DRAINAGE REPORT

for

COLORADO KIDS RANCH
18065 SADDLEWOOD ROAD, MONUMENT, CO 80132

Prepared for:

Colorado Pumpkin Patch LLC
18065 Saddlewood Road
Monument, CO 80132

January 12, 2024
Revised February 28, 2024
Revised April 11, 2024

Prepared by:

JPS
ENGINEERING

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JPS Project No. 112301
PCD Filing No. PPR2235

COLORADO KIDS RANCH
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.

COLORADO REGISTERED
JOHN P. SCHWAB
4/11/24
29891
PROFESSIONAL ENGINEER

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: John Chapman 4·24·24

Date

Colorado Pumpkin Patch LLC
18065 Saddlewood Road, Monument, CO 80132

El Paso County's Statement

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

Gilbert LaForce, P.E.
Digitally signed by Gilbert LaForce, P.E.
Reason: On Behalf of the County Engineer
Date: 2024.04.30 09:24:00-06'00'
4/30/2024

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

Date

Conditions:

I. INTRODUCTION

A. Property Location and Description

Colorado Pumpkin Patch LLC is planning site improvements to the "Colorado Kids Ranch" agritainment center at 18065 Saddlewood Road in northern El Paso County, Colorado. The project site is a developed, unplatted 40.5-acre property located on the north side of Saddlewood Road (El Paso County Assessor's Parcel Number 61160-00-001). The property is zoned Rural Residential (RR-5). The property has been utilized as an agritainment site since the current owners acquired the parcel in 2018. In September, 2023, El Paso County conditionally approved a Special Use (County Project No. AL217) allowing agritainment activities on the property with up to 325 vehicles on site, with one of the conditions being approval of the currently proposed Site Development Plan.

The project consists of agritainment site improvements along with associated parking and access improvements. Access to the site will continue to be provided by the existing private driveway connection to Saddlewood Road along the south boundary of the property. Additionally, a new private driveway access will connect to Highway 105 along the north boundary of the property, subject to County approval of traffic control plans for events.

The anticipated disturbed area is approximately 17 acres.

The site is described as a tract in the North Half of Section 16 lying east of Canterbury West, North of Saddlewood Road, and West of Canterbury East, Section 16, Township 11 South, Range 66 West of the 6th Principal Meridian, El Paso County, Colorado.

The property is bounded by rural residential lots along the west boundary (platted as Lots 29-35 of Canterbury West Subdivision; Zoned RR-5). The east boundary of the site adjoins developed rural residential lots platted as Tracts 106-112, Canterbury East Subdivision (Zoned RR-5). The south boundary of the property adjoins Saddlewood Road, which is an improved, gravel-paved local public roadway, and the north boundary of the property adjoins County Road 105, which is an improved, asphalt-paved arterial public roadway.

The site is located in the West Cherry Creek Drainage Basin, and surface drainage from this site sheet flows northeasterly to an existing Unnamed Tributary drainage channel of West Cherry Creek, which flows northerly along the east side of the property.

B. Scope

This report will provide a summary of site drainage issues impacting the proposed commercial 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 of 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, Volumes 1 and 2," revised October 31, 2018.

Classic Consulting Engineers & Surveyors, "Final Drainage Report for Cherry Springs Ranch," June, 2007 (approved by El Paso County 7/2/07).

El Paso County "Engineering Criteria Manual," revised December 13, 2016.

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C0285G, December 7, 2018.

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 "Type 92: Tomah-Crowfoot loamy sand" soils (west side of property), and "Type 101: Ustic Torrifluvents, loamy" (east side of property). These soils are both classified as hydrologic soils group "B" (moderate infiltration rate).

The major drainage channel identified as an Unnamed Tributary of West Cherry Creek flows northerly along the east side of the property. Classic Consulting Engineers & Surveyors (CCES) prepared a detailed study of the major drainageway during preparation of a FEMA Letter of Map Revision (LOMR) for the Cherry Springs Ranch Subdivision located directly north of this site. The 2007 "Final Drainage Report for Cherry Springs Ranch" by CCES identified the major basin tributary area as 2.55 square miles, with a 100-year flow of 1,454 cfs in the Unnamed Tributary of West Cherry Creek. The existing major drainage channel is a broad, grass-lined, stable natural channel with no signs of erosion within the property.

The existing property is a developed ranch and agritainment site. The site is impacted by off-site drainage basins along the west boundary (Basins OA1.1, OA1.2, and OA2 as depicted on Figure EX1.1, Appendix E). Basin OA1.1 (72.7-acres) comprises an upstream area of rural residential lots which flows into the northwest corner of the property in an existing grass-lined drainage swale, with existing peak flows calculated as $Q_5 = 20.7$ cfs and $Q_{100} = 99.6$ cfs.

Basin OA1.2 (4.4-acres) comprises a smaller upstream area of rural residential lots, which flows into the west side of the property in an existing grass-lined drainage swale, with existing peak flows calculated as $Q_5 = 2.0$ cfs and $Q_{100} = 9.5$ cfs.

Basin OA2 (26.8-acres) comprises another upstream area of rural residential lots, which flows into the west side of the property in an existing grass-lined drainage swale, with existing peak flows calculated as $Q_5 = 9.4$ cfs and $Q_{100} = 45.3$ cfs.

As shown on the enclosed Existing Conditions Drainage Plan (Figure EX2, Appendix E), the property has been delineated as three on-site drainage basins.

On-site drainage from the northwest part of the property (Basin A1; 14.2-acres) sheet flows northeasterly across the site, with existing peak flows calculated as $Q_5 = 3.7$ cfs and $Q_{100} = 22.4$ cfs. Existing development within Basin A1 includes gravel driveways and various agritainment structures. Off-site drainage from Basins OA1.1 and OA1.2 combines with Basin A1 at Design Point #1, with existing peak flows calculated as $Q_5 = 25.0$ cfs and $Q_{100} = 123.5$ cfs.

On-site drainage from the south part of the property (Basin A2; 18.5-acres) sheet flows northeasterly across the site, with existing peak flows calculated as $Q_5 = 7.4$ cfs and $Q_{100} = 35.1$ cfs. Existing development within Basin A2 includes an existing ranch house, horse arena, gravel driveways, and various accessory structures. Off-site drainage from Basin OA2 combines with Basin A2 at Design Point #2, with existing peak flows calculated as $Q_5 = 15.9$ cfs and $Q_{100} = 76.2$ cfs.

The existing floodplain area in the northeast corner of the property has been delineated as Basin A3 (7.6 acres), which flows northeasterly in the existing broad, grass-lined drainage channel of the Unnamed Tributary of West Cherry Creek, ultimately reaching the existing set of four parallel 24-inch corrugated metal pipe (CMP) culverts crossing County Road 105 at the northeast corner of the site. Existing development within Basin A3 includes gravel driveways. Existing peak flows from Basin A3 (Design Point #3) are calculated as $Q_5 = 3.8$ cfs and $Q_{100} = 22.4$ cfs. Off-site drainage from Basin OA2 combines with Basins A2 and A3 at Design Point #3, with existing peak flows calculated as $Q_5 = 14.2$ cfs and $Q_{100} = 69.6$ cfs.

B. Developed Drainage Plan

Developed flows have been calculated based on the impervious areas associated with the proposed site and parking improvements. Surface drainage swales and ditches will convey the majority of developed flows to the proposed private Detention Pond A near the northeast corner of the site. The primary site development impact of this project will be construction and paving (crushed asphalt) of the proposed parking lot in the northwest corner of the site, along with the proposed private access drive connection to County Road 105 at the north boundary of the property.

The northwest edge of the developed site has been delineated as Sub-Basin A1.1 (1.1-acre), which consists of the meadow / landscaped area on the northwest side of the new parking lot. The approximate area of disturbance within Sub-Basin A1.1 is limited to approximately 0.7-acres.

Developed peak flows from Basin A1.1 (Design Point A1.1a) are calculated as $Q_5 = 0.6$ cfs and $Q_{100} = 2.7$ cfs. Drainage from Basin A1.1 will be conveyed northerly along the west edge of the new parking lot by grass-lined interceptor Ditch A1.1a.

The existing off-site flows from Basin OA1.1 will combine with the on-site flow from Basin A1.1 at Design Point A1.1, with developed peak flows calculated as $Q_5 = 19.4$ cfs and $Q_{100} = 93.5$ cfs. The proposed private Culvert A1.1 (30" RCP) will convey the flow from DP-A1.1 northeasterly across the new site access drive, flowing into the proposed Channel A1.1 (trapezoidal channel; 8' bottom width; 4:1 side slopes; with turf-reinforcement mats), flowing easterly along the south side of County Road 105, allowing the off-site flows to bypass the new private detention pond.

The new parking lot in the northwest part of the property has been delineated as Sub-Basin A1.2 (6.4-acres), which will sheet flow easterly into the proposed private Detention Pond A. The new parking lot will be graded to provide positive drainage and sheet flow to an 8-foot wide curb opening along the east edge of the parking lot (see channel hydraulic calculation for Curb Chase A1.2 in Appendix C), where a riprap apron and grass-lined drainage Channel A1.2 (trapezoidal channel; 4' bottom width; 4:1 side slopes; with turf-reinforcement mats) will convey the developed flows into Detention Pond A.

Developed peak flows from Basin A1.2 are calculated as $Q_5 = 10.3$ cfs and $Q_{100} = 22.7$ cfs. The existing off-site flows from Basin OA1.2 will combine with the on-site flow from Basin A1.2 in the proposed Detention Pond A, with developed peak flows at Design Point A1.2 calculated as $Q_5 = 9.7$ cfs and $Q_{100} = 25.9$ cfs. As detailed in the detention basin calculations in Appendix D, detained peak flows from Detention Basin A are calculated as $Q_5 = 1.1$ cfs and $Q_{100} = 10.5$ cfs.

The 18" HDPE discharge pipe from Detention Pond A (along with overflows from the pond spillway) will drain northeasterly to the existing downstream drainage swale (Channel A3) flowing through Basin A3 to the existing culverts crossing County Road 105 at the northeast corner of the property. A riprap apron will be provided for erosion control at the pipe outlet.

Sub-Basin A1.3 has been delineated as a part of the central area of the property with existing agritainment facilities and minimal improvements proposed. Sub-Basin A1.3 (6.7-acres) sheet flows northeasterly, with developed peak flows calculated as $Q_5 = 2.4$ cfs and $Q_{100} = 13.5$ cfs.

Off-site drainage from Basins OA1.1-OA1.2 combines with developed flows from Basins A1.1-1.3 at Design Point #1, with developed peak flows calculated as $Q_5 = 27.4$ cfs and $Q_{100} = 118.9$ cfs. Developed flow impacts will be mitigated by routing the majority of developed flows from the site through Detention Pond A, and the resulting detained flows at Design Point #1 are calculated as $Q_5 = 22.9$ cfs and $Q_{100} = 117.5$ cfs. The calculated detained flows discharged downstream of the property will be lower than the existing flows.

No significant development impacts are planned with Basin A2, which will continue to sheet flow northeasterly across the site, with developed peak flows calculated as Q_5 = 7.4 cfs and Q_{100} = 35.1 cfs. Off-site drainage from Basin OA2 will continue to combine with Basin A2 at Design Point #2, with developed peak flows calculated as Q_5 = 15.9 cfs and Q_{100} = 76.2 cfs (no change compared to existing conditions).

No significant development impacts are planned with Basin A3, which will continue to flow northeasterly to the existing culverts at the northeast corner of the property. Developed peak flows at Design Point #A3 are calculated as Q_5 = 3.8 cfs and Q_{100} = 22.4 cfs (no change compared to existing conditions). Off-site drainage from Basin OA2 will continue to combine with Basins A2 and A3 at Design Point #3, with developed peak flows calculated as Q_5 = 14.2 cfs and Q_{100} = 69.6 cfs (no change compared to existing conditions).

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

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: The majority of developed flows from the site will be routed through the proposed on-site Detention Basin A, which will be grass-lined to encourage stormwater infiltration. Grass-lined swales, ditches, and channels will also encourage stormwater infiltration within the property.

Step 2: Stabilize Drainageways

- The existing major drainage channel identified as an Unnamed Tributary of West Cherry Creek flows northerly along the east side of this property. No significant development impacts are planned within the existing drainageway. 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 majority of the developed site will drain through an on-site Private Full-Spectrum Extended Detention Basin (EDB) at the northeast 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

- No industrial uses are proposed for this site.
- 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) 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. 08041C0285G, dated December 7, 2018, the northeast corner of this site is impacted by the delineated 100-year FEMA floodplain. No significant impacts to the existing floodplain are proposed.

V. STORMWATER DETENTION AND WATER QUALITY

Proposed drainage improvements will include construction of a new Private Full-Spectrum Extended Detention Basin (EDB) 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.

The proposed Detention Basin has been designed utilizing the Denver Mile High Flood District's "MH-Detention_v4.06" software package. Calculations and details for the proposed Detention Basin are enclosed in Appendix D, and design parameters for the Detention Basin are summarized as follows:

Detention Basin	Tributary Drainage Basins	Tributary Area (ac)	Impervious Percentage	Min. 100-Yr FSD Vol. (af)	Design Volume (af)
A	OA1.2, A1.2	10.8	35.0	0.79	0.9

The proposed on-site Full-Spectrum Detention Pond A provides a storage volume of 0.9 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.

A concrete forebay has been designed at the entrance to the proposed detention pond (see "UD-BMP" calculation in Appendix D). A concrete trickle channel will be provided along the bottom of the pond between the forebay and outlet structure.

A buried riprap spillway will be provided for stabilization of the pond overflow spillway, which has been sized to convey the fully-developed flow entering the detention pond in the event of a fully clogged condition. Based on the relatively low developed peak flow entering the pond at Design Point A1.2 (Q_{100} = 25.9 cfs), buried riprap will provide appropriate stabilization and there is no need for concrete cutoff walls for the spillway or underground piping.

The new on-site Detention Basin will be privately owned and maintained by the property owner, and maintenance access will be provided from the gravel driveways along the south and east boundaries of the site.

As detailed in the detention basin calculations in Appendix D, detained peak flows from Detention Basin A are calculated as Q_5 = 0.3 cfs and Q_{100} = 10.2 cfs. The combined detained flows at Design Point #1 are calculated as Q_5 = 22.1 cfs and Q_{100} = 117.2 cfs, and the detained flows are below the calculated existing condition flows.

The estimated cost of the proposed private detention facilities is approximately $32,376 (see estimate in Appendix D).

