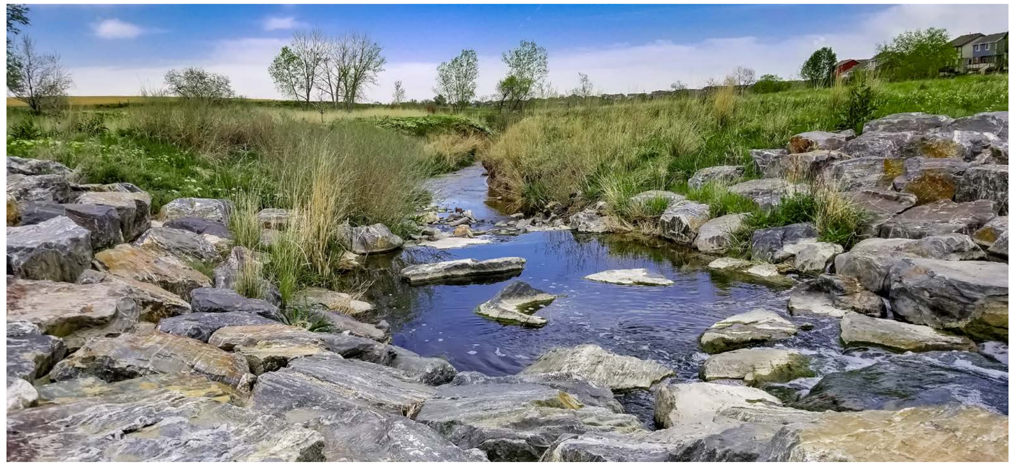

BRANTNER GULCH AND TRIBUTARIES

DRAFT MAJOR DRAINAGEWAY PLAN

June 2023

olsson | ADAMS COUNTY COLORADO | MHFD MILE HIGH FLOOD DISTRICT | CITY OF Northglenn | City of Thornton

olsson

June 9, 2023

Andy Stewart
Project Manager, Watershed Services
Mile High Flood District
2480 W. 26th Avenue, Suite 156B
Denver, CO 80211

Re: Brantner Gulch and Tributaries MDP
Agreement No. 18-06.38
Olsson Project No. 018-2897

Dear Mr. Stewart:

Olsson is pleased to submit the draft alternatives report for Brantner Gulch and Tributaries. This report documents the updated hydrology, hydraulics, problem identification, and alternatives analysis for Brantner Gulch, its tributaries, South Platte River South Tributary 6, South Platte River North Tributary 7, the Regional Park watershed, and several South Platte River direct flow area watersheds.

The alternatives analysis report was prepared with the cooperation of MHFD, the City of Northglenn, the City of Thornton, and Adams County. The information from this study provides the project sponsors with design flows to be used for future construction and development projects in the watersheds.

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

Sincerely,

Deb Ohlinger, PE, CFM
Team Leader

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

Hannah Pring, PE
Project Engineer

CC: Jim Kaiser, City of Thornton
Rachelle Plas, City of Thornton
Pam Acre, City of Northglenn
Russell Nelson, Adams County
Denise Beltran Torresdey, Adams County

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ABBREVIATIONS INDEX

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
MHFD – Mile High Flood District
N – North
NLCD – National Land Cover Database
No. – Number
NOAA – National Oceanic and Atmospheric Administration
Northglenn – City of Northglenn
NRCS – Natural Resources Conservation Service
O&M – operations and maintenance
O.F. - Overflow
OSP – Outfall Systems Plan
Rd – Road
RCBC – reinforced concrete box culvert
RCP – reinforced concrete pipe
S – South
SEO – State Engineer's Office
SPRS 6 – South Platte River Southern Tributary 6
SPRN 7 – South Platte River Northern Tributary 7
SSP – smooth steel pipe
St – Street
SWMM – Storm Water Management Model
UDFCD – Urban Drainage and Flood Control District
U/S – upstream
USACE – United States Army Corps of Engineers
USDCM – Urban Storm Drainage Criteria Manual
Thornton – City of Thornton
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. INTRODUCTION

1.1 Authorization

Olsson was retained to complete a Major Drainageway Plan (MDP) and a Flood Hazard Area Delineation (FHAD) for Brantner Gulch and Tributaries, South Platte River South Tributary 6 (SPRS 6), and South Platte River North Tributary 7 (SPRN 7). The project was co-sponsored by the Mile High Flood District (MHFD), formerly Urban Drainage and Flood Control District, City of Northglenn (Northglenn), Adams County, and City of Thornton (Thornton). The Agreement Regarding Major Drainageway Plan and Flood Hazard Area Delineation for Brantner Gulch and Tributaries (Agreement No. 18-06.38) was executed on September 7, 2018.

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 information from this study provides a guide for project sponsors to use for future construction projects within the four watersheds: Brantner Gulch, SPRS 6, SPRN 7, and the Adams County Regional Park. A total of four South Platte River direct flow areas were also included in the study. The Brantner Gulch watershed is mostly developed, with some undeveloped areas primarily in the eastern portion of the watershed. The SPRS 6, SPRN 7, and Regional Park watersheds are less developed. The MDP will be used to identify and propose solutions to potential flooding, drainage, channel stability, and ecological hazards along the drainageways. The MDP will also provide guidance to the project sponsors for future construction as the watershed continues to develop or redevelop. The scope of this study was updated by the project sponsors to include the Regional Park and the South Platte River direct flow area watersheds in Adams County.

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

- Collected existing information, including the previous FHAD and major drainageway plans (MDPs), development drainage studies, and drainage improvement as-built plans.
- Solicited input from project sponsors
- Obtained base mapping, structure surveys, and GIS information from MHFD, Adams County, Thornton, and Northglenn
- Obtained future land use mapping from Adams County, Thornton, and Northglenn
- 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), version 2.0.0 and the Environmental Protection Agency Stormwater Management Model (EPA SWMM) 5.1, version 5.1.013
- Reconciled the hydrology with previous studies
- Completed a hydraulic analysis of Brantner Gulch and its tributaries, SPRS 6, and SPRN 7 using HEC-RAS, version 6.2
- Identified problem areas along the selected drainageways
- Evaluated alternative solutions to rectify identified problems
- Prepared a recommended plan
- Completed a report

1.3 Planning Process

Hydrology of the Brantner Gulch, SPRS 6, and SPRN 7 watersheds was completed for the *Flood Hazard Area Delineation" Brantner Gulch and Tributaries* in January 1983 by Sellards & Grigg, Inc. (1983 FHAD). Updated hydrology was completed in the *Lower Brantner Gulch Major Drainageway Planning Update* in January 2005 (2005 MDP), developed by Love & Associates, Inc. In June of 2010, hydrology for a portion of the watershed was updated as part of the *Brantner Gulch Northern Tributary Watersheds Hydrology Update* (2010 Hydrology Update) developed by ICON Engineering. The baseline hydrology developed for this study represents an updated analysis for the entire Brantner Gulch watershed, SPRN 6, SPRN 7, Regional Park, and direct flow area watersheds using CUHP, version 2.0.0 and EPA SWMM, version 5.1.013. Further information regarding the hydrologic modeling process is included in Section 3.0. The goals and objectives of the FHAD and MDP are to provide comprehensive and cohesive hydrology for the watersheds. This updated hydrology provided a baseline for proposed solutions for known problem areas, as well as inform future potential development and roadway improvements.

The hydraulic evaluation of Brantner Gulch and its tributaries, SPRS 6, and SPRN 7 will be used to identify the limits of the 100-year and 500-year floodplains and will be used develop the Flood Hazard Area Delineation.

A kickoff meeting was held on September 24, 2018 with MHFD, Northglenn, Adams County Parks and Open Space, and Thornton to discuss the project goals, hydrologic analysis, areas of concern, and potential alternatives. Meetings to discuss the hydrology comments, FHAD modeling, and alternatives analysis were held on May 13, 2019, November 20, 2019, November 3, 2020, November 16, 2020, February 10, 2021, July 21, 2022, and January 3, 2023. Meeting minutes are included in Appendix A.

1.4 Mapping and Surveys

MHFD provided 1-foot (ft) interval 2014 LiDAR mapping for the entire Brantner Gulch study limits, as well as 2020 LiDAR to be used in select areas, and limited survey of the crossing structures and drop structures in the project area. The City of Thornton provided supplemental survey of Detention Basin 365 for the hydrology model. The LiDAR mapping and survey is referenced to the NAVD 88 vertical datum and the NAD 83 horizontal datum. Channel improvements were underway in several areas throughout the watershed. In addition to the LiDAR and supplemental survey, record drawings, as-built topography, or design topography verified as as-built, were obtained from MHFD, Thornton, and Northglenn for the following areas and incorporated into the existing conditions models:

- The Brantner Gulch Ohio Lake spill path has been altered by the Washington Center Filing 1 development designed by Redland and Karl's Farm Filing No. 1 development designed by Innovative Land Consultants, Inc.
- The Brantner Gulch Eastlake Reservoir No. 2 storm drain system was designed by Sellards & Grigg, Inc. The vertical datum of the plans was unknown. A datum conversion of +1.38' was used to convert the elevations to NAVD 88, based on the average differences between the as-built elevations and the survey elevations at the upstream and downstream ends of the pipe.
- The Brantner Gulch Eastlake Reservoir Number 3 storm drain system was designed by

Montgomery Watson. A +2.96-foot elevation conversion from NGVD 29 to NAVD 88 was used to convert the elevations.

- The Brantner Gulch ground at the 500-year floodplain was modified between E. 128th Avenue and Quebec Street as part of the Riverdale Ranch development, designed by Harris Kocher Smith.
- Brantner Gulch crossing improvements at 128th Avenue were designed by Martin/Martin Consulting Engineers for Thornton.
- Brantner Gulch improvements at Riverdale Road were designed by Muller Engineering.
- Fairgrounds Tributary channel improvements were completed between Uinta Street and East 130th Circle. The project was completed in two phases, one designed by Dewberry Engineers, Inc. for MHFD and the other by JR Engineering for the Timberleaf Filing No. 1 development.
- Horizon Tributary pedestrian crossing improvements between 136th Avenue and Quebec Street were designed by CVL Consultants.
- South Platte River South Tributary 6 improvements were completed upstream of Riverdale Road. A 100-year storm drain system parallel to Yosemite Street was designed by JVA Consulting Engineering for the School District 27J High School #3 development. The water quality pond upstream of Riverdale Road was modified by several projects. Supplemental survey and 2020 LiDAR was used for the model in this area.

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

1.5 Data Collection

Drainage studies, as-built plans, and MDPs were collected from MHFD, Adams County, and Thornton. The Adams County, Colorado and Incorporated Areas Flood Insurance Rate Maps (FIRMs) were obtained from the Federal Emergency Management Agency (FEMA). The key studies and plans that were reviewed in the preparation of this report are shown in Table 2.

Table 1 – Data Collected

Title	Date	Author
Final Drainage Report: Washington Center Filing No. 1, 10th Amendment (Fieldhouse Apartments)	November 4, 2021	Redland
Riverdale Ranch	June 06, 2021	Harris Kocher Smith
Timberleaf Filing No. 1 Fairgrounds Tributary – Record Drawings	April 9, 2021	JR Engineering
Horizon Creek Culvert Improvements – As-Constructed Drawings	December 2020	CVL Consultants
Fairgrounds Tributary Construction Plans	September 2020	Dewberry Engineers, Inc.
Brantner Gulch Drainage Improvements at 128th Avenue – Record Drawings	September 2020	Martin/Martin Consulting Engineers
Final Drainage Report: Karl's Farm Filing No. 1 – District Infrastructure	March 6, 2020	Innovative Land consultants, Inc.
School District 27J – High School #3 – Record Drawings	September 2018	JVA Consulting Engineers
Adams County Riverdale Regional Park Master Plan	April 2018	Design Workshop
Final Drainage Report: High School No. 3 - Offsite Improvements	April 2016	JVA Consulting Engineers
Final Drainage Report: High School No. 3 - Onsite Improvements.	April 2016	JVA Consulting Engineers
Addendum to Phase III Drainage Study for The Northwesterly 153 Single Family Lots of Amber Creek Subdivision	March 2015	MM&D Engineering Services, LLC
Riverdale Road Crossing on Lower Brantner Gulch	February 2014	Muller Engineering
Brantner Gulch/Holly Street Drainage and Roadway Improvements – Record Drawings	January 2013	ICON Engineering, Inc.
Brantner Gulch Northern Tributary Watersheds Hydrology Update	June 2010	ICON Engineering, Inc.
The Villages at Riverdale Filing No. 3 – Record Drawings	March 2006	Carroll & Lange, Inc.
Lower Brantner Gulch MDP Update	January 2005	Love & Associates, Inc.
Eastlake Reservoir No. 2 – Asbuilt Drawings	September 2004	Sellards & Grigg, Inc.
Drainage Report for Fairgrounds Tributary Improvements and Regional Detention Pond for the Villages at Riverdale Filing No. 3.	August 2002	Carroll & Lange, Inc.
Gleneagle Estates Construction Drawings with the Attachment of East 128th Avenue Improvement Plans	January 2002	Merrick Architects and Engineers
Phase III Drainage Report for Washington Center Apartments	January 2000	York Engineering Services
Phase III Drainage Report for Northbrook Subdivision	April 2000	Stantec Consulting, Inc.
Eastlake Reservoir No. 3 Dam and Downstream Improvements – Asbuilt Drawings	February 1999	Montgomery Watson
Final Drainage Study for Meadow Park	September 1999	MMC Engineering
Phase III Drainage Report for Eastlake Village III Development-Phase I	May 1998	Sellards & Grigg, Inc.
Phase III Drainage Report Madison Park Phase One	December 1996	DHM Design Corporation
Final Drainage Report: Wright Farms, Filing No. 3, First Plat	April 1994	Carroll & Lange, Inc.
Flood Hazard Area Delineation: Brantner Gulch and Tributaries	January 1983	Sellards & Grigg, Inc.

1.6 Acknowledgements

The MDP and FHAD were prepared with the cooperation of MHFD, Northglenn, Adams County, and Thornton. The representatives who were involved with this study are listed in Table 2.

Table 2 - Project Participants

Name	Representing	Assignment
Andy Stewart	MHFD	Watershed Manager
Hung-Teng Ho	MHFD	Hydraulic Modeler
Drew Roberts	MHFD	Project Sponsor
Russell T. Nelson	Adams County	Project Sponsor
Denise Beltran Torresdey	Adams County	Project Sponsor
Trevor Graf	Adams County Parks and Open Space	Project Sponsor
Kurt Carlson	Adams County Parks and Open Space	Project Sponsor
Pam Acre	City of Northglenn	Project Sponsor
Jim Kaiser	City of Thornton	Project Sponsor
Rachelle Plas	City of Thornton	Project Sponsor
Deb Ohlinger	Olsson	Team Leader
Amy Gabor	Olsson	Project Manager
Hannah Pring	Olsson	Project Engineer
Erika Bowman	Olsson	Associate Engineer

2. STUDY AREA DESCRIPTION

2.1 Project Area

Watershed and Drainageway Description

Six separate watersheds were evaluated: the Brantner Gulch Watershed (3600), South Platte River South Tributary 6 Watershed (0052), South Platte River North Tributary 7 Watershed (0052), the Regional Park Watershed, and four direct flow areas to the South Platte River (Basins S25, D01, D06, and D08). The watersheds are shown in Figure 1.

The Brantner Gulch watershed covers an area of approximately 10.1 square miles. The major tributaries of Brantner Gulch include: Fairgrounds (0.4 square miles), Horizon (2.0 square miles), Pheasants Run (0.4 square miles), Quails Way (0.1 square miles), Plains (0.6 square miles), and Lakeview (0.9 square miles) Tributaries. The southern limit of the watershed is around East 120th Parkway. The westernmost limit of the watershed is located near Community Center Drive. The northernmost boundary lies just north of 140th Avenue East of Yosemite Street. Brantner Gulch flows into Mann-Nyholt Lake, which outlets to the South Platte River. The Brantner Gulch watershed is approximately 6.5 miles long and 3.1 miles wide and is located in the cities of Thornton and Northglenn, and unincorporated Adams County. The watershed generally slopes down to the east toward the South Platte River, with flow path slopes ranging from 0.05 to 3.80 percent (%). The lowest and highest watershed elevations are 5001 and 5425, respectively.

South Platte River South Tributary 6 watershed encompasses 0.8 square miles. The watershed generally slopes from the northwest to the southeast from the intersection of Quebec Street and E 140th Avenue to the confluence with SPRN 7, just west of the Fishing is Fun Pond. The South Platte River South Tributary 6 watershed is approximately 2.1 miles long and 0.5 miles wide and is located in the City of Thornton and Adams County. The watershed generally slopes down to the southeast toward the South Platte River, with flow path slopes ranging from 0.59% to 3.15%. The lowest and highest watershed elevations are 5002.3 and 5295, respectively.

South Platte River North Tributary 7 watershed encompasses 1.9 square miles. The watershed flows generally from the northwest to the southeast from the intersection of Quebec Street and E 140th Avenue to the South Platte River at the Fishing is Fun Pond. The South Platte River North Tributary 7 watershed is approximately 2.3 miles long and 0.5 miles wide and is located in the City of Thornton and Adams County. The watershed generally slopes down to the southeast toward the South Platte River, with flow path slopes ranging from 0.26% to 4.50%. The lowest and highest watershed elevations are 4998 and 5292, respectively.

The Regional Park watershed covers an area of 0.2 square miles. The watershed is located south of E-470 and generally slopes from the west to the east across Riverdale Road. The Regional Park watershed is approximately 0.7 miles long and 0.3 miles wide and is located in Adams County. The watershed generally slopes down to the east toward the South Platte River, with flow path slopes ranging from 0.3% to 5.0%. The lowest and highest watershed elevations are 4995 and 5146, respectively.

Four direct flow areas to the South Platte River were included in the study so that hydrology and peak flows could be developed. They all flow generally from west to east and outfall into the South Plate River. Basin S25 is located between the Mann-Nyholt Lake and Fishing is Fun Pond. It encompasses 56 acres adjacent to the South Platte River. Basin D01 is located south of Mann-Nyholt Lake and adjacent to the South Platte River. It serves as the outlet point to the river for Subbasins D03, D04, and D05, which have an area of 294 acres, a length of 1.1 miles, and a width of 0.5 mile, when combined with Subbasin D01. Basin D06 is located south of Basin D01 and has an area of 80 acres. Combined with Subbasin D07, it has an area of 190 acres and is approximately one mile long by 0.3 mile wide. Basin D08, located south of Basin D06, north of 120th Parkway, and adjacent to the South Platte River, has an area of 65 acres. It is approximately 0.6 mile long by 0.2 mile wide.

Gravel Pits

Three former gravel mines are located at the eastern edge of the study area adjacent to the South Platte River on its west bank. All of the study area flows into these gravel pits, which overflow into the South Platte River. No infrastructure is located downstream of the gravel pits other than the spillways that discharge into the river. Additional gravel pits are located in the direct flow area Subbasins D01, D03, and D06.

Existing Regional Detention Basins and Other Detention Basins

Regional detention basins and other detention basins requested by the project sponsors were included in the baseline hydrology. A total of 28 detention basins dispersed throughout the watersheds were included in the baseline hydrologic models. More detailed information is included in Section 3.4.

Irrigation Ditches

In the western portion of the watershed, the Farmers Highline Canal generally flows into the watershed east of Community Center Drive and north of Malley Drive. It flows generally northeast until it becomes Signal Ditch and flows north out of the watershed. Lee Lateral diverts from Signal Ditch near York Street and flows east and north through the watershed until it exits the watershed northeast of 136th Avenue and Monaco Street.

New Union ditch diverts from the Farmers Highline Canal east of Grant Street and just south of 120th Avenue. It flows mostly east and, to a lesser degree, north, near the southern boundary of the watershed until it ends south of 120th Avenue approximately one-half mile east of Holly Street. Eastlake Ditch diverts from New Union Ditch near 120th Avenue and Claude Court and flows into Eastlake Reservoir. 3.

Two irrigation ditches flow through the eastern project area. The 2005 MDP states:

> *A lateral off the Lower Clear Creek Ditch delivers irrigation water to the Knolls Golf Course and crosses Brantner Gulch in an elevated 12-inch pipe. The delivery requirement for this lateral is approximately 3.5 cfs.*

The Brantner Irrigation Ditch (110 cfs decreed water right) intersects Brantner Gulch at an at-grade bifurcation structure. Under normal base flow conditions, Brantner Ditch intercepts 100% of the flow in the Brantner Gulch and conveys the water to the north in the Brantner Ditch. During large runoff events the Brantner Ditch Company will manually open a radial gate allowing large discharges of both ditch and gulch water to flow down the concrete-lined Brantner Gulch channel into Mann-Nyholt Lake.

Planned Construction

A couple of significant developments were under construction at the time of this study. These developments were considered to be complete in the existing land use. Future land use and zoning was taken into account for potential future development, which is reflected in the future conditions hydrology models.

Soils

Soil types were determined using the Natural Resources Conservation Service (NRCS) Web Soil Survey. Over 90% of the soils in the watersheds consist of hydrologic soils groups (HSG) C and D, which are generally characterized by low infiltration rates, as defined by the NRCS. The remaining area of the watersheds are HSG A soils, which are generally characterized by high infiltration rates. The soils map is included on Figure B-1 in Appendix B.

PROJECT: 018-2897
DRAWN BY: ELB
DATE: 3/10/2023

MILE HIGH FLOOD DISTRICT, CITY OF THORNTON, NORTHGLENN, & ADAMS COUNTY

BRANTNER GULCH MDP STUDY AREA MAP

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FIGURE 1

2.2 Land Use

The watersheds are mostly developed, with areas of land that remain undeveloped, primarily in the South Platte River South Tributary 6, South Platte River North Tributary 7, and the Regional Park watersheds. Existing development consists mostly of single-family residential, with some multi-family residential and several institutional developments. Pockets of industrial, commercial, and open space/recreational areas are also present. Existing land use was verified using aerial imagery.

Outside of the existing developed area, future land use will consist mostly of low density residential areas, medium density residential areas, urban reserve areas, and urban village areas, with pockets of commercial areas, institutional areas, mixed-use, and open space/recreational areas. Future land use information was obtained from Thornton zoning maps and Karl's Farm Master Plan, included in Appendix B, and Thornton and Adams County GIS information. Additional discussion of land uses and corresponding percent impervious values is included in Section 3.3.

2.3 Reach Description

Table 3 summarizes the major crossing structure inventory for the major drainageways. Figure 2 shows the locations of the major crossing structures along the major drainageways.

Brantner Gulch – Reach 1

Existing Channel Conditions

Approximately half of Brantner Gulch – Reach 1 is routed through Mann-Nyholt Lake and the remaining is an irregular channel with an average slope of 0.8%. The entire reach stretches approximately 1.3 miles. Bound between the Mann-Nyholt Lake outlet into the South Platte River and the crossing at Riverdale Road, the reach lies within the jurisdiction of Adams County.

The irregular channel consists of a concrete-lined low flow channel and flat areas outside of the low flow. The concrete-lined low flow channel is trapezoidal with a 5-foot bottom width and 3:1 side slopes. In many locations along the concrete-lined channel vegetation grows through the concrete. Vegetation outside of the low flow channel typically consists of sod. The concrete-lined low flow channel appears to be in poor condition. Areas outside of the low flow are in good condition as this portion of the reach flows through the Riverdale Dunes & Knolls Golf Courses.

Brantner Gulch – Reach 2

Existing Channel Conditions

Brantner Gulch – Reach 2 is a vegetated channel with an average slope of 0.2% stretching approximately 0.1 miles. Bound between the confluence with Fairgrounds Tributary and the confluence with Horizons Tributary – Reach 1, the reach lies within the jurisdiction of the City of Thornton.

The channel is irregularly shaped and naturally meandering. The channel generally has an unvegetated low flow channel with side slopes varying from vertical to 3:1. The channel is unstable and entrenched with unvegetated vertical banks. Areas of failed bank have sloughed into the channel, and there is sparse vegetation in these areas. This material will likely get transported downstream in higher events, leaving vertical banks. Outside of the low flow channel, the channel is gradually sloping. Vegetation outside of the low flow channel typically consists of native grasses. The channel is in poor condition.

Brantner Gulch – Reach 3

Existing Channel Conditions

Brantner Gulch – Reach 3, located between the junction with Horizons Tributary and the junction with Pheasants Run, is a primarily vegetated channel with an average slope of 0.4% stretching approximately 1.6 miles. The reach lies within the jurisdictions of the City of Thornton and Adams County.

Between the confluence with Horizons Tributary – Reach 1 and East 128th Avenue, the channel is under the jurisdiction of the City of Thornton. This portion of the reach is naturally meandering with a grade control structure. The channel is irregular and mostly an unvegetated low flow channel with side slopes varying from vertical to 3:1. The channel is unstable and entrenched with unvegetated vertical banks. Areas of failed bank have sloughed into the channel, and there is sparse vegetation in these areas. This material will likely get transported downstream in higher events, leaving vertical banks. Some areas show significant erosion has occurred between 2014 and 2020, in a comparison of LiDAR along the outer banks of the channel. Outside of the low flow channel, the channel is gradually sloping. Vegetation inside and outside of the low flow channel typically consists of native grasses. This portion of the channel appears to be in poor condition, with channel entrenchment and bends showing signs of erosion and deposition.

Between East 128th Avenue and Rosemary Street, the channel is within Adams County. This portion of the reach is naturally meandering with grade control structures. The channel is irregular with a vegetated low flow channel with side slopes varying from vertical to 3:1. The channel is unstable and entrenched with unvegetated vertical banks. Areas of failed bank have sloughed into the channel, and there is sparse vegetation in these areas. This material will likely get transported downstream in higher events, leaving vertical banks. Some areas show significant erosion has occurred between 2014 and 2020, in a comparison of LiDAR along the outer banks of the channel. Outside of the low flow channel, the channel is gradually sloping on the left bank and steeper on the right bank. Vegetation outside of the low flow channel typically consists of native and non-native grasses. Vegetation within the low flow channel consists of native grasses, shrubs, bushes, and some trees. This portion of the channel appears to be in poor condition, with channel entrenchment and bends showing signs of erosion and deposition.

Between Rosemary Street and the confluence with Plains Tributary, the channel is primarily under the jurisdiction of the City of Thornton with some areas under Adams County. This portion of the reach is naturally meandering and irregular with a vegetated low flow. The low flow channel has side slopes varying from vertical to 2:1. The channel is unstable and entrenched with unvegetated vertical banks. Areas of failed bank have sloughed into the channel, and there is sparse vegetation in these areas. This material will likely get transported downstream in higher events, leaving vertical banks. Some areas show significant erosion has occurred between 2014 and 2020, in a comparison of LiDAR along the outer banks of the channel. Outside of the low flow channel, the channel is sloping to vertical. Vegetation outside of the low flow channel typically consists of native and non-native grasses. Vegetation within the low flow channel consists of native grasses, shrubs, bushes, and some trees. This portion of the channel appears to be in poor condition, with channel entrenchment and bends showing signs of erosion and deposition.

Brantner Gulch – Reach 4

Existing Channel Conditions

Brantner Gulch – Reach 4 is a primarily vegetated channel with an average slope of 0.4% stretching approximately 0.4 miles. Bound between the confluences with Pheasants Run Tributary and Lakeview Tributary, the reach lies primarily within the jurisdiction of the City of Thornton with some areas within the jurisdiction of Adams County.

This reach is naturally meandering with a grade control structure. The channel is irregular with a vegetated low flow channel with side slopes varying from vertical to 3:1. The channel is unstable and entrenched with unvegetated vertical banks. Areas of failed bank have sloughed into the channel, and there is sparse vegetation in these areas. This material will likely get transported downstream in higher events, leaving vertical banks. Some areas show significant erosion has occurred between 2014 and 2020, in a comparison of LiDAR along the outer banks of the channel. Outside of the low flow channel, the channel is gradually sloping on the left bank and steeper on the right bank. Vegetation outside of the low flow channel typically consists of native and non-native grasses. Vegetation within the low flow channel consists of native grasses, shrubs, bushes, and some trees. This portion of the channel appears to be in poor condition, with channel entrenchment, and bends showing signs of erosion and deposition.

Brantner Gulch – Reach 5

Existing Channel Conditions

Brantner Gulch – Reach 5 is a primarily vegetated channel with an average slope of 0.7% stretching approximately 4.5 miles. The reach lies within the jurisdictions of the City of Thornton, Adams County, and Northglenn.

Between the confluence with Lakeview Tributary and Colorado Boulevard, the channel is primarily under jurisdiction of the City of Thornton, with a section that lies within Adams County. This portion of the reach is naturally meandering with grade control structures, pedestrian crossings, and the Holly Street crossing. The channel is irregular with a densely vegetated low flow channel with side slopes varying from vertical to 4:1. The channel is unstable in areas and entrenched with unvegetated vertical banks. Areas of failed bank have sloughed into the channel, and there is sparse vegetation in these areas. This material will likely get transported downstream in higher events, leaving vertical banks. Some areas show significant erosion has occurred between 2014 and 2020, in a comparison of LiDAR along the outer banks of the channel. A drop structure is being compromised by an approaching head cut. Outside of the low flow channel, slopes vary between steep and flat. Vegetation outside of the low flow channel typically consists of native and non-native grasses. Vegetation within the low flow channel consists of tall grasses, shrubs, bushes, and some trees. This portion of the channel appears to be in fair condition, with some areas that are stable and other areas showing signs of erosion.

Between Colorado Boulevard and the Stellar Elementary School Driveway, the channel is within the City of Thornton. This portion of the reach is engineered with a grade control structure. The channel has a concrete-lined trickle channel with a 4-foot bottom width and 1-foot vertical curbs. Outside of the concrete-lined trickle channel, side slopes are 4:1. Vegetation outside of the concrete-lined trickle channel typically consists of native and non-native grasses. This portion of the channel appears to be in good condition.

Between the Stellar Elementary School Driveway and the Eastlake Reservoir 3 outlet, the reach is under jurisdiction of the City of Thornton and consists of pipe flow.

Between the Eastlake Reservoir 3 outlet and East 124th Avenue, the reach is under the jurisdiction of the City of Thornton. This portion of the reach is naturally wide and flat. A clear flow path was not easily defined. The channel is densely vegetated with tall grasses, shrubs, bushes, and some trees.

Between East 124th Avenue and Steele Street, the reach is under the jurisdiction of the City of Thornton. This portion of the reach is engineered with a concrete-lined trickle channel. The concrete-lined trickle channel has an approximate 6-foot bottom width. Outside of the concrete-lined trickle channel, side slopes right of bank are 12:1 and left of bank are 4:1. Vegetation outside of the concrete-lined trickle channel typically consists of native and non-native grasses. This portion of the channel appears to be in good condition.

Between Steele Street and the Eastlake Reservoir 2 outlet, the reach is under jurisdiction of the City of Thornton. This portion of Brantner Gulch is carried within a pipe that generally has capacity for the 100-year storm event, except near the downstream end of the pipe.

Between the Eastlake Reservoir 2 outlet and Claude Court, the reach lies within the City of Thornton. This portion of the reach is naturally wide and flat as it is through Eastlake Reservoir 2. A clear flow path was not easily defined. The channel is densely vegetated with tall grasses, shrubs, bushes, and some trees.

Between Claude Court and Signal Ditch, the reach is under the jurisdiction of Northglenn. This portion of the reach is naturally wide and flat, as it flows through Eastlake Reservoir 1. A clear flow path was not easily defined. The channel is densely vegetated with tall grasses, shrubs, bushes, and some trees.

Between Signal Ditch and Washington Street, the reach is under the jurisdiction of the City of Thornton. This portion of the reach is engineered with 4:1 side slopes. The channel is densely vegetated with tall grasses, shrubs, bushes, and some trees. This portion of the channel appears to be in good condition.

Ohio Lake Overflow

Existing Channel Conditions

This reach consists of a 2,300-foot spill path that conveys flows in the 100-year even that cannot be contained in the outlet structure of Ohio Lake, upstream of Washington Center Parkway. See “Spill Modeling Approach” in Section 4.1. The reach travels across Washington Center Parkway and along an ill-defined swale in between two developments, Karl’s Farm and Red Hawk Ranch. Flows then potentially split and travel along one of two concrete pans, which are parallel to each other, and run along Irma Drive until entering back into Brantner Gulch. The reach is located in City of Thornton and Northglenn.

Eastlake 2 Overflow

Existing Channel Conditions

This reach consists of a 1,440-foot spill flow path that carries the 500-year overflow that cannot be conveyed by the pipe downstream of Eastlake Reservoir 2. See "Spill Modeling Approach" In Section 4.1. The reach is approximately 1,400 feet long at a 1.9% slope. It flows through residential streets and into 124th Avenue. Downstream of 124th Avenue, the water flows north back into Brantner Gulch at Eastlake Reservoir 3. The reach is located in the City of Thornton.

Lakeview Tributary

Existing Channel Conditions

Lakeview Tributary is a vegetated channel with an average slope of 0.8% stretching approximately 1.3 miles. Bound between the junction with Brantner Gulch and Summit Grove Parkway, the reach lies within the jurisdiction of the City of Thornton.

Multiple on-line detention basins are located along the reach. The channel was generally preserved during development, with the exceptions of the detention basins, crossings, and multiple grade control structures. The channel is typically trapezoidal with dense vegetation defining areas of low flow. Vegetation outside of the low flow channel typically consists of native and non-native grasses. Vegetation within the low flow channel consists of tall grasses, shrubs, bushes, and some trees. This reach appears to be in good condition, with the exception of the confluence with Brantner Gulch. The alignment of this confluence is entrenched and not ideal.

Plains Tributary

Existing Channel Conditions

Plains Tributary is a vegetated channel with an average slope of 1% stretching approximately 1.5 miles. The reach lies between the confluence with Brantner Gulch and Holly Street, within the City of Thornton.

The channel is engineered with multiple grade control structures. An on-line detention basin is located north, upstream, of 128th Avenue. The channel is typically trapezoidal with dense vegetation defining areas of low flow. Riprap is present in some areas, mostly at the grade control structures. Vegetation outside of the low flow channel typically consists of native and non-native grasses. Vegetation within the low flow channel consists of tall grasses, shrubs, bushes, and some trees. This reach appears to be in good condition, with the exception of the confluence with Brantner Gulch. Flows spread out at the downstream end and spill over a vertical bank into Brantner Gulch.

Horizons Tributary – Reach 1

Existing Channel Conditions

Horizons Tributary – Reach 1 is a vegetated channel with an average slope of 0.6% stretching approximately 0.9 miles. Bound between the junction with Brantner Gulch and the junction with Pheasants Run Tributary, the reach lies within the jurisdiction of the City of Thornton.

During development, it appears that the channel was generally preserved, with the addition of multiple grade control structures and crossings. Several of these grade control structures have become exposed and have deteriorated over time, developing holes where water can pass through the structure. Additionally, scour holes have developed downstream of these structures, but the signs of instability are isolated to these areas. The channel contains dense vegetation in areas of low flow. Vegetation outside of the low flow channel typically consists of native and non-native grasses. Vegetation within the low flow channel consists of tall grasses, shrubs, bushes, and some trees. This reach appears to be in good condition, with the exception of the confluence with Brantner Gulch. Flows spread out at the downstream end and spill over a vertical bank into Brantner Gulch.

Horizons Tributary – Reach 2

Existing Channel Conditions

Horizons Tributary – Reach 2 is a vegetated channel with an average slope of 1.5% stretching approximately 1.9 miles. Bound between the junction with Pheasants Run Tributary and Northbrook Park, the reach lies within the jurisdiction of the City of Thornton.

During development, the channel was generally preserved, with the addition of multiple grade control structures and pedestrian crossings. It contains dense vegetation in areas of low flow. Vegetation outside of the low flow channel typically consists of native and non-native grasses. Vegetation within the low flow channel consists of tall grasses, shrubs, bushes, and some trees. This reach appears to be in good condition.

Quails Way Tributary

Existing Channel Conditions

An approximate 1,000-foot reach of Quails Way Tributary in the area of 136th Avenue is included in the MDP portion of the project. The reach has an average slope of 2.7%. The channel in this reach has been preserved, with the exception of the 136th Avenue culvert crossing. The channel contains dense vegetation in the low flow channel, consisting of native and non-native grasses, shrubs, and some trees. The reach appears to be in good condition.

Pheasants Run Tributary

Existing Channel Conditions

Pheasants Run Tributary is a vegetated channel with an average slope of 1.7% stretching approximately 1 mile. Bound between the junction with Horizons Tributary and East 136th Avenue, the reach lies within the jurisdiction of the City of Thornton.

The channel was generally preserved during development, with the exception of the reach between Quebec Street and 136th Avenue, which was undergoing modification at the time of this study. The channel contains dense vegetation defining areas of low flow and concrete check structures. Vegetation outside of the low flow channel typically consists of native and non-native grasses. Vegetation within the low flow channel consists of tall grasses, shrubs, bushes, and some trees. This reach appears to be in good condition.

Fairgrounds Tributary

Existing Channel Conditions

Fairgrounds Tributary is a primarily vegetated channel with an average slope of 1.4% stretching approximately 1.5 miles. Bound between Riverdale Road and Quebec Street, the reach lies within the jurisdiction of the City of Thornton.

Portions of the channel were modified when the surrounding area developed and contain multiple grade control structures. The channel is typically trapezoidal with dense vegetation defining areas of low flow. Vegetation outside of the low flow channel typically consists of native and non-native grasses. Vegetation within the low flow channel consists of tall grasses, shrubs, and bushes. This reach appears to be in good condition with the exception of the confluence with Brantner Gulch. Flows spread out at the downstream end and spill over a vertical bank into Brantner Gulch.

South Platte River South Tributary 6 Downstream

Existing Channel Conditions

South Platte River South Tributary 6 Downstream is located between the confluence with the South Platter River North Tributary 7 and upstream of Yosemite Street, within the City of Thornton and Adams County. The channel extends upstream of Yosemite in the Timberleaf development. The overall reach is approximately 1.6 miles long at an average slope of 1.6%.

The drainageway is in storm sewer that parallels Yosemite Street on the east side and is designed for the 100-year storm event until it discharges into the Riverdale Dunes Golf Course. It flows through the golf course and the Adams County Fairgrounds. The drainageway/flow path is not well-defined. It is in good condition, as it is maintained by the golf course.

South Platte River North Tributary 7

Existing Channel Conditions

The South Platte River North Tributary 7 reach originates one half mile east of Quebec Street, north of 136th Avenue, flows southeast to Riverdale Road and then through the Riverdale Dunes Golf Course until it joins South Platte River South Tributary 6. The overall reach is approximately 1.8 miles long at an average slope of 1.7%. Upstream of Riverdale Road, the channel exists in a generally natural state other than road crossings. Vegetation within the channel corridor consists mainly of grasses and shrubs with a couple of trees. The reach appears to be in good condition. It is located within Adams County.

South Platte River North Tributary 7 Downstream

Existing Channel Conditions

South Platte River North Tributary 7 Downstream is primarily routed through the Fishing is Fun Pond. Bound between the South Platte River and the confluence of South Platter River South Tributary 6 and North Tributary 7, the reach lies within the jurisdiction of Adams County.

Regional Park

Existing Channel Conditions

The Regional Park area flows in multiple drainage paths northeast to southwest in defined drainage paths until it reaches East 136th Avenue and Riverdale Road, where there are no existing crossings. The western drainage will overtop East 136th Avenue and flow into the South Platte River North Tributary 7 drainage. The eastern drainage path will overtop Riverdale Road and continue flowing to the east toward the South Platte River with no defined drainage path. The flows downstream of the roadways will be intercepted by the Brantner Ditch in existing conditions. The reach lies within the jurisdiction of Adams County.

Brantner 5

Surveyed Identifier	Street Name	Existing Structure	Condition
1	Washington Center Parkway	Outlet structure and (1) 10-foot (S) x 5-foot (R) RCBC	Dense vegetation in channel bottom
2	Dirt Path	(1) 24-inch CPP	Dense vegetation in channel bottom. Culvert is clear of debris
3	Claude Ct	(2) 10-foot (S) x 4-foot (R) RCBC	Good
4	Railroad	(3) 16-foot (S) x 8-foot (R) RCBC	Good
5	Bike Path	(1) 48-inch CPP	Possible blockage
6	Bike Path	Outlet structure and (1) 60-inch RCP	Good
10	124th Ave	(1) 60-inch RCP	Good
11	Bike Path	Outlet structure and (1) 36-inch RCP	Good
12	Colorado Boulevard	(1) 8-foot (S) x 7-foot (R) RCBC	Good
13	Pedestrian Crossing	100-foot Span Bridge	Good
14	Pipe Aerial Crossing	Lateral crossing of 6" fiber optic conduit	Heavily eroded vertical banks
15	Pedestrian Crossing	(1) 100-foot Span Bridge	Good
16	Pedestrian Crossing	(1) 100-foot Span Bridge	Good
17	Holly Street	(1) 24-foot (S) x 16.6-foot (R) Conspan Arch Culvert	Good
18	Pedestrian Crossing	(1) 75-foot Span Bridge	Good

Brantner 3

Surveyed Identifier	Street Name	Existing Structure	Condition
19	Quebec Street	(2) 22-foot (S) x 12-foot (R) RCBC	Bike Path filled with debris
1B	Pedestrian Crossing	(1) 78-foot Span Bridge	Good
20	E 128th Avenue	(1) 42-inch RCP and (4) 48-inch overflow RCPs	Dense vegetation in channel bottom. Culvert is blocked by vegetation.

