

DRAINAGE REPORT

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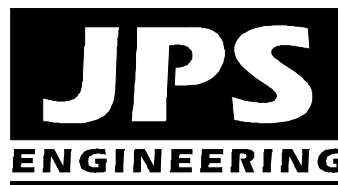
**HAVEN SCHOOL
5490 Burgess Road
Colorado Springs, CO 80908**

Prepared for:

**Haven Education
5490 Burgess Road
Colorado Springs, CO 80908**

July 2, 2025

Prepared by:



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**JPS Project No. 122401
PCD Project No. PPR2423**

**HAVEN FOREST SCHOOL
FINAL DRAINAGE REPORT
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DRAINAGE STATEMENT

Engineer's Statement:

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

John P. Schwab, P.E. #29891

Developer's Statement:

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

By:

Printed Name: Emily Hill, President
Haven Education
5490 Burgess Road, Colorado Springs, CO 80908

Date

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.

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

Date

Conditions:

I. GENERAL LOCATION AND DESCRIPTION

A. Background

Haven Forest School is an existing private home school enrichment program serving families with K-6th grade students in the Colorado Springs area. The existing school is located on a 27.5-acre unplatted parcel addressed as 5490 Burgess Road in El Paso County, Colorado (El Paso County Assessor's Number 62130-00-037). The property is located on the north side of Burgess Road between High Meadows Drive and Brook Meadows Point. The site is located in the Southeast Quarter of Section 13, Township 12 South, Range 66 West of the 6th Principal Meridian. Existing school facilities include a residence which has been converted into classrooms, an existing barn building converted to school use, and several accessory structures.

Haven Education (Owner) is planning on campus improvements to include widening of the site access drive and completion of an asphalt loop road around the school buildings to meet fire access standards. Additional site improvements include a proposed gravel parking area and ADA sidewalk / pedestrian access improvements. Based on recommendations of the project traffic study, site access improvements along Burgess Road will include a new eastbound to northbound left-turn deceleration lane.

B. Scope

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

C. Site Location and Description

The property is zoned RR5 (rural residential), and El Paso County approved a Special Use permit for the Haven School (EDARP #AL2322) for use as an educational institution in September, 2024. The proposed site improvements are fully consistent with the approved Special Use permit for the site.

Burgess Road is an asphalt-paved public street along the south boundary of the site, and access to the property is provided by an existing drive connection to Burgess Road.

The site is surrounded by developed rural residential properties (zoned RR5) on all sides. The west boundary of the property adjoins the High Meadows Subdivision, the southwest boundary of the property adjoins the Jan-Lee Estates Subdivision, and the southeast boundary of the property adjoins the Brook Meadows Subdivision (all 5-acre minimum rural residential lots).

The site is located in the Kettle Creek Drainage Basin, and the existing on-site drainage swales flow northwesterly towards the Kettle Creek drainage channel. The main channel of Kettle Creek is located within a half-mile north of the northern boundary of the site.

The terrain is rolling with average grades ranging from 2 to 8 percent. Ground elevations within the site range from approximately 7,084 to 7,192 feet above mean sea level. The site is vegetated with meadow grasses and trees.

D. General Soil 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 40-41: Kettle gravelly loamy sand” and “Type 71: Pring coarse sandy loam” soils. These soils are classified as hydrologic soils group “B” (moderate infiltration rate).

E. References

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

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

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

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

FEMA, Flood Insurance Rate Map (FIRM) Number 08041C0315G, December 7, 2018.

JR Engineering LLC, “Drainage Basin Planning Study for Kettle Creek Basin,” May 5, 2015 (approved by City 5/3/15).

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

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

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

II. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

The proposed development lies completely within the Kettle Creek Drainage Basin (FOMO3000) as classified by El Paso County. Stormwater runoff from the property drains northwesterly to existing grass-lined drainage swales flowing towards the main channel of Kettle Creek, ultimately flowing to a downstream confluence with Monument Creek.

B. Floodplain Impacts

This site is not impacted by any FEMA 100-year floodplain limits. The delineated floodplain limits in vicinity of the site are shown in FEMA Flood Insurance Rate Map (FIRM) Number 08041C0315G, dated December 7, 2018 (see FIRMette exhibit in Appendix E).

C. Sub-Basin Description

The site has been delineated as three on-site drainage basins (A-C), with several adjoining off-site drainage basins (OA1-OC1).

Basin A consists of the southeast and central parts of the existing property, which drains by sheet flow and existing drainage swales flowing towards the west boundary of the property.

Basin B consists of the southwest part of the existing property, which drains by sheet flow and existing drainage swales flowing towards the west boundary of the property.

Basin C consists of the north part of the existing property, which drains by sheet flow and existing drainage swales flowing towards the north boundary of the property.

III. DRAINAGE DESIGN CRITERIA

A. Development Criteria Reference

This report is based on the guidelines and criteria presented in the El Paso County Drainage Criteria Manual.

B. Hydrologic Criteria

Rational Method Hydrology procedures were utilized for calculation of peak flows based on the following assumptions:

- Design storm (minor) 5-year
- Design storm (major) 100-year
- Rainfall Intensities El Paso County I-D-F Curve

• Hydrologic soil type	B	
	<u>C5</u>	<u>C100</u>
• Runoff Coefficients - undeveloped:		
Meadow / Forest areas	0.08	0.35
Rural residential areas (5-acre lots)	0.137	0.393
• Runoff Coefficients - developed:		
Proposed Building / Pavement Areas	0.90	0.96
(see composite runoff coefficient calculations in Appendix B)		

Hydrologic calculations are enclosed in Appendix B, and peak design flows are identified on the drainage plan drawings.

IV. 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 will be routed through an on-site detention basin, which will be grass-lined to encourage stormwater infiltration.
- Minimize Impacts: The proposed rural school campus improvements will have a development intensity fully consistent with the surrounding rural residential area (5-acre minimum lot sizes). This provides for inherently minimal drainage impacts based on the limited impervious areas associated with rural residential development.
- Minimize Directly Connected Impervious Areas (MDCIA): The rural site development will have grass-lined roadside ditches along driveways and parking areas, providing for impervious areas to drain across pervious areas. Based on the roadside ditches throughout the site, the property is classified as MDCIA Level One.
- Grass Swales: The proposed rural site development will have grass-lined roadside and driveway ditches to encourage stormwater infiltration.

Step 2: Stabilize Drainageways

- There are no major drainageways directly adjacent to this project site. Implementation of the on-site drainage improvements and water quality pond 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 Extended Detention Basin (EDB). The extended detention basin which will capture and slowly release the WQCV over an extended release period.
- Water quality mitigation for the proposed site development will be provided by the on-site “Water Quality Pond A1” serving as a Permanent Control Measure (PCM).

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.
- The majority of on-site developed drainage will be routed through the Extended Detention Basin (EDB) to minimize introduction of contaminants to the downstream drainage system.

V. GENERAL DRAINAGE RECOMMENDATIONS

The developed drainage plan for the site is to provide and maintain positive drainage away from structures and conform to the established drainage patterns for the overall site. JPS Engineering recommends that positive drainage be established and maintained away from all structures within the site in conformance with applicable building codes and geotechnical engineering recommendations.

Building site grading and drainage is the sole responsibility of the property owner. Final grading of each building site should establish proper protective slopes and positive drainage in accordance with HUD guidelines and building codes.

In general, we recommend a minimum of 6 inches clearance from the top of concrete foundation walls to adjacent finished site grades. Positive drainage slopes should be maintained away from all structures, with a minimum recommended slope of 5 percent for the first 10 feet away from buildings in landscaped areas, a minimum recommended slope of 2 percent for the first 10 feet away from buildings in paved areas, and a minimum slope of 1 percent for paved areas beyond buildings.

VI. DRAINAGE FACILITY DESIGN

A. General Concept

The proposed site development will primarily consist of private driveway improvements within the existing school property. Public improvements will include a new eastbound to northbound left turn lane along Burgess Road approaching the site access drive. The general concept for management of developed storm runoff is to establish and maintain positive drainage away from the buildings and divert runoff to drainage swales following historic drainage patterns.

B. Specific Details

1. Existing Drainage Conditions

Existing site drainage conditions are depicted on the “Existing Conditions Drainage Plan” (Sh. EX1 and EX2, Appendix E). Existing drainage facilities within the property include drainage swales, driveway culverts, and an existing stock pond in the center of the site.

The existing southeast and central parts of the property have been delineated as Basin A, which drains by sheet flow and existing drainage swales flowing towards the west boundary of the site. Basin A receives off-site flow from two large off-site basins (Basins OA1-OA2) extending from a ridge southeast of Burgess Road. These basins drain to an existing stock pond on the adjoining property to the east, and the drainage discharged from the adjoining pond flows northwesterly into a large existing stock pond located near the center of the property within Basin A.

Basin A (13.3-acres) consists of the southeast and central parts of the existing property, which drains by sheet flow and drainage swales to a large existing drainage channel and stock pond in the center of the property. Existing flows from off-site Basins OA1 and OA2 combine with on-site Basin A at Design Point #1, with peak flows calculated as $Q_5 = 53.0$ cfs and $Q_{100} = 253.1$ cfs.

Basin B (4.1-acres) consists of the southwest part of the existing property, which drains by sheet flow and existing drainage swales flowing towards the west boundary of the property. Existing peak flows from Basin B are calculated as $Q_5 = 1.4$ cfs and $Q_{100} = 9.2$ cfs. Basin B receives off-site flow from a small off-site basin (Basin OB1) comprising the north half of the adjoining Burgess Road (west of the site access drive). Existing flows from off-site Basin OB1 combine with on-site Basin B at Design Point #2, with peak flows calculated as $Q_5 = 2.1$ cfs and $Q_{100} = 11.4$ cfs.

Basin OB2 (9.3-acres) has been delineated as the off-site area on the south side of Burgess Road along the frontage of the Haven School property. Basin OB2 flows northwesterly into the existing ditch along the south side of Burgess Road, and the existing ditch continues flowing west along the south side of the road. Existing peak flows from Basin OB2 are calculated as $Q_5 = 4.1$ cfs and $Q_{100} = 19.9$ cfs.

Basin C (10.5-acres) consists of the north part of the existing property, which drains by sheet flow and existing drainage swales flowing towards the north boundary of the property. Existing peak flows from Basin C are calculated as $Q_5 = 3.6$ cfs and $Q_{100} = 22.8$ cfs. Basin C receives off-site flow from an off-site basin (Basin OC1) comprising a part of the adjoining property to the east. Existing flows from off-site Basin OC1 (3.9-acres) combine with on-site Basin C at Design Point #3, with peak flows calculated as $Q_5 = 4.6$ cfs and $Q_{100} = 26.5$ cfs.

2. Developed Drainage Conditions

As shown on the enclosed Developed Drainage Plan (Figure D1, Appendix E), developed runoff will continue to follow the existing drainage patterns. Developed flows have been calculated based on the impervious areas associated with the proposed site improvements. Hydrologic calculations for the site are detailed in the attached spreadsheets (Appendix B), and peak flows are identified on Figure D1 (Appendix E).

Basin A1

Basin A1 (11.7-acres) consists of the southeast and central parts of the property, which drain by sheet flow, ditches, and culverts flowing to the pond within the center of the property. Developed Basin A1 has been delineated as the area flowing into the existing pond, which will be upgraded to serve as an extended detention basin (EDB). Water Quality Pond A1 has been designed to meet the County stormwater quality requirements for the proposed site development.

Off-site flows from Basins OA1 and OA2 will continue to drain into the existing drainage channel entering the existing stock pond, which will be upgraded to serve as full-spectrum Detention Pond A1. The new gravel parking area on the south side of the stock pond will drain to a proposed private culvert (SD-A1) which will convey developed flows from the parking area into the pond.

Developed flows from off-site Basins OA1 and OA2 will combine with on-site Basin A1 at Design Point #A1.1 (Water Quality Pond A1), with peak flows calculated as $Q_5 = 53.6$ cfs and $Q_{100} = 256.9$ cfs.

Basin A2

The site area along the west fringe of the property, downstream of the detention pond, has been delineated as Basin A2 (1.6 acres), which sheet flows westerly to the existing grass-lined drainage swale at the west boundary of the property. Developed peak flows from Basin A2 are calculated as $Q_5 = 1.7$ cfs and $Q_{100} = 5.3$ cfs.

The limit of disturbance of the new southwest loop road extending through Basin A2 is 0.39-acres. Basin A2 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.

Developed flows from off-site Basins OA1 and OA2 will combine with on-site Basins A1 and A2 at Design Point #1, with peak flows calculated as $Q_5 = 53.6$ cfs and $Q_{100} = 255.8$ cfs (negligible increase of $Q_{100} = 2.7$ cfs, or approximately 1.0 percent, in comparison to existing conditions).

Basin B

Basin B consists of the southwest part of the existing property, which drains by sheet flow and existing drainage swales flowing towards the west boundary of the property. Existing peak flows from Basin B are calculated as $Q_5 = 1.4$ cfs and $Q_{100} = 9.0$ cfs.

Basin B receives off-site flow from a small off-site basin (Basin OB1) comprising the north half of the adjoining Burgess Road (west of the site access drive).

The new impervious area along Burgess Road within Basin OB1 is 0.16-acres. Basin OB1 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.

