# FINAL DRAINAGE REPORT

## SUMMERFIELD NORTH SUBDIVISION

LOCATED IN THE SOUTHEAST QUARTER OF SECTION 26,
TOWNSHIP 2 NORTH, RANGE 64 WEST OF THE 6$^{TH}$ P.M.
TOWN OF KEENESBURG
COUNTY OF WELD
STATE OF COLORADO


Prepared By:

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**October 19, 2021**

BASELINE
Engineering · Planning · Surveying

## CERTIFICATION

This report for the final design of the Summerfield North Subdivision was prepared by me or under my direct supervision in accordance with the provisions of the Town of Keenesburg and Weld County criteria. I understand that the Town of Keenesburg and its designated city authority do not and will not assume liability for drainage facilities designed by others.

______________________________________
Signature

______________________________________
Colorado P.E. License No.

______________________________________
Seal and Date

# Table of Contents

# Introduction

It is Baseline Engineering's understanding that MSP Investment Co., LLP will be developing a subdivision in the Town of Keenesburg, Colorado. The proposed development will create 190 single-family homes, as well as future multi-family townhomes, on a total of 59.96 acres. This drainage report is designed to be in conformance with the Town of Keenesburg and Weld County drainage design standards.

## Site Location

1. The property is located in the southwest quarter of Section 26, Township 2 North, Range 64 West of the $6^{th}$ Principal Meridian, Town of Keenesburg, County Weld, State of Colorado.

2. The property is bounded to the north and west by residential lots, to the east by Weld County Road 59, to the south by open space, wetlands and floodplain. The existing Town of Keenesburg wastewater treatment facility is located southwest of this site.

3. The proposed site will be zoned R-1 for the single family lots and R-3 for the future multi-family development.

4. The Lost Creek runs through the Southern portion of the Summerfield North site and portions of the site are covered by Zone A (100-Year floodplain). Refer to FEMA FIRM Map No. 08123C2157E (**Reference 5**) with an effective date of January 20, 2016 (see **Appendix A**).

## Site Description

1. For purposes of this report, the developed property has been broken up into three subbasins; "Basin A", "Basin B", and "Basin C". Each subbasin will contain a detention pond to release drainage at historic rates. The historical drainage basin shall be referred to as "Basin X." The total area for the property is 59.96 acres. Refer to the drainage plans in **Appendix C** for more information.

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1. Historical ground cover for the site consists of native grasses which generally slope from the northwest corner of the site to the southeast corner. The hydrologic soil group is type 'B' (Colby loam). A soil map for the entire drainage area, developed

using the online NRCS Web Soil Survey mapping tool, can be found in **Appendix A** (**Reference 4**).

2. The site slopes gradually towards the southeast with slopes ranging from 1% to 10%. The existing Sloans Reservoir No. 1 is located at the southwest corner and an existing wetland area to the south of the site.

## Proposed Project Description

1. The proposed improvements consist of 190 single-family residential homes, with lot sizes varying from 5,500 SF to 10,500 SF at a density of 3.68 DU/acre, as well as future multi-family townhomes on 8.30 acres at a density of 10 DU/acre. Additional improvements include the associated roadways, trail system, community park, open space, and several proposed detention ponds.

# Historic Drainage System

## Major Basin

1. The existing site is located within a larger drainage basin that ultimately reaches Lost Creek via surface flow.

2. There is an existing protected wetlands and effective 100-year floodplain located at the south end of the property. However, the entirety of the proposed development is to occur outside both the wetlands and 100-year floodplains (see **Appendix A**).

3. Runoff drainage patterns were defined based on ground topography surveyed using both GPS and conventional survey methods. Refer to the Drainage Plans in **Appendix C** for existing and proposed contours.

## Site Drainage

1. Historically, the site generally drains from its northwest corner towards the southeast corner. In historic conditions, all the flows are transmitted overland via sheet flow across the property. The hydrologic analysis and hydraulic design for the site is based on the criteria established in the Urban Storm Drainage (Mile High Flood District) Criteria Manual Volumes 1, 2, and 3 (**References 1 and 2**) as well as the Town of Keenesburg and Weld County Engineering and Construction Guidelines (**Reference 3**). The Rational Method was used to calculate peak runoff

flows for the sub-basins (refer to forms SF-2 and SF-3 in **Appendix B**). Runoff flows were analyzed for the 5-year (minor) and 100-year (major) storms.

# Proposed (Developed) Drainage System

The regulations, guidelines and drainage design criteria used for this report are those contained within the Urban Storm Drainage (Mile High Flood District) Criteria Manual, Volumes 1, 2 and 3 (**References 1 and 2**).

## Hydrology Criteria

1. In accordance with the Mile High Flood District (MHFD) criteria, the design storms analyzed for this site were the minor 5-year storm and the major 100-year storm. One-hour rainfalls of 1.14 and 2.65 inches have been used for the 5-Year and 100-Year runoff calculations, respectively, using the NOAA Atlas 14 Point Precipitation Frequency Estimates (**Reference 6**) for the project site. Refer to **Appendix A** for supporting information.

2. The peak discharge for sizing the detention ponds, the onsite storm sewer and for the street capacity calculations was calculated using the following Rational Method formula:

   Q = CIA

   Where:

   Q = peak discharge (cfs)
   C = runoff coefficient
   I = rainfall intensity (inches/hour)
   A = drainage area (acres)

   See **Appendix B** for Rational Method flow calculations.

   These flows were routed through the site using the UDFCD SF-3 form to determine the total flow at respective design points. See **Appendix B** for routing spreadsheets.

## Hydraulic Criteria

1. The MHFD Full-Spectrum Detention method was used to determine the required detention volume for this project.

2. Stormwater quality and detention for the on-site detention ponds will be provided using the MHFD methods for full spectrum detention in accordance with the Mile High Flood District Detention Basin Design Workbook (MHFD-Detention, Version 4.04). In coordination with the Town of Keenesburg the maximum allowable 100-year release rate for a full spectrum detention facility shall be no greater than the predevelopment 100-year storm water discharge of the upstream watershed. The predevelopment 100-year unit discharge for specific soil types per acre of tributary catchment varies based on the watershed slope and watershed shape. The peak unit flow rate is based on one-hour precipitation depth from NOAA Atlas 14, watershed flow path slope, watershed flow path length, the tributary area, and coefficients dependent on event frequency tables for a soil with a hydraulic soil grouping of 'B'. Please refer to the 5-year and 100-year detention volume calculations in **Appendix B** of this report.

3. The proposed detention ponds will be installed with the initial phase of construction. The detention ponds have been designed based on the Town of Keenesburg Criteria specified below and will act as permanent stormwater facilities that will remain in place.

4. A proposed storm sewer system will be installed for the proposed site and for the proposed detention pond outfalls. The proposed storm sewer is discussed in more detail in the applicable section.

## Variance from Criteria

1. This project has no requests for variances from criteria.

## Runoff

1. The developed site consists of single-family residences with piped roof drainage and associated private driveways, proposed roadways and right-of-way improvements, and the open space & trail network. The site will consist of public streets with curb & gutter, infrastructure, and open space tracts. The Rational Method was used for this analysis, and design storm frequencies of 5-year and 100-year storms were analyzed (see **Appendix B**).

2. The majority of stormwater runoff from the project site will be directed to the proposed detention ponds which will be located at the downstream design points for each basin. Stormwater will be conveyed to the ponds by surface flow, curb &

gutter or a proposed storm sewer network. Pond C will capture the WQCV while ponds A and B will provide full-spectrum detention and will outfall to the south of the site and overland flow in its historical fashion to the existing wetland areas south of the site. A 4-foot-wide concrete trickle channel and outlet structure will be designed for the ponds. A Restrictor plate for the outlet structure was designed to release the runoff from the 100-year storm at a controlled rate in accordance with Urban Storm Drainage Criteria Manual Volume 2, Storage Chapter (**Reference 1**). This design can be found in **Appendix B**.

3. The ponds have emergency spillways which have been designed to spill south of the proposed site. The ponds have been sized for the entirety of the development including compensatory storage for the runoff that is not detained on site.

4. The ponds are sized based on the contributing impervious area which determine the water quality capture volume, the 5-year, and the 100-year detention volumes.

5. Developed runoff onsite follows the typical pattern in which roof drainage will be collected in gutters and piped into downspouts. Flows will then sheet flow across landscaped areas and be conveyed into the curb and gutter system in the proposed roadways. Flows will then enter into the proposed storm sewer network and ultimately be conveyed to the respective detention ponds at the design points for each basin.

   Flows from Basin A and B will flow to the proposed local street curb and gutter and then continue into the proposed storm sewer system, eventually out falling into the detention pond for each basin. Flows from Basin C will sheet flow into the grass lined swale at the east side of the project along Colorado Road 59 then outfall into the water quality pond for that basin.

   These flows will be detained and release following the criteria stated in the Detention section of this report. The flows will ultimately outfall on the south end of the site, and flow to the existing floodplain south of the project. There are no anticipated offsite flows that make it to the site.

   Curb & gutter, storm sewer, and inlet design calculations can be found in **Appendix B**.

## Detention

Detention design for the site operates in a staged fashion. There are two proposed Full Spectrum Detention Basins on the site, relative to the major drainage basins for the site. Runoff from Basin A will flow to Pond A at the west side of the site, and runoff from Basin B will flow to the large Pond B located at the south end of the site. Runoff from Basin C will flow through a grass lined swale and outfall into a Water Quality Pond treating only WQCV before release into Lost Creek at the south end of the site. Detention design for the developed site will consist of:

1. The structural BMPs to be utilized for water quality will be Full Spectrum Detention Basins.

2. The release rate for the 100-year storm will be controlled with an orifice plate inside the outlet structure for each basin.

3. A 4-foot-wide concrete trickle channel with a minimum 0.5% longitudinal slope has been incorporated into the pond bottom to promote drainage of the ponds. The ponds will be graded with a minimum pond bottom slope of 2% toward the trickle channel.

4. Excess stormwater, greater than the 100-year major event, will pass through the ponds, overtop the concrete spillway and spill south to the Lost Creek and maintain historic drainage patterns from there.

5. The emergency overflow for pond A has been designed to be 14-ft in length at elevation 4904.50 ft and will be protected with Type 'VL' riprap for the entire length. The emergency overflow for Pond B has been designed to be 14-ft in length at an elevation of 4899.10 and will be protected with Type 'VL' riprap for the entire length. The emergency spillway for WQCV Pond C is designed to be 14-ft in length at an elevation of 4891.00 ft and will be protected with Type 'VL' riprap for the entire length.

6. The outlet structures and 100-yr restrictor plates will be designed to provide appropriate release rates ***(***see MHFD spreadsheet in **Appendix B*)***. The outlet structures will consist of an orifice plate containing a vertical column of small, equally spaced orifices. The proposed orifice plate for detention pond A will consist of three 1-inch diameter orifices, spaced 8-inches apart. The proposed orifice plate for detention pond B will consist of three 2-inch diameter orifices, spaced 7.5-inches apart. The ground at the outfall of the pipe from the detention

ponds will be protected from erosion with the installation of riprap pads. The riprap is type 'VL' which is sized to handle the flows that will be released from the detention ponds (see calculation for sizing of riprap pads in **Appendix B**).

7. The detention pond outlet pipe will be set 2 feet above the channel water surface and a flapgate will be installed to prevent water from backing into the pond during large storm events.

The following tables show the required and provided volumes and the corresponding water surface elevations at each required stage:

| ***Pond A*** | *Required Volume (ac-ft)* | *Provided Volume (ac-ft)* | *Water Surface Elevation* |
|---|---|---|---|
| *WQCV* | 0.27 | 0.28 | 4903.00 |
| *5-year* | 0.67 | 0.68 | 4903.36 |
| *100-year* | 1.57 | 1.58 | 4904.01 |

| ***Pond B*** | *Required Volume (ac-ft)* | *Provided Volume (ac-ft)* | *Water Surface Elevation* |
|---|---|---|---|
| *WQCV* | 0.63 | 0.63 | 4896.83 |
| *5-year* | 1.55 | 1.57 | 4897.21 |
| *100-year* | 3.61 | 3.62 | 4898.01 |

| ***Pond C*** | *Required Volume (ac-ft)* | *Provided Volume (ac-ft)* | *Water Surface Elevation* |
|---|---|---|---|
| *WQCV* | .091 | .092 | 4890.92 |

These calculations include the mandatory one-foot of freeboard provided above the emergency overflow water surface elevation.

## Streets

1. Street capacity for the minor storm was based on flows not overtopping the curb and gutter for all private streets on-site. Flows in local streets can spread to the crown of the street in major storm events. The spread criteria control the flow depth for the Residential Collector Streets that run through the site. Refer to **Appendix B** for calculations.

## Storm Sewer System

1. The MHFD drainage criteria requires that the minor storm be conveyed into the storm system with no curb overtopping, and flow may spread to the crown of the street, while the major storm shall be conveyed into the system with a depth less than or equal to 12" above the gutter flowline. The major storm criterion has been

met and the adjacent buildings have been sufficiently graded so that a 100-yr storm will not have any negative impacts.

2. The MHFD drainage criteria requires that the minor storm be conveyed within the storm sewer pipe, while the major storm shall be conveyed in the roadway with a depth less than or equal to 12” above the gutter flowline. This criterion has been met, refer to **Appendix B** for calculations.

3. All proposed storm sewer located within the Town of Keenesburg’s Right Of Way has been sized to meet a minimum standard of 18” RCP.

# Conclusions

## Compliance with Applicable Code

The drainage conveyance and detention volume has been designed in compliance with The Town of Keenesburg design standards, and the MHFD manual.

## Flood Hazard

The proposed improvements will stay out of the 100-year floodplain limits and the existing floodplain will not be impacted by this project.

## Impact of the Improvements

1. This proposed development will provide sedimentation and filtration of runoff through proposed Full Spectrum Detention Ponds and controlled release rates for the WQCV and 100-yr events meeting MHFD release rates for the soil type to mimic predeveloped release rates. The proposed street improvements will include curb and gutter to provide adequate containment of the major and minor storm flows.

## Maintenance of Improvements

1. The proposed improvements shall be maintained in order to ensure runoff is appropriately routed. The property owners shall be responsible for the maintenance of all drainage infrastructure on their property up to the edge of the sidewalk or roadway. The Town of Keenesburg has the right to enter an owner’s property in order to maintain the drainage infrastructure when deemed fit.

2. The proposed detention ponds shall be maintained by the Homeowners Association. The maintenance responsibility will eventually be transferred to a metropolitan district once one is established.

# References


1. *Urban Storm Drainage Criteria Manual, Volumes 1 & 2*; Urban Drainage and Flood Control District, Denver, CO. Updated March 2017, with updates on September 2017.

2. *Urban Storm Drainage Criteria Manual, Volumes 3*; Urban Drainage and Flood Control District, Denver, CO. November 2010, with updates on January 2021.

3. *Weld County Engineering and Construction Guidelines*; Weld County, CO. April 2012, with updates on July 2017.

4. *Natural Resources Conservation Center Web Soil Survey, United States Department of Agriculture,* site visited August 2021.

5. *Federal Emergency Management Agency Flood Insurance Rate Map, Community-Panel Number 08123C2157E* revised January 20, 2016.

6. *NOAA's National Weather Service, Hydrometeorological Design Studies Center, Precipitation Frequency Data Server (PFDS),* site visited October 2021.

# APPENDIX

# Appendix A

*Vicinity Map*

*Hydrologic Soils Group*

*FIRM Map*

*NOAA Atlas Rainfall Data*


PROJECT SITE
E Kiser Ave
Kipp Ave
Woodward Ave
ge Rd
Cou
16
Crawford Ave
S Pine St

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

# Weld County, Colorado, Southern Part


August 16, 2021

# 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.

# Contents

# How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

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

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

# Soil Map

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

Soil Map


104° 30' 53" W
104° 30' 28" W
40° 6' 30" N
40° 6' 5" N
541370
541460
541550
541640
541730
541820
541910
4439900
4439810
4439720
4439630
4439540
4439450
4439360
4439270
4439180
59
County Road 59
15
16
26
85
18
Soil Map may not be valid at this scale.
Map Scale: 1:3,720 if printed on A portrait (8.5" x 11") sheet.
Meters
0 50 100 200 300
Feet
0 150 300 600 900
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: Weld County, Colorado, Southern Part
Survey Area Data: Version 19, 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: Jul 19, 2018—Aug 10, 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 |
|---|---|---|---|
| 15 | Colby loam, 1 to 3 percent slopes | 30.3 | 48.9% |
| 16 | Colby loam, 3 to 5 percent slopes | 26.8 | 43.3% |
| 18 | Colby-Adena loams, 3 to 9 percent slopes | 0.1 | 0.2% |
| 26 | Haverson loam, 1 to 3 percent slopes | 3.8 | 6.1% |
| 85 | Water | 0.9 | 1.4% |
| **Totals for Area of Interest** | | **61.9** | **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.