Brantner 1

Surveyed Identifier	Street Name	Existing Structure	Condition
21	Riverdale Road	(3) 16-foot (S) x 12-foot (R) RCBC partially filled in	Outer boxes filled with vegetation
22	Golf Cart Path	(1) 14.9-foot Span Bridge	Good
23	Lateral Pipe	(1) 15-inch Lateral CMP Aerial Crossing	Lateral pipe crossing
24	Golf Cart Path	(1) 23.2-foot Span Bridge	Good
25	Golf Cart Path	(1) 14.75-foot Span Bridge	Good
26	Golf Cart Path	(1) 17.8-foot Span Bridge	Good
27	Golf Cart Path	(1) 14.6-foot Span Bridge	Good
28	Golf Cart Path	(1) 15-foot Span Bridge	Good
29	Golf Cart Path	(1) 18-foot Span Bridge	Good
30	Golf Cart Path	(1) 33.3-foot Span Bridge	Vegetation in channel bottom.
31	Golf Cart Path	(1) 24.5-foot Span Bridge	Vegetation in channel bottom.
32	Fairgrounds Road	(1) 18-foot (S) x 4.7-foot (R) RCBC	Vegetation in channel bottom.
33	Lateral Pipe (Fairgrounds Rd & Golf Course Way)	12-inch Lateral Aerial Pipe Crossing	Lateral pipe crossing
34	Golf Cart Path	(1) 23.3-foot Span Bridge	Good
35	Pedestrian Trail	(1) 77.65-foot Span Bridge	Good

Lakeview Tributary

Surveyed Identifier	Street Name	Existing Structure	Condition
36	Detention Basin Outlet	Outlet structure - (1) 21-inch Opening in Metal Plate	Dense vegetation in front of pipe
37	Pedestrian Crossing	(1) 46-foot Span Bridge	Good
38	Pedestrian Crossing	(1) 31.3-foot Span Bridge	Dense vegetation in channel bottom
39	Summit Grove Parkway	Outlet structure - (1) 36-inch RCP	Good
40	Sidewalk	(1) 24-inch RCP	Good
41	Trail	(1) 18-inch CMP	Good
42	Holly Street	Outlet structure and (1) 18-inch RCP and (3) 24-inch RCP	Good
43	128th Avenue	(3) 54-inch RCP and (1) 10-foot (S) x 10-foot (R) RCBC Pedestrian Underpass	Dense vegetation in channel bottom
44	Sidewalk	Outlet structure and (1) 15-inch RCP	Good
45	Pedestrian Crossing	(2) 10-foot (S) x 3.15-foot (R) RCBC	Dense vegetation in channel bottom

Plains Tributary

Surveyed Identifier	Street Name	Existing Structure	Condition
50	132nd Avenue	(1) 10-foot (S) x 6-foot (R) RCBC	Good
51	E 130th Avenue	(2) 11-foot (S) x 4-foot (R) RCBC	Good
52	Sidewalk	(2) 18-inch RCP	Dense vegetation in channel bottom.
53	Access	(1) 18-inch RCP	Good
54	Sidewalk	Outlet structure and (1) 18-in RCP	Good
55	E 128th Avenue	(2) 54-inch RCP	Good
56	E 128th Avenue	(1) 10-foot (S) x 10-foot (R) RCBC	Good

Horizons Trib 1

Surveyed Identifier	Street Name	Existing Structure	Condition
74	Detention Basin Outlet	(1) 14-foot (S) x 5-foot (R) RCBC	Good
75	Tamarac Street	(4) 14-foot (S) x 6-foot (R) RCP	Dense vegetation in channel bottom
76	Valentia Street	(2) 14-foot (S) x 7-foot (R) RCP	Good
77	Pedestrian Trail	(2) 48-inch RCP	Good

Horizons Trib 2

Surveyed Identifier	Street Name	Existing Structure	Condition
57	Detention Basin Outlet	Outlet structure with 66-inch RCP	Good
58	Holly Street	(1) 48-inch RCP	Good
59	E 136th Avenue	(1) 84-inch RCP	Good
60	E 136th Avenue	(1) 10-foot (S) x 10-foot (R)	Good
63	Marshall Dam	Outlet Structure and (1) 72-inch RCP	Good
64	Pedestrian Sidewalk	(2) 8-foot (S) x 5-foot (R) RCBC	Dense vegetation in channel bottom.
69	Pedestrian Sidewalk	(4) 7-foot (S) x 3-foot (R) RCBC	Good
70	Pedestrian Bridge	(1) 49-foot Span Bridge	Good
71	Quebec Street	(1) 14-foot (S) x 14-foot (R) and (1) 10-foot (S) x 10-foot (R) RCBC	Good

Quails Way Tributary

Surveyed Identifier	Street Name	Existing Structure	Condition
65	E 136th Avenue	(1) 42-inch RCP	Good

Pheasants Run Trail

Surveyed Identifier	Street Name	Existing Structure	Condition
72	E 135th Avenue	(1) 54-inch RCP	Trash Rack has come loose.
73	Quebec Street	(1) 54-inch RCP	Good

Fairgrounds Tributary

Surveyed Identifier	Street Name	Existing Structure	Condition
78	E 138th Avenue	(1) 36-in RCP	Good
79	Spillway	Outlet structure and (1) 8-inch PVC	Dense vegetation
80	136th Avenue	(1) 72-inch RCP	Good
81	135th Avenue/Spruce Street	(2) 60-inch RCP	Good
82	Uinta Street	Outlet structure and (1) 36-in RCP	Good
T1	Pedestrian Trail	(1) 10-foot (S) x 2-foot (R) RCBC	Good
83	E. 130th Circle	(2) 54-inch RCP	Good
84	Detention Basin Berm	Outlet structure with (2) 54-in RCP	Good
85	E 130th Avenue	(2) 66-inch RCP	Good
86	Sidewalk	(1) 2.5-foot (S) x 1.5-foot (R) HERCP	Good

SPR South Tributary 6

Surveyed Identifier	Street Name	Existing Structure	Condition
87	E 136th Avenue	Outlet structure with 24-inch RCP	Good

SPR South Tributary 6 DS

Surveyed Identifier	Street Name	Existing Structure	Condition
88	Yosemite Street	(1) 6-foot (S) x 4-foot (R) RCBC	Good
89	Yosemite Street	(1) 60-inch (S) x 36-inch (R) HERCP	Dense vegetation in channel bottoms.
90	Yosemite Street	(1) 36-inch RCP	Trash rack blocked with debris.
91	Riverdale Road	(1) 8-foot (S) x 4-foot (R) RCBC	Good

SPR North Tributary 7

Surveyed Identifier	Street Name	Existing Structure	Condition
92	Yosemite Street	(1) 72-inch CMP	Good
93	E 136th Avenue	(1) 12-inch RCP	Good
94	Riverdale Road	(1) 48-inch CMP	Poor - squashed. Dense vegetation in channel

PROJECT: 018-2897	
DRAWN BY: ELB	
DATE: 3/10/2023	

MILE HIGH FLOOD DISTRICT,
CITY OF THORNTON, NORTHGLENN, & ADAMS COUNTY

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FIGURE
2

Table 3 - Major Structure Crossing Inventory

Reach	Str. Survey No.	Station	Jurisdiction	Street Name	Street Classification	Existing Structure	Culvert Length/ Bridge Width (ft)	Source	Condition	Notes
Brantner 5	1	41162	Thornton	Washington Center Parkway	Local	Outlet structure and (1) 10-foot (S) x 5-foot (R) RCBC	160.82	COT Survey/MHFD Survey	Dense vegetation in channel bottom	Detention basin outlet not modeled - used set WSE used for detention basin outlet
	2	37998	Northglenn	Dirt Path	Trail	(1) 24-inch CPP	9.9	MHFD Survey 1	Dense vegetation in channel bottom. Culvert is clear of debris	Not modeled - assumed to be blocked
	3	36861	Northglenn	Claude Ct	Local	(2) 10-foot (S) x 4-foot (R) RCBC	74.56	MHFD Survey 1	Good	
	4	36698	Northglenn	Railroad	Railroad	(3) 16-foot (S) x 8-foot (R) RCBC	39.97	MHFD Survey 1	Good	
	5	36455	Thornton	Bike Path	Trail	(1) 48-inch CPP	61.32	MHFD Survey 1	Possible blockage	
	6	34346	Thornton	Bike Path	Trail	Outlet structure and (1) 60-inch RCP	2233.8	MHFD Survey 1 and As-Built Information: Eastlake Reservoir No. 2	Good	Detention basin outlet not modeled - used set WSE used for detention basin outlet. Storm drain capacity in StormCAD.
	10	31738	Thornton	124th Ave	Local	(1) 60-inch RCP	200.5	MHFD Survey 1	Good	
	11	30445	Thornton	Bike Path	Trail	Outlet structure and (1) 36-inch RCP	2181	MHFD Survey 1 and As-Built Information: Eastlake Reservoir No. 3 Dam and Downstream Improvements	Good	Detention basin outlet not modeled - used set WSE used for detention basin outlet. Storm drain capacity in StormCAD.
	12	27585	Thornton	Colorado Boulevard	Principal Arterial	(1) 8-foot (S) x 7-foot (R) RCBC	168.33	MHFD Survey 1	Good	
	13	26493	Thornton	Pedestrian Crossing	Trail	100-foot Span Bridge	9.86	MHFD Survey 1	Good	
	14	25221	Thornton	Pipe Aerial Crossing	Park	Lateral crossing of 6" fiber optic conduit	0.55	MHFD Survey 1	Heavily eroded vertical banks	Modeled as a bridge
	15	24107	Thornton	Pedestrian Crossing	Trail	(1) 100-foot Span Bridge	10.24	MHFD Survey 1	Good	
	16	23269	Thornton	Pedestrian Crossing	Trail	(1) 100-foot Span Bridge	16.5	MHFD Survey 1	Good	
	17	21984	Adams County/ Thornton	Holly Street	Collector	(1) 24-foot (S) x 16.6-foot (R) Conspan Arch Culvert	89.61	MHFD Survey 1	Good	
	18	21626	Adams County	Pedestrian Crossing	Trail	(1) 75-foot Span Bridge	13.24	MHFD Survey 1	Good	
Brantner 3	19	15430	Thornton	Quebec Street	Local	(2) 22-foot (S) x 12-foot (R) RCBC	50.38	MHFD Survey 1	Bike Path filled with debris	Right cell has a pedestrian underpass with an elevated trail
	1B	12505	Thornton	Pedestrian Crossing	Trail	(1) 78-foot Span Bridge	11.79	MHFD Survey 2	Good	
	20	9639	Adams County/ Thornton	E 128th Avenue	Principal Arterial	(1) 42-inch RCP and (4) 48-inch overflow RCPs	73.79/104	MHFD Survey 1 and As-Built Information: Brantner Gulch Drainage Improvements at 128th Avenue (COT Project Number 19-243)	Dense vegetation in channel bottom. Culvert is blocked be vegetation.	

Table 3 - Major Structure Crossing Inventory

Reach	Str. Survey No.	Station	Jurisdiction	Street Name	Street Classification	Existing Structure	Culvert Length/ Bridge Width (ft)	Source	Condition	Notes
Brantner 1	21	7084	Adams County/ Thornton	Riverdale Road	Collector	(3) 16-foot (S) x 12-foot (R) RCBC partially filled in	65.41	MHFD survey 1 and "Riverdale Road Crossings on Lower Brantner Gulch" As-Builts	Outer boxes filled with vegetation	
	22	6673	Adams County	Golf Cart Path	Bridge	(1) 14.9-foot Span Bridge	9.09	MHFD Survey 1	Good	
	23	6564	Adams County	Lateral Pipe	Golf Course	(1) 15-inch Lateral CMP Aerial Crossing	1.25	MHFD Survey 1	Lateral pipe crossing	Modeled as a bridge
	24	6468	Adams County	Golf Cart Path	Bridge	(1) 23.2-foot Span Bridge	13.1	MHFD Survey 1	Good	
	25	6110	Adams County	Golf Cart Path	Bridge	(1) 14.75-foot Span Bridge	9.11	MHFD Survey 1	Good	
	26	5752	Adams County	Golf Cart Path	Bridge	(1) 17.8-foot Span Bridge	9.12	MHFD Survey 1	Good	
	27	5527	Adams County	Golf Cart Path	Bridge	(1) 14.6-foot Span Bridge	9.34	MHFD Survey 1	Good	
	28	5252	Adams County	Golf Cart Path	Bridge	(1) 15-foot Span Bridge	17.1	MHFD Survey 1	Good	
	29	5035	Adams County	Golf Cart Path	Bridge	(1) 18-foot Span Bridge	17.5	MHFD Survey 1	Good	
	30	4618	Adams County	Golf Cart Path	Bridge	(1) 33.3-foot Span Bridge	23.7	MHFD Survey 1	Vegetation in channel bottom.	
	31	4446	Adams County	Golf Cart Path	Bridge	(1) 24.5-foot Span Bridge	4.69	MHFD Survey 1	Vegetation in channel bottom.	
	32	4103	Adams County	Park Blvd	Local	(1) 18-foot (S) x 4.7-foot (R) RCBC	50	MHFD Survey 1	Vegetation in channel bottom.	
	33	4023	Adams County	Lateral Pipe (Park Blvd & Golf Course Way)	Private	12-inch Lateral Aerial Pipe Crossing	1	MHFD Survey 1	Lateral pipe crossing	Modeled as a bridge
	34	3932	Adams County	Golf Cart Path	Bridge	(1) 23.3-foot Span Bridge	9.9	MHFD Survey 1	Good	
	35	1973	Adams County	Pedestrian Trail	Trail	(1) 77.65-foot Span Bridge	10	MHFD Survey 1	Good	
Lakeview Tributary	36	---	Thornton	Detention Basin Outlet	N/A	Outlet structure - (1) 21-inch Opening in Metal Plate	0.55	MHFD Survey 1	Dense vegetation in front of pipe	Upstream of model limits
	37	---	Thornton	Pedestrian Crossing	Trail	(1) 46-foot Span Bridge	9.5	MHFD Survey 1	Good	Upstream of model limits
	38	---	Thornton	Pedestrian Crossing	Trail	(1) 31.3-foot Span Bridge	9.68	MHFD Survey 1	Dense vegetation in channel bottom	Upstream of model limits
	39	---	Thornton	Summit Grove Pkwy	Local	Outlet structure - (1) 36-inch RCP	205.58	MHFD Survey 1	Good	Upstream of model limits

Table 3 - Major Structure Crossing Inventory

Reach	Str. Survey No.	Station	Jurisdiction	Street Name	Street Classification	Existing Structure	Culvert Length/ Bridge Width (ft)	Source	Condition	Notes
	40	---	Thornton	Sidewalk	Trail	(1) 24-inch RCP	20.98	MHFD Survey 1	Good	Upstream of model limits
	41	---	Thornton	Trail	Trail	(1) 18-inch CMP	17.38	MHFD Survey 1	Good	Upstream of model limits
	42	54978	Thornton	Holly Street	Collector	Outlet structure and (1) 18-inch RCP and (3) 24-inch RCP	202.92	MHFD Survey 1	Good	Detention basin outlet not modeled - used set WSE used for detention basin outlet
	43	53761	Thornton	128th Avenue	Principal Arterial	(3) 54-inch RCP	426.52	MHFD Survey 1	Dense vegetation in channel bottom	
	43	53761	Thornton	128th Avenue	Principal Arterial	(3) 54-inch RCP and (1) 10-foot (S) x 10-foot (R) RCBC Pedestrian Underpass	234.72	MHFD Survey 1	Good	
	44	52430	Thornton	Sidewalk	Trail	Outlet structure and (1) 15-inch RCP	9.25	MHFD Survey 1	Good	Detention basin outlet not modeled - used set WSE used for detention basin outlet
	45	52396	Thornton	Pedestrian Crossing	Trail	(2) 10-foot (S) x 3.15-foot (R) RCBC	27.91	MHFD Survey 1	Dense vegetation in channel bottom	
Plains Tributary	50	67042	Thornton	132nd Avenue	Local	(1) 10-foot (S) x 6-foot (R) RCBC	71.64	MHFD Survey 1	Good	
	51	65602	Thornton	E 130th Avenue	Local	(2) 11-foot (S) x 4-foot (R) RCBC	89.74	MHFD Survey 1	Good	
	52	65150	Thornton	Sidewalk	Trail	(2) 18-inch RCP	23.80	MHFD Survey 1	Dense vegetation in channel bottom.	Not modeled - assumed to be blocked
	53	64826	Thornton	Access	Access	(1) 18-inch RCP	38.61	MHFD Survey 1	Good	Not modeled - assumed to be blocked
	54	64301	Thornton	Sidewalk	Trail	Outlet structure and (1) 18-in RCP	70.74	MHFD Survey 1	Good	Detention basin outlet not modeled - used set WSE used for detention basin outlet
	55	63282	Thornton	E 128th Avenue	Collector	(2) 54-inch RCP	250.97	MHFD Survey 1	Good	
	56	63282	Thornton	E 128th Avenue	Collector	(1) 10-foot (S) x 10-foot (R) RCBC	141.78	MHFD Survey 1	Good	Pedestrian underpass modeled with outside calculations
Horizons Tributary 1	74	74217	Thornton	Detention Basin Outlet	Trail	(1) 14-foot (S) x 5-foot (R) RCBC	17.11	MHFD Survey 1	Good	Detention basin outlet not modeled - used set WSE used for detention basin outlet
	75	73432	Thornton	Tamarac Street	Local	(4) 14-foot (S) x 6-foot (R) RCP	70.59	MHFD Survey 1	Dense vegetation in channel bottom	
	76	72227	Thornton	Valentia Street	Local	(2) 14-foot (S) x 7-foot (R) RCP	65.85	MHFD Survey 1	Good	
	77	70576	Thornton	Pedestrian Trail	Trail	(2) 48-inch RCP	36	MHFD Survey 1	Good	
Horizons Tributary 2	57	---	Thornton	Detention Basin Outlet	Access	Outlet structure with 66-inch RCP	528.94	MHFD Survey 1	Good	Upstream of model limits
	58	83712	Thornton	Holly Street	Collector	(1) 48-inch RCP	319.5	MHFD Survey 1	Good	
	59	82763	Thornton	E 136th Avenue	Principal Arterial	(1) 84-inch RCP	350.26	MHFD Survey 1	Good	

Table 3 - Major Structure Crossing Inventory

Reach	Str. Survey No.	Station	Jurisdiction	Street Name	Street Classification	Existing Structure	Culvert Length/ Bridge Width (ft)	Source	Condition	Notes
	60	82763	Thornton	E 136th Avenue	Principal Arterial	(1) 10-foot (S) x 10-foot (R)	209.84	MHFD Survey 1	Good	Pedestrian underpass modeled with outside calculations
	63	80570	Thornton	Marshall Dam	Dam	Outlet Structure and (1) 72-inch RCP	132.78	MHFD Survey 1	Good	Detention basin outlet not modeled - used set WSE used for detention basin outlet
	64	79624	Thornton	Pedestrian Sidewalk	Trail	(2) 8-foot (S) x 5-foot (R) RCBC	50	As-builts from Horizon Creek Culvert Improvements	Dense vegetation in channel bottom.	Surveyed structure was replaced - used as-builts for model
	69	78723	Thornton	Pedestrian Sidewalk	Trail	(4) 7-foot (S) x 3-foot (R) RCBC	111	As-builts from Horizon Creek Culvert Improvements	Good	Surveyed structure was replaced - used as-builts for model
	70	77208	Thornton	Pedestrian Bridge	Trail	(1) 49-foot Span Bridge	9.7	MHFD Survey 1	Good	
	71	76412	Thornton	Quebec Street	Principal Arterial	(1) 14-foot (S) x 14-foot (R), (1) 10-foot (S) x 10-foot (R) RCBC	155	MHFD Survey 1	Good	
Quails Way Tributary	65	85738	Thornton	E 136th Avenue	Principal Arterial	(1) 42-inch RCP	224.28	MHFD Survey 1	Good	
Pheasants Run Trail	72	---	Thornton	E 135th Avenue	Local	(1) 54-inch RCP	317.53	MHFD Survey 1	Trash Rack has come loose.	
	73	---	Thornton	Quebec Street	Collector	(1) 54-inch RCP	412.5	MHFD Survey 1	Good	
Fairgrounds Tributary	78	---	Thornton	E 138th Avenue	Local	(1) 36-in RCP	70.89	MHFD Survey 1	Good	Upstream of model limits
	79	97217	Thornton	Spillway	Spillway	Outlet structure and (1) 8-inch PVC	61.63	MHFD Survey 1	Dense vegetation	Detention basin not modeled - assume outlet is clogged
	80	97131	Thornton	136th Avenue	Principal Arterial	(1) 72-inch RCP	134.35	MHFD Survey 1	Good	
	81	96229	Thornton	135th Avenue/Spruce Street	Local	(2) 60-inch RCP	79.56/85.66	MHFD Survey 1	Good	
	82	94494	Thornton	Uinta Street	Local	Outlet structure and (1) 36-in RCP	181.92	MHFD Survey 1	Good	Detention basin outlet not modeled - used set WSE used for detention basin outlet
	T1	93181	Thornton	Pedestrian Trail	Trail	(1) 10-foot (S) x 2-foot (R) RCBC	15.1	Timberleaf Filing No. 1 As-Built Plan	Good	
	83	92674	Thornton	E. 130th Circle	Local	(2) 54-inch RCP	72.85	MHFD Survey 1	Good	
	84	92025	Thornton	Detention Basin Berm	Access	Outlet structure with (2) 54-in RCP	36	MHFD Survey 1	Good	Detention basin not modeled - assume outlet is clogged
	85	91540	Thornton	E 130th Avenue	Local	(2) 66-inch RCP	153	MHFD Survey 1	Good	
	86	90570	Thornton	Sidewalk	Trail	(1) 2.5-foot (S) x 1.5-foot (R) HERCP	22.6	MHFD Survey 1	Good	Not modeled - assumed to be blocked

Table 3 - Major Structure Crossing Inventory

Reach	Str. Survey No.	Station	Jurisdiction	Street Name	Street Classification	Existing Structure	Culvert Length/ Bridge Width (ft)	Source	Condition	Notes
SPR South Tributary 6	87	---	Adams County/ Thornton	E 136th Avenue	Collector	Outlet structure with 24-inch RCP	433.13	MHFD Survey 1	Good	Upstream of model limits
SPR South Tributary 6 Downstream	88	108207	Thornton	Yosemite Street	Section Line Arterial	(1) 6-foot (S) x 4-foot (R) RCBC	964.00	MHFD Survey 1	Good	
	89	---	Adams County	Yosemite Street	Section Line Arterial	(1) 60-inch (S) x 36-inch (R) HERCP	52.24	MHFD Survey 1	Dense vegetation in channel bottoms.	Lateral inflow pipe into detention basin. Outside of model limits
	90	---	Adams County	Yosemite Street	Section Line Arterial	(1) 36-inch RCP		MHFD Survey 1	Trash rack blocked with debris.	Low flow pipe diversion from South Platte Tributary 6 to Brantner Gulch at Riverdale Road. Incorporated into hydrology, not included in HEC-RAS model
	91	107047	Adams County	Riverdale Road	Collector	(1) 8-foot (S) x 4-foot (R) RCBC	106.56	MHFD Survey 1	Good	
SPR North Tributary 7	92	120636	Adams County/ Thornton	Yosemite Street	Section Line Arterial	(1) 72-inch CMP	127.15	MHFD Survey 1	Good	
	93	119838	Adams County	E 136th Avenue	Collector	(1) 12-inch RCP	55.48	MHFD Survey 1	Good	Not modeled - assumed to be blocked
	94	117273	Adams County	Riverdale Road	Collector	(1) 48-inch CMP	123.94	MHFD Survey 1	Poor - squashed. Dense vegetation in channel	

2.4 Flood History

The Brantner Gulch drainageway has a FEMA-designated Zone A floodplain from the South Platte River to west of Holly Street, where it has a Zone AE floodplain with a floodway west to Colorado Boulevard and a Zone A floodplain west a few blocks. The Horizon and Pheasants Run tributaries have FEMA-designated Zone A floodplains. South Platte River South Tributary 6 has a Zone A floodplain extending from the South Platte River to approximately 750 feet north of the intersection of Yosemite Street and Riverdale Road, along Yosemite Street. South Platte River North Tributary 7 has a Zone A floodplain extending from the South Platte River to a point approximately 1000 feet northwest of the intersection of Yosemite Street and E 136th Avenue. The South Platte River floodplain extends into the study area with a Zone AE floodplain and a floodway. The FEMA FIRM panels are included in Appendix C. Additional best available floodplains are available on all the named tributaries in the study area, based on the 1983 FHAD.

2.5 Environmental Assessment

Wetland and riparian zones within the Brantner Gulch, South Platte River South Tributary 6, South Platte River North Tributary 7 watersheds primarily occur in riverine areas, freshwater ponds, or lakes. Areas where there is increased urbanization, or a concrete channel will be less likely to have wetland qualities. Areas directly alongside non-vertical banks of Brantner Gulch or any of its tributaries are likely to qualify as a wetland. This information was acquired through the U.S. Fish & Wildlife Service's National Wetlands Inventory. See Appendix D for the delineation of wetlands in the study area.

3. HYDROLOGIC ANALYSIS

3.1 Overview

Hydrology was developed for the baseline condition using existing infrastructure, for the historic (undeveloped), 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 2.0.0, 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 2005 MDP and 2010 Hydrology Update. The hydrology comparison is detailed in Section 3.6 and shown in Tables 8 and 9.

3.2 Design Rainfall

The one-hour and 6-hour rainfall depths from the National Oceanic and Atmospheric Administration (NOAA) Atlas 14 were input into CUHP to model the watershed hydrology for each storm event and are shown in Table 4. The NOAA Atlas 14 rainfall information is included in Appendix B. Area adjustments were used for the 2-, 5-, and 10-year storm events with tributary drainage basins greater than 5 square miles in the Brantner Gulch watershed. Area correction values are included in Table 5. No area adjustment factors were necessary for the 25-, 50-, 100-, and 500-year storm events. The South Platte River tributary, Regional Park, and direct flow area watersheds did not require any area adjustment factors. Tables of the unadjusted and adjusted rainfall distributions for each storm event are included as Tables B-1A through Tables B-1C, in Appendix B.

Table 4 - One-Hour Rainfall (Inches)

Duration	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
1-Hour	0.829	1.11	1.38	1.79	2.15	2.54	3.58
6-Hour	1.25	1.65	2.02	2.60	3.09	3.62	5.04

Table 5 - Depth Reduction Factors for Design Rainfall Distributions 2-, 5-, and 10-yr Design Rainfall

Time (minutes)	Correction Factor by Watershed Area in Square Miles		
	2	5	10
5	1	1	1
10	1	1	1
15	1	0.97	0.94
20	1	0.86	0.75
25	1	0.86	0.75
30	1	0.89	0.75
35	1	0.97	0.94
40	1	0.97	0.94
45-120	1	1	1

3.3 Subwatershed Characteristics

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

3.3.1 Subwatershed Delineation

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

The Brantner Gulch, South Platte River Tributary, Regional Park, and direct flow area watersheds were divided into 147 subwatersheds that were delineated based on the LiDAR mapping provided by MHFD (Section 1.4), various drainage studies, and as-built construction plans. Subwatershed boundaries reflect the major, 100-year, storm event conditions and do not include minor storm drain systems, typically designed for 5- or 10-year storm events. Major storm drain systems, including detention pond outlets, were included in the model. The subwatersheds range in size from 1.9 acres to 156.2 acres, with an average subwatershed size of 58.0 acres. Two subwatershed exceed the 130 acre limit. The watersheds could not be divided without resulting in undesirable subwatershed shapes.

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

3.3.2 Length, Distance to Centroid, Slope

The LiDAR data was used to determine subwatershed flow path lengths, distance to centroid values, and slopes. Flow paths were based on major drainage overland paths. Some storm drain systems that serve as detention basin outlets were modeled. The low flow diversion pipe from SPRN6 to Brantner Gulch was also modeled based on the rating curve from the design plans. Some private detention facilities were included in the model, as directed by the project sponsors, where the detention basins are on public property or in a drainage easement and have a tributary area greater than 130 acres. Where unmodeled detention basins were present, flow paths were determined based on the overflow path from the ponds, assuming the outlets would be clogged.

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

r = Length to Centroid / Total Length
(if $0.1 \le r < 0.3$, 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 the nature of the urbanized portion of the watershed. Flow paths were generally delineated following streets, which resulted in longer paths than a more direct, undeveloped path. The subwatersheds with questionable r values had reasonable unit discharges, as compared to similar subwatersheds.

The Brantner Gulch, South Platte River Tributaries, Regional Park, and direct flow area watersheds generally slope down toward the east and southeast. Subbasin flow path slopes ranged from 0.05% to 4.5 %, averaging at 1.69%. The lowest and highest watershed elevations are 4995 and 5425, respectively. Slopes were estimated using the weighted slope equation from the CUHP manual.

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

All but two of the slopes were below 4%. Subbasins S13 and RP03 had slopes above 4%, and 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*.

3.3.3 Watershed Imperviousness

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

- The NLCD 0% imperviousness value used for water was changed to 100%
- All 0% NLCD values that were not water were changed to 2%
- The database was developed in 2011. Aerial imagery from 2011 was compared to 2018 aerial imagery to determine areas in the watershed that developed after the database was compiled. These areas of post-2011 development were added into the existing conditions percent imperviousness calculations.
- Several developments were under construction at the time of this study. These areas of 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 watersheds is 32%. The existing percent impervious values for each subbasin are shown on Figure B-1 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 Urban Storm Drainage Criteria Manual (USDCM) Table 6-3 were used. The future land use areas are shown on Figure B-1 in Appendix B. The future land use designations and corresponding percent imperviousness values are shown in Table 6. The future percent imperviousness values were deemed appropriate by the project sponsors for master planning purposes, but do not replace zoning requirements for future development. Future development will be required to follow jurisdictional zoning requirements and associated percent imperviousness values. The overall future percent imperviousness of the watersheds was estimated to be 39%. The future percent impervious values for each subbasin are shown on Figure B-1 in Appendix B.

Table 6 – Land Uses and Corresponding Impervious Values

Land Use Designation from Corresponding Plan	Percent Imperviousness
Residential Low	30
Residential Estate	30
Residential Medium	45
Institutional	55
Mixed Use	75
Residential High	75
Urban Reserve	75
Urban Village	75
Commercial	95
Employment Center	95

3.3.4 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 0.05, which represents sloped roofs, and 0.1, which represents large paved areas, was used for residential areas. A value of 0.1, which represents flat roofs and large paved areas, was used for commercial, office, and industrial areas. A value of 0.4 for the pervious depression loss and 0.1 for the impervious depression loss was used in the historic conditions model.

3.3.5 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 Figure B-1, in Appendix B.

Table 7 - Horton's Equation Parameters

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

3.4 Detention

Pursuant to MHFD's policy to recognize only regional and publicly-owned facilities, all private detention basins, irrigation reservoirs, and inadvertent detention areas were generally not modeled, with some exceptions. While some detention ponds are privately owned, Thornton has maintenance easements over them, and several showed enough impact that they were accounted for in the baseline hydrology, as directed by the project sponsors. Detention basins to be included in the model were discussed during the kickoff meeting on September 24, 2018. This list was refined over email conversations ranging from the meeting through November 19, 2018. Minutes for this meeting can be found in Appendix A.

In total, 28 detention basins were modeled in the baseline hydrology. The detention basins were removed from the historic conditions model by converting them to junctions and converting the outlet links to dummy links.

Stage-storage-discharge information for the detention basins was developed using varying sources. The detention basin stage-storage and stage-discharge tables, including information on how the values were determined, are shown in Table B-2, in Appendix B. A summary of information used to develop the stage-storage-discharge curves is included below. Where needed, UD_Detention-v2.34 was used to calculate supplemental stage-discharge information.

1. The storage-discharge information from the 2005 MDP was used for Detention Basins 339, 340, 341, and 342.
2. The storage-discharge information from the 2005 MDP was used and extended to prevent the model from stacking storage for Detention Basins 349 and 353.
3. The stage-area-storage-discharge information from the 2010 Hydrology Update was used for Detention Basins F304, H303, H306, L302, L305, L306, L309, P303, P306, and P307.
4. The stage-area-storage-discharge information from the 2010 Hydrology Update was used and extended to prevent the model from stacking storage for Detention Basins H307 and L307.
5. Drainage reports, construction drawings, as-builts, and supplemental survey was used to determine stage-area-storage-discharge information for Detention Basins 318, 330, 346, 347, 352, 360, 365, H312, Q301, and S306.

3.5 Hydrograph Routing

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

Channel geometry was determined using the LiDAR mapping. For flows that are conveyed via streets, the street sections were models as trapezoidal sections with a 5-foot depth, 1-foot bottom width, and 20-foot horizontal to 1-foot vertical (20:1) side slopes. 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. Overflow elements are shown on Figure B-2A through B-2D, in Appendix B.

The Manning's n values for engineered conveyance elements, including pipe and street, were increased at least 25 percent in accordance with the USDCM. 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 0.01875 in the model. Channel section Manning's n values were set at 0.045 in the model. None of the streams provided more substantial attenuation, so USDCM Eq. 6-8 was not used to determine the Manning's n values.

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 Figure B-1 and a schematic of the model is shown on Figure B-2A through B-2D in Appendix B.

3.6 Previous Studies

The Brantner Gulch, SPRN 6, and SPRN 7 watersheds were previously studied in full, or in part, in the 1983 FHAD, 2005 MDP, and the 2010 Hydrology Update. The 2010 Hydrology Update included updated models for Brantner Gulch as well. The South Platte Tributaries 6 and 7 were included in the 1983 FHAD.

In order to help validate flows, a comparison of 100-year peak flows between this study and the 2005 MDP/2010 Hydrology Update is shown in Table 8. A comparison between the 1983 FHAD and this study is included in Table 9. Differences and similarities between these studies are noted below.

- The 2005 MDP used CUHPF95 and UDSWM2000. The 2010 Hydrology Update used CUHP2000 version 1.1 and UDSWM2000 version 1.4.6. This study used CUHP 2.0.0 and SWMM 5.1.013 for the baseline hydrology.

- The rainfall values used for the 2005 MDP and 2010 Hydrology Update were significantly higher than the NOAA Atlas 14 Point Precipitation Frequency Estimates used for this study. The previous studies' 100-year 1-hour point rainfall depth was 2.71 inches, while this study's 100-year 1-hour point rainfall depth was 2.54 inches. All studies used a 2-hour storm distribution.

- The composite future percent imperviousness of the previous studies was approximately 45%, which is slightly higher than this study's future percent imperviousness of 39%. Future percent impervious values for this study were developed using the National Land Cover Database, Thornton's future land use map, and manual updates described in Section 3.3, which could account for differences between the studies.

- The 1983 FHAD did not include detention basins. The 2005 MDP included 15 detention basins, including Mann-Nyholt Lake. The 2010 Hydrology Update included 22 detention basins, including Mann-Nyholt Lake. This study included 28 detention basins. Detention at Mann-Nyholt Lake was not included in this model.

In order to better compare the hydrology from this study to the previous studies and reconcile the differences to validate the hydrology results and determine if calibration was necessary, modifications were made to the future conditions model from this study. The modifications included using the old point rainfall values and removing the additional detention basins from the model, as shown in Tables 8 and 9. The percent difference in peak flows is reduced when these two parameters are modified.

Table 8 – Hydrology Reconciliation with 2005 MDP/2010 Hydrology Update

Reference Location	2010 Hydrology Update		2022 MDP/FHAD				2022 MDP/FHAD Modified Comparison Model		
	Design Point	Future 100-Year Peak Discharge (cfs)	Design Point	Peak Discharges (cfs) EX Q100	FTR Q100	% Diff (FTR Q100 to 2010 Update Q100)	Old Rainfall - 2010 Det	% Diff (Old Rainfall, 2010 Det to 2010 Update Q100)	% Diff unit discharge (cfs/ac)
Mann-Nyholt Lake	999	3851	101	4364	4599	19%	5729	49%	54%
Downstream of Fairgrounds Tributary Confluence/Riverdale Road	701	6139	103T	4569	4716	-23%	6041	-2%	-3%
Downstream of Plains Tributary Confluence/Quebec Street	706	4571	115T	3112	3164	-31%	4218	-8%	-9%
Downstream of Lakeview Tributary	710	3818	117T	2675	2705	-29%	3764	-1%	-7%
Holly Street	711	3167	119	2066	2097	-34%	2971	-6%	-9%
Colorado Boulevard	712	1829	135T	635	644	-65%	1292	-29%	-29%
Fairgrounds Tributary	849	444	F101	222	269	-39%	344	-23%	-24%
Horizons Tributary	836	1595	H101	909	948	-41%	1138	-29%	-27%
Quails Way Tributary	813	51	Q101O	96	96	88%	111	117%	-24%
Pheasants Run Tributary	825	522	R101	301	384	-26%	421	-19%	-20%
Plains Tributary	864	470	P101	307	316	-33%	348	-26%	-16%
Lakeview Tributary	882	655	L101	413	416	-37%	474	-28%	-28%

Table 9 – Hydrology Reconciliation 1983 FHAD

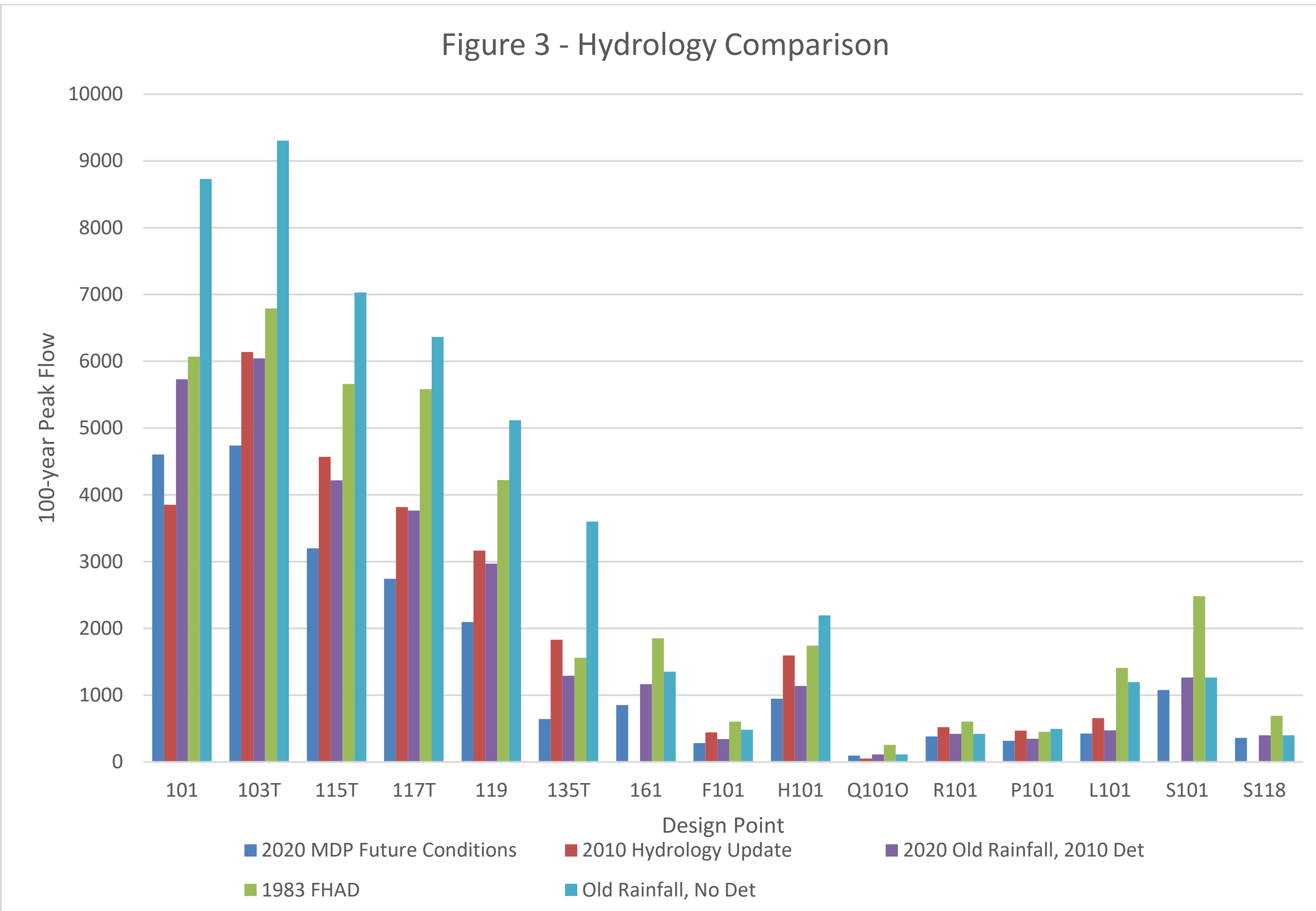
Reference Location	1983 FHAD		2022 MDP/FHAD				2022 MDP/FHAD Modified Comparison Model	
	Design Point	Future 100-Year Peak Discharge (cfs)	Design Point	Peak Discharges (cfs) EX Q100	FTR Q100	% Diff (FTR Q100 to 1983 FHAD Q100)	No Det, Old Rainfall	% Diff (No Det, Old Rainfall to 1983 FHAD Q100)
Mann-Nyholt Lake	A-15	6069	101	4364	4599	-24%	8731	44%
Downstream of Fairgrounds Tributary Confluence/Riverdale Road	A-100	6790	103T	4569	4716	-31%	9303	37%
Downstream of Plains Tributary Confluence/Quebec Street	A-125	5660	115T	3112	3164	-44%	7030	24%
Downstream of Lakeview Tributary	A-140	5584	117T	2675	2705	-52%	6364	14%
Holly Street	A-150	4220	119	2066	2097	-50%	5116	21%
Colorado Boulevard	A-178	1561	135T	635	644	-59%	3600	131%
Railroad Bridge	A-195	1850	161	672	853	-54%	1350	-27%
Fairgrounds Tributary	E-605	602	F101	222	269	-55%	481	-20%
Horizons Tributary	D-500	1743	H101	909	948	-46%	2197	26%
Quails Way Tributary	D-550	254	Q101O	96	96	-62%	111	-56%
Pheasants Run Tributary	D-575	606	R101	301	384	-37%	421	-31%
Plains Tributary	C-400	452	P101	307	316	-30%	495	9%
Lakeview Tributary	B-300	1407	L101	413	416	-70%	1193	-15%
Fishing Is Fun Pond	A-10	2483	S101	870	1079	-57%	1263	-49%
SPR Southern Tributary 006 at Yosemite Street	F-710	690	S118	309	362	-47%	398	-42%

The updated hydrology generally resulted in lower peak discharges throughout the watershed as compared to both the 2010 Hydrology Update and the 1983 FHAD. The differences are mostly due to the lower rainfall data and additional detention basins being modeled. When comparing the models with these two variables matching the old studies, the results were much closer. The increase in peak discharges at the downstream end as compared to the 2010 MDP is a result of removing detention from the Mann-Nyholt Lake.