Developed flows from off-site Basin OB1 combine with on-site Basin B at Design Point #2, with peak flows calculated as $Q_5 = 2.2$ cfs and $Q_{100} = 11.6$ cfs (negligible increase of $Q_{100} = 0.2$ cfs in comparison to existing conditions).

Basin OB2 (9.3-acres) along the south side of Burgess Road will continue to flow northwesterly into the improved ditch along the south side of Burgess Road, and the ditch will continue flowing west along the south side of the road. The new impervious area within Basin OB2 from the proposed roadway widening is approximately 0.2 acres, and developed peak flows from Basin OB2 are calculated as $Q_5 = 4.6$ cfs and $Q_{100} = 20.6$ cfs (negligible increase of $Q_{100} = 0.7$ cfs in comparison to existing conditions).

The limit of disturbance along the south side of Burgess Road within Basin OB2 is 0.41-acres. Basin OB2 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.

Basin C

Basin C consists of the north part of the existing property, which drains by sheet flow and existing drainage swales flowing towards the north boundary of the property. Existing peak flows from Basin C (Design Point #3) are calculated as $Q_5 = 4.1$ cfs and $Q_{100} = 23.7$ cfs.

Water quality treatment for Basin C will be provided through runoff reduction based on preservation of the significant downstream grass-lined drainage swale flowing towards the north boundary of the property (see Runoff Reduction calculations in Appendix D).

Developed flows from off-site Basin OC1 will continue to combine with on-site Basin C at Design Point #3, with peak flows calculated as $Q_5 = 5.0$ cfs and $Q_{100} = 27.1$ cfs (negligible increase of $Q_{100} = 0.6$ cfs in comparison to existing conditions).

C. On-Site Drainage Facility Design

Developed drainage basins and drainage patterns are depicted on the enclosed Developed Drainage Plan (Sheet D1). Private ditches and culverts will convey the majority of developed flows to Water Quality Pond A1. As discussed above, the existing grass-lined drainage swales along the north and west boundaries of the property provide adequate drainage outfall points in accordance with ECM Section 3.2.4.

VII. EROSION CONTROL / SEDIMENT CONTROL

Contractors and Owners will need to implement and maintain proper Best Management Practices (BMP's) and control measures for erosion and sediment control during and after construction. Erosion control measures should include installation of silt fence at the toe of disturbed areas, sediment control logs protecting drainage ditches, vehicle tracking control pads at access points, riprap protection at culvert outlets, and revegetation of disturbed areas. Cut slopes will need to be stabilized during excavation as necessary and vegetation will need to be re-established as soon as possible for stabilization of graded areas.

VIII. STORMWATER DETENTION AND WATER QUALITY

Based on the rural nature of this private school site development, there will be no significant increase in developed flows compared to the existing conditions, and there is no need for on-site flood control stormwater detention.

Water quality mitigation for the proposed site development will be provided by upgrading the existing on-site stock pond to a Water Quality Pond serving as a permanent water quality control measure. The existing stock pond will be improved with a new outlet structure, allowing the pond to serve as an Extended Detention Basin (EDB) meeting County water quality standards.

The proposed Water Quality Pond improvements have been designed utilizing the Denver Mile High Flood District's "MHFD-Detention_v4.06" software package. Calculations and details for the Water Quality Pond are enclosed in Appendix D, and design parameters for "Pond A1" are summarized as follows:

Water Quality Facility (EDB)	Tributary Drainage Basins	Tributary Area (ac)	Impervious Percentage	Min. WQCV (af)	Design Volume (af)
Pond A1	OA1-OA2,A1-A2	197.9	7.3	0.84	2.7

The proposed Extended Detention Basin ("Pond A1") provides a volume of 2.7 acre-feet, which exceeds the required Water Quality Capture Volume (WQCV).

The proposed improvements to Water Quality Pond A1 will include riprap aprons for erosion control at the culvert entry points into the pond. The outlet structure has been designed with a water quality orifice plate to maintain a 40-hour release of the WQCV. The pond will continue to have a vegetated bottom to encourage stormwater infiltration prior to discharging into the downstream drainage swale.

The on-site stormwater quality facilities will be privately owned and maintained by the property owner, and maintenance access is readily available from the adjoining private driveway. A gravel maintenance access ramp will be provided from the existing driveway into the bottom of the pond.

The “Water Quality Summary Table” on the enclosed “Developed Drainage Plan” (Sh. D1, Appendix E) provides a summary of the basin areas draining to the on-site water quality facility, as well as the areas with applicable exclusions from permanent BMP requirements.

Areas Excluded from Water Quality Facilities

Areas excluded from water quality facilities include the following three areas of limited development within the site:

- New southwest loop driveway (Basin A2; 0.39-ac LOD)
- Burgess Road widening – northwest (Basin OB1; 0.16-ac LOD)
- Burgess Road widening – south side (Basin OB2; 0.41-ac LOD)

The total limit of disturbance (LOD) of these excluded parts of the project site is 0.96-acres, which is less than one-acre. These areas are excluded from water quality requirements based on ECM Appendix I.7.1.C.1 (see previous discussion in Paragraph VI.B.2).

IX. DRAINAGE COSTS AND DRAINAGE FEES

The property owner will be responsible for all construction costs associated with the proposed site improvements. There are no reimbursable public drainage improvements required for this subdivision replat.

The estimated cost of the proposed private water quality pond facilities is approximately \$20,704 (see estimate in Appendix D).

The property is located entirely within the Kettle Creek Drainage Basin (FOM 03000). There are no drainage or bridge fees applicable at this time as there is no subdivision platting proposed.

X. SUMMARY

The developed drainage patterns associated with the proposed Haven Forest School improvement project at 5490 Burgess Road will remain consistent with existing conditions and the established drainage patterns for area. The majority of developed drainage from the site will drain through a Private Water Quality Pond prior to discharging to the existing downstream drainage swales.

The on-site drainage facilities have been designed to mitigate developed flow impacts and meet the County's water quality requirements. Construction and proper maintenance of the on-site drainage facilities and Water Quality Pond, in conjunction with proper erosion control practices, will ensure that the proposed site development 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 30, 2024

Preface

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

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

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

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

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

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

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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

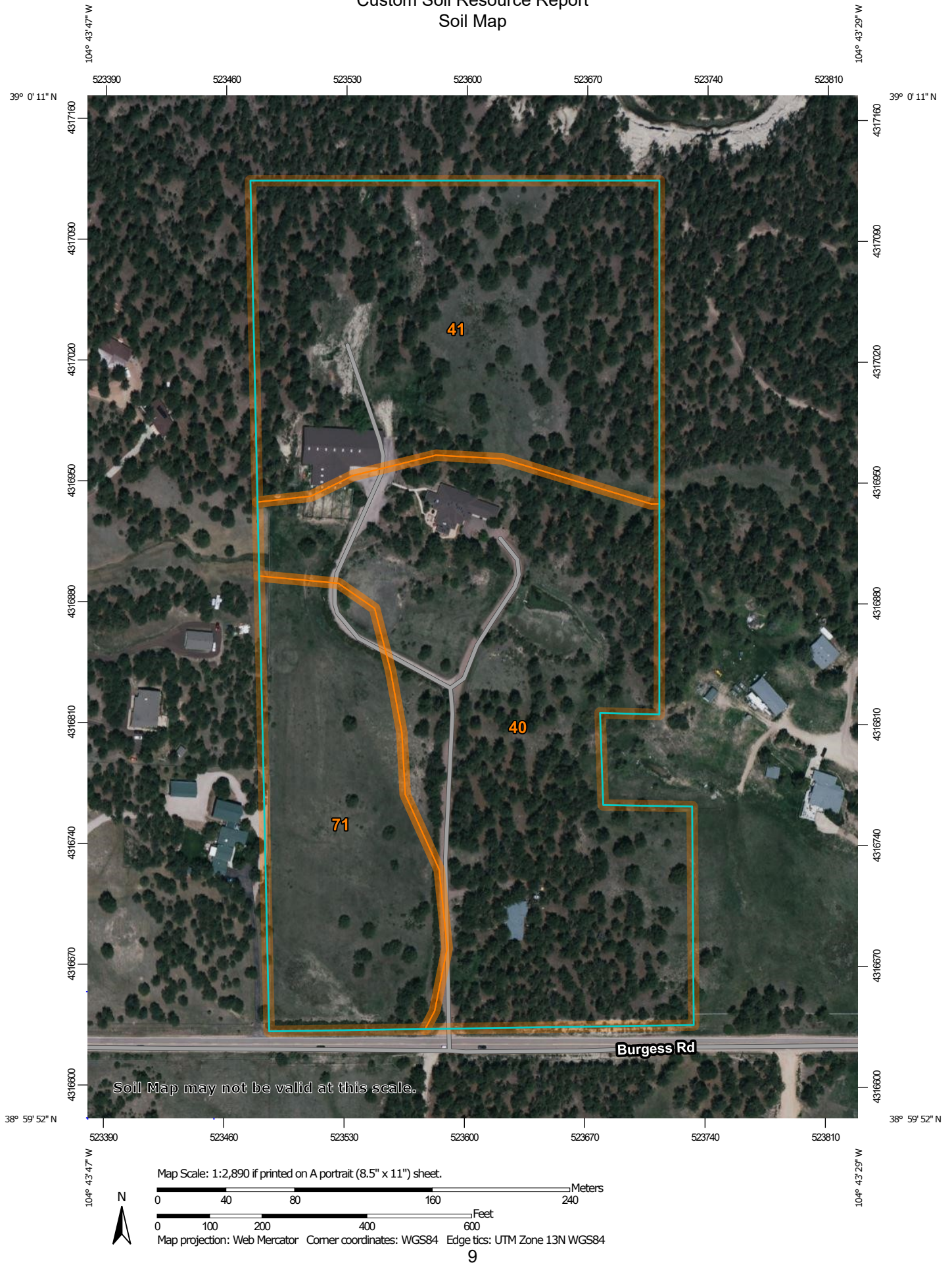
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identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

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.

Custom Soil Resource Report Soil Map



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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 22, Sep 3, 2024

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

Date(s) aerial images were photographed: 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
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	12.8	45.0%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	10.1	35.3%
71	Pring coarse sandy loam, 3 to 8 percent slopes	5.6	19.7%
Totals for Area of Interest		28.5	100.0%

Map Unit Descriptions

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

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

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

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or

landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

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

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

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

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

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

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

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

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

El Paso County Area, Colorado

40—Kettle gravelly loamy sand, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 368g

Elevation: 7,000 to 7,700 feet

Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 85 percent

Minor components: 5 percent

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

Description of Kettle

Setting

Landform: Hills

Landform position (three-dimensional): Side slope

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Sandy alluvium derived from arkose

Typical profile

E - 0 to 16 inches: gravelly loamy sand

Bt - 16 to 40 inches: gravelly sandy loam

C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Somewhat excessively drained

Runoff class: Low

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

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water supply, 0 to 60 inches: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 4e

Hydrologic Soil Group: B

Ecological site: F048AY908CO - Mixed Conifer

Hydric soil rating: No

Minor Components

Pleasant

Percent of map unit: 5 percent

Landform: Depressions

Hydric soil rating: Yes

Other soils

Percent of map unit:

Hydric soil rating: No

41—Kettle gravelly loamy sand, 8 to 40 percent slopes

Map Unit Setting

National map unit symbol: 368h
Elevation: 7,000 to 7,700 feet
Farmland classification: Not prime farmland

Map Unit Composition

Kettle and similar soils: 85 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kettle

Setting

Landform: Hills
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile

E - 0 to 16 inches: gravelly loamy sand
Bt - 16 to 40 inches: gravelly sandy loam
C - 40 to 60 inches: extremely gravelly loamy sand

Properties and qualities

Slope: 8 to 40 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: B
Ecological site: F048AY908CO - Mixed Conifer
Hydric soil rating: No

Minor Components

Pleasant

Percent of map unit: 5 percent

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Landform: Depressions

Hydric soil rating: Yes

Other soils

Percent of map unit:

Hydric soil rating: No

71—Pring coarse sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 369k

Elevation: 6,800 to 7,600 feet

Farmland classification: Not prime farmland

Map Unit Composition

Pring and similar soils: 85 percent

Minor components: 5 percent

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

Description of Pring

Setting

Landform: Hills

Landform position (three-dimensional): Side slope

Down-slope shape: Linear

Across-slope shape: Linear

Parent material: Arkosic alluvium derived from sedimentary rock

Typical profile

A - 0 to 14 inches: coarse sandy loam

C - 14 to 60 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent

Depth to restrictive feature: More than 80 inches

Drainage class: Well drained

Runoff class: Low

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

Depth to water table: More than 80 inches

Frequency of flooding: None

Frequency of ponding: None

Available water supply, 0 to 60 inches: Low (about 6.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: B

Ecological site: R048AY222CO - Loamy Park

Hydric soil rating: No

Minor Components

Pleasant

Percent of map unit: 5 percent

Landform: Depressions

Hydric soil rating: Yes

Other soils

Percent of map unit:

