# SHEEP DRAW

## Major Drainageway Plan










1525 Raleigh Street, Suite 400, Denver, CO 80204

olsson®

City of Greeley Colorado

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# SHEEP DRAW Major Drainageway Plan

## ABBREVIATIONS INDEX

Ave – Avenue
Blvd – Boulevard
BMP – Best Management Practice
CDOT – Colorado Department of Transportation
CMP – corrugated metal pipe
CUHP– Colorado Urban Hydrograph Procedure
CWCB – Colorado Water Conservation Board
D/S – downstream
E – East
EGL – energy grade line
EPA – Environmental Protection Agency
EURV – excess urban runoff volume
EX – existing
FEMA – Federal Emergency Management Agency
FHAD – Flood Hazard Area Delineation
FIRM – Flood Insurance Rate Map
FTR – future
GIS – Geographic Information System
Greeley – The City of Greeley
HEC-RAS – Hydrologic Engineering Center River Analysis System
HSG – hydrologic soils group
I/Imp. – Imperviousness
LiDAR – light detection and ranging
LOMR – Letter of Map Revision
MDP – Major Drainageway Plan
MHFD – Mile High Flood District
N – North
NAD – North American Datum
NAVD – North American Vertical Datum
NLCD – National Land Cover Database
No. – Number
NOAA – National Oceanic and Atmospheric Administration
NRCS – Natural Resources Conservation Service
O&M – operations and maintenance
O.F. - Overflow
OSP – Outfall Systems Plan
Rd – Road
RCBC – reinforced concrete box culvert
RCP – reinforced concrete pipe
S – South
SEO – State Engineer's Office
SSP – smooth steel pipe
St – Street
SWMM – Storm Water Management Model
UDFCD – Urban Drainage and Flood Control District
U/S – upstream
USACE – United States Army Corps of Engineers
USDCM – Urban Storm Drainage Criteria Manual
W – West
WQCV – water quality capture volume
WSE – water surface elevation
% – percent
ac – acre
AF/ac-ft – acre-feet
cfs – cubic feet per second
ft or ' – foot/feet
in or " – inch/inches
mi – mile

April 2026

# 1. INTRODUCTION

## 1.1 Authorization

Olsson was retained to complete a Major Drainageway Plan (MDP) and floodplain map update for Sheep Draw, located in the City of Greeley and Weld County, Colorado. The project was sponsored by the City of Greeley.

## 1.2 Purpose and Scope

The purpose of this study was to develop baseline hydrology and an existing conditions hydraulic model to be used to update the floodplain and identify problem areas along Sheep Draw. The project includes completion of an alternatives analysis, conceptual design of the selected alternative, and a Letter of Map Revision (LOMR) for the updated floodplain. The Sheep Draw watershed has a growing developed area, with undeveloped areas primarily in the upper portion of the watershed.

The following tasks were completed as part of the major drainageway plan:

- Collected existing information, including the previous MDPs, development drainage studies, and drainage improvement as-built plans.
- Solicited input from project sponsors
- Obtained base mapping, structure surveys, and GIS information from the City of Greeley, Weld County, and Colorado Water Conservation Board (CWCB)
- Obtained future land use mapping from City of Greeley
- Determined subwatershed boundaries and parameters in accordance with Mile High Flood District (MHFD) criteria
- Developed existing and future (fully developed) conditions baseline hydrology using the Colorado Urban Hydrograph Procedure (CUHP), version 2.0.1 and the Environmental Protection Agency Stormwater Management Model (EPA SWMM) 5.2, version 5.2.3
- Developed an existing and future (fully developed) conditions hydraulic model of Sheep Draw using HEC-RAS version 6.4.1
- Evaluated problem areas along Sheep Draw
- Evaluated alternatives to mitigate identified problems
- Completed a report documenting the baseline hydrology, hydraulics, problem areas, and alternatives analysis

## 1.3 Planning Process

Hydrology of the Sheep Draw watershed was previously updated in March 2006 for the *City of Greeley Comprehensive Drainage Plan* by Anderson Consulting Engineers, Inc. The baseline hydrology developed for this study represents an updated analysis for the entire Sheep Draw watershed using CUHP, version 2.0.1 and EPA SWMM, version 5.2.3. Further information regarding the hydrologic modeling process is included in Section 3.0. The goals and objectives of the MDP are to capture the existing conditions of the watershed to help prepare for future development and planning. By developing a baseline hydrology condition, a comparison can be made between the existing and future hydrology scenarios to determine current and future problem areas and inform solutions for targeted planning and improvement efforts.

The hydraulic evaluation of Sheep Draw was used to identify problem areas and potential future problem areas along Sheep Draw. Additionally, it will be used to identify the limits of the 100-year and 500-year floodplains as part of the LOMR. The alternatives analysis will be used to identify the recommended plan for improvements in the watershed.

A kickoff meeting was held on April 7, 2023 with the City of Greeley to discuss the project goals, hydrologic analysis, areas of concern, and potential alternatives. Meetings to discuss the hydrology comments, hydraulic modeling, and alternatives analysis were held throughout the study timeline. Meeting minutes are included in Appendix A.

## 1.4 Mapping and Surveys

The City of Greeley provided 3D Elevation Program, Quality Level 1 Light Detection and Ranging (3DEP QL1 LiDAR) for mapping the majority of Sheep Draw study limits; additional LiDAR (2018 3DEP East CO Block 2 QL2 North) was obtained from CWCB to supplement at the Sheep Draw watershed basin boundary. The combination of the two LiDAR sources listed above were used as the terrain surface for hydrologic and hydraulic calculations/models. Additionally, Olsson surveyed (May 8, 2023) crossing structures and flowlines along Sheep Draw to be used in the hydraulic evaluation. The LiDAR terrain surface and survey are referenced to the North American Vertical Datum (NAVD) 88 vertical datum and the North American Datum (NAD) 83 horizontal datum.

Weld County and the City of Greeley provided GIS files of city boundaries, parcels, parks, trails, railways, building footprints, street centerlines, ditches, detention ponds, zoning, storm sewer pipes and structures, and sanitary sewer pipes and structures, water pipes and structures in the watershed.

## 1.5 Data Collection

Drainage studies, as-built plans, and MDPs were collected from Greeley. The Weld County, Colorado and Incorporated Areas Flood Insurance Rate Maps (FIRMs) were obtained from the Federal Emergency Management Agency (FEMA). The key studies and plans that were reviewed in the preparation of this report are shown in Table 1.

**Table 1 – Data Collected**

| Title | Date | Author |
|---|---|---|
| City of Greeley Comprehensive Drainage Plan – Sheep Draw Basin | March 8, 2006 | Anderson Consulting Engineers, Inc. |
| Drainage Report for Boomerang Ranch First Filing | October 28, 1998 | Pickett Engineering Company |
| Pumpkin Ridge Subdivision Final Drainage Report | October 25, 2002 | Ketterling, Butherus and Norton Engineers, LLC. |
| Final Drainage Report for C St Roadway Improvements 59th to 66th Avenue | June 2023 | Olsson |
| Imagine Greeley Comprehensive Plan | February 6, 2018 | City of Greeley |

## 1.6 Acknowledgements

The MDP and LOMR were prepared with the cooperation of Greeley, Weld County, and ICON Engineering. The representatives who were involved with this study are listed in Table 2.

**Table 2 – Project Participants**

| Name | Representing | Assignment |
|---|---|---|
| Brian Fischer | Greeley | Project Manager |
| Brian Hathaway | Greeley | Floodplain Administrator |
| Mary Mateo | Greeley | Stormwater Engineer |
| Karen Reynolds | Greeley | Stormwater Manager |
| Aaron Stines | Greeley | Stormwater Engineer |
| Don Threewit | Greeley | City Planner |
| Karen Scopel | Greeley | Environmental Planner |
| Monique Perez | Greeley | Real Estate Specialist |
| Dave Wells | Greeley | City Engineer |
| Amy Gabor | Olsson | Project Manager |
| Michelle Danaher | Olsson | Project Engineer |
| Madison Stewart | Olsson | Engineer |
| Duke Douglas | Olsson | Assistant Engineer |
| Kiersten Rasmussen | Olsson | Assistant Engineer |
| Justen Hamann | ICON | Independent Reviewer |
| Melissa King | Weld County | Floodplain Management |
| Diana August | Weld County | Floodplain Management |

# 2. STUDY AREA DESCRIPTION

## 2.1 Project Area

### 2.1.1 Watershed and Drainageway Description

The 15.8-square-mile Sheep Draw watershed is the largest drainage basin in Greeley, outside of the Cache la Poudre River, of which it is tributary to. The Sheep Draw contributing drainage area is shown in Figure 1. The watershed generally slopes from the southwest to the northeast and is located within the city limits of Greeley and unincorporated Weld County. The western most limit of the watershed is approximately 1 mile west of the intersection of State Highway 257 and County Road 56. The southern most limit of the watershed is just south of 37th Street and State Highway 257. The eastern most limit is located northeast of B Street and North 51st Avenue. The northern most limit is bounded by the Cache la Poudre River between North 59th Avenue and North 67th Avenue. The Sheep Draw watershed is approximately 6.5 miles wide and 12 miles long. The watershed generally slopes northeast, with flow path slopes ranging from 0.11 to 2.6 percent (%). The lowest and highest watershed elevations are 4695 feet and 5054 feet, respectively.

### 2.1.2 Existing Detention Basins

No detention ponds were included in the baseline hydrology. The City of Greeley shows 28 City-owned detention basins within the Sheep Draw watershed. Of these 28 detention basins, the City had stage-storage-discharge information for five city-owned ponds, including: the Northridge Estates Subdivision, Pumpkin Ridge Subdivision Ponds A1-1, A2, and B, and the Boomerang Ranch Basin 1. The detention pond stage-area-discharge for these 5 detention basins is included in Table B-2A in Appendix B. Olsson performed a detention sensitivity analysis to determine the impact of all the detention basins throughout the watershed and found the City-owned detention ponds did not have much impact on the peak flows, and were therefore not included in the baseline hydrology. More detailed information on the detention sensitivity analysis is included in Section 3.4.

### 2.1.3 Irrigation Ditches

There are four irrigation ditches within the Sheep Draw boundary: Greeley No.3 Ditch, Boomerang Ditch, North Boomerang Extension, and Company Ditch. Two adjacent irrigation ditches include Grapevine Ditch and the Loveland and Greeley Canal.

In the northern portion of the watershed, Sheep Draw intersects Greeley No.3 Ditch, which transfers water from the Cache la Poudre River through Greeley. The canal enters the Sheep Draw watershed north of F Street at North 71st Avenue intersection and continues east towards North 59th Avenue. The canal was assumed to be full for the hydrologic and hydraulic analysis.

In the southwest portion of the watershed, Sheep Draw intersects Boomerang Ditch and North Boomerang Extension. The Boomerang Ditch crossing is southeast of the intersection of Highway 34 and Promontory Parkway. The North Boomerang Extension intersects Sheep Draw north of 90th Avenue underground and resurfaces north of the intersection of 10th Street and 80th Avenue. The Greeley No.3 Ditch was assumed to be full for the hydrologic and hydraulic analysis.

In the central east portion of the watershed, Company Ditch runs north south on the east side of 65th Avenue, crossing US Highway 34. Company Ditch does not intersect with Sheep Draw.

### 2.1.4 Planned Construction

Some significant developments were under construction at the time of this study. These developments were considered to be complete in the existing land use. Some of the areas considered were residential developments located east of Promontory Park, northwest of the 71st Avenue and Highway 34 intersection, and southeast of 4th Street and 71st Avenue. Other developments included Tointon Academy and Northridge Estates. Future land use and zoning was taken into account for potential future development, which is reflected in the future conditions. hydrology models.

### 2.1.5 Soils

Soil types were determined using the Natural Resources Conservation Service (NRCS) Web Soil Survey. Approximately 50% of the soils in the watersheds consist of hydrologic soils groups (HSG) A, which are generally characterized by high infiltration rates, as defined by the NRCS. Approximately 33% of the soils in the watersheds consist of hydrologic soils groups (HSG) B, which are generally characterized by moderate infiltration rates. The remaining area of the watersheds are HSG C and D soils, which are generally characterized by moderate and low infiltration rates, respectively. The soils map is included on Figure B-1 in Appendix B.

**Legend**

- Water Bodies
- Sheep Draw
- Basin Boundary
- Subbasin Boundary
- Weld County
- City Boundary
- Greeley Parcels
- XXX Streets

N

0 0.25 0.5 1 Miles

F ST
G ST
4TH ST
10TH ST
71ST AVE
59TH AVE
65TH AVE
83RD AVE
95TH AVE
US HWY 34 BUS
US HWY 34
STATE HWY 257
COUNTY ROAD 56
37TH ST
Sheep Draw

| | | | |
|---|---|---|---|
| PROJECT: 022-01690<br>DRAWN BY: ELB<br>DATE: 3/18/2024 | **CITY OF GREELEY** | **SHEEP DRAW MDP<br>STUDY AREA MAP** | FIGURE<br>1 |

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## 2.2 Land Use

The north half of the Sheep Draw watershed (north of Hwy 34) is mostly developed, with areas of land that remain undeveloped, primarily in south portions of the watershed. Existing development consists mostly of single-family residential and some multi-family residential developments. Pockets of industrial, commercial, and open space/recreational areas are also present. Existing land use was verified using aerial imagery.

Outside of the existing developed area, future land use will consist mostly of low-density residential areas, medium-density residential areas, pockets of commercial areas, industrial areas, mixed-use, and rural areas. Future land use information was obtained from Greeley zoning maps and the Imagine Greeley Comprehensive Plan, included in Appendix B. Additional discussion of land uses and corresponding percent impervious values is included in Section 3.3.

## 2.3 Reach Description

Table 3 summarizes the major crossing structure inventory for the major drainageways. Figure 2 shows the locations of the major crossing structures along the major drainageways. Sheep Draw is irregularly shaped and naturally meandering. The channel generally has a vegetated low flow channel with side slopes approximately 4:1. The channel appears to be generally stable, with flat to moderate slopes and fringe wetlands along the banks within the riparian corridor. The floodplain is narrow and incised in some areas, which may continue to worsen as the watershed continues to develop. Sheep Draw was broken into three hydraulic reaches, as described below.

### 2.3.1 Sheep Draw – Reach 1 (SD R1)

Reach 1 of Sheep Draw extends 2.9 miles from the confluence of the Cache la Poudre River to its upstream limit at the 71st Avenue Split reach. The upstream portion of the reach from the split flow to West 10th St is well vegetated with minimal lateral and longitudinal erosion. Halfway between W 10th St. and W 4th St, the main channel has an oxbow split east of the channel. The oxbow is not an official split reach along Sheep Draw. The reach area between W 10th St to W 4th St exhibit signs of minor bank erosion in multiple spots. The section of reach north of W 4th St has signs of minor to moderate bank erosion, stable vegetation and currently no exposed utilities. There is a significant cutbank approximately 665 feet due south of W C St. North of C St the inset low flow channel shallows and the floodplain widens. Channel vegetation is stable and consists mostly of native grasses and crops. The channel between the start of the overbanks consists mostly of grasses and non-wooded shrubbery. Toward the upper portions of the reach. The channel overbanks contain wooded vegetation such as trees, shrubs, and willows. Three Kinder Morgan 22” – 24” diameter steel gas lines cross Sheep Draw between C St and 4th St. These gas lines are large, high pressure, critical infrastructure and should be protected.

### 2.3.2 Sheep Draw – Reach 2 (SD R2)

Sheep Draw Reach 2 extends 0.2 miles from the downstream confluence with the 71st Ave Split reach to the upstream limit of the 71st Ave Split reach. The upstream end of the reach has signs of moderate bank erosion. Channel vegetation outside of the eroded areas is well established and stable. Channel vegetation consists of mostly grasses and trees within the channel banks. Near the halfway mark of the reach there is a pungent smell of sanitary infrastructure where the sanitary might be exposed nearby; however, there was no visual confirmation of exposure. Near the confluence with Sheep Draw Reach 1, the channel is incised. Moderate bank erosion and scouring exists upstream and downstream near the Sheep Draw Trail crossing.

### 2.3.3 Sheep Draw – Reach 3 (SD R3)

Sheep Draw Reach 3 extends 4.9 miles from the upstream end of the 71st Ave Split reach to the upstream limit of the study, near Weld County Road 56. Reach 3 is the longest of the hydraulic reaches. Reach 3 is generally stable and well vegetated, with some minor erosion. Channel vegetation consists of grasses. Within the channel banks there are areas of dense wetland vegetation. Sparse trees and woody vegetation inconsistently line the banks of the reach. There is ponding on the upstream of the crossing upstream of 71st Ave. Scouring exists downstream of the crossing upstream of 71st Ave. Between 77th Avenue and 71st Avenue, near the confluence with Triple Creek, Sheep Draw spills into a secondary flow path in the right overbank. Flow backs up at 95th Avenue and Highway 34 and spills onto the road in the major storm event. Upstream of Highway 34, Sheep Draw is adjacent to agricultural fields, which are expected to develop in the future. Approximately one mile downstream of the study limit, Sheep Draw is obstructed by berms, creating a ponding and wetland area.

### 2.3.4 71st Ave Split

The 71st Ave Split Flow reach is 0.2 miles long and heavily vegetated. Ponding exists near the Sheep Draw Trail area. The reach is well vegetated with minimal signs of lateral and longitudinal erosion. Channel vegetation is stable and well established, consisting of mostly grasses and trees within the channel banks.



**Photo showing the typical channel characteristics of Sheep Draw (typical all reaches).**

*FOR MAJOR STRUCTURE CROSSING INVENTORY SEE TABLE 3

**Legend**

- CANAL/DITCH CENTERLINE
- ROADS
- JURISDICTIONAL BOUNDARY
- WATER BODY
- WATERSHED BOUNDARY
- SHEEP DRAW STUDY LIMITS

STRUCTURE MODELED

- NO
- YES
- CITY OF GREELEY
- WELD COUNTY

N

0 750 1,500 3,000 Feet

WILLIAM A JONES DITCH
BOYD FREEMAN DITCH
CANAL 3 DITCH
N 71st Ave
C St
7th St
4th St
10th St
16th St
18th St
20th St
US Hwy 34
95th Ave
83rd Ave
71st Ave
66th Ave
State Hwy 257
37th St
LOVELAND GREELEY CANAL

1 2 3 4 5 6 7 8 N-1 9 9.5 10 11 12 N-2 13 14 15 16 17 18 19 20 21 22 23 N-3 N-4

| | | | |
|---|---|---|---|
| PROJECT: 022-01690 | **CITY OF GREELEY** | **SHEEP DRAW MASTER PLAN MAJOR CROSSING STRUCTURES** | FIGURE 2 |
| DRAWN BY: DD | | | |
| DATE: 3/2025 | | | |

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**Table 3 – Major Crossing Structures**

| Reach | Structure Survey Number | Station | Jurisdiction | Street Name | Street Classification | Existing Structure | Culvert Length/ Bridge Width (ft) | Source | Condition* |
|---|---|---|---|---|---|---|---|---|---|
| SD R1 | 1 | 101+20 | City of Greeley | Poudre River Trail | Trail | 84-inch CMP | 24.2 | Olsson survey | Fair – Culvert appears to be in good condition, but headwall connection to pipe has exposed rebar |
| | 2 | 113+25 | City of Greeley | Sheep Draw Nature Trail | Trail | 84-inch CMP | 40.72 | Olsson survey | Fair |
| | 3 | 113+70 | City of Greeley | Greeley No. 3 Ditch | N/A | Concrete canal weir RCBC | 19.62 | Olsson survey | Fair |
| | 4 | 126+00 | Weld County | N/A | N/A | Irrigation water crossing: 1.5-foot diameter utility poles on upstream side of 15-inch PVC. PVC extends beyond utility poles. | 3.34 | Olsson survey | Good |
| | 5 | 129+85 | Weld County | N/A | N/A | Access bridge with railing | 2.5 | Olsson survey | Good |
| | 6 | 131+00 | City of Greeley and Weld County | C Street | Local | Metal/wood bridge with railing | 28.18 | Olsson survey | Fair |
| | 7 | 180+75 | City of Greeley | Sheep Draw Trail | Trail | Double-barreled 36-inch CMP | 32.94 (L)/ 33.07 (R) | Olsson survey | Good |
| | 8 | 184+50 | City of Greeley | 4th Street | Minor Arterial | Concrete bridge with pier and railing | 70.14 | Olsson survey | Fair |
| | 9 | 201+45 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing | 11.21 | Olsson survey | Excellent |
| | 9.5 | 222+00 | City of Greeley | Sheep Draw Trail | Trail | Double-barreled 42-inch RCP | 28.42 (L)/ 28.38 (R) | As-Built | Excellent |
| | 10 | 224+50 | City of Greeley | 10th Street | Major Arterial | Concrete bridge with railing | 87.44 | Olsson survey | Good |
| | 11 | 225+25 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | 10.16 | Olsson survey | Good |
| | 12 | 230+80 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | 9.72 | Olsson survey | Good |
| SD R2 | 13 | 255+50 | City of Greeley | Sheep Draw Trail | Trail | 36-inch RCP | 38.67 | Olsson survey | Good |

**Table 3 – Major Crossing Structures**

| Reach | Structure Survey Number | Station | Jurisdiction | Street Name | Street Classification | Existing Structure | Culvert Length/ Bridge Width (ft) | Source | Condition* |
|---|---|---|---|---|---|---|---|---|---|
| SD R3 | 16 | 266+50 | City of Greeley | 71st Avenue | Minor Arterial | Concrete bridge with pier and railing | 68.87 | Olsson survey | Excellent |
| | 17 | 267+50 | City of Greeley | Sheep Draw Trail | Trail | 7' span by 3' rise RCBC | 38.74 | Olsson survey | Poor |
| | 18 | 298+40 | City of Greeley | Sheep Draw Trail | Trail | 46-inch CMP | 49.78 | Olsson survey | Good |
| | 19 | 337+50 | City of Greeley | 83rd Avenue | Major Arterial | Concrete bridge with pier and railing | 81.93 | Olsson survey | Good |
| | 20 | 366+40 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | 10.05 | As-built | Excellent |
| | 21 | 406+50 | City of Greeley | 95th Avenue | Local | 22' span by 5' rise RCBC | 75.14 | Olsson survey | Fair |
| | 22 | 412+00 | City of Greeley | Highway 34 | Highway | 26' span by 4' RCBC | 228.96 | Olsson survey | Poor |
| | 23 | 434+00 | City of Greeley | Private driveway | N/A | 48-inch CMP | 30.71 | Olsson survey | Fair |
| 71st Ave Split | 14 | 17+00 | City of Greeley | Sheep Draw Trail | Trail | Pedestrian bridge with 4.5' handrails and 30"x19" HERCP | 9.28 (Br)/ 40.82 (Culv) | LOMR As-built | Good |
| | 15 | 20+00 | City of Greeley | Sheep Draw Trail | Trail | 30"x19" HERCP | 52.84 | LOMR As-built | Good |
| Not Modeled | N-1, SD R1 | 186+08 | City of Greeley | Sheep Draw Trail | Trail | (2) 36-inch RCP | | Olsson survey | Highly inundated. Crossing not modeled. See Section 4 for more details. |
| | N-2, SD R3 | 275+95 | City of Greeley | Private trail access | N/A | 28-inch CMP (Deformed 30-inch) | | Olsson survey | Crossing size <36" and assumed clogged. Crossing not modeled. |
| | N-3, SD R3 | 444+80 | City of Greeley | Private driveway | N/A | 48-inch CMP | | Olsson survey | Smooshed pipe. Crossing not modeled. See Section 4 for more details. |
| | N-4, SD R3 | 459+56 | City of Greeley | Private driveway | N/A | 30-inch CMP | | Olsson survey | Crossing size <36" and assumed clogged. Crossing not modeled. |

*Conditions were determined by observation and review of existing site photos and information. Poor conditions are those where the structure was significantly inundated and the true state of the structure below the water levels is unknown. Fair conditions are those where there are visible defects in the structure, heavy vegetation blocking the structure entrance or exits, and/or come standing water in the structure. Good conditions are those where there are minimal visible defects in the structure and water flows through the structure, or no water exists within the structure. Excellent conditions are those where the structure appears to be new and water flows through the structure, or no water exists within the structure.

## 2.4 Flood History

The FIRMs show a FEMA-designated Zone AE floodplain with a 1-foot floodway from the Cache la Poudre River to north of Weld County Road 56. The FEMA FIRM panels are included in Appendix C. Greeley has documented high flows in July 2021 and August 2025. The following photos were provided by the City of crossings on Sheep Draw during the storms.



*Photo of storm flows at the 4th St Bridge July 1, 2021. Photo credit City of Greeley.*



*Photo of storm flows at the Pumpkin Ridge Bridge July 1, 2021. Photo credit City of Greeley.*



*Photo of storm flows at the 10th St  Bridge July 1, 2021. Photo credit City of Greeley.*



*Photo of storm flows at the 4th St Bridge August 2025. Photo credit City of Greeley.*

## 2.5 Environmental Assessment

Wetland and riparian zones within the Sheep Draw watershed primarily occur in riverine areas, freshwater ponds, or lakes. Areas where there is increased urbanization will be less likely to have wetland qualities. This information was acquired through the U.S. Fish & Wildlife Service's National Wetlands Inventory. See Appendix D for the delineation of wetlands in the study area.



*Photo showing the wetland areas along the riparian corridor.*

# 3. HYDROLOGIC ANALYSIS

## 3.1 Overview

Hydrology was developed for the baseline condition using existing infrastructure, for the existing and future (fully developed) land uses. The LOMR hydrology is based on existing land use conditions. Peak discharges for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year return period storms were analyzed using CUHP, version 2.0.1, to generate hydrographs for each subwatershed. Hydrographs for the subwatersheds were routed using EPA SWMM, version 5.2.3, to determine peak discharge rates at select design points. The updated EPA SWMM results were compared to the 2006 MDP. The hydrology comparison is detailed in Section 3.4 and shown in Appendix B Tables B-3A and B-3B.

## 3.2 Design Rainfall

The one-hour and 6-hour rainfall depths from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 were input into CUHP to model the watershed hydrology for each storm event and are shown in Table 4. One point, at the centroid of the watershed, was used to determine the rainfall depths for the entire watershed. The NOAA Atlas 14 rainfall information at the watershed centroid is included in Appendix B. Area adjustments per MHFD criteria were initially used for the minor events (2-, 5-, and 10-year storm events) with tributary drainage basins greater than 5, 10, and 15 square miles in the Sheep Draw watershed. Area adjustment factors were initially evaluated for the major events (25-, 50-, 100-, and 500-year storm events) with tributary drainage basins greater than 15 square miles. When area correction factors are applied, CUHP uses the 1-hour and 6-hour rainfall depths to determine an area corrected rainfall distributed over 2 hours. When area correction factors are not applied, CUHP distributes the 1-hour rainfall depth over a 2-hour distribution.

Once the factors were applied, the flow profiles were evaluated. The overall watershed is only 15.8 square miles and utilizing the 15 square mile adjustment resulted in flow decreases for the downstream portion of the watershed. Because the watershed is right on the 15 square mile threshold and there was not a reasonable way to eliminate the peak flow decreases downstream, the 15 square mile area correction factors were not used in the final model for any storm event. The future conditions minor events showed a slight decrease in the flow profile at the 5 square mile area adjustment. To smooth out the flow profiles, this correction factors were instead applied at the 5.5 square mile threshold. The existing conditions peak flow profiles showed a decrease in peak flows between 5 and 10 square miles, but the future conditions did not. No modifications to eliminate these decreases were completed. Area correction values from the final version of the model are included in Table 5. Tables of the unadjusted and adjusted rainfall distributions for each storm event are included as Tables B-1A through Tables B-1D, in Appendix B.

**Table 4 – One-Hour Rainfall (Inches)**

| Duration | 2-Year | 5-Year | 10-Year | 25-Year | 50-Year | 100-Year | 500-Year |
|---|---|---|---|---|---|---|---|
| 1-Hour | 0.849 | 1.12 | 1.4 | 1.87 | 2.29 | 2.76 | 4.10 |
| 6-Hour | 1.28 | 1.67 | 2.07 | 2.75 | 3.36 | 4.05 | 6.00 |

**Table 5 – Depth Reduction Factors for Design Rainfall Distributions**

| Time (minutes) | 2-, 5-, and 10-Year Design Rainfall | | | 25-, 50-, 100-, and 500-Year Design Rainfall |
|---|---|---|---|---|
| | Correction Factor by Watershed Area in Square Miles | | | |
| | 0 | 5.5 | 10 | 0 |
| 5 | 1 | 1 | 1 | 1 |
| 10 | 1 | 1 | 1 | 1 |
| 15 | 1 | 0.97 | 0.94 | 1 |
| 20 | 1 | 0.86 | 0.75 | 1 |
| 25 | 1 | 0.86 | 0.75 | 1 |
| 30 | 1 | 0.86 | 0.75 | 1 |
| 35 | 1 | 0.97 | 0.94 | 1 |
| 40 | 1 | 0.97 | 0.94 | 1 |
| 45 | 1 | 1 | 1 | 1 |
| 50 | 1 | 1 | 1 | 1 |
| 55 | 1 | 1 | 1 | 1 |
| 60 | 1 | 1 | 1 | 1 |
| 65-120 | 1 | 1 | 1 | 1 |

## 3.3 Subwatershed Characteristics

A summary of the CUHP model parameters can be found in Appendix B. LiDAR mapping, structure survey information, as-built drawings, and drainage studies were used to determine input parameters.

### 3.3.1 Subwatershed Delineation

The overall watershed boundaries were delineated using LiDAR and checked for general agreement with the previous Sheep Draw drainage study. Some delineations based on LiDAR were modified or verified using drainage studies and as-built information.

The Sheep Draw watershed was divided into 176 subwatersheds that were delineated based on the LiDAR mapping provided by Greeley (Section 1.4), the previous drainage studies, and as-built construction plans. Subwatershed boundaries reflect the major, 100-year, storm event conditions and do not include storm drain systems. The subwatersheds range in size from 1.84 acres to 138.83 acres, with an average subwatershed size of 57.41 acres. Two subwatersheds exceed the 130-acre limit. These two subwatersheds could not be further divided without resulting in undesirable subwatershed shapes.

Pursuant to MHFD policy, ditches and canals were assumed to be at full capacity for the baseline hydrology, meaning that stormwater runoff would flow over the canals. The subwatersheds are shown on Figure B-1 in Appendix B.

### 3.3.2 Length, Distance to Centroid, Slope

The LiDAR data was used to determine subwatershed flow path lengths, distance to centroid values, and slopes. Flow paths were based on major drainage overland paths. Where unmodeled detention basins were present, flow paths were determined based on the overflow path from the ponds, assuming the outlets would be clogged.

Subwatersheds were generally delineated to avoid shapes with elongated tails and very narrow and long shapes, which can skew the results. To check these two scenarios, the following equations were used:

r = Length to Centroid / Total Length
(if $0.1 \leq r < 0.3$, the subwatershed may have an elongated tail)

$r = Length^2 / Area$
(if $r > 4$, the subwatershed may be very narrow and long)

If the r value of a subwatershed indicated that it may have an elongated tail, or be very narrow and long, it was checked. Many of the subwatersheds in question did not have an elongated tail and were not long and narrow in shape. The questionable r values were generally a result of the nature of the urbanized portion of the watershed. Flow paths were generally delineated following streets, which resulted in longer paths rather than a more direct, undeveloped path. The subwatersheds with questionable r values had reasonable unit discharges, as compared to similar subwatersheds.

The Sheep Draw direct flow area of subwatersheds generally slope down toward the midline of the watershed, some basins flowing northwest and other southeast towards Sheep Draw. Subbasin flow path slopes ranged from 0.11 to 2.66%, averaging at 1.3%. The lowest and highest watershed elevations are 4695 feet and 5054 feet, respectively. Slopes were estimated using the weighted slope equation from the CUHP manual.

$$((L_1 s_1^{0.24} + \ldots + L_n s_n^{0.24}) / (L_1 + \ldots + L_n))^{4.17}$$

### 3.3.3 Watershed Imperviousness

The existing and future land uses are discussed in Section 2.2. For the historic conditions, a percent impervious value of 2% was used. To determine the existing conditions percent imperviousness, the National Land Cover Database (NLCD) was used. Several changes to the NLCD information were made to determine the existing percent imperviousness:

- The NLCD 0% imperviousness value used for water was changed to 100%
- All 0% NLCD values that were not water were changed to 2%
- The database was developed in 2021. Aerial imagery from 2021 was compared to 2023 aerial imagery to determine areas in the watershed that developed after the database was compiled. These areas of post-2021 development were factored into the existing conditions percent imperviousness calculations.
- Several developments were under construction at the time of this study. These areas of development were factored into the existing conditions percent imperviousness calculations using the corresponding impervious values shown in Table 5.

After the aforementioned changes were made to the NLCD percent imperviousness values, the percent impervious values were checked for accuracy and were determined to be acceptable. The overall existing percent imperviousness of the watersheds is 18%. The existing percent impervious values for each subbasin are shown on Figure B-1 in Appendix B.

For informational purposes, the future land use hydrology was also evaluated. To determine appropriate future land use percent imperviousness values in the undeveloped portions of the watershed, Greeley's zoning descriptions and MHFD's Urban Storm Drainage Criteria Manual (USDCM) Table 6-3: *Recommended Percentage Imperviousness Values* were used. The future land use areas are shown on Figure B-1 in Appendix B. The future land use designations and corresponding percent imperviousness values are shown in Table 6. Greeley zoning has two unspecified impervious value categories: Holding Agricultural and Planned Unit Development. The future percent impervious values for these areas were determined using the Imagine Greeley Comprehensive Plan. The future percent imperviousness values were deemed appropriate by the project sponsors for master planning purposes, but do not replace zoning requirements for future development. Future development will be required to follow jurisdictional zoning requirements and associated percent imperviousness values. The overall future percent imperviousness of the watersheds was estimated to be 38.7%. The future percent impervious values for each subbasin are shown on Figure B-1 in Appendix B.

**Table 6 – Land Uses and Corresponding Impervious Values**

| Zoning | Percent Imperviousness | Notes |
|---|---|---|
| Conservation District (C-D) | Existing (NLCD) | |
| Commercial High Intensity (C-H) | 95 | |
| Commercial Low Intensity (C-L) | 75 | |
| Holding Agricultural (H-A) | 12-85 | Holding agricultural area values are based on Imagine Greeley Comprehensive Plan. |
| Industrial High Intensity (I-H) | 90 | |
| Industrial Low Intensity (I-L) | 80 | |
| Industrial Medium Intensity (I-L) | 85 | |
| Mixed Use High Intensity | 85 | Mixed use high intensity areas based on Imagine Greeley Comprehensive Plan. |
| Mixed Use | 75 | Mixed use based on Imagine Greeley Comprehensive Plan. |
| Planned Unit Development (PUD) | 60-75 | Used aerial verification and zoning where development is being constructed |
| Residential Estate (R-E) / Rural | 12 | Rural areas based on Imagine Greeley Comprehensive Plan. |
| Residential High Density (R-H) | 75 | |
| Residential Low Density (R-L) | 30 | |
| Residential Medium Density (R-M) / Suburban | 45 | Suburban areas based on Imagine Greeley Comprehensive Plan. |

### 3.3.4 Depression Losses

Depression losses were determined using Table 6-6: *Typical Depression Losses for Various Land Covers* in the USDCM. A weighted average was used for the depression losses in each subbasin, based on land use designation and qualitative, visual analysis. A pervious depression loss of 0.35 inches, which represents areas that have been graded to drain such as lawns and parks, was used for the developed portions of the watershed, and a value of 0.4, which represents open fields, was used for the undeveloped portions of the watershed. An average of an impervious depression loss of 0.05, which represents sloped roofs, and 0.1, which represents large, paved areas, was used for residential areas. A value of 0.1, which represents flat roofs and large, paved areas, was used for commercial, office, and industrial areas. Weighted averages of the depression losses were calculated based on land use in each subbasin. Depression loss calculations are included in Appendix B.

### 3.3.5 Infiltration

Initial and final infiltration rates and Horton's decay rates were determined using Table 6-7: *Recommended Horton's Equation Parameters* in the USDCM and are shown in Table 7. A weighted average of soil type was used to determine subwatershed rates; calculations are included in Appendix B. The hydrologic soil groups are shown on Figure B-1, in Appendix B.

**Table 7 – Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) | | Decay Coefficient |
|---|---|---|---|
| | Initial | Final | |
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

## 3.4 Detention

No detention ponds were included in the baseline hydrology. This section summarizes the detention pond sensitivity analysis that was completed to help determine if, or what, detention should be included or not. Pursuant to FEMA's policy to recognize only regional and publicly owned facilities, all private detention basins, irrigation reservoirs, and inadvertent detention areas were not modeled. However, a sensitivity analysis was performed using seven SWMM model scenarios to analyze the impact that the City-owned and privately owned ponds that were previously included throughout the watershed have on peak flows in Sheep Draw, shown in Figure 3. Detention basins to be included in the model were discussed during the January 4, 2024, progress meeting. This list was refined over e-mail conversations ranging from the meeting through January 24, 2024. Following the draft submittal, a meeting was held on March 1, 2024 to discuss the Hydrology Conditional Letter of Map Revision (CLOMR) submittal and it was discussed that operations and maintenance plans, and agreements showing the ponds should be used for detention would be needed for the CLOMR. The City had only partial information and the City-owned ponds had very little impact on the peak flows. Therefore, it was decided that all detention ponds would be removed from the model for the baseline condition. Minutes for this meeting can be found in Appendix A.

The 2006 MDP modeled 40 detention storage areas. Of those 40, three of the detention storage areas modeled were outside the watershed boundary for this study and only 6 contained adequate stage-storage-discharge information. Using a combination of data from development studies and the previous 2006 Sheep Draw drainage study, seven scenarios were compared using the existing conditions 100-year peak flows:

- Scenario 1A approximates the 2006 detention basins. To simplify this scenario, the 6 detention ponds (yellow detention pentagons in Figure B-3, Appendix B)that had stage-area-discharge curves in the 2006 study were included in the model, and the remaining detention ponds (purple and green detention pentagons in Figure B-3, Appendix B), that only had two point curves with 0,0 being the first point, were modeled by disconnecting the upstream tributary area and using a lateral inflow equal to the maximum shown in the 2006 study. The 2006 storage-discharge points are shown in Table B-2B in Appendix B. The results of this analysis are slightly higher as compared to modeling the two-point stage-storage-discharge curves previously modeled.
- Scenario 1B used Scenario 1A as a baseline but incorporated the 5 City ponds from Scenario 3, summarized below, (green circles in Figure B-3, Appendix B). Three of these City ponds overlapped with Scenario 1A ponds, and the updated information was used,

and 2 were ponds in addition to Scenario 1A. The ponds with the updated stage-storage information are called out on Figure B-3, Appendix B.

- Scenario 2 used existing stage-storage-discharge data provided from Greeley for 5 ponds, as well as the stage-storage-discharge data from the 2006 Sheep Draw drainage study for 6 ponds that had adequate data (green circles and yellow detention pentagons in Figure B-3, Appendix B).
- Scenario 3 used existing stage-storage-discharge data provided from Greeley for 5 City-owned and maintained ponds (green detention pentagons in Figure B-3, Appendix B). The stage-area discharge information for the five City-owned ponds is included in Table B-2A in Appendix B. The five city-owned ponds in Scenario 3 includes data from the following sources:
    - Final Drainage Report for C St Roadway Improvements 59th to 66th Avenue – prepared by Olsson
    - Pumpkin Ridge Subdivision Final Drainage Report (October 25, 2002) – prepared by Ketterlin, Butherus and Norton Engineers, LLC.
    - Drainage Report for Boomerang Ranch First Filing (October 28, 1998) – prepared by Pickett Engineering Company
- Scenario 4 used existing stage-storage-discharge data provided from Greeley for 5 ponds, as well as inflows from 2006 for 8 City-owned ponds (green circles and remaining green detention pentagons in Figure B-3, Appendix B). Some of the peak flow locations in this scenario ended up higher than Scenario 3, which is likely due to straight adding in a peak flow without accounting for timing. If we added these in as detention with curves, the results may be higher or lower, depending on that timing, but would likely remain similar to the results included herein.
- Scenario 5 used existing stage-storage-discharge data provided from Greeley for 5 ponds, inflows from 2006 for 8 City-owned ponds, and 4 additional City ponds to model all City ponds (green circles, remaining green detention pentagons, and cyan ponds in Figure B-3, Appendix B). The 4 additional City ponds had their SWMM links detached from the downstream node to give a high-level measure of each pond's impact on Sheep Draw peak flows.
- Scenario 6 targeted City-owned ponds that had larger impacts on the peak flows to narrow in on what ponds may be beneficial to incorporate additional information. These detention basins do not significantly reduce the peak flows and are not recommended for inclusion in the model.
- Scenario 7 evaluated the peak flows if no detention was included in the model. This scenario decreased some peak flows slightly as compared to Scenario 3. Detention lower in the watershed can end up causing increases in peak flows due to the detained peak flows aligning with the time to peak along the mainstem.

Each scenario was run with the 100-year, existing conditions flows. Six locations were used as comparison points for the sensitivity analysis. A summary of the sensitivity analysis results can be found in in Table B3-B in Appendix B. In general, detention north of US 34 did not appear to significantly impact the peak flows. The six private detention ponds upstream of US 34 had a significant impact on peak flows but are not recommended for inclusion since they are not owned and maintained by the City of Greeley.

Scenario 7, no detention, was selected as the basis for this study. All results herein, reflect the peak flows resulting from this Scenario.

## 3.5 Hydrograph Routing

The parameters for the EPA SWMM model conveyance elements were determined using LiDAR data, as-built drawings, and drainage reports. Some conveyance elements in the SWMM model contain short and steep sections. The slope used for the conveyance element in the model reflects the actual slope of the ground between drop structures and not the calculated slope between two design points. To adjust the slope in the SWMM model, the drops were modeled in EPA SWMM as one large drop at the downstream end of the conveyance element using an outlet offset.

Dummy links were used in the model where flows from multiple subbasins joined at a single location. At dummy links, the inlet and outlet nodes are the same elevation which would normally result in a warning regarding the zero slope. To remove this warning, the dummy links were assigned a length of 10 feet and an inlet offset of 0.01 ft to provide a minimum slope of 0.001 ft/ft. If inlet offsets were not assigned to each dummy link, the model would automatically assign the links with the minimum slope of 0.001 ft/ft. The model results are identical between the two approaches.

Channel geometry was determined using the LiDAR terrain, creating an irregular transect in SWMM of a representative section for each SWMM link. For flows that are conveyed via streets, the street sections were models as one of three typical sections:

1. 2-Lane-Full:
    a. full street, width = 40ft
    b. curb = 0.5ft
    c. cross-slope = 0.02ft/ft
    d. bank-slope = 0.02ft/ft
    e. bank-height = 1ft
2. 4-Lane-Full:
    a. Full street, width = 60ft
    b. curb = 1ft (increased to contain 500-year flows)
    c. cross-slope = 0.02ft/ft
    d. bank-slope = 0.02ft/ft
    e. bank-height = 2ft

3. 4-Lane-Half
    a. Half street, width = 30ft
    b. curb = 1ft (increased to contain 500-year flows)
    c. cross-slope = 0.02ft/ft
    d. bank-slope = 0.02ft/ft
    e. bank-height = 2ft

The Manning's n values for engineered conveyance elements, including pipe and street, were increased 25 percent in accordance with the USDCM. Manning's n values are representative of actual channel conditions and vegetation. The below photo shows typical channel conditions and vegetation referenced for justification of Manning's n values. Street section Manning's n values were set at 0.016, or 0.02 in the model. Channel section Manning's n values were typically set at 0.05 and 0.06 in the model.



*Photo showing the typical channel conditions and vegetation of Sheep Draw*

A 6-hour SWMM run-time is used in the hydrologic analysis because that is what is shown in the CUHP manual and is recommended by MHFD. This run-time is recommended in the City of Greeley Storm Drainage Design Criteria and Construction Specifications.

The EPA SWMM 5.2.3 input parameters and 100-year existing and future conditions output are included in Appendix B. EPA SWMM 5.2.3 model elements, including subwatersheds, design points and conveyance elements are shown on Figure B-1 and a schematic of the model is shown on Figure B-2A through B-2D in Appendix B.

## 3.6 Previous Studies

Sheep Draw was previously studied in full by Anderson Consulting Engineers, Inc. in 2006. The previous study consisted of hydrologic and hydraulic analyses and a floodplain with floodway map update. The previous study used CUHP and EPA SWMM to model peak flows in the watershed. Comparisons between the effective flows listed in the FIS report and the updated existing conditions flows are shown in Table **8**.

In order to help validate flows, a comparison of 100-year peak flows between this study and the 2006 MDP is shown in Table B3 in Appendix B. Differences and similarities between these studies are noted below.

- The 2006 MDP used CUHP (1982) and EPA SWMM 2003. This study used CUHP 2.0.1 and SWMM 5.2.3 for the baseline hydrology. MHFD underwent a calibration effort of CUHP in 2015. The results of the calibration typically resulted in lower peak flows as compared to previous versions.

- The 2006 MDP used one-hour rainfall values from NOAA Atlas 2, Vol. 3 Colorado (1973) to develop a 3-hour design storm hyetograph. This study used NOAA Atlas 14, Vol. 8, Version 2 to develop a 2-hour design storm. Area correction factors were applied for minor events in this study, as described in Section 3.2.

- The composite existing percent imperviousness of the previous studies was approximately 13.5%, which is lower than this study's existing percent imperviousness of 18.4%.

- The 2006 MDP included 40 detention basins, most of them privately owned. Only 6 of the detention basins, which are privately owned, had detailed stage-storage-discharge information. This study does not have any detention ponds modeled.

In order to better compare the hydrology from this study to the previous studies, reconcile the differences, and determine if calibration was necessary, modifications were made to the baseline hydrology to better align with the previous study. Scenario 1A, as described in Section 3.4, was used as a basis of the analysis. Modifications to the CUHP model were completed only in an effort to better align with the 2006 study. These modifications included:

1. Updating the rainfall to utilize the hyetograph from the 2006 Sheep Draw drainage study.

2. Update select percent impervious values to better align with the 2006 percent impervious values.

The peak flows in the Scenario 1A model that was modified to better align with the 2006 rainfall and percent imperviousness to better reconcile peak flow differences resulted in lower peak flow than the 2006 effective model. The difference in peak flows for the modified Scenario 1A (Olsson's 2024 model with 2006 parameter inserted) ranged from 24% lower to 3% lower, as compared to the 2006 study when

these factors were applied, as shown in Table B3-B under the column heading “2006 Rainfall and Approximate Imperviousness” in Appendix B. The differences are reasonable, and no calibration is recommended for the peak flows in this study.

To further validate the updated hydrology included herein, three other comparisons were completed, listed in Table 9. The first peak flow comparison looked at modeling the entire Sheep Draw basin using area average CUHP parameters for a single basin. The second comparison split the Sheep Draw basin into two subbasins based on the more undeveloped upstream area at U.S. Highway 34 and the more developed lower subbasin, using the area-average CUHP parameters for each subbasin. The CUHP flows for the two basins were then routed in the baseline SWMM model. The third peak flow comparison used Stream Stats; a tool developed by the USGS that automatically develops basin parameters to calculate peak flows. These additional studies help contextualize the results reported from this hydrology analysis but are much less accurate. The differences are reasonable, and no calibration is recommended for the peak flows in this study.

**Table 8 – Effective and Updated Existing Conditions Flow Comparison**

| Location Description from the FIS Report | 2024 Hydrology | | 2006 Effective | 2024 Hydrology | | | |
|---|---|---|---|---|---|---|---|
| | | | | Existing Conditions Peak Flow (cfs) | | | |
| | Design Point | Drainage Area (sm) | Existing 100-Year Peak Flow | 10% Annual Chance | 2% Annual Chance | 1% Annual Chance | 0.2% Annual Chance |
| At upstream side of Greeley No. 3 Ditch | 104 | 15.5 | 4,673 | 512 | 3,445 | 5,715 | 12,014 |
| At upstream side of C Street | 105 | 15.4 | 4,596 | 515 | 3,466 | 5,746 | 12,062 |
| Downstream of Hunter's Cove Detention Pond | 110 | 14.9 | 4,556 | 502 | 3,468 | 5,739 | 12,010 |
| Downstream of Summer Park Detention Pond | 112T | 14.6 | 4,558 | 503 | 3,479 | 5,762 | 12,076 |
| At upstream side of 4th Street | 113 | 14.6 | 4,502 | 499 | 3,479 | 5,762 | 12,071 |
| Downstream of HP Detention Pond | 122 | 14.0 | 4,436 | 462 | 3,440 | 5,688 | 11,843 |
| At upstream side of 10th Street | 124 | 13.8 | 4,425 | 451 | 3,433 | 5,669 | 11,776 |
| Tributary Inflow (Downstream of 71st Avenue) | 152 | 11.1 | 4,216 | 282 | 3,060 | 5,054 | 10,321 |
| Tributary Inflow (River Station 17237) | 154T | 10.7 | 3,756 | 281 | 3,070 | 5,059 | 10,318 |
| Tributary Inflow (Upstream of 77th Avenue) | 154T | 10.7 | 3,743 | 281 | 3,070 | 5,059 | 10,318 |
| Tributary Inflow (River Station 20280) | 154 | 9.6 | 3,506 | 237 | 2,892 | 4,766 | 9,616 |
| Downstream of 83rd Avenue | 170T | 9.4 | 3,494 | 231 | 2,874 | 4,735 | 9,516 |
| Tributary Inflow (River Station 23334) | 172 | 9.3 | 3,491 | 219 | 2,857 | 4,710 | 9,462 |
| Downstream of Mountain Shadows Detention Pond | 176 | 8.9 | 3,304 | 182 | 2,797 | 4,607 | 9,219 |
| Downstream of Pebble Brook Detention Pond | 186T | 8.4 | 3,185 | 159 | 2,736 | 4,490 | 8,892 |
| Left Bank Tributary Inflow | 187 | 8.4 | 3,176 | 156 | 2,733 | 4,486 | 8,880 |
| Downstream of 95th Avuenue | 193T | 7.8 | 3,055 | 144 | 2,659 | 4,310 | 8,443 |
| Upstream of 95th Avenue | 198 | 7.4 | 2,585 | 142 | 2,596 | 4,185 | 8,143 |
| Upstream of U.S. Highway 34 Bypass | 1123 | 5.1 | 2,498 | 244 | 1,925 | 3,045 | 5,779 |
| At Confluence with Irrigation Reservoir No. 2 | 1128 | 4.8 | 2,028 | 241 | 1,875 | 2,941 | 5,529 |
| Outflow from Irrigation Reservoir No. 1 | 1136 | 4.1 | 1,597 | 229 | 1,724 | 2,664 | 4,950 |
| Inflow from Irrigation Reservoir No. 1 | 1149 | 3.0 | 1,638 | 196 | 1,331 | 2,015 | 3,683 |
| Upstream Limit of Study | 1169 | 0.9 | 872 | 83 | 473 | 695 | 1,223 |

**Table 9 – 100-Year Flow Comparison**

| Study | Study Description | Basin Description | Design Point | Basin Area (Sq. Mi) | Peak Flow (cfs) | % Difference from 2024 Baseline |
|---|---|---|---|---|---|---|
| 1 | CUHP | Entire Basin | 100 | 15.8 | 4,439 | -23% |
| 2 | CUHP | Entire Basin | 100 | 15.8 | 4,752 | -17% |
| | | Upper Basin | 189 | 8.3 | 3,477 | -22% |
| 3 | Stream Stats | Entire Basin | 100 | 15.4 | 7,510 | 30% |
| | | Upper Basin | 189 | 8.5 | 4,860 | 9% |
| 4 | Baseline | Entire Basin | 100 | 15.8 | 5,757 | 0% |
| | | Upper Basin | 189 | 8.3 | 4,459 | 0% |

## 3.7 Results of Analysis

In general, the peak flows from the baseline hydrology are higher than the previous study. The increase in peak flow can be mostly attributed to the differences in detention basins modeled, different rainfall values and distributions, and higher percent imperviousness values in this study, as discussed in Section 3.6. The baseline peak discharges and volumes for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year storm events for all the EPA SWMM 5.2.3 design points can be found in Tables B-4 and B-5, respectively, in Appendix B. The peak discharges and volumes versus channel station for each drainageway are shown in Tables B-6 and B-7 and are also shown in Figures B-4A and B-4B. Select SWMM generated hydrographs are included as Figure B-5 in Appendix B

# 4. HYDRAULICS

## 4.1 Analysis Method

The U.S. Army Corps of Engineers' Hydrologic Engineering Center River Analysis System (HEC-RAS) version 6.4.1 was used to develop the baseline hydraulic/LOMR model.

### 4.1.1 Existing Conditions Model Development

Cross sections for the HEC-RAS model were developed using AutoCAD Civil3D and 1-foot interval 2023 LiDAR data. Survey data was collected by Olsson at all major bridges, culverts, and grade control structures. Additionally, ten (10) cross sections were surveyed at various locations and thalweg elevations were surveyed every 400-feet along Sheep Draw. Survey data was used to supplement the LiDAR data and is noted at various cross sections in the HEC-RAS model. Thalweg elevations were used to modify the surface associated with the 1-D geometry. Points were projected onto the Sheep Draw centerline and "burned into" the LiDAR surface with a 5-ft bottom width and 2 to 1 side slopes to meet the LiDAR surface. Generally, all thalweg elevations used to supplement the LiDAR data was below the LiDAR surface. Cross sections were set upstream and downstream of all major crossings and grade control structures at intervals spaced no greater than 400 feet of stream length apart and maintaining a difference in water surface elevation (WSE) less than 10 feet between cross sections where the channel is steep, uniform, and confined. Because much of the Sheep Draw floodplain is wide and flat, 2D modeling was used to inform cross section orientation. Cross section orientation was previously reviewed by ICON Engineering, Inc. Comment responses are attached. Cross sections were laid out so that a consistent water surface elevation spans across the entire cross section while maintaining perpendicularity with topography contours. Bank stations were set below the 100-year storm WSE and were typically in the low flow channel. Bank stations were identified based on changes in the cross section geometry and to provide reasonable horizontal and vertical continuity.

## 4.2 Input Parameters

### 4.2.1 Downstream Boundary Conditions

A normal depth slope of 0.31% was used at the downstream boundary condition which is based on the observed downstream channel slope.

### 4.2.2 Steady Flows

Existing and future (developed) flows were calculated during the 2024 hydrology update by Olsson. Existing conditions flows have been submitted to the Federal Emergency Management Agency (FEMA) through the CLOMR process. The LOMR model is based on the existing flow conditions. Future flows were used for the development of the alternatives analysis to provide watershed improvement recommendations. Flows used in the steady flow analysis are summarized in Table 10.

**Table 10 – Steady Flow Summary**

| Design Point | HEC-RAS Station | $Q_2$ (cfs) Ex/Fut | $Q_5$ (cfs) Ex/Fut | $Q_{10}$ (cfs) Ex/Fut | $Q_{25}$ (cfs) Ex/Fut | $Q_{50}$ (cfs) Ex/Fut | $Q_{100}$ (cfs) Ex/Fut | $Q_{500}$ (cfs) Ex/Fut |
|---|---|---|---|---|---|---|---|---|
| 1169 | 52501 | 3/134 | 11/202 | 83/315 | 311/618 | 473/836 | 695/1,100 | 1,223/1,807 |
| 1153 | 51964 | 6/147 | 20/233 | 160/423 | 693/1,037 | 1,084/1,490 | 1,631/2,084 | 2,957/3,590 |
| 1149 | 48647 | 13/280 | 32/425 | 196/677 | 849/1,467 | 1,331/2,052 | 2,015/2,825 | 3,683/4,798 |
| 1136 | 47211 | 16/320 | 38/496 | 229/806 | 1,071/1,827 | 1,724/2,601 | 2,664/3,647 | 4,950/6,316 |
| 1127T | 45123 | 17/344 | 40/530 | 241/859 | 1,146/1,975 | 1,880/2,845 | 2,953/4,039 | 5,566/7,091 |
| 1125 | 43802 | 17/359 | 40/552 | 242/889 | 1,160/2,025 | 1,909/2,917 | 3,007/4,139 | 5,687/7,287 |
| 1123 | 42350 | 17/370 | 41/567 | 244/907 | 1,167/2,053 | 1,925/2,960 | 3,045/4,206 | 5,779/7,418 |
| 1113 | 41100 | 57/413 | 82/646 | 244/907 | 1,350/2,398 | 2,196/3,437 | 3,461/4,871 | 6,589/8,639 |
| 198 | 40860 | 58/493 | 84/760 | 244/1,051 | 1,558/2,840 | 2,596/4,129 | 4,185/5,942 | 8,143/10,685 |
| 193T | 40465 | 61/531 | 89/812 | 244/1,119 | 1,587/2,951 | 2,659/4,289 | 4,310/6,163 | 8,443/11,128 |
| 189 | 39206 | 78/561 | 112/854 | 244/1,170 | 1,613/3,040 | 2,721/4,452 | 4,459/6,411 | 8,799/11,654 |
| 185 | 38151 | 79/572 | 115/869 | 244/1,190 | 1,620/3,078 | 2,741/4,513 | 4,503/6,510 | 8,931/11,870 |
| 176 | 35696 | 88/609 | 130/921 | 244/1,257 | 1,648/3,162 | 2,797/4,636 | 4,607/6,696 | 9,219/12,252 |
| 172 | 34635 | 106/628 | 156/950 | 244/1,298 | 1,681/3,228 | 2,857/4,737 | 4,710/6,849 | 9,462/12,574 |
| 168 | 33550 | 111/636 | 165/963 | 244/1,317 | 1,698/3,262 | 2,889/4,782 | 4,757/6,920 | 9,582/12,715 |
| 167T | 30553 | 111/638 | 167/966 | 244/1,322 | 1,697/3,265 | 2,893/4,791 | 4,768/6,935 | 9,616/12,756 |
| 154T | 29868 | 133/663 | 202/973 | 281/1,322 | 1,799/3,471 | 3,070/5,090 | 5,059/7,378 | 10,318/13,663 |
| 154T* | 26510 | 101/285 | 132/394 | 161/527 | 706/1,298 | 1,152/1,944 | 1,925/2,932 | 4,398/6,091 |
| 154T* | 26165 | 101/284 | 132/391 | 161/519 | 689/1,156 | 1,053/1,508 | 1,485/1,881 | 2,157/2,447 |
| 142T* | 25737 | 121/226 | 151/290 | 184/357 | 416/621 | 558/812 | 810/1,043 | 1,067/1,122 |
| 142T | 25407 | 167/719 | 256/1,050 | 368/1,421 | 1,897/3,672 | 3,275/5,408 | 5,409/7,847 | 11,130/14,772 |
| 124 | 23660 | 201/760 | 308/1,105 | 450/1,499 | 1,966/3,822 | 3,433/5,646 | 5,669/8,227 | 11,775/15,622 |
| 121T | 21662 | 212/768 | 330/1,118 | 471/1,519 | 1,973/3,848 | 3,455/5,691 | 5,714/8,303 | 11,910/15,806 |

| Design Point | HEC-RAS Station | $Q_2$ (cfs) Ex/Fut | $Q_5$ (cfs) Ex/Fut | $Q_{10}$ (cfs) Ex/Fut | $Q_{25}$ (cfs) Ex/Fut | $Q_{50}$ (cfs) Ex/Fut | $Q_{100}$ (cfs) Ex/Fut | $Q_{500}$ (cfs) Ex/Fut |
|---|---|---|---|---|---|---|---|---|
| 113 | 18608 | 223/779 | 352/1,131 | 496/1,538 | 1,981/3,878 | 3,478/5,747 | 5,762/8,393 | 12,071/16,024 |
| 105 | 13221 | 226/779 | 357/1,136 | 512/1,547 | 1,981/3,883 | 3,478/5,751 | 5,762/8,370 | 12,062/16,127 |
| 100 | 10900 | 226/779 | 357/1,136 | 510/1,547 | 2,059/3,888 | 3,478/5,760 | 5,757/8,419 | 12,117/16,237 |
| 154T* | 2060 | 33/379 | 70/580 | 121/795 | 1,094/2,174 | 1,918/3,146 | 3,135/4,446 | 5,920/7,573 |
| 154T* | 1737 | 33/380 | 70/583 | 121/803 | 1,111/2,316 | 2,017/3,582 | 3,575/5,497 | 8,191/11,217 |
| 142T* | 1200 | 47/493 | 105/760 | 184/1,064 | 1,482/3,051 | 2,718/4,596 | 4,600/6,804 | 10,063/13,650 |

*Steady flows at split were determined using flows from an optimized run along the lateral structures and upstream junction between the 71st Avenue Split and Sheep Draw, Reach 2 cross sections.

### 4.2.3 Manning's n Values

Manning's "n" values were determined based on field observation and aerial photography. Manning's "n" values for each cross section were generated using RASMapper. A high Manning's "n" value was used to represent developed areas rather than using more typical values and blocked obstructions for buildings. This approach better models the impact of obstructions like fences, landscaping, and cars, while also incorporating the impact of buildings. Manning's "n" values delineated in the map layer are summarized in Table 11.

**Table 11 – Manning's "n" Summary**

| Land Description | Manning's "n" Value | Meaning |
|---|---|---|
| NoData** | 0.05 | Grasses and non-woody materials |
| Channel Bottom | 0.035 | Unvegetated, silty or rocky bottom |
| Light Development | 0.15 | Low density residential areas (larger land plots), sports fields, industrial areas |
| Medium Development | 0.2 | Single family residential areas (smaller land plots) typically beginning at fence lines |
| Heavy Development | 0.2 | Multi-family residential areas, commercial areas |
| Dense Vegetation | 0.07 | Dense tree stands, woody materials |
| Medium Vegetation | 0.06 | Sparse tree stands, tall grasses, woody and non-woody materials |
| Agriculture | 0.04 | Tilled fields used for farming |
| Split Rail Fence | 0.07 | Split rail fence perpendicular to the floodplain |

**NoData value used for all land outside of the other categories. Typically used for light vegetation and grassed areas.

### 4.2.4 Junctions

Junctions were used in the model at the Sheep Draw – R3 and 71st Avenue Split confluence and the 71st Avenue Split and Sheep Draw – R1 confluence. The energy equation computation mode was used at the junctions. Sheep Draw – R2 and the 71st Avenue Split begin to spill into each other near 71st Avenue. The junction was optimized along with the downstream lateral structure to determine the flow splits between the two reaches in this location. The flows were then input into the hard coded model, which does not optimize the junction or the later structures. A gutter line was added to the floodplain mapping to differentiate the Sheep Draw – R2 and 71st Avenue Split cross sections.

### 4.2.5 Expansion and Contraction Coefficients

Generally, the contraction and expansion coefficients for cross sections were 0.1 and 0.3, respectively. At cross sections immediately upstream and downstream of the crossing structure and the second cross section upstream of crossing structures, the contraction and expansion coefficients were changed to 0.3 and 0.5, respectively.

At select locations, the expansion and contraction coefficients were raised where there is significant horizontal or vertical expansion/contraction in order to reduce or eliminate drawdowns greater than 0.5 feet in the 100-year profile. Notes are included in the cross section descriptions within the model where they were increased.

## 4.3 Structure Modeling Approach

The techniques used to model major crossing structures are summarized below.

### 4.3.1 Cross Section Orientation and Spacing

Cross sections immediately upstream and downstream of the crossing structure were typically oriented perpendicular to the channel at the low flow channel. Second cross sections upstream and downstream of the crossing structure were typically spaced at a distance that would allow flow to expand or contract so that flow through the second cross sections were not affected by the structure. In some areas, enough space was not available between crossing structures to allow for the second cross section flow to avoid being affected by the crossing structure. In these areas, ineffective flow areas were applied to the second cross sections.

Cross sections at the structures were generally oriented to avoid crossing the roads or trails, with select exceptions. Exceptions were taken where the majority of flow overtops and there is insignificant approaching roadway/trail embankment in the floodplain, in order to more accurately model the floodplain.

Bounding cross sections were typically located outside of the limits of the wingwalls, with an exception upstream of Highway 34. An exception was made in this case because the channel curves into the structure and a perpendicular cross section outside of the wingwalls would place the bounding cross section too far from the structure face.

#### 4.3.2 Excluded Crossings

Crossings with diameters of less than 36 inches were typically not modeled, as noted in Table 3. In these cases, a blocked obstruction was added to the upstream cross section up to the road/path overtopping elevation. Along the 71st Avenue split, two HERCP with round equivalents of 24 inches are modeled to remain consistent with the FIS modeling approach.

Additional low flow crossings were excluded at select locations, including crossings at stations 444+80 and 186+08. At station 444+80, the surveyed 48-inch corrugated metal pipe (CMP) crossing is smooshed and covered in vegetation. A blocked obstruction was added at this location up to the overtopping elevation. At station 186+08, the surveyed double-barreled 36-inch reinforced concrete pipe (RCP) was initially included in the model. The structure caused a significant and unreasonable rise in the 500-year water surface elevation, so a blocked obstruction was added at this location up to the overtopping elevation. This modeling approach did not significantly impact the 100-year water surface elevation.

#### 4.3.3 HEC-RAS Bridge Modeling Approach

HEC-RAS contains numerous options to model each crossing within the "Bridge Modeling Approach" form. At bridge crossings without piers, the energy method was used to compute low flows. At bridge crossings with piers, the highest energy answer was used to compute low flows between the energy method, momentum method, and Yarnell method. Crossings with piers include crossings at Highway 34 (station 412+00), 83rd Avenue (station 337+50), 71st Avenue (station 266+50), 4th Street (station 184+50), and the irrigation water crossing (station 126+00). Pressure and/or weir flow was selected for all high flows. The crossing at Highway 34 (station 412+00) is a RCBC but the true rise is unknown because the structure is completely inundated with water at the culvert entrance and exit. As a result, the structure was modeled as a bridge instead of an RCBC.

### 4.4 Incorporation of Existing LOMR and As-Built Models

One LOMR is effective along Sheep Draw – LOMR case number 20-08-0390P, effective February 16, 2021. LOMR 20-08-0390P spans between cross sections 236+60 and 315+77. Generally, the LOMR approach was incorporated into the updated modelling approach, but the cross section alignments have been revised with guidance from the 2-D model. Downstream of 71st Avenue, the split flows were modeled similarly to the LOMR approach. Additionally, structure information from the LOMR as-builts was used for structures at stations 267+50, 20+00, and 17+00.

### 4.5 Ineffective Flow Areas

#### 4.5.1 IEFAs At Structures

On the upstream side of crossing structures, permanent ineffective flow area elevations were typically set based on a 1:1 contraction ratio at the top of roadway. On the downstream side of crossing structures, non-permanent ineffective flow area elevations were set at a 1:2 expansion rate between the crown of culverts or the low chord of bridges and the top of the road based on what storm events overtop the road.

#### 4.5.2 IEFAs Outside of Structures

Non-permanent ineffective flow areas were added to cross sections at high-points where flow would need to overtop the high-point to be effective. The floodplains were evaluated to determine what storm events could effectively flow in these areas. Ineffective flow areas were also added to cross sections that expand or contract quickly. Descriptions were included in the model at cross sections with atypical ineffective flow areas.

#### 4.5.3 IEFAs Downstream of C Street

Downstream of C Street, the floodplain is flat and wide. Non-permanent ineffective flow areas were initially added to the cross sections between C Street and the canal to slowly expand the flow events up to the 50-year. When added, the non-permanent ineffective flow areas caused crossing profiles and as a result non-permanent ineffective flow areas were not included at these cross sections.

### 4.6 Spills and Split Flows

#### 4.6.1 Sheep Draw – R3

The Sheep Draw crossing at Highway 34 is overtopped in the 25-year storm. The spill onto Highway 34 begins between stations 419+35 and 415+75 and is not contained within the channel. Downstream of Highway 34, flows are not contained within the right side of the channel and would continue to spill onto Highway 34. Lateral structures were added to the model to better understand how the flow is moving in this area when optimized. The Highway 34 crossing is located at a sump and so all flow spilling onto Highway 34 will eventually make its way back to Sheep Draw.

#### 4.6.2 71st Avenue Split

Downstream of 71st Avenue, Sheep Draw splits into the 71st Avenue Split. To remain consistent with the 20-08-0390P modelling approach, a reach was defined for the 71st Avenue Split. Right overbanks of cross sections along 71st Avenue Split meet the left overbanks of cross sections along Sheep Draw – R2. Lateral structures were added to the model to better understand how much flow is spilling from Sheep Draw – R2 to the 71st Avenue Split. Limits of the lateral structures were based on the topography between the cross sections. Between cross sections 26510/2060 and 26097/1676 the topography forms a berm. Between cross section 26097/1676 and 25531/1040 the topography is flatter but still has high ground along the trail. Flows within the 71st Avenue Split was determined with a run that optimizes the lateral structures along the split, in addition to optimizing the upstream junction.

### 4.7 Flood Hazards

Flood hazards along the tributaries were identified in several ways and are detailed below. The specific flood hazards in each reach are shown on Figures 3 and 4. Detailed structure capacity summary tables for the existing infrastructure, future land use flows are included in Table 14 and Table 15.

#### 4.7.1 Hydraulic Analysis

The HEC-RAS model that was developed for the LOMR and detailed in Section 4.1 was used to help identify capacity and stability issues along Sheep Draw both for existing land use and future land use flow conditions.

Capacity
For capacity issues, the model was used to evaluate crossing structures and identify channel capacity issues based on the floodplain extents. The crossing structure capacities were determined based on City of Greeley and Weld County criteria. The criteria is summarized in Table 12.

**Table 12 – Crossing Structure Criteria**

| Jurisdiction | 100-Year Bridge Freeboard | 100-Year Culvert Headwater: Depth | 100-Year Street Overtopping at Culverts |
|---|---|---|---|
| City of Greeley | • <1,000 cfs (Collector, Local, and Local Low Volume): Low chord ≤ EGL on Collector, Local, and Local Low Volume<br>• >1,000 cfs (all roadways): 1' freeboard between low chord and EGL | • ≤1.5 | • Arterial – No Overtopping<br>• Collector – Depth at crown ≤3"<br>• Local – Depth at crown ≤6"<br>• Local Low Volume – Depth at crown ≤9"<br>• Alley – Flow may spread to alley edge<br>• All – Depth at gutter flowline ≤12"<br>• All – Ponding ≤12" below finished floor |
| Weld County | • 4' freeboard between low chord and WSE (high debris),<br>• 2' freeboard between low chord and WSE (low-moderate debris) | • <36" – 2<br>• 36"-60" – 1.7<br>• >60"-<84" – 1.5<br>• 84"-120" – 1.2<br>• ≥120" – 1.0 | • Collector/Local – Depth at crown ≤ 18"<br>• Highways/arterials – To be determined by Public Works Director |

Stability
For stability issues, the model was used to identify areas with higher velocities and shear stresses in the minor (5-year) and major (100-year) storm events. Guidance from FHWA HEC No 15 was used to identify where the channel is susceptible to erosion in the 5-yr and 100-yr events. The permissible shear stresses for different vegetation classes are summarized in Table 13. Areas with calculated shear stresses that exceed the permissible shear stress were identified as areas with the potential for erosion.

**Table 13 – Permissible Shear Stresses (FHWA HEC 15)**

| Veg Class / Soil | Veg,. Height | Max. Permissible Shear (lbs/ft2) | Source |
|---|---|---|---|
| Riprap, D50 = 6in | -- | 2.4 | HEC15 |
| Riprap, D50 = 12in | -- | 4.8 | HEC15 |
| A | >24" | 3.7 | HEC15 |
| B | 12"-24" | 2.1 | HEC15 |
| C | 6"-12" | 1 | HEC15/MHFD |
| D | 2"-6" | 0.6 | HEC15 |
| E | <2" | 0.35 | HEC15 |

Velocities and shear stresses for future and existing conditions were compared and are shown on Figure 4. The percent change in peak flows and volumes from existing to future land use were compared along Sheep Draw to help inform areas susceptible to instability in the future as the watershed continues to develop. Figures C-1A and C-1B compare the existing and future flows and are included in Appendix C.

### 4.7.2 Desktop Analysis

Stability
A comparison of 2014 LiDAR and 2023 LiDAR data was completed. Differences in the channel bottom may be due to different vegetation growth or processing, but differences along the banks could denote where the channel has migrated laterally in the 9-year period. The differences between the 2014 and 2020 LiDAR information were used to supplement the analysis of lateral bank migration, along with field verification to identify areas that are more rapidly eroding.

Additionally, the calculated shears and velocities were compared to GIS information for sanitary sewer, water, and stormwater utilities to identify utilities that may be at risk as the channel erodes.

Capacity
A comparison of the floodplain as it relates to infrastructure such as insurable structures was used to identify capacity issues along Sheep Draw.

Water Quality
Greeley provided GIS layers and a pond database that showed ponds in the watershed that have water quality plates, do not have water quality plates, or with an unknown status regarding the water quality plates. The ponds were broken into these three categories, as shown on Figures 5A and 5B, to identify areas that do not appear to have water quality provided. Ponds serving developments without water quality plates have the potential to be retrofitted to increase the number of developments with appropriate water quality measures.

### 4.7.3 Study Area Site Walk

A site visit was conducted on July 30, 2024 with the purpose of observing the existing conditions of Sheep Draw. Particular attention was paid to areas of high velocities and shear stresses as identified in the hydraulic model and lateral erosion identified with the comparison of 2014 and 2023 LiDAR.

### 4.7.4 Flood Hazard Subcategories

In general, flood hazards were placed into several different categories:

Stability
The areas in the channel that were considered stability related flood hazards include, but are not limited to:

- Entrenchment
- Vertical banks
- Bank Failure

Stability was classified based on the extent of existing erosion and the proximity to infrastructure.

Capacity
Areas were classified as capacity flood hazards include, but are not limited to, the following:

- Major crossing structures overtopping

- Insurable structures in the floodplain
- Floodplain encroaching on or threatening private property

Capacity hazards were identified using both existing and future land use peak flows.

### 4.7.5 Inundated Structures

A total of 20 insurable structures are impacted by the 100-yr floodplain with existing land use conditions. With future land use hydrology, 36 insurable structures would be impacted by the 100-yr floodplain, assuming no regional detention in the future.

## 4.8 Previous Analysis

A Comprehensive Drainage Plan for the Sheep Draw basin was completed by Anderson Consulting Engineers, Inc. in 2006. The 2006 study identified undersized road crossings on Sheep Draw in both existing and future conditions. The study included recommendations for detention basins and upsizing roadway crossings. More information regarding the previously identified recommended alternatives was included with the Alternatives Analysis phase of the study.

## Table 14 - Crossing Structure Capacities (Existing Infrastructure, Existing Land Use Flows)

| Reach | Structure Survey Number | Jurisdiction | Street Name | Street Classification | Existing Structure | Notes | $Q_2$ (cfs) | $Q_2$ Overtop Depth (ft) | $Q_5$ (cfs) | $Q_5$ Overtop Depth (ft) | $Q_{10}$ (cfs) | $Q_{10}$ Overtop Depth (ft) | $Q_{25}$ (cfs) | $Q_{25}$ Overtop Depth (ft) | $Q_{50}$ (cfs) | $Q_{50}$ Overtop Depth (ft) | $Q_{100}$ (cfs) | $Q_{100}$ Overtop Depth (ft) | Bridge Freeboard Height (ft) | Bridge Freeboard Elevation | HW/D Criteria | HW:D Criteria Elev | Overtop Elev | Overtop Elev Notes | Controlling Criteria | Controlling Elevation | Capacity per Criteria (Storm Event) | Capacity before Overtopping (Storm Event) | 100-Year Criteria Met? | 100-Year Overtop? | Alternatives for Consideration |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SD R1** | 1 | City of Greeley | Poudre River Trail | Trail | 84-inch CMP | | 229 | 0.06 | 360 | 0.4 | 515 | 0.7 | 2062 | 1.77 | 3479 | 2.22 | 5762 | 2.74 | --- | --- | 1.5 | 4700.31 | 4693.00 | Trail surface | HW:D | 4700.31 | >100-YEAR | < 2-YEAR | YES | YES | Trail - replace CMP |
| | 2 | City of Greeley | Sheep Draw Nature Trail | Trail | 84-inch CMP | Dense vegetation at the culvert enterance and exit, otherwise holding up | 229 | 0.92 | 360 | 1.17 | 515 | 1.33 | 1981 | 1.97 | 3479 | 2.36 | 5762 | 2.65 | --- | --- | 1.5 | 4702.3 | 4697 | Trail surface in LOB, overtopping upstream of structure | HW:D | 4702.30 | >100-YEAR | < 2-YEAR | YES | YES | Trail - replace CMP |
| | 3 | City of Greeley | Greeley No. 3 Ditch | N/A | Concrete canal weir RCBC | Multiple cracks in the structure, rust spots suggest exposed reinforcement | 229 | 1.11 | 360 | 1.33 | 515 | 1.5 | 1981 | 2.13 | 3479 | 2.54 | 5762 | 2.87 | --- | --- | 1.5 | 4702.9 | 4697.00 | Trail surface in LOB, overtopping upstream of structure | HW:D | 4702.90 | >100-YEAR | < 2-YEAR | YES | YES | Formalize ditch spillway |
| | 4 | Weld County | N/A | N/A | Irrigation water crossing: 1.5-foot diameter utility poles on upstream side of 15-inch PVC. PVC extends beyond utility poles. | Primitive materials appear to be in good condition but are likely to degrade quickly | 229 | --- | 360 | --- | 515 | --- | 1981 | 0.18 | 3479 | 0.77 | 5762 | 1.64 | 2 | 4700.34 | --- | --- | 4703.78 | Bridge deck | Bridge FB | 4700.34 | < 2-YEAR | 10-YEAR | NO | YES | Private crossing - no alternatives evaluated |
| | 5 | Weld County | N/A | N/A | Access bridge with railing | Primitive wood bridge but appears to be in good condition. Likely to degrade quickly due to materials used | 229 | 0.38 | 360 | 0.94 | 515 | 1.52 | 1981 | 3.83 | 3479 | 4.74 | 5762 | 5.95 | 2 | 4700.27 | --- | --- | 4701.53 | Bridge deck | Bridge FB | 4700.27 | < 2-YEAR | < 2-YEAR | NO | YES | Private crossing - no alternatives to be evaluated |
| | 6 | City of Greeley and Weld County | C Street | Local | Metal/wood bridge with railing | | 229 | --- | 360 | --- | 515 | --- | 1981 | 0.73 | 3479 | 2.42 | 5762 | 3.31 | 1 | 4705.36 | --- | --- | 4707.04 | Bridge deck | Bridge FB | 4705.36 | 10-YEAR | 10-YEAR | NO | YES | Evaluate capacity improvements |
| | 7 | City of Greeley | Sheep Draw Trail | Trail | Double-barreled 36-inch CMP | | 225 | 1.32 | 354 | 1.66 | 499 | 1.93 | 1981 | 3.69 | 3479 | 4.71 | 5762 | 5.85 | --- | --- | 1.5 | 4723.46 | 4724 | Trail surface | HW:D | 4723.46 | < 2-YEAR | < 2-YEAR | NO | YES | Trail - replace CMP |
| | 8 | City of Greeley | 4th Street | Minor Arterial | Concrete bridge with pier and railing | Inundated with water | 225 | --- | 354 | --- | 499 | --- | 1981 | --- | 3479 | --- | 5762 | --- | 1 | 4731.1 | --- | --- | 4735 | Bridge deck | Bridge FB | 4731.10 | 25-YEAR | >100-YEAR | NO | NO | Evaluate capacity improvements |
| | 9 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing | Medium dense vegetation at the bridge entrance and exit | 214 | --- | 331 | 0.51 | 472 | 1.2 | 1973 | 3.22 | 3455 | 3.82 | 5714 | 4.39 | 1 | 4731.18 | --- | --- | 4732.71 | Bridge deck | Bridge FB | 4731.18 | < 2-YEAR | 2-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| | 9.5 | City of Greeley | Sheep Draw Trail | Trail | Double-barreled 42-inch RCP | | 203 | 0.75 | 309 | 1.29 | 451 | 1.59 | 1966 | 3.35 | 3433 | 4.41 | 5669 | 5.74 | --- | --- | 1.5 | 4741.47 | 4741.55 | Trail surface | HW:D | 4741.47 | < 2-YEAR | < 2-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| | 10 | City of Greeley | 10th Street | Major Arterial | Concrete bridge with railing | | 203 | --- | 309 | --- | 451 | --- | 1966 | --- | 3433 | --- | 5669 | --- | 1 | 4749.16 | --- | --- | 4756.00 | Bridge deck | Bridge FB | 4749.16 | 50-YEAR | >100-YEAR | NO | NO | Evaluate capacity improvements |
| | 11 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | | 203 | --- | 309 | --- | 451 | --- | 1966 | 3.36 | 3433 | 5.17 | 5669 | 7.09 | 1 | 4743.36 | --- | --- | 4745 | Bridge deck | Bridge FB | 4743.36 | < 2-YEAR | 10-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| | 12 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | Dense vegetation at the bridge entrance and exit | 203 | 0.51 | 309 | 0.66 | 451 | 0.88 | 1966 | 2.44 | 3433 | 3.95 | 5669 | 5.85 | 1 | 4745.6 | --- | --- | 4747.00 | Bridge deck | Bridge FB | 4745.60 | < 2-YEAR | < 2-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| **SD R2** | 13 | City of Greeley | Sheep Draw Trail | Trail | 36-inch RCP | | 124 | 0.5 | 153 | 0.68 | 186 | 0.8 | 427 | 1.54 | 585 | 1.86 | 881 | 2.6 | --- | --- | 1.5 | 4758.94 | 4760.00 | Trail surface | HW:D | 4758.94 | < 2-YEAR | < 2-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| **SD R3** | 16 | City of Greeley | 71st Avenue | Minor Arterial | Concrete bridge with pier and railing | | 133 | --- | 202 | --- | 281 | --- | 1799 | --- | 3070 | --- | 5059 | 0.95 | 1 | 4773.84 | --- | --- | 4775.70 | Bridge deck | Bridge FB | 4773.84 | 25-YEAR | 50-YEAR | NO | YES | Evaluate capacity improvements |
| | 17 | City of Greeley | Sheep Draw Trail | Trail | 7' span by 3' rise RCBC | Completely inundated with water at the culvert entrance and exit. Wingwalls appear to be in good condition | 133 | 6.39 | 202 | 6.87 | 281 | 7.21 | 1799 | 10.58 | 3070 | 12.56 | 5059 | 15.75 | --- | --- | 1.5 | 4767.28 | 4761.31 | Road deck | HW:D | 4767.28 | < 2-YEAR | < 2-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| | 18 | City of Greeley | Sheep Draw Trail | Trail | 46-inch CMP | | 133 | 0.33 | 202 | 0.47 | 281 | 0.68 | 1799 | 2.17 | 3070 | 2.95 | 5059 | 3.85 | --- | --- | 1.5 | 4784.295 | 4782.8 | Trail surface | HW:D | 4784.30 | 10-YEAR | < 2-YEAR | NO | YES | Trail - replace CMP |
| | 19 | City of Greeley | 83rd Avenue | Major Arterial | Concrete bridge with pier and railing | Inundated with water | 106 | --- | 156 | --- | 244 | --- | 1681 | --- | 2857 | --- | 4710 | --- | 1 | 4808.92 | --- | --- | 4812.76 | Bridge deck | Bridge FB | 4808.92 | 25-YEAR | >100-YEAR | NO | NO | Evaluate capacity improvements |
| | 20 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | | 79 | --- | 115 | --- | 244 | --- | 1620 | --- | 2741 | 0.8 | 4503 | 1.54 | 1 | 4818.82 | --- | --- | 4820.1 | Bridge deck | Bridge FB | 4818.82 | 10-YEAR | 25-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| | 21 | City of Greeley | 95th Avenue | Local | 22' span by 5' rise RCBC | Dense vegetation and sedimentation at the culvert entrance and exit, multiple lateral cracks and wingwall separation, otherwise holding up | 58 | --- | 84 | --- | 244 | --- | 1558 | 0.43 | 2596 | 1.91 | 4185 | 2.89 | --- | --- | 1.5 | 4845.62 | 4851.97 | Road deck | HW:D | 4845.62 | 10-YEAR | 10-YEAR | NO | YES | Evaluate capacity improvements |
| | 22 | City of Greeley | Highway 34 | Highway | 26' span by 4' RCBC | Completely inundated with water at the culvert entrance and exit. Wingwalls appear to be in good condition. Due to inundation, the true rise is unknown and this crossing is modelled as a bridge instead of a culvert. | 17 | --- | 41 | --- | 244 | --- | 1167 | 0.59 | 1925 | 1.63 | 3045 | 2.48 | --- | --- | 1.5 | 4847.18 | 4856.32 | Road deck | HW:D | 4847.18 | 10-YEAR | 10-YEAR | NO | YES | Evaluate capacity improvements |
| | 23 | City of Greeley | Private driveway | N/A | 48-inch CMP | Inundated with water and adversely sloped | 17 | --- | 40 | 0.3 | 242 | 1.47 | 1160 | 2.17 | 1909 | 2.38 | 3007 | 3.04 | --- | --- | 1.5 | 4864.09 | 4861 | Drive surface | HW:D | 4864.09 | >100-YEAR | 2-YEAR | YES | YES | Private driveway - replace CMP |
| **71st Ave Split** | 14 | City of Greeley | Sheep Draw Trail | Trail | Pedestrian bridge with 4.5' handrails and 30"x19" HERCP | | 33 | --- | 68 | --- | 119 | --- | 1108 | --- | 1978 | --- | 3461 | --- | 1 | 4760.27 | 1.5 | 4763.23 | 4820.1 | Bridge deck | Bridge FB | 4760.27 | < 2-YEAR | >100-YEAR | NO | NO | Trail - no alternatives to be evaluated |
| | 15 | City of Greeley | Sheep Draw Trail | Trail | 30"x19" HERCP | | 33 | --- | 68 | --- | 119 | --- | 1092 | --- | 1914 | --- | 3133 | --- | --- | --- | 1.5 | 4764.07 | 4812.76 | Bridge deck | HW:D | 4764.07 | < 2-YEAR | >100-YEAR | NO | NO | Trail - no alternatives to be evaluated |

## Table 15 - Crossing Structure Capacities (Existing Infrastructure, Future Land Use Flows)

| Reach | Structure Survey Number | Jurisdiction | Street Name | Street Classification | Existing Structure | Notes | $Q_2$ (cfs) | $Q_2$ Overtop Depth (ft) | $Q_5$ (cfs) | $Q_5$ Overtop Depth (ft) | $Q_{10}$ (cfs) | $Q_{10}$ Overtop Depth (ft) | $Q_{25}$ (cfs) | $Q_{25}$ Overtop Depth (ft) | $Q_{50}$ (cfs) | $Q_{50}$ Overtop Depth (ft) | $Q_{100}$ (cfs) | $Q_{100}$ Overtop Depth (ft) | Bridge Freeboard Height (ft) | Bridge Freeboard Elevation | HW/D Criteria | HW:D Criteria Elev | Overtop Elev | Overtop Elev Notes | Controlling Criteria | Controlling Elevation | Capacity per Criteria (Storm Event) | Capacity before Overtopping (Storm Event) | 100-Year Criteria Met? | 100-Year Overtop? | Alternatives for Consideration |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SD R1** | 1 | City of Greeley | Poudre River Trail | Trail | 84-inch CMP | | 779 | 1.02 | 1136 | 1.33 | 1547 | 1.55 | 3888 | 2.35 | 5760 | 2.74 | 8419 | 3.17 | --- | --- | 1.5 | 4700.31 | 4693 | Trail surface | HW:D | 4700.31 | >100-YEAR | < 2-YEAR | YES | YES | Trail - replace CMP |
| | 2 | City of Greeley | Sheep Draw Nature Trail | Trail | 84-inch CMP | Dense vegetation at the culvert enterance and exit, otherwise holding up | 779 | 1.5 | 1136 | 1.7 | 1547 | 1.83 | 3883 | 2.38 | 5751 | 2.68 | 8370 | 3 | --- | --- | 1.5 | 4702.3 | 4697 | Trail surface in LOB, overtopping upstream of structure | HW:D | 4702.30 | >100-YEAR | < 2-YEAR | YES | YES | Trail - replace CMP |
| | 3 | City of Greeley | Greeley No. 3 Ditch | N/A | Concrete canal weir RCBC | Multiple cracks in the structure, rust spots suggest exposed reinforcement | 779 | 1.68 | 1136 | 1.9 | 1547 | 2.05 | 3883 | 2.58 | 5751 | 2.89 | 8370 | 3.23 | --- | --- | 1.5 | 4702.9 | 4697 | Trail surface in LOB, overtopping upstream of structure | HW:D | 4702.90 | >100-YEAR | < 2-YEAR | YES | YES | Formalize ditch spillway |
| | 4 | Weld County | N/A | N/A | Irrigation water crossing: 1.5-foot diameter utility poles on upstream side of 15-inch PVC. PVC extends beyond utility poles. | Primitive materials appear to be in good condition but are likely to degrade quickly | 779 | --- | 1136 | --- | 1547 | --- | 3883 | 0.96 | 5751 | 1.65 | 8370 | 3.3 | 2 | 4700.34 | --- | --- | 4703.78 | Bridge deck | Bridge FB | 4700.34 | < 2-YEAR | 10-YEAR | NO | YES | Private crossing - no alternatives evaluated |
| | 5 | Weld County | N/A | N/A | Access bridge with railing | Primitive wood bridge but appears to be in good condition. Likely to degrade quickly due to materials used | 779 | 2.14 | 1136 | 2.85 | 1547 | 3.86 | 3883 | 5 | 5751 | 5.95 | 8370 | 6.69 | 2 | 4700.27 | --- | --- | 4701.53 | Bridge deck | Bridge FB | 4700.27 | < 2-YEAR | < 2-YEAR | NO | YES | Private crossing - no alternatives to be evaluated |
| | 6 | City of Greeley and Weld County | C Street | Local | Metal/wood bridge with railing | | 779 | --- | 1136 | 0.73 | 1547 | 0.73 | 3883 | 2.61 | 5751 | 3.31 | 8370 | 3.88 | 1 | 4705.36 | --- | --- | 4707.04 | Bridge deck | Bridge FB | 4705.36 | < 2-YEAR | 2-YEAR | NO | YES | Evaluate capacity improvements |
| | 7 | City of Greeley | Sheep Draw Trail | Trail | Double-barreled 36-inch CMP | | 779 | 2.43 | 1131 | 2.83 | 1538 | 3.22 | 3878 | 4.88 | 5747 | 5.84 | 8393 | 6.84 | --- | --- | 1.5 | 4723.46 | 4724 | Trail surface | HW:D | 4723.46 | < 2-YEAR | < 2-YEAR | NO | YES | Trail - replace CMP |
| | 8 | City of Greeley | 4th Street | Minor Arterial | Concrete bridge with pier and railing | Inundated with water | 779 | --- | 1131 | --- | 1538 | --- | 3878 | --- | 5747 | --- | 8393 | 0.51 | 1 | 4731.1 | --- | --- | 4735 | Bridge deck | Bridge FB | 4731.10 | 10-YEAR | 50-YEAR | NO | YES | Evaluate capacity improvements |
| | 9 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing | Medium dense vegetation at the bridge entrance and exit | 768 | 1.92 | 1118 | 2.38 | 1519 | 3 | 3848 | 3.93 | 5691 | 4.38 | 8303 | 5.1 | 1 | 4731.18 | --- | --- | 4732.71 | Bridge deck | Bridge FB | 4731.18 | < 2-YEAR | < 2-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| | 9.5 | City of Greeley | Sheep Draw Trail | Trail | Double-barreled 42-inch RCP | | 760 | 2.13 | 1105 | 2.48 | 1499 | 2.93 | 3822 | 4.62 | 5646 | 5.72 | 8227 | 7.02 | --- | --- | 1.5 | 4741.47 | 4741.55 | Trail surface | HW:D | 4741.47 | < 2-YEAR | < 2-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| | 10 | City of Greeley | 10th Street | Major Arterial | Concrete bridge with railing | | 760 | --- | 1105 | --- | 1499 | --- | 3822 | --- | 5646 | --- | 8227 | --- | 1 | 4749.16 | --- | --- | 4756.00 | Bridge deck | Bridge FB | 4749.16 | 25-YEAR | >100-YEAR | NO | NO | Evaluate capacity improvements |
| | 11 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | | 760 | 0.57 | 1105 | 1.72 | 1499 | 2.64 | 3822 | 5.54 | 5646 | 7.07 | 8227 | 9.84 | 1 | 4743.36 | --- | --- | 4745 | Bridge deck | Bridge FB | 4743.36 | < 2-YEAR | < 2-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| | 12 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | Dense vegetation at the bridge entrance and exit | 760 | 1.25 | 1105 | 1.6 | 1499 | 1.99 | 3822 | 4.32 | 5646 | 5.83 | 8227 | 8.43 | 1 | 4745.6 | --- | --- | 4747 | Bridge deck | Bridge FB | 4745.60 | < 2-YEAR | < 2-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| **SD R2** | 13 | City of Greeley | Sheep Draw Trail | Trail | 36-inch RCP | | 226 | 0.98 | 290 | 1.19 | 357 | 1.39 | 621 | 1.97 | 812 | 2.57 | 1043 | 3.32 | --- | --- | 1.5 | 4758.94 | 4760.00 | Trail surface | HW:D | 4758.94 | < 2-YEAR | < 2-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| **SD R3** | 16 | City of Greeley | 71st Avenue | Minor Arterial | Concrete bridge with pier and railing | | 663 | --- | 973 | --- | 1322 | --- | 3471 | --- | 5090 | 0.96 | 7378 | 1.94 | 1 | 4773.84 | --- | --- | 4775.70 | Bridge deck | Bridge FB | 4773.84 | 10-YEAR | 25-YEAR | NO | YES | Evaluate capacity improvements |
| | 17 | City of Greeley | Sheep Draw Trail | Trail | 7' span by 3' rise RCBC | Completely inundated with water at the culvert entrance and exit. Wingwalls appear to be in good condition | 663 | 8.21 | 973 | 8.92 | 1322 | 9.71 | 3471 | 13.12 | 5090 | 15.76 | 7378 | 16.76 | --- | --- | 1.5 | 4767.28 | 4761.31 | Road deck | HW:D | 4767.28 | < 2-YEAR | < 2-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| | 18 | City of Greeley | Sheep Draw Trail | Trail | 46-inch CMP | | 663 | 1.13 | 973 | 1.46 | 1322 | 1.8 | 3471 | 3.15 | 5090 | 3.86 | 7378 | 4.69 | --- | --- | 1.5 | 4784.295 | 4782.8 | Trail surface | HW:D | 4784.30 | 5-YEAR | < 2-YEAR | NO | YES | Trail - replace CMP |
| | 19 | City of Greeley | 83rd Avenue | Major Arterial | Concrete bridge with pier and railing | Inundated with water | 628 | --- | 950 | --- | 1298 | --- | 3228 | --- | 4737 | --- | 6849 | 1.4 | 1 | 4808.92 | --- | --- | 4812.76 | Bridge deck | Bridge FB | 4808.92 | 10-YEAR | 50-YEAR | NO | YES | Evaluate capacity improvements |
| | 20 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | | 572 | --- | 869 | --- | 1190 | --- | 3078 | 1.07 | 4513 | 1.54 | 6510 | 4.32 | 1 | 4818.82 | --- | --- | 4820.1 | Bridge deck | Bridge FB | 4818.82 | 10-YEAR | 10-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| | 21 | City of Greeley | 95th Avenue | Local | 22' span by 5' rise RCBC | Dense vegetation and sedimentation at the culvert entrance and exit, multiple lateral cracks and wingwall separation, otherwise holding up | 493 | --- | 760 | --- | 1051 | --- | 2840 | 2.12 | 4129 | 2.85 | 5942 | 3.66 | --- | --- | 1.5 | 4845.62 | 4851.97 | Road deck | HW:D | 4845.62 | 5-YEAR | 10-YEAR | NO | YES | Evaluate capacity improvements |
| | 22 | City of Greeley | Highway 34 | Highway | 26' span by 4' RCBC | Completely inundated with water at the culvert entrance and exit. Wingwalls appear to be in good condition. Due to inundation, the true rise is unknown and this crossing is modelled as a bridge instead of a culvert. | 370 | --- | 567 | --- | 907 | --- | 2053 | 1.76 | 2960 | 2.43 | 4206 | 3.17 | --- | --- | 1.5 | 4847.18 | 4856.32 | Road deck | HW:D | 4847.18 | < 2-YEAR | 10-YEAR | NO | YES | Evaluate capacity improvements |
| | 23 | City of Greeley | Private driveway | N/A | 48-inch CMP | Inundated with water and adversely sloped | 359 | 1.65 | 552 | 1.83 | 889 | 2.02 | 2025 | 2.42 | 2917 | 3.07 | 4139 | 3.53 | --- | --- | 1.5 | 4864.09 | 4861 | Drive surface | HW:D | 4864.09 | 50-YEAR | < 2-YEAR | NO | YES | Private driveway - replace CMP |
| **71st Ave Split** | 14 | City of Greeley | Sheep Draw Trail | Trail | Pedestrian bridge with 4.5' handrails and 30"x19" HERCP | | 380 | 70.42 | 583 | 71.11 | 803 | 71.51 | 2316 | 72.96 | 3582 | 73.75 | 5497 | 74.66 | 1 | 4760.27 | 1.5 | 4763.23 | 4693 | Bridge deck | Bridge FB | 4760.27 | < 2-YEAR | < 2-YEAR | NO | YES | Trail - no alternatives to be evaluated |
| | 15 | City of Greeley | Sheep Draw Trail | Trail | 30"x19" HERCP | | 379 | 2.25 | 580 | 2.69 | 795 | 3.08 | 2174 | 4.88 | 3146 | 5.98 | 4446 | 6.97 | --- | --- | 1.5 | 4764.07 | 4764.55 | Trail surface | HW:D | 4764.07 | < 2-YEAR | < 2-YEAR | NO | YES | Trail - no alternatives to be evaluated |

## Legend

- Roadway Crossing Structures
- Trail Crossing Structures
- MDP Reach Breaks
- Odd Numbered MDP Reach
- Even Numbered MDP Reach
- Canal/Ditch Centerline
- Sewer Mains
- Storm Mains
- Water Mains
- Trails
- River Centerline Within Private Parcels
- Sheep Draw Regional Trail
- Roads
- Watershed Boundary
- City of Greeley
- Weld County
- Water Bodies
- Undeveloped Areas

**Stability Problems**
- Potential for Erosion,> 20 ft from Infrastructure
- Potential for Erosion,< 20 ft from Infrastructure
- Significant or Fast Eroding,< 20 ft from Infrastructure
- Significant or Fast Eroding,> 20 ft from Infrastructure

**Existing Capacity Problems**
- Does Not Meet 100-Year Criteria, 100-Year Does Not Overtop
- Does Not Meet 100-Year Criteria, 100-Year Overtops
- Does Not Meet 100-Year Criteria, 100-Year Overtops (Non Roadway)

**Floodplain Layers**
- Existing 100-Year Floodplain
- Existing 100-year Floodplain Encroaches onto Private Property (Excludes areas where Sheep Draw centerline is on private property)
- Structures Within the 100-Year Floodplain

**Greeley Parcels**
- Private
- Public

NOTES:
1. FEATURE NAMING CONVENTIONS HAVE BEEN SHORTENED FOR CLAIRTY.

**Interactive Figures**

Existing Stability Problems ON/OFF
Existing Capacity Problems ON/OFF
Pedestrian and Maintenance Accessibility ON/OFF

Roads ON/OFF
Roadway and Trail Symbols ON/OFF
Utilities ON/OFF
Parcels ON/OFF
Aerial ON/OFF
Undeveloped Areas ON/OFF
Regional Trail ON/OFF
100-Year Floodplain Existing ON/OFF

N

0 600 1,200 2,400 US Feet

R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
SD R1
SD R2
SD R3
71st Ave Split
F ST
C ST
4TH ST
10TH ST
71ST AVE
59TH AVE
65TH AVE
83RD AVE
95TH AVE
US HWY 34 BUS
US HWY 85
STATE HWY 257
COUNTY ROAD 56

| | | | |
|---|---|---|---|
| PROJECT: 022-0169<br>DRAWN BY: DD<br>DATE: 3/2025 | **CITY OF GREELEY** | **SHEEP DRAW MASTER PLAN**<br>**EXISTING DRAINAGE PROBLEM AREAS** | olsson<br>1525 Raleigh Street<br>Suite 400<br>Denver, CO 80204<br>TEL: 303.237.2072<br>FAX: 303.237.2659<br>www.olsson.com | FIGURE<br>3 |

# Legend

- Roadway Crossing Structures
- Trails Crossing Structures
- MDP Reach Breaks
- Odd Numbered MDP Reach
- Even Numbered MDP Reach
- Canal/Ditch Centerline
- Sewer Mains
- Storm Mains
- Water Mains
- Sheep Draw Regional Trail
- Roads
- Watershed Boundary
- City of Greeley
- Weld County
- Water Bodies

**Future Land Use - % Impervious**

- Industrial Low Intensity - 80%
- Commercial Low Intensity - 75%
- Commercial High Intensity - 95%
- Mixed Use - 75%
- Mixed Use High Intensity - 85%
- Residential Estate - 12%
- Residential Low Density - 30%
- Residential Medium Density - 45%
- Residential High Density - 75%

**Future Stability Problems**

- Potential for Erosion,> 20 ft from Infrastructure
- Potential for Erosion,< 20 ft from Infrastructure
- Significant or Fast Eroding,> 20 ft from Infrastructure
- Significant or Fast Eroding,< 20 ft from Infrastructure

**Future Capacity Problems**

- Future Conditions Does Not Meet 100-Year Criteria, 100-Year Does Not Overtop
- Future Conditions Does Not Meet 100-Year Criteria, 100-Year Overtops
- Future Conditions Does Not Meet 100-Year Criteria, 100-Year Overtops (Non Roadway)

**Floodplain Layers**

- Future 100-Year Floodplain
- Future 100-year Floodplain Encroaches onto Private Property (Excludes areas where Sheep Draw centerline is on private property)
- Structures Within the Future 100-Year Floodplain

**Greeley Parcels**

- Private
- Public
- Field Visit Notes

**Areas of Concern**

- Exposure Risk: Utility Crossing

**Subbasin Boundaries**

- Basin Boundary

**Floodplain Layers**

- Draft Future 500-year

**Increase in shear stress (future to existing) lb/ft²**

- .2-.4
- .4-.6
- .6-.8
- .8-1
- 1-1.2
- 1.2-1.4
- 1.4-1.6
- 1.6-3.7

**Increase in Velocity (future to existing) ft/s**

- .5-1
- 1-1.5
- 1.5-2
- 2-2.5
- 2.5-3
- 3-3.5
- 3.5-4
- 4-4.9
- Watershed Boundary

NOTES:
1. FEATURE NAMING CONVENTIONS HAVE BEEN SHORTENED FOR CLARITY.

N

0 600 1,200 2,400 US Feet

**Interactive Figures**

**Potential Future Stability Problems ON/OFF**
**Future Capacity Problems ON/OFF**

**Roads ON/OFF**
**Roadway and Trail Symbols ON/OFF**
**Utilities ON/OFF**
**Parcels ON/OFF**
**Aerial ON/OFF**
**Future Land Use ON/OFF**
**Increase in Shear Stress ON/OFF**
**Increase in Velocity ON/OFF**
**Regional Trail ON/OFF**
**100-Year Floodplain Future ON/OFF**

71st Ave Split
SD R1
SD R2
SD R3
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
C ST
4TH ST
10TH ST
71ST AVE
95TH AVE
83RD AVE
US HWY 34 BUS
US HWY 85
STATE HWY 257
COUNTY ROAD 56

| | | | |
|---|---|---|---|
| PROJECT: 022-0169<br>DRAWN BY: DD<br>DATE: 3/2025 | **CITY OF GREELEY** | **SHEEP DRAW MASTER PLAN**<br>**FUTURE DRAINAGE PROBLEM AREAS** | olsson<br>1525 Raleigh Street<br>Suite 400<br>Denver, CO 80204<br>TEL: 303.237.2072<br>FAX: 303.237.2659<br>www.olsson.com | FIGURE<br>4 |

## Legend

- Ponds With Water Quality
- Ponds Without Water Quality
- SWMM Links
- MDP Reach Breaks
- Odd Numbered MDP Reach
- Even Numbered MDP Reach
- Storm Mains
- Roads
- Major (5-Ft) Contour
- Watershed Boundary
- City of Greeley
- Weld County
- Subbasins
- Water Bodies
- Undeveloped Areas

N

0 600 1,200 2,400 US Feet

**Interactive Figures**

Roads ON/OFF
Storm Sewer ON/OFF
Contours ON/OFF
Subbasins ON/OFF
Aerial ON/OFF

NOTES:
1. THE STATUS OF WATER QUALITY PLATES FOR PONDS WITH MISSING DATA SHOULD BE CONFIRMED PRIOR TO PRIORITIZING DESIGN OF A WATER QUALITY PROJECT.
2. PONDS WITH UNKNOWN WATER QUALITY PLATE WERE EVALUATED ASSUMING THEY DO NOT PROVIDE WATER QUALITY TREATMENT.
3. PONDS WERE EVALUATED ASSUMING HIGHER PRIORITY (TYPICALLY DOWNSTREAM) IMPROVEMENTS ARE ADRESSED
4. FEATURE NAMING CONVENTIONS HAVE BEEN SHORTENED FOR CLAIRTY.

R1 R2 R3 R4 R5 R6 R7 R8 R9 R10 R11

F ST
C ST
4TH ST
10TH ST
US HWY 34 BUS
71ST AVE
59TH AVE
65TH AVE
83RD AVE
95TH AVE
US HWY 34
STATE HWY 257
COUNTY ROAD 66

| | | | |
|---|---|---|---|
| PROJECT: 022-0169 | **CITY OF GREELEY** | **SHEEP DRAW MASTER PLAN WATER QUALITY MAP** | FIGURE 5 |
| DRAWN BY: DD | | | |
| DATE: 3/2025 | | | |

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# 5. ALTERNATIVES ANALYSIS

## 5.1 Alternative Development Process

After completing a hydraulic analysis of the existing drainage systems and discussing the goals of the alternative analysis, the alternative development process began.

The primary goals of the alternative analysis were to increase channel stability, reduce erosion potential, increase conveyance capacity to reduce road overtopping, remove insurable structures from the floodplain, protect utilities, and enhance water quality and environmental conditions.

Each reach-specific and watershed-wide alternative was first evaluated based on site constraints, feasibility, and constructability. From the alternatives that passed this first screening process, the recommended plan was determined based on benefits, cost, including land acquisition and maintenance costs, and environmental impacts.

## 5.2 Alternatives Categories, Criteria, and Approach

The hydrologic and hydraulic analysis of the alternatives was performed in accordance with City of Greeley and Weld County criteria.

Specific channel sections and slopes were not identified in the alternatives analysis. Future improvements should meet the goals of each reach and follow the criteria at the time of final design. Alternatives were investigated per reach and are summarized in respective tables. To provide clarity where improvements were investigated, Sheep Draw was further subdivided from the hydraulic reaches, as defined in Section 2.3, to better match major crossroads and jurisdiction boundaries. The alternatives' pre-screening matrix is shown in Table 16 for alternatives considered in each reach. The alternatives that were considered for this analysis include: maintaining the status quo, infrastructure protection and channel stabilization, regional detention, capacity improvements with and without detention improvements, water quality and environmental considerations, pedestrian and maintenance accessibility, and future development considerations. Regional detention, water quality and environmental considerations, and future development consideration alternatives are not included in Table 16 because they are watershed-based and not reach specific.

**Table 16 – Alternatives Pre-Screening Matrix**

| Reach | Reach Description | Status Quo | Pedestrian and Maintenance Accessibility | Infrastructure Protection / Channel Stabilization | Capacity Improvements w/o Detention Improvements | Capacity Improvements w/ Detention Improvements |
|---|---|---|---|---|---|---|
| Sheep Draw Reach 1 | Downstream Study Limits to Weld County Border Upstream of Greeley No.3 Ditch | X | X | X | X | X |
| Sheep Draw Reach 2 | Weld County Border Upstream of Greeley No.3 Ditch to Downstream of C St. | X | X | X | | |
| Sheep Draw Reach 3 | Downstream of C St. to Downstream of 4th St. | X | X | X | X | X |
| Sheep Draw Reach 4 | Downstream of 4th St. to Downstream of 10th St. | X | | X | X | X |
| Sheep Draw Reach 5 | Downstream of 10th St. to Confluence with 71st Ave. Split | X | X | X | X | X |
| Sheep Draw Reach 6 | Confluence with 71st Ave. Split to Downstream of 71st Ave. | X | | X | | |
| Sheep Draw Reach 7 | 71st Ave. Split | X | | X | | |
| Sheep Draw Reach 8 | Downstream of 71st Ave. to Downstream of 83rd Ave. | X | X | X | | X |
| Sheep Draw Reach 9 | Downstream of 83rd Ave. to Downstream of US Highway 34 | X | X | X | X | X |
| Sheep Draw Reach 10 | Downstream of US Highway 34 to Weld County Border | X | X | X | X | X |
| Sheep Draw Reach 11 | Weld County Border to Upstream Study Limits | X | X | | | |

Stream and infrastructure maintenance is recommended for all alternatives, including the status quo alternative. Maintenance would include weed and debris removal, vegetation management, inspection of the channel for erosion and sedimentation, and inspection of bridges, culverts, and check/drop structures for signs of potential failure.

### 5.2.1 Regional Detention

The regional detention alternatives were developed using City of Greeley and Weld County design criteria. While subregional detention is recommended for future developments, alternatives were developed to identify locations where regional detention would benefit Sheep Draw on the watershed scale. Conceptual detention pond calculations were completed using the 2023 LiDAR data and MHFD_Detention, version 4.06 to conceptually size outlet structures. The calculated stage-area-discharge was then input into the baseline EPA SWMM 5.2.3 model to evaluate the impacts on the downstream flows.

### 5.2.2 Water Quality and Environmental Considerations

Detention ponds were evaluated based on their current outlet structure configuration and whether water quality plates are included or not, based on the information provided by the City of Greeley.

### 5.2.3 Pedestrian and Maintenance Accessibility

Portions of Sheep Draw are located on private property, making maintenance or capital improvement projects in the channel challenging. Sheep Draw is located on private property primarily in undeveloped areas. It is recommended that as these areas develop, an easement for Sheep Draw is obtained. In developed areas, it is recommended to obtain easements when issues arise, or projects are being completed in the area.

A regional trail generally parallels Sheep Draw between C Street and US Highway 34. The trail can serve a dual purpose of pedestrian mobility and maintenance access. At the time of this study, the City was finalizing a trail master plan. The trail master plan shows the regional trail connecting through the gap at 83rd Avenue and continuing south generally along Sheep Draw through the extents of the study reaches.

### 5.2.4 Infrastructure Protection and Channel Stabilization

For the alternatives analysis, a high-level approach was taken for channel stabilization and infrastructure protection. In areas of instability and erosion, stabilization improvements were recommended where erosion was significant or fast eroding and could threaten utilities and/or the regional trail. In areas of potential instability and erosion, monitoring was recommended where there was potential for future erosion to threaten utilities and/or the regional trail. Where utilities, such as gas, water, and sanitary, cross Sheep Draw, check structures were recommended downstream of the crossings to protect the utilities and prevent exposure from future erosion. A full hydraulic analysis was not completed for the infrastructure and channel stabilization alternatives and will need to be further investigated during the conceptual design phase.

### 5.2.5 Capacity Improvements – Future Flows, No Detention

All capacity alternatives were developed using City of Greeley and Weld County design criteria. A summary of the criteria used to evaluate the alternatives for the structure crossings is included in Table 12, Section 4.8. A summary of proposed crossing structure improvements is included as Table E-4, in Appendix E.

Capacity improvements were evaluated under future flow conditions, assuming no regional detention improvements would be implemented. Capacity improvements, including retrofit or structure replacement, channel grading, and installation of side culverts, were evaluated to meet criteria and not just to prevent overtopping of the structure under future flow conditions. Private and pedestrian crossings were not included in the alternatives analysis. This alternatives analysis was performed using the baseline hydraulic model in HEC-RAS, version 6.4.1. For the alternatives analysis, areas of needed channel capacity improvements were identified based on the HEC-RAS model, but specific improvements were not evaluated.

### 5.2.6 Capacity Improvements – Future Flows, With Detention

All capacity alternatives were developed using City of Greeley and Weld County design criteria. A summary of the criteria used to evaluate the alternatives for the structure crossings is included in Table 12, Section 4.8. A summary of proposed crossing structure improvements is included as Table E-4, in Appendix E.

Capacity improvements were evaluated under future flow conditions, assuming regional detention Alternative D improvements as described in Section 5.3.1 would be implemented. Capacity improvements, including retrofit or structure replacement, channel grading, and installation of side culverts, were evaluated to match criteria and not just to prevent overtopping of the structure under the detained future flow conditions. Private and pedestrian crossings were not included in the alternatives analysis. This alternatives analysis was performed using the baseline hydraulic model in HEC-RAS, version 6.4.1. For the alternatives analysis, areas of needed channel capacity improvements were identified based on the HEC-RAS model, but specific improvements were not evaluated.

## 5.3 Alternative Costs

A cost estimate for proposed improvements should be done at the time of design, and costs provided within this study are high level estimates and include many caveats and assumptions. Costs within this study are not guaranteed costs, will likely increase with time and inflation, and are for planning purposes only. The cost estimates only include reach-specific alternatives and regional detention alternatives. The watershed-scale alternatives for water quality and future development considerations is not included.

The construction costs of the evaluated improvements were estimated using UD-MP Cost, version 2.2, which adjusts unit costs based upon the most recent Colorado Construction Cost Index (CCI), Quarter 3 of 2024. Many of the unit costs are pre-determined within UD-MP Cost and adjusted automatically based on the CCI. Specific costs were developed for some items, as summarized in Table 17. Costs for contingencies, engineering, legal and administration, and construction management were included as a percentage of capital improvement costs as follows: 25%, 15%, 5%, and 10%, respectively. For formalizing the detention ponds, only property acquisition, additional needed grading, outlet structure, and outlet pipe were included in the cost. For new detention, property acquisition and the complete-in-place cost was used to account for all components of the new detention pond.

Easement and right-of-way costs were provided by the City of Greeley, valuated by CBRE. Property acquisition costs for detention ponds were assumed to be split evenly between the future developer and the City of Greeley using the upper limit of the large tract estimate. Property acquisition costs for channel stability and capacity improvements on developed parcels were assumed to be paid for in full by the City of Greeley. For developed properties in the floodplain, acquisition cost for channel stability and capacity improvements was based on the mid-range limit of the small tract estimate. For developed properties outside the floodplain, acquisition cost for channel stability and capacity improvements was based on the upper limit of the small tract estimate. It was assumed that portions of the channel that are on undeveloped private property would be dedicated during the development process and therefore, no property acquisition costs were included. Excerpts from the CBRE property valuation are included in Appendix E.

**Table 17 – Unit Costs**

| Item Description | Unit | Unit Cost | Unit Cost Source |
|---|---|---|---|
| Concrete[1] | CY | $1,200 | UD-MP Cost |
| Steel (concrete reinforcement)[1] | LB | $2 | UD-MP Cost |
| 48-inch RCP | LF | $288 | UD-MP Cost |
| 60-inch RCP | LF | $480 | UD-MP Cost |
| 84-inch RCP | LF | $840 | UD-MP Cost |
| 48-inch Flared End Section | EA | $4,119 | UD-MP Cost |
| Removal of culvert pipe (48-inch<D<84-inch) | LF | $100 | UD-MP Cost |
| Removal of Concrete Box Culvert | LF/Cell | $200 | UD-MP Cost |
| Removal of Bridge | SF | $45 | Estimated from 2022 C Street Structure Selection Cost Estimate (Increased for Inflation) |
| Bridge | SF | $475 | Estimated from 2022 C Street Structure Selection Cost Estimate (Increased for Inflation) |
| Raise Road | SF | $25 | Pavement removal ($15/SY), fill ($48/CY), and base course/pavement ($150/SY), rounded up |
| Sheet Pile, Steel, Heavy, PSC-13 | SF | $45 | Recent bid data averaged |
| Concrete Cap | LF | $100 | Recent bid data averaged |
| Excavation, Mid Range | CY | $48 | UD-MP Cost |
| Detention (Complete In-Place) | AC-FT | $91,177 | UD-MP Cost |
| Outlet Works | EA | $75,000 | Recent bid data averaged |
| Water Quality Appurtenances | EA | $10,000 | Recent bid data averaged |
| Channel Improvements | LF | $1,400 | Recent bid data averaged |
| Check Structure, Concrete | LF | $540 | UD-MP Cost |
| Trail / Path, Concrete (10’ width) | LF | $105 | Recent bid data |
| Easement/ROW Acquisition – Detention Ponds | ACRE | $25,000 | CBRE Valuation |
| Easement/ROW Acquisition – Channel Stability/Capacity Improvements within Floodplain | ACRE | $150,000[2] | CBRE Valuation |
| Easement/ROW Acquisition – Channel Stability/Capacity Improvements out of Floodplain | ACRE | $175,000[2] | CBRE Valuation |
| Culvert Maintenance | LF | $2 | UD-MP Cost |
| Hydraulic Structure Maintenance | EA | $1,000 | UD-MP Cost |
| Channel Maintenance | LF | $400 | UD-MP Cost |
| Detention/WQ Maintenance | ACRE | $2,999 | UD-MP Cost |
| Mowing | ACRE | $100 | UD-MP Cost |
| Trail Maintenance | LF | $10 | UD-MP Cost |

[1]Unit costs for concrete and steel are used to estimate installed concrete box culverts of various sizes.
[2]Unit costs shown in detailed cost sheets are a weighted average based on land acquisition needs inside and outside of the floodplain

## 5.4 Alternatives Plans

Alternatives were developed at the watershed scale and reach specific scale. Watershed scale alternatives include evaluating alternatives that provide benefit to Sheep Draw as a whole including regional detention, water quality, and future development considerations. Reach specific alternatives include evaluating the reaches for pedestrian and maintenance accessibility, infrastructure protection and channel stability, and capacity with and without the recommended detention.

Maps of the alternatives are shown on Figure 6. All alternatives were evaluated using the existing infrastructure, future land use hydrology as a basis of the analysis. The existing conditions for the status quo alternative are shown on Figure 4. A summary of the costs for the recommended plan is included in Table 22, at the end of this section. The summary of costs includes contingencies, engineering design services, legal and administrative services, construction observation and material testing, easements, and operations and maintenance completed three times per year over a course of 50 years. Costs associated with each reach for the selected plan are included in Appendix E.

## Legend

- Roadway Crossing Structures
- Trail Crossing Structures
- MDP Reach Breaks
- Odd Numbered MDP Reach
- Even Numbered MDP Reach
- Canal/Ditch Centerline
- Sewer Mains
- Storm Mains
- Water Mains
- Gas Lines
- Trails
- Sheep Draw Regional Trail
- Roads
- Watershed Boundary
- City of Greeley
- Weld County
- Undeveloped Areas

**Greeley Parcels**
- Private
- Public

**Floodplain Layers**
- Future 100-Year Floodplain
- Future 100-year Floodplain Encroaches onto Private Property (Excludes areas where Sheep Draw centerline is on private property)
- Structures Within the Future 100-Year Floodplain

NOTES:
1. FEATURE NAMING CONVENTIONS HAVE BEEN SHORTENED FOR CLAIRTY.

- Ponds With Water Quality
- Ponds Without Water Quality

**Ponds Without Water Quality - Priority Level**
- 1-No Downstream Treatment, Close Proximity to Stream
- 2-No Downstream Treatment, Routed Through Open Channel or More Distance from Stream
- 3-Routed to Downstream Facitlity Prior to Outfall

**Detention Alternatives**
- Recommended
- Not Recommended
- Crossing Structure Alternatives
- Channel Capacity Improvements No Detention
- Channel Capacity Improvements With Detention

**Channel Stability Improvements**
- Channel Stability Improvements
- Monitor Channel Stability
- Install Check Structure to Protect Utility Crossing
- Acquire Stream Easement on Private Property
- Sheep Draw Regional Trail Expansion

N

0 600 1,200 2,400 US Feet

**Interactive Figures**

Detention Alternatives ON/OFF
Capacity Alternatives - No Detention ON/OFF
Capacity Alternatives - With Detention ON/OFF
Water Quality Alternatives ON/OFF
Stability Alternatives ON/OFF
Pedestrian and Maintenance Accessibility ON/OFF
Recommended Plan ON/OFF

Roads ON/OFF
Crossing Structure Symbols ON/OFF
Utilities ON/OFF
Parcels ON/OFF
Aerial ON/OFF
Undeveloped Areas ON/OFF
Regional Trail ON/OFF
100-Year Future Floodplain ON/OFF

CACHE LA POUDRE RIVER
GREELEY NO. 3 DITCH
NORTH BOOMERANG DITCH EXTENSION
BOOMERANG DITCH
US HWY 34 BUS
US HWY 34
C ST
4TH ST
10TH ST
71ST AVE
59TH AVE
65TH AVE
63RD AVE
STATE HWY 257
COUNTY ROAD 56
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
N-1
N-2
N-3
N-4

| | | | |
|---|---|---|---|
| PROJECT: 022-0169<br>DRAWN BY: DD<br>DATE: 3/2025 | **CITY OF GREELEY** | **SHEEP DRAW MASTER PLAN ALTERNATIVES ANALYSIS FIGURE** | olsson<br>1525 Raleigh Street<br>Suite 400<br>Denver, CO 80204<br>TEL: 303.237.2072<br>FAX: 303.237.2659<br>www.olsson.com | FIGURE<br>6 |

### 5.4.1 Watershed-Scale Alternative – Regional Detention

The Sheep Draw watershed is approximately 54% developed. Future development is anticipated in the upper portion of the watershed. While subregional detention is recommended for future developments, alternatives were developed to identify locations where regional detention would benefit Sheep Draw on the watershed scale. When hydrology is updated in the future and more of the watershed is developed, only regional, City-owned and maintained detention ponds will be able to be included in effective hydrology. Multiple detention ponds were evaluated on an individual scale and with combinations of ponds to identify the most effective alternative. Pond locations were selected for evaluation based on the impact of ponds included in the effective hydrologic analysis and by identifying locations where hydrograph timing results in significant flow increases along the Sheep Draw alignment. A summary of detention evaluated with this alternative is included in Table 18.

For implementation of any of the proposed regional detention ponds, Greeley will need to acquire property and/or easements and develop operations and maintenance plans to be considered in the future effective hydrology. The impacts of each detention alternative on peak flows on Sheep Draw are shown in Figure 7. Table E-1 in Appendix E summarizes the detention peak flows. When the detention ponds are formalized and designed, the future land use hydrology should be updated to reflect any development that has occurred since this master plan was completed to ensure they meet the goals of the master plan.

**Table 18 – Detention Alternatives Summary**

| Pond ID | Design Point | Location | Approach | Notes | Recommended? |
|---|---|---|---|---|---|
| 301 | 1170 | Upstream of SH 257 | Formalize existing pond into regional detention. | Location included in 2006 hydrology. Detention would include raising the road, excavation, or a combination to gain 2 additional feet of ponding depth. | Yes |
| 304 | 1136 | South of US HWY 34 | Formalize existing pond into regional detention. | Location included in 2006 hydrology. | Yes |
| 309 | 1129 | South of US HWY 34 | Formalize existing pond into regional detention. | Location included in 2006 hydrology. | Yes |
| 311 | 1011T | Southwest of US HWY 34 and 95th Ave | Formalize existing pond into regional detention. | Location included in 2006 hydrology. | Yes |
| 312 | 1103 | Upstream of Pond 311 | Formalize existing pond into regional detention. | Location included in 2006 hydrology. Detention would include raising the road, excavation, or a combination to gain 3additional feet of ponding depth. | No - pond in series, minimal benefit to additional pond |
| 313 | 1104 | Upstream of Pond 312 | Formalize existing pond into regional detention. | Location included in 2006 hydrology. | No - pond in series, minimal benefit to additional pond |
| 364 | 164 | Upstream of US HWY 34, East of 83rd Ave | Construct new regional pond and re-route Subbasins 83 and 84 | Assumes utilizing existing storm drains across highway for pond outlet. | Yes |

- Detention Alternative A is a combination of Ponds 301, 304, and 311. This alternative results in reduced peak flows being at County Road 21, to near existing conditions peak flows. Flows are lower than existing between US 34 and 71st Avenue. Downstream of 71st Avenue, peak flows are reduced from future peak flows but higher than existing. **This alternative is not recommended.**

- Detention Alternative B is a combination of Ponds 301 and 304. This alternative results in reduced peak flows being at County Road 21, to near existing conditions peak flows. This alternative would not reduce flows enough at 71st Avenue to negate the need for structure capacity improvements. **This alternative is not recommended.**

- Detention Alternative C is a combination of Ponds 301 and 311. This alternative results in reduced peak flows being at County Road 21, to near existing conditions peak flows. This alternative would not reduce flows enough at 71st Avenue to negate the need for structure capacity improvements. **This alternative is not recommended.**

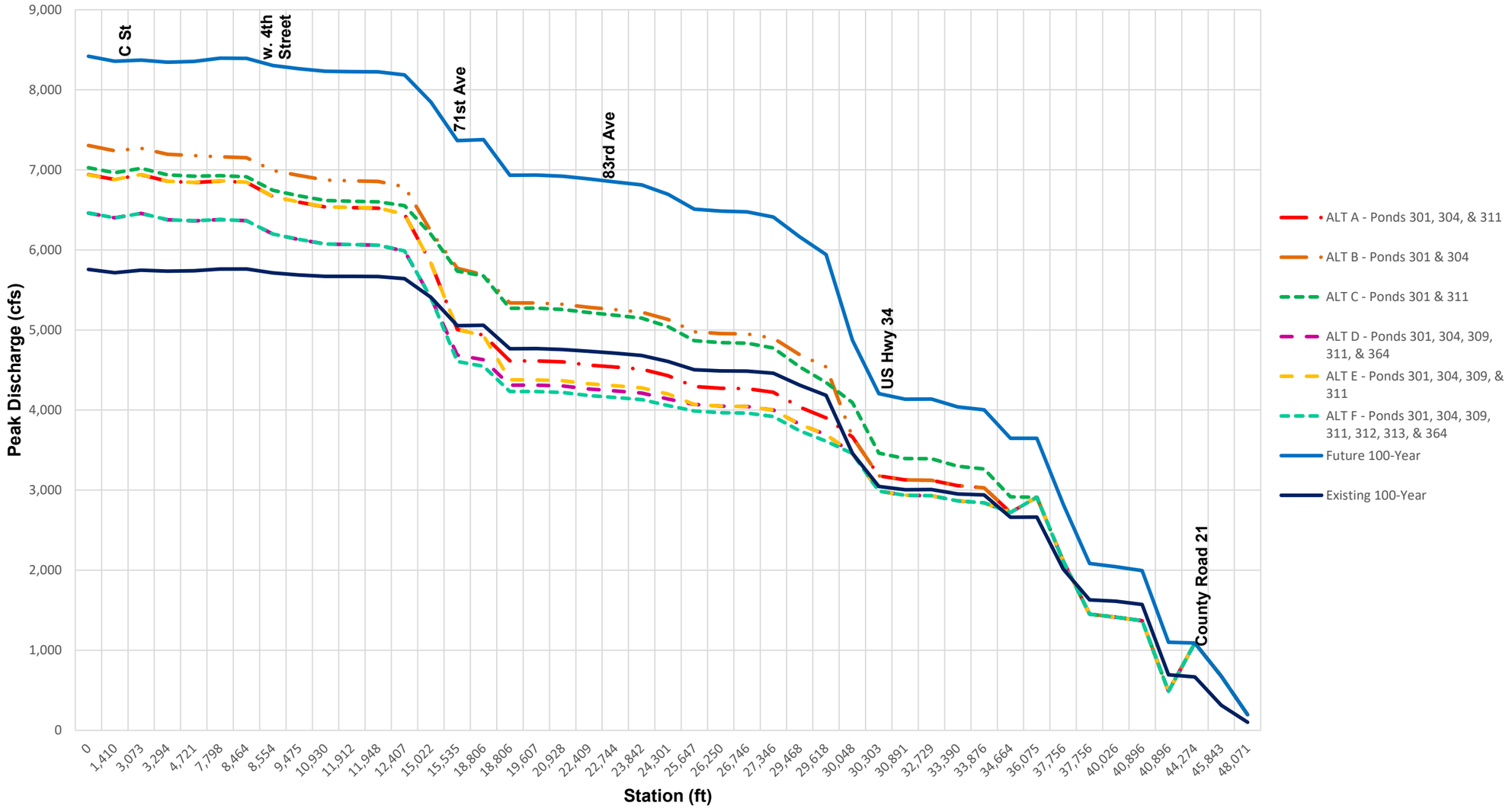
- Detention Alternative D is a combination of Ponds 301, 304, 309, 311, and 364. This alternative results in reduced peak flows being at County Road 21, to near existing conditions peak flows. Flows are lower than existing between US 34 and 71st Avenue. Downstream of 71st Avenue, peak flows are reduced from future peak flows to the same extent as Alternative F, where all ponds are modeled. **This is the recommended alternative.**

  The peak flows are still higher than existing conditions downstream of 71st Avenue. To further reduce the peak flows to existing conditions, additional regional detention for developed areas downstream of US Highway 34 would be needed. This detention alternative results in a double peak in the lower reaches, and the peak flows are controlled by the first peak. The tributary area downstream of US Highway 34 largely contributes to the first peak, while the second peak is mostly impacted by the detention upstream of US Highway 34. Several detention ponds would be needed to reduce the peak flows to existing conditions, since the undeveloped areas downstream of US Highway 34 are more dispersed. Additional detention would not significantly reduce the structure capacity alternatives and therefore was not evaluated further.

- Detention Alternative E is a combination of Ponds 301, 304, 309, and 311. This alternative results in reduced peak flows being at County Road 21, to near existing conditions peak flows. Flows are lower than existing between US 34 and 71st Avenue. Downstream of 71st Avenue, peak flows are reduced from future peak flows but higher than existing. This alternative does not provide as much benefit as Detention Alternative D. **This alternative is not recommended.**

- Detention Alternative F is a combination of all of the analyzed ponds: 301, 304, 309, 311, 312, 313, and 364. This alternative results in lower flows than existing between US 34 and 71st Avenue. Peak flows are higher than existing, though significantly reduced downstream of 71st Avenue. **This alternative is not recommended** because it provides nominally more flow reduction than Alternative D.

**Figure 7 – Detention Alternatives Peak Flow Comparison**
**Sheep Draw**
**Peak Discharge vs. Drainageway Station**



### 5.4.2 Watershed-Scale Alternative – Water Quality and Environmental Considerations

Each existing pond was evaluated and assigned a priority level, with one being the most pressing and three being the least pressing, to retrofit the pond to provide water quality treatment. Priority levels are shown on Figure 6 and were assigned based on their proximity to Sheep Draw and the existing or proposed water quality benefit of features downstream. Ponds where prioritized assuming that higher priority ponds would be addressed first. Descriptions of priorities levels are included below.

- Priority 1 – ponds that do not have a water quality plate and are close into proximity to Sheep Draw or outfall directly to Sheep Draw via storm drains. These ponds do not route into a downstream treatment facility, or facility that could provide treatment in the future.
- Priority 2 – ponds that do not have a water quality plate and do not route into a downstream treatment facility but are located farther away from Sheep Draw and/or outfall into an open channel prior to reaching Sheep Draw, where some water quality treatment could be passively achieved.
- Priority 3 – ponds that do not have a water quality plate but route through a treatment facility, or facility that could provide treatment in the future, prior to reaching Sheep Draw.

**Sub-regional water quality is recommended for future developments.**

There is a wetland area east of 71st Avenue that is providing passive water quality benefits prior to flows reaching Sheep Draw. It is recommended that this area be maintained as a wetland area to continue providing this passive water quality treatment.

The City of Greeley is evaluating the potential for using areas along Sheep Draw for wetland banking. Areas used for wetland banking will need to be monitored to ensure the vegetation remains healthy, especially as the upper watershed develops. A monitoring plan should be prepared for any wetland banking areas. The additional development consideration recommendations included in Section 5.3.3 would help mitigate changes in the flow regime that could compromise the existing vegetation along Sheep Draw.

The dense wetland vegetation along much of Sheep Draw helps to stabilize the channel, making it more resilient to changes in the watershed. This vegetation should be maintained, species diversity enhanced where it is lacking, and weeds maintained in the future. A dredging project was completed near the Pumpkin Ridge development north of 10th Street and the vegetation has not fully re-established. This area could be reshaped with future channel work to better facilitate the ecological function of Sheep Draw in this reach.

### 5.4.3 Watershed-Scale Alternative – Future Development Considerations

The intent of the alternatives and recommended plan are to help future Master Plan users understand what the goals and constraints are in each reach, and encourage further, in-depth analysis of each problem area as they are addressed. Future developments shall follow the City of Greeley criteria, including the incorporation of private full spectrum detention and water quality. **It is recommended that as the watershed develops, the future land use percent impervious assumptions be reviewed for consistency with this master plan.** Additionally, considerations of the incorporation of artificial turf and other more impervious surfaces should be considered when validating future land use assumptions in this master plan. A large portion of the watershed is undeveloped, and the future land use hydrology incorporates many assumptions. As such, it is recommended that intermediate updates to the master plan hydrology model be completed to validate the master plan flows as both development occurs and regional detention ponds are designed and formalized. In general, regional detention should be implemented when areas tributary to the detention ponds develop to mitigate increases in peak flows downstream.

While full spectrum detention helps reduce downstream peak flows to pre-developed conditions, it does not significantly impact the increases in the volume of runoff. This change in flow regime can impact downstream reaches that were historically stable. Future developments should consider implementing additional measures to help offset the changes in flow regime. The use of directly connected impervious areas (DCIA) and rain barrels was investigated to determine potential impacts.

Investigations into the benefit of utilizing DCIA as criteria options for new developments in the watershed were evaluated to determine their contribution in reducing future peak flows and volumes in the system. Any reduction in peak flows would not be realized with effective flows but would help with future channel stability. CUHP includes options to input different DCIA levels. Two DCIA scenarios, Level 1 and Level 2, were evaluated to determine potential impacts on the downstream system. The levels were updated for all subbasins that are primarily undeveloped, and the remainder of the developed subbasins were left at Level 0. A DCIA Level 1 includes directing runoff from impervious surface to flow over grass or permeable pavement before it reaches a stormwater conveyance system. A DCIA Level 2 is an enhancement to Level 1 and in addition to Level 1 practices, replaces traditional curbs and gutters with no curb, slotted curbs, grass-lined swales, and/or pervious shoulders such that the main conveyance system is primarily pervious.

The 2-year and 100-year future land use peak flows and volumes were compared to baseline conditions for each of the two DCIA scenarios. Both DCIA scenarios had minimal effect on the 100-year peak flows and volumes, averaging at approximately 1% reduction as compared to the future land use baseline hydrology. However, there were more substantial decreases in the 2-year storm event. The Level 1 scenarios averaged a 14% reduction in peak flows and a 13% reduction in volumes, while the Level 2 scenario averaged a 29% reduction in peak flows and a 28% reduction in volumes for the 2-year event. The reduction does not reduce flows down to pre-development conditions; however, the analysis shows that incorporating DCIA practices into the development in the upper watershed provides meaningful reductions for frequent storm events. At a minimum, it is recommended the development in the upper watershed include DCIA Level 1 practices to the extents feasible, and enhancements to a Level 2 are encouraged.

To further reduce peak flows and volumes in the downstream watershed as development occurs, the impacts of a rain barrel program for residential properties was evaluated. Any reduction in peak flows would not be realized with effective flows but would help with future channel stability. The analysis assumed that only new development would incorporate rain barrels, and no changes to the areas already developed were included in the analysis. Additionally, it was assumed that a rain barrel would capture 50% of the roof area of a single-family home. To evaluate the impacts of rain barrels on the downstream system, the area of each future residential zoning area was determined for each subbasin. An average lot size for each residential zone was then assumed based on the City of Greeley's Residential Development Standards. A percentage was applied to each area to subtract out areas assumed to

consist of multi-family units, roadways, parks, and other infrastructure in order to determine the number of lots, or roofs, in each subbasin. An average roof area was applied to each residential zone based on a sampling of areas in developed portions of the watershed. The total assumed roof area in each subbasin was then calculated and a 50% reduction was applied to account for capturing only half of the roof area. This area was then subtracted from the total subbasin area, and the percent impervious value was adjusted to remove the roof area as well. The assumptions used in the rain barrel analysis are included in Table 19.

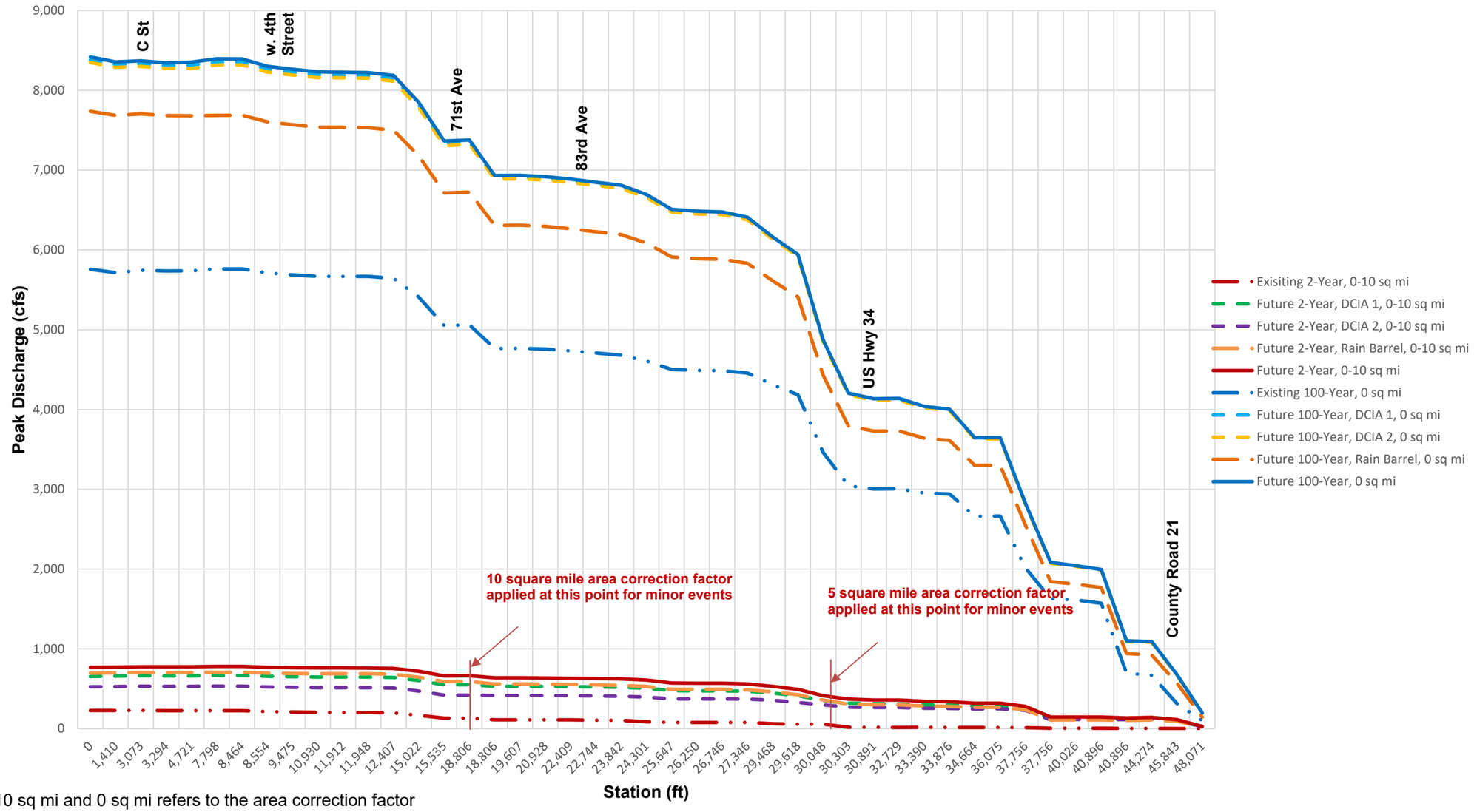
**Table 19 – Rain Barrel Analysis Assumptions**

| Zoning | Lot Area Assumption (SF) | % Single-Family Lots | Assumed Roof Area (SF) | Notes |
|---|---|---|---|---|
| Residential-Estate | 13,000 | 90% | 3000 | Estate Lot, 10% outside of lots |
| Residential-Low | 6,000 | 85% | 2000 | Assume average will be standard lot, 15% outside of lots |
| Residential-Medium | 4,500 | 60% | 2000 | Assume average will be medium lot, assume 25% will be multi-family and only apply 75% of the area, 25% outside of lots |
| Residential-High | 3,000 | 20% | 2000 | Assume average will be small lot, assume 25% will be multi-family and only apply 75% of the area, 25% outside of lots |

The 2-year and 100-year future land use peak flows and volumes were compared to baseline conditions for the rain barrel scenario. The rain barrel scenario averaged a 14% reduction in peak flows and a 12% reduction in volumes for the 2-year event, and a 10% reduction in peak flows and a 7% reduction in volumes for the 100-year event. The reductions are meaningful and included potential reductions for larger storm events. However, implementation and long-term performance is not as certain as implementing DCIA practices. Several key considerations are the amount of water captured in rain barrels is limited by State of Colorado law, rain barrels may be full when a storm event occurs, and individual property owners may decide to no longer maintain them. For these reasons, it is recommended to encourage the use of rain barrels, but not to have them considered as a criteria.

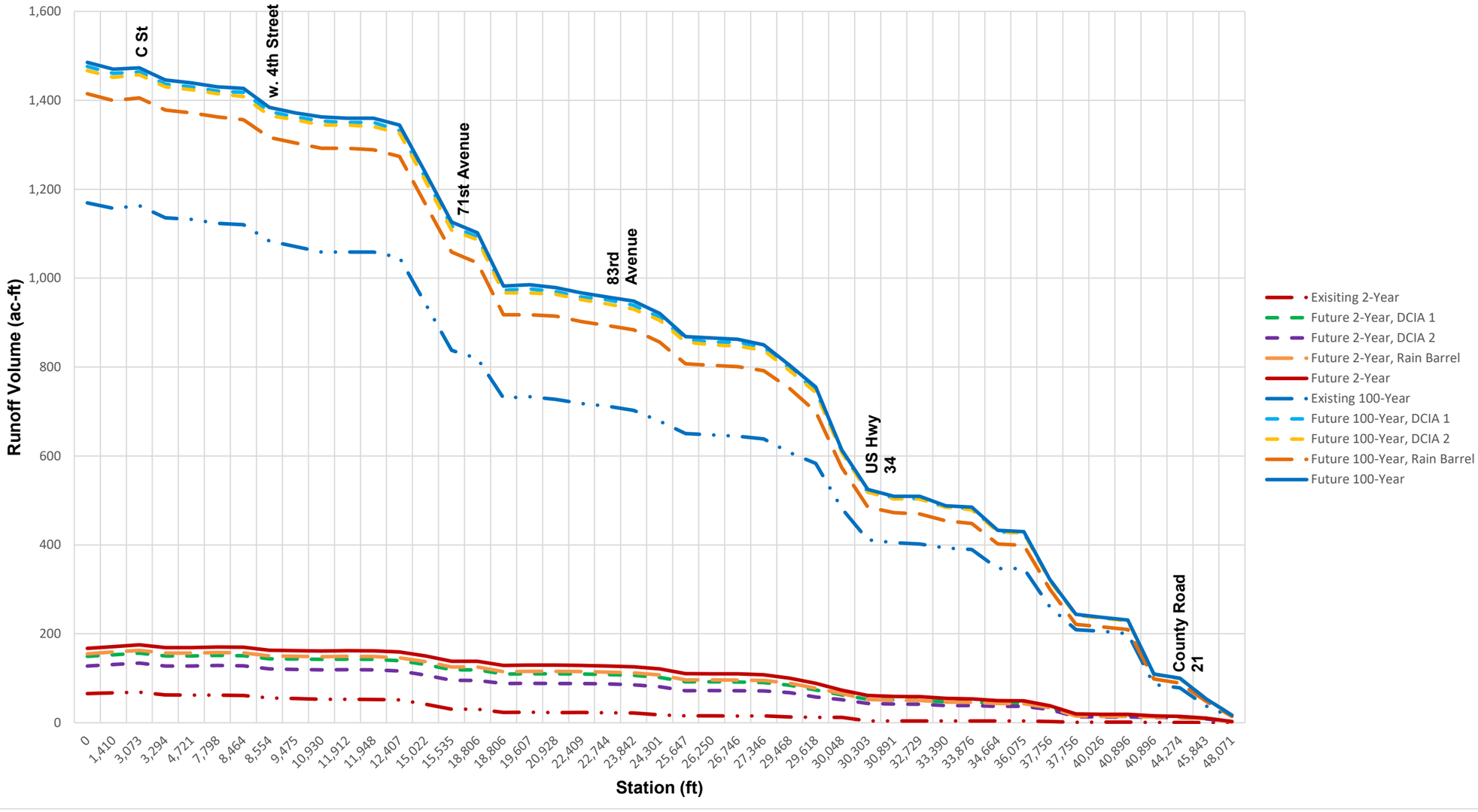
Comparisons of peak flows and volumes along the drainageway are shown in Figure 8 and Figure 9. The peak flows and runoff volumes are included in Tables E-2 and E-3 in Appendix E.

**Figure 8 – DCIA and Rain Barrel Peak Flow and Runoff Volume Comparisons**
**Sheep Draw**
**Peak Discharge vs. Drainageway Station**




[1]0-10 sq mi and 0 sq mi refers to the area correction factor

**Figure 9 – DCIA and Rain Barrel Peak Flow and Runoff Volume Comparisons**
**Sheep Draw**
**Runoff Volume vs. Drainageway Station**



### 5.4.4 Reach-Specific Alternatives

Alternatives specific to each reach were prepared to evaluate the reaches for pedestrian and maintenance accessibility, infrastructure protection and channel stability, and capacity with and without the recommended detention. Reach-specific recommendations for each goal are detailed in the following tables.

## Alternatives: Sheep Draw Reach 1– Downstream Study Limits to Weld County Border Upstream of Greeley No.3 Ditch[1]

**Existing Condition**

- Irregularly shaped, meandering natural with wide, flat, native grass overbanks
- Two pedestrian trail crossings and Greeley No.3 Ditch crossing

**Problem Areas/ Status Quo**

**Infrastructure and Stability**

- Sanitary sewer crossing

**Capacity**

- Future 100-year floodplain overtops pedestrian trail crossing
- Sheep Draw flows into Greeley No.3 Ditch and minor and major storm will overtop the berm

**Maintenance**

- No maintenance access path exists along the channel in this reach

**Improvement Goals**

**Overall Goals**

1. Provide access for community
2. Provide access for maintenance
3. Protect existing utilities from erosion
4. Protect existing trails from erosion
5. Protect private property from erosion
6. Stabilize channel, no infrastructure threatened
7. Increase channel capacity to remove insurable structure from future 100-year floodplain
8. Increase channel capacity to remove private property from future 100-year floodplain
9. Increase crossing capacity to remove insurable structures from future 100-year floodplain
10. Increase crossing capacity to meet future 100-year criteria

**Site Photos:**

Left to Right:

[1]Canal Crossing at Greeley No.3 Ditch looking downstream

[2]CMP trail crossing

1



2



**ALTERNATIVE**

**Pedestrian and Maintenance Accessibility**

**Improvement Goals:**

**2**

**RECOMMENDED:**

- The regional trail is not shown extending parallel to Sheep Draw in this reach. Maintenance access could be added in the future, if needed.

