VAN BIBBER CREEK

Draft Major Drainageway Plan

February 2021

1525 Raleigh St suite 400,
Denver, CO 80204

olsson | City of Arvada | Jefferson County Colorado | MHFD Mile High Flood District

February 17, 2020

Mrs. Brooke Seymour, PE, CFM
Project Manager, Watershed Services
Mile High Flood District
2480 W. 26th Avenue, Suite 156B
Denver, CO 80211

Re: Van Bibber Creek MDP
Agreement No. 19-08.11
Olsson Project No. 019-2294

Dear Mrs. Seymour:

Olsson is pleased to submit the final hydrology report for Van Bibber Creek. This report documents the baseline hydrology development process.

The updated hydrology report was prepared with the cooperation of MHFD, the City of Arvada, and Jefferson County. The information from this study provides the project sponsors with design flows to be used for future construction and development projects in the watershed.

We appreciate the opportunity to work with you on this project and look forward to developing alternatives to solve problems within the watershed.

Sincerely,

Deb Ohlinger, PE, CFM
Project Manager

Amy M. Gabor, PE, CFM, LEED® AP
Project Engineer

Madison Stewart, EI
Assistant Engineer

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ABBREVIATIONS INDEX

Arvada – City of Arvada
Ave – Avenue
Blvd – Boulevard
BMP – Best Management Practice
CDOT – Colorado Department of Transportation
CMP – corrugated metal pipe
CUHP– Colorado Urban Hydrograph Procedure
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
HSG – hydrologic soils group
I/Imp. – Imperviousness
LiDAR – light detection and ranging
MDP – Major Drainageway Plan
MDFD – Mile High Flood District
N – North
NLCD – National Land Cover Database
No. – Number
NOAA – National Oceanic and Atmospheric Administration
NRCS – Natural Resources Conservation Service
O&M – operations and maintenance
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
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

1.0 INTRODUCTION

1.1 Authorization

Olsson was retained to complete a Major Drainageway Plan (MDP) and Flood Hazard Area Delineation (FHAD) for Van Bibber Creek, co-sponsored by the Mile High Flood District (MHFD), Jefferson County, and City of Arvada (Arvada). The Agreement Regarding Major Drainageway Plan and Flood Hazard Area Delineation for Van Bibber Creek (Agreement No. 19-08.11) was executed on August 20, 2019.

1.2 Purpose and Scope

The purpose of this study was to update the hydrology, develop alternatives to alleviate potential flooding, and complete a conceptual design of the plan selected by the project sponsors. The hydrology was completed for the entire watershed. Proposed improvements will provide a guide for project sponsors to use for future construction projects for the reach of Van Bibber Creek within the MHFD boundary. The watershed is partially developed and the MDP will be used both to identify and rectify potential flooding hazards along Van Bibber Creek, as well as provide guidance to the project sponsors for future construction as the watershed continues to develop. The scope was modified to include Ramstetter Creek in the FHAD submittal.

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

- Collected existing information, including a previous FHAD and MDP, development drainage studies, and drainage improvement as-built plans
- Solicited input from project sponsors
- Obtained base mapping, structure surveys, and GIS information from MHFD, Jefferson County, and Arvada.
- Obtained future land use mapping from Arvada and Jefferson County
- Set up and maintained a project website linked to MHFD's website
- Determined subwatershed boundaries and parameters in accordance with MHFD criteria
- Developed existing and future (fully developed) conditions baseline hydrology using the Colorado Urban Hydrograph Procedure (CUHP) 2005, version 2.0.1 and the Environmental Protection Agency Stormwater Management Model (EPA SWMM) 5.1, version 5.1.013
- Calibrated peak flows upstream of Highway 93
- Reconciled the hydrology with previous studies
- Completed a report documenting the baseline hydrology

1.3 Planning Process

The effective hydrology of the Van Bibber Creek watershed was completed for the *Major Drainageway Planning: Van Bibber Creek* by Gingery Associates, Inc. in March 1977 upstream of Indiana Street and the *Major Drainageway Panning Study for Lower Ralston/Van Bibber and Leyden Creeks* prepared by Wright Water Engineers, Inc. in February 1986 (1986 MDP) below Indiana Street, according to the Flood Insurance Study (FIS) for Jefferson County and Incorporated Areas, dated December 20, 2019. The hydrology development was discussed in greater detail in the *Major Drainageway Panning Study for Lower Ralston/Van Bibber and Leyden Creeks Phase A Report* by Wright Water Engineers dated March 1984.

The baseline hydrology developed for this study represents an updated analysis using CUHP 2005, version 2.0.1 and EPA SWMM, version 5.1.013. Further information regarding the hydrologic modeling process is included in Section 3.0.

A kickoff meeting was held on September 11, 2019 to discuss the project goals, hydrologic analysis, and areas of concern with MHFD, Jefferson County, and Arvada. Three meetings were held to discuss hydrology results and calibration on April 30, July 28, and October 5, 2020, as discussed in Section 3.6. Minutes from the meeting are included in Appendix A.

MHFD, Jefferson County, and Arvada reviewed the draft baseline hydrology, draft alternatives analysis, and draft conceptual design and returned comments on April 9, 2020, XXXX, and XXXX, respectively. The comments were incorporated into this final report. Summaries of the key review comments and responses for the draft hydrology, alternatives analysis, and draft conceptual design are supplemented in the meeting minutes for the April 30, 2020, XXXX, and XXXX meetings, respectively, included in Appendix A.

1.4 Mapping and Surveys

MHFD provided 1-foot (ft) interval 2013 LiDAR mapping for the entire Van Bibber Creek watershed. The LiDAR mapping is referenced to the NAVD 88 vertical datum and the NAD 83 horizontal datum. The road crossing structures were surveyed by Wilson & Company, Inc. Jefferson County and Arvada provided GIS files of parcels, street centerlines, trails, zoning, and some utilities in the watershed.

1.5 Data Collection

Drainage studies and as-built plans were collected from MHFD, Jefferson County, and Arvada. The Jefferson County, Colorado and Incorporated Areas FIS and Flood Insurance Rate Maps (FIRMs) were obtained from the Federal Emergency Management Agency (FEMA). The main studies and plans that were reviewed in the preparation of this report are shown in Table 1. A list of all studies reviewed in the preparation of this report is shown in Section 7.

Table 1 – Data Collected

Title	Date	Author
Van Bibber Creek: Major Drainageway Planning – Phase A	December 1974	Frasier & Gingery, Inc.
Van Bibber Creek: Major Drainageway Planning – Phase B	March 1977	Gingery Associates, Inc.
Major Drainageway Planning: Lower Ralston/Van Bibber/ Leyden Creeks – Phase A Report	March 1984	Wright Water Engineers, Inc.
Major Drainageway Planning: Lower Ralston/Van Bibber/ Leyden Creeks – Phase B Report	February 1986	Wright Water Engineers, Inc.
Van Bibber Creek FHAD	January 1974	Urban Drainage and Flood Control District
Ralston Creek – Leyden Creek FHAD	June 2004	Boyle Engineering Corporation
Comprehensive Master Plan	November 8, 2017	Jefferson County Planning and Zoning Division
Zoning Map	June 2019	Jefferson County
Future Land Use Map	July 16, 2018	City of Arvada
Radar Rainfall Analysis	July 2, 2020	Vieux & Associates

1.6 Acknowledgements

The MDP was prepared with the cooperation of MHFD, Jefferson County, and the City of Arvada. The representatives who were involved with this study are listed in Table 2.

Table 2 – Project Participants

Name	Representing	Assignment
Brooke Seymour	MHFD	Project Manager, Watershed Services
Andy Stewart	City of Arvada	Project Sponsor
John Conn	Jefferson County	Project Sponsor
Lauren Copenhagen	Jefferson County	Project Sponsor
Deb Ohlinger	Olsson	Project Manager
Amy Gabor	Olsson	Project Engineer
Michelle Danaher	Olsson	Associate Engineer
Madison Stewart	Olsson	Assistant Engineer

2.0 STUDY AREA DESCRIPTION

2.1 Project Area

Watershed and Drainageway Description

The 17.4 square mile Van Bibber Creek watershed, Reuse number 4306, includes the 2.7 square mile Ramstetter Creek Tributary watershed. The overall Van Bibber Creek watershed extends from east of Mount Tom to its confluence with Ralston Creek, south of Ralston Road and west of Garrison Street. The watershed extends through Jefferson County and Arvada, as shown on Figure 1. The watershed is approximately 13.5 miles long and 2.7 miles wide. Van Bibber Creek generally slopes down toward Ralston Creek in an eastern direction, with slopes generally ranging from 0.4 to 12 percent (%). The lowest and highest watershed elevations are 5338 and 9734, respectively.

Reservoirs

Four large, off-stream reservoirs are located in the watershed: Hyatt Lake, Broad Lake, Ramstetter Reservoir, and Kelly Lake. None of these reservoirs were included in the baseline hydrology for this study.

Existing Regional Detention Basins

No regional detention basins exist in the watershed.

Irrigation Ditches

Three irrigation ditches cross the Van Bibber Creek watershed. Church Ditch crosses Van Bibber Creek approximately 1,700 feet downstream of Easley Road. The Highline Canal crosses the creek just west of McIntyre Street. The Croke Canal crosses Van Bibber Creek approximately 1,400 feet downstream of McIntyre Street, and carries water adjacent to Hyatt Lake.

Soils

Soil types were determined using the Natural Resources Conservation Service (NRCS) Web Soil Survey. The soils in the watershed consist primarily of hydrologic soils groups (HSG) C and D, which are generally characterized by low infiltration rates, as defined by the NRCS. Significant areas of HSG B soils, generally characterized by moderate infiltration rates, are also present, primarily near the drainageway of Van Bibber Creek. Only a small area of HSG A soils, which are generally characterized by high infiltration rates, is present in the watershed. The soils map is included on Figures B-1A through B-1C in Appendix B.

2.2 Land Use

The watershed is partially developed, with areas of land that remain undeveloped, primarily west of Highway 93. Existing development consists mostly of single-family residential. Pockets of industrial, commercial, and open space/recreational areas are also present. Existing land use was verified using aerial imagery and site visit observations.

Outside of the existing developed area and the western portion of the watershed that is to remain undeveloped, future land use will consist mostly of residential and mixed-use areas, with some areas of industrial, school, and commercial. Future land use information was obtained from Jefferson County and Arvada zoning maps, included in Appendix B, and GIS information. Additional discussion of land uses and corresponding percent impervious values is included in Section 3.3.

2.3 Reach Description

This section, along with Table 3, will be completed with the alternatives analysis.

2.4 Flood History

The FIRMs show a FEMA-designated Zone AE floodplain with pockets of Zone AO and Zone X, on Van Bibber Creek form the confluence with Ralston Creek, up to approximately 1 miles west of Highway 93, where it switches to a Zone A floodplain up to Glencoe Valley Road. A floodway is defined from the downstream end, up to Miller Street. A FEMA-designated Zone AE floodplain on Ramstetter Creek (shown as Van Bibber Creek Tributary on the FIRM panels) extends from the confluence with Van Bibber Creek, up to Ramstetter Reservoir. The FEMA FIRM panels are included in Appendix C. Several Letters of Map Revisions (LOMR) have been completed along Van Bibber Creek.

Areas of concern and observed problem areas were discussed at the kickoff meeting. Specific areas of concern were not noted. The sponsors' main project goals were to update the previous study to have better information regarding flood risk and drainage problems and to have a better effective floodplain model for use in the CLOMR/LOMR process.

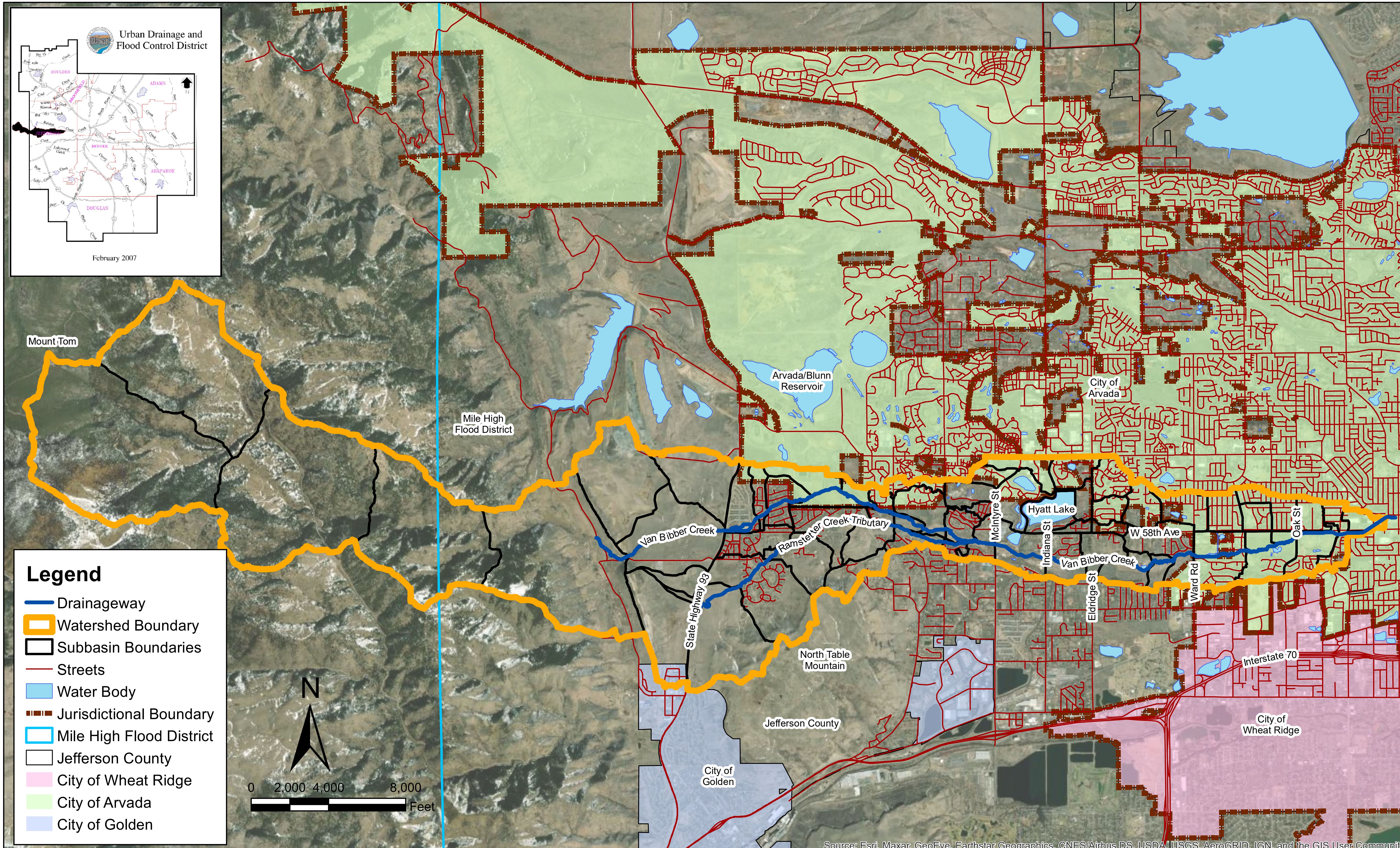
Water & Earth Technologies completed the *September 11-13, 2013 Arvada Flood Event Reconstruction and Documentation* report in March 2014 (2014 WET Report). The report documents flooding that occurred along the Croke Canal from stormwater that was intercepted from Van Bibber Creek, Moon Gulch, and Ralston Creek. The stormwater that entered the Croke Canal from Van Bibber Creek was a result of the capacity of the siphon that conveys the creek below the canal being exceeded, resulting in the canal embankment being overtopped. It was noted in the report that this interception likely occurs frequently. Outside of the Croke Canal flooding, the 2014 WET Report states that few problems were reported during the 2013 storm along Van Bibber Creek.

The Urban Drainage and Flood Control District April 2009 *Ralston Creek Flood Warning Plan* report included the following flooding information:

> *2003, July 29. A strong thunderstorm developed approximately 1 mile north of Golden near the Van Bibber Creek basin between 1:00 pm and 3:00 pm. Heavy rainfall caused flooding and flash flooding problems in central Jefferson County. State Highway 93, north of Golden, was closed due to flooding. In Golden, flash floods left several backyards and basements full of standing water. At least one car was submerged in a garage. Radar estimated 1 to 1.5 inches of rain had fallen in the area in approximately 30 minutes.*

2.5 Environmental Assessment

This section will be completed with the alternatives analysis.



PROJECT: 019-2294 DRAWN BY: MS DATE: 2/2021	MILE HIGH FLOOD DISTRICT, CITY OF ARVADA, AND JEFFERSON COUNTY	VAN BIBBER CREEK STUDY AREA MAP	olsson	1525 Raleigh Street Suite 400 Denver, CO 80204	TEL: 303.237.2072 FAX: 303.237.2659 www.olsson.com	FIGURE 1

3.0 HYDROLOGIC ANALYSIS

3.1 Overview

Hydrology was developed for the baseline condition using existing infrastructure, for both existing and future (fully developed) land uses. 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 5.1.013, to determine peak discharge rates at select design points. The updated EPA SWMM results were compared to the 1977 Phase B, 1986 MDP, and 2004 Ralston FHAD. The hydrology comparison is detailed in Section 3.6 and shown in Table 8.

3.2 Design Rainfall

One-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. Area adjustments were used for the 2-, 5-, and 10-year storm events with tributary drainage basins greater than 5 square miles, 10 square miles, and 15 square miles. Area adjustments were used for the 25-, 50-, 100-, and 500-year storm events with tributary areas greater than 15 square miles. When the 25-, 50-, 100-, and 500-year storm events were corrected for the 15 square mile watershed, it resulted in a significant decrease in peak flows where the area adjustment was applied, and where it was not. After evaluating the peak flows, it was determined to start the 15 square mile area adjustment downstream of the Ramstetter Creek confluence, with a tributary area greater than 13.7 square miles. The minor storm events were not modified and do not apply the 15 square mile adjustment until the tributary area is at 15 square miles. Area correction values are included in Table 5. Tables of the adjusted and unadjusted rainfall distributions for each storm event are included as Tables B-1A through B-1D, in Appendix B.

Table 4 - One-Hour Point Rainfall (inches)

Duration	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
1-Hour	0.763	1.03	1.27	1.63	1.93	2.24	3.04
6-Hour	1.20	1.58	1.93	2.43	2.85	3.29	4.42

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**	**10**	**15**	**0**	**13.7**
5	1	1	1	1	1	1.15
10	1	1	1	1	1	1.15
15	1	0.97	0.94	0.91	1	1.15
20	1	0.86	0.75	0.68	1	1.25
25	1	0.86	0.75	0.68	1	0.73
30	1	0.86	0.75	0.68	1	0.73
35	1	0.97	0.94	0.91	1	0.73
40	1	0.97	0.94	0.91	1	1.05
45	1	1	1	1.02	1	1.20
50	1	1	1	1.02	1	1.15
55	1	1	1	1.02	1	1.15
60	1	1	1	1.02	1	1.15
65	1	1	1	1.02	1	1.08
70	1	1	1	1.02	1	1.08
75	1	1	1	1.02	1	1.08
80	1	1	1	1.02	1	1.08
85	1	1	1	1.02	1	1.08
90	1	1	1	1.02	1	1.08
95	1	1	1	1.02	1	1.08
100	1	1	1	1.02	1	1.08
105	1	1	1	1.02	1	1.08
110	1	1	1	1.02	1	1.08
115	1	1	1	1.02	1	1.08
120	1	1	1	1.02	1	1.08
125-180	---	---	---	1.00	---	1.08
185-360	---	---	---	1.23	---	1.05

3.3 Subwatershed Characteristics

A summary of the CUHP 2.0.1 model parameters can be found in Appendix B. The 2013 LiDAR mapping, structure survey information, as-built drawings, drainage studies, aerial imagery, and future land use maps were used to determine input parameters.

Subwatershed Delineation
The overall watershed boundary was delineated using LiDAR mapping and then checked for general agreement with previous studies.

In the first iteration of subwatershed delineation and peak flow calculations the Van Bibber Creek watershed was divided into 140 subwatersheds at an average size of 79.7 acres. The CUHP model results from that iteration gave higher than reasonable peak flows coming from the upper watershed at the hogback. After consulting with the project sponsors during the April 30, 2020 meeting, the upper watershed area was re-delineated to be seven larger subbasins. The meeting minutes leading to this decision are shown in Appendix A.

In the second iteration of subwatershed delineation and peak flow calculations the Van Bibber Creek watershed was divided into 77 subwatersheds at an average size of 144.9 acres. After consulting with project sponsors during the July 28, 2020 meeting, the Ramstetter Creek subbasins and all subbasins upstream of Highway 93 that have areas of steep were re-delineated to be larger subbasins. The meeting minutes leading to this decision are shown in Appendix A.

The final iteration of the Van Bibber Creek watershed was divided into 63 subwatersheds that were delineated based on the LiDAR mapping MHFD provided (Section 1.4), various drainage studies, and site observations. Subwatershed boundaries reflect the overland flowpaths and generally do not reflect storm drain systems, with the exception of Subbasin 0. Van Bibber Creek is primarily conveyed in a storm drain system in Subbasin 0 to its confluence with Ralston Creek. The Subbasin 0 boundary was delineated based on the storm drain system inflow locations. The subwatersheds range in size from 20.8 acres to 1,378.7 acres, with an average subwatershed size of 177.0 acres.

Pursuant to MHFD policy, Ramstetter Reservoir, Hyatt Lake, Broad Lake, Church Ditch, Highline Canal, and Croke Canal were assumed to be at full capacity for the baseline hydrology, so stormwater runoff would flow over the canals and lake/reservoir low points. The subwatersheds are shown on Figures B-1A through B-1C in Appendix B.

Length, Distance to Centroid, Slope
The LiDAR data and structure survey information were used to determine subwatershed flow path lengths, distance to centroid values, and slopes. Flow paths were based on major drainage overland paths and, therefore, storm drain systems were not modeled, with the exception of the major storm drain system that conveys Van Bibber Creek at the downstream end. Private detention facilities and irrigation reservoirs were not included in the model. Where private detention basins and irrigation reservoirs 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. To check these two scenarios, the following equations were used:

r = Length to Centroid / Total Length (if $0.1 \le r < 0.3$, 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 more winding flow paths, which results in longer flow paths. The subwatersheds with questionable r values had reasonable unit discharges, as compared to similar subwatersheds.

The Van Bibber Creek watershed generally slopes down toward the east. Subbasin flow path slopes ranged from 0.01 to 13.5 percent (%). The lowest and highest watershed elevations are 5338 and 9734, respectively. Slopes were estimated using the weighted slope equation from the CUHP manual.

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

For subbasins with slopes greater than 4 percent, a slope correction was applied based on Figure 6-4: Slope Correction for Streams and Vegetated Channels, in the MHFD *Urban Storm Drainage Criteria Manual Volume 1* (USDCM). The subbasins eligible for slope correction were generally in the upper watershed. A table of the slopes and slope adjustments is included in Table B-2, in Appendix B.

Watershed Imperviousness
The existing and future land uses are discussed in Section 2.2. To determine the existing conditions percent imperviousness, the 2016 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 2016. Aerial imagery from 2016 was compared to 2019 aerial imagery to determine areas in the watershed that developed after the database was compiled. These areas of post-2016 development were added into the existing conditions percent imperviousness calculations.

After the aforementioned changes were made to the NLCD percent imperviousness values, the percent impervious values were spot checked for accuracy and were determined to be acceptable. The overall existing percent imperviousness of the watershed is 11.1%. The existing percent impervious values for each subbasin are shown on Figures B-1A through B-1C, in Appendix B.

To determine appropriate future land use percent imperviousness values in the undeveloped portions of the watershed, the zoning descriptions and MHFD's USDCM Table 6-3 were used. The future land use designations and corresponding percent imperviousness values were discussed with the project sponsors and are shown in Table 6. The overall future percent imperviousness of the watershed was estimated to be 18.3%. The future land use areas and future percent impervious values for each subbasin are shown on Figures B-1A through B-1C, in Appendix B.

Table 6 - Land Uses and Corresponding Impervious Values

Jurisdiction	Land Use	Percent Imperviousness
Jefferson County	Open Space/Public	2
Arvada		
Jefferson County	Agricultural	12
Jefferson County	Low Density Residential	45
Arvada		
Jefferson County	Medium Density Residential	55
Arvada		
Jefferson County	School	55
Jefferson County	Industrial	80
Arvada		
Jefferson County	Mixed Use	85
Arvada		
Jefferson County	Commercial	95
Arvada		

Depression Losses

Depression losses were determined using Table 6-6 in the USDCM. A weighted average was used for the depression losses in each subbasin, based on land use designation. A pervious depression loss of 0.35 inches, which represents lawns and grass, 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 0.07, 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.

Infiltration

Initial and final infiltration rates and Horton's decay rate were determined using Table 6-7 in the USDCM and are shown in Table 7. A weighted average of soil type was used to determine subwatershed rates. The hydrologic soil groups are shown on Figures B-1A through B-1C, 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

Pursuant to MHFD's policy to recognize only regional and publicly-owned facilities, private detention basins, irrigation reservoirs, and inadvertent detention areas were not modeled. No detention was included in the baseline hydrology.

3.5 Hydrograph Routing

The parameters for the EPA SWMM model conveyance elements were determined using the LiDAR data and structure survey information. Channel geometry was determined using the LiDAR mapping; sections that could not be defined by a trapezoidal section were modeled as irregular composite sections. For flows that are conveyed via streets, the street sections were modeled as irregular sections, separated by minor and major road type. Overflow elements were added where they were needed to convey the full future 500-year storm event to ensure no inadvertent detention was being modeled at these locations. The underground storm drain system was not modeled, except for the major storm event pipe at the downstream end of Van Bibber Creek.

The Manning's n values for engineered conveyance elements, including engineered channels, pipe, and street, were increased 25 percent in accordance with the USDCM. Channel section Manning's n values ranged from 0.04 to 0.08 in the model. Street section Manning's n values were set at 0.016, or 0.02 in the model. Concrete pipe Manning's n values were set at 0.015, or 0.019 in the model.

The EPA SWMM 5.1 input parameters and 100-year future conditions output are included in Appendix B. EPA SWMM 5.1 model elements, including subwatersheds, design points and conveyance elements are shown on Figures B-1A through B-1C and a schematic of the model is shown on Figures B-2A through B-2B in Appendix B. No flow diversions were included in the analysis.

3.6 Previous Studies

Van Bibber Creek has been studied in several previous studies. The most recent hydrology studies include the 1986 MDP and the hydrology that was completed for the *Flood Hazard Area Delineation: Ralston Creek – Leyden Creek* in June 2004 (2004 FHAD) by Boyle Engineering Corporation. The 1977 Phase B hydrology is the basis for the effective peak flows upstream of Indiana Street and the 1986 MDP is the basis for the effective peak flows downstream of Indiana Street. Documentation of the 2013 flood impacts was prepared in 2014 WET Report. This document does not assess the watershed but does offer valuable insight as to realistic values for peak flows during a 100-year storm through measured data.

A comparison of 100-year peak flows from the 1977 Phase B, 1986 MDP, 2004 FHAD, and this study is shown in Table 8. Differences and similarities between the 1977 Phase B, 1986 MDP, 2004 FHAD, and this study are noted below.

- All four studies have similar watershed areas, ranging between 17.1 square miles and 17.7 square miles.

- The 1977 Phase B was divided into eight subbasins, and the 1986 MDP and 2004 FHAD were divided into 13 subbasins for the Van Bibber Creek watershed, whereas this study was divided into 63 subbasins.

- Rainfall values and distributions differed between the studies. The 100-year point rainfall value used in this study was 2.24 inches. The point rainfall used in the 1977 FHAD and 1986 MDP were lower than this study, ranging between 1.75 inches and 2.15 inches. The 2004 FHAD point rainfall values were higher, ranging from 2.4 inches to 2.65 inches. All four studies used different distribution and area correction factors.

- The 1977 Phase B, 1986 MDP, 2004 FHAD, and this study used an overall future percent imperviousness value of 18.5%, 11.4%, 11.0%, and 18.3%, respectively. The 1977 Phase B and this study match closely, whereas the future percent imperviousness in the 1986 MDP and 2004 FHAD are much closer to the existing conditions percent imperviousness in this study, which is 11.1%.

- The previous studies did not include a slope adjustment. Over 8 square miles of the watershed in the previous studies was modeled very steep. This study adjusted the CUHP slopes based on MHFD criteria, with a maximum 6% slope.

- The 1977 Phase B and 1986 MDP used MITCAT to calculate peak flows, the 2004 FHAD used CUHP 2000 and UDSWMM, and this study used CUHP v. 2.0.1 and EPA SWMM 5.1.013.

- The 2004 FHAD hydrology files were available for review. The 2004 FHAD used significantly wider channel sections than this study, which matches the LiDAR, to route peak flows. It is likely that all of the older studies used similar channel geometries.

Extensive calibration and comparison efforts were completed for this study, as documented in detail in the April 30, 2020, July 28, 2020, and October 5, 2020 meeting minutes in Appendix A. A summary of the calibration is included herein. First, the upper watershed was calibrated using 2013 storm event gage data and Jarrett's initial discharge measurement of 750 cfs. It was determined that using larger subbasins in this steep terrain resulted in peak flows that closely matched Jarrett's initial discharge measurement when the 2013 storm event was modeled. The upper watershed was divided into 7 subbasins during calibration with areas ranging from 368 acres to 1,379 acres.

Following this initial calibration analysis, MHFD worked with WET, WWE, and Bob Jarrett to re-evaluate the estimated 2013 storm event peak flow at Highway 93. It was determined that the peak flow at Highway 93 during the 2013 storm event was 394 cfs, instead of the initial estimate of 750 cfs. To calibrate the upper model, the peak runoff coefficient (C_p) values of the seven upper subwatersheds (45 through 51) were multiplied by a factor that was iterated until the resulting peak flow at Highway 93, Design Point 145, was approximately 394 cfs during the 2013 storm event. The unadjusted C_p values for the upper watershed basins were multiplied by a factor of 0.48 resulting in a flow at Highway 93 of 395 cfs, compared to the 394 cfs. Following the 2013 storm event calibration process, separate CUHP models were created for each storm event overriding the upper watershed C_p values with a correction factor of 0.48 for Subwatershed 45 through 51. A summary of the CUHP 2.0.1 model parameters, including the C_p override values, can be found in Appendix B.

After the upper watershed was calibrated, the lower watershed was evaluated in more detail. Portions of the Ramstetter Creek watershed originate on North Table Mountain. A similar approach to the upper watershed was used, where larger subbasins were used in steep areas. It was determined that the wide channel geometries used in the older studies significantly reduced peak flows. When these channel geometries were used in this study's model, the peak flows generally had good agreement; therefore, it was determined that the differences in channel geometries was a significant cause for the differences in peak flows. The higher peak flows in this study are a result of using the LiDAR for channel geometries, which better approximates the existing channel geometry.

The "EX Q100" and "FTR Q100" peak flows shown in Table 8 represent the existing land use and future land use baseline hydrology from this study. The peak flows in this study are similar to previous studies. Differences are primarily a result of different rainfall values and distributions, different modeling approaches, different slopes in the steep upper section of the watershed, and different channel geometries used for routing peak flows. The previous studies had approximate unit discharges of 0.3 cubic feet per second (cfs) per acre. After calibration, the overall unit discharge in this watershed is 0.34 cfs per acre for future land use conditions.

Table 8 – Previous Studies Hydrology Reconciliation

Reference Location	1977 Phase B	1986 MDP	2004 FHAD	2020 MDP			Comparisons		
	Future 100-Year Peak Discharge (cfs)			Design Point	Peak Discharges (cfs) EX Q100	Peak Discharges (cfs) FTR Q100	% Diff (FTR Q100 to 1977 Ph B Q100)	% Diff (FTR Q100 to 1986 MDP Q100)	% Diff (FTR Q100 to 2004 FHAD Q100)
Confluence w/ Ralston Creek	3,450	2,700	3,157	100	3,343	3,815	-3%	24%	6%
Confluence of Ramstetter	2,750	2,400	---	134	3,136	3,473	14%	31%	---
Hogback	1,570	1,800	2,833	149	1,704	1,704	9%	-5%	-40%
Ramstetter Creek at Confluence w/ Van Bibber	1,400	1,100	---	R101	1,626	1,759	16%	48%	---

3.7 Results of Analysis

In general, the peak flows are similar to the previous studies, 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 5.1 design points can be found in Table B-3 and B-4, respectively, in Appendix B. The peak discharges and volumes versus channel station for Van Bibber Creek and Ramstetter Creek are shown in Tables B-5 through B-8 and are also shown in Figures B-3A and B-3B, in Appendix B. Select SWMM generated hydrographs are included as Figure B-4, in Appendix B.

