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Engineering Review
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Final Drainage Report

Tract DD, Hannah Ridge at Feathergrass Filing No. 1 El Paso County, Colorado

Prepared for:
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Project #: 096302009

Prepared: January 29, 2021

Add PCD File Number: PPR-21-017

Kimley»Horn

CERTIFICATION

DESIGN ENGINEER'S STATEMENT

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

SIGNATURE (Affix Seal): ____
Colorado P.E. No. 49487 Date

OWNER/DEVELOPER'S STATEMENT

I, the developer, have read and will comply with all of the requirements specified in this Drainage Report and Plan.

____
Name of Developer

____
Authorized Signature Date

____
Printed Name

____
Title

____
Address:

EL PASO COUNTY

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.

____ ______________________
Jennifer Irvine, P.E. Date
County Engineer/ ECM Administrator

Conditions:

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INTRODUCTION

PURPOSE AND SCOPE OF STUDY

The purpose of this Final Drainage Report (FDR) is to provide the hydrologic and hydraulic calculations and to document and finalize the drainage design methodology in support of the proposed Tract DD of Hannah Ridge at Feathergrass ("the Project") Filing No. 1 ("the Site") for Watermark Residential. 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 for the County and City of Colorado Springs, described below.

LOCATION

The 15.39-acre parcel (TSN: 53324-04-001) is located at the northwest corner of the Marksheffel Road and Constitution Avenue intersections. The site is also adjacent to Akers Drive at its terminus with Constitution Avenue on the westernmost site boundary. A vicinity map has been provided in the **Appendix A** of this report.

DESCRIPTION OF PROPERTY

The Project is located on approximately 15.39 acres of land consisting of vacant land with native vegetation and is classified as "Undeveloped" per Table 6-6 of the City of Colorado Springs Drainage Criteria Manual. Filing No 1 consists of 9 multi-family buildings, 12 garage buildings, a front office building, and a clubhouse amenity space with a pool deck. The Site does not currently provide water quality or detention for the Project area. The existing land use is undeveloped vacant land.

The existing topography consists of slopes ranging from 1% to 40% and generally slopes from North to South.

NRCS soil data is available for this Site and it has been noted that soils onsite are generally USCS Type A/B. The NRCS soil data can be found in **Appendix B**. There are no major drainage ways or irrigation facilities within the Site.

Improvements will consist of mowing, clearing and grubbing, weed control, paved access road construction, roadway grading, one detention ponds, culverts, drainage swales, and native seeding.

An updated Topographic field survey was completed for the Project by Barren Land, LLC. dated September 23, 2020 and is the basis for design for the drainage improvements.

DRAINAGE BASINS

MAJOR BASIN DESCRIPTIONS

The Site improvements are located in Zone X, as determined by the Flood Insurance Rate Map (FIRM) number 08041C0756G effective date, December 7, 2018 (see **Appendix A**).

The Project is located within El Paso County's Sand Creek Drainage Basin.

EXISTING SUB-BASIN DESCRIPTIONS

Site runoff flows from north to south via sheet flow over vacant land to Constitution Ave. Below is a description of the existing onsite sub-basin.

Add the offsite basins

is currently(?)

Sub-Basin EX-A

Sub-Basin EX-A consists of the entirety of the 15.39-acre multi-family development. Drainage flows overland from North to South and conveys along the southern boundary to the West at Design Point 1. Runoff during the 5-year and 100-year events are 3.92 cfs and 28.77 cfs respectively. Runoff from this basin will be directed to design point 1 where it will drain into the crosspan along the north side of Constitution Avenue across Akers Drive, where it conveys into an existing drainage channel that runs underneath Constitution Avenue to the South. This sub-basin has an area of 15.39 acres. The impervious value for this basin is 2%. Refer to **Appendix D** for the Existing Conditions Drainage Map.

inlet and storm drain system

PROPOSED RATIONAL SUB-BASIN DESCRIPTIONS

Sub-Basin B1 consists of a portion of the multi-family development in a portion of the west half of the site. Runoff from this basin will be directed to design point B1 where it will drain into the full spectrum detention South Pond, which will outfall through the proposed outlet structure to the west into an existing 24-inch storm drain pipe. This sub-basin has an area of 2.97 acres. The impervious value for this basin is 100%. The basin will generate runoff of 13.80 cfs and 24.69 cfs in the minor and major storm event.

Address quantity and where offsite runoff from the north goes.

Sub-Basin B2 consists of the a portion of landscaping, club house, and building unit in the west side of the site. Runoff from this basin will be directed to Swale B2 which will outfall to Culvert 1 at design point B2 and ultimate outfall into the South Pond. This sub-basin has an area of 1.02 acres. The impervious value for Sub-Basin DA2 is 16%. The basin will generate runoff of 0.80 cfs and 3.11 cfs in the minor and major storm event.

Sub-Basin B3 consists of a portion of a roof of a proposed building unit. Runoff from this basin will be directed into the proposed storm drain system where it will be directed to the South Pond. This sub-basin has an area of 0.16 acres. The impervious value for Sub-Basin DA3 is 90%. The basin will generate runoff of 0.61 cfs and 1.13 cfs in the minor and major storm event.

Sub-Basin B4 consists of landscaping, sidewalk and a parking lot. Runoff from this basin will be directed into design point B4 and where it will be directed to the west through a curb cut and outfall to a Swale B5. This sub-basin has an area of 0.23 acres. The impervious value for Sub-Basin DA4 is 100%. The basin will generate runoff of 1.08 cfs and 1.93 cfs in the minor and major storm event.

Sub-Basin B5 consists of landscaping at the west side of the site. Runoff from this basin will be directed into design point B5 and where it will be directed the South Pond. This sub-basin has an area of 0.16 acres. The impervious value is 2%. The basin will generate runoff of 0.05 cfs and 0.37 cfs in the minor and major storm event.

Sub-Basin B6 consists of a portion of a roof of a proposed building unit. Runoff from this basin will be directed into the proposed storm drain system where it will be directed to the South Pond. This sub-basin has an area of 0.13 acres. The impervious value for Sub-Basin DA6 is 90%. The basin will generate runoff of 0.49 cfs and 0.91 cfs in the minor and major storm event.

Sub-Basin B7 consists of the South Pond and portions of the roofs of the proposed building units. This sub-basin has an area of 1.66 acres. The impervious value for this basin is 17%. The basin will generate runoff of 1.58 cfs and 5.91 cfs in the minor and major storm event.

Sub-Basin B8 consists of a portion of a roof of a proposed building unit. Runoff from this basin will be directed into the proposed storm drain system where it will be directed to the South Pond. This sub-basin has an area of 0.16 acres. The impervious value for this basin is 90%. The basin will generate runoff of 0.62 cfs and 1.15 cfs in the minor and major storm event.

Sub-Basin B9 consists of a portion of the multi-family development in a portion of the east half of the site. Runoff from this basin will be directed into design point B9 where it will be directed to the South Pond. This sub-basin has an area of 4.10 acres. The impervious value for this basin is 100%. The basin will generate runoff of 16.87 cfs and 30.19 cfs in the minor and major storm event.

Sub-Basin B10 consists of landscaping and roofs of the multiple building units. Runoff from this basin will be directed into design point B10 where it will be capture by an inlet and directed to the South Pond via storm drain system. This sub-basin has an area of 0.94 acres. The impervious value for this basin is 41%. The basin will generate runoff of 1.59 cfs and 4.01 cfs in the minor and major storm event.

Sub-Basin B11 consists of a portion of a roof of a proposed building unit. Runoff from this basin will be directed into the proposed storm drain system where it will be directed to the South Pond. This sub-basin has an area of 0.16 acres. The impervious value for this basin is 90%. The basin will generate runoff of 0.61 cfs and 1.14 cfs in the minor and major storm event.

Sub-Basin B12 consists of a portion of a roof of a proposed building unit. Runoff from this basin will be directed into the proposed storm drain system where it will be directed to the South Pond. This sub-basin has an area of 0.15 acres. The impervious value for this basin is 90%. The basin will generate runoff of 0.56 cfs and 1.05 cfs in the minor and major storm event.

Sub-Basin B13 consists of a portion of a roof of a proposed building unit. Runoff from this basin will be directed into the proposed storm drain system where it will be directed to the South Pond. This sub-basin has an area of 0.11 acres. The impervious value for this basin is 90%. The basin will generate runoff of 0.41 cfs and 0.76 cfs in the minor and major storm event.

Sub-Basin B14 consists of a portion of a roof of a proposed building unit. Runoff from this basin will be directed into the proposed storm drain system where it will be directed to the South Pond. This sub-basin has an area of 0.11 acres. The impervious value for this basin is 90%. The basin will generate runoff of 0.43 cfs and 0.80 cfs in the minor and major storm event.

Sub-Basin B15 consists of landscaping and roofs of the multiple building units. Runoff from this basin will be directed into design point B15 where it will be capture by an inlet and directed to the South Pond via storm drain system. This sub-basin has an area of 0.86 acres. The impervious value for this basin is 42%. The basin will generate runoff of 1.57 cfs and 3.93 cfs in the minor and major storm event.

Sub-Basin B16 consists of a portion of a roof of a proposed building unit. Runoff from this basin will be directed into the proposed storm drain system where it will be directed to the South Pond. This sub-basin has an area of 0.14 acres. The impervious value for this basin is 90%. The basin will generate runoff of 0.52 cfs and 0.97 cfs in the minor and major storm event.

Sub-Basin B17 consists of a portion of a roof of a proposed building unit. Runoff from this basin will be directed into the proposed storm drain system where it will be directed to the South Pond. This sub-basin has an area of 0.14 acres. The impervious value for this basin is 90%. The basin will generate runoff of 0.51 cfs and 0.95 cfs in the minor and major storm event.

Sub-Basin B18 consists of landscaping. Runoff from this basin will be directed into design point B18 and where it outfalls into the full spectrum detention South Pond. This sub-basin has an area of 1.09 acres. The impervious value for this basin is 2%. The basin will generate runoff of 0.27 cfs and 1.96 cfs in the minor and major storm event.

Address quantity and where offsite runoff from the north goes.

DRAINAGE DESIGN CRITERIA

DEVELOPMENT CRITERIA REFERENCE

The proposed storm facilities are designed to be in compliance with the City of Colorado Springs and El Paso County "Drainage Criteria Manual (DCM)" dated October 2018 ("the MANUAL"), El Paso County "Engineering Criteria Manual" ("the Engineering Manual"), Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs Drainage Criteria Manual dated May 2014 ("the Colorado Springs MANUAL").

There are no known master plans or studies for the site.

HYDROLOGIC CRITERIA

The 5-year and 100-year design storm events were used in determining rainfall and runoff for the existing and proposed drainage analysis per the MANUAL. The rainfall depths for site were determined from equation 6-1, equation 6-2 utilizing Figures 6-6, 6-11, 6-12, and 6 -17 from the DCM. Refer to **Table 1** below for the rainfall depths utilized for the site and **Appendix B** for the hydrologic calculations for the site.

Table 1: ***Rainfall Depths***

	Duration (HRS)
Storm Event	**1 HR**
5 Year	1.52
100 Year	2.55

Calculations for the runoff coefficients and percent impervious are included in the **Appendix B**. Rational method was used to determine the peak flows for the project. These flows were used to determine the size of the proposed curb cuts, inlets, culvert, storm drain system and on-site swales.

The proposed impervious values in Table 6-6 of the DCM were utilized in this report for the final design. Refer to **Appendix B** of this report for Table 6-6.

The Site is providing one full spectrum detention pond. The Site is maintaining the historic drainage patterns as much as possible.

There are no additional provisions selected or deviations from the criteria in both the MANUAL and Colorado Springs MANUAL.

HYDRAULIC CRITERIA

Applicable design methods were utilized to size the proposed pond, culvert and drainage swales, which includes the use of the UD-Detention spreadsheet, UD-Inlet spreadsheet, rational calculations spreadsheet, StormCAD, HY-8 and FlowMaster, V8i software.

Proposed drainage features on-site have been analyzed and sized for the following design storm events:

- Major Storm: 100-year Storm Event

One full spectrum detention pond is proposed in order to maintain historic flows and water quality. The detention pond known as the South Pond. The South Pond is in the southwest corner of the Site with a proposed volume of 1.5 ac-ft and designed for the 100-year storm event. With a discharge rate of 21.9 cfs, water from the South Pond is discharged into an existing 24-inch storm drain located at the southwest corner of the site and ultimately out falling to Sand Creek (Sand Creek's East Fork). Pond calculations are provided in the **Appendix C**.

Curb cuts, inlets, grass lined swales, and storm drain pipes are designed to carry flows from to the South Pond. The curb cuts, inlets, swales, and storm drain pipes calculations are provided in the **Appendix C** and the design points are provided in the Proposed Drainage Map located in **Appendix D**.

Address downstream conveyances for 100-year flows and emergency conditions.

THE FOUR STEP PROCESS

The Project was designed in accordance with the four-step process to minimize adverse impacts of urbanization, as outlined in Chapter 1 Section 4.0 of the Colorado Springs MANUAL.

Please use the County's "Four-Step Process" for selecting structural BMPs (ECM Section I.7.2 BMP Selection)

Step 1. Employ Runoff Reduction Practices- The project is proposing a residential development that will be designed to minimize the impact to the current existing terrain. The Site's proposed paved roadways will increase the Site's impervious area; however, drainage swales will be constructed to slow down the runoff velocity and reduce runoff peaks. A full spectrum detention pond will be used to capture stormwater and maintain flows discharging off site at or below historic levels.

Step 2. Implement BMPs That Provide a Water Quality Capture Volume with Slow Release –Permanent water quality measures and detention facilities will be necessary for the Project. Temporary water quality and erosion control measures will be provided during construction to prevent sediment laden water from discharging from the Site.

Step 3 Stabilize Drainageways– Stabilizing proposed drainage swales by designing them with slopes that control the flow rates. Placement of riprap upstream and downstream of culverts to help reduce erosion of the drainage swales. Rock chutes will be constructed to reduce the velocities of runoff entering the ponds at the channel locations. We anticipate this will minimize erosion.

Step 4. Implement Site Specific and Other Source Control BMPs – The erosion control construction BMPs of the Project were designed to reduce contamination. Source control BMPs include the use of vehicle tracking control, culvert protection, stockpile management, and stabilized staging areas.

DRAINAGE FACILITY DESIGN

GENERAL CONCEPT

The proposed drainage patterns will match the historic patterns. To maintain historic flows, a full spectrum detention pond is being proposed and will capture and control the flows from the proposed development to convey flows with a series of swales, parking lot sheet flow, and a storm drain system.

Provided in the **Appendix B** are hydrologic calculations utilizing the Rational method for the existing and proposed conditions. Provided in **Appendix C** are the hydraulic calculations for the proposed conditions HY-8 culvert calculations, Flowmaster details and cross sections for proposed drainage features. As previously mentioned, the and existing drainage map and proposed drainage map can be found in **Appendix D.**

SPECIFIC DETAILS

The existing conditions of the Site have flows conveying from the north to the south corner and spill into Constitution Ave. Runoff conditions for the Site were developed utilizing the Rational Method described in the Hydrologic Criteria section of this report.

Sub-basins B1 through B18 consist of a future multi-family buildings and detention pond. All basins have flows being captured and conveyed onsite. Flows are conveyed from the north side of the Site to the southwest corner of the Site. On site flows enter South Pond which then discharges into an existing 24-inch storm drain pipe at the northeast corner of Constitution Ave and Akers Drive.

The hydrologic calculations, hydraulic calculations, and Drainage Maps are included in the **Appendix B, Appendix C,** and **Appendix D** of this report for reference.

not correct

The Site will disturb more than 1 acre and will require a Colorado Discharge Permit System (CDPS) General Permit for Stormwater Discharge Associated with Construction Activities from the Colorado Department of Public Health and Environment (CDPHE).

There are no current drainage and fees for the Project as the fees were paid when the initial plat for the site was completed.

Check with Classic to see if drainage credits will be allocated to this site. If not, drainage fees will be due.

SUMMARY

The proposed drainage design is to maintain the historic drainage patterns, the overall imperviousness and release rates for the Site. Runoff from the Site will flow through an existing storm drain system to an existing El Paso County drainage basin: The Sand Creek Basin. The basin ultimately discharges to Sand Creek. The drainage design presented within this report conforms to the criteria presented in both the MANUAL and the Colorado Springs MANUAL. Additionally, the Site runoff and storm drain facilities will not adversely affect the downstream and surrounding developments, including Sand Creek.