**Design Constraints and Considerations**

- No constraints

**ALTERNATIVE**

**Capacity Improvements Future Flows, No Detention**

**Improvement Goals:**

**Protect berm**

**NOT RECOMMENDED:**

- Improvements to capacity of pedestrian crossings are not included in this analysis. However, it is recommended that the two CMP trail crossings are replaced with RCP when needed.
- Improvements to the Greeley No.3 Ditch to protect the berm from damage during minor storm event overtopping is recommended. The low areas on the berm west of the channel will be filled in and a 450-foot-wide spillway will be constructed on the east side of the channel to convey flows up to the 10-year event.

**Design Constraints and Considerations**

- The Greeley No.3 Ditch berm fill and spillway should be configured such that there is no rise in the 100-year floodplain on the private property south of the ditch. A 100-year spillway is not feasible without extensive channel grading on the upstream and downstream sides and was therefore not investigated further.

**ALTERNATIVE**

**Infrastructure Protection and Channel Stabilization**

**Improvement Goals:**

**3**

**RECOMMENDED:**

- Implement check structure downstream of sanitary sewer crossing

**Design Constraints and Considerations**

- No constraints

**ALTERNATIVE**

**Capacity Improvements Future Flows, With Detention**

**Improvement Goals:**

**Protect berm**

**RECOMMENDED:**

- Improvements to capacity of pedestrian crossings are not included in this analysis. However, it is recommended that the two CMP trail crossings are replaced with RCP when needed.
- Improvements to the Greeley No.3 Ditch to protect the berm from damage during minor storm event overtopping is recommended. The low areas on the berm west of the channel will be filled in and a 450-foot-wide spillway will be constructed on the east side of the channel to convey flows up to the 10-year event.

**Design Constraints and Considerations**

- The Greeley No.3 Ditch berm fill and spillway should be configured such that there is no rise in the 100-year floodplain on the private property south of the ditch. A 100-year spillway is not feasible without extensive channel grading on the upstream and downstream sides and was therefore not investigated further.

[1]Regional detention, water quality and environmental considerations, and future development consideration alternatives are not included in alternative tables because they are watershed-based and not reach specific. See Sections 5.4.1-5.4.3 for more information regarding these alternatives.

## Alternatives: Sheep Draw Reach 2– Weld County Border Upstream of Greeley No.3 Ditch to Downstream of C St.[1]

**Existing Condition**

- Irregularly shaped, meandering natural with wide, flat, native grass overbanks
- Three private pedestrian crossings
- Private property

**Problem Areas/ Status Quo**

**Infrastructure and Stability**

- Active fast erosion on some outer bends

**Capacity**

- Future 100-year floodplain overtops pedestrian trail crossings
- Insurable structures located in the future 100-year floodplain
- Future 100-year floodplain threatens private property

**Maintenance**

- There is no maintenance access path or easement along the channel in this reach

**Improvement Goals**

**Overall Goals**

1. Provide access for community
2. Provide access for maintenance
3. Protect existing utilities from erosion
4. Protect existing trails from erosion
5. Protect private property from erosion
6. Stabilize channel, no infrastructure threatened
7. Increase channel capacity to remove insurable structure from future 100-year floodplain
8. Increase channel capacity to remove private property from future 100-year floodplain
9. Increase crossing capacity to remove insurable structures from future 100-year floodplain
10. Increase crossing capacity to meet future 100-year criteria

**Site Photos:**

Left to Right:

[1]Access bridge with railing

[2]Irrigation water crossing: 1.5' diameter utility poles on upstream side of 15" PVC

[3]C St. bridge looking downstream

1



2



3



**ALTERNATIVE**

**Pedestrian and Maintenance Accessibility**

**Improvement Goals:** 2

**RECOMMENDED:**

- Acquire easement along Sheep Draw

**Design Constraints and Considerations**

- Channel is located fully on one private property
- Easement can be obtained when channel improvements are needed

**ALTERNATIVE**

**Capacity Improvements Future Flows, No Detention**

**Improvement Goals:** 7

**NOT RECOMMENDED:**

- Widen channel downstream of C Street to remove insurable structure from the future 100-year floodplain

**Design Constraints and Considerations**

- Channel is located on private property and will require an easement
- Might require replacement of private pedestrian crossings

**ALTERNATIVE**

**Infrastructure Protection and Channel Stabilization**

**Improvement Goals:** 5, 6

**RECOMMENDED:**

- Monitor erosion and implement stabilization improvements if needed

**Design Constraints and Considerations**

- Channel is located on private property and will require an easement for any work

**ALTERNATIVE**

**Capacity Improvements Future Flows, With Detention**

**Improvement Goals:** 7

**RECOMMENDED:**

- Widen channel downstream of C Street to remove insurable structure from the future 100-year floodplain

**Design Constraints and Considerations**

- Channel is located on private property and will require an easement
- Might require replacement of private pedestrian crossings

[1]Regional detention, water quality and environmental considerations, and future development consideration alternatives are not included in alternative tables because they are watershed-based and not reach specific. See Sections 5.4.1-5.4.3 for more information regarding these alternatives.

# Alternatives: Sheep Draw Reach 3 – Downstream of C St to Downstream of 4th St.[1]

**Existing Condition**

- Irregularly shaped, meandering natural with native grass overbanks
- Sanitary sewer parallels channel and crosses in two locations
- Storm and detention pond outfalls
- One pedestrian trail crossing and C St roadway crossing

**Problem Areas/ Status Quo**

**Infrastructure and Stability**

- Active fast erosion on some outer bends
- Potential for erosion on some outer bends
- Active fast erosion near large diameter, high-pressure gas crossing
- Active and potential erosion threatening pedestrian trail and sanitary sewer that run parallel to channel
- Potential for erosion at one sanitary sewer crossing
- Active fast erosion threatening storm outfall

**Capacity**

- Future 100-year floodplain overtops C St and pedestrian trail crossing
- Insurable structures located in the future 100-year floodplain
- Future 100-year floodplain encroaches onto and threatens private property

**Maintenance**

- There is no easement I one area of the channel in this reach

**Improvement Goals**

**Overall Goals**

1. Provide access for community
2. Provide access for maintenance
3. Protect existing utilities from erosion
4. Protect existing trails from erosion
5. Protect private property from erosion
6. Stabilize channel, no infrastructure threatened
7. Increase channel capacity to remove insurable structure from future 100-year floodplain
8. Increase channel capacity to remove private property from future 100-year floodplain
9. Increase crossing capacity to remove insurable structures from future 100-year floodplain
10. Increase crossing capacity to meet future 100-year criteria

**Site Photos:**

Left to Right:

[1]Looking downstream at C St crossing

[2]Streambank erosion along pedestrian trail

[3]Streambank erosion along pedestrian trail

[4]Channel facing 61st Ave













**ALTERNATIVE**

**Pedestrian and Maintenance Accessibility**

**Improvement Goals:** 2

**RECOMMENDED:**

- Acquire easement along Sheep Draw north of 4th Street

**Design Constraints and Considerations**

- Channel is located fully on one private property
- Easement can be obtained when channel improvements are needed

**ALTERNATIVE**

**Capacity Improvements Future Flows, No Detention**

**Improvement Goals:** 7-10

**NOT RECOMMENDED:**

- Replace the existing C Street bridge with a 130-foot span bridge and raise the low chord and street by 4.4 feet
- Increase channel capacity to remove insurable structures and private property from the future 100-year floodplain
- Both the crossing and channel improvements are needed to reduce the floodplain upstream of C Street
- It is recommended that the CMP trail crossing be replaced with RCP when needed

**Design Constraints and Considerations**

- Utilities and roadway tie-ins along C Street, consider overflow path for 500-year when raising roadway
- Parts of channel are located on private property and will require an easement for any work

**ALTERNATIVE**

**Infrastructure Protection and Channel Stabilization**

**Improvement Goals:** 3-6

**RECOMMENDED:**

- Implement one check structure downstream of gas line and one downstream of sanitary crossing
- Implement stabilization improvements along right bank to protect sanitary sewer and trail
- Monitor erosion and implement stabilization improvements if needed

**Design Constraints and Considerations**

- Sanitary sewer paralleling channel
- Parts of channel are located on private property and will require an easement for any work

**ALTERNATIVE**

**Capacity Improvements Future Flows, With Detention**

**Improvement Goals:** 7-10

**RECOMMENDED:**

- Replace the existing C Street bridge with a 110-foot span bridge and raise the low chord and street by 3.6 feet
- Increase channel capacity to remove insurable structures and private property from the future 100-year floodplain
- Both the crossing and upstream channel improvements are needed to reduce the floodplain upstream of C Street
- It is recommended that the CMP trail crossing be replaced with RCP when needed

**Design Constraints and Considerations**

- Utilities and roadway tie-ins along C Street, consider overflow path for 500-year when raising roadway
- Parts of channel are located on private property and will require an easement for any work

[1]Regional detention, water quality and environmental considerations, and future development consideration alternatives are not included in alternative tables because they are watershed-based and not reach specific. See Sections 5.4.1-5.4.3 for more information regarding these alternatives.

# Alternatives: Sheep Draw Reach 4 – Downstream of 4th St to Downstream of 10th St.[1]

**Existing Condition**

- Irregularly shaped, meandering natural with native grass overbanks
- Sanitary sewer parallels channel and crosses in two locations
- Storm and detention pond outfalls
- Three pedestrian trail crossings and 4th St roadway crossing

**Problem Areas/ Status Quo**

**Infrastructure and Stability**

- Active fast erosion on some outer bends
- Potential for erosion on some outer bends
- Active fast erosion threatening one sanitary sewer crossing
- Potential for erosion at one sanitary sewer crossing
- Active and potential erosion threatening pedestrian trail and sanitary sewer that run parallel to channel
- Potential for erosion at one water crossing

**Capacity**

- Future 100-year floodplain overtops three pedestrian trail crossings
- 4th St crossing does not meet future 100-year criteria
- Insurable structures located in the future 100-year floodplain
- Future 100-year floodplain encroaches onto and threatens private property

**Improvement Goals**

**Overall Goals**

1. Provide access for community
2. Provide access for maintenance
3. Protect existing utilities from erosion
4. Protect existing trails from erosion
5. Protect private property from erosion
6. Stabilize channel, no infrastructure threatened
7. Increase channel capacity to remove insurable structure from future 100-year floodplain
8. Increase channel capacity to remove private property from future 100-year floodplain
9. Increase crossing capacity to remove insurable structures from future 100-year floodplain
10. Increase crossing capacity to meet future 100-year criteria

**Site Photos:**

Left to Right:

[1]Channel Overbanks Showing Native Vegetation Around Stream

[2]General channel conditions

1



2



**ALTERNATIVE**

**Pedestrian and Maintenance Accessibility**

**Improvement Goals:**

**N/A**

**NOT RECOMMENDED:**

- No improvements recommended

**Design Constraints and Considerations**

- No constraints

**ALTERNATIVE**

**Capacity Improvements Future Flows, No Detention**

**Improvement Goals:**

**7-10**

**NOT RECOMMENDED:**

- Replace the existing 4th Street bridge with a 150-foot span bridge and raise the low chord and street by 2.3 feet
- Relocate the pedestrian bridge upstream of 4th Street to remove insurable properties from the 100-year floodplain
- Increase channel capacity to remove insurable structures and private property from the future 100-year floodplain

**Design Constraints and Considerations**

- Utilities and roadway tie-ins along 4th Street
- The 4th Street bridge is controlled by the tailwater form the downstream channel, which is partially located on private property. Channel improvements on both sides of 4th Street are needed in addition to the crossing, and pedestrian crossing relocation to remove insurable structures from the 100-year future floodplain

**ALTERNATIVE**

**Infrastructure Protection and Channel Stabilization**

**Improvement Goals:**

**3-4, 6**

**RECOMMENDED:**

- Implement two check structures downstream of sanitary sewer crossings
- Implement stabilization improvements along right bank near 10th Street to protect sanitary sewer and trail
- Monitor erosion and implement stabilization improvements if needed

**Design Constraints and Considerations**

- Sanitary sewer paralleling channel

**ALTERNATIVE**

**Capacity Improvements Future Flows, With Detention**

**Improvement Goals:**

**7-10**

**RECOMMENDED:**

- Add (1) 20-foot by 10-foot RCBC adjacent to the existing 4th Street bridge
- Increase channel capacity to remove insurable structures and private property from the future 100-year floodplain

**Design Constraints and Considerations**

- Utilities and roadway tie-ins along 4th Street
- The 4th Street bridge is controlled by the tailwater form the downstream channel, which is partially located on private property. Channel improvements on both sides of 4th Street are needed in addition to the crossing, and pedestrian crossing relocation to remove insurable structures from the 100-year future floodplain

[1]Regional detention, water quality and environmental considerations, and future development consideration alternatives are not included in alternative tables because they are watershed-based and not reach specific. See Sections 5.4.1-5.4.3 for more information regarding these alternatives.

# Alternatives: Sheep Draw Reach 5 – Downstream of 10th St. to Confluence with 71st Ave. Split[1]

**Existing Condition**

- Irregularly shaped, meandering natural with native grass overbanks
- Sanitary sewer parallels channel
- Water main parallels channel and crosses in one location
- Storm and detention pond outfalls
- Two pedestrian trail crossings and 10th Street roadway crossing

**Problem Areas/ Status Quo**

**Infrastructure and Stability**

- Active fast erosion on some outer bends
- Active fast erosion threatening one sanitary sewer crossing
- Active and potential erosion threatening pedestrian trail and sanitary sewer that run parallel to channel
- Active fast erosion at one water crossing

**Capacity**

- Future 100-year floodplain overtops two pedestrian trail crossings
- 10th St crossing does not meet future 100-year criteria
- Insurable structures located in the future 100-year floodplain
  Future 100-year floodplain encroaches onto and threatens private property

**Maintenance**

- There is no easement along one area of the channel in this reach

**Improvement Goals**

**Overall Goals**

1. Provide access for community
2. Provide access for maintenance
3. Protect existing utilities from erosion
4. Protect existing trails from erosion
5. Protect private property from erosion
6. Stabilize channel, no infrastructure threatened
7. Increase channel capacity to remove insurable structure from future 100-year floodplain
8. Increase channel capacity to remove private property from future 100-year floodplain
9. Increase crossing capacity to remove insurable structures from future 100-year floodplain
10. Increase crossing capacity to meet future 100-year criteria

**Site Photos:**

Left to Right:

[1]Looking downstream at the water main crossing

[2]Looking upstream at crossing structure 11

[3]General channel conditions

1



2



3



**ALTERNATIVE**
**Pedestrian and Maintenance Accessibility**
**Improvement Goals: 2**

**RECOMMENDED:**

- Acquire easement along Sheep Draw south of 10th Street

**Design Constraints and Considerations**

- Channel is located fully on one private property
- Easement can be obtained when channel improvements are needed

**ALTERNATIVE**
**Capacity Improvements Future Flows, No Detention**
**Improvement Goals: 9-10**

**NOT RECOMMENDED:**

- Add (2) 26-foot by 10-foot RCBC adjacent to the existing 10th Street bridge, channel grading downstream
- Reconfigure pedestrian trail crossing upstream of 10th Street to remove insurable properties from the future 100-year floodplain

**Design Constraints and Considerations**

- Utilities within 10th Street and crossing Sheep Draw in the vicinity of the bridge
- Both the crossing improvements (10th St and the pedestrian crossing) are needed to reduce the floodplain upstream of 10th Street

**ALTERNATIVE**
**Infrastructure Protection and Channel Stabilization**
**Improvement Goals: 3-4**

**RECOMMENDED:**

- Implement one check structure downstream of water line
- Implement stabilization improvements to protect sanitary sewer and water line
- Monitor erosion and implement stabilization improvements if needed

**Design Constraints and Considerations**

- Sanitary sewer and water line paralleling channel

**ALTERNATIVE**
**Capacity Improvements Future Flows, With Detention**
**Improvement Goals: 9-10**

**RECOMMENDED:**

- Add (1) 12-foot by 10-foot RCBC adjacent to the existing 10th Street bridge

**Design Constraints and Considerations**

- Utilities within 10th Street and crossing Sheep Draw in the vicinity of the bridge

[1]Regional detention, water quality and environmental considerations, and future development consideration alternatives are not included in alternative tables because they are watershed-based and not reach specific. See Sections 5.4.1-5.4.3 for more information regarding these alternatives.

## Alternatives: Sheep Draw Reach 6 – Confluence with 71st Ave. Split to Downstream of 71st Ave.[1]

**Existing Condition**

- Irregularly shaped, meandering natural with native grass overbanks
- Sanitary sewer parallels channel and crosses in one location
- One pedestrian trail crossing

**Problem Areas/ Status Quo**

**Infrastructure and Stability**

- Active fast erosion on some outer bends
- Pedestrian trail and sanitary sewer run parallel to channel

**Capacity**

- Future 100-year floodplain overtops one pedestrian trail crossing

**Improvement Goals**

**Overall Goals**

1. Provide access for community
2. Provide access for maintenance
3. Protect existing utilities from erosion
4. Protect existing trails from erosion
5. Protect private property from erosion
6. Stabilize channel, no infrastructure threatened
7. Increase channel capacity to remove insurable structure from future 100-year floodplain
8. Increase channel capacity to remove private property from future 100-year floodplain
9. Increase crossing capacity to remove insurable structures from future 100-year floodplain
10. Increase crossing capacity to meet future 100-year criteria

**Site Photos:**

1 and 2General channel conditions







**ALTERNATIVE**
**Pedestrian and Maintenance Accessibility**
**Improvement Goals:**
**N/A**

**NOT RECOMMENDED:**

- No improvements recommended

**Design Constraints and Considerations**

- No constraints

**ALTERNATIVE**
**Capacity Improvements Future Flows, No Detention**
**Improvement Goals:**
**N/A**

**NOT RECOMMENDED:**

- No improvements recommended

**Design Constraints and Considerations**

- No constraints

**ALTERNATIVE**
**Infrastructure Protection and Channel Stabilization**
**Improvement Goals:**
**3, 6**

**RECOMMENDED:**

- Monitor erosion and implement stabilization improvements if needed

**Design Constraints and Considerations**

- Sanitary sewer paralleling channel with one crossing

**ALTERNATIVE**
**Capacity Improvements Future Flows, With Detention**
**Improvement Goals:**
**N/A**

**NOT RECOMMENDED:**

- No improvements recommended

**Design Constraints and Considerations**

- No constraints

[1]Regional detention, water quality and environmental considerations, and future development consideration alternatives are not included in alternative tables because they are watershed-based and not reach specific. See Sections 5.4.1-5.4.3 for more information regarding these alternatives.

## Alternatives: Reach 7 - 71st Ave Split[1]

**Existing Condition**

- Irregularly shaped, meandering natural with native grass overbanks
- Sanitary sewer parallels channel and crosses in one location
- Two pedestrian trail crossings

**Problem Areas/ Status Quo**

**Infrastructure and Stability**

- Potential for erosion on some outer bends
- Potential erosion threatening pedestrian trail and sanitary sewer that run parallel to channel

**Capacity**

- Future 100-year floodplain overtops two pedestrian trail crossings

**Improvement Goals**

**Overall Goals**

1. Provide access for community
2. Provide access for maintenance
3. Protect existing utilities from erosion
4. Protect existing trails from erosion
5. Protect private property from erosion
6. Stabilize channel, no infrastructure threatened
7. Increase channel capacity to remove insurable structure from future 100-year floodplain
8. Increase channel capacity to remove private property from future 100-year floodplain
9. Increase crossing capacity to remove insurable structures from future 100-year floodplain
10. Increase crossing capacity to meet future 100-year criteria

**Site Photos:**

[1]Storm sewer outfall

[2]Looking upstream from crossing structure 14

1



2



**ALTERNATIVE**

**Pedestrian and Maintenance Accessibility**

**Improvement Goals:**

**N/A**

**NOT RECOMMENDED:**

- No improvements recommended

**Design Constraints and Considerations**

- No constraints

**ALTERNATIVE**

**Capacity Improvements Future Flows, No Detention**

**Improvement Goals:**

**N/A**

**NOT RECOMMENDED:**

- No capacity improvements are recommended for 100-year conveyance

**Design Constraints and Considerations**

- No constraints

**ALTERNATIVE**

**Infrastructure Protection and Channel Stabilization**

**Improvement Goals:**

**3, 6**

**RECOMMENDED:**

- Implement one check structure downstream of sanitary sewer crossing
- Monitor erosion and implement stabilization improvements if needed

**Design Constraints and Considerations**

- Sanitary sewer paralleling channel with one crossing

**ALTERNATIVE**

**Capacity Improvements Future Flows, With Detention**

**Improvement Goals:**

**N/A**

**NOT RECOMMENDED:**

- No capacity improvements are recommended for 100-year conveyance

**Design Constraints and Considerations**

- No constraints

[1]Regional detention, water quality and environmental considerations, and future development consideration alternatives are not included in alternative tables because they are watershed-based and not reach specific. See Sections 5.4.1-5.4.3 for more information regarding these alternatives.

# Alternatives: Sheep Draw Reach 8 – Downstream of 71st Ave. to Downstream of 83rd Ave.

**Existing Condition**

- Irregularly shaped, meandering natural with native grass overbanks
- Sanitary sewer parallels channel and crosses in four locations
- Storm and detention pond outfalls
- Three pedestrian trail crossings and 71st Ave roadway crossing

**Problem Areas/ Status Quo**

**Infrastructure and Stability**

- Active fast erosion on some outer bends
- Potential for erosion on some outer bends
- Active fast erosion threatening two sanitary sewer crossings
- Potential for erosion at two sanitary sewer crossings
- Active and potential erosion threatening pedestrian trail and sanitary sewer that run parallel to channel

**Capacity**

- Future 100-year floodplain overtops 71st Ave
- Future 100-year floodplain overtops three pedestrian trail crossings
- Insurable structures located in the future 100-year floodplain
- 100-year floodplain threatens private property

**Maintenance**

There is no maintenance access path/easement along portions of the channel in this reach

**Improvement Goals**

**Overall Goals**

1. Provide access for community
2. Provide access for maintenance
3. Protect existing utilities from erosion
4. Protect existing trails from erosion
5. Protect private property from erosion
6. Stabilize channel, no infrastructure threatened
7. Increase channel capacity to remove insurable structure from future 100-year floodplain
8. Increase channel capacity to remove private property from future 100-year floodplain
9. Increase crossing capacity to remove insurable structures from future 100-year floodplain
10. Increase crossing capacity to meet future 100-year criteria

**ALTERNATIVE**
**Pedestrian and Maintenance Accessibility**
**Improvement Goals:**
**1-2**

**RECOMMENDED:**

- Acquire easement along Sheep Draw for majority of the reach
- Extend regional trail through 83rd Ave to connect to each side

**Design Constraints and Considerations**

- Channel is located fully on several properties that are mostly undeveloped
- Easement can be obtained when development occurs, or when improvements are needed

**ALTERNATIVE**
**Infrastructure Protection and Channel Stabilization**
**Improvement Goals:**
**3-6**

**RECOMMENDED:**

- Implement four check structure downstream of sanitary sewer crossings
- Implement stabilization improvements to protect sanitary sewer and trail
- Monitor erosion and implement stabilization improvements if needed

**Design Constraints and Considerations**

- Sanitary sewer and trail paralleling channel and multiple sanitary sewer crossings
- Parts of channel are located on private property

**Site Photos:**

Left to Right:

[1]General channel conditions

[2]Channel bank along stream near 77th Ave

[3]Looking downstream at crossing structure 18

1



2



3



**ALTERNATIVE**
**Capacity Improvements Future Flows, No Detention**
**Improvement Goals:**
**10**

**NOT RECOMMENDED:**

- Replace the existing 71nd Ave bridge with a 150-foot span bridge and raise the low chord and street by 1.3-foot
- It is recommended that the CMP trail crossing be replaced with RCP when needed

**Design Constraints and Considerations**

- Utilities and roadway tie-ins along 71nd Ave

**ALTERNATIVE**
**Capacity Improvements Future Flows, With Detention**
**Improvement Goals:**
**10**

**RECOMMENDED:**

- Add (1) 10-foot by 10-foot RCBC adjacent to the existing 71nd Ave bridge
- It is recommended that the CMP trail crossing be replaced with RCP when needed

**Design Constraints and Considerations**

- Utilities along 72nd Ave
-

[1]Regional detention, water quality and environmental considerations, and future development consideration alternatives are not included in alternative tables because they are watershed-based and not reach specific. See Sections 5.4.1-5.4.3 for more information regarding these alternatives.

# Alternatives: Sheep Draw Reach 9 – Downstream of 83rd Ave. to Downstream of US Highway 34[1]

**Existing Condition**

- Irregularly shaped, meandering natural with native grass overbanks
- Sanitary sewer parallels channel and crosses in five locations
- Storm and detention pond outfalls
- Water crossing
- Pedestrian trail crossing and 83rd Ave and 95th Ave roadway crossings

**Problem Areas/ Status Quo**

**Infrastructure and Stability**

- Potential for erosion on some outer bends
- Active fast erosion threatening two sanitary sewer crossings
- Active and potential erosion threatening pedestrian trail and sanitary sewer that run parallel to channel

**Capacity**

- 100-year floodplain overtops 83rd Ave, 95th Ave, and pedestrian trail crossing.
- Insurable structures located in the future 100-year floodplain
- Future 100-year floodplain encroaches onto and threatens private property

**Maintenance**

- There is no maintenance access path/easement along portions of the channel in this reach

**Improvement Goals**

**Overall Goals**

1. Provide access for community
2. Provide access for maintenance
3. Protect existing utilities from erosion
4. Protect existing trails from erosion
5. Protect private property from erosion
6. Stabilize channel, no infrastructure threatened
7. Increase channel capacity to remove insurable structure from future 100-year floodplain
8. Increase channel capacity to remove private property from future 100-year floodplain
9. Increase crossing capacity to remove insurable structures from future 100-year floodplain
10. Increase crossing capacity to meet future 100-year criteria

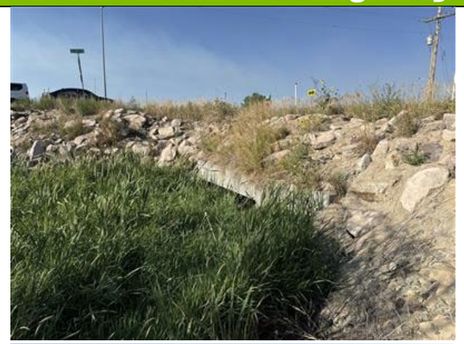
**Site Photos:**

Left to Right:

[1]95th Ave RCBC outlet

[2]Looking downstream near sewer main crossing

[3]General channel conditions







**ALTERNATIVE**

**Pedestrian and Maintenance Accessibility**

**Improvement Goals:** 1-2

**RECOMMENDED:**

- Acquire easement along Sheep Draw for majority of the reach
- Extend regional trail up to US Highway 34

**Design Constraints and Considerations**

- Channel is located fully on several properties, some that are undeveloped
- Easement can be obtained when development occurs, or when improvements are needed

**ALTERNATIVE**

**Capacity Improvements Future Flows, No Detention**

**Improvement Goals:** 8-10

**NOT RECOMMENDED:**

- Replace the existing 83rd Ave bridge with a 130-foot span bridge and raise the street by 2.5 feet and the low chord 3.9 feet offset from the road low point
- Replace the existing 95th Ave structure with (3) 20-foot by 10-foot RCBC
- Increase channel conveyance to remove private properties from future 100-year floodplain

**Design Constraints and Considerations**

- Utilities and roadway tie-ins along 83rd Avenue
- Utilities along 95th Avenue
- Sanitary sewer paralleling channel

**ALTERNATIVE**

**Infrastructure Protection and Channel Stabilization**

**Improvement Goals:** 3-4, 6

**RECOMMENDED:**

- Implement five check structures to protect sanitary sewer crossings and water crossing
- Monitor erosion and implement stabilization improvements if needed

**Design Constraints and Considerations**

- Sanitary sewer and trail paralleling channel and multiple sanitary sewer crossings
- Parts of channel are located on private property

**ALTERNATIVE**

**Capacity Improvements Future Flows, With Detention**

**Improvement Goals:** 8-10

**RECOMMENDED:**

- Add (2) 16-foot by 10-foot RCBC adjacent to the existing 83rd Ave bridge
- Replace the existing 95th Ave structure with (2) 20-foot by 10-foot RCBC
- Increase channel conveyance to remove private properties from future 100-year floodplain

**Design Constraints and Considerations**

- Utilities within 83rd Ave and 95th Avenue
- Sanitary sewer paralleling channel

[1]Regional detention, water quality and environmental considerations, and future development consideration alternatives are not included in alternative tables because they are watershed-based and not reach specific. See Sections 5.4.1-5.4.3 for more information regarding these alternatives.

## Alternatives: Sheep Draw Reach 10 – Downstream of US Highway 34 to Weld County Border[1]

**Existing Condition**

- Irregularly shaped, meandering natural with native grass overbanks
- Two private driveway crossings, one pedestrian trail crossing.
- Sanitary sewer parallels channel and crosses at two locations
- Detention pond outfall
- Land is currently used for agriculture
- US Highway 34 roadway crossing

**Problem Areas/ Status Quo**

**Infrastructure and Stability**

- Sanitary sewer runs parallel to channel for majority of reach

**Capacity**

- 100-year floodplain overtops US Highway 34, private driveways, and pedestrian trail crossing.

**Maintenance**

- There is no maintenance access path/easement along the channel in this reach

**Improvement Goals**

**Overall Goals**

1. Provide access for community
2. Provide access for maintenance
3. Protect existing utilities from erosion
4. Protect existing trails from erosion
5. Protect private property from erosion
6. Stabilize channel, no infrastructure threatened
7. Increase channel capacity to remove insurable structure from future 100-year floodplain
8. Increase channel capacity to remove private property from future 100-year floodplain
9. Increase crossing capacity to remove insurable structures from future 100-year floodplain
10. Increase crossing capacity to meet future 100-year criteria

**Site Photos:**

Left to Right:

[1]Downstream side of US Highway 34 Culvert

[2]Upstream side of US Highway 34 Culvert

1



2



**ALTERNATIVE**

**Pedestrian and Maintenance Accessibility**

**Improvement Goals: 1-2**

**RECOMMENDED:**

- Acquire easement along Sheep Draw for majority of the reach
- Extend regional trail through this reach

**Design Constraints and Considerations**

- Channel is located fully on several properties, mostly undeveloped
- Easement can be obtained when development occurs, or when improvements are needed

**ALTERNATIVE**

**Infrastructure Protection and Channel Stabilization**

**Improvement Goals: 3**

**RECOMMENDED:**

- Implement two check structures to protect sanitary sewer crossings

**Design Constraints and Considerations**

- Sanitary sewer paralleling channel with multiple crossings
- Most of the channel is located on private property

**ALTERNATIVE**

**Capacity Improvements Future Flows, No Detention**

**Improvement Goals: 10**

**NOT RECOMMENDED:**

- Replace the existing US Highway 34 structure with (3) 20-foot by 10-foot RCBC
- Widen channel upstream and downstream of US Highway 34
- It is recommended that the CMP crossing be replaced with RCP when needed

**Design Constraints and Considerations**

- Utilities within US Highway 34

**ALTERNATIVE**

**Capacity Improvements Future Flows, With Detention**

**Improvement Goals: 10**

**RECOMMENDED:**

- Replace the existing US Highway 34 structure with (2) 20-foot by 10-foot RCBC
- Widen channel upstream and downstream of US Highway 34
- Is it recommended that the CMP crossing be replaced with RCP when needed

**Design Constraints and Considerations**

- Utilities within US Highway 34

[1]Regional detention, water quality and environmental considerations, and future development consideration alternatives are not included in alternative tables because they are watershed-based and not reach specific. See Sections 5.4.1-5.4.3 for more information regarding these alternatives.

## Alternatives: Sheep Draw Reach 11 – Weld County Border to Upstream Study Limits[1]

**Existing Condition**

- Irregularly shaped, meandering natural with native grass overbanks
- Land is currently used for agriculture

**Site Photos:**

No photos available along reach on private property

**Problem Areas/ Status Quo**

**Maintenance**

- There is no maintenance access path/easement along the channel in this reach

**Improvement Goals**

**Overall Goals**

1. Provide access for community
2. Provide access for maintenance
3. Protect existing utilities from erosion
4. Protect existing trails from erosion
5. Protect private property from erosion
6. Stabilize channel, no infrastructure threatened
7. Increase channel capacity to remove insurable structure from future 100-year floodplain
8. Increase channel capacity to remove private property from future 100-year floodplain
9. Increase crossing capacity to remove insurable structures from future 100-year floodplain
10. Increase crossing capacity to meet future 100-year criteria

**ALTERNATIVE**

**Pedestrian and Maintenance Accessibility**

**Improvement Goals:**

**1-2**

**RECOMMENDED:**

- Acquire easement along Sheep Draw for majority of the reach
- Extend regional trail through this reach

**Design Constraints and Considerations**

- Channel is located fully on several properties, mostly undeveloped
- Easement can be obtained when development occurs, or when improvements are needed

**ALTERNATIVE**

**Capacity Improvements Future Flows, No Detention**

**Improvement Goals:**

**N/A**

**NOT RECOMMENDED:**

- No recommended improvements

**Design Constraints and Considerations**

- No constraints

**ALTERNATIVE**

**Infrastructure Protection and Channel Stabilization**

**Improvement Goals:**

**N/A**

**NOT RECOMMENDED:**

- No recommended improvements

**Design Constraints and Considerations**

- No constraints

**ALTERNATIVE**

**Capacity Improvements Future Flows, With Detention**

**Improvement Goals:**

**N/A**

**NOT RECOMMENDED:**

- No recommended improvements

**Design Constraints and Considerations**

- No constraints

[1]Regional detention, water quality and environmental considerations, and future development consideration alternatives are not included in alternative tables because they are watershed-based and not reach specific. See Sections 5.4.1-5.4.3 for more information regarding these alternatives.

## 5.5 Benefit Cost Analysis

A benefit-cost analysis (BCA) was prepared independently by ICON. The BCA determined a benefit cost ratio (BCR) for each reach alternative plus regional detention by dividing the total project benefits by the project costs. When a BCR is greater than 1.0, the project is considered cost effective. The watershed-scale alternatives for water quality and future development considerations were not included in the cost estimates or BCA. The BCA is summarized in Table 20. The full BCA memorandum is included in Appendix E.

**Table 20 – Benefit-Cost Analysis**

| Reach and Detention Alternatives | Alternative Cost | Present Value of Damages (PVD) | Benefit-Cost Ratio |
|---|---|---|---|
| Without Detention | $72,801,745 | $4,614,520 | 0.06 |
| With Detention | $48,565,377 | $4,614,520 | 0.10 |

While the BCA does not show a cost-effective improvement overall, the majority of the cost is at roadway crossings and for regional detention. The upsized roadway crossings contribute to removing insurable structures form the floodplain, but the main benefit is to reduce the roadway overtopping in a major event and enhance safety. The detention improvements will reduce the needed future infrastructure and will also help protect the stability of the channel as the upstream watershed develops. In turn, maintenance costs and channel improvement costs will be lower, which is not factored into the BCA. Therefore, these improvements are still recommended despite the BCA being less than 1.0.

## 5.6 Evaluation of Alternatives

In evaluating the reach, regional detention, and water quality alternatives the improvements were evaluated not only based on costs, but also on qualitative aspects. Future development considerations were not included in this evaluation. The following quantitative and qualitative aspects were considered in the alternatives analysis:

- Public safety
- Flood protection
- Stream stability
- Operations and maintenance
- Cost
- Public and property owner acceptance
- Environmental and water quality impacts
- Right-of-way acquisition or easements

When the hydraulic analysis of future conditions 100-year improvements was complete, the feasibility of each alternative with respect to qualitative aspects was evaluated. The recommended alternative provides the highest benefit when considering quantitative and qualitative aspects of the project.

An alternatives evaluation matrix was then completed to help determine the Recommended Plan. Each component of the matrix was assigned a percentage weight as determined by the City. Each alternative was evaluated on a scale of one to five, with five being the most beneficial rating. Each type of alternative was compared against the status quo and other applicable alternatives. For example, no additional acquisitions or easements would be necessary under status quo conditions, therefore, across the board, status quo conditions received a score of 5. On the other hand, all alternatives would require acquisitions or easements to some extent, and all received a score less than 5 based on the extent of the proposed improvements. Scores for each category were multiplied by their percentage weight, respectively, and summed together for an average score. All improvements recommended in section 5.6 score higher than the status quo and provide more benefit across each category. The alternatives evaluation matrix is shown in Table 21.

## 5.7 Recommended Plan

This section provides a summary of the recommended plan. See Section 5.4 for a full description of each watershed-scale and reach alternative, which includes labels of what alternatives were recommended or not. The Recommended Plan was chosen based on a combination of quantitative and qualitative measurements. The recommended improvements are shown in Figure 6, improvement costs will be summarized in Table 22, and detailed costs are included in Appendix E. The Recommended Plan consists of:

- Infrastructure protection with channel stabilization in all reaches, which also encompasses water quality improvements.
- Incorporate regional detention, Alternative D.
- All capacity improvements with Detention Alternative D.
- Field verification of the ponds with unknown treatment status prior to initiating retrofit projects.
- Retrofit existing ponds with water quality treatment as shown on Figure 6.
- Obtain easements for the entirety of Sheep Draw.
- Extend the regional trail.
- Future development should implement DCIA Level 1 practices.
- DCIA Level 2 and rain barrels are encouraged for future development.

The main themes in the recommended plan were to lower future peak flows by implementing detention, to provide sufficient capacity at crossings to meet existing criteria, to remove insurable structures from the floodplain, to remedy floodplain encroachment on private property, to protect existing infrastructure, and to improve overall reach stability, water quality, and ecology. Areas where private property, utilities, and pedestrian trails are threatened should be completed first. In areas where upstream development is anticipated to change the minor and/or major storm event flows significantly (greater than 30%), stabilization measures should be constructed as development occurs to help protect the natural channel from erosion. Capacity improvements should be implemented first in areas that remove insurable structures from the floodplain and where roadway overtopping occurs. Lower priorities would be areas that encroach on private property, followed by those areas that threaten private properties. Crossings that do not overtop when future flows are detained, but do not meet headwater to depth or freeboard criteria in the 100-year event would be the lowest priority as they generally pose less risk than crossings that overtop.

The majority of the channel reaches can be maintained via trails and roadways. The exceptions, as noted in the individual reach sections, are Sheep Draw MDP Reach 1, Sheep Draw MDP Reach 2, Sheep Draw MDP Reach 10, Sheep Draw MDP Reach 11, and a small portion of Sheep Draw MDP Reach 9. It is recommended that the regional trail be extended to dual as a maintenance access path.

Some of the channel reaches are located on publicly owned property or on Homeowner Association Property, allowing for maintenance. The rest are located on private property, including Sheep Draw MDP Reach 2, Sheep Draw MDP Reach 8, Sheep Draw MDP Reach 9, Sheep Draw MDP Reach 10, Sheep Draw MDP

Reach 11, as well as smaller portions of Sheep Draw MDP Reach 3 and Sheep Draw MDP Reach 5. It is recommended that easements be obtained for the entirety of Sheep Draw. In undeveloped areas, easements can be obtained when the property develops.

## 5.8 Comparison to Previous Recommendations

This section provides a summary of the Sheep Draw recommended plan presented in the *City of Greeley Comprehensive Drainage Plan* by Anderson Consulting Engineers, Inc. published on March 8th, 2006. The plan covered Sheep Draw from State Highway 257 to the Cache la Poudre River confluence. The recommended plan of improvements included utilizing inadvertent detention at State Highway 256, acquisition of 4 irrigation reservoirs, and improvements of bridge/culvert structures at C Street, 71st Ave, 95th Ave, and US Highway 34. It was identified that multiple structures within the Sheep Draw basin do not pass the 100-year storm event in existing conditions. It was assumed that all new development in the basin will update the crossing structures and implement water quality basins and extended detention to meet criteria.

Similarly to the prior recommended plan, the recommended plan provided in this document recommends utilizing detention to prepare for future development and increasing structure capacity at major crossings. This updated master plan does not change the overarching goals of the previous study recommendations. The master plan shall be used to help inform recommendations for development as it occurs in the upper watershed, and also to provide recommendations for improvements to reduce flooding potential and enhance the stream system.

**Table 21 – Alternatives Evaluation Matrix[1]**

| Category | Public Safety | Prevent Flooding | Stream Stability | Operations and Maintenance | Cost | Public Acceptance | Environmental and Water Quality Impacts | ROW Acquisition/ Easements | Weighted Average | Recommended? |
|---|---|---|---|---|---|---|---|---|---|---|
| **Weight:** | **20%** | **15%** | **15%** | **15%** | **10%** | **10%** | **10%** | **5%** | **100%** | |
| Water Quality – Status Quo | 3 | 1 | 2 | 3 | 5 | 3 | 3 | 5 | 2.9 | No |
| Water Quality – Alternative | 3 | 1 | 3 | 3 | 4 | 5 | 5 | 4 | 3.3 | Yes |
| Floodplain Preservation with Channel Stabilization – Status Quo | 4 | 2 | 3 | 3 | 5 | 3 | 3 | 5 | 3.4 | No |
| Floodplain Preservation with Channel Stabilization – Alternative | 5 | 2 | 5 | 5 | 3 | 4 | 5 | 4 | 4.2 | Yes |
| Capacity – Status Quo | 2 | 2 | 3 | 3 | 5 | 3 | 3 | 5 | 3.0 | No |
| Capacity Improvements with Regional Detention – Alternative | 5 | 5 | 4 | 3 | 2 | 3 | 4 | 3 | 3.9 | Yes |
| Capacity Improvements without Detention – Alternative | 4 | 5 | 3 | 3 | 3 | 3 | 3 | 4 | 3.6 | No |
| Pedestrian and Maintenance Accessibility – Status Quo | 3 | 1 | 1 | 2 | 5 | 3 | 1 | 5 | 2.4 | No |
| Pedestrian and Maintenance Accessibility – Alternative | 3 | 1 | 1 | 5 | 3 | 5 | 1 | 3 | 2.7 | Yes |
| All Recommended Alternatives | 4.00 | 2.25 | 3.25 | 4.00 | 3.00 | 4.25 | 3.75 | 3.50 | 3.50 | Yes |

[1] Alternative Ranking is on a scale of 1 to 5, with 5 being the most beneficial. The alternative with the highest score would be the preferred alternative.

**Table 22 – Recommended Plan Cost Summary[1]**

| Reach | Capital Cost | ROW/Easement | Engineering | Legal/Administration | Contract Admin/CM | Contingency | Total Capital Cost |
|---|---|---|---|---|---|---|---|
| SD-Reach1 | $523,804 | $0 | $78,571 | $26,190 | $52,380 | $130,951 | $811,896 |
| SD-Reach2 | $764,160 | $607,500 | $114,624 | $38,208 | $76,416 | $191,040 | $1,791,948 |
| SD-Reach3 | $12,239,812 | $288,750 | $1,835,972 | $611,990 | $1,223,981 | $3,059,953 | $19,260,458 |
| SD-Reach4 | $5,898,270 | $0 | $884,740 | $294,913 | $589,827 | $1,474,568 | $9,142,318 |
| SD-Reach5 | $1,611,294 | $0 | $241,694 | $80,565 | $161,129 | $402,824 | $2,497,506 |
| SD-Reach6 | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| 71ST-Reach7 | $64,700 | $0 | $9,705 | $3,235 | $6,470 | $16,175 | $100,285 |
| SD-Reach8[2] | $6,295,007 | $920,750 | $944,251 | $314,750 | $629,500 | $1,573,752 | $10,678,010 |
| SD-Reach9 | $4,793,879 | $180,000 | $719,082 | $239,694 | $479,388 | $1,198,470 | $7,610,513 |
| SD-Reach10[2] | $5,738,303 | $755,500 | $860,745 | $286,915 | $573,830 | $1,434,576 | $9,649,869 |
| SD-Reach11[2] | $951,816 | $517,250 | $142,772 | $47,591 | $95,182 | $237,954 | $1,992,565 |
| **Total** | **$38,881,045** | **$3,269,750** | **$5,832,156** | **$1,944,051** | **$3,888,103** | **$9,720,263** | **$63,535,368** |

[1]Water quality and future development considerations are not included in cost estimates.

[2]Reach includes regional detention.

# 6. CONCEPTUAL DESIGN

## 6.1 Plan Development Overview

The Recommended Plan detailed in the Alternatives Analysis, outlined in Section 5, is intended to provide adequate protection while adhering to the City of Greeley and Weld County's drainage criteria. The Recommended Plan consists of channel stabilization, storm capacity improvements for the master plan 100-year peak flows, including crossing, and channel improvements, ecological improvements, regional detention, water quality, and pedestrian and maintenance accessibility. As the recommended plan was advanced to conceptual design, refinements were made to the analysis and recommendations. The intent of the conceptual design to help future Master Plan users understand what the goals and constraints are in each reach, and encourage further, in-depth analysis of each problem area as they are addressed. Future projects should follow the current City of Greeley criteria at the time of the project. The recommended plan is shown on Figure 10.

The conceptual design consists of both watershed-scale and reach-specific improvements. The watershed-scale improvements for water quality and future development considerations is not included in the cost estimates. These improvements are described in Sections 6.1.3 and 6.1.4, respectively. Regional detention provides a watershed-scale benefit, but since the regional detention recommended improvements were reduced to just a few locations, descriptions of regional detention were added into the reach-specific descriptions rather than keeping it as a watershed-scale reach-specific improvements and regional detention are included in the cost estimates and are summarized in Section 6.2.

### 6.1.1 MDP Hydrology

The MDP hydrology used the existing infrastructure, future land use hydrology as a basis and added in proposed regional Detention Ponds 301, 304, 309, 311, 364. The pond locations, routing, and stage-storage curves Peak flows are summarized in Table F-4, in Appendix F. The resulting master plan hydrology was used to size the capacity improvements.

### 6.1.2 Conceptual Design Hydraulics

The HEC-RAS model prepared for the LOMR was used as a basis for the conceptual design. The proposed improvements and master plan peak flows were input into the HEC-RAS model to determine the conceptual design floodplain and profiles. The conceptual design plan and profiles are included in Appendices G and H.

### 6.1.3 Conceptual Design Water Quality and Environmental Considerations

The Sheep Draw watershed contains many detention ponds. These detention ponds are not included in the baseline hydrology since they do not meet the requirements of being regional or have insignificant impact on peak flows, but they do have significant potential to support the overall water quality in Sheep Draw and ultimately the Cache la Poudre River. Some of the existing detention ponds in the Sheep Draw watershed provide water quality capture volume, and others do not. Retrofitting a detention pond to provide water quality treatment typically would consist of modifying or replacing the outlet structure and can be done with more minimal construction.

It is recommended that existing detention ponds be retrofitted to provide water quality capture volume for the overall health of the stream corridor. The cost associated with retrofitting existing detention ponds is not included in the overall cost estimates of the conceptual design. Each existing detention pond was evaluated and assigned a priority level, with one being the most pressing and three being the least pressing, to retrofit the pond to provide water quality treatment. Specific details regarding prioritization are included in the alternatives analysis, Section 5.4.2. No changes were made to the prioritizations summarized in the alternatives analysis. Water quality priorities are included in Figure 10.

**Sub-regional water quality is recommended for future developments.**

In addition to providing water quality capture volume, the wetland areas in and along Sheep Draw should be maintained and protected. This would include the wetland area east of 71st Avenue, as well as along the stream corridor. Several areas where wetland and vegetation enhancements would be beneficial were identified and included in the reach-specific descriptions. These areas include the Pumpkin Ridge development north of 10th Street and the downstream segment at the Cache la Poudre River confluence. Additional channel stability recommendations are included throughout the reaches. These improvements are important to maintain the overall ecology of the stream corridor and provide passive water quality treatment.

The City of Greeley is evaluating the potential for using areas along Sheep Draw for wetland banking. Areas used for wetland banking will need to be monitored to ensure the vegetation remains healthy, especially as the upper watershed develops. A monitoring plan should be prepared for any wetland banking areas. The additional development consideration recommendations included in Section 6.1.4 would help mitigate changes in the flow regime that could compromise the existing vegetation along Sheep Draw.

### 6.1.4 Future Development Considerations

Future developments shall follow the City of Greeley criteria, including the incorporation of private full spectrum detention and water quality. **It is recommended that as the watershed develops, the future land use percent impervious assumptions be reviewed for consistency with this master plan.**

As development occurs in the watershed, the volume of water in Sheep Draw will increase. While full spectrum detention helps reduce downstream peak flows to pre-developed conditions, it does not significantly impact the increases in the volume of runoff. This change in flow regime can impact downstream reaches that were historically stable. Future developments should consider implementing additional measures to help offset the changes in flow regime. The recommendations herein are intended to help maintain stability along Sheep Draw as development occurs. Even with these measures in place, channel degradation and erosion may occur. If channel degradation and erosion are observed in the field as a result of the increased flow volume, stability improvements are recommended.

The use of directly connected impervious areas (DCIA) and rain barrels was investigated during the alternatives analysis to determine potential impacts. No changes were made to the future development recommendations from the alternatives analysis, Section 5.4.3.

A DCIA Level 1 includes directing runoff from impervious surface to flow over grass or permeable pavement before it reaches a stormwater conveyance system. **It is recommended that future developments implement DCIA Level 1 practices.**

A DCIA Level 2 is an enhancement to Level 1 and in addition to Level 1 practices, replaces traditional curbs and gutters with no curb, slotted curbs, grass-lined swales, and/or pervious shoulders such that the main conveyance system is primarily pervious. **It is encouraged that future developments implement DCIA Level 2 practices, to the extents feasible.**

Rain barrel implementation and long-term performance is not as certain as implementing DCIA practices. Several key considerations are the amount of water captured in rain barrels is limited by State of Colorado law, rain barrels may be full when a storm event occurs, and individual property owners may decide to no longer maintain them. **It is encouraged that future developments consider incorporating rain barrels, to the extents feasible.**

### 6.1.5 Channel Stabilization

The goals of channel stabilization improvements is to protect the natural ecology of Sheep Draw, maintain or provide floodplain connectivity, and protect infrastructure, including private properties, trails, and utilities.

Check structures were recommended downstream of utility crossings, to protect the utility from potential future incision. For costing purposes, check structures were assumed to span the 10-year floodplain.

Areas with higher velocities in future flow conditions are recommended for monitoring. If channel degradation and erosion is observed in the field, a stability improvement is recommended.

Bank protection is recommended where lateral migration or incision of Sheep Draw would threaten infrastructure, typically utilities and trails. Several example bank stabilization measures are shown on Figure G-1C, included in Appendix G. Channel stabilization should consider the ecology of Sheep Draw and maintaining a healthy river system. Actual stabilization measures should be based on current criteria at the time the design is completed.

### 6.1.6 Conceptual Design Capacity Improvements

Under existing land use conditions, roadway crossings along Sheep Draw will overtop and private properties and structures will be impacted by the 100-year storm event. As the watershed develops, the peak flows will increase. The goal of the capacity improvements was to provide recommended improvements to reduce flooding potential for both existing and future land use conditions. The master plan 100-year peak flows incorporate proposed regional detention to help reduce future land use peak flows. The goal of capacity improvements along the channel was to prevent overtopping of roadways, to remove structures for the master plan 100-year floodplain, and, where possible, private parcels from the master plan 100-year floodplain.

Capacity improvements were sized using the master plan hydrology, which is based on the future land use conditions with proposed detention in-place. A combination of larger crossing structures and channel grading improvements to increase flood conveyance were analyzed for capacity improvements. A summary of the proposed crossing structures is shown in Table F-5 included in Appendix F. Multistage channel sections were analyzed in HEC-RAS, using the channel modification tools. Conceptual channel sections are shown on Figures G-1A through G-1C, included in Appendix G. The intent of the cross sections is to give an overall idea of the width and extents of channel grading needed and should not be used for final design. Final design should consider current criteria at the time of design and complete grading that would enhance the ecological benefits along Sheep Draw. Final design should also consider minimizing impacts to the existing wetlands, to the extents feasible, while still achieving the capacity goals.

### 6.1.7 Conceptual Design Cost

A summary of the methods and unit costs used for the master plan improvements is included in Section 5.3 and Table 17. A cost estimate for proposed improvements should be done at the time of design, and costs provided within this study are high level estimates and include many caveats and assumptions. Costs within this study are not guaranteed costs, will likely increase with time and inflation, and are for planning purposes only.

Costs for dewatering, traffic control, and utility coordination and relocation were refined from the alternatives analysis. These costs are estimated based on the type of proposed improvement and known impacts. Assumptions are summarized in Table 23 through Table 25.

**Table 23 – Dewatering / Water Control**

| | |
|---|---|
| Base Cost | $25,000.00 |
| Cost per LF of Stream Improvements | $ 130.00 |
| Cost per Structure | $10,000.00 |
| Cost per Detention Pond | $30,000.00 |

**Table 24 – Traffic Control**

| Crossing Type | Cost per Crossing |
|---|---|
| Non-Roadway | $ 25,000.00 |
| Local | $ 50,000.00 |
| Minor Arterial | $ 75,000.00 |
| Major Arterial | $ 90,000.00 |
| Highway | $ 110,000.00 |

**Table 25 – Utility Coordination and Relocation**

| | |
|---|---|
| No known utilities | $ 10,000.00 |
| Cost per Utility Stream Crossing | $ 20,000.00 |
| Cost per Roadway Crossing | $ 30,000.00 |

Operations and maintenance costs were estimated assuming maintenance activities occur twice a year for culverts and channels and annually for detention ponds. The costs encompass all reaches and includes the existing channel and structures as well as the proposed improvements. The total maintenance cost over 50 years is calculated using an assumed effective interest rate of 4 percent. Easement costs were included everywhere proposed improvements were included on private property. Costs were not included for locations where easements are recommended for Sheep Draw on private property, but no improvements are shown.

A summary of the conceptual design costs is included in Table 26. Detailed cost breakdowns are included in the Master Plan reach descriptions.

**Table 26 – Conceptual Design Cost Summary**

| Reach | Capital Cost | ROW/Easement | Engineering | Legal/Administration | Contract Admin/CM | Contingency | Total Capital Cost | Annual O&M Cost | 50-Year O&M Cost |
|---|---|---|---|---|---|---|---|---|---|
| SD-Reach1 | $638,164.00 | $0.00 | $95,725.00 | $31,908.00 | $63,816.00 | $159,541.00 | $989,154.00 | $11,204.00 | $240,686.00 |
| SD-Reach2 | $811,240.00 | $150,000.00 | $121,686.00 | $40,562.00 | $81,124.00 | $202,810.00 | $1,407,422.00 | $12,960.00 | $278,409.00 |
| SD-Reach3 | $10,887,329.00 | $37,950.00 | $1,633,099.00 | $544,366.00 | $1,088,733.00 | $2,721,832.00 | $16,913,309.00 | $44,752.00 | $961,371.00 |
| SD-Reach4 | $5,383,614.00 | $0.00 | $807,542.00 | $269,181.00 | $538,361.00 | $1,345,904.00 | $8,344,602.00 | $32,240.00 | $692,586.00 |
| SD-Reach5 | $2,349,478.00 | $0.00 | $352,422.00 | $117,474.00 | $234,948.00 | $587,370.00 | $3,641,692.00 | $24,632.00 | $529,149.00 |
| SD-Reach6 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $8,428.00 | $181,052.00 |
| 71$^{ST}$-Reach7 | $124,053.00 | $0.00 | $18,608.00 | $6,203.00 | $12,405.00 | $31,013.00 | $192,282.00 | $9,128.00 | $196,089.00 |
| SD-Reach8 | $6,629,465.00 | $259,750.00 | $994,420.00 | $331,473.00 | $662,947.00 | $1,657,366.00 | $10,535,421.00 | $79,697.00 | $1,712,066.00 |
| SD-Reach9 | $5,564,902.00 | $78,000.00 | $834,735.00 | $278,245.00 | $556,490.00 | $1,391,226.00 | $8,703,598.00 | $59,832.00 | $1,285,322.00 |
| SD-Reach10 | $5,503,679.00 | $897,500.00 | $825,552.00 | $275,184.00 | $550,368.00 | $1,375,920.00 | $9,428,203.00 | $143,663.00 | $3,086,195.00 |
| SD-Reach11 | $891,816.00 | $520,000.00 | $133,772.00 | $44,591.00 | $89,182.00 | $222,954.00 | $1,902,315.00 | $75,494.00 | $1,621,776.00 |
| **Total** | $38,753,725 | $1,943,200 | $5,813,059 | $1,937,687 | $3,875,372 | $9,688,432 | $62,011,475 | $502,030 | $10,784,701 |

# Legend

- MDP Reach Breaks
- Odd Numbered MDP Reach
- Even Numbered MDP Reach
- Canal/Ditch Centerline
- Sewer Mains
- Storm Mains
- Water Mains
- Gas Lines
- Trails
- Sheep Draw Regional Trail
- Roads
- Watershed Boundary
- Roadway Crossing Structures
- Trail Crossing Structures
- City of Greeley
- Weld County
- Undeveloped Areas
- Private Property
- Public Property
- Parcel on Conservation Easement
- Structures Within the Existing Infrastructure, Future Land Use 100-year Floodplain
- Existing Infrastructure, Future Land Use 100-year Floodplain
- Approximate Master Plan 100-Year Floodplain
- Effective (Existing) 100-Year Floodplain

NOTES:
1. FEATURE NAMING CONVENTIONS HAVE BEEN SHORTENED FOR CLAIRTY.

- Ponds With Water Quality
- Ponds Without Water Quality

Ponds Without Water Quality - Priority Level

- 1-No Downstream Treatment, Close Proximity to Stream
- 2-No Downstream Treatment, Routed Through Open Channel or More Distance from Stream
- 3-Routed to Downstream Facitlity Prior to Outfall

Proposed Improvements

- Proposed Regional Detention
- Crossing Structure Improvements
- Channel Capacity Improvements With Detention
- Install Grade Control Structure
- Proposed Split Flow
- Channel Stability Improvements
- Monitor Channel Stability
- Stability Improvement Within Capacity Improvement
- Install Check Structure to Protect Utility Crossing
- Acquire Stream Easement on Private Property
- Sheep Draw Regional Trail Expansion

## Interactive Figures

Detention Improvements ON/OFF
Capacity Improvements - With Detention ON/OFF
Water Quality Improvements ON/OFF
Stability Improvements ON/OFF
Pedestrian and Maintenance Improvements ON/OFF
All Conceptual Design Improvements ON/OFF

Roads ON/OFF
Crossing Structure Symbols ON/OFF
Utilities ON/OFF
Parcels ON/OFF
Aerial ON/OFF
Undeveloped Areas ON/OFF
Regional Trail ON/OFF
100-Year Existing (Effective) Floodplain ON/OFF
100-Year Future Floodplain ON/OFF
Master Plan 100-Year Floodplain ON/OFF

N

0 600 1,200 2,400 US Feet

THIS PROPERTY IS UNDER A CONSERVATION EASEMENT. ANY WORK IN THIS SECTION WILL REQUIRE REVIEW AND APPROVAL OF THE CONSERVATION EASEMENT HOLDER (TOWN OF WINDSOR).
CACHE LA POUDRE RIVER
R1
1 TRAIL - REPLACE CMP WITH RCP
LOWER GRADE ADJACENT TO CHANNEL TO CREATE WETLAND BENCHES AND A MORE FUNCTIONAL FLOODPLAIN
GREELEY NO. 3 DITCH
2 TRAIL - REPLACE CMP WITH RCP
GREELEY NO. 3 DITCH CROSSING - ADD A 450-FT SPILLWAY TO THE EAST OF CROSSING AND FILL LOW BERM AREAS ON WEST SIDE OF CROSSING TO PROTECT CANAL BERM FROM DAMAGE DURING OVERTOPPING OF MINOR STORM EVENTS.
3 ACQUIRE EASEMENT FOR SHEEP DRAW CHANNEL LOCATED ON PRIVATE PROPERTY
R2
4 MONITOR EROSION AND IMPLEMENT STABILIZATION IMPROVEMENTS IF NEEDED
5 INCREASE CHANNEL CONVEYANCE TO REMOVE INSURABLE STRUCTURES FROM FLOODPLAIN
C ST - REPLACE WITH 110-FT BRIDGE. RAISE ROAD DECK 3.6-FT TO MEET 100-YEAR CRITERIA AND REMOVE INSURABLE STRUCTURES FROM THE FLOODPLAIN.
C ST
6 INCREASE CHANNEL CONVEYANCE TO REMOVE INSURABLE STRUCTURES FROM FLOODPLAIN
IMPLEMENT STABILIZATION IMPROVEMENTS ALONG LEFT BANK TO PROTECT SEWER MAIN, GAS LINES, AND TRAIL
R3
IMPLEMENT STABILIZATION IMPROVEMENTS ALONG RIGHT BANK TO PROTECT SEWER MAIN, GAS LINES, AND TRAIL
INCREASE CHANNEL CONVEYANCE AND INSTALL GRADE CONTROL STRUCTURE TO REMOVE PRIVATE PROPERTIES FROM FLOODPLAIN
MONITOR EROSION AND IMPLEMENT STABILIZATION IMPROVEMENTS IF NEEDED
INSTALL 3.2 FT GRADE CONTROL STRUCTURE
59TH AVE
MONITOR EROSION AND IMPLEMENT STABILIZATION IMPROVEMENTS IF NEEDED
ACQUIRE EASEMENT FOR SHEEP DRAW CHANNEL LOCATED ON PRIVATE PROPERTY
71ST AVE
7 TRAIL - REPLACE CMP WITH RCP
8 IMPLEMENT STABILIZATION IMPROVEMENTS ALONG RIGHT BANK TO PROTECT SEWER MAIN AND TRAIL
4TH ST
INCREASE CHANNEL CONVEYANCE TO REMOVE INSURABLE STRUCTURES FROM FLOODPLAIN
MONITOR EROSION AND IMPLEMENT STABILIZATION IMPROVEMENTS IF NEEDED
INCREASE CHANNEL CONVEYANCE TO REMOVE INSURABLE STRUCTURES FROM FLOODPLAIN
N-1
4TH ST - ADD (1) 20-FT (S) X 10-FT (R) RCBC ADJACENT TO EXISTING BRIDGE TO PREVENT OVERTOPPING AND REMOVE INSURABLE STRUCTURES FROM THE FLOODPLAIN. CHANNEL IMPROVEMENTS IN THE VICINITY OF THE CULVERT TO ACCOMMODATE PROPOSED CELL
R4
9
LARGE WOODY DEBRIS BANK PROTECTION TO BE PLACED AT OUTSIDE MEANDER BEND TO PROVIDE BANK PROTECTION.
GRADE WETLAND BENCH FOR IMPROVED FLOODPLAIN CONNECTIVITY AND TO SUPPORT DIVERSE CHANNEL ECOLOGY.
MONITOR EROSION AND IMPLEMENT STABILIZATION IMPROVEMENTS IF NEEDED
INCREASE CHANNEL CONVEYANCE TO REMOVE PRIVATE PROPERTIES FROM FLOODPLAIN
NORTH BOOMERANG DITCH EXTENSION
IMPLEMENT STABILIZATION IMPROVEMENTS ALONG LEFT BANK TO PROTECT TRAIL
SPLIT FLOW TO BE FORMALIZED. SPLIT FLOW TO BE ACTIVATED DURING 1 - YEAR FLOOD EVENT. LARGE WOODY DEBRIS TO BE PLACED AT OUTSIDE MEADER BEND OF SPLIT FLOW TO PROVIDE NATURAL HABITAT, BANK PROTECTION, AND PROTECT NEARBY INFRASTRUCTURE.
CHANNEL IMPROVEMENTS UPSTREAM AND DOWNSTREAM OF BRIDGE TO PREVENT STRUCTURE OVERTOPPING AND REMOVE INSURABLE STRUCTURES FROM FLOODPLAIN
9.5
10TH ST
US HWY 34 BUS
INSTALL 150-FT PEDESTRIAN CROSSING WITH 10-YEAR CAPACITY CRITICAL FACILITY TO THE NORTH ENSURE CROSSING STRUCTURE DESIGN DOES NOT ADVERSLEY IMPACT 100-YEAR OR 500-YEAR FLOOD RISK ON PROPERTY
R5
10
11
ACQUIRE EASEMENT FOR SHEEP DRAW CHANNEL LOCATED ON PRIVATE PROPERTY
BOOMERANG DITCH
MONITOR EROSION AND IMPLEMENT STABILIZATION IMPROVEMENTS IF NEEDED
71ST AVE - ADD (1) 10-FT (S) X 8-FT (R) ADJACENT TO THE EXISTING BRIDGE TO MEET 100-YEAR CRITERIA CHANNEL IMPROVEMENTS IN THE VICINITY OF THE CULVERT TO ACCOMMODATE PROPOSED CELL
R7
12
IMPLEMENT STABILIZATION IMPROVEMENTS ALONG RIGHT BANK TO PROTECT SEWER MAIN AND WATER LINE
IMPLEMENT STABILIZATION IMPROVEMENTS ALONG LEFT BANK TO PROTECT SEWER MAIN
MONITOR EROSION AND IMPLEMENT STABILIZATION IMPROVEMENTS IF NEEDED
14
15
IMPLEMENT STABILIZATION IMPROVEMENTS ALONG LEFT BANK TO PROTECT SEWER MAIN AND TRAIL
N-2
13
R6
IMPLEMENT STABILIZATION IMPROVEMENTS ALONG LEFT BANK TO PROTECT SEWER MAIN AND TRAIL
SHEEP DRAW REGIONAL TRAIL EXPANSION
17
16
83RD AVE - ADD (1) 16-FT X 8FT RCBC TO THE EXISTING BRIDGE TO MEET 100-YEAR CRITERIA AND REMOVE INSURABLE STRUCTURES FROM THE FLOODPLAIN. CHANNEL IMPROVEMENTS IN THE VICINITY OF THE CULVERT TO ACCOMMODATE PROPOSED CELL
R8
18
ACQUIRE EASEMENT FOR SHEEP DRAW CHANNEL LOCATED ON PRIVATE PROPERTY
MONITOR EROSION AND IMPLEMENT STABILIZATION IMPROVEMENTS IF NEEDED
19
TRAIL - REPLACE CMP WITH RCP
MONITOR EROSION AND IMPLEMENT STABILIZATION IMPROVEMENTS IF NEEDED
ACQUIRE EASEMENT FOR SHEEP DRAW CHANNEL LOCATED ON PRIVATE PROPERTY
R9
20
THIS PROPERTY IS UNDER A CONSERVATION EASEMENT. ANY WORK IN THIS SECTION WILL REQUIRE REVIEW AND APPROVAL OF THE CONSERVATION EASEMENT HOLDER (CITY OF GREELEY NATURAL AREAS AND TRAILS DIVISION).
INCREASE CHANNEL CONVEYANCE TO REMOVE PRIVATE PROPERTIES FROM FLOODPLAIN
ACQUIRE EASEMENT FOR SHEEP DRAW CHANNEL LOCATED ON PRIVATE PROPERTY
MONITOR EROSION AND IMPLEMENT STABILIZATION IMPROVEMENTS IF NEEDED
65TH AVE
MONITOR EROSION AND IMPLEMENT STABILIZATION IMPROVEMENTS IF NEEDED
21
US HWY 34 - REPLACE WITH (2) 20-FT (S) X 10-FT (R) RCBC TO MEET 100-YEAR CRITERIA CHANNEL IMPROVEMENTS IN THE VICINITY OF THE CULVERT TO ACCOMMODATE PROPOSED
95TH AVE - REPLACE WITH (2) 20-FT (S) X 10-FT (R) RCBC TO MEET 100-YEAR CRITERIA
22
TRAIL - REPLACE CMP WITH RCP
23
POND 311 - SOUTH OF US HWY 34 AND 95TH AVE
FORMALIZE EXISTING POND INTO REGIONAL DETENTION POND
95TH AVE
83RD AVE
R10
ACQUIRE EASEMENT FOR SHEEP DRAW CHANNEL LOCATED ON PRIVATE PROPERTY
N-3
POND 304 - SOUTH OF US HWY 34
FORMALIZE EXISTING POND INTO REGIONAL DETENTION POND
N-4
POND 309 - SOUTH OF US HWY 34
FORMALIZE EXISTING POND INTO REGIONAL DETENTION POND
SHEEP DRAW REGIONAL TRAIL EXPANSION
POND 364 - UPSTREAM OF US HWY 34, EAST OF 83RD AVE
CONSTRUCT NEW REGIONAL POND. REROUTE FLOW FROM SUBBASINS 83 AND 84 VIA STORM PIPE OR OPEN CHANNEL. UTILIZE EXISTING PIPES UNDER US HWY 34, IF POSSIBLE
US HWY 85
POND 301 - UPSTREAM OF STATE HWY 257
FORMALIZE EXISTING POND INTO REGIONAL DETENTION POND BY RAISING THE ROAD OR EXCAVATING FOR AN ADDITIONAL 2-FEET OF STORAGE
STATE HWY 257
R11
BOOMERANG DITCH
COUNTY ROAD 56

| | | | |
|---|---|---|---|
| PROJECT: 022-0169<br>DRAWN BY: DD<br>DATE: 2/2026 | CITY OF GREELEY | SHEEP DRAW MASTER PLAN<br>CONCEPTUAL DESIGN SCHEMATIC FIGURE | olsson<br>1525 Raleigh Street<br>Suite 400<br>Denver, CO 80204<br>TEL: 303.237.2072<br>FAX: 303.237.2659<br>www.olsson.com | FIGURE<br>10 |

## 6.2 Master Plan Description

### 6.2.1 Sheep Draw Reach 1 – Downstream Study Limits to Weld County Border Upstream of Greeley No.3 Ditch

**Channel Stabilization**
One check structure would be installed downstream of a sanitary crossing and Greeley No.3 Ditch.

**Structure Improvements**
Near Greeley No.3 ditch crossing the recommendation is to add a formal spillway to the east side of the crossing and fill low berm areas on west side of crossing to protect canal berm from damage during overtopping of minor storm events. At the trail crossings, the existing CMPs would be replaced with RCP of the same diameter.

**Ecological Improvements**
Between Greeley No.3 Ditch and the confluence with Cache la Poudre, the overbanks will be lowered to establish wetland benches and encourage more floodplain connectivity. The benches will improve the ecology and habitat on the reach.

**Access**
A project is planned to reroute the Poudre River Trail between the confluence and 59th Ave. The project will include relocating a trail crossing. The trail alignment will be designed by others. Access to the stream can be included with the channel improvements.

Reach 1 is within a conservation easement, the Sheep Draw Natural Area. Any work will require review and approval from the easement holder. The Sheep Draw Natural Area CE is jointly held by Town of Windsor, 301 Walnut St, Windsor CO 80550, and Larimer County 200 Oak St, 2nd Floor, Fort Collins CO 80521.

**Maintenance**
Maintenance in the reach would consist of weed and debris removal along the drainageway. There is a maintenance road along the left bank of Sheep Draw.

**MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH**

| | |
|---|---|
| PROJECT : | Sheep Draw MDP - Conceptual Design |
| DRAINAGEWAY : | Sheep Draw |
| REACH : | 1 |
| JURISDICTION : | Greeley |
| REACH ID: | SD-Reach1 |
| | Kiersten Rasmussen |
| DATE : | 1/20/2026 |

| DESCRIPTION | | | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|---|---|
| **Pipe Culverts and Storm Drains** | | | | | | | |
| Circular Pipes | | | | | | | |
| Diameter (in) | Length (ft) | No. of Barrels | | | | | |
| 84-inch | 24 | 1 | 24 | L.F. | $840.00 | $20,160.00 | Replace existing CMP with RCP - Structure 1 |
| 84-inch | 41 | 1 | 41 | L.F. | $840.00 | $34,440.00 | Replace existing CMP with RCP - Structure 2 |
| Headwalls | | | | | | | |
| Diameter (in) | Applicable | No. of Barrels | | | | | |
| 84-inch | Yes | 1 | 2 | EA | $4,722.00 | $9,444.00 | Replace existing CMP with RCP - Structure 1 |
| 84-inch | Yes | 1 | 2 | EA | $4,722.00 | $9,444.00 | Replace existing CMP with RCP - Structure 2 |
| Wingwalls (includes concrete apron) | | | | | | | |
| Diameter (in) | | No. of Barrels | | | | | |
| 84-inch | | 1 | 2 | EA | $27,237.94 | $54,476.00 | |
| 84-inch | | 1 | 2 | EA | $27,237.94 | $54,476.00 | |
| **Hydraulic Structures** | | | | | | | |
| Check Structures | | | | | | | |
| Check Structure, Concrete | | | 37 | L.F. | $540.00 | $19,910.00 | 1 check structure (downstream of utility crossing) |
| **Channel Improvements** | | | | | | | |
| Excavation, Low Range | | | 5590 | C.Y. | $22.00 | $122,980.00 | Excavate wetland benches |
| **Removals** | | | | | | | |
| Removal of culvert pipe (48"<D<84") | | | 65 | L.F. | $100.00 | $6,500.00 | Replace existing CMP with RCP - Structures 1 & 2 |
| **Special Items (User Defined)** | | | | | | | |
| Sheet Pile, Steel, Heavy, PZC-13 | <----User Defined Items | | 2700 | SF | $45.00 | $121,500.00 | Greeley Ditch no 3. spillway formalization - 450 ft x 6ft sheet pile |
| Concrete Cap | <----User Defined Items | | 450 | L.F. | $100.00 | $45,000.00 | Greeley Ditch no 3. spillway formalization |

| Master Plan Capital Improvement Cost Summary | | | | |
|---|---|---|---|---|
| Capital Improvement Costs | | | | |
| Pipe Culverts and Storm Drains | | | | $182,440.00 |
| Concrete Box Culverts | | | | $0.00 |
| Hydraulic Structures | | | | $19,910.00 |
| Channel Improvements | | | | $122,980.00 |
| Detention/Water Quality Facilities | | | | $0.00 |
| Removals | | | | $6,500.00 |
| Landscaping and Maintenance Improvements | | | | $0.00 |
| Special Items (User Defined) | | | | $166,500.00 |
| **Subtotal Capital Improvement Costs** | | | | **$498,330.00** |
| Additional Capital Improvement Costs | | | | |
| Dewatering | $45,000.00 | L.S. | | $45,000.00 |
| Mobilization | 5% | | | $24,917.00 |
| Traffic Control | $25,000.00 | L.S. | | $25,000.00 |
| Utility Coordination/Relocation | $20,000.00 | L.S. | | $20,000.00 |
| Stormwater Management/Erosion Control | 5% | | | $24,917.00 |
| **Subtotal Additional Capital Improvement Costs** | | | | **$139,834.00** |
| Land Acquisition Costs | | | | |
| ROW/Easements | | | | $0.00 |
| **Subtotal Land Acquisition Costs** | | | | **$0.00** |
| Other Costs (percentage of Capital Improvement Costs) | | | | |
| Engineering | 15% | | | $95,725.00 |
| Legal/Administrative | 5% | | | $31,908.00 |
| Contract Admin/Construction Management | 10% | | | $63,816.00 |
| Contingency | 25% | | | $159,541.00 |
| **Subtotal Other Costs** | | | | $350,990.00 |
| **Total Capital Improvement Costs** | | | | **$989,154.00** |

| Master Plan Operation and Maintenance Cost Summary | | | | |
|---|---|---|---|---|
| Description | Quantity | Unit | Unit Cost | Total Annual Cost |
| Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs | 85 | L.F. | $2.00 | $340.00 |
| Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.) | 1358 | L.F. | $4.00 | $10,864.00 |
| **Total Annual Operation and Maintenance Cost** | | | | **$11,204.00** |
| Effective Interest Rate | | | | 4.00% |
| **Total Operation and Maintenance Costs Over 50 Years** | | | | **$240,686.00** |

### 6.2.2 Sheep Draw Reach 2 – Weld County Border Upstream of Greeley No.3 Ditch to Downstream of C St

**Channel Stabilization**
A section of the channel should be monitored for erosion and stabilization efforts completed as necessary.

**Capacity Improvements**
A multistage channel would be graded from downstream of C Street to increase channel conveyance and remove structures from the floodplain. The approximate limits of channel improvements and the typical section are included in Figure G-1A included in Appendix G. The channel improvements are on private property and would require an easement.

A private access road crosses Sheep Draw downstream of C Street. The crossing does not have 100-year capacity and impacts the water surface elevations upstream. Replacing or removing the crossing would help reduce impacts of the future floodplain on structures. Since the crossing is privately owned, it was assumed the structure would remain in place as it relates to the conceptual design of the C Street crossing in Reach 3. Additionally, revisions to the crossing are not included in the MDP model or cost estimates

**Maintenance**
Maintenance in the reach would consist of weed and debris removal along the drainageway. Easements would need to be acquired to perform channel maintenance since Sheep Draw is on private property through the reach.

**MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH**

| | | | | | |
|---|---|---|---|---|---|
| PROJECT : | Sheep Draw MDP - Conceptual Design | | | | |
| DRAINAGEWAY : | Sheep Draw | | | | |
| REACH : | 2 | | | | |
| JURISDICTION : | Weld County | | | | |
| REACH ID: | SD-Reach2 | Kiersten Rasmussen | | DATE : | 1/20/2026 |

| DESCRIPTION | | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|---|
| **Special Items (User Defined)** | | | | | | |
| Channel Capacity Improvements | <----User Defined Items | 450 | L.F. | $1,400.00 | $630,000.00 | |
| **Land Acquisition** | | | | | | |
| Easement/ROW Acquisition | | 1.00 | ACRE | $150,000.00 | $150,000.00 | Easement for grading along capacity improvements length |

| Master Plan Capital Improvement Cost Summary | | | | |
|---|---|---|---|---|
| **Capital Improvement Costs** | | | | |
| Pipe Culverts and Storm Drains | | | | $0.00 |
| Concrete Box Culverts | | | | $0.00 |
| Hydraulic Structures | | | | $0.00 |
| Channel Improvements | | | | $0.00 |
| Detention/Water Quality Facilities | | | | $0.00 |
| Removals | | | | $0.00 |
| Landscaping and Maintenance Improvements | | | | $0.00 |
| Special Items (User Defined) | | | | $630,000.00 |
| **Subtotal Capital Improvement Costs** | | | | **$630,000.00** |
| **Additional Capital Improvement Costs** | | | | |
| Dewatering | $83,240.00 | L.S. | | $83,240.00 |
| Mobilization | 5% | | | $31,500.00 |
| Traffic Control | $25,000.00 | L.S. | | $25,000.00 |
| Utility Coordination/Relocation | $10,000.00 | L.S. | | $10,000.00 |
| Stormwater Management/Erosion Control | 5% | | | $31,500.00 |
| **Subtotal Additional Capital Improvement Costs** | | | | **$181,240.00** |
| **Land Acquisition Costs** | | | | |
| ROW/Easements | | | | $150,000.00 |
| **Subtotal Land Acquisition Costs** | | | | **$150,000.00** |
| **Other Costs (percentage of Capital Improvement Costs)** | | | | |
| Engineering | 15% | | | $121,686.00 |
| Legal/Administrative | 5% | | | $40,562.00 |
| Contract Admin/Construction Management | 10% | | | $81,124.00 |
| Contingency | 25% | | | $202,810.00 |
| **Subtotal Other Costs** | | | | **$446,182.00** |
| **Total Capital Improvement Costs** | | | | **$1,407,422.00** |

| Master Plan Operation and Maintenance Cost Summary | | | | | |
|---|---|---|---|---|---|
| **Description** | **Quantity** | **Unit** | **Unit Cost** | **Total Annual Cost** | |
| Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.) | 1620 | L.F. | $4.00 | $12,960.00 | |
| **Total Annual Operation and Maintenance Cost** | | | | **$12,960.00** | |
| Effective Interest Rate | | | | 4.00% | |
| **Total Operation and Maintenance Costs Over 50 Years** | | | | **$278,409.00** | |

### 6.2.3 Sheep Draw Reach 3 – Downstream of C Street to Downstream of 4th St

**Channel Stabilization**

Two check structures are recommended within the reach to protect utility crossings: a sanitary sewer crossing and three Kinder Morgan 22" – 24" diameter steel gas lines.

Locations of higher velocities were identified to be monitored for erosion and stabilization efforts completed as necessary at approximate stations 162+00 and 175+00. Where monitoring locations overlap with proposed channel improvements, action should be taken if channel degradation is observed prior to a larger grading project to address the capacity problems.

In locations where trails or utilities parallel Sheep Draw and lateral migration of the channel would threaten the infrastructure; bank stabilization improvements were identified. Within Reach 3, the bank stabilization is within limits of channel grading for capacity improvements and was not costed separately.

**Capacity Improvements**

At C Street, the existing bridge should be replaced with a 110-ft bridge and the road raised to provide 100-year conveyance and meet the Greeley criteria. Replacing the crossing coupled with channel improvements upstream and downstream of C Street remove structures from the floodplain. Channel improvements assume a multistage channel section, which is included on Figure G-1A included in Appendix G.

At approximately station 170+94, a drop structure would be installed and the channel thalweg lowered to reduce the floodplain on private properties.

At the trail crossing downstream of 4th street, the CMPs should be replaced with RCP of the same size. Realigning or relocating the crossing would provide additional flood conveyance benefit. Channel improvements are recommended downstream of 4th Street. Sheep Draw is on private property downstream of 4th Street and easements would be required for any work.

**Maintenance**

Maintenance in the reach would consist of weed and debris removal along the drainageway. While most of the reach is in natural areas owned by the City of Greeley, immediately downstream of 4th Street, Sheep Draw is on private property and easements would be required for maintenance activities.

**MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH**

| | |
|---|---|
| PROJECT : | Sheep Draw MDP - Conceptual Design |
| DRAINAGEWAY : | Sheep Draw |
| REACH : | 3 |
| JURISDICTION : | Greeley |
| REACH ID: | SD-Reach3 |
| | Kiersten Rasmussen |
| DATE : | 1/20/2026 |

| DESCRIPTION | | | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|---|---|
| **Pipe Culverts and Storm Drains** | | | | | | | |
| Circular Pipes | | | | | | | |
| Diameter (in) | Length (ft) | No. of Barrels | | | | | |
| 36-inch | 33 | 2 | 66 | L.F. | $216.00 | $14,256.00 | Replace existing CMP with RCP - Structure 7 |
| Flare End Sections | | | | | | | |
| Diameter (in) | Applicable | No. of Barrels | | | | | |
| 36-inch | Yes | 2 | 4 | EA | $3,219.00 | $12,876.00 | Replace existing CMP with RCP - Structure 7 |
| **Hydraulic Structures** | | | | | | | |
| Sloping Drop Structures | | | | | | | |
| Height (ft) | Bottom Width (ft) | Yn (ft) | | | | | |
| 3.2 | 30 | 6 | 1 | EA | $200,159.02 | $200,159.00 | Drop structure at STA: 170+94 |
| Check Structures | | | | | | | |
| Check Structure, Concrete | | | 148 | L.F. | $540.00 | $79,904.00 | 2 check structures (downstream of utility crossings) |
| **Removals** | | | | | | | |
| Removal of culvert pipe (D<48") | | | 66 | L.F. | $40.00 | $2,640.00 | |
| **Special Items (User Defined)** | | | | | | | |
| Channel Improvements | <----User Defined Items | | 4770 | L.F. | $1,400.00 | $6,678,000.00 | Channel Improvements |
| Removal of Bridge | <----User Defined Items | | 560 | SF | $45.00 | $25,200.00 | Remove existing 20-ft span Wood/Metal bridge at C St |
| Bridge | <----User Defined Items | | 3100 | SF | $475.00 | $1,472,500.00 | New 110-ft span bridge at C St |
| Raise Road | <----User Defined Items | | 27224 | SF | $25.00 | $680,600.00 | Raise C St roadway by 3.6-ft |
| **Land Acquisition** | | | | | | | |
| Easement/ROW Acquisition | | | 0.23 | ACRE | $165,000.00 | $37,950.00 | Easement for grading along capacity improvements length, Easement for gradi |

| Master Plan Capital Improvement Cost Summary | | | | |
|---|---|---|---|---|
| Capital Improvement Costs | | | | |
| Pipe Culverts and Storm Drains | | | | $27,132.00 |
| Concrete Box Culverts | | | | $0.00 |
| Hydraulic Structures | | | | $280,063.00 |
| Channel Improvements | | | | $0.00 |
| Detention/Water Quality Facilities | | | | $0.00 |
| Removals | | | | $2,640.00 |
| Landscaping and Maintenance Improvements | | | | $0.00 |
| Special Items (User Defined) | | | | $8,856,300.00 |
| **Subtotal Capital Improvement Costs** | | | | **$9,166,135.00** |
| Additional Capital Improvement Costs | | | | |
| Dewatering | $664,580.00 | L.S. | | $664,580.00 |
| Mobilization | 5% | | | $458,307.00 |
| Traffic Control | $50,000.00 | L.S. | | $50,000.00 |
| Utility Coordination/Relocation | $90,000.00 | L.S. | | $90,000.00 |
| Stormwater Management/Erosion Control | 5% | | | $458,307.00 |
| **Subtotal Additional Capital Improvement Costs** | | | | **$1,721,194.00** |
| Land Acquisition Costs | | | | |
| ROW/Easements | | | | $37,950.00 |
| **Subtotal Land Acquisition Costs** | | | | **$37,950.00** |
| Other Costs (percentage of Capital Improvement Costs) | | | | |
| Engineering | 15% | | | $1,633,099.00 |
| Legal/Administrative | 5% | | | $544,366.00 |
| Contract Admin/Construction Management | 10% | | | $1,088,733.00 |
| Contingency | 25% | | | $2,721,832.00 |
| **Subtotal Other Costs** | | | | **$5,988,030.00** |
| **Total Capital Improvement Costs** | | | | **$16,913,309.00** |

| Master Plan Operation and Maintenance Cost Summary | | | | |
|---|---|---|---|---|
| Description | Quantity | Unit | Unit Cost | Total Annual Cost |
| Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs | 66 | L.F. | $2.00 | $264.00 |
| Hydraulic Structure Maintenance (e.g. debris removal, erosion, structural repairs, etc.) | 1 | EA | $1,000.00 | $2,000.00 |
| Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.) | 5311 | L.F. | $4.00 | $42,488.00 |
| **Total Annual Operation and Maintenance Cost** | | | | **$44,752.00** |
| Effective Interest Rate | | | | 4.00% |
| **Total Operation and Maintenance Costs Over 50 Years** | | | | **$961,371.00** |

### 6.2.4 Sheep Draw Reach 4 – Downstream of 4th St to Downstream of 10th St

**Channel Stabilization**
Two check structures are recommended within the reach to protect utility crossings sanitary sewer crossings.

Upstream of 4th Street, the channel should be monitored for erosion. Action should be taken if channel degradation is observed prior to a larger grading project to address the capacity problems. The main stem of Sheep Draw along the split flow should be monitored for erosion, and action taken as necessary, approximately stations 200+00-210+00.

Downstream of 10th Street, bank stabilization should be installed in the left bank to protect the trail.

**Capacity Improvements**
A multistage channel would be graded upstream of 4th Street and upstream of the split flow to increase conveyance and remove structures from the floodplain. Approximately between stations 184+95 to 201+59 and stations 209+85 to 212+80.

A 20-foot x 10-foot RCBC, adjacent to the existing bridge would provide additional conveyance and prevent roadway overtopping at 4th Street. When coupled with the channel improvements, structures upstream of the crossing would be removed from the floodplain.

**Ecological Improvements**
Sheep Draw Reach 4 is in the Pumpkin Ridge Natural Area. The existing split flow will be improved by lowering the vegetated area between the split flow and Sheep Draw and formalized to activate in the 1-year event. Lowering the land between Sheep Draw and the split flow would provide more floodplain connectivity. On the split flow, the left bank will be lowered to allow floodplain connectivity and support wetland vegetation. The goal would be to establish diverse wetland species on the bench, supported by the more frequent inundation. Woody material would be used as bank stabilization on the outside bends of the split flow.

**Maintenance**
Maintenance in the reach would consist of weed and debris removal along the drainageway.

**MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH**

| | |
|---|---|
| PROJECT : | Sheep Draw MDP - Conceptual Design |
| DRAINAGEWAY : | Sheep Draw |
| REACH : | 4 |
| JURISDICTION : | Greeley |
| REACH ID: | SD-Reach4 |
| | Kiersten Rasmussen |
| DATE : | 1/20/2026 |

| DESCRIPTION | | | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|---|---|
| **Concrete Box Culverts** | | | | | | | |
| Box Culvert Pipe | | | | | | | |
| Individual Box Span (ft) | Box Height (ft) | No. of Barrels | Length (ft) | | | | |
| 20 | 10 | 1 | 75 | L.F. | $5,494.80 | $412,110.00 | Add (1) 20-ft (S) x 10-ft (R) RCBC at 4th St |
| Headwall and Toewalls | | | | | | | |
| Individual Box Span (ft) | No. of Barrels | Total Span (ft) | | | | | |
| 20 | 1 | 22.00 | 2 | EA | $3,942.40 | $7,885.00 | Add (1) 20-ft (S) x 10-ft (R) RCBC at 4th St |
| Wingwalls (includes wingwalls on either side of channel and concrete apron) | | | | | | | |
| Individual Box Span (ft) | Box Rise (ft) | No. of Barrels | | | | | |
| 20 | 10 | 1 | 2 | EA | $51,761.25 | $103,522.50 | Add (1) 20-ft (S) x 10-ft (R) RCBC at 4th St |
| **Hydraulic Structures** | | | | | | | |
| Check Structures | | | | | | | |
| Check Structure, Concrete | | | 270 | L.F. | $540.00 | $145,881.00 | 2 check structures (downstream of utility crossings) |
| **Channel Improvements** | | | | | | | |
| Excavation, Low Range | | | 5803 | C.Y. | $22.00 | $127,666.00 | Volume of lower floodplain reconection area to be graded near the split flow. An |
| Excavation, Mid Range | | | 5882 | C.Y. | $48.00 | $282,336.00 | Volume of higher floodplain reconection area to be graded near the split flow. A |
| **Special Items (User Defined)** | | | | | | | |
| Channel Improvements | <-----User Defined Items | | 1983 | L.F. | $1,400.00 | $2,776,803.00 | Channel Capacity Improvements |
| Channel Stability Improvements | <-----User Defined Items | | 640 | L.F. | $1,000.00 | $640,000.00 | Channel Stability Improvements |

| Master Plan Capital Improvement Cost Summary | | | | |
|---|---|---|---|---|
| Capital Improvement Costs | | | | |
| Pipe Culverts and Storm Drains | | | | $0.00 |
| Concrete Box Culverts | | | | $523,518.00 |
| Hydraulic Structures | | | | $145,881.00 |
| Channel Improvements | | | | $410,002.00 |
| Detention/Water Quality Facilities | | | | $0.00 |
| Removals | | | | $0.00 |
| Landscaping and Maintenance Improvements | | | | $0.00 |
| Special Items (User Defined) | | | | $3,416,803.00 |
| **Subtotal Capital Improvement Costs** | | | | **$4,496,204.00** |
| Additional Capital Improvement Costs | | | | |
| Dewatering | $292,790.00 | L.S. | | $292,790.00 |
| Mobilization | 5% | | | $224,810.00 |
| Traffic Control | $75,000.00 | L.S. | | $75,000.00 |
| Utility Coordination/Relocation | $70,000.00 | L.S. | | $70,000.00 |
| Stormwater Management/Erosion Control | 5% | | | $224,810.00 |
| **Subtotal Additional Capital Improvement Costs** | | | | **$887,410.00** |
| Land Acquisition Costs | | | | |
| ROW/Easements | | | | $0.00 |
| **Subtotal Land Acquisition Costs** | | | | **$0.00** |
| Other Costs (percentage of Capital Improvement Costs) | | | | |
| Engineering | 15% | | | $807,542.00 |
| Legal/Administrative | 5% | | | $269,181.00 |
| Contract Admin/Construction Management | 10% | | | $538,361.00 |
| Contingency | 25% | | | $1,345,904.00 |
| **Subtotal Other Costs** | | | | **$2,960,988.00** |
| **Total Capital Improvement Costs** | | | | **$8,344,602.00** |

| Master Plan Operation and Maintenance Cost Summary | | | | |
|---|---|---|---|---|
| Description | Quantity | Unit | Unit Cost | Total Annual Cost |
| Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, | 132 | L.F. | $2.00 | $528.00 |
| Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.) | 3964 | L.F. | $4.00 | $31,712.00 |
| **Total Annual Operation and Maintenance Cost** | | | | **$32,240.00** |
| Effective Interest Rate | | | | 4.00% |
| **Total Operation and Maintenance Costs Over 50 Years** | | | | **$692,586.00** |

### 6.2.5 Sheep Draw Reach 5 – Downstream od 10th St to Confluence with 71st Ave Split

**Channel Stabilization**
One check structure is recommended to protect a waterline crossing.

Downstream of the confluence with the 71st Ave Split, bank stabilization should be installed in the right bank to protect the water line and sanitary sewer which parallel the channel.

The channel should be monitored for erosion immediately downstream of the confluence with the 71st Ave Split.

**Capacity Improvements**
Upstream of 10th Street, channel grading would be required so the existing bridge will meet 100-year criteria. Realigning or relocating the pedestrian crossing upstream would provide additional floodplain reduction. Replacing the pedestrian crossing is not included in the conceptual design model or costs.

**Access**
People cross Sheep Draw in this reach as evidenced by social trails. A pedestrian bridge is included in the conceptual design around station 245+00, in line with one of the existing social trails. The bridge would have 10-year capacity. The rehab facility to the north of the proposed crossing is a critical facility and care should be taken in design that the crossing does not adversely impact the 100- or 500-year floodplains.

**Maintenance**
Maintenance in the reach would consist of weed and debris removal along the drainageway.

**MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH**

| | |
|---|---|
| PROJECT : | Sheep Draw MDP - Conceptual Design |
| DRAINAGEWAY : | Sheep Draw |
| REACH : | 5 |
| JURISDICTION : | Greeley |
| REACH ID: | SD-Reach5 |
| | Kiersten Rasmussen |
| DATE : | 1/20/2026 |

| DESCRIPTION | | | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|---|---|
| **Concrete Box Culverts** | | | | | | | |
| Box Culvert Pipe | | | | | | | |
| Individual Box Span (ft) | Box Height (ft) | No. of Barrels | Length (ft) | | | | |
| 12 | 10 | 1 | 90 | L.F. | $2,676.00 | $240,840.00 | Add (1) 12-ft (S) x 10-ft (R) RCBC at 10th St |
| Headwall and Toewalls | | | | | | | |
| Individual Box Span (ft) | No. of Barrels | Total Span (ft) | | | | | |
| 12 | 1 | 14.00 | 2 | EA | $2,200.80 | $4,402.00 | Add (1) 12-ft (S) x 10-ft (R) RCBC at 10th St |
| Wingwalls (includes wingwalls on either side of channel and concrete apron) | | | | | | | |
| Individual Box Span (ft) | Box Rise (ft) | No. of Barrels | | | | | |
| 12 | 10 | 1 | 2 | EA | $46,912.85 | $93,825.70 | Add (1) 12-ft (S) x 10-ft (R) RCBC at 10th St |
| **Hydraulic Structures** | | | | | | | |
| Check Structures | | | | | | | |
| Check Structure, Concrete | | | 164 | L.F. | $540.00 | $88,484.00 | 1 check structure (downstream of utility crossing) |
| **Special Items (User Defined)** | | | | | | | |
| Channel Stability Improvements | <----User Defined Items | | 610 | L.F. | $1,000.00 | $610,000.00 | |
| Pedestrian Bridge | <----User Defined Items | | 2100 | S.F | $400.00 | $840,000.00 | Pedestrian Bridge |

| Master Plan Capital Improvement Cost Summary | | | | |
|---|---|---|---|---|
| Capital Improvement Costs | | | | |
| Pipe Culverts and Storm Drains | | | | $0.00 |
| Concrete Box Culverts | | | | $339,068.00 |
| Hydraulic Structures | | | | $88,484.00 |
| Channel Improvements | | | | $0.00 |
| Detention/Water Quality Facilities | | | | $0.00 |
| Removals | | | | $0.00 |
| Landscaping and Maintenance Improvements | | | | $0.00 |
| Special Items (User Defined) | | | | $1,450,000.00 |
| **Subtotal Capital Improvement Costs** | | | | **$1,877,552.00** |
| Additional Capital Improvement Costs | | | | |
| Dewatering | $124,170.00 | L.S. | | $124,170.00 |
| Mobilization | 5% | | | $93,878.00 |
| Traffic Control | $90,000.00 | L.S. | | $90,000.00 |
| Utility Coordination/Relocation | $70,000.00 | L.S. | | $70,000.00 |
| Stormwater Management/Erosion Control | 5% | | | $93,878.00 |
| **Subtotal Additional Capital Improvement Costs** | | | | **$471,926.00** |
| Land Acquisition Costs | | | | |
| ROW/Easements | | | | $0.00 |
| **Subtotal Land Acquisition Costs** | | | | **$0.00** |
| Other Costs (percentage of Capital Improvement Costs) | | | | |
| Engineering | 15% | | | $352,422.00 |
| Legal/Administrative | 5% | | | $117,474.00 |
| Contract Admin/Construction Management | 10% | | | $234,948.00 |
| Contingency | 25% | | | $587,370.00 |
| **Subtotal Other Costs** | | | | **$1,292,214.00** |
| **Total Capital Improvement Costs** | | | | **$3,641,692.00** |

| Master Plan Operation and Maintenance Cost Summary | | | | |
|---|---|---|---|---|
| Description | Quantity | Unit | Unit Cost | Total Annual Cost |
| Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.) | 3079 | L.F. | $4.00 | $24,632.00 |
| **Total Annual Operation and Maintenance Cost** | | | | **$24,632.00** |
| Effective Interest Rate | | | | 4.00% |
| **Total Operation and Maintenance Costs Over 50 Years** | | | | **$529,149.00** |

### 6.2.6 Sheep Draw Reach 6 – Confluence with 71st Ave Split to Downstream of 71st Ave

**Channel Stabilization**
The reach should be monitored for erosion. Action should be taken if channel degradation is observed.

**Maintenance**
Maintenance in the reach would consist of weed and debris removal along the drainageway.

**MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH**

| | | | |
|---|---|---|---|
| PROJECT : | Sheep Draw MDP - Conceptual Design | | |
| DRAINAGEWAY : | Sheep Draw | | |
| REACH : | 6 | | |
| JURISDICTION : | Greeley | | |
| REACH ID: | SD-Reach6 | Kiersten Rasmussen | DATE : 1/20/2026 |

| DESCRIPTION | | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|---|
| **Master Plan Capital Improvement Cost Summary** | | | | | | |
| **Capital Improvement Costs** | | | | | | |
| Pipe Culverts and Storm Drains | | | | | $0.00 | |
| Concrete Box Culverts | | | | | $0.00 | |
| Hydraulic Structures | | | | | $0.00 | |
| Channel Improvements | | | | | $0.00 | |
| Detention/Water Quality Facilities | | | | | $0.00 | |
| Removals | | | | | $0.00 | |
| Landscaping and Maintenance Improvements | | | | | $0.00 | |
| Special Items (User Defined) | | | | | $0.00 | |
| **Subtotal Capital Improvement Costs** | | | | | **$0.00** | |
| **Additional Capital Improvement Costs** | | | | | | |
| Dewatering | | | L.S. | | $0.00 | |
| Mobilization | | 5% | | | $0.00 | |
| Traffic Control | | | L.S. | | $0.00 | |
| Utility Coordination/Relocation | | | L.S. | | $0.00 | |
| Stormwater Management/Erosion Control | | 5% | | | $0.00 | |
| **Subtotal Additional Capital Improvement Costs** | | | | | **$0.00** | |
| **Land Acquisition Costs** | | | | | | |
| ROW/Easements | | | | | $0.00 | |
| **Subtotal Land Acquisition Costs** | | | | | **$0.00** | |
| **Other Costs (percentage of Capital Improvement Costs)** | | | | | | |
| Engineering | | 15% | | | $0.00 | |
| Legal/Administrative | | 5% | | | $0.00 | |
| Contract Admin/Construction Management | | 10% | | | $0.00 | |
| Contingency | | 25% | | | $0.00 | |
| **Subtotal Other Costs** | | | | | **$0.00** | |
| **Total Capital Improvement Costs** | | | | | **$0.00** | |

| Master Plan Operation and Maintenance Cost Summary | | | | | |
|---|---|---|---|---|---|
| **Description** | **Quantity** | **Unit** | **Unit Cost** | **Total Annual Cost** | |
| Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs) | 39 | L.F. | $2.00 | $156.00 | |
| Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.) | 1034 | L.F. | $4.00 | $8,272.00 | |
| **Total Annual Operation and Maintenance Cost** | | | | **$8,428.00** | |
| Effective Interest Rate | | | | 4.00% | |
| **Total Operation and Maintenance Costs Over 50 Years** | | | | **$181,052.00** | |

### 6.2.7 Reach 7 – 71st Ave Split

**Channel Stabilization**
One check structure would be installed downstream of a sanitary sewer crossing.

The reach should be monitored for erosion. Action should be taken if channel degradation is observed.

**Maintenance**
Maintenance in the reach would consist of weed and debris removal along the drainageway.

**MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH**

| | | | |
|---|---|---|---|
| PROJECT : | Sheep Draw MDP - Conceptual Design | | |
| DRAINAGEWAY : | 71st Ave Split | | |
| REACH : | 7 | | |
| JURISDICTION : | Greeley | | |
| REACH ID: | 71ST-Reach7 | Kiersten Rasmussen | DATE : 1/20/2026 |

| DESCRIPTION | | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|---|
| **Hydraulic Structures** | | | | | | |
| Check Structures | | | | | | |
| Check Structure, Concrete | | 150 | L.F. | $540.00 | $80,957.00 | 1 check structure (downstream of utility crossing ) |

| Master Plan Capital Improvement Cost Summary | | | | | |
|---|---|---|---|---|---|
| **Capital Improvement Costs** | | | | | |
| Pipe Culverts and Storm Drains | | | | | $0.00 |
| Concrete Box Culverts | | | | | $0.00 |
| Hydraulic Structures | | | | | $80,957.00 |
| Channel Improvements | | | | | $0.00 |
| Detention/Water Quality Facilities | | | | | $0.00 |
| Removals | | | | | $0.00 |
| Landscaping and Maintenance Improvements | | | | | $0.00 |
| Special Items (User Defined) | | | | | $0.00 |
| **Subtotal Capital Improvement Costs** | | | | | **$80,957.00** |
| **Additional Capital Improvement Costs** | | | | | |
| Dewatering | | $15,000.00 | L.S. | | $15,000.00 |
| Mobilization | | 5% | | | $4,048.00 |
| Traffic Control | | $10,000.00 | L.S. | | $10,000.00 |
| Utility Coordination/Relocation | | $10,000.00 | L.S. | | $10,000.00 |
| Stormwater Management/Erosion Control | | 5% | | | $4,048.00 |
| **Subtotal Additional Capital Improvement Costs** | | | | | **$43,096.00** |
| **Land Acquisition Costs** | | | | | |
| ROW/Easements | | | | | $0.00 |
| **Subtotal Land Acquisition Costs** | | | | | **$0.00** |
| **Other Costs (percentage of Capital Improvement Costs)** | | | | | |
| Engineering | | 15% | | | $18,608.00 |
| Legal/Administrative | | 5% | | | $6,203.00 |
| Contract Admin/Construction Management | | 10% | | | $12,405.00 |
| Contingency | | 25% | | | $31,013.00 |
| **Subtotal Other Costs** | | | | | **$68,229.00** |
| **Total Capital Improvement Costs** | | | | | **$192,282.00** |

| Master Plan Operation and Maintenance Cost Summary | | | | | |
|---|---|---|---|---|---|
| **Description** | **Quantity** | **Unit** | **Unit Cost** | **Total Annual Cost** | |
| Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs) | 94 | L.F. | $2.00 | $376.00 | |
| Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.) | 1094 | L.F. | $4.00 | $8,752.00 | |
| **Total Annual Operation and Maintenance Cost** | | | | **$9,128.00** | |
| Effective Interest Rate | | | | 4.00% | |
| **Total Operation and Maintenance Costs Over 50 Years** | | | | **$196,089.00** | |

### 6.2.8 Sheep Draw Reach 8 – Downstream of 71st Ave to Downstream of 83rd Ave

**Channel Stabilization**
Five check structures would be installed downstream sanitary sewer crossings throughout the reach.

Sediment deposition has been observed at the 83rd Avenue crossing. Downstream of 83rd Avenue, the channel should be monitored for erosion and action taken to improve stability if degradation is observed.

Bank stabilization is recommended in multiple locations along the left bank to protect the sanitary line and trails.

**Capacity Improvements**
A 10-foot x 8-foot RCBC, adjacent to the existing bridge would provide additional conveyance and prevent roadway overtopping at 71st Ave crossing and remove structures from the floodplain. Channel improvements would be required at the crossing to accommodate the proposed culvert cell. It is recommended that the trail CMP be replaced with RCP of the same diameter, when needed.

**Regional Detention**
Pond 364, would be installed upstream of US Highway 34 and east of 83rd Ave. Flows would be rerouted into the pond and existing infrastructure would be utilized to convey flows to Reach 8.

**Access**
Extend the regional trail through 83rd Ave and connect to the existing trail west of the crossing.

The Triple Creek conservation easement is located in Reach 8. Any work within this easement requires notification to the easement holder, the City of Greeley so notice should be addressed to the City of Greeley Natural Areas and Trails Division, 321 N 16th Ave, Greeley CO 80631.

**Maintenance**
Maintenance in the reach would consist of weed and debris removal along the drainageway. Sheep Draw is on undeveloped private property for much of Reach 8. Easements will be required for maintenance activities and can be acquired as development occurs.

**MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH**

| | |
|---|---|
| PROJECT : | Sheep Draw MDP - Conceptual Design |
| DRAINAGEWAY : | Sheep Draw |
| REACH : | 8 |
| JURISDICTION : | Greeley |
| REACH ID: | SD-Reach8 |
| | Kiersten Rasmussen |
| DATE : | 1/20/2026 |

| DESCRIPTION | | | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|---|---|
| **Pipe Culverts and Storm Drains** | | | | | | | |
| Circular Pipes | | | | | | | |
| Diameter (in) | Length (ft) | No. of Barrels | | | | | |
| 48-inch | 50 | 1 | 50 | L.F. | $288.00 | $14,400.00 | Replace CMP with RCP - Structure 18 |
| Flare End Sections | | | | | | | |
| Diameter (in) | Applicable | No. of Barrels | | | | | |
| 48-inch | Yes | 1 | 2 | EA | $4,119.00 | $8,238.00 | Replace CMP with RCP - Structure 18 |
| **Concrete Box Culverts** | | | | | | | |
| Box Culvert Pipe | | | | | | | |
| Individual Box Span (ft) | Box Height (ft) | No. of Barrels | Length (ft) | | | | |
| 10 | 8 | 1 | 70 | L.F. | $2,096.80 | $146,776.00 | Add (1) 10-ft (S) x 8-ft (R) RCBC at 71st St |
| Headwall and Xorewalls | | | | | | | |
| Individual Box Span (ft) | No. of Barrels | Total Span (ft) | | | | | |
| 10 | 1 | 12.00 | 2 | EA | $1,900.80 | $3,802.00 | Add (1) 10-ft (S) x 8-ft (R) RCBC at 71st St |
| Wingwalls (includes wingwalls on either side of channel and concrete apron) | | | | | | | |
| Individual Box Span (ft) | Box Rise (ft) | No. of Barrels | | | | | |
| 10 | 8 | 1 | 2 | EA | $31,863.38 | $63,726.80 | Add (1) 10-ft (S) x 8-ft (R) RCBC at 71st St |
| **Hydraulic Structures** | | | | | | | |
| Check Structures | | | | | | | |
| Check Structure, Concrete | | | 898 | L.F. | $540.00 | $484,720.00 | 5 check structures (downstream of utility crossings) |
| **Detention/Water Quality Facilities** | | | | | | | |
| Detention (Complete-in-Place) | | | | | | | |
| Detention Facility 1 (Complete-in-Place) | | | 41 | AC-FT | $91,177.00 | $3,738,257.00 | Pond 364 based on 100yr storage |
| **Removals** | | | | | | | |
| Removal of culvert pipe (48"<D<84") | | | 50 | L.F. | $100.00 | $5,000.00 | Replace CMP with RCP - Structure 18 |
| **Special Items (User Defined)** | | | | | | | |
| Channel Stability Improvements | <-----User Defined Items | | 1150 | L.F. | $1,000.00 | $1,150,000.00 | Channel Stability Improvements |
| Trail/Path, Concrete (10' Width) | <-----User Defined Items | | 375 | LF | $105.00 | $39,375.00 | Extend trail to 83rd |
| **Land Acquisition** | | | | | | | |
| Easement/ROW Acquisition | | | 10.39 | ACRE | $25,000.00 | $259,750.00 | Assumed 50/50 split between City and developer for pond footprint 8.33 Acres f |

| Master Plan Capital Improvement Cost Summary | | | |
|---|---|---|---|
| Capital Improvement Costs | | | |
| Pipe Culverts and Storm Drains | | | $22,638.00 |
| Concrete Box Culverts | | | $214,305.00 |
| Hydraulic Structures | | | $484,720.00 |
| Channel Improvements | | | $0.00 |
| Detention/Water Quality Facilities | | | $3,738,257.00 |
| Removals | | | $5,000.00 |
| Landscaping and Maintenance Improvements | | | $0.00 |
| Special Items (User Defined) | | | $1,189,375.00 |
| **Subtotal Capital Improvement Costs** | | | **$5,654,295.00** |
| Additional Capital Improvement Costs | | | |
| Dewatering | $204,740.00 | L.S. | $204,740.00 |
| Mobilization | 5% | | $282,715.00 |
| Traffic Control | $75,000.00 | L.S. | $75,000.00 |
| Utility Coordination/Relocation | $130,000.00 | L.S. | $130,000.00 |
| Stormwater Management/Erosion Control | 5% | | $282,715.00 |
| **Subtotal Additional Capital Improvement Costs** | | | **$975,170.00** |
| Land Acquisition Costs | | | |
| ROW/Easements | | | $259,750.00 |
| **Subtotal Land Acquisition Costs** | | | **$259,750.00** |
| Other Costs (percentage of Capital Improvement Costs) | | | |
| Engineering | 15% | | $994,420.00 |
| Legal/Administrative | 5% | | $331,473.00 |
| Contract Admin/Construction Management | 10% | | $662,947.00 |
| Contingency | 25% | | $1,657,366.00 |
| **Subtotal Other Costs** | | | **$3,646,206.00** |
| **Total Capital Improvement Costs** | | | **$10,535,421.00** |

| Master Plan Operation and Maintenance Cost Summary | | | | |
|---|---|---|---|---|
| Description | Quantity | Unit | Unit Cost | Total Annual Cost |
| Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, | 157 | L.F. | $2.00 | $628.00 |
| Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.) | 7072 | L.F. | $4.00 | $56,576.00 |
| Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal | 7.5 | ACRE | $2,999.00 | $22,493.00 |
| **Total Annual Operation and Maintenance Cost** | | | | **$79,697.00** |
| Effective Interest Rate | | | | 4.00% |
| **Total Operation and Maintenance Costs Over 50 Years** | | | | **$1,712,066.00** |

### 6.2.9 Sheep Draw Reach 9 – Downstream of 83rd Ave to Downstream of US Highway 34

**Channel Stabilization**
Six check structures would be installed downstream of sanitary and water crossings.

Multiple locations were identified to monitor erosion. Action should be taken if channel degradation is observed. Where monitoring locations overlap with proposed channel improvements, action should be taken if channel degradation is observed prior to a larger grading project to address the capacity problems.

**Capacity Improvements**
A 16-foot x 8-foot RCBC, adjacent to the existing bridge would provide additional conveyance and prevent roadway overtopping at 83rd Avenue, meet 100-year criteria, and remove structures from the floodplain. Channel improvements would be required at the crossing to accommodate the proposed culvert cell.

Between stations 366+50 and 385+00, a multistage channel would be graded to increase conveyance capacity and pull private properties out of the floodplain.

The existing culverts at 95th Ave should be removed and replaced with (2) 20-foot x 10-foot RCBC to eliminate roadway overtopping.

**Access**
Extend the regional trail up to US Highway 34.

**Maintenance**
Maintenance in the reach would consist of weed and debris removal along the drainageway. Sheep Draw is on private property through stretches of this reach and easements will be required for maintenance activities on private property.

**MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH**

| | |
|---|---|
| PROJECT : | Sheep Draw MDP - Conceptual Design |
| DRAINAGEWAY : | Sheep Draw |
| REACH : | 9 |
| JURISDICTION : | Greeley |
| REACH ID: | SD-Reach9 |
| | Kiersten Rasmussen |
| DATE : | 1/20/2026 |

| DESCRIPTION | | | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|---|---|
| **Concrete Box Culverts** | | | | | | | |
| Box Culvert Pipe | | | | | | | |
| Individual Box Span (ft) | Box Height (ft) | No. of Barrels | Length (ft) | | | | |
| 16 | 8 | 1 | 100 | L.F. | $3,670.80 | $367,080.00 | Add (1) 16-ft (S) x 8-ft (R) RCBC at 83rd Ave |
| 20 | 10 | 2 | 75 | L.F. | $10,989.60 | $824,220.00 | (2) 20-ft (S) x 10-ft (R) RCBC at 95th Ave |
| Headwall and Toewalls | | | | | | | |
| Individual Box Span (ft) | No. of Barrels | Total Span (ft) | | | | | |
| 16 | 1 | 18.00 | 2 | EA | $2,998.80 | $5,998.00 | Add (1) 16-ft (S) x 8-ft (R) RCBC at 83rd Ave |
| 20 | 2 | 43.00 | 2 | EA | $7,705.60 | $15,411.00 | (2) 20-ft (S) x 10-ft (R) RCBC at 95th Ave |
| Wingwalls (Includes wingwalls on either side of channel and concrete apron) | | | | | | | |
| Individual Box Span (ft) | Box Rise (ft) | No. of Barrels | | | | | |
| 16 | 8 | 1 | 2 | EA | $35,000.80 | $70,001.60 | Add (1) 16-ft (S) x 8-ft (R) RCBC at 83rd Ave |
| 20 | 10 | 2 | 2 | EA | $64,488.29 | $128,976.60 | (2) 20-ft (S) x 10-ft (R) RCBC at 95th Ave |
| **Hydraulic Structures** | | | | | | | |
| Check Structures | | | | | | | |
| Check Structure, Concrete | | | 657 | L.F. | $540.00 | $354,537.00 | 6 check structures (downstream of utility crossings) |
| **Removals** | | | | | | | |
| Concrete Box Culvert | | | 150 | L.F./CELL | $200.00 | $30,000.00 | Remove exisintg 5.7-ft(S) x 5-ft (R) and 13.7-ft (S) x 5-ft (R) RCBC's at 95th Ave |
| **Special Items (User Defined)** | | | | | | | |
| Channel Capacity Improvements | <----User Defined Items | | 1870 | L.F. | $1,400.00 | $2,618,000.00 | |
| Trail/Path, Concrete (10' Width) | <----User Defined Items | | 1230 | L.F. | $105.00 | $129,150.00 | Extend regional trail to US HWY 34 |
| **Land Acquisition** | | | | | | | |
| Easement/ROW Acquisition | | | 0.52 | ACRE | $150,000.00 | $78,000.00 | Easement for grading along capacity improvements length |

| Master Plan Capital Improvement Cost Summary | | | | |
|---|---|---|---|---|
| Capital Improvement Costs | | | | |
| Pipe Culverts and Storm Drains | | | | $0.00 |
| Concrete Box Culverts | | | | $1,411,687.00 |
| Hydraulic Structures | | | | $354,537.00 |
| Channel Improvements | | | | $0.00 |
| Detention/Water Quality Facilities | | | | $0.00 |
| Removals | | | | $30,000.00 |
| Landscaping and Maintenance Improvements | | | | $0.00 |
| Special Items (User Defined) | | | | $2,747,150.00 |
| **Subtotal Capital Improvement Costs** | | | | **$4,543,374.00** |
| Additional Capital Improvement Costs | | | | |
| Dewatering | $287,190.00 | L.S. | | $287,190.00 |
| Mobilization | 5% | | | $227,169.00 |
| Traffic Control | $140,000.00 | L.S. | | $140,000.00 |
| Utility Coordination/Relocation | $140,000.00 | L.S. | | $140,000.00 |
| Stormwater Management/Erosion Control | 5% | | | $227,169.00 |
| **Subtotal Additional Capital Improvement Costs** | | | | **$1,021,528.00** |
| Land Acquisition Costs | | | | |
| ROW/Easements | | | | $78,000.00 |
| **Subtotal Land Acquisition Costs** | | | | **$78,000.00** |
| Other Costs (percentage of Capital Improvement Costs) | | | | |
| Engineering | 15% | | | $834,735.00 |
| Legal/Administrative | 5% | | | $278,245.00 |
| Contract Admin/Construction Management | 10% | | | $556,490.00 |
| Contingency | 25% | | | $1,391,226.00 |
| **Subtotal Other Costs** | | | | **$3,060,696.00** |
| **Total Capital Improvement Costs** | | | | **$8,703,598.00** |

| Master Plan Operation and Maintenance Cost Summary | | | | |
|---|---|---|---|---|
| Description | Quantity | Unit | Unit Cost | Total Annual Cost |
| Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs | 250 | L.F. | $2.00 | $1,000.00 |
| Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.) | 7354 | L.F. | $4.00 | $58,832.00 |
| **Total Annual Operation and Maintenance Cost** | | | | **$59,832.00** |
| Effective Interest Rate | | | | 4.00% |
| **Total Operation and Maintenance Costs Over 50 Years** | | | | **$1,285,322.00** |

## 6.2.10 Sheep Draw Reach 10 - Downstream of US Highway 34 to Weld County Border

### Channel Stabilization

Two check structures would be installed downstream of sanitary sewer crossings.

### Structure Improvements

The existing culverts at US Highway 34 should be removed and replaced with (2) 20-foot x 10-foot RCBC to eliminate roadway overtopping. It is recommended that the trail CMP be replaced with RCP of the same diameter, when needed.

### Regional Detention

Multiple regional detention ponds are recommended upstream of Highway 34. Ponds 311, 309, and 304 exist and would be formalized into regional detention ponds. Pond 304 extends past the Greeley City limits, into Sheep Draw Reach 11, but costs for the pond are included only Reach 10.

### Maintenance

Maintenance in the reach would consist of weed and debris removal along the drainageway. Sheep Draw is on private property through this reach and easements will be required for maintenance activities on private property.

**MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH**

| | |
|---|---|
| PROJECT : | Sheep Draw MDP - Conceptual Design |
| DRAINAGEWAY : | Sheep Draw |
| REACH : | 10 |
| JURISDICTION : | Greeley |
| REACH ID: | SD-Reach10 |
| | Kiersten Rasmussen |
| DATE : | 1/20/2026 |

| DESCRIPTION | | | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|---|---|
| **Pipe Culverts and Storm Drains** | | | | | | | |
| Circular Pipes | | | | | | | |
| Diameter (in) | Length (ft) | No. of Barrels | | | | | |
| 48-inch | 31 | 1 | 31 | L.F. | $288.00 | $8,928.00 | Replace CMP with RCP - Structure 23 |
| 48-inch | 85 | 1 | 85 | L.F. | $288.00 | $24,480.00 | Pond 309 Outlet Pipe |
| 48-inch | 60 | 1 | 60 | L.F. | $288.00 | $17,280.00 | Pond 311 Outlet Pipe |
| Flare End Sections | | | | | | | |
| Diameter (in) | Applicable | No. of Barrels | | | | | |
| 48-inch | Yes | 1 | 2 | EA | $4,119.00 | $8,238.00 | Replace CMP with RCP - Structure 23 |
| **Concrete Box Culverts** | | | | | | | |
| Box Culvert Pipe | | | | | | | |
| Individual Box Span (ft) | Box Height (ft) | No. of Barrels | Length (ft) | | | | |
| 20 | 10 | 2 | 222 | L.F. | $10,989.60 | $2,439,691.00 | (2) 20-ft (S) x 10-ft (R) RCBC at US HWY 34 |
| 20 | 8 | 2 | 150 | L.F. | $10,523.20 | $1,578,480.00 | Pond 304 Outlet Pipe |
| Headwall and Toewalls | | | | | | | |
| Individual Box Span (ft) | No. of Barrels | Total Span (ft) | | | | | |
| 20 | 2 | 43.00 | 2 | EA | $7,705.60 | $15,411.00 | (2) 20-ft (S) x 10-ft (R) RCBC at US HWY 34 |
| 20 | 2 | 43.00 | 1 | EA | $7,705.60 | $7,706.00 | Pond 304 Outlet Pipe |
| Wingwalls (includes wingwalls on either side of channel and concrete apron) | | | | | | | |
| Individual Box Span (ft) | Box Rise (ft) | No. of Barrels | | | | | |
| 20 | 10 | 2 | 2 | EA | $64,488.29 | $128,976.60 | (2) 20-ft (S) x 10-ft (R) RCBC at US HWY 34 |
| 20 | 8 | 2 | 1 | EA | $48,073.40 | $48,073.40 | Pond 304 Outlet Pipe |
| **Hydraulic Structures** | | | | | | | |
| Check Structures | | | | | | | |
| Check Structure, Concrete | | | 121 | L.F. | $540.00 | $65,545.00 | 2 check structures (downstream of utility crossings) |
| **Detention/Water Quality Facilities** | | | | | | | |
| Detention (User Entered Quantities) | | | | | | | |
| Outlet Works | | | 3 | EA | $75,000.00 | $225,000.00 | |
| Water Quality Appurtenances | | | 3 | EA | $10,000.00 | $30,000.00 | |
| **Removals** | | | | | | | |
| Removal of culvert pipe (48"<D<84") | | | 31 | L.F. | $100.00 | $3,100.00 | Replace CMP with RCP - Structure 23 |
| Concrete Box Culvert | | | 444 | L.F./CELL | $200.00 | $88,800.00 | Remove 26-ft (S) x 4-ft (R) RCBC at US HWY 34 |
| **Land Acquisition** | | | | | | | |
| Easement/ROW Acquisition | | | 35.90 | ACRE | $25,000.00 | $897,500.00 | Assumed 50/50 split between City and developer for pond footprints |

| Master Plan Capital Improvement Cost Summary | | | | |
|---|---|---|---|---|
| Capital Improvement Costs | | | | |
| Pipe Culverts and Storm Drains | | | | $58,926.00 |
| Concrete Box Culverts | | | | $4,218,338.00 |
| Hydraulic Structures | | | | $65,545.00 |
| Channel Improvements | | | | $0.00 |
| Detention/Water Quality Facilities | | | | $255,000.00 |
| Removals | | | | $91,900.00 |
| Landscaping and Maintenance Improvements | | | | $0.00 |
| Special Items (User Defined) | | | | $0.00 |
| **Subtotal Capital Improvement Costs** | | | | **$4,689,709.00** |
| Additional Capital Improvement Costs | | | | |
| Dewatering | $125,000.00 | L.S. | | $125,000.00 |
| Mobilization | 5% | | | $234,485.00 |
| Traffic Control | $110,000.00 | L.S. | | $110,000.00 |
| Utility Coordination/Relocation | $110,000.00 | L.S. | | $110,000.00 |
| Stormwater Management/Erosion Control | 5% | | | $234,485.00 |
| **Subtotal Additional Capital Improvement Costs** | | | | **$813,970.00** |
| Land Acquisition Costs | | | | |
| ROW/Easements | | | | $897,500.00 |
| **Subtotal Land Acquisition Costs** | | | | **$897,500.00** |
| Other Costs (percentage of Capital Improvement Costs) | | | | |
| Engineering | 15% | | | $825,552.00 |
| Legal/Administrative | 5% | | | $275,184.00 |
| Contract Admin/Construction Management | 10% | | | $550,368.00 |
| Contingency | 25% | | | $1,375,920.00 |
| **Subtotal Other Costs** | | | | **$3,027,024.00** |
| **Total Capital Improvement Costs** | | | | **$9,428,203.00** |

| Master Plan Operation and Maintenance Cost Summary | | | | |
|---|---|---|---|---|
| Description | Quantity | Unit | Unit Cost | Total Annual Cost |
| Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs | 475 | L.F. | $2.00 | $1,900.00 |
| Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.) | 6999 | L.F. | $4.00 | $55,992.00 |
| Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal | 28.6 | ACRE | $2,999.00 | $85,771.00 |
| **Total Annual Operation and Maintenance Cost** | | | | **$143,663.00** |
| Effective Interest Rate | | | | 4.00% |
| **Total Operation and Maintenance Costs Over 50 Years** | | | | **$3,086,195.00** |

### 6.2.11 Sheep Draw Reach 11 - Weld County Border to Upstream Study Limits

**Regional Detention**
Upstream of State Highway 257, the existing pond, Pond 301, would be formalized into regional detention. The pond would need to be excavated deeper, and the road embankment raised to maximize benefit.

**Access**
Acquire easements and extend the regional trail through this reach.

**Maintenance**
Maintenance in the reach would consist of weed and debris removal along the drainageway. Sheep Draw is on private property through this reach and easements will be required for maintenance activities on private property.

**MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH**

| | |
|---|---|
| PROJECT : | Sheep Draw MDP - Conceptual Design |
| DRAINAGEWAY : | Sheep Draw |
| REACH : | 11 |
| JURISDICTION : | Weld County |
| REACH ID: | SD-Reach11 |
| | Kiersten Rasmussen |
| DATE : | 1/20/2026 |

| DESCRIPTION | | | QUANTITY | UNIT | UNIT COST | TOTAL COST | USER COMMENTS |
|---|---|---|---|---|---|---|---|
| **Concrete Box Culverts** | | | | | | | |
| Box Culvert Pipe | | | | | | | |
| Individual Box Span (ft) | Box Height (ft) | No. of Barrels | Length (ft) | | | | |
| 10 | 6 | 1 | 85 | L.F. | $1,903.20 | $161,772.00 | Pond 301 Outlet pipe to route under SH 257 |
| Headwall and Toewalls | | | | | | | |
| Individual Box Span (ft) | No. of Barrels | Total Span (ft) | | | | | |
| 10 | 1 | 12.00 | 1 | EA | $1,900.80 | $1,901.00 | Pond 301 |
| Wingwalls (includes wingwalls on either side of channel and concrete apron) | | | | | | | |
| Individual Box Span (ft) | Box Rise (ft) | No. of Barrels | | | | | |
| 10 | 6 | 1 | 1 | EA | $23,122.59 | $23,122.60 | Pond 301 |
| **Detention/Water Quality Facilities** | | | | | | | |
| Detention (User Entered Quantities) | | | | | | | |
| Excavation, Mid Range | | | 9050 | C.Y. | $48.00 | $434,400.00 | Pond 301 additonal 2 ft excavation in bottom of pond |
| Outlet Works | | | 1 | EA | $75,000.00 | $75,000.00 | |
| Water Quality Appurtenances | | | 1 | EA | $10,000.00 | $10,000.00 | |
| **Land Acquisition** | | | | | | | |
| Easement/ROW Acquisition | | | 20.80 | ACRE | $25,000.00 | $520,000.00 | Assumed 50/50 spilt between City and developer for pond footprint |

| Master Plan Capital Improvement Cost Summary | | | | |
|---|---|---|---|---|
| Capital Improvement Costs | | | | |
| Pipe Culverts and Storm Drains | | | | $0.00 |
| Concrete Box Culverts | | | | $186,796.00 |
| Hydraulic Structures | | | | $0.00 |
| Channel Improvements | | | | $0.00 |
| Detention/Water Quality Facilities | | | | $519,400.00 |
| Removals | | | | $0.00 |
| Landscaping and Maintenance Improvements | | | | $0.00 |
| Special Items (User Defined) | | | | $0.00 |
| **Subtotal Capital Improvement Costs** | | | | **$706,196.00** |
| Additional Capital Improvement Costs | | | | |
| Dewatering | $55,000.00 | L.S. | | $55,000.00 |
| Mobilization | 5% | | | $35,310.00 |
| Traffic Control | $50,000.00 | L.S. | | $50,000.00 |
| Utility Coordination/Relocation | $10,000.00 | L.S. | | $10,000.00 |
| Stormwater Management/Erosion Control | 5% | | | $35,310.00 |
| **Subtotal Additional Capital Improvement Costs** | | | | **$185,620.00** |
| Land Acquisition Costs | | | | |
| ROW/Easements | | | | $520,000.00 |
| **Subtotal Land Acquisition Costs** | | | | **$520,000.00** |
| Other Costs (percentage of Capital Improvement Costs) | | | | |
| Engineering | 15% | | | $133,772.00 |
| Legal/Administrative | 5% | | | $44,591.00 |
| Contract Admin/Construction Management | 10% | | | $89,182.00 |
| Contingency | 25% | | | $222,954.00 |
| **Subtotal Other Costs** | | | | **$490,499.00** |
| **Total Capital Improvement Costs** | | | | **$1,902,315.00** |

| Master Plan Operation and Maintenance Cost Summary | | | | |
|---|---|---|---|---|
| Description | Quantity | Unit | Unit Cost | Total Annual Cost |
| Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.) | 4226 | L.F. | $4.00 | $33,808.00 |
| Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal | 13.9 | ACRE | $2,999.00 | $41,686.00 |
| **Total Annual Operation and Maintenance Cost** | | | | **$75,494.00** |
| Effective Interest Rate | | | | 4.00% |
| **Total Operation and Maintenance Costs Over 50 Years** | | | | **$1,621,776.00** |

## 6.3 Prioritization and Phasing

In general, the conveyance improvements may be completed at any time. Ideally, structure and channel improvements would be implemented downstream to upstream. However, the reality of the phasing along Sheep Draw will be that the City of Greeley will construct improvements as funding permits that will provide the greatest benefits to the citizens. Check structures should be installed if the channel begins to erode. Regional detention should be implemented as development occurs to reduce peak flows and the size of infrastructure downstream.

As development occurs, the hydrology should be updated and the corresponding floodplain limits checked in the HEC-RAS model. Capacity improvements should be implemented, as funding allows, when the updated 100-year floodplain is shown to start impacting, or further impacting, private properties as compared to the existing (effective) conditions 100-year floodplain. It is also recommended to monitor the stability of the channel as development occurs. Implementing stabilization measures when the channel shows initial signs of degradation or sedimentation can help avoid costly improvements later.

## 6.4 Water Quality Impacts

Implementation of the master plan improvements will enhance and protect the water quality in Sheep Draw and ultimately the Cache la Poudre River. Improvements to enhance the water quality include retrofitting existing detention ponds to provide water quality capture volume and protecting the wetland areas that provide passive treatment. To protect the overall water quality along Sheep Draw, any development that occurs in the watershed should be required to provide water quality BMPs.

## 6.5 Operations and Maintenance

Routine maintenance should be completed in Sheep Draw. Maintenance will include weed and debris removal along the drainageway. Maintenance access will be from the regional trail adjacent to the creek in areas where the regional trail exists. In all other areas, maintenance access will be from the road.

Regional detention ponds and water quality ponds will require routine maintenance to ensure proper function.

## 6.6 Environmental Safety Assessment

Construction of the master plan improvements would impact potential wetlands and riparian habitat in select areas, primarily during the construction of road crossings, drop structures, and check structures. A wetland delineation and jurisdictional determination regarding the wetlands should be made to determine permitting requirements.

Providing capacity along the stream corridor and at roadway crossings for the master plan 100-year storm event would increase public safety by preventing roadway overtopping and private property and structure flooding. Preventing overtopping at the roads would provide access for emergency vehicles during a large storm event. In addition, the potential flood damage to structures as a result of the 100-year storm would be reduced.

## 7. REFERENCES

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US Environmental Protection Agency. February 12, 2023. *EPA SWMM 5.2.3*

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# APPENDIX A

## PROJECT CORRESPONDENCE

olsson®

SHEEP DRAW Major Drainageway Plan

# MEETING MINUTES

olsson®

# MEETING MINUTES

## Kickoff Meeting

| | |
|---|---|
| **Date:** | April 7, 2023 10:30 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Andrew Fisher | Greeley | Andrew.Fisher@Greeleygov.com |
| | Bhooshan Karnik | Greeley | Bhooshan.Karnik@Greeleygov.com |
| X | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| | Brittany Hathaway | Greeley | Brittany.Hathaway@Greeleygov.com |
| X | Don Threewitt | Greeley | Don.Threewitt@Greeleygov.com |
| X | Dylan Belanger | Greeley | Dylan.Belanger@Greeleygov.com |
| | Justin Scharton | Greeley | Justin.Scharton@greeleygov.com |
| | Kally Moran | Greeley | Kally.Moran@greeleygov.com |
| | Karen Reynolds | Greeley | Karen.Reynolds@Greeleygov.com |
| X | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| X | Monique Perez | Greeley | Monique.Perez@greeleygov.com |
| X | Nelvis Alvarez | Greeley | Nelvis.Alvarez@greeleygov.com |
| X | Scott Logan | Greeley | Scott.Logan@Greeleygov.com |
| X | Steven Younkin | Greeley | Steven.Younkin@greeleygov.com |
| | Winna MacLaren | Greeley | Winna.Maclaren@greeleygov.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |
| X | Erika Bowman | Olsson | ebowman@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |

**The main purpose of the meeting was to kick-off the Sheep Draw Master Plan and Regulatory Floodplain Update project. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions. The non-bold items comprised the meeting agenda. The bold items resulted from the discussions.**

1. Introductions
   a. Other invitees to meetings?

2. Project Background
   a. 16 sq. mi. Sheep Draw Basin draining to the Cache La Poudre
      i. MP last completed in 2006
      ii. Sheep Draw is the primary tributary
   b. City growth requires identification of Stormwater issues and planning for the future
   c. Sheep Draw Floodplain has significant impacts to the community
      i. Sheep Draw is vital resource that the City wants to utilize
      ii. Floodplain will impact growth
   d. Projected to last till December 2024

3. Project Goals
   a. Develop new and improved hydrologic and hydraulic models for Sheep Draw to identify problem areas and inform solutions for future and ongoing projects
   b. Provide clear guidance for future and ongoing development
   c. Identify CIP projects with shared objectives of stakeholders
   d. Update the regulatory floodplain
      i. Coordination with CWCB on approval of Hydrology and acceptance of the Floodplain
   e. Main areas of concern?
      i. Identification of incoming developments and coordinating with developers
         - Working with developers on changes and impacts that are discovered through this project
      ii. Important Sheep Draw aspects
         - Channel degradation
         - Existing crossing structures
         - Trails and Recreation
         - Identification of impacts in relation to transportation, development, and trails
         - **Utility crossings and potential utility impacts**
         - **Ecological and environmental integrity of corridor – we want to protect habitat and unique dragonfly species**
   f. Observed problems/issues?
      - **Not too many issues because open space was deliberately reserved within the Sheep Draw corridor to be a public amenity**

4. Communication
   a. Urgent items should be by phone or urgent flagged emails
   b. Floodplain items can be coordinated with floodplain admin first.
      **i. Brian Hathaway and Brian Fischer will be sharing floodplain administrator tasks**
   c. Critical items and final decisions include project manager **(Brian Fischer)**
   d. Contact list for submittals
      **i. We will start with Brian Fischer and can add additional contacts as needed**
   e. Sheep Draw LOMR and coordination with CWCB on floodplain updates
      **i. ICON will be involved in LOMR coordination**
   f. Alternatives Analysis
      i. Stakeholders will be involved for input
   g. **Project input, idea sharing, and collaboration is encouraged**

5. Needed Information
   a. Data Collection – Permission to enter forms
      **i. Permission to enter (PTE) letters have not been mailed out and may take a month or more to receive a response**
      **ii. Introduction letter will include a general timeframe (beginning of May) and will emphasize that it is a non-invasive survey**
      **iii. City has specific considerations and protocols for vehicles accessing public trails**
      **iv. Olsson will provide a priority list of property owners to contact out of the approximately 50 properties in total**
      **v.** Timeframe to complete **- Olsson survey team can be ready to begin field work in 2-3 weeks. Field work on public property could be prioritized if PTE responses are delayed. There are protocols that will need to be followed if vehicular access on trails is needed.**
   b. GIS
      **i. Brian Fischer will provide current GIS files**
      **ii. Ditches, open channels, and swales are not separate GIS layers**

| Category | Title | Source |
|---|---|---|
| **Buildings** | Buildings | City of Greeley |
| **GeoProcessing** | HydroLine | City of Greeley |
| | HydroBody | City of Greeley |
| **Linear Features** | Railroads | City of Greeley |
| | Roads | City of Greeley |
| | Ditches – newly updated | City of Greeley |
| | OpenChannels | City of Greeley |
| **Political Boundaries** | Parcels | City of Greeley |
| **Utilities** | Sewer | City of Greeley |
| | Stormwater | City of Greeley |
| | Water | City of Greeley |

c. Proposed development drainage reports or as-built plans
   i. **Brian has coordinated with Randy from EDR to get as-builts and will forward to Olsson**
   ii. **Historic water reservoir information is available from the State database – information includes reservoir effect and active/dormant/abandoned status**
   iii. **Gathering pond certifications is new program but the City would most likely have pond certifications for ponds developed in the last 2-3 years**
d. Proposed design files
   i. **Pumpkin Ridge and the 83rd Avenue underpass are active proposed trail developments in the Sheep Draw floodplain; both managed by Dave Wells**
   ii. **Pumpkin Ridge crossing may be moving north**
   iii. **83rd Avenue underpass CLOMR is accepted, but the design needs to be re-evaluated based on sedimentation since the design phase.**
e. Detention pond information for 28 City-owned and maintained detention ponds
f. **City will have new flyover imagery mid to late summer and processed LiDAR in May**
   i. **LiDAR will include all of City limits**
   ii. **2023 LiDAR will be used in hydraulic and hydrologic modeling instead of 2018 LiDAR**

6. Hydrology
   a. Use NOAA Atlas 14 rainfall, EPA SWMM 5.2.3, CUHP 2005 Version 2.0.1
   b. Existing and future land use – NLCD 2019 for existing conditions and zoning maps for undeveloped areas
      i. **Override percent impervious values for open space (2%) and open water (100%)**
      ii. **Olsson will work with the City to develop percent impervious changes from present to future**
      iii. **New aerial imagery will help update land use from 2019 NLCD**
   c. Detention pond storage-discharge information
      i. Compile from existing Sheep Draw Master Plan and drainage reports/plans
      ii. If needed, can supplement with LiDAR and survey
   d. **Basin delineations will be completed using updated LiDAR**

7. Hydraulics
   a. Use HEC-RAS 6.3.1
      i. **2D model will be developed and will inform the cross-section alignments**
      ii. **RAS mapper will be used to develop layers (i.e. Manning's n) to standardize how future projects along Sheep Draw are analyzed**
   b. ~~2018 LiDAR DEM from CWCB~~ **Updated LiDAR from the City**
   c. Generally, crossing structures under 36-inches will be assumed clogged and therefore not modeled. Small crossings will be identified and discussed with the City.
   d. Phased approach with reviews with ICON

8. Public Engagement
   a. Public Meetings – Two open house public meetings
      i. **The City requires 6 weeks or more to promote event – Nelvis will coordinate**
      ii. **Typically, engagement is low at public meetings (2-5 people)**

9. Schedule
   a. Survey: Field work to start in 2-3 weeks
      i. **Olsson will prioritize public land while waiting for responses to PTEs**
   b. Hydrology: 6/5/2023
      i. **This will be delayed so the basin delineations can be completed on the 2023 LiDAR – Olsson will start on pond hydrology**
   c. Hydraulic Model (LOMR): 10/9/2023
   d. **C Street crossing**
      i. **Olsson has developed the HEC-RAS model for the C Street portion but will be delayed in finalizing the model until the hydrology is finalized. Once hydrology is completed and the model revised as needed based on new flows, Olsson will prioritize this area and have ICON review in advance of the rest of the model in order for the C Street Phase II project to continue in design.**
   e. City comments and review: 2 weeks minimum
   f. **Updated project schedule will be provided once LiDAR is received. In an effort to compress the schedule as much as possible, the hydrologic and hydraulic models will be worked on concurrently.**

10. Upcoming meetings
   a. Monthly progress meetings (virtual)
      i. **Olsson will have the relevant staff attend**
      ii. **Brain Fischer and Brian Hathaway will be the main contacts and will forward the agenda to additional, relevant City people prior to meeting**
      iii. **Brian Fischer will coordinate a time to meet**
   b. Six additional progress meetings (two virtual and four in person)
   c. City of Greeley and CWCB
      i. Two meetings
         - After development of baseline hydrology
         - Prior to LOMR submittal

11. Other
   a. **CDPHE will be testing for E Coli TMDL associated with discharge from Sheep Draw to the Cache La Poudre River in late 2023, early 2024.**
   b. **The Sheep Draw corridor has been, and is, a vital corridor for Greeley with a rich history that includes Native American uses.**

12. **Action Items**

**Olsson:**

- **Provide a priority list of property owners to contact**

**City of Greeley:**

- **Forward pond as-builts and drainage reports**
- **Provide GIS files**
- **Coordinate a time to meet monthly**
- **Send out PTE forms with general survey start date as May**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Erika Bowman**
**cc: Attendees, File**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | August 24, 2023 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| X | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |

The main purpose of the meeting was to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

1. Project Status
   a. General
      i. Greeley sent final information on the 2023 LiDAR and it meets FEMA's base specifications to be used for the hydrology and hydraulics.
      ii. Survey should have all of the PTEs that are needed, Amy will confirm. They will have one final mobilization left to collect the remaining structure surveys and flowline shots. **After the meeting, it was determined that there were still a few PTEs missing. An updated map showing the needed PTEs is attached.**
   b. Hydrology
      i. Subbasins have been delineated and are being reviewed internally
      ii. The 28 detention pond locations have been identified and Olsson is starting to review the relevant studies to obtain stage-area-discharge information. Olsson will send any questions to Brian Fischer as the information is reviewed.
      iii. Olsson will use the 2019 NLCD data to determine existing percent impervious values with a few modifications. All 0% impervious values will be changed to 2%, open water will be changed to 100%, and areas that have developed since the latest NLCD data will be incorporated into the existing land use model. For future land use, Olsson will prepare a table of future land use and recommended percent imperviousness based on City criteria and zoning documents, supplemented with MHFD criteria. Olsson will send this table to the City for review prior to incorporating into the model.
      iv. Draft hydrology will be submitted to the City in mid-October.
   c. Hydraulics
      i. A rough 2D model of Sheep Draw has been prepared to help inform the cross section alignments and locations.
      ii. A Manning's n layer has been developed and is being reviewed internally.
      iii. Olsson is developing the alignment and initial cross section layout for external review by ICON. After comments are received, the remained of the model will be prepared.
      iv. A full draft model will be submitted to ICON in mid-November. The City does not need to be included on these interim external submittals.
   d. Projects are occurring in the corridor and in the watershed. Olsson will coordinate with the City as the study progresses.

2. Schedule
   a. An updated schedule is attached. In an effort to condense the schedule, it is assumed that portions of the project will proceed before FEMA acceptance has been received on the hydrology and hydraulics.

Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.

Minutes prepared by: Amy Gabor
cc: Attendees, File

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | October 5, 2023 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| X | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| X | Dave Wells | Greeley | dave.wells@greeleygov.com |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Erika Bowman | Olsson | ebowman@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |
| X | Monique Perez | Greeley - REM | Monique.Perez@greeleygov.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

1. General
   a. PTEs – Waiting on final 5 PTEs for one last survey mobilization. Summary PDF attached. Finalize with PTEs received to date?
      **i. Received 4 PTE approvals from Brian in advance of meeting. 1 left to collect – just downstream of 83rd (Parcel #21) – Xcel property**
         - **Brian – City has reached out to Xcel multiple times with no response**
         - **Dave – had a meeting about 3 months ago with real estate, have license agreement with trail construction that allows for survey**
         - **Easement along sanitary or use design project agreement? – Monique will look into**

      **ii. Only parcels where access was denied are Parcel #11 (can access information on other parcels, so OK) and Parcel #1 (already have majority of survey from C St project, and will access ditch crossing from other side).**

2. Hydrology
   a. Information we have received for the 28 detention pond locations has been reviewed. Majority of detention ponds do not have adequate stage-storage-discharge data to include in the model.

      Options include:
      i. Verify if any additional information is available and incorporate if it is.
         - **Brian – no additional information is available.**
      ii. Use LiDAR for stage-area, obtain survey of outlet structure, prepare calculations for stage-discharge curve and include in the model (would require additional survey and time to complete calculations)
         - **Madison – at a high-level look, majority of ponds appear to be large enough to be modeled**
      iii. Prepare hydrology with only detention ponds we have information for and compare to effective flows. Determine if additional detention pond inclusion would be beneficial to the project goals. Determine what detention ponds appear to affect the hydrology the most and obtain additional information for only these locations.
         - **Amy's recommendation and Brian agrees**
      **iv. Northridge Estates – use existing or proposed? Grading and outlet structure changing with C Street model.**
         - **Amy to follow up with Matt Olsson about C Street schedule – following the meeting Matt confirmed the schedule is to construct late 2024, or summer of 2025.**
         - **Brian – concern about C St project timeline due to property owner issues**
         - **Significant amount of effort to change from existing or proposed or vice versa?**
            - **At downstream end of Sheep Draw so may not be a problem**
            - **We will run both scenarios to compare the impact on the Sheep Draw peak flows – if not significant we will model existing**

   b. Future land use percent impervious values.

| Zoning | Percent Imperviousness | Notes |
|---|---|---|
| Conservation District (C-D) | Existing (NLCD) | |
| Commercial High Intensity (C-H) | 95 | |
| Commercial Low Intensity (C-L) | 75 | |
| Holding Agricultural (H-A) | ? | Currently agricultural, could be rezoned in future |
| Industrial High Intensity (I-H) | 90 | |
| Industrial Low Intensity (I-L) | 80 | |
| Industrial Medium Intensity (I-L) | 85 | |
| Planned Unit Development (PUD) | Varies | Use drainage reports/aerial verification where development is planned or being constructed |
| Residential Estate (R-E) | 12 | |
| Residential High Density (R-H) | 75 | |
| Residential Low Density (R-L) | 30 | |
| Residential Medium Density (R-M) | 45 | |

- **Holding agriculture – For agricultural land use, MHFD lists 2%**
   a. **Contact from planning to reach out for more updated planning zoning and clarification on classifications. Don Threewit – would have the best knowledge of what HA may turn into to help narrow and target percent imperviousness**
   b. **Brain Sullivan – updated shapefiles for zoning**
   c. **Dave – oil and gas setbacks, between 71st and 83rd, probably for next 20-30 years. Cross-reference with Master Plan.**

3. Hydraulics
   a. A rough 2D model of Sheep Draw was prepared

b. Alignment and cross section locations are being reviewed internally and then will be sent to ICON for review.

