

# **FINAL DRAINAGE REPORT**

**for**

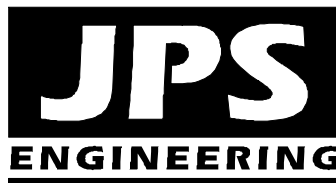
## **KANG STORAGE – 11401 E. HIGHWAY 24 LOT 1, ABIDING WORD LUTHERAN CHURCH SUBDIVISION**

**Prepared for:**

**Hammers Construction, Inc.**  
1411 Woolsey Heights  
Colorado Springs, CO 80915

June 22, 2026

**Prepared by:**



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**JPS Project No. 022601  
PCD Filing No. PPR26** 20

**KANG STORAGE – 11401 E. HIGHWAY 24**  
**DRAINAGE REPORT**  
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## DRAINAGE STATEMENT

### Engineer's Statement:

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

---

John P. Schwab, P.E. #29891

### Developer's Statement:

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

By:

---

Date

Hammers Construction  
1411 Woolsey Heights, Colorado Springs, CO 80915

### El Paso County's Statement

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 J. Palmer, P.E.  
County Engineer / ECM Administrator

Date

Conditions:

CDOT has indicated to the County that this roadway (Bluestem Rd) will be a public El Paso County owned and maintained road. Please revise narrative.

## I. INTRODUCTION

### A. Property Location and Description

The portion Falcon Highway adjacent to the property is City of Colorado Springs maintained and owned. Please revise.

Mr. Steve Kang (property owner) is planning to develop the proposed Kang Storage project on the vacant site at 11041 E. Highway 24 in the Falcon area of El Paso County, Colorado. The project site (El Paso County Assessor's Parcel Number 53130-01-013) is a 12.3-acre property located at the southeast corner of US Highway 24 and Falcon Highway. The property is platted as Lot 1, Abiding Word Lutheran Church Subdivision, and the site is zoned CS (Commercial Service). The property is located in the North Half of Section 13, Township 13 South, Range 65 West of the 6<sup>th</sup> Principal Meridian, El Paso County, Colorado.

The west boundary of the property adjoins US Highway 24 (US24), which is an asphalt-paved arterial CDOT highway. In preparation for upcoming highway improvements, CDOT has acquired a strip of right-of-way along the west boundary of the site. CDOT has also acquired a corridor along the eastern boundary of this site for a proposed private road to be constructed by CDOT for access to properties to the south, minimizing direct access connections to US24.

The north boundary of the property adjoins Falcon Highway, which is an asphalt-paved arterial County roadway. The east boundary of the property adjoins an unplatted 16.1-acre ranch property (Zoned RR5; Rural Residential), and the southwest boundary adjoins another unplatted 5-acre ranch property (Zoned RR5; Rural Residential).

The proposed site improvements consist of crushed asphalt paving of the majority of the developed site for uncovered storage use. Additionally, gated storage yards will be enclosed with fencing along the southwest side of the property. The proposed site improvements will have minimal impacts on the existing Mountain View Electric Association (MVEA) easement along the southwest boundary of the property. Access to the site will be provided by a driveway connection to the proposed private road along the east boundary of the property.

The site is located in the Sand Creek Drainage Basin, and surface drainage from this site sheet flows southwesterly to an existing drainage swale at the south boundary of the property, draining to an existing public double 24-inch culvert crossing US24 beyond the southwest corner of the property.

The site is located within the Sand Creek Drainage Basin and the Falcon Drainage Basin. Please revise narrative and hydrologic analysis accordingly.

### B. Scope

This report will provide a summary of site drainage issues impacting the proposed commercial site development. The report will analyze upstream drainage patterns, site-specific developed drainage patterns, and impacts on downstream facilities. This report is based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual, and the report is intended to fulfill the requirements for a "Final Drainage Report" for this property.

## **C. References**

City of Colorado Springs & El Paso County “Drainage Criteria Manual,” revised October 31, 2018.

City of Colorado Springs “Drainage Criteria Manual, Volume 1,” revised January, 2021.

City of Colorado Springs “Drainage Criteria Manual, Volume 2,” revised December, 2020.

El Paso County “Engineering Criteria Manual,” revised July 18, 2023.

Mile High Flood District, “Urban Storm Drainage Criteria Manual, Volume 1,” revised August, 2018.

Mile High Flood District, “Urban Storm Drainage Criteria Manual, Volume 2,” revised September, 2017.

Mile High Flood District, “Urban Storm Drainage Criteria Manual, Volume 3,” revised January, 2021.

MVE, Inc., “Abiding Word Lutheran Church Subdivision” Drainage Report, July 10, 2006 (approved by County 10/25/06).

## **II. EXISTING / PROPOSED DRAINAGE CONDITIONS**

### **A. Existing Drainage Conditions**

According to the Custom Soil Resource Report for this site (see details in Appendix A) provided by the Natural Resources Conservation Service (NRCS), on-site soils are comprised of the following:

- “Type 9: Blakeland-Fluvaquentic Haplaquolls” soils. These soils are classified as hydrologic soils group “A” (high infiltration rate).
- “Type 97: Truckton sandy loam” soils (majority of site). These soils are classified as hydrologic soils group “A” (high infiltration rate).

As shown on the enclosed Existing Conditions Drainage Plan (Figure EX1, Appendix E), the property has been delineated as a single on-site drainage basin (Basin A, 12.36-acres), which sheet flows to the southwest corner of the site. Existing peak flows from Basin A are calculated as  $Q_5 = 3.0$  cfs and  $Q_{100} = 22.3$  cfs.

The adjoining CDOT private road corridor along the east boundary of the site has been delineated as Off-site Basin OA1 (1.64-acres), which contributes off-site drainage flowing into Basin A. Existing peak flows from Basin OA1 are calculated as  $Q_5 = 0.4$  cfs and  $Q_{100} = 3.0$  cfs.

Drainage from Basin OA1 combines with Basin A at Design Point #1, with existing peak flows calculated as  $Q_5 = 3.4$  cfs and  $Q_{100} = 25.2$  cfs.

## **B. Developed Drainage Plan**

Developed flows have been calculated based on the impervious areas associated with the proposed parking and storage area improvements. Developed drainage from Basin A will continue to sheet flow southwesterly across the site.

### Sub-Basin A1

The next page and other documents refer to the pond as EDB-A1, please update the submitted text and drawings accordingly with consistent labeling throughout

The majority of the developed site has been delineated as Sub-Basin A1 (10.79-acres), and this area has been planned for compacted crushed asphalt surfacing and use as uncovered outdoor storage areas. Sub-Basin A1 will sheet flow southwesterly to the proposed private stormwater detention pond at the southwest corner of the property. Site drainage from Basin A1 will flow southwest to Design Point #A1 (Detention Pond A1), with developed peak flows calculated as  $Q_5 = 24.5$  cfs and  $Q_{100} = 49.2$  cfs.

The 18" HDPE discharge pipe from Detention Pond A1 (along with overflows from the pond spillway) will drain southwesterly to the existing downstream drainage swale at the southwest boundary of the property. A riprap apron will be provided for erosion control at the pipe outlet.

### Sub-Basin A2

The vegetated areas along the south and west edges of the developed site has been delineated as Sub-Basin A2 (1.55-acres), which will sheet flow southwesterly to the adjoining grass-lined drainage swales along the perimeter of the property. Developed peak flows from Sub-Basin A2 are calculated as  $Q_5 = 0.4$  cfs and  $Q_{100} = 3.0$  cfs.

Sub-Basin A2 is excluded from permanent water quality requirements based on ECM Appendix I, which allows for 20%, not to exceed 1-acre, of the applicable development site area to not be captured. The disturbed area within Basin A2 is limited to 0.6 acres.

Specify ECM Appendix I.6.3.A.1.A

### Combined Flows and Developed Drainage Impact

Site drainage from Basins A1 and A2 will continue to flow southwest to Design Point #1, with developed peak flows calculated as  $Q_5 = 24.8$  cfs and  $Q_{100} = 52.0$  cfs.

Developed drainage impacts will be mitigated by routing developed flows through the proposed Detention Pond A1, and the resulting detained flows at Design Point #1 are calculated as  $Q_5 = 0.7$  cfs and  $Q_{100} = 10.2$  cfs. The detained flows discharged downstream of the property will be significantly lower than the historic flows.

Hydrologic and hydraulic calculations for the site are detailed in Appendix B, and peak flows are identified on Figure D1 (Appendix D).

### **III. DRAINAGE PLANNING FOUR STEP PROCESS**

El Paso County Drainage Criteria require drainage planning to include a Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainageways, and implementing long-term source controls.

As stated in ECM Appendix I.7., the Four Step Process is applicable to all new and re-development projects with construction activities that disturb 1 acre or greater or that disturb less than 1 acre but are part of a larger common plan of development. The Four Step Process has been implemented as follows in the planning of this project:

#### Step 1: Employ Runoff Reduction Practices

- Extended Detention Basin: Developed flows from the site will be routed through the proposed on-site detention basin, which will be grass-lined to encourage stormwater infiltration.

#### Step 2: Stabilize Drainageways

- There are no major drainageways within this project site. Implementation of the proposed on-site drainage improvements and detention basin will minimize downstream drainage impacts from this site.

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

- EDB: The developed site will drain through an on-site Private Extended Detention Basin (EDB-A1) at the southwest corner of the property. The extended detention basin which will capture and slowly release the WQCV over an extended release period.

#### Step 4: Consider Need for Industrial and Commercial BMPs

- The property owner will implement a Stormwater Management Plan including proper housekeeping practices and spill containment procedures.
- On-site drainage will be routed through the Full-Spectrum Extended Detention Basin (EDB-A1) to minimize introduction of contaminants to the downstream drainage system.

### **IV. FLOODPLAIN IMPACTS**

According to the FEMA floodplain map for this area, El Paso County FIRM Panel No. 08041C0561G, dated December 7, 2018, the site is located beyond the limits of any delineated 100-year floodplains.

### **V. STORMWATER DETENTION AND WATER QUALITY**

Proposed drainage improvements will include construction of a new Private Full-Spectrum Extended Detention Basin (EDB-A1) to meet current full-spectrum detention

design standards. The proposed detention facility has been designed to provide the required stormwater detention and water quality mitigation for the overall site in accordance with current El Paso County drainage criteria. The required on-site detention volume has been calculated based on the developed impervious area of the site. While the current development plan shows proposed crushed asphalt paving over the majority of the site, the detention pond has been conservatively designed assuming potential future asphalt pavement of the full developed site area.

