Final Drainage Report

Kristin Estates
El Paso County, Colorado

PCD File No.: SF2521

Prepared for:
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Project #: 196663001

Prepared: June 1, 2026

Kimley»Horn

CERTIFICATION

ENGINEERS 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 El Paso County, Colorado for drainage reports and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.

SIGNATURE (Affix Seal): _____

Kevin R. Kofford Date
Colorado P.E. No. 57234

DEVELOPER'S STATEMENT

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

Michael Butler (GWH, LLC)
Developer Name

_____
Signature:

Developer/Owner
Title:

23218 Colorado State Highway 94 (EPC Parcel No. 3412000026)
Address:

EL PASO COUNTY STATEMENT

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

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

Conditions:

GENERAL LOCATION AND DESCRIPTION

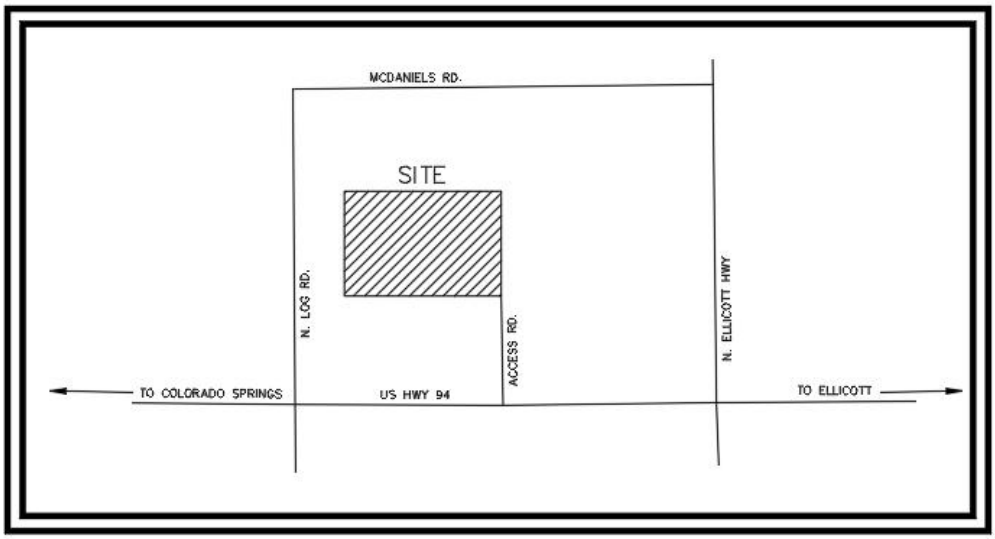
PURPOSE AND SCOPE OF STUDY

The purpose of this Final Drainage Report (FDR) is to provide the hydrologic and hydraulic calculations in addition to documenting and finalizing the drainage design methodology in support of the proposed Kristen Estates single-family development ("the Project") for GWH, LLC ("the Owner"). The Project is located within the jurisdictional limits of El Paso County ("the County"). Thus, the guidelines for the hydrologic and hydraulic design components were based on the criteria outlined by the County.

LOCATION

The Project is located at 23218 Colorado State Highway 94 (EPC Parcel No. 3412000026) northeast of the intersection of Colorado State Highway 94 and North Log Rd. in El Paso County, Colorado. More specifically, the Project is within a portion The east half of the northwest quarter of the southwest quarter and the northeast quarter of the southwest quarter of Section 12, Township 14 South, Range 63 West of the 6th P.M., County of El Paso, State of Colorado. A vicinity map has been provided below.

VICINITY MAP



DESCRIPTION OF PROPERTY

The Project is located on approximately ±60.00 acres (EPC Parcel No. 3412000026). In existing conditions, there is one existing residential modular home with an existing gravel driveway. Existing vegetation on the Site consists of natural vegetation with scattered patches or native shrubs and trees. Currently, the site does not provide stormwater quality or detention. The site generally drains from northwest to southeast with slopes ranging from 1% to 10%, with the steeper slopes along the existing tributary creek banks that ultimately drains to Black Squirrel Creek. Runoff generally flows throughout the Site as overland sheet flow with some channelized flow within the existing tributary on the west side of the site.

The property is currently owned by GWH LLC. The topographic survey along with LiDAR elevation data and aerial imagery was the basis for design of the drainage maps, report, and calculations. The survey was completed by Land Development Consultants, Inc. in December 2024.

SOILS DATA

NRCS soil data for the Site is provided in the ***Appendix.*** Onsite soils are USCS Hydrologic Soil Group A. Group A soils generally have high infiltration rates even when thoroughly wetted, consisting chiefly of deep, well to excessively drained sand and/or gravel. These soils have a high rate of water transmission and would result in a low runoff potential.

PROJECT CHARACTERISTICS

The proposed project has a total drainage study area of approximately ±208.59 acres and is located within the Ellicott Consolidated Drainage Basin. The proposed Project consists of a total of eleven (11) lots in the range of 5-6 acres as a part of a proposed subdivision and final plat. The proposed lots will be accessed by the proposed private gravel road with driveways. Developed flows within the site will generally sheetflow across the site over existing natural vegetation into a proposed private full spectrum detention basin.

DRAINAGE DESIGN CRITERIA

DEVELOPMENT CRITERIA REFERENCE

The proposed stormwater facilities follow the El Paso County Drainage Criteria Manual (the “CRITERIA”), El Paso Engineering Criteria Manual (the “ECM”), and the Mile High Flood District Urban Storm Drainage Criteria Manual (the “MANUAL”). Site drainage is not significantly impacted by such constraints as utilities or existing development. Further detail regarding proposed onsite drainage patterns is provided in the Proposed Drainage Conditions Section.

HYDROLOGIC CRITERIA

The 5-year and 100-year design storm events were used in determining rainfall and runoff for the proposed drainage system per chapter 6 of the CRITERIA. Table 6-2 of the CRITERIA is the source for rainfall data for the 5-year and 100-year design storm events. Design runoff was calculated using the Rational Method for developed conditions as established in the CRITERIA and MANUAL. Runoff coefficients for the proposed development were determined using Table 6-6 of the CRITERIA by calculating weighted impervious values for each specific site basin.

HYDRAULIC CRITERIA

The proposed drainage facilities are designed in accordance with the CRITERIA and MANUAL.

Roadside ditches are provided along the proposed private road to route flows to the proposed culverts. The roadside ditch is sized to convey the major event flow. The proposed roadside ditches comply with Table 6-1 of the EPC DCM V1. The roadside ditches have been designed to have an average depth of 2.5 feet, a v-ditch, and side slope of 4:1 along the shoulder and then varying slope to tie back into existing grade but not to exceed 3:1. Roadside ditch calculations and summary table has been provided in the **Appendix**

Results of the hydraulic calculations are summarized in the ***Appendix***.

DEVIATIONS FROM CRITERIA

There are currently two variances with this proposed development. A request to allow for multiple pipe crossings in a culvert and a request to allow for extended length for a non-through cul-de-sac road.

DRAINAGE BASINS AND SUB-BASINS

MAJOR BASIN DESCRIPTIONS

The Property is within the Ellicott Consolidated Drainage Basin and stormwater runoff ultimately drains to Black Squirrel Creek. Minor drainageway improvements are proposed within the project to better route stormwater runoff through three (3) 36" RCP culverts. Due to the stormwater improvements included within this project, runoff developed in the proposed condition is less than in the existing condition. The project is not anticipated to adversely affect downstream conditions or cause excessive erosion within the existing tributary of Black Squirrel Creek embankments. There are no identified nearby irrigation facilities or other obstructions which could influence the local drainage. Currently, there is not an approved drainage report for the property.

EXISTING DRAINAGE CONDITIONS

The existing Site has been divided into four (4) on-site (E1, E2, E3, & E4) and five (5) off-site (OE1, OE3, OE4, OE5, & OE6) existing sub-basins. A description of each sub-basin is listed below. In existing conditions, the total studied drainage area of the site is ±208.59 acres. Flows from stormwater runoff generally travel overland into existing tributaries of Black Squirrel Creek at slopes of 1% to 10%. Stormwater runoff flows then travel generally southeast within tributaries ultimately into Black Squirrel Creek. Calculations of the existing sub-basins on the Project Site have been completed using current stormwater criteria. An Existing Conditions Drainage Map is provided in the ***Appendix*** of this report. The weighted imperviousness of the drainage area under existing conditions is 2.4%. Total flows generated in existing conditions are 54.13 cfs for the 5-year event and 336.84 cfs for the 100-year event.

Sub-Basin E1

Existing sub-basin E1 is approximately 9.70 acres and consists of the western area of the Site. This sub-basin consists of existing native grasses and vegetation along with an existing creek bed. The runoff developed within this basin generally sheet flows to the channel from northwest to southeast to design point E1 at slopes ranging from 0.5% to 5%, towards design point E1. Flows within E1 are channelized within the existing drainageway and continue southwardly until eventually out-falling at Black Squirrel Creek. The weighted imperviousness of existing sub-basin E1 is 0.0%. The existing direct runoff from existing sub-basin E1 is 2.52 cfs for the 5-year event and 18.50 cfs for the 100-year event.

Sub-Basin E2

Existing sub-basin E2 is approximately 19.83 acres and consists of the central and western areas of the Site. This sub-basin consists of existing native grasses and vegetation, gravel driveway, and a residential structure. The runoff developed within this basin sheet flows from northwest to southeast at slopes ranging from 0.5% to 3% towards design point E2. Flows continue southeastwardly with flows from the delineated basin overtopping the existing gravel road towards an existing detention facility southeast of the site. Flows then continue beneath highway 94 and continue into Black Squirrel Creek. The weighted imperviousness of existing sub-basin E2 is 5.2%. The existing direct runoff from existing sub-basin E2 is 6.83 cfs for the 5-year event and 37.70 cfs for the 100-year event.

Sub-Basin E3

Existing sub-basin E3 is approximately 20.01 acres and generally consists of the central and eastern areas of the Site. This sub-basin consists of existing native grasses and vegetation, gravel driveway, and a residential structure. The runoff developed within this basin sheet flows from northwest to southeast at slopes ranging from 0.5% to 3% towards design point E3. Flows continue southeastwardly following historical flows then continue beneath highway 94 and continue into Black Squirrel Creek. The weighted imperviousness of existing sub-basin E3 is 1.9%. The existing direct runoff from existing sub-basin E3 is 5.52 cfs for the 5-year event and 35.84 cfs for the 100-year event.

Sub-Basin E4

Existing sub-basin E4 is approximately 10.47 acres and generally consists of the northeast area of the Site. This sub-basin consists of existing native grasses and vegetation, and gravel driveway. The runoff developed within this basin sheet flows from northwest to southeast at slopes ranging from 0.5% to 2% towards design point E4. Flows continue southeastwardly following historical flows then continue beneath highway 94 and continue into Black Squirrel Creek. The weighted imperviousness of existing sub-basin E4 is 5.8%. The existing direct runoff from existing sub-basin E4 is 3.92 cfs for the 5-year event and 21.15 cfs for the 100-year event.

Sub-Basin OE1

Existing sub-basin OE1 is approximately 30.00 acres and consists of the off-site area of sub-basin E1 northwest of the site. This sub-basin consists of existing native grass and vegetation, an existing creek bed, gravel road/driveway, and a residential structure. The runoff developed within this basin is channelized within an existing tributary of Black Squirrel Creek. This tributary continues into the site and is accounted for in sub-basin E1. Flows are conveyed northwest to southeast at slopes that range approximately 1% to 6%, towards design point OE1. Flows continue southeastwardly towards Black Squirrel Creek. The weighted imperviousness of existing sub-basin OE1 is 2.9%. The existing direct runoff from existing sub-basin OE1 is 8.24 cfs for the 5-year event and 50.97 cfs for the 100-year event.

Sub-Basin OE3

Existing sub-basin OE3 is approximately 96.87 acres and consists of the off-site area of sub-basin E3 north of the site. This sub-basin consists of existing native grasses and vegetation, gravel road/driveway, and a residential structure. The runoff developed within this basin generally sheet flows from northwest to southeast at slopes ranging approximately 0.5% to 3%, towards design point OE3. Flows continue southeastwardly into sub-basin E3. The weighted imperviousness of existing sub-basin OE3 is 1.4%. The existing direct runoff from existing sub-basin OE3 is 22.69 cfs for the 5-year event and 152.22 cfs for the 100-year event.

Sub-Basin OE4

Existing sub-basin OE4 is approximately 11.20 acres and consists of the off-site area of sub-basin E4 northeast of the site. This sub-basin consists of existing native grasses and vegetation, gravel road, and residential structure. The runoff developed within this basin generally sheet flows from northwest to southeast at slopes ranging from 0.5% to 3%, towards design point OE4. Flows continue southeastwardly into sub-basin E4. The weighted imperviousness of sub-basin OE4 is 2.6%. The existing direct runoff from existing sub-basin OE4 is 3.41 cfs for the 5-year event and 21.37 cfs for the 100-year event.

Sub-Basin OE5

Existing sub-basin OE5 is approximately 8.65 acres and consists of the off-site area that flows to the culvert under the access road south of the site. This sub-basin consists of existing native grasses and vegetation. The runoff developed within this basin generally sheet flows from northwest to southeast at slopes ranging from 0.5% to 3%, towards design point OE5. Flows continue southeastwardly following historical flows. The weighted imperviousness of sub-basin OE5 is 0%. The existing direct runoff from existing sub-basin OE5 is 2.41 cfs for the 5-year event and 17.74 cfs for the 100-year event.

Sub-Basin OE6

Existing sub-basin OE6 is approximately 1.82 acres and consists of the off-site area that contains the existing private drive. The runoff developed within this basin generally sheet flows from northwest to southeast at slopes ranging from 0.5% to 3%, towards design point OE6. Flows continue southeastwardly eventually crossing highway 94. The weighted imperviousness of sub-basin OE6 is 25.9%. The existing direct runoff from existing sub-basin OE6 is 1.52 cfs for the 5-year event and 4.82 cfs for the 100-year event.

PROPOSED DRAINAGE CONDITIONS

The proposed Site has been divided into four (4) on-site (P1-P4), and five (5) off-site (OP1, OP3, OP4, OP5, & OP6) proposed sub-basins. A description of each sub-basin is listed below. Under the proposed conditions, the total studied drainage area is ±208.59 acres in size. The project involves the construction of a gravel road and cul-de-sac, and tributary improvements to effectively convey stormwater runoff under the proposed gravel road. Generally, runoff flows from northwest to southeast at slopes ranging from approximately 1% to 10%. A portion of the stormwater runoff generated onsite will be conveyed via a proposed roadside ditch along the north side of the proposed private gravel roadway and cul-de-sac. Stormwater runoff will then flow under the proposed gravel road via proposed culverts. Ultimately, these flows will enter the proposed private, above ground, full spectrum extended detention basin (“Pond A”). Also included in this project is a proposed 24” RCP culvert and roadside ditch which runs parallel to the existing private drive at the eastern frontage of the Site. This ditch conveys any additional runoff not conveyed through the (3) 36” RCP culverts to the north of the proposed gravel road, to the Pond A. All culverts are designed to convey at least the 100-year storm. Per direction from the County and other Projects, 5-acre lots have an assumed impervious of 7%, reference the **Appendix** for calculations. Flows generated in the proposed condition follow existing historic drainage patterns. Under proposed conditions the studied drainage area associated with this project is ±208.59 acres with a 4.2% proposed weighted imperviousness and flows of 60.23 cfs and 344.91 cfs for the 5-year and 100-year events, respectively.

Basins P5 and OP6 have been determined to be excluded as part of code section in the ECM I.7.1.B.2 (Excluded Roadway Redevelopment). Additionally, per code section in the ECM I.7.1.B.6

(Non-Residential and Non-Commercial Infiltration Conditions), the culvert improvements located in basin OP6 can be excluded. The roadway widening and culvert improvements together, are less than an acre, therefore, are excluded and do not need stormwater quality control. An exclusions map has been provided in the **Appendix**.

Reference **Appendix** for the Proposed Drainage Map and delineation of proposed sub-basins. Reference the proposed rational calculations in **Appendix** for each sub-basin area, minor storm runoff, and major storm runoff.

Sub-Basin P1

Proposed sub-basin P1 is approximately 9.70 acres and consists of the western area of the Site. This sub-basin consists of existing native grasses and vegetation along with an existing creek bed. Runoff developed within this basin flow from northwest to southeast at slopes ranging from 0.5% to 5%, towards Design Point P1. Flows within P1 are channelized within the existing drainageway and continue southwardly until eventually out-falling at Black Squirrel Creek. The weighted imperviousness of proposed sub-basin P1 is 7.0%. The existing direct runoff from proposed sub-basin P1 is 3.78 cfs for the 5-year event and 20.62 cfs for the 100-year event.

Sub-Basin P2

Proposed sub-basin P2 is 25.32 acres and consists of the central-southern portion of the Site, on the south side of the proposed private gravel road. This sub-basin consists of proposed and existing gravel driveway, proposed stormwater facility, and native grasses. The runoff developed within this basin flow from northwest to southeast at slopes ranging from 2% to 5%, towards design point P2. Flows then enter the proposed Pond A and eventually continue southeastwardly towards the proposed culvert C in the north-south road then continues southeast until channelizing within Black Squirrel Creek. The weighted imperviousness of proposed sub-basin P2 is 8.6%. The developed direct runoff from proposed sub-basin P2 is 10.05 cfs for the 5-year event and 51.23 cfs for the 100-year event.

Sub-Basin P3

Proposed sub-basin P3 is 16.53 acres and consists of the central-northern portion of the Site. This sub-basin consists of proposed gravel driveways, proposed residential homes, and native grasses. The runoff developed within this basin flow from northwest to southeast at slopes ranging from 1% to 5%, towards design point P3. At design point P3 flows pass beneath the proposed gravel road via three 36” RCP culverts and ultimately converge into the proposed stormwater detention facility. The weighted imperviousness of proposed sub-basin P3 is 8.7%. The developed direct runoff from proposed sub-basin P3 is 6.46 cfs for the 5-year event and 32.78 cfs for the 100-year event.

Sub-Basin P4

Proposed sub-basin P4 is approximately 5.81 acres and generally consists of the northeast portion of the Site. This sub-basin consists of existing native grasses and vegetation, and existing and proposed gravel road. The runoff developed within this basin flow from north to south at slopes ranging from 1% to 5%, towards design point P4. Flows then pass beneath the proposed gravel road via a proposed 24” RCP culvert and ultimately converge into the proposed stormwater detention facility. The weighted imperviousness of proposed sub-basin P4 is 8.4%. The developed direct runoff from proposed sub-basin P4 is 2.41 cfs for the 5-year event and 12.38 cfs for the 100-year event.

Sub-Basin P5

Proposed sub-basin P5 is approximately 1.60 acres and generally consists of the east portion of the Site. This sub-basin consists of existing private gravel drive. The runoff developed within this basin flow from north to south at slopes ranging from 1% to 5%, towards design point P5. Flows then pass into sub-basin OP6. The weighted imperviousness of proposed sub-basin P5 is 30.2%. The developed direct runoff from proposed sub-basin P5 is 1.47 cfs for the 5-year event and 4.36 cfs for the 100-year event.

Sub-Basin P6

Proposed sub-basin P6 is approximately 1.04 acres and generally consists of the southeast corner of the Site. This sub-basin consists of undisturbed native grasses and vegitation. The runoff developed within this basin flow from north to south at slopes ranging from 1% to 5%, towards design point P6. Flows then pass beneath the existing gravel road via a proposed 30" RCP triple culvert and ultimately discharge to follow historical flows. The weighted imperviousness of proposed sub-basin P6 is 7.0%. The developed direct runoff from proposed sub-basin P6 is 0.47 cfs for the 5-year event and 2.58 cfs for the 100-year event.

Sub-Basin OP1

Proposed sub-basin OP1 is approximately 30.00 acres and consists of the off-site area of sub-basin P1 northwest of the site. This sub-basin consists of existing native grasses and vegetation, an existing creek bed, gravel road/driveway, and a residential structure. The runoff developed within this basin is channelized within an existing tributary of Black Squirrel Creek. This tributary continues onto the site and is accounted for in sub-basin P1. Flows are conveyed northwest to southeast at slopes that range approximately 1% to 6%, towards design point OP1. The weighted imperviousness of proposed sub-basin OP1 is 2.9%. The existing direct runoff from proposed sub-basin OP1 is 8.24 cfs for the 5-year event and 50.97 cfs for the 100-year event.

Sub-Basin OP3

Proposed sub-basin OP3 is approximately 96.87 acres and consists of the off-site area of sub-basin P3 north of the site. This sub-basin consists of existing native grasses and vegetation, gravel road/driveway, and a residential structure. The runoff developed within this basin flows from northwest to southeast at slopes ranging from 0.5% to 3%, towards design point OP3. Flows then continue to travel southeast into sub-basin P3 and eventually enter the proposed Pond A. The weighted imperviousness of proposed sub-basin OP3 is 1.4%. The existing direct runoff from sub-basin OP3 is 22.18 cfs for the 5-year event and 148.77 cfs for the 100-year event.

Sub-Basin OP4

Proposed sub-basin OP4 is approximately 11.20 acres and consists of the off-site area of sub-basin P4 northeast of the site. This sub-basin consists of existing native grasses and vegetation, gravel road, and a residential structure. The runoff developed within this basin flows from northwest to southeast at slopes ranging from 0.5% to 3%, towards design point OP4. From design point OP4, flows continue into sub-basin P4 and eventually enter the proposed Pond A. The weighted imperviousness of proposed sub-basin OP4 is 2.6%. The existing direct runoff from proposed sub-basin OP4 is 3.41 cfs for the 5-year event and 21.37 cfs for the 100-year event.

Sub-Basin OP5

Proposed sub-basin OP5 is approximately 8.65 acres and consists of the off-site area that flows to the proposed 30" RCP triple culvert under the private access road south of the site. This sub-basin consists of existing native grasses and vegetation. The runoff developed within this basin generally sheet flows from northwest to southeast at slopes ranging from 0.5% to 3%, towards design point OP5. Flows continue southeastwardly following historical flows. The weighted imperviousness of sub-basin OP5 is 0.0%. The existing direct runoff from existing sub-basin OP5 is 2.41 cfs for the 5-year event and 17.74 cfs for the 100-year event.

Sub-Basin OP6

Proposed sub-basin OP6 is approximately 1.82 acres and consists of the off-site area that contains the existing private drive. The runoff developed within this basin generally sheet flows from northwest to southeast at slopes ranging from 0.5% to 3%, towards design point OP6. Flows continue southeastwardly eventually crossing highway 94. The weighted imperviousness of sub-basin OP6 is 25.9%. The existing direct runoff from existing sub-basin OP6 is 2.12 cfs for the 5-year event and 5.52 cfs for the 100-year event.

FOUR-STEP PROCCESS

The Site was designed in accordance with the four-step process to minimize adverse impacts of urbanization, as outlined in Section I.7.2 BMP Selection of the MANUAL. The four-step process per the MANUAL provides guidance and requirements for the selection of structural Best Management Practices (BMPs) for new development and significant redevelopment.

Step 1: Employ Runoff Reduction Practices

The purpose of this project is to create eleven (11) lots between 5-6 acres. Per Section I.7.1B of Appendix I of the ECM, the single-family residences fall under the large lot exemption as the total impervious area is less than 10% of the area. A BESQCP permit will be required by the County to prevent erosion and mitigate any runoff due to those activities.