Hydric soil rating: No

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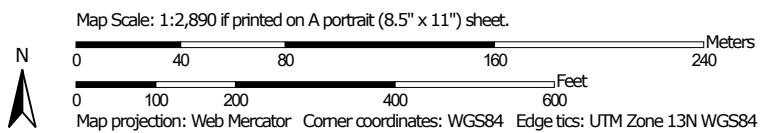
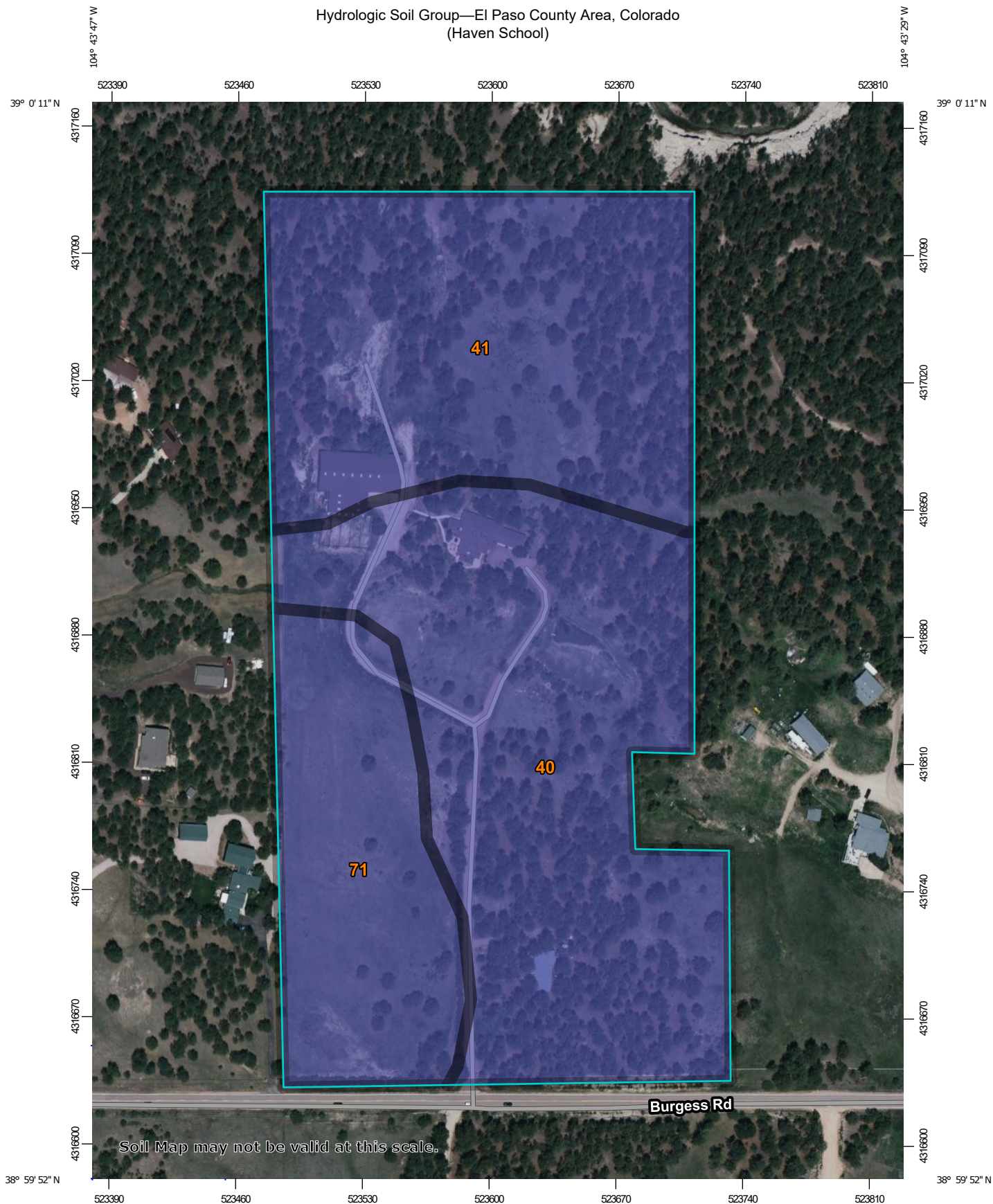
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Hydrologic Soil Group—El Paso County Area, Colorado (Haven School)



Hydrologic Soil Group—El Paso County Area, Colorado
(Haven School)

MAP LEGEND

Area of Interest (AOI)









 Area of Interest (AOI)

Soils

Soil Rating Polygons





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

Soil Rating Lines


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

Soil Rating Points






 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available


Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

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

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

Date(s) aerial images were photographed: 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
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	B	12.8	45.0%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	10.1	35.3%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	5.6	19.7%
Totals for Area of Interest			28.5	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_r) 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_r) of the time of concentration can be estimated from the hydraulic properties of the storm sewer, gutter, swale, ditch, or drainageway. Initial time, on the other hand, will vary with surface slope, depression storage, surface cover, antecedent rainfall, and infiltration capacity of the soil, as well as distance of surface flow. The time of concentration is represented by Equation 6-7 for both urban and non-urban areas.

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

Where:

t_c = time of concentration (min)

t_i = overland (initial) flow time (min)

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

3.2.1 Overland (Initial) Flow Time

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

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

Where:

t_i = overland (initial) flow time (min)

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

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

S = average basin slope (ft/ft)

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

3.2.2 Travel Time

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

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

Where:

V = velocity (ft/s)

C_v = conveyance coefficient (from Table 6-7)

S_w = watercourse slope (ft/ft)

Table 6-7. Conveyance Coefficient, C_v

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

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

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

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

3.2.3 First Design Point Time of Concentration in Urban Catchments

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

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

Where:

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

L = waterway length (ft)

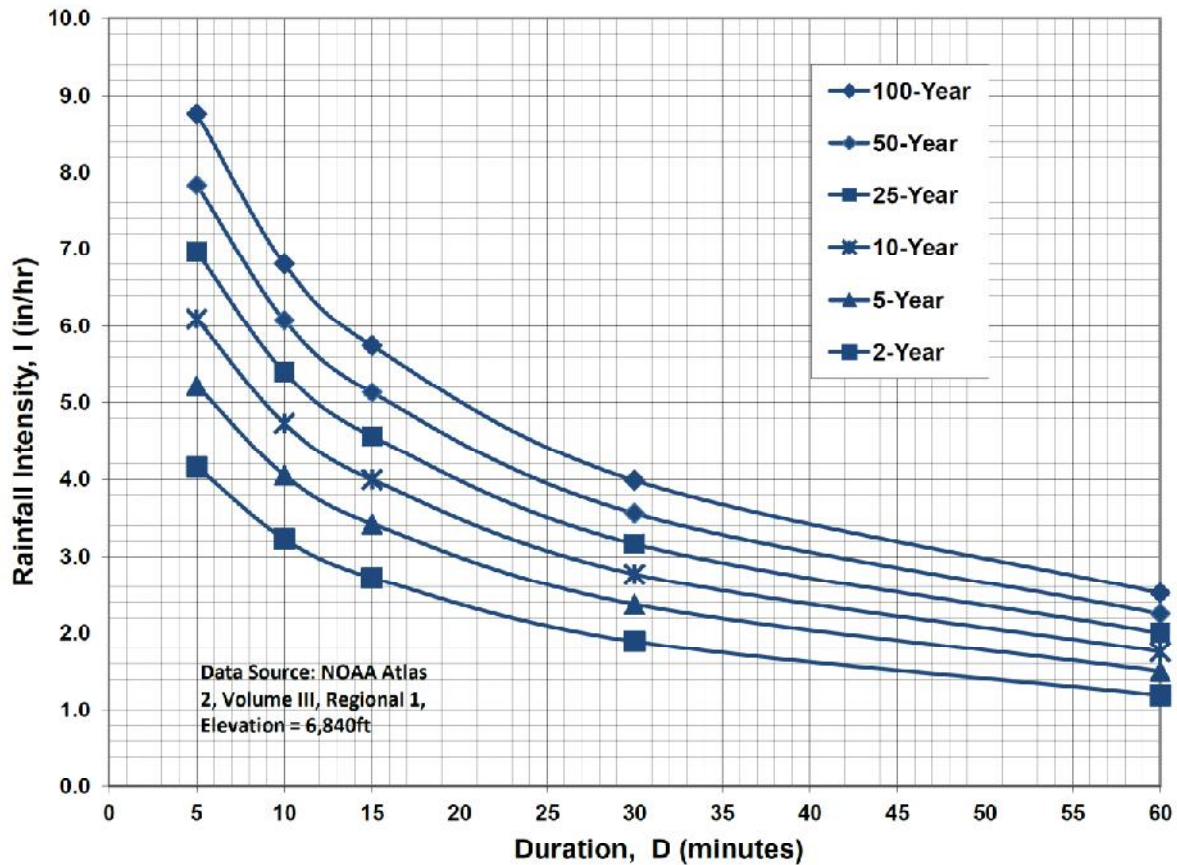
Equation 6-10 was developed using the rainfall-runoff data collected in the Denver region and, in essence, represents regional “calibration” of the Rational Method. Normally, Equation 6-10 will result in a lesser time of concentration at the first design point and will govern in an urbanized watershed.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

3.2.4 Minimum Time of Concentration

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

3.2.5 Post-Development Time of Concentration

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

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

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

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

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

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

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

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

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

COMPOSITE RUNOFF COEFFICIENTS - TYPICAL RURAL RESIDENTIAL AREA (5-ACRE MIN. LOT SIZES)												
DEVELOPED CONDITIONS												
100-YEAR C VALUES												
BASIN	TOTAL AREA (AC)	SOIL TYPE	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
5-ACRE LOTS	5.00	B	7.00	BLDG/DRIVEWAY	0.9	93.00	LAWN/MEADOW	0.08				0.137
100-YEAR C VALUES												
BASIN	TOTAL AREA (AC)	SOIL TYPE	AREA (%)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 2 DEVELOPMENT/ COVER	C	AREA (%)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
5-ACRE LOTS	5.00	B	7.00	BLDG/DRIVEWAY	0.96	93.00	LAWN/MEADOW	0.35				0.393

HAVEN FOREST SCHOOL
COMPOSITE RUNOFF COEFFICIENTS

EXISTING CONDITIONS											
5-YEAR C VALUES											
BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1	173.10	173.10	RURAL RESIDENTIAL	0.137							0.137
OA2	11.50	11.50	RURAL RESIDENTIAL	0.137							0.137
OA1,OA2	184.60										0.137
A	13.32	1.10	BUILDINGS / PAVEMENT	0.9	0.00	GRAVEL	0.59	12.22	LANDSCAPED	0.08	0.148
OA1,OA2,A	197.92										0.138
OB1	0.27	0.11	PAVED/IMPERVIOUS	0.9	0.16	LANDSCAPED	0.08				0.408
B	4.05	0.07	PAVED/IMPERVIOUS	0.9	3.98	LANDSCAPED	0.08				0.094
OB1,B	4.32										0.114
OC1	3.86	3.86	RURAL RESIDENTIAL	0.137							0.137
C	10.51	0.20	PAVED/IMPERVIOUS	0.9	10.31	LANDSCAPED	0.08				0.096
OC1,C	14.37										0.107
100-YEAR C VALUES											
BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1	173.10	173.10	RURAL RESIDENTIAL	0.393							0.393
OA2	11.50	11.50	RURAL RESIDENTIAL	0.393							0.393
OA1,OA2	184.60										0.393
A	13.32	1.10	BUILDINGS / PAVEMENT	0.96	0.00	GRAVEL	0.7	12.22	LANDSCAPED	0.35	0.400
OA1,OA2,A	197.92										0.393
OB1	0.27	0.11	PAVED/IMPERVIOUS	0.96	0.16	LANDSCAPED	0.35				0.594
B	4.05	0.07	PAVED/IMPERVIOUS	0.96	3.98	LANDSCAPED	0.35				0.361
OB1,B	4.32										0.375
OC1	3.86	3.86	RURAL RESIDENTIAL	0.393							0.393
C	10.51	0.20	PAVED/IMPERVIOUS	0.96	10.31	LANDSCAPED	0.35				0.362
OC1,C	14.37										0.370

HAVEN FOREST SCHOOL
RATIONAL METHOD

EXISTING CONDITIONS

BASIN	DESIGN POINT	AREA (AC)	C		Overland Flow			Channel flow					TOTAL T _c ⁽⁴⁾ (MIN)	TOTAL T _c ⁽⁴⁾ (MIN)	INTENSITY ⁽⁶⁾		PEAK FLOW	
			5-YEAR	100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	T _{co} ⁽¹⁾ (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS ⁽²⁾ VELOCITY (FT/S)	T _t ⁽³⁾ (MIN)			5-YR (IN/HR)	100-YR (IN/HR)	Q5 ⁽⁶⁾ (CFS)	Q100 ⁽⁶⁾ (CFS)
OA1		173.10	0.137	0.393	300	0.067	16.2	4050	15	0.069	3.94	17.1	33.3	33.3	2.32	3.90	55.09	265.18
Tt OA1-OA2								835	15	0.048	3.29	4.2						
OA2		11.50	0.137	0.393	300	0.067	16.2	790	15	0.025	2.37	5.6	21.8	21.8	2.96	4.97	4.67	22.48
OA1,OA2	OA2.1	184.60	0.137	0.393									37.6	37.6	2.14	3.60	54.21	260.94
A		13.32	0.148	0.400	100	0.120	7.6	1110	15	0.056	3.55	5.2	12.8	12.8	3.76	6.30	7.40	33.59
Tt OA2 to DP1								825	15	0.028	2.51	5.5						
OA1-OA2,A	1	197.92	0.138	0.393									43.1	43.1	1.94	3.25	52.97	253.09
OB1		0.27	0.408	0.594	60	0.067	5.2	0				0.0	5.2	5.2	5.11	8.58	0.56	1.38
B		4.05	0.094	0.361	100	0.090	8.9	760	15	0.042	3.07	4.1	13.0	13.0	3.74	6.28	1.42	9.17
Tt OB1-B								840	15	0.045	3.18	4.4						
OB1,B	2	4.32	0.114	0.375									9.6	9.6	4.19	7.03	2.06	11.39
OB2		9.27	0.137	0.393	100	0.050	10.3	1520	15	0.049	3.32	7.6	17.9	17.9	3.25	5.46	4.13	19.89
OC1		3.86	0.137	0.393	300	0.060	16.8	230	15	0.066	3.85	1.0	17.8	17.8	3.26	5.48	1.73	8.31
C		10.51	0.096	0.362	200	0.130	11.1	795	15	0.065	3.82	3.5	14.5	14.5	3.57	5.99	3.60	22.79
Tt OC1-C								910	15	0.066	3.85	3.9						
OC1,C	2	14.37	0.107	0.370									21.7	21.7	2.96	4.98	4.56	26.45