# Weld County, Colorado, Southern Part

## 15—Colby loam, 1 to 3 percent slopes

### Map Unit Setting

*National map unit symbol:* 361q
*Elevation:* 4,850 to 5,050 feet
*Mean annual precipitation:* 12 to 16 inches
*Mean annual air temperature:* 48 to 50 degrees F
*Frost-free period:* 135 to 155 days
*Farmland classification:* Prime farmland if irrigated

### Map Unit Composition

*Colby and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Colby

#### Setting

*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Calcareous eolian deposits

#### Typical profile

*H1 - 0 to 7 inches:* loam
*H2 - 7 to 60 inches:* silt loam

#### Properties and qualities

*Slope:* 1 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 (0.57 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:* 15 percent
*Available water supply, 0 to 60 inches:* High (about 10.6 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 4e
*Hydrologic Soil Group:* B
*Ecological site:* R067BY002CO - Loamy Plains
*Hydric soil rating:* No

### Minor Components

#### Wiley

*Percent of map unit:* 9 percent
*Hydric soil rating:* No

#### Keith

*Percent of map unit:* 6 percent

*Hydric soil rating:* No

## 16—Colby loam, 3 to 5 percent slopes

### Map Unit Setting

*National map unit symbol:* 361r
*Elevation:* 4,850 to 5,050 feet
*Mean annual precipitation:* 12 to 16 inches
*Mean annual air temperature:* 48 to 50 degrees F
*Frost-free period:* 135 to 155 days
*Farmland classification:* Farmland of statewide importance

### Map Unit Composition

*Colby and similar soils:* 85 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Colby

#### Setting

*Landform:* Ridges, hills
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Calcareous eolian deposits

#### Typical profile

*H1 - 0 to 7 inches:* loam
*H2 - 7 to 60 inches:* silt loam

#### Properties and qualities

*Slope:* 3 to 5 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 (0.57 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:* 15 percent
*Available water supply, 0 to 60 inches:* High (about 10.6 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 4e
*Hydrologic Soil Group:* B
*Ecological site:* R067BY002CO - Loamy Plains
*Hydric soil rating:* No

**Minor Components**

**Wiley**

*Percent of map unit:* 8 percent
*Hydric soil rating:* No

**Keith**

*Percent of map unit:* 7 percent
*Hydric soil rating:* No

## 18—Colby-Adena loams, 3 to 9 percent slopes

**Map Unit Setting**

*National map unit symbol:* 361t
*Elevation:* 4,750 to 4,900 feet
*Mean annual precipitation:* 12 to 16 inches
*Mean annual air temperature:* 48 to 55 degrees F
*Frost-free period:* 120 to 160 days
*Farmland classification:* Not prime farmland

**Map Unit Composition**

*Colby and similar soils:* 55 percent
*Adena and similar soils:* 30 percent
*Minor components:* 15 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Colby**

**Setting**

*Landform:* Ridges, hills, plains
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Calcareous eolian deposits

**Typical profile**

*H1 - 0 to 7 inches:* loam
*H2 - 7 to 60 inches:* silt loam

**Properties and qualities**

*Slope:* 5 to 9 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 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:* 15 percent
*Available water supply, 0 to 60 inches:* High (about 10.6 inches)

**Interpretive groups**

*Land capability classification (irrigated):* None specified
*Land capability classification (nonirrigated):* 4e
*Hydrologic Soil Group:* B
*Ecological site:* R067BY008CO - Loamy Slopes
*Hydric soil rating:* No

### Description of Adena

**Setting**

*Landform:* Plains, ridges, hills
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Calcareous eolian deposits

**Typical profile**

*H1 - 0 to 6 inches:* loam
*H2 - 6 to 9 inches:* clay loam
*H3 - 9 to 60 inches:* silt loam

**Properties and qualities**

*Slope:* 3 to 7 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Well drained
*Runoff class:* Medium
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high (0.20 to 0.60 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* None
*Frequency of ponding:* None
*Calcium carbonate, maximum content:* 15 percent
*Available water supply, 0 to 60 inches:* High (about 10.1 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 4e
*Hydrologic Soil Group:* C
*Ecological site:* R067BY002CO - Loamy Plains
*Hydric soil rating:* No

### Minor Components

**Kim**

*Percent of map unit:* 5 percent
*Hydric soil rating:* No

**Keith**

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

**Wiley**

*Percent of map unit:* 3 percent
*Hydric soil rating:* No

**Weld**

*Percent of map unit:* 3 percent
*Hydric soil rating:* No

## 26—Haverson loam, 1 to 3 percent slopes

### Map Unit Setting

*National map unit symbol:* 2tlq0
*Elevation:* 4,140 to 5,080 feet
*Mean annual precipitation:* 13 to 17 inches
*Mean annual air temperature:* 50 to 54 degrees F
*Frost-free period:* 135 to 160 days
*Farmland classification:* Prime farmland if irrigated

### Map Unit Composition

*Haverson, rarely flooded, and similar soils:* 90 percent
*Minor components:* 10 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Haverson, Rarely Flooded

#### Setting

*Landform:* Terraces, flood plains
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Parent material:* Stratified alluvium derived from mixed sources

#### Typical profile

*Ap - 0 to 4 inches:* loam
*A - 4 to 11 inches:* loam
*C1 - 11 to 19 inches:* loam
*C2 - 19 to 80 inches:* stratified sandy loam to loam

#### Properties and qualities

*Slope:* 1 to 3 percent
*Depth to restrictive feature:* More than 80 inches
*Drainage class:* Well drained
*Runoff class:* Low
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.20 to 6.00 in/hr)
*Depth to water table:* More than 80 inches
*Frequency of flooding:* Rare
*Frequency of ponding:* None
*Calcium carbonate, maximum content:* 5 percent
*Maximum salinity:* Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
*Sodium adsorption ratio, maximum:* 1.0
*Available water supply, 0 to 60 inches:* Moderate (about 7.6 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 3e
*Land capability classification (nonirrigated):* 4c
*Hydrologic Soil Group:* B

*Ecological site:* R067BY036CO - Overflow
*Hydric soil rating:* No

**Minor Components**

**Bijou**

*Percent of map unit:* 10 percent
*Landform:* Stream terraces
*Landform position (three-dimensional):* Tread
*Down-slope shape:* Linear
*Across-slope shape:* Linear
*Ecological site:* R067BY024CO - Sandy Plains
*Hydric soil rating:* No

## 85—Water

**Map Unit Composition**

*Water:* 95 percent
*Minor components:* 5 percent
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Minor Components**

**Aquolls**

*Percent of map unit:* 5 percent
*Landform:* Marshes
*Hydric soil rating:* Yes

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# NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) Report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS Report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

**Coastal Base Flood Elevations** shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study Report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

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

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

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD 83, GRS 1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

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

**Base map** information shown on this FIRM was derived from NAIP Orthophotography produced with a one meter ground resolution from photography dated 2013.

The **profile baselines** depicted on this map represent the hydraulic modeling baselines that match the flood profiles in the FIS report. As a result of improved topographic data, the **profile baseline**, in some cases, may deviate significantly from the channel centerline or appear outside the SFHA.

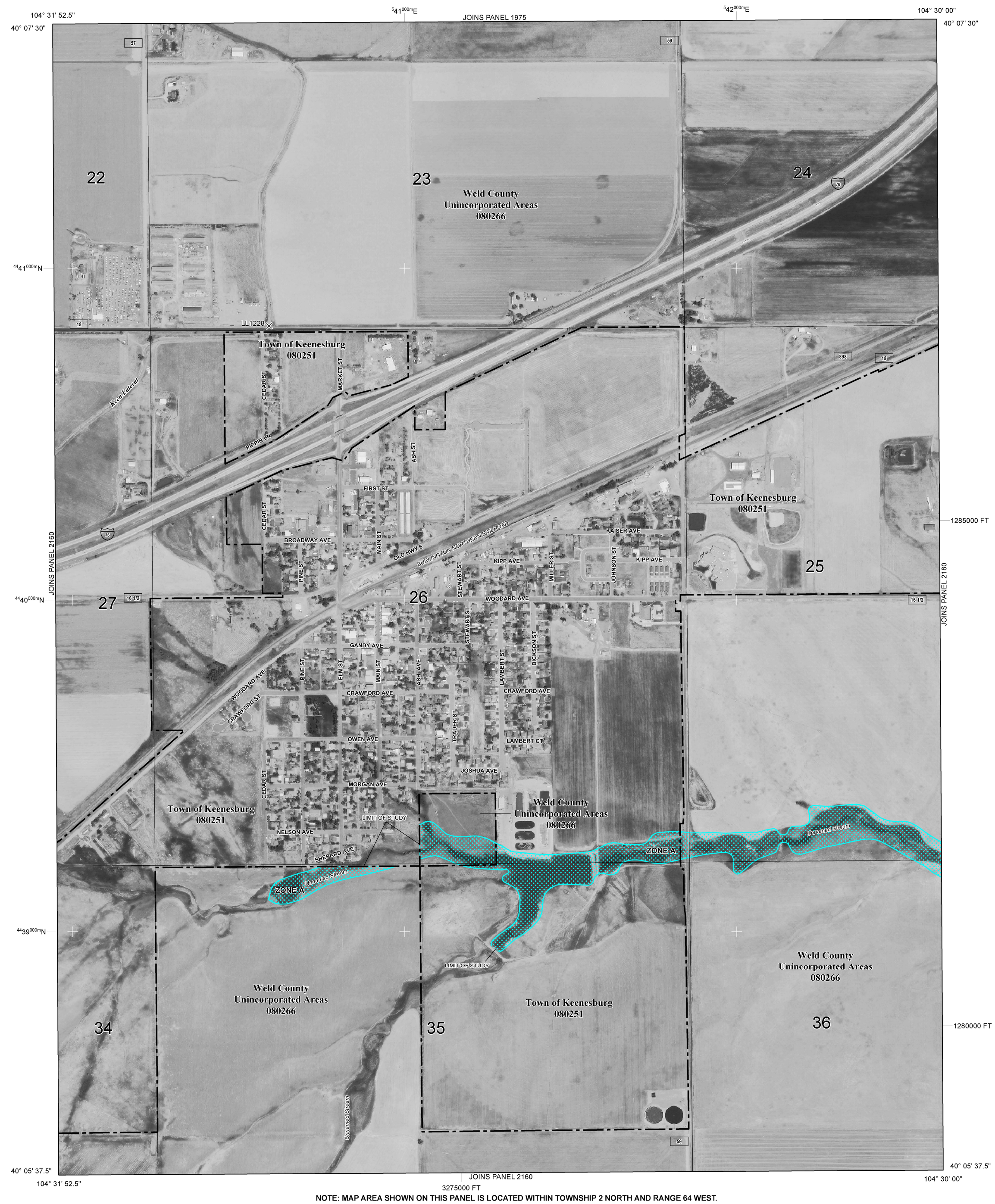
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

**Corporate limits** shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

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

For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

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




NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 2 NORTH AND RANGE 64 WEST.

# LEGEND

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

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

| | |
|---|---|
| **ZONE A** | No Base Flood Elevations determined. |
| **ZONE AE** | Base Flood Elevations determined. |
| **ZONE AH** | Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined. |
| **ZONE AO** | Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined. |
| **ZONE AR** | Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood. |
| **ZONE A99** | Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined. |
| **ZONE V** | Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined. |
| **ZONE VE** | Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined. |

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

| | |
|---|---|
| | 1% Annual Chance Floodplain Boundary |
| | 0.2% Annual Chance Floodplain Boundary |
| | Floodway boundary |
| | Zone D boundary |
| | CBRS and OPA boundary |
| | Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths, or flood velocities. |
| 513 | Base Flood Elevation line and value; elevation in feet* |
| (EL 987) | Base Flood Elevation value where uniform within zone; elevation in feet* |

*Referenced to the North American Vertical Datum of 1988

| | |
|---|---|
| A — A | Cross section line |
| 23 - - - - 23 | Transect line |
| 45° 02' 08", 93° 02' 12" | Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere |
| 3100000 FT | 5000-foot ticks: Colorado State Plane Central Zone (FIPS Zone 0502), Lambert Conformal Conic projection |
| 4989000m N | 1000-meter Universal Transverse Mercator grid values, zone 13 |
| DX5510 × | Bench mark (see explanation in Notes to Users section of this FIRM panel) |
| • M1.5 | River Mile |

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
January 20, 2016

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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

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

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2157E

# FIRM
## FLOOD INSURANCE RATE MAP
## WELD COUNTY, COLORADO
### AND INCORPORATED AREAS

**PANEL 2157 OF 2250**
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

| COMMUNITY | NUMBER | PANEL | SUFFIX |
|---|---|---|---|
| KEENESBURG, TOWN OF | 080251 | 2157 | E |
| WELD COUNTY | 080266 | 2157 | E |

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

**MAP NUMBER**
**08123C2157E**

**EFFECTIVE DATE**
**JANUARY 20, 2016**

Federal Emergency Management Agency

**NOAA Atlas 14, Volume 8, Version 2**
**Location name: Keenesburg, Colorado, USA***
**Latitude: 40.106°, Longitude: -104.5119°**
**Elevation: 4915.91 ft****
* source: ESRI Maps
** source: USGS

## POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Deborah Martin, Sandra Pavlovic, Ishani Roy, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Michael Yekta, Geoffery Bonnin

