

FINAL DRAINAGE REPORT

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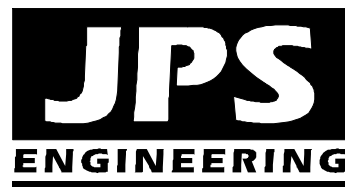
**HAVEN SCHOOL
5490 Burgess Road
Colorado Springs, CO 80908**

Prepared for:

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

July 2, 2025
Revised November 8, 2025
Revised May 14, 2026

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 extension of a fire access drive along the west side of the school buildings, with appropriate turn-arounds 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.

We are not aware of any previous drainage reports on file 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 F).

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

- Rain Garden: The majority of developed flows will be routed through a new on-site private Rain Garden water quality facility, which will be vegetated 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 Rain Garden will minimize downstream drainage impacts from this site.

Step 3: Provide Water Quality Capture Volume (WQCV)

- RG: The majority of the developed site will drain through an on-site Private Rain Garden (RG). The Rain Garden 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 “Rain Garden A2” 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 Rain Garden (RG) 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 and maintain 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 F). 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; see Sh. EX1, Appendix F) 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 F), 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 F).

Basin A1

Basin A1 (6.69-acres) consists of the southeast and central parts of the property, which drain by sheet flow, ditches, and culverts flowing to the existing pond within the center of the property. Developed Basin A1 has been delineated as the area flowing into the existing stock pond. Developed flows from Basin A1 are calculated as $Q_5 = 3.7$ cfs and $Q_{100} = 16.8$ cfs. The on-site flows from Basin A1 are minimal in comparison to the upstream flows entering the property at Design Point #OA2.1 ($Q_5 = 54.2$ cfs and $Q_{100} = 260.9$ cfs).

Flows from Basins OA1, OA2, and A1 will continue to drain into the existing drainage channel flowing through the existing stock pond, which will be preserved in its existing condition. The proposed on-site improvements within A1 will be minimal, allowing the existing drainage channel and pond to remain undisturbed and continue to function in their existing conditions. The large off-site tributary areas will continue to flow northwesterly through the site with no significant impact from the proposed on-site improvements.

The limit of disturbance within Basin A1 associated with widening of the driveway and fire access turn-around improvements is 0.33-acres. A portion of the disturbed area within Basin A1 is excluded from permanent water quality requirements based on ECM Appendix I.6.1.B.7 (Sites with Land Disturbance to Undeveloped Land that Will Remain Undeveloped), which allows for exclusion of disturbed areas that will remain undeveloped. Within Basin A1, 0.17-acres of the disturbed area will remain undeveloped open space area.

Basin A2

The area along the south and west sides of the property has been delineated as Basin A2, which encompasses the majority of the proposed site improvement area. Basin A2.1 (3.45 acres), comprises the area along the southeast side of the existing driveway, which sheet flows northwesterly to the grass-lined ditch along the east side of the main driveway. Developed peak flows from Basin A2.1 are calculated as $Q_5 = 2.0$ cfs and $Q_{100} = 9.1$ cfs.

Proposed private culvert A2.1 (18" HDPE) will intercept the flow from the east ditch of the main driveway ("Ditch A2.1") and convey this flow west along the north side of the new west fire access drive, flowing to Rain Garden A2.

All flows from Basin A2 ultimately drain into the proposed Rain Garden A2 along the west boundary of the property.

Basin A2.2 (2.72 acres), comprises the area along the west side of the new west fire access drive and gravel parking area, which will flow westerly to the new Rain Garden A2 along the west boundary of the site. Developed peak flows from Basin A2.2 are calculated as $Q_5 = 5.1$ cfs and $Q_{100} = 12.0$ cfs.

Proposed private Culvert A2.2 (18" HDPE) will convey the flow from the ditch along the north side of the west fire access drive into the proposed Rain Garden A2. Turf-reinforcement mat (TRM) lining will be provided for stabilization along the proposed Ditch A2.2 (see calculations in Appendix C). Riprap rundowns will be provided where the grass-lined ditches along the west side of the fire access drive flow into the Rain Garden A2 forebays.

Developed flows from Basins A2.1 and A2.2 combine at Design Point #A2 (Rain Garden A2), with peak flows calculated as $Q_5 = 6.3$ cfs and $Q_{100} = 19.0$ cfs.

All of the disturbed areas within Basins A2.1 and A2.2 will flow to Rain Garden A2, which has been designed to meet County stormwater quality requirements as a Permanent Control Measure (PCM) for the proposed site development.

Basin A3

The small area along the westerly fringe of the property, downstream of Rain Garden A2, has been delineated as Basin A3 (0.39 acres). Basin A3 sheet flows westerly to the existing grass-lined drainage swale (Design Point #1) at the west boundary of the site. Developed peak flows from Basin A3 are calculated as $Q_5 = 0.1$ cfs and $Q_{100} = 1.0$ cfs.

Basin A3 (0.16-acres of disturbed area) is excluded from permanent water quality requirements based on ECM Appendix I.6.1.B.7 (Sites with Land Disturbance to Undeveloped Land that Will Remain Undeveloped), which allows for exclusion of disturbed areas that will remain undeveloped.

Combined Flows and Developed Drainage Impact

Developed flows from off-site Basins OA1 and OA2 will combine with on-site Basins A1-A3 at Design Point #1, with peak flows calculated as $Q_5 = 54.4$ cfs and $Q_{100} = 256.3$ cfs (negligible increase of $Q_{100} = 3.2$ cfs, or approximately 1.0 percent, in comparison to existing conditions). Recognizing the negligible increase in developed flows, no on-site stormwater detention is required.

Drainage from Design Point #1 flows to an existing stable, grass-lined drainage swale at the west boundary of the site.

The existing grass-lined drainage channel immediately downstream of the western site boundary has been identified as “Swale A” on Sh. D1. The calculated channel hydraulic properties are summarized in the “Ditch / Swale Calculation Summary” table in Appendix C. While the calculated velocities and Froude numbers indicate supercritical flow conditions, the existing observed conditions do not show any erosion concerns. Notably, the channel calculations show a negligible increase between the existing and developed flow conditions, indicating no significant developed drainage impact from the proposed site improvements.

As depicted on the photograph in Appendix E, the existing outfall channel is in stable, well-vegetated condition, and the existing swale serves as a suitable drainage outfall.

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. Developed 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 disturbed area along Burgess Road within Basin OB1 is 0.17-acres. By definition in ECM Appendix I.6.1.A, permanent water quality control measures are required for projects that have a cumulative non-excluded disturbed area of 1-acre or greater. The disturbed area within Basin OB1 falls within the allowable cumulative disturbed area of site improvements, remaining below 1-acre of total non-excluded site disturbance.

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

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).

Turf-reinforcement mat (TRM) lining will be provided for stabilization along the steep segment of the roadside ditch along the south side of Burgess Road (proposed Ditch OB2; see calculations in Appendix C).

The limit of disturbance along the south side of Burgess Road within Basin OB2 is 0.45-acres. A portion of the disturbed area within Basin OB2 is excluded from permanent water quality requirements based on ECM Appendix I.6.1.B.7 (Sites with Land Disturbance to Undeveloped Land that Will Remain Undeveloped), which allows for exclusion of disturbed areas that will remain undeveloped. Within Basin OB2, 0.17-acres of the disturbed area will remain undeveloped roadside meadow area.

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. Proposed site improvements within Basin C will be negligible, consisting of minor sidewalk and driveway improvements. Developed peak flows from Basin C (Design Point #3) are calculated as $Q_5 = 3.7$ cfs and $Q_{100} = 23.1$ cfs.

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 $Q_5 = 4.6$ cfs and $Q_{100} = 26.7$ cfs (equivalent to existing conditions).

The limit of disturbance within Basin C is 2.59-acres, much of which is for septic system and leach field improvements, which will match existing grades and be restored to native conditions. A significant part of the disturbed area within Basin A1 is excluded from permanent water quality requirements based on ECM Appendix I.6.1.B.7 (Sites with Land Disturbance to Undeveloped Land that Will Remain Undeveloped), which allows for exclusion of disturbed areas that will remain undeveloped. Within Basin C, 2.47-acres of the disturbed area will remain undeveloped open space area.

Drainage from Design Point #3 flows to an existing stable, vegetated drainage swale at the north end of the site. As detailed in Appendix C, the hydraulic capacity of the existing drainage swale has been evaluated, and the existing vegetated swale (designated as "Swale C" on Sh. D1) is adequate to convey the developed flows.

As depicted on the photograph in Appendix E, the existing outfall channel is in stable, well-vegetated condition, and the existing swale serves as a suitable drainage outfall.

Basin OD1

Basin OD1 (0.31-acres) has been delineated as the area along the north side of Burgess Road, west of the site boundary, where the road will be widened for the proposed left-turn lane improvements. Basin OD1 will continue to sheet flow to the north, flowing to the existing grass-lined drainage swale along the north side of the roadway, with developed peak flows calculated as $Q_5 = 1.5$ cfs and $Q_{100} = 2.9$ cfs (small increase of $Q_{100} = 1.0$ cfs in comparison to existing conditions).

The disturbed area along Burgess Road within Basin OD1 is 0.3-acres. The disturbed area within Basin OB1 falls within the allowable cumulative disturbed area of site improvements, remaining below 1-acre of total non-excluded site disturbance.

C. On-Site Drainage Facility Design

Developed drainage basins and drainage patterns are depicted on the enclosed Developed Drainage Plan (Sheet D1).

The asphalt trail along the west side of the existing stock pond serves as a stable emergency spillway, and no improvements to the existing stock pond are required. There is no evidence of erosion at existing pond discharge at the west boundary of the property.

Private ditches and culverts will convey the majority of developed flows to the new Rain Garden A2. 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

The property owner and contractors will need to implement and maintain proper 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.

As discussed in Section VI.B.2. above, flows from Basins OA1, OA2, and A1 will continue to drain into the existing channel flowing through the on-site stock pond, which will be preserved in its existing condition. The proposed on-site improvements within A1 will be minimal, allowing the existing drainage channel and pond to remain undisturbed and continue to function in their existing conditions.

Water quality mitigation for the proposed site development will be provided by construction of the proposed Rain Garden A2 serving as a permanent water quality control measure.

The proposed water quality facility improvements have been designed utilizing the Denver Mile High Flood District’s “SCM-Design-v4.00” software package. Calculations and details for the rain garden are enclosed in Appendix D, and design parameters for “Rain Garden A2” are summarized as follows:

Water Quality Facility (RG)	Tributary Drainage Basins	Tributary Area (ac)	Impervious Percentage	Min. WQCV (cf)	Design Volume (cf)
Rain Garden A2	A2.1-A2.2	6.2	25.0	2,428	2,535

The proposed Rain Garden A2 provides a volume of 2,535 cubic-feet, which exceeds the required Water Quality Capture Volume (WQCV).

The proposed Rain Garden A2 will include concrete forebays and riprap aprons for erosion control at the entry points into the rain garden. The outlet structure has been designed with a water quality orifice plate to maintain a 12-hour release of the WQCV. The rain garden will have a vegetated bottom to encourage stormwater infiltration prior to discharging into the downstream drainage swale. The rain garden will have a buried riprap emergency spillway to safely convey major storm overflows to the existing downstream drainage swale (see spillway calculations in Appendix D).

Recognizing that no geotechnical information is currently available regarding existing groundwater depths in vicinity of the proposed rain garden, it is recommended that the rain garden be excavated at the early stages of construction and monitored for groundwater throughout the construction / acceptance process so that appropriate measures can be taken to mitigate groundwater if encountered. Options for mitigation may include underdrains and/or subgrade stabilization with cobble material.

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

The “Water Quality Treatment Summary Table” on the enclosed “Developed Drainage Plan” (Sh. D1, Appendix F) 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 PCM requirements.

Areas Excluded from Water Quality Facilities

The drainage areas flowing to Rain Garden A2 (PCM Tributary Areas) and the areas excluded from water quality treatment are detailed in the “Water Quality Treatment Summary Table” in Appendix D. As previously discussed in Paragraph VI.B.2, several areas of the site are excluded from permanent water quality requirements based on ECM Appendix I.6.1.B.7 (Sites with Land Disturbance to Undeveloped Land that Will Remain Undeveloped), which allows for exclusion

of disturbed areas that will remain undeveloped. On this project, several areas of the site that will be restored to open space or meadow areas meet this applicable exclusion.

The total limit of disturbance (LOD) of the remaining non-excluded areas of the project site is 0.95-acres, which is less than the allowable 1-acre of total site area not requiring water quality treatment.

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 facilities is approximately \$28,357 (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 Rain Garden 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 Rain Garden, 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



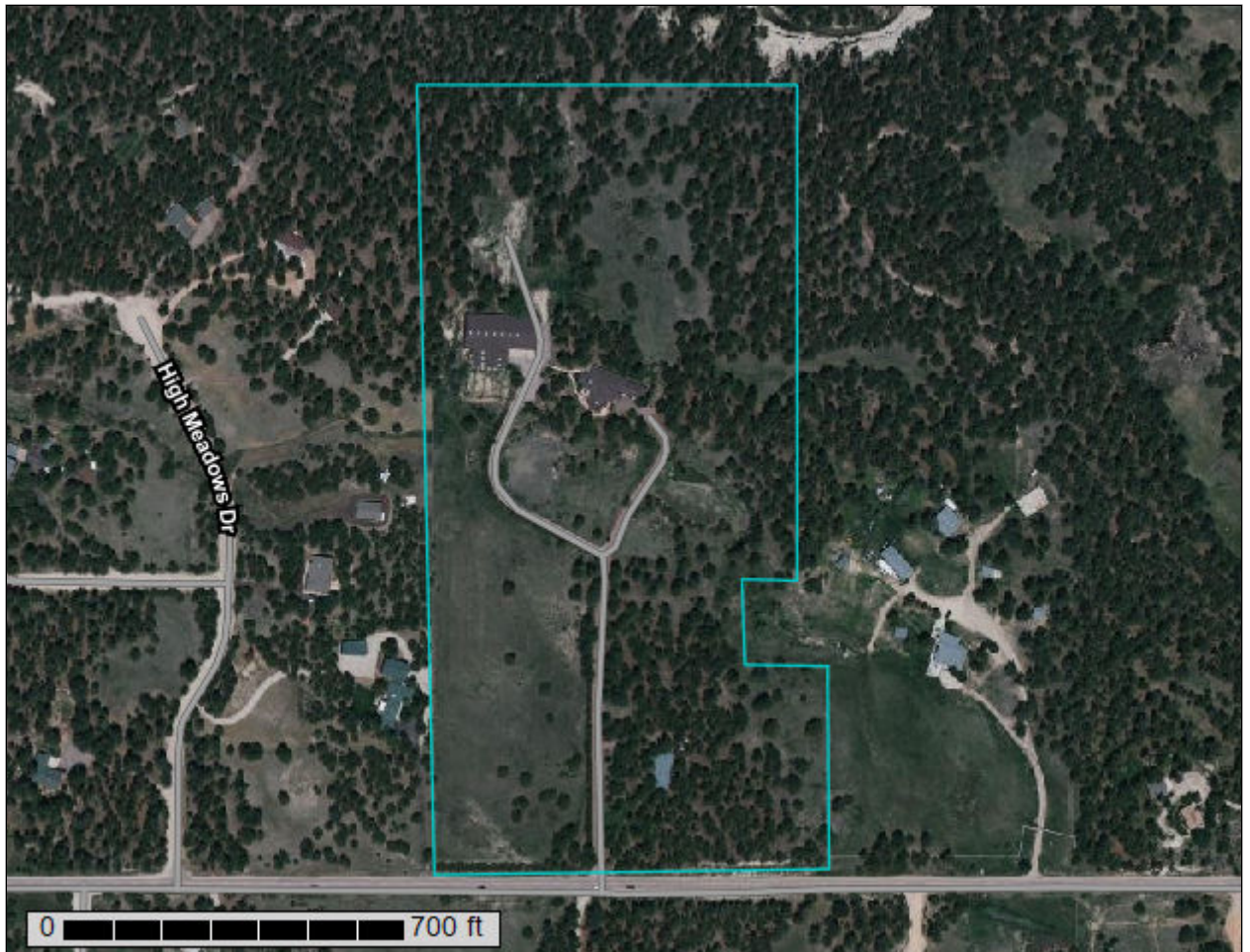
United States
Department of
Agriculture

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



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

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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