A full spectrum extended detention basin is proposed as a part of this project and will have a water quality capture volume designed to accommodate the total imperviousness from the proposed gravel road and residential sites. The final pond A design takes into account the total tributary area and total overall weighted imperviousness for the total studied drainage area.

Step 2: Stabilize Drainageways

Generally, stormwater runoff from the site ultimately drains through existing tributaries into Black Squirrel Creek and eventually reaches the Arkansas River. There are no proposed drainageway improvements anticipated as a part of this project. Additionally, there is only a slight increase in overall site imperviousness. The existing overall onsite imperviousness is 3.4% and the proposed overall onsite imperviousness is 8.9%. The existing gravel road will be removed as a part of this project and a private gravel road will be added to serve future development of the residential lots.

A portion of the 100-year flood plain encroaches on the property boundary. To show that this reach of the unnamed tributary onsite is stable, a FlowMaster analysis was performed. This analysis included three (3) cross sections of the tributary where it runs through the site. The location of these cross sections can be seen in Figure 1. Station elevation data for these cross sections was pulled from Lidar downloaded from the Colorado Water Conservation Board

(CWCB). The slope at each cross section was also determined from the Lidar and is shown below in Table 1. The effective 1D HEC-RAS model for this tributary was also provided by CWCB. This model identified that approximately 1233 cfs of flow is running through the tributary at the site. Photos of the tributary were used to determine the appropriate Manning's n for the model. These photos are included below in Figures X1 and X2. This tributary was determined to have a varied Manning's n value throughout the cross section. The primary channel has a sandy bottom and was assigned a value of 0.035. The floodplain on either side of the channel has scattered brush and heavy weeds and was assigned a Manning's n value of 0.05.

Figure 1

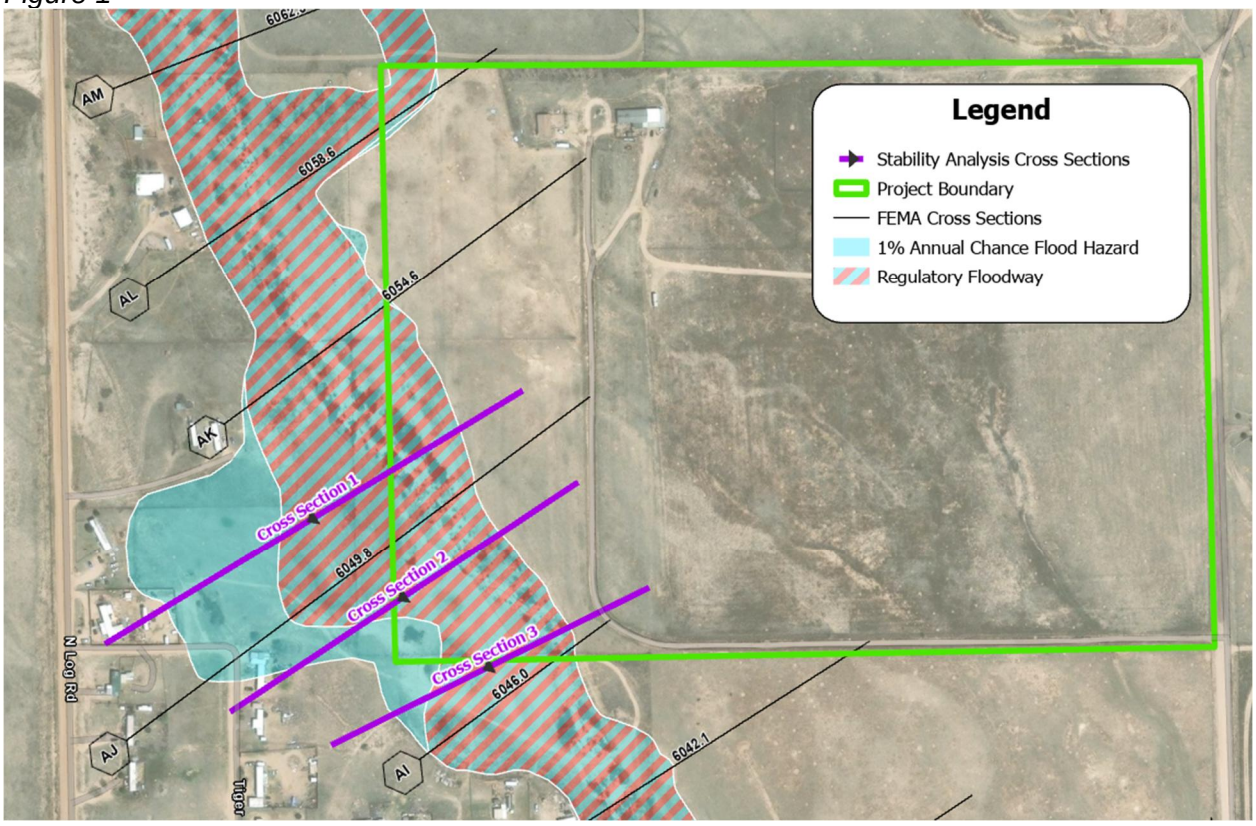


Table 1

Cross Section	Slope
Cross Section 1	0.011
Cross Section 2	0.014
Cross Section 3	0.012

Figure 2

Figure 3

The simulations for the three cross sections were run to determine velocity and Froude number. The detailed inputs and results from the FlowMaster analysis can be found in the **Appendix**. Table X1 below shows the results for each cross section. According to the El Paso

County drainage criteria manual, a channel with a velocity of less than 6 ft/s and Froude number less than 0.9 does not require additional armoring. The model results show that the channel on site does not exceed these thresholds, therefore, the channel was determined to be stable.

Table 2

Cross Section	Velocity	Froude
Cross Section 1	4.35	0.603
Cross Section 2	3.70	0.631
Cross Section 3	3.96	0.607

Step 3: Provide Water Quality Capture Volume (WQCV)
The proposed private full spectrum extended detention basin was designed with a water quality capture volume to include the proposed gravel road and associated imperviousness. However, the overall design of the pond A accounts for the final tributary areas adjacent to pond A and associated overall imperviousness.

Full Exclusions per I.7.1.B.5

Large Lot - Single Family Sites
A single-family residential lot, or agricultural zoned lands, greater than or equal to 2.5 acres in size per dwelling and having a total lot impervious area of less than 10 percent. A total lot imperviousness greater than 10 percent is allowed when a study specific to the watershed and/or MS4 shows that expected soil and vegetation conditions are suitable for infiltration/filtration of the WQCV for a typical site, and the permittee accepts such study as applicable within its MS4 boundaries. The maximum total lot impervious covered under this exclusion shall be 20 percent.

Step 4: Consider need for Industrial and Commercial BMPs
The proposed Project consists of residential lots with a Final Plat. There are no industrial and commercial uses or developments proposed with the project.

WATER QUALITY DESIGN

A private full spectrum extended detention basin is proposed to provide water quality for the proposed gravel road, and to provide adequate capture volume for all tributary flows entering from offsite or being generated onsite. The required pond A capacity for water quality is 0.029 ac-ft. There is approximately 158 acres of area tributary to the Pond A. This tributary area is delineated in the Proposed Drainage Map, and excludes sub-basins P1 & OP1, as these flows are channelized within an adjacent established drainageway. The required 100-year detention volume for tributary area to Pond A is 1.707 ac-ft. The total volume provided for Pond A is 2.12 ac-ft. The proposed full spectrum detention facility includes a riprap rock chute and forebay, trickle channels, a concrete cast-in-place outlet structure, and a 6” type VL (12” depth) riprap emergency spillway. A gravel maintenance road is provided for access to the outlet structure and emergency spillway, from the existing private gravel road at the eastern frontage of the Site. The detention facility is designed to adequately manage stormwater flows as required by the County and State. Flows leaving Pond A do so at a rate ~80% of the pre-existing condition. Design documents for the proposed detention facility are included in the Appendix.

FLOODPLAIN STATEMENT

According to the National Flood Insurance Program, Flood Insurance Rate Map Panel 08041C0809G and 08041C0807G with an effective date of December 7, 2018, the subject property is partially within Zone AE 100-year floodplain. A regulatory floodway is within Zone AE, as well as base flood elevations. A proposed drainage easement will be included to mitigate construction within the floodplain. Please reference the ***Appendix*** for the FEMA Firmette and FIRM Panels.

FEES DEVELOPMENT

Applicable Fees

The project is within the Ellicott Consolidated Drainage Basin, and per the 2025 El Paso County Drainage Basin Fees there are no Drainage Basin Fees or Bridge Fees associated with this Drainage Basin.

Construction Cost Opinion

There are no improvements anticipated within the public right-of-way and the proposed stormwater facility and gravel road will be privately owned, therefore a Construction Cost Opinion is not required.

MAINTENANCE AND OPERATIONS

The proposed stormwater facility is anticipated to be privately owned and maintained by an HOA that will be established for the development.

GRADING AND EROSION CONTROL

Grading and erosion control plans have been submitted concurrently with this final drainage report.

OTHER GOVERNMENT AGENCY REQUIREMENTS

Approval from other agencies such as the FEMA, the Army Corps of Engineers, Colorado State Engineer, Colorado Water Conservation Board, and others are not needed with this Project.

SUMMARY

Overall, the existing cumulative flows for the site are 54.13 cfs and 336.84 cfs for the 5-year and 100-year storm events respectively. The proposed flows are 60.88 cfs and 349.01 cfs for the 5-year and 100-year storm events respectively. Additionally, there is only a slight increase in overall site imperviousness. The existing overall onsite imperviousness is 3.4% and the proposed overall onsite imperviousness is 8.9%. The proposed condition for the Site consists of single-family lots at 7% imperviousness, with a minimum lot size of 5-acres. There are 3 proposed culverts on the site, two that carry runoff tributary to the private full spectrum detention facility. These culverts outfall into proposed swales that outfall into the pond. The third culvert is an existing culvert that will be demolished and upsized.

A private full spectrum detention facility is proposed with this project to adequately provide water quality for the proposed gravel road, and to provide adequate storage volume for tributary upstream runoff.

There is no net increase in discharge flow due to the proposed project. Effluent stormwater processed through the proposed detention facility is released at 80% of the pre-existing rate.

COMPLIANCE WITH STANDARDS

The drainage design presented within this report conforms to the El Paso County Drainage Criteria Manual, El Paso Engineering Criteria Manual, and the Mile High Flood District Urban Storm Drainage Criteria Manual. Additionally, the single-family residential development is not anticipated to adversely affect the downstream and surrounding developments or waterways.

REFERENCES

1. El Paso County Drainage Criteria Manual, Vol. 1 and 2, October 1994.
2. City of Colorado Springs Drainage Criteria Manual, May 2014, Revised 2021.
3. El Paso County Engineering Criteria Manual, December 2004, Revised 2016
4. Mile High Flood District Drainage Criteria Manual (MHFDCM), Vol. 1, prepared by Wright-McLaughlin Engineers, June 2001, with latest revisions.
5. Flood Insurance Rate Map, El Paso County, Colorado and Incorporated Areas, Map Number 08041C0809G Effective Date December 7, 2018, prepared by the Federal Emergency Management Agency (FEMA).

APPENDIX

SOIL STUDY

United States Department of Agriculture

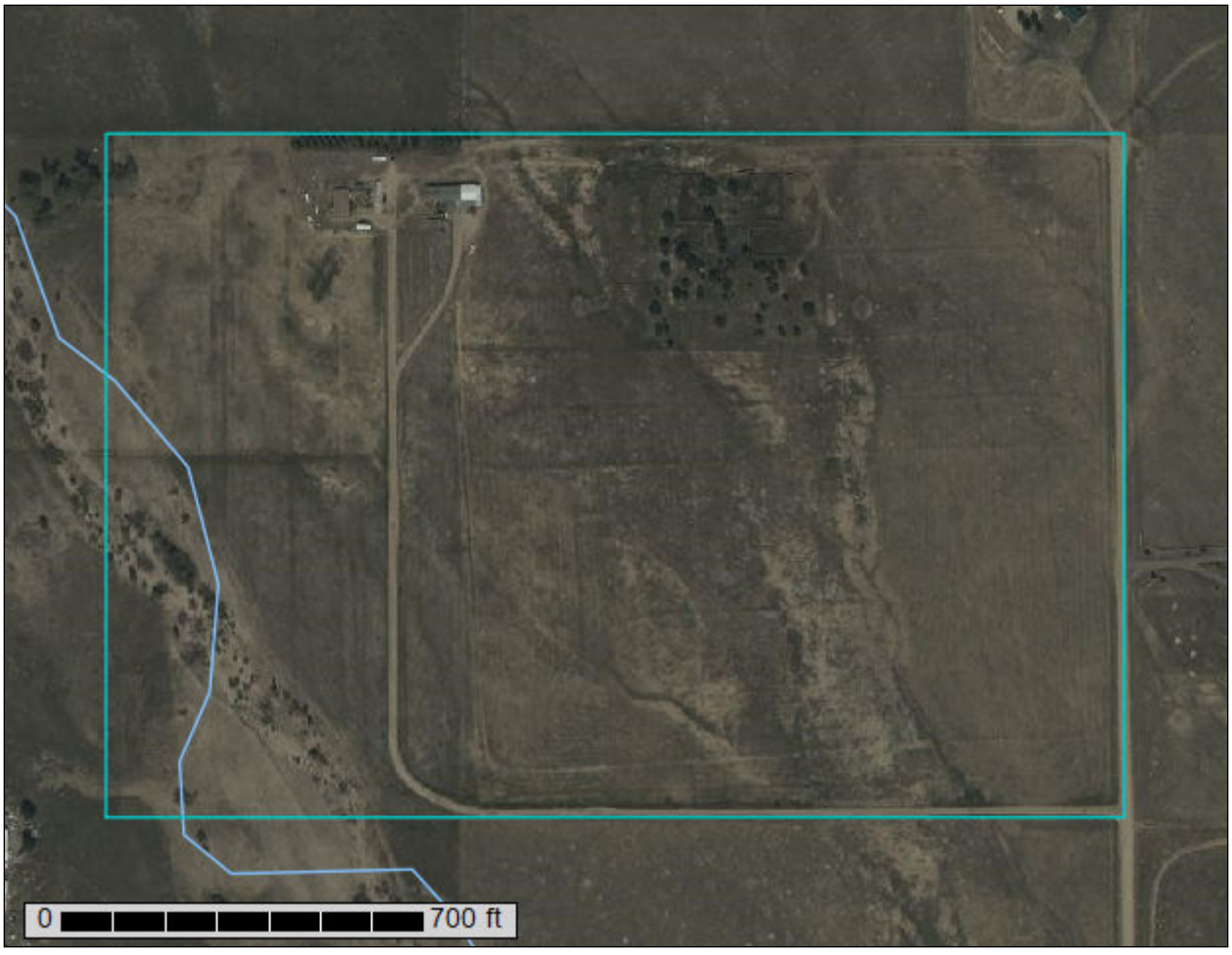
NRCS

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

Kristin Estates



March 14, 2025

Contents

How Soil Surveys Are Made

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

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

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

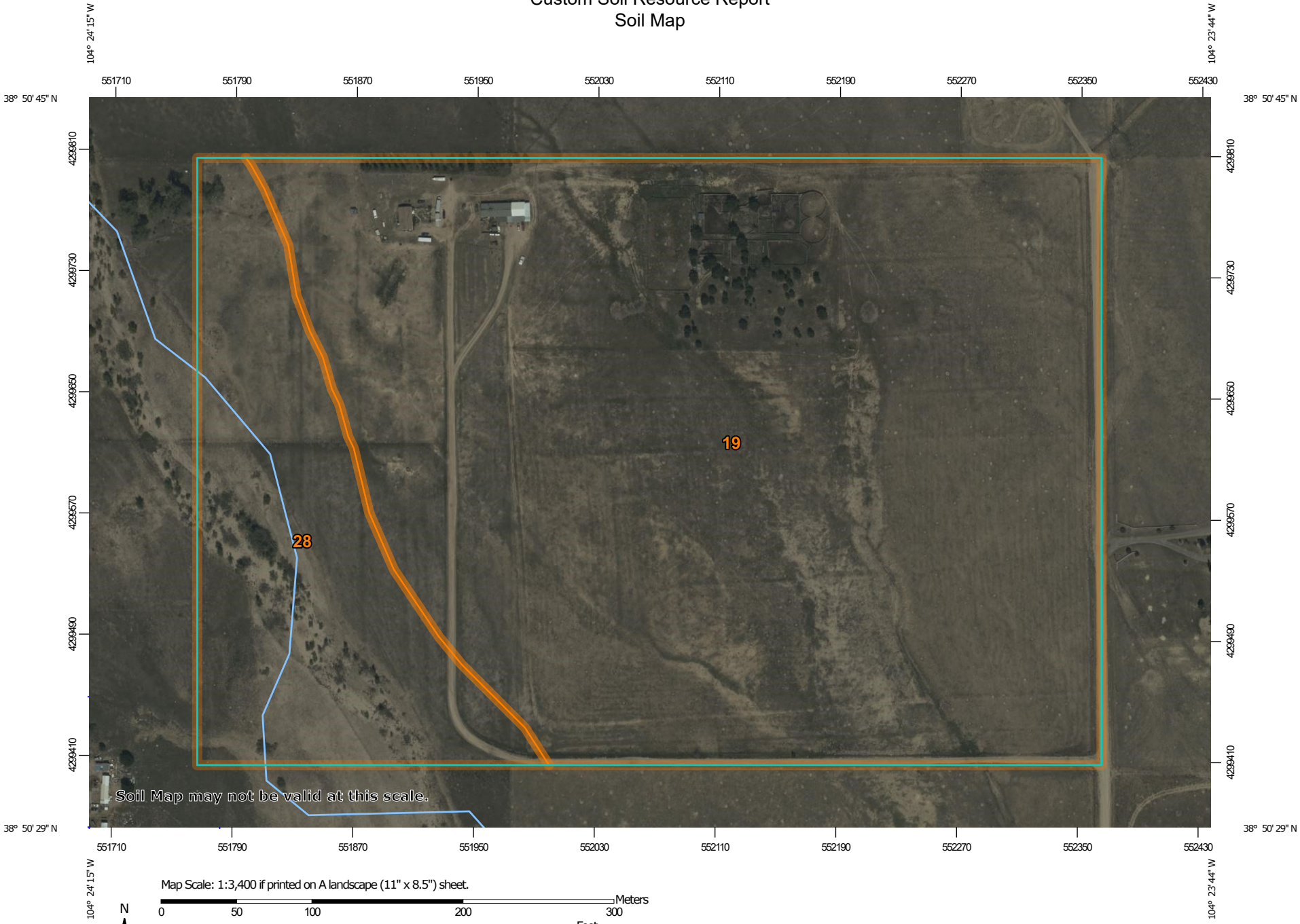
Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations,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

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

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: 1:3,400 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 150 300 600 900

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: El Paso County Area, Colorado
Survey Area Data: Version 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: Sep 11, 2018—Oct 20, 2018

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
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	48.2	80.9%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	11.4	19.1%
Totals for Area of Interest		**59.6**	**100.0%**

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

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

El Paso County Area, Colorado

19—Columbine gravelly sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 367p
Elevation: 6,500 to 7,300 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Columbine and similar soils: 97 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Columbine

Setting

Landform: Fans, fan terraces, flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 14 inches: gravelly sandy loam
C - 14 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 2.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R049XY214CO - Gravelly Foothill
Hydric soil rating: No

Minor Components

Fluvaquentic haplaquolls

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

Other soils

Percent of map unit: 1 percent
Hydric soil rating: No

Pleasant

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

28—Ellicott loamy coarse sand, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 3680
Elevation: 5,500 to 6,500 feet
Mean annual precipitation: 13 to 15 inches
Mean annual air temperature: 47 to 50 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Ellicott and similar soils: 97 percent
Minor components: 3 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ellicott

Setting

Landform: Stream terraces, flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium

Typical profile

A - 0 to 4 inches: loamy coarse sand
C - 4 to 60 inches: stratified coarse sand to sandy loam

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Frequent
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: A
Ecological site: R069XY031CO - Sandy Bottomland
Other vegetative classification: SANDY BOTTOMLAND (069AY031CO)
Hydric soil rating: No

Minor Components

Fluvaquentic haplaquoll
Percent of map unit: 1 percent
Landform: Swales
Hydric soil rating: Yes

Other soils
Percent of map unit: 1 percent
Hydric soil rating: No

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

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Erosion Factors

Soil Erosion Factors are soil properties and interpretations used in evaluating the soil for potential erosion. Example soil erosion factors can include K factor for the whole soil or on a rock free basis, T factor, wind erodibility group and wind erodibility index.

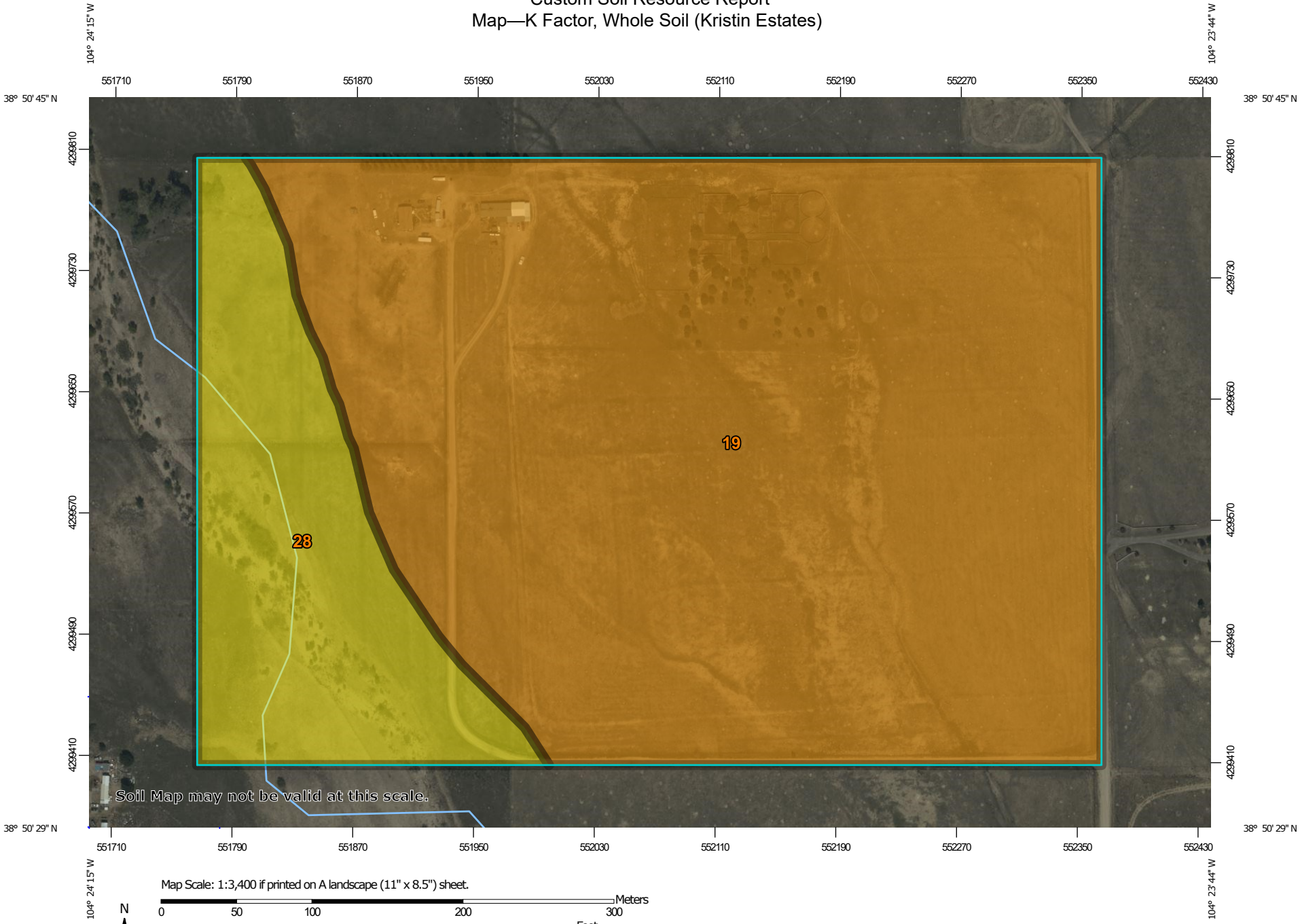
K Factor, Whole Soil (Kristin Estates)

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kw (whole soil)" indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Factor K does not apply to organic horizons and is not reported for those layers.