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

# PF tabular

**PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]**

| Duration | Average recurrence interval (years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 | 200 | 500 | 1000 |
| 5-min | **0.243** (0.194-0.307) | **0.296** (0.236-0.373) | **0.394** (0.313-0.498) | **0.488** (0.385-0.619) | **0.634** (0.492-0.854) | **0.762** (0.572-1.03) | **0.901** (0.652-1.25) | **1.06** (0.730-1.50) | **1.28** (0.848-1.86) | **1.46** (0.937-2.13) |
| 10-min | **0.356** (0.285-0.449) | **0.433** (0.346-0.546) | **0.577** (0.459-0.729) | **0.714** (0.564-0.906) | **0.929** (0.720-1.25) | **1.12** (0.838-1.51) | **1.32** (0.955-1.83) | **1.55** (1.07-2.19) | **1.87** (1.24-2.72) | **2.14** (1.37-3.12) |
| 15-min | **0.435** (0.347-0.548) | **0.528** (0.421-0.666) | **0.704** (0.559-0.889) | **0.871** (0.688-1.11) | **1.13** (0.878-1.53) | **1.36** (1.02-1.84) | **1.61** (1.16-2.23) | **1.88** (1.30-2.68) | **2.28** (1.51-3.32) | **2.61** (1.67-3.81) |
| 30-min | **0.583** (0.466-0.734) | **0.706** (0.563-0.890) | **0.938** (0.746-1.19) | **1.16** (0.917-1.47) | **1.51** (1.17-2.04) | **1.82** (1.37-2.46) | **2.15** (1.56-2.98) | **2.52** (1.75-3.58) | **3.06** (2.03-4.45) | **3.50** (2.25-5.11) |
| 60-min | **0.717** (0.573-0.903) | **0.860** (0.687-1.09) | **1.14** (0.906-1.44) | **1.41** (1.12-1.79) | **1.85** (1.44-2.50) | **2.23** (1.68-3.03) | **2.66** (1.93-3.69) | **3.13** (2.17-4.46) | **3.82** (2.54-5.57) | **4.40** (2.82-6.42) |
| 2-hr | **0.850** (0.684-1.06) | **1.01** (0.816-1.27) | **1.34** (1.07-1.68) | **1.66** (1.32-2.09) | **2.18** (1.71-2.93) | **2.65** (2.01-3.57) | **3.16** (2.31-4.36) | **3.74** (2.62-5.28) | **4.59** (3.08-6.63) | **5.30** (3.43-7.65) |
| 3-hr | **0.927** (0.749-1.15) | **1.10** (0.887-1.37) | **1.44** (1.16-1.80) | **1.79** (1.43-2.24) | **2.35** (1.86-3.14) | **2.85** (2.18-3.83) | **3.42** (2.51-4.68) | **4.05** (2.85-5.69) | **4.98** (3.36-7.16) | **5.76** (3.75-8.27) |
| 6-hr | **1.09** (0.888-1.34) | **1.28** (1.04-1.58) | **1.65** (1.34-2.04) | **2.03** (1.64-2.52) | **2.65** (2.11-3.51) | **3.20** (2.46-4.25) | **3.81** (2.83-5.18) | **4.51** (3.20-6.27) | **5.53** (3.77-7.86) | **6.39** (4.20-9.07) |
| 12-hr | **1.29** (1.06-1.58) | **1.52** (1.25-1.86) | **1.96** (1.60-2.40) | **2.37** (1.93-2.91) | **3.02** (2.40-3.92) | **3.58** (2.77-4.68) | **4.19** (3.13-5.60) | **4.87** (3.48-6.67) | **5.86** (4.02-8.21) | **6.66** (4.42-9.37) |
| 24-hr | **1.53** (1.27-1.85) | **1.81** (1.50-2.19) | **2.31** (1.90-2.80) | **2.76** (2.26-3.37) | **3.45** (2.75-4.40) | **4.02** (3.13-5.18) | **4.64** (3.48-6.10) | **5.30** (3.81-7.15) | **6.25** (4.32-8.64) | **7.02** (4.70-9.76) |
| 2-day | **1.75** (1.46-2.09) | **2.10** (1.75-2.52) | **2.70** (2.24-3.24) | **3.21** (2.65-3.88) | **3.95** (3.16-4.94) | **4.54** (3.54-5.74) | **5.15** (3.88-6.66) | **5.79** (4.18-7.68) | **6.66** (4.63-9.06) | **7.35** (4.97-10.1) |
| 3-day | **1.91** (1.60-2.28) | **2.27** (1.90-2.71) | **2.88** (2.40-3.44) | **3.40** (2.82-4.08) | **4.14** (3.33-5.15) | **4.74** (3.72-5.96) | **5.35** (4.06-6.88) | **6.00** (4.36-7.90) | **6.88** (4.81-9.29) | **7.56** (5.15-10.3) |
| 4-day | **2.04** (1.72-2.42) | **2.40** (2.01-2.85) | **3.01** (2.52-3.58) | **3.53** (2.94-4.22) | **4.28** (3.45-5.29) | **4.88** (3.84-6.11) | **5.50** (4.18-7.04) | **6.14** (4.48-8.06) | **7.03** (4.93-9.46) | **7.73** (5.28-10.5) |
| 7-day | **2.33** (1.97-2.75) | **2.72** (2.30-3.21) | **3.37** (2.84-3.98) | **3.92** (3.28-4.65) | **4.69** (3.80-5.74) | **5.30** (4.20-6.56) | **5.92** (4.53-7.50) | **6.56** (4.82-8.52) | **7.43** (5.25-9.89) | **8.10** (5.58-10.9) |
| 10-day | **2.58** (2.19-3.03) | **3.00** (2.55-3.53) | **3.69** (3.12-4.35) | **4.27** (3.59-5.04) | **5.07** (4.12-6.16) | **5.69** (4.52-7.00) | **6.32** (4.86-7.95) | **6.96** (5.13-8.97) | **7.81** (5.54-10.3) | **8.46** (5.85-11.4) |
| 20-day | **3.32** (2.84-3.86) | **3.81** (3.26-4.43) | **4.62** (3.94-5.38) | **5.27** (4.47-6.17) | **6.16** (5.04-7.38) | **6.83** (5.47-8.29) | **7.49** (5.80-9.30) | **8.16** (6.07-10.4) | **9.02** (6.46-11.8) | **9.66** (6.75-12.8) |
| 30-day | **3.91** (3.36-4.52) | **4.48** (3.85-5.18) | **5.38** (4.61-6.24) | **6.12** (5.21-7.12) | **7.10** (5.83-8.44) | **7.83** (6.30-9.43) | **8.54** (6.64-10.5) | **9.24** (6.90-11.7) | **10.1** (7.29-13.1) | **10.8** (7.59-14.2) |
| 45-day | **4.63** (4.00-5.32) | **5.30** (4.58-6.10) | **6.37** (5.48-7.34) | **7.22** (6.18-8.35) | **8.33** (6.87-9.83) | **9.15** (7.39-10.9) | **9.94** (7.77-12.1) | **10.7** (8.03-13.4) | **11.6** (8.42-15.0) | **12.3** (8.72-16.1) |
| 60-day | **5.21** (4.52-5.97) | **5.99** (5.19-6.86) | **7.21** (6.23-8.28) | **8.17** (7.02-9.42) | **9.42** (7.79-11.1) | **10.3** (8.37-12.3) | **11.2** (8.77-13.6) | **12.0** (9.04-14.9) | **13.0** (9.43-16.6) | **13.7** (9.72-17.8) |

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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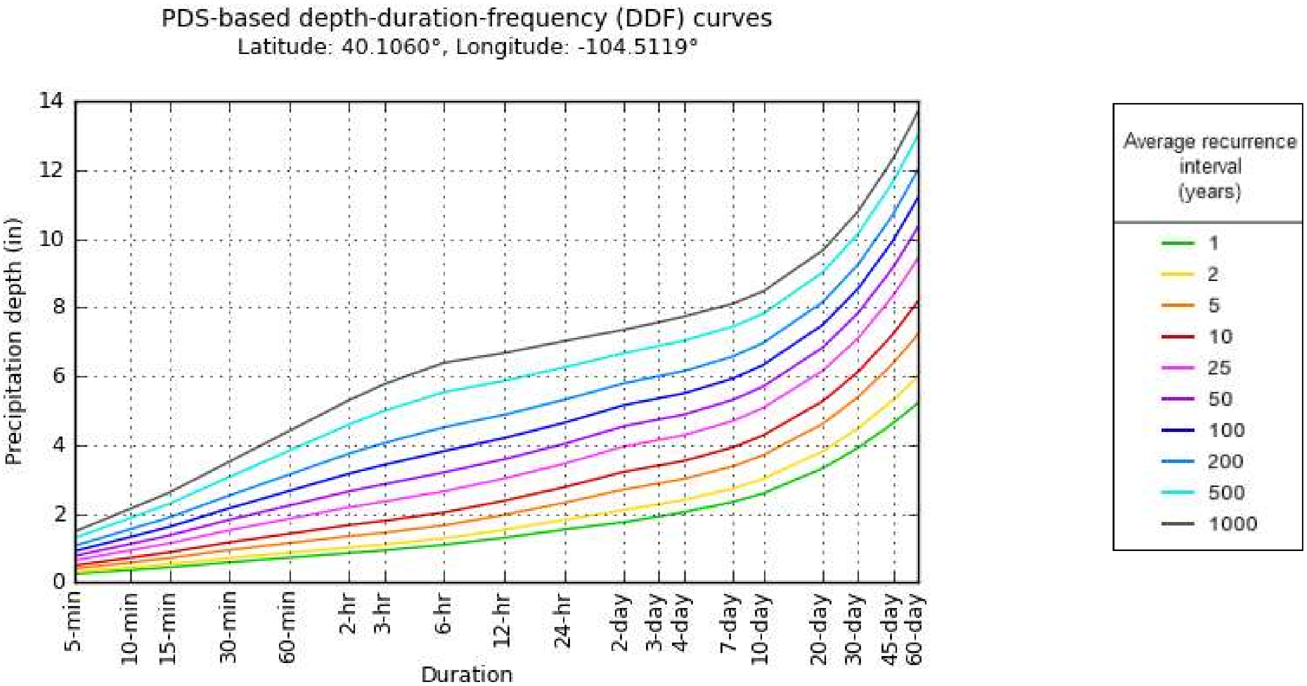
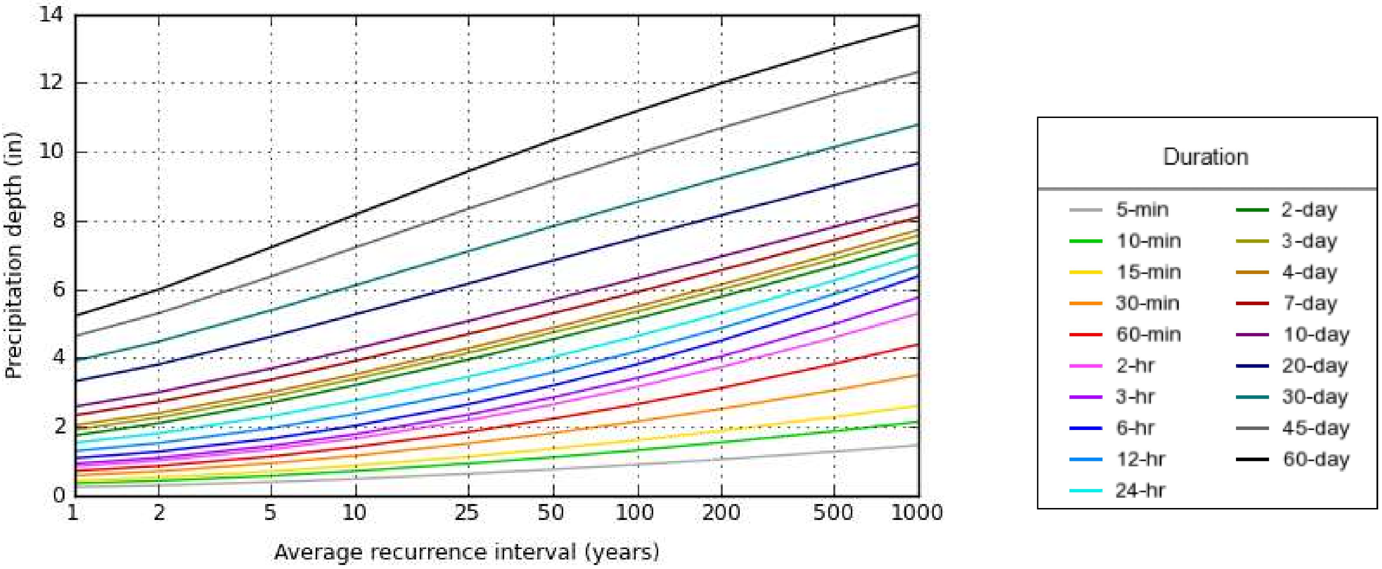
# PF graphical




NOAA Atlas 14, Volume 8, Version 2 Created (GMT): Thu Oct 7 17:12:06 2021

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## Maps & aerials

### Small scale terrain

# Appendix B

*Hydrologic and Hydraulic Calculations*

*Detention Pond Calculations*

BASELINE
Engineering · Planning · Surveying

PROJECT: Keenesburg East
JOB NO.: CO3519
CALC. BY: CLS
DATE: 10/17/2021

= FORMULA CELLS
= USER INPUT CELLS

| Project Location |
|---|
| User Input |

## IDF Rainfall Data

| $T_d$ | $P_1$: 1-hour Rainfall Depths (inches) | |
|---|---|---|
| | **Minor Storm** | **Major Storm** |
| | 5-Year | 100-Year |
| Minutes | **1.14** | **2.65** |
| 5 | 3.87 | 8.99 |
| 10 | 3.08 | 7.17 |
| 20 | 2.24 | 5.21 |
| 30 | 1.79 | 4.16 |
| 40 | 1.50 | 3.49 |
| 50 | 1.30 | 3.02 |
| 60 | 1.15 | 2.68 |
| 120 | 0.71 | 1.65 |

Equation 5-1 $I=(28.5*P_1)/(10+T_d)^{0.786}$

I = rainfall intensity (inches per hour)

$P_1$ = 1-hour point rainfall depth (inches)

$T_d$ = storm duration (minutes)

Reference:

1) Urban Drainage and Flood Control District - Urban Storm Drainage Criteria Manual Volume 1, 2017
2) NOAA Atlas 14, Volume 8, Version 2
   http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=co

PROJECT: Keenesburg East
JOB NO.: CO3519
CALC. BY: CLS
DATE: 10/17/2021

**Impervious Percentages - from Urban Drainage Table 6-3**

| | | | |
|---|---|---|---|
| Historic flow analysis | 2% | Historic flow analysis | 2% |
| Paved | 100% | Land Use | 56% |
| Drive and walks | 90% | Land Use | 57% |
| Roofs | 90% | Land Use | 60% |

**SOIL TYPE:** B (use equation from Table 6-4)

= FORMULA CELLS
= USER INPUT CELLS

## HISTORIC COMPOSITE IMPERVIOUSNESS

| | | Weighted Impervious and C Values | | | | | Areas (ac) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Basin | Area (ac) | Imp. | $C_2$ | $C_5$ | $C_{10}$ | $C_{100}$ | Historic flow analysis | Paved | Drive and walks | Roofs | Historic flow analysis | Land Use | Land Use | Land Use |
| X1 | 76.80 | 2% | 0.01 | 0.01 | 0.07 | 0.44 | 76.80 | | | | | | | |
| | | | | | | | | | | | | | | |
| OS1 | 2.32 | 2% | 0.01 | 0.01 | 0.07 | 0.44 | 2.32 | | | | | | | |
| OS2 | 11.40 | 2% | 0.01 | 0.01 | 0.07 | 0.44 | 11.40 | | | | | | | |
| OS3 | 4.25 | 2% | 0.01 | 0.01 | 0.07 | 0.44 | 4.25 | | | | | | | |

BASELINE
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# STANDARD FORM SF-2

## TIME OF CONCENTRATION SUMMARY

Calculated By: CLS
Date: 10/17/2021

Project: Keenesburg East
Job No.: CO3519
Checked By: xxxxxxxxxx

| SUB-BASIN DATA | | | | INITIAL/OVERLAND TIME ($t_i$) | | | TRAVEL TIME ($t_t$) | | | | | $t_c$ CHECK (URBANIZED BASINS) | | | | FINAL $t_c$ | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Basin (1) | i (2) | $C_5$ (3) | AREA Ac (4) | LENGTH Ft (5) | SLOPE % (6) | $t_i$ Min (7) | LENGTH Ft (8) | Cv | SLOPE % (9) | VEL. FPS (10) | $t_t$ Min (11) | COMP. $t_c$ (12) | TOT. LENGTH Ft (13) | $S_o$ % (14) | tc (Equation 6-5) Min (15) | Min (16) | |
| X1 | 0.02 | 0.01 | 76.80 | 500 | 1.74 | 36.58 | 1,589 | 7 | 1.74 | 0.92 | 28.68 | 65.3 | 2,089 | 1.74 | 54.1 | 54.10 | |
| | | | | | | | | | | | | | | | | | |
| OS1 | 0.02 | 0.01 | 2.32 | 500 | 1.78 | 36.31 | 1,702 | 7 | 1.02 | 0.7 | 40.1 | 76.4 | 2,202 | 1.19 | 61.9 | 61.9 | |
| OS2 | 0.02 | 0.01 | 11.40 | 500 | 1.41 | 39.21 | 1,092 | 7 | 1.46 | 0.8 | 21.5 | 60.7 | 1,592 | 1.44 | 49.5 | 49.5 | |
| OS3 | 0.02 | 0.01 | 4.25 | 500 | 2.18 | 33.96 | 417 | 7 | 1.75 | 0.9 | 7.5 | 41.5 | 917 | 1.98 | 37.4 | 37.4 | |
| | | | | | | | | | | | | | | | | | |
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Equation 6-3 $t_i=((0.395(1.1-C_5)SQRT(L))/(S_o\text{^}0.33))$

Equation 6-5 $t_c=(26-17i)+(L_t/(60(14i+9)SQRT(S_o)))$

= FORMULA CELLS

= USER INPUT CELLS

| NRCS Conveyance Factor K Table - Cv Value | |
|---|---|
| Heavy Meadow | 2.5 |
| Tillage/Field | 5 |
| Short Pasture and Lawns | 7 |
| Nearly Bare Ground | 10 |
| Grassed Waterway | 15 |
| Paved Areas and Shallow Paved Swales | 20 |

Calculated By: CLS
Date: 10/17/2021
Checked By: xxxxxxxxxx
5-Year 1-hour rainfall= 1.14

# STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Project: Keenesburg East
Job No.: CO3519
Design Storm: 5-Year

= FORMULA CELLS
= USER INPUT CELLS

| BASIN | DIRECT RUNOFF | | | | | | | | TOTAL RUNOFF | | | | STREET | | PIPE | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DESIGN POINT | AREA DESIGN | AREA (AC) | RUNOFF COEFF | $t_c$ (MIN) | C * A (AC) | I (IN/HR) | Q (CFS) | $t_c$ (MIN) | S (C * A) (CA) | I (IN/HR) | Q (CFS) | SLOPE (%) | STREET FLOW | DESIGN FLOW (CFS) | SLOPE (%) | PIPE DIAM. (IN.) | LENGTH (FT) | VELOCITY (FPS) | $t_t$ (MIN) | |
| | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) |
| X1 | 5 | 76.80 | 76.80 | 0.01 | 54.1 | 0.94 | 1.23 | **1.16** | 54.1 | 1.70 | 1.23 | **2.10** | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| OS1 | 1 | 2.32 | 2.32 | 0.01 | 61.9 | 0.03 | 1.13 | **0.03** | 61.9 | 1.18 | 1.13 | **1.33** | | | | | | | | | |
| OS2 | 2 | 11.40 | 11.40 | 0.01 | 49.5 | 0.14 | 1.31 | **0.18** | 49.5 | 1.47 | 1.31 | **1.93** | | | | | | | | | |
| OS3 | 3 | 4.25 | 4.25 | 0.01 | 37.4 | 0.05 | 1.57 | **0.08** | 37.4 | 2.10 | 1.57 | **3.29** | | | | | | | | | |