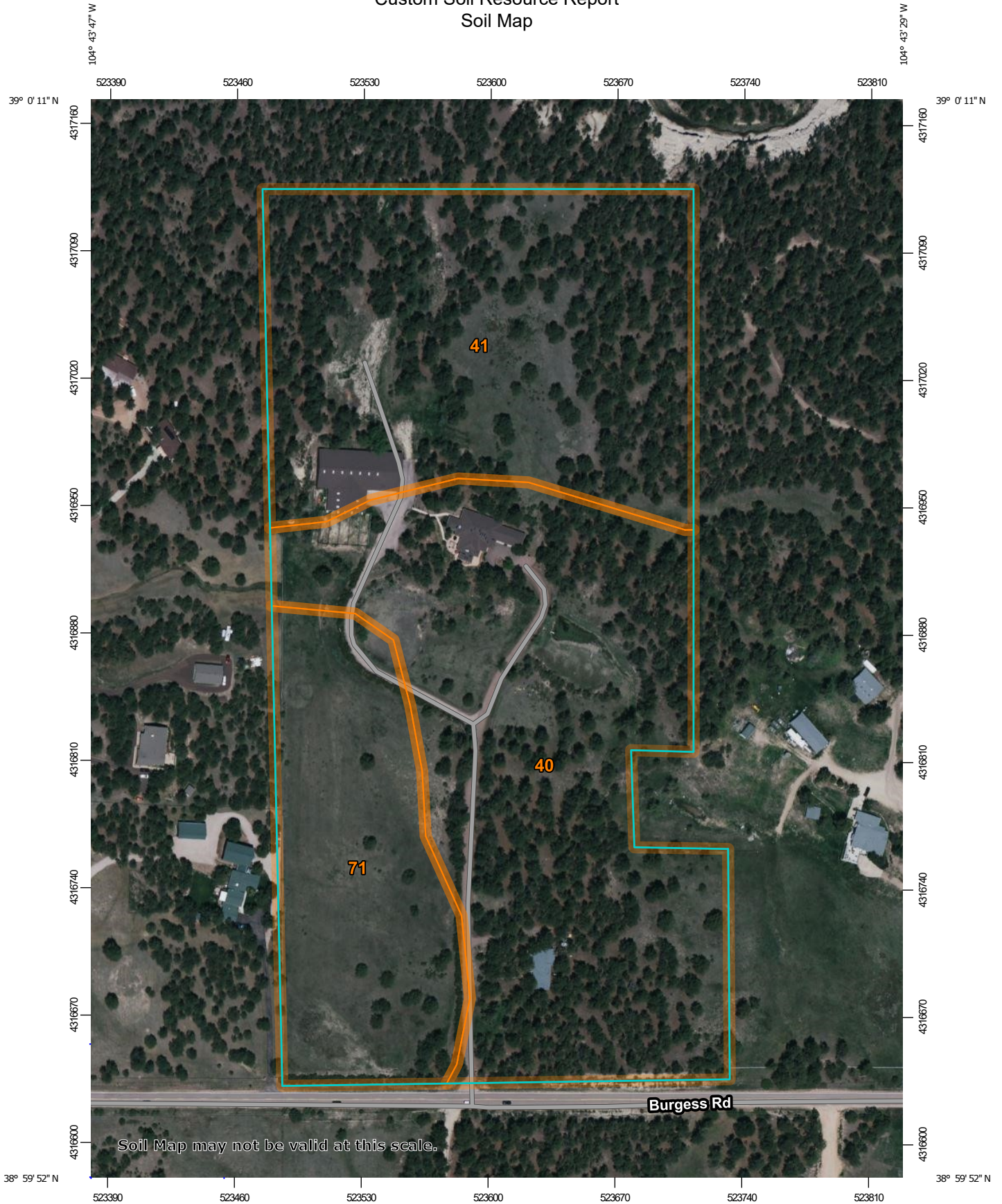
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identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

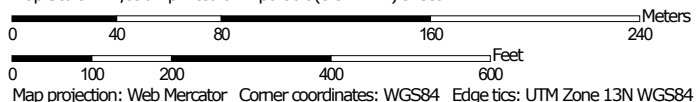
Soil Map

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




Map Scale: 1:2,890 if printed on A portrait (8.5" x 11") sheet.



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

MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)




















Soils







 Soil Map Unit Polygons

 Soil Map Unit Lines


 Soil Map Unit Points

Special Point Features






-  Blowout
-  Borrow Pit
-  Clay Spot
-  Closed Depression
-  Gravel Pit
-  Gravelly Spot
-  Landfill
-  Lava Flow
-  Marsh or swamp
-  Mine or Quarry
-  Miscellaneous Water
-  Perennial Water
-  Rock Outcrop
-  Saline Spot
-  Sandy Spot
-  Severely Eroded Spot
-  Sinkhole
-  Slide or Slip
-  Sodic Spot

-  Spoil Area
-  Stony Spot
-  Very Stony Spot
-  Wet Spot
-  Other
-  Special Line Features


Water Features

 Streams and Canals

Transportation

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

Background

 Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
 Survey Area Data: Version 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

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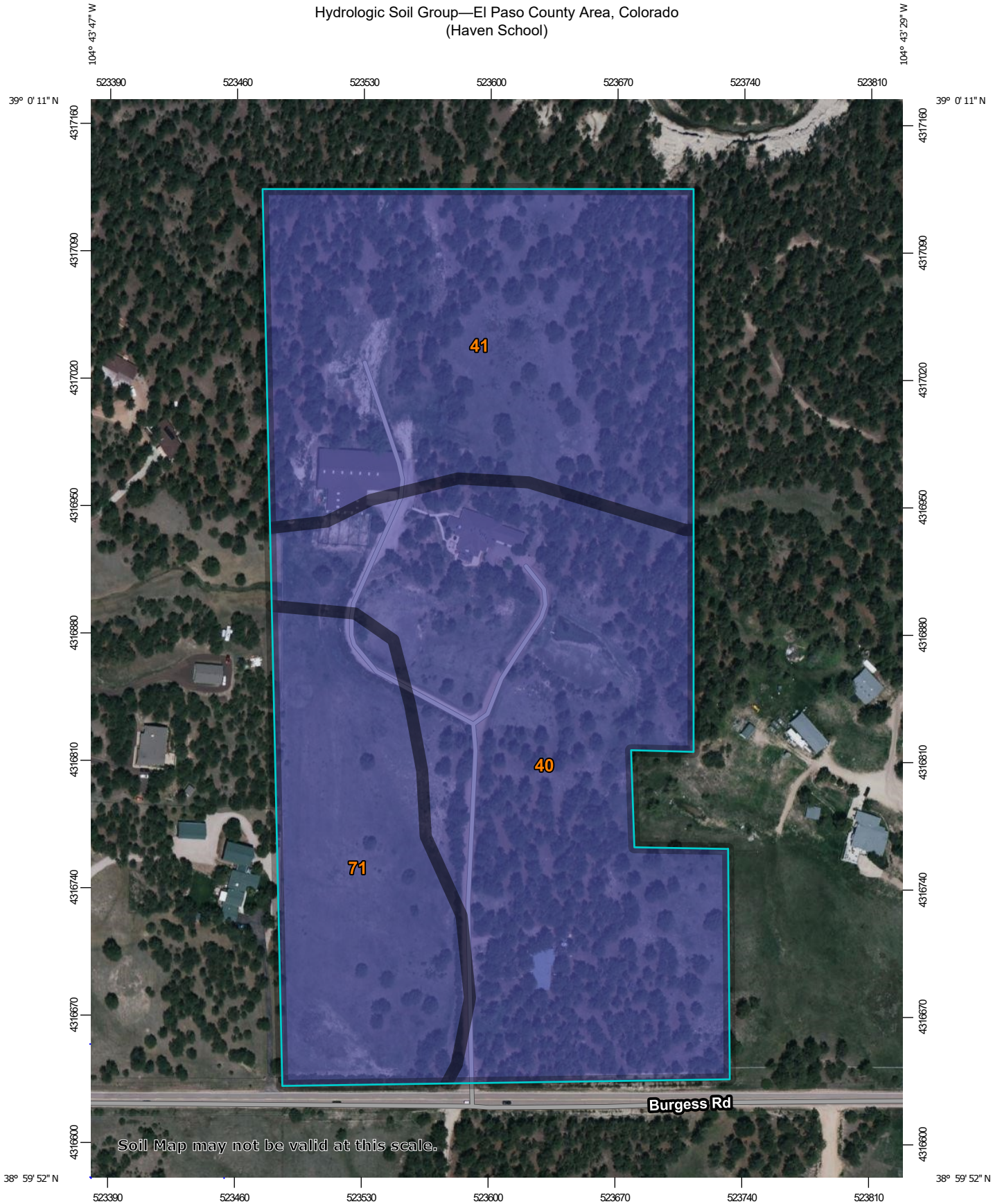
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United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

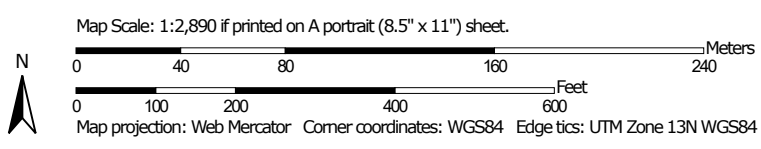
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Hydrologic Soil Group—El Paso County Area, Colorado
(Haven School)




Soil Map may not be valid at this scale.



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.

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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)

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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.

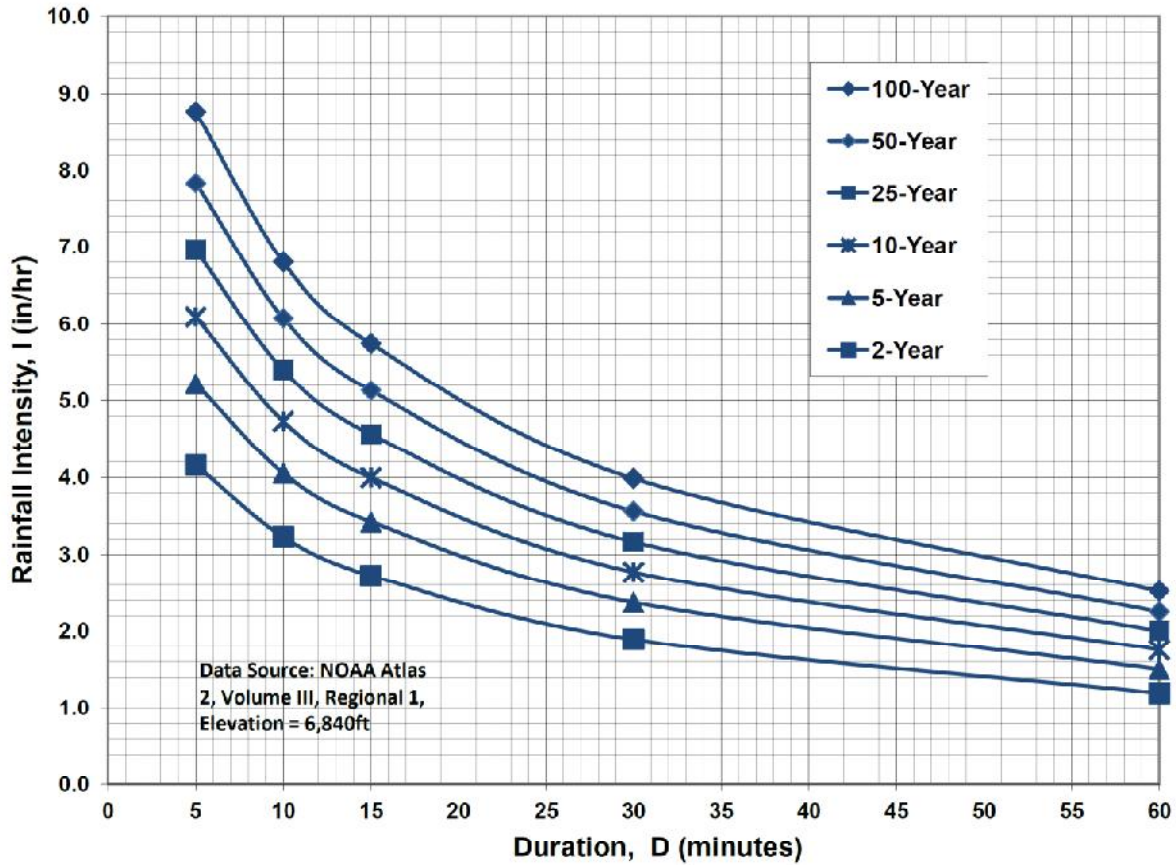
3.2.4 Minimum Time of Concentration

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
OD1	0.40	0.15	PAVED/IMPERVIOUS	0.9	0.25	MEADOW	0.08				0.388
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
OD1	0.40	0.15	PAVED/IMPERVIOUS	0.96	0.25	MEADOW	0.35				0.579

HAVEN FOREST SCHOOL
RATIONAL METHOD

EXISTING CONDITIONS

BASIN	DESIGN POINT	AREA (AC)	C		Overland Flow			Channel flow					TOTAL Tc ⁽⁴⁾ (MIN)	TOTAL Tc ⁽⁴⁾ (MIN)	INTENSITY ⁽⁵⁾		PEAK FLOW	
			5-YEAR	100-YEAR	LENGTH (FT)	SLOPE (FT/FT)	Tco ⁽¹⁾ (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS ⁽²⁾ VELOCITY (FT/S)	Tt ⁽³⁾ (MIN)			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	197.9	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	4.3	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	3	14.4	0.107	0.370									21.7	21.7	2.96	4.98	4.56	26.45
OD1	OD1	0.40	0.388	0.579	60	0.120	4.4	190	15	0.027	2.46	1.3	5.7	5.7	4.97	8.35	0.77	1.93