4.0 REFERENCES

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APPENDIX A

PROJECT CORRESPONDENCE

olsson

KICKOFF MEETING MINUTES

Van Bibber Creek MDP and FHAD
Wednesday, September 11, 2019
10:30 am at Mile High Flood District

Attendees:

Name	Company	E-mail
John Conn	Jefferson County	jconn@co.jefferson.co.us
Robyn Brown	Arvada	robrown@arvada.org
Brooke Seymour	Mile High Flood District (MHFD)	bseymour@udfcd.org
Deb Ohlinger	Olsson	dohlinger@olsson.com
Amy Gabor	Olsson	agabor@olsson.com
Michelle Danaher	Olsson	mdanaher@olsson.com

Discussion Items:

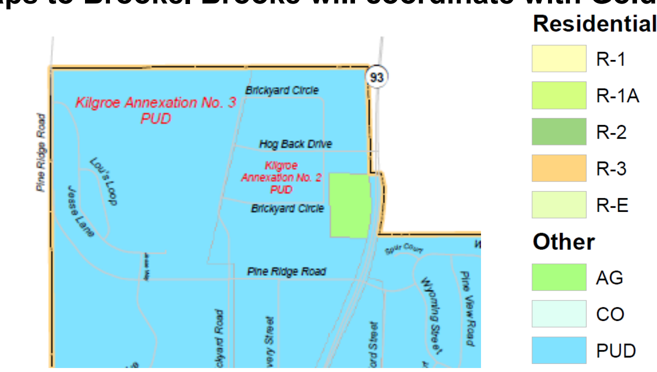
The main purpose of the meeting was to discuss the start of the project. While this summary is not intended to represent a comprehensive account of the meeting, it is intended to reflect the key points raised and issues for further consideration and to identify the action items resulting from the discussions. The non-bold items comprised the meeting agenda. The items in bold resulted from the discussions.

1) Introductions
   a) Other invitees to meetings?
      i) **Bill Jennings will be invited and cc'd on project meetings and correspondence.**

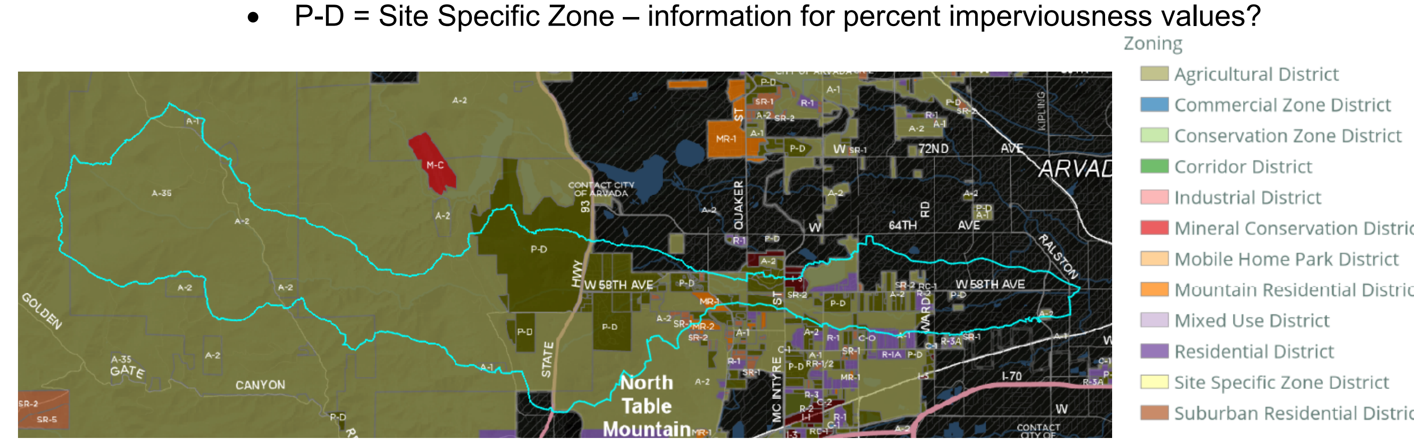
2) Project goals
   a) Main areas of concern
      i) **The main project goal from Arvada's and Jefferson County's standpoints is to update the old study and have better information on flood risk and drainage problems.**
      ii) **The main project goal from MHFD's perspective is to have a better floodplain model that more accurately identifies flood risk. An updated model will make the CLOMR/LOMR process easier because the effective model will have more realistic tie-ins.**
      iii) **Hydrology will be completed for the whole watershed but master planning will be within the District boundary.**

   b) Observed problems/issues?

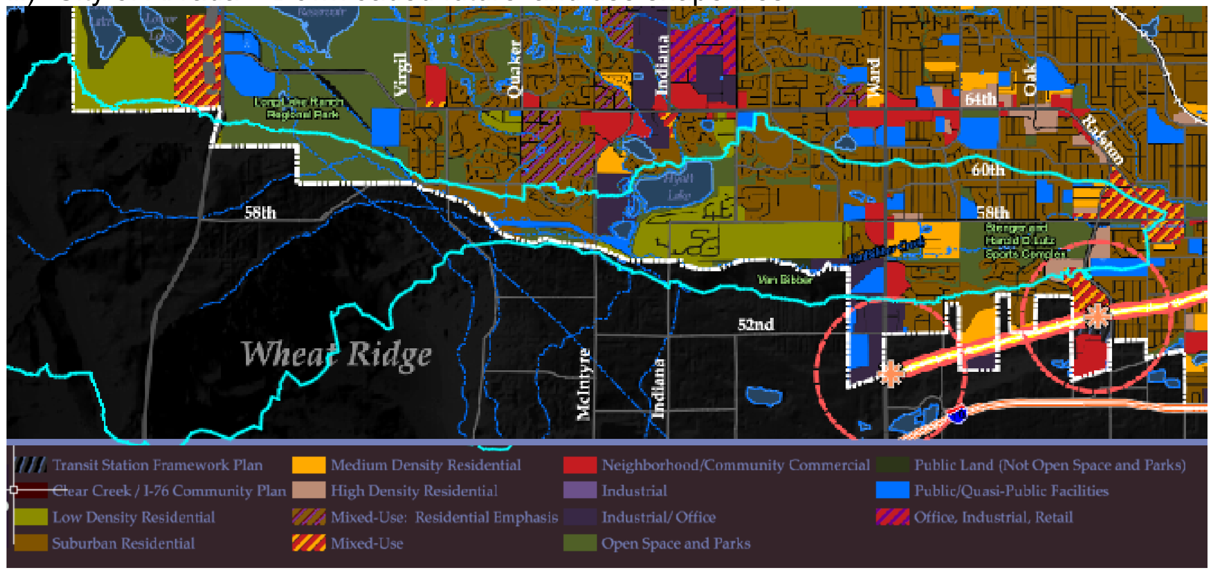
3) Needed information
   a) GIS contours – *already provided*
   b) Abutting watershed boundaries – *already provided*
   c) GIS
      i) Downloaded parcels, roads, zoning from Arvada and Jefferson County websites
      ii) Need utilities
         - **Olsson will send a shapefile of the area of interest to Arvada and Arvada will provide utility shapefiles.**
         - **Jefferson County does not have utility shapefiles. John will investigate whether they have storm sewer information for the newer developments near Highway 93. The County has very few utilities in the area. North Table Mountain Water and Sanitation District and others have utilities in the area.**
         - **A large Denver Water conduit likely crosses Van Bibber. Olsson will contact Denver Water for information on the crossing. (After the meeting, information on Denver Water's website was consulted and the conduit crosses Van Bibber where the creek crosses 60th Avenue. It is a 66-inch and 72-inch pipe in the area.)**
   d) Future land use (existing land use will be National Land Cover Data base)
      i) Small area in Golden – use City of Golden land use maps **– Olsson will send maps/link to maps to Brooke. Brooke will coordinate with Golden to verify the accuracy of the maps.**



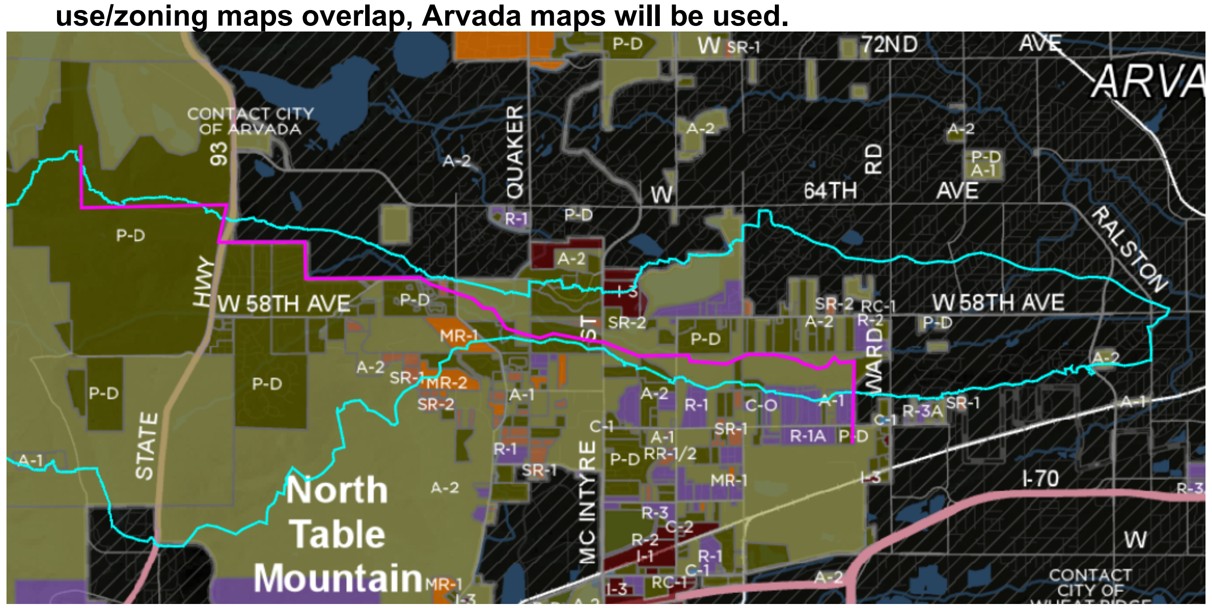
      ii) Jefferson County – downloaded zoning shape files
         - P-D = Site Specific Zone – information for percent imperviousness values?



iii) City of Arvada – Downloaded future land use shape files



iv) Area of overlap between Jefferson County maps and Arvada maps – which to use? **Where land use/zoning maps overlap, Arvada maps will be used.**



e) Proposed development drainage reports, if any
f) Structure surveys – *already provided*
   i) **Brooke will send a Dropbox link to everybody (Arvada, Jefferson County, Olsson)**
g) Ponds – any regional detention?
   i) Broad, Hyatt, or Kelly Lakes?
   ii) Design plans (1982) for detention on Van Bibber Creek west of Ward Road
   iii) **No regional detention is known in the watershed. Brooke will double check MHFD adequate assurance agreements.**
h) As-constructed documents for channel projects
   i) Have plans for near new Kipling

- **A non-regulatory floodwall is reflected in the effective mapping on the parcel north of 58th Avenue. It will not be reflected in the FHAD.**
- **Planned development north of 58th near Kipling.**

4) New hydrology to be developed
   a) Use EPA SWMM 5.1.013 and CUHP 2.0.0
   b) Existing and future land use?
      i) **Olsson will compare the existing and future percent imperviousness. Due to the nature of the watershed, we will likely develop flows for both conditions. That decision will be made once the impervious values have been compared.**
   c) Detention to be included in baseline hydrology?
      i) Storage-discharge information
         - LiDAR
         - As-builts or survey

5) Schedule to follow agreement
   a) Draft hydrology due November 20, 2019 (10 weeks from today)

6) Upcoming meetings
   a) During hydrology
   b) After hydrology review

7) Other

   a) Near the intersection of Violet Way and 60th Avenue, fill has been recently placed near the creek. The area is within Arvada. Robyn will investigate what work was permitted and if they have survey from the project.

   b) A new bridge is currently under construction on McIntyre at Van Bibber Creek. Muller will move forward with the LOMR process. We will check in regarding LOMR/FHAD timing when we get to the FHAD phase.

      i) Jefferson County will furnish as-builts when the project is complete.

   c) RESPEC is completing a stormwater master plan for Arvada. They have delineated some sub-basins as a part of that effort. Arvada will send a link to the RESPEC map.

   d) The standard interactive hydrology map will be used.

Action Items:

Olsson

- **Send Arvada a boundary for utility shapefiles.**
- **Send MHFD Golden's land use maps**

MHFD

- **Send Dropbox link with structure surveys**

- **Coordinate with Golden to verify accuracy of land use maps.**

Arvada

- **Send utility GIS data.**
- **Investigate the approved plan/survey for fill area near Violet Way and 60th Avenue.**
- **Provide any drainage reports for developments.**
- **Send RESPC basin map and information regarding Hyatt and Broad lakes that was provided to Arvada.**
- **Send any known flooding problems.**

Jefferson County

- **Check for storm sewer information for the developments near Highway 93 and 58th Avenue.**
- **Check on “P-D” developments/land use.**
- **Provide any drainage reports for developments.**
- **Provide McIntyre Street bridge as-builts.**
- **Send any known flooding problems.**

Please contact Olsson at 303-237-2072 with any 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, Bill Jennings

Hydrology Comments Meeting Minutes

Van Bibber Creek Major Drainageway Plan
Thursday, April 30, 2020
11:00 am Virtual Meeting on Microsoft Teams

Attendees:

Name	Company	E-mail
John Conn	Jefferson County	jconn@co.jefferson.co.us
Jacob Beedle	Arvada	jbeedle@arvada.org
Andy Stewart	Arvada	astewart@arvada.org
Brooke Seymour	MHFD	bseymour@udfcd.org
Kevin Stewart	MHFD	kstewart@udfcd.org
Shea Thomas	MHFD	sthomas@udfcd.ord
Amy Gabor	Olsson	agabor@olsson.com
Deb Ohlinger	Olsson	dohlinger@olsson.com
Madison Stewart	Olsson	mstewart@olsson.com

Discussion Items:

The main purpose of the meeting was to discuss if and how to calibrate peak flows for the Van Bibber Creek watershed. Specifically, to discuss the high peak flows coming from the foothills as a result of discretizing individual subbasins in the foothills for use in CUHP. 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
2) Peak flow comparisons

Table 1: Calculated 100-Year Peak Flows

Study	Location	Date	Tributary Area (ac)	Tributary Area (sm)	100-Year Peak Flow (cfs)	Unit Discharge (cfs/acre)
Draft 2020 MDP (Future Conditions)	DP 100 @ confluence with Ralston (Total/Downstream of DP157T)	2020	11154	17.43	7618	0.7
			5836	9.12	5739	1.0
Draft 2020 MDP (Future Conditions)	DP134 @ confluence w/ Ramstetter (Total/Downstream of DP157T)	2020	8761	13.69	6884	0.8
			3443	5.38	4028	1.2
Draft 2020 MDP (Existing/Future Conditions)	DP157T @ Hwy 93	2020	5318	8.31	5,216	1.0
One Basin Draft 2020 MDP (Existing/Future Conditions)	DP157T @ Hwy 93	2020	5318	8.31	2,198	0.4
StreamStats (Existing Conditions - Average)	DP157T @ Hwy 93	2020	6016	9.4	523	0.1

Results from the Draft 2020 MDP are not completely unexpected because of the limitations and intended use of CUHP. MHFD expected flows from the foothills to realistically look more like the One Basin Draft 2020 MDP results (see above). CUHP was not calibrated for areas like the foothills, where much more runoff infiltrates. Streamstats should not be considered when calibrating flows originating from the foothills because there is not enough historical data backing it.

Table 2: 100-Year Peak Flow Comparison

Stream	Design Point	Tributary Area (sm)	100-Year Peak Flow (cfs)	Unit Discharge (cfs/acre)
Van Bibber Creek	157T	8.31	5216	1.0
Dutch Creek	D-1	2.3	1210	0.8
Massey Draw	123	5	2070	0.6
Mt Vernon Creek	Mouth	10	4395	0.7
Tucker Gulch	Mouth	11	2800	0.4
Ralston Creek	Upstream reservoir	48	7228	0.2
Coal Creek	3260	15	3370	0.4
Bear Canyon Creek	401	2.84	1063	0.6

Some of the studies in Table 2 are older studies and used much larger subbasins. The calculated one basin peak flows on Van Bibber Creek matches closely with similar watersheds.

Table 3: Measured Peak Flows

Study	Location	Date	Tributary Area (ac)	Tributary Area (sm)	Peak Flow (cfs)	Unit Discharge (cfs/acre)
Ralston Creek Flood Warning Plan	DP 157T @ Hwy 93 (Station 330)	7/22/1991	5318	8.31	560	0.11
Ralston Creek Flood Warning Plan	DP 105T @ Sports Complex (Station 320)	5/18/1995	10871	16.99	440	0.04
Jarrett	DP 169	2013	4262	6.66	580	0.14
September 11-13, 2013 Arvada Flood Event	Van Bibber Creek at Gage 333 Hwy 93	2013	5318	8.31	750	0.14
September 11-13, 2013 Arvada Flood Event	Van Bibber Creek at Gage 323 Sports Complex	2013	10871	16.99	426	0.04

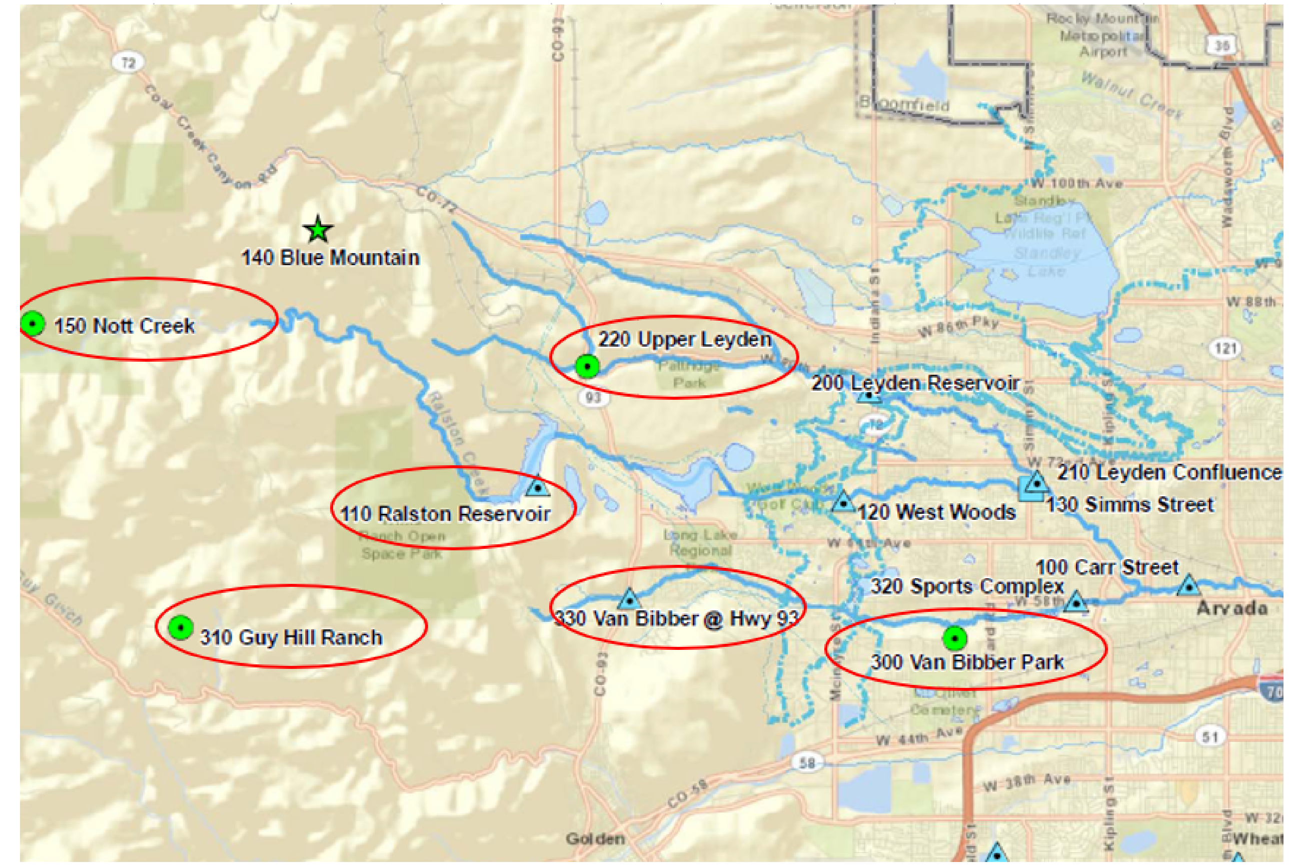
The September 2013 flood event was a less intense, long duration storm. CUHP models a short duration, intense storm event.

Table 4. Historic Annual Peak Flows on Van Bibber Creek.

Year	Van Bibber Creek at Gage *333 Highway 93*		Van Bibber Creek at Gage *323 Sports Complex*	
	Peak Stage (ft)	Peak Discharge (cfs)	Peak Stage (ft)	Peak Discharge (cfs)
2013	2.58	750	3.64	426
2012	2.54	396	3.07	353
2011	2.25	349	3.53	404
2010	2.68	417	3.00	350
2009	2.46	383	3.1	352
2008	--	--	2.53	296
2007	2.60	402	2.92	337
2006	--	--	1.70	--
2005	--	--	2.40	157
2004	2.50	387	3.30	375
2003	4.30	665	2.66	309
2002	2.60	402	2.86	331
2001	--	--	3.40	387
2000	--	--	3.50	406
1999	4.21	652	3.34	382
1998	--	--	2.94	339
1997	3.67	571	2.81	325
1996	--	--	2.72	315
1995	3.60	560	2.80	324
1994	2.75	428	2.50	292
1993	2.84	442	2.80	324
1992	2.75	428	2.80	324
1991	2.93	456	3.70	440
1990	--	--	2.50	292

Credit: September 11-13, 2013 Arvada Flood Event: Reconstruction and Documentation. Water & Earth Technologies. March 2014.

Kevin mentioned that not all of the peak flows listed in Table 4 are accurate. The 2013 flood event has been studied in depth and will be used to help calibrate flows.

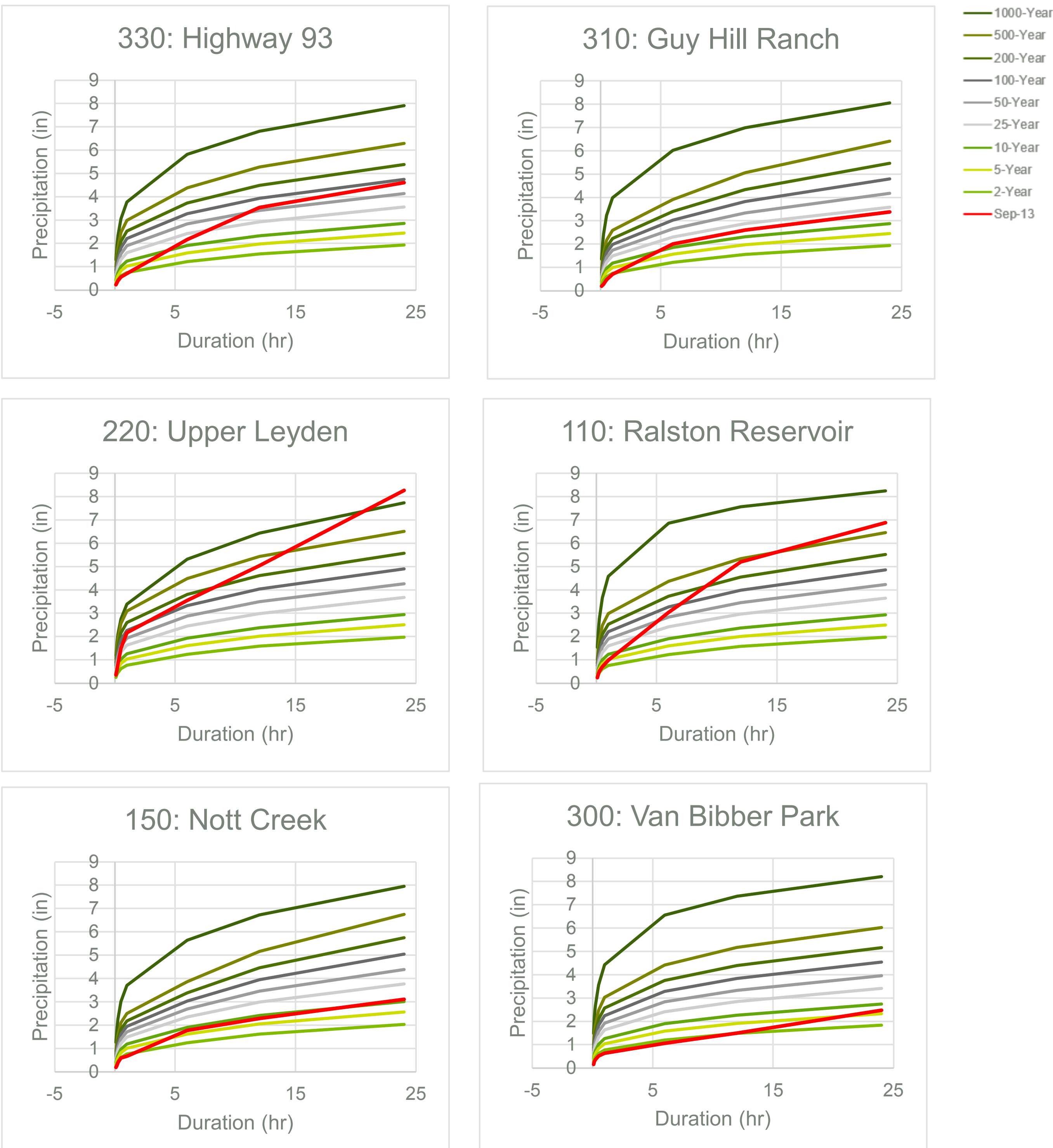


Credit: September 11-13, 2013 Arvada Flood Event: Reconstruction and Documentation. Water & Earth Technologies. March 2014.

Inconsistencies in peak flows from Draft 2020 MDP and previous studies may result from the large catchment areas used in old studies. MHFD suggested that if justification cannot be made for higher flows due to changes in percent impervious, changes in rainfall, and how canals were studied previously, etc., then calibration should be done. Arvada is concerned that if higher flows are justified then other projects have been under designed, new or current projects would need increased design, and remapping would be needed.

Olsson will use GARR data and the September 2013 flood data to calibrate the upper watershed on Van Bibber Creek. Following the meeting, Olsson discussed with MHFD and it was decided to start the calibration using the single basin upstream of Highway 93 CUHP model. Olsson will then evaluate the lower watershed peak flows to determine whether the increases are justified, or if additional calibration is needed.

NOAA Atlas 14 IDF Curve and September 2013 Flood Event Data from Alert5:



Action Items:

Olsson

- **Calibrate upper watershed flows using GARR data and September 2013 flood data.**
- **Review lower watershed results after upper watershed is calibrated and determine whether additional calibration is needed.**

MHFD

- **Send Water and Earth Tech post 2013 event study (completed)**
- **Send hydrology calculations on Ward Road Dam design project (completed)**

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

Hydrology Calibration Meeting Minutes

Van Bibber Creek Major Drainageway Plan
Tuesday July 28, 2020
1:00 pm Virtual Meeting on Microsoft Teams

Attendees:

Name	Company	E-mail
John Conn	Jefferson County	jconn@co.jefferson.co.us
Andy Stewart	Arvada	astewart@arvada.org
Brooke Seymour	MHFD	bseymour@udfcd.org
Shea Thomas	MHFD	sthomas@udfcd.ord
Amy Gabor	Olsson	agabor@olsson.com
Deb Ohlinger	Olsson	dohlinger@olsson.com
Madison Stewart	Olsson	mstewart@olsson.com

Discussion Items:

The main purpose of the meeting was to discuss the calibration process and results for the Van Bibber Creek watershed peak flows. 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

2) Upper watershed calibration
   a. Evaluated full, discretized model upstream of Highway 93 using GARR data
   b. Evaluated a seven subbasin model upstream of Highway 93 using GARR data

Table 1 – Upper Watershed Comparisons with GARR data

Study	Location	Tributary Area	Peak Flow	Unit Discharge	Peak Flow Percent Difference with 2013 Gage Data
		(acres)	(cfs)	(cfs/acre)	(%)
Draft 2020 MDP Calibration Discretized	DP147 @HWY 93	6096	1135	0.19	51%
Draft 2020 MDP Calibration Seven	DP147 @HWY 93	6096	712	0.12	-5%
September 11-13, 2013 Arvada Flood Event	Van Bibber Creek at Gage 333 Hwy 93	6096	750	0.12	---

   c. Based on results, the discretized model (70 subbasins) over-estimates peak flows in the foothills. Recommend proceeding with seven subbasin model upstream of Highway 93. Lower watershed results are based on utilizing the seven subbasin model.

3) Lower watershed calibration
   a. Compared hydrology models to 1974 Phase A, 1977 Phase B, 1977 Ralston MDP, 1986 MDP, and 2004 Ralston MDP
      i. Percent imperviousness for each study is similar to the 2020 existing and future conditions models. Comparisons were made to the model that most closely matched the previous study
      ii. Comparisons based on unit discharge
      iii. Evaluated models using rainfall values from previous studies
      iv. Previous studies all similar to each other, but lower than this study, even after accounting for rainfall
      v. Time to peak was determined to be affecting the peak flows

Table 2 – Previous Studies Comparisons

Location	Parameter	1974 Phase A	1977 Phase B	1977 Ralston MDP	1986 MDP	2004 Ralston MDP	2020 Rec EX	2020 Rec FTR	2020 Future with 1974 Phase A Rainfall	2020 Future with 1977 Phase B Rainfall	2020 Existing with 1986 MDP Rainfall
D/S End at Ralston Creek (Design Point 100)	Tributary Area (sm)	17.52	17.52	17.1	17.13	17.67	17.43	17.43	17.43	17.43	17.43
	Imp. (%)	18.49	18.49	8.16	11.36	10.98	11.05	18.32	18.32	18.32	11.05
	100-Year Peak Flow	3480	3450	3400	2700	3157	5046	5237	4421	6702	4822
	Unit Discharge (cfs/ac)	0.31	0.31	0.31	0.25	0.28	0.45	0.47	0.40	0.60	0.43
	Percent Difference to 1974 Phase A	0%	-1%	0%	-21%	-10%	---	51%	28%	---	---
	Percent Difference to 1977 Phase B	1%	0%	1%	-20%	-9%	---	53%	---	95%	---
	Percent Difference to 1977 Ralston MDP	0%	-1%	0%	-21%	-10%	46%	---	---	---	---
	Percent Difference to 1986 MDP	26%	25%	26%	0%	13%	84%	---	---	---	76%
	Percent Difference to 2004 Ralston	11%	10%	11%	-12%	0%	62%	---	---	---	---
Hogback (Design Point 149)	Tributary Area (sm)	8.29	8.29	---	8.03	---	8.31	8.31	8.31	8.31	8.31
	Imp. (%)	10.00	10.00	---	0.00	---	2.16	2.19	2.19	2.19	2.16
	100-Year Peak Flow	2940	1570	---	1800	2833	4207	4208	2537	4017	4401
	Unit Discharge (cfs/ac)	0.55	0.30	---	0.35	---	0.79	0.79	0.48	0.76	0.83
	Percent Difference to 1974 Phase A	0%	-47%	---	-37%	---	---	43%	-14%	---	---
	Percent Difference to 1977 Phase B	87%	0%	---	18%	---	---	167%	---	155%	---
	Percent Difference to 1986 MDP	58%	-16%	---	0%	---	126%	---	---	---	136%

   b. Additional comparisons were made using the 2004 Ralston MDP model, which was similar to all of the previous studies. The 2004 Ralston MDP models were available and could more easily be used for comparisons.

i. Several versions of the 2004 Ralston MDP models were used for comparisons
    1. Original model
    2. Updated CUHP version and rainfall
    3. Upper watershed disconnected at the hogback

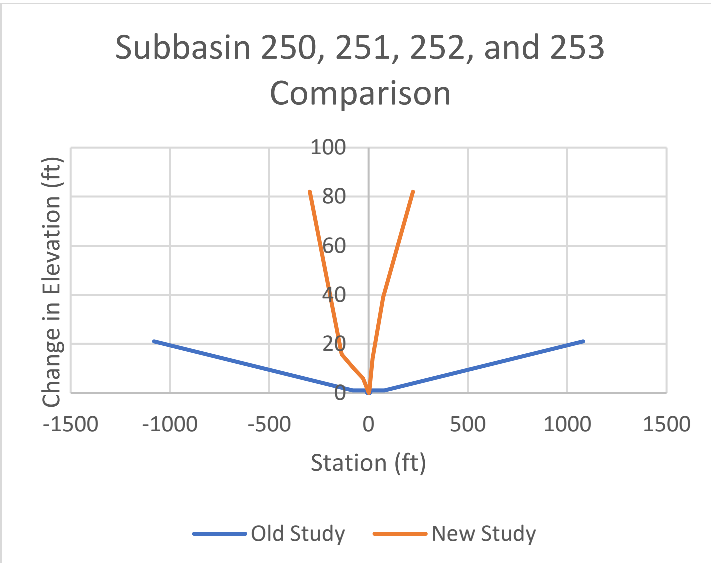
ii. Draft 2020 hydrology was updated to use Manning's n of 0.07 instead of 0.04 and 0.045 for a more similar comparison to previous models

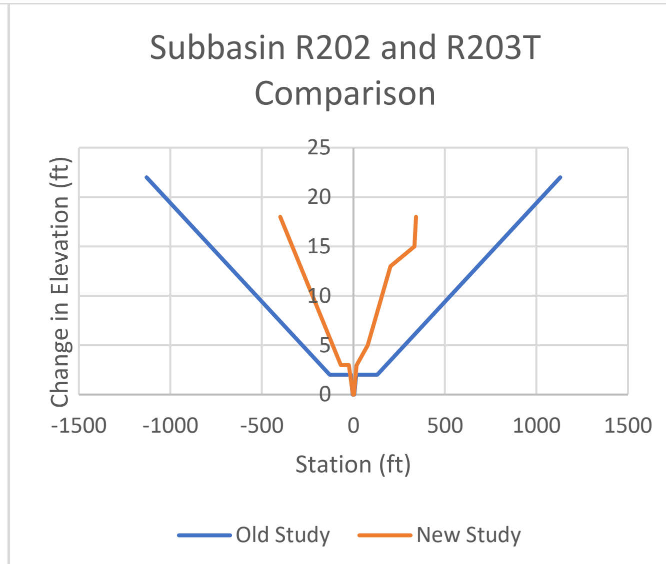
iii. 2004 Ralston MDP SWMM link geometries were used in 2020 model – generally good agreement between model