4. Sheep Draw at 83rd
   a. Stream profile has changed, looking at the need to raise the trail
      i. Does raising the trail affect CLOMR?
      ii. Need PTE 21 to finalize survey in this area and help inform any design changes
   b. Want to bid ASAP
      i. How long is bidding process? Could it be started while draft hydrology is finalized to help inform changes? Change order or force account if needed to design changes?
         - **Used to take six but has been taking much longer hopefully less than 12 weeks, they are at lease 2-4 weeks before starting bid**
   c. **Dave – seeing higher water levels, stream profile may not have changed**
      **i. SW corner is the only area that may have changed**
      **ii. Water levels may have been drawn down form irrigation**
      **iii. When surveyors get flowline shots in this area, we will also have them pick up water levels**
      **iv. Project cross section from riprap base – assume sediment at bridge scoured out from 100-yr flows**
      **v. MDP – look at aggradation and degradation areas**
      **vi. Proceed with adding in project CLOMR into our model, and then can replace with as-built information and submit with this LOMR instead of having a separate project LOMR.**

5. **Karen: Beaver activity north of 4th street – Hunters Cove. No dams but they have been felling trees**

6. **For floodplain model, future land use conditions can be used if difference between existing and future conditions is less than 30%. Will revisit what to use in HEC-RAS FEMA submittal once hydrology is done.**

**Action Items**
**City of Greeley:**
- **Look into agreement with Xcel on remaining property for PTE**
- **Provide feedback on proposed future land use percent impervious values, shown in the table in Section 2.b.**

**Olsson:**
- **Contact Don Threewit regarding H-A zoning**
- **Send survey information near 83rd to Dave Wells after completed**
- **Evaluate EX versus PR C Street detention and send Greeley recommendation of which scenario to include in baseline hydrology**
- **Complete sensitivity analysis of detention ponds and send recommendations for detention ponds to include to Greeley**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Erika Bowman**
**cc: Attendees, File**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | October 26, 2023 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| | Dave Wells | Greeley | dave.wells@greeleygov.com |
| | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Erika Bowman | Olsson | ebowman@olsson.com |
| | Madison Stewart | Olsson | mstewart@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

1. General
   a. PTEs – Waiting on final PTE for Xcel property. Requires 3 days notice.
      **i. Legal review by Xcel, expected to hear back Nov 8.**

2. Hydrology
   a. Subbasin delineations, longest flow paths, SWMM link alignments, design points have been completed and QCed.
   b. Working on remaining CUHP parameters (slopes, soils, percent imperviousness, depression storage)
   c. Working on remaining SWMM model parameters (link geometry, offsets, etc.)
   d. Would Greeley like an interim review of subbasin delineations before models are completed?
      **i. Subbasins will be sent with minutes**
      - **Notes on subbasin – not too long and skinny, balance between splitting up basins and longer flow paths**
      - **Planning for subbasin review – sooner rather than later would be helpful since other parameters (such as percent imperviousness, land uses, and soils) are based on those subbasin delineations**
   e. Rainfall
      i. NOAA Atlas 14 point rainfall at centroid of watershed
      ii. Apply Depth Reduction Factor (DRF) adjustments per MHFD criteria
      - **Amy - May only need DRF for minor storms**

      iii. Peak flows for each design point will be reported based on their tributary area and what DRF applies
      iv. Peak flow profiles along the main stem will be evaluated to make sure there are not dips where a DRF is applied. If changes to where a DRF is applied are recommended, they will be discussed with the City.
      - **Draft criteria typically aligning with MHFD. Brian H. will send Olsson the near-final draft criteria.**

   f. Detention ponds
      i. Detention ponds with tributary areas < 130 ac – recommend not including
      - **Only 5 of the 28 greater than 130 ac**
      - **Impact to 100-year typically not very significant from detention basins serving 130 ac. Will reassess as sensitivity analysis is completed.**

      ii. Sensitivity analysis underway
   g. Future land use percent impervious values.
      i. Brian F okay with percent imperviousness listed in table below

| Zoning | Percent Imperviousness | Notes |
|---|---|---|
| Conservation District (C-D) | Existing (NLCD) | |
| Commercial High Intensity (C-H) | 95 | |
| Commercial Low Intensity (C-L) | 75 | |
| Holding Agricultural (H-A) | Varies | Use Imagine Greeley designations – shapefiles available? **Erika has requested them and Jeff Woeber is working on it** |
| Industrial High Intensity (I-H) | 90 | |
| Industrial Low Intensity (I-L) | 80 | |
| Industrial Medium Intensity (I-L) | 85 | |
| Planned Unit Development (PUD) | Varies | Use drainage reports/aerial verification where development is planned or being constructed, or Imagine Greeley |
| Residential Estate (R-E) | 12 | |
| Residential High Density (R-H) | 75 | |
| Residential Low Density (R-L) | 30 | |
| Residential Medium Density (R-M) | 45 | |

3. Hydraulics
   a. No updates from last meeting

4. Sheep Draw at 83rd
   a. Need PTE 21 to finalize survey in this area

**Action Items**
**City of Greeley:**
- **Send follow-up on Xcel property access when received**
- **Provide feedback on subbasin delineations**

**Olsson:**

- **Send survey information near 83rd to Dave Wells after completed**
- **Complete sensitivity analysis of detention ponds and send recommendations for detention ponds to include to Greeley**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Erika Bowman**
**cc: Attendees, File**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | November 30, 2023 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| X | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| X | Dave Wells | Greeley | dave.wells@greeleygov.com |
| X | Mary Mateo | Greeley | mary.mateo@greeleygov.com |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Erika Bowman | Olsson | ebowman@olsson.com |
| | Madison Stewart | Olsson | mstewart@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.

1. General
   a. PTEs – Waiting on final PTE for Xcel property. Any update?
      i. **Greeley attorneys had amended the agreement and sent to Xcel, waiting for response.**
      ii. **Dave – Surveyors as part of 83rd Avenue Trail project could potentially get survey instead with their previous permissions.**
         - **Brian will check internally and get back to the group if this is the decided path forward.**
   b. Survey completed except for at 83rd.

2. Hydrology
   a. Olsson has integrated Greeley comments from interim hydrology review – thank you!
   b. Some CUHP parameters are complete (area, length, length to centroid, soils) and the SWMM model is set up
   c. In progress –
      i. SWMM conduit geometries
         - Irregular sections for Sheep Draw itself
         - Typical roadway sections based on Greeley details and checked against existing roadway sections for verification
         - Smaller, more regular channels/swales – trapezoidal sections
         - Limited pipes, only as warranted for detention ponds, or large capacity storm drain systems
      ii. SWMM Manning's n values – developed per MHFD criteria
         - Increased 25% for engineered sections (ie pipe, street, concrete)
         - Higher end of typical Manning's n for natural sections (ie Sheep Draw)
         - **Brian asked about the Manning's n guidance. The Manning's n adjustments are summarized in the Urban Strom Drainage Criteria Manual Volume 1, Section 4.2.1 and 4.2.2. An excerpt is included below.**

**Discretizing large catchments into smaller ones:**

Discretizing large catchments into smaller ones often results in increased unit discharges. The following recommendations can help eliminate the effect of the increase to provide more realistic hydraulic routing through the conveyance network in the EPA SWMM:

- Carefully estimate the effective longitudinal channel slope instead of relying on the elevations at the two ends of each routing element. If there are drop structures or other forms of vertical offsets in the channel reach, the effective channel slope between drops should be used rather than an overall reach slope between endpoints.
- Select the irregular natural channel option in the SWMM conduit cross-section editor to accurately represent actual channel cross-sections rather than selecting general geometric channels. This will ensure a more accurate wetted perimeter.
- Use appropriate Manning's n values that are reflective of the nuances in channel geometry and other flow controls along its reaches, namely those recommended in Section 7.2.3 of the *Open Channels* Chapter of the USDCM by following these guidelines:
  - For lined channels and pipes, increase Manning's n value by 25% over what would normally be used for the design as described in Section 4.2.2 below.
  - For grass-lined, riprap-lined and natural channels use the higher range of the values for the appropriate type of channel reach as recommended in Table B.2. Manning's Roughness Coefficients for Various Boundaries of the FHWA publication HDS-4, Introduction to Highway Hydraulics.
  - Whenever HEC-RAS sections are available, use the roughness coefficients for the main channel and overbanks from those studies unless the values obtained from item 3.b above are higher.

      iii. SWMM conduit offsets
         - Outlet offsets used to adjust conduit slope to be more reflective of average slopes
            - **Brian asked about how the offsets are identified. The profiles of the SWMM links are reviewed and the height of steep areas are added together and input as the offset. Then, the corresponding slope is checked against the section to make sure it is a reasonable slope to apply to the full length.**
         - Inlet offsets used where detention ponds or local depressions are not modeled
            - **Similar to the outlet offset, the corresponding slopes when offsets are applied (at one end or both) are checked for reasonableness.**
      iv. CUHP calculations (percent impervious, slopes, depression storage values)
         - **Working through weighted slopes using MHFD equation for weighted slope**
      v. Detention ponds – Sensitivity analysis following model completion
3. Hydraulics
   a. Olsson is wrapping up XS and stream alignment and will be sending to ICON to review this week

4. Sheep Draw at 83rd
   a. Need PTE 21 to finalize survey in this area

5. Next meeting – December 28. Need to reschedule?

a. **Meeting will be rescheduled for January 4.**

6. Anticipated schedule
   a. Draft hydrology models by mid-December, then final QC process and detention pond sensitivity analysis.
   b. Draft report and submittal mid- to late-January
      i. **Brian F – okay with this schedule update**
      ii. **Brain F – assume 2-3 weeks for City review**
      iii. **An updated schedule with 3 weeks for City review is attached**

7. Addition questions or concerns?
   a. **Dave asked about when as-builts for the 83rd Avenue Trail project would need to be submitted in order to be incorporated into this LOMR.**
      i. **Dave said as-builts would not be available until at least 4 months from now**
         - **Amy – thinks that it will fit in schedule before submittal to FEMA, but Amy will send an updated schedule with a highlighted date for as-builts to be included**
      ii. **The design CLOMR model can be put into the Olsson HEC-RAS model so that only minor adjustments will be needed to incorporate the as-built conditions.**
         - **Dave noted that there has been sedimentation at the bridge and that the CLOMR showed a 2' rise from the effective model due to changed existing conditions.**
         - **Dave will check with Drexel Barrell and can send over the CLOMR submittal. The model, design drawings, and any electronic CAD or GIS files would be helpful to make sure the project is fully incorporated into this study.**
      iii. **The sedimentation occurring at bridges will be further discussed in the MDP portion of this study.**
   b. **1%+ event – We have obtained the latest spreadsheet from MHFD and will use it to determine the 1% plus flows.**

**Action Items**
**City of Greeley:**
- **Send follow-up on Xcel property access when received**
- **Provide CLOMR submittal for inclusion in this study**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Erika Bowman**
**cc: Attendees, File**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | January 4, 2024 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| X | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| | Dave Wells | Greeley | dave.wells@greeleygov.com |
| X | Mary Mateo | Greeley | mary.mateo@greeleygov.com |
| | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Erika Bowman | Olsson | ebowman@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. General
   a. Survey completed except for at 83rd. We have Xcel agreement and will give 3 days notice and follow requirements when ready. We plan to get this survey when we determine survey cross section locations so we can combine the trip.

2. Hydrology
   a. Base CUHP and SWMM models are complete
   b. CUHP QC is complete and SWMM QC is in progress
   c. Initial results (subject to change with QC process)
      i. Base models have no detention and are therefore showing higher peak flows
   d. Detention ponds sensitivity analysis next steps
      A comparison table will be prepared summarizing different detention pond scenarios to determine the most beneficial dentition ponds to include in the baseline model.
      i. Scenario 1: Evaluate potential effects of detention from previous study (40 detention ponds). This analysis will be completed by disconnecting the upstream area and adding an inflow to the next design point based on the previous model.
         - **Purple and green pentagon symbols on attached figure**
         - **This scenario will be used to help validate the hydrology results as compared to the effective hydrology as it will provide more of an apples to apples comparison. If any private/inadvertent detention is deemed to have large impacts and inclusion in this study is desired, additional discussions will possibly be needed for FEMA concurrence.**
      ii. Scenario 2: Evaluate effects of City owned and maintained detention ponds from previous study – remove private detention ponds, irrigation ponds, and inadvertent detention from Scenario 1 (12 detention ponds). Add in one additional detention pond we have information for a total of 13 detention ponds.
         - **Green pentagon and cyan circle with black ring symbols on attached figure.**
      iii. Scenario 3: Evaluate detention ponds that are City owned/maintained and that we have information for (5 detention ponds). These will be modeled with stage-area-discharge or storage-discharge information.
         - **Green pentagon and cyan circle symbols with black ring on attached figure.**
      iv. Scenario 4: Evaluate location of remaining City owned/maintained detention ponds that were not in the previous study, or in the 5 we have information for, to determine maximum benefit to adding detention (15 detention ponds). This analysis will be completed by disconnection portions of the model and evaluating the effects on Sheep Draw. It is anticipated that this scenario will consist of several combinations of detention pond locations.
         - **Cyan symbols on attached figure.**
         - **This will be a high-level analysis to determine what additional ponds we may need to gather additional information for to include in the model.**
      v. Scenario 5: Based on the results of Scenarios 1-4, prepare a recommended detention pond approximate model and provide a summary of needed information to complete the recommended model.

3. Hydraulics
   a. XS and stream alignment were sent to ICON to review. They anticipate sending back comments mid-January.

4. Anticipated schedule
   a. No changes from last schedule update - January 24, pending if additional detention pond information is needed
      i. **The findings and recommendations of the detention pond sensitivity analysis will be sent in advance of the submittal and a call will be set up to discuss the results. Current plan is to submit full draft and not wait on additional survey/calculations for detention ponds.**
      ii. **Next steps following review and approval of hydrology will be to submit a hydrology CLOMR.**

5. Additional questions or concerns?
   a. **Will we need to submit to Weld County to get buyoff on hydrology?**
      i. **An initial conversation would be beneficial**
      ii. **Olsson coordinate with Diana Aungst after the draft hydrology is submitted**
   b. **Karen is interested in how open space corridors will play a role. The current channel is needing attention and becoming more incised. Olsson will be looking at both existing conditions and future risks at the upstream area develops.**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Madison Stewart**
**cc: Attendees, File, Michelle Danaher, Dave Wells**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | January 25, 2024 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees**:

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| | Dave Wells | Greeley | dave.wells@greeleygov.com |
| X | Mary Mateo | Greeley | mary.mateo@greeleygov.com |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Erika Bowman | Olsson | ebowman@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. Hydrology
   a. Draft submitted 01/24/24
      **i. The report PDF is large, and we can attach the larger documents instead of including them in the report PDF if desired, similar to how the EPA SWMM Input and Output was included.**
      **ii. There are placeholders for parts of the report to be completed in a later phase.**
      **iii. The report includes PDF bookmarks and figures with interactive toggles to aid in review.**
   b. Detention pond sensitivity analysis summary of 7 scenarios
      **i. The City needs some time to review the pond scenarios.**
      **ii. There are a total of 7 scenarios based on existing land use/percent imperviousness:**
      - **Scenario 1A and 1 B is intended to help explain differences between effective hydrology and our hydrology. The only difference between the two scenarios is one used information solely from the 2006 study (1A) and the other (1B) used information for the 5 City ponds that we have information for and the remainder from the 2006 study. To better understand differences between the models, the rainfall was updated to the 2006 distribution and select changes were made to approximate the 2006 percent impervious values. Resulting flows range between 3% and 24% lower than the effective hydrology, which seems reasonable.**
      - **Scenario 2 included the 6 large detention ponds upstream of US 24 form the 2006 study. These 6 ponds have a significant impact on the peak flows and Scenario 2 most closely matches the effective flows. However, Brian H. said 4 of the ponds (309, 311, 312, and 313) are definitely privately owned and used for irrigation and is fairly certain that the remaining 2 are also. Additionally, applications have come in proposing to remove one of these ponds. Although these ponds were included in the effective hydrology, they do not appear to meet current policy to be included in the baseline hydrology used for the updated floodplain analysis.**
      - **Scenarios 3-6 included different combinations of modeling the ponds owned and maintained by the City. Scenario 3 includes only the City-owned ponds that adequate data is available now to include in the model. If another scenario is selected for the final hydrology, additional data and calculations will be needed to model the ponds. In general, these four scenarios are similar in resulting peak flows showing that there is only minimal benefit to including any additional detention in the model. Scenario 3 was recommended and included as the baseline model in the draft hydrology.**
      - **Scenario 7 does not have any detention modeled. The peak flows are lower than Scenario 3 due to the timing of the peak flows from detention in the lower watershed.**
      - **Brian F.'s initial thought is that Scenario 3 or 7 makes the most sense.**
      **iii. While reviewing, the City will confirm that the ponds in Scenario 3 are actually owned by the City.**
   c. Area correction factor adjustments
      **i. Watershed is just beyond 15 square mile threshold (15.8). We ended up not using the 15 square mile area correction factors for any storm events due to the dip in flows.**
      **ii. The 5 square mile area correction factor for the minor events was applied at 5.5 square miles to eliminate a dip in the future profiles.**
   d. Draft results of Scenario 3
      **i. Scenario 3 increases the existing conditions flows 26%-46% as compared to effective.**
      **ii. Calibration is not recommended.**
   e. LOMR flows – Difference between existing and future peak flows >30%
      **i. Existing flows should be used for the LOMR and future flows are recommended to be used for the MDP.**

2. Hydraulics
   a. XS and stream alignment ICON comments received. Moving forward with model based on draft hydrology.

3. CWCB study participation
   a. **CWCB would contribute up to $50,000 and funds need to be used by June.**
   b. **Brian F. will move forward with coordination and application and check if any submittals are required by June.**

4. Anticipated schedule
   a. No changes from last schedule update – City review comments by 02/15/24

5. Additional questions or concerns?

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Erika Bowman and Madison Stewart**
**cc: Attendees, File, Karen Scopel, Dave Wells**

# MEETING AGENDA

## Progress Meeting

| | |
|---|---|
| **Date:** | February 22, 2024 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| | Dave Wells | Greeley | dave.wells@greeleygov.com |
| X | Mary Mateo | Greeley | mary.mateo@greeleygov.com |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Erika Bowman | Olsson | ebowman@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. Hydrology
   a. Comments received 02-12-2024 – edits underway
   b. CLOMR
      i. Would a pre-submittal meeting with CWCB be helpful to discuss the results and CLOMR submittal?
         - **Meeting with CWCB to show that our flows justify changing the hydrology for the area.**
         - **Brian is open to the idea if the CWCB makes process smoother**
         - **Working with Terri, Amy to reach out to outline the proposed hydrology changes.**
         - **CC everyone on regular Sheep Draw progress meetings**
         - **Brian just has to submit invoice to CWCB for funding, can start using on next invoices.**
      ii. CLOMR narrative will be a modified version of hydrology report
   c. Anticipated schedule
      i. Submit final hydrology to City by 03/05/24
      ii. Submit final hydrology and draft CLOMR documents to City at the same time?
         - **Brian agrees with sending both.**
      iii. Weld County review after City review or at same time?



- **Can review at the same time. Diana Aungst is floodplain administrator. Brian H and Brian F are okay with Olsson to initiate conversations with Weld County to let them know about on-going study.**

2. Hydraulics
   a. Base model completed
   b. Adding IEFAs where needed
   c. Internal QC underway
   d. When internal model QC is complete, will send to ICON for external review
   e. 83rd Ave – model will reflect existing conditions and will not include CLOMR since construction will be delayed?
      i. **To not include CLOMR information of 83rd project due to construction delays in our model. We will model existing conditions.**
   f. Anticipated schedule to follow current schedule – draft submittal to the City 05/24/2024 (pending timing of external reviews)

3. Additional questions or concerns?
   a. **Brian F – asking about ArcGIS pro. Requested meta data for GIS files to be included with final hydrology submittal. I.e. Defining properties such as "what is meant by Basin?" etc.**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Erika Bowman**
**cc: Attendees, File, Karen Scopel, Dave Wells**

# MEETING MINUTES

## Pre-CLOMR Meeting

| | |
|---|---|
| **Date:** | March 1, 2024 9:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

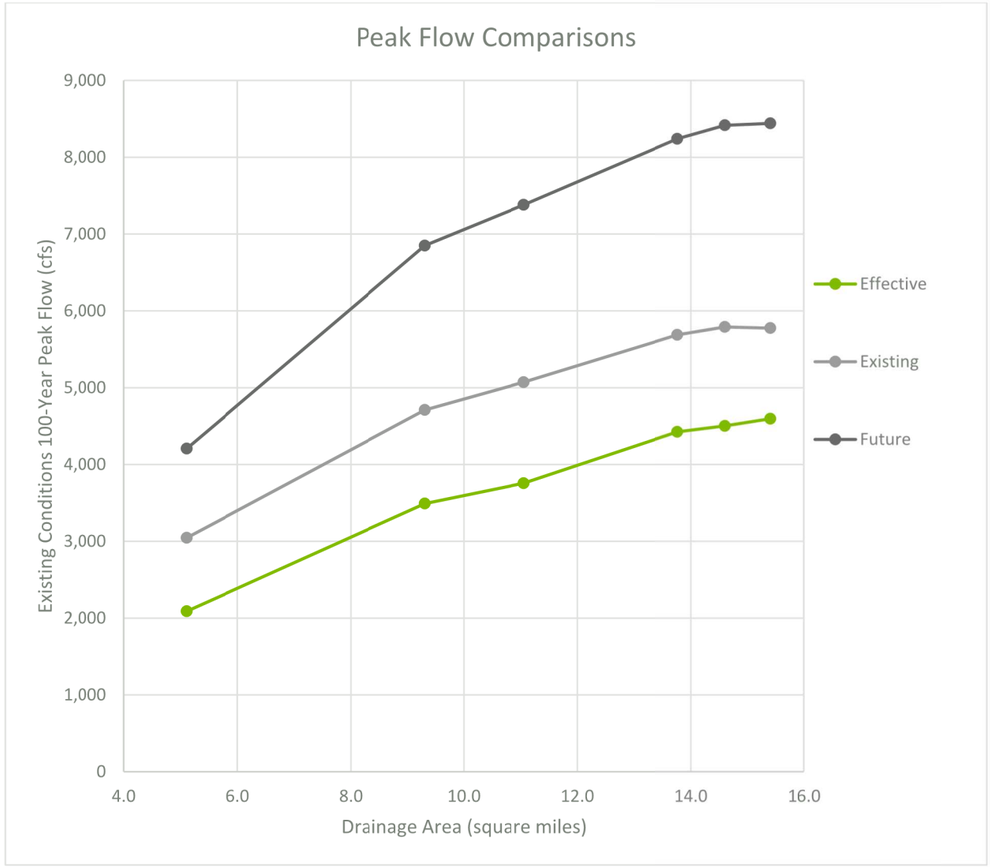
| Attended | Name | Company | E-mail |
|---|---|---|---|
| | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| | Joe Kuechenmeister | Michael Baker International | jkuechenmeister@mbakerintl.com |
| | Thomas Wilbert | Michael Baker International | wthomas@mbakerintl.com |
| | Sarah Houghland | Colorado Water Conservation Board (CWCB) | sarah.houghland@state.co.us |
| | Terri Fead | CWCB | Terri.fead@state.co.us |
| | Amy Gabor | Olsson | agabor@olsson.com |
| | Michelle Danaher | Olsson | mdanaher@olsson.com |

The main purpose of the meeting is to discuss the hydrology CLOMR submittal to ensure a complete submittal package. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. Hydrology
   a. Flow comparison

| Hydrology Comparison | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Location | 2024 Hydrology | | 2006 Effective | 2024 Hydrology | | | | |
| | | | Existing 100-Year Peak Flow | 100-Year Peak Flow (cfs) | | Percent Difference | Percent Difference to Effective | |
| | Design Point | Drainage Area ($mi^2$) | | Existing | Future | Future to Existing | Existing | Future |
| C Street Crossing | 105 | 15.4 | 4,596 | 5,775 | 8,442 | 46% | 26% | 84% |
| 4th Street Crossing | 113 | 14.6 | 4,502 | 5,791 | 8,417 | 45% | 29% | 87% |
| 10th Street Crossing | 124 | 13.8 | 4,425 | 5,688 | 8,240 | 45% | 29% | 86% |
| 71st Street Crossing | 152 | 11.1 | 3,756 | 5,072 | 7,380 | 46% | 35% | 96% |
| 83rd Street Crossing | 172 | 9.3 | 3,491 | 4,710 | 6,849 | 45% | 35% | 96% |
| US Hwy 34 | 1123 | 5.1 | 2,089 | 3,045 | 4,206 | 38% | 46% | 101% |






- **The study meets the thresholds for updating the hydrology. CLOMR should be based on existing land use flows. Master plan will be based on the future flows.**

b. Detention ponds

- **To include detention ponds in the hydrology, the ponds must be publicly owned ponds that are dedicated for flood control purposes with an operations and maintenance plan that indicates the pond use. If criteria cannot be met, it is safer not to include the ponds.**
- **Olsson and Greeley will coordinate about whether the ponds have O&M plans.**

c. Weld County

- **Weld County will not sign MT-2 form until the FEMA review is done. Michael Baker has an established workflow with Weld County regarding the signature timeline.**
- **Weld County has been reluctant to include community contact information on the property owner notifications. FEMA has confirmed that an engineer familiar with the changes can be included as the contact for questions. The notifications still need to reference community is changing flood hazards within their jurisdiction.**
- **The community acknowledgement of notification is required when a consultant sends the notification on the community's behalf.**

d. Existing or Future hydrology?

- **Existing flows should be used for FEMA regulatory products.**

e. Submittal package
   i. MT-2 Forms
   ii. Hydrology report / narrative – set up similar to MHFD MDP/FHAD. Keep all flows in report (existing and future), or just final flows for CLOMR?
   - **Can include both flows and helpful to have future flows in FEMA files for reference. The report will include about a statement to the effect of 'Future flows for information only, request is based on existing conditions'**

   iii. CUHP/SWMM Model
   **iv. GIS data: subbasins, land use, soils, detention info, etc will be included.**
   **v. The reviewer needs to be able to run models and reproduce results.**
   **vi. Include some statistical validation of hydrology.**

2. Hydraulics – timing of Sheep Draw LOMR relative to the hydrology CLOMR

   a. **Hydrology-only CLOMR does not include the 120 day appeal period**

   b. **Can use the discharge as soon as it is approved**

   c. **Michael Baker can help sequence so the timing works out – they can issue an AD letter on the LOMR to delay the timing, if necessary**

3. Additional questions or concerns?

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Michelle Danaher**
**cc: Attendees, File**

# MEETING MINUTES

## Pre-CLOMR Meeting

| | |
|---|---|
| **Date:** | March 5, 2024 1:00 pm via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees**:

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Melissa King | Weld County | mking@weld.gov |
| X | Diana August | Weld County | daungst@weld.gov |
| X | Amy Gabor | Olsson | agabor@olsson.com |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |

The main purpose of the meeting is to discuss the hydrology CLOMR submittal and Sheep Draw LOMR. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. Project background

   a. **The purposed of the new study is to more accurately reflect existing and future land use hydrology and hydraulics as development continues in the watershed, identify problem areas along Sheep Draw, evaluate alternatives to alleviate issues, and provide a conceptual design of the selected alternative.**

2. Study components

   a. Hydrology CLOMR

      **i. CUHP, SWMM, NOAA Atlas 14 Rainfall were used for the hydrologic model**

      ii. Detention ponds

      - **40 different ponds included in the effective hydrology. Some detention ponds in the effective hydrology are privately owned and do not meet the current criteria to be included in the effective hydrology.**
      - **6 detention ponds upstream of US 34 have major impact on detention flows – privately owned irrigation facilities and cannot be included in hydrology**

      **iii. The CHAMP only included updates for the Cache La Poudre River and did not include Sheep Draw.**



iv. Results

| Hydrology Comparison | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Location | 2024 Hydrology | | 2006 Effective | 2024 Hydrology | | | | |
| | | | Existing 100-Year Peak Flow | 100-Year Peak Flow (cfs) | | Percent Difference | Percent Difference to Effective | |
| | Design Point | Drainage Area ($mi^2$) | | Existing | Future | Future to Existing | Existing | Future |
| C Street Crossing | 105 | 15.4 | 4,596 | 5,775 | 8,442 | 46% | 26% | 84% |
| 4th Street Crossing | 113 | 14.6 | 4,502 | 5,791 | 8,417 | 45% | 29% | 87% |
| 10th Street Crossing | 124 | 13.8 | 4,425 | 5,688 | 8,240 | 45% | 29% | 86% |
| 71st Street Crossing | 152 | 11.1 | 3,756 | 5,072 | 7,380 | 46% | 35% | 96% |
| 83rd Street Crossing | 172 | 9.3 | 3,491 | 4,710 | 6,849 | 45% | 35% | 96% |
| US Hwy 34 | 1123 | 5.1 | 2,089 | 3,045 | 4,206 | 38% | 46% | 101% |

   b. Hydraulics – Sheep Draw LOMR will be based on existing land use flows
   c. Master Plan – will be based on future land use flows

3. Schedule

   a. Hydrology CLOMR – To be submitted to Greeley and Weld County for review in March. FEMA submittal anticipated in April.

   b. Hydraulics LOMR – Anticipate submitting to Greeley and Weld County for review end of May (pending external QC review timeframes). FEMA submittal to follow addressing comments.

      **i. Weld County will need the floodplain shapefiles – they prefer polygons, but can deal with lines**

      **ii. Olsson will consider and prepare verbiage for when a LOMR shows a rise based on the reflecting the current / more detailed conditions.**

4. Additional questions or concerns?

   a. **Melissa will be the primary contact for floodplain administration at Weld County. Include both Melissa and Diana on any correspondences.**
   b. **Study area map includes parcels in the City of Greeley in the Weld County Boundary**
      **i. Around US 34 and the subdivision have been annexed by Greeley**
      **ii. Olsson will download a SHP file of the city limits and update the study area map**
   c. **The County will review the notification letter and the list of people that will be notified. Olsson's contact information should be used in the letter. This approach has been accepted by FEMA.**
   d. **The County does not sign MT-2 Forms until FEMA has accepted the submittal. This approach has been accepted by FEMA.**

e. **The submittal package should be sent to both Melissa and Diana. When the CLOMR is submitted to the County, more detailed information should be including about the parcels that are in Weld County i.e. how the flows are changing and preliminary model results.**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Michelle Danaher**
**cc: Attendees, File**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | March 28, 2024 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| | Dave Wells | Greeley | dave.wells@greeleygov.com |
| X | Mary Mateo | Greeley | mary.mateo@greeleygov.com |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| | Erika Bowman | Olsson | ebowman@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. Hydrology
   a. Draft CLOMR submitted to Greeley and Weld County 03-19-2024
   b. Next steps – address comments from Greeley and Weld County and then submit to FEMA
      i. **Brian F. and Brian H. do not have any comments. Mary will review and see if there are comments. Brian F. will sign the MT-2 Form.**
      ii. **AG will follow up with Weld County next week**

2. Hydraulics
   a. Model and initial internal QC/addressing comments complete
   b. Final model internal QC underway
   c. Submit to ICON for full model review
   d. Anticipated schedule to follow current schedule – draft submittal to the City 05/24/2024 (pending timing of external reviews)

3. Survey
   a. Survey complete. Required additional visits than scoped due to property access.
      i. **AG will see if overage can be absorbed by the overall budget (still tracking in the survey category)**

4. Additional questions or concerns?
   a. **With surveying – did they fill out forms or just shoot the data? Additional information available – Sheets were be provided for bridges but not culverts. Olsson will send all survey information.**
   b. **Submit draft model to Greely at the same time as ICON**
   c. **Olsson to add an area correction factor graph to help explain why the 15 square mile adjustment was not used – include in the report.**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Michelle Danaher and Madison Stewart**
**cc: Attendees, File**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | May 23, 2024 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| | Dave Wells | Greeley | dave.wells@greeleygov.com |
| X | Mary Mateo | Greeley | mary.mateo@greeleygov.com |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Erika Bowman | Olsson | ebowman@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. Hydrology
   a. CLOMR submitted to FEMA May 2, 2024. Comments anticipated by July 31, 2024.
   b. **No CLOMR Fee, waived for hydrology**

2. Hydraulics
   a. ICON comments received May 2, 2024
   b. Anticipated schedule slightly delayed – Submit draft model with ICON comments addressed to the City June 28, 2024
   c. LOMR schedule – can likely submit prior to CLOMR acceptance based on previous meeting. Waiting to do detailed floodplain mapping until initial CLOMR comments received could eliminate risk of re-work. The remainder of the LOMR submittal could be prepared without as much risk for re-work. Greeley preference to wait or submit as soon as possible?
      i. **Greeley preference is to wait on detailed mapping until we receive hydrology CLOMR comments.**

3. Problem identification
   a. Begin process now or after the draft model submittal? **Olsson will begin problem identification and alternatives before the hydraulics LOMR is submitted.**
   b. **Brian would like to attend the site visit. Olsson will send a Microsoft meeting poll for the latter half of June or July.**

4. Additional questions or concerns?
   a. **ICON commented on using blocked obstructions for buildings. The Olsson model currently uses a higher Manning's n at the fenceline. Olsson will investigate the impact of using the higher, weighted n value vs blocking out buildings using a buildings shapefile.**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Michelle Danaher**
**cc: Attendees, Karen Scopel, Dave Wells, File**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | July 25, 2024 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| X | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| X | Dave Wells | Greeley | dave.wells@greeleygov.com |
| X | Mary Mateo | Greeley | mary.mateo@greeleygov.com |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. Hydrology
   a. CLOMR submitted to FEMA May 2, 2024. Comments anticipated by July 31, 2024.

2. Hydraulics
   a. Draft model submitted to the City June 28, 2024
   b. Comments on draft model?
      i. **Brian F will send comments to Olsson today (7/25) or tomorrow (7/26)**
   c. Floodway analysis and floodplain mapping will be started after initial hydrology comments are received from FEMA.

3. Problem identification and site visit
   a. Desktop analysis
   b. Map on your device browser – link
      i. **Trail section upstream of 83rd Avenue should be on the south side of Sheep Draw – Olsson will revise on the map**
   c. Field Maps – "MAP_SheepDrawMDPSiteWork_20230723_DEV"
   d. Other ways to view
      i. **None requested.**
   e. Site visit logistics
      i. **Meet at the cul-de-sac on the corner of W 19th Street Road and W 18th Street.**
      ii. **Cars will shuttle to drop off one car at the 60th Avenue cul-de-sac and we will bike down to 60th Avenue from the corner of W 19th Street Road and W 18th Street.**

4. Additional questions or concerns?
   a. **Brian F would like to review an interim submittal between problem identification and alternatives analysis.**
   b. **After receipt of CLOMR comments from FEMA, Olsson will update the schedule.**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Madison Stewart**
**cc: Attendees**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | August 22, 2024 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| **X** | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| | Dave Wells | Greeley | dave.wells@greeleygov.com |
| **X** | Mary Mateo | Greeley | mary.mateo@greeleygov.com |
| **X** | Michelle Danaher | Olsson | mdanaher@olsson.com |
| **X** | Madison Stewart | Olsson | mstewart@olsson.com |
| **X** | Amy Gabor | Olsson | agabor@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

Hydrology

a. CLOMR comments
    i. None of the comments are anticipated to change the hydrology, pending clarifications. Specific clarifications include:
        - Depression storage approach
        - Runoff coefficients
        - Rainfall comments – durations, rainfall intensity, 24-hour storm, precipitation frequency estimates at design points
        - Removing future land use information

2. Hydraulics
    a. Comments on the draft model
        i. Bank stations
            - **Olsson will provide more detail and context in the memo to address.**
        ii. Crossing 186+08
            - **Olsson will provide more detail and context in the memo to address.**
        iii. Crossings under 36” not modeled
            - **Olsson will provide more detail and context in the memo to address.**
        iv. FlowMaster calculations – what is City’s model preference for these type of irregular channel Manning’s calculations?
            - **Greeley’s preference is to use Hydraulic Toolbox or another open-source application.**
            - **Output PDFs from FlowMaster provide enough information to be recreated in other programs.**
        v. Other general comments will be addressed
    b. Hazleton bridge to be added pending as-built information
        i. No as-builts available but BH is looking into this
        ii. Worst case, Olsson can go out and get a structure survey on the bridge
    c. Finalize model and start floodway/mapping pending results of CLOMR meeting
        **i. Goals of the CLOMR meeting:**
            - **All questions are answered**
            - **Understand the review timeline**

3. Problem identification and site visit
    a. Web map images, as noted by Brian
    b. Will finalize and submit after model edits are completed
        **i. The primary focus of the problem identification will be protecting the stream from potential instability in future condition flows.**

4. Schedule – will send update after CLOMR meeting
    a. **No comments on the revised schedule from the City at this time.**

5. Additional questions or concerns?

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Madison Stewart**
**cc: Attendees**

# MEETING MINUTES

## CLOMR Comments Meeting

| | |
|---|---|
| **Date:** | September 3, 2024 9:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley | Brian.Fischer@Greeleygov.com |
| | Brian Hathaway | City of Greeley | Brian.Hathaway@Greeleygov.com |
| X | Dakota Duran | CDM Smith | durandc@cdmsmith.com |
| X | Paul Anderson | CDM Smith | andersonp@cdmsmith.com |
| X | Pei Yin (Michelle) January | CDM Smith | januaryp@cdmsmith.com |
| | Dawn Anderson | Weld County | dranderson@weld.gov |
| | Diana Aungst | Weld County | daungst@weld.gov |
| | Melissa King | Weld County | mking@weld.gov |
| X | Shea Thomas | Dept. of Natural Resources (DNR) | shea.thomas@state.co.us |
| X | Sarah Houghland | DNR | sarah.houghland@state.co.us |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |

The main purpose of the meeting is to discuss comments provided by CDM Smith on the Sheep Draw Master Plan and Regulatory Floodplain Update project CLOMR. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. Comment: The EPA SWMM model contains error messages concerning the elevation drop exceeding conduit lengths. Please provide an updated executable EPA SWMM model that does not contain error messages and produces results.

   a. Warning 04 shown on dummy links.
      i. **Add offset for slope and document in report.**

2. Comment: There is an error with flow interface files for CUHP. Please provide an updated executable CUHP model that does not contain error messages and provides results

   a. CUHP walk through

3. Comment: Backup information for the parameters in the hydrologic model was not provided. Please provide a table to show percent of weight average of each soil type for each subcatchment to determine the values of depression storage parameters, the values of initial rate and final rate of Horton's Infiltration parameters, as well as the values of runoff coefficient of $C_A$, $C_B$, and $C_{C/D}$ for NRCS HSG A, B or C and D soil types respectively. Additionally, please provide the value of each runoff coefficient of $C_A$, $C_B$, and $C_{C/D}$ used in the CUHP calculations.

   a. CUHP uses Horton's Equation which does not use runoff coefficients like the Rational Method.
      i. **OK not to include runoff coefficients since not used in calculations.**

   b. Impervious depression storage: 0.07 used for residential to be an average of sloped roofs (0.05) and pavement/sidewalks (0.1). Commercial, parks, industrial typically at 0.1 for flat surfaces/roofs

   c. Pervious depression storage: 0.35 for graded/developed areas, 0.4 for natural/open space areas.

   d. **Provide table of impervious and pervious depression storage calculations.**

4. Comment: According to MHFD Urban Storm Drainage Criteria Manual Volume 1 Table 5-1 Storm duration and area adjustment for CUHP modeling, 2 hours is recommended for design storms 50%, 20%, 10%, 4%, 2%, 1% and 0.2% annual percent chance with watershed area less than 15 square miles. For watershed area equal or more than 15 square miles, 6 hours duration is recommended to design storms 50%, 20%, 10%, 4%, 2%, 1% and 0.2% annual percent chance. Please provide the rainfall intensity (inches per hour) for each watershed area.

   a. CUHP calculates the 2-hour storm using the 1-hour and 6-hour inputs

> It is important to note that the *Multiple Runs* worksheet is only intended to be used with area corrected raingages of type "distarea". User-defined raingages (type "sheet") are unique and there is no way to update them based on rainfall depths, return period or area correction. Raingages without area correction (type "dist") are also not compatible with the *Multiple Runs* worksheet since they do not include inputs for the 6-hour rainfall depth or area correction factor. However, the actual rainfall distribution from a type "dist" raingage can be duplicated with the type "distarea" raingage by simply setting the area correction factor equal to zero. If the area correction factor is set equal to zero, the 6-hour rainfall depth is not needed and the resulting rainfall distribution will be a 2-hour distribution without area adjustment. If on the *Subcatchments* worksheet, the user specifies a raingage of type "sheet" or "dist" for a subcatchment, that subcatchment will continue to be run for each scenario but with the original raingage distribution regardless of the return period selected for the scenario on the *Multiple Runs* worksheet.

> 7. Next, the **Correction Area** in column N can range from 0 to 75 square miles. The first 8 scenarios in the example from Figure 4.5 do not have an area correction and were given a correction area value of zero (these 8 scenarios will be based on a 2-hour rainfall distribution). For example purposes an area correction of 25 square miles was included in Figure 4.5. It should be noted that the WQ event always has a correction area equal to

5. Comment: Please provide Point Precipitation Frequency Estimates from NOAA Atlas 14 which should be used in conjunction with the design point of hydrology analysis.

   a. One point approach

6. Please provide an explanation in the report for why the 24-hour duration is not being used in the hydrologic analysis.

   a. CUHP manual recommendation
      i. **Shea confirmed 6 hour is standard practice unless Greeley requires something different. Greeley concurs with the standard 6-hour approach.**

7. Please only include information that you would like to be reviewed for this CLOMR, please remove the “Future conditions” model as well as any information regarding to the detention pond sensitivity analysis if it is not included in the model.

    a. Pre-CLOMR meeting
        i. **Since previously discussed, OK to keep future land use conditions in the report for future reference.**

8. Please submit updated digital mapping files that reflect the changes to the work map requested above. Please ensure all necessary files are included to expedite final mapping production. This includes all as-built cross sections, as-built centerline, hydraulic structure alignments, and revised floodplain delineations.

    a. LOMR will follow CLOMR

9. Additional questions or concerns?

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Michelle Danaher**
**cc: Attendees**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | October 10, 2024 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| X | Mary Mateo | Greeley | mary.mateo@greeleygov.com |
| | Karen Reynolds | Greeley | karen.reynolds@greeleygov.com |
| X | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| X | Aaron Stines | Greeley | aaron.stines@greeleygov.com |
| X | Dave Wells | Greeley | dave.wells@greeleygov.com |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. Hydrology
   a. CLOMR
      i. Resubmitted to FEMA 09-30-2024
         - FEMA review of 90 days – 12/29/2024
      ii. Minor edits to hydrology model, but minimal impact to flows
      iii. Risk of additional comments affecting hydrology with next review is low. Previously discussed moving forward with floodway model and detailed floodplain mapping for LOMR since first review comments were minor – approach still good?
         - **This approach is still acceptable**

2. Hydraulics
   a. LOMR
      i. Model generally complete
      ii. Floodway model to start
         - Greeley preference on approach?
            - **Try to reduce the floodway as much as possible to remove structures and trails where feasible**
            - **Upstream of Highway 34 we will plan to make floodplain equal floodway to protect the corridor in the future**
         - ICON review – TBD
      iii. Figures and narrative setup
      iv. Detailed floodplain mapping to start

3. Existing conditions and problem identification
   a. Approach
      i. Report
      ii. Table of crossing structure capacity issues
      iii. Include information on percent change in flows, volumes, shears, and velocities between existing and future land use
      iv. Figures
         - Existing and future land use figures - On/off toggles: Parcel lines, utilities (water, storm, sanitary), topo, aerial, trail crossings, roadway crossings, City-owned and County-owned parcels
         - Existing land use problem areas
            - Stability issues
            - Capacity issues
            - Pedestrian and maintenance access issues
         - Future land use problem areas
            - Stability issues
            - Capacity issues
         - Water quality issues
            - In developed areas, highlight subbasins fully, partially, or not served by ponds with water quality plates.
            - **Once map is developed, see if it conveys useful information, or if information should be provided in a different way.**
         - Include ponds without water quality plates for reference

4. Schedule
   a. Submit existing conditions and problem identification on 10/18/24
      i. Assume 3 weeks for review adequate?
   b. Submit draft LOMR on 11/13/24 (pending ICON coordination on floodway model)
      i. Assume 4 weeks for review adequate?
      **ii. The City's preference is to wait for the submittal until after ICON's review. An updated schedule will be provided once the review timeframe is determined.**

5. Additional questions or concerns?
   a. **Future trail LOMR near 83rd Ave**
      **i. Trail was paused to be packaged together with the roadway. The projects are currently paused.**
      **ii. Dave will determine if the CLOMR is expired**
      **iii. If the CLOMR is expired, then the CLOMR will need to be resubmitted with the updated hydrology information**
      **iv. Dave will keep Olsson updated on the project progress**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Madison Stewart**
**cc: Attendees**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | November 14, 2024 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| X | Mary Mateo | Greeley | mary.mateo@greeleygov.com |
| | Karen Reynolds | Greeley | karen.reynolds@greeleygov.com |
| | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| X | Aaron Stines | Greeley | aaron.stines@greeleygov.com |
| X | Dave Wells | Greeley | dave.wells@greeleygov.com |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. Hydrology
   a. CLOMR
      i. Resubmitted to FEMA 09-30-2024
         - FEMA review of 90 days – 12/29/2024
2. Hydraulics
   a. LOMR
      i. Draft floodway model results
         - **Generally kept properties and trails out of the floodway to the extents possible.**
      ii. Floodway model submitted to ICON this week for review. Anticipate comments by December 6
         - **Olsson will send Greeley the floodway model after ICON comments have been addressed.**
      iii. Anticipate full draft LOMR submittal to Greeley and Weld County by December 20, 2024

3. Existing conditions and problem identification
   a. Existing conditions
      i. **Dave asked about identified problem areas at 83rd. The models show some potential stability issues downstream of 83rd and the roadway will overtop in the 100-year event based on the updated flows.**
   b. Future conditions
   c. Water quality
      i. **Ponds with water quality plates were determined based on the database Greeley provided.**
   d. Separating stormwater from ditch water at downstream end will be added to the maps
   e. Initial comments?
      **i. Greeley will send comments by Monday, November 18**

4. Additional questions or concerns?
   a. **Olsson will send Greeley the link to the Brantner Gulch MDP report as an example of the potential layout for the alternatives analysis phase of the project**
   b. **Is Greeley interested in creating wetland banks along Sheep Draw?**
      **i. Would be a long process**
      **ii. Brian F. will reach out to Mary Powell at MHFD**
   c. **Olsson will send Greeley the floodway model after ICON comments have been addressed**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Madison Stewart**
**cc: Attendees**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | January 9, 2025 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | Brian.Fischer@Greeleygov.com |
| X | Brian Hathaway | Greeley | Brian.Hathaway@Greeleygov.com |
| X | Mary Mateo | Greeley | mary.mateo@greeleygov.com |
| | Karen Reynolds | Greeley | karen.reynolds@greeleygov.com |
| X | Karen Scopel | Greeley | Karen.Scopel@Greeleygov.com |
| X | Aaron Stines | Greeley | aaron.stines@greeleygov.com |
| X | Dave Wells | Greeley | dave.wells@greeleygov.com |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. Hydrology
   a. CLOMR
      i. Comments received 12/27/2024
         - Comments might affect the hydrology (Manning's n values and DRFs)
         - **Comments regarding the depth reduction factor at the downstream end are slightly different than what was previously discussed.**
         - **We have responded with clarifications but have not received responses from reviewers yet.**
2. Hydraulics
   a. LOMR
      i. Full submittal nearly complete. Currently paused – status dependent on acceptance of the CLOMR comments approach, e-mailed 01-03-25

3. Existing conditions and problem identification
   a. City of Greeley comments received 11/18/24
   b. Comments were minor and will be addressed and incorporated into next submittal for alternatives analysis

4. Alternatives analysis
   a. Draft rating criteria and weight of each
      - Public Safety – 15%
      - Cost – 15%
      - Prevent Flooding – 15%
      - Stream Stability – 15%
      - Operations and Maintenance – 10%
      - Environmental & Water Quality Impacts – 10%
      - ROW Acquisitions/Easements – 10%
      - Public Acceptance – 10%
   b. **Greeley is interested in stream resilience and improved ecosystem function projects. There was dredging completed near Pumkin Ridge where material was laid in an adjacent area. Greeley is interested in looking at opportunities to improve this area.**

   c. Capacity alternatives
      i. Evaluate detention – use future land use flows for analysis
         - Target existing peak flows, or could over-detain to eliminate existing flooding problems
         - Focus on area upstream of US 34
         - To be considered in any future effective hydrology updates, would need to be City maintained and preferably owned
         - Regional versus on-site (with City maintenance)
            - **Regional detention is the City's preferred approach**

      ii. Upsize infrastructure to solve capacity issues – future land use flows with and without detention alternatives
         - Roadway crossings. **Recommendations to upsize are typically to meet criteria, not just to prevent overtopping.**
         - Channel capacity improvements where needed to remove inundated insurable structures and encroachment onto private property
            - 16 insurable structures impacted by the existing 100-year floodplain flows
            - 47 insurable structures impacted by the future 100-year floodplain flows
         - Any trail crossings to be considered?
            - **Karen will determine if any trail crossings should be considered**
            - **Some of the existing bridges were designed to be "breakaway" bridges**

   d. Stability alternatives
      i. Existing stability problems – identify areas in need of improvements and priority areas
      ii. Future stability problems
         - Identify additional areas in need of improvements and priority areas as development occurs
         - Potential criteria options for new development – primarily affecting minor storm runoff
            - Directly connected impervious areas **(DCIA)**
               - **The newly updated criteria includes guidance and recommendations on DCIA, but no specific requirements**
               - **Worth evaluating to see if the impact is great enough to incorporate specific requirements and/or recommendations in the Sheep Draw watershed**
            - Rain barrels
               - **Mass implementation would make the most impact, within State law allowances**
               - **Would be used to mitigate erosion issues, not effective flows**
               - **Worth evaluating to see if the impact is great enough to incorporate specific requirements and/or recommendations in the Sheep Draw watershed**
            - Full spectrum on-site detention

- **Greeley's updated criteria covers full spectrum detention, no need to incorporate anything specific to Sheep Draw watershed**

- **Impacts of artificial turf to drainage – Greeley is interested in understanding potential impacts to help identify recommendations related to artificial turf. Greeley noted the state bill prohibiting artificial turf in commercial and public property. The bill does not limit use on private residential properties.**

e. Water quality
   i. Inventory reconciliation
      - **Greeley supports a recommendation to field verify the status of water quality plates on the ponds that are missing that attribute.**
   ii. Prioritize ponds to retrofit with water quality
      - **Specific tributary areas for ponds will not be included in the prioritization evaluation, but a general look at locations of water quality treatment using the subbasin delineations from the baseline hydrology and storm drain system GIS files will be used to aid in the evaluation of recommended priorties.**
   **iii. Olsson will share data to support water quality roadmap by RESPEC and Otak – kickoff was 1/8/2025**
   **iv. Additional regional water quality alternatives will also be included in select areas. Dave Wells noted an old irrigation pond located near the 71st Split could be a good location for formalized water quality treatment**

f. Community values
   i. Recommendations for easements and trail connectivity
      - **Greeley does not have easements for the creek where it is on private property. Olsson will recommend acquiring easements with developments in the MDP.**
   **ii. Greeley has an updated trails master plan – not yet approved, Greeley will provide the draft plan. The drainage MDP will not duplicate information from the trails master plan, but will reference the master plan. The plan will be up for approval at the February council meeting.**

g. Greeley Ditch No. 3
   i. Channelize Sheep Draw and install a structure to bypass flows
   ii. Ditch company contacts for feasible improvements?
      - **Leah in water and sewer would know some information about the No. 3 Ditch – the City will set up a meeting**
   iii. Would the ditch company be receptive to modifications to the ditch itself?
   iv. Storm event passing at the ditch?
   v. Typical flows of the ditch? Water rights of the ditch company?
      - **Greeley does not think the ditch company has water rights in Sheep Draw**

h. Costs
   i. Developed in UD-MP Cost spreadsheet
   ii. ICON to prepare the benefit cost analysis

5. Additional questions or concerns?
   a. **North of 10th Street, at Pumpkin Ridge, there is potential for wetland banking that the City is looking into**
   b. **Greeley will send old irrigation maps if Olsson does not already have those**

6. Schedule
   a. **Olsson anticipates submitting the alternatives analysis in approximately 6 weeks, pending CLOMR hydrology comment outcomes.**
   b. **LOMR is on-hold until CLOMR comment clarifications are received.**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Madison Stewart**
**cc: Attendees**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | February 13, 2025 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | brian.fischer@greeleygov.com |
| X | Brian Hathaway | Greeley | brian.hathaway@greeleygov.com |
| X | Mary Mateo | Greeley | mary.mateo@greeleygov.com |
| | Karen Reynolds | Greeley | karen.reynolds@greeleygov.com |
| | Karen Scopel | Greeley | karen.scopel@greeleygov.com |
| X | Aaron Stines | Greeley | aaron.stines@greeleygov.com |
| X | Dave Wells | Greeley | dave.wells@greeleygov.com |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |
| X | Alex Tennant | Greeley | alex.tennant@greeleygov.com |
| X | Leah Hubbard | Greeley | leah.hubbard@greeleygov.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. Alternatives analysis
   a. Greeley Ditch No. 3
      i. Channelize Sheep Draw and install a structure to bypass flows
         - Why would we want to channelize a natural draw? Or if they are saying the company has done this it is because it directly flows into GIC
         - Improvements / channelizing Sheep Draw would convey flows to the Poudre and separate storm flows from irrigation flows. If GIC has rights to Sheep Draw water, it may be more a question of formalizing the overflow path while still allowing the main flow path along to ditch to the F Street return.
      ii. Would the ditch company be receptive to modifications to the ditch itself?
         - Likely not but if it was beneficial to both parties it could be a maybe
      iii. Storm event passing at the ditch?
         - Flows go into the ditch and then out of F street return
         - Greeley Ditch No. 3 Daily Flows Summary | Greeley Irrigation Company
      iv. Typical flows of the ditch? Water rights of the ditch company?
         - Greeley Irrigation Company (GIC) does have a strange water right associated with Sheep Draw natural flows which may impede bypassing and modifications to the ditch
         - **GIC has a senior water right, but it is unknown exactly how much water along Sheep Draw they have a right for.**
         - **The F Street structure is an augmentation structure, not a Sheep Draw bypass. The structure has capacity for 60 cfs.**
         - **In the winter they leave the structure open and there are flows from Sheep Draw**
         - **In the summer the structure sees 10-15 cfs, in the winter it's 5-10 cfs**
         - **35% Greeley, 50% Central Colorado Water Conservancy, 15% GIC**
         - **Bypassing Sheep Draw would likely not be acceptable to GIC. For the MP, the current flow path directing flows through the ditch will be maintained.**
         - **GIC might be open to revitalizing the structure between the ditch and Sheep Draw and/or constructing a formal overflow for large storm events to better control the overtopping location and protect the ditch from damage. Suggested overflow improvements should consider the available freeboard in the ditch.**
   b. Alternatives are in progress and targeting the end of the month
   c. The BCA will be completed by ICON following Greeley's review of the alternatives. – **Greeley is good with this approach**
      i. BCA based on existing land use flows and/or future?
         - **Future**

2. Hydrology
   a. CLOMR
      i. Resubmitted January 23, 2025.
      ii. Expect final determination or additional data letter April 23, 2025

3. Hydraulics
   a. LOMR
      i. Full submittal nearly complete. Anticipate submitting to Greeley by end of the month.
         - **Olsson will send the LOMR to Weld County at the same time.**
      ii. **The pedestrian bridge north of 10th Street has been constructed and needs to be added to the model.**
         - **As-builts are needed to incorporate into the LOMR model. If as-builts are not available, design plans could supplement until as-builts are available**
         - **Brian Fischer will check on status of as-builts/design plans.**

4. Existing conditions and problem identification
   a. City of Greeley comments received 11/18/24
   b. Comments were minor and were addressed and incorporated for the next submittal for alternatives analysis

5. Additional questions or concerns?
   a. **Olsson will add Alex and Leah as optional attendees to the progress meetings**

6. Schedule
   a. **Olsson will send an updated schedule with the meeting minutes.**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Madison Stewart**
**cc: Attendees, File, Karen Reynolds, Karen Scopel**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | March 13, 2025 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
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| X | Brian Fischer | City of Greeley (Greeley) | brian.fischer@greeleygov.com |
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| | Leah Hubbard | Greeley | leah.hubbard@greeleygov.com |
| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. Alternatives analysis
   a. Alternatives were submitted Tuesday (3/11/25)
      i. High-level overview
         - **A monitoring program would be beneficial to implement in the future once development activity gets underway – Olsson will add this to the Alternatives Analysis recommendations**
      ii. Adding adjacent structures versus bridge replacement
         - **With the no detention alternative, many of the alternatives call out bridge replacement and raising of roadway. With the detention alternative, many of the recommendations include the existing structure and adding adjacent structures.**
         - **Brian will send the Alternatives Analysis to the Greeley transportation team to get their thoughts on crossing alternatives, specifically their thoughts on installing adjacent structures.**
      iii. Level of service/freeboard at crossing structures – currently 100-year based on EGL freeboard
      iv. Easement/ROW
         - Undeveloped areas vs. developed
         - $200,000/acre a reasonable unit cost?
            - **Brian sent this question to the Greeley real estate team and is waiting for a response**
      v. Regional detention ponds – feasible locations?
      vi. Alternatives Appendix content?
         - **Greeley does not want the calculations from the alternatives analysis included in the appendix – calculations will be included in a digital submittal format.**
      vii. Initial thoughts/comments?
   b. The BCA will be completed by ICON following Greeley's review of the alternatives.

2. Hydrology
   a. CLOMR
      i. Last piece before acceptance: signed MT-2 Form 1 from Weld County
         - **The most recent email from Weld County has more information on who will sign Form 1.**

3. Hydraulics
   a. LOMR
      i. Additional comments?
         - **Brian does not have additional comments on the LOMR.**
         - **A deadline is set for others at the City to provide comments.**
      ii. Waiting on letter from Weld County
      iii. Pedestrian trail downstream of 10th Street
         - As-built survey does not include culvert dimensions. Also, are there railings and if so, what are dimensions?
         - Are there design plans to use with the as-built survey or a record drawing set?
         - Are photos available?
         - Are digital survey files available?
         - **Brain has received some additional information regarding the pedestrian trail crossing downstream of 10th Street. He will filter through the information and send to Olsson.**
         - **Placeholders for this crossing have been included in the alternatives report, as Crossing 9.5, and will be added to the LOMR report.**
      iv. Notification letters
         - **Brian will talk to Greeley administrators to see if they are available to send out the letters – still a long time out, letters are sent after FEMA approval.**
         - **When LOMR approval is approximately a month or two away, Olsson will send a brief overview of what needs to be done with the notification letters.**

4. Additional questions or concerns?

5. Schedule
   a. Anticipated LOMR and Alternatives Analysis review timeframe?
      **i. An estimated 3 weeks is needed to review the Alternatives Analysis.**
   b. Will send updated schedule with minutes

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**Minutes prepared by: Madison Stewart**
**cc: Attendees, File, Karen Reynolds, Alex Tennant, Leah Hubbard**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | April 10, 2025 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

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The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. LOMR
   a. Additional comments? Received comments from Alex T. and verification of no comments from Mary M. and Brian H.
      i. **No additional comments are anticipated from the City.**
   b. Waiting on comments and/or letter from Weld County – followed-up on 03/31/25
   c. Since submittal, we added in the pedestrian trail crossing downstream of 10th Street, ready for internal QC and then submittal documents will be updated to reflect the change. **It is not necessary to resend the LOMR for review.**
   d. **Olsson will update the date on the MT-2 forms and send to City for signature.**

2. Alternatives analysis
   a. Alternatives were submitted Tuesday (3/11/25)
      i. Comments?
         - **Brian F. will send comments to Olsson following the meeting.**
         - **Recommendations are interspersed in the text and Brian F. would like some of the text to be within the reach recommendations so that it isn't buried in a different section and missed in the future.**
         - **The future conceptual design section will include more specific and concise recommendations. Olsson will also include more specific and concise recommendations in the recommended plan section.**
         - **Olsson will highlight the alternatives portion of the tables in the text and will also call out improvements that are not recommended in the alternative tables.**
         - **Brian F. recommends the inventory of the unknown water quality ponds be completed now and the report updated. Brian F. will discuss a path forward with Brian H. to see about verifying the missing data.**
         - **Olsson will clarify Table 21 and also add some text regarding how Table 21 was used to come up with the recommended alternative.**
         - **Brian F. will recommend percentages for weighing the alternatives.**
      ii. 10th Street proposed improvements will need re-evaluation with the addition of the pedestrian trail crossing downstream
      iii. Thoughts on previous discussion items at last meeting
         - Adding adjacent structures versus bridge replacement
            - **The City transportation team does not want to raise the roadways. Where possible, the recommended approach will be installation of adjacent structures. In locations where the Olsson recommends bridge replacement, the road may be raised.**
         - Easement/ROW
            - Undeveloped areas vs. developed – **specifically are easements given to the City when an area is developed and there is a drainageway or proposed pond on the parcel, or does the City pay for these easements?**
            - $200,000/acre a reasonable unit cost?
            - **Brian F. will follow up with the real estate department.**
      iv. Regional detention ponds – feasible locations?
         - **Brian H. will provide feedback on the feasibility of pond locations.**

3. Hydrology
   a. CLOMR
      i. Waiting for final acceptance

4. Additional questions or concerns?

5. Schedule
   a. LOMR – dependent on any final City/County comments and receiving signed MT-2 Form (Greeley) and Letter of Concurrence (Weld County)
   b. Alternatives Analysis – dependent on review timeframe
      i. **Olsson can wrap up the alternatives before we fill in the blanks on some questions (such as WQ inventory and ROW/easement acquisition).**
      ii. **Olsson should hold off having ICON complete the BCA until we hear back on the feasibility of the detention pond locations.**
   c. Will send updated schedule with minutes

**Action Items:**

1. **Olsson**
    a. **Finalize LOMR and send Greeley updated MT-2 Form 1 for signature.**
    b. **Submit LOMR to FEMA once MT-2 Form and Letter on Concurrence are received.**
    c. **Coordinate with ICON on BCA once proposed pond locations are confirmed.**
    d. **Address comments on alternatives analysis report and resubmit.**

2. **Greeley**
    a. **Send alternatives analysis comments to Olsson.**
    b. **Send Olsson information on easements/ROW.**
    c. **Send information to Olsson regarding the feasibility of proposed detention pond locations.**
    d. **Send Olsson recommended weighting percentages for Table 21.**
    e. **Coordinate internally on verifying water quality pond information.**
    f. **Send signed MT-2 Form once received from Olsson.**

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**Minutes prepared by: Madison Stewart**
**cc: Attendees, File, Karen Reynolds, Karen Scopel, Dave Wells, Alex Tennant, Leah Hubbard**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | May 8, 2025 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | brian.fischer@greeleygov.com |
| X | Brian Hathaway | Greeley | brian.hathaway@greeleygov.com |
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The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. CLOMR/LOMR – CLOMR accepted by FEMA. LOMR submitted to FEMA 05/05/25

2. Alternatives analysis
   a. BCA coordination – ICON to provide BCA by end of month, finalized with results after that
   b. **The overall recommended plan will be analyzed in the BCA rather than a per-reach approach.**
      **i. Once completed, the City will review and determine if a per-reach approach is desired.**
   c. Easement/ROW
      i. Per previous discussion, assume no cost for FP easements in undeveloped areas
      ii. Proposed pond locations – sometimes this is a shared cost with developers if they can use it as well. Assume ½ cost for easements for proposed ponds?
         - **This approach is reasonable.**
      iii. Updates on reasonable ballpark cost for easements on developed parcels?
         - **The City is working through contracting to perform this work and an agreement is anticipated the second week of June.**
         - **Olsson will hold off on the next submittal until ballpark costs are provided. Brian F will check-in on the status of easement cost around the next submittal to inform schedule.**

3. Additional questions or concerns?

4. Schedule
   a. No changes from previous schedule

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**Minutes prepared by: Madison Stewart**
**cc: Attendees, File, Karen Reynolds, Karen Scopel, Dave Wells, Alex Tennant, Leah Hubbard**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | July 10, 2025 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | brian.fischer@greeleygov.com |
| X | Brian Hathaway | Greeley | brian.hathaway@greeleygov.com |
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| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. CLOMR/LOMR – CLOMR accepted by FEMA. LOMR submitted to FEMA 05/05/25
   a. **Comments anticipated by 08/03/25**

2. Alternatives analysis – Submitted 06/30/25
   a. Anticipated timeline for comments on recommended plan for conceptual design?
      i. **Greeley anticipates that the comments on the recommended plan improvements to be included in the conceptual design phase will be provided in 3 weeks (07/31/25).**
      ii. **For future submittals, Olsson will send to Brian Fischer and he will distribute to the appropriate people at Greeley.**

3. Additional questions or concerns?

4. Schedule
   a. TBD with comments
   b. **Since the Greeley comments will be coming in close to the FEMA first review comments, Olsson will address FEMA comments on the LOMR before starting the conceptual design. This approach will allow Olsson to incorporate FEMA comments into the model that will be used for conceptual design.**

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Madison Stewart**
**cc: Attendees, File, Karen Reynolds, Karen Scopel, Dave Wells, Alex Tennant, Leah Hubbard**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | August 14, 2025 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | brian.fischer@greeleygov.com |
| | Brian Hathaway | Greeley | brian.hathaway@greeleygov.com |
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The main purpose of the meeting is to discuss progress on the/ Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. LOMR – Received comments from FEMA 08/01/25
   a. Addressing comments will be a mix of model edits and explanations/documentation
   b. Anticipate resubmitting 09/19/25

2. Alternatives analysis – Received comments from Greeley 07/31/25
   a. Will incorporate edits into Conceptual Design submittal
   b. The alternatives HEC-RAS model will not be updated with LOMR edits
   c. **Karen has not had a chance to review the alternatives. Her goals are to maintain the ecosystem and preserve critical vegetation. She would like to closely collaborate to address stormwater capacity and ecosystem health for the area.**
   d. **Karen will look through the alternatives report and figure and send over comments. She will also mark locations where she wants us to look into vegetation improvements. She will return comments by 09/19/25.**

3. Conceptual design
   a. Begin working on conceptual design phase after LOMR is resubmitted (09/19/25)
   b. Conceptual design will use updated LOMR model as a base model
   c. Conceptual design maps and profiles will be in the same format as the LOMR map and profile but will include proposed information.
   d. Conceptual design report section preferences
      i. Will organize section the same way as alternatives (after edits are completed)
      ii. For reach-based alternatives, format preference?
         - Like alternatives, or more in text format and not in table format?
            - **Format as text and not tables**
         - Include any existing information/photos like alternatives section?
            - **Don't duplicate. Users can refer back to the other section**
         - Include selected plan schematic figure, or just reference recommended plan link on alternative analysis figure since it would be the same?
            - **If it is the same, do not duplicate**
            - **If there are slight differences based on Karen's comments, we will update the recommended plan figure and alternatives, rather than having a separate figure.**
   e. Anticipate submitting 10/31/25

4. Public meetings
   a. Timing (note – LOMR notifications will not go out until FEMA gives go ahead on them)
   b. Location
   c. Notifications
   d. Meeting format (anticipated open house)
   e. Materials
   f. Content
      i. One for LOMR and one for MP?
   g. **Brian will discuss internally and follow up with Olsson.**

5. City Council presentation
   a. Draft PowerPoint presentation for City to present
   b. Timing
   c. Content (example?)
      **i. There are templates and content guidance that will be provided**
   d. **Brian will inquire and determine the next steps**

6. Schedule
   a. See attached

7. Additional questions or concerns?

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Madison Stewart**
**cc: Attendees, File, Brian Hathaway, Karen Reynolds, Aaron Stines, Dave Wells, Alex Tennant, Leah Hubbard**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | September 11, 2025 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | brian.fischer@greeleygov.com |
| X | Brian Hathaway | Greeley | brian.hathaway@greeleygov.com |
| X | Mary Mateo | Greeley | mary.mateo@greeleygov.com |
| | Karen Reynolds | Greeley | karen.reynolds@greeleygov.com |
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| | Michelle Danaher | Olsson | mdanaher@olsson.com |
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| X | Madison Stewart | Olsson | mstewart@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. LOMR – Received comments from FEMA 08/01/25
   a. Addressing comments is a mix of model edits and explanations/documentation
   b. Meeting to discuss comments with the reviewers is scheduled for 9/16
   c. Schedule dependent on direction from the 9/16 meeting but we anticipate resubmitting 9/30

2. Environmental comments on the alternatives analysis
   a. Trail crossings and realignments
      i. Trail crossing north of Twin Rivers Community Park
         - **This trail crossing and realignment is not included in other documentation or cost analyses**
         - **Olsson will include this improvement in the recommended plan, and the crossing should pass the 10-year storm event**
      ii. Poudre River Trail realignment
         - **Greeley has a grant for design but does not have money set aside for construction**
         - **Olsson will show a potential alignment in the Master Plan and call out that the trail alignment will be designed by others**
         - **The culvert should pass the channelized Sheep Draw flow and the realignment pulled back from the Cache La Poudre River.**
      iii. Should we propose the trail realignments or just reference the Trails Master Plan?
   b. Habitat improvements
      i. Increased channel conveyance and habitat between Greeley No. 3 Ditch and confluence will be included in the conceptual design
         - What is preferred approach for including habitat enhancements?
            - **Sheep Draw has become incised – Olsson will include a more functional floodplain with wetland benches and access to the stream as part of the conceptual design**
      ii. Detention pond capacity near Hunter's Cover development (cattails)
         - Cattail impacts to drainage capacity was not assessed
         - Detention ponds are not included in the baseline hydrology and therefore would not impact the effective baseline flows
         - This detention basin and others are not proposed to be used in the recommended plan
         - Is additional analysis desired, and if so, to what extent?
            - **No action is needed from Olsson right now – Brian Fischer and Brian Hathaway will coordinate what should be done with the detention ponds**
      iii. Improvements to Pumpkin Ridge split flow habitat will be included in the conceptual design
         - What is preferred approach for including habitat enhancements?
            - **The creek is currently incised and artificial dirt /spoil piles are located on the banks**
            - **Olsson will investigate improvements to enhance the channel function in this area.**
   c. Conservation easements
      i. Work within should be reviewed by NAT – who will coordinate with NAT?
         - **Karen will coordinate with NAT before the conceptual design is submitted**
   d. Spring 2025 work north of 10th Street
      i. Should we remove the stabilization improvements along the right bank to protect the sewer main and trail?
         - **No, improvements to the right bank should remain in the recommended plan**
   e. An assessment of the Fox Run drainage was not performed, but it is included in the hydrology as it relates to Sheep Draw
      **i. Several water events have come down Fox Run**
      **ii. Olsson will look at the model to see if there are any recommendations at the confluence**

3. Schedule

4. Additional questions or concerns?
   a. **There was a recent flood event in the Sheep Draw watershed (0.5" in 10-min)**
      **i. Flooding occurred along Sheep Draw at 10th Street and 4th Street**
      **ii. Greeley will share photos and Olsson will include documentation of the event in the master plan report**
   b. **The crossing near 83rd has not been incorporated in the model because it has not been built yet**

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**Minutes prepared by: Madison Stewart**
**cc: Attendees, File, Karen Reynolds, Alex Tennant, Leah Hubbard, Brian Von Seggern, Michelle Danaher**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | October 9, 2025 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
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| X | Amy Gabor | Olsson | agabor@olsson.com |
| X | Madison Stewart | Olsson | mstewart@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. LOMR
   a. Received comments from FEMA 08/01/25
   b. Resubmitted to FEMA 10/06/25

2. Conceptual Design
   a. Utilize revised LOMR model as a basis
   b. Conceptual design of recommended plan, plus additional areas with environmental concerns (as discussed in the 09/11/25 meeting)
   c. Any updates on NAT coordination (Karen)?
      **i. Amy will follow up with Karen**
   d. Photos/information on recent flooding event this year?
      **i. Amy will follow up with Karen**

3. Public meeting
   a. Any updates on preferred timing/content (LOMR/MP)?
      **i. Brian F. confirmed no public meeting will be held**

4. City Council presentation
   a. Any updates on template/content guidance?
      **i. Brian F. confirmed that no City Council presentation is needed**

5. Schedule
   a. Submit draft conceptual design mid-November
   b. **Amy will include an updated schedule with the meeting minutes**

6. Additional questions or concerns?

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**Minutes prepared by: Madison Stewart**
**cc: Attendees, File, Karen Reynolds, Karen Scopel, Dave Wells, Alex Tennant, Leah Hubbard, Brian Von Seggern, Michelle Danaher**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | December 11, 2025 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
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The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. LOMR
   a. Resubmitted to FEMA 10/06/25

2. Conceptual Design
   a. Conceptual pond design updated, flows slightly lower than recommended plan
      i. **Will likely not impact recommended improvements.**
   b. Any updates on NAT coordination (Karen)?
      i. **Amy followed-up with Karen via e-mail.**
   c. Photos/information on recent flooding event this year we can include in the report?
      i. **Amy followed-up with Karen via e-mail.**
   d. **The property owner near the downstream end is concerned that the ditch overflow is set too high and results in flooding onto the property upstream of the ditch. This diversion elevation was likely set based on the ditch needs. The only recommended improvements included in this area currently are to formalize a stormwater spillway to protect the ditch berm from damage during storm event overtopping. Improvements in this area were discussed and documented in the February 13, 2025 meeting minutes. One option to reduce flooding upstream could be to fill in the portion of ground that is in the floodplain (with a floodplain development permit).**

3. Schedule
   a. Submit draft conceptual design by end of year
      i. **Brian noted that the schedule is not critical for end of year and a January submittal would be fine. Olsson appreciates the flexibility and will try for an end of year submittal but will let Greeley know if it will slide into January instead.**

4. Additional questions or concerns?

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Amy Gabor**
**cc: Attendees, File, Karen Reynolds, Karen Scopel, Dave Wells, Alex Tennant, Leah Hubbard, Madison Stewart**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | February 12, 2026 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | brian.fischer@greeleygov.com |
| | Brian Hathaway | Greeley | brian.hathaway@greeleygov.com |
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| X | Michelle Danaher | Olsson | mdanaher@olsson.com |
| X | Amy Gabor | Olsson | agabor@olsson.com |
| | Madison Stewart | Olsson | mstewart@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. LOMR
   a. Resubmitted to FEMA 02/23/26
      i. Notification letters
         - **Greeley is OK with Olsson printing, compiling, and mailing letters**

2. Conceptual Design
   a. Refined from alternatives
      i. **Alternatives HEC-RAS Model based on a previous draft LOMR model. Final LOMR model was used as basis for conceptual design**
      ii. **Conceptual detention was refined, which impacted peak flows – slightly lower than recommended alternative**
      iii. **Grading added into HEC-RAS model for channel improvements using HEC-RAS channel modification tool**
      iv. **Crossing structure improvements reduced in some areas based on updated conceptual design flows and conceptual grading in HEC-RAS**
   b. Any initial questions? **None at this time**

3. Schedule
   a. Review timeframe?
      i. **Anticipating having review comments to Olsson by 03/02/26**

4. Amendment?
   a. **Some phases of the project took more time than anticipated during scoping. Some overages were absorbed in unused scope items but could not be fully absorbed. Olsson will submit an amendment request for consideration after the review comments on the Conceptual Design are received.**

5. Additional questions or concerns?

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Amy Gabor**
**cc: Attendees, File, Brian Hathaway, Karen Reynolds, Karen Scopel, Dave Wells, Alex Tennant, Leah Hubbard, Brian Von Seggern, Madison Stewart**

# MEETING MINUTES

## Progress Meeting

| | |
|---|---|
| **Date:** | April 9, 2026 11:00 am via Teams |
| **RE:** | Sheep Draw Master Plan and Regulatory Floodplain Update |
| **Attendees:** | Attendees listed below |
| **Project #** | 022-01690 |

**Attendees:**

| Attended | Name | Company | E-mail |
|---|---|---|---|
| X | Brian Fischer | City of Greeley (Greeley) | brian.fischer@greeleygov.com |
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| X | Amy Gabor | Olsson | agabor@olsson.com |
| | Madison Stewart | Olsson | mstewart@olsson.com |

The main purpose of the meeting is to discuss progress on the Sheep Draw Master Plan and Regulatory Floodplain Update project. **While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions.**

1. LOMR
   a. Submitted receipts for notification letters to FEMA 03/16/26
   b. Public comments?
      i. **Greeley has received some calls regarding the floodplain change, mostly seeking some clarifications.**

2. Conceptual Design
   a. Completing final QA/QC of report edits

3. Project Close-Out
   a. Compiling technical appendix for full study
      i. Submit all except any final FEMA documents for LOMR

4. Schedule
   a. Anticipate submitting final report 04/10/26
   b. Anticipate submitting technical appendix 04/17/26

5. Amendment request
   a. Anticipate submitting an amendment request for review 04/10/26

6. Additional questions or concerns?

**Please contact Olsson at 303-237-2072 with changes or questions regarding these meeting minutes. These minutes will be considered final unless comments are received within seven days of distribution. Although comments will be incorporated, as appropriate, only major revisions will be redistributed.**

**Minutes prepared by: Amy Gabor**
**cc: Attendees, File, Brian Hathaway, Mary Mateo, Karen Reynolds, Dave Wells, Alex Tennant, Leah Hubbard, Brian Von Seggern, Madison Stewart**

# MEMORANDUM

**TO:** Michelle Danaher, P.E., CFM – Project Engineer / Water -- Olsson
**FROM:** Chenchen Ma, E.I. – Design Engineer
Justen Hamann, P.E. – Project Manager
**RE:** Sheep Draw 1-D HEC-RAS Model Geometry Review
**DATE:** 01/19/2024

Olsson asked ICON Engineering, Inc. (ICON) to review the initial 1-Dimensional model geometry for a HEC-RAS model they have prepared for Sheep Draw. Olsson provided ICON with the HEC-RAS hydraulic models (version 6.4.1) for this project which included a computed 2-Dimensional model run, as well as a 1-Dimensional geometry file showing the cross-section alignment and station/elevation data for each section. Our review focused only on the 1-Dimensional geometry file.

This memo documents our review comments on the cross-section and centerline layout in anticipation of the future model work still needed for this flooding source such as the addition of bridges, culverts, etc.

1. Blocked obstructions and conveyance shadow ineffective flow areas should be added to any cross-sections which extend into urban/suburban areas containing insurable structures such as the right overbank of Cross-sections 38854 through 36640.

2. Recommend extending the left endpoint of Cross-section 49688 to an elevation that is similar to the right endpoint of the section. Sections 48935 through 48647, 45763, 45020 through 44750, 44427, 44382, 38000, 36985, 36868, 29950, and 22191 should also be extended.

3. An additional section appears to be needed between Cross-sections 47393.99 and 47000.93 to reflect the wider floodplain transition before the downstream “pinch point” at Section 47000.93.

4. Depending on how the culvert/outlet is modeled between sections 46536.7 and 47000.93, two cross-sections should be added to reflect both the wide floodplain transition—after the pinch point at 47000.93—and the higher overtopping elevations indicated by the terrain upstream of Cross-section 46536.7.

5. Recommend extending the right endpoint of Cross-section 45956 to an elevation that is similar to the left endpoint of the section. Sections 32955 through 32070, as well as 16192, should also be extended.

6. Recommend moving Cross-section 41417 closer to the highway culvert downstream so it can be used as the upstream bounding cross-section when this structure is modeled. The left endpoint of section 41475 may need to be bent more to the west to avoid crossing the downstream section.

7. An additional section appears to be needed upstream of Cross-section 40697 to serve as the fully expanded cross-section of the typical 4-section structure layout for modeling the crossing at 95th Avenue.

8. Recommend adding a section approximately 150-feet upstream of Cross-section 33907 to account for the encroached topography in the left overbank.

9. The 83rd Avenue crossing will likely need to have bridge skew applied to this structure.

10. There is a potential for non-levee embankment issues for the pond adjacent to the left overbank of the channel from Cross-sections 31947 through 31234. Recommend extending these sections so a floodplain can be plotted within the pond.

11. An additional cross-section is needed upstream of Cross-section 22348 to serve as the downstream bounding cross-section when this structure is modeled. The right overbank of Section 22348 will also need to be adjusted to align more with Cross-section 22238 downstream.

12. Recommend adding additional cross-sections between Sections 20194 and 20085 in order to model the pedestrian bridge at this location.

13. It appears that a tributary stream (or split) joins the main channel between Sections 20985 and 19984. For the main channel model, we recommend adding permanent ineffective flow area for the tributary or breaking these cross-sections at a high point to model the tributary separately.

14. There is a potential for intersecting cross-sections in the left overbank of Sections 18608, 18542 and 18495. Once the two structures in this area are added to the model, the alignment of these sections may require reorientation depending on the flows modeled with this analysis.

15. Additional cross-sections are recommended upstream of Cross-sections 18364 and 18020 to serve as the downstream bounding cross-sections for the structures in these areas.

16. Recommend adding additional cross-sections between Sections 11373 and 11275 in order to better model the crossing structure downstream of Section 11373.

**END OF MEMORANDUM**

# Hydraulic Model Approach Memo

☐ Overnight
☐ Regular Mail
☐ Hand Delivery
☒ Other: Email

| | |
|---|---|
| **To:** | ICON Engineering, Inc.<br>Attn: Mr. Justen Hamann<br>7000 S Yosemite St., Ste 120<br>Centennial, CO 80112 |
| **From:** | Madison Stewart, PE and Michelle Danaher, PE, CFM |
| **RE:** | Sheep Draw 1-D HEC-RAS Model |
| **Date:** | April 2, 2024 |

The purpose of this memorandum is to document the modeling approach for the Sheep Draw hydraulics model for ICON Engineering, Inc. review. Once finalized, the model will be used in the Letter of Map Revision (LOMR) to update the regulatory floodplain following a Conditional Letter of Map Revision (CLOMR) to revise the effective hydrology. The following are included in this submittal:

- HEC-RAS 6.4.1 Model – Hydraulic model to be reviewed
- V_XTOPO_02201690 – CAD file of the 2023 Olsson survey
- Bridge Sketches – Bridge survey sheets from the 2023 Olsson survey
- V_XTOPO_02108519_Combined_01-06-2023 – CAD file of Olsson survey near C Street
- Excerpts from LOMR 20-08-0390P – Appendix E as-builts
- Sheep Draw Trail 71st Avenue As-Built Survey
- 2024 Sheep Draw MDP – Information regarding the 2024 hydrology update

## Hydraulic Modeling General Approach

The U.S. Army Corps of Engineers' Hydrologic Engineering Center River Analysis System (HEC-RAS) version 6.4.1 was used to develop the draft LOMR model.

Cross sections for the HEC-RAS model were developed using AutoCAD Civil3D and 1-foot interval 2023 LiDAR data. Survey data was collected by Olsson at all major bridges, culverts, and grade control structures. Additionally, ten (10) cross sections were surveyed at various locations and thalweg elevations were surveyed every 400-feet along Sheep Draw. Survey data was used to supplement the LiDAR data and is noted at various cross sections in the HEC-RAS model. Thalweg elevations were used to modify the surface associated with the 1-D geometry. Points were projected onto the Sheep Draw centerline and "burned into" the LiDAR surface with a 5-ft bottom width and 2 to 1 side slopes to meet the LiDAR surface. Generally, all thalweg elevations used to supplement the LiDAR data was below the LiDAR surface. Cross sections were set upstream and downstream of all major crossings and grade control structures at intervals spaced no greater than 400 feet of stream length apart and maintaining a difference in water surface elevation (WSE) less than 10 feet between cross sections where the channel is steep, uniform, and confined. Because much of the Sheep Draw floodplain is wide and flat, 2D modeling was used to inform cross section orientation. Cross section orientation was previously reviewed by ICON Engineering, Inc. Comment responses are attached. Cross sections were laid out so that a consistent

1525 N. Raleigh Street / Suite 400 / Denver, CO 80204
**Phone** 303.237.2072 / **Fax** 303.237.2659 / **olsson.com**

water surface elevation spans across the entire cross section while maintaining perpendicularity with topography contours. Bank stations were set below the 100-year storm WSE and were typically in the low flow channel.

Manning's "n" values were determined based on field observation and aerial photography. Manning's "n" values for each cross section were generated using RASMapper. A high Manning's "n" value was used to represent developed areas rather than using more typical values and blocked obstructions for buildings. This approach better models the impact of obstructions like fences, landscaping, and cars, while also incorporating the impact of buildings. Manning's "n" values delineated in the map layer are summarized below in Table 1.

***Table 1 Manning's "n" Summary***

| Land Description | Manning's "n" Value | Meaning |
|---|---|---|
| **NoData*** | 0.05 | Grasses and non-woody materials |
| **Channel Bottom** | 0.035 | Unvegetated, silty or rocky bottom |
| **Light Development** | 0.15 | Low density residential areas (larger land plots), sports fields, industrial areas |
| **Medium Development** | 0.2 | Single family residential areas (smaller land plots) typically beginning at fence lines |
| **Heavy Development** | 0.2 | Multi-family residential areas, commercial areas |
| **Dense Vegetation** | 0.07 | Dense tree stands, woody materials |
| **Medium Vegetation** | 0.06 | Sparse tree stands, tall grasses, woody and non-woody materials |
| **Agriculture** | 0.04 | Tilled fields used for farming |
| **Split Rail Fence** | 0.07 | Split rail fence perpendicular to the floodplain |

*NoData value used for all land outside of the other categories. Typically used for light vegetation and grassed areas.

## Steady Flows

Existing and future (developed) flows were calculated during the 2024 hydrology update by Olsson. Existing conditions flows will be submitted to the Federal Emergency Management Agency (FEMA) through the CLOMR process. The LOMR model will be based on the existing flow conditions. Future flows will be used to provide watershed improvement recommendations and are included in the model for reference. Flows used in the steady flow analysis are summarized in Table 2.

***Table 2 Steady Flow Summary***

| Design Point | HEC-RAS Station | $Q_2$ (cfs) Ex/Fut | $Q_5$ (cfs) Ex/Fut | $Q_{10}$ (cfs) Ex/Fut | $Q_{25}$ (cfs) Ex/Fut | $Q_{50}$ (cfs) Ex/Fut | $Q_{100}$ (cfs) Ex/Fut | $Q_{500}$ (cfs) Ex/Fut |
|---|---|---|---|---|---|---|---|---|
| 1169 | 52501 | 3/134 | 11/202 | 83/315 | 311/618 | 473/836 | 695/1,100 | 1,223/1,807 |
| 1153 | 51964 | 6/147 | 20/233 | 160/423 | 693/1,037 | 1,084/1,490 | 1,631/2,084 | 2,957/3,590 |
| 1149 | 48647 | 13/280 | 32/425 | 196/677 | 849/1,467 | 1,331/2,052 | 2,015/2,825 | 3,683/4,798 |
| 1136 | 47211 | 16/320 | 38/496 | 229/806 | 1,071/1,827 | 1,724/2,601 | 2,664/3,647 | 4,950/6,316 |
| 1127T | 45123 | 17/344 | 40/530 | 241/859 | 1,146/1,975 | 1,880/2,845 | 2,953/4,039 | 5,566/7,091 |
| 1125 | 43802 | 17/359 | 40/552 | 242/889 | 1,160/2,025 | 1,909/2,917 | 3,007/4,139 | 5,687/7,287 |
| 1123 | 42350 | 17/370 | 41/567 | 244/907 | 1,167/2,053 | 1,925/2,960 | 3,045/4,206 | 5,779/7,418 |
| 1113 | 41100 | 57/413 | 82/646 | 244/907 | 1,350/2,398 | 2,196/3,437 | 3,461/4,871 | 6,589/8,639 |
| 198 | 40860 | 58/493 | 84/760 | 244/1,051 | 1,558/2,840 | 2,596/4,129 | 4,185/5,942 | 8,143/10,685 |
| 193T | 40465 | 61/531 | 89/812 | 244/1,119 | 1,587/2,951 | 2,659/4,289 | 4,310/6,163 | 8,443/11,128 |
| 189 | 39206 | 78/561 | 112/854 | 244/1,170 | 1,613/3,040 | 2,721/4,452 | 4,459/6,411 | 8,799/11,654 |
| 185 | 38151 | 79/572 | 115/869 | 244/1,190 | 1,620/3,078 | 2,741/4,513 | 4,503/6,510 | 8,931/11,870 |
| 176 | 35696 | 88/609 | 130/921 | 244/1,257 | 1,648/3,162 | 2,797/4,636 | 4,607/6,696 | 9,219/12,252 |
| 172 | 34635 | 106/628 | 156/950 | 244/1,298 | 1,681/3,228 | 2,857/4,737 | 4,710/6,849 | 9,462/12,574 |
| 168 | 33550 | 111/636 | 165/963 | 244/1,317 | 1,698/3,262 | 2,889/4,782 | 4,757/6,920 | 9,582/12,715 |
| 167T | 30553 | 111/638 | 167/966 | 244/1,322 | 1,697/3,265 | 2,893/4,791 | 4,768/6,935 | 9,616/12,756 |
| 154T | 29868 | 133/663 | 202/973 | 281/1,322 | 1,799/3,471 | 3,070/5,090 | 5,059/7,378 | 10,318/13,663 |
| 154T** | 26510 | 67/332 | 101/487 | 141/661 | 900/1,736 | 1,535/2,545 | 2,530/3,689 | 5,159/6,832 |
| 142T** | 26097 | 84/360 | 128/525 | 184/711 | 949/1,836 | 1,638/2,704 | 2,705/3,924 | 5,565/7,386 |
| 142T | 25407 | 167/719 | 256/1,050 | 368/1,421 | 1,897/3,672 | 3,275/5,408 | 5,409/7,847 | 11,130/14,772 |
| 124 | 23660 | 201/760 | 308/1,105 | 450/1,499 | 1,966/3,822 | 3,433/5,646 | 5,669/8,227 | 11,775/15,622 |
| 121T | 21662 | 212/768 | 330/1,118 | 471/1,519 | 1,973/3,848 | 3,455/5,691 | 5,714/8,303 | 11,910/15,806 |

| Design Point | HEC-RAS Station | $Q_2$ (cfs) Ex/Fut | $Q_5$ (cfs) Ex/Fut | $Q_{10}$ (cfs) Ex/Fut | $Q_{25}$ (cfs) Ex/Fut | $Q_{50}$ (cfs) Ex/Fut | $Q_{100}$ (cfs) Ex/Fut | $Q_{500}$ (cfs) Ex/Fut |
|---|---|---|---|---|---|---|---|---|
| 113 | 18608 | 223/779 | 352/1,131 | 496/1,538 | 1,981/3,878 | 3,478/5,747 | 5,762/8,393 | 12,071/16,024 |
| 105 | 13221 | 226/779 | 357/1,136 | 512/1,547 | 1,981/3,883 | 3,478/5,751 | 5,762/8,370 | 12,062/16,127 |
| 100 | 10900 | 226/779 | 357/1,136 | 510/1,547 | 2,059/3,888 | 3,478/5,760 | 5,757/8,419 | 12,117/16,237 |
| 154T** | 2060 | 67/332 | 101/487 | 141/661 | 900/1,736 | 1,535/2,545 | 2,530/3,689 | 5,159/6,832 |
| 142T** | 1670 | 84/360 | 128/525 | 184/711 | 949/1,836 | 1,638/2,704 | 2,705/3,924 | 5,565/7,386 |

**Steady flows at split were assumed to be evenly split between Sheep Draw – R2 and the 71st Avenue Split based on 2D flow analysis

## Structure Modeling Approach

The techniques used to model major crossing structures are summarized below.

- Cross section orientation and spacing – Cross sections immediately upstream and downstream of the crossing structure were typically oriented perpendicular to the channel at the low flow channel. Second cross sections upstream and downstream of the crossing structure were typically spaced at a distance that would allow flow to expand or contract so that flow through the second cross sections were not affected by the structure. In some areas, enough space was not available between crossing structures to allow for the second cross section flow to avoid being affected by the crossing structure. In these areas, ineffective flow areas were applied to the second cross sections.

  Cross sections at the structures were generally oriented to avoid crossing the roads or trails, with select exceptions. Exceptions were taken where the majority of flow overtops and there is insignificant approaching roadway/trail embankment in the floodplain, in order to more accurately model the floodplain.

  Bounding cross sections were typically located outside of the limits of the wingwalls, with an exception upstream of Highway 34. An exception was made in this case because the channel curves into the structure and a perpendicular cross section outside of the wingwalls would place the bounding cross section too far from the structure face.

- Excluded Crossings – Crossings with diameters of less than 36 inches were typically not modeled, as noted in Table 3. In these cases, a blocked obstruction was added to the upstream cross section up to the road/path overtopping elevation.

  Additional low flow crossings were excluded at select locations, including crossings at stations 444+80 and 186+08. At station 444+80, the surveyed 48-inch corrugated metal pipe (CMP) crossing is smooshed and covered in vegetation. A blocked obstruction was added at this location up to the overtopping elevation. At station 186+08, the surveyed double-barreled 36-inch reinforced concrete pipe (RCP) was initially included in the model. The structure caused a significant and unreasonable rise in the 500-year water surface elevation so a blocked obstruction was added at this location up to the overtopping elevation. This modeling approach did not significantly impact the 100-year water surface elevation.

- Contraction and Expansion Coefficients – Generally, the contraction and expansion coefficients for cross sections were 0.1 and 0.3, respectively. At cross sections immediately upstream and downstream of the crossing structure and the second cross section upstream of crossing structures, the contraction and expansion coefficients were changed to 0.3 and 0.5, respectively.

  At select locations, the expansion and contraction coefficients were raised where there is significant horizontal or vertical expansion/contraction to reduce or eliminate drawdowns greater than 0.5 feet in the 100-year profile. Notes are included in the cross section descriptions within the model where they were increased.

- HEC-RAS "Bridge Modeling Approach" – HEC-RAS contains numerous options to model each crossing within the "Bridge Modeling Approach" form. At bridge crossings without piers, the energy method was used to compute low flows. At bridge crossings with piers, the highest energy answer was used to compute low flows between the energy method, momentum method, and Yarnell method. Crossings with piers include crossings at Highway 34 (station 412+00), 83rd Avenue (station 337+50), 71st Avenue (station 266+50), 4th Street (station 184+50), and the irrigation water crossing (station 126+00). Pressure and/or weir flow was selected for all high flows.

## Incorporation of Existing LOMR and As-Built Models

One LOMR is effective along Sheep Draw – LOMR case number 20-08-0390P, effective February 16, 2021. LOMR 20-08-0390P spans between cross sections 236+60 and 315+77. Generally, the LOMR approach was incorporated into the updated modelling approach, but the cross section alignments have been revised with guidance from the 2-D model. Downstream of 71st Avenue, the split flows were modelled similarly to the LOMR approach. Additionally, structure information from the LOMR as-builts was used for structures at stations 267+50, 20+00, and 17+00.

## Ineffective Flow Areas

- Ineffective flow areas at structures – On the upstream side of crossing structures, permanent ineffective flow area elevations were typically set based on a 1:1 contraction ratio at the top of roadway. On the downstream side of crossing structures, non-permanent ineffective flow area elevations were set at a 1:2 expansion rate between the crown of culverts or the low chord of bridges and the top of the road based on what storm events overtop the road.

- Ineffective flow areas outside of structures – Non-permanent ineffective flow areas were added to cross sections at high-points where flow would need to overtop the high-point in order to be effective. The floodplains were evaluated to determine what storm events could effectively flow in these areas. Ineffective flow areas were also added to cross sections that expand or contract quickly.

- Downstream of C Street, the floodplain is flat and wide. Non-permanent ineffective flow areas were initially added to the cross sections between C Street and the canal to slowly expand the flow events up to the 50-year. When added, the non-permanent ineffective flow areas caused crossing profiles and as a result non-permanent ineffective flow areas were not included at these cross sections.

## Boundary Conditions

A normal depth slope of 0.31% was used at the downstream boundary condition.

## Spills and Split Flows

*Sheep Draw – R3*

The Sheep Draw crossing at Highway 34 is overtopped in the 25-year storm. The spill onto Highway 34 begins between stations 419+35 and 415+75 and is not contained within the channel. Downstream of Highway 34, flows are not contained within the right side of the channel and would continue to spill onto Highway 34. The Highway 34 crossing is located at a sump and so all flow spilling onto Highway 34 will eventually make its way back to Sheep Draw. Lateral structures were added to the model to better understand how the flow is moving in this area when optimized.

*71st Avenue Split*

Downstream of 71st Avenue, Sheep Draw splits into the 71st Avenue Split. To remain consistent with the 20-08-0390P modelling approach, a reach was defined for the 71st Avenue Split. Right overbanks of cross sections along 71st Avenue Split meet the left overbanks of cross sections along Sheep Draw – R2. The flow is assumed to be evenly distributed between the two reaches and would realistically comingle along the high point between the reach cross sections.

## Junctions

Junctions were used in the model at the Sheep Draw – R3 and 71st Avenue Split confluence and the 71st Avenue Split and Sheep Draw – R1 confluence. The energy equation computation mode was used at the junctions. Sheep Draw – R2 and the 71st Avenue Split begin to spill into each other near 71st Avenue. A gutter line will be added to the floodplain mapping to differentiate the Sheep Draw – R2 and 71st Avenue Split cross sections.

# MEMORANDUM

**TO:** Michelle Danaher, P.E., CFM – Project Engineer / Water -- Olsson
**FROM:** Chenchen Ma, E.I. – Design Engineer
Justen Hamann, P.E. – Project Manager
**RE:** Sheep Draw 1-D HEC-RAS Model Geometry Review
**DATE:** 01/19/2024

Olsson asked ICON Engineering, Inc. (ICON) to review the initial 1-Dimensional model geometry for a HEC-RAS model they have prepared for Sheep Draw. Olsson provided ICON with the HEC-RAS hydraulic models (version 6.4.1) for this project which included a computed 2-Dimensional model run, as well as a 1-Dimensional geometry file showing the cross-section alignment and station/elevation data for each section. Our review focused only on the 1-Dimensional geometry file.

This memo documents our review comments on the cross-section and centerline layout in anticipation of the future model work still needed for this flooding sou

Artificially higher Manning's n values were used in urban/suburban areas. IEFAs have been added to cross sections based on expansion/contraction, stuctures, and/or high ground.

1. Blocked obstructions and conveyance shadow ineffective flow areas should be added to any cross-sections which extend into urban/suburban areas containing insurable structures such as the right overbank of Cross-sections 38854 through 36640.

Addressed.

2. Recommend extending the left endpoint of Cross-section 49688 to an elevation that is similar to the right endpoint of the section. Sections 48935 through 48647, 45763, 45020 through 44750, 44427, 44382, 38000, 36985, 36868, 29950, and 22191 should also be extended.

Cross section added.

3. An additional section appears to be needed between Cross-sections 47393.99 and 47000.93 to reflect the wider floodplain transition before the downstream “pinch point” at Section 47000.93.

4. Depending on how the culvert/outlet is modeled between sections 46536.7 and 47000.93, two cross-sections should be added to reflect both the wide floodplain transition—after the pinch point at 47000.93—and the higher overtopping elevations indicated by the terrain upstream of Cross-section 46536.7.

No culvert was found at the berm during the survey. Additional cross section has not been added.

5. Recommend extending the right endpoint of Cross-section 45956 to an elevation that is similar to the left endpoint of the section. Sections 32955 through 32070, as well as 16192, should also be extended.

Addressed.

6. Recommend moving Cross-section 41417 closer to the highway culvert downstream so it can be used as the upstream bounding cross-section when this structure is modeled. The left endpoint of section 41475 may need to be bent more to the west to avoid crossing the downstream section.

Cross section has been added closer to structure.

7. An additional section appears to be needed upstream of Cross-section 40697 to serve as the fully expanded cross-section of the typical 4-section structure layout for modeling the crossing at 95th Avenue.

Cross section has been added.

8. Recommend adding a section approximately 150-feet upstream of Cross-section 33907 to account for the encroached topography in the left overbank.

Cross section has been added.

9. The 83rd Avenue crossing will likely need to have bridge skew applied to this structure.

Bridge manually skewed by projecting open area on the upstream cross section.

10. There is a potential for non-levee embank[illegible]ft overbank of the channel from Cross-sections 31947 through 31234. Recommend extending these sections so a floodplain can be plotted within the pond.

Cross section have been extended.

11. An additional cross-section is needed upstream of Cross-section 22348 to serve as the downstream bounding cross-section when this structure is modeled. The right overbank of Section 22348 will also need to be adjusted to align more with Cross-section 22238 downstream.

Cross section has been added.

12. Recommend adding additional cross-sections between Sections 20194 and 20085 in order to model the pedestrian bridge at this location.

Cross sections reconfigured and added in this area. Crossing structure located between these cross sections.

13. It appears that a tributary stream (or split) joins the main channel between Sections 20985 and 19984. For the main channel model, we recommend adding permanent ineffective flow area for the tributary or breaking these cross-sections at a high point to model the tributary separately.

IEFAs were evaluated using mapper and are based on high ground for each storm event.

14. There is a potential for intersecting cross-sections in the left overbank of Sections 18608, 18542 and 18495. Once the two structures in this area are added to the model, the alignment of these sections may require reorientation depending on the flows modeled with this analysis.

Cross section alignments have been revised.

15. Additional cross-sections are recommended upstream of Cross-sections 18364 and 18020 to serve as the downstream bounding cross-sections for the structures in these areas.

Cross sections reconfigured and added in this area.

16. Recommend adding additional cross-sections between Sections 11373 and 11275 in order to better model the crossing structure downstream of Section 11373.

Cross sections reconfigured and added in this area.

**END OF MEMORANDUM**

# MEMORANDUM

**TO:** Michelle Danaher, P.E., CFM – Project Engineer / Water -- Olsson
**FROM:** Chenchen Ma, E.I. – Design Engineer
Justen Hamann, P.E. – Project Manager
**RE:** Sheep Draw 1-D HEC-RAS Model Review
**DATE:** 05/01/2024

Olsson asked ICON Engineering, Inc. (ICON) to review a 1-Dimensional HEC-RAS hydraulic model they have prepared for Sheep Draw. Olsson provided ICON with the HEC-RAS hydraulic models (version 6.4.1) for this project which included 4 computed 1-Dimensional model runs (or plans) including: Sheep Draw Existing Conditions, Sheep Draw Future Conditions, Sheep Draw Existing Conditions Optimized and Sheep Draw Future Conditions Optimized. According to the Hydraulic Model Approach Memo submitted by Olsson, the existing conditions flows are anticipated to be submitted to FEMA as part of a hydrology CLOMR submittal, followed by a LOMR/PMR which includes the resulting channel hydraulics. The future flow conditions will be utilized to formulate recommendations for watershed enhancements and are incorporated as a reference therefore, our review focused on the existing conditions plans.

This memo documents our review comments on the bridges, culverts, cross-sections, centerline layout and other general modeling recommendations.

1. We recommend removing some ineffective Flow Areas (IFAs) which appear to be unnecessary at Sections 43282, 41100, 29950, 22937, 22572, 22518, 20237, 20159, 20136, 20085, 18608, 18020, 11469, 2060, 1988, 1949, 1676, 1648.

2. It appears that several of the invert elevations of the modeled bridges do not match the submitted surveyed data. Discrepancies found between the two sources are listed below:

| Bridge cross section | HEC-RAS | | Surveyed data | |
|---|---|---|---|---|
| | Upstream | Downstream | Upstream | Downstream |
| 22450 | 4739.37 | 4737.88 | 4739.19 | 4738.79 |
| 26650 | 4763.69 | 4763.33 | 4763.42 | 4763.73 |
| 33750 | 4801.37 | 4800.23 | 4798.20 | 4800.60 |
| 40650 | 4837.51 | 4837.35 | 4838.30 | 4838.10 |
| 12985 | 4697.72 | 4697.42 | 4694.25 | 4693.93 |
| 13100 | 4698.33 | 4698.29 | 4698.65 | 4698.44 |
| 12600 | 4696.19 | 4696.09 | 4696.46 | 4696.35 |
| 22525 | 4739.71 | 4739.22 | 4739.90 | 4739.22 |

3. The Access Bridge with Railing modeled at river station 12985 appears to deviate from the submitted bridge photos. Specifically, the significant bridge deck height appears to reflect a railing that is assumed fully blocked, which the submitted bridge photos and survey sketch indicate does

not exist. Additionally, the bridge deck low-chord appears to be higher than indicated by the survey information and does not appear to tie-in to the banks. Any debris blockage would appear to be likely only beneath the narrow bridge rail. Use of the pressure and/or weir high flow method bridge modeling approach should also be re-evaluated for this crossing.

4. Certain IFAs at cross-sections bounding bridges and culverts do not appear to accurately reflect the overtopping elevations of the embankment to the left or right of where they are located. Examples include Cross-sections: 43400, 29840, 26750, 26650, 18450, and 13100.

5. It is recommended to quantify the spill and the average depth of the 1%- and 0.2%-annual-chance (A.C.) discharges leaving the system at the lateral structures. If the spills do not qualify as shallow flooding, it may be necessary to add split-flow reaches to the 1-D model and map the spills until they return to Sheep Draw.

6. The elevation and placement of the IFA at Cross-section 47001 should be informed by the more constrictive geometry of Cross-section 46537 downstream.

7. We recommend adding permanent IFAs to Cross-section 46081 based on the elevation of the blocked obstruction downstream at Cross-section 45956.

8. The IFA placed on the left overbank of Cross-section 43282 appears to be unnecessary, and the IFA along the right overbank is much narrower than that of Section 43380—upon which it appears to be based.

9. We recommend utilizing an elevation-based IFA for Sections 42350 through 42135 instead of basing the IFA placement on expansion and contraction as noted in the model.

10. Consistent with current FEMA guidance, we recommend adding blocked obstructions and permanent ineffective flow areas representing conveyance shadows to any cross-sections which extend into urban/suburban areas containing buildings instead of using a high manning's 'n' value to account for these areas.

11. There appears to be an adjacent pond along the right overbank at Cross-sections 37505 and 37449 which is separated from the channel by what FEMA is likely to consider a "non-levee embankment." We recommend extending these cross-sections into the pond so the 1%- and 0.2%-A.C. floodplains can be plotted within the pond.

12. The alignment of Cross-section 36052 should be reconsidered, as its severe bend upstream for containment appears to neglect the likelihood of 0.2%- and potentially minor 1%-A.C flood spills toward the southeast. Additionally, it appears active conveyance correlating with this potential spill is likely to occur downstream on the right overbank of Cross-section 35513.

13. We recommend re-evaluating the IFA placement at some cross-sections as it appears that the IFAs are not correlated to the physical features of the channel and lack a discernable basis. Examples include Cross-sections 43282, 33685, and 26820 through 26700.

14. It appears that the sinuous secondary channel along the right overbank of Cross-sections 20884 through 19815 should be modeled with permanent IFA up to its top of bank since it does not appear to actively convey flow downstream and even doubles back to flow upstream before rejoining the main channel.

15. Non-permanent elevation-based IFA is recommended along the right overbank of Sections 17366 through 17094, to ensure flood discharges fill the main channel and floodplain before utilizing conveyance landward of the trail running roughly parallel to the channel.

16. Consider adding IFAs for Sections 11590 through 10100, to ensure that the main channel is filled before water reaches the overbanks.

17. We recommend extending the left endpoint of Cross-sections 11059 through 11357 to an elevation that is similar to the right endpoint of the sections.

18. According to recent FEMA guidance, any relatively narrow high ground used to map low-lying areas to the landward side as outside of the 1% A.C. floodplain (despite being below the BFE) may be considered a non-levee embankment. It is possible that cross-sections ending at local high points such as roadways, trails, railroads, or the high ground between a channel and adjacent pond, may need to be extended to natural high ground, and the low-lying area mapped within the floodplain. It appears this may be the case with N 59th Ave, for example.

19. We recommend double checking the irregularities in bridge deck high-chord elevations of the 10th Street Bridge guardrail, as well as the transitions between guardrail and roadway at 10th Street and the bridge at river station 20145.

20. The bridge deck of the irrigation water crossing at station 12600 does not tie-in well to the left bank on the upstream side. We recommend checking the positioning and length of the “bridge” deck, as well as potentially moving the upstream cross-section closer, as the distance is currently much greater than the width of the crossing.

**END OF MEMORANDUM**

# MEMORANDUM

**TO:** Michelle Danaher, P.E., CFM – Project Engineer / Water -- Olsson
**FROM:** Chenchen Ma, E.I. – Design Engineer
Justen Hamann, P.E. – Project Manager
**RE:** Sheep Draw 1-D HEC-RAS Model Review
**DATE:** 05/01/2024

Olsson asked ICON Engineering, Inc. (ICON) to review a 1-Dimensional HEC-RAS hydraulic model they have prepared for Sheep Draw. Olsson provided ICON with the HEC-RAS hydraulic models (version 6.4.1) for this project which included 4 computed 1-Dimensional model runs (or plans) including: Sheep Draw Existing Conditions, Sheep Draw Future Conditions, Sheep Draw Existing Conditions Optimized and Sheep Draw Future Conditions Optimized. According to the Hydraulic Model Approach Memo submitted by Olsson, the existing conditions flows are anticipated to be submitted to FEMA as part of a hydrology CLOMR submittal, followed by a LOMR/PMR which includes the resulting channel hydraulics. The future flow conditions will be utilized to formulate recommendations for watershed enhancements and are incorporated as a reference therefore, our review focused on the existing conditions plans.

This memo documents our review comments on the bridges, culverts, cross-sections, centerline layout and other general modeling recommendations.

Addressed.

1. We recommend removing some ineffective Flow Areas (IFAs) which appear to be unnecessary at Sections 43282, 41100, 29950, 22937, 22572, 22518, 20237, 20159, 20136, 20085, 18608, 18020, 11469, 2060, 1988, 1949, 1676, 1648.

Inverts are based on survey data interpolated along the channel centerline. Descriptions have been added to XSCs where flowline does not match

Reported survey data does not match what is shown in CAD. Bridge sheets have been updated to match what is shown in CAD.

ert elevations of the modeled bridges do not
und between the two sources are listed below

| Bridge cross section | HEC-RAS | | Surveyed data | |
|---|---|---|---|---|
| | Upstream | Downstream | Upstream | Downstream |
| 22450 | 4739.20 | 4738.60 | 4739.19 | 4738.79 |
| 26650 | 4763.11 | 4763.33 | 4763.42 | 4763.73 |
| 33750 | 4699.77 | 4800.23 | 4798.20 | 4800.60 |
| 40650 | 4837.51 | 4837.35 | 4838.30 | 4838.10 |
| 12985 | 4697.72 | 4697.42 | 4694.25 | 4693.93 |
| 13100 | 4698.53 | 4698.31 | 4698.65 | 4698.44 |
| 12600 | 4696.32 | 4696.19 | 4696.46 | 4696.35 |
| 22525 | 4739.90 | 4739.22 | 4739.90 | 4739.22 |

3. The Access Bridge with Railing modeled at river station 12985 appears to deviate from the submitted bridge photos. Specifically, the significant bridge deck height appears to reflect a railing that is assumed fully blocked, which the submitted bridge photos and survey sketch indicate does

Bridge information is correct. The submitted photo was incorrect and will be updated.

not exist. Additionally, the bridge deck low-chord appears to be higher than indicated by the survey [illegible]n and does not appear to tie-in to the banks. Any debris blockage would appear to be likely [illegible]th the narrow bridge rail. Use of the pressure and/or weir high flow method bridge [illegible]approach should also be re-evaluated for this crossing.

US IEFAs were lowered where appropriate. DS IEFAs were held at the crown or top of low chord.

4. Certain IFAs at cross-sections bounding bridges and culverts do not appear to accurately reflect the [illegible]ns of the embankment to the left or right of where they are located. Examples [illegible]ns: 43400, 29840, 26750, 26650, 18450, and 13100.

Flow master calculation of the road and northern swale was done for this spill. The road is crowned and does not have a gutter. Spill is located at a sump so all flows are directed back to the channel.

[illegible]o quantify the spill and the average depth of the 1%- and 0.2%-annual-chance [illegible]ving the system at the lateral structures. If the spills do not qualify as shallow flooding, it may be necessary to add split-flow reaches to the 1-D model and map the spills until they return to Sheep Draw.

Addressed.

6. The elevation and placement of the IFA at Cross-section 47001 should be informed by the more constrictive geometry of Cross-section 46537 downstream.

Addressed.

7. We recommend adding permanent IFAs to Cross-section 46081 based on the elevation of the blocked obstruction downstream at Cross-section 45956.

Addressed.

[illegible] overbank of Cross-section 43282 appears to be unnecessary, and the IFA [illegible]s much narrower than that of Section 43380—upon which it appears to be

Looked into this with building footprints and lower Manning's n (0.15 instead of 0.2). Did not project the building footprints. Results show almost no change. Differences range from 0.02' lower to 0.05' higher than the run without BOs and with higher Manning's n values.

Addressed.

[illegible]an elevation-based IFA for Sections 42350 through 42135 instead of [illegible] on expansion and contraction as noted in the model.

10. Consistent with current FEMA guidance, we recommend adding blocked obstructions and permanent ineffective flow areas representing conveyance shadows to any cross-sections which extend into urban/suburban areas containing buildings instead of using a high manning's 'n' value to account for these areas.

Addressed.

[illegible]ears to be an adjacent pond along the right overbank at Cross-sections 37505 and 37449 [illegible]eparated from the channel by what FEMA is likely to consider a "non-levee embankment." [illegible]mend extending these cross-sections into the pond so the 1%- and 0.2%-A.C. floodplains [illegible]tted within the pond.

Cross section was realigned. Effective flow for 500-year. Perm IEFA at berm height.

12. The alignment of Cross-section 36052 should be reconsidered, as its severe bend upstream for containment appears to neglect the likelihood of 0.2%- and potentially minor 1%-A.C flood spills toward the southeast. Additionally, it appears active conveyance correlating with this potential spill is likely to occur downstream on the right overbank of Cross-section 35513.

13. We recommend re-evaluating the IFA placement at some cross-sections as it appears that the IFAs are not correlated to the physical features of the channel and lack a discernable basis. Examples include Cross-sections 43282, 33685, and 36820 through 26700.

IEFA was removed for cross section 43282. Other IEFAs are based on the structure expansion and contraction.

Addressed. EFAs were also modified for cross sections 16915 through 15678. Permanent IEFA was based on DS high ground, now non-permanent IEFA is based on adjacent high ground and BO based on DS high ground

Permanent IEFA was added to low flow channel.

14. It appears that the sinuous secondary channel along the right overbank of Cross-sections 20884 through 19815 should be modeled with permanent IFA up to its top of bank since it does not appear to actively convey flow downstream and even doubles back to flow upstream before rejoining the main channel.

15. Non-permanent elevation-based IFA is recommended along the right overbank of Sections 17366 through 17094, to ensure flood discharges fill the main channel and floodplain before utilizing ce landward of the trail running roughly parallel to the channel.

This was previously investigated and was causing crossing profiles.

adding IFAs for Sections 11590 through 10100, to ensure that the main channel is filled before water reaches the overbanks.

Addressed.

Extending the cross sections East of N 59th Ave would inform mapping the BFE for the NLE, but will not impact model results. The cross sections. The road crown has ~2-3 ft of freeboard on the 500-year WSE. Cross sections will not be updated at this time.

ing the left endpoint of Cross-sections 11059 through 11357 to an elevation ht endpoint of the sections.

MA guidance, any relatively narrow high ground used to map low-lying areas to utside of the 1% A.C. floodplain (despite being below the BFE) may be embankment. It is possible that cross-sections ending at local high points such as roadways, trails, railroads, or the high ground between a channel and adjacent pond, may need to be extended to natural high ground, and the low-lying area mapped within the floodplain. It appears this may be the case with N 59th Ave, for example.

Addressed.

19. We recommend double checking the irregularities in bridge deck high-chord elevations of the 10th Street Bridge guardrail, as well as the transitions between guardrail and roadway at 10th Street and the bridge at river station 20145.

20. The bridge deck of the irrigation water crossing at station 12600 does not tie-in well to the left bank on the upstream side. We recommend checking the positioning and length of the “bridge” deck, as well as potentially moving the upstream cross-section closer, as the distance is currently much greater than the width of the crossing.

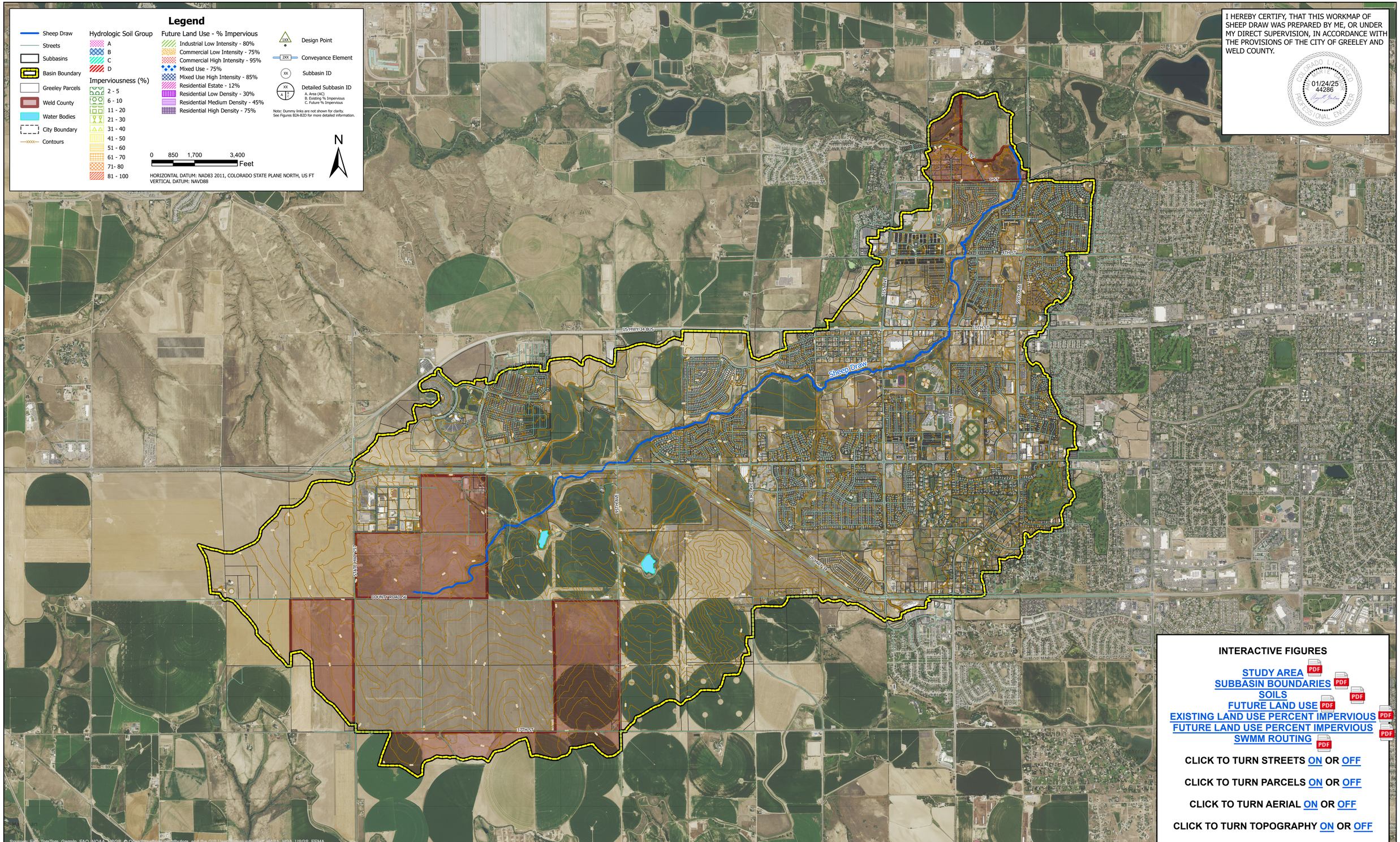
This structure has varying bridge deck thicknesses. Information has not been changed.

**END OF MEMORANDUM**

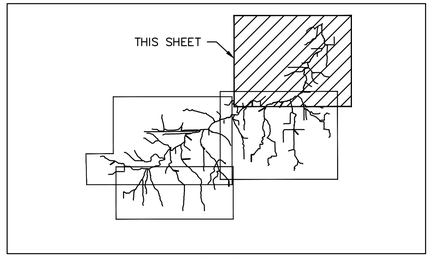
# APPENDIX B

## HYDROLOGIC ANALYSIS

olsson®




| | | | | |
|---|---|---|---|---|
| PROJECT: 022-01690<br>DRAWN BY: ELB<br>DATE: 1/24/2025 | CITY OF GREELEY | SHEEP DRAW MDP<br>HYDROLOGY WORKMAP | olsson<br>1525 Raleigh Street<br>Suite 400<br>Denver, CO 80204<br>TEL: 303.237.2072<br>FAX: 303.237.2659<br>www.olsson.com | FIGURE<br>B-1 |




KEY MAP

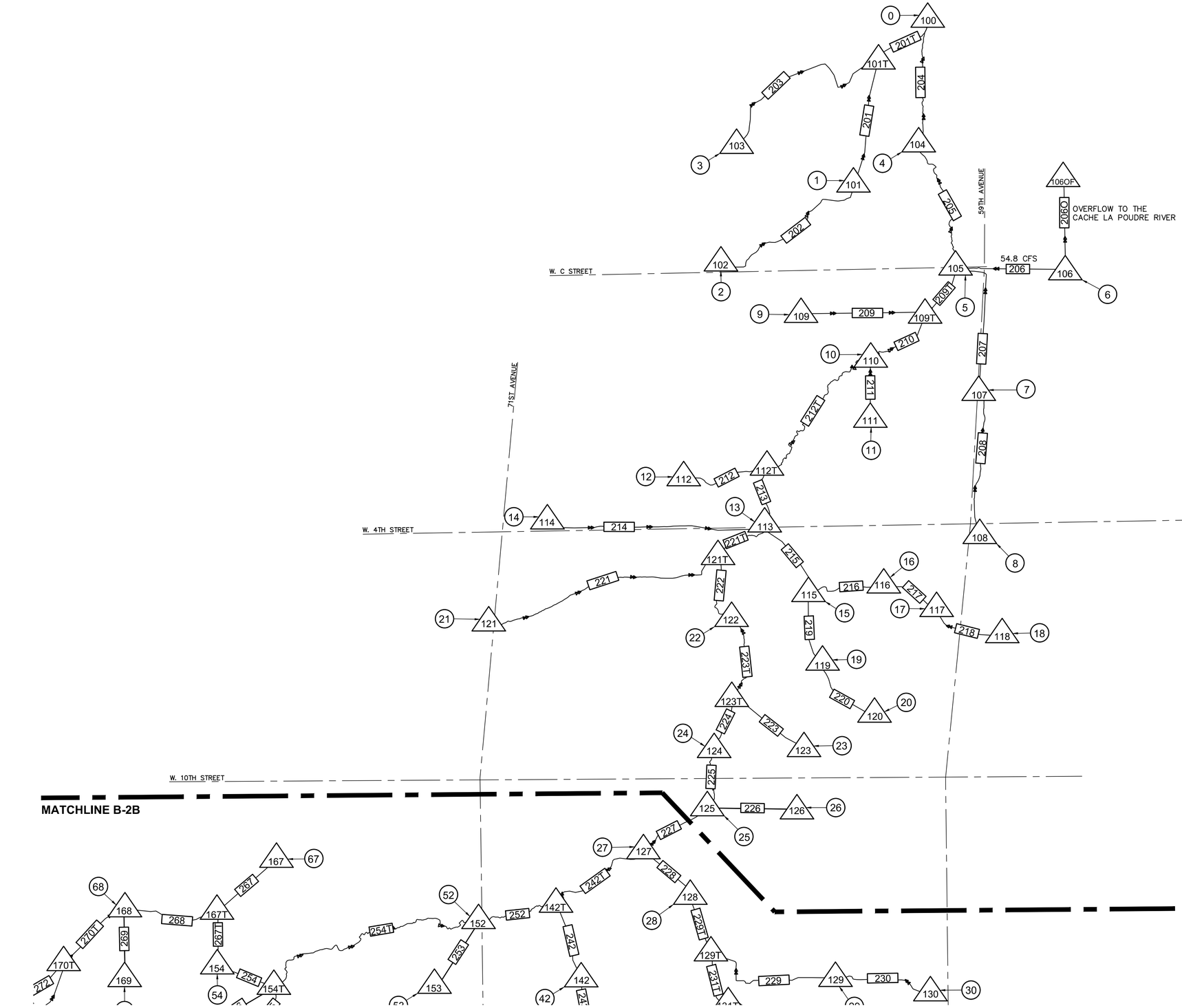
N

LEGEND

XX — SUBWATERSHED ID

1XX — DESIGN POINT ID

2XX — CONVEYANCE ELEMENT ID




| REV NO. | DATE | REVISIONS DESCRIPTION |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

REVISIONS

olsson
1525 Raleigh Street
Suite 400
Denver, CO 80204
TEL 303.237.2072
FAX 303.237.2659

designed by: EB
drawn by: KR
checked by: AG
project no.: 022-01690
date: 03/2024

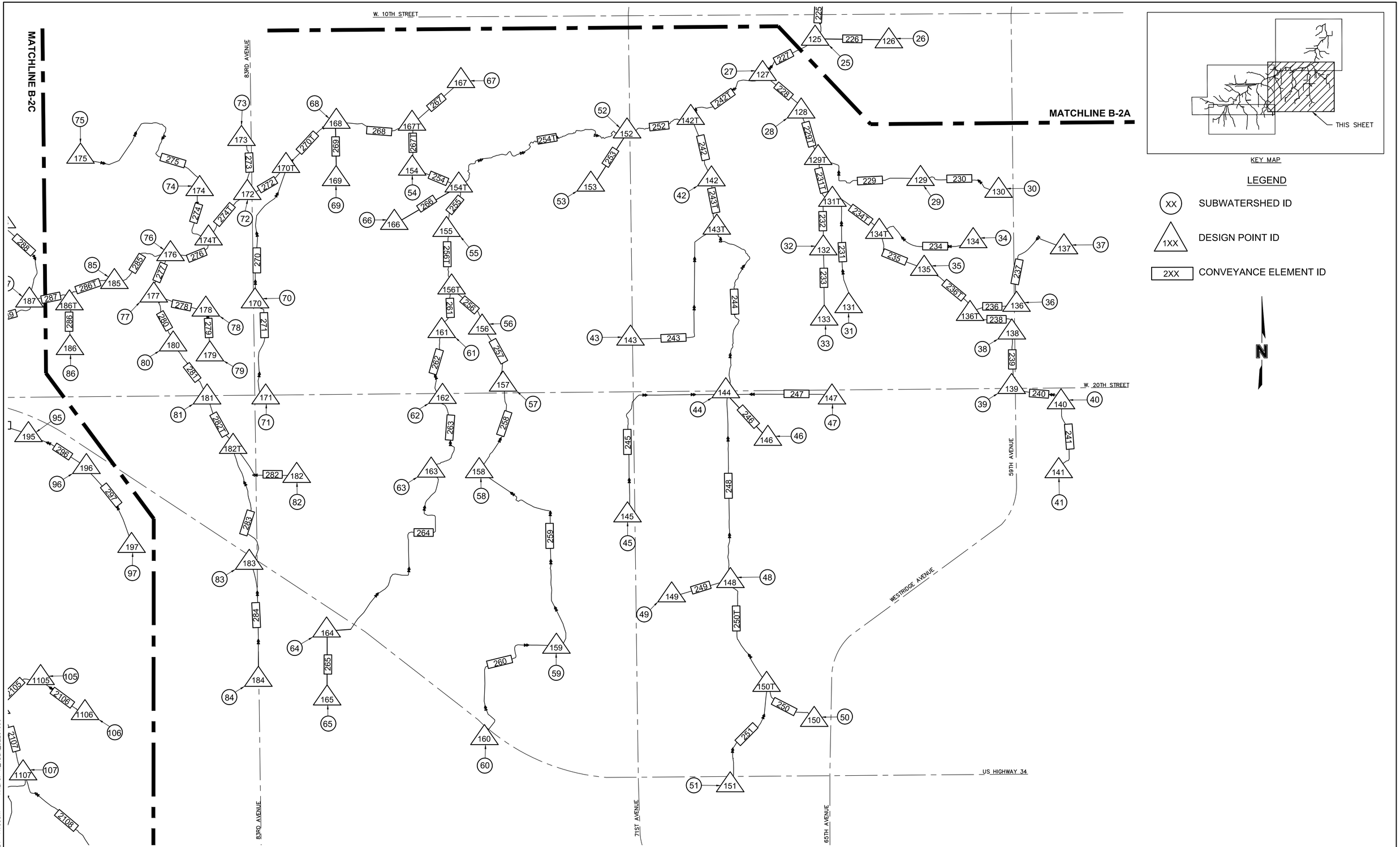
CITY OF GREELEY

SHEEP DRAW MDP

SWMM ROUTING SCHEMATIC

FIGURE B-2A

DWG: \\od.od.oaconsulting.com\fnts-ns1\projects\2022\01501-02000\022-01690\40-Design\AutoCAD\Final Plans\Sheets\WTRS\W_SWMM_ROUT_02201690.dwg USER: krasmussen
DATE: Mar 18, 2024 11:33am XREFS: W_TBLK_02201690




| REV NO. | DATE | REVISIONS DESCRIPTION |
|---|---|---|
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REVISIONS

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designed by: EB
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checked by: AG
project no.: 022-01690
date: 03/2024

CITY OF GREELEY

SHEEP DRAW MDP

SWMM ROUTING SCHEMATIC

FIGURE B-2B

DWG: \\oa.ad.oaconsulting.com\fnts-ns1\projects\2022\01501-02000\022-01690\40-Design\AutoCAD\Final Plans\Sheets\WTRS\W_SWMM_ROUT_02201690.dwg USER: krasmussen
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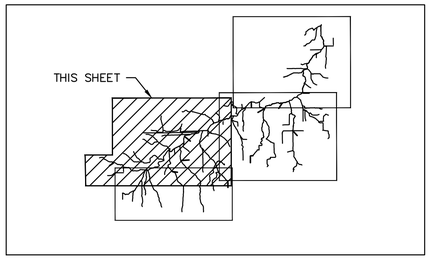


KEY MAP

LEGEND

XX SUBWATERSHED ID

1XX DESIGN POINT ID

2XX CONVEYANCE ELEMENT ID

N

COLORADO HIGHWAY 257

US HIGHWAY 34

PROMONTORY PARKWAY

95TH AVENUE

MATCHLINE B-2B

MATCHLINE B-2D

| REV NO. | DATE | REVISIONS DESCRIPTION |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

REVISIONS

olsson
1525 Raleigh Street
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Denver, CO 80204
TEL 303.237.2072
FAX 303.237.2659

designed by: EB
drawn by: KR
checked by: AG
project no.: 022-01690
date: 03/2024

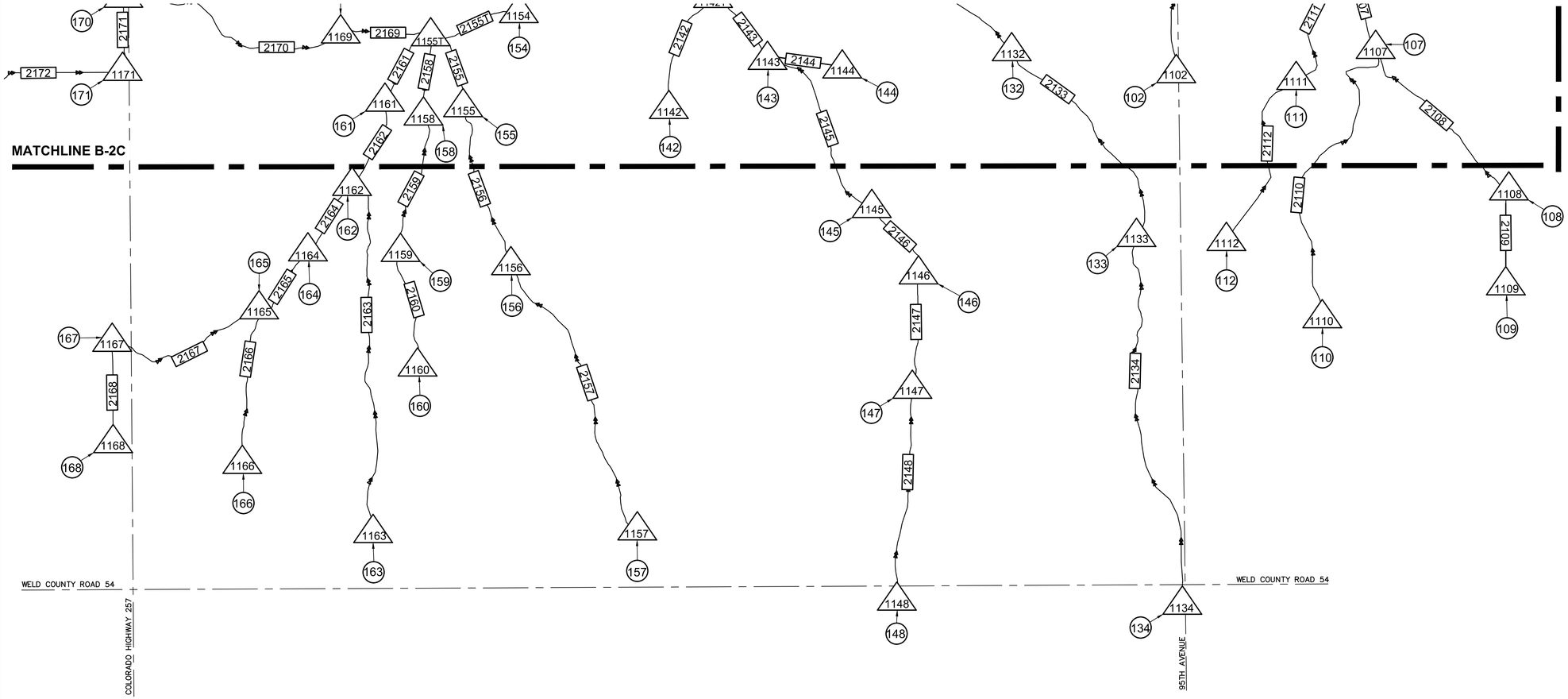
CITY OF GREELEY

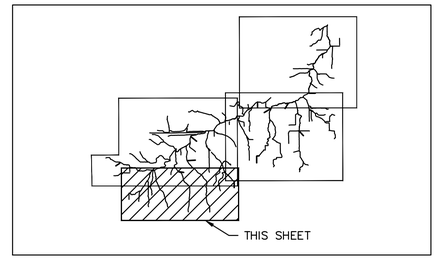
SHEEP DRAW MDP

SWMM ROUTING SCHEMATIC

FIGURE B-2C

DWG: \\oa.ad.oaconsulting.com\fnts-ns1\projects\2022\01501-02000\022-01690\40-Design\AutoCAD\Final Plans\Sheets\WTRS\W_SWMM_ROUT_02201690.dwg USER: krasmussen
DATE: Mar 18, 2024 11:33am XREFS: W_TBLK_02201690




KEY MAP

LEGEND

XX SUBWATERSHED ID

1XX DESIGN POINT ID

2XX CONVEYANCE ELEMENT ID

N

DWG: \\oa.od.oaconsulting.com\fnts-ns1\projects\2022\01501-02000\022-01690\40-Design\AutoCAD\Final Plans\Sheets\WTRS\W_SWMM_ROUT_02201690.dwg USER: krasmussen
DATE: Mar 18, 2024 11:33am XREFS: W_TBLK_02201690

| REV NO. | DATE | REVISIONS DESCRIPTION |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |

REVISIONS

olsson
1525 Raleigh Street
Suite 400
Denver, CO 80204
TEL 303.237.2072
FAX 303.237.2659

designed by: EB
drawn by: KR
checked by: AG
project no.: 022-01690
date: 03/2024

CITY OF GREELEY

SHEEP DRAW MDP

SWMM ROUTING SCHEMATIC

FIGURE B-2D

# LAND USE MAPS

olsson®

# City of Greeley
# Official 2021 Zoning Map

## Legend

- Airport
- Cemetery
- Hospital
- Govemment
- Library
- Parcel Boundary
- Roads
- FIRM Map Boundary
- Floodway
- 100yr Floodplain
- Stream
- Water Body
- Entertainment District
- General Improvement District
- Airport Overlay District
- Redevelopment District
- Character Overlay District (Northeast Greeley Mercado District)
- Development Concept Master Plan
- Conservation District (C-D)
- Commercial High Intensity (C-H)
- Commercial Low Intensity (C-L)
- Holding Agriculture (H-A)
- Industrial High Intensity (I-H)
- Industrial Low Intensity (I-L)
- Industrial Medium Intensity (I-M)
- Planned Unit Development (PUD)
- Residential Estate (R-E)
- Residential High Density (R-H)
- Residential Low Density (R-L)
- Residential Medium Density (R-M)
- Residential Mobile Home (R-MH)
- ROW Vacations

### Other Municipal Boundaries

- EVANS
- GARDEN CITY
- KERSEY
- WINDSOR




Official 2021 Zoning Map Designation

This is to certify that this is a copy of the Zoning Map of the City of Greeley, Colorado. The official version of this Zoning Map is maintained by the City Clerk and the Director's designee and that version may contain changes not reflected on this copy. (Reference Section 18.30.040 Zoning and Land Use Standards)

Signatures:

Public Works Director

City Clerk

Notes:

All planimetric data was digitized from aerial photographs dated 2005, 2008 and 2012. Updates are continued and data representation will change over time. This product is not necessarily accurate to engineering or surveying standards. The City assumes no responsibility. It is not intended to be used for the preparation of construction documents. All legal property descriptions should be validated via a licensed surveyor.

The floodway and flood plain data shown on this map is from the most recent flood study for each area. These newer flood boundaries have been submitted to FEMA for inclusion in the official Flood Insurance Rate Maps. The newer flood boundaries included here have been accepted as the most accurate, regardless of official acceptance by FEMA.

| Drainage | Flood Data Source |
|---|---|
| South Platte River | FEMA, 1982, 1991 |
| Sand Creek | FEMA, 1982, 1991 |
| Eaton Creek | FEMA, 1982, 1991 |
| Greeley-Loveland Law Ditch | FEMA, 1982, 1991 |
| Cache la Poudre River | Army Corps of Engineers Study, 2006 |
| Sheep Draw | Lidstone-Anderson Study, 2008 |
| Coulbrook Creek | PBS&J Study, 2008 |

Individual flood studies should be referred to for detailed flood boundaries and data.

Copyright:
Information contained on this document remains the property of the City of Greeley. Copying any portion of this map without the written permission of the City of Greeley is strictly prohibited.