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

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

C = 2.5 FOR HEAVY MEADOW

C = 5 FOR TILLAGE/FIELD

C = 7 FOR SHORT PASTURE AND LAWNS

C = 10 FOR NEARLY BARE GROUND

C = 15 FOR GRASSED WATERWAY

C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES

3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)

4) Tc = Tco + Tt

*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED

5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL

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

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

6) Q = CiA

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	6.69	0.53	BUILDINGS / PAVEMENT	0.9	0.02	GRAVEL	0.59	6.14	LANDSCAPED	0.08	0.146
OA1,OA2,A1	191.29										0.137
A2.1	3.45	0.27	BUILDINGS / PAVEMENT	0.9	0.03	GRAVEL	0.59	3.15	LANDSCAPED	0.08	0.149
A2.2	2.72	0.92	BUILDINGS / PAVEMENT	0.9	0.39	GRAVEL	0.59	1.41	LANDSCAPED	0.08	0.430
A2.1,A2.2	6.17										0.273
A3	0.39	0.39	MEADOW	0.08							0.080
OA1,OA2,A1-A3	197.9										0.141
OB1	0.27	0.14	PAVED/IMPERVIOUS	0.9	0.14	LANDSCAPED	0.08				0.490
B	3.96	0.07	PAVED/IMPERVIOUS	0.9	3.89	LANDSCAPED	0.08				0.094
OB1,B	4.23										0.120
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	0.22	PAVED/IMPERVIOUS	0.9	10.39	LANDSCAPED	0.08				0.097
OC1,C	14.47										0.108
OD1	0.40	0.31	PAVED/IMPERVIOUS	0.9	0.09	LANDSCAPED	0.08				0.716
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	6.69	0.53	BUILDINGS / PAVEMENT	0.96	0.02	GRAVEL	0.7	6.14	LANDSCAPED	0.35	0.399
OA1,OA2,A1	191.29										0.393
A2.1	3.45	0.27	BUILDINGS / PAVEMENT	0.96	0.03	GRAVEL	0.7	3.15	LANDSCAPED	0.35	0.401
A2.2	2.72	0.92	BUILDINGS / PAVEMENT	0.96	0.39	GRAVEL	0.7	1.41	LANDSCAPED	0.35	0.607
A2.1,A2.2	6.17										0.491
A3	0.39	0.39	MEADOW	0.35							0.350
OA1,OA2,A1-A3	197.9										0.396
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	0.22	PAVED/IMPERVIOUS	0.96	10.39	LANDSCAPED	0.35				0.363
OC1,C	14.47										0.371
OD1	0.40	0.31	PAVED/IMPERVIOUS	0.96	0.09	LANDSCAPED	0.35				0.823

HAVEN FOREST SCHOOL
DEVELOPED CONDITIONS

BASIN	DESIGN POINT	AREA (AC)	Overland Flow					Channel flow						TOTAL Tc ⁽⁴⁾ (MIN)	TOTAL Tc ⁽⁴⁾ (MIN)	INTENSITY ⁽⁵⁾		PEAK FLOW	
			C		LENGTH (FT)	SLOPE (FT/FT)	Tco ⁽¹⁾ (MIN)	CHANNEL LENGTH (FT)	CONVEYANCE COEFFICIENT C	SLOPE (FT/FT)	SCS ⁽²⁾ VELOCITY (FT/S)	Tt ⁽³⁾ (MIN)	5-YR (IN/HR)			100-YR (IN/HR)	Q5 ⁽⁶⁾ (CFS)	Q100 ⁽⁶⁾ (CFS)	
			5-YEAR	100-YEAR															
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		6.69	0.146	0.399	100	0.120	7.6	1110	15	0.056	3.55	5.2	12.8	12.8	3.75	6.30	3.67	16.82	
Tt OA2 to A1								665	15	0.029	2.55	4.3							
OA1-OA2,A1	A1.1	191.3	0.137	0.393									41.9	41.9	1.98	3.32	51.88	249.69	
Tt A1 to DP1								160	20	0.025	3.16	0.8							
A2.1		3.45	0.149	0.401	100	0.160	6.9	835	15	0.041	3.04	4.6	11.5	11.5	3.92	6.58	2.01	9.10	
Tt A2.1 to A2								350	15	0.066	3.85	1.5							
A2.2		2.72	0.430	0.607	100	0.130	5.2	600	15	0.037	2.89	3.5	8.7	8.7	4.34	7.29	5.08	12.03	
A2.1,A2.2	A2	6.17	0.273	0.491									13.0	13.0	3.73	6.27	6.29	18.99	
A3		0.39	0.080	0.350	100	0.160	7.4	160	15	0.075	4.11	0.6	8.1	8.1	4.45	7.47	0.14	1.02	
OA1-OA2,A1-A2	1	197.9	0.141	0.396									42.8	42.8	1.95	3.27	54.39	256.29	
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	0.120	0.380									9.0	9.0	4.29	7.20	2.18	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	0.097	0.363	200	0.130	11.1	795	15	0.065	3.82	3.5	14.5	14.5	3.57	5.99	3.67	23.08	
Tt OC1-C								910	15	0.066	3.85	3.9							
OC1,C	3	14.5	0.108	0.371									21.7	21.7	2.96	4.98	4.63	26.71	
OD1	OD1	0.40	0.716	0.823	60	0.120	2.4	190	15	0.027	2.46	1.3	3.7	5.0	5.17	8.68	1.48	2.86	

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

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

C = 2.5 FOR HEAVY MEADOW

C = 5 FOR TILLAGE/FIELD

C = 7 FOR SHORT PASTURE AND LAWNS

C = 10 FOR NEARLY BARE GROUND

C = 15 FOR GRASSED WATERWAY

C = 20 FOR PAVED AREAS AND SHALLOW PAVED SWALES

3) MANNING'S CHANNEL TRAVEL TIME = L/V (WHEN CHANNEL VELOCITY IS KNOWN)

4) Tc = Tco + Tt

*** IF TOTAL TIME OF CONCENTRATION IS LESS THAN 5 MINUTES, THEN 5 MINUTES IS USED

5) INTENSITY BASED ON I-D-F EQUATIONS IN CITY OF COLORADO SPRINGS DRAINAGE CRITERIA MANUAL

I₅ = -1.5 * ln(Tc) + 7.583

I₁₀₀ = -2.52 * ln(Tc) + 12.735

6) Q = CiA

APPENDIX C
HYDRAULIC CALCULATIONS

**HAVEN SCHOOL
DITCH / SWALE CALCULATION SUMMARY**

ROADWAY	FROM STA	TO STA	SIDE	SLOPE (%)	SIDE SLOPE (Z)	CHANNEL DEPTH (FT)	FRICTION FACTOR (n)	DP/ BASIN	Q100 FLOW (CFS)	DITCH FLOW % OF BASIN	DITCH FLOW (CFS)	Q100 DEPTH (FT)	Q100 VELOCITY (FT/S)	DITCH LINING
ON-SITE:														
PR. DITCH A2.1				2.9	3:1	1.0	0.030	A2.1	11.3	100	11.3	0.9	4.7	GRASS
PR. DITCH A2.2				10.0	3:1	1.0	0.030	A2.1	11.3	100	11.3	0.7	7.6	GRASS W/ TRM
EX. SWALE A (EX. FLOW)				7.0	20:1	20.0	0.030	DP1	253.1	100	253.1	0.8	8.82	GRASS
EX. SWALE A (DEV. FLOW)				7.0	20:1	20.0	0.030	DP1	256.3	100	256.3	0.8	8.85	GRASS
EX. SWALE C				5.9	6:1	16.0	0.030	DP3	26.7	100	26.7	0.3	5.0	GRASS
BURGESS ROAD:														
BURGESS ROAD	2+40	5+00	N	1.9	4:1/3:1	2.0	0.030	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	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	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	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	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	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	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	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	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	OB2	20.6	50	10.3	0.9	3.7	GRASS

- 1) Channel flow calculations based on Manning's Equation
- 2) n = 0.03 for grass-lined non-irrigated channels (minimum)
- 3) Vmax = 5.0 fps per El Paso County criteria (p. 10-13) for fescue (dry land grass) for 100-year flows
- 4) 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 - On-Site Ditches-Swales

Designer: JPS

Project Date: Saturday, November 8, 2025

Project Units: U.S. Customary Units

Notes:

Channel Analysis: Channel Analysis - Ditch A2.1

Notes:

Input Parameters

Channel Type: Triangular

Side Slope 1 (Z1): 3.0000 ft/ft

Side Slope 2 (Z2): 3.0000 ft/ft

Longitudinal Slope: 0.0290 ft/ft

Manning's n: 0.0300

Flow: 11.3000 cfs

Result Parameters

Depth: 0.8906 ft

Area of Flow: 2.3794 ft²

Wetted Perimeter: 5.6325 ft

Hydraulic Radius: 0.4224 ft

Average Velocity: 4.7491 ft/s

Top Width: 5.3435 ft

Froude Number: 1.2542

Critical Depth: 0.9750 ft

Critical Velocity: 3.9621 ft/s

Critical Slope: 0.0179 ft/ft

Critical Top Width: 5.85 ft

Calculated Max Shear Stress: 1.6116 lb/ft²

Calculated Avg Shear Stress: 0.7644 lb/ft²

Channel Analysis: Channel Analysis - Ditch A2.2

Notes:

Input Parameters

Channel Type: Triangular
Side Slope 1 (Z1): 3.0000 ft/ft
Side Slope 2 (Z2): 3.0000 ft/ft
Longitudinal Slope: 0.1000 ft/ft
Manning's n: 0.0300
Flow: 11.3000 cfs

Result Parameters

Depth: 0.7061 ft
Area of Flow: 1.4958 ft²
Wetted Perimeter: 4.4659 ft
Hydraulic Radius: 0.3349 ft
Average Velocity: 7.5545 ft/s **> 5 fps.....Use TRM Lining**
Top Width: 4.2367 ft
Froude Number: 2.2406
Critical Depth: 0.9750 ft
Critical Velocity: 3.9621 ft/s
Critical Slope: 0.0179 ft/ft
Critical Top Width: 5.85 ft
Calculated Max Shear Stress: 4.4061 lb/ft²
Calculated Avg Shear Stress: 2.0900 lb/ft²

Channel Analysis: Channel Analysis - Ex. Swale A - Ex. Flow

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 20.0000 ft/ft
Side Slope 2 (Z2): 20.0000 ft/ft
Channel Width: 20.0000 ft
Longitudinal Slope: 0.0700 ft/ft
Manning's n: 0.0300
Flow: 253.1000 cfs

Result Parameters

Depth: 0.7979 ft
Area of Flow: 28.6908 ft²
Wetted Perimeter: 51.9558 ft
Hydraulic Radius: 0.5522 ft
Average Velocity: 8.8217 ft/s
Top Width: 51.9159 ft
Froude Number: 2.0912
Critical Depth: 1.1745 ft
Critical Velocity: 4.9552 ft/s
Critical Slope: 0.0144 ft/ft
Critical Top Width: 66.98 ft
Calculated Max Shear Stress: 3.4852 lb/ft²
Calculated Avg Shear Stress: 2.4121 lb/ft²

Channel Analysis: Channel Analysis - Ex. Swale A - Dev. Flow

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 20.0000 ft/ft
Side Slope 2 (Z2): 20.0000 ft/ft
Channel Width: 20.0000 ft
Longitudinal Slope: 0.0700 ft/ft
Manning's n: 0.0300
Flow: 256.3000 cfs

Result Parameters

Depth: 0.8030 ft
Area of Flow: 28.9563 ft²
Wetted Perimeter: 52.1603 ft
Hydraulic Radius: 0.5551 ft
Average Velocity: 8.8513 ft/s **...Matches Existing Conditions**
Top Width: 52.1201 ft
Froude Number: 2.0927
Critical Depth: 1.1820 ft
Critical Velocity: 4.9686 ft/s
Critical Slope: 0.0144 ft/ft
Critical Top Width: 67.28 ft
Calculated Max Shear Stress: 3.5075 lb/ft²
Calculated Avg Shear Stress: 2.4249 lb/ft²

Channel Analysis: Channel Analysis - Ex. Swale C

Notes:

Input Parameters

Channel Type: Trapezoidal
Side Slope 1 (Z1): 6.0000 ft/ft
Side Slope 2 (Z2): 6.0000 ft/ft
Channel Width: 16.0000 ft
Longitudinal Slope: 0.0590 ft/ft
Manning's n: 0.0300
Flow: 26.7000 cfs

Result Parameters

Depth: 0.2984 ft
Area of Flow: 5.3085 ft²
Wetted Perimeter: 19.6301 ft
Hydraulic Radius: 0.2704 ft
Average Velocity: 5.0297 ft/s
Top Width: 19.5807 ft
Froude Number: 1.7023
Critical Depth: 0.4186 ft
Critical Velocity: 3.4453 ft/s
Critical Slope: 0.0184 ft/ft
Critical Top Width: 21.02 ft
Calculated Max Shear Stress: 1.0986 lb/ft²
Calculated Avg Shear Stress: 0.9956 lb/ft²