1) OVERLAND FLOW T_{co} = (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) T_c = T_{co} + T_t

*** 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

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

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

6) Q = C_iA

HAVEN FOREST SCHOOL
COMPOSITE RUNOFF COEFFICIENTS

DEVELOPED CONDITIONS											
5-YEAR C VALUES											
BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1	173.10	173.10	RURAL RESIDENTIAL	0.137							0.137
OA2	11.50	11.50	RURAL RESIDENTIAL	0.137							0.137
OA1,OA2	184.60										0.137
A1	11.72	0.85	BUILDINGS / PAVEMENT	0.9	0.40	GRAVEL	0.59	10.47	LANDSCAPED	0.08	0.157
OA1,OA2,A1	196.32										0.138
A2	1.61	0.35	BUILDINGS / PAVEMENT	0.9	0.00	GRAVEL	0.59	1.26	LANDSCAPED	0.08	0.258
OA1,OA2,A1,A2	197.93										0.139
OB1	0.27	0.14	PAVED/IMPERVIOUS	0.9	0.14	LANDSCAPED	0.08				0.490
B	4.05	0.07	PAVED/IMPERVIOUS	0.9	3.98	LANDSCAPED	0.08				0.094
OB1,B	4.32										0.119
OB2	9.27	0.20	NEW PAVEMENT	0.9	9.07	RURAL RESIDENTIAL	0.137				0.153
OC1	3.86	3.86	RURAL RESIDENTIAL	0.137							0.137
C	10.61	0.37	PAVED/IMPERVIOUS	0.9	10.24	LANDSCAPED	0.08				0.109
OC1,C	14.47										0.116
100-YEAR C VALUES											
BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	C	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	C	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	C	WEIGHTED C VALUE
OA1	173.10	173.10	RURAL RESIDENTIAL	0.393							0.393
OA2	11.50	11.50	RURAL RESIDENTIAL	0.393							0.393
OA1,OA2	184.60										0.393
A1	11.72	0.85	BUILDINGS / PAVEMENT	0.96	0.40	GRAVEL	0.7	10.47	LANDSCAPED	0.35	0.406
OA1,OA2,A1	196.32										0.394
A2	1.61	0.35	BUILDINGS / PAVEMENT	0.96	0.00	GRAVEL	0.7	1.26	LANDSCAPED	0.35	0.483
OA1,OA2,A1,A2	197.93										0.395
OB1	0.27	0.14	PAVED/IMPERVIOUS	0.96	0.14	LANDSCAPED	0.35				0.655
B	3.96	0.07	PAVED/IMPERVIOUS	0.96	3.89	LANDSCAPED	0.35				0.361
OB1,B	4.23										0.380
OB2	9.27	0.20	NEW PAVEMENT	0.96	9.07	RURAL RESIDENTIAL	0.393				0.405
OC1	3.86	3.86	RURAL RESIDENTIAL	0.393							0.393
C	10.61	0.37	PAVED/IMPERVIOUS	0.96	10.24	LANDSCAPED	0.35				0.371
OC1,C	14.47										0.377

HAVEN FOREST SCHOOL
DEVELOPED CONDITIONS

BASIN	DESIGN POINT	AREA (AC)	C		Overland Flow			Channel flow					TOTAL T _c ⁽⁴⁾ (MIN)	TOTAL T _c ⁽⁴⁾ (MIN)	INTENSITY ⁽⁵⁾		PEAK FLOW	
			5-YEAR	100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	T _{co} ⁽¹⁾ (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS ⁽²⁾ VELOCITY (FT/S)	T _t ⁽³⁾ (MIN)			5-YR (IN/HR)	100-YR (IN/HR)	Q5 ⁽⁶⁾ (CFS)	Q100 ⁽⁶⁾ (CFS)
OA1		173.10	0.137	0.393	300	0.067	16.2	4050	15	0.069	3.94	17.1	33.3	33.3	2.32	3.90	55.09	265.18
Tt OA1-OA2								835	15	0.048	3.29	4.2						
OA2		11.50	0.137	0.393	300	0.067	16.2	790	15	0.025	2.37	5.6	21.8	21.8	2.96	4.97	4.67	22.48
OA1,OA2	OA2.1	184.60	0.137	0.393									37.6	37.6	2.14	3.60	54.21	260.94
A1		11.72	0.157	0.406	100	0.120	7.5	1110	15	0.056	3.55	5.2	12.8	12.8	3.76	6.32	6.93	30.07
Tt OA2 to A1								665	15	0.029	2.55	4.3						
OA1-OA2,A1	A1.1	196.32	0.138	0.394									41.9	41.9	1.98	3.32	53.63	256.91
A2		1.61	0.258	0.483	100	0.050	9.0	240	15	0.029	2.55	1.6	10.6	10.6	4.04	6.79	1.68	5.28
Tt A1 to A2								160	20	0.025	3.16	0.8						
OA1-OA2,A1-A2	1	197.93	0.139	0.395									42.8	42.8	1.95	3.27	53.64	255.75
OB1		0.27	0.490	0.655	60	0.067	4.6	0				0.0	4.6	5.0	5.17	8.68	0.68	1.53
B		3.96	0.094	0.361	100	0.090	8.9	760	15	0.042	3.07	4.1	13.0	13.0	3.74	6.28	1.39	8.97
Tt OB1-B								840	15	0.045	3.18	4.4						
OB1,B	2	4.23	0.119	0.380									9.0	9.0	4.29	7.20	2.16	11.57
OB2		9.27	0.153	0.405	100	0.050	10.1	1520	15	0.049	3.32	7.6	17.8	17.8	3.27	5.48	4.63	20.59
OC1		3.86	0.137	0.393	300	0.060	16.8	230	15	0.066	3.85	1.0	17.8	17.8	3.26	5.48	1.73	8.31
C		10.61	0.109	0.371	200	0.130	10.9	795	15	0.065	3.82	3.5	14.4	14.4	3.58	6.02	4.14	23.68
Tt OC1-C								910	15	0.066	3.85	3.9						
OC1,C	2	14.47	0.116	0.377									21.7	21.7	2.96	4.98	4.98	27.14

- 1) OVERLAND FLOW T_{co} = (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) T_c = T_{co} + T_t
- *** 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
- I₅ = -1.5 * ln(T_c) + 7.583
- I₁₀₀ = -2.52 * ln(T_c) + 12.735
- 6) Q = C_iA

APPENDIX C
HYDRAULIC CALCULATIONS

**HAVEN SCHOOL
DITCH CALCULATION SUMMARY**

PROPOSED ROADSIDE DITCHES


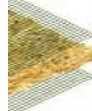
ROADWAY	FROM STA	TO STA	SIDE	SLOPE (%)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)	ROW WIDTH (ft)	DP/ BASIN	Q100 FLOW (CFS)	DITCH FLOW % OF BASIN	DITCH FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	DITCH LINING
BURGESS ROAD	2+40	5+00	N	1.9	4:1/3:1	2.0	0.030	60	OB1	1.5	100	1.5	0.4	2.4	GRASS
BURGESS ROAD	2+40	5+00	S	1.9	4:1/3:1	2.0	0.030	60	OB2	20.6	100	20.6	1.1	4.5	GRASS
BURGESS ROAD	5+00	7+50	N	5.6	4:1/3:1	2.0	0.030	60	OB1	1.5	70	1.1	0.3	3.3	GRASS
BURGESS ROAD	5+00	7+50	S	5.6	4:1/3:1	2.0	0.030	60	OB2	20.6	80	16.5	0.8	6.4	GRASS W/ TRM
BURGESS ROAD	7+50	9+35	N	7.5	4:1/3:1	2.0	0.030	60	OB1	1.5	35	0.5	0.2	3.0	GRASS
BURGESS ROAD	7+50	9+35	S	7.5	4:1/3:1	2.0	0.030	60	OB2	20.6	80	16.5	0.8	7.2	GRASS W/ TRM
BURGESS ROAD	9+35	11+50	N	7.5	4:1/3:1	2.0	0.030	60	A1	30.1	10	3.0	0.4	4.7	GRASS
BURGESS ROAD	9+35	11+50	S	7.5	4:1/3:1	2.0	0.030	60	OB2	20.6	80	16.5	0.8	7.2	GRASS W/ TRM
BURGESS ROAD	11+50	12+90	N	1.8	4:1/3:1	2.0	0.030	60	A1	30.1	10	3.0	0.6	2.8	GRASS
BURGESS ROAD	11+50	12+90	S	1.8	4:1/3:1	2.0	0.030	60	OB2	20.6	50	10.3	0.9	3.7	GRASS

- 1) Channel flow calculations based on Manning's Equation
- 2) Channel depth includes 1' minimum freeboard
- 3) n = 0.03 for grass-lined non-irrigated channels (minimum)
- 4) n = 0.045 for riprap-lined channels
- 5) Vmax = 5.0 fps per El Paso County criteria (p. 10-13) for fescue (dry land grass) for 100-year flows
- 6) Vmax = 8.0 fps with Turf Reinforcement Mat (TRM) Lining (Tensar 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 - Haven School - Burgess Rd
Designer: JPS
Project Date: Wednesday, July 2, 2025
Project Units: U.S. Customary Units
Notes:

Channel Analysis: Ditch-STA 2+40-5+00-N

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0190 ft/ft
Manning's n: 0.0300
Flow: 1.5000 cfs

Result Parameters

Depth: 0.4254 ft
Area of Flow: 0.6332 ft²
Wetted Perimeter: 3.0989 ft
Hydraulic Radius: 0.2043 ft
Average Velocity: 2.3688 ft/s
Top Width: 2.9775 ft
Froude Number: 0.9052
Critical Depth: 0.4104 ft
Critical Velocity: 2.5442 ft/s
Critical Slope: 0.0230 ft/ft
Critical Top Width: 2.93 ft
Calculated Max Shear Stress: 0.5043 lb/ft²
Calculated Avg Shear Stress: 0.2423 lb/ft²

Channel Analysis: Ditch-STA 2+40-5+00-S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0190 ft/ft
Manning's n: 0.0300
Flow: 19.9000 cfs

Result Parameters

Depth: 1.1215 ft
Area of Flow: 4.4019 ft²
Wetted Perimeter: 8.1703 ft
Hydraulic Radius: 0.5388 ft
Average Velocity: 4.5207 ft/s
Top Width: 7.8503 ft
Froude Number: 1.0639
Critical Depth: 1.1544 ft
Critical Velocity: 4.2668 ft/s
Critical Slope: 0.0163 ft/ft
Critical Top Width: 8.25 ft
Calculated Max Shear Stress: 1.3296 lb/ft²
Calculated Avg Shear Stress: 0.6388 lb/ft²

Channel Analysis: Ditch-STA 5+00-7+50-N

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0560 ft/ft
Manning's n: 0.0300
Flow: 1.1000 cfs

Result Parameters

Depth: 0.3092 ft
Area of Flow: 0.3346 ft²
Wetted Perimeter: 2.2525 ft
Hydraulic Radius: 0.1485 ft
Average Velocity: 3.2876 ft/s
Top Width: 2.1643 ft
Froude Number: 1.4735
Critical Depth: 0.3625 ft
Critical Velocity: 2.3912 ft/s
Critical Slope: 0.0240 ft/ft
Critical Top Width: 2.59 ft
Calculated Max Shear Stress: 1.0804 lb/ft²
Calculated Avg Shear Stress: 0.5191 lb/ft²

Channel Analysis: Ditch-STA 5+00-7+50-S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0560 ft/ft
Manning's n: 0.0300
Flow: 15.9000 cfs

Result Parameters

Depth: 0.8418 ft
Area of Flow: 2.4804 ft²
Wetted Perimeter: 6.1330 ft
Hydraulic Radius: 0.4044 ft
Average Velocity: 6.4104 ft/s **> 5fps.....Use TRM Lining**
Top Width: 5.8928 ft
Froude Number: 1.7412
Critical Depth: 1.0553 ft
Critical Velocity: 4.0796 ft/s
Critical Slope: 0.0168 ft/ft
Critical Top Width: 7.54 ft
Calculated Max Shear Stress: 2.9417 lb/ft²
Calculated Avg Shear Stress: 1.4132 lb/ft²

Channel Analysis: Ditch-STA 7+50-9+35-N

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0750 ft/ft
Manning's n: 0.0300
Flow: 0.5000 cfs