The lower watershed compared very closely to the 2010 Hydrology Update using the old rainfall values and detention basins. The peak flows along the tributaries varied from the old study when looking at percentage, but the change in peak flow was not significant since the overall peak flows are lower.

The differences between this model and the 1983 FHAD show higher decreases in peak discharges primarily because the 1983 FHAD did not include any detention basins. Removing the detention basins and using old rainfall values resulted in higher peak flows as compared to the 1983 FHAD in the lower watershed, and lower peak flows along the tributaries.

The differences in model results are in line with trends of other watersheds and will need no calibration. Figure 3 shows a comparison of the peak flows from the different modeling sources.



3.7 Results of Analysis

In general, the peak flows are lower than 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 Tables B-3 and B-4, respectively, in Appendix B. The peak discharges and volumes versus channel station for each drainageway are shown in Tables B-5 through B-22 and are also shown in Figures B-3 through B-11. Select SWMM generated hydrographs are included as Figure B-12, in Appendix B.

4. HYDRAULICS

4.1 Evaluation of Existing Facilities

Hydraulic Modeling General Approach

The hydraulic analysis was based on existing infrastructure and the future peak flows, as detailed in Section 3. Brantner Gulch, Lakeview Tributary, Plains Tributary, Horizon Tributary, the upstream portion of Quails Way Tributary, Pheasants Run Tributary, Fairgrounds Tributary, South Platte River South Tributary 6, and South Platte River North Tributary 7 were included in the MDP HEC-RAS model. The FHAD model limits were reduced in some areas, as discussed with the project sponsors. The Regional Park watershed was evaluated with the alternatives analysis phase but was not included in the HEC-RAS model. The MDP and FHAD limits are shown on Figure 2.

The U.S. Army Corps of Engineers' HEC-RAS River Analysis, version 6.2 was used to evaluate both the floodplain and the infrastructure crossing structure capacities. A summary of peak flows used in the HEC-RAS model is included as Table C-1 in Appendix C. Cross sections for HEC-RAS were developed electronically using 1-foot interval 2014 LiDAR data, as-built topography, 2020 LiDAR, and record drawings, described in Section 1.4. The topographic mapping sources are shown on Figure 4. The project information was modeled in NAD83 Colorado State Plane North coordinate system. Limited land survey data was collected at all major bridges, culverts, and drop structures and incorporated into the model to better represent existing conditions. The LiDAR ground was adjusted between surveyed hard points to better represent the low flow channel, which is heavily vegetated in areas and not well represented by the LiDAR. Surveyed adverse slopes were not modified.

Cross section locations were set upstream and downstream of all crossings and drop structures, generally spaced no farther than 400 feet apart throughout long reaches, and were based on LiDAR and survey data, described in Section 1.4. Bank stations were typically set at the low flow channel.

Manning's "n" values were determined based on observations made during site visits and supplemented with aerial photography. The channel and bank roughness values ranged from 0.02 to 0.08. Concrete-lined channels were set to 0.02. Areas that appeared to have short grasses were generally set to 0.04. Areas with longer grass and scattered trees were set to 0.04-0.05. Areas with thick trees and brush ranged from 0.06 to 0.08. Photos illustrating the Manning's "n" values for sample reaches are shown below.

Overbanks n = 0.04
Main Channel n = 0.08

Overbanks n = 0.04
Low Flow Channel n = 0.04

Overbanks n = 0.04
Low Flow Channel n = 0.05

Structure Modeling Approach

The majority of the structures in the watersheds were culverts, with a few bridge crossings, and many low flow bridge crossings through the golf course on lower Brantner Gulch. The modeling techniques used for the crossing structures are summarized below.

- Cross section orientation – At the road crossing structures, the cross sections were generally oriented perpendicular to the channel. Survey data was used to input the crossing structures so that bridge openings were not exaggerated at skewed crossings.

- Contraction and Expansion coefficients – The contraction coefficient was changed from the default value of 0.1 to 0.3 and the expansion coefficient was changed from the default value of 0.3 to 0.5 at the two upstream and one downstream bounding cross section, respectively, of all major crossing structures. The HEC-RAS model includes numerous low flow crossings along Brantner Gulch downstream of Riverdale Road. These crossings are inundated during the 100-year event and are also overtopped during most of the smaller return period events. Additionally, the model is sensitive to the contraction and expansion coefficients. Therefore, the contraction and expansion ratios were not increased at these low flow crossings and notes were added to the cross sections in the model.

- Ineffective flow areas – Ineffective flow area contraction and expansion ratios were applied at the crossing structures. Generally, a 1:1 contraction ratio and a 3:1 expansion ratio were used to determine ineffective areas upstream and downstream of crossings, respectively. Select areas required special consideration to determine reasonable ineffective areas. The ineffective areas were set to permanent on the upstream sides of structures and were set at the roadway top. Ineffective areas were non-permanent on the downstream sides of structures and the elevations were set between the culvert crown/bridge low chord and the roadway elevation, based on allowing effective flows for the storm events that overtop the roadways.

- HEC-RAS "Bridge Modeling Approach" – HEC-RAS contains numerous options to model each crossing withing the "Bridge Modeling Approach" form. None of the crossing structures had piers, so the energy method was used to compute low flows. Pressure and/or weir flow was selected for high flows.

- The Colorado Boulevard Brantner Gulch crossing (Crossing 12) is a modified inlet. The model structure represents the actual culvert dimensions, and not the inlet face dimensions.

PROJECT: 018-2897	MILE HIGH FLOOD DISTRICT, CITY OF THORNTON, NORTHGLENN, & ADAMS COUNTY	BRANTNER GULCH MDP TERRAIN RECONCILIATION MAP	olsson 1525 Raleigh Street Suite 400 Denver, CO 80204 TEL: 303.237.2072 FAX: 303.237.2659 www.olsson.com	FIGURE 4
DRAWN BY: HP				
DATE: 09/2022				

Spill Modeling Approach

- Brantner Reach 5: Ohio Lake (Upstream of Washington Center Parkway) Overflow – Ohio Lake, Detention Basin 365, Crossing 1, does not contain the 100-year or 500-year flows. Approximately 9 and 134 cfs will overtop the spillway during the 100-year and 500-year events, respectively, as determined in the baseline hydrology models. The overflows overtop the spillway at the intersection of Washington Center Parkway and Thorncreek Crossing Parking Lot Road. The overflows will flow north in Washington Center Parkway to a sump in the roadway where they will spill into a small drainageway that eventually flows back into Brantner Gulch upstream of Eastlake Reservoir No. 1. The sump inlets and storm drain system do not appear to have capacity for the design flows, and therefore were not considered to be able to convey any of the overflows. An overflow reach is included in the HEC-RAS model. The full flows were used in the mainstem of Brantner Gulch downstream of Ohio Lake, and the overflows were not subtracted from the 100-year or 500-year flows. The overflows will spill into the Karl's Farm development roadway. A total of 54 cfs in the 500-year storm event will spill out of the roadway at the downstream end and ultimately spill into Brantner Gulch, as determined based on the HEC-RAS Lateral Structure 130753.

- Brantner Reach 5: Eastlake Reservoir Number 2 Overflow – Detention Basin 360, Crossing 6, does not contain the 500-year flows. Approximately 194 cfs will overtop the spillway during the 500-year events, as determined in the baseline hydrology models. The overflows overtop the spillway at E 123rd Avenue, east of the intersection with E 123rd Drive. The overflows will flow along the streets until eventually flowing back into Brantner Gulch in Eastlake Reservoir Number 3. An overflow reach is included in the HEC-RAS model. The full flows were used in the mainstem of Brantner Gulch downstream of Eastlake Reservoir Number 2, and the overflows were not subtracted from the 500-year flows.

- Brantner Reach 5: The channel upstream of 124th Avenue does not contain the 500-year peak flow. A lateral structure (32050) was used in the model to quantify the spill of 103 cfs. The spill flows will flow down E. 123rd Drive in an existing detention basin, and back into Brantner Gulch downstream. A FlowMaster, version 10.02.00.01 calculation was prepared for the street, which has adequate capacity for the overflow. An additional calculation was done for downstream of Colorado Boulevard to evaluate the streets capacity and to understand the extents of the 500-year floodplain.

- Brantner Reach 1: Brantner Gulch downstream of Riverdale Road does not have capacity for the majority of the design storm events. Flows will overtop to the south, to the direct flow areas D02, D03, and D01, and to the north toward SPRS Tributary 6. A FLO-2D model was prepared to inform the alignments, cross sections, and split flows for the 1D HEC-RAS model. The Brantner Gulch cross sections were extended across D02 to better model the area and a lateral structure was added to the north (6405) and south (4973) sides of Brantner Gulch. The weir coefficients were adjusted until the 100-year spill peak flows closely matched the FLO-2D results. The full Brantner Gulch flows were modeled downstream of the spills. The flows that overtop to the north were added to the SPRS Tributary 6 flows. Flows overtopping to the south will flow into the gravel pit in Subbasins D03 and D01 before flowing into the South Platte River. The overflows were not subtracted out of the Brantner Gulch flows downstream of the spills. A small spill (lateral structure 6636) occurs on Brantner Gulch, which will spill back into the channel downstream. A summary of the flows leaving Brantner Gulch to the north and south are shown in Table 10.

Table 10 – Brantner Gulch Spill Flows

Lateral Structure	Description	Flow Leaving (cfs)						
		2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
6636	Spill back into downstream Brantner Gulch	0	0	0	4	17	59	434
6405	Spill north to SPRS Tributary 6	0	0	9	556	1000	1620	3383
4973	Spill south, over Henderson Road	30	90	328	728	946	1209	1796

- Horizon Tributary Reach 2: 500-year flows will overtop the pedestrian trail downstream of Marshall Dam, Cross Section 80570, and flow into a spill channel. A total of 133 cfs will overtop the trail, as determined in the baseline hydrology models. A portion of the flow will spill into the downstream channel, while the remainder will flow in a split channel. To be conservative, it was assumed that the total 133 cfs will flow in the split channel. A FlowMaster, version 10.02.00.01 calculation was prepared for the spill to map the 500-year floodplain limits.

- Horizon Tributary Reach 2: 500-year flows will overtop the pedestrian trail crossing located approximately 950 feet downstream of Marshall Dam, Crossing 79582, and flow into a split channel. A total of 136 cfs will overtop the trail, as determined from the culvert overtopping flows reported in HEC-RAS. A portion of the flow will spill into the downstream channel, while the remainder will flow in a split channel. To be conservative, it was assumed that the total 136 cfs will flow in the split channel. A FlowMaster, version 10.02.00.01 calculation was prepared for the spill to map the 500-year floodplain limits.

- SPRS Tributary 6 and SPRN Tributary 7 generally do not have a defined flow path downstream of Riverdale Road. A FLO-2D model was prepared in this area to inform the 1D HEC-RAS model alignment and cross sections.

StormCAD Calculations

Several storm drain systems were evaluated using StormCAD.

- Brantner Reach 5: Ohio Lake, Design Point 165O (Upstream of Washington Center Parkway), Overflow – The storm drain system downstream of the Washington Center Parkway was evaluated in StormCAD to see if it had excess capacity for the 100-year and 500-year overflows from Ohio Lake. The storm drain system information was taken from the *Phase II Drainage Report for Washington Center Apartments*, prepared by York Engineering & Surveying Services, Inc. January 28, 2000 report. It was found to be surcharged with the design flows and was therefore not considered available to convey the overflows. A spill reach for the Ohio Lake spill was included in the model.

- Brantner Reach 5: Eastlake Reservoir Number 2, Design Point 160O, Outlet – The Eastlake Reservoir Number 2 detention basin outlets into a 60-inch RCP storm drain system. The storm drain system was modeled in StormCAD based on the *Construction Drawings for Eastlake Reservoir No. 2* As-built plans, prepared in July 2003 by Sellards & Grigg, Inc. The upper storm drain system has capacity for the 500-year flows, but the downstream system is surcharged above ground. The storm drain system does not control the detention basin outlet works. The vertical datum of the plans was unknown. A datum conversion of +1.38' was used to convert the elevations to NAVD 88, based on the average differences between the as-built elevations and the survey elevations at the upstream and downstream ends of the pipe.

  At the bend in the storm drain system at Steele Street the pipe has capacity for 206 cfs, which contains the 100-year storm event, but surcharges the 500-year event. The Eastlake Resevoir Number 2 spillway is activated in the 500-year, as such, only 239 cfs would be captured in the storm drain system during the 500-year event. Based on the flows in the pipe system during the 500-year, a total of 33 cfs would bubble out of the system at this location. A FlowMaster, version 10.02.00.01 calculation was done for the 33 cfs 500-year spill, which will spill down Adams Street into an existing detention pond, and then follow E. 123rd Drive to another existing detention pond, and finally back into Brantner Gulch. If full flows were used in the pipe system, a total of 227 cfs during the 500-year storm event would bubble out of the storm drain system at this location. FlowMaster calculations were completed for this scenario as well.

  The limiting pipe capacity of the system downstream of the bend is 160 cfs, which results in a 46 cfs spill in the 100-year, and a 273 cfs spill in the 500-year storm event. These spill flows in HEC-RAS represent the full flows, and do not subtract out the spillway flows. HEC-RAS cross sections were added to the model to represent the overflows from the storm drain system at this location.

- Brantner Reach 5: Eastlake Reservoir Number 3, Design Point 152O, Outlet – The Eastlake Reservoir Number 3 detention basin outlets into a 36-inch RCP and 60-inch x 38-inch HERCP storm drain system. The storm drain system was modeled in StormCAD based on the *Eastlake Reservoir No. 3 Dam and Downstream Improvements* As-built plans, prepared in February 1999 by Montgomery Watson with a +2.96-foot elevation conversion from NGVD 29 to NAVD 88. The upper storm drain system generally has capacity for the 500-year flows, including the design inflows near the downstream end of the system. A small section of the system is surcharged above ground near the upstream end, but is negligible and was not modeled further. The storm drain system does not control the detention basin outlet works.

- SPRS Tributary 6 DS: Yosemite Street, Crossing 88 – A 100-year reinforced concrete box storm drain system was constructed in Yosemite Street. A MHFD_Culvert, version 4.0 calculation was prepared to evaluate the water surface elevations upstream of the culvert. The pipe is inlet controlled. A StormCAD model was also prepared based on the *School District 27J – High School #3 Off-Site* as-built plans prepared by JVA Consulting Engineers in September 2013. The StormCAD model confirmed the pipe has capacity for the 100-year storm event. The upstream system has adequate capacity for the 500-year flows. However, flows in excess of the 100-year event will begin to surcharge the system at the inlets located in Yosemite Street approximately 750 feet north of Riverdale Road. The model alignment follows the overland path along Yosemite Street for the 500-year overflows. The model alignment follows the overland path along Yosemite Street for the 500-year overflows, which will bubble out of the inlets in Yosemite Street. The first HEC-RAS cross section on Yosemite Street represents where the 500-year surcharges the pipe system.

Confluence Modeling Approach

The confluence locations of Brantner Gulch and its tributaries were determined using the delineated stream centerlines. Junctions were used to model each confluence. The energy equation computation mode was used at each junction, except for at Junction B4, the confluence of Brantner Gulch and Lakeview Tributary, where the use of the Momentum energy equation was found to give more reasonable results. The impact of the junction lengths on the water surfaces elevations were investigated by disconnecting the tributaries, adding additional cross sections, and comparing results with different boundary conditions. Normal depth based on the thalweg slope at the downstream end of each reach was used and a steeper normal depth was compared to evaluate the impact of the slope. Generally, the downstream boundary condition affects the downstream most water surface elevations, but the impacts are not propagated beyond 400 feet from the confluence with Brantner Gulch. Using a junction as the downstream boundary condition is generally slightly conservative. No structures are impacted by the floodplain at the confluences. Junctions were used for the downstream boundary condition to avoid crossing cross sections between reaches.

Overflow at Pedestrian Underpasses Modeling Approach

Two overflow pedestrian underpasses are located in the study limits: Plans Tributary at E. 128th Avenue. and Horizon Tributary at E. 136th Avenue. The HEC-RAS model does not include the pedestrian underpasses and represents the water surface elevations that would be needed to convey the full flow across the roads, which is a conservative approach. This approach was discussed with the project sponsors and deemed reasonable, since the resulting floodplains do not impact private property.

- Along Plains Tributary at E 128th Avenue, Crossing 55 does not have capacity for the full 500-year flow before spilling into the pedestrian underpass at Crossing 56. To map the spill and check the capacity of Crossing 56 calculations were performed in FlowMaster, version 10.02.00.01 and the MHFD Culvert spreadsheet, version 4.0.

  The cross section used in FlowMaster was cut from survey and LiDAR data representing the high point between Crossing 55 and Crossing 56. Flow used in FlowMaster is the difference between the 100-year storm and 500-year storm flows at Crossing 55/56 – 175 cfs. Using the difference between the storm events is a conservative approach because the water surface elevation of the 100-year storm is lower than the elevation of the spill. Results from FlowMaster were used to map the spill at Crossing 55/56.

  The capacity of the underpass was checked using the MHFD Culvert spreadsheet with the tailwater set to the water surface elevation at the downstream side of Crossing 55. The headwater elevation was iterated to target a flowrate of 175 cfs. Results prove that Crossing 56 has capacity for the spill flow and will be used to map the spill at Crossing 55/56.

- Along Horizons Tributary – Reach 2 E. 136th Avenue, Crossing 59 does not have capacity for the full 100-year or 500-year flows before spilling into the pedestrian underpass at Crossing 60. To map the spill and check the capacity of Crossing 60 calculations were performed in FlowMaster, version 10.02.00.01 and the MHFD Culvert spreadsheet, version 4.0.

  The cross section used in FlowMaster was cut from LiDAR data representing the high point between Crossing 59 and Crossing 60. Flow used in FlowMaster is the difference between the 100-year and 500-year storm flows with the 50-year storm flow at Crossing 59/60 – 154 cfs and 513 cfs, respectively. Using the difference between the storm events is a conservative approach because the water surface elevation of the 50-year storm is lower than the elevation of the spill. Results from FlowMaster were used to map the spill at Crossing 59/60.

  The capacity of the underpass was checked using the MHFD Culvert spreadsheet. The tailwater elevation at this location would not impact the Crossing 60 outlet. The headwater elevation was iterated to target flowrates of 154 cfs and 513 cfs. Results prove that Crossing 56 has capacity for the 100-year and 500-year spill flows and will be used to map the spill at Crossing 55/56.

Boundary Conditions and Set Internal Water Surface Elevations

A normal depth downstream boundary condition was used for Brantner Gulch and South Platte River North Tributary 7 based on a 0.2% slope of the South Platte River.

The Quails Way Tributary was only modeled to the downstream end of the E. 136th Avenue crossing. A normal depth boundary condition was used based on the downstream slope of 0.0264 ft/ft.

A known water surface elevation was used as the downstream boundary condition for the two spill reaches: Eastlake 2 O.F. (Overflow) and Ohio Lake O.F. (Overflow), based on Cross Sections 31405 and 39269, respectively.

Nine on-line detention basins (SWMM hydrologic design points 365, 360, 352, F304, H306, H303, P303, L305, L302) are located in the study area. Set water surface elevations based on the hydrology calculations were used in the HEC-RAS model on the cross sections immediately upstream of the detention basin outlet structures. The water surface elevations were set using the elevation-discharge information that was calculated. The floodplain mapping uses this set water surface elevation across the controlling spillway elevation at each detention basin. A summary of the detention basin set water surface elevations is shown in Table C-2, in Appendix C. Detention Basin H306 has a spillway channel that will be activated in the 500-year storm event. Cross sections were extended across the channel, but the downstream 500-year water surface elevations are lower than the spillway channel invert elevations. A FlowMaster, version 10.02.00.01 calculation was prepared to determine the depth in the channel and was used to map the 500-year floodplain in the spillway channel.

Design/As-Built Improvements

The HEC-RAS model incorporated information from several as-built documents, as summarized below. The StormCAD models were also based on as-built information, as referenced in the StormCAD section above.

- Brantner Reach 1: The Brantner Gulch Riverdale Road crossing was recently constructed. The *Riverdale Road Crossing on Lower Brantner Gulch* as-built plans prepared by Muller Engineering in February 2014 and the design topography that was confirmed to be built per plan was used to model the updated alignment, cross sections, and crossing.

- Brantner Reach 3: The Brantner Gulch 128th Avenue crossing was recently improved. A quadruple 48-inch RCP structure parallel with the existing structure was constructed. Low flows are directed exclusively to the original structure, which is located west of the quadruple 48-inch parallel RCP's. Near the point this structure reaches "full pipe" flows, flow spills to the new structure. The goal of the project was for the combined structures, as modeled in HY-8, to convey the 10-year discharge per the preliminary FHAD hydrology. The *Brantner Gulch Drainage Improvements at 128th Avenue* as-built plans prepared by Martin/Martin in March 2020 and the design topography that was confirmed to be built per plan was used to model the updated crossing.

- Brantner Gulch Reach 3: The ground at the 500-year floodplain limits was modified between E. 128th Avenue and Quebec Street as part of the Riverdale Ranch development, designed by Harris Kocher Smith. The model cross sections were modified based on the Riverdale Ranch as-built topography and record drawings, prepared by Harris Kocher Smith in June 2021.

- Brantner Gulch Reach 5: The Ohio Lake spill path has been altered by the Washington Center Filing 1 development designed by Redland and the Karl's Farm Filing No. 1 development designed by Innovative Land Consultants, Inc. The topography from these two developments was input into the model.

- Horizon Tributary: During the time of the study, two trail crossing projects on Horizon Tributary between Marshall Reservoir and Quebec Street (Survey Crossing 64 and 69) were constructed and the as-built information from the *Horizon Creek Culvert Improvements* as-built plans, prepared by CVL Consultants in December 2020 was included in this study. The trail crossings are located immediately upstream of the Quails Way confluence and approximately 850 feet upstream of the confluence.

- Fairgrounds Tributary: Channel improvements and a trail crossing were constructed along Fairgrounds Tributary through the Timberleaf development between Uinta Street and E. 130th Circle. The design topography verified to be built per plan, the *Timberleaf Filing No. 1 Fairgrounds Tributary* as-built plans prepared by J.R. Engineering in April 2021, and the *Fairgrounds Tributary* as-built plans prepared by Dewberry in September 2020 were used to update cross sections and the crossing at this location.

- As-built plans were used to determine drop structure stilling basins to supplement the survey in several areas, including:

  - The drop structure sill elevation for the Brantner Gulch drop structure downstream of the Eastlake Reservoir Number 3 outlet pipe was based on the as-built elevation shown in the *Eastlake Reservoir No. 3 Dam and Downstream Improvements* As-built plans, prepared in February 1999 by Montgomery Watson with a +2.96-foot elevation conversion from NGVD 29 to NAVD 88. Additionally, the low flow was adjusted to include the concrete trickle channel section in this reach based on these as-built plans

- Three drop structures along Fairgrounds Tributary from E 130th Circle to just south of E 130th Avenue were determined to not have stilling basins based on the *Gleneagle Estates Construction Drawings as-built plans*, prepared by Merrick in September 2007.

- Three drop structures along Fairgrounds Tributary from Spruce Street to just south of Uinta Street were determined to have 1-foot stilling basins based on the *Drainage Report for Fairgrounds Tributary Improvements and Regional Detention Pond for the Villages at Riverdale Filing No. 3* prepared by Carroll & Lange, Inc. in August 2002 and *The Villages at Riverdale Filing No. 3* as-built plans prepared by Carroll & Lange, Inc. in March 2006.

Unbound Cross Sections

The HEC-RAS model has several areas with unbound cross sections. In general, all unbound cross sections are connected to a lateral structure, with the spill flows modeled as described herein. There are a few additional cross sections that are unbound where a lateral structure did not add any meaningful information, and a description was added to the cross section instead, as described below:

- SPRN North Tributary 7 Cross Sections 116899 and 115694 are located in a depressed area and will spill over the berm directly to Cross Section 115367.

- SPRN North Tributary 7 cross Sections 111238, 110838, and 110438 are located at the downstream end and spill directly into the South Platte River.

Existing Crossing Structure Capacities

CDOT, Adams County, City of Thornton, and City of Northglenn criteria were used to determine the crossing structure capacities. A summary of the criteria used to evaluate alternatives is included in Table 11. Brantner Gulch was assumed to have low to moderate debris for existing and future land use conditions.

The HEC-RAS model that was developed for this study, as described in Section 4.1, was used to determine structure capacities based on the criteria for the 100-year storm event. Notes were added to crossings where 100-year capacities may not be needed, such as pedestrian trails and golf cart paths. Detailed structure capacity summary tables for the existing infrastructure, future land use flows are included in Tables 12.

Table 11 - Crossing Structure Criteria

Jurisdiction	Max. Culvert Headwater:Depth	Bridge Freeboard	Street Overtopping
CDOT	Rise/Diameter: <36" – 2 36"-60" – 1.7 >60"-<84" – 1.5 84"-120" – 1.2 ≥120" – 1.0	4' (high debris), $0.1Q^{0.3} + 0.008V^2$ (low-moderate debris)	No overtopping
Adams County	≤1.5	References MHFD, which then References CDOT	No overtopping
City of Thornton	≤1.5	See CDOT	No overtopping
City of Northglenn	≤1.5*	References MHFD, which then References CDOT	No overtopping*

*MHFD

4.2 Flood Hazards

Flood hazards along the tributaries were identified in several ways and are detailed below. The specific flood hazards in each reach are documented in detail in Section 5.6, and shown on Figure 5. A comparison of the existing infrastructure, future land use 100-year floodplain and the effective floodplains is included in Appendix C as Figure C-1.

Hydraulic Analysis

The HEC-RAS model that was developed for the FHAD, and detailed in Section 4.1, was used to identify areas with higher velocities and shear stresses in both minor and major events. The model was also used to identify undersized channels and crossing structures.

Study Area Site Walk

Two site visits were conducted. The first was on February 20, 2023, and a follow up visit on April 23, 2023. The purpose of the site visits was to observe the existing conditions of the major drainageways, with particular attention to areas with high velocities, shear stresses, or capacity issues as determined based on the hydraulic modeling.

Desktop Analysis

While 2014 LiDAR was used for the hydraulic modeling, 2020 LiDAR became available during the alternatives analysis portion of this study. A comparison of 2014 LiDAR and 2020 LiDAR information was completed. Differences in the channel bottom may be due to different vegetation growth or processing, but differences along the banks could denote where the channel has migrated laterally in that 6-year period. In some cases, scour holes and headcuts could also be seen, and were field verified in the study area site walk. The differences between the 2014 and 2020 LiDAR information was used to supplement our analysis of lateral bank migration. Floodplain results were compared to GIS information for sanitary sewer, water, and stormwater utilities.

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

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

- Deteriorating concrete
- Informal confluence areas
- Undesirable confluence configurations
- Entrenchment
- Incised low flow
- Vertical banks, without vegetation
- Bank failure
- Active, fast erosion between the years 2014-2020 based on LiDAR
- Headcutting

Failure Risk
The areas in the channel that were considered a Failure Risk were hazards that were identified to be imminently at risk of continued erosion compromising the integrity of a structure. In some cases, in channel grade control is actively protecting a utility crossing upstream that would be further compromised if the structure were to fail. Areas observed to be at risk of failure could include but are not limited to:

- Grouted boulder drop structures
- Boulder walls
- Riprap grade control structures
- Pedestrian Trail

Exposure Risk
The areas in the channel that were considered an Exposure Risk were hazards identified to be at risk of continued erosion exposing or further exposing existing infrastructure, or utilities. Utilities could be in the form of a crossing, threatened by a headcut, or run parallel to the channel and threatened by migrating banks. Areas observed to be at risk of exposure could include but are not limited to:

- Utility Crossings
- Parallel Utilities
- Sheet Pile Cutoff Walls
- Pedestrian Trail

Capacity
Areas were deemed a capacity flood hazard could include but are not limited to the following:

- Channel spilling in the existing infrastructure, future land use 100-year event or less
- Major crossing structures overtopping
- On-line detention pond spillway overtopping in existing infrastructure, future land use 100-year event or less
- Insurable structures in the floodplain
- Floodplain encroaching or threatening private property
- Dense vegetation

4.3 Previous Analysis

The Brantner Gulch drainageway has a FEMA-designated Zone A floodplain from the South Platte River to west of Holly Street, where it has a Zone AE floodplain with a floodway west to Colorado Boulevard and a Zone A floodplain west a few blocks. The Horizon and Pheasants Run tributaries have FEMA-designated Zone A floodplains. South Platte River South Tributary 6 has a Zone A floodplain extending from the South Platte River to approximately 750 feet north of the intersection of Yosemite Street and Riverdale Road, along Yosemite Street. South Platte River North Tributary 7 has a Zone A floodplain extending from the South Platte River to a point approximately 1000 feet northwest of the intersection of Yosemite Street and E 136th Avenue. The South Platte River floodplain extends into the study area with a Zone AE floodplain and a floodway. The FEMA FIRM panels are included in Appendix C. Additional best available floodplains are available on all the named tributaries in the study area, based on the 1983 FHAD.

Table 12 - Crossing Structure Capacities (Existing Infrastructure, Future Land Use Flows)

Reach	Struc. No.	US XS	Juris-diction	Street Name	Street Classific-ation	Existing Structure	Q_2 (cfs)	Q_2 Overtop Depth (ft)	Q_5 (cfs)	Q_5 Overtop Depth (ft)	Q_{10} (cfs)	Q_{10} Overtop Depth (ft)	Q_{25} (cfs)	Q_{25} Overtop Depth (ft)	Q_{50} (cfs)	Q_{50} Overtop Depth (ft)	Q_{100} (cfs)	Q_{100} Overtop Depth (ft)	Bridge Free-board Height (ft)	Bridge Free-board Elev	HW/D Criteria	HW:D Criteria Elev	Overtop Elev	Controlling Criteria	Controlling Elevation	Capacity per Criteria (Storm Event)	Capacity before Overtop (Storm Event)	100-Year Criteria Met?	100-Year Overtop?	Notes/ Alts?
Brantner 5	1	41162	Thornton	Washington Center Parkway	Local	Outlet structure and (1) 10-foot (S) x 5-foot (R) RCBC	45	---	50	---	50	---	79	---	129	---	198	0.1	---	---	1.5	5312.64	5314.72	HW:D	5312.64	10-YEAR	50-YEAR	NO	YES	Pond alt
	2	37998	Northglenn	Dirt Path	Trail	(1) 24-inch CPP	81	1.3	108	1.46	108	1.46	207	1.93	254	2.09	313	2.21	---	---	1.5	5279.6	5280.2	HW:D	5279.60	< 2-YEAR	< 2-YEAR	NO	YES	OK - Trail
	3	36861	Northglenn	Claude Ct	Local	(2) 10-foot (S) x 4-foot (R) RCBC	149	---	217	---	217	---	492	---	645	---	853	---	---	---	1.5	5268.77	5268.83	HW:D	5268.77	>100-YEAR	>100-YEAR	YES	NO	OK
	4	36698	Northglenn	Railroad	Railroad	(3) 16-foot (S) x 8-foot (R) RCBC	149	---	217	---	217	---	492	---	645	---	853	---	---	---	1.5	5274.69	5276	HW:D	5274.69	>100-YEAR	>100-YEAR	YES	NO	OK
	5	36455	Thornton	Bike Path	Trail	(1) 48-inch CPP	149	0.73	217	0.93	217	0.93	492	1.41	645	1.63	853	1.82	---	---	1.5	5266.49	5264	Overtop	5264.00	< 2-YEAR	< 2-YEAR	NO	YES	OK - Trail
	6	34346	Thornton	Bike Path	Trail	Outlet structure and (1) 60-inch RCP	154	---	227	---	227	---	537	---	708	---	940	---	---	---	1.5	5259.58	5260.12	HW:D	5259.58	50-YEAR	>100-YEAR	NO	NO	OK - Trail
	10	31738	Thornton	124th Ave	Local	(1) 60-inch RCP	77	---	97	---	97	---	157	---	185	---	220	0.46	---	---	1.5	5231.47	5232.14	HW:D	5231.47	50-YEAR	50-YEAR	NO	YES	Capacity alt
	11	30445	Thornton	Bike Path	Trail	Outlet structure and (1) 36-inch RCP	146	---	219	---	219	---	543	---	699	---	894	---	---	---	1.5	5225.84	5227.58	HW:D	5225.84	>100-YEAR	>100-YEAR	YES	NO	OK
	12	27585	Thornton	Colorado Boulevard	Principal Arterial	(1) 8-foot (S) x 7-foot (R) RCBC	60	---	92	---	92	---	251	---	388	---	567	---	---	---	1.5	5193.54	5292.31	HW:D	5193.54	>100-YEAR	>100-YEAR	YES	NO	OK
	13	26493	Thornton	Pedestrian Crossing	Trail	100-foot Span Bridge	84	---	133	---	133	---	344	---	475	---	701	---	1.01	5178.26	---	---	5179.77	Bridge FB	5178.26	>100-YEAR	>100-YEAR	YES	NO	OK
	14	25221	Thornton	Pipe Aerial Crossing	Park	Lateral crossing of 6" fiber optic conduit	84	---	133	0.6	133	0.6	344	3.42	475	4.3	701	5.26	0.93	5152.94	---	---	5154.42	Bridge FB	5152.94	< 2-YEAR	2-YEAR	NO	YES	Protect utility
	15	24107	Thornton	Pedestrian Crossing	Trail	(1) 100-foot Span Bridge	176	---	299	---	299	---	932	---	1234	---	1604	---	1.19	5150.84	---	---	5152.53	Bridge FB	5150.84	>100-YEAR	>100-YEAR	YES	NO	OK
	16	23269	Thornton	Pedestrian Crossing	Trail	(1) 100-foot Span Bridge	199	---	335	---	335	---	1039	---	1383	---	1805	0.18	1.09	5142.84	---	---	5145.03	Bridge FB	5142.84	2-YEAR	50-YEAR	NO	YES	OK - Trail
	17	21984	Adams County/ Thornton	Holly Street	Collector	(1) 24-foot (S) x 16.6-foot (R) Conspan Arch Culvert	232	---	387	---	387	---	1192	---	1596	---	2097	---	---	---	1.5	5147.08	5141.05	Overtop	5141.05	>100-YEAR	>100-YEAR	YES	NO	OK
	18	21626	Adams County	Pedestrian Crossing	Trail	(1) 75-foot Span Bridge	232	---	387	---	387	---	1192	---	1596	---	2097	---	1.25	5127.04	---	---	5128.84	Bridge FB	5127.04	10-YEAR	>100-YEAR	NO	NO	OK - Trail
Brantner 3	19	15430	Thornton	Quebec Street	Local	(2) 22-foot (S) x 12-foot (R) RCBC	271	---	463	---	463	---	1749	---	2365	---	3242	---	---	---	1.5	5089.68	5086.4	Overtop	5086.40	>100-YEAR	>100-YEAR	YES	NO	OK
	1B	12505	Thornton	Pedestrian Crossing	Trail	(1) 78-foot Span Bridge	281	---	484	---	484	---	1834	0.78	2509	1.42	3449	2.07	1.28	5062.99	---	---	5066.56	Bridge FB	5062.99	2-YEAR	10-YEAR	NO	YES	OK - Trail
	20	9639	Adams County/ Thornton	E 128th Avenue	Principal Arterial	(1) 42-inch RCP and (4) 48-inch overflow RCPs	279	---	490	---	490	---	1839	3.53	2526	4.02	3491	4.73	---	---	1.5	5049.22	5054	HW:D	5049.22	2-YEAR	10-YEAR	NO	YES	Capacity alt

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Table 12 - Crossing Structure Capacities (Existing Infrastructure, Future Land Use Flows)

Reach	Struc. No.	US XS	Juris-diction	Street Name	Street Classific-ation	Existing Structure	Q_2 (cfs)	Q_2 Overtop Depth (ft)	Q_5 (cfs)	Q_5 Overtop Depth (ft)	Q_{10} (cfs)	Q_{10} Overtop Depth (ft)	Q_{25} (cfs)	Q_{25} Overtop Depth (ft)	Q_{50} (cfs)	Q_{50} Overtop Depth (ft)	Q_{100} (cfs)	Q_{100} Overtop Depth (ft)	Bridge Free-board Height (ft)	Bridge Free-board Elev	HW/D Criteria	HW:D Criteria Elev	Overtop Elev	Controlling Criteria	Controlling Elevation	Capacity per Criteria (Storm Event)	Capacity before Overtop (Storm Event)	100-Year Criteria Met?	100-Year Overtop?	Notes/ Alts?
Brantner 1	21	7084	Adams County/ Thornton	Riverdale Road	Collector	(3) 16-foot (S) x 12-foot (R) RCBC partially filled in	371	---	639	---	639	---	2447	0.16	3385	1.5	4716	2.6	---	---	1.5	5045.41	5043.72	Overtop	5043.72	10-YEAR	10-YEAR	NO	YES	Capacity alt
	22	6673	Adams County	Golf Cart Path	Bridge	(1) 14.9-foot Span Bridge	371	0.97	639	1.64	639	1.64	2447	3.72	3385	4.39	4716	5.15	1.87	5033.67	---	---	5036.24	Bridge FB	5033.67	< 2-YEAR	< 2-YEAR	NO	YES	Golf course alt
	23	6564	Adams County	Lateral Pipe	Golf Course	(1) 15-inch Lateral CMP Aerial Crossing	371	1.27	639	2.2	639	2.2	2447	4.18	3385	4.65	4716	5.38	2.03	5032.01	---	---	5035.29	Bridge FB	5032.01	< 2-YEAR	< 2-YEAR	NO	YES	Protect utility
	24	6468	Adams County	Golf Cart Path	Bridge	(1) 23.2-foot Span Bridge	371	1.35	639	1.76	639	1.76	2447	4.17	3385	4.86	4716	5.92	2.44	5030.91	---	---	5033.86	Bridge FB	5030.91	< 2-YEAR	< 2-YEAR	NO	YES	Golf course alt
	25	6110	Adams County	Golf Cart Path	Bridge	(1) 14.75-foot Span Bridge	371	0.05	639	0.88	639	0.88	2447	2.21	3385	2.53	4716	3.08	2.15	5028.73	---	---	5031.72	Bridge FB	5028.73	< 2-YEAR	< 2-YEAR	NO	YES	Golf course alt
	26	5752	Adams County	Golf Cart Path	Bridge	(1) 17.8-foot Span Bridge	371	---	639	---	639	---	2447	0.72	3385	0.96	4716	1.2	2.25	5025.73	---	---	5028.68	Bridge FB	5025.73	< 2-YEAR	10-YEAR	NO	YES	Golf course alt
	27	5527	Adams County	Golf Cart Path	Bridge	(1) 14.6-foot Span Bridge	371	---	639	0.14	639	0.14	2447	1.24	3385	1.64	4716	1.88	2.21	5022.96	---	---	5025.86	Bridge FB	5022.96	< 2-YEAR	2-YEAR	NO	YES	Golf course alt
	28	5252	Adams County	Golf Cart Path	Bridge	(1) 15-foot Span Bridge	371	---	639	0.24	639	0.24	2447	1.06	3385	1.34	4716	1.65	2.23	5019.05	---	---	5023.54	Bridge FB	5019.05	< 2-YEAR	2-YEAR	NO	YES	Golf course alt
	29	5035	Adams County	Golf Cart Path	Bridge	(1) 18-foot Span Bridge	371	---	639	---	639	---	2447	0.04	3385	0.27	4716	0.56	1.93	5018.46	---	---	5022.54	Bridge FB	5018.46	2-YEAR	10-YEAR	NO	YES	Golf course alt
	30	4618	Adams County	Golf Cart Path	Bridge	(1) 33.3-foot Span Bridge	371	---	639	---	639	---	2447	---	3385	---	4716	0.32	1.96	5015.23	---	---	5018.89	Bridge FB	5015.23	< 2-YEAR	50-YEAR	NO	YES	Golf course alt
	31	4446	Adams County	Golf Cart Path	Bridge	(1) 24.5-foot Span Bridge	371	0.03	639	0.52	639	0.52	2447	1.27	3385	1.57	4716	1.86	1.80	5013.85	---	---	5016.48	Bridge FB	5013.85	< 2-YEAR	< 2-YEAR	NO	YES	Golf course alt
	32	4103	Adams County	Park Boulevard	Local	(1) 18-foot (S) x 4.7-foot (R) RCBC	371	---	639	---	639	---	2447	0.45	3385	0.63	4716	0.78	---	---	1.5	5016.92	5017	HW:D	5016.92	10-YEAR	10-YEAR	NO	YES	Golf course alt
	33	4023	Adams County	Lateral Pipe (Park Blvd & Golf Course Way)	Private	12-inch Lateral Aerial Pipe Crossing	371	---	639	---	639	---	2447	0.84	3385	1.17	4716	1.43	1.86	5011.51	---	---	5014.37	Bridge FB	*5011.51*	10-YEAR	10-YEAR	NO	YES	Protect utility
	34	3932	Adams County	Golf Cart Path	Bridge	(1) 23.3-foot Span Bridge	371	---	639	---	639	---	2447	2.08	3385	2.95	4716	3.2	1.48	5007.93	---	---	5009	Bridge FB	5007.93	2-YEAR	10-YEAR	NO	YES	Golf course alt
	35	1973	Adams County	Pedestrian Trail	Trail	(1) 77.65-foot Span Bridge	371	---	639	---	639	---	2447	1.27	3385	1.69	4716	2.27	1.38	5005.94	---	---	5007.84	Bridge FB	5005.94	< 2-YEAR	10-YEAR	NO	YES	Golf course alt