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

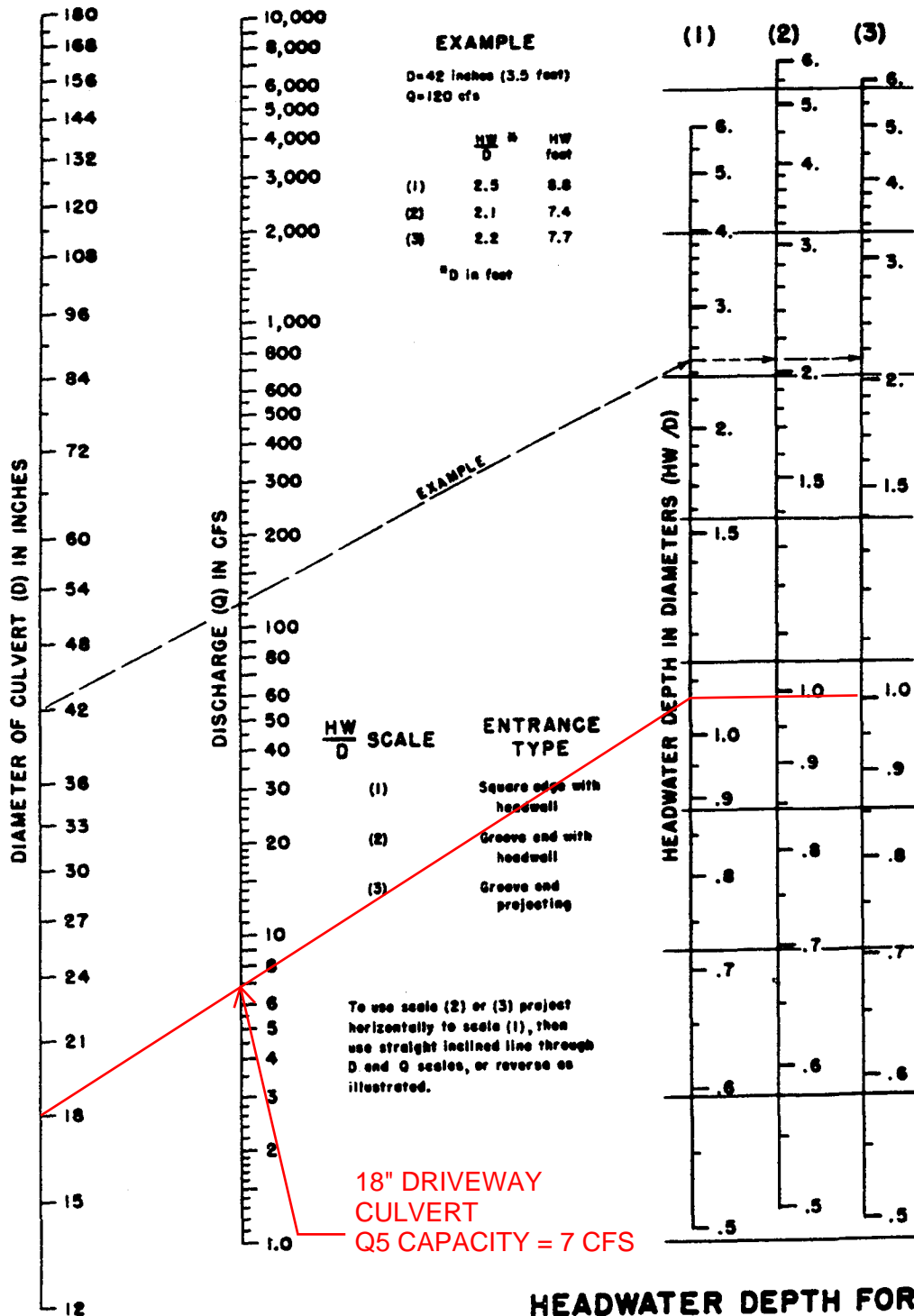
Notes:

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 DEPTH FOR
 CONCRETE PIPE CULVERTS
 WITH INLET CONTROL**

HEADWATER SCALES 2&3
 REVISED MAY 1964

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)
A2.1	A2.1	2.0	100	2.0	18
A2.2	A2.1	2.0	100	2.0	18

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

$Q_{100} \text{ (DP-A2)} = 19.0 \text{ cfs}; D = 1.5 \text{ ft}$
 $Q / D^{1.5} = 19.0 / (1.5^{1.5}) = 10.3$

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

Equation 9-19

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

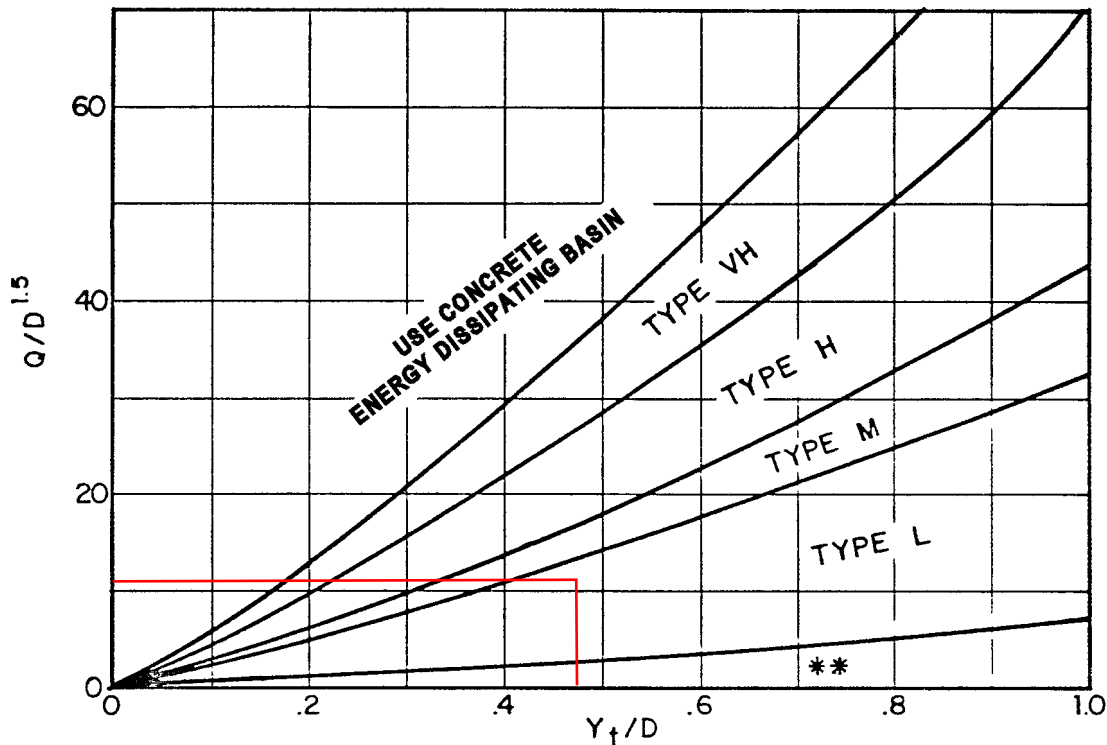
D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

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

H = height of rectangular culvert (ft)

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



$Y_t = 0.7 \text{ ft}; Y_t / D = (0.7 / 1.5) = 0.47$

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

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

Use Type M (Conservative)

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

APPENDIX D
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	6.69	0.53	BUILDINGS / PAVEMENT	100	0.02	GRAVEL	80	6.14	LANDSCAPED	0.00	8.114
OA1,OA2,A1	191.29										7.039
A2.1	3.45	0.27	BUILDINGS / PAVEMENT	100	0.03	GRAVEL	80	3.15	LANDSCAPED	0.00	8.522
A2.2	2.72	0.92	BUILDINGS / PAVEMENT	100	0.39	GRAVEL	80	1.41	LANDSCAPED	0.00	45.294
A2.1,A2.2	6.17										24.733
A3	0.39	0.39	MEADOW	0							0.000
OA1,OA2,A1-A3	197.9										7.577
OB1	0.27	0.14	PAVED/IMPERVIOUS	100	0.14	LANDSCAPED	0				50.000
B	3.96	0.07	PAVED/IMPERVIOUS	100	3.89	LANDSCAPED	0				1.768
OB1,B	4.2										4.846
OC1	3.86	3.86	RURAL RESIDENTIAL	7							7.000
C	10.61	0.22	PAVED/IMPERVIOUS	100	10.39	LANDSCAPED	0				2.074
OC1,C	14.5										3.388
OD1	0.40	0.31	PAVED/IMPERVIOUS	100	0.09	LANDSCAPED	0				77.500
TOTAL ON-SITE AREA:											
A1,A2,B,C	27.4										8.599

Site Layout

SCM Design, Version 4.00 (April 2024)

Designer: JPS

Company: JPS

Date: May 12, 2026

Project: Haven Forest School

Location: Rain Garden A2

SITE LAYOUT INFO (User Input in Blue Cells)

Water Quality Event (WQE) inches

Outfall ID	A2											
Total Tributary Area (ft ²)	270,072											
Imperviousness (%)	25.0%											
MS4 Design Standard	WQCV											
SCM Type	BR											

Notes:

OUTFALL RESULTS

SCM Worksheet Name	BR_A2											
Untreated Area (ft ³)	0											
Default WQCV (ft ³)	2,428											
WQCV Reduction (ft ³)	0											
Remaining WQCV (ft ³)	2,428											
WQCV Reduction (%)	0%											
Design WQCV of SCM (ft ³)	2,557											
Pollutant Removal (ft ³)	0											
Untreated WQCV (ft ³)	0											

TOTAL SITE RESULTS (Sums results from all Outfalls)

Total Site Area	270,072	ft ²	6.20	acres
Treated Area	270,072	ft ²	6.20	acres
Untreated Area	0	ft ²	0.00	acres
Total Site Imperviousness	25.0%	%		
Default WQCV	2,428	ft ³	0.056	acre-feet
Remaining WQCV	2,428	ft ³	0.056	acre-feet
WQCV Reduction	0%	%		
Design WQCV	2,557	ft ³	0.059	acre-feet
Untreated WQCV	0	ft ³	0.000	acre-feet

**Total area is not consistent with Site Assessment worksheet.
Please confirm all areas are included.**

Bioretention System (BR)

SCM Design, Version 4.00 (April 2024)

Designer: JPS
Company: JPS
Date: May 12, 2026
Project: Haven Forest School
Location: Rain Garden A2
Outfall ID: A2

1. Subsurface Exploration and Infiltration System Selection

A) Identify Site Constraints

- i) Is subgrade depth to bedrock < 3 feet?
- ii) Is subgrade depth to seasonal high groundwater table < 3 feet?

B) Identify Site Risks

- i) Are expansive/collapsible soils present?
- ii) Are highly concentrated pollutant sources present (hotspot)?
- iii) Is site located above contaminated soils or groundwater?
- iv) Is SCM located at top of steep slope? (> 3H:1V)
- v) Is SCM located adjacent to building, hardscape, or pavement?
- vi) Is SCM located above building foundation wall backfill?
- vii) Are there other concerns that indicate high risk for infiltration?

C) Preliminary Infiltration/Percolation Tests of underlying soils

- i) Were preliminary infiltration/percolation tests conducted?
- ii) Preliminary estimate of infiltration rate

$F_{prelim} =$ in/hr

D) Final Design Infiltrometer Test

- i) Were infiltrometer tests conducted?
- ii) Select type of infiltrometer test performed:
- iii) How many locations were tested?
- iv) Describe test locations relative to borings/pits

$N_{tests} =$

- v) What was the maximum infiltration rate tested?
- vi) What was the minimum infiltration rate tested?
- vii) Design Infiltration Rate

$F_{Max} =$ in/hr

$F_{Min} =$ in/hr

$F_{Design} =$ in/hr

E) Recommended Infiltration System

Please provide estimated infiltration rates to get a recommended infiltration system.

F) Select Infiltration System to use for Design

Bioretention System (BR)

SCM Design, Version 4.00 (April 2024)

Designer: JPS
Company: JPS
Date: May 12, 2026
Project: Haven Forest School
Location: Rain Garden A2
Outfall ID: A2

2. Inlet Design and Pretreatment

A) Is RPA (GB/GS) used for Runoff Reduction upstream of SCM?

NO

Define inflow points for all areas tributary to the SCM below.

B) Inflow Points contributing to SCM (max 8)

	A2.1	A2.2					
Inflow Design Point ID	A2.1	A2.2					
Tributary Area to Inflow Point (ft ²)	182,952	87,120					
Imperviousness above Inflow Point (%)	15.0%	45.3%					
Default WQCV for Inflow Point (ft ³)	1,138	1,125					
WQCV Reduction above Inflow Point (ft ³)	0	0					
Remaining WQCV at Inflow Point (ft ³)	1,138	1,125					
Will pretreatment be provided with a Sedimentation MTD (HDS)	NO	NO					
Paired Pretreatment HDS Worksheet Name		--					
Sheet or Concentrated Flow	Conc	Conc					

C) Sheet Flow

Select sheet flow inflow feature	--	--					
Is Concrete Edger used?	--	--					
Spacing between slots, recommend ≤ 2 ft on center (ft)	--	--					
Slot Opening Length, recommend 1.5 (in)	--	--					
Select type of blind swale used to distribute flow	--	--					
Select energy dissipation method for level spreader	--	--					
Height of drop, recommend 2 to 3 (in)	--	--					
Is concrete mowing strip provided to facilitate maintenance?	--	--					

D) Concentrated Flow

Select concentrated flow inflow feature	Pipe	Swale					
Is downspout extension needed to bridge backfill zone?	--	--					
Depth of gutter flow line depression for curb opening, recommend 3 (in)	--	--					
Curb opening inlet width (ft)	--	--					
Height of drop to sediment pad/forebay, recommend ≥ 1 (in)	--	--					
Select energy dissipation method for downspouts and/or curb openings.	--	--					
Select energy dissipation method for swales, channels, and piped outfalls	Other	Other					

Concrete Forebays

v) Forebay

Impervious area tributary to concentrated inflow location (ft ²)	27,443	39,465					
Forebay Type (Concrete Sediment Pad sufficient for Imp Area ≤ 2 acre)	Forebay	Forebay					
Minimum Forebay Volume (ft ³)	11	11					
Design Forebay Volume (ft ³)	60						
Maximum Forebay Depth (in)	--	--					
Design Forebay Depth (in)	12.00	12.00					
Rectangular Weir Notch Width to Empty Forebay in 5-minutes (in)	0.35	0.35					
Design Notch Width (in)	0.35	0.35					
Forebay Drain Time (minutes)	5.0	4.9					

Provide pretreatment to remove coarse sediment, trash and debris. This is especially critical for roadway runoff to bioretention systems.

Bioretention System (BR)

SCM Design, Version 4.00 (April 2024)

Designer: JPS
Company: JPS
Date: May 12, 2026
Project: Haven Forest School
Location: Rain Garden A2
Outfall ID: A2

<p>3. Design Storage Volume</p> <p>A) Contributing Watershed Area (including bioretention area)</p> <p>B) Imperviousness of Tributary Area</p> <p>C) Default WQCV</p> <p>D) WQCV Reduction resulting from Upstream RPA (GB/GS)</p> <p>E) Remaining WQCV</p>	<p style="text-align: center; color: blue;">Inflow Points above should be fully defined before proceeding below</p> <p style="text-align: right;">Area = <input style="width: 100px;" type="text" value="270,072"/> ft²</p> <p style="text-align: right;">i = <input style="width: 100px;" type="text" value="25.0%"/> %</p> <p style="text-align: right;">V_{WQCV Default} = <input style="width: 100px;" type="text" value="2,428"/> ft³</p> <p style="text-align: right;">WQCV Reduction = <input style="width: 100px;" type="text" value="0"/> ft³</p> <p style="text-align: right;">V_{WQCV Remaining} = <input style="width: 100px;" type="text" value="2,428"/> ft³</p>
<p>4. Bioretention System Basin Geometry</p> <p>A) Minimum Filter Media Surface Area</p> <p>B) Design Filter Media Surface Area</p> <p>C) WQCV Ponding Depth (recommend max. 12-inch)</p> <p>D) Media Surface Slope (typically flat or mild slope < 0.01 ft/ft)</p> <p>E) Max. Side Slope (Z = 4:1 or flatter, horiz. dist per unit vertical) (Use "0" if bioretention has vertical walls)</p> <p>F) Media Surface Length-to-Width Ratio</p> <p>G) Calculated WQCV (based on A_{F Design}, D_{WQCV}, and Z)</p> <p>H) Design WQCV (based on actual design geometry)</p> <p>I) If basin geometry is irregular, design volume differs, or media pore space is being utilized, please provide description.</p>	<p style="text-align: right;">A_{F Min} = <input style="width: 100px;" type="text" value="1,350"/> ft²</p> <p style="text-align: right;">A_{F Design} = <input style="width: 100px;" type="text" value="1,870"/> ft²</p> <p style="text-align: right;">D_{WQCV} = <input style="width: 100px;" type="text" value="12.00"/> in</p> <p style="text-align: right;">S_{Surface} = <input style="width: 100px;" type="text" value="0.005"/> ft / ft</p> <p style="text-align: right;">Z = <input style="width: 100px;" type="text" value="4.00"/> ft / ft</p> <p style="text-align: right;">R_{LW} = <input style="width: 100px;" type="text" value="5"/></p> <p style="text-align: right;">V_{WQCV Calculated} = <input style="width: 100px;" type="text" value="2,366"/> ft³ Calculated WQCV < Required WQCV</p> <p style="text-align: right;">V_{WQCV Design} = <input style="width: 100px;" type="text" value="2,535"/> ft³ Explain difference from Calculated WQCV</p> <p style="text-align: right;">Irregular basin geometry (per plan)</p> <p>_____</p> <p>_____</p> <p>_____</p>

Bioretention System (BR)

SCM Design, Version 4.00 (April 2024)

Designer: JPS
Company: JPS
Date: May 12, 2026
Project: Haven Forest School
Location: Rain Garden A2
Outfall ID: A2

5. Underdrain System, Impermeable Liner, and Geotextile

A) Are underdrains provided?