Result Parameters

Depth: 0.2178 ft
Area of Flow: 0.1660 ft²
Wetted Perimeter: 1.5866 ft
Hydraulic Radius: 0.1046 ft
Average Velocity: 3.0120 ft/s
Top Width: 1.5245 ft
Froude Number: 1.6085
Critical Depth: 0.2645 ft
Critical Velocity: 2.0423 ft/s
Critical Slope: 0.0266 ft/ft
Critical Top Width: 1.89 ft
Calculated Max Shear Stress: 1.0192 lb/ft²
Calculated Avg Shear Stress: 0.4896 lb/ft²

Channel Analysis: Ditch-STA 7+50-9+35-S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0750 ft/ft
Manning's n: 0.0300
Flow: 15.9000 cfs

Result Parameters

Depth: 0.7970 ft
Area of Flow: 2.2230 ft²
Wetted Perimeter: 5.8061 ft
Hydraulic Radius: 0.3829 ft
Average Velocity: 7.1526 ft/s > **5fps.....Use TRM Lining**
Top Width: 5.5787 ft
Froude Number: 1.9968
Critical Depth: 1.0553 ft
Critical Velocity: 4.0796 ft/s
Critical Slope: 0.0168 ft/ft
Critical Top Width: 7.54 ft
Calculated Max Shear Stress: 3.7298 lb/ft²
Calculated Avg Shear Stress: 1.7918 lb/ft²

Channel Analysis: Ditch-STA 9+35-11+50-N

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0750 ft/ft
Manning's n: 0.0300
Flow: 3.0000 cfs

Result Parameters

Depth: 0.4264 ft
Area of Flow: 0.6364 ft²
Wetted Perimeter: 3.1066 ft
Hydraulic Radius: 0.2049 ft
Average Velocity: 4.7140 ft/s
Top Width: 2.9849 ft
Froude Number: 1.7991
Critical Depth: 0.5416 ft
Critical Velocity: 2.9225 ft/s
Critical Slope: 0.0210 ft/ft
Critical Top Width: 3.87 ft
Calculated Max Shear Stress: 1.9956 lb/ft²
Calculated Avg Shear Stress: 0.9587 lb/ft²

Channel Analysis: Ditch-STA 9+35-11+50-S

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0750 ft/ft
Manning's n: 0.0300
Flow: 15.9000 cfs

Result Parameters

Depth: 0.7970 ft
Area of Flow: 2.2230 ft²
Wetted Perimeter: 5.8061 ft
Hydraulic Radius: 0.3829 ft
Average Velocity: 7.1526 ft/s > **5fps.....Use TRM Lining**
Top Width: 5.5787 ft
Froude Number: 1.9968
Critical Depth: 1.0553 ft
Critical Velocity: 4.0796 ft/s
Critical Slope: 0.0168 ft/ft
Critical Top Width: 7.54 ft
Calculated Max Shear Stress: 3.7298 lb/ft²
Calculated Avg Shear Stress: 1.7918 lb/ft²

Channel Analysis: Ditch-STA 11+50-12+90-N

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0180 ft/ft
Manning's n: 0.0300
Flow: 3.0000 cfs

Result Parameters

Depth: 0.5572 ft
Area of Flow: 1.0868 ft²
Wetted Perimeter: 4.0597 ft
Hydraulic Radius: 0.2677 ft
Average Velocity: 2.7604 ft/s
Top Width: 3.9007 ft
Froude Number: 0.9216
Critical Depth: 0.5416 ft
Critical Velocity: 2.9225 ft/s
Critical Slope: 0.0210 ft/ft
Critical Top Width: 3.87 ft
Calculated Max Shear Stress: 0.6259 lb/ft²
Calculated Avg Shear Stress: 0.3007 lb/ft²

Channel Analysis: Ditch-STA 11+50-12+90-S

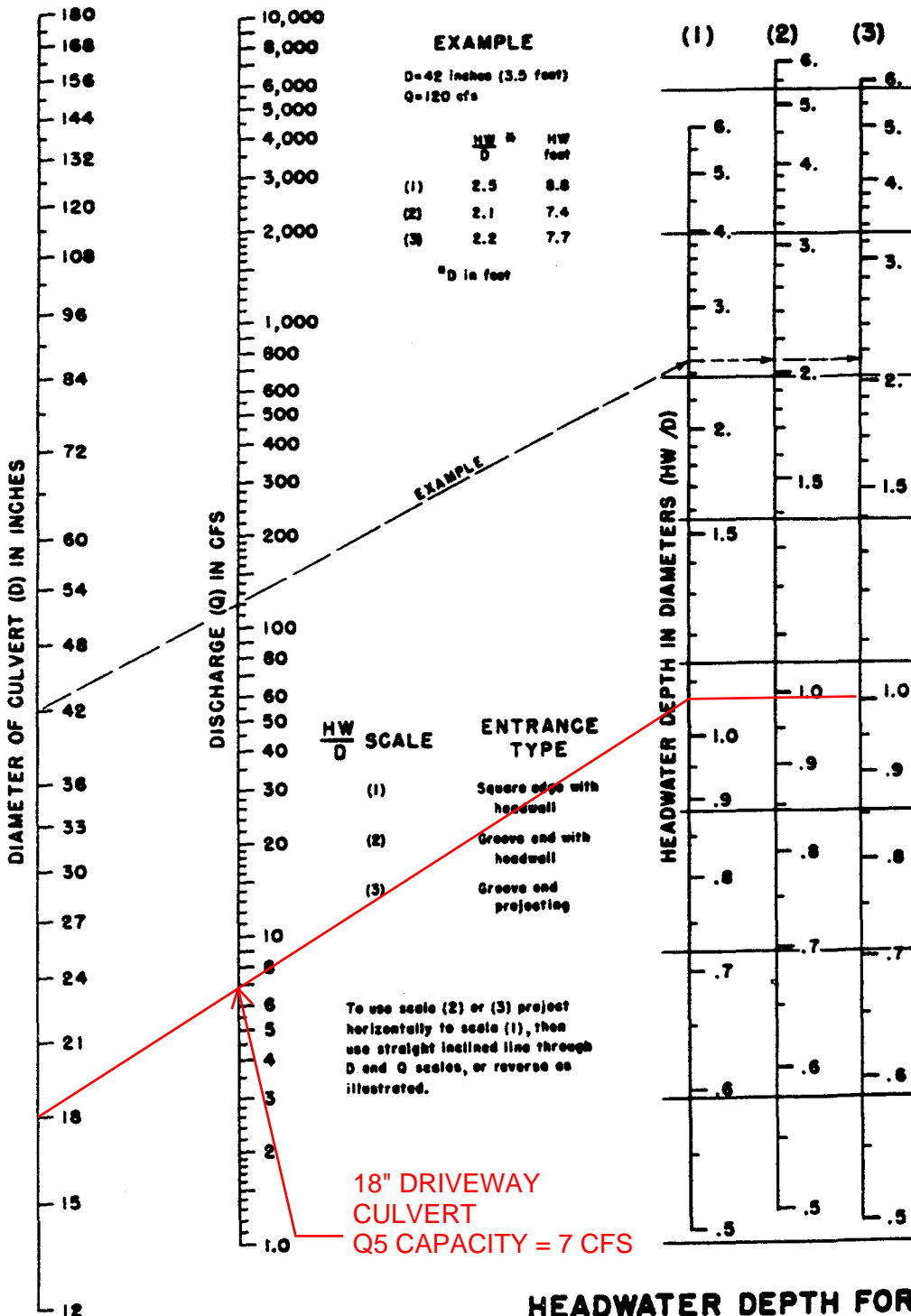
Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 4.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.0180 ft/ft
Manning's n: 0.0300
Flow: 10.0000 cfs

Result Parameters

Depth: 0.8752 ft
Area of Flow: 2.6811 ft²
Wetted Perimeter: 6.3764 ft
Hydraulic Radius: 0.4205 ft
Average Velocity: 3.7298 ft/s
Top Width: 6.1266 ft
Froude Number: 0.9936
Critical Depth: 0.8766 ft
Critical Velocity: 3.7182 ft/s
Critical Slope: 0.0179 ft/ft
Critical Top Width: 6.26 ft
Calculated Max Shear Stress: 0.9831 lb/ft²
Calculated Avg Shear Stress: 0.4723 lb/ft²



HEADWATER SCALES 2&3
 REVISED MAY 1984

BUREAU OF PUBLIC ROADS JAN 1963



HDR Infrastructure, Inc.
 A Centerra Company

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

Date

OCT. 1987

Figure

9-34

**HAVEN FOREST SCHOOL
DRIVEWAY CULVERT SIZING SUMMARY**

PRIVATE CULVERT	DP	Q5 FLOW (CFS)	FLOW % AT DVWY CULVERT	CULVERT FLOW (Q5, CFS)	CULVERT SIZE (IN)
A1.1	A1.1	30.1	20	6.0	18
C	C	23.7	25	5.9	18

* CULVERT SIZING BASED ON EPC DCM, FIGURE 9-34; ASSUMING MAX. HW/D = 1.0 FOR Q5

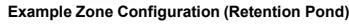
APPENDIX D

STORMWATER DETENTION / WATER QUALITY CALCULATIONS

HAVEN FOREST SCHOOL COMPOSITE IMPERVIOUS AREAS											
IMPERVIOUS AREAS											
BASIN	TOTAL AREA (AC)	(AC)	SUB-AREA 1 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	AREA (AC)	SUB-AREA 2 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	(AC)	SUB-AREA 3 DEVELOPMENT/ COVER	PERCENT IMPERVIOUS	WEIGHTED % IMP
OA1	173.10	173.10	RURAL RESIDENTIAL	7							7.000
OA2	11.50	11.50	RURAL RESIDENTIAL	7							7.000
OA1,OA2	184.60										7.000
A1	11.72	0.85	BUILDINGS / PAVEMENT	100	0.40	GRAVEL	80	10.47	LANDSCAPED	0.00	9.983
OA1,OA2,A1	196.32										7.178
A2	1.61	0.35	BUILDINGS / PAVEMENT	100	0.00	GRAVEL	80	1.26	LANDSCAPED	0.00	21.739
OA1,OA2,A1,A2	197.93										7.297
OB1	0.27	0.14	PAVED/IMPERVIOUS	100	0.14	LANDSCAPED	0.00				50.000
B	3.96	0.07	PAVED/IMPERVIOUS	100	3.89	LANDSCAPED	0.00				1.768
OB1,B	4.23										4.846
OC1	3.86	3.86	RURAL RESIDENTIAL	7							7.000
C	10.61	0.37	PAVED/IMPERVIOUS	100	10.24	LANDSCAPED	0.00				3.487
OC1,C	14.47										4.424
TOTAL ON-SITE AREA:											
A1,A2,B,C	27.90										7.025

MHFD-Detention, Version 4.06 (July 2022)

Basin ID: Detention Pond A1

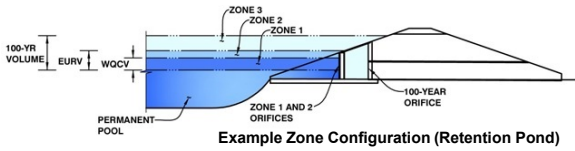


Total detention volume is less than 100-year volume.

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Haven Forest School
Basin ID: Detention Pond A1



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.35	0.840	Orifice Plate
Zone 2 (EURV)	5.77	0.484	Orifice Plate
Zone 3 (User)	9.01	1.417	Weir&Pipe (Restrict)
Total (all zones)		2.741	

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 =	4.35	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	8.00	inches
Orifice Plate: Orifice Area per Row =	3.28	sq. inches (diameter = 2 inches)

Calculated Parameters for Plate	
WQ Orifice Area per Row =	2.278E-02 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	1.45	2.90					
Orifice Area (sq. inches)	3.28	3.28	3.28					

	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	
Vertical Orifice Area =	N/A ft ²
Vertical Orifice Centroid =	N/A feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, H _o =	6.00	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Gate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Gate Type =	Type C Gate	N/A	
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir	
Height of Gate Upper Edge, H _u =	6.00 feet
Overflow Weir Slope Length =	4.00 feet
Gate Open Area / 100-yr Orifice Area =	7.08
Overflow Gate Open Area w/o Debris =	11.14 ft ²
Overflow Gate Open Area w/ Debris =	5.57 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 =	0.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	15.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate	
Outlet Orifice Area =	1.57 ft ²
Outlet Orifice Centroid =	0.68 feet
Half-Central Angle of Restrictor Plate on Pipe =	2.30 radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage =	9.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	40.00	feet
Spillway End Slopes =	8.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway	
Spillway Design Flow Depth =	1.37 feet
Stage at Top of Freeboard =	11.37 feet
Basin Area at Top of Freeboard =	0.69 acres
Basin Volume at Top of Freeboard =	3.94 acre-ft

