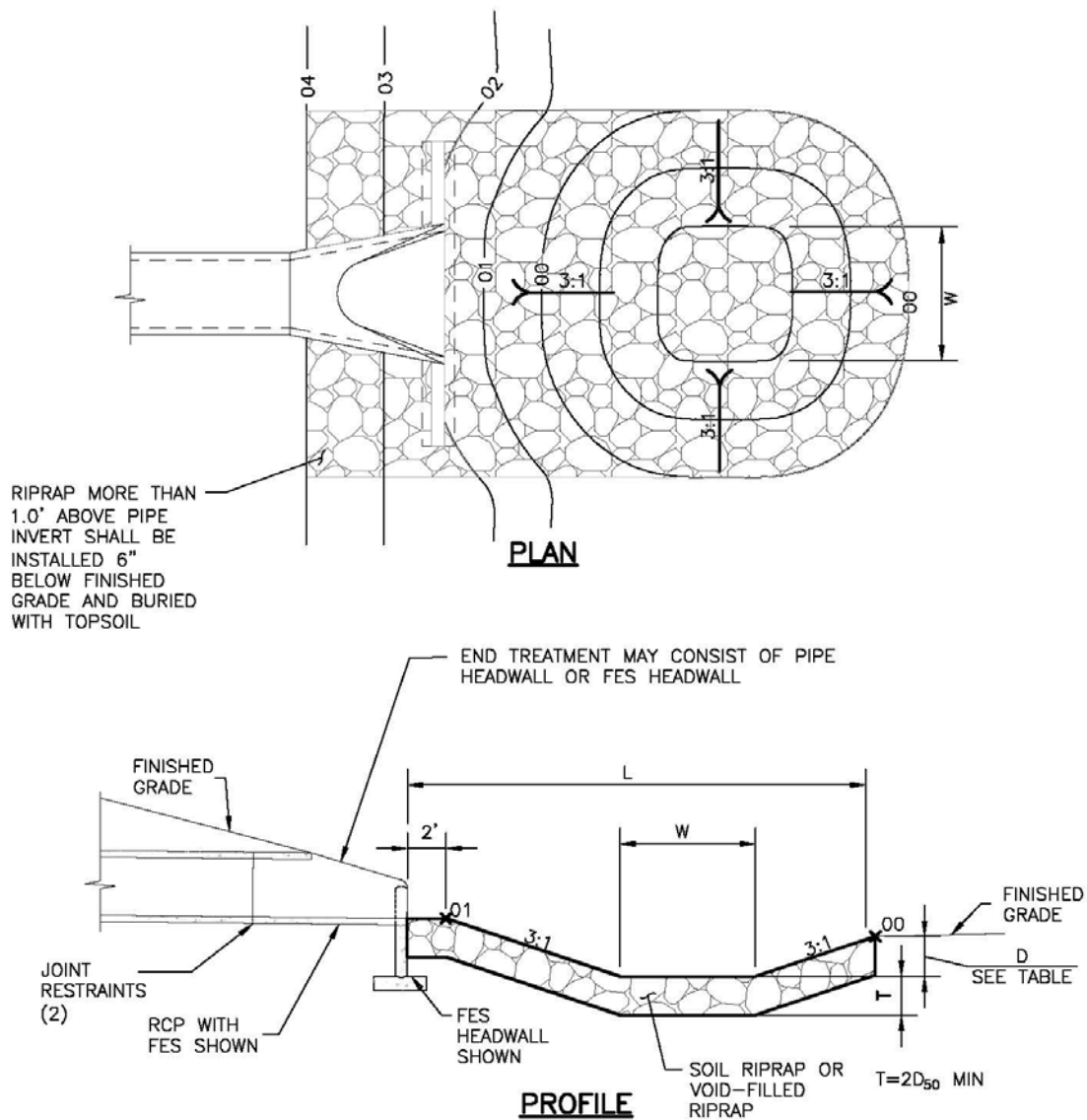
Figure 9-37 includes a layout of a standard low tailwater riprap basin with the geometry parameters provided. The minimum length of the basin ( $L$ ) and the width of the bottom of the basin ( $W1$ ) are provided in a table at the bottom of Figure 9-37. All slopes in the low tailwater basin shall be 3(H):1(V), minimum.

#### Other Design Requirements

Extend riprap up the outlet embankment slope to the mid-pipe level, minimum. It is recommended that riprap that extends more than 1 foot above the outlet pipe invert be installed 6 inches below finished grade and buried with topsoil.

Provide pipe end treatment in the form of a pipe headwall or a flared-end section headwall. See Section 3.1 for options.





PIPE SIZE OR BOX HEIGHT	D	W*	L
18" - 24"	1'-0"	4'	15'
30" - 36"	1'-6"	6'	20'
42" - 48"	2'-0"	7'	24'
54" - 60"	2'-6"	8'	28'
66" - 72"	3'-0"	9'	32'

\* IF OUTLET PIPE IS A BOX CULVERT WITH A WIDTH GREATER THAN W, THEN W = CULVERT WIDTH

**Figure 9-37. Low tailwater riprap basin**

### 3.2.3 Rock Sizing for Riprap Apron and Low Tailwater Basin

Scour resulting from highly turbulent, rapidly decelerating flow is a common problem at conduit outlets. The following section summarizes the method for sizing riprap protection for both riprap aprons (Section 3.2.1) and low tailwater basins (Section 3.2.2).

Use Figure 9-38 to determine the required rock size for circular conduits and Figure 9-39 for rectangular conduits. Figure 9-38 is valid for  $Q/D_c^{2.5}$  of 6.0 or less and Figure 9-39 is valid for  $Q/WH^{1.5}$  of 8.0 or less. The parameters in these two figures are:

1.  $Q/D^{1.5}$  or  $Q/WH^{0.5}$  in which  $Q$  is the design discharge in cfs,  $D_c$  is the diameter of a circular conduit in feet, and  $W$  and  $H$  are the width and height of a rectangular conduit in feet.
2.  $Y_t/D_c$  or  $Y_t/H$  in which  $Y_t$  is the tailwater depth in feet,  $D_c$  is the diameter of a circular conduit in feet, and  $H$  is the height of a rectangular conduit in feet. In cases where  $Y_t$  is unknown or a hydraulic jump is suspected downstream of the outlet, use  $Y_t/D_t = Y_t/H = 0.40$  when using Figures 9-38 and 9-39.
3. The riprap size requirements in Figures 9-38 and 9-39 are based on the non-dimensional parametric Equations 9-16 and 9-17 (Steven, Simons, and Watts 1971 and Smith 1975).

Circular culvert:

$$d_{50} = \frac{0.023Q}{Y_t^{1.2} D_c^{0.3}} \quad \text{Equation 9-16}$$

Rectangular culvert:

$$d_{50} = \frac{0.014H^{0.5}Q}{Y_t W} \quad \text{Equation 9-17}$$

These rock size requirements assume that the flow in the culvert is subcritical. It is possible to use Equations 9-16 and 9-17 when the flow in the culvert is supercritical (and less than full) if the value of  $D_c$  or  $H$  is modified for use in Figures 9-38 and 9-39. Note that rock sizes referenced in these figures are defined in the *Open Channels* chapter. Whenever the flow is supercritical in the culvert, substitute  $D_a$  for  $D_c$  and  $H_a$  for  $H$ , in which  $D_a$  is defined as:

$$D_a = \frac{(D_c + Y_n)}{2} \quad \text{Equation 9-18}$$

Where the maximum value of  $D_a$  shall not exceed  $D_c$ , and

$$H_a = \frac{(H + Y_n)}{2}$$

Equation 9-19

Where the maximum value of  $H_a$  shall not exceed  $H$ , and:

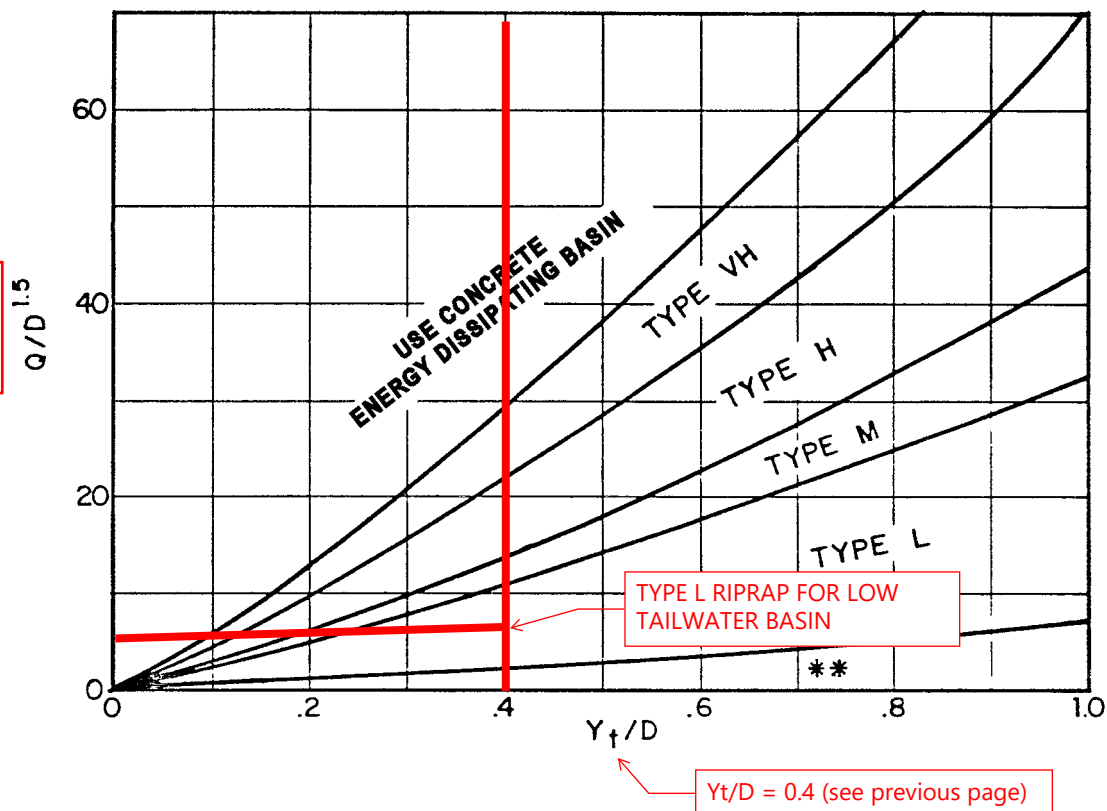
$D_a$  = parameter to use in place of  $D$  in Figure 9-38 when flow is supercritical (ft)

$D_c$  = diameter of circular culvert (ft)

$H_a$  = parameter to use in place of  $H$  in Figure 9-39 when flow is supercritical (ft)

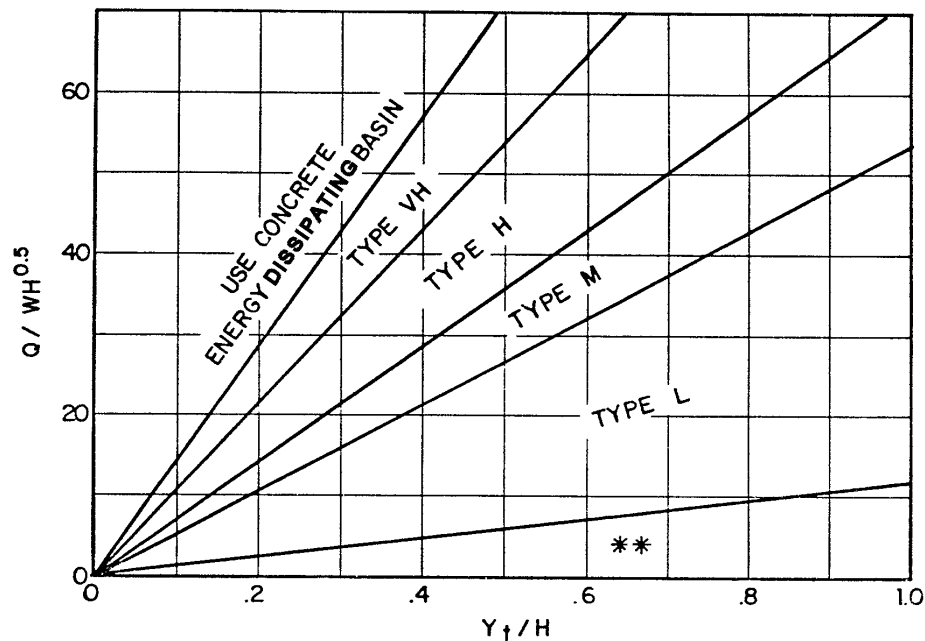
$H$  = height of rectangular culvert (ft)

$Y_n$  = normal depth of supercritical flow in the culvert (ft)



Use  $D_a$  instead of  $D$  whenever flow is supercritical in the barrel.  
 \*\* Use Type L for a distance of  $3D$  downstream.

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for  $Q/D^{2.5} \leq 6.0$ )



Use  $H_a$  instead of  $H$  whenever culvert has supercritical flow in the barrel.  
 \*\*Use Type L for a distance of  $3H$  downstream.

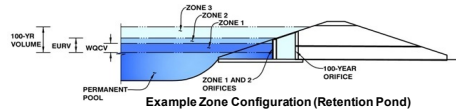
**Figure 9-39. Riprap erosion protection at rectangular conduit outlet (valid for  $Q/WH^{1.5} \leq 8.0$ )**

### 3.2.4 Outfalls and Rundowns

A grouted boulder outfall or “rundown” dissipates energy and provides erosion control protection. Grouted boulder outfalls are most commonly used in large rivers like the South Platte. Figure 9-40 provides a plan view and cross section for a standard grouted boulder rundown. See the grouted boulder drop profiles (A1, A2, and A3) in Figure 9-12 for site specific profile options, (i.e., depressed or free-draining basin for use with a stable downstream channel or with no basin for use in channels subject to degradation). Figure 9-41 provides a plan view of the same structure for use when the structure is in-line with the channel. Evaluate the following when designing a grouted boulder outfall or rundown:

- Minimize disturbance to channel bank
- Determine water surface elevation in receiving channel for base flow and design storm(s)
- Determine flow rate, velocity, depth, etc. of flow exiting the outfall pipe for the design storm(s)
- Evaluate permitting procedures and requirements for construction adjacent to large river system.

MHFD-Detention, Version 4.06 (July 2022)

Basin ID: POND 1

### Example Zone Configuration (Retention Pond)

Selected BMP Type =	<b>EDB</b>	
Watershed Area =	6.84	acres
Watershed Length =	935	ft
Watershed Length to Centroid =	387	ft
Watershed Slope =	0.023	ft/ft
Watershed Imperviousness =	62.70%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Group C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths = User Input		

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

Water Quality Capture Volume (WQCV) =	0.140	acre-feet
Excess Urban Runoff Volume (EURV) =	0.527	acre-feet
2-yr Runoff Volume ( $P1 = 0.91$ in.) =	0.282	acre-feet
5-yr Runoff Volume ( $P1 = 1.19$ in.) =	0.377	acre-feet
10-yr Runoff Volume ( $P1 = 1.45$ in.) =	0.475	acre-feet
25-yr Runoff Volume ( $P1 = 1.84$ in.) =	0.640	acre-feet
50-yr Runoff Volume ( $P1 = 2.17$ in.) =	0.803	acre-feet
100-yr Runoff Volume ( $P1 = 2.52$ in.) =	0.995	acre-feet
500-yr Runoff Volume ( $P1 = 3.45$ in.) =	1.501	acre-feet
Approximate 2-yr Detention Volume =	0.262	acre-feet
Approximate 5-yr Detention Volume =	0.355	acre-feet
Approximate 10-yr Detention Volume =	0.448	acre-feet
Approximate 25-yr Detention Volume =	0.600	acre-feet
Approximate 50-yr Detention Volume =	0.694	acre-feet
Approximate 100-yr Detention Volume =	0.792	acre-feet

Zone 1 Volume (WQCV) =	0.140	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.387	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.265	acre-feet
Total Detention Basin Volume =	0.792	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 ( $H_{FLOOR}$ )	=	user	ft
Length of Basin Floor ( $L_{FLOOR}$ )	=	user	ft
Width of Basin Floor ( $W_{FLOOR}$ )	=	user	ft
Area of Basin Floor ( $A_{FLOOR}$ )	=	user	ft <sup>2</sup>
Volume of Basin Floor ( $V_{FLOOR}$ )	=	user	ft <sup>3</sup>
Depth of Main Basin ( $H_{MAIN}$ )	=	user	ft
Length of Main Basin ( $L_{MAIN}$ )	=	user	ft
Width of Main Basin ( $W_{MAIN}$ )	=	user	ft
Area of Main Basin ( $A_{MAIN}$ )	=	user	ft <sup>2</sup>
Volume of Main Basin ( $V_{MAIN}$ )	=	user	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TOTAL}$ )	=	user	acre-feet