B) Is a Drain Trench provided consistent with Figure 4-2?
 - Trench Bottom Width \geq 12 inches, Trench Depth \geq 15 inches
 - Drain gravel satisfies gradation specifications for AASHTO M 43 No. 8 coarse aggregate
 - Filter sand above drain gravel satisfies gradation specifications for AASHTO M 43 fine aggregate
 - Filter sand depth above drain trench \geq 6 inches
 - Filter sand extends \geq 12 inches beyond trench top width

C) Select Factory-Slotted Pipe Size and Material

D) Does the specified pipe material meet the specifications for slot configurations shown in Table 4-6 and Figure 4-3.

E) Are cleanouts provided for inspection and maintenance?

F) Is an impermeable geomembrane liner provided?

G) Are details provided regarding sealing at underdrain penetrations similar to Figure 4-6?

H) Are geomembrane connections to vertical concrete surfaces consistent with Figure 4-7?

I) Do the plans specify thermal welding and air lance testing of joints?

6. Bioretention Media

A) Depth of Media (18-inch minimum, 36-inch when trees planted)

$D_{Media} =$ in

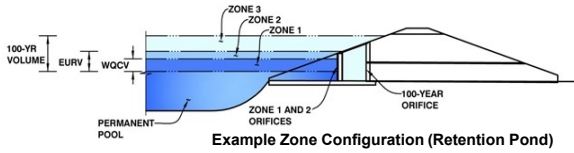
B) Do construction documents specify media testing requirements?

Analyze gradation and nutrient content of media after delivery to the site and preferably, prior to placement.

DETENTION BASIN OUTLET STRUCTURE DESIGN

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

Project: Haven Forest School
Basin ID: Rain Garden A2



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.97	0.056	Filtration Media
Zone 2			
Zone 3			
Total (all zones)		0.056	

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

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

Calculated Parameters for Underdrain
 Underdrain Orifice Area = ft²
 Underdrain Orifice Centroid = feet

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

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

Calculated Parameters for Plate
 WQ Orifice Area per Row = ft²
 Elliptical Half-Width = feet
 Elliptical Slot Centroid = feet
 Elliptical Slot Area = ft²

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

	Row 1 (optional)	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)								
Orifice Area (sq. inches)								

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice
 Vertical Orifice Area = ft²
 Vertical Orifice Centroid = feet

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

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

Calculated Parameters for Overflow Weir
 Height of Gate Upper Edge, H₁ = feet
 Overflow Weir Slope Length = feet
 Gate Open Area / 100-yr Orifice Area =
 Overflow Gate Open Area w/o Debris = ft²
 Overflow Gate Open Area w/ Debris = ft²

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

Depth to Invert of Outlet Pipe = ft (distance below basin bottom at Stage = 0 ft)
 Circular Orifice Diameter = inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate
 Outlet Orifice Area = ft²
 Outlet Orifice Centroid = feet
 Half-Central Angle of Restrictor Plate on Pipe = radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

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

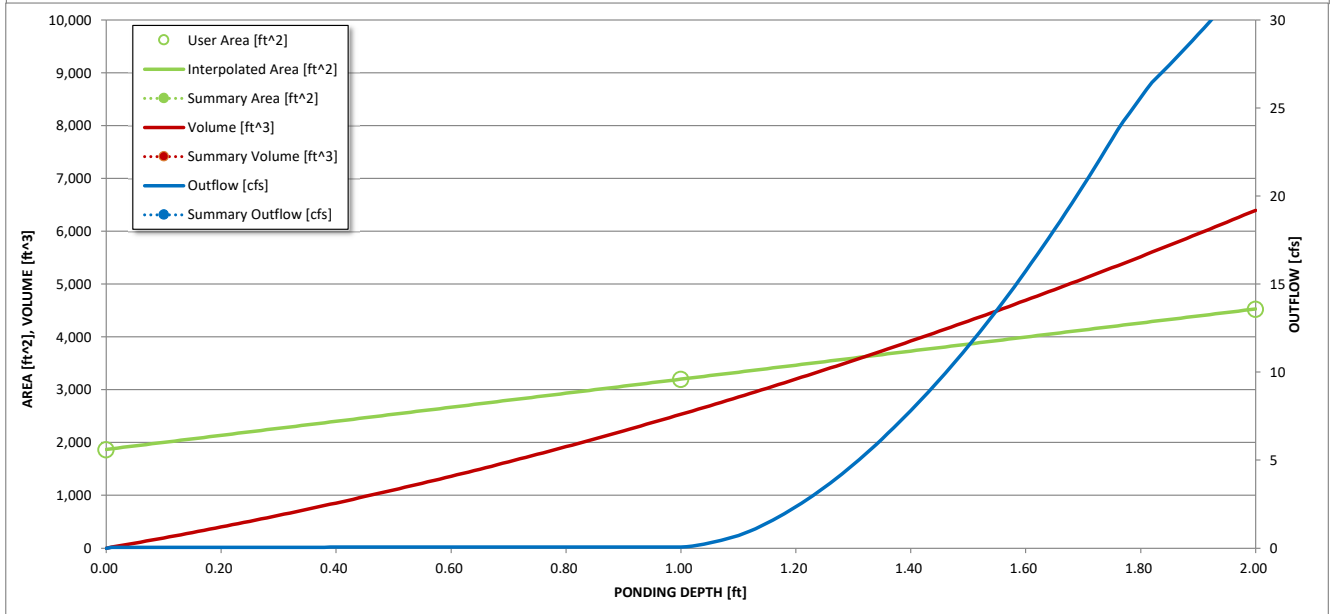
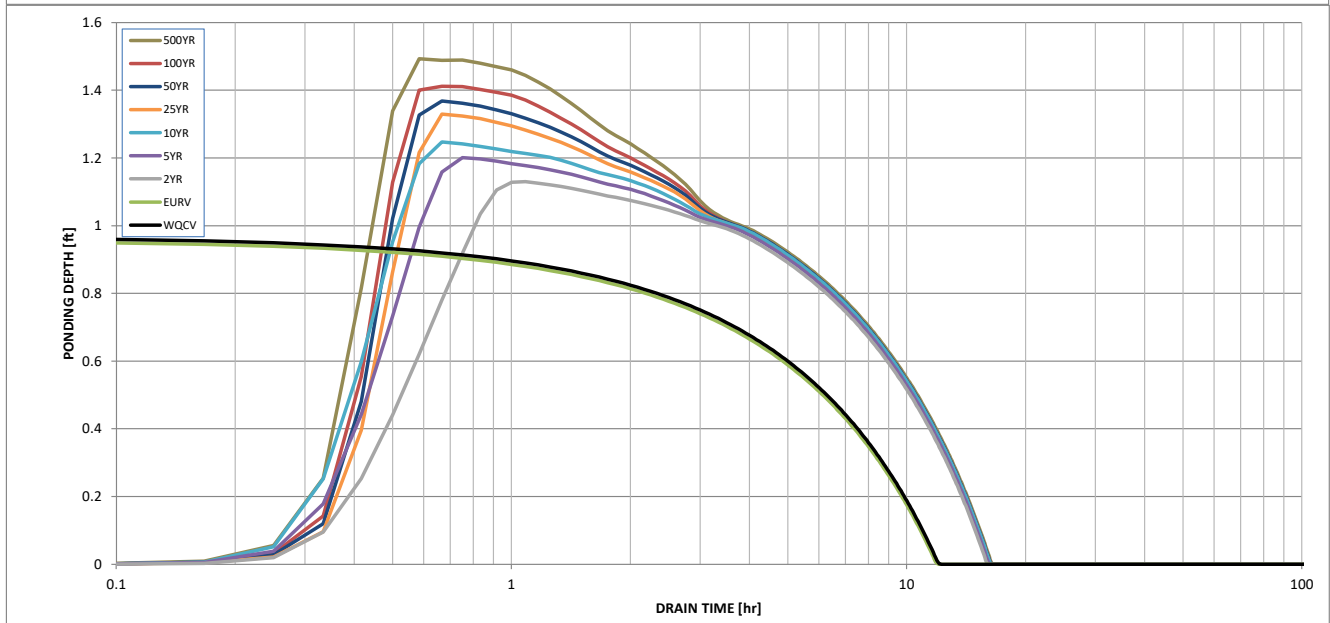
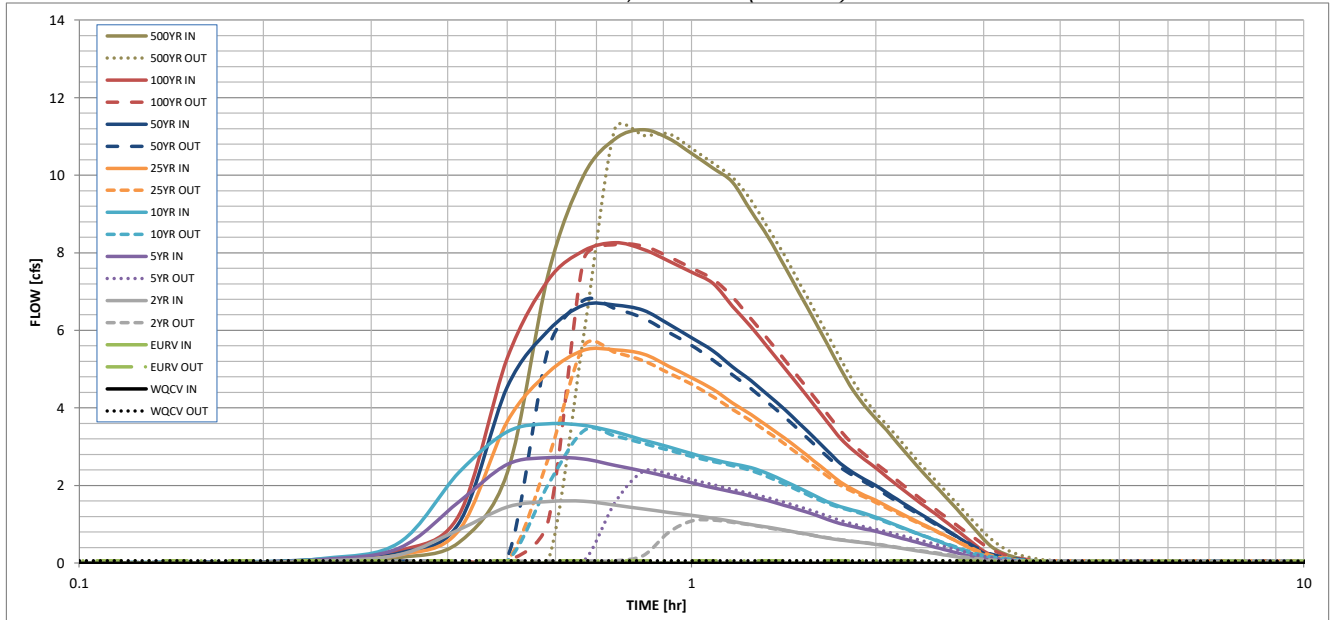
Routed Hydrograph Results

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

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period									
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)	0.056	0.157	0.163	0.279	0.387	0.556	0.680	0.850	1.173
Inflow Hydrograph Volume (acre-ft)	N/A	N/A	0.163	0.279	0.387	0.556	0.680	0.850	1.173
CUHP Predevelopment Peak Q (cfs)	N/A	N/A	0.7	1.6	2.4	4.2	5.3	6.8	9.4
OPTIONAL Override Predevelopment Peak Q (cfs)	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre)	N/A	N/A	0.11	0.26	0.39	0.68	0.85	1.09	1.52
Peak Inflow Q (cfs)	N/A	N/A	1.6	2.7	3.6	5.5	6.7	8.3	11.2
Peak Outflow Q (cfs)	0.1	14.8	1.1	2.4	3.4	5.6	6.8	8.2	11.2
Ratio Peak Outflow to Predevelopment Q	N/A	N/A	N/A	1.5	1.4	1.3	1.3	1.2	1.2
Structure Controlling Flow	Filtration Media	Filtration Media	Spillway	Spillway	Spillway	Spillway	Spillway	Spillway	Spillway
Max Velocity through Gate 1 (fps)	N/A	N/A	0.14	0.3	0.4	0.6	0.7	0.8	1.0
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)	12	11	15	14	14	12	12	11	9
Time to Drain 99% of Inflow Volume (hours)	12	12	16	16	15	15	15	14	14
Maximum Ponding Depth (ft)	0.97	0.95	1.13	1.20	1.25	1.33	1.37	1.41	1.49
Area at Maximum Ponding Depth (acres)	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.09	0.09
Maximum Volume Stored (acre-ft)	0.056	0.055	0.068	0.073	0.077	0.083	0.087	0.091	0.098

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.07 (June 2025)



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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: _____