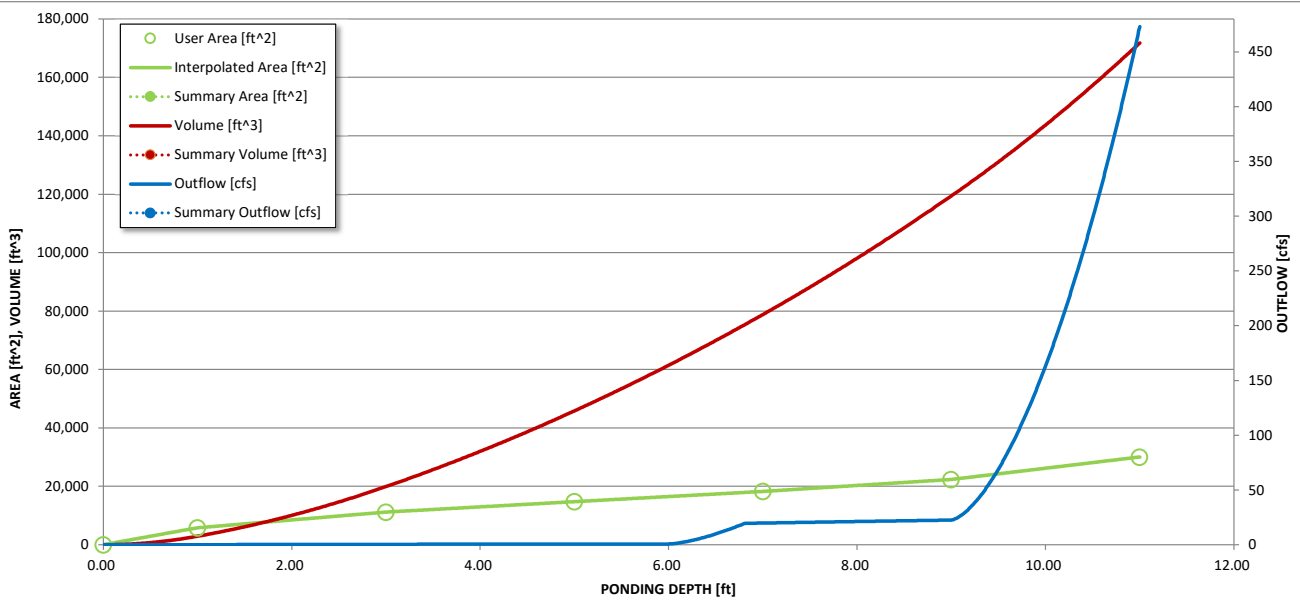
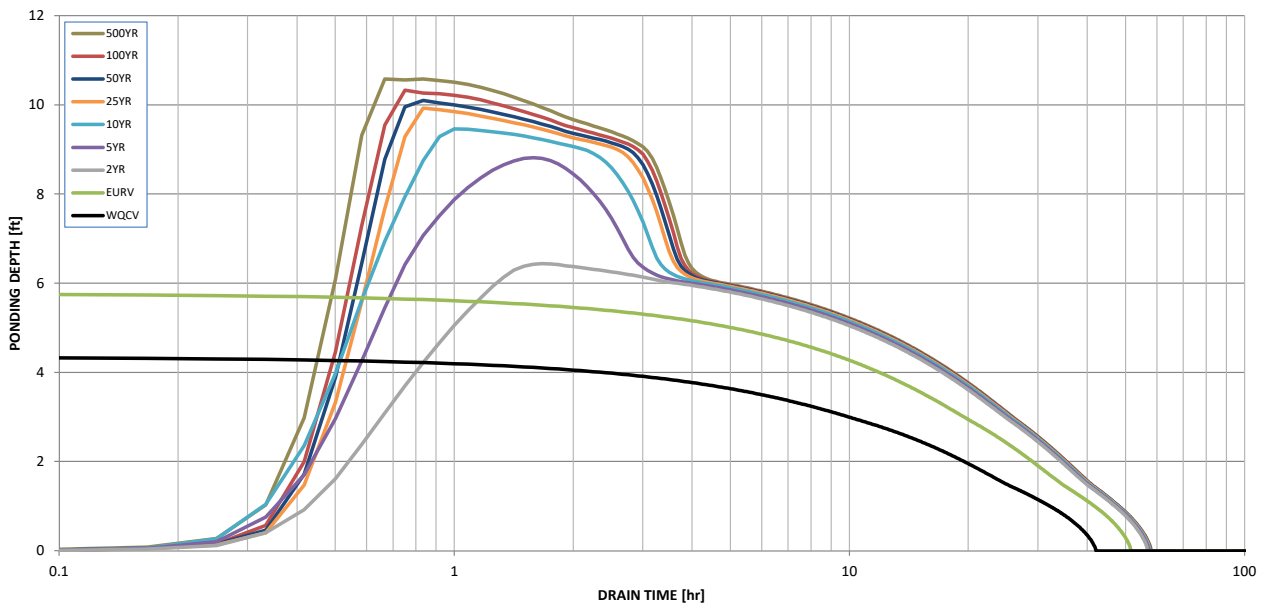
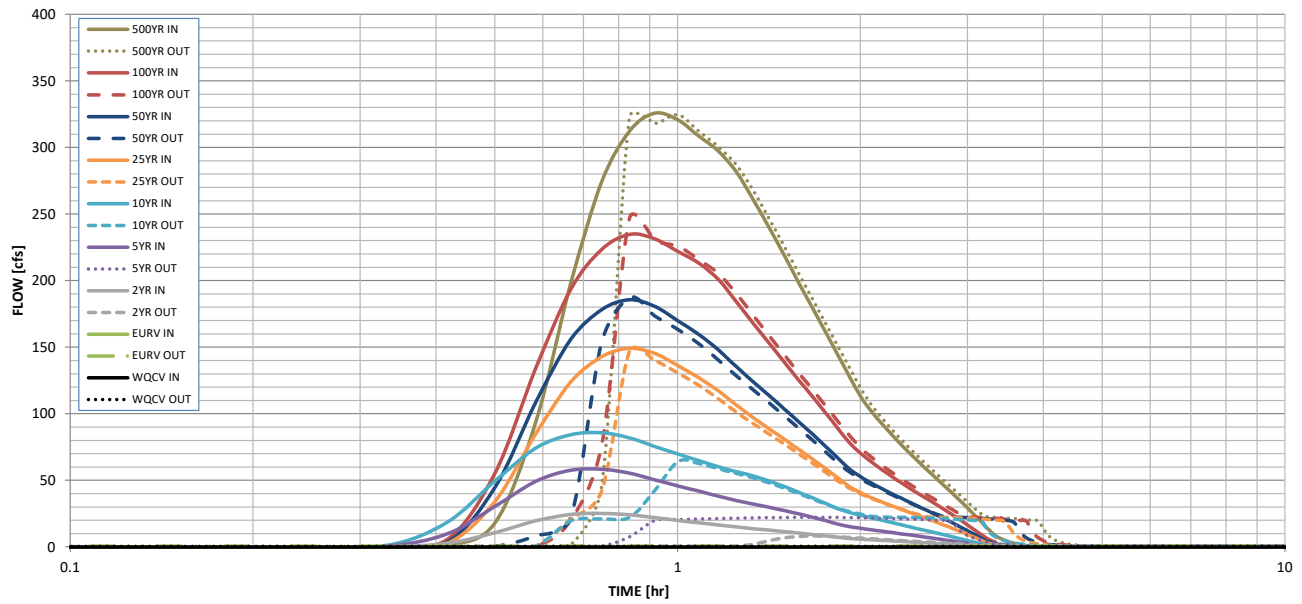
Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.840	1.324	2.247	5.328	8.457	14.209	18.051	23.662	33.779
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	2.247	5.328	8.457	14.209	18.051	23.662	33.779
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	17.9	50.5	77.8	141.2	177.5	226.2	316.9
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.09	0.26	0.39	0.71	0.90	1.14	1.60
Peak Inflow Q (cfs) =	N/A	N/A	25.3	58.4	85.9	149.3	185.7	234.9	325.8
Peak Outflow Q (cfs) =	0.5	0.7	8.3	22.3	64.2	147.0	187.4	247.2	324.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.4	0.8	1.0	1.1	1.1	1.0
Structure Controlling Flow =	Plate	Plate	Overflow Weir 1	Outlet Plate 1	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Gate 1 (fps) =	N/A	N/A	0.68	1.9	2.0	2.0	2.1	2.1	2.1
Max Velocity through Gate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	37	45	47	39	34	27	23	19	12
Time to Drain 99% of Inflow Volume (hours) =	40	49	53	49	46	41	38	35	31
Maximum Ponding Depth (ft) =	4.35	5.77	6.44	8.82	9.47	9.93	10.10	10.33	10.59
Area at Maximum Ponding Depth (acres) =	0.31	0.37	0.40	0.50	0.55	0.59	0.61	0.63	0.65
Maximum Volume Stored (acre-ft) =	0.840	1.324	1.581	2.644	2.986	3.250	3.359	3.495	3.662

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)



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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02
	0:15:00	0.00	0.00	0.05	0.09	0.11	0.07	0.10	0.09	0.16
	0:20:00	0.00	0.00	0.27	0.76	1.34	0.29	0.35	0.40	1.31
	0:25:00	0.00	0.00	2.78	9.78	18.40	2.67	3.50	5.57	17.99
	0:30:00	0.00	0.00	10.75	30.38	49.54	34.15	44.57	55.25	93.12
	0:35:00	0.00	0.00	19.64	49.23	74.12	84.74	108.46	133.93	198.11
	0:40:00	0.00	0.00	24.40	57.66	84.38	123.90	155.93	193.54	274.48
	0:45:00	0.00	0.00	25.29	58.45	85.88	142.92	178.29	223.57	312.47
	0:50:00	0.00	0.00	24.16	55.37	81.90	149.28	185.67	234.91	325.81
	0:55:00	0.00	0.00	22.01	50.47	75.49	145.37	180.76	231.53	320.79
	1:00:00	0.00	0.00	19.91	45.87	69.82	136.22	170.02	221.94	308.63
	1:05:00	0.00	0.00	18.24	41.94	64.90	127.02	159.51	213.15	297.29
	1:10:00	0.00	0.00	16.60	38.18	60.18	117.22	148.07	200.87	281.44
	1:15:00	0.00	0.00	15.02	34.90	56.53	106.37	135.19	183.95	260.27
	1:20:00	0.00	0.00	13.73	32.23	53.25	96.86	123.77	167.60	239.06
	1:25:00	0.00	0.00	12.59	29.74	49.46	88.52	113.38	152.57	218.41
	1:30:00	0.00	0.00	11.50	27.29	45.30	80.70	103.42	138.37	198.33
	1:35:00	0.00	0.00	10.44	24.85	41.09	73.21	93.86	125.25	179.54
	1:40:00	0.00	0.00	9.39	22.37	36.90	66.05	84.71	112.92	161.80
	1:45:00	0.00	0.00	8.35	19.82	32.80	59.03	75.77	100.96	144.65
	1:50:00	0.00	0.00	7.32	17.29	28.87	52.13	67.01	89.34	128.11
	1:55:00	0.00	0.00	6.44	15.30	25.99	45.47	58.60	78.36	113.06
	2:00:00	0.00	0.00	5.89	14.01	23.86	40.77	52.75	70.37	101.93
	2:05:00	0.00	0.00	5.44	12.92	21.93	37.05	48.03	63.93	92.77
	2:10:00	0.00	0.00	5.02	11.89	20.10	33.87	43.91	58.22	84.49
	2:15:00	0.00	0.00	4.61	10.89	18.36	30.96	40.09	53.05	76.91
	2:20:00	0.00	0.00	4.20	9.92	16.66	28.32	36.61	48.28	69.89
	2:25:00	0.00	0.00	3.80	8.97	15.02	25.77	33.27	43.80	63.29
	2:30:00	0.00	0.00	3.42	8.05	13.44	23.32	30.08	39.61	57.14
	2:35:00	0.00	0.00	3.04	7.13	11.91	20.96	27.03	35.72	51.42
	2:40:00	0.00	0.00	2.67	6.24	10.44	18.63	24.02	31.86	45.80
	2:45:00	0.00	0.00	2.30	5.35	9.03	16.31	21.06	28.02	40.28
	2:50:00	0.00	0.00	1.93	4.48	7.63	14.01	18.12	24.19	34.77
	2:55:00	0.00	0.00	1.57	3.61	6.24	11.71	15.19	20.36	29.28
	3:00:00	0.00	0.00	1.20	2.74	4.86	9.42	12.27	16.54	23.80
	3:05:00	0.00	0.00	0.84	1.89	3.49	7.14	9.35	12.73	18.34
	3:10:00	0.00	0.00	0.50	1.11	2.27	4.87	6.47	8.97	13.05
	3:15:00	0.00	0.00	0.25	0.63	1.57	2.89	3.96	5.70	8.66
	3:20:00	0.00	0.00	0.16	0.45	1.21	1.79	2.58	3.75	5.95
	3:25:00	0.00	0.00	0.12	0.34	0.94	1.13	1.72	2.50	4.13
	3:30:00	0.00	0.00	0.10	0.27	0.74	0.72	1.16	1.62	2.81
	3:35:00	0.00	0.00	0.07	0.21	0.58	0.45	0.77	1.01	1.85
	3:40:00	0.00	0.00	0.06	0.16	0.44	0.29	0.52	0.58	1.16
	3:45:00	0.00	0.00	0.04	0.12	0.32	0.18	0.34	0.29	0.67
	3:50:00	0.00	0.00	0.03	0.09	0.22	0.11	0.22	0.15	0.39
	3:55:00	0.00	0.00	0.03	0.07	0.15	0.08	0.16	0.11	0.27
	4:00:00	0.00	0.00	0.02	0.05	0.10	0.06	0.11	0.09	0.20
	4:05:00	0.00	0.00	0.02	0.03	0.08	0.04	0.09	0.07	0.16
	4:10:00	0.00	0.00	0.01	0.02	0.06	0.03	0.07	0.05	0.12
	4:15:00	0.00	0.00	0.01	0.01	0.04	0.02	0.05	0.04	0.09
	4:20:00	0.00	0.00	0.01	0.01	0.03	0.02	0.03	0.03	0.06
	4:25:00	0.00	0.00	0.00	0.01	0.02	0.01	0.02	0.02	0.04
	4:30:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.02
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

**HAVEN SCHOOL - 5490 BURGESS ROAD
ENGINEER'S COST ESTIMATE
DRAINAGE IMPROVEMENTS - DETENTION POND A1 (PRIVATE)**

Item No.	Description	Quantity	Unit	Unit Cost (\$\$)	Total Cost (\$\$)
	PRIVATE DRAINAGE FACILITIES (NON-REIMBURSABLE)				
	Aggregate Base Course (Access Ramp)	31	CY	\$66	\$2,046
	Riprap Aprons (12" Riprap)	15	TN	\$104	\$1,560
	18" RCP Driveway Culvert	88	LF	\$82	\$7,216
	Detention Basin Outlet Structure	1	LS	\$8,000	\$8,000
	SUBTOTAL				\$18,822
	Contingency @ 10%				\$1,882
	TOTAL				\$20,704

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.