Areas Excluded from Water Quality Facilities

Basin A1.1 is excluded from permanent water quality requirements based on ECM Appendix I.7.1.C.1, which allows for 20%, not to exceed 1-acre, of the applicable development site area to not be captured. While the total area of Basin A1.1 is 1.1-acres, the proposed soil disturbance is limited to approximately 0.7-acres, which is below the 1-acre limit for exclusion. The soil disturbance area within Basin A1.1 is also less than 20% of the "applicable development site," which is defined as the total non-excluded disturbed area (combined area of Basins A1.1 and A1.2 consists of 7.5-acres). The disturbed area of 0.7-acres within Basin A1.1 amounts to approximately 9.3% of the applicable development site, which is less than the 20% limit for exclusion.

The existing developed areas in the south and east parts of the site (Basins A1.3, A2, and A3) are excluded from permanent water quality requirements because there are no significant improvements or soil disturbance proposed in these basins.

VI. DRAINAGE BASIN FEES

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 West Cherry Creek Drainage Basin, which is ultimately tributary to the South Platte River.

Drainage and bridge fees are not applicable at this time as no subdivision platting is proposed.

VII. SUMMARY

The developed drainage patterns for the proposed site development on the Colorado Kids Ranch site will remain consistent with the established drainage plan for this site. Developed flows from the site will drain through a Private Full-Spectrum Detention Pond at the northeast corner of the property prior to discharging to the existing downstream drainage channel. The proposed on-site Detention Pond has been designed to provide both stormwater detention and water quality requirements for the site. 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

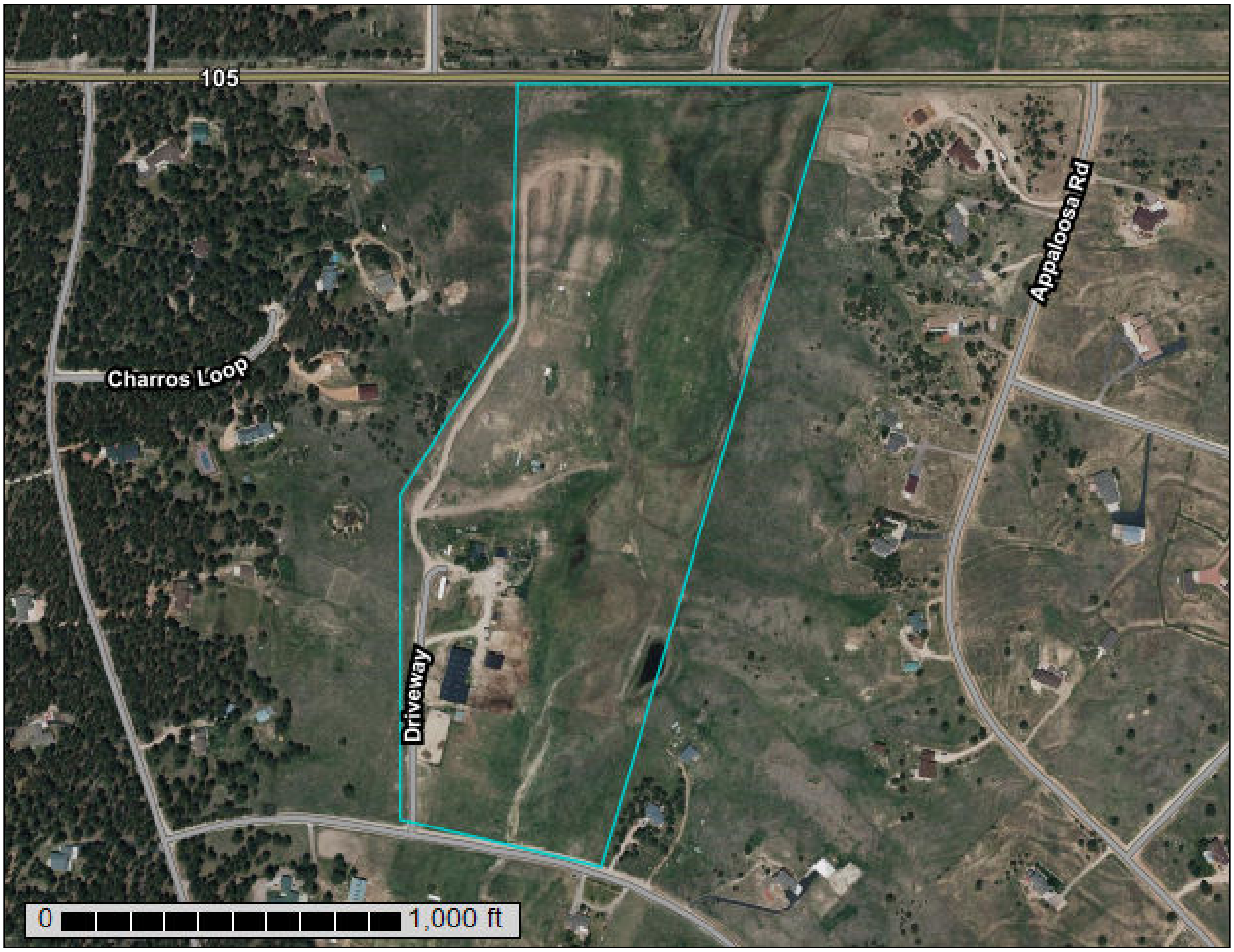
United States
Department of
Agriculture

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



December 5, 2023

Preface

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

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

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

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

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

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

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

Contents

How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

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

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

Soil Map

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

Soil Map

Map Scale: 1:4,100 if printed on A portrait (8.5" x 11") sheet.

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 21, Aug 24, 2023

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

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

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	23.5	57.3%
101	Ustic Torrifluvents, loamy	17.5	42.7%
Totals for Area of Interest		**41.0**	**100.0%**

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

El Paso County Area, Colorado

92—Tomah-Crowfoot loamy sands, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 36b9
Elevation: 7,300 to 7,600 feet
Farmland classification: Not prime farmland

Map Unit Composition

Tomah and similar soils: 50 percent
Crowfoot and similar soils: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tomah

Setting

Landform: Hills, alluvial fans
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from arkose and/or residuum weathered from arkose

Typical profile

A - 0 to 10 inches: loamy sand
E - 10 to 22 inches: coarse sand
Bt - 22 to 48 inches: stratified coarse sand to sandy clay loam
C - 48 to 60 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.6 inches)

Interpretive groups

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

Description of Crowfoot

Setting

Landform: Alluvial fans, hills
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear
Across-slope shape: Linear

Parent material: Alluvium

Typical profile

A - 0 to 12 inches: loamy sand
E - 12 to 23 inches: sand
Bt - 23 to 36 inches: sandy clay loam
C - 36 to 60 inches: coarse sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.7 inches)

Interpretive groups

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

Minor Components

Other soils

Percent of map unit:
Hydric soil rating: No

Pleasant

Percent of map unit:
Landform: Depressions
Hydric soil rating: Yes

101—Ustic Torrifluvents, loamy

Map Unit Setting

National map unit symbol: 3673
Elevation: 5,500 to 7,000 feet
Mean annual precipitation: 13 to 16 inches
Mean annual air temperature: 47 to 52 degrees F
Frost-free period: 125 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition

Ustic torrifluvents and similar soils: 95 percent

Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ustic Torrifluvents

Setting

Landform: Flood plains, stream terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy, clayey, stratified loamy

Typical profile

A - 0 to 6 inches: variable
C - 6 to 60 inches: stratified loamy sand to clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R069XY037CO - Saline Overflow
Other vegetative classification: OVERFLOW (069BY036CO)
Hydric soil rating: No

Minor Components

Other soils

Percent of map unit: 4 percent
Hydric soil rating: No

Pleasant

Percent of map unit: 1 percent
Landform: Depressions
Hydric soil rating: Yes

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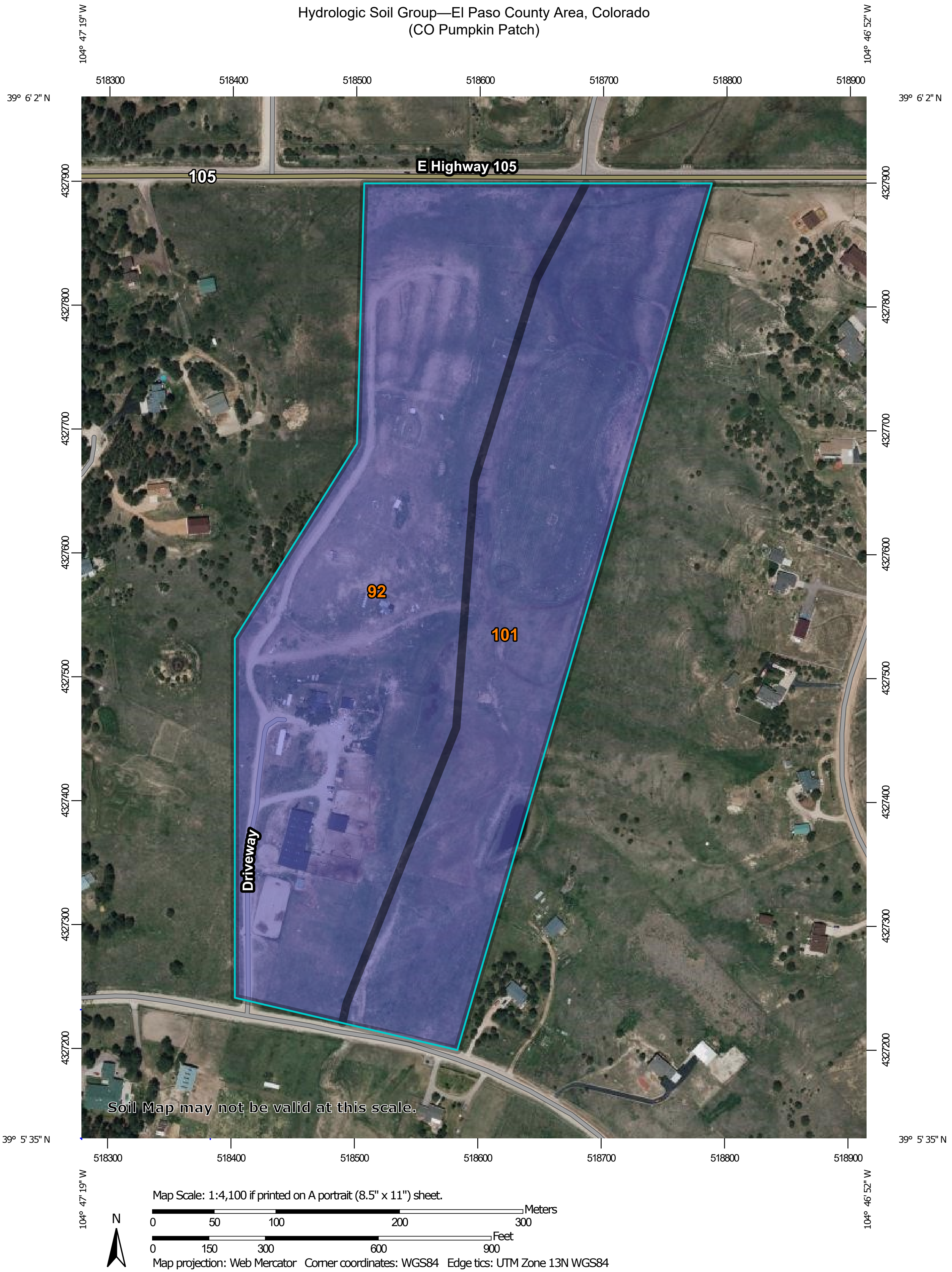
Hydrologic Soil Group—El Paso County Area, Colorado
(CO Pumpkin Patch)



Map Scale: 1:4,100 if printed on A portrait (8.5" x 11") sheet.

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

MAP LEGEND

Area of Interest (AOI)

- ▭ Area of Interest (AOI)

Soils

Soil 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.

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Survey Area Data: Version 21, Aug 24, 2023

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

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

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
92	Tomah-Crowfoot loamy sands, 3 to 8 percent slopes	B	23.5	57.3%
101	Ustic Torrifluvents, loamy	B	17.5	42.7%
Totals for Area of Interest			**41.0**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

APPENDIX B

HYDROLOGIC CALCULATIONS

Table 6-6. Runoff Coefficients for Rational Method

(Source: UDFCD 2001)

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

3.2 Time of Concentration

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

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

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

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.

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

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).

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

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.

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

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.

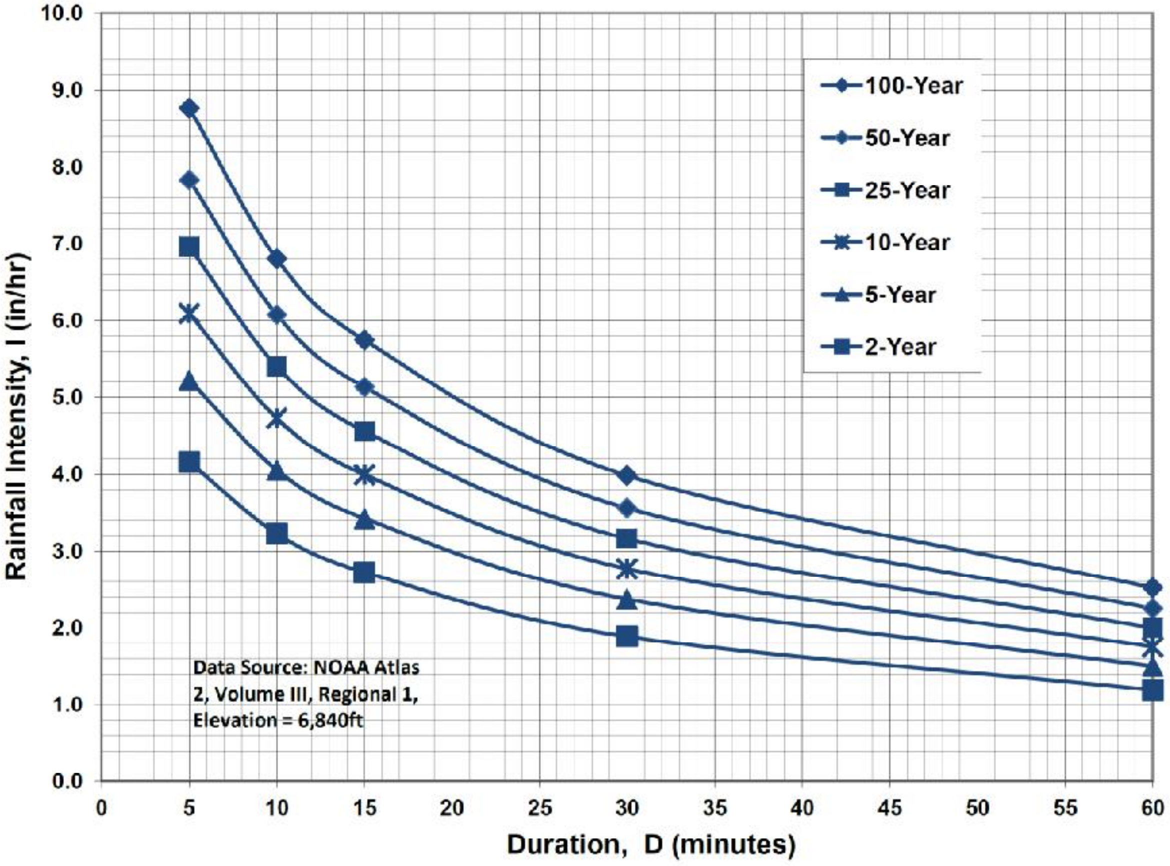
3.2.4 Minimum Time of Concentration

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.