Inflow Hydrographs

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

Time Interval	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02
	0:15:00	0	0.00	0.06	0.10	0.12	0.08	0.10	0.10	0.14
	0:20:00	0	0.00	0.22	0.40	0.54	0.21	0.26	0.32	0.54
	0:25:00	0	0.00	0.86	1.58	2.34	0.84	1.03	1.24	2.32
	0:30:00	0	0.00	1.45	2.54	3.39	3.65	4.54	5.28	7.45
	0:35:00	0	0.00	1.59	2.72	3.59	4.91	5.99	7.30	10.00
	0:40:00	0	0.00	1.60	2.69	3.55	5.49	6.66	8.06	10.94
	0:45:00	0	0.00	1.50	2.52	3.38	5.50	6.66	8.26	11.18
	0:50:00	0	0.00	1.40	2.38	3.18	5.40	6.53	8.09	10.95
	0:55:00	0	0.00	1.31	2.22	3.00	5.08	6.17	7.79	10.57
	1:00:00	0	0.00	1.23	2.08	2.83	4.78	5.82	7.50	10.19
	1:05:00	0	0.00	1.16	1.94	2.68	4.49	5.48	7.22	9.82
	1:10:00	0	0.00	1.08	1.84	2.56	4.13	5.06	6.62	9.08
	1:15:00	0	0.00	1.00	1.73	2.46	3.83	4.71	6.10	8.41
	1:20:00	0	0.00	0.93	1.61	2.31	3.52	4.33	5.56	7.67
	1:25:00	0	0.00	0.85	1.49	2.12	3.23	3.97	5.04	6.96
	1:30:00	0	0.00	0.78	1.37	1.93	2.93	3.60	4.56	6.29
	1:35:00	0	0.00	0.71	1.26	1.75	2.64	3.25	4.09	5.64
	1:40:00	0	0.00	0.65	1.13	1.58	2.36	2.90	3.64	5.02
	1:45:00	0	0.00	0.60	1.02	1.46	2.09	2.57	3.22	4.47
	1:50:00	0	0.00	0.56	0.95	1.37	1.90	2.34	2.92	4.06
	1:55:00	0	0.00	0.52	0.88	1.28	1.75	2.16	2.67	3.72
	2:00:00	0	0.00	0.49	0.82	1.19	1.62	2.00	2.46	3.43
	2:05:00	0	0.00	0.44	0.75	1.08	1.47	1.82	2.23	3.10
	2:10:00	0	0.00	0.40	0.67	0.97	1.33	1.65	2.01	2.80
	2:15:00	0	0.00	0.36	0.60	0.87	1.20	1.48	1.81	2.51
	2:20:00	0	0.00	0.32	0.54	0.77	1.08	1.33	1.62	2.25
	2:25:00	0	0.00	0.28	0.47	0.68	0.96	1.18	1.44	2.00
	2:30:00	0	0.00	0.25	0.41	0.59	0.84	1.04	1.27	1.76
	2:35:00	0	0.00	0.22	0.35	0.51	0.73	0.90	1.10	1.52
	2:40:00	0	0.00	0.18	0.30	0.43	0.62	0.76	0.94	1.29
	2:45:00	0	0.00	0.15	0.24	0.35	0.51	0.63	0.77	1.06
	2:50:00	0	0.00	0.12	0.19	0.28	0.40	0.50	0.61	0.83
	2:55:00	0	0.00	0.09	0.14	0.21	0.30	0.37	0.45	0.61
	3:00:00	0	0.00	0.06	0.10	0.16	0.21	0.25	0.31	0.43
	3:05:00	0	0.00	0.05	0.08	0.13	0.15	0.18	0.22	0.32
	3:10:00	0	0.00	0.04	0.07	0.11	0.11	0.14	0.16	0.24
	3:15:00	0	0.00	0.03	0.06	0.09	0.08	0.11	0.12	0.17
	3:20:00	0	0.00	0.03	0.05	0.07	0.06	0.08	0.09	0.13
	3:25:00	0	0.00	0.02	0.04	0.06	0.05	0.06	0.06	0.10
	3:30:00	0	0.00	0.02	0.03	0.05	0.04	0.05	0.04	0.07
	3:35:00	0	0.00	0.02	0.02	0.04	0.03	0.04	0.03	0.05
	3:40:00	0	0.00	0.01	0.02	0.03	0.02	0.03	0.03	0.04
	3:45:00	0	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.03
	3:50:00	0	0.00	0.01	0.01	0.02	0.01	0.02	0.02	0.03
	3:55:00	0	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	4:00:00	0	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	4:05:00	0	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	4:10:00	0	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.01
	4:15:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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	5:45:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Haven Forest School
Rain Garden A2 Spillway

Figure 13-12c. Emergency Spillway Protection

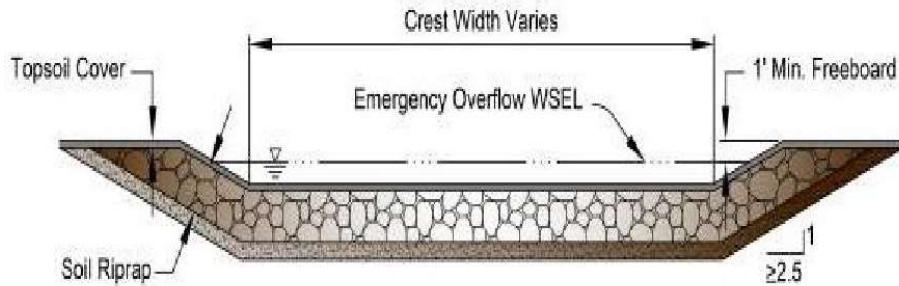
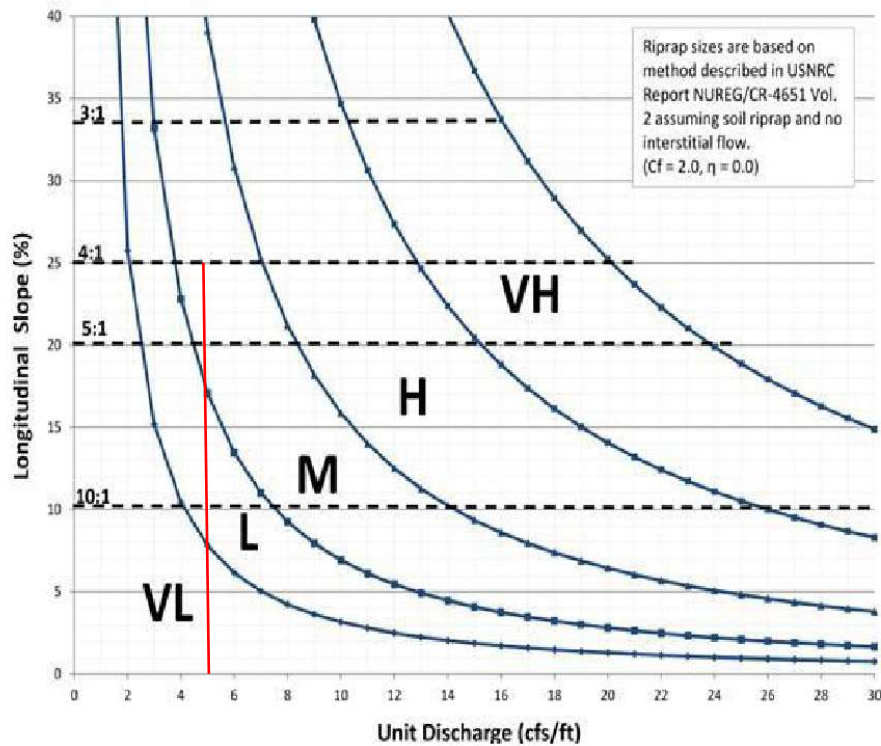


Figure 13-12d. Riprap Types for Emergency Spillway Protection



Spillway Q100 = 19.0 cfs (DP-A2)
Set Spillway Crest Width = 4 ft
Unit Discharge = (19.0 cfs / 4 ft) = 4.8

**HAVEN FOREST SCHOOL
ENGINEER'S COST ESTIMATE
DRAINAGE IMPROVEMENTS - WATER QUALITY RAIN GARDEN A2**

Item No.	Description	Quantity	Unit	Unit Cost (\$\$)	Total Cost (\$\$\$)
PRIVATE DRAINAGE FACILITIES (NON-REIMBURSABLE)					
	Earthwork	100	CY	\$5	\$500
	Aggregate Base Course (Access Ramp)	22	CY	\$66	\$1,452
	Riprap Rundown / Apron	36	TN	\$104	\$3,744
	Concrete Forebays	2	EA	\$1,800	\$3,600
	Rain Garden Infiltration Media	104	CY	\$20	\$2,080
	Filter Sand	6	CY	\$20	\$120
	Drain Gravel	11	CY	\$20	\$220
	4" PVC Underdain	98	LF	\$20	\$1,960
	18" HDPE Outlet Pipe	29	LF	\$70	\$2,030
	Outlet Structure	1	LS	\$5,000	\$5,000
	Buried Soil Riprap Spillway	38	TN	\$104	\$3,952
	SUBTOTAL				\$24,658
	Engineering @ 10%				\$2,466
	Contingency @ 5%				\$1,233
	TOTAL (NON-REIMBURSABLE)				\$28,357
Note: This estimate does not include costs for street improvements and general civil costs (curb & gutter, crosspans, retaining walls, etc.)					

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.

Water Quality Treatment Summary Table

Basin ID(s)	Total Tributary Basin Area (ac)	Total Disturbed Area (ac)	PCM Tributary Area (ac)	Excluded LOD Area (ac)	Non-Excluded LOD Area (ac)	PCM ID / Exclusion
A1	6.69	0.33		0.17	0.16	Excluded per ECM I.6.1.B.7
A2.1	3.45	0.72	3.45			Rain Garden A2
A2.2	2.72	2.28	2.72			Rain Garden A2
A3	0.39	0.16		0.16	0	Excluded per ECM I.6.1.B.7
OB1	0.27	0.17		0	0.17	
OB2	9.27	0.45		0.25	0.2	Excluded per ECM I.6.1.B.7
B	3.96	0		0	0	
C	10.61	2.59		2.47	0.12	Excluded per ECM I.6.1.B.7
OD1	0.4	0.3		0	0.3	Excluded per ECM I.6.1.B.7
Total	37.8	7.0	6.17	3.05	0.95	

**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				New Water Quality Rain Garden A2
Proposed on or offsite PCM(s) to be built with a future project?		X			

APPENDIX E
SITE PHOTOGRAPHS



Existing stable “Swale A” at west property boundary



Existing stable “Swale C” at north end of property

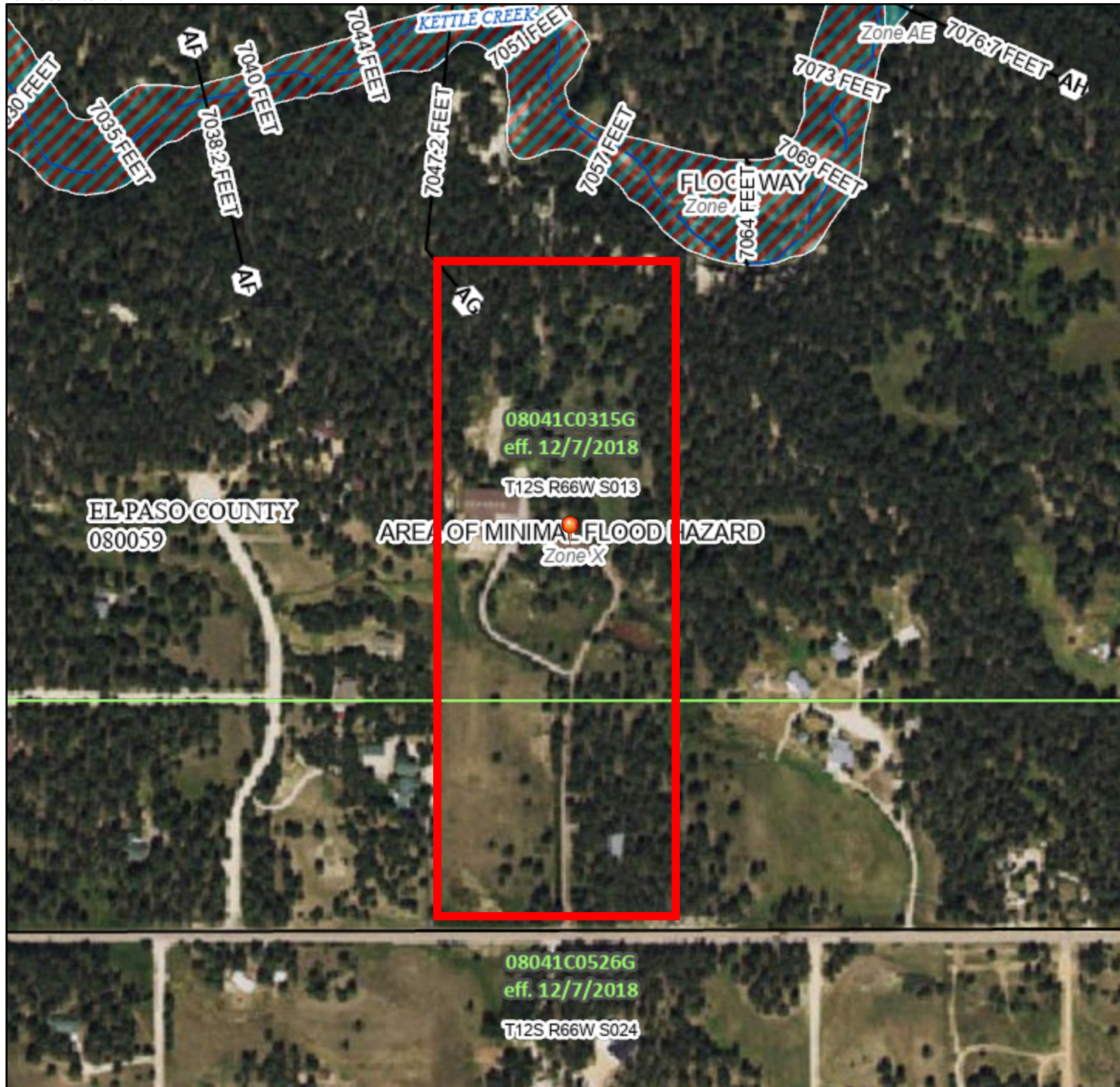
APPENDIX F

FIGURES

National Flood Hazard Layer FIRMMette



104°43'58"W 39°0'18"N



Legend

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

SPECIAL FLOOD HAZARD AREAS		Without Base Flood Elevation (BFE) Zone A, V, A99
		With BFE or Depth Zone AE, AO, AH, VE, AR
		Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD		0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
		Future Conditions 1% Annual Chance Flood Hazard Zone X
		Area with Reduced Flood Risk due to Levee. See Notes. Zone X
		Area with Flood Risk due to Levee Zone D

OTHER AREAS		NO SCREEN Area of Minimal Flood Hazard Zone X
		Effective LOMRs
		Area of Undetermined Flood Hazard Zone D

GENERAL STRUCTURES		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall

OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance Water Surface Elevation
		17.5 Cross Sections with 1% Annual Chance Base Flood Elevation
		Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature

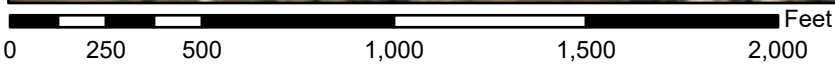
MAP PANELS		Digital Data Available
		No Digital Data Available
		Unmapped
		The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.



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.