Calculated By: CLS
Date: 10/17/2021
Checked By: xxxxxxxxxx
100-Year 1-hour rainfall= 2.65

# STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Project: Keenesburg East
Job No.: CO3519
Design Storm: 100-Year

= FORMULA CELLS
= USER INPUT CELLS

| | DIRECT RUNOFF | | | | | | | | TOTAL RUNOFF | | | | STREET | | PIPE | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BASIN | DESIGN POINT | AREA DESIGN | AREA (AC) | RUNOFF COEFF | $t_c$ (MIN) | C * A (AC) | I (IN/HR) | Q (CFS) | $t_c$ (MIN) | S (C * A) (CA) | I (IN/HR) | Q (CFS) | SLOPE (%) | STREET FLOW | DESIGN FLOW (CFS) | SLOPE (%) | PIPE DIAM. (IN.) | LENGTH (FT) | VELOCITY (FPS) | $t_t$ (MIN) | REMARKS |
| | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) |
| X1 | 5 | 76.80 | 76.80 | 0.44 | 54.1 | 33.44 | 2.87 | **95.97** | 54.1 | 1.7 | 2.87 | **4.88** | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| OS1 | 1 | 2.32 | 2.32 | 0.44 | 61.9 | 1.01 | 2.62 | **2.65** | 61.9 | 1.2 | 2.62 | **3.10** | | | | | | | | | |
| OS2 | 2 | 11.40 | 11.40 | 0.44 | 49.5 | 4.96 | 3.05 | **15.11** | 49.5 | 1.5 | 3.05 | **4.48** | | | | | | | | | |
| OS3 | 3 | 4.25 | 4.25 | 0.44 | 37.4 | 1.85 | 3.64 | **6.74** | 37.4 | 2.1 | 3.64 | **7.65** | | | | | | | | | |
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PROJECT: Keenesburg East
JOB NO.: CO3519
CALC. BY: CLS
DATE: 10/17/2021

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## RUNOFF SUMMARY

| BASIN LABEL | DESIGN POINT | AREA | Imp. | C5 | C100 | LOCAL (CFS) | | ACCUMULATIVE (CFS) | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Q5 | Q100 | Q5 | Q100 | |
| X1 | 5.00 | 76.80 | 0.02 | 0.01 | 0.44 | 1.16 | 95.97 | | | |
| | | | | | | | | | | |
| OS1 | 1.0 | 2.3 | 0.0 | 0.01 | 0.44 | 0.03 | 2.65 | | | |
| OS2 | 2.0 | 11.4 | 0.0 | 0.01 | 0.44 | 0.18 | 15.11 | | | |
| OS3 | 3.0 | 4.3 | 0.0 | 0.01 | 0.44 | 0.08 | 6.74 | | | |

= FORMULA CELLS
= USER INPUT CELLS

PROJECT: Keenesburg North
JOB NO.: CO3519
CALC. BY: CLS
DATE: 10/18/2021

= FORMULA CELLS
= USER INPUT CELLS

**Project Location**
User Input

**IDF Rainfall Data**

| $T_d$ | $P_1$: 1-hour Rainfall Depths (inches) | |
|---|---|---|
| | **Minor Storm** | **Major Storm** |
| | 5-Year | 100-Year |
| Minutes | **1.14** | **2.65** |
| 5 | 3.87 | 8.99 |
| 10 | 3.08 | 7.17 |
| 20 | 2.24 | 5.21 |
| 30 | 1.79 | 4.16 |
| 40 | 1.50 | 3.49 |
| 50 | 1.30 | 3.02 |
| 60 | 1.15 | 2.68 |
| 120 | 0.71 | 1.65 |

Equation 5-1 $I=(28.5*P_1)/(10+T_d)^{0.786}$

I = rainfall intensity (inches per hour)

$P_1$ = 1-hour point rainfall depth (inches)

$T_d$ = storm duration (minutes)

Reference:

1) Urban Drainage and Flood Control District - Urban Storm Drainage Criteria Manual Volume 1, 2017

2) NOAA Atlas 14, Volume 8, Version 2
http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=co

| | |
|---|---|
| PROJECT: | Keenesburg North |
| JOB NO.: | CO3519 |
| CALC. BY: | CLS |
| DATE: | 10/18/2021 |

**Impervious Percentages - from Urban Drainage Table 6-3**

| | |
|---|---|
| Historic flow analysis | 2% |
| Paved | 100% |
| Drive and walks | 90% |
| Roofs | 90% |
| Parks, cemeteries | 10% |
| Residental - 0.25 AC or less | 45% |
| Multi Family | 54% |

| Townhome Quantity |
|---|
| 41 small townhomes |
| 32 large townhomes |
| 73 total townhomes |

**SOIL TYPE:** B (use equation from Table 6-4)

= FORMULA CELLS

= USER INPUT CELLS

## PROPOSED COMPOSITE IMPERVIOUSNESS

| | | Weighted Impervious and C Values | | | | | Areas (ac) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Basin** | **Area (ac)** | **Imp.** | **$C_2$** | **$C_5$** | **$C_{10}$** | **$C_{100}$** | **Historic flow analysis** | **Paved** | **Drive and walks** | **Roofs** | **Parks, cemeteries** | **Residental - 0.25 AC or less** | **Multi Family** |
| A | 16.21 | 48% | 0.36 | 0.39 | 0.45 | 0.65 | | 2.97 | | | 3.58 | 8.13 | 1.53 |
| B | 36.19 | 56% | 0.42 | 0.46 | 0.51 | 0.69 | | 7.26 | | | 1.62 | 22.23 | 5.08 |
| C | 4.58 | 61% | 0.47 | 0.50 | 0.55 | 0.71 | | 2.61 | | | 1.97 | | |

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# STANDARD FORM SF-2

## TIME OF CONCENTRATION SUMMARY

Calculated By: CLS
Date: 10/18/2021

Project: Keenesburg North
Job No.: CO3519
Checked By: MJL

| SUB-BASIN DATA | | | | INITIAL/OVERLAND TIME ($t_i$) | | | TRAVEL TIME ($t_t$) | | | | | $t_c$ CHECK (URBANIZED BASINS) | | | | FINAL $t_c$ | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Basin (1) | i (2) | $C_5$ (3) | AREA Ac (4) | LENGTH Ft (5) | SLOPE % (6) | $t_i$ Min (7) | LENGTH Ft (8) | Cv | SLOPE % (9) | VEL. FPS (10) | $t_t$ Min (11) | COMP. $t_c$ (12) | TOT. LENGTH Ft (13) | $S_o$ % (14) | tc (Equation 6-5) Min (15) | Min (16) | |
| A | 0.48 | 0.39 | 16.21 | 322 | 2.14 | 17.93 | 833 | 15 | 2.64 | 2.44 | 5.70 | 23.6 | 1,155 | 2.50 | 25.5 | 23.62 | |
| B | 0.56 | 0.46 | 36.19 | 231 | 2.15 | 13.74 | 2,790 | 20 | 0.95 | 1.9 | 23.9 | 37.6 | 3,021 | 1.04 | 45.9 | 37.6 | |
| C | 0.61 | 0.50 | 4.58 | | | | 1,760 | 15 | 1.20 | 1.6 | 17.9 | | 1,760 | 1.20 | 30.8 | 30.8 | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |

Equation 6-3 $t_i=((0.395(1.1-C_5)SQRT(L))/(S_o\text{^}0.33))$

Equation 6-5 $t_c=(26-17i)+(L_t/(60(14i+9)SQRT(S_o)))$

= FORMULA CELLS
= USER INPUT CELLS

| NRCS Conveyance Factor K Table - Cv Value | |
|---|---|
| Heavy Meadow | 2.5 |
| Tillage/Field | 5 |
| Short Pasture and Lawns | 7 |
| Nearly Bare Ground | 10 |
| Grassed Waterway | 15 |
| Paved Areas and Shallow Paved Swales | 20 |

Calculated By: CLS
Date: 10/18/2021
Checked By: MJL
5-Year 1-hour rainfall= 1.14

# STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Project: Keenesburg North
Job No.: CO3519
Design Storm: 5-Year

= FORMULA CELLS
= USER INPUT CELLS

| BASIN | DIRECT RUNOFF | | | | | | | | TOTAL RUNOFF | | | | STREET | | PIPE | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DESIGN POINT | AREA DESIGN | AREA (AC) | RUNOFF COEFF | $t_c$ (MIN) | C * A (AC) | I (IN/HR) | Q (CFS) | $t_c$ (MIN) | S (C * A) (CA) | I (IN/HR) | Q (CFS) | SLOPE (%) | STREET FLOW | DESIGN FLOW (CFS) | SLOPE (%) | PIPE DIAM. (IN.) | LENGTH (FT) | VELOCITY (FPS) | $t_t$ (MIN) | |
| | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) |
| A | 1 | 16.21 | 16.21 | 0.39 | 23.6 | 6.30 | 2.05 | **12.9** | | | | | | | | | | | | | |
| B | 2 | 36.19 | 36.19 | 0.46 | 37.6 | 16.48 | 1.56 | **25.7** | | | | | | | | | | | | | |
| C | 3 | 4.58 | 4.58 | 0.50 | 30.8 | 2.31 | 1.76 | **4.1** | | | | | | | | | | | | | |
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Calculated By: CLS
Date: 10/18/2021
Checked By: xxxxxxxxxx
100-Year 1-hour rainfall= 2.65

# STANDARD FORM SF-3

STORM DRAINAGE SYSTEM DESIGN
(RATIONAL METHOD PROCEDURE)

Project: Keenesburg North
Job No.: CO3519
Design Storm: 100-Year

= FORMULA CELLS
= USER INPUT CELLS

| BASIN | DIRECT RUNOFF | | | | | | | | TOTAL RUNOFF | | | | STREET | | PIPE | | | | | | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | DESIGN POINT | AREA DESIGN | AREA (AC) | RUNOFF COEFF | $t_c$ (MIN) | C * A (AC) | I (IN/HR) | Q (CFS) | $t_c$ (MIN) | S (C * A) (CA) | I (IN/HR) | Q (CFS) | SLOPE (%) | STREET FLOW | DESIGN FLOW (CFS) | SLOPE (%) | PIPE DIAM. (IN.) | LENGTH (FT) | VELOCITY (FPS) | $t_t$ (MIN) | |
| | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | (13) | (14) | (15) | (16) | (17) | (18) | (19) | (20) | (21) | (22) |
| A | 1 | 16.21 | 16.21 | 0.65 | 23.6 | 10.58 | 4.77 | **50.4** | | | | | | | | | | | | | |
| B | 2 | 36.19 | 36.19 | 0.69 | 37.6 | 24.90 | 3.63 | **90.3** | | | | | | | | | | | | | |
| C | 3 | 4.58 | 4.58 | 0.71 | 30.8 | 3.27 | 4.09 | **13.4** | | | | | | | | | | | | | |
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PROJECT: Keenesburg North
JOB NO.: CO3519
CALC. BY: CLS
DATE: 10/18/2021

BASELINE
Engineering · Planning · Surveying

## RUNOFF SUMMARY

| BASIN LABEL | DESIGN POINT | AREA | Imp. | C5 | C100 | LOCAL (CFS) | | ACCUMULATIVE (CFS) | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Q5 | Q100 | Q5 | Q100 | |
| A | 1 | 16.21 | 0.48 | 0.39 | 0.65 | 12.92 | 50.41 | | | |
| B | 2 | 36.19 | 0.56 | 0.46 | 0.69 | 25.70 | 90.29 | | | |
| C | 3 | 4.58 | 0.61 | 0.50 | 0.71 | 4.07 | 13.38 | | | |
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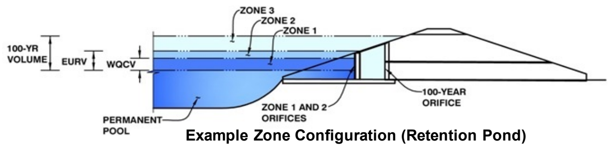
= FORMULA CELLS
= USER INPUT CELLS