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Table 12 - Crossing Structure Capacities (Existing Infrastructure, Future Land Use Flows)

Reach	Struc. No.	US XS	Juris-diction	Street Name	Street Classific-ation	Existing Structure	Q_2 (cfs)	Q_2 Overtop Depth (ft)	Q_5 (cfs)	Q_5 Overtop Depth (ft)	Q_{10} (cfs)	Q_{10} Overtop Depth (ft)	Q_{25} (cfs)	Q_{25} Overtop Depth (ft)	Q_{50} (cfs)	Q_{50} Overtop Depth (ft)	Q_{100} (cfs)	Q_{100} Overtop Depth (ft)	Bridge Free-board Height (ft)	Bridge Free-board Elev	HW/D Criteria	HW:D Criteria Elev	Overtop Elev	Controlling Criteria	Controlling Elevation	Capacity per Criteria (Storm Event)	Capacity before Overtop (Storm Event)	100-Year Criteria Met?	100-Year Overtop?	Notes/ Alts?
Lakeview Tributary	42	54978	Thornton	Holly Street	Collector	Outlet structure and (1) 18-inch RCP and (3) 24-inch RCP	46	---	71	---	71	---	171	---	219	0.16	277	0.41	---	---	1.5	5164.34	5169.26	HW:D	5164.34	2-YEAR	25-YEAR	NO	YES	Pond alt
	43	53761	Thornton	128th Avenue	Principal Arterial	(3) 54-inch RCP and (1) 10-foot (S) x 10-foot (R) RCBC Pedestrian Underpass	60	---	89	---	89	---	150	---	212	---	321	---	---	---	1.5	5136.3	5152.35	HW:D	5136.30	>100-YEAR	>100-YEAR	YES	NO	OK
	44	52430	Thornton	Sidewalk	Trail	Outlet structure and (1) 15-inch RCP	75	---	114	---	114	---	214	---	263	---	404	0.12	---	---	1.5	5125.62	5127.98	HW:D	5125.62	< 2-YEAR	50-YEAR	NO	YES	OK - Pond, trail
	45	52396	Thornton	Pedestrian Crossing	Trail	(2) 10-foot (S) x 3.15-foot (R) RCBC	50	---	86	---	86	---	174	---	243	---	374	---	---	---	1.5	5128.38	5127.98	Overtop	5127.98	>100-YEAR	>100-YEAR	YES	NO	OK
Plains Tributary	50	67042	Thornton	132nd Avenue	Local	(1) 10-foot (S) x 6-foot (R) RCBC	4	---	7	---	7	---	36	---	56	---	73	---	---	---	1.5	5194.86	5194.33	Overtop	5194.33	>100-YEAR	>100-YEAR	YES	NO	OK
	51	65602	Thornton	E 130th Avenue	Local	(2) 11-foot (S) x 4-foot (R) RCBC	20	---	31	---	31	---	78	---	102	---	142	---	---	---	1.5	5176.52	5176.17	Overtop	5176.17	>100-YEAR	>100-YEAR	YES	NO	OK
	52	65150	Thornton	Sidewalk	Trail	(2) 18-inch RCP	20	0.42	31	0.52	31	0.52	78	0.83	102	0.95	142	1.13	---	---	1.5	5160.09	5160.48	HW:D	5160.09	< 2-YEAR	< 2-YEAR	NO	YES	OK - Trail
	53	64826	Thornton	Access	Access	(1) 18-inch RCP	37	0.55	57	0.69	57	0.69	139	1.02	180	1.12	233	1.24	---	---	1.5	5154.93	5155.68	HW:D	5154.93	< 2-YEAR	< 2-YEAR	NO	YES	OK - Pond forebay
	54	64301	Thornton	Sidewalk	Trail	Outlet structure and (1) 18-in RCP	37	---	57	---	57	---	139	---	180	---	233	---	---	---	1.5	5146.16	5157.98	HW:D	5146.16	< 2-YEAR	>100-YEAR	NO	NO	OK - Pond
	55	63282	Thornton	E 128th Avenue	Collector	(2) 54-inch RCP	20	---	43	---	43	---	143	---	200	---	276	---	---	---	1.5	5131.93	5141.44	HW:D	5131.93	>100-YEAR	>100-YEAR	YES	NO	OK
	56	63282	Thornton	E 128th Avenue	Collector	(1) 10-foot (S) x 10-foot (R) RCBC	20	---	43	---	43	---	143	---	200	---	276	---	---	---	1.5	5143.82	5141.44	Overtop	5141.44	>100-YEAR	>100-YEAR	YES	NO	OK
Horizon Trib 1	74	74217	Thornton	Detention Basin Outlet	Trail	(1) 14-foot (S) x 5-foot (R) RCBC	85	---	134	---	134	---	430	---	632	---	901	0.47	---	---	1.5	5093.32	5092.15	Overtop	5092.15	50-YEAR	50-YEAR	NO	YES	OK - Pond, trail
	75	73538	Thornton	Tamarac Street	Local	(4) 14-foot (S) x 6-foot (R) RCP	70	---	119	---	119	---	415	---	587	---	852	---	---	---	1.5	5082.45	5094	HW:D	5082.45	>100-YEAR	>100-YEAR	YES	NO	OK
	76	72298	Thornton	Valentia Street	Local	(2) 14-foot (S) x 7-foot (R) RCP	73	---	132	---	132	---	452	---	639	---	929	---	---	---	1.5	5072.51	5072.2	Overtop	5072.20	>100-YEAR	>100-YEAR	YES	NO	OK
	77	70600	Thornton	Pedestrian Trail	Trail	(2) 48-inch RCP	74	---	134	---	134	---	462	1.53	653	1.97	948	2.45	---	---	1.5	5046.94	5047.51	HW:D	5046.94	10-YEAR	10-YEAR	NO	YES	OK - Trail

Table 12 - Crossing Structure Capacities (Existing Infrastructure, Future Land Use Flows)

Reach	Struc. No.	US XS	Juris-diction	Street Name	Street Classific-ation	Existing Structure	Q_2 (cfs)	Q_2 Overtop Depth (ft)	Q_5 (cfs)	Q_5 Overtop Depth (ft)	Q_{10} (cfs)	Q_{10} Overtop Depth (ft)	Q_{25} (cfs)	Q_{25} Overtop Depth (ft)	Q_{50} (cfs)	Q_{50} Overtop Depth (ft)	Q_{100} (cfs)	Q_{100} Overtop Depth (ft)	Bridge Free-board Height (ft)	Bridge Free-board Elev	HW/D Criteria	HW:D Criteria Elev	Overtop Elev	Controlling Criteria	Controlling Elevation	Capacity per Criteria (Storm Event)	Capacity before Overtop (Storm Event)	100-Year Criteria Met?	100-Year Overtop?	Notes/ Alts?
Horizon Trib 2	58	83712	Thornton	Holly Street	Collector	(1) 48-inch RCP	49	---	77	---	77	---	236	---	334	0.35	484	0.75	---	---	1.5	5217.24	5234.08	HW:D	5217.24	10-YEAR	25-YEAR	NO	YES	Capacity alt
	59	82763	Thornton	E 136th Avenue	Principal Arterial	(1) 84-inch RCP	50	---	78	---	78	---	243	---	343	---	497	---	---	---	1.5	5202.92	5206	HW:D	5202.92	50-YEAR	>100-YEAR	NO	NO	Capacity alt
	60	82763	Thornton	E 136th Avenue	Principal Arterial	(1) 10-foot (S) x 10-foot (R)	50	---	78	---	78	---	243	---	343	---	497	---	---	---	1.5	5210.81	5206	Overtop	5206.00	>100-YEAR	>100-YEAR	YES	NO	OK
	63	80569	Thornton	Marshall Dam	Dam	Outlet Structure and (1) 72-inch RCP	98	---	145	---	145	---	371	---	504	---	703	---	---	---	1.5	5173.91	5179.82	HW:D	5173.91	< 2-YEAR	>100-YEAR	NO	NO	OK - Pond
	64	79624	Thornton	Pedestrian Sidewalk	Trail	(2) 8-foot (S) x 5-foot (R) RCBC	53	---	87	---	87	---	250	---	344	---	482	---	---	---	1.5	5147.5	5145.66	Overtop	5145.66	>100-YEAR	>100-YEAR	YES	NO	OK
	69	78723	Thornton	Pedestrian Sidewalk	Trail	(4) 7-foot (S) x 3-foot (R) RCBC	53	---	87	---	87	---	250	---	344	---	482	---	---	---	1.5	5131.25	5138.53	HW:D	5131.25	50-YEAR	>100-YEAR	NO	NO	OK - Trail
	70	77207	Thornton	Pedestrian Bridge	Trail	(1) 49-foot Span Bridge	56	---	95	---	95	---	308	---	434	---	610	---	0.83	5118.81	---	---	5119	Bridge FB	5118.81	>100-YEAR	>100-YEAR	YES	NO	OK
	71	76412	Thornton	Quebec Street	Principal Arterial	(1) 14-foot (S) x 14-foot (R) and (1) 10-foot (S) x 10-foot (R) RCBC	56	---	95	---	95	---	308	---	434	---	610	---	---	---	1.5	5121.03	5121	Overtop	5121.00	>100-YEAR	>100-YEAR	YES	NO	OK
Quails Way Tributary	65	85738	Thornton	E 136th Avenue	Principal Arterial	(1) 42-inch RCP	2	---	5	---	5	---	20	---	27	---	37	---	---	---	1.5	5203.17	5209.27	HW:D	5203.17	>100-YEAR	>100-YEAR	YES	NO	OK
Fairgrounds Tributary	79	97218	Thornton	Spillway	Spillway	Outlet structure and (1) 8-inch PVC	23	1	34	1.17	34	1.17	87	1.72	114	1.93	146	2.13	---	---	1.5	5174.04	5175.68	HW:D	5174.04	< 2-YEAR	< 2-YEAR	NO	YES	OK - Pond (not modeled)
	80	97131	Thornton	136th Avenue	Principal Arterial	(1) 72-inch RCP	23	---	34	---	34	---	87	---	114	---	146	---	---	---	1.5	5173.44	5172.23	Overtop	5172.23	>100-YEAR	>100-YEAR	YES	NO	OK
	81	96230	Thornton	135th Avenue/ Spruce Street	Local	(2) 60-inch RCP	23	---	34	---	34	---	87	---	114	---	146	---	---	---	1.5	5153.79	5153.85	HW:D	5153.79	>100-YEAR	>100-YEAR	YES	NO	OK
	82	94495	Thornton	Uinta Street	Local	Outlet structure and (1) 36-in RCP	44	---	71	---	71	---	195	---	256	---	333	---	---	---	1.5	5113.95	5121.83	HW:D	5113.95	10-YEAR	>100-YEAR	NO	NO	OK - Pond
	T1	93181	Thornton	Pedestrian Trail	Trail	(1) 10-foot (S) x 2-foot (R) RCBC	42	---	60	---	60	---	106	0.29	174	0.45	208	0.5	---	---	1.5	5086.91	5087.23	HW:D	5086.91	< 2-YEAR	10-YEAR	NO	YES	OK - Trail
	83	92674	Thornton	E. 130th Circle	Local	(2) 54-inch RCP	42	---	60	---	60	---	106	---	174	---	208	---	---	---	1.5	5084.01	5087.05	HW:D	5084.01	>100-YEAR	>100-YEAR	YES	NO	OK
	84	92025	Thornton	Detention Basin Berm	Access	Outlet structure with (2) 54-in RCP	42	0.71	60	0.83	60	0.83	106	1.11	174	1.43	208	1.57	---	---	1.5	5074.1	5078.1	HW:D	5074.10	< 2-YEAR	< 2-YEAR	NO	YES	OK - Pond (not modeled)
	85	91540	Thornton	E 130th Avenue	Local	(2) 66-inch RCP	45	---	64	---	64	---	123	---	197	---	246	---	---	---	1.5	5067.22	5069.62	HW:D	5067.22	>100-YEAR	>100-YEAR	YES	NO	OK
	86	90570	Thornton	Sidewalk	Trail	(1) 2.5-foot (S) x 1.5-foot (R) HERCP	46	0.38	67	0.47	67	0.47	136	0.73	212	0.85	269	0.95	---	---	1.5	5049.67	5048.93	Overtop	5048.93	< 2-YEAR	< 2-YEAR	NO	YES	OK - Trail

Table 12 - Crossing Structure Capacities (Existing Infrastructure, Future Land Use Flows)

Reach	Struc. No.	US XS	Juris-diction	Street Name	Street Classific-ation	Existing Structure	Q_2 (cfs)	Q_2 Overtop Depth (ft)	Q_5 (cfs)	Q_5 Overtop Depth (ft)	Q_{10} (cfs)	Q_{10} Overtop Depth (ft)	Q_{25} (cfs)	Q_{25} Overtop Depth (ft)	Q_{50} (cfs)	Q_{50} Overtop Depth (ft)	Q_{100} (cfs)	Q_{100} Overtop Depth (ft)	Bridge Free-board Height (ft)	Bridge Free-board Elev	HW/D Criteria	HW:D Criteria Elev	Overtop Elev	Controlling Criteria	Controlling Elevation	Capacity per Criteria (Storm Event)	Capacity before Overtop (Storm Event)	100-Year Criteria Met?	100-Year Overtop?	Notes/ Alts?
SPR South Tributary 6 DS	88	108207	Thornton	Yosemite Street	Section Line Arterial	(1) 6-foot (S) x 4-foot (R) RCBC	17	---	30	---	30	---	120	---	164	---	222	---	---	---	1.5	5080.87	5085.45	HW:D	5080.87	>100-YEAR	>100-YEAR	YES	NO	OK
SPR South Tributary 6 DS	91	107047	Adams County	Riverdale Road	Collector	(1) 8-foot (S) x 4-foot (R) RCBC	29	---	50	---	50	---	195	---	268	---	362	0.6	---	---	1.5	5059.63	5060.3	HW:D	5059.63	50-YEAR	50-YEAR	NO	YES	Capacity alt
SPR North Tributary 7	92	120636	Adams County/ Thornton	Yosemite Street	Section Line Arterial	(1) 72-inch CMP	43	---	64	---	64	---	165	---	216	---	279	---	---	---	1.5	5090.58	5098.26	HW:D	5090.58	50-YEAR	>100-YEAR	NO	NO	Capacity alt
SPR North Tributary 7	93	119839	Adams County	E 136th Avenue	Collector	(1) 12-inch RCP	64	0.16	102	0.28	102	0.28	279	0.71	368	0.88	478	1.08	---	---	1.5	5070.51	5070.81	HW:D	5070.51	< 2-YEAR	< 2-YEAR	NO	YES	Capacity alt
SPR North Tributary 7	94	117273	Adams County	Riverdale Road	Collector	(1) 48-inch CMP	73	0.18	120	3.07	120	3.07	352	3.61	468	3.83	614	4.11	---	---	1.5	5034.95	5033.3	Overtop	5033.30	< 2-YEAR	< 2-YEAR	NO	YES	Capacity alt

PROJECT: 018-2897	MILE HIGH FLOOD DISTRICT, CITY OF THORNTON, NORTHGLENN, & ADAMS COUNTY	BRANTNER GULCH MDP DRAINAGE PROBLEM AREAS	olsson	FIGURE 5
DRAWN BY: ELB			1525 Raleigh Street, Suite 400, Denver, CO 80204	
DATE: 6/06/2023			TEL: 303.237.2072 FAX: 303.237.2659 www.olsson.com	

5. ALTERNATIVES ANALYSIS

5.1 Alternative Development Process

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

The primary goals of the alternative analysis were to increase channel stability, reduce erosion potential, increase conveyance capacity to reduce road overtopping, eliminate on-line detention basin overtopping in the 100-year event, remove insurable structures from the floodplain, protect utilities, and enhance water quality and environmental conditions.

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

5.2 Criteria and Constraints

Floodplain Preservation with Channel Stabilization

For the alternatives analysis, a high-level approach was taken for floodplain preservation and channel stabilization. This is due to the ever-changing approaches that can be taken for channel stabilization, and an effort to recognize the most up to date industry standards and practices.
In areas of instability, the channel corridor was analyzed to see if there was enough room to account for variances in the floodplain if the channel was realigned and regraded. The channel thalweg was observed to see if there was opportunity for grade control and a shallower longitudinal slope. Total drop height, and stable slope were not determined as a part of the alternatives analysis since these are dependent on criteria and industry standards at the time of final design. A full hydraulic analysis was not done for alternatives and will need to be fully investigated for a final design for construction of improvements. The intent of the alternatives and recommended plan are to help future Master Plan users understand what the goals and constraints are in each reach, and encourage further, in depth analysis of each problem area as they are addressed.

Capacity Improvements

All alternatives were developed using CDOT, City of Thornton, Adams County, and MHFD design criteria. A summary of the criteria used to evaluate the alternatives for the structure crossings is included in Table 11, Section 4.1. Some locations required channel grading in addition to crossing structure improvements to meet criteria. These locations are described in more detail in Section 5.6. Private, pedestrian, and golf cart crossings were not included in the alternatives analysis, unless there was a benefit to replacing them, other than reducing overtopping at the structures themselves.

Channel improvements were analyzed in areas where the improvements either remove residences from the floodplain or prevent roadway overtopping.

New detention basin alternatives were not evaluated since the channels generally have capacity for the existing infrastructure, future land use 100-year storm event. Improvements to existing on-line detention basins were investigated for the detention basins that were overtopping in events at or below the 100-year event. The existing detention basins were evaluated to determine the best approach to eliminate the 100-year spillway overtopping. Only two on-line detention basins locations were determined to have a benefit to preventing the 100-year spillway overtopping. It was determined that modifications to the outlet structure or outlet pipe would be best in both locations. Updated stage-discharge curves were added to the EPA SWMM model to determine if the spills would be eliminated and what the downstream impacts were. Neither detention basin significantly impacted downstream peak flows. A summary of the existing versus proposed detention basin stage-area-discharge curves is included in Appendix E.

Water Quality

On-line regional water quality was not considered because it does not meet MHFD and EPA requirements for water quality. Sub-regional water quality is recommended for future developments. Bank and channel improvements in areas of instability to address eroded channel alignments would implement natural water quality processes once vegetation is reestablished. This would prevent further sediment transported downstream.

5.3 Alternative Categories

The alternatives that were considered for this analysis include: maintaining the status quo, floodplain preservation with channel stabilization, capacity improvements, and water quality. Floodplain preservation is the preferred alternative; therefore, constructing a defined channel was only evaluated where there was substantial benefit. Some of the tributaries in this study were in better shape than others, so in an effort to provide clarity where improvements were investigated, Brantner Gulch and its tributaries were further subdivided from the hydraulic reaches. See the below alternatives pre-screening matrix is shown in Table 13 for alternatives considered in each reach, as well as their new descriptions.

Table 13 - Alternatives Pre-Screening Matrix

Reach	Reach Description	Status Quo	Floodplain Preservation with Channel Stabilization	Capacity Improvements	Water Quality
Brantner Gulch - Reach 5A	Railroad Tracks to Upstream Study Limits	X	X	X	X
Brantner Gulch - Reach 5B	Colorado Blvd to Railroad Tracks	X	X	X	X
Brantner Gulch - Reach 5C	Holly St to Colorado Boulevard	X	X		X
Brantner Gulch - Reach 5D	Confluence with Lakeview Tributary to Holly St	X	X	X	X
Brantner Gulch - Reach 4	Plains Tributary to Lakeview Tributary Confluence	X	X	X	X
Brantner Gulch - Reach 3A	Pedestrian Bridge to Confluence with Plains Tributary	X	X	X	X
Brantner Gulch - Reach 3B	E 128th Ave to Pedestrian Bridge	X	X	X	X
Brantner Gulch - Reach 3C	Confluence with Horizon Tributary to E 128th Avenue	X	X		X
Brantner Gulch – Reach 2	Confluence with Fairgrounds Tributary to Horizons Tributary	X	X		X
Brantner Gulch – Reach 1	Confluence with South Platte River to Confluence with Fairgrounds Tributary	X	X	X	X
Ohio Lake O.F.	Ohio Lake to confluence with Brantner Gulch	X		X	
Eastlake 2 O.F.	Eastlake 2 to Brantner Gulch	X		X	
Lakeview Tributary – Reach 1A	Confluence with Brantner Gulch to East 128th Avenue	X	X	X	X
Lakeview Tributary – Reach 1B	East 128th Avenue to Upstream Study Limits	X	X	X	X
Plains Tributary – Reach 1A	Confluence with Brantner Gulch to East 128th Avenue	X	X		X
Plains Tributary – Reach 1B	East 128th Ave to Study Limits	X		X	
Horizon Tributary – Reach 1	Brantner Gulch to Pheasants Run Tributary Confluence	X	X	X	X
Horizon Tributary – Reach 2	Pheasants Run Tributary to Upstream Study Limits	X	X	X	
Quails Way Tributary	Entire Study Reach	X			
Pheasants Run Tributary	Entire Study Reach	X	X		X
Fairgrounds Tributary	Brantner Gulch to Upstream Study Limits	X	X	X	X
South Platte River South Tributary 6	Entire Study Reach	X	X	X	X
South Platte River North Tributary 7	Entire Study Reach	X	X	X	X
Regional Park	Entire Study Reach	X		X	

Each reach should be maintained for all alternatives, including the status quo alternative. Maintenance would include weed and debris removal, vegetation management, and inspection of bridges, culverts, and drop structures for signs of potential failure.

5.4 Alternatives Hydraulics

The hydraulic analysis of the alternatives was performed in accordance with MHFD, City of Thornton, Adams County, and Northglenn criteria. The existing HEC-RAS model was modified for select alternatives to determine appropriate structure improvements to evaluate the system as a whole. Crossing structure improvements were completed for all roadways that did not meet criteria, as shown in Table 12. Trails were not included in the alternatives analysis. Detention basin alternatives were based on preventing the existing land use, future infrastructure 100-year storm event from overtopping the spillway. Improvements for the Regional Park drainage were completed in MHFD_Culvert version 3.05 and FlowMaster. Specific channel sections and slopes were not identified in the alternatives analysis. Channel improvements should meet the goals of each reach and follow the criteria at the time of final design. Alternatives were investigated per reach and are summarized in respective tables.

5.5 Alternative Costs

The construction costs of the evaluated improvements were estimated using unit costs obtained from the UD-MP Cost, Version 2.2, which adjusts unit costs based upon the most recent Colorado Construction Cost Index (CCI). The unit costs are summarized in Table 14. Costs for contingencies, engineering, legal and administration, and construction management were included as a percentage of capital improvement costs as follows: 25%, 15%, 5%, and 10%, respectively. The cost estimates will be discussed with the project sponsors and provided following review of the alternatives analysis by the sponsors.

Table 14 – Unit Costs

Item	Unit	2023 Unit Cost
Removal of culvert pipe (D<48"")	LF	
Removal of culvert pipe (48""<D<84"")	LF	
Removal of culvert pipe (D>84"")	LF	
Concrete Box Culvert Removal	LF/CELL	
48-inch RCP	LF	
Concrete	CY	
Steel	LB	
Grouted Boulders, 36-Inch	SY	
Excavation, Mid Range	CY	
Temporary Easements	EA	
Easement/ROW Acquisition	ACRE	
Culvert Maintenance	LF	
Manhole and Inlet Maintenance	EA	
Hydraulic Structure Maintenance	EA	
Channel Maintenance	LF	
Detention/WQ Maintenance	ACRE	
Mowing	ACRE	
Trail Maintenance	LF	

5.6 Alternatives Plans

Maps of the alternatives are shown on Figure 6, included at the end of this section. All alternatives were evaluated based on existing infrastructure, future land use flows. The existing conditions for the status quo alternative are shown on Figure 5. A summary of the costs for each alternative will be included in Table 15, at the end of this section, with the next submittal. The operations and maintenance cost for each alternative represents maintenance for the entire reach with the alternative improvements in place. The summary of costs includes contingencies, engineering design services, legal and administrative services, construction observation and material testing, easements, and operations and maintenance completed three times per year over a course of 50 years. Costs associated with each reach and alternative will be included in Appendix E with the next submittal.

Alternatives: Brantner Gulch Reach 5A – Railroad Tracks to Upstream Study Limits

Existing Condition

- Irregularly shaped, meandering natural channel with native grass overbanks
- On-line Ohio Lake detention pond
- Utility crossings
- Development is occurring in this reach and will pipe the channel at the outlet of Ohio Lake

Problem Areas

Stability

- Minor signs of channel instability
  - Vertical banks, with no vegetation, 1'-2' high
  - Bank failure
- Active, fast erosion between the years 2014-2020 on some outer bends
- Flow regime change as development occurs of greater than 30% for minor storm events. As development occurs, the change in flow regime will likely increase the erosion potential, and more rapidly advance areas already showing erosion

Capacity

- 100-year overtops Ohio Lake detention basin to an ill-defined path and will encroach on four insurable structures and threatens a fifth structure
- 100-year floodplain encroaches onto private property

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Channel near Karl's Farm Development

Ohio Lake Detention Basin

Ohio Lake outlet structure

Status Quo

- Maintain existing conditions – problem areas will continue to advance

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Capacity Improvements

- Modify Ohio Lake outlet structure to prevent 100-year spill and remove insurable structures from the floodplain. Lowering the top of the box and the top notch by 0.2-foot would eliminate the spillway overtopping in the 100-year event. The outflows would increase from 198 cfs to 203 cfs immediately downstream of the detention basin
- Channel improvements where floodplain encroaches onto private property. Increasing the conveyance of the trail crossing downstream of the railroad in Reach 5B was investigated, but did not impact the upstream floodplain

Improvement Goals: 2-4,7,10

Design Constraints and Considerations

- Ohio Lake:
  - Survey the full detention basin to verify stage-area prior to final design
  - Ohio Lake has an existing berm. Check if final design triggers a jurisdictional dam designation
  - Consider Brantner Gulch downstream of the detention basin will be piped with development
  - To the extent feasible, the design should try to match the FHAD 100-year peak flow of 198 cfs
  - Consider minor events and try to minimize increases in peak flows for more frequent storm events
- Channel improvements would be located in a narrow corridor with many trees and will likely require temporary construction easements

Floodplain Preservation with Channel Stabilization

- Monitor channel for changes in condition and implement channel and bank stabilization as needed
- As development occurs, implement channel stabilization to limit future erosion Implement on-site full spectrum detention and limit directly connected impervious surfaces to limit erosion potential from new development

Improvement Goals: 1-2, 5-8, 10

Design Constraints and Considerations

- No constraints

Water Quality

- Implement on-site water quality features with new development
- Preserve floodplain open channel and stabilize with new development

Improvement Goals: 1, 5-6

Design Constraints and Considerations

- No constraints

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Alternatives: Brantner Gulch Reach 5B – Colorado Boulevard to Railroad Tracks

Existing Condition

- Channel between Stellar Elementary School and Colorado Boulevard is concrete lined low flow with vegetated side slopes and engineered grade control
- Long portions of piped conveyance from Eastlake Reservoirs 2 and 3 outlets
- Channel through Eastlake Reservoir 2 and 3 are wide, flat and vegetated with no clearly defined channel
- Channel parallel to Steele Street is boulder lined

Problem Areas

Stability

- Active, fast erosion between the years 2014-2020 near trail crossing
- Flow regime change as development occurs of greater than 30% for minor storm events. As development occurs, the change in flow regime will likely increase the erosion potential, and more rapidly advance areas already showing erosion and could compromise existing crossing structures

Capacity

- 100-Year floodplain spills into Steele Street and encroaches onto private property
- Eastlake Number 2 outlet pipe surcharges in 50-year event and flows into Steele Street
- Eastlake Number 2 Overflow has potential for part of 500-year flow to travel along swale to the south, and threaten 12293 Clayton Court
- Major crossing structures that don't meet criteria
  - Surveyed Crossing 5 – Bike Path (impacts other structures and floodplain upstream)
  - Surveyed Crossing 10 – East 124th Avenue

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Boulder Lined Channel near Steele St and East 124th Avenue

Looking downstream of Railroad Tracks, at Eastlake Number 2

Downstream of railroad crossing, looking upstream

2022 Google Earth Imagery: Downstream of Eastlake Reservoir 2 Overflow




Status Quo

Improvement Goals: N/A

- Maintain existing conditions – problem areas will continue to advance

Design Constraints and Considerations

- No constraints

Capacity Improvements

Improvement Goals: 4, 10

- Supplement East 124th Avenue crossing with (1) 48-inch RCP to prevent overtopping of Steele Street and overtopping of East 124th Avenue
- The structure improvements at East 124th Avenue will also impact the surcharged Eastlake Number 2 outlet pipe in downstream segment. The proposed improvements at E. 124th Avenue eliminate the surcharging conditions in the 100-year event by lowering the tailwater condition
- Construct diversion structure to limit 500-year along each spill reach – see Eastllake 2 O.F. reach

Design Constraints and Considerations

- Utility crossings at E. 124th Avenue structure
- Improvements should consider impacts on the Eastlake Number 2 outlet pipe and ensure the water surface elevation at the pipe outlet is low enough to eliminate the existing surcharged condition

Floodplain Preservation with Channel Stabilization

Improvement Goals: 1-2, 5-7, 9

- Monitor channel for changes in condition and implement channel and bank stabilization measures, as needed
- Implement on-site full spectrum detention and limit directly connected impervious surfaces to limit erosion potential from new development

Design Constraints and Considerations

- Channel stabilization work will require coordination with the railroad to work within the railroad right-of-way

Water Quality

Improvement Goals: 1, 5-6

- Implement on-site water quality features with new development
- Preserve floodplain open channel and stabilize with new development

Design Constraints and Considerations

- No constraints

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Alternatives: Brantner Gulch Reach 5C – Holly Street to Colorado Boulevard

Existing Condition

- Irregularly shaped, meandering natural channel
- Varying side slopes of nearly vertical, 1:1 (Horizontal: Vertical), and 2:1 (Horizontal: Vertical)
- Overbanks vegetated with native grasses
- Exposed fiber optic line crossing
- 15' Riprap waterfall, protecting a sanitary sewer line crossing the channel
- Sanitary line parallels channel and crosses upstream of drop structure
- Three pedestrian bridge crossings

Problem Areas

Stability

- Channel instability along entire reach
  - Entrenchment
  - Incised low flow
  - Vertical banks, with no vegetation
  - Bank failure
  - Erosions at outfalls
  - Sediment being transported downstream
  - Pedestrian trail threatened by lateral migration of channel
- Active, fast erosion between the years 2014-2020 on some outer bends

Failure Risk

- 15-foot riprap waterfall protecting sanitary sewer line will be undermined by active head cut in future
- Exposed fiber optic line
- Natural vegetation grade control, or potentially beaver dams, are located downstream of the pedestrian bridge near the downstream end of the reach. This grade control has helped stabilize a portion of the reach upstream of the bridge, but appears to be failing

Exposure Risk

- Channel is encroaching on the sanitary line in several outer bend locations

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Looking Downstream near Skyview Elementary School

Exposed Fiber Optic Line

Unstable bank near sanitary sewer line

Status Quo

- Maintain existing conditions – problem areas will continue to advance

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Capacity Improvements

- No capacity improvements are needed for 100-year conveyance; however, channel stabilization improvements should maintain the 100-year capacity in the channel plus freeboard and not encroach onto private property

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Floodplain Preservation with Channel Stabilization

- Construct bank and channel improvements to address eroded channel – in general channel could be raised to fit within corridor with a natural channel design and provide cover over exposed fiber optic
- Realign channel to be a less erosive configuration with a multistage, natural channel to provide ecological benefits and protect sanitary sewer line and trail
- Grade control for long term stability and utility protection, including formalizing vegetation drop

Improvement Goals: 1-2, 5-9

Design Constraints and Considerations

- Sanitary sewer crossings
- Sanitary sewer line paralleling channel
- Fiber optic line crossing
- Confined channel corridor in areas

Water Quality

- Construct bank and channel improvements in areas of instability to address eroded channel alignment and implement natural water quality processes
- Revegetate bank improvements with native species

Improvement Goals: 1-2, 5-9

Design Constraints and Considerations

- Sanitary line crossing
- Sanitary sewer line paralleling channel
- Fiber optic line crossing
- Confined channel corridor in areas

Alternatives: Brantner Gulch Reach 5D – Confluence with Lakeview Tributary to Holly Street

Existing Condition

- Irregularly shaped, meandering natural channel
- Varying side slopes of nearly vertical, 1:1 (Horizontal: Vertical), and 2:1 (Horizontal: Vertical)
- Overbanks vegetated with native grasses
- Significant cattails upstream of drop structure
- Grouted boulder drop structure upstream of confluence with Lakeview Tributary
- Cutoff wall that spans channel, depth unknown
- Sanitary line parallels channel and crosses at upstream end of reach

Problem Areas

Stability

- Pedestrian trail threatened by lateral migration of channel
- Incised low flow
- Severe channel instability in areas for 400-feet upstream of Lakeview Tributary confluence
  - Entrenchment
  - Vertical banks, with no vegetation
  - Bank Failure
  - Sediment being transported downstream
  - Pedestrian trail threatened by lateral migration of channel
  - Active, fast erosion between the years 2014-2020

Failure Risk

- Grouted boulder drop structure threatened to be undermined by active head cut, compromising the stability of the channel upstream

Exposure Risk

- Sanitary sewer line on the outer bend of north side of channel. Parts of sanitary sewer line and manholes are in areas of dense wetlands, making maintenance difficult

Capacity

- 100-year floodplain threatens private property in several areas
- Upstream of compromised drop structure, significant cattails, but appears to have adequate capacity

Site Photos:

Left to Right:

Looking Downstream near Holly Street

Mid-reach

Lower reach upstream of drop structure

Between drop structure and confluence with Lakeview Tributary

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Status Quo

Improvement Goals: N/A

- Maintain existing conditions – problem areas will continue to advance

Design Constraints and Considerations

- No constraints

Capacity Improvements

Improvement Goals: 3, 10

- Maintain cattails to prevent any more overgrowth that would result in encroachment onto private property

Design Constraints and Considerations

- No constraints

Floodplain Preservation with Channel Stabilization

Improvement Goals: 1-2, 5-10

- Construct bank and channel improvements from confluence to drop structure
- Realign channel to be a less erosive configuration with a multistage, natural channel to provide ecological benefits and protect sanitary sewer line, trail, and private property
- Grade control for long term stability and protect sanitary sewer line crossings
- A stabilization design project is underway starting upstream of the Lakeview Tributary confluence. An excerpt from the CLOMR is included in Appendix E.

Design Constraints and Considerations

- Sanitary line crossing
- Sanitary sewer line paralleling channel

Water Quality

Improvement Goals: 1-2, 5-9

- Construct bank and channel improvements in areas of instability to address eroded channel alignment and implement natural water quality processes
- Revegetate bank improvements with native species

Design Constraints and Considerations

- Sanitary line crossing
- Sanitary sewer line paralleling channel

Alternatives: Brantner Gulch Reach 4 – Confluence with Plains Tributary to Confluence with Lakeview Tributary

Existing Condition

- Irregularly shaped, meandering natural channel
- Varying side slopes of nearly vertical, 1:1 (Horizontal: Vertical), and 2:1 (Horizontal: Vertical)
- Overbanks vegetated with native grasses
- Sanitary line parallels channel and crosses upstream of drop structure

Site Photos:

Left to Right:

Looking downstream at Brantner, mid reach

Confluence area with Lakeview Tributary

Problem Areas

Stability

- Signs of instability along entirety of reach
  - Entrenchment
  - Vertical banks, with no vegetation
  - Bank Failure
  - Sediment being transported downstream
  - Active head cutting threatens several private properties
- Active, fast erosion between the years 2014-2020 on some outer bends
- Lakeview confluence configuration is unstable and not ideal

Capacity

- 100-year floodplain threatens private property

Maintenance

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

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Status Quo

Improvement Goals: N/A

- Maintain existing conditions – problem areas will continue to advance

Design Constraints and Considerations

No constraints

Capacity Improvements

Improvement Goals: 3, 7, 10

- Realign channel and regrade to protect private property

Design Constraints and Considerations

- Confinement between pedestrian trail and properties in upper reach

Floodplain Preservation with Channel Stabilization

Improvement Goals: 1-2, 5-8, 10

- Construct bank and channel improvements in areas of instability to address eroded channel
- Realign channel to be a less erosive configuration with a multistage, natural channel to provide ecological benefits and protect sanitary sewer line and private property
- Grade control for long term stability and to protect sanitary sewer line crossings
- Construct maintenance access path along reach as improvements are constructed
- A stabilization design project is underway in this reach. An excerpt from the CLOMR is included in Appendix E.

Design Constraints and Considerations

- Sanitary line crossing
- Sanitary sewer line paralleling channel
- Private property

Water Quality

Improvement Goals: 1-2, 5-8, 10

- Construct bank and channel improvements in areas of instability to address eroded channel alignment and implement natural water quality processes
- Revegetate bank improvements with native species

Design Constraints and Considerations

- Sanitary line crossing
- Sanitary sewer line paralleling channel
- Private property

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Alternatives: Brantner Gulch Reach 3A – Pedestrian Bridge to Confluence with Plains Tributary

Existing Condition

- Irregularly shaped, meandering natural channel
- Varying side slopes of nearly vertical, 1:1 (Horizontal: Vertical), and 2:1 (Horizontal: Vertical)
- Overbanks vegetated with native grasses
- Grouted boulder wall and boulder drop structure upstream of pedestrian bridge
- Sanitary line parallels channel and crosses the channel three times
- Several detention pond outfalls
- Informal Confluence of Plains Tributary

Problem Areas

Stability

- Sheet flow from Plains Tributary enter Brantner Gulch over a vertical bank
- Active, fast erosion between the years 2014-2020 on some outer bends
- Significant instability for 400-feet upstream of pedestrian bridge
  - Entrenchment
  - Vertical banks, with no vegetation
  - Bank failure
  - Erosion at outfalls
  - Pedestrian trail threatened
- Similar signs of instability along entirety of reach, but non-threatening

Capacity

- Insurable structures located in the 100-year floodplain
- 100-year floodplain threatens private property

Maintenance

- There is no maintenance access path along the channel between the confluence and Quebec St.

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Brantner Gulch downstream of Confluence with Plains Tributary

Status Quo

Improvement Goals: N/A

- Maintain existing conditions – problem areas will continue to advance

Design Constraints and Considerations

- No constraints

Capacity Improvements

Improvement Goals: 3, 7, 10

- Realign channel and regrade to protect insurable structures in Adams County
- Channel improvements to protect private property in lower reach

Design Constraints and Considerations

- Channel is located on private property in Adams County

Floodplain Preservation with Channel Stabilization

Improvement Goals: 1-2, 5-10

- Formalize confluence with Plains Tributary
- Construct bank and channel improvements in areas of instability to address eroded channel
- Realign channel to be a less erosive configuration with a multistage, natural channel to provide ecological benefits and protect sanitary sewer line, trail, and private property
- Grade control for long term stability
- Retrofit existing grade control structure to be a formal drop structure
- Construct maintenance access path along reach as improvements are constructed
- A stabilization design project is underway upstream of Quebec St, see excerpt in Appendix E.