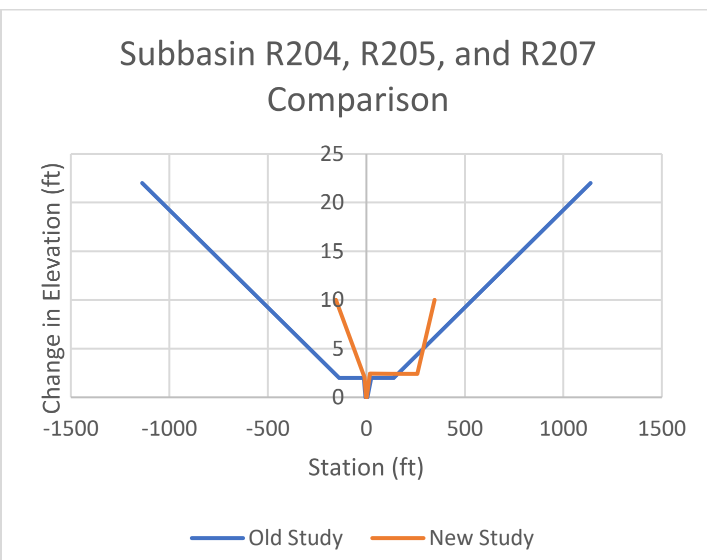
Table 3 – Lower Watershed Comparisons with 2004 Ralston MDP

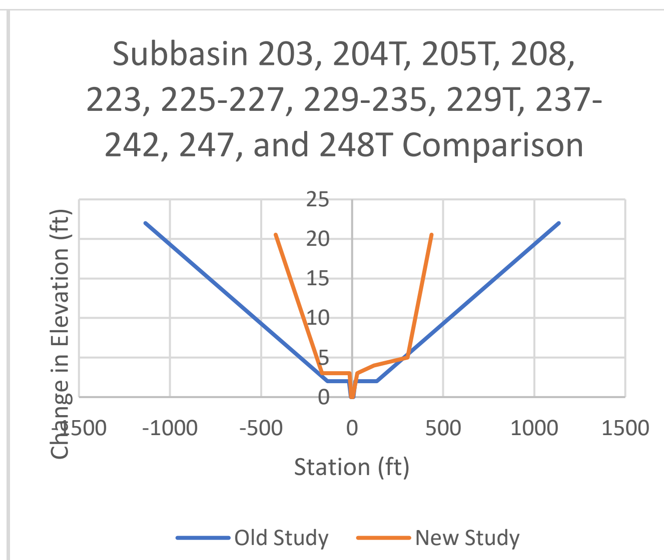
Location	Parameter	Design Point	2004 Ralston MDP				2020 Recommended Existing			Draft 2020 Geometry, n=0.07		2004 Channel Geometry	
			Orig	Disconnect	Updated CUHP/ Rain	Update and Disconnect	Design Point	Baseline	Disconnect	Baseline	Disconnect	Baseline	Disconnect
Hogback	100-year Peak Flow (cfs)	189 (un)	2728	2728	3629	3629	149	4207	4207	4084	4084	3047	3047
	Unit Discharge (cfs)		0.52	0.52	0.69	0.69		0.69	0.69	0.67	0.67	0.50	0.50
	% Diff to 2004 MDP		0%	0%	33%	33%		34%	34%	30%	30%	-3%	-3%
	% Diff to Updated 2004 MDP		-25%	-25%	0%	0%		1%	1%	-2%	-2%	-27%	-27%
	Time to Peak (min)		100	100	110	110		87	87	91	91	122	122
	Tributary Area (sm)		8.27	8.27	8.27	8.27		9.52	9.52	9.52	9.52	9.52	9.52
	Imperviousness (%)		2	2	2	2		2.16	2.16	2.16	2.16	2.16	2.16
D/S End	100-year Peak Flow (cfs)	181 (a4 - 10-20 sm)	3157	2433	3833	2351	100	5046	3028	5139	3277	3253	2182
	Unit Discharge (cfs)		0.28	0.40	0.34	0.39		0.45	0.60	0.46	0.65	0.29	0.43
	% Diff to 2004 MDP		0%	0%	21%	-3%		62%	48%	65%	60%	4%	7%
	% Diff to Updated 2004 MDP		-18%	3%	0%	0%		33%	53%	36%	66%	-14%	10%
	Time to Peak (min)		195	135	230	195		194	194	188	171	263	220
	Tributary Area (sm)		17.67	9.40	17.67	9.40		17.43	7.90	17.43	7.90	17.43	7.90
	Imperviousness (%)		11.92	20.65	11.92	20.65		11.05	21.76	11.05	21.76	11.05	21.76

4) SWMM links in previous study do not accurately portray the channel, resulting in lower peak flows









5) Recommended baseline model:
   a. Used seven subbasin model upstream of Highway 93
   b. Updated baseline SWMM links to add more definition. Previously used trapezoidal sections that generally ignored low flow channel. Typical HEC-RAS cross sections in each reach were simplified and used in the SWMM model.
   c. Updated Manning's n values in the lower watershed along main channel from 0.04 and 0.045 to 0.08 in low flow and 0.05 above low flow. Middle portion of Ramstetter Tributary, Manning's n = 0.05. Above Highway 93, used Manning's n = 0.045.
   d. Results in peak flows lower than draft study, but higher than previous studies

Table 4 – Peak Flow Comparisons at Downstream End (Design Point 100)

Parameter	Previous Studies	2020 Draft EX	2020 Draft FTR	2020 Rec EX	2020 Rec FTR
100-year Peak Flow at Downstream End (Design Point 100)	2,700 – 3,450	7,196	7,618	5,046	5,237

6) Other
   - **MHFD has not studied how significant the use of composite channels may be for SWMM models; however, there has been one previous study where geometry was modified during calibration.**
   - **Olsson will discuss Manning's n values with Bill Spitz, who is doing fluvial hazard mapping for the creek and should have good information on existing conditions.**
   - **The goal is to use updated hydrology in the FHAD model and understand the differences in the flows between the old studies and this current study. The project team will need to decide if risk is being properly communicated by using new flows or old flows.**

Action Items:

Olsson

- **Recalculate hydrology using combined subbasins downstream of the hogback to see if lower flows can be achieved with a less discretized model in urban areas. The combined subbasins will target 2 square miles. Subbasin size will likely be less than 2 square miles in order to avoid using subbasins that are long and skinny.**

MHFD

- **Confirm what the effective flows are based on and track down the effective model, if available. It appears the flows may be based on the 1977 Phase B Report.**
- **Check with Jefferson County to see if they have as-builts for culvert at Highway 93 and send to Olsson.**
- **Determine which alignment should be used for the HEC-RAS model downstream of Highway 93 (historic or new).**

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

MHFD
MILE HIGH FLOOD DISTRICT
2480 W. 26th Ave Suite 156-B | Denver, CO 80211
TEL 303 455 6277 | FAX 303 455 7880
www.mhfd.org

MEETING SUMMARY

Hydrology Approach – Van Bibber MDP & FHAD
Monday, October 5, 2020
11:00 am Virtual Meeting

Attendees:

Lauren Copenhagan	Jefferson County	lcopenha@co.jefferson.co.us
Andy Stewart	City of Arvada	astewart@arvada.org
Don Wick	City of Arvada	dwick@arvada.org
Jacqueline Rhoades	City of Arvada	jrhoades@arvada.org
Amy Gabor	Olsson	agabor@olsson.com
Shea Thomas	MHFD	sthomas@mhfd.org
Kevin Stewart	MHFD	kstewart@mhfd.org
Brooke Seymour	MHFD	bseymour@mhfd.org

Discussion Items:

1. Van Bibber Creek hydrology previously was studied in 1977 and 1986. The hydrology from the current study is significantly higher than the previous studies.

2. Is there justification to change flows? Biggest difference in results with current study is timing – previous hydrology shows three distinct peaks, while current hydrology shows overlapping peaks. The previous flows can generally be replicated by using cross section geometries from the previous study in the current SWMM model. However, the cross sections used in the previous study have a wide trapezoidal geometry with very mild bank slopes, which is not representative of actual topography.
   a. Kevin requested that Olsson check Froude numbers in the model to ensure results are not supercritical, which is unrealistic for any extended length in natural channels. Froude no. less than 0.8 recommended. Subsequent to the meeting, Olsson determined that there were a few links in the model with Froude numbers above 0.8, which can be reduced by increasing Manning's n-value.

3. There is development activity along Van Bibber in Jefferson County, so it will be helpful to have draft hydrology and hydraulic modeling available to help guide the stream corridor through the developments.

4. The special hydrology study that Kevin is managing includes Van Bibber Creek, Little Dry Creek and Lena Gulch. Kevin is pushing for early results for Van Bibber, hopefully by the end of the month.
   a. The revised annual peaks at Highway 93 have resulted in a lower 2013 peak flow estimate. The current best estimate is 400 cfs, not the 750 cfs used by Olsson in their 7-subcatchment calibration. Related to this, it was noted that the 2018 paleoflood investigation independently supported this lower estimate. The upper basin calibration may need to be revisited.
   b. Note that the District has policies in place regarding onsite detention, inadvertent detention, canal interception and land-use for major drainageway master planning that will often produce different results than stream flow gage data. The upper watershed of Van Bibber presents a unique opportunity to compare the model to gage data, since this area isn't impacted by these policies and development isn't occurring upstream of the Highway 93 gage.

5. We recognize that the there is a varying range of statistically accurate peak flow rates and do not suggest recommending improvements to upsize reaches of the stream that have already been improved based on the previous hydrology. However, we suggest the team consider using the more conservative flows to identify recommendations to guide new development and improvements going forward. Once the special hydrology study and the initial hydraulic analysis have been completed, we will work through options for the MDP and FHAD as a group.
   a. Arvada is particularly concerned about the Arvada Plaza, where flood control improvements have already been implemented based on the previous/effective hydrology. This area is politically sensitive with a high interest in redevelopment. The team agreed that due to the uncertainty in hydrologic estimates in general, we would not recommend improvements to areas such as the Arvada Plaza where flood control improvements have already been implemented based on previous hydrologic analysis.
   b. Regarding the FHAD, it was made clear that the District would not remap the floodplain without the local government's support.

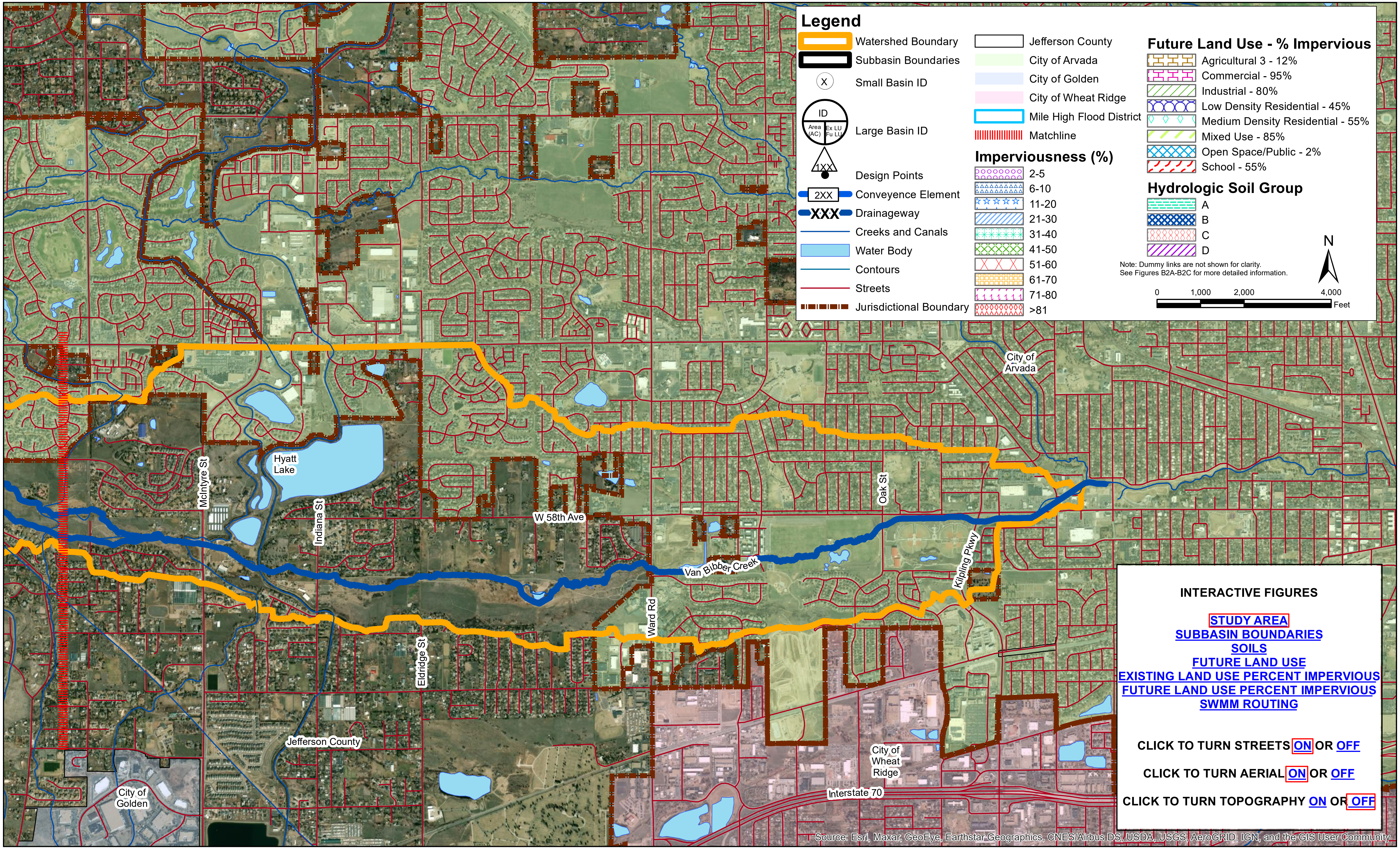
6. It will be important to document this full effort, including outside studies, in the master plan report.

Next Steps:

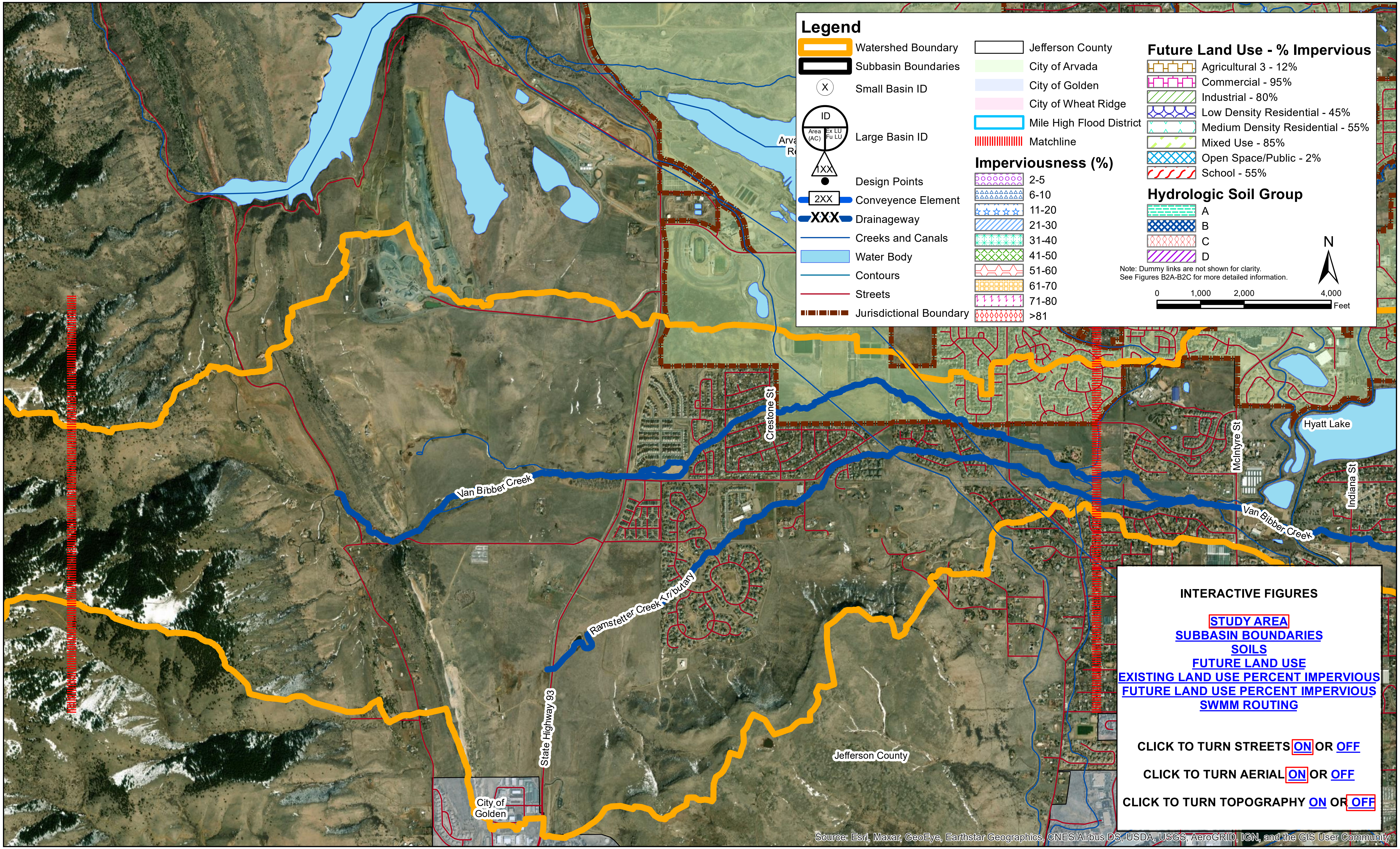
1. Olsson will proceed with both revised and effective hydrology in the HEC-RAS model so that we can understand how significant the differences are to the flood hazard delineation.
2. We will regroup and discuss the approach again once the special hydrology study is complete.

APPENDIX B

HYDROLOGIC ANALYSIS

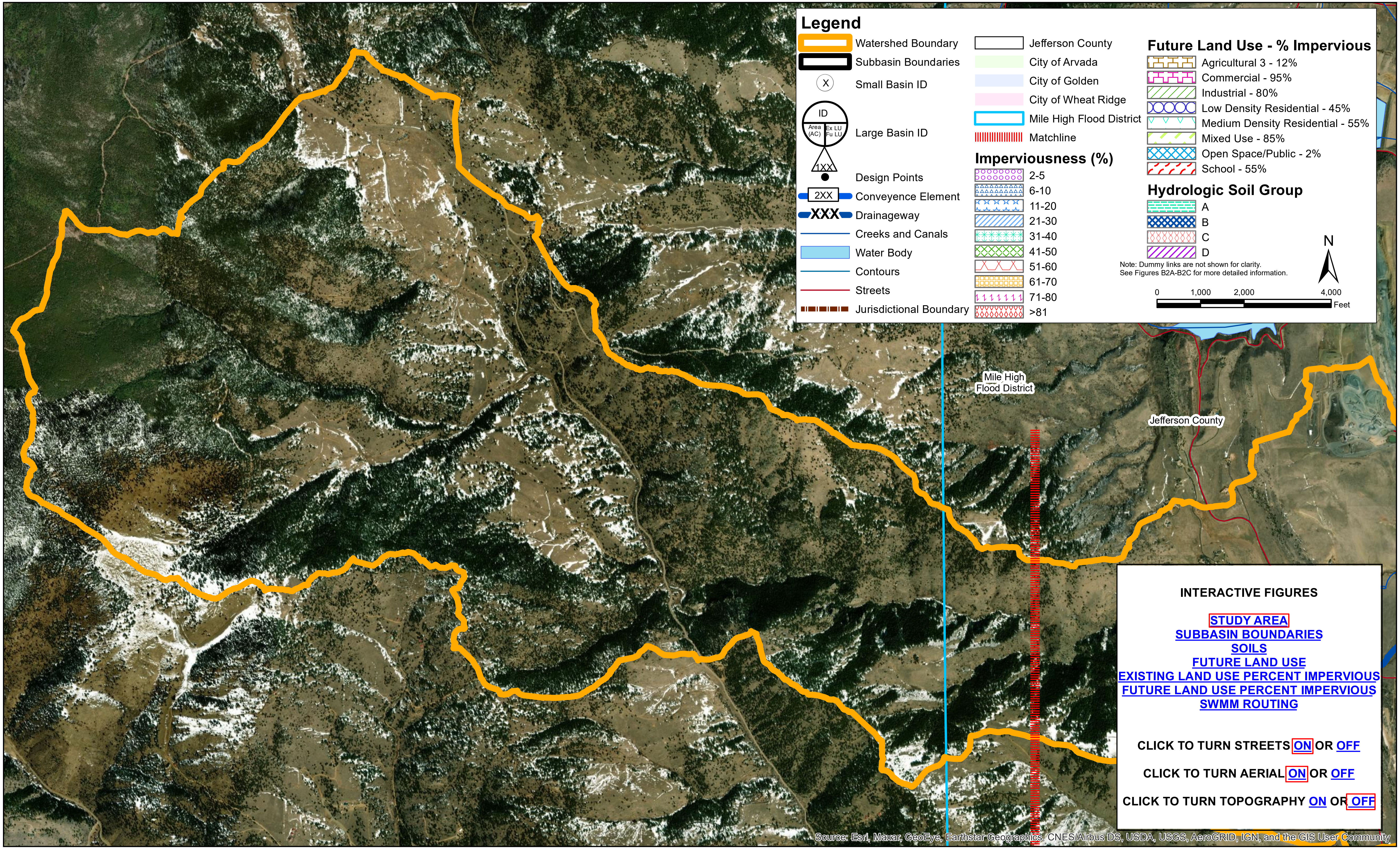


PROJECT: 019-2294 DRAWN BY: MS DATE: 2/2021	MILE HIGH FLOOD DISTRICT, CITY OF ARVADA, AND JEFFERSON COUNTY	VAN BIBBER CREEK HYDROLOGY WORKMAP	olsson	1525 Raleigh Street Suite 400 Denver, CO 80204	TEL: 303.237.2072 FAX: 303.237.2659 www.olsson.com	FIGURE B-1A



PROJECT: 019-2294 DRAWN BY: MS DATE: 2/2021	**MILE HIGH FLOOD DISTRICT, CITY OF ARVADA, AND JEFFERSON COUNTY**	**VAN BIBBER CREEK HYDROLOGY WORKMAP**	olsson	1525 Raleigh Street Suite 400 Denver, CO 80204	TEL: 303.237.2072 FAX: 303.237.2659 www.olsson.com

FIGURE
B-1B



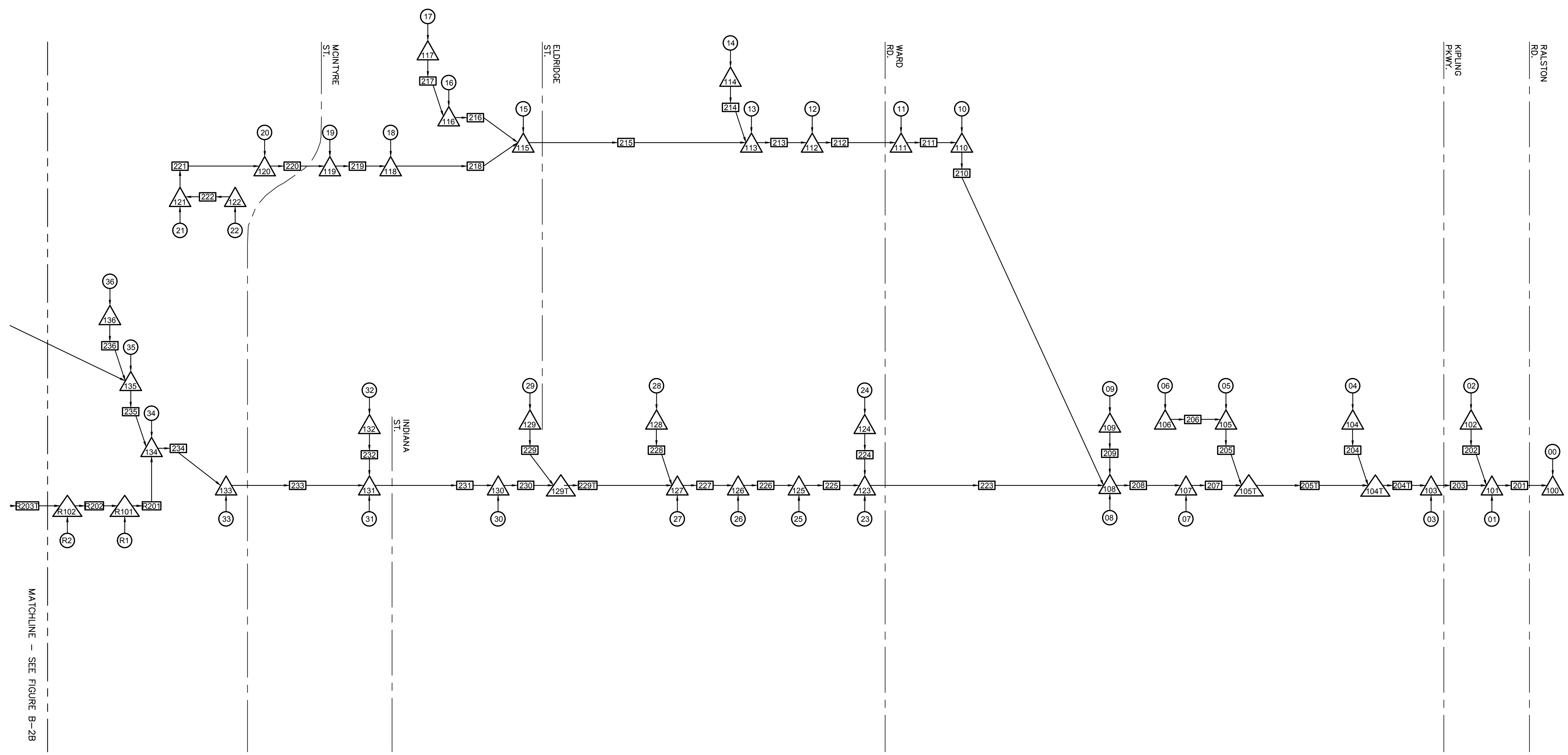
PROJECT: 019-2294 DRAWN BY: MS DATE: 2/2021	MILE HIGH FLOOD DISTRICT, CITY OF ARVADA, AND JEFFERSON COUNTY	VAN BIBBER CREEK HYDROLOGY WORKMAP	olsson 1525 Raleigh Street Suite 400 Denver, CO 80204 TEL: 303.237.2072 FAX: 303.237.2659 www.olsson.com	FIGURE B-1C

LEGEND

(XX) SUBWATERSHED ID

(1XX triangle) DESIGN POINT ID

[2XX] CONVEYANCE ELEMENT ID



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Denver, CO 80204
TEL 303.237.2072
www.olsson.com

REVISIONS

REV. NO.	DATE	REVISIONS DESCRIPTION

SWMM SCHEMATIC

VAN BIBBER CREEK MASTER DRAINAGE PLAN

ARVADA, COLORADO

2020

drawn by:	MS
checked by:	MD
approved by:	AG
QA/QC by:	AG
project no.:	019-2294
drawing no.:	
date:	2/2021

FIGURE B-2A

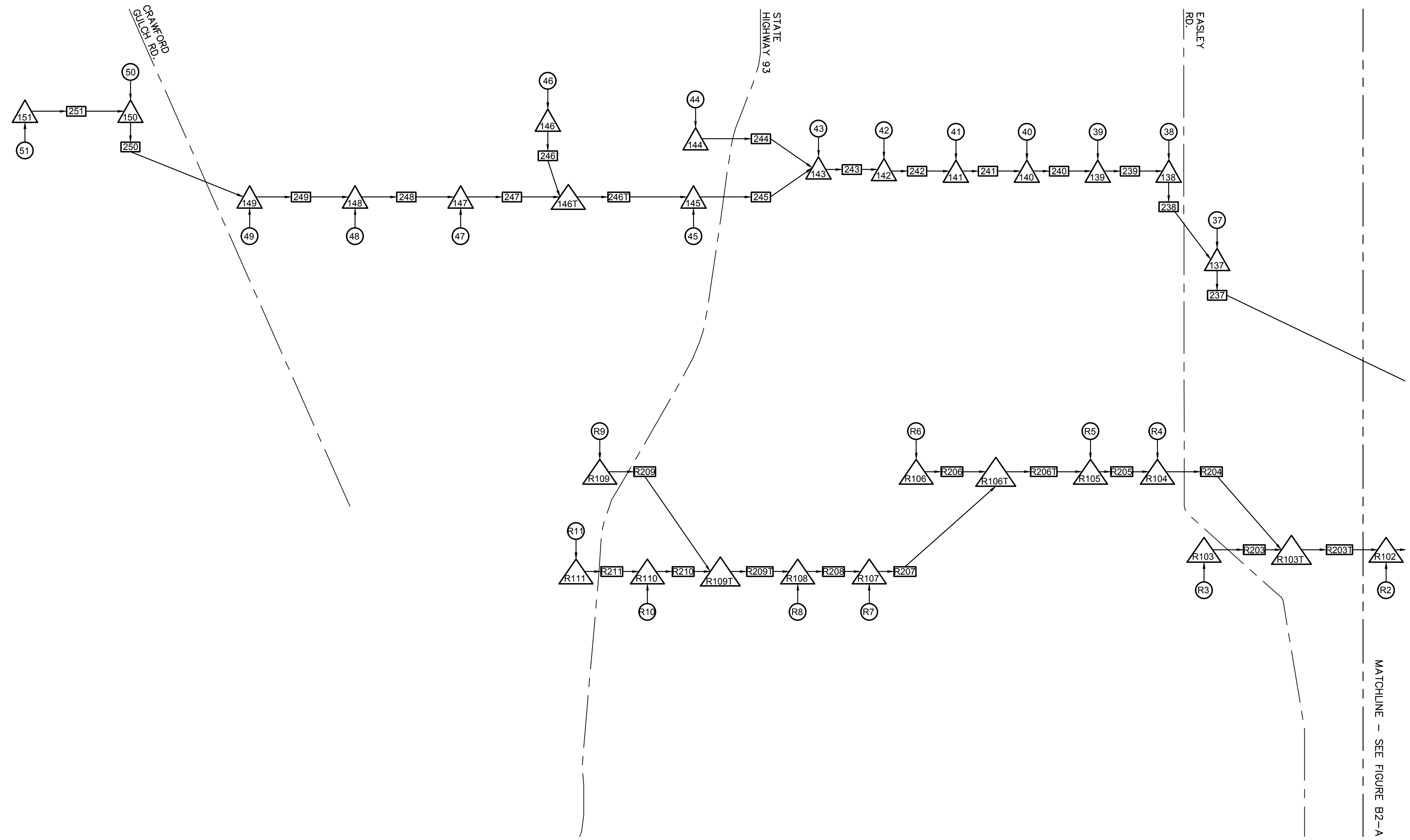
DWG: F:\2019\2001-2500\019-2294\40-Design\Calcs\WTRS\7 AUTOCAD FILES\Baseline Hydrology\W_SWMMROUT_019-2294.dwg USER: mstewart
DATE: Feb 15, 2021 2:25pm XREFS: W_TTBLK_019-2294

LEGEND

(XX) SUBWATERSHED ID

△ 1XX DESIGN POINT ID

[2XX] CONVEYANCE ELEMENT ID



olsson

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TEL 303.237.2072
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REV. NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