The proposed Detention Basin has been designed utilizing the Denver Mile High Flood District's "MH-Detention\_v4.07" software package. Calculations and details for the proposed Detention Basin are enclosed in Appendix C, and design parameters for the Detention Basin are summarized as follows:

| <b>Detention Basin</b> | <b>Tributary Drainage Basins</b> | <b>Tributary Area (ac)</b> | <b>Impervious Percentage</b> | <b>Min. 100-Yr FSD Vol. (af)</b> | <b>Design Volume (af)</b> |
|------------------------|----------------------------------|----------------------------|------------------------------|----------------------------------|---------------------------|
| A1                     | OA1-A1                           | 12.4                       | 68.0                         | 1.6                              | 1.9                       |

The proposed on-site Full-Spectrum Detention Pond **EDB-A1** provides a storage volume of 1.9 acre-feet, which meets the required 100-year detention and WQCV volume.

The proposed detention pond will include an outlet structure with a water quality orifice plate to maintain discharges below the allowable release rates. The pond outlet structure has been designed for a 40-hour release of the WQCV, and outlet structure sizing to maintain maximum allowable release rates from the pond. The detention pond will have a grass-lined bottom to encourage infiltration of stormwater prior to discharging into the downstream drainage system.

Forebays are not required due to the sheet flow (minimal concentrated flows) entering the proposed detention pond. Concrete trickle channels will be provided along the bottom of the pond.

The new on-site Detention Basin will be privately owned and maintained by the property owner, and maintenance access will be provided from the existing gravel driveway within the site.

As detailed in the detention basin calculations in Appendix C, detained peak flows from at Design Point #A1 are calculated as  $Q_5 = 0.7$  cfs and  $Q_{100} = 10.2$  cfs, well below the calculated historic flows.

The estimated cost for the proposed private detention facilities is approximately \$28,232 (see estimate in Appendix C).

#### Areas Excluded from Water Quality Facilities

As discussed in Section II.B. above, Sub-Basin A2 (1.55-acres) is excluded from permanent water quality requirements based on ECM Appendix I, which allows for 20%,

not to exceed 1-acre, of the applicable development site area to not be captured. The disturbed area within Basin A2 is limited to 0.6 acres.

## **VI. DRAINAGE BASIN FEES**

The site is located within the Sand Creek Drainage Basin and the Falcon Drainage Basin. Please revise.

The proposed site development will include construction of private stormwater detention and water quality facilities. No public drainage improvements are required.

The site lies entirely within the Sand Creek Drainage Basin, which is tributary to Fountain Creek.

Drainage and bridge fees are not applicable at this time as this site is a previously platted property (Lot 1, Abiding Word Lutheran Church Subdivision).

## **VII. SUMMARY**

The developed drainage patterns for the proposed Kang Storage site development at 11401 E. Highway 24 will remain consistent with the historic drainage patterns for this site. Developed flows from the site will drain through a Private Full-Spectrum Detention Pond at the southwest corner of the property prior to discharging to the existing downstream drainage system. The existing grass-lined drainage swale downstream of the proposed detention pond outlet pipe and spillway (southwest corner of the property) is in stable, well-vegetated condition, and the existing swale serves as a suitable drainage outfall.

The proposed on-site Detention Pond has been designed to provide both stormwater detention and water quality requirements for the site in accordance with El Paso County Drainage Criteria Manual standards. Construction and proper maintenance of the on-site drainage facilities and Extended Detention Basin, in conjunction with proper erosion control practices, will ensure that this developed site has no significant adverse drainage impact on downstream or surrounding areas.

**APPENDIX A**

**SOILS INFORMATION**



United States  
Department of  
Agriculture

NRCS

Natural  
Resources  
Conservation  
Service

A product of the National  
Cooperative Soil Survey,  
a joint effort of the United  
States Department of  
Agriculture and other  
Federal agencies, State  
agencies including the  
Agricultural Experiment  
Stations, and local  
participants

# Custom Soil Resource Report for El Paso County Area, Colorado



March 16, 2026

# Preface

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

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

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist ([http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2\\_053951](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951)).

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

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

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

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

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# How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

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

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

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

## Custom Soil Resource Report

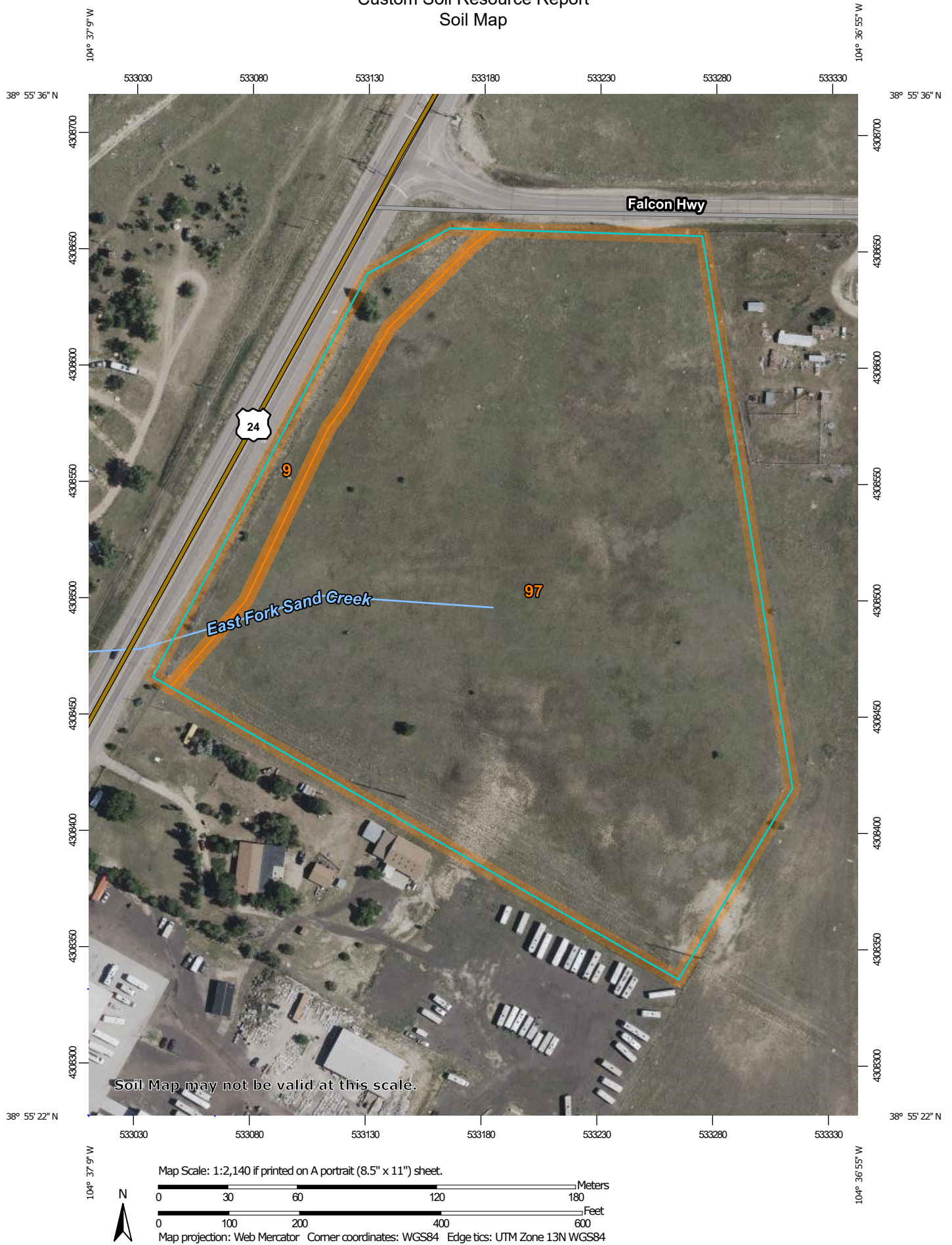
identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

# Soil Map

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

# Custom Soil Resource Report Soil Map



# Custom Soil Resource Report

## MAP LEGEND

### Area of Interest (AOI)

 Area of Interest (AOI)

### Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

### Special Point Features

 Blowout

 Borrow Pit

 Clay Spot

 Closed Depression

 Gravel Pit

 Gravelly Spot

 Landfill

 Lava Flow

 Marsh or swamp

 Mine or Quarry

 Miscellaneous Water

 Perennial Water

 Rock Outcrop

 Saline Spot

 Sandy Spot

 Severely Eroded Spot

 Sinkhole

 Slide or Slip

 Sodic Spot

 Spoil Area

 Stony Spot

 Very Stony Spot

 Wet Spot

 Other

 Special Line Features

### Water Features

 Streams and Canals

### Transportation

 Rails

 Interstate Highways

 US Routes

 Major Roads

 Local Roads

### Background

 Aerial Photography

## MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado  
Survey Area Data: Version 23, Aug 29, 2025

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.

## Map Unit Legend

| Map Unit Symbol                    | Map Unit Name                                 | Acres in AOI | Percent of AOI |
|------------------------------------|-----------------------------------------------|--------------|----------------|
| 9                                  | Blakeland-Fluvaquentic<br>Haplaquolls         | 1.0          | 7.2%           |
| 97                                 | Truckton sandy loam, 3 to 9<br>percent slopes | 13.2         | 92.8%          |
| <b>Totals for Area of Interest</b> |                                               | <b>14.2</b>  | <b>100.0%</b>  |

## Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

## El Paso County Area, Colorado

### 9—Blakeland-Fluvaquentic Haplaquolls

#### Map Unit Setting

*National map unit symbol:* 36b6  
*Landscape:* Uplands  
*Elevation:* 3,500 to 5,800 feet  
*Mean annual precipitation:* 13 to 17 inches  
*Mean annual air temperature:* 46 to 55 degrees F  
*Frost-free period:* 110 to 165 days  
*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Blakeland and similar soils:* 60 percent  
*Fluvaquentic haplaquolls and similar soils:* 38 percent  
*Minor components:* 2 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Blakeland

##### Setting

*Landscape:* Uplands  
*Landform:* Flats, Hills  
*Landform position (three-dimensional):* Side slope, talf  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Sandy alluvium derived from arkose and/or eolian deposits  
derived from arkose

##### Typical profile

*A - 0 to 11 inches:* loamy sand  
*AC - 11 to 27 inches:* loamy sand  
*C - 27 to 60 inches:* sand

##### Properties and qualities

*Slope:* 1 to 9 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Somewhat excessively drained  
*Runoff class:* Low  
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 5 percent  
*Available water supply, 0 to 60 inches:* Low (about 4.5 inches)

##### Interpretive groups

*Land capability classification (irrigated):* 3e  
*Land capability classification (nonirrigated):* 6e  
*Hydrologic Soil Group:* A  
*Ecological site:* R049XB210CO - Sandy Foothill  
*Hydric soil rating:* No