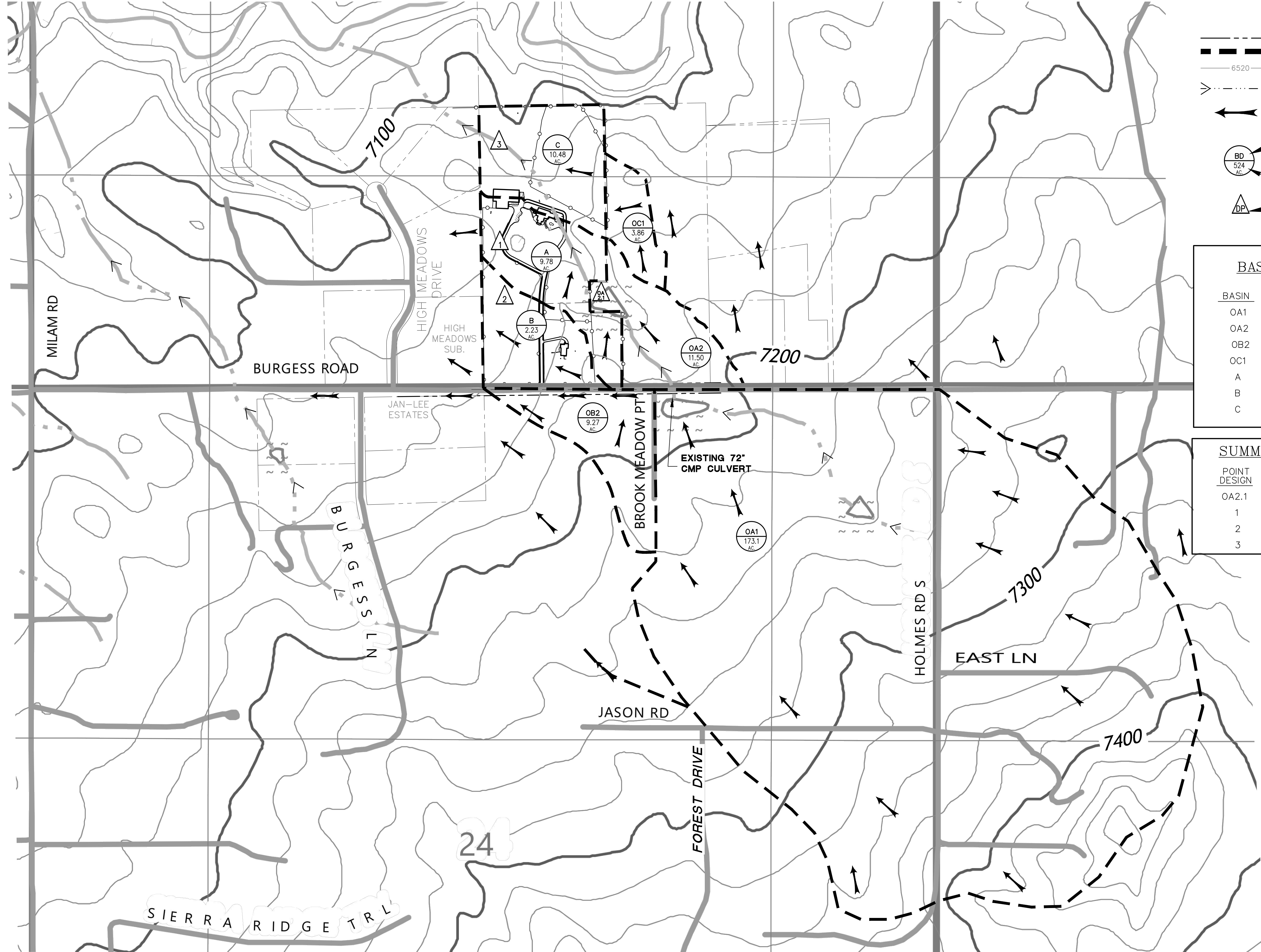
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104°43'20"W 38°59'50"N

Basemap Imagery Source: USGS National Map 2023

HAVEN FOREST SCHOOL
5490 Burgess Road, El Paso County, CO

**MAJOR BASIN /
HISTORIC DRAINAGE PLAN**



LEGEND

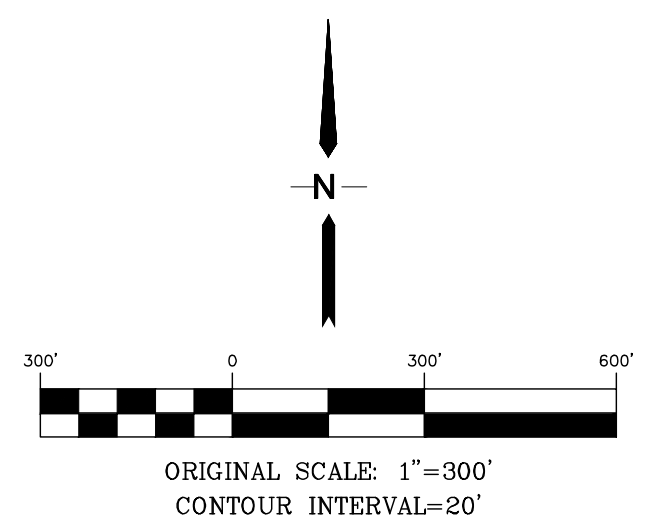
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- MAJOR BASIN BOUNDARY
- EXISTING CONTOUR
- FLOWLINE
- PROPOSED FLOW DIRECTION ARROW
- BASIN DESIGNATION
- BASIN AREA (ACRES)
- DESIGN POINT

BASIN SUMMARY TABLE

BASIN	Q5 (CFS)	Q100 (CFS)
OA1	55.1	265.2
OA2	4.7	22.5
OB2	4.1	19.9
OC1	1.7	8.3
A	7.4	33.6
B	1.4	9.2
C	3.6	22.8

SUMMARY HYDROLOGY TABLE

POINT DESIGN	Q5 (CFS)	Q100 (CFS)
OA2.1	54.2	260.9
1	53.0	253.1
2	2.1	11.4
3	4.6	26.5



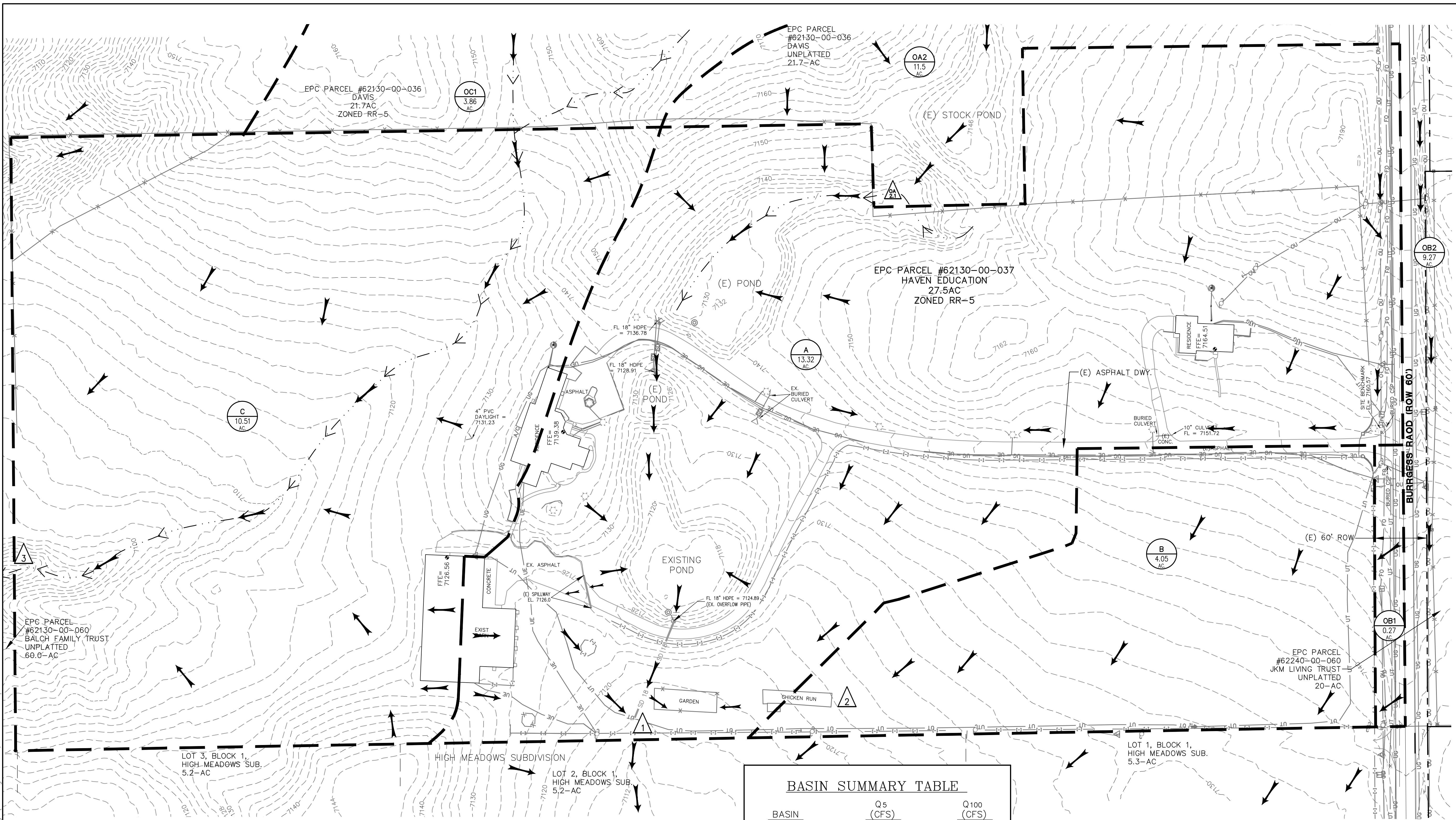
No.	REVISION	BY	DATE

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VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: USGS	CHECKED: JPS
CREATED: 12/29/24	LAST MODIFIED: 11/7/25
PROJECT NO: 122401	MODIFIED BY: MSP

EX1

C:\Users\Michael\Dropbox\jpsprojects\122401\haven\dwg\Drainage\EX1.dwg Nov 06, 2025 - 11:19pm

C:\Users\Michael\Dropbox\jpsprojects\122401.haven\dwg\Drainage_EX2.dwg Nov. 07. 2025 - 4:05pm



LEGEND

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

EXISTING IMPERVIOUS AREA CALCULATIONS

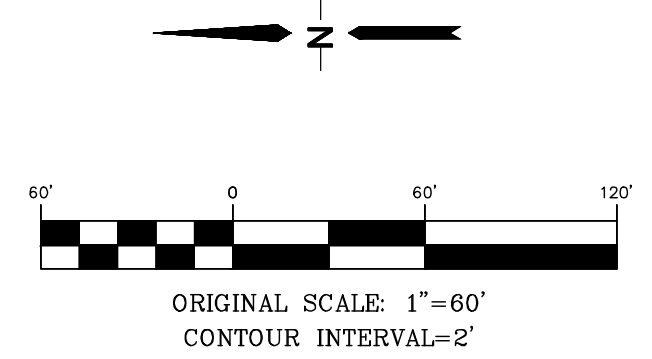
BASIN A	
BUILDING STRUCTURES	0.37 ACRES
PAVED ROADWAY	0.73 ACRES
BASIN B	
BUILDING STRUCTURES	N/A ACRES
PAVED ROADWAY	0.07 ACRES
BASIN C	
BUILDING STRUCTURES	0.07 ACRES
PAVED ROADWAY	0.01 ACRES

BASIN SUMMARY TABLE

BASIN	Q5 (CFS)	Q100 (CFS)
A	7.4	33.6
OB1	0.6	1.4
B	1.4	9.2
OC1	1.7	8.3
C	3.6	22.8

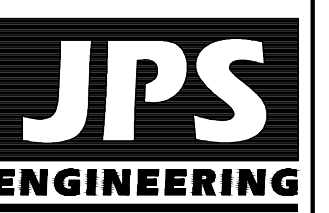
SUMMARY HYDROLOGY TABLE

POINT DESIGN	Q5 (CFS)	Q100 (CFS)
OA2.1	54.2	260.9
1	53.0	253.1
2	2.1	11.4
3	4.6	26.5



HAVEN FOREST SCHOOL
5490 Burgess Road, El Paso County, CO

**EXISTING CONDITIONS
DRAINAGE PLAN**



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



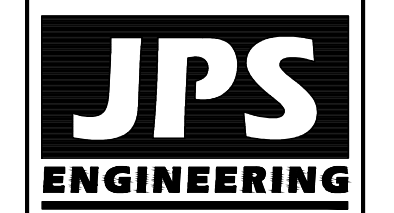
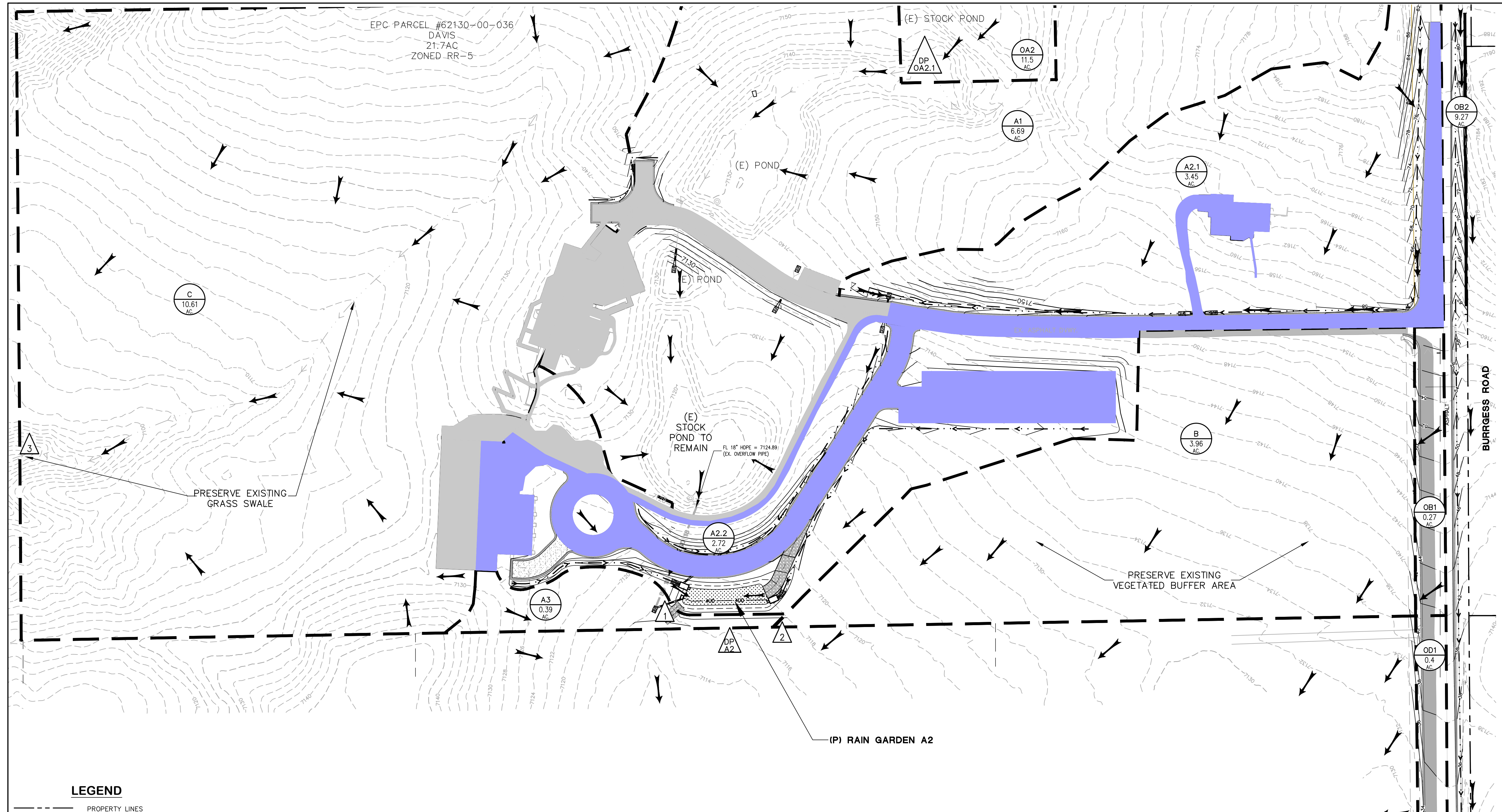
CALL UTILITY NOTIFICATION
CENTER OF COLORADO
1-800-922-1987
CALL 2-BUSINESS DAYS IN ADVANCE
BEFORE YOU DIG, GRADE, OR EXCAVATE
FOR THE LOCATION OF UNDERGROUND
MEMBER UTILITIES.