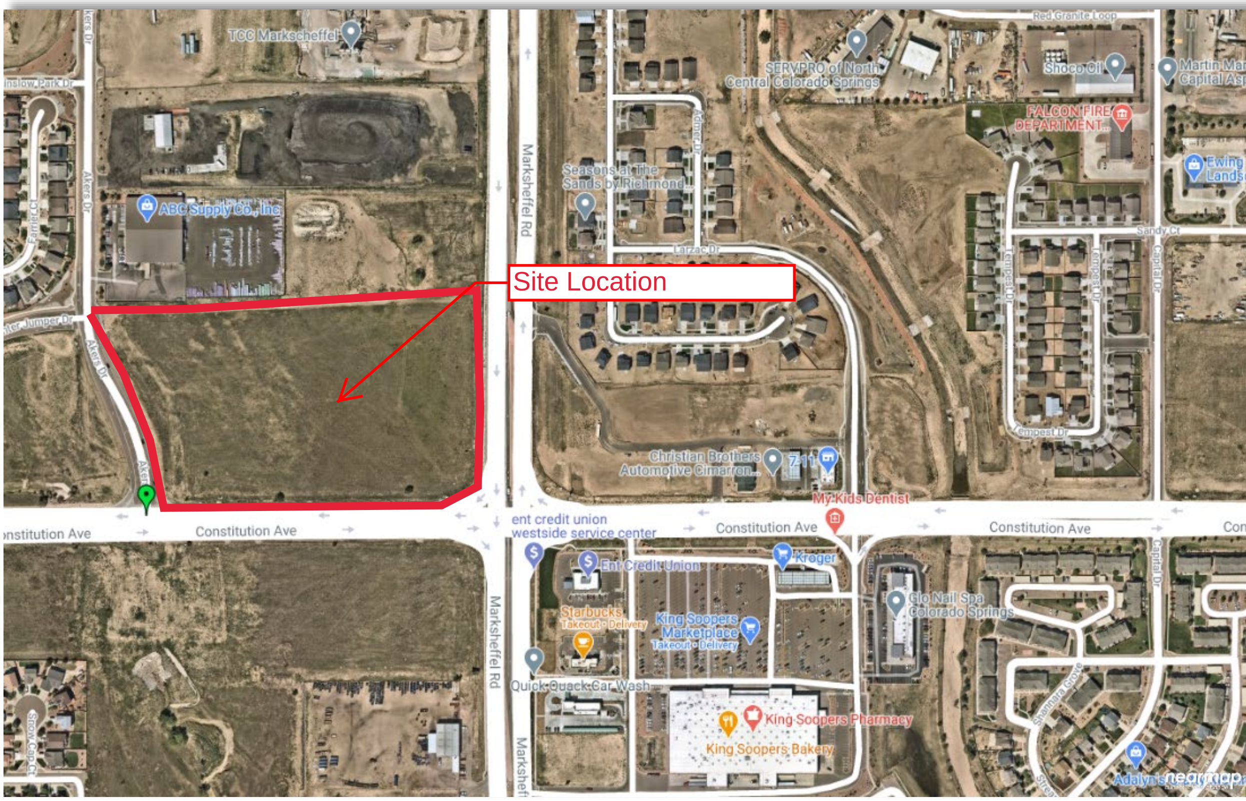
REFERENCES

1. City of Colorado Springs “Drainage Criteria Manual (DCM) Volume 1”, dated May, 2014
2. El Paso County “Drainage Criteria Manual”, dated October 31, 2018
3. El Paso County “Engineering Criteria Manual” Revision 6, dated December 13, 2016
4. Chapter 6 and Section 3.2.1. of Chapter 13-City of Colorado Springs Drainage Criteria Manual, May 2014.
5. Urban Drainage and Flood Control District Drainage Criteria Manual (UDFCDCM), Vol. 1, prepared by Wright-McLaughlin Engineers, June 2001, with latest revisions.
6. Flood Insurance Rate Map, El Paso County, Colorado and Incorporated Areas, Map Number 08041C0756G, Effective Date December 7, 2018, prepared by the Federal Emergency Management Agency (FEMA).

APPENDIX

APPENDIX A: FIGURES

Vicinity Map



National Flood Hazard Layer FIRMette

FEMA

104°41'25"W 38°52'21"N

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

1:6,000

104°40'48"W 38°51'53"N

Legend

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

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

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

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

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

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

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 1/5/2021 at 5:09 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.

APPENDIX B: HYDROLOGY

United States Department of Agriculture

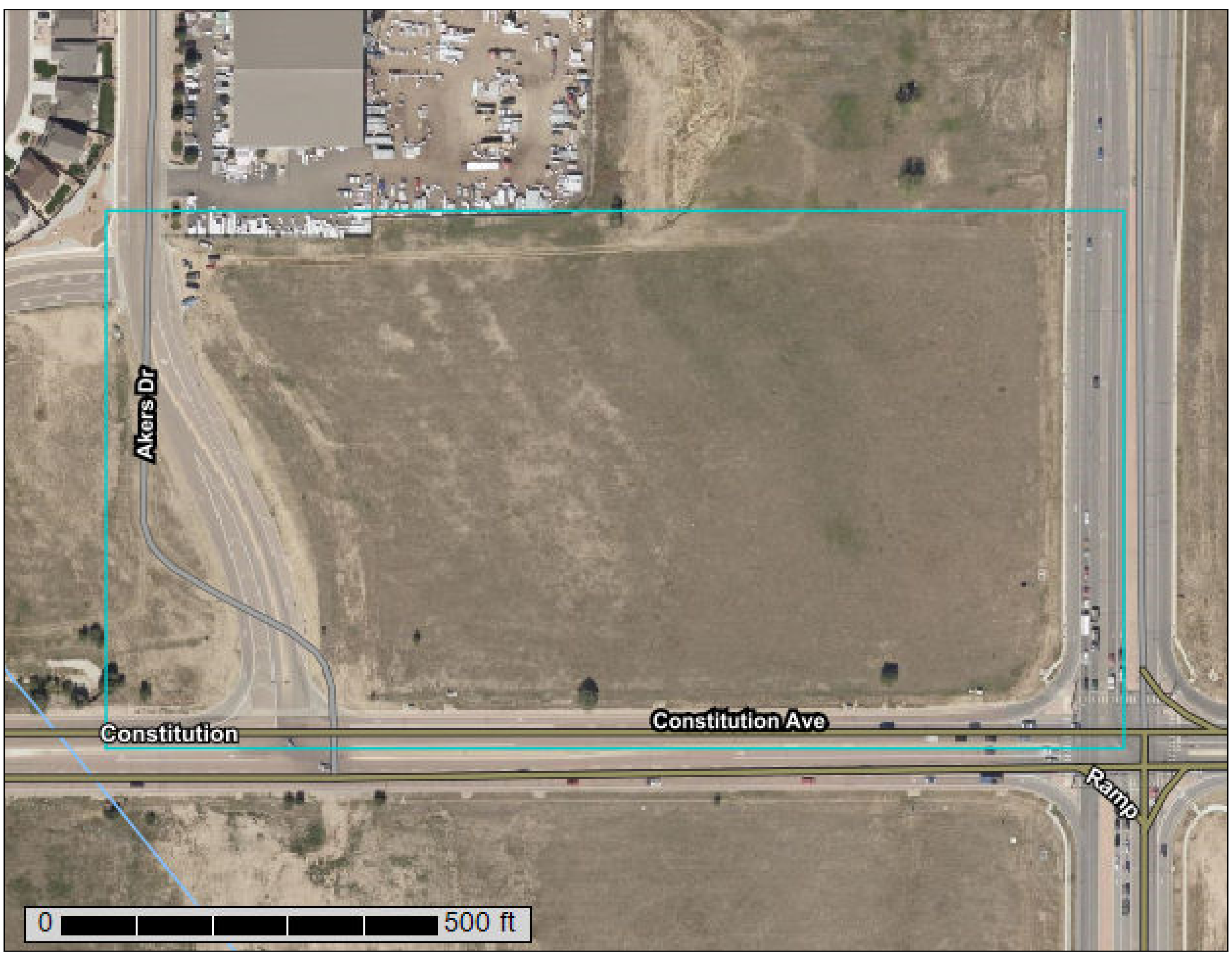
NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for

El Paso County Area, Colorado



December 24, 2020

Preface

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

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

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

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

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

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

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

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How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

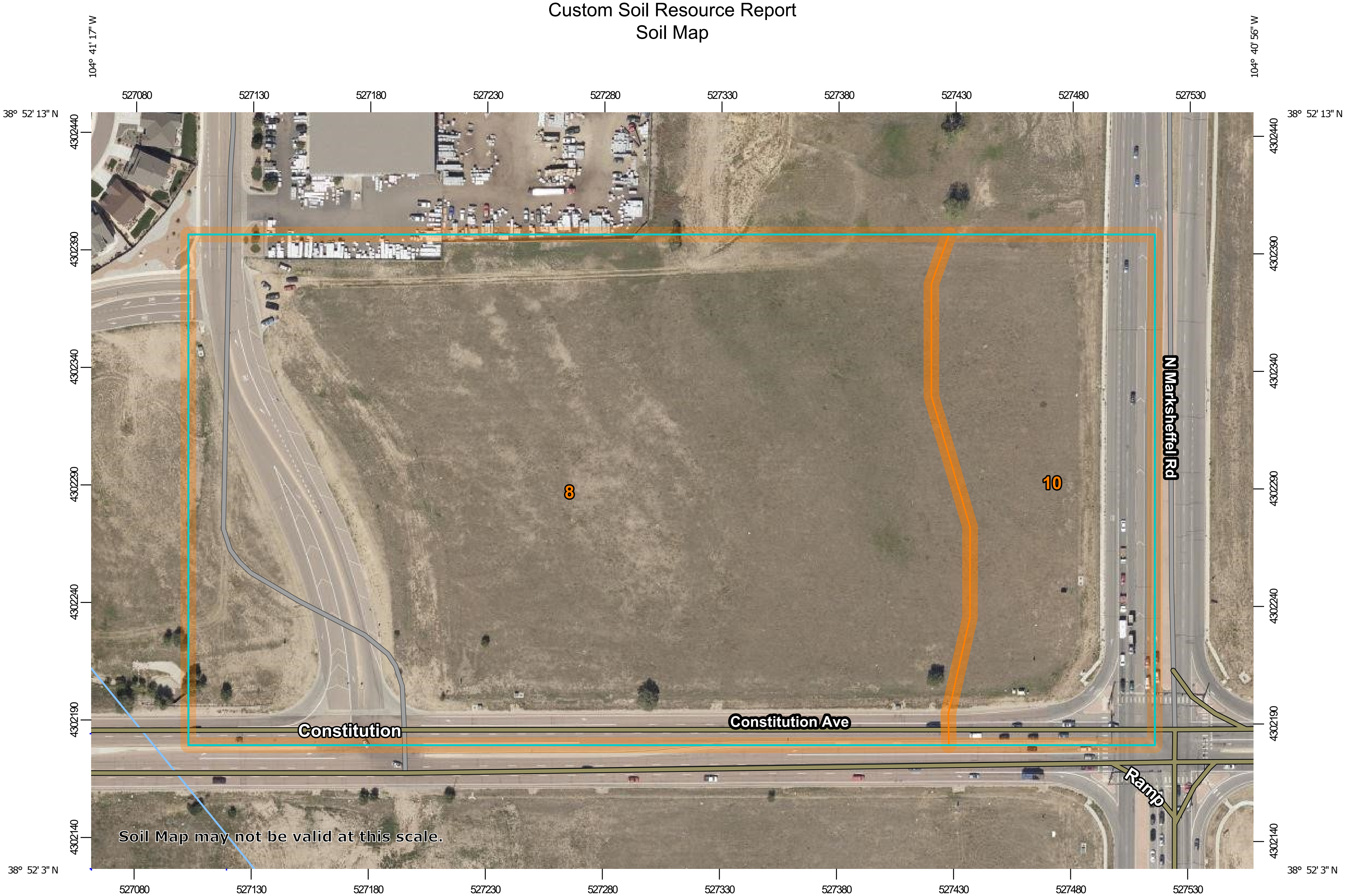
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree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

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

Soil Map

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

Soil Map



Map Scale: 1:2,270 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 30, 60, 120, 180

Feet: 0, 100, 200, 400, 600

N

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 18, Jun 5, 2020

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

Date(s) aerial images were photographed: Aug 19, 2018—Sep 23, 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
8	Blakeland loamy sand, 1 to 9 percent slopes	17.5	78.8%
10	Blendon sandy loam, 0 to 3 percent slopes	4.7	21.2%
Totals for Area of Interest		**22.3**	**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

8—Blakeland loamy sand, 1 to 9 percent slopes

Map Unit Setting

National map unit symbol: 369v
Elevation: 4,600 to 5,800 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition

Blakeland and similar soils: 98 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blakeland

Setting

Landform: Hills, flats
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock and/or eolian deposits derived from sedimentary rock

Typical profile

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

Properties and qualities

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

Interpretive groups

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

Minor Components

Pleasant

Percent of map unit: 1 percent

Landform: Depressions
Hydric soil rating: Yes

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

10—Blendon sandy loam, 0 to 3 percent slopes

Map Unit Setting
National map unit symbol: 3671
Elevation: 6,000 to 6,800 feet
Mean annual precipitation: 14 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 125 to 145 days
Farmland classification: Not prime farmland

Map Unit Composition
Blendon and similar soils: 98 percent
Minor components: 2 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blendon

Setting
Landform: Terraces, alluvial fans
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Sandy alluvium derived from arkose

Typical profile
A - 0 to 10 inches: sandy loam
Bw - 10 to 36 inches: sandy loam
C - 36 to 60 inches: gravelly sandy loam

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 2 percent
Available water capacity: Moderate (about 6.2 inches)

Interpretive groups
Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: B
Ecological site: R049XB210CO - Sandy Foothill
Hydric soil rating: No

Minor Components

Pleasant

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

Other soils

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

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The methods described in this Manual require only that the 1-hour, 6-hour and 24-hours depths be used as input. The storm return periods required for the application of methods in this Manual are the 2-, 5-, 10-, 25-, 50- and 100-year events. The 6-hour and 24-hour depths for these return periods can be read directly from Figures 6-6 through 6-17 at the end of this chapter. The1-hour depth for return periods can be calculated for all design return periods following this procedure:

Step 1: Calculate 2-year, 1-hour rainfall based on 2-year, 6-hour and 24-hour values.

$$Y_2 = 0.218 + 0.709 \cdot (X_1 \cdot X_1 / X_2) \qquad \text{(Eq. 6-1)}$$

Where:

Y_2 = 2-year, 1-hour rainfall (in)

X_1 = 2-year, 6-hour rainfall (in) from Figure 6-6

X_2 = 2-year, 24-hour rainfall (in) from Figure 6-12

Step 2: Calculate 100-year, 1-hour rainfall based on 2-year 6-hour and 24-hour values

$$Y_{100} = 1.897 + 0.439 \cdot (X_3 \cdot X_3 / X_4) - 0.008\ Z \qquad \text{(Eq. 6-2)}$$

Where

Y_{100} = 100-year, 1-hour rainfall (in)

X_3 = 100-year, 6-hour rainfall (in) from Figure 6-11

X_4 = 100-year, 24-hour rainfall (in) from Figure 6-17

Z = Elevation in hundreds of feet above sea level

Step 3: Plot the 2-year and 100-year, 1-hour values on the diagram provided in Figure 6-18 and connect the points with a straight line. The 1-hour point rainfall values for other recurrence intervals can be read directly from the straight line drawn on Figure 6-18.

Example: Determine the 10-year, 1-hour rainfall depth for downtown Colorado Springs.

Step 1*:* Calculate 2-year, 1-hour rainfall (Y_2) based on 2-year, 6-hour and 24-hour values. From Figure 6-6, the 2-year, 6-hour rainfall depth for downtown Colorado Springs is approximately 1.7 inches (X_1), and from Figure 6-12, the 2-year 24-hour depth is approximately 2.1 inches (X_2). The 2-year, 1-hour rainfall is calculated as follows:

$$Y_2 = 0.218 + 0.709 \cdot (1.7 \cdot 1.7 / 2.1) = 1.19 \text{ in} \qquad \text{(Eq. 6-3)}$$

Step 2*:* Calculate 100-year, 1-hour rainfall (Y_{100}) based on 100-year, 6-hour and 24-hour values. From Figure 6-11, the 100-year, 6-hour rainfall depth for downtown Colorado Springs is approximately 3.5 inches (X_3), and from Figure 6-17, the 100-year 24-hour depth is approximately 4.5 inches (X_4). Assume an elevation of 6,840 feet for Colorado Springs. The 100-year, 1-hour rainfall is calculated as follows:

$$Y_{100} = 1.897 + 0.439 \cdot (3.5 \cdot 3.5 / 4.6) - 0.008 \cdot (6{,}840/100) = 2.52 \text{ in} \qquad \text{(Eq. 6-4)}$$

Step 3*:* Plot 2-year and 100-year, 1-hour rainfall depths on Figure 6-18 and read 10-year value from straight line. This example is illustrated on Figure 6-18, with a 1-hour, 10-year rainfall depth of approximately 1.75 inches. Figure 6-18a provides the example, and Figure 6-18b provides a blank chart.