## **Description of Fluvaquentic Haplaquolls**

### **Setting**

*Landform:* Swales

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Alluvium

### **Typical profile**

*H1 - 0 to 12 inches:* variable

*H2 - 12 to 60 inches:* stratified very gravelly sand to loam

### **Properties and qualities**

*Slope:* 1 to 2 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Poorly drained

*Runoff class:* Very high

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 6.00 in/hr)

*Depth to water table:* About 0 to 24 inches

*Frequency of flooding:* Occasional

*Frequency of ponding:* None

*Maximum salinity:* Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)

*Available water supply, 0 to 60 inches:* Moderate (about 6.2 inches)

### **Interpretive groups**

*Land capability classification (irrigated):* 6w

*Land capability classification (nonirrigated):* 6w

*Hydrologic Soil Group:* D

*Ecological site:* R048AY241CO - Mountain Meadow

*Hydric soil rating:* Yes

## **Minor Components**

### **Other soils**

*Percent of map unit:* 1 percent

*Hydric soil rating:* No

### **Pleasant**

*Percent of map unit:* 1 percent

*Landform:* Depressions

*Hydric soil rating:* Yes

## **97—Truckton sandy loam, 3 to 9 percent slopes**

### **Map Unit Setting**

*National map unit symbol:* 2x0j2

*Landscape:* Uplifted piedmonts

*Elevation:* 5,300 to 6,850 feet

*Mean annual precipitation:* 14 to 19 inches

## Custom Soil Resource Report

*Mean annual air temperature:* 48 to 52 degrees F

*Frost-free period:* 85 to 155 days

*Farmland classification:* Not prime farmland

### Map Unit Composition

*Truckton and similar soils:* 85 percent

*Minor components:* 15 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Truckton

#### Setting

*Landscape:* Uplifted piedmonts

*Landform:* Backslopes of hillslopes, Sideslopes of interfluves

*Landform position (two-dimensional):* Backslope

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Re-worked alluvium derived from arkose

#### Typical profile

*A - 0 to 4 inches:* sandy loam

*Bt1 - 4 to 12 inches:* sandy loam

*Bt2 - 12 to 19 inches:* sandy loam

*C - 19 to 80 inches:* sandy loam

#### Properties and qualities

*Slope:* 3 to 9 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Well drained

*Runoff class:* Low

*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Calcium carbonate, maximum content:* 1 percent

*Maximum salinity:* Nonsaline (0.1 to 1.9 mmhos/cm)

*Available water supply, 0 to 60 inches:* Moderate (about 6.6 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 6e

*Land capability classification (nonirrigated):* 6e

*Hydrologic Soil Group:* A

*Ecological site:* R049XB210CO - Sandy Foothill

*Hydric soil rating:* No

### Minor Components

#### Blakeland

*Percent of map unit:* 8 percent

*Landscape:* Uplifted piedmonts

*Landform:* Shoulders and backslopes of hillslopes, Sideslopes and crests of interfluves

*Landform position (two-dimensional):* Shoulder, backslope, summit

*Landform position (three-dimensional):* Crest, side slope

*Down-slope shape:* Convex, linear

## Custom Soil Resource Report

*Across-slope shape:* Convex, linear  
*Ecological site:* R049XB210CO - Sandy Foothill  
*Hydric soil rating:* No

### **Bresser**

*Percent of map unit:* 7 percent  
*Landscape:* Uplifted piedmonts  
*Landform:* Toeslopes or footslopes of low hills, Baseslopes of interfluves  
*Landform position (two-dimensional):* Footslope, toeslope  
*Landform position (three-dimensional):* Base slope  
*Down-slope shape:* Concave, linear  
*Across-slope shape:* Concave, linear  
*Ecological site:* R049XB210CO - Sandy Foothill  
*Hydric soil rating:* No

# References

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- American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.
- American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.
- Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.
- Federal Register. July 13, 1994. Changes in hydric soils of the United States.
- Federal Register. September 18, 2002. Hydric soils of the United States.
- Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.
- National Research Council. 1995. Wetlands: Characteristics and boundaries.
- Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_054262](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262)
- Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_053577](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577)
- Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_053580](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580)
- Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.
- United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.
- United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2\\_053374](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374)
- United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084>

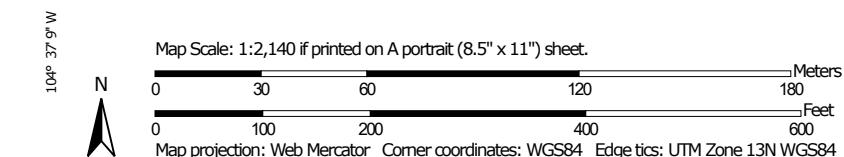
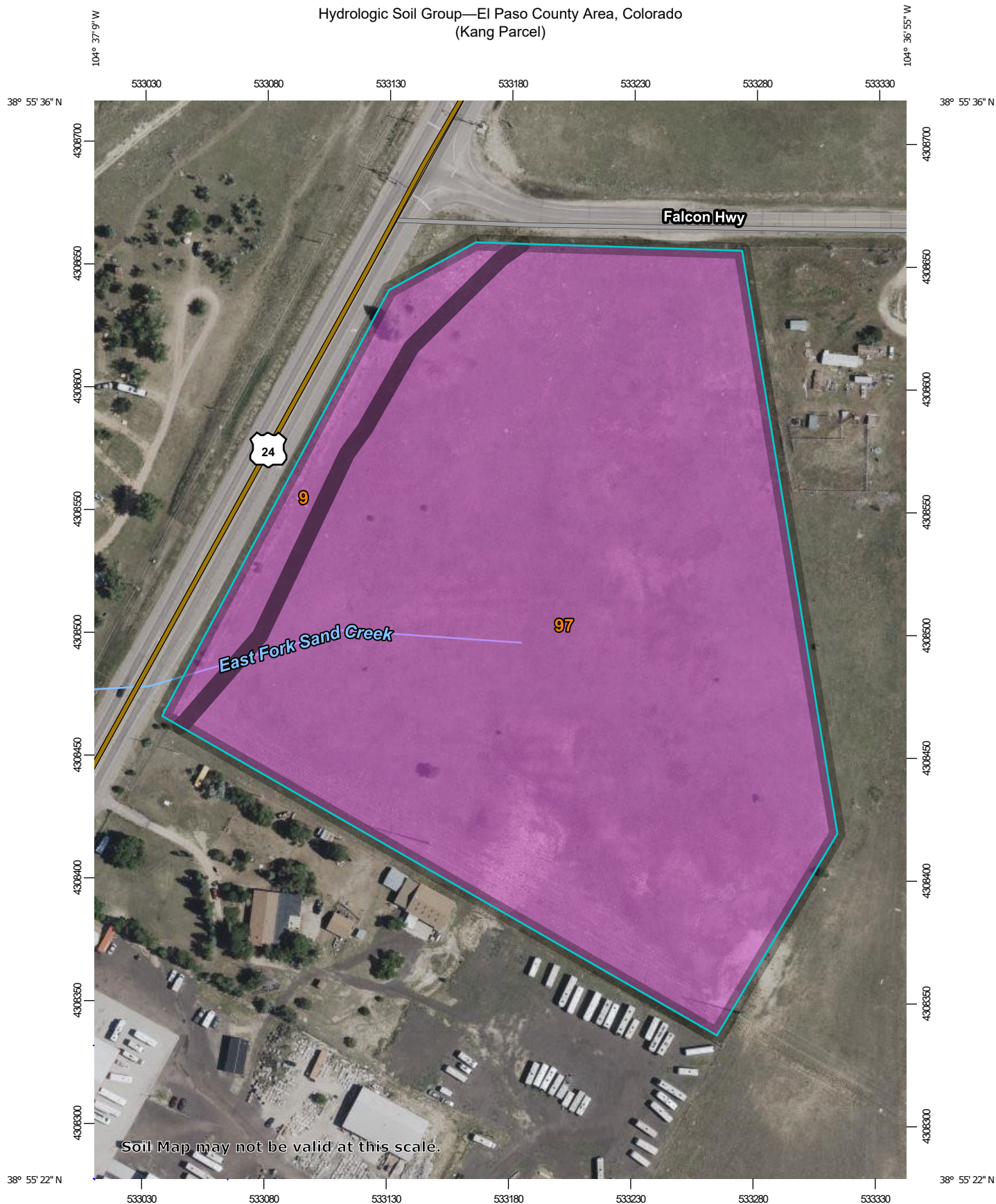
## Custom Soil Resource Report

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2\\_054242](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242)

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2\\_053624](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624)

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. [http://www.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/nrcs142p2\\_052290.pdf](http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf)

# Hydrologic Soil Group—El Paso County Area, Colorado (Kang Parcel)



Natural Resources  
Conservation Service

Web Soil Survey  
National Cooperative Soil Survey

3/16/2026  
Page 1 of 4

Hydrologic Soil Group—El Paso County Area, Colorado  
(Kang Parcel)

## 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 23, Aug 29, 2025

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 |
|------------------------------------|--------------------------------------------|--------|--------------|----------------|
| 9                                  | Blakeland-Fluvaquentic Haplaquolls         | A      | 1.0          | 7.2%           |
| 97                                 | Truckton sandy loam, 3 to 9 percent slopes | A      | 13.2         | 92.8%          |
| <b>Totals for Area of Interest</b> |                                            |        | <b>14.2</b>  | <b>100.0%</b>  |

## Description

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

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

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

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

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

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

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

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff: None Specified*

*Tie-break Rule: Higher*

## **APPENDIX B**

### **HYDROLOGIC CALCULATIONS**

In addition to the hydrologic calculations, please provide hydraulic calculations for the pond outflow pipe for both the 5-year and 100-year peak flows to confirm that the pipe has adequate capacity.

**Table 6-6. Runoff Coefficients for Rational Method**

(Source: UDFCD 2001)

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

### 3.2 Time of Concentration

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

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

$$t_c = t_i + t_t \quad (\text{Eq. 6-7})$$

Where:

$t_c$  = time of concentration (min)

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

$t_t$  = travel time in the ditch, channel, gutter, storm sewer, etc. (min)

### 3.2.1 Overland (Initial) Flow Time

The overland flow time,  $t_i$ , may be calculated using Equation 6-8.

$$t_i = \frac{0.395(1.1 - C_5)\sqrt{L}}{S^{0.33}} \quad (\text{Eq. 6-8})$$

Where:

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

$C_5$  = runoff coefficient for 5-year frequency (see Table 6-6)

$L$  = length of overland flow (300 ft maximum for non-urban land uses, 100 ft maximum for urban land uses)

$S$  = average basin slope (ft/ft)

Note that in some urban watersheds, the overland flow time may be very small because flows quickly concentrate and channelize.