Custom Soil Resource Report
Map—K Factor, Whole Soil (Kristin Estates)



Map Scale: 1:3,400 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 150 300 600 900

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Soil Rating Lines

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Soil Rating Points

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
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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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: Sep 11, 2018—Oct 20, 2018

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Table—K Factor, Whole Soil (Kristin Estates)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	.10	48.2	80.9%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	.17	11.4	19.1%
Totals for Area of Interest			**59.6**	**100.0%**

Rating Options—K Factor, Whole Soil (Kristin Estates)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

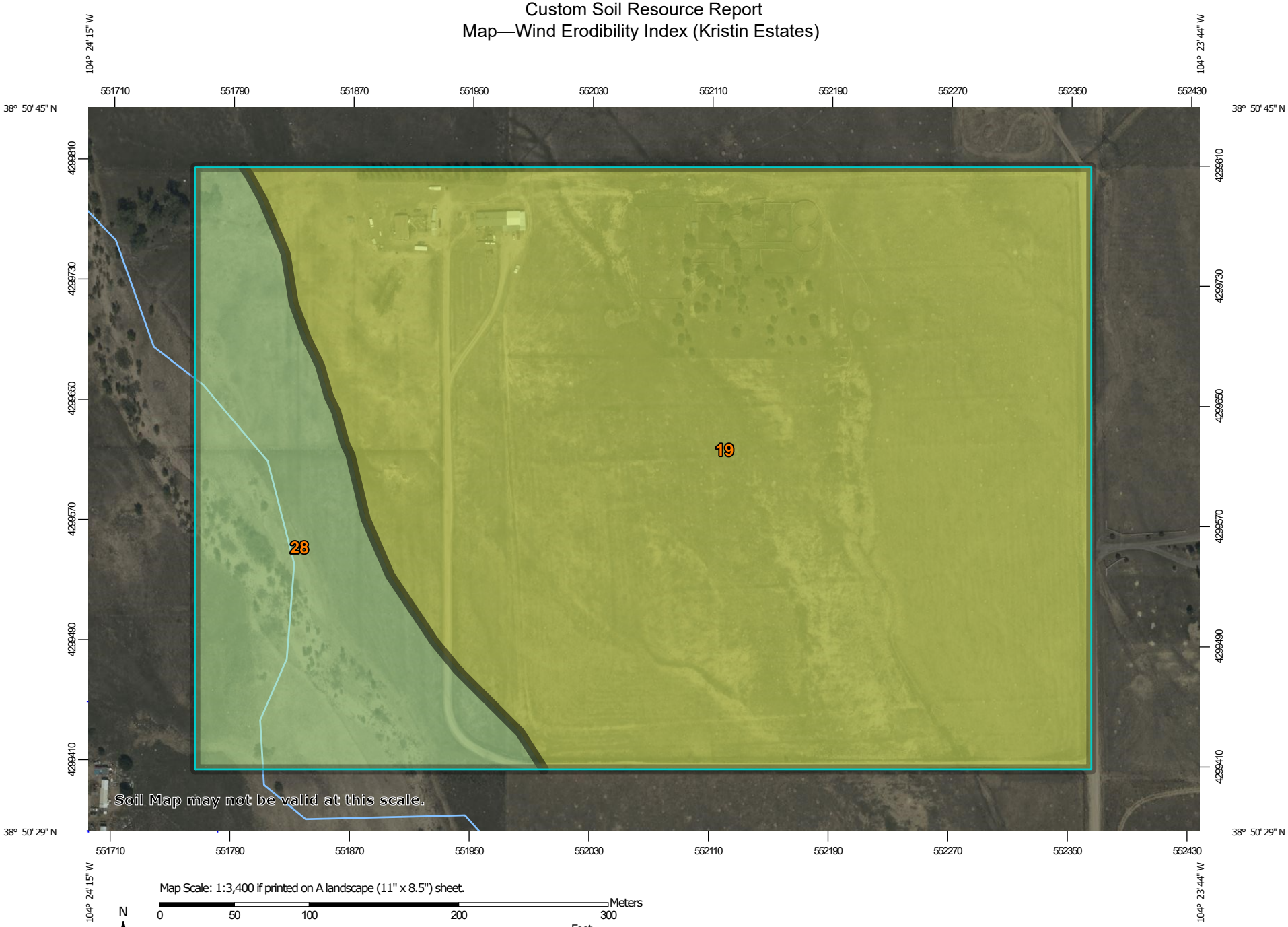
Tie-break Rule: Higher

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Wind Erodibility Index (Kristin Estates)

The wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Custom Soil Resource Report
Map—Wind Erodibility Index (Kristin Estates)



Map Scale: 1:3,400 if printed on A landscape (11" x 8.5") sheet.

N

0 50 100 200 300 Meters

0 150 300 600 900 Feet

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

0
38
48
56
86
134
160
180
220
250
310
Not rated or not available

Soil Rating Lines

0
38
48
56
86
134
160
180
220
250
310
Not rated or not available

Soil Rating Points

0
38
48
56
86
134
160
180
220
250
310
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

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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.

Table—Wind Erodibility Index (Kristin Estates)

Map unit symbol	Map unit name	Rating (tons per acre per year)	Acres in AOI	Percent of AOI
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	86	48.2	80.9%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	134	11.4	19.1%
Totals for Area of Interest			**59.6**	**100.0%**

Rating Options—Wind Erodibility Index (Kristin Estates)

Units of Measure: tons per acre per year

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group (Kristin Estates)

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

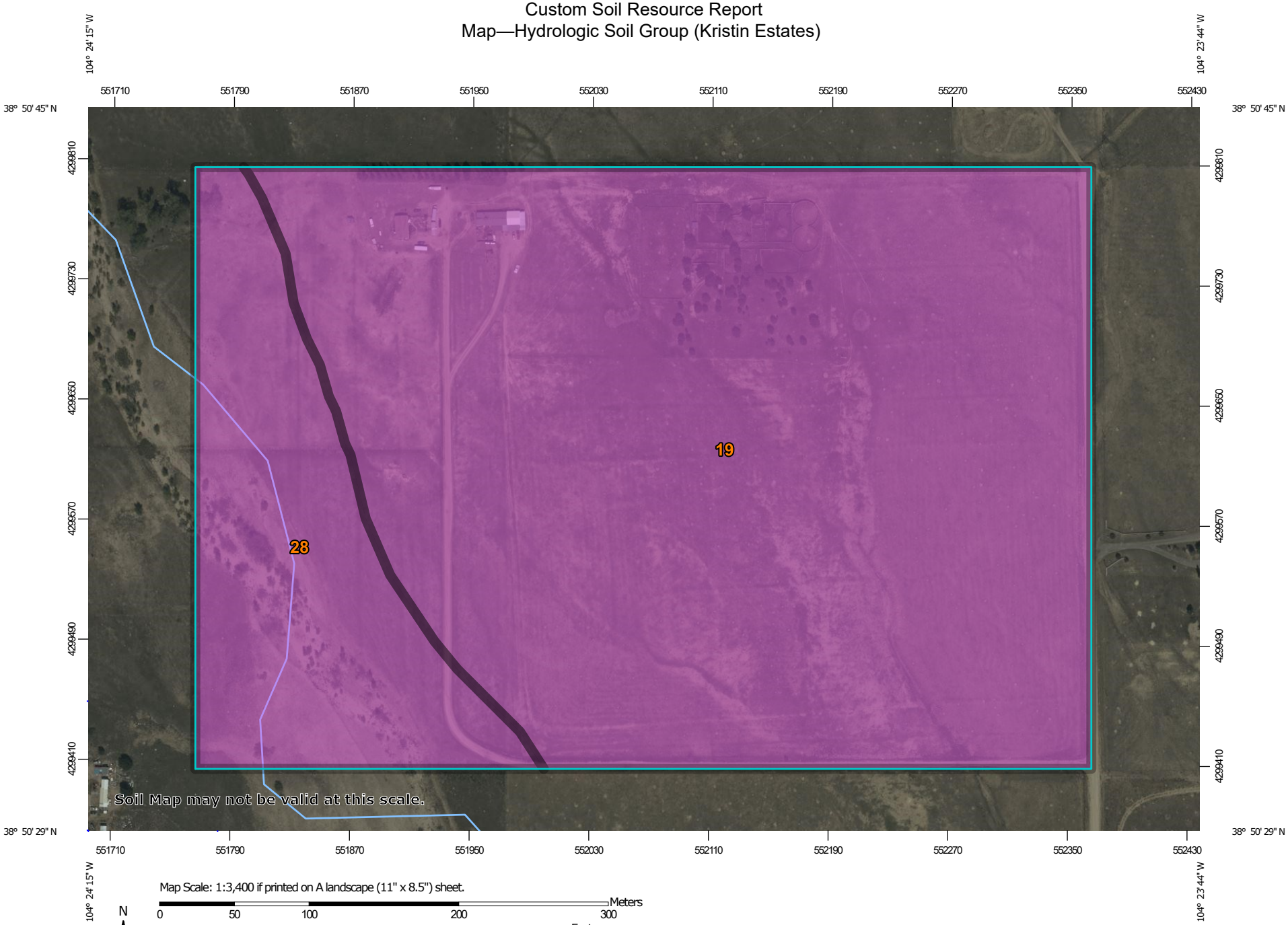
soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

Custom Soil Resource Report
Map—Hydrologic Soil Group (Kristin Estates)



Map Scale: 1:3,400 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 150 300 600 900

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

Date(s) aerial images were photographed: Sep 11, 2018—Oct 20, 2018

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.

Table—Hydrologic Soil Group (Kristin Estates)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	A	48.2	80.9%
28	Ellicott loamy coarse sand, 0 to 5 percent slopes	A	11.4	19.1%
Totals for Area of Interest			**59.6**	**100.0%**

Rating Options—Hydrologic Soil Group (Kristin Estates)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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FEMA FIRM PANEL & FIRMETTES

National Flood Hazard Layer FIRMette

FEMA

104°24'24"W 38°50'58"N

104°23'46"W 38°50'30"N

Feet

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

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

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

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

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

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

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

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface 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

N

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

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

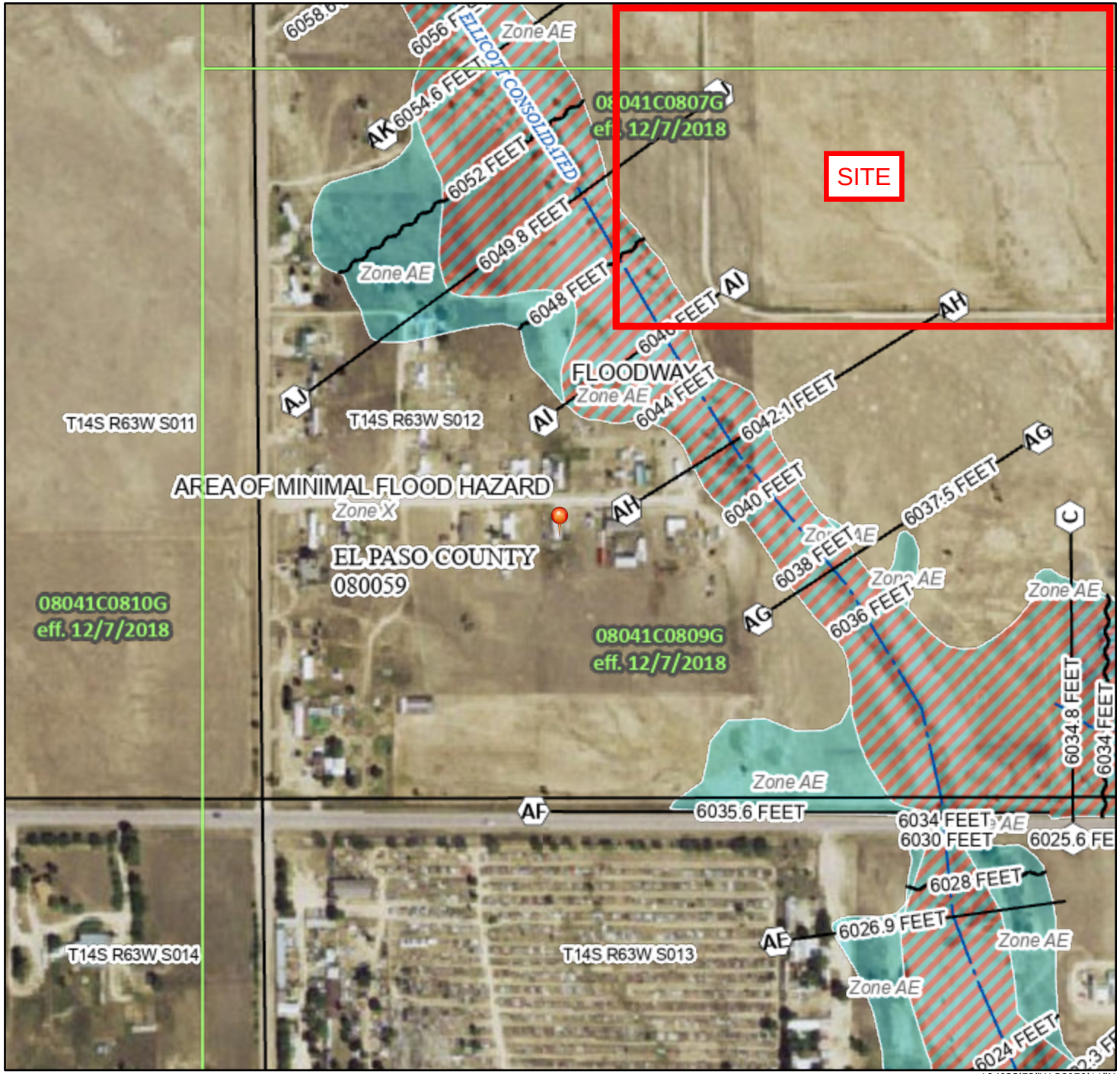
The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/7/2025 at 4:29 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new 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.

National Flood Hazard Layer FIRMette

FEMA

104°24'29"W 38°50'39"N



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

1:6,000

104°23'52"W 38°50'11"N

Basemap Imagery Source: USGS National Map 2023

Legend

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

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

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

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NOTES TO USERS

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Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

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Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

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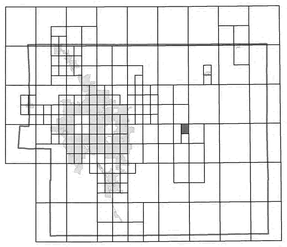
If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)

REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION

Panel Location Map



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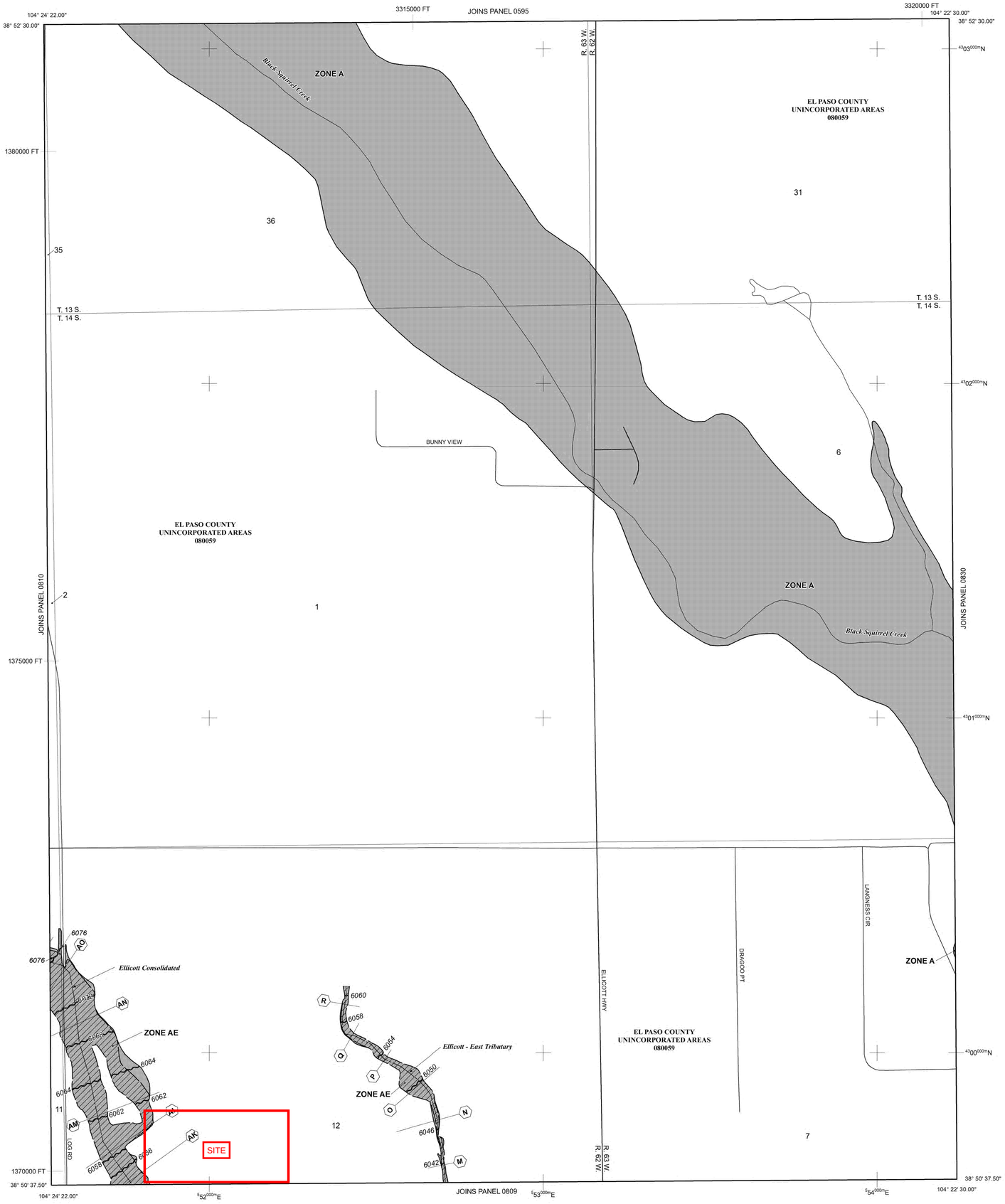

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.
ZONE AE Base Flood Elevations determined.
ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
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ZONE AR Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513 — Base Flood Elevation line and value; elevation in feet*
(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A — Cross section line
23 — 23 — Transect line
97° 07' 30.00" / 32° 22' 30.00" — Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN — 1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT — 5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 — Bench mark (see explanation in Notes to Users section of this FIRM panel)
M1.5 — River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

PANEL 0807G

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 807 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0807	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
08041C0807G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

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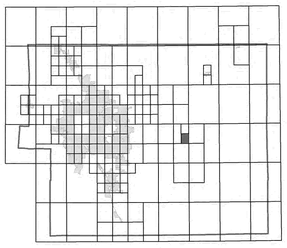

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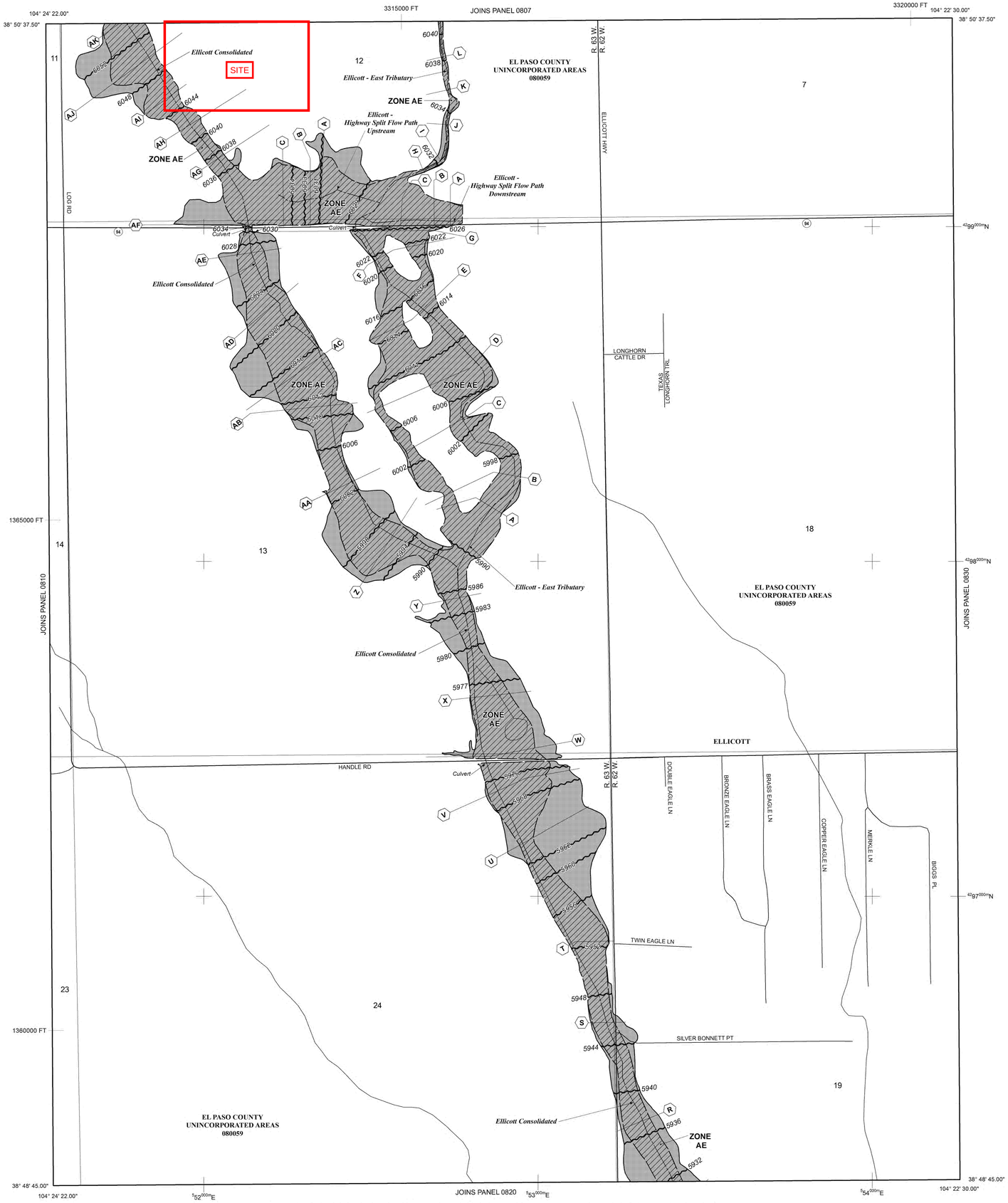

NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 14 SOUTH, RANGE 62 WEST, AND TOWNSHIP 14 SOUTH, RANGE 63 WEST.