Design Constraints and Considerations

- Sanitary line crossing and line paralleling channel
- Pedestrian trail
- Parts of channel in Adams County are located on private property

Water Quality

Improvement Goals: 1-2, 5-10

- Construct bank and channel improvements in areas of instability to address eroded channel alignment and implement natural water quality processes
- Revegetate bank improvements with native species

Design Constraints and Considerations

- Sanitary line crossing and line paralleling channel
- Pedestrian trail
- Parts of channel in Adams County are located on private property

Alternatives: Brantner Gulch Reach 3B – East 128th Avenue to Pedestrian Bridge

Existing Condition

- Irregularly shaped, meandering natural channel
- Varying side slopes of nearly vertical, 1:1 (Horizontal: Vertical), and 2:1 (Horizontal: Vertical)
- Overbanks vegetated with native grasses
- Grade control structure located approximately halfway up reach
- Sanitary line parallels channel and crosses channel one time

Problem Areas

Stability

- Channel instability threatens pedestrian trail in areas
- Channel instability threatens private property in areas
- Channel instability in areas for the first 500-feet upstream of 128th Avenue
  - Entrenchment
  - Vertical banks, with no vegetation
  - Bank Failure
- Active, fast erosion between the years 2014-2020 according to LiDAR on outer bends

Exposure Risk

- Sanitary sewer line imminently at risk of being exposed in two outer bend locations at downstream reach limit
- Channel outer bends are encroaching on the sanitary line in several other locations
- Sanitary sewer crossings could be exposed with channel degradation

Capacity

- 100-year floodplain threatens and encroaches onto private property in several areas
- Major crossing structures that don't meet criteria
  - Surveyed Crossing 20 – East 128th Avenue

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Brantner Gulch upstream of East 128th Avenue

Unstable bank compromising sanitary sewer line

Stable bank near sanitary line



Status Quo

- Maintain existing conditions – problem areas will continue to advance

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Capacity Improvements

- Construct approximately 1,250 linear feet of roadway improvements along E. 128th Avenue to raise the low point 4 feet and replace the existing structure with (2) 20-foot span by 10-foot rise RCBCs. Constructing this crossing improvement would reduce the 100-year floodplain encroachment on properties upstream of the crossing, since the floodplain in this area is currently controlled by the crossing and not the channel.

Improvement Goals: 3-4, 7, 10

Design Constraints and Considerations

- Roadway connections and adjacent properties would be impacted by the roadway improvements
- Utilities in East 128th Avenue
- Consider incorporating a pedestrian crossing into the design for trail connectivity

Floodplain Preservation with Channel Stabilization

- Realign channel to be a less erosive configuration with a multistage, natural channel to provide ecological benefits and protect sanitary sewer line, trail, and private property
- Grade control for long term stability and to protect sanitary sewer line crossings

Improvement Goals: 1-2, 5-10

Design Constraints and Considerations

- Sanitary sewer line crossing
- Sanitary sewer line paralleling channel

Water Quality

- Construct bank and channel improvements in areas of instability to address eroded channel alignment and implement natural water quality processes
- Revegetate bank improvements with native species

Improvement Goals: 1-2, 5-10

Design Constraints and Considerations

- Sanitary line crossing
- Sanitary sewer line paralleling channel

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Alternatives: Brantner Gulch Reach 3C – Confluence with Horizon Tributary to East 128th Avenue

Existing Condition

- Irregularly shaped, meandering natural channel
- Varying side slopes of nearly vertical, 1:1 (Horizontal: Vertical), and 2:1 (Horizontal: Vertical)
- Overbanks vegetated with native grasses
- Grouted boulder wall and boulder drop structure halfway between confluence and E. 128th Ave.
- Cutoff wall that spans channel, depth unknown
- Sanitary line parallels channel and crosses upstream of drop structure

Problem Areas

Stability

- Channel instability along entire reach
  - Entrenchment
  - Vertical banks, with no vegetation
  - Bank Failure
  - Headcutting
  - Threatening pedestrian trail at outer bends
- Active, fast erosion between the years 2014-2020 according to LiDAR on outer bends

Failure Risk

- Boulder wall and drop structure infrastructure
  - Headcut and thalweg has dropped compromising the integrity of the structure
  - Riprap at downstream tie in location washed away
  - Boulder wall has sinkholes behind top row
- Unknow utility exposed

Exposure Risk

- Sanitary sewer line crossing upstream of grade control
- Erosion at outer bends threatening sanitary sewer line that parallels channel

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Downstream extents of boulder wall riprap unraveling

Unknown utility crossing exposed in channel

Downstream view of East 128th Ave. Crossing

General channel conditions

Status Quo

- Maintain existing conditions – problem areas will continue to advance

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Capacity Improvements

- No capacity improvements are needed for 100-year conveyance; however, channel stabilization improvements should maintain the 100-year capacity in the channel plus freeboard and not encroach onto private property

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Floodplain Preservation with Channel Stabilization

- Construct bank and channel improvements to address eroded channel
- Realign channel to be a less erosive configuration with a multistage, natural channel to provide ecological benefits and protect sanitary sewer line and trail
- Grade control for long term stability and to protect unknown utility
- Retrofit existing drop structure to repair damage

Improvement Goals: 1-2, 5-9

Design Constraints and Considerations

- 36-inch crossing of sanitary sewer line upstream of boulder drop structure
- Unknown utility crossing upstream of boulder drop structure
- Pedestrian trail to the north
- Sanitary sewer line paralleling channel

Water Quality

- Construct bank and channel improvements in areas of instability to address eroded channel alignment and implement natural water quality processes
- Revegetate bank improvements with native species

Improvement Goals: 1-2, 5-9

Design Constraints and Considerations

- 36-inch crossing of sanitary sewer line upstream of boulder drop structure
- Unknown utility crossing upstream of boulder drop structure
- Pedestrian trail to the north
- Sanitary sewer line paralleling channel

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Alternatives: Brantner Gulch Reach 2 – Confluence with Fairgrounds Tributary to Confluence with Horizon Tributary

Existing Condition

- Irregularly shaped, meandering natural channel
- Varying side slopes of nearly vertical, 1:1 (Horizontal: Vertical), and 2:1 (Horizontal: Vertical)
- Eroded banks on outside bends, and generally unvegetated or poorly vegetated
- Overbanks vegetated with native grasses.
- Informal confluence with Fairgrounds Tributary – tributary spills over the Brantner Gulch bank
- Formal confluence with Horizon Tributary
- Sanitary sewer crossing at Farigrounds Tributary confluence

Problem Areas

Stability

- Channel instability throughout entire reach include:
  - Entrenchment
  - Vertical banks, with no vegetation
  - Bank Failure
  - Headcutting
- Active, fast erosion between the years 2014-2020 according to LiDAR on outer bends
- Confluence with Horizon Tributary
  - Horizon Tributary enters Brantner at a 90-degree angle
  - Vertical banks, without vegetation
  - Entrenchment

Exposure Risk

- Sanitary sewer crossing at Fairgrounds Tributary is in more stable area, but has potential to become exposed, especially as the Fairgrounds Tributary watershed continues to develop

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Confluence of Brantner Gulch and Horizon Tributary

General channel conditions

Confluence of Brantner Gulch and Fairgrounds Tributary



Status Quo

- Maintain existing conditions – problem areas will continue to advance

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Capacity Improvements

- No capacity improvements are needed for 100-year conveyance; however, channel stabilization improvements should maintain the 100-year capacity in the channel plus freeboard and not encroach onto private property

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Floodplain Preservation with Channel Stabilization

- Construct bank and channel improvements to address eroded channel
- Implement a multistage channel to provide ecological benefits and protect sanitary sewer line
- Address stabilization issues at Horizon Tributary confluence
- Grade control for long term stability and to protect sanitary sewer crossing
- Formalize confluence between Brantner Gulch and Fairgrounds Tributary

Improvement Goals: 1-2, 5-8

Design Constraints and Considerations

- 36-inch crossing of sanitary sewer line near confluence with Fairgrounds Tributary
- Hydraulic incorporation of Horizon Tributary

Water Quality

- Construct bank and channel improvements in areas of instability to address eroded channel alignment and implement natural water quality processes
- Revegetate bank improvements with native species
- Formalize confluence between Brantner Gulch and Horizon

Improvement Goals: 1-2, 5-8

Design Constraints and Considerations

- 36-inch crossing of sanitary sewer line near confluence with Fairgrounds Tributary
- Hydraulic incorporation of Horizon Tributary

Alternatives: Brantner Gulch Reach 1 – Confluence with South Platte River to Confluence with Fairgrounds Tributary

Existing Condition

- Natural channel between the confluence with Fairgrounds Tributary and the upstream-most golf cart crossing
- Straight, concrete-lined channel through golf course to Mann-Nyholt Lakes
- Rest of reach routed through Mann-Nyholt Lakes to the South Platte River
- Two lateral aerial pipe crossings

Problem Areas

Stability

- The concrete-lined channel is stable in its current condition; however, the concrete lining is deteriorating and spalling in some areas and vegetation is growing within the concrete
- Some signs of an incision along the low flow upstream of Riverdale Road

Capacity

- Issues from Riverdale Road to upstream of Mann Nyholt Lake
  - Flows will spill out of the channel to the north, across the golf course to South Platte River South Tributary 6, and to the south across Henderson Road and into the pits
- Insurable structures located in the 100-year floodplain
- Major crossing structures that don't meet criteria:
  - Surveyed Crossing 21 – Riverdale Road
  - Surveyed Crossing 32 – Park Bouolevard

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Reach Specific Goals

11. Avoid conflict with the Brantner Gulch Irrigation Ditch
12. Limit impact to the golf course during storm events
13. Enhance water quality of golf course

Site Photos:

Looking upstream at Brantner Gulch, near Park Boulevard and Golf Course Way

Status Quo

Improvement Goals: N/A

- Maintain existing conditions – problem areas will continue to advance

Design Constraints and Considerations

- No constraints

Capacity Improvements

Improvement Goals: 2-10

- Implement channel and crossing improvements as defined in the Adams County Regional Park & Fairgrounds Master Plan, which realigns the channel to represent a more historic alignment. An excerpt from the 2006 Preliminary Design of the channel improvements is included in Appendix E.
- The channel would provide protection for storm events between the 25-50-year event, nearly eliminating the north spill and reducing the south spill out of Brantner Gulch in the 100-year event, and remove the insurable structures from the 100-year Brantner Gulch floodplain
- Major crossing structure improvements:
  - Remove the fill that was placed in the Riverdale Road crossing to increase the capacity, incorporate grade control upstream. Full downstream channel improvements could be implemented, or just the upstream portion of channel improvements to tie into the lower culvert invert
  - Replace the Park Boulevard crossing with an (3) 16-foot by 10-foot RCBC to meet 100-year capacity
  - The Brantner Ditch crossing would consist of (3) 20-foot by 6-foot RCBC to prevent 100-year overtopping
  - Channel realignment will allow for the removal of several existing golf cart crossings. In areas where a crossing is still required, bridges spanning between 150-250 feet are likely to span channel improvements. Smaller crossings can be considered as an alternative to spanning the channel

Design Constraints and Considerations

- Brantner Ditch – maintain clearance from RCBC to bottom of ditch
- Impacts to golf course infrastructure and playability include: several holes where the course has the fairway crossing the channel, tee boxes close to the existing channel, course water hazards
- Improvements should be designed in consideration of golf course master plan
- Lateral aerial pipe crossings

Floodplain Preservation with Channel Stabilization

Improvement Goals: 2-10

- Monitor low flow between Fairgrounds Tributary and upstream-most golf cart
- Replace concrete channel with a natural channel to provide ecological benefits. This alternative is further defined in the capacity improvements alternative section, including constraints

Design Constraints and Considerations

- No constraints upstream of golf course. Constraints for channel improvements are included in capacity alternatives section

Water Quality

Improvement Goals: 2-10

- Replace the existing concrete-lined channel with a natural channel alignment to implement natural water quality processes

Design Constraints and Considerations

- Same constraints as listed in capacity improvement section

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Alternatives: Ohio Lake O.F.

Existing Condition

- Informal spill
- Ill-defined grass, flat spill path
- Concrete pan, with grass side slopes
- Will flow along roadways as well

Problem Areas

Capacity

- 100-year overtops Ohio Lake spillway
- 100-year event will overtop Washington Center Parkway
- Spill in between Red Hawk Ranch and Karl's Farm Development encroaches onto private property
- 4 insurable structures located in the floodplain and a fifth is threatened

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Ohio Lake

Spill between Red Hawk Ranch and Karl's Farm Development

Potential Spill Path

Potential Spill Path




Status Quo

- Maintain existing conditions – problem areas will continue to threaten private property

Design Constraints and Considerations

- No constraints

Improvement Goals: N/A

Capacity Improvements

- Eliminate Ohio Lake spillway overtopping, as described in Brantner 5A reach. No capacity improvements along the spill path are included, since they would be more extensive than eliminating the 100-year spill

Design Constraints and Considerations

- See Brantner 5A reach

Improvement Goals: 4, 10

Floodplain Preservation with Channel Stabilization

- No stabilization improvements were evaluated

Design Constraints and Considerations

- No constraints

Improvement Goals: N/A

Water Quality

- No water quality improvements were evaluated as they relate to the spill

Design Constraints and Considerations

- No constraints

Improvement Goals: N/A

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Alternatives: Eastlake 2 O.F.

Existing Condition

- Formal 500-year spill
- Street flow
  - 123rd Avenue
  - Filmore Court
  - 124th Avenue

Site Photos:

Left to Right:

2022 Google Earth Streat view – Swale on left

Problem Areas

Capacity

- Eastlake Number 2 Overflow has potential for part of 500-year flow to travel along swale to the south, and threaten 12293 Clayton Court
- Eastlake Number 2 Overflow 500-year flow encroaches onto private properties along roadways

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Status Quo

- Maintain existing conditions – problem areas will continue to threaten private properties

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Capacity Improvements

- Install formal diversion structure to split the 500-year overflows
  - 128 cfs of flow along 123rd Avenue
  - 65 cfs of flow along swale, routing around 12293 Clayton Court property

Because the spill is a 500-year spill, the intent is not to fully remove private properties form the 500-year spill, but rather better control the spill paths to limit damage during the 500-year event to the extent practicable

Improvement Goals: 4, 10

Design Constraints and Considerations

- Private property acquisition/ROW

Floodplain Preservation with Channel Stabilization

- None recommended

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Water Quality

- None recommended

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Alternatives: Lakeview Tributary Reach 1A – Confluence with Brantner Gulch to East 128th Avenue

Existing Condition

- Generally trapezoidal with areas of irregular geometry
- Channel widens and flattens near confluence
- Meandering natural channel
- Dense vegetation in channel bottom
- Overbanks vegetated with native grasses
- Sheet pile check structures with riprap
- On-line detention basin

Problem Areas

Stability

- Confluence with Brantner Gulch configuration is not ideal

Capacity

- Berm 570 feet upstream of confluence causing pinch point in floodplain
- Dense vegetation in low flow
- Detention basins that overtop the spillway in a 100-year event or less:
  - Surveyed Crossing 44 – Sidewalk overtops in 100-year event

Exposure Risk

- Grade control protecting sanitary crossing upstream of confluence
- Erosion at sheet pile check structures

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

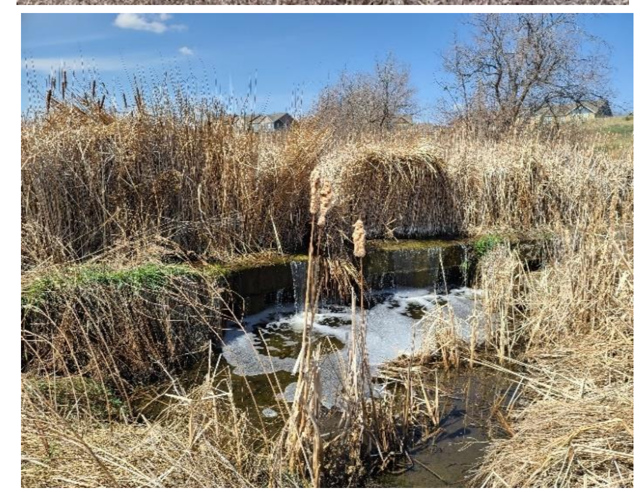
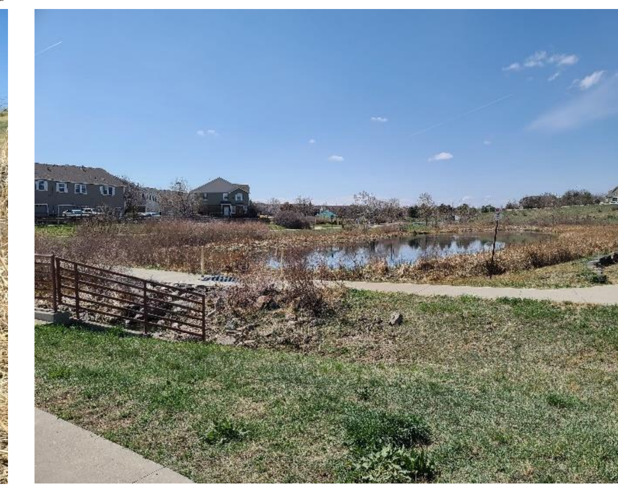
Lakeview Tributary and Brantner Gulch Confluence

Channel conditions upstream of confluence

Sheet pile check structure downstream of Sage Creek Park

Looking upstream at Sage Creek Park detention basin outlet



Status Quo

Improvement Goals: N/A

- Maintain existing conditions – problem areas will continue to advance

Design Constraints and Considerations

- No constraints

Capacity Improvements

Improvement Goals: 3-4

- Remove berm 570 feet upstream of confluence
- Vegetation management
- Detention basins:
  - Surveyed Crossing 44 – Although the on-line detention basin overtops the spillway in the 100-year event, the spill will flow over the trail and directly back into the channel downstream. The immediate downstream trail will not overtop in a 100-year event and the tributary has adequate capacity for the future 100-year floodplain. No detention improvements are recommended.

Design Constraints and Considerations

- No constraints

Floodplain Preservation with Channel Stabilization

Improvement Goals: 1-2, 5-8

- Formalize confluence with Brantner Gulch
- Formalize grade control to protect sanitary sewer near Brantner Gulch confluence
- Formalize drop structures at sheet pile check structure for long term stability
- Remove berm 570 feet upstream of confluence

Design Constraints and Considerations

- Sanitary sewer line crossings
- Dense vegetation

Water Quality

Improvement Goals: 1-2, 5-8

- Construct bank and channel improvements in areas of instability to address eroded channel alignment and implement natural water quality processes
- Revegetate bank improvements with native species

Design Constraints and Considerations

- Sanitary sewer line crossing just upstream of confluence with Brantner

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Alternatives: Lakeview Tributary Reach 1B – East 128th Avenue to Upstream Study Limits

Existing Condition

- Generally trapezoidal with areas of irregular geometry
- Meandering natural channel
- Vegetation in the low flow
- Overbanks vegetated with native grasses
- Sheet pile check structures with riprap
- On-line detention basin

Problem Areas

Capacity

- Detention basins that overtop the spillway in a 100-year event or less:
  - Surveyed Crossing 42 – Holly Street overtops in 50-year event

Exposure Risk

- Erosion at sheet pile check structures

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Detention basin upstream of Holly Street

Holly Street detention basin outlet structure


Status Quo

- Maintain existing conditions – problem areas will continue to advance

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Capacity Improvements

- Holly Street Detention Basin
  - Outlet is controlled by the outlet pipe size at the overflow structure. Verify outlet pipe sizes and elevations at the overflow box and update stage-discharge calculations as needed to ensure improvements are needed
  - Remove and replace outlet pipes to increase conveyance capacity, targeting a maximum outflow of the FHAD 100-year event

Improvement Goals: 4

Design Constraints and Considerations

- Holly Street Detention
  - Utilities in Holly Street

Floodplain Preservation with Channel Stabilization

- Formalize drop structures at sheet pile check structure for long term stability

Improvement Goals: 1-2, 5-6

Design Constraints and Considerations

- Dense vegetation

Water Quality

- Formalize drop structures at sheet pile check structure for long term stability

Improvement Goals: 1-2, 5-6

Design Constraints and Considerations

- Dense vegetation

Alternatives: Plains Tributary Reach 1A – Confluence with Brantner Gulch to East 128th Avenue

Existing Condition

- Generally trapezoidal with areas of irregular geometry
- Channel widens and flattens near confluence
- Meandering natural channel
- Dense vegetation in the low flow
- Overbanks vegetated with native grasses
- Sheet pile check structure

Site Photos:

Left to Right:

Brantner Gulch confluence with Plains Tributary entering on the left

Looking upstream at Plains Tributary

Problem Areas

Stability

- Channel instability at confluence with Brantner Gulch
- Flows spread out upstream of the confluence, no formal channel
- Although mostly stable in its existing conditions, development is occurring adjacent to the channel in this reach. The change in flow regime will likely cause instability in the channel downstream of where the development flows come into the channel

Exposure Risk

- Sanitary crossing upstream of confluence

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Status Quo

Improvement Goals: N/A

- Maintain existing conditions – problem areas will continue to advance

Design Constraints and Considerations

- No constraints

Capacity Improvements

Improvement Goals: N/A

- None recommended

Design Constraints and Considerations

- No constraints

Floodplain Preservation with Channel Stabilization

Improvement Goals: 1-2, 5-6, 8

- Formalize confluence with Brantner Gulch
- Implement a multistage channel at the downstream end to provide a defined flow path and provide ecological benefits as development occurs
- Grade control to protect sanitary sewer
- Grade control along reach as development occurs for stability
- Formalize sheet pile grade control for long term stability

Design Constraints and Considerations

- Sanitary sewer line crossing near confluence
- Property line to the east

Water Quality

Improvement Goals: 1-2, 5-6, 8

- Construct bank and channel improvements in areas of instability to address eroded channel alignment and implement natural water quality processes
- Revegetate bank improvements with native species

Design Constraints and Considerations

- Sanitary sewer line crossing near confluence

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Alternatives: Plains Tributary Reach 1B – East 128th Avenue to Upstream Study Limits

Existing Condition

- Generally trapezoidal with areas of irregular geometry
- Natural channel
- Dense vegetation in the low flow
- Overbanks vegetated with native grasses
- Sheet pile grade control structures with riprap
- On-line detention basin

Site Photos:

Left to Right:

Plains Tributary grade control

Channel Conditions

Channel conditions at 130th Avenue

Upstream channel conditions near Kearney Way




Problem Areas

Capacity

- Dense willows and cattails in places

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Status Quo

- Maintain existing conditions – Channel shall be monitored for changes in conditions

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Capacity Improvements

- Vegetation management as needed so that channel capacity stays adequate

Improvement Goals: 1

Design Constraints and Considerations

- No constraints

Floodplain Preservation with Channel Stabilization

- No improvements evaluated

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Water Quality

- No improvements evaluated

Improvement Goals: N/A

Design Constraints and Considerations

- No constraints

Alternatives: Horizon Tributary Reach 1 – Confluence with Brantner Gulch to Confluence with Pheasants Run Tributary

Existing Condition

- Generally trapezoidal with areas of irregular geometry
- Meandering natural channel
- Dense vegetation in the low flow
- Overbanks vegetated with native grasses
- Sheet pile check structures
- On-line detention basin

Problem Areas

Stability

- Brantner Gulch Confluence
  - Channel conditions and configuration is unstable
- Channel instability for downstream 1,300 feet
  - Entrenchment
  - Vertical banks, with no vegetation
  - Bank failure
  - Erosion at outfalls
  - Pedestrian trail threatened by sinkholes
- Burn area upstream of Valentia Street

Capacity

- Floodplain encroaching onto private property
- Detention basin Survey Number 74 overtops spillway in the 100-year event

Exposure Risk

- Erosion at sheet pile check structures
- Sanitary sewer crossing threatened by erosion

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Brantner Gulch Confluence with Horizon Tributary

Exposed sheet pile with scour hole

General channel conditions

On-line detention basin outlet




Status Quo

Improvement Goals: N/A

- Maintain existing conditions – problem areas will continue to advance

Design Constraints and Considerations

- No constraints

Capacity Improvements

Improvement Goals: 3, 7, 10

- Vegetation management as needed to maintain adequate capacity. It appears that vegetation management can eliminate the 100-year floodplain encroachment onto private property
- Although the on-line detention basin overtops the spillway in the 100-year event, the spill will flow over the trail and directly back into the channel downstream. The tributary generally has adequate capacity for the future 100-year floodplain with only minor areas where there is encroachment. No detention improvements are recommended.

Design Constraints and Considerations

- Confinement between pedestrian trail and properties

Floodplain Preservation with Channel Stabilization

Improvement Goals: 1-2, 5-10

- Formalize confluence with Brantner Gulch
- Channel improvements and grade control for downstream 550 feet
- Formalize drop structures at sheet pile check structures for long term stability
- Minor channel improvements upstream of lower 550 feet where drop structures are formalized
- Revegetate burn area upstream of Valentia Street to prevent erosion and sediment transport

Design Constraints and Considerations

- Sanitary line crossing at pedestrian trail

Water Quality

Improvement Goals: 1-2, 5-10

- Construct bank and channel improvements at the confluence to address eroded channel alignment and implement natural water quality processes
- Revegetate confluence improvements with native species
- Revegetate burn area upstream of Valentia Street to prevent erosion and sediment transport

Design Constraints and Considerations

- Sanitary line crossing at pedestrian trail

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Alternatives: Horizons Tributary Reach 2 – Confluence with Pheasants Run Tributary to Upstream Study Limits

Existing Condition

- Generally trapezoidal with areas of irregular geometry
- Meandering natural channel
- Dense vegetation in the low flow
- Overbanks vegetated with native grasses
- Sheet pile check structures
- Grouted boulder grade control structures
- On-line detention basin

Problem Areas

Capacity

- Major crossing structures that don't meet criteria:
  - Surveyed Crossing 58 – Holly Street
  - Surveyed Crossing 59 – E. 136th Avenue
- Dense vegetation in channel

Exposure Risk

- Erosion at sheet pile check structures

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Channel conditions upstream of Quebec Street

Spillway at Marshall

Channel Conditions downstream of Holly Street

Holly Street crossing blocked




Status Quo

Improvement Goals: N/A

- Maintain existing conditions – problem areas will continue to advance

Design Constraints and Considerations

- No constraints

Capacity Improvements

Improvement Goals: 4

- Major crossing structures:
  - Surveyed Crossing 58 – Holly Street: When inadvertent detention is considered at this crossing, Holly Street is not overtopped; however, the 100-year would be 19 feet deep and is at a high school. To meet headwater to depth criteria in a 100-year event to improve safety at the crossing, the existing structure would be supplemented with a 72" RCP
  - Surveyed Crossing 59 – E. 136th Avenue: Supplement existing structure with (1) 36-inch RCP to meet 100-year capacity. The crossing does not currently overtop in the 100-year and is a low priority.
- Vegetation management as needed to maintain adequate capacity

Design Constraints and Considerations

- Utility crossings
- Nearby high school

Floodplain Preservation with Channel Stabilization

Improvement Goals: 1,2, 5-7

- Formalize drop structures at sheet pile check structures for long term stability
- Monitor channel and implement additional channel and bank stabilization, if needed

Design Constraints and Considerations

- No constraints

Water Quality

Improvement Goals: N/A

- No improvements recommended

Design Constraints and Considerations

- No constraints

Alternatives: Quails Way Tributary

Existing Condition

- Meandering natural channel
- Dense vegetation in the low flow
- Overbanks vegetated with native grasses

Problem Areas

- No observed problems

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Channel downstream of East 136th Avenue

Status Quo

- Maintain existing conditions – Channel shall be monitored for changes in conditions

Design Constraints and Considerations

- No constraints

Improvement Goals: N/A

Capacity Improvements

- No improvements recommended

Design Constraints and Considerations

- No constraints

Improvement Goals: N/A

Floodplain Preservation with Channel Stabilization

- No improvements recommended

Design Constraints and Considerations

- No constraints

Improvement Goals: N/A

Water Quality

- No improvements recommended

Design Constraints and Considerations

- No constraints

Improvement Goals: N/A

Alternatives: Pheasants Run Tributary

Existing Condition
- Generally trapezoidal with areas of irregular geometry
- Meandering natural channel
- Dense vegetation in the low flow
- Overbanks vegetated with native grasses
- Check structures

Problem Areas
- No observed problems
- Flow regime change as development occurs of greater than 30% for minor storm events. As development occurs, the change in flow regime will likely increase the erosion potential, and current stable areas may begin to erode

Site Photos:

Left to Right:

Pheasants Run at confluence with Horizon Tribtutary

Pheasants Run downstream of Quebec Street

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Status Quo
- Maintain existing conditions – Channel shall be monitored for changes in conditions

Design Constraints and Considerations
- No constraints

Improvement Goals: N/A

Capacity Improvements
- No improvements recommended

Design Constraints and Considerations
- No constraints

Improvement Goals: N/A

Floodplain Preservation with Channel Stabilization
- Formalize drop structures at sheet pile check structures for long term stability
- As development occurs, implement channel stabilization to limit erosion potential
- Implement on-site full spectrum detention and limit directly connected impervious surfaces to limit erosion potential from new development

Design Constraints and Considerations
- Upper reach is located on private property

Improvement Goals: 1-2

Water Quality
- Formalize drop structures at sheet pile check structures for long term stability
- Implement on-site water quality features with new development
- Preserve floodplain open channel and stabilize with new development

Design Constraints and Considerations
- Upper reach is located on private property

Improvement Goals: 1-2, 5-6

Alternatives: Fairgrounds Tributary – Confluence with Brantner Gulch to Upstream Study Limits

Existing Condition

- Generally trapezoidal with areas of irregular geometry
- Meandering natural channel
- Dense vegetation in the low flow
- Overbanks vegetated with native grasses
- Sheet pile check structures
- Grouted boulder grade control structures
- On-line detention basins

Problem Areas

Stability

- Headcutting beginning to appear near Brantner Gulch
- No formal channel for downstream 550 feet of channel
- Channel instability in several areas
- Flow regime change as development occurs of greater than 30% for minor storm events for the whole reach and greater than 30% for major events as well upstream of Uinta Street. As development occurs, the change in flow regime will likely increase the erosion potential, and current stable areas may begin to erode.

Capacity

- Floodplain encroaching onto private property

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Channelization beginning to headcut up Fairgrounds Tributary

Channelization beginning to headcut just upstream of Brantner Confluence

Looking downstream Fairgrounds Tributary at pedestrian crossing

General channel conditions

Status Quo

Improvement Goals: N/A

- Maintain existing conditions – problem areas will continue to advance

Design Constraints and Considerations

- No constraints

Capacity Improvements

Improvement Goals: 3, 7, 10

- Channel improvements to remove floodplain from private property

Design Constraints and Considerations

- Confinement between pedestrian trail and properties

Floodplain Preservation with Channel Stabilization

Improvement Goals: 1-2

- Formalize channel at downstream 550 feet
- Formalize confluence with Brantner Gulch
- Formalize drop structures at sheet pile check structures for long term stability
- As development occurs, implement channel stabilization to limit erosion potential
- Implement on-site full spectrum detention and limit directly connected impervious surfaces to limit erosion potential from new development

Design Constraints and Considerations

- Sanitary line crossing Fairgrounds Tributary
- Sanitary sewer line crossing Brantner Gulch near confluence

Water Quality

Improvement Goals: 1-2, 5-6

- As development occurs, implement channel stabilization to limit erosion potential
- Implement on-site water quality features with new development
- Preserve floodplain open channel and stabilize with new development

Design Constraints and Considerations

- No constraints

Alternatives: South Platte River South Tributary 6

Existing Condition

- Irregular, natural grass lined channel geometry upstream of Yosemite Street
- Portion piped below Yosemite Street with 100-year capacity
- Poorly defined channel through low points in golf course to confluence with South Platte River North Tributary 7
- Turf in the low flow

Site Photos:

Left to Right:

Looking downstream at South Platte River South Tributary 6 from Riverdale Road

Problem Areas

Stability

- Flow regime change as development occurs of greater than 30% for minor storm events for the whole reach. As development occurs, the change in flow regime will likely increase the erosion potential, and current stable areas through the golf course may begin to erode

Capacity

- Flows from minor events spill to the south in the golf course 1,200 feet downstream of Riverdale Road
- Sheet flow across 4-H Arena
- Insurable structures located in the 100-year floodplain
- Major crossing structures that don't meet criteria:
  - Surveyed Crossing 91 - Riverdale Road

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Status Quo

Improvement Goals: N/A

- Maintain existing conditions – problem areas will continue to advance

Design Constraints and Considerations

- No constraints

Capacity Improvements

Improvement Goals: 3-4, 7, 10

- Alternative 1: Pipe flows up to the 100-year event from Riverdale Rd to the east in a 7-foot (S) x 4-foot (R) RCBC, transitioning to a 14-foot (S) x 4-foot (R) RCBC at a flatter slope underneath Brantner Agricultural Ditch
  - Channel daylights downstream of Brantner Agricultural Ditch to an open channel that conveys the 100-year event to South Platte River Tributary 7
  - Channel corridor required is approximately 60-foot
- Alternative 2: Pipe flows up to the 100-year event from Riverdale Rd to the south in a 7-foot (S) x4-foot (R) RCBC
  - Channel daylights an open channel that conveys the 100-year event to Brantner Gulch
  - Channel will require grade control
- Major crossing structures that don't meet criteria:
  - Surveyed Crossing 91 - Riverdale Road: Supplement existing crossing with (1) 48-inch RCP to meet 100-year criteria and prevent 100-year overtopping

Design Constraints and Considerations

- Utility conflicts
- Golf course infrastructure impacts

Floodplain Preservation with Channel Stabilization

Improvement Goals: 1-2, 10

- Channel upstream of Yosemite Street shall be monitored for changes in conditions and channel stabilization implemented as needed
- Drainage path through golf course shall be monitored and improvements implemented as needed
- Implement on-site full spectrum detention and limit directly connected impervious surfaces to limit erosion potential from new development

Design Constraints and Considerations

- Channel and 100-year floodplain are located on private property upstream of Yosemite Street

Water Quality

Improvement Goals: 5

- Implement on-site water quality features with new development

Design Constraints and Considerations

- No constraints

Alternatives: South Platte River North Tributary 7

Existing Condition

- Irregular, natural grass lined channel geometry upstream of Riverdale Road
- Poorly defined, turf swales through golf course to confluence with South Platte River
- Portion of downstream channel is routed through Fishing is Fun Pond

Problem Areas

Stability

- Flow regime change as development occurs of greater than 30% for minor storm events for the whole reach and greater than 30% for major events as well upstream of Riverdale Street. As development occurs, the change in flow regime will likely increase the erosion potential, and current stable areas may begin to erode.

Capacity

- Flows split and spill through golf course area
- Flows spill over East 136th Avenue, but eventually make it back to the South Platte River
- Major crossing structures that don't meet criteria:
  - Surveyed Crossing 92 – Future Yosemite Street
  - Surveyed Crossing 93 - East 136th Avenue
  - Surveyed Crossing 94 – Riverdale Road

Maintenance

- There is no maintenance access path along this drainageway upstream of Riverdale Road

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Channel looking downstream at E. 136th Avenue

Channel looking upstream at E. 136th Avenue

Status Quo

Improvement Goals: N/A

- Maintain existing conditions – problem areas will continue to advance

Design Constraints and Considerations

- No constraints

Capacity Improvements

Improvement Goals: 3-4, 7

- Increase channel capacity at upstream portion of golf course to prevent 100-year spill
- Major crossing structures:
  - Surveyed Crossing 92 – Future Yosemite Street: Remove existing (1) 72-inch CMP and replace with (1) 72-inch RCP when roadway is extended to meet 100-year criteria
  - Surveyed Crossing 93 - East 136th Avenue: Construct approximately 360 linear feet of roadway improvements along E. 136th Avenue to raise the low point 2.2 feet and replace the existing structure with (1) 12-foot span by 6-foot rise RCBC
  - Surveyed Crossing 94 – Riverdale Road: Remove existing 48-inch CMP and replace with 10-foot (S) x 8-foot (R) RCBC. Grading and grade control required upstream and downstream of culvert to lower the culvert inverts approximately 6.5' to prevent 100-year overtopping
  - Brantner Ditch – Install (1) 12-foot (S) x 6-foot (R) RCBC

Design Constraints and Considerations

- Utility conflicts
- Golf course infrastructure impacts
- Ditch crossing

Floodplain Preservation with Channel Stabilization

Improvement Goals: 1-2, 7

- Drainage path through golf course shall be monitored and channel stabilization improvements implemented as needed
- As development occurs, stabilize channel to limit erosion potential upstream of Riverdale Road
- Implement on-site full spectrum detention and limit directly connected impervious surfaces to limit erosion potential from new development
- Construct maintenance access path as improvements are constructed

Design Constraints and Considerations

- No constraints
- Upstream of Yosemite Street, the channel is located on private property

Water Quality

Improvement Goals: 5

- Implement on-site water quality features with new development

Design Constraints and Considerations

- No constraints

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Alternatives: Regional Park Drainage

Existing Condition

- Meandering natural channels
- No formal crossings at E. 136th Avenue or Riverdale Road
- Flows intercepted by Brantner Ditch

Problem Areas

- No defined path downstream of Riverdale Road
- Spills into Brantner Ditch
- Major crossing structures that don't meet criteria:
  - East 136th Avenue
  - Riverdale Road

Improvement Goals

Overall Goals

1. Preservation of floodplain
2. Stable channel conditions
3. Increased channel conveyance capacity
4. Increased crossing conveyance capacity
5. Improved water quality
6. Increased ecological value
7. Incorporation of the latest findings related to the design of high functioning, low-maintenance streams and bioengineering
8. Protect existing utilities
9. Protect existing trails
10. Protect private property

Site Photos:

Left to Right:

Channel upstream of East 136th Avenue and Riverdale Road

Brantner Ditch downstream of Riverdale Road

Status Quo

Improvement Goals: N/A

- Maintain existing conditions – Channel shall be monitored for changes in conditions

Design Constraints and Considerations

- No constraints

Capacity Improvements

Improvement Goals: 3-4, 7

- Direct all flows toward Riverdale Road and eliminate East 136th Ave overtopping. Flows in the Riverdale Bluffs area would have a total 100-year peak flow of 92 cfs at Design Point S104 and 9 cfs at Design Point RP102
- Grade a defined natural channel downstream of Riverdale Road
- Grade control or drop manholes would be required to achieve necessary
- Major crossing structures:
  - Future Regional Park Access Road: Install (2) 36-inch RCP
  - Riverdale Road/Brantner Agricultural Ditch/future pedestrian crossing: Install 8-foot (S) x 2-foot (R) RCBC

Design Constraints and Considerations

- Utility conflicts
- Brantner Ditch
- Improvements should consider Riverdale Bluffs design project. An excerpt from the master plan is included in Appendix E

Floodplain Preservation with Channel Stabilization

Improvement Goals: N/A

- No improvements recommended

Design Constraints and Considerations

- No constraints

Water Quality

Improvement Goals: N/A

- No improvements recommended

Design Constraints and Considerations

- No constraints

PROJECT: 018-2897 DRAWN BY: ELB DATE: 6/06/2023	MILE HIGH FLOOD DISTRICT, CITY OF THORNTON, NORTHGLENN, & ADAMS COUNTY	BRANTNER GULCH MDP ALTERNATIVES FIGURE	FIGURE 6

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Table 15 – Alternative Cost Summary

5.7 Benefit Cost Analysis

A benefit-cost analysis (BCA) was prepared only for portions of alternatives that removed habitable structures from the 100-year floodplain to help quantify the flood damage savings that could be realized with these alternatives and determine how those savings relate back to the cost of each alternative. The benefit-cost analysis will be completed with the next submittal and will be summarized in Table 16.

Table 16 - Benefit-Cost Analysis

Alternative	Reach	Construction Cost	Quantitative Benefit Over 50-years	Benefit-Cost Ratio
Capacity Improvements at Ohio Lake	Brantner 5A/ Ohio Lake O.F.			
Capacity Improvements	Brantner 3A			
Capacity Improvements	Brantner 1			
Capacity Improvements	SPRS Trib 6			
Recommended Plan[1]				

[1]Costs reflect only alternatives in the recommended plan that are directly connected with removing structures from the floodplain

5.8 Evaluation of Alternatives

In evaluating the alternatives, the improvements were evaluated not only based on costs, but also on qualitative aspects. The following quantitative and qualitative aspects were considered in the alternatives analysis:

- Public safety
- Meeting the City's or local jurisdiction's policies
- Cost
- Flood protection
- Operations and maintenance
- Stream stability
- Right-of-way acquisition or easements
- Public and property owner acceptance
- Water quality and environmental impacts
- Aesthetics

When the hydraulic analysis of future conditions 100-year improvements was complete, the feasibility of each alternative with respect to qualitative aspects was evaluated. The recommended alternative provides the highest benefit when considering quantitative and qualitative aspects of the project. An alternatives evaluation matrix was then completed to help determine the Recommended Plan. Each component of the matrix was assigned a percentage weight and each alternative was evaluated on a scale of one to three, with three being the most beneficial rating. The alternatives evaluation matrix is shown in Table 17.