### 3.2.2 Travel Time

For catchments with overland and channelized flow, the time of concentration needs to be considered in combination with the travel time,  $t_t$ , which is calculated using the hydraulic properties of the swale, ditch, or channel. For preliminary work, the overland travel time,  $t_t$ , can be estimated with the help of Figure 6-25 or Equation 6-9 (Guo 1999).

$$V = C_v S_w^{0.5} \quad (\text{Eq. 6-9})$$

Where:

$V$  = velocity (ft/s)

$C_v$  = conveyance coefficient (from Table 6-7)

$S_w$  = watercourse slope (ft/ft)

**Table 6-7. Conveyance Coefficient,  $C_v$** 

| Type of Land Surface                 | $C_v$ |
|--------------------------------------|-------|
| Heavy meadow                         | 2.5   |
| Tillage/field                        | 5     |
| Riprap (not buried)*                 | 6.5   |
| Short pasture and lawns              | 7     |
| Nearly bare ground                   | 10    |
| Grassed waterway                     | 15    |
| Paved areas and shallow paved swales | 20    |

\* For buried riprap, select  $C_v$  value based on type of vegetative cover.

The travel time is calculated by dividing the flow distance (in feet) by the velocity calculated using Equation 6-9 and converting units to minutes.

The time of concentration ( $t_c$ ) is then the sum of the overland flow time ( $t_i$ ) and the travel time ( $t_t$ ) per Equation 6-7.

### 3.2.3 First Design Point Time of Concentration in Urban Catchments

Using this procedure, the time of concentration at the first design point (typically the first inlet in the system) in an urbanized catchment should not exceed the time of concentration calculated using Equation 6-10. The first design point is defined as the point where runoff first enters the storm sewer system.

$$t_c = \frac{L}{180} + 10 \quad (\text{Eq. 6-10})$$

Where:

$t_c$  = maximum time of concentration at the first design point in an urban watershed (min)

$L$  = waterway length (ft)

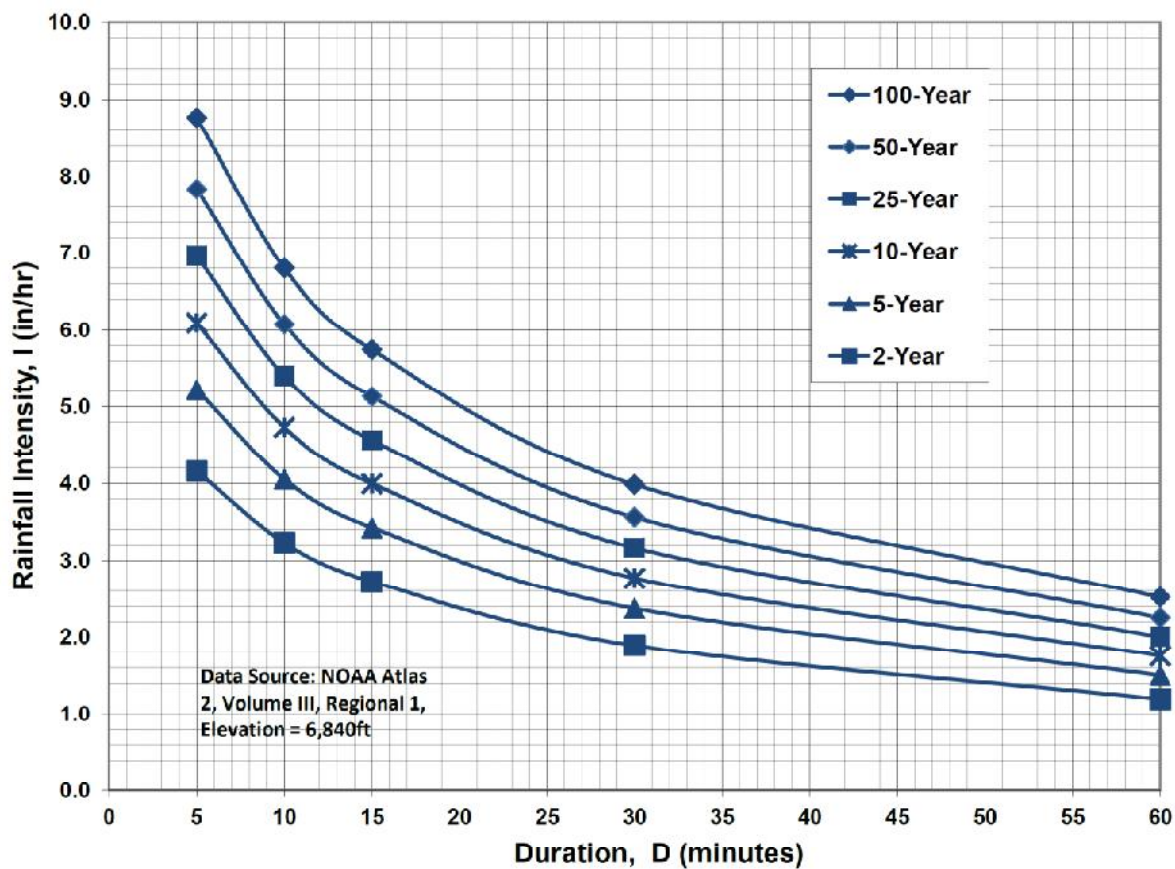
Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional “calibration” of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed. For subsequent design points, the time of concentration is calculated by accumulating the travel times in downstream drainageway reaches.

### 3.2.4 Minimum Time of Concentration

If the calculations result in a  $t_c$  of less than 10 minutes for undeveloped conditions, it is recommended that a minimum value of 10 minutes be used. The minimum  $t_c$  for urbanized areas is 5 minutes.

### 3.2.5 Post-Development Time of Concentration

As Equation 6-8 indicates, the time of concentration is a function of the 5-year runoff coefficient for a drainage basin. Typically, higher levels of imperviousness (higher 5-year runoff coefficients) correspond to shorter times of concentration, and lower levels of imperviousness correspond to longer times of

**Figure 6-5. Colorado Springs Rainfall Intensity Duration Frequency****IDF Equations**

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

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

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

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

$$I_5 = -1.50 \ln(D) + 7.583$$

$$I_2 = -1.19 \ln(D) + 6.035$$

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

**KANG PARCEL  
COMPOSITE RUNOFF COEFFICIENTS**

| <b>DEVELOPED CONDITIONS</b> |                       |       |                                     |      |              |                                     |      |       |                                     |      |                     |
|-----------------------------|-----------------------|-------|-------------------------------------|------|--------------|-------------------------------------|------|-------|-------------------------------------|------|---------------------|
| <b>5-YEAR C VALUES</b>      |                       |       |                                     |      |              |                                     |      |       |                                     |      |                     |
| BASIN                       | TOTAL<br>AREA<br>(AC) | (AC)  | SUB-AREA 1<br>DEVELOPMENT/<br>COVER | C    | AREA<br>(AC) | SUB-AREA 2<br>DEVELOPMENT/<br>COVER | C    | (AC)  | SUB-AREA 3<br>DEVELOPMENT/<br>COVER | C    | WEIGHTED<br>C VALUE |
| OA1                         | 1.64                  | 0.550 | PAVEMENT                            | 0.9  | 0.000        | GRAVEL                              | 0.59 | 1.090 | LANDSCAPED                          | 0.08 | 0.355               |
| A1                          | 10.79                 | 7.894 | ASPHALT / CONCRETE                  | 0.9  | 0.000        | GRAVEL                              | 0.59 | 2.896 | LANDSCAPED                          | 0.08 | 0.680               |
| OA1,A1                      | 12.43                 |       |                                     |      |              |                                     |      |       |                                     |      | 0.637               |
| A2                          | 1.55                  | 0.000 | ASPHALT / CONCRETE                  | 0.9  | 0.000        | GRAVEL                              | 0.59 | 1.550 | LANDSCAPED                          | 0.08 | 0.080               |
| OA1,A1,A2                   | 13.98                 |       |                                     |      |              |                                     |      |       |                                     |      | 0.575               |
|                             |                       |       |                                     |      |              |                                     |      |       |                                     |      |                     |
| <b>100-YEAR C VALUES</b>    |                       |       |                                     |      |              |                                     |      |       |                                     |      |                     |
| BASIN                       | TOTAL<br>AREA<br>(AC) | (AC)  | SUB-AREA 1<br>DEVELOPMENT/<br>COVER | C    | AREA<br>(AC) | SUB-AREA 2<br>DEVELOPMENT/<br>COVER | C    | (AC)  | SUB-AREA 3<br>DEVELOPMENT/<br>COVER | C    | WEIGHTED<br>C VALUE |
| OA1                         | 1.64                  | 0.550 | PAVEMENT                            | 0.96 | 0.000        | GRAVEL                              | 0.70 | 1.090 | LANDSCAPED                          | 0.35 | 0.555               |
| A1                          | 10.79                 | 7.894 | ASPHALT / CONCRETE                  | 0.96 | 0.000        | GRAVEL                              | 0.70 | 2.896 | LANDSCAPED                          | 0.35 | 0.796               |
| OA1,A1                      | 12.43                 |       |                                     |      |              |                                     |      |       |                                     |      | 0.764               |
| A2                          | 1.55                  | 0.000 | ASPHALT / CONCRETE                  | 0.96 | 0.000        | GRAVEL                              | 0.70 | 1.550 | LANDSCAPED                          | 0.35 | 0.350               |
| OA1,A1,A2                   | 13.98                 |       |                                     |      |              |                                     |      |       |                                     |      | 0.718               |
|                             |                       |       |                                     |      |              |                                     |      |       |                                     |      |                     |

The historic scenario appears to be fully pervious, so applying a conveyance coefficient for paved areas and shallow paved swales is inconsistent with historic conditions. Please revise the coefficient to accurately represent pervious historic conditions or provide a clear justification demonstrating that impervious or engineered conveyance features were historically present.