Date: 4/14/2021
By: The City of Greeley, hps.
Contact: 350-9500 or 970GIS@greeleygov.com
File Name: Zoning_OfficialMap2021.mxd

Miles
0 0.5 1

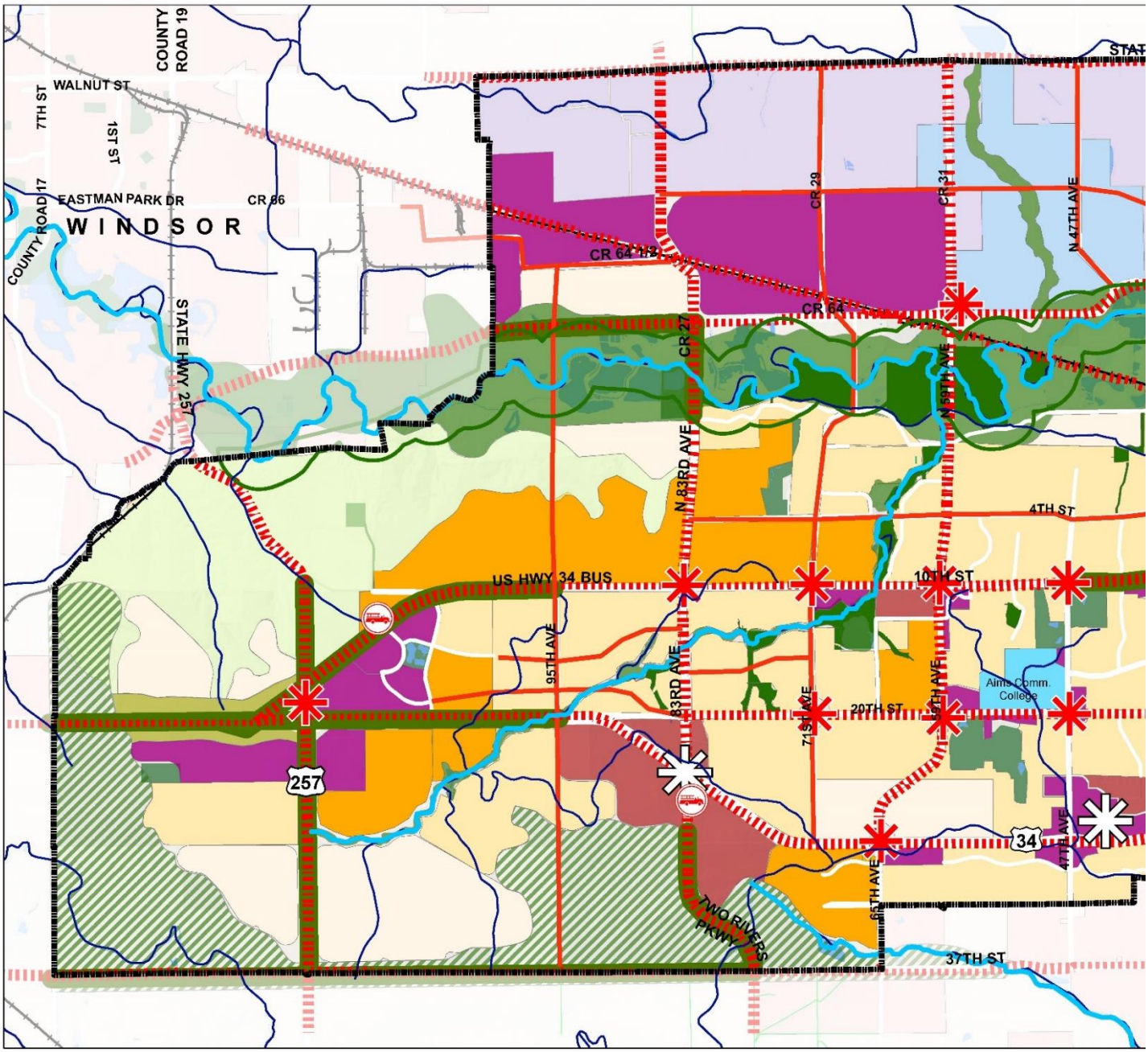
City of Greeley

5

## FEMA FIRM (Flood Insurance Rate Maps) Reference

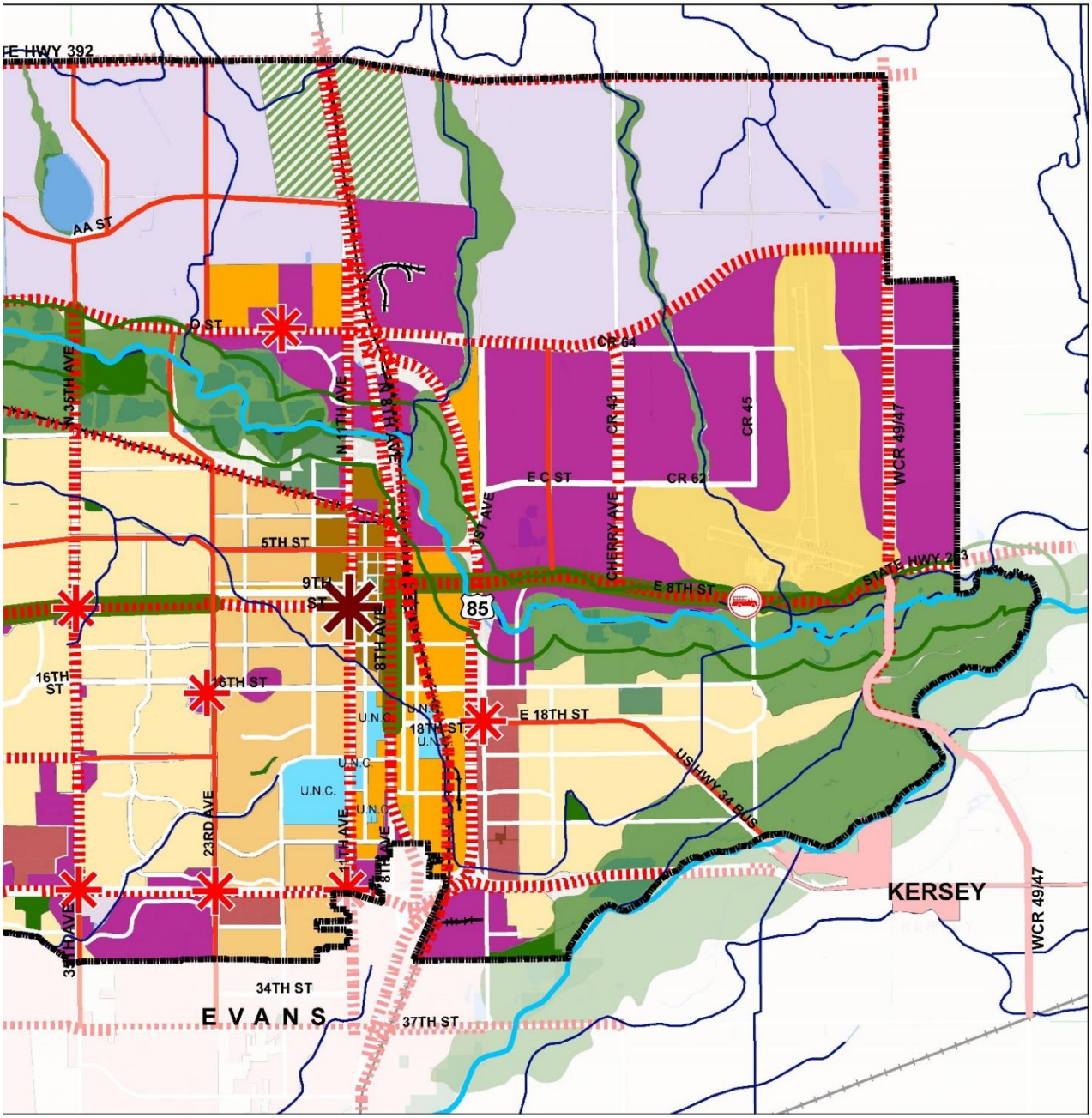
| FIRM Flood Insurance Rate Maps | | |
|---|---|---|
| Panel 5 of 14 | 08069C 0005 G | Map Revised 9/23/98 |
| 0005 thr 0075 | 0005 D | NW - County Line, SE Prairie Riv. @ WC Rd 23 |
| 0005 thr 0075 | 0005 E | NW - County Line, SE Prairie Riv. |
| 0005 | 0005 H | E. of #45 along Poudre to Tet Ave. |
| 0006 of 0075 | 0006 C | 9/28/82 | 71st to 35th along Poudre and Sheep Draw |
| 0006 of 0075 (Sheep Draw 1 of 2) | 0006 D | 9/28/1982 | 35th to 19th along Sheep Draw |
| 0117 of 0075 (Sheep Draw 1 of 2) | 0117 C | - | 71st to 59th along Sheep Draw to 10th St. |
| 0118 of 0075 | 0019 C | - | Down by Arrowhead #36 to South Platte |
| 0125 of 0075 | 0125 C | - | Greeley Divd #2 NE & E to Sterling Road WCR66 @ WCR 41 |
| 0127 of 0075 | 0127 C | - | Greeley Divd #2 NE W & E to Sterling Road |
| 0128 of 0075 | 0128 C | - | Sand Creek NE of & East from to Poudre River |
| 0129 of 0075 | 0129 C | - | Poudre Riv at Poudre Canyon Rd to Colorado River by Bliss Rd |
| 0130 of 0075 | 0130 C | - | Poudre Riv at Poudre Canyon to County to SW part of town |
| 0135 of 0075 | 0135 C | - | Poudre Riv at Poudre Canyon to Colorado River at Platte |
| 0150 | 0150 C | - | South Platte from #45 down around Evans |
| 0150 of 0075 | 0150 D | - | South Platte from #45 down |
| 0185 | 0185 C | - | South Platte by Kersey |

| Floodway / Wold County Unincorporated - (approx. 22sf Acre /or Cherry Acre.) | | |
|---|---|---|
| Panel 2 of 14 Panel 4 | 08069C0002 | Map Revised 9/28/1982 |
| 5 of 14 | 0004 | - | Sheep Draw and Poudre |
| Panel 6 of 14 | 0006 | - | Sheep Draw and Poudre to Airport |
| Panel 8 of 14 | 0008 | - | Poudre from Airport to Confluence |
| 10 of 14 | 0010 | - | Sheep Draw and Poudre |
| Panel 10 of 14 | | | |




IMAGINE GREELEY

# LAND USE GUIDANCE MAP




N

**OPEN LANDS & NATURAL AREAS**

- Bluffs
- Community Separator
- Entryway Character Corridor
- Riparian Land
- City Owned Natural Areas

**NEIGHBORHOODS**

- Rural
- Suburban
- Legacy Urban
- Mixed Use
- Downtown

**Town of Kersey**

- Town of Kersey

0 0.375 0.75 1.5 2.25 3 Miles

**Adopted February 6, 2018**

**NOAA Atlas 14, Volume 8, Version 2**
**Location name: Greeley, Colorado, USA***
**Latitude: 40.4066°, Longitude: -104.8269°**
**Elevation: 4871 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 | **0.242** (0.192-0.306) | **0.291** (0.230-0.368) | **0.387** (0.306-0.492) | **0.483** (0.379-0.617) | **0.638** (0.493-0.879) | **0.775** (0.579-1.08) | **0.929** (0.667-1.32) | **1.10** (0.755-1.62) | **1.35** (0.889-2.05) | **1.56** (0.990-2.37) |
| 10-min | **0.354** (0.281-0.448) | **0.426** (0.338-0.539) | **0.567** (0.448-0.721) | **0.707** (0.555-0.904) | **0.934** (0.722-1.29) | **1.14** (0.849-1.58) | **1.36** (0.977-1.94) | **1.61** (1.11-2.37) | **1.98** (1.30-3.00) | **2.29** (1.45-3.48) |
| 15-min | **0.432** (0.343-0.547) | **0.519** (0.412-0.658) | **0.691** (0.546-0.879) | **0.862** (0.677-1.10) | **1.14** (0.881-1.57) | **1.38** (1.04-1.92) | **1.66** (1.19-2.37) | **1.97** (1.35-2.89) | **2.42** (1.59-3.66) | **2.79** (1.77-4.24) |
| 30-min | **0.577** (0.459-0.731) | **0.693** (0.549-0.878) | **0.922** (0.728-1.17) | **1.15** (0.903-1.47) | **1.52** (1.18-2.10) | **1.85** (1.38-2.57) | **2.22** (1.59-3.16) | **2.63** (1.81-3.87) | **3.24** (2.13-4.90) | **3.75** (2.37-5.68) |
| 60-min | **0.716** (0.569-0.907) | **0.849** (0.673-1.08) | **1.12** (0.887-1.43) | **1.40** (1.10-1.79) | **1.87** (1.45-2.59) | **2.29** (1.72-3.19) | **2.76** (1.99-3.96) | **3.30** (2.27-4.87) | **4.10** (2.70-6.22) | **4.77** (3.02-7.24) |
| 2-hr | **0.855** (0.684-1.07) | **1.00** (0.803-1.26) | **1.32** (1.05-1.67) | **1.66** (1.31-2.10) | **2.22** (1.74-3.05) | **2.73** (2.07-3.77) | **3.31** (2.41-4.70) | **3.98** (2.76-5.80) | **4.96** (3.30-7.44) | **5.79** (3.70-8.68) |
| 3-hr | **0.938** (0.754-1.17) | **1.09** (0.878-1.36) | **1.43** (1.14-1.79) | **1.79** (1.42-2.25) | **2.40** (1.90-3.29) | **2.96** (2.26-4.08) | **3.60** (2.64-5.08) | **4.34** (3.03-6.29) | **5.44** (3.64-8.10) | **6.36** (4.10-9.47) |
| 6-hr | **1.09** (0.882-1.34) | **1.28** (1.03-1.58) | **1.67** (1.35-2.07) | **2.07** (1.66-2.58) | **2.75** (2.18-3.71) | **3.36** (2.58-4.56) | **4.05** (2.99-5.63) | **4.84** (3.41-6.92) | **6.00** (4.05-8.82) | **6.98** (4.54-10.3) |
| 12-hr | **1.28** (1.04-1.56) | **1.52** (1.24-1.86) | **1.98** (1.61-2.44) | **2.43** (1.96-3.00) | **3.14** (2.49-4.13) | **3.76** (2.89-4.99) | **4.44** (3.29-6.05) | **5.19** (3.68-7.28) | **6.29** (4.28-9.08) | **7.20** (4.73-10.4) |
| 24-hr | **1.53** (1.26-1.85) | **1.80** (1.48-2.18) | **2.30** (1.89-2.80) | **2.78** (2.26-3.39) | **3.51** (2.80-4.55) | **4.14** (3.21-5.42) | **4.83** (3.61-6.49) | **5.59** (4.00-7.72) | **6.68** (4.59-9.50) | **7.58** (5.03-10.8) |
| 2-day | **1.77** (1.47-2.12) | **2.09** (1.73-2.50) | **2.65** (2.19-3.20) | **3.17** (2.60-3.83) | **3.94** (3.15-5.00) | **4.58** (3.57-5.89) | **5.27** (3.96-6.95) | **6.01** (4.33-8.16) | **7.05** (4.88-9.86) | **7.89** (5.30-11.1) |
| 3-day | **1.93** (1.61-2.30) | **2.25** (1.88-2.69) | **2.83** (2.35-3.38) | **3.35** (2.76-4.02) | **4.12** (3.32-5.20) | **4.78** (3.74-6.10) | **5.47** (4.14-7.17) | **6.22** (4.50-8.38) | **7.28** (5.07-10.1) | **8.13** (5.49-11.4) |
| 4-day | **2.05** (1.72-2.44) | **2.38** (1.99-2.84) | **2.97** (2.48-3.54) | **3.50** (2.90-4.19) | **4.29** (3.46-5.38) | **4.94** (3.89-6.28) | **5.64** (4.28-7.35) | **6.40** (4.65-8.57) | **7.46** (5.21-10.3) | **8.31** (5.64-11.6) |
| 7-day | **2.33** (1.96-2.74) | **2.72** (2.29-3.21) | **3.40** (2.85-4.02) | **3.98** (3.32-4.73) | **4.82** (3.90-5.95) | **5.50** (4.34-6.88) | **6.20** (4.72-7.95) | **6.93** (5.07-9.15) | **7.93** (5.58-10.8) | **8.72** (5.97-12.0) |
| 10-day | **2.57** (2.17-3.01) | **3.02** (2.55-3.54) | **3.76** (3.17-4.43) | **4.39** (3.68-5.19) | **5.27** (4.27-6.44) | **5.96** (4.72-7.39) | **6.66** (5.10-8.47) | **7.38** (5.42-9.65) | **8.34** (5.89-11.2) | **9.08** (6.25-12.4) |
| 20-day | **3.29** (2.80-3.81) | **3.82** (3.26-4.43) | **4.68** (3.97-5.44) | **5.38** (4.55-6.29) | **6.34** (5.17-7.62) | **7.07** (5.64-8.63) | **7.79** (6.01-9.75) | **8.52** (6.31-11.0) | **9.46** (6.75-12.5) | **10.2** (7.08-13.7) |
| 30-day | **3.86** (3.31-4.45) | **4.45** (3.81-5.13) | **5.40** (4.61-6.25) | **6.17** (5.24-7.17) | **7.21** (5.90-8.59) | **7.99** (6.40-9.67) | **8.75** (6.78-10.9) | **9.51** (7.08-12.1) | **10.5** (7.52-13.8) | **11.2** (7.85-15.0) |
| 45-day | **4.53** (3.90-5.19) | **5.22** (4.49-5.99) | **6.31** (5.42-7.26) | **7.19** (6.14-8.30) | **8.36** (6.87-9.88) | **9.22** (7.42-11.1) | **10.1** (7.84-12.4) | **10.9** (8.14-13.7) | **11.9** (8.58-15.5) | **12.6** (8.92-16.8) |
| 60-day | **5.07** (4.38-5.78) | **5.86** (5.06-6.69) | **7.10** (6.11-8.13) | **8.09** (6.93-9.30) | **9.39** (7.74-11.0) | **10.3** (8.35-12.3) | **11.2** (8.79-13.7) | **12.1** (9.11-15.2) | **13.2** (9.56-17.0) | **14.0** (9.91-18.4) |

[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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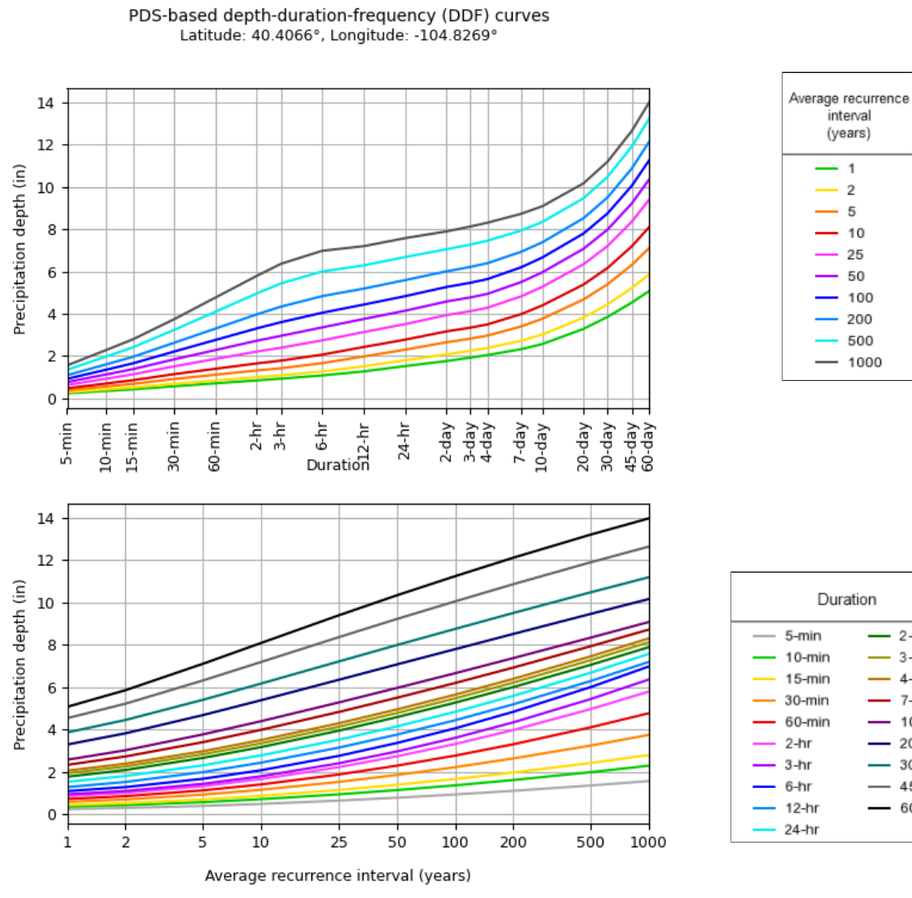
## PF graphical




NOAA Atlas 14, Volume 8, Version 2

Created (GMT): Tue Jan 23 20:26:07 2024

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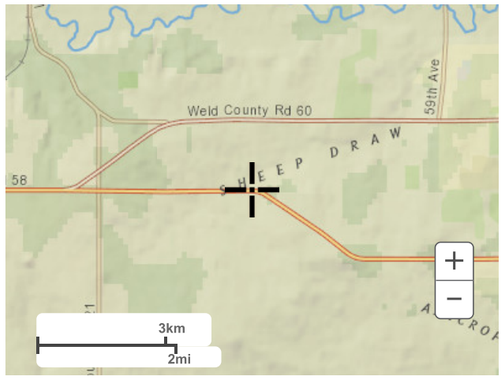
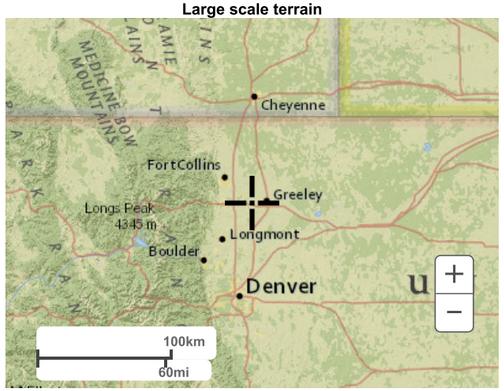
## Maps & aerials

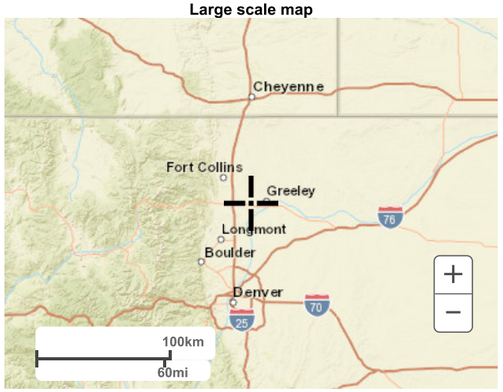
**Small scale terrain**



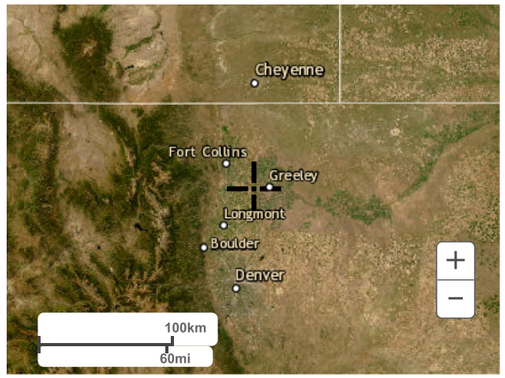

**Large scale terrain**




**Large scale map**




**Large scale aerial**

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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
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Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

## Table B-1A - Unadjusted Rainfall Distributions

| 1Hr Depth | 0.849 |
|---|---|
| Return Period | 2 |
| Time | Depth |
| 0:05 | 0.0170 |
| 0:10 | 0.0340 |
| 0:15 | 0.0713 |
| 0:20 | 0.1358 |
| 0:25 | 0.2122 |
| 0:30 | 0.1189 |
| 0:35 | 0.0535 |
| 0:40 | 0.0424 |
| 0:45 | 0.0255 |
| 0:50 | 0.0255 |
| 0:55 | 0.0255 |
| 1:00 | 0.0255 |
| 1:05 | 0.0255 |
| 1:10 | 0.0170 |
| 1:15 | 0.0170 |
| 1:20 | 0.0170 |
| 1:25 | 0.0170 |
| 1:30 | 0.0170 |
| 1:35 | 0.0170 |
| 1:40 | 0.0170 |
| 1:45 | 0.0170 |
| 1:50 | 0.0170 |
| 1:55 | 0.0085 |
| 2:00 | 0.0085 |

| 1Hr Depth | 1.12 |
|---|---|
| Return Period | 5 |
| Time | Depth |
| 0:05 | 0.0224 |
| 0:10 | 0.0414 |
| 0:15 | 0.0974 |
| 0:20 | 0.1714 |
| 0:25 | 0.2800 |
| 0:30 | 0.1456 |
| 0:35 | 0.0650 |
| 0:40 | 0.0493 |
| 0:45 | 0.0403 |
| 0:50 | 0.0403 |
| 0:55 | 0.0336 |
| 1:00 | 0.0336 |
| 1:05 | 0.0336 |
| 1:10 | 0.0336 |
| 1:15 | 0.0280 |
| 1:20 | 0.0246 |
| 1:25 | 0.0246 |
| 1:30 | 0.0246 |
| 1:35 | 0.0246 |
| 1:40 | 0.0168 |
| 1:45 | 0.0168 |
| 1:50 | 0.0168 |
| 1:55 | 0.0168 |
| 2:00 | 0.0146 |

| 1Hr Depth | 1.40 |
|---|---|
| Return Period | 10 |
| Time | Depth |
| 0:05 | 0.0280 |
| 0:10 | 0.0518 |
| 0:15 | 0.1148 |
| 0:20 | 0.2100 |
| 0:25 | 0.3500 |
| 0:30 | 0.1680 |
| 0:35 | 0.0784 |
| 0:40 | 0.0602 |
| 0:45 | 0.0532 |
| 0:50 | 0.0448 |
| 0:55 | 0.0448 |
| 1:00 | 0.0448 |
| 1:05 | 0.0448 |
| 1:10 | 0.0448 |
| 1:15 | 0.0448 |
| 1:20 | 0.0350 |
| 1:25 | 0.0266 |
| 1:30 | 0.0266 |
| 1:35 | 0.0266 |
| 1:40 | 0.0266 |
| 1:45 | 0.0266 |
| 1:50 | 0.0266 |
| 1:55 | 0.0238 |
| 2:00 | 0.0182 |

| 1Hr Depth | 1.87 |
|---|---|
| Return Period | 25 |
| Time | Depth |
| 0:05 | 0.0243 |
| 0:10 | 0.0655 |
| 0:15 | 0.0935 |
| 0:20 | 0.1496 |
| 0:25 | 0.2805 |
| 0:30 | 0.4675 |
| 0:35 | 0.2244 |
| 0:40 | 0.1496 |
| 0:45 | 0.0935 |
| 0:50 | 0.0935 |
| 0:55 | 0.0598 |
| 1:00 | 0.0598 |
| 1:05 | 0.0598 |
| 1:10 | 0.0449 |
| 1:15 | 0.0449 |
| 1:20 | 0.0337 |
| 1:25 | 0.0337 |
| 1:30 | 0.0262 |
| 1:35 | 0.0262 |
| 1:40 | 0.0262 |
| 1:45 | 0.0262 |
| 1:50 | 0.0262 |
| 1:55 | 0.0262 |
| 2:00 | 0.0262 |

| 1Hr Depth | 2.29 |
|---|---|
| Return Period | 50 |
| Time | Depth |
| 0:05 | 0.0298 |
| 0:10 | 0.0801 |
| 0:15 | 0.1145 |
| 0:20 | 0.1832 |
| 0:25 | 0.3435 |
| 0:30 | 0.5725 |
| 0:35 | 0.2748 |
| 0:40 | 0.1832 |
| 0:45 | 0.1145 |
| 0:50 | 0.1145 |
| 0:55 | 0.0733 |
| 1:00 | 0.0733 |
| 1:05 | 0.0733 |
| 1:10 | 0.0550 |
| 1:15 | 0.0550 |
| 1:20 | 0.0412 |
| 1:25 | 0.0412 |
| 1:30 | 0.0321 |
| 1:35 | 0.0321 |
| 1:40 | 0.0321 |
| 1:45 | 0.0321 |
| 1:50 | 0.0321 |
| 1:55 | 0.0321 |
| 2:00 | 0.0321 |

| 1Hr Depth | 2.76 |
|---|---|
| Return Period | 100 |
| Time | Depth |
| 0:05 | 0.0276 |
| 0:10 | 0.0828 |
| 0:15 | 0.1270 |
| 0:20 | 0.2208 |
| 0:25 | 0.3864 |
| 0:30 | 0.6900 |
| 0:35 | 0.3864 |
| 0:40 | 0.2208 |
| 0:45 | 0.1711 |
| 0:50 | 0.1380 |
| 0:55 | 0.1104 |
| 1:00 | 0.1104 |
| 1:05 | 0.1104 |
| 1:10 | 0.0552 |
| 1:15 | 0.0552 |
| 1:20 | 0.0331 |
| 1:25 | 0.0331 |
| 1:30 | 0.0331 |
| 1:35 | 0.0331 |
| 1:40 | 0.0331 |
| 1:45 | 0.0331 |
| 1:50 | 0.0331 |
| 1:55 | 0.0331 |
| 2:00 | 0.0331 |

| 1Hr Depth | 4.1 |
|---|---|
| Return Period | 500 |
| Time | Depth |
| 0:05 | 0.0410 |
| 0:10 | 0.1230 |
| 0:15 | 0.1886 |
| 0:20 | 0.3280 |
| 0:25 | 0.5740 |
| 0:30 | 1.0250 |
| 0:35 | 0.5740 |
| 0:40 | 0.3280 |
| 0:45 | 0.2542 |
| 0:50 | 0.2050 |
| 0:55 | 0.1640 |
| 1:00 | 0.1640 |
| 1:05 | 0.1640 |
| 1:10 | 0.0820 |
| 1:15 | 0.0820 |
| 1:20 | 0.0492 |
| 1:25 | 0.0492 |
| 1:30 | 0.0492 |
| 1:35 | 0.0492 |
| 1:40 | 0.0492 |
| 1:45 | 0.0492 |
| 1:50 | 0.0492 |
| 1:55 | 0.0492 |
| 2:00 | 0.0492 |

## Table B-1B - Adjusted Rainfall Distributions for 5 Square Miles

| 1Hr Depth | 0.849 |
|---|---|
| Return Period | 2 |
| Time | Depth |
| 0:05 | 0.0170 |
| 0:10 | 0.0340 |
| 0:15 | 0.0692 |
| 0:20 | 0.1168 |
| 0:25 | 0.1825 |
| 0:30 | 0.1022 |
| 0:35 | 0.0519 |
| 0:40 | 0.0412 |
| 0:45 | 0.0255 |
| 0:50 | 0.0255 |
| 0:55 | 0.0255 |
| 1:00 | 0.0255 |
| 1:05 | 0.0255 |
| 1:10 | 0.0170 |
| 1:15 | 0.0170 |
| 1:20 | 0.0170 |
| 1:25 | 0.0170 |
| 1:30 | 0.0170 |
| 1:35 | 0.0170 |
| 1:40 | 0.0170 |
| 1:45 | 0.0170 |
| 1:50 | 0.0170 |
| 1:55 | 0.0085 |
| 2:00 | 0.0085 |

| 1Hr Depth | 1.12 |
|---|---|
| Return Period | 5 |
| Time | Depth |
| 0:05 | 0.0224 |
| 0:10 | 0.0414 |
| 0:15 | 0.0945 |
| 0:20 | 0.1474 |
| 0:25 | 0.2408 |
| 0:30 | 0.1252 |
| 0:35 | 0.0630 |
| 0:40 | 0.0478 |
| 0:45 | 0.0403 |
| 0:50 | 0.0403 |
| 0:55 | 0.0336 |
| 1:00 | 0.0336 |
| 1:05 | 0.0336 |
| 1:10 | 0.0336 |
| 1:15 | 0.0280 |
| 1:20 | 0.0246 |
| 1:25 | 0.0246 |
| 1:30 | 0.0246 |
| 1:35 | 0.0246 |
| 1:40 | 0.0168 |
| 1:45 | 0.0168 |
| 1:50 | 0.0168 |
| 1:55 | 0.0168 |
| 2:00 | 0.0146 |

| 1Hr Depth | 1.40 |
|---|---|
| Return Period | 10 |
| Time | Depth |
| 0:05 | 0.0280 |
| 0:10 | 0.0518 |
| 0:15 | 0.1114 |
| 0:20 | 0.1806 |
| 0:25 | 0.3010 |
| 0:30 | 0.1445 |
| 0:35 | 0.0760 |
| 0:40 | 0.0584 |
| 0:45 | 0.0532 |
| 0:50 | 0.0448 |
| 0:55 | 0.0448 |
| 1:00 | 0.0448 |
| 1:05 | 0.0448 |
| 1:10 | 0.0448 |
| 1:15 | 0.0448 |
| 1:20 | 0.0350 |
| 1:25 | 0.0266 |
| 1:30 | 0.0266 |
| 1:35 | 0.0266 |
| 1:40 | 0.0266 |
| 1:45 | 0.0266 |
| 1:50 | 0.0266 |
| 1:55 | 0.0238 |
| 2:00 | 0.0182 |

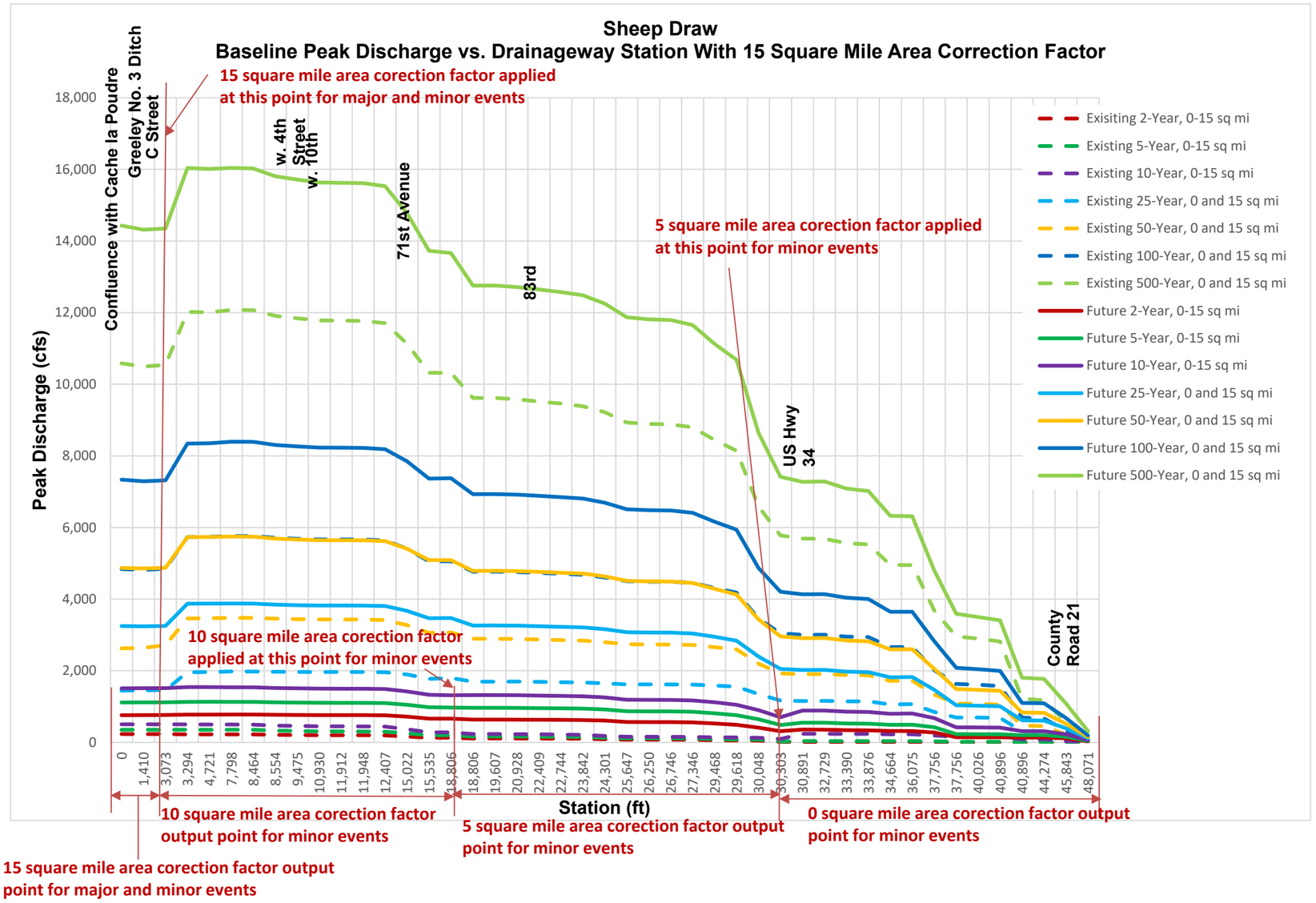
## Table B-1C - Adjusted Rainfall Distributions for 10 Square Miles

| 1Hr Depth | 0.849 |
|---|---|
| Return Period | 2 |
| Time | Depth |
| 0:05 | 0.0170 |
| 0:10 | 0.0340 |
| 0:15 | 0.0670 |
| 0:20 | 0.1019 |
| 0:25 | 0.1592 |
| 0:30 | 0.0891 |
| 0:35 | 0.0503 |
| 0:40 | 0.0399 |
| 0:45 | 0.0255 |
| 0:50 | 0.0255 |
| 0:55 | 0.0255 |
| 1:00 | 0.0255 |
| 1:05 | 0.0255 |
| 1:10 | 0.0170 |
| 1:15 | 0.0170 |
| 1:20 | 0.0170 |
| 1:25 | 0.0170 |
| 1:30 | 0.0170 |
| 1:35 | 0.0170 |
| 1:40 | 0.0170 |
| 1:45 | 0.0170 |
| 1:50 | 0.0170 |
| 1:55 | 0.0085 |
| 2:00 | 0.0085 |

| 1Hr Depth | 1.12 |
|---|---|
| Return Period | 5 |
| Time | Depth |
| 0:05 | 0.0224 |
| 0:10 | 0.0414 |
| 0:15 | 0.0916 |
| 0:20 | 0.1285 |
| 0:25 | 0.2100 |
| 0:30 | 0.1092 |
| 0:35 | 0.0611 |
| 0:40 | 0.0463 |
| 0:45 | 0.0403 |
| 0:50 | 0.0403 |
| 0:55 | 0.0336 |
| 1:00 | 0.0336 |
| 1:05 | 0.0336 |
| 1:10 | 0.0336 |
| 1:15 | 0.0280 |
| 1:20 | 0.0246 |
| 1:25 | 0.0246 |
| 1:30 | 0.0246 |
| 1:35 | 0.0246 |
| 1:40 | 0.0168 |
| 1:45 | 0.0168 |
| 1:50 | 0.0168 |
| 1:55 | 0.0168 |
| 2:00 | 0.0146 |

| 1Hr Depth | 1.40 |
|---|---|
| Return Period | 10 |
| Time | Depth |
| 0:05 | 0.0280 |
| 0:10 | 0.0518 |
| 0:15 | 0.1079 |
| 0:20 | 0.1575 |
| 0:25 | 0.2625 |
| 0:30 | 0.1260 |
| 0:35 | 0.0737 |
| 0:40 | 0.0566 |
| 0:45 | 0.0532 |
| 0:50 | 0.0448 |
| 0:55 | 0.0448 |
| 1:00 | 0.0448 |
| 1:05 | 0.0448 |
| 1:10 | 0.0448 |
| 1:15 | 0.0448 |
| 1:20 | 0.0350 |
| 1:25 | 0.0266 |
| 1:30 | 0.0266 |
| 1:35 | 0.0266 |
| 1:40 | 0.0266 |
| 1:45 | 0.0266 |
| 1:50 | 0.0266 |
| 1:55 | 0.0238 |
| 2:00 | 0.0182 |

## Table B-1D - Adjusted Rainfall Distributions for 15 Square Miles (NOT USED IN FINAL MODEL)




A smooth tranistion to the 15 square mile area correction peak flows could not be achieved without causing a significant decrease in peak flows at the transition, as demonstrated in the graph above. Since the overall watershed is only slightly larger than 15 square miles, no 15 square mile area correction factor was used in the final analysis. The 5 square mile adjustment on minor events was moved to be at 5.5 square miles to eliminate the drawdown in peak flows at the transition.

# Table B-2A - Scenario 3 Detention Basin Stage-Storage-Discharge Information

| Design Point 309 (Northridge Estates Subdivision) | | | | |
|---|---|---|---|---|
| Elevation | Stage (ft) | Area (sf) | Stage (ft) | Discharge (cfs) |
| 4703.13 | 0 | 27 | 0.00 | 0.00 |
| 4704.00 | 0.87 | 7357 | 0.87 | 0.27 |
| 4705.00 | 1.87 | 20487 | 1.87 | 0.75 |
| 4706.00 | 2.87 | 27576 | 2.87 | 1.37 |
| 4707.00 | 3.87 | 35534 | 3.87 | 2.10 |
| 4708.00 | 4.87 | 44646 | 4.87 | 2.66 |
| 4709.00 | 5.87 | 55212 | 5.87 | 6.67 |
| 4710.00 | 6.87 | 65600 | 6.87 | 9.45 |
| 4710.44 | 7.31 | 70166 | 7.31 | 10.40 |
| 4711.00 | 7.87 | 75978 | 7.87 | 24.17 |
| 4711.95 | 8.82 | 85882 | 8.82 | 65.52 |
| 4713.00 | 9.87 | 96711 | 9.87 | 237.22 |
| 4714.00 | 10.87 | 108687 | 10.87 | 534.43 |

| Design Point 315 (Pumpkin Ridge Subdivision Pond A1-1) | | | | |
|---|---|---|---|---|
| Elevation | Stage (ft) | Area (sf) | Stage (ft) | Discharge (cfs) |
| 4725.00 | 0.00 | 1 | 0.00 | 0.00 |
| 4726.00 | 1.00 | 11767 | 1.00 | 3.50 |
| 4727.00 | 2.00 | 37981 | 2.00 | 10.00 |
| 4727.36 | -- | -- | 2.36 | 11.00 |
| 4728.00 | 3.00 | 68308 | 3.00 | 38.89 |
| 4729.00 | 4.00 | 90493 | 4.00 | 243.73 |
| 4729.50 | 4.50 | 94621 | 4.50 | 440.09 |
| 4730.00 | 5.00 | 98772 | 5.00 | 711.60 |
| 4731.00 | 6.00 | 107457 | 6.00 | 1509.47 |

| Design Point 367 (Boomerang Ranch Basin 1) | | | | |
|---|---|---|---|---|
| Elevation | Stage (ft) | Area (sf) | Stage (ft) | Discharge (cfs) |
| 4784.00 | 0 | 7354 | 0.00 | 0.00 |
| 4784.33 | -- | -- | 0.33 | 0.00 |
| 4784.67 | -- | -- | 0.67 | 0.00 |
| 4785.00 | 1 | 8825 | 1.00 | 0.00 |
| 4785.33 | -- | -- | 1.33 | 0.00 |
| 4785.67 | -- | -- | 1.67 | 0.00 |
| 4786.00 | 2 | 10510 | 2.00 | 0.00 |
| 4786.33 | -- | -- | 2.33 | 0.00 |
| 4786.67 | -- | -- | 2.67 | 0.00 |
| 4787.00 | 3 | 12385 | 3.00 | 0.00 |
| 4787.07 | -- | -- | 3.07 | 0.00 |
| 4787.13 | -- | -- | 3.13 | 0.00 |
| 4787.20 | -- | -- | 3.20 | 0.00 |
| 4787.47 | -- | -- | 3.47 | 0.90 |
| 4787.73 | -- | -- | 3.73 | 2.60 |
| 4788.00 | 4 | 14451 | 4.00 | 4.80 |
| 4788.33 | -- | -- | 4.33 | 8.10 |
| 4788.67 | -- | -- | 4.67 | 11.90 |
| 4789.00 | 5 | 16709 | 5.00 | 16.20 |
| 4789.33 | -- | -- | 5.33 | 20.80 |
| 4789.67 | -- | -- | 5.67 | 21.90 |
| 4790.00 | 6 | 19131 | 6.00 | 24.40 |
| 4790.33 | -- | -- | 6.33 | 26.70 |
| 4790.67 | -- | -- | 6.67 | 28.80 |
| 4791.00 | 7 | 21716 | 7.00 | 30.80 |
| 4791.33 | -- | -- | 7.33 | 32.70 |
| 4791.67 | -- | -- | 7.67 | 34.40 |
| 4792.00 | 8 | 24466 | 8.00 | 36.10 |
| 4792.33 | -- | -- | 8.33 | 37.70 |
| 4792.67 | -- | -- | 8.67 | 39.20 |
| 4793.00 | 9 | 27344 | 9.00 | 40.70 |
| 4793.13 | -- | -- | 9.13 | 41.30 |
| 4793.27 | -- | -- | 9.27 | 41.80 |
| 4793.40 | -- | -- | 9.40 | 42.40 |
| 4793.60 | -- | -- | 9.60 | 55.10 |
| 4793.80 | -- | -- | 9.80 | 77.70 |
| 4794.00 | 10 | 29814 | 10.00 | 106.70 |
| 4794.33 | -- | -- | 10.33 | 166.10 |
| 4794.67 | -- | -- | 10.67 | 237.00 |
| 4795.00 | 11 | 32415 | 11.00 | 317.80 |

| Design Point 319 (Pumpkin Ridge Subdivision Pond A2) | | | | |
|---|---|---|---|---|
| Elevation | Stage (ft) | Area (sf) | Stage (ft) | Discharge (cfs) |
| 4730.00 | 0.00 | 1 | 0.00 | 0.00 |
| 4731.00 | 1.00 | 6375 | 1.00 | 6.80 |
| 4732.00 | 2.00 | 18781 | 2.00 | 20.00 |
| 4732.25 | -- | -- | 2.25 | 64.25 |
| 4732.50 | -- | -- | 2.50 | 152.78 |
| 4733.00 | 3.00 | 29641 | 3.00 | 446.73 |

| Design Point 323 (Pumpkin Ridge Subdivision Pond B) | | | | |
|---|---|---|---|---|
| Elevation | Stage (ft) | Area (sf) | Stage (ft) | Discharge (cfs) |
| 4737.50 | 0.00 | 1 | 0.00 | 0.00 |
| 4738.00 | 0.50 | 665 | 0.50 | 0.00 |
| 4739.00 | 1.50 | 15822 | -- | -- |
| 4739.69 | -- | -- | 2.19 | 26.00 |
| 4740.00 | 2.50 | 43590 | | |
| 4740.51 | -- | -- | 3.01 | 34.30 |
| 4740.99 | -- | -- | 3.49 | 146.34 |
| 4741.00 | 3.50 | 57538 | | |
| 4742.00 | 4.50 | 62592 | 4.50 | 664.98 |

## Table B-2B - 2006 Detention Storage-Discharge Information

| 2006 MDP SWMM ID | 2024 SWMM ID | 2006 Storage ac-ft | 2006 Discharge cfs | Notes |
|---|---|---|---|---|
| 371* | 109 | 6.13 | 118 | |
| 373 | 106 | 28.20 | 27.7 | |
| 367 | Not in watershed | 3.50 | 56.6 | |
| 372** | 111 | 11.36 | 59.2 | |
| 362 | Not in watershed | 4.99 | 62.4 | |
| 363 | Not in watershed | 3.85 | 1.7 | |
| 369 | 112 | 9.81 | 120.6 | |
| 360** | 108 | 7.72 | 14.4 | |
| 358* | 115 | 11.39 | 295.5 | |
| 359 | 118 | 5.77 | 32 | Detention effects captured with downstream Detention Pond 358 |
| 357 | 122 | 11.36 | 76.7 | For detention model, routed only Subbasin 122 to this pond |
| 352 | 130 | 6.21 | 1.6 | Detention effects captured with downstream Detention Pond 358/350 |
| 350** | 128 | 28.52 | 245 | |
| 351** | 136T | 43.41 | 118.4 | Detention effects captured with downstream Detention Pond 350 |
| 343** | 142 | 7.92 | 71.8 | For detention model, routed only Subbasin 42 to this pond |
| 346** | 132 | 8.73 | 12.1 | Detention effects captured with downstream Detention Pond 350 |
| 344 | 144 | 10.32 | 475 | |
| 339 | 148 | 24.93 | 391 | Detention effects captured with downstream Detention Pond 344 |
| 340 | 144 | 6.57 | 476 | Detention effects captured with downstream Detention Pond 345 |
| 341 | 146 | 13.29 | 12.4 | Detention effects captured with downstream Detention Pond 346 |
| 342 | 147 | 9.57 | 16.9 | Detention effects captured with downstream Detention Pond 346 |
| 329* | 167 | 3.18 | 41.5 | |
| 332 | 155 | 8.36 | 14 | For detention model, routed only Subbasin 55 to this pond |
| 336** | 156 | 10.66 | 46 | |
| 337 | 157 | 19.91 | 25.70 | Detention effects captured with downstream Detention Pond 336 |
| 324** | 177 | 8.45 | 91 | For detention model, routed only Subbasins 77-80 to this pond |
| 322 | 186 | 5.08 | 8.7 | |
| 326 | 170 | 2.78 | 39.6 | |
| 316 | 1116 | 21.13 | 100 | For detention model, routed only Subbasins 116 and 118 to this pond |
| 317 | 192 | 10.12 | 20 | |
| 318 | 1115 | 16.15 | 18.5 | |
| 319 | 1114 | 3.75 | 47 | For detention model, route only Subbasin 114 to this pond |
| 307 | 1124 | 12.87 | 2.8 | |
| 306 | 1137 | 8.62 | 34.8 | For detention model, route only Subbasin 137 to this pond |
| 304 | 1136 | | | DEPTH,FT. / SURFACE AREA,SQ.FT. / STORAGE,CU.FT. / OUTFLOW,CFS<br>0.00 / 383118.0 / 0.0 / 0.00<br>0.18 / 391047.0 / 70239.0 / 13.00<br>1.18 / 435093.0 / 460456.0 / 187.00<br>2.18 / 490253.0 / 949672.0 / 803.00<br>2.96 / 533278.0 / 1331260.0 / 2000.00 |
| 309 | 1129 | | | DEPTH,FT. / SURFACE AREA,SQ.FT. / STORAGE,CU.FT. / OUTFLOW,CFS<br>0.00 / 168944.0 / 0.0 / 0.00<br>1.58 / 185587.0 / 276418.0 / 101.00<br>2.58 / 193860.0 / 470219.0 / 220.00<br>3.58 / 202133.0 / 664020.0 / 321.00<br>4.58 / 210087.0 / 874057.0 / 1328.00 |
| 311 | 1100 | | | DEPTH,FT. / SURFACE AREA,SQ.FT. / STORAGE,CU.FT. / OUTFLOW,CFS<br>0.00 / 227076.0 / 0.0 / 0.00<br>1.00 / 255440.0 / 239671.0 / 32.00<br>3.00 / 300720.0 / 795216.0 / 119.00<br>3.14 / 304929.0 / 841462.0 / 124.00<br>3.60 / 318760.0 / 993414.0 / 300.00<br>4.78 / 354238.0 / 1383203.0 / 2000.00 |
| 312 | 1103 | | | DEPTH,FT. / SURFACE AREA,SQ.FT. / STORAGE,CU.FT. / OUTFLOW,CFS<br>0.00 / 0.0 / 0.0 / 0.00<br>7.50 / 125970.0 / 373707.0 / 0.00<br>8.00 / 137440.0 / 430570.0 / 111.00<br>9.00 / 158920.0 / 589004.0 / 1000.00<br>9.56 / 170949.0 / 677727.0 / 1960.00 |
| 313 | 1104 | | | DEPTH,FT. / SURFACE AREA,SQ.FT. / STORAGE,CU.FT. / OUTFLOW,CFS<br>0.00 / 334295.0 / 0.0 / 0.00<br>0.94 / 365040.0 / 342678.0 / 61.00<br>1.94 / 471840.0 / 778236.0 / 203.00<br>3.94 / 600200.0 / 1847704.0 / 1085.00 |
| 301 | 1170 | | | DEPTH,FT. / SURFACE AREA,SQ.FT. / STORAGE,CU.FT. / OUTFLOW,CFS<br>0.00 / 32053.0 / 0.0 / 0.00<br>5.50 / 602577.0 / 1812575.0 / 0.00<br>6.00 / 648254.0 / 2089768.0 / 230.00<br>6.09 / 658022.0 / 2157644.0 / 360.00<br>6.74 / 728568.0 / 2647861.0 / 2000.00 |

*City pond with data **City pond, no data

## Legend

- Basin Boundary
- Subbasins
- Sheep Draw
- City Ponds
- XX Basin ID

**2006 Modeled Detention**

- 2006 Modeled Detention
- 2006 Stage-Storage-Discharge Data
- City Owned Ponds in 2006 Model

- Scenario 1A
- Scenario 1B
- Scenario 2
- Scenario 3
- Scenario 4
- Scenario 5
- Scenario 6

N

0 850 1,700 3,400 Feet

Updated stage-storage-discharge data

Uses 2006 inflow data for Scenario 1A

Small tributary area, not included in high-level analysis

Updated stage-storage-discharge data

Uses 2006 inflow data for Scenario 1A

Detention accounted for by 360, not included in high-level analysis

Updated stage-storage-discharge data

Uses 2006 inflow data for Scenario 1A

Small tributary area, not included in high-level analysis

Detention accounted for by 350, not included in high-level analysis

Detention accounted for by 324, not included in high-level analysis

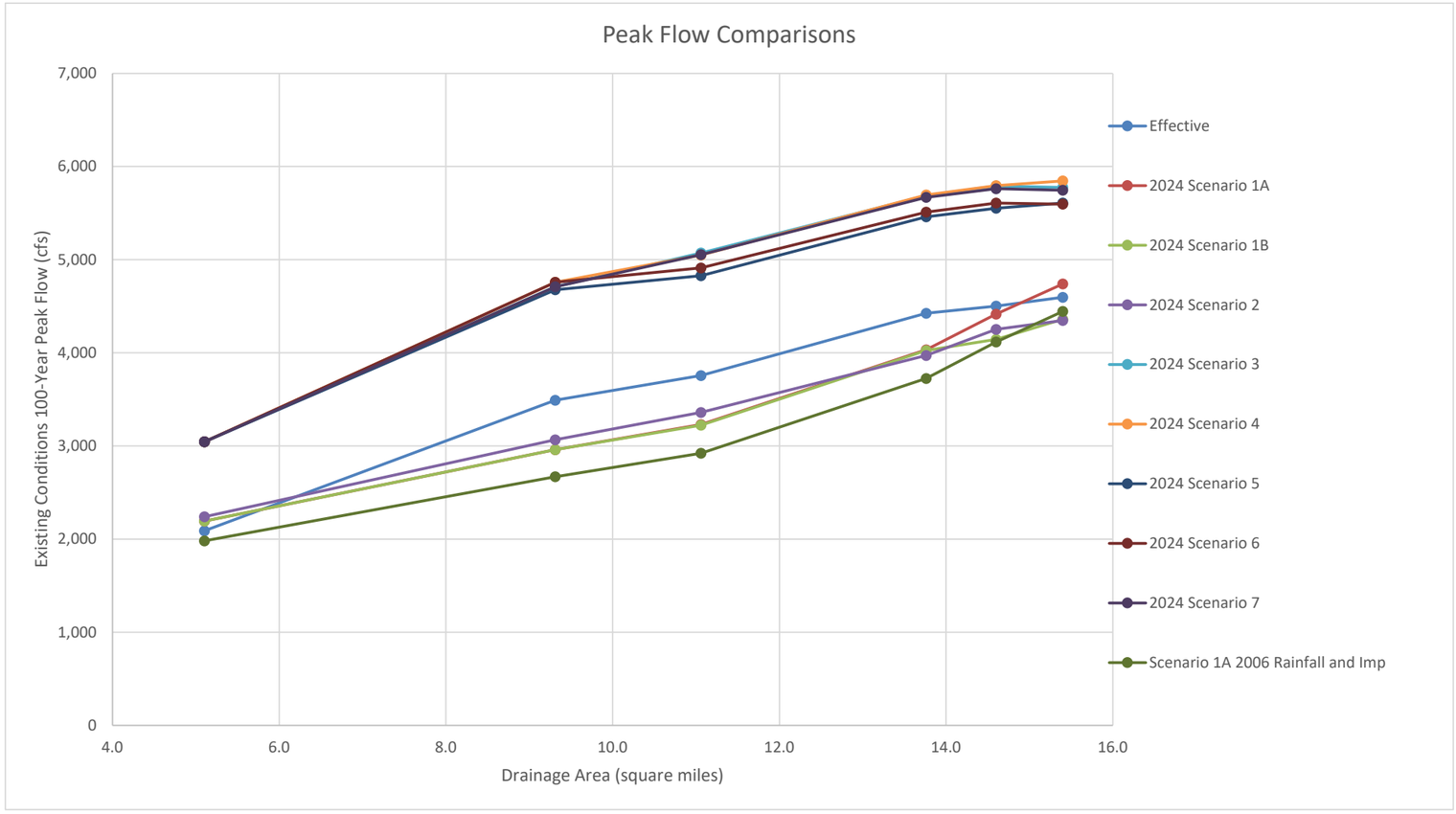
**INTERACTIVE FIGURES**

- SCENARIO 1A
- SCENARIO 1B
- SCENARIO 2
- SCENARIO 3
- SCENARIO 4
- SCENARIO 5
- SCENARIO 6

| | | | | |
|---|---|---|---|---|
| PROJECT: 022-01690<br>DRAWN BY: ELB<br>DATE: 1/2/2025 | **CITY OF GREELEY** | **SHEEP DRAW MDP<br>DETENTION SCENARIOS** | olsson<br>1525 Raleigh Street<br>Suite 400<br>Denver, CO 80204<br>TEL: 303.237.2072<br>FAX: 303.237.2659<br>www.olsson.com | City of Greeley Colorado<br>Great. From the Ground Up. | FIGURE<br>B-3 |

## Table B-3 - Detention Scenarios Flow Comparison Summary

| Location | 2024 Hydrology | | 2006 Effective | 2006 Rainfall and Approximate Imperviousness | | | | 2024 Hydrology | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Existing 100-Year Peak Flow | | Percent Difference to Effective | | Existing 100-Year Peak Flow | | | | | | | | Percent Difference to Effective | | | | | | | |
| | Design Point | Drainage Area (sm) | Existing 100-Year Peak Flow | 1A | 1B | 1A | 1B | 1A | 1B | 2 | 3 | 4 | 5 | 6 | 7 | 1A | 1B | 2 | 3 | 4 | 5 | 6 | 7 |
| C Street Crossing | 105 | 15.4 | 4,596 | 4,445 | 4,051 | -3% | -12% | 4,740 | 4,360 | 4,348 | 5,775 | 5,845 | 5,608 | 5,596 | 5,746 | 3% | -5% | -5% | 26% | 27% | 22% | 22% | 25% |
| 4th Street Crossing | 113 | 14.6 | 4,502 | 4,117 | 3,839 | -9% | -15% | 4,416 | 4,144 | 4,252 | 5,791 | 5,796 | 5,553 | 5,608 | 5,762 | -2% | -8% | -6% | 29% | 29% | 23% | 25% | 28% |
| 10th Street Crossing | 124 | 13.8 | 4,425 | 3,724 | 3,713 | -16% | -16% | 4,033 | 4,025 | 3,971 | 5,688 | 5,696 | 5,461 | 5,511 | 5,669 | -9% | -9% | -10% | 29% | 29% | 23% | 25% | 28% |
| 71st Street Crossing | 152 | 11.1 | 3,756 | 2,923 | 2,912 | -22% | -22% | 3,231 | 3,223 | 3,360 | 5,072 | 5,049 | 4,828 | 4,912 | 5,054 | -14% | -14% | -11% | 35% | 34% | 29% | 31% | 35% |
| 83rd Street Crossing | 172 | 9.3 | 3,491 | 2,670 | 2,670 | -24% | -24% | 2,959 | 2,959 | 3,066 | 4,710 | 4,758 | 4,678 | 4,758 | 4,710 | -15% | -15% | -12% | 35% | 36% | 34% | 36% | 35% |
| US Hwy 34 | 1123 | 5.1 | 2,089 | 1,982 | 1,982 | -5% | -5% | 2,194 | 2,194 | 2,241 | 3,045 | 3,045 | 3,045 | 3,045 | 3,045 | 5% | 5% | 7% | 46% | 46% | 46% | 46% | 46% |




| Scenario ID | Description |
|---|---|
| Scenario 1A | Incorporate inflows and stage-area-discharge for 40 detention ponds in 2006 study |
| Scenario 1B | Scenario 3 ponds incorporated into Scenario 1A (replace data for 3 ponds and add 2 additional ponds) |
| Scenario 2 | 11 ponds we have data for (Scenario 3 plus 6 from 2006 study) |
| Scenario 3 | 5 City ponds we have data for |
| Scenario 4 | 5 City ponds we have data for, inflows from 2006 for additional 8 City ponds |
| Scenario 5 | All City ponds (Scenario 4 plus high level detatch for 4 ponds). Other City ponds either have small drainage areas or are upstream of a 2006 study pond included in the high-level analysis |
| Scenario 6 | Targeted City ponds with largest impact |
| Scenario 7 | No detention |

# CUHP INPUT TABLE

olsson®

# CUHP SUBCATCHMENTS

Columns with this color heading are for required user-input
Columns with this color heading are for optional override values
Columns with this color heading are for program-calculated values

| | | | | | | | | | Maximum Depression Storage (Watershed inches) | | Horton's Infiltration Parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($ft^2$) | Length to Centroid (ft) | Length (ft) | Slope (ft/ft) | Existing Percent Imperviousness | Future Percent Imperviousness | Pervious | Impervious | Initial Rate (in/hr) | Decay Coefficient (1/seconds) | Final Rate (in/hr) |
| 0 | 100 | Rainfall | 6047523 | 1892 | 4164 | 0.001 | 3.36 | 3.36 | 0.400 | 0.080 | 3.150 | 0.001717 | 0.538 |
| 1 | 101 | Rainfall | 1438358 | 1019 | 2270 | 0.023 | 6.27 | 6.27 | 0.395 | 0.070 | 4.750 | 0.000838 | 0.937 |
| 2 | 102 | Rainfall | 474022 | 598 | 1033 | 0.021 | 7.17 | 7.17 | 0.390 | 0.070 | 5.000 | 0.000700 | 1.000 |
| 3 | 103 | Rainfall | 1006658 | 1680 | 2525 | 0.019 | 10.38 | 10.38 | 0.395 | 0.075 | 4.790 | 0.000815 | 0.948 |
| 4 | 104 | Rainfall | 1844402 | 1786 | 2850 | 0.012 | 5.47 | 5.47 | 0.400 | 0.100 | 4.168 | 0.001157 | 0.792 |
| 5 | 105 | Rainfall | 1465513 | 1049 | 1754 | 0.014 | 33.76 | 33.76 | 0.375 | 0.070 | 4.974 | 0.000757 | 0.979 |
| 6 | 106 | Rainfall | 5684430 | 1908 | 3651 | 0.017 | 50.30 | 50.30 | 0.350 | 0.065 | 4.919 | 0.000879 | 0.935 |
| 7 | 107 | Rainfall | 1632785 | 1013 | 2320 | 0.017 | 48.98 | 50.28 | 0.370 | 0.070 | 4.501 | 0.001798 | 0.601 |
| 8 | 108 | Rainfall | 2695478 | 1815 | 3459 | 0.015 | 47.95 | 48.55 | 0.350 | 0.070 | 4.745 | 0.001261 | 0.796 |
| 9 | 109 | Rainfall | 3217149 | 1647 | 3857 | 0.012 | 35.35 | 46.06 | 0.385 | 0.100 | 5.000 | 0.000700 | 1.000 |
| 10 | 110 | Rainfall | 4051216 | 4067 | 6207 | 0.012 | 28.93 | 37.33 | 0.375 | 0.100 | 5.000 | 0.000700 | 1.000 |
| 11 | 111 | Rainfall | 3026896 | 1146 | 2646 | 0.017 | 35.14 | 35.14 | 0.375 | 0.070 | 4.958 | 0.000792 | 0.966 |
| 12 | 112 | Rainfall | 1741257 | 1385 | 2444 | 0.020 | 58.21 | 58.21 | 0.350 | 0.070 | 5.000 | 0.000700 | 1.000 |
| 13 | 113 | Rainfall | 4431934 | 2366 | 4694 | 0.007 | 60.63 | 60.63 | 0.400 | 0.100 | 4.992 | 0.000718 | 0.994 |
| 14 | 114 | Rainfall | 880117 | 1107 | 1707 | 0.007 | 64.37 | 64.37 | 0.350 | 0.100 | 4.901 | 0.000918 | 0.921 |
| 15 | 115 | Rainfall | 1550870 | 1055 | 2545 | 0.012 | 29.60 | 29.60 | 0.380 | 0.075 | 4.930 | 0.000854 | 0.944 |
| 16 | 116 | Rainfall | 553374 | 537 | 1750 | 0.016 | 13.98 | 13.98 | 0.400 | 0.100 | 4.997 | 0.000708 | 0.997 |
| 17 | 117 | Rainfall | 1051746 | 964 | 2629 | 0.012 | 11.84 | 53.55 | 0.400 | 0.100 | 4.747 | 0.001257 | 0.798 |
| 18 | 118 | Rainfall | 2060777 | 702 | 2013 | 0.021 | 18.77 | 39.35 | 0.380 | 0.090 | 4.985 | 0.000733 | 0.988 |
| 19 | 119 | Rainfall | 1915337 | 1796 | 3301 | 0.016 | 43.69 | 51.70 | 0.375 | 0.070 | 4.979 | 0.000747 | 0.983 |
| 20 | 120 | Rainfall | 483407 | 444 | 1329 | 0.017 | 34.30 | 39.40 | 0.400 | 0.100 | 5.000 | 0.000700 | 1.000 |
| 21 | 121 | Rainfall | 3523061 | 2240 | 3812 | 0.012 | 41.22 | 41.22 | 0.375 | 0.100 | 4.714 | 0.001329 | 0.771 |
| 22 | 122 | Rainfall | 4664947 | 2830 | 5607 | 0.010 | 45.35 | 45.35 | 0.390 | 0.090 | 4.978 | 0.000749 | 0.982 |
| 23 | 123 | Rainfall | 1028572 | 1429 | 2456 | 0.020 | 38.72 | 38.72 | 0.380 | 0.100 | 5.000 | 0.000700 | 1.000 |
| 24 | 124 | Rainfall | 494064 | 793 | 1835 | 0.015 | 48.70 | 48.70 | 0.380 | 0.100 | 4.993 | 0.000704 | 0.998 |
| 25 | 125 | Rainfall | 3805420 | 3253 | 4343 | 0.022 | 35.51 | 64.79 | 0.388 | 0.100 | 4.917 | 0.000846 | 0.946 |
| 26 | 126 | Rainfall | 474647 | 949 | 1902 | 0.008 | 5.68 | 55.95 | 0.400 | 0.100 | 4.671 | 0.000881 | 0.918 |
| 27 | 127 | Rainfall | 4708804 | 1936 | 4473 | 0.007 | 25.02 | 25.02 | 0.375 | 0.100 | 4.614 | 0.000935 | 0.896 |
| 28 | 128 | Rainfall | 5384829 | 2408 | 4954 | 0.012 | 32.72 | 32.82 | 0.380 | 0.085 | 4.703 | 0.001014 | 0.876 |
| 29 | 129 | Rainfall | 683879 | 581 | 1261 | 0.016 | 38.56 | 63.02 | 0.380 | 0.070 | 5.000 | 0.000700 | 1.000 |
| 30 | 130 | Rainfall | 962735 | 686 | 1419 | 0.007 | 47.51 | 47.51 | 0.370 | 0.095 | 5.000 | 0.000700 | 1.000 |
| 31 | 131 | Rainfall | 1909104 | 1412 | 2838 | 0.018 | 17.29 | 17.29 | 0.375 | 0.100 | 4.968 | 0.000770 | 0.975 |
| 32 | 132 | Rainfall | 1200277 | 1244 | 2565 | 0.008 | 52.67 | 52.67 | 0.363 | 0.100 | 4.999 | 0.000701 | 1.000 |

# CUHP SUBCATCHMENTS

Columns with this color heading are for required user-input
Columns with this color heading are for optional override values
Columns with this color heading are for program-calculated values

| | | | | | | | | | Maximum Depression Storage (Watershed inches) | | Horton's Infiltration Parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($ft^2$) | Length to Centroid (ft) | Length (ft) | Slope (ft/ft) | Existing Percent Imperviousness | Future Percent Imperviousness | Pervious | Impervious | Initial Rate (in/hr) | Decay Coefficient (1/seconds) | Final Rate (in/hr) |
| 33 | 133 | Rainfall | 1331840 | 841 | 1830 | 0.016 | 45.39 | 45.39 | 0.363 | 0.085 | 5.000 | 0.000700 | 1.000 |
| 34 | 134 | Rainfall | 438572 | 383 | 1010 | 0.018 | 51.16 | 54.66 | 0.350 | 0.085 | 5.000 | 0.000700 | 1.000 |
| 35 | 135 | Rainfall | 2502373 | 870 | 2749 | 0.010 | 34.39 | 45.00 | 0.380 | 0.070 | 4.565 | 0.001034 | 0.860 |
| 36 | 136 | Rainfall | 4322600 | 1906 | 3028 | 0.013 | 51.63 | 51.63 | 0.363 | 0.080 | 4.865 | 0.000910 | 0.921 |
| 37 | 137 | Rainfall | 1217058 | 1449 | 2484 | 0.003 | 60.77 | 60.77 | 0.350 | 0.070 | 5.000 | 0.000700 | 1.000 |
| 38 | 138 | Rainfall | 1032579 | 1159 | 2029 | 0.009 | 37.24 | 37.24 | 0.390 | 0.100 | 4.289 | 0.001498 | 0.687 |
| 39 | 139 | Rainfall | 2124428 | 1517 | 3912 | 0.012 | 22.07 | 22.07 | 0.380 | 0.070 | 4.531 | 0.001551 | 0.685 |
| 40 | 140 | Rainfall | 5330426 | 2220 | 4062 | 0.015 | 18.03 | 18.03 | 0.350 | 0.070 | 4.778 | 0.001141 | 0.838 |
| 41 | 141 | Rainfall | 2853646 | 1802 | 2798 | 0.014 | 10.47 | 10.47 | 0.370 | 0.070 | 4.333 | 0.001532 | 0.678 |
| 42 | 142 | Rainfall | 4969441 | 1560 | 3949 | 0.009 | 43.33 | 43.33 | 0.363 | 0.070 | 4.896 | 0.000824 | 0.952 |
| 43 | 143 | Rainfall | 765829 | 655 | 1477 | 0.008 | 64.87 | 64.87 | 0.350 | 0.070 | 4.793 | 0.001155 | 0.834 |
| 44 | 144 | Rainfall | 5179356 | 1170 | 3722 | 0.007 | 41.17 | 48.89 | 0.360 | 0.080 | 4.851 | 0.000795 | 0.958 |
| 45 | 145 | Rainfall | 944810 | 969 | 1945 | 0.014 | 33.55 | 43.87 | 0.360 | 0.070 | 5.000 | 0.000700 | 1.000 |
| 46 | 146 | Rainfall | 4440383 | 2831 | 4950 | 0.013 | 20.48 | 20.48 | 0.370 | 0.070 | 4.605 | 0.001126 | 0.832 |
| 47 | 147 | Rainfall | 3116805 | 1582 | 3305 | 0.013 | 26.23 | 26.23 | 0.375 | 0.070 | 4.765 | 0.001143 | 0.837 |
| 48 | 148 | Rainfall | 5286964 | 1524 | 4362 | 0.013 | 8.86 | 9.95 | 0.388 | 0.090 | 4.324 | 0.001401 | 0.721 |
| 49 | 149 | Rainfall | 4926803 | 2322 | 5266 | 0.014 | 39.40 | 43.62 | 0.388 | 0.090 | 4.927 | 0.000740 | 0.982 |
| 50 | 150 | Rainfall | 2768882 | 1613 | 2414 | 0.013 | 21.86 | 21.86 | 0.370 | 0.070 | 4.388 | 0.001537 | 0.680 |
| 51 | 151 | Rainfall | 2148393 | 1389 | 3639 | 0.015 | 40.75 | 49.74 | 0.400 | 0.100 | 3.772 | 0.001489 | 0.655 |
| 52 | 152 | Rainfall | 4952512 | 2730 | 4552 | 0.006 | 23.25 | 32.88 | 0.365 | 0.075 | 4.852 | 0.000869 | 0.934 |
| 53 | 153 | Rainfall | 5067009 | 2821 | 3954 | 0.011 | 5.23 | 22.84 | 0.400 | 0.090 | 4.760 | 0.000972 | 0.893 |
| 54 | 154 | Rainfall | 355154 | 727 | 1340 | 0.007 | 6.00 | 6.00 | 0.400 | 0.100 | 4.976 | 0.000713 | 0.994 |
| 55 | 155 | Rainfall | 2586333 | 1956 | 3962 | 0.014 | 28.59 | 38.26 | 0.365 | 0.070 | 4.793 | 0.001156 | 0.834 |
| 56 | 156 | Rainfall | 2460135 | 1915 | 2942 | 0.008 | 43.20 | 43.20 | 0.363 | 0.070 | 4.842 | 0.001047 | 0.874 |
| 57 | 157 | Rainfall | 2407287 | 1307 | 2785 | 0.008 | 45.77 | 45.77 | 0.363 | 0.070 | 4.772 | 0.000887 | 0.922 |
| 58 | 158 | Rainfall | 4189855 | 1684 | 3119 | 0.020 | 38.60 | 54.85 | 0.370 | 0.070 | 4.783 | 0.000962 | 0.898 |
| 59 | 159 | Rainfall | 1511614 | 1471 | 2510 | 0.013 | 69.72 | 69.72 | 0.400 | 0.070 | 4.749 | 0.001252 | 0.799 |
| 60 | 160 | Rainfall | 455232 | 413 | 955 | 0.027 | 6.80 | 85.00 | 0.400 | 0.100 | 5.000 | 0.000700 | 1.000 |
| 61 | 161 | Rainfall | 647097 | 823 | 1678 | 0.013 | 43.84 | 43.84 | 0.375 | 0.060 | 4.822 | 0.001092 | 0.858 |
| 62 | 162 | Rainfall | 2359580 | 1482 | 3337 | 0.013 | 41.52 | 41.52 | 0.363 | 0.070 | 4.759 | 0.001230 | 0.807 |
| 63 | 163 | Rainfall | 4777936 | 1814 | 4389 | 0.012 | 29.62 | 48.39 | 0.375 | 0.080 | 4.750 | 0.001249 | 0.800 |
| 64 | 164 | Rainfall | 2236441 | 1638 | 2977 | 0.014 | 13.57 | 81.81 | 0.400 | 0.100 | 4.960 | 0.000787 | 0.968 |
| 65 | 165 | Rainfall | 4175972 | 1261 | 3067 | 0.024 | 6.78 | 84.76 | 0.400 | 0.100 | 4.969 | 0.000769 | 0.975 |

# CUHP SUBCATCHMENTS

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| | | | | | | | | | Maximum Depression Storage (Watershed inches) | | Horton's Infiltration Parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($ft^2$) | Length to Centroid (ft) | Length (ft) | Slope (ft/ft) | Existing Percent Imperviousness | Future Percent Imperviousness | Pervious | Impervious | Initial Rate (in/hr) | Decay Coefficient (1/seconds) | Final Rate (in/hr) |
| 66 | 166 | Rainfall | 2717171 | 944 | 2330 | 0.020 | 4.28 | 24.58 | 0.400 | 0.100 | 4.677 | 0.001066 | 0.856 |
| 67 | 167 | Rainfall | 1960563 | 1058 | 3154 | 0.012 | 40.99 | 49.67 | 0.363 | 0.070 | 4.235 | 0.001745 | 0.601 |
| 68 | 168 | Rainfall | 1300177 | 1568 | 2917 | 0.008 | 15.63 | 39.72 | 0.388 | 0.070 | 4.440 | 0.001665 | 0.641 |
| 69 | 169 | Rainfall | 2749734 | 1526 | 3292 | 0.010 | 3.71 | 30.26 | 0.400 | 0.100 | 4.671 | 0.001287 | 0.782 |
| 70 | 170 | Rainfall | 1073523 | 717 | 2187 | 0.016 | 35.93 | 48.74 | 0.375 | 0.070 | 4.519 | 0.001758 | 0.615 |
| 71 | 171 | Rainfall | 768206 | 593 | 1514 | 0.009 | 64.77 | 64.77 | 0.350 | 0.070 | 4.671 | 0.001380 | 0.751 |
| 72 | 172 | Rainfall | 1734217 | 858 | 2222 | 0.008 | 23.84 | 23.84 | 0.388 | 0.070 | 4.901 | 0.000918 | 0.921 |
| 73 | 173 | Rainfall | 1704753 | 867 | 2629 | 0.007 | 10.02 | 85.08 | 0.375 | 0.070 | 4.641 | 0.001490 | 0.713 |
| 74 | 174 | Rainfall | 5734692 | 1775 | 4670 | 0.008 | 57.34 | 57.77 | 0.350 | 0.070 | 4.911 | 0.000895 | 0.929 |
| 75 | 175 | Rainfall | 1087044 | 1039 | 1896 | 0.011 | 2.63 | 42.44 | 0.400 | 0.100 | 4.610 | 0.001558 | 0.688 |
| 76 | 176 | Rainfall | 544112 | 752 | 1447 | 0.004 | 10.72 | 10.72 | 0.400 | 0.080 | 5.000 | 0.000700 | 1.000 |
| 77 | 177 | Rainfall | 1512120 | 1123 | 3101 | 0.017 | 45.91 | 45.91 | 0.363 | 0.070 | 5.000 | 0.000700 | 1.000 |
| 78 | 178 | Rainfall | 1134873 | 1565 | 2375 | 0.013 | 49.57 | 52.20 | 0.363 | 0.070 | 4.841 | 0.000996 | 0.891 |
| 79 | 179 | Rainfall | 605368 | 699 | 1909 | 0.021 | 45.65 | 50.12 | 0.363 | 0.070 | 5.000 | 0.000700 | 1.000 |
| 80 | 180 | Rainfall | 474826 | 717 | 1848 | 0.013 | 19.74 | 30.70 | 0.400 | 0.080 | 4.397 | 0.001032 | 0.849 |
| 81 | 181 | Rainfall | 2989681 | 794 | 2455 | 0.015 | 16.92 | 74.41 | 0.388 | 0.100 | 4.715 | 0.001043 | 0.867 |
| 82 | 182 | Rainfall | 795368 | 694 | 1860 | 0.012 | 11.13 | 85.51 | 0.400 | 0.100 | 4.588 | 0.001606 | 0.670 |
| 83 | 183 | Rainfall | 2998779 | 999 | 2657 | 0.026 | 9.04 | 84.61 | 0.400 | 0.100 | 4.975 | 0.000754 | 0.980 |
| 84 | 184 | Rainfall | 1477636 | 1319 | 3212 | 0.011 | 5.43 | 65.15 | 0.388 | 0.100 | 4.879 | 0.000965 | 0.903 |
| 85 | 185 | Rainfall | 2109022 | 1603 | 3641 | 0.012 | 2.36 | 25.88 | 0.400 | 0.090 | 4.931 | 0.000851 | 0.945 |
| 86 | 186 | Rainfall | 757375 | 624 | 1531 | 0.025 | 46.37 | 46.37 | 0.350 | 0.070 | 4.889 | 0.000945 | 0.911 |
| 87 | 187 | Rainfall | 885482 | 654 | 1567 | 0.022 | 4.24 | 39.21 | 0.400 | 0.100 | 5.000 | 0.000700 | 1.000 |
| 88 | 188 | Rainfall | 3009955 | 1481 | 3282 | 0.009 | 5.78 | 44.59 | 0.400 | 0.100 | 4.953 | 0.000804 | 0.962 |
| 89 | 189 | Rainfall | 2687069 | 953 | 2612 | 0.010 | 13.69 | 44.45 | 0.388 | 0.090 | 4.342 | 0.001221 | 0.782 |
| 90 | 190 | Rainfall | 2390735 | 1301 | 3130 | 0.013 | 2.12 | 45.00 | 0.400 | 0.100 | 4.392 | 0.001035 | 0.848 |
| 91 | 191 | Rainfall | 4719122 | 1822 | 3492 | 0.008 | 3.64 | 45.00 | 0.400 | 0.100 | 4.801 | 0.000900 | 0.920 |
| 92 | 192 | Rainfall | 3339754 | 1116 | 2855 | 0.007 | 58.30 | 58.30 | 0.380 | 0.070 | 4.926 | 0.000862 | 0.941 |
| 93 | 193 | Rainfall | 227599 | 619 | 1313 | 0.020 | 51.68 | 51.68 | 0.350 | 0.100 | 3.879 | 0.001509 | 0.656 |
| 94 | 194 | Rainfall | 3093120 | 1489 | 3012 | 0.007 | 2.87 | 83.78 | 0.400 | 0.100 | 4.805 | 0.000963 | 0.899 |
| 95 | 195 | Rainfall | 1142409 | 1423 | 2877 | 0.018 | 33.98 | 34.74 | 0.388 | 0.100 | 4.794 | 0.001154 | 0.835 |
| 96 | 196 | Rainfall | 5218082 | 1905 | 4019 | 0.025 | 4.71 | 83.49 | 0.400 | 0.100 | 4.743 | 0.001265 | 0.795 |
| 97 | 197 | Rainfall | 1111282 | 1014 | 1978 | 0.023 | 2.00 | 85.00 | 0.400 | 0.100 | 5.000 | 0.000700 | 1.000 |
| 98 | 198 | Rainfall | 4734045 | 1600 | 3969 | 0.014 | 3.12 | 44.75 | 0.400 | 0.100 | 4.755 | 0.000835 | 0.939 |

# CUHP SUBCATCHMENTS

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Columns with this color heading are for optional override values
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| | | | | | | | | | Maximum Depression Storage (Watershed inches) | | Horton's Infiltration Parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($ft^2$) | Length to Centroid (ft) | Length (ft) | Slope (ft/ft) | Existing Percent Imperviousness | Future Percent Imperviousness | Pervious | Impervious | Initial Rate (in/hr) | Decay Coefficient (1/seconds) | Final Rate (in/hr) |
| 99 | 199 | Rainfall | 427410 | 432 | 980 | 0.009 | 20.33 | 41.74 | 0.400 | 0.100 | 4.068 | 0.001213 | 0.767 |
| 100 | 1100 | Rainfall | 4536609 | 2087 | 4580 | 0.012 | 8.33 | 45.00 | 0.400 | 0.100 | 4.756 | 0.000889 | 0.921 |
| 101 | 1101 | Rainfall | 1512926 | 1677 | 3013 | 0.024 | 2.77 | 38.81 | 0.400 | 0.100 | 4.853 | 0.001023 | 0.883 |
| 102 | 1102 | Rainfall | 1049430 | 1039 | 2928 | 0.010 | 4.22 | 4.22 | 0.400 | 0.100 | 4.839 | 0.000996 | 0.891 |
| 103 | 1103 | Rainfall | 4652578 | 1245 | 3282 | 0.016 | 9.78 | 48.52 | 0.400 | 0.100 | 4.502 | 0.001243 | 0.786 |
| 104 | 1104 | Rainfall | 2275465 | 609 | 1959 | 0.018 | 2.00 | 43.01 | 0.400 | 0.100 | 4.468 | 0.001497 | 0.699 |
| 105 | 1105 | Rainfall | 1931125 | 1694 | 2897 | 0.018 | 2.00 | 73.74 | 0.400 | 0.100 | 4.998 | 0.000705 | 0.998 |
| 106 | 1106 | Rainfall | 3893920 | 1464 | 3494 | 0.019 | 2.11 | 54.59 | 0.400 | 0.100 | 4.911 | 0.000896 | 0.929 |
| 107 | 1107 | Rainfall | 5653349 | 1765 | 3456 | 0.022 | 2.00 | 2.52 | 0.400 | 0.100 | 4.640 | 0.001475 | 0.718 |
| 108 | 1108 | Rainfall | 3498100 | 1046 | 2890 | 0.019 | 2.31 | 2.31 | 0.400 | 0.100 | 4.663 | 0.001441 | 0.731 |
| 109 | 1109 | Rainfall | 2655979 | 1615 | 2914 | 0.023 | 2.44 | 2.44 | 0.400 | 0.100 | 4.513 | 0.001771 | 0.611 |
| 110 | 1110 | Rainfall | 2329951 | 958 | 2421 | 0.011 | 2.00 | 2.00 | 0.400 | 0.100 | 3.630 | 0.001800 | 0.542 |
| 111 | 1111 | Rainfall | 1815815 | 943 | 2382 | 0.023 | 2.61 | 2.89 | 0.400 | 0.100 | 4.769 | 0.001207 | 0.816 |
| 112 | 1112 | Rainfall | 1732932 | 1703 | 3567 | 0.011 | 2.30 | 2.30 | 0.400 | 0.100 | 3.291 | 0.001800 | 0.519 |
| 113 | 1113 | Rainfall | 1850023 | 1556 | 3029 | 0.017 | 11.52 | 42.59 | 0.400 | 0.100 | 4.872 | 0.000799 | 0.958 |
| 114 | 1114 | Rainfall | 3170352 | 1774 | 4741 | 0.010 | 55.30 | 55.46 | 0.375 | 0.070 | 4.822 | 0.000914 | 0.917 |
| 115 | 1115 | Rainfall | 3639888 | 2040 | 3950 | 0.009 | 59.81 | 59.95 | 0.350 | 0.070 | 5.000 | 0.000700 | 1.000 |
| 116 | 1116 | Rainfall | 4415397 | 3117 | 3786 | 0.012 | 17.53 | 66.28 | 0.388 | 0.100 | 4.706 | 0.001346 | 0.765 |
| 117 | 1117 | Rainfall | 4380255 | 1696 | 3770 | 0.014 | 7.38 | 80.72 | 0.400 | 0.100 | 4.634 | 0.001449 | 0.726 |
| 118 | 1118 | Rainfall | 3204898 | 1453 | 3512 | 0.007 | 55.07 | 64.81 | 0.350 | 0.100 | 4.969 | 0.000767 | 0.976 |
| 119 | 1119 | Rainfall | 101950 | 903 | 1845 | 0.003 | 65.80 | 65.80 | 0.350 | 0.100 | 4.536 | 0.001722 | 0.628 |
| 120 | 1120 | Rainfall | 87330 | 808 | 1615 | 0.011 | 72.43 | 72.43 | 0.350 | 0.100 | 4.500 | 0.001800 | 0.600 |
| 121 | 1121 | Rainfall | 80169 | 499 | 1004 | 0.025 | 75.50 | 75.50 | 0.350 | 0.100 | 4.500 | 0.001800 | 0.600 |
| 122 | 1122 | Rainfall | 203948 | 1357 | 2729 | 0.014 | 79.00 | 79.00 | 0.350 | 0.100 | 4.500 | 0.001800 | 0.600 |
| 123 | 1123 | Rainfall | 3471738 | 1638 | 4710 | 0.008 | 11.00 | 51.76 | 0.400 | 0.100 | 4.451 | 0.001195 | 0.799 |
| 124 | 1124 | Rainfall | 556942 | 530 | 1650 | 0.009 | 26.81 | 73.38 | 0.380 | 0.100 | 4.500 | 0.001800 | 0.600 |
| 125 | 1125 | Rainfall | 2331915 | 1746 | 2944 | 0.010 | 2.49 | 74.63 | 0.400 | 0.100 | 4.511 | 0.001771 | 0.610 |
| 126 | 1126 | Rainfall | 2020949 | 952 | 2417 | 0.006 | 2.00 | 51.64 | 0.400 | 0.100 | 4.656 | 0.001026 | 0.868 |
| 127 | 1127 | Rainfall | 1414367 | 1035 | 2573 | 0.024 | 2.00 | 44.64 | 0.400 | 0.100 | 5.000 | 0.000700 | 1.000 |
| 128 | 1128 | Rainfall | 1833439 | 890 | 1954 | 0.011 | 3.90 | 38.87 | 0.400 | 0.100 | 4.452 | 0.001139 | 0.817 |
| 129 | 1129 | Rainfall | 2529920 | 1045 | 2987 | 0.009 | 8.71 | 45.00 | 0.400 | 0.100 | 4.641 | 0.001157 | 0.824 |
| 130 | 1130 | Rainfall | 4246012 | 2438 | 4824 | 0.017 | 2.00 | 28.76 | 0.400 | 0.100 | 4.745 | 0.001233 | 0.805 |
| 131 | 1131 | Rainfall | 1190515 | 1334 | 2523 | 0.020 | 2.00 | 25.57 | 0.400 | 0.100 | 4.678 | 0.000933 | 0.901 |

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| | | | | | | | | | Maximum Depression Storage (Watershed inches) | | Horton's Infiltration Parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($ft^2$) | Length to Centroid (ft) | Length (ft) | Slope (ft/ft) | Existing Percent Imperviousness | Future Percent Imperviousness | Pervious | Impervious | Initial Rate (in/hr) | Decay Coefficient (1/seconds) | Final Rate (in/hr) |
| 132 | 1132 | Rainfall | 1792589 | 1093 | 2937 | 0.013 | 2.00 | 2.86 | 0.400 | 0.100 | 4.487 | 0.000983 | 0.871 |
| 133 | 1133 | Rainfall | 4234680 | 1858 | 4244 | 0.013 | 2.40 | 3.64 | 0.400 | 0.100 | 3.380 | 0.001759 | 0.539 |
| 134 | 1134 | Rainfall | 982334 | 709 | 1450 | 0.005 | 3.54 | 3.54 | 0.400 | 0.100 | 3.076 | 0.001800 | 0.505 |
| 135 | 1135 | Rainfall | 656139 | 986 | 1959 | 0.010 | 2.00 | 45.00 | 0.400 | 0.100 | 4.744 | 0.001262 | 0.796 |
| 136 | 1136 | Rainfall | 2920711 | 1503 | 3974 | 0.024 | 2.00 | 52.97 | 0.400 | 0.100 | 4.673 | 0.001129 | 0.835 |
| 137 | 1137 | Rainfall | 3829752 | 1237 | 3470 | 0.016 | 3.11 | 73.15 | 0.388 | 0.100 | 4.597 | 0.001586 | 0.678 |
| 138 | 1138 | Rainfall | 3026302 | 1423 | 2904 | 0.018 | 29.64 | 29.64 | 0.388 | 0.100 | 4.500 | 0.001800 | 0.600 |
| 139 | 1139 | Rainfall | 677353 | 520 | 1594 | 0.008 | 2.00 | 2.00 | 0.400 | 0.100 | 4.500 | 0.001800 | 0.600 |
| 140 | 1140 | Rainfall | 622992 | 577 | 1435 | 0.008 | 2.00 | 27.63 | 0.400 | 0.100 | 4.907 | 0.000751 | 0.977 |
| 141 | 1141 | Rainfall | 1448120 | 881 | 1768 | 0.014 | 2.00 | 45.00 | 0.400 | 0.100 | 4.119 | 0.001185 | 0.780 |
| 142 | 1142 | Rainfall | 1808495 | 1503 | 3352 | 0.019 | 2.00 | 15.81 | 0.400 | 0.100 | 4.320 | 0.001099 | 0.822 |
| 143 | 1143 | Rainfall | 3005565 | 2193 | 4409 | 0.025 | 2.00 | 20.51 | 0.400 | 0.100 | 3.995 | 0.001465 | 0.678 |
| 144 | 1144 | Rainfall | 2181972 | 1886 | 3975 | 0.019 | 2.00 | 30.45 | 0.400 | 0.100 | 4.439 | 0.001018 | 0.857 |
| 145 | 1145 | Rainfall | 2597193 | 1229 | 3761 | 0.022 | 2.00 | 12.30 | 0.400 | 0.100 | 4.133 | 0.001512 | 0.672 |
| 146 | 1146 | Rainfall | 2558106 | 1428 | 3097 | 0.020 | 2.00 | 10.73 | 0.400 | 0.100 | 4.416 | 0.001795 | 0.596 |
| 147 | 1147 | Rainfall | 3933374 | 1157 | 3073 | 0.018 | 2.39 | 10.06 | 0.400 | 0.100 | 4.234 | 0.001792 | 0.585 |
| 148 | 1148 | Rainfall | 2305518 | 1249 | 2113 | 0.006 | 2.86 | 2.86 | 0.400 | 0.100 | 3.479 | 0.001800 | 0.532 |
| 149 | 1149 | Rainfall | 4980321 | 2187 | 4546 | 0.013 | 3.32 | 68.77 | 0.400 | 0.090 | 4.399 | 0.001451 | 0.710 |
| 150 | 1150 | Rainfall | 4718768 | 1257 | 3391 | 0.007 | 2.97 | 79.28 | 0.400 | 0.100 | 4.156 | 0.001800 | 0.577 |
| 151 | 1151 | Rainfall | 2339695 | 1876 | 3393 | 0.012 | 36.53 | 37.52 | 0.388 | 0.100 | 4.376 | 0.001800 | 0.592 |
| 152 | 1152 | Rainfall | 4064800 | 1334 | 2536 | 0.012 | 4.52 | 84.70 | 0.400 | 0.100 | 3.924 | 0.001800 | 0.562 |
| 153 | 1153 | Rainfall | 2605562 | 1657 | 3440 | 0.008 | 2.00 | 31.09 | 0.400 | 0.100 | 4.920 | 0.000744 | 0.980 |
| 154 | 1154 | Rainfall | 2222410 | 1460 | 3290 | 0.017 | 2.00 | 10.47 | 0.400 | 0.100 | 3.827 | 0.001345 | 0.707 |
| 155 | 1155 | Rainfall | 1310085 | 1309 | 2597 | 0.010 | 2.00 | 12.00 | 0.400 | 0.100 | 3.783 | 0.001417 | 0.680 |
| 156 | 1156 | Rainfall | 5540950 | 2134 | 4607 | 0.015 | 2.00 | 12.00 | 0.400 | 0.100 | 4.353 | 0.001798 | 0.591 |
| 157 | 1157 | Rainfall | 4102357 | 1308 | 2688 | 0.008 | 2.53 | 5.82 | 0.400 | 0.100 | 4.029 | 0.001800 | 0.569 |
| 158 | 1158 | Rainfall | 426287 | 1026 | 1762 | 0.011 | 2.00 | 12.00 | 0.400 | 0.100 | 4.091 | 0.001200 | 0.773 |
| 159 | 1159 | Rainfall | 774909 | 848 | 1876 | 0.011 | 2.00 | 12.00 | 0.400 | 0.100 | 3.654 | 0.001800 | 0.544 |
| 160 | 1160 | Rainfall | 4599836 | 2355 | 4789 | 0.011 | 2.42 | 8.06 | 0.400 | 0.100 | 3.886 | 0.001800 | 0.559 |
| 161 | 1161 | Rainfall | 3099012 | 1930 | 4781 | 0.011 | 2.67 | 11.66 | 0.400 | 0.100 | 4.287 | 0.001658 | 0.633 |
| 162 | 1162 | Rainfall | 1759611 | 2334 | 4505 | 0.011 | 2.00 | 12.00 | 0.400 | 0.100 | 4.096 | 0.001769 | 0.583 |
| 163 | 1163 | Rainfall | 3534812 | 1776 | 3574 | 0.011 | 2.51 | 5.20 | 0.400 | 0.100 | 4.208 | 0.001800 | 0.581 |
| 164 | 1164 | Rainfall | 2624803 | 1369 | 3227 | 0.013 | 2.05 | 12.00 | 0.400 | 0.100 | 3.651 | 0.001721 | 0.570 |

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| | | | | | | | | | Maximum Depression Storage (Watershed inches) | | Horton's Infiltration Parameters | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Subcatchment Name | EPA SWMM Target Node | Raingage | Area ($ft^2$) | Length to Centroid (ft) | Length (ft) | Slope (ft/ft) | Existing Percent Imperviousness | Future Percent Imperviousness | Pervious | Impervious | Initial Rate (in/hr) | Decay Coefficient (1/seconds) | Final Rate (in/hr) |
| 165 | 1165 | Rainfall | 2136943 | 906 | 2271 | 0.011 | 2.56 | 12.00 | 0.400 | 0.100 | 4.317 | 0.001800 | 0.588 |
| 166 | 1166 | Rainfall | 3122536 | 1695 | 2870 | 0.014 | 2.44 | 10.87 | 0.400 | 0.100 | 3.850 | 0.001800 | 0.557 |
| 167 | 1167 | Rainfall | 407273 | 305 | 902 | 0.012 | 3.23 | 12.00 | 0.400 | 0.100 | 4.199 | 0.001800 | 0.580 |
| 168 | 1168 | Rainfall | 3420803 | 617 | 2041 | 0.005 | 2.60 | 12.00 | 0.400 | 0.100 | 3.044 | 0.001800 | 0.503 |
| 169 | 1169 | Rainfall | 2351544 | 2375 | 4178 | 0.007 | 2.54 | 32.43 | 0.400 | 0.100 | 3.582 | 0.001666 | 0.583 |
| 170 | 1170 | Rainfall | 3276992 | 941 | 2891 | 0.014 | 2.22 | 48.28 | 0.400 | 0.100 | 3.031 | 0.001800 | 0.502 |
| 171 | 1171 | Rainfall | 4660673 | 1542 | 3570 | 0.011 | 2.68 | 12.74 | 0.400 | 0.100 | 3.351 | 0.001800 | 0.523 |
| 172 | 1172 | Rainfall | 4270922 | 1237 | 3217 | 0.007 | 2.45 | 13.09 | 0.400 | 0.100 | 3.000 | 0.001800 | 0.500 |
| 173 | 1173 | Rainfall | 2779342 | 2050 | 3702 | 0.007 | 2.00 | 82.78 | 0.400 | 0.100 | 3.979 | 0.001800 | 0.565 |
| 174 | 1174 | Rainfall | 5053405 | 1115 | 3649 | 0.013 | 2.00 | 56.60 | 0.400 | 0.100 | 3.449 | 0.001800 | 0.530 |
| 175 | 1175 | Rainfall | 3902957 | 1915 | 3254 | 0.008 | 2.29 | 47.42 | 0.400 | 0.100 | 3.000 | 0.001800 | 0.500 |

SHEEP DRAW Major Drainageway Plan

# CUHP BACKUP CALCULATIONS

olsson®

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | | | Final Values Used in CUHP | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a | | Infiltration (inches per hour) | | Decay Coefficient - a | |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | | Basin ID | Summed Weight | Initial - $f_i$ | Final - $f_o$ | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F | A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |
| 19 | Polygon ZM | CO618 | 13 | 95190 | A | 0 | 0.074937 | 3264.247572 | 5.0 | 1.0 | 0.0007 | 0.000539726 | 0.00269863 | 0.00053973 | 3.7781E-07 | 0 | 1.00 | 3.15 | 0.54 | 0.0017 |
| 30 | Polygon ZM | CO618 | 3 | 95208 | D | 0 | 128.152815 | 5582336.604 | 3.0 | 0.5 | 0.0018 | 0.923008985 | 2.76902696 | 0.46150449 | 0.00166142 | 1 | 1.00 | 4.75 | 0.94 | 0.0008 |
| 42 | Polygon ZM | CO618 | 10 | 95187 | A | 0 | 10.346042 | 450673.6031 | 5.0 | 1.0 | 0.0007 | 0.074516428 | 0.37258214 | 0.07451643 | 5.2161E-05 | 2 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 43 | Polygon ZM | CO618 | 85 | 95269 | D | 0 | 0.268641 | 11701.99234 | 3.0 | 0.5 | 0.0018 | 0.001934861 | 0.00580458 | 0.00096743 | 3.4827E-06 | 3 | 1.00 | 4.79 | 0.95 | 0.0008 |
| 1 | Polygon ZM | CO618 | 13 | 95190 | A | 1 | 0.301103 | 13116.03393 | 5.0 | 1.0 | 0.0007 | 0.009118066 | 0.04559033 | 0.00911807 | 6.3826E-06 | 4 | 1.00 | 4.17 | 0.79 | 0.0012 |
| 8 | Polygon ZM | CO618 | 51 | 95232 | A | 1 | 9.863585 | 429657.7793 | 5.0 | 1.0 | 0.0007 | 0.298691498 | 1.49345749 | 0.2986915 | 0.00020908 | 5 | 1.00 | 4.97 | 0.98 | 0.0008 |
| 15 | Polygon ZM | CO618 | 51 | 95232 | A | 1 | 0.206088 | 8977.203319 | 5.0 | 1.0 | 0.0007 | 0.006240814 | 0.03120407 | 0.00624081 | 4.3686E-06 | 6 | 1.00 | 4.92 | 0.93 | 0.0009 |
| 18 | Polygon ZM | CO618 | 52 | 95233 | A | 1 | 1.787211 | 77850.92052 | 5.0 | 1.0 | 0.0007 | 0.054120766 | 0.27060383 | 0.05412077 | 3.7885E-05 | 7 | 1.00 | 4.50 | 0.60 | 0.0018 |
| 22 | Polygon ZM | CO618 | 13 | 95190 | A | 1 | 16.73323 | 728899.5004 | 5.0 | 1.0 | 0.0007 | 0.506719753 | 2.53359876 | 0.50671975 | 0.0003547 | 8 | 1.00 | 4.74 | 0.80 | 0.0013 |
| 33 | Polygon ZM | CO618 | 3 | 95208 | D | 1 | 4.131434 | 179965.2823 | 3.0 | 0.5 | 0.0018 | 0.125109104 | 0.37532731 | 0.06255455 | 0.0002252 | 9 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 4 | Polygon ZM | CO618 | 51 | 95232 | A | 2 | 10.451648 | 455273.7795 | 5.0 | 1.0 | 0.0007 | 0.96037608 | 4.8018804 | 0.96037608 | 0.00067226 | 10 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 20 | Polygon ZM | CO618 | 13 | 95190 | A | 2 | 0.431222 | 18784.02865 | 5.0 | 1.0 | 0.0007 | 0.03962392 | 0.1981196 | 0.03962392 | 2.7737E-05 | 11 | 1.00 | 4.96 | 0.97 | 0.0008 |
| 5 | Polygon ZM | CO618 | 51 | 95232 | A | 3 | 2.799153 | 121931.1059 | 5.0 | 1.0 | 0.0007 | 0.12111554 | 0.6055777 | 0.12111554 | 8.4781E-05 | 12 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 21 | Polygon ZM | CO618 | 13 | 95190 | A | 3 | 17.888548 | 779225.1575 | 5.0 | 1.0 | 0.0007 | 0.774013117 | 3.87006558 | 0.77401312 | 0.00054181 | 13 | 1.00 | 4.99 | 0.99 | 0.0007 |
| 31 | Polygon ZM | CO618 | 3 | 95208 | D | 3 | 2.423726 | 105577.5249 | 3.0 | 0.5 | 0.0018 | 0.104871344 | 0.31461403 | 0.05243567 | 0.00018877 | 14 | 1.00 | 4.90 | 0.92 | 0.0009 |
| 0 | Polygon ZM | CO618 | 13 | 95190 | A | 4 | 4.106928 | 178897.7715 | 5.0 | 1.0 | 0.0007 | 0.09698768 | 0.4849384 | 0.09698768 | 6.7891E-05 | 15 | 1.00 | 4.93 | 0.94 | 0.0009 |
| 9 | Polygon ZM | CO618 | 51 | 95232 | A | 4 | 20.630724 | 898674.3244 | 5.0 | 1.0 | 0.0007 | 0.487207512 | 2.43603756 | 0.48720751 | 0.00034105 | 16 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 29 | Polygon ZM | CO618 | 3 | 95208 | D | 4 | 17.607188 | 766969.0942 | 3.0 | 0.5 | 0.0018 | 0.415804807 | 1.24741442 | 0.2079024 | 0.00074845 | 17 | 1.00 | 4.75 | 0.80 | 0.0013 |
| 13 | Polygon ZM | CO618 | 51 | 95232 | A | 5 | 20.23964 | 881638.7032 | 5.0 | 1.0 | 0.0007 | 0.601544674 | 3.00772337 | 0.60154467 | 0.00042108 | 18 | 1.00 | 4.99 | 0.99 | 0.0007 |
| 24 | Polygon ZM | CO618 | 13 | 95190 | A | 5 | 0.020839 | 907.742819 | 5.0 | 1.0 | 0.0007 | 0.000619356 | 0.00309678 | 0.00061936 | 4.3355E-07 | 19 | 1.00 | 4.98 | 0.98 | 0.0007 |
| 28 | Polygon ZM | CO618 | 38 | 95217 | B | 5 | 1.737682 | 75693.41305 | 4.5 | 0.6 | 0.0018 | 0.051645838 | 0.23240627 | 0.0309875 | 9.2963E-05 | 20 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 37 | Polygon ZM | CO618 | 52 | 95233 | A | 5 | 11.647952 | 507384.7928 | 5.0 | 1.0 | 0.0007 | 0.346190133 | 1.73095066 | 0.34619013 | 0.00024233 | 21 | 1.00 | 4.71 | 0.77 | 0.0013 |
| 11 | Polygon ZM | CO618 | 51 | 95232 | A | 6 | 2.011389 | 87616.1146 | 5.0 | 1.0 | 0.0007 | 0.015412181 | 0.0770609 | 0.01541218 | 1.0789E-05 | 22 | 1.00 | 4.98 | 0.98 | 0.0007 |
| 23 | Polygon ZM | CO618 | 13 | 95190 | A | 6 | 7.254471 | 316004.7506 | 5.0 | 1.0 | 0.0007 | 0.055587061 | 0.2779353 | 0.05558706 | 3.8911E-05 | 23 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 26 | Polygon ZM | CO618 | 38 | 95217 | B | 6 | 21.221946 | 924427.9468 | 4.5 | 0.6 | 0.0018 | 0.162612214 | 0.73175496 | 0.09756733 | 0.0002927 | 24 | 1.00 | 4.99 | 1.00 | 0.0007 |
| 35 | Polygon ZM | CO618 | 52 | 95233 | A | 6 | 33.299327 | 1450518.672 | 5.0 | 1.0 | 0.0007 | 0.255154611 | 1.27577306 | 0.25515461 | 0.00017861 | 25 | 1.00 | 4.92 | 0.95 | 0.0008 |
| 44 | Polygon ZM | CO618 | 51 | 95232 | A | 6 | 66.719334 | 2906294.202 | 5.0 | 1.0 | 0.0007 | 0.511233934 | 2.55616967 | 0.51123393 | 0.00035786 | 26 | 1.00 | 4.67 | 0.92 | 0.0009 |
| 27 | Polygon ZM | CO618 | 38 | 95217 | B | 7 | 37.406452 | 1629425.063 | 4.5 | 0.6 | 0.0018 | 0.997865716 | 4.49039572 | 0.59871943 | 0.00179616 | 27 | 1.00 | 4.61 | 0.90 | 0.0009 |
| 36 | Polygon ZM | CO618 | 52 | 95233 | A | 7 | 0.056065 | 2442.180673 | 5.0 | 1.0 | 0.0007 | 0.0014956 | 0.007478 | 0.0014956 | 1.0469E-06 | 28 | 1.00 | 4.70 | 0.88 | 0.0010 |
| 41 | Polygon ZM | CO618 | 13 | 95190 | A | 7 | 0.023942 | 1042.913375 | 5.0 | 1.0 | 0.0007 | 0.000638684 | 0.00319342 | 0.00063868 | 4.4708E-07 | 29 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 63 | Polygon ZM | CO618 | 13 | 95190 | A | 8 | 18.112964 | 789000.6918 | 5.0 | 1.0 | 0.0007 | 0.292690252 | 1.46345126 | 0.29269025 | 0.00020488 | 30 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 64 | Polygon ZM | CO618 | 38 | 95217 | B | 8 | 31.580709 | 1375655.671 | 4.5 | 0.6 | 0.0018 | 0.510317683 | 2.29642957 | 0.30619061 | 0.00091857 | 31 | 1.00 | 4.97 | 0.97 | 0.0008 |
| 65 | Polygon ZM | CO618 | 53 | 95234 | A | 8 | 11.148254 | 485617.9606 | 5.0 | 1.0 | 0.0007 | 0.180146411 | 0.90073206 | 0.18014641 | 0.0001261 | 32 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 78 | Polygon ZM | CO618 | 13 | 95190 | A | 8 | 1.042483 | 45410.57706 | 5.0 | 1.0 | 0.0007 | 0.016845655 | 0.08422827 | 0.01684565 | 1.1792E-05 | 33 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 6 | Polygon ZM | CO618 | 51 | 95232 | A | 9 | 14.525463 | 632729.177 | 5.0 | 1.0 | 0.0007 | 0.196658927 | 0.98329464 | 0.19665893 | 0.00013766 | 34 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 12 | Polygon ZM | CO618 | 51 | 95232 | A | 9 | 26.975834 | 1175067.328 | 5.0 | 1.0 | 0.0007 | 0.365223366 | 1.82611683 | 0.36522337 | 0.00025566 | 35 | 1.00 | 4.56 | 0.86 | 0.0010 |
| 16 | Polygon ZM | CO618 | 52 | 95233 | A | 9 | 32.358245 | 1409525.148 | 5.0 | 1.0 | 0.0007 | 0.438095339 | 2.1904767 | 0.43809534 | 0.00030667 | 36 | 1.00 | 4.86 | 0.92 | 0.0009 |
| 32 | Polygon ZM | CO618 | 3 | 95208 | D | 9 | 0.001652 | 71.963967 | 3.0 | 0.5 | 0.0018 | 2.23672E-05 | 6.7101E-05 | 1.1184E-05 | 4.0261E-08 | 37 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 3 | Polygon ZM | CO618 | 52 | 95233 | A | 10 | 0.036781 | 1602.185283 | 5.0 | 1.0 | 0.0007 | 0.000395452 | 0.00197726 | 0.00039545 | 2.7682E-07 | 38 | 1.00 | 4.29 | 0.69 | 0.0015 |
| 7 | Polygon ZM | CO618 | 51 | 95232 | A | 10 | 10.919462 | 475651.7719 | 5.0 | 1.0 | 0.0007 | 0.117400667 | 0.58700334 | 0.11740067 | 8.218E-05 | 39 | 1.00 | 4.53 | 0.69 | 0.0016 |
| 14 | Polygon ZM | CO618 | 51 | 95232 | A | 10 | 9.894279 | 430994.7784 | 5.0 | 1.0 | 0.0007 | 0.1063784 | 0.531892 | 0.1063784 | 7.4465E-05 | 40 | 1.00 | 4.78 | 0.84 | 0.0011 |
| 17 | Polygon ZM | CO618 | 52 | 95233 | A | 10 | 58.691322 | 2556593.98 | 5.0 | 1.0 | 0.0007 | 0.631020122 | 3.15510061 | 0.63102012 | 0.00044171 | 41 | 1.00 | 4.33 | 0.68 | 0.0015 |
| 39 | Polygon ZM | CO618 | 53 | 95234 | A | 10 | 13.468378 | 586682.5671 | 5.0 | 1.0 | 0.0007 | 0.144805358 | 0.72402679 | 0.14480536 | 0.00010136 | 42 | 1.00 | 4.90 | 0.95 | 0.0008 |
| 2 | Polygon ZM | CO618 | 52 | 95233 | A | 11 | 5.585658 | 243311.2621 | 5.0 | 1.0 | 0.0007 | 0.080376943 | 0.40188472 | 0.08037694 | 5.6264E-05 | 43 | 1.00 | 4.79 | 0.83 | 0.0012 |
| 10 | Polygon ZM | CO618 | 51 | 95232 | A | 11 | 28.023224 | 1220691.651 | 5.0 | 1.0 | 0.0007 | 0.40325081 | 2.01625405 | 0.40325081 | 0.00028228 | 44 | 1.00 | 4.85 | 0.96 | 0.0008 |
| 25 | Polygon ZM | CO618 | 38 | 95217 | B | 11 | 5.826215 | 253789.9259 | 4.5 | 0.6 | 0.0018 | 0.08383853 | 0.37727338 | 0.05030312 | 0.00015091 | 45 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 34 | Polygon ZM | CO618 | 52 | 95233 | A | 11 | 3.069364 | 133701.5131 | 5.0 | 1.0 | 0.0007 | 0.044167783 | 0.22083891 | 0.04416778 | 3.0917E-05 | 46 | 1.00 | 4.61 | 0.83 | 0.0011 |
| 38 | Polygon ZM | CO618 | 53 | 95234 | A | 11 | 0.921672 | 40148.02177 | 5.0 | 1.0 | 0.0007 | 0.013262745 | 0.06631373 | 0.01326275 | 9.2839E-06 | 47 | 1.00 | 4.76 | 0.84 | 0.0011 |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | Weight based on area | Calculated values based on area | | | Final Values Used in CUHP | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | | Infiltration (inches per hour) | | Decay Coefficient - a | Basin ID | Summed Weight | Infiltration (inches per hour) | | Decay Coefficient - a |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | | | | Initial - $f_i$ | Final - $f_o$ | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F | A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |
| 40 | Polygon ZM | CO618 | 13 | 95190 | A | 11 | 12.218571 | 532240.9424 | 5.0 | 1.0 | 0.0007 | 0.175823756 | 0.87911878 | 0.17582376 | 0.00012308 | 48 | 1.00 | 4.32 | 0.72 | 0.0014 |
| 45 | Polygon ZM | CO618 | 53 | 95234 | A | 11 | 13.848583 | 603244.2705 | 5.0 | 1.0 | 0.0007 | 0.199279433 | 0.99639717 | 0.19927943 | 0.0001395 | 49 | 1.00 | 4.93 | 0.98 | 0.0007 |
| 72 | Polygon ZM | CO618 | 51 | 95232 | A | 12 | 12.015344 | 523388.3719 | 5.0 | 1.0 | 0.0007 | 0.30055774 | 1.5027887 | 0.30055774 | 0.00021039 | 50 | 1.00 | 4.39 | 0.68 | 0.0015 |
| 73 | Polygon ZM | CO618 | 52 | 95233 | A | 12 | 27.96148 | 1218002.055 | 5.0 | 1.0 | 0.0007 | 0.69944226 | 3.4972113 | 0.69944226 | 0.00048961 | 51 | 1.00 | 3.77 | 0.66 | 0.0015 |
| 56 | Polygon ZM | CO618 | 51 | 95232 | A | 13 | 4.531475 | 197391.0461 | 5.0 | 1.0 | 0.0007 | 0.04453493 | 0.22267465 | 0.04453493 | 3.1174E-05 | 52 | 1.00 | 4.85 | 0.93 | 0.0009 |
| 57 | Polygon ZM | CO618 | 53 | 95234 | A | 13 | 0.50822 | 22138.07353 | 5.0 | 1.0 | 0.0007 | 0.004994743 | 0.02497372 | 0.00499474 | 3.4963E-06 | 53 | 1.00 | 4.76 | 0.89 | 0.0010 |
| 58 | Polygon ZM | CO618 | 51 | 95232 | A | 13 | 32.624414 | 1421119.492 | 5.0 | 1.0 | 0.0007 | 0.320629831 | 1.60314915 | 0.32062983 | 0.00022444 | 54 | 1.00 | 4.98 | 0.99 | 0.0007 |
| 59 | Polygon ZM | CO618 | 52 | 95233 | A | 13 | 31.17471 | 1357970.359 | 5.0 | 1.0 | 0.0007 | 0.306382264 | 1.53191132 | 0.30638226 | 0.00021447 | 55 | 1.00 | 4.79 | 0.83 | 0.0012 |
| 74 | Polygon ZM | CO618 | 53 | 95234 | A | 13 | 13.060427 | 568912.1965 | 5.0 | 1.0 | 0.0007 | 0.128356709 | 0.64178355 | 0.12835671 | 8.985E-05 | 56 | 1.00 | 4.84 | 0.87 | 0.0010 |
| 76 | Polygon ZM | CO618 | 47 | 95227 | B | 13 | 1.650201 | 71882.74003 | 4.5 | 0.6 | 0.0018 | 0.016218025 | 0.07298111 | 0.00973081 | 2.9192E-05 | 57 | 1.00 | 4.77 | 0.92 | 0.0009 |
| 81 | Polygon ZM | CO618 | 53 | 95234 | A | 13 | 3.074761 | 133936.5963 | 5.0 | 1.0 | 0.0007 | 0.030218478 | 0.15109239 | 0.03021848 | 2.1153E-05 | 58 | 1.00 | 4.78 | 0.90 | 0.0010 |
| 84 | Polygon ZM | CO618 | 53 | 95234 | A | 13 | 1.267775 | 55224.26583 | 5.0 | 1.0 | 0.0007 | 0.012459576 | 0.06229788 | 0.01245958 | 8.7217E-06 | 59 | 1.00 | 4.75 | 0.80 | 0.0013 |
| 86 | Polygon ZM | CO618 | 52 | 95233 | A | 13 | 13.859044 | 603699.9436 | 5.0 | 1.0 | 0.0007 | 0.136205444 | 0.68102722 | 0.13620544 | 9.5344E-05 | 60 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 224 | Polygon ZM | CO618 | 51 | 95232 | A | 14 | 0.341095 | 14858.10162 | 5.0 | 1.0 | 0.0007 | 0.016880678 | 0.08440339 | 0.01688068 | 1.1816E-05 | 61 | 1.00 | 4.82 | 0.86 | 0.0011 |
| 225 | Polygon ZM | CO618 | 52 | 95233 | A | 14 | 15.85263 | 690540.553 | 5.0 | 1.0 | 0.0007 | 0.784541191 | 3.92270595 | 0.78454119 | 0.00054918 | 62 | 1.00 | 4.76 | 0.81 | 0.0012 |
| 257 | Polygon ZM | CO618 | 38 | 95217 | B | 14 | 3.096408 | 134879.5185 | 4.5 | 0.6 | 0.0018 | 0.15324015 | 0.68958068 | 0.09194409 | 0.00027583 | 63 | 1.00 | 4.75 | 0.80 | 0.0012 |
| 273 | Polygon ZM | CO618 | 37 | 95216 | B | 14 | 0.91611 | 39905.76285 | 4.5 | 0.6 | 0.0018 | 0.045337981 | 0.20402092 | 0.02720279 | 8.1608E-05 | 64 | 1.00 | 4.96 | 0.97 | 0.0008 |
| 46 | Polygon ZM | CO618 | 52 | 95233 | A | 15 | 6.831182 | 297566.2782 | 5.0 | 1.0 | 0.0007 | 0.191855823 | 0.95927911 | 0.19185582 | 0.0001343 | 65 | 1.00 | 4.97 | 0.97 | 0.0008 |
| 47 | Polygon ZM | CO618 | 51 | 95232 | A | 15 | 17.962471 | 782445.2401 | 5.0 | 1.0 | 0.0007 | 0.504481476 | 2.52240738 | 0.50448148 | 0.00035314 | 66 | 1.00 | 4.68 | 0.86 | 0.0011 |
| 48 | Polygon ZM | CO618 | 53 | 95234 | A | 15 | 0.136756 | 5957.09628 | 5.0 | 1.0 | 0.0007 | 0.003840837 | 0.01920419 | 0.00384084 | 2.6886E-06 | 67 | 1.00 | 4.24 | 0.60 | 0.0017 |
| 80 | Polygon ZM | CO618 | 53 | 95234 | A | 15 | 0.913113 | 39775.18853 | 5.0 | 1.0 | 0.0007 | 0.025645048 | 0.12822524 | 0.02564505 | 1.7952E-05 | 68 | 1.00 | 4.44 | 0.64 | 0.0017 |
| 88 | Polygon ZM | CO618 | 38 | 95217 | B | 15 | 4.973961 | 216665.7444 | 4.5 | 0.6 | 0.0018 | 0.139695213 | 0.62862846 | 0.08381713 | 0.00025145 | 69 | 1.00 | 4.67 | 0.78 | 0.0013 |
| 93 | Polygon ZM | CO618 | 52 | 95233 | A | 15 | 4.788326 | 208579.4927 | 5.0 | 1.0 | 0.0007 | 0.134481603 | 0.67240802 | 0.1344816 | 9.4137E-05 | 70 | 1.00 | 4.52 | 0.62 | 0.0018 |
| 60 | Polygon ZM | CO618 | 13 | 95190 | A | 16 | 1.871087 | 81504.54741 | 5.0 | 1.0 | 0.0007 | 0.147275302 | 0.73637651 | 0.1472753 | 0.00010309 | 71 | 1.00 | 4.67 | 0.75 | 0.0014 |
| 61 | Polygon ZM | CO618 | 51 | 95232 | A | 16 | 1.240342 | 54029.30315 | 5.0 | 1.0 | 0.0007 | 0.097628687 | 0.48814343 | 0.09762869 | 6.834E-05 | 72 | 1.00 | 4.90 | 0.92 | 0.0009 |
| 62 | Polygon ZM | CO618 | 53 | 95234 | A | 16 | 8.885734 | 387062.5733 | 5.0 | 1.0 | 0.0007 | 0.699405851 | 3.49702926 | 0.69940585 | 0.00048958 | 73 | 1.00 | 4.64 | 0.71 | 0.0015 |
| 90 | Polygon ZM | CO618 | 38 | 95217 | B | 16 | 0.088559 | 3857.650692 | 4.5 | 0.6 | 0.0018 | 0.006970613 | 0.03136776 | 0.00418237 | 1.2547E-05 | 74 | 1.00 | 4.91 | 0.93 | 0.0009 |
| 94 | Polygon ZM | CO618 | 52 | 95233 | A | 16 | 0.618967 | 26962.18965 | 5.0 | 1.0 | 0.0007 | 0.048719547 | 0.24359773 | 0.04871955 | 3.4104E-05 | 75 | 1.00 | 4.61 | 0.69 | 0.0016 |
| 69 | Polygon ZM | CO618 | 53 | 95234 | A | 17 | 9.782493 | 426125.3769 | 5.0 | 1.0 | 0.0007 | 0.405128669 | 2.02564335 | 0.40512867 | 0.00028359 | 76 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 91 | Polygon ZM | CO618 | 38 | 95217 | B | 17 | 12.218479 | 532236.924 | 4.5 | 0.6 | 0.0018 | 0.506011724 | 2.27705276 | 0.30360703 | 0.00091082 | 77 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 95 | Polygon ZM | CO618 | 52 | 95233 | A | 17 | 2.14566 | 93464.9562 | 5.0 | 1.0 | 0.0007 | 0.088859607 | 0.44429803 | 0.08885961 | 6.2202E-05 | 78 | 1.00 | 4.84 | 0.89 | 0.0010 |
| 70 | Polygon ZM | CO618 | 13 | 95190 | A | 18 | 27.207396 | 1185154.181 | 5.0 | 1.0 | 0.0007 | 0.575056326 | 2.87528163 | 0.57505633 | 0.00040254 | 79 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 71 | Polygon ZM | CO618 | 53 | 95234 | A | 18 | 18.694698 | 814341.0386 | 5.0 | 1.0 | 0.0007 | 0.395131682 | 1.97565841 | 0.39513168 | 0.00027659 | 80 | 1.00 | 4.40 | 0.85 | 0.0010 |
| 92 | Polygon ZM | CO618 | 38 | 95217 | B | 18 | 1.410482 | 61440.6017 | 4.5 | 0.6 | 0.0018 | 0.029811992 | 0.13415396 | 0.0178872 | 5.3662E-05 | 81 | 1.00 | 4.72 | 0.87 | 0.0010 |
| 49 | Polygon ZM | CO618 | 52 | 95233 | A | 19 | 18.700383 | 814588.6916 | 5.0 | 1.0 | 0.0007 | 0.425265078 | 2.12632539 | 0.42526508 | 0.00029769 | 82 | 1.00 | 4.59 | 0.67 | 0.0016 |
| 50 | Polygon ZM | CO618 | 51 | 95232 | A | 19 | 5.617723 | 244708.0235 | 5.0 | 1.0 | 0.0007 | 0.127752543 | 0.63876271 | 0.12775254 | 8.9427E-05 | 83 | 1.00 | 4.98 | 0.98 | 0.0008 |
| 51 | Polygon ZM | CO618 | 53 | 95234 | A | 19 | 17.777475 | 774386.8237 | 5.0 | 1.0 | 0.0007 | 0.404277246 | 2.02138623 | 0.40427725 | 0.00028299 | 84 | 1.00 | 4.88 | 0.90 | 0.0010 |
| 89 | Polygon ZM | CO618 | 38 | 95217 | B | 19 | 1.877893 | 81801.02434 | 4.5 | 0.6 | 0.0018 | 0.042705134 | 0.1921731 | 0.02562308 | 7.6869E-05 | 85 | 1.00 | 4.93 | 0.95 | 0.0009 |
| 52 | Polygon ZM | CO618 | 53 | 95234 | A | 20 | 11.098346 | 483443.9594 | 5.0 | 1.0 | 0.0007 | 1 | 5 | 1 | 0.0007 | 86 | 1.00 | 4.89 | 0.91 | 0.0009 |
| 220 | Polygon ZM | CO618 | 47 | 95227 | B | 21 | 35.869084 | 1562457.314 | 4.5 | 0.6 | 0.0018 | 0.443460355 | 1.9955716 | 0.26607621 | 0.00079823 | 87 | 1.00 | 5.00 | 1.00 | 0.0007 |
| 221 | Polygon ZM | CO618 | 51 | 95232 | A | 21 | 28.775828 | 1253475.088 | 5.0 | 1.0 | 0.0007 | 0.355764284 | 1.77882142 | 0.35576428 | 0.00024903 | 88 | 1.00 | 4.95 | 0.96 | 0.0008 |
| 222 | Polygon ZM | CO618 | 52 | 95233 | A | 21 | 0.542876 | 23647.6851 | 5.0 | 1.0 | 0.0007 | 0.006711742 | 0.03355871 | 0.00671174 | 4.6982E-06 | 89 | 1.00 | 4.34 | 0.78 | 0.0012 |
| 223 | Polygon ZM | CO618 | 51 | 95232 | A | 21 | 1.24763 | 54346.76024 | 5.0 | 1.0 | 0.0007 | 0.015424827 | 0.07712413 | 0.01542483 | 1.0797E-05 | 90 | 1.00 | 4.39 | 0.85 | 0.0010 |
| 243 | Polygon ZM | CO618 | 37 | 95216 | B | 21 | 5.316788 | 231599.2726 | 4.5 | 0.6 | 0.0018 | 0.065733057 | 0.29579876 | 0.03943983 | 0.00011832 | 91 | 1.00 | 4.80 | 0.92 | 0.0009 |
| 256 | Polygon ZM | CO618 | 38 | 95217 | B | 21 | 0.114682 | 4995.556426 | 4.5 | 0.6 | 0.0018 | 0.001417851 | 0.00638033 | 0.00085071 | 2.5521E-06 | 92 | 1.00 | 4.93 | 0.94 | 0.0009 |
| 258 | Polygon ZM | CO618 | 38 | 95217 | B | 21 | 4.950189 | 215630.2175 | 4.5 | 0.6 | 0.0018 | 0.061200682 | 0.27540307 | 0.03672041 | 0.00011016 | 93 | 1.00 | 3.88 | 0.66 | 0.0015 |
| 271 | Polygon ZM | CO618 | 77 | 95260 | A | 21 | 4.067457 | 177178.4252 | 5.0 | 1.0 | 0.0007 | 0.050287202 | 0.25143601 | 0.0502872 | 3.5201E-05 | 94 | 1.00 | 4.80 | 0.90 | 0.0010 |
| 66 | Polygon ZM | CO618 | 52 | 95233 | A | 22 | 0.282092 | 12287.94099 | 5.0 | 1.0 | 0.0007 | 0.002633898 | 0.01316949 | 0.0026339 | 1.8437E-06 | 95 | 1.00 | 4.79 | 0.83 | 0.0012 |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | | Final Values Used in CUHP | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a | Infiltration (inches per hour) | | Decay Coefficient - a |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | | Initial - $f_i$ | Final - $f_o$ | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |
| 67 | Polygon ZM | CO618 | 51 | 95232 | A | 22 | 13.122896 | 571633.3596 | 5.0 | 1.0 | 0.0007 | 0.12252858 | 0.6126429 | 0.12252858 | 8.577E-05 | | | |
| 68 | Polygon ZM | CO618 | 52 | 95233 | A | 22 | 68.247168 | 2972846.66 | 5.0 | 1.0 | 0.0007 | 0.637224322 | 3.18612161 | 0.63722432 | 0.00044606 | | | |
| 75 | Polygon ZM | CO618 | 53 | 95234 | A | 22 | 1.715739 | 74737.58954 | 5.0 | 1.0 | 0.0007 | 0.016019868 | 0.08009934 | 0.01601987 | 1.1214E-05 | | | |
| 77 | Polygon ZM | CO618 | 47 | 95227 | B | 22 | 4.77849 | 208151.0229 | 4.5 | 0.6 | 0.0018 | 0.044616797 | 0.20077558 | 0.02677008 | 8.031E-05 | | | |
| 79 | Polygon ZM | CO618 | 51 | 95232 | A | 22 | 6.881208 | 299745.4276 | 5.0 | 1.0 | 0.0007 | 0.064249892 | 0.32124946 | 0.06424989 | 4.4975E-05 | | | |
| 82 | Polygon ZM | CO618 | 53 | 95234 | A | 22 | 0.965726 | 42067.02568 | 5.0 | 1.0 | 0.0007 | 0.009016991 | 0.04508496 | 0.00901699 | 6.3119E-06 | | | |
| 83 | Polygon ZM | CO618 | 53 | 95234 | A | 22 | 2.450509 | 106744.156 | 5.0 | 1.0 | 0.0007 | 0.022880417 | 0.11440209 | 0.02288042 | 1.6016E-05 | | | |
| 85 | Polygon ZM | CO618 | 53 | 95234 | A | 22 | 4.481568 | 195217.1028 | 5.0 | 1.0 | 0.0007 | 0.041844434 | 0.20922217 | 0.04184443 | 2.9291E-05 | | | |
| 87 | Polygon ZM | CO618 | 52 | 95233 | A | 22 | 4.175299 | 181876.0375 | 5.0 | 1.0 | 0.0007 | 0.038984801 | 0.194924 | 0.0389848 | 2.7289E-05 | | | |
| 53 | Polygon ZM | CO618 | 52 | 95233 | A | 23 | 10.029977 | 436905.7815 | 5.0 | 1.0 | 0.0007 | 0.424736381 | 2.1236819 | 0.42473638 | 0.00029732 | | | |
| 54 | Polygon ZM | CO618 | 51 | 95232 | A | 23 | 4.725809 | 205856.2417 | 5.0 | 1.0 | 0.0007 | 0.200122403 | 1.00061202 | 0.2001224 | 0.00014009 | | | |
| 55 | Polygon ZM | CO618 | 53 | 95234 | A | 23 | 8.858807 | 385889.6333 | 5.0 | 1.0 | 0.0007 | 0.375141216 | 1.87570608 | 0.37514122 | 0.0002626 | | | |
| 165 | Polygon ZM | CO618 | 52 | 95233 | A | 24 | 9.332566 | 406526.5764 | 5.0 | 1.0 | 0.0007 | 0.822757923 | 4.11378961 | 0.82275792 | 0.00057593 | | | |
| 166 | Polygon ZM | CO618 | 53 | 95234 | A | 24 | 1.968745 | 85758.51304 | 5.0 | 1.0 | 0.0007 | 0.173564289 | 0.86782144 | 0.17356429 | 0.0001215 | | | |
| 167 | Polygon ZM | CO618 | 4 | 95219 | D | 24 | 0.041717 | 1817.203684 | 3.0 | 0.5 | 0.0018 | 0.003677788 | 0.01103337 | 0.00183889 | 6.62E-06 | | | |
| 187 | Polygon ZM | CO618 | 51 | 95232 | A | 25 | 20.307551 | 884596.9427 | 5.0 | 1.0 | 0.0007 | 0.232438958 | 1.16219479 | 0.23243896 | 0.00016271 | | | |
| 188 | Polygon ZM | CO618 | 53 | 95234 | A | 25 | 41.584993 | 1811442.288 | 5.0 | 1.0 | 0.0007 | 0.475979215 | 2.37989607 | 0.47597921 | 0.00033319 | | | |
| 189 | Polygon ZM | CO618 | 52 | 95233 | A | 25 | 0.291549 | 12699.87015 | 5.0 | 1.0 | 0.0007 | 0.00333705 | 0.01668525 | 0.00333705 | 2.3359E-06 | | | |
| 190 | Polygon ZM | CO618 | 4 | 95219 | D | 25 | 0.973391 | 42400.90348 | 3.0 | 0.5 | 0.0018 | 0.01114137 | 0.03342411 | 0.00557068 | 2.0054E-05 | | | |
| 198 | Polygon ZM | CO618 | 38 | 95217 | B | 25 | 6.13593 | 267281.1164 | 4.5 | 0.6 | 0.0018 | 0.070231471 | 0.31604162 | 0.04213888 | 0.00012642 | | | |
| 201 | Polygon ZM | CO618 | 38 | 95217 | B | 25 | 4.466667 | 194568.0202 | 4.5 | 0.6 | 0.0018 | 0.051125191 | 0.23006336 | 0.03067511 | 9.2025E-05 | | | |
| 212 | Polygon ZM | CO618 | 52 | 95233 | A | 25 | 0.767211 | 33419.72815 | 5.0 | 1.0 | 0.0007 | 0.008781453 | 0.04390727 | 0.00878145 | 6.147E-06 | | | |
| 215 | Polygon ZM | CO618 | 13 | 95190 | A | 25 | 12.839953 | 559308.337 | 5.0 | 1.0 | 0.0007 | 0.146965291 | 0.73482646 | 0.14696529 | 0.00010288 | | | |
| 168 | Polygon ZM | CO618 | 51 | 95232 | A | 26 | 5.877729 | 256033.8838 | 5.0 | 1.0 | 0.0007 | 0.539377294 | 2.69688647 | 0.53937729 | 0.00037756 | | | |
| 169 | Polygon ZM | CO618 | 52 | 95233 | A | 26 | 0.359455 | 15657.85685 | 5.0 | 1.0 | 0.0007 | 0.032985839 | 0.16492919 | 0.03298584 | 2.309E-05 | | | |
| 170 | Polygon ZM | CO618 | 4 | 95219 | D | 26 | 1.791534 | 78039.22694 | 3.0 | 0.5 | 0.0018 | 0.164402408 | 0.49320722 | 0.0822012 | 0.00029592 | | | |
| 199 | Polygon ZM | CO618 | 53 | 95234 | A | 26 | 2.868532 | 124953.2404 | 5.0 | 1.0 | 0.0007 | 0.263234458 | 1.31617229 | 0.26323446 | 0.00018426 | | | |
| 158 | Polygon ZM | CO618 | 47 | 95227 | B | 27 | 2.206687 | 96123.2875 | 4.5 | 0.6 | 0.0018 | 0.020411935 | 0.09185371 | 0.01224716 | 3.6741E-05 | | | |
| 159 | Polygon ZM | CO618 | 52 | 95233 | A | 27 | 9.054324 | 394406.3654 | 5.0 | 1.0 | 0.0007 | 0.083752826 | 0.41876413 | 0.08375283 | 5.8627E-05 | | | |
| 160 | Polygon ZM | CO618 | 52 | 95233 | A | 27 | 23.6718 | 1031143.618 | 5.0 | 1.0 | 0.0007 | 0.218965005 | 1.09482502 | 0.218965 | 0.00015328 | | | |
| 161 | Polygon ZM | CO618 | 51 | 95232 | A | 27 | 13.542553 | 589913.6027 | 5.0 | 1.0 | 0.0007 | 0.125269102 | 0.62634551 | 0.1252691 | 8.7688E-05 | | | |
| 162 | Polygon ZM | CO618 | 53 | 95234 | A | 27 | 24.212263 | 1054686.177 | 5.0 | 1.0 | 0.0007 | 0.223964305 | 1.11982153 | 0.22396431 | 0.00015678 | | | |
| 163 | Polygon ZM | CO618 | 4 | 95219 | D | 27 | 17.374566 | 756836.1104 | 3.0 | 0.5 | 0.0018 | 0.160715365 | 0.48214609 | 0.08035768 | 0.00028929 | | | |
| 164 | Polygon ZM | CO618 | 51 | 95232 | A | 27 | 14.473612 | 630470.5469 | 5.0 | 1.0 | 0.0007 | 0.133881434 | 0.66940717 | 0.13388143 | 9.3717E-05 | | | |
| 203 | Polygon ZM | CO618 | 4 | 95219 | D | 27 | 2.729959 | 118916.9981 | 3.0 | 0.5 | 0.0018 | 0.025252216 | 0.07575665 | 0.01262611 | 4.5454E-05 | | | |
| 206 | Polygon ZM | CO618 | 53 | 95234 | A | 27 | 0.066209 | 2884.052107 | 5.0 | 1.0 | 0.0007 | 0.000612433 | 0.00306217 | 0.00061243 | 4.287E-07 | | | |
| 208 | Polygon ZM | CO618 | 38 | 95217 | B | 27 | 0.775714 | 33790.08897 | 4.5 | 0.6 | 0.0018 | 0.00717538 | 0.03228921 | 0.00430523 | 1.2916E-05 | | | |
| 191 | Polygon ZM | CO618 | 51 | 95232 | A | 28 | 8.219723 | 358051.1403 | 5.0 | 1.0 | 0.0007 | 0.066487405 | 0.33243702 | 0.0664874 | 4.6541E-05 | | | |
| 192 | Polygon ZM | CO618 | 38 | 95217 | B | 28 | 13.977282 | 608850.4244 | 4.5 | 0.6 | 0.0018 | 0.113058946 | 0.50876526 | 0.06783537 | 0.00020351 | | | |
| 193 | Polygon ZM | CO618 | 52 | 95233 | A | 28 | 7.285811 | 317369.9106 | 5.0 | 1.0 | 0.0007 | 0.058933206 | 0.29466603 | 0.05893321 | 4.1253E-05 | | | |
| 194 | Polygon ZM | CO618 | 53 | 95234 | A | 28 | 4.720637 | 205630.9682 | 5.0 | 1.0 | 0.0007 | 0.038184125 | 0.19092062 | 0.03818412 | 2.6729E-05 | | | |
| 195 | Polygon ZM | CO618 | 52 | 95233 | A | 28 | 1.231962 | 53664.26295 | 5.0 | 1.0 | 0.0007 | 0.00996505 | 0.04982525 | 0.00996505 | 6.9755E-06 | | | |
| 196 | Polygon ZM | CO618 | 4 | 95219 | D | 28 | 12.703318 | 553356.5389 | 3.0 | 0.5 | 0.0018 | 0.102754149 | 0.30826245 | 0.05137707 | 0.00018496 | | | |
| 197 | Polygon ZM | CO618 | 51 | 95232 | A | 28 | 44.950819 | 1958057.695 | 5.0 | 1.0 | 0.0007 | 0.363596592 | 1.81798296 | 0.36359659 | 0.00025452 | | | |
| 200 | Polygon ZM | CO618 | 53 | 95234 | A | 28 | 1.630942 | 71043.82185 | 5.0 | 1.0 | 0.0007 | 0.013192304 | 0.06596152 | 0.0131923 | 9.2346E-06 | | | |
| 202 | Polygon ZM | CO618 | 38 | 95217 | B | 28 | 0.004801 | 209.118528 | 4.5 | 0.6 | 0.0018 | 3.88317E-05 | 0.00017474 | 2.3299E-05 | 6.9897E-08 | | | |
| 205 | Polygon ZM | CO618 | 38 | 95217 | B | 28 | 8.568368 | 373238.1105 | 4.5 | 0.6 | 0.0018 | 0.069307511 | 0.3118838 | 0.04158451 | 0.00012475 | | | |
| 207 | Polygon ZM | CO618 | 53 | 95234 | A | 28 | 1.365544 | 59483.10856 | 5.0 | 1.0 | 0.0007 | 0.011045566 | 0.05522783 | 0.01104557 | 7.7319E-06 | | | |

| Basin ID | Summed Weight |
|---|---|
| A | K = SUM($G_A$) |
| 96 | 1.00 |
| 97 | 1.00 |
| 98 | 1.00 |
| 99 | 1.00 |
| 100 | 1.00 |
| 101 | 1.00 |
| 102 | 1.00 |
| 103 | 1.00 |
| 104 | 1.00 |
| 105 | 1.00 |
| 106 | 1.00 |
| 107 | 1.00 |
| 108 | 1.00 |
| 109 | 1.00 |
| 110 | 1.00 |
| 111 | 1.00 |
| 112 | 1.00 |
| 113 | 1.00 |
| 114 | 1.00 |
| 115 | 1.00 |
| 116 | 1.00 |
| 117 | 1.00 |
| 118 | 1.00 |
| 119 | 1.00 |
| 120 | 1.00 |
| 121 | 1.00 |
| 122 | 1.00 |
| 123 | 1.00 |
| 124 | 1.00 |
| 125 | 1.00 |
| 126 | 1.00 |
| 127 | 1.00 |
| 128 | 1.00 |
| 129 | 1.00 |
| 130 | 1.00 |
| 131 | 1.00 |
| 132 | 1.00 |
| 133 | 1.00 |
| 134 | 1.00 |
| 135 | 1.00 |
| 136 | 1.00 |
| 137 | 1.00 |
| 138 | 1.00 |
| 139 | 1.00 |
| 140 | 1.00 |
| 141 | 1.00 |
| 142 | 1.00 |
| 143 | 1.00 |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a | |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F | |
| 213 | Polygon ZM | CO618 | 52 | 95233 | A | 28 | 18.969067 | 826292.5626 | 5.0 | 1.0 | 0.0007 | 0.153436316 | 0.76718158 | 0.15343632 | 0.00010741 | |
| 185 | Polygon ZM | CO618 | 53 | 95234 | A | 29 | 15.56224 | 677891.1901 | 5.0 | 1.0 | 0.0007 | 0.991167077 | 4.95583539 | 0.99116708 | 0.00069382 | |
| 211 | Polygon ZM | CO618 | 52 | 95233 | A | 29 | 0.138685 | 6041.12134 | 5.0 | 1.0 | 0.0007 | 0.008832923 | 0.04416461 | 0.00883292 | 6.183E-06 | |
| 186 | Polygon ZM | CO618 | 53 | 95234 | A | 30 | 12.178348 | 530488.8417 | 5.0 | 1.0 | 0.0007 | 0.550979847 | 2.75489923 | 0.55097985 | 0.00038569 | |
| 214 | Polygon ZM | CO618 | 13 | 95190 | A | 30 | 9.924725 | 432321.0412 | 5.0 | 1.0 | 0.0007 | 0.449020153 | 2.24510077 | 0.44902015 | 0.00031431 | |
| 110 | Polygon ZM | CO618 | 38 | 95217 | B | 31 | 2.772515 | 120770.7649 | 4.5 | 0.6 | 0.0018 | 0.063255471 | 0.28464962 | 0.03795328 | 0.00011386 | |
| 152 | Polygon ZM | CO618 | 51 | 95232 | A | 31 | 41.057927 | 1788483.302 | 5.0 | 1.0 | 0.0007 | 0.936744529 | 4.68372265 | 0.93674453 | 0.00065572 | |
| 183 | Polygon ZM | CO618 | 52 | 95233 | A | 32 | 9.497633 | 413716.8961 | 5.0 | 1.0 | 0.0007 | 0.344657432 | 1.72328716 | 0.34465743 | 0.00024126 | |
| 184 | Polygon ZM | CO618 | 51 | 95232 | A | 32 | 18.043837 | 785989.5277 | 5.0 | 1.0 | 0.0007 | 0.654788661 | 3.2739433 | 0.65478866 | 0.00045835 | |
| 204 | Polygon ZM | CO618 | 4 | 95219 | D | 32 | 0.015264 | 664.893799 | 3.0 | 0.5 | 0.0018 | 0.000553907 | 0.00166172 | 0.00027695 | 9.9703E-07 | |
| 124 | Polygon ZM | CO618 | 52 | 95233 | A | 33 | 7.837265 | 341391.2466 | 5.0 | 1.0 | 0.0007 | 0.256310287 | 1.28155143 | 0.25631029 | 0.00017942 | |
| 150 | Polygon ZM | CO618 | 51 | 95232 | A | 33 | 22.739989 | 990553.9159 | 5.0 | 1.0 | 0.0007 | 0.743689713 | 3.71844857 | 0.74368971 | 0.00052058 | |
| 171 | Polygon ZM | CO618 | 53 | 95234 | A | 34 | 9.627227 | 419362.0054 | 5.0 | 1.0 | 0.0007 | 0.956124298 | 4.78062149 | 0.9561243 | 0.00066929 | |
| 209 | Polygon ZM | CO618 | 52 | 95233 | A | 34 | 0.441785 | 19244.153 | 5.0 | 1.0 | 0.0007 | 0.043875702 | 0.21937851 | 0.0438757 | 3.0713E-05 | |
| 172 | Polygon ZM | CO618 | 52 | 95233 | A | 35 | 10.633656 | 463202.0342 | 5.0 | 1.0 | 0.0007 | 0.185090588 | 0.92545294 | 0.18509059 | 0.00012956 | |
| 173 | Polygon ZM | CO618 | 53 | 95234 | A | 35 | 13.25288 | 577295.4653 | 5.0 | 1.0 | 0.0007 | 0.230681105 | 1.15340552 | 0.2306811 | 0.00016148 | |
| 174 | Polygon ZM | CO618 | 47 | 95227 | B | 35 | 6.587233 | 286939.856 | 4.5 | 0.6 | 0.0018 | 0.114658103 | 0.51596146 | 0.06879486 | 0.00020638 | |
| 175 | Polygon ZM | CO618 | 52 | 95233 | A | 35 | 1.733844 | 75526.26462 | 5.0 | 1.0 | 0.0007 | 0.030179489 | 0.15089745 | 0.03017949 | 2.1126E-05 | |
| 176 | Polygon ZM | CO618 | 53 | 95234 | A | 35 | 1.355185 | 59031.87672 | 5.0 | 1.0 | 0.0007 | 0.023588508 | 0.11794254 | 0.02358851 | 1.6512E-05 | |
| 177 | Polygon ZM | CO618 | 52 | 95233 | A | 35 | 3.310814 | 144219.0698 | 5.0 | 1.0 | 0.0007 | 0.057628401 | 0.288142 | 0.0576284 | 4.034E-05 | |
| 178 | Polygon ZM | CO618 | 4 | 95219 | D | 35 | 10.853852 | 472793.7762 | 3.0 | 0.5 | 0.0018 | 0.188923345 | 0.56677004 | 0.09446167 | 0.00034006 | |
| 179 | Polygon ZM | CO618 | 51 | 95232 | A | 35 | 6.298103 | 274345.3791 | 5.0 | 1.0 | 0.0007 | 0.109625485 | 0.54812742 | 0.10962548 | 7.6738E-05 | |
| 210 | Polygon ZM | CO618 | 52 | 95233 | A | 35 | 3.42552 | 149215.641 | 5.0 | 1.0 | 0.0007 | 0.059624977 | 0.29812489 | 0.05962498 | 4.1737E-05 | |
| 97 | Polygon ZM | CO618 | 53 | 95234 | A | 36 | 5.498262 | 239504.3062 | 5.0 | 1.0 | 0.0007 | 0.055403111 | 0.27701556 | 0.05540311 | 3.8782E-05 | |
| 98 | Polygon ZM | CO618 | 4 | 95219 | D | 36 | 2.645345 | 115231.2165 | 3.0 | 0.5 | 0.0018 | 0.026655754 | 0.07996726 | 0.01332788 | 4.798E-05 | |
| 118 | Polygon ZM | CO618 | 47 | 95227 | B | 36 | 16.277951 | 709067.5301 | 4.5 | 0.6 | 0.0018 | 0.164024388 | 0.73810975 | 0.09841463 | 0.00029524 | |
| 121 | Polygon ZM | CO618 | 52 | 95233 | A | 36 | 56.963375 | 2481324.6 | 5.0 | 1.0 | 0.0007 | 0.573990109 | 2.86995054 | 0.57399011 | 0.00040179 | |
| 136 | Polygon ZM | CO618 | 51 | 95232 | A | 36 | 17.856106 | 777811.9978 | 5.0 | 1.0 | 0.0007 | 0.179926638 | 0.89963319 | 0.17992664 | 0.00012595 | |
| 180 | Polygon ZM | CO618 | 53 | 95234 | A | 37 | 12.106551 | 527361.378 | 5.0 | 1.0 | 0.0007 | 0.433274396 | 2.16637198 | 0.4332744 | 0.00030329 | |
| 181 | Polygon ZM | CO618 | 51 | 95232 | A | 37 | 1.650427 | 71892.60746 | 5.0 | 1.0 | 0.0007 | 0.059066188 | 0.29533094 | 0.05906619 | 4.1346E-05 | |
| 182 | Polygon ZM | CO618 | 52 | 95233 | A | 37 | 14.185017 | 617899.3532 | 5.0 | 1.0 | 0.0007 | 0.507659416 | 2.53829708 | 0.50765942 | 0.00035536 | |
| 96 | Polygon ZM | CO618 | 4 | 95219 | D | 38 | 5.498322 | 239506.8918 | 3.0 | 0.5 | 0.0018 | 0.231931835 | 0.69579551 | 0.11596592 | 0.00041748 | |
| 116 | Polygon ZM | CO618 | 47 | 95227 | B | 38 | 11.696067 | 509480.6977 | 4.5 | 0.6 | 0.0018 | 0.493366985 | 2.22015143 | 0.29602019 | 0.00088806 | |
| 127 | Polygon ZM | CO618 | 53 | 95234 | A | 38 | 3.532124 | 153859.3343 | 5.0 | 1.0 | 0.0007 | 0.148993115 | 0.74496557 | 0.14899311 | 0.0001043 | |
| 132 | Polygon ZM | CO618 | 52 | 95233 | A | 38 | 2.92744 | 127519.2916 | 5.0 | 1.0 | 0.0007 | 0.123486147 | 0.61743074 | 0.12348615 | 8.644E-05 | |
| 153 | Polygon ZM | CO618 | 51 | 95232 | A | 38 | 0.052674 | 2294.486911 | 5.0 | 1.0 | 0.0007 | 0.002221918 | 0.01110959 | 0.00222192 | 1.5553E-06 | |
| 100 | Polygon ZM | CO618 | 57 | 95238 | D | 39 | 2.664287 | 116056.3493 | 3.0 | 0.5 | 0.0018 | 0.054624993 | 0.16387498 | 0.0273125 | 9.8325E-05 | |
| 113 | Polygon ZM | CO618 | 47 | 95227 | B | 39 | 34.95866 | 1522799.229 | 4.5 | 0.6 | 0.0018 | 0.716745764 | 3.22535594 | 0.43004746 | 0.00129014 | |
| 130 | Polygon ZM | CO618 | 52 | 95233 | A | 39 | 5.64903 | 246071.7375 | 5.0 | 1.0 | 0.0007 | 0.115820176 | 0.57910088 | 0.11582018 | 8.1074E-05 | |
| 138 | Polygon ZM | CO618 | 48 | 95228 | B | 39 | 0.102193 | 4451.542257 | 4.5 | 0.6 | 0.0018 | 0.002095236 | 0.00942856 | 0.00125714 | 3.7714E-06 | |
| 148 | Polygon ZM | CO618 | 51 | 95232 | A | 39 | 5.3802 | 234361.5178 | 5.0 | 1.0 | 0.0007 | 0.110308452 | 0.55154226 | 0.11030845 | 7.7216E-05 | |
| 154 | Polygon ZM | CO618 | 52 | 95233 | A | 39 | 0.019772 | 861.269258 | 5.0 | 1.0 | 0.0007 | 0.000405379 | 0.0020269 | 0.00040538 | 2.8377E-07 | |
| 108 | Polygon ZM | CO618 | 13 | 95190 | A | 40 | 1.320666 | 57528.2024 | 5.0 | 1.0 | 0.0007 | 0.010791565 | 0.05395783 | 0.01079157 | 7.5541E-06 | |
| 111 | Polygon ZM | CO618 | 85 | 95269 | D | 40 | 1.773485 | 77252.98587 | 3.0 | 0.5 | 0.0018 | 0.014491686 | 0.04347506 | 0.00724584 | 2.6085E-05 | |
| 117 | Polygon ZM | CO618 | 47 | 95227 | B | 40 | 47.253667 | 2058369.732 | 4.5 | 0.6 | 0.0018 | 0.386124206 | 1.73755893 | 0.23167452 | 0.00069502 | |
| 120 | Polygon ZM | CO618 | 52 | 95233 | A | 40 | 60.633692 | 2641203.607 | 5.0 | 1.0 | 0.0007 | 0.495456492 | 2.47728246 | 0.49545649 | 0.00034682 | |
| 129 | Polygon ZM | CO618 | 72 | 95255 | A | 40 | 5.638773 | 245624.9396 | 5.0 | 1.0 | 0.0007 | 0.046076141 | 0.23038071 | 0.04607614 | 3.2253E-05 | |
| 135 | Polygon ZM | CO618 | 51 | 95232 | A | 40 | 5.340993 | 232653.6758 | 5.0 | 1.0 | 0.0007 | 0.043642896 | 0.21821448 | 0.0436429 | 3.055E-05 | |

| | | Final Values Used in CUHP | | |
|---|---|---|---|---|
| | | Infiltration (inches per hour) | | Decay Coefficient - a |
| Basin ID | Summed Weight | Initial - $f_i$ | Final - $f_o$ | |
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |
| 144 | 1.00 | 4.44 | 0.86 | 0.0010 |
| 145 | 1.00 | 4.13 | 0.67 | 0.0015 |
| 146 | 1.00 | 4.42 | 0.60 | 0.0018 |
| 147 | 1.00 | 4.23 | 0.58 | 0.0018 |
| 148 | 1.00 | 3.48 | 0.53 | 0.0018 |
| 149 | 1.00 | 4.40 | 0.71 | 0.0015 |
| 150 | 1.00 | 4.16 | 0.58 | 0.0018 |
| 151 | 1.00 | 4.38 | 0.59 | 0.0018 |
| 152 | 1.00 | 3.92 | 0.56 | 0.0018 |
| 153 | 1.00 | 4.92 | 0.98 | 0.0007 |
| 154 | 1.00 | 3.83 | 0.71 | 0.0013 |
| 155 | 1.00 | 3.78 | 0.68 | 0.0014 |
| 156 | 1.00 | 4.35 | 0.59 | 0.0018 |
| 157 | 1.00 | 4.03 | 0.57 | 0.0018 |
| 158 | 1.00 | 4.09 | 0.77 | 0.0012 |
| 159 | 1.00 | 3.65 | 0.54 | 0.0018 |
| 160 | 1.00 | 3.89 | 0.56 | 0.0018 |
| 161 | 1.00 | 4.29 | 0.63 | 0.0017 |
| 162 | 1.00 | 4.10 | 0.58 | 0.0018 |
| 163 | 1.00 | 4.21 | 0.58 | 0.0018 |
| 164 | 1.00 | 3.65 | 0.57 | 0.0017 |
| 165 | 1.00 | 4.32 | 0.59 | 0.0018 |
| 166 | 1.00 | 3.85 | 0.56 | 0.0018 |
| 167 | 1.00 | 4.20 | 0.58 | 0.0018 |
| 168 | 1.00 | 3.04 | 0.50 | 0.0018 |
| 169 | 1.00 | 3.58 | 0.58 | 0.0017 |
| 170 | 1.00 | 3.03 | 0.50 | 0.0018 |
| 171 | 1.00 | 3.35 | 0.52 | 0.0018 |
| 172 | 1.00 | 3.00 | 0.50 | 0.0018 |
| 173 | 1.00 | 3.98 | 0.57 | 0.0018 |
| 174 | 1.00 | 3.45 | 0.53 | 0.0018 |
| 175 | 1.00 | 3.00 | 0.50 | 0.0018 |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a | |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F | |
| 157 | Polygon ZM | CO618 | 74 | 95257 | A | 40 | 0.418172 | 18215.5799 | 5.0 | 1.0 | 0.0007 | 0.003417013 | 0.01708507 | 0.00341701 | 2.3919E-06 | |
| 102 | Polygon ZM | CO618 | 57 | 95238 | D | 41 | 5.518155 | 240370.8187 | 3.0 | 0.5 | 0.0018 | 0.084226317 | 0.25267895 | 0.04211316 | 0.00015161 | |
| 107 | Polygon ZM | CO618 | 13 | 95190 | A | 41 | 0.925289 | 40305.57016 | 5.0 | 1.0 | 0.0007 | 0.014123136 | 0.07061568 | 0.01412314 | 9.8862E-06 | |
| 115 | Polygon ZM | CO618 | 47 | 95227 | B | 41 | 36.926537 | 1608519.955 | 4.5 | 0.6 | 0.0018 | 0.563627952 | 2.53632579 | 0.33817677 | 0.00101453 | |
| 123 | Polygon ZM | CO618 | 57 | 95238 | D | 41 | 7.08999 | 308839.9716 | 3.0 | 0.5 | 0.0018 | 0.108218018 | 0.32465405 | 0.05410901 | 0.00019479 | |
| 133 | Polygon ZM | CO618 | 13 | 95190 | A | 41 | 15.055831 | 655832.0002 | 5.0 | 1.0 | 0.0007 | 0.229804577 | 1.14902288 | 0.22980458 | 0.00016086 | |
| 232 | Polygon ZM | CO618 | 52 | 95233 | A | 42 | 31.848711 | 1387329.83 | 5.0 | 1.0 | 0.0007 | 0.279150252 | 1.39575126 | 0.27915025 | 0.00019541 | |
| 233 | Polygon ZM | CO618 | 4 | 95219 | D | 42 | 3.633085 | 158257.1666 | 3.0 | 0.5 | 0.0018 | 0.031843565 | 0.0955307 | 0.01592178 | 5.7318E-05 | |
| 234 | Polygon ZM | CO618 | 52 | 95233 | A | 42 | 0.04256 | 1853.898035 | 5.0 | 1.0 | 0.0007 | 0.00037303 | 0.00186515 | 0.00037303 | 2.6112E-07 | |
| 235 | Polygon ZM | CO618 | 51 | 95232 | A | 42 | 67.938829 | 2959415.382 | 5.0 | 1.0 | 0.0007 | 0.595475951 | 2.97737975 | 0.59547595 | 0.00041683 | |
| 236 | Polygon ZM | CO618 | 38 | 95217 | B | 42 | 9.204825 | 400962.1761 | 4.5 | 0.6 | 0.0018 | 0.080679223 | 0.3630565 | 0.04840753 | 0.00014522 | |
| 253 | Polygon ZM | CO618 | 52 | 95233 | A | 42 | 1.423633 | 62013.45828 | 5.0 | 1.0 | 0.0007 | 0.012477979 | 0.0623899 | 0.01247798 | 8.7346E-06 | |
| 226 | Polygon ZM | CO618 | 51 | 95232 | A | 43 | 6.097518 | 265607.8764 | 5.0 | 1.0 | 0.0007 | 0.346796896 | 1.73398448 | 0.3467969 | 0.00024276 | |
| 227 | Polygon ZM | CO618 | 38 | 95217 | B | 43 | 7.275045 | 316900.9398 | 4.5 | 0.6 | 0.0018 | 0.413768838 | 1.86195977 | 0.2482613 | 0.00074478 | |
| 252 | Polygon ZM | CO618 | 52 | 95233 | A | 43 | 4.209826 | 183380.0352 | 5.0 | 1.0 | 0.0007 | 0.239434266 | 1.19717133 | 0.23943427 | 0.0001676 | |
| 304 | Polygon ZM | CO618 | 52 | 95233 | A | 44 | 1.055741 | 45988.05984 | 5.0 | 1.0 | 0.0007 | 0.008878404 | 0.04439202 | 0.0088784 | 6.2149E-06 | |
| 305 | Polygon ZM | CO618 | 52 | 95233 | A | 44 | 40.43969 | 1761552.894 | 5.0 | 1.0 | 0.0007 | 0.340083466 | 1.70041733 | 0.34008347 | 0.00023806 | |
| 306 | Polygon ZM | CO618 | 51 | 95232 | A | 44 | 67.162055 | 2925579.117 | 5.0 | 1.0 | 0.0007 | 0.564809089 | 2.82404545 | 0.56480909 | 0.00039537 | |
| 307 | Polygon ZM | CO618 | 4 | 95219 | D | 44 | 8.423686 | 366935.7682 | 3.0 | 0.5 | 0.0018 | 0.070840216 | 0.21252065 | 0.03542011 | 0.00012751 | |
| 308 | Polygon ZM | CO618 | 38 | 95217 | B | 44 | 1.829902 | 79710.51365 | 4.5 | 0.6 | 0.0018 | 0.015388824 | 0.06924971 | 0.00923329 | 2.77E-05 | |
| 295 | Polygon ZM | CO618 | 52 | 95233 | A | 45 | 7.022593 | 305904.1301 | 5.0 | 1.0 | 0.0007 | 0.323747326 | 1.61873663 | 0.32374733 | 0.00022662 | |
| 296 | Polygon ZM | CO618 | 51 | 95232 | A | 45 | 14.668992 | 638981.2965 | 5.0 | 1.0 | 0.0007 | 0.676252674 | 3.38126337 | 0.67625267 | 0.00047338 | |
| 103 | Polygon ZM | CO618 | 57 | 95238 | D | 46 | 7.669473 | 334082.2526 | 3.0 | 0.5 | 0.0018 | 0.07523131 | 0.22569393 | 0.03761565 | 0.00013542 | |
| 106 | Polygon ZM | CO618 | 47 | 95227 | B | 46 | 12.567962 | 547460.4442 | 4.5 | 0.6 | 0.0018 | 0.123281515 | 0.55476682 | 0.07396891 | 0.00022191 | |
| 122 | Polygon ZM | CO618 | 35 | 95214 | D | 46 | 4.877576 | 212467.2037 | 3.0 | 0.5 | 0.0018 | 0.047845062 | 0.14353519 | 0.02392253 | 8.6121E-05 | |
| 140 | Polygon ZM | CO618 | 48 | 95228 | B | 46 | 13.20276 | 575112.2109 | 4.5 | 0.6 | 0.0018 | 0.129508361 | 0.58278762 | 0.07770502 | 0.00023312 | |
| 144 | Polygon ZM | CO618 | 4 | 95219 | D | 46 | 1.140097 | 49662.64272 | 3.0 | 0.5 | 0.0018 | 0.011183431 | 0.03355029 | 0.00559172 | 2.013E-05 | |
| 151 | Polygon ZM | CO618 | 51 | 95232 | A | 46 | 23.195713 | 1010405.246 | 5.0 | 1.0 | 0.0007 | 0.227531123 | 1.13765562 | 0.22753112 | 0.00015927 | |
| 156 | Polygon ZM | CO618 | 52 | 95233 | A | 46 | 39.291649 | 1711544.224 | 5.0 | 1.0 | 0.0007 | 0.385419198 | 1.92709599 | 0.3854192 | 0.00026979 | |
| 101 | Polygon ZM | CO618 | 57 | 95238 | D | 47 | 1.617945 | 70477.68621 | 3.0 | 0.5 | 0.0018 | 0.022610363 | 0.06783109 | 0.01130518 | 4.0699E-05 | |
| 105 | Polygon ZM | CO618 | 47 | 95227 | B | 47 | 1.697459 | 73941.32672 | 4.5 | 0.6 | 0.0018 | 0.023721554 | 0.10674699 | 0.01423293 | 4.2699E-05 | |
| 114 | Polygon ZM | CO618 | 47 | 95227 | B | 47 | 3.181117 | 138569.4647 | 4.5 | 0.6 | 0.0018 | 0.044455288 | 0.2000488 | 0.02667317 | 8.002E-05 | |
| 128 | Polygon ZM | CO618 | 38 | 95217 | B | 47 | 20.334404 | 885766.6283 | 4.5 | 0.6 | 0.0018 | 0.284168023 | 1.2787561 | 0.17050081 | 0.0005115 | |
| 131 | Polygon ZM | CO618 | 52 | 95233 | A | 47 | 0.017434 | 759.440104 | 5.0 | 1.0 | 0.0007 | 0.00024364 | 0.0012182 | 0.00024364 | 1.7055E-07 | |
| 139 | Polygon ZM | CO618 | 48 | 95228 | B | 47 | 1.99116 | 86734.91443 | 4.5 | 0.6 | 0.0018 | 0.02782594 | 0.12521673 | 0.01669556 | 5.0087E-05 | |
| 149 | Polygon ZM | CO618 | 51 | 95232 | A | 47 | 23.297623 | 1014844.438 | 5.0 | 1.0 | 0.0007 | 0.325578238 | 1.62789119 | 0.32557824 | 0.0002279 | |
| 155 | Polygon ZM | CO618 | 52 | 95233 | A | 47 | 19.420536 | 845958.5367 | 5.0 | 1.0 | 0.0007 | 0.271396954 | 1.35698477 | 0.27139695 | 0.00018998 | |
| 99 | Polygon ZM | CO618 | 57 | 95238 | D | 48 | 0.888173 | 38688.80241 | 3.0 | 0.5 | 0.0018 | 0.007317188 | 0.02195156 | 0.00365859 | 1.3171E-05 | |
| 112 | Polygon ZM | CO618 | 52 | 95233 | A | 48 | 0.008505 | 370.484915 | 5.0 | 1.0 | 0.0007 | 7.00696E-05 | 0.00035035 | 7.007E-05 | 4.9049E-08 | |
| 119 | Polygon ZM | CO618 | 51 | 95232 | A | 48 | 2.903916 | 126494.5673 | 5.0 | 1.0 | 0.0007 | 0.023923834 | 0.11961917 | 0.02392383 | 1.6747E-05 | |
| 125 | Polygon ZM | CO618 | 47 | 95227 | B | 48 | 15.950546 | 694805.7632 | 4.5 | 0.6 | 0.0018 | 0.131408157 | 0.59133671 | 0.07884489 | 0.00023653 | |
| 137 | Polygon ZM | CO618 | 48 | 95228 | B | 48 | 32.465227 | 1414185.305 | 4.5 | 0.6 | 0.0018 | 0.267463936 | 1.20358771 | 0.16047836 | 0.00048144 | |
| 142 | Polygon ZM | CO618 | 56 | 95237 | D | 48 | 3.194455 | 139150.4646 | 3.0 | 0.5 | 0.0018 | 0.026317436 | 0.07895231 | 0.01315872 | 4.7371E-05 | |
| 143 | Polygon ZM | CO618 | 4 | 95219 | D | 48 | 24.814362 | 1080913.599 | 3.0 | 0.5 | 0.0018 | 0.204432478 | 0.61329743 | 0.10221624 | 0.00036798 | |
| 145 | Polygon ZM | CO618 | 52 | 95233 | A | 48 | 0.329745 | 14363.68629 | 5.0 | 1.0 | 0.0007 | 0.002716595 | 0.01358297 | 0.00271659 | 1.9016E-06 | |
| 146 | Polygon ZM | CO618 | 53 | 95234 | A | 48 | 2.838096 | 123627.4741 | 5.0 | 1.0 | 0.0007 | 0.023381583 | 0.11690791 | 0.02338158 | 1.6367E-05 | |
| 147 | Polygon ZM | CO618 | 51 | 95232 | A | 48 | 37.988676 | 1654786.725 | 5.0 | 1.0 | 0.0007 | 0.312968724 | 1.56484362 | 0.31296872 | 0.00021908 | |
| 290 | Polygon ZM | CO618 | 52 | 95233 | A | 49 | 21.109245 | 919518.7196 | 5.0 | 1.0 | 0.0007 | 0.186621051 | 0.93310525 | 0.18662105 | 0.00013063 | |