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.04 (February 2021)*

**Project: CO3519 Keenseburg North**

**Basin ID: Basin A**




**Example Zone Configuration (Retention Pond)**

Depth Increment = 0.50 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 | | 8.5 | 8.5 | 72 | | 0.002 | | |
| **ISV** | 0.50 | | 8.5 | 8.5 | 72 | | 0.002 | 36 | 0.001 |
| | 1.00 | | 8.5 | 8.5 | 72 | | 0.002 | 72 | 0.002 |
| | 1.50 | | 135.0 | 71.0 | 9,580 | | 0.220 | 1,826 | 0.042 |
| **Zone 1 (WQCV)** | 2.00 | | 261.5 | 133.5 | 34,901 | | 0.801 | 12,288 | 0.282 |
| **Floor** | 2.32 | | 342.4 | 173.5 | 59,405 | | 1.364 | 27,204 | 0.625 |
| **Zone 2 (5-year)** | 2.36 | | 342.7 | 173.7 | 59,529 | | 1.367 | 29,583 | 0.679 |
| | 2.50 | | 343.5 | 174.6 | 59,963 | | 1.377 | 37,947 | 0.871 |
| | 3.00 | | 346.5 | 177.6 | 61,527 | | 1.412 | 68,319 | 1.568 |
| **Zone 3 (100-year)** | 3.01 | | 346.6 | 177.6 | 61,558 | | 1.413 | 68,934 | 1.583 |
| | 3.50 | | 349.5 | 180.6 | 63,108 | | 1.449 | 99,477 | 2.284 |
| | 4.00 | | 352.5 | 183.6 | 64,707 | | 1.485 | 131,429 | 3.017 |
| | 4.50 | | 355.5 | 186.6 | 66,324 | | 1.523 | 164,187 | 3.769 |
| | 5.00 | | 358.5 | 189.6 | 67,959 | | 1.560 | 197,757 | 4.540 |
| | 5.50 | | 361.5 | 192.6 | 69,613 | | 1.598 | 232,149 | 5.329 |
| | 6.00 | | 364.5 | 195.6 | 71,284 | | 1.636 | 267,372 | 6.138 |
| | 6.50 | | 367.5 | 198.6 | 72,973 | | 1.675 | 303,436 | 6.966 |
| | 7.00 | | 370.5 | 201.6 | 74,680 | | 1.714 | 340,349 | 7.813 |
| | 7.50 | | 373.5 | 204.6 | 76,406 | | 1.754 | 378,119 | 8.680 |
| | 8.00 | | 376.5 | 207.6 | 78,149 | | 1.794 | 416,757 | 9.567 |
| | 8.50 | | 379.5 | 210.6 | 79,910 | | 1.834 | 456,271 | 10.475 |
| | 9.00 | | 382.5 | 213.6 | 81,689 | | 1.875 | 496,670 | 11.402 |
| | 9.50 | | 385.5 | 216.6 | 83,486 | | 1.917 | 537,963 | 12.350 |
| | 10.00 | | 388.5 | 219.6 | 85,302 | | 1.958 | 580,160 | 13.319 |
| | 10.50 | | 391.5 | 222.6 | 87,135 | | 2.000 | 623,268 | 14.308 |
| | 11.00 | | 394.5 | 225.6 | 88,986 | | 2.043 | 667,297 | 15.319 |
| | 11.50 | | 397.5 | 228.6 | 90,855 | | 2.086 | 712,257 | 16.351 |
| | 12.00 | | 400.5 | 231.6 | 92,743 | | 2.129 | 758,156 | 17.405 |
| | 12.50 | | 403.5 | 234.6 | 94,648 | | 2.173 | 805,003 | 18.480 |
| | 13.00 | | 406.5 | 237.6 | 96,571 | | 2.217 | 852,807 | 19.578 |
| | 13.50 | | 409.5 | 240.6 | 98,512 | | 2.262 | 901,577 | 20.697 |
| | 14.00 | | 412.5 | 243.6 | 100,471 | | 2.307 | 951,322 | 21.839 |
| | 14.50 | | 415.5 | 246.6 | 102,449 | | 2.352 | 1,002,051 | 23.004 |
| | 15.00 | | 418.5 | 249.6 | 104,444 | | 2.398 | 1,053,774 | 24.191 |
| | 15.50 | | 421.5 | 252.6 | 106,457 | | 2.444 | 1,106,498 | 25.402 |
| | 16.00 | | 424.5 | 255.6 | 108,488 | | 2.491 | 1,160,234 | 26.635 |
| | 16.50 | | 427.5 | 258.6 | 110,538 | | 2.538 | 1,214,989 | 27.892 |
| | 17.00 | | 430.5 | 261.6 | 112,605 | | 2.585 | 1,270,774 | 29.173 |
| | 17.50 | | 433.5 | 264.6 | 114,690 | | 2.633 | 1,327,597 | 30.477 |
| | 18.00 | | 436.5 | 267.6 | 116,793 | | 2.681 | 1,385,467 | 31.806 |
| | 18.50 | | 439.5 | 270.6 | 118,914 | | 2.730 | 1,444,393 | 33.159 |
| | 19.00 | | 442.5 | 273.6 | 121,054 | | 2.779 | 1,504,385 | 34.536 |
| | 19.50 | | 445.5 | 276.6 | 123,211 | | 2.829 | 1,565,450 | 35.938 |
| | 20.00 | | 448.5 | 279.6 | 125,386 | | 2.878 | 1,627,599 | 37.365 |
| | 20.50 | | 451.5 | 282.6 | 127,579 | | 2.929 | 1,690,839 | 38.816 |
| | 21.00 | | 454.5 | 285.6 | 129,791 | | 2.980 | 1,755,181 | 40.293 |
| | 21.50 | | 457.5 | 288.6 | 132,020 | | 3.031 | 1,820,633 | 41.796 |
| | 22.00 | | 460.5 | 291.6 | 134,267 | | 3.082 | 1,887,204 | 43.324 |
| | 22.50 | | 463.5 | 294.6 | 136,532 | | 3.134 | 1,954,903 | 44.878 |
| | 23.00 | | 466.5 | 297.6 | 138,815 | | 3.187 | 2,023,739 | 46.459 |
| | 23.50 | | 469.5 | 300.6 | 141,117 | | 3.240 | 2,093,721 | 48.065 |
| | 24.00 | | 472.5 | 303.6 | 143,436 | | 3.293 | 2,164,859 | 49.698 |
| | 24.50 | | 475.5 | 306.6 | 145,773 | | 3.346 | 2,237,160 | 51.358 |
| | 25.00 | | 478.5 | 309.6 | 148,128 | | 3.401 | 2,310,635 | 53.045 |
| | 25.50 | | 481.5 | 312.6 | 150,502 | | 3.455 | 2,385,292 | 54.759 |
| | 26.00 | | 484.5 | 315.6 | 152,893 | | 3.510 | 2,461,139 | 56.500 |
| | 26.50 | | 487.5 | 318.6 | 155,302 | | 3.565 | 2,538,187 | 58.269 |
| | 27.00 | | 490.5 | 321.6 | 157,729 | | 3.621 | 2,616,445 | 60.065 |
| | 27.50 | | 493.5 | 324.6 | 160,174 | | 3.677 | 2,695,920 | 61.890 |
| | 28.00 | | 496.5 | 327.6 | 162,638 | | 3.734 | 2,776,622 | 63.742 |
| | 28.50 | | 499.5 | 330.6 | 165,119 | | 3.791 | 2,858,560 | 65.624 |
| | 29.00 | | 502.5 | 333.6 | 167,618 | | 3.848 | 2,941,744 | 67.533 |
| | 29.50 | | 505.5 | 336.6 | 170,135 | | 3.906 | 3,026,182 | 69.472 |
| | 30.00 | | 508.5 | 339.6 | 172,671 | | 3.964 | 3,111,882 | 71.439 |

## Watershed Information

| | | | | |
|---|---|---|---|---|
| Selected BMP Type = | **EDB** | | | |
| Watershed Area = | 16.21 | acres | | |
| Watershed Length = | 1,480 | ft | | |
| Watershed Length to Centroid = | 740 | ft | | |
| Watershed Slope = | 0.025 | ft/ft | | |
| Watershed Imperviousness = | 49.00% | percent | | |
| Percentage Hydrologic Soil Group A = | 0.0% | percent | | |
| Percentage Hydrologic Soil Group B = | 100.0% | percent | | |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent | | |
| Target WQCV Drain Time = | 40.0 | hours | | |
| Location for 1-hr Rainfall Depths = User Input | | | | |

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

| | | | Optional User Overrides | |
|---|---|---|---|---|
| Water Quality Capture Volume (WQCV) = | 0.275 | acre-feet | | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 0.848 | acre-feet | | acre-feet |
| 2-yr Runoff Volume (P1 = 0.86 in.) = | 0.503 | acre-feet | 0.86 | inches |
| 5-yr Runoff Volume (P1 = 1.14 in.) = | 0.728 | acre-feet | 1.14 | inches |
| 10-yr Runoff Volume (P1 = 1.41 in.) = | 1.030 | acre-feet | 1.41 | inches |
| 25-yr Runoff Volume (P1 = 1.84 in.) = | 1.665 | acre-feet | 1.84 | inches |
| 50-yr Runoff Volume (P1 = 2.23 in.) = | 2.185 | acre-feet | 2.23 | inches |
| 100-yr Runoff Volume (P1 = 2.65 in.) = | 2.820 | acre-feet | 2.65 | inches |
| 500-yr Runoff Volume (P1 = 3.13 in.) = | 3.493 | acre-feet | 3.13 | inches |
| Approximate 2-yr Detention Volume = | 0.461 | acre-feet | | |
| Approximate 5-yr Detention Volume = | 0.666 | acre-feet | | |
| Approximate 10-yr Detention Volume = | 0.938 | acre-feet | | |
| Approximate 25-yr Detention Volume = | 1.175 | acre-feet | | |
| Approximate 50-yr Detention Volume = | 1.324 | acre-feet | | |
| Approximate 100-yr Detention Volume = | 1.571 | acre-feet | | |

## Define Zones and Basin Geometry

| | | |
|---|---|---|
| Zone 1 Volume (WQCV) = | 0.275 | acre-feet |
| Zone 2 Volume (5-year - Zone 1) = | 0.391 | acre-feet |
| Zone 3 Volume (100-year - Zones 1 & 2) = | 0.905 | acre-feet |
| Total Detention Basin Volume = | 1.571 | acre-feet |
| Initial Surcharge Volume (ISV) = | 36 | $ft^3$ |
| Initial Surcharge Depth (ISD) = | 0.50 | ft |
| Total Available Detention Depth ($H_{total}$) = | 3.00 | ft |
| Depth of Trickle Channel ($H_{TC}$) = | 0.50 | ft |
| Slope of Trickle Channel ($S_{TC}$) = | 0.004 | ft/ft |
| Slopes of Main Basin Sides ($S_{main}$) = | 3 | H:V |
| Basin Length-to-Width Ratio ($R_{L/W}$) = | 2 | |

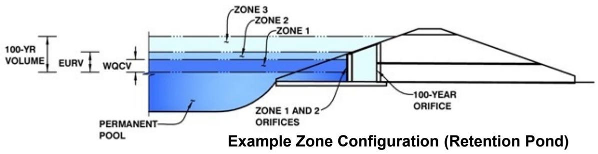
| | | |
|---|---|---|
| Initial Surcharge Area ($A_{ISV}$) = | 72 | $ft^2$ |
| Surcharge Volume Length ($L_{ISV}$) = | 8.5 | ft |
| Surcharge Volume Width ($W_{ISV}$) = | 8.5 | ft |
| Depth of Basin Floor ($H_{FLOOR}$) = | 1.32 | ft |
| Length of Basin Floor ($L_{FLOOR}$) = | 342.4 | ft |
| Width of Basin Floor ($W_{FLOOR}$) = | 173.5 | ft |
| Area of Basin Floor ($A_{FLOOR}$) = | 59,405 | $ft^2$ |
| Volume of Basin Floor ($V_{FLOOR}$) = | 27,079 | $ft^3$ |
| Depth of Main Basin ($H_{MAIN}$) = | 0.68 | ft |
| Length of Main Basin ($L_{MAIN}$) = | 346.5 | ft |
| Width of Main Basin ($W_{MAIN}$) = | 177.6 | ft |
| Area of Main Basin ($A_{MAIN}$) = | 61,527 | $ft^2$ |
| Volume of Main Basin ($V_{MAIN}$) = | 41,115 | $ft^3$ |
| Calculated Total Basin Volume ($V_{total}$) = | **1.567** | acre-feet |

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.04 (February 2021)*

**Project:** **CO3519 Keenseburg North**

**Basin ID:** **Basin A**




**Example Zone Configuration (Retention Pond)**

| | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (WQCV) | 2.00 | 0.275 | Orifice Plate |
| Zone 2 (5-year) | 2.36 | 0.391 | Circular Orifice |
| Zone 3 (100-year) | 3.01 | 0.905 | Weir&Pipe (Restrict) |
| Total (all zones) | | 1.571 | |

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 = | 2.00 | ft (relative to basin bottom at Stage = 0 ft) |
| Orifice Plate: Orifice Vertical Spacing = | 6.60 | inches |
| Orifice Plate: Orifice Area per Row = | 0.79 | sq. inches (diameter = 1 inch) |

Calculated Parameters for Plate

| | | |
|---|---|---|
| WQ Orifice Area per Row = | 5.486E-03 | $ft^2$ |
| Elliptical Half-Width = | N/A | feet |
| Elliptical Slot Centroid = | N/A | feet |
| Elliptical Slot Area = | N/A | $ft^2$ |

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

| | Row 1 (required) | Row 2 (optional) | Row 3 (optional) | Row 4 (optional) | Row 5 (optional) | Row 6 (optional) | Row 7 (optional) | Row 8 (optional) |
|---|---|---|---|---|---|---|---|---|
| Stage of Orifice Centroid (ft) | 0.00 | 0.67 | 1.33 | | | | | |
| Orifice Area (sq. inches) | 0.79 | 0.79 | 0.79 | | | | | |

| | 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)

| | Zone 2 Circular | Not Selected | |
|---|---|---|---|
| Invert of Vertical Orifice = | 2.36 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Depth at top of Zone using Vertical Orifice = | 3.00 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Vertical Orifice Diameter = | 0.38 | N/A | inches |

Calculated Parameters for Vertical Orifice

| | Zone 2 Circular | Not Selected | |
|---|---|---|---|
| Vertical Orifice Area = | 0.00 | N/A | $ft^2$ |
| Vertical Orifice Centroid = | 0.02 | N/A | feet |

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

| | Zone 3 Weir | Not Selected | |
|---|---|---|---|
| Overflow Weir Front Edge Height, Ho = | 2.36 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Overflow Weir Front Edge Length = | 10.00 | N/A | feet |
| Overflow Weir Grate Slope = | 4.00 | N/A | H:V |
| Horiz. Length of Weir Sides = | 0.00 | N/A | feet |
| Overflow Grate Type = | Type C Grate | N/A | |
| Debris Clogging % = | 50% | N/A | % |

Calculated Parameters for Overflow Weir

| | Zone 3 Weir | Not Selected | |
|---|---|---|---|
| Height of Grate Upper Edge, $H_t$ = | 2.36 | N/A | feet |
| Overflow Weir Slope Length = | 0.00 | N/A | feet |
| Grate Open Area / 100-yr Orifice Area = | 0.00 | N/A | |
| Overflow Grate Open Area w/o Debris = | 0.00 | N/A | $ft^2$ |
| Overflow Grate Open Area w/ Debris = | 0.00 | 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 = | 2.50 | N/A | ft (distance below basin bottom at Stage = 0 ft) |
| Outlet Pipe Diameter = | 18.00 | N/A | inches |
| Restrictor Plate Height Above Pipe Invert = | 6.00 | | inches |

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

| | Zone 3 Restrictor | Not Selected | |
|---|---|---|---|
| Outlet Orifice Area = | 0.52 | N/A | $ft^2$ |
| Outlet Orifice Centroid = | 0.29 | N/A | feet |
| Half-Central Angle of Restrictor Plate on Pipe = | 1.23 | N/A | radians |

User Input: Emergency Spillway (Rectangular or Trapezoidal)

| | | |
|---|---|---|
| Spillway Invert Stage= | 3.50 | ft (relative to basin bottom at Stage = 0 ft) |
| Spillway Crest Length = | 14.00 | feet |
| Spillway End Slopes = | 4.00 | H:V |
| Freeboard above Max Water Surface = | 1.00 | feet |

Calculated Parameters for Spillway

| | | |
|---|---|---|
| Spillway Design Flow Depth= | 0.87 | feet |
| Stage at Top of Freeboard = | 5.37 | feet |
| Basin Area at Top of Freeboard = | 1.59 | acres |
| Basin Volume at Top of Freeboard = | 5.12 | 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).*

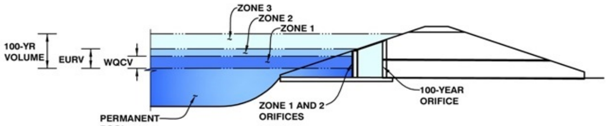
| Design Storm Return Period = | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|---|---|---|---|---|---|---|---|---|
| One-Hour Rainfall Depth (in) = | N/A | N/A | 0.86 | 1.14 | 1.41 | 1.84 | 2.23 | 2.65 | 3.13 |
| CUHP Runoff Volume (acre-ft) = | 0.275 | 0.848 | 0.503 | 0.728 | 1.030 | 1.665 | 2.185 | 2.820 | 3.493 |
| Inflow Hydrograph Volume (acre-ft) = | N/A | N/A | 0.503 | 0.728 | 1.030 | 1.665 | 2.185 | 2.820 | 3.493 |
| CUHP Predevelopment Peak Q (cfs) = | N/A | N/A | 0.1 | 0.5 | 3.0 | 9.8 | 14.5 | 20.4 | 26.3 |
| OPTIONAL Override Predevelopment Peak Q (cfs) = | N/A | N/A | | | | | | | |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | N/A | N/A | 0.01 | 0.03 | 0.18 | 0.61 | 0.90 | 1.26 | 1.62 |
| Peak Inflow Q (cfs) = | N/A | N/A | 6.7 | 9.7 | 14.3 | 24.1 | 31.8 | 40.8 | 50.2 |
| Peak Outflow Q (cfs) = | 0.1 | 1.4 | 0.1 | 0.2 | 1.9 | 5.5 | 5.7 | 5.9 | 10.9 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 0.3 | 0.6 | 0.6 | 0.4 | 0.3 | 0.4 |
| Structure Controlling Flow = | Plate | N/A | Plate | Vertical Orifice 1 | N/A | Outlet Plate 1 | Outlet Plate 1 | Outlet Plate 1 | Spillway |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Max Velocity through Grate 2 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Time to Drain 97% of Inflow Volume (hours) = | 42 | 95 | 70 | 95 | 96 | 93 | 92 | 90 | 87 |
| Time to Drain 99% of Inflow Volume (hours) = | **43** | 98 | 73 | 98 | 101 | 100 | 100 | 99 | 99 |
| Maximum Ponding Depth (ft) = | 2.00 | 2.49 | 2.21 | 2.38 | 2.51 | 2.74 | 3.02 | 3.42 | 3.73 |
| Area at Maximum Ponding Depth (acres) = | 0.80 | 1.38 | 1.14 | 1.37 | 1.38 | 1.39 | 1.41 | 1.44 | 1.46 |
| Maximum Volume Stored (acre-ft) = | 0.282 | 0.857 | 0.475 | 0.693 | 0.871 | 1.190 | 1.597 | 2.154 | 2.604 |

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.04 (February 2021)*

**Project: CO3519 Keenseburg North**

**Basin ID: Basin B**




**Example Zone Configuration (Retention Pond)**

Watershed Information

| | | |
|---|---|---|
| Selected BMP Type = | **EDB** | |
| Watershed Area = | 36.19 | acres |
| Watershed Length = | 3,022 | ft |
| Watershed Length to Centroid = | 1,660 | ft |
| Watershed Slope = | 0.010 | ft/ft |
| Watershed Imperviousness = | 51.00% | percent |
| Percentage Hydrologic Soil Group A = | 0.0% | percent |
| Percentage Hydrologic Soil Group B = | 100.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent |
| Target WQCV Drain Time = | 40.0 | hours |
| Location for 1-hr Rainfall Depths = | User Input | |