Figure 6-6. 2-Year, 6-Hour Precipitation Tenths of an Inch (NOAA Atlas 2)

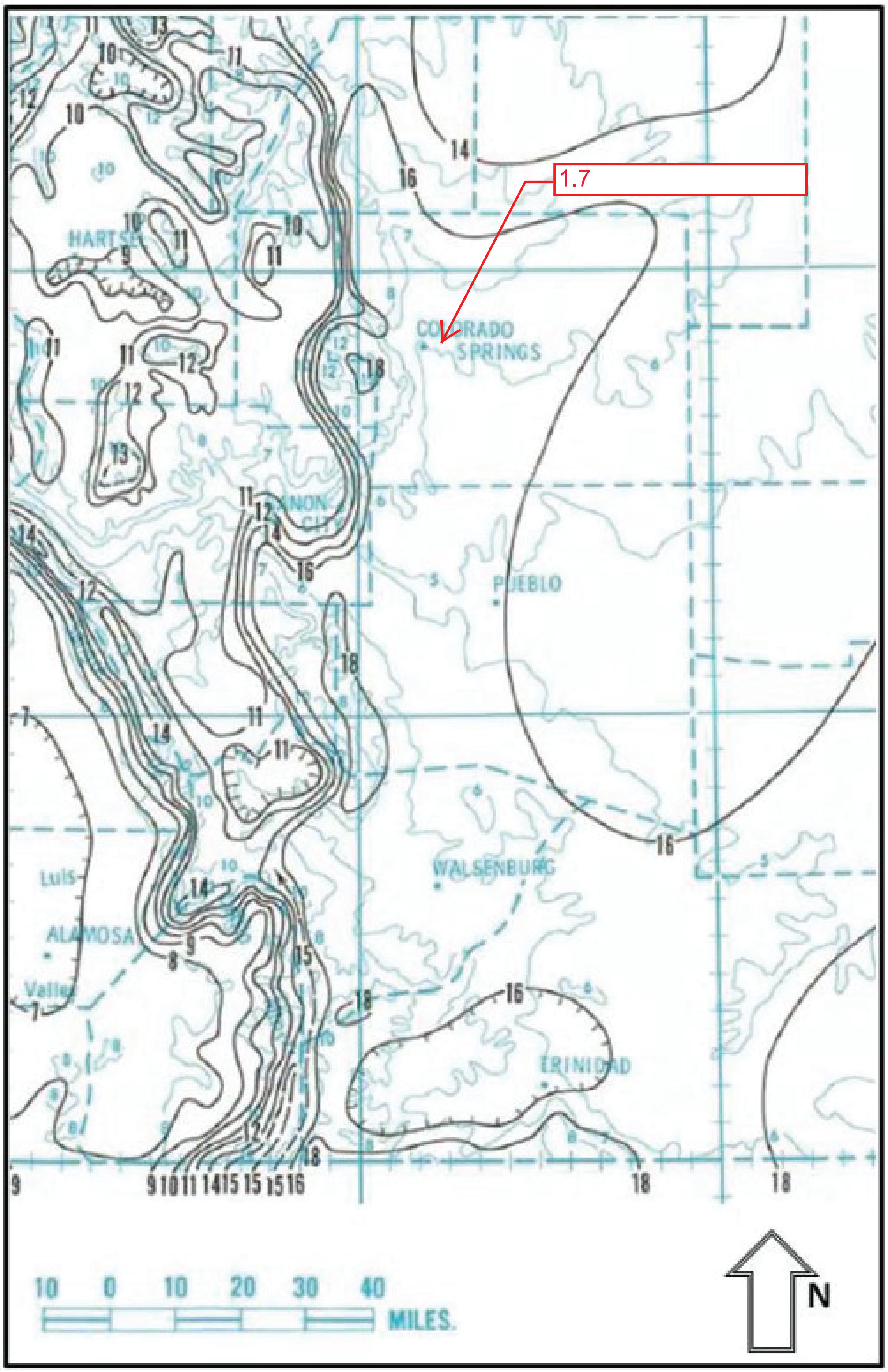


Figure 6-12. 2-Year, 24-Hour Precipitation Tenths of an Inch (NOAA Atlas 2)

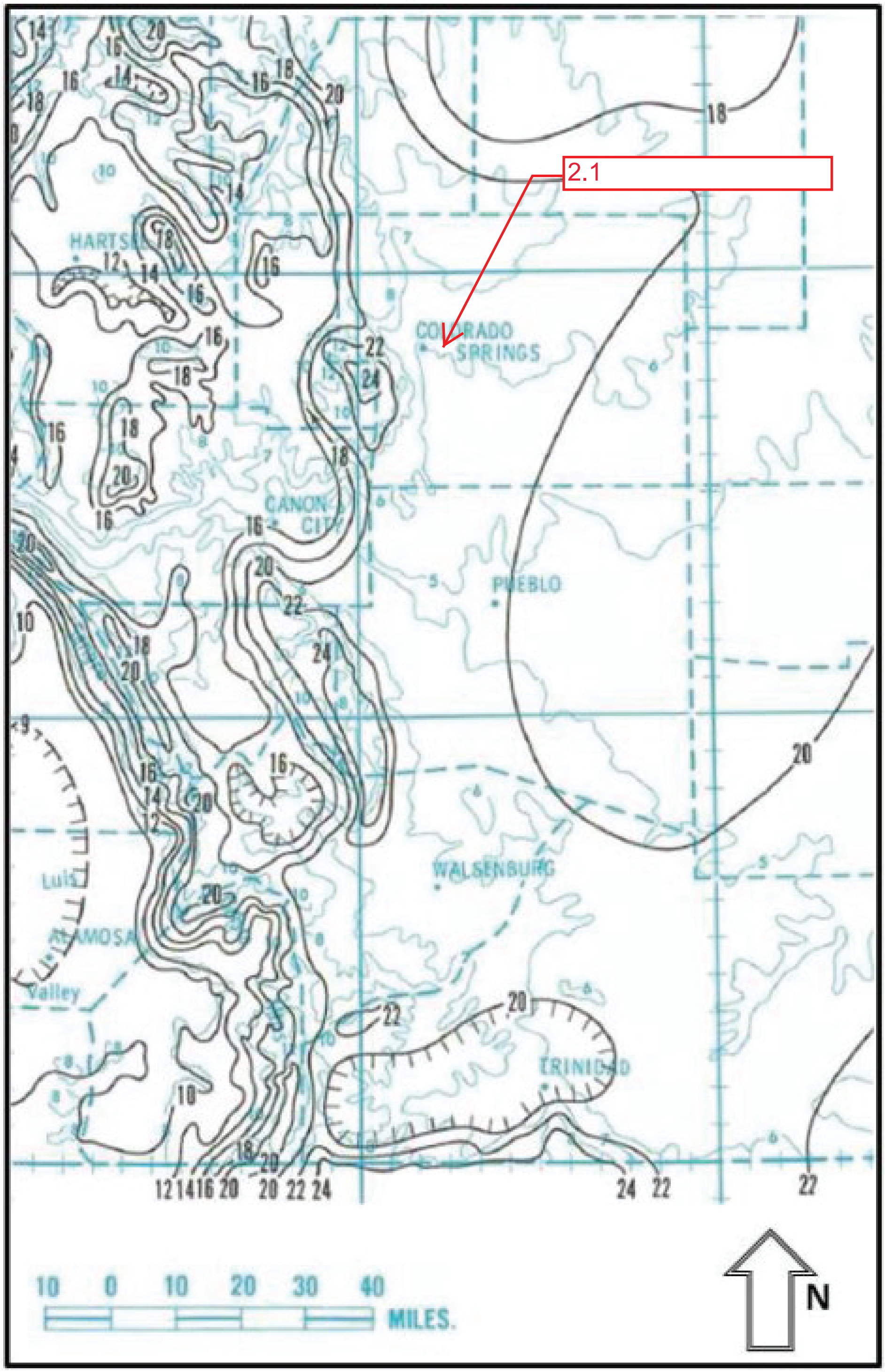


Figure 6-11. 100-Year, 6-Hour Precipitation Tenths of an Inch (NOAA Atlas 2)

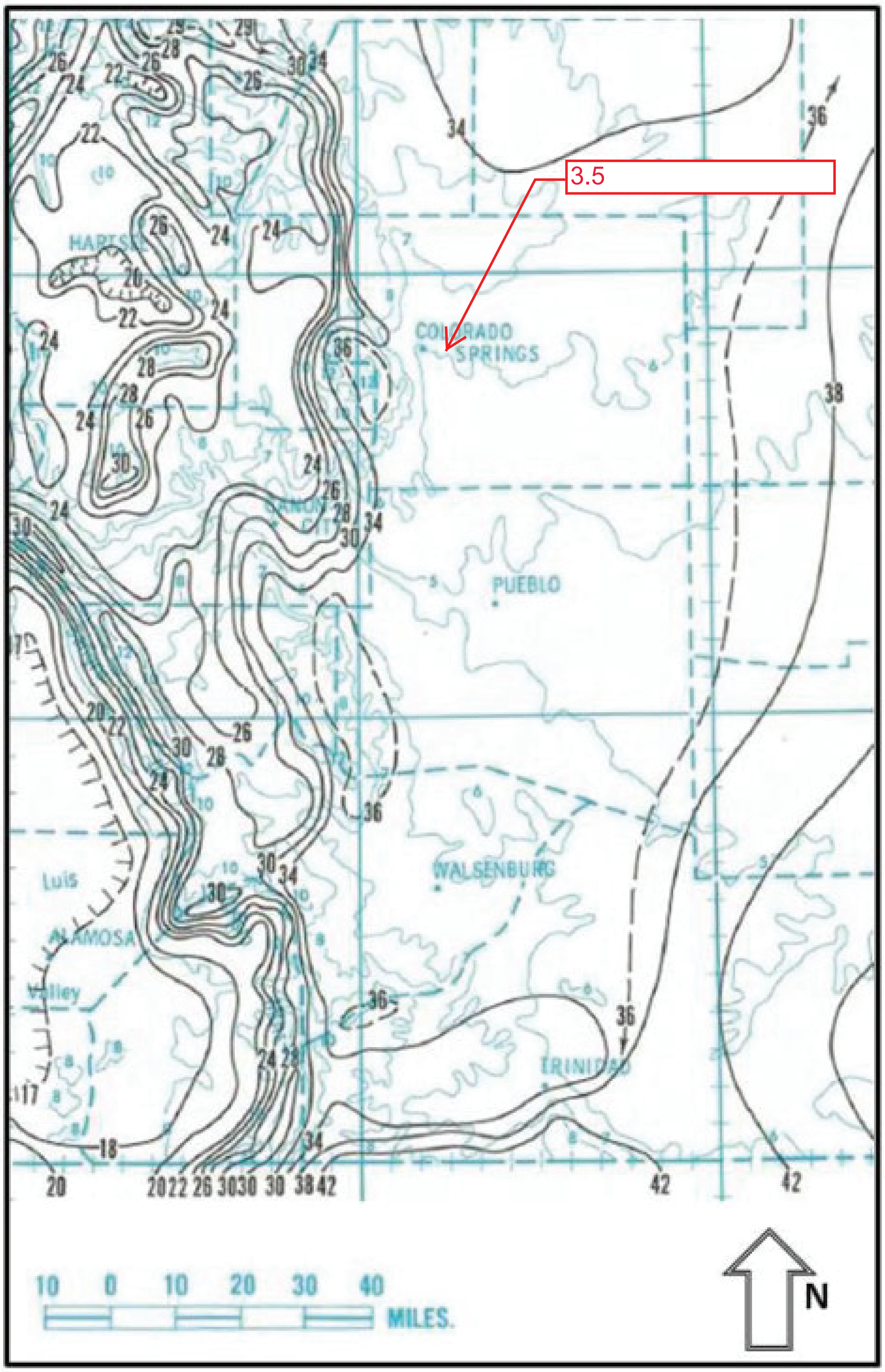
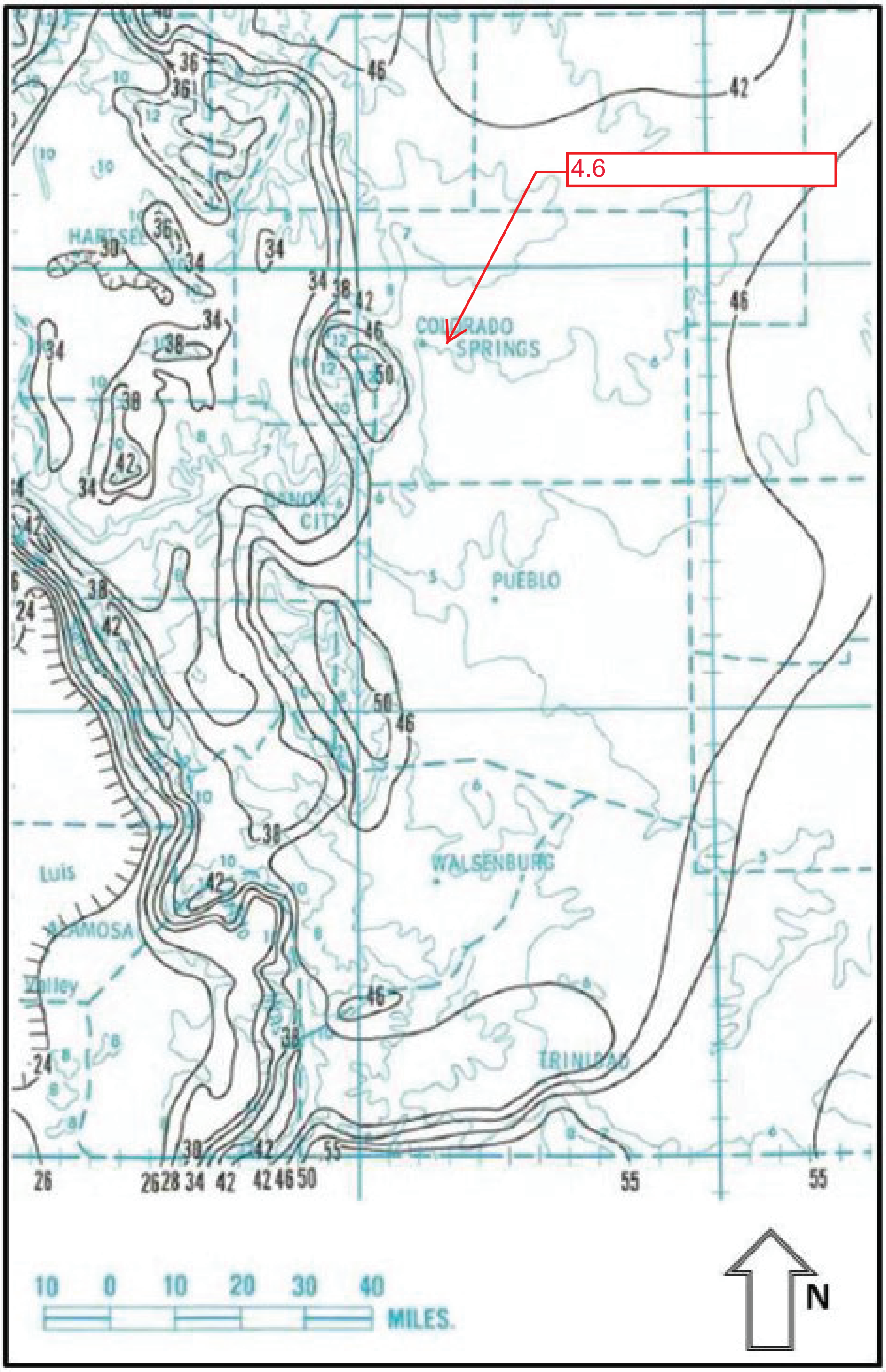
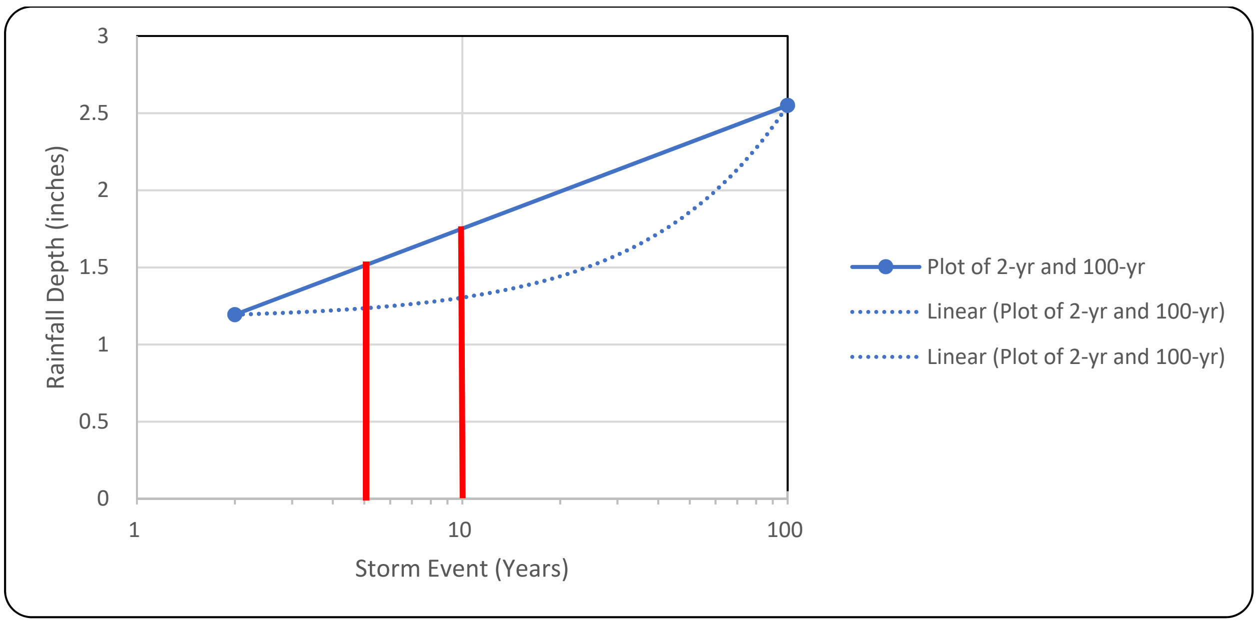