5.9 Recommended Plan

This section provides a summary of the recommended plan. See Section 5.6 for a full description of each alternative. The Recommended Plan was chosen based on a combination of quantitative and qualitative measurements. A legal opinion was provided by MHFD and is included in Appendix D. The recommended improvements are shown in Figure 6, improvement costs will be summarized in Table 18 in the next submittal, and detailed costs will be shown in Appendix E. The Recommended Plan consists of:

- Floodplain preservation with channel stabilization in all reaches, which also encompasses water quality improvements.
- All capacity improvements, expect the SPRS Tributary 6 Alternative 1 alignment. The Alternative 2 alignment will route peak flows to Brantner Gulch and will be a shorter path than trying to route flows through the ill-defined paths in the golf course area. The Brantner Ditch crossing along Alignment 2 also would have minimal cover. Additionally, due to the timing of peak flows, the additional flows will not significantly impact the Brantner Gulch improvements.

  The SPRS Tributary 6 and SPRN Tributary 7 golf course improvements are recommended to be constructed considering both minor and major events, as the improvements are more limited in nature. The Brantner Gulch improvements as shown in the 2006 Preliminary Design are significant and could be reduced to provide a lower level of protection as deemed necessary by Adams County, as the majority of the problem areas are located on the golf course property. Either all channel and crossing improvements could be reduced for a lower level of protection, or, alternatively, the channel improvements, Brantner Ditch, and Park Boulevard improvements could be designed for more major event conveyance, while the remaining golf cart crossings could be reduced to minor event crossings.
- Future development should implement private detention and water quality facilities, per criteria, and maximize volume reduction best management practices to the extent practicable.

The main themes in the recommended plan were to provide sufficient capacity at crossings to eliminate overtopping, to remove habitable structures from the floodplain, to remedy floodplain encroachment on private property, and to improve overall reach stability, water quality, and ecology. In general, channel stabilization measures in already developed areas have eroded down to more stable slopes already and improvements should be implemented based on what the erosion threatens and in areas that show active erosion. Areas where private property, utilities, and pedestrian trails are threatened should be completed first. In areas where upstream development is anticipated to change the minor and/or major storm event flows significantly (greater than 30%), stabilization measures should be constructed as development occurs to help protect the natural channel from erosion. Capacity improvements are more isolated from each other, with the exception of in Adams County in the golf course area downstream of Riverdale Road. Capacity improvements should be implemented first in areas that remove insurable structures from the floodplain and where roadway overtopping occurs. Lower priorities would be areas that encroach on private property, followed by those areas that threaten private properties. Crossings that do not overtop, but do not meet headwater to depth or freeboard criteria in the 100-year event would be the lowest priority as they generally pose less rick than crossings that overtop. The exception would be on Horizon Tributary at Holly Street, where the 100-year depth of water could pose a safety risk given the adjacent high school.

The majority of the channel reaches can be maintained via trails and roadways. The exceptions, as noted in the individual reach sections, are Brantner Gulch Reach 4, a small portion of Brantner Gulch Reach 3A, and the South Platte River North Tributary 7 upstream of Riverdale Road.

The majority of the channel reaches are located on publicly-owned property or on Homeowner Association Property, allowing for maintenance. The exceptions are a few areas along Brantner Gulch Reach 3A, the upper reach of Pheasants Run Tributary, and the upper reach of the South Platte River North Tributary 7.

Table 17 - Alternatives Evaluation Matrix[1]

Reach	Category	Public Safety	Meets Policy	Cost	Prevent Flooding	Operations and Maintenance	Stream Stability	ROW Acquisition/ Easements	Public Acceptance	Environmental and Water Quality Impacts	Aesthetics	Weighted Average	Recommended?
	Weight:	**15%**	**15%**	**15%**	**15%**	**10%**	**10%**	**5%**	**5%**	**5%**	**5%**	**100%**	
All reaches	Status Quo	3	3	5	2	3	3	5	3	3	3	3.3	NO
	Floodplain Preservation with Channel Stabilization/Water Quality	4	5	3	2	4	5	3	4	5	4	3.8	YES
	Capacity Improvements	4	5	3	5	4	3	4	4	3	3	4.0	YES
South Platte River South Tributary 6	Capacity Improvements - Alignment 1	4	3	2	4	2	3	5	4	3	3	3.2	NO
	Capacity Improvements - Alignment 2	4	4	3	4	3	3	5	4	4	3	3.7	YES
Recommended Alternative	Recommended	4.0	4.7	3.0	3.7	3.7	3.7	4.0	4.0	4.0	3.3	3.8	YES

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

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Table 18 – Recommended Plan Cost Summary

6. CONCEPTUAL DESIGN

6.1 Plan Development Overview

6.2 Master Plan Description

6.3 Prioritization and Phasing

6.4 Water Quality Impacts

6.5 Operations and Maintenance

6.6 Environmental and Safety Assessment

7. REFERENCES

Adams County. October 4, 2018. *Adams County GIS Layers.*

Bentley. November 20, 2020. StormCAD version 10.03.02.04.

Carroll & Lange, Inc. March 23, 2006. *The Villages at Riverdale Filing No. 3.*

Carroll & Lange, Inc. August 9, 2002. *Drainage Report for Fairgrounds Tributary Improvements and Regional Detention Pond for the Villages at Riverdale Filing No. 3.*

Carroll & Lange, Inc. April 1994. *Final Drainage Report: Wright Farms, Filing No. 3, First Plat*.

City of Thornton. 2012 (Updated August 28, 2018). *City of Thornton Comprehensive Plan, Figure 3-3: Future Land Use Map.*

City of Thornton. November 19, 2018. *City of Thornton GIS Layers.*

CVL Consultants. December 22, 2020. *Horizon Creek Culvert Improvements – Record Drawings.*

Dewberry Engineers, Inc. September 4, 2020. *Fairgrounds Tributary Construction Plans.*

DHM Design Corporation. October 1996 (Revised December 1996). *Phase III Drainage Report Madison Park Phase One.*

ICON Engineering, Inc. January 2013. *Brantner Gulch/Holly Street Drainage and Roadway Improvements – Record Drawings.*

ICON Engineering, Inc. June 2010. *Brantner Gulch Northern Tributary Watersheds Hydrology Update.*

Innovative Land Consultants, Inc. March 6, 2020. *Final Drainage Report: Karl's Farm Filing No. 1 – District Infrastructure.*

JR Engineering. April 2021. *Timberleaf Filing No. 1 Fairgrounds Tributary – Record Drawings*.

JVA Consulting Engineers. September 13, 2018. School District 27J – High School #3 – *Record Drawings.*

JVA Consulting Engineers. April 2016 (Revised June 2016). *Final Drainage Report High School No. 3 – Offsite Improvements.*

Harris, Kocher, Smith. June 2021. *Riverdale Ranch.*

Love & Associates. January 2005. *Lower Brantner Gulch Major Drainageway Planning Update Alternatives Analysis – Phase A Report.*

Love & Associates. March 2004. *Lower Brantner Gulch Major Drainageway Planning Update Preliminary Design – Phase B Report.*

Martin/Martin Consulting Engineers. September 9, 2020. *Brantner Gulch Drainage Improvements at 128th Avenue – Record Drawings.*

Merrick Architects and Engineers. January 29, 2002. *Gleneagle Estates Construction Drawings with the Attachment of East 128th Avenue Improvement Plans – Record Drawings.*

Mile High Flood District. November 2016. *CUHP 2005 Version 2.0.0.*

MMC Engineering. September 1999. *Final Drainage Study for Meadow Park.*

MM&D Engineering Services, LLC. August 2014 (Revised March 2015). *Addendum to Phase III Drainage Study for Amber Creek Subdivision.*

Montgomery Watson. February 3, 1999. *Eastlake Reservoir No. 2 Dam and Downstream Improvements – Record Drawings*.

Muller Engineering. February 2014. *Riverdale Road Crossing on Lower Brantner Gulch*.

Redland. November 4, 2021. *Final Drainage Report: Washington Center Filing No. 1, 10th Amendment (Fieldhouse Apartments).*

Sellards & Grigg, Inc. September 30, 2004. *Eastlake Reservoir No. 2 – Asbuilt Drawings.*

Sellards & Grigg, Inc. May 1998. *Phase III Drainage Report for Eastlake Village III Development – Phase I.*

Stantec Consulting, Inc. April 2000 (Revised August 2000). *Phase III Drainage Report for Northbrook Subdivision.*

Urban Drainage and Flood Control District. Urban Storm Drainage Criteria Manual. January 2016.

U.S. Army Corps of Engineers' HEC-RAS River Analysis System, version 6.0.

U.S. Department of Homeland Security, Federal Emergency Management Agency. July 2003. *Letter of Map Revision Determination Document, Case No. 03-08-0433P*.

U.S. Department of Homeland Security, Federal Emergency Management Agency. November 29, 2013. *Letter of Map Revision Determination Document, Case No. 13-08-0534P*.

U.S. Department of Homeland Security, Federal Emergency Management Agency. January 20, 2016. *Flood Insurance Rate Map, Adams County, Colorado and Incorporated Areas: Map Number 08001C0311J.*

U.S. Department of Homeland Security, Federal Emergency Management Agency. March 5, 2007. *Flood Insurance Rate Map, Adams County, Colorado and Incorporated Areas: Map Numbers 08001C0308H, 08001C0300H, 08001C0312H, 08001C0316H, 08001C0317H, 08001C0328H, and 08001C0336H.*

U.S. Department of Agriculture, Natural Resources Conservations Service. November 14, 2018. Custom Soil Resource Report for Parts of Adams County, Colorado.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Atlas 14, Volume 8, Version 2. December 2, 2018. Point Precipitation Frequency Estimates.

US Environmental Protection Agency. July 31, 2018. *EPA SWMM 5.1.013*

U.S. Geological Survey. January 1, 2015. *National Land Cover Database – 2011 Dataset.*

York Engineering Services. January 28, 2000. *Phase III Drainage Report for Washington Center Apartments.*

APPENDIX A

PROJECT CORRESPONDENCE

MEETING MINUTES

OLSSON ASSOCIATES

KICKOFF MEETING MINUTES

Brantner Gulch MDP and FHAD
Monday, September 24, 2018
2:00 pm at Urban Drainage and Flood Control District

Attendees:

Name	Company	E-mail
Dave Skuodas	Urban Drainage and Flood Control District (UDFCD)	dskuodas@udfcd.org
Pam Acre	City of Northglenn (Northglenn)	pacre@northglenn.org
Kurt Carlson	Adams County Parks and Open Space	kcarlson@adcogov.org
Jim Kaiser	City of Thornton (Thornton)	Jim.kaiser@cityofthornton.net
Matt Eberly	Thornton	Matt.eberly@cityofthornton.net
Deb Ohlinger	Olsson Associates (Olsson)	dohlinger@olssonassociates.com
Amy Gabor	Olsson Associates	agabor@olssonassociates.com
Mark Schutte	Olsson Associates	mschutte@olssonassociates.com

The meeting was held to discuss the start of the project, identify needed information, and determine known issues and problem areas. This summary is intended to reflect the key points raised, issues for further consideration, and action items resulting from the discussions.

1) Introductions
   a) Other invitees to meetings? None discussed.

2) Project goals
   a) Main areas of concern and of note
      i) Claude Court and RTD culverts
         (1) New RTD culvert was sized based on MDP flows
         (2) Claude Court culvert – not improved yet
      ii) Water quality is desired upstream of Mann-Nyholt Lake. Water augmentation occurs at the Mann-Nyholt Lake
      iii) Infrastructure in fairgrounds – need to maintain access by at least one of the two bridges during storm events
      iv) Brantner Ditch interface – separate flows from Brantner Gulch
         (1) triple cell, 16x12 culverts are located under Riverdale Road but were filled in 5 feet deep. The culverts can be cleaned out to provide full conveyance. One cell is desired for use as a trail connection. It could be the north or south cell.
      v) Karl's Farm detention – part of irrigation system, detention in area just west of Claude Court
      vi) Irma Drive and Race Street are planned to extend north, but are not planned to cross Brantner Gulch at this time. Race Street may extend up to Eastlake Avenue in the future.
      vii) Several new developments are in progress or have been recently completed within the watershed.
         (1) High school at Yosemite and 136th. Low flows routed into storm sewers; high flows routed through Riverdale Road culvert into golf course

         (2) King Soopers south of 136th, east of Monaco
         (3) Creekside development south of 128th, west of Quebec. Include channel stabilization following the old stock pond breach. The master plan should not contradict Otak design plans for the development.
         (4) City Park at 136th, west of Holly – 110-acre area. Has sand filter detention basin, two 18" pipes outlet south for overflow
         (5) Church at 132nd and Quebec
   b) Observed problems/issues?
      i) Childcare facility at Colorado Avenue and 124th is shown to be located in the floodplain
      ii) Floodplain stops at Claude Court. For this study, we may show the floodplain and associated risk in the MDP, but not include the extents in the FHAD
   c) Follow Adams County Riverdale Regional Park Master Plan
      i) Shows anticipated future alignment
      ii) Continuous riparian corridor from 120th to 136th
      iii) Enhance fishing and bird habitat – keep wildlife corridors accessible
   d) Evaluate reintroducing flows between Mann-Nyholt Lake and the Fishing is Fun Pond along the historic Brantner Gulch channel alignment
   e) Dave commented that he would like to be able to easily find information in the MDP, such as design flows at key locations
   f) A major goal is to develop comprehensive hydrology for the main stem and all tributaries

3) Needed information
   a) GIS contours – already provided by UDFCD
   b) Abutting watershed boundaries, if different than what is available on-line
   c) GIS – utilities, parcels, roads, etc.
   d) Future land use (existing land use will be National Land Cover Database)
   e) Proposed development drainage reports
   f) Structure surveys. Photos of both sides of the structures, drop structures, and descriptions of shots would be helpful.
      i) To be provided by UDFCD
   g) Detention basins – see below
   h) As-constructed documents for channel projects, if not available on UDFCD website

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) Three model scenarios will be developed: historic (2% impervious everywhere, no detention), existing (current conditions), and future (land use based on zoning and development projects)
   c) Detention to be included in baseline hydrology?
      i) See attached list of detention basins included in previous studies and identified from aerial imagery. Thornton has easements and maintains some detention basins that do not necessarily qualify as regional. The project sponsors will provide input on whether the detention basins should be included. Thornton noted that five smaller detention basins were modeled in the Lakeview Tributary watershed and were included in a model by ICON for 2012 Brantner Gulch and Lakeview Tributary channel improvements.
      ii) Drainage reports for existing and new detention basins

iii) Storage-discharge information will be developed from one of the following:
(1) 2005 MDP – 2005 model stage-area/storage-discharge to be used where detention basins were included. Volumes will be spot checked using LiDAR
(2) Drainage reports to be used for stage-area-discharge where available. Volumes will be spot checked using LiDAR
(3) LiDAR – to be used for stage-area where detention basin varies from 2005 MDP model, was not included in MDP model, and/or no drainage reports are available
(4) As-builts or survey – to be used to develop stage-discharge for detention basins that were not included in 2005 MDP, and where no drainage reports are available.

d) Calibration – Olsson will compare the newly-developed flows to those included in previous studies.
e) Jim noted that the Brantner routing in the 2005 MDP should be updated to show the discharge from Eastlake Reservoir No. 2 going to Eastlake Reservoir No. 3, then down to 124th.

5) Schedule to follow agreement
   a) Draft hydrology due December 3, 2018 (10 weeks from today)

6) Upcoming meetings
   a) During hydrology. Olsson will schedule for when draft hydrology is expected to be complete.
   b) After hydrology review

7) Other

<u>Actions Items</u>

Olsson:
- Create a map and list of detention basins included in previous studies or seen in Google Earth for the sponsors to evaluate regarding inclusion in the hydrology models – *Completed*

City of Northglenn:
- Check to see if Irma or Race extension crossing Brantner is desirable
- Provide contact to Olsson for GIS shapefiles – *Completed*
- Provide as-constructed documents for completed non-UDFCD projects
- Provide input on detention basin list

City of Thornton:
- Provide Drainage Report for ICON Brantner Gulch and Lakeview Tributary Channel Improvements Project
- Provide ICON Report – five detention basins in series, circa 2010
- Provide contact to Olsson for GIS shapefiles
- Provide as-constructed documents for non-UDFCD completed projects
- Provide drainage reports for new and under construction developments that will affect the hydrology
- Provide input on detention basin list

Adams County Parks and Open Space:
- Provide contact to Olsson for GIS shapefiles – *Completed*
- Provide input on detention basin list

UDFCD:
- Provide Drainage Report for ICON Brantner Gulch and Lakeview Tributary Channel Improvements Project
- Provide shapefiles for abutting watershed boundaries, if different than what is available on-line
- Determine whether Olsson or UDFCD will identify the structures to be surveyed. Dave will discuss with Shea
- Provide structure surveys, once structures have been identified

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: Mark Schutte
cc: Attendees

olsson

HYDROLOGY MEETING MINUTES

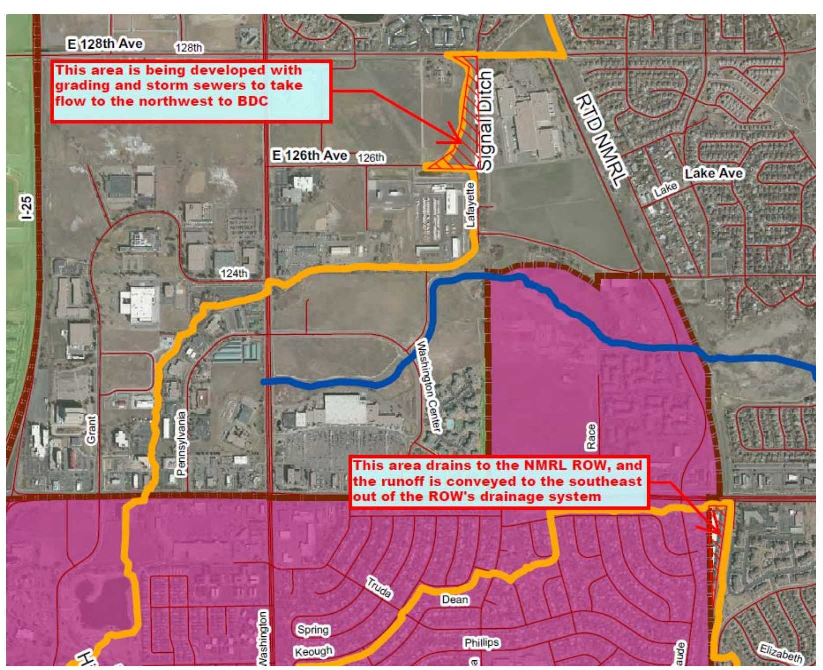
Brantner Gulch MDP and FHAD
Monday, May 13, 2019
10:00 am at Urban Drainage and Flood Control District

Attendees:

Name	Company	E-mail
Dave Skuodas	Urban Drainage and Flood Control District (UDFCD)	dskuodas@udfcd.org
Mark Schutte	UDFCD	mschutte@udfcd.org
Pam Acre	City of Northglenn (Northglenn)	pacre@northglenn.org
Russell T. Nelson	Adams County Parks and Open Space	RNelson@adcogov.org
Jim Kaiser	City of Thornton (Thornton)	Jim.kaiser@cityofthornton.net
Matt Eberly	Thornton	Matt.eberly@cityofthornton.net
Rachelle Plas	Thornton	Rachelle.Plas@cityofthornton.net
Amy Gabor	Olsson	agabor@olsson.com
Hannah Pring	Olsson	hpring@olsson.com

The meeting was held to discuss review comments on the hydrology report and models. This summary is intended to reflect the key points raised, issues for further consideration, and action items resulting from the discussions.

1) Hydrology comments
   a) Watershed boundary adjustments
      i) Subbasin 57 will be cut off along Lafayette Street. See image below.
      ii) Subbasin 50 will have triangular area added. See image below.



   b) Mann-Nyholt Lake
      i) Flood attenuation in Mann-Nyholt Lake will not be accounted for in the baseline hydrology.
      ii) Olsson will evaluate the existing connection between the lake and the South Platte River and will discuss with the project sponsors if flood attenuation should be accounted for in a future spillway design.
   c) City of Thornton future land use percent imperviousness (max 80%)
      i) Although the City of Thornton limits development to a maximum of 80%, the higher percent impervious values will continue to be used in the study to be more conservative. A clarification statement will be added to the report to state that although future impervious values are shown as 95% for master planning purposes, future development will be required to follow City of Thornton zoning requirements and associated percent imperviousness values.
   d) Decrease in peak flows from old studies
      i) Additional detention basins in this study as compared to past studies
      ii) Lower rainfall in this study as compared to past studies
      iii) Slightly lower overall percent imperviousness in this study as compared to past studies
      iv) Olsson ran the future conditions model with the old point rainfall values, and removed the additional detention basins from the model for a more direct comparison of peak flows, as shown on Table 1. Olsson will incorporate these results into the report in a graphical representation. A separate report/graph will be completed for the 1983 FHAD and the 2010 MDP.
      v) Graphical representation of comparison between the various studies will be simplified and incorporated into the report.
      vi) Results of the difference in water volume will also be reported.
      vii) Design Point 181 will be added to Table 7 within the report to compare the new model with the 1983 FHAD.
   e) Flow profile views will be reversed to better follow direction of flow.

2) Schedule to follow agreement
   a) Final hydrology due 3 weeks after receiving final comments

3) Upcoming meetings
   a) After existing hydraulics modeling and identification of problem areas

4) Other

Table 1 - Comparison of Peak Flows

Reference Location	1983 FHAD	No Det, Old Rainfall	% Diff (No Det, Old Rainfall to 1983 FHAD Q100)	2010 MDP	Old Rainfall - 2010 Det	% Diff (Old Rainfall, 2010 Det to 2010 Update Q100)	% Diff unit discharge (cfs/ac)
Mann-Nyholt Lake	6069	8700	43%	3851	5653	47%	52%
Downstream of Fairgrounds Tributary Confluence/Riverdale Road	6790	9288	37%	6139	5963	-3%	-5%
Downstream of Plains Tributary Confluence/Quebec Street	5660	7056	25%	4571	4190	-8%	-9%
Downstream of Lakeview Tributary	5584	6388	14%	3818	3736	-2%	-8%
Holly Street	4220	5134	22%	3167	2942	-7%	-10%
Colorado Boulevard	1561	3618	132%	1829	1281	-30%	-30%
Fairgrounds Tributary	602	481	-20%	444	344	-23%	-24%
Horizons Tributary	1743	2199	26%	1595	1140	-29%	-27%
Quails Way Tributary	254	111	-56%	51	111	117%	-24%
Pheasants Run Tributary	606	423	-30%	522	423	-19%	-20%
Plains Tributary	452	495	9%	470	348	-26%	-16%
Lakeview Tributary	1407	1193	-15%	655	474	-28%	-28%
Fishing Is Fun Pond	2483	1344	-46%	---	1344	---	---
SPR Southern Tributary 006 at Yosemite Street	690	404	-41%	---	404	---	---

<u>Actions Items</u>

Project Sponsors:

- Submit comments on hydrology report/models

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: Hannah Pring
cc: Attendees

FHAD MODEL REVIEW MEETING MINUTES

Brantner Gulch MDP and FHAD
Tuesday, November 3, 2020
1:00 pm via Microsoft Teams

Name	Company	E-mail
Jim Kaiser	**City of Thornton**	**Jim.Kaiser@thorntonco.gov**
Rachelle Plas	**City of Thornton**	**Rachelle.Plas@thorntonco.gov**
Russell Nelson	**Adams County**	**RNelson@adcogov.org**
Dave Skuodas	**Mile High Flood District**	**dskuodas@udfcd.org**
Hung-Teng Ho	**Mile High Flood District**	**hho@udfcd.org**
Brooke Seymour	**Mile High Flood District**	**bseymour@udfcd.org**
Amy Gabor	**Olsson**	**Agabor@olsson.com**
Deb Ohlinger	**Olsson**	**dohlinger@olsson.com**
Hannah Pring	**Olsson**	**hpring@olsson.com**

The meeting was held to discuss the FHAD modeling comments provided by the Mile High Flood District. This summary is intended to reflect the key points raised, issues for further consideration, and action items resulting from the discussions. The non-bold items comprised the meeting agenda. The items in bold resulted from the discussions.

Comment Discussion Items

1) General Clarifications
   a) All flows will be updated in the model – FHAD model was submitted prior to receiving additional detention pond information. Final hydrology incorporated new detention pond information, which is why it changed. Also applies to data relevant to Detention Basin 365 and 360.

   b) Report is intended to be part of more comprehensive MDP report, not the FHAD report. The FHAD report will be submitted after the model reviews are completed and will start with the MDP report and then delete out extraneous information. That way, only one report needs updated until the end. Because of the dual nature of the MDP and FHAD reports, some sections were scoped in the MDP portion and the FHAD report scope was only intended to modify the MDP report. The crossing structure table, reach descriptions, and flood hazards sections are included in the alternatives analysis scope, which has not yet been authorized.

      i) **The information listed above should be included now to help with reviews and workflow moving forward, The items had been included in the MDP phase based on the way Olsson structured the fee estimate. Olsson will keep track of this work, but it should not be an issue as it is assumed the MDP will be authorized.**

2) General Modeling Approaches
   a) Limited drop structure survey in most areas – best way to approach? Some of the survey only includes one crest shot and one toe drop and does not include the sill elevation. Preference for how much of channel to adjust based on limited survey data? The original intent was to adjust the low flow between drops and structures. After seeing the channel generally conveyed the flows without lowering the channel invert, and considering the limited data, we generally just used LiDAR. In some cases we used drop structure survey shots at two drop structure cross sections, and then tied into LiDAR, but that ends up showing a short steep section at the interface of the data.
      i) **The cross sections in between the drops could be interpolated, but that information is not accurate based on the fact that there are no survey points for the sill of the drop.**
      ii) **Despite the floodplain being shown as well contained within the channel, the modeling for the drop structures is stringent. The survey data or as-built information must be used at hydraulic structures, or FEMA will not approve the model. The LiDAR and survey interface will be reviewed. Typically, the channel profile will be adjusted based on survey at the hard points (crossing structures and drop structures), unless that approach is questionable.**
      iii) As-builts can be used. Thornton will check to see whether any are available. The large vertical drops were constructed in the late 90's and early 00's when the development was moving very quickly and information might not be available, unless it was maintenance eligible
      iv) Adverse slopes are appropriate if there is something that we can base that information on, such as someone reporting it in the field. However, an adverse slope due to switching between data sources is not acceptable without justification. In the areas where there is a vertical concrete cutoff wall with a scour hole, based on visual inspection an adverse slope is appropriate.
      v) Olsson will evaluate which drops need additional survey information based on the working profile and request the additional survey.

   b) Drop structure cross section alignments were generally placed based on LiDAR at the surveyed crest points. Aerial and survey where available can be referenced to adjust alignments to better match crest configuration.
      i) Cross section alignment at the drop structures will be checked and updated as needed to ensure the alignment reflects the controlling section.

   c) Incorporating survey at crossings – preferences?

      i) Incorporating survey points into cross sections is more accurate. One drawback could be that the mapping might end up crossing contours and not always follow LiDAR when survey defines much of cross section.
      ii) The upstream cross sections will typically be updated to include the survey information in order to catch the low flow information. If the data appears it will cause a mapping issue later, Olsson will discuss with MHFD.
      iii) Typically, one survey shot downstream. Preference on incorporating survey?
         (1) The cross section downstream of culverts will be updated to match the culvert invert. The width should represent the natural channel geometry

without including any part of the structure. If the culvert width is a good approximation of the natural channel geometry, it can be used to adjust the ground based on the survey, but should be evaluated to make sure it is appropriate.

d) Structure IEFAs – recommend permanent IEFA up to culvert crown/bridge LC. Preference?
   i) **Downstream ineffective areas should have the elevations updated to be between the culvert crown/bridge low chord and the road elevation, and will be based on the flow events that are overtopping. Generally, once the flows are overtopping, it is considered effective flow. The upstream ineffective flow area is permanent and set to road deck elevation. The downstream ineffective flow area is not permanent and is in between the road deck elevation and the top of the culvert. The approach may vary where there are crossing profiles in order to eliminate them.**

e) Low flow crossings – did not model culverts with an opening of less than 36” based on discussions on past FHADs, agree with approach?
   i) Some culverts less than 36” may be significant if there are multiple culverts, or span a larger width. We will provide MHFD a list of recommended smaller culverts to include in the model for review.

f) Rating curves versus set WSE – preference?
   i) Rating curves are better if a flow changes in future, rating curve should be able to reflect updated WSE versus a set WSE
      (1) Rating curves are preferred.
   ii) Set WSE are more visible in model and easier to see where they are versus the rating curve
   iii) Remove structures downstream of rating curves/set WSEs? Were included in model more for a visual reference of a structure. Detention basin discharge flow location was shown immediately upstream of the outlet pipe so that it would not interfere with the set WSE or rating curve. The discharge location will be moved downstream of the detention basin if the structures are going to be removed from the model.
      (1) Preference is to not include the culvert downstream of the rating curve for consistency. The use of culverts downstream of a rating curve deems providing valuable structure information. The model approach is OK only if the in-line facility was not overtopped by the events studied. However, the culvert hydraulics may not be calculated appropriately with known water surface elevations set at the inlet of the culverts. A clear description should be provided in the model for the future user to be aware of the model assumption and culvert capacities.
      (2) When the events overtop the structures, the model approach may not calculate the overflow condition appropriately.
      (3) Once additional data on the long pipes is received, the detention basin calculations will be double checked to see if any adjustments need to be made to the stage-discharge info.

3) Hydrology

   a) DP 160O diversion – pipe link shows a little less than actual capacity in it because n value was increased 25% per criteria and kinematic model uses Manning’s equation to determine pipe capacity. Used more detailed rating curve to verify if flows overtop of not. Can decrease Manning’s n value to keep pipe capacity more in line with outside calculations, but it will be a deviation from typical model setup. Updating Manning’s n for this link should have negligible effect on peak flows. Update?
      i) The link flow was not used in the HEC-RAS model and SWMM does not need to be updated. A note will be added as to why there is a difference between the HEC RAS flow and the SWMM Model.
      ii) As mentioned in 2)f)iii)(2) additional data will be collected and the detention basin calculations verified and adjusted if necessary.

   b) P303 and F304 detention basin stage-storage-discharge from old study Brantner Gulch Northing Tribs Hydrology Update 2010). Elevations are similar to survey, but not exact. Since general agreement, utilized WSEs based on rating table in old study.
      i) Please verify the set water surface elevations that do not match the SWMM outputs. Please verify that the invert of design point P303 can calculated correct water surface elevations to be used in HEC-RAS.
         (1) Validate the elevations related to storage-discharge information, and if it is not matching, the information will be updated in the hydrology.
         (2) It appears that P303 assumes the WQCV is full at the start of the design event due to antecedent runoff (or clogging). MHFD will confirm that this approach is acceptable.

      ii) F304:
         - SWMM design point invert elevation does not match HEC-RAS culvert upstream invert elevation of 5309.45.
         - 1. Can the W.S.E. be used directly in the HEC-RAS model?
         - 2. Survey information shows outlet box elevation of 5117.8 (Table shows 5117.75. OK!)
         - 3. So, the rating curve indicates that spillway will be activated at elevation of 5120 and above.
         - 4. However, the surveyed roadway low point at approximate 5122.
         - Please verify if the detention overflows in the 100- and 500-year events.
            (1) Validate the elevations related to storage-discharge information, and if it is not matching, update the information in the hydrology.

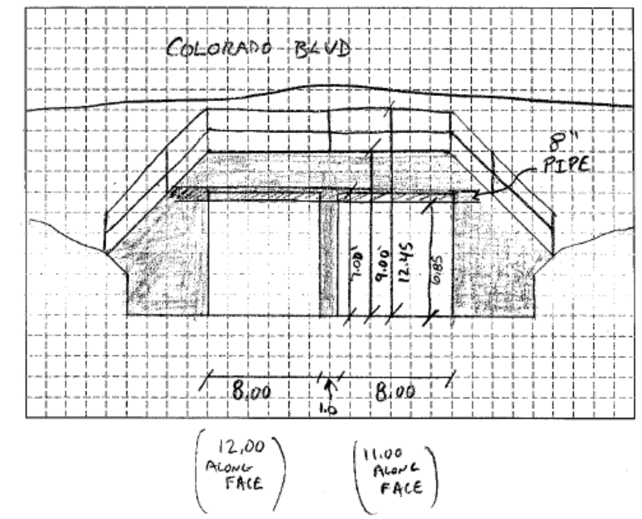
4) Specific Comments
   a) Brantner Gulch – missing survey data for Washington Street culvert. Prefer to get survey or trim model to downstream side of Washington?
      i) **Trim model to east of Washington Street.**
   b) XS 35429 to 35211, the cross section alignments are likely not perpendicular to the flow direction. Let’s discuss.
      i) **Ignore the trail alignment, do not cut the cross section parallel to the trail since there is a low point. Cut the sections perpendicular to the flow,**

ignoring/crossing the trail. We will evaluate how the new aligned cross sections work and impact the model to make sure the new approach is reasonable.

c) 500-year spill channel and 100-year storm drain system downstream of detention ponds
   i) Plans or survey needed for storm drain system to verify alignment (based on GIS) and capacity with StormCAD
      (1) **Thornton will look for as-builts. If none are available, survey will be needed for the storm drain systems.**
      (2) **Near Washington Center Parkway, a small amount of flows overtop in a 100-year storm event. The overflows go to a sump in the road where two inlets convey the flow to a storm drain system. It is possible that the storm drain system may have capacity for the 100-year spill. MHFD will discuss and get back to Olsson on if this storm drain system can be included in the analysis, or if the 100-year flows need to be routed overland. Olsson noted that buildings are located near the overland path and may be impacted by the 100-year spill. If the storm drain system can be included, Olsson will need either as-builts or survey to complete the analysis.**
   ii) Develop spill reach for 500-year overtopping flows
      (1) Spill occurs at Eastlake #2 (DP 360) weir then into 123rd Avenue to 124th, perhaps across the tennis courts into pond. The swale that is shown in the LiDAR is incorrect. If this is a 500-year spill only, this would be a good place to use a 2D model to analyze spill path.

d) Alignments through large detention ponds
   i) **It is more important to follow the LiDAR than the aerial. If combined, and the aerial agrees with the LiDAR it may be acceptable to follow the aerial.**
   ii) **It is acceptable to not follow the thalweg through the detention basin, unless the detention basin is large enough that the downstream rating curve doesn't control, or if the 100-year floodplain does not contain the alignment in the model.**

e) Colorado Blvd modified inlet culvert – modeling preference? Not sure if culvert is also slope tapered and if it is face or throat controlled.
   i) There is a daycare facility located close to this area, in the southwest quadrant of the intersection, which is considered a critical facility.
   ii) **It is likely that the survey information is the skewed face dimensions of the culvert. In the model, a skewed faced culvert can be selected with chart number 11.**
   iii) **Model the whole culvert as 8x7, without the 8-inch utility pipe crossing the top of the culvert, since the culvert is outlet controlled.**



f) XS 27135 to 23980, the LiDAR may be inaccurate at the low flow area because of dense vegetation. Let's discuss the adjustment of the low flow area and channel invert using structure survey and field reconnaissance wherever needed.
   i) **The LiDAR information should overrule where there is conflict. But if the aerial can clarify, and it also agrees with the LiDAR, then the alignment will be adjusted to match both.**

g) Let's discuss model approach at E 128th Ave.
   i) Thornton's new Stormwater Utility's first CIP project has been completed at this crossing. A quadruple 48-inch RCP structure parallel with the existing structure was constructed. Low flows are directed exclusively to the original structure. Near the point this structure reaches "full pipe" flows, flow spills to the new structure. The goal of the project was for the combined structures, as modeled in HY-8, to convey the 10-year discharge per the preliminary FHAD hydrology. The low point/overflow in 128th Avenue is well to the east of the structures. As-built information is available with the updated contour information is available and will be incorporated into the model once provided. Post project, a conflicting utility was lowered, allowing city forces to excavate out a lower channel exit from the structures, removing backwater in low flow conditions from the new quad-culverts. This should not impact modeling in high flow conditions.

h) Junctions
   i) **Add a cross section closer so there is less distance along the junction.**
   ii) **Perhaps only use one junction instead of multiple where the junctions are close together. Either keep the junctions and add cross sections to see how that works or model the reach separately, whichever is more appropriate after iteration.**

i) Riverdale Rd - Let's discuss the culvert modeling and data information.
   i) The model is good, the topo was not provided for review. The as-built CAD files will be incorporated and stitched into the terrain for the next review.

j) South Platte River boundary condition – normal depth, set WSE, other?

- **i) 10-year effective WSEL for the South Platte River, though FEMA prefers normal depth.**

k) Golf course area
- i) Trans-watershed flow
  - **(1) 2D model results make sense, but it will likely be difficult to replicate in a 1D model. It is a good starting point to try and figure out where water flows in this area.**
  - **(2) There are plans for developing the channel along Brantner Gulch in the golf course, so it would be helpful to have a 2D model to identify the spills and flow paths and then regroup with the results.**
  - **(3) The other two tributaries have less of a defined alignment, so these areas would benefit from a 2D model to provide potential flow paths.**
- ii) Contraction/expansion coefficients
  - (1) **Add a note "No significant contraction and expansion, values have not been updated to reflect as such."**

l) Let's discuss the model approach for the concrete check structures (like weir structure) in Plains Tributary.
- i) **Issues are related to survey elevations, as discussed previously.**

m) XS 65137 (maybe also XS 65147 & 65148) and XS 64800, please use permanent IEFA at low flow portion to account the impact from the downstream blocked obstruction. However, let's discuss which crossing structures are negligible.
- **i) Olsson will send information on the crossing structures recommended to not be included in the model for concurrence with MHFD.**

n) Culvert 62946 (Plains Tributary, E 128 Ave), let's discuss the model approach. It appears that only the 500-year event will overtops the eastern berm.
- **i) Keep the main model along the storm culvert, then estimate the overtopping flow and culvert capacity with outside calculations. If it is insignificant, then no split flow will be necessary.**
- **ii) A FlowMaster calculation will likely be sufficient for the floodplain mapping.**

o) Culvert 82364 (Horizons Tributary, E 136th Avenue), the current model approach is not able to calculate the potential highest W.S.E. upstream of the culvert. The highest W.S.E. should be equal or higher than the berm crest elevation at left bank. Let's discuss.
- i) **Use a similar approach as item 4n.**

p) Culvert 79518 (Horizons Tributary, Pedestrian Sidewalk), please provide the full title of the design plans. Is there a drop structure at XS 79592 and design grading? Let's discuss using parallel bounding XSs, skew and a lateral structure for 500-year event.
- **i) This culvert was built per plan. MHFD will look into providing as-builts. The 500-year overtopping flows will be routed to the east and then down to the main channel farther downstream. The full flow will still be used downstream of the culvert. A FlowMaster calculation will be used to determine the limits of the 500-year floodplain.**

q) Culvert 78519 (Horizons Tributary, Pedestrian Sidewalk), please provide the full title of the design plans. Is there a drop at XS 78668? Please incorporate the design grading and revise the bounding cross sections accordingly. Let's discuss.
- i) **This structure was not built per plan. MHFD will look into providing as-builts.**
- ii) **Incorporate drop structure on upstream side once the as-builts for the drop structure are provided.**

r) Is the as-built grading at ROB of the XS 73331 to XS 72852 available? The new development seems not impacting the 100- and 500-year floodplains. Please verify.
- **i) Channel should not have been modified. As long as the cross sections are contained, then the cross sections will be shortened so that they are not in the area that has been updated.**

s) XS 73252 & XS 72500 to72478, let's discuss the alignments for modeling drop structures.
- **i) Previously discussed.**

t) XS 116428 to 116404 in Fairgrounds Tributary, let's discuss the cutline alignments for modeling the drop structures.
- **i) Previously discussed.**

u) Culvert 131763 under 136th Ave in SPR S Tributary 6, the 100-year overland flow is significant because the private owned detention was not modeled or assumed clogged. Let's discuss the model approach and potential split flow in 136th Ave.
- i) **Cut off model south of 136th Avenue.**

v) Culvert 127662 in Yosemite St in SPR S Tributary 6, let's discuss the model approach for the long culvert and the as-built/proposed grading of the channel tie in to the culvert.
- **i) FHAD model will start downstream of the culvert. Upstream of the culvert, the MDP model is for information only for development. A StormCAD model will be used to evaluate the pipe capacity.**

w) SPR S Tributary 6, from XS 125200 to the confluence with SPR N Tributary 7, let's discuss the model approach, profile baseline and cross section alignments.
- **i) See Item 4k, above.**

x) XS 137357 in SPR N Tributary 7 to the confluence with SPR, let's discuss the model approach.
- **i) The SPR 10-year water surface elevation will be used.**

5) Other
- a) **Developed Area south of 128th avenue, new development should be added to the modeling. Thornton to provide the development As-Built information. If the design information is provided before the As-Built information is provided, then this will be helpful to update model, then the as-builts can be reviewed later to confirm the design and update the model as needed.**

Action Items:

Thornton:

1. **Provide PDFs and CAD files of the drainage, as-built, and design information for the areas below:**
   - a. **Drop structure as-built information (Olsson will confirm location of drop structures in question)**
   - b. **Storm Drain as-built information**
   - c. **CIP Project Number 1**

MHFD:

1. **Confirm whether or not water quality should be assumed to be clogged when verifying the stage-storage-discharge information.**

2. **Discuss if the storm drain system can be counted for the 100-year and 500-year spills downstream of Washington Center Parkway**
3. **Provide as-built information in AutoCAD and PDFs for culverts along Horizons Tributary.**

Olsson:

1. **Develop a request for additional survey information.**
2. **Send a list of crossings that were excluded from the model to MHFD.**
3. **Develop a 2D model for the golf course to help determine flow paths.**

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: Hannah Pring
cc: Attendees, Pam Acre, File

olsson

HYDROLOGY/FHAD MODEL COMMENTS MEETING MINUTES

Brantner Gulch MDP and FHAD
Monday, November 16, 2020
1:00 pm via Microsoft Teams

Name	Company	E-mail
Jim Kaiser	City of Thornton	Jim.Kaiser@thorntonco.gov
Rachelle Plas	City of Thornton	Rachelle.Plas@thorntonco.gov
Dave Skuodas	Mile High Flood District	dskuodas@udfcd.org
Amy Gabor	Olsson	Agabor@olsson.com

The meeting was held to discuss hydrology and FHAD modeling questions. This summary is intended to reflect the key points raised, issues for further consideration, and action items resulting from the discussions. The non-bold items comprised the meeting agenda. The items in bold resulted from the discussions.