Design Procedure Form: Runoff Reduction

UD-BMP (Version 3.07, March 2018)

Sheet 1 of 1

Designer: JPS
 Company: JPS
 Date: July 2, 2025
 Project: Haven School
 Location: Runoff Reduction from existing Grass Swales

SITE INFORMATION (User Input in Blue Cells)

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

Area Type	UIA:RPA	SPA											
Area ID	UIA-C	SPA-C											
Downstream Design Point ID	DP3	DP3											
Downstream BMP Type	None	None											
DCIA (ft ²)	--	--											
UIA (ft ²)	16,117	--											
RPA (ft ²)	7,360	--											
SPA (ft ²)	--	438,694											
HSG A (%)	0%	0%											
HSG B (%)	100%	100%											
HSG C/D (%)	0%	0%											
Average Slope of RPA (ft/ft)	0.065	--											
UIA:RPA Interface Width (ft)	6.00	--											

CALCULATED RUNOFF RESULTS

Area ID	UIA-C	SPA-C											
UIA:RPA Area (ft ²)	23,477	--											
L / W Ratio	16.00	--											
UIA / Area	0.6865	--											
Runoff (in)	0.00	0.00											
Runoff (ft ³)	0	0											
Runoff Reduction (ft ³)	672	21935											

CALCULATED WQCV RESULTS

Area ID	UIA-C	SPA-C											
WQCV (ft ³)	672	0											
WQCV Reduction (ft ³)	672	0											
WQCV Reduction (%)	100%	0%											
Untreated WQCV (ft ³)	0	0											

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

Downstream Design Point ID	DP3												
DCIA (ft ²)	0												
UIA (ft ²)	16,117												
RPA (ft ²)	7,360												
SPA (ft ²)	438,694												
Total Area (ft ²)	462,171												
Total Impervious Area (ft ²)	16,117												
WQCV (ft ³)	672												
WQCV Reduction (ft ³)	672												
WQCV Reduction (%)	100%												
Untreated WQCV (ft ³)	0												

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

Total Area (ft ²)	462,171
Total Impervious Area (ft ²)	16,117
WQCV (ft ³)	672
WQCV Reduction (ft ³)	672
WQCV Reduction (%)	100%
Untreated WQCV (ft ³)	0

Water Quality Treatment Summary Table		
Basin ID(s)	PCM Tributary Area (ac)	PCM ID
OA1-OA2,A1	196.3	Pond A1
C	10.6	Runoff Reduction
A2	0.39	Excluded*
OB1	0.16	Excluded*
OB2	0.41	Excluded*

* Excluded based on ECM App I.7.1.C.1

**Summary of the PCM(s) that the Site is Utilizing to Meet
WQ Treatment and/or Detention Requirements**

Questions (about the PCM(s) that the site is tributary to)	Yes	No	PCM Identifier(s)	EDARP File # That The Existing or Proposed PCM(s) Was/Were Designed/Built With:	Comments
Existing on or offsite PCM(s) that will <u>not</u> be modified with this project?		X			
Existing on or offsite PCM(s), but will be modified with this project?		X			
Proposed on or offsite PCM(s) to be built with this project?	X				Existing stock pond to be upgraded to serve as Water Quality Pond A1
Proposed on or offsite PCM(s) to be built with a future project?		X			

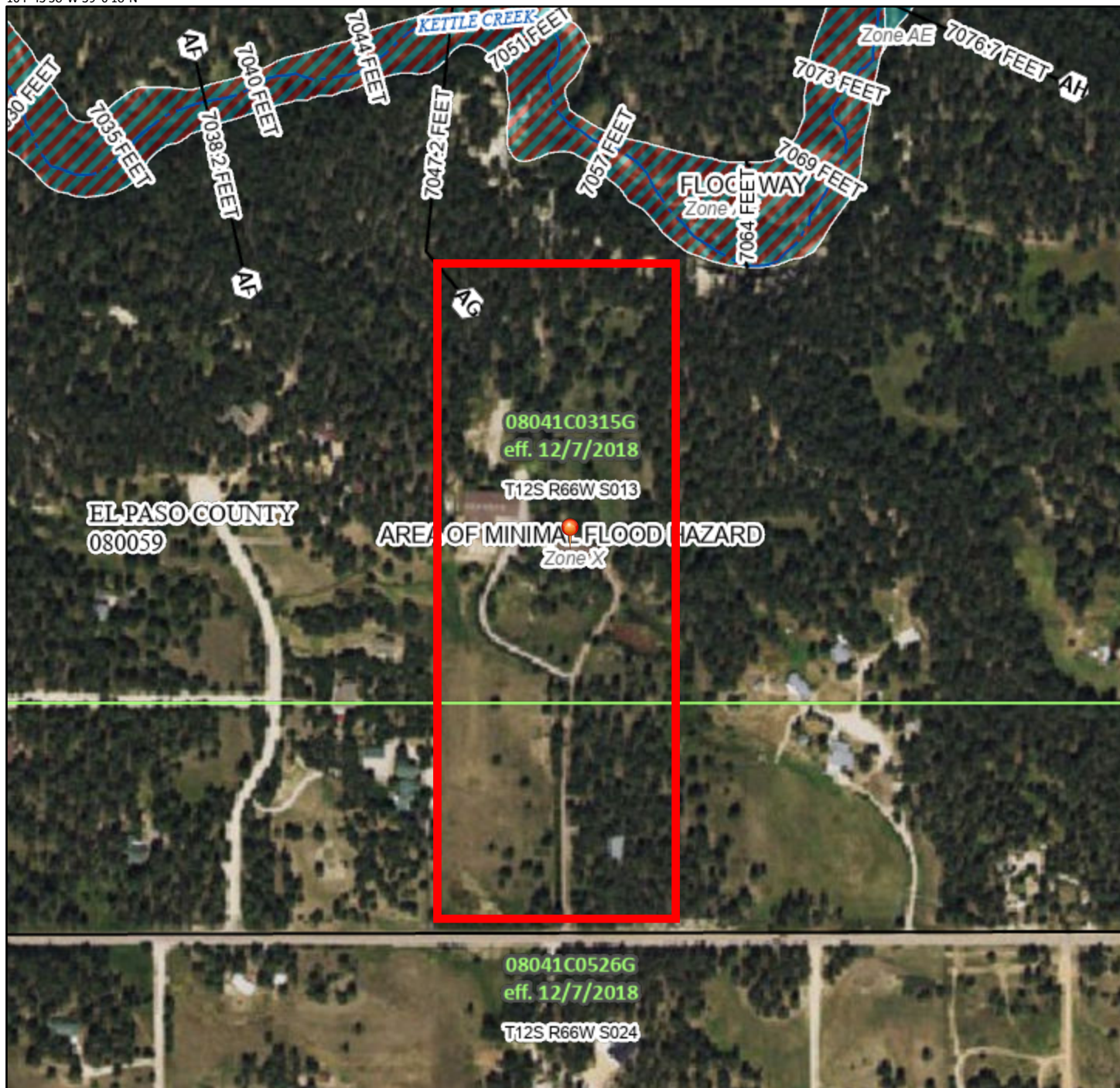
APPENDIX E

FIGURES

National Flood Hazard Layer FIRMette



104°43'58"W 39°0'18"N



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

1:6,000

104°43'20"W 38°59'50"N

Basemap Imagery Source: USGS National Map 2023

Legend

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

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



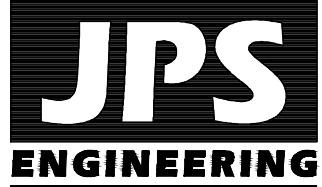
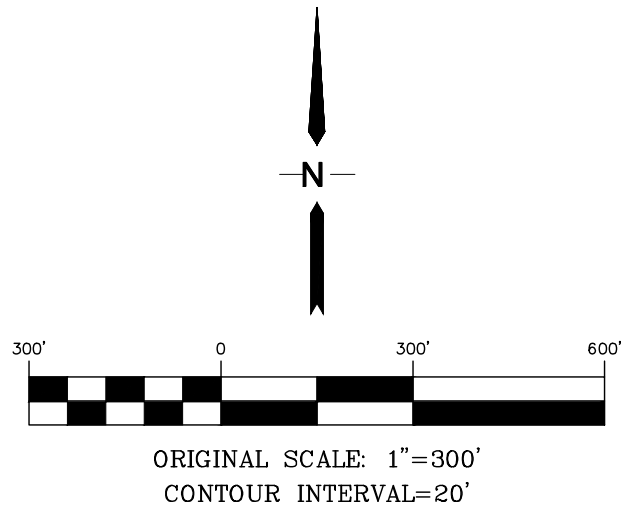
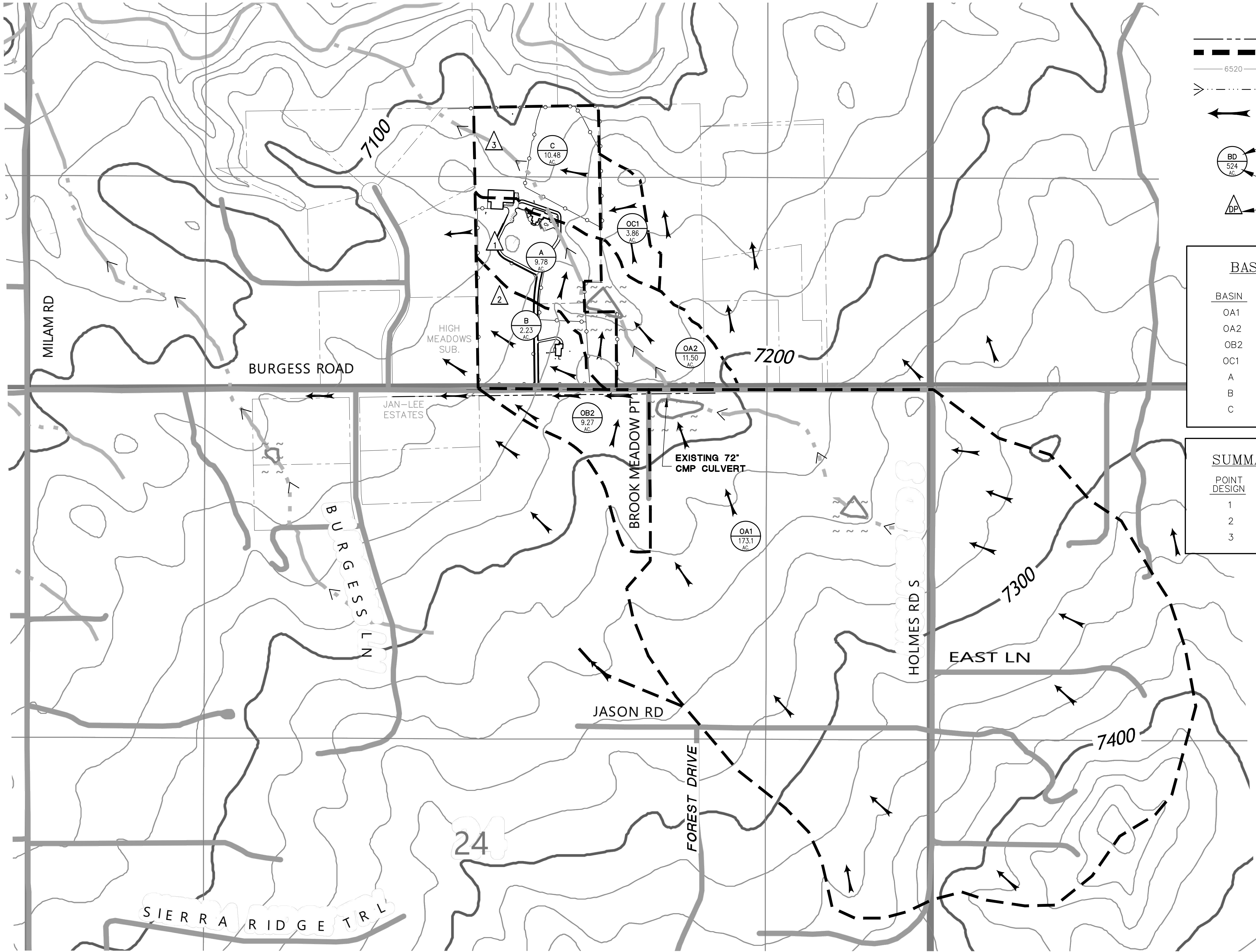
The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **12/30/2024 at 6:32 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.