Figure 6-17. 100-Year, 24-Hour Precipitation Tenths of an Inch (NOAA Atlas 2)



Rainfall Depths			
			Notes
2 yr, 6 hr rainfall (in)	X_1 =	1.7	From Figure 6-6
2 yr, 24 hr rainfall (in)	X_2 =	2.1	From Figure 6-12
100 yr, 6 hr rainfall (in)	X_3 =	3.5	From Figure 6-11
100 yr, 24 hr rainfall (in)	X_4 =	4.6	From Figure 6-17
Elevation (hundreds of feet)]	Z =	64.5	
2 yr, 1 hr rainfall (in)	Y_2 =	1.193719	Equation 6-1
100 yr, 1 hr rainfall (in)	Y_{100} =	2.550076	Equation 6-2
Graph			
X-axis		Y-axis	
2	Y2	1.193719	Calculated from Eq 6-1
100	Y100	2.550076	Calculated from Eq 6-2
	Y5	1.52	Determined From Graph below
	Y10	2.75	Determined From Graph below



$$I = \frac{28.5\ P_1}{(10+T_D)^{0.786}}$$

Where:

I = rainfall intensity (inches per hour)

P_1 = one-hour rainfall depth (inches) from Table 6-2 One-hour Point Rainfall Depth City of Colorado Springs Drainage Design

T_C = storm duration (minutes)

	2-yr	5-yr	10-yr	100-yr
P_1 =	1.19	1.52	1.75	2.55

Time Intensity Frequency Tabulation

TIME	2 YR	5 YR	10 YR	100 YR
5	4.05	5.16	5.94	8.65
10	3.23	4.11	4.73	6.90
15	2.71	3.45	3.97	5.79
30	1.87	2.38	2.75	4.00
60	1.21	1.54	1.77	2.58
120	0.74	0.94	1.09	1.58

Table 6-6. Runoff Coefficients for Rational Method

(Source: UDFCD 2001)

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

3.2 Time of Concentration

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

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

Provide calculations for offsite basins

Weighted Imperviousness Calculations

SUB-	AREA	AREA	ROOF	ROOF	ROOF				LANDSCAPE	LANDSCAPE	LANDSCAPE				PAVEMENT	PAVEMENT	PAVEMENT				WEIGHTED	WEIGHTED COEFFICIENTS			
BASIN	(SF)	(Acres)	AREA	IMPERVIOUSNESS	C2	C5	C10	C100	AREA	IMPERVIOUSNESS	C2	C5	C10	C100	AREA	IMPERVIOUSNESS	C2	C5	C10	C100	IMPERVIOUSNESS	C2	C5	C10	C100
EX-A	670487	15.39	0	90%	0.71	0.73	0.75	0.81	15.39226	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	2%	0.02	0.08	0.15	0.35
TOTAL		15.39	0.00	90%	0.71	0.73	0.75	0.81	15.39	2%	0.02	0.08	0.15	0.35	0.00	100%	0.89	0.90	0.92	0.96	2%	0.02	0.08	0.15	0.35

SUMMARY - PROPOSED RUNOFF TABLE						
DESIGN POINT	**BASIN DESIGNATION**	**BASIN AREA (ACRES)**	**DIRECT 5-YR RUNOFF (CFS)**	**DIRECT 100-YR RUNOFF (CFS)**	**CUMULATIVE 5-YR RUNOFF (CFS)**	**CUMULATIVE 100-YR RUNOFF (CFS)**
EX-A	EX-A	15.39	3.92	28.77	3.92	28.77

Tract DD, Hannah Ridge at Feathergrass Filing No. 1 - Drainage Report
Existing Runoff Calculations
Time of Concentration

Watercourse Coefficient

Forest & Meadow 2.50	Short 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	DRAIN 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.
EX-A	EX-A	670,487	15.39	0.08	100	2.0%	14.8	1287	1.0%	10.00	1.0	21.5	36.3	1387	17.7	17.7

Tract DD, Hannah Ridge at Feathergrass Filing No. 1 - Drainage Report

Existing Runoff Calculations **Design Storm** ***5 Year***

(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN 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	
EX-A	EX-A	15.39	0.08	17.7	1.23	3.18	3.92					

Provide calculations for offsite basins

Tract DD, Hannah Ridge at Feathergrass Filing No. 1 - Drainage Report

Existing Runoff Calculations ***Design Storm*** ***100 Year***

(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN 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	
EX-A	EX-A	15.39	0.35	17.7	5.39	5.34	28.77					

Weighted Imperviousness Calculations

SUB-	AREA	AREA	ROOF	ROOF	ROOF				LANDSCAPE	LANDSCAPE	LANDSCAPE				PAVEMENT	PAVEMENT	PAVEMENT				WEIGHTED	WEIGHTED COEFFICIENTS			
BASIN	(SF)	(Acres)	AREA	IMPERVIOUSNESS	C2	C5	C10	C100	AREA	IMPERVIOUSNESS	C2	C5	C10	C100	AREA	IMPERVIOUSNESS	C2	C5	C10	C100	IMPERVIOUSNESS	C2	C5	C10	C100
B1	129508	2.97	0	90%	0.71	0.73	0.75	0.81	0	2%	0.02	0.08	0.15	0.35	2.9731	100%	0.89	0.90	0.92	0.96	100%	0.89	0.90	0.92	0.96
B2	44269.7	1.02	0.16	90%	0.71	0.73	0.75	0.81	0.856293	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	16%	0.13	0.18	0.24	0.42
B3	7044.73	0.16	0.161725	90%	0.71	0.73	0.75	0.81	0	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	90%	0.71	0.73	0.75	0.81
B4	10113.6	0.23	0	90%	0.71	0.73	0.75	0.81	0	2%	0.02	0.08	0.15	0.35	0.23218	100%	0.89	0.90	0.92	0.96	100%	0.89	0.90	0.92	0.96
B5	7011.97	0.16	0	90%	0.71	0.73	0.75	0.81	0.160973	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	2%	0.02	0.08	0.15	0.35
B6	5654.31	0.13	0.129805	90%	0.71	0.73	0.75	0.81	0	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	90%	0.71	0.73	0.75	0.81
B7	72490.5	1.66	0.29	90%	0.71	0.73	0.75	0.81	1.374153	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	17%	0.14	0.19	0.25	0.43
B8	7168.58	0.16	0.164568	90%	0.71	0.73	0.75	0.81	0	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	90%	0.71	0.73	0.75	0.81
B9	178640	4.10	0	90%	0.71	0.73	0.75	0.81	0	2%	0.02	0.08	0.15	0.35	4.101	100%	0.89	0.90	0.92	0.96	100%	0.89	0.90	0.92	0.96
B10	41057.6	0.94	0.42	90%	0.71	0.73	0.75	0.81	0.522552	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	41%	0.33	0.37	0.42	0.55
B11	7068.52	0.16	0.162271	90%	0.71	0.73	0.75	0.81	0	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	90%	0.71	0.73	0.75	0.81
B12	6531.54	0.15	0.149943	90%	0.71	0.73	0.75	0.81	0	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	90%	0.71	0.73	0.75	0.81
B13	4736.89	0.11	0.108744	90%	0.71	0.73	0.75	0.81	0	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	90%	0.71	0.73	0.75	0.81
B14	4984.61	0.11	0.114431	90%	0.71	0.73	0.75	0.81	0	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	90%	0.71	0.73	0.75	0.81
B15	37253.1	0.86	0.39	90%	0.71	0.73	0.75	0.81	0.465214	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	42%	0.33	0.38	0.42	0.56
B16	6028.31	0.14	0.138391	90%	0.71	0.73	0.75	0.81	0	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	90%	0.71	0.73	0.75	0.81
B17	5882.72	0.14	0.135049	90%	0.71	0.73	0.75	0.81	0	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	90%	0.71	0.73	0.75	0.81
B18	47411	1.09	0	90%	0.71	0.73	0.75	0.81	1.088406	2%	0.02	0.08	0.15	0.35	0	100%	0.89	0.90	0.92	0.96	2%	0.02	0.08	0.15	0.35
TOTAL		14.30	2.52	90%	0.71	0.73	0.75	0.81	4.47	2%	0.02	0.08	0.15	0.35	7.31	100%	0.89	0.90	0.92	0.96	68%	0.59	0.61	0.65	0.74

SUMMARY - PROPOSED RUNOFF TABLE

DESIGN POINT	BASIN DESIGNATION	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)	CUMULATIVE 5-YR RUNOFF (CFS)	CUMULATIVE 100-YR RUNOFF (CFS)
B1	B1	2.97	13.80	24.69	13.80	24.69
B2	B2	1.02	0.80	3.11	0.80	3.11
B3	B3	0.16	0.61	1.13	0.61	1.13
B4	B4	0.23	1.08	1.93	1.08	1.93
B5	B5	0.16	0.05	0.37	0.05	0.37
B6	B6	0.13	0.49	0.91	0.49	0.91
B7	B7	1.66	1.58	5.91	1.58	5.91
B8	B8	0.16	0.62	1.15	0.62	1.15
B9	B9	4.10	16.87	30.19	16.87	30.19
B10	B10	0.94	1.59	4.01	1.59	4.01
B11	B11	0.16	0.61	1.14	0.61	1.14
B12	B12	0.15	0.56	1.05	0.56	1.05
B13	B13	0.11	0.41	0.76	0.41	0.76
B14	B14	0.11	0.43	0.80	0.43	0.80
B15	B15	0.86	1.57	3.93	1.57	3.93
B16	B16	0.14	0.52	0.97	0.52	0.97
B17	B17	0.14	0.51	0.95	0.51	0.95
B18	B18	1.09	0.27	1.96	0.27	1.96

Tract DD, Hannah Ridge at Feathergrass Filing No. 1 - Drainage Report																	
Proposed Runoff Calculations										Watercourse Coefficient							
Time of Concentration					Forest & Meadow		2.50	Short 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	DRAIN 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.	
B1	B1	129,508	2.97	0.90	49	6.5%	1.4	772	3.5%	20.00	3.7	3.4	5.0	821	14.6	5.0	
B2	B2	44,270	1.02	0.18	68	8.5%	6.8	218	7.0%	7.00	1.9	2.0	8.8	286	11.6	8.8	
B3	B3	7,045	0.16	0.73	32	0.5%	4.8	0		20.00	0.0	0.0	5.0	32	10.2	5.0	
B4	B4	10,114	0.23	0.90	15	4.5%	0.9	229	1.5%	20.00	2.4	1.6	5.0	244	11.4	5.0	
B5	B5	7,012	0.16	0.08	36	3.0%	7.8	152	1.0%	7.00	0.7	3.6	11.4	188	11.0	11.0	
B6	B6	5,654	0.13	0.73	29	0.5%	4.6	0		20.00	0.0	0.0	5.0	29	10.2	5.0	
B7	B7	72,490	1.66	0.19	85	17.5%	5.9	0		20.00	0.0	0.0	5.9	85	10.5	5.9	
B8	B8	7,169	0.16	0.73	33	0.5%	4.9	0		20.00	0.0	0.0	5.0	33	10.2	5.0	
B9	B9	178,640	4.10	0.90	97	1.5%	3.2	813	2.5%	20.00	3.2	4.3	7.5	910	15.1	7.5	
B10	B10	41,058	0.94	0.37	34	2.0%	6.2	240	2.5%	20.00	3.2	1.3	7.5	274	11.5	7.5	
B11	B11	7,069	0.16	0.73	31	0.5%	4.8	0		20.00	0.0	0.0	5.0	31	10.2	5.0	
B12	B12	6,532	0.15	0.73	30	0.5%	4.7	0		20.00	0.0	0.0	5.0	30	10.2	5.0	
B13	B13	4,737	0.11	0.73	32	0.5%	4.8	0		20.00	0.0	0.0	5.0	32	10.2	5.0	
B14	B14	4,985	0.11	0.73	33	0.5%	4.9	0		20.00	0.0	0.0	5.0	33	10.2	5.0	
B15	B15	37,253	0.86	0.38	64	9.0%	5.1	190	2.8%	20.00	3.3	0.9	6.0	254	11.4	6.0	
B16	B16	6,028	0.14	0.73	32	0.5%	4.8	0		20.00	0.0	0.0	5.0	32	10.2	5.0	
B17	B17	5,883	0.14	0.73	32	0.5%	4.8	0		20.00	0.0	0.0	5.0	32	10.2	5.0	
B18	B18	47,411	1.09	0.08	112	8.5%	9.7	1530	1.0%	7.00	0.7	36.4	46.1	1642	19.1	19.1	

Tract DD, Hannah Ridge at Feathergrass Filing No. 1 - Drainage Report
Proposed Runoff Calculations ***Design Storm 5 Year***
(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN 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	
B1	B1	2.97	0.90	5.0	2.68	5.16	13.80					
B2	B2	1.02	0.18	8.8	0.19	4.32	0.80					
B3	B3	0.16	0.73	5.0	0.12	5.16	0.61					
B4	B4	0.23	0.90	5.0	0.21	5.16	1.08					
B5	B5	0.16	0.08	11.0	0.01	3.96	0.05					
B6	B6	0.13	0.73	5.0	0.09	5.16	0.49					
B7	B7	1.66	0.19	5.9	0.32	4.92	1.58					
B8	B8	0.16	0.73	5.0	0.12	5.16	0.62					
B9	B9	4.10	0.90	7.5	3.69	4.57	16.87					
B10	B10	0.94	0.37	7.5	0.35	4.57	1.59					
B11	B11	0.16	0.73	5.0	0.12	5.16	0.61					
B12	B12	0.15	0.73	5.0	0.11	5.16	0.56					
B13	B13	0.11	0.73	5.0	0.08	5.16	0.41					
B14	B14	0.11	0.73	5.0	0.08	5.16	0.43					
B15	B15	0.86	0.38	6.0	0.32	4.89	1.57					
B16	B16	0.14	0.73	5.0	0.10	5.16	0.52					
B17	B17	0.14	0.73	5.0	0.10	5.16	0.51					
B18	B18	1.09	0.08	19.1	0.09	3.06	0.27					

Tract DD, Hannah Ridge at Feathergrass Filing No. 1 - Drainage Report
Proposed Runoff Calculations ***Design Storm*** ***100 Year***
(Rational Method Procedure)

BASIN INFORMATION				DIRECT RUNOFF				CUMMULATIVE RUNOFF				NOTES
DESIGN POINT	DRAIN 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	
B1	B1	2.97	0.96	5.0	2.85	8.65	24.69					
B2	B2	1.02	0.42	8.8	0.43	7.25	3.11					
B3	B3	0.16	0.81	5.0	0.13	8.65	1.13					
B4	B4	0.23	0.96	5.0	0.22	8.65	1.93					
B5	B5	0.16	0.35	11.0	0.06	6.64	0.37					
B6	B6	0.13	0.81	5.0	0.11	8.65	0.91					
B7	B7	1.66	0.43	5.9	0.72	8.26	5.91					
B8	B8	0.16	0.81	5.0	0.13	8.65	1.15					
B9	B9	4.10	0.96	7.5	3.94	7.67	30.19					
B10	B10	0.94	0.55	7.5	0.52	7.67	4.01					
B11	B11	0.16	0.81	5.0	0.13	8.65	1.14					
B12	B12	0.15	0.81	5.0	0.12	8.65	1.05					
B13	B13	0.11	0.81	5.0	0.09	8.65	0.76					
B14	B14	0.11	0.81	5.0	0.09	8.65	0.80					
B15	B15	0.86	0.56	6.0	0.48	8.20	3.93					
B16	B16	0.14	0.81	5.0	0.11	8.65	0.97					
B17	B17	0.14	0.81	5.0	0.11	8.65	0.95					
B18	B18	1.09	0.35	19.1	0.38	5.14	1.96					

APPENDIX C: HYDRAULICS

Curb Cut - Design Point B1 - 5-yr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.006 ft/ft
Bottom Width	4.00 ft
Discharge	3.17 cfs

Results

Normal Depth	3.0 in
Flow Area	1.0 ft²
Wetted Perimeter	4.5 ft
Hydraulic Radius	2.6 in
Top Width	4.00 ft
Critical Depth	3.2 in
Critical Slope	0.005 ft/ft
Velocity	3.22 ft/s
Velocity Head	0.16 ft
Specific Energy	0.41 ft
Froude Number	1.145
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	3.0 in
Critical Depth	3.2 in
Channel Slope	0.006 ft/ft
Critical Slope	0.005 ft/ft