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

| | | | Optional User Overrides | |
|---|---|---|---|---|
| Water Quality Capture Volume (WQCV) = | 0.630 | acre-feet | | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 1.976 | acre-feet | | acre-feet |
| 2-yr Runoff Volume (P1 = 0.86 in.) = | 1.188 | acre-feet | 0.86 | inches |
| 5-yr Runoff Volume (P1 = 1.14 in.) = | 1.712 | acre-feet | 1.14 | inches |
| 10-yr Runoff Volume (P1 = 1.41 in.) = | 2.402 | acre-feet | 1.41 | inches |
| 25-yr Runoff Volume (P1 = 1.84 in.) = | 3.832 | acre-feet | 1.84 | inches |
| 50-yr Runoff Volume (P1 = 2.23 in.) = | 5.011 | acre-feet | 2.23 | inches |
| 100-yr Runoff Volume (P1 = 2.65 in.) = | 6.440 | acre-feet | 2.65 | inches |
| 500-yr Runoff Volume (P1 = 3.13 in.) = | 7.960 | acre-feet | 3.13 | inches |
| Approximate 2-yr Detention Volume = | 1.080 | acre-feet | | |
| Approximate 5-yr Detention Volume = | 1.554 | acre-feet | | |
| Approximate 10-yr Detention Volume = | 2.175 | acre-feet | | |
| Approximate 25-yr Detention Volume = | 2.715 | acre-feet | | |
| Approximate 50-yr Detention Volume = | 3.057 | acre-feet | | |
| Approximate 100-yr Detention Volume = | 3.611 | acre-feet | | |

Define Zones and Basin Geometry

| | | |
|---|---|---|
| Zone 1 Volume (WQCV) = | 0.630 | acre-feet |
| Zone 2 Volume (5-year - Zone 1) = | 0.924 | acre-feet |
| Zone 3 Volume (100-year - Zones 1 & 2) = | 2.057 | acre-feet |
| Total Detention Basin Volume = | 3.611 | acre-feet |
| Initial Surcharge Volume (ISV) = | 82 | $ft^3$ |
| Initial Surcharge Depth (ISD) = | 0.50 | ft |
| Total Available Detention Depth ($H_{total}$) = | 3.00 | ft |
| Depth of Trickle Channel ($H_{TC}$) = | 0.50 | ft |
| Slope of Trickle Channel ($S_{TC}$) = | 0.002 | ft/ft |
| Slopes of Main Basin Sides ($S_{main}$) = | 3 | H:V |
| Basin Length-to-Width Ratio ($R_{L/W}$) = | 2 | |
| Initial Surcharge Area ($A_{ISV}$) = | 165 | $ft^2$ |
| Surcharge Volume Length ($L_{ISV}$) = | 12.8 | ft |
| Surcharge Volume Width ($W_{ISV}$) = | 12.8 | ft |
| Depth of Basin Floor ($H_{FLOOR}$) = | 0.89 | ft |
| Length of Basin Floor ($L_{FLOOR}$) = | 460.5 | ft |
| Width of Basin Floor ($W_{FLOOR}$) = | 235.3 | ft |
| Area of Basin Floor ($A_{FLOOR}$) = | 108,373 | $ft^2$ |
| Volume of Basin Floor ($V_{FLOOR}$) = | 33,453 | $ft^3$ |
| Depth of Main Basin ($H_{MAIN}$) = | 1.11 | ft |
| Length of Main Basin ($L_{MAIN}$) = | 467.2 | ft |
| Width of Main Basin ($W_{MAIN}$) = | 242.0 | ft |
| Area of Main Basin ($A_{MAIN}$) = | 113,051 | $ft^2$ |
| Volume of Main Basin ($V_{MAIN}$) = | 122,881 | $ft^3$ |
| Calculated Total Basin Volume ($V_{total}$) = | **3.593** | acre-feet |

Depth Increment = 0.50 ft

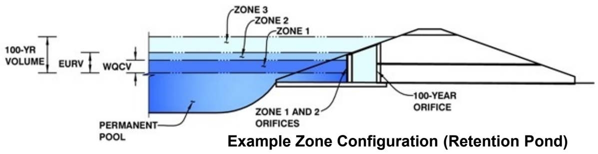
| Stage - Storage Description | Stage (ft) | Optional Override Stage (ft) | Length (ft) | Width (ft) | Area ($ft^2$) | Optional Override Area ($ft^2$) | Area (acre) | Volume ($ft^3$) | Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| **Top of Micropool** | 0.00 | | 12.8 | 12.8 | 165 | | 0.004 | | |
| **ISV** | 0.50 | | 12.8 | 12.8 | 165 | | 0.004 | 82 | 0.002 |
| | 1.00 | | 12.8 | 12.8 | 165 | | 0.004 | 165 | 0.004 |
| | 1.50 | | 264.3 | 137.8 | 36,435 | | 0.836 | 6,695 | 0.154 |
| **Zone 1 (WQCV)** | 1.83 | | 430.3 | 220.3 | 94,816 | | 2.177 | 27,598 | 0.634 |
| **Floor** | 1.89 | | 460.5 | 235.3 | 108,373 | | 2.488 | 33,689 | 0.773 |
| | 2.00 | | 461.2 | 236.0 | 108,833 | | 2.498 | 45,635 | 1.048 |
| **Zone 2 (5-year)** | 2.21 | | 462.4 | 237.3 | 109,713 | | 2.519 | 68,582 | 1.574 |
| | 2.50 | | 464.2 | 239.0 | 110,933 | | 2.547 | 100,576 | 2.309 |
| | 3.00 | | 467.2 | 242.0 | 113,051 | | 2.595 | 156,571 | 3.594 |
| **Zone 3 (100-year)** | 3.01 | | 467.2 | 242.1 | 113,094 | | 2.596 | 157,702 | 3.620 |
| | 3.50 | | 470.2 | 245.0 | 115,188 | | 2.644 | 213,630 | 4.904 |
| | 4.00 | | 473.2 | 248.0 | 117,342 | | 2.694 | 271,762 | 6.239 |
| | 4.50 | | 476.2 | 251.0 | 119,515 | | 2.744 | 330,976 | 7.598 |
| | 5.00 | | 479.2 | 254.0 | 121,705 | | 2.794 | 391,280 | 8.983 |
| | 5.50 | | 482.2 | 257.0 | 123,914 | | 2.845 | 452,684 | 10.392 |
| | 6.00 | | 485.2 | 260.0 | 126,140 | | 2.896 | 515,197 | 11.827 |
| | 6.50 | | 488.2 | 263.0 | 128,385 | | 2.947 | 578,827 | 13.288 |
| | 7.00 | | 491.2 | 266.0 | 130,647 | | 2.999 | 643,585 | 14.775 |
| | 7.50 | | 494.2 | 269.0 | 132,928 | | 3.052 | 709,478 | 16.287 |
| | 8.00 | | 497.2 | 272.0 | 135,226 | | 3.104 | 776,515 | 17.826 |
| | 8.50 | | 500.2 | 275.0 | 137,543 | | 3.158 | 844,707 | 19.392 |
| | 9.00 | | 503.2 | 278.0 | 139,877 | | 3.211 | 914,061 | 20.984 |
| | 9.50 | | 506.2 | 281.0 | 142,230 | | 3.265 | 984,587 | 22.603 |
| | 10.00 | | 509.2 | 284.0 | 144,600 | | 3.320 | 1,056,294 | 24.249 |
| | 10.50 | | 512.2 | 287.0 | 146,989 | | 3.374 | 1,129,190 | 25.923 |
| | 11.00 | | 515.2 | 290.0 | 149,395 | | 3.430 | 1,203,286 | 27.624 |
| | 11.50 | | 518.2 | 293.0 | 151,820 | | 3.485 | 1,278,588 | 29.352 |
| | 12.00 | | 521.2 | 296.0 | 154,262 | | 3.541 | 1,355,108 | 31.109 |
| | 12.50 | | 524.2 | 299.0 | 156,723 | | 3.598 | 1,432,854 | 32.894 |
| | 13.00 | | 527.2 | 302.0 | 159,201 | | 3.655 | 1,511,834 | 34.707 |
| | 13.50 | | 530.2 | 305.0 | 161,698 | | 3.712 | 1,592,058 | 36.549 |
| | 14.00 | | 533.2 | 308.0 | 164,212 | | 3.770 | 1,673,534 | 38.419 |
| | 14.50 | | 536.2 | 311.0 | 166,744 | | 3.828 | 1,756,273 | 40.318 |
| | 15.00 | | 539.2 | 314.0 | 169,295 | | 3.886 | 1,840,282 | 42.247 |
| | 15.50 | | 542.2 | 317.0 | 171,863 | | 3.945 | 1,925,571 | 44.205 |
| | 16.00 | | 545.2 | 320.0 | 174,450 | | 4.005 | 2,012,148 | 46.193 |
| | 16.50 | | 548.2 | 323.0 | 177,054 | | 4.065 | 2,100,023 | 48.210 |
| | 17.00 | | 551.2 | 326.0 | 179,677 | | 4.125 | 2,189,206 | 50.257 |
| | 17.50 | | 554.2 | 329.0 | 182,317 | | 4.185 | 2,279,703 | 52.335 |
| | 18.00 | | 557.2 | 332.0 | 184,976 | | 4.246 | 2,371,526 | 54.443 |
| | 18.50 | | 560.2 | 335.0 | 187,652 | | 4.308 | 2,464,682 | 56.581 |
| | 19.00 | | 563.2 | 338.0 | 190,347 | | 4.370 | 2,559,181 | 58.751 |
| | 19.50 | | 566.2 | 341.0 | 193,059 | | 4.432 | 2,655,032 | 60.951 |
| | 20.00 | | 569.2 | 344.0 | 195,790 | | 4.495 | 2,752,243 | 63.183 |
| | 20.50 | | 572.2 | 347.0 | 198,538 | | 4.558 | 2,850,825 | 65.446 |
| | 21.00 | | 575.2 | 350.0 | 201,305 | | 4.621 | 2,950,785 | 67.741 |
| | 21.50 | | 578.2 | 353.0 | 204,089 | | 4.685 | 3,052,132 | 70.067 |
| | 22.00 | | 581.2 | 356.0 | 206,892 | | 4.750 | 3,154,877 | 72.426 |
| | 22.50 | | 584.2 | 359.0 | 209,712 | | 4.814 | 3,259,027 | 74.817 |
| | 23.00 | | 587.2 | 362.0 | 212,551 | | 4.879 | 3,364,592 | 77.240 |
| | 23.50 | | 590.2 | 365.0 | 215,407 | | 4.945 | 3,471,581 | 79.697 |
| | 24.00 | | 593.2 | 368.0 | 218,282 | | 5.011 | 3,580,002 | 82.186 |
| | 24.50 | | 596.2 | 371.0 | 221,174 | | 5.077 | 3,689,865 | 84.708 |
| | 25.00 | | 599.2 | 374.0 | 224,085 | | 5.144 | 3,801,179 | 87.263 |
| | 25.50 | | 602.2 | 377.0 | 227,013 | | 5.212 | 3,913,953 | 89.852 |
| | 26.00 | | 605.2 | 380.0 | 229,959 | | 5.279 | 4,028,195 | 92.475 |
| | 26.50 | | 608.2 | 383.0 | 232,924 | | 5.347 | 4,143,915 | 95.131 |
| | 27.00 | | 611.2 | 386.0 | 235,906 | | 5.416 | 4,261,122 | 97.822 |
| | 27.50 | | 614.2 | 389.0 | 238,907 | | 5.485 | 4,379,825 | 100.547 |
| | 28.00 | | 617.2 | 392.0 | 241,925 | | 5.554 | 4,500,032 | 103.307 |
| | 28.50 | | 620.2 | 395.0 | 244,962 | | 5.624 | 4,621,753 | 106.101 |
| | 29.00 | | 623.2 | 398.0 | 248,016 | | 5.694 | 4,744,997 | 108.930 |
| | 29.50 | | 626.2 | 401.0 | 251,089 | | 5.764 | 4,869,772 | 111.795 |
| | 30.00 | | 629.2 | 404.0 | 254,179 | | 5.835 | 4,996,089 | 114.694 |

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.04 (February 2021)*

**Project: CO3519 Keenseburg North**

**Basin ID: Basin B**




**Example Zone Configuration (Retention Pond)**

| | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (WQCV) | 1.83 | 0.630 | Orifice Plate |
| Zone 2 (5-year) | 2.21 | 0.924 | Rectangular Orifice |
| Zone 3 (100-year) | 3.01 | 2.057 | Weir&Pipe (Restrict) |
| | Total (all zones) | 3.611 | |

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 = | 1.83 | ft (relative to basin bottom at Stage = 0 ft) |
| Orifice Plate: Orifice Vertical Spacing = | 7.30 | inches |
| Orifice Plate: Orifice Area per Row = | 1.96 | sq. inches (diameter = 1-9/16 inches) |

Calculated Parameters for Plate

| | | |
|---|---|---|
| WQ Orifice Area per Row = | 1.361E-02 | $ft^2$ |
| Elliptical Half-Width = | N/A | feet |
| Elliptical Slot Centroid = | N/A | feet |
| Elliptical Slot Area = | N/A | $ft^2$ |

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

| | Row 1 (required) | Row 2 (optional) | Row 3 (optional) | Row 4 (optional) | Row 5 (optional) | Row 6 (optional) | Row 7 (optional) | Row 8 (optional) |
|---|---|---|---|---|---|---|---|---|
| Stage of Orifice Centroid (ft) | 0.00 | 0.61 | 1.22 | | | | | |
| Orifice Area (sq. inches) | 1.96 | 1.96 | 1.96 | | | | | |

| | 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)

| | Zone 2 Rectangular | Not Selected | |
|---|---|---|---|
| Invert of Vertical Orifice = | 1.83 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Depth at top of Zone using Vertical Orifice = | 2.20 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Vertical Orifice Height = | 2.00 | N/A | inches |
| Vertical Orifice Width = | | | inches |

Calculated Parameters for Vertical Orifice

| | Zone 2 Rectangular | Not Selected | |
|---|---|---|---|
| Vertical Orifice Area = | 0.00 | N/A | $ft^2$ |
| Vertical Orifice Centroid = | 0.08 | N/A | feet |

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

| | Zone 3 Weir | Not Selected | |
|---|---|---|---|
| Overflow Weir Front Edge Height, Ho = | 2.20 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Overflow Weir Front Edge Length = | | N/A | feet |
| Overflow Weir Grate Slope = | | N/A | H:V |
| Horiz. Length of Weir Sides = | | N/A | feet |
| Overflow Grate Type = | | N/A | |
| Debris Clogging % = | | N/A | % |

Calculated Parameters for Overflow Weir

| | Zone 3 Weir | Not Selected | |
|---|---|---|---|
| Height of Grate Upper Edge, $H_t$ = | | N/A | feet |
| Overflow Weir Slope Length = | | N/A | feet |
| Grate Open Area / 100-yr Orifice Area = | | N/A | |
| Overflow Grate Open Area w/o Debris = | | N/A | $ft^2$ |
| Overflow Grate Open Area w/ Debris = | | 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 = | | N/A | ft (distance below basin bottom at Stage = 0 ft) |
| Outlet Pipe Diameter = | | N/A | inches |
| Restrictor Plate Height Above Pipe Invert = | | | inches |

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

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

User Input: Emergency Spillway (Rectangular or Trapezoidal)

| | | |
|---|---|---|
| Spillway Invert Stage= | 4.10 | ft (relative to basin bottom at Stage = 0 ft) |
| Spillway Crest Length = | 21.00 | feet |
| Spillway End Slopes = | 4.00 | H:V |
| Freeboard above Max Water Surface = | 1.00 | feet |

Calculated Parameters for Spillway

| | | |
|---|---|---|
| Spillway Design Flow Depth= | 0.90 | feet |
| Stage at Top of Freeboard = | 6.00 | feet |
| Basin Area at Top of Freeboard = | 2.90 | acres |
| Basin Volume at Top of Freeboard = | 11.83 | 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).*