#### HISTORIC CONDITIONS

| BASIN | DESIGN POINT | AREA (AC) | C      |          | Overland Flow |               |                                      | Channel flow        |                          |               |                                    |                                     | TOTAL T <sub>c</sub> <sup>(4)</sup> (MIN) | TOTAL T <sub>c</sub> <sup>(4)</sup> (MIN) | INTENSITY <sup>(5)</sup> |                | PEAK FLOW                           |                                       |
|-------|--------------|-----------|--------|----------|---------------|---------------|--------------------------------------|---------------------|--------------------------|---------------|------------------------------------|-------------------------------------|-------------------------------------------|-------------------------------------------|--------------------------|----------------|-------------------------------------|---------------------------------------|
|       |              |           | 5-YEAR | 100-YEAR | LENGTH (FT)   | SLOPE (FT/FT) | T <sub>co</sub> <sup>(1)</sup> (MIN) | CHANNEL LENGTH (FT) | CONVEYANCE COEFFICIENT C | SLOPE (FT/FT) | SCS <sup>(2)</sup> VELOCITY (FT/S) | T <sub>t</sub> <sup>(3)</sup> (MIN) |                                           |                                           | 5-YR (IN/HR)             | 100-YR (IN/HR) | Q <sub>5</sub> <sup>(6)</sup> (CFS) | Q <sub>100</sub> <sup>(6)</sup> (CFS) |
| OA1   |              | 1.64      | 0.080  | 0.350    | 100           | 0.010         | 18.7                                 | 185                 | 20                       | 0.008         | 1.79                               | 1.7                                 | 20.4                                      | 20.4                                      | 3.06                     | 5.14           | 0.40                                | 2.95                                  |
| A     |              | 12.4      | 0.080  | 0.350    | 100           | 0.020         | 14.8                                 | 735                 | 20                       | 0.013         | 2.28                               | 5.4                                 | 20.2                                      | 20.2                                      | 3.07                     | 5.16           | 3.04                                | 22.33                                 |
| OA1,A | 1            | 14.00     | 0.080  | 0.350    |               |               |                                      |                     |                          |               |                                    |                                     | 20.4                                      | 20.4                                      | 3.06                     | 5.14           | 3.43                                | 25.17                                 |

#### DEVELOPED CONDITIONS

| BASIN           | DESIGN POINT | AREA (AC) | C      |          | Overland Flow |               |                                      | Channel flow        |                          |               |                                    |                                     | TOTAL T <sub>c</sub> <sup>(4)</sup> (MIN) | TOTAL T <sub>c</sub> <sup>(4)</sup> (MIN) | INTENSITY <sup>(5)</sup> |                | PEAK FLOW                           |                                       |
|-----------------|--------------|-----------|--------|----------|---------------|---------------|--------------------------------------|---------------------|--------------------------|---------------|------------------------------------|-------------------------------------|-------------------------------------------|-------------------------------------------|--------------------------|----------------|-------------------------------------|---------------------------------------|
|                 |              |           | 5-YEAR | 100-YEAR | LENGTH (FT)   | SLOPE (FT/FT) | T <sub>co</sub> <sup>(1)</sup> (MIN) | CHANNEL LENGTH (FT) | CONVEYANCE COEFFICIENT C | SLOPE (FT/FT) | SCS <sup>(2)</sup> VELOCITY (FT/S) | T <sub>t</sub> <sup>(3)</sup> (MIN) |                                           |                                           | 5-YR (IN/HR)             | 100-YR (IN/HR) | Q <sub>5</sub> <sup>(6)</sup> (CFS) | Q <sub>100</sub> <sup>(6)</sup> (CFS) |
| OA1             |              | 1.64      | 0.355  | 0.555    | 100           | 0.010         | 13.6                                 | 185                 | 20                       | 0.008         | 1.79                               | 1.7                                 | 15.4                                      | 15.4                                      | 3.49                     | 5.85           | 2.03                                | 5.33                                  |
| Tt OA1 to DP-A1 |              |           |        |          |               |               |                                      | 685                 | 20                       | 0.015         | 2.45                               | 4.7                                 |                                           |                                           |                          |                |                                     |                                       |
| A1              |              | 10.79     | 0.680  | 0.796    | 100           | 0.020         | 6.1                                  | 735                 | 20                       | 0.013         | 2.28                               | 5.4                                 | 11.5                                      | 11.5                                      | 3.92                     | 6.59           | 28.78                               | 56.56                                 |
| OA1,A1          | A1           | 12.43     | 0.637  | 0.764    |               |               |                                      |                     |                          |               |                                    |                                     | 20.0                                      | 20.0                                      | 3.09                     | 5.18           | 24.45                               | 49.22                                 |
| Tt DP-A1 to DP1 |              |           |        |          |               |               |                                      | 145                 | 20                       | 0.007         | 1.67                               | 1.4                                 |                                           |                                           |                          |                |                                     |                                       |
| A2              |              | 1.55      | 0.080  | 0.350    | 100           | 0.020         | 14.8                                 | 515                 | 15                       | 0.030         | 2.60                               | 3.3                                 | 18.1                                      | 18.1                                      | 3.24                     | 5.43           | 0.40                                | 2.95                                  |
| OA1,A1,A2       | 1            | 13.98     | 0.575  | 0.718    |               |               |                                      |                     |                          |               |                                    |                                     | 20.0                                      | 20.0                                      | 3.09                     | 5.18           | 24.82                               | 52.02                                 |

#### DETAINED CONDITIONS

| BASIN           | DESIGN POINT | AREA (AC) | C      |          | Overland Flow |               |                                      | Channel flow        |                          |               |                                    |                                     | TOTAL T <sub>c</sub> <sup>(4)</sup> (MIN) | TOTAL T <sub>c</sub> <sup>(4)</sup> (MIN) | INTENSITY <sup>(5)</sup> |                | PEAK FLOW                           |                                       |
|-----------------|--------------|-----------|--------|----------|---------------|---------------|--------------------------------------|---------------------|--------------------------|---------------|------------------------------------|-------------------------------------|-------------------------------------------|-------------------------------------------|--------------------------|----------------|-------------------------------------|---------------------------------------|
|                 |              |           | 5-YEAR | 100-YEAR | LENGTH (FT)   | SLOPE (FT/FT) | T <sub>co</sub> <sup>(1)</sup> (MIN) | CHANNEL LENGTH (FT) | CONVEYANCE COEFFICIENT C | SLOPE (FT/FT) | SCS <sup>(2)</sup> VELOCITY (FT/S) | T <sub>t</sub> <sup>(3)</sup> (MIN) |                                           |                                           | 5-YR (IN/HR)             | 100-YR (IN/HR) | Q <sub>5</sub> <sup>(6)</sup> (CFS) | Q <sub>100</sub> <sup>(6)</sup> (CFS) |
| POND A1 OUTFLOW |              | 12.43     |        |          |               |               |                                      |                     |                          |               |                                    |                                     |                                           |                                           |                          |                | 0.3                                 | 7.2                                   |
| A2              |              | 1.55      | 0.080  | 0.350    | 100           | 0.020         | 14.8                                 | 515                 | 15                       | 0.030         | 2.60                               | 3.3                                 | 18.1                                      | 18.1                                      | 3.24                     | 5.43           | 0.40                                | 2.95                                  |
| A1,A2           | 1            | 13.98     | 0.438  | 0.598    |               |               |                                      |                     |                          |               |                                    |                                     |                                           |                                           |                          |                | 0.70                                | 10.15                                 |

- 1) OVERLAND FLOW T<sub>co</sub> = (0.395\*(1.1-RUNOFF COEFFICIENT))\*(OVERLAND FLOW LENGTH<sup>(0.5)</sup>/(SLOPE<sup>(0.333)</sup>))
- 2) SCS VELOCITY = C \* ((SLOPE(FT/FT)<sup>0.5</sup>))  
C = 2.5 FOR HEAVY MEADOW  
C = 5 FOR TILLAGE/FIELD  
C = 7 FOR SHORT PASTURE AND LAWNS  
C = 10 FOR NEARLY BARE GROUND  
C = 15 FOR GRASSED WATERWAY  
C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES
- 3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)
- 4) T<sub>c</sub> = T<sub>co</sub> + T<sub>t</sub>  
\*\*\* IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED
- 5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL  
I<sub>5</sub> = -1.5 \* ln(T<sub>c</sub>) + 7.583  
I<sub>100</sub> = -2.52 \* ln(T<sub>c</sub>) + 12.735
- 6) Q = CiA

I am unable to follow your methodology for determining T<sub>c</sub> = 20.0 min. at Design Point A1 and Design Point 1. Please clarify the steps and assumptions used to arrive at this value.

## **APPENDIX C**

### **DETENTION POND CALCULATIONS**

Provide calculations for the trickle channel. trickle channel should at a minimum provide capacity equal to twice the release capacity at the upstream forebay outlet.

Provide forebay sizing and forebay notch calculations

**KANG STORAGE  
COMPOSITE IMPERVIOUS AREAS**
**IMPERVIOUS AREAS - INITIAL CONDITIONS**

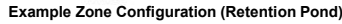
| BASIN     | TOTAL<br>AREA<br>(AC) | (AC)  | SUB-AREA 1<br>DEVELOPMENT/<br>COVER | PERCENT<br>IMPERVIOUS | AREA<br>(AC) | SUB-AREA 2<br>DEVELOPMENT/<br>COVER | PERCENT<br>IMPERVIOUS | (AC)  | SUB-AREA 3<br>DEVELOPMENT/<br>COVER | PERCENT<br>IMPERVIOUS | WEIGHTED<br>% IMP |
|-----------|-----------------------|-------|-------------------------------------|-----------------------|--------------|-------------------------------------|-----------------------|-------|-------------------------------------|-----------------------|-------------------|
| OA1       | 1.64                  | 0.550 | PAVEMENT                            | 100                   | 0.000        | GRAVEL                              | 80.00                 | 1.090 | LANDSCAPED                          | 0                     | 33.537            |
| A1        | 10.79                 | 0.087 | ASPHALT / CONCRETE                  | 100                   | 7.807        | GRAVEL                              | 80.00                 | 2.896 | LANDSCAPED                          | 0                     | 58.690            |
| OA1,A1    | 12.43                 |       |                                     |                       |              |                                     |                       |       |                                     |                       | 55.371            |
| A2        | 1.55                  | 0.000 | BUILDING / CONCRETE                 | 100                   | 0.000        | GRAVEL                              | 80.00                 | 1.550 | LANDSCAPED                          | 0                     | 0.000             |
| OA1,A1,A2 | 13.98                 |       |                                     |                       |              |                                     |                       |       |                                     |                       | 49.232            |

**IMPERVIOUS AREAS - POTENTIAL ULTIMATE CONDITIONS (ON-SITE STORAGE AREA FULLY PAVED)**

| BASIN         | TOTAL<br>AREA<br>(AC) | (AC)  | SUB-AREA 1<br>DEVELOPMENT/<br>COVER | PERCENT<br>IMPERVIOUS | AREA<br>(AC) | SUB-AREA 2<br>DEVELOPMENT/<br>COVER | PERCENT<br>IMPERVIOUS | (AC)  | SUB-AREA 3<br>DEVELOPMENT/<br>COVER | PERCENT<br>IMPERVIOUS | WEIGHTED<br>% IMP |
|---------------|-----------------------|-------|-------------------------------------|-----------------------|--------------|-------------------------------------|-----------------------|-------|-------------------------------------|-----------------------|-------------------|
| OA1           | 1.64                  | 0.550 | PAVEMENT                            | 100                   | 0.000        | GRAVEL                              | 80.00                 | 1.090 | LANDSCAPED                          | 0                     | 33.537            |
| A1            | 10.79                 | 7.894 | ASPHALT / CONCRETE                  | 100                   | 0.000        | GRAVEL                              | 80.00                 | 2.896 | LANDSCAPED                          | 0                     | 73.160            |
| <b>OA1,A1</b> | <b>12.43</b>          |       |                                     |                       |              |                                     |                       |       |                                     |                       | <b>67.932</b>     |
| A2            | 1.55                  | 0.000 | BUILDING / CONCRETE                 | 100                   | 0.000        | GRAVEL                              | 80.00                 | 1.550 | LANDSCAPED                          | 0                     | 0.000             |
| OA1,A1,A2     | 13.98                 |       |                                     |                       |              |                                     |                       |       |                                     |                       | 60.401            |