CO PUMPKIN PATCH
COMPOSITE RUNOFF COEFFICIENTS

EXISTING CONDITIONS

5-YEAR C-VALUES

BASIN	TOTAL AREA (AC)	AREA (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1.1	72.7	72.7	5-AC LOTS	0.137							0.137
OA1.2	4.4	4.4	5-AC LOTS	0.137							0.137
A1	14.2	0.038	BUILDING / PAVEMENT	0.900	0.447	GRAVEL	0.70	13.72	MEADOW	0.08	0.102
OA1.1,OA1.2,A1	91.3										0.132
OA2,A2	26.8	26.80	5-AC LOTS	0.137							0.137
A2	18.5	0.434	BUILDING / PAVEMENT	0.9	1.120	GRAVEL	0.70	16.95	MEADOW	0.08	0.137
OA2,A2	45.3										0.137
A3	7.6	0.000	BUILDING / PAVEMENT	0.9	0.291	GRAVEL	0.70	7.31	MEADOW	0.08	0.104
OA2,A2,A3	52.9										0.132

100-YEAR C-VALUES

BASIN	TOTAL AREA (AC)	AREA (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1.1	72.7	72.7	5-AC LOTS	0.393							0.393
OA1.2	4.4	4.4	5-AC LOTS	0.393							0.393
A1	14.2	0.038	BUILDING / PAVEMENT	0.960	0.447	GRAVEL	0.74	13.72	MEADOW	0.35	0.364
OA1.1,OA1.2,A1	91.3										0.388
OA2	26.8	26.80	5-AC LOTS	0.393							0.393
A2	18.5	0.434	BUILDING / PAVEMENT	0.960	1.120	GRAVEL	0.74	16.95	MEADOW	0.35	0.388
OA2,A2	45.3										0.391
A3	7.6	0.000	BUILDING / PAVEMENT	0.960	0.291	GRAVEL	0.74	7.31	MEADOW	0.35	0.365
OA2,A2,A3	52.9										0.387

CO PUMPKIN PATCH
RATIONAL METHOD

EXISTING CONDITIONS FLOWS

			C		Overland Flow			Channel flow							INTENSITY $^{(5)}$		PEAK FLOW	
BASIN	**DESIGN POINT**	**AREA (AC)**	**5-YEAR**	**100-YEAR**	**LENGTH (FT)**	**SLOPE (FT/FT)**	**Tco $^{(1)}$ (MIN)**	**CHANNEL LENGTH (FT)**	**CONVEYANCE COEFFICIENT C**	**SLOPE (FT/FT)**	**SCS $^{(2)}$ VELOCITY (FT/S)**	**Tt $^{(3)}$ (MIN)**	**TOTAL Tc $^{(4)}$ (MIN)**	**TOTAL Tc $^{(4)}$ (MIN)**	**5-YR (IN/HR)**	**100-YR (IN/HR)**	**Q5 $^{(6)}$ (CFS)**	**Q100 $^{(6)}$ (CFS)**
OA1.1	OA1.1	72.7	0.137	0.393	300	0.040	19.2	3325	15	0.034	2.77	20.0	39.3	39.3	2.08	3.48	20.69	99.56
OA1.2	OA1.2	4.4	0.137	0.393	300	0.067	16.2	280	15	0.036	2.85	1.6	17.8	17.8	3.26	5.47	1.97	9.46
A1	A1	14.2	0.102	0.364	100	0.010	18.3	1510	15	0.029	2.55	9.9	28.1	28.1	2.58	4.33	3.73	22.36
Tt OA1.1-DP1								880	15	0.026	2.42	6.1						
OA1,A1	1	91.3	0.132	0.388									39.3	39.3	2.08	3.48	25.03	123.45
OA2	OA2	26.8	0.137	0.393	300	0.020	24.2	790	15	0.044	3.15	4.2	28.4	28.4	2.56	4.30	9.41	45.29
A2	A2	18.5	0.137	0.388	100	0.030	12.2	1300	15	0.02	2.12	10.2	22.4	22.4	2.92	4.90	7.39	35.14
Tt OA2 -DP-A2								850	15	0.042	3.07	4.6						
OA2,A2	2	45.3	0.137	0.391									28.4	28.4	2.56	4.30	15.90	76.16
A3	A3	7.6	0.104	0.365	100	0.290	5.9	90	15	0.067	3.88	0.4	6.3	6.3	4.82	8.09	3.81	22.43
Tt DP2-DP3								1200	15	0.012	1.64	12.2						
OA2,A2,A3	3	52.9	0.132	0.387									40.6	40.6	2.03	3.40	14.16	69.64

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))

2) SCS VELOCITY = C * ((SLOPE(FT/FT)^0.5)

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) Tc = Tco + Tt

*** 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

$I_5 = -1.5 * \ln(Tc) + 7.583$

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

6) Q = CiA

CO PUMPKIN PATCH
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS

5-YEAR C-VALUES

BASIN	TOTAL AREA (AC)	AREA (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1.1	72.7	72.7	5-AC LOTS	0.137							0.137
A1.1	1.1	0.00	BUILDING / PAVEMENT	0.900	0.124	GRAVEL	0.70	0.98	MEADOW	0.08	0.150
OA1.1,A1.1	73.8										0.137
OA1.2	4.4	4.4	5-AC LOTS	0.137							0.137
A1.2	6.4	0.005	BUILDING / PAVEMENT	0.900	3.650	GRAVEL	0.70	2.75	MEADOW	0.08	0.434
OA1.2,A1.2	10.8										0.313
A1.3	6.7	0.034	BUILDING / PAVEMENT	0.900	0.262	GRAVEL	0.70	6.40	MEADOW	0.08	0.108
OA1,A1.1-A1.3	91.3										0.156
OA2	26.8	26.80	5-AC LOTS	0.137							0.137
A2	18.5	0.434	BUILDING / PAVEMENT	0.9	1.120	GRAVEL	0.70	16.95	MEADOW	0.08	0.137
OA2,A2	45.3										0.137
A3	7.6	0.000	BUILDING / PAVEMENT	0.9	0.291	GRAVEL	0.70	7.31	MEADOW	0.08	0.104
OA2,A2,A3	52.9										0.132

100-YEAR C-VALUES

BASIN	TOTAL AREA (AC)	AREA (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1.1	72.7	72.7	5-AC LOTS	0.393							0.393
A1.1	1.1	0.00	BUILDING / ASPHALT	0.960	0.124	GRAVEL	0.74	0.98	MEADOW	0.35	0.394
OA1.1,A1.1	73.8										0.393
OA1.2	4.4	4.4	5-AC LOTS	0.393							0.393
A1.2	6.4	0.005	BUILDING / PAVEMENT	0.960	3.650	GRAVEL	0.74	2.75	MEADOW	0.35	0.573
OA1.2,A1.2	10.8										0.500
A1.3	6.7	0.034	BUILDING / PAVEMENT	0.960	0.262	GRAVEL	0.74	6.40	MEADOW	0.35	0.368
OA1,A1.1-A1.3	91.3										0.404
OA2	26.8	26.80	5-AC LOTS	0.393							0.393
A2	18.5	0.434	BUILDING / ASPHALT	0.960	1.12	GRAVEL	0.74	16.95	MEADOW	0.35	0.388
OA2,A2	45.3										0.391
A3	7.6	0.000	BUILDING / PAVEMENT	0.960	0.291	GRAVEL	0.74	7.31	MEADOW	0.35	0.365
OA2,A2,A3	52.9										0.387

CO PUMPKIN PATCH
RATIONAL METHOD

DEVELOPED FLOWS

					Overland Flow			Channel flow										
			C												INTENSITY (5)		PEAK FLOW	
BASIN	DESIGN POINT	AREA (AC)	5-YEAR	100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco (1) (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS (2) VELOCITY (FT/S)	Tt (3) (MIN)	TOTAL Tc (4) (MIN)	TOTAL Tc (4) (MIN)	5-YR (IN/HR)	100-YR (IN/HR)	Q5 (6) (CFS)	Q100 (6) (CFS)
OA1.1	OA1.1	72.7	0.137	0.393	300	0.040	19.2	3325	15	0.034	2.77	20.0	39.3	39.3	2.08	3.48	20.69	99.56
A1.1	A1.1a	1.1	0.150	0.394	55	0.146	5.3	1100	15	0.022	2.22	8.2	13.5	13.5	3.68	6.17	0.61	2.68
Tt OA1.1 A1.1								690	15	0.032	2.68	4.3						
OA1.1,A1.1	A1.1	73.8	0.137	0.393									43.6	43.6	1.92	3.22	19.43	93.50
OA1.2	OA1.2	4.4	0.137	0.393	300	0.067	16.2	280	15	0.036	2.85	1.6	17.8	17.8	3.26	5.47	1.97	9.46
A1.2	A1.2	6.4	0.434	0.573	100	0.040	7.7	1080	15	0.044	3.15	5.7	13.4	13.4	3.69	6.19	10.25	22.71
Tt OA1.2 -A1.2								1090	15	0.048	3.29	5.5						
OA1.2,A1.2	**A1.2**	**10.8**	**0.313**	**0.500**									**23.4**	**23.4**	**2.86**	**4.79**	**9.65**	**25.88**
A1.3	A1.3	6.7	0.108	0.368	100	0.020	14.4	670	15	0.048	3.29	3.4	17.8	17.8	3.26	5.48	2.36	13.50
OA1,A1.1-A1.3	**1**	**91.3**	**0.156**	**0.404**									**43.6**	**43.6**	**1.92**	**3.22**	**27.37**	**118.91**
OA2	OA2	26.8	0.137	0.393	300	0.020	24.2	790	15	0.044	3.15	4.2	28.4	28.4	2.56	4.30	9.41	45.29
A2	A2	18.5	0.137	0.388	100	0.030	12.2	1300	15	0.02	2.12	10.2	22.4	22.4	2.92	4.90	7.39	35.14
Tt OA2 -DP-A2								850	15	0.042	3.07	4.6						
OA2,A2	2	45.3	0.137	0.391									28.4	28.4	2.56	4.30	15.90	76.16
A3	A3	7.6	0.104	0.365	100	0.290	5.9	90	15	0.067	3.88	0.4	6.3	6.3	4.82	8.09	3.81	22.43
Tt DP2-DP3								1200	15	0.012	1.64	12.2						
OA2,A2,A3	3	52.9	0.132	0.387									40.6	40.6	2.03	3.40	14.16	69.64

DETAINED CONDITIONS

					Overland Flow			Channel flow										
			C												INTENSITY (5)		PEAK FLOW	
BASIN	DESIGN POINT	AREA (AC)	5-YEAR	100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco (1) (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS (2) VELOCITY (FT/S)	Tt (3) (MIN)	TOTAL Tc (4) (MIN)	TOTAL Tc (4) (MIN)	5-YR (IN/HR)	100-YR (IN/HR)	Q5 (6) (CFS)	Q100 (6) (CFS)
OA1.1,A1.1	A1.1	73.8															19.43	93.50
POND A OUTFLOW	**A1.2**	**10.8**															**1.10**	**10.50**
A1.3	A1.3	6.7															2.36	13.50
OA1,A1.1-A1.3	**1**	**91.3**															**22.89**	**117.51**

1) OVERLAND FLOW Tco = (0.395*(1.1-RUNOFF COEFFICIENT)*(OVERLAND FLOW LENGTH^(0.5)/(SLOPE^(0.333))
2) SCS VELOCITY = C * ((SLOPE(FT/FT)^0.5)
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) Tc = Tco + Tt
*** 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
$I_5 = -1.5 * \ln(Tc) + 7.583$
$I_{100} = -2.52 * \ln(Tc) + 12.735$
6) Q = CiA

APPENDIX C

HYDRAULIC CALCULATIONS

CO PUMPKIN PATCH
CHANNEL CALCULATIONS
DEVELOPED FLOWS

PROPOSED CHANNELS

CHANNEL	DESIGN POINT	PROPOSED SLOPE (%)	BOTTOM WIDTH (B, FT)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)	DP	Q100 FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	CHANNEL LINING
DITCH A1.1a	A1.1a	0.015	0	3:1	1.5	0.030	A1.1a	2.7	0.6	2.6	GRASS
CHANNEL A1.1	A1.1	0.040	8	4:1	2.0	0.030	A1.1	93.5	1.0	8.0	**GRASS / TRM**
CURB CHASE A1.2	A1.2	0.020	8	0:1	0.5	0.013	A1.2	25.9	0.4	8.2	**CONCRETE**
CHANNEL A1.2	A1.2	0.052	8	4:1	2.0	0.030	A1.2	25.9	0.4	5.9	**GRASS / TRM**
CHANNEL A3	A1.1	0.004	8	4:1	3.0	0.030	A1.1	93.5	1.8	3.5	GRASS

1) Channel flow calculations based on Manning's Equation
2) n = 0.03 for grass-lined non-irrigated channels (minimum)
3) Vmax = 4.0 fps for 100-year flows w/ grass-lined channels
4) Vmax = 8.0 fps for 100-year flows w/ Erosion Control Blankets / Turf Reinforcement Mats (Eronet SC150 or equal)

The complete line of RollMax™ products offers a variety of options for both short-term and permanent erosion control needs. Reference the RollMax Products Chart below to find the right solution for your next project.