C:\Users\Michael\OneDrive\Projects\122401 Haven\dwg\Drainage\EX1.dwg Jul 02, 2025 1:51pm



19 E. Willamette Ave.
Colorado Springs, CO
80903
PH: 719-477-9429
FAX: 719-471-0766

HAVEN FOREST SCHOOL

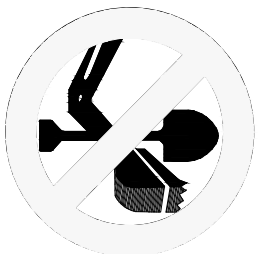
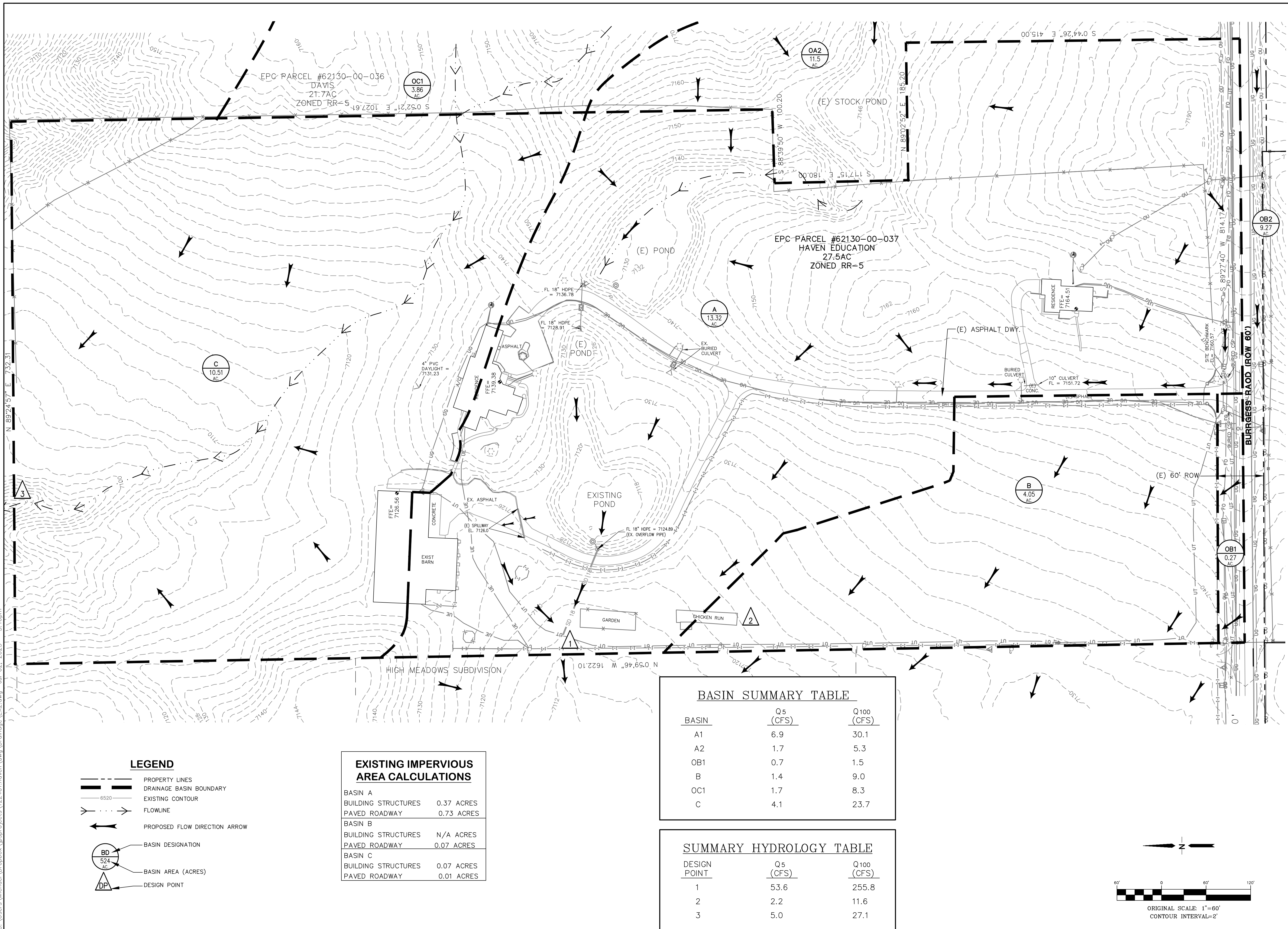
5490 Burgess Road, El Paso County, CO

MAJOR BASIN / HISTORIC DRAINAGE PLAN

HORZ. SCALE:	1"=300'	DRAWN:	MSP
VERT. SCALE:	N/A	DESIGNED:	JPS
SURVEYED:	USGS	CHECKED:	JPS
CREATED:	12/29/24	LAST MODIFIED:	7/2/25
PROJECT NO:	122401	MODIFIED BY:	MSP

SHEET:

EX1



HAVEN SCHOOL
5490 Burgess Road, El Paso County, CO

[illegible]

DRAWN:	MSP
DESIGNED:	JPS
CHECKED:	JPS
LAST MODIFIED:	7/2/25
MODIFIED BY:	MSP

SHEET:

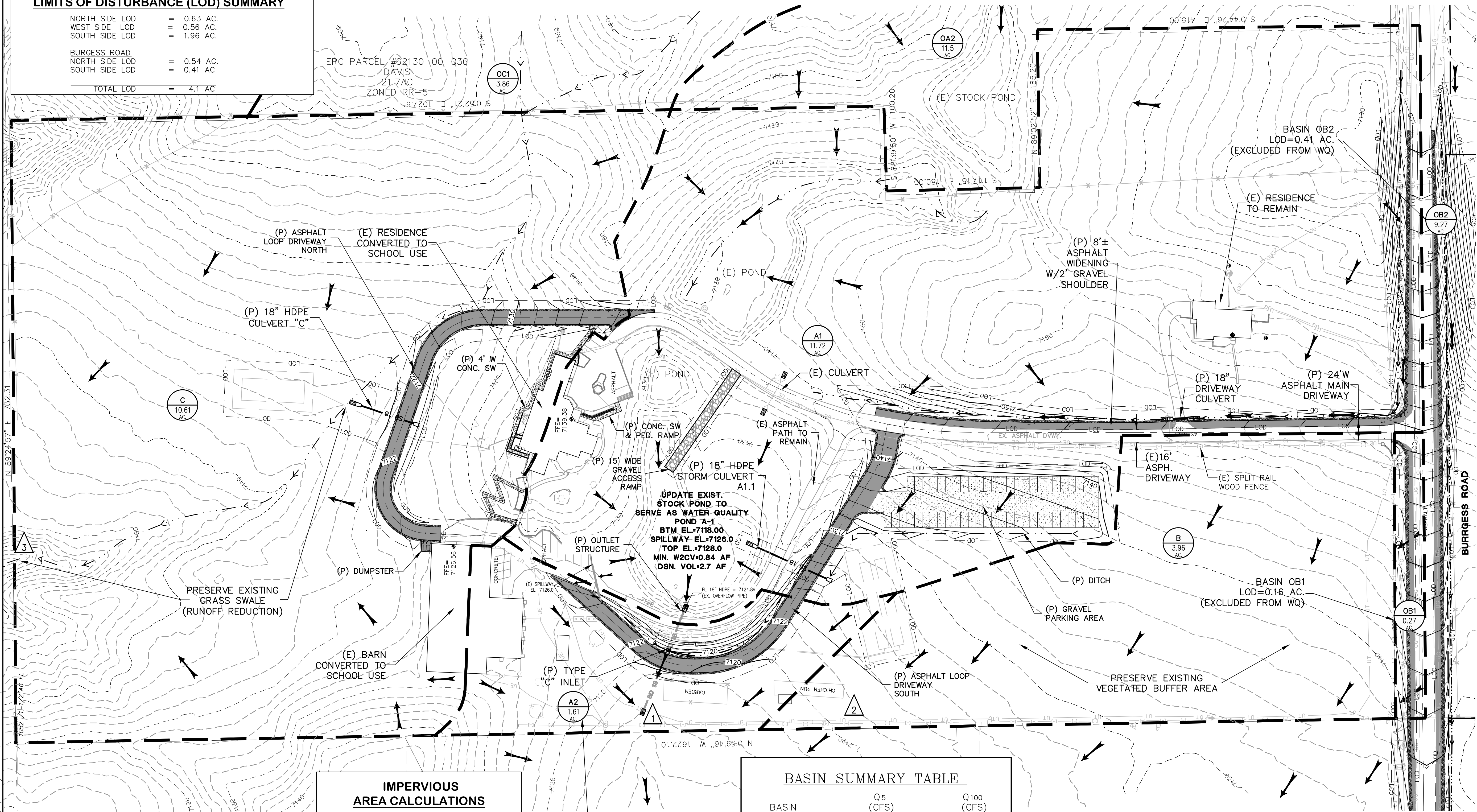
EX2

C:\Users\Michael\Dropbox\jpsprojects\122401\haven\dwg\Drainage\D1.dwg Jul 02, 2025 -- 4:32pm

LIMITS OF DISTURBANCE (LOD) SUMMARY

NORTH SIDE LOD	=	0.63 AC.
WEST SIDE LOD	=	0.56 AC.
SOUTH SIDE LOD	=	1.96 AC.
BURGESS ROAD		
NORTH SIDE LOD	=	0.54 AC.
SOUTH SIDE LOD	=	0.41 AC.
TOTAL LOD	=	4.1 AC.

EPC PARCEL #62130-00-Q36
DAVIS
21.7 AC
ZONED RR-5



LEGEND

- PROPERTY LINES
- DRAINAGE BASIN BOUNDARY
- EXISTING CONTOUR
- FLOWLINE
- PROPOSED FLOW DIRECTION ARROW
- BASIN DESIGNATION
- BASIN AREA (ACRES)
- DESIGN POINT
- NEW IMPERVIOUS AREAS

IMPERVIOUS AREA CALCULATIONS

BASIN A1	
EX. BUILDING STRUCTURES	0.14 ACRES
EX. PAVED ROADWAY/SW	0.61 ACRES
PR. PAVED ROADWAY	0.10 ACRES
PR. GRAVEL PARKING	0.4 ACRES
BASIN A2	
EX. BUILDING STRUCTURES	0.15 ACRES
EX. PAVED ROADWAY	0.07 ACRES
PR. PAVED ROADWAY	0.13 ACRES
BASIN B	
BUILDING STRUCTURES	N/A ACRES
EX. PAVED ROADWAY	0.07 ACRES
PR. PAVED ROADWAY	N/A ACRES
BASIN C	
EX. BUILDING STRUCTURES	0.16 ACRES
EX. PAVED ROADWAY	0.04 ACRES
PR. PAVED ROADWAY/SW	0.17 ACRES

BASIN SUMMARY TABLE

BASIN	Q5 (CFS)	Q100 (CFS)
A1	6.9	30.1
A2	1.7	5.3
OB1	0.7	1.5
B	1.4	9.0
OC1	1.7	8.3
C	4.1	23.7

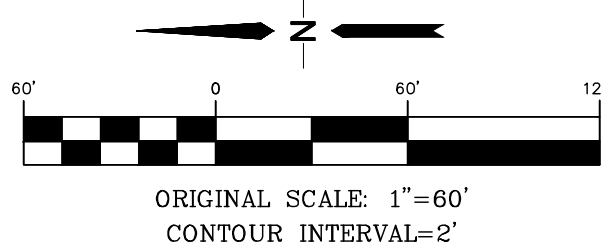
SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
1	53.6	255.8
2	2.2	11.6
3	5.0	27.1

Water Quality Treatment Summary Table

Basin ID(s)	PCM Tributary Area (ac)	PCM ID
OA1-OA2,A1	196.3	Pond A1
C	10.6	Runoff Reduction
A2	0.39	Excluded*
OB1	0.16	Excluded*
OB2	0.41	Excluded*

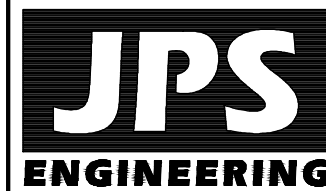
* Excluded based on ECM App I.7.1.C.1



HAVEN FOREST SCHOOL

5490 Burgess Road, El Paso County, CO

DEVELOPED DRAINAGE PLAN



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Colorado Springs, CO 80903
PH: 719-477-9429
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CALL UTILITY NOTIFICATION
CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE
BEFORE YOU DIG, GRADE, OR EXCAVATE
FOR THE MARKING OF UNDERGROUND
MEMBER UTILITIES.

No.	REVISION	BY	DATE

HORZ. SCALE: 1"=60'	DRAWN: MSP
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: COMPASS	CHECKED: JPS
CREATED: 12/29/24	LAST MODIFIED: 7/2/25
PROJECT NO: 122401	MODIFIED BY: MSP

SHEET:

D1