SWMM SCHEMATIC

VAN BIBBER CREEK MASTER DRAINAGE PLAN

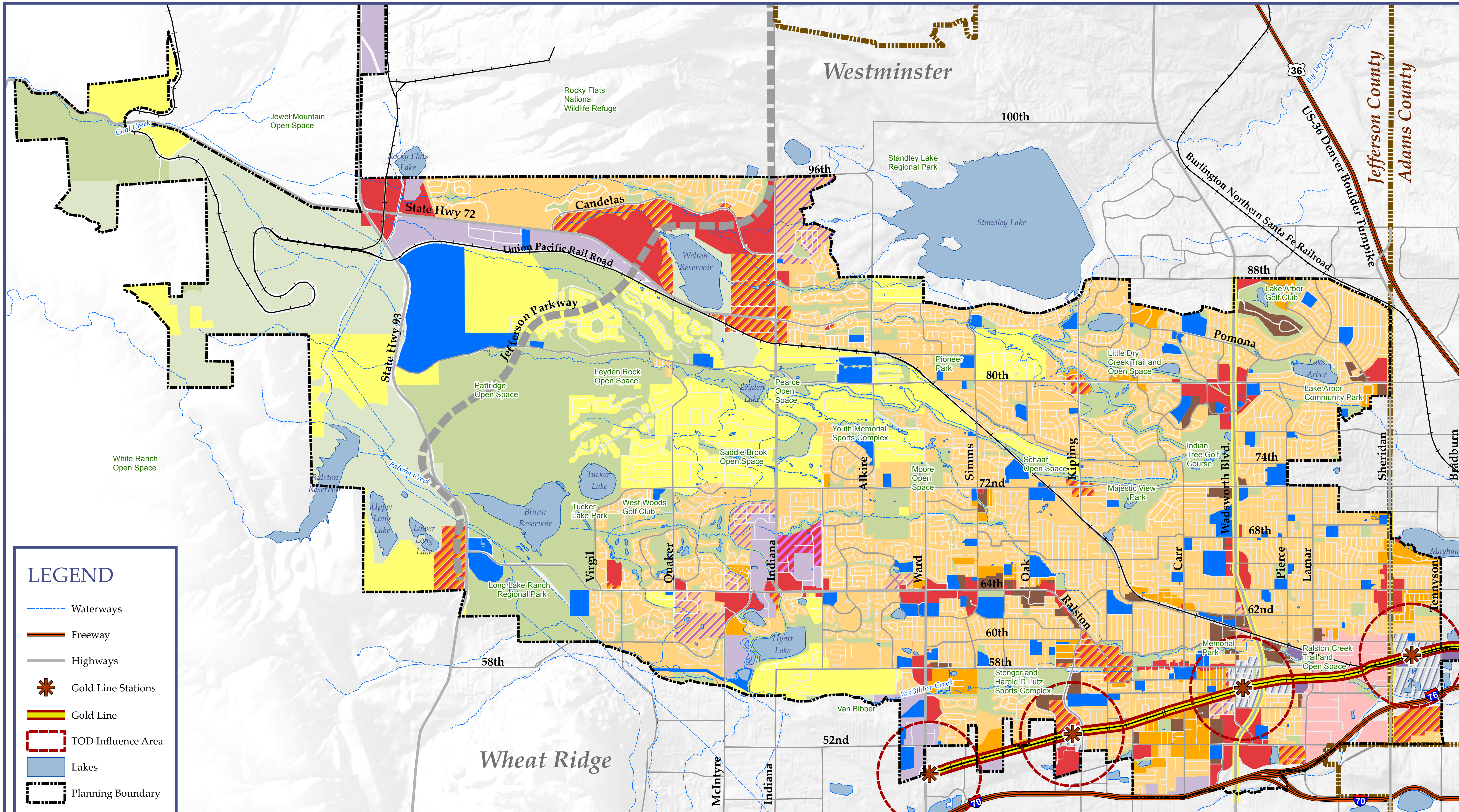
ARVADA, COLORADO

2020

drawn by:	MS
checked by:	AG
approved by:	AG
QA/QC by:	DO
project no.:	019-2294
drawing no.:	
date:	2/2021

FIGURE B-2B

DWG: F:\2019\2001-2500\019-2294\40-Design\Calcs\WTRS\7 AUTOCAD FILES\Baseline Hydrology\W_SWMROUT_019-2294.dwg USER: mstewart
DATE: Feb 15, 2021 2:25pm XREFS: W_TTBLK_019-2294



Transit Station Framework Plan
Clear Creek / I-76 Community Plan
Low Density Residential
Suburban Residential
Medium Density Residential
High Density Residential
Mixed-Use: Residential Emphasis
Mixed-Use
Neighborhood/Community Commercial
Industrial
Industrial/ Office
Open Space and Parks
Public Land (Not Open Space and Parks)
Public/Quasi-Public Facilities
Office, Industrial, Retail

Figure 2-8

FUTURE LAND USE

0 0.75 1.5 3 Miles

Adopted: August 19th, 2014
Revised: July 16th, 2018

Sources: City of Arvada, DRCOG, CDOT, USGS
Land Use descriptions can be found in Chapter 2 of the Arvada Comprehensive Plan

Jefferson County, Colorado
Zoning Map

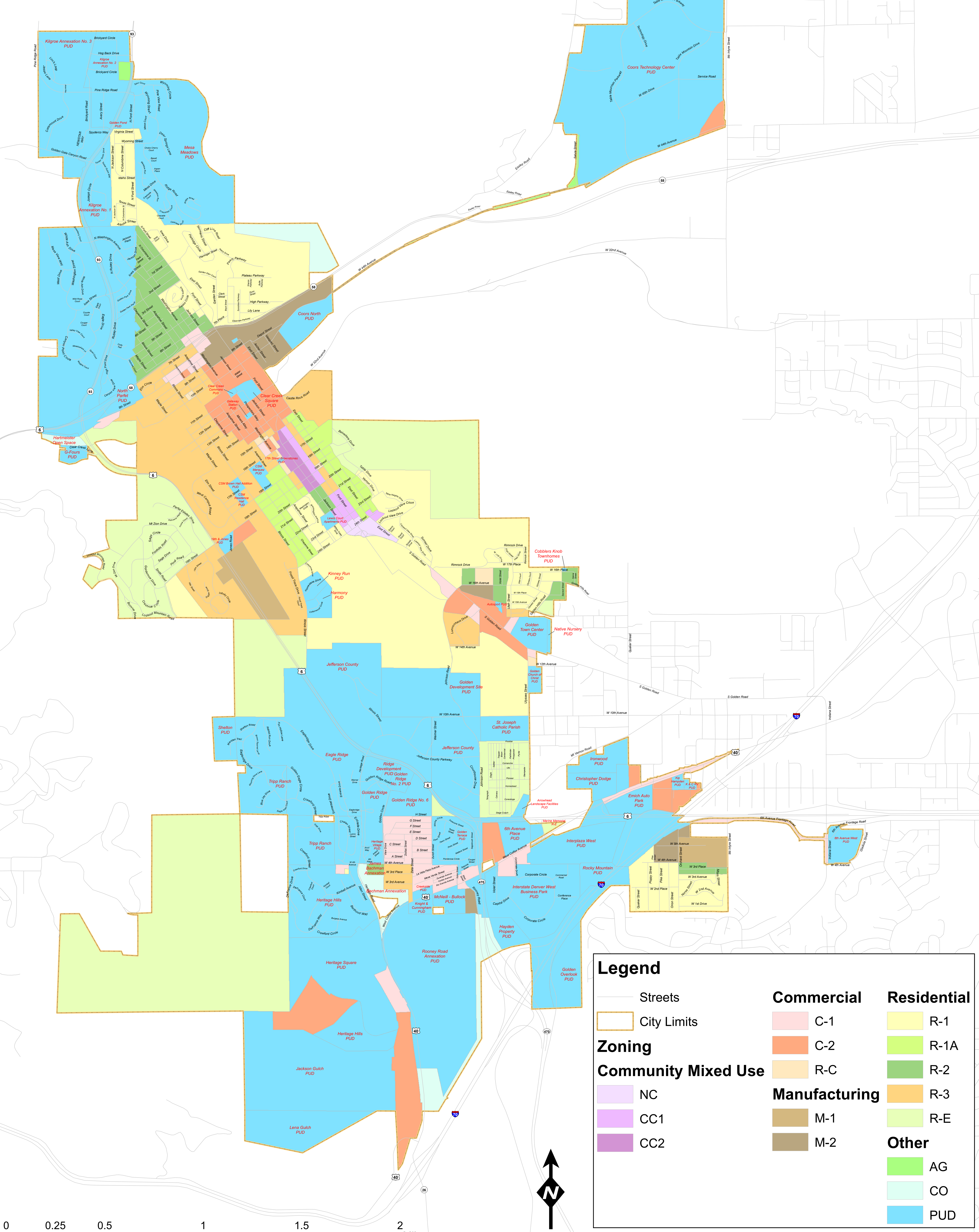
Information and Map prepared by Jefferson County I.T. Services Division GIS Services Section.

This information has been compiled from the best available records and is provided "as is". There is no express or implied warranty by Jefferson County for the accuracy or validity of the data including but not limited to, warranties of title or merchandising or fitness for a particular purpose. Jefferson County shall not be held liable for any damages resulting from the use of this data.

The information is provided for planning purposes only. Date Produced: June 2019

JEFFERSON COUNTY COLORADO

City of Golden Zoning Map



Map Current as of February 2019

Table B-1A - Unadjusted Rainfall Distributions

1Hr Depth	0.763
Return Period	2
Time	Depth
0:05	0.0153
0:10	0.0305
0:15	0.0641
0:20	0.1221
0:25	0.1908
0:30	0.1068
0:35	0.0481
0:40	0.0382
0:45	0.0229
0:50	0.0229
0:55	0.0229
1:00	0.0229
1:05	0.0229
1:10	0.0153
1:15	0.0153
1:20	0.0153
1:25	0.0153
1:30	0.0153
1:35	0.0153
1:40	0.0153
1:45	0.0153
1:50	0.0153
1:55	0.0076
2:00	0.0076

1Hr Depth	1.03
Return Period	5
Time	Depth
0:05	0.0206
0:10	0.0381
0:15	0.0896
0:20	0.1576
0:25	0.2575
0:30	0.1339
0:35	0.0597
0:40	0.0453
0:45	0.0371
0:50	0.0371
0:55	0.0309
1:00	0.0309
1:05	0.0309
1:10	0.0309
1:15	0.0257
1:20	0.0227
1:25	0.0227
1:30	0.0227
1:35	0.0227
1:40	0.0154
1:45	0.0154
1:50	0.0154
1:55	0.0154
2:00	0.0134

1Hr Depth	1.27
Return Period	10
Time	Depth
0:05	0.0254
0:10	0.0470
0:15	0.1041
0:20	0.1905
0:25	0.3175
0:30	0.1524
0:35	0.0711
0:40	0.0546
0:45	0.0483
0:50	0.0406
0:55	0.0406
1:00	0.0406
1:05	0.0406
1:10	0.0406
1:15	0.0406
1:20	0.0317
1:25	0.0241
1:30	0.0241
1:35	0.0241
1:40	0.0241
1:45	0.0241
1:50	0.0241
1:55	0.0216
2:00	0.0165

1Hr Depth	1.63
Return Period	25
Time	Depth
0:05	0.0212
0:10	0.0571
0:15	0.0815
0:20	0.1304
0:25	0.2445
0:30	0.4075
0:35	0.1956
0:40	0.1304
0:45	0.0815
0:50	0.0815
0:55	0.0522
1:00	0.0522
1:05	0.0522
1:10	0.0391
1:15	0.0391
1:20	0.0293
1:25	0.0293
1:30	0.0228
1:35	0.0228
1:40	0.0228
1:45	0.0228
1:50	0.0228
1:55	0.0228
2:00	0.0228

1Hr Depth	1.93
Return Period	50
Time	Depth
0:05	0.0251
0:10	0.0675
0:15	0.0965
0:20	0.1544
0:25	0.2895
0:30	0.4825
0:35	0.2316
0:40	0.1544
0:45	0.0965
0:50	0.0965
0:55	0.0618
1:00	0.0618
1:05	0.0618
1:10	0.0463
1:15	0.0463
1:20	0.0347
1:25	0.0347
1:30	0.0270
1:35	0.0270
1:40	0.0270
1:45	0.0270
1:50	0.0270
1:55	0.0270
2:00	0.0270

1Hr Depth	2.24
Return Period	100
Time	Depth
0:05	0.0224
0:10	0.0672
0:15	0.1030
0:20	0.1792
0:25	0.3136
0:30	0.5600
0:35	0.3136
0:40	0.1792
0:45	0.1389
0:50	0.1120
0:55	0.0896
1:00	0.0896
1:05	0.0896
1:10	0.0448
1:15	0.0448
1:20	0.0269
1:25	0.0269
1:30	0.0269
1:35	0.0269
1:40	0.0269
1:45	0.0269
1:50	0.0269
1:55	0.0269
2:00	0.0269

1Hr Depth	3.04
Return Period	500
Time	Depth
0:05	0.0304
0:10	0.0912
0:15	0.1398
0:20	0.2432
0:25	0.4256
0:30	0.7600
0:35	0.4256
0:40	0.2432
0:45	0.1885
0:50	0.1520
0:55	0.1216
1:00	0.1216
1:05	0.1216
1:10	0.0608
1:15	0.0608
1:20	0.0365
1:25	0.0365
1:30	0.0365
1:35	0.0365
1:40	0.0365
1:45	0.0365
1:50	0.0365
1:55	0.0365
2:00	0.0365

Table B-1B - Adjusted Rainfall Distributions for 5 Square Miles

1Hr Depth	0.763
Return Period	2
Time	Depth
0:05	0.0153
0:10	0.0305
0:15	0.0622
0:20	0.1050
0:25	0.1640
0:30	0.0919
0:35	0.0466
0:40	0.0370
0:45	0.0229
0:50	0.0229
0:55	0.0229
1:00	0.0229
1:05	0.0229
1:10	0.0153
1:15	0.0153
1:20	0.0153
1:25	0.0153
1:30	0.0153
1:35	0.0153
1:40	0.0153
1:45	0.0153
1:50	0.0153
1:55	0.0076
2:00	0.0076

1Hr Depth	1.03
Return Period	5
Time	Depth
0:05	0.0206
0:10	0.0381
0:15	0.0869
0:20	0.1355
0:25	0.2214
0:30	0.1152
0:35	0.0579
0:40	0.0440
0:45	0.0371
0:50	0.0371
0:55	0.0309
1:00	0.0309
1:05	0.0309
1:10	0.0309
1:15	0.0257
1:20	0.0227
1:25	0.0227
1:30	0.0227
1:35	0.0227
1:40	0.0154
1:45	0.0154
1:50	0.0154
1:55	0.0154
2:00	0.0134

1Hr Depth	1.27
Return Period	10
Time	Depth
0:05	0.0254
0:10	0.0470
0:15	0.1010
0:20	0.1638
0:25	0.2730
0:30	0.1311
0:35	0.0690
0:40	0.0530
0:45	0.0483
0:50	0.0406
0:55	0.0406
1:00	0.0406
1:05	0.0406
1:10	0.0406
1:15	0.0406
1:20	0.0317
1:25	0.0241
1:30	0.0241
1:35	0.0241
1:40	0.0241
1:45	0.0241
1:50	0.0241
1:55	0.0216
2:00	0.0165

Table B-1C - Adjusted Rainfall Distributions for 10 Square Miles

1Hr Depth	0.763
Return Period	2
Time	Depth
0:05	0.0153
0:10	0.0305
0:15	0.0602
0:20	0.0916
0:25	0.1431
0:30	0.0801
0:35	0.0452
0:40	0.0359
0:45	0.0229
0:50	0.0229
0:55	0.0229
1:00	0.0229
1:05	0.0229
1:10	0.0153
1:15	0.0153
1:20	0.0153
1:25	0.0153
1:30	0.0153
1:35	0.0153
1:40	0.0153
1:45	0.0153
1:50	0.0153
1:55	0.0076
2:00	0.0076

1Hr Depth	1.03
Return Period	5
Time	Depth
0:05	0.0206
0:10	0.0381
0:15	0.0842
0:20	0.1182
0:25	0.1931
0:30	0.1004
0:35	0.0562
0:40	0.0426
0:45	0.0371
0:50	0.0371
0:55	0.0309
1:00	0.0309
1:05	0.0309
1:10	0.0309
1:15	0.0257
1:20	0.0227
1:25	0.0227
1:30	0.0227
1:35	0.0227
1:40	0.0154
1:45	0.0154
1:50	0.0154
1:55	0.0154
2:00	0.0134

1Hr Depth	1.27
Return Period	10
Time	Depth
0:05	0.0254
0:10	0.0470
0:15	0.0979
0:20	0.1429
0:25	0.2381
0:30	0.1143
0:35	0.0669
0:40	0.0513
0:45	0.0483
0:50	0.0406
0:55	0.0406
1:00	0.0406
1:05	0.0406
1:10	0.0406
1:15	0.0406
1:20	0.0317
1:25	0.0241
1:30	0.0241
1:35	0.0241
1:40	0.0241
1:45	0.0241
1:50	0.0241
1:55	0.0216
2:00	0.0165

Table B-1D - Adjusted Rainfall Distributions for 15 Square Miles

1Hr Depth	0.763
Return Period	2
Time	Depth
0:05	0.0153
0:10	0.0305
0:15	0.0575
0:20	0.0818
0:25	0.1278
0:30	0.0716
0:35	0.0431
0:40	0.0347
0:45	0.0233
0:50	0.0233
0:55	0.0233
1:00	0.0233
1:05	0.0233
1:10	0.0156
1:15	0.0156
1:20	0.0156
1:25	0.0156
1:30	0.0156
1:35	0.0156
1:40	0.0156
1:45	0.0156
1:50	0.0156
1:55	0.0125
2:00	0.0110

1Hr Depth	1.03
Return Period	5
Time	Depth
0:05	0.0206
0:10	0.0381
0:15	0.0815
0:20	0.1072
0:25	0.1751
0:30	0.0911
0:35	0.0544
0:40	0.0412
0:45	0.0378
0:50	0.0378
0:55	0.0315
1:00	0.0315
1:05	0.0315
1:10	0.0315
1:15	0.0263
1:20	0.0231
1:25	0.0231
1:30	0.0231
1:35	0.0231
1:40	0.0158
1:45	0.0158
1:50	0.0158
1:55	0.0158
2:00	0.0137

1Hr Depth	1.27
Return Period	10
Time	Depth
0:05	0.0254
0:10	0.0470
0:15	0.0948
0:20	0.1295
0:25	0.2159
0:30	0.1036
0:35	0.0647
0:40	0.0497
0:45	0.0492
0:50	0.0415
0:55	0.0415
1:00	0.0415
1:05	0.0415
1:10	0.0415
1:15	0.0415
1:20	0.0324
1:25	0.0246
1:30	0.0246
1:35	0.0246
1:40	0.0246
1:45	0.0246
1:50	0.0246
1:55	0.0220
2:00	0.0168

1Hr Depth	1.63
Return Period	25
Time	Depth
0:05	0.0244
0:10	0.0656
0:15	0.0937
0:20	0.1630
0:25	0.1785
0:30	0.2975
0:35	0.1428
0:40	0.1369
0:45	0.0978
0:50	0.0937
0:55	0.0600
1:00	0.0600
1:05	0.0563
1:10	0.0422
1:15	0.0422
1:20	0.0317
1:25	0.0317
1:30	0.0246
1:35	0.0246
1:40	0.0246
1:45	0.0246
1:50	0.0246
1:55	0.0246
2:00	0.0246

1Hr Depth	1.93
Return Period	50
Time	Depth
0:05	0.0289
0:10	0.0777
0:15	0.1110
0:20	0.1930
0:25	0.2113
0:30	0.3522
0:35	0.1691
0:40	0.1621
0:45	0.1158
0:50	0.1110
0:55	0.0710
1:00	0.0710
1:05	0.0667
1:10	0.0500
1:15	0.0500
1:20	0.0375
1:25	0.0375
1:30	0.0292
1:35	0.0292
1:40	0.0292
1:45	0.0292
1:50	0.0292
1:55	0.0292
2:00	0.0292

1Hr Depth	2.24
Return Period	100
Time	Depth
0:05	0.0258
0:10	0.0773
0:15	0.1185
0:20	0.2240
0:25	0.2289
0:30	0.4088
0:35	0.2289
0:40	0.1882
0:45	0.1667
0:50	0.1288
0:55	0.1030
1:00	0.1030
1:05	0.0968
1:10	0.0484
1:15	0.0484
1:20	0.0290
1:25	0.0290
1:30	0.0290
1:35	0.0290
1:40	0.0290
1:45	0.0290
1:50	0.0290
1:55	0.0290
2:00	0.0290

1Hr Depth	3.04
Return Period	500
Time	Depth
0:05	0.0350
0:10	0.1049
0:15	0.1608
0:20	0.3040
0:25	0.3107
0:30	0.5548
0:35	0.3107
0:40	0.2554
0:45	0.2262
0:50	0.1748
0:55	0.1398
1:00	0.1398
1:05	0.1313
1:10	0.0657
1:15	0.0657
1:20	0.0394
1:25	0.0394
1:30	0.0394
1:35	0.0394
1:40	0.0394
1:45	0.0394
1:50	0.0394
1:55	0.0394
2:00	0.0394

Table B-2 - Adjusted Slope

Basin	Weighted Slope Before Correction (ft/ft)	Need Adjusted	Adjusted Slope (ft/ft)	CUHP Slope (ft/ft)
0	0.006	No		0.0058
1	0.024	No		0.0235
2	0.006	No		0.0062
3	0.008	No		0.0077
4	0.010	No		0.0102
5	0.016	No		0.0159
6	0.018	No		0.0181
7	0.005	No		0.0047
8	0.010	No		0.0099
9	0.008	No		0.0077
10	0.020	No		0.0202
11	0.019	No		0.0195
12	0.020	No		0.0196
13	0.019	No		0.0189
14	0.022	No		0.0218
15	0.030	No		0.0302
16	0.002	No		0.0021
17	0.017	No		0.0175
18	0.000	No		0.0001
19	0.001	No		0.0011
20	0.032	No		0.0316
21	0.013	No		0.0133
22	0.018	No		0.0182
23	0.022	No		0.0218
24	0.018	No		0.0184
25	0.018	No		0.0177
26	0.017	No		0.0167
27	0.012	No		0.0116
28	0.029	No		0.0291
29	0.019	No		0.0192
30	0.009	No		0.0093
31	0.006	No		0.0061
32	0.019	No		0.0191
33	0.013	No		0.0131
34	0.026	No		0.0256
35	0.012	No		0.0123
36	0.010	No		0.0096
37	0.012	No		0.0118
38	0.012	No		0.0117
39	0.017	No		0.0166
40	0.036	No		0.0359
41	0.020	No		0.0203
42	0.036	No		0.0363
43	0.040	Yes	0.041	0.0411
44	0.044	Yes	0.043	0.0432
45	0.033	No		0.0331
46	0.041	Yes	0.042	0.0416
47	0.075	Yes	0.056	0.0558
48	0.098	Yes	0.059	0.0591
49	0.048	Yes	0.046	0.0459
50	0.100	Yes	0.059	0.0592
51	0.111	Yes	0.060	0.0600
R1	0.017	No		0.0170
R2	0.015	No		0.0149
R3	0.135	Yes	0.060	0.0600
R4	0.051	Yes	0.047	0.0470
R5	0.030	No		0.0303
R6	0.021	No		0.0206
R7	0.080	Yes	0.057	0.0568
R8	0.068	Yes	0.054	0.0540
R9	0.038	No		0.0385
R10	0.030	No		0.0302
R11	0.025	No		0.0249

CUHP Input Table

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			DCIA
Subcatchment Name	EPA SWMM Target Node	Raingage	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Existing Percent Imperviousness	Future Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Level 0, 1, or 2
0	100	Rainfall	0.063749255	0.29257853	0.587864004	0.005751761	74.26	74.26	0.35	0.1	3.000638021	0.0018	0.500042535	0
1	101	Rainfall	0.060103203	0.4032877	0.628105059	0.023500465	49.26	49.26	0.35	0.07	3	0.0018	0.5	0
2	102	Rainfall	0.056283922	0.381939274	0.712992508	0.006210251	52.78	52.78	0.35	0.07	3	0.0018	0.5	0
3	103	Rainfall	0.174305928	0.547228697	0.878724392	0.007728482	33.31	33.31	0.35	0.085	3	0.0018	0.5	0
4	104	Rainfall	0.087226798	0.22498298	0.636910672	0.010245867	34.39	34.39	0.3625	0.07	3	0.0018	0.5	0
5	105	Rainfall	0.132786186	0.394780581	0.995739583	0.015851133	39.04	39.04	0.35	0.07	3	0.0018	0.5	0
6	106	Rainfall	0.080777517	0.136692634	0.537776706	0.018101762	34	34	0.35	0.07	3	0.0018	0.5	0
7	107	Rainfall	0.203413742	0.423780409	0.9925676	0.004718059	20.78	24.05	0.3625	0.07	3	0.0018	0.5	0
8	108	Rainfall	0.148872514	0.34886791	0.872864184	0.009854241	33.88	36.99	0.35	0.0775	3	0.0018	0.5	0
9	109	Rainfall	0.115579747	0.376488013	0.740508814	0.007685031	29.27	47.77	0.4	0.0775	3	0.0018	0.5	0
10	110	Rainfall	0.125923625	0.303421566	0.83181515	0.020185883	39.13	39.13	0.35	0.07	3	0.0018	0.5	0
11	111	Rainfall	0.146763467	0.50686263	0.783323758	0.019494957	31.76	39.66	0.375	0.07	3	0.0018	0.5	0
12	112	Rainfall	0.131859533	0.216317187	0.491926828	0.019582818	26.43	40.05	0.366666667	0.07	3	0.0018	0.5	0
13	113	Rainfall	0.079252578	0.301336626	0.487969375	0.018945762	32.54	33.45	0.366665	0.07	3	0.0018	0.5	0
14	114	Rainfall	0.127684973	0.32926382	0.531130663	0.021756622	46.25	46.25	0.35	0.07	3	0.0018	0.5	0
15	115	Rainfall	0.063275947	0.073433542	0.29032092	0.030233669	11.45	11.45	0.383333333	0.07	3	0.0018	0.5	0
16	116	Rainfall	0.127371572	0.189444448	0.522811415	0.002142508	35.75	35.75	0.366666667	0.07	3	0.0018	0.5	0
17	117	Rainfall	0.109872509	0.240504253	0.745247331	0.017462745	46.69	46.69	0.35	0.1	3.043539222	0.0018	0.502902615	0
18	118	Rainfall	0.163651091	0.242747348	0.565678597	6.1783E-05	71.83	71.83	0.4	0.1	3	0.0018	0.5	0
19	119	Rainfall	0.183656184	0.1248125	0.557157761	0.001117758	37.19	45.76	0.3875	0.085	3	0.0018	0.5	0
20	120	Rainfall	0.065936244	0.17579809	0.346660689	0.031595741	41.91	59.25	0.375	0.085	3.014179403	0.0018	0.500945294	0
21	121	Rainfall	0.109954389	0.270459976	0.646280057	0.013312596	19.13	60.23	0.4	0.1	3.001320635	0.0018	0.500088042	0
22	122	Rainfall	0.034121905	0.202237316	0.459073117	0.018170485	45.65	50.4	0.35	0.07	3	0.0018	0.5	0
23	123	Rainfall	0.072678492	0.189376703	0.445192773	0.021806697	13.69	23.24	0.4	0.1	3	0.0018	0.5	0
24	124	Rainfall	0.194120183	0.567808545	0.926308735	0.018389407	25.35	31.17	0.375	0.079999	3	0.0018	0.5	0
25	125	Rainfall	0.058335198	0.258790509	0.544117614	0.017689114	3.47	3.47	0.4	0.07	3	0.0018	0.5	0
26	126	Rainfall	0.134510206	0.333110178	0.718225733	0.016671675	7.86	7.86	0.4	0.07	3	0.0018	0.5	0
27	127	Rainfall	0.138256436	0.272935857	0.514421441	0.011625587	9.61	9.61	0.383333333	0.07	3	0.0018	0.5	0
28	128	Rainfall	0.037178159	0.020452928	0.277689864	0.029077691	25.51	30.03	0.35	0.07	3	0.0018	0.5	0
29	129	Rainfall	0.03544828	0.110984461	0.43745064	0.019245584	29.84	29.84	0.35	0.07	3	0.0018	0.5	0
30	130	Rainfall	0.167491195	0.270629716	0.72533722	0.009273619	22.61	22.61	0.375	0.07	3	0.0018	0.5	0
31	131	Rainfall	0.092051275	0.228561648	0.559767669	0.00612325	19.69	19.69	0.38	0.09	3.609424376	0.0018	0.540628292	0
32	132	Rainfall	0.11942312	0.381019366	0.769948089	0.019066203	19.88	30.28	0.383333333	0.09	3.081079451	0.0018	0.505405297	0
33	133	Rainfall	0.097804973	0.305409136	0.597555388	0.013071184	23.41	26.43	0.375	0.07	3.32608575	0.0018	0.52173905	0
34	134	Rainfall	0.095281728	0.266550895	0.515733087	0.025595707	21.89	21.89	0.366666667	0.07	3.249290256	0.0018	0.51661935	0
35	135	Rainfall	0.177219459	0.426642938	0.76847096	0.012272595	17.94	39.51	0.375	0.07	3.10762331	0.0018	0.507174887	0
36	136	Rainfall	0.057158973	0.389564648	0.699929273	0.009570387	45.08	45.08	0.35	0.07	3.003373696	0.0018	0.500224913	0
37	137	Rainfall	0.036201664	0.190033698	0.401835174	0.011763184	2.79	4.81	0.4	0.1	3.487158026	0.0018	0.532477202	0

CUHP SUBCATCHMENTS

Columns with this color heading are for required user-input
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Columns with this color heading are for program-calculated values

									Maximum Depression Storage (Watershed inches)		Horton's Infiltration Parameters			DCIA
Subcatchment Name	EPA SWMM Target Node	Raingage	Area (mi^2)	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Existing Percent Imperviousness	Future Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Level 0, 1, or 2
38	138	Rainfall	0.046566548	0.217758249	0.517096222	0.011684855	37.98	40.72	0.3625	0.07	3.176947193	0.0018	0.51179648	0
39	139	Rainfall	0.121903061	0.333138123	0.932561134	0.016561119	4.12	4.12	0.4	0.1	3.418172557	0.0018	0.52787817	0
40	140	Rainfall	0.122453055	0.378940267	0.899778761	0.035881602	2.62	2.62	0.375	0.1	3.214406935	0.0018	0.514293796	0
41	141	Rainfall	0.147779539	0.392543242	0.787648411	0.020285854	24.18	24.18	0.3625	0.07	3.588447182	0.0018	0.539229812	0
42	142	Rainfall	0.074638763	0.171497956	0.587425044	0.036303323	23.56	23.56	0.366666667	0.07	3.233298535	0.0018	0.515553236	0
43	143	Rainfall	0.158293392	0.291269503	0.645565973	0.041138148	32.32	32.32	0.3625	0.07	3.437543739	0.0018	0.529169583	0
44	144	Rainfall	0.367882286	0.389661809	1.047947561	0.043243971	2.54	50.51	0.4	0.1	3.077909004	0.0018	0.505193934	0
45	145	Rainfall	0.574635092	0.537877076	1.257884659	0.0331412	2.31	66.28	0.4	0.1	3.729719464	0.0018	0.548647964	0
46	146	Rainfall	0.639377845	0.359285439	1.233432665	0.04155519	2	58.98337364	0.4	0.1	3.059824421	0.0018	0.503988295	0
47	147	Rainfall	1.555964475	0.976910494	2.284859602	0.055765033	2.21	2.33	0.4	0.1	3.700195075	0.0018	0.546679672	0
48	148	Rainfall	1.245179713	0.99350458	2.091231098	0.059099031	2	2	0.4	0.1	3	0.0018	0.5	0
49	149	Rainfall	1.843805656	1.318160292	2.461505227	0.045896763	2.36	2.36	0.4	0.1	3.080488473	0.0018	0.505365898	0
50	150	Rainfall	1.511409698	0.706329557	2.33046142	0.059212338	2.24	2.24	0.4	0.1	3.128772747	0.001799847	0.508635986	0
51	151	Rainfall	2.154145516	0.966015034	2.464105057	0.06	2	2	0.4	0.1	3.102725506	0.0018	0.506848367	0
R1	R101	Rainfall	0.032572163	0.218498609	0.372746623	0.017020081	20.71	23.56	0.37	0.07	3.5805397	0.0018	0.538702647	0
R2	R102	Rainfall	0.082196633	0.32666554	0.746331009	0.014856308	10.6	16.72	0.38	0.07	3.095620456	0.0018	0.506374697	0
R3	R103	Rainfall	0.141808756	0.494217275	0.796098316	0.06	5.41	5.41	0.4	0.07	3	0.0018	0.5	0
R4	R104	Rainfall	0.170958611	0.340536005	0.769121765	0.047031287	8.73	15.34	0.3875	0.07	3.09885217	0.0018	0.506590145	0
R5	R105	Rainfall	0.233576048	0.436203909	0.950465939	0.030328196	18.55	21.16	0.383333333	0.07	3.141729261	0.0018	0.509448617	0
R6	R106	Rainfall	0.147765648	0.36076643	0.933455826	0.02064313	38.09	41.67	0.366666667	0.08	4.127524886	0.0018	0.575168326	0
R7	R107	Rainfall	0.229102105	0.501285568	0.878363445	0.056840353	7.29	13.63	0.4	0.09	3.172101573	0.0018	0.511473438	0
R8	R108	Rainfall	0.55426417	0.477990191	1.134027939	0.054025673	21.07	21.07	0.383333333	0.08	3.154403623	0.0018	0.510293575	0
R9	R109	Rainfall	0.089561014	0.306188912	0.771665761	0.0384861	2.08	13.77	0.4	0.1	4.274181937	0.0018	0.584945462	0
R10	R110	Rainfall	0.635655003	0.868369184	1.526705996	0.030190741	2.85	2.91	0.4	0.1	3.048362243	0.0018	0.50322415	0
R11	R111	Rainfall	0.441032923	0.233737936	1.112921581	0.024938705	7.04	27.68	0.4	0.1	3.885961237	0.001759234	0.572652665	0

CUHP SUBCATCHMENTS

Note: C_p values shown to the sixth decimal place - unrounded values used in model