Depth Increment =	
-------------------	--

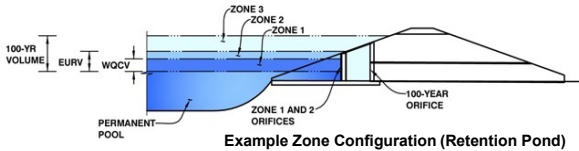
CottagesPond\_v4-06.xlsm, Basin

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: COTTAGES AT KETTLE CREEK

Basin ID: POND 1



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.16	0.140	Orifice Plate
Zone 2 (EURV)	6.12	0.387	Rectangular Orifice
Zone 3 (100-year)	7.49	0.265	Weir&Pipe (Restrict)
Total (all zones)		0.792	

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)

Calculated Parameters for Plate

Centroid of Lowest Orifice = 0.00 ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate = 3.16 ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing = 12.60 inches  
Orifice Plate: Orifice Area per Row = 0.54 sq. inches (diameter = 13/16 inch)

WQ Orifice Area per Row = 3.750E-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	1.05	2.11					
Orifice Area (sq. inches)	0.54	0.54	0.54					

	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)

Calculated Parameters for Vertical Orifice

Zone 2 Rectangular Not Selected  
Invert of Vertical Orifice = 3.16 N/A ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice = 6.12 N/A ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Height = 2.00 N/A inches  
Vertical Orifice Width = 0.44 inches

Vertical Orifice Area = 0.01 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)

Calculated Parameters for Overflow Weir

Zone 3 Weir Not Selected  
Overflow Weir Front Edge Height, H<sub>o</sub> = 6.60 N/A ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length = 2.00 N/A feet  
Overflow Weir Gate Slope = 0.00 N/A H:V  
Horiz. Length of Weir Sides = 2.00 N/A feet  
Overflow Gate Type = Type C Gate  
Debris Clogging % = 50% N/A %

Height of Gate Upper Edge, H<sub>g</sub> = 6.60 N/A feet  
Overflow Weir Slope Length = 2.00 N/A feet  
Gate Open Area / 100-yr Orifice Area = 10.93 N/A  
Overflow Gate Open Area w/o Debris = 2.78 N/A ft<sup>2</sup>  
Overflow Gate Open Area w/ Debris = 1.39 N/A ft<sup>2</sup>

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

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

Zone 3 Restrictor Not Selected  
Depth to Invert of Outlet Pipe = 2.50 N/A ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter = 24.00 N/A inches  
Restrictor Plate Height Above Pipe Invert = 3.25 inches

Outlet Orifice Area = 0.25 N/A ft<sup>2</sup>  
Outlet Orifice Centroid = 0.16 N/A feet  
Half-Central Angle of Restrictor Plate on Pipe = 0.75 N/A radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Calculated Parameters for Spillway

Spillway Invert Stage = 7.30 ft (relative to basin bottom at Stage = 0 ft)  
Spillway Crest Length = 6.00 feet  
Spillway End Slopes = 4.00 H:V  
Freeboard above Max Water Surface = 1.00 feet

Spillway Design Flow Depth = 0.77 feet  
Stage at Top of Freeboard = 9.07 feet  
Basin Area at Top of Freeboard = 0.27 acres  
Basin Volume at Top of Freeboard = 1.17 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).

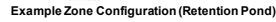
	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.91	1.19	1.45	1.84	2.17	2.52	3.45
One-Hour Rainfall Depth (in) =	N/A	N/A	0.282	0.377	0.475	0.640	0.803	0.995	1.501
CUHP Runoff Volume (acre-ft) =	N/A	N/A	0.282	0.377	0.475	0.640	0.803	0.995	1.501
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.0	0.0	0.1	0.5	2.0	4.0	8.9
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.0	0.1	0.5	2.0	4.0	8.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.0	0.1	0.5	2.0	4.0	8.9
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.01	0.07	0.30	0.58	1.30
Peak Inflow Q (cfs) =	N/A	N/A	4.4	5.8	7.2	10.4	13.4	17.2	26.0
Peak Outflow Q (cfs) =	0.1	0.2	0.1	0.1	0.2	0.2	2.0	3.8	12.9
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	3.5	2.0	0.4	1.0	1.0	1.5
Structure Controlling Flow =	Plate	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Gate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	0.6	1.3	1.3
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	65	51	57	63	72	71	69	64
Time to Drain 99% of Inflow Volume (hours) =	40	72	55	63	69	79	79	78	75
Maximum Ponding Depth (ft) =	3.16	6.12	4.30	5.00	5.64	6.58	6.87	7.28	7.83
Area at Maximum Ponding Depth (acres) =	0.09	0.17	0.12	0.14	0.16	0.19	0.19	0.21	0.23
Maximum Volume Stored (acre-ft) =	0.140	0.528	0.262	0.354	0.449	0.611	0.664	0.746	0.867

COTTAGES AT KETTLE CREEK  
Q100 TO PROPOSED  
OUTFALL

TOTAL FLOW = 3.8 + 8.2 CFS  
= 12.0 CFS

MHFD-Detention, Version 4.06 (July 2022)

**Basin ID: PRELIM POND SIZING**



THIS POND REPRESENTS A FUTURE PROJECT THAT WILL EVENTUALLY UTILIZE THE SAME PROPOSED OUTFALL. SEE NEXT SHEET FOR 100-YEAR DISCHARGE RATE.

	acre-feet
	acre-feet
0.91	inches
1.19	inches
1.45	inches
1.84	inches
2.17	inches
2.52	inches
3.45	inches

Optional Override Area (ft <sup>2</sup> )	Area (acre)	Volume (ft <sup>3</sup> )	Volume (ac-ft)
0	0.000		
2,560	0.059	1,280	0.029
6,167	0.142	5,643	0.130

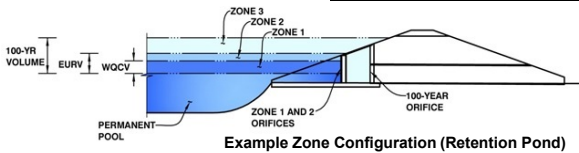
[illegible]

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: **CHALLENGER PROJECT**

Basin ID: **PRELIM POND SIZING**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.47	0.370	Orifice Plate
Zone 2 (EURV)	7.55	1.039	Circular Orifice
Zone 3 (100-year)	9.44	0.690	Weir&Pipe (Restrict)
Total (all zones)		2.099	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV 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 WQCV 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  
WQ 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	1.16	2.31					
Orifice Area (sq. inches)	1.45	1.40	1.40					

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

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Circular	Not Selected	
Invert of Vertical Orifice =	3.47	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	7.55	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	1.39	N/A	inches

Calculated Parameters for Vertical Orifice  
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	Not Selected	
Overflow Weir Front Edge Height, H <sub>o</sub> =	7.55	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Gate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Gate Type =	Type C Gate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir  
Height of Gate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate 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)

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	5.90		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 =	9.20	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	14.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway  
Spillway Design Flow Depth =  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).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.91	1.19	1.45	1.84	2.17	2.52	3.45
One-Hour Rainfall Depth (in) =	N/A	N/A	0.91	1.19	1.45	1.84	2.17	2.52	3.45
CUHP Runoff Volume (acre-ft) =	0.370	1.408	0.769	1.029	1.297	1.741	2.172	2.680	4.014
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.769	1.029	1.297	1.741	2.172	2.680	4.014
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.1	0.2	1.1	4.6	9.0	20.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.01	0.06	0.26	0.52	1.18
Peak Inflow Q (cfs) =	N/A	N/A	11.4	14.9	18.6	26.6	34.2	43.3	65.2
Peak Outflow Q (cfs) =	0.2	0.5	0.3	0.4	0.4	3.4	7.8	8.2	34.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.2	2.4	3.2	1.7	0.9	1.7
Structure Controlling Flow =	Vertical Orifice 1	Overflow Weir 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Gate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.5	1.2	1.2	1.3
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	65	52	58	63	67	65	63	58
Time to Drain 99% of Inflow Volume (hours) =	40	72	56	63	70	75	73	72	69
Maximum Ponding Depth (ft) =	3.47	7.55	5.09	6.07	6.97	7.83	8.20	9.14	9.86
Area at Maximum Ponding Depth (acres) =	0.19	0.33	0.24	0.27	0.31	0.34	0.35	0.39	0.42
Maximum Volume Stored (acre-ft) =	0.370	1.409	0.714	0.965	1.222	1.502	1.630	1.982	2.271