RollMax Product Selection Chart

	TEMPORARY						
	ERONET						BIONET
							
	DS75	**DS150**	**S75**	**S150**	**SC150**	**C125**	**S75BN**
Longevity	45 days	60 days	12 mo.	12 mo.	24 mo.	36 mo.	12 mo.
Applications	Low Flow Channels 4:1-3:1 Slopes	Moderate Flow Channels 3:1-2:1 Slopes	Low Flow Channels 4:1-3:1 Slopes	Moderate Flow Channels 3:1-2:1 Slopes	Medium Flow Channels 2:1-1:1 Slopes	High-Flow Channels 1:1 and Greater Slopes	Low Flow Channels 4:1-3:1 Slopes
Design Permissible Shear Stress lbs/ft^2 (Pa)	Unvegetated 1.55 (74)	Unvegetated 1.75 (84)	Unvegetated 1.55 (74)	Unvegetated 1.75 (84)	Unvegetated 2.00 (96)	Unvegetated 2.25 (108)	Unvegetated 1.60 (76)
Design Permissible Velocity ft/s (m/s)	Unvegetated 5.00 (1.52)	Unvegetated 6.00 (1.52)	Unvegetated 5.00 (1.2)	Unvegetated 6.00 (1.83)	Unvegetated 8.00 (2.44)	Unvegetated 10.00 (3.05)	Unvegetated 5.00 (1.52)
Top Net	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft^2 (0.73 kg/100 m^2) approx wt	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft^2 (0.73 kg/100 m^2) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft^2 (0.73 kg/100 m^2) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft^2 (0.73 kg/100 m^2) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft^2 (1.47 kg/100 m^2) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft^2 (1.47 kg/100 m^2) approx wt	Leno woven. 100% biodegradable jute fiber 9.30 lbs/1000 ft^2 (4.53 kg/100 m^2) approx wt
Center Net	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fiber Matrix	Straw fiber 0.50 lbs/yd^2 (0.27 kg/m^2)	Straw fiber 0.50 lbs/yd^2 (0.27 kg/m^2)	Straw fiber 0.50 lbs/yd^2 (0.27 kg/m^2)	Straw fiber 0.50 lbs/yd^2 (0.27 kg/m^2)	Straw/coconut matrix 70% Straw 0.35 lbs/yd^2 (0.19 kg/m^2) 30% Coconut 0.15 lbs/yd^2 (0.08 kg/m^2)	Coconut fiber 0.50 lbs/yd^2 (0.27 kg/m^2)	Straw fiber 0.50 lbs/yd^2 (0.27 kg/m^2)
Bottom Net	N/A	Lightweight accelerated photodegradable polypropylene 1.50 lbs/1000 ft^2 (0.73 kg/100 m^2) approx wt	N/A	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft^2 (0.73 kg/100 m^2) approx wt	Lightweight photodegradable polypropylene 1.50 lbs/1000 ft^2 (0.73 kg/100 m^2) approx wt	Heavyweight UV-stabilized polypropylene 2.9 lbs/1000 ft^2 (1.47 kg/100 m^2) approx wt	N/A
Thread	Accelerated degradable	Accelerated degradable	Degradable	Degradable	Degradable	UV-stabilized polypropylene	Biodegradable

Hydraulic Analysis Report

Project Data

Project Title: Project - CO Pumpkin Patch
Designer: JPS
Project Date: Thursday, January 11, 2024
Project Units: U.S. Customary Units
Notes:

Channel Analysis: Channel Analysis-A1.1a

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 3.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0150 ft/ft
Manning's n: 0.0300
Flow: 2.7000 cfs

Result Parameters

Depth: 0.5891 ft
Area of Flow: 1.0412 ft^2
Wetted Perimeter: 3.7260 ft
Hydraulic Radius: 0.2795 ft
Average Velocity: 2.5931 ft/s
Top Width: 3.5348 ft
Froude Number: 0.8420
Critical Depth: 0.5500 ft
Critical Velocity: 2.9756 ft/s
Critical Slope: 0.0217 ft/ft
Critical Top Width: 3.30 ft
Calculated Max Shear Stress: 0.5514 lb/ft^2
Calculated Avg Shear Stress: 0.2616 lb/ft^2

Channel Analysis: Channel Analysis-A1.1

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0400 ft/ft

Manning's n: 0.0300

Flow: 93.5000 cfs

Result Parameters

Depth: 0.9801 ft

Area of Flow: 11.6829 ft^2

Wetted Perimeter: 16.0820 ft

Hydraulic Radius: 0.7265 ft

Average Velocity: 8.0032 ft/s

Top Width: 15.8407 ft

Froude Number: 1.6423

Critical Depth: 1.2966 ft

Critical Velocity: 5.4688 ft/s

Critical Slope: 0.0137 ft/ft

Critical Top Width: 18.37 ft

Calculated Max Shear Stress: 2.4463 lb/ft^2

Calculated Avg Shear Stress: 1.8132 lb/ft^2

Channel Analysis: Curb-Chase-A1.2

Notes:

Input Parameters

Channel Type: Rectangular

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0200 ft/ft

Manning's n: 0.0130

Flow: 25.9000 cfs

Result Parameters

Depth: 0.3961 ft

Area of Flow: 3.1685 ft^2

Wetted Perimeter: 8.7921 ft

Hydraulic Radius: 0.3604 ft

Average Velocity: 8.1741 ft/s

Top Width: 8.0000 ft

Froude Number: 2.2889

Critical Depth: 0.6879 ft

Critical Velocity: 4.7064 ft/s

Critical Slope: 0.0034 ft/ft

Critical Top Width: 8.00 ft

Calculated Max Shear Stress: 0.4943 lb/ft^2

Calculated Avg Shear Stress: 0.4498 lb/ft^2

Channel Analysis: Channel Analysis-A1.2

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0520 ft/ft

Manning's n: 0.0300

Flow: 25.9000 cfs

Result Parameters

Depth: 0.4489 ft

Area of Flow: 4.3976 ft^2

Wetted Perimeter: 11.7020 ft

Hydraulic Radius: 0.3758 ft

Average Velocity: 5.8896 ft/s

Top Width: 11.5915 ft

Froude Number: 1.6851

Critical Depth: 0.6167 ft

Critical Velocity: 4.0127 ft/s

Critical Slope: 0.0168 ft/ft

Critical Top Width: 12.93 ft

Calculated Max Shear Stress: 1.4567 lb/ft^2

Calculated Avg Shear Stress: 1.2194 lb/ft^2

Channel Analysis: Channel Analysis-A3

Notes:

Input Parameters

Channel Type: Trapezoidal

Side Slope 1 (Z1): 4.0000 ft/ft

Side Slope 2 (Z2): 4.0000 ft/ft

Channel Width: 8.0000 ft

Longitudinal Slope: 0.0040 ft/ft

Manning's n: 0.0300

Flow: 93.5000 cfs

Result Parameters

Depth: 1.7705 ft

Area of Flow: 26.7022 ft^2

Wetted Perimeter: 22.5997 ft

Hydraulic Radius: 1.1815 ft

Average Velocity: 3.5016 ft/s

Top Width: 22.1638 ft

Froude Number: 0.5622

Critical Depth: 1.2961 ft

Critical Velocity: 5.4719 ft/s

Critical Slope: 0.0138 ft/ft

Critical Top Width: 18.37 ft

Calculated Max Shear Stress: 0.4419 lb/ft^2

Calculated Avg Shear Stress: 0.2949 lb/ft^2

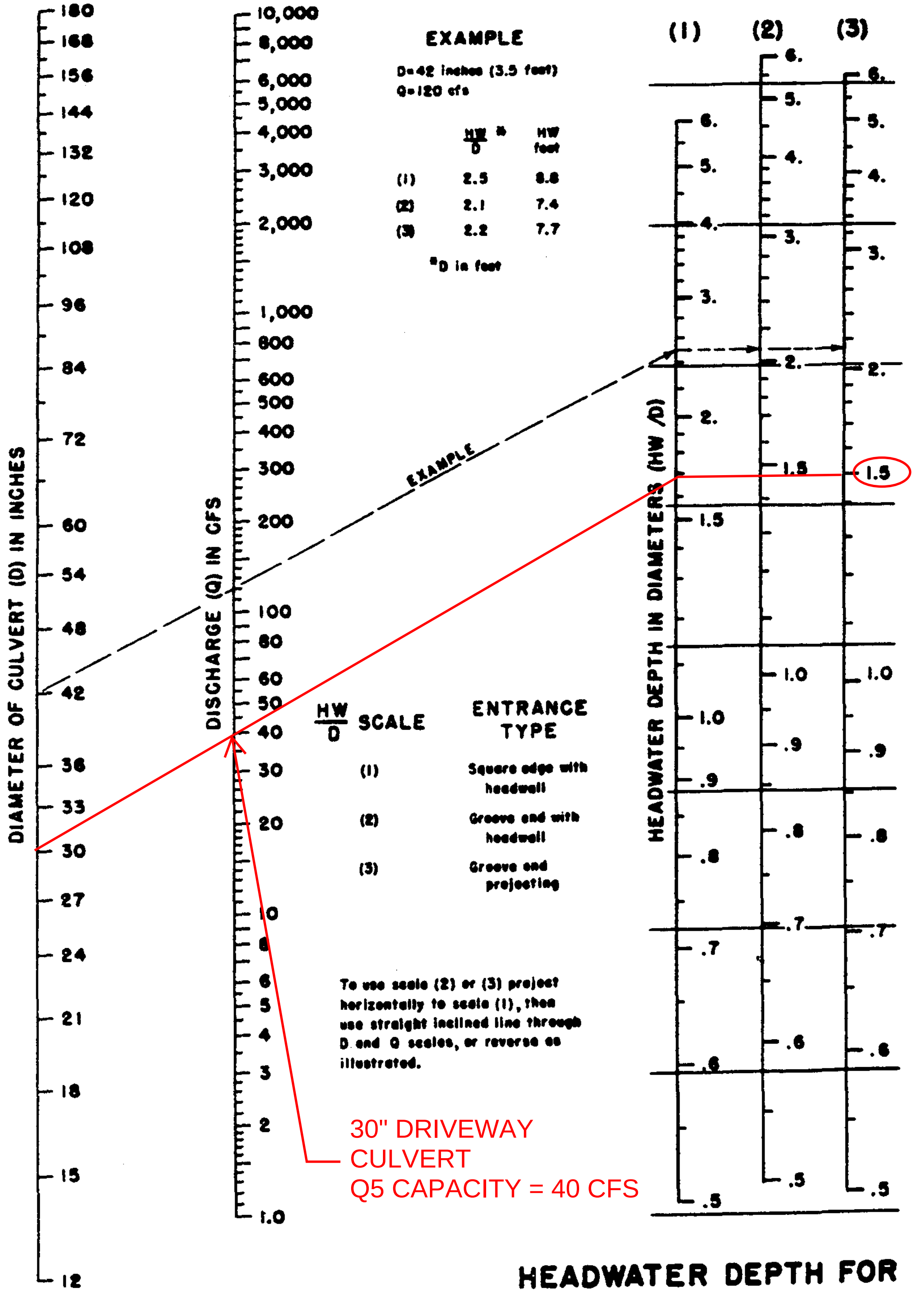
JPS ENGINEERING

CO PUMPKIN PATCH
DRIVEWAY CULVERT SIZING SUMMARY

PRIVATE CULVERT	DP	Q5 FLOW (CFS)	CULVERT SIZE (IN)
A1.1	A1.1	19.4	30

* CULVERT SIZING BASED ON EPC DCM, FIG. 9-34; ASSUMING MAX. ALLOWABLE HW/D = 1.5 FOR Q5

PRIVATE DRIVEWAY CULVERT A1.1



EXAMPLE

D=42 inches (3.5 feet)
Q=120 cfs

	$\frac{HW}{D}$ *	HW feet
(1)	2.5	8.8
(2)	2.1	7.4
(3)	2.2	7.7

*D in feet

$\frac{HW}{D}$ SCALE	ENTRANCE TYPE
(1)	Square edge with headwall
(2)	Groove end with headwall
(3)	Groove end projecting

To use scale (2) or (3) project horizontally to scale (1), then use straight inclined line through D and Q scales, or reverse as illustrated.

30" DRIVEWAY
CULVERT
Q5 CAPACITY = 40 CFS

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HDR Infrastructure, Inc.
A Centerra Company

The City of Colorado Springs / El Paso County
Drainage Criteria Manual

Date
OCT. 1987

Figure
9-34

APPENDIX D

DETENTION POND CALCULATIONS

CO PUMPKIN PATCH
IMPERVIOUS AREA CALCULATIONS

IMPERVIOUS AREAS - DEVELOPED CONDITIONS

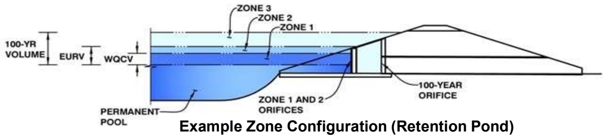
BASIN	TOTAL AREA (AC)	AREA (AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
OA1.1	72.7	72.7	5-AC LOTS	7.0							7.00
A1.1	1.1	0.00	BUILDING / PAVEMENT	100	0.124	GRAVEL	80	0.98	MEADOW	0	9.018
OA1.1,A1.1	73.8										7.030
OA1.2	4.4	4.4	5-AC LOTS	7.0							7.00
A1.2	**6.4**	**0.005**	**BUILDING / PAVEMENT**	**100**	**3.650**	**ASPHALT MILLINGS**	**90**	**2.75**	**MEADOW**	**0**	**51.406**
OA1.2,A1.2	**10.8**										**33.315**
A1.3	6.7	0.034	BUILDING / PAVEMENT	100	0.262	GRAVEL	80	6.40	MEADOW	0	3.636
OA1,A1.1-A1.3	91.3										9.890
OA2	26.8	26.80	5-AC LOTS	7.0							7.00
A2	18.5	0.434	BUILDING / PAVEMENT	100	1.120	GRAVEL	80	16.95	MEADOW	0	7.189
OA2,A2	45.3										7.077
A3	7.6	0.000	BUILDING / PAVEMENT	100	0.291	GRAVEL	80	7.31	MEADOW	0	3.063

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: **Colorado Kids Ranch (CO Pumpkin Patch LLC) - 18065 Saddlewood Road, Monument, CO 80132**

Basin ID: **Full-Spectrum Detention Pond A**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	10.80	acres
Watershed Length =	1,670	ft
Watershed Length to Centroid =	835	ft
Watershed Slope =	0.049	ft/ft
Watershed Imperviousness =	35.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	100.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.150	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.393	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.389	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.604	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.800	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.086	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	1.308	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	1.600	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	2.170	acre-feet	3.14	inches
Approximate 2-yr Detention Volume =	0.286	acre-feet		
Approximate 5-yr Detention Volume =	0.403	acre-feet		
Approximate 10-yr Detention Volume =	0.569	acre-feet		
Approximate 25-yr Detention Volume =	0.647	acre-feet		
Approximate 50-yr Detention Volume =	0.680	acre-feet		
Approximate 100-yr Detention Volume =	0.791	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.150	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.243	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.398	acre-feet
Total Detention Basin Volume =	0.791	acre-feet