No.	REVISION	BY	DATE

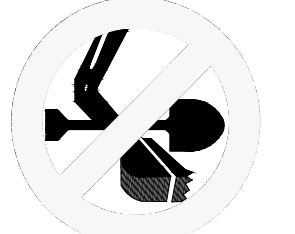
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VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: COMPASS	CHECKED: JPS
CREATED: 12/29/24	LAST MODIFIED: 11/7/25
PROJECT NO: 122401	MODIFIED BY: MSP

SHEET: **EX2**

EPC PARCEL #62130-00-036
DAVIS
21.7AC
ZONED RR-5



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



CALL UTILITY NOTIFICATION
CENTER OF COLORADO
1-800-922-1987
CALL BEFORE YOU DIG
BEFORE YOU GRADE OR EXCAVATE
FOR THE MARKING OF UNDERGROUND
MEMBER UTILITIES.

HAVEN FOREST SCHOOL

5490 Burgess Road, El Paso County, CO

No.	REVISION	BY	DATE

PBMP APPLICABILITY EXHIBIT

LEGEND

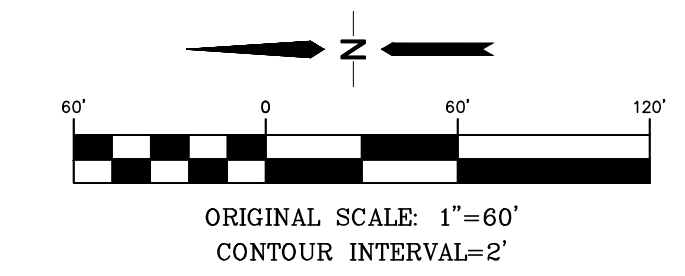
- PROPERTY LINES
- DRAINAGE BASIN BOUNDARY
- EXISTING CONTOUR
- FLOWLINE
- PROPOSED FLOW DIRECTION ARROW
- BASIN DESIGNATION
- BASIN AREA (ACRES)
- DESIGN POINT
- EXISTING IMPERVIOUS AREAS

PBMP LEGEND

- UNCONNECTED IMPERVIOUS AREA (UIA) TRIBUTARY TO RAIN GARDEN A2
- EXCLUDED FROM PBMP REQUIREMENTS PER ECM

Water Quality Treatment Summary Table

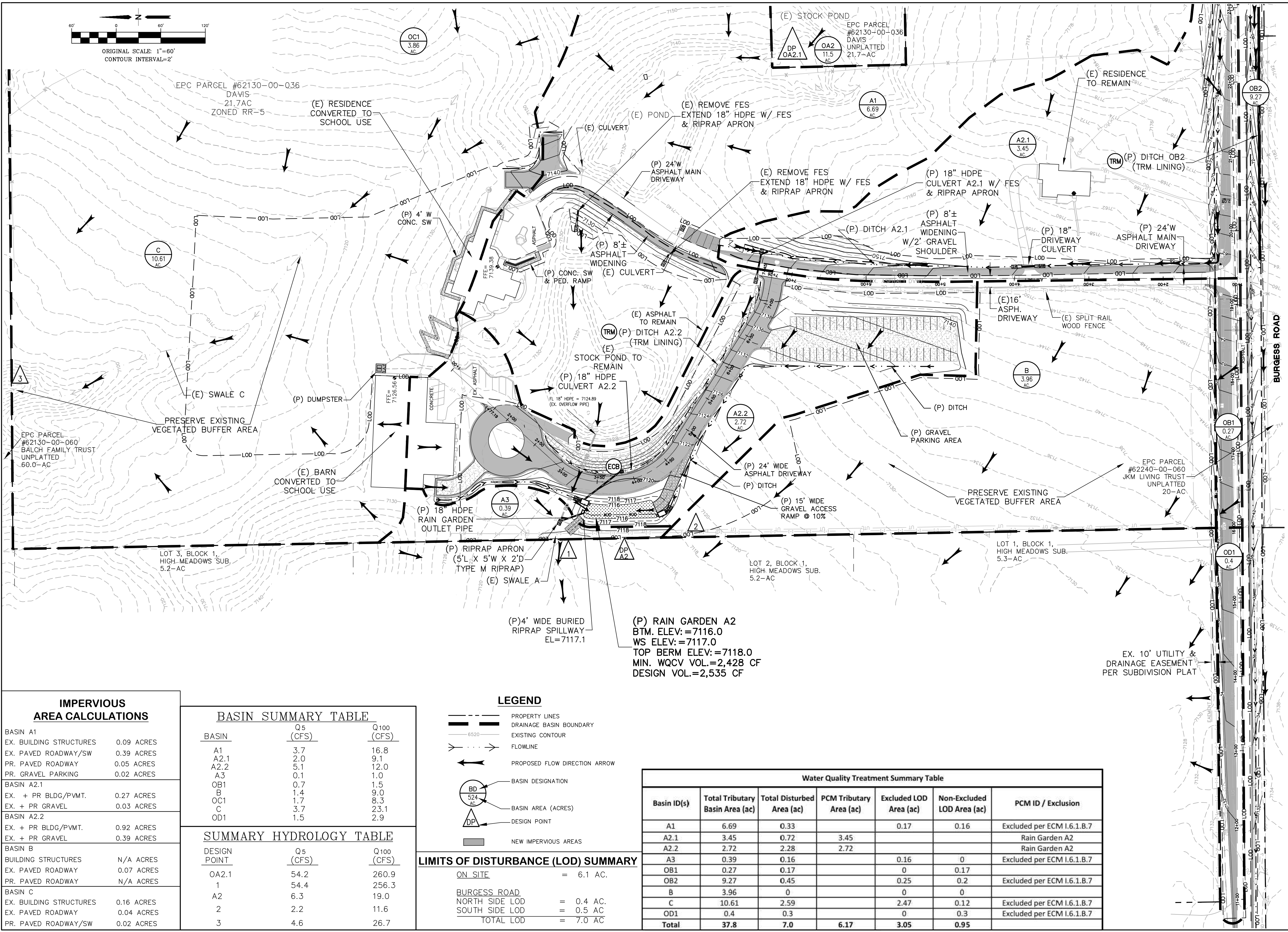
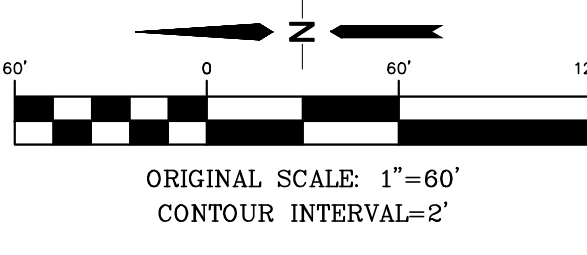
Basin ID(s)	Total Tributary Basin Area (ac)	Total Disturbed Area (ac)	PCM Tributary Area (ac)	Excluded LOD Area (ac)	Non-Excluded LOD Area (ac)	PCM ID / Exclusion
A1	6.69	0.33		0.17	0.16	Excluded per ECM I.6.1.B.7
A2.1	3.45	0.72	3.45			Rain Garden A2
A2.2	2.72	2.28	2.72			Rain Garden A2
A3	0.39	0.16		0.16	0	Excluded per ECM I.6.1.B.7
OB1	0.27	0.17		0	0.17	
OB2	9.27	0.45		0.25	0.2	Excluded per ECM I.6.1.B.7
B	3.96	0		0	0	
C	10.61	2.59		2.47	0.12	Excluded per ECM I.6.1.B.7
OD1	0.4	0.3		0	0.3	Excluded per ECM I.6.1.B.7
Total	37.8	7.0	6.17	3.05	0.95	



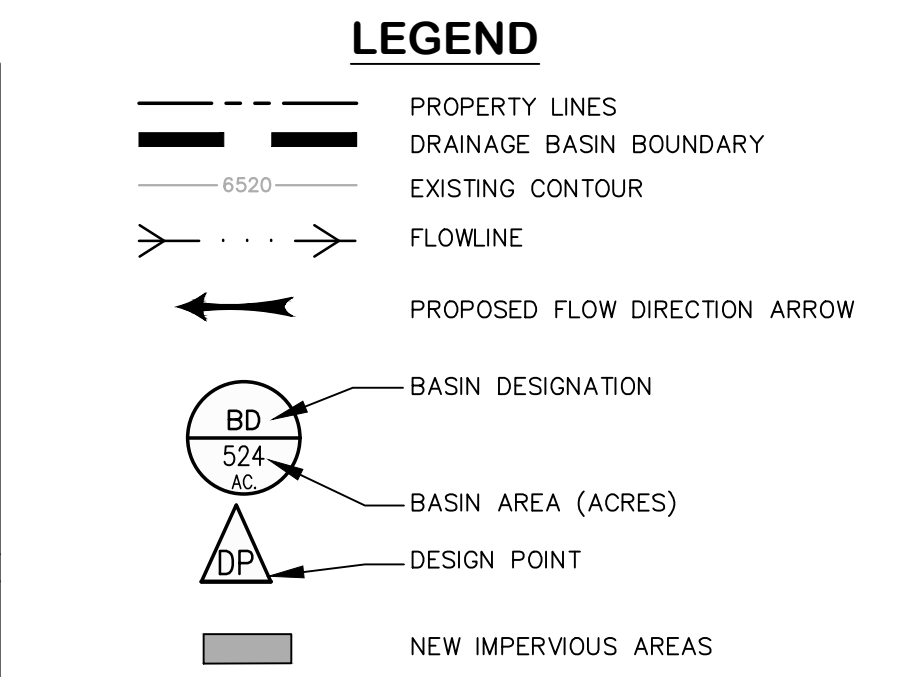
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VERT. SCALE: N/A
SURVEYED: COMPASS
CREATED: 12/29/24
PROJECT NO: 122401

DRAWN: PV
DESIGNED: JPS
CHECKED: JPS
LAST MODIFIED: 05/14/26
MODIFIED BY: PV

PBMP



(P) RAIN GARDEN A2
 BTM. ELEV.=7116.0
 WS ELEV.=7117.0
 TOP BERM ELEV.=7118.0
 MIN. WQCV VOL.=2,428 CF
 DESIGN VOL.=2,535 CF



LIMITS OF DISTURBANCE (LOD) SUMMARY

ON SITE	= 6.1 AC.
BURGESS ROAD	
NORTH SIDE LOD	= 0.4 AC.
SOUTH SIDE LOD	= 0.5 AC
TOTAL LOD	= 7.0 AC

Water Quality Treatment Summary Table

Basin ID(s)	Total Tributary Basin Area (ac)	Total Disturbed Area (ac)	PCM Tributary Area (ac)	Excluded LOD Area (ac)	Non-Excluded LOD Area (ac)	PCM ID / Exclusion
A1	6.69	0.33		0.17	0.16	Excluded per ECM I.6.1.B.7
A2.1	3.45	0.72	3.45			Rain Garden A2
A2.2	2.72	2.28	2.72			Rain Garden A2
A3	0.39	0.16		0.16	0	Excluded per ECM I.6.1.B.7
OB1	0.27	0.17		0	0.17	
OB2	9.27	0.45		0.25	0.2	Excluded per ECM I.6.1.B.7
B	3.96	0		0	0	
C	10.61	2.59		2.47	0.12	Excluded per ECM I.6.1.B.7
OD1	0.4	0.3		0	0.3	Excluded per ECM I.6.1.B.7
Total	37.8	7.0	6.17	3.05	0.95	

IMPERVIOUS AREA CALCULATIONS

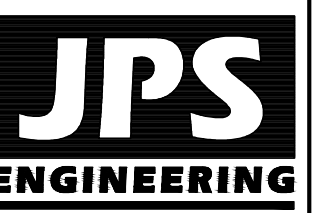
Basin	Category	Area (Acres)	
BASIN A1	EX. BUILDING STRUCTURES	0.09 ACRES	
	EX. PAVED ROADWAY/SW	0.39 ACRES	
	PR. PAVED ROADWAY	0.05 ACRES	
	PR. GRAVEL PARKING	0.02 ACRES	
BASIN A2.1	EX. + PR BLDG/PVMT.	0.27 ACRES	
	EX. + PR GRAVEL	0.03 ACRES	
	BASIN A2.2	EX. + PR BLDG/PVMT.	0.92 ACRES
		EX. + PR GRAVEL	0.39 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	0.02 ACRES	

BASIN SUMMARY TABLE

BASIN	Q5 (CFS)	Q100 (CFS)
A1	3.7	16.8
A2.1	2.0	9.1
A2.2	5.1	12.0
A3	0.1	1.0
OB1	0.7	1.5
B	1.4	9.0
OC1	1.7	8.3
C	3.7	23.1
OD1	1.5	2.9

SUMMARY HYDROLOGY TABLE

DESIGN POINT	Q5 (CFS)	Q100 (CFS)
OA2.1	54.2	260.9
1	54.4	256.3
A2	6.3	19.0
2	2.2	11.6
3	4.6	26.7



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 Colorado Springs, CO 80903
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 FAX: 719-471-0766
 www.jpsegr.com



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 1-800-922-1987
 CALL 2-BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MEMBER UTILITIES.

HAVEN FOREST SCHOOL
 5490 BURGESS ROAD, EL PASO COUNTY, CO

DEVELOPED DRAINAGE PLAN

HORIZ. SCALE: 1"=60'	DRAWN: PV
VERT. SCALE: N/A	DESIGNED: JPS
SURVEYED: COMPASS	CHECKED: JPS
CREATED: 12/29/24	LAST MODIFIED: 05/14/25
PROJECT NO: 122401	MODIFIED BY: PV
SHEET:	D1