CHALLENGER SITE Q100 TO PROPOSED OUTFALL

TOTAL FLOW = 3.8 + 8.2 CFS  
= 12.0 CFS



## CHAPTER 7

### 4 STEP PROCESS AND DETENTION PRINCIPLES

#### Contents

<b>1.0</b>	<b>DEFINITIONS</b>	<b>1</b>
<b>2.0</b>	<b>4 STEP PROCESS AND DETENTION TRIGGERS</b>	<b>2</b>
2.1	DISTURBANCE AREA	2
2.1.1	Utility Installation and Maintenance	2
2.1.2	Areas to Remain Pervious	3
2.1.3	Channel Stabilization	3
2.1.4	Trails	3
2.1.5	Stormwater Facilities	3
2.2	4 STEP PROCESS	3
2.2.1	Larger Common Plan	3
2.3	DETENTION	4
2.3.1	New Development	4
2.3.2	Redevelopment	4
2.3.3	Site Expansion	5
<b>3.0</b>	<b>PERMANENT CONTROL MEASURE PRINCIPLES</b>	<b>6</b>
3.1.1	PCM Consolidation	6
3.1.2	PCM Location	6
3.1.3	PCM Maintenance	6
3.1.4	DBPSs and Land Use Plans	7
3.1.5	PCM Timing	7
3.1.6	PCMs and the Development Process	7
3.1.7	Underground PCMs	7

**State Waters (Waters of the State):** Any and all surface waters and subsurface waters which are contained in or flow in or through this state, but does not include waters in sewage systems, waters in treatment works for disposal systems, waters in potable water distribution systems, and all water withdrawn for use until use and treatment have been completed. This definition can include water courses that are usually dry. State waters are also known as waters of the state. For the purposes of the City MS4 Permit, State Waters does not include subsurface waters.

**Temporary WQSV Facility:** A temporary control measure designed to treat the WQSV for an interim condition.

**Water Quality Capture Volume (WQCV):** A volume of water generated by the 80<sup>th</sup> percentile runoff event, in watershed inches. In the Colorado Springs area this volume is 0.6 inches.

**Water Quality Storage Volume (WQSV):** A volume of water, in acre-feet, calculated as the runoff occurring from the water quality storm event for a specific area. This is a quantity of water used for the design of certain water quality measures.

## 2.0 4 STEP PROCESS AND DETENTION TRIGGERS

### 2.1 Disturbance Area

The disturbance area for a project is the total disturbance area, less any applicable exclusions. The total disturbance area includes public improvements required on behalf of a development.

Some areas can be excluded from disturbance area calculations. The following exclusions may be used to reduce or eliminate the amount of disturbance area associated with a project for the purposes of applying the 4 Step Process and detention requirements.

The exclusions in this section are not applicable to disturbance area calculations associated with grading and erosion control requirements.

Claiming one or more of the exclusions in this section is optional. It is up to the site engineer to determine whether claiming exclusions would benefit the development site.

#### **2.1.1 Utility Installation and Maintenance**

All utility installation and maintenance that does not permanently alter the terrain, ground cover, or drainage patterns from those present prior to the project may be excluded. Utility tie-ins extending beyond the project site are also included in this exclusion.

### **2.1.2 Areas to Remain Pervious**

Areas that will remain pervious without underdrains after development are included in this exclusion.

### **2.1.3 Channel Stabilization**

Channel stabilization projects, where channel stabilization is the main purpose of the project, are included in this exclusion.

Any portion of a trail or public infrastructure project (e.g., access roads, drop structures, bank stabilization, spillways), occurring within the proposed top of bank limits of a named channel is included in this exclusion.

### **2.1.4 Trails**

Trails shown as Urban Trails in the Parks, Recreation, and Cultural Services Park System Master Plan are included in this exclusion. Additionally, trails constructed by the City are included in this exclusion.

### **2.1.5 Stormwater Facilities**

Stormwater facilities constructed by the City, including unpaved maintenance roads, are included in this exclusion.

## **2.2 4 Step Process**

All sites with 1 acre or more of disturbance, including projects with less than 1 acre of disturbance that are part of a larger common plan of development, must comply with the 4 Step Process.

Redevelopment sites that disturb less than 1 acre and are not part of a larger common plan must comply with the conditions of any existing previously approved drainage reports related to the 4 Step Process.

### **2.2.1 Larger Common Plan**

Generally, sites are considered to be part of a larger common plan of development if the site area is included in a Land Use Plan, Concept Plan, Development Plan, Master Development Drainage Plan, Preliminary Drainage Report, or Final Drainage Report approved after November 1, 2002, that includes an area associated with 1 or more acres of disturbance.

Redevelopment sites impacting an area within an existing development that were not contemplated during the design of the original development are generally not considered to be a larger common plan. For example, a portion of a parking lot redeveloped to be a building is not considered to be a larger common plan because the building was not contemplated during the design of the original development.



STORMWATER  
ENTERPRISE

---

## POLICY STATEMENT

---

**SUBJECT:** 4 STEP PROCESS EXCLUSIONS

**DATE:** MAY 31, 2023

**OVERVIEW:**

New requirements surrounding the 4 Step Process must be added to the City of Colorado Springs' stormwater criteria to maintain compliance with the City's MS4 Permit.

**DETAILS:**

On May 31<sup>st</sup>, 2023, the Colorado Department of Public Health & Environment issued Modification #1 to the City of Colorado Springs MS4 Permit. To comply with the requirements of the new permit, the following is incorporated into City stormwater criteria.

**POLICY:**

All projects that disturb one acre or more, including projects less than one acre that are part of a larger common plan of development or sale, must comply with the Four Step Process.

The following areas are excluded from this requirement. These exclusions must be clearly documented in the applicable drainage report.

- All utility installation and maintenance that does not permanently alter the terrain, ground cover, or drainage patterns from those present prior to the project. Utility tie-ins extending beyond the project site are excluded.
- Staging areas that do not permanently alter the terrain, ground cover, or drainage patterns from those present prior to the project.
- Stream stabilization projects
- Trails shown on the Parks and Recreation Urban Trails layer in SpringsView (not including bike lanes for roadways or sidewalks)
- Stormwater facilities, including maintenance roads

Excluded areas are not counted toward the one acre of disturbance. Unless covered under an exclusion above, runoff from all disturbed areas must be treated under the 4 Step Process.

Engineers may choose to not treat up to 5 percent, not to exceed 1 acre, of the applicable disturbance area if they show that it is not practicable to capture runoff from portions of the site that will not drain towards permanent control measures. Not treated areas must be clearly documented in the applicable drainage report.