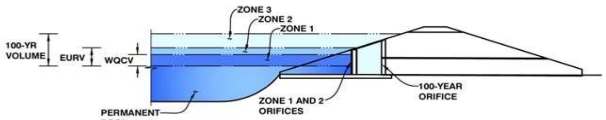
| Design Storm Return Period = | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|---|---|---|---|---|---|---|---|---|
| One-Hour Rainfall Depth (in) = | N/A | N/A | 0.86 | 1.14 | 1.41 | 1.84 | 2.23 | 2.65 | 3.13 |
| CUHP Runoff Volume (acre-ft) = | 0.630 | 1.976 | 1.188 | 1.712 | 2.402 | 3.832 | 5.011 | 6.440 | 7.960 |
| Inflow Hydrograph Volume (acre-ft) = | N/A | N/A | 1.188 | 1.712 | 2.402 | 3.832 | 5.011 | 6.440 | 7.960 |
| CUHP Predevelopment Peak Q (cfs) = | N/A | N/A | 0.2 | 0.7 | 3.8 | 13.5 | 20.1 | 29.1 | 37.6 |
| OPTIONAL Override Predevelopment Peak Q (cfs) = | N/A | N/A | | | | | | | |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | N/A | N/A | 0.00 | 0.02 | 0.11 | 0.37 | 0.55 | 0.80 | 1.04 |
| Peak Inflow Q (cfs) = | N/A | N/A | 10.4 | 14.9 | 21.3 | 37.7 | 49.3 | 63.6 | 78.1 |
| Peak Outflow Q (cfs) = | 0.2 | 0.3 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.4 | 10.2 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 0.4 | 0.1 | 0.0 | 0.0 | 0.0 | 0.3 |
| Structure Controlling Flow = | Plate | Plate | Plate | Plate | Plate | Plate | Plate | Plate | Spillway |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Max Velocity through Grate 2 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Time to Drain 97% of Inflow Volume (hours) = | 39 | 105 | 69 | 94 | >120 | >120 | >120 | >120 | >120 |
| Time to Drain 99% of Inflow Volume (hours) = | **41** | 109 | 71 | 97 | >120 | >120 | >120 | >120 | >120 |
| Maximum Ponding Depth (ft) = | 1.83 | 2.37 | 2.03 | 2.24 | 2.51 | 3.06 | 3.51 | 4.04 | 4.38 |
| Area at Maximum Ponding Depth (acres) = | 2.18 | 2.53 | 2.50 | 2.52 | 2.55 | 2.60 | 2.64 | 2.70 | 2.73 |
| Maximum Volume Stored (acre-ft) = | 0.634 | 1.979 | 1.123 | 1.625 | 2.309 | 3.750 | 4.904 | 6.320 | 7.270 |

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.04 (February 2021)*

**Project: CO3519 Keenseburg North**

**Basin ID: Basin C**




**Example Zone Configuration (Retention Pond)**

## Watershed Information

| | | |
|---|---|---|
| Selected BMP Type = | **EDB** | |
| Watershed Area = | 4.58 | acres |
| Watershed Length = | 1,760 | ft |
| Watershed Length to Centroid = | 1,098 | ft |
| Watershed Slope = | 0.012 | ft/ft |
| Watershed Imperviousness = | 61.00% | percent |
| Percentage Hydrologic Soil Group A = | 0.0% | percent |
| Percentage Hydrologic Soil Group B = | 100.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 0.0% | percent |
| Target WQCV Drain Time = | 40.0 | hours |
| Location for 1-hr Rainfall Depths = | User Input | |

**Note: L / W Ratio > 8**

**L / W Ratio = 15.53**

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) = | 0.091 | acre-feet | | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 0.303 | acre-feet | | acre-feet |
| 2-yr Runoff Volume (P1 = 0.86 in.) = | 0.185 | acre-feet | 0.86 | inches |
| 5-yr Runoff Volume (P1 = 1.14 in.) = | 0.262 | acre-feet | 1.14 | inches |
| 10-yr Runoff Volume (P1 = 1.41 in.) = | 0.354 | acre-feet | 1.41 | inches |
| 25-yr Runoff Volume (P1 = 1.84 in.) = | 0.535 | acre-feet | 1.84 | inches |
| 50-yr Runoff Volume (P1 = 2.23 in.) = | 0.687 | acre-feet | 2.23 | inches |
| 100-yr Runoff Volume (P1 = 2.65 in.) = | 0.867 | acre-feet | 2.65 | inches |
| 500-yr Runoff Volume (P1 = 3.13 in.) = | 1.061 | acre-feet | 3.13 | inches |
| Approximate 2-yr Detention Volume = | 0.169 | acre-feet | | |
| Approximate 5-yr Detention Volume = | 0.239 | acre-feet | | |
| Approximate 10-yr Detention Volume = | 0.326 | acre-feet | | |
| Approximate 25-yr Detention Volume = | 0.403 | acre-feet | | |
| Approximate 50-yr Detention Volume = | 0.452 | acre-feet | | |
| Approximate 100-yr Detention Volume = | 0.523 | acre-feet | | |

## Define Zones and Basin Geometry

| | | |
|---|---|---|
| Zone 1 Volume (WQCV) = | 0.091 | acre-feet |
| Select Zone 2 Storage Volume (Optional) = | | acre-feet |
| Select Zone 3 Storage Volume (Optional) = | | acre-feet |
| Total Detention Basin Volume = | 0.091 | acre-feet |
| Initial Surcharge Volume (ISV) = | 12 | $ft^3$ |
| Initial Surcharge Depth (ISD) = | 0.50 | ft |
| Total Available Detention Depth ($H_{total}$) = | 3.00 | ft |
| Depth of Trickle Channel ($H_{TC}$) = | 0.50 | ft |
| Slope of Trickle Channel ($S_{TC}$) = | 0.002 | ft/ft |
| Slopes of Main Basin Sides ($S_{main}$) = | 3 | H:V |
| Basin Length-to-Width Ratio ($R_{L/W}$) = | 2 | |

**Total detention volume is less than 100-year volume.**

| | | |
|---|---|---|
| Initial Surcharge Area ($A_{ISV}$) = | 24 | $ft^2$ |
| Surcharge Volume Length ($L_{ISV}$) = | 4.9 | ft |
| Surcharge Volume Width ($W_{ISV}$) = | 4.9 | ft |
| Depth of Basin Floor ($H_{FLOOR}$) = | 0.10 | ft |
| Length of Basin Floor ($L_{FLOOR}$) = | 55.2 | ft |
| Width of Basin Floor ($W_{FLOOR}$) = | 29.9 | ft |
| Area of Basin Floor ($A_{FLOOR}$) = | 1,649 | $ft^2$ |
| Volume of Basin Floor ($V_{FLOOR}$) = | 62 | $ft^3$ |
| Depth of Main Basin ($H_{MAIN}$) = | 1.90 | ft |
| Length of Main Basin ($L_{MAIN}$) = | 66.6 | ft |
| Width of Main Basin ($W_{MAIN}$) = | 41.3 | ft |
| Area of Main Basin ($A_{MAIN}$) = | 2,749 | $ft^2$ |
| Volume of Main Basin ($V_{MAIN}$) = | 4,135 | $ft^3$ |
| Calculated Total Basin Volume ($V_{total}$) = | **0.097** | acre-feet |

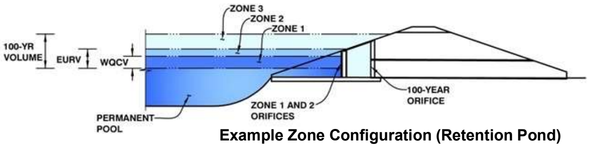
Depth Increment = 0.50 ft

| 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 | | 4.9 | 4.9 | 24 | | 0.001 | | |
| **ISV** | 0.50 | | 4.9 | 4.9 | 24 | | 0.001 | 12 | 0.000 |
| | 1.00 | | 4.9 | 4.9 | 24 | | 0.001 | 24 | 0.001 |
| **Floor** | 1.10 | | 55.2 | 29.9 | 1,649 | | 0.038 | 87 | 0.002 |
| | 1.50 | | 57.6 | 32.3 | 1,859 | | 0.043 | 788 | 0.018 |
| | 2.00 | | 60.6 | 35.3 | 2,138 | | 0.049 | 1,787 | 0.041 |
| | 2.50 | | 63.6 | 38.3 | 2,435 | | 0.056 | 2,929 | 0.067 |
| **Zone 1 (WQCV)** | 2.92 | | 66.1 | 40.8 | 2,698 | | 0.062 | 4,006 | 0.092 |
| | 3.00 | | 66.6 | 41.3 | 2,749 | | 0.063 | 4,224 | 0.097 |
| | 3.50 | | 69.6 | 44.3 | 3,082 | | 0.071 | 5,681 | 0.130 |
| | 4.00 | | 72.6 | 47.3 | 3,433 | | 0.079 | 7,309 | 0.168 |
| | 4.50 | | 75.6 | 50.3 | 3,801 | | 0.087 | 9,117 | 0.209 |
| | 5.00 | | 78.6 | 53.3 | 4,188 | | 0.096 | 11,113 | 0.255 |
| | 5.50 | | 81.6 | 56.3 | 4,592 | | 0.105 | 13,308 | 0.306 |
| | 6.00 | | 84.6 | 59.3 | 5,015 | | 0.115 | 15,709 | 0.361 |
| | 6.50 | | 87.6 | 62.3 | 5,456 | | 0.125 | 18,326 | 0.421 |
| | 7.00 | | 90.6 | 65.3 | 5,914 | | 0.136 | 21,168 | 0.486 |
| | 7.50 | | 93.6 | 68.3 | 6,391 | | 0.147 | 24,243 | 0.557 |
| | 8.00 | | 96.6 | 71.3 | 6,886 | | 0.158 | 27,562 | 0.633 |
| | 8.50 | | 99.6 | 74.3 | 7,398 | | 0.170 | 31,132 | 0.715 |
| | 9.00 | | 102.6 | 77.3 | 7,929 | | 0.182 | 34,963 | 0.803 |
| | 9.50 | | 105.6 | 80.3 | 8,478 | | 0.195 | 39,064 | 0.897 |
| | 10.00 | | 108.6 | 83.3 | 9,044 | | 0.208 | 43,443 | 0.997 |
| | 10.50 | | 111.6 | 86.3 | 9,629 | | 0.221 | 48,111 | 1.104 |
| | 11.00 | | 114.6 | 89.3 | 10,231 | | 0.235 | 53,075 | 1.218 |
| | 11.50 | | 117.6 | 92.3 | 10,852 | | 0.249 | 58,345 | 1.339 |
| | 12.00 | | 120.6 | 95.3 | 11,491 | | 0.264 | 63,930 | 1.468 |
| | 12.50 | | 123.6 | 98.3 | 12,147 | | 0.279 | 69,839 | 1.603 |
| | 13.00 | | 126.6 | 101.3 | 12,822 | | 0.294 | 76,081 | 1.747 |
| | 13.50 | | 129.6 | 104.3 | 13,515 | | 0.310 | 82,664 | 1.898 |
| | 14.00 | | 132.6 | 107.3 | 14,225 | | 0.327 | 89,598 | 2.057 |
| | 14.50 | | 135.6 | 110.3 | 14,954 | | 0.343 | 96,892 | 2.224 |
| | 15.00 | | 138.6 | 113.3 | 15,700 | | 0.360 | 104,555 | 2.400 |
| | 15.50 | | 141.6 | 116.3 | 16,465 | | 0.378 | 112,596 | 2.585 |
| | 16.00 | | 144.6 | 119.3 | 17,248 | | 0.396 | 121,023 | 2.778 |
| | 16.50 | | 147.6 | 122.3 | 18,048 | | 0.414 | 129,846 | 2.981 |
| | 17.00 | | 150.6 | 125.3 | 18,867 | | 0.433 | 139,074 | 3.193 |
| | 17.50 | | 153.6 | 128.3 | 19,704 | | 0.452 | 148,716 | 3.414 |
| | 18.00 | | 156.6 | 131.3 | 20,558 | | 0.472 | 158,781 | 3.645 |
| | 18.50 | | 159.6 | 134.3 | 21,431 | | 0.492 | 169,277 | 3.886 |
| | 19.00 | | 162.6 | 137.3 | 22,321 | | 0.512 | 180,215 | 4.137 |
| | 19.50 | | 165.6 | 140.3 | 23,230 | | 0.533 | 191,602 | 4.399 |
| | 20.00 | | 168.6 | 143.3 | 24,157 | | 0.555 | 203,448 | 4.671 |
| | 20.50 | | 171.6 | 146.3 | 25,101 | | 0.576 | 215,762 | 4.953 |
| | 21.00 | | 174.6 | 149.3 | 26,064 | | 0.598 | 228,552 | 5.247 |
| | 21.50 | | 177.6 | 152.3 | 27,045 | | 0.621 | 241,829 | 5.552 |
| | 22.00 | | 180.6 | 155.3 | 28,043 | | 0.644 | 255,600 | 5.868 |
| | 22.50 | | 183.6 | 158.3 | 29,060 | | 0.667 | 269,875 | 6.195 |
| | 23.00 | | 186.6 | 161.3 | 30,095 | | 0.691 | 284,663 | 6.535 |
| | 23.50 | | 189.6 | 164.3 | 31,147 | | 0.715 | 299,973 | 6.886 |
| | 24.00 | | 192.6 | 167.3 | 32,218 | | 0.740 | 315,813 | 7.250 |
| | 24.50 | | 195.6 | 170.3 | 33,306 | | 0.765 | 332,193 | 7.626 |
| | 25.00 | | 198.6 | 173.3 | 34,413 | | 0.790 | 349,122 | 8.015 |
| | 25.50 | | 201.6 | 176.3 | 35,538 | | 0.816 | 366,609 | 8.416 |
| | 26.00 | | 204.6 | 179.3 | 36,680 | | 0.842 | 384,663 | 8.831 |
| | 26.50 | | 207.6 | 182.3 | 37,841 | | 0.869 | 403,293 | 9.258 |
| | 27.00 | | 210.6 | 185.3 | 39,020 | | 0.896 | 422,507 | 9.699 |
| | 27.50 | | 213.6 | 188.3 | 40,216 | | 0.923 | 442,315 | 10.154 |
| | 28.00 | | 216.6 | 191.3 | 41,431 | | 0.951 | 462,726 | 10.623 |
| | 28.50 | | 219.6 | 194.3 | 42,663 | | 0.979 | 483,749 | 11.105 |
| | 29.00 | | 222.6 | 197.3 | 43,914 | | 1.008 | 505,393 | 11.602 |
| | 29.50 | | 225.6 | 200.3 | 45,183 | | 1.037 | 527,666 | 12.114 |
| | 30.00 | | 228.6 | 203.3 | 46,469 | | 1.067 | 550,578 | 12.640 |

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.04 (February 2021)*

**Project:** **CO3519 Keensburg North**
**Basin ID:** **Basin C**




**Example Zone Configuration (Retention Pond)**

| | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (WQCV) | 2.92 | 0.091 | Orifice Plate |
| Zone 2 | | | Weir&Pipe (Rect.) |
| Zone 3 | | | Not Utilized |
| Total (all zones) | | 0.091 | |

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 = | 2.98 | ft (relative to basin bottom at Stage = 0 ft) |
| Orifice Plate: Orifice Vertical Spacing = | 11.90 | inches |
| Orifice Plate: Orifice Area per Row = | 0.39 | sq. inches (diameter = 11/16 inch) |

Calculated Parameters for Plate

| | | |
|---|---|---|
| WQ Orifice Area per Row = | 2.708E-03 | ft$^2$ |
| Elliptical Half-Width = | N/A | feet |
| Elliptical Slot Centroid = | N/A | feet |
| Elliptical Slot Area = | N/A | ft$^2$ |

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

| | Row 1 (required) | Row 2 (optional) | Row 3 (optional) | Row 4 (optional) | Row 5 (optional) | Row 6 (optional) | Row 7 (optional) | Row 8 (optional) |
|---|---|---|---|---|---|---|---|---|
| Stage of Orifice Centroid (ft) | 0.00 | 0.99 | 1.99 | | | | | |
| Orifice Area (sq. inches) | 0.39 | 0.39 | 0.39 | | | | | |

| | 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 2 Weir | Not Selected | |
|---|---|---|---|
| Overflow Weir Front Edge Height, Ho = | 2.98 | N/A | ft (relative to basin bottom at Stage = 0 ft) |
| Overflow Weir Front Edge Length = | | N/A | feet |
| Overflow Weir Grate Slope = | | N/A | H:V |
| Horiz. Length of Weir Sides = | | N/A | feet |
| Overflow Grate Type = | | N/A | |
| Debris Clogging % = | | N/A | % |

Calculated Parameters for Overflow Weir

| | Zone 2 Weir | Not Selected | |
|---|---|---|---|
| Height of Grate Upper Edge, $H_t$ = | | N/A | feet |
| Overflow Weir Slope Length = | | N/A | feet |
| Grate Open Area / 100-yr Orifice Area = | | N/A | |
| Overflow Grate Open Area w/o Debris = | | N/A | ft$^2$ |
| Overflow Grate Open Area w/ Debris = | | N/A | ft$^2$ |