LEGEND

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ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

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MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

PANEL 0809G

MAP REVISED TO REFLECT LOMR(S) EFFECTIVE PRIOR TO DECEMBER 7, 2018

FIRM

FLOOD INSURANCE RATE MAP

EL PASO COUNTY, COLORADO AND INCORPORATED AREAS

PANEL 809 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
EL PASO COUNTY	080059	0809	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 08041C0809G

MAP REVISED DECEMBER 7, 2018

Federal Emergency Management Agency

HYDROLOGIC CALCULATIONS

Weighted Imperviousness Calculations: Existing Conditions

SUB-BASIN	AREA (SF)	AREA (Acres)	SOIL TYPE	LANDSCAPE AREA	LANDSCAPE IMP.	LANDSCAPE C2	LANDSCAPE C5	LANDSCAPE C10	LANDSCAPE C100	GRAVEL AREA	GRAVEL IMP.	GRAVEL C2	GRAVEL C5	GRAVEL C10	GRAVEL C100	ROOF AREA	ROOF IMP.	ROOF C2	ROOF C5	ROOF C10	ROOF C100	RESIDENTIAL AREA	RESIDENTIAL IMP.	RESIDENTIAL C2	RESIDENTIAL C5	RESIDENTIAL C10	RESIDENTIAL C100	WEIGHTED IMP.	WEIGHTED COEFFICIENTS C2	WEIGHTED COEFFICIENTS C5	WEIGHTED COEFFICIENTS C10	WEIGHTED COEFFICIENTS C100
E1	422,402	9.70	A	422,402	0%	0.02	0.08	0.15	0.35	0	80%	0.57	0.59	0.63	0.70	0	90%	0.71	0.73	0.75	0.81	0	7%	0.89	0.90	0.92	0.92	0.0%	0.02	0.08	0.15	0.35
E2	863,671	19.83	A	808,478	0%	0.02	0.08	0.15	0.35	50,655	80%	0.57	0.59	0.63	0.70	4,538	90%	0.71	0.73	0.75	0.81	0	7%	0.89	0.90	0.92	0.92	5.2%	0.06	0.11	0.18	0.37
E3	871,495	20.01	A	850,933	0%	0.02	0.08	0.15	0.35	16,024	80%	0.57	0.59	0.63	0.70	4,538	90%	0.71	0.73	0.75	0.81	0	7%	0.89	0.90	0.92	0.92	1.9%	0.03	0.09	0.16	0.36
E4	456,263	10.47	A	423,366	0%	0.02	0.08	0.15	0.35	32,898	80%	0.57	0.59	0.63	0.70	0	90%	0.71	0.73	0.75	0.81	0	7%	0.89	0.90	0.92	0.92	5.8%	0.06	0.12	0.18	0.38
OE1	1,306,891	30.00	A	1,260,143	0%	0.02	0.08	0.15	0.35	45,248	80%	0.57	0.59	0.63	0.70	1,500	90%	0.71	0.73	0.75	0.81	0	7%	0.89	0.90	0.92	0.92	2.9%	0.04	0.10	0.17	0.36
OE3	4,219,495	96.87	A	4,144,389	0%	0.02	0.08	0.15	0.35	73,606	80%	0.57	0.59	0.63	0.70	1,500	90%	0.71	0.73	0.75	0.81	0	7%	0.89	0.90	0.92	0.92	1.4%	0.03	0.09	0.16	0.36
OE4	487,774	11.20	A	472,787	0%	0.02	0.08	0.15	0.35	10,487	80%	0.57	0.59	0.63	0.70	4,500	90%	0.71	0.73	0.75	0.81	0	7%	0.89	0.90	0.92	0.92	2.6%	0.04	0.10	0.17	0.36
OE5	376,612	8.65	A	376,612	0%	0.02	0.08	0.15	0.35	0	80%	0.57	0.59	0.63	0.70	0	90%	0.71	0.73	0.75	0.81	0	7%	0.89	0.90	0.92	0.92	0.0%	0.02	0.08	0.15	0.35
OE6	81,424	1.87	A	55,028	0%	0.02	0.08	0.15	0.35	26,396	80%	0.57	0.59	0.63	0.70	0	90%	0.71	0.73	0.75	0.81	0	7%	0.89	0.90	0.92	0.92	25.9%	0.20	0.25	0.31	0.46
Total	9,086,028	208.59		8,814,138	0%					255,314	80%					16,576	90%					0	7%					2.4%				
Total Onsite (E1-E4)	2,613,832	60.01		2,505,179	0%					99,577	80%					9,076	90%					0	7%					3.4%				

Kristin Estates
Existing Runoff Calculations
Time of Concentration

Watercourse Coefficient

Forest & Meadow	2.50	ort Grass Pasture & Lawns	7.00	Grassed Waterway	15.00
Fallow or Cultivation	5.00	Nearly Bare Ground	10.00	Paved Area & Shallow Gutter	20.00

SUB-BASIN DATA					INITIAL / OVERLAND TIME			TRAVEL TIME T(t)					T(c) CHECK (URBANIZED BASINS)			FINAL T(c)
DESIGN POINT	DRAINAGE BASIN	AREA sq. ft.	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	TOTAL LENGTH	L/180+10	min.
E1	E1	422,402	9.70	0.08	300	1.8%	26.6	1138	1.5%	7.00	0.9	22.1	48.7	1438	18.0	18.0
E2	E2	863,671	19.83	0.11	300	3.0%	21.7	1617	1.2%	7.00	0.8	35.1	56.8	1917	20.7	20.7
E3	E3	871,495	20.01	0.09	300	1.6%	27.3	1785	1.4%	7.00	0.8	35.9	63.2	2085	21.6	21.6
E4	E4	456,263	10.47	0.12	300	1.3%	28.6	1229	1.0%	7.00	0.7	29.3	57.9	1529	18.5	18.5
OE1	OE1	1,306,891	30.00	0.10	300	3.0%	22.0	2293	1.0%	7.00	0.7	54.6	76.6	2593	24.4	24.4
OE3	OE3	4,219,495	96.87	0.09	300	1.8%	26.4	2795	1.0%	7.00	0.7	66.5	92.9	3095	27.2	27.2
OE4	OE4	487,774	11.20	0.10	300	1.3%	29.1	1378	1.2%	7.00	0.8	30.0	59.1	1678	19.3	19.3
OE5	OE5	376,612	8.65	0.08	300	2.0%	25.9	645	1.5%	7.00	0.8	12.7	38.6	945	15.3	15.3
OE6	OE6	81,424	1.87	0.25	100	0.5%	19.7	1195	0.9%	10.00	0.9	21.4	41.1	1295	17.2	17.2

Kristin Estates
Existing Runoff Calculations *Design Storm* *5 Year*
(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAINAGE BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
E1	E1	9.70	0.08	18.0	0.78	3.25	2.52	24.4	3.73	2.79	10.41	OE1 is tributary to E1. E1 is not tributary to the proposed pond.
E2	E2	19.83	0.11	20.7	2.25	3.04	6.83					
E3	E3	20.01	0.09	21.6	1.86	2.97	5.52	27.2	10.5	2.63	27.57	OE3 is tributary to E3
E4	E4	10.47	0.12	18.5	1.22	3.21	3.92	18.5	1.7	3.21	5.39	OE4 is tributary to E4
OE1	OE1	30.00	0.10	24.4	2.95	2.79	8.24					
OE3	OE3	96.87	0.09	27.2	8.63	2.63	22.69					
OE4	OE4	11.20	0.10	19.3	1.09	3.14	3.41					
OE5	OE5	8.65	0.08	15.3	0.69	3.49	2.41					
OE6	OE6	1.87	0.25	17.2	0.46	3.32	1.52					

Kristin Estates
Existing Runoff Calculations *Design Storm* *100 Year*
(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAINAGE BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
E1	E1	9.70	0.35	18.0	3.39	5.45	18.50	24.4	14.27	4.68	66.87	OE1 is tributary to E1. E1 is not tributary to the proposed pond.
E2	E2	19.83	0.37	20.7	7.39	5.10	37.70					
E3	E3	20.01	0.36	21.6	7.18	4.99	35.84	27.2	41.7	4.41	183.89	OE3 is trubutary to E3
E4	E4	10.47	0.38	18.5	3.93	5.38	21.15	18.5	4.8	5.38	25.82	OE4 is trubutary to E4
OE1	OE1	30.00	0.36	24.4	10.88	4.68	50.97					
OE3	OE3	96.87	0.36	27.2	34.51	4.41	152.22					
OE4	OE4	11.20	0.36	19.3	4.05	5.28	21.37					
OE5	OE5	8.65	0.35	15.3	3.03	5.86	17.74					
OE6	OE6	1.87	0.46	17.2	0.87	5.57	4.82					

SUMMARY - EXISTING RUNOFF TABLE						
DESIGN POINT	SUB-BASIN	AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)	WEIGHTED COEFF. (C100)	IMP. (%)
On-Site Basins						
E1	E1	9.70	2.52	18.50	0.35	0.0%
E2	E2	19.83	6.83	37.70	0.37	5.2%
E3	E3	20.01	5.52	35.84	0.36	1.9%
E4	E4	10.47	3.92	21.15	0.38	5.8%
Off-Site Basins						
OE1	OE1	30.00	8.24	50.97	0.36	2.9%
OE3	OE3	96.87	22.69	152.22	0.36	1.4%
OE4	OE4	11.20	3.41	21.37	0.36	2.6%
OE5	OE5	8.65	2.41	17.74	0.35	0.0%
OE6	OE6	1.87	1.52	4.82	0.46	25.9%
OE1+E1	CUMULATIVE		10.41	66.87		
OE3+E3	CUMULATIVE		27.57	183.89		
OE4+E4	CUMULATIVE		5.39	25.82		
TOTAL CUMULATIVE FLOW			54.13	336.84		

Weighted Imperviousness Calculations: Proposed Conditions

SUB-BASIN	AREA (SF)	AREA (Acres)	SOIL TYPE	LANDSCAPE AREA	LANDSCAPE IMP.	LANDSCAPE C2	LANDSCAPE C5	LANDSCAPE C10	LANDSCAPE C100	GRAVEL AREA	GRAVEL IMP.	GRAVEL C2	GRAVEL C5	GRAVEL C10	GRAVEL C100	ROOF AREA	ROOF IMP.	ROOF C2	ROOF C5	ROOF C10	ROOF C100	RESIDENTIAL AREA	RESIDENTIAL IMP.	RESIDENTIAL (> 5 AC) C2	RESIDENTIAL (> 5 AC) C5	RESIDENTIAL (> 5 AC) C10	RESIDENTIAL (> 5 AC) C100	WEIGHTED IMP.	WEIGHTED COEFFICIENTS C2	WEIGHTED COEFFICIENTS C5	WEIGHTED COEFFICIENTS C10	WEIGHTED COEFFICIENTS C100
P1	422,402	9.70	A	0	0%	0.02	0.08	0.15	0.35	0	80%	0.57	0.59	0.63	0.70	0	90%	0.71	0.73	0.75	0.81	422,402	7%	0.05	0.12	0.20	0.39	7.0%	0.05	0.12	0.20	0.39
P2	1,103,073	25.32	A	21,759	0%	0.02	0.08	0.15	0.35	26,934	80%	0.57	0.59	0.63	0.70	0	90%	0.71	0.73	0.75	0.81	1,054,380	7%	0.05	0.12	0.20	0.39	8.6%	0.06	0.13	0.21	0.40
P3	720,205	16.53	A	14,862	0%	0.02	0.08	0.15	0.35	18,585	80%	0.57	0.59	0.63	0.70	0	90%	0.71	0.73	0.75	0.81	686,758	7%	0.05	0.12	0.20	0.39	8.7%	0.06	0.13	0.21	0.40
P4	253,117	5.81	A	4,514	0%	0.02	0.08	0.15	0.35	5,330	80%	0.57	0.59	0.63	0.70	0	90%	0.71	0.73	0.75	0.81	243,273	7%	0.05	0.12	0.20	0.39	8.4%	0.06	0.13	0.21	0.40
P5	69,872	1.60	A	43,483	0%	0.02	0.08	0.15	0.35	26,389	80%	0.57	0.59	0.63	0.70	0	90%	0.71	0.73	0.75	0.81	0	7%	0.05	0.12	0.20	0.39	30.2%	0.23	0.27	0.33	0.48
P6	45,164	1.04	A	0	0%	0.02	0.08	0.15	0.35	0	80%	0.57	0.59	0.63	0.70	0	90%	0.71	0.73	0.75	0.81	45,164	7%	0.05	0.12	0.20	0.39	7.0%	0.05	0.12	0.20	0.39
OP1	1,306,891	30.00	A	1,260,143	0%	0.02	0.08	0.15	0.35	45,248	80%	0.57	0.59	0.63	0.70	1,500	90%	0.71	0.73	0.75	0.81	0	7%	0.05	0.12	0.20	0.39	2.9%	0.04	0.10	0.17	0.36
OP3	4,219,495	96.87	A	4,144,389	0%	0.02	0.08	0.15	0.35	73,606	80%	0.57	0.59	0.63	0.70	1,500	90%	0.71	0.73	0.75	0.81	0	7%	0.05	0.12	0.20	0.39	1.4%	0.03	0.09	0.16	0.36
OP4	487,774	11.20	A	472,787	0%	0.02	0.08	0.15	0.35	10,487	80%	0.57	0.59	0.63	0.70	4,500	90%	0.71	0.73	0.75	0.81	0	7%	0.05	0.12	0.20	0.39	2.6%	0.04	0.10	0.17	0.36
OP5	376,612	8.65	A	376,612	0%	0.02	0.08	0.15	0.35	0	80%	0.57	0.59	0.63	0.70	0	90%	0.71	0.73	0.75	0.81	0	7%	0.05	0.12	0.20	0.39	0.0%	0.02	0.08	0.15	0.35
OP6	81,424	1.87	A	39,499	0%	0.02	0.08	0.15	0.35	41,925	80%	0.57	0.59	0.63	0.70	0	90%	0.71	0.73	0.75	0.81	0	7%	0.05	0.12	0.20	0.39	41.2%	0.30	0.34	0.40	0.53
Total	9,086,029	208.59		6,378,048	0%					248,504	80%					7,500	90%					2,451,977	7%					4.2%				
Total Onsite (P1-P6)	2,613,833	60.01		84,618	0%					77,238	80%					0	90%					2,451,977	7%					8.9%				
Pond Total (P2-P4, OP3-OP4)	6,783,664	155.73		4,658,311	0%					134,942	80%					6,000	90%					1,984,411	7%					3.7%				

Kristen Estates
Proposed Runoff Calculations
Time of Concentration

Watercourse Coefficient

Forest & Meadow	2.50	ort Grass Pasture & Lawns	7.00	Grassed Waterway	15.00
Fallow or Cultivation	5.00	Nearly Bare Ground	10.00	Paved Area & Shallow Gutter	20.00

SUB-BASIN DATA					INITIAL / OVERLAND TIME			TRAVEL TIME T(t)					T(c) CHECK (URBANIZED BASINS)			FINAL T(c)
DESIGN POINT	DRAINAGE BASIN	AREA sq. ft.	AREA ac.	C(5)	Length ft.	Slope %	T(i) min	Length ft.	Slope %	Coeff.	Velocity fps	T(t) min.	COMP. T(c)	TOTAL LENGTH	L/180+10	min.
P1	P1	422,402	9.70	0.12	300	1.8%	25.5	1138	1.5%	7.00	0.9	22.1	47.6	1438	18.0	18.0
P2	P2	1,103,073	25.32	0.13	300	1.5%	26.9	1617	1.2%	7.00	0.8	35.1	62.0	1917	20.7	20.7
P3	P3	720,205	16.53	0.13	300	1.4%	27.5	1785	1.0%	15.00	1.5	19.8	47.3	2085	21.6	21.6
P4	P4	253,117	5.81	0.13	300	1.4%	27.5	1229	0.8%	15.00	1.3	15.3	42.8	1529	18.5	18.5
P5	P5	69,872	1.60	0.27	130	0.9%	17.9	1071	0.9%	10.00	1.0	18.4	36.3	1201.2	16.7	16.7
P6	P6	45,164	1.04	0.12	50	1.2%	11.9	400	1.2%	7.00	0.8	8.7	20.6	450	12.5	12.5
OP1	OP1	1,306,891	30.00	0.10	300	3.0%	22.0	2293	1.0%	7.00	0.7	54.6	76.6	2593	24.4	24.4
OP3	OP3	4,219,495	96.87	0.09	300	1.0%	32.1	3000	1.0%	7.00	0.7	71.4	103.5	3300	28.3	28.3
OP4	OP4	487,774	11.20	0.10	300	1.3%	29.1	1378	1.2%	7.00	0.8	30.0	59.1	1678	19.3	19.3
OP5	OP5	376,612	8.65	0.08	300	2.0%	25.7	645	1.5%	7.00	0.9	12.5	38.2	945	15.3	15.3
OP6	OP6	81,424	1.87	0.34	100	0.5%	17.5	1195	0.9%	10.00	0.9	21.0	38.5	1295	17.2	17.2

Kristen Estates
Proposed Runoff Calculations *Design Storm* *5 Year*
(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAINAGE BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
P1	P1	9.70	0.12	18.0	1.16	3.25	3.78	24.4	4.12	2.79	11.49	OP1 is tributary to P1. P1 is not tributary to the proposed Pond.
P2	P2	25.32	0.13	20.7	3.31	3.04	10.05					
P3	P3	16.53	0.13	21.6	2.17	2.97	6.46	28.3	10.8	2.57	27.75	OP3 is tributary to P3
P4	P4	5.81	0.13	18.5	0.75	3.21	2.41	18.5	1.4	3.21	4.46	OP4 is tributary to P4
P5	P5	1.60	0.27	16.7	0.44	3.36	1.47					
P6	P6	1.04	0.12	12.5	0.12	3.79	0.47					
OP1	OP1	30.00	0.10	24.4	2.95	2.79	8.24					
OP3	OP3	96.87	0.09	28.3	8.63	2.57	22.18					
OP4	OP4	11.20	0.10	19.3	1.09	3.14	3.41					
OP5	OP5	8.65	0.08	15.3	0.69	3.49	2.41					
OP6	OP6	1.87	0.34	17.2	0.64	3.32	2.12					

Kristen Estates
Proposed Runoff Calculations *Design Storm* *100 Year*
(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAINAGE BASIN	AREA ac.	RUNOFF COEFF	T(c) min	C x A	I in/hr	Q cfs	T(c) min	C x A	I in/hr	Q cfs	
P1	P1	9.70	0.39	18.0	3.78	5.45	20.62	24.4	14.66	4.68	68.69	OP1 is tributary to P1. P1 is not tributary to the proposed Pond.
P2	P2	25.32	0.40	20.7	10.05	5.10	51.23					
P3	P3	16.53	0.40	21.6	6.57	4.99	32.78	28.3	41.1	4.31	177.08	OP3 is tributary to P3
P4	P4	5.81	0.40	18.5	2.30	5.38	12.38	18.5	3.3	5.38	17.71	OP4 is tributary to P4
P5	P5	1.60	0.48	16.7	0.77	5.64	4.36					
P6	P6	1.04	0.39	12.5	0.40	6.37	2.58					
OP1	OP1	30.00	0.36	24.4	10.88	4.68	50.97					
OP3	OP3	96.87	0.36	28.3	34.51	4.31	148.77					
OP4	OP4	11.20	0.36	19.3	4.05	5.28	21.37					
OP5	OP5	8.65	0.35	15.3	3.03	5.86	17.74					
OP6	OP6	1.87	0.53	17.2	0.99	5.57	5.52					

SUMMARY - PROPOSED RUNOFF TABLE						
DESIGN POINT	SUB-BASIN	AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)	WEIGHTED COEFF. (C100)	IMP. (%)
On-Site Basins						
P1	P1	9.70	3.78	20.62	0.39	7.0%
P2	P2	25.32	10.05	51.23	0.40	8.6%
P3	P3	16.53	6.46	32.78	0.40	8.7%
P4	P4	5.81	2.41	12.38	0.40	8.4%
P5	P5	1.60	1.47	4.36	0.48	30.2%
P6	P6	1.04	0.47	2.58	0.39	7.0%
Off-Site Basins						
OP1	OP1	30.00	8.24	50.97	0.36	2.9%
OP3	OP3	96.87	22.18	148.77	0.36	1.4%
OP4	OP4	11.20	3.41	21.37	0.36	2.6%
OP5	OP5	8.65	2.41	17.74	0.35	0.0%
OP6	OP6	1.87	2.12	5.52	0.53	41.2%
OP1+P1	CUMULATIVE		11.49	68.69		
OP3+P3	CUMULATIVE		27.75	177.08		
OP4+E4	CUMULATIVE		4.46	17.71		
TOTAL CUMULATIVE FLOW			60.23	344.91		

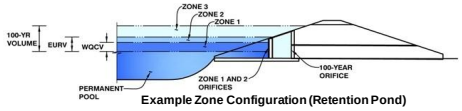
HYDRAULIC CALCULATIONS

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Kristen Estates

Basin ID: Overall Pond Design (WQCV Override)



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	156.00	acres
Watershed Length =	4,420	ft
Watershed Length to Centroid =	1,210	ft
Watershed Slope =	0.015	ft/ft
Watershed Imperviousness =	3.70%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.032	acre-feet	0.032	acre-feet
Excess Urban Runoff Volume (EURV) =	0.321	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.162	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.302	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.424	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	2.250	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	4.263	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	7.040	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	13.462	acre-feet		inches
Approximate 2-yr Detention Volume =	0.184	acre-feet		
Approximate 5-yr Detention Volume =	0.259	acre-feet		
Approximate 10-yr Detention Volume =	0.358	acre-feet		
Approximate 25-yr Detention Volume =	0.516	acre-feet		
Approximate 50-yr Detention Volume =	0.941	acre-feet		
Approximate 100-yr Detention Volume =	2.149	acre-feet		

See WQCV for override calculations provided in this document

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.032	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.289	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.828	acre-feet
Total Detention Basin Volume =	2.149	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	