Depth Increement = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	10	0.000		
Bot EL=7310.0	--	1.00	--	--	--	9,174	0.211	4,592	0.105
	--	3.00	--	--	--	12,763	0.293	26,529	0.609
Spillway=7313.0	--	4.00	--	--	--	15,193	0.349	40,507	0.930
Top EL=7315.0	--	6.00	--	--	--	20,050	0.460	75,750	1.739
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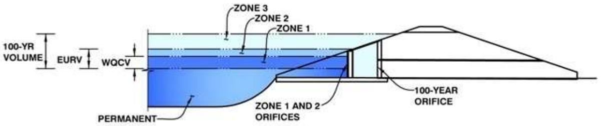
DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Colorado Kids Ranch (CO Pumpkin Patch LLC) - 18065 Saddlewood Road, Monument, CO 80132
Basin ID: Full-Spectrum Detention Pond A



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.21	0.150	Orifice Plate
Zone 2 (EURV)	2.22	0.243	Orifice Plate
Zone 3 (100-year)	3.59	0.398	Weir&Pipe (Restrict)
Total (all zones)		0.791	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.22	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	8.90	inches
Orifice Plate: Orifice Area per Row =	1.35	sq. inches (diameter = 1-5/16 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	9.375E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.74	1.48					
Orifice Area (sq. inches)	1.35	1.35	1.35					

	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)

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

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.60	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	2.50	N/A	feet
Overflow Grate Type =	Type C Grate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	2.60	N/A	feet
Overflow Weir Slope Length =	2.50	N/A	feet
Grate Open Area / 100-yr Orifice Area =	5.41	N/A	
Overflow Grate Open Area w/o Debris =	6.96	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.48	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	12.30		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	1.29	N/A	ft^2
Outlet Orifice Centroid =	0.57	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.95	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	5.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.84	feet
Stage at Top of Freeboard =	5.84	feet
Basin Area at Top of Freeboard =	0.45	acres
Basin Volume at Top of Freeboard =	1.67	acre-ft

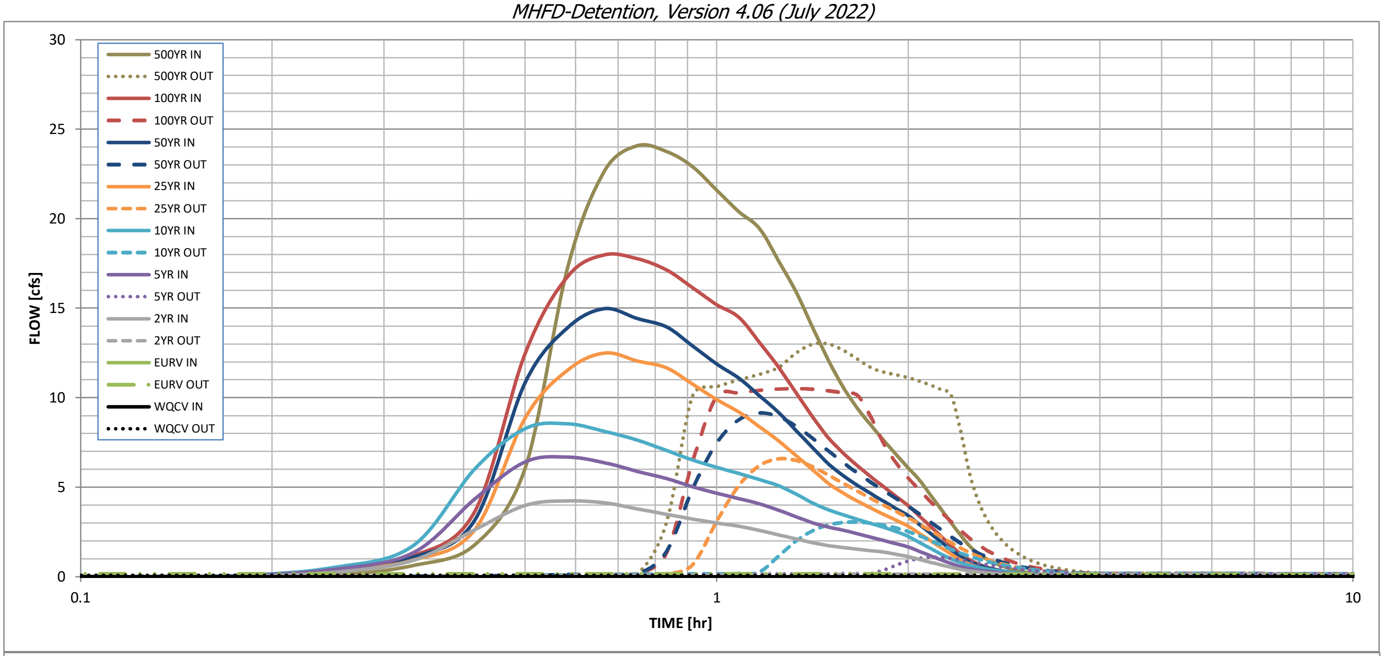
Routed Hydrograph Results

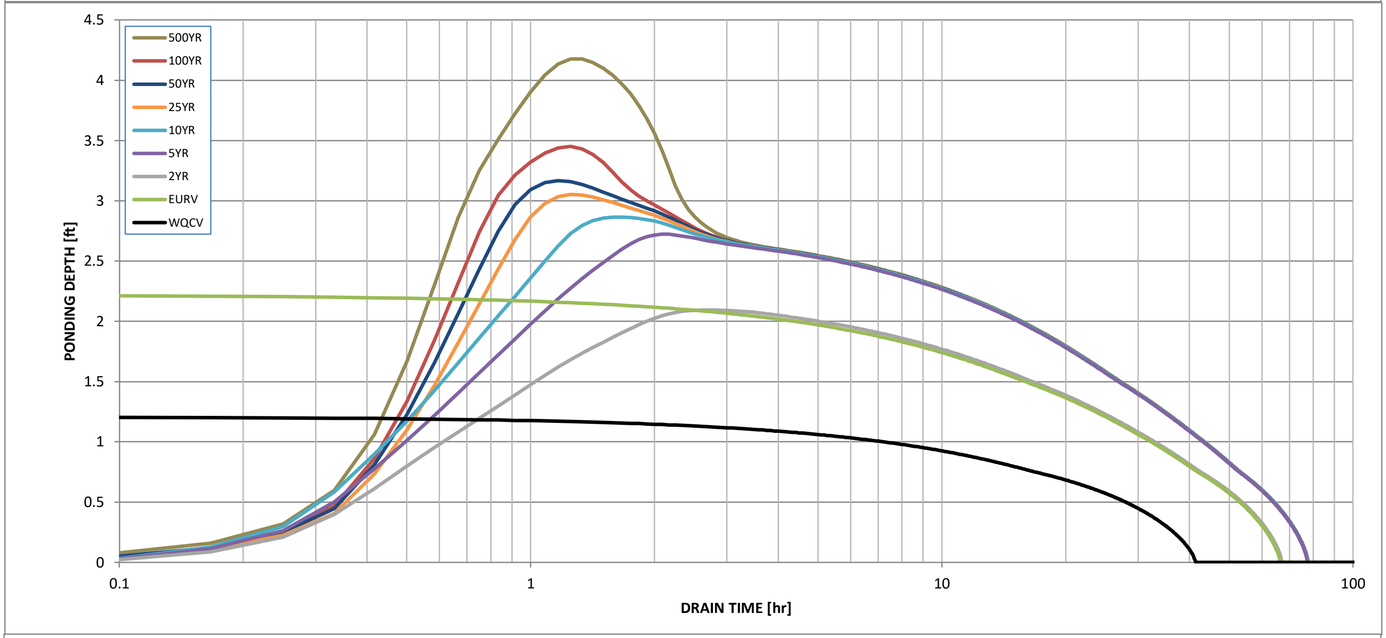
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

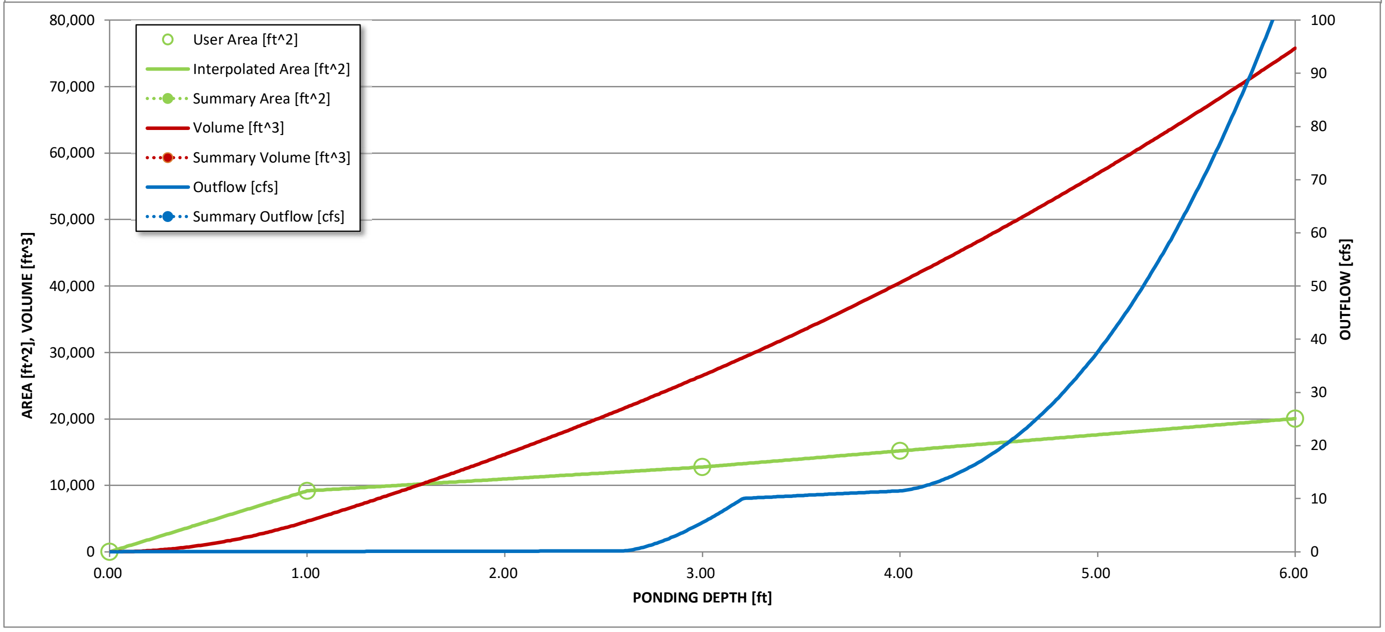
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.150	0.393	0.389	0.604	0.800	1.086	1.308	1.600	2.170
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.389	0.604	0.800	1.086	1.308	1.600	2.170
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.9	2.5	3.9	7.0	8.8	11.3	15.8
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.08	0.23	0.36	0.65	0.82	1.05	1.46
Peak Inflow Q (cfs) =	N/A	N/A	4.2	6.7	8.5	12.5	15.0	18.0	24.1
Peak Outflow Q (cfs) =	0.1	0.2	0.2	1.1	3.1	6.6	9.1	10.5	13.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.8	0.9	1.0	0.9	0.8
Structure Controlling Flow =	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	0.1	0.4	0.9	1.3	1.5	1.7
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	59	60	67	65	62	60	57	52
Time to Drain 99% of Inflow Volume (hours) =	**40**	63	64	73	72	71	70	68	66
Maximum Ponding Depth (ft) =	1.21	2.22	2.09	2.72	2.86	3.05	3.17	3.45	4.18
Area at Maximum Ponding Depth (acres) =	0.22	0.26	0.26	0.28	0.29	0.30	0.30	0.32	0.36
Maximum Volume Stored (acre-ft) =	0.151	0.393	0.359	0.529	0.568	0.624	0.657	0.747	0.990

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.09
	0:15:00	0.00	0.00	0.25	0.41	0.52	0.35	0.44	0.43	0.62
	0:20:00	0.00	0.00	0.92	1.33	1.74	0.92	1.08	1.15	1.79
	0:25:00	0.00	0.00	2.63	4.34	6.03	2.63	3.17	3.64	6.10
	0:30:00	0.00	0.00	3.99	6.42	8.28	8.88	10.86	12.50	17.32
	0:35:00	0.00	0.00	4.23	6.68	8.53	11.55	13.92	16.78	22.68
	0:40:00	0.00	0.00	4.12	6.37	8.12	12.50	14.98	17.98	24.08
	0:45:00	0.00	0.00	3.79	5.88	7.63	12.05	14.41	17.76	23.75
	0:50:00	0.00	0.00	3.49	5.48	7.05	11.67	13.96	17.13	22.90
	0:55:00	0.00	0.00	3.22	5.03	6.52	10.76	12.88	16.14	21.59
	1:00:00	0.00	0.00	3.00	4.67	6.11	9.90	11.88	15.20	20.39
	1:05:00	0.00	0.00	2.82	4.36	5.77	9.21	11.09	14.49	19.46
	1:10:00	0.00	0.00	2.58	4.07	5.43	8.39	10.12	13.10	17.67
	1:15:00	0.00	0.00	2.34	3.72	5.08	7.60	9.19	11.72	15.89
	1:20:00	0.00	0.00	2.11	3.35	4.61	6.75	8.16	10.26	13.89
	1:25:00	0.00	0.00	1.90	3.01	4.11	5.96	7.19	8.91	12.07
	1:30:00	0.00	0.00	1.74	2.77	3.74	5.21	6.29	7.75	10.54
	1:35:00	0.00	0.00	1.63	2.60	3.45	4.66	5.63	6.88	9.38
	1:40:00	0.00	0.00	1.53	2.39	3.20	4.21	5.09	6.18	8.43
	1:45:00	0.00	0.00	1.45	2.20	2.97	3.82	4.62	5.56	7.58
	1:50:00	0.00	0.00	1.37	2.01	2.75	3.47	4.19	5.00	6.80
	1:55:00	0.00	0.00	1.24	1.84	2.51	3.14	3.79	4.47	6.08
	2:00:00	0.00	0.00	1.12	1.66	2.25	2.82	3.41	3.97	5.40
	2:05:00	0.00	0.00	0.96	1.41	1.91	2.41	2.91	3.38	4.58
	2:10:00	0.00	0.00	0.81	1.17	1.58	2.02	2.42	2.82	3.80
	2:15:00	0.00	0.00	0.66	0.95	1.28	1.63	1.96	2.27	3.04
	2:20:00	0.00	0.00	0.53	0.74	1.00	1.28	1.52	1.76	2.33
	2:25:00	0.00	0.00	0.41	0.56	0.78	0.95	1.13	1.28	1.70
	2:30:00	0.00	0.00	0.32	0.44	0.63	0.69	0.83	0.93	1.26
	2:35:00	0.00	0.00	0.26	0.36	0.52	0.52	0.64	0.70	0.96
	2:40:00	0.00	0.00	0.21	0.30	0.43	0.40	0.49	0.52	0.73
	2:45:00	0.00	0.00	0.18	0.25	0.35	0.31	0.38	0.39	0.55
	2:50:00	0.00	0.00	0.14	0.20	0.28	0.24	0.30	0.29	0.41
	2:55:00	0.00	0.00	0.12	0.16	0.23	0.19	0.23	0.22	0.30
	3:00:00	0.00	0.00	0.10	0.13	0.18	0.15	0.18	0.16	0.23
	3:05:00	0.00	0.00	0.08	0.11	0.15	0.12	0.15	0.13	0.18
	3:10:00	0.00	0.00	0.07	0.09	0.11	0.09	0.12	0.10	0.14
	3:15:00	0.00	0.00	0.05	0.07	0.09	0.07	0.09	0.08	0.11
	3:20:00	0.00	0.00	0.04	0.05	0.07	0.06	0.07	0.06	0.09
	3:25:00	0.00	0.00	0.03	0.04	0.05	0.04	0.05	0.05	0.07
	3:30:00	0.00	0.00	0.02	0.03	0.04	0.03	0.04	0.04	0.05
	3:35:00	0.00	0.00	0.02	0.02	0.03	0.02	0.03	0.02	0.03
	3:40:00	0.00	0.00	0.01	0.01	0.02	0.01	0.02	0.02	0.02
	3:45:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Design Procedure Form: Extended Detention Basin (EDB)