C_p Override														
Subcatchment Name	Existing 2 Year	Existing 5 Year	Existing 10 Year	Existing 25 Year	Existing 50 Year	Existing 100 Year	Existing 500 Year	Future 2 Year	Future 5 Year	Future 10 Year	Future 25 Year	Future 50 Year	Future 100 Year	Future 500 Year
45	0.147200	0.146572	0.146244	0.145922	0.145736	0.145589	0.145333	0.188183	0.188780	0.189073	0.189351	0.189509	0.189632	0.189844
46	0.152450	0.151964	0.151698	0.151433	0.151278	0.151157	0.150946	0.185798	0.186514	0.186885	0.187244	0.187450	0.187610	0.187886
47	0.198754	0.197948	0.197526	0.197111	0.196870	0.196680	0.196350	0.198388	0.197541	0.197098	0.196662	0.196409	0.196210	0.195864
48	0.186167	0.185582	0.185261	0.184940	0.184752	0.184605	0.184350	0.186167	0.185582	0.185261	0.184940	0.184752	0.184605	0.184350
49	0.208265	0.207483	0.207057	0.206631	0.206383	0.206188	0.205850	0.208265	0.207483	0.207057	0.206631	0.206383	0.206188	0.205850
50	0.196615	0.195905	0.195520	0.195134	0.194910	0.194734	0.194428	0.196615	0.195905	0.195520	0.195134	0.194910	0.194734	0.194428
51	0.219497	0.218790	0.218406	0.218021	0.217798	0.217622	0.217316	0.219497	0.218790	0.218406	0.218021	0.217798	0.217622	0.217316

EPA SWMM 5.1 Input Parameters

```
[TITLE]
;;Project Title/Notes

[OPTIONS]
;;Option             Value
FLOW_UNITS           CFS
INFILTRATION         HORTON
FLOW_ROUTING         KINWAVE
LINK_OFFSETS         DEPTH
MIN_SLOPE            0
ALLOW_PONDING        NO
SKIP_STEADY_STATE    NO

START_DATE           01/01/2005
START_TIME           00:00:00
REPORT_START_DATE    01/01/2005
REPORT_START_TIME    00:00:00
END_DATE             01/03/2005
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:15:00
WET_STEP             00:05:00
DRY_STEP             01:00:00
ROUTING_STEP         0:00:30
RULE_STEP            00:00:00

INERTIAL_DAMPING     PARTIAL
NORMAL_FLOW_LIMITED  BOTH
FORCE_MAIN_EQUATION  H-W
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         12.566
MAX_TRIALS           8
HEAD_TOLERANCE       0.005
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              1

[FILES]
;;Interfacing Files
USE INFLOWS "F:\2019\2001-2500\019-2294\40-Design\Calcs\WTRS\1 HYDROLOGY\Baseline\CUHP v. 2.0.1\Output
Files\Future\39_Fut_100yr_15mi^2_VanBibber_CUHP_201_Output.txt"

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
CONSTANT         0.0
DRY_ONLY         NO

[JUNCTIONS]
;;Name           Elevation  MaxDepth   InitDepth  SurDepth   Aponded
;;-------------- ---------- ---------- ---------- ---------- ----------
102              5345.77    0          0          0          0
103              5363.59    0          0          0          0
104              5368       0          0          0          0
104T             5365       0          0          0          0
105              5382       0          0          0          0
105T             5376       0          0          0          0
106              5400       0          0          0          0
107              5379.58    0          0          0          0
108              5400.51    0          0          0          0
109              5400.51    0          0          0          0
110              5425       0          0          0          0
111              5442       0          0          0          0
112              5484       0          0          0          0
113              5509       0          0          0          0
114              5519       0          0          0          0
115              5536       0          0          0          0
116              5553       0          0          0          0
117              5568       0          0          0          0
118              5567       0          0          0          0
119              5569       0          0          0          0
120              5596       0          0          0          0
121              5613       0          0          0          0
122              5613       0          0          0          0
123              5431.03    0          0          0          0
124              5431.03    0          0          0          0
125              5443.07    0          0          0          0
126              5459.94    0          0          0          0
```



```
127              5482.23    0          0          0          0
128              5526       0          0          0          0
129              5554       0          0          0          0
129T             5495       0          0          0          0
130              5507.19    0          0          0          0
131              5539.31    0          0          0          0
132              5539.31    0          0          0          0
133              5584.26    0          0          0          0
134              5600       0          0          0          0
135              5631       0          0          0          0
136              5660       0          0          0          0
137              5649.76    0          0          0          0
138              5688.15    0          0          0          0
139              5709.34    0          0          0          0
140              5742.51    0          0          0          0
141              5768.84    0          0          0          0
142              5813.44    0          0          0          0
143              5819.76    0          0          0          0
144              5866       0          0          0          0
145              5871.82    0          0          0          0
146T             5903       0          0          0          0
146              5967       0          0          0          0
147              6037       0          0          0          0
148              6489       0          0          0          0
149              7099       0          0          0          0
150              7558       0          0          0          0
151              7671       0          0          0          0
R101             5600       0          0          0          0
R102             5640       0          0          0          0
R103             5745       0          0          0          0
R103T            5657       0          0          0          0
R104             5690       0          0          0          0
R105             5712       0          0          0          0
R106             5803       0          0          0          0
R106T            5743       0          0          0          0
R107             5775       0          0          0          0
R108             5834       0          0          0          0
R109T            5841       0          0          0          0
R109             5931       0          0          0          0
R110             5884       0          0          0          0
R111             5932       0          0          0          0
101              5345.77    0          0          0          0

[OUTFALLS]
;;Name           Elevation  Type       Stage Data       Gated    Route To
;;-------------- ---------- ---------- ---------------- -------- ----------------
100              5338.29    FREE                        NO

[CONDUITS]
;;Name           From Node        To Node          Length     Roughness  InOffset   OutOffset  InitFlow
MaxFlow
;;-------------- ---------------- ---------------- ---------- ---------- ---------- ---------- ----------
----------
201              101              100              1479.02    0.019      0          0          0          0

202              102              101              0.1        0.01       0          0          0          0

203              103              101              1434.58    0.04       0          11         0          0

204              104              104T             163.65     0.019      0          0          0          0

204T             104T             103              272.17     0.04       0          0          0          0

205              105              105T             417.75     0.019      0          0          0          0

205T             105T             104T             1572.68    0.04       0          4          0          0

206              106              105              1262.0265  0.045      0          0          0          0

207              107              105T             367.36     .06        0          0          0          0

208              108              107              3381.95    0.045      0          2          0          0

209              109              108              0.1        0.01       0          0          0          0

210              110              108              1413.35    0.02       0          0          0          0

211              111              110              1701.35    0.02       0          0          0          0

212              112              111              2664.52    0.045      0          3          0          0

213              113              112              1883.70    0.045      0          0          0          0
```

214	114	113	500.91	0.045	5	0	0	0
215	115	113	2052.99	0.045	0	0	0	0
216	116	115	1124.97	0.045	0	0	0	0
217	117	116	2413.14	0.02	0	0	0	0
218	118	115	1364.43	0.045	0	0	0	0
219	119	118	1939.66	0.01	0	0	0	0
220	120	119	2510.44	0.045	0	13	0	0
221	121	120	1166.25	0.02	0	0	0	0
222	122	121	0.1	0.01	0	0	0	0
223	123	108	3162.07	0.045	0	0	0	0
224	124	123	0.1	0.01	0	0	0	0
225	125	123	1207.05	0.045	0	0	0	0
226	126	125	1903.23	0.045	0	0	0	0
227	127	126	1940.94	0.045	0	2	0	0
228	128	127	1855.08	0.02	0	0	0	0
229	129	129T	1733.55	0.045	0	0	0	0
229T	129T	127	1036.08	0.045	0	0	0	0
230	130	129T	1057.33	0.045	0	0	0	0
231	131	130	2584.65	0.045	0	0	0	0
232	132	131	0.1	0.01	0	0	0	0
233	133	131	2996.30	0.045	0	6	0	0
234	134	133	1025.35	0.045	0	0	0	0
235	135	134	1988.14	0.045	0	0	0	0
236	136	135	2162.39	0.019	0	0	0	0
237	137	135	1283.20	0.045	0	3	0	0
238	138	137	1946.16	0.045	0	0	0	0
239	139	138	1259.89	0.045	0	0	0	0
240	140	139	2212.31	0.045	0	0	0	0
241	141	140	1633.30	0.045	0	0	0	0
242	142	141	2773.90	0.045	0	0	0	0
243	143	142	717.69	.06	0	0	0	0
244	144	143	2309.01	0.045	0	16	0	0
245	145	143	2060.42	0.045	0	30	0	0
246T	146T	145	1305.25	0.045	0	3	0	0
246	146	146T	2939.46	0.045	0	3	0	0
247	147	146T	4278.98	0.045	0	17	0	0
248	148	147	8566.63	0.045	0	41	0	0
249	149	148	9192.37	0.045	0	111	0	0
250	150	149	10999.62	0.045	0	71	0	0
251	151	150	2202.09	0.045	0	0	0	0
R201	R101	134	0.1	0.01	0	0	0	0

R202	R102	R101	1813.66	0.045	2	6	0	0
R203	R103	R103T	2773.51	0.0325	0	16	0	0
R203T	R103T	R102	1138.86	0.045	0	3	0	0
R204	R104	R103T	1710.92	0.045	0	0	0	0
R205	R105	R104	1361.66	0.045	0	0	0	0
R206T	R106T	R105	1937.05	0.045	0	5	0	0
R206	R106	R106T	2567.15	0.02	0	5	0	0
R207	R107	R106T	1419.40	.05	0	12	0	0
R208	R108	R107	2994.43	.05	0	4	0	0
R209T	R109T	R108	452.42	.05	0	0	0	0
R209	R109	R109T	3658.11	0.045	0	5	0	0
R210	R110	R109T	1721.29	.05	0	11	0	0
R211	R111	R110	3672.97	0.045	0	0	0	0

```
[XSECTIONS]
;;Link          Shape        Geom1            Geom2      Geom3      Geom4      Barrels    Culvert
;;-------------- ------------ ---------------- ---------- ---------- ---------- ---------- ----------
201             IRREGULAR    201              0          0          0          1
202             DUMMY        0                0          0          0          1
203             IRREGULAR    203              0          0          0          1
204             RECT_CLOSED  5                7          0          0          3
204T            IRREGULAR    204T             0          0          0          1
205             RECT_OPEN    5                7          0          0          1
205T            IRREGULAR    205T             0          0          0          1
206             TRAPEZOIDAL  3                4          4          8          1
207             TRAPEZOIDAL  12               80         6.5        3          1
208             IRREGULAR    208              0          0          0          1
209             DUMMY        0                0          0          0          1
210             IRREGULAR    Minor            0          0          0          1
211             IRREGULAR    Minor            0          0          0          1
212             TRAPEZOIDAL  17               51.2       2.6        2.5        1
213             TRAPEZOIDAL  15               60         12.1       12.8       1
214             TRAPEZOIDAL  6                15         7          5          1
215             TRAPEZOIDAL  10               35         2.5        3          1
216             TRAPEZOIDAL  8                30         28.6       44.9       1
217             IRREGULAR    Minor            0          0          0          1
218             TRAPEZOIDAL  5                30         7          7          1
219             DUMMY        0                0          0          0          1
220             TRAPEZOIDAL  10               44.8       3          3          1
221             IRREGULAR    Major            0          0          0          1
222             DUMMY        0                0          0          0          1
223             IRREGULAR    223              0          0          0          1
224             DUMMY        0                0          0          0          1
225             IRREGULAR    225              0          0          0          1
226             IRREGULAR    226              0          0          0          1
227             IRREGULAR    227              0          0          0          1
228             IRREGULAR    Minor            0          0          0          1
229             IRREGULAR    229              0          0          0          1
229T            IRREGULAR    229T             0          0          0          1
230             IRREGULAR    230              0          0          0          1
231             IRREGULAR    231              0          0          0          1
232             DUMMY        0                0          0          0          1
233             IRREGULAR    233              0          0          0          1
234             IRREGULAR    234              0          0          0          1
235             IRREGULAR    235              0          0          0          1
236             CIRCULAR     3.5              0          0          0          1
237             IRREGULAR    237              0          0          0          1
238             IRREGULAR    238              0          0          0          1
239             IRREGULAR    239              0          0          0          1
240             IRREGULAR    240              0          0          0          1
241             IRREGULAR    241              0          0          0          1
242             IRREGULAR    242              0          0          0          1
243             TRAPEZOIDAL  10               30         10         6          1
244             TRAPEZOIDAL  8                18.6       4          4          1
245             IRREGULAR    247              0          0          0          1
246T            IRREGULAR    248T             0          0          0          1
246             TRAPEZOIDAL  5                15         10         3          1
247             TRAPEZOIDAL  10               15         4          4          1
```

```
248              IRREGULAR    250             0          0          0          1
249              IRREGULAR    251             0          0          0          1
250              IRREGULAR    252             0          0          0          1
251              IRREGULAR    253             0          0          0          1
R201             DUMMY        0               0          0          0          1
R202             IRREGULAR    R202            0          0          0          1
R203             TRAPEZOIDAL  5               15         8          8          1
R203T            IRREGULAR    R203T           0          0          0          1
R204             IRREGULAR    R204            0          0          0          1
R205             IRREGULAR    R205            0          0          0          1
R206T            IRREGULAR    R207            0          0          0          1
R206             IRREGULAR    Minor           0          0          0          1
R207             TRAPEZOIDAL  9               12.5       3          3          1
R208             TRAPEZOIDAL  11              12         3.1        1.5        1
R209T            TRAPEZOIDAL  12              8.3        1.5        1.5        1
R209             TRAPEZOIDAL  15              92.5       12.5       15         1
R210             TRAPEZOIDAL  12              11.4       4          4.5        1
R211             TRAPEZOIDAL  18              30         8          6          1

[TRANSECTS]
;;Transect Data in HEC-2 format
;
;Minor Street
NC 0.02     0.02     0.02
X1 Minor             7        0.0      390      0.0      0.0      0.0      0.0      0.0
GR 4        0        0.5      175      0        175      0.4      195      0        215
GR 0.5      215      4        390
;
;Major Street
NC 0.02     0.02     0.02
X1 Major             7        0.0      390      0.0      0.0      0.0      0.0      0.0
GR 0.75     0        0.5      175      0        175      0.95     195      0        215
GR 0.5      215      0.75     390
;
;Composite channel from LiDAR
NC .045     .045     .045
X1 253               9        151.73   354.98   0.0      0.0      0.0      0.0      0.0
GR 7668.28  0        7653     82.2     7629.11  151.73   7620.98  202.25   7624.07  281.07
GR 7624     319.43   7638     354.98   7648.25  390.36   7668.28  476.65
;
;Composite channel from LiDAR
NC .045     .045     .045
X1 252               11       267.54   316.02   0.0      0.0      0.0      0.0      0.0
GR 7538.04  0        7472     159.7    7471.64  161.51   7466     221.02   7462     267.54
GR 7458     287.09   7456     295.88   7457     299.61   7470     316.02   7495     369.76
GR 7538.04  519.28
;
;Composite channel from LiDAR
NC .045     .045     .045
X1 251               6        139.28   212.92   0.0      0.0      0.0      0.0      0.0
GR 6759.44  0        6671.93  139.28   6671.85  168.47   6666.98  195.42   6668     212.92
GR 6759.44  325.63
;
;Composite channel from LiDAR
NC .045     .045     .045
X1 250               12       364.61   400.59   0.0      0.0      0.0      0.0      0.0
GR 6221.62  0        6148     160.12   6100     364.61   6095.02  384.45   6097     395.41
GR 6102     400.59   6107     447.59   6107     474.12   6129.52  584.04   6161.3   710.54
GR 6175     1089.07  6221.62  1149.94
;
;Composite channel from LiDAR
NC .045     .045     .045
X1 248T              19       135.52   239.78   0.0      0.0      0.0      0.0      0.0
GR 5919.9   0        5907.03  77.18    5899     135.52   5897.8   152.84   5895.35  166.09
GR 5890.99  178.7    5891     190.41   5893.1   204.31   5898.31  232.5    5898.35  239.78
GR 5895.03  318.68   5895     370.65   5895     403.61   5895     419.64   5895.55  487.59
GR 5895     504.08   5895     522.13   5901.08  588.7    5919.9   922.6
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 247               18       196.74   360.32   0.0      0.0      0.0      0.0      0.0
GR 5875     0        5870     14.12    5868     68.59    5865     77.47    5864.74  196.74
GR 5863.09  228.86   5860     237.5    5859.12  288.49   5857     295.61   5857     320.25
GR 5862     333.55   5864     360.32   5866     480.63   5866     630.76   5872     683.07
GR 5874     798.46   5874     844.06   5875     850
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 242               15       693.78   801.33   0.0      0.0      0.0      0.0      0.0
GR 5798     0        5792     123.71   5791.8   383.36   5791.26  513.22   5791.19  603.83
GR 5791.92  693.78   5789     710.86   5785     748.57   5785     752.14   5792.32  801.33
GR 5792     889.11   5792.98  1120.69  5792.99  1166.88  5794     1265.78  5798     1419.93
```



```
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 241               10       330.39   376.09   0.0      0.0      0.0      0.0      0.0
GR 5760.86  0        5754.82  287.03   5753.75  330.39   5751.02  362.29   5751     364.94
GR 5751.12  365.55   5752.51  376.09   5753.1   1086.04  5756     1186.61  5760.86  1434.27
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 240               13       328.38   365.16   0.0      0.0      0.0      0.0      0.0
GR 5733.47  0        5732.99  41.33    5730     184.21   5730     298.72   5728     328.38
GR 5724     346.38   5723.9   350.12   5728     365.16   5728.3   388.98   5728.4   625.32
GR 5730.19  681.03   5733.47  899.61   5733.47  1074.5
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 239               12       166.27   196      0.0      0.0      0.0      0.0      0.0
GR 5717     0        5714     58.82    5714     101.55   5711     158.86   5710     166.27
GR 5706     181.45   5706     186.56   5709     196      5710     220.2    5713.79  309.05
GR 5714     496.5    5717     518.44
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 238               7        111.58   184.61   0.0      0.0      0.0      0.0      0.0
GR 5683.75  0        5683.11  31.87    5674     111.58   5670     143.47   5670     171.48
GR 5674     184.61   5683.75  700.97
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 237               9        313.62   402.16   0.0      0.0      0.0      0.0      0.0
GR 5651.39  0        5647.93  84.89    5643     154.89   5643     313.62   5638     354.15
GR 5638.03  366.67   5642     402.16   5642     503.83   5651.39  574.5
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 235               8        174.01   215.6    0.0      0.0      0.0      0.0      0.0
GR 5638.48  0        5629     174.01   5623.03  179.5    5623.01  182.13   5625     203.08
GR 5629     215.6    5631.1   419.11   5638.48  474.93
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 234               10       406.81   447.85   0.0      0.0      0.0      0.0      0.0
GR 5615.54  0        5603.54  173.52   5598     255.31   5598     406.81   5595     415.48
GR 5595     424.22   5598.02  447.85   5599     539.43   5600     724.3    5615.54  856.06
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 233               8        99.21    138.33   0.0      0.0      0.0      0.0      0.0
GR 5582.49  0        5576     38.22    5576     99.21    5572.99  122.43   5573     127.1
GR 5576     138.33   5575.87  562.64   5582.49  573.64
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 231               10       257.96   306.16   0.0      0.0      0.0      0.0      0.0
GR 5536.97  0        5522     158.66   5521.39  257.96   5520     276.63   5518     280.86
GR 5518     281.37   5521.05  291.86   5522     306.16   5522     480.46   5536.97  683.01
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 230               11       928.94   945.92   0.0      0.0      0.0      0.0      0.0
GR 5507.9   0        5500     245.32   5500     783.03   5501.21  845.11   5502     904.02
GR 5502     928.94   5499.88  935.52   5499.99  940.13   5502.22  945.92   5504     975.13
GR 5507.9   1138.19
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 229T              8        479.42   499.19   0.0      0.0      0.0      0.0      0.0
GR 5507.33  0        5489.05  230.2    5489     479.42   5487.97  489.91   5488     492.1
GR 5488.78  499.19   5488.58  1172.12  5507.33  1405.45
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 229               7        30.1     523.01   0.0      0.0      0.0      0.0      0.0
GR 5512.95  0        5507.81  30.1     5505.92  132.85   5506.66  196.82   5506.91  430.59
GR 5508.64  523.01   5512.95  593.23
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 227               8        252.7    295.83   0.0      0.0      0.0      0.0      0.0
GR 5495     0        5493.2   109.82   5479     252.7    5478.34  275.93   5478.56  295.83
GR 5477     689.75   5481.27  808.5    5495     973.62
;
```

```
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 226               11       391.29   500.47   0.0      0.0      0.0      0.0      0.0
GR 5475.3   0        5460.84  200.23   5458.66  391.29   5456     441.46   5453     456.33
GR 5453     460.44   5454     464.22   5458     500.47   5460.02  821.81   5469.45  922.98
GR 5475.3   955.64
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 225               10       563.27   651.17   0.0      0.0      0.0      0.0      0.0
GR 5467     0        5457     266.03   5451     537.08   5447     563.27   5444.2   616.72
GR 5442.24  636.25   5447.01  651.17   5447.4   677.51   5448     1178.93  5467     1377.71
;
;Composite channel from LiDAR
NC .045     .045     .045
X1 223               8        1165.28  1258.87  0.0      0.0      0.0      0.0      0.0
GR 5432.62  0        5424.99  148.31   5425.53  420.28   5420     1165.28  5412.03  1180.84
GR 5419.74  1258.87  5424.03  1557.33  5432.62  1736
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 208               11       884.36   969.99   0.0      0.0      0.0      0.0      0.0
GR 5411.55  0        5401.97  262.71   5401.69  316.28   5400.53  637.54   5401     884.36
GR 5400.16  918.58   5395     939.65   5395     943.09   5401     969.99   5402     1295.25
GR 5411.55  1321.7
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 205T              8        42.88    140.3    0.0      0.0      0.0      0.0      0.0
GR 5388     0        5385     42.88    5376     87.96    5376     98.53    5383     140.3
GR 5384     395.02   5386.05  547.46   5388     552.01
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 204T              8        1108.84  1217.03  0.0      0.0      0.0      0.0      0.0
GR 5381.96  0        5375     365.55   5375     1108.84  5365     1167.11  5365     1183.81
GR 5372     1217.03  5372     1274.11  5381.96  1406.21
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 203               9        760.87   922.95   0.0      0.0      0.0      0.0      0.0
GR 5373.38  0        5370     54.57    5370     204.11   5365.97  760.87   5352     827.63
GR 5352.08  837.72   5365     922.95   5367.66  1203.15  5373.38  1337.89
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 R207              8        30.34    132.13   0.0      0.0      0.0      0.0      0.0
GR 5727     0        5725.74  30.34    5723.98  47.91    5719     71.7     5719     78.74
GR 5719.57  90.52    5725.82  132.13   5727     141.15
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 R205              7        996.31   1011.46  0.0      0.0      0.0      0.0      0.0
GR 5706.32  0        5696     557.69   5696     996.31   5692.56  1005.24  5695     1011.46
GR 5694.87  1214.17  5706.32  1473.93
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 R204              7        145.18   172.59   0.0      0.0      0.0      0.0      0.0
GR 5675     0        5667.04  145.18   5665     152.78   5665     156.36   5667.44  172.59
GR 5667.41  413      5675     500.85
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 R203T             10       374.88   417.32   0.0      0.0      0.0      0.0      0.0
GR 5663     0        5648     331.72   5647.98  374.88   5645     397.48   5645     402.16
GR 5647.95  417.32   5650     477.93   5658     601.1    5660     732.25   5663     741.8
;
;Composite channel from LiDAR
NC 0.05     0.05     0.08
X1 R202              9        171.33   431.53   0.0      0.0      0.0      0.0      0.0
GR 5644     0        5640     68.17    5635.5   171.33   5630     228.78   5629.51  263.41
GR 5630     359.67   5634     431.53   5642     466.52   5644     503.03
;
;RCBC and Overflow Section
NC 0.02     0.019    0.02
X1 201               6        99.9     129.1    0.0      0.0      0.0      0.0      0.0
GR 5359.27  0        5354.27  99.9     5345.77  100      5345.77  129      5354.27  129.1
GR 5359.27  229.1

[REPORT]
;;Reporting Options
```



```
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS -2500.000 0.000 12500.000 10000.000
Units      None

[COORDINATES]
;;Node           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
102              11900.743          4583.512
103              11795.320          4502.417
104              11706.116          4575.402
104T             11734.499          4530.800
105              11329.637          4585.054
105T             11442.558          4518.636
106              11077.336          4574.394
107              11345.244          4449.705
108              10825.034          4354.074
109              10778.838          4421.591
110              10750.409          4574.394
111              10405.716          4599.268
112              9894.005           4759.178
113              9524.437           4823.142
114              9531.544           4965.284
115              9147.761           4883.552
116              9073.136           5061.229
117              8707.121           5281.549
118              8948.762           4716.535
119              8621.836           4908.427
120              8277.143           5153.621
121              8103.019           4915.534
122              8103.019           4837.356
123              10256.467          4272.342
124              10245.806          4393.163
125              10021.933          4204.825
126              9815.827           4208.379
127              9520.883           4265.235
128              9531.544           4549.519
129              9151.314           4556.626
129T             9336.099           4251.021
130              9083.797           4211.932
131              8660.925           4236.807
132              8657.372           4290.110
133              8120.787           4396.716
134              7879.146           4471.341
135              7580.648           4570.840
136              7573.541           5011.480
137              7346.114           4588.608
138              7026.295           4752.071
139              6820.189           4816.035
140              6454.174           5015.033
141              6116.588           4919.087
142              5679.502           4762.732
143              5562.235           4691.661
144              5260.183           4951.069
145              5213.987           4560.179
146T             4894.168           4560.179
146              4467.743           4816.035
147              4211.888           4293.664
148              2786.916           4325.646
149              1351.285           4659.679
150              214.150            5725.742
151              -119.883           5402.370
R101             7813.567           4396.994
R102             7545.955           4433.486
R103             6945.853           4311.844
R103T            7351.327           4490.253
R104             7026.948           4603.785
R105             6759.779           4666.786
R106             5935.357           4563.733
R106T            6400.871           4656.125
R107             6162.784           4506.876
R108             5697.269           4215.486
R109T            5626.198           4158.629
R109             4997.221           4069.790
R110             5352.575           3927.649
R111             4844.419           3646.919
101              12066.987          4522.691
```

```
100              12362.983          4664.606

[VERTICES]
;;Link           X-Coord            Y-Coord
;;-------------- ------------------ ------------------
R209             5295.719           4002.273
```

EPA SWMM 5.1 100-Year Future Output

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)
--------------------------------------------------------------

WARNING 04: minimum elevation drop used for Conduit 202
WARNING 04: minimum elevation drop used for Conduit 209
WARNING 04: minimum elevation drop used for Conduit 222
WARNING 04: minimum elevation drop used for Conduit 224
WARNING 04: minimum elevation drop used for Conduit 232
WARNING 04: minimum elevation drop used for Conduit R201

*********************************************************
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
*********************************************************

****************
Analysis Options
****************
Flow Units ............... CFS
Process Models:
  Rainfall/Runoff ........ NO
  RDII ................... NO
  Snowmelt ............... NO
  Groundwater ............ NO
  Flow Routing ........... YES
  Ponding Allowed ........ NO
  Water Quality .......... NO
Flow Routing Method ...... KINWAVE
Starting Date ............ 01/01/2005 00:00:00
Ending Date .............. 01/03/2005 00:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:15:00
Routing Time Step ........ 30.00 sec


**************************        Volume         Volume
Flow Routing Continuity        acre-feet       10^6 gal
**************************     ---------      ---------
Dry Weather Inflow .......         0.000          0.000
Wet Weather Inflow .......         0.000          0.000
Groundwater Inflow .......         0.000          0.000
RDII Inflow ..............         0.000          0.000
External Inflow ..........      1281.696        417.660
External Outflow .........      1296.647        422.532
Flooding Loss ............         0.000          0.000
Evaporation Loss .........         0.000          0.000
Exfiltration Loss ........         0.000          0.000
Initial Stored Volume ....         0.000          0.000
Final Stored Volume ......         0.000          0.000
Continuity Error (%) .....        -1.166


********************************
Highest Flow Instability Indexes
********************************
All links are stable.


*************************
Routing Time Step Summary
*************************
Minimum Time Step           :    30.00 sec
Average Time Step           :    30.00 sec
Maximum Time Step           :    30.00 sec
Percent in Steady State     :     0.00
Average Iterations per Step :     1.00
Percent Not Converging      :     0.00