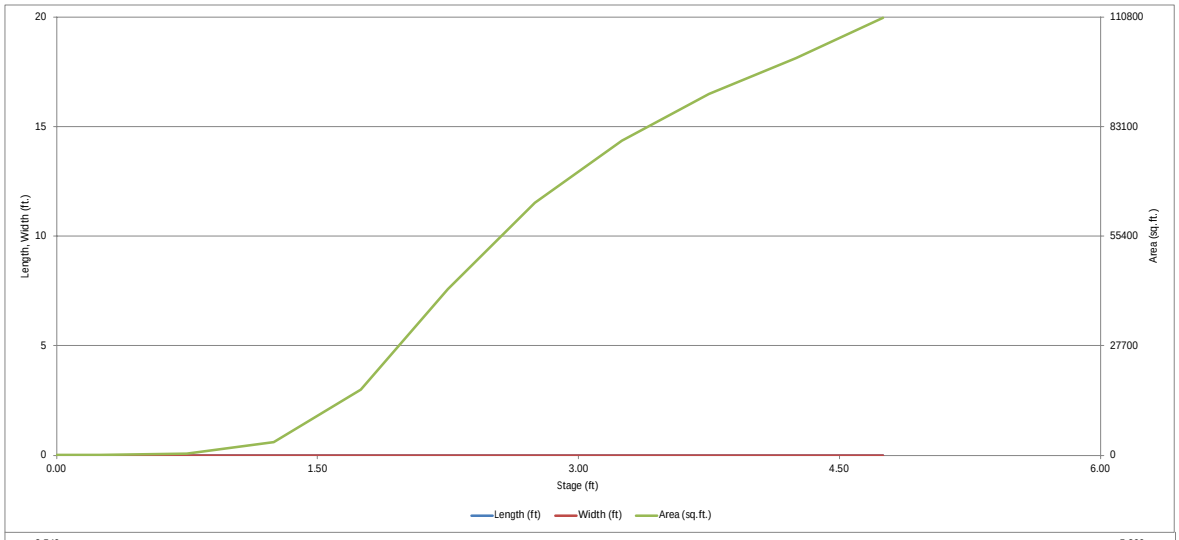
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

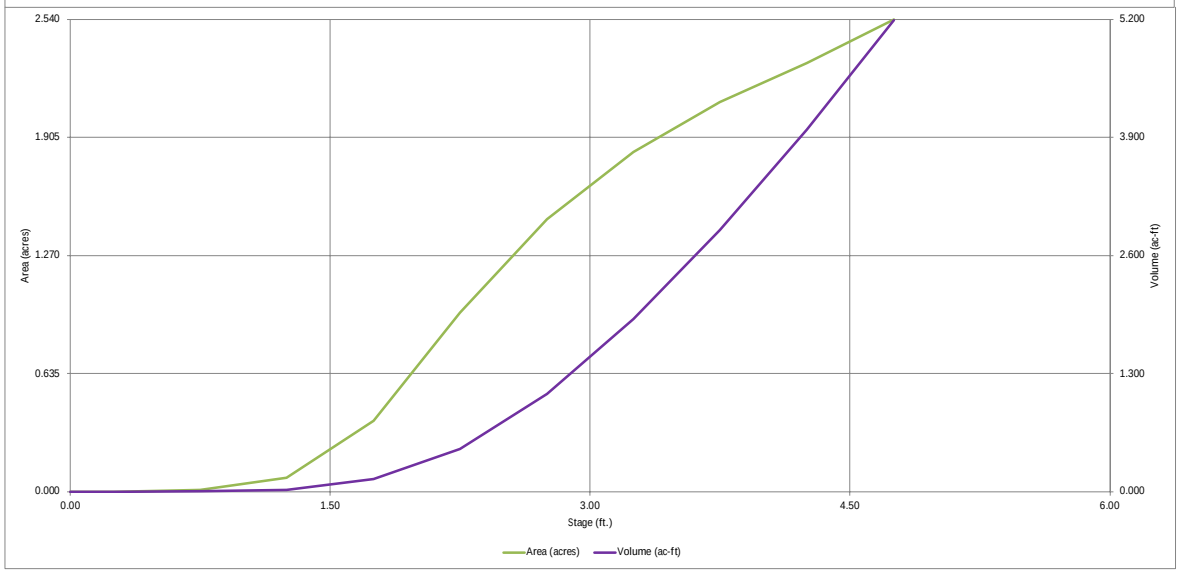
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	50	0.001		
6039	--	0.25	--	--	--	50	0.001	13	0.000
6039.5	--	0.75	--	--	--	366	0.008	117	0.003
6040	--	1.25	--	--	--	3,287	0.075	1,030	0.024
6040.5	--	1.75	--	--	--	16,559	0.380	5,991	0.138
6041	--	2.25	--	--	--	41,906	0.962	20,607	0.473
6041.5	--	2.75	--	--	--	63,807	1.465	47,036	1.080
6042	--	3.25	--	--	--	79,588	1.827	82,884	1.903
6042.5	--	3.75	--	--	--	91,289	2.096	125,604	2.883
6043	--	4.25	--	--	--	100,386	2.305	173,522	3.984
6043.5	--	4.75	--	--	--	110,626	2.540	226,275	5.195

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



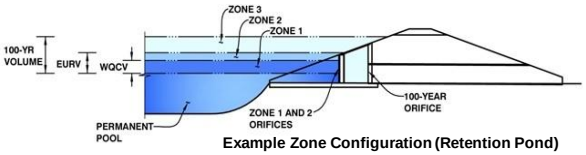


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Kristen Estates

Basin ID: Overall Pond Design (WQCV Override)



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.34	0.032	Orifice Plate
Zone 2 (EURV)	2.08	0.289	Weir&Pipe (Restrict)
Zone 3 (100-year)	3.39	1.828	Weir (No Pipe)
Total (all zones)		2.149	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft^2
Depth at top of Zone using Orifice Plate =	2.08	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft^2

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.05						
Orifice Area (sq. inches)	0.11	2.24						

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

User Input: Vertical Orifice (Circular or Rectangular)

	Not Selected	Not Selected			Not Selected	Not Selected	
Invert of Vertical Orifice =		N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Area =	N/A	N/A	ft^2
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)	Vertical Orifice Centroid =	N/A	N/A	feet
Vertical Orifice Diameter =	N/A	N/A	inches				

Calculated Parameters for Vertical Orifice

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

	Zone 2 Weir	Zone 3 Weir			Zone 2 Weir	Zone 3 Weir	
Overflow Weir Front Edge Height, Ho =	2.08	1.30	ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	2.08	N/A	feet
Weir Front Edge Length OR Weir Bottom Length	10.00	10.00	feet	Overflow Weir Slope Length =	5.00	N/A	feet
Weir Grate Slope OR Weir Side Slopes	0.00	0.00	H:V	Grate Open Area / 100-yr Orifice Area =	19.69	N/A	
Horiz. Length of Weir Sides =	5.00	N/A	feet	Overflow Grate Open Area w/o Debris =	34.80	N/A	ft^2
Overflow Grate Type =	Type C Grate	N/A		Overflow Grate Open Area w/ Debris =	17.40	N/A	ft^2
Debris Clogging % =	50%	N/A	%				

Calculated Parameters for Overflow Weir

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

	Zone 2 Restrictor	Not Selected			Zone 2 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.51	N/A	ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	1.77	N/A	ft^2
Outlet Pipe Diameter =	18.00	N/A	inches	Outlet Orifice Centroid =	0.75	N/A	feet
Restrictor Plate Height Above Pipe Invert =	18.00		inches	Half-Central Angle of Restrictor Plate on Pipe =	3.14	N/A	radians

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.21	ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	0.54	feet
Spillway Crest Length =	75.00	feet	Stage at Top of Freeboard =	4.75	feet
Spillway End Slopes =	4.00	H:V	Basin Area at Top of Freeboard =	2.54	acres
Freeboard above Max Water Surface =	1.00	feet	Basin Volume at Top of Freeboard =	5.19	acre-ft

Calculated Parameters for Spillway

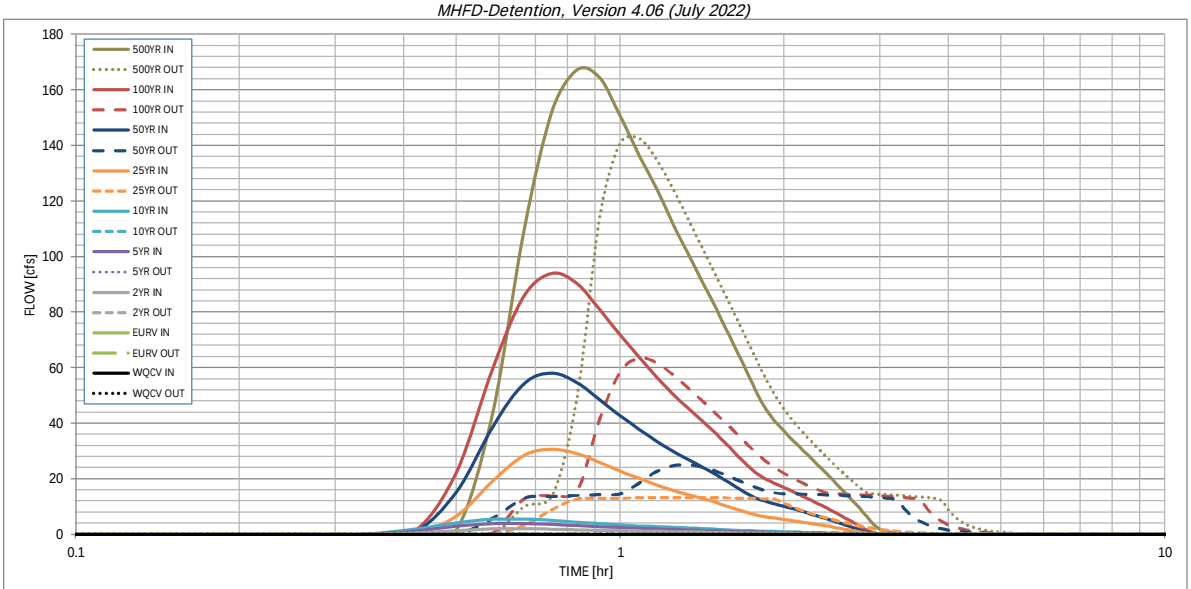
Routed Hydrograph Results

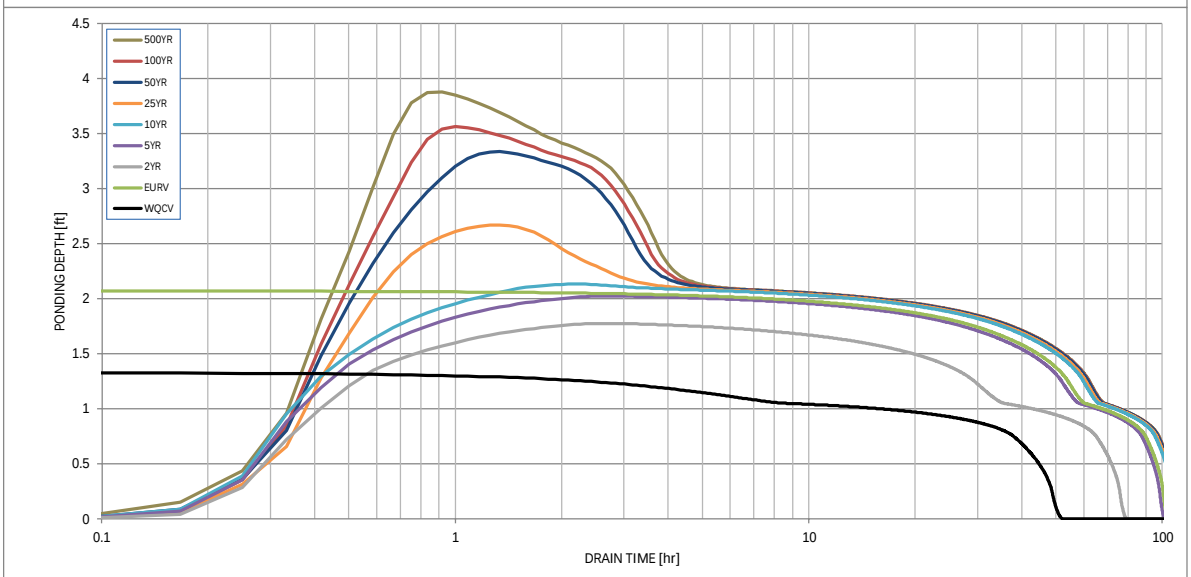
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

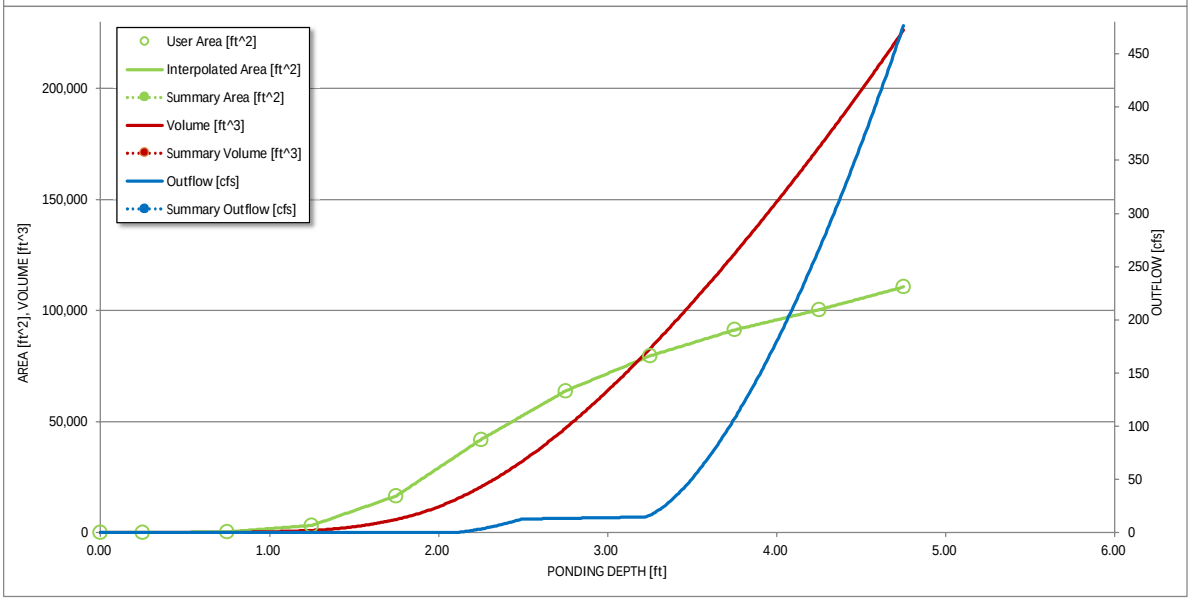
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.032	0.321	0.162	0.302	0.424	2.250	4.263	7.040	13.462
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.162	0.302	0.424	2.250	4.263	7.040	13.462
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.1	2.1	3.0	27.3	54.5	90.3	163.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.17	0.35	0.58	1.05
Peak Inflow Q (cfs) =	N/A	N/A	2.1	4.0	5.5	30.6	58.0	94.0	167.3
Peak Outflow Q (cfs) =	0.0	0.1	0.1	0.1	0.7	13.3	25.1	63.5	142.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.0	0.2	0.5	0.5	0.7	0.9
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Overflow Weir 1	Outlet Plate 1	Spillway	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.4	0.4	0.4	0.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	45	66	57	65	65	50	39	25	5
Time to Drain 99% of Inflow Volume (hours) =	49	88	69	86	90	61	56	50	38
Maximum Ponding Depth (ft) =	1.34	2.08	1.78	2.03	2.13	2.67	3.34	3.56	3.88
Area at Maximum Ponding Depth (acres) =	0.13	0.76	0.40	0.69	0.82	1.37	1.87	1.99	2.15
Maximum Volume Stored (acre-ft) =	0.033	0.326	0.145	0.283	0.366	0.952	2.051	2.495	3.138

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	0:15:00	0.00	0.00	0.02	0.02	0.03	0.02	0.03	0.03	0.04
	0:20:00	0.00	0.00	0.07	0.10	0.12	0.08	0.09	0.09	0.13
	0:25:00	0.00	0.00	0.55	1.25	1.83	0.39	0.75	0.97	1.81
	0:30:00	0.00	0.00	1.42	3.00	4.25	6.65	15.37	22.57	44.37
	0:35:00	0.00	0.00	1.98	3.91	5.43	19.34	39.06	60.24	110.48
	0:40:00	0.00	0.00	2.06	3.96	5.51	28.50	54.39	86.12	152.61
	0:45:00	0.00	0.00	1.92	3.64	5.06	30.65	58.01	94.02	167.32
	0:50:00	0.00	0.00	1.70	3.18	4.42	29.07	54.63	90.31	164.26
	0:55:00	0.00	0.00	1.50	2.82	3.92	25.87	48.40	80.83	150.43
	1:00:00	0.00	0.00	1.35	2.52	3.49	22.73	42.75	71.73	136.43
	1:05:00	0.00	0.00	1.21	2.23	3.09	20.20	37.90	63.90	124.20
	1:10:00	0.00	0.00	1.09	2.03	2.82	17.84	33.45	56.52	111.83
	1:15:00	0.00	0.00	1.00	1.85	2.61	15.89	29.94	50.53	100.82
	1:20:00	0.00	0.00	0.91	1.68	2.39	14.37	27.00	45.49	90.77
	1:25:00	0.00	0.00	0.82	1.50	2.15	12.89	24.20	40.72	81.03
	1:30:00	0.00	0.00	0.73	1.32	1.89	11.43	21.43	36.08	71.69
	1:35:00	0.00	0.00	0.64	1.15	1.63	9.99	18.67	31.50	62.71
	1:40:00	0.00	0.00	0.56	1.00	1.42	8.56	15.94	26.96	53.85
	1:45:00	0.00	0.00	0.51	0.91	1.29	7.30	13.62	23.04	46.28
	1:50:00	0.00	0.00	0.48	0.84	1.19	6.45	12.11	20.39	41.09
	1:55:00	0.00	0.00	0.44	0.78	1.10	5.90	11.04	18.51	37.07
	2:00:00	0.00	0.00	0.41	0.71	1.01	5.39	10.08	16.85	33.52
	2:05:00	0.00	0.00	0.37	0.64	0.91	4.89	9.13	15.27	30.24
	2:10:00	0.00	0.00	0.33	0.57	0.81	4.40	8.19	13.70	27.09
	2:15:00	0.00	0.00	0.29	0.50	0.70	3.90	7.25	12.15	23.99
	2:20:00	0.00	0.00	0.25	0.42	0.60	3.40	6.32	10.62	21.01
	2:25:00	0.00	0.00	0.21	0.35	0.50	2.91	5.40	9.09	18.09
	2:30:00	0.00	0.00	0.17	0.28	0.40	2.42	4.47	7.57	15.19
	2:35:00	0.00	0.00	0.13	0.21	0.30	1.93	3.55	6.05	12.28
	2:40:00	0.00	0.00	0.09	0.15	0.21	1.45	2.63	4.53	9.38
	2:45:00	0.00	0.00	0.06	0.08	0.12	0.96	1.71	3.02	6.48
	2:50:00	0.00	0.00	0.04	0.05	0.07	0.48	0.81	1.53	3.63
	2:55:00	0.00	0.00	0.03	0.04	0.06	0.17	0.30	0.62	1.93
	3:00:00	0.00	0.00	0.02	0.03	0.05	0.08	0.12	0.27	1.10
	3:05:00	0.00	0.00	0.02	0.03	0.04	0.05	0.07	0.14	0.65
	3:10:00	0.00	0.00	0.02	0.02	0.03	0.03	0.05	0.08	0.39
	3:15:00	0.00	0.00	0.01	0.02	0.03	0.03	0.04	0.05	0.23
	3:20:00	0.00	0.00	0.01	0.02	0.02	0.02	0.03	0.03	0.11
	3:25:00	0.00	0.00	0.01	0.01	0.02	0.02	0.02	0.02	0.04
	3:30:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.02
	3:35:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	3:40:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01
	3:45:00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

Stage - Storage Description	Stage [ft]	Area [ft ^{2}]	Area [acres]	Volume [ft ^{3}]	Volume [ac-ft]	Total Outflow [cfs]

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

MHFD EDB Design Spreadsheet

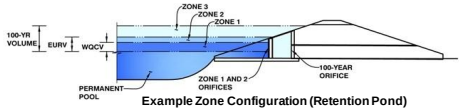
WQCV

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Kristen Estates

Basin ID: Proposed Conditions Sub-Basins (WQCV for Proposed Gravel Road)



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB		Note: L / W Ratio > 8
Watershed Area =	1.17	acres	L / W Ratio = 39.56
Watershed Length =	1,420	ft	
Watershed Length to Centroid =	710	ft	
Watershed Slope =	0.015	ft/ft	
Watershed Imperviousness =	80.00%	percent	
Percentage Hydrologic Soil Group A =	100.0%	percent	
Percentage Hydrologic Soil Group B =	0.0%	percent	
Percentage Hydrologic Soil Groups C/D =	0.0%	percent	
Target WQCV Drain Time =	40.0	hours	
Location for 1-hr Rainfall Depths =	User Input		

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.032	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.123	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.089	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.116	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.137	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	0.162	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	0.186	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	0.214	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	0.276	acre-feet		inches
Approximate 2-yr Detention Volume =	0.081	acre-feet		
Approximate 5-yr Detention Volume =	0.105	acre-feet		
Approximate 10-yr Detention Volume =	0.125	acre-feet		
Approximate 25-yr Detention Volume =	0.149	acre-feet		
Approximate 50-yr Detention Volume =	0.163	acre-feet		
Approximate 100-yr Detention Volume =	0.176	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.032	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.091	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.052	acre-feet
Total Detention Basin Volume =	0.176	acre-feet
Initial Surcharge Volume (ISV) =	4	ft^3
Initial Surcharge Depth (ISD) =		ft
Total Available Detention Depth (H_{total}) =		ft
Depth of Trickle Channel (H_{TC}) =		ft
Slope of Trickle Channel (S_{TC}) =		ft/ft
Slopes of Main Basin Sides (S_{main}) =		H:V
Basin Length-to-Width Ratio (R_{LW}) =		

Initial Surcharge Area (A_{ISV}) =		ft^2
Surcharge Volume Length (L_{ISV}) =		ft
Surcharge Volume Width (W_{ISV}) =		ft
Depth of Basin Floor (H_{FLOOR}) =		ft
Length of Basin Floor (L_{FLOOR}) =		ft
Width of Basin Floor (W_{FLOOR}) =		ft
Area of Basin Floor (A_{FLOOR}) =		ft^2
Volume of Basin Floor (V_{FLOOR}) =		ft^3
Depth of Main Basin (H_{MAIN}) =		ft
Length of Main Basin (L_{MAIN}) =		ft
Width of Main Basin (W_{MAIN}) =		ft
Area of Main Basin (A_{MAIN}) =		ft^2
Volume of Main Basin (V_{MAIN}) =		ft^3
Calculated Total Basin Volume (V_{total}) =		acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool									

Stage storage calculations not applicable for WQCV

MHFD EDB Design Spreadsheet

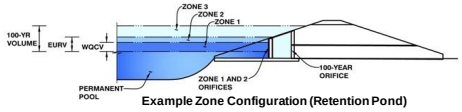
Temporary Sediment Basin

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)

Project: Kristen Estates

Basin ID: TSB A



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	EDB	
Watershed Area =	144.78	acres
Watershed Length =	4,420	ft
Watershed Length to Centroid =	1,210	ft
Watershed Slope =	0.015	ft/ft
Watershed Imperviousness =	3.70%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

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

			Optional User Overrides
Water Quality Capture Volume (WQCV) =	0.329	acre-feet	acre-feet
Excess Urban Runoff Volume (EURV) =	0.298	acre-feet	acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.150	acre-feet	1.19 inches
5-yr Runoff Volume (P1 = 1.5 in.) =	0.280	acre-feet	1.50 inches
10-yr Runoff Volume (P1 = 1.75 in.) =	0.393	acre-feet	1.75 inches
25-yr Runoff Volume (P1 = 2 in.) =	2.087	acre-feet	2.00 inches
50-yr Runoff Volume (P1 = 2.25 in.) =	3.954	acre-feet	2.25 inches
100-yr Runoff Volume (P1 = 2.52 in.) =	6.530	acre-feet	2.52 inches
500-yr Runoff Volume (P1 = 3.14 in.) =	12.486	acre-feet	inches
Approximate 2-yr Detention Volume =	0.171	acre-feet	
Approximate 5-yr Detention Volume =	0.241	acre-feet	
Approximate 10-yr Detention Volume =	0.332	acre-feet	
Approximate 25-yr Detention Volume =	0.478	acre-feet	
Approximate 50-yr Detention Volume =	0.873	acre-feet	
Approximate 100-yr Detention Volume =	1.995	acre-feet	

Define Zones and Basin Geometry

Zone 1 Volume (User Defined) =	1.690	acre-feet
Select Zone 2 Storage Volume (Optional) =		acre-feet
Select Zone 3 Storage Volume (Optional) =		acre-feet
Total Detention Basin Volume =	1.690	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio (R_{LW}) =	user	

Total detention volume is less than 100-year volume.