Curb Cut - Design Point B1 - 100-yr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.006 ft/ft
Bottom Width	4.00 ft
Discharge	5.68 cfs

Results

Normal Depth	4.3 in
Flow Area	1.4 ft^2
Wetted Perimeter	4.7 ft
Hydraulic Radius	3.6 in
Top Width	4.00 ft
Critical Depth	4.8 in
Critical Slope	0.004 ft/ft
Velocity	3.99 ft/s
Velocity Head	0.25 ft
Specific Energy	0.60 ft
Froude Number	1.179
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	4.3 in
Critical Depth	4.8 in
Channel Slope	0.006 ft/ft
Critical Slope	0.004 ft/ft

Curb Cut - Design Point B4 - 5-yr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.006 ft/ft
Bottom Width	3.00 ft
Discharge	1.08 cfs

Results

Normal Depth	1.8 in
Flow Area	0.5 ft²
Wetted Perimeter	3.3 ft
Hydraulic Radius	1.7 in
Top Width	3.00 ft
Critical Depth	1.9 in
Critical Slope	0.005 ft/ft
Velocity	2.37 ft/s
Velocity Head	0.09 ft
Specific Energy	0.24 ft
Froude Number	1.071
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	1.8 in
Critical Depth	1.9 in
Channel Slope	0.006 ft/ft
Critical Slope	0.005 ft/ft

Curb Cut - Design Point B4 - 100-yr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.006 ft/ft
Bottom Width	3.00 ft
Discharge	1.93 cfs

Results

Normal Depth	2.6 in
Flow Area	0.7 ft²
Wetted Perimeter	3.4 ft
Hydraulic Radius	2.3 in
Top Width	3.00 ft
Critical Depth	2.8 in
Critical Slope	0.005 ft/ft
Velocity	2.94 ft/s
Velocity Head	0.13 ft
Specific Energy	0.35 ft
Froude Number	1.107
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	2.6 in
Critical Depth	2.8 in
Channel Slope	0.006 ft/ft
Critical Slope	0.005 ft/ft

Curb Cut - Design Point B9 - 5-yr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.022 ft/ft
Bottom Width	9.00 ft
Discharge	16.87 cfs

Results

Normal Depth	3.3 in
Flow Area	2.5 ft²
Wetted Perimeter	9.5 ft
Hydraulic Radius	3.1 in
Top Width	9.00 ft
Critical Depth	5.7 in
Critical Slope	0.004 ft/ft
Velocity	6.86 ft/s
Velocity Head	0.73 ft
Specific Energy	1.00 ft
Froude Number	2.315
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	3.3 in
Critical Depth	5.7 in
Channel Slope	0.022 ft/ft
Critical Slope	0.004 ft/ft

Curb Cut - Design Point B9 - 100-yr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013
Channel Slope	0.022 ft/ft
Bottom Width	9.00 ft
Discharge	30.19 cfs

Results

Normal Depth	4.7 in
Flow Area	3.5 ft²
Wetted Perimeter	9.8 ft
Hydraulic Radius	4.3 in
Top Width	9.00 ft
Critical Depth	8.5 in
Critical Slope	0.003 ft/ft
Velocity	8.57 ft/s
Velocity Head	1.14 ft
Specific Energy	1.53 ft
Froude Number	2.416
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	4.7 in
Critical Depth	8.5 in
Channel Slope	0.022 ft/ft
Critical Slope	0.003 ft/ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0.8 cfs

Design Flow: 3.11 cfs

Maximum Flow: 10 cfs

Table 1 - Summary of Culvert Flows at Crossing: Crossing 1

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
6448.44	0.80	0.80	0.00	1
6448.66	1.72	1.72	0.00	1
6448.85	2.64	2.64	0.00	1
6448.94	3.11	3.11	0.00	1
6449.19	4.48	4.48	0.00	1
6449.34	5.40	5.40	0.00	1
6449.49	6.32	6.32	0.00	1
6449.65	7.24	7.24	0.00	1
6449.83	8.16	8.16	0.00	1
6450.03	9.08	9.08	0.00	1
6450.24	10.00	10.00	0.00	1
6451.00	12.65	12.65	0.00	Overtopping

Rating Curve Plot for Crossing: Crossing 1

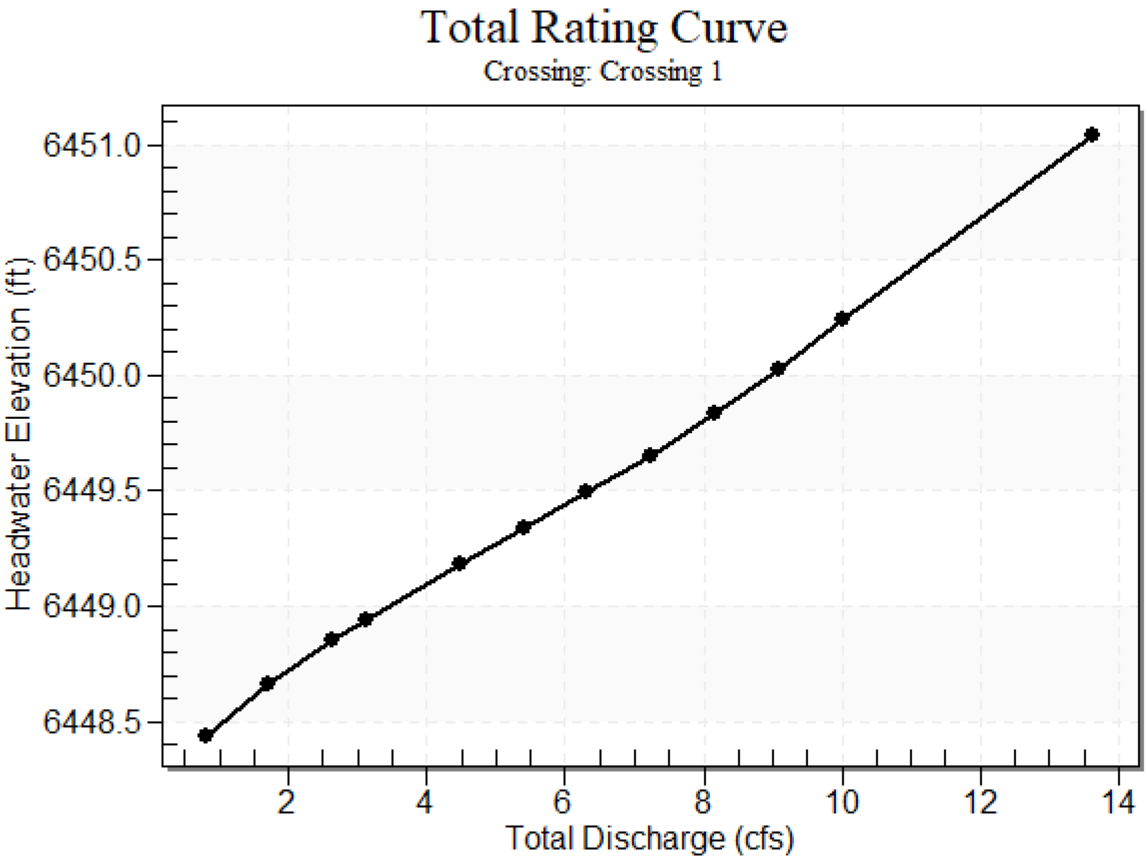


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.80	0.80	6448.44	0.441	0.0*	1-S2n	0.202	0.333	0.202	0.352	5.614	1.395
1.72	1.72	6448.66	0.660	0.0*	1-S2n	0.294	0.493	0.294	0.469	7.035	1.690
2.64	2.64	6448.85	0.850	0.0*	1-S2n	0.364	0.616	0.364	0.551	7.967	1.881
3.11	3.11	6448.94	0.944	0.0*	1-S2n	0.395	0.671	0.395	0.586	8.350	1.959
4.48	4.48	6449.19	1.187	0.0*	1-S2n	0.477	0.812	0.485	0.672	9.066	2.147
5.40	5.40	6449.34	1.338	0.0*	1-S2n	0.527	0.895	0.527	0.720	9.755	2.249
6.32	6.32	6449.49	1.492	0.0*	1-S2n	0.573	0.972	0.584	0.764	9.923	2.339
7.24	7.24	6449.65	1.654	0.0*	5-S2n	0.617	1.042	0.617	0.804	10.564	2.420
8.16	8.16	6449.83	1.830	0.0*	5-S2n	0.660	1.106	0.678	0.841	10.524	2.494
9.08	9.08	6450.03	2.026	0.0*	5-S2n	0.701	1.165	0.701	0.875	11.212	2.561
10.00	10.00	6450.24	2.242	0.0*	5-S2n	0.741	1.219	0.741	0.908	11.491	2.624

Ensure that culvert calculations include total flows for the contributing acreages.

* Full Flow Headwater elevation is below inlet invert.

****

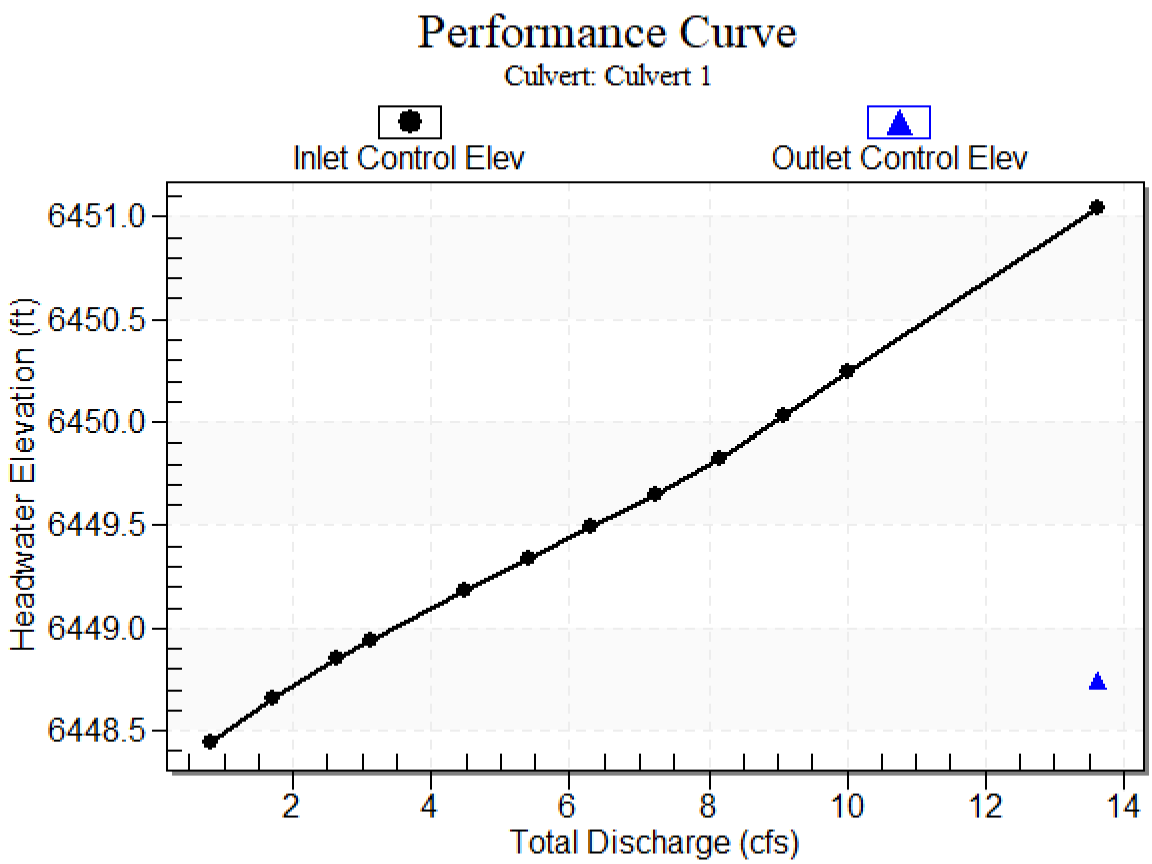
Straight Culvert

Inlet Elevation (invert): 6448.00 ft,   Outlet Elevation (invert): 6444.88 ft

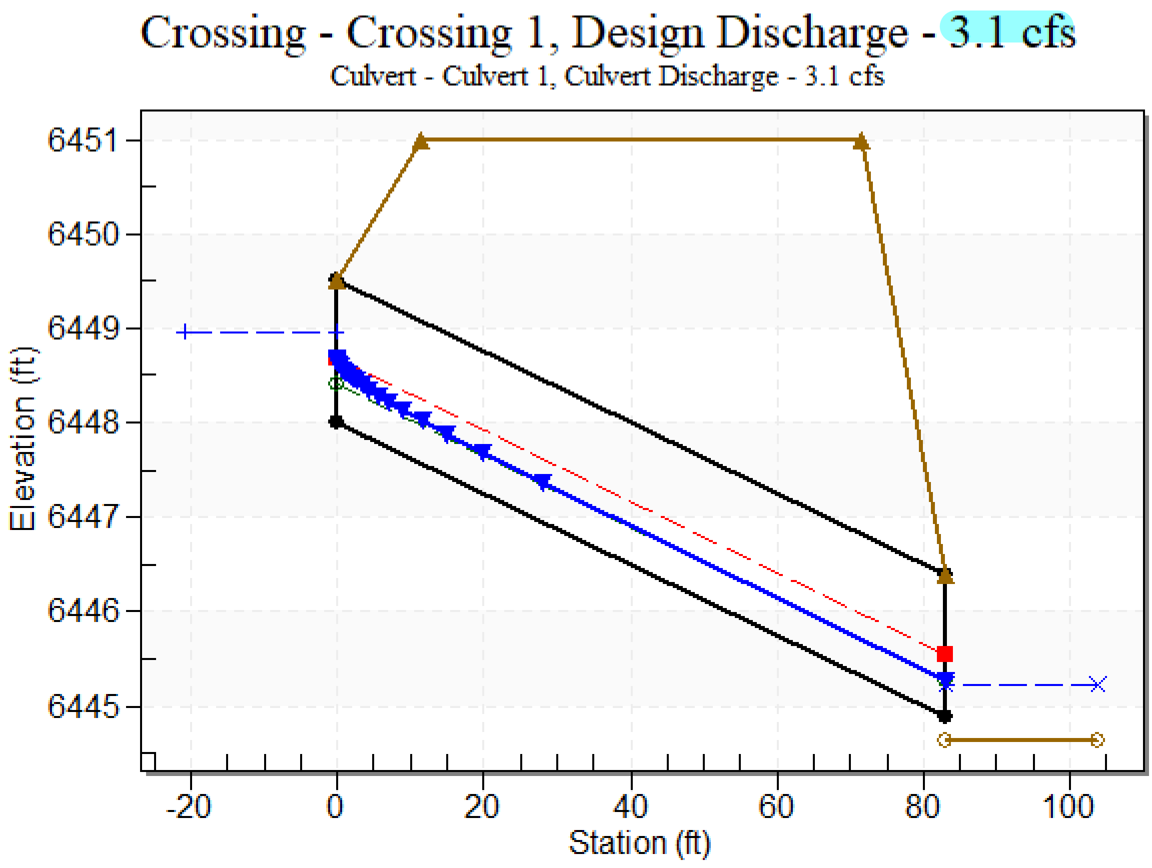
Culvert Length: 83.06 ft,   Culvert Slope: 0.0376

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 6448.00 ft

Outlet Station: 83.00 ft

Outlet Elevation: 6444.88 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0130

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: Crossing 1)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.80	6444.99	0.35	1.40	0.18	0.59
1.72	6445.11	0.47	1.69	0.24	0.61
2.64	6445.19	0.55	1.88	0.29	0.63
3.11	6445.23	0.59	1.96	0.30	0.64
4.48	6445.31	0.67	2.15	0.35	0.65
5.40	6445.36	0.72	2.25	0.37	0.66
6.32	6445.40	0.76	2.34	0.40	0.67
7.24	6445.44	0.80	2.42	0.42	0.67
8.16	6445.48	0.84	2.49	0.44	0.68
9.08	6445.52	0.88	2.56	0.45	0.68
10.00	6445.55	0.91	2.62	0.47	0.69

Tailwater Channel Data - Crossing 1

Tailwater Channel Option: Irregular Channel

Roadway Data for Crossing: Crossing 1

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 30.00 ft

Crest Elevation: 6451.00 ft

Roadway Surface: Paved

Roadway Top Width: 60.00 ft

Ensure that swale calculations include total flows for the contributing acreages.