## **APPENDIX F – DRAINAGE MAPS**

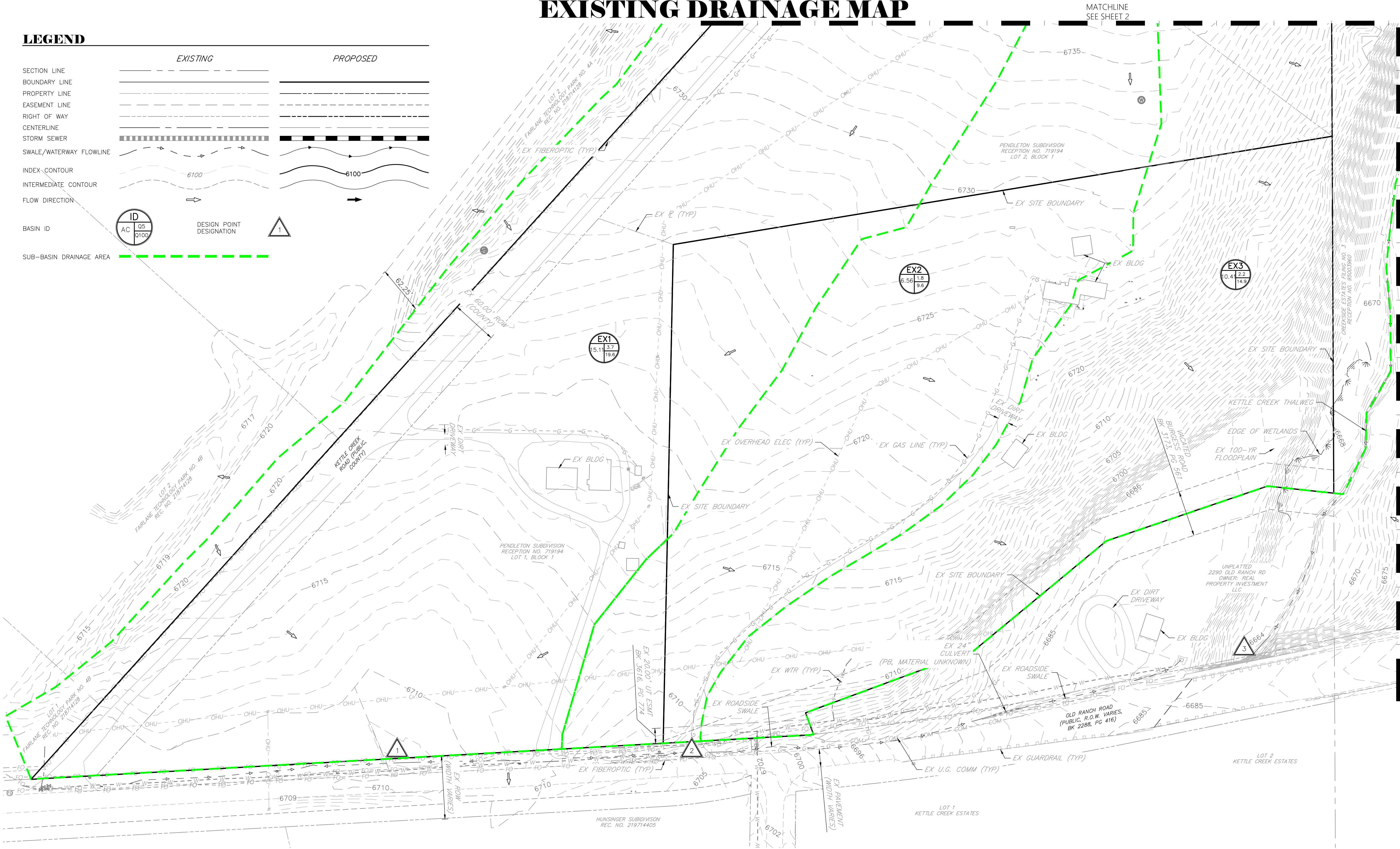


# COTTAGES AT KETTLE CREEK

## EXISTING DRAINAGE MAP

### LEGEND

	EXISTING	PROPOSED
SECTION LINE	---	---
BOUNDARY LINE	---	---
PROPERTY LINE	---	---
EASEMENT LINE	---	---
RIGHT OF WAY	---	---
CENTERLINE	---	---
STORM SEWER	---	---
SWALE/WATERWAY FLOWLINE	---	---
INDEX CONTOUR	---	---
INTERMEDIATE CONTOUR	---	---
FLOW DIRECTION	---	---
BASIN ID	---	---
SUB-BASIN DRAINAGE AREA	---	---



EX DRAINAGE CALCS - BASIN SUMMARY TABLE							
Tributary Sub-basin	Area (acres)	Percent Impervious	C <sub>s</sub>	C <sub>100</sub>	t <sub>c</sub> (min)	Q <sub>s</sub> (cfs)	Q <sub>100</sub> (cfs)
EX1	15.11	7%	0.09	0.36	40.5	3.7	19.6
EX2	6.56	6%	0.09	0.36	34.3	1.8	9.6
EX3	10.41	2%	0.09	0.36	32.3	2.2	14.9

DESIGN POINT SUMMARY TABLE		
DP#	Q <sub>s</sub> -YR	Q <sub>100</sub> -YR
1	3.7	19.6
2	1.8	9.6
3	3.9	23.9