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 3

Designer: JPS
Company: JPS
Date: January 11, 2024
Project: CO Pumpkin Patch
Location: Detention Pond A - Forebay A1.2

1. Basin Storage Volume

A) Effective Imperviousness of Tributary Area, I_a — I_a = 30.0 %

B) Tributary Area's Imperviousness Ratio ($i = I_a / 100$) — i = 0.300

C) Contributing Watershed Area — Area = 10.800 ac

D) For Watersheds Outside of the Denver Region, Depth of Average Runoff Producing Storm — d_6 = in

E) Design Concept
(Select EURV when also designing for flood control)

Choose One
○ Water Quality Capture Volume (WQCV)
● Excess Urban Runoff Volume (EURV)

F) Design Volume (WQCV) Based on 40-hour Drain Time
($V_{DESIGN} = (1.0 * (0.91 * i^3 - 1.19 * i^2 + 0.78 * i) / 12 * Area$) — V_{DESIGN}= 0.136 ac-ft

G) For Watersheds Outside of the Denver Region,
Water Quality Capture Volume (WQCV) Design Volume
($V_{WQCV\ OTHER} = (d_6*(V_{DESIGN}/0.43))$ — $V_{DESIGN\ OTHER}$= ac-ft

H) User Input of Water Quality Capture Volume (WQCV) Design Volume
(Only if a different WQCV Design Volume is desired) — $V_{DESIGN\ USER}$= ac-ft

I) NRCS Hydrologic Soil Groups of Tributary Watershed
- i) Percentage of Watershed consisting of Type A Soils — HSG_A = 0 %
- ii) Percentage of Watershed consisting of Type B Soils — HSG_B = 100 %
- iii) Percentage of Watershed consisting of Type C/D Soils — $HSG_{C/D}$ = 0 %

J) Excess Urban Runoff Volume (EURV) Design Volume
For HSG A: $EURV_A = 1.68 * i^{1.28}$
For HSG B: $EURV_B = 1.36 * i^{1.08}$
For HSG C/D: $EURV_{C/D} = 1.20 * i^{1.08}$
— $EURV_{DESIGN}$ = 0.333 ac-f t

K) User Input of Excess Urban Runoff Volume (EURV) Design Volume
(Only if a different EURV Design Volume is desired) — $EURV_{DESIGN\ USER}$= ac-f t

2. Basin Shape: Length to Width Ratio
(A basin length to width ratio of at least 2:1 will improve TSS reduction.) — L : W = 3.0 : 1

3. Basin Side Slopes

A) Basin Maximum Side Slopes
(Horizontal distance per unit vertical, 4:1 or flatter preferred) — Z = 4.00 ft / ft

4. Inlet

A) Describe means of providing energy dissipation at concentrated inflow locations: — Concrete Forebay

5. Forebay

A) Minimum Forebay Volume
(V_{FMIN} = 2% of the WQCV) — V_{FMIN} = 0.003 ac-ft

B) Actual Forebay Volume — V_F = 0.005 ac-ft

C) Forebay Depth
(D_F = 18 inch maximum) — D_F = 18.0 in

D) Forebay Discharge

- i) Undetained 100-year Peak Discharge — Q_{100} = 25.90 cfs
- ii) Forebay Discharge Design Flow ($Q_F = 0.02 * Q_{100}$) — Q_F = 0.52 cfs

E) Forebay Discharge Design

Choose One
○ Berm With Pipe
● Wall with Rect. Notch
○ Wall with V-Notch Weir

Flow too small for berm w/ pipe

F) Discharge Pipe Size (minimum 8-inches) — Calculated D_P = in

G) Rectangular Notch Width — Calculated W_N = 4.6 in

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 2 of 3

Designer: JPS
Company: JPS
Date: January 11, 2024
Project: CO Pumpkin Patch
Location: Detention Pond A - Forebay A1.2

6. Trickle Channel

A) Type of Trickle Channel

Choose One
● Concrete
○ Soft Bottom

F) Slope of Trickle Channel

S = 0.0040 ft / ft

7. Micropool and Outlet Structure

A) Depth of Micropool (2.5-feet minimum)

D_M = 2.5 ft

B) Surface Area of Micropool (10 ft^2 minimum)

A_M = 10 sq ft

C) Outlet Type

Choose One
● Orifice Plate
○ Other (Describe):

D) Smallest Dimension of Orifice Opening Based on Hydrograph Routing
(Use UD-Detention)

$D_{orifice}$ = 1.25 inches

E) Total Outlet Area

A_{ot} = 3.63 square inches

8. Initial Surcharge Volume

A) Depth of Initial Surcharge Volume
(Minimum recommended depth is 4 inches)

D_{IS} = 6 in

B) Minimum Initial Surcharge Volume
(Minimum volume of 0.3% of the WQCV)

V_{IS} = cu ft

C) Initial Surcharge Provided Above Micropool

V_s= 5.0 cu ft

9. Trash Rack

A) Water Quality Screen Open Area: $A_t = A_{ot} * 38.5*(e^{-0.095D})$

A_t = 124 square inches

B) Type of Screen (If specifying an alternative to the materials recommended in the USDCM, indicate "other" and enter the ratio of the total open are to the total screen are for the material specified.)

Aluminum Amico-Klemp SR Series with Cross Rods 2" O.C.

Other (Y/N): N

C) Ratio of Total Open Area to Total Area (only for type 'Other')

User Ratio =

D) Total Water Quality Screen Area (based on screen type)

A_{total} = 175 sq. in.

E) Depth of Design Volume (EURV or WQCV)
(Based on design concept chosen under 1E)

H= 1.99 feet

F) Height of Water Quality Screen (H_{TR})

H_{TR}= 51.88 inches

G) Width of Water Quality Screen Opening ($W_{opening}$)
(Minimum of 12 inches is recommended)

$W_{opening}$ = 12.0 inches

**VALUE LESS THAN RECOMMENDED MIN. WIDTH.
WIDTH HAS BEEN SET TO 12 INCHES.**

Design Procedure Form: Extended Detention Basin (EDB)

Sheet 3 of 3

Designer: JPS
Company: JPS
Date: January 11, 2024
Project: CO Pumpkin Patch
Location: Detention Pond A - Forebay A1.2

10. Overflow Embankment

A) Describe embankment protection for 100-year and greater overtopping: Buried Soil Riprap Spillway

B) Slope of Overflow Embankment
(Horizontal distance per unit vertical, 4:1 or flatter preferred)
Ze = 4.00 ft / ft

11. Vegetation

Choose One
○ Irrigated
● Not Irrigated

12. Access

A) Describe Sediment Removal Procedures: Periodic inspection and removal as needed; Access ramp provided to pond bottom

Notes:

Colorado Kids Ranch
Detention Pond A Spillway

Figure 13-12c. Emergency Spillway Protection

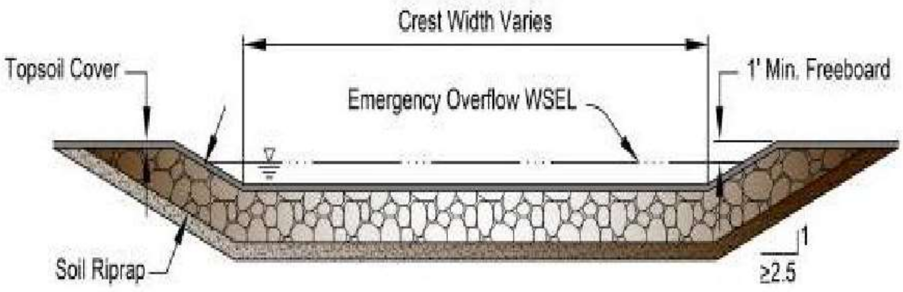
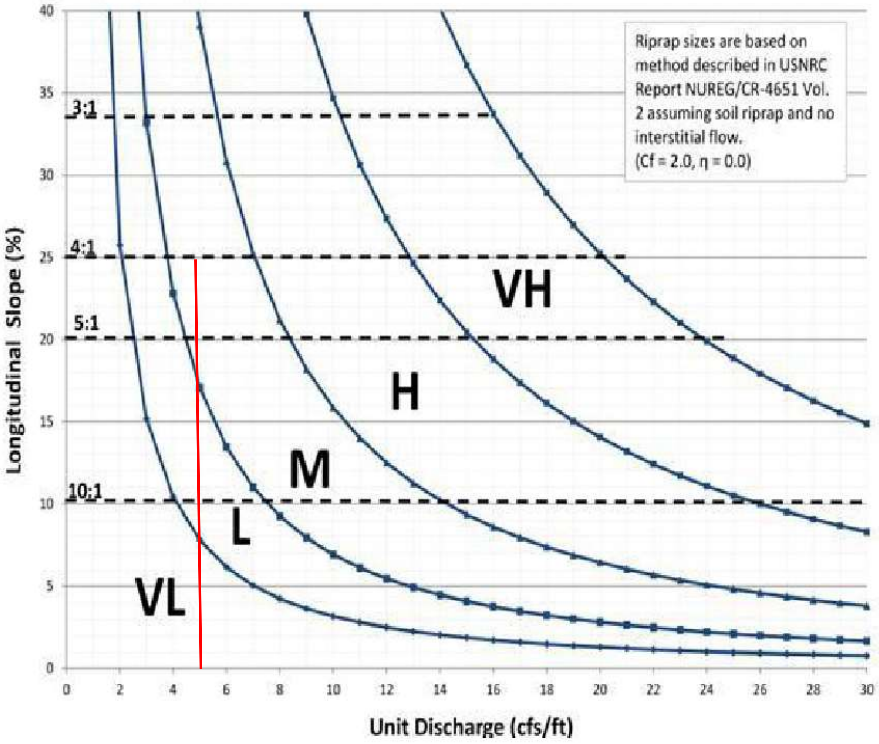


Figure 13-12d. Riprap Types for Emergency Spillway Protection



Spillway Q100 = 25.9 cfs (Undetained DP-A1.2)
Unit Discharge = (25.9 cfs / 5 ft) = 5.2
Use Type M Riprap

Colorado Kids Ranch
Detention Pond Outlet Pipe - RR Apron

Q100 (Pond Discharge) = 10.2 cfs; D = 1.5 ft
Q / D^1.5 = 10.2 / (1.5^1.5) = 5.6

$$H_a = \frac{(H + Y_n)}{2}$$ Equation 9-19

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

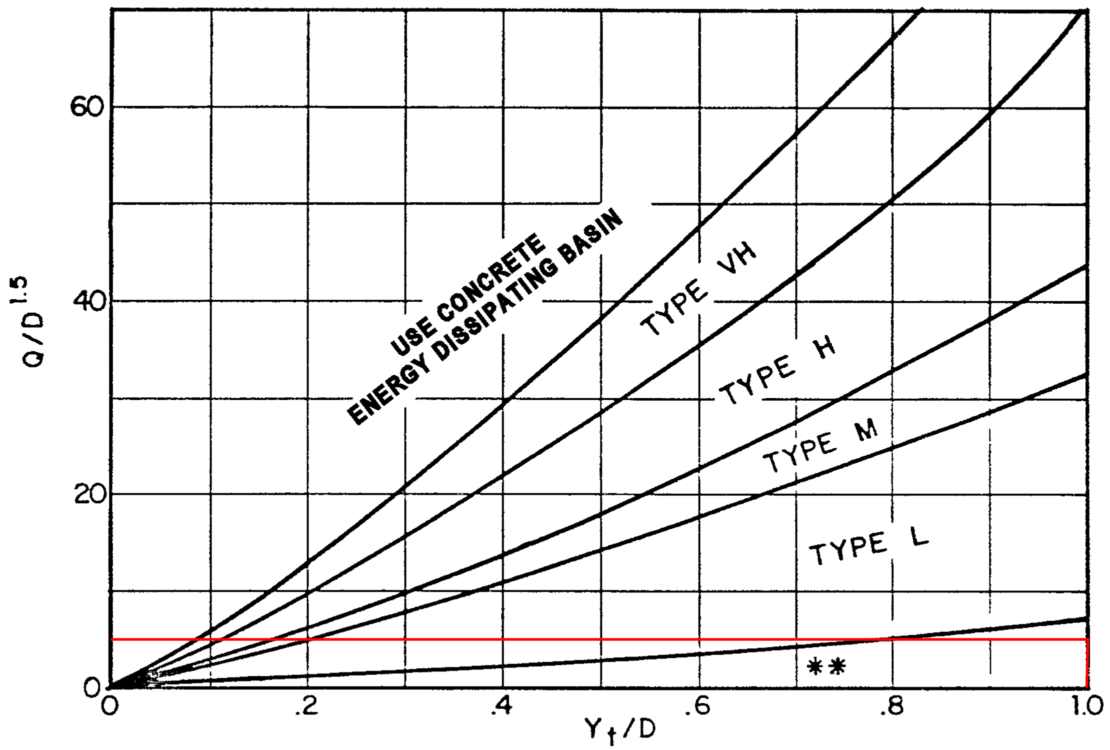
D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