******************
Node Depth Summary
******************

---------------------------------------------------------------------------------
```


Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days	Time of Max Occurrence hr:min	Reported Max Depth Feet
102	JUNCTION	0.00	0.00	5345.77	0	00:00	0.00
103	JUNCTION	1.84	12.31	5375.90	0	03:07	12.28
104	JUNCTION	0.02	0.56	5368.56	0	00:45	0.56
104T	JUNCTION	5.69	13.68	5378.68	0	03:06	13.67
105	JUNCTION	0.07	2.45	5384.45	0	00:46	2.44
105T	JUNCTION	1.68	9.68	5385.68	0	03:00	9.68
106	JUNCTION	0.05	1.70	5401.70	0	00:40	1.68
107	JUNCTION	3.63	9.49	5389.07	0	03:00	9.49
108	JUNCTION	1.70	9.59	5410.10	0	02:50	9.58
109	JUNCTION	0.00	0.00	5400.51	0	00:00	0.00
110	JUNCTION	0.12	1.98	5426.98	0	01:07	1.93
111	JUNCTION	3.10	5.79	5447.79	0	01:04	5.75
112	JUNCTION	0.10	2.80	5486.80	0	01:00	2.80
113	JUNCTION	0.11	2.95	5511.95	0	00:58	2.94
114	JUNCTION	5.03	6.32	5525.32	0	00:40	6.28
115	JUNCTION	0.10	2.96	5538.96	0	00:54	2.90
116	JUNCTION	0.04	1.07	5554.07	0	00:51	1.04
117	JUNCTION	0.03	0.93	5568.93	0	00:40	0.92
118	JUNCTION	0.07	2.03	5569.03	0	00:51	1.96
119	JUNCTION	13.05	14.65	5583.65	0	00:53	14.60
120	JUNCTION	0.05	1.73	5597.73	0	00:43	1.72
121	JUNCTION	0.03	0.78	5613.78	0	00:40	0.78
122	JUNCTION	0.00	0.00	5613.00	0	00:00	0.00
123	JUNCTION	1.45	9.59	5440.62	0	02:41	9.59
124	JUNCTION	0.00	0.00	5431.03	0	00:00	0.00
125	JUNCTION	1.38	7.45	5450.52	0	02:39	7.44
126	JUNCTION	2.72	7.45	5467.39	0	02:33	7.44
127	JUNCTION	0.43	2.73	5484.96	0	02:29	2.73
128	JUNCTION	0.01	0.54	5526.54	0	00:35	0.50
129	JUNCTION	0.02	0.56	5554.56	0	00:40	0.56
129T	JUNCTION	0.38	1.97	5496.97	0	02:26	1.97
130	JUNCTION	1.15	6.01	5513.20	0	02:24	6.00
131	JUNCTION	6.79	10.51	5549.82	0	02:19	10.51
132	JUNCTION	0.00	0.00	5539.31	0	00:00	0.00
133	JUNCTION	0.83	5.15	5589.41	0	02:13	5.15
134	JUNCTION	1.12	8.26	5608.26	0	02:21	8.24
135	JUNCTION	3.76	8.85	5639.85	0	02:17	8.84
136	JUNCTION	0.08	1.83	5661.83	0	00:50	1.79
137	JUNCTION	0.76	6.02	5655.78	0	02:14	6.02
138	JUNCTION	0.95	7.31	5695.46	0	02:10	7.30
139	JUNCTION	0.97	7.31	5716.65	0	02:07	7.29
140	JUNCTION	0.89	6.03	5748.54	0	02:02	6.03
141	JUNCTION	0.85	7.10	5775.94	0	01:58	7.10
142	JUNCTION	0.83	7.11	5820.55	0	01:46	7.11
143	JUNCTION	30.72	37.37	5857.13	0	01:48	37.37
144	JUNCTION	0.07	2.92	5868.92	0	00:40	2.83
145	JUNCTION	3.53	8.04	5879.86	0	01:45	8.04
146T	JUNCTION	17.48	22.40	5925.40	0	01:46	22.39
146	JUNCTION	0.10	2.90	5969.90	0	00:45	2.90
147	JUNCTION	41.53	46.84	6083.84	0	01:44	46.84
148	JUNCTION	111.35	115.16	6604.16	0	01:39	115.14
149	JUNCTION	71.46	76.52	7175.52	0	01:29	76.52
150	JUNCTION	0.45	5.56	7563.56	0	01:16	5.56
151	JUNCTION	0.19	2.30	7673.30	0	01:15	2.30
R101	JUNCTION	6.15	8.80	5608.80	0	01:27	8.79
R102	JUNCTION	3.34	8.15	5648.15	0	01:22	8.11
R103	JUNCTION	0.03	0.78	5745.78	0	00:50	0.77
R103T	JUNCTION	16.03	16.78	5673.78	0	00:59	16.78
R104	JUNCTION	0.36	3.69	5693.69	0	01:16	3.69
R105	JUNCTION	5.29	11.04	5723.04	0	01:11	11.01
R106	JUNCTION	0.03	0.75	5803.75	0	00:45	0.75
R106T	JUNCTION	12.24	17.60	5760.60	0	01:05	17.52
R107	JUNCTION	4.23	9.35	5784.35	0	01:04	9.31
R108	JUNCTION	0.25	5.54	5839.54	0	01:03	5.52
R109T	JUNCTION	11.16	14.71	5855.71	0	01:02	14.70
R109	JUNCTION	0.01	0.27	5931.27	0	00:50	0.26
R110	JUNCTION	0.15	3.71	5887.71	0	00:59	3.71
R111	JUNCTION	0.05	1.98	5933.98	0	00:40	1.98
101	JUNCTION	12.85	23.31	5369.08	0	03:11	23.30
100	OUTFALL	0.97	9.98	5348.27	0	03:14	9.98

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
102	JUNCTION	44.32	44.32	0 00:50	1.79	1.79	0.000
103	JUNCTION	117.76	4338.08	0 03:07	4.84	416	0.000
104	JUNCTION	76.06	76.06	0 00:45	2.43	2.43	0.000
104T	JUNCTION	0.00	4321.08	0 03:06	0	412	0.000
105	JUNCTION	113.35	204.81	0 00:46	3.85	6.1	0.000
105T	JUNCTION	0.00	4324.81	0 03:00	0	409	0.000
106	JUNCTION	93.93	93.93	0 00:40	2.25	2.25	0.000
107	JUNCTION	107.47	4318.84	0 02:59	5.25	403	0.000
108	JUNCTION	126.89	4324.47	0 02:44	4.25	397	0.000
109	JUNCTION	107.82	107.82	0 00:45	3.5	3.5	0.000
110	JUNCTION	128.03	1392.04	0 01:06	3.65	44.5	0.000
111	JUNCTION	134.30	1295.09	0 01:03	4.23	40.8	0.000
112	JUNCTION	177.34	1186.40	0 01:00	3.8	36.5	0.000
113	JUNCTION	71.83	1072.15	0 00:56	2.19	32.6	0.000
114	JUNCTION	168.72	168.72	0 00:40	3.87	3.87	-0.000
115	JUNCTION	74.72	877.58	0 00:54	1.44	26.5	0.000
116	JUNCTION	112.89	233.41	0 00:51	3.58	6.93	0.000
117	JUNCTION	133.11	133.11	0 00:40	3.32	3.32	0.000
118	JUNCTION	131.90	590.68	0 00:51	5.74	18.1	0.000
119	JUNCTION	222.50	462.61	0 00:50	5.49	12.4	0.000
120	JUNCTION	120.82	284.77	0 00:43	2.13	6.78	0.000
121	JUNCTION	151.99	189.72	0 00:40	3.58	4.64	0.000
122	JUNCTION	37.73	37.73	0 00:40	1.06	1.06	0.000
123	JUNCTION	61.11	4139.59	0 02:41	1.82	345	0.000
124	JUNCTION	141.67	141.67	0 00:50	5.25	5.25	0.000
125	JUNCTION	30.17	4113.68	0 02:38	1.24	337	0.000
126	JUNCTION	78.78	4110.06	0 02:33	2.96	336	0.000
127	JUNCTION	95.62	4096.07	0 02:29	3.12	333	-0.000
128	JUNCTION	69.26	69.26	0 00:35	0.946	0.946	0.000
129	JUNCTION	32.81	32.81	0 00:40	0.957	0.957	0.000
129T	JUNCTION	0.00	4081.17	0 02:26	0	329	0.000
130	JUNCTION	121.87	4076.00	0 02:23	4.24	328	-0.000
131	JUNCTION	54.58	4054.90	0 02:18	2.18	323	-0.000
132	JUNCTION	89.13	89.13	0 00:50	3.18	3.18	0.000
133	JUNCTION	66.65	4025.03	0 02:12	2.51	318	0.000
134	JUNCTION	75.72	4006.51	0 02:10	2.37	315	0.000
135	JUNCTION	169.25	3135.16	0 02:17	5.07	247	0.000
136	JUNCTION	43.00	43.00	0 00:50	1.73	1.73	0.000
137	JUNCTION	17.87	3096.35	0 02:14	0.744	241	-0.000
138	JUNCTION	41.69	3092.64	0 02:10	1.34	240	-0.000
139	JUNCTION	59.03	3084.13	0 02:07	2.5	238	0.000
140	JUNCTION	67.87	3066.16	0 02:02	2.57	236	0.000
141	JUNCTION	100.57	3043.68	0 01:57	3.69	233	0.000
142	JUNCTION	65.61	3036.12	0 01:46	1.88	229	0.000
143	JUNCTION	180.14	3016.43	0 01:44	4.24	227	0.000
144	JUNCTION	544.36	544.36	0 00:40	11.2	11.2	0.000
145	JUNCTION	559.29	2918.00	0 01:41	19.2	212	0.000
146T	JUNCTION	0.00	2670.72	0 01:42	0	192	0.000
146	JUNCTION	702.02	702.02	0 00:45	20.7	20.7	0.000
147	JUNCTION	460.21	2400.99	0 01:41	30.7	171	0.000
148	JUNCTION	381.37	2024.05	0 01:36	26	141	0.000
149	JUNCTION	488.11	1703.60	0 01:28	38.4	115	0.000
150	JUNCTION	531.52	1242.68	0 01:16	31.3	75.8	0.000
151	JUNCTION	718.40	718.40	0 01:15	44.6	44.6	0.000
R101	JUNCTION	20.23	1758.75	0 01:27	0.804	65.5	0.000
R102	JUNCTION	43.24	1756.59	0 01:22	1.96	64.6	0.000
R103	JUNCTION	87.47	87.47	0 00:50	3.05	3.05	0.000
R103T	JUNCTION	0.00	1724.39	0 01:19	0	62.6	0.000
R104	JUNCTION	136.14	1657.26	0 01:15	4.02	59.5	0.000
R105	JUNCTION	169.03	1574.16	0 01:10	5.76	55.4	0.000
R106	JUNCTION	145.19	145.19	0 00:45	4.15	4.15	0.000
R106T	JUNCTION	0.00	1440.25	0 01:05	0	49.5	0.000
R107	JUNCTION	163.42	1315.53	0 01:03	5.23	45.3	0.000
R108	JUNCTION	490.26	1172.13	0 00:59	13.6	40	0.000
R109T	JUNCTION	0.00	748.61	0 01:02	0	26.4	0.000
R109	JUNCTION	52.19	52.19	0 00:50	1.9	1.9	0.000

R110	JUNCTION	323.41	711.70	0 00:59	13.3	24.3	0.000
R111	JUNCTION	431.07	431.07	0 00:40	10.8	10.8	0.000
101	JUNCTION	58.86	4340.88	0 03:11	1.86	420	0.000
100	OUTFALL	76.25	4339.80	0 03:14	2.28	423	0.000

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
100	73.26	446.16	4339.80	422.500
System	73.26	446.16	4339.80	422.500

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
201	CHANNEL	4339.18	0 03:14	16.32	0.37	0.74
202	DUMMY	44.32	0 00:50			
203	CHANNEL	4335.62	0 03:11	4.43	0.08	0.58
204	CONDUIT	76.01	0 00:46	6.50	0.05	0.11
204T	CHANNEL	4320.80	0 03:07	4.26	0.07	0.60
205	CONDUIT	204.79	0 00:46	11.96	0.39	0.49
205T	CHANNEL	4319.69	0 03:06	4.04	0.36	0.81
206	CONDUIT	91.97	0 00:46	3.91	0.26	0.56
207	CONDUIT	4318.73	0 03:00	6.79	0.26	0.49
208	CHANNEL	4292.39	0 03:00	2.95	0.04	0.45
209	DUMMY	107.82	0 00:45			
210	CHANNEL	1390.05	0 01:08	9.02	0.12	0.46
211	CHANNEL	1290.89	0 01:07	7.22	0.15	0.49
212	CONDUIT	1178.36	0 01:04	7.30	0.04	0.16
213	CONDUIT	1064.88	0 01:01	5.46	0.02	0.15
214	CONDUIT	168.01	0 00:41	5.61	0.04	0.22
215	CONDUIT	873.33	0 00:58	6.90	0.10	0.30
216	CONDUIT	231.60	0 00:56	3.17	0.01	0.13
217	CHANNEL	123.63	0 00:53	4.27	0.02	0.22
218	CONDUIT	588.95	0 00:54	6.62	0.17	0.40
219	DUMMY	462.61	0 00:50			
220	CONDUIT	263.67	0 00:53	3.32	0.04	0.16
221	CHANNEL	184.29	0 00:46	4.83	0.32	0.82
222	DUMMY	37.73	0 00:40			
223	CHANNEL	4132.10	0 02:50	8.64	0.02	0.47
224	DUMMY	141.67	0 00:50			
225	CHANNEL	4112.39	0 02:42	3.89	0.01	0.27
226	CHANNEL	4106.72	0 02:39	3.86	0.02	0.33
227	CHANNEL	4093.23	0 02:33	9.49	0.02	0.15
228	CHANNEL	65.30	0 00:39	8.31	0.00	0.13
229	CHANNEL	29.38	0 01:01	4.35	0.00	0.08
229T	CHANNEL	4079.87	0 02:29	>50.00	0.01	0.10
230	CHANNEL	4074.61	0 02:26	4.05	0.06	0.22
231	CHANNEL	4049.91	0 02:24	5.08	0.03	0.32
232	DUMMY	89.13	0 00:50			
233	CHANNEL	4016.63	0 02:19	4.53	0.10	0.47
234	CHANNEL	4005.14	0 02:13	5.04	0.02	0.25
235	CHANNEL	3130.76	0 02:21	5.73	0.07	0.53
236	CONDUIT	42.72	0 00:54	8.46	0.54	0.52
237	CHANNEL	3094.28	0 02:17	4.53	0.07	0.44

SWMM 100-Year Future Output: 0 SqMi

238	CHANNEL	3090.06	0	02:14	6.52	0.07	0.44
239	CHANNEL	3082.96	0	02:10	6.63	0.16	0.66
240	CHANNEL	3058.84	0	02:08	4.86	0.13	0.63
241	CHANNEL	3039.66	0	02:02	3.74	0.03	0.29
242	CHANNEL	3005.31	0	01:58	5.64	0.03	0.55
243	CONDUIT	3016.18	0	01:46	5.77	0.37	0.64
244	CONDUIT	527.94	0	00:44	6.21	0.12	0.36
245	CHANNEL	2911.37	0	01:48	4.75	0.04	0.41
246T	CHANNEL	2669.26	0	01:45	8.85	0.01	0.17
246	CONDUIT	691.93	0	00:49	7.21	0.30	0.58
247	CONDUIT	2397.86	0	01:46	12.19	0.25	0.54
248	CHANNEL	2013.88	0	01:44	15.34	0.00	0.05
249	CHANNEL	1685.35	0	01:39	14.12	0.00	0.04
250	CHANNEL	1218.77	0	01:29	16.63	0.00	0.07
251	CHANNEL	716.49	0	01:18	9.36	0.00	0.05
R201	DUMMY	1758.75	0	01:27			
R202	CHANNEL	1744.83	0	01:27	4.29	0.03	0.19
R203	CONDUIT	86.11	0	00:59	5.27	0.02	0.15
R203T	CHANNEL	1720.65	0	01:22	4.55	0.02	0.29
R204	CHANNEL	1650.36	0	01:19	4.44	0.04	0.36
R205	CHANNEL	1560.71	0	01:16	3.74	0.01	0.27
R206T	CHANNEL	1429.64	0	01:11	4.84	0.46	0.75
R206	CHANNEL	141.64	0	00:52	7.93	0.01	0.19
R207	CONDUIT	1314.31	0	01:05	8.03	0.35	0.62
R208	CONDUIT	1167.60	0	01:04	9.04	0.21	0.49
R209T	CONDUIT	748.46	0	01:03	8.12	0.19	0.46
R209	CONDUIT	46.13	0	01:17	2.05	0.00	0.02
R210	CONDUIT	711.01	0	01:02	7.09	0.07	0.31
R211	CONDUIT	406.31	0	00:55	5.00	0.01	0.11

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Mon Feb 15 09:56:03 2021
Analysis ended on: Mon Feb 15 09:56:03 2021
Total elapsed time: < 1 sec

EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.013)

WARNING 04: minimum elevation drop used for Conduit 202
WARNING 04: minimum elevation drop used for Conduit 209
WARNING 04: minimum elevation drop used for Conduit 222
WARNING 04: minimum elevation drop used for Conduit 224
WARNING 04: minimum elevation drop used for Conduit 232
WARNING 04: minimum elevation drop used for Conduit R201

****
NOTE: The summary statistics displayed in this report are
based on results found at every computational time step,
not just on results from each reporting time step.
****

****
Analysis Options
****

Flow Units .... CFS
Process Models:
  Rainfall/Runoff .... NO
  RDII .... NO
  Snowmelt .... NO
  Groundwater .... NO
  Flow Routing .... YES
  Ponding Allowed .... NO
  Water Quality .... NO
Flow Routing Method ...... KINWAVE
Starting Date 01/01/2005 00:00:00
Ending Date 01/03/2005 00:00:00
Antecedent Dry Days 0.0
Report Time Step 00:15:00
Routing Time Step .... 30.00 sec

****
Flow Routing Continuity
****

Flow Routing Continuity	Volume acre-feet	Volume 10^6 gal
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.000	0.000
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	1219.246	397.309
External Outflow	1229.435	400.630
Flooding Loss	0.000	0.000
Evaporation Loss	0.000	0.000
Exfiltration Loss	0.000	0.000
Initial Stored Volume	0.000	0.000
Final Stored Volume	0.000	0.000
Continuity Error (%)	-0.836	

****
Highest Flow Instability Indexes
****

All links are stable.

****
Routing Time Step Summary
****

Minimum Time Step :	30.00 sec
Average Time Step :	30.00 sec
Maximum Time Step :	30.00 sec
Percent in Steady State :	0.00
Average Iterations per Step :	1.00
Percent Not Converging :	0.00

****
Node Depth Summary
****

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days	Time of Max Occurrence hr:min	Reported Max Depth Feet
102	JUNCTION	0.00	0.00	5345.77	0	00:00	0.00
103	JUNCTION	1.84	11.68	5375.27	0	03:17	11.68
104	JUNCTION	0.02	0.50	5368.50	0	00:50	0.49
104T	JUNCTION	5.70	13.43	5378.43	0	03:16	13.43
105	JUNCTION	0.09	2.15	5384.15	0	00:51	2.10
105T	JUNCTION	1.69	9.43	5385.43	0	03:09	9.42
106	JUNCTION	0.07	1.55	5401.55	0	00:45	1.55
107	JUNCTION	3.65	9.37	5388.95	0	03:09	9.36
108	JUNCTION	1.71	9.32	5409.83	0	02:58	9.32
109	JUNCTION	0.00	0.00	5400.51	0	00:00	0.00
110	JUNCTION	0.16	1.87	5426.87	0	01:11	1.87
111	JUNCTION	3.13	5.56	5447.56	0	01:09	5.51
112	JUNCTION	0.13	2.56	5486.56	0	01:04	2.54
113	JUNCTION	0.14	2.70	5511.70	0	01:02	2.69
114	JUNCTION	5.05	6.17	5525.17	0	00:45	6.17
115	JUNCTION	0.14	2.70	5538.70	0	00:58	2.70
116	JUNCTION	0.06	0.99	5553.99	0	00:55	0.98
117	JUNCTION	0.05	0.86	5568.86	0	00:45	0.85
118	JUNCTION	0.10	1.86	5568.86	0	00:55	1.85
119	JUNCTION	13.07	14.49	5583.49	0	00:57	14.48
120	JUNCTION	0.08	1.53	5597.53	0	00:47	1.52
121	JUNCTION	0.07	0.76	5613.76	0	00:45	0.76
122	JUNCTION	0.00	0.00	5613.00	0	00:00	0.00
123	JUNCTION	1.44	9.34	5440.37	0	02:24	9.33
124	JUNCTION	0.00	0.00	5431.03	0	00:00	0.00
125	JUNCTION	1.38	7.27	5450.34	0	02:20	7.26
126	JUNCTION	2.71	7.28	5467.22	0	02:12	7.27
127	JUNCTION	0.43	2.58	5484.81	0	02:06	2.56
128	JUNCTION	0.02	0.47	5526.47	0	00:35	0.45
129	JUNCTION	0.03	0.52	5554.52	0	00:50	0.52
129T	JUNCTION	0.38	1.88	5496.88	0	02:03	1.87
130	JUNCTION	1.15	5.82	5513.01	0	02:00	5.82
131	JUNCTION	6.79	10.37	5549.68	0	01:54	10.36
132	JUNCTION	0.00	0.00	5539.31	0	00:00	0.00
133	JUNCTION	0.83	5.00	5589.26	0	01:45	5.00
134	JUNCTION	1.11	8.05	5608.05	0	02:28	8.05
135	JUNCTION	3.75	8.66	5639.66	0	02:24	8.66
136	JUNCTION	0.11	1.68	5661.68	0	00:55	1.68
137	JUNCTION	0.75	5.74	5655.50	0	02:21	5.72
138	JUNCTION	0.93	7.04	5695.19	0	02:17	7.04
139	JUNCTION	0.96	7.04	5716.38	0	02:14	7.04
140	JUNCTION	0.89	5.86	5748.37	0	02:09	5.85
141	JUNCTION	0.84	6.93	5775.77	0	02:05	6.92
142	JUNCTION	0.82	6.95	5820.39	0	01:50	6.94
143	JUNCTION	30.70	36.95	5856.71	0	01:52	36.91
144	JUNCTION	0.10	2.57	5868.57	0	00:45	2.57
145	JUNCTION	3.51	7.87	5879.69	0	01:48	7.87
146T	JUNCTION	17.44	22.01	5925.01	0	01:50	22.00
146	JUNCTION	0.14	2.67	5969.67	0	00:50	2.65
147	JUNCTION	41.49	46.47	6083.47	0	01:48	46.46
148	JUNCTION	111.32	114.86	6603.86	0	01:42	114.86
149	JUNCTION	71.43	76.19	7175.19	0	01:33	76.18
150	JUNCTION	0.45	5.23	7563.23	0	01:20	5.21
151	JUNCTION	0.19	2.18	7673.18	0	01:20	2.17
R101	JUNCTION	6.17	8.58	5608.58	0	01:33	8.56
R102	JUNCTION	3.40	7.94	5647.94	0	01:28	7.93
R103	JUNCTION	0.03	0.71	5745.71	0	01:00	0.71
R103T	JUNCTION	16.03	16.71	5673.71	0	01:08	16.70
R104	JUNCTION	0.46	3.61	5693.61	0	01:22	3.59
R105	JUNCTION	5.33	10.61	5722.61	0	01:17	10.60
R106	JUNCTION	0.04	0.69	5803.69	0	00:50	0.69
R106T	JUNCTION	12.26	17.17	5760.17	0	01:12	17.16
R107	JUNCTION	4.24	8.93	5783.93	0	01:11	8.90
R108	JUNCTION	0.26	5.09	5839.09	0	01:11	5.07
R109T	JUNCTION	11.17	14.42	5855.42	0	01:09	14.39
R109	JUNCTION	0.01	0.24	5931.24	0	01:00	0.24
R110	JUNCTION	0.17	3.42	5887.42	0	01:06	3.39
R111	JUNCTION	0.07	1.76	5933.76	0	00:50	1.74
101	JUNCTION	12.84	22.68	5368.45	0	03:21	22.66
100	OUTFALL	0.93	8.21	5346.50	0	03:22	8.18

****
Node Inflow Summary
****

Node	Type	Maximum Lateral Inflow CFS	Maximum Total Inflow CFS	Time of Max Occurrence days	hr:min	Lateral Inflow Volume 10^6 gal	Total Inflow Volume 10^6 gal	Flow Balance Error Percent
102	JUNCTION	38.53	38.53	0	00:55	1.96	1.96	0.000
103	JUNCTION	101.78	3800.89	0	03:17	4.87	394	0.000
104	JUNCTION	63.57	63.57	0	00:50	2.46	2.46	0.000
104T	JUNCTION	0.00	3782.92	0	03:15	0	389	0.000
105	JUNCTION	96.08	170.89	0	00:51	4	6.28	0.000
105T	JUNCTION	0.00	3782.76	0	03:09	0	386	0.000
106	JUNCTION	75.61	75.61	0	00:45	2.27	2.27	0.000
107	JUNCTION	94.44	3770.33	0	03:09	5.03	380	0.000
108	JUNCTION	107.30	3775.10	0	02:48	4.36	375	0.000
109	JUNCTION	90.98	90.98	0	00:50	3.77	3.77	0.000
110	JUNCTION	106.39	1205.38	0	01:10	3.8	47.5	0.000
111	JUNCTION	112.43	1119.01	0	01:08	4.42	43.7	0.000
112	JUNCTION	140.65	1020.37	0	01:04	3.98	39.3	0.000
113	JUNCTION	59.89	917.31	0	01:01	2.2	35.2	0.000
114	JUNCTION	134.81	134.81	0	00:45	4.15	4.15	0.000
115	JUNCTION	57.79	747.04	0	00:58	1.29	28.8	0.000
116	JUNCTION	94.37	197.55	0	00:55	3.65	7.25	0.000
117	JUNCTION	107.65	107.65	0	00:45	3.57	3.57	0.000
118	JUNCTION	116.91	503.99	0	00:55	6.69	20.3	0.000
119	JUNCTION	178.73	389.84	0	00:55	5.87	13.6	0.000
120	JUNCTION	90.01	231.50	0	00:47	2.39	7.6	0.000
121	JUNCTION	122.32	153.55	0	00:45	4.04	5.2	0.000
122	JUNCTION	31.27	31.27	0	00:50	1.16	1.16	0.000
123	JUNCTION	50.65	3592.52	0	02:24	1.73	319	0.000
124	JUNCTION	120.44	120.44	0	01:00	5.22	5.22	0.000
125	JUNCTION	25.68	3555.49	0	02:20	1.07	312	0.000
126	JUNCTION	66.40	3578.58	0	02:12	2.61	311	0.000
127	JUNCTION	78.92	3572.07	0	02:06	2.78	308	0.000
128	JUNCTION	49.12	49.12	0	00:35	0.935	0.935	0.000
129	JUNCTION	27.40	27.40	0	00:50	0.945	0.945	0.000
129T	JUNCTION	0.00	3551.21	0	02:03	0	304	0.000
130	JUNCTION	102.03	3545.33	0	01:59	4.03	303	0.000
131	JUNCTION	46.22	3525.83	0	01:53	2.02	299	-0.000
132	JUNCTION	75.23	75.23	0	00:55	3.14	3.14	0.000
133	JUNCTION	56.32	3502.20	0	01:45	2.42	294	0.000
134	JUNCTION	62.47	3473.34	0	01:42	2.23	291	0.000
135	JUNCTION	140.33	2714.74	0	02:23	5.29	229	0.000
136	JUNCTION	37.21	37.21	0	00:55	1.84	1.84	0.000
137	JUNCTION	15.11	2678.26	0	02:21	0.639	222	0.000
138	JUNCTION	35.09	2675.52	0	02:16	1.41	221	0.000
139	JUNCTION	49.96	2667.61	0	02:14	2.15	220	0.000
140	JUNCTION	56.81	2650.87	0	02:09	2.23	217	0.000
141	JUNCTION	84.10	2632.48	0	02:04	3.5	215	0.000
142	JUNCTION	54.23	2633.10	0	01:50	1.79	211	0.000
143	JUNCTION	142.71	2616.17	0	01:49	4.23	209	0.000
144	JUNCTION	425.07	425.07	0	00:45	12.2	12.2	0.000
145	JUNCTION	478.23	2526.97	0	01:45	22.1	193	0.000
146T	JUNCTION	0.00	2299.69	0	01:45	0	171	0.000
146	JUNCTION	590.75	590.75	0	00:50	23.3	23.3	0.000
147	JUNCTION	387.00	2053.09	0	01:45	25.9	147	0.000
148	JUNCTION	328.51	1735.75	0	01:40	22.5	122	0.000
149	JUNCTION	420.65	1459.67	0	01:31	33.2	99	0.000