EX DRAINAGE MAP

COTTAGES AT KETTLE CREEK

JOB NO. 24026

LOCATION: CS

09/30/2024

SHEET

1

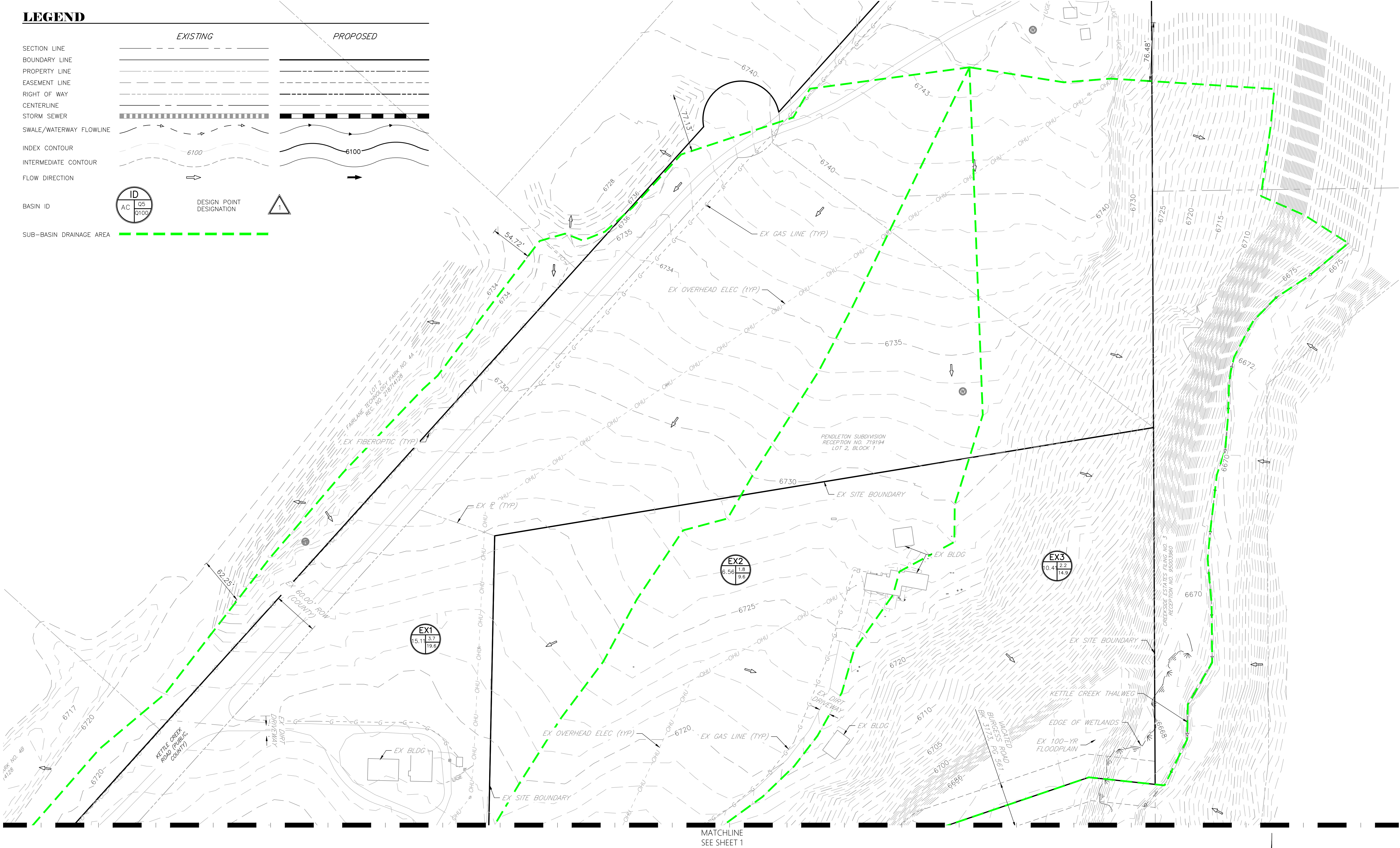


# COTTAGES AT KETTLE CREEK

## EXISTING DRAINAGE MAP

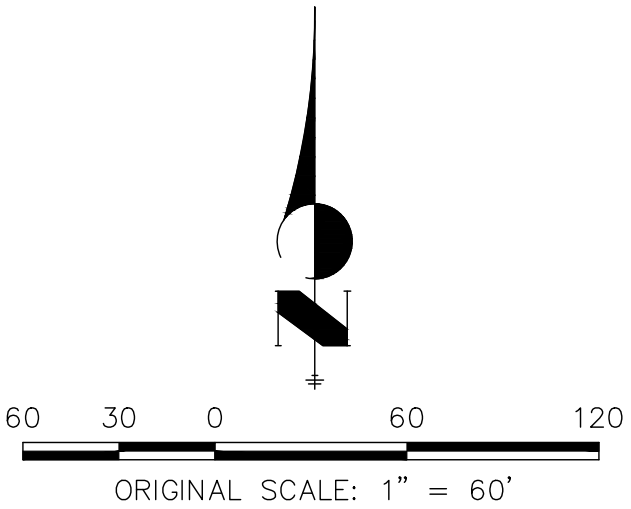
### LEGEND

	EXISTING	PROPOSED
SECTION LINE		
BOUNDARY LINE		
PROPERTY LINE		
EASEMENT LINE		
RIGHT OF WAY		
CENTERLINE		
STORM SEWER		
SWALE/WATERWAY FLOWLINE		
INDEX CONTOUR		
INTERMEDIATE CONTOUR		
FLOW DIRECTION		
BASIN ID		
SUB-BASIN DRAINAGE AREA		



EX DRAINAGE CALCS - BASIN SUMMARY TABLE							
Tributary Sub-basin	Area (acres)	Percent Impervious	C <sub>s</sub>	C <sub>100</sub>	t <sub>c</sub> (min)	Q <sub>s</sub> (cfs)	Q <sub>100</sub> (cfs)
EX1	15.11	7%	0.09	0.36	40.5	3.7	19.6
EX2	6.56	6%	0.09	0.36	34.3	1.8	9.6
EX3	10.41	2%	0.09	0.36	32.3	2.2	14.9

DESIGN POINT SUMMARY TABLE		
DP#	Q <sub>s</sub> -YR	Q <sub>100</sub> -YR
1	3.7	19.6
2	1.8	9.6
3	3.9	23.9