Swale B2 - 100-yr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.069 ft/ft
Discharge	3.11 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	6,453.25
0+12	6,451.98
0+20	6,451.92
0+28	6,452.06
0+62	6,452.39
0+72	6,452.74
0+84	6,455.67
0+85	6,455.62

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 6,453.25)	(0+85, 6,455.62)	0.030

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	1.6 in
Roughness Coefficient	0.030
Elevation	6,452.05 ft
Elevation Range	6,451.9 to 6,455.7 ft
Flow Area	1.3 ft²
Wetted Perimeter	16.1 ft
Hydraulic Radius	1.0 in
Top Width	16.09 ft
Normal Depth	1.6 in
Critical Depth	1.9 in
Critical Slope	0.029 ft/ft
Velocity	2.41 ft/s
Velocity Head	0.09 ft

Results

Specific Energy	0.22 ft
Froude Number	1.502
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	1.6 in
Critical Depth	1.9 in
Channel Slope	0.069 ft/ft
Critical Slope	0.029 ft/ft

Swale B5 - 100-yr

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.008 ft/ft
Discharge	0.37 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	6,450.19
0+29	6,444.64
0+37	6,446.64

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 6,450.19)	(0+37, 6,446.64)	0.030

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	3.2 in
Roughness Coefficient	0.030
Elevation	6,444.91 ft
Elevation Range	6,444.6 to 6,450.2 ft
Flow Area	0.3 ft²
Wetted Perimeter	2.5 ft
Hydraulic Radius	1.6 in
Top Width	2.46 ft
Normal Depth	3.2 in
Critical Depth	2.5 in
Critical Slope	0.029 ft/ft
Velocity	1.14 ft/s
Velocity Head	0.02 ft
Specific Energy	0.29 ft
Froude Number	0.549
Flow Type	Subcritical

GVF Input Data

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	3.2 in
Critical Depth	2.5 in
Channel Slope	0.008 ft/ft
Critical Slope	0.029 ft/ft

Swale B10 - 100-yr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.026 ft/ft
Discharge	4.01 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	6,451.28
0+25	6,449.17
0+49	6,450.29

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 6,451.28)	(0+49, 6,450.29)	0.030

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	3.8 in
Roughness Coefficient	0.030
Elevation	6,449.49 ft
Elevation Range	6,449.2 to 6,451.3 ft
Flow Area	1.7 ft²
Wetted Perimeter	10.6 ft
Hydraulic Radius	1.9 in
Top Width	10.62 ft
Normal Depth	3.8 in
Critical Depth	3.9 in
Critical Slope	0.024 ft/ft
Velocity	2.36 ft/s
Velocity Head	0.09 ft
Specific Energy	0.41 ft
Froude Number	1.037
Flow Type	Supercritical

GVF Input Data

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	3.8 in
Critical Depth	3.9 in
Channel Slope	0.026 ft/ft
Critical Slope	0.024 ft/ft

Swale B15 - 100-yr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.018 ft/ft
Discharge	3.93 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	6,457.79
0+35	6,450.55
0+59	6,453.92

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 6,457.79)	(0+59, 6,453.92)	0.030

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	6.0 in
Roughness Coefficient	0.030
Elevation	6,451.05 ft
Elevation Range	6,450.6 to 6,457.8 ft
Flow Area	1.5 ft²
Wetted Perimeter	6.1 ft
Hydraulic Radius	3.0 in
Top Width	6.00 ft
Normal Depth	6.0 in
Critical Depth	5.8 in
Critical Slope	0.021 ft/ft
Velocity	2.62 ft/s
Velocity Head	0.11 ft
Specific Energy	0.61 ft
Froude Number	0.922
Flow Type	Subcritical

GVF Input Data

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	6.0 in
Critical Depth	5.8 in
Channel Slope	0.018 ft/ft
Critical Slope	0.021 ft/ft

Swale B18 - 100-yr

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.010 ft/ft
Discharge	1.96 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+04	6,457.41
0+19	6,452.38
0+29	6,453.11

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+04, 6,457.41)	(0+29, 6,453.11)	0.030

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	4.5 in
Roughness Coefficient	0.030
Elevation	6,452.76 ft
Elevation Range	6,452.4 to 6,457.4 ft
Flow Area	1.2 ft²
Wetted Perimeter	6.5 ft
Hydraulic Radius	2.2 in
Top Width	6.39 ft
Normal Depth	4.5 in
Critical Depth	3.8 in
Critical Slope	0.025 ft/ft
Velocity	1.62 ft/s
Velocity Head	0.04 ft
Specific Energy	0.42 ft
Froude Number	0.657
Flow Type	Subcritical

GVF Input Data

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	4.5 in
Critical Depth	3.8 in
Channel Slope	0.010 ft/ft
Critical Slope	0.025 ft/ft

Type 13 Design Point R1

Project Description	
Solve For	Spread

Input Data	
Discharge	3.93 cfs
Left Side Slope	0.229 H:V
Right Side Slope	0.175 H:V
Bottom Width	3.33 ft
Grate Width	1.91 ft
Grate Length	3.3 ft
Local Depression	0.0 in
Local Depression Width	23.0 in
Grate Type	Curved Vaned
Clogging	50.0 %

Results	
Spread	3.5 ft
Depth	5.2 in
Wetted Perimeter	4.2 ft
Top Width	3.50 ft
Open Grate Area	1.1 ft^2
Active Grate Weir Length	8.6 ft

Type 13 Design Point R2

Project Description	
Solve For	Spread

Input Data	
Discharge	4.01 cfs
Left Side Slope	40.000 H:V
Right Side Slope	40.000 H:V
Bottom Width	3.33 ft
Grate Width	1.91 ft
Grate Length	3.3 ft
Local Depression	0.0 in
Local Depression Width	23.0 in
Grate Type	Curved Vaned
Clogging	50.0 %

Results	
Spread	39.3 ft
Depth	5.4 in
Wetted Perimeter	39.3 ft
Top Width	39.28 ft
Open Grate Area	1.1 ft²
Active Grate Weir Length	8.6 ft

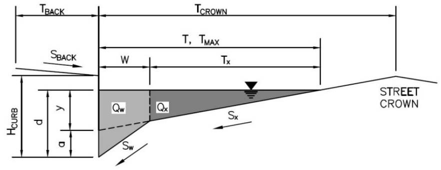
Version 4.06 Released August 2018

ALLOWABLE CAPACITY FOR ONE-HALF OF STREET (Minor & Major Storm)

(Based on Regulated Criteria for Maximum Allowable Flow Depth and Spread)

Project: Watermark at Akers

Inlet ID: Inlet B5



Gutter Geometry (Enter data in the blue cells)

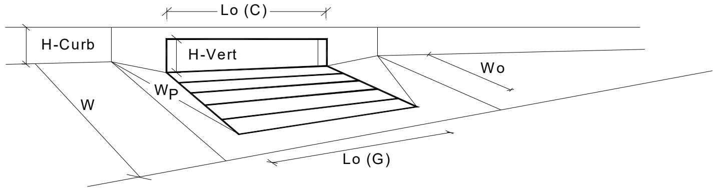
Maximum Allowable Width for Spread Behind Curb	T_{BACK} =	0.0	ft
Side Slope Behind Curb (leave blank for no conveyance credit behind curb)	S_{BACK} =		ft/ft
Manning's Roughness Behind Curb (typically between 0.012 and 0.020)	n_{BACK} =	0.020	
Height of Curb at Gutter Flow Line	H_{CURB} =	6.00	inches
Distance from Curb Face to Street Crown	T_{CROWN} =	35.0	ft
Gutter Width	W =	2.00	ft
Street Transverse Slope	S_X =	0.014	ft/ft
Gutter Cross Slope (typically 2 inches over 24 inches or 0.083 ft/ft)	S_W =	0.083	ft/ft
Street Longitudinal Slope - Enter 0 for sump condition	S_O =	0.000	ft/ft
Manning's Roughness for Street Section (typically between 0.012 and 0.020)	n_{STREET} =	0.016	

		Minor Storm	Major Storm	
Max. Allowable Spread for Minor & Major Storm	T_{MAX} =	35.0	35.0	ft
Max. Allowable Depth at Gutter Flowline for Minor & Major Storm	d_{MAX} =	6.0	6.0	inches
Check boxes are not applicable in SUMP conditions		☐	☐	

		Minor Storm	Major Storm	
MINOR STORM Allowable Capacity is based on Depth Criterion				
MAJOR STORM Allowable Capacity is based on Depth Criterion	Q_{allow} =	**SUMP**	**SUMP**	**cfs**

INLET IN A SUMP OR SAG LOCATION

Version 4.06 Released August 2018



Design Information (Input)		MINOR	MAJOR	
Type of Inlet (CDOT Type R Curb Opening)	Type =	CDOT Type R Curb Opening		
Local Depression (additional to continuous gutter depression 'a' from above)	a_{local} =	3.00	3.00	inches
Number of Unit Inlets (Grate or Curb Opening)	No =	6	6	
Water Depth at Flowline (outside of local depression)	Ponding Depth =	6.0	6.0	inches
Grate Information		MINOR	MAJOR	Override Depths
Length of a Unit Grate	L_o (G) =	N/A	N/A	feet
Width of a Unit Grate	W_o =	N/A	N/A	feet
Area Opening Ratio for a Grate (typical values 0.15-0.90)	A_{ratio} =	N/A	N/A	
Clogging Factor for a Single Grate (typical value 0.50 - 0.70)	C_f (G) =	N/A	N/A	
Grate Weir Coefficient (typical value 2.15 - 3.60)	C_w (G) =	N/A	N/A	
Grate Orifice Coefficient (typical value 0.60 - 0.80)	C_o (G) =	N/A	N/A	
Curb Opening Information		MINOR	MAJOR	
Length of a Unit Curb Opening	L_o (C) =	5.00	5.00	feet
Height of Vertical Curb Opening in Inches	H_{vert} =	6.00	6.00	inches
Height of Curb Orifice Throat in Inches	H_{throat} =	6.00	6.00	inches
Angle of Throat (see USDCM Figure ST-5)	Theta =	63.40	63.40	degrees
Side Width for Depression Pan (typically the gutter width of 2 feet)	W_p =	2.00	2.00	feet
Clogging Factor for a Single Curb Opening (typical value 0.10)	C_f (C) =	0.10	0.10	
Curb Opening Weir Coefficient (typical value 2.3-3.7)	C_w (C) =	3.60	3.60	
Curb Opening Orifice Coefficient (typical value 0.60 - 0.70)	C_o (C) =	0.67	0.67	

Low Head Performance Reduction (Calculated)		MINOR	MAJOR	
Depth for Grate Midwidth	d_{Grate} =	N/A	N/A	ft
Depth for Curb Opening Weir Equation	d_{Curb} =	0.33	0.33	ft
Combination Inlet Performance Reduction Factor for Long Inlets	$RF_{Combination}$ =	0.57	0.57	
Curb Opening Performance Reduction Factor for Long Inlets	RF_{Curb} =	0.79	0.79	
Grated Inlet Performance Reduction Factor for Long Inlets	RF_{Grate} =	N/A	N/A	

		MINOR	MAJOR	
Total Inlet Interception Capacity (assumes clogged condition)	Q_a =	**27.6**	**27.6**	**cfs**
Inlet Capacity IS GOOD for Minor and Major Storms(>Q PEAK)	$Q_{PEAK\ REQUIRED}$ =	13.8	24.7	cfs

Rip-Rap Calculation

Culvert 1

.

Applicable Equations:

$L_p = (1/2\tan\Theta)(A_t/Y_t - D)$	Equation 9-11 per USCDM
$A_t = Q/V$	Equation 9-12 per USDCM
$\Theta = \tan^{-1}(1/(2*\text{ExpansionFactor}))$	Equation 9-13 per USDCM
$W = 2(L_p\tan\Theta)+D$	Equation 9-14 per USDCM
$T = 2D_{50}$	Equation 9-15 per USDCM

Assumptions

Maximum Major Event Velocity is 7fps for FES outletting into trickle channels

Input parameters:

Description		Variable	Input	Unit
Width of the conduit (use diameter for circular conduits),		D:	1.50	ft
Rectangular conduit		H:	0.00	
HGL Elevation			6445.47	ft
Invert Elevation			6444.88	ft
Tailwater depth (ft),		Y_t:	0.59	ft
Expansion angle of the culvert flow		Θ:	0.08	radians
Design discharge (cfs)*		Q:	3.11	cfs
Froude Number		F_r	0.40	Subcritical
Unitless Variables for Tables:				
	For Figure 9-35	$Q/D^{2.5}$	1.13	
	For Figure 9-36	$Q/WH^{3/2}$	#DIV/0!	
	For Figure 9-35	Y_t/D	0.39	
	For Figure 9-38	$Q/D^{1.5}$	1.69	
	For Figure 9-38	Y_t/D	0.39	
Allowable non-eroding velocity in the downstream channel (ft/sec)		V:	5	ft/sec
Expansion Factor (Figure 9-35), 1/(2tan(θ))			6.5	

Solve for:

Description	Variable	Output	Unit
1. Required area of flow at allowable velocity (ft^2)	A_t:	0.62	ft^2
2. Length of Protection	L_p:	-2.90	ft
	L_p < 3D?	Yes	
	L_{pmin}:	4.50	ft
3. Width of downstream riprap protection	W:	2.00	ft
4. Rip Rap Type (Figure 9-38)	-	L	
5. Rip Rap Size (Figure 8-34)	D_{50}:	9	inches

Rip Rap Summary

Length	L_p	5.00	ft
Width	W	2.00	ft
Size	D_{50}	9	inches
Type	-	L	-
Thickness	T	18	inches

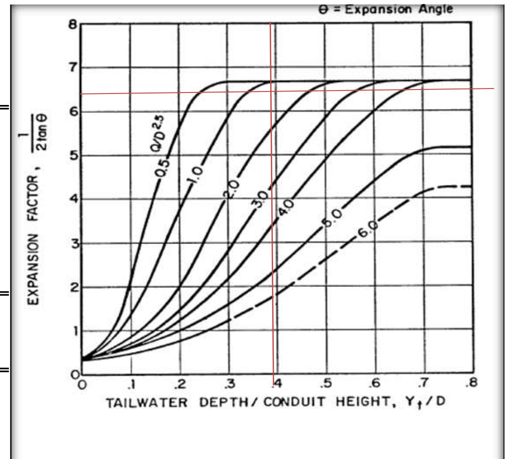
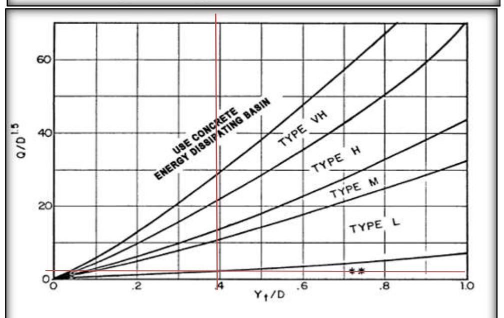


Figure 9-35. Expansion factor for circular conduits



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

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

RIPRAP DESIGNATION	% SMALLER THAN GIVEN SIZE BY WEIGHT	INTERMEDIATE ROCK DIMENSION (INCHES)	D_{50}* (INCHES)
TYPE VL	70 – 100 50 – 70 35 – 50 2 – 10	12 9 6 2	6
TYPE L	70 – 100 50 – 70 35 – 50 2 – 10	15 12 9 3	9
TYPE M	70 – 100 50 – 70 35 – 50 2 – 10	21 18 12 4	12
TYPE H	70 – 100 50 – 70 35 – 50 2 – 10	30 24 18 6	18
*D_{50} = MEAN ROCK SIZE			

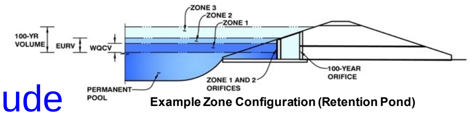
Figure 8-34. Riprap and soil riprap placement and gradation (part 1 of 3)

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

Project: **Watermark at Akers**

Basin ID: **South Pond**



Example Zone Configuration (Retention Pond)