**Final Values Used in CUHP**

| Basin ID | Summed Weight | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|---|
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a | |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F | |
| 291 | Polygon ZM | CO618 | 56 | 95237 | A | 49 | 1.064655 | 46376.35637 | 5.0 | 1.0 | 0.0007 | 0.00941232 | 0.0470616 | 0.00941232 | 6.5886E-06 | |
| 292 | Polygon ZM | CO618 | 52 | 95233 | A | 49 | 29.489665 | 1284569.791 | 5.0 | 1.0 | 0.0007 | 0.260710042 | 1.30355021 | 0.26071004 | 0.0001825 | |
| 293 | Polygon ZM | CO618 | 51 | 95232 | A | 49 | 47.129969 | 2052981.463 | 5.0 | 1.0 | 0.0007 | 0.416663141 | 2.0833157 | 0.41666314 | 0.00029166 | |
| 294 | Polygon ZM | CO618 | 4 | 95219 | D | 49 | 4.132628 | 180017.2744 | 3.0 | 0.5 | 0.0018 | 0.036535431 | 0.10960629 | 0.01826772 | 6.5764E-05 | |
| 325 | Polygon ZM | CO618 | 53 | 95234 | A | 49 | 10.186722 | 443733.6044 | 5.0 | 1.0 | 0.0007 | 0.090058016 | 0.45029008 | 0.09005802 | 6.3041E-05 | |
| 104 | Polygon ZM | CO618 | 57 | 95238 | D | 50 | 9.820763 | 427792.4419 | 3.0 | 0.5 | 0.0018 | 0.154487661 | 0.46346298 | 0.07724383 | 0.00027808 | |
| 109 | Polygon ZM | CO618 | 77 | 95260 | A | 50 | 14.526805 | 632787.631 | 5.0 | 1.0 | 0.0007 | 0.228517084 | 1.14258542 | 0.22851708 | 0.00015996 | |
| 126 | Polygon ZM | CO618 | 47 | 95227 | B | 50 | 15.28968 | 666018.4701 | 4.5 | 0.6 | 0.0018 | 0.240517657 | 1.08232946 | 0.14431059 | 0.00043293 | |
| 134 | Polygon ZM | CO618 | 13 | 95190 | A | 50 | 0.690841 | 30093.01606 | 5.0 | 1.0 | 0.0007 | 0.010867419 | 0.05433709 | 0.01086742 | 7.6072E-06 | |
| 141 | Polygon ZM | CO618 | 48 | 95228 | B | 50 | 23.241798 | 1012412.707 | 4.5 | 0.6 | 0.0018 | 0.365610179 | 1.64524581 | 0.21936611 | 0.0006581 | |
| 310 | Polygon ZM | CO618 | 47 | 95227 | B | 51 | 0.325377 | 14173.40707 | 4.5 | 0.6 | 0.0018 | 0.006596687 | 0.02968509 | 0.00395801 | 1.1874E-05 | |
| 311 | Polygon ZM | CO618 | 52 | 95233 | A | 51 | 3.618954 | 157641.6278 | 5.0 | 1.0 | 0.0007 | 0.073370674 | 0.36685337 | 0.07337067 | 5.1359E-05 | |
| 312 | Polygon ZM | CO618 | 56 | 95237 | D | 51 | 28.572166 | 1244603.533 | 3.0 | 0.5 | 0.0018 | 0.579272121 | 1.73781636 | 0.28963606 | 0.00104269 | |
| 321 | Polygon ZM | CO618 | 38 | 95217 | B | 51 | 0.316506 | 13786.98994 | 4.5 | 0.6 | 0.0018 | 0.006416838 | 0.02887577 | 0.0038501 | 1.155E-05 | |
| 327 | Polygon ZM | CO618 | 53 | 95234 | A | 51 | 10.320725 | 449570.7819 | 5.0 | 1.0 | 0.0007 | 0.209242392 | 1.04621196 | 0.20924239 | 0.00014647 | |
| 331 | Polygon ZM | CO618 | 38 | 95217 | B | 51 | 6.170528 | 268788.193 | 4.5 | 0.6 | 0.0018 | 0.125101289 | 0.5629558 | 0.07506077 | 0.00022518 | |
| 228 | Polygon ZM | CO618 | 47 | 95227 | B | 52 | 5.535944 | 241145.7387 | 4.5 | 0.6 | 0.0018 | 0.048687823 | 0.2190952 | 0.02921269 | 8.7638E-05 | |
| 229 | Polygon ZM | CO618 | 51 | 95232 | A | 52 | 50.064391 | 2180804.885 | 5.0 | 1.0 | 0.0007 | 0.440309014 | 2.20154507 | 0.44030901 | 0.00030822 | |
| 230 | Polygon ZM | CO618 | 53 | 95234 | A | 52 | 12.584828 | 548195.1034 | 5.0 | 1.0 | 0.0007 | 0.110681725 | 0.55340862 | 0.11068172 | 7.7477E-05 | |
| 231 | Polygon ZM | CO618 | 4 | 95219 | D | 52 | 5.360916 | 233521.4865 | 3.0 | 0.5 | 0.0018 | 0.047148471 | 0.14144541 | 0.02357424 | 8.4867E-05 | |
| 242 | Polygon ZM | CO618 | 38 | 95217 | B | 52 | 0.10657 | 4642.20301 | 4.5 | 0.6 | 0.0018 | 0.00093727 | 0.00421772 | 0.00056236 | 1.6871E-06 | |
| 244 | Polygon ZM | CO618 | 37 | 95216 | B | 52 | 6.499102 | 283100.8785 | 4.5 | 0.6 | 0.0018 | 0.057158653 | 0.25721394 | 0.03429519 | 0.00010289 | |
| 263 | Polygon ZM | CO618 | 51 | 95232 | A | 52 | 15.982673 | 696205.2509 | 5.0 | 1.0 | 0.0007 | 0.140565279 | 0.7028264 | 0.14056528 | 9.8396E-05 | |
| 267 | Polygon ZM | CO618 | 52 | 95233 | A | 52 | 3.04492 | 132636.7357 | 5.0 | 1.0 | 0.0007 | 0.026779631 | 0.13389816 | 0.02677963 | 1.8746E-05 | |
| 269 | Polygon ZM | CO618 | 53 | 95234 | A | 52 | 10.954743 | 477188.608 | 5.0 | 1.0 | 0.0007 | 0.096345366 | 0.48172683 | 0.09634537 | 6.7442E-05 | |
| 270 | Polygon ZM | CO618 | 52 | 95233 | A | 52 | 2.254368 | 98200.29036 | 5.0 | 1.0 | 0.0007 | 0.019826842 | 0.09913421 | 0.01982684 | 1.3879E-05 | |
| 272 | Polygon ZM | CO618 | 77 | 95260 | A | 52 | 1.314396 | 57255.11145 | 5.0 | 1.0 | 0.0007 | 0.011559925 | 0.05779963 | 0.01155993 | 8.0919E-06 | |
| 217 | Polygon ZM | CO618 | 4 | 95219 | D | 53 | 9.020936 | 392951.9807 | 3.0 | 0.5 | 0.0018 | 0.077544988 | 0.23263496 | 0.03877249 | 0.00013958 | |
| 218 | Polygon ZM | CO618 | 51 | 95232 | A | 53 | 73.115997 | 3184932.846 | 5.0 | 1.0 | 0.0007 | 0.628513385 | 3.14256692 | 0.62851338 | 0.00043996 | |
| 219 | Polygon ZM | CO618 | 38 | 95217 | B | 53 | 19.761765 | 860822.5041 | 4.5 | 0.6 | 0.0018 | 0.169874372 | 0.76443467 | 0.10192462 | 0.00030577 | |
| 248 | Polygon ZM | CO618 | 53 | 95234 | A | 53 | 7.180856 | 312798.0903 | 5.0 | 1.0 | 0.0007 | 0.061727451 | 0.30863726 | 0.06172745 | 4.3209E-05 | |
| 251 | Polygon ZM | CO618 | 52 | 95233 | A | 53 | 0.130965 | 5704.855682 | 5.0 | 1.0 | 0.0007 | 0.001125794 | 0.00562897 | 0.00112579 | 7.8806E-07 | |
| 255 | Polygon ZM | CO618 | 52 | 95233 | A | 53 | 6.754677 | 294233.7483 | 5.0 | 1.0 | 0.0007 | 0.058063971 | 0.29031986 | 0.05806397 | 4.0645E-05 | |
| 262 | Polygon ZM | CO618 | 51 | 95232 | A | 53 | 0.097048 | 4227.410492 | 5.0 | 1.0 | 0.0007 | 0.000834236 | 0.00417118 | 0.00083424 | 5.8396E-07 | |
| 268 | Polygon ZM | CO618 | 53 | 95234 | A | 53 | 0.034697 | 1511.388093 | 5.0 | 1.0 | 0.0007 | 0.000298257 | 0.00149128 | 0.00029826 | 2.0878E-07 | |
| 276 | Polygon ZM | CO618 | 52 | 95233 | A | 53 | 0.234705 | 10223.73046 | 5.0 | 1.0 | 0.0007 | 0.002017547 | 0.01008773 | 0.00201755 | 1.4123E-06 | |
| 239 | Polygon ZM | CO618 | 4 | 95219 | D | 54 | 0.099064 | 4315.237743 | 3.0 | 0.5 | 0.0018 | 0.012149392 | 0.03644818 | 0.0060747 | 2.1869E-05 | |
| 240 | Polygon ZM | CO618 | 51 | 95232 | A | 54 | 0.04443 | 1935.364805 | 5.0 | 1.0 | 0.0007 | 0.005448948 | 0.02724474 | 0.00544895 | 3.8143E-06 | |
| 250 | Polygon ZM | CO618 | 53 | 95234 | A | 54 | 5.617026 | 244677.6717 | 5.0 | 1.0 | 0.0007 | 0.688880933 | 3.44440467 | 0.68888093 | 0.00048222 | |
| 280 | Polygon ZM | CO618 | 51 | 95232 | A | 54 | 2.393322 | 104253.093 | 5.0 | 1.0 | 0.0007 | 0.293520727 | 1.46760363 | 0.29352073 | 0.00020546 | |
| 247 | Polygon ZM | CO618 | 53 | 95234 | A | 55 | 7.535663 | 328253.4606 | 5.0 | 1.0 | 0.0007 | 0.126908568 | 0.63454284 | 0.12690857 | 8.8836E-05 | |
| 260 | Polygon ZM | CO618 | 51 | 95232 | A | 55 | 0.452169 | 19696.48419 | 5.0 | 1.0 | 0.0007 | 0.007615008 | 0.03807504 | 0.00761501 | 5.3305E-06 | |
| 261 | Polygon ZM | CO618 | 52 | 95233 | A | 55 | 18.708938 | 814961.3516 | 5.0 | 1.0 | 0.0007 | 0.315078408 | 1.57539204 | 0.31507841 | 0.00022055 | |
| 266 | Polygon ZM | CO618 | 47 | 95227 | B | 55 | 18.030365 | 785402.6956 | 4.5 | 0.6 | 0.0018 | 0.303650512 | 1.3664273 | 0.18219031 | 0.00054657 | |
| 275 | Polygon ZM | CO618 | 38 | 95217 | B | 55 | 6.561116 | 285802.2226 | 4.5 | 0.6 | 0.0018 | 0.110496172 | 0.49723277 | 0.0662977 | 0.00019889 | |
| 279 | Polygon ZM | CO618 | 51 | 95232 | A | 55 | 8.090424 | 352418.8499 | 5.0 | 1.0 | 0.0007 | 0.136251333 | 0.68125666 | 0.13625133 | 9.5376E-05 | |
| 237 | Polygon ZM | CO618 | 51 | 95232 | A | 56 | 14.452575 | 629554.163 | 5.0 | 1.0 | 0.0007 | 0.255882251 | 1.27941126 | 0.25588225 | 0.00017912 | |
| 238 | Polygon ZM | CO618 | 38 | 95217 | B | 56 | 17.792865 | 775057.2112 | 4.5 | 0.6 | 0.0018 | 0.315021956 | 1.4175988 | 0.18901317 | 0.00056704 | |

| Final Values Used in CUHP | | | | |
|---|---|---|---|---|
| | | Infiltration (inches per hour) | | Decay Coefficient - a |
| Basin ID | Summed Weight | Initial - $f_i$ | Final - $f_o$ | |
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a | |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F | |
| 249 | Polygon ZM | CO618 | 53 | 95234 | A | 56 | 23.022358 | 1002853.91 | 5.0 | 1.0 | 0.0007 | 0.40760991 | 2.03804955 | 0.40760991 | 0.00028533 | |
| 254 | Polygon ZM | CO618 | 52 | 95233 | A | 56 | 0.129255 | 5630.32795 | 5.0 | 1.0 | 0.0007 | 0.002288446 | 0.01144223 | 0.00228845 | 1.6019E-06 | |
| 277 | Polygon ZM | CO618 | 52 | 95233 | A | 56 | 1.084297 | 47231.98187 | 5.0 | 1.0 | 0.0007 | 0.019197436 | 0.09598718 | 0.01919744 | 1.3438E-05 | |
| 301 | Polygon ZM | CO618 | 51 | 95232 | A | 57 | 25.786343 | 1123253.118 | 5.0 | 1.0 | 0.0007 | 0.466568591 | 2.33284296 | 0.46656859 | 0.0003266 | |
| 302 | Polygon ZM | CO618 | 38 | 95217 | B | 57 | 4.087728 | 178061.4122 | 4.5 | 0.6 | 0.0018 | 0.073961835 | 0.33282826 | 0.0443771 | 0.00013313 | |
| 303 | Polygon ZM | CO618 | 53 | 95234 | A | 57 | 20.085252 | 874913.5558 | 5.0 | 1.0 | 0.0007 | 0.363415137 | 1.81707568 | 0.36341514 | 0.00025439 | |
| 319 | Polygon ZM | CO618 | 47 | 95227 | B | 57 | 0.048103 | 2095.375004 | 4.5 | 0.6 | 0.0018 | 0.000870361 | 0.00391663 | 0.00052222 | 1.5667E-06 | |
| 329 | Polygon ZM | CO618 | 64 | 95246 | C | 57 | 5.26064 | 229153.4642 | 3.0 | 0.5 | 0.0018 | 0.095184075 | 0.28555223 | 0.04759204 | 0.00017133 | |
| 285 | Polygon ZM | CO618 | 52 | 95233 | A | 58 | 3.010414 | 131133.6173 | 5.0 | 1.0 | 0.0007 | 0.031295401 | 0.15647701 | 0.0312954 | 2.1907E-05 | |
| 286 | Polygon ZM | CO618 | 51 | 95232 | A | 58 | 59.622008 | 2597134.666 | 5.0 | 1.0 | 0.0007 | 0.619813388 | 3.09906694 | 0.61981339 | 0.00043387 | |
| 287 | Polygon ZM | CO618 | 53 | 95234 | A | 58 | 8.713265 | 379549.8165 | 5.0 | 1.0 | 0.0007 | 0.090580616 | 0.45290308 | 0.09058062 | 6.3406E-05 | |
| 313 | Polygon ZM | CO618 | 53 | 95234 | A | 58 | 1.946252 | 84778.72346 | 5.0 | 1.0 | 0.0007 | 0.020232677 | 0.10116339 | 0.02023268 | 1.4163E-05 | |
| 316 | Polygon ZM | CO618 | 47 | 95227 | B | 58 | 16.605959 | 723355.5896 | 4.5 | 0.6 | 0.0018 | 0.172630817 | 0.77683868 | 0.10357849 | 0.00031074 | |
| 328 | Polygon ZM | CO618 | 64 | 95246 | C | 58 | 6.295585 | 274235.663 | 3.0 | 0.5 | 0.0018 | 0.065447101 | 0.1963413 | 0.03272355 | 0.0001178 | |
| 288 | Polygon ZM | CO618 | 52 | 95233 | A | 59 | 0.037862 | 1649.280429 | 5.0 | 1.0 | 0.0007 | 0.001090985 | 0.00545492 | 0.00109098 | 7.6369E-07 | |
| 289 | Polygon ZM | CO618 | 51 | 95232 | A | 59 | 14.428066 | 628486.5635 | 5.0 | 1.0 | 0.0007 | 0.415738462 | 2.07869231 | 0.41573846 | 0.00029102 | |
| 317 | Polygon ZM | CO618 | 47 | 95227 | B | 59 | 17.420682 | 758844.9273 | 4.5 | 0.6 | 0.0018 | 0.5019694 | 2.2588623 | 0.30118164 | 0.00090354 | |
| 324 | Polygon ZM | CO618 | 53 | 95234 | A | 59 | 2.818059 | 122754.6601 | 5.0 | 1.0 | 0.0007 | 0.081201153 | 0.40600577 | 0.08120115 | 5.6841E-05 | |
| 323 | Polygon ZM | CO618 | 53 | 95234 | A | 60 | 10.451515 | 455267.9923 | 5.0 | 1.0 | 0.0007 | 1 | 5 | 1 | 0.0007 | |
| 246 | Polygon ZM | CO618 | 53 | 95234 | A | 61 | 5.905298 | 257234.7688 | 5.0 | 1.0 | 0.0007 | 0.397489743 | 1.98744872 | 0.39748974 | 0.00027824 | |
| 259 | Polygon ZM | CO618 | 51 | 95232 | A | 61 | 3.660996 | 159472.9776 | 5.0 | 1.0 | 0.0007 | 0.246424203 | 1.23212102 | 0.2464242 | 0.0001725 | |
| 265 | Polygon ZM | CO618 | 47 | 95227 | B | 61 | 5.290185 | 230440.446 | 4.5 | 0.6 | 0.0018 | 0.356086054 | 1.60238724 | 0.21365163 | 0.00064095 | |
| 281 | Polygon ZM | CO618 | 52 | 95233 | A | 62 | 19.675203 | 857051.8456 | 5.0 | 1.0 | 0.0007 | 0.363193435 | 1.81596717 | 0.36319343 | 0.00025424 | |
| 282 | Polygon ZM | CO618 | 38 | 95217 | B | 62 | 4.018915 | 175063.9368 | 4.5 | 0.6 | 0.0018 | 0.074186962 | 0.33384133 | 0.04451218 | 0.00013354 | |
| 283 | Polygon ZM | CO618 | 47 | 95227 | B | 62 | 17.978871 | 783159.6265 | 4.5 | 0.6 | 0.0018 | 0.33188008 | 1.49346036 | 0.19912805 | 0.00059738 | |
| 284 | Polygon ZM | CO618 | 53 | 95234 | A | 62 | 8.41559 | 366583.0964 | 5.0 | 1.0 | 0.0007 | 0.155347164 | 0.77673582 | 0.15534716 | 0.00010874 | |
| 332 | Polygon ZM | CO618 | 63 | 95245 | B | 62 | 1.754224 | 76413.99565 | 4.5 | 0.6 | 0.0018 | 0.03238201 | 0.14571905 | 0.01942921 | 5.8288E-05 | |
| 334 | Polygon ZM | CO618 | 47 | 95227 | B | 62 | 2.329991 | 101494.3976 | 4.5 | 0.6 | 0.0018 | 0.043010349 | 0.19354657 | 0.02580621 | 7.7419E-05 | |
| 297 | Polygon ZM | CO618 | 77 | 95260 | A | 63 | 6.268935 | 273074.7918 | 5.0 | 1.0 | 0.0007 | 0.057148745 | 0.28574372 | 0.05714874 | 4.0004E-05 | |
| 298 | Polygon ZM | CO618 | 52 | 95233 | A | 63 | 29.816186 | 1298793.067 | 5.0 | 1.0 | 0.0007 | 0.271809759 | 1.35904879 | 0.27180976 | 0.00019027 | |
| 299 | Polygon ZM | CO618 | 47 | 95227 | B | 63 | 1.106731 | 48209.21881 | 4.5 | 0.6 | 0.0018 | 0.010089164 | 0.04540124 | 0.0060535 | 1.816E-05 | |
| 300 | Polygon ZM | CO618 | 53 | 95234 | A | 63 | 3.235411 | 140934.5246 | 5.0 | 1.0 | 0.0007 | 0.029494598 | 0.14747299 | 0.0294946 | 2.0646E-05 | |
| 314 | Polygon ZM | CO618 | 53 | 95234 | A | 63 | 15.606956 | 679838.9855 | 5.0 | 1.0 | 0.0007 | 0.142275837 | 0.71137919 | 0.14227584 | 9.9593E-05 | |
| 318 | Polygon ZM | CO618 | 47 | 95227 | B | 63 | 28.251622 | 1230640.662 | 4.5 | 0.6 | 0.0018 | 0.257546911 | 1.1589611 | 0.15452815 | 0.00046358 | |
| 322 | Polygon ZM | CO618 | 63 | 95245 | B | 63 | 1.547876 | 67425.46255 | 4.5 | 0.6 | 0.0018 | 0.014110715 | 0.06349822 | 0.00846643 | 2.5399E-05 | |
| 330 | Polygon ZM | CO618 | 47 | 95227 | B | 63 | 19.44117 | 846857.3512 | 4.5 | 0.6 | 0.0018 | 0.177229228 | 0.79753153 | 0.10633754 | 0.00031901 | |
| 333 | Polygon ZM | CO618 | 63 | 95245 | B | 63 | 3.821318 | 166456.607 | 4.5 | 0.6 | 0.0018 | 0.034835827 | 0.15676122 | 0.0209015 | 6.2704E-05 | |
| 335 | Polygon ZM | CO618 | 47 | 95227 | B | 63 | 0.598849 | 26085.86893 | 4.5 | 0.6 | 0.0018 | 0.005459217 | 0.02456648 | 0.00327553 | 9.8266E-06 | |
| 309 | Polygon ZM | CO618 | 77 | 95260 | A | 64 | 2.777478 | 120986.9221 | 5.0 | 1.0 | 0.0007 | 0.054093669 | 0.27046834 | 0.05409367 | 3.7866E-05 | |
| 315 | Polygon ZM | CO618 | 13 | 95190 | A | 64 | 4.688683 | 204239.0251 | 5.0 | 1.0 | 0.0007 | 0.09131597 | 0.45657985 | 0.09131597 | 6.3921E-05 | |
| 320 | Polygon ZM | CO618 | 47 | 95227 | B | 64 | 4.063533 | 177007.5003 | 4.5 | 0.6 | 0.0018 | 0.079140662 | 0.35613298 | 0.0474844 | 0.00014245 | |
| 326 | Polygon ZM | CO618 | 53 | 95234 | A | 64 | 39.816012 | 1734385.463 | 5.0 | 1.0 | 0.0007 | 0.7754497 | 3.8772485 | 0.7754497 | 0.00054281 | |
| 473 | Polygon ZM | CO618 | 77 | 95260 | A | 65 | 57.072768 | 2486089.763 | 5.0 | 1.0 | 0.0007 | 0.595284543 | 2.97642272 | 0.59528454 | 0.0004167 | |
| 474 | Polygon ZM | CO618 | 63 | 95245 | B | 65 | 0.939771 | 40936.42398 | 4.5 | 0.6 | 0.0018 | 0.009802068 | 0.04410931 | 0.00588124 | 1.7644E-05 | |
| 475 | Polygon ZM | CO618 | 47 | 95227 | B | 65 | 4.298407 | 187238.5887 | 4.5 | 0.6 | 0.0018 | 0.044833553 | 0.20175099 | 0.02690013 | 8.07E-05 | |
| 476 | Polygon ZM | CO618 | 53 | 95234 | A | 65 | 5.392196 | 234884.0742 | 5.0 | 1.0 | 0.0007 | 0.05624208 | 0.2812104 | 0.05624208 | 3.9369E-05 | |
| 477 | Polygon ZM | CO618 | 74 | 95257 | A | 65 | 13.4528 | 586003.9753 | 5.0 | 1.0 | 0.0007 | 0.140316377 | 0.70158189 | 0.14031638 | 9.8221E-05 | |
| 478 | Polygon ZM | CO618 | 70 | 95253 | A | 65 | 10.895445 | 474605.5801 | 5.0 | 1.0 | 0.0007 | 0.113642464 | 0.56821232 | 0.11364246 | 7.955E-05 | |

| Final Values Used in CUHP | | | | |
|---|---|---|---|---|
| | | Infiltration (inches per hour) | | Decay Coefficient - a |
| Basin ID | Summed Weight | Initial - $f_i$ | Final - $f_o$ | |
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| | | GIS Output | | | | | | | Parameters for each area | | | | Calculated values based on area | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F |
| 485 | Polygon ZM | CO618 | 48 | 95228 | B | 65 | 0.762394 | 33209.88412 | 4.5 | 0.6 | 0.0018 | 0.007951978 | 0.0357839 | 0.00477119 | 1.4314E-05 |
| 491 | Polygon ZM | CO618 | 76 | 95259 | A | 65 | 3.060988 | 133336.6231 | 5.0 | 1.0 | 0.0007 | 0.031926937 | 0.15963468 | 0.03192694 | 2.2349E-05 |
| 216 | Polygon ZM | CO618 | 4 | 95219 | D | 66 | 6.511865 | 283656.8441 | 3.0 | 0.5 | 0.0018 | 0.104385994 | 0.31315798 | 0.052193 | 0.00018789 |
| 241 | Polygon ZM | CO618 | 38 | 95217 | B | 66 | 8.147783 | 354917.4435 | 4.5 | 0.6 | 0.0018 | 0.130609964 | 0.58774484 | 0.07836598 | 0.0002351 |
| 245 | Polygon ZM | CO618 | 53 | 95234 | A | 66 | 0.096595 | 4207.695196 | 5.0 | 1.0 | 0.0007 | 0.001548436 | 0.00774218 | 0.00154844 | 1.0839E-06 |
| 264 | Polygon ZM | CO618 | 47 | 95227 | B | 66 | 5.196756 | 226370.6968 | 4.5 | 0.6 | 0.0018 | 0.083304636 | 0.37487086 | 0.04998278 | 0.00014995 |
| 274 | Polygon ZM | CO618 | 38 | 95217 | B | 66 | 0.90056 | 39228.38244 | 4.5 | 0.6 | 0.0018 | 0.014436083 | 0.06496237 | 0.00866165 | 2.5985E-05 |
| 278 | Polygon ZM | CO618 | 51 | 95232 | A | 66 | 41.528996 | 1809003.073 | 5.0 | 1.0 | 0.0007 | 0.665714887 | 3.32857444 | 0.66571489 | 0.000466 |
| 356 | Polygon ZM | CO618 | 37 | 95216 | B | 67 | 9.562818 | 416556.3554 | 4.5 | 0.6 | 0.0018 | 0.212451246 | 0.95603061 | 0.12747075 | 0.00038241 |
| 357 | Polygon ZM | CO618 | 38 | 95217 | B | 67 | 17.852233 | 777643.2749 | 4.5 | 0.6 | 0.0018 | 0.39661208 | 1.78475436 | 0.23796725 | 0.0007139 |
| 358 | Polygon ZM | CO618 | 48 | 95228 | B | 67 | 6.653968 | 289846.8478 | 4.5 | 0.6 | 0.0018 | 0.147827114 | 0.66522201 | 0.08869627 | 0.00026609 |
| 359 | Polygon ZM | CO618 | 51 | 95232 | A | 67 | 2.246707 | 97866.54519 | 5.0 | 1.0 | 0.0007 | 0.049913701 | 0.24956851 | 0.0499137 | 3.494E-05 |
| 360 | Polygon ZM | CO618 | 4 | 95219 | D | 67 | 0.542569 | 23634.31185 | 3.0 | 0.5 | 0.0018 | 0.012053925 | 0.03616177 | 0.00602696 | 2.1697E-05 |
| 369 | Polygon ZM | CO618 | 56 | 95237 | D | 67 | 8.153529 | 355167.7169 | 3.0 | 0.5 | 0.0018 | 0.181141934 | 0.5434258 | 0.09057097 | 0.00032606 |
| 346 | Polygon ZM | CO618 | 38 | 95217 | B | 68 | 17.445679 | 759933.7909 | 4.5 | 0.6 | 0.0018 | 0.584439242 | 2.62997659 | 0.35066355 | 0.00105199 |
| 347 | Polygon ZM | CO618 | 4 | 95219 | D | 68 | 2.424305 | 105602.7449 | 3.0 | 0.5 | 0.0018 | 0.081215481 | 0.24364644 | 0.04060774 | 0.00014619 |
| 363 | Polygon ZM | CO618 | 32 | 95211 | A | 68 | 3.67367 | 160025.0541 | 5.0 | 1.0 | 0.0007 | 0.123069829 | 0.61534914 | 0.12306983 | 8.6149E-05 |
| 379 | Polygon ZM | CO618 | 47 | 95227 | B | 68 | 6.306633 | 274716.9261 | 4.5 | 0.6 | 0.0018 | 0.211275448 | 0.95073952 | 0.12676527 | 0.0003803 |
| 348 | Polygon ZM | CO618 | 51 | 95232 | A | 69 | 29.459826 | 1283270.005 | 5.0 | 1.0 | 0.0007 | 0.466651995 | 2.33325997 | 0.46665199 | 0.00032666 |
| 349 | Polygon ZM | CO618 | 47 | 95227 | B | 69 | 10.911225 | 475292.974 | 4.5 | 0.6 | 0.0018 | 0.172836904 | 0.77776607 | 0.10370214 | 0.00031111 |
| 350 | Polygon ZM | CO618 | 38 | 95217 | B | 69 | 2.846029 | 123973.0098 | 4.5 | 0.6 | 0.0018 | 0.045081902 | 0.20286856 | 0.02704914 | 8.1147E-05 |
| 351 | Polygon ZM | CO618 | 4 | 95219 | D | 69 | 2.632575 | 114674.9652 | 3.0 | 0.5 | 0.0018 | 0.041700734 | 0.1251022 | 0.02085037 | 7.5061E-05 |
| 352 | Polygon ZM | CO618 | 38 | 95217 | B | 69 | 17.274704 | 752486.1277 | 4.5 | 0.6 | 0.0018 | 0.273636219 | 1.23136299 | 0.16418173 | 0.00049255 |
| 353 | Polygon ZM | CO618 | 47 | 95227 | B | 69 | 0.005824 | 253.672657 | 4.5 | 0.6 | 0.0018 | 9.22463E-05 | 0.00041511 | 5.5348E-05 | 1.6604E-07 |
| 354 | Polygon ZM | CO618 | 51 | 95232 | A | 70 | 0.54036 | 23538.0852 | 5.0 | 1.0 | 0.0007 | 0.021924316 | 0.10962158 | 0.02192432 | 1.5347E-05 |
| 355 | Polygon ZM | CO618 | 38 | 95217 | B | 70 | 23.698476 | 1032305.599 | 4.5 | 0.6 | 0.0018 | 0.961530821 | 4.32688869 | 0.57691849 | 0.00173076 |
| 383 | Polygon ZM | CO618 | 51 | 95232 | A | 70 | 0.407775 | 17762.67013 | 5.0 | 1.0 | 0.0007 | 0.016544863 | 0.08272432 | 0.01654486 | 1.1581E-05 |
| 450 | Polygon ZM | CO618 | 47 | 95227 | B | 71 | 0.118521 | 5162.79203 | 4.5 | 0.6 | 0.0018 | 0.00672005 | 0.03024023 | 0.00403203 | 1.2096E-05 |
| 451 | Polygon ZM | CO618 | 63 | 95245 | B | 71 | 2.415755 | 105230.2721 | 4.5 | 0.6 | 0.0018 | 0.136970988 | 0.61636944 | 0.08218259 | 0.00024655 |
| 452 | Polygon ZM | CO618 | 52 | 95233 | A | 71 | 5.224137 | 227563.4287 | 5.0 | 1.0 | 0.0007 | 0.29620362 | 1.4810181 | 0.29620362 | 0.00020734 |
| 453 | Polygon ZM | CO618 | 38 | 95217 | B | 71 | 8.134699 | 354347.5016 | 4.5 | 0.6 | 0.0018 | 0.461229704 | 2.07553367 | 0.27673782 | 0.00083021 |
| 454 | Polygon ZM | CO618 | 35 | 95214 | D | 71 | 0.232859 | 10143.33918 | 3.0 | 0.5 | 0.0018 | 0.013202885 | 0.03960866 | 0.00660144 | 2.3765E-05 |
| 455 | Polygon ZM | CO618 | 51 | 95232 | A | 71 | 1.511009 | 65819.53735 | 5.0 | 1.0 | 0.0007 | 0.085672752 | 0.42836376 | 0.08567275 | 5.9971E-05 |
| 338 | Polygon ZM | CO618 | 51 | 95232 | A | 72 | 17.244791 | 751183.0972 | 5.0 | 1.0 | 0.0007 | 0.43312014 | 2.1656007 | 0.43312014 | 0.00030318 |
| 339 | Polygon ZM | CO618 | 38 | 95217 | B | 72 | 6.531885 | 284528.9314 | 4.5 | 0.6 | 0.0018 | 0.164054824 | 0.73824671 | 0.09843289 | 0.0002953 |
| 340 | Polygon ZM | CO618 | 38 | 95217 | B | 72 | 1.126735 | 49080.58173 | 4.5 | 0.6 | 0.0018 | 0.028299077 | 0.12734585 | 0.01697945 | 5.0938E-05 |
| 361 | Polygon ZM | CO618 | 32 | 95211 | A | 72 | 9.875149 | 430161.4845 | 5.0 | 1.0 | 0.0007 | 0.248024221 | 1.2401211 | 0.24802422 | 0.00017362 |
| 371 | Polygon ZM | CO618 | 53 | 95234 | A | 72 | 4.786681 | 208507.8286 | 5.0 | 1.0 | 0.0007 | 0.120222274 | 0.60111137 | 0.12022227 | 8.4156E-05 |
| 378 | Polygon ZM | CO618 | 47 | 95227 | B | 72 | 0.250019 | 10890.80665 | 4.5 | 0.6 | 0.0018 | 0.006279465 | 0.02825759 | 0.00376768 | 1.1303E-05 |
| 364 | Polygon ZM | CO618 | 32 | 95211 | A | 73 | 11.025932 | 480289.6048 | 5.0 | 1.0 | 0.0007 | 0.28171378 | 1.4085689 | 0.28171378 | 0.0001972 |
| 380 | Polygon ZM | CO618 | 47 | 95227 | B | 73 | 28.112843 | 1224595.421 | 4.5 | 0.6 | 0.0018 | 0.71828622 | 3.23228799 | 0.43097173 | 0.00129292 |
| 365 | Polygon ZM | CO618 | 32 | 95211 | A | 74 | 104.413832 | 4548266.538 | 5.0 | 1.0 | 0.0007 | 0.793052718 | 3.96526359 | 0.79305272 | 0.00055514 |
| 366 | Polygon ZM | CO618 | 52 | 95233 | A | 74 | 1.74262 | 75908.54261 | 5.0 | 1.0 | 0.0007 | 0.013235697 | 0.06617848 | 0.0132357 | 9.265E-06 |
| 368 | Polygon ZM | CO618 | 37 | 95216 | B | 74 | 17.105827 | 745129.8209 | 4.5 | 0.6 | 0.0018 | 0.129923615 | 0.58465627 | 0.07795417 | 0.00023386 |
| 375 | Polygon ZM | CO618 | 53 | 95234 | A | 74 | 0.949575 | 41363.4984 | 5.0 | 1.0 | 0.0007 | 0.007212294 | 0.03606147 | 0.00721229 | 5.0486E-06 |
| 377 | Polygon ZM | CO618 | 52 | 95233 | A | 74 | 1.178867 | 51351.44333 | 5.0 | 1.0 | 0.0007 | 0.008953829 | 0.04476915 | 0.00895383 | 6.2677E-06 |
| 381 | Polygon ZM | CO618 | 47 | 95227 | B | 74 | 6.269923 | 273117.8529 | 4.5 | 0.6 | 0.0018 | 0.047621848 | 0.21429831 | 0.02857311 | 8.5719E-05 |
| 399 | Polygon ZM | CO618 | 37 | 95216 | B | 75 | 19.468594 | 848051.9729 | 4.5 | 0.6 | 0.0018 | 0.780084351 | 3.51037958 | 0.46805061 | 0.00140415 |

**Final Values Used in CUHP**

| Basin ID | Summed Weight | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|---|
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a | |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F | |
| 400 | Polygon ZM | CO618 | 32 | 95211 | A | 75 | 5.488443 | 239076.5821 | 5.0 | 1.0 | 0.0007 | 0.219915649 | 1.09957825 | 0.21991565 | 0.00015394 | |
| 342 | Polygon ZM | CO618 | 51 | 95232 | A | 76 | 1.358021 | 59155.41458 | 5.0 | 1.0 | 0.0007 | 0.108710595 | 0.54355298 | 0.1087106 | 7.6097E-05 | |
| 362 | Polygon ZM | CO618 | 32 | 95211 | A | 76 | 2.950187 | 128510.1541 | 5.0 | 1.0 | 0.0007 | 0.236164609 | 1.18082304 | 0.23616461 | 0.00016532 | |
| 373 | Polygon ZM | CO618 | 53 | 95234 | A | 76 | 8.183871 | 356489.4374 | 5.0 | 1.0 | 0.0007 | 0.655124796 | 3.27562398 | 0.6551248 | 0.00045859 | |
| 336 | Polygon ZM | CO618 | 51 | 95232 | A | 77 | 2.866751 | 124875.673 | 5.0 | 1.0 | 0.0007 | 0.082576665 | 0.41288332 | 0.08257666 | 5.7804E-05 | |
| 337 | Polygon ZM | CO618 | 77 | 95260 | A | 77 | 15.170728 | 660836.9304 | 5.0 | 1.0 | 0.0007 | 0.436992316 | 2.18496158 | 0.43699232 | 0.00030589 | |
| 370 | Polygon ZM | CO618 | 53 | 95234 | A | 77 | 16.678757 | 726526.6409 | 5.0 | 1.0 | 0.0007 | 0.480431019 | 2.40215509 | 0.48043102 | 0.0003363 | |
| 343 | Polygon ZM | CO618 | 51 | 95232 | A | 78 | 2.46906 | 107552.2712 | 5.0 | 1.0 | 0.0007 | 0.094762844 | 0.47381422 | 0.09476284 | 6.6334E-05 | |
| 344 | Polygon ZM | CO618 | 52 | 95233 | A | 78 | 7.213469 | 314218.688 | 5.0 | 1.0 | 0.0007 | 0.276853814 | 1.38426907 | 0.27685381 | 0.0001938 | |
| 345 | Polygon ZM | CO618 | 38 | 95217 | B | 78 | 6.595645 | 287306.3108 | 4.5 | 0.6 | 0.0018 | 0.253141685 | 1.13913758 | 0.15188501 | 0.00045566 | |
| 367 | Polygon ZM | CO618 | 35 | 95214 | D | 78 | 0.426029 | 18557.83155 | 3.0 | 0.5 | 0.0018 | 0.016351053 | 0.04905316 | 0.00817553 | 2.9432E-05 | |
| 374 | Polygon ZM | CO618 | 53 | 95234 | A | 78 | 6.453798 | 281127.4192 | 5.0 | 1.0 | 0.0007 | 0.247697547 | 1.23848774 | 0.24769755 | 0.00017339 | |
| 382 | Polygon ZM | CO618 | 51 | 95232 | A | 78 | 2.897152 | 126199.9463 | 5.0 | 1.0 | 0.0007 | 0.111193057 | 0.55596528 | 0.11119306 | 7.7835E-05 | |
| 341 | Polygon ZM | CO618 | 77 | 95260 | A | 79 | 7.018048 | 305706.1921 | 5.0 | 1.0 | 0.0007 | 0.504952888 | 2.52476444 | 0.50495289 | 0.00035347 | |
| 372 | Polygon ZM | CO618 | 53 | 95234 | A | 79 | 6.643534 | 289392.3445 | 5.0 | 1.0 | 0.0007 | 0.478006347 | 2.39003173 | 0.47800635 | 0.0003346 | |
| 376 | Polygon ZM | CO618 | 76 | 95259 | A | 79 | 0.23684 | 10316.73991 | 5.0 | 1.0 | 0.0007 | 0.017040766 | 0.08520383 | 0.01704077 | 1.1929E-05 | |
| 438 | Polygon ZM | CO618 | 52 | 95233 | A | 80 | 0.999059 | 43518.99773 | 5.0 | 1.0 | 0.0007 | 0.091645313 | 0.45822656 | 0.09164531 | 6.4152E-05 | |
| 439 | Polygon ZM | CO618 | 76 | 95259 | A | 80 | 1.459038 | 63555.70596 | 5.0 | 1.0 | 0.0007 | 0.133839998 | 0.66919999 | 0.13384 | 9.3688E-05 | |
| 440 | Polygon ZM | CO618 | 53 | 95234 | A | 80 | 4.905417 | 213679.9737 | 5.0 | 1.0 | 0.0007 | 0.449982055 | 2.24991028 | 0.44998206 | 0.00031499 | |
| 441 | Polygon ZM | CO618 | 35 | 95214 | D | 80 | 3.286044 | 143140.0611 | 3.0 | 0.5 | 0.0018 | 0.301434233 | 0.9043027 | 0.15071712 | 0.00054258 | |
| 442 | Polygon ZM | CO618 | 51 | 95232 | A | 80 | 0.251804 | 10968.58377 | 5.0 | 1.0 | 0.0007 | 0.023098402 | 0.11549201 | 0.0230984 | 1.6169E-05 | |
| 462 | Polygon ZM | CO618 | 77 | 95260 | A | 81 | 22.173796 | 965890.5653 | 5.0 | 1.0 | 0.0007 | 0.323048867 | 1.61524434 | 0.32304887 | 0.00022613 | |
| 463 | Polygon ZM | CO618 | 63 | 95245 | B | 81 | 0.000191 | 8.301511 | 4.5 | 0.6 | 0.0018 | 2.7765E-06 | 1.2494E-05 | 1.6659E-06 | 4.9977E-09 | |
| 464 | Polygon ZM | CO618 | 47 | 95227 | B | 81 | 15.46446 | 673631.8924 | 4.5 | 0.6 | 0.0018 | 0.225300906 | 1.01385408 | 0.13518054 | 0.00040554 | |
| 465 | Polygon ZM | CO618 | 52 | 95233 | A | 81 | 3.34526 | 145719.5076 | 5.0 | 1.0 | 0.0007 | 0.04873691 | 0.24368455 | 0.04873691 | 3.4116E-05 | |
| 466 | Polygon ZM | CO618 | 76 | 95259 | A | 81 | 0.896045 | 39031.71153 | 5.0 | 1.0 | 0.0007 | 0.013054429 | 0.06527215 | 0.01305443 | 9.1381E-06 | |
| 467 | Polygon ZM | CO618 | 76 | 95259 | A | 81 | 15.069178 | 656413.4113 | 5.0 | 1.0 | 0.0007 | 0.219542065 | 1.09771032 | 0.21954206 | 0.00015368 | |
| 468 | Polygon ZM | CO618 | 35 | 95214 | D | 81 | 5.912965 | 257568.762 | 3.0 | 0.5 | 0.0018 | 0.086145677 | 0.25843703 | 0.04307284 | 0.00015506 | |
| 469 | Polygon ZM | CO618 | 51 | 95232 | A | 81 | 1.017749 | 44333.1604 | 5.0 | 1.0 | 0.0007 | 0.014827536 | 0.07413768 | 0.01482754 | 1.0379E-05 | |
| 488 | Polygon ZM | CO618 | 77 | 95260 | A | 81 | 4.759495 | 207323.6054 | 5.0 | 1.0 | 0.0007 | 0.069340832 | 0.34670416 | 0.06934083 | 4.8539E-05 | |
| 456 | Polygon ZM | CO618 | 63 | 95245 | B | 82 | 5.418583 | 236033.4925 | 4.5 | 0.6 | 0.0018 | 0.296736537 | 1.33531442 | 0.17804192 | 0.00053413 | |
| 457 | Polygon ZM | CO618 | 47 | 95227 | B | 82 | 8.869016 | 386334.3476 | 4.5 | 0.6 | 0.0018 | 0.485691735 | 2.18561281 | 0.29141504 | 0.00087425 | |
| 458 | Polygon ZM | CO618 | 63 | 95245 | B | 82 | 0.755856 | 32925.0798 | 4.5 | 0.6 | 0.0018 | 0.041392745 | 0.18626735 | 0.02483565 | 7.4507E-05 | |
| 459 | Polygon ZM | CO618 | 52 | 95233 | A | 82 | 3.214139 | 140007.8956 | 5.0 | 1.0 | 0.0007 | 0.176015097 | 0.88007549 | 0.1760151 | 0.00012321 | |
| 460 | Polygon ZM | CO618 | 35 | 95214 | A | 82 | 0.002993 | 130.360353 | 5.0 | 1.0 | 0.0007 | 0.000163886 | 0.00081943 | 0.00016389 | 1.1472E-07 | |
| 445 | Polygon ZM | CO618 | 77 | 95260 | A | 83 | 11.742033 | 511482.9411 | 5.0 | 1.0 | 0.0007 | 0.170550286 | 0.85275143 | 0.17055029 | 0.00011939 | |
| 446 | Polygon ZM | CO618 | 47 | 95227 | B | 83 | 3.383947 | 147404.7383 | 4.5 | 0.6 | 0.0018 | 0.049151044 | 0.2211797 | 0.02949063 | 8.8472E-05 | |
| 447 | Polygon ZM | CO618 | 76 | 95259 | A | 83 | 15.063884 | 656182.7997 | 5.0 | 1.0 | 0.0007 | 0.218799407 | 1.09399704 | 0.21879941 | 0.00015316 | |
| 448 | Polygon ZM | CO618 | 74 | 95257 | A | 83 | 27.092453 | 1180147.25 | 5.0 | 1.0 | 0.0007 | 0.393511563 | 1.96755781 | 0.39351156 | 0.00027546 | |
| 449 | Polygon ZM | CO618 | 70 | 95253 | A | 83 | 11.565604 | 503797.7055 | 5.0 | 1.0 | 0.0007 | 0.1679877 | 0.8399385 | 0.1679877 | 0.00011759 | |
| 471 | Polygon ZM | CO618 | 74 | 95257 | A | 84 | 14.851766 | 646942.9313 | 5.0 | 1.0 | 0.0007 | 0.437787845 | 2.18893922 | 0.43778784 | 0.00030645 | |
| 472 | Polygon ZM | CO618 | 70 | 95253 | A | 84 | 0.374001 | 16291.4951 | 5.0 | 1.0 | 0.0007 | 0.011024494 | 0.05512247 | 0.01102449 | 7.7171E-06 | |
| 484 | Polygon ZM | CO618 | 48 | 95228 | B | 84 | 8.184863 | 356532.6255 | 4.5 | 0.6 | 0.0018 | 0.241266489 | 1.0856992 | 0.14475989 | 0.00043428 | |
| 490 | Polygon ZM | CO618 | 76 | 95259 | A | 84 | 10.513944 | 457987.3883 | 5.0 | 1.0 | 0.0007 | 0.309921172 | 1.54960586 | 0.30992117 | 0.00021694 | |
| 388 | Polygon ZM | CO618 | 52 | 95233 | A | 85 | 8.759454 | 381561.8034 | 5.0 | 1.0 | 0.0007 | 0.180904646 | 0.90452323 | 0.18090465 | 0.00012663 | |
| 389 | Polygon ZM | CO618 | 53 | 95234 | A | 85 | 7.87612 | 343083.7816 | 5.0 | 1.0 | 0.0007 | 0.162661591 | 0.81330796 | 0.16266159 | 0.00011386 | |
| 390 | Polygon ZM | CO618 | 37 | 95216 | B | 85 | 6.649876 | 289668.6076 | 4.5 | 0.6 | 0.0018 | 0.13733659 | 0.61801466 | 0.08240195 | 0.00024721 | |
| 391 | Polygon ZM | CO618 | 32 | 95211 | A | 85 | 25.134831 | 1094873.222 | 5.0 | 1.0 | 0.0007 | 0.519097172 | 2.59548586 | 0.51909717 | 0.00036337 | |

| Final Values Used in CUHP | | | | |
|---|---|---|---|---|
| | | Infiltration (inches per hour) | | Decay Coefficient - a |
| Basin ID | Summed Weight | Initial - $f_i$ | Final - $f_o$ | |
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F |
| 392 | Polygon ZM | CO618 | 77 | 95260 | A | 86 | 6.689265 | 291384.3705 | 5.0 | 1.0 | 0.0007 | 0.384698909 | 1.92349455 | 0.38469891 | 0.00026929 |
| 393 | Polygon ZM | CO618 | 47 | 95227 | B | 86 | 3.868557 | 168514.3544 | 4.5 | 0.6 | 0.0018 | 0.222480321 | 1.00116145 | 0.13348819 | 0.00040046 |
| 394 | Polygon ZM | CO618 | 53 | 95234 | A | 86 | 6.83049 | 297536.1507 | 5.0 | 1.0 | 0.0007 | 0.39282077 | 1.96410385 | 0.39282077 | 0.00027497 |
| 404 | Polygon ZM | CO618 | 52 | 95233 | A | 87 | 5.98372 | 260650.832 | 5.0 | 1.0 | 0.0007 | 0.294337637 | 1.47168818 | 0.29433764 | 0.00020604 |
| 405 | Polygon ZM | CO618 | 53 | 95234 | A | 87 | 7.677717 | 334441.3485 | 5.0 | 1.0 | 0.0007 | 0.377664922 | 1.88832461 | 0.37766492 | 0.00026437 |
| 406 | Polygon ZM | CO618 | 32 | 95211 | A | 87 | 0.393573 | 17144.02571 | 5.0 | 1.0 | 0.0007 | 0.019359739 | 0.09679869 | 0.01935974 | 1.3552E-05 |
| 423 | Polygon ZM | CO618 | 51 | 95232 | A | 87 | 6.274432 | 273314.2623 | 5.0 | 1.0 | 0.0007 | 0.308637703 | 1.54318851 | 0.3086377 | 0.00021605 |
| 384 | Polygon ZM | CO618 | 52 | 95233 | A | 88 | 6.847812 | 298290.6773 | 5.0 | 1.0 | 0.0007 | 0.099093659 | 0.4954683 | 0.09909366 | 6.9366E-05 |
| 385 | Polygon ZM | CO618 | 53 | 95234 | A | 88 | 1.176545 | 51250.31487 | 5.0 | 1.0 | 0.0007 | 0.017025612 | 0.08512806 | 0.01702561 | 1.1918E-05 |
| 386 | Polygon ZM | CO618 | 37 | 95216 | B | 88 | 6.51659 | 283862.6775 | 4.5 | 0.6 | 0.0018 | 0.094300605 | 0.42435272 | 0.05658036 | 0.00016974 |
| 387 | Polygon ZM | CO618 | 32 | 95211 | A | 88 | 10.382991 | 452283.0958 | 5.0 | 1.0 | 0.0007 | 0.150250713 | 0.75125356 | 0.15025071 | 0.00010518 |
| 414 | Polygon ZM | CO618 | 52 | 95233 | A | 88 | 0.651515 | 28380.00337 | 5.0 | 1.0 | 0.0007 | 0.009427979 | 0.0471399 | 0.00942798 | 6.5996E-06 |
| 421 | Polygon ZM | CO618 | 51 | 95232 | A | 88 | 43.512798 | 1895417.459 | 5.0 | 1.0 | 0.0007 | 0.629667187 | 3.14833593 | 0.62966719 | 0.00044077 |
| 426 | Polygon ZM | CO618 | 47 | 95227 | B | 88 | 0.016187 | 705.121628 | 4.5 | 0.6 | 0.0018 | 0.000234245 | 0.0010541 | 0.00014055 | 4.2164E-07 |
| 407 | Polygon ZM | CO618 | 47 | 95227 | B | 89 | 11.881642 | 517564.3186 | 4.5 | 0.6 | 0.0018 | 0.192597765 | 0.86668994 | 0.11555866 | 0.00034668 |
| 408 | Polygon ZM | CO618 | 53 | 95234 | A | 89 | 31.488652 | 1371645.68 | 5.0 | 1.0 | 0.0007 | 0.510421378 | 2.55210689 | 0.51042138 | 0.00035729 |
| 417 | Polygon ZM | CO618 | 53 | 95234 | A | 89 | 0.166395 | 7248.1753 | 5.0 | 1.0 | 0.0007 | 0.002697215 | 0.01348608 | 0.00269722 | 1.8881E-06 |
| 419 | Polygon ZM | CO618 | 52 | 95233 | A | 89 | 0.193111 | 8411.91497 | 5.0 | 1.0 | 0.0007 | 0.00313027 | 0.01565135 | 0.00313027 | 2.1912E-06 |
| 429 | Polygon ZM | CO618 | 76 | 95259 | A | 89 | 0.628645 | 27383.75963 | 5.0 | 1.0 | 0.0007 | 0.010190136 | 0.05095068 | 0.01019014 | 7.1331E-06 |
| 434 | Polygon ZM | CO618 | 61 | 95243 | D | 89 | 1.681855 | 73261.59095 | 3.0 | 0.5 | 0.0018 | 0.027262348 | 0.08178704 | 0.01363117 | 4.9072E-05 |
| 437 | Polygon ZM | CO618 | 24 | 95202 | C | 89 | 15.651184 | 681765.5771 | 3.0 | 0.5 | 0.0018 | 0.253700887 | 0.76110266 | 0.12685044 | 0.00045666 |
| 403 | Polygon ZM | CO618 | 53 | 95234 | A | 90 | 9.938156 | 432906.0553 | 5.0 | 1.0 | 0.0007 | 0.181062339 | 0.9053117 | 0.18106234 | 0.00012674 |
| 415 | Polygon ZM | CO618 | 52 | 95233 | A | 90 | 13.899489 | 605461.7206 | 5.0 | 1.0 | 0.0007 | 0.2532335 | 1.2661675 | 0.2532335 | 0.00017726 |
| 416 | Polygon ZM | CO618 | 53 | 95234 | A | 90 | 9.169038 | 399403.2989 | 5.0 | 1.0 | 0.0007 | 0.167049859 | 0.8352493 | 0.16704986 | 0.00011693 |
| 422 | Polygon ZM | CO618 | 51 | 95232 | A | 90 | 3.54062 | 154229.4111 | 5.0 | 1.0 | 0.0007 | 0.064506231 | 0.32253115 | 0.06450623 | 4.5154E-05 |
| 427 | Polygon ZM | CO618 | 47 | 95227 | B | 90 | 0.048732 | 2122.76469 | 4.5 | 0.6 | 0.0018 | 0.000887843 | 0.00399529 | 0.00053271 | 1.5981E-06 |
| 428 | Polygon ZM | CO618 | 76 | 95259 | A | 90 | 0.096364 | 4197.623441 | 5.0 | 1.0 | 0.0007 | 0.00175565 | 0.00877825 | 0.00175565 | 1.229E-06 |
| 431 | Polygon ZM | CO618 | 4 | 95219 | D | 90 | 8.850237 | 385516.3184 | 3.0 | 0.5 | 0.0018 | 0.161241649 | 0.48372495 | 0.08062082 | 0.00029023 |
| 432 | Polygon ZM | CO618 | 51 | 95232 | A | 90 | 1.533578 | 66802.66445 | 5.0 | 1.0 | 0.0007 | 0.027940119 | 0.13970059 | 0.02794012 | 1.9558E-05 |
| 436 | Polygon ZM | CO618 | 24 | 95202 | C | 90 | 7.811819 | 340282.8341 | 3.0 | 0.5 | 0.0018 | 0.142322809 | 0.42696843 | 0.0711614 | 0.00025618 |
| 591 | Polygon ZM | CO618 | 51 | 95232 | A | 91 | 0.652095 | 28405.24126 | 5.0 | 1.0 | 0.0007 | 0.00601871 | 0.03009355 | 0.00601871 | 4.2131E-06 |
| 592 | Polygon ZM | CO618 | 52 | 95233 | A | 91 | 47.367062 | 2063309.223 | 5.0 | 1.0 | 0.0007 | 0.437189045 | 2.18594522 | 0.43718904 | 0.00030603 |
| 593 | Polygon ZM | CO618 | 4 | 95219 | D | 91 | 7.761696 | 338099.4692 | 3.0 | 0.5 | 0.0018 | 0.071638988 | 0.21491696 | 0.03581949 | 0.00012895 |
| 594 | Polygon ZM | CO618 | 53 | 95234 | A | 91 | 0.770831 | 33577.38503 | 5.0 | 1.0 | 0.0007 | 0.007114622 | 0.03557311 | 0.00711462 | 4.9802E-06 |
| 595 | Polygon ZM | CO618 | 51 | 95232 | A | 91 | 7.897059 | 343995.8914 | 5.0 | 1.0 | 0.0007 | 0.072888365 | 0.36444182 | 0.07288836 | 5.1022E-05 |
| 596 | Polygon ZM | CO618 | 47 | 95227 | B | 91 | 6.74071 | 293625.3467 | 4.5 | 0.6 | 0.0018 | 0.062215485 | 0.27996968 | 0.03732929 | 0.00011199 |
| 597 | Polygon ZM | CO618 | 76 | 95259 | A | 91 | 15.479177 | 674272.9338 | 5.0 | 1.0 | 0.0007 | 0.142869879 | 0.7143494 | 0.14286988 | 0.00010001 |
| 626 | Polygon ZM | CO618 | 38 | 95217 | B | 91 | 4.388664 | 191170.2067 | 4.5 | 0.6 | 0.0018 | 0.040506541 | 0.18227944 | 0.02430392 | 7.2912E-05 |
| 632 | Polygon ZM | CO618 | 51 | 95232 | A | 91 | 12.102422 | 527181.4891 | 5.0 | 1.0 | 0.0007 | 0.111703069 | 0.55851534 | 0.11170307 | 7.8192E-05 |
| 637 | Polygon ZM | CO618 | 51 | 95232 | A | 91 | 4.330114 | 188619.7813 | 5.0 | 1.0 | 0.0007 | 0.039966138 | 0.19983069 | 0.03996614 | 2.7976E-05 |
| 640 | Polygon ZM | CO618 | 47 | 95227 | B | 91 | 0.854747 | 37232.79943 | 4.5 | 0.6 | 0.0018 | 0.007889158 | 0.03550121 | 0.00473349 | 1.42E-05 |
| 585 | Polygon ZM | CO618 | 52 | 95233 | A | 92 | 2.907951 | 126670.3649 | 5.0 | 1.0 | 0.0007 | 0.037925089 | 0.18962545 | 0.03792509 | 2.6548E-05 |
| 586 | Polygon ZM | CO618 | 76 | 95259 | A | 92 | 7.135632 | 310828.1082 | 5.0 | 1.0 | 0.0007 | 0.093061892 | 0.46530946 | 0.09306189 | 6.5143E-05 |
| 615 | Polygon ZM | CO618 | 73 | 95256 | A | 92 | 55.347243 | 2410925.919 | 5.0 | 1.0 | 0.0007 | 0.721830882 | 3.60915441 | 0.72183088 | 0.00050528 |
| 625 | Polygon ZM | CO618 | 38 | 95217 | B | 92 | 0.030156 | 1313.613686 | 4.5 | 0.6 | 0.0018 | 0.000393296 | 0.00176983 | 0.00023598 | 7.0793E-07 |
| 630 | Polygon ZM | CO618 | 38 | 95217 | B | 92 | 11.255209 | 490276.9185 | 4.5 | 0.6 | 0.0018 | 0.146788841 | 0.66054978 | 0.0880733 | 0.00026422 |
| 398 | Polygon ZM | CO618 | 47 | 95227 | B | 93 | 1.216382 | 52985.58953 | 4.5 | 0.6 | 0.0018 | 0.232783569 | 1.04752606 | 0.13967014 | 0.00041901 |
| 411 | Polygon ZM | CO618 | 76 | 95259 | A | 93 | 0.489973 | 21343.23384 | 5.0 | 1.0 | 0.0007 | 0.093768026 | 0.46884013 | 0.09376803 | 6.5638E-05 |

**Final Values Used in CUHP**

| Basin ID | Summed Weight | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|---|
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F |
| 418 | Polygon ZM | CO618 | 52 | 95233 | A | 93 | 0.89393 | 38939.57632 | 5.0 | 1.0 | 0.0007 | 0.171074695 | 0.85537347 | 0.17107469 | 0.00011975 |
| 433 | Polygon ZM | CO618 | 61 | 95243 | D | 93 | 2.625092 | 114348.9953 | 3.0 | 0.5 | 0.0018 | 0.50237371 | 1.50712113 | 0.25118686 | 0.00090427 |
| 409 | Polygon ZM | CO618 | 47 | 95227 | B | 94 | 13.412634 | 584254.3325 | 4.5 | 0.6 | 0.0018 | 0.188873389 | 0.84993025 | 0.11332403 | 0.00033997 |
| 412 | Polygon ZM | CO618 | 76 | 95259 | A | 94 | 50.658921 | 2206702.586 | 5.0 | 1.0 | 0.0007 | 0.713366375 | 3.56683188 | 0.71336638 | 0.00049936 |
| 420 | Polygon ZM | CO618 | 52 | 95233 | A | 94 | 2.730835 | 118955.1693 | 5.0 | 1.0 | 0.0007 | 0.038454941 | 0.19227471 | 0.03845494 | 2.6918E-05 |
| 430 | Polygon ZM | CO618 | 53 | 95234 | A | 94 | 0.633266 | 27585.07839 | 5.0 | 1.0 | 0.0007 | 0.008917499 | 0.04458749 | 0.0089175 | 6.2422E-06 |
| 435 | Polygon ZM | CO618 | 61 | 95243 | D | 94 | 3.578233 | 155867.8468 | 3.0 | 0.5 | 0.0018 | 0.050387796 | 0.15116339 | 0.0251939 | 9.0698E-05 |
| 401 | Polygon ZM | CO618 | 77 | 95260 | A | 95 | 13.065368 | 569127.4092 | 5.0 | 1.0 | 0.0007 | 0.498142264 | 2.49071132 | 0.49814226 | 0.0003487 |
| 402 | Polygon ZM | CO618 | 47 | 95227 | B | 95 | 10.827767 | 471657.5409 | 4.5 | 0.6 | 0.0018 | 0.41282945 | 1.85773252 | 0.24769767 | 0.00074309 |
| 425 | Polygon ZM | CO618 | 76 | 95259 | A | 95 | 2.33505 | 101714.7942 | 5.0 | 1.0 | 0.0007 | 0.089028286 | 0.44514143 | 0.08902829 | 6.232E-05 |
| 395 | Polygon ZM | CO618 | 77 | 95260 | A | 96 | 9.183843 | 400048.2056 | 5.0 | 1.0 | 0.0007 | 0.076659671 | 0.38329836 | 0.07665967 | 5.3662E-05 |
| 396 | Polygon ZM | CO618 | 47 | 95227 | B | 96 | 46.005994 | 2004021.082 | 4.5 | 0.6 | 0.0018 | 0.384022714 | 1.72810221 | 0.23041363 | 0.00069124 |
| 397 | Polygon ZM | CO618 | 74 | 95257 | A | 96 | 10.949002 | 476938.5394 | 5.0 | 1.0 | 0.0007 | 0.091393865 | 0.45696933 | 0.09139387 | 6.3976E-05 |
| 410 | Polygon ZM | CO618 | 76 | 95259 | A | 96 | 5.637561 | 245572.1771 | 5.0 | 1.0 | 0.0007 | 0.047058035 | 0.23529017 | 0.04705803 | 3.2941E-05 |
| 413 | Polygon ZM | CO618 | 38 | 95217 | B | 96 | 15.540987 | 676965.3845 | 4.5 | 0.6 | 0.0018 | 0.129724226 | 0.58375902 | 0.07783454 | 0.0002335 |
| 424 | Polygon ZM | CO618 | 76 | 95259 | A | 96 | 32.482801 | 1414950.832 | 5.0 | 1.0 | 0.0007 | 0.271141488 | 1.35570744 | 0.27114149 | 0.0001898 |
| 443 | Polygon ZM | CO618 | 76 | 95259 | A | 97 | 8.282902 | 360803.2244 | 5.0 | 1.0 | 0.0007 | 0.324647286 | 1.62323643 | 0.32464729 | 0.00022725 |
| 444 | Polygon ZM | CO618 | 74 | 95257 | A | 97 | 17.23064 | 750566.6824 | 5.0 | 1.0 | 0.0007 | 0.675352714 | 3.37676357 | 0.67535271 | 0.00047275 |
| 587 | Polygon ZM | CO618 | 53 | 95234 | A | 98 | 1.03429 | 45053.69084 | 5.0 | 1.0 | 0.0007 | 0.009516207 | 0.04758103 | 0.00951621 | 6.6613E-06 |
| 588 | Polygon ZM | CO618 | 61 | 95243 | D | 98 | 1.326698 | 57790.97516 | 3.0 | 0.5 | 0.0018 | 0.012206566 | 0.0366197 | 0.00610328 | 2.1972E-05 |
| 589 | Polygon ZM | CO618 | 24 | 95202 | C | 98 | 10.79439 | 470203.6153 | 3.0 | 0.5 | 0.0018 | 0.099316053 | 0.29794816 | 0.04965803 | 0.00017877 |
| 590 | Polygon ZM | CO618 | 76 | 95259 | A | 98 | 90.902308 | 3959704.538 | 5.0 | 1.0 | 0.0007 | 0.836365807 | 4.18182904 | 0.83636581 | 0.00058546 |
| 611 | Polygon ZM | CO618 | 4 | 95219 | D | 98 | 1.172112 | 51057.19678 | 3.0 | 0.5 | 0.0018 | 0.010784263 | 0.03235279 | 0.00539213 | 1.9412E-05 |
| 616 | Polygon ZM | CO618 | 73 | 95256 | A | 98 | 1.41752 | 61747.1786 | 5.0 | 1.0 | 0.0007 | 0.013042193 | 0.06521096 | 0.01304219 | 9.1295E-06 |
| 623 | Polygon ZM | CO618 | 52 | 95233 | A | 98 | 1.839789 | 80141.20888 | 5.0 | 1.0 | 0.0007 | 0.016927366 | 0.08463683 | 0.01692737 | 1.1849E-05 |
| 631 | Polygon ZM | CO618 | 51 | 95232 | A | 98 | 0.200153 | 8718.6462 | 5.0 | 1.0 | 0.0007 | 0.001841546 | 0.00920773 | 0.00184155 | 1.2891E-06 |
| 599 | Polygon ZM | CO618 | 61 | 95243 | D | 99 | 4.572601 | 199182.4927 | 3.0 | 0.5 | 0.0018 | 0.465985446 | 1.39795634 | 0.23299272 | 0.00083877 |
| 603 | Polygon ZM | CO618 | 85 | 95269 | D | 99 | 0.000291 | 12.675212 | 3.0 | 0.5 | 0.0018 | 2.96535E-05 | 8.8961E-05 | 1.4827E-05 | 5.3376E-08 |
| 636 | Polygon ZM | CO618 | 74 | 95257 | A | 99 | 5.239863 | 228248.4233 | 5.0 | 1.0 | 0.0007 | 0.5339849 | 2.6699245 | 0.5339849 | 0.00037379 |
| 571 | Polygon ZM | CO618 | 76 | 95259 | A | 100 | 27.848279 | 1213071.042 | 5.0 | 1.0 | 0.0007 | 0.267374685 | 1.33687342 | 0.26737468 | 0.00018716 |
| 572 | Polygon ZM | CO618 | 74 | 95257 | A | 100 | 21.780953 | 948778.323 | 5.0 | 1.0 | 0.0007 | 0.209121557 | 1.04560779 | 0.20912156 | 0.00014639 |
| 573 | Polygon ZM | CO618 | 61 | 95243 | D | 100 | 5.66276 | 246669.8098 | 3.0 | 0.5 | 0.0018 | 0.054368838 | 0.16310651 | 0.02718442 | 9.7864E-05 |
| 574 | Polygon ZM | CO618 | 76 | 95259 | A | 100 | 6.081294 | 264901.1822 | 5.0 | 1.0 | 0.0007 | 0.05838724 | 0.2919362 | 0.05838724 | 4.0871E-05 |
| 575 | Polygon ZM | CO618 | 38 | 95217 | B | 100 | 6.960038 | 303179.2663 | 4.5 | 0.6 | 0.0018 | 0.066824166 | 0.30070875 | 0.0400945 | 0.00012028 |
| 576 | Polygon ZM | CO618 | 70 | 95253 | A | 100 | 2.558411 | 111444.3745 | 5.0 | 1.0 | 0.0007 | 0.02456361 | 0.12281805 | 0.02456361 | 1.7195E-05 |
| 577 | Polygon ZM | CO618 | 53 | 95234 | A | 100 | 22.653929 | 986805.1322 | 5.0 | 1.0 | 0.0007 | 0.217503099 | 1.0875155 | 0.2175031 | 0.00015225 |
| 602 | Polygon ZM | CO618 | 85 | 95269 | D | 100 | 5.303717 | 231029.8967 | 3.0 | 0.5 | 0.0018 | 0.050921623 | 0.15276487 | 0.02546081 | 9.1659E-05 |
| 633 | Polygon ZM | CO618 | 74 | 95257 | A | 100 | 5.305129 | 231091.4148 | 5.0 | 1.0 | 0.0007 | 0.050935182 | 0.25467591 | 0.05093518 | 3.5655E-05 |
| 498 | Polygon ZM | CO618 | 74 | 95257 | A | 101 | 1.80716 | 78719.90205 | 5.0 | 1.0 | 0.0007 | 0.052027349 | 0.26013675 | 0.05202735 | 3.6419E-05 |
| 499 | Polygon ZM | CO618 | 70 | 95253 | A | 101 | 6.178677 | 269143.1656 | 5.0 | 1.0 | 0.0007 | 0.177881389 | 0.88940694 | 0.17788139 | 0.00012452 |
| 500 | Polygon ZM | CO618 | 47 | 95227 | B | 101 | 2.144668 | 93421.73441 | 4.5 | 0.6 | 0.0018 | 0.061744046 | 0.2778482 | 0.03704643 | 0.00011114 |
| 543 | Polygon ZM | CO618 | 53 | 95234 | A | 101 | 6.470262 | 281844.6011 | 5.0 | 1.0 | 0.0007 | 0.186275988 | 0.93137994 | 0.18627599 | 0.00013039 |
| 546 | Polygon ZM | CO618 | 38 | 95217 | B | 101 | 8.042897 | 350348.6146 | 4.5 | 0.6 | 0.0018 | 0.231551479 | 1.04198166 | 0.13893089 | 0.00041679 |
| 563 | Polygon ZM | CO618 | 76 | 95259 | A | 101 | 10.091149 | 439570.4648 | 5.0 | 1.0 | 0.0007 | 0.290519749 | 1.45259874 | 0.29051975 | 0.00020336 |
| 539 | Polygon ZM | CO618 | 47 | 95227 | B | 102 | 6.054641 | 263740.1511 | 4.5 | 0.6 | 0.0018 | 0.251297485 | 1.13083868 | 0.15077849 | 0.00045234 |
| 545 | Polygon ZM | CO618 | 53 | 95234 | A | 102 | 11.142705 | 485376.2106 | 5.0 | 1.0 | 0.0007 | 0.462477255 | 2.31238627 | 0.46247725 | 0.00032373 |
| 562 | Polygon ZM | CO618 | 79 | 95262 | C | 102 | 0.431287 | 18786.86402 | 3.0 | 0.5 | 0.0018 | 0.017900542 | 0.05370163 | 0.00895027 | 3.2221E-05 |
| 567 | Polygon ZM | CO618 | 76 | 95259 | A | 102 | 6.464887 | 281610.4658 | 5.0 | 1.0 | 0.0007 | 0.268324718 | 1.34162359 | 0.26832472 | 0.00018783 |

| | | Final Values Used in CUHP | | |
|---|---|---|---|---|
| | | Infiltration (inches per hour) | | Decay Coefficient - a |
| Basin ID | Summed Weight | Initial - $f_i$ | Final - $f_o$ | |
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a | |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F | |
| 522 | Polygon ZM | CO618 | 47 | 95227 | B | 103 | 23.77967 | 1035842.422 | 4.5 | 0.6 | 0.0018 | 0.222620646 | 1.00179291 | 0.13357239 | 0.00040072 | |
| 523 | Polygon ZM | CO618 | 38 | 95217 | B | 103 | 0.985484 | 42927.70416 | 4.5 | 0.6 | 0.0018 | 0.009225914 | 0.04151661 | 0.00553555 | 1.6607E-05 | |
| 524 | Polygon ZM | CO618 | 74 | 95257 | A | 103 | 21.827027 | 950785.2921 | 5.0 | 1.0 | 0.0007 | 0.204340381 | 1.02170191 | 0.20434038 | 0.00014304 | |
| 525 | Polygon ZM | CO618 | 61 | 95243 | D | 103 | 0.814812 | 35493.19242 | 3.0 | 0.5 | 0.0018 | 0.007628108 | 0.02288432 | 0.00381405 | 1.3731E-05 | |
| 526 | Polygon ZM | CO618 | 53 | 95234 | A | 103 | 5.922801 | 257997.2301 | 5.0 | 1.0 | 0.0007 | 0.055448115 | 0.27724058 | 0.05544812 | 3.8814E-05 | |
| 527 | Polygon ZM | CO618 | 51 | 95232 | A | 103 | 9.25616 | 403198.3241 | 5.0 | 1.0 | 0.0007 | 0.086654369 | 0.43327184 | 0.08665437 | 6.0658E-05 | |
| 528 | Polygon ZM | CO618 | 74 | 95257 | A | 103 | 6.556095 | 285583.4818 | 5.0 | 1.0 | 0.0007 | 0.061376883 | 0.30688441 | 0.06137688 | 4.2964E-05 | |
| 529 | Polygon ZM | CO618 | 70 | 95253 | A | 103 | 5.741889 | 250116.6691 | 5.0 | 1.0 | 0.0007 | 0.053754445 | 0.26877222 | 0.05375444 | 3.7628E-05 | |
| 530 | Polygon ZM | CO618 | 47 | 95227 | B | 103 | 8.728088 | 380195.5117 | 4.5 | 0.6 | 0.0018 | 0.081710662 | 0.36769798 | 0.0490264 | 0.00014708 | |
| 531 | Polygon ZM | CO618 | 35 | 95214 | D | 103 | 5.352484 | 233154.1838 | 3.0 | 0.5 | 0.0018 | 0.05010891 | 0.15032673 | 0.02505446 | 9.0196E-05 | |
| 532 | Polygon ZM | CO618 | 35 | 95214 | A | 103 | 0.048538 | 2114.322797 | 5.0 | 1.0 | 0.0007 | 0.000454405 | 0.00227202 | 0.0004544 | 3.1808E-07 | |
| 533 | Polygon ZM | CO618 | 85 | 95269 | D | 103 | 11.717844 | 510429.2723 | 3.0 | 0.5 | 0.0018 | 0.109700174 | 0.32910052 | 0.05485009 | 0.00019746 | |
| 534 | Polygon ZM | CO618 | 53 | 95234 | A | 103 | 1.270078 | 55324.60575 | 5.0 | 1.0 | 0.0007 | 0.011890225 | 0.05945112 | 0.01189022 | 8.3232E-06 | |
| 547 | Polygon ZM | CO618 | 38 | 95217 | B | 103 | 1.330446 | 57954.23391 | 4.5 | 0.6 | 0.0018 | 0.012455378 | 0.0560492 | 0.00747323 | 2.242E-05 | |
| 566 | Polygon ZM | CO618 | 76 | 95259 | A | 103 | 3.485587 | 151832.1555 | 5.0 | 1.0 | 0.0007 | 0.032631385 | 0.16315692 | 0.03263138 | 2.2842E-05 | |
| 513 | Polygon ZM | CO618 | 74 | 95257 | A | 104 | 2.136393 | 93061.25984 | 5.0 | 1.0 | 0.0007 | 0.040894416 | 0.20447208 | 0.04089442 | 2.8626E-05 | |
| 514 | Polygon ZM | CO618 | 53 | 95234 | A | 104 | 2.100966 | 91518.09782 | 5.0 | 1.0 | 0.0007 | 0.040216296 | 0.20108148 | 0.0402163 | 2.8151E-05 | |
| 515 | Polygon ZM | CO618 | 48 | 95228 | B | 104 | 13.184006 | 574295.2869 | 4.5 | 0.6 | 0.0018 | 0.252365702 | 1.13564566 | 0.15141942 | 0.00045426 | |
| 516 | Polygon ZM | CO618 | 74 | 95257 | A | 104 | 0.572301 | 24929.41502 | 5.0 | 1.0 | 0.0007 | 0.010954868 | 0.05477434 | 0.01095487 | 7.6684E-06 | |
| 517 | Polygon ZM | CO618 | 70 | 95253 | A | 104 | 7.939424 | 345841.3155 | 5.0 | 1.0 | 0.0007 | 0.151974931 | 0.75987465 | 0.15197493 | 0.00010638 | |
| 518 | Polygon ZM | CO618 | 47 | 95227 | B | 104 | 16.024012 | 698005.9578 | 4.5 | 0.6 | 0.0018 | 0.306728555 | 1.3802785 | 0.18403713 | 0.00055211 | |
| 519 | Polygon ZM | CO618 | 35 | 95214 | D | 104 | 5.886737 | 256426.2729 | 3.0 | 0.5 | 0.0018 | 0.112682792 | 0.33804838 | 0.0563414 | 0.00020283 | |
| 520 | Polygon ZM | CO618 | 85 | 95269 | D | 104 | 0.004418 | 192.455518 | 3.0 | 0.5 | 0.0018 | 8.45718E-05 | 0.00025372 | 4.2286E-05 | 1.5223E-07 | |
| 521 | Polygon ZM | CO618 | 53 | 95234 | A | 104 | 1.098214 | 47838.19381 | 5.0 | 1.0 | 0.0007 | 0.021021798 | 0.10510899 | 0.0210218 | 1.4715E-05 | |
| 551 | Polygon ZM | CO618 | 48 | 95228 | B | 104 | 2.763065 | 120359.1139 | 4.5 | 0.6 | 0.0018 | 0.05289006 | 0.23800527 | 0.03173404 | 9.5202E-05 | |
| 565 | Polygon ZM | CO618 | 76 | 95259 | A | 104 | 0.532134 | 23179.76729 | 5.0 | 1.0 | 0.0007 | 0.010186011 | 0.05093006 | 0.01018601 | 7.1302E-06 | |
| 461 | Polygon ZM | CO618 | 74 | 95257 | A | 105 | 39.362337 | 1714623.401 | 5.0 | 1.0 | 0.0007 | 0.887817456 | 4.43908728 | 0.88781746 | 0.00062147 | |
| 480 | Polygon ZM | CO618 | 48 | 95228 | B | 105 | 0.213322 | 9292.304365 | 4.5 | 0.6 | 0.0018 | 0.004811476 | 0.02165164 | 0.00288689 | 8.6607E-06 | |
| 483 | Polygon ZM | CO618 | 51 | 95232 | A | 105 | 2.973201 | 129512.6168 | 5.0 | 1.0 | 0.0007 | 0.067060535 | 0.33530267 | 0.06706053 | 4.6942E-05 | |
| 497 | Polygon ZM | CO618 | 53 | 95234 | A | 105 | 1.787211 | 77850.89528 | 5.0 | 1.0 | 0.0007 | 0.040310533 | 0.20155267 | 0.04031053 | 2.8217E-05 | |
| 479 | Polygon ZM | CO618 | 74 | 95257 | A | 106 | 67.003906 | 2918690.125 | 5.0 | 1.0 | 0.0007 | 0.749490501 | 3.7474525 | 0.7494905 | 0.00052464 | |
| 482 | Polygon ZM | CO618 | 48 | 95228 | B | 106 | 15.9568 | 695078.2261 | 4.5 | 0.6 | 0.0018 | 0.178489153 | 0.80320119 | 0.10709349 | 0.00032128 | |
| 486 | Polygon ZM | CO618 | 48 | 95228 | B | 106 | 0.000263 | 11.471992 | 4.5 | 0.6 | 0.0018 | 2.94589E-06 | 1.3257E-05 | 1.7675E-06 | 5.3026E-09 | |
| 492 | Polygon ZM | CO618 | 76 | 95259 | A | 106 | 2.625245 | 114355.6755 | 5.0 | 1.0 | 0.0007 | 0.029365396 | 0.14682698 | 0.0293654 | 2.0556E-05 | |
| 494 | Polygon ZM | CO618 | 13 | 95190 | A | 106 | 3.813058 | 166096.8113 | 5.0 | 1.0 | 0.0007 | 0.042652004 | 0.21326002 | 0.042652 | 2.9856E-05 | |
| 503 | Polygon ZM | CO618 | 53 | 95234 | A | 107 | 20.620436 | 898226.2106 | 5.0 | 1.0 | 0.0007 | 0.158871134 | 0.79435567 | 0.15887113 | 0.00011121 | |
| 504 | Polygon ZM | CO618 | 38 | 95217 | B | 107 | 0.151929 | 6618.009314 | 4.5 | 0.6 | 0.0018 | 0.001170541 | 0.00526743 | 0.00070232 | 2.107E-06 | |
| 505 | Polygon ZM | CO618 | 13 | 95190 | A | 107 | 5.751693 | 250543.7679 | 5.0 | 1.0 | 0.0007 | 0.044314196 | 0.22157098 | 0.0443142 | 3.102E-05 | |
| 506 | Polygon ZM | CO618 | 48 | 95228 | B | 107 | 22.187964 | 966507.6934 | 4.5 | 0.6 | 0.0018 | 0.170948222 | 0.769267 | 0.10256893 | 0.00030771 | |
| 507 | Polygon ZM | CO618 | 70 | 95253 | A | 107 | 11.961853 | 521058.3141 | 5.0 | 1.0 | 0.0007 | 0.092160666 | 0.46080333 | 0.09216067 | 6.4512E-05 | |
| 508 | Polygon ZM | CO618 | 48 | 95228 | B | 107 | 17.89319 | 779427.3756 | 4.5 | 0.6 | 0.0018 | 0.137858938 | 0.62036522 | 0.08271536 | 0.00024815 | |
| 536 | Polygon ZM | CO618 | 47 | 95227 | B | 107 | 0.576559 | 25114.89152 | 4.5 | 0.6 | 0.0018 | 0.004442123 | 0.01998955 | 0.00266527 | 7.9958E-06 | |
| 550 | Polygon ZM | CO618 | 48 | 95228 | B | 107 | 13.707873 | 597114.9437 | 4.5 | 0.6 | 0.0018 | 0.10561296 | 0.47525832 | 0.06336778 | 0.0001901 | |
| 553 | Polygon ZM | CO618 | 47 | 95227 | B | 107 | 36.252118 | 1579142.241 | 4.5 | 0.6 | 0.0018 | 0.279306166 | 1.25687775 | 0.1675837 | 0.00050275 | |
| 557 | Polygon ZM | CO618 | 79 | 95262 | C | 107 | 0.689859 | 30050.27135 | 3.0 | 0.5 | 0.0018 | 0.005315054 | 0.01594516 | 0.00265753 | 9.5671E-06 | |
| 470 | Polygon ZM | CO618 | 74 | 95257 | A | 108 | 14.214748 | 619194.4279 | 5.0 | 1.0 | 0.0007 | 0.176994477 | 0.88497238 | 0.17699448 | 0.0001239 | |
| 481 | Polygon ZM | CO618 | 48 | 95228 | B | 108 | 5.459798 | 237828.7854 | 4.5 | 0.6 | 0.0018 | 0.067982494 | 0.30592122 | 0.0407895 | 0.00012237 | |
| 487 | Polygon ZM | CO618 | 13 | 95190 | A | 108 | 3.406982 | 148408.1289 | 5.0 | 1.0 | 0.0007 | 0.042421924 | 0.21210962 | 0.04242192 | 2.9695E-05 | |

| Final Values Used in CUHP | | | | |
|---|---|---|---|---|
| | | Infiltration (inches per hour) | | Decay Coefficient - a |
| Basin ID | Summed Weight | Initial - $f_i$ | Final - $f_o$ | |
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F |
| 489 | Polygon ZM | CO618 | 38 | 95217 | B | 108 | 46.638889 | 2031590 | 4.5 | 0.6 | 0.0018 | 0.580722618 | 2.61325178 | 0.34843357 | 0.0010453 |
| 493 | Polygon ZM | CO618 | 13 | 95190 | A | 108 | 3.678377 | 160230.0835 | 5.0 | 1.0 | 0.0007 | 0.045801187 | 0.22900594 | 0.04580119 | 3.2061E-05 |
| 495 | Polygon ZM | CO618 | 48 | 95228 | B | 108 | 1.983029 | 86380.76284 | 4.5 | 0.6 | 0.0018 | 0.024691627 | 0.11111232 | 0.01481498 | 4.4445E-05 |
| 496 | Polygon ZM | CO618 | 53 | 95234 | A | 108 | 4.929995 | 214750.5771 | 5.0 | 1.0 | 0.0007 | 0.061385672 | 0.30692836 | 0.06138567 | 4.297E-05 |
| 509 | Polygon ZM | CO618 | 53 | 95234 | A | 109 | 1.601852 | 69776.68068 | 5.0 | 1.0 | 0.0007 | 0.026269425 | 0.13134713 | 0.02626943 | 1.8389E-05 |
| 510 | Polygon ZM | CO618 | 38 | 95217 | B | 109 | 46.284214 | 2016140.369 | 4.5 | 0.6 | 0.0018 | 0.759033655 | 3.41565145 | 0.45542019 | 0.00136626 |
| 511 | Polygon ZM | CO618 | 48 | 95228 | B | 109 | 8.876639 | 386666.3869 | 4.5 | 0.6 | 0.0018 | 0.145571611 | 0.65507225 | 0.08734297 | 0.00026203 |
| 554 | Polygon ZM | CO618 | 47 | 95227 | B | 109 | 4.21511 | 183610.2062 | 4.5 | 0.6 | 0.0018 | 0.069125309 | 0.31106389 | 0.04147519 | 0.00012443 |
| 512 | Polygon ZM | CO618 | 48 | 95228 | B | 110 | 22.452167 | 978016.4057 | 4.5 | 0.6 | 0.0018 | 0.41972437 | 1.88875966 | 0.25183462 | 0.0007555 |
| 559 | Polygon ZM | CO618 | 79 | 95262 | C | 110 | 31.040479 | 1352123.267 | 3.0 | 0.5 | 0.0018 | 0.58027563 | 1.74082689 | 0.29013782 | 0.0010445 |
| 501 | Polygon ZM | CO618 | 70 | 95253 | A | 111 | 3.380948 | 147274.0764 | 5.0 | 1.0 | 0.0007 | 0.081099739 | 0.40549869 | 0.08109974 | 5.677E-05 |
| 502 | Polygon ZM | CO618 | 48 | 95228 | B | 111 | 12.217275 | 532184.5053 | 4.5 | 0.6 | 0.0018 | 0.293059209 | 1.31876644 | 0.17583553 | 0.00052751 |
| 535 | Polygon ZM | CO618 | 47 | 95227 | B | 111 | 6.873645 | 299415.978 | 4.5 | 0.6 | 0.0018 | 0.164880054 | 0.74196024 | 0.09892803 | 0.00029678 |
| 552 | Polygon ZM | CO618 | 47 | 95227 | B | 111 | 0.132486 | 5771.07013 | 4.5 | 0.6 | 0.0018 | 0.003177968 | 0.01430086 | 0.00190678 | 5.7203E-06 |
| 564 | Polygon ZM | CO618 | 76 | 95259 | A | 111 | 19.084407 | 831316.7711 | 5.0 | 1.0 | 0.0007 | 0.45778303 | 2.28891515 | 0.45778303 | 0.00032045 |
| 538 | Polygon ZM | CO618 | 47 | 95227 | B | 112 | 7.709256 | 335815.2015 | 4.5 | 0.6 | 0.0018 | 0.193768756 | 0.8719594 | 0.11626125 | 0.00034878 |
| 561 | Polygon ZM | CO618 | 79 | 95262 | C | 112 | 32.076602 | 1397256.778 | 3.0 | 0.5 | 0.0018 | 0.806231244 | 2.41869373 | 0.40311562 | 0.00145122 |
| 569 | Polygon ZM | CO618 | 61 | 95243 | D | 113 | 0.089207 | 3885.874281 | 3.0 | 0.5 | 0.0018 | 0.00210028 | 0.00630084 | 0.00105014 | 3.7805E-06 |
| 570 | Polygon ZM | CO618 | 76 | 95259 | A | 113 | 31.35492 | 1365820.313 | 5.0 | 1.0 | 0.0007 | 0.738213577 | 3.69106788 | 0.73821358 | 0.00051675 |
| 607 | Polygon ZM | CO618 | 4 | 95219 | D | 113 | 2.119722 | 92335.09479 | 3.0 | 0.5 | 0.0018 | 0.049906287 | 0.14971886 | 0.02495314 | 8.9831E-05 |
| 614 | Polygon ZM | CO618 | 73 | 95256 | A | 113 | 0.272864 | 11885.95728 | 5.0 | 1.0 | 0.0007 | 0.006424253 | 0.03212126 | 0.00642425 | 4.497E-06 |
| 617 | Polygon ZM | CO618 | 38 | 95217 | B | 113 | 1.500868 | 65377.7892 | 4.5 | 0.6 | 0.0018 | 0.035336106 | 0.15901248 | 0.02120166 | 6.3605E-05 |
| 621 | Polygon ZM | CO618 | 52 | 95233 | A | 113 | 7.004958 | 305135.9872 | 5.0 | 1.0 | 0.0007 | 0.164923253 | 0.82461626 | 0.16492325 | 0.00011545 |
| 624 | Polygon ZM | CO618 | 85 | 95269 | D | 113 | 0.13151 | 5728.577808 | 3.0 | 0.5 | 0.0018 | 0.003096245 | 0.00928873 | 0.00154812 | 5.5732E-06 |
| 691 | Polygon ZM | CO618 | 85 | 95269 | D | 114 | 3.91106 | 170365.758 | 3.0 | 0.5 | 0.0018 | 0.053732585 | 0.16119776 | 0.02686629 | 9.6719E-05 |
| 692 | Polygon ZM | CO618 | 76 | 95259 | A | 114 | 11.627716 | 506503.3136 | 5.0 | 1.0 | 0.0007 | 0.159748841 | 0.79874421 | 0.15974884 | 0.00011182 |
| 693 | Polygon ZM | CO618 | 48 | 95228 | B | 114 | 10.236928 | 445920.5709 | 4.5 | 0.6 | 0.0018 | 0.14064132 | 0.63288594 | 0.08438479 | 0.00025315 |
| 694 | Polygon ZM | CO618 | 73 | 95256 | A | 114 | 47.01178 | 2047833.129 | 5.0 | 1.0 | 0.0007 | 0.645877254 | 3.22938627 | 0.64587725 | 0.00045211 |
| 568 | Polygon ZM | CO618 | 76 | 95259 | A | 115 | 2.525021 | 109989.8959 | 5.0 | 1.0 | 0.0007 | 0.030215565 | 0.15107783 | 0.03021557 | 2.1151E-05 |
| 613 | Polygon ZM | CO618 | 73 | 95256 | A | 115 | 81.041862 | 3530183.5 | 5.0 | 1.0 | 0.0007 | 0.969784435 | 4.84892217 | 0.96978443 | 0.00067885 |
| 704 | Polygon ZM | CO618 | 48 | 95228 | B | 116 | 23.965616 | 1043942.247 | 4.5 | 0.6 | 0.0018 | 0.236413644 | 1.0638614 | 0.14184819 | 0.00042554 |
| 705 | Polygon ZM | CO618 | 73 | 95256 | A | 116 | 41.864545 | 1823619.584 | 5.0 | 1.0 | 0.0007 | 0.412981227 | 2.06490614 | 0.41298123 | 0.00028909 |
| 718 | Polygon ZM | CO618 | 47 | 95227 | B | 116 | 35.541384 | 1548182.672 | 4.5 | 0.6 | 0.0018 | 0.350605129 | 1.57772308 | 0.21036308 | 0.00063109 |
| 780 | Polygon ZM | CO618 | 18 | 95195 | B | 117 | 25.101721 | 1093430.946 | 4.5 | 0.6 | 0.0018 | 0.24960677 | 1.12323046 | 0.14976406 | 0.00044929 |
| 781 | Polygon ZM | CO618 | 44 | 95224 | B | 117 | 8.791875 | 382974.0775 | 4.5 | 0.6 | 0.0018 | 0.087424746 | 0.39341136 | 0.05245485 | 0.00015736 |
| 782 | Polygon ZM | CO618 | 47 | 95227 | B | 117 | 13.273684 | 578201.6545 | 4.5 | 0.6 | 0.0018 | 0.131991003 | 0.59395951 | 0.0791946 | 0.00023758 |
| 783 | Polygon ZM | CO618 | 52 | 95233 | A | 117 | 28.834779 | 1256042.957 | 5.0 | 1.0 | 0.0007 | 0.286727595 | 1.43363797 | 0.28672759 | 0.00020071 |
| 784 | Polygon ZM | CO618 | 48 | 95228 | B | 117 | 16.072499 | 700118.0429 | 4.5 | 0.6 | 0.0018 | 0.159821892 | 0.71919852 | 0.09589314 | 0.00028768 |
| 785 | Polygon ZM | CO618 | 73 | 95256 | A | 117 | 3.241053 | 141180.2581 | 5.0 | 1.0 | 0.0007 | 0.032228417 | 0.16114208 | 0.03222842 | 2.256E-05 |
| 790 | Polygon ZM | CO618 | 15 | 95192 | B | 117 | 3.51658 | 153182.2314 | 4.5 | 0.6 | 0.0018 | 0.034968209 | 0.15735694 | 0.02098093 | 6.2943E-05 |
| 791 | Polygon ZM | CO618 | 61 | 95243 | D | 117 | 1.732874 | 75483.97869 | 3.0 | 0.5 | 0.0018 | 0.017231369 | 0.05169411 | 0.00861568 | 3.1016E-05 |
| 702 | Polygon ZM | CO618 | 48 | 95228 | B | 118 | 4.501965 | 196105.5773 | 4.5 | 0.6 | 0.0018 | 0.061184545 | 0.27533045 | 0.03671073 | 0.00011013 |
| 703 | Polygon ZM | CO618 | 73 | 95256 | A | 118 | 47.013826 | 2047922.266 | 5.0 | 1.0 | 0.0007 | 0.638947625 | 3.19473813 | 0.63894763 | 0.00044726 |
| 717 | Polygon ZM | CO618 | 76 | 95259 | A | 118 | 22.064303 | 961121.0378 | 5.0 | 1.0 | 0.0007 | 0.299867829 | 1.49933915 | 0.29986783 | 0.00020991 |
| 698 | Polygon ZM | CO618 | 76 | 95259 | A | 119 | 0.166396 | 7248.218534 | 5.0 | 1.0 | 0.0007 | 0.071104675 | 0.35552338 | 0.07110468 | 4.9773E-05 |
| 699 | Polygon ZM | CO618 | 48 | 95228 | B | 119 | 2.173762 | 94689.08032 | 4.5 | 0.6 | 0.0018 | 0.928895325 | 4.18002896 | 0.55733719 | 0.00167201 |
| 706 | Polygon ZM | CO618 | 48 | 95228 | B | 120 | 2.005061 | 87340.438 | 4.5 | 0.6 | 0.0018 | 1 | 4.5 | 0.6 | 0.0018 |
| 700 | Polygon ZM | CO618 | 48 | 95228 | B | 121 | 1.059875 | 46168.17101 | 4.5 | 0.6 | 0.0018 | 0.57584392 | 2.59129764 | 0.34550635 | 0.00103652 |

| | | Final Values Used in CUHP | | |
|---|---|---|---|---|
| | | Infiltration (inches per hour) | | Decay Coefficient - a |
| Basin ID | Summed Weight | Initial - $f_i$ | Final - $f_o$ | |
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a | |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F | |
| 720 | Polygon ZM | CO618 | 47 | 95227 | B | 121 | 0.780685 | 34006.62882 | 4.5 | 0.6 | 0.0018 | 0.42415608 | 1.90870236 | 0.25449365 | 0.00076348 | |
| 758 | Polygon ZM | CO618 | 18 | 95195 | B | 122 | 1.763714 | 76827.38585 | 4.5 | 0.6 | 0.0018 | 0.37657313 | 1.69457909 | 0.22594388 | 0.00067783 | |
| 759 | Polygon ZM | CO618 | 44 | 95224 | B | 122 | 0.678932 | 29574.29561 | 4.5 | 0.6 | 0.0018 | 0.144959834 | 0.65231925 | 0.0869759 | 0.00026093 | |
| 760 | Polygon ZM | CO618 | 48 | 95228 | B | 122 | 1.105986 | 48176.73931 | 4.5 | 0.6 | 0.0018 | 0.236140607 | 1.06263273 | 0.14168436 | 0.00042505 | |
| 786 | Polygon ZM | CO618 | 15 | 95192 | B | 122 | 1.134958 | 49438.75337 | 4.5 | 0.6 | 0.0018 | 0.24232643 | 1.09046893 | 0.14539586 | 0.00043619 | |
| 582 | Polygon ZM | CO618 | 76 | 95259 | A | 123 | 4.23675 | 184552.8375 | 5.0 | 1.0 | 0.0007 | 0.053154429 | 0.26577215 | 0.05315443 | 3.7208E-05 | |
| 583 | Polygon ZM | CO618 | 61 | 95243 | D | 123 | 5.820119 | 253524.3718 | 3.0 | 0.5 | 0.0018 | 0.073019432 | 0.21905829 | 0.03650972 | 0.00013143 | |
| 584 | Polygon ZM | CO618 | 76 | 95259 | A | 123 | 15.488645 | 674685.3827 | 5.0 | 1.0 | 0.0007 | 0.194321133 | 0.97160567 | 0.19432113 | 0.00013602 | |
| 605 | Polygon ZM | CO618 | 48 | 95228 | B | 123 | 7.351094 | 320213.6642 | 4.5 | 0.6 | 0.0018 | 0.092227109 | 0.41502199 | 0.05533627 | 0.00016601 | |
| 610 | Polygon ZM | CO618 | 4 | 95219 | D | 123 | 11.38032 | 495726.7273 | 3.0 | 0.5 | 0.0018 | 0.142777926 | 0.42833378 | 0.07138896 | 0.000257 | |
| 620 | Polygon ZM | CO618 | 38 | 95217 | B | 123 | 11.293805 | 491958.1638 | 4.5 | 0.6 | 0.0018 | 0.141692514 | 0.63761631 | 0.08501551 | 0.00025505 | |
| 622 | Polygon ZM | CO618 | 52 | 95233 | A | 123 | 0.215003 | 9365.536034 | 5.0 | 1.0 | 0.0007 | 0.002697437 | 0.01348719 | 0.00269744 | 1.8882E-06 | |
| 635 | Polygon ZM | CO618 | 74 | 95257 | A | 123 | 23.9207 | 1041985.712 | 5.0 | 1.0 | 0.0007 | 0.300110021 | 1.5005501 | 0.30011002 | 0.00021008 | |
| 701 | Polygon ZM | CO618 | 48 | 95228 | B | 124 | 12.786562 | 556982.6524 | 4.5 | 0.6 | 0.0018 | 1 | 4.5 | 0.6 | 0.0018 | |
| 580 | Polygon ZM | CO618 | 76 | 95259 | A | 125 | 0.127226 | 5541.944973 | 5.0 | 1.0 | 0.0007 | 0.002376378 | 0.01188189 | 0.00237638 | 1.6635E-06 | |
| 581 | Polygon ZM | CO618 | 53 | 95234 | A | 125 | 1.283684 | 55917.2871 | 5.0 | 1.0 | 0.0007 | 0.023977251 | 0.11988625 | 0.02397725 | 1.6784E-05 | |
| 604 | Polygon ZM | CO618 | 48 | 95228 | B | 125 | 25.977216 | 1131567.529 | 4.5 | 0.6 | 0.0018 | 0.485214499 | 2.18346525 | 0.2911287 | 0.00087339 | |
| 609 | Polygon ZM | CO618 | 4 | 95219 | D | 125 | 0.061847 | 2694.054193 | 3.0 | 0.5 | 0.0018 | 0.001155206 | 0.00346562 | 0.0005776 | 2.0794E-06 | |
| 619 | Polygon ZM | CO618 | 38 | 95217 | B | 125 | 14.956586 | 651508.885 | 4.5 | 0.6 | 0.0018 | 0.279366056 | 1.25714725 | 0.16761963 | 0.00050286 | |
| 628 | Polygon ZM | CO618 | 47 | 95227 | B | 125 | 11.131033 | 484867.8169 | 4.5 | 0.6 | 0.0018 | 0.20791061 | 0.93559774 | 0.12474637 | 0.00037424 | |
| 578 | Polygon ZM | CO618 | 76 | 95259 | A | 126 | 6.782252 | 295434.8823 | 5.0 | 1.0 | 0.0007 | 0.146174597 | 0.73087298 | 0.1461746 | 0.00010232 | |
| 579 | Polygon ZM | CO618 | 53 | 95234 | A | 126 | 12.167935 | 530035.246 | 5.0 | 1.0 | 0.0007 | 0.262249629 | 1.31124815 | 0.26224963 | 0.00018357 | |
| 608 | Polygon ZM | CO618 | 4 | 95219 | D | 126 | 6.067569 | 264303.3044 | 3.0 | 0.5 | 0.0018 | 0.130771386 | 0.39231416 | 0.06538569 | 0.00023539 | |
| 618 | Polygon ZM | CO618 | 38 | 95217 | B | 126 | 2.904526 | 126521.136 | 4.5 | 0.6 | 0.0018 | 0.062599839 | 0.28169927 | 0.0375599 | 0.00011268 | |
| 627 | Polygon ZM | CO618 | 47 | 95227 | B | 126 | 4.774895 | 207994.4441 | 4.5 | 0.6 | 0.0018 | 0.102911016 | 0.46309957 | 0.06174661 | 0.00018524 | |
| 634 | Polygon ZM | CO618 | 74 | 95257 | A | 126 | 8.080472 | 351985.3802 | 5.0 | 1.0 | 0.0007 | 0.174154523 | 0.87077262 | 0.17415452 | 0.00012191 | |
| 638 | Polygon ZM | CO618 | 74 | 95257 | A | 126 | 5.620643 | 244835.2174 | 5.0 | 1.0 | 0.0007 | 0.12113901 | 0.60569505 | 0.12113901 | 8.4797E-05 | |
| 659 | Polygon ZM | CO618 | 76 | 95259 | A | 127 | 2.336909 | 101795.7465 | 5.0 | 1.0 | 0.0007 | 0.071966907 | 0.35983453 | 0.07196691 | 5.0377E-05 | |
| 660 | Polygon ZM | CO618 | 76 | 95259 | A | 127 | 4.470559 | 194737.5496 | 5.0 | 1.0 | 0.0007 | 0.137674309 | 0.68837154 | 0.13767431 | 9.6372E-05 | |
| 661 | Polygon ZM | CO618 | 53 | 95234 | A | 127 | 25.664524 | 1117946.654 | 5.0 | 1.0 | 0.0007 | 0.790358784 | 3.95179392 | 0.79035878 | 0.00055325 | |
| 598 | Polygon ZM | CO618 | 53 | 95234 | A | 128 | 22.920985 | 998438.1017 | 5.0 | 1.0 | 0.0007 | 0.544528014 | 2.72264007 | 0.54452801 | 0.00038117 | |
| 600 | Polygon ZM | CO618 | 47 | 95227 | B | 128 | 3.923191 | 170894.1895 | 4.5 | 0.6 | 0.0018 | 0.093202246 | 0.41941011 | 0.05592135 | 0.00016776 | |
| 601 | Polygon ZM | CO618 | 85 | 95269 | D | 128 | 0.032052 | 1396.192127 | 3.0 | 0.5 | 0.0018 | 0.000761455 | 0.00228437 | 0.00038073 | 1.3706E-06 | |
| 606 | Polygon ZM | CO618 | 48 | 95228 | B | 128 | 0.206071 | 8976.439788 | 4.5 | 0.6 | 0.0018 | 0.004895569 | 0.02203006 | 0.00293734 | 8.812E-06 | |
| 612 | Polygon ZM | CO618 | 4 | 95219 | D | 128 | 9.737382 | 424160.3477 | 3.0 | 0.5 | 0.0018 | 0.231328503 | 0.69398551 | 0.11566425 | 0.00041639 | |
| 629 | Polygon ZM | CO618 | 47 | 95227 | B | 128 | 2.912017 | 126847.4619 | 4.5 | 0.6 | 0.0018 | 0.069180049 | 0.31131022 | 0.04150803 | 0.00012452 | |
| 639 | Polygon ZM | CO618 | 74 | 95257 | A | 128 | 2.36161 | 102871.723 | 5.0 | 1.0 | 0.0007 | 0.056104164 | 0.28052082 | 0.05610416 | 3.9273E-05 | |
| 664 | Polygon ZM | CO618 | 47 | 95227 | B | 129 | 0.578474 | 25198.33505 | 4.5 | 0.6 | 0.0018 | 0.009959336 | 0.04481701 | 0.0059756 | 1.7927E-05 | |
| 665 | Polygon ZM | CO618 | 85 | 95269 | D | 129 | 3.782455 | 164763.7511 | 3.0 | 0.5 | 0.0018 | 0.065120872 | 0.19536262 | 0.03256044 | 0.00011722 | |
| 666 | Polygon ZM | CO618 | 4 | 95219 | D | 129 | 0.009844 | 428.787014 | 3.0 | 0.5 | 0.0018 | 0.000169473 | 0.00050842 | 8.4736E-05 | 3.0505E-07 | |
| 667 | Polygon ZM | CO618 | 53 | 95234 | A | 129 | 33.96675 | 1479591.629 | 5.0 | 1.0 | 0.0007 | 0.584790629 | 2.92395315 | 0.58479063 | 0.00040935 | |
| 680 | Polygon ZM | CO618 | 61 | 95243 | D | 129 | 2.071449 | 90232.32656 | 3.0 | 0.5 | 0.0018 | 0.035663232 | 0.10698969 | 0.01783162 | 6.4194E-05 | |
| 683 | Polygon ZM | CO618 | 26 | 95204 | B | 129 | 1.766733 | 76958.88672 | 4.5 | 0.6 | 0.0018 | 0.030417066 | 0.1368768 | 0.01825024 | 5.4751E-05 | |
| 689 | Polygon ZM | CO618 | 47 | 95227 | B | 129 | 15.907903 | 692948.2719 | 4.5 | 0.6 | 0.0018 | 0.273879392 | 1.23245726 | 0.16432764 | 0.00049298 | |
| 674 | Polygon ZM | CO618 | 15 | 95192 | B | 130 | 0.181206 | 7893.332546 | 4.5 | 0.6 | 0.0018 | 0.001858849 | 0.00836482 | 0.00111531 | 3.3459E-06 | |
| 675 | Polygon ZM | CO618 | 33 | 95212 | A | 130 | 18.759594 | 817167.9295 | 5.0 | 1.0 | 0.0007 | 0.192439895 | 0.96219947 | 0.19243989 | 0.00013471 | |
| 676 | Polygon ZM | CO618 | 80 | 95264 | C | 130 | 0.639757 | 27867.79982 | 3.0 | 0.5 | 0.0018 | 0.006562759 | 0.01968828 | 0.00328138 | 1.1813E-05 | |
| 677 | Polygon ZM | CO618 | 18 | 95195 | B | 130 | 11.887399 | 517815.1209 | 4.5 | 0.6 | 0.0018 | 0.121943463 | 0.54874558 | 0.07316608 | 0.0002195 | |

| | | Final Values Used in CUHP | | |
|---|---|---|---|---|
| | | Infiltration (inches per hour) | | Decay Coefficient - a |
| Basin ID | Summed Weight | Initial - $f_i$ | Final - $f_o$ | |
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a | |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F | |
| 678 | Polygon ZM | CO618 | 53 | 95234 | A | 130 | 31.526123 | 1373277.916 | 5.0 | 1.0 | 0.0007 | 0.323401651 | 1.61700825 | 0.32340165 | 0.00022638 | |
| 681 | Polygon ZM | CO618 | 61 | 95243 | D | 130 | 0.21157 | 9215.986706 | 3.0 | 0.5 | 0.0018 | 0.002170329 | 0.00651099 | 0.00108516 | 3.9066E-06 | |
| 690 | Polygon ZM | CO618 | 47 | 95227 | B | 130 | 34.277226 | 1493115.984 | 4.5 | 0.6 | 0.0018 | 0.351623054 | 1.58230374 | 0.21097383 | 0.00063292 | |
| 662 | Polygon ZM | CO618 | 33 | 95212 | A | 131 | 0.000265 | 11.543921 | 5.0 | 1.0 | 0.0007 | 9.6958E-06 | 4.8479E-05 | 9.6958E-06 | 6.7871E-09 | |
| 663 | Polygon ZM | CO618 | 53 | 95234 | A | 131 | 21.543954 | 938454.6477 | 5.0 | 1.0 | 0.0007 | 0.788212836 | 3.94106418 | 0.78821284 | 0.00055175 | |
| 679 | Polygon ZM | CO618 | 61 | 95243 | D | 131 | 3.930938 | 171231.6406 | 3.0 | 0.5 | 0.0018 | 0.143818327 | 0.43145498 | 0.07190916 | 0.00025887 | |
| 682 | Polygon ZM | CO618 | 26 | 95204 | B | 131 | 1.857504 | 80912.88201 | 4.5 | 0.6 | 0.0018 | 0.067959142 | 0.30581614 | 0.04077548 | 0.00012233 | |
| 645 | Polygon ZM | CO618 | 33 | 95212 | A | 132 | 12.066466 | 525615.2706 | 5.0 | 1.0 | 0.0007 | 0.293192212 | 1.46596106 | 0.29319221 | 0.00020523 | |
| 646 | Polygon ZM | CO618 | 80 | 95264 | C | 132 | 10.556561 | 459843.7858 | 3.0 | 0.5 | 0.0018 | 0.256504375 | 0.76951313 | 0.12825219 | 0.00046171 | |
| 647 | Polygon ZM | CO618 | 18 | 95195 | B | 132 | 0.033509 | 1459.632946 | 4.5 | 0.6 | 0.0018 | 0.000814194 | 0.00366387 | 0.00048852 | 1.4655E-06 | |
| 648 | Polygon ZM | CO618 | 53 | 95234 | A | 132 | 18.498945 | 805814.0281 | 5.0 | 1.0 | 0.0007 | 0.449489218 | 2.24744609 | 0.44948922 | 0.00031464 | |
| 537 | Polygon ZM | CO618 | 47 | 95227 | B | 133 | 0.126673 | 5517.893815 | 4.5 | 0.6 | 0.0018 | 0.001302919 | 0.00586314 | 0.00078175 | 2.3453E-06 | |
| 541 | Polygon ZM | CO618 | 64 | 95246 | C | 133 | 2.661368 | 115929.2096 | 3.0 | 0.5 | 0.0018 | 0.027373925 | 0.08212177 | 0.01368696 | 4.9273E-05 | |
| 544 | Polygon ZM | CO618 | 53 | 95234 | A | 133 | 3.667885 | 159773.0901 | 5.0 | 1.0 | 0.0007 | 0.037726614 | 0.18863307 | 0.03772661 | 2.6409E-05 | |
| 549 | Polygon ZM | CO618 | 18 | 95195 | B | 133 | 2.488736 | 108409.3449 | 4.5 | 0.6 | 0.0018 | 0.025598287 | 0.11519229 | 0.01535897 | 4.6077E-05 | |
| 555 | Polygon ZM | CO618 | 80 | 95264 | C | 133 | 46.747361 | 2036315.026 | 3.0 | 0.5 | 0.0018 | 0.480827344 | 1.44248203 | 0.24041367 | 0.00086549 | |
| 556 | Polygon ZM | CO618 | 15 | 95192 | B | 133 | 17.133259 | 746324.7678 | 4.5 | 0.6 | 0.0018 | 0.176226837 | 0.79302077 | 0.1057361 | 0.00031721 | |
| 560 | Polygon ZM | CO618 | 79 | 95262 | C | 133 | 24.397475 | 1062754.009 | 3.0 | 0.5 | 0.0018 | 0.250944074 | 0.75283222 | 0.12547204 | 0.0004517 | |
| 540 | Polygon ZM | CO618 | 64 | 95246 | C | 134 | 8.824911 | 384413.1177 | 3.0 | 0.5 | 0.0018 | 0.39129457 | 1.17388371 | 0.19564728 | 0.00070433 | |
| 542 | Polygon ZM | CO618 | 15 | 95192 | B | 134 | 0.729611 | 31781.85491 | 4.5 | 0.6 | 0.0018 | 0.032350788 | 0.14557855 | 0.01941047 | 5.8231E-05 | |
| 548 | Polygon ZM | CO618 | 18 | 95195 | B | 134 | 0.416438 | 18140.05663 | 4.5 | 0.6 | 0.0018 | 0.018464785 | 0.08309153 | 0.01107887 | 3.3237E-05 | |
| 558 | Polygon ZM | CO618 | 79 | 95262 | C | 134 | 12.582153 | 548078.5984 | 3.0 | 0.5 | 0.0018 | 0.557889857 | 1.67366957 | 0.27894493 | 0.0010042 | |
| 641 | Polygon ZM | CO618 | 53 | 95234 | A | 135 | 7.363333 | 320746.8029 | 5.0 | 1.0 | 0.0007 | 0.488800466 | 2.44400233 | 0.48880047 | 0.00034216 | |
| 687 | Polygon ZM | CO618 | 47 | 95227 | B | 135 | 7.700755 | 335444.8847 | 4.5 | 0.6 | 0.0018 | 0.511199534 | 2.3003979 | 0.30671972 | 0.00092016 | |
| 709 | Polygon ZM | CO618 | 85 | 95269 | D | 136 | 5.854392 | 255017.3007 | 3.0 | 0.5 | 0.0018 | 0.087306481 | 0.26191944 | 0.04365324 | 0.00015715 | |
| 710 | Polygon ZM | CO618 | 4 | 95219 | D | 136 | 0.041748 | 1818.53797 | 3.0 | 0.5 | 0.0018 | 0.000622586 | 0.00186776 | 0.00031129 | 1.1207E-06 | |
| 711 | Polygon ZM | CO618 | 44 | 95224 | B | 136 | 18.179538 | 791900.6806 | 4.5 | 0.6 | 0.0018 | 0.27111126 | 1.22000067 | 0.16266676 | 0.000488 | |
| 712 | Polygon ZM | CO618 | 48 | 95228 | B | 136 | 2.083678 | 90765.01445 | 4.5 | 0.6 | 0.0018 | 0.031073868 | 0.13983241 | 0.01864432 | 5.5933E-05 | |
| 713 | Polygon ZM | CO618 | 53 | 95234 | A | 136 | 40.896281 | 1781441.995 | 5.0 | 1.0 | 0.0007 | 0.609885805 | 3.04942902 | 0.6098858 | 0.00042692 | |
| 695 | Polygon ZM | CO618 | 44 | 95224 | B | 137 | 32.504634 | 1415901.836 | 4.5 | 0.6 | 0.0018 | 0.369681817 | 1.66356818 | 0.22180909 | 0.00066543 | |
| 696 | Polygon ZM | CO618 | 48 | 95228 | B | 137 | 36.548743 | 1592063.226 | 4.5 | 0.6 | 0.0018 | 0.415676293 | 1.87054332 | 0.24940578 | 0.00074822 | |
| 697 | Polygon ZM | CO618 | 53 | 95234 | A | 137 | 17.077837 | 743910.573 | 5.0 | 1.0 | 0.0007 | 0.194229717 | 0.97114858 | 0.19422972 | 0.00013596 | |
| 719 | Polygon ZM | CO618 | 47 | 95227 | B | 137 | 1.79476 | 78179.75076 | 4.5 | 0.6 | 0.0018 | 0.020412172 | 0.09185478 | 0.0122473 | 3.6742E-05 | |
| 761 | Polygon ZM | CO618 | 18 | 95195 | B | 138 | 26.7542 | 1165412.95 | 4.5 | 0.6 | 0.0018 | 0.385072669 | 1.73282701 | 0.2310436 | 0.00069313 | |
| 762 | Polygon ZM | CO618 | 44 | 95224 | B | 138 | 12.502269 | 544598.8472 | 4.5 | 0.6 | 0.0018 | 0.179944912 | 0.80975211 | 0.10796695 | 0.0003239 | |
| 763 | Polygon ZM | CO618 | 48 | 95228 | B | 138 | 5.729772 | 249588.8783 | 4.5 | 0.6 | 0.0018 | 0.082468498 | 0.37110824 | 0.0494811 | 0.00014844 | |
| 787 | Polygon ZM | CO618 | 15 | 95192 | B | 138 | 24.492073 | 1066874.703 | 4.5 | 0.6 | 0.0018 | 0.352513921 | 1.58631265 | 0.21150835 | 0.00063453 | |
| 764 | Polygon ZM | CO618 | 18 | 95195 | B | 139 | 9.177768 | 399783.5804 | 4.5 | 0.6 | 0.0018 | 0.590167676 | 2.65575454 | 0.35410061 | 0.0010623 | |
| 765 | Polygon ZM | CO618 | 44 | 95224 | B | 139 | 6.247819 | 272155.0127 | 4.5 | 0.6 | 0.0018 | 0.4017601 | 1.80792045 | 0.24105606 | 0.00072317 | |
| 766 | Polygon ZM | CO618 | 48 | 95228 | B | 139 | 0.125532 | 5468.178972 | 4.5 | 0.6 | 0.0018 | 0.008072224 | 0.03632501 | 0.00484333 | 1.453E-05 | |
| 707 | Polygon ZM | CO618 | 85 | 95269 | D | 140 | 0.662746 | 28869.19453 | 3.0 | 0.5 | 0.0018 | 0.046335926 | 0.13900778 | 0.02316796 | 8.3405E-05 | |
| 708 | Polygon ZM | CO618 | 53 | 95234 | A | 140 | 13.640314 | 594172.0853 | 5.0 | 1.0 | 0.0007 | 0.953664074 | 4.76832037 | 0.95366407 | 0.00066756 | |
| 722 | Polygon ZM | CO618 | 79 | 95262 | C | 141 | 14.651527 | 638220.5084 | 3.0 | 0.5 | 0.0018 | 0.440687985 | 1.32206395 | 0.22034399 | 0.00079324 | |
| 723 | Polygon ZM | CO618 | 53 | 95234 | A | 141 | 18.595413 | 810016.1822 | 5.0 | 1.0 | 0.0007 | 0.559312015 | 2.79656008 | 0.55931202 | 0.00039152 | |
| 735 | Polygon ZM | CO618 | 18 | 95195 | B | 142 | 1.251641 | 54521.47475 | 4.5 | 0.6 | 0.0018 | 0.030145006 | 0.13565253 | 0.018087 | 5.4261E-05 | |
| 736 | Polygon ZM | CO618 | 79 | 95262 | C | 142 | 0.998666 | 43501.91151 | 3.0 | 0.5 | 0.0018 | 0.024052273 | 0.07215682 | 0.01202614 | 4.3294E-05 | |
| 737 | Polygon ZM | CO618 | 53 | 95234 | A | 142 | 26.474011 | 1153207.905 | 5.0 | 1.0 | 0.0007 | 0.637610393 | 3.18805197 | 0.63761039 | 0.00044633 | |
| 755 | Polygon ZM | CO618 | 79 | 95262 | C | 142 | 12.796352 | 557409.0906 | 3.0 | 0.5 | 0.0018 | 0.308192329 | 0.92457699 | 0.15409616 | 0.00055475 | |

| Final Values Used in CUHP | | | | |
|---|---|---|---|---|
| | | Infiltration (inches per hour) | | Decay Coefficient - a |
| Basin ID | Summed Weight | Initial - $f_i$ | Final - $f_o$ | |
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a | |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F | |
| 724 | Polygon ZM | CO618 | 18 | 95195 | B | 143 | 17.714066 | 771624.7056 | 4.5 | 0.6 | 0.0018 | 0.2567112 | 1.1552004 | 0.15402672 | 0.00046208 | |
| 725 | Polygon ZM | CO618 | 79 | 95262 | C | 143 | 23.769148 | 1035384.106 | 3.0 | 0.5 | 0.0018 | 0.344461102 | 1.03338331 | 0.17223055 | 0.00062003 | |
| 726 | Polygon ZM | CO618 | 53 | 95234 | A | 143 | 21.040992 | 916545.6314 | 5.0 | 1.0 | 0.0007 | 0.304924826 | 1.52462413 | 0.30492483 | 0.00021345 | |
| 752 | Polygon ZM | CO618 | 79 | 95262 | C | 143 | 6.479661 | 282254.0463 | 3.0 | 0.5 | 0.0018 | 0.093902871 | 0.28170861 | 0.04695144 | 0.00016903 | |
| 649 | Polygon ZM | CO618 | 18 | 95195 | B | 144 | 0.601474 | 26200.2169 | 4.5 | 0.6 | 0.0018 | 0.012006614 | 0.05402976 | 0.00720397 | 2.1612E-05 | |
| 650 | Polygon ZM | CO618 | 53 | 95234 | A | 144 | 35.602739 | 1550855.323 | 5.0 | 1.0 | 0.0007 | 0.710701052 | 3.55350526 | 0.71070105 | 0.00049749 | |
| 685 | Polygon ZM | CO618 | 79 | 95262 | C | 144 | 13.891026 | 605093.0844 | 3.0 | 0.5 | 0.0018 | 0.277292334 | 0.831877 | 0.13864617 | 0.00049913 | |
| 642 | Polygon ZM | CO618 | 18 | 95195 | B | 145 | 24.210589 | 1054613.252 | 4.5 | 0.6 | 0.0018 | 0.406025959 | 1.82711681 | 0.24361558 | 0.00073085 | |
| 643 | Polygon ZM | CO618 | 79 | 95262 | C | 145 | 1.820431 | 79297.95636 | 3.0 | 0.5 | 0.0018 | 0.030529702 | 0.09158911 | 0.01526485 | 5.4953E-05 | |
| 644 | Polygon ZM | CO618 | 53 | 95234 | A | 145 | 15.617711 | 680307.5071 | 5.0 | 1.0 | 0.0007 | 0.261918298 | 1.30959149 | 0.2619183 | 0.00018334 | |
| 684 | Polygon ZM | CO618 | 79 | 95262 | C | 145 | 17.979449 | 783184.7991 | 3.0 | 0.5 | 0.0018 | 0.301526041 | 0.90457812 | 0.15076302 | 0.00054275 | |
| 655 | Polygon ZM | CO618 | 15 | 95192 | B | 146 | 2.561307 | 111570.5307 | 4.5 | 0.6 | 0.0018 | 0.043610978 | 0.1962494 | 0.02616659 | 7.85E-05 | |
| 656 | Polygon ZM | CO618 | 79 | 95262 | C | 146 | 0.0051 | 222.16596 | 3.0 | 0.5 | 0.0018 | 8.68408E-05 | 0.00026052 | 4.342E-05 | 1.5631E-07 | |
| 657 | Polygon ZM | CO618 | 18 | 95195 | B | 146 | 51.430922 | 2240330.962 | 4.5 | 0.6 | 0.0018 | 0.875706378 | 3.9406787 | 0.52542383 | 0.00157627 | |
| 658 | Polygon ZM | CO618 | 53 | 95234 | A | 146 | 0.292043 | 12721.38449 | 5.0 | 1.0 | 0.0007 | 0.004972568 | 0.02486284 | 0.00497257 | 3.4808E-06 | |
| 686 | Polygon ZM | CO618 | 79 | 95262 | C | 146 | 3.374023 | 146972.4491 | 3.0 | 0.5 | 0.0018 | 0.057448972 | 0.17234692 | 0.02872449 | 0.00010341 | |
| 688 | Polygon ZM | CO618 | 47 | 95227 | B | 146 | 1.067389 | 46495.45268 | 4.5 | 0.6 | 0.0018 | 0.018174263 | 0.08178418 | 0.01090456 | 3.2714E-05 | |
| 668 | Polygon ZM | CO618 | 15 | 95192 | B | 147 | 0.163814 | 7135.718325 | 4.5 | 0.6 | 0.0018 | 0.001814 | 0.008163 | 0.0010884 | 3.2652E-06 | |
| 669 | Polygon ZM | CO618 | 64 | 95246 | C | 147 | 1.133911 | 49393.16348 | 3.0 | 0.5 | 0.0018 | 0.012556439 | 0.03766932 | 0.00627822 | 2.2602E-05 | |
| 670 | Polygon ZM | CO618 | 79 | 95262 | C | 147 | 5.492898 | 239270.6484 | 3.0 | 0.5 | 0.0018 | 0.060825973 | 0.18247792 | 0.03041299 | 0.00010949 | |
| 671 | Polygon ZM | CO618 | 18 | 95195 | B | 147 | 73.251151 | 3190820.126 | 4.5 | 0.6 | 0.0018 | 0.811151469 | 3.65018161 | 0.48669088 | 0.00146007 | |
| 672 | Polygon ZM | CO618 | 79 | 95262 | C | 147 | 9.601955 | 418261.18 | 3.0 | 0.5 | 0.0018 | 0.10632789 | 0.31898367 | 0.05316394 | 0.00019139 | |
| 673 | Polygon ZM | CO618 | 53 | 95234 | A | 147 | 0.661416 | 28811.26677 | 5.0 | 1.0 | 0.0007 | 0.00732423 | 0.03662115 | 0.00732423 | 5.127E-06 | |
| 651 | Polygon ZM | CO618 | 64 | 95246 | C | 148 | 0.416561 | 18145.4149 | 3.0 | 0.5 | 0.0018 | 0.007869787 | 0.02360936 | 0.00393489 | 1.4166E-05 | |
| 652 | Polygon ZM | CO618 | 79 | 95262 | C | 148 | 2.00974 | 87544.2601 | 3.0 | 0.5 | 0.0018 | 0.037968527 | 0.11390558 | 0.01898426 | 6.8343E-05 | |
| 653 | Polygon ZM | CO618 | 18 | 95195 | B | 148 | 16.906743 | 736457.7386 | 4.5 | 0.6 | 0.0018 | 0.31940661 | 1.43732974 | 0.19164397 | 0.00057493 | |
| 654 | Polygon ZM | CO618 | 79 | 95262 | C | 148 | 33.598682 | 1463558.591 | 3.0 | 0.5 | 0.0018 | 0.634755076 | 1.90426523 | 0.31737754 | 0.00114256 | |
| 714 | Polygon ZM | CO618 | 44 | 95224 | B | 149 | 27.963617 | 1218095.166 | 4.5 | 0.6 | 0.0018 | 0.244562152 | 1.10052969 | 0.14673729 | 0.00044021 | |
| 715 | Polygon ZM | CO618 | 53 | 95234 | A | 149 | 36.278157 | 1580276.531 | 5.0 | 1.0 | 0.0007 | 0.317278847 | 1.58639424 | 0.31727885 | 0.0002221 | |
| 716 | Polygon ZM | CO618 | 18 | 95195 | B | 149 | 30.330102 | 1321179.245 | 4.5 | 0.6 | 0.0018 | 0.265258782 | 1.19366452 | 0.15915527 | 0.00047747 | |
| 721 | Polygon ZM | CO618 | 79 | 95262 | C | 149 | 19.76968 | 861167.2652 | 3.0 | 0.5 | 0.0018 | 0.172900218 | 0.51870065 | 0.08645011 | 0.00031122 | |
| 778 | Polygon ZM | CO618 | 18 | 95195 | B | 150 | 83.479201 | 3636354.01 | 4.5 | 0.6 | 0.0018 | 0.770553558 | 3.46749101 | 0.46233213 | 0.001387 | |
| 779 | Polygon ZM | CO618 | 79 | 95262 | C | 150 | 24.857462 | 1082791.043 | 3.0 | 0.5 | 0.0018 | 0.229446442 | 0.68833933 | 0.11472322 | 0.000413 | |
| 769 | Polygon ZM | CO618 | 18 | 95195 | B | 151 | 40.081973 | 1745970.749 | 4.5 | 0.6 | 0.0018 | 0.746179451 | 3.35780753 | 0.44770767 | 0.00134312 | |
| 788 | Polygon ZM | CO618 | 15 | 95192 | B | 151 | 9.203803 | 400917.6744 | 4.5 | 0.6 | 0.0018 | 0.171341089 | 0.7710349 | 0.10280465 | 0.00030841 | |
| 792 | Polygon ZM | CO618 | 79 | 95262 | C | 151 | 4.430489 | 192992.0791 | 3.0 | 0.5 | 0.0018 | 0.082479459 | 0.24743838 | 0.04123973 | 0.00014846 | |
| 775 | Polygon ZM | CO618 | 18 | 95195 | B | 152 | 53.905478 | 2348122.604 | 4.5 | 0.6 | 0.0018 | 0.577626612 | 2.59931975 | 0.34657597 | 0.00103973 | |
| 776 | Polygon ZM | CO618 | 79 | 95262 | C | 152 | 15.005361 | 653633.5041 | 3.0 | 0.5 | 0.0018 | 0.160790627 | 0.48237188 | 0.08039531 | 0.00028942 | |
| 789 | Polygon ZM | CO618 | 15 | 95192 | B | 152 | 3.591474 | 156444.6258 | 4.5 | 0.6 | 0.0018 | 0.038484609 | 0.17318074 | 0.02309077 | 6.9272E-05 | |
| 793 | Polygon ZM | CO618 | 79 | 95262 | C | 152 | 20.820046 | 906921.1891 | 3.0 | 0.5 | 0.0018 | 0.223098152 | 0.66929446 | 0.11154908 | 0.00040158 | |
| 747 | Polygon ZM | CO618 | 79 | 95262 | C | 153 | 1.151073 | 50140.74911 | 3.0 | 0.5 | 0.0018 | 0.019242191 | 0.05772657 | 0.0096211 | 3.4636E-05 | |
| 748 | Polygon ZM | CO618 | 53 | 95234 | A | 153 | 57.438366 | 2502015.234 | 5.0 | 1.0 | 0.0007 | 0.960182195 | 4.80091098 | 0.9601822 | 0.00067213 | |
| 757 | Polygon ZM | CO618 | 79 | 95262 | C | 153 | 1.230839 | 53615.34509 | 3.0 | 0.5 | 0.0018 | 0.020575614 | 0.06172684 | 0.01028781 | 3.7036E-05 | |
| 727 | Polygon ZM | CO618 | 53 | 95234 | A | 154 | 21.100157 | 919122.8334 | 5.0 | 1.0 | 0.0007 | 0.413537197 | 2.06768598 | 0.4135372 | 0.00028948 | |
| 753 | Polygon ZM | CO618 | 79 | 95262 | C | 154 | 29.923444 | 1303465.22 | 3.0 | 0.5 | 0.0018 | 0.586462803 | 1.75938841 | 0.2932314 | 0.00105563 | |
| 728 | Polygon ZM | CO618 | 79 | 95262 | C | 155 | 6.660558 | 290133.9233 | 3.0 | 0.5 | 0.0018 | 0.221444208 | 0.66433263 | 0.1107221 | 0.0003986 | |
| 729 | Polygon ZM | CO618 | 18 | 95195 | B | 155 | 1.73333 | 75503.85922 | 4.5 | 0.6 | 0.0018 | 0.057628188 | 0.25932685 | 0.03457691 | 0.00010373 | |
| 730 | Polygon ZM | CO618 | 53 | 95234 | A | 155 | 10.469261 | 456041.0157 | 5.0 | 1.0 | 0.0007 | 0.348072506 | 1.74036253 | 0.34807251 | 0.00024365 | |

| Final Values Used in CUHP | | | | |
|---|---|---|---|---|
| | | Infiltration (inches per hour) | | Decay Coefficient - a |
| Basin ID | Summed Weight | Initial - $f_i$ | Final - $f_o$ | |
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |

## CUHP Soils - Backup Calculations

**Recommended Horton's Equation Parameters**

| NRCS Hydrologic Soil Group | Infiltration (inches per hour) Initial - $f_i$ | Infiltration (inches per hour) Final - $f_o$ | Decay Coefficient - a |
|---|---|---|---|
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a | |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F | |
| 754 | Polygon ZM | CO618 | 79 | 95262 | C | 155 | 11.214667 | 488510.9126 | 3.0 | 0.5 | 0.0018 | 0.372855098 | 1.11856529 | 0.18642755 | 0.00067114 | |
| 743 | Polygon ZM | CO618 | 79 | 95262 | C | 156 | 1.854944 | 80801.36205 | 3.0 | 0.5 | 0.0018 | 0.014581403 | 0.04374421 | 0.0072907 | 2.6247E-05 | |
| 744 | Polygon ZM | CO618 | 18 | 95195 | B | 156 | 112.914396 | 4918551.083 | 4.5 | 0.6 | 0.0018 | 0.887601063 | 3.99420478 | 0.53256064 | 0.00159768 | |
| 745 | Polygon ZM | CO618 | 79 | 95262 | C | 156 | 0.8045 | 35044.03015 | 3.0 | 0.5 | 0.0018 | 0.006324041 | 0.01897212 | 0.00316202 | 1.1383E-05 | |
| 746 | Polygon ZM | CO618 | 53 | 95234 | A | 156 | 0.257416 | 11213.03836 | 5.0 | 1.0 | 0.0007 | 0.002023503 | 0.01011752 | 0.0020235 | 1.4165E-06 | |
| 751 | Polygon ZM | CO618 | 15 | 95192 | B | 156 | 1.513879 | 65944.58432 | 4.5 | 0.6 | 0.0018 | 0.011900351 | 0.05355158 | 0.00714021 | 2.1421E-05 | |
| 756 | Polygon ZM | CO618 | 79 | 95262 | C | 156 | 9.867867 | 429844.2711 | 3.0 | 0.5 | 0.0018 | 0.077569639 | 0.23270892 | 0.03878482 | 0.00013963 | |
| 738 | Polygon ZM | CO618 | 18 | 95195 | B | 157 | 57.461918 | 2503041.157 | 4.5 | 0.6 | 0.0018 | 0.610097277 | 2.74543775 | 0.36605837 | 0.00109818 | |
| 739 | Polygon ZM | CO618 | 79 | 95262 | C | 157 | 29.574815 | 1288278.962 | 3.0 | 0.5 | 0.0018 | 0.314008216 | 0.94202465 | 0.15700411 | 0.00056521 | |
| 749 | Polygon ZM | CO618 | 15 | 95192 | B | 157 | 7.148112 | 311371.7796 | 4.5 | 0.6 | 0.0018 | 0.075894507 | 0.34152528 | 0.0455367 | 0.00013661 | |
| 731 | Polygon ZM | CO618 | 79 | 95262 | C | 158 | 4.447343 | 193726.2603 | 3.0 | 0.5 | 0.0018 | 0.454413965 | 1.3632419 | 0.22720698 | 0.00081795 | |
| 732 | Polygon ZM | CO618 | 53 | 95234 | A | 158 | 5.339643 | 232594.8371 | 5.0 | 1.0 | 0.0007 | 0.545586035 | 2.72793017 | 0.54558603 | 0.00038191 | |
| 733 | Polygon ZM | CO618 | 79 | 95262 | C | 159 | 10.034417 | 437099.2034 | 3.0 | 0.5 | 0.0018 | 0.564019515 | 1.69205855 | 0.28200976 | 0.00101524 | |
| 734 | Polygon ZM | CO618 | 18 | 95195 | B | 159 | 7.756487 | 337872.5693 | 4.5 | 0.6 | 0.0018 | 0.435980485 | 1.96191218 | 0.26158829 | 0.00078476 | |
| 740 | Polygon ZM | CO618 | 79 | 95262 | C | 160 | 16.456221 | 716832.9993 | 3.0 | 0.5 | 0.0018 | 0.15582618 | 0.46747854 | 0.07791309 | 0.00028049 | |
| 741 | Polygon ZM | CO618 | 18 | 95195 | B | 160 | 27.389261 | 1193076.202 | 4.5 | 0.6 | 0.0018 | 0.259352607 | 1.16708673 | 0.15561156 | 0.00046683 | |
| 742 | Polygon ZM | CO618 | 79 | 95262 | C | 160 | 26.776789 | 1166396.907 | 3.0 | 0.5 | 0.0018 | 0.253553024 | 0.76065907 | 0.12677651 | 0.0004564 | |
| 750 | Polygon ZM | CO618 | 15 | 95192 | B | 160 | 34.983997 | 1523902.908 | 4.5 | 0.6 | 0.0018 | 0.331268189 | 1.49070685 | 0.19876091 | 0.00059628 | |
| 806 | Polygon ZM | CO618 | 79 | 95262 | C | 161 | 13.145152 | 572602.8374 | 3.0 | 0.5 | 0.0018 | 0.184754637 | 0.55426391 | 0.09237732 | 0.00033256 | |
| 807 | Polygon ZM | CO618 | 18 | 95195 | B | 161 | 48.837459 | 2127359.702 | 4.5 | 0.6 | 0.0018 | 0.686408702 | 3.08883916 | 0.41184522 | 0.00123554 | |
| 808 | Polygon ZM | CO618 | 53 | 95234 | A | 161 | 9.166631 | 399298.4344 | 5.0 | 1.0 | 0.0007 | 0.128836661 | 0.6441833 | 0.12883666 | 9.0186E-05 | |
| 796 | Polygon ZM | CO618 | 79 | 95262 | C | 162 | 11.265801 | 490738.2826 | 3.0 | 0.5 | 0.0018 | 0.27886764 | 0.83660292 | 0.13943382 | 0.00050196 | |
| 797 | Polygon ZM | CO618 | 18 | 95195 | B | 162 | 28.002808 | 1219802.321 | 4.5 | 0.6 | 0.0018 | 0.693166615 | 3.11924977 | 0.41589997 | 0.0012477 | |
| 798 | Polygon ZM | CO618 | 53 | 95234 | A | 162 | 1.129771 | 49212.81498 | 5.0 | 1.0 | 0.0007 | 0.027965745 | 0.13982872 | 0.02796574 | 1.9576E-05 | |
| 809 | Polygon ZM | CO618 | 79 | 95262 | C | 163 | 0.878868 | 38283.47326 | 3.0 | 0.5 | 0.0018 | 0.010829533 | 0.0324886 | 0.00541477 | 1.9493E-05 | |
| 810 | Polygon ZM | CO618 | 17 | 95194 | B | 163 | 20.313387 | 884851.1442 | 4.5 | 0.6 | 0.0018 | 0.250304472 | 1.12637012 | 0.15018268 | 0.00045055 | |
| 811 | Polygon ZM | CO618 | 18 | 95195 | B | 163 | 45.056792 | 1962673.846 | 4.5 | 0.6 | 0.0018 | 0.555196254 | 2.49838314 | 0.33311775 | 0.00099935 | |
| 812 | Polygon ZM | CO618 | 79 | 95262 | C | 163 | 14.905665 | 649290.7614 | 3.0 | 0.5 | 0.0018 | 0.183669742 | 0.55100922 | 0.09183487 | 0.00033061 | |
| 799 | Polygon ZM | CO618 | 79 | 95262 | C | 164 | 35.54886 | 1548508.35 | 3.0 | 0.5 | 0.0018 | 0.589904608 | 1.76971382 | 0.2949523 | 0.00106183 | |
| 800 | Polygon ZM | CO618 | 18 | 95195 | B | 164 | 20.381887 | 887834.9963 | 4.5 | 0.6 | 0.0018 | 0.338220944 | 1.52199425 | 0.20293257 | 0.0006088 | |
| 801 | Polygon ZM | CO618 | 53 | 95234 | A | 164 | 4.331302 | 188671.4936 | 5.0 | 1.0 | 0.0007 | 0.071874448 | 0.35937224 | 0.07187445 | 5.0312E-05 | |
| 802 | Polygon ZM | CO618 | 79 | 95262 | C | 165 | 6.000764 | 261393.275 | 3.0 | 0.5 | 0.0018 | 0.122311257 | 0.36693377 | 0.06115563 | 0.00022016 | |
| 803 | Polygon ZM | CO618 | 18 | 95195 | B | 165 | 43.060655 | 1875722.15 | 4.5 | 0.6 | 0.0018 | 0.877688743 | 3.94959934 | 0.52661325 | 0.00157984 | |
| 820 | Polygon ZM | CO618 | 79 | 95262 | C | 166 | 31.052812 | 1352660.5 | 3.0 | 0.5 | 0.0018 | 0.433157252 | 1.29947175 | 0.21657863 | 0.00077968 | |
| 821 | Polygon ZM | CO618 | 17 | 95194 | B | 166 | 0.943552 | 41101.14588 | 4.5 | 0.6 | 0.0018 | 0.013161661 | 0.05922748 | 0.007897 | 2.3691E-05 | |
| 822 | Polygon ZM | CO618 | 18 | 95195 | B | 166 | 39.693102 | 1729031.509 | 4.5 | 0.6 | 0.0018 | 0.553681087 | 2.49156489 | 0.33220865 | 0.00099663 | |
| 804 | Polygon ZM | CO618 | 79 | 95262 | C | 167 | 1.876658 | 81747.21972 | 3.0 | 0.5 | 0.0018 | 0.200702353 | 0.60210706 | 0.10035118 | 0.00036126 | |
| 805 | Polygon ZM | CO618 | 18 | 95195 | B | 167 | 7.473795 | 325558.5162 | 4.5 | 0.6 | 0.0018 | 0.799297647 | 3.59683941 | 0.47957859 | 0.00143874 | |
| 813 | Polygon ZM | CO618 | 79 | 95262 | C | 168 | 76.212324 | 3319808.827 | 3.0 | 0.5 | 0.0018 | 0.970397592 | 2.91119278 | 0.4851988 | 0.00174672 | |
| 814 | Polygon ZM | CO618 | 18 | 95195 | B | 168 | 2.324891 | 101272.2379 | 4.5 | 0.6 | 0.0018 | 0.029602408 | 0.13321084 | 0.01776144 | 5.3284E-05 | |
| 815 | Polygon ZM | CO618 | 18 | 95195 | B | 169 | 3.151019 | 137258.3723 | 4.5 | 0.6 | 0.0018 | 0.058364794 | 0.26264157 | 0.03501888 | 0.00010506 | |
| 816 | Polygon ZM | CO618 | 79 | 95262 | C | 169 | 35.214406 | 1533939.504 | 3.0 | 0.5 | 0.0018 | 0.652259395 | 1.95677818 | 0.3261297 | 0.00117407 | |
| 817 | Polygon ZM | CO618 | 18 | 95195 | B | 169 | 9.055485 | 394456.9278 | 4.5 | 0.6 | 0.0018 | 0.167730368 | 0.75478665 | 0.10063822 | 0.00030191 | |
| 818 | Polygon ZM | CO618 | 53 | 95234 | A | 169 | 6.567436 | 286077.5229 | 5.0 | 1.0 | 0.0007 | 0.121645444 | 0.60822722 | 0.12164544 | 8.5152E-05 | |
| 770 | Polygon ZM | CO618 | 18 | 95195 | B | 170 | 1.561975 | 68039.62497 | 4.5 | 0.6 | 0.0018 | 0.020761182 | 0.09342532 | 0.01245671 | 3.737E-05 | |
| 771 | Polygon ZM | CO618 | 79 | 95262 | C | 170 | 73.666118 | 3208896.094 | 3.0 | 0.5 | 0.0018 | 0.979142327 | 2.93742698 | 0.48957116 | 0.00176246 | |
| 772 | Polygon ZM | CO618 | 18 | 95195 | B | 170 | 0.00726 | 316.224494 | 4.5 | 0.6 | 0.0018 | 9.64907E-05 | 0.00043421 | 5.7894E-05 | 1.7368E-07 | |
| 794 | Polygon ZM | CO618 | 79 | 95262 | C | 171 | 81.946413 | 3569585.736 | 3.0 | 0.5 | 0.0018 | 0.7658335 | 2.2975005 | 0.38291675 | 0.0013785 | |

| | | Final Values Used in CUHP | | |
|---|---|---|---|---|
| | | Infiltration (inches per hour) | | Decay Coefficient - a |
| Basin ID | Summed Weight | Initial - $f_i$ | Final - $f_o$ | |
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |

**CUHP Soils - Backup Calculations**

| Recommended Horton's Equation Parameters | | | |
|---|---|---|---|
| NRCS Hydrologic Soil Group | Infiltration (inches per hour) | | Decay Coefficient - a |
| | Initial - $f_i$ | Final - $f_o$ | |
| A | 5.0 | 1.0 | 0.0007 |
| B | 4.5 | 0.6 | 0.0018 |
| C | 3.0 | 0.5 | 0.0018 |
| D | 3.0 | 0.5 | 0.0018 |

| GIS Output | | | | | | | | | Parameters for each area | | | | Calculated values based on area | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Infiltration (inches per hour) | | Decay Coefficient - a | Weight based on area | Infiltration (inches per hour) | | Decay Coefficient - a | |
| FID | Shape * | AREASYMBOL | MUSYM | MUKEY | HSG | BasinID | Area_AC | Area_SqFt | Initial - $f_i$ | Final - $f_o$ | | | Initial - $f_i$ | Final - $f_o$ | | |
| | | | | | | A | B | C | D | E | F | G = C / SUM($C_A$) | H = G * D | I = G * E | J = G * F | |
| 795 | Polygon ZM | CO618 | 18 | 95195 | B | 171 | 25.056497 | 1091461.003 | 4.5 | 0.6 | 0.0018 | 0.2341665 | 1.05374925 | 0.1404999 | 0.0004215 | |
| 819 | Polygon ZM | CO618 | 79 | 95262 | C | 172 | 98.054762 | 4271265.423 | 3.0 | 0.5 | 0.0018 | 1 | 3 | 0.5 | 0.0018 | |
| 767 | Polygon ZM | CO618 | 18 | 95195 | B | 173 | 41.652781 | 1814395.125 | 4.5 | 0.6 | 0.0018 | 0.652762975 | 2.93743339 | 0.39165778 | 0.00117497 | |
| 768 | Polygon ZM | CO618 | 79 | 95262 | C | 173 | 22.157181 | 965166.8227 | 3.0 | 0.5 | 0.0018 | 0.347237025 | 1.04171108 | 0.17361851 | 0.00062503 | |
| 773 | Polygon ZM | CO618 | 18 | 95195 | B | 174 | 34.708614 | 1511907.21 | 4.5 | 0.6 | 0.0018 | 0.299161691 | 1.34622761 | 0.17949701 | 0.00053849 | |
| 774 | Polygon ZM | CO618 | 79 | 95262 | C | 174 | 81.310966 | 3541905.673 | 3.0 | 0.5 | 0.0018 | 0.700838309 | 2.10251493 | 0.35041915 | 0.00126151 | |
| 777 | Polygon ZM | CO618 | 79 | 95262 | C | 175 | 89.606662 | 3903266.217 | 3.0 | 0.5 | 0.0018 | 1 | 3 | 0.5 | 0.0018 | |

| | | Final Values Used in CUHP | | |
|---|---|---|---|---|
| | | Infiltration (inches per hour) | | Decay Coefficient - a |
| Basin ID | Summed Weight | Initial - $f_i$ | Final - $f_o$ | |
| A | K = SUM($G_A$) | L = SUM($H_A$) | M = SUM($I_A$) | N = SUM($J_A$) |

| CUHP Depression Storage - Backup Calculations | | | | | | |
|---|---|---|---|---|---|---|
| Basin ID | Percent Lawn Grass | Percent Wooded Areas and Open Fields | Depression Pervious | Percent Large Paved Areas and Flat Roofs | Percent Sloped Roofs | Depression Impervious |
| 0 | 0% | 100% | 0.4 | 60% | 40% | 0.08 |
| 1 | 10% | 90% | 0.395 | 40% | 60% | 0.07 |
| 2 | 20% | 80% | 0.39 | 40% | 60% | 0.07 |
| 3 | 10% | 90% | 0.395 | 50% | 50% | 0.075 |
| 4 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 5 | 50% | 50% | 0.375 | 40% | 60% | 0.07 |
| 6 | 100% | 0% | 0.35 | 30% | 70% | 0.065 |
| 7 | 60% | 40% | 0.37 | 40% | 60% | 0.07 |
| 8 | 100% | 0% | 0.35 | 40% | 60% | 0.07 |
| 9 | 30% | 70% | 0.385 | 100% | 0% | 0.1 |
| 10 | 50% | 50% | 0.375 | 100% | 0% | 0.1 |
| 11 | 50% | 50% | 0.375 | 40% | 60% | 0.07 |
| 12 | 100% | 0% | 0.35 | 40% | 60% | 0.07 |
| 13 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 14 | 100% | 0% | 0.35 | 100% | 0% | 0.1 |
| 15 | 40% | 60% | 0.38 | 50% | 50% | 0.075 |
| 16 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 17 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 18 | 40% | 60% | 0.38 | 80% | 20% | 0.09 |
| 19 | 50% | 50% | 0.375 | 40% | 60% | 0.07 |
| 20 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 21 | 50% | 50% | 0.375 | 100% | 0% | 0.1 |
| 22 | 20% | 80% | 0.39 | 80% | 20% | 0.09 |
| 23 | 40% | 60% | 0.38 | 100% | 0% | 0.1 |
| 24 | 40% | 60% | 0.38 | 100% | 0% | 0.1 |
| 25 | 25% | 75% | 0.3875 | 100% | 0% | 0.1 |
| 26 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 27 | 50% | 50% | 0.375 | 100% | 0% | 0.1 |
| 28 | 40% | 60% | 0.38 | 70% | 30% | 0.085 |
| 29 | 40% | 60% | 0.38 | 40% | 60% | 0.07 |
| 30 | 60% | 40% | 0.37 | 90% | 10% | 0.095 |
| 31 | 50% | 50% | 0.375 | 100% | 0% | 0.1 |
| 32 | 75% | 25% | 0.3625 | 100% | 0% | 0.1 |
| 33 | 75% | 25% | 0.3625 | 70% | 30% | 0.085 |
| 34 | 100% | 0% | 0.35 | 70% | 30% | 0.085 |
| 35 | 40% | 60% | 0.38 | 40% | 60% | 0.07 |
| 36 | 75% | 25% | 0.3625 | 60% | 40% | 0.08 |
| 37 | 100% | 0% | 0.35 | 40% | 60% | 0.07 |
| 38 | 20% | 80% | 0.39 | 100% | 0% | 0.1 |
| 39 | 40% | 60% | 0.38 | 40% | 60% | 0.07 |
| 40 | 100% | 0% | 0.35 | 40% | 60% | 0.07 |

**Table 6-6. Typical depression losses for various land covers**

(All values in inches for use with the CUHP.)

| Land Cover | Range in Depression (Retention) Losses | Recommended |
|---|---|---|
| Impervious: | | |
| Large paved areas | 0.05 - 0.15 | 0.1 |
| Roofs-flat | 0.1 - 0.3 | 0.1 |
| Roofs-sloped | 0.05 - 0.1 | 0.05 |
| Pervious: | | |
| Lawn grass | 0.2 - 0.5 | 0.35 |
| Wooded areas and open fields | 0.2 - 0.6 | 0.4 |

| CUHP Depression Storage - Backup Calculations | | | | | | |
|---|---|---|---|---|---|---|
| **Basin ID** | **Percent Lawn Grass** | **Percent Wooded Areas and Open Fields** | **Depression Pervious** | **Percent Large Paved Areas and Flat Roofs** | **Percent Sloped Roofs** | **Depression Impervious** |
| 41 | 60% | 40% | 0.37 | 40% | 60% | 0.07 |
| 42 | 75% | 25% | 0.3625 | 40% | 60% | 0.07 |
| 43 | 100% | 0% | 0.35 | 40% | 60% | 0.07 |
| 44 | 80% | 20% | 0.36 | 60% | 40% | 0.08 |
| 45 | 80% | 20% | 0.36 | 40% | 60% | 0.07 |
| 46 | 60% | 40% | 0.37 | 40% | 60% | 0.07 |
| 47 | 50% | 50% | 0.375 | 40% | 60% | 0.07 |
| 48 | 25% | 75% | 0.3875 | 80% | 20% | 0.09 |
| 49 | 25% | 75% | 0.3875 | 80% | 20% | 0.09 |
| 50 | 60% | 40% | 0.37 | 40% | 60% | 0.07 |
| 51 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 52 | 70% | 30% | 0.365 | 50% | 50% | 0.075 |
| 53 | 0% | 100% | 0.4 | 80% | 20% | 0.09 |
| 54 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 55 | 70% | 30% | 0.365 | 40% | 60% | 0.07 |
| 56 | 75% | 25% | 0.3625 | 40% | 60% | 0.07 |
| 57 | 75% | 25% | 0.3625 | 40% | 60% | 0.07 |
| 58 | 60% | 40% | 0.37 | 40% | 60% | 0.07 |
| 59 | 0% | 100% | 0.4 | 40% | 60% | 0.07 |
| 60 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 61 | 50% | 50% | 0.375 | 20% | 80% | 0.06 |
| 62 | 75% | 25% | 0.3625 | 40% | 60% | 0.07 |
| 63 | 50% | 50% | 0.375 | 60% | 40% | 0.08 |
| 64 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 65 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 66 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 67 | 75% | 25% | 0.3625 | 40% | 60% | 0.07 |
| 68 | 25% | 75% | 0.3875 | 40% | 60% | 0.07 |
| 69 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 70 | 50% | 50% | 0.375 | 40% | 60% | 0.07 |
| 71 | 100% | 0% | 0.35 | 40% | 60% | 0.07 |
| 72 | 25% | 75% | 0.3875 | 40% | 60% | 0.07 |
| 73 | 50% | 50% | 0.375 | 40% | 60% | 0.07 |
| 74 | 100% | 0% | 0.35 | 40% | 60% | 0.07 |
| 75 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 76 | 0% | 100% | 0.4 | 60% | 40% | 0.08 |
| 77 | 75% | 25% | 0.3625 | 40% | 60% | 0.07 |
| 78 | 75% | 25% | 0.3625 | 40% | 60% | 0.07 |
| 79 | 75% | 25% | 0.3625 | 40% | 60% | 0.07 |
| 80 | 0% | 100% | 0.4 | 60% | 40% | 0.08 |
| 81 | 25% | 75% | 0.3875 | 100% | 0% | 0.1 |

| CUHP Depression Storage - Backup Calculations | | | | | | |
|---|---|---|---|---|---|---|
| **Basin ID** | **Percent Lawn Grass** | **Percent Wooded Areas and Open Fields** | **Depression Pervious** | **Percent Large Paved Areas and Flat Roofs** | **Percent Sloped Roofs** | **Depression Impervious** |
| 82 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 83 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 84 | 25% | 75% | 0.3875 | 100% | 0% | 0.1 |
| 85 | 0% | 100% | 0.4 | 80% | 20% | 0.09 |
| 86 | 100% | 0% | 0.35 | 40% | 60% | 0.07 |
| 87 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 88 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 89 | 25% | 75% | 0.3875 | 80% | 20% | 0.09 |
| 90 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 91 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 92 | 40% | 60% | 0.38 | 40% | 60% | 0.07 |
| 93 | 100% | 0% | 0.35 | 100% | 0% | 0.1 |
| 94 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 95 | 25% | 75% | 0.3875 | 100% | 0% | 0.1 |
| 96 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 97 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 98 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 99 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 100 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 101 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 102 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 103 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 104 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 105 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 106 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 107 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 108 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 109 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 110 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 111 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 112 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 113 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 114 | 50% | 50% | 0.375 | 40% | 60% | 0.07 |
| 115 | 100% | 0% | 0.35 | 40% | 60% | 0.07 |
| 116 | 25% | 75% | 0.3875 | 100% | 0% | 0.1 |
| 117 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 118 | 100% | 0% | 0.35 | 100% | 0% | 0.1 |
| 119 | 100% | 0% | 0.35 | 100% | 0% | 0.1 |
| 120 | 100% | 0% | 0.35 | 100% | 0% | 0.1 |
| 121 | 100% | 0% | 0.35 | 100% | 0% | 0.1 |
| 122 | 100% | 0% | 0.35 | 100% | 0% | 0.1 |

| CUHP Depression Storage - Backup Calculations | | | | | | |
|---|---|---|---|---|---|---|
| **Basin ID** | **Percent Lawn Grass** | **Percent Wooded Areas and Open Fields** | **Depression Pervious** | **Percent Large Paved Areas and Flat Roofs** | **Percent Sloped Roofs** | **Depression Impervious** |
| 123 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 124 | 40% | 60% | 0.38 | 100% | 0% | 0.1 |
| 125 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 126 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 127 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 128 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 129 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 130 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 131 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 132 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 133 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 134 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 135 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 136 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 137 | 25% | 75% | 0.3875 | 100% | 0% | 0.1 |
| 138 | 25% | 75% | 0.3875 | 100% | 0% | 0.1 |
| 139 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 140 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 141 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 142 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 143 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 144 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 145 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 146 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 147 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 148 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 149 | 0% | 100% | 0.4 | 80% | 20% | 0.09 |
| 150 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 151 | 25% | 75% | 0.3875 | 100% | 0% | 0.1 |
| 152 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 153 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 154 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 155 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 156 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 157 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 158 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 159 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 160 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 161 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 162 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 163 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |

| CUHP Depression Storage - Backup Calculations | | | | | | |
|---|---|---|---|---|---|---|
| **Basin ID** | **Percent Lawn Grass** | **Percent Wooded Areas and Open Fields** | **Depression Pervious** | **Percent Large Paved Areas and Flat Roofs** | **Percent Sloped Roofs** | **Depression Impervious** |
| 164 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 165 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 166 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 167 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 168 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 169 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 170 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 171 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 172 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 173 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 174 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |
| 175 | 0% | 100% | 0.4 | 100% | 0% | 0.1 |

# EPA SWMM INPUT AND EPA SWMM 100-YEAR OUTPUT

olsson®

## Table B-4 - Baseline Peak Flows

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Existing Conditions Peak Flow (cfs) | | | | | | | Future Conditions Peak Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 100 | 10104 | 15.8 | 18 | 39 | 228 | 354 | 512 | 2,062 | 3,456 | 5,757 | 12,118 | 769 | 1,132 | 1,541 | 3,888 | 5,760 | 8,419 | 16,238 |
| 101T | 67 | 0.1 | 8 | 8 | 0 | 1 | 1 | 6 | 16 | 31 | 79 | 0 | 1 | 1 | 6 | 16 | 31 | 79 |
| 101 | 44 | 0.1 | 6 | 6 | 0 | 1 | 1 | 6 | 17 | 33 | 76 | 0 | 1 | 1 | 6 | 17 | 33 | 76 |
| 102 | 11 | 0.0 | 7 | 7 | 0 | 0 | 0 | 1 | 4 | 8 | 19 | 0 | 0 | 0 | 1 | 4 | 8 | 19 |
| 103 | 23 | 0.0 | 10 | 10 | 0 | 0 | 1 | 3 | 7 | 13 | 29 | 0 | 0 | 1 | 3 | 7 | 13 | 29 |
| 104 | 9898 | 15.5 | 19 | 40 | 228 | 357 | 512 | 2,306 | 3,445 | 5,715 | 12,014 | 772 | 1,134 | 1,545 | 3,872 | 5,730 | 8,357 | 16,104 |
| 105 | 9856 | 15.4 | 19 | 40 | 229 | 360 | 515 | 1,960 | 3,466 | 5,746 | 12,062 | 777 | 1,136 | 1,547 | 3,883 | 5,751 | 8,370 | 16,127 |
| 106OF | 130 | 0.2 | 50 | 50 | 0 | 14 | 35 | 104 | 167 | 246 | 458 | 0 | 14 | 35 | 104 | 167 | 246 | 458 |
| 106 | 130 | 0.2 | 50 | 50 | 51 | 69 | 90 | 159 | 222 | 301 | 513 | 51 | 69 | 90 | 159 | 222 | 301 | 513 |
| 107 | 99 | 0.2 | 48 | 49 | 31 | 44 | 61 | 116 | 157 | 209 | 343 | 32 | 45 | 62 | 118 | 159 | 211 | 347 |
| 108 | 62 | 0.1 | 48 | 49 | 18 | 26 | 34 | 66 | 90 | 120 | 199 | 18 | 26 | 34 | 67 | 91 | 121 | 201 |
| 109T | 9592 | 15.0 | 18 | 40 | 227 | 354 | 505 | 1,958 | 3,461 | 5,736 | 12,021 | 775 | 1,134 | 1,544 | 3,875 | 5,735 | 8,344 | 16,034 |
| 109 | 74 | 0.1 | 35 | 46 | 10 | 14 | 19 | 35 | 58 | 86 | 166 | 19 | 25 | 33 | 55 | 83 | 116 | 209 |
| 110 | 9518 | 14.9 | 18 | 40 | 226 | 353 | 502 | 1,964 | 3,468 | 5,739 | 12,010 | 776 | 1,134 | 1,543 | 3,878 | 5,738 | 8,353 | 16,009 |
| 111 | 69 | 0.1 | 35 | 35 | 13 | 19 | 26 | 51 | 80 | 116 | 217 | 13 | 19 | 26 | 51 | 80 | 116 | 217 |
| 112T | 9356 | 14.6 | 18 | 40 | 226 | 357 | 503 | 1,981 | 3,479 | 5,762 | 12,076 | 780 | 1,132 | 1,539 | 3,879 | 5,749 | 8,395 | 16,038 |
| 112 | 40 | 0.1 | 58 | 58 | 18 | 24 | 31 | 48 | 67 | 89 | 151 | 18 | 24 | 31 | 48 | 67 | 89 | 151 |
| 113 | 9316 | 14.6 | 17 | 40 | 225 | 354 | 499 | 1,981 | 3,479 | 5,762 | 12,071 | 780 | 1,131 | 1,538 | 3,878 | 5,747 | 8,393 | 16,024 |
| 114 | 20 | 0.0 | 64 | 64 | 9 | 12 | 15 | 25 | 33 | 44 | 71 | 9 | 12 | 15 | 25 | 33 | 44 | 71 |
| 115 | 175 | 0.3 | 27 | 41 | 15 | 23 | 32 | 71 | 122 | 192 | 382 | 36 | 50 | 67 | 125 | 190 | 275 | 505 |
| 116 | 84 | 0.1 | 16 | 40 | 3 | 6 | 9 | 26 | 51 | 84 | 176 | 20 | 27 | 38 | 69 | 106 | 152 | 277 |
| 117 | 71 | 0.1 | 16 | 44 | 3 | 5 | 8 | 24 | 46 | 76 | 156 | 20 | 27 | 37 | 67 | 101 | 143 | 257 |
| 118 | 47 | 0.1 | 19 | 39 | 2 | 5 | 8 | 18 | 36 | 58 | 121 | 14 | 19 | 26 | 45 | 70 | 101 | 187 |
| 119 | 55 | 0.1 | 42 | 49 | 11 | 14 | 19 | 34 | 51 | 74 | 138 | 15 | 20 | 26 | 43 | 63 | 89 | 158 |
| 120 | 11 | 0.0 | 34 | 39 | 2 | 3 | 4 | 6 | 11 | 16 | 31 | 3 | 4 | 5 | 8 | 13 | 18 | 34 |
| 121T | 9019 | 14.1 | 17 | 39 | 214 | 331 | 472 | 1,973 | 3,455 | 5,714 | 11,911 | 769 | 1,119 | 1,519 | 3,848 | 5,691 | 8,303 | 15,807 |
| 121 | 81 | 0.1 | 41 | 41 | 16 | 23 | 31 | 68 | 96 | 131 | 221 | 16 | 23 | 31 | 68 | 96 | 131 | 221 |
| 122 | 8938 | 14.0 | 16 | 39 | 209 | 322 | 462 | 1,968 | 3,440 | 5,688 | 11,843 | 764 | 1,112 | 1,510 | 3,831 | 5,665 | 8,264 | 15,715 |
| 123T | 8831 | 13.8 | 16 | 39 | 204 | 311 | 452 | 1,964 | 3,432 | 5,669 | 11,784 | 761 | 1,106 | 1,501 | 3,821 | 5,646 | 8,231 | 15,634 |
| 123 | 24 | 0.0 | 39 | 39 | 4 | 5 | 7 | 12 | 19 | 28 | 53 | 4 | 5 | 7 | 12 | 19 | 28 | 53 |
| 124 | 8808 | 13.8 | 16 | 39 | 203 | 309 | 451 | 1,966 | 3,433 | 5,669 | 11,776 | 761 | 1,105 | 1,500 | 3,822 | 5,646 | 8,227 | 15,622 |
| 125 | 8796 | 13.7 | 16 | 39 | 202 | 308 | 450 | 1,966 | 3,432 | 5,667 | 11,770 | 761 | 1,104 | 1,499 | 3,820 | 5,643 | 8,223 | 15,613 |
| 126 | 11 | 0.0 | 6 | 56 | 0 | 0 | 0 | 1 | 3 | 5 | 12 | 3 | 4 | 5 | 9 | 13 | 17 | 29 |
| 127 | 8698 | 13.6 | 16 | 39 | 198 | 302 | 443 | 1,958 | 3,417 | 5,642 | 11,705 | 755 | 1,099 | 1,491 | 3,807 | 5,621 | 8,187 | 15,531 |
| 128 | 718 | 1.1 | 33 | 34 | 90 | 131 | 183 | 413 | 627 | 923 | 1,688 | 98 | 141 | 196 | 432 | 649 | 949 | 1,726 |
| 129T | 595 | 0.9 | 33 | 34 | 80 | 114 | 160 | 357 | 538 | 784 | 1,427 | 87 | 124 | 172 | 374 | 558 | 809 | 1,463 |
| 129 | 38 | 0.1 | 44 | 54 | 11 | 14 | 19 | 31 | 48 | 68 | 123 | 16 | 21 | 27 | 42 | 60 | 82 | 143 |
| 130 | 22 | 0.0 | 48 | 48 | 7 | 9 | 12 | 20 | 30 | 42 | 74 | 7 | 9 | 12 | 20 | 30 | 42 | 74 |
| 131T | 557 | 0.9 | 32 | 33 | 72 | 104 | 146 | 332 | 500 | 728 | 1,319 | 78 | 111 | 154 | 344 | 514 | 746 | 1,345 |
| 131 | 44 | 0.1 | 17 | 17 | 1 | 3 | 4 | 10 | 21 | 34 | 73 | 1 | 3 | 4 | 10 | 21 | 34 | 73 |
| 132 | 58 | 0.1 | 49 | 49 | 17 | 23 | 30 | 50 | 74 | 102 | 181 | 17 | 23 | 30 | 50 | 74 | 102 | 181 |
| 133 | 31 | 0.0 | 45 | 45 | 10 | 13 | 17 | 29 | 43 | 60 | 107 | 10 | 13 | 17 | 29 | 43 | 60 | 107 |
| 134T | 455 | 0.7 | 31 | 33 | 59 | 86 | 121 | 284 | 424 | 613 | 1,093 | 64 | 92 | 129 | 295 | 437 | 630 | 1,117 |
| 134 | 10 | 0.0 | 51 | 55 | 5 | 6 | 8 | 13 | 18 | 25 | 44 | 5 | 7 | 9 | 14 | 20 | 27 | 46 |
| 135 | 445 | 0.7 | 31 | 32 | 58 | 83 | 118 | 278 | 414 | 599 | 1,064 | 62 | 89 | 125 | 289 | 427 | 614 | 1,086 |
| 136T | 388 | 0.6 | 30 | 30 | 53 | 76 | 105 | 247 | 362 | 518 | 911 | 53 | 76 | 105 | 247 | 362 | 518 | 911 |
| 136 | 127 | 0.2 | 54 | 54 | 44 | 59 | 78 | 137 | 191 | 258 | 439 | 44 | 59 | 78 | 137 | 191 | 258 | 439 |
| 137 | 28 | 0.0 | 61 | 61 | 9 | 12 | 15 | 24 | 32 | 43 | 72 | 9 | 12 | 15 | 24 | 32 | 43 | 72 |

## Table B-4 - Baseline Peak Flows

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Existing Conditions Peak Flow (cfs) | | | | | | | Future Conditions Peak Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 138 | 260 | 0.4 | 19 | 19 | 14 | 24 | 39 | 127 | 195 | 287 | 517 | 14 | 24 | 39 | 127 | 195 | 287 | 517 |
| 139 | 237 | 0.4 | 17 | 17 | 11 | 19 | 32 | 110 | 171 | 254 | 460 | 11 | 19 | 32 | 110 | 171 | 254 | 460 |
| 140 | 188 | 0.3 | 15 | 15 | 8 | 14 | 23 | 85 | 135 | 202 | 371 | 8 | 14 | 23 | 85 | 135 | 202 | 371 |
| 141 | 66 | 0.1 | 10 | 10 | 2 | 4 | 9 | 33 | 50 | 73 | 131 | 2 | 4 | 9 | 33 | 50 | 73 | 131 |
| 142T | 7871 | 12.3 | 14 | 40 | 167 | 256 | 368 | 1,897 | 3,275 | 5,409 | 11,130 | 719 | 1,050 | 1,421 | 3,672 | 5,408 | 7,847 | 14,772 |
| 142 | 793 | 1.2 | 31 | 34 | 78 | 115 | 164 | 394 | 613 | 926 | 1,740 | 93 | 135 | 190 | 436 | 665 | 989 | 1,834 |
| 143T | 679 | 1.1 | 29 | 32 | 61 | 91 | 132 | 334 | 521 | 787 | 1,469 | 75 | 110 | 157 | 374 | 571 | 846 | 1,557 |
| 143 | 18 | 0.0 | 65 | 65 | 10 | 13 | 17 | 28 | 37 | 47 | 76 | 10 | 13 | 17 | 28 | 37 | 47 | 76 |
| 144 | 661 | 1.0 | 28 | 31 | 57 | 85 | 125 | 323 | 505 | 763 | 1,426 | 71 | 104 | 150 | 363 | 555 | 822 | 1,515 |
| 145 | 22 | 0.0 | 34 | 44 | 3 | 4 | 6 | 10 | 17 | 25 | 49 | 6 | 7 | 9 | 16 | 24 | 34 | 62 |
| 146 | 102 | 0.2 | 20 | 20 | 5 | 8 | 12 | 36 | 58 | 88 | 163 | 5 | 8 | 12 | 36 | 58 | 88 | 163 |
| 147 | 72 | 0.1 | 26 | 26 | 6 | 10 | 14 | 38 | 58 | 85 | 154 | 6 | 10 | 14 | 38 | 58 | 85 | 154 |
| 148 | 347 | 0.5 | 26 | 29 | 30 | 44 | 67 | 185 | 287 | 425 | 783 | 36 | 54 | 81 | 206 | 312 | 456 | 827 |
| 149 | 113 | 0.2 | 39 | 44 | 20 | 27 | 36 | 64 | 100 | 145 | 269 | 25 | 33 | 44 | 76 | 114 | 163 | 295 |
| 150T | 113 | 0.2 | 30 | 34 | 14 | 22 | 34 | 86 | 123 | 171 | 292 | 18 | 27 | 42 | 96 | 135 | 185 | 311 |
| 150 | 64 | 0.1 | 22 | 22 | 6 | 9 | 15 | 42 | 61 | 86 | 149 | 6 | 9 | 15 | 42 | 61 | 86 | 149 |
| 151 | 49 | 0.1 | 41 | 50 | 11 | 16 | 23 | 48 | 65 | 88 | 147 | 15 | 22 | 31 | 58 | 78 | 103 | 168 |
| 152 | 7078 | 11.1 | 12 | 40 | 133 | 200 | 282 | 1,772 | 3,060 | 5,054 | 10,321 | 662 | 981 | 1,329 | 3,467 | 5,090 | 7,366 | 13,729 |
| 153 | 116 | 0.2 | 5 | 23 | 0 | 1 | 3 | 21 | 44 | 78 | 167 | 6 | 10 | 15 | 40 | 66 | 104 | 200 |
| 154T | 6848 | 10.7 | 12 | 41 | 133 | 202 | 281 | 1,799 | 3,070 | 5,059 | 10,318 | 663 | 973 | 1,315 | 3,471 | 5,090 | 7,378 | 13,663 |
| 154 | 6148 | 9.6 | 10 | 39 | 111 | 167 | 237 | 1,696 | 2,892 | 4,766 | 9,616 | 638 | 966 | 1,322 | 3,264 | 4,787 | 6,933 | 12,753 |
| 155 | 638 | 1.0 | 32 | 57 | 87 | 127 | 174 | 375 | 569 | 842 | 1,560 | 245 | 338 | 443 | 780 | 1,055 | 1,406 | 2,322 |
| 156T | 579 | 0.9 | 32 | 59 | 83 | 120 | 163 | 348 | 528 | 780 | 1,448 | 237 | 325 | 425 | 739 | 997 | 1,323 | 2,179 |
| 156 | 253 | 0.4 | 44 | 54 | 58 | 81 | 108 | 216 | 308 | 431 | 750 | 77 | 107 | 141 | 264 | 366 | 500 | 849 |
| 157 | 197 | 0.3 | 44 | 57 | 48 | 67 | 90 | 177 | 252 | 351 | 608 | 68 | 92 | 122 | 224 | 309 | 419 | 706 |
| 158 | 141 | 0.2 | 44 | 61 | 35 | 49 | 65 | 130 | 184 | 256 | 443 | 54 | 73 | 97 | 177 | 241 | 324 | 540 |
| 159 | 45 | 0.1 | 55 | 73 | 19 | 25 | 32 | 52 | 68 | 88 | 143 | 23 | 31 | 40 | 66 | 87 | 114 | 183 |
| 160 | 10 | 0.0 | 7 | 85 | 0 | 0 | 0 | 1 | 5 | 9 | 22 | 11 | 14 | 18 | 26 | 33 | 41 | 64 |
| 161 | 326 | 0.5 | 23 | 63 | 25 | 39 | 56 | 136 | 230 | 362 | 710 | 160 | 219 | 285 | 480 | 636 | 830 | 1,341 |
| 162 | 311 | 0.5 | 22 | 64 | 23 | 36 | 51 | 125 | 216 | 342 | 672 | 159 | 219 | 283 | 471 | 622 | 808 | 1,303 |
| 163 | 257 | 0.4 | 18 | 69 | 13 | 21 | 31 | 83 | 158 | 259 | 525 | 151 | 206 | 267 | 427 | 559 | 720 | 1,154 |
| 164 | 147 | 0.2 | 9 | 84 | 1 | 3 | 7 | 24 | 65 | 121 | 274 | 133 | 177 | 223 | 322 | 411 | 521 | 811 |
| 165 | 96 | 0.1 | 7 | 85 | 1 | 2 | 4 | 15 | 46 | 87 | 200 | 98 | 129 | 163 | 234 | 297 | 378 | 587 |
| 166 | 62 | 0.1 | 4 | 25 | 0 | 1 | 2 | 22 | 43 | 74 | 148 | 6 | 11 | 16 | 41 | 65 | 96 | 177 |
| 167T | 6139 | 9.6 | 10 | 39 | 111 | 167 | 237 | 1,697 | 2,893 | 4,768 | 9,616 | 638 | 966 | 1,322 | 3,265 | 4,791 | 6,935 | 12,756 |
| 167 | 45 | 0.1 | 41 | 50 | 12 | 17 | 26 | 51 | 69 | 90 | 148 | 16 | 23 | 34 | 61 | 81 | 105 | 169 |
| 168 | 6094 | 9.5 | 10 | 39 | 111 | 165 | 232 | 1,698 | 2,889 | 4,757 | 9,582 | 636 | 963 | 1,317 | 3,262 | 4,782 | 6,920 | 12,715 |
| 169 | 63 | 0.1 | 4 | 30 | 0 | 1 | 1 | 18 | 34 | 54 | 105 | 7 | 10 | 15 | 38 | 56 | 81 | 143 |
| 170T | 6001 | 9.4 | 10 | 39 | 111 | 164 | 231 | 1,692 | 2,874 | 4,735 | 9,516 | 632 | 957 | 1,308 | 3,245 | 4,763 | 6,887 | 12,648 |
| 170 | 42 | 0.1 | 48 | 55 | 15 | 21 | 30 | 56 | 75 | 99 | 161 | 18 | 26 | 36 | 64 | 85 | 111 | 178 |
| 171 | 18 | 0.0 | 65 | 65 | 10 | 15 | 19 | 31 | 40 | 52 | 82 | 10 | 15 | 19 | 31 | 40 | 52 | 82 |
| 172 | 5959 | 9.3 | 10 | 39 | 106 | 156 | 219 | 1,681 | 2,857 | 4,710 | 9,462 | 628 | 950 | 1,298 | 3,228 | 4,737 | 6,849 | 12,574 |
| 173 | 39 | 0.1 | 10 | 85 | 1 | 2 | 4 | 18 | 28 | 42 | 75 | 33 | 44 | 55 | 81 | 102 | 127 | 194 |
| 174T | 5880 | 9.2 | 10 | 39 | 105 | 154 | 215 | 1,674 | 2,843 | 4,681 | 9,386 | 623 | 942 | 1,286 | 3,214 | 4,715 | 6,811 | 12,486 |
| 174 | 157 | 0.2 | 49 | 55 | 55 | 73 | 95 | 160 | 219 | 290 | 490 | 57 | 76 | 99 | 169 | 232 | 314 | 531 |
| 175 | 25 | 0.0 | 3 | 42 | 0 | 0 | 1 | 10 | 16 | 25 | 46 | 6 | 9 | 12 | 26 | 35 | 47 | 79 |
| 176 | 5724 | 8.9 | 9 | 39 | 88 | 130 | 182 | 1,648 | 2,797 | 4,607 | 9,219 | 609 | 921 | 1,257 | 3,162 | 4,636 | 6,696 | 12,252 |
| 177 | 275 | 0.4 | 21 | 68 | 20 | 29 | 41 | 97 | 167 | 278 | 572 | 130 | 180 | 237 | 393 | 523 | 687 | 1,127 |

## Table B-4 - Baseline Peak Flows

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Existing Conditions Peak Flow (cfs) | | | | | | | Future Conditions Peak Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 178 | 40 | 0.1 | 48 | 51 | 11 | 15 | 19 | 34 | 48 | 66 | 114 | 12 | 16 | 21 | 37 | 52 | 71 | 120 |
| 179 | 14 | 0.0 | 46 | 50 | 4 | 5 | 7 | 11 | 17 | 24 | 43 | 5 | 6 | 8 | 13 | 19 | 26 | 46 |
| 180 | 201 | 0.3 | 12 | 75 | 3 | 7 | 12 | 48 | 100 | 180 | 388 | 111 | 155 | 203 | 332 | 435 | 564 | 911 |
| 181 | 190 | 0.3 | 11 | 78 | 4 | 7 | 11 | 44 | 96 | 172 | 371 | 113 | 156 | 203 | 330 | 430 | 555 | 893 |
| 182T | 121 | 0.2 | 8 | 79 | 1 | 2 | 4 | 21 | 51 | 95 | 212 | 78 | 106 | 137 | 215 | 276 | 349 | 559 |
| 182 | 18 | 0.0 | 11 | 86 | 1 | 1 | 2 | 9 | 14 | 21 | 37 | 15 | 21 | 26 | 39 | 49 | 61 | 93 |
| 183 | 103 | 0.2 | 8 | 78 | 1 | 2 | 4 | 16 | 43 | 80 | 181 | 78 | 104 | 132 | 192 | 244 | 312 | 489 |
| 184 | 34 | 0.1 | 5 | 65 | 0 | 0 | 1 | 5 | 11 | 21 | 44 | 14 | 19 | 25 | 41 | 55 | 71 | 116 |
| 185 | 5436 | 8.5 | 8 | 37 | 79 | 115 | 159 | 1,620 | 2,741 | 4,503 | 8,931 | 572 | 869 | 1,190 | 3,078 | 4,513 | 6,510 | 11,870 |
| 186T | 5388 | 8.4 | 8 | 37 | 79 | 115 | 159 | 1,619 | 2,736 | 4,490 | 8,892 | 571 | 867 | 1,187 | 3,069 | 4,498 | 6,484 | 11,813 |
| 186 | 17 | 0.0 | 46 | 46 | 6 | 9 | 12 | 21 | 30 | 41 | 70 | 6 | 9 | 12 | 21 | 30 | 41 | 70 |
| 187 | 5370 | 8.4 | 8 | 37 | 78 | 113 | 156 | 1,617 | 2,733 | 4,486 | 8,880 | 570 | 866 | 1,185 | 3,066 | 4,493 | 6,476 | 11,793 |
| 188 | 69 | 0.1 | 6 | 45 | 0 | 1 | 2 | 8 | 22 | 42 | 98 | 17 | 23 | 30 | 53 | 79 | 111 | 198 |
| 189 | 5281 | 8.3 | 8 | 37 | 78 | 112 | 156 | 1,613 | 2,721 | 4,459 | 8,799 | 561 | 854 | 1,170 | 3,040 | 4,452 | 6,411 | 11,654 |
| 190 | 240 | 0.4 | 21 | 49 | 32 | 43 | 55 | 116 | 185 | 286 | 542 | 71 | 94 | 122 | 214 | 313 | 441 | 765 |
| 191 | 185 | 0.3 | 26 | 51 | 34 | 44 | 57 | 107 | 165 | 246 | 456 | 60 | 79 | 101 | 172 | 252 | 354 | 612 |
| 192 | 77 | 0.1 | 58 | 58 | 37 | 49 | 64 | 104 | 141 | 189 | 314 | 37 | 49 | 64 | 104 | 141 | 189 | 314 |
| 193T | 4979 | 7.8 | 7 | 37 | 61 | 89 | 144 | 1,587 | 2,659 | 4,310 | 8,443 | 531 | 812 | 1,119 | 2,951 | 4,289 | 6,163 | 11,128 |
| 193 | 177 | 0.3 | 10 | 76 | 5 | 9 | 13 | 66 | 115 | 182 | 352 | 117 | 160 | 204 | 318 | 408 | 521 | 819 |
| 194 | 71 | 0.1 | 3 | 84 | 0 | 0 | 1 | 12 | 27 | 49 | 107 | 52 | 70 | 88 | 132 | 167 | 211 | 327 |
| 195 | 172 | 0.3 | 9 | 76 | 4 | 7 | 11 | 61 | 108 | 173 | 337 | 115 | 159 | 203 | 312 | 400 | 510 | 801 |
| 196 | 145 | 0.2 | 4 | 84 | 1 | 3 | 4 | 46 | 86 | 141 | 281 | 113 | 155 | 197 | 298 | 380 | 480 | 749 |
| 197 | 26 | 0.0 | 2 | 85 | 0 | 0 | 0 | 1 | 7 | 15 | 38 | 22 | 29 | 37 | 54 | 68 | 87 | 135 |
| 198 | 4731 | 7.4 | 7 | 34 | 58 | 84 | 142 | 1,558 | 2,596 | 4,185 | 8,143 | 493 | 760 | 1,051 | 2,840 | 4,129 | 5,942 | 10,685 |
| 199 | 872 | 1.4 | 4 | 27 | 2 | 5 | 20 | 216 | 423 | 740 | 1,542 | 98 | 142 | 190 | 464 | 704 | 1,058 | 1,986 |
| 1100 | 862 | 1.3 | 4 | 26 | 2 | 5 | 20 | 214 | 418 | 733 | 1,527 | 97 | 140 | 188 | 459 | 697 | 1,048 | 1,966 |
| 1101T | 758 | 1.2 | 3 | 24 | 2 | 6 | 21 | 224 | 421 | 716 | 1,447 | 96 | 134 | 181 | 430 | 646 | 964 | 1,800 |
| 1101 | 59 | 0.1 | 3 | 25 | 0 | 0 | 1 | 9 | 19 | 36 | 78 | 6 | 8 | 11 | 25 | 38 | 58 | 108 |
| 1102 | 24 | 0.0 | 4 | 4 | 0 | 0 | 0 | 4 | 8 | 14 | 31 | 0 | 0 | 0 | 4 | 8 | 14 | 31 |
| 1103 | 699 | 1.1 | 3 | 24 | 2 | 6 | 21 | 216 | 403 | 680 | 1,370 | 90 | 127 | 171 | 407 | 609 | 908 | 1,693 |
| 1104 | 592 | 0.9 | 2 | 19 | 1 | 3 | 19 | 194 | 358 | 591 | 1,179 | 75 | 103 | 138 | 333 | 507 | 765 | 1,422 |
| 1105 | 134 | 0.2 | 2 | 61 | 0 | 0 | 1 | 14 | 45 | 91 | 215 | 59 | 79 | 104 | 173 | 238 | 319 | 535 |
| 1106 | 89 | 0.1 | 2 | 55 | 0 | 0 | 1 | 15 | 38 | 72 | 162 | 39 | 52 | 69 | 116 | 160 | 216 | 365 |
| 1107 | 325 | 0.5 | 2 | 2 | 1 | 2 | 14 | 143 | 244 | 380 | 720 | 1 | 2 | 15 | 143 | 245 | 381 | 720 |
| 1108 | 141 | 0.2 | 2 | 2 | 1 | 2 | 8 | 73 | 119 | 179 | 330 | 1 | 2 | 8 | 73 | 119 | 179 | 330 |
| 1109 | 61 | 0.1 | 2 | 2 | 0 | 1 | 7 | 33 | 50 | 73 | 132 | 0 | 1 | 7 | 33 | 50 | 73 | 132 |
| 1110 | 53 | 0.1 | 2 | 2 | 0 | 1 | 9 | 34 | 50 | 73 | 128 | 0 | 1 | 9 | 34 | 50 | 73 | 128 |
| 1111 | 81 | 0.1 | 2 | 3 | 0 | 1 | 5 | 25 | 42 | 70 | 136 | 0 | 1 | 5 | 25 | 42 | 70 | 136 |
| 1112 | 40 | 0.1 | 2 | 2 | 0 | 1 | 5 | 16 | 24 | 35 | 62 | 0 | 1 | 5 | 16 | 24 | 35 | 62 |
| 1113 | 3751 | 5.9 | 8 | 36 | 57 | 82 | 133 | 1,350 | 2,196 | 3,461 | 6,589 | 413 | 646 | 900 | 2,398 | 3,437 | 4,871 | 8,639 |
| 1114 | 432 | 0.7 | 36 | 66 | 64 | 89 | 118 | 257 | 379 | 550 | 992 | 170 | 237 | 308 | 531 | 710 | 944 | 1,559 |
| 1115 | 84 | 0.1 | 60 | 60 | 34 | 45 | 56 | 90 | 123 | 163 | 274 | 34 | 45 | 57 | 90 | 123 | 164 | 275 |
| 1116 | 275 | 0.4 | 24 | 71 | 30 | 42 | 57 | 150 | 228 | 330 | 592 | 150 | 205 | 263 | 430 | 561 | 722 | 1,145 |
| 1117 | 101 | 0.2 | 7 | 81 | 2 | 4 | 6 | 45 | 73 | 110 | 203 | 78 | 107 | 136 | 206 | 263 | 329 | 509 |
| 1118 | 74 | 0.1 | 55 | 65 | 26 | 35 | 46 | 77 | 107 | 144 | 245 | 35 | 47 | 60 | 96 | 129 | 170 | 279 |
| 1119 | 11 | 0.0 | 74 | 74 | 3 | 4 | 5 | 9 | 12 | 15 | 24 | 3 | 4 | 5 | 9 | 12 | 15 | 24 |
| 1120 | 9 | 0.0 | 77 | 77 | 3 | 4 | 5 | 8 | 10 | 13 | 21 | 3 | 4 | 5 | 8 | 10 | 13 | 21 |
| 1121 | 7 | 0.0 | 78 | 78 | 2 | 3 | 4 | 7 | 9 | 11 | 17 | 2 | 3 | 4 | 7 | 9 | 11 | 17 |

## Table B-4 - Baseline Peak Flows

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Existing Conditions Peak Flow (cfs) | | | | | | | Future Conditions Peak Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 1122 | 5 | 0.0 | 79 | 79 | 2 | 2 | 3 | 4 | 6 | 7 | 11 | 2 | 2 | 3 | 4 | 6 | 7 | 11 |
| 1123 | 3266 | 5.1 | 4 | 32 | 16 | 41 | 244 | 1,167 | 1,925 | 3,045 | 5,779 | 370 | 567 | 907 | 2,053 | 2,960 | 4,206 | 7,418 |
| 1124T | 3186 | 5.0 | 4 | 31 | 16 | 40 | 243 | 1,156 | 1,904 | 3,005 | 5,692 | 360 | 553 | 888 | 2,020 | 2,911 | 4,135 | 7,277 |
| 1124 | 13 | 0.0 | 27 | 73 | 1 | 2 | 4 | 9 | 13 | 18 | 31 | 8 | 11 | 15 | 23 | 30 | 38 | 59 |
| 1125 | 3173 | 5.0 | 4 | 31 | 16 | 40 | 242 | 1,160 | 1,909 | 3,007 | 5,687 | 359 | 552 | 889 | 2,025 | 2,917 | 4,139 | 7,287 |
| 1126 | 46 | 0.1 | 2 | 52 | 0 | 0 | 0 | 10 | 21 | 37 | 76 | 16 | 22 | 29 | 53 | 73 | 98 | 166 |
| 1127T | 3074 | 4.8 | 4 | 30 | 17 | 40 | 241 | 1,146 | 1,880 | 2,953 | 5,566 | 344 | 530 | 859 | 1,975 | 2,845 | 4,039 | 7,091 |
| 1127 | 32 | 0.1 | 2 | 45 | 0 | 0 | 0 | 1 | 8 | 19 | 48 | 9 | 12 | 16 | 26 | 40 | 57 | 103 |
| 1128 | 3041 | 4.8 | 4 | 30 | 16 | 40 | 241 | 1,146 | 1,875 | 2,941 | 5,529 | 339 | 524 | 850 | 1,959 | 2,822 | 4,003 | 7,019 |
| 1129 | 344 | 0.5 | 3 | 19 | 1 | 2 | 14 | 86 | 154 | 266 | 537 | 18 | 28 | 44 | 128 | 205 | 325 | 620 |
| 1130 | 286 | 0.4 | 2 | 14 | 1 | 2 | 15 | 78 | 135 | 228 | 452 | 10 | 16 | 33 | 104 | 166 | 263 | 499 |
| 1131 | 27 | 0.0 | 2 | 26 | 0 | 0 | 0 | 4 | 10 | 18 | 39 | 2 | 3 | 4 | 10 | 17 | 26 | 50 |
| 1132 | 161 | 0.3 | 2 | 3 | 1 | 2 | 15 | 59 | 95 | 148 | 280 | 1 | 2 | 16 | 60 | 96 | 149 | 281 |
| 1133 | 120 | 0.2 | 3 | 4 | 1 | 2 | 16 | 56 | 84 | 124 | 223 | 1 | 2 | 16 | 57 | 85 | 125 | 223 |
| 1134 | 23 | 0.0 | 4 | 4 | 0 | 1 | 4 | 13 | 20 | 28 | 48 | 0 | 1 | 4 | 13 | 20 | 28 | 48 |
| 1135T | 2655 | 4.1 | 4 | 31 | 15 | 38 | 227 | 1,058 | 1,715 | 2,662 | 4,956 | 320 | 494 | 799 | 1,817 | 2,596 | 3,647 | 6,326 |
| 1135 | 15 | 0.0 | 2 | 45 | 0 | 0 | 0 | 3 | 6 | 11 | 21 | 3 | 5 | 6 | 12 | 17 | 24 | 40 |
| 1136 | 2640 | 4.1 | 4 | 31 | 16 | 38 | 229 | 1,071 | 1,724 | 2,664 | 4,950 | 320 | 496 | 806 | 1,827 | 2,601 | 3,647 | 6,316 |
| 1137 | 173 | 0.3 | 14 | 49 | 9 | 14 | 29 | 100 | 155 | 229 | 413 | 67 | 92 | 120 | 188 | 242 | 313 | 537 |
| 1138T | 85 | 0.1 | 25 | 25 | 9 | 14 | 25 | 64 | 93 | 130 | 225 | 9 | 14 | 25 | 64 | 93 | 130 | 225 |
| 1138 | 69 | 0.1 | 30 | 30 | 11 | 16 | 28 | 64 | 89 | 122 | 206 | 11 | 16 | 28 | 64 | 89 | 122 | 206 |
| 1139 | 16 | 0.0 | 2 | 2 | 0 | 0 | 2 | 8 | 12 | 18 | 32 | 0 | 0 | 2 | 8 | 12 | 18 | 32 |
| 1140 | 470 | 0.7 | 2 | 17 | 1 | 3 | 25 | 174 | 293 | 462 | 878 | 19 | 34 | 69 | 231 | 356 | 530 | 965 |
| 1141 | 455 | 0.7 | 2 | 17 | 1 | 3 | 26 | 174 | 291 | 456 | 862 | 18 | 32 | 68 | 228 | 350 | 520 | 942 |
| 1142T | 422 | 0.7 | 2 | 14 | 1 | 3 | 26 | 167 | 276 | 428 | 803 | 14 | 26 | 58 | 207 | 320 | 476 | 862 |
| 1142 | 42 | 0.1 | 2 | 16 | 0 | 0 | 0 | 9 | 19 | 32 | 64 | 1 | 3 | 4 | 14 | 24 | 37 | 70 |
| 1143 | 381 | 0.6 | 2 | 14 | 1 | 3 | 26 | 158 | 259 | 398 | 741 | 13 | 24 | 55 | 194 | 298 | 440 | 794 |
| 1144 | 50 | 0.1 | 2 | 30 | 0 | 0 | 0 | 9 | 19 | 33 | 69 | 4 | 7 | 10 | 24 | 36 | 54 | 99 |
| 1145 | 262 | 0.4 | 2 | 9 | 1 | 3 | 25 | 133 | 210 | 312 | 570 | 7 | 14 | 39 | 147 | 223 | 326 | 584 |
| 1146 | 202 | 0.3 | 2 | 8 | 1 | 2 | 22 | 108 | 168 | 248 | 450 | 5 | 10 | 32 | 117 | 176 | 257 | 459 |
| 1147 | 143 | 0.2 | 3 | 7 | 1 | 2 | 17 | 79 | 123 | 181 | 328 | 4 | 7 | 22 | 84 | 128 | 186 | 333 |
| 1148 | 53 | 0.1 | 3 | 3 | 1 | 1 | 9 | 29 | 43 | 62 | 109 | 1 | 1 | 9 | 29 | 43 | 62 | 109 |
| 1149 | 1930 | 3.0 | 3 | 32 | 13 | 32 | 196 | 849 | 1,331 | 2,015 | 3,683 | 280 | 425 | 677 | 1,467 | 2,052 | 2,825 | 4,798 |
| 1150 | 255 | 0.4 | 11 | 72 | 8 | 13 | 38 | 137 | 208 | 308 | 560 | 127 | 173 | 223 | 366 | 472 | 608 | 983 |
| 1151T | 147 | 0.2 | 16 | 67 | 7 | 12 | 28 | 90 | 133 | 194 | 343 | 72 | 95 | 124 | 204 | 264 | 342 | 550 |
| 1151 | 54 | 0.1 | 37 | 38 | 9 | 13 | 21 | 45 | 61 | 83 | 137 | 9 | 14 | 22 | 46 | 63 | 84 | 140 |
| 1152 | 93 | 0.1 | 5 | 85 | 2 | 3 | 18 | 64 | 95 | 136 | 241 | 94 | 127 | 163 | 238 | 299 | 374 | 570 |
| 1153 | 1561 | 2.4 | 2 | 22 | 6 | 20 | 160 | 693 | 1,084 | 1,631 | 2,957 | 147 | 233 | 423 | 1,037 | 1,490 | 2,084 | 3,590 |
| 1154 | 1501 | 2.3 | 2 | 22 | 6 | 21 | 163 | 695 | 1,079 | 1,613 | 2,900 | 147 | 231 | 419 | 1,025 | 1,468 | 2,044 | 3,500 |
| 1155T | 1450 | 2.3 | 2 | 23 | 6 | 21 | 162 | 682 | 1,054 | 1,571 | 2,819 | 146 | 229 | 416 | 1,008 | 1,438 | 1,995 | 3,409 |
| 1155 | 251 | 0.4 | 2 | 10 | 1 | 2 | 17 | 97 | 159 | 250 | 472 | 5 | 9 | 28 | 109 | 171 | 262 | 486 |
| 1156 | 221 | 0.3 | 2 | 9 | 1 | 1 | 16 | 90 | 147 | 229 | 431 | 5 | 9 | 25 | 100 | 157 | 240 | 442 |
| 1157 | 94 | 0.1 | 3 | 6 | 1 | 2 | 15 | 58 | 87 | 125 | 223 | 2 | 4 | 17 | 60 | 89 | 128 | 225 |
| 1158 | 133 | 0.2 | 2 | 9 | 1 | 1 | 12 | 54 | 83 | 124 | 223 | 2 | 5 | 17 | 59 | 89 | 130 | 229 |
| 1159 | 123 | 0.2 | 2 | 9 | 1 | 1 | 13 | 54 | 81 | 119 | 213 | 3 | 5 | 17 | 58 | 86 | 124 | 218 |
| 1160 | 106 | 0.2 | 2 | 8 | 1 | 1 | 11 | 46 | 70 | 102 | 182 | 2 | 4 | 15 | 49 | 73 | 106 | 186 |

## Table B-4 - Baseline Peak Flows

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Existing Conditions Peak Flow (cfs) | | | | | | | Future Conditions Peak Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 1161 | 462 | 0.7 | 2 | 11 | 2 | 7 | 51 | 224 | 344 | 511 | 916 | 13 | 26 | 76 | 250 | 372 | 539 | 948 |
| 1162 | 390 | 0.6 | 2 | 10 | 2 | 7 | 49 | 202 | 308 | 453 | 806 | 12 | 24 | 70 | 224 | 331 | 476 | 833 |
| 1163 | 81 | 0.1 | 3 | 5 | 1 | 1 | 9 | 39 | 59 | 86 | 155 | 1 | 2 | 10 | 40 | 61 | 88 | 156 |
| 1164 | 269 | 0.4 | 2 | 12 | 2 | 5 | 40 | 158 | 241 | 352 | 630 | 10 | 21 | 59 | 178 | 262 | 374 | 655 |
| 1165 | 209 | 0.3 | 3 | 12 | 2 | 6 | 37 | 134 | 201 | 290 | 516 | 9 | 19 | 51 | 150 | 218 | 307 | 536 |
| 1166 | 72 | 0.1 | 2 | 11 | 1 | 1 | 10 | 39 | 59 | 85 | 152 | 3 | 5 | 15 | 44 | 64 | 91 | 158 |
| 1167 | 88 | 0.1 | 3 | 12 | 1 | 5 | 24 | 72 | 107 | 151 | 262 | 6 | 12 | 31 | 79 | 115 | 158 | 270 |
| 1168 | 79 | 0.1 | 3 | 12 | 1 | 5 | 23 | 66 | 98 | 137 | 237 | 5 | 11 | 29 | 72 | 104 | 143 | 243 |
| 1169 | 604 | 0.9 | 2 | 40 | 3 | 11 | 83 | 311 | 473 | 695 | 1,223 | 134 | 202 | 315 | 618 | 836 | 1,100 | 1,807 |
| 1170 | 550 | 0.9 | 2 | 41 | 3 | 12 | 86 | 303 | 458 | 667 | 1,175 | 141 | 206 | 317 | 610 | 823 | 1,092 | 1,771 |
| 1171 | 205 | 0.3 | 3 | 13 | 2 | 6 | 36 | 119 | 178 | 255 | 441 | 9 | 19 | 50 | 134 | 194 | 272 | 460 |
| 1172 | 98 | 0.2 | 2 | 13 | 1 | 4 | 21 | 62 | 93 | 131 | 227 | 6 | 12 | 28 | 71 | 101 | 140 | 237 |
| 1173 | 269 | 0.4 | 2 | 60 | 1 | 5 | 39 | 143 | 215 | 314 | 558 | 114 | 161 | 228 | 394 | 522 | 677 | 1,081 |
| 1174 | 116 | 0.2 | 2 | 57 | 1 | 3 | 24 | 83 | 123 | 176 | 307 | 64 | 91 | 129 | 219 | 290 | 372 | 592 |
| 1175 | 90 | 0.1 | 2 | 47 | 1 | 3 | 16 | 48 | 71 | 101 | 177 | 28 | 42 | 63 | 113 | 150 | 196 | 315 |

## Table B-5 - Baseline Runoff Volumes

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Existing Conditions Runoff Volume (acre-feet) | | | | | | | Future Condtions Runoff Volume (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 100 | 10104 | 15.8 | 18 | 39 | 66 | 94 | 130 | 476 | 761 | 1,169 | 2243 | 167 | 242 | 328 | 758 | 1,068 | 1,485 | 2599 |
| 101T | 67 | 0.1 | 8 | 8 | 0 | 0 | 0 | 1 | 3 | 6 | 13 | 0 | 0 | 0 | 1 | 3 | 6 | 13 |
| 101 | 44 | 0.1 | 6 | 6 | 0 | 0 | 0 | 1 | 2 | 3 | 8 | 0 | 0 | 0 | 1 | 2 | 3 | 8 |
| 102 | 11 | 0.0 | 7 | 7 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| 103 | 23 | 0.0 | 10 | 10 | 0 | 0 | 0 | 0 | 1 | 2 | 4 | 0 | 0 | 0 | 0 | 1 | 2 | 4 |
| 104 | 9898 | 15.5 | 19 | 40 | 67 | 96 | 131 | 473 | 752 | 1,157 | 2213 | 171 | 246 | 331 | 755 | 1,059 | 1,470 | 2566 |
| 105 | 9856 | 15.4 | 19 | 40 | 69 | 98 | 134 | 479 | 758 | 1,163 | 2219 | 175 | 251 | 338 | 758 | 1,065 | 1,473 | 2569 |
| 106OF | 130 | 0.2 | 50 | 50 | 0 | 0 | 1 | 4 | 8 | 13 | 26 | 0 | 0 | 1 | 4 | 8 | 13 | 26 |
| 106 | 130 | 0.2 | 50 | 50 | 4 | 6 | 7 | 11 | 15 | 21 | 35 | 4 | 6 | 7 | 11 | 15 | 21 | 35 |
| 107 | 99 | 0.2 | 48 | 49 | 3 | 4 | 6 | 10 | 13 | 17 | 29 | 3 | 4 | 6 | 10 | 13 | 18 | 29 |
| 108 | 62 | 0.1 | 48 | 49 | 2 | 3 | 3 | 6 | 8 | 10 | 18 | 2 | 3 | 3 | 6 | 8 | 11 | 18 |
| 109T | 9592 | 15.0 | 18 | 40 | 63 | 89 | 123 | 460 | 737 | 1,135 | 2176 | 169 | 242 | 325 | 743 | 1,043 | 1,445 | 2526 |
| 109 | 74 | 0.1 | 35 | 46 | 1 | 2 | 2 | 4 | 6 | 9 | 16 | 2 | 3 | 3 | 5 | 7 | 10 | 18 |
| 110 | 9518 | 14.9 | 18 | 40 | 62 | 89 | 122 | 460 | 733 | 1,132 | 2167 | 169 | 242 | 325 | 740 | 1,040 | 1,439 | 2513 |
| 111 | 69 | 0.1 | 35 | 35 | 1 | 2 | 2 | 4 | 6 | 8 | 16 | 1 | 2 | 2 | 4 | 6 | 8 | 16 |
| 112T | 9356 | 14.6 | 18 | 40 | 62 | 88 | 121 | 460 | 733 | 1,123 | 2148 | 170 | 243 | 325 | 740 | 1,034 | 1,430 | 2489 |
| 112 | 40 | 0.1 | 58 | 58 | 1 | 2 | 3 | 4 | 5 | 7 | 11 | 1 | 2 | 3 | 4 | 5 | 7 | 11 |
| 113 | 9316 | 14.6 | 17 | 40 | 61 | 87 | 119 | 457 | 730 | 1,120 | 2139 | 170 | 242 | 325 | 737 | 1,031 | 1,427 | 2480 |
| 114 | 20 | 0.0 | 64 | 64 | 1 | 1 | 1 | 2 | 3 | 4 | 6 | 1 | 1 | 1 | 2 | 3 | 4 | 6 |
| 115 | 175 | 0.3 | 27 | 41 | 2 | 3 | 4 | 8 | 13 | 19 | 38 | 4 | 6 | 7 | 12 | 17 | 23 | 42 |
| 116 | 84 | 0.1 | 16 | 40 | 0 | 1 | 1 | 2 | 5 | 8 | 17 | 2 | 3 | 3 | 5 | 8 | 11 | 20 |
| 117 | 71 | 0.1 | 16 | 44 | 0 | 1 | 1 | 2 | 4 | 7 | 14 | 2 | 3 | 3 | 5 | 7 | 10 | 18 |
| 118 | 47 | 0.1 | 19 | 39 | 0 | 0 | 1 | 1 | 2 | 4 | 9 | 1 | 1 | 2 | 3 | 4 | 6 | 11 |
| 119 | 55 | 0.1 | 42 | 49 | 1 | 2 | 2 | 4 | 5 | 7 | 13 | 2 | 2 | 3 | 4 | 6 | 8 | 14 |
| 120 | 11 | 0.0 | 34 | 39 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 1 | 1 | 1 | 3 |
| 121T | 9019 | 14.1 | 17 | 39 | 56 | 79 | 110 | 439 | 703 | 1,083 | 2068 | 163 | 232 | 313 | 715 | 1,000 | 1,384 | 2403 |
| 121 | 81 | 0.1 | 41 | 41 | 2 | 3 | 4 | 7 | 9 | 13 | 22 | 2 | 3 | 4 | 7 | 9 | 13 | 22 |
| 122 | 8938 | 14.0 | 16 | 39 | 54 | 77 | 107 | 436 | 694 | 1,071 | 2050 | 162 | 231 | 310 | 709 | 991 | 1,372 | 2385 |
| 123T | 8831 | 13.8 | 16 | 39 | 53 | 75 | 104 | 430 | 687 | 1,059 | 2029 | 161 | 230 | 307 | 703 | 985 | 1,363 | 2363 |
| 123 | 24 | 0.0 | 39 | 39 | 0 | 1 | 1 | 1 | 2 | 3 | 5 | 0 | 1 | 1 | 1 | 2 | 3 | 5 |
| 124 | 8808 | 13.8 | 16 | 39 | 53 | 75 | 104 | 430 | 687 | 1,059 | 2025 | 162 | 230 | 310 | 703 | 985 | 1,360 | 2360 |
| 125 | 8796 | 13.7 | 16 | 39 | 52 | 75 | 104 | 430 | 684 | 1,059 | 2022 | 162 | 230 | 307 | 703 | 982 | 1,360 | 2357 |
| 126 | 11 | 0.0 | 6 | 56 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 1 | 1 | 1 | 1 | 2 | 3 |
| 127 | 8698 | 13.6 | 16 | 39 | 51 | 73 | 102 | 424 | 678 | 1,046 | 2004 | 159 | 226 | 303 | 694 | 970 | 1,344 | 2329 |
| 128 | 718 | 1.1 | 33 | 34 | 12 | 18 | 25 | 47 | 68 | 98 | 178 | 13 | 19 | 26 | 48 | 70 | 100 | 180 |
| 129T | 595 | 0.9 | 33 | 34 | 10 | 15 | 21 | 39 | 57 | 81 | 147 | 11 | 16 | 22 | 41 | 59 | 83 | 149 |
| 129 | 38 | 0.1 | 44 | 54 | 1 | 1 | 2 | 3 | 4 | 5 | 9 | 1 | 2 | 2 | 3 | 4 | 6 | 10 |
| 130 | 22 | 0.0 | 48 | 48 | 1 | 1 | 1 | 2 | 2 | 3 | 5 | 1 | 1 | 1 | 2 | 2 | 3 | 5 |
| 131T | 557 | 0.9 | 32 | 33 | 10 | 14 | 19 | 37 | 53 | 76 | 138 | 10 | 14 | 20 | 37 | 54 | 78 | 140 |
| 131 | 44 | 0.1 | 17 | 17 | 0 | 0 | 1 | 1 | 2 | 4 | 8 | 0 | 0 | 1 | 1 | 2 | 4 | 8 |
| 132 | 58 | 0.1 | 49 | 49 | 2 | 2 | 3 | 4 | 6 | 8 | 15 | 2 | 2 | 3 | 4 | 6 | 8 | 15 |
| 133 | 31 | 0.0 | 45 | 45 | 1 | 1 | 1 | 2 | 3 | 4 | 7 | 1 | 1 | 1 | 2 | 3 | 4 | 7 |
| 134T | 455 | 0.7 | 31 | 33 | 8 | 11 | 16 | 31 | 45 | 64 | 115 | 8 | 12 | 16 | 32 | 46 | 65 | 116 |
| 134 | 10 | 0.0 | 51 | 55 | 0 | 0 | 1 | 1 | 1 | 1 | 3 | 0 | 0 | 1 | 1 | 1 | 2 | 3 |
| 135 | 445 | 0.7 | 31 | 32 | 7 | 11 | 15 | 30 | 44 | 63 | 113 | 8 | 11 | 16 | 31 | 45 | 64 | 114 |
| 136T | 388 | 0.6 | 30 | 30 | 6 | 9 | 13 | 26 | 38 | 55 | 98 | 6 | 9 | 13 | 26 | 38 | 55 | 98 |
| 136 | 127 | 0.2 | 54 | 54 | 4 | 6 | 8 | 11 | 15 | 21 | 35 | 4 | 6 | 8 | 11 | 15 | 21 | 35 |
| 137 | 28 | 0.0 | 61 | 61 | 1 | 1 | 2 | 3 | 4 | 5 | 8 | 1 | 1 | 2 | 3 | 4 | 5 | 8 |

## Table B-5 - Baseline Runoff Volumes

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Existing Conditions Runoff Volume (acre-feet) | | | | | | | Future Condtions Runoff Volume (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 138 | 260 | 0.4 | 19 | 19 | 2 | 3 | 5 | 15 | 23 | 34 | 63 | 2 | 3 | 5 | 15 | 23 | 34 | 63 |
| 139 | 237 | 0.4 | 17 | 17 | 2 | 3 | 4 | 13 | 20 | 30 | 56 | 2 | 3 | 4 | 13 | 20 | 30 | 56 |
| 140 | 188 | 0.3 | 15 | 15 | 1 | 2 | 3 | 9 | 15 | 23 | 44 | 1 | 2 | 3 | 9 | 15 | 23 | 44 |
| 141 | 66 | 0.1 | 10 | 10 | 0 | 0 | 1 | 4 | 6 | 9 | 16 | 0 | 0 | 1 | 4 | 6 | 9 | 16 |
| 142T | 7871 | 12.3 | 14 | 40 | 41 | 59 | 83 | 377 | 608 | 942 | 1808 | 150 | 212 | 284 | 644 | 896 | 1,237 | 2130 |
| 142 | 793 | 1.2 | 31 | 34 | 13 | 19 | 26 | 51 | 75 | 108 | 196 | 15 | 21 | 29 | 54 | 78 | 111 | 200 |
| 143T | 679 | 1.1 | 29 | 32 | 11 | 15 | 21 | 43 | 63 | 91 | 167 | 12 | 17 | 24 | 46 | 67 | 95 | 171 |
| 143 | 18 | 0.0 | 65 | 65 | 1 | 1 | 1 | 2 | 3 | 3 | 5 | 1 | 1 | 1 | 2 | 3 | 3 | 5 |
| 144 | 661 | 1.0 | 28 | 31 | 10 | 14 | 20 | 40 | 60 | 88 | 161 | 11 | 16 | 22 | 44 | 64 | 92 | 165 |
| 145 | 22 | 0.0 | 34 | 44 | 0 | 0 | 1 | 1 | 2 | 2 | 5 | 1 | 1 | 1 | 1 | 2 | 3 | 5 |
| 146 | 102 | 0.2 | 20 | 20 | 1 | 1 | 2 | 5 | 8 | 12 | 24 | 1 | 1 | 2 | 5 | 8 | 12 | 24 |
| 147 | 72 | 0.1 | 26 | 26 | 1 | 1 | 2 | 4 | 6 | 9 | 17 | 1 | 1 | 2 | 4 | 6 | 9 | 17 |
| 148 | 347 | 0.5 | 26 | 29 | 5 | 7 | 10 | 22 | 33 | 47 | 86 | 5 | 8 | 11 | 23 | 34 | 49 | 88 |
| 149 | 113 | 0.2 | 39 | 44 | 2 | 3 | 4 | 7 | 10 | 14 | 27 | 3 | 4 | 5 | 8 | 11 | 15 | 28 |
| 150T | 113 | 0.2 | 30 | 34 | 2 | 3 | 4 | 9 | 13 | 18 | 31 | 2 | 3 | 5 | 9 | 13 | 18 | 31 |
| 150 | 64 | 0.1 | 22 | 22 | 1 | 1 | 2 | 4 | 6 | 9 | 16 | 1 | 1 | 2 | 4 | 6 | 9 | 16 |
| 151 | 49 | 0.1 | 41 | 50 | 1 | 2 | 2 | 4 | 6 | 8 | 14 | 2 | 2 | 3 | 5 | 7 | 9 | 15 |
| 152 | 7078 | 11.1 | 12 | 40 | 31 | 44 | 63 | 328 | 534 | 838 | 1614 | 138 | 196 | 261 | 592 | 822 | 1,126 | 1933 |
| 153 | 116 | 0.2 | 5 | 23 | 0 | 0 | 0 | 2 | 5 | 10 | 22 | 1 | 2 | 2 | 5 | 8 | 13 | 26 |
| 154T | 6848 | 10.7 | 12 | 41 | 30 | 44 | 63 | 325 | 528 | 819 | 1574 | 138 | 195 | 260 | 583 | 807 | 1,102 | 1884 |
| 154 | 6148 | 9.6 | 10 | 39 | 23 | 34 | 58 | 285 | 466 | 730 | 1409 | 129 | 183 | 249 | 516 | 718 | 982 | 1685 |
| 155 | 638 | 1.0 | 32 | 57 | 11 | 16 | 21 | 39 | 57 | 83 | 154 | 23 | 32 | 41 | 64 | 85 | 112 | 185 |
| 156T | 579 | 0.9 | 32 | 59 | 10 | 15 | 19 | 35 | 52 | 75 | 139 | 22 | 30 | 39 | 59 | 78 | 103 | 169 |
| 156 | 253 | 0.4 | 44 | 54 | 7 | 9 | 12 | 20 | 28 | 38 | 67 | 9 | 12 | 15 | 24 | 32 | 42 | 71 |
| 157 | 197 | 0.3 | 44 | 57 | 5 | 7 | 10 | 15 | 21 | 30 | 52 | 7 | 10 | 13 | 19 | 25 | 34 | 56 |
| 158 | 141 | 0.2 | 44 | 61 | 4 | 5 | 7 | 11 | 15 | 21 | 37 | 6 | 8 | 10 | 15 | 19 | 25 | 41 |
| 159 | 45 | 0.1 | 55 | 73 | 2 | 2 | 3 | 4 | 6 | 8 | 13 | 2 | 3 | 4 | 6 | 7 | 9 | 14 |
| 160 | 10 | 0.0 | 7 | 85 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 2 | 3 |
| 161 | 326 | 0.5 | 23 | 63 | 3 | 5 | 7 | 15 | 24 | 37 | 73 | 13 | 18 | 23 | 36 | 47 | 60 | 98 |
| 162 | 311 | 0.5 | 22 | 64 | 3 | 5 | 7 | 14 | 22 | 35 | 69 | 13 | 18 | 23 | 34 | 45 | 58 | 94 |
| 163 | 257 | 0.4 | 18 | 69 | 2 | 3 | 4 | 9 | 16 | 26 | 54 | 11 | 16 | 20 | 30 | 39 | 49 | 79 |
| 164 | 147 | 0.2 | 9 | 84 | 0 | 0 | 1 | 2 | 6 | 11 | 26 | 8 | 11 | 14 | 20 | 25 | 31 | 48 |
| 165 | 96 | 0.1 | 7 | 85 | 0 | 0 | 0 | 1 | 3 | 6 | 16 | 5 | 7 | 9 | 13 | 16 | 20 | 31 |
| 166 | 62 | 0.1 | 4 | 25 | 0 | 0 | 0 | 2 | 3 | 6 | 12 | 1 | 1 | 1 | 3 | 5 | 8 | 14 |
| 167T | 6139 | 9.6 | 10 | 39 | 24 | 35 | 58 | 287 | 470 | 733 | 1409 | 130 | 184 | 250 | 519 | 718 | 985 | 1685 |
| 167 | 45 | 0.1 | 41 | 50 | 1 | 2 | 2 | 4 | 6 | 8 | 13 | 1 | 2 | 3 | 5 | 6 | 8 | 14 |
| 168 | 6094 | 9.5 | 10 | 39 | 23 | 34 | 57 | 285 | 466 | 727 | 1399 | 130 | 183 | 249 | 516 | 715 | 979 | 1676 |
| 169 | 63 | 0.1 | 4 | 30 | 0 | 0 | 0 | 2 | 4 | 7 | 13 | 1 | 1 | 2 | 4 | 6 | 9 | 16 |
| 170T | 6001 | 9.4 | 10 | 39 | 23 | 34 | 58 | 282 | 460 | 718 | 1381 | 129 | 182 | 247 | 509 | 706 | 967 | 1654 |
| 170 | 42 | 0.1 | 48 | 55 | 1 | 2 | 3 | 4 | 6 | 8 | 13 | 2 | 2 | 3 | 5 | 6 | 8 | 13 |
| 171 | 18 | 0.0 | 65 | 65 | 1 | 1 | 1 | 2 | 3 | 3 | 5 | 1 | 1 | 1 | 2 | 3 | 3 | 5 |
| 172 | 5959 | 9.3 | 10 | 39 | 22 | 33 | 56 | 278 | 454 | 712 | 1369 | 128 | 180 | 245 | 506 | 700 | 957 | 1642 |
| 173 | 39 | 0.1 | 10 | 85 | 0 | 0 | 0 | 2 | 3 | 5 | 9 | 2 | 3 | 4 | 6 | 7 | 9 | 14 |
| 174T | 5880 | 9.2 | 10 | 39 | 22 | 32 | 55 | 276 | 451 | 703 | 1353 | 126 | 178 | 241 | 500 | 694 | 948 | 1620 |
| 174 | 157 | 0.2 | 49 | 55 | 5 | 7 | 9 | 14 | 19 | 26 | 43 | 6 | 8 | 10 | 15 | 20 | 27 | 45 |
| 175 | 25 | 0.0 | 3 | 42 | 0 | 0 | 0 | 1 | 2 | 3 | 6 | 1 | 1 | 1 | 2 | 3 | 4 | 7 |
| 176 | 5724 | 8.9 | 9 | 39 | 18 | 27 | 48 | 262 | 433 | 678 | 1310 | 121 | 171 | 232 | 485 | 672 | 921 | 1577 |
| 177 | 275 | 0.4 | 21 | 68 | 3 | 4 | 6 | 12 | 19 | 30 | 60 | 12 | 16 | 21 | 31 | 40 | 51 | 83 |

## Table B-5 - Baseline Runoff Volumes

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Existing Conditions Runoff Volume (acre-feet) | | | | | | | Future Condtions Runoff Volume (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 178 | 40 | 0.1 | 48 | 51 | 1 | 2 | 2 | 3 | 4 | 6 | 11 | 1 | 2 | 2 | 3 | 5 | 6 | 11 |
| 179 | 14 | 0.0 | 46 | 50 | 0 | 1 | 1 | 1 | 1 | 2 | 3 | 0 | 1 | 1 | 1 | 2 | 2 | 4 |
| 180 | 201 | 0.3 | 12 | 75 | 1 | 1 | 2 | 6 | 11 | 19 | 41 | 10 | 13 | 17 | 25 | 32 | 40 | 63 |
| 181 | 190 | 0.3 | 11 | 78 | 1 | 1 | 2 | 5 | 10 | 18 | 38 | 10 | 13 | 17 | 24 | 31 | 38 | 60 |
| 182T | 121 | 0.2 | 8 | 79 | 0 | 0 | 1 | 3 | 6 | 10 | 23 | 6 | 9 | 11 | 16 | 20 | 25 | 39 |
| 182 | 18 | 0.0 | 11 | 86 | 0 | 0 | 0 | 1 | 2 | 2 | 4 | 1 | 1 | 2 | 3 | 3 | 4 | 6 |
| 183 | 103 | 0.2 | 8 | 78 | 0 | 0 | 0 | 2 | 4 | 8 | 18 | 5 | 7 | 9 | 13 | 16 | 21 | 33 |
| 184 | 34 | 0.1 | 5 | 65 | 0 | 0 | 0 | 1 | 2 | 3 | 6 | 1 | 2 | 2 | 4 | 5 | 6 | 10 |
| 185 | 5436 | 8.5 | 8 | 37 | 16 | 24 | 44 | 252 | 414 | 651 | 1249 | 110 | 156 | 214 | 454 | 632 | 868 | 1495 |
| 186T | 5388 | 8.4 | 8 | 37 | 16 | 24 | 44 | 252 | 411 | 648 | 1243 | 110 | 156 | 213 | 454 | 629 | 865 | 1482 |
| 186 | 17 | 0.0 | 46 | 46 | 0 | 1 | 1 | 1 | 2 | 3 | 5 | 0 | 1 | 1 | 1 | 2 | 3 | 5 |
| 187 | 5370 | 8.4 | 8 | 37 | 15 | 23 | 43 | 250 | 411 | 644 | 1240 | 110 | 156 | 212 | 451 | 629 | 862 | 1479 |
| 188 | 69 | 0.1 | 6 | 45 | 0 | 0 | 0 | 1 | 2 | 5 | 12 | 2 | 2 | 3 | 5 | 7 | 10 | 17 |
| 189 | 5281 | 8.3 | 8 | 37 | 15 | 23 | 43 | 250 | 408 | 638 | 1224 | 108 | 153 | 209 | 445 | 620 | 850 | 1458 |
| 190 | 240 | 0.4 | 21 | 49 | 3 | 4 | 5 | 11 | 17 | 27 | 52 | 7 | 10 | 13 | 20 | 28 | 38 | 64 |
| 191 | 185 | 0.3 | 26 | 51 | 3 | 4 | 5 | 9 | 14 | 22 | 41 | 6 | 8 | 10 | 16 | 21 | 29 | 50 |
| 192 | 77 | 0.1 | 58 | 58 | 3 | 4 | 5 | 7 | 10 | 13 | 22 | 3 | 4 | 5 | 7 | 10 | 13 | 22 |
| 193T | 4979 | 7.8 | 7 | 37 | 13 | 20 | 39 | 238 | 390 | 608 | 1160 | 100 | 142 | 195 | 420 | 586 | 804 | 1378 |
| 193 | 177 | 0.3 | 10 | 76 | 1 | 1 | 2 | 6 | 11 | 19 | 38 | 9 | 12 | 16 | 23 | 29 | 37 | 57 |
| 194 | 71 | 0.1 | 3 | 84 | 0 | 0 | 0 | 1 | 3 | 6 | 13 | 4 | 5 | 7 | 10 | 12 | 15 | 24 |
| 195 | 172 | 0.3 | 9 | 76 | 1 | 1 | 1 | 6 | 11 | 18 | 36 | 9 | 12 | 15 | 22 | 28 | 36 | 56 |
| 196 | 145 | 0.2 | 4 | 84 | 0 | 0 | 0 | 4 | 8 | 14 | 29 | 8 | 11 | 14 | 20 | 26 | 32 | 49 |
| 197 | 26 | 0.0 | 2 | 85 | 0 | 0 | 0 | 0 | 1 | 1 | 4 | 1 | 2 | 2 | 3 | 4 | 5 | 8 |
| 198 | 4731 | 7.4 | 7 | 34 | 12 | 19 | 37 | 230 | 374 | 583 | 1108 | 89 | 126 | 175 | 390 | 546 | 755 | 1298 |
| 199 | 872 | 1.4 | 4 | 27 | 1 | 2 | 5 | 31 | 55 | 93 | 188 | 14 | 20 | 28 | 59 | 86 | 125 | 222 |
| 1100 | 862 | 1.3 | 4 | 26 | 1 | 1 | 4 | 30 | 55 | 92 | 185 | 14 | 19 | 27 | 58 | 85 | 123 | 219 |
| 1101T | 758 | 1.2 | 3 | 24 | 0 | 1 | 4 | 28 | 50 | 83 | 165 | 11 | 15 | 22 | 50 | 73 | 107 | 191 |
| 1101 | 59 | 0.1 | 3 | 25 | 0 | 0 | 0 | 1 | 3 | 5 | 11 | 1 | 1 | 1 | 3 | 5 | 7 | 13 |
| 1102 | 24 | 0.0 | 4 | 4 | 0 | 0 | 0 | 0 | 1 | 2 | 5 | 0 | 0 | 0 | 0 | 1 | 2 | 5 |
| 1103 | 699 | 1.1 | 3 | 24 | 0 | 1 | 4 | 27 | 47 | 77 | 153 | 10 | 14 | 20 | 47 | 69 | 100 | 178 |
| 1104 | 592 | 0.9 | 2 | 19 | 0 | 1 | 3 | 22 | 40 | 65 | 130 | 7 | 9 | 15 | 37 | 56 | 82 | 148 |
| 1105 | 134 | 0.2 | 2 | 61 | 0 | 0 | 0 | 1 | 4 | 9 | 23 | 5 | 7 | 9 | 13 | 18 | 23 | 38 |
| 1106 | 89 | 0.1 | 2 | 55 | 0 | 0 | 0 | 1 | 3 | 7 | 16 | 3 | 4 | 5 | 8 | 11 | 14 | 25 |
| 1107 | 325 | 0.5 | 2 | 2 | 0 | 0 | 2 | 15 | 25 | 40 | 76 | 0 | 0 | 2 | 15 | 25 | 40 | 76 |
| 1108 | 141 | 0.2 | 2 | 2 | 0 | 0 | 1 | 6 | 11 | 17 | 33 | 0 | 0 | 1 | 6 | 11 | 17 | 33 |
| 1109 | 61 | 0.1 | 2 | 2 | 0 | 0 | 1 | 3 | 5 | 8 | 15 | 0 | 0 | 1 | 3 | 5 | 8 | 15 |
| 1110 | 53 | 0.1 | 2 | 2 | 0 | 0 | 1 | 3 | 5 | 7 | 14 | 0 | 0 | 1 | 3 | 5 | 7 | 14 |
| 1111 | 81 | 0.1 | 2 | 3 | 0 | 0 | 1 | 4 | 6 | 10 | 19 | 0 | 0 | 1 | 4 | 6 | 10 | 19 |
| 1112 | 40 | 0.1 | 2 | 2 | 0 | 0 | 1 | 2 | 4 | 6 | 10 | 0 | 0 | 1 | 2 | 4 | 6 | 10 |
| 1113 | 3751 | 5.9 | 8 | 36 | 12 | 18 | 35 | 199 | 316 | 482 | 902 | 73 | 106 | 147 | 322 | 448 | 614 | 1046 |
| 1114 | 432 | 0.7 | 36 | 66 | 9 | 13 | 17 | 32 | 45 | 64 | 112 | 19 | 26 | 34 | 49 | 64 | 82 | 132 |
| 1115 | 84 | 0.1 | 60 | 60 | 3 | 4 | 6 | 8 | 11 | 14 | 23 | 3 | 4 | 6 | 8 | 11 | 14 | 23 |
| 1116 | 275 | 0.4 | 24 | 71 | 3 | 5 | 7 | 16 | 25 | 37 | 67 | 13 | 18 | 23 | 33 | 43 | 55 | 87 |
| 1117 | 101 | 0.2 | 7 | 81 | 0 | 0 | 1 | 4 | 7 | 12 | 23 | 5 | 7 | 10 | 14 | 17 | 22 | 34 |
| 1118 | 74 | 0.1 | 55 | 65 | 2 | 3 | 4 | 7 | 9 | 12 | 20 | 3 | 4 | 5 | 8 | 10 | 13 | 21 |
| 1119 | 11 | 0.0 | 74 | 74 | 1 | 1 | 1 | 1 | 2 | 2 | 4 | 1 | 1 | 1 | 1 | 2 | 2 | 4 |
| 1120 | 9 | 0.0 | 77 | 77 | 0 | 1 | 1 | 1 | 1 | 2 | 3 | 0 | 1 | 1 | 1 | 1 | 2 | 3 |
| 1121 | 7 | 0.0 | 78 | 78 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 1 | 1 | 1 | 1 | 2 |

## Table B-5 - Baseline Runoff Volumes

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Existing Conditions Runoff Volume (acre-feet) | | | | | | | Future Condtions Runoff Volume (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 1122 | 5 | 0.0 | 79 | 79 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 1 | 1 | 1 | 2 |
| 1123 | 3266 | 5.1 | 4 | 32 | 4 | 9 | 39 | 165 | 267 | 411 | 779 | 61 | 90 | 138 | 269 | 381 | 525 | 902 |
| 1124T | 3186 | 5.0 | 4 | 31 | 4 | 9 | 39 | 162 | 262 | 405 | 761 | 59 | 87 | 134 | 262 | 368 | 509 | 881 |
| 1124 | 13 | 0.0 | 27 | 73 | 0 | 0 | 0 | 1 | 1 | 2 | 3 | 1 | 1 | 1 | 2 | 2 | 3 | 4 |
| 1125 | 3173 | 5.0 | 4 | 31 | 4 | 9 | 39 | 161 | 261 | 402 | 761 | 59 | 86 | 133 | 261 | 368 | 509 | 875 |
| 1126 | 46 | 0.1 | 2 | 52 | 0 | 0 | 0 | 1 | 2 | 4 | 9 | 1 | 2 | 3 | 4 | 6 | 8 | 13 |
| 1127T | 3074 | 4.8 | 4 | 30 | 4 | 9 | 38 | 158 | 254 | 393 | 740 | 55 | 80 | 126 | 250 | 353 | 488 | 844 |
| 1127 | 32 | 0.1 | 2 | 45 | 0 | 0 | 0 | 0 | 1 | 2 | 5 | 1 | 1 | 1 | 2 | 3 | 4 | 8 |
| 1128 | 3041 | 4.8 | 4 | 30 | 4 | 9 | 38 | 158 | 254 | 390 | 733 | 54 | 79 | 124 | 248 | 350 | 485 | 838 |
| 1129 | 344 | 0.5 | 3 | 19 | 0 | 1 | 3 | 14 | 24 | 39 | 77 | 3 | 5 | 9 | 21 | 32 | 47 | 86 |
| 1130 | 286 | 0.4 | 2 | 14 | 0 | 0 | 2 | 12 | 20 | 33 | 64 | 2 | 3 | 6 | 16 | 25 | 37 | 70 |
| 1131 | 27 | 0.0 | 2 | 26 | 0 | 0 | 0 | 0 | 1 | 2 | 5 | 0 | 0 | 1 | 1 | 2 | 3 | 6 |
| 1132 | 161 | 0.3 | 2 | 3 | 0 | 0 | 2 | 8 | 13 | 21 | 39 | 0 | 0 | 2 | 9 | 14 | 21 | 39 |
| 1133 | 120 | 0.2 | 3 | 4 | 0 | 0 | 2 | 7 | 12 | 17 | 31 | 0 | 0 | 2 | 8 | 12 | 17 | 31 |
| 1134 | 23 | 0.0 | 4 | 4 | 0 | 0 | 0 | 1 | 2 | 3 | 6 | 0 | 0 | 0 | 1 | 2 | 3 | 6 |
| 1135T | 2655 | 4.1 | 4 | 31 | 4 | 8 | 36 | 143 | 228 | 347 | 648 | 50 | 73 | 114 | 224 | 313 | 433 | 740 |
| 1135 | 15 | 0.0 | 2 | 45 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 0 | 1 | 1 | 1 | 2 | 2 | 4 |
| 1136 | 2640 | 4.1 | 4 | 31 | 4 | 8 | 36 | 143 | 228 | 347 | 644 | 49 | 73 | 113 | 223 | 313 | 430 | 737 |
| 1137 | 173 | 0.3 | 14 | 49 | 1 | 2 | 4 | 11 | 17 | 24 | 44 | 5 | 8 | 11 | 18 | 24 | 32 | 52 |
| 1138T | 85 | 0.1 | 25 | 25 | 1 | 2 | 3 | 7 | 10 | 14 | 23 | 1 | 2 | 3 | 7 | 10 | 14 | 23 |
| 1138 | 69 | 0.1 | 30 | 30 | 1 | 2 | 3 | 6 | 8 | 11 | 19 | 1 | 2 | 3 | 6 | 8 | 11 | 19 |
| 1139 | 16 | 0.0 | 2 | 2 | 0 | 0 | 0 | 1 | 1 | 2 | 4 | 0 | 0 | 0 | 1 | 1 | 2 | 4 |
| 1140 | 470 | 0.7 | 2 | 17 | 0 | 1 | 4 | 21 | 35 | 56 | 108 | 3 | 6 | 10 | 29 | 44 | 64 | 118 |
| 1141 | 455 | 0.7 | 2 | 17 | 0 | 1 | 4 | 21 | 35 | 55 | 106 | 3 | 5 | 10 | 28 | 43 | 63 | 115 |
| 1142T | 422 | 0.7 | 2 | 14 | 0 | 1 | 3 | 20 | 33 | 52 | 99 | 2 | 4 | 8 | 25 | 39 | 58 | 106 |
| 1142 | 42 | 0.1 | 2 | 16 | 0 | 0 | 0 | 1 | 2 | 4 | 8 | 0 | 0 | 1 | 2 | 3 | 5 | 9 |
| 1143 | 381 | 0.6 | 2 | 14 | 0 | 1 | 3 | 18 | 30 | 48 | 90 | 2 | 4 | 8 | 23 | 36 | 53 | 96 |
| 1144 | 50 | 0.1 | 2 | 30 | 0 | 0 | 0 | 1 | 2 | 5 | 10 | 1 | 1 | 1 | 3 | 4 | 7 | 12 |
| 1145 | 262 | 0.4 | 2 | 9 | 0 | 0 | 3 | 14 | 23 | 34 | 64 | 1 | 2 | 5 | 16 | 24 | 36 | 66 |
| 1146 | 202 | 0.3 | 2 | 8 | 0 | 0 | 3 | 11 | 18 | 27 | 50 | 1 | 1 | 4 | 13 | 19 | 28 | 52 |
| 1147 | 143 | 0.2 | 3 | 7 | 0 | 0 | 2 | 8 | 13 | 19 | 36 | 0 | 1 | 3 | 9 | 14 | 20 | 37 |
| 1148 | 53 | 0.1 | 3 | 3 | 0 | 0 | 1 | 3 | 5 | 7 | 14 | 0 | 0 | 1 | 3 | 5 | 7 | 14 |
| 1149 | 1930 | 3.0 | 3 | 32 | 3 | 6 | 29 | 111 | 173 | 261 | 482 | 38 | 56 | 88 | 170 | 237 | 322 | 549 |
| 1150 | 255 | 0.4 | 11 | 72 | 2 | 2 | 6 | 17 | 26 | 37 | 67 | 13 | 18 | 24 | 35 | 44 | 55 | 86 |
| 1151T | 147 | 0.2 | 16 | 67 | 1 | 2 | 4 | 11 | 16 | 23 | 41 | 7 | 10 | 13 | 20 | 25 | 32 | 49 |
| 1151 | 54 | 0.1 | 37 | 38 | 1 | 2 | 3 | 5 | 7 | 9 | 15 | 1 | 2 | 3 | 5 | 7 | 9 | 15 |
| 1152 | 93 | 0.1 | 5 | 85 | 0 | 0 | 1 | 6 | 9 | 13 | 24 | 5 | 7 | 10 | 14 | 17 | 21 | 33 |
| 1153 | 1561 | 2.4 | 2 | 22 | 1 | 3 | 23 | 88 | 139 | 209 | 387 | 20 | 31 | 55 | 121 | 174 | 244 | 427 |
| 1154 | 1501 | 2.3 | 2 | 22 | 1 | 4 | 23 | 88 | 137 | 206 | 377 | 19 | 30 | 53 | 118 | 169 | 237 | 411 |
| 1155T | 1450 | 2.3 | 2 | 23 | 1 | 4 | 23 | 86 | 134 | 200 | 368 | 19 | 29 | 52 | 116 | 165 | 231 | 402 |
| 1155 | 251 | 0.4 | 2 | 10 | 0 | 0 | 3 | 14 | 23 | 34 | 63 | 1 | 2 | 5 | 16 | 25 | 36 | 65 |
| 1156 | 221 | 0.3 | 2 | 9 | 0 | 0 | 3 | 13 | 20 | 30 | 56 | 1 | 2 | 5 | 14 | 22 | 32 | 57 |
| 1157 | 94 | 0.1 | 3 | 6 | 0 | 0 | 1 | 5 | 8 | 13 | 23 | 0 | 0 | 2 | 6 | 9 | 13 | 24 |
| 1158 | 133 | 0.2 | 2 | 9 | 0 | 0 | 2 | 8 | 12 | 18 | 33 | 0 | 1 | 3 | 8 | 13 | 19 | 34 |
| 1159 | 123 | 0.2 | 2 | 9 | 0 | 0 | 2 | 7 | 11 | 17 | 31 | 0 | 1 | 2 | 8 | 12 | 18 | 32 |
| 1160 | 106 | 0.2 | 2 | 8 | 0 | 0 | 1 | 6 | 10 | 14 | 26 | 0 | 1 | 2 | 7 | 10 | 15 | 27 |

## Table B-5 - Baseline Runoff Volumes

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Existing Conditions Runoff Volume (acre-feet) | | | | | | | Future Condtions Runoff Volume (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 1161 | 462 | 0.7 | 2 | 11 | 0 | 1 | 6 | 27 | 41 | 63 | 115 | 2 | 4 | 10 | 30 | 45 | 66 | 120 |
| 1162 | 390 | 0.6 | 2 | 10 | 0 | 1 | 6 | 23 | 36 | 53 | 98 | 2 | 3 | 9 | 26 | 39 | 57 | 102 |
| 1163 | 81 | 0.1 | 3 | 5 | 0 | 0 | 1 | 5 | 7 | 11 | 20 | 0 | 0 | 1 | 5 | 7 | 11 | 20 |
| 1164 | 269 | 0.4 | 2 | 12 | 0 | 1 | 4 | 16 | 25 | 37 | 68 | 1 | 3 | 7 | 18 | 27 | 40 | 71 |
| 1165 | 209 | 0.3 | 3 | 12 | 0 | 1 | 3 | 13 | 19 | 29 | 53 | 1 | 2 | 5 | 14 | 21 | 31 | 55 |
| 1166 | 72 | 0.1 | 2 | 11 | 0 | 0 | 1 | 4 | 6 | 10 | 18 | 0 | 1 | 2 | 5 | 7 | 10 | 19 |
| 1167 | 88 | 0.1 | 3 | 12 | 0 | 0 | 2 | 6 | 9 | 13 | 23 | 0 | 1 | 3 | 6 | 9 | 13 | 24 |
| 1168 | 79 | 0.1 | 3 | 12 | 0 | 0 | 2 | 5 | 8 | 11 | 21 | 0 | 1 | 2 | 6 | 8 | 12 | 21 |
| 1169 | 604 | 0.9 | 2 | 40 | 1 | 2 | 11 | 38 | 58 | 86 | 157 | 15 | 23 | 35 | 61 | 83 | 110 | 182 |
| 1170 | 550 | 0.9 | 2 | 41 | 0 | 2 | 10 | 35 | 53 | 78 | 143 | 14 | 21 | 32 | 56 | 75 | 100 | 166 |
| 1171 | 205 | 0.3 | 3 | 13 | 0 | 1 | 4 | 13 | 20 | 29 | 54 | 1 | 2 | 6 | 15 | 22 | 32 | 56 |
| 1172 | 98 | 0.2 | 2 | 13 | 0 | 0 | 2 | 6 | 10 | 14 | 26 | 1 | 1 | 3 | 7 | 11 | 15 | 27 |
| 1173 | 269 | 0.4 | 2 | 60 | 0 | 1 | 5 | 17 | 25 | 38 | 69 | 11 | 15 | 21 | 33 | 42 | 54 | 87 |
| 1174 | 116 | 0.2 | 2 | 57 | 0 | 0 | 2 | 7 | 11 | 16 | 30 | 4 | 6 | 8 | 13 | 18 | 23 | 37 |
| 1175 | 90 | 0.1 | 2 | 47 | 0 | 0 | 2 | 6 | 9 | 13 | 24 | 3 | 4 | 6 | 10 | 13 | 17 | 28 |

## Table B-6 - Baseline Peak Flows Along Sheep Draw

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Length (feet) | Existing Peak Flows (cfs) | | | | | | | Future Peak Flows (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 100 | --- | Confluence with Cache La Poudre River | 10104 | 15.8 | 0 | 228 | 354 | 512 | 2,062 | 3,456 | 5,757 | 12,118 | 769 | 1,132 | 1,541 | 3,888 | 5,760 | 8,419 | 16,238 |
| 104 | 204 | Greeley No. 3 Ditch | 9898 | 15.5 | 1,410 | 228 | 357 | 512 | 2,306 | 3,445 | 5,715 | 12,014 | 772 | 1,134 | 1,545 | 3,872 | 5,730 | 8,357 | 16,104 |
| 105 | 205 | C Street | 9856 | 15.4 | 3,073 | 229 | 360 | 515 | 1,960 | 3,466 | 5,746 | 12,062 | 777 | 1,136 | 1,547 | 3,883 | 5,751 | 8,370 | 16,127 |
| 109T | 209T | | 9592 | 15.0 | 3,294 | 227 | 354 | 505 | 1,958 | 3,461 | 5,736 | 12,021 | 775 | 1,134 | 1,544 | 3,875 | 5,735 | 8,344 | 16,034 |
| 110 | 210 | | 9518 | 14.9 | 4,721 | 226 | 353 | 502 | 1,964 | 3,468 | 5,739 | 12,010 | 776 | 1,134 | 1,543 | 3,878 | 5,738 | 8,353 | 16,009 |
| 112T | 212T | | 9356 | 14.6 | 7,798 | 226 | 357 | 503 | 1,981 | 3,479 | 5,762 | 12,076 | 780 | 1,132 | 1,539 | 3,879 | 5,749 | 8,395 | 16,038 |
| 113 | 213 | W. 4th Street | 9316 | 14.6 | 8,464 | 225 | 354 | 499 | 1,981 | 3,479 | 5,762 | 12,071 | 780 | 1,131 | 1,538 | 3,878 | 5,747 | 8,393 | 16,024 |
| 121T | 215 | | 9019 | 14.1 | 8,554 | 214 | 331 | 472 | 1,973 | 3,455 | 5,714 | 11,911 | 769 | 1,119 | 1,519 | 3,848 | 5,691 | 8,303 | 15,807 |
| 122 | 222 | | 8938 | 14.0 | 9,475 | 209 | 322 | 462 | 1,968 | 3,440 | 5,688 | 11,843 | 764 | 1,112 | 1,510 | 3,831 | 5,665 | 8,264 | 15,715 |
| 123T | 223T | | 8831 | 13.8 | 10,930 | 204 | 311 | 452 | 1,964 | 3,432 | 5,669 | 11,784 | 761 | 1,106 | 1,501 | 3,821 | 5,646 | 8,231 | 15,634 |
| 124 | 224 | W. 10th Street | 8808 | 13.8 | 11,912 | 203 | 309 | 451 | 1,966 | 3,433 | 5,669 | 11,776 | 761 | 1,105 | 1,500 | 3,822 | 5,646 | 8,227 | 15,622 |
| 125 | 225 | | 8796 | 13.7 | 11,948 | 202 | 308 | 450 | 1,966 | 3,432 | 5,667 | 11,770 | 761 | 1,104 | 1,499 | 3,820 | 5,643 | 8,223 | 15,613 |
| 127 | 227 | | 8698 | 13.6 | 12,407 | 198 | 302 | 443 | 1,958 | 3,417 | 5,642 | 11,705 | 755 | 1,099 | 1,491 | 3,807 | 5,621 | 8,187 | 15,531 |
| 142T | 242T | | 7871 | 12.3 | 15,022 | 167 | 256 | 368 | 1,897 | 3,275 | 5,409 | 11,130 | 719 | 1,050 | 1,421 | 3,672 | 5,408 | 7,847 | 14,772 |
| 152 | 252 | 71st Avenue | 7078 | 11.1 | 15,535 | 133 | 200 | 282 | 1,772 | 3,060 | 5,054 | 10,321 | 662 | 981 | 1,329 | 3,467 | 5,090 | 7,366 | 13,729 |
| 154T | 254T | | 6848 | 10.7 | 18,806 | 133 | 202 | 281 | 1,799 | 3,070 | 5,059 | 10,318 | 663 | 973 | 1,315 | 3,471 | 5,090 | 7,378 | 13,663 |
| 154 | 254 | | 6148 | 9.6 | 18,806 | 111 | 167 | 237 | 1,696 | 2,892 | 4,766 | 9,616 | 638 | 966 | 1,322 | 3,264 | 4,787 | 6,933 | 12,753 |
| 167T | 267T | | 6139 | 9.6 | 19,607 | 111 | 167 | 237 | 1,697 | 2,893 | 4,768 | 9,616 | 638 | 966 | 1,322 | 3,265 | 4,791 | 6,935 | 12,756 |
| 168 | 268 | | 6094 | 9.5 | 20,928 | 111 | 165 | 232 | 1,698 | 2,889 | 4,757 | 9,582 | 636 | 963 | 1,317 | 3,262 | 4,782 | 6,920 | 12,715 |
| 170T | 270T | | 6001 | 9.4 | 22,409 | 111 | 164 | 231 | 1,692 | 2,874 | 4,735 | 9,516 | 632 | 957 | 1,308 | 3,245 | 4,763 | 6,887 | 12,648 |
| 172 | 272 | 83rd Avenue | 5959 | 9.3 | 22,744 | 106 | 156 | 219 | 1,681 | 2,857 | 4,710 | 9,462 | 628 | 950 | 1,298 | 3,228 | 4,737 | 6,849 | 12,574 |
| 174T | 274T | | 5880 | 9.2 | 23,842 | 105 | 154 | 215 | 1,674 | 2,843 | 4,681 | 9,386 | 623 | 942 | 1,286 | 3,214 | 4,715 | 6,811 | 12,486 |
| 176 | 276 | | 5724 | 8.9 | 24,301 | 88 | 130 | 182 | 1,648 | 2,797 | 4,607 | 9,219 | 609 | 921 | 1,257 | 3,162 | 4,636 | 6,696 | 12,252 |
| 185 | 285 | | 5436 | 8.5 | 25,647 | 79 | 115 | 159 | 1,620 | 2,741 | 4,503 | 8,931 | 572 | 869 | 1,190 | 3,078 | 4,513 | 6,510 | 11,870 |
| 186T | 286T | | 5388 | 8.4 | 26,250 | 79 | 115 | 159 | 1,619 | 2,736 | 4,490 | 8,892 | 571 | 867 | 1,187 | 3,069 | 4,498 | 6,484 | 11,813 |
| 187 | 287 | | 5370 | 8.4 | 26,746 | 78 | 113 | 156 | 1,617 | 2,733 | 4,486 | 8,880 | 570 | 866 | 1,185 | 3,066 | 4,493 | 6,476 | 11,793 |
| 189 | 289 | | 5281 | 8.3 | 27,346 | 78 | 112 | 156 | 1,613 | 2,721 | 4,459 | 8,799 | 561 | 854 | 1,170 | 3,040 | 4,452 | 6,411 | 11,654 |
| 193T | 293T | | 4979 | 7.8 | 29,468 | 61 | 89 | 144 | 1,587 | 2,659 | 4,310 | 8,443 | 531 | 812 | 1,119 | 2,951 | 4,289 | 6,163 | 11,128 |
| 198 | 298 | | 4731 | 7.4 | 29,618 | 58 | 84 | 142 | 1,558 | 2,596 | 4,185 | 8,143 | 493 | 760 | 1,051 | 2,840 | 4,129 | 5,942 | 10,685 |
| 1113 | 2113 | | 3751 | 5.9 | 30,048 | 57 | 82 | 133 | 1,350 | 2,196 | 3,461 | 6,589 | 413 | 646 | 900 | 2,398 | 3,437 | 4,871 | 8,639 |
| 1123 | 2123 | US Hwy 34 | 3266 | 5.1 | 30,303 | 16 | 41 | 244 | 1,167 | 1,925 | 3,045 | 5,779 | 370 | 567 | 907 | 2,053 | 2,960 | 4,206 | 7,418 |
| 1124T | 2124T | | 3186 | 5.0 | 30,891 | 16 | 40 | 243 | 1,156 | 1,904 | 3,005 | 5,692 | 360 | 553 | 888 | 2,020 | 2,911 | 4,135 | 7,277 |
| 1125 | 2125 | | 3173 | 5.0 | 32,729 | 16 | 40 | 242 | 1,160 | 1,909 | 3,007 | 5,687 | 359 | 552 | 889 | 2,025 | 2,917 | 4,139 | 7,287 |
| 1127T | 2127T | | 3074 | 4.8 | 33,390 | 17 | 40 | 241 | 1,146 | 1,880 | 2,953 | 5,566 | 344 | 530 | 859 | 1,975 | 2,845 | 4,039 | 7,091 |
| 1128 | 2128 | | 3041 | 4.8 | 33,876 | 16 | 40 | 241 | 1,146 | 1,875 | 2,941 | 5,529 | 339 | 524 | 850 | 1,959 | 2,822 | 4,003 | 7,019 |
| 1135T | 2135T | | 2655 | 4.1 | 34,664 | 15 | 38 | 227 | 1,058 | 1,715 | 2,662 | 4,956 | 320 | 494 | 799 | 1,817 | 2,596 | 3,647 | 6,326 |
| 1136 | 2136 | | 2640 | 4.1 | 36,075 | 16 | 38 | 229 | 1,071 | 1,724 | 2,664 | 4,950 | 320 | 496 | 806 | 1,827 | 2,601 | 3,647 | 6,316 |
| 1149 | 2149 | | 1930 | 3.0 | 37,756 | 13 | 32 | 196 | 849 | 1,331 | 2,015 | 3,683 | 280 | 425 | 677 | 1,467 | 2,052 | 2,825 | 4,798 |
| 1153 | 2153 | | 1561 | 2.4 | 37,756 | 6 | 20 | 160 | 693 | 1,084 | 1,631 | 2,957 | 147 | 233 | 423 | 1,037 | 1,490 | 2,084 | 3,590 |
| 1154 | 2154 | | 1501 | 2.3 | 40,026 | 6 | 21 | 163 | 695 | 1,079 | 1,613 | 2,900 | 147 | 231 | 419 | 1,025 | 1,468 | 2,044 | 3,500 |
| 1155T | 2155T | | 1450 | 2.3 | 40,896 | 6 | 21 | 162 | 682 | 1,054 | 1,571 | 2,819 | 146 | 229 | 416 | 1,008 | 1,438 | 1,995 | 3,409 |
| 1169 | 2169 | | 604 | 0.9 | 40,896 | 3 | 11 | 83 | 311 | 473 | 695 | 1,223 | 134 | 202 | 315 | 618 | 836 | 1,100 | 1,807 |
| 1170 | 2170 | CO Hwy 257 | 550 | 0.9 | 44,274 | 3 | 12 | 86 | 303 | 458 | 667 | 1,175 | 141 | 206 | 317 | 610 | 823 | 1,092 | 1,771 |
| 1173 | 2173 | | 269 | 0.4 | 45,843 | 1 | 5 | 39 | 143 | 215 | 314 | 558 | 114 | 161 | 228 | 394 | 522 | 677 | 1,081 |
| 1175 | 2175 | | 90 | 0.1 | 48,071 | 1 | 3 | 16 | 48 | 71 | 101 | 177 | 28 | 42 | 63 | 113 | 150 | 196 | 315 |

## Table B-7 - Baseline Runoff Volumes Along Sheep Draw

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | | Future Runoff Volumes (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 100 | --- | Confluence with Cache La Poudre River | 10104 | 15.8 | 0 | 66 | 94 | 130 | 476 | 761 | 1,169 | 2,243 | 167 | 242 | 328 | 758 | 1,068 | 1,485 | 2,599 |
| 104 | 204 | Greeley No. 3 Ditch | 9898 | 15.5 | 1,410 | 67 | 96 | 131 | 473 | 752 | 1,157 | 2,213 | 171 | 246 | 331 | 755 | 1,059 | 1,470 | 2,566 |
| 105 | 205 | C Street | 9856 | 15.4 | 3,073 | 69 | 98 | 134 | 479 | 758 | 1,163 | 2,219 | 175 | 251 | 338 | 758 | 1,065 | 1,473 | 2,569 |
| 109T | 209T | | 9592 | 15.0 | 3,294 | 63 | 89 | 123 | 460 | 737 | 1,135 | 2,176 | 169 | 242 | 325 | 743 | 1,043 | 1,445 | 2,526 |
| 110 | 210 | | 9518 | 14.9 | 4,721 | 62 | 89 | 122 | 460 | 733 | 1,132 | 2,167 | 169 | 242 | 325 | 740 | 1,040 | 1,439 | 2,513 |
| 112T | 212T | | 9356 | 14.6 | 7,798 | 62 | 88 | 121 | 460 | 733 | 1,123 | 2,148 | 170 | 243 | 325 | 740 | 1,034 | 1,430 | 2,489 |
| 113 | 213 | W. 4th Street | 9316 | 14.6 | 8,464 | 61 | 87 | 119 | 457 | 730 | 1,120 | 2,139 | 170 | 242 | 325 | 737 | 1,031 | 1,427 | 2,480 |
| 121T | 215 | | 9019 | 14.1 | 8,554 | 56 | 79 | 110 | 439 | 703 | 1,083 | 2,068 | 163 | 232 | 313 | 715 | 1,000 | 1,384 | 2,403 |
| 122 | 222 | | 8938 | 14.0 | 9,475 | 54 | 77 | 107 | 436 | 694 | 1,071 | 2,050 | 162 | 231 | 310 | 709 | 991 | 1,372 | 2,385 |
| 123T | 223T | | 8831 | 13.8 | 10,930 | 53 | 75 | 104 | 430 | 687 | 1,059 | 2,029 | 161 | 230 | 307 | 703 | 985 | 1,363 | 2,363 |
| 124 | 224 | W. 10th Street | 8808 | 13.8 | 11,912 | 53 | 75 | 104 | 430 | 687 | 1,059 | 2,025 | 162 | 230 | 310 | 703 | 985 | 1,360 | 2,360 |
| 125 | 225 | | 8796 | 13.7 | 11,948 | 52 | 75 | 104 | 430 | 684 | 1,059 | 2,022 | 162 | 230 | 307 | 703 | 982 | 1,360 | 2,357 |
| 127 | 227 | | 8698 | 13.6 | 12,407 | 51 | 73 | 102 | 424 | 678 | 1,046 | 2,004 | 159 | 226 | 303 | 694 | 970 | 1,344 | 2,329 |
| 142T | 242T | | 7871 | 12.3 | 15,022 | 41 | 59 | 83 | 377 | 608 | 942 | 1,808 | 150 | 212 | 284 | 644 | 896 | 1,237 | 2,130 |
| 152 | 252 | 71st Avenue | 7078 | 11.1 | 15,535 | 31 | 44 | 63 | 328 | 534 | 838 | 1,614 | 138 | 196 | 261 | 592 | 822 | 1,126 | 1,933 |
| 154T | 254T | | 6848 | 10.7 | 18,806 | 30 | 44 | 63 | 325 | 528 | 819 | 1,574 | 138 | 195 | 260 | 583 | 807 | 1,102 | 1,884 |
| 154 | 254 | | 6148 | 9.6 | 18,806 | 23 | 34 | 58 | 285 | 466 | 730 | 1,409 | 129 | 183 | 249 | 516 | 718 | 982 | 1,685 |
| 167T | 267T | | 6139 | 9.6 | 19,607 | 24 | 35 | 58 | 287 | 470 | 733 | 1,409 | 130 | 184 | 250 | 519 | 718 | 985 | 1,685 |
| 168 | 268 | | 6094 | 9.5 | 20,928 | 23 | 34 | 57 | 285 | 466 | 727 | 1,399 | 130 | 183 | 249 | 516 | 715 | 979 | 1,676 |
| 170T | 270T | | 6001 | 9.4 | 22,409 | 23 | 34 | 58 | 282 | 460 | 718 | 1,381 | 129 | 182 | 247 | 509 | 706 | 967 | 1,654 |
| 172 | 272 | 83rd Avenue | 5959 | 9.3 | 22,744 | 22 | 33 | 56 | 278 | 454 | 712 | 1,369 | 128 | 180 | 245 | 506 | 700 | 957 | 1,642 |
| 174T | 274T | | 5880 | 9.2 | 23,842 | 22 | 32 | 55 | 276 | 451 | 703 | 1,353 | 126 | 178 | 241 | 500 | 694 | 948 | 1,620 |
| 176 | 276 | | 5724 | 8.9 | 24,301 | 18 | 27 | 48 | 262 | 433 | 678 | 1,310 | 121 | 171 | 232 | 485 | 672 | 921 | 1,577 |
| 185 | 285 | | 5436 | 8.5 | 25,647 | 16 | 24 | 44 | 252 | 414 | 651 | 1,249 | 110 | 156 | 214 | 454 | 632 | 868 | 1,495 |
| 186T | 286T | | 5388 | 8.4 | 26,250 | 16 | 24 | 44 | 252 | 411 | 648 | 1,243 | 110 | 156 | 213 | 454 | 629 | 865 | 1,482 |
| 187 | 287 | | 5370 | 8.4 | 26,746 | 15 | 23 | 43 | 250 | 411 | 644 | 1,240 | 110 | 156 | 212 | 451 | 629 | 862 | 1,479 |
| 189 | 289 | | 5281 | 8.3 | 27,346 | 15 | 23 | 43 | 250 | 408 | 638 | 1,224 | 108 | 153 | 209 | 445 | 620 | 850 | 1,458 |
| 193T | 293T | | 4979 | 7.8 | 29,468 | 13 | 20 | 39 | 238 | 390 | 608 | 1,160 | 100 | 142 | 195 | 420 | 586 | 804 | 1,378 |
| 198 | 298 | | 4731 | 7.4 | 29,618 | 12 | 19 | 37 | 230 | 374 | 583 | 1,108 | 89 | 126 | 175 | 390 | 546 | 755 | 1,298 |
| 1113 | 2113 | | 3751 | 5.9 | 30,048 | 12 | 18 | 35 | 199 | 316 | 482 | 902 | 73 | 106 | 147 | 322 | 448 | 614 | 1,046 |
| 1123 | 2123 | US Hwy 34 | 3266 | 5.1 | 30,303 | 4 | 9 | 39 | 165 | 267 | 411 | 779 | 61 | 90 | 138 | 269 | 381 | 525 | 902 |
| 1124T | 2124T | | 3186 | 5.0 | 30,891 | 4 | 9 | 39 | 162 | 262 | 405 | 761 | 59 | 87 | 134 | 262 | 368 | 509 | 881 |
| 1125 | 2125 | | 3173 | 5.0 | 32,729 | 4 | 9 | 39 | 161 | 261 | 402 | 761 | 59 | 86 | 133 | 261 | 368 | 509 | 875 |
| 1127T | 2127T | | 3074 | 4.8 | 33,390 | 4 | 9 | 38 | 158 | 254 | 393 | 740 | 55 | 80 | 126 | 250 | 353 | 488 | 844 |
| 1128 | 2128 | | 3041 | 4.8 | 33,876 | 4 | 9 | 38 | 158 | 254 | 390 | 733 | 54 | 79 | 124 | 248 | 350 | 485 | 838 |
| 1135T | 2135T | | 2655 | 4.1 | 34,664 | 4 | 8 | 36 | 143 | 228 | 347 | 648 | 50 | 73 | 114 | 224 | 313 | 433 | 740 |
| 1136 | 2136 | | 2640 | 4.1 | 36,075 | 4 | 8 | 36 | 143 | 228 | 347 | 644 | 49 | 73 | 113 | 223 | 313 | 430 | 737 |
| 1149 | 2149 | | 1930 | 3.0 | 37,756 | 3 | 6 | 29 | 111 | 173 | 261 | 482 | 38 | 56 | 88 | 170 | 237 | 322 | 549 |
| 1153 | 2153 | | 1561 | 2.4 | 37,756 | 1 | 3 | 23 | 88 | 139 | 209 | 387 | 20 | 31 | 55 | 121 | 174 | 244 | 427 |
| 1154 | 2154 | | 1501 | 2.3 | 40,026 | 1 | 4 | 23 | 88 | 137 | 206 | 377 | 19 | 30 | 53 | 118 | 169 | 237 | 411 |
| 1155T | 2155T | | 1450 | 2.3 | 40,896 | 1 | 4 | 23 | 86 | 134 | 200 | 368 | 19 | 29 | 52 | 116 | 165 | 231 | 402 |
| 1169 | 2169 | | 604 | 0.9 | 40,896 | 1 | 2 | 11 | 38 | 58 | 86 | 157 | 15 | 23 | 35 | 61 | 83 | 110 | 182 |
| 1170 | 2170 | CO Hwy 257 | 550 | 0.9 | 44,274 | 0 | 2 | 10 | 35 | 53 | 78 | 143 | 14 | 21 | 32 | 56 | 75 | 100 | 166 |
| 1173 | 2173 | | 269 | 0.4 | 45,843 | 0 | 1 | 5 | 17 | 25 | 38 | 69 | 11 | 15 | 21 | 33 | 42 | 54 | 87 |
| 1175 | 2175 | | 90 | 0.1 | 48,071 | 0 | 0 | 2 | 6 | 9 | 13 | 24 | 3 | 4 | 6 | 10 | 13 | 17 | 28 |

**Figure B-4A**
**Sheep Draw**
**Baseline Peak Discharge vs. Drainageway Station**

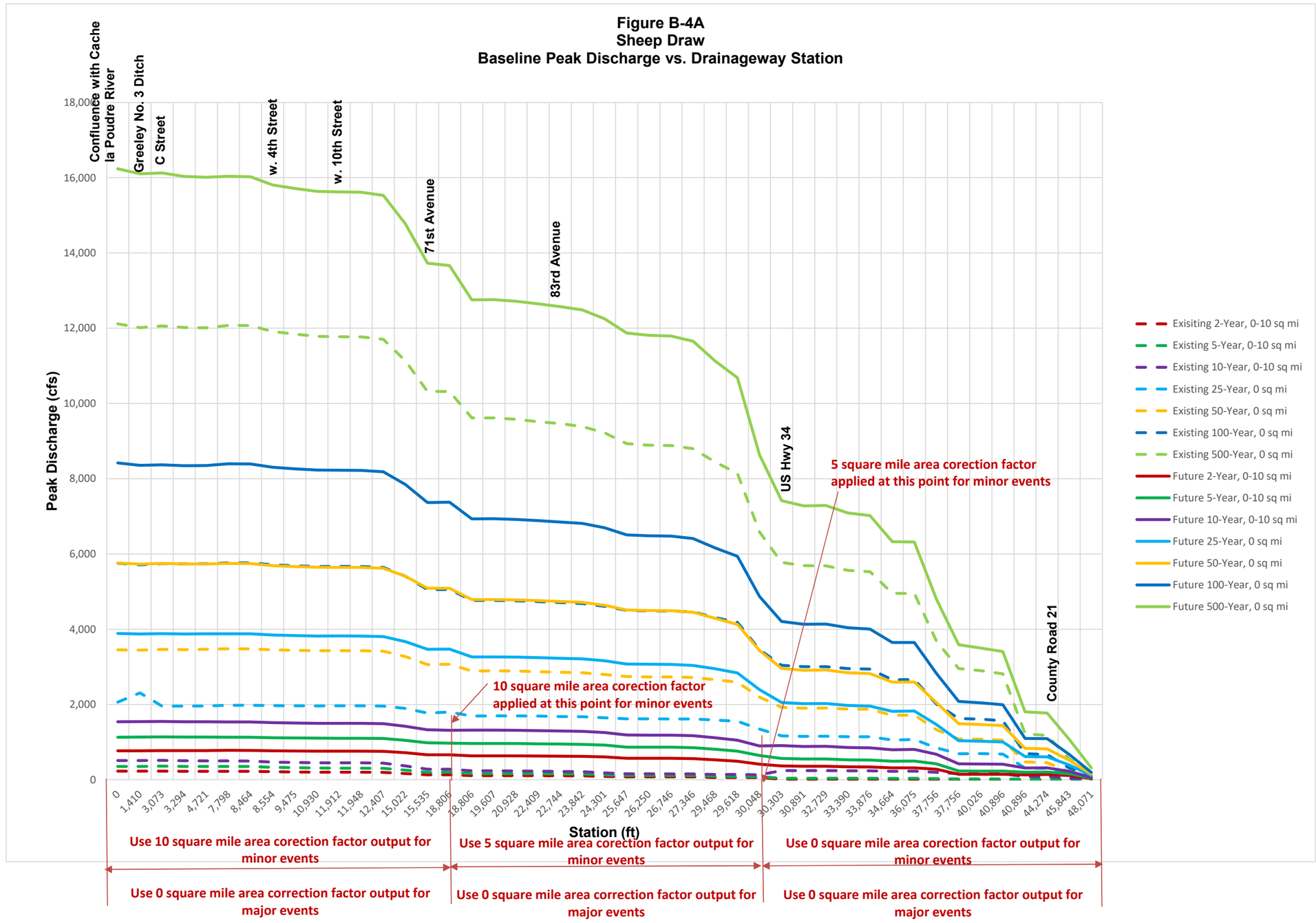
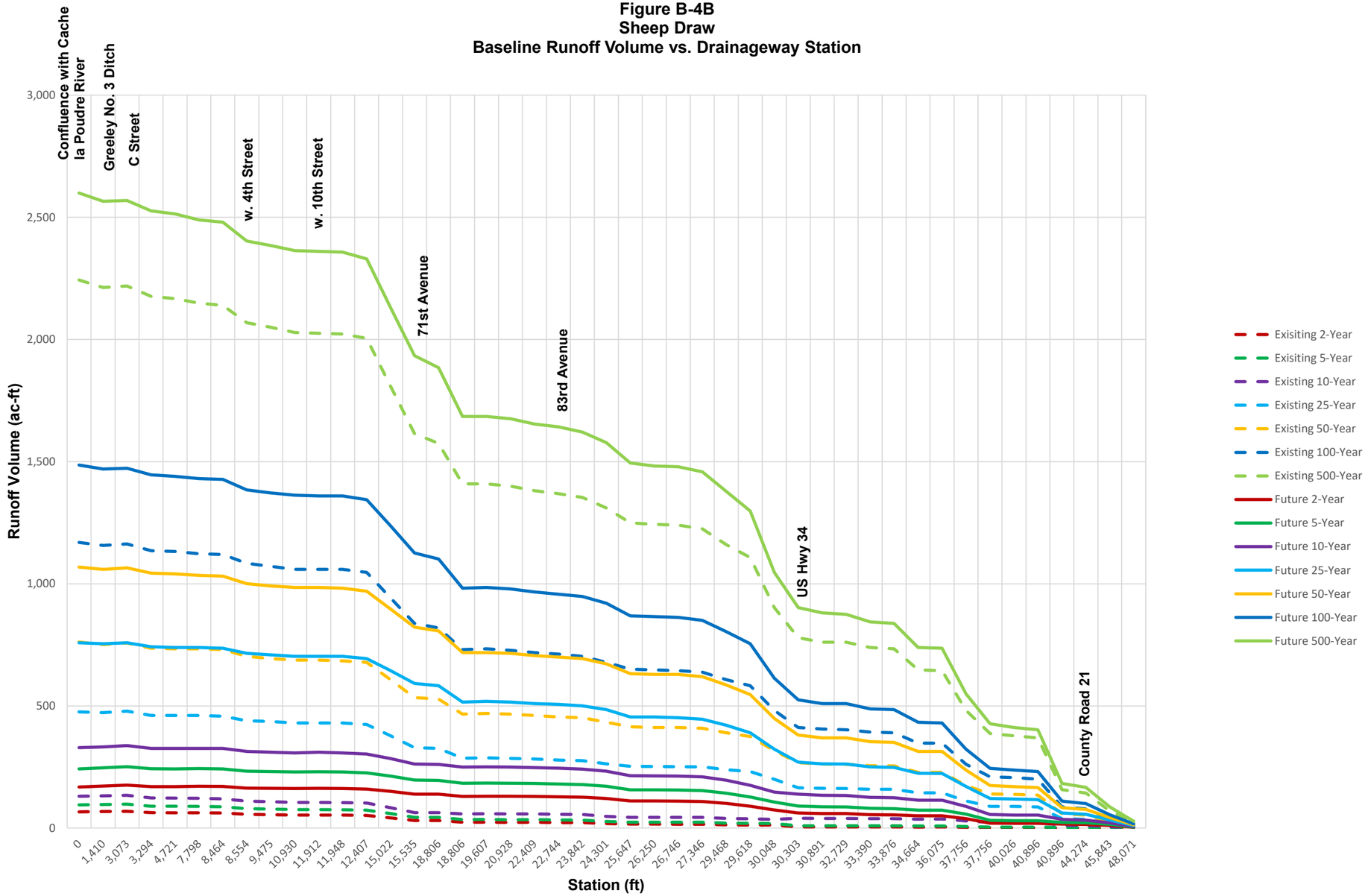
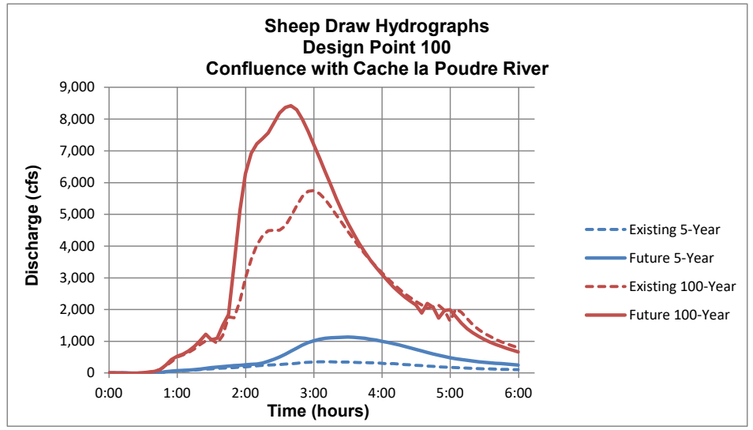
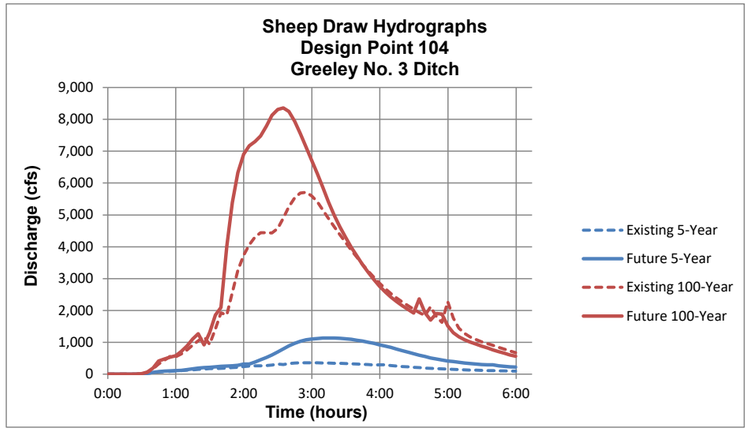


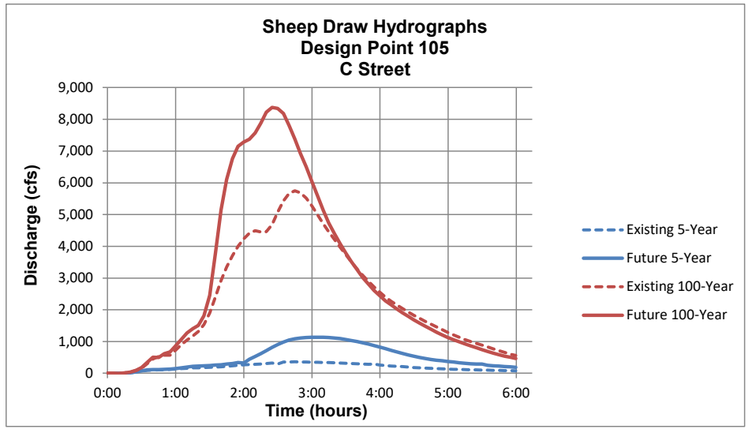
**Figure B-4B**
**Sheep Draw**
**Baseline Runoff Volume vs. Drainageway Station**

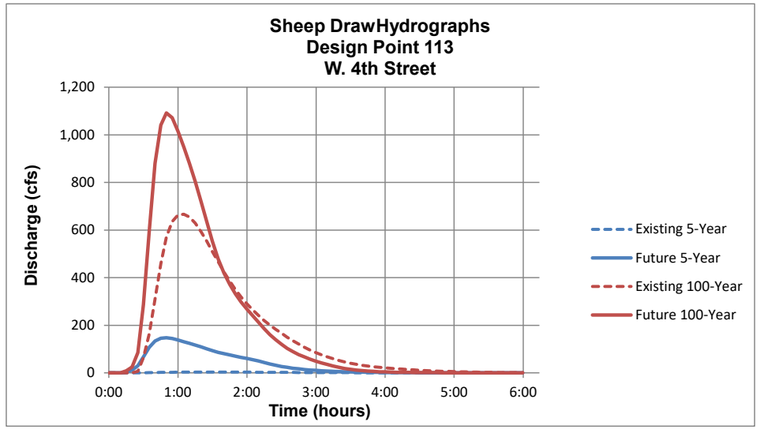


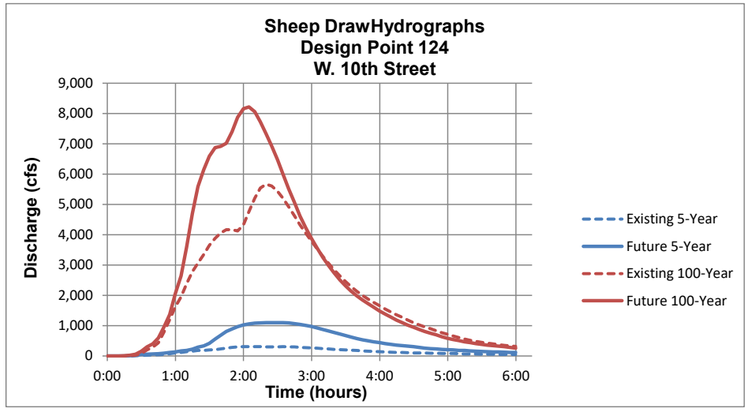
## Figure B-5 - Baseline Hydrographs

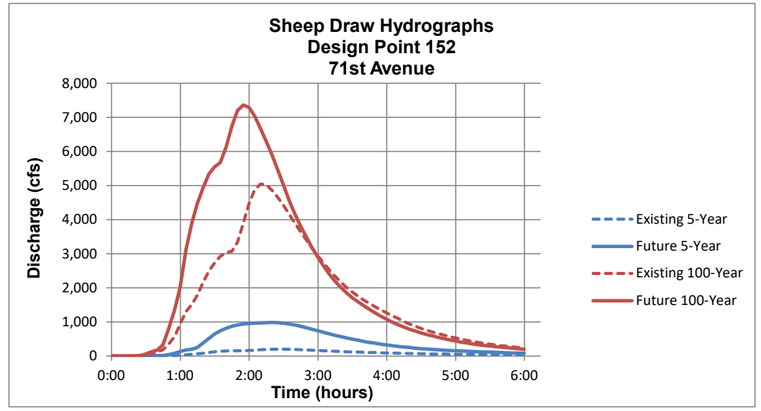


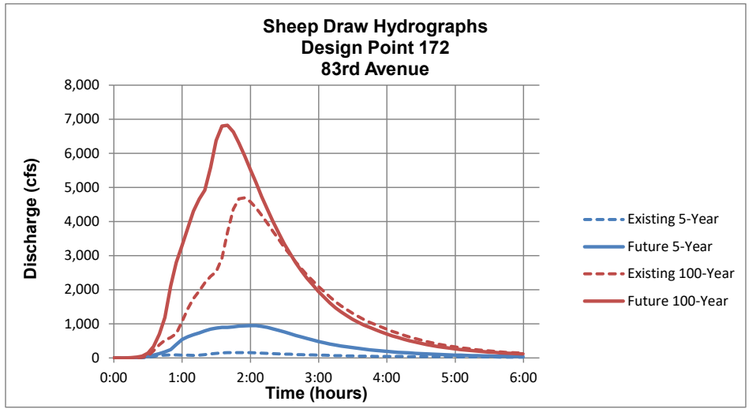



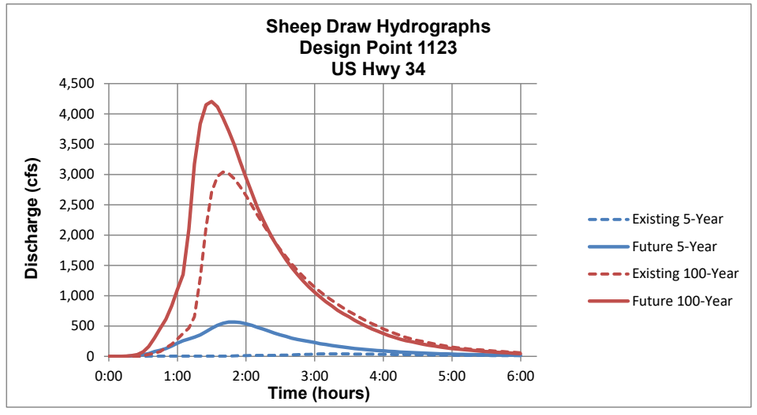



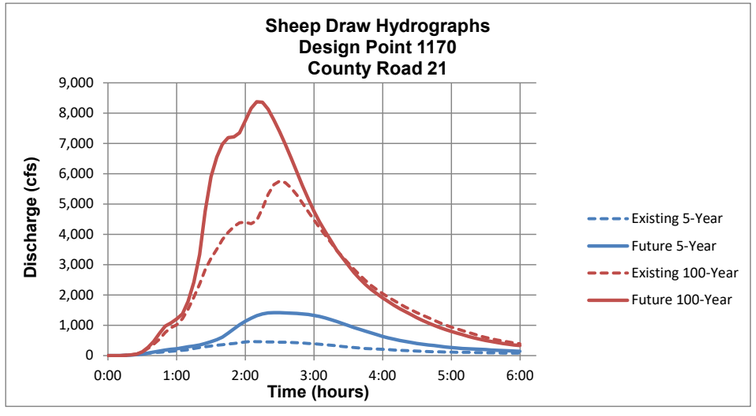



# APPENDIX C

## HYDRAULIC ANALYSIS

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# EXISTING CONDITIONS HEC-RAS OUTPUT

## TABLE, PROFILES, AND CROSS SECTIONS

(DOUBLE-CLICK ICON ABOVE)

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# FUTURE CONDITIONS HEC-RAS OUTPUT

## TABLE, PROFILES, AND CROSS SECTIONS

(DOUBLE-CLICK ICON ABOVE)

olsson®

**Figure C-1A**
**Sheep Draw**
**All Storm Events Percent Change Existing to Future Land Use Peak Flows and Volumes**

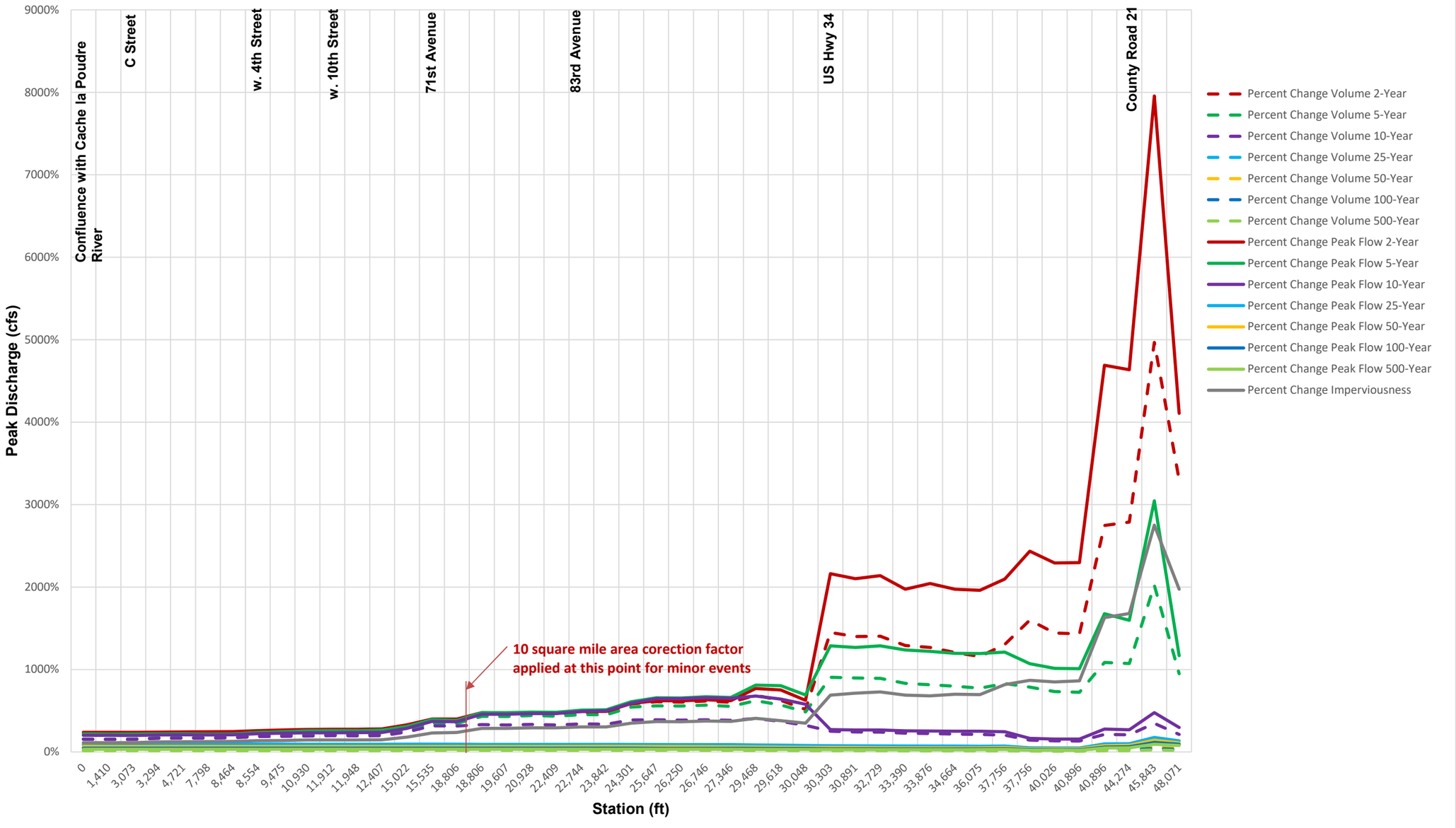
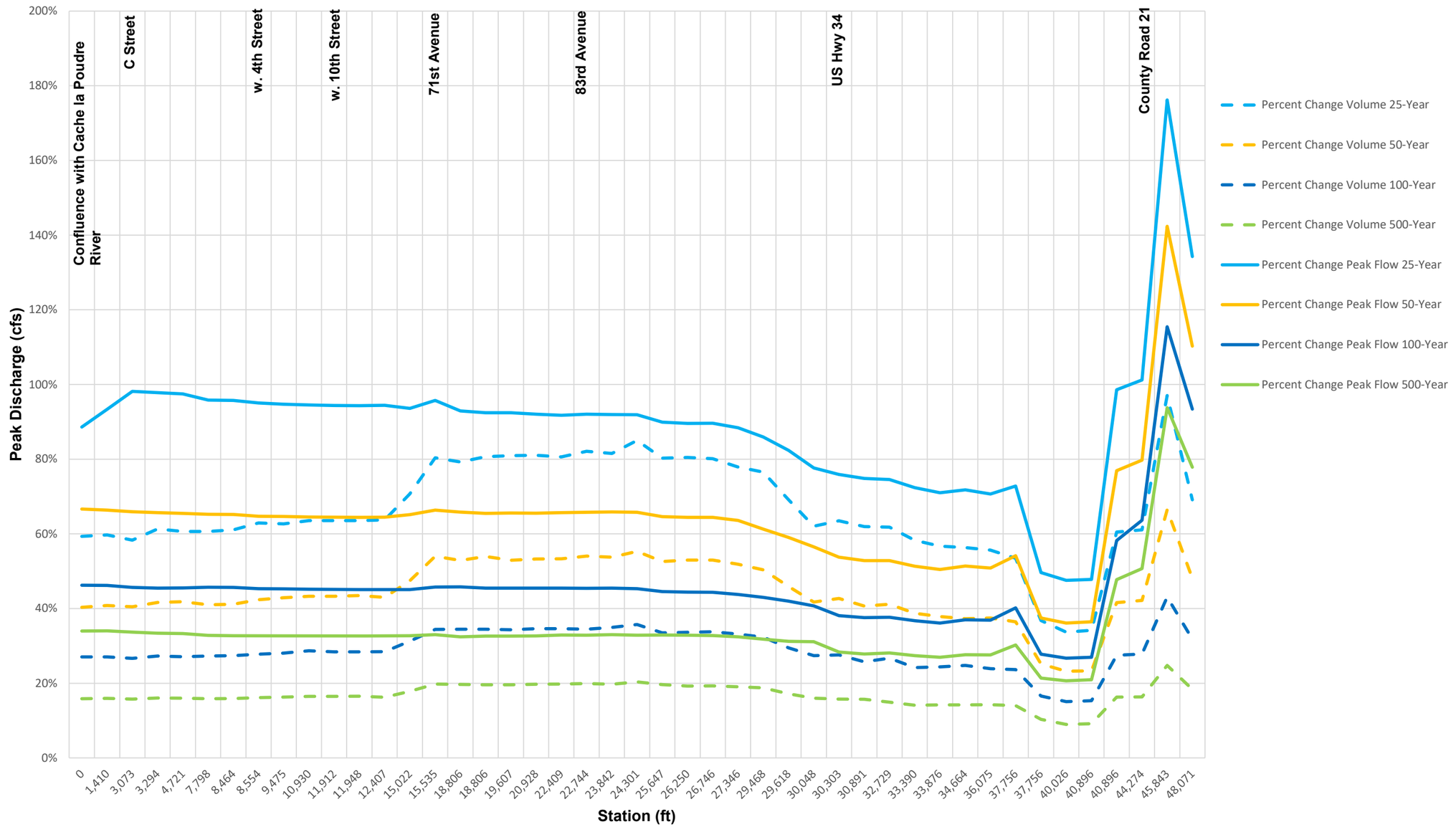


**Figure C-1B**
**Major Storm Events Percent Change Existing to Future Land Use Peak Flows and Volumes**



# FEMA FIRM PANELS




(DOUBLE-CLICK ICON ABOVE)

olsson®

**Major Crossing Structure Photos**



Structure 1
Station 101+20
Poudre River Trail
84-inch CMP



Structure 2
Station 113+25
Sheep Draw Nature Trail
84-inch CMP



Structure 3
Station 113+70
Greeley No. 3 Ditch
Concrete canal weir RCBC



Structure 4
Station 126+00
Irrigation water crossing: 1.5-foot diameter utility poles on upstream side of 15-inch PVC. PVC extends beyond utility poles.