EX DRAINAGE MAP

COTTAGES AT KETTLE CREEK

JOB NO. 24026

LOCATION: CS

09/30/2024

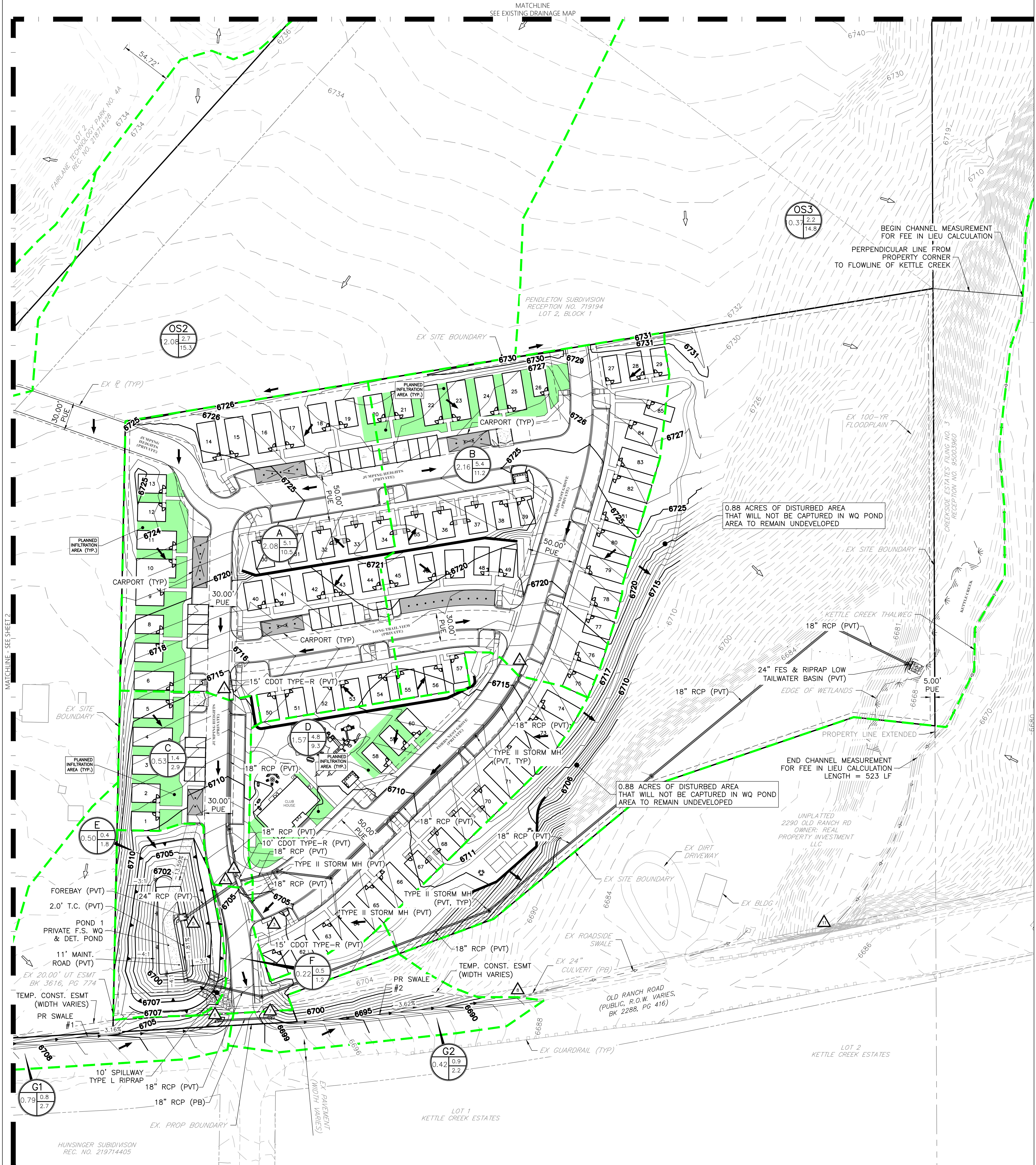
SHEET 2

ALL TERRAIN ENGINEERING

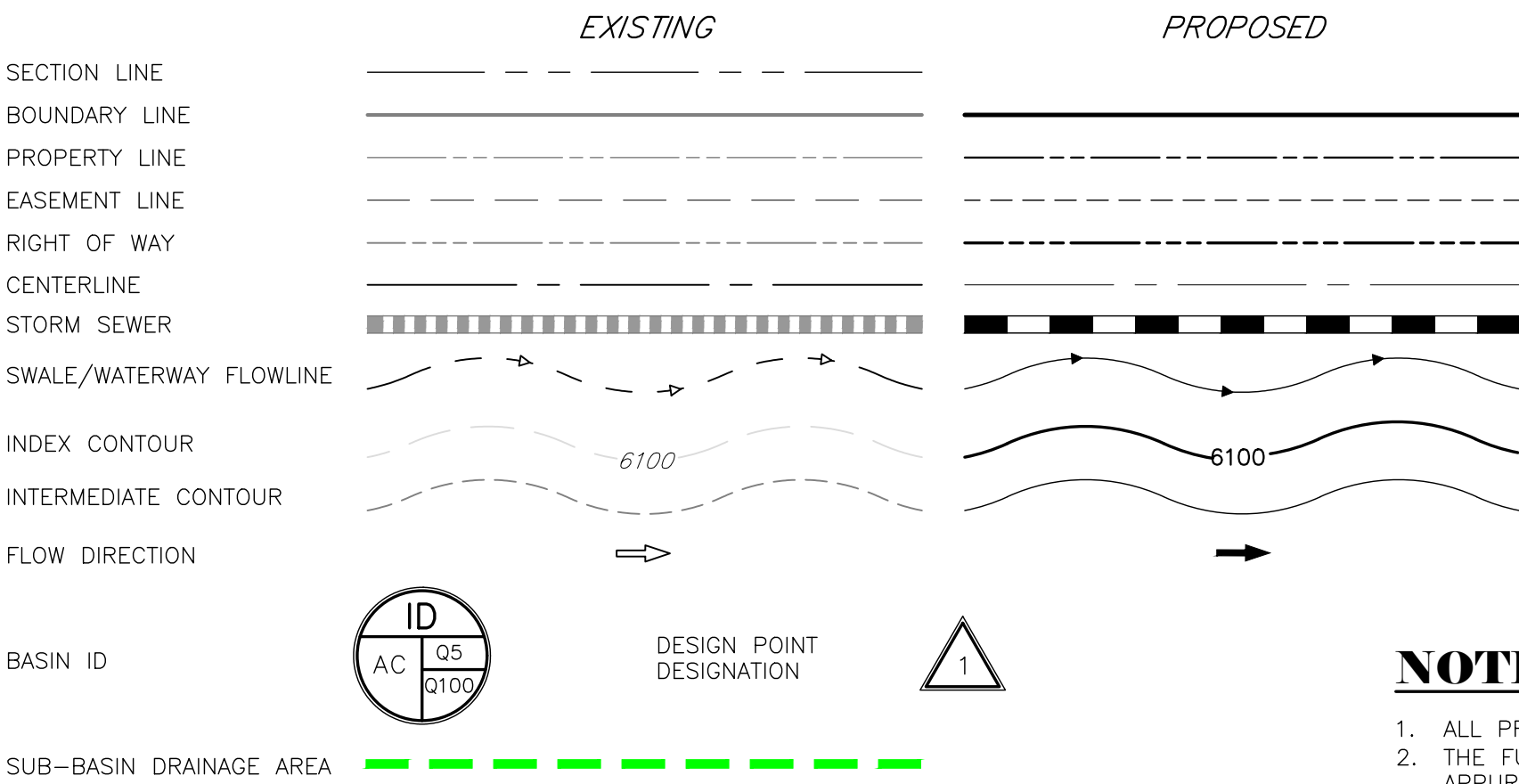


# COTTAGES AT KETTLE CREEK

## PROPOSED DRAINAGE MAP



### LEGEND



### NOTES

- ALL PROPOSED STORM SEWER IS PRIVATE, UNLESS OTHERWISE NOTED.
- THE FULL SPECTRUM (F.S.) WATER QUALITY AND DETENTION POND AND ITS APPURTENANCES ARE ALL PRIVATE.
- NON-STORMWATER, EXISTING UTILITIES ARE NOT SHOWN, SEE EXISTING DRAINAGE MAP FOR REFERENCE.
- SEE EXISTING DRAINAGE MAP FOR NORTHERN LIMITS OF BASIN OS1 AND OS2. THERE ARE NO IMPROVEMENTS OR CHANGES TO DRAINAGE BEYOND THE LIMITS OF THIS DRAINAGE MAP.

### PROPOSED CALCS - BASIN SUMMARY TABLE

Tributary Sub-basin	Area (acres)	Percent Impervious	C <sub>s</sub>	C <sub>100</sub>	t <sub>c</sub> (min)	Q <sub>s</sub> (cfs)	Q <sub>100</sub> (cfs)
A	2.08	64%	0.58	0.72	17.5	5.1	10.5
B	2.16	63%	0.57	0.71	18.5	5.0	10.5
C	0.53	65%	0.60	0.73	15.9	1.4	2.9
D	1.57	76%	0.69	0.80	15.4	4.8	9.3
E	0.50	12%	0.17	0.42	25.9	0.4	1.8
F	0.22	47%	0.46	0.63	19.7	0.5	1.2
G1	0.79	21%	0.25	0.47	25.1	0.8	2.7
G2	0.42	44%	0.43	0.61	18.9	0.9	2.2
G3	0.14	57%	0.53	0.68	17.7	0.3	0.7
OS1	1.99	14%	0.17	0.41	35.5	1.1	4.6
OS2	12.08	5%	0.11	0.38	40.9	2.7	15.3
OS3	10.37	2%	0.09	0.36	17.5	2.2	14.8

### DESIGN POINT SUMMARY TABLE

DP#	Q <sub>s</sub> -YR	Q <sub>100</sub> -YR
1	5.1	10.5
2	5.0	10.5
3	4.8	8.9
4	1.4	3.9
4.1	10.4	28.8
5	10.7	30.0
6	0.8	2.7
7	1.3	3.7
8	1.9	5.2
9	2.9	15.6
10	1.1	4.6
11	2.2	14.8

### PROPOSED DRAINAGE MAP

COTTAGES AT KETTLE CREEK

JOB NO. 24026

LOCATION: CS

03/21/2025

SHEET

1

ALL TERRAIN  
ENGINEERING

50 25 0 50 100  
ORIGINAL SCALE: 1" = 50'