*MHFD-Detention, Version 4.07 (June 2025)*

**Basin ID:** EDB-A1



|                                          |       |           |
|------------------------------------------|-------|-----------|
| Zone 1 Volume (WQCV) =                   | 0.276 | acre-feet |
| Zone 2 Volume (EURV - Zone 1) =          | 0.786 | acre-feet |
| Zone 3 Volume (100-year - Zones 1 & 2) = | 0.505 | acre-feet |
| Total Detention Basin Volume =           | 1.567 | acre-feet |

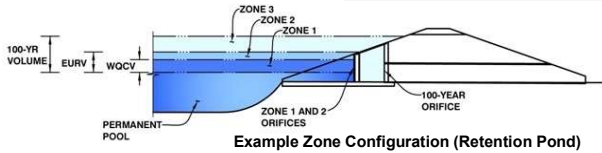
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# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.07 (June 2025)

Project: **Kang Storage (11401 E. HIGHWAY 24)**

Basin ID: **EDB-A1**



Example Zone Configuration (Retention Pond)

|                   | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type          |
|-------------------|----------------------|--------------------------|----------------------|
| Zone 1 (WQCV)     | 1.51                 | 0.276                    | Orifice Plate        |
| Zone 2 (EURV)     | 2.92                 | 0.786                    | Orifice Plate        |
| Zone 3 (100-year) | 3.58                 | 0.505                    | Weir&Pipe (Restrict) |
| Total (all zones) |                      | 1.567                    |                      |

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

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 SCM)

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 (diameter = 1-11/16 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) | <input type="text" value="0.00"/> | <input type="text" value="0.97"/> | <input type="text" value="1.95"/> |                  |                  |                  |                  |                  |
| Orifice Area (sq. inches)      | <input type="text" value="2.22"/> | <input type="text" value="2.22"/> | <input type="text" value="2.22"/> |                  |                  |                  |                  |                  |

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

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  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 Grate and Outlet Pipe OR Rectangular/Trapezoidal Weir and No Outlet Pipe)

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

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

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

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

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

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

## Routed Hydrograph Results

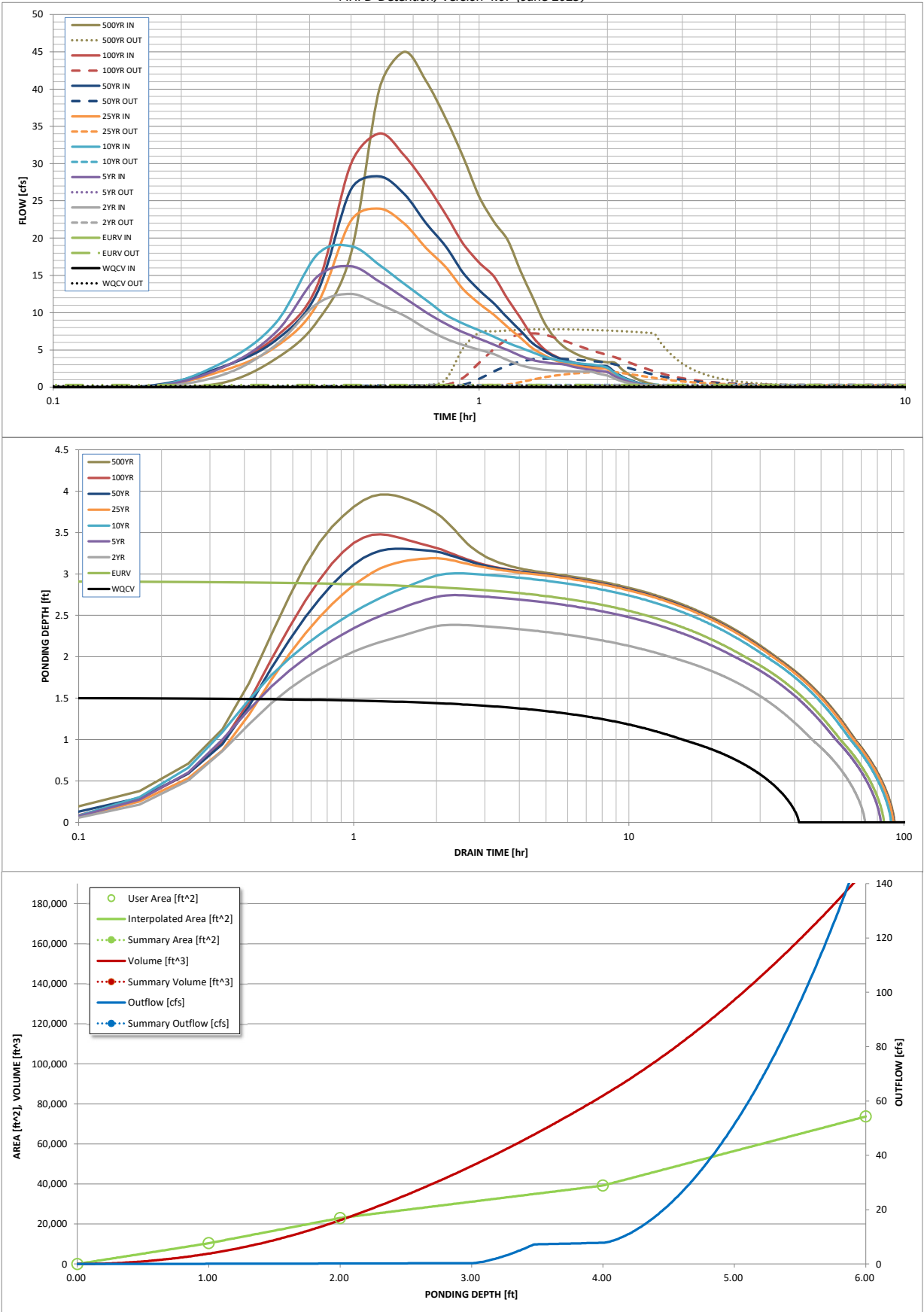
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

|                                                 | WQCV  | EURV  | 2 Year | 5 Year | 10 Year         | 25 Year         | 50 Year         | 100 Year       | 500 Year       |
|-------------------------------------------------|-------|-------|--------|--------|-----------------|-----------------|-----------------|----------------|----------------|
| Design Storm Return Period =                    | N/A   | N/A   | 1.19   | 1.50   | 1.75            | 2.00            | 2.25            | 2.52           | 3.14           |
| One-Hour Rainfall Depth (in) =                  | 0.276 | 1.062 | 0.759  | 0.992  | 1.179           | 1.418           | 1.652           | 1.934          | 2.551          |
| CUHP Runoff Volume (acre-ft) =                  | N/A   | N/A   | 0.759  | 0.992  | 1.179           | 1.418           | 1.652           | 1.934          | 2.551          |
| Inflow Hydrograph Volume (acre-ft) =            | N/A   | N/A   | 0.2    | 0.4    | 0.6             | 2.7             | 5.0             | 7.8            | 13.6           |
| CUHP Predevelopment Peak Q (cfs) =              | N/A   | N/A   |        |        |                 |                 |                 |                |                |
| OPTIONAL Override Predevelopment Peak Q (cfs) = | N/A   | N/A   |        |        |                 |                 |                 |                |                |
| Predevelopment Unit Peak Flow, q (cfs/acre) =   | N/A   | N/A   | 0.02   | 0.04   | 0.05            | 0.22            | 0.40            | 0.63           | 1.09           |
| Peak Inflow Q (cfs) =                           | N/A   | N/A   | 12.5   | 16.2   | 18.9            | 23.9            | 28.3            | 34.1           | 45.0           |
| Peak Outflow Q (cfs) =                          | 0.1   | 0.3   | 0.3    | 0.3    | 0.3             | 2.1             | 3.8             | 7.2            | 7.8            |
| Ratio Peak Outflow to Predevelopment Q =        | N/A   | N/A   | N/A    | 0.6    | 0.5             | 0.8             | 0.8             | 0.9            | 0.6            |
| Structure Controlling Flow =                    | Plate | Plate | Plate  | Plate  | Overflow Weir 1 | Overflow Weir 1 | Overflow Weir 1 | Outlet Plate 1 | Outlet Plate 1 |
| Max Velocity through Grate 1 (fps) =            | N/A   | N/A   | N/A    | N/A    | 0.0             | 0.2             | 0.5             | 1.0            | 1.1            |
| Max Velocity through Grate 2 (fps) =            | N/A   | N/A   | N/A    | N/A    | N/A             | N/A             | N/A             | N/A            | N/A            |
| Time to Drain 97% of Inflow Volume (hours) =    | 38    | 75    | 65     | 73     | 79              | 80              | 78              | 77             | 74             |
| Time to Drain 99% of Inflow Volume (hours) =    | 40    | 80    | 69     | 78     | 85              | 86              | 86              | 85             | 84             |
| Maximum Ponding Depth (ft) =                    | 1.51  | 2.92  | 2.39   | 2.74   | 3.01            | 3.19            | 3.30            | 3.48           | 3.96           |
| Area at Maximum Ponding Depth (acres) =         | 0.39  | 0.70  | 0.60   | 0.67   | 0.71            | 0.75            | 0.77            | 0.80           | 0.89           |
| Maximum Volume Stored (acre-ft) =               | 0.278 | 1.067 | 0.716  | 0.944  | 1.123           | 1.262           | 1.346           | 1.480          | 1.886          |

Time to Drain 97% of Inflow Volume (Hours): This does not meet the drain time requirements indicated in Senate Bill 15-212. Please revise accordingly.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.07 (June 2025)



| 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:

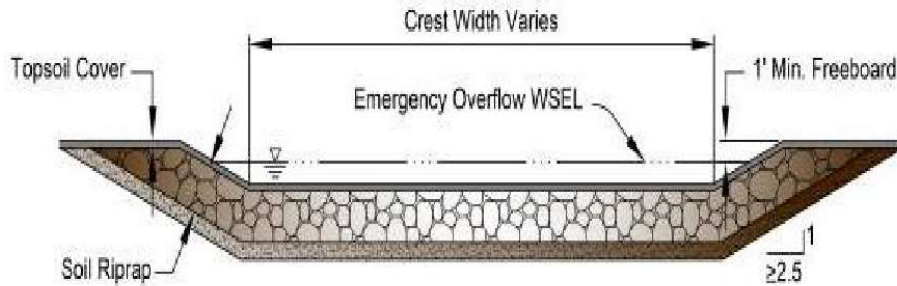
## Inflow Hydrographs

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

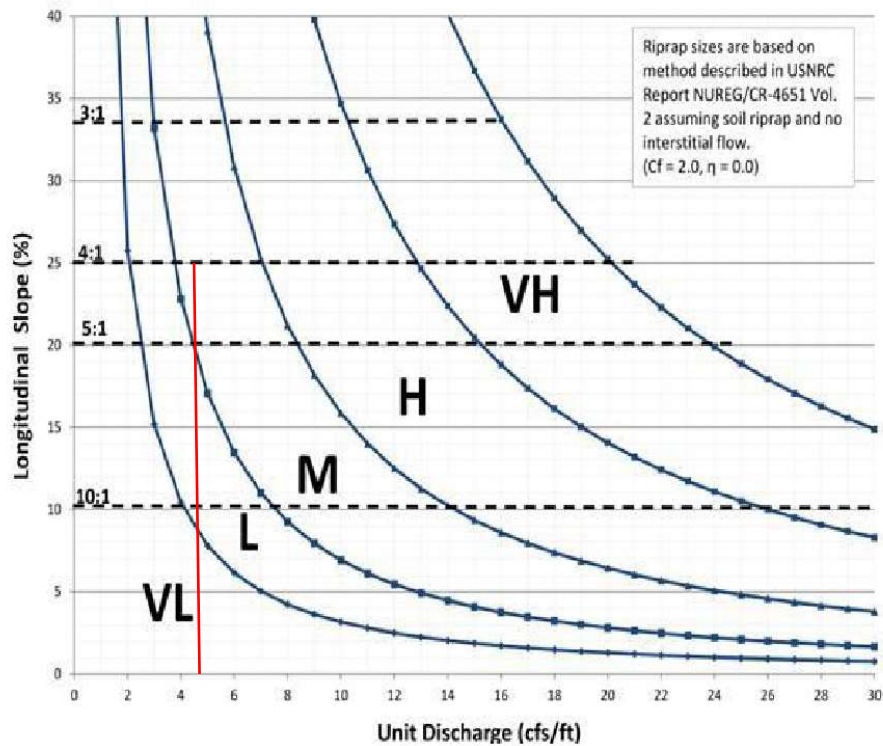
|               | SOURCE  | CUHP       | CUHP       | CUHP         | CUHP         | CUHP          | CUHP          | CUHP          | CUHP           | CUHP           |
|---------------|---------|------------|------------|--------------|--------------|---------------|---------------|---------------|----------------|----------------|
| 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          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 0:05:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 0:10:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.19          | 0.02           | 0.60           |
|               | 0:15:00 | 0          | 0.00       | 1.64         | 2.67         | 3.31          | 2.22          | 2.75          | 2.71           | 3.82           |
|               | 0:20:00 | 0          | 0.00       | 5.66         | 7.36         | 8.63          | 5.43          | 6.30          | 6.78           | 8.78           |
|               | 0:25:00 | 0          | 0.00       | 11.20        | 14.80        | 17.78         | 11.08         | 12.65         | 13.59          | 17.94          |
|               | 0:30:00 | 0          | 0.00       | 12.50        | 16.22        | 18.93         | 22.33         | 26.54         | 29.97          | 40.04          |
|               | 0:35:00 | 0          | 0.00       | 11.10        | 14.15        | 16.41         | 23.94         | 28.28         | 34.05          | 44.98          |
|               | 0:40:00 | 0          | 0.00       | 9.61         | 12.00        | 13.87         | 21.95         | 25.92         | 31.09          | 41.10          |
|               | 0:45:00 | 0          | 0.00       | 7.87         | 10.05        | 11.71         | 18.69         | 22.02         | 27.25          | 36.15          |
|               | 0:50:00 | 0          | 0.00       | 6.53         | 8.52         | 9.75          | 16.15         | 18.95         | 23.25          | 30.93          |
|               | 0:55:00 | 0          | 0.00       | 5.67         | 7.38         | 8.55          | 13.18         | 15.36         | 19.28          | 25.57          |
|               | 1:00:00 | 0          | 0.00       | 5.03         | 6.52         | 7.64          | 11.22         | 13.02         | 16.72          | 22.19          |
|               | 1:05:00 | 0          | 0.00       | 4.44         | 5.71         | 6.75          | 9.71          | 11.22         | 14.83          | 19.72          |
|               | 1:10:00 | 0          | 0.00       | 3.62         | 4.98         | 5.94          | 8.05          | 9.27          | 11.81          | 15.60          |
|               | 1:15:00 | 0          | 0.00       | 2.96         | 4.21         | 5.30          | 6.62          | 7.57          | 9.29           | 12.15          |
|               | 1:20:00 | 0          | 0.00       | 2.56         | 3.65         | 4.69          | 5.23          | 5.93          | 6.82           | 8.84           |
|               | 1:25:00 | 0          | 0.00       | 2.35         | 3.36         | 4.12          | 4.35          | 4.92          | 5.19           | 6.70           |
|               | 1:30:00 | 0          | 0.00       | 2.23         | 3.18         | 3.73          | 3.67          | 4.13          | 4.23           | 5.41           |
|               | 1:35:00 | 0          | 0.00       | 2.16         | 3.06         | 3.46          | 3.24          | 3.64          | 3.65           | 4.63           |
|               | 1:40:00 | 0          | 0.00       | 2.12         | 2.74         | 3.26          | 2.94          | 3.31          | 3.25           | 4.09           |
|               | 1:45:00 | 0          | 0.00       | 2.09         | 2.50         | 3.13          | 2.75          | 3.09          | 2.98           | 3.74           |
|               | 1:50:00 | 0          | 0.00       | 2.06         | 2.32         | 3.04          | 2.62          | 2.94          | 2.79           | 3.49           |
|               | 1:55:00 | 0          | 0.00       | 1.77         | 2.19         | 2.88          | 2.53          | 2.84          | 2.67           | 3.33           |
|               | 2:00:00 | 0          | 0.00       | 1.56         | 2.03         | 2.60          | 2.47          | 2.78          | 2.62           | 3.26           |
|               | 2:05:00 | 0          | 0.00       | 1.13         | 1.47         | 1.87          | 1.78          | 2.01          | 1.90           | 2.36           |
|               | 2:10:00 | 0          | 0.00       | 0.80         | 1.04         | 1.32          | 1.26          | 1.42          | 1.35           | 1.68           |
|               | 2:15:00 | 0          | 0.00       | 0.55         | 0.72         | 0.93          | 0.89          | 1.00          | 0.95           | 1.18           |
|               | 2:20:00 | 0          | 0.00       | 0.38         | 0.49         | 0.63          | 0.61          | 0.68          | 0.65           | 0.81           |
|               | 2:25:00 | 0          | 0.00       | 0.25         | 0.32         | 0.43          | 0.41          | 0.46          | 0.44           | 0.54           |
|               | 2:30:00 | 0          | 0.00       | 0.16         | 0.22         | 0.28          | 0.28          | 0.31          | 0.30           | 0.37           |
|               | 2:35:00 | 0          | 0.00       | 0.09         | 0.13         | 0.17          | 0.17          | 0.19          | 0.18           | 0.23           |
|               | 2:40:00 | 0          | 0.00       | 0.04         | 0.07         | 0.09          | 0.09          | 0.10          | 0.10           | 0.12           |
|               | 2:45:00 | 0          | 0.00       | 0.02         | 0.03         | 0.03          | 0.04          | 0.04          | 0.04           | 0.05           |
|               | 2:50:00 | 0          | 0.00       | 0.00         | 0.01         | 0.01          | 0.01          | 0.01          | 0.01           | 0.01           |
|               | 2:55:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 3:00:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 3:05:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 3:10:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 3:15:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 3:20:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 3:25:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 3:30:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 3:35:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 3:40:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 3:45:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 3:50:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 3:55:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:00:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:05:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:10:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:15:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:20:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:25:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:30:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:35:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:40:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:45:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:50:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 4:55:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:00:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:05:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:10:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:15:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:20:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:25:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:30:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:35:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:40:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:45:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:50:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 5:55:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |
|               | 6:00:00 | 0          | 0.00       | 0.00         | 0.00         | 0.00          | 0.00          | 0.00          | 0.00           | 0.00           |

## Kang Storage Detention Pond A1 Spillway

**Figure 13-12c. Emergency Spillway Protection**



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



Spillway Q100 = 49.2 cfs (Undetained DP-A1)  
 Unit Discharge = (49.2 cfs / 11 ft) = 4.5  
 ....Use Type M Riprap

$Q_{100}$  (Pond Discharge) = 7.2 cfs;  $D = 1.5$  ft  
 $Q / D^{1.5} = 7.2 / (1.5^{1.5}) = 3.9$

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

Equation 9-19

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

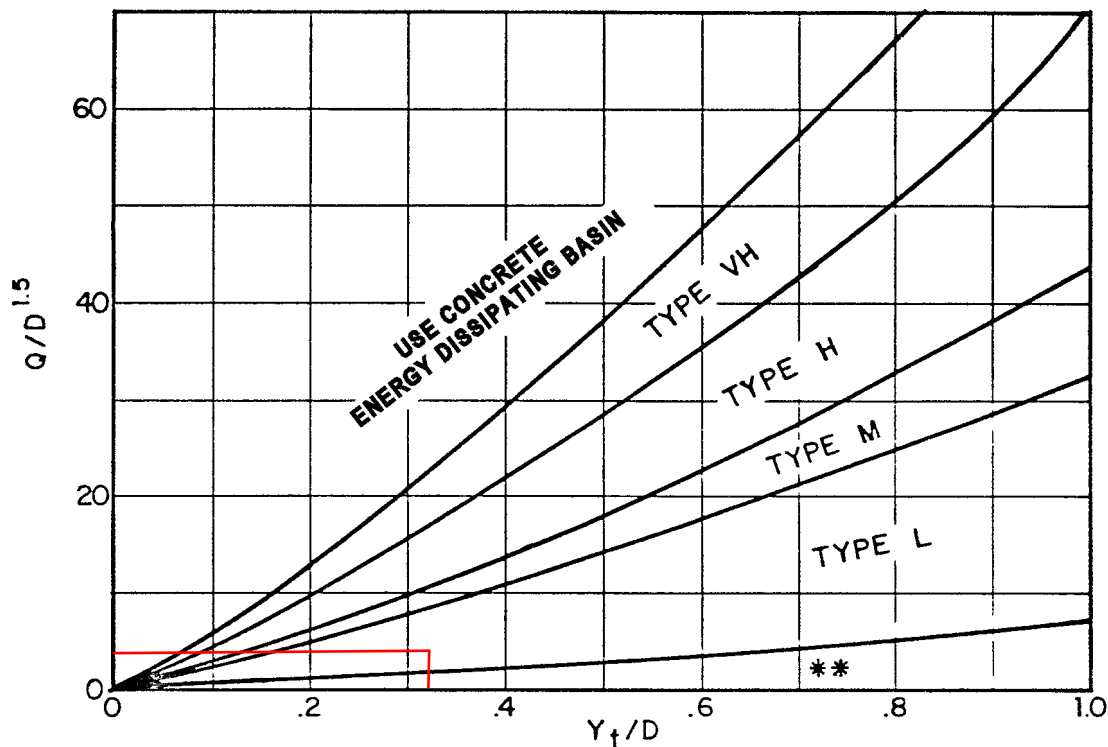
$D_a$  = parameter to use in place of  $D$  in Figure 9-38 when flow is supercritical (ft)

$D_c$  = 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)



$Y_t = 0.5$  ft;  $Y_t / D = (0.5 / 1.5) = 0.33$

Use  $D_a$  instead of  $D$  whenever flow is supercritical in the barrel.