Needs to include the total contributing acreage

match previous values? (pdf pg 39)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	15.39	acres
Watershed Length =	1,050	ft
Watershed Length to Centroid =	525	ft
Watershed Slope =	0.015	ft/ft
Watershed Imperviousness =	68.00%	percent
Percentage Hydrologic Soil Group A =	80.0%	percent
Percentage Hydrologic Soil Group B =	20.0%	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) =	0.342	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	1.281	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 1.19 in.) =	0.951	acre-feet	1.19	inches
5-yr Runoff Volume (P1 = 1.5 in.) =	1.241	acre-feet	1.50	inches
10-yr Runoff Volume (P1 = 1.75 in.) =	1.484	acre-feet	1.75	inches
25-yr Runoff Volume (P1 = 2 in.) =	1.827	acre-feet	2.00	inches
50-yr Runoff Volume (P1 = 2.25 in.) =	2.125	acre-feet	2.25	inches
100-yr Runoff Volume (P1 = 2.52 in.) =	2.494	acre-feet	2.52	inches
500-yr Runoff Volume (P1 = 3.14 in.) =	3.284	acre-feet		inches
Approximate 2-yr Detention Volume =	0.864	acre-feet		
Approximate 5-yr Detention Volume =	1.134	acre-feet		
Approximate 10-yr Detention Volume =	1.380	acre-feet		
Approximate 25-yr Detention Volume =	1.618	acre-feet		
Approximate 50-yr Detention Volume =	1.760	acre-feet		
Approximate 100-yr Detention Volume =	1.916	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.342	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.940	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.634	acre-feet
Total Detention Basin Volume =	1.916	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	--	--	--	1,666	0.038		
6440	--	1.00	--	--	--	9,592	0.220	5,629	0.129
6441	--	2.00	--	--	--	15,337	0.352	18,093	0.415
6442	--	3.00	--	--	--	21,000	0.482	36,262	0.832
6443	--	4.00	--	--	--	26,200	0.601	59,862	1.374
6443.5	--	4.50	--	--	--	30,412	0.698	74,015	1.699
6444	--	5.00	--	--	--	31,750	0.729	89,555	2.056
6445	--	6.00	--	--	--	38,605	0.886	124,733	2.863
6446	--	7.00	--	--	--	47,914	1.100	167,992	3.857
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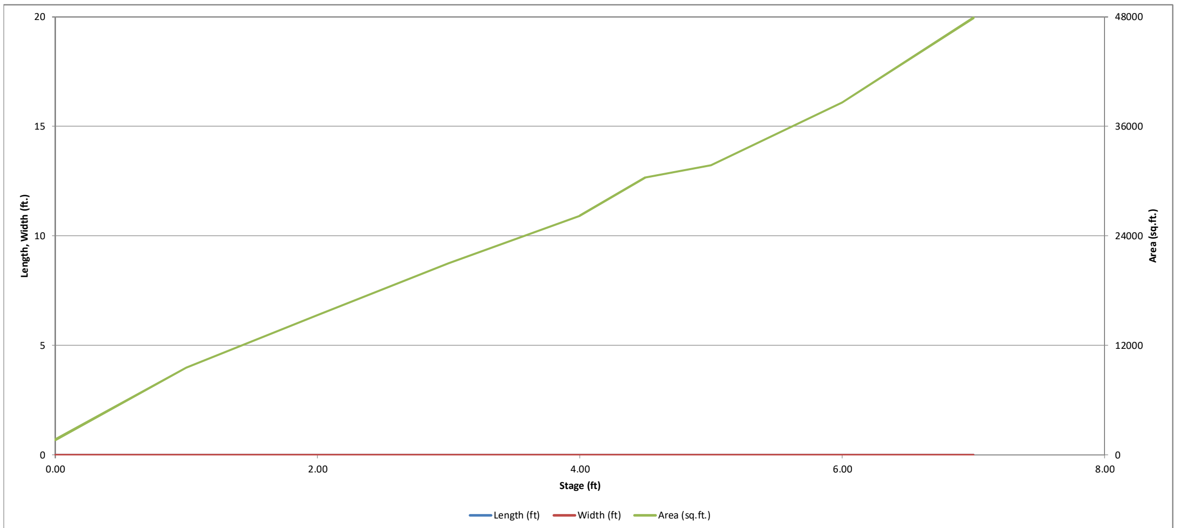
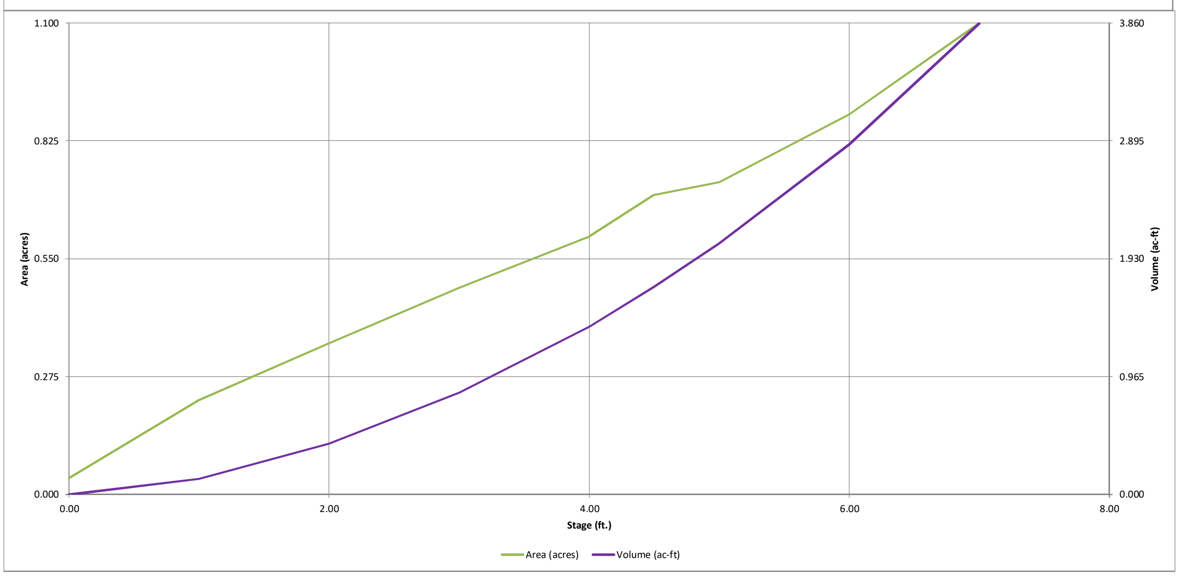
DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

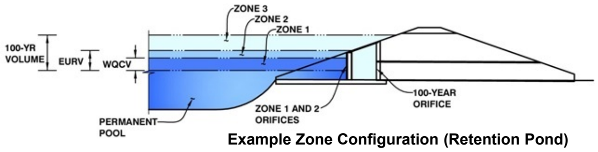




DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.03 (May 2020)

Project: **Watermark at Akers**
Basin ID: **South Pond**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.79	0.342	Orifice Plate
Zone 2 (EURV)	3.85	0.940	Orifice Plate
Zone 3 (100-year)	4.81	0.634	Weir&Pipe (Restrict)
Total (all zones)		1.916	

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

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

Calculated Parameters for Underdrain

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

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.82	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	9.15	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

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

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.80	1.60	2.40	3.20			
Orifice Area (sq. inches)	1.77	3.14	3.98	12.57	12.57			

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

User Input: Vertical Orifice (Circular or Rectangular)

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

Calculated Parameters for Vertical Orifice

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

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.90	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	23.36	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	2.92	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.90	N/A	feet
Overflow Weir Slope Length =	2.92	N/A	feet
Grate Open Area / 100-yr Orifice Area =	18.89	N/A	
Overflow Grate Open Area w/o Debris =	47.75	N/A	ft^2
Overflow Grate Open Area w/ Debris =	23.87	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	0.00	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	24.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	18.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	2.53	N/A	ft^2
Outlet Orifice Centroid =	0.83	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	2.09	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.22	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	70.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Ratio should be less than or equal to 1.

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.35	feet
Stage at Top of Freeboard =	6.57	feet
Basin Area at Top of Freeboard =	1.01	acres
Basin Volume at Top of Freeboard =	3.39	acre-ft

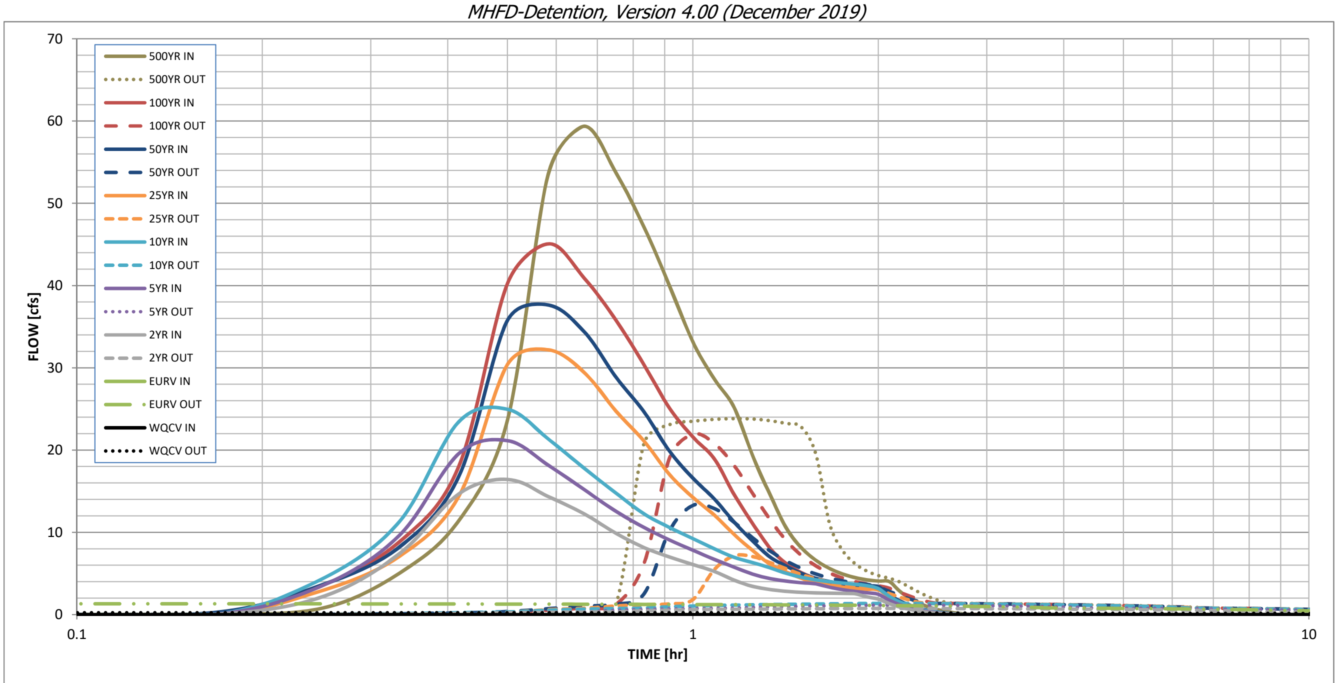
Routed Hydrograph Results

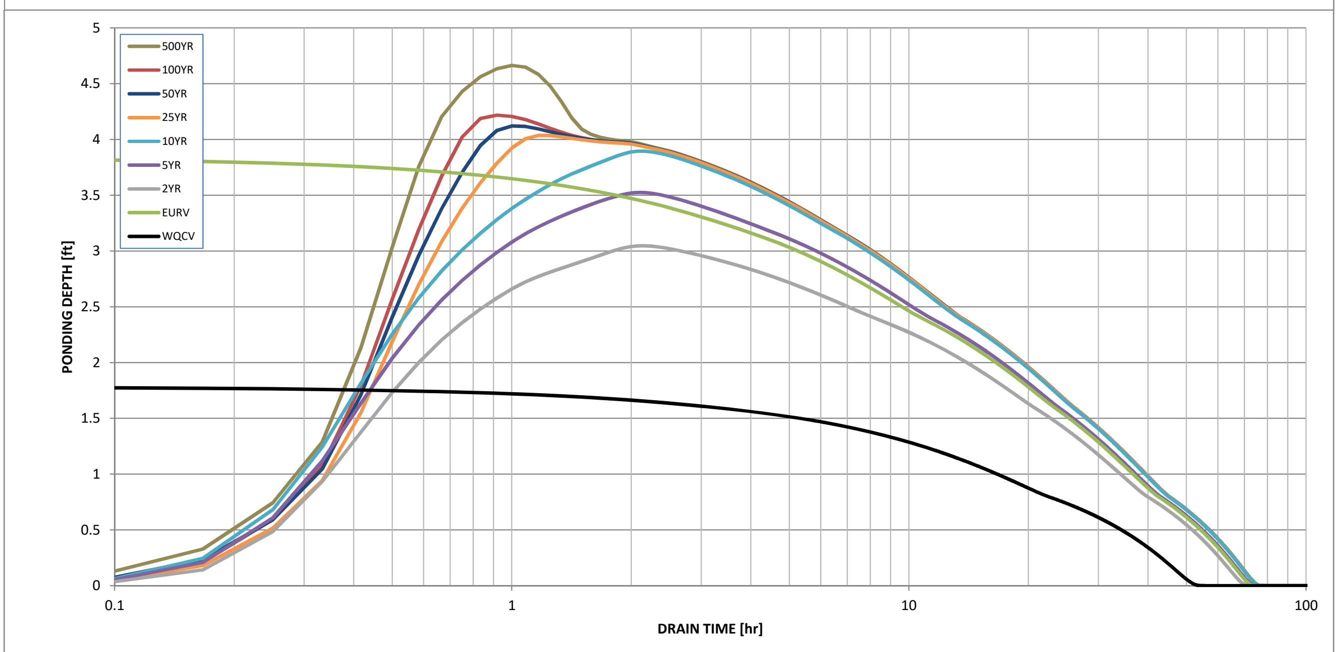
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

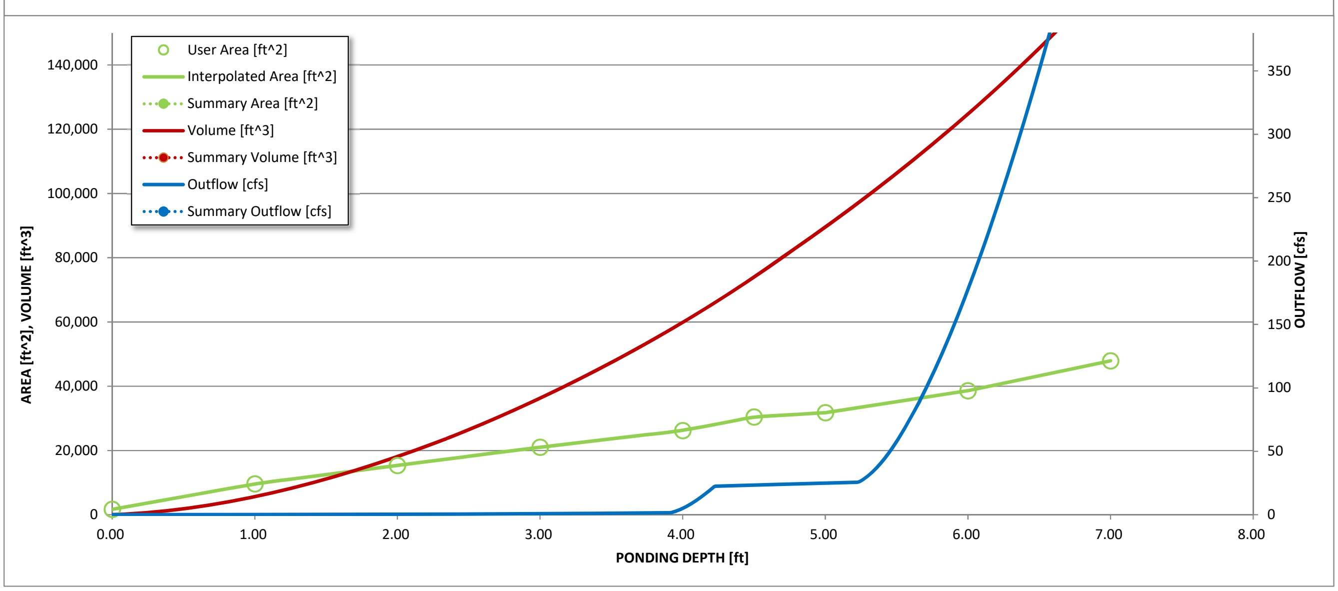
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	N/A	1.19	1.50	1.75	2.00	2.25	2.52	3.14
CUHP Runoff Volume (acre-ft) =	0.342	1.281	0.951	1.241	1.484	1.827	2.125	2.494	3.284
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.951	1.241	1.484	1.827	2.125	2.494	3.284
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.2	0.3	1.0	5.8	8.7	12.4	20.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.01	0.02	0.07	0.37	0.56	0.80	1.34
Peak Inflow Q (cfs) =	N/A	N/A	16.4	21.2	25.0	32.2	37.6	45.1	59.4
Peak Outflow Q (cfs) =	0.2	1.3	0.8	1.2	1.4	7.2	13.3	21.9	23.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.1	1.3	1.2	1.5	1.8	1.2
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.1	0.2	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	55	56	56	56	54	51	49	44
Time to Drain 99% of Inflow Volume (hours) =	**49**	64	63	65	66	65	64	62	60
Maximum Ponding Depth (ft) =	1.79	3.85	3.05	3.53	3.90	4.04	4.12	4.22	4.66
Area at Maximum Ponding Depth (acres) =	0.32	0.58	0.49	0.54	0.59	0.61	0.62	0.64	0.71
Maximum Volume Stored (acre-ft) =	0.344	1.285	0.852	1.099	1.309	1.392	1.448	1.505	1.812

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)