Comment Discussion Items

1) Should the FHAD or MDP include modeling upstream of Quebec Street on Pheasants Run Tributary since it is now piped?

   a) Information from Jim: "For R203, we can provide the calculations/drainage report for the full length 54-inch pipe system. It included headwater/surcharge conditions for the upstream/north side of 136th Avenue. Significant overlot grading has occurred where the channel had been, additional grading will occur with build out of the commercial site. If the 500-year flow spills, we will want to incorporate the latest "as-built" contours into the FHAD model before publishing it. The conditions along 136th Avenue have also changed since the 2014 topo was flown, so the upper reaches of some basins may be altered. Also, the developer has agreed to raise 134th Avenue so that the low point in the street, approximately 200-feet west of the Quebec centerline, is above the calculated HGL in the 54-inch system where the soon to be enlarged detention basin that serves the new subdivision (including the proposed commercial) joins the system. A 500-year flow placing a higher surcharge on the system upstream of 136th Avenue would likely still push flow out of the system in this location, with the overflow running into Quebec, before spilling to the east at the Quebec sump, south of 134th Avenue."

   b) **It was determined that hydraulic modeling upstream of Quebec Street will not be needed. The HEC-RAS model will be trimmed to start immediately downstream of Quebec Street.**

2) Should the detention basin upstream of 140th on Horizon Tributary be included in the baseline hydrology model?

   a) **The undetained 100-year discharge of Subbasin H11 is 21 cubic feet per second (cfs). When the detention basin is functioning, flows are routed to the next downstream detention basin; however, if the outlet structure were**

   clogged, the detention basin would overtop into 140th Avenue near the intersection, and then continue down Holly Street, bypassing the next downstream detention basin. It was determined that the detention basin will not be added to the baseline hydrology, and that the SWMM routing will continue to be based on the overflow path when the detention basin overtops, assuming the outlet is clogged.

3) Jim noted the inadvertent detention occurring in Horizon Tributary, more specifically: "At DP H110 (Holly Street north of 136th Avenue) we may now effectively have detention when Basin H312 is releasing higher flows. H312 is controlled above the 5-year event by a 42-inch orifice. The culvert under Holly Street is 48-inch RCP, and all of Subbasin H10 (as well as H13 and H14) is routed to the upstream side of the crossing. When we widened Holly Street in 2019, we did not dig up a 20-foot deep culvert to construct what the previous masterplan had recommended. Minor events will likely pass through unattenuated. Whether or not this is worth modeling attenuation of "major" events is the question."

   a) **It was determined that the inadvertent detention will not be included in the baseline hydrology. Formalizing detention in this location will be evaluated in the alternatives analysis if the reach could benefit from additional detention.**

4) Should the detention basin upstream of 136th on South Platte Tributary 6 be included in the baseline hydrology model?

   a) Information from Jim: "I had brought up possibly modeling detention at S124, north of 136th Avenue. The as-built grading for this subdivision has pushed the divide between subbasin F05 and S24 right up to Syracuse Street on many of the intersecting streets, increasing the basin size to where the detention at DP S124 may merit consideration. This will decrease peak flows in both reach S224 and F205."

   b) **The subbasin boundary was double checked and follows the development plan in this area. It was determined that the detention basin will not be included in the baseline hydrology since it has less than 130 tributary acres.**

5) Other

   a) **The detention basin upstream of Washington Center Parkway was discussed. Dave will investigate whether the inlet and storm drain system capacities can be included in the hydraulic analysis for the 100-year and 500-year spills out of the detention basin. The MDP will include alternatives to prevent the spill and provide freeboard in this detention basin.**

Action Items:

MHFD:

1. **Discuss whether the storm drain system can be counted for the 100-year and 500-year spills downstream of Washington Center Parkway.**

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

Minutes prepared by: Amy Gabor
cc: Attendees, Russell Nelson, Pam Acre, File

olsson

PROGRESS MEETING MINUTES

Brantner Gulch MDP and FHAD
Wednesday, November 20, 2019
11:00 am - 1:00 pm at Olsson

Name	Company	E-mail
Jim Kaiser	City of Thornton	Jim.Kaiser@cityofthornton.net
Rachelle Plas	City of Thornton	Rachelle.Plas@cityofthornton.net
Pam Acre	Northglenn	pacre@northglenn.org
Dave Skuodas	Mile High Flood District	dskuodas@udfcd.org
Amy Gabor	Olsson	Agabor@olsson.com
Deb Ohlinger	Olsson	dohlinger@olsson.com
Hannah Pring	Olsson	hpring@olsson.com

The meeting was held to discuss the MDP and FHAD modeling in several areas where construction is in progress or unknown. This summary is intended to reflect the key points raised, issues for further consideration, and action items resulting from the discussions. The non-bold items comprised the meeting agenda. The items in bold resulted from the discussions.

1) Hydrology
   a) Status
      i) **Final hydrology will be completed and included with FHAD submittal.**
   b) Tailwater
      i) **Tailwater analysis determined that there was not enough of an impact to include in the modeling. Detailed evaluation beyond the scope of a master plan would be needed to determine exact locations where tailwater could impact the discharge rating curves.**

2) SPR Trib 6 – Timberleaf (NOT CONSTRUCTED)
   a) The proposed Timberleaf Residential subdivision on the west side of Yosemite Street will be extending the existing storm sewer stub and improving the drainageway to the northwest.
      i) Thornton has not approved the floodplain permit. Construction timing is unknown. For the FHAD, the existing conditions will be modeled using 2013 LiDAR. Both stems will be modeled to the northern side of 136th avenue
      ii) The Fairgrounds channel to the southwest will also be impacted by future development, in part with the development, and the rest as a fee in lieu project. Construction timing is unknown, so this portion will also be modeled using existing 2013 LiDAR.
   b) Stamped plans 09/30/2019 - these plans have not been released for construction yet, but are very close
      i) **MHFD has updated plans, however there do not seem to be any changes to the proposed channel.**
   c) Yosemite pipe (CONSTRUCTED, AS-BUILTS UNKNOWN)
      i) The pipe within Yosemite Street does not have capacity for the 500-year storm event
      ii) Bypass pipe - low flow bypass pipe from the Riverdale Road intersection down to the Brantner Gulch box culverts
         (1) The low flow pipe will be included in the hydraulic model.
         (2) Thornton will see if they have, or can obtain, the storm drain system hydraulic models for this area and will provide them to Olsson. Olsson will review the models to determine if as-built survey of the overflow path along Yosemite is necessary for the 500-year floodplain. Olsson will provide a scope and fee for as-built overland survey, if deemed necessary.
         (3) Olsson will prepare a scope and fee to survey the as-built condition of the storm drain system.

3) Pheasants Run – Amber Creek (SOUTH OF 134TH CONSTRUCTED, 134TH TO 136TH NOT CONSTRUCTED)
   a) 134TH – 136TH: Stamped plans 08-07-2019 – 54-inch pipe
      i) **A 54-inch pipe is planned, but has not been constructed, as the floodplain permit has not been approved yet. Thornton is waiting for a floodplain assurance letter to be signed, and then once that is done, the permit will be issued. The FHAD model will start on the downstream side of the pipe under Quebec. The MDP existing conditions model will extend to north of 136th Avenue using the 2013 LiDAR, without the proposed pipe.**
   b) Drainage report shows as-constructed elevations for pipe under Quebec. As-builts available
      i) The existing pipe is undersized and results in a hydraulic grade line above the elevation of the sump in 134th Avenue when considering fully developed land use with no detention. The City of Thornton will require the development to keep the hydraulic grade line below the road elevation. Olsson will highlight this condition in the MDP.
   c) The detention basin NW of 134th & Quebec may not be its final configuration, and is not an "in-line" basin. The detention basin will discharge to the trunk line, not vice-versa. Thornton working through final comments on the FDP, and once issued, the construction will likely happen quickly; probably before the FHAD is finalized.

4) Quails Way – Amber Creek (STORM SYSTEM CONSTRUCTED)
   a) Stamped plans 08-28-2017
   b) All storm sewer and detention pond infrastructure have been constructed. Individual home sites within the western portion of the Amber Creek Phase 4 area may still be under construction (Magnolia Ct, Magnolia St, 135h Ave) but all overlot grading should be complete. The Phase 4 area drains to the south and discharges into Detention Pond C which is just southeast of the Monaco Court cul-de-sac.
      i) The MDP will include existing floodplain limits from 136th Avenue to 137th Avenue, so data is available for future development. The MDP will then reference the development for the remainder of Quails Way Tributary
      ii) The FHAD will not include Quails Way Tributary.

5) Brantner Gulch – Riverdale Road crossing (CONSTRUCTED)
   a) Have record drawings, but no as-built topography or as-built HEC-RAS model
      i) This project was built per plan. Olsson will use the design contours and supplement with as-built elevations in this area. MHFD will provide proposed contours in AutoCAD format, if possible. The culverts were blocked out intentionally and will be modeled as such.
   b) Survey?
      i) No survey will be needed.

6) Brantner Gulch – Creekside Village

a) Have 08/17/18 plans – status?
    i) **A CLOMR for the Creekside Village improvements has been completed. Construction timing is unknown. The improvements will not be incorporated into the model. The FHAD model will utilize LiDAR in this area.**

7) Other

a) Northglenn: Karl's Farm

i) Northglenn would like to see the model extended as far as Irma Street. The model is currently set up to extend to the west side of Washington Street.

b) Horizons Tributary

i) Two new 100-year trail crossings will be constructed in the near future. MHFD will provide proposed construction plans and the new crossings will be incorporated into the draft model based on design information. Once as-built information is available, the model input will be updated.

c) Fairgrounds Tributary

i) Olsson will confirm the hydrology within the Gleneagle development is up to date and the hydraulics incorporate the existing crossings.

d) 128th Street

i) Plans to update the 128th street crossing will not be incorporated into the FHAD. The culverts currently being constructed do not convey the 100-year event, and Thornton is working to get additional conveyance in this area.

Action Items:

Thornton:

1) Provide hydraulic model for the Yosemite Street pipe along SPR Tributary 6.

MHFD:

1) Provide most up to date construction drawings for Timberleaf development.

2) Provide Horizon Tributary Trail Crossing Plans – ***Complete***

Olsson:

1) Evaluate Yosemite Street storm drain system to see if overland model will be needed.

2) Prepare scope and fee for survey of Yosemite Street storm drain system and possibly the overland path.

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: Hannah Pring
cc: Attendees, Russ Nelson, File

olsson

GOLF COURSE HYDROLOGY/FHAD MODEL MEETING MINUTES

Brantner Gulch MDP and FHAD
Wednesday, February 10, 2021
9:00 am via Microsoft Teams

Name	Company	E-mail
Jim Kaiser	City of Thornton	Jim.Kaiser@thorntonco.gov
Rachelle Plas	City of Thornton	Rachelle.Plas@thorntonco.gov
Dave Skuodas	Mile High Flood District	dskuodas@mhfd.org
Brooke Seymour	Mile High Flood District	bseymour@mhfd.org
Hung-Teng Ho	Mile High Flood District	hho@mhfd.org
Pam Acre	Northglenn	pacre@northglenn.org
Russ Nelson	Adams County	rneslon@adcogov.org
Rene Valdez	Adams County	rvaldez@adcogov.org
Kurt Carlson	Adams County	kcarlson@adcogov.org
Marc Pedrucci	Adams County	mpedrucci@adcogov.org
D'Ann Kimbrel	Riverdale Golf Course	d@riverdalegolf.com
Rob Neuhauser	Riverdale Golf Course	robn@riverdalegolf.com
Amy Gabor	Olsson	agabor@olsson.com
Deb Ohlinger	Olsson	dohlinger@olsson.com
Hannah Pring	Olsson	hpring@olsson.com

The meeting was held to discuss FLO-2D results in the golf course area, how they compare with the 1D results, and discuss how to model this area. This summary is intended to reflect the key points raised, issues for further consideration, and action items resulting from the discussions.

Comment Discussion Items

Brantner Gulch Watershed Boundary

a. Southern basin boundary is in question since water spills south.
b. One option is to put a "Limit of Study."
c. DFA 0054 is the southernmost watershed that has been studied, but the north boundary is at 120th Avenue. The area between the Brantner Gulch watershed and the DFA 0054 watershed is considered South Platte Tributary Area, and there is no known study available.
d. Mann Lakes #1, #2, and #3 are located south of Henderson Road. Mann Lake #1 is adjacent to the South Platte River, Mann Lake #2 is between Riverdale Road and Mann Lake #1, and Mann Lake #3 is located south of these two lakes. The initial FLO-2D results show flows spilling into Mann Lake #2. Adams County noted that there was damage to Mann Lake #1 from flooding.
Todd Creek Village Metro District through an IGA with Adams County will also be installing the outlet pump station at the northeastern corner of Mann Lake #1. There is currently a small electrical building there that is half finished that will provide the power for those future pumps. There is also a gravity outlet (RCP) at that same northeastern corner (directly across the river from the South Platte Henderson Gauge).

Mann Lakes #1, #2, and #3 are hydraulically connected with low flow pipes and an overflow pipe under Park Boulevard An inlet structure from the South Platte River allows for water to be pumped into the cells individually.
   i. If these hydraulics are accurate, then a split flow model can be added all the way to the South Platte River.
e. Including the two lakes would be beneficial to the sponsors, as there are projects planned for the future within Mann Lake #1.
f. The hydrology will be updated to include the tributary area into Mann Lakes #1, #2, and #3. The Brantner Gulch and DFA 0054 watershed boundaries will be used to delineate this overall watershed, and then it will be subdivided as needed to meet criteria.

Brantner Gulch Modeling

g. In the 1D HEC-RAS model, lateral structures will be added to the north and south of the channel and the split flows will be optimized concurrently.
   i. Calculate the split flow in the 2D model, then adjust the weir coefficient in the 1D model to calibrate to the 2D model results.
   ii. Once the total flow leaving Brantner Gulch is determined, Olsson will send the sponsors this information to decide whether the full flows should be modeled in Brantner Gulch, or if the flows should be subtracted from Brantner Gulch downstream of the spills.

SPR Tributary 6

a. For the north spill out of Brantner Gulch, consider doing outside calculations to map the floodplain to the SPR Tributary 6 reach instead of doing a split flow. Hand calculations would likely be sufficient, as those flows would likely be eliminated instead of modified with the improvements shown in the Regional Park Master Plan.
b. Potential exists for a railroad to be placed in between Mann Nyholt lake and the South Platte River as part of the museum.
c. Jim noted following the meeting that the subdivision to the northwest has constructed the infrastructure to connect SPR 6 flow into the culvert within Yosemite, and constructed a roadway entrance that will stop high flows from propagating south along the west side of Yosemite.

For the Alternatives Phase:

a. Is there any option for SPR Tributary 6 to combine with Brantner Gulch? If there are improvements needed in the area where SPR 6 meanders through the golf course, it may make sense for the county to invest in additional improvements to Brantner Gulch to account for the SPR Tributary 6 flow. Brantner Gulch improvement plans from 2006 show the expansion of the channel to contain an approximate 50-year event for Brantner Gulch based on the updated hydrology in this study. These options will be discussed with Adams County and should complement their vision for the golf course.
b. The golf course does not like the flows coming through the course at the Yosemite intersection. A low flow pipe that connects to Brantner Gulch was installed to help alleviate the frequent flows through the golf course. This low flow pipe was accounted for in the hydrology phase of this study.
c. Adams County is currently planning on installation of a fairly elaborate Veteran's Memorial at the small parking lot (peninsula) north of Henderson Rd at Mann-Nyholt Lake.

SPR Tributaries 6 and 7

a. Model cross sections do not need to contain a lot of detail, as long as they generally agree with the 2D model results.

Northern Portion of Golf Course

a. The Regional Park area will be added to the HEC-RAS model starting upstream of Riverdale Road for the MDP. This reach will not be included in the FHAD. Olsson will include a map with the next submittal showing the MDP and FHAD model limits.

FLO-2D

a. Currently 75-ft cells. Recommend reducing the grid size to use these results to extract the flow splits. Perhaps use around 25 feet.
b. Use a steady flow method.
c. Assume all irrigation ditches are full.
d. Olsson will follow up with an updated FLO-2D model, with annotated figures denoting flows, velocities, and flow depths at the split flows. Velocities will be broken into 1 ft/s increments.

Action Items:

Olsson:

1. Update FLO-2D with smaller cell size and blocking off canal.

2. Prepare figures with callouts of flow splits, and include velocity and depth ranges.

MHFD:

1. Send DFA 0054 hydrology documents. *Completed*

Please contact Olsson at 303-237-2072 or email 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: Hannah Pring
cc: Attendees, File

FHAD MODEL COMMENTS – SUBMITTAL 2
MEETING MINUTES

Brantner Gulch MDP and FHAD
Thursday, July 21, 2022
11:00 am via Microsoft Teams

Attendees

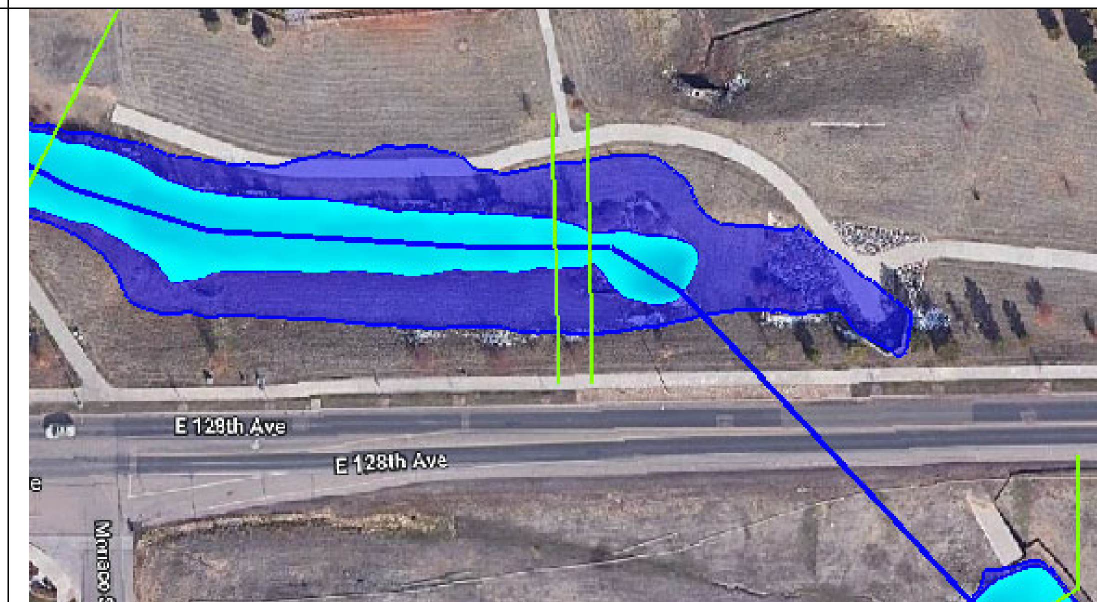
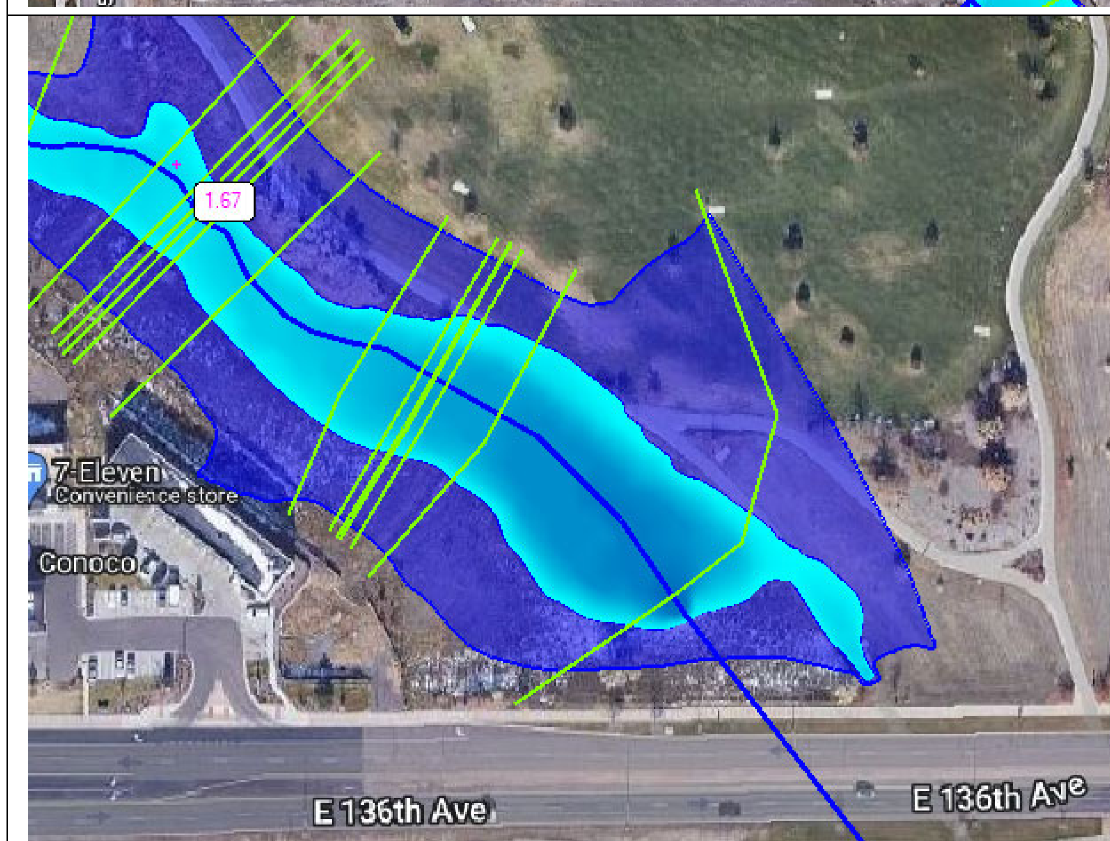
Name	Company	E-mail
Hung-Teng Ho	Mile High Flood District (MHFD)	Hho@mhfd.org
Colin Haggerty	MHFD	chaggerty@mhfd.org
Haley Koesters	MHFD	hkoesters@mhfd.org
Andy Stewart	MHFD	astewart@mhfd.org
Jim Kaiser	City of Thornton	Jim.Kaiser@thorntonco.gov
Amy Gabor	Olsson	Agabor@olsson.com
Hannah Pring	Olsson	hpring@olsson.com

The meeting was held to discuss FHAD modeling questions. This summary is intended to reflect the key points raised, issues for further consideration, and action items resulting from the discussions. The non-bold items comprised the meeting agenda. The items in bold resulted from the discussions.

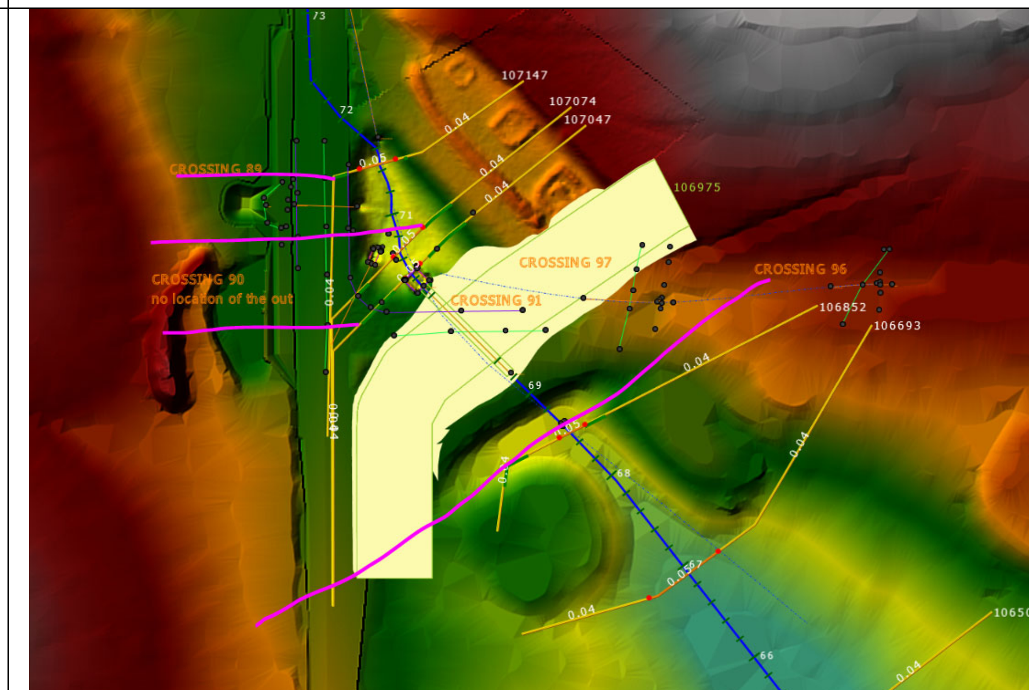
Comment Discussion Items

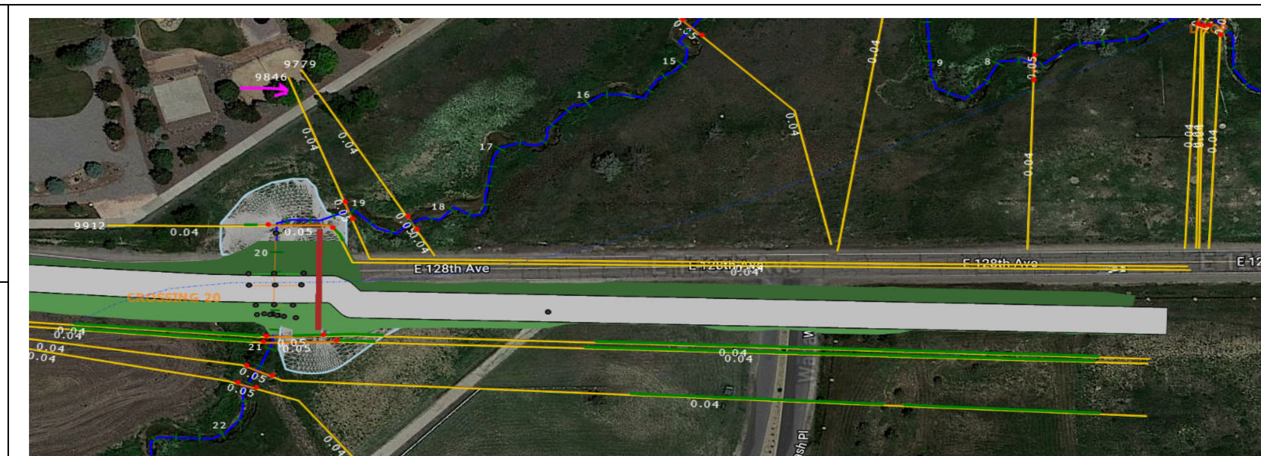
1) Model Comments

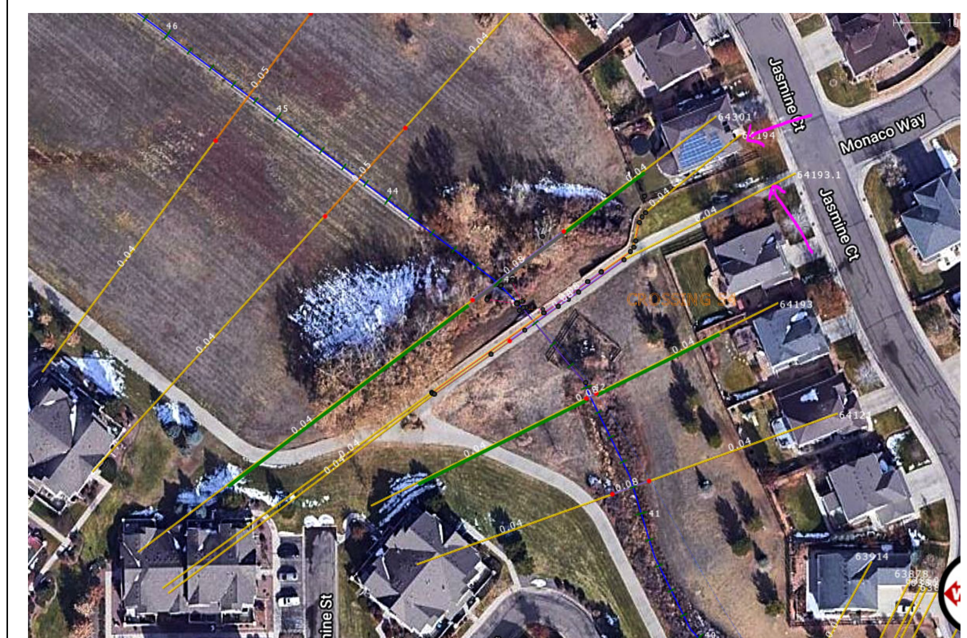
Agenda Number	Comment Page Number/ Object ID	Comment Source	Comment	Olsson Questions	Supporting Figures
1	3	General Comments - Word Doc	All geometry must be based on the existing condition. The information shall be documented clearly either in the model, report, or both where it is appropriate. It is important to provide clarity for the geometry that are based on either as-built contours or design contours that have been verified to be built per plan. For example, the descriptions for the XS 13112 to 11879 in Reach 3 of Brantner Gulch that do not provide the necessary clarity. An excerpt of the description is “Overbank information is based on Riverdale Ranch Design Contours and Ditch As-built information”.	In areas where design contours were used, it was because they were verified to be built per plan. What is the preference of the district when it comes to the language used in the plans? Can we have something that says "design contours were used and verified to be built per plan." Or, should we refer to everything as as-builts?	n/a
Notes: Use the language of “design contours verified to be built per plan.”					

Agenda Number	Comment Page Number/ Object ID	Comment Source	Comment	Olsson Questions	Supporting Figures
2	92	General Comments - Word Doc	XS 63118, E 128th Avenue crossing structure, the conservative water surface elevation based on all flows flowing through the main culvert group is appropriate for the 500-year event. However, the 100-year event will have to be on a case-by-case basis. The existing inlet configuration including a spillway has been designed to consider the overtopping conditions. Do we have a copy of the hydraulic design report to help us understand the design hydraulics?	Comment 92: Plains Tributary – 100-year doesn't spill, 500-year WSE conservative and is controlled by structure 3 XS upstream. Comment 95: Horizon Tributary – 100-year and 500-year WSE are conservative and controlled by structure up to drop structure. From the Report, in red: We would like to discuss the preferred path forward in the HEC-RAS model to see if reflecting a more realistic water surface elevation upstream of the crossing is desired. Potential solutions include: modify the road deck information to reflect the high ground in the LOB and add notes (drawback is it may appear road overtops for future users), hard code flow change immediately upstream and then downstream of the crossing (drawback is adding frequent flow changes, and dependent on outside calcs), add LS in this area and then hard code flow change (drawback is frequent flow changes).	
3	95	Model Related Comments - PDF	XS 82763, E 136th Avenue, Horizon Tributary - Please see comment in the memo (comment 92 also applies here).		

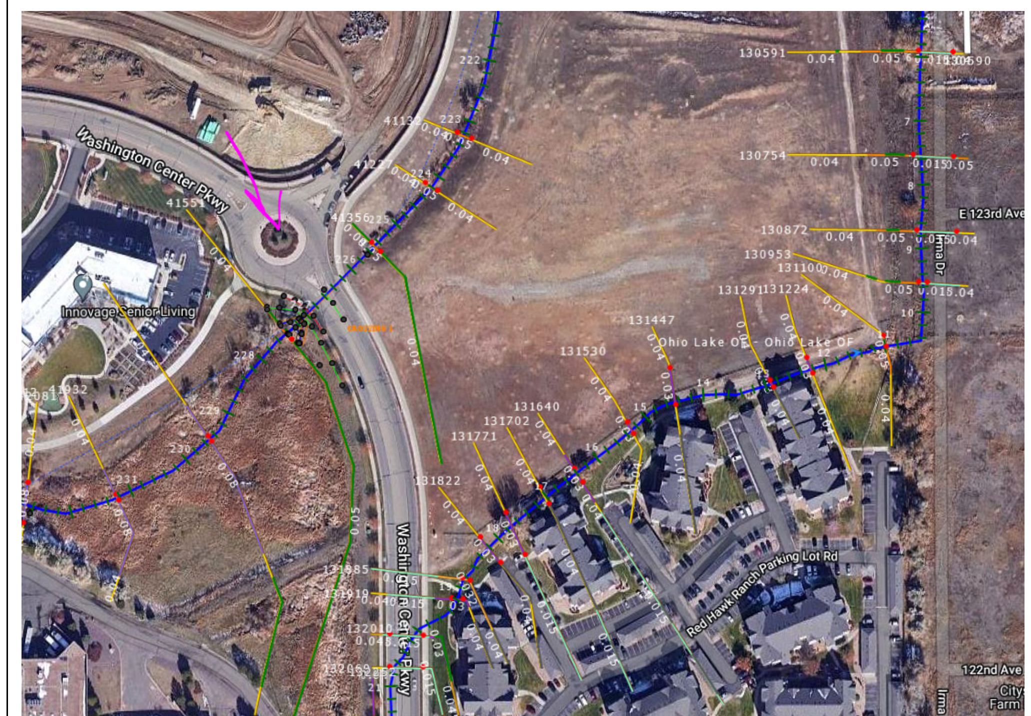
Notes: JK, From a mapping standpoint, if the mapping is showing the flows going through the culvert we should show that. If the floodplain is on the trail, he isn't worried. As long as we are accurate in the mapping, and aren't showing structures in the floodplain, the backwater into the area on the left near the 7 Eleven on the west side of the above screenshot is a detention pond and he isn't worried about this.
HTH: Prefers a more simplified, conservative approach. Leave as is, since it is conservative and there is not anything concerning in terms of where the floodplain is impacting.

Agenda Number	Comment Page Number/ Object ID	Comment Source	Comment	Olsson Questions	Supporting Figures
4	6	General Comments - Word Doc	In SPR South Tributary 6, our detailed review revealed the following issues: • Please review the terrain from XS 106852 to 108213. • Please update the alignment of XS 106852, 107047, 107074 and 107147 to represent the terrain and flow direction more accurately. • Please review the downstream barrel centerline station to align the culvert and downstream thalweg. There is no hydraulic concern, just modeling consistency.	The plan in this area is to realign the sections and have them cross Yosemite so there is not a long tail as shown.	
Notes: The approach looks good. Make sure that the 2020 Lidar is incorporated into the final combined terrain and reflects the current roadway configurations.					
5	PDF page 28	Model Related Comments - PDF	It will depend on the timing and detail of the as-built. The mapping accuracy is not critical for 81 cfs of 500-year flow. Let's circle back this area near the end of this study and determine the base information for mapping.	This is in relation to the Karl's farm area. We will continue to keep track of this area as we move forward with study. The area will remain as red in the report text. Pam Acre was unable to attend this meeting, but we will follow up with her to see what the status of this area is.	
Notes: Approach is good.					

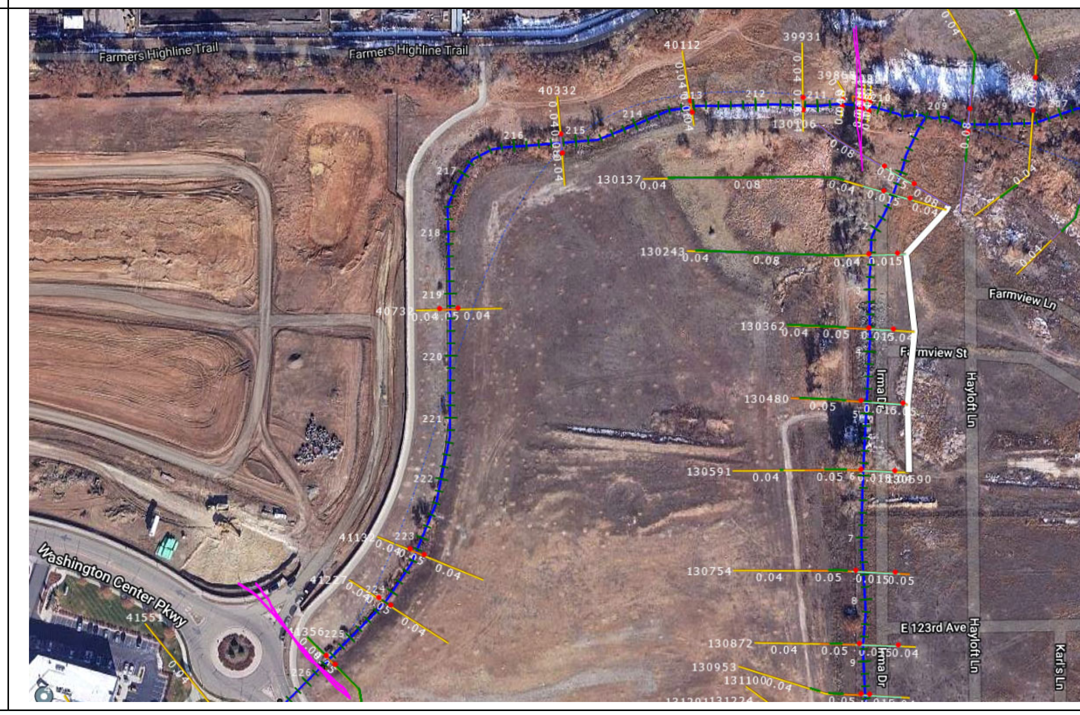
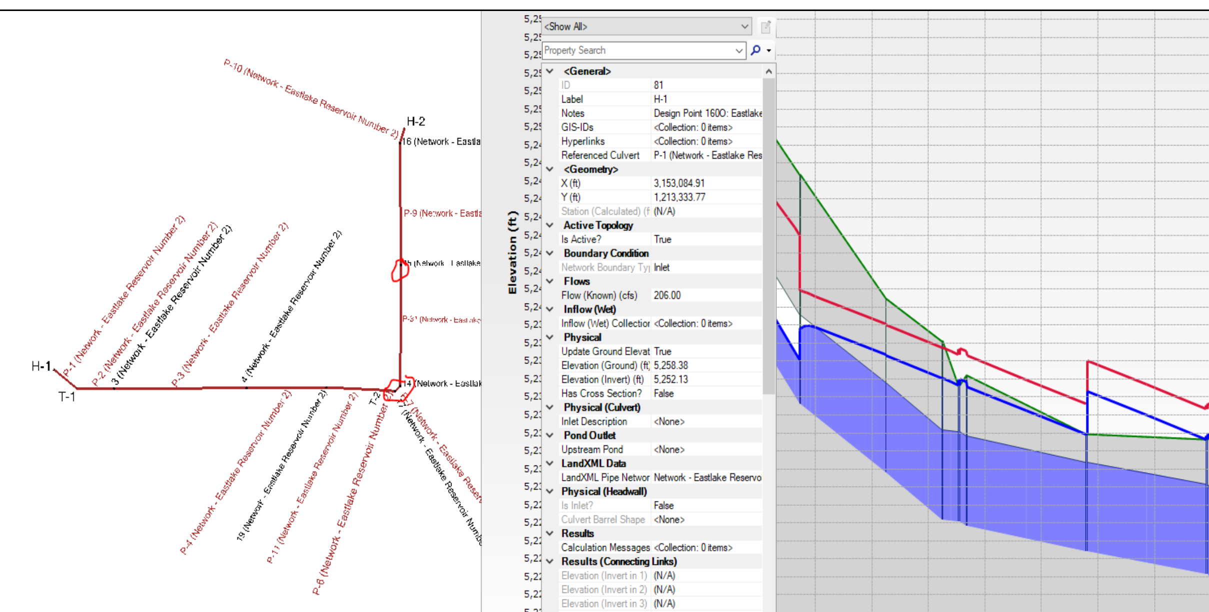
Agenda Number	Comment Page Number/ Object ID	Comment Source	Comment	Olsson Questions	Supporting Figures
6	PDF page 28	Model Related Comments - PDF	Did the FlowMaster analysis consider the area downstream of the existing detention to Colorado Blvd? If not, a few cross-sections at several critical locations might be necessary to understand the 500-year floodplain extents.	No, the flowmaster is from a cross section that cuts across 123rd Dr, then it is assumed that the flows go into the detention pond, then into the storm system. For reference, 100-year spill is 15 cfs and 500-year spill is 220 cfs. Does the full spill need to be modeled until it returns to Brantner Gulch? What additional analysis needs to be performed in this area?	
Notes: This is on-site detention pond. Assume that the pond is full for the 500-year event so that we can understand how flows spread out downstream. Cut two or three cross sections in FlowMaster downstream of the pond where flows spill. If it is contained in the street, then we will not need an actual split within the model and it can be mapped based on the normal depth calculations. Check to see if the 2020 LiDAR needs to be referenced in this area for improved resolution.					
7	PDF page 30	Model Related Comments - PDF	The floodplain mapping will use this set WSE across the controlling spillway elevation. This general modeling assumption might not be appropriate but shall be on a case-by-case basis. Let's discuss.	There are some detention ponds that have been specifically called out in the comments, which we have been investigating. Should we look into every pond in the model, or only the ones called out in these comments?	
Notes: Just need to look at the ones that we had comments on.					
8	70	MHFD Review Shapefile	Downstream of E 128th Ave., please investigate expanding the right end of XS 9912 to show flow continuity across roadway. There is a hydraulic control downstream of the XS 9912. Please investigate the need for additional cross-section.	Discuss modeling approach	
9	PDF page 30	Model Related Comments - PDF	The channel downstream of 128th Avenue makes a hard turn to the east. The water overflow 128th Ave will flow overland and spread across several downstream cross-sections to return to the mainstream. Please investigate the modeling approach to fill in a gap between 128th Ave to the downstream floodplain.	Discuss modeling approach	
Notes: HTH – Do we need to show any more detail in this area for the floodplain? JK – The north is all open space and there is not any planned development, so no additional detail is needed. Everything is built out, so we don't need to provide more detail. Approach is acceptable as shown.					