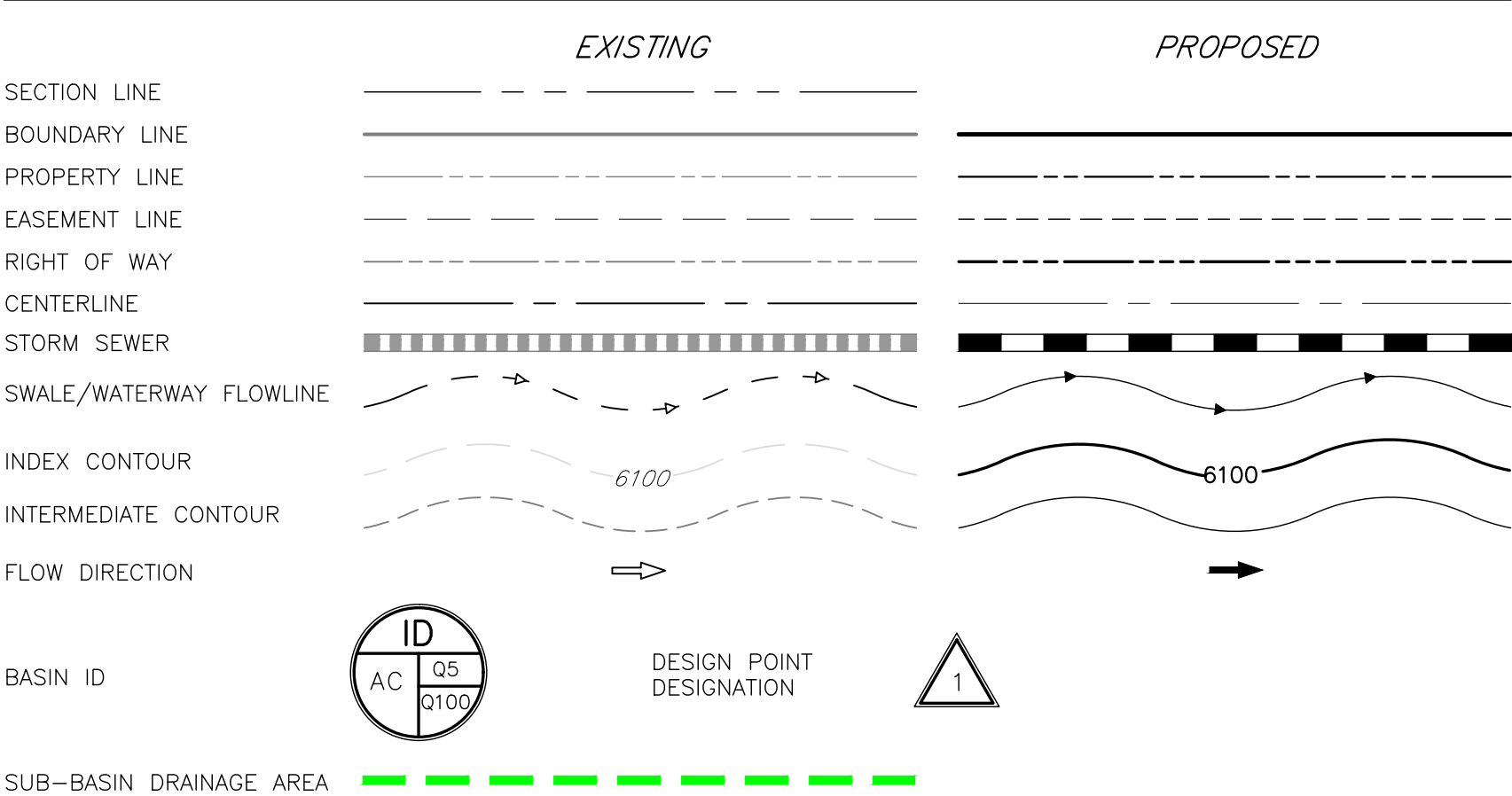


# COTTAGES AT KETTLE CREEK

## PROPOSED DRAINAGE MAP



### LEGEND

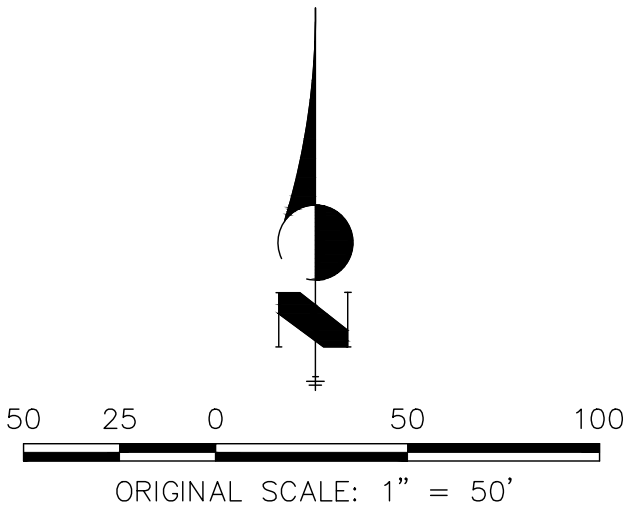


PROPOSED CALCS - BASIN SUMMARY TABLE							
Tributary Sub-basin	Area (acres)	Percent Impervious	C <sub>s</sub>	C <sub>100</sub>	t <sub>c</sub> (min)	Q <sub>s</sub> (cfs)	Q <sub>100</sub> (cfs)
A	2.08	64%	0.58	0.72	17.5	5.1	10.5
B	2.16	63%	0.57	0.71	18.5	5.0	10.5
C	0.53	65%	0.60	0.73	15.9	1.4	2.9
D	1.57	76%	0.69	0.80	15.4	4.8	9.3
E	0.50	12%	0.17	0.42	25.9	0.4	1.8
F	0.22	47%	0.46	0.63	19.7	0.5	1.2
G1	0.79	21%	0.25	0.47	25.1	0.8	2.7
G2	0.42	44%	0.43	0.61	18.9	0.9	2.2
G3	0.14	57%	0.53	0.68	17.7	0.3	0.7
OS1	1.99	14%	0.17	0.41	35.5	1.1	4.6
OS2	12.08	5%	0.11	0.38	40.9	2.7	15.3
OS3	10.37	2%	0.09	0.36	17.5	2.2	14.8

DESIGN POINT SUMMARY TABLE		
DP#	Q <sub>5-YR</sub>	Q <sub>100-YR</sub>
1	5.1	10.5
2	5.0	10.5
3	4.8	8.9
4	1.4	3.9
4.1	10.4	28.8
5	10.7	30.0
6	0.8	2.7
7	1.3	3.7
8	1.9	5.2
9	2.9	15.6
10	1.1	4.6
11	2.2	14.8

### NOTES

- ALL PROPOSED STORM SEWER IS PRIVATE, UNLESS OTHERWISE NOTED.
- THE FULL SPECTRUM (F.S.) WATER QUALITY AND DETENTION POND AND ITS APPURTENANCES ARE ALL PRIVATE.
- NON-STORMWATER, EXISTING UTILITIES ARE NOT SHOWN, SEE EXISTING DRAINAGE MAP FOR REFERENCE.
- SEE EXISTING DRAINAGE MAP FOR NORTHERN LIMITS OF BASIN OS1 AND OS2. THERE ARE NO IMPROVEMENTS OR CHANGES TO DRAINAGE BEYOND THE LIMITS OF THIS DRAINAGE MAP.



PROPOSED DRAINAGE MAP

COTTAGES AT KETTLE CREEK

JOB NO. 24026

LOCATION: CS

03/21/2025

SHEET 2

ALL TERRAIN ENGINEERING



# COTTAGES AT KETTLE CREEK

## RUNOFF REDUCTION MAP










# COTTAGES AT KETTLE CREEK

## WQ EXCLUSION MAP

### LEGEND:

- TOTAL DISTURBED AREA 
- APPLICABLE DISTURBED AREA RECEIVING PCM TREATMENT 
- APPLICABLE DISTURBANCE AREA NOT RECEIVING PCM TREATMENT (AREA MUST BE LESS THAN 1 ACRE & LESS THAN 5% OF ADA) 
- DISTURBED AREA - EXCLUDED FROM PCM PER 4-STEP PROCESS ALLOWABLE EXCLUSIONS 
- DRAINAGE BASIN LIMITS 

### APPLICABLE DISTURBANCE AREA (ADA) SUMMARY:

9 TOTAL DISTURBED AREA (TDA) = 9.31 AC  
TOTAL EXCLUSION AREA (TEA) = 0.87 + 0.70 + 0.04 + 0.12 + 0.14 + 0.11 + 0.16 = 2.14 AC  
APPLICABLE DISTURBANCE AREA (ADA) = TDA - TEA = 9.31 AC - 2.14 AC = 7.17 AC  
8 ADA RECEIVING PCM TREATMENT = 7.17 - 0.02 - 0.08 - 0.21 - 0.09 - 0.02 = 6.84 AC  
7 ADA NOT RECEIVING PCM TREATMENT = 0.02 + 0.08 + 0.12 + 0.09 + 0.02 = 0.33 AC ~ 4.8% OF ADA (LESS THAN 5%)

#### BASIN OS1 & OS2

DISTURBED AREA = 0.70 AC  
AREA EXCLUDED FROM PCM TREATMENT PER EXCLUSION 2.1.2 - AREA TO REMAIN PERVIOUS

#### BASIN G3

DISTURBED AREA = 0.04 AC  
AREA EXCLUDED FROM PCM TREATMENT PER EXCLUSION 2.1.2 - AREA TO REMAIN PERVIOUS

#### BASIN G3

DISTURBED AREA = 0.02 AC  
CONTRIBUTES TO ALLOWABLE 1 ACRE OF ADA NOT TREATED BY PCM, SEE SUMMARY TABLE THIS SHEET

#### BASIN G1

DISTURBED AREA = 0.08 AC  
CONTRIBUTES TO ALLOWABLE 1 ACRE OF ADA NOT TREATED BY PCM, SEE SUMMARY TABLE THIS SHEET

#### BASIN G1

DISTURBED AREA = 0.11 AC  
AREA EXCLUDED FROM PCM TREATMENT PER EXCLUSION 2.1.2 - AREA TO REMAIN PERVIOUS

#### BASIN G2

DISTURBED AREA = 0.14 AC  
AREA EXCLUDED FROM PCM TREATMENT PER EXCLUSION 2.1.2 - AREA TO REMAIN PERVIOUS

#### BASIN G2

DISTURBED AREA = 0.09 AC  
CONTRIBUTES TO ALLOWABLE 1 ACRE OF ADA NOT TREATED BY PCM, SEE SUMMARY TABLE THIS SHEET

#### BASIN F

DISTURBED AREA = 0.12 AC  
CONTRIBUTES TO ALLOWABLE 1 ACRE OF ADA NOT TREATED BY PCM, SEE SUMMARY TABLE THIS SHEET

#### BASIN OS3

DISTURBED AREA = 0.87 AC  
AREA EXCLUDED FROM PCM TREATMENT PER EXCLUSION 2.1.2 - AREA TO REMAIN PERVIOUS

#### BASIN OS3

DISTURBED AREA = 0.16 AC  
AREA EXCLUDED FROM PCM TREATMENT PER EXCLUSION 2.1.1 - UTILITY INSTALLATION

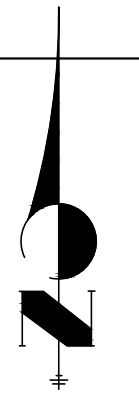
#### BASIN OS3

DISTURBED AREA = 0.02 AC  
AREA EXCLUDED FROM PCM TREATMENT PER EXCLUSION 2.1.2 - AREA TO REMAIN PERVIOUS

#### BASIN F

DISTURBED AREA = 0.11 AC  
AREA EXCLUDED FROM PCM TREATMENT PER EXCLUSIONS 2.1.1 & 2.1.2 - UTILITY INSTALLATION & AREA TO REMAIN PERVIOUS

OLD RANCH ROAD  
(R.O.W. VARIES)  
(BOOK 2288 PAGE 416)



60 30 0 60 120  
ORIGINAL SCALE: 1" = 60'

WQ EXCLUSION MAP

COTTAGES AT KETTLE CREEK

JOB NO. 24026

LOCATION: CS

03/21/2025

SHEET

1