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)



Yt = 1.8 ft (Channel A3); Yt / D = (1.8 / 1.5) = 1.2

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/D2.5 ≤ 6.0)

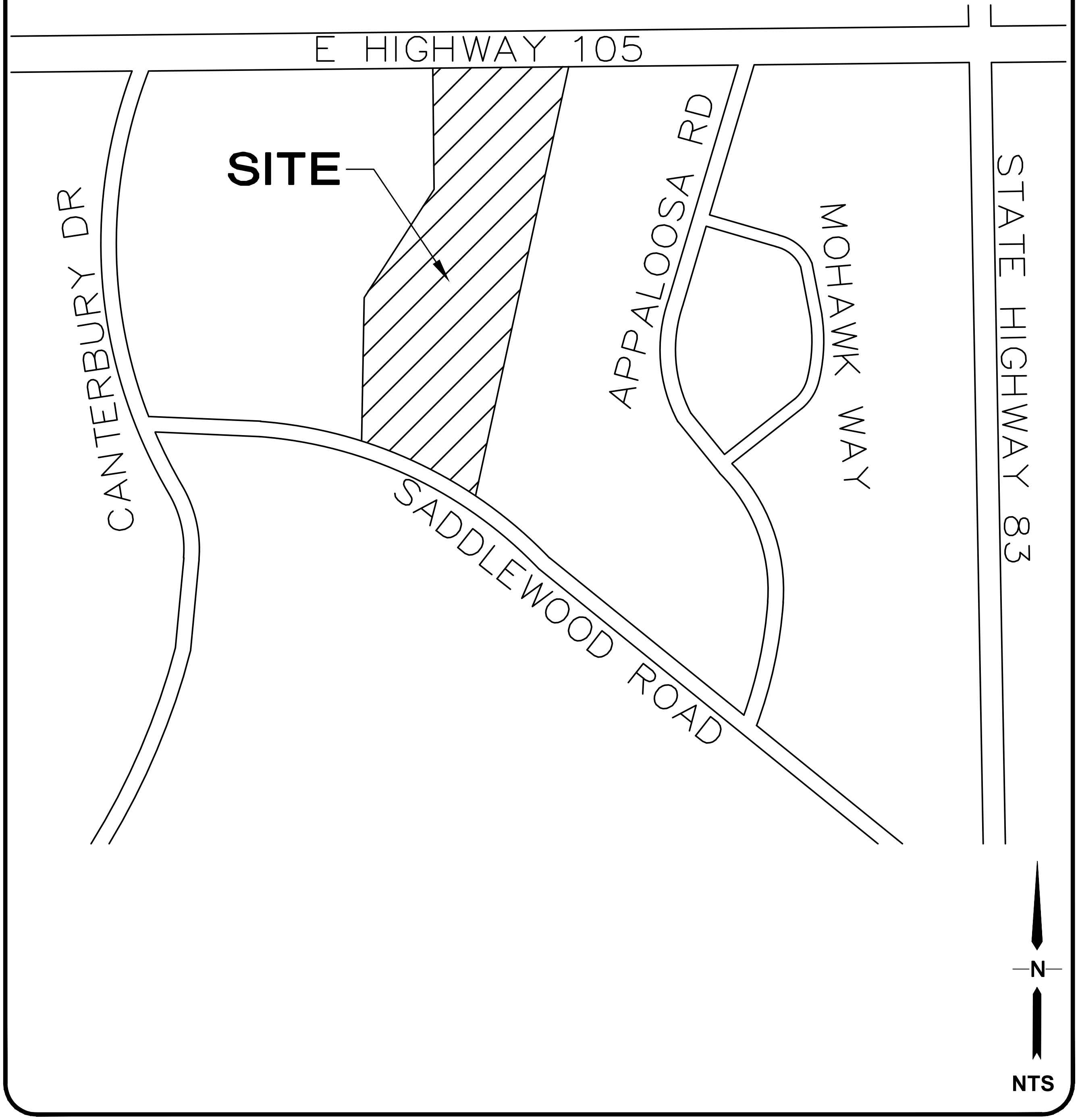
CO PUMPKIN PATCH
ENGINEER'S COST ESTIMATE
DRAINAGE IMPROVEMENTS - FULL-SPECTRUM DETENTION FACILITY (PRIVATE)

Item No.	Description	Quantity	Unit	Unit Cost ($$$)	Total Cost ($$$)
	PRIVATE DRAINAGE FACILITIES (NON-REIMBURSABLE)				
	Aggregate Base Course (Access Drive / Ramp)	140	CY	$61	$8,540
	Riprap Aprons (12" Riprap)	2.5	CY	$65	$163
	Concrete Forebay	1	LS	$2,500	$2,500
	Concrete Trickle Channel	57	SY	$40	$2,280
	18" HDPE Pond Discharge Line	107	LF	$50	$5,350
	Detention Basin Outlet Structure	1	LS	$8,000	$8,000
	Buried Soil Riprap Spillway	40	CY	$65	$2,600
	SUBTOTAL				**$29,433**
	Contingency @ 10%				$2,943
	TOTAL				**$32,376**

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 E

FIGURES



VICINITY MAP

JPS ENGINEERING

18065 SADDLEWOOD ROAD
EL PASO COUNTY, CO

FIGURE A1

JPS PROJ NO. 231331

National Flood Hazard Layer FIRMette

FEMA

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

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

SPECIAL FLOOD HAZARD AREAS	🟦	Without Base Flood Elevation (BFE) *Zone A, V, A99* With BFE or Depth *Zone AE, AO, AH, VE, AR*
	▨	Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD	🟧	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
	▨	Future Conditions 1% Annual Chance Flood Hazard *Zone X*
	▨	Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
	▨	Area with Flood Risk due to Levee *Zone D*
OTHER AREAS	NO SCREEN	Area of Minimal Flood Hazard *Zone X*
	▭	Effective LOMRs
	▭	Area of Undetermined Flood Hazard *Zone D*
GENERAL STRUCTURES	– – –	Channel, Culvert, or Storm Sewer
	ııııııı	Levee, Dike, or Floodwall
OTHER FEATURES	B 20.2 / 17.5	Cross Sections with 1% Annual Chance Water Surface Elevation
	8 – – –	Coastal Transect
	~~ 513 ~~~~	Base Flood Elevation Line (BFE)
	━━	Limit of Study
	━━	Jurisdiction Boundary
	- - - - -	Coastal Transect Baseline
	- ━━	Profile Baseline
	━━	Hydrographic Feature
MAP PANELS	☐	Digital Data Available
	☐	No Digital Data Available
	☒	Unmapped

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 2/26/2024 at 12:21 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.

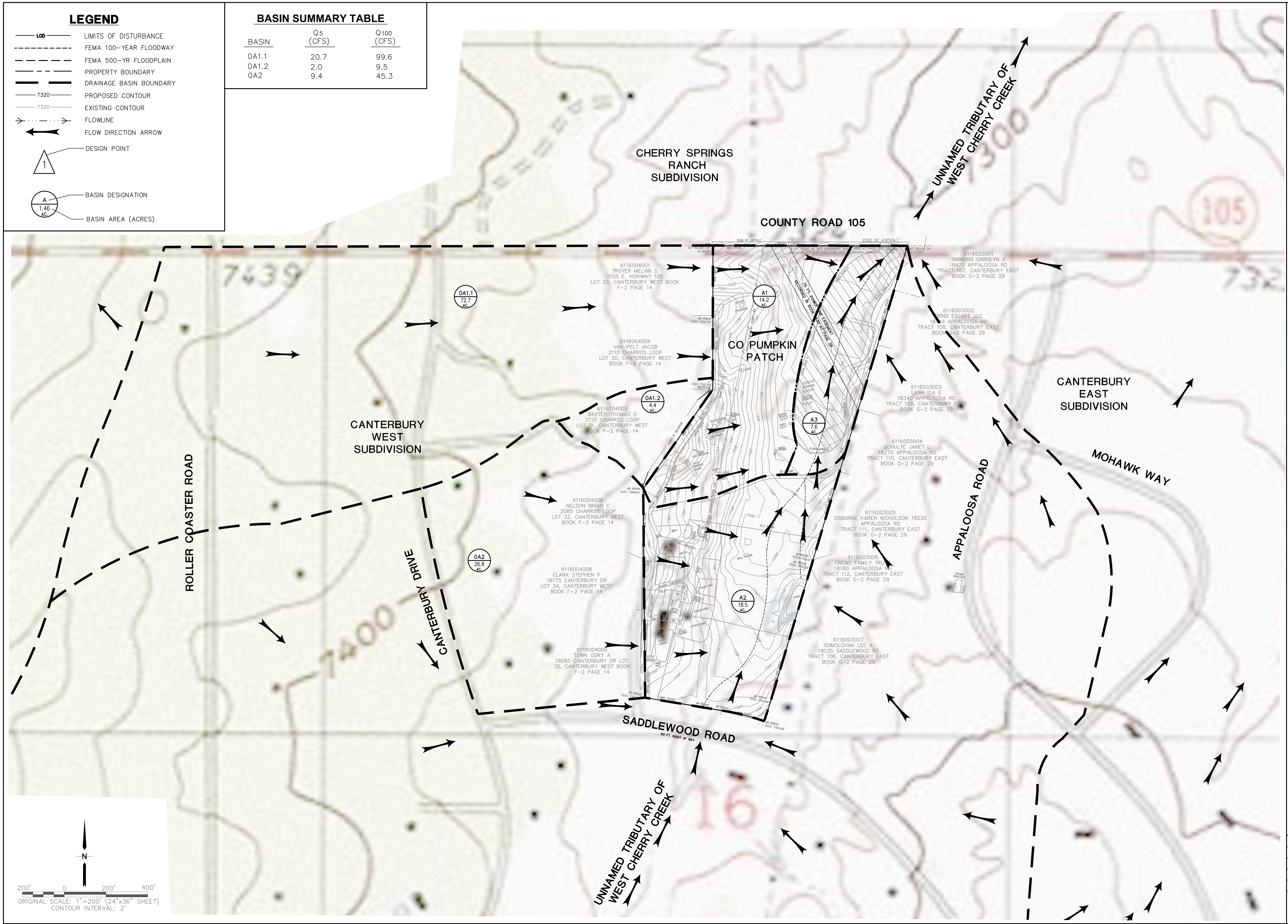
This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory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

LEGEND

—— LOD ——	LIMITS OF DISTURBANCE
- - - - - - -	FEMA 100-YEAR FLOODWAY
— — — — —	FEMA 500-YR FLOODPLAIN
—— - - ——	PROPERTY BOUNDARY
▬▬ ▬▬	DRAINAGE BASIN BOUNDARY
—— 7320 ——	PROPOSED CONTOUR
—— 7320 ——	EXISTING CONTOUR
>· · · — · · ·>	FLOWLINE
←	FLOW DIRECTION ARROW
△ 1	DESIGN POINT
A	BASIN DESIGNATION
1.46 AC.	BASIN AREA (ACRES)

BASIN SUMMARY TABLE

BASIN	Q_5 (CFS)	Q_{100} (CFS)
0A1.1	20.7	99.6
0A1.2	2.0	9.5
0A2	9.4	45.3



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MEMBER UTILITIES.