\*\* Use Type L for a distance of  $3D$  downstream.

Use Type M (Conservative)

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

**KANG STORAGE - 11401 E. HIGHWAY 24**  
**ENGINEER'S COST ESTIMATE**  
**DRAINAGE IMPROVEMENTS - FULL-SPECTRUM DETENTION FACILITY (PRIVATE)**

| Item No. | Description                                           | Quantity | Unit | Unit Cost (\$\$) | Total Cost (\$\$) |
|----------|-------------------------------------------------------|----------|------|------------------|-------------------|
|          |                                                       |          |      |                  |                   |
|          |                                                       |          |      |                  |                   |
|          | <b>PRIVATE DRAINAGE FACILITIES (NON-REIMBURSABLE)</b> |          |      |                  |                   |
|          | Aggregate Base Course (Access Drive / Ramp)           | 32       | CY   | \$61             | \$1,952           |
|          | Riprap Aprons (12" Riprap)                            | 5        | CY   | \$65             | \$325             |
|          | Concrete Trickle Channel                              | 265      | SY   | \$40             | \$10,600          |
|          | 18" HDPE Pond Discharge Line                          | 125      | LF   | \$50             | \$6,250           |
|          | Detention Basin Outlet Structure                      | 1        | LS   | \$8,000          | \$8,000           |
|          | Buried Riprap Spillway                                | 17       | CY   | \$65             | \$1,105           |
|          | <b>TOTAL</b>                                          |          |      |                  | <b>\$28,232</b>   |
|          |                                                       |          |      |                  |                   |
|          |                                                       |          |      |                  |                   |

The cost estimate submitted herein is based on time-honored practices within the construction industry. As such the engineer does not control the cost of labor, materials, equipment or a contractor's method of determining prices and competitive bidding practices or market conditions. The estimate represents our best judgement as design professionals using current information available at the time of the preparation. The engineer cannot guarantee that proposals, bids and/or construction costs will not vary from this cost estimate.

## **APPENDIX D**

### **FIGURES**

# National Flood Hazard Layer FIRMMette



104°37'21"W 38°55'45"N



0 250 500 1,000 1,500 2,000 Feet 1:6,000

Basemap Imagery Source: USGS National Map 2023

104°36'43"W 38°55'17"N

## Legend

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

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



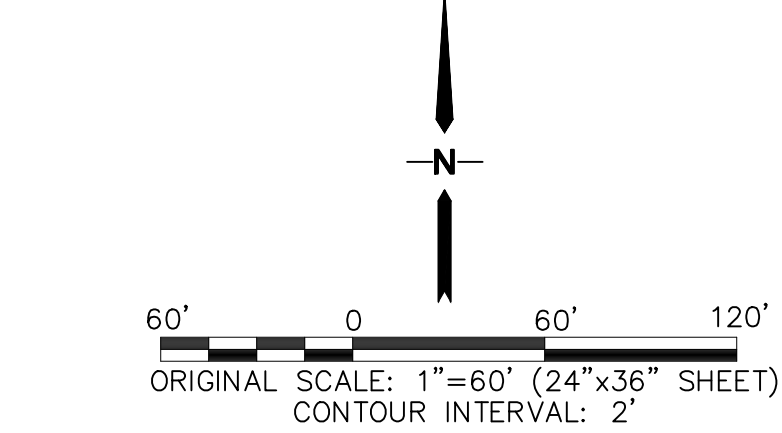
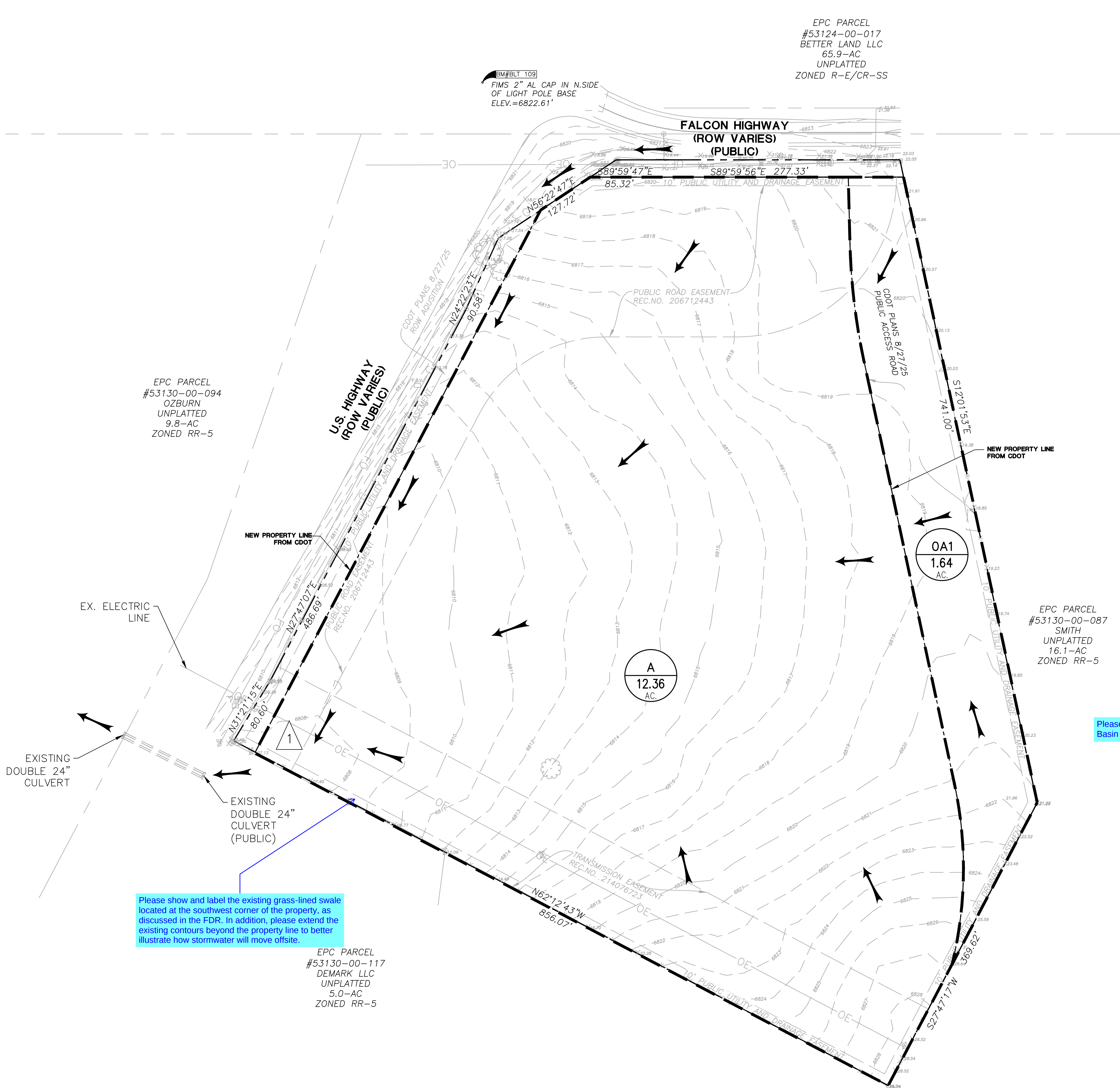
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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 6/21/2026 at 7:33 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Please show path(s) chosen for computation of time of concentration for both the existing conditions drainage plan and developed conditions drainage plan.



**LEGEND**

- FEMA 100-YEAR FLOODWAY
- FEMA 100-YR FLOODPLAIN
- PROPERTY BOUNDARY
- DRAINAGE BASIN BOUNDARY
- 6815 PROPOSED CONTOUR
- 6815 EXISTING CONTOUR
- FLOWLINE
- FLOW DIRECTION ARROW
- △ DESIGN POINT
- 1 BASIN DESIGNATION
- A BASIN AREA (ACRES)
- (E) EXISTING
- (P) PROPOSED

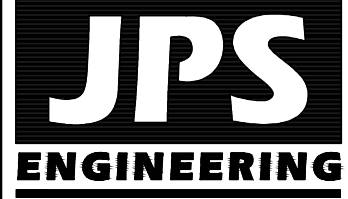
**BASIN SUMMARY TABLE**

| BASIN | Q5<br>(CFS) | Q100<br>(CFS) |
|-------|-------------|---------------|
| OA1   | 0.4         | 3.0           |
| A     | 3.0         | 22.3          |

**SUMMARY HYDROLOGY TABLE**

| DESIGN<br>POINT | Q5<br>(CFS) | Q100<br>(CFS) |
|-----------------|-------------|---------------|
| 1               | 3.4         | 25.2          |

⊙ BENCHMARK:  
FIMS 2" AL CAP IN N. SIDE  
OF LIGHT POLE BASE  
ELEV.=6822.61'



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80903

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MEMBER UTILITIES.

| No. | REVISION |  | BY |  | DATE |  |
|-----|----------|--|----|--|------|--|
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EXISTING CONDITIONS  
DRAINAGE PLAN

KANG STORAGE - 11401 E. HIGHWAY 24  
LOT 1, ABIDING WORD LUTHERAN CHURCH SUBDIVISION

|                     |                         |
|---------------------|-------------------------|
| HORZ. SCALE: 1"=60' | DRAWN: PV               |
| VERT. SCALE: N/A    | DESIGNED: JPS           |
| SURVEYED: RIDGELINE | CHECKED: JPS            |
| CREATED: 03/12/26   | LAST MODIFIED: 06/22/26 |
| PROJECT NO: 022601  | MODIFIED BY: PV         |

SHEET: EX1