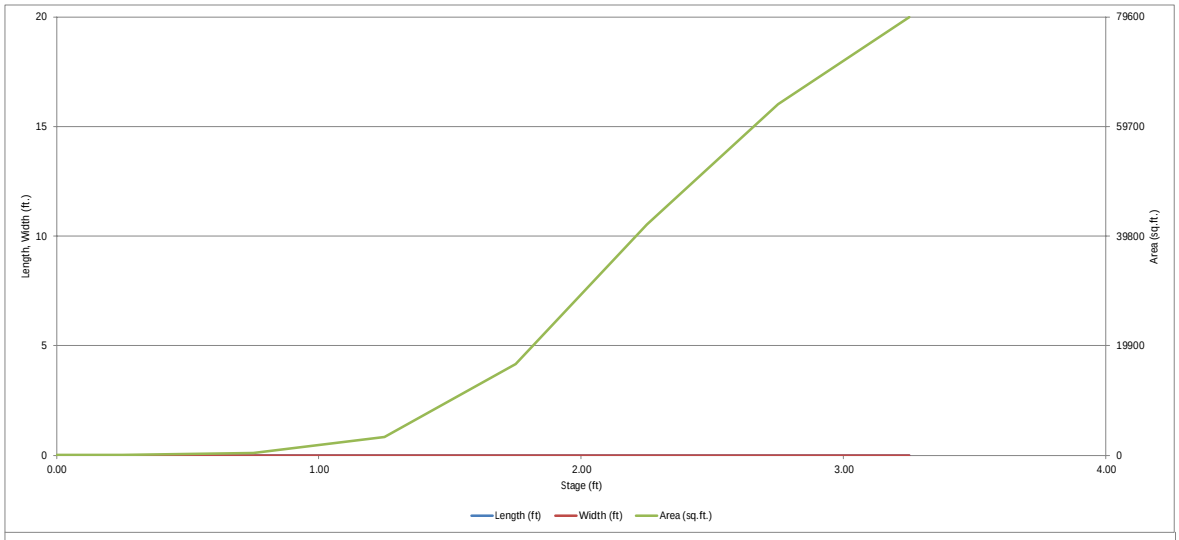
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	user	acre-feet

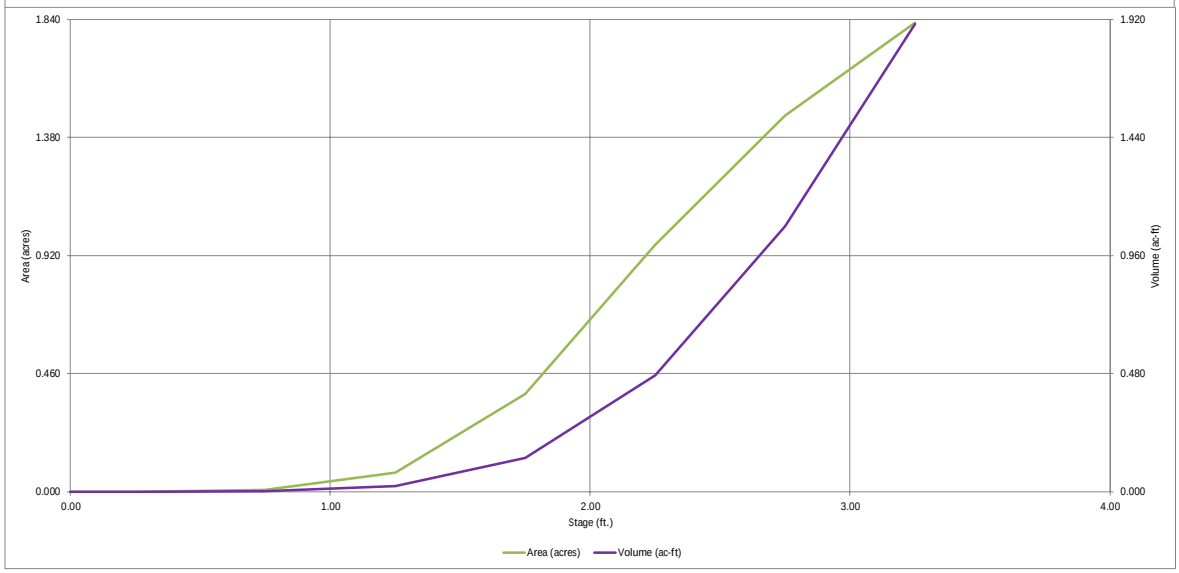
Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	50	0.001		
6039	--	0.25	--	--	--	50	0.001	13	0.000
6039.5	--	0.75	--	--	--	366	0.008	116	0.003
6040	--	1.25	--	--	--	3,287	0.075	1,030	0.024
6040.5	--	1.75	--	--	--	16,559	0.380	5,991	0.138
6041	--	2.25	--	--	--	41,906	0.962	20,607	0.473
6041.5	--	2.75	--	--	--	63,807	1.465	47,035	1.080
6042	--	3.25	--	--	--	79,588	1.827	82,884	1.903

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.06 (July 2022)



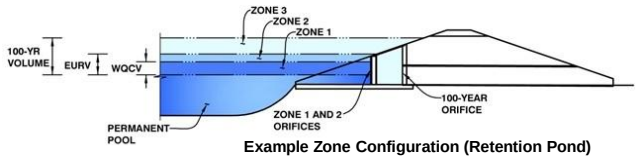


DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.06 (July 2022)

Project: Kristen Estates

Basin ID: TSB A



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (User)	3.14	1.690	Orifice Plate
Zone 2			
Zone 3			
Total (all zones)		1.690	

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)	Underdrain Orifice Area =	N/A	ft²
Underdrain Orifice Diameter =	N/A	inches	Underdrain Orifice Centroid =	N/A	feet

Calculated Parameters for Underdrain

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

Centroid of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)	WQ Orifice Area per Row =	N/A	ft²
Depth at top of Zone using Orifice Plate =	3.14	ft (relative to basin bottom at Stage = 0 ft)	Elliptical Half-Width =	N/A	feet
Orifice Plate: Orifice Vertical Spacing =	N/A	inches	Elliptical Slot Centroid =	N/A	feet
Orifice Plate: Orifice Area per Row =	N/A	sq. inches	Elliptical Slot Area =	N/A	ft²

Calculated Parameters for Plate

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.25	0.75	1.25					
Orifice Area (sq. inches)	0.60	0.60	0.60					

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orific

Not Selected	Not Selected

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

	Not Selected	Not Selected			
Overflow Weir Front Edge Height, Ho =			ft (relative to basin bottom at Stage = 0 ft)	Height of Grate Upper Edge, H_t =	
Overflow Weir Front Edge Length =			feet	Overflow Weir Slope Length =	
Overflow Weir Grate Slope =			H:V	Grate Open Area / 100-yr Orifice Area =	
Horiz. Length of Weir Sides =			feet	Overflow Grate Open Area w/o Debris =	
Overflow Grate Type =				Overflow Grate Open Area w/ Debris =	
Debris Clogging % =			%		

Calculated Parameters for Overflow Wei

Not Selected	Not Selected

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

	Not Selected	Not Selected			
Depth to Invert of Outlet Pipe =			ft (distance below basin bottom at Stage = 0 ft)	Outlet Orifice Area =	
Circular Orifice Diameter =			inches	Outlet Orifice Centroid =	
				Half-Central Angle of Restrictor Plate on Pipe =	N/A

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plat

Not Selected	Not Selected
N/A	N/A

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=		ft (relative to basin bottom at Stage = 0 ft)	Spillway Design Flow Depth=	feet
Spillway Crest Length =		feet	Stage at Top of Freeboard =	feet
Spillway End Slopes =		H:V	Basin Area at Top of Freeboard =	acres
Freeboard above Max Water Surface =		feet	Basin Volume at Top of Freeboard =	acre-ft

Calculated Parameters for Spillway

Routed Hydrograph Results

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

Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52
CUHP Runoff Volume (acre-ft) =	0.329	0.298	0.150	0.280	0.393	2.087	3.954	6.530
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.150	0.280	0.393	2.087	3.954	6.530
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	1.0	1.9	2.7	24.8	49.6	82.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A						
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.01	0.02	0.17	0.34	0.57
Peak Inflow Q (cfs) =	N/A	N/A	1.9	3.6	5.0	27.9	52.7	85.5
Peak Outflow Q (cfs) =	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.0	0.0	0.0	0.0	0.0
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Plate	N/A	N/A	N/A
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	68	63	38	61	79	>120	>120	>120
Time to Drain 99% of Inflow Volume (hours) =	72	66	40	64	83	>120	>120	>120
Maximum Ponding Depth (ft) =	2.09	2.05	1.75	2.00	2.14	3.25	3.25	3.25
Area at Maximum Ponding Depth (acres) =	0.78	0.73	0.38	0.66	0.83	1.83	1.83	1.83
Maximum Volume Stored (acre-ft) =	0.334	0.304	0.138	0.262	0.374	1.903	1.903	1.903

Forebay Design

Rock Chute Design Data

(Version WI-July-2010, Based on Design of Rock Chutes by Robinson, Rice, Kadavy, ASAE, 1998)

Project: Kristin Estates **County:** El Paso, CO
Designer: DJS **Checked by:**
Date: May 1, 2026 **Date:**

Input Geometry:

→ Upstream Channel	→ Chute		→ Downstream Channel
Bw = 12.0 ft.	Bw = 10.0 ft.		Bw = 20.0 ft.
Side slopes = 4.0 (m:1)	Factor of safety = 1.20 (F_s)	1.2 Min	Side slopes = 1.0 (m:1)
Velocity n-value = 0.040	Side slopes = 3.0 (m:1) →	2.0:1 max.	Velocity n-value = 0.040
Bed slope = 0.0046 ft./ft.	Bed slope (25:1) = 0.040 ft./ft →	3.0:1 max.	Bed slope = 0.0040 ft./ft.
Note: n value = a) velocity n from waterway program	Freeboard = 1.0 ft. →		
or b) computed mannings n for channel	Outlet apron depth, d = 0.0 ft.		Base flow = 177.1cfs

Design Storm Data (Table 2, FOTG, WI-NRCS Grade Stabilization Structure No. 410):

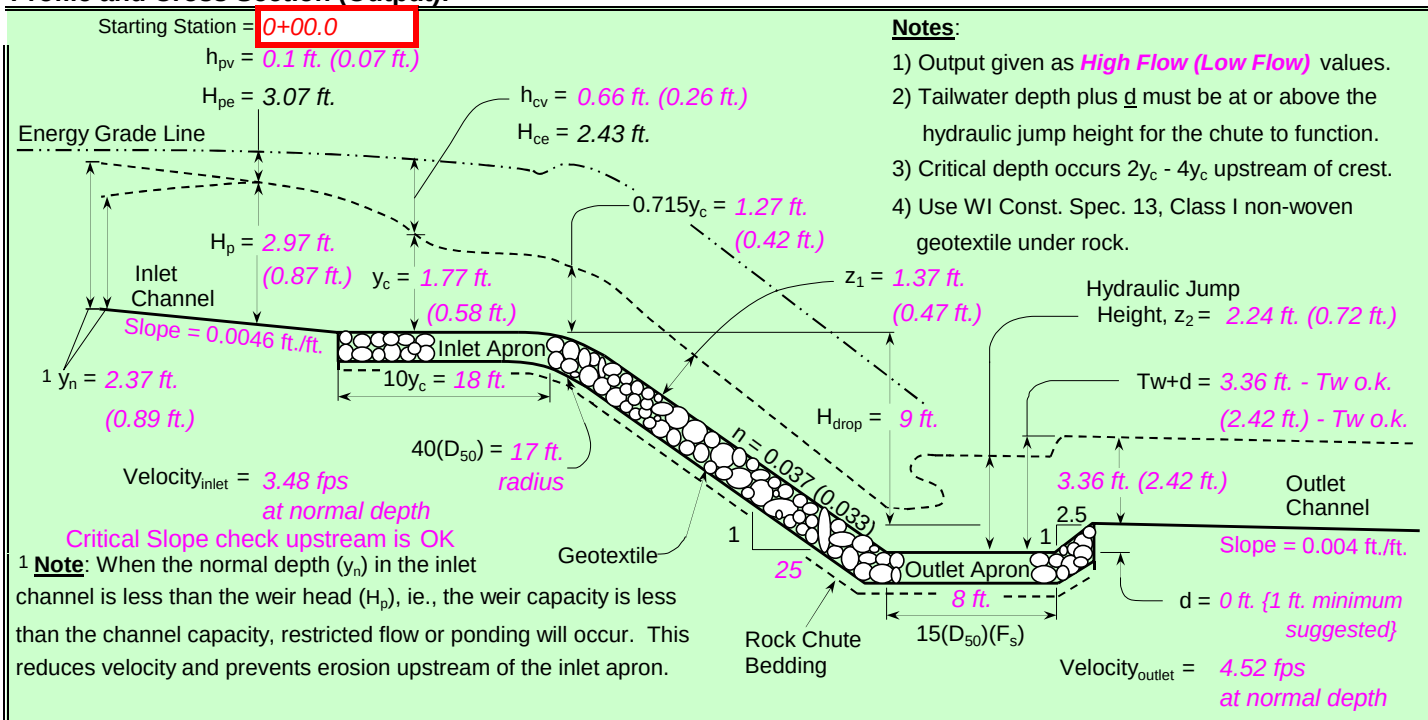
Apron elev. --- Inlet = 100.0 ft. ------- Outlet 91.0 ft. --- (H_{drop} = 9 ft.)

Q_{high} = Runoff from design storm capacity from Table 2, FOTG Standard 410
Q_5 = Runofff from a 5-year,24-hour storm.

Q_{high} = 177.1 cfs High flow storm through chute → Tw (ft.) = Program
Q_5 = 27.8 cfs Low flow storm through chute → Tw (ft.) = Program

***Note**: The total required capacity is routed through the chute (principal spillway) or in combination with an auxiliary spillway.*
***Input tailwater (Tw)**:* 0.04 1.20

Profile and Cross Section (Output):

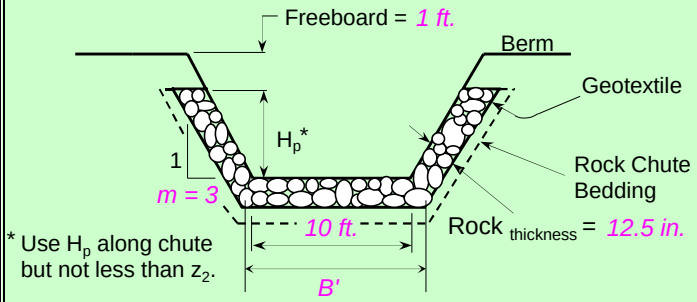


Notes:
1) Output given as ***High Flow (Low Flow)*** values.
2) Tailwater depth plus d must be at or above the hydraulic jump height for the chute to function.
3) Critical depth occurs 2y_c - 4y_c upstream of crest.
4) Use WI Const. Spec. 13, Class I non-woven geotextile under rock.

[1] **Note**: When the normal depth (y_n) in the inlet channel is less than the weir head (H_p), ie., the weir capacity is less than the channel capacity, restricted flow or ponding will occur. This reduces velocity and prevents erosion upstream of the inlet apron.

Profile Along Centerline of Chute

Typical Cross Section



* Use H_p along chute but not less than z_2.

	13.42 cfs/ft.	Equivalent unit discharge
F_S =	1.20	Factor of safety (multiplier)
z_1 =	1.37 ft.	Normal depth in chute
n-value =	0.037	Manning's roughness coefficient
$D_{50}(F_s)$ =	6.2 in.	Minimum Design D50*
$2(D_{50})(F_s)$ =	12.5 in.	Rock chute thickness
Tw + d =	3.36 ft.	Tailwater above outlet apron
z_2 =	2.24 ft.	Hydraulic jump height
*** The outlet	will	function adequately

High Flow Storm Information

Kimley»Horn

Rock Chute Forebay

Contributing Sub-Basins: OP3 and P3

Date	7/1/2026	
Prepared By	RES	
Checked By	KRK	

		Forebay A	
	Required	Flow: Q_{100} = (cfs)	Release Rate
Forebay Release and Configuration	Release 2% of the undetained 100-year peak discharge by way of a wall/notch or berm/pipe configuration	177.10	3.54

			Required (CF)	Provided (CF)
Minimum Forebay Volume Required	2% of the WQCV	40hr drain time, a = 1 I = 0.02 A = 113.4 AC	124.57	391.00

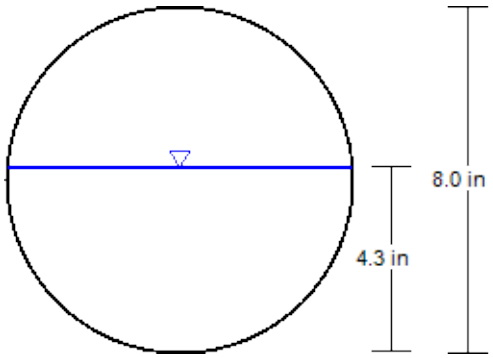
Kristin Estates - Forebay Volume
Project: Kristin Estates
Basin Description:

Contour Elevation	Contour Area (sq. ft)	Depth (ft)	Incremental Volume Avg. End (cu. ft)	Cumulative Volume Avg. End (cu. ft)	Incremental Volume Conic (cu. ft)	Cumulative Volume Conic (cu. ft)
6,040.800	20.64	N/A	N/A	0.00	N/A	0.00
6,041.000	120.72	0.200	14.14	14.14	12.75	12.75
6,041.200	177.44	0.200	29.82	43.95	29.63	42.39
6,041.400	240.61	0.200	41.80	85.76	41.64	84.03
6,041.600	307.54	0.200	54.82	140.57	54.68	138.71
6,041.800	379.87	0.200	68.74	209.31	68.61	207.32
6,042.000	458.61	0.200	83.85	293.16	83.72	291.05
6,042.200	546.30	0.200	100.49	393.65	100.36	391.41

Cross Section for Circular Pipe - 1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Roughness Coefficient	0.010
Channel Slope	0.160 ft/ft
Normal Depth	4.3 in
Diameter	8.0 in
Discharge	3.54 cfs



V: 1
H: 1

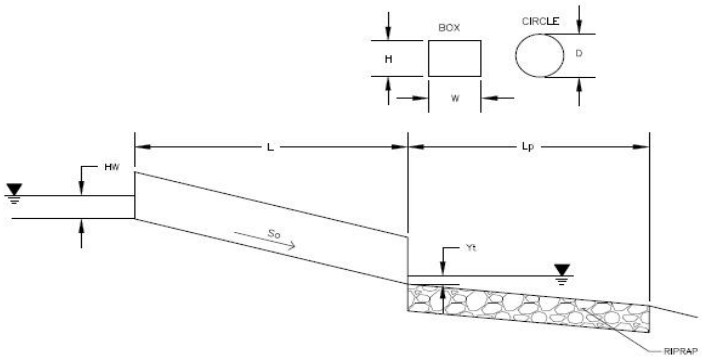
Culvert & Outlet Pipe Sizing,
Riprap Design,
Ditch Calculations,
&
Trickle Channel Calculations

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Kristin Estates Final Plat

ID: Culvert A - Three (3) 36" RCP



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

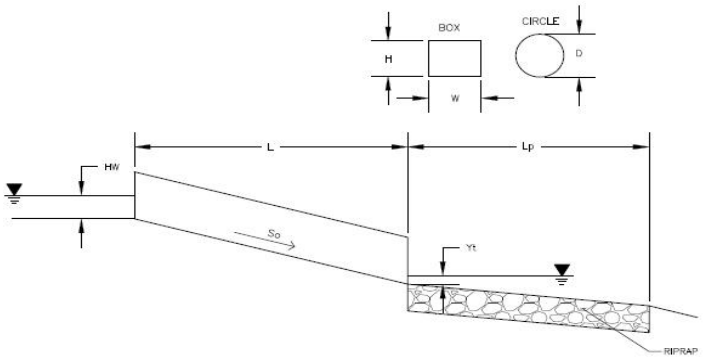
Design Information:				
	Design Discharge	Q =	177.08	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	36	inches
	Inlet Edge Type (Choose from pull-down list)		Beveled Edge (1:1)	
OR:				
Box Culvert:			OR	
	Barrel Height (Rise) in Feet	H (Rise) =		ft
	Barrel Width (Span) in Feet	W (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	# Barrels =	3	
	Inlet Elevation	Elev IN =	6045.26	ft
	Outlet Elevation OR Slope	Elev OUT =	6044.88	ft
	Culvert Length	L =	60	ft
	Manning's Roughness	n =	0.013	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
	Max Allowable Channel Velocity	V =	7	ft/s
Calculated Results:				
	Culvert Cross Sectional Area Available	A =	7.07	ft^2
	Culvert Normal Depth	Y_n =	3.00	ft
	Culvert Critical Depth	Y_c =	2.48	ft
	Froude Number	Fr =	-	Pressure flow!
	Entrance Loss Coefficient	k_e =	0.20	
	Friction Loss Coefficient	k_f =	0.43	
	Sum of All Loss Coefficients	k_s =	1.63	ft
Headwater:				
	Inlet Control Headwater	HW_I =	4.48	ft
	Outlet Control Headwater	HW_O =	4.13	ft
	Design Headwater Elevation	HW =	6049.74	ft
	Headwater/Diameter OR Headwater/Rise Ratio	HW/D =	1.49	
Outlet Protection:				
	Flow/(Diameter^2.5)	Q/D^2.5 =	3.79	$ft^{0.5}/s$
	Tailwater Surface Height	Y_t =	1.20	ft
	Tailwater/Diameter	Yt/D =	0.40	
	Expansion Factor	1/(2*tan(Θ)) =	3.69	
	Flow Area at Max Channel Velocity	A_t =	25.30	ft^2
	Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	9.00	ft
	Length of Riprap Protection	L_p =	30	ft
	Width of Riprap Protection at Downstream End	T =	18	ft
	Adjusted Diameter for Supercritical Flow	Da =	-	ft
	Minimum Theoretical Riprap Size	d_{50} min=	9	in
	Nominal Riprap Size	d_{50} nominal=	12	in
	MHFD Riprap Type	Type =	M	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: Kristen Estates Final Plat

ID: Culvert B - 24" RCP



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

Supercritical Flow! Using Adjusted Diameter to calculate protection type.