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

DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

Inflow Hydrographs

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

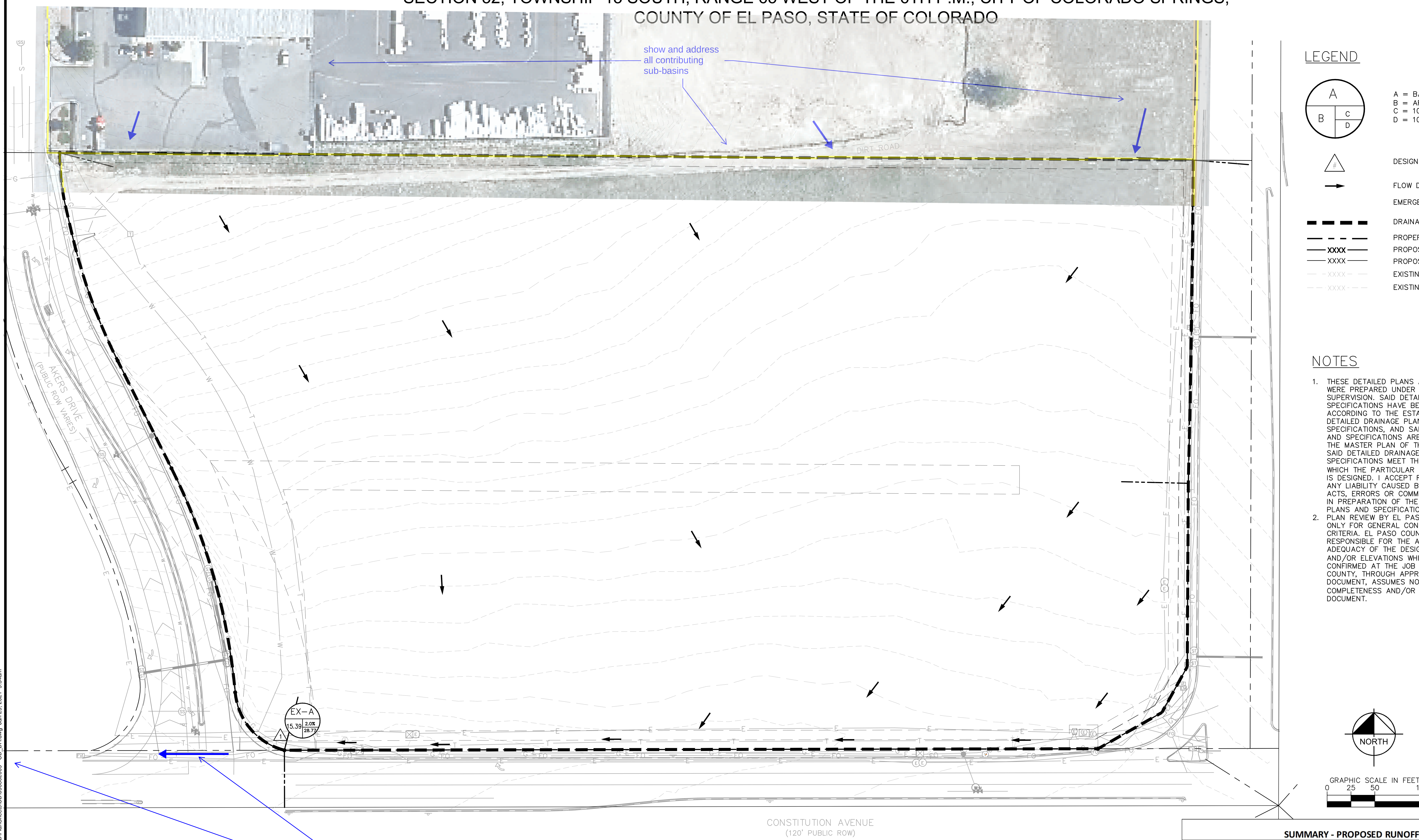
Time Interval: 5.00 min

SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
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	0.24	0.02	0.78
0:15:00	0.00	0.00	2.16	3.52	4.36	2.93	3.62	3.56	5.01
0:20:00	0.00	0.00	7.37	9.59	11.24	7.06	8.19	8.82	11.41
0:25:00	0.00	0.00	14.67	19.56	23.43	14.35	16.77	17.99	23.63
0:30:00	0.00	0.00	16.44	21.15	24.97	30.40	35.77	40.25	53.76
0:35:00	0.00	0.00	14.33	18.13	21.31	32.19	37.64	45.09	59.38
0:40:00	0.00	0.00	12.24	15.19	17.78	29.42	34.37	40.89	53.74
0:45:00	0.00	0.00	9.89	12.55	14.78	24.75	28.88	35.80	47.08
0:50:00	0.00	0.00	8.15	10.60	12.25	21.08	24.64	30.36	39.97
0:55:00	0.00	0.00	7.00	9.07	10.59	17.02	19.85	25.08	33.14
1:00:00	0.00	0.00	6.09	7.84	9.25	14.26	16.60	21.60	28.65
1:05:00	0.00	0.00	5.26	6.71	8.00	12.12	14.07	18.94	25.19
1:10:00	0.00	0.00	4.19	5.77	6.97	9.74	11.25	14.59	19.33
1:15:00	0.00	0.00	3.44	4.93	6.33	7.80	8.96	11.11	14.64
1:20:00	0.00	0.00	3.05	4.39	5.71	6.14	7.02	8.09	10.60
1:25:00	0.00	0.00	2.84	4.08	5.03	5.20	5.92	6.23	8.12
1:30:00	0.00	0.00	2.72	3.88	4.56	4.41	5.00	5.10	6.59
1:35:00	0.00	0.00	2.65	3.74	4.23	3.90	4.41	4.39	5.62
1:40:00	0.00	0.00	2.60	3.33	3.99	3.56	4.02	3.91	4.96
1:45:00	0.00	0.00	2.56	3.04	3.83	3.34	3.76	3.59	4.52
1:50:00	0.00	0.00	2.54	2.82	3.71	3.18	3.58	3.37	4.22
1:55:00	0.00	0.00	2.17	2.67	3.52	3.09	3.47	3.26	4.07
2:00:00	0.00	0.00	1.90	2.47	3.17	3.03	3.41	3.22	4.02
2:05:00	0.00	0.00	1.34	1.75	2.23	2.14	2.40	2.28	2.84
2:10:00	0.00	0.00	0.93	1.21	1.55	1.49	1.67	1.59	1.98
2:15:00	0.00	0.00	0.63	0.82	1.06	1.02	1.15	1.10	1.37
2:20:00	0.00	0.00	0.42	0.54	0.71	0.68	0.77	0.73	0.91
2:25:00	0.00	0.00	0.27	0.35	0.46	0.45	0.50	0.48	0.60
2:30:00	0.00	0.00	0.16	0.22	0.29	0.29	0.32	0.31	0.38
2:35:00	0.00	0.00	0.08	0.13	0.16	0.16	0.18	0.18	0.22
2:40:00	0.00	0.00	0.03	0.06	0.07	0.08	0.08	0.08	0.10
2:45:00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.03
2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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

APPENDIX D: DRAINAGE MAPS

WATERMARK AT AKERS
SITE DEVELOPMENT PLAN
TRACT DD, HANNAH RIDGE AT FEATHERGRASS FILING NO. 1, AS AMENDED
SECTION 32, TOWNSHIP 13 SOUTH, RANGE 65 WEST OF THE 6TH P.M., CITY OF COLORADO SPRINGS, COUNTY OF EL PASO, STATE OF COLORADO

See https://epcdevplanreview.com/Public/ProjectDetails/110809



Identify the flow path to inlet and size of inlet

LEGEND

A = BASIN DESIGNATION
B = AREA (ACRES)
C = 100–YR COMPOSITE RUNOFF COEFFICIENT
D = 100–YR DESIGN STORM RUNOFF (CFS)

DESIGN POINT
FLOW DIRECTION
EMERGENCY OVERFLOW PATH
DRAINAGE BASIN BOUNDARY
PROPERTY LINE
XXXX PROPOSED MAJOR CONTOUR
XXXX PROPOSED MINOR CONTOUR
XXXX EXISTING MAJOR CONTOUR
XXXX EXISTING MAJOR CONTOUR

NOTES

1. THESE DETAILED PLANS AND SPECIFICATIONS WERE PREPARED UNDER MY DIRECTION AND SUPERVISION. SAID DETAILED PLANS AND SPECIFICATIONS HAVE BEEN PREPARED ACCORDING TO THE ESTABLISHED CRITERIA FOR DETAILED DRAINAGE PLANS AND SPECIFICATIONS, AND SAID DETAILED PLANS AND SPECIFICATIONS ARE IN CONFORMITY WITH THE MASTER PLAN OF THE DRAINAGE BASIN. SAID DETAILED DRAINAGE PLANS AND SPECIFICATIONS MEET THE PURPOSES FOR WHICH THE PARTICULAR DRAINAGE FACILITY(S) IS DESIGNED. I ACCEPT RESPONSIBILITY FOR ANY LIABILITY CAUSED BY ANY NEGLIGENT ACTS, ERRORS OR COMMISSIONS ON MY PART IN PREPARATION OF THE DETAILED DRAINAGE PLANS AND SPECIFICATIONS.
2. PLAN REVIEW BY EL PASO COUNTY IS PROVIDED ONLY FOR GENERAL CONFORMANCE WITH DESIGN CRITERIA. EL PASO COUNTY IS NOT RESPONSIBLE FOR THE ACCURACY AND ADEQUACY OF THE DESIGN, DIMENSIONS, AND/OR ELEVATIONS WHICH SHALL BE CONFIRMED AT THE JOB SITE. EL PASO COUNTY, THROUGH APPROVAL OF THIS DOCUMENT, ASSUMES NO RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THIS DOCUMENT.

SUMMARY - PROPOSED RUNOFF TABLE

DESIGN POINT	BASIN DESIGNATION	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)	CUMULATIVE 5-YR RUNOFF (CFS)	CUMULATIVE 100-YR RUNOFF (CFS)
EX-A	EX-A	15.39	3.92	28.77	3.92	28.77

Kimley»Horn

2 NORTH NEVADA AVENUE, SUITE 300
COLORADO SPRINGS, COLORADO 80903 (719) 453–0180

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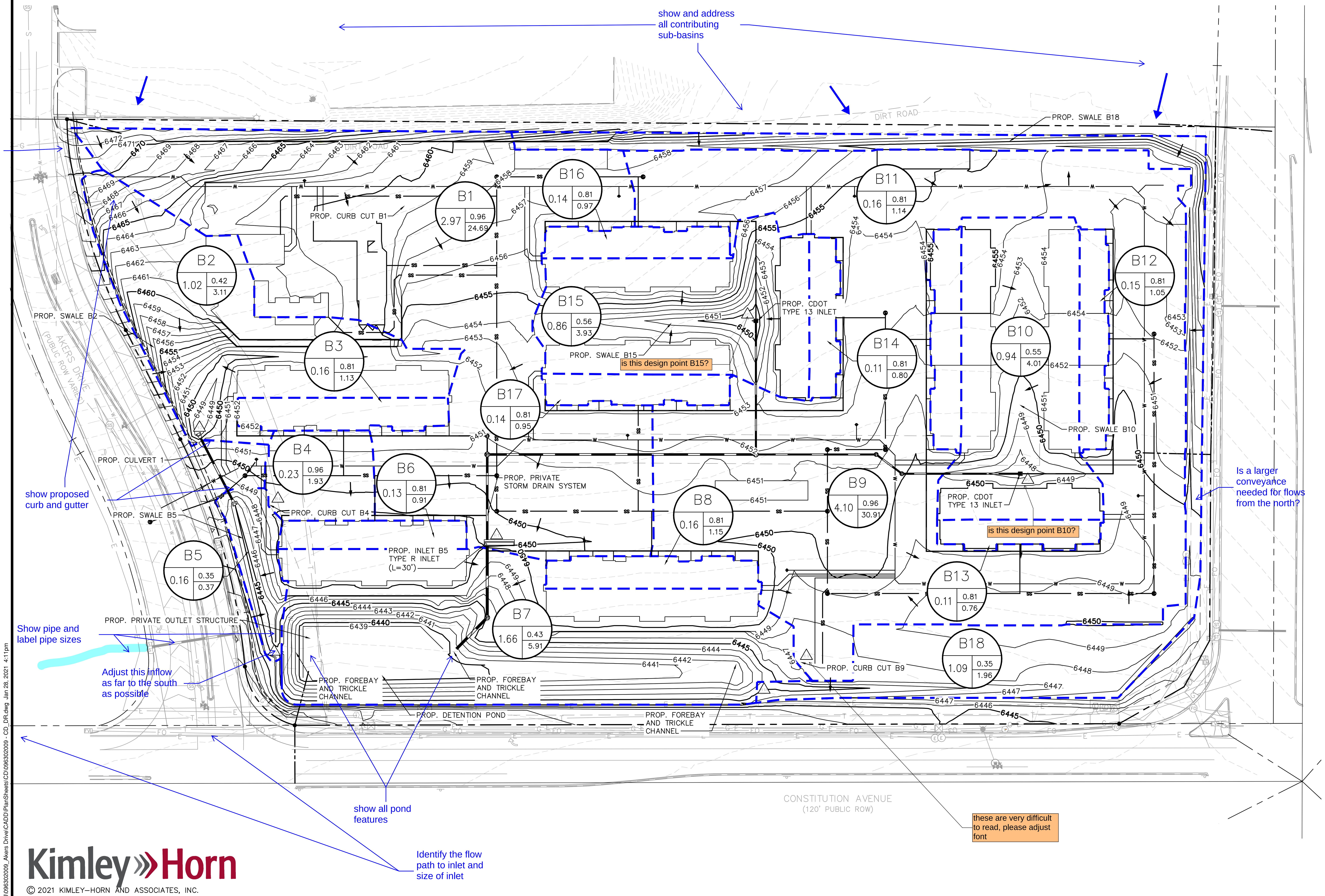
WATERMARK AT AKERS

SITE DEVELOPMENT PLAN

TRACT DD, HANNAH RIDGE AT FEATHERGRASS FILING NO. 1, AS AMENDED

SECTION 32, TOWNSHIP 13 SOUTH, RANGE 65 WEST OF THE 6TH P.M., CITY OF COLORADO SPRINGS, COUNTY OF EL PASO, STATE OF COLORADO



LEGEND

A = BASIN DESIGNATION
B = AREA (ACRES)
C = 100-YR COMPOSITE RUNOFF COEFFICIENT
D = 100-YR DESIGN STORM RUNOFF (CFS)

- DESIGN POINT
- FLOW DIRECTION
- DRAINAGE BASIN BOUNDARY
- PROPERTY LINE
- XXXX PROPOSED MAJOR CONTOUR
- XXXX PROPOSED MINOR CONTOUR
- XXXX EXISTING MAJOR CONTOUR
- XXXX EXISTING MAJOR CONTOUR

NOTES

1. THESE DETAILED PLANS AND SPECIFICATIONS WERE PREPARED UNDER MY DIRECTION AND SUPERVISION. SAID DETAILED PLANS AND SPECIFICATIONS HAVE BEEN PREPARED ACCORDING TO THE ESTABLISHED CRITERIA FOR DETAILED DRAINAGE PLANS AND SPECIFICATIONS, AND SAID DETAILED PLANS AND SPECIFICATIONS ARE IN CONFORMITY WITH THE MASTER PLAN OF THE DRAINAGE BASIN. SAID DETAILED DRAINAGE PLANS AND SPECIFICATIONS MEET THE PURPOSES FOR WHICH THE PARTICULAR DRAINAGE FACILITY(S) IS DESIGNED. I ACCEPT RESPONSIBILITY FOR ANY LIABILITY CAUSED BY ANY NEGLIGENT ACTS, ERRORS OR COMMISSIONS ON MY PART IN PREPARATION OF THE DETAILED DRAINAGE PLANS AND SPECIFICATIONS.
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SUMMARY - PROPOSED RUNOFF TABLE

DESIGN POINT	BASIN DESIGNATION	BASIN AREA (ACRES)	DIRECT 5-YR RUNOFF (CFS)	DIRECT 100-YR RUNOFF (CFS)	CUMULATIVE 5-YR RUNOFF (CFS)	CUMULATIVE 100-YR RUNOFF (CFS)
B1	B1	2.97	13.80	24.69	13.80	24.69
B2	B2	1.02	0.80	3.11	0.80	3.11
B3	B3	0.16	0.61	1.13	0.61	1.13
B4	B4	0.23	1.08	1.93	1.08	1.93
B5	B5	0.16	0.05	0.37	0.05	0.37
B6	B6	0.13	0.49	0.91	0.49	0.91
B7	B7	1.66	1.58	5.91	1.58	5.91
B8	B8	0.16	0.62	1.15	0.62	1.15
B9	B9	4.10	16.87	30.19	16.87	30.19
B10	B10	0.94	1.59	4.01	1.59	4.01
B11	B11	0.16	0.61	1.14	0.61	1.14
B12	B12	0.15	0.56	1.05	0.56	1.05
B13	B13	0.11	0.41	0.76	0.41	0.76
B14	B14	0.11	0.43	0.80	0.43	0.80
B15	B15	0.86	1.57	3.93	1.57	3.93
B16	B16	0.14	0.52	0.97	0.52	0.97
B17	B17	0.14	0.51	0.95	0.51	0.95
B18	B18	1.09	0.27	1.96	0.27	1.96

NORTH

GRAPHIC SCALE IN FEET
0 25 50 100

Kimley»Horn

2 NORTH NEVADA AVENUE, SUITE 300
COLORADO SPRINGS, COLORADO 80903 (719) 453-0180

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