150	JUNCTION	457.24	1065.46	0	01:20	27	65.5	0.000
151	JUNCTION	616.29	616.29	0	01:20	38.5	38.5	0.000
R101	JUNCTION	17.12	1495.11	0	01:33	0.76	60.4	0.000
R102	JUNCTION	37.55	1491.77	0	01:28	1.81	59.5	0.000
R103	JUNCTION	72.79	72.79	0	01:00	2.67	2.67	0.000
R103T	JUNCTION	0.00	1464.13	0	01:25	0	57.7	0.000
R104	JUNCTION	111.09	1407.15	0	01:21	3.67	55	0.000
R105	JUNCTION	140.73	1336.19	0	01:15	5.42	51.3	0.000
R106	JUNCTION	118.99	118.99	0	00:50	4.35	4.35	-0.000
R106T	JUNCTION	0.00	1221.17	0	01:11	0	45.8	-0.000
R107	JUNCTION	134.71	1113.05	0	01:09	4.72	41.4	0.000
R108	JUNCTION	397.27	990.75	0	01:05	12.8	36.7	0.000
R109T	JUNCTION	0.00	630.71	0	01:11	0	23.8	-0.000
R109	JUNCTION	42.78	42.78	0	01:00	1.67	1.67	0.000

R110	JUNCTION	273.75	598.17	0	01:06	11.6	22.1	0.000
R111	JUNCTION	346.22	346.22	0	00:50	10.4	10.4	0.000
101	JUNCTION	49.68	3809.06	0	03:21	2.02	398	0.000
100	OUTFALL	64.52	3815.06	0	03:22	2.67	401	0.000

****
Node Flooding Summary
****

No nodes were flooded.

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
100	73.85	419.65	3815.06	400.600
System	73.85	419.65	3815.06	400.600

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days	hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
201	CHANNEL	3808.93	0	03:22	15.94	0.33	0.61
202	DUMMY	38.53	0	00:55			
203	CHANNEL	3799.19	0	03:21	4.29	0.07	0.55
204	CONDUIT	63.57	0	00:51	6.09	0.04	0.10
204T	CHANNEL	3782.67	0	03:17	4.25	0.06	0.58
205	CONDUIT	170.88	0	00:52	11.35	0.32	0.43
205T	CHANNEL	3779.17	0	03:16	3.90	0.31	0.79
206	CONDUIT	74.98	0	00:51	3.71	0.21	0.51
207	CONDUIT	3770.28	0	03:10	6.51	0.23	0.46
208	CHANNEL	3745.30	0	03:09	2.95	0.03	0.44
209	DUMMY	90.98	0	00:50			
210	CHANNEL	1203.99	0	01:12	8.71	0.10	0.44
211	CHANNEL	1116.33	0	01:11	6.96	0.13	0.47
212	CONDUIT	1015.45	0	01:09	6.93	0.03	0.15
213	CONDUIT	913.05	0	01:05	5.21	0.02	0.14
214	CONDUIT	134.55	0	00:46	5.25	0.03	0.19
215	CONDUIT	744.58	0	01:02	6.53	0.09	0.27
216	CONDUIT	196.47	0	01:01	3.03	0.01	0.12
217	CHANNEL	103.80	0	00:57	4.28	0.01	0.21
218	CONDUIT	502.72	0	00:58	6.31	0.14	0.37
219	DUMMY	389.84	0	00:55			
220	CONDUIT	220.36	0	00:57	3.08	0.03	0.15
221	CHANNEL	151.60	0	00:51	4.11	0.26	0.80
222	DUMMY	31.27	0	00:50			
223	CHANNEL	3560.67	0	02:58	8.58	0.02	0.45
224	DUMMY	120.44	0	01:00			
225	CHANNEL	3549.57	0	02:25	3.72	0.01	0.27
226	CHANNEL	3546.96	0	02:20	3.69	0.02	0.33
227	CHANNEL	3555.98	0	02:12	9.48	0.02	0.14
228	CHANNEL	47.56	0	00:42	8.32	0.00	0.11
229	CHANNEL	25.72	0	01:10	4.35	0.00	0.07
229T	CHANNEL	3546.68	0	02:06	>50.00	0.01	0.10
230	CHANNEL	3540.60	0	02:03	3.86	0.05	0.20
231	CHANNEL	3506.11	0	02:00	4.82	0.03	0.31
232	DUMMY	75.23	0	00:55			
233	CHANNEL	3468.21	0	01:54	4.27	0.08	0.46
234	CHANNEL	3470.74	0	01:45	4.83	0.02	0.24
235	CHANNEL	2710.38	0	02:28	5.72	0.06	0.52
236	CONDUIT	37.17	0	01:02	8.18	0.47	0.48
237	CHANNEL	2676.58	0	02:24	4.35	0.06	0.42

238	CHANNEL	2673.19	0	02:21	6.35	0.06	0.42
239	CHANNEL	2666.72	0	02:17	6.41	0.14	0.64
240	CHANNEL	2647.07	0	02:14	4.66	0.11	0.61
241	CHANNEL	2629.89	0	02:09	3.53	0.02	0.28
242	CHANNEL	2600.57	0	02:05	5.61	0.03	0.53
243	CONDUIT	2615.83	0	01:51	5.56	0.32	0.60
244	CONDUIT	420.52	0	00:48	5.80	0.10	0.32
245	CHANNEL	2520.20	0	01:52	4.66	0.03	0.39
246T	CHANNEL	2298.37	0	01:48	8.84	0.00	0.17
246	CONDUIT	585.13	0	00:54	6.87	0.25	0.53
247	CONDUIT	2050.15	0	01:50	11.70	0.22	0.50
248	CHANNEL	1727.28	0	01:48	14.92	0.00	0.04
249	CHANNEL	1445.17	0	01:42	13.99	0.00	0.04
250	CHANNEL	1042.71	0	01:33	11.82	0.00	0.06
251	CHANNEL	615.40	0	01:22	9.22	0.00	0.05
R201	DUMMY	1495.11	0	01:33			
R202	CHANNEL	1483.36	0	01:33	4.07	0.02	0.18
R203	CONDUIT	72.65	0	01:08	5.05	0.02	0.14
R203T	CHANNEL	1461.39	0	01:28	4.34	0.02	0.27
R204	CHANNEL	1402.12	0	01:25	4.19	0.04	0.34
R205	CHANNEL	1327.42	0	01:22	3.70	0.01	0.26
R206T	CHANNEL	1214.18	0	01:17	4.71	0.39	0.70
R206	CHANNEL	117.39	0	00:57	7.92	0.01	0.17
R207	CONDUIT	1112.26	0	01:12	7.69	0.30	0.57
R208	CONDUIT	987.37	0	01:11	8.66	0.18	0.45
R209T	CONDUIT	630.63	0	01:11	7.77	0.16	0.42
R209	CONDUIT	38.52	0	01:22	1.92	0.00	0.01
R210	CONDUIT	597.30	0	01:09	6.78	0.06	0.28
R211	CONDUIT	331.48	0	01:00	4.77	0.01	0.10

****
Conduit Surcharge Summary
****

No conduits were surcharged.

Analysis begun on: Mon Feb 15 11:07:03 2021
Analysis ended on: Mon Feb 15 11:07:04 2021
Total elapsed time: 00:00:01

Table B-3 - 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	11154	17.4	11	18	121	216	311	1,307	2,229	3,343	6,097	281	433	568	1,768	2,708	3,815	6,653
101	11113	17.4	11	18	117	210	302	1,304	2,225	3,343	6,091	279	430	565	1,765	2,703	3,809	6,643
102	36	0.1	53	53	8	12	17	28	35	44	64	8	12	17	28	35	44	64
103	11039	17.2	11	18	113	203	292	1,301	2,222	3,369	6,084	277	427	562	1,761	2,697	3,801	6,630
104	56	0.1	34	34	9	15	24	45	59	76	114	9	15	24	45	59	76	114
104T	10927	17.1	10	18	108	194	278	1,298	2,214	3,391	6,054	274	425	559	1,754	2,684	3,783	6,594
105	137	0.2	37	37	26	42	67	124	160	205	306	26	42	67	124	160	205	306
105T	10871	17.0	10	18	107	192	273	1,301	2,221	3,306	6,055	274	424	558	1,757	2,685	3,783	6,590
106	52	0.1	34	34	11	19	30	57	74	94	140	11	19	30	57	74	94	140
107	10735	16.8	10	17	99	179	254	1,296	2,214	3,298	6,035	271	420	554	1,751	2,675	3,770	6,565
108	10604	16.6	10	17	102	181	255	1,326	2,265	3,441	6,045	274	437	611	1,820	2,746	3,775	6,546
109	74	0.1	29	48	7	11	19	41	54	72	110	18	26	38	67	85	108	159
110	940	1.5	39	46	134	221	347	694	923	1,225	1,878	175	281	426	808	1,061	1,392	2,110
111	860	1.3	39	47	126	206	322	644	855	1,131	1,730	167	266	401	758	992	1,295	1,959
112	766	1.2	40	47	121	194	301	595	787	1,035	1,580	158	249	373	700	913	1,186	1,790
113	681	1.1	41	48	116	184	280	544	716	935	1,421	149	233	347	641	832	1,072	1,609
114	82	0.1	46	46	28	42	62	106	135	169	247	28	42	62	106	135	169	247
115	549	0.9	41	50	95	149	225	437	574	748	1,134	129	198	291	531	685	878	1,311
116	152	0.2	41	41	31	50	76	141	182	233	349	31	50	76	141	182	233	349
117	70	0.1	47	47	21	33	48	83	106	133	195	21	33	48	83	106	133	195
118	357	0.6	45	58	64	98	142	274	358	465	703	97	147	208	364	465	591	873
119	252	0.4	34	52	35	56	88	187	251	333	517	68	105	153	278	360	463	694
120	134	0.2	31	58	22	33	49	102	136	178	274	51	76	106	177	226	285	418
121	92	0.1	25	58	10	16	28	60	80	106	162	37	54	74	122	153	190	274
122	22	0.0	46	50	6	9	13	22	28	35	51	7	10	14	24	30	38	55
123	9495	14.8	6	14	50	111	174	1,241	2,130	3,222	5,758	244	400	565	1,672	2,523	3,593	6,214
124	124	0.2	25	31	11	17	32	69	91	121	185	15	24	40	82	109	142	215
125	9324	14.6	6	14	50	111	172	1,238	2,118	3,200	5,714	244	400	564	1,667	2,499	3,555	6,163
126	9287	14.5	6	14	50	112	174	1,244	2,125	3,203	5,716	246	403	572	1,692	2,513	3,579	6,160
127	9201	14.4	6	14	51	114	178	1,247	2,124	3,195	5,700	251	407	584	1,704	2,513	3,572	6,139
128	24	0.0	26	30	6	11	20	37	49	64	95	8	13	23	40	53	69	102
129	23	0.0	30	30	3	6	10	19	26	33	50	3	6	10	19	26	33	50
129T	9088	14.2	6	14	52	115	179	1,248	2,120	3,187	5,680	254	409	587	1,701	2,500	3,551	6,112
130	9066	14.2	6	14	53	115	179	1,248	2,119	3,184	5,676	254	409	588	1,700	2,496	3,545	6,106
131	8959	14.0	6	14	54	116	180	1,250	2,113	3,170	5,653	264	417	601	1,710	2,490	3,526	6,071
132	76	0.1	20	30	5	8	17	40	54	73	113	9	14	24	51	68	89	136
133	8823	13.8	6	14	54	115	177	1,251	2,106	3,150	5,621	276	451	625	1,738	2,492	3,502	6,024
134	8761	13.7	5	13	53	113	173	1,246	2,096	3,136	5,596	275	449	621	1,726	2,473	3,473	5,994
135	6934	10.8	4	13	22	43	64	1,344	2,030	2,941	5,040	228	340	454	1,558	2,243	3,135	5,239
136	37	0.1	45	45	7	10	15	27	34	43	63	7	10	15	27	34	43	63
137	6784	10.6	3	12	18	35	51	1,323	2,001	2,901	4,963	218	324	432	1,535	2,215	3,096	5,162
138	6761	10.6	3	12	19	36	51	1,323	2,000	2,898	4,957	219	326	432	1,535	2,214	3,093	5,154
139	6731	10.5	3	12	17	32	47	1,319	1,994	2,890	4,944	218	323	428	1,530	2,208	3,084	5,138
140	6653	10.4	3	12	17	33	46	1,317	1,983	2,872	4,912	219	325	432	1,523	2,197	3,066	5,101
141	6575	10.3	3	12	18	33	46	1,312	1,971	2,852	4,872	231	334	445	1,513	2,185	3,044	5,055
142	6480	10.1	3	12	16	28	38	1,299	1,963	2,866	4,846	237	332	444	1,496	2,178	3,036	5,013
143	6432	10.1	3	12	13	22	30	1,291	1,951	2,848	4,816	235	327	438	1,487	2,164	3,016	4,980
144	235	0.4	3	51	2	4	35	132	190	265	428	94	139	197	339	433	544	797

Table B-3 - 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}
145	6096	9.5	2	10	2	17	48	1,238	1,875	2,735	4,611	205	303	390	1,426	2,092	2,918	4,819
146T	5728	8.9	2	6	2	22	47	1,182	1,789	2,595	4,365	110	163	211	1,267	1,885	2,671	4,441
146	409	0.6	2	59	2	3	33	135	197	281	459	137	200	272	448	565	702	1,016
147	5319	8.3	2	2	1	16	44	1,092	1,655	2,401	4,030	2	16	44	1,093	1,655	2,401	4,030
148	4323	6.8	2	2	4	15	41	932	1,399	2,024	3,372	4	15	41	932	1,399	2,024	3,372
149	3526	5.5	2	2	4	15	36	784	1,171	1,704	2,830	4	15	36	784	1,171	1,704	2,830
150	2346	3.7	2	2	7	16	135	579	855	1,243	2,054	7	16	135	579	855	1,243	2,054
151	1379	2.2	2	2	4	9	78	334	494	718	1,187	4	9	78	334	494	718	1,187
R101	1765	2.8	12	17	53	100	236	783	1,142	1,626	2,681	82	155	309	889	1,260	1,759	2,850
R102	1745	2.7	12	17	55	102	236	786	1,141	1,623	2,672	84	156	312	894	1,260	1,757	2,843
R103	91	0.1	5	5	1	3	13	44	63	87	141	1	3	13	44	63	87	141
R103T	1692	2.6	12	17	54	100	232	774	1,121	1,593	2,619	83	153	308	879	1,238	1,724	2,787
R104	1601	2.5	12	18	54	99	231	748	1,079	1,528	2,503	83	154	309	852	1,195	1,657	2,668
R105	1492	2.3	12	18	55	97	221	710	1,028	1,450	2,358	83	150	295	811	1,140	1,574	2,514
R106T	1342	2.1	11	17	51	87	196	648	939	1,324	2,140	77	137	270	746	1,048	1,440	2,289
R106	95	0.1	38	42	18	27	40	79	104	135	203	21	31	45	87	113	145	217
R107	1248	1.9	9	15	36	63	166	585	853	1,208	1,963	62	114	236	676	954	1,316	2,098
R108	1101	1.7	10	16	37	61	150	525	762	1,075	1,740	59	106	215	607	854	1,172	1,866
R109T	746	1.2	4	13	6	15	67	313	466	667	1,095	35	60	126	384	544	749	1,197
R109	57	0.1	2	14	0	1	3	21	32	46	77	2	4	7	26	38	52	84
R110	689	1.1	5	13	6	15	67	302	448	633	1,036	35	60	125	370	520	712	1,132
R111	282	0.4	7	28	7	14	37	164	243	339	553	41	66	100	237	327	431	677

Table B-4 - 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	11154	17.4	11	18	58	91	129	509	764	1,099	1829	119	174	234	629	890	1,231	1979
101	11113	17.4	11	18	55	88	125	503	758	1,093	1820	117	171	230	623	884	1,221	1967
102	36	0.1	53	53	1	2	2	3	4	5	8	1	2	2	3	4	5	8
103	11039	17.2	11	18	52	84	120	497	749	1,080	1801	114	167	225	614	875	1,209	1949
104	56	0.1	34	34	1	2	3	4	6	7	11	1	2	3	4	6	7	11
104T	10927	17.1	10	18	51	81	116	488	737	1,065	1777	112	164	220	605	862	1,194	1927
105	137	0.2	37	37	3	4	7	11	15	19	28	3	4	7	11	15	19	28
105T	10871	17.0	10	18	49	79	114	482	730	1,056	1765	111	162	218	602	856	1,185	1915
106	52	0.1	34	34	1	2	2	4	5	7	10	1	2	2	4	5	7	10
107	10735	16.8	10	17	46	75	107	470	715	1,037	1737	108	157	212	589	841	1,166	1887
108	10604	16.6	10	17	45	72	104	463	703	1,022	1709	106	155	208	580	829	1,151	1860
109	74	0.1	29	48	1	2	3	5	7	9	14	2	3	4	7	9	11	16
110	940	1.5	39	46	20	31	46	78	102	130	196	25	37	53	85	108	137	203
111	860	1.3	39	47	19	29	42	72	93	119	179	23	35	49	78	99	125	186
112	766	1.2	40	47	17	26	38	64	83	106	160	21	31	44	70	89	112	166
113	681	1.1	41	48	16	24	35	58	75	96	143	19	28	40	63	80	100	148
114	82	0.1	46	46	2	3	5	7	9	12	18	2	3	5	7	9	12	18
115	549	0.9	41	50	13	19	28	47	60	77	115	16	23	33	51	65	81	120
116	152	0.2	41	41	3	5	8	13	17	21	32	3	5	8	13	17	21	32
117	70	0.1	47	47	2	3	4	6	8	10	15	2	3	4	6	8	10	15
118	357	0.6	45	58	9	13	19	31	41	51	76	12	18	24	36	45	56	81
119	252	0.4	34	52	5	7	11	20	26	33	51	8	11	16	24	31	38	56
120	134	0.2	31	58	2	3	5	10	13	17	27	5	7	9	13	17	21	30
121	92	0.1	25	58	1	2	3	6	9	11	18	3	4	6	9	12	14	21
122	22	0.0	46	50	1	1	1	2	3	3	5	1	1	1	2	3	3	5
123	9495	14.8	6	14	15	31	49	368	580	865	1473	51	83	117	473	694	979	1605
124	124	0.2	25	31	1	2	4	9	12	15	24	2	3	5	9	12	16	25
125	9324	14.6	6	14	14	28	46	359	565	844	1442	49	79	113	460	675	957	1571
126	9287	14.5	6	14	14	28	46	356	565	841	1436	49	79	113	460	675	954	1565
127	9201	14.4	6	14	13	28	45	353	559	832	1421	49	79	112	457	669	945	1553
128	24	0.0	26	30	0	0	1	2	2	3	4	0	1	1	2	2	3	4
129	23	0.0	30	30	0	1	1	2	2	3	5	0	1	1	2	2	3	5
129T	9088	14.2	6	14	13	27	44	347	549	822	1402	48	78	110	451	660	933	1534
130	9066	14.2	6	14	13	27	43	347	546	819	1399	48	77	110	448	657	930	1528
131	8959	14.0	6	14	12	25	41	338	537	807	1378	47	76	108	442	648	918	1510
132	76	0.1	20	30	1	1	2	5	7	9	14	1	2	3	6	7	10	15
133	8823	13.8	6	14	11	24	39	331	528	792	1353	46	74	105	433	635	902	1482
134	8761	13.7	5	13	11	23	38	328	522	783	1344	46	73	103	430	629	893	1470
135	6934	10.8	4	13	5	10	19	322	482	697	1166	36	54	76	384	546	758	1231
136	37	0.1	45	45	1	1	2	3	4	5	8	1	1	2	3	4	5	8
137	6784	10.6	3	12	3	8	15	313	466	678	1135	33	50	70	371	528	740	1200
138	6761	10.6	3	12	3	8	15	313	466	675	1132	33	50	70	368	528	737	1197
139	6731	10.5	3	12	3	7	14	310	463	672	1126	32	49	69	368	525	730	1191
140	6653	10.4	3	12	3	7	14	305	457	666	1114	32	49	68	362	519	724	1175
141	6575	10.3	3	12	3	7	14	302	451	657	1099	32	48	68	359	513	715	1163
142	6480	10.1	3	12	2	5	12	295	442	644	1080	31	47	66	353	503	703	1145
143	6432	10.1	3	12	1	5	11	292	439	638	1071	30	46	64	350	497	697	1135
144	235	0.4	3	51	0	0	3	11	16	24	39	7	10	14	22	27	34	51

Table B-4 - 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}
145	6096	9.5	2	10	1	4	13	273	411	602	1013	25	40	60	319	460	651	1062
146T	5728	8.9	2	6	0	4	12	258	390	568	954	13	22	36	280	411	589	979
146	409	0.6	2	59	0	1	4	19	28	41	68	14	20	27	41	52	64	93
147	5319	8.3	2	2	0	3	11	239	359	525	884	0	3	11	239	359	525	884
148	4323	6.8	2	2	1	4	11	199	297	433	724	1	4	11	199	297	433	724
149	3526	5.5	2	2	1	4	9	161	242	353	589	1	4	9	161	242	353	589
150	2346	3.7	2	2	1	3	25	106	160	233	390	1	3	25	106	160	233	390
151	1379	2.2	2	2	1	2	15	63	94	137	230	1	2	15	63	94	137	230
R101	1765	2.8	12	17	9	16	35	95	137	192	310	14	23	44	104	147	201	322
R102	1745	2.7	12	17	8	15	34	94	135	189	307	13	23	43	103	145	198	316
R103	91	0.1	5	5	0	0	1	4	7	9	16	0	0	1	4	7	9	16
R103T	1692	2.6	12	17	8	15	33	91	131	183	298	13	22	41	100	140	192	307
R104	1601	2.5	12	18	8	14	31	86	124	173	282	13	22	40	95	133	183	292
R105	1492	2.3	12	18	8	14	29	81	116	162	263	12	20	37	89	124	170	272
R106T	1342	2.1	11	17	7	12	25	71	103	144	235	11	18	33	79	111	152	243
R106	95	0.1	38	42	2	3	4	7	10	12	19	2	3	4	8	10	13	19
R107	1248	1.9	9	15	5	9	21	64	93	132	216	8	15	28	71	101	139	224
R108	1101	1.7	10	16	4	8	19	56	82	116	191	8	13	25	63	89	123	198
R109T	746	1.2	4	13	1	2	8	34	51	74	124	4	7	15	40	58	81	132
R109	57	0.1	2	14	0	0	0	2	3	5	9	0	0	1	3	4	6	10
R110	689	1.1	5	13	1	2	8	31	47	69	115	4	7	14	37	53	75	121
R111	282	0.4	7	28	0	1	3	12	18	27	46	3	6	9	18	25	33	52

Table B-5 - Baseline Peak Flows Along Van Bibber Creek

Design Point	Downstream Conveyance Element	Location	Total Drainage Area (acres)	Total Drainage Area (mi^2)	Link Length (ft)	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 Ralston Creek	11,154	17.4	0	0	121	216	311	1,307	2,229	3,343	6,097	281	433	568	1,768	2,708	3,815	6,653
101	201	W 58th Avenue	11,113	17.4	1,479	1,479	117	210	302	1,304	2,225	3,343	6,091	279	430	565	1,765	2,703	3,809	6,643
103	203	Kipling Parkway	11,039	17.2	1,435	2,914	113	203	292	1,301	2,222	3,369	6,084	277	427	562	1,761	2,697	3,801	6,630
104T	204T		10,927	17.1	272	3,186	108	194	278	1,298	2,214	3,391	6,054	274	425	559	1,754	2,684	3,783	6,594
105T	205T		10,871	17.0	1,573	4,758	107	192	273	1,301	2,221	3,306	6,055	274	424	558	1,757	2,685	3,783	6,590
107	207	Oak Street	10,735	16.8	367	5,126	99	179	254	1,296	2,214	3,298	6,035	271	420	554	1,751	2,675	3,770	6,565
108	208		10,604	16.6	3,382	8,508	102	181	255	1,326	2,265	3,441	6,045	274	437	611	1,820	2,746	3,775	6,546
123	223	Ward Road	9,495	14.8	3,162	11,670	50	111	174	1,241	2,130	3,222	5,758	244	400	565	1,672	2,523	3,593	6,214
125	225		9,324	14.6	1,207	12,877	50	111	172	1,238	2,118	3,200	5,714	244	400	564	1,667	2,499	3,555	6,163
126	226		9,287	14.5	1,903	14,780	50	112	174	1,244	2,125	3,203	5,716	246	403	572	1,692	2,513	3,579	6,160
127	227		9,201	14.4	1,941	16,721	51	114	178	1,247	2,124	3,195	5,700	251	407	584	1,704	2,513	3,572	6,139
129T	229T		9,088	14.2	1,036	17,757	52	115	179	1,248	2,120	3,187	5,680	254	409	587	1,701	2,500	3,551	6,112
130	230		9,066	14.2	1,057	18,814	53	115	179	1,248	2,119	3,184	5,676	254	409	588	1,700	2,496	3,545	6,106
131	231	Indiana Street	8,959	14.0	2,585	21,399	54	116	180	1,250	2,113	3,170	5,653	264	417	601	1,710	2,490	3,526	6,071
133	233	McIntyre Street	8,823	13.8	2,996	24,395	54	115	177	1,251	2,106	3,150	5,621	276	451	625	1,738	2,492	3,502	6,024
134	234	Ramstetter Creek confluence	8,761	13.7	1,025	25,421	53	113	173	1,246	2,096	3,136	5,596	275	449	621	1,726	2,473	3,473	5,994
135	235		6,934	10.8	1,988	27,409	22	43	64	1,344	2,030	2,941	5,040	228	340	454	1,558	2,243	3,135	5,239
137	237		6,784	10.6	1,283	28,692	18	35	51	1,323	2,001	2,901	4,963	218	324	432	1,535	2,215	3,096	5,162
138	238	Easley Road	6,761	10.6	1,946	30,638	19	36	51	1,323	2,000	2,898	4,957	219	326	432	1,535	2,214	3,093	5,154
139	239	W 60th Avenue	6,731	10.5	1,260	31,898	17	32	47	1,319	1,994	2,890	4,944	218	323	428	1,530	2,208	3,084	5,138
140	240		6,653	10.4	2,212	34,110	17	33	46	1,317	1,983	2,872	4,912	219	325	432	1,523	2,197	3,066	5,101
141	241		6,575	10.3	1,633	35,744	18	33	46	1,312	1,971	2,852	4,872	231	334	445	1,513	2,185	3,044	5,055
142	242	Dunraven Street	6,480	10.1	2,774	38,518	16	28	38	1,299	1,963	2,866	4,846	237	332	444	1,496	2,178	3,036	5,013
143	243	El Diente Street	6,432	10.1	718	39,235	13	22	30	1,291	1,951	2,848	4,816	235	327	438	1,487	2,164	3,016	4,980
145	245	State Highway 93	6,096	9.5	2,060	41,296	2	17	48	1,238	1,875	2,735	4,611	205	303	390	1,426	2,092	2,918	4,819
146T	246T		5,728	8.9	1,305	42,601	2	22	47	1,182	1,789	2,595	4,365	110	163	211	1,267	1,885	2,671	4,441
147	247		5,319	8.3	4,279	46,880	1	16	44	1,092	1,655	2,401	4,030	2	16	44	1,093	1,655	2,401	4,030
148	248		4,323	6.8	8,567	55,447	4	15	41	932	1,399	2,024	3,372	4	15	41	932	1,399	2,024	3,372
149	249		3,526	5.5	9,192	64,639	4	15	36	784	1,171	1,704	2,830	4	15	36	784	1,171	1,704	2,830
150	250	Crawford Gulch Road	2,346	3.7	11,000	75,639	7	16	135	579	855	1,243	2,054	7	16	135	579	855	1,243	2,054
151	251		1,379	2.2	2,202	77,841	4	9	78	334	494	718	1,187	4	9	78	334	494	718	1,187

Table B-6 - Baseline Runoff Volumes Along Van Bibber Creek