Design Information:

Design Discharge	Q =	17.71	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	24	inches
Inlet Edge Type (Choose from pull-down list)		Beveled Edge (1:1)	
OR:			
Box Culvert:		OR	
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	6045.9	ft
Outlet Elevation OR Slope	Elev OUT =	6045.2	ft
Culvert Length	L =	60	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
Max Allowable Channel Velocity	V =	7	ft/s

Calculated Results:

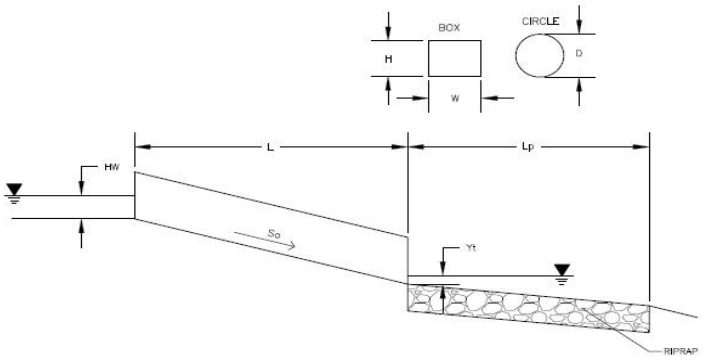
Culvert Cross Sectional Area Available	A =	3.14	ft^2
Culvert Normal Depth	Y_n =	1.26	ft
Culvert Critical Depth	Y_c =	1.52	ft
Froude Number	Fr =	1.44	Supercritical!
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.74	
Sum of All Loss Coefficients	k_s =	1.94	ft
Headwater:			
Inlet Control Headwater	HW_I =	2.46	ft
Outlet Control Headwater	HW_O =	2.02	ft
Design Headwater Elevation	HW =	6048.36	ft
Headwater/Diameter OR Headwater/Rise Ratio	HW/D =	1.23	
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	3.13	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.80	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	4.27	
Flow Area at Max Channel Velocity	A_t =	2.53	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	L_p =	6	ft
Width of Riprap Protection at Downstream End	T =	4	ft
Adjusted Diameter for Supercritical Flow	Da =	1.63	ft
Minimum Theoretical Riprap Size	d_{50} min=	6	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	Type =	VL	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.01 (April 2025)

Project: Kristin Estates Final Plat

ID: Culvert C - Three (3) 30" RCP



Soil Type:
Choose One:
○ Sandy
◉ Non-Sandy

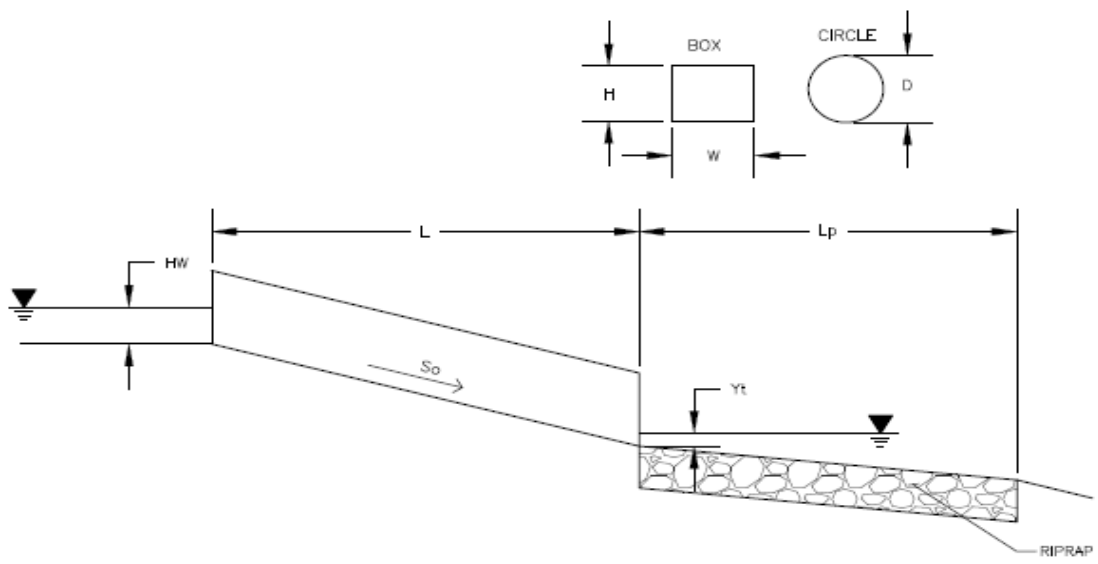
Design Information:				
	Design Discharge	Q =	96.44	cfs
Circular Culvert:				
	Barrel Diameter in Inches	D =	30	inches
	Inlet Edge Type (Choose from pull-down list)		Beveled Edge (1:1)	
OR:				
Box Culvert:			OR	
	Barrel Height (Rise) in Feet	H (Rise) =		ft
	Barrel Width (Span) in Feet	W (Span) =		ft
	Inlet Edge Type (Choose from pull-down list)			
	Number of Barrels	# Barrels =	3	
	Inlet Elevation	Elev IN =	6029.93	ft
	Outlet Elevation OR Slope	Elev OUT =	6029.7	ft
	Culvert Length	L =	41.04	ft
	Manning's Roughness	n =	0.013	
	Bend Loss Coefficient	k_b =	0	
	Exit Loss Coefficient	k_x =	1	
	Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
	Max Allowable Channel Velocity	V =	7	ft/s
Calculated Results:				
	Culvert Cross Sectional Area Available	A =	4.91	ft^2
	Culvert Normal Depth	Y_n =	2.17	ft
	Culvert Critical Depth	Y_c =	1.93	ft
	Froude Number	Fr =	0.77	
	Entrance Loss Coefficient	k_e =	0.20	
	Friction Loss Coefficient	k_f =	0.38	
	Sum of All Loss Coefficients	k_s =	1.58	ft
Headwater:				
	Inlet Control Headwater	HW_I =	3.19	ft
	Outlet Control Headwater	HW_O =	3.04	ft
	Design Headwater Elevation	HW =	6033.12	ft
	Headwater/Diameter OR Headwater/Rise Ratio	HW/D =	1.28	
Outlet Protection:				
	Flow/(Diameter^2.5)	Q/D^2.5 =	3.25	$ft^{0.5}/s$
	Tailwater Surface Height	Y_t =	1.00	ft
	Tailwater/Diameter	Yt/D =	0.40	
	Expansion Factor	1/(2*tan(Θ)) =	4.16	
	Flow Area at Max Channel Velocity	A_t =	13.78	ft^2
	Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	7.50	ft
	Length of Riprap Protection	L_p =	25	ft
	Width of Riprap Protection at Downstream End	T =	14	ft
	Adjusted Diameter for Supercritical Flow	Da =	-	ft
	Minimum Theoretical Riprap Size	d_{50} min=	7	in
	Nominal Riprap Size	d_{50} nominal=	9	in
	MHFD Riprap Type	Type =	L	

DETERMINATION OF CULVERT HEADWATER AND OUTLET PROTECTION

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Kristen Estates Final Plat**

ID: **Pond Outlet Pipe - 18" RCP**



Soil Type:

Choose One:

○ Sandy

◉ Non-Sandy

Design Information:

Design Discharge	Q =	12.8	cfs
Circular Culvert:			
Barrel Diameter in Inches	D =	18	inches
Inlet Edge Type (Choose from pull-down list)		Beveled Edge (1:1)	
OR:		**OR**	
Box Culvert:			
Barrel Height (Rise) in Feet	H (Rise) =		ft
Barrel Width (Span) in Feet	W (Span) =		ft
Inlet Edge Type (Choose from pull-down list)			
Number of Barrels	# Barrels =	1	
Inlet Elevation	Elev IN =	6038.24	ft
Outlet Elevation **OR** Slope	Elev OUT =	6038	ft
Culvert Length	L =	48	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	k_b =	0	
Exit Loss Coefficient	k_x =	1	
Tailwater Surface Elevation	$Y_{t,\ Elevation}$ =		ft
Max Allowable Channel Velocity	V =	7	ft/s

Calculated Results:

Culvert Cross Sectional Area Available	A =	1.77	ft^2
Culvert Normal Depth	Y_n =	1.50	ft
Culvert Critical Depth	Y_c =	1.34	ft
Froude Number	Fr =	-	**Pressure flow!**
Entrance Loss Coefficient	k_e =	0.20	
Friction Loss Coefficient	k_f =	0.87	
Sum of All Loss Coefficients	k_s =	2.07	ft
Headwater:			
Inlet Control Headwater	HW_I =	2.86	ft
Outlet Control Headwater	HW_O =	3.04	ft
Design Headwater Elevation	**HW =**	**6041.28**	**ft**
Headwater/Diameter OR Headwater/Rise Ratio	**HW/D =**	**2.03**	**HW/D > 1.5!**
Outlet Protection:			
Flow/(Diameter^2.5)	Q/D^2.5 =	4.64	$ft^{0.5}/s$
Tailwater Surface Height	Y_t =	0.60	ft
Tailwater/Diameter	Yt/D =	0.40	
Expansion Factor	1/(2*tan(Θ)) =	2.80	
Flow Area at Max Channel Velocity	A_t =	1.83	ft^2
Width of Equivalent Conduit for Multiple Barrels	W_{eq} =	-	ft
Length of Riprap Protection	**L_p =**	**5**	**ft**
Width of Riprap Protection at Downstream End	**T =**	**4**	**ft**
Adjusted Diameter for Supercritical Flow	Da =	-	ft
Minimum Theoretical Riprap Size	d_{50} min=	6	in
Nominal Riprap Size	d_{50} nominal=	6	in
MHFD Riprap Type	**Type =**	**VL**	

Figure 13-12c. Emergency Spillway Protection

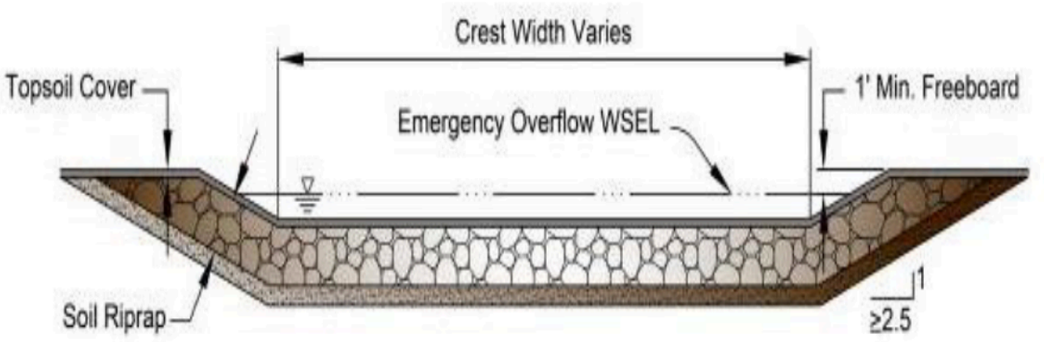
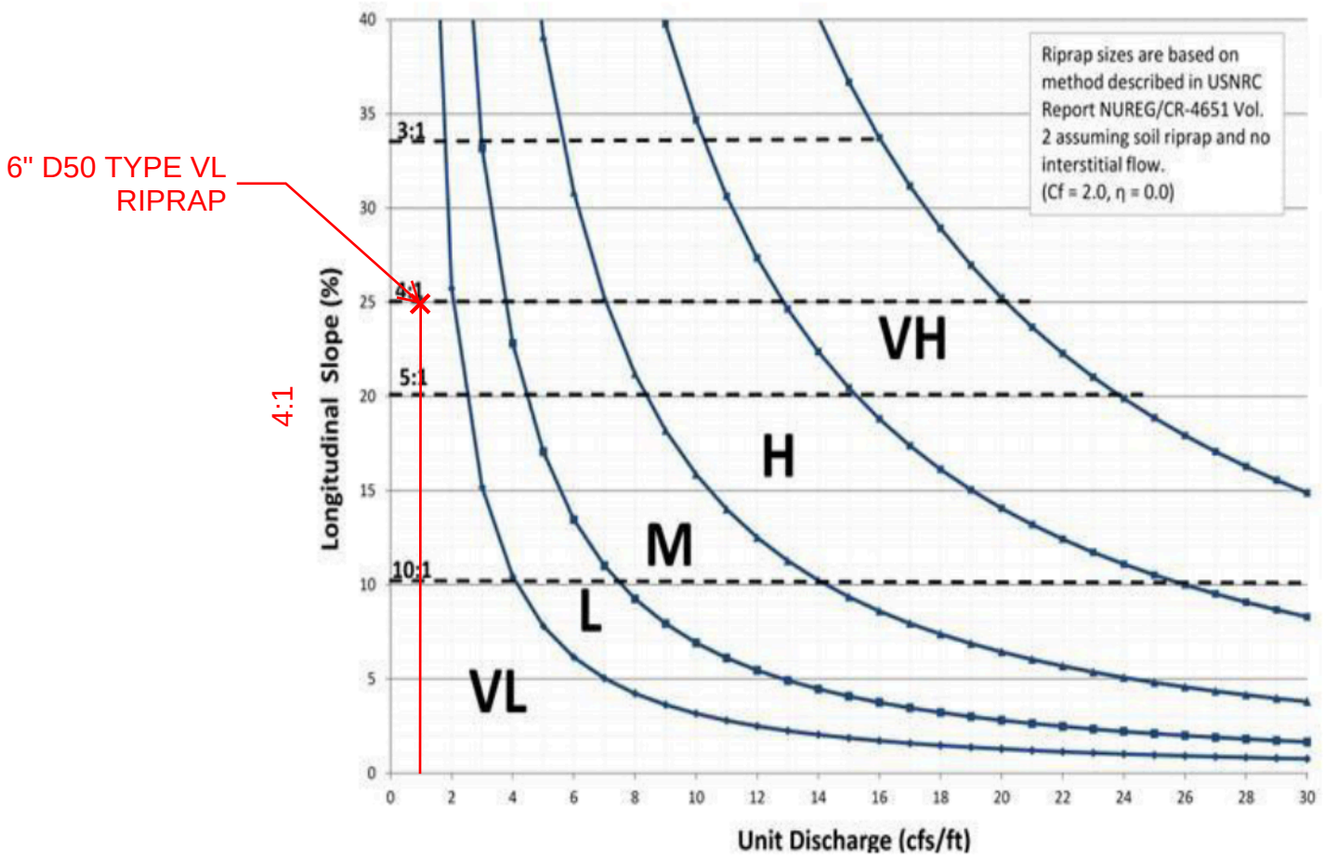


Figure 13-12d. Riprap Types for Emergency Spillway Protection



74.1 CFS / 75 FT = 0.988

Worksheet for Roadside Ditch_0+00-9+00

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030
Channel Slope	0.005 ft/ft
Left Side Slope	4.000 H:V
Right Side Slope	90.000 H:V
Discharge	90.60 cfs

Results

Normal Depth	11.4 in
Flow Area	42.5 ft²
Wetted Perimeter	89.5 ft
Hydraulic Radius	5.7 in
Top Width	89.39 ft
Critical Depth	9.0 in
Critical Slope	0.018 ft/ft
Velocity	2.13 ft/s
Velocity Head	0.07 ft
Specific Energy	1.02 ft
Froude Number	0.545
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	11.4 in
Critical Depth	9.0 in
Channel Slope	0.005 ft/ft
Critical Slope	0.018 ft/ft

Worksheet for Roadside Ditch_9+00-12+50

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030
Channel Slope	0.006 ft/ft
Left Side Slope	4.000 H:V
Right Side Slope	90.000 H:V
Discharge	90.60 cfs

Results

Normal Depth	11.0 in
Flow Area	39.7 ft²
Wetted Perimeter	86.5 ft
Hydraulic Radius	5.5 in
Top Width	86.39 ft
Critical Depth	9.0 in
Critical Slope	0.018 ft/ft
Velocity	2.28 ft/s
Velocity Head	0.08 ft
Specific Energy	1.00 ft
Froude Number	0.594
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	11.0 in
Critical Depth	9.0 in
Channel Slope	0.006 ft/ft
Critical Slope	0.018 ft/ft

Worksheet for Roadside Ditch_12+50-14+20

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.030
Channel Slope	0.050 ft/ft
Left Side Slope	4.000 H:V
Right Side Slope	90.000 H:V
Discharge	17.71 cfs

Results

Normal Depth	4.0 in
Flow Area	5.3 ft²
Wetted Perimeter	31.5 ft
Hydraulic Radius	2.0 in
Top Width	31.47 ft
Critical Depth	4.7 in
Critical Slope	0.023 ft/ft
Velocity	3.36 ft/s
Velocity Head	0.18 ft
Specific Energy	0.51 ft
Froude Number	1.449
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	4.0 in
Critical Depth	4.7 in
Channel Slope	0.050 ft/ft
Critical Slope	0.023 ft/ft

Worksheet for Trickle Channel

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.004 ft/ft
Bottom Width	4.00 ft
Discharge	3.54 cfs

Results

Normal Depth	3.6 in
Flow Area	1.2 ft²
Wetted Perimeter	4.6 ft
Hydraulic Radius	3.1 in
Top Width	4.00 ft
Critical Depth	3.5 in
Critical Slope	0.004 ft/ft
Velocity	2.95 ft/s
Velocity Head	0.14 ft
Specific Energy	0.44 ft
Froude Number	0.950
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	3.6 in
Critical Depth	3.5 in
Channel Slope	0.004 ft/ft
Critical Slope	0.004 ft/ft

STABILIZED DRAINAGE WAY – CROSS SECTIONS

Worksheet for Cross Section 1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.011 ft/ft
Discharge	1,233.00 cfs

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 6,052.85)	(3+17, 6,047.95)	0.050
(3+17, 6,047.95)	(3+27, 6,047.89)	0.035
(3+27, 6,047.89)	(11+00, 6,057.82)	0.050

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	28.6 in
Roughness Coefficient	0.049
Elevation	6,050.27 ft
Elevation Range	6,047.9 to 6,057.8 ft
Flow Area	283.7 ft²
Wetted Perimeter	176.4 ft
Hydraulic Radius	19.3 in
Top Width	176.04 ft
Normal Depth	28.6 in
Critical Depth	22.6 in
Critical Slope	0.033 ft/ft
Velocity	4.35 ft/s
Velocity Head	0.29 ft
Specific Energy	2.67 ft
Froude Number	0.603
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

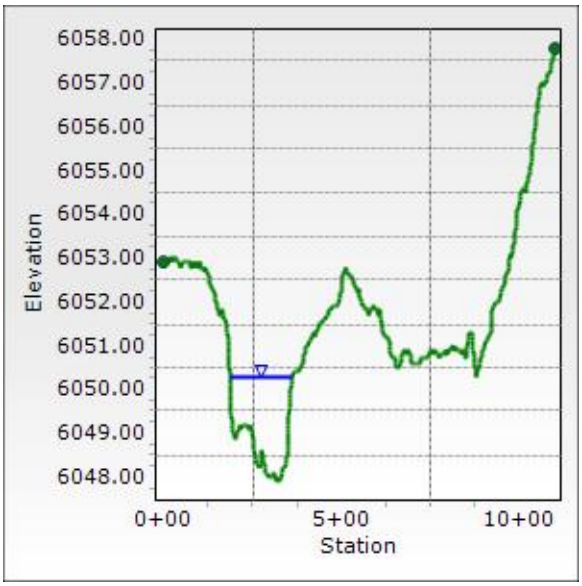
Worksheet for Cross Section 1

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	28.6 in
Critical Depth	22.6 in
Channel Slope	0.011 ft/ft
Critical Slope	0.033 ft/ft

Cross Section for Cross Section 1

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.011 ft/ft
Normal Depth	28.8 in
Discharge	1,233.00 cfs



Worksheet for Cross Section 2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.014 ft/ft
Discharge	1,233.00 cfs

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 6,051.02)	(3+12, 6,045.39)	0.050
(3+12, 6,045.39)	(3+22, 6,045.39)	0.035
(3+22, 6,045.39)	(9+38, 6,048.77)	0.050

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	31.3 in
Roughness Coefficient	0.050
Elevation	6,047.90 ft
Elevation Range	6,045.3 to 6,051.1 ft
Flow Area	333.4 ft²
Wetted Perimeter	313.2 ft
Hydraulic Radius	12.8 in
Top Width	312.63 ft
Normal Depth	31.3 in
Critical Depth	24.3 in
Critical Slope	0.034 ft/ft
Velocity	3.70 ft/s
Velocity Head	0.21 ft
Specific Energy	2.82 ft
Froude Number	0.631
Flow Type	Subcritical

GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

Worksheet for Cross Section 2

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s
Upstream Velocity	0.00 ft/s
Normal Depth	31.3 in
Critical Depth	24.3 in
Channel Slope	0.014 ft/ft
Critical Slope	0.034 ft/ft

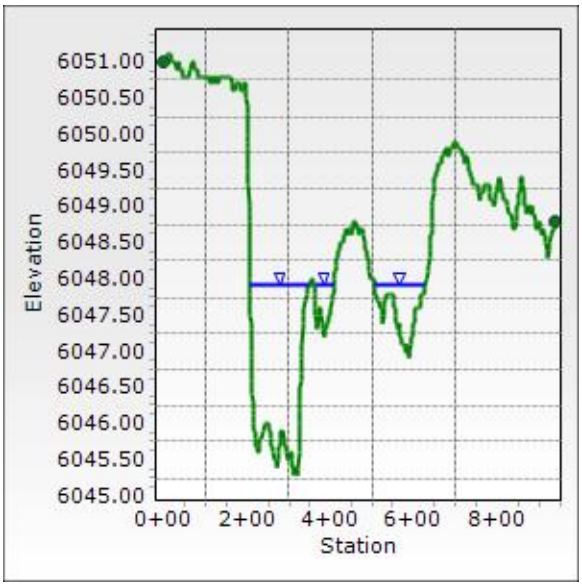
Messages:

Flow is divided.