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

| | Zone 2 Rectangular | Not Selected | |
|---|---|---|---|
| Depth to Invert of Outlet Pipe = | | N/A | ft (distance below basin bottom at Stage = 0 ft) |
| Rectangular Orifice Width = | | N/A | inches |
| Rectangular Orifice Height = | | | inches |

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

| | Zone 2 Rectangular | Not Selected | |
|---|---|---|---|
| Outlet Orifice Area = | | N/A | ft$^2$ |
| Outlet Orifice Centroid = | | N/A | feet |
| Half-Central Angle of Restrictor Plate on Pipe = | N/A | N/A | radians |

User Input: Emergency Spillway (Rectangular or Trapezoidal)

| | | |
|---|---|---|
| Spillway Invert Stage= | 3.00 | ft (relative to basin bottom at Stage = 0 ft) |
| Spillway Crest Length = | 3.00 | feet |
| Spillway End Slopes = | 4.00 | H:V |
| Freeboard above Max Water Surface = | 1.00 | feet |

Calculated Parameters for Spillway

| | | |
|---|---|---|
| Spillway Design Flow Depth= | 0.64 | feet |
| Stage at Top of Freeboard = | 4.64 | feet |
| Basin Area at Top of Freeboard = | 0.09 | acres |
| Basin Volume at Top of Freeboard = | 0.22 | acre-ft |

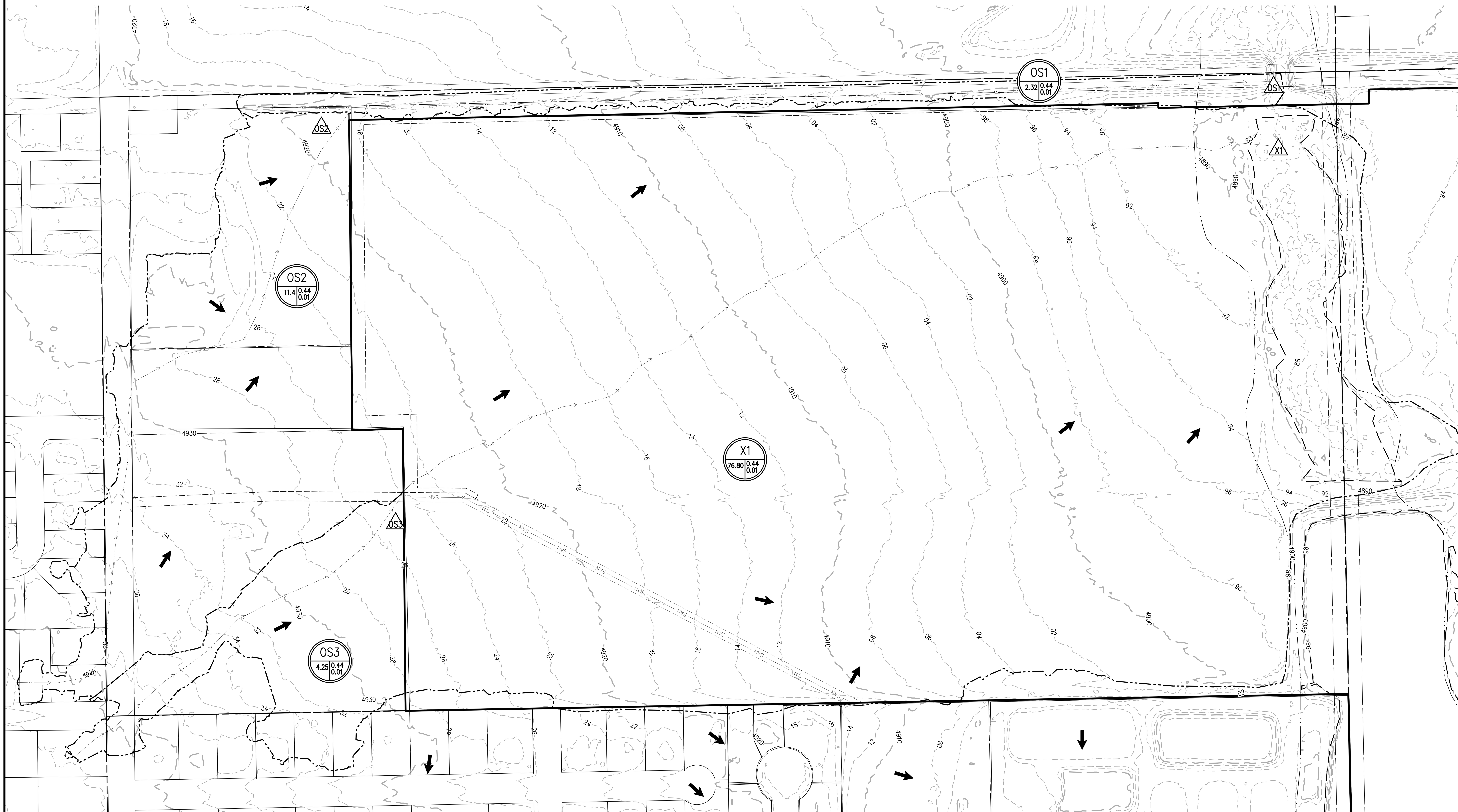
Routed Hydrograph Results

*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 | 0.86 | 1.14 | 1.41 | 1.84 | 2.23 | 2.65 | 3.13 |
| CUHP Runoff Volume (acre-ft) = | 0.091 | 0.303 | 0.185 | 0.262 | 0.354 | 0.535 | 0.687 | 0.867 | 1.061 |
| Inflow Hydrograph Volume (acre-ft) = | N/A | N/A | 0.185 | 0.262 | 0.354 | 0.535 | 0.687 | 0.867 | 1.061 |
| CUHP Predevelopment Peak Q (cfs) = | N/A | N/A | 0.0 | 0.1 | 0.3 | 1.2 | 1.7 | 2.6 | 3.4 |
| OPTIONAL Override Predevelopment Peak Q (cfs) = | N/A | N/A | | | | | | | |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | N/A | N/A | 0.00 | 0.01 | 0.07 | 0.25 | 0.38 | 0.56 | 0.73 |
| Peak Inflow Q (cfs) = | N/A | N/A | 1.3 | 1.8 | 2.4 | 4.1 | 5.3 | 6.7 | 8.2 |
| Peak Outflow Q (cfs) = | 0.1 | 32.1 | 0.8 | 1.4 | 2.0 | 3.8 | 5.1 | 6.7 | 8.2 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 24.8 | 6.4 | 3.3 | 2.9 | 2.6 | 2.4 |
| Structure Controlling Flow = | Plate | Spillway | Spillway | Spillway | Spillway | Spillway | Spillway | Spillway | Spillway |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Max Velocity through Grate 2 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Time to Drain 97% of Inflow Volume (hours) = | 32 | 28 | 36 | 35 | 33 | 30 | 28 | 26 | 23 |
| Time to Drain 99% of Inflow Volume (hours) = | **33** | 30 | 38 | 38 | 37 | 36 | 35 | 34 | 33 |
| Maximum Ponding Depth (ft) = | 2.91 | 5.48 | 3.17 | 3.24 | 3.30 | 3.43 | 3.51 | 3.59 | 3.66 |
| Area at Maximum Ponding Depth (acres) = | 0.06 | 0.11 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |
| Maximum Volume Stored (acre-ft) = | 0.091 | 0.303 | 0.107 | 0.112 | 0.117 | 0.126 | 0.131 | 0.136 | 0.141 |

# Appendix C

*Drainage Plans*




## LEGEND

| EXISTING LINETYPES | PROPOSED LINETYPES | |
|---|---|---|
| | | PROPERTY BOUNDARY |
| 81 | 81 | MINOR CONTOUR (1' INTERVAL) |
| 5280 | 5280 | MAJOR CONTOUR (5' INTERVAL) |
| | | RIGHT-OF-WAY |
| | | LOT LINE |
| | | FLOODPLAIN |
| | | DRAINAGE BASIN BOUNDARY |

△ 0 — DESIGN POINT DESIGNATION

X = BASIN ID
A.AA = BASIN AREA (ACRES)
X.XX = 100YR COEFFICIENT
Y.YY = 5YR COEFFICIENT

| RUNOFF SUMMARY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| BASIN LABEL | DESIGN POINT | AREA | % IMP | C5 | C100 | LOCAL (CFS) | | NOTES |
| | | | | | | Q5 | Q100 | |
| OS1 | 1 | 2.32 | 2 | 0.01 | 0.44 | 0.03 | 2.65 | |
| OS2 | 2 | 11.40 | 2 | 0.01 | 0.44 | 0.18 | 15.11 | |
| OS3 | 3 | 4.25 | 2 | 0.01 | 0.44 | 0.08 | 6.74 | |
| X1 | 5 | 76.80 | 2 | 0.01 | 0.44 | 1.16 | 95.97 | HISTORIC ONSITE BASIN |

N

GRAPHIC SCALE
100 0 100 200
(IN FEET)
1 INCH = 100 FT

1 EXISTING DRAINAGE PLAN

**BASELINE**
Engineering · Planning · Surveying
112 N RUBEY DRIVE, SUITE 210 • GOLDEN, COLORADO 80403
P: 303.940.9966 • F: 303.940.9959 • www.baselinecorp.com

DESIGNED BY MBR
DRAWN BY MBR
CHECKED BY MLL

| REVISION DESCRIPTION | PREPARED BY | DATE |
|---|---|---|
| TOWN COMMENTS | MLL | 10/13/2021 |

# MSP INVESTMENT CO, LLP

## SUMMERFIELD NORTH
SKETCH PLAN
EXISTING DRAINAGE PLAN

TOWN OF KEENESBURG
WELD COUNTY

PREPARED UNDER THE DIRECT SUPERVISION OF

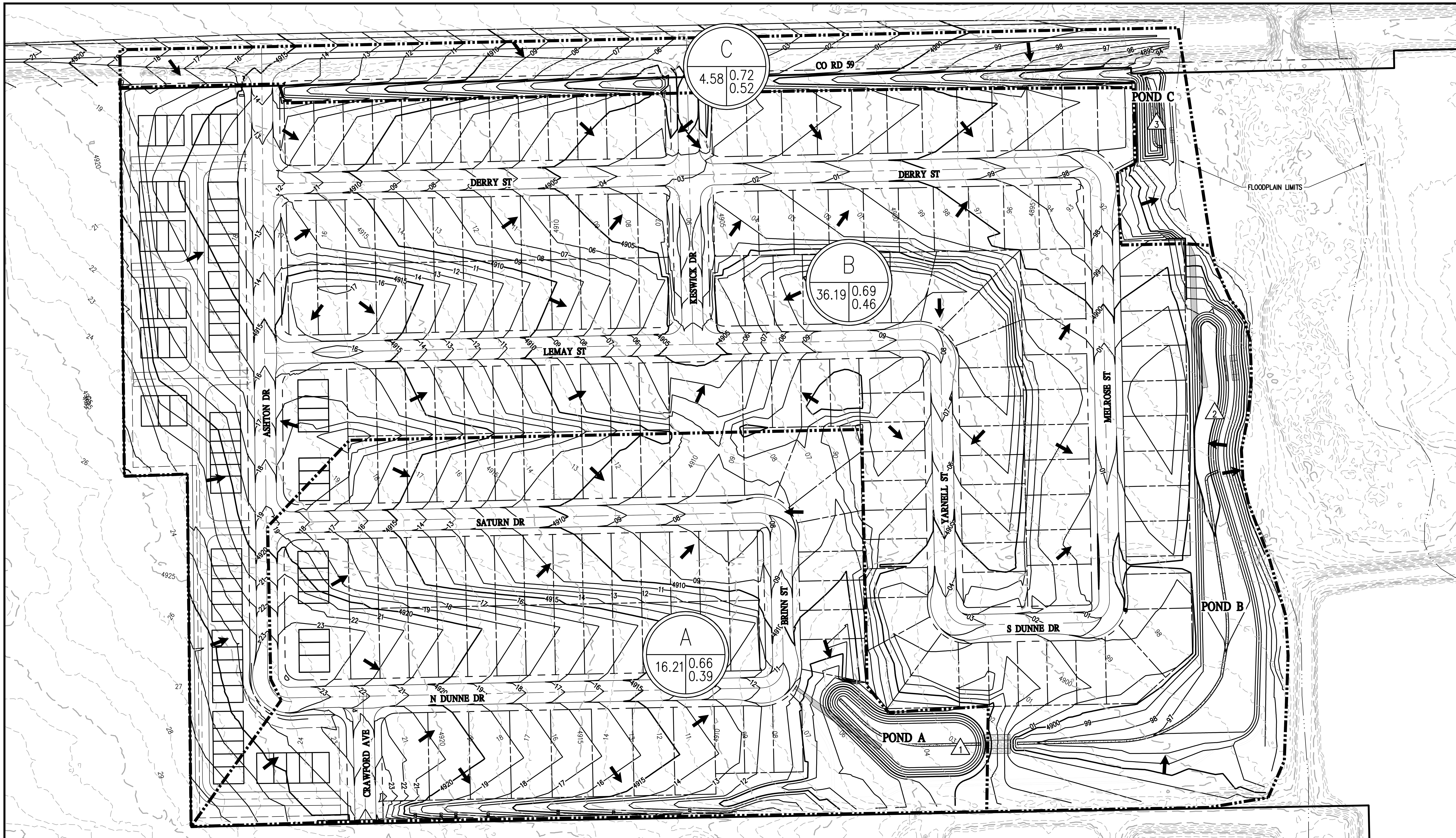
PRELIMINARY NOT FOR CONSTRUCTION

FOR AND ON BEHALF OF BASELINE CORPORATION

| | |
|---|---|
| INITIAL SUBMITTAL | 09/08/2021 |
| DRAWING SIZE | 24" X 36" |
| SURVEY FIRM: FLATIRONS | SURVEY DATE: 05/06/2021 |
| JOB NO. | C03519 |
| DRAWING NAME: 3519 Existing Drainage Map.dwg | |
| SHEET ----- OF | 11 |

DR1

N:\co3519 - Summerfield Keenesburg East\Drawings\Drainage Maps\3519 Existing Drainage Map.dwg, 10/19/2021 2:10:27 PM, Cameron Stone




## LEGEND

| EXISTING LINETYPES | PROPOSED LINETYPES | |
|---|---|---|
| | | PROPERTY BOUNDARY |
| 81 | 81 | MINOR CONTOUR (1' INTERVAL) |
| 5280 | 5280 | MAJOR CONTOUR (5' INTERVAL) |
| | | RIGHT-OF-WAY |
| | | LOT LINE |
| | | FLOODPLAIN |
| | | DRAINAGE BASIN BOUNDARY |

DESIGN FLOW DIRECTION

DESIGN POINT DESIGNATION

P = PROPOSED BASIN ID
A.AA = PROPOSED BASIN AREA (ACRES)
X.XX = PROPOSED 100YR COEFFICIENT
Y.YY = PROPOSED 5YR COEFFICIENT

| RUNOFF SUMMARY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| BASIN LABEL | DESIGN POINT | AREA | % IMP | C5 | C100 | LOCAL (CFS) | | NOTES |
| | | | | | | Q5 | Q100 | |
| A | 1 | 16.21 | 48% | 0.39 | 0.66 | 13.29 | 51.35 | |
| B | 2 | 36.19 | 56% | 0.46 | 0.69 | 25.72 | 89.29 | |
| C | 3 | 4.58 | 61% | 0.52 | 0.72 | 4.33 | 14.03 | |

**NOTE:**

BASINS ARE PRELIMINARY AND ARE SUBJECT TO CHANGE

GRAPHIC SCALE
80 0 80 160
(IN FEET)
1 INCH = 80 FT

811 Know what's **below.** **Call** before you dig.

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DESIGNED BY MLL
DRAWN BY MBR
CHECKED BY MBR

REVISION DESCRIPTION | PREPARED BY | DATE

**MSP INVESTMENT CO. LLP**
SUMMERFIELD NORTH
CONSTRUCTION DOCUMENTS
PROPOSED DRAINAGE PLAN
TOWN OF KEENESBURG
WELD COUNTY

PREPARED UNDER THE DIRECT SUPERVISION OF

PRELIMINARY NOT FOR CONSTRUCTION

FOR AND ON BEHALF OF BASELINE CORPORATION

| | |
|---|---|
| INITIAL SUBMITTAL | 10/19/2021 |
| DRAWING SIZE | 24" X 36" |
| SURVEY FIRM: FLATIRONS | SURVEY DATE: 05/06/2021 |
| JOB NO. | C03519 |
| DRAWING NAME | 3519 Proposed Drainage Map.dwg |
| SHEET ----- OF | 88 |

DR2