No.	REVISION	BY	DATE

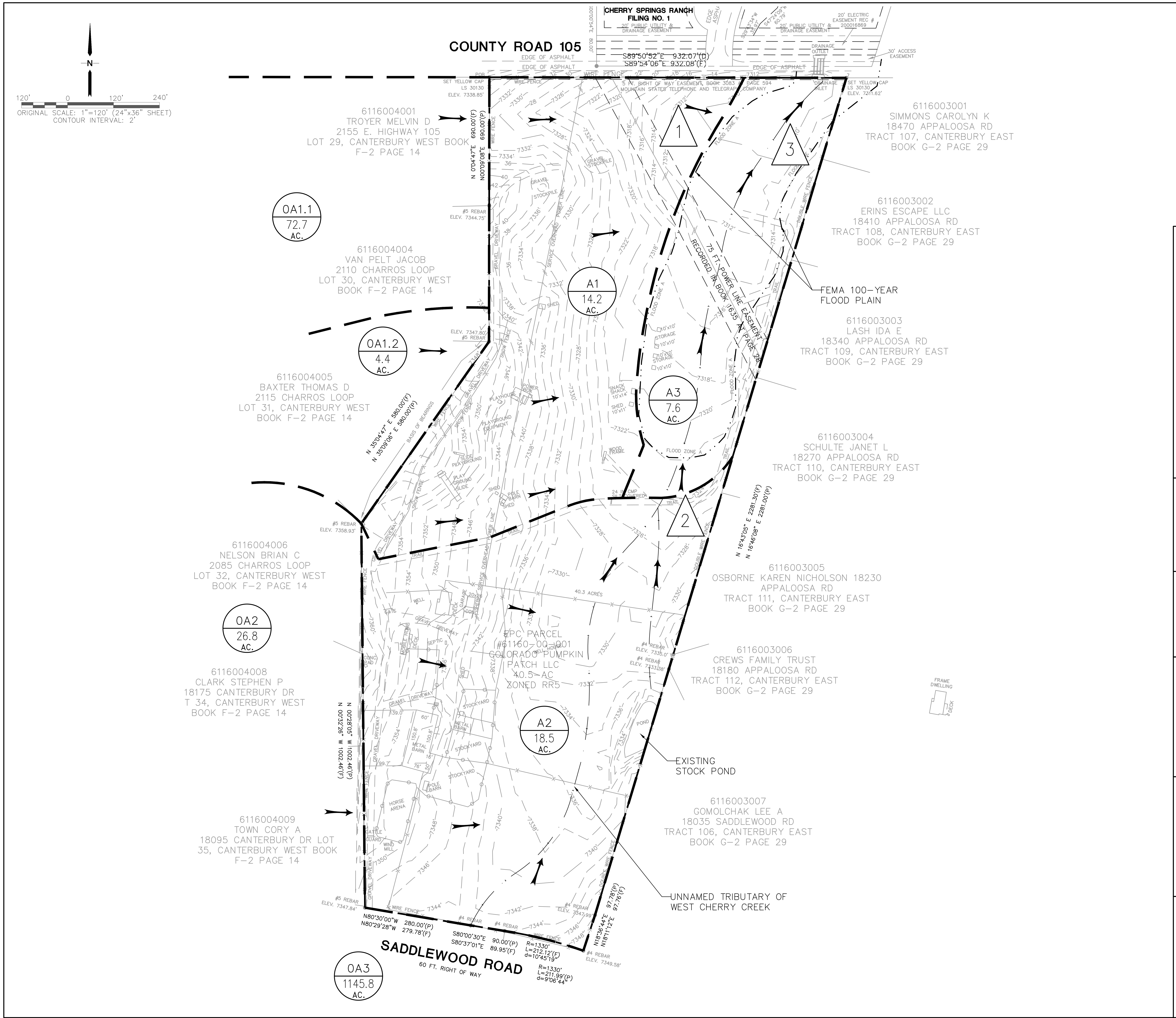
COLORADO KIDS RANCH

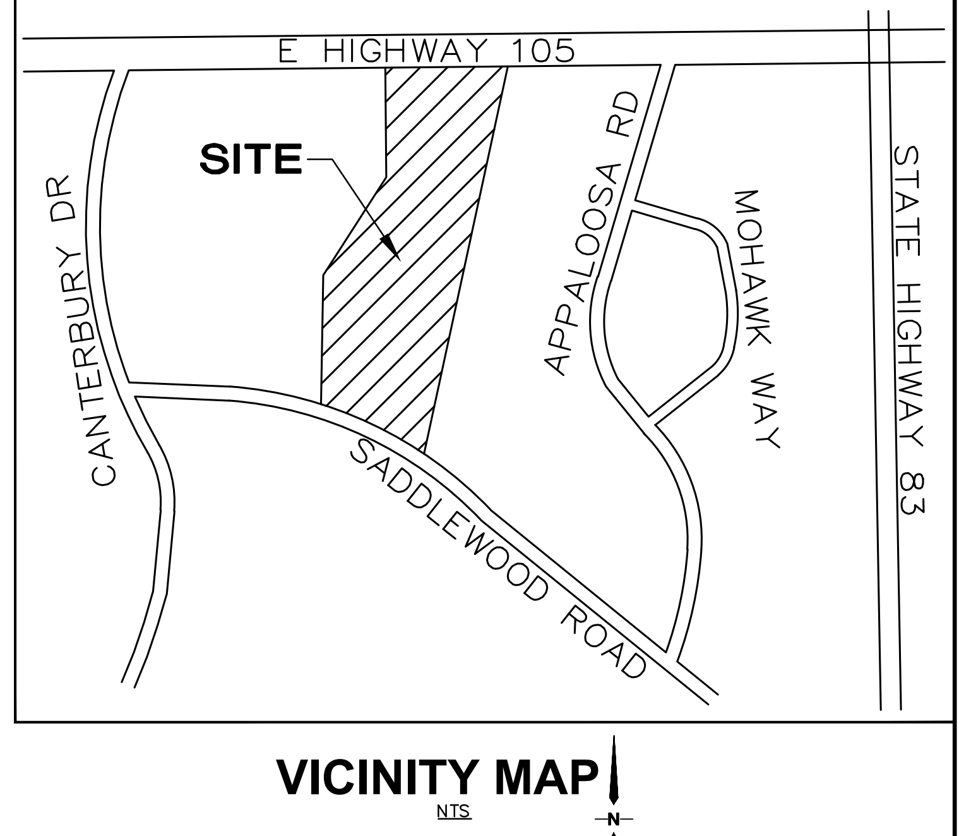
18065 SADDLEWOOD ROAD, MONUMENT, CO 80132

MAJOR BASIN/HISTORIC DRAINAGE PLAN

HORZ. SCALE:	1"=200'	DRAWN:	PV
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	ALESSI	CHECKED:	JPS
CREATED:	12/06/23	LAST MODIFIED:	01/15/24
PROJECT NO:	112301	MODIFIED BY:	PV

SHEET: EX1.1





VICINITY MAP
NTS

LEGEND

LOD	LIMITS OF DISTURBANCE
— · — · —	FEMA 100-YEAR FLOODWAY
— — — —	FEMA 500-YR FLOODPLAIN
— — — —	PROPERTY BOUNDARY
━ ━ ━	DRAINAGE BASIN BOUNDARY
7320	PROPOSED CONTOUR
7320	EXISTING CONTOUR
→ · · · →	FLOWLINE
←	FLOW DIRECTION ARROW
△ 1	DESIGN POINT
A 1.46 AC.	BASIN DESIGNATION BASIN AREA (ACRES)

BASIN SUMMARY TABLE

BASIN	Q5 (CFS)	Q100 (CFS)
A1	3.7	22.4
A2	7.4	35.1
A3	3.8	22.4

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
1	25.0	123.5
2	15.9	76.2
3	14.2	69.6

IMPERVIOUS AREA CALCULATIONS:
BASIN A1 AREA = 14.3 AC.

SURFACE TYPE	AREA	
BUILDINGS	1,670 SF	
GRAVEL		
(19,462 SF)*80% IMPERVIOUS	15,570 SF	
TOTAL IMPERVIOUS AREA	17,240 SF	= 0.4 AC
		= 2.8%

IMPERVIOUS AREA CALCULATIONS:
BASIN A2 AREA = 18.4 AC.

SURFACE TYPE	AREA	
BUILDINGS	18,921 SF	
GRAVEL		
(48,800 SF)*80% IMPERVIOUS	39,040 SF	
TOTAL IMPERVIOUS AREA	57,961 SF	= 1.3 AC
		= 7.0%

IMPERVIOUS AREA CALCULATIONS:
BASIN A3 AREA = 7.6 AC.

SURFACE TYPE	AREA	
BUILDINGS	0 SF	
GRAVEL		
(12,671 SF)*80% IMPERVIOUS	10,137 SF	
TOTAL IMPERVIOUS AREA	10,137 SF	=0.23 AC
		= 3.0%

COLORADO KIDS RANCH
18065 SADDLEWOOD ROAD, MONUMENT, CO 80132

EXISTING CONDITIONS
DRAINAGE PLAN

No.	REVISION	BY	DATE

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HORZ. SCALE: 1"=120'	DRAWN: PV
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: ALESSI	CHECKED: JPS
CREATED: 12/06/23	LAST MODIFIED: 02/27/24
PROJECT NO: 112301	MODIFIED BY: PV

SHEET: EX2

IMPERVIOUS AREA CALCULATIONS–A1.1:

BASIN A1.1 AREA = 1.1 AC.

SURFACE TYPE	AREA	
EX. BUILDINGS	0,000 SF	
EX. GRAVEL (5,402 SF)*80% IMPERVIOUS	4,322 SF	
PR.GRAVEL (0 SF)*80% IMPERVIOUS	0,000 SF	
TOTAL IMPERVIOUS AREA	4,322 SF	= 0.1 AC
		= 9.1%

IMPERVIOUS AREA CALCULATIONS–A1.2:

BASIN A1.2 AREA= 6.4 AC.

SURFACE TYPE	AREA	
EX. BUILDINGS	198 SF	
EX. GRAVEL (8,784 SF)*80% IMPERVIOUS	7,027 SF	
PR.GRAVEL (150,229 SF)*80% IMPERVIOUS	120,183 SF	
TOTAL IMPERVIOUS AREA	127,408 SF	= 2.92 AC
		= 45.63%

IMPERVIOUS AREA CALCULATIONS–A1.3:

BASIN A1.3 AREA= 6.7 AC.

SURFACE TYPE	AREA	
EX. BUILDINGS	1,473 SF	
EX. GRAVEL (5,277 SF)*80% IMPERVIOUS	4,222 SF	
PR.GRAVEL (6,143 SF)*80% IMPERVIOUS	4,914 SF	
TOTAL IMPERVIOUS AREA	10,609 SF	= 0.24 AC
		= 3.6%

IMPERVIOUS AREA CALCULATIONS–A2:

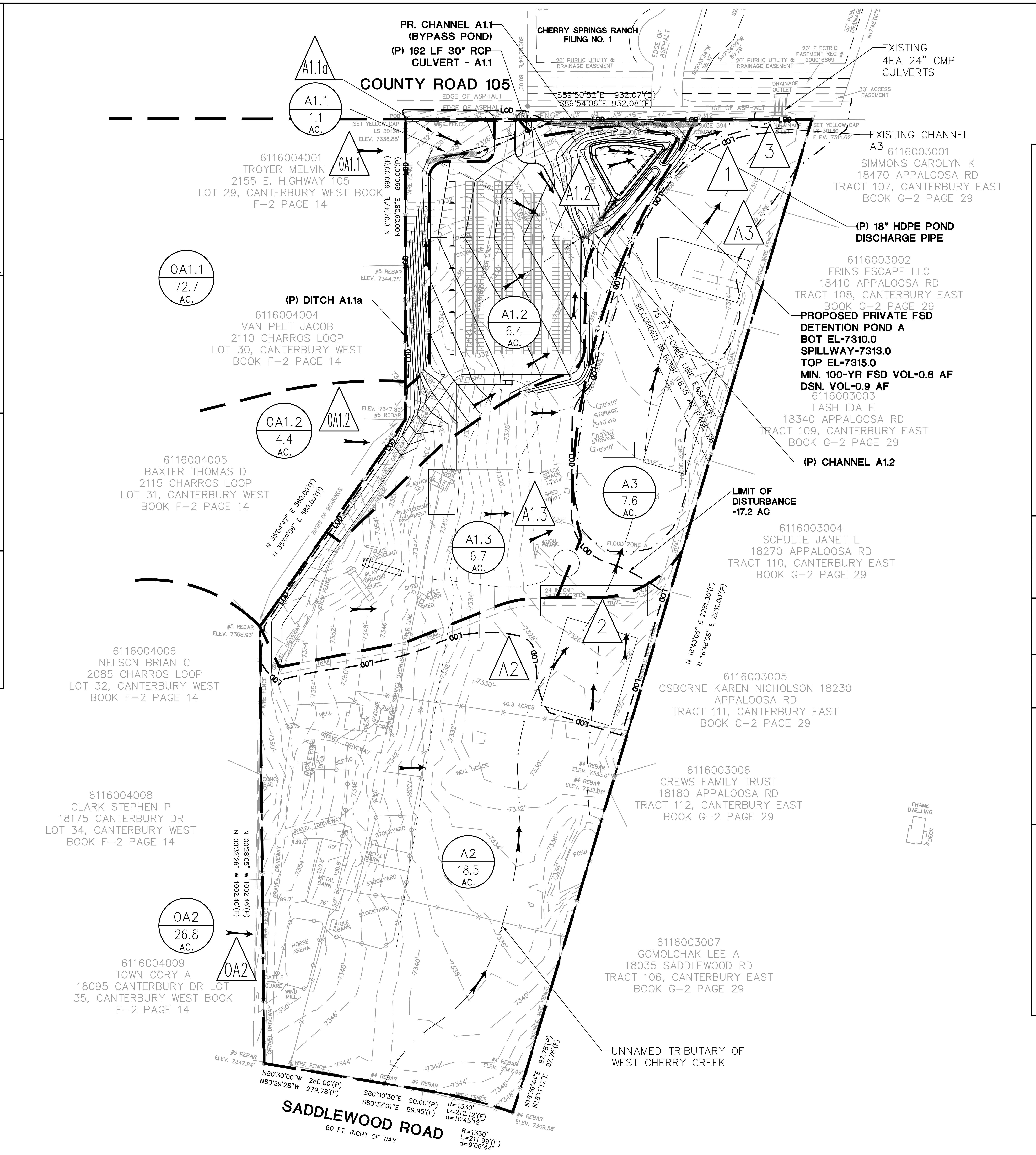
BASIN A2 AREA = 18.4 AC.

SURFACE TYPE	AREA	
EX. BUILDINGS	18,921 SF	
EX. GRAVEL (48,800 SF)*80% IMPERVIOUS	39,040 SF	
TOTAL IMPERVIOUS AREA	57,961 SF	= 1.3 AC
		= 7.0%

IMPERVIOUS AREA CALCULATIONS–A3:

BASIN A3 AREA = 7.6 AC.

SURFACE TYPE	AREA	
EX. BUILDINGS	0,000 SF	
EX. GRAVEL (12,671 SF)*80% IMPERVIOUS	10,137 SF	
TOTAL IMPERVIOUS AREA	10,137 SF	=0.23 AC
		= 3.0%



N

120' 0 120' 240'

ORIGINAL SCALE: 1"=120' (24"x36" SHEET)
CONTOUR INTERVAL: 2'

LEGEND

—LOD—	LIMITS OF DISTURBANCE
– – – – –	FEMA 100–YEAR FLOODWAY
— – — –	FEMA 100–YR FLOODPLAIN
— - - —	PROPERTY BOUNDARY
▬ ▬ ▬	DRAINAGE BASIN BOUNDARY
———	PROPOSED EDGE OF GRAVEL PAVEMENT
—7350—	PROPOSED CONTOUR
—7350—	EXISTING CONTOUR
→··	FLOWLINE
→	FLOW DIRECTION ARROW
(E)	EXISTING
(P)	PROPOSED
△1	DESIGN POINT
A	BASIN DESIGNATION
1.3 AC.	BASIN AREA (ACRES)

PBMP SUMMARY TABLE

BASINS	PBMP TRIBUTARY AREA (AC)	PBMP
A1.2	10.8	FSD DETENTION POND A
A1.1		EXCLUDED*

* EXCLUDED BASED ON LESS THAN 1–ACRE OF DEVELOPED AREA PER ECM APP. 1.7.1.C.1.

A1.3,A2,A3		EXCLUDED*

* EXCLUDED BASED ON NO SOIL DISTURBANCE

BASIN SUMMARY TABLE

BASIN	Q_5 (CFS)	Q_{100} (CFS)
A1.1	0.6	2.7
A1.2	10.3	22.7
A1.3	2.4	13.5
A2	7.4	35.1
A3	3.8	22.4

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q_5 (CFS)	Q_{100} (CFS)
0A1.1a	0.6	2.7
0A1.2	2.0	9.5
A1.1	19.4	93.5
A1.2(DEV)	9.7	25.9
A1.2(DET)	1.1	10.5
A1.3	2.4	13.5
1(DEV)	27.4	118.9
1(DET)	22.9	117.5
0A2	9.4	45.3
A2	7.4	35.1
2	15.9	76.2
3	14.2	69.6

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No.	REVISION	BY	DATE

DEVELOPED DRAINAGE PLAN

HORZ. SCALE: 1"=120'	DRAWN: PV
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: ALESSI	CHECKED: JPS
CREATED: 12/06/23	LAST MODIFIED: 03/22/24
PROJECT NO: 112301	MODIFIED BY: PV

SHEET: D1