Cross Section for Cross Section 2

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.014 ft/ft
Normal Depth	31.3 in
Discharge	1,233.00 cfs



Worksheet for Cross Section 3

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.012 ft/ft
Discharge	1,233.00 cfs

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 6,048.34)	(2+25, 6,042.41)	0.050
(2+25, 6,042.41)	(2+35, 6,042.30)	0.035
(2+35, 6,042.30)	(7+98, 6,048.31)	0.050

Options	
Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results	
Normal Depth	30.1 in
Roughness Coefficient	0.049
Elevation	6,044.72 ft
Elevation Range	6,042.2 to 6,049.0 ft
Flow Area	311.5 ft²

Worksheet for Cross Section 3

Results		
Wetted Perimeter	236.3	ft
Hydraulic Radius	15.8	in
Top Width	235.99	ft
Normal Depth	30.1	in
Critical Depth	24.6	in
Critical Slope	0.035	ft/ft
Velocity	3.96	ft/s
Velocity Head	0.24	ft
Specific Energy	2.75	ft
Froude Number	0.607	
Flow Type	Subcritical	

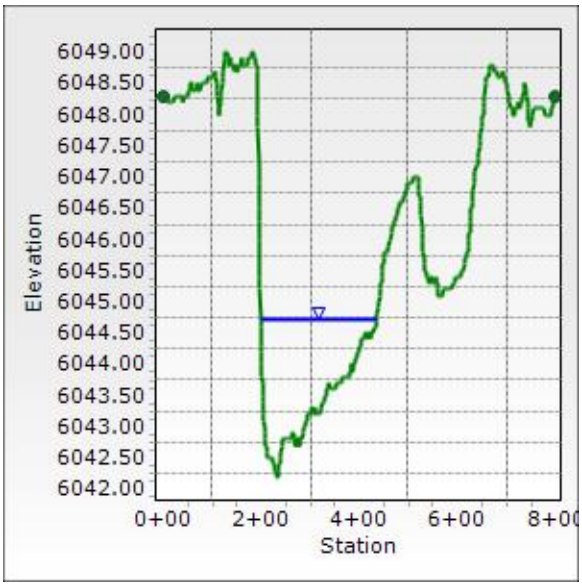
GVF Input Data		
Downstream Depth	0.0	in
Length	0.0	ft
Number Of Steps	0	

GVF Output Data		
Upstream Depth	0.0	in
Profile Description	N/A	
Profile Headloss	0.00	ft
Downstream Velocity	0.00	ft/s
Upstream Velocity	0.00	ft/s
Normal Depth	30.1	in
Critical Depth	24.6	in
Channel Slope	0.012	ft/ft
Critical Slope	0.035	ft/ft

Cross Section for Cross Section 3

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.012 ft/ft
Normal Depth	30.2 in
Discharge	1,233.00 cfs



POND COST

Kimley»Horn

2 North Nevada, Suite 900
Colorado Springs, Colorado 80903

Project: Kristin Estates
Project Number: 196663001
Date: 5/26/2026

Prepared By: RES
Checked By: KRK

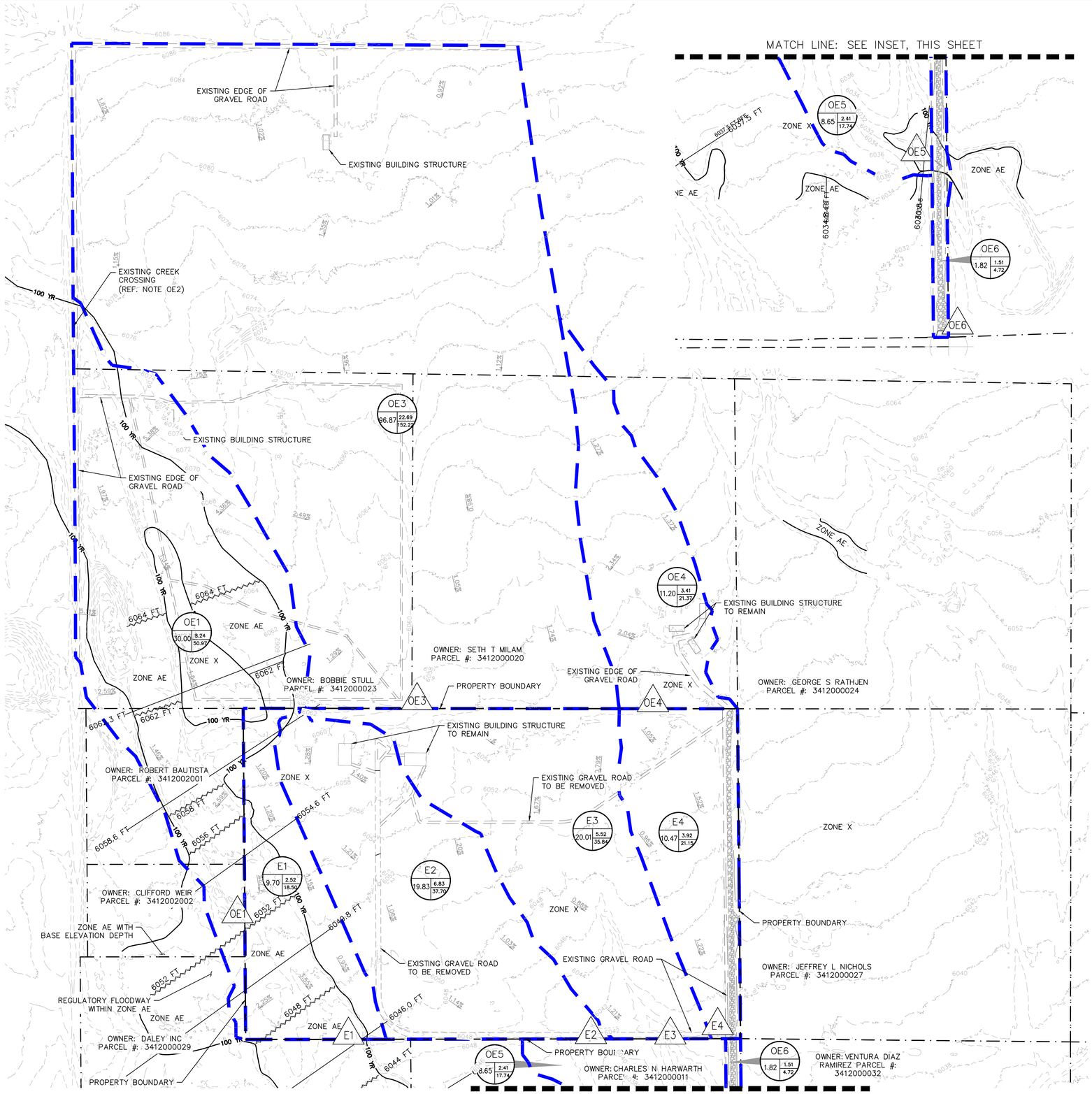
Kristin Estates - Full Spectrum Extended Detention Basin A

Item	Unit	Quantity	Unit Cost	Cost
Rip Rap Rock Chute / Forebay	CY	89	$ 210.00	$ 18,690.00
Concrete Trickle Channel	LF	886	$ 32.00	$ 28,352.00
Concrete Micropool	EA	1	$ 10,000.00	$ 10,000.00
Concrete Outlet Structure	EA	1	$ 5,200.00	$ 5,200.00
18" RCP Outfall Pipe	LF	41	$ 151.00	$ 6,191.00
18" RCP FES	EA	1	$ 906.00	$ 906.00
Toe Wall (FES)	EA	1	$ 2,000.00	$ 2,000.00
Outfall Riprap Protection	CY	1	$ 210.00	$ 210.00
Rip Rap Emergency Spillway	CY	71	$ 210.00	$ 14,910.00
Maintenance Road (6" Thick)	CY	115	$ 56.00	$ 6,440.00
Total				$ 92,899.00

Conceptual Opinion of Probable Construction Cost

The Engineer has no control over the cost of labor, materials, equipment, or over the Contractor's methods of determining prices or over competitive bidding or market conditions. Opinions of probable costs provided herein are based on the information known to Engineer at this time and represent only the Engineer's judgment as a design professional familiar with the construction industry. The Engineer cannot and does not guarantee that proposals, bids, or actual construction costs will not vary from its opinions of probable costs.

DRAINAGE MAPS



LEGEND

- PROPERTY LINE
- EX. MAJOR CONTOUR
- EX. MINOR CONTOUR
- EX. SUB–BASIN BOUNDARY
- A = BASIN DESIGNATION
  B = AREA IN ACRES
  C = 5–YR RUNOFF
  D = 100–YR RUNOFF
- # = DESIGN POINT DESIGNATION
- EXISTING SLOPE ARROW
- FLOW DIRECTIONAL ARROW
- REGULATORY FLOODWAY WITHIN ZONE AE
- ZONE AE W/ BFE'S

SUMMARY - EXISTING RUNOFF TABLE

DESIGN POINT	SUB-BASIN	AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)	WEIGHTED COEFF. (C100)	IMP. (%)
On-Site Basins						
E1	E1	9.70	2.52	18.50	0.35	0.0%
E2	E2	19.83	6.83	37.70	0.37	5.2%
E3	E3	20.01	5.52	35.84	0.36	1.9%
E4	E4	10.47	3.92	21.15	0.38	5.8%
Off-Site Basins						
OE1	OE1	30.00	8.24	50.97	0.36	2.9%
OE3	OE3	96.87	22.69	152.22	0.36	1.4%
OE4	OE4	11.20	3.41	21.37	0.36	2.6%
OE5	OE5	8.65	2.41	17.74	0.35	0.0%
OE6	OE6	1.87	1.52	4.82	0.46	25.9%
OE1+E1	**CUMULATIVE**		**10.41**	**66.87**		
OE3+E3	**CUMULATIVE**		**27.57**	**183.89**		
OE4+E4	**CUMULATIVE**		**5.39**	**25.82**		
TOTAL CUMULATIVE FLOW			**54.13**	**336.84**		

OE2

DESIGN POINT OE2 REPRESENTS TOTAL FLOWS FROM A TRIBUTARY OF BLACK SQUIRREL CREEK

TRIBUTARY AREA: ±38 SQ MI
5–YR EVENT: ±358 CFS
100–YR EVENT: ±2,140 CFS

PLEASE REFERENCE FINAL DRAINAGE REPORT NARRATIVE AND ASSOCIATED APPENDIX FOR 'STREAMSTATS' MODEL AND CALCULATIONS

*NOTE THAT THE CALCULATED FLOWS AND BASIN DELINEATION UTILIZE USGS CONTOURS WHICH SERVE TO SHOW A 'HIGH LEVEL' ESTIMATION AND DO NOT TAKE INTO ACCOUNT SOME NEWER DEVELOPMENTS AND STORM INFRASTRUCTURE/DETENTION PONDS WITHIN THE BASIN, THE OVERALL AREA OF THE BASIN AND DEVELOPED FLOWS MAY DIFFER

NORTH

GRAPHIC SCALE IN FEET
0 100 200 400

KRISTEN ESTATES - EXISTING CONDITIONS DRAINAGE MAP

Kimley»Horn

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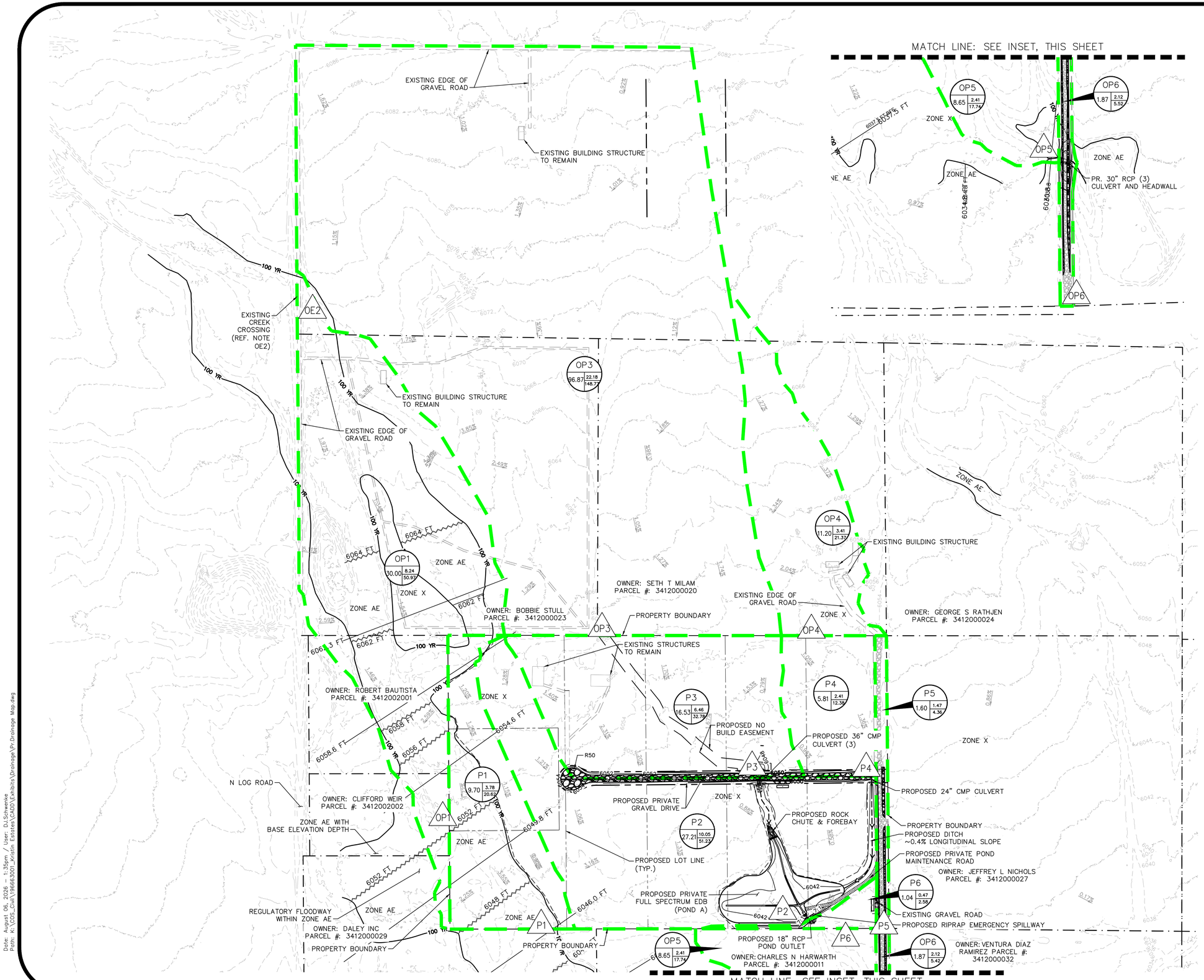

LEGEND

- PROPERTY LINE
- FLOODPLAIN BOUNDARY
- XXXX — EX. MAJOR CONTOUR
- XXXX — EX. MINOR CONTOUR
- XXXX — PROP. MAJOR CONTOUR
- XXXX — PROP. MINOR CONTOUR
- PROPOSED SUB-BASIN BOUNDARY
- PROP. LOT LINE
- PROP. RIGHT-OF-WAY LINE

A = BASIN DESIGNATION
B = AREA IN ACRES
C = % IMPERVIOUSNESS
D = 100-YR RUNOFF

= DESIGN POINT DESIGNATION

- EXISTING SLOPE ARROW
- PROPOSED SLOPE ARROW
- FLOW DIRECTIONAL ARROW
- REGULATORY FLOODWAY WITHIN ZONE AE
- ZONE AE W/ BFE'S

SUMMARY - PROPOSED RUNOFF TABLE

DESIGN POINT	SUB-BASIN	AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)	WEIGHTED COEFF. (C100)	IMP. (%)
On-Site Basins						
P1	P1	9.70	3.78	20.62	0.39	7.0%
P2	P2	25.32	10.05	51.23	0.40	8.6%
P3	P3	16.53	6.46	32.78	0.40	8.7%
P4	P4	5.81	2.41	12.38	0.40	8.4%
P5	P5	1.60	1.47	4.36	0.48	30.2%
P6	P6	1.04	0.47	2.58	0.39	7.0%
Off-Site Basins						
OP1	OP1	30.00	8.24	50.97	0.36	2.9%
OP3	OP3	96.87	22.18	148.77	0.36	1.4%
OP4	OP4	11.20	3.41	21.37	0.36	2.6%
OP5	OP5	8.65	2.41	17.74	0.35	0.0%
OP6	OP6	1.87	2.12	5.52	0.53	41.2%
OP1+P1	**CUMULATIVE**	**11.49**	**68.69**			
OP3+P3	**CUMULATIVE**	**27.75**	**177.08**			
OP4+E4	**CUMULATIVE**	**4.46**	**17.71**			
TOTAL CUMULATIVE FLOW		**60.23**	**344.91**			

OE2

DESIGN POINT OE2 REPRESENTS TOTAL FLOWS FROM A TRIBUTARY OF BLACK SQUIRREL CREEK

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5-YR EVENT: ±358 CFS
100-YR EVENT: ±2,140 CFS

PLEASE REFERENCE FINAL DRAINAGE REPORT NARRATIVE AND ASSOCIATED APPENDIX FOR 'STREAMSTATS' MODEL AND CALCULATIONS

*NOTE THAT THE CALCULATED FLOWS AND BASIN DELINEATION UTILIZE USGS CONTOURS WHICH SERVE TO SHOW A 'HIGH LEVEL' ESTIMATION AND DO NOT TAKE INTO ACCOUNT SOME NEWER DEVELOPMENTS AND STORM INFRASTRUCTURE/DETENTION PONDS WITHIN THE BASIN, THE OVERALL AREA OF THE BASIN AND DEVELOPED FLOWS MAY DIFFER

NORTH

GRAPHIC SCALE IN FEET
0 100 200 400

KRISTEN ESTATES - PROPOSED CONDITIONS DRAINAGE MAP

Kimley»Horn

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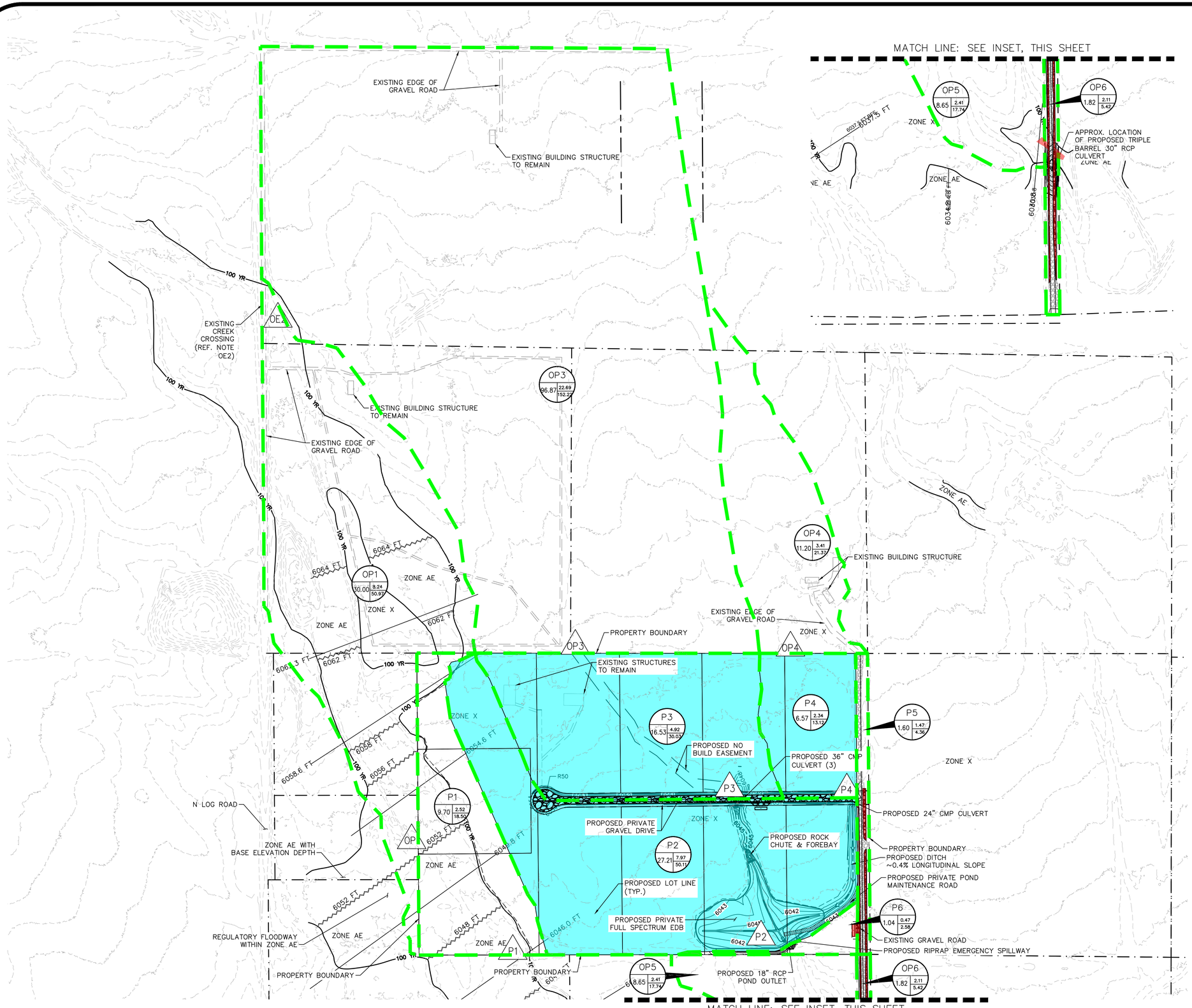

NORTH

GRAPHIC SCALE IN FEET
0 100 200 400

LEGEND

- PROPERTY LINE
- FLOODPLAIN BOUNDARY
- XXXX EX. MAJOR CONTOUR
- XXXX EX. MINOR CONTOUR
- XXXX PROP. MAJOR CONTOUR
- XXXX PROP. MINOR CONTOUR
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A = BASIN DESIGNATION
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C = % IMPERVIOUSNESS
D = 100-YR RUNOFF

\# = DESIGN POINT DESIGNATION

X.XX% EXISTING SLOPE ARROW

X.XX% PROPOSED SLOPE ARROW

FLOW DIRECTIONAL ARROW

REGULATORY FLOODWAY WITHIN ZONE AE

ZONE AE W/ BFE'S

AREA TRIBUTARY TO PROPOSED FULL SPECTRUM EDB

ROADWAY AREA NOT TREATED (SEE NOTE 2)

NOTES:
1. NON-ROADWAY AREAS NOT TREATED BY A PBMP ARE EXCLUDED BASED ON ECM APP I.7.1.B.5. THE PORTION OF THE AREA NOT WITHIN THE DRAINAGE EASEMENT WILL BE PART OF A "LARGE LOT" 2.5 ACRES OR GREATER WITH AND IMPERVIOUS PERCENTAGE LESS THAN 10%
2. ROADWAY AREA NOT TREATED BY A PBMP TOTALS 0.637 ACRES AND IS EXCLUDED BASED ON ECM APP I.7.1.C.1.

OE2

DESIGN POINT OE2 REPRESENTS TOTAL FLOWS FROM A TRIBUTARY OF BLACK SQUIRREL CREEK

TRIBUTARY AREA: ±38 SQ MI
5-YR EVENT: ±358 CFS
100-YR EVENT: ±2,140 CFS

PLEASE REFERENCE FINAL DRAINAGE REPORT NARRATIVE AND ASSOCIATED APPENDIX FOR 'STREAMSTATS' MODEL AND CALCULATIONS

*NOTE THAT THE CALCULATED FLOWS AND BASIN DELINEATION UTILIZE USGS CONTOURS WHICH SERVE TO SHOW A 'HIGH LEVEL' ESTIMATION AND DO NOT TAKE INTO ACCOUNT SOME NEWER DEVELOPMENTS AND STORM INFRASTRUCTURE/DETENTION PONDS WITHIN THE BASIN, THE OVERALL AREA OF THE BASIN AND DEVELOPED FLOWS MAY DIFFER

KRISTEN ESTATES - EXCLUSIONS MAP

Kimley»Horn

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