Structure 5
Station 129+85
Access bridge with railing



Structure 6
Station 131+00
C Street
Metal/wood bridge with railing



Structure 7
Station 180+75
Sheep Draw Trail
Double-barreled 36-inch CMP



Structure 8
Station 184+50
4th Street
Concrete bridge with pier and railing

**Major Crossing Structure Photos**



Structure 9
Station 201+45
Sheep Draw Trail
Concrete bridge trail crossing



Structure 9.5
Station 222+00
Sheep Draw Trail
Double-barreled 42-inch RCP



Structure 10
Station 224+50
10th Street
Concrete bridge with railing



Structure 11
Station 225+25
Sheep Draw Trail
Concrete bridge trail crossing with railing



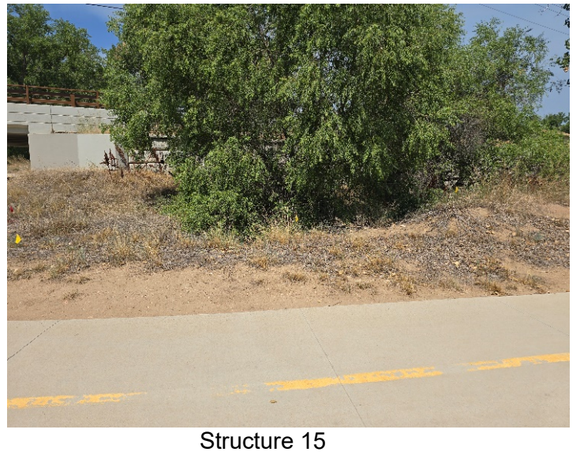
Structure 12
Station 230+80
Sheep Draw Trail
Concrete bridge trail crossing with railing



Structure 13
Station 255+50
Sheep Draw Trail
36-inch RCP



Structure 14
Station 17+00
Sheep Draw Trail
Pedestrian bridge with 4.5’ handrails and 30”x19” HERCP



Structure 15
Station 20+00
Sheep Draw Trail
30”x19” HERCP

**Major Crossing Structure Photos**



Structure 16
Station 266+50
71st Avenue
Concrete bridge with pier and railing



Structure 17
Station 267+50
Sheep Draw Trail
7’ span by 3’ rise RCBC



Structure 18
Station 298+40
Sheep Draw Trail
46-inch CMP



Structure 19
Station 337+50
83rd Avenue
Concrete bridge with pier and railing



Structure 20
Station 366+40
Sheep Draw Trail
Concrete bridge trail crossing with railing



Structure 21
Station 406+50
95th Avenue
22’ span by 5’ rise RCBC



Structure 22
Station 412+00
Highway 34
26’ span by 4’ RCBC



Structure 23
Station 434+00
Private Driveway
48-inch CMP

**Major Crossing Structure Photos**



Structure N-1
Station 186+08
Sheep Draw Trail
(2) 36-inch RCP
Not Modeled



Structure N-2
Station 275+95
Private Trail
28-inch CMP (Deformed 30-inch)
Not Modeled



Structure N-3
Station 444+80
Private Driveway
48-inch CMP (Smooshed)
Not Modeled



Structure N-4
Station 459-56
Private Driveway
30-inch CMP
Not Modeled

# APPENDIX D

## WETLAND AND RIPARIAN INVENTORY

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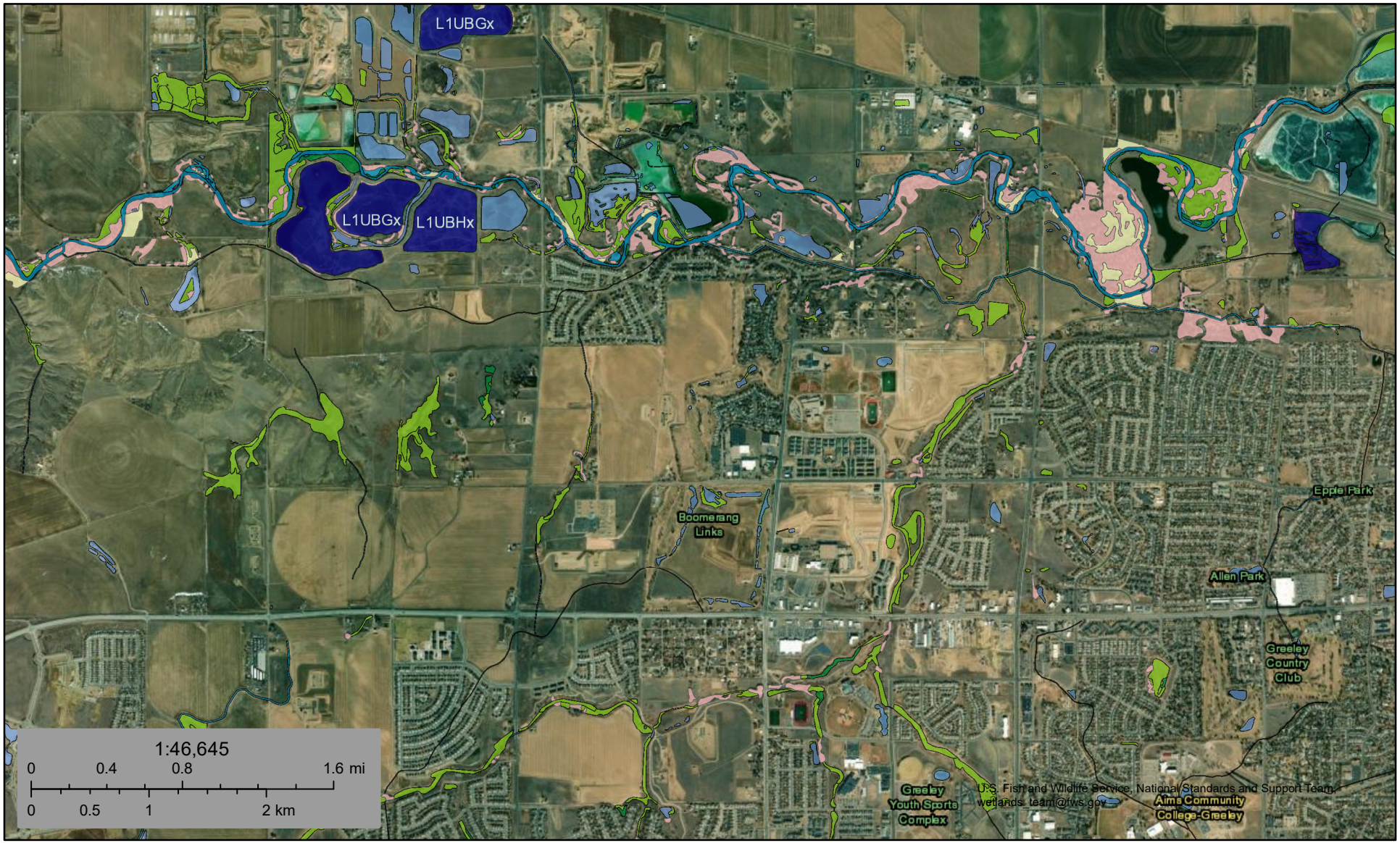
U.S. Fish and Wildlife Service

# National Wetlands Inventory

## SheepDraw1




January 23, 2024

**Wetlands**

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

U.S. Fish and Wildlife Service

# National Wetlands Inventory

## SheepDraw2




January 23, 2024

**Wetlands**

- Estuarine and Marine Deepwater
- Estuarine and Marine Wetland
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

# APPENDIX E

## ALTERNATIVES ANALYSIS

olsson®

## Table E-1- Detention Alternatives Peak Flows Along Sheep Draw

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area ($mi^2$) | 100-Year Peak Flows (cfs) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Existing $Q_{100}$ | Future $Q_{100}$ | ALT A - Ponds 301, 304, & 311 | ALT B - Ponds 301 & 304 | ALT C - Ponds 301 & 311 | ALT D - Ponds 301, 304, 309, 311, & 364 | ALT E - Ponds 301, 304, 309, & 311 | ALT F - Ponds 301, 304, 309, 311, 312, 313, & 364 |
| 100 | --- | Confluence with Cache la Poudre River | 15.8 | 5,757 | 8,419 | 6,941 | 7,305 | 7,027 | 6,460 | 6,937 | 6,461 |
| 104 | 204 | Greeley No. 3 Ditch | 15.5 | 5,715 | 8,357 | 6,880 | 7,237 | 6,964 | 6,400 | 6,879 | 6,401 |
| 105 | 205 | C Street | 15.4 | 5,746 | 8,370 | 6,941 | 7,270 | 7,019 | 6,456 | 6,943 | 6,457 |
| 109T | 209T | | 15.0 | 5,736 | 8,344 | 6,857 | 7,196 | 6,938 | 6,377 | 6,859 | 6,378 |
| 110 | 210 | | 14.9 | 5,739 | 8,353 | 6,841 | 7,177 | 6,922 | 6,364 | 6,843 | 6,365 |
| 112T | 212T | | 14.6 | 5,762 | 8,395 | 6,860 | 7,164 | 6,927 | 6,379 | 6,862 | 6,380 |
| 113 | 213 | W. 4th Street | 14.6 | 5,762 | 8,393 | 6,845 | 7,150 | 6,913 | 6,365 | 6,847 | 6,366 |
| 121T | 215 | | 14.1 | 5,714 | 8,303 | 6,667 | 6,994 | 6,744 | 6,198 | 6,669 | 6,199 |
| 122 | 222 | | 14.0 | 5,688 | 8,264 | 6,595 | 6,929 | 6,676 | 6,130 | 6,597 | 6,131 |
| 123T | 223T | | 13.8 | 5,669 | 8,231 | 6,537 | 6,873 | 6,617 | 6,074 | 6,539 | 6,075 |
| 124 | 224 | W. 10th Street | 13.8 | 5,669 | 8,227 | 6,529 | 6,863 | 6,608 | 6,066 | 6,531 | 6,066 |
| 125 | 225 | | 13.7 | 5,667 | 8,223 | 6,522 | 6,857 | 6,601 | 6,059 | 6,524 | 6,060 |
| 127 | 227 | | 13.6 | 5,642 | 8,187 | 6,445 | 6,790 | 6,553 | 5,986 | 6,448 | 5,987 |
| 142T | 242T | | 12.3 | 5,409 | 7,847 | 5,833 | 6,234 | 6,195 | 5,400 | 5,834 | 5,400 |
| 152 | 252 | 71st Avenue | 11.1 | 5,054 | 7,366 | 5,006 | 5,772 | 5,735 | 4,686 | 5,007 | 4,608 |
| 154T | 254T | | 10.7 | 5,059 | 7,378 | 4,935 | 5,690 | 5,674 | 4,628 | 4,928 | 4,547 |
| 154 | 254 | | 9.6 | 4,766 | 6,933 | 4,613 | 5,338 | 5,272 | 4,312 | 4,377 | 4,231 |
| 167T | 267T | | 9.6 | 4,768 | 6,935 | 4,613 | 5,338 | 5,272 | 4,312 | 4,377 | 4,231 |
| 168 | 268 | | 9.5 | 4,757 | 6,920 | 4,602 | 5,323 | 5,255 | 4,301 | 4,366 | 4,220 |
| 170T | 270T | | 9.4 | 4,735 | 6,887 | 4,561 | 5,282 | 5,218 | 4,262 | 4,327 | 4,181 |
| 172 | 272 | 83rd Avenue | 9.3 | 4,710 | 6,849 | 4,537 | 5,254 | 5,184 | 4,240 | 4,304 | 4,158 |
| 174T | 274T | | 9.2 | 4,681 | 6,811 | 4,510 | 5,223 | 5,149 | 4,213 | 4,277 | 4,131 |
| 176 | 276 | | 8.9 | 4,607 | 6,696 | 4,430 | 5,132 | 5,042 | 4,137 | 4,201 | 4,056 |
| 185 | 285 | | 8.5 | 4,503 | 6,510 | 4,295 | 4,978 | 4,868 | 4,071 | 4,071 | 3,989 |
| 186T | 286T | | 8.4 | 4,490 | 6,484 | 4,273 | 4,955 | 4,843 | 4,049 | 4,049 | 3,968 |
| 187 | 287 | | 8.4 | 4,486 | 6,476 | 4,268 | 4,950 | 4,835 | 4,045 | 4,045 | 3,964 |
| 189 | 289 | | 8.3 | 4,459 | 6,411 | 4,222 | 4,899 | 4,775 | 4,000 | 4,000 | 3,918 |
| 193T | 293T | | 7.8 | 4,310 | 6,163 | 4,036 | 4,690 | 4,540 | 3,823 | 3,823 | 3,741 |
| 198 | 298 | | 7.4 | 4,185 | 5,942 | 3,903 | 4,539 | 4,345 | 3,694 | 3,694 | 3,612 |
| 1113 | 2113 | | 5.9 | 3,461 | 4,871 | 3,664 | 3,664 | 4,093 | 3,457 | 3,457 | 3,457 |
| 1123 | 2123 | US Hwy 34 | 5.1 | 3,045 | 4,206 | 3,180 | 3,180 | 3,462 | 2,987 | 2,988 | 2,987 |
| 1124T | 2124T | | 5.0 | 3,005 | 4,135 | 3,127 | 3,127 | 3,395 | 2,936 | 2,937 | 2,936 |
| 1125 | 2125 | | 5.0 | 3,007 | 4,139 | 3,122 | 3,122 | 3,392 | 2,931 | 2,931 | 2,931 |
| 1127T | 2127T | | 4.8 | 2,953 | 4,039 | 3,055 | 3,055 | 3,298 | 2,867 | 2,867 | 2,867 |
| 1128 | 2128 | | 4.8 | 2,941 | 4,003 | 3,029 | 3,029 | 3,265 | 2,842 | 2,843 | 2,842 |
| 1135T | 2135T | | 4.1 | 2,662 | 3,647 | 2,723 | 2,723 | 2,916 | 2,722 | 2,723 | 2,722 |
| 1136 | 2136 | | 4.1 | 2,664 | 3,647 | 2,911 | 2,911 | 2,911 | 2,911 | 2,911 | 2,911 |
| 1149 | 2149 | | 3.0 | 2,015 | 2,825 | 2,115 | 2,115 | 2,115 | 2,115 | 2,115 | 2,115 |
| 1153 | 2153 | | 2.4 | 1,631 | 2,084 | 1,451 | 1,451 | 1,451 | 1,451 | 1,451 | 1,451 |
| 1154 | 2154 | | 2.3 | 1,613 | 2,044 | 1,413 | 1,413 | 1,413 | 1,413 | 1,413 | 1,413 |
| 1155T | 2155T | | 2.3 | 1,571 | 1,995 | 1,371 | 1,371 | 1,371 | 1,371 | 1,371 | 1,371 |
| 1169 | 2169 | | 0.9 | 695 | 1,100 | 488 | 488 | 488 | 488 | 488 | 488 |
| 1170 | 2170 | CO Hwy 257 | 0.9 | 667 | 1,092 | 1,092 | 1,092 | 1,092 | 1,092 | 1,092 | 1,092 |
| 1173 | 2173 | | 0.4 | 314 | 677 | 677 | 677 | 677 | 677 | 677 | 677 |
| 1175 | 2175 | | 0.1 | 101 | 196 | 196 | 196 | 196 | 196 | 196 | 196 |

## Table E-2 - DCIA and Rain Barrel Peak Flows Along Sheep Draw

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Length (feet) | Existing Peak Flows (cfs) | | | | | | Future Peak Flows (cfs) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $Q_{2, EX}$ | $Q_{2, DCIA\ 1}$ | $Q_{2, DCIA\ 2}$ | $Q_{100, DCIA\ 1}$ | $Q_{100, DCIA\ 2}$ | $Q_{100,EX}$ | $Q_2$ | $Q_{2,RAIN}$ | $Q_{100,RAIN}$ | $Q_{100}$ |
| 100 | --- | Confluence with Cache la Poudre River | 10104 | 15.8 | 0 | 228 | 655 | 526 | 8,383 | 8,349 | 5,757 | 769 | 696 | 7,737 | 8,419 |
| 104 | 204 | Greeley No. 3 Ditch | 9898 | 15.5 | 1,410 | 228 | 658 | 529 | 8,320 | 8,287 | 5,715 | 772 | 699 | 7,687 | 8,357 |
| 105 | 205 | C Street | 9856 | 15.4 | 3,073 | 229 | 663 | 532 | 8,332 | 8,299 | 5,746 | 777 | 704 | 7,706 | 8,370 |
| 109T | 209T | | 9592 | 15.0 | 3,294 | 227 | 661 | 530 | 8,308 | 8,275 | 5,736 | 775 | 702 | 7,685 | 8,344 |
| 110 | 210 | | 9518 | 14.9 | 4,721 | 226 | 662 | 531 | 8,316 | 8,275 | 5,739 | 776 | 703 | 7,682 | 8,353 |
| 112T | 212T | | 9356 | 14.6 | 7,798 | 226 | 666 | 533 | 8,356 | 8,318 | 5,762 | 780 | 707 | 7,686 | 8,395 |
| 113 | 213 | W. 4th Street | 9316 | 14.6 | 8,464 | 225 | 666 | 532 | 8,354 | 8,318 | 5,762 | 780 | 706 | 7,688 | 8,393 |
| 121T | 215 | | 9019 | 14.1 | 8,554 | 214 | 655 | 523 | 8,266 | 8,230 | 5,714 | 769 | 696 | 7,606 | 8,303 |
| 122 | 222 | | 8938 | 14.0 | 9,475 | 209 | 651 | 518 | 8,227 | 8,192 | 5,688 | 764 | 692 | 7,569 | 8,264 |
| 123T | 223T | | 8831 | 13.8 | 10,930 | 204 | 648 | 514 | 8,193 | 8,159 | 5,669 | 761 | 688 | 7,539 | 8,231 |
| 124 | 224 | W. 10th Street | 8808 | 13.8 | 11,912 | 203 | 648 | 515 | 8,190 | 8,156 | 5,669 | 761 | 689 | 7,536 | 8,227 |
| 125 | 225 | | 8796 | 13.7 | 11,948 | 202 | 648 | 514 | 8,186 | 8,152 | 5,667 | 761 | 688 | 7,533 | 8,223 |
| 127 | 227 | | 8698 | 13.6 | 12,407 | 198 | 643 | 510 | 8,150 | 8,116 | 5,642 | 755 | 683 | 7,500 | 8,187 |
| 142T | 242T | | 7871 | 12.3 | 15,022 | 167 | 604 | 473 | 7,813 | 7,782 | 5,409 | 719 | 645 | 7,177 | 7,847 |
| 152 | 252 | 71st Avenue | 7078 | 11.1 | 15,535 | 133 | 548 | 419 | 7,334 | 7,306 | 5,054 | 662 | 591 | 6,715 | 7,366 |
| 154T | 254T | | 6848 | 10.7 | 18,806 | 133 | 551 | 421 | 7,350 | 7,325 | 5,059 | 663 | 591 | 6,724 | 7,378 |
| 154 | 254 | | 6148 | 9.6 | 18,806 | 111 | 531 | 416 | 6,909 | 6,888 | 4,766 | 638 | 561 | 6,307 | 6,933 |
| 167T | 267T | | 6139 | 9.6 | 19,607 | 111 | 531 | 416 | 6,911 | 6,891 | 4,768 | 638 | 561 | 6,310 | 6,935 |
| 168 | 268 | | 6094 | 9.5 | 20,928 | 111 | 530 | 415 | 6,895 | 6,875 | 4,757 | 636 | 558 | 6,295 | 6,920 |
| 170T | 270T | | 6001 | 9.4 | 22,409 | 111 | 527 | 413 | 6,864 | 6,845 | 4,735 | 632 | 554 | 6,264 | 6,887 |
| 172 | 272 | 83rd Avenue | 5959 | 9.3 | 22,744 | 106 | 523 | 410 | 6,826 | 6,808 | 4,710 | 628 | 549 | 6,229 | 6,849 |
| 174T | 274T | | 5880 | 9.2 | 23,842 | 105 | 519 | 407 | 6,788 | 6,770 | 4,681 | 623 | 543 | 6,194 | 6,811 |
| 176 | 276 | | 5724 | 8.9 | 24,301 | 88 | 507 | 397 | 6,673 | 6,656 | 4,607 | 609 | 530 | 6,087 | 6,696 |
| 185 | 285 | | 5436 | 8.5 | 25,647 | 79 | 476 | 374 | 6,490 | 6,475 | 4,503 | 572 | 493 | 5,912 | 6,510 |
| 186T | 286T | | 5388 | 8.4 | 26,250 | 79 | 475 | 374 | 6,465 | 6,451 | 4,490 | 571 | 493 | 5,892 | 6,484 |
| 187 | 287 | | 5370 | 8.4 | 26,746 | 78 | 474 | 373 | 6,457 | 6,442 | 4,486 | 570 | 492 | 5,884 | 6,476 |
| 189 | 289 | | 5281 | 8.3 | 27,346 | 78 | 468 | 371 | 6,392 | 6,378 | 4,459 | 561 | 486 | 5,833 | 6,411 |
| 193T | 293T | | 4979 | 7.8 | 29,468 | 61 | 447 | 356 | 6,147 | 6,135 | 4,310 | 531 | 461 | 5,611 | 6,163 |
| 198 | 298 | | 4731 | 7.4 | 29,618 | 58 | 412 | 330 | 5,928 | 5,916 | 4,185 | 493 | 424 | 5,410 | 5,942 |
| 1113 | 2113 | | 3751 | 5.9 | 30,048 | 57 | 352 | 297 | 4,859 | 4,848 | 3,461 | 413 | 358 | 4,427 | 4,871 |
| 1123 | 2123 | US Hwy 34 | 3266 | 5.1 | 30,303 | 16 | 321 | 270 | 4,196 | 4,187 | 3,045 | 370 | 309 | 3,794 | 4,206 |
| 1124T | 2124T | | 3186 | 5.0 | 30,891 | 16 | 313 | 265 | 4,124 | 4,115 | 3,005 | 360 | 300 | 3,731 | 4,135 |
| 1125 | 2125 | | 3173 | 5.0 | 32,729 | 16 | 311 | 265 | 4,128 | 4,119 | 3,007 | 359 | 298 | 3,731 | 4,139 |
| 1127T | 2127T | | 3074 | 4.8 | 33,390 | 17 | 298 | 255 | 4,029 | 4,020 | 2,953 | 344 | 284 | 3,640 | 4,039 |
| 1128 | 2128 | | 3041 | 4.8 | 33,876 | 16 | 295 | 254 | 3,994 | 3,985 | 2,941 | 339 | 281 | 3,614 | 4,003 |
| 1135T | 2135T | | 2655 | 4.1 | 34,664 | 15 | 283 | 248 | 3,639 | 3,631 | 2,662 | 320 | 269 | 3,298 | 3,647 |
| 1136 | 2136 | | 2640 | 4.1 | 36,075 | 16 | 283 | 249 | 3,640 | 3,633 | 2,664 | 320 | 269 | 3,300 | 3,647 |
| 1149 | 2149 | | 1930 | 3.0 | 37,756 | 13 | 254 | 230 | 2,819 | 2,812 | 2,015 | 280 | 237 | 2,553 | 2,825 |
| 1153 | 2153 | | 1561 | 2.4 | 37,756 | 6 | 127 | 110 | 2,078 | 2,072 | 1,631 | 147 | 108 | 1,843 | 2,084 |
| 1154 | 2154 | | 1501 | 2.3 | 40,026 | 6 | 130 | 115 | 2,040 | 2,035 | 1,613 | 147 | 108 | 1,810 | 2,044 |
| 1155T | 2155T | | 1450 | 2.3 | 40,896 | 6 | 130 | 115 | 1,992 | 1,987 | 1,571 | 146 | 108 | 1,768 | 1,995 |
| 1169 | 2169 | | 604 | 0.9 | 40,896 | 3 | 124 | 114 | 1,096 | 1,090 | 695 | 134 | 104 | 943 | 1,100 |
| 1170 | 2170 | CO Hwy 257 | 550 | 0.9 | 44,274 | 3 | 131 | 121 | 1,089 | 1,084 | 667 | 141 | 109 | 923 | 1,092 |
| 1173 | 2173 | | 269 | 0.4 | 45,843 | 1 | 109 | 102 | 673 | 668 | 314 | 114 | 94 | 570 | 677 |
| 1175 | 2175 | | 90 | 0.1 | 48,071 | 1 | 26 | 24 | 195 | 192 | 101 | 28 | 18 | 146 | 196 |

## Table E-3 - DCIA and Rain Barrel Runoff Volumes Along Sheep Draw

| Design Point | Downstream Conveyance Element | Location | Total Drainage Area (acres) | Total Drainage Area ($mi^2$) | Length (feet) | Existing Runoff Volumes (acre-feet) | | | | | | Future Runoff Volumes (acre-feet) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | $V_{2, EX}$ | $V_{2, DCIA\ 1}$ | $V_{2, DCIA\ 2}$ | $V_{100, DCIA\ 1}$ | $V_{100, DCIA\ 2}$ | $V_{100,EX}$ | $V_2$ | $V_{2,RAIN}$ | $V_{100,RAIN}$ | $V_{100}$ |
| 100 | --- | Confluence with Cache la Poudre River | 10104 | 15.8 | 0 | 66 | 149 | 127 | 1,476 | 1,467 | 1,169 | 167 | 155 | 1,415 | 1,485 |
| 104 | 204 | Greeley No. 3 Ditch | 9898 | 15.5 | 1,410 | 67 | 153 | 131 | 1,461 | 1,452 | 1,157 | 171 | 159 | 1,399 | 1,470 |
| 105 | 205 | C Street | 9856 | 15.4 | 3,073 | 69 | 157 | 134 | 1,464 | 1,458 | 1,163 | 175 | 163 | 1,406 | 1,473 |
| 109T | 209T | | 9592 | 15.0 | 3,294 | 63 | 150 | 128 | 1,436 | 1,430 | 1,135 | 169 | 157 | 1,378 | 1,445 |
| 110 | 210 | | 9518 | 14.9 | 4,721 | 62 | 150 | 128 | 1,430 | 1,424 | 1,132 | 169 | 157 | 1,372 | 1,439 |
| 112T | 212T | | 9356 | 14.6 | 7,798 | 62 | 152 | 129 | 1,421 | 1,415 | 1,123 | 170 | 158 | 1,363 | 1,430 |
| 113 | 213 | W. 4th Street | 9316 | 14.6 | 8,464 | 61 | 151 | 128 | 1,418 | 1,409 | 1,120 | 170 | 157 | 1,356 | 1,427 |
| 121T | 215 | | 9019 | 14.1 | 8,554 | 56 | 144 | 121 | 1,375 | 1,366 | 1,083 | 163 | 150 | 1,317 | 1,384 |
| 122 | 222 | | 8938 | 14.0 | 9,475 | 54 | 143 | 120 | 1,363 | 1,356 | 1,071 | 162 | 149 | 1,304 | 1,372 |
| 123T | 223T | | 8831 | 13.8 | 10,930 | 53 | 142 | 119 | 1,353 | 1,344 | 1,059 | 161 | 149 | 1,292 | 1,363 |
| 124 | 224 | W. 10th Street | 8808 | 13.8 | 11,912 | 53 | 143 | 119 | 1,350 | 1,344 | 1,059 | 162 | 149 | 1,292 | 1,360 |
| 125 | 225 | | 8796 | 13.7 | 11,948 | 52 | 142 | 119 | 1,350 | 1,341 | 1,059 | 162 | 149 | 1,289 | 1,360 |
| 127 | 227 | | 8698 | 13.6 | 12,407 | 51 | 140 | 116 | 1,332 | 1,326 | 1,046 | 159 | 146 | 1,274 | 1,344 |
| 142T | 242T | | 7871 | 12.3 | 15,022 | 41 | 131 | 107 | 1,224 | 1,218 | 942 | 150 | 137 | 1,166 | 1,237 |
| 152 | 252 | 71st Avenue | 7078 | 11.1 | 15,535 | 31 | 119 | 95 | 1,117 | 1,108 | 838 | 138 | 126 | 1,059 | 1,126 |
| 154T | 254T | | 6848 | 10.7 | 18,806 | 30 | 119 | 95 | 1,093 | 1,086 | 819 | 138 | 125 | 1,034 | 1,102 |
| 154 | 254 | | 6148 | 9.6 | 18,806 | 23 | 110 | 88 | 973 | 967 | 730 | 129 | 115 | 918 | 982 |
| 167T | 267T | | 6139 | 9.6 | 19,607 | 24 | 110 | 89 | 976 | 967 | 733 | 130 | 115 | 918 | 985 |
| 168 | 268 | | 6094 | 9.5 | 20,928 | 23 | 110 | 88 | 970 | 964 | 727 | 130 | 115 | 915 | 979 |
| 170T | 270T | | 6001 | 9.4 | 22,409 | 23 | 110 | 88 | 957 | 951 | 718 | 129 | 115 | 902 | 967 |
| 172 | 272 | 83rd Avenue | 5959 | 9.3 | 22,744 | 22 | 108 | 87 | 951 | 942 | 712 | 128 | 114 | 893 | 957 |
| 174T | 274T | | 5880 | 9.2 | 23,842 | 22 | 106 | 85 | 939 | 930 | 703 | 126 | 112 | 884 | 948 |
| 176 | 276 | | 5724 | 8.9 | 24,301 | 18 | 102 | 81 | 911 | 905 | 678 | 121 | 107 | 856 | 921 |
| 185 | 285 | | 5436 | 8.5 | 25,647 | 16 | 92 | 72 | 862 | 856 | 651 | 110 | 96 | 807 | 868 |
| 186T | 286T | | 5388 | 8.4 | 26,250 | 16 | 92 | 72 | 856 | 850 | 648 | 110 | 96 | 804 | 865 |
| 187 | 287 | | 5370 | 8.4 | 26,746 | 15 | 91 | 72 | 856 | 847 | 644 | 110 | 96 | 801 | 862 |
| 189 | 289 | | 5281 | 8.3 | 27,346 | 15 | 91 | 72 | 844 | 838 | 638 | 108 | 95 | 792 | 850 |
| 193T | 293T | | 4979 | 7.8 | 29,468 | 13 | 84 | 68 | 798 | 792 | 608 | 100 | 89 | 752 | 804 |
| 198 | 298 | | 4731 | 7.4 | 29,618 | 12 | 74 | 58 | 746 | 743 | 583 | 89 | 77 | 700 | 755 |
| 1113 | 2113 | | 3751 | 5.9 | 30,048 | 12 | 63 | 52 | 611 | 608 | 482 | 73 | 66 | 574 | 614 |
| 1123 | 2123 | US Hwy 34 | 3266 | 5.1 | 30,303 | 4 | 53 | 43 | 519 | 519 | 411 | 61 | 52 | 485 | 525 |
| 1124T | 2124T | | 3186 | 5.0 | 30,891 | 4 | 51 | 42 | 506 | 503 | 405 | 59 | 51 | 473 | 509 |
| 1125 | 2125 | | 3173 | 5.0 | 32,729 | 4 | 50 | 42 | 503 | 503 | 402 | 59 | 50 | 470 | 509 |
| 1127T | 2127T | | 3074 | 4.8 | 33,390 | 4 | 47 | 39 | 485 | 485 | 393 | 55 | 46 | 454 | 488 |
| 1128 | 2128 | | 3041 | 4.8 | 33,876 | 4 | 46 | 39 | 482 | 479 | 390 | 54 | 46 | 448 | 485 |
| 1135T | 2135T | | 2655 | 4.1 | 34,664 | 4 | 44 | 37 | 430 | 430 | 347 | 50 | 43 | 402 | 433 |
| 1136 | 2136 | | 2640 | 4.1 | 36,075 | 4 | 43 | 37 | 427 | 427 | 347 | 49 | 43 | 399 | 430 |
| 1149 | 2149 | | 1930 | 3.0 | 37,756 | 3 | 34 | 30 | 322 | 319 | 261 | 38 | 33 | 300 | 322 |
| 1153 | 2153 | | 1561 | 2.4 | 37,756 | 1 | 17 | 13 | 242 | 242 | 209 | 20 | 15 | 221 | 244 |
| 1154 | 2154 | | 1501 | 2.3 | 40,026 | 1 | 16 | 13 | 236 | 235 | 206 | 19 | 14 | 215 | 237 |
| 1155T | 2155T | | 1450 | 2.3 | 40,896 | 1 | 16 | 13 | 230 | 229 | 200 | 19 | 14 | 210 | 231 |
| 1169 | 2169 | | 604 | 0.9 | 40,896 | 1 | 14 | 12 | 109 | 109 | 86 | 15 | 13 | 99 | 110 |
| 1170 | 2170 | CO Hwy 257 | 550 | 0.9 | 44,274 | 0 | 13 | 11 | 100 | 99 | 78 | 14 | 11 | 89 | 100 |
| 1173 | 2173 | | 269 | 0.4 | 45,843 | 0 | 10 | 9 | 54 | 54 | 38 | 11 | 9 | 48 | 54 |
| 1175 | 2175 | | 90 | 0.1 | 48,071 | 0 | 2 | 2 | 17 | 17 | 13 | 3 | 2 | 14 | 17 |

**Table E-4 - Proposed Crossing Structures**

| Reach | Structure Survey Number | Jurisdiction | Street Name | Street Classification | Existing Structure | Proposed Structure - No Detention | Proposed Structure - With Detention |
|---|---|---|---|---|---|---|---|
| **SD R1** | 1 | City of Greeley | Poudre River Trail | Trail | 84-inch CMP | Replace CMP with RCP | Replace CMP with RCP |
| | 2 | City of Greeley | Sheep Draw Nature Trail | Trail | 84-inch CMP | Replace CMP with RCP | Replace CMP with RCP |
| | 3 | City of Greeley | Greeley No. 3 Ditch | N/A | Concrete canal weir RCBC | Spillway for minor flows | Spillway for minor flows |
| | 4 | Weld County | N/A | N/A | Irrigation water crossing: 1.5-foot diameter utility poles on upstream side of 15-inch PVC. PVC extends beyond utility poles. | Existing | Existing |
| | 5 | Weld County | N/A | N/A | Access bridge with railing | Existing | Existing |
| | 6 | City of Greeley and Weld County | C Street | Local | Metal/wood bridge with railing | 130-ft bridge, raise road 4.4 feet | 110-ft bridge, raise road 3.6 feet |
| | 7 | City of Greeley | Sheep Draw Trail | Trail | Double-barreled 36-inch CMP | Replace CMP with RCP | Replace CMP with RCP |
| | 8 | City of Greeley | 4th Street | Minor Arterial | Concrete bridge with pier and railing | 150-ft bridge, raise road 2.3 feet | Existing bridge with (1) 20'W x 10' H RCBC adjacent to bridge |
| | 9 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing | Existing | Existing |
| | 9.5 | City of Greeley | Sheep Draw Trail | Trail | Double-barreled 42-inch RCP | Existing | Existing |
| | 10 | City of Greeley | 10th Street | Major Arterial | Concrete bridge with railing | Existing bridge with (2) 26'W x 10'H RCBC adjacent to bridge | Existing bridge with (1) 12'W x 10' H RCBC adjacent to bridge |
| | 11 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | Remove and relocate bridge | Existing |
| | 12 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | Existing | Existing |
| **SD R2** | 13 | City of Greeley | Sheep Draw Trail | Trail | 36-inch RCP | Existing | Existing |
| **SD R3** | 16 | City of Greeley | 71st Avenue | Minor Arterial | Concrete bridge with pier and railing | 150-ft bridge, raise road 1.3 feet | Existing bridge with (1) 10'W x 10' H RCBC adjacent to bridge |
| | 17 | City of Greeley | Sheep Draw Trail | Trail | 7' span by 3' rise RCBC | Existing | Existing |
| | 18 | City of Greeley | Sheep Draw Trail | Trail | 46-inch CMP | Replace CMP with RCP | Replace CMP with RCP |
| | 19 | City of Greeley | 83rd Avenue | Major Arterial | Concrete bridge with pier and railing | 130-ft bridge, raise road 2.5 feet | Existing bridge with (2) 16'W x 10' H RCBC adjacent to bridge |
| | 20 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | Existing | Existing |
| | 21 | City of Greeley | 95th Avenue | Local | 22' span by 5' rise RCBC | (3) 20' W x 10' H RCBC | (2) 20' W x 10' H RCBC |
| | 22 | City of Greeley | Highway 34 | Highway | 26' span by 4' RCBC | (3) 20' W x 10' H RCBC | (2) 20' W x 10' H RCBC |
| | 23 | City of Greeley | Private driveway | N/A | 48-inch CMP | Replace CMP with RCP | Replace CMP with RCP |
| **71st Ave Split** | 14 | City of Greeley | Sheep Draw Trail | Trail | Pedestrian bridge with 4.5' handrails and 30"x19" HERCP | Existing | Existing |
| | 15 | City of Greeley | Sheep Draw Trail | Trail | 30"x19" HERCP | Existing | Existing |

# COST ESTIMATES

(DOUBLE-CLICK ICON ABOVE)

olsson®

# BENEFIT COST ANALYSIS

(DOUBLE-CLICK ICON ABOVE)

olsson®

# EXCERPTS FROM BASIC REPORT OF SHEEP DRAW CORRIDOR PARCELS (CBRE PROPERTY VALUATION)

(DOUBLE-CLICK ICON ABOVE)

olsson®

# APPENDIX F

## CONCEPTUAL DESIGN

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## Table F-1 - Future Baseline vs MDP Peak Flows

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Future Conditions Peak Flow (cfs) | | | | | | | MDP Conditions Peak Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 100 | 10104 | 15.8 | 18 | 39 | 769 | 1,132 | 1,541 | 3,888 | 5,760 | 8,419 | 16,238 | 637 | 924 | 1,256 | 2,906 | 4,335 | 6,317 | 11,454 |
| 101T | 67 | 0.1 | 8 | 8 | 0 | 1 | 1 | 6 | 16 | 31 | 79 | 0 | 1 | 1 | 6 | 16 | 31 | 79 |
| 101 | 44 | 0.1 | 6 | 6 | 0 | 1 | 1 | 6 | 17 | 33 | 76 | 0 | 1 | 1 | 6 | 17 | 33 | 76 |
| 102 | 11 | 0.0 | 7 | 7 | 0 | 0 | 0 | 1 | 4 | 8 | 19 | 0 | 0 | 0 | 1 | 4 | 8 | 19 |
| 103 | 23 | 0.0 | 10 | 10 | 0 | 0 | 1 | 3 | 7 | 13 | 29 | 0 | 0 | 1 | 3 | 7 | 13 | 29 |
| 104 | 9898 | 15.5 | 19 | 40 | 772 | 1,134 | 1,545 | 3,872 | 5,730 | 8,357 | 16,104 | 640 | 928 | 1,265 | 2,924 | 4,318 | 6,253 | 11,292 |
| 105 | 9856 | 15.4 | 19 | 40 | 777 | 1,136 | 1,547 | 3,883 | 5,751 | 8,370 | 16,127 | 646 | 933 | 1,271 | 3,010 | 4,375 | 6,299 | 11,325 |
| 106OF | 130 | 0.2 | 50 | 50 | 0 | 14 | 35 | 104 | 167 | 246 | 458 | 0 | 14 | 35 | 104 | 167 | 246 | 458 |
| 106 | 130 | 0.2 | 50 | 50 | 51 | 69 | 90 | 159 | 222 | 301 | 513 | 51 | 69 | 90 | 159 | 222 | 301 | 513 |
| 107 | 99 | 0.2 | 48 | 49 | 32 | 45 | 62 | 118 | 159 | 211 | 347 | 32 | 45 | 62 | 118 | 159 | 211 | 347 |
| 108 | 62 | 0.1 | 48 | 49 | 18 | 26 | 34 | 67 | 91 | 121 | 201 | 18 | 26 | 34 | 67 | 91 | 121 | 201 |
| 109T | 9592 | 15.0 | 18 | 40 | 775 | 1,134 | 1,544 | 3,875 | 5,735 | 8,344 | 16,034 | 644 | 930 | 1,266 | 2,984 | 4,322 | 6,222 | 11,165 |
| 109 | 74 | 0.1 | 35 | 46 | 19 | 25 | 33 | 55 | 83 | 116 | 209 | 19 | 25 | 33 | 55 | 83 | 116 | 209 |
| 110 | 9518 | 14.9 | 18 | 40 | 776 | 1,134 | 1,543 | 3,878 | 5,738 | 8,353 | 16,009 | 645 | 931 | 1,266 | 2,985 | 4,315 | 6,206 | 11,158 |
| 111 | 69 | 0.1 | 35 | 35 | 13 | 19 | 26 | 51 | 80 | 116 | 217 | 13 | 19 | 26 | 51 | 80 | 116 | 217 |
| 112T | 9356 | 14.6 | 18 | 40 | 780 | 1,132 | 1,539 | 3,879 | 5,749 | 8,395 | 16,038 | 650 | 936 | 1,269 | 2,993 | 4,313 | 6,207 | 11,151 |
| 112 | 40 | 0.1 | 58 | 58 | 18 | 24 | 31 | 48 | 67 | 89 | 151 | 18 | 24 | 31 | 48 | 67 | 89 | 151 |
| 113 | 9316 | 14.6 | 17 | 40 | 780 | 1,131 | 1,538 | 3,878 | 5,747 | 8,393 | 16,024 | 650 | 934 | 1,267 | 2,987 | 4,303 | 6,194 | 11,148 |
| 114 | 20 | 0.0 | 64 | 64 | 9 | 12 | 15 | 25 | 33 | 44 | 71 | 9 | 12 | 15 | 25 | 33 | 44 | 71 |
| 115 | 175 | 0.3 | 27 | 41 | 36 | 50 | 67 | 125 | 190 | 275 | 505 | 36 | 50 | 67 | 125 | 190 | 275 | 505 |
| 116 | 84 | 0.1 | 16 | 40 | 20 | 27 | 38 | 69 | 106 | 152 | 277 | 20 | 27 | 38 | 69 | 106 | 152 | 277 |
| 117 | 71 | 0.1 | 16 | 44 | 20 | 27 | 37 | 67 | 101 | 143 | 257 | 20 | 27 | 37 | 67 | 101 | 143 | 257 |
| 118 | 47 | 0.1 | 19 | 39 | 14 | 19 | 26 | 45 | 70 | 101 | 187 | 14 | 19 | 26 | 45 | 70 | 101 | 187 |
| 119 | 55 | 0.1 | 42 | 49 | 15 | 20 | 26 | 43 | 63 | 89 | 158 | 15 | 20 | 26 | 43 | 63 | 89 | 158 |
| 120 | 11 | 0.0 | 34 | 39 | 3 | 4 | 5 | 8 | 13 | 18 | 34 | 3 | 4 | 5 | 8 | 13 | 18 | 34 |
| 121T | 9019 | 14.1 | 17 | 39 | 769 | 1,119 | 1,519 | 3,848 | 5,691 | 8,303 | 15,807 | 639 | 918 | 1,243 | 2,916 | 4,192 | 6,028 | 11,035 |
| 121 | 81 | 0.1 | 41 | 41 | 16 | 23 | 31 | 68 | 96 | 131 | 221 | 16 | 23 | 31 | 68 | 96 | 131 | 221 |
| 122 | 8938 | 14.0 | 16 | 39 | 764 | 1,112 | 1,510 | 3,831 | 5,665 | 8,264 | 15,715 | 634 | 911 | 1,233 | 2,891 | 4,151 | 5,961 | 10,976 |
| 123T | 8831 | 13.8 | 16 | 39 | 761 | 1,106 | 1,501 | 3,821 | 5,646 | 8,231 | 15,634 | 631 | 905 | 1,224 | 2,872 | 4,119 | 5,904 | 10,922 |
| 123 | 24 | 0.0 | 39 | 39 | 4 | 5 | 7 | 12 | 19 | 28 | 53 | 4 | 5 | 7 | 12 | 19 | 28 | 53 |
| 124 | 8808 | 13.8 | 16 | 39 | 761 | 1,105 | 1,500 | 3,822 | 5,646 | 8,227 | 15,622 | 631 | 905 | 1,223 | 2,871 | 4,115 | 5,895 | 10,915 |
| 125 | 8796 | 13.7 | 16 | 39 | 761 | 1,104 | 1,499 | 3,820 | 5,643 | 8,223 | 15,613 | 631 | 904 | 1,221 | 2,868 | 4,110 | 5,888 | 10,910 |
| 126 | 11 | 0.0 | 6 | 56 | 3 | 4 | 5 | 9 | 13 | 17 | 29 | 3 | 4 | 5 | 9 | 13 | 17 | 29 |
| 127 | 8698 | 13.6 | 16 | 39 | 755 | 1,099 | 1,491 | 3,807 | 5,621 | 8,187 | 15,531 | 626 | 896 | 1,209 | 2,832 | 4,058 | 5,816 | 10,869 |
| 128 | 718 | 1.1 | 33 | 34 | 98 | 141 | 196 | 432 | 649 | 949 | 1,726 | 98 | 141 | 196 | 432 | 649 | 949 | 1,726 |
| 129T | 595 | 0.9 | 33 | 34 | 87 | 124 | 172 | 374 | 558 | 809 | 1,463 | 87 | 124 | 172 | 374 | 558 | 809 | 1,463 |
| 129 | 38 | 0.1 | 44 | 54 | 16 | 21 | 27 | 42 | 60 | 82 | 143 | 16 | 21 | 27 | 42 | 60 | 82 | 143 |
| 130 | 22 | 0.0 | 48 | 48 | 7 | 9 | 12 | 20 | 30 | 42 | 74 | 7 | 9 | 12 | 20 | 30 | 42 | 74 |
| 131T | 557 | 0.9 | 32 | 33 | 78 | 111 | 154 | 344 | 514 | 746 | 1,345 | 78 | 111 | 154 | 344 | 514 | 746 | 1,345 |
| 131 | 44 | 0.1 | 17 | 17 | 1 | 3 | 4 | 10 | 21 | 34 | 73 | 1 | 3 | 4 | 10 | 21 | 34 | 73 |
| 132 | 58 | 0.1 | 49 | 49 | 17 | 23 | 30 | 50 | 74 | 102 | 181 | 17 | 23 | 30 | 50 | 74 | 102 | 181 |
| 133 | 31 | 0.0 | 45 | 45 | 10 | 13 | 17 | 29 | 43 | 60 | 107 | 10 | 13 | 17 | 29 | 43 | 60 | 107 |
| 134T | 455 | 0.7 | 31 | 33 | 64 | 92 | 129 | 295 | 437 | 630 | 1,117 | 64 | 92 | 129 | 295 | 437 | 630 | 1,117 |
| 134 | 10 | 0.0 | 51 | 55 | 5 | 7 | 9 | 14 | 20 | 27 | 46 | 5 | 7 | 9 | 14 | 20 | 27 | 46 |
| 135 | 445 | 0.7 | 31 | 32 | 62 | 89 | 125 | 289 | 427 | 614 | 1,086 | 62 | 89 | 125 | 289 | 427 | 614 | 1,086 |
| 136T | 388 | 0.6 | 30 | 30 | 53 | 76 | 105 | 247 | 362 | 518 | 911 | 53 | 76 | 105 | 247 | 362 | 518 | 911 |
| 136 | 127 | 0.2 | 54 | 54 | 44 | 59 | 78 | 137 | 191 | 258 | 439 | 44 | 59 | 78 | 137 | 191 | 258 | 439 |
| 137 | 28 | 0.0 | 61 | 61 | 9 | 12 | 15 | 24 | 32 | 43 | 72 | 9 | 12 | 15 | 24 | 32 | 43 | 72 |

## Table F-1 - Future Baseline vs MDP Peak Flows

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Future Conditions Peak Flow (cfs) | | | | | | | MDP Conditions Peak Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 138 | 260 | 0.4 | 19 | 19 | 14 | 24 | 39 | 127 | 195 | 287 | 517 | 14 | 24 | 39 | 127 | 195 | 287 | 517 |
| 139 | 237 | 0.4 | 17 | 17 | 11 | 19 | 32 | 110 | 171 | 254 | 460 | 11 | 19 | 32 | 110 | 171 | 254 | 460 |
| 140 | 188 | 0.3 | 15 | 15 | 8 | 14 | 23 | 85 | 135 | 202 | 371 | 8 | 14 | 23 | 85 | 135 | 202 | 371 |
| 141 | 66 | 0.1 | 10 | 10 | 2 | 4 | 9 | 33 | 50 | 73 | 131 | 2 | 4 | 9 | 33 | 50 | 73 | 131 |
| 142T | 7871 | 12.3 | 14 | 40 | 719 | 1,050 | 1,421 | 3,672 | 5,408 | 7,847 | 14,772 | 586 | 843 | 1,131 | 2,609 | 3,682 | 5,228 | 10,357 |
| 142 | 793 | 1.2 | 31 | 34 | 93 | 135 | 190 | 436 | 665 | 989 | 1,834 | 93 | 135 | 190 | 436 | 665 | 989 | 1,834 |
| 143T | 679 | 1.1 | 29 | 32 | 75 | 110 | 157 | 374 | 571 | 846 | 1,557 | 75 | 110 | 157 | 374 | 571 | 846 | 1,557 |
| 143 | 18 | 0.0 | 65 | 65 | 10 | 13 | 17 | 28 | 37 | 47 | 76 | 10 | 13 | 17 | 28 | 37 | 47 | 76 |
| 144 | 661 | 1.0 | 28 | 31 | 71 | 104 | 150 | 363 | 555 | 822 | 1,515 | 71 | 104 | 150 | 363 | 555 | 822 | 1,515 |
| 145 | 22 | 0.0 | 34 | 44 | 6 | 7 | 9 | 16 | 24 | 34 | 62 | 6 | 7 | 9 | 16 | 24 | 34 | 62 |
| 146 | 102 | 0.2 | 20 | 20 | 5 | 8 | 12 | 36 | 58 | 88 | 163 | 5 | 8 | 12 | 36 | 58 | 88 | 163 |
| 147 | 72 | 0.1 | 26 | 26 | 6 | 10 | 14 | 38 | 58 | 85 | 154 | 6 | 10 | 14 | 38 | 58 | 85 | 154 |
| 148 | 347 | 0.5 | 26 | 29 | 36 | 54 | 81 | 206 | 312 | 456 | 827 | 36 | 54 | 81 | 206 | 312 | 456 | 827 |
| 149 | 113 | 0.2 | 39 | 44 | 25 | 33 | 44 | 76 | 114 | 163 | 295 | 25 | 33 | 44 | 76 | 114 | 163 | 295 |
| 150T | 113 | 0.2 | 30 | 34 | 18 | 27 | 42 | 96 | 135 | 185 | 311 | 18 | 27 | 42 | 96 | 135 | 185 | 311 |
| 150 | 64 | 0.1 | 22 | 22 | 6 | 9 | 15 | 42 | 61 | 86 | 149 | 6 | 9 | 15 | 42 | 61 | 86 | 149 |
| 151 | 49 | 0.1 | 41 | 50 | 15 | 22 | 31 | 58 | 78 | 103 | 168 | 15 | 22 | 31 | 58 | 78 | 103 | 168 |
| 152 | 7078 | 11.1 | 12 | 40 | 662 | 981 | 1,329 | 3,467 | 5,090 | 7,366 | 13,729 | 530 | 762 | 1,020 | 2,284 | 3,268 | 4,496 | 9,668 |
| 153 | 116 | 0.2 | 5 | 23 | 6 | 10 | 15 | 40 | 66 | 104 | 200 | 6 | 10 | 15 | 40 | 66 | 104 | 200 |
| 154T | 6848 | 10.7 | 12 | 41 | 663 | 973 | 1,315 | 3,471 | 5,090 | 7,378 | 13,663 | 532 | 756 | 1,007 | 2,266 | 3,244 | 4,442 | 9,624 |
| 154 | 6045 | 9.4 | 10 | 39 | 638 | 966 | 1,322 | 3,264 | 4,787 | 6,933 | 12,753 | 508 | 722 | 970 | 2,118 | 3,033 | 4,133 | 8,940 |
| 155 | 741 | 1.2 | 29 | 60 | 245 | 338 | 443 | 780 | 1,055 | 1,406 | 2,322 | 133 | 187 | 248 | 483 | 672 | 924 | 1,576 |
| 156T | 682 | 1.1 | 29 | 62 | 237 | 325 | 425 | 739 | 997 | 1,323 | 2,179 | 124 | 174 | 231 | 443 | 615 | 843 | 1,433 |
| 156 | 253 | 0.4 | 44 | 54 | 77 | 107 | 141 | 264 | 366 | 500 | 849 | 77 | 107 | 141 | 264 | 366 | 500 | 849 |
| 157 | 197 | 0.3 | 44 | 57 | 68 | 92 | 122 | 224 | 309 | 419 | 706 | 68 | 92 | 122 | 224 | 309 | 419 | 706 |
| 158 | 141 | 0.2 | 44 | 61 | 54 | 73 | 97 | 177 | 241 | 324 | 540 | 54 | 73 | 97 | 177 | 241 | 324 | 540 |
| 159 | 45 | 0.1 | 55 | 73 | 23 | 31 | 40 | 66 | 87 | 114 | 183 | 23 | 31 | 40 | 66 | 87 | 114 | 183 |
| 160 | 10 | 0.0 | 7 | 85 | 11 | 14 | 18 | 26 | 33 | 41 | 64 | 11 | 14 | 18 | 26 | 33 | 41 | 64 |
| 161 | 429 | 0.7 | 19 | 67 | 160 | 219 | 285 | 480 | 636 | 830 | 1,341 | 47 | 68 | 90 | 180 | 250 | 343 | 584 |
| 162 | 414 | 0.6 | 18 | 67 | 159 | 219 | 283 | 471 | 622 | 808 | 1,303 | 45 | 65 | 85 | 169 | 234 | 320 | 544 |
| 163 | 360 | 0.6 | 15 | 71 | 151 | 206 | 267 | 427 | 559 | 720 | 1,154 | 34 | 49 | 65 | 123 | 170 | 230 | 391 |
| 164D | 250 | 0.4 | 9 | 81 | --- | --- | --- | --- | --- | --- | --- | 18 | 28 | 40 | 54 | 64 | 74 | 244 |
| 364 | 250 | 0.4 | 9 | 81 | --- | --- | --- | --- | --- | --- | --- | 140 | 188 | 243 | 382 | 499 | 646 | 1,054 |
| 164 | 250 | 0.4 | 9 | 81 | 133 | 177 | 223 | 322 | 411 | 521 | 811 | 140 | 188 | 243 | 382 | 499 | 646 | 1,054 |
| 165 | 96 | 0.1 | 7 | 85 | 98 | 129 | 163 | 234 | 297 | 378 | 587 | 98 | 129 | 163 | 234 | 297 | 378 | 587 |
| 166 | 62 | 0.1 | 4 | 25 | 6 | 11 | 16 | 41 | 65 | 96 | 177 | 6 | 11 | 16 | 41 | 65 | 96 | 177 |
| 167T | 6037 | 9.4 | 10 | 39 | 638 | 966 | 1,322 | 3,265 | 4,791 | 6,935 | 12,756 | 508 | 722 | 970 | 2,119 | 3,033 | 4,133 | 8,941 |
| 167 | 45 | 0.1 | 41 | 50 | 16 | 23 | 34 | 61 | 81 | 105 | 169 | 16 | 23 | 34 | 61 | 81 | 105 | 169 |
| 168 | 5992 | 9.4 | 10 | 39 | 636 | 963 | 1,317 | 3,262 | 4,782 | 6,920 | 12,715 | 505 | 716 | 962 | 2,116 | 3,030 | 4,122 | 8,921 |
| 169 | 63 | 0.1 | 4 | 30 | 7 | 10 | 15 | 38 | 56 | 81 | 143 | 7 | 10 | 15 | 38 | 56 | 81 | 143 |
| 170T | 5899 | 9.2 | 10 | 39 | 632 | 957 | 1,308 | 3,245 | 4,763 | 6,887 | 12,648 | 500 | 709 | 949 | 2,100 | 3,006 | 4,084 | 8,863 |
| 170 | 42 | 0.1 | 48 | 55 | 18 | 26 | 36 | 64 | 85 | 111 | 178 | 18 | 26 | 36 | 64 | 85 | 111 | 178 |
| 171 | 18 | 0.0 | 65 | 65 | 10 | 15 | 19 | 31 | 40 | 52 | 82 | 10 | 15 | 19 | 31 | 40 | 52 | 82 |
| 172 | 5856 | 9.2 | 10 | 39 | 628 | 950 | 1,298 | 3,228 | 4,737 | 6,849 | 12,574 | 492 | 698 | 935 | 2,091 | 2,992 | 4,062 | 8,823 |
| 173 | 39 | 0.1 | 10 | 85 | 33 | 44 | 55 | 81 | 102 | 127 | 194 | 33 | 44 | 55 | 81 | 102 | 127 | 194 |
| 174T | 5777 | 9.0 | 10 | 38 | 623 | 942 | 1,286 | 3,214 | 4,715 | 6,811 | 12,486 | 484 | 688 | 920 | 2,081 | 2,975 | 4,035 | 8,773 |
| 174 | 157 | 0.2 | 49 | 55 | 57 | 76 | 99 | 169 | 232 | 314 | 531 | 57 | 76 | 99 | 169 | 232 | 314 | 531 |
| 175 | 25 | 0.0 | 3 | 42 | 6 | 9 | 12 | 26 | 35 | 47 | 79 | 6 | 9 | 12 | 26 | 35 | 47 | 79 |

## Table F-1 - Future Baseline vs MDP Peak Flows

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Future Conditions Peak Flow (cfs) | | | | | | | MDP Conditions Peak Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 176 | 5621 | 8.8 | 9 | 38 | 609 | 921 | 1,257 | 3,162 | 4,636 | 6,696 | 12,252 | 459 | 661 | 892 | 2,055 | 2,930 | 3,962 | 8,633 |
| 177 | 172 | 0.3 | 30 | 62 | 130 | 180 | 237 | 393 | 523 | 687 | 1,127 | 81 | 113 | 147 | 244 | 327 | 431 | 708 |
| 178 | 40 | 0.1 | 48 | 51 | 12 | 16 | 21 | 37 | 52 | 71 | 120 | 12 | 16 | 21 | 37 | 52 | 71 | 120 |
| 179 | 14 | 0.0 | 46 | 50 | 5 | 6 | 8 | 13 | 19 | 26 | 46 | 5 | 6 | 8 | 13 | 19 | 26 | 46 |
| 180 | 98 | 0.2 | 16 | 72 | 111 | 155 | 203 | 332 | 435 | 564 | 911 | 61 | 85 | 111 | 181 | 237 | 306 | 490 |
| 181 | 87 | 0.1 | 16 | 77 | 113 | 156 | 203 | 330 | 430 | 555 | 893 | 63 | 88 | 114 | 180 | 234 | 302 | 480 |
| 182T | 18 | 0.0 | 11 | 86 | 78 | 106 | 137 | 215 | 276 | 349 | 559 | 15 | 20 | 26 | 38 | 48 | 60 | 92 |
| 182 | 18 | 0.0 | 11 | 86 | 15 | 21 | 26 | 39 | 49 | 61 | 93 | 15 | 21 | 26 | 39 | 49 | 61 | 93 |
| 183 | 103 | 0.2 | 8 | 78 | 78 | 104 | 132 | 192 | 244 | 312 | 489 | 78 | 104 | 132 | 192 | 244 | 312 | 489 |
| 184 | 34 | 0.1 | 5 | 65 | 14 | 19 | 25 | 41 | 55 | 71 | 116 | 14 | 19 | 25 | 41 | 55 | 71 | 116 |
| 185 | 5436 | 8.5 | 8 | 37 | 572 | 869 | 1,190 | 3,078 | 4,513 | 6,510 | 11,870 | 432 | 635 | 868 | 2,025 | 2,884 | 3,897 | 8,515 |
| 186T | 5388 | 8.4 | 8 | 37 | 571 | 867 | 1,187 | 3,069 | 4,498 | 6,484 | 11,813 | 430 | 633 | 865 | 2,019 | 2,872 | 3,876 | 8,469 |
| 186 | 17 | 0.0 | 46 | 46 | 6 | 9 | 12 | 21 | 30 | 41 | 70 | 6 | 9 | 12 | 21 | 30 | 41 | 70 |
| 187 | 5370 | 8.4 | 8 | 37 | 570 | 866 | 1,185 | 3,066 | 4,493 | 6,476 | 11,793 | 428 | 631 | 864 | 2,018 | 2,869 | 3,872 | 8,462 |
| 188 | 69 | 0.1 | 6 | 45 | 17 | 23 | 30 | 53 | 79 | 111 | 198 | 17 | 23 | 30 | 53 | 79 | 111 | 198 |
| 189 | 5281 | 8.3 | 8 | 37 | 561 | 854 | 1,170 | 3,040 | 4,452 | 6,411 | 11,654 | 416 | 620 | 853 | 2,001 | 2,842 | 3,827 | 8,376 |
| 190 | 240 | 0.4 | 21 | 49 | 71 | 94 | 122 | 214 | 313 | 441 | 765 | 71 | 94 | 122 | 214 | 313 | 441 | 765 |
| 191 | 185 | 0.3 | 26 | 51 | 60 | 79 | 101 | 172 | 252 | 354 | 612 | 60 | 79 | 101 | 172 | 252 | 354 | 612 |
| 192 | 77 | 0.1 | 58 | 58 | 37 | 49 | 64 | 104 | 141 | 189 | 314 | 37 | 49 | 64 | 104 | 141 | 189 | 314 |
| 193T | 4979 | 7.8 | 7 | 37 | 531 | 812 | 1,119 | 2,951 | 4,289 | 6,163 | 11,128 | 379 | 582 | 817 | 1,941 | 2,749 | 3,658 | 8,068 |
| 193 | 177 | 0.3 | 10 | 76 | 117 | 160 | 204 | 318 | 408 | 521 | 819 | 117 | 160 | 204 | 318 | 408 | 521 | 819 |
| 194 | 71 | 0.1 | 3 | 84 | 52 | 70 | 88 | 132 | 167 | 211 | 327 | 52 | 70 | 88 | 132 | 167 | 211 | 327 |
| 195 | 172 | 0.3 | 9 | 76 | 115 | 159 | 203 | 312 | 400 | 510 | 801 | 115 | 159 | 203 | 312 | 400 | 510 | 801 |
| 196 | 145 | 0.2 | 4 | 84 | 113 | 155 | 197 | 298 | 380 | 480 | 749 | 113 | 155 | 197 | 298 | 380 | 480 | 749 |
| 197 | 26 | 0.0 | 2 | 85 | 22 | 29 | 37 | 54 | 68 | 87 | 135 | 22 | 29 | 37 | 54 | 68 | 87 | 135 |
| 198 | 4731 | 7.4 | 7 | 34 | 493 | 760 | 1,051 | 2,840 | 4,129 | 5,942 | 10,685 | 350 | 530 | 764 | 1,874 | 2,657 | 3,536 | 7,841 |
| 199 | 872 | 1.4 | 4 | 27 | 98 | 142 | 190 | 464 | 704 | 1,058 | 1,986 | 23 | 37 | 59 | 159 | 225 | 282 | 1,399 |
| 1100D | 862 | 1.3 | 4 | 26 | --- | --- | --- | --- | --- | --- | --- | 23 | 37 | 59 | 159 | 224 | 282 | 1,391 |
| 3100 | 862 | 1.3 | 4 | 26 | --- | --- | --- | --- | --- | --- | --- | 97 | 140 | 188 | 459 | 697 | 1,048 | 1,966 |
| 1100 | 862 | 1.3 | 4 | 26 | 97 | 140 | 188 | 459 | 697 | 1,048 | 1,966 | 97 | 140 | 188 | 459 | 697 | 1,048 | 1,966 |
| 1101T | 758 | 1.2 | 3 | 24 | 96 | 134 | 181 | 430 | 646 | 964 | 1,800 | 96 | 134 | 181 | 430 | 646 | 964 | 1,800 |
| 1101 | 59 | 0.1 | 3 | 25 | 6 | 8 | 11 | 25 | 38 | 58 | 108 | 6 | 8 | 11 | 25 | 38 | 58 | 108 |
| 1102 | 24 | 0.0 | 4 | 4 | 0 | 0 | 0 | 4 | 8 | 14 | 31 | 0 | 0 | 0 | 4 | 8 | 14 | 31 |
| 1103 | 699 | 1.1 | 3 | 24 | 90 | 127 | 171 | 407 | 609 | 908 | 1,693 | 90 | 127 | 171 | 407 | 609 | 908 | 1,693 |
| 1104 | 592 | 0.9 | 2 | 19 | 75 | 103 | 138 | 333 | 507 | 765 | 1,422 | 75 | 103 | 138 | 333 | 507 | 765 | 1,422 |
| 1105 | 134 | 0.2 | 2 | 61 | 59 | 79 | 104 | 173 | 238 | 319 | 535 | 59 | 79 | 104 | 173 | 238 | 319 | 535 |
| 1106 | 89 | 0.1 | 2 | 55 | 39 | 52 | 69 | 116 | 160 | 216 | 365 | 39 | 52 | 69 | 116 | 160 | 216 | 365 |
| 1107 | 325 | 0.5 | 2 | 2 | 1 | 2 | 15 | 143 | 245 | 381 | 720 | 1 | 2 | 15 | 143 | 245 | 381 | 720 |
| 1108 | 141 | 0.2 | 2 | 2 | 1 | 2 | 8 | 73 | 119 | 179 | 330 | 1 | 2 | 8 | 73 | 119 | 179 | 330 |
| 1109 | 61 | 0.1 | 2 | 2 | 0 | 1 | 7 | 33 | 50 | 73 | 132 | 0 | 1 | 7 | 33 | 50 | 73 | 132 |
| 1110 | 53 | 0.1 | 2 | 2 | 0 | 1 | 9 | 34 | 50 | 73 | 128 | 0 | 1 | 9 | 34 | 50 | 73 | 128 |
| 1111 | 81 | 0.1 | 2 | 3 | 0 | 1 | 5 | 25 | 42 | 70 | 136 | 0 | 1 | 5 | 25 | 42 | 70 | 136 |
| 1112 | 40 | 0.1 | 2 | 2 | 0 | 1 | 5 | 16 | 24 | 35 | 62 | 0 | 1 | 5 | 16 | 24 | 35 | 62 |
| 1113 | 3751 | 5.9 | 8 | 36 | 413 | 646 | 900 | 2,398 | 3,437 | 4,871 | 8,639 | 329 | 499 | 714 | 1,715 | 2,418 | 3,231 | 6,354 |
| 1114 | 432 | 0.7 | 36 | 66 | 170 | 237 | 308 | 531 | 710 | 944 | 1,559 | 170 | 237 | 308 | 531 | 710 | 944 | 1,559 |
| 1115 | 84 | 0.1 | 60 | 60 | 34 | 45 | 57 | 90 | 123 | 164 | 275 | 34 | 45 | 57 | 90 | 123 | 164 | 275 |
| 1116 | 275 | 0.4 | 24 | 71 | 150 | 205 | 263 | 430 | 561 | 722 | 1,145 | 150 | 205 | 263 | 430 | 561 | 722 | 1,145 |
| 1117 | 101 | 0.2 | 7 | 81 | 78 | 107 | 136 | 206 | 263 | 329 | 509 | 78 | 107 | 136 | 206 | 263 | 329 | 509 |

## Table F-1 - Future Baseline vs MDP Peak Flows

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Future Conditions Peak Flow (cfs) | | | | | | | MDP Conditions Peak Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 1118 | 74 | 0.1 | 55 | 65 | 35 | 47 | 60 | 96 | 129 | 170 | 279 | 35 | 47 | 60 | 96 | 129 | 170 | 279 |
| 1119 | 11 | 0.0 | 74 | 74 | 3 | 4 | 5 | 9 | 12 | 15 | 24 | 3 | 4 | 5 | 9 | 12 | 15 | 24 |
| 1120 | 9 | 0.0 | 77 | 77 | 3 | 4 | 5 | 8 | 10 | 13 | 21 | 3 | 4 | 5 | 8 | 10 | 13 | 21 |
| 1121 | 7 | 0.0 | 78 | 78 | 2 | 3 | 4 | 7 | 9 | 11 | 17 | 2 | 3 | 4 | 7 | 9 | 11 | 17 |
| 1122 | 5 | 0.0 | 79 | 79 | 2 | 2 | 3 | 4 | 6 | 7 | 11 | 2 | 2 | 3 | 4 | 6 | 7 | 11 |
| 1123 | 3266 | 5.1 | 4 | 32 | 370 | 567 | 907 | 2,053 | 2,960 | 4,206 | 7,418 | 291 | 445 | 707 | 1,489 | 2,101 | 2,804 | 5,511 |
| 1124T | 3186 | 5.0 | 4 | 31 | 360 | 553 | 888 | 2,020 | 2,911 | 4,135 | 7,277 | 285 | 435 | 694 | 1,465 | 2,067 | 2,758 | 5,414 |
| 1124 | 13 | 0.0 | 27 | 73 | 8 | 11 | 15 | 23 | 30 | 38 | 59 | 8 | 11 | 15 | 23 | 30 | 38 | 59 |
| 1125 | 3173 | 5.0 | 4 | 31 | 359 | 552 | 889 | 2,025 | 2,917 | 4,139 | 7,287 | 282 | 433 | 692 | 1,463 | 2,063 | 2,750 | 5,419 |
| 1126 | 46 | 0.1 | 2 | 52 | 16 | 22 | 29 | 53 | 73 | 98 | 166 | 16 | 22 | 29 | 53 | 73 | 98 | 166 |
| 1127T | 3074 | 4.8 | 4 | 30 | 344 | 530 | 859 | 1,975 | 2,845 | 4,039 | 7,091 | 273 | 420 | 675 | 1,436 | 2,021 | 2,698 | 5,294 |
| 1127 | 32 | 0.1 | 2 | 45 | 9 | 12 | 16 | 26 | 40 | 57 | 103 | 9 | 12 | 16 | 26 | 40 | 57 | 103 |
| 1128 | 3041 | 4.8 | 4 | 30 | 339 | 524 | 850 | 1,959 | 2,822 | 4,003 | 7,019 | 269 | 415 | 668 | 1,425 | 2,005 | 2,677 | 5,244 |
| 1129D | 344 | 0.5 | 3 | 19 | --- | --- | --- | --- | --- | --- | --- | 7 | 11 | 20 | 59 | 93 | 125 | 481 |
| 3129 | 344 | 0.5 | 3 | 19 | --- | --- | --- | --- | --- | --- | --- | 18 | 28 | 44 | 128 | 205 | 325 | 620 |
| 1129 | 344 | 0.5 | 3 | 19 | 18 | 28 | 44 | 128 | 205 | 325 | 620 | 18 | 28 | 44 | 128 | 205 | 325 | 620 |
| 1130 | 286 | 0.4 | 2 | 14 | 10 | 16 | 33 | 104 | 166 | 263 | 499 | 10 | 16 | 33 | 104 | 166 | 263 | 499 |
| 1131 | 27 | 0.0 | 2 | 26 | 2 | 3 | 4 | 10 | 17 | 26 | 50 | 2 | 3 | 4 | 10 | 17 | 26 | 50 |
| 1132 | 161 | 0.3 | 2 | 3 | 1 | 2 | 16 | 60 | 96 | 149 | 281 | 1 | 2 | 16 | 60 | 96 | 149 | 281 |
| 1133 | 120 | 0.2 | 3 | 4 | 1 | 2 | 16 | 57 | 85 | 125 | 223 | 1 | 2 | 16 | 57 | 85 | 125 | 223 |
| 1134 | 23 | 0.0 | 4 | 4 | 0 | 1 | 4 | 13 | 20 | 28 | 48 | 0 | 1 | 4 | 13 | 20 | 28 | 48 |
| 1135T | 2655 | 4.1 | 4 | 31 | 320 | 494 | 799 | 1,817 | 2,596 | 3,647 | 6,326 | 260 | 402 | 647 | 1,371 | 1,916 | 2,549 | 4,839 |
| 1135 | 15 | 0.0 | 2 | 45 | 3 | 5 | 6 | 12 | 17 | 24 | 40 | 3 | 5 | 6 | 12 | 17 | 24 | 40 |
| 1136D | 2640 | 4.1 | 4 | 31 | --- | --- | --- | --- | --- | --- | --- | 259 | 402 | 647 | 1,371 | 1,914 | 2,541 | 4,840 |
| 3136 | 2640 | 4.1 | 4 | 31 | --- | --- | --- | --- | --- | --- | --- | 264 | 419 | 696 | 1,516 | 2,124 | 2,965 | 5,023 |
| 1136 | 2640 | 4.1 | 4 | 31 | 320 | 496 | 806 | 1,827 | 2,601 | 3,647 | 6,316 | 264 | 419 | 696 | 1,516 | 2,124 | 2,965 | 5,023 |
| 1137 | 173 | 0.3 | 14 | 49 | 67 | 92 | 120 | 188 | 242 | 313 | 537 | 67 | 92 | 120 | 188 | 242 | 313 | 537 |
| 1138T | 85 | 0.1 | 25 | 25 | 9 | 14 | 25 | 64 | 93 | 130 | 225 | 9 | 14 | 25 | 64 | 93 | 130 | 225 |
| 1138 | 69 | 0.1 | 30 | 30 | 11 | 16 | 28 | 64 | 89 | 122 | 206 | 11 | 16 | 28 | 64 | 89 | 122 | 206 |
| 1139 | 16 | 0.0 | 2 | 2 | 0 | 0 | 2 | 8 | 12 | 18 | 32 | 0 | 0 | 2 | 8 | 12 | 18 | 32 |
| 1140 | 470 | 0.7 | 2 | 17 | 19 | 34 | 69 | 231 | 356 | 530 | 965 | 19 | 34 | 69 | 231 | 356 | 530 | 965 |
| 1141 | 455 | 0.7 | 2 | 17 | 18 | 32 | 68 | 228 | 350 | 520 | 942 | 18 | 32 | 68 | 228 | 350 | 520 | 942 |
| 1142T | 422 | 0.7 | 2 | 14 | 14 | 26 | 58 | 207 | 320 | 476 | 862 | 14 | 26 | 58 | 207 | 320 | 476 | 862 |
| 1142 | 42 | 0.1 | 2 | 16 | 1 | 3 | 4 | 14 | 24 | 37 | 70 | 1 | 3 | 4 | 14 | 24 | 37 | 70 |
| 1143 | 381 | 0.6 | 2 | 14 | 13 | 24 | 55 | 194 | 298 | 440 | 794 | 13 | 24 | 55 | 194 | 298 | 440 | 794 |
| 1144 | 50 | 0.1 | 2 | 30 | 4 | 7 | 10 | 24 | 36 | 54 | 99 | 4 | 7 | 10 | 24 | 36 | 54 | 99 |
| 1145 | 262 | 0.4 | 2 | 9 | 7 | 14 | 39 | 147 | 223 | 326 | 584 | 7 | 14 | 39 | 147 | 223 | 326 | 584 |
| 1146 | 202 | 0.3 | 2 | 8 | 5 | 10 | 32 | 117 | 176 | 257 | 459 | 5 | 10 | 32 | 117 | 176 | 257 | 459 |
| 1147 | 143 | 0.2 | 3 | 7 | 4 | 7 | 22 | 84 | 128 | 186 | 333 | 4 | 7 | 22 | 84 | 128 | 186 | 333 |
| 1148 | 53 | 0.1 | 3 | 3 | 1 | 1 | 9 | 29 | 43 | 62 | 109 | 1 | 1 | 9 | 29 | 43 | 62 | 109 |
| 1149 | 1930 | 3.0 | 3 | 32 | 280 | 425 | 677 | 1,467 | 2,052 | 2,825 | 4,798 | 224 | 350 | 574 | 1,173 | 1,595 | 2,163 | 3,530 |
| 1150 | 255 | 0.4 | 11 | 72 | 127 | 173 | 223 | 366 | 472 | 608 | 983 | 127 | 173 | 223 | 366 | 472 | 608 | 983 |
| 1151T | 147 | 0.2 | 16 | 67 | 72 | 95 | 124 | 204 | 264 | 342 | 550 | 72 | 95 | 124 | 204 | 264 | 342 | 550 |
| 1151 | 54 | 0.1 | 37 | 38 | 9 | 14 | 22 | 46 | 63 | 84 | 140 | 9 | 14 | 22 | 46 | 63 | 84 | 140 |
| 1152 | 93 | 0.1 | 5 | 85 | 94 | 127 | 163 | 238 | 299 | 374 | 570 | 94 | 127 | 163 | 238 | 299 | 374 | 570 |
| 1153 | 1561 | 2.4 | 2 | 22 | 147 | 233 | 423 | 1,037 | 1,490 | 2,084 | 3,590 | 127 | 202 | 360 | 805 | 1,097 | 1,490 | 2,510 |
| 1154 | 1501 | 2.3 | 2 | 22 | 147 | 231 | 419 | 1,025 | 1,468 | 2,044 | 3,500 | 125 | 198 | 353 | 792 | 1,073 | 1,452 | 2,445 |
| 1155T | 1450 | 2.3 | 2 | 23 | 146 | 229 | 416 | 1,008 | 1,438 | 1,995 | 3,409 | 124 | 196 | 350 | 777 | 1,047 | 1,409 | 2,380 |

## Table F-1 - Future Baseline vs MDP Peak Flows

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Future Conditions Peak Flow (cfs) | | | | | | | MDP Conditions Peak Flow (cfs) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ | $Q_2$ | $Q_5$ | $Q_{10}$ | $Q_{25}$ | $Q_{50}$ | $Q_{100}$ | $Q_{500}$ |
| 1155 | 251 | 0.4 | 2 | 10 | 5 | 9 | 28 | 109 | 171 | 262 | 486 | 5 | 9 | 28 | 109 | 171 | 262 | 486 |
| 1156 | 221 | 0.3 | 2 | 9 | 5 | 9 | 25 | 100 | 157 | 240 | 442 | 5 | 9 | 25 | 100 | 157 | 240 | 442 |
| 1157 | 94 | 0.1 | 3 | 6 | 2 | 4 | 17 | 60 | 89 | 128 | 225 | 2 | 4 | 17 | 60 | 89 | 128 | 225 |
| 1158 | 133 | 0.2 | 2 | 9 | 2 | 5 | 17 | 59 | 89 | 130 | 229 | 2 | 5 | 17 | 59 | 89 | 130 | 229 |
| 1159 | 123 | 0.2 | 2 | 9 | 3 | 5 | 17 | 58 | 86 | 124 | 218 | 3 | 5 | 17 | 58 | 86 | 124 | 218 |
| 1160 | 106 | 0.2 | 2 | 8 | 2 | 4 | 15 | 49 | 73 | 106 | 186 | 2 | 4 | 15 | 49 | 73 | 106 | 186 |
| 1161 | 462 | 0.7 | 2 | 11 | 13 | 26 | 76 | 250 | 372 | 539 | 948 | 13 | 26 | 76 | 250 | 372 | 539 | 948 |
| 1162 | 390 | 0.6 | 2 | 10 | 12 | 24 | 70 | 224 | 331 | 476 | 833 | 12 | 24 | 70 | 224 | 331 | 476 | 833 |
| 1163 | 81 | 0.1 | 3 | 5 | 1 | 2 | 10 | 40 | 61 | 88 | 156 | 1 | 2 | 10 | 40 | 61 | 88 | 156 |
| 1164 | 269 | 0.4 | 2 | 12 | 10 | 21 | 59 | 178 | 262 | 374 | 655 | 10 | 21 | 59 | 178 | 262 | 374 | 655 |
| 1165 | 209 | 0.3 | 3 | 12 | 9 | 19 | 51 | 150 | 218 | 307 | 536 | 9 | 19 | 51 | 150 | 218 | 307 | 536 |
| 1166 | 72 | 0.1 | 2 | 11 | 3 | 5 | 15 | 44 | 64 | 91 | 158 | 3 | 5 | 15 | 44 | 64 | 91 | 158 |
| 1167 | 88 | 0.1 | 3 | 12 | 6 | 12 | 31 | 79 | 115 | 158 | 270 | 6 | 12 | 31 | 79 | 115 | 158 | 270 |
| 1168 | 79 | 0.1 | 3 | 12 | 5 | 11 | 29 | 72 | 104 | 143 | 243 | 5 | 11 | 29 | 72 | 104 | 143 | 243 |
| 1169 | 604 | 0.9 | 2 | 40 | 134 | 202 | 315 | 618 | 836 | 1,100 | 1,807 | 105 | 156 | 234 | 384 | 450 | 520 | 1,026 |
| 1170D | 550 | 0.9 | 2 | 41 | --- | --- | --- | --- | --- | --- | --- | 103 | 151 | 224 | 362 | 420 | 481 | 998 |
| 3170 | 550 | 0.9 | 2 | 41 | --- | --- | --- | --- | --- | --- | --- | 141 | 206 | 317 | 610 | 823 | 1,092 | 1,771 |
| 1170 | 550 | 0.9 | 2 | 41 | 141 | 206 | 317 | 610 | 823 | 1,092 | 1,771 | 141 | 206 | 317 | 610 | 823 | 1,092 | 1,771 |
| 1171 | 205 | 0.3 | 3 | 13 | 9 | 19 | 50 | 134 | 194 | 272 | 460 | 9 | 19 | 50 | 134 | 194 | 272 | 460 |
| 1172 | 98 | 0.2 | 2 | 13 | 6 | 12 | 28 | 71 | 101 | 140 | 237 | 6 | 12 | 28 | 71 | 101 | 140 | 237 |
| 1173 | 269 | 0.4 | 2 | 60 | 114 | 161 | 228 | 394 | 522 | 677 | 1,081 | 114 | 161 | 228 | 394 | 522 | 677 | 1,081 |
| 1174 | 116 | 0.2 | 2 | 57 | 64 | 91 | 129 | 219 | 290 | 372 | 592 | 64 | 91 | 129 | 219 | 290 | 372 | 592 |
| 1175 | 90 | 0.1 | 2 | 47 | 28 | 42 | 63 | 113 | 150 | 196 | 315 | 28 | 42 | 63 | 113 | 150 | 196 | 315 |

## Table F-2 - Future Baseline vs MDP Runoff Volumes

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Future Condtions Runoff Volume (acre-feet) | | | | | | | MDP Condtions Runoff Volume (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 100 | 10104 | 15.8 | 18 | 39 | 167 | 242 | 328 | 758 | 1,068 | 1,485 | 2599 | 203 | 282 | 374 | 822 | 1,145 | 1,571 | 2710 |
| 101T | 67 | 0.1 | 8 | 8 | 0 | 0 | 0 | 1 | 3 | 6 | 13 | 0 | 0 | 0 | 2 | 3 | 6 | 14 |
| 101 | 44 | 0.1 | 6 | 6 | 0 | 0 | 0 | 1 | 2 | 3 | 8 | 0 | 0 | 0 | 1 | 2 | 3 | 8 |
| 102 | 11 | 0.0 | 7 | 7 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 2 |
| 103 | 23 | 0.0 | 10 | 10 | 0 | 0 | 0 | 0 | 1 | 2 | 4 | 0 | 0 | 0 | 0 | 1 | 2 | 4 |
| 104 | 9898 | 15.5 | 19 | 40 | 171 | 246 | 331 | 755 | 1,059 | 1,470 | 2566 | 203 | 282 | 371 | 813 | 1,126 | 1,544 | 2658 |
| 105 | 9856 | 15.4 | 19 | 40 | 175 | 251 | 338 | 758 | 1,065 | 1,473 | 2569 | 203 | 282 | 371 | 810 | 1,123 | 1,541 | 2648 |
| 106OF | 130 | 0.2 | 50 | 50 | 0 | 0 | 1 | 4 | 8 | 13 | 26 | 0 | 0 | 1 | 4 | 8 | 13 | 26 |
| 106 | 130 | 0.2 | 50 | 50 | 4 | 6 | 7 | 11 | 15 | 21 | 35 | 4 | 6 | 7 | 11 | 15 | 21 | 35 |
| 107 | 99 | 0.2 | 48 | 49 | 3 | 4 | 6 | 10 | 13 | 18 | 29 | 3 | 4 | 6 | 10 | 13 | 18 | 29 |
| 108 | 62 | 0.1 | 48 | 49 | 2 | 3 | 3 | 6 | 8 | 11 | 18 | 2 | 3 | 3 | 6 | 8 | 11 | 18 |
| 109T | 9592 | 15.0 | 18 | 40 | 169 | 242 | 325 | 743 | 1,043 | 1,445 | 2526 | 196 | 273 | 362 | 792 | 1,099 | 1,510 | 2602 |
| 109 | 74 | 0.1 | 35 | 46 | 2 | 3 | 3 | 5 | 7 | 10 | 18 | 2 | 3 | 3 | 5 | 7 | 10 | 18 |
| 110 | 9518 | 14.9 | 18 | 40 | 169 | 242 | 325 | 740 | 1,040 | 1,439 | 2513 | 194 | 270 | 359 | 789 | 1,093 | 1,501 | 2587 |
| 111 | 69 | 0.1 | 35 | 35 | 1 | 2 | 2 | 4 | 6 | 8 | 16 | 1 | 2 | 2 | 4 | 6 | 8 | 16 |
| 112T | 9356 | 14.6 | 18 | 40 | 170 | 243 | 325 | 740 | 1,034 | 1,430 | 2489 | 192 | 267 | 353 | 779 | 1,080 | 1,479 | 2547 |
| 112 | 40 | 0.1 | 58 | 58 | 1 | 2 | 3 | 4 | 5 | 7 | 11 | 1 | 2 | 3 | 4 | 5 | 7 | 11 |
| 113 | 9316 | 14.6 | 17 | 40 | 170 | 242 | 325 | 737 | 1,031 | 1,427 | 2480 | 190 | 265 | 350 | 773 | 1,074 | 1,473 | 2538 |
| 114 | 20 | 0.0 | 64 | 64 | 1 | 1 | 1 | 2 | 3 | 4 | 6 | 1 | 1 | 1 | 2 | 3 | 4 | 6 |
| 115 | 175 | 0.3 | 27 | 41 | 4 | 6 | 7 | 12 | 17 | 23 | 42 | 4 | 6 | 7 | 12 | 17 | 23 | 42 |
| 116 | 84 | 0.1 | 16 | 40 | 2 | 3 | 3 | 5 | 8 | 11 | 20 | 2 | 3 | 3 | 5 | 8 | 11 | 20 |
| 117 | 71 | 0.1 | 16 | 44 | 2 | 3 | 3 | 5 | 7 | 10 | 18 | 2 | 3 | 3 | 5 | 7 | 10 | 18 |
| 118 | 47 | 0.1 | 19 | 39 | 1 | 1 | 2 | 3 | 4 | 6 | 11 | 1 | 1 | 2 | 3 | 4 | 6 | 11 |
| 119 | 55 | 0.1 | 42 | 49 | 2 | 2 | 3 | 4 | 6 | 8 | 14 | 2 | 2 | 3 | 4 | 6 | 8 | 14 |
| 120 | 11 | 0.0 | 34 | 39 | 0 | 0 | 0 | 1 | 1 | 1 | 3 | 0 | 0 | 0 | 1 | 1 | 1 | 3 |
| 121T | 9019 | 14.1 | 17 | 39 | 163 | 232 | 313 | 715 | 1,000 | 1,384 | 2403 | 183 | 255 | 338 | 752 | 1,040 | 1,430 | 2458 |
| 121 | 81 | 0.1 | 41 | 41 | 2 | 3 | 4 | 7 | 9 | 13 | 22 | 2 | 3 | 4 | 7 | 9 | 13 | 22 |
| 122 | 8938 | 14.0 | 16 | 39 | 162 | 231 | 310 | 709 | 991 | 1,372 | 2385 | 181 | 253 | 335 | 743 | 1,031 | 1,418 | 2437 |
| 123T | 8831 | 13.8 | 16 | 39 | 161 | 230 | 307 | 703 | 985 | 1,363 | 2363 | 179 | 249 | 331 | 737 | 1,022 | 1,402 | 2409 |
| 123 | 24 | 0.0 | 39 | 39 | 0 | 1 | 1 | 1 | 2 | 3 | 5 | 0 | 1 | 1 | 1 | 2 | 3 | 5 |
| 124 | 8808 | 13.8 | 16 | 39 | 162 | 230 | 310 | 703 | 985 | 1,360 | 2360 | 178 | 249 | 328 | 733 | 1,019 | 1,399 | 2406 |
| 125 | 8796 | 13.7 | 16 | 39 | 162 | 230 | 307 | 703 | 982 | 1,360 | 2357 | 178 | 248 | 328 | 733 | 1,019 | 1,396 | 2403 |
| 126 | 11 | 0.0 | 6 | 56 | 0 | 1 | 1 | 1 | 1 | 2 | 3 | 0 | 1 | 1 | 1 | 1 | 2 | 3 |
| 127 | 8698 | 13.6 | 16 | 39 | 159 | 226 | 303 | 694 | 970 | 1,344 | 2329 | 175 | 244 | 322 | 724 | 1,004 | 1,381 | 2372 |
| 128 | 718 | 1.1 | 33 | 34 | 13 | 19 | 26 | 48 | 70 | 100 | 180 | 13 | 19 | 26 | 48 | 70 | 100 | 180 |
| 129T | 595 | 0.9 | 33 | 34 | 11 | 16 | 22 | 41 | 59 | 83 | 149 | 11 | 16 | 22 | 41 | 59 | 83 | 149 |
| 129 | 38 | 0.1 | 44 | 54 | 1 | 2 | 2 | 3 | 4 | 6 | 10 | 1 | 2 | 2 | 3 | 4 | 6 | 10 |
| 130 | 22 | 0.0 | 48 | 48 | 1 | 1 | 1 | 2 | 2 | 3 | 5 | 1 | 1 | 1 | 2 | 2 | 3 | 5 |
| 131T | 557 | 0.9 | 32 | 33 | 10 | 14 | 20 | 37 | 54 | 78 | 140 | 10 | 14 | 20 | 37 | 54 | 78 | 140 |
| 131 | 44 | 0.1 | 17 | 17 | 0 | 0 | 1 | 1 | 2 | 4 | 8 | 0 | 0 | 1 | 1 | 2 | 4 | 8 |
| 132 | 58 | 0.1 | 49 | 49 | 2 | 2 | 3 | 4 | 6 | 8 | 15 | 2 | 2 | 3 | 4 | 6 | 8 | 15 |
| 133 | 31 | 0.0 | 45 | 45 | 1 | 1 | 1 | 2 | 3 | 4 | 7 | 1 | 1 | 1 | 2 | 3 | 4 | 7 |
| 134T | 455 | 0.7 | 31 | 33 | 8 | 12 | 16 | 32 | 46 | 65 | 116 | 8 | 12 | 16 | 32 | 46 | 65 | 116 |
| 134 | 10 | 0.0 | 51 | 55 | 0 | 0 | 1 | 1 | 1 | 2 | 3 | 0 | 0 | 1 | 1 | 1 | 2 | 3 |
| 135 | 445 | 0.7 | 31 | 32 | 8 | 11 | 16 | 31 | 45 | 64 | 114 | 8 | 11 | 16 | 31 | 45 | 64 | 114 |
| 136T | 388 | 0.6 | 30 | 30 | 6 | 9 | 13 | 26 | 38 | 55 | 98 | 6 | 9 | 13 | 26 | 38 | 55 | 98 |
| 136 | 127 | 0.2 | 54 | 54 | 4 | 6 | 8 | 11 | 15 | 21 | 35 | 4 | 6 | 8 | 11 | 15 | 21 | 35 |
| 137 | 28 | 0.0 | 61 | 61 | 1 | 1 | 2 | 3 | 4 | 5 | 8 | 1 | 1 | 2 | 3 | 4 | 5 | 8 |
| 138 | 260 | 0.4 | 19 | 19 | 2 | 3 | 5 | 15 | 23 | 34 | 63 | 2 | 3 | 5 | 15 | 23 | 34 | 63 |
| 139 | 237 | 0.4 | 17 | 17 | 2 | 3 | 4 | 13 | 20 | 30 | 56 | 2 | 3 | 4 | 13 | 20 | 30 | 56 |
| 140 | 188 | 0.3 | 15 | 15 | 1 | 2 | 3 | 9 | 15 | 23 | 44 | 1 | 2 | 3 | 9 | 15 | 23 | 44 |
| 141 | 66 | 0.1 | 10 | 10 | 0 | 0 | 1 | 4 | 6 | 9 | 16 | 0 | 0 | 1 | 4 | 6 | 9 | 16 |
| 142T | 7871 | 12.3 | 14 | 40 | 150 | 212 | 284 | 644 | 896 | 1,237 | 2130 | 163 | 227 | 300 | 669 | 927 | 1,267 | 2167 |

## Table F-2 - Future Baseline vs MDP Runoff Volumes

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Future Condtions Runoff Volume (acre-feet) | | | | | | | MDP Condtions Runoff Volume (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 142 | 793 | 1.2 | 31 | 34 | 15 | 21 | 29 | 54 | 78 | 111 | 200 | 15 | 21 | 29 | 54 | 78 | 112 | 200 |
| 143T | 679 | 1.1 | 29 | 32 | 12 | 17 | 24 | 46 | 67 | 95 | 171 | 12 | 17 | 24 | 46 | 67 | 95 | 171 |
| 143 | 18 | 0.0 | 65 | 65 | 1 | 1 | 1 | 2 | 3 | 3 | 5 | 1 | 1 | 1 | 2 | 3 | 3 | 5 |
| 144 | 661 | 1.0 | 28 | 31 | 11 | 16 | 22 | 44 | 64 | 92 | 165 | 11 | 16 | 22 | 44 | 64 | 92 | 165 |
| 145 | 22 | 0.0 | 34 | 44 | 1 | 1 | 1 | 1 | 2 | 3 | 5 | 1 | 1 | 1 | 1 | 2 | 3 | 5 |
| 146 | 102 | 0.2 | 20 | 20 | 1 | 1 | 2 | 5 | 8 | 12 | 24 | 1 | 1 | 2 | 5 | 8 | 12 | 24 |
| 147 | 72 | 0.1 | 26 | 26 | 1 | 1 | 2 | 4 | 6 | 9 | 17 | 1 | 1 | 2 | 4 | 6 | 9 | 17 |
| 148 | 347 | 0.5 | 26 | 29 | 5 | 8 | 11 | 23 | 34 | 49 | 88 | 5 | 8 | 11 | 23 | 34 | 49 | 88 |
| 149 | 113 | 0.2 | 39 | 44 | 3 | 4 | 5 | 8 | 11 | 15 | 28 | 3 | 4 | 5 | 8 | 11 | 15 | 28 |
| 150T | 113 | 0.2 | 30 | 34 | 2 | 3 | 5 | 9 | 13 | 18 | 31 | 2 | 3 | 5 | 9 | 13 | 18 | 31 |
| 150 | 64 | 0.1 | 22 | 22 | 1 | 1 | 2 | 4 | 6 | 9 | 16 | 1 | 1 | 2 | 4 | 6 | 9 | 16 |
| 151 | 49 | 0.1 | 41 | 50 | 2 | 2 | 3 | 5 | 7 | 9 | 15 | 2 | 2 | 3 | 5 | 7 | 9 | 15 |
| 152 | 7078 | 11.1 | 12 | 40 | 138 | 196 | 261 | 592 | 822 | 1,126 | 1933 | 150 | 209 | 277 | 614 | 847 | 1,154 | 1967 |
| 153 | 116 | 0.2 | 5 | 23 | 1 | 2 | 2 | 5 | 8 | 13 | 26 | 1 | 2 | 2 | 5 | 8 | 13 | 26 |
| 154T | 6848 | 10.7 | 12 | 41 | 138 | 195 | 260 | 583 | 807 | 1,102 | 1884 | 147 | 205 | 271 | 602 | 826 | 1,123 | 1912 |
| 154 | 6045 | 9.4 | 10 | 39 | 129 | 183 | 249 | 516 | 718 | 982 | 1685 | 133 | 186 | 252 | 522 | 721 | 982 | 1679 |
| 155 | 741 | 1.2 | 29 | 60 | 23 | 32 | 41 | 64 | 85 | 112 | 185 | 29 | 39 | 51 | 77 | 102 | 133 | 218 |
| 156T | 682 | 1.1 | 29 | 62 | 22 | 30 | 39 | 59 | 78 | 103 | 169 | 28 | 38 | 48 | 73 | 95 | 124 | 203 |
| 156 | 253 | 0.4 | 44 | 54 | 9 | 12 | 15 | 24 | 32 | 42 | 71 | 9 | 12 | 15 | 24 | 32 | 42 | 71 |
| 157 | 197 | 0.3 | 44 | 57 | 7 | 10 | 13 | 19 | 25 | 34 | 56 | 7 | 10 | 13 | 19 | 25 | 34 | 56 |
| 158 | 141 | 0.2 | 44 | 61 | 6 | 8 | 10 | 15 | 19 | 25 | 41 | 6 | 8 | 10 | 15 | 19 | 25 | 41 |
| 159 | 45 | 0.1 | 55 | 73 | 2 | 3 | 4 | 6 | 7 | 9 | 14 | 2 | 3 | 4 | 6 | 7 | 9 | 14 |
| 160 | 10 | 0.0 | 7 | 85 | 1 | 1 | 1 | 1 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 2 | 2 | 3 |
| 161 | 429 | 0.7 | 19 | 67 | 13 | 18 | 23 | 36 | 47 | 60 | 98 | 19 | 26 | 33 | 49 | 64 | 82 | 131 |
| 162 | 414 | 0.6 | 18 | 67 | 13 | 18 | 23 | 34 | 45 | 58 | 94 | 19 | 25 | 33 | 48 | 62 | 79 | 127 |
| 163 | 360 | 0.6 | 15 | 71 | 11 | 16 | 20 | 30 | 39 | 49 | 79 | 17 | 23 | 30 | 43 | 56 | 71 | 113 |
| 164D | 250 | 0.4 | 9 | 81 | --- | --- | --- | --- | --- | --- | --- | 14 | 19 | 24 | 33 | 42 | 52 | 82 |
| 364 | 250 | 0.4 | 9 | 81 | --- | --- | --- | --- | --- | --- | --- | 14 | 19 | 24 | 33 | 42 | 52 | 82 |
| 164 | 250 | 0.4 | 9 | 81 | 8 | 11 | 14 | 20 | 25 | 31 | 48 | 14 | 19 | 24 | 33 | 42 | 52 | 82 |
| 165 | 96 | 0.1 | 7 | 85 | 5 | 7 | 9 | 13 | 16 | 20 | 31 | 5 | 7 | 9 | 13 | 16 | 20 | 31 |
| 166 | 62 | 0.1 | 4 | 25 | 1 | 1 | 1 | 3 | 5 | 8 | 14 | 1 | 1 | 1 | 3 | 5 | 8 | 14 |
| 167T | 6037 | 9.4 | 10 | 39 | 130 | 184 | 250 | 519 | 718 | 985 | 1685 | 133 | 186 | 252 | 522 | 721 | 982 | 1679 |
| 167 | 45 | 0.1 | 41 | 50 | 1 | 2 | 3 | 5 | 6 | 8 | 14 | 1 | 2 | 3 | 5 | 6 | 8 | 14 |
| 168 | 5992 | 9.4 | 10 | 39 | 130 | 183 | 249 | 516 | 715 | 979 | 1676 | 131 | 184 | 249 | 516 | 712 | 973 | 1663 |
| 169 | 63 | 0.1 | 4 | 30 | 1 | 1 | 2 | 4 | 6 | 9 | 16 | 1 | 1 | 2 | 4 | 6 | 9 | 16 |
| 170T | 5899 | 9.2 | 10 | 39 | 129 | 182 | 247 | 509 | 706 | 967 | 1654 | 130 | 182 | 246 | 509 | 703 | 961 | 1639 |
| 170 | 42 | 0.1 | 48 | 55 | 2 | 2 | 3 | 5 | 6 | 8 | 13 | 2 | 2 | 3 | 5 | 6 | 8 | 13 |
| 171 | 18 | 0.0 | 65 | 65 | 1 | 1 | 1 | 2 | 3 | 3 | 5 | 1 | 1 | 1 | 2 | 3 | 3 | 5 |
| 172 | 5856 | 9.2 | 10 | 39 | 128 | 180 | 245 | 506 | 700 | 957 | 1642 | 128 | 180 | 244 | 503 | 697 | 951 | 1627 |
| 173 | 39 | 0.1 | 10 | 85 | 2 | 3 | 4 | 6 | 7 | 9 | 14 | 2 | 3 | 4 | 6 | 7 | 9 | 14 |
| 174T | 5777 | 9.0 | 10 | 38 | 126 | 178 | 241 | 500 | 694 | 948 | 1620 | 126 | 176 | 239 | 497 | 687 | 939 | 1602 |
| 174 | 157 | 0.2 | 49 | 55 | 6 | 8 | 10 | 15 | 20 | 27 | 45 | 6 | 8 | 10 | 15 | 20 | 27 | 45 |
| 175 | 25 | 0.0 | 3 | 42 | 1 | 1 | 1 | 2 | 3 | 4 | 7 | 1 | 1 | 1 | 2 | 3 | 4 | 7 |
| 176 | 5621 | 8.8 | 9 | 38 | 121 | 171 | 232 | 485 | 672 | 921 | 1577 | 121 | 169 | 230 | 482 | 666 | 911 | 1559 |
| 177 | 172 | 0.3 | 30 | 62 | 12 | 16 | 21 | 31 | 40 | 51 | 83 | 7 | 9 | 12 | 18 | 23 | 30 | 50 |
| 178 | 40 | 0.1 | 48 | 51 | 1 | 2 | 2 | 3 | 5 | 6 | 11 | 1 | 2 | 2 | 3 | 5 | 6 | 11 |
| 179 | 14 | 0.0 | 46 | 50 | 0 | 1 | 1 | 1 | 2 | 2 | 4 | 0 | 1 | 1 | 1 | 2 | 2 | 4 |
| 180 | 98 | 0.2 | 16 | 72 | 10 | 13 | 17 | 25 | 32 | 40 | 63 | 5 | 6 | 8 | 12 | 15 | 19 | 30 |
| 181 | 87 | 0.1 | 16 | 77 | 10 | 13 | 17 | 24 | 31 | 38 | 60 | 4 | 6 | 8 | 11 | 14 | 18 | 28 |
| 182T | 18 | 0.0 | 11 | 86 | 6 | 9 | 11 | 16 | 20 | 25 | 39 | 1 | 1 | 2 | 3 | 3 | 4 | 6 |
| 182 | 18 | 0.0 | 11 | 86 | 1 | 1 | 2 | 3 | 3 | 4 | 6 | 1 | 1 | 2 | 3 | 3 | 4 | 6 |
| 183 | 103 | 0.2 | 8 | 78 | 5 | 7 | 9 | 13 | 16 | 21 | 33 | 5 | 7 | 9 | 13 | 16 | 21 | 33 |

## Table F-2 - Future Baseline vs MDP Runoff Volumes

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Future Condtions Runoff Volume (acre-feet) | | | | | | | MDP Condtions Runoff Volume (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 184 | 34 | 0.1 | 5 | 65 | 1 | 2 | 2 | 4 | 5 | 6 | 10 | 1 | 2 | 2 | 4 | 5 | 6 | 10 |
| 185 | 5436 | 8.5 | 8 | 37 | 110 | 156 | 214 | 454 | 632 | 868 | 1495 | 114 | 161 | 219 | 463 | 641 | 881 | 1507 |
| 186T | 5388 | 8.4 | 8 | 37 | 110 | 156 | 213 | 454 | 629 | 865 | 1482 | 114 | 160 | 218 | 460 | 638 | 875 | 1495 |
| 186 | 17 | 0.0 | 46 | 46 | 0 | 1 | 1 | 1 | 2 | 3 | 5 | 0 | 1 | 1 | 1 | 2 | 3 | 5 |
| 187 | 5370 | 8.4 | 8 | 37 | 110 | 156 | 212 | 451 | 629 | 862 | 1479 | 113 | 159 | 217 | 460 | 638 | 872 | 1491 |
| 188 | 69 | 0.1 | 6 | 45 | 2 | 2 | 3 | 5 | 7 | 10 | 17 | 2 | 2 | 3 | 5 | 7 | 10 | 17 |
| 189 | 5281 | 8.3 | 8 | 37 | 108 | 153 | 209 | 445 | 620 | 850 | 1458 | 111 | 157 | 214 | 454 | 629 | 859 | 1470 |
| 190 | 240 | 0.4 | 21 | 49 | 7 | 10 | 13 | 20 | 28 | 38 | 64 | 7 | 10 | 13 | 20 | 28 | 38 | 64 |
| 191 | 185 | 0.3 | 26 | 51 | 6 | 8 | 10 | 16 | 21 | 29 | 50 | 6 | 8 | 10 | 16 | 21 | 29 | 50 |
| 192 | 77 | 0.1 | 58 | 58 | 3 | 4 | 5 | 7 | 10 | 13 | 22 | 3 | 4 | 5 | 7 | 10 | 13 | 22 |
| 193T | 4979 | 7.8 | 7 | 37 | 100 | 142 | 195 | 420 | 586 | 804 | 1378 | 103 | 145 | 199 | 427 | 592 | 813 | 1387 |
| 193 | 177 | 0.3 | 10 | 76 | 9 | 12 | 16 | 23 | 29 | 37 | 57 | 9 | 12 | 16 | 23 | 29 | 37 | 57 |
| 194 | 71 | 0.1 | 3 | 84 | 4 | 5 | 7 | 10 | 12 | 15 | 24 | 4 | 5 | 7 | 10 | 12 | 15 | 24 |
| 195 | 172 | 0.3 | 9 | 76 | 9 | 12 | 15 | 22 | 28 | 36 | 56 | 9 | 12 | 15 | 22 | 28 | 36 | 56 |
| 196 | 145 | 0.2 | 4 | 84 | 8 | 11 | 14 | 20 | 26 | 32 | 49 | 8 | 11 | 14 | 20 | 26 | 32 | 49 |
| 197 | 26 | 0.0 | 2 | 85 | 1 | 2 | 2 | 3 | 4 | 5 | 8 | 1 | 2 | 2 | 3 | 4 | 5 | 8 |
| 198 | 4731 | 7.4 | 7 | 34 | 89 | 126 | 175 | 390 | 546 | 755 | 1298 | 91 | 129 | 178 | 396 | 552 | 761 | 1304 |
| 199 | 872 | 1.4 | 4 | 27 | 14 | 20 | 28 | 59 | 86 | 125 | 222 | 14 | 20 | 28 | 60 | 87 | 126 | 224 |
| 1100D | 862 | 1.3 | 4 | 26 | --- | --- | --- | --- | --- | --- | --- | 14 | 20 | 28 | 59 | 86 | 124 | 221 |
| 3100 | 862 | 1.3 | 4 | 26 | --- | --- | --- | --- | --- | --- | --- | 14 | 20 | 28 | 59 | 86 | 124 | 221 |
| 1100 | 862 | 1.3 | 4 | 26 | 14 | 19 | 27 | 58 | 85 | 123 | 219 | 14 | 20 | 28 | 59 | 86 | 124 | 221 |
| 1101T | 758 | 1.2 | 3 | 24 | 11 | 15 | 22 | 50 | 73 | 107 | 191 | 11 | 15 | 22 | 50 | 74 | 107 | 192 |
| 1101 | 59 | 0.1 | 3 | 25 | 1 | 1 | 1 | 3 | 5 | 7 | 13 | 1 | 1 | 1 | 3 | 5 | 7 | 13 |
| 1102 | 24 | 0.0 | 4 | 4 | 0 | 0 | 0 | 0 | 1 | 2 | 5 | 0 | 0 | 0 | 0 | 1 | 2 | 5 |
| 1103 | 699 | 1.1 | 3 | 24 | 10 | 14 | 20 | 47 | 69 | 100 | 178 | 10 | 14 | 21 | 47 | 69 | 100 | 179 |
| 1104 | 592 | 0.9 | 2 | 19 | 7 | 9 | 15 | 37 | 56 | 82 | 148 | 7 | 10 | 15 | 37 | 56 | 82 | 148 |
| 1105 | 134 | 0.2 | 2 | 61 | 5 | 7 | 9 | 13 | 18 | 23 | 38 | 5 | 7 | 9 | 13 | 18 | 23 | 38 |
| 1106 | 89 | 0.1 | 2 | 55 | 3 | 4 | 5 | 8 | 11 | 14 | 25 | 3 | 4 | 5 | 8 | 11 | 14 | 25 |
| 1107 | 325 | 0.5 | 2 | 2 | 0 | 0 | 2 | 15 | 25 | 40 | 76 | 0 | 0 | 2 | 15 | 25 | 40 | 76 |
| 1108 | 141 | 0.2 | 2 | 2 | 0 | 0 | 1 | 6 | 11 | 17 | 33 | 0 | 0 | 1 | 6 | 11 | 17 | 33 |
| 1109 | 61 | 0.1 | 2 | 2 | 0 | 0 | 1 | 3 | 5 | 8 | 15 | 0 | 0 | 1 | 3 | 5 | 8 | 15 |
| 1110 | 53 | 0.1 | 2 | 2 | 0 | 0 | 1 | 3 | 5 | 7 | 14 | 0 | 0 | 1 | 3 | 5 | 7 | 14 |
| 1111 | 81 | 0.1 | 2 | 3 | 0 | 0 | 1 | 4 | 6 | 10 | 19 | 0 | 0 | 1 | 4 | 6 | 10 | 19 |
| 1112 | 40 | 0.1 | 2 | 2 | 0 | 0 | 1 | 2 | 4 | 6 | 10 | 0 | 0 | 1 | 2 | 4 | 6 | 10 |
| 1113 | 3751 | 5.9 | 8 | 36 | 73 | 106 | 147 | 322 | 448 | 614 | 1046 | 75 | 108 | 149 | 328 | 454 | 620 | 1056 |
| 1114 | 432 | 0.7 | 36 | 66 | 19 | 26 | 34 | 49 | 64 | 82 | 132 | 19 | 26 | 34 | 49 | 64 | 82 | 132 |
| 1115 | 84 | 0.1 | 60 | 60 | 3 | 4 | 6 | 8 | 11 | 14 | 23 | 3 | 4 | 6 | 8 | 11 | 14 | 23 |
| 1116 | 275 | 0.4 | 24 | 71 | 13 | 18 | 23 | 33 | 43 | 55 | 87 | 13 | 18 | 23 | 33 | 43 | 55 | 87 |
| 1117 | 101 | 0.2 | 7 | 81 | 5 | 7 | 10 | 14 | 17 | 22 | 34 | 5 | 7 | 10 | 14 | 17 | 22 | 34 |
| 1118 | 74 | 0.1 | 55 | 65 | 3 | 4 | 5 | 8 | 10 | 13 | 21 | 3 | 4 | 5 | 8 | 10 | 13 | 21 |
| 1119 | 11 | 0.0 | 74 | 74 | 1 | 1 | 1 | 1 | 2 | 2 | 4 | 1 | 1 | 1 | 1 | 2 | 2 | 4 |
| 1120 | 9 | 0.0 | 77 | 77 | 0 | 1 | 1 | 1 | 1 | 2 | 3 | 0 | 1 | 1 | 1 | 1 | 2 | 3 |
| 1121 | 7 | 0.0 | 78 | 78 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 1 | 1 | 1 | 1 | 2 |
| 1122 | 5 | 0.0 | 79 | 79 | 0 | 0 | 0 | 1 | 1 | 1 | 2 | 0 | 0 | 0 | 1 | 1 | 1 | 2 |
| 1123 | 3266 | 5.1 | 4 | 32 | 61 | 90 | 138 | 269 | 381 | 525 | 902 | 63 | 92 | 141 | 273 | 384 | 528 | 908 |
| 1124T | 3186 | 5.0 | 4 | 31 | 59 | 87 | 134 | 262 | 368 | 509 | 881 | 60 | 88 | 136 | 266 | 374 | 516 | 884 |
| 1124 | 13 | 0.0 | 27 | 73 | 1 | 1 | 1 | 2 | 2 | 3 | 4 | 1 | 1 | 1 | 2 | 2 | 3 | 4 |
| 1125 | 3173 | 5.0 | 4 | 31 | 59 | 86 | 133 | 261 | 368 | 509 | 875 | 60 | 87 | 135 | 264 | 371 | 513 | 881 |
| 1126 | 46 | 0.1 | 2 | 52 | 1 | 2 | 3 | 4 | 6 | 8 | 13 | 1 | 2 | 3 | 4 | 6 | 8 | 13 |

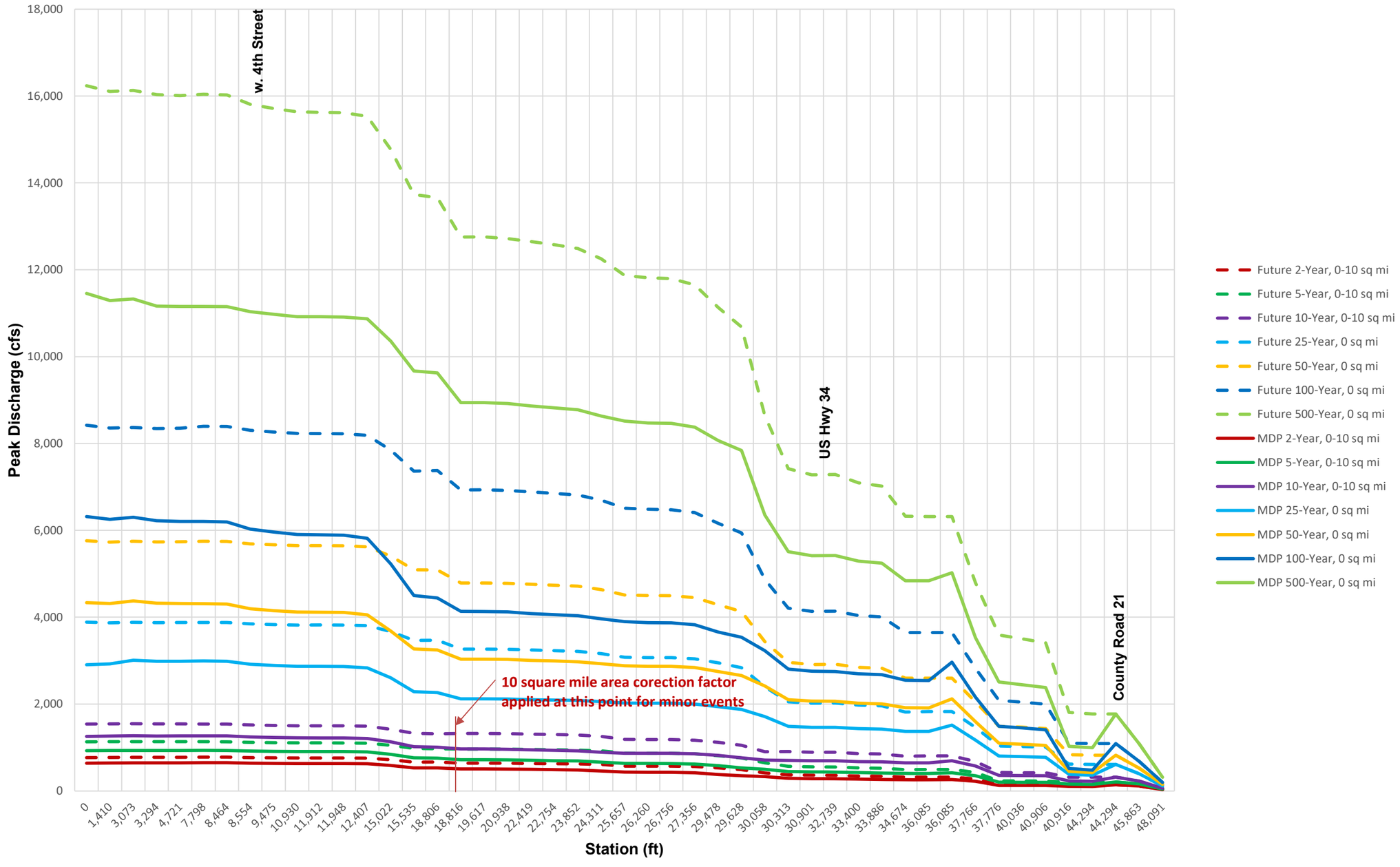
## Table F-2 - Future Baseline vs MDP Runoff Volumes

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Future Condtions Runoff Volume (acre-feet) | | | | | | | MDP Condtions Runoff Volume (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 1127T | 3074 | 4.8 | 4 | 30 | 55 | 80 | 126 | 250 | 353 | 488 | 844 | 56 | 82 | 127 | 253 | 356 | 494 | 850 |
| 1127 | 32 | 0.1 | 2 | 45 | 1 | 1 | 1 | 2 | 3 | 4 | 8 | 1 | 1 | 1 | 2 | 3 | 4 | 8 |
| 1128 | 3041 | 4.8 | 4 | 30 | 54 | 79 | 124 | 248 | 350 | 485 | 838 | 55 | 80 | 126 | 250 | 353 | 488 | 841 |
| 1129D | 344 | 0.5 | 3 | 19 | --- | --- | --- | --- | --- | --- | --- | 3 | 5 | 9 | 21 | 32 | 47 | 86 |
| 3129 | 344 | 0.5 | 3 | 19 | --- | --- | --- | --- | --- | --- | --- | 3 | 5 | 9 | 21 | 32 | 47 | 86 |
| 1129 | 344 | 0.5 | 3 | 19 | 3 | 5 | 9 | 21 | 32 | 47 | 86 | 3 | 5 | 9 | 21 | 32 | 47 | 86 |
| 1130 | 286 | 0.4 | 2 | 14 | 2 | 3 | 6 | 16 | 25 | 37 | 70 | 2 | 3 | 6 | 16 | 25 | 37 | 70 |
| 1131 | 27 | 0.0 | 2 | 26 | 0 | 0 | 1 | 1 | 2 | 3 | 6 | 0 | 0 | 1 | 1 | 2 | 3 | 6 |
| 1132 | 161 | 0.3 | 2 | 3 | 0 | 0 | 2 | 9 | 14 | 21 | 39 | 0 | 0 | 2 | 9 | 14 | 21 | 39 |
| 1133 | 120 | 0.2 | 3 | 4 | 0 | 0 | 2 | 8 | 12 | 17 | 31 | 0 | 0 | 2 | 8 | 12 | 17 | 31 |
| 1134 | 23 | 0.0 | 4 | 4 | 0 | 0 | 0 | 1 | 2 | 3 | 6 | 0 | 0 | 0 | 1 | 2 | 3 | 6 |
| 1135T | 2655 | 4.1 | 4 | 31 | 50 | 73 | 114 | 224 | 313 | 433 | 740 | 51 | 74 | 115 | 226 | 316 | 436 | 746 |
| 1135 | 15 | 0.0 | 2 | 45 | 0 | 1 | 1 | 1 | 2 | 2 | 4 | 0 | 1 | 1 | 1 | 2 | 2 | 4 |
| 1136D | 2640 | 4.1 | 4 | 31 | --- | --- | --- | --- | --- | --- | --- | 50 | 74 | 114 | 225 | 316 | 433 | 740 |
| 3136 | 2640 | 4.1 | 4 | 31 | --- | --- | --- | --- | --- | --- | --- | 50 | 74 | 114 | 225 | 316 | 433 | 740 |
| 1136 | 2640 | 4.1 | 4 | 31 | 49 | 73 | 113 | 223 | 313 | 430 | 737 | 50 | 74 | 114 | 225 | 316 | 433 | 740 |
| 1137 | 173 | 0.3 | 14 | 49 | 5 | 8 | 11 | 18 | 24 | 32 | 52 | 5 | 8 | 11 | 18 | 24 | 32 | 52 |
| 1138T | 85 | 0.1 | 25 | 25 | 1 | 2 | 3 | 7 | 10 | 14 | 23 | 1 | 2 | 3 | 7 | 10 | 14 | 23 |
| 1138 | 69 | 0.1 | 30 | 30 | 1 | 2 | 3 | 6 | 8 | 11 | 19 | 1 | 2 | 3 | 6 | 8 | 11 | 19 |
| 1139 | 16 | 0.0 | 2 | 2 | 0 | 0 | 0 | 1 | 1 | 2 | 4 | 0 | 0 | 0 | 1 | 1 | 2 | 4 |
| 1140 | 470 | 0.7 | 2 | 17 | 3 | 6 | 10 | 29 | 44 | 64 | 118 | 3 | 6 | 11 | 29 | 44 | 65 | 118 |
| 1141 | 455 | 0.7 | 2 | 17 | 3 | 5 | 10 | 28 | 43 | 63 | 115 | 3 | 5 | 10 | 28 | 43 | 63 | 115 |
| 1142T | 422 | 0.7 | 2 | 14 | 2 | 4 | 8 | 25 | 39 | 58 | 106 | 2 | 4 | 9 | 25 | 39 | 58 | 106 |
| 1142 | 42 | 0.1 | 2 | 16 | 0 | 0 | 1 | 2 | 3 | 5 | 9 | 0 | 0 | 1 | 2 | 3 | 5 | 9 |
| 1143 | 381 | 0.6 | 2 | 14 | 2 | 4 | 8 | 23 | 36 | 53 | 96 | 2 | 4 | 8 | 24 | 36 | 53 | 96 |
| 1144 | 50 | 0.1 | 2 | 30 | 1 | 1 | 1 | 3 | 4 | 7 | 12 | 1 | 1 | 1 | 3 | 4 | 7 | 12 |
| 1145 | 262 | 0.4 | 2 | 9 | 1 | 2 | 5 | 16 | 24 | 36 | 66 | 1 | 2 | 5 | 16 | 25 | 36 | 66 |
| 1146 | 202 | 0.3 | 2 | 8 | 1 | 1 | 4 | 13 | 19 | 28 | 52 | 1 | 1 | 4 | 13 | 19 | 28 | 52 |
| 1147 | 143 | 0.2 | 3 | 7 | 0 | 1 | 3 | 9 | 14 | 20 | 37 | 0 | 1 | 3 | 9 | 14 | 20 | 37 |
| 1148 | 53 | 0.1 | 3 | 3 | 0 | 0 | 1 | 3 | 5 | 7 | 14 | 0 | 0 | 1 | 3 | 5 | 7 | 14 |
| 1149 | 1930 | 3.0 | 3 | 32 | 38 | 56 | 88 | 170 | 237 | 322 | 549 | 38 | 56 | 88 | 171 | 237 | 322 | 549 |
| 1150 | 255 | 0.4 | 11 | 72 | 13 | 18 | 24 | 35 | 44 | 55 | 86 | 13 | 18 | 24 | 35 | 44 | 56 | 86 |
| 1151T | 147 | 0.2 | 16 | 67 | 7 | 10 | 13 | 20 | 25 | 32 | 49 | 7 | 10 | 13 | 20 | 25 | 32 | 49 |
| 1151 | 54 | 0.1 | 37 | 38 | 1 | 2 | 3 | 5 | 7 | 9 | 15 | 1 | 2 | 3 | 5 | 7 | 9 | 15 |
| 1152 | 93 | 0.1 | 5 | 85 | 5 | 7 | 10 | 14 | 17 | 21 | 33 | 5 | 7 | 10 | 14 | 17 | 21 | 33 |
| 1153 | 1561 | 2.4 | 2 | 22 | 20 | 31 | 55 | 121 | 174 | 244 | 427 | 20 | 31 | 55 | 121 | 174 | 244 | 427 |
| 1154 | 1501 | 2.3 | 2 | 22 | 19 | 30 | 53 | 118 | 169 | 237 | 411 | 19 | 30 | 53 | 118 | 170 | 238 | 414 |
| 1155T | 1450 | 2.3 | 2 | 23 | 19 | 29 | 52 | 116 | 165 | 231 | 402 | 19 | 29 | 52 | 116 | 166 | 231 | 402 |
| 1155 | 251 | 0.4 | 2 | 10 | 1 | 2 | 5 | 16 | 25 | 36 | 65 | 1 | 2 | 5 | 16 | 25 | 36 | 65 |
| 1156 | 221 | 0.3 | 2 | 9 | 1 | 2 | 5 | 14 | 22 | 32 | 57 | 1 | 2 | 5 | 15 | 22 | 32 | 58 |
| 1157 | 94 | 0.1 | 3 | 6 | 0 | 0 | 2 | 6 | 9 | 13 | 24 | 0 | 0 | 2 | 6 | 9 | 13 | 24 |
| 1158 | 133 | 0.2 | 2 | 9 | 0 | 1 | 3 | 8 | 13 | 19 | 34 | 0 | 1 | 3 | 8 | 13 | 19 | 34 |
| 1159 | 123 | 0.2 | 2 | 9 | 0 | 1 | 2 | 8 | 12 | 18 | 32 | 0 | 1 | 2 | 8 | 12 | 18 | 32 |
| 1160 | 106 | 0.2 | 2 | 8 | 0 | 1 | 2 | 7 | 10 | 15 | 27 | 0 | 1 | 2 | 7 | 10 | 15 | 27 |
| 1161 | 462 | 0.7 | 2 | 11 | 2 | 4 | 10 | 30 | 45 | 66 | 120 | 2 | 4 | 10 | 30 | 46 | 67 | 120 |
| 1162 | 390 | 0.6 | 2 | 10 | 2 | 3 | 9 | 26 | 39 | 57 | 102 | 2 | 3 | 9 | 26 | 39 | 57 | 102 |

## Table F-2 - Future Baseline vs MDP Runoff Volumes

| Design Point | Drainage Area (acres) | Drainage Area (sm) | Existing Percent Imperviousness | Future Percent Imperviousness | Future Condtions Runoff Volume (acre-feet) | | | | | | | MDP Condtions Runoff Volume (acre-feet) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ | $V_2$ | $V_5$ | $V_{10}$ | $V_{25}$ | $V_{50}$ | $V_{100}$ | $V_{500}$ |
| 1163 | 81 | 0.1 | 3 | 5 | 0 | 0 | 1 | 5 | 7 | 11 | 20 | 0 | 0 | 1 | 5 | 7 | 11 | 20 |
| 1164 | 269 | 0.4 | 2 | 12 | 1 | 3 | 7 | 18 | 27 | 40 | 71 | 1 | 3 | 7 | 18 | 27 | 40 | 71 |
| 1165 | 209 | 0.3 | 3 | 12 | 1 | 2 | 5 | 14 | 21 | 31 | 55 | 1 | 2 | 5 | 14 | 21 | 31 | 55 |
| 1166 | 72 | 0.1 | 2 | 11 | 0 | 1 | 2 | 5 | 7 | 10 | 19 | 0 | 1 | 2 | 5 | 7 | 10 | 19 |
| 1167 | 88 | 0.1 | 3 | 12 | 0 | 1 | 3 | 6 | 9 | 13 | 24 | 0 | 1 | 3 | 6 | 9 | 13 | 24 |
| 1168 | 79 | 0.1 | 3 | 12 | 0 | 1 | 2 | 6 | 8 | 12 | 21 | 0 | 1 | 2 | 6 | 8 | 12 | 21 |
| 1169 | 604 | 0.9 | 2 | 40 | 15 | 23 | 35 | 61 | 83 | 110 | 182 | 15 | 23 | 35 | 61 | 83 | 110 | 182 |
| 1170D | 550 | 0.9 | 2 | 41 | --- | --- | --- | --- | --- | --- | --- | 14 | 21 | 32 | 56 | 75 | 100 | 166 |
| 3170 | 550 | 0.9 | 2 | 41 | --- | --- | --- | --- | --- | --- | --- | 14 | 21 | 32 | 56 | 75 | 100 | 166 |
| 1170 | 550 | 0.9 | 2 | 41 | 14 | 21 | 32 | 56 | 75 | 100 | 166 | 14 | 21 | 32 | 56 | 75 | 100 | 166 |
| 1171 | 205 | 0.3 | 3 | 13 | 1 | 2 | 6 | 15 | 22 | 32 | 56 | 1 | 2 | 6 | 15 | 22 | 32 | 56 |
| 1172 | 98 | 0.2 | 2 | 13 | 1 | 1 | 3 | 7 | 11 | 15 | 27 | 1 | 1 | 3 | 7 | 11 | 15 | 27 |
| 1173 | 269 | 0.4 | 2 | 60 | 11 | 15 | 21 | 33 | 42 | 54 | 87 | 11 | 15 | 21 | 33 | 42 | 54 | 87 |
| 1174 | 116 | 0.2 | 2 | 57 | 4 | 6 | 8 | 13 | 18 | 23 | 37 | 4 | 6 | 8 | 13 | 18 | 23 | 37 |
| 1175 | 90 | 0.1 | 2 | 47 | 3 | 4 | 6 | 10 | 13 | 17 | 28 | 3 | 4 | 6 | 10 | 13 | 17 | 28 |

**Figure F-1A**
**Sheep Draw**
**Future Baseline vs MDP Peak Discharge vs. Drainageway Station**



# Sheep Draw LOMR

## Table F-3 Conceptual Design (Future Land Use With Proposed Detention) HEC-RAS Flow Change Locations

**Monday, January 26, 2026**

| Design Point | HEC-RAS Station | Hydrology Flows | | | | | | | HEC-RAS Flows | | | | | | | Difference (HEC-RAS Flows - Hydrology Flows) | | | | | | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $Q_2$ (cfs) | $Q_5$ (cfs) | $Q_{10}$ (cfs) | $Q_{25}$ (cfs) | $Q_{50}$ (cfs) | $Q_{100}$ (cfs) | $Q_{500}$ (cfs) | $Q_2$ (cfs) | $Q_5$ (cfs) | $Q_{10}$ (cfs) | $Q_{25}$ (cfs) | $Q_{50}$ (cfs) | $Q_{100}$ (cfs) | $Q_{500}$ (cfs) | $Q_2$ (cfs) | $Q_5$ (cfs) | $Q_{10}$ (cfs) | $Q_{25}$ (cfs) | $Q_{50}$ (cfs) | $Q_{100}$ (cfs) | $Q_{500}$ (cfs) | |
| | | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | |
| 1169 | 52501 | 105 | 156 | 234 | 384 | 450 | 520 | 1026 | 105 | 156 | 234 | 384 | 450 | 520 | 1026 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1155T | --- | 124 | 196 | 350 | 777 | 1047 | 1409 | 2380 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, <10% difference from downstream, used DP 1153 |
| 1154 | --- | 125 | 198 | 353 | 792 | 1073 | 1452 | 2445 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, <10% difference from downstream, used DP 1153 |
| 1153 | 51964 | 127 | 202 | 360 | 805 | 1097 | 1490 | 2510 | 127 | 202 | 360 | 805 | 1097 | 1490 | 2510 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Applied at DP 1155T |
| 1149 | 48647 | 224 | 350 | 574 | 1173 | 1595 | 2163 | 3530 | 224 | 350 | 574 | 1173 | 1595 | 2163 | 3530 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1136 | 47211 | 264 | 419 | 696 | 1516 | 2124 | 2965 | 5023 | 264 | 419 | 696 | 1516 | 2124 | 2965 | 5023 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 1136D | 46450 | 259 | 402 | 647 | 1371 | 1914 | 2541 | 4840 | 259 | 402 | 647 | 1371 | 1914 | 2541 | 4840 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Added flow change for MDP model |
| 1135T | --- | 260 | 402 | 647 | 1371 | 1916 | 2549 | 4839 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, flow essentially the same as upstream |
| 1128 | --- | 269 | 415 | 668 | 1425 | 2005 | 2677 | 5244 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, near DP 1127T and flows will spread out and reach this area, used DP 1127T |
| 1127T | 45123 | 273 | 420 | 675 | 1436 | 2021 | 2698 | 5294 | 273 | 420 | 675 | 1436 | 2021 | 2698 | 5294 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Applied at DP 1128 |
| 1125 | 43802 | 282 | 433 | 692 | 1463 | 2063 | 2750 | 5419 | 282 | 433 | 692 | 1463 | 2063 | 2750 | 5419 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Matched upstream flow for 2-year to eliminate flow decrease |
| 1124T | --- | 285 | 435 | 694 | 1465 | 2067 | 2758 | 5414 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded - most of Subbasin 123 flows reach this location, used DP 1123 |
| 1123 | 42350 | 291 | 445 | 707 | 1489 | 2101 | 2804 | 5511 | 291 | 445 | 707 | 1489 | 2101 | 2804 | 5511 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Applied upstream of 1124T where most of subbasin flows enter. Matched upstream flow for 2-year to eliminate flow decrease |
| 1113 | 41100 | 329 | 499 | 714 | 1715 | 2418 | 3231 | 6354 | 329 | 499 | 714 | 1715 | 2418 | 3231 | 6354 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Matched upstream flow for 10-year to eliminate flow decrease |
| 198 | 40860 | 350 | 530 | 764 | 1874 | 2657 | 3536 | 7841 | 350 | 530 | 764 | 1874 | 2657 | 3536 | 7841 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Matched upstream flow for 10-year to eliminate flow decrease |
| 193T | 40465 | 379 | 582 | 817 | 1941 | 2749 | 3658 | 8068 | 379 | 582 | 817 | 1941 | 2749 | 3658 | 8068 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Matched upstream flow for 10-year to eliminate flow decrease |
| 189 | 39206 | 416 | 620 | 853 | 2001 | 2842 | 3827 | 8376 | 416 | 620 | 853 | 2001 | 2842 | 3827 | 8376 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Applied upstream of DP 189 where most of Subbasin 89 flows enter. Matched upstream flow for 10-year to eliminate flow decrease |
| 187 | --- | 428 | 631 | 864 | 2018 | 2869 | 3872 | 8462 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, DPs are close together and flows <10% difference from downstream, used DP 185 |
| 186T | --- | 430 | 633 | 865 | 2019 | 2872 | 3876 | 8469 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, DPs are close together and flows <10% difference from downstream, used DP 185 |
| 185 | 38151 | 432 | 635 | 868 | 2025 | 2884 | 3897 | 8515 | 432 | 635 | 868 | 2025 | 2884 | 3897 | 8515 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Applied at DP 187. Matched upstream flow for 10-year to eliminate flow decrease |
| 176 | 35696 | 459 | 661 | 892 | 2055 | 2930 | 3962 | 8633 | 459 | 661 | 892 | 2055 | 2930 | 3962 | 8633 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Matched upstream flow for 10-year to eliminate flow decrease |
| 174T | --- | 484 | 688 | 920 | 2081 | 2975 | 4035 | 8773 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, near where most of Subbasin 72 flows enter and <10% difference from downstream |
| 172 | 34635 | 492 | 698 | 935 | 2091 | 2992 | 4062 | 8823 | 492 | 698 | 935 | 2091 | 2992 | 4062 | 8823 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Applied near DP 174T where most of flows from Subbasin 72 enter. Matched upstream flow for 10-year to eliminate flow decrease |

# Sheep Draw LOMR

## Table F-3 Conceptual Design (Future Land Use With Proposed Detention) HEC-RAS Flow Change Locations

**Monday, January 26, 2026**

| Design Point | HEC-RAS Station | Hydrology Flows | | | | | | | HEC-RAS Flows | | | | | | | Difference (HEC-RAS Flows - Hydrology Flows) | | | | | | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $Q_2$ (cfs) | $Q_5$ (cfs) | $Q_{10}$ (cfs) | $Q_{25}$ (cfs) | $Q_{50}$ (cfs) | $Q_{100}$ (cfs) | $Q_{500}$ (cfs) | $Q_2$ (cfs) | $Q_5$ (cfs) | $Q_{10}$ (cfs) | $Q_{25}$ (cfs) | $Q_{50}$ (cfs) | $Q_{100}$ (cfs) | $Q_{500}$ (cfs) | $Q_2$ (cfs) | $Q_5$ (cfs) | $Q_{10}$ (cfs) | $Q_{25}$ (cfs) | $Q_{50}$ (cfs) | $Q_{100}$ (cfs) | $Q_{500}$ (cfs) | |
| | | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | |
| 170T | --- | 500 | 709 | 949 | 2100 | 3006 | 4084 | 8863 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, near where most of Subbasin 68 and 69 flows enter and <10% difference from downstream |
| 168 | 33550 | 505 | 716 | 962 | 2116 | 3030 | 4122 | 8921 | 505 | 716 | 962 | 2116 | 3030 | 4122 | 8921 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Applied near DP 170T. Matched upstream flow for 10-year to eliminate flow decrease |
| 167T | 30553 | 508 | 722 | 970 | 2119 | 3033 | 4133 | 8941 | 508 | 722 | 970 | 2119 | 3033 | 4133 | 8941 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Matched upstream flow for 10- and 25-year to eliminate flow decrease |
| 154 | --- | 508 | 722 | 970 | 2118 | 3033 | 4133 | 8940 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, flow decreases - use upstream flow |
| 154T | 29868 | 532 | 756 | 1007 | 2266 | 3244 | 4442 | 9624 | 532 | 756 | 1007 | 2266 | 3244 | 4442 | 9624 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 154T* | 26510 | 532 | 756 | 1007 | 2266 | 3244 | 4442 | 9624 | 243 | 315 | 408 | 878 | 1221 | 1661 | 4073 | -289 | -441 | -599 | -1388 | -2023 | -2781 | -5551 | Steady flows at split were determined using flows from an optimized run along the lateral structures and upstream junction between the 71st Avenue Split and Sheep Draw, Reach 2 cross sections. |
| 154T* | 26165 | 532 | 756 | 1007 | 2266 | 3244 | 4442 | 9624 | 243 | 314 | 404 | 850 | 1142 | 1441 | 2448 | -289 | -442 | -603 | -1416 | -2102 | -3001 | -7176 | Steady flows at split were determined using flows from an optimized run along the lateral structures and upstream junction between the 71st Avenue Split and Sheep Draw, Reach 2 cross sections. |
| 152 | --- | 530 | 762 | 1020 | 2284 | 3268 | 4496 | 9668 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, flow decreases - use upstream flow |
| 142T* | 25737 | 586 | 843 | 1131 | 2609 | 3682 | 5228 | 10357 | 207 | 259 | 318 | 583 | 679 | 936 | 1100 | -379 | -584 | -813 | -2026 | -3003 | -4292 | -9257 | Steady flows at split were determined using flows from an optimized run along the lateral structures and upstream junction between the 71st Avenue Split and Sheep Draw, Reach 2 cross sections. |
| 142T | 25407 | 586 | 843 | 1131 | 2609 | 3682 | 5228 | 10357 | 586 | 843 | 1131 | 2609 | 3682 | 5228 | 10357 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 127 | --- | 626 | 896 | 1209 | 2832 | 4058 | 5816 | 10869 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, DPs are close together and flows <10% difference from downstream, used DP 124 |
| 125 | --- | 631 | 904 | 1221 | 2868 | 4110 | 5888 | 10910 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, DPs are close together and flows <10% difference from downstream, used DP 124 |
| 124 | 23660 | 631 | 905 | 1223 | 2871 | 4115 | 5895 | 10915 | 631 | 905 | 1223 | 2871 | 4115 | 5895 | 10915 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Applied upstream of DP 127 |
| 123T | --- | 631 | 905 | 1224 | 2872 | 4119 | 5904 | 10922 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, some flows the same and rest are <10% difference from downstream, used DP 121T |
| 122 | --- | 634 | 911 | 1233 | 2891 | 4151 | 5961 | 10976 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, DPs are closer together and flows <10% difference from downstream, used DP 121T |
| 121T | 21662 | 639 | 918 | 1243 | 2916 | 4192 | 6028 | 11035 | 639 | 918 | 1243 | 2916 | 4192 | 6028 | 11035 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Applied at DP 123T |
| 113 | 18608 | 650 | 934 | 1267 | 2987 | 4303 | 6194 | 11148 | 650 | 934 | 1267 | 2987 | 4303 | 6194 | 11148 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 112T | --- | 650 | 936 | 1269 | 2993 | 4313 | 6207 | 11151 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, some flows the same as upstream and rest are <10% difference from downstream, used DP 113 |
| 110 | --- | 645 | 931 | 1266 | 2985 | 4315 | 6206 | 11158 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, flow decreases - use upstream flow from DP 113 |
| 109T | --- | 644 | 930 | 1266 | 2984 | 4322 | 6222 | 11165 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded - some flows descrease others are <10% difference from downstream, used DP 113 |
| 105 | 13221 | 646 | 933 | 1271 | 3010 | 4375 | 6299 | 11325 | 646 | 933 | 1271 | 3010 | 4375 | 6299 | 11325 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Matched upstream flow for 25- through 500-year to eliminate flow decrease |
| 104 | --- | 640 | 928 | 1265 | 2924 | 4318 | 6253 | 11292 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | Excluded, flow decreases - use upstream flow |

## Sheep Draw LOMR

## Table F-3 Conceptual Design (Future Land Use With Proposed Detention) HEC-RAS Flow Change Locations

**Monday, January 26, 2026**

| Design Point | HEC-RAS Station | Hydrology Flows | | | | | | | HEC-RAS Flows | | | | | | | Difference (HEC-RAS Flows - Hydrology Flows) | | | | | | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $Q_2$ (cfs) | $Q_5$ (cfs) | $Q_{10}$ (cfs) | $Q_{25}$ (cfs) | $Q_{50}$ (cfs) | $Q_{100}$ (cfs) | $Q_{500}$ (cfs) | $Q_2$ (cfs) | $Q_5$ (cfs) | $Q_{10}$ (cfs) | $Q_{25}$ (cfs) | $Q_{50}$ (cfs) | $Q_{100}$ (cfs) | $Q_{500}$ (cfs) | $Q_2$ (cfs) | $Q_5$ (cfs) | $Q_{10}$ (cfs) | $Q_{25}$ (cfs) | $Q_{50}$ (cfs) | $Q_{100}$ (cfs) | $Q_{500}$ (cfs) | |
| | | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | MDP | |
| 100 | 10900 | 637 | 924 | 1256 | 2906 | 4335 | 6317 | 11454 | 637 | 924 | 1256 | 2906 | 4335 | 6317 | 11454 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Applied upstream of DP 100. Matched upstream flow for 2- through 10- and 50- through 100-year to eliminate flow decreases |
| 154T* | 2060 | 532 | 756 | 1007 | 2266 | 3244 | 4442 | 9624 | 289 | 441 | 599 | 1388 | 2023 | 2781 | 5551 | -243 | -315 | -408 | -878 | -1221 | -1661 | -4073 | Steady flows at split were determined using flows from an optimized run along the lateral structures and upstream junction between the 71st Avenue Split and Sheep Draw, Reach 2 cross sections. |
| 154T* | 1737 | 532 | 756 | 1007 | 2266 | 3244 | 4442 | 9624 | 289 | 442 | 603 | 1416 | 2102 | 3001 | 7176 | -243 | -314 | -404 | -850 | -1142 | -1441 | -2448 | Steady flows at split were determined using flows from an optimized run along the lateral structures and upstream junction between the 71st Avenue Split and Sheep Draw, Reach 2 cross sections. |
| 142T* | 1200 | 586 | 843 | 1131 | 2609 | 3682 | 5228 | 10357 | 379 | 584 | 813 | 2026 | 3003 | 4292 | 9257 | -207 | -259 | -318 | -583 | -679 | -936 | -1100 | Steady flows at split were determined using flows from an optimized run along the lateral structures and upstream junction between the 71st Avenue Split and Sheep Draw, Reach 2 cross sections. |

# Table F-4 - Proposed Detention Pond Conceptual Stage-Area-Storage-Discharge

**Pond 3170 / Pond 301**

| Elevation | Stage | Area | Area | Volume | Discharge | Notes |
|---|---|---|---|---|---|---|
| | (ft) | (sf) | (ac) | (AF) | (cfs) | |
| 4972.06 | 0.00 | - | 0 | 0.0 | 0.00 | Existing |
| 4973 | 0.94 | 57,895 | 1.3 | 0.6 | 19.10 | |
| 4974 | 1.94 | 86,801 | 2.0 | 2.3 | 70.88 | |
| 4975 | 2.94 | 122,092 | 2.8 | 4.7 | 150.42 | |
| 4976 | 3.94 | 252,453 | 5.8 | 9.0 | 255.52 | |
| 4977 | 4.94 | 359,672 | 8.3 | 16.0 | 355.37 | |
| 4978 | 5.94 | 472,731 | 10.9 | 25.6 | 416.22 | Last EX closed contour |
| 4979 | 6.94 | 582,281 | 13.4 | 37.7 | 469.24 | |
| 4980 | 7.94 | 688,352 | 15.8 | 52.3 | 516.85 | |
| 4980.5 | 8.49 | 742,546 | 17.0 | 60.5 | 539.08 | Proposed spillway crest |
| 4981 | 8.94 | 796,741 | 18.3 | 69.3 | 814.99 | |
| 4982 | 9.94 | 905,757 | 20.8 | 88.8 | 2,364.49 | |

*Utilize existing topography, raise road to create additional storage
*Proposed outlet: 10-ft (W) x 4.5-ft (H) RCBC
*Proposed spillway: Raised roadway section with 200' long crest and 1% side slopes

**Pond 3136 / Pond 306**

| Elevation | Stage | Area | Area | Volume | Discharge | Notes |
|---|---|---|---|---|---|---|
| | (ft) | (sf) | (ac) | (AF) | (cfs) | |
| 4891 | 0.00 | - | 0 | 0.0 | 0.00 | Lower than existing |
| 4892 | 1.00 | 17,759 | 0.4 | 0.2 | 53.61 | |
| 4893 | 2.00 | 71,689 | 1.6 | 1.2 | 187.98 | |
| 4894 | 3.00 | 152,398 | 3.5 | 3.8 | 391.59 | |
| 4895 | 4.00 | 253,747 | 5.8 | 8.5 | 659.13 | |
| 4896 | 5.00 | 302,043 | 6.9 | 14.8 | 987.14 | Last EX closed contour |
| 4897 | 6.00 | 344,473 | 7.9 | 22.3 | 1,373.08 | |
| 4898 | 7.00 | 393,471 | 9.0 | 30.7 | 1,814.97 | |
| 4899 | 8.00 | 444,982 | 10.2 | 40.4 | 2,311.19 | |
| 4900 | 9.00 | 502,811 | 11.5 | 51.2 | 2,583.99 | Proposed spillway crest |
| 4901 | 10.00 | 619,689 | 14.2 | 64.1 | 3,670.62 | |
| 4902 | 11.00 | 683,532 | 15.7 | 79.1 | 6,112.12 | |

*Utilize existing topography, 1' lower for outlet. Raise road to create additional storage
*Proposed outlet: (3) 10-ft (W) x 8-ft (H) RCBC
*Proposed spillway: Raised roadway section with 200' long crest and 1% side slopes

**Pond 3129 / Pond 309**

| Elevation | Stage | Area | Area | Volume | Discharge | Notes |
|---|---|---|---|---|---|---|
| | (ft) | (sf) | (ac) | (AF) | (cfs) | |
| 4892.95 | 0 | 0 | 0.0 | 0.0 | 0.00 | Existing |
| 4894 | 1.05 | 152,377 | 3.5 | 1.8 | 7.60 | |
| 4895 | 2.05 | 168,537 | 3.9 | 5.5 | 25.52 | |
| 4896 | 3.05 | 179,490 | 4.1 | 9.5 | 52.38 | |
| 4897 | 4.05 | 187,738 | 4.3 | 13.7 | 86.63 | |
| 4898 | 5.05 | 194,228 | 4.5 | 18.1 | 105.67 | |
| 4899 | 6.05 | 203,482 | 4.7 | 22.7 | 121.77 | |
| 4900 | 7.05 | 209,840 | 4.8 | 27.4 | 135.97 | Proposed spillway crest |
| 4901 | 8.05 | 216,879 | 5.0 | 32.3 | 568.83 | |