Design Point	Downstream Conveyance Element	Location	Total Drainage Area (acres)	Total Drainage Area (mi^2)	Link Length (ft)	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 Ralston Creek	11,154	17.4	0	0	121	216	311	1,307	2,229	3,343	6,097	281	433	568	1,768	2,708	3,815	6,653
101	201	W 58th Avenue	11,113	17.4	1,479	1,479	117	210	302	1,304	2,225	3,343	6,091	279	430	565	1,765	2,703	3,809	6,643
103	203	Kipling Parkway	11,039	17.2	1,435	2,914	113	203	292	1,301	2,222	3,369	6,084	277	427	562	1,761	2,697	3,801	6,630
104T	204T		10,927	17.1	272	3,186	108	194	278	1,298	2,214	3,391	6,054	274	425	559	1,754	2,684	3,783	6,594
105T	205T		10,871	17.0	1,573	4,758	107	192	273	1,301	2,221	3,306	6,055	274	424	558	1,757	2,685	3,783	6,590
107	207	Oak Street	10,735	16.8	367	5,126	99	179	254	1,296	2,214	3,298	6,035	271	420	554	1,751	2,675	3,770	6,565
108	208		10,604	16.6	3,382	8,508	102	181	255	1,326	2,265	3,441	6,045	274	437	611	1,820	2,746	3,775	6,546
123	223	Ward Road	9,495	14.8	3,162	11,670	50	111	174	1,241	2,130	3,222	5,758	244	400	565	1,672	2,523	3,593	6,214
125	225		9,324	14.6	1,207	12,877	50	111	172	1,238	2,118	3,200	5,714	244	400	564	1,667	2,499	3,555	6,163
126	226		9,287	14.5	1,903	14,780	50	112	174	1,244	2,125	3,203	5,716	246	403	572	1,692	2,513	3,579	6,160
127	227		9,201	14.4	1,941	16,721	51	114	178	1,247	2,124	3,195	5,700	251	407	584	1,704	2,513	3,572	6,139
129T	229T		9,088	14.2	1,036	17,757	52	115	179	1,248	2,120	3,187	5,680	254	409	587	1,701	2,500	3,551	6,112
130	230		9,066	14.2	1,057	18,814	53	115	179	1,248	2,119	3,184	5,676	254	409	588	1,700	2,496	3,545	6,106
131	231	Indiana Street	8,959	14.0	2,585	21,399	54	116	180	1,250	2,113	3,170	5,653	264	417	601	1,710	2,490	3,526	6,071
133	233	McIntyre Street	8,823	13.8	2,996	24,395	54	115	177	1,251	2,106	3,150	5,621	276	451	625	1,738	2,492	3,502	6,024
134	234	Ramstetter Creek confluence	8,761	13.7	1,025	25,421	53	113	173	1,246	2,096	3,136	5,596	275	449	621	1,726	2,473	3,473	5,994
135	235		6,934	10.8	1,988	27,409	22	43	64	1,344	2,030	2,941	5,040	228	340	454	1,558	2,243	3,135	5,239
137	237		6,784	10.6	1,283	28,692	18	35	51	1,323	2,001	2,901	4,963	218	324	432	1,535	2,215	3,096	5,162
138	238	Easley Road	6,761	10.6	1,946	30,638	19	36	51	1,323	2,000	2,898	4,957	219	326	432	1,535	2,214	3,093	5,154
139	239	W 60th Avenue	6,731	10.5	1,260	31,898	17	32	47	1,319	1,994	2,890	4,944	218	323	428	1,530	2,208	3,084	5,138
140	240		6,653	10.4	2,212	34,110	17	33	46	1,317	1,983	2,872	4,912	219	325	432	1,523	2,197	3,066	5,101
141	241		6,575	10.3	1,633	35,744	18	33	46	1,312	1,971	2,852	4,872	231	334	445	1,513	2,185	3,044	5,055
142	242	Dunraven Street	6,480	10.1	2,774	38,518	16	28	38	1,299	1,963	2,866	4,846	237	332	444	1,496	2,178	3,036	5,013
143	243	El Diente Street	6,432	10.1	718	39,235	13	22	30	1,291	1,951	2,848	4,816	235	327	438	1,487	2,164	3,016	4,980
145	245	State Highway 93	6,096	9.5	2,060	41,296	2	17	48	1,238	1,875	2,735	4,611	205	303	390	1,426	2,092	2,918	4,819
146T	246T		5,728	8.9	1,305	42,601	2	22	47	1,182	1,789	2,595	4,365	110	163	211	1,267	1,885	2,671	4,441
147	247		5,319	8.3	4,279	46,880	1	16	44	1,092	1,655	2,401	4,030	2	16	44	1,093	1,655	2,401	4,030
148	248		4,323	6.8	8,567	55,447	4	15	41	932	1,399	2,024	3,372	4	15	41	932	1,399	2,024	3,372
149	249		3,526	5.5	9,192	64,639	4	15	36	784	1,171	1,704	2,830	4	15	36	784	1,171	1,704	2,830
150	250	Crawford Gulch Road	2,346	3.7	11,000	75,639	7	16	135	579	855	1,243	2,054	7	16	135	579	855	1,243	2,054
151	251		1,379	2.2	2,202	77,841	4	9	78	334	494	718	1,187	4	9	78	334	494	718	1,187

Table B-7 - Baseline Peak Flows Along Ramstetter Creek

Design Point	Downstream Conveyance Element	Location	Total Drainage Area (acres)	Total Drainage Area (mi^2)	Link Length (ft)	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}
R101	R201	Confluence with Van Bibber Creek	1,765	2.8	0	0	53	100	236	783	1,142	1,626	2,681	82	155	309	889	1,260	1,759	2,850
R102	R202		1,745	2.7	1,814	1,814	55	102	236	786	1,141	1,623	2,672	84	156	312	894	1,260	1,757	2,843
R103T	R203T		1,692	2.6	1,139	2,953	54	100	232	774	1,121	1,593	2,619	83	153	308	879	1,238	1,724	2,787
R104	R204	Easley Road	1,601	2.5	1,711	4,663	54	99	231	748	1,079	1,528	2,503	83	154	309	852	1,195	1,657	2,668
R105	R205	Virgil Court	1,492	2.3	1,362	6,025	55	97	221	710	1,028	1,450	2,358	83	150	295	811	1,140	1,574	2,514
R106T	R206T		1,342	2.1	1,937	7,962	51	87	196	648	939	1,324	2,140	77	137	270	746	1,048	1,440	2,289
R107	R207	W 58th Avenue	1,248	1.9	1,419	9,382	36	63	166	585	853	1,208	1,963	62	114	236	676	954	1,316	2,098
R108	R208		1,101	1.7	2,994	12,376	37	61	150	525	762	1,075	1,740	59	106	215	607	854	1,172	1,866
R109T	R209T	W 56th Avenvue	746	1.2	452	12,828	6	15	67	313	466	667	1,095	35	60	126	384	544	749	1,197
R110	R210		689	1.1	1,721	14,550	6	15	67	302	448	633	1,036	35	60	125	370	520	712	1,132
R111	R211	State Highway 93	282	0.4	3,673	18,223	7	14	37	164	243	339	553	41	66	100	237	327	431	677

Table B-8 - Baseline Runoff Volumes Along Ramstetter Creek

Design Point	Downstream Conveyance Element	Location	Total Drainage Area (acres)	Total Drainage Area (mi^2)	Link Length (ft)	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}
R101	R201	Confluence with Van Bibber Creek	1,765	2.8	0	0	9	16	35	95	137	192	310	14	23	44	104	147	201	322
R102	R202		1,745	2.7	1,814	1,814	8	15	34	94	135	189	307	13	23	43	103	145	198	316
R103T	R203T		1,692	2.6	1,139	2,953	8	15	33	91	131	183	298	13	22	41	100	140	192	307
R104	R204	Easley Road	1,601	2.5	1,711	4,663	8	14	31	86	124	173	282	13	22	40	95	133	183	292
R105	R205	Virgil Court	1,492	2.3	1,362	6,025	8	14	29	81	116	162	263	12	20	37	89	124	170	272
R106T	R206T		1,342	2.1	1,937	7,962	7	12	25	71	103	144	235	11	18	33	79	111	152	243
R107	R207	W 58th Avenue	1,248	1.9	1,419	9,382	5	9	21	64	93	132	216	8	15	28	71	101	139	224
R108	R208		1,101	1.7	2,994	12,376	4	8	19	56	82	116	191	8	13	25	63	89	123	198
R109T	R209T	W 56th Avenvue	746	1.2	452	12,828	1	2	8	34	51	74	124	4	7	15	40	58	81	132
R110	R210		689	1.1	1,721	14,550	1	2	8	31	47	69	115	4	7	14	37	53	75	121
R111	R211	State Highway 93	282	0.4	3,673	18,223	0	1	3	12	18	27	46	3	6	9	18	25	33	52

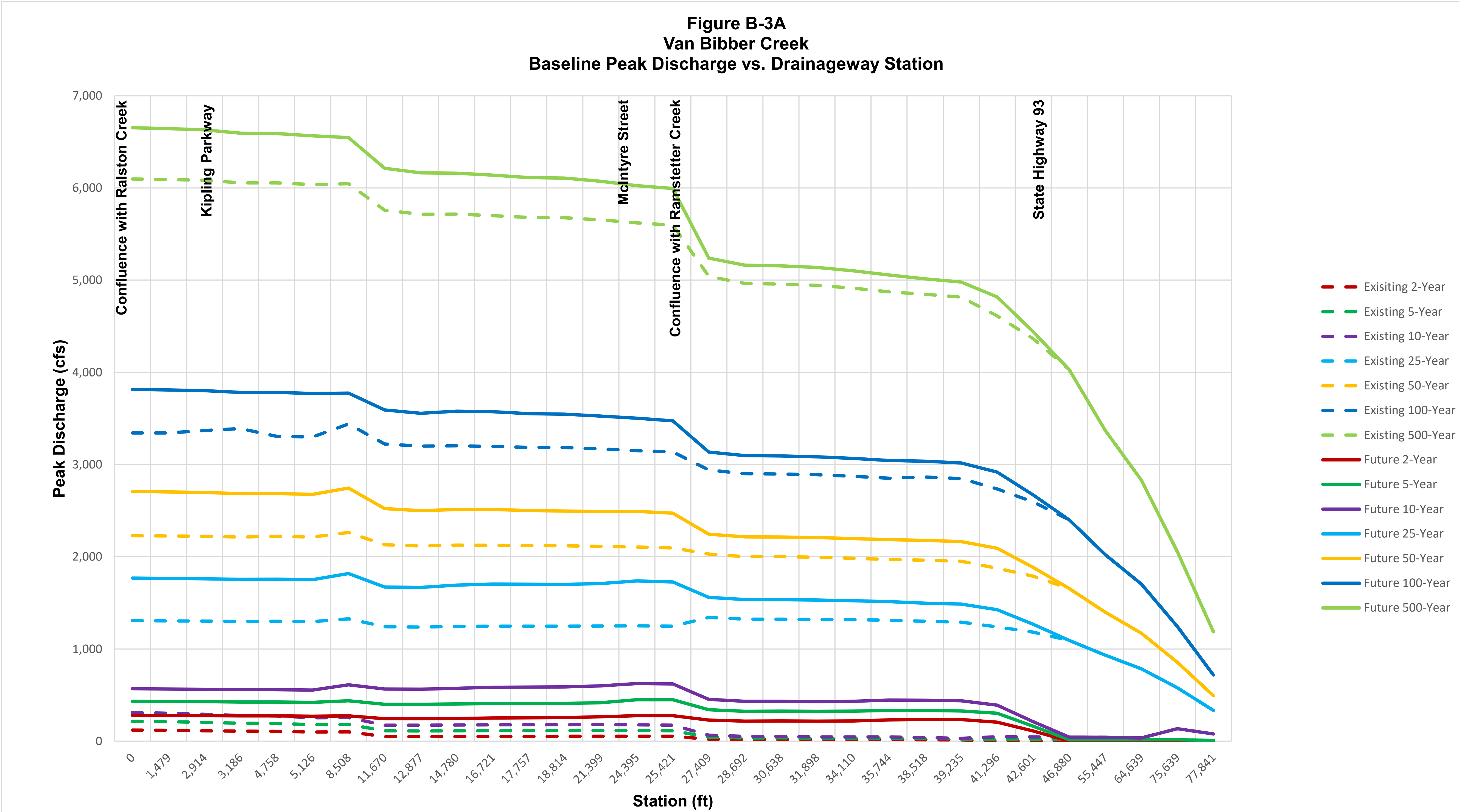


Figure B-3A
Van Bibber Creek
Baseline Peak Discharge vs. Drainageway Station
Peak Discharge (cfs)
Station (ft)
Confluence with Ralston Creek
Kipling Parkway
McIntyre Street
Confluence with Ramstetter Creek
State Highway 93
Exisiting 2-Year
Existing 5-Year
Existing 10-Year
Existing 25-Year
Existing 50-Year
Existing 100-Year
Existing 500-Year
Future 2-Year
Future 5-Year
Future 10-Year
Future 25-Year
Future 50-Year
Future 100-Year
Future 500-Year

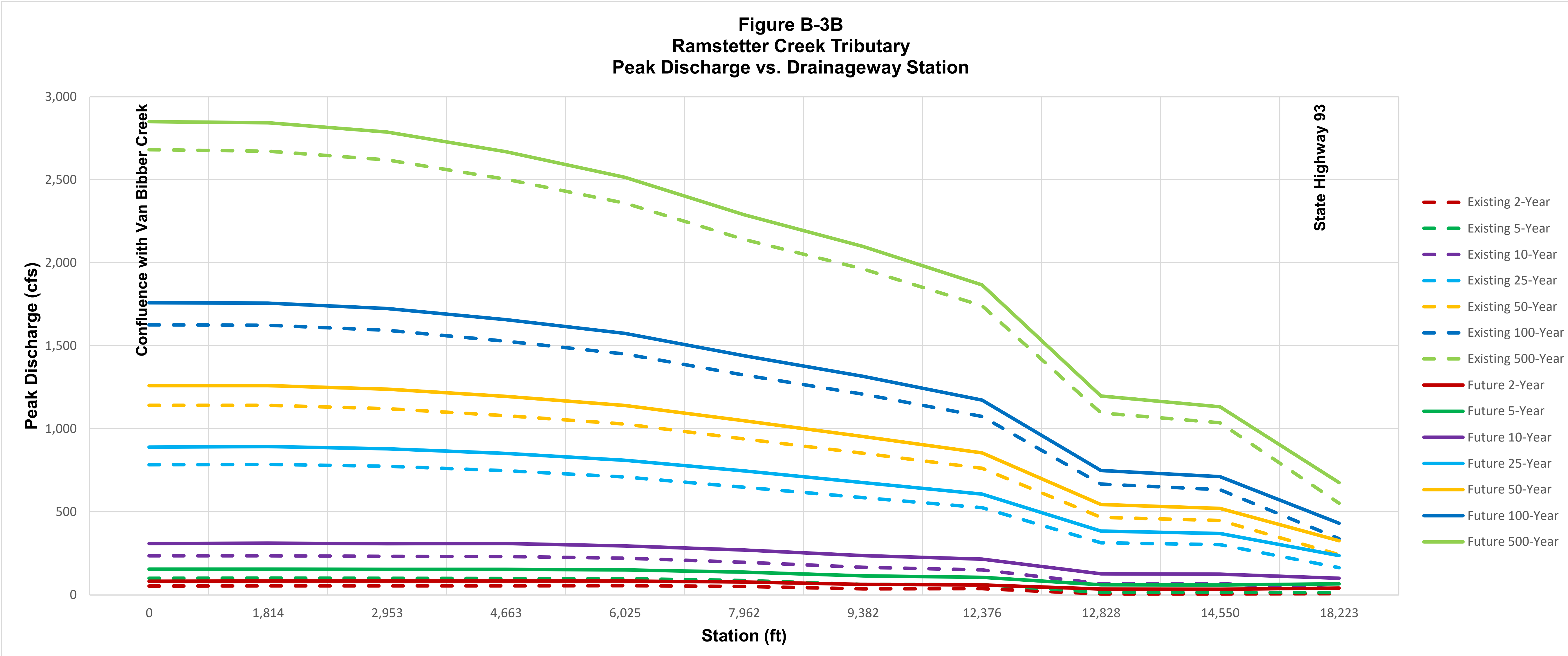
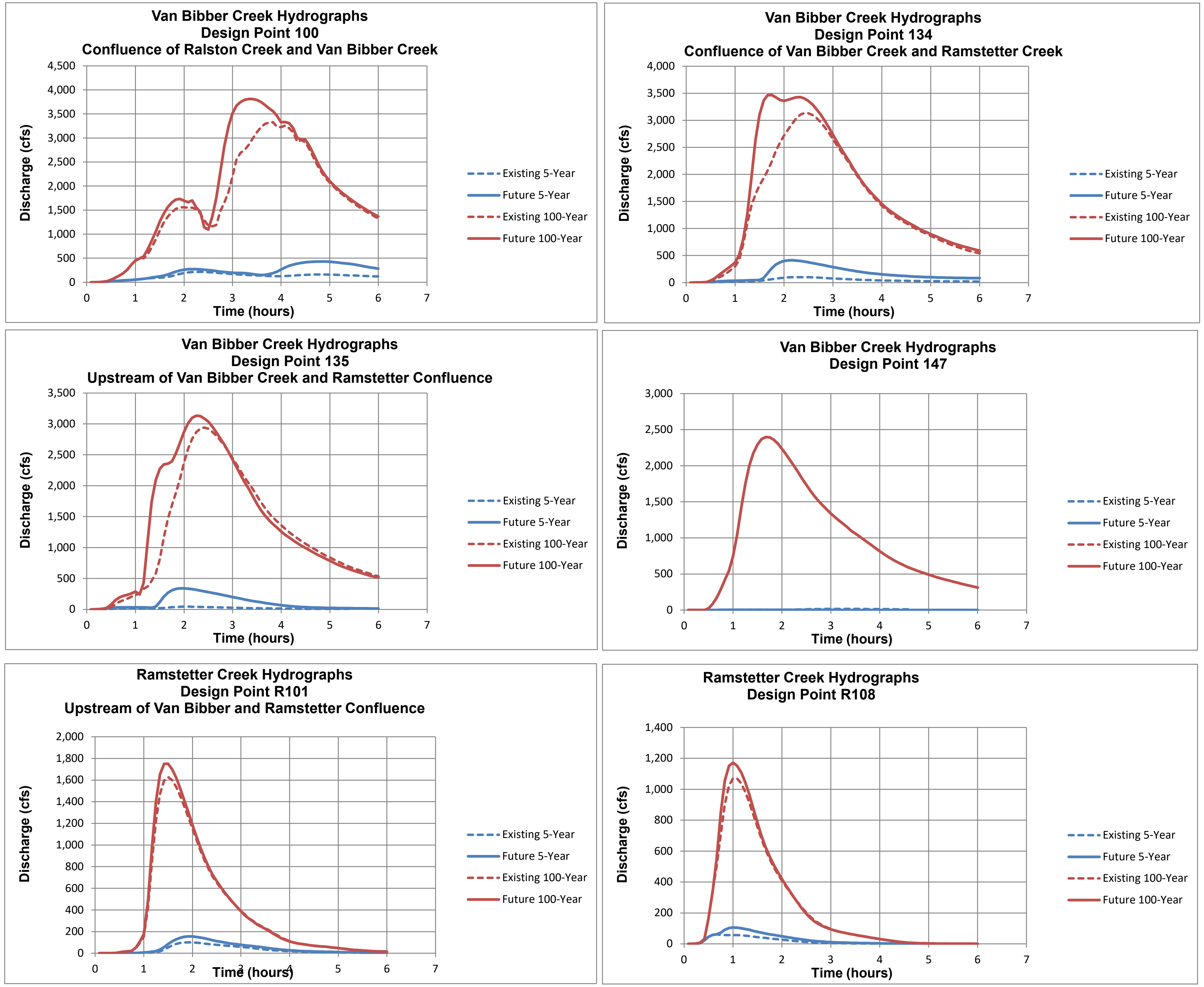


Figure B-3B
Ramstetter Creek Tributary
Peak Discharge vs. Drainageway Station
Peak Discharge (cfs)
3,000
2,500
2,000
1,500
1,000
500
0
Station (ft)
0
1,814
2,953
4,663
6,025
7,962
9,382
12,376
12,828
14,550
18,223
Confluence with Van Bibber Creek
State Highway 93
Existing 2-Year
Existing 5-Year
Existing 10-Year
Existing 25-Year
Existing 50-Year
Existing 100-Year
Existing 500-Year
Future 2-Year
Future 5-Year
Future 10-Year
Future 25-Year
Future 50-Year
Future 100-Year
Future 500-Year

Figure B-4 - Baseline Hydrographs



APPENDIX C

HYDRAULIC ANALYSIS

NOTES TO USERS

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

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

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

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

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

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

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

Base map information shown on this FIRM was derived from U.S. Geological Survey Digital Orthophoto Quadrangles produced at a scale of 1:12,000 from photography dated 1998 or later.

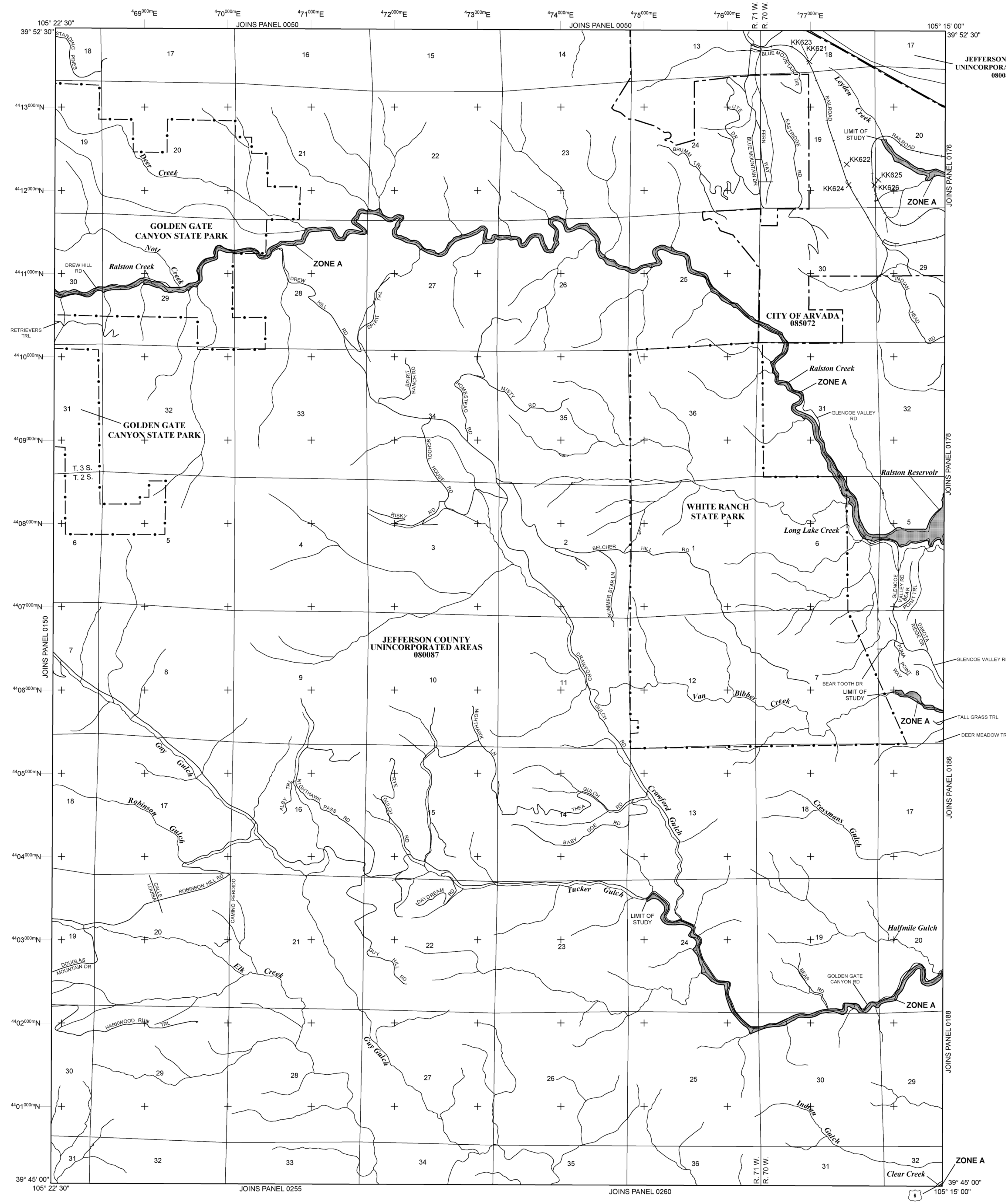
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to these new stream channel configurations. As a result, the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

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

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

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

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



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

1% Annual Chance Floodplain Boundary

0.2% Annual Chance Floodplain Boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A	Cross section line
23 - - - 23	Transect line
45° 02' 08", 93° 02' 12"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
4989000m N	1000-meter Universal Transverse Mercator grid values, zone 13N
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 17, 2003

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
February 5, 2014: to update corporate limits, to change base flood elevations, to add base flood elevations, to add special flood hazard areas, to update map format, to add roads and road names, to reflect updated topographic information, to incorporate previously issued letters of map revision.

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

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

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET
600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0175F

FIRM
FLOOD INSURANCE RATE MAP

JEFFERSON COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 175 OF 675
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ARVADA, CITY OF	085072	0175	F
JEFFERSON COUNTY	080087	0175	F

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

MAP NUMBER
08059C0175F

MAP REVISED
FEBRUARY 5, 2014

Federal Emergency Management Agency

NOTES TO USERS

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

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

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

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

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

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

Base map information shown on this FIRM was derived from U.S. Geological Survey Digital Orthophoto Quadrangles produced at a scale of 1:12,000 from photography dated 1998 or later.

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

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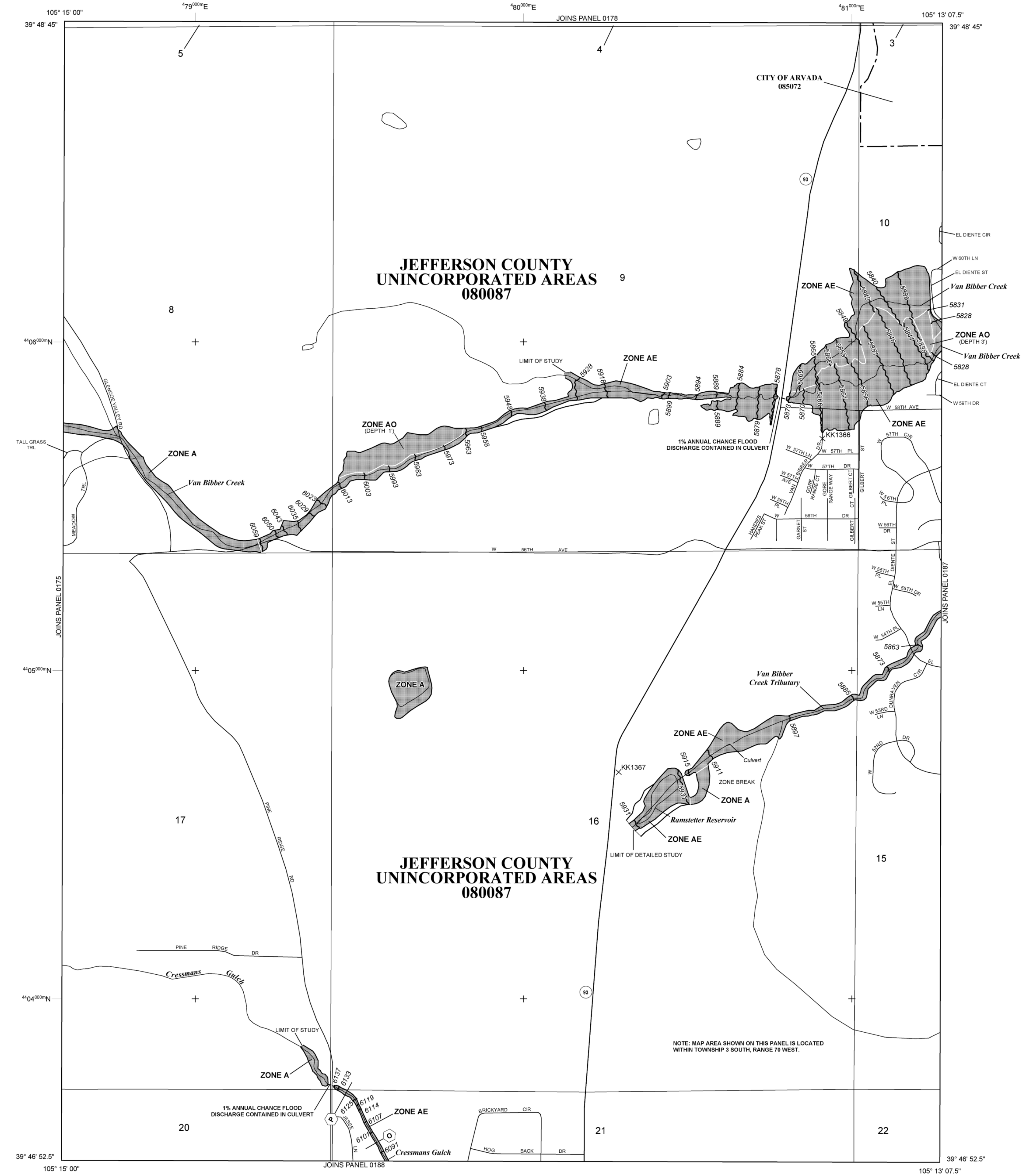

LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

*Referenced to the North American Vertical Datum of 1988

A — A: Cross section line
23 - - - 23: Transect line
45° 02' 08", 93° 02' 12": Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
4989000m N: 1000-meter Universal Transverse Mercator grid values, zone 13N
DX5510 ×: Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5: River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 17, 2003
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
February 5, 2014: to update corporate limits, to change base flood elevations, to add base flood elevations, to add special flood hazard areas, to update map format, to add roads and road names, to reflect updated topographic information, to incorporate previously issued letters of map revision.

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

N

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0186F

FIRM
FLOOD INSURANCE RATE MAP

JEFFERSON COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 186 OF 675
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ARVADA, CITY OF	085072	0186	F
JEFFERSON COUNTY	080087	0186	F

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

MAP NUMBER
08059C0186F

MAP REVISED
FEBRUARY 5, 2014

Federal Emergency Management Agency

NOTES TO USERS

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

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

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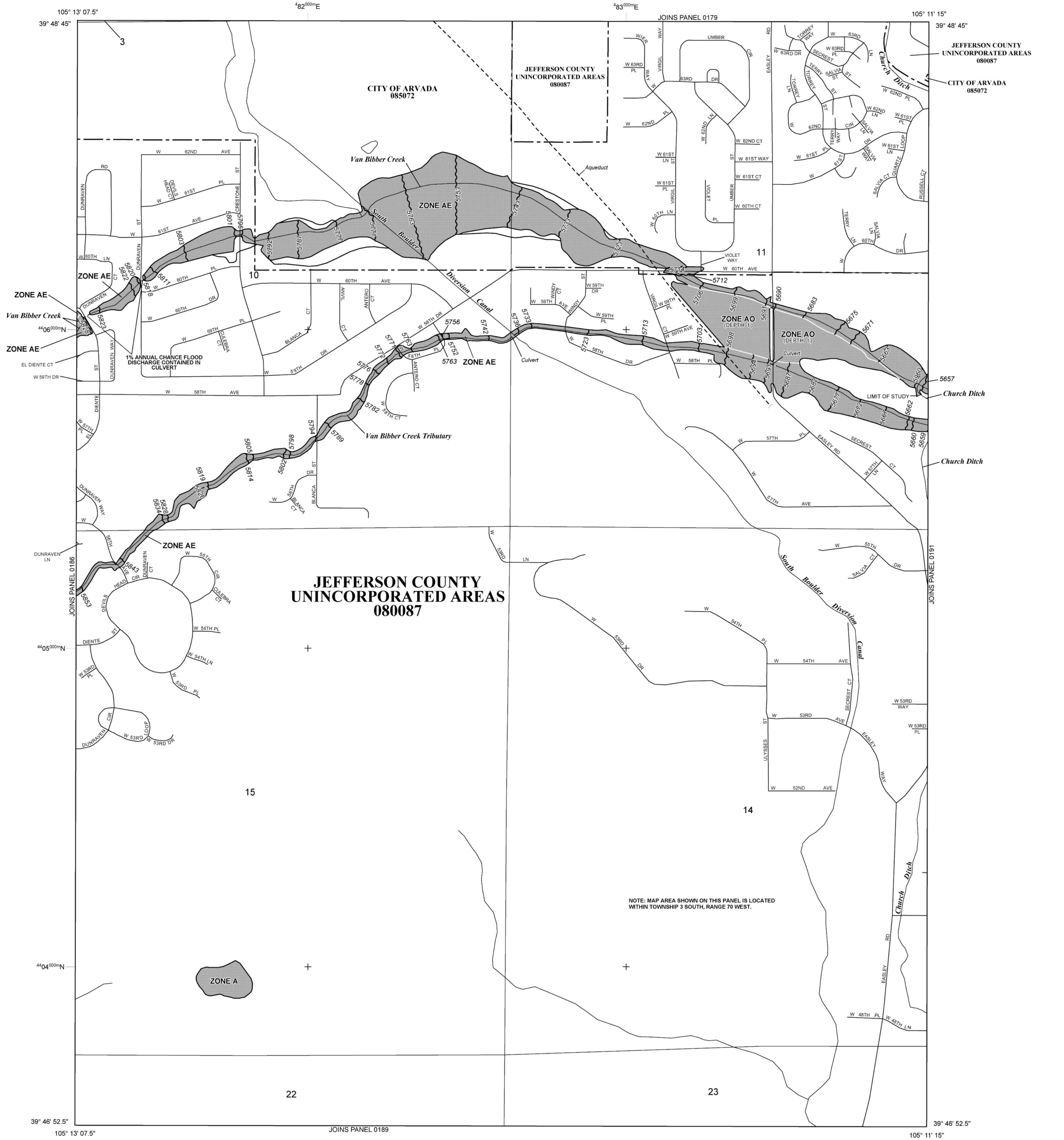

LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

1% Annual Chance Floodplain Boundary

0.2% Annual Chance Floodplain Boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A —— A	Cross section line
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45° 02' 08", 93° 02' 12"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
4989000m N	1000-meter Universal Transverse Mercator grid values, zone 13N
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 17, 2003
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
February 5, 2014: to update corporate limits, to change base flood elevations, to add base flood elevations, to add special flood hazard areas, to update map format, to add roads and road names, to reflect updated topographic information, to incorporate previously issued letters of map revision.

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N

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0187F

FIRM
FLOOD INSURANCE RATE MAP

JEFFERSON COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 187 OF 675
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ARVADA, CITY OF	085072	0187	F
JEFFERSON COUNTY	080087	0187	F

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

MAP NUMBER
08059C0187F

MAP REVISED
FEBRUARY 5, 2014

Federal Emergency Management Agency

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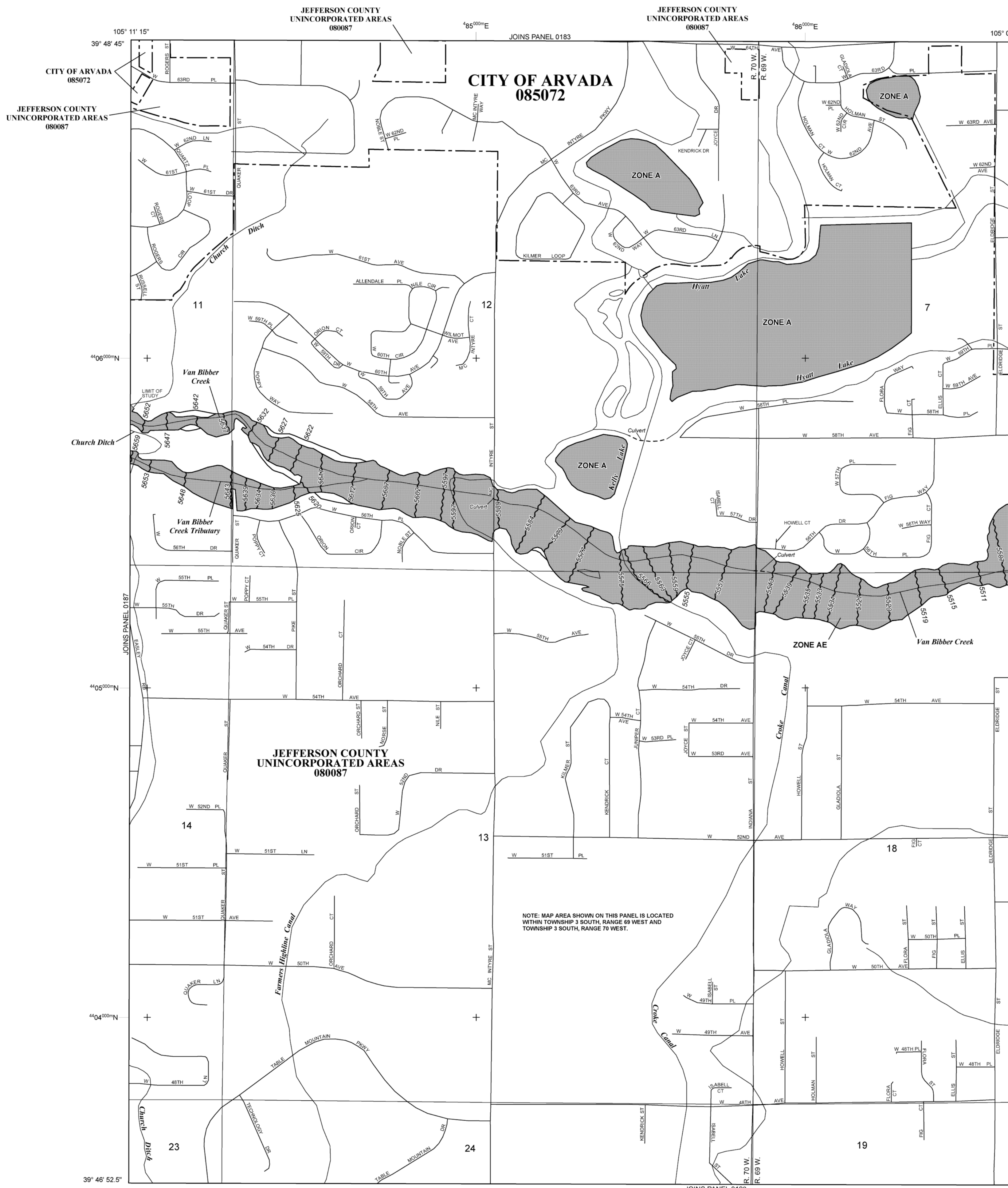

LEGEND

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

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ZONE A No Base Flood Elevations determined.

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ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

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ZONE AR Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

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

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

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OTHERWISE PROTECTED AREAS (OPAs)

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1% Annual Chance Floodplain Boundary

0.2% Annual Chance Floodplain Boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513 — Base Flood Elevation line and value; elevation in feet*

(EL 987) — Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A Cross section line

23 - - - 23 Transect line

45° 02' 08", 93° 02' 12" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere

$^{49}89^{000m}$ N 1000-meter Universal Transverse Mercator grid values, zone 13N

DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel)

• M1.5 River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 17, 2003

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
February 5, 2014: to update corporate limits, to change base flood elevations, to add base flood elevations, to add special flood hazard areas, to update map format, to add roads and road names, to reflect updated topographic information, to incorporate previously issued letters of map revision.

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MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0191F

FIRM
FLOOD INSURANCE RATE MAP

JEFFERSON COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 191 OF 675
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ARVADA, CITY OF	085072	0191	F
JEFFERSON COUNTY	080087	0191	F

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

MAP NUMBER 08059C0191F

MAP REVISED FEBRUARY 5, 2014

Federal Emergency Management Agency

NOTES TO USERS

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

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

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

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

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

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

Base map information shown on this FIRM was derived from U.S. Geological Survey Digital Orthophoto Quadrangles produced at a scale of 1:12,000 from photography dated 1998 or later.

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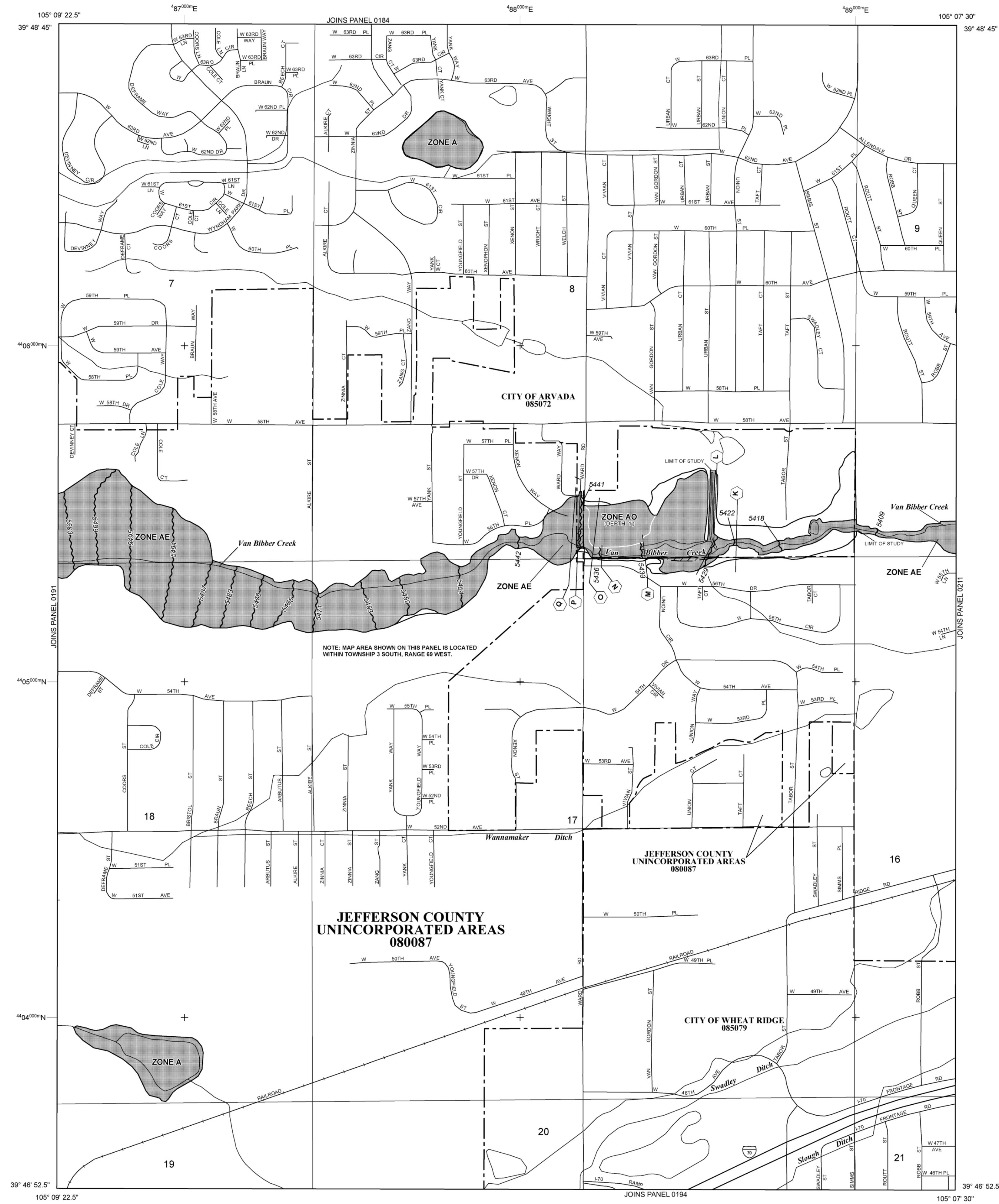

LEGEND

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

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

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

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

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

1% Annual Chance Floodplain Boundary

0.2% Annual Chance Floodplain Boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513 Base Flood Elevation line and value; elevation in feet*

(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

(A)—(A) Cross section line

(23)- - - -(23) Transect line

45° 02' 08", 93° 02' 12" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere

4989000m N 1000-meter Universal Transverse Mercator grid values, zone 13N

DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel)

• M1.5 River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 17, 2003
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
February 5, 2014: to update corporate limits, to change base flood elevations, to add base flood elevations, to add special flood hazard areas, to update map format, to add roads and road names, to reflect updated topographic information, to incorporate previously issued letters of map revision.

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MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0192F

FIRM
FLOOD INSURANCE RATE MAP

JEFFERSON COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 192 OF 675
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ARVADA, CITY OF	085072	0192	F
JEFFERSON COUNTY	080087	0192	F
WHEAT RIDGE, CITY OF	085079	0192	F

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MAP NUMBER
08059C0192F

MAP REVISED
FEBRUARY 5, 2014

Federal Emergency Management Agency

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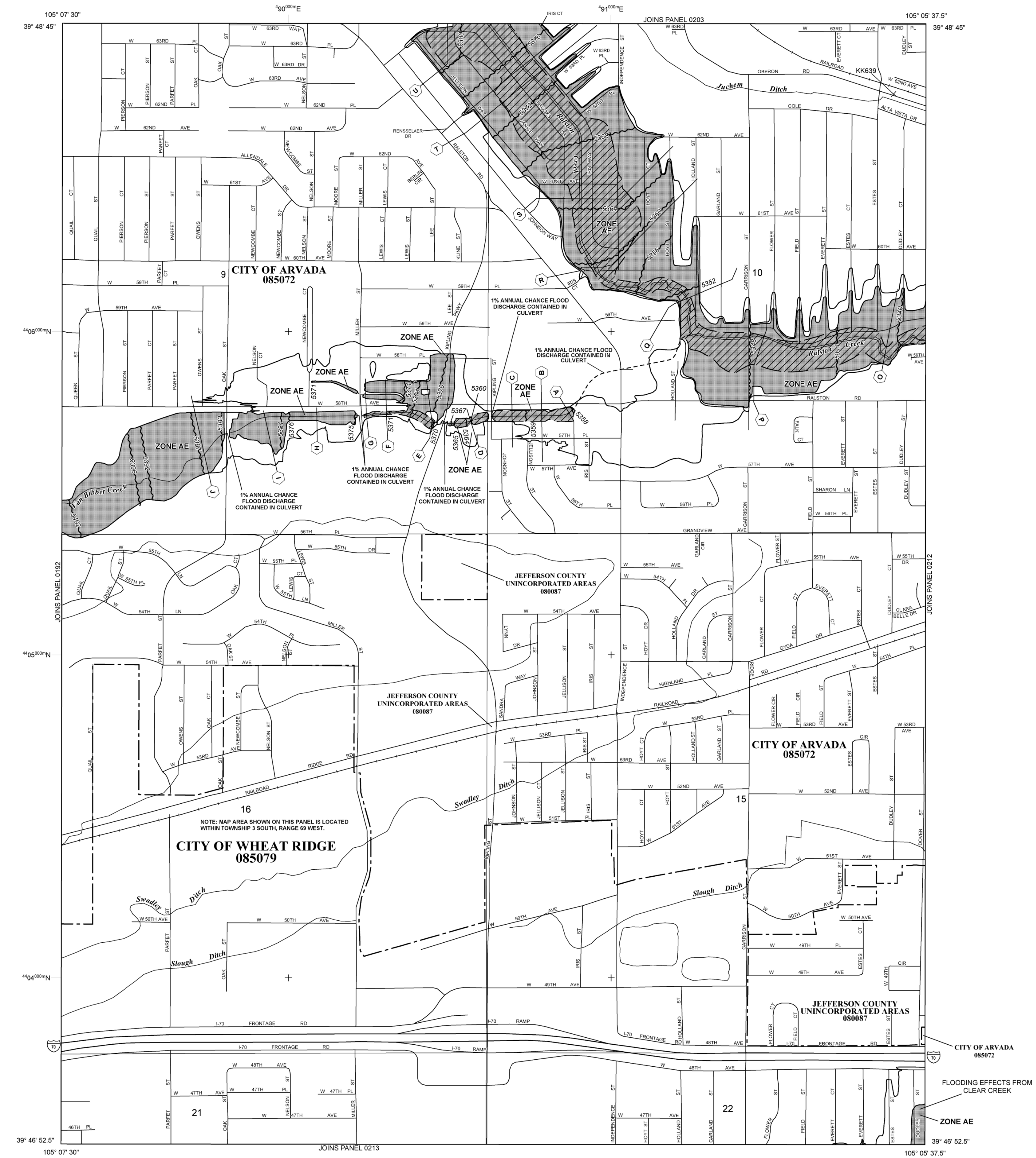

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NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0211F

FIRM

FLOOD INSURANCE RATE MAP

JEFFERSON COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 211 OF 675

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

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MAP NUMBER 08059C0211F

MAP REVISED FEBRUARY 5, 2014

Federal Emergency Management Agency