*Utilize existing topography, formalize spillway
*Proposed outlet: 48-inch RCP
*Proposed spillway: Formalize exsiting with 100' long crest and 2% side slopes

**Pond 3100 / Pond 311**

| Elevation | Stage | Area | Area | Volume | Discharge | Notes |
|---|---|---|---|---|---|---|
| | (ft) | (sf) | (ac) | (AF) | (cfs) | |
| 4865 | 0.00 | 233,648 | 0 | 0.0 | 0.00 | Existing |
| 4866 | 1.00 | 252,590 | 5.8 | 5.6 | 8.67 | |
| 4867 | 2.00 | 274,028 | 6.3 | 11.6 | 30.40 | Last EX closed contour |
| 4868 | 3.00 | 308,472 | 7.1 | 18.3 | 63.33 | |
| 4869 | 4.00 | 337,041 | 7.7 | 25.7 | 106.60 | |
| 4870 | 5.00 | 373,321 | 8.6 | 33.9 | 159.64 | |
| 4871 | 6.00 | 420,498 | 9.7 | 43.0 | 206.23 | |
| 4872 | 7.00 | 468,844 | 10.8 | 53.2 | 235.83 | |
| 4873 | 8.00 | 513,326 | 11.8 | 64.5 | 262.11 | |
| 4874 | 9.00 | 557,503 | 12.8 | 76.8 | 285.99 | Proposed spillway crest |
| 4875 | 10.00 | 611,898 | 14.0 | 90.2 | 848.02 | |
| 4876 | 11.00 | 664,820 | 15.3 | 104.8 | 2,534.75 | |

*Utilize existing topography, raise road to create additional storage
*Proposed outlet: 66-inch RCP
*Proposed spillway: Raised roadway section with 100' long crest and 1% side slopes

**Pond 364**

| Elevation | Stage | Area | Area | Volume | Discharge | Notes |
|---|---|---|---|---|---|---|
| | (ft) | (sf) | (ac) | (AF) | (cfs) | |
| 4917.66 | 0 | 250392.3 | 0.0 | 0.0 | 0.00 | Existing |
| 4918.66 | 1 | 262379.5 | 6.0 | 5.9 | 5.71 | |
| 4919.66 | 2 | 274494.2 | 6.3 | 12.0 | 20.01 | |
| 4920.66 | 3 | 286736.3 | 6.6 | 18.5 | 41.68 | |
| 4921.66 | 4 | 299106 | 6.9 | 25.2 | 53.81 | |
| 4922.66 | 5 | 311603.1 | 7.2 | 32.2 | 63.67 | |
| 4923.66 | 6 | 324227.8 | 7.4 | 39.5 | 72.20 | |
| 4924.66 | 7 | 336979.9 | 7.7 | 47.1 | 79.82 | |
| 4925.66 | 8 | 349859.6 | 8.0 | 55.0 | 86.77 | |
| 4925.86 | 8.2 | 352461 | 8.1 | 56.6 | 88.10 | Proposed spillway crest |
| 4926.66 | 9 | 362866.7 | 8.3 | 63.2 | 380.86 | |

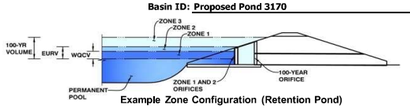
*Proposed grading
*Proposed outlet: 36-inch RCP (existing)
*Proposed spillway: Spillway section with 70' long crest and 1% side slopes

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.06 (July 2022)*

**Project:** Sheep Draw Stormwater MP

**Basin ID:** Proposed Pond 3170




**Example Zone Configuration (Retention Pond)**

Depth Increment = ft

| Stage - Storage Description | Stage (ft) | Optional Override Stage (ft) | Length (ft) | Width (ft) | Area (ft²) | Optional Override Area (ft²) | Area (acre) | Volume (ft³) | Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| 4973 **Media Surface** | -- | 0.00 | -- | -- | -- | 0 | 0.000 | | |
| **4973** | -- | 0.94 | -- | -- | -- | 57,895 | 1.329 | 27,209 | 0.625 |
| **4974** | -- | 1.94 | -- | -- | -- | 86,801 | 1.993 | 99,557 | 2.286 |
| **4975** | -- | 2.94 | -- | -- | -- | 122,092 | 2.803 | 204,003 | 4.683 |
| **4976** | -- | 3.94 | -- | -- | -- | 252,453 | 5.796 | 391,276 | 8.982 |
| **4977** | -- | 4.94 | -- | -- | -- | 359,672 | 8.257 | 697,338 | 16.009 |
| **4978 - Last Closed** | -- | 5.94 | -- | -- | -- | 472,731 | 10.852 | 1,113,539 | 25.563 |
| **4979** | -- | 6.94 | -- | -- | -- | 582,281 | 13.367 | 1,641,045 | 37.673 |
| **4980** | -- | 7.94 | -- | -- | -- | 688,352 | 15.802 | 2,276,361 | 52.258 |
| **4981** | -- | 8.94 | -- | -- | -- | 796,741 | 18.291 | 3,018,907 | 69.305 |
| **4982** | -- | 9.94 | -- | -- | -- | 905,757 | 20.793 | 3,870,156 | 88.847 |

Watershed Information

**Flood Control Only**

| | | |
|---|---|---|
| Selected BMP Type = | **No BMP** | |
| Watershed Area = | 75.23 | acres |
| Watershed Length = | 2,891 | ft |
| Watershed Length to Centroid = | 941 | ft |
| Watershed Slope = | 0.014 | ft/ft |
| Watershed Imperviousness = | 2.22% | percent |
| Percentage Hydrologic Soil Group A = | 0.0% | percent |
| Percentage Hydrologic Soil Group B = | 5.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 95.0% | percent |
| Target WQCV Drain Time = | N/A | hours |
| Location for 1-hr Rainfall Depths = | Brighton - City Hall | |

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) = | 0.105 acre-feet | | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 0.124 acre-feet | | acre-feet |
| 2-yr Runoff Volume (P1 = 0.85 in.) = | 0.071 acre-feet | 0.85 | inches |
| 5-yr Runoff Volume (P1 = 1.12 in.) = | 0.595 acre-feet | 1.12 | inches |
| 10-yr Runoff Volume (P1 = 1.4 in.) = | 1.828 acre-feet | 1.40 | inches |
| 25-yr Runoff Volume (P1 = 1.87 in.) = | 5.113 acre-feet | 1.87 | inches |
| 50-yr Runoff Volume (P1 = 2.29 in.) = | 7.654 acre-feet | 2.29 | inches |
| 100-yr Runoff Volume (P1 = 2.76 in.) = | 11.105 acre-feet | 2.76 | inches |
| 500-yr Runoff Volume (P1 = 4.1 in.) = | 19.991 acre-feet | 4.10 | inches |
| Approximate 2-yr Detention Volume = | 0.065 acre-feet | | |
| Approximate 5-yr Detention Volume = | 0.381 acre-feet | | |
| Approximate 10-yr Detention Volume = | 0.692 acre-feet | | |
| Approximate 25-yr Detention Volume = | 0.897 acre-feet | | |
| Approximate 50-yr Detention Volume = | 0.940 acre-feet | | |
| Approximate 100-yr Detention Volume = | 1.588 acre-feet | | |

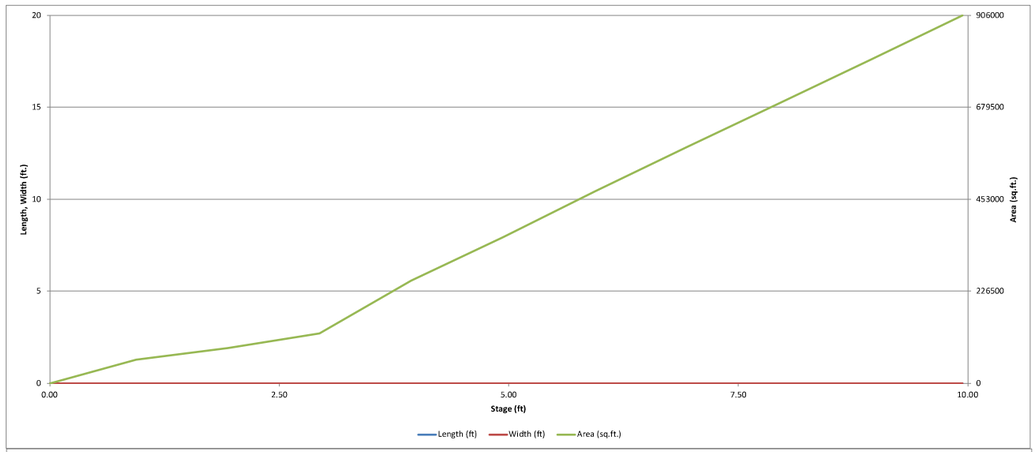
Define Zones and Basin Geometry

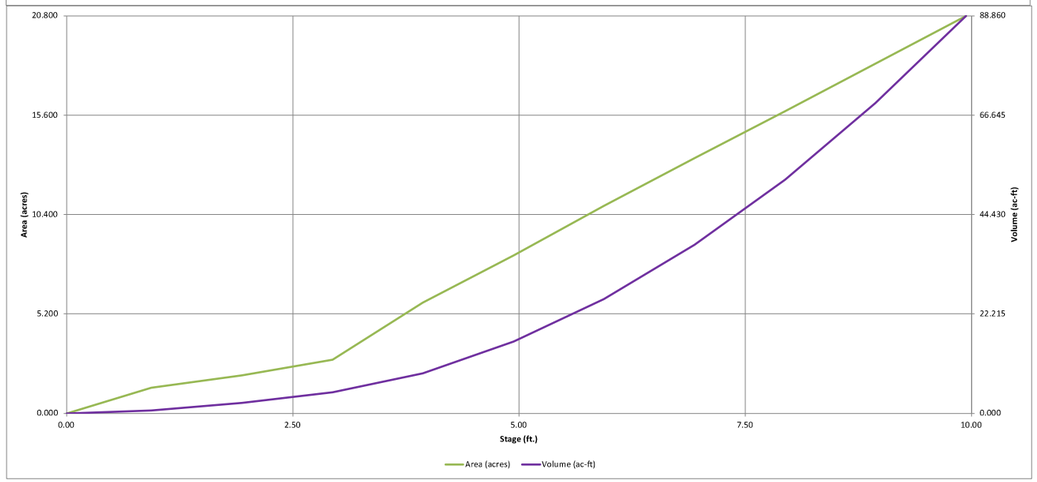
| | | |
|---|---|---|
| Zone 1 Volume (100-year) = | 1.588 | acre-feet |
| Select Zone 2 Storage Volume (Optional) = | | acre-feet |
| Select Zone 3 Storage Volume (Optional) = | | acre-feet |
| Total Detention Basin Volume = | 1.588 | acre-feet |
| Initial Surcharge Volume (ISV) = | N/A | ft³ |
| Initial Surcharge Depth (ISD) = | N/A | ft |
| Total Available Detention Depth ($H_{total}$) = | user | ft |
| Depth of Trickle Channel ($H_{TC}$) = | user | ft |
| Slope of Trickle Channel ($S_{TC}$) = | user | ft/ft |
| Slopes of Main Basin Sides ($S_{main}$) = | user | H:V |
| Basin Length-to-Width Ratio ($R_{L/W}$) = | user | |
| Initial Surcharge Area ($A_{ISV}$) = | user | ft² |
| Surcharge Volume Length ($L_{ISV}$) = | user | ft |
| Surcharge Volume Width ($W_{ISV}$) = | user | ft |
| Depth of Basin Floor ($H_{FLOOR}$) = | user | ft |
| Length of Basin Floor ($L_{FLOOR}$) = | user | ft |
| Width of Basin Floor ($W_{FLOOR}$) = | user | ft |
| Area of Basin Floor ($A_{FLOOR}$) = | user | ft² |
| Volume of Basin Floor ($V_{FLOOR}$) = | user | ft³ |
| Depth of Main Basin ($H_{MAIN}$) = | user | ft |
| Length of Main Basin ($L_{MAIN}$) = | user | ft |
| Width of Main Basin ($W_{MAIN}$) = | user | ft |
| Area of Main Basin ($A_{MAIN}$) = | user | ft² |
| Volume of Main Basin ($V_{MAIN}$) = | user | ft³ |
| Calculated Total Basin Volume ($V_{total}$) = | **user** | acre-feet |



DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.06 (July 2022)*



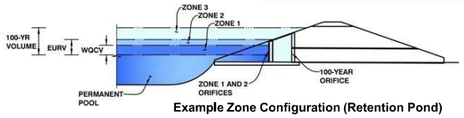

MHFD-Detention_POND3170_v4-06.xlsm, Basin 1/2/2026, 4:49 PM

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*

**Project:** Sheep Draw Stormwater MP

**Basin ID:** Proposed Pond 3170




**Example Zone Configuration (Retention Pond)**

| | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (100-year) | 1.57 | 1.588 | Rectangular Orifice |
| Zone 2 | | | |
| Zone 3 | | | |
| Total (all zones) | | 1.588 | |

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

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

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

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

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

| | Row 1 (optional) | Row 2 (optional) | Row 3 (optional) | Row 4 (optional) | Row 5 (optional) | Row 6 (optional) | Row 7 (optional) | Row 8 (optional) |
|---|---|---|---|---|---|---|---|---|
| Stage of Orifice Centroid (ft) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Orifice Area (sq. inches) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

| | 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) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Orifice Area (sq. inches) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

User Input: Vertical Orifice (Circular or Rectangular)

| | Zone 1 Rectangular | Not Selected | | Calculated Parameters for Vertical Orifice | Zone 1 Rectangular | Not Selected | |
|---|---|---|---|---|---|---|---|
| Invert of Vertical Orifice = | 0.00 | | ft (relative to basin bottom at Stage = 0 ft) | Vertical Orifice Area = | 45.00 | | $ft^2$ |
| Depth at top of Zone using Vertical Orifice = | 9.94 | | ft (relative to basin bottom at Stage = 0 ft) | Vertical Orifice Centroid = | 2.25 | | feet |
| Vertical Orifice Height = | 54.00 | | inches | | | | |
| Vertical Orifice Width = | 120.00 | | inches | | | | |

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

| | Not Selected | Not Selected | | Calculated Parameters for Overflow Weir | Not Selected | Not Selected | |
|---|---|---|---|---|---|---|---|
| Overflow Weir Front Edge Height, Ho = | | | ft (relative to basin bottom at Stage = 0 ft) | Height of Grate Upper Edge, $H_t$ = | N/A | | feet |
| Overflow Weir Front Edge Length = | | | feet | Overflow Weir Slope Length = | N/A | | feet |
| Overflow Weir Grate Slope = | | | H:V | Grate Open Area / 100-yr Orifice Area = | N/A | | |
| Horiz. Length of Weir Sides = | N/A | | feet | Overflow Grate Open Area w/o Debris = | N/A | | $ft^2$ |
| Overflow Grate Type = | N/A | | | Overflow Grate Open Area w/ Debris = | N/A | | $ft^2$ |
| Debris Clogging % = | N/A | | % | | | | |

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

| | Not Selected | Not Selected | | Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate | Not Selected | Not Selected | |
|---|---|---|---|---|---|---|---|
| Depth to Invert of Outlet Pipe = | N/A | | ft (distance below basin bottom at Stage = 0 ft) | Outlet Orifice Area = | N/A | | $ft^2$ |
| Circular Orifice Diameter = | N/A | | inches | 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= | 8.44 | ft (relative to basin bottom at Stage = 0 ft) | Spillway Design Flow Depth= | 1.15 | feet |
| Spillway Crest Length = | 200.00 | feet | Stage at Top of Freeboard = | 9.59 | feet |
| Spillway End Slopes = | 100.00 | H:V | Basin Area at Top of Freeboard = | 19.92 | acres |
| Freeboard above Max Water Surface = | 0.00 | feet | Basin Volume at Top of Freeboard = | 81.72 | acre-ft |

Routed Hydrograph Results

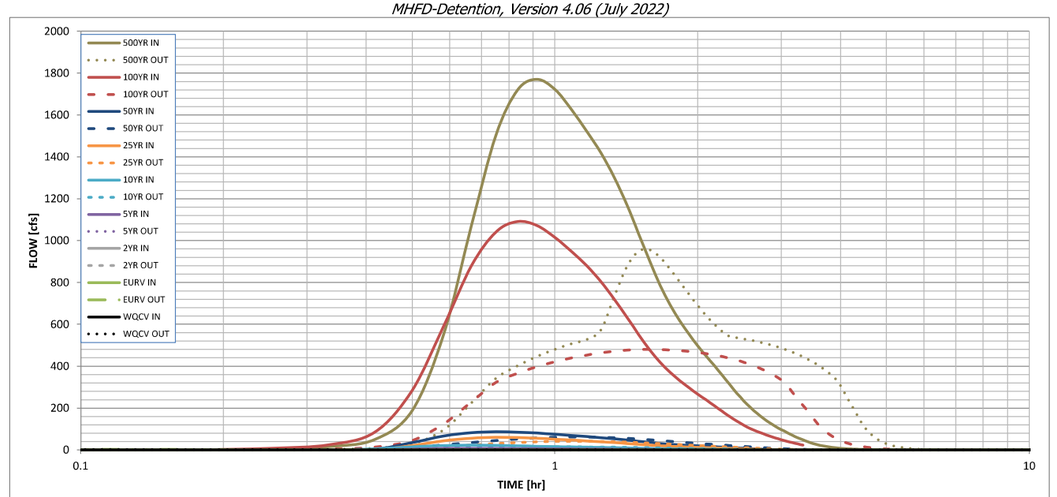
*The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

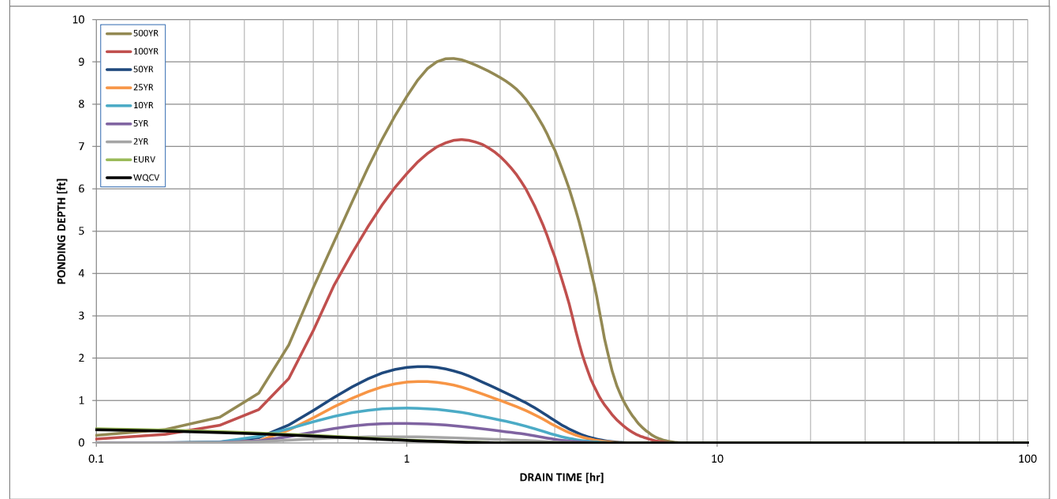
| | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|---|---|---|---|---|---|---|---|---|
| Design Storm Return Period = | N/A | N/A | 0.85 | 1.12 | 1.40 | 1.87 | 2.29 | 2.76 | 4.10 |
| One-Hour Rainfall Depth (in) = | 0.105 | 0.124 | 0.071 | 0.595 | 1.828 | 5.113 | 7.654 | 11.105 | 19.991 |
| CUHP Runoff Volume (acre-ft) = | N/A | N/A | 0.071 | 0.595 | 1.828 | 5.113 | 7.654 | 100.074 | 165.991 |
| User Override Inflow Hydrograph Volume (acre-ft) = | N/A | N/A | 0.8 | 8.0 | 22.8 | 60.2 | 86.9 | 120.7 | 207.2 |
| CUHP Predevelopment Peak Q (cfs) = | N/A | N/A | | | | | | | |
| OPTIONAL Override Predevelopment Peak Q (cfs) = | N/A | N/A | 0.01 | 0.11 | 0.30 | 0.80 | 1.16 | 1.60 | 2.75 |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | N/A | N/A | 0.9 | 8.1 | 22.9 | 60.3 | 87.0 | 1091.3 | 1771.0 |
| Peak Inflow Q (cfs) = | 3.4 | 4.0 | 0.6 | 5.2 | 14.9 | 41.8 | 62.0 | 480.5 | 956.0 |
| Peak Outflow Q (cfs) = | N/A | N/A | N/A | 0.7 | 0.7 | 0.7 | 0.7 | 4.0 | 4.6 |
| Ratio Peak Outflow to Predevelopment Q = | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Spillway |
| Structure Controlling Flow = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Max Velocity through Grate 1 (fps) = | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Max Velocity through Grate 2 (fps) = | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 4 | 4 |
| Time to Drain 97% of Inflow Volume (hours) = | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 4 | 5 |
| Time to Drain 99% of Inflow Volume (hours) = | 0.39 | 0.42 | 0.14 | 0.46 | 0.82 | 1.45 | 1.80 | 7.17 | 9.08 |
| Maximum Ponding Depth (ft) = | 0.55 | 0.59 | 0.20 | 0.64 | 1.15 | 1.66 | 1.90 | 13.90 | 18.64 |
| Area at Maximum Ponding Depth (acres) = | 0.107 | 0.125 | 0.014 | 0.143 | 0.464 | 1.372 | 2.013 | 40.673 | 71.890 |

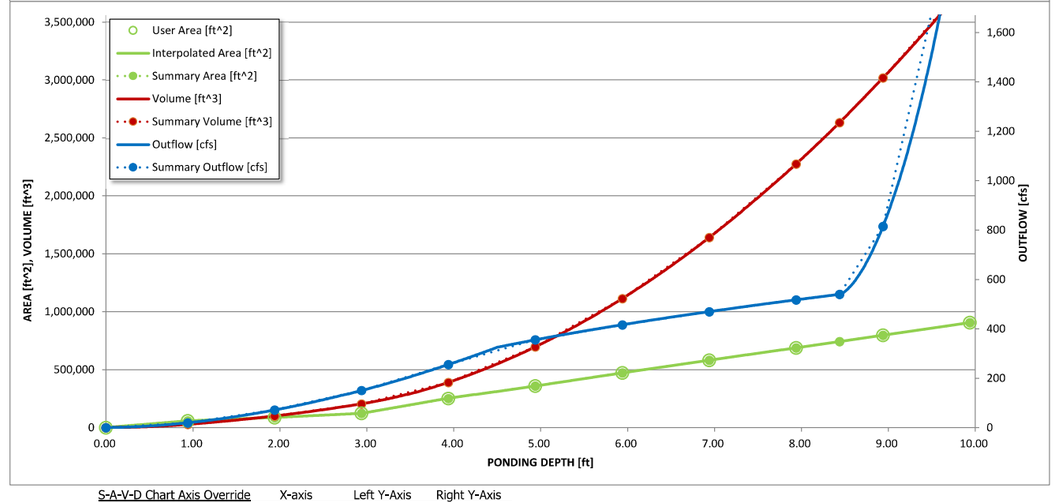


DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*




S-A-V-D Chart Axis Override

| | X-axis | Left Y-Axis | Right Y-Axis |
|---|---|---|---|
| minimum bound | | | |
| maximum bound | | | |

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*Outflow Hydrograph Workbook Filename:*

Inflow Hydrographs

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

| | SOURCE | CUHP | CUHP | CUHP | CUHP | CUHP | CUHP | CUHP | USER | USER |
|---|---|---|---|---|---|---|---|---|---|---|
| Time Interval | TIME | WQCV [cfs] | EURV [cfs] | 2 Year [cfs] | 5 Year [cfs] | 10 Year [cfs] | 25 Year [cfs] | 50 Year [cfs] | 100 Year [cfs] | 500 Year [cfs] |
| 5.00 min | 0:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0:05:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0:10:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.63 | 3.89 |
| | 0:15:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 8.40 | 16.21 |
| | 0:20:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.12 | 0.01 | 0.08 | 24.61 | 50.17 |
| | 0:25:00 | 0.00 | 0.00 | 0.24 | 0.56 | 5.57 | 0.53 | 3.73 | 84.77 | 189.58 |
| | 0:30:00 | 0.00 | 0.00 | 0.62 | 4.16 | 15.64 | 20.75 | 34.91 | 286.17 | 555.57 |
| | 0:35:00 | 0.00 | 0.00 | 0.83 | 7.34 | 21.64 | 44.10 | 67.03 | 593.78 | 1071.79 |
| | 0:40:00 | 0.00 | 0.00 | 0.89 | 8.13 | 22.88 | 56.29 | 82.46 | 880.40 | 1502.39 |
| | 0:45:00 | 0.00 | 0.00 | 0.85 | 7.80 | 21.96 | 60.29 | 87.04 | 1040.98 | 1720.61 |
| | 0:50:00 | 0.00 | 0.00 | 0.77 | 6.94 | 19.95 | 59.19 | 85.05 | 1091.25 | 1771.00 |
| | 0:55:00 | 0.00 | 0.00 | 0.70 | 6.17 | 17.96 | 55.97 | 80.70 | 1071.84 | 1722.46 |
| | 1:00:00 | 0.00 | 0.00 | 0.63 | 5.50 | 16.15 | 51.74 | 75.12 | 1014.74 | 1626.45 |
| | 1:05:00 | 0.00 | 0.00 | 0.57 | 4.88 | 14.57 | 47.56 | 69.64 | 948.59 | 1522.47 |
| | 1:10:00 | 0.00 | 0.00 | 0.52 | 4.39 | 13.37 | 43.21 | 64.10 | 880.21 | 1419.54 |
| | 1:15:00 | 0.00 | 0.00 | 0.47 | 3.99 | 12.36 | 39.10 | 58.88 | 804.74 | 1302.17 |
| | 1:20:00 | 0.00 | 0.00 | 0.42 | 3.60 | 11.22 | 35.13 | 53.32 | 720.51 | 1171.86 |
| | 1:25:00 | 0.00 | 0.00 | 0.37 | 3.20 | 9.96 | 31.24 | 47.46 | 634.78 | 1036.07 |
| | 1:30:00 | 0.00 | 0.00 | 0.32 | 2.80 | 8.69 | 27.54 | 41.80 | 552.58 | 903.66 |
| | 1:35:00 | 0.00 | 0.00 | 0.28 | 2.41 | 7.41 | 23.94 | 36.29 | 478.53 | 787.78 |
| | 1:40:00 | 0.00 | 0.00 | 0.24 | 2.03 | 6.43 | 20.42 | 31.11 | 419.19 | 693.94 |
| | 1:45:00 | 0.00 | 0.00 | 0.22 | 1.81 | 5.78 | 17.94 | 27.45 | 371.44 | 617.59 |
| | 1:50:00 | 0.00 | 0.00 | 0.20 | 1.65 | 5.24 | 16.01 | 24.53 | 331.96 | 552.68 |
| | 1:55:00 | 0.00 | 0.00 | 0.18 | 1.50 | 4.75 | 14.39 | 22.05 | 297.45 | 496.90 |
| | 2:00:00 | 0.00 | 0.00 | 0.16 | 1.36 | 4.28 | 12.92 | 19.79 | 267.03 | 448.21 |
| | 2:05:00 | 0.00 | 0.00 | 0.15 | 1.21 | 3.81 | 11.59 | 17.71 | 239.64 | 403.52 |
| | 2:10:00 | 0.00 | 0.00 | 0.13 | 1.07 | 3.35 | 10.30 | 15.70 | 212.09 | 357.97 |
| | 2:15:00 | 0.00 | 0.00 | 0.11 | 0.93 | 2.90 | 9.07 | 13.79 | 185.40 | 313.07 |
| | 2:20:00 | 0.00 | 0.00 | 0.09 | 0.79 | 2.46 | 7.88 | 11.96 | 160.72 | 271.80 |
| | 2:25:00 | 0.00 | 0.00 | 0.08 | 0.66 | 2.03 | 6.71 | 10.18 | 138.78 | 235.66 |
| | 2:30:00 | 0.00 | 0.00 | 0.06 | 0.52 | 1.61 | 5.55 | 8.44 | 119.77 | 203.59 |
| | 2:35:00 | 0.00 | 0.00 | 0.05 | 0.39 | 1.19 | 4.39 | 6.70 | 103.15 | 175.83 |
| | 2:40:00 | 0.00 | 0.00 | 0.03 | 0.25 | 0.78 | 3.24 | 4.97 | 88.99 | 152.50 |
| | 2:45:00 | 0.00 | 0.00 | 0.02 | 0.13 | 0.45 | 2.09 | 3.29 | 77.12 | 131.86 |
| | 2:50:00 | 0.00 | 0.00 | 0.01 | 0.06 | 0.28 | 1.26 | 2.11 | 66.73 | 113.67 |
| | 2:55:00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.20 | 0.78 | 1.40 | 57.66 | 97.67 |
| | 3:00:00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.14 | 0.49 | 0.94 | 49.33 | 83.86 |
| | 3:05:00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.11 | 0.30 | 0.62 | 41.76 | 70.30 |
| | 3:10:00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.08 | 0.18 | 0.40 | 35.02 | 58.51 |
| | 3:15:00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.06 | 0.10 | 0.25 | 29.01 | 48.54 |
| | 3:20:00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.05 | 0.14 | 23.39 | 38.79 |
| | 3:25:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.07 | 18.60 | 30.74 |
| | 3:30:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.04 | 14.73 | 24.68 |
| | 3:35:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.03 | 11.73 | 19.76 |
| | 3:40:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 | 9.36 | 15.76 |
| | 3:45:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 7.51 | 12.62 |
| | 3:50:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 6.09 | 10.20 |
| | 3:55:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 4.88 | 8.23 |
| | 4:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.96 | 6.66 |
| | 4:05:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.24 | 5.48 |
| | 4:10:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.65 | 4.56 |
| | 4:15:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.18 | 3.76 |
| | 4:20:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.86 | 3.11 |
| | 4:25:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.60 | 2.57 |
| | 4:30:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.38 | 2.13 |
| | 4:35:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.17 | 1.78 |
| | 4:40:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.99 | 1.52 |
| | 4:45:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.85 | 1.32 |
| | 4:50:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.72 | 1.13 |
| | 4:55:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.62 | 0.95 |
| | 5:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.54 | 0.80 |
| | 5:05:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.46 | 0.67 |
| | 5:10:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.40 | 0.57 |
| | 5:15:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.35 | 0.48 |
| | 5:20:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.30 | 0.41 |
| | 5:25:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.27 | 0.36 |
| | 5:30:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.24 | 0.31 |
| | 5:35:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.21 | 0.27 |
| | 5:40:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.19 | 0.24 |
| | 5:45:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.17 | 0.21 |
| | 5:50:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.15 | 0.19 |
| | 5:55:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.13 | 0.17 |
| | 6:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.12 | 0.15 |



# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

| Stage - Storage Description | Stage [ft] | Area [ft²] | Area [acres] | Volume [ft³] | Volume [ac-ft] | Total Outflow [cfs] |
|---|---|---|---|---|---|---|
| 4972.06 | 0.00 | 0 | 0.000 | 0 | 0.000 | 0.00 |
| 4973 | 0.94 | 57895 | 1.329 | 27,209 | 0.625 | 19.10 |
| 4974 | 1.94 | 86801 | 1.993 | 99,557 | 2.286 | 70.88 |
| 4975 | 2.94 | 122092 | 2.803 | 204,003 | 4.683 | 150.42 |
| 4976 | 3.94 | 252453 | 5.796 | 391,276 | 8.982 | 255.52 |
| 4977 | 4.94 | 359672 | 8.257 | 697,338 | 16.009 | 355.37 |
| 4978 - Last EX Closed Contour | 5.94 | 472731 | 10.852 | 1,113,539 | 25.563 | 416.22 |
| 4979 | 6.94 | 582281 | 13.367 | 1,641,045 | 37.673 | 469.24 |
| 4980 | 7.94 | 688352 | 15.802 | 2,276,361 | 52.258 | 516.85 |
| 4980.5 - Spillway Crest | 8.44 | 742546 | 17.047 | 2,634,086 | 60.470 | 539.08 |
| 4981 | 8.94 | 796741 | 18.291 | 3,018,907 | 69.305 | 814.99 |
| 4982 | 9.94 | 905757 | 20.793 | 3,870,156 | 88.847 | 2,364.49 |

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

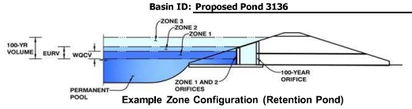
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.06 (July 2022)*

**Project:** Sheep Draw MP

**Basin ID:** Proposed Pond 3136




**Example Zone Configuration (Retention Pond)**

Watershed Information

**Flood Control Only**

| | | |
|---|---|---|
| Selected BMP Type = | **No BMP** | |
| Watershed Area = | 67.05 | acres |
| Watershed Length = | 2,987 | ft |
| Watershed Length to Centroid = | 1,045 | ft |
| Watershed Slope = | 0.009 | ft/ft |
| Watershed Imperviousness = | 8.71% | percent |
| Percentage Hydrologic Soil Group A = | 60.0% | percent |
| Percentage Hydrologic Soil Group B = | 30.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 10.0% | percent |
| Target WQCV Drain Time = | N/A | hours |
| Location for 1-hr Rainfall Depths = | Brighton - City Hall | |

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) = | 0.333 acre-feet | | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 0.459 acre-feet | | acre-feet |
| 2-yr Runoff Volume (P1 = 0.85 in.) = | 0.114 acre-feet | 0.85 | inches |
| 5-yr Runoff Volume (P1 = 1.12 in.) = | 0.253 acre-feet | 1.12 | inches |
| 10-yr Runoff Volume (P1 = 1.4 in.) = | 0.433 acre-feet | 1.40 | inches |
| 25-yr Runoff Volume (P1 = 1.87 in.) = | 2.484 acre-feet | 1.87 | inches |
| 50-yr Runoff Volume (P1 = 2.29 in.) = | 4.297 acre-feet | 2.29 | inches |
| 100-yr Runoff Volume (P1 = 2.76 in.) = | 7.264 acre-feet | 2.76 | inches |
| 500-yr Runoff Volume (P1 = 4.1 in.) = | 14.437 acre-feet | 4.10 | inches |
| Approximate 2-yr Detention Volume = | 0.206 acre-feet | | |
| Approximate 5-yr Detention Volume = | 0.346 acre-feet | | |
| Approximate 10-yr Detention Volume = | 0.609 acre-feet | | |
| Approximate 25-yr Detention Volume = | 0.972 acre-feet | | |
| Approximate 50-yr Detention Volume = | 1.231 acre-feet | | |
| Approximate 100-yr Detention Volume = | 1.967 acre-feet | | |

Define Zones and Basin Geometry

| | |
|---|---|
| Zone 1 Volume (100-year) = | 1.967 acre-feet |
| Select Zone 2 Storage Volume (Optional) = | acre-feet |
| Select Zone 3 Storage Volume (Optional) = | acre-feet |
| Total Detention Basin Volume = | 1.967 acre-feet |
| Initial Surcharge Volume (ISV) = | N/A $ft^3$ |
| Initial Surcharge Depth (ISD) = | N/A ft |
| Total Available Detention Depth ($H_{total}$) = | user ft |
| Depth of Trickle Channel ($H_{TC}$) = | user ft |
| Slope of Trickle Channel ($S_{TC}$) = | user ft/ft |
| Slopes of Main Basin Sides ($S_{main}$) = | user H:V |
| Basin Length-to-Width Ratio ($R_{L/W}$) = | user |
| Initial Surcharge Area ($A_{ISV}$) = | user $ft^2$ |
| Surcharge Volume Length ($L_{ISV}$) = | user ft |
| Surcharge Volume Width ($W_{ISV}$) = | user ft |
| Depth of Basin Floor ($H_{FLOOR}$) = | user ft |
| Length of Basin Floor ($L_{FLOOR}$) = | user ft |
| Width of Basin Floor ($W_{FLOOR}$) = | user ft |
| Area of Basin Floor ($A_{FLOOR}$) = | user $ft^2$ |
| Volume of Basin Floor ($V_{FLOOR}$) = | user $ft^3$ |
| Depth of Main Basin ($H_{MAIN}$) = | user ft |
| Length of Main Basin ($L_{MAIN}$) = | user ft |
| Width of Main Basin ($W_{MAIN}$) = | user ft |
| Area of Main Basin ($A_{MAIN}$) = | user $ft^2$ |
| Volume of Main Basin ($V_{MAIN}$) = | user $ft^3$ |
| Calculated Total Basin Volume ($V_{total}$) = | **user** acre-feet |

Depth Increment = ft

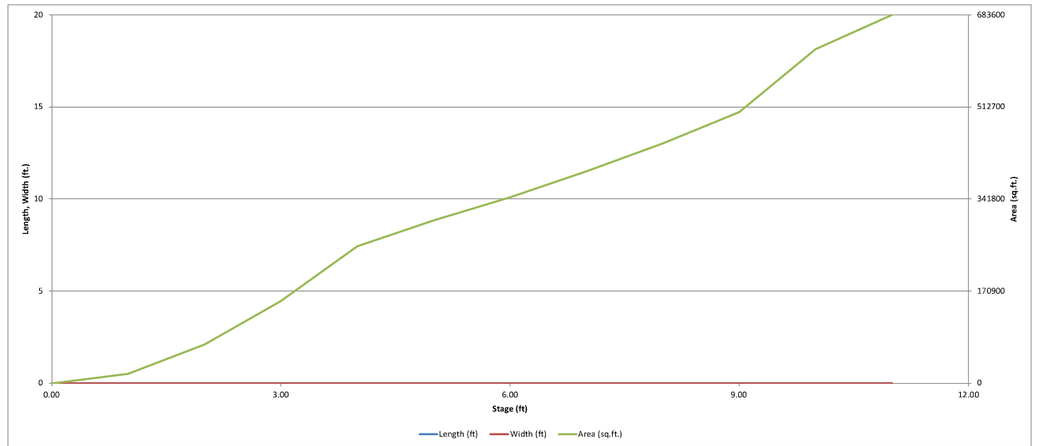
| Stage - Storage Description | Stage (ft) | Optional Override Stage (ft) | Length (ft) | Width (ft) | Area ($ft^2$) | Optional Override Area ($ft^2$) | Area (acre) | Volume ($ft^3$) | Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| **Media Surface** | 0.00 | | -- | -- | -- | 0 | 0.000 | | |
| **4892** | 1.00 | | -- | -- | -- | 17,759 | 0.408 | 8,879 | 0.204 |
| **4893 - Estimated** | 2.00 | | -- | -- | -- | 71,689 | 1.646 | 53,602 | 1.231 |
| **4894** | 3.00 | | -- | -- | -- | 152,398 | 3.499 | 165,646 | 3.803 |
| **4895** | 4.00 | | -- | -- | -- | 253,747 | 5.825 | 368,718 | 8.465 |
| **4896 - Last Closed** | 5.00 | | -- | -- | -- | 302,043 | 6.934 | 646,613 | 14.844 |
| **4897** | 6.00 | | -- | -- | -- | 344,473 | 7.908 | 969,871 | 22.265 |
| **4898** | 7.00 | | -- | -- | -- | 393,471 | 9.033 | 1,338,843 | 30.736 |
| **4899** | 8.00 | | -- | -- | -- | 444,982 | 10.215 | 1,758,070 | 40.360 |
| **4900** | 9.00 | | -- | -- | -- | 502,811 | 11.543 | 2,231,966 | 51.239 |
| **4901** | 10.00 | | -- | -- | -- | 619,689 | 14.226 | 2,793,216 | 64.123 |
| **4902** | 11.00 | | -- | -- | -- | 683,532 | 15.692 | 3,444,827 | 79.082 |

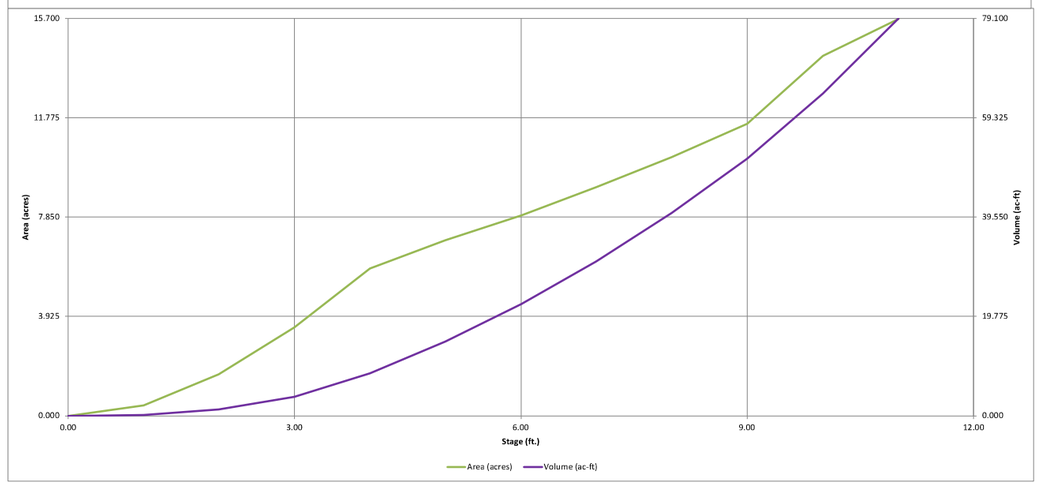
4982



DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.06 (July 2022)*



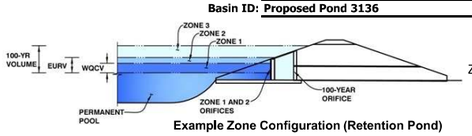

MHFD-Detention_POND3136_v4-06.xlsm, Basin 1/2/2026, 4:39 PM

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*

**Project:** **Sheep Draw MP**

**Basin ID:** **Proposed Pond 3136**




**Example Zone Configuration (Retention Pond)**

| | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (100-year) | 2.38 | 1.967 | Rectangular Orifice |
| Zone 2 | | | |
| Zone 3 | | | |
| Total (all zones) | | 1.967 | |

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

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

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

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

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

| | Row 1 (optional) | Row 2 (optional) | Row 3 (optional) | Row 4 (optional) | Row 5 (optional) | Row 6 (optional) | Row 7 (optional) | Row 8 (optional) |
|---|---|---|---|---|---|---|---|---|
| Stage of Orifice Centroid (ft) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Orifice Area (sq. inches) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

| | 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) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Orifice Area (sq. inches) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

User Input: Vertical Orifice (Circular or Rectangular)

| | Zone 1 Rectangular | Not Selected | | Calculated Parameters for Vertical Orifice | Zone 1 Rectangular | Not Selected | |
|---|---|---|---|---|---|---|---|
| Invert of Vertical Orifice = | 0.00 | | ft (relative to basin bottom at Stage = 0 ft) | Vertical Orifice Area = | 240.00 | | $ft^2$ |
| Depth at top of Zone using Vertical Orifice = | 11.00 | | ft (relative to basin bottom at Stage = 0 ft) | Vertical Orifice Centroid = | 4.00 | | feet |
| Vertical Orifice Height = | 96.00 | | inches | | | | |
| Vertical Orifice Width = | 360.00 | | inches | | | | |

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

| | Not Selected | Not Selected | | Calculated Parameters for Overflow Weir | Not Selected | Not Selected | |
|---|---|---|---|---|---|---|---|
| Overflow Weir Front Edge Height, Ho = | | | ft (relative to basin bottom at Stage = 0 ft) | Height of Grate Upper Edge, $H_t$ = | N/A | | feet |
| Overflow Weir Front Edge Length = | | | feet | Overflow Weir Slope Length = | N/A | | feet |
| Overflow Weir Grate Slope = | | | H:V | Grate Open Area / 100-yr Orifice Area = | N/A | | |
| Horiz. Length of Weir Sides = | N/A | | feet | Overflow Grate Open Area w/o Debris = | N/A | | $ft^2$ |
| Overflow Grate Type = | N/A | | | Overflow Grate Open Area w/ Debris = | N/A | | $ft^2$ |
| Debris Clogging % = | N/A | | % | | | | |

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

| | Not Selected | Not Selected | | Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate | Not Selected | Not Selected | |
|---|---|---|---|---|---|---|---|
| Depth to Invert of Outlet Pipe = | N/A | | ft (distance below basin bottom at Stage = 0 ft) | Outlet Orifice Area = | N/A | | $ft^2$ |
| Circular Orifice Diameter = | N/A | | inches | 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= | 9.00 | ft (relative to basin bottom at Stage = 0 ft) | Spillway Design Flow Depth= | 1.96 feet |
| Spillway Crest Length = | 200.00 | feet | Stage at Top of Freeboard = | 10.96 feet |
| Spillway End Slopes = | 100.00 | H:V | Basin Area at Top of Freeboard = | 15.63 acres |
| Freeboard above Max Water Surface = | 0.00 | feet | Basin Volume at Top of Freeboard = | 78.46 acre-ft |

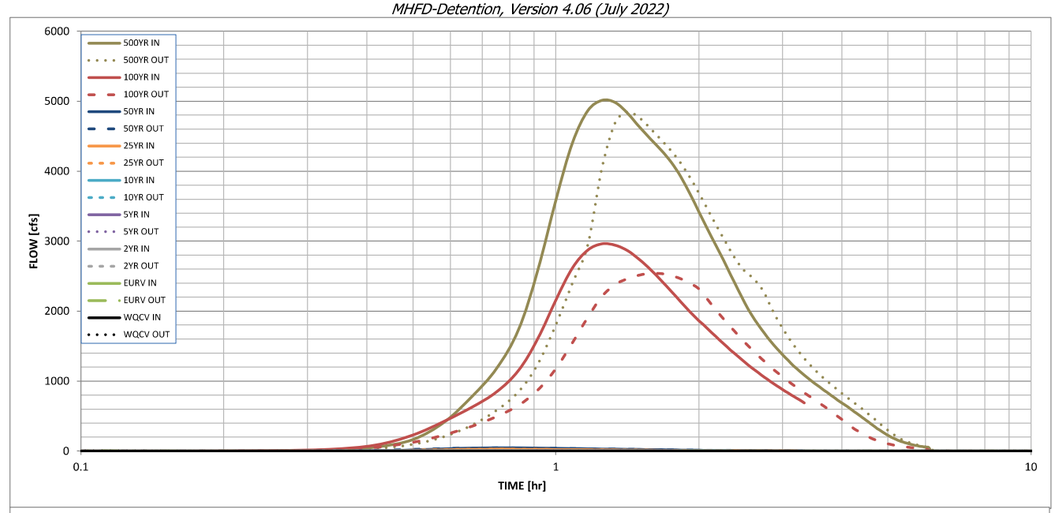
Routed Hydrograph Results — *The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

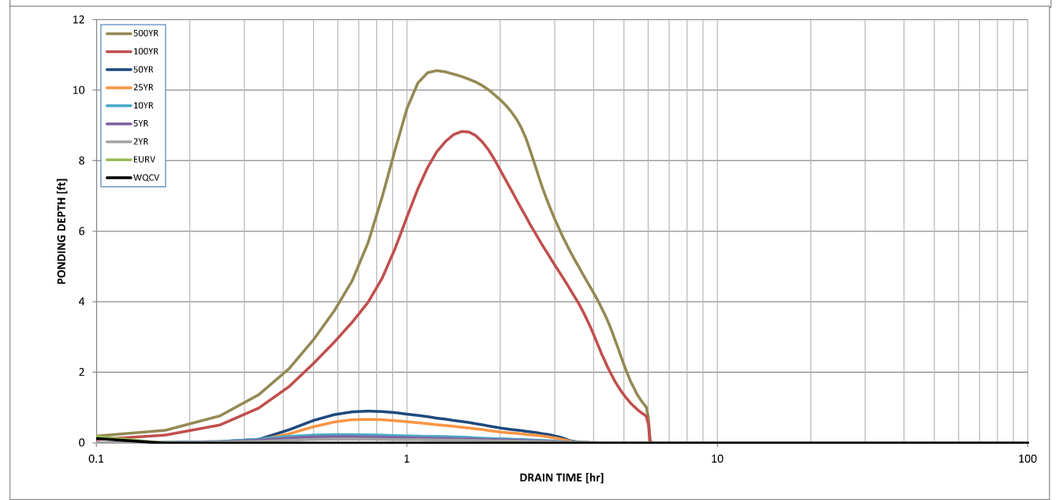
| Design Storm Return Period = | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|---|---|---|---|---|---|---|---|---|
| One-Hour Rainfall Depth (in) = | N/A | N/A | 0.85 | 1.12 | 1.40 | 1.87 | 2.29 | 2.76 | 4.10 |
| CUHP Runoff Volume (acre-ft) = | 0.333 | 0.459 | 0.114 | 0.253 | 0.433 | 2.484 | 4.297 | 7.264 | 14.437 |
| User Override Inflow Hydrograph Volume (acre-ft) = | N/A | N/A | 0.114 | 0.253 | 0.433 | 2.484 | 4.297 | 429.627 | 736.071 |
| CUHP Predevelopment Peak Q (cfs) = | N/A | N/A | 0.2 | 0.5 | 0.9 | 22.1 | 40.6 | 66.5 | 129.4 |
| 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 | 0.01 | 0.33 | 0.61 | 0.99 | 1.93 |
| Peak Inflow Q (cfs) = | N/A | N/A | 1.0 | 2.5 | 4.1 | 26.3 | 44.8 | 2961.6 | 5014.6 |
| Peak Outflow Q (cfs) = | 46.3 | 62.4 | 1.0 | 2.5 | 4.1 | 26.1 | 44.6 | 2540.2 | 4846.2 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 4.6 | 4.4 | 1.2 | 1.1 | 38.2 | 37.5 |
| Structure Controlling Flow = | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 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) = | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 3 | 3 |
| Time to Drain 99% of Inflow Volume (hours) = | 0 | 0 | 2 | 2 | 2 | 2 | 2 | 4 | 4 |
| Maximum Ponding Depth (ft) = | 1.24 | 1.40 | 0.11 | 0.18 | 0.24 | 0.67 | 0.90 | 8.83 | 10.56 |
| Area at Maximum Ponding Depth (acres) = | 0.70 | 0.90 | 0.04 | 0.07 | 0.10 | 0.27 | 0.37 | 11.32 | 15.03 |
| Maximum Volume Stored (acre-ft) = | 0.337 | 0.466 | 0.002 | 0.007 | 0.012 | 0.091 | 0.165 | 49.296 | 72.169 |

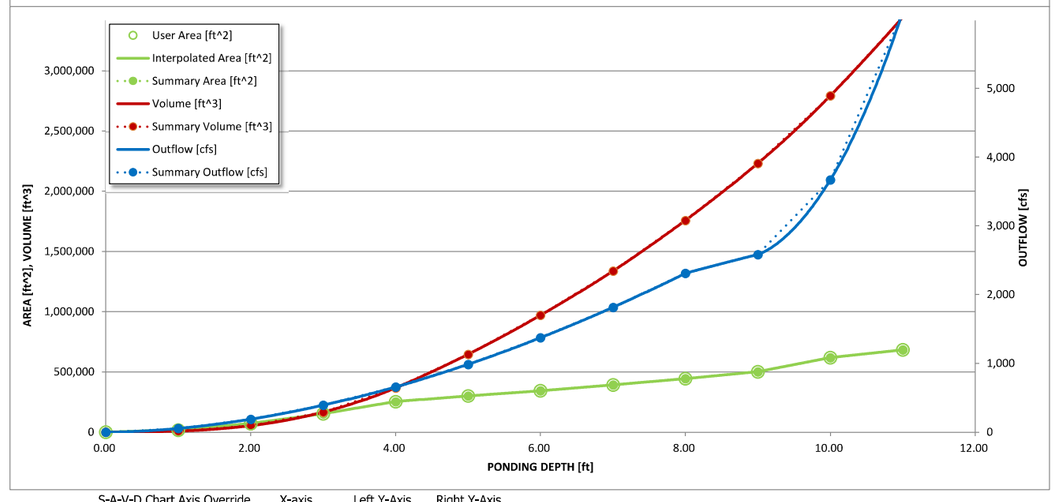


# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*




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

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*Outflow Hydrograph Workbook Filename:*

Inflow Hydrographs

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

| | SOURCE | CUHP | CUHP | CUHP | CUHP | CUHP | CUHP | CUHP | USER | USER |
|---|---|---|---|---|---|---|---|---|---|---|
| Time Interval | TIME | WQCV [cfs] | EURV [cfs] | 2 Year [cfs] | 5 Year [cfs] | 10 Year [cfs] | 25 Year [cfs] | 50 Year [cfs] | 100 Year [cfs] | 500 Year [cfs] |
| 5.00 min | 0:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0:05:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0:10:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.44 | 2.75 |
| | 0:15:00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.05 | 0.05 | 0.07 | 6.16 | 14.02 |
| | 0:20:00 | 0.00 | 0.00 | 0.09 | 0.15 | 0.20 | 0.16 | 0.22 | 26.10 | 55.40 |
| | 0:25:00 | 0.00 | 0.00 | 0.26 | 0.91 | 1.63 | 0.82 | 1.50 | 84.74 | 164.76 |
| | 0:30:00 | 0.00 | 0.00 | 0.70 | 1.97 | 3.32 | 8.27 | 16.02 | 229.92 | 420.26 |
| | 0:35:00 | 0.00 | 0.00 | 0.99 | 2.48 | 4.03 | 18.38 | 32.89 | 431.66 | 788.14 |
| | 0:40:00 | 0.00 | 0.00 | 1.03 | 2.53 | 4.14 | 24.52 | 41.78 | 633.65 | 1183.73 |
| | 0:45:00 | 0.00 | 0.00 | 1.01 | 2.42 | 4.01 | 26.33 | 44.78 | 848.73 | 1732.26 |
| | 0:50:00 | 0.00 | 0.00 | 0.95 | 2.23 | 3.71 | 26.06 | 44.77 | 1152.14 | 2587.24 |
| | 0:55:00 | 0.00 | 0.00 | 0.88 | 2.04 | 3.42 | 24.46 | 42.14 | 1607.29 | 3591.92 |
| | 1:00:00 | 0.00 | 0.00 | 0.82 | 1.89 | 3.20 | 22.44 | 38.81 | 2163.47 | 4405.18 |
| | 1:05:00 | 0.00 | 0.00 | 0.78 | 1.75 | 3.00 | 20.65 | 35.72 | 2616.34 | 4863.06 |
| | 1:10:00 | 0.00 | 0.00 | 0.73 | 1.62 | 2.81 | 18.92 | 32.69 | 2872.84 | 5014.63 |
| | 1:15:00 | 0.00 | 0.00 | 0.68 | 1.50 | 2.68 | 17.17 | 29.66 | 2961.56 | 4983.44 |
| | 1:20:00 | 0.00 | 0.00 | 0.64 | 1.41 | 2.54 | 15.68 | 27.16 | 2943.11 | 4822.02 |
| | 1:25:00 | 0.00 | 0.00 | 0.61 | 1.32 | 2.37 | 14.39 | 24.96 | 2860.48 | 4630.67 |
| | 1:30:00 | 0.00 | 0.00 | 0.57 | 1.23 | 2.20 | 13.22 | 22.92 | 2737.59 | 4458.47 |
| | 1:35:00 | 0.00 | 0.00 | 0.54 | 1.15 | 2.02 | 12.10 | 20.93 | 2593.62 | 4299.96 |
| | 1:40:00 | 0.00 | 0.00 | 0.50 | 1.05 | 1.84 | 11.00 | 19.01 | 2437.88 | 4124.51 |
| | 1:45:00 | 0.00 | 0.00 | 0.47 | 0.96 | 1.67 | 9.92 | 17.12 | 2282.75 | 3916.67 |
| | 1:50:00 | 0.00 | 0.00 | 0.44 | 0.86 | 1.50 | 8.85 | 15.24 | 2132.36 | 3676.75 |
| | 1:55:00 | 0.00 | 0.00 | 0.40 | 0.78 | 1.36 | 7.79 | 13.40 | 1991.79 | 3418.73 |
| | 2:00:00 | 0.00 | 0.00 | 0.37 | 0.73 | 1.27 | 6.91 | 11.91 | 1865.15 | 3170.58 |
| | 2:05:00 | 0.00 | 0.00 | 0.35 | 0.68 | 1.18 | 6.26 | 10.82 | 1749.81 | 2950.05 |
| | 2:10:00 | 0.00 | 0.00 | 0.32 | 0.63 | 1.09 | 5.76 | 9.94 | 1639.70 | 2730.89 |
| | 2:15:00 | 0.00 | 0.00 | 0.30 | 0.58 | 1.00 | 5.33 | 9.16 | 1536.62 | 2515.95 |
| | 2:20:00 | 0.00 | 0.00 | 0.27 | 0.53 | 0.91 | 4.91 | 8.45 | 1441.16 | 2309.37 |
| | 2:25:00 | 0.00 | 0.00 | 0.25 | 0.48 | 0.83 | 4.52 | 7.77 | 1352.93 | 2115.17 |
| | 2:30:00 | 0.00 | 0.00 | 0.22 | 0.44 | 0.75 | 4.13 | 7.10 | 1269.60 | 1947.66 |
| | 2:35:00 | 0.00 | 0.00 | 0.20 | 0.39 | 0.67 | 3.75 | 6.45 | 1192.69 | 1805.17 |
| | 2:40:00 | 0.00 | 0.00 | 0.18 | 0.35 | 0.60 | 3.38 | 5.80 | 1121.81 | 1679.78 |
| | 2:45:00 | 0.00 | 0.00 | 0.16 | 0.31 | 0.53 | 3.01 | 5.16 | 1056.03 | 1568.28 |
| | 2:50:00 | 0.00 | 0.00 | 0.14 | 0.27 | 0.46 | 2.64 | 4.52 | 993.89 | 1468.38 |
| | 2:55:00 | 0.00 | 0.00 | 0.12 | 0.23 | 0.39 | 2.27 | 3.89 | 935.39 | 1377.39 |
| | 3:00:00 | 0.00 | 0.00 | 0.10 | 0.19 | 0.33 | 1.90 | 3.25 | 880.31 | 1294.11 |
| | 3:05:00 | 0.00 | 0.00 | 0.08 | 0.15 | 0.26 | 1.54 | 2.62 | 829.40 | 1217.98 |
| | 3:10:00 | 0.00 | 0.00 | 0.07 | 0.11 | 0.20 | 1.17 | 1.99 | 782.58 | 1148.58 |
| | 3:15:00 | 0.00 | 0.00 | 0.05 | 0.08 | 0.13 | 0.81 | 1.36 | 736.66 | 1085.60 |
| | 3:20:00 | 0.00 | 0.00 | 0.04 | 0.05 | 0.10 | 0.46 | 0.75 | 690.75 | 1027.13 |
| | 3:25:00 | 0.00 | 0.00 | 0.03 | 0.04 | 0.08 | 0.24 | 0.42 | 645.36 | 972.46 |
| | 3:30:00 | 0.00 | 0.00 | 0.03 | 0.04 | 0.07 | 0.14 | 0.25 | 600.24 | 920.46 |
| | 3:35:00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.06 | 0.09 | 0.16 | 556.32 | 870.73 |
| | 3:40:00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.05 | 0.06 | 0.10 | 513.02 | 822.95 |
| | 3:45:00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.04 | 0.05 | 0.07 | 467.88 | 776.47 |
| | 3:50:00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.03 | 0.03 | 0.05 | 422.80 | 731.41 |
| | 3:55:00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.02 | 0.02 | 0.04 | 380.90 | 688.44 |
| | 4:00:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 342.12 | 648.44 |
| | 4:05:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 304.81 | 607.94 |
| | 4:10:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 271.11 | 565.75 |
| | 4:15:00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 242.09 | 524.49 |
| | 4:20:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 216.50 | 483.22 |
| | 4:25:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 193.81 | 443.38 |
| | 4:30:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 174.55 | 403.19 |
| | 4:35:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 157.04 | 363.34 |
| | 4:40:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 141.05 | 324.55 |
| | 4:45:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 126.64 | 288.72 |
| | 4:50:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 113.72 | 254.80 |
| | 4:55:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 101.91 | 224.47 |
| | 5:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 91.72 | 197.76 |
| | 5:05:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 82.84 | 174.75 |
| | 5:10:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 75.00 | 154.39 |
| | 5:15:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 68.12 | 137.49 |
| | 5:20:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 61.86 | 122.66 |
| | 5:25:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 56.54 | 109.11 |
| | 5:30:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 52.02 | 96.71 |
| | 5:35:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 47.85 | 86.17 |
| | 5:40:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 43.83 | 77.05 |
| | 5:45:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 40.13 | 69.17 |
| | 5:50:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 36.67 | 62.30 |
| | 5:55:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 33.58 | 56.59 |
| | 6:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 30.75 | 51.45 |



# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

| Stage - Storage Description | Stage [ft] | Area [ft²] | Area [acres] | Volume [ft³] | Volume [ac-ft] | Total Outflow [cfs] |
|---|---|---|---|---|---|---|
| 4891 - Lower than EX | 0.00 | 0 | 0.000 | 0 | 0.000 | 0 |
| 4892 | 1.00 | 17759 | 0.408 | 8,879 | 0.204 | 54 |
| 4893 | 2.00 | 71689 | 1.646 | 53,602 | 1.231 | 188 |
| 4894 | 3.00 | 152398 | 3.499 | 165,646 | 3.803 | 392 |
| 4895 | 4.00 | 253747 | 5.825 | 368,718 | 8.465 | 659 |
| 4896 - Last EX closed contour | 5.00 | 302043 | 6.934 | 646,613 | 14.844 | 987 |
| 4897 | 6.00 | 344473 | 7.908 | 969,871 | 22.265 | 1373 |
| 4898 | 7.00 | 393471 | 9.033 | 1,338,843 | 30.736 | 1815 |
| 4899 | 8.00 | 444982 | 10.215 | 1,758,070 | 40.360 | 2311 |
| 4900 - SW Crest | 9.00 | 502811 | 11.543 | 2,231,966 | 51.239 | 2584 |
| 4901 | 10.00 | 619689 | 14.226 | 2,793,216 | 64.123 | 3671 |
| 4902 | 11.00 | 683532 | 15.692 | 3,444,827 | 79.082 | 6112 |

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

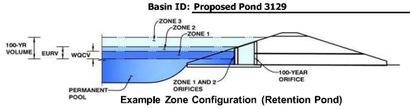
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.06 (July 2022)*

**Project:** Sheep Draw MP

**Basin ID:** Proposed Pond 3129




**Example Zone Configuration (Retention Pond)**

Depth Increment = ft

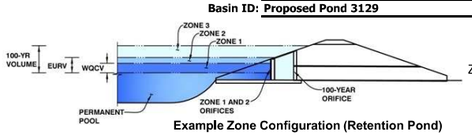
| Stage - Storage Description | Stage (ft) | Optional Override Stage (ft) | Length (ft) | Width (ft) | Area ($ft^2$) | Optional Override Area ($ft^2$) | Area (acre) | Volume ($ft^3$) | Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| **Media Surface** | -- | 0.00 | -- | -- | -- | 0 | 0.000 | | |
| **4894** | -- | 1.05 | -- | -- | -- | 152,377 | 3.498 | 79,993 | 1.836 |
| **4895** | -- | 2.05 | -- | -- | -- | 168,537 | 3.869 | 240,450 | 5.520 |
| **4896** | -- | 3.05 | -- | -- | -- | 179,490 | 4.121 | 414,463 | 9.515 |
| **4897** | -- | 4.05 | -- | -- | -- | 187,738 | 4.310 | 598,077 | 13.730 |
| **4898** | -- | 5.05 | -- | -- | -- | 194,228 | 4.459 | 789,060 | 18.114 |
| **4899** | -- | 6.05 | -- | -- | -- | 203,482 | 4.671 | 987,915 | 22.679 |
| **4900** | -- | 7.05 | -- | -- | -- | 209,840 | 4.817 | 1,194,576 | 27.424 |
| **4901** | -- | 8.05 | -- | -- | -- | 216,879 | 4.979 | 1,407,936 | 32.322 |
| | -- | | -- | -- | -- | | | | |
| | -- | | -- | -- | -- | | | | |
| | -- | | -- | -- | -- | | | |

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*

**Project:** Sheep Draw MP

**Basin ID:** Proposed Pond 3129




**Example Zone Configuration (Retention Pond)**

| | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (100-year) | 1.02 | 1.704 | Circular Orifice |
| Zone 2 | | | |
| Zone 3 | | | |
| Total (all zones) | | 1.704 | |

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

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

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

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

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

| | Row 1 (optional) | Row 2 (optional) | Row 3 (optional) | Row 4 (optional) | Row 5 (optional) | Row 6 (optional) | Row 7 (optional) | Row 8 (optional) |
|---|---|---|---|---|---|---|---|---|
| Stage of Orifice Centroid (ft) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Orifice Area (sq. inches) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

| | 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) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Orifice Area (sq. inches) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

User Input: Vertical Orifice (Circular or Rectangular)

| | Zone 1 Circular | Not Selected | | Calculated Parameters for Vertical Orifice | Zone 1 Circular | Not Selected | |
|---|---|---|---|---|---|---|---|
| Invert of Vertical Orifice = | 0.00 | | ft (relative to basin bottom at Stage = 0 ft) | Vertical Orifice Area = | 12.57 | | $ft^2$ |
| Depth at top of Zone using Vertical Orifice = | 8.05 | | ft (relative to basin bottom at Stage = 0 ft) | Vertical Orifice Centroid = | 2.00 | | feet |
| Vertical Orifice Diameter = | 48.00 | | inches | | | | |

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

| | Not Selected | Not Selected | | Calculated Parameters for Overflow Weir | Not Selected | Not Selected | |
|---|---|---|---|---|---|---|---|
| Overflow Weir Front Edge Height, Ho = | | | ft (relative to basin bottom at Stage = 0 ft) | Height of Grate Upper Edge, $H_t$ = | N/A | | feet |
| Overflow Weir Front Edge Length = | | | feet | Overflow Weir Slope Length = | N/A | | feet |
| Overflow Weir Grate Slope = | | | H:V | Grate Open Area / 100-yr Orifice Area = | N/A | | |
| Horiz. Length of Weir Sides = | N/A | | feet | Overflow Grate Open Area w/o Debris = | N/A | | $ft^2$ |
| Overflow Grate Type = | N/A | | | Overflow Grate Open Area w/ Debris = | N/A | | $ft^2$ |
| Debris Clogging % = | N/A | | % | | | | |

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

| | Not Selected | Not Selected | | Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate | Not Selected | Not Selected | |
|---|---|---|---|---|---|---|---|
| Depth to Invert of Outlet Pipe = | N/A | | ft (distance below basin bottom at Stage = 0 ft) | Outlet Orifice Area = | N/A | | $ft^2$ |
| Circular Orifice Diameter = | N/A | | inches | 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= | 7.05 | ft (relative to basin bottom at Stage = 0 ft) | Spillway Design Flow Depth= | 0.76 | feet |
| Spillway Crest Length = | 100.00 | feet | Stage at Top of Freeboard = | 7.81 | feet |
| Spillway End Slopes = | 50.00 | H:V | Basin Area at Top of Freeboard = | 4.94 | acres |
| Freeboard above Max Water Surface = | 0.00 | feet | Basin Volume at Top of Freeboard = | 31.13 | acre-ft |

Routed Hydrograph Results

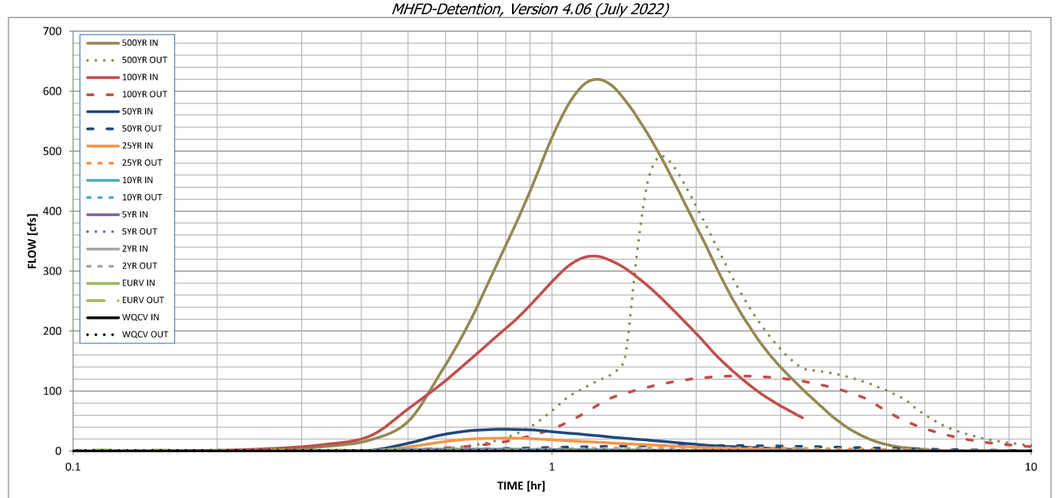
*The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

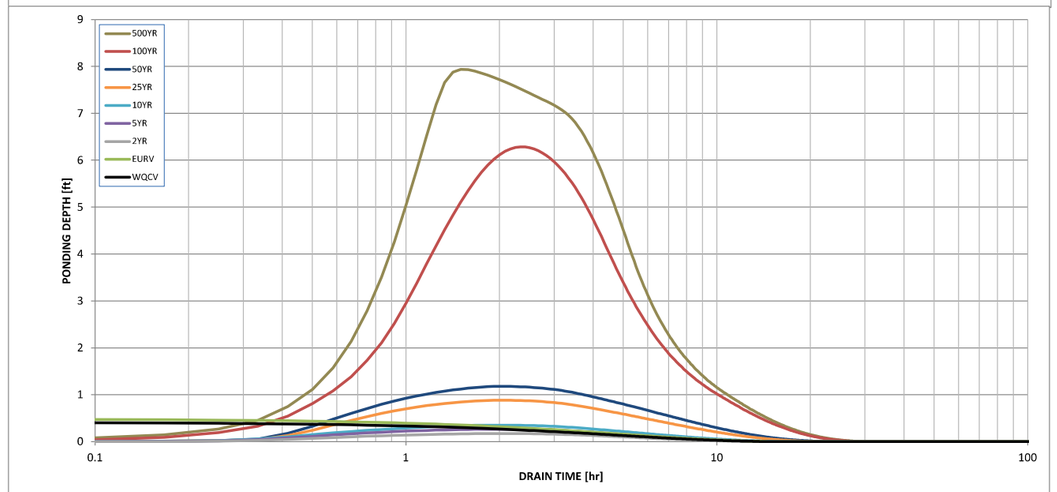
| Design Storm Return Period = | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|---|---|---|---|---|---|---|---|---|
| One-Hour Rainfall Depth (in) = | N/A | N/A | 0.85 | 1.12 | 1.40 | 1.87 | 2.29 | 2.76 | 4.10 |
| CUHP Runoff Volume (acre-ft) = | 0.288 | 0.397 | 0.098 | 0.219 | 0.375 | 2.152 | 3.723 | 6.295 | 12.512 |
| User Override Inflow Hydrograph Volume (acre-ft) = | N/A | N/A | 0.098 | 0.219 | 0.375 | 2.152 | 3.723 | 46.787 | 85.639 |
| CUHP Predevelopment Peak Q (cfs) = | N/A | N/A | 0.2 | 0.4 | 0.7 | 17.9 | 33.1 | 54.2 | 105.7 |
| 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 | 0.01 | 0.31 | 0.57 | 0.93 | 1.82 |
| Peak Inflow Q (cfs) = | N/A | N/A | 0.8 | 2.0 | 3.4 | 21.3 | 36.6 | 324.6 | 620.2 |
| Peak Outflow Q (cfs) = | 1.4 | 1.9 | 0.3 | 0.6 | 1.1 | 5.6 | 9.4 | 125.3 | 490.2 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 1.4 | 1.4 | 0.3 | 0.3 | 2.3 | 4.6 |
| Structure Controlling Flow = | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 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) = | 7 | 8 | 8 | 9 | 9 | 10 | 11 | 11 | 10 |
| Time to Drain 99% of Inflow Volume (hours) = | 9 | 9 | 10 | 10 | 11 | 12 | 13 | 14 | 13 |
| Maximum Ponding Depth (ft) = | 0.42 | 0.49 | 0.17 | 0.27 | 0.35 | 0.88 | 1.18 | 6.29 | 7.94 |
| Area at Maximum Ponding Depth (acres) = | 1.40 | 1.63 | 0.57 | 0.87 | 1.17 | 2.93 | 3.54 | 4.70 | 4.96 |
| Maximum Volume Stored (acre-ft) = | 0.294 | 0.400 | 0.048 | 0.113 | 0.204 | 1.290 | 2.259 | 23.758 | 31.775 |

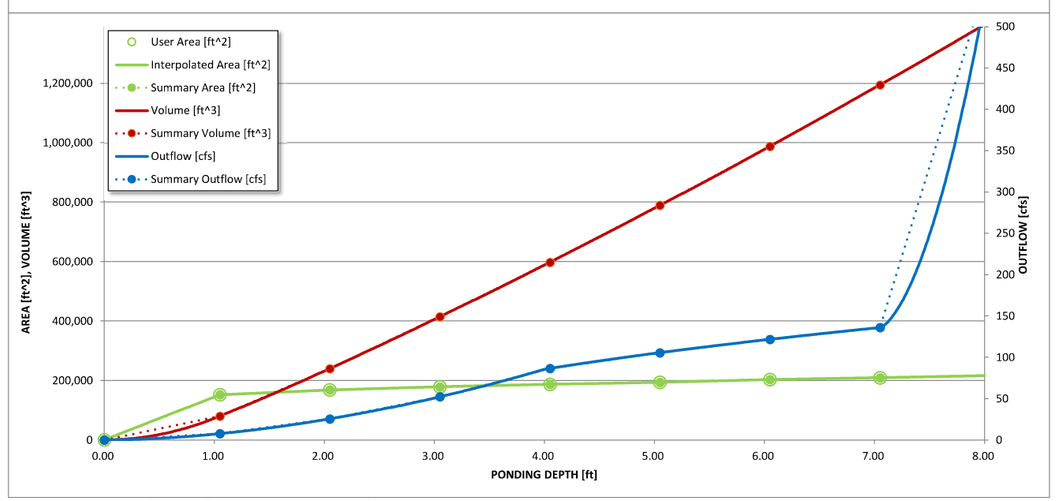


DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*




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

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*Outflow Hydrograph Workbook Filename:*

Inflow Hydrographs

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

| | SOURCE | CUHP | CUHP | CUHP | CUHP | CUHP | CUHP | CUHP | USER | USER |
|---|---|---|---|---|---|---|---|---|---|---|
| Time Interval | TIME | WQCV [cfs] | EURV [cfs] | 2 Year [cfs] | 5 Year [cfs] | 10 Year [cfs] | 25 Year [cfs] | 50 Year [cfs] | 100 Year [cfs] | 500 Year [cfs] |
| 5.00 min | 0:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0:05:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0:10:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 | 1.72 |
| | 0:15:00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.04 | 0.04 | 0.06 | 3.74 | 7.32 |
| | 0:20:00 | 0.00 | 0.00 | 0.07 | 0.12 | 0.16 | 0.13 | 0.18 | 10.65 | 18.20 |
| | 0:25:00 | 0.00 | 0.00 | 0.21 | 0.73 | 1.31 | 0.65 | 1.20 | 24.96 | 49.43 |
| | 0:30:00 | 0.00 | 0.00 | 0.56 | 1.58 | 2.67 | 6.61 | 12.80 | 70.56 | 128.44 |
| | 0:35:00 | 0.00 | 0.00 | 0.80 | 2.00 | 3.24 | 14.74 | 26.39 | 110.02 | 208.78 |
| | 0:40:00 | 0.00 | 0.00 | 0.83 | 2.05 | 3.35 | 19.73 | 33.64 | 148.93 | 295.42 |
| | 0:45:00 | 0.00 | 0.00 | 0.82 | 1.98 | 3.29 | 21.31 | 36.26 | 185.12 | 373.26 |
| | 0:50:00 | 0.00 | 0.00 | 0.79 | 1.86 | 3.09 | 21.30 | 36.62 | 217.17 | 448.83 |
| | 0:55:00 | 0.00 | 0.00 | 0.74 | 1.71 | 2.86 | 20.29 | 35.01 | 250.05 | 522.75 |
| | 1:00:00 | 0.00 | 0.00 | 0.69 | 1.59 | 2.68 | 18.72 | 32.32 | 282.54 | 578.76 |
| | 1:05:00 | 0.00 | 0.00 | 0.65 | 1.48 | 2.53 | 17.30 | 29.93 | 308.96 | 611.72 |
| | 1:10:00 | 0.00 | 0.00 | 0.62 | 1.38 | 2.40 | 15.98 | 27.63 | 322.91 | 620.19 |
| | 1:15:00 | 0.00 | 0.00 | 0.58 | 1.28 | 2.27 | 14.66 | 25.35 | 324.62 | 609.51 |
| | 1:20:00 | 0.00 | 0.00 | 0.54 | 1.20 | 2.16 | 13.37 | 23.14 | 316.85 | 586.21 |
| | 1:25:00 | 0.00 | 0.00 | 0.52 | 1.13 | 2.03 | 12.30 | 21.34 | 305.15 | 558.71 |
| | 1:30:00 | 0.00 | 0.00 | 0.49 | 1.07 | 1.90 | 11.37 | 19.73 | 291.22 | 529.16 |
| | 1:35:00 | 0.00 | 0.00 | 0.47 | 1.00 | 1.77 | 10.52 | 18.21 | 276.09 | 498.48 |
| | 1:40:00 | 0.00 | 0.00 | 0.44 | 0.93 | 1.63 | 9.69 | 16.75 | 260.06 | 466.94 |
| | 1:45:00 | 0.00 | 0.00 | 0.42 | 0.86 | 1.50 | 8.88 | 15.33 | 243.71 | 435.55 |
| | 1:50:00 | 0.00 | 0.00 | 0.39 | 0.79 | 1.38 | 8.07 | 13.92 | 227.37 | 404.86 |
| | 1:55:00 | 0.00 | 0.00 | 0.36 | 0.72 | 1.25 | 7.27 | 12.52 | 211.43 | 375.14 |
| | 2:00:00 | 0.00 | 0.00 | 0.33 | 0.65 | 1.13 | 6.48 | 11.14 | 196.10 | 346.78 |
| | 2:05:00 | 0.00 | 0.00 | 0.31 | 0.60 | 1.04 | 5.73 | 9.85 | 180.55 | 318.29 |
| | 2:10:00 | 0.00 | 0.00 | 0.28 | 0.56 | 0.97 | 5.18 | 8.95 | 165.62 | 291.23 |
| | 2:15:00 | 0.00 | 0.00 | 0.26 | 0.52 | 0.90 | 4.78 | 8.25 | 152.04 | 266.67 |
| | 2:20:00 | 0.00 | 0.00 | 0.24 | 0.48 | 0.83 | 4.44 | 7.65 | 140.12 | 245.05 |
| | 2:25:00 | 0.00 | 0.00 | 0.22 | 0.44 | 0.77 | 4.13 | 7.10 | 129.45 | 225.58 |
| | 2:30:00 | 0.00 | 0.00 | 0.21 | 0.41 | 0.70 | 3.83 | 6.60 | 119.67 | 207.70 |
| | 2:35:00 | 0.00 | 0.00 | 0.19 | 0.38 | 0.64 | 3.54 | 6.10 | 110.55 | 191.25 |
| | 2:40:00 | 0.00 | 0.00 | 0.17 | 0.34 | 0.59 | 3.26 | 5.60 | 102.14 | 176.37 |
| | 2:45:00 | 0.00 | 0.00 | 0.16 | 0.31 | 0.53 | 2.98 | 5.12 | 94.50 | 163.05 |
| | 2:50:00 | 0.00 | 0.00 | 0.14 | 0.28 | 0.48 | 2.70 | 4.64 | 87.61 | 151.10 |
| | 2:55:00 | 0.00 | 0.00 | 0.13 | 0.25 | 0.43 | 2.43 | 4.16 | 81.41 | 140.27 |
| | 3:00:00 | 0.00 | 0.00 | 0.11 | 0.22 | 0.38 | 2.15 | 3.69 | 75.71 | 130.26 |
| | 3:05:00 | 0.00 | 0.00 | 0.10 | 0.19 | 0.33 | 1.88 | 3.22 | 70.45 | 120.84 |
| | 3:10:00 | 0.00 | 0.00 | 0.08 | 0.16 | 0.28 | 1.60 | 2.74 | 65.37 | 111.92 |
| | 3:15:00 | 0.00 | 0.00 | 0.07 | 0.13 | 0.23 | 1.33 | 2.27 | 60.59 | 103.43 |
| | 3:20:00 | 0.00 | 0.00 | 0.06 | 0.10 | 0.18 | 1.06 | 1.80 | 55.82 | 95.33 |
| | 3:25:00 | 0.00 | 0.00 | 0.05 | 0.07 | 0.13 | 0.79 | 1.33 | 51.23 | 87.56 |
| | 3:30:00 | 0.00 | 0.00 | 0.03 | 0.05 | 0.09 | 0.52 | 0.87 | 46.96 | 80.08 |
| | 3:35:00 | 0.00 | 0.00 | 0.03 | 0.04 | 0.07 | 0.28 | 0.47 | 42.95 | 72.91 |
| | 3:40:00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.06 | 0.15 | 0.27 | 39.13 | 65.99 |
| | 3:45:00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.05 | 0.09 | 0.16 | 35.43 | 59.25 |
| | 3:50:00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.04 | 0.06 | 0.10 | 31.91 | 53.20 |
| | 3:55:00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.03 | 0.04 | 0.07 | 28.84 | 47.62 |
| | 4:00:00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.03 | 0.03 | 0.05 | 26.10 | 42.40 |
| | 4:05:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 23.55 | 37.74 |
| | 4:10:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 21.36 | 33.65 |
| | 4:15:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 19.32 | 29.86 |
| | 4:20:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 17.36 | 26.34 |
| | 4:25:00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 15.48 | 23.24 |
| | 4:30:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 13.80 | 20.45 |
| | 4:35:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 12.30 | 17.98 |
| | 4:40:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.95 | 15.79 |
| | 4:45:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.72 | 13.90 |
| | 4:50:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 8.68 | 12.26 |
| | 4:55:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 7.74 | 10.84 |
| | 5:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.74 | 9.58 |
| | 5:05:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 6.13 | 8.50 |
| | 5:10:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 5.47 | 7.57 |
| | 5:15:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.98 | 6.48 |
| | 5:20:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.47 | 5.97 |
| | 5:25:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.00 | 5.41 |
| | 5:30:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.57 | 4.88 |
| | 5:35:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.20 | 4.40 |
| | 5:40:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.88 | 3.97 |
| | 5:45:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.60 | 3.59 |
| | 5:50:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.36 | 3.25 |
| | 5:55:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.15 | 2.95 |
| | 6:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.96 | 2.69 |



# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*

Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.
The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

| Stage - Storage Description | Stage [ft] | Area [ft²] | Area [acres] | Volume [ft³] | Volume [ac-ft] | Total Outflow [cfs] |
|---|---|---|---|---|---|---|
| 4892.95 - Existing | 0.00 | 0 | 0.000 | 0 | 0.000 | 0.00 |
| 4894 | 1.05 | 152,377 | 3.498 | 79,993 | 1.836 | 7.60 |
| 4895 | 2.05 | 168,537 | 3.869 | 240,450 | 5.520 | 25.52 |
| 4896 | 3.05 | 179,490 | 4.121 | 414,463 | 9.515 | 52.38 |
| 4897 | 4.05 | 187,738 | 4.310 | 598,077 | 13.730 | 86.63 |
| 4898 | 5.05 | 194,228 | 4.459 | 789,060 | 18.114 | 105.67 |
| 4899 | 6.05 | 203,482 | 4.671 | 987,915 | 22.679 | 121.77 |
| 4900 - Spillway Crest | 7.05 | 209,840 | 4.817 | 1,194,576 | 27.424 | 135.97 |
| 4901 | 8.05 | 216,879 | 4.979 | 1,407,936 | 32.322 | 568.83 |

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

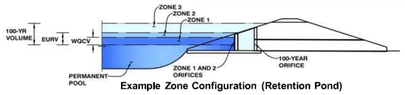
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.06 (July 2022)*

**Project:** Sheep Draw MP

**Basin ID:** Proposed Pond 3100




**Example Zone Configuration (Retention Pond)**

Depth Increment = ft

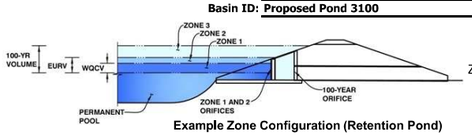
| Stage - Storage Description | Stage (ft) | Optional Override Stage (ft) | Length (ft) | Width (ft) | Area ($ft^2$) | Optional Override Area ($ft^2$) | Area (acre) | Volume ($ft^3$) | Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| **Media Surface** | -- | 0.00 | -- | -- | -- | 233,648 | 5.364 | | |
| **4866** | -- | 1.00 | -- | -- | -- | 252,590 | 5.799 | 243,119 | 5.581 |
| **4867 - Last Closed** | -- | 2.00 | -- | -- | -- | 274,028 | 6.291 | 506,428 | 11.626 |
| **4868** | -- | 3.00 | -- | -- | -- | 308,472 | 7.082 | 797,678 | 18.312 |
| **4869** | -- | 4.00 | -- | -- | -- | 337,041 | 7.737 | 1,120,434 | 25.722 |
| **4870** | -- | 5.00 | -- | -- | -- | 373,321 | 8.570 | 1,475,615 | 33.875 |
| **4871** | -- | 6.00 | -- | -- | -- | 420,498 | 9.653 | 1,872,524 | 42.987 |
| **4872** | -- | 7.00 | -- | -- | -- | 468,844 | 10.763 | 2,317,196 | 53.195 |
| **4873** | -- | 8.00 | -- | -- | -- | 513,326 | 11.784 | 2,808,281 | 64.469 |
| **4874** | -- | 9.00 | -- | -- | -- | 557,503 | 12.799 | 3,343,696 | 76.761 |
| **4875** | -- | 10.00 | -- | -- | -- | 611,898 | 14.047 | 3,928,396 | 90.184 |
| **4876** | -- | 11.00 | -- | -- | -- | 664,820 | 15.262 | 4,566,754 | 104.838 |
| | -- | | -- | -- | -- | | | | |
| | -- | | -- | -- | -- | | | | |
| | -- | | -- | -- | -- | | | |

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*

**Project:** Sheep Draw MP

**Basin ID:** Proposed Pond 3100




**Example Zone Configuration (Retention Pond)**

| | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (100-year) | 0.50 | 2.689 | Circular Orifice |
| Zone 2 | | | |
| Zone 3 | | | |
| Total (all zones) | | 2.689 | |

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

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

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)

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

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

| | Row 1 (optional) | Row 2 (optional) | Row 3 (optional) | Row 4 (optional) | Row 5 (optional) | Row 6 (optional) | Row 7 (optional) | Row 8 (optional) |
|---|---|---|---|---|---|---|---|---|
| Stage of Orifice Centroid (ft) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Orifice Area (sq. inches) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

| | 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) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Orifice Area (sq. inches) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

User Input: Vertical Orifice (Circular or Rectangular)

| | Zone 1 Circular | Not Selected | | Calculated Parameters for Vertical Orifice | Zone 1 Circular | Not Selected | |
|---|---|---|---|---|---|---|---|
| Invert of Vertical Orifice = | 0.00 | | ft (relative to basin bottom at Stage = 0 ft) | Vertical Orifice Area = | 23.76 | | ft² |
| Depth at top of Zone using Vertical Orifice = | 11.00 | | ft (relative to basin bottom at Stage = 0 ft) | Vertical Orifice Centroid = | 2.75 | | feet |
| Vertical Orifice Diameter = | 66.00 | | inches | | | | |

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

| | Not Selected | Not Selected | | Calculated Parameters for Overflow Weir | Not Selected | Not Selected | |
|---|---|---|---|---|---|---|---|
| Overflow Weir Front Edge Height, Ho = | | | ft (relative to basin bottom at Stage = 0 ft) | Height of Grate Upper Edge, $H_t$ = | N/A | | feet |
| Overflow Weir Front Edge Length = | | | feet | Overflow Weir Slope Length = | N/A | | feet |
| Overflow Weir Grate Slope = | | | H:V | Grate Open Area / 100-yr Orifice Area = | N/A | | |
| Horiz. Length of Weir Sides = | N/A | | feet | Overflow Grate Open Area w/o Debris = | N/A | | ft² |
| Overflow Grate Type = | N/A | | | Overflow Grate Open Area w/ Debris = | N/A | | ft² |
| Debris Clogging % = | N/A | | % | | | | |

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

| | Not Selected | Not Selected | | Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate | Not Selected | Not Selected | |
|---|---|---|---|---|---|---|---|
| Depth to Invert of Outlet Pipe = | N/A | | ft (distance below basin bottom at Stage = 0 ft) | Outlet Orifice Area = | N/A | | ft² |
| Circular Orifice Diameter = | N/A | | inches | 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)

| | | | Calculated Parameters for Spillway | | |
|---|---|---|---|---|---|
| Spillway Invert Stage= | 9.00 | ft (relative to basin bottom at Stage = 0 ft) | Spillway Design Flow Depth= | 1.34 | feet |
| Spillway Crest Length = | 100.00 | feet | Stage at Top of Freeboard = | 10.34 | feet |
| Spillway End Slopes = | 100.00 | H:V | Basin Area at Top of Freeboard = | 14.46 | acres |
| Freeboard above Max Water Surface = | 0.00 | feet | Basin Volume at Top of Freeboard = | 95.03 | acre-ft |

Routed Hydrograph Results

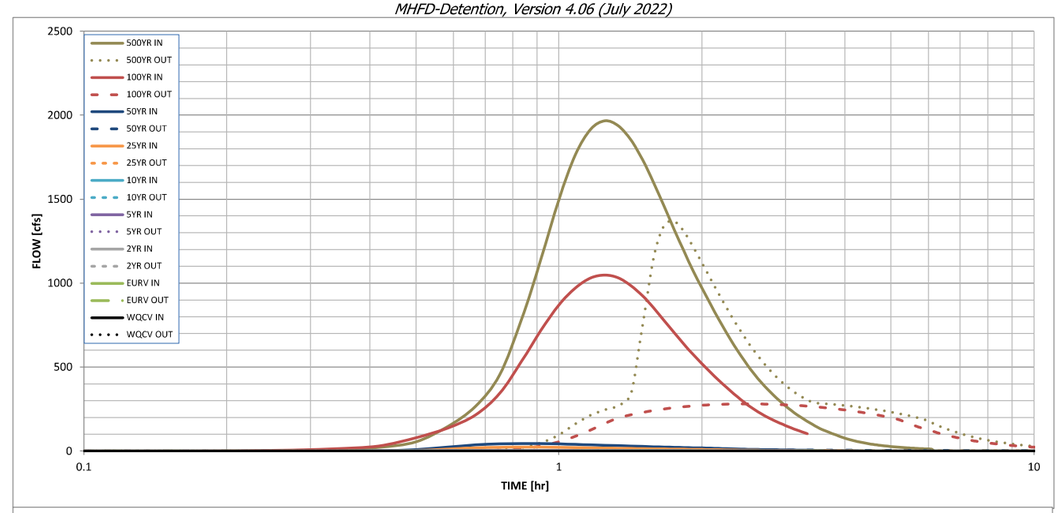
*The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

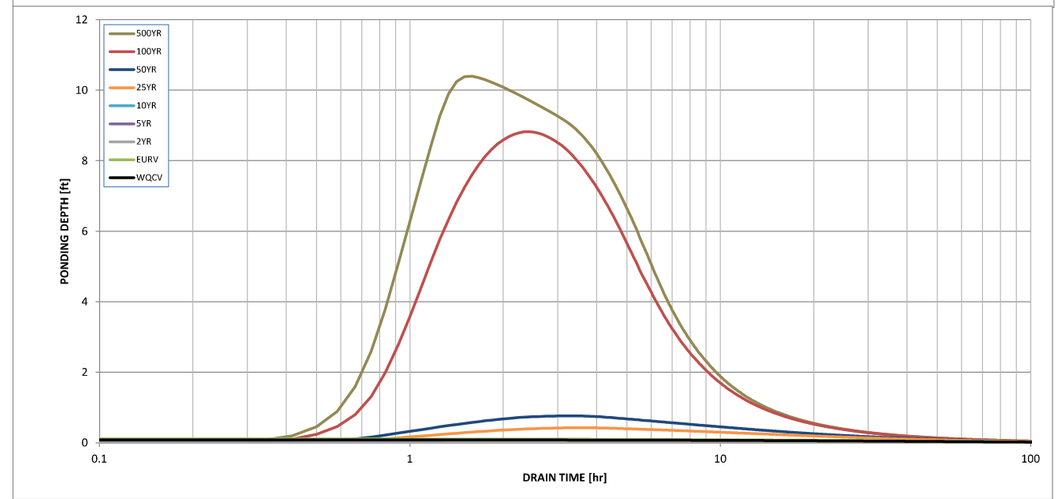
| Design Storm Return Period = | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|---|---|---|---|---|---|---|---|---|
| One-Hour Rainfall Depth (in) = | N/A | N/A | 0.85 | 1.12 | 1.40 | 1.87 | 2.29 | 2.76 | 4.10 |
| CUHP Runoff Volume (acre-ft) = | 0.497 | 0.636 | 0.105 | 0.301 | 0.512 | 2.741 | 5.280 | 9.463 | 20.400 |
| User Override Inflow Hydrograph Volume (acre-ft) = | N/A | N/A | 0.105 | 0.301 | 0.512 | 2.741 | 5.280 | 123.027 | 219.502 |
| CUHP Predevelopment Peak Q (cfs) = | N/A | N/A | 0.1 | 0.5 | 0.9 | 18.0 | 38.6 | 69.9 | 150.5 |
| OPTIONAL Override Predevelopment Peak Q (cfs) = | N/A | N/A | | | | | | | |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | N/A | N/A | 0.00 | 0.00 | 0.01 | 0.17 | 0.37 | 0.67 | 1.45 |
| Peak Inflow Q (cfs) = | N/A | N/A | 0.6 | 2.3 | 4.0 | 23.4 | 44.5 | 1048.1 | 1966.2 |
| Peak Outflow Q (cfs) = | 0.1 | 0.2 | 0.0 | 0.0 | 0.1 | 1.9 | 5.4 | 282.1 | 1366.9 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 0.1 | 0.1 | 0.1 | 0.1 | 4.0 | 9.1 |
| Structure Controlling Flow = | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 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) = | >120 | >120 | >120 | >120 | >120 | >120 | >120 | 17 | 13 |
| Time to Drain 99% of Inflow Volume (hours) = | **>120** | >120 | >120 | >120 | >120 | >120 | >120 | 36 | 25 |
| Maximum Ponding Depth (ft) = | 0.10 | 0.12 | 0.02 | 0.05 | 0.09 | 0.43 | 0.77 | 8.83 | 10.40 |
| Area at Maximum Ponding Depth (acres) = | 5.41 | 5.42 | 5.37 | 5.39 | 5.40 | 5.55 | 5.70 | 12.62 | 14.52 |
| Maximum Volume Stored (acre-ft) = | 0.539 | 0.647 | 0.054 | 0.269 | 0.485 | 2.347 | 4.259 | 74.473 | 95.754 |

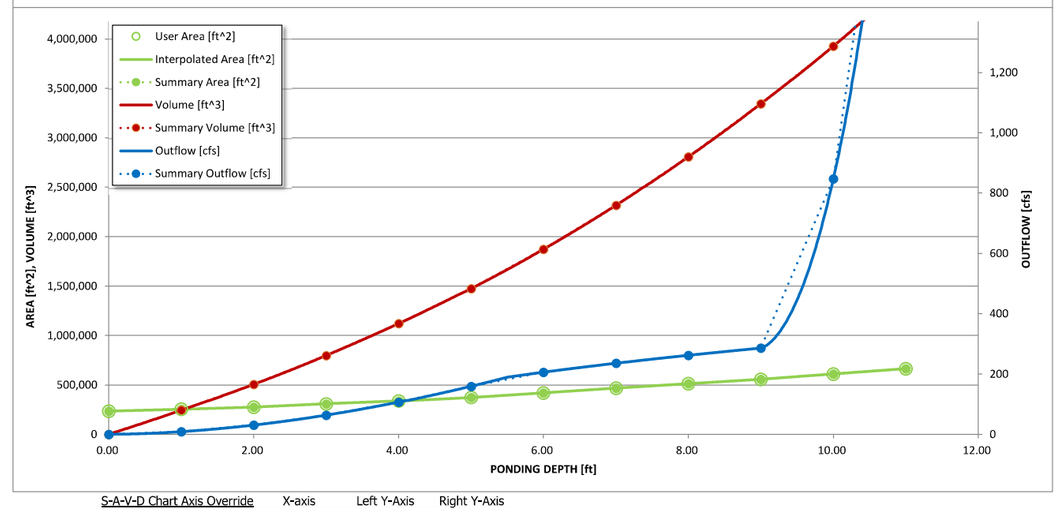


DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*




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

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*Outflow Hydrograph Workbook Filename:*

Inflow Hydrographs

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

| | SOURCE | CUHP | CUHP | CUHP | CUHP | CUHP | CUHP | CUHP | USER | USER |
|---|---|---|---|---|---|---|---|---|---|---|
| Time Interval | TIME | WQCV [cfs] | EURV [cfs] | 2 Year [cfs] | 5 Year [cfs] | 10 Year [cfs] | 25 Year [cfs] | 50 Year [cfs] | 100 Year [cfs] | 500 Year [cfs] |
| 5.00 min | 0:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0:05:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0:10:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.28 | 1.73 |
| | 0:15:00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.03 | 0.03 | 0.05 | 3.90 | 8.28 |
| | 0:20:00 | 0.00 | 0.00 | 0.06 | 0.10 | 0.14 | 0.12 | 0.17 | 12.67 | 21.53 |
| | 0:25:00 | 0.00 | 0.00 | 0.20 | 0.52 | 1.00 | 0.47 | 0.92 | 30.04 | 55.51 |
| | 0:30:00 | 0.00 | 0.00 | 0.38 | 1.31 | 2.47 | 4.21 | 9.31 | 79.27 | 147.31 |
| | 0:35:00 | 0.00 | 0.00 | 0.53 | 1.97 | 3.57 | 11.70 | 24.02 | 138.33 | 267.03 |
| | 0:40:00 | 0.00 | 0.00 | 0.60 | 2.24 | 3.98 | 18.77 | 36.46 | 216.03 | 454.80 |
| | 0:45:00 | 0.00 | 0.00 | 0.63 | 2.27 | 4.02 | 22.38 | 42.49 | 344.39 | 783.31 |
| | 0:50:00 | 0.00 | 0.00 | 0.64 | 2.24 | 3.93 | 23.36 | 44.47 | 533.50 | 1141.29 |
| | 0:55:00 | 0.00 | 0.00 | 0.63 | 2.15 | 3.75 | 23.11 | 44.30 | 718.79 | 1499.11 |
| | 1:00:00 | 0.00 | 0.00 | 0.62 | 2.02 | 3.49 | 22.18 | 42.61 | 871.29 | 1765.16 |
| | 1:05:00 | 0.00 | 0.00 | 0.60 | 1.89 | 3.25 | 20.72 | 39.77 | 971.81 | 1916.93 |
| | 1:10:00 | 0.00 | 0.00 | 0.59 | 1.80 | 3.07 | 19.20 | 36.98 | 1031.97 | 1966.22 |
| | 1:15:00 | 0.00 | 0.00 | 0.57 | 1.71 | 2.92 | 17.87 | 34.53 | 1048.07 | 1936.70 |
| | 1:20:00 | 0.00 | 0.00 | 0.55 | 1.62 | 2.76 | 16.67 | 32.24 | 1032.02 | 1852.79 |
| | 1:25:00 | 0.00 | 0.00 | 0.53 | 1.53 | 2.59 | 15.50 | 29.95 | 985.51 | 1735.77 |
| | 1:30:00 | 0.00 | 0.00 | 0.51 | 1.45 | 2.44 | 14.34 | 27.68 | 926.18 | 1597.13 |
| | 1:35:00 | 0.00 | 0.00 | 0.50 | 1.38 | 2.31 | 13.28 | 25.65 | 852.93 | 1457.21 |
| | 1:40:00 | 0.00 | 0.00 | 0.49 | 1.32 | 2.20 | 12.41 | 23.98 | 777.12 | 1315.26 |
| | 1:45:00 | 0.00 | 0.00 | 0.48 | 1.26 | 2.10 | 11.67 | 22.50 | 703.00 | 1190.46 |
| | 1:50:00 | 0.00 | 0.00 | 0.46 | 1.20 | 1.99 | 10.97 | 21.10 | 636.54 | 1073.56 |
| | 1:55:00 | 0.00 | 0.00 | 0.45 | 1.14 | 1.88 | 10.28 | 19.74 | 575.25 | 971.27 |
| | 2:00:00 | 0.00 | 0.00 | 0.43 | 1.07 | 1.77 | 9.60 | 18.40 | 520.47 | 875.60 |
| | 2:05:00 | 0.00 | 0.00 | 0.41 | 1.00 | 1.64 | 8.91 | 17.06 | 469.36 | 787.08 |
| | 2:10:00 | 0.00 | 0.00 | 0.38 | 0.92 | 1.51 | 8.21 | 15.70 | 423.26 | 705.65 |
| | 2:15:00 | 0.00 | 0.00 | 0.35 | 0.84 | 1.38 | 7.51 | 14.35 | 380.95 | 632.68 |
| | 2:20:00 | 0.00 | 0.00 | 0.32 | 0.76 | 1.24 | 6.81 | 13.00 | 341.51 | 567.03 |
| | 2:25:00 | 0.00 | 0.00 | 0.29 | 0.70 | 1.14 | 6.11 | 11.67 | 306.21 | 508.55 |
| | 2:30:00 | 0.00 | 0.00 | 0.27 | 0.65 | 1.06 | 5.54 | 10.61 | 274.88 | 455.47 |
| | 2:35:00 | 0.00 | 0.00 | 0.25 | 0.61 | 1.00 | 5.13 | 9.86 | 247.38 | 409.01 |
| | 2:40:00 | 0.00 | 0.00 | 0.24 | 0.57 | 0.94 | 4.83 | 9.27 | 223.06 | 368.82 |
| | 2:45:00 | 0.00 | 0.00 | 0.22 | 0.54 | 0.88 | 4.56 | 8.74 | 202.10 | 332.47 |
| | 2:50:00 | 0.00 | 0.00 | 0.21 | 0.51 | 0.83 | 4.31 | 8.25 | 184.17 | 299.38 |
| | 2:55:00 | 0.00 | 0.00 | 0.19 | 0.47 | 0.78 | 4.06 | 7.77 | 168.15 | 269.43 |
| | 3:00:00 | 0.00 | 0.00 | 0.18 | 0.44 | 0.72 | 3.81 | 7.30 | 153.20 | 242.58 |
| | 3:05:00 | 0.00 | 0.00 | 0.17 | 0.41 | 0.67 | 3.57 | 6.83 | 138.77 | 218.35 |
| | 3:10:00 | 0.00 | 0.00 | 0.15 | 0.38 | 0.62 | 3.33 | 6.37 | 125.82 | 196.97 |
| | 3:15:00 | 0.00 | 0.00 | 0.14 | 0.35 | 0.58 | 3.10 | 5.92 | 113.88 | 177.63 |
| | 3:20:00 | 0.00 | 0.00 | 0.13 | 0.32 | 0.53 | 2.86 | 5.46 | 103.29 | 160.09 |
| | 3:25:00 | 0.00 | 0.00 | 0.12 | 0.29 | 0.48 | 2.62 | 5.01 | 92.94 | 143.37 |
| | 3:30:00 | 0.00 | 0.00 | 0.11 | 0.27 | 0.44 | 2.39 | 4.56 | 83.05 | 128.89 |
| | 3:35:00 | 0.00 | 0.00 | 0.10 | 0.24 | 0.39 | 2.15 | 4.11 | 74.44 | 116.18 |
| | 3:40:00 | 0.00 | 0.00 | 0.09 | 0.21 | 0.34 | 1.92 | 3.66 | 67.20 | 105.42 |
| | 3:45:00 | 0.00 | 0.00 | 0.08 | 0.19 | 0.30 | 1.68 | 3.21 | 61.03 | 95.04 |
| | 3:50:00 | 0.00 | 0.00 | 0.07 | 0.16 | 0.26 | 1.45 | 2.76 | 55.19 | 84.83 |
| | 3:55:00 | 0.00 | 0.00 | 0.06 | 0.13 | 0.21 | 1.22 | 2.31 | 50.06 | 76.15 |
| | 4:00:00 | 0.00 | 0.00 | 0.05 | 0.11 | 0.17 | 0.99 | 1.86 | 45.53 | 68.90 |
| | 4:05:00 | 0.00 | 0.00 | 0.04 | 0.08 | 0.13 | 0.75 | 1.41 | 41.46 | 62.85 |
| | 4:10:00 | 0.00 | 0.00 | 0.04 | 0.06 | 0.08 | 0.52 | 0.97 | 37.81 | 56.98 |
| | 4:15:00 | 0.00 | 0.00 | 0.03 | 0.04 | 0.06 | 0.30 | 0.54 | 34.64 | 51.75 |
| | 4:20:00 | 0.00 | 0.00 | 0.03 | 0.04 | 0.05 | 0.15 | 0.28 | 31.74 | 47.19 |
| | 4:25:00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.04 | 0.08 | 0.16 | 29.16 | 43.22 |
| | 4:30:00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.04 | 0.06 | 0.11 | 26.88 | 39.64 |
| | 4:35:00 | 0.00 | 0.00 | 0.02 | 0.02 | 0.03 | 0.04 | 0.07 | 24.82 | 36.48 |
| | 4:40:00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.03 | 0.03 | 0.05 | 22.98 | 33.74 |
| | 4:45:00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.02 | 0.03 | 0.04 | 21.32 | 31.29 |
| | 4:50:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 | 0.02 | 0.03 | 19.90 | 29.05 |
| | 4:55:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 18.60 | 27.01 |
| | 5:00:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 17.39 | 25.22 |
| | 5:05:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 16.29 | 23.63 |
| | 5:10:00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.01 | 15.28 | 22.12 |
| | 5:15:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 14.33 | 20.70 |
| | 5:20:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 13.45 | 19.38 |
| | 5:25:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 12.62 | 18.14 |
| | 5:30:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.86 | 16.99 |
| | 5:35:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 11.17 | 15.92 |
| | 5:40:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 10.51 | 14.95 |
| | 5:45:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.90 | 14.06 |
| | 5:50:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 9.35 | 13.23 |
| | 5:55:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 8.84 | 12.47 |
| | 6:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 8.37 | 11.77 |



DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*

Summary Stage-Area-Volume-Discharge Relationships

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

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

| Stage - Storage Description | Stage [ft] | Area [ft²] | Area [acres] | Volume [ft³] | Volume [ac-ft] | Total Outflow [cfs] |
|---|---|---|---|---|---|---|
| 4865 - Existing | 0.00 | 233,648 | 5.364 | 0 | 0.000 | 0.00 |
| 4866 | 1.00 | 252,590 | 5.799 | 243,119 | 5.581 | 8.67 |
| 4867 - Last EX closed contour | 2.00 | 274,028 | 6.291 | 506,428 | 11.626 | 30.40 |
| 4868 | 3.00 | 308,472 | 7.082 | 797,678 | 18.312 | 63.33 |
| 4869 | 4.00 | 337,041 | 7.737 | 1,120,434 | 25.722 | 106.60 |
| 4870 | 5.00 | 373,321 | 8.570 | 1,475,615 | 33.875 | 159.64 |
| 4871 | 6.00 | 420,498 | 9.653 | 1,872,524 | 42.987 | 206.23 |
| 4872 | 7.00 | 468,844 | 10.763 | 2,317,196 | 53.195 | 235.83 |
| 4873 | 8.00 | 513,326 | 11.784 | 2,808,281 | 64.469 | 262.11 |
| 4874 - SW Crest | 9.00 | 557,503 | 12.799 | 3,343,696 | 76.761 | 285.99 |
| 4875 | 10.00 | 611,898 | 14.047 | 3,928,396 | 90.184 | 848.02 |
| 4876 | 11.00 | 664,820 | 15.262 | 4,566,754 | 104.838 | 2,534.75 |

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

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

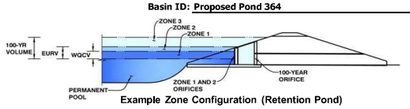
MHFD-Detention_POND3100_v4-06.xlsm, Outlet Structure 1/2/2026, 4:27 PM

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.06 (July 2022)*

**Project:** Sheep Draw MP

**Basin ID:** Proposed Pond 364




**Example Zone Configuration (Retention Pond)**

Depth Increment = ft

| Stage - Storage Description | Stage (ft) | Optional Override Stage (ft) | Length (ft) | Width (ft) | Area ($ft^2$) | Optional Override Area ($ft^2$) | Area (acre) | Volume ($ft^3$) | Volume (ac-ft) |
|---|---|---|---|---|---|---|---|---|---|
| **Media Surface** | -- | 0.00 | -- | -- | -- | 250,392 | 5.748 | | |
| **4918.66** | -- | 1.00 | -- | -- | -- | 262,380 | 6.023 | 256,386 | 5.886 |
| **4919.66** | -- | 2.00 | -- | -- | -- | 274,494 | 6.302 | 524,823 | 12.048 |
| **4920.66** | -- | 3.00 | -- | -- | -- | 286,736 | 6.583 | 805,438 | 18.490 |
| **4921.66** | -- | 4.00 | -- | -- | -- | 299,106 | 6.867 | 1,098,359 | 25.215 |
| **4922.66** | -- | 5.00 | -- | -- | -- | 311,603 | 7.153 | 1,403,714 | 32.225 |
| **4923.66** | -- | 6.00 | -- | -- | -- | 324,228 | 7.443 | 1,721,629 | 39.523 |
| **4924.66** | -- | 7.00 | -- | -- | -- | 336,980 | 7.736 | 2,052,233 | 47.113 |
| **4925.66** | -- | 8.00 | -- | -- | -- | 349,860 | 8.032 | 2,395,653 | 54.997 |
| **4926.66** | -- | 9.00 | -- | -- | -- | 362,867 | 8.330 | 2,752,016 | 63.178 |

## Watershed Information

**Flood Control Only**

| | | |
|---|---|---|
| Selected BMP Type = | **No BMP** | |
| Watershed Area = | 75.23 | acres |
| Watershed Length = | 2,891 | ft |
| Watershed Length to Centroid = | 941 | ft |
| Watershed Slope = | 0.014 | ft/ft |
| Watershed Imperviousness = | 2.22% | percent |
| Percentage Hydrologic Soil Group A = | 0.0% | percent |
| Percentage Hydrologic Soil Group B = | 5.0% | percent |
| Percentage Hydrologic Soil Groups C/D = | 95.0% | percent |
| Target WQCV Drain Time = | N/A | hours |
| Location for 1-hr Rainfall Depths = | Brighton - City Hall | |

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) = | 0.105 acre-feet | | acre-feet |
| Excess Urban Runoff Volume (EURV) = | 0.124 acre-feet | | acre-feet |
| 2-yr Runoff Volume (P1 = 0.85 in.) = | 0.071 acre-feet | 0.85 | inches |
| 5-yr Runoff Volume (P1 = 1.12 in.) = | 0.595 acre-feet | 1.12 | inches |
| 10-yr Runoff Volume (P1 = 1.4 in.) = | 1.828 acre-feet | 1.40 | inches |
| 25-yr Runoff Volume (P1 = 1.87 in.) = | 5.113 acre-feet | 1.87 | inches |
| 50-yr Runoff Volume (P1 = 2.29 in.) = | 7.654 acre-feet | 2.29 | inches |
| 100-yr Runoff Volume (P1 = 2.76 in.) = | 11.105 acre-feet | 2.76 | inches |
| 500-yr Runoff Volume (P1 = 4.1 in.) = | 19.991 acre-feet | 4.10 | inches |
| Approximate 2-yr Detention Volume = | 0.065 acre-feet | | |
| Approximate 5-yr Detention Volume = | 0.381 acre-feet | | |
| Approximate 10-yr Detention Volume = | 0.692 acre-feet | | |
| Approximate 25-yr Detention Volume = | 0.897 acre-feet | | |
| Approximate 50-yr Detention Volume = | 0.940 acre-feet | | |
| Approximate 100-yr Detention Volume = | 1.588 acre-feet | | |

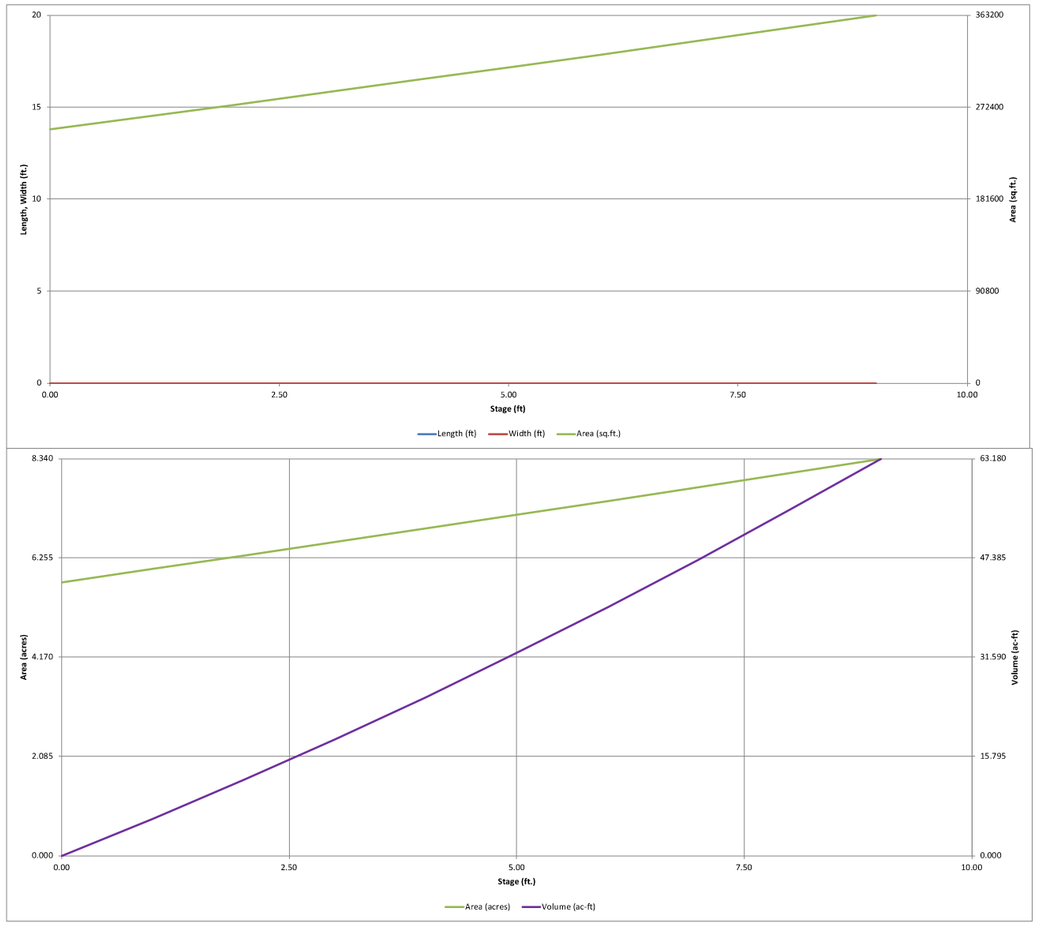
## Define Zones and Basin Geometry

| | | |
|---|---|---|
| Zone 1 Volume (100-year) = | 1.588 | acre-feet |
| Select Zone 2 Storage Volume (Optional) = | | acre-feet |
| Select Zone 3 Storage Volume (Optional) = | | acre-feet |
| Total Detention Basin Volume = | 1.588 | acre-feet |
| Initial Surcharge Volume (ISV) = | N/A | $ft^3$ |
| Initial Surcharge Depth (ISD) = | N/A | ft |
| Total Available Detention Depth ($H_{total}$) = | user | ft |
| Depth of Trickle Channel ($H_{TC}$) = | user | ft |
| Slope of Trickle Channel ($S_{TC}$) = | user | ft/ft |
| Slopes of Main Basin Sides ($S_{main}$) = | user | H:V |
| Basin Length-to-Width Ratio ($R_{L/W}$) = | user | |
| Initial Surcharge Area ($A_{ISV}$) = | user | $ft^2$ |
| Surcharge Volume Length ($L_{ISV}$) = | user | ft |
| Surcharge Volume Width ($W_{ISV}$) = | user | ft |
| Depth of Basin Floor ($H_{FLOOR}$) = | user | ft |
| Length of Basin Floor ($L_{FLOOR}$) = | user | ft |
| Width of Basin Floor ($W_{FLOOR}$) = | user | ft |
| Area of Basin Floor ($A_{FLOOR}$) = | user | $ft^2$ |
| Volume of Basin Floor ($V_{FLOOR}$) = | user | $ft^3$ |
| Depth of Main Basin ($H_{MAIN}$) = | user | ft |
| Length of Main Basin ($L_{MAIN}$) = | user | ft |
| Width of Main Basin ($W_{MAIN}$) = | user | ft |
| Area of Main Basin ($A_{MAIN}$) = | user | $ft^2$ |
| Volume of Main Basin ($V_{MAIN}$) = | user | $ft^3$ |
| Calculated Total Basin Volume ($V_{total}$) = | **user** | acre-feet |



DETENTION BASIN STAGE-STORAGE TABLE BUILDER

*MHFD-Detention, Version 4.06 (July 2022)*

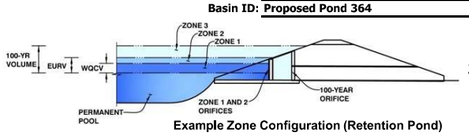


# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*

**Project: Sheep Draw MP**

**Basin ID: Proposed Pond 364**




**Example Zone Configuration (Retention Pond)**

| | Estimated Stage (ft) | Estimated Volume (ac-ft) | Outlet Type |
|---|---|---|---|
| Zone 1 (100-year) | 0.28 | 1.588 | Circular Orifice |
| Zone 2 | | | |
| Zone 3 | | | |
| Total (all zones) | | 1.588 | |

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

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

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

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

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

| | Row 1 (optional) | Row 2 (optional) | Row 3 (optional) | Row 4 (optional) | Row 5 (optional) | Row 6 (optional) | Row 7 (optional) | Row 8 (optional) |
|---|---|---|---|---|---|---|---|---|
| Stage of Orifice Centroid (ft) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Orifice Area (sq. inches) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

| | 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) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| Orifice Area (sq. inches) | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |

User Input: Vertical Orifice (Circular or Rectangular)

| | Zone 1 Circular | Not Selected | | Calculated Parameters for Vertical Orifice | Zone 1 Circular | Not Selected | |
|---|---|---|---|---|---|---|---|
| Invert of Vertical Orifice = | 0.00 | | ft (relative to basin bottom at Stage = 0 ft) | Vertical Orifice Area = | 7.07 | | ft² |
| Depth at top of Zone using Vertical Orifice = | 9.00 | | ft (relative to basin bottom at Stage = 0 ft) | Vertical Orifice Centroid = | 1.50 | | feet |
| Vertical Orifice Diameter = | 36.00 | | inches | | | | |

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

| | Not Selected | Not Selected | | Calculated Parameters for Overflow Weir | Not Selected | Not Selected | |
|---|---|---|---|---|---|---|---|
| Overflow Weir Front Edge Height, Ho = | | | ft (relative to basin bottom at Stage = 0 ft) | Height of Grate Upper Edge, $H_t$ = | N/A | | feet |
| Overflow Weir Front Edge Length = | | | feet | Overflow Weir Slope Length = | N/A | | feet |
| Overflow Weir Grate Slope = | | | H:V | Grate Open Area / 100-yr Orifice Area = | N/A | | |
| Horiz. Length of Weir Sides = | N/A | | feet | Overflow Grate Open Area w/o Debris = | N/A | | ft² |
| Overflow Grate Type = | N/A | | | Overflow Grate Open Area w/ Debris = | N/A | | ft² |
| Debris Clogging % = | N/A | | % | | | | |

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

| | Not Selected | Not Selected | | Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate | Not Selected | Not Selected | |
|---|---|---|---|---|---|---|---|
| Depth to Invert of Outlet Pipe = | N/A | | ft (distance below basin bottom at Stage = 0 ft) | Outlet Orifice Area = | N/A | | ft² |
| Circular Orifice Diameter = | N/A | | inches | 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= | 8.20 | ft (relative to basin bottom at Stage = 0 ft) | Spillway Design Flow Depth= | 1.19 feet |
| Spillway Crest Length = | 70.00 | feet | Stage at Top of Freeboard = | 9.39 feet |
| Spillway End Slopes = | 100.00 | H:V | Basin Area at Top of Freeboard = | 8.33 acres |
| Freeboard above Max Water Surface = | 0.00 | feet | Basin Volume at Top of Freeboard = | 63.18 acre-ft |

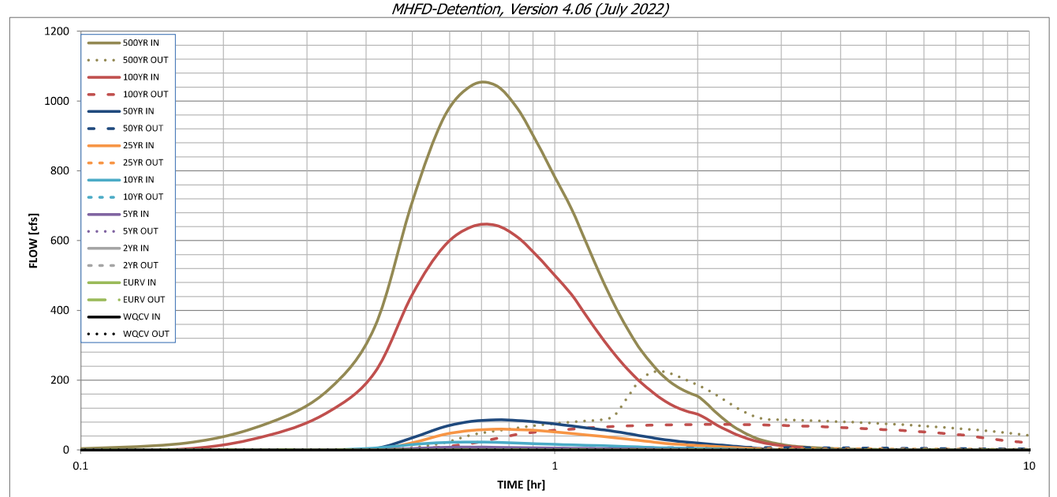
Routed Hydrograph Results — *The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).*

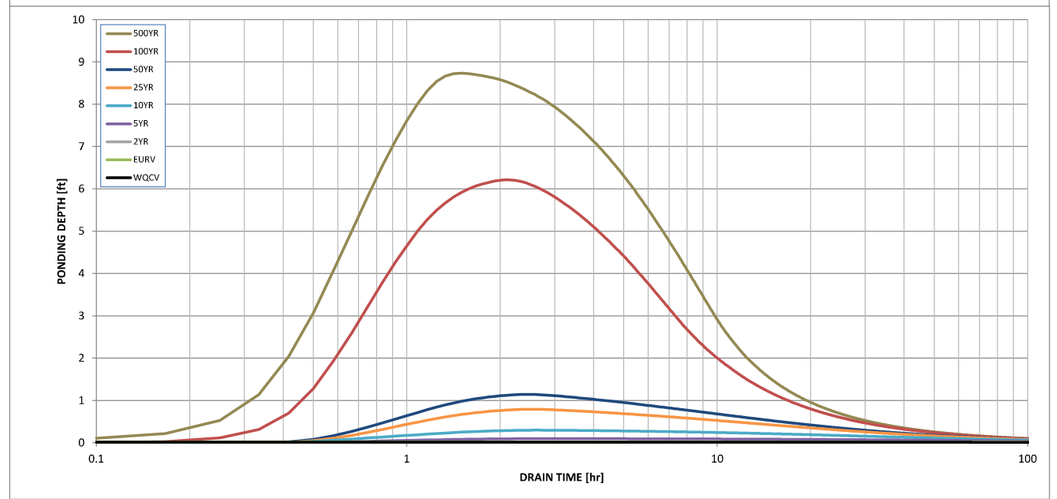
| | WQCV | EURV | 2 Year | 5 Year | 10 Year | 25 Year | 50 Year | 100 Year | 500 Year |
|---|---|---|---|---|---|---|---|---|---|
| Design Storm Return Period = | | | | | | | | | |
| One-Hour Rainfall Depth (in) = | N/A | N/A | 0.85 | 1.12 | 1.40 | 1.87 | 2.29 | 2.76 | 4.10 |
| CUHP Runoff Volume (acre-ft) = | 0.105 | 0.124 | 0.071 | 0.595 | 1.828 | 5.113 | 7.654 | 11.105 | 19.991 |
| User Override Inflow Hydrograph Volume (acre-ft) = | N/A | N/A | 0.071 | 0.595 | 1.828 | 5.113 | 7.654 | 52.268 | 81.495 |
| CUHP Predevelopment Peak Q (cfs) = | N/A | N/A | 0.8 | 8.0 | 22.8 | 60.2 | 86.9 | 120.7 | 207.2 |
| OPTIONAL Override Predevelopment Peak Q (cfs) = | N/A | N/A | | | | | | | |
| Predevelopment Unit Peak Flow, q (cfs/acre) = | N/A | N/A | 0.01 | 0.11 | 0.30 | 0.80 | 1.16 | 1.60 | 2.75 |
| Peak Inflow Q (cfs) = | N/A | N/A | 0.9 | 8.1 | 22.9 | 60.3 | 87.0 | 643.6 | 1045.2 |
| Peak Outflow Q (cfs) = | 0.0 | 0.0 | 0.0 | 0.1 | 0.6 | 3.8 | 7.3 | 73.9 | 225.9 |
| Ratio Peak Outflow to Predevelopment Q = | N/A | N/A | N/A | 0.0 | 0.0 | 0.1 | 0.1 | 0.6 | 1.1 |
| Structure Controlling Flow = | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 1 | Vertical Orifice 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) = | >120 | >120 | >120 | >120 | >120 | >120 | >120 | 46 | 35 |
| Time to Drain 99% of Inflow Volume (hours) = | **>120** | >120 | >120 | >120 | >120 | >120 | >120 | 108 | 79 |
| Maximum Ponding Depth (ft) = | 0.02 | 0.03 | 0.01 | 0.10 | 0.30 | 0.79 | 1.14 | 6.21 | 8.74 |
| Area at Maximum Ponding Depth (acres) = | 5.75 | 5.76 | 5.75 | 5.78 | 5.83 | 5.97 | 6.06 | 7.50 | 8.25 |
| Maximum Volume Stored (acre-ft) = | 0.115 | 0.173 | 0.057 | 0.576 | 1.737 | 4.627 | 6.732 | 41.093 | 60.939 |

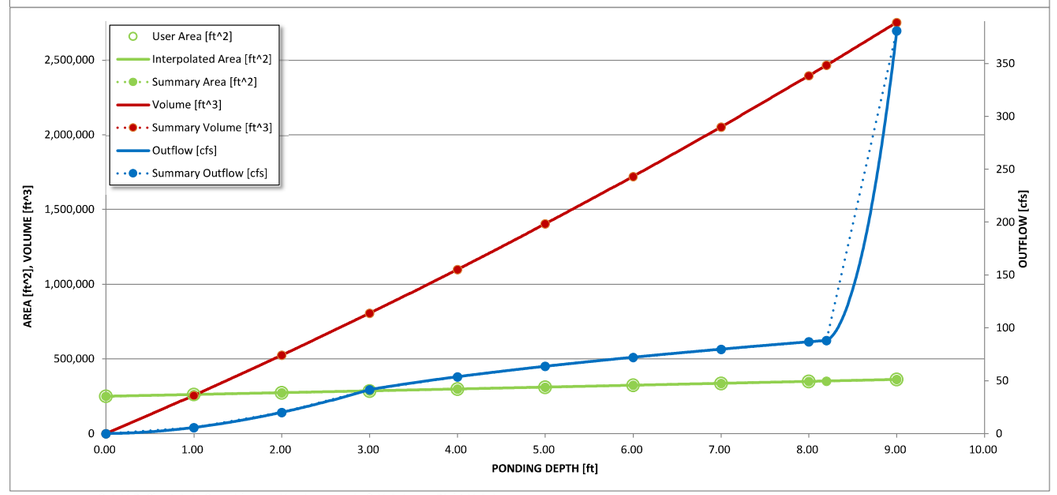


DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*




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

# DETENTION BASIN OUTLET STRUCTURE DESIGN

*Outflow Hydrograph Workbook Filename:*

Inflow Hydrographs

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

| | SOURCE | CUHP | CUHP | CUHP | CUHP | CUHP | CUHP | CUHP | USER | USER |
|---|---|---|---|---|---|---|---|---|---|---|
| Time Interval | TIME | WQCV [cfs] | EURV [cfs] | 2 Year [cfs] | 5 Year [cfs] | 10 Year [cfs] | 25 Year [cfs] | 50 Year [cfs] | 100 Year [cfs] | 500 Year [cfs] |
| 5.00 min | 0:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| | 0:05:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 20.15 |
| | 0:10:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.27 | 78.78 |
| | 0:15:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 43.04 | 173.94 |
| | 0:20:00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.12 | 0.01 | 0.08 | 110.00 | 352.17 |
| | 0:25:00 | 0.00 | 0.00 | 0.24 | 0.56 | 5.57 | 0.53 | 3.73 | 221.85 | 711.83 |
| | 0:30:00 | 0.00 | 0.00 | 0.62 | 4.16 | 15.64 | 20.75 | 34.91 | 445.96 | 952.66 |
| | 0:35:00 | 0.00 | 0.00 | 0.83 | 7.34 | 21.64 | 44.10 | 67.03 | 583.31 | 1044.75 |
| | 0:40:00 | 0.00 | 0.00 | 0.89 | 8.13 | 22.88 | 56.29 | 82.46 | 639.62 | 1045.22 |
| | 0:45:00 | 0.00 | 0.00 | 0.85 | 7.80 | 21.96 | 60.29 | 87.04 | 643.56 | 978.09 |
| | 0:50:00 | 0.00 | 0.00 | 0.77 | 6.94 | 19.95 | 59.19 | 85.05 | 609.76 | 880.68 |
| | 0:55:00 | 0.00 | 0.00 | 0.70 | 6.17 | 17.96 | 55.97 | 80.70 | 556.33 | 781.95 |
| | 1:00:00 | 0.00 | 0.00 | 0.63 | 5.50 | 16.15 | 51.74 | 75.12 | 499.77 | 692.05 |
| | 1:05:00 | 0.00 | 0.00 | 0.57 | 4.88 | 14.57 | 47.56 | 69.64 | 446.28 | 589.99 |
| | 1:10:00 | 0.00 | 0.00 | 0.52 | 4.39 | 13.37 | 43.21 | 64.10 | 383.01 | 496.99 |
| | 1:15:00 | 0.00 | 0.00 | 0.47 | 3.99 | 12.36 | 39.10 | 58.88 | 325.08 | 417.29 |
| | 1:20:00 | 0.00 | 0.00 | 0.42 | 3.60 | 11.22 | 35.13 | 53.32 | 275.51 | 349.92 |
| | 1:25:00 | 0.00 | 0.00 | 0.37 | 3.20 | 9.96 | 31.24 | 47.46 | 233.63 | 296.36 |
| | 1:30:00 | 0.00 | 0.00 | 0.32 | 2.80 | 8.69 | 27.54 | 41.80 | 200.55 | 254.53 |
| | 1:35:00 | 0.00 | 0.00 | 0.28 | 2.41 | 7.41 | 23.94 | 36.29 | 172.67 | 220.79 |
| | 1:40:00 | 0.00 | 0.00 | 0.24 | 2.03 | 6.43 | 20.42 | 31.11 | 149.90 | 194.99 |
| | 1:45:00 | 0.00 | 0.00 | 0.22 | 1.81 | 5.78 | 17.94 | 27.45 | 131.93 | 177.45 |
| | 1:50:00 | 0.00 | 0.00 | 0.20 | 1.65 | 5.24 | 16.01 | 24.53 | 119.03 | 164.12 |
| | 1:55:00 | 0.00 | 0.00 | 0.18 | 1.50 | 4.75 | 14.39 | 22.05 | 109.72 | 153.94 |
| | 2:00:00 | 0.00 | 0.00 | 0.16 | 1.36 | 4.28 | 12.92 | 19.79 | 102.77 | 134.85 |
| | 2:05:00 | 0.00 | 0.00 | 0.15 | 1.21 | 3.81 | 11.59 | 17.71 | 90.41 | 112.58 |
| | 2:10:00 | 0.00 | 0.00 | 0.13 | 1.07 | 3.35 | 10.30 | 15.70 | 76.24 | 92.90 |
| | 2:15:00 | 0.00 | 0.00 | 0.11 | 0.93 | 2.90 | 9.07 | 13.79 | 63.86 | 75.81 |
| | 2:20:00 | 0.00 | 0.00 | 0.09 | 0.79 | 2.46 | 7.88 | 11.96 | 53.06 | 61.70 |
| | 2:25:00 | 0.00 | 0.00 | 0.08 | 0.66 | 2.03 | 6.71 | 10.18 | 43.95 | 50.00 |
| | 2:30:00 | 0.00 | 0.00 | 0.06 | 0.52 | 1.61 | 5.55 | 8.44 | 36.25 | 40.51 |
| | 2:35:00 | 0.00 | 0.00 | 0.05 | 0.39 | 1.19 | 4.39 | 6.70 | 29.85 | 32.90 |
| | 2:40:00 | 0.00 | 0.00 | 0.03 | 0.25 | 0.78 | 3.24 | 4.97 | 24.67 | 27.02 |
| | 2:45:00 | 0.00 | 0.00 | 0.02 | 0.13 | 0.45 | 2.09 | 3.29 | 20.55 | 22.56 |
| | 2:50:00 | 0.00 | 0.00 | 0.01 | 0.06 | 0.28 | 1.26 | 2.11 | 17.35 | 18.90 |
| | 2:55:00 | 0.00 | 0.00 | 0.01 | 0.03 | 0.20 | 0.78 | 1.40 | 14.73 | 15.93 |
| | 3:00:00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.14 | 0.49 | 0.94 | 12.52 | 13.47 |
| | 3:05:00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.11 | 0.30 | 0.62 | 10.67 | 11.46 |
| | 3:10:00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.08 | 0.18 | 0.40 | 9.18 | 9.87 |
| | 3:15:00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.06 | 0.10 | 0.25 | 7.99 | 8.67 |
| | 3:20:00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.04 | 0.05 | 0.14 | 7.04 | 7.65 |
| | 3:25:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.02 | 0.03 | 0.07 | 6.26 | 6.80 |
| | 3:30:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 0.04 | 5.58 | 6.06 |
| | 3:35:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.03 | 5.01 | 5.43 |
| | 3:40:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.02 | 4.52 | 4.90 |
| | 3:45:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.02 | 4.10 | 4.37 |
| | 3:50:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 3.66 | 3.95 |
| | 3:55:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.01 | 3.33 | 3.56 |
| | 4:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 3.02 | 3.20 |
| | 4:05:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.73 | 2.87 |
| | 4:10:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.47 | 2.59 |
| | 4:15:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.24 | 2.34 |
| | 4:20:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 2.04 | 2.12 |
| | 4:25:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.85 | 1.92 |
| | 4:30:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.69 | 1.75 |
| | 4:35:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.55 | 1.60 |
| | 4:40:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.42 | 1.46 |
| | 4:45:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.30 | 1.34 |
| | 4:50:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.20 | 1.23 |
| | 4:55:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.11 | 1.14 |
| | 5:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.03 | 1.05 |
| | 5:05:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | 1.02 |
| | 5:10:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.92 | 0.94 |
| | 5:15:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.86 | 0.87 |
| | 5:20:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.79 | 0.81 |
| | 5:25:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.74 | 0.75 |
| | 5:30:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.69 | 0.70 |
| | 5:35:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.64 | 0.65 |
| | 5:40:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.60 | 0.61 |
| | 5:45:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.57 | 0.57 |
| | 5:50:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.53 | 0.54 |
| | 5:55:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.50 | 0.51 |
| | 6:00:00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.47 | 0.00 |



# DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.06 (July 2022)*

Summary Stage-Area-Volume-Discharge Relationships

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

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

| Stage - Storage Description | Stage [ft] | Area [ft²] | Area [acres] | Volume [ft³] | Volume [ac-ft] | Total Outflow [cfs] |
|---|---|---|---|---|---|---|
| 4917.66 | 0.00 | 250,392 | 5.748 | 0 | 0.000 | 0.00 |
| 4918.66 | 1.00 | 262,380 | 6.023 | 256,386 | 5.886 | 5.71 |
| 4919.66 | 2.00 | 274,494 | 6.302 | 524,823 | 12.048 | 20.01 |
| 4920.66 | 3.00 | 286,736 | 6.583 | 805,438 | 18.490 | 41.68 |
| 4921.66 | 4.00 | 299,106 | 6.867 | 1,098,359 | 25.215 | 53.81 |
| 4922.66 | 5.00 | 311,603 | 7.153 | 1,403,714 | 32.225 | 63.67 |
| 4923.66 | 6.00 | 324,228 | 7.443 | 1,721,629 | 39.523 | 72.20 |
| 4924.66 | 7.00 | 336,980 | 7.736 | 2,052,233 | 47.113 | 79.82 |
| 4925.66 | 8.00 | 349,860 | 8.032 | 2,395,653 | 54.997 | 86.77 |
| 4925.86 - SW Crest | 8.20 | 352,461 | 8.091 | 2,465,885 | 56.609 | 88.10 |
| 4926.66 | 9.00 | 362,867 | 8.330 | 2,752,016 | 63.178 | 380.86 |

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

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

# SHEEP DRAW Major Drainageway Plan

## Table F5 - Crossing Structure Capacities (Existing Infrastructure, Future Land Use Flows, with Proposed Detention)

| Reach | Structure Survey Number | Jurisdiction | Street Name | Street Classification | Existing Structure | $Q_{100}$ (cfs) | $V_{100}$ (ft/s) | $EGL_{100}$ | $WSE_{100}$ | Bridge Freeboard Height (ft) | Bridge Freeboard Elevation | HW/D Criteria | HW:D Criteria Elev | Overtop Elev | Overtop Elev Notes | Controlling Criteria | Controlling Elevation | Capacity per Criteria (Storm Event) | Capacity before Overtopping (Storm Event) | 100-Year Criteria Met? | 100-Year Overtop? | Proposed Structure |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **SD R1** | 1 | City of Greeley | Poudre River Trail | Trail | 84-inch CMP | 6317 | 2.3 | 4695.89 | 4695.83 | --- | --- | 1.5 | 4700.31 | 4693 | Trail surface | HW:D | 4700.31 | >100-YEAR | < 2-YEAR | YES | YES | Replace CMP with RCP |
| | 2 | City of Greeley | Sheep Draw Nature Trail | Trail | 84-inch CMP | 6299 | 6.52 | 4699.97 | 4699.76 | --- | --- | 1.5 | 4702.3 | 4697 | Trail surface in LOB, overtopping upstream of structure | HW:D | 4702.30 | >100-YEAR | < 2-YEAR | YES | YES | Replace CMP with RCP |
| | 3 | City of Greeley | Greeley No. 3 Ditch | N/A | Concrete canal weir RCBC | 6299 | 4.8 | 4700.07 | 4699.95 | --- | --- | 1.5 | 4702.9 | 4697 | Trail surface in LOB, overtopping upstream of structure | HW:D | 4702.90 | >100-YEAR | < 2-YEAR | YES | YES | Spillway for minor flows |
| | 4 | Weld County | N/A | N/A | Irrigation water crossing: 1.5-foot diameter utility poles on upstream side of 15-inch PVC. PVC extends beyond utility poles. | 6299 | 5.01 | 4706.18 | 4705.86 | 2 | 4700.34 | --- | --- | 4703.78 | Bridge deck | Bridge FB | 4700.34 | < 2-YEAR | 10-YEAR | NO | YES | Existing, but assumed to be extended to span new channel improvements (private crossing) |
| | 5 | Weld County | N/A | N/A | Access bridge with railing | 6299 | 5.96 | 4707.55 | 4707.14 | 2 | 4700.27 | --- | --- | 4701.53 | Bridge deck | Bridge FB | 4700.27 | < 2-YEAR | < 2-YEAR | NO | YES | Existing, but road deck assumed to be extended to span new channel improvements (private crossing) |
| | 6 | City of Greeley and Weld County | C Street | Local | Metal/wood bridge with railing | 6299 | 7.6 | 4709.18 | 4708.31 | 1 | 4708.96 | --- | --- | 4710.64 | Bridge deck | Bridge FB | 4708.96 | 50-YEAR | >100-YEAR | NO | NO | 110-ft bridge, raise road 3.6 feet |
| | 7 | City of Greeley | Sheep Draw Trail | Trail | Double-barreled 36-inch CMP | 6194 | 7.87 | 4730.7 | 4729.86 | --- | --- | 1.5 | 4723.46 | 4724 | Trail surface | HW:D | 4723.46 | < 2-YEAR | < 2-YEAR | NO | YES | Replace CMP with RCP |
| | 8 | City of Greeley | 4th Street | Minor Arterial | Concrete bridge with pier and railing | 6194 | 4.98 | 4732.48 | 4732.09 | 1 | 4731.1 | --- | --- | 4735 | Bridge deck | Bridge FB | 4731.10 | 25-YEAR | >100-YEAR | NO | NO | Existing bridge with (1) 20'W x 10' H RCBC left of the bridge |
| | 9 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing | 6028 | 5.69 | 4736.86 | 4736.53 | 1 | 4731.18 | --- | --- | 4732.71 | Bridge deck | Bridge FB | 4731.18 | < 2-YEAR | < 2-YEAR | NO | YES | Existing |
| | 9.5 | City of Greeley | Sheep Draw Trail | Trail | Double-barreled 42-inch RCP | 5895 | 7.56 | 4748.06 | 4747.43 | --- | --- | 1.5 | 4741.47 | 4741.55 | Trail surface | HW:D | 4741.47 | < 2-YEAR | < 2-YEAR | NO | YES | Existing |
| | 10 | City of Greeley | 10th Street | Major Arterial | Concrete bridge with railing | 5895 | 8.72 | 4750.07 | 4748.98 | 1 | 4749.16 | --- | --- | 4756.00 | Bridge deck | Bridge FB | 4749.16 | 50-YEAR | >100-YEAR | NO | NO | Existing |
| | 11 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | 5895 | 10.32 | 4750.48 | 4749.59 | 1 | 4743.36 | --- | --- | 4745 | Bridge deck | Bridge FB | 4743.36 | < 2-YEAR | < 2-YEAR | NO | YES | Existing |
| | 12 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | 5895 | 5.57 | 4752.12 | 4751.8 | 1 | 4745.6 | --- | --- | 4747.00 | Bridge deck | Bridge FB | 4745.60 | < 2-YEAR | < 2-YEAR | NO | YES | Existing |
| **SD R2** | 13 | City of Greeley | Sheep Draw Trail | Trail | 36-inch RCP | 933 | 3.78 | 4762.72 | 4762.56 | --- | --- | 1.5 | 4758.94 | 4760.00 | Trail surface | HW:D | 4758.94 | < 2-YEAR | < 2-YEAR | NO | YES | Existing |
| **SD R3** | 16 | City of Greeley | 71st Avenue | Minor Arterial | Concrete bridge with pier and railing | 4442 | 5.78 | 4773.99 | 4773.52 | 1 | 4773.84 | --- | --- | 4775.70 | Bridge deck | Bridge FB | 4773.84 | 50-YEAR | >100-YEAR | NO | NO | Existing bridge with (1) 10'W x 8' H RCBC right of the bridge |
| | 17 | City of Greeley | Sheep Draw Trail | Trail | 7' span by 3' rise RCBC | 4442 | 5.46 | 4774.3 | 4774.03 | --- | --- | 1.5 | 4767.28 | 4767.31 | Road deck | HW:D | 4767.28 | < 2-YEAR | < 2-YEAR | NO | YES | Existing |
| | 18 | City of Greeley | Sheep Draw Trail | Trail | 46-inch CMP | 4442 | 3.22 | 4786.57 | 4786.39 | --- | --- | 1.5 | 4784.295 | 4782.00 | Trail surface | HW:D | 4784.30 | 5-YEAR | < 2-YEAR | NO | YES | Replace CMP with RCP |
| | 19 | City of Greeley | 83rd Avenue | Major Arterial | Concrete bridge with pier and railing | 4062 | 5.91 | 4809.69 | 4809.15 | 1 | 4808.92 | --- | --- | 4812.76 | Bridge deck | Bridge FB | 4808.92 | 10-YEAR | >100-YEAR | NO | NO | Existing bridge with (1) 16'W x 8' H RCBC right of the bridge |
| | 20 | City of Greeley | Sheep Draw Trail | Trail | Concrete bridge trail crossing with railing | 3897 | 4.96 | 4822.35 | 4821.97 | 1 | 4818.82 | --- | --- | 4820.10 | Bridge deck | Bridge FB | 4818.82 | 10-YEAR | 10-YEAR | NO | YES | Existing |
| | 21 | City of Greeley | 95th Avenue | Local | 22' span by 5' rise RCBC | 3536 | 8.78 | 4849.48 | 4848.3 | --- | --- | 1.5 | 4853.12 | 4851.97 | Road deck | Overtop | 4852.47 | >100-YEAR | >100-YEAR | YES | NO | (2) 20' W x 10' H RCBC |
| | 22 | City of Greeley | Highway 34 | Highway | 26' span by 4' RCBC | 2804 | 6.66 | 4852.7 | 4852.01 | --- | --- | 1.5 | 4856.18 | 4856.32 | Road deck | HW:D | 4856.18 | >100-YEAR | >100-YEAR | YES | NO | (2) 20' W x 10' H RCBC |
| | 23 | City of Greeley | Private driveway | N/A | 48-inch CMP | 2750 | 6.23 | 4864.29 | 4864 | --- | --- | 1.5 | 4864.09 | 4861.00 | Drive surface | HW:D | 4864.09 | >100-YEAR | < 2-YEAR | YES | YES | Replace CMP with RCP |
| **71st Ave Split** | 14 | City of Greeley | Sheep Draw Trail | Trail | Pedestrian bridge with 4.5' handrails and 30"x19" HERCP | 3001 | 5.25 | 4766.66 | 4766.42 | 1 | 4760.27 | 1.5 | 4763.23 | 4762.35 | Bridge deck | Bridge FB | 4760.27 | < 2-YEAR | < 2-YEAR | NO | YES | Existing |
| | 15 | City of Greeley | Sheep Draw Trail | Trail | 30"x19" HERCP | 2781 | 7.74 | 4770.77 | 4770.05 | --- | --- | 1.5 | 4764.07 | 4764.55 | Trail surface | HW:D | 4764.07 | < 2-YEAR | < 2-YEAR | NO | YES | Existing |

# CONCEPTUAL DESIGN HEC-RAS OUTPUT

## TABLE, PROFILES, AND CROSS SECTIONS

(DOUBLE-CLICK ICON ABOVE)

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# APPENDIX G

## CONCEPTUAL DESIGN MAPS

(DOUBLE-CLICK ICON ABOVE)

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# APPENDIX H

## CONCEPTUAL DESIGN PROFILES

(DOUBLE-CLICK ICON ABOVE)

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