Agenda Number	Comment Page Number/ Object ID	Comment Source	Comment	Olsson Questions	Supporting Figures
10	16/91	MHFD Comment Shapefile	Please consider an additional cross section at the weir for modeling overflow. Use set water surface elevations.	Discuss modeling the notch. No separated flows are currently calculated.	
11	17/91	MHFD Comment Shapefile	Please consider an additional cross section at the top of the trail crossing for modeling overflow condition and flow change location.	Discuss modeling the notch. No separated flows are currently calculated.	

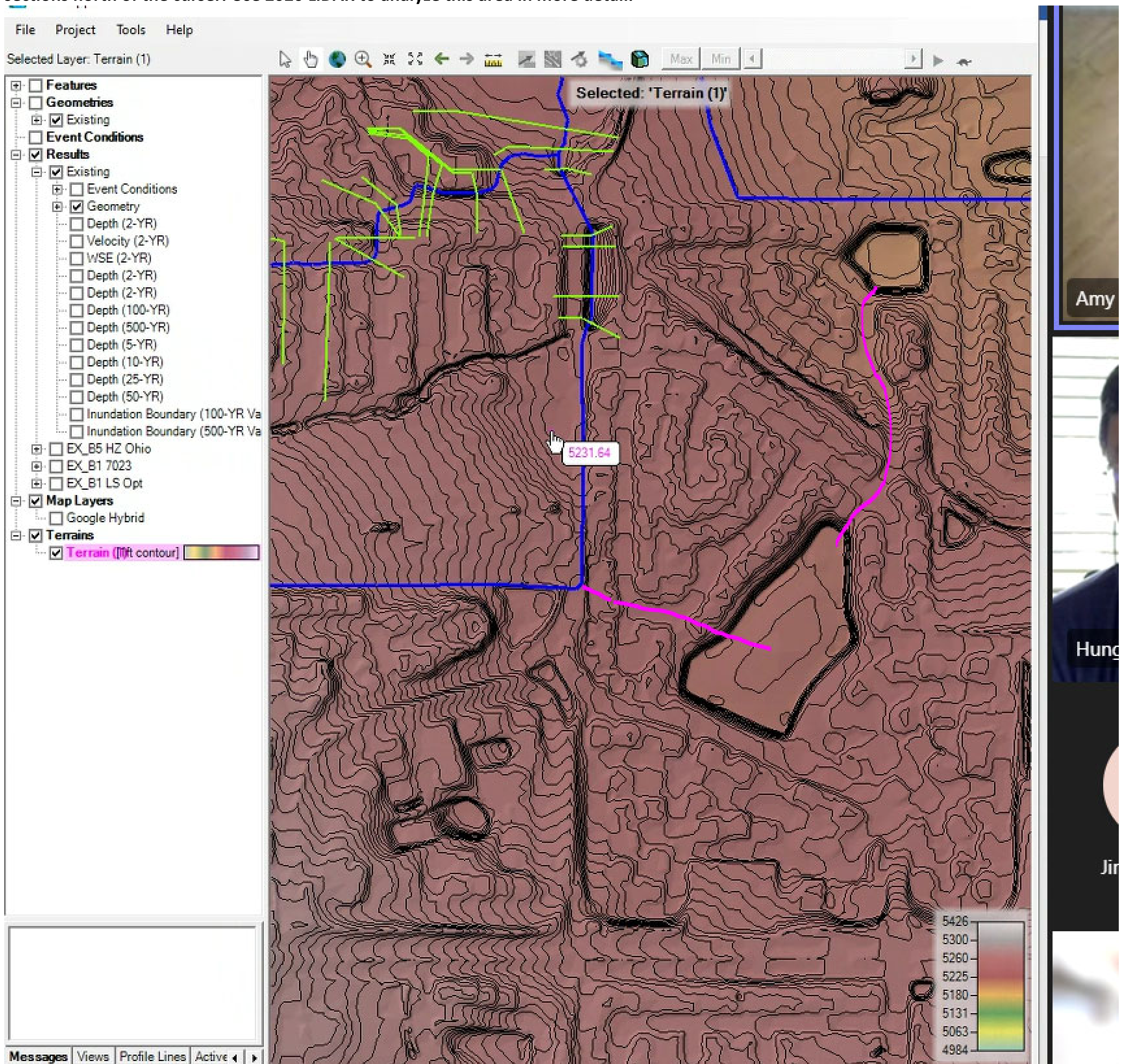
Notes: Current approach is enough. Sometimes the spillway distance between upstream and downstream cross section is so long and if structures are close to the floodplain, more detail is needed. Since that is not the case here, the simplified approach is OK.

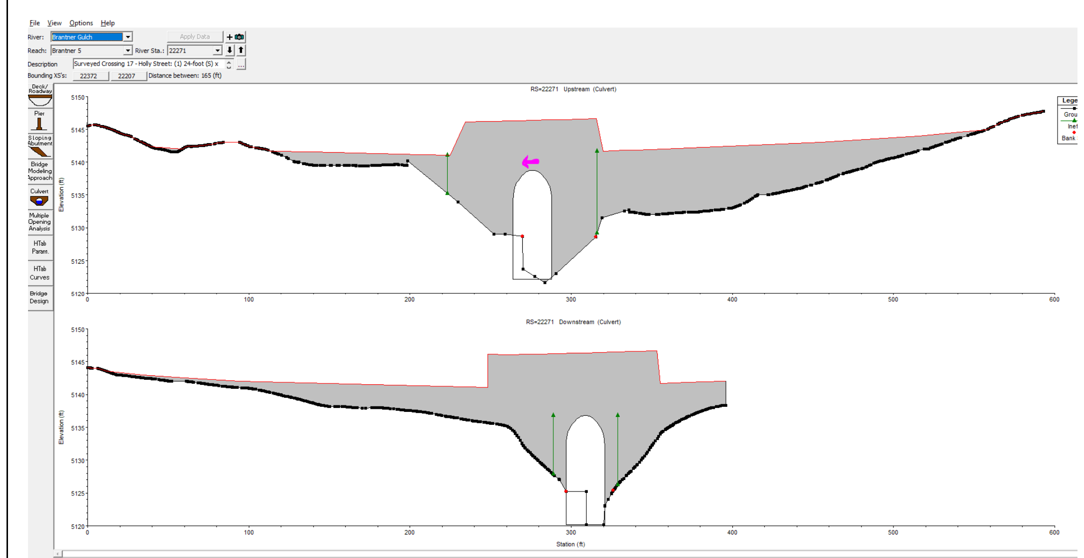
Agenda Number	Comment Page Number/ Object ID	Comment Source	Comment	Olsson Questions	Supporting Figures
12	12	MHFD Review Shapefile	Okay. Let's discuss adding the culvert back to the hydraulic model to provide detail for flood profiles since the overtopping condition was modeled with a separated reach./ Let's discuss the modeling approach for overtopping flow condition at a crossing structure that was not directly modeled due to hydraulic complexity.	Discuss modeling approach at Detention Pond H306.	

Notes: Add the culvert back in since we have an offset spill reach. Move the flow change that reflects the detention pond outflows to the cross section immediately upstream of the crossing and keep the set water surface elevation at this location.

Agenda Number	Comment Page Number/ Object ID	Comment Source	Comment	Olsson Questions	Supporting Figures
13	15	MHFD Review Shapefile	XS 41356 replaced previous XSs. Invert elevation 5303.5 does not match the surveyed invert elevation 5303.61.	The flowline was interpolated between survey points. Since the cross section is downstream of the survey point, the interpolation resulted in a lower elevation. Need to confirm approach is acceptable.	
Notes: Provide explanation in description. Jim noted the development is piping the channel in this reach and it is under construction. If updated information is received in time, it can be incorporated into the model, otherwise the model will show the pre-development conditions.					
14	32	MHFD Review Shapefile	Okay with the response. Please look at the potential overflows bubble out of manhole and estimate if it warrants a 1D model for computing the flood risk or a normal depth calculation suffices.	At the bend in the pipe, the storm pipe has capacity for the 100-year flow, but will surcharge in the 500-year (difference of 33 cfs). Storm pipe has a capacity of 160 cfs before the HGL is above ground at the lower end. 100-year flows are 206 cfs (46 cfs difference) and 500-year flows are 239 cfs (79 cfs difference) in the pipe.	

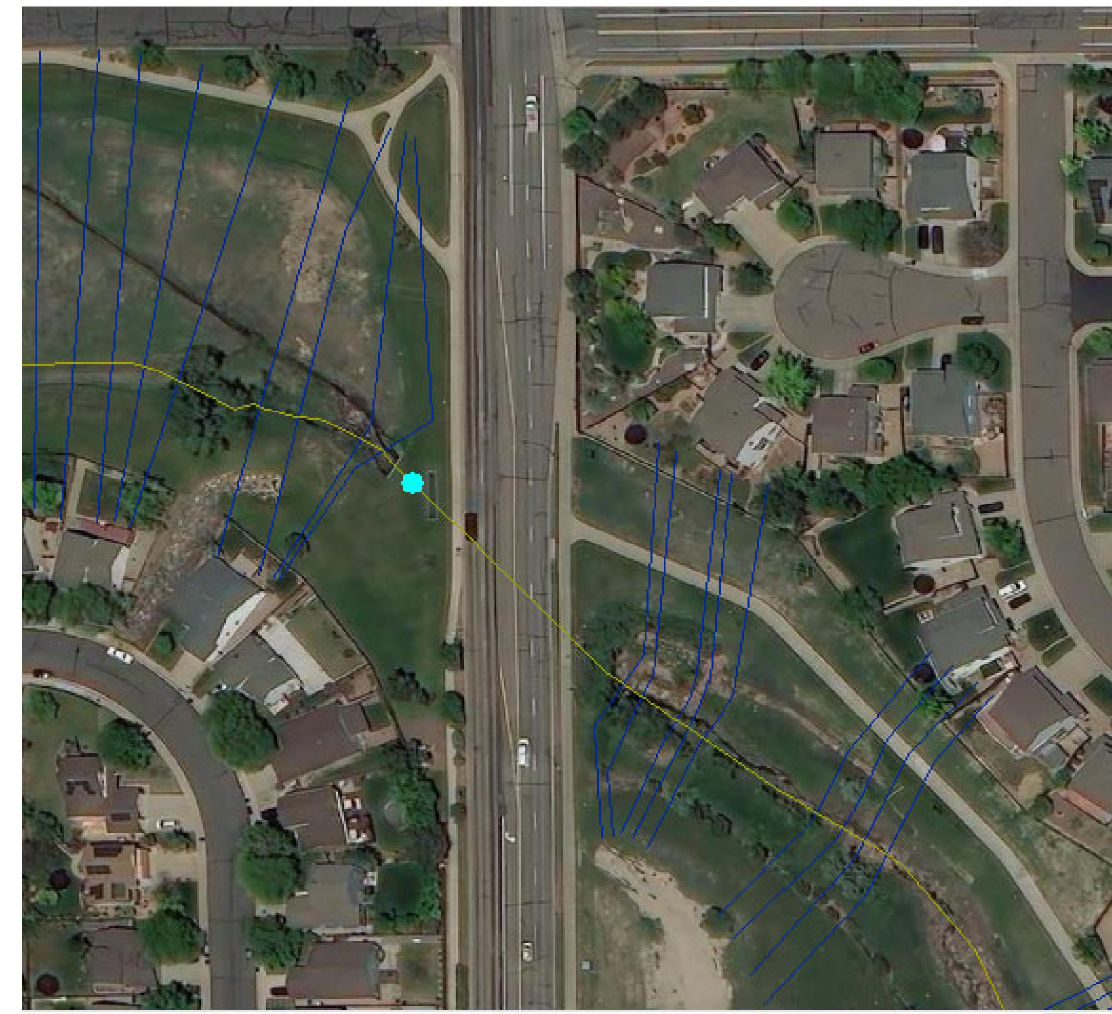
Agenda Number	Comment Page Number/ Object ID	Comment Source	Comment	Olsson Questions	Supporting Figures
Notes: Add a few cross sections to see if the 33 cfs is carried in the street in FlowMaster. Assume downstream pond is full, confirm it stays in the street based on the normal depth calculations and see if we need a split flow. Add two more additional cross sections north of the curser. Use 2020 LiDAR to analyze this area in more detail.					

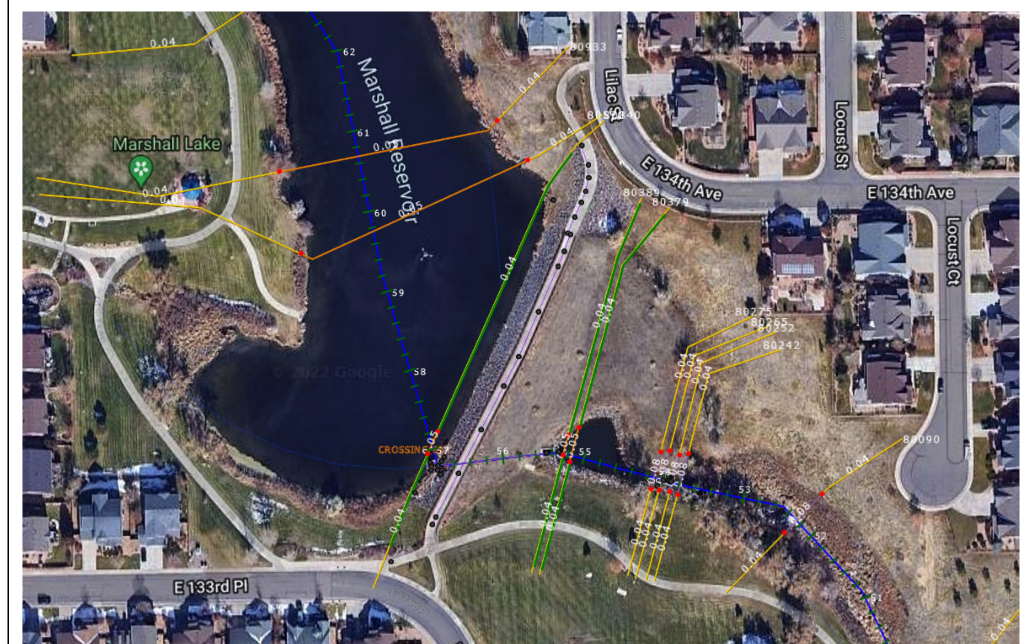


Agenda Number	Comment Page Number/ Object ID	Comment Source	Comment	Olsson Questions	Supporting Figures
15	44	MHFD Review Shapefile	Please confirm the updated invert elevation 5181.57 that does not match the surveyed invert elevation 5181.75 or provide a clarification.	The elevation of 5181.57 is an interpolated value between the invert of the culvert upstream and the crest of the drop structure downstream. There are notes in the description of the cross section saying this. Need to confirm approach is acceptable, same as comment 15.	n/a
Notes: Approach is good, make sure the notes are in description.					
16	54	MHFD Review Shapefile	It is correct to add pedestrian crossing information to the bounding cross-sections. The trail embankment, using depth blocked, should be added inside the conspan to reflect the true effective flow area.	Should we come up with a depth to block the bottom of the culvert that is equivalent to the reduction in area caused by the pedestrian trail embankment?	
Notes: Fill in the bottom based on the equivalent area for the conspan.					

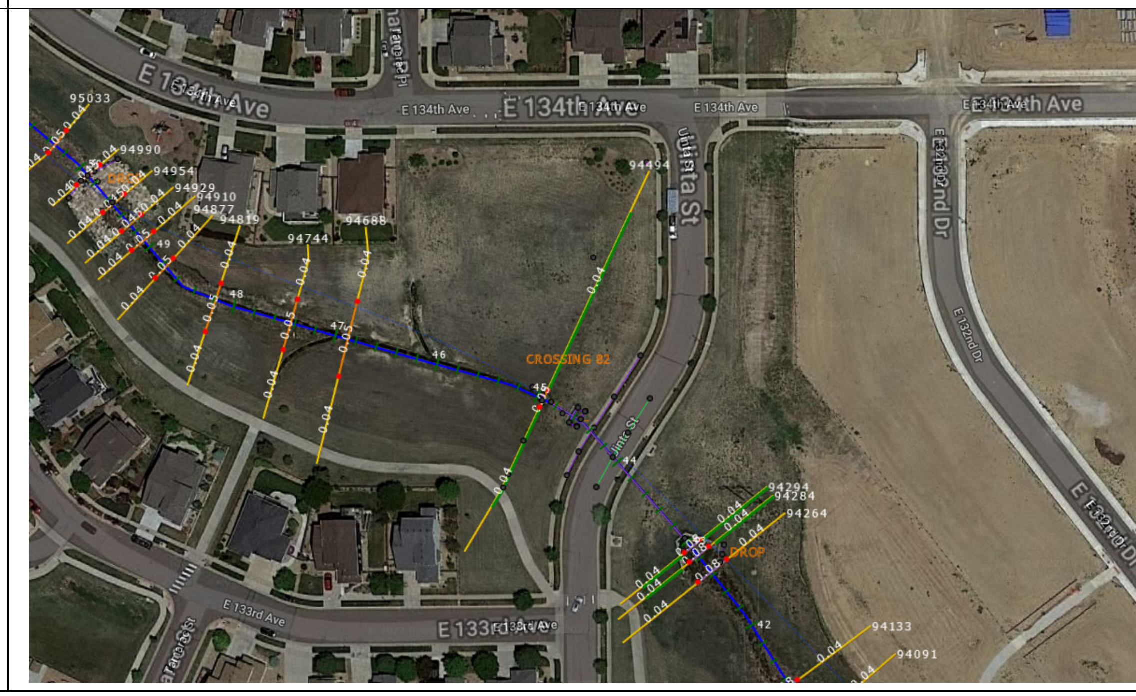
Agenda Number	Comment Page Number/ Object ID	Comment Source	Comment	Olsson Questions	Supporting Figures
17	76		The lowest berm elevation was found to be approximate 5004 instead of 5008. Please update the elevation for blocked obstruction. Let's discuss using limited cross-sections and adjusting cutline alignment to facilitate the model setup.	Discuss modeling updates	

Notes: Don't need the 400 feet interval of the cross sections in this area. Want to represent the spill and add the backwater. Have one on the berm and remove some of the cross sections in the detention pond area.

Agenda Number	Comment Page Number/ Object ID	Comment Source	Comment	Olsson Questions	Supporting Figures
18	79	MHFD Review Shapefile	In the instance of ignoring the crossing structures, please add two or three cross-sections at minimum to account the overland flow condition across the deck/roadway.	Detention Pond L305 - Discuss. If cross sections are added, update alignment to follow overflow path?	
Notes: Current approach is ok. Account for over topping in the mapping. DS XS will be mapped wider than what the FP is showing based on overtopping condition.					

Agenda Number	Comment Page Number/ Object ID	Comment Source	Comment	Olsson Questions	Supporting Figures
19	99	MHFD Review Shapefile	Let's discuss the modeling approach for overtopping flow condition at a crossing structure that was not directly modeled due to hydraulic complexity.	Detention Pond H306 – Discuss approach	

Notes: Current approach is good.

Agenda Number	Comment Page Number/ Object ID	Comment Source	Comment	Olsson Questions	Supporting Figures
20	133	MHFD Review Shapefile	Please confirm that there is no overtopping	According to the set WSEL that we used, we are overtopping somewhere between the 100/500 year events. The survey points show a low point on the berm at elevation 5121.83, and the 500 year is at 5122.47	
Notes: Current approach is good.					
21	7	General Comments - Word Doc	In SPR North Tributary 7 from downstream of Riverdale Rd to the confluence with South Platte River, our detailed review revealed the following issues: • XS 114250, 114530, 115694 and 116899 in the reach of SPR N Trib 7 and XS 110438, 110838, and 111238 in the reach of SPR N Trib_DS, the end points do not contain all events. Please expand or adjust alignment to fully contain all events. • The current modeling configuration is very complicated and substantially increases the challenges for arranging all elements appropriately. Since this reach is located within the golf course, a simplified modeling approach only emphasizes the critical controls that might facilitate the model setup and still provides reasonable hydraulics in this reach.	Discuss modeling approach. Per the report: A total of four cross sections are unbound on the SPRN North Tributary 7 reach in the golf course (Cross Sections 114250, 114530, 115694, and 116899). Flows will generally follow the main alignment through this reach, but will find other overland paths through the golf course as well. The golf course area is modeled as ineffective flow area in the 1D model. The desired modeling approach in this area will be discussed after the next review to determine if modeling changes are needed and discuss the approach for the unbound cross sections if the modeling approach does not change.	
Notes: Look to try and eliminate some of the cross sections and try and simplify the model. Remove non-controlling sections. Perhaps focus on high grounds and contain them, then focus on the mapping. 400 feet is more of a District requirement, and not necessary in this instance. The profile will be referenced to determine which cross sections can be removed without impacting water surface elevations.					

Agenda Number	Comment Page Number/ Object ID	Comment Source	Comment	Olsson Questions	Supporting Figures
22	31	Model Related Comments - PDF	[Golf course area] Let's discuss a simplified modeling approach for these areas.	Discuss model approach.	n/a
Notes: See above remarks on golf course area.					

2) Other
   a. Olsson to work on updating these final comments for one more review before doing the floodway model.
   b. Karl's Farm is currently under construction.

Action Items:

MHFD:

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: Hannah Pring
cc: Attendees, Rachelle Plas, Russ Nelson, Marc Pedrucci, Kurt Carlson, Pam Acre, File

olsson

ALTERNATIVES KICKOFF MEETING MINUTES

Brantner Gulch MDP and FHAD
Tuesday, January 3, 2023
9:00-10:30 am Microsoft Teams

Anticipated Attendees:

Attended	Name	Company	E-mail
x	Andy Stewart	Mile High Flood District (MHFD)	astewart@mhfd.org
x	Drew Roberts	MHFD	droberts@mhfd.org
x	Pam Acre	City of Northglenn (Northglenn)	pacre@northglenn.org
x	Russ Nelson	Adams County	rnelson@adcogov.org
x	Denise Beltran Torresdey	Adams County	dbeltrantorresdey@adcogov.org
x	Trevor Graf	Adams County Parks and Open Space	tgraf@adcogov.org
x	Jim Kaiser	City of Thornton (Thornton)	Jim.kaiser@ThorntonCO.gov
x	Rachelle Plas	Thornton	Rachelle.Plas@ThorntonCO.gov
x	Amy Gabor	Olsson	agabor@olsson.com
x	Hannah Pring	Olsson	hpring@olsson.com

The meeting was held to discuss the FHAD status and kickoff the alternatives phase of the study. This summary is intended to reflect the key points raised, issues for further consideration, and action items resulting from the discussions. The non-bold items comprised the meeting agenda. The items in bold resulted from the discussions.

1) FHAD
   a) Address final model comments (SPR Trib 7 in golf course)
      i) **Lee's Farm development at Quebec Street and E. 136th Avenue along Fairgrounds Tributary is not incorporated into the FHAD model. Timing is unknown. Development might not have large impact on actual channel. If timing allows, MDP can consider development as it relates to the channel and crossing structure.**
   b) Floodway model
      i) General approach
         (1) Floodplain=floodway when contained in channel (majority of channels)
            (a) Backwater conditions of detention ponds shall not be included as floodplain=floodway. Encroachments are to be added at the WSEL along the channel.
         (2) Keep trails outside of floodway where possible
      ii) Sponsor preferences for FW?
         (1) MHFD would prefer a 3/10 of a foot floodway not to exceed.
      iii) Golf course area
         (1) A floodway that is too wide would theoretically require a CLOMR for any golf course sculpting. An overly wide floodway doesn't protect much within the course and would not serve the people of Adams County productively. A minimized floodway in this area would be better. Defining the floodway where flow splits occur will be discussed with Hung-Teng Ho at MHFD.
         (2) Floodway should be a holistic approach to prevent inhibiting future grading in the golf course area.
         (3) A new Master Plan in this area has been completed and will be provided by Adams County. The floodway model will consider the master plan to the extent feasible.
         (4) The Brantner Gulch floodplain spill over Henderson Road will be handled in the floodplain mapping portion of the project and will be informed by the 2D model.
   c) Prepare and submit floodplain mapping, profiles, tables, and complete report

2) Problem areas
   a) Will evaluate capacity of each structure based on crossing type and local jurisdiction's criteria
   b) Overtopping street crossings in 100-year event
      i) E 124th Avenue (Brantner Gulch)
      ii) E. 128th Avenue (Brantner Gulch)
      iii) Riverdale Road (Brantner Gulch)
         (1) Crossing was designed for the 100-year and 2 of 3 cells were partially filled. The MDP alternatives will validate the design of this crossing in the event of a channel being built in the Golf Course.
      iv) Holly Street (Horizon Tributary) – evaluate upstream detention in MDP to see if it overtops with detention counted
      v) E. 136th Avenue (SPRN Trib 7)
      vi) Riverdale Road (SPRN Trib 7)
      vii) Riverdale Road (SPRS Trib 6)
      viii) Riverdale Road (Riverdale Bluffs area)
   c) East Lake No. 2 storm drain system capacity
   d) Ohio Lake spill
      i) Eliminating the Ohio Lake spill would eliminate the spill reach that flows into the Karl's Farm development in Northglenn
   e) Golf course area and Riverdale Bluffs
   f) Channel capacity will be further evaluated as floodplain is delineated
      i) Along Brantner Gulch, the CLOMR approval for Creekside Village is 19-08-0681R; approved October 31, 2019. The extent of this work is from just upstream of the Lakeview Tributary confluence to Quebec Street; within the property owned by the Creekside Village developer. It does not propose any work in the oxbow to the south into (presently) unincorporated Adams County (re: 2.f.ii), just west of Quebec Street. Alternatives for this oxbow, and the balance of the length west to Holly Street should still be evaluated. Creekside Village also has approved grading plans and a Floodplain Development Permit for both the Plains and Lakeview Tributaries through their site, from 128th to the respective confluences. Since not SFHA today, this work was not included in the CLOMR. See excerpted pages illustrating the extent of the work, and the proposed post construction BFE and tie-in limits.
      ii) Holly Street to 128th Avenue on Brantner Gulch and a portion of the South Platte River North Tributary 7 may require coordination between Thornton and Adams County improvements and criteria. There is a possible annexation of property south of Brantner Gulch and west of Quebec Street.

g) Erosion and channel instability will be identified

3) Original Project Goals to consider during Alternatives
   a) Main areas of concern and of note
      i) Claude Court and RTD culverts (both appear to have capacity in draft model)
      ii) Water quality is desired upstream of Mann-Nyholt Lake. Water augmentation occurs at the Mann-Nyholt Lake
      iii) Infrastructure in fairgrounds – need to maintain access by at least one of the two bridges during storm events
      iv) Brantner Ditch interface – separate flows from Brantner Gulch
         (1) triple cell, 16x12 culverts are located under Riverdale Road but were filled in 5 feet deep. The culverts can be cleaned out to provide full conveyance. One cell is desired for use as a trail connection. It could be the north or south cell.
   b) Observed problems/issues?
      i) Childcare facility at Colorado Avenue and 124th is shown to be located in the floodplain – will review as floodplain mapping is completed
   c) Follow Adams County Riverdale Regional Park Master Plan
      i) Shows anticipated future alignment
      ii) Continuous riparian corridor from 120th to 136th
      iii) Enhance fishing and bird habitat – keep wildlife corridors accessible
   d) Evaluate reintroducing flows between Mann-Nyholt Lake and the Fishing is Fun Pond along the historic Brantner Gulch channel alignment
4) Alternatives
   a) Crossing structures
   b) Future road/trail crossings
   c) Channel improvements
      i) Level of detail for alternatives?
   d) Detention – **new detention facilities** are not anticipated for this study
      i) Existing detention ponds will be analyzed and improvement recommendations made if needed.
      ii) Ohio Lake will likely need to be enhanced, and outlet structure improved. Will work to eliminate this spill in the alternatives.
   e) Water quality
      i) Eastlake No. 3 – This lake likely needs to have a sediment analysis done and could potentially require dredging. Scope of this project may be a larger study for the parks department later down the road.
   f) The impacts of the Thornton developments along/north of Eastlake Avenue (124th) to Northglenn are a concern. Where will these developments outfall their stormwater? There is not 100-year capacity in the 128th railroad culvert/storm sewer that flows east into Eastlake No. 3. The south portion of this area historically flowed southeast towards the culvert/storm sewer in the Eastlake Avenue ROW north of the City of Northglenn public works yard.

   g) Use SWIFT, or just GIS interface for alternatives?
      i) To be determined by MHFD.
   h) Deliverables:
      i) Consider providing a document that shows proposed improvements that will withstand the test of time on a shelf, before the improvements are brought to final design. The plan should focus on what the improvements are trying to fix, with less specific recommendations that still adhere to the most recent criteria.
      ii) Provide GIS interface with attributes that will interface well with MHFD's Confluence.
      iii) Olsson will put together an example excerpt that outlines what we think could be useful information to include in the alternatives report for the project sponsors to review, and get buyoff prior to completing the full alternatives submittal.

h. Schedule
   a. Draft alternatives to be submitted 10 weeks from authorization (to be completed)

i. Upcoming meetings
   a. After Draft Alternatives Analysis Report is reviewed

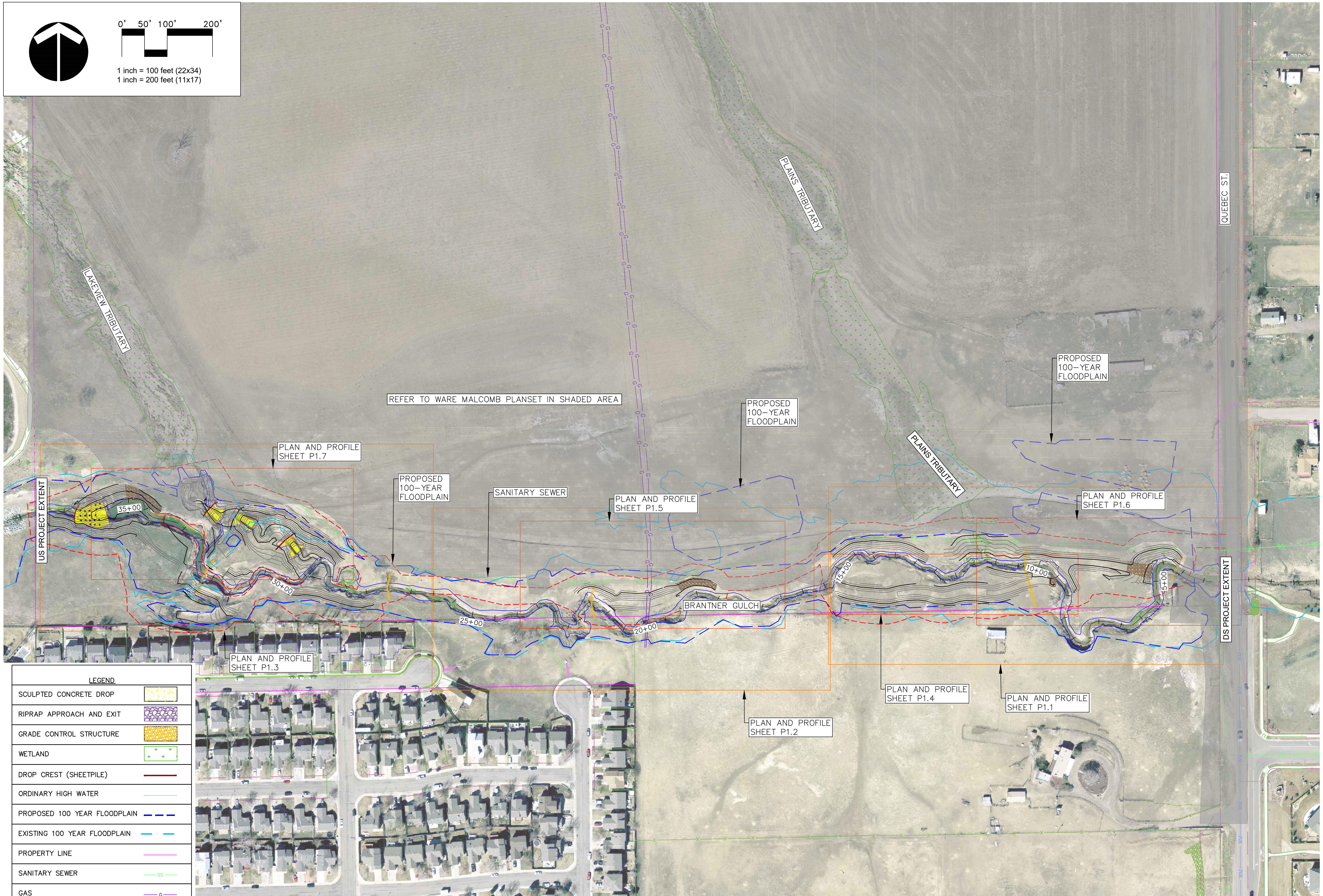
j. Other

Action Items:

- **Adam's County: Provide most recent parks Master Plan**
- **MHFD: Direct Olsson on if SWIFT tool should be used for alternatives**

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: Hannah Pring
cc: Attendees, File



LEGEND

SCULPTED CONCRETE DROP	
RIPRAP APPROACH AND EXIT	
GRADE CONTROL STRUCTURE	
WETLAND	
DROP CREST (SHEETPILE)	
ORDINARY HIGH WATER	
PROPOSED 100 YEAR FLOODPLAIN	
EXISTING 100 YEAR FLOODPLAIN	
PROPERTY LINE	
SANITARY SEWER	SS
GAS	G
LIMITS OF DISTURBANCE	

NO.	DATE	BY	REVISION COMMENTS

Design	Drawn	Checked	Date	Initial Issue Date:
KP/JEA	KP/AN	JEA	8/17/18	

PREPARED FOR:

WOODBURY CORPORATION

PROPOSED CONDITIONS OVERVIEW

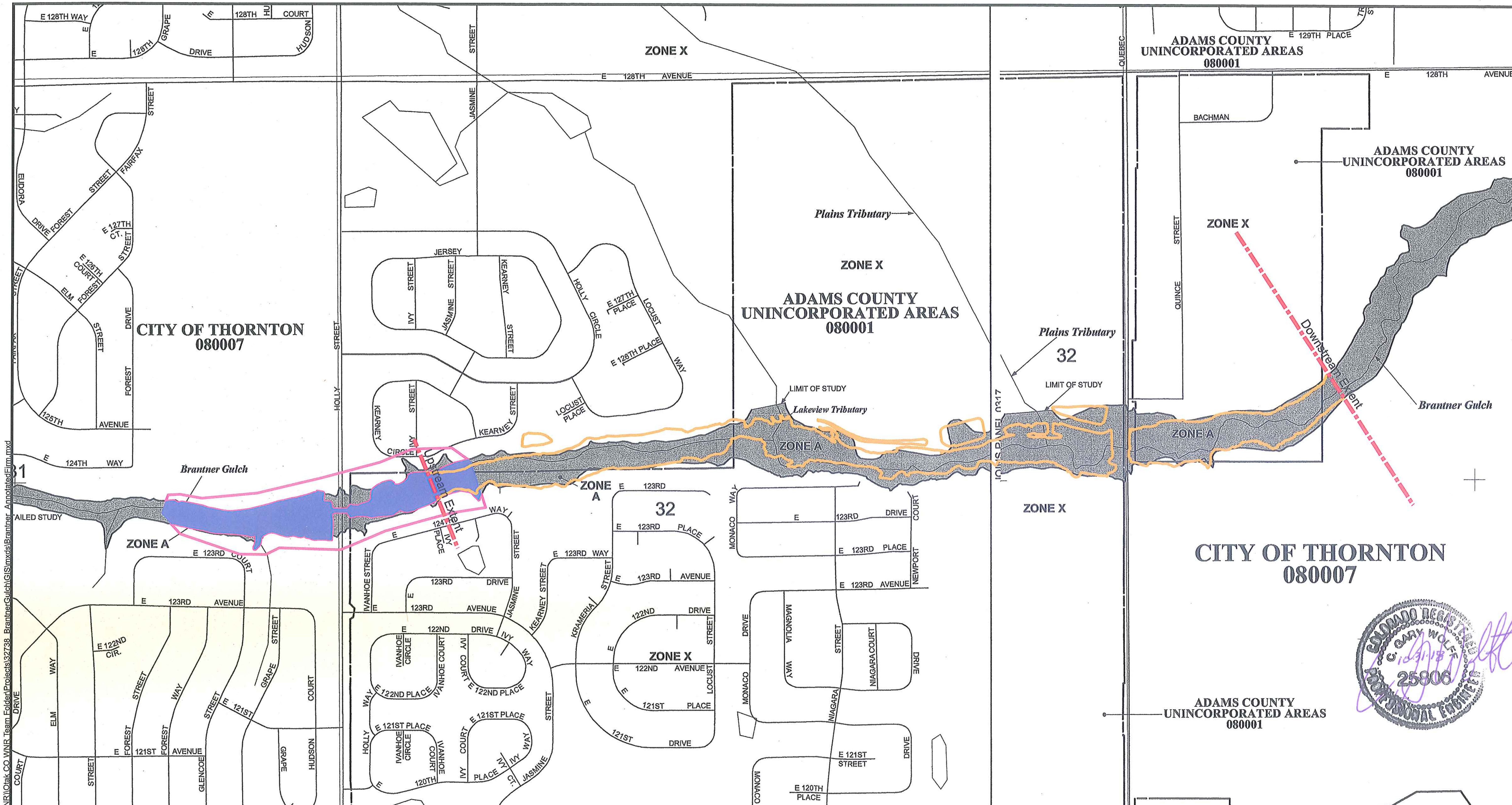
BRANTNER GULCH AT CREEKSIDE
STABILIZATION PROJECT
THORNTON, CO

otak

5777 Central Avenue
Suite 228
Boulder, Colorado 80301
Phone: 303-296-3304
Fax: 303-296-3699

032738
Project No. Drawing No.
P1.0B
Sheet No.

Plotted: Aug 17, 2018 - 5:11pm ollisonn C:\Dropbox (Otak CO WNR)\Otak CO WNR Team Folder\Projects\32738_BrantnerGulch\CAD\Planset\32738_Overview.dwg Layout Name: PROPOSED CONDITIONS OVERVIEW



Document Path: C:\Dropbox (Otak CO WNR)\Otak CO WNR\Team Folder\Projects\32738_BrantnerGulch\GIS\mxds\Brantner_AnnotatedFirm.mxd

Legend

- Limit of Map Revision
- Revised 1% Annual Chance Floodplain
- Effective Zone A Holly Street LOMR
- Effective Holly Street LOMR

N

0 320 640 1,280 Feet

Vertical Datum: NAVD88
Horizontal Datum: NAD83 (1991)
Colorado North State Plane Coordinate System

FIGURE 3
ANNOTATED FIRM
BRANTNER GULCH PROJECT

Last Modified: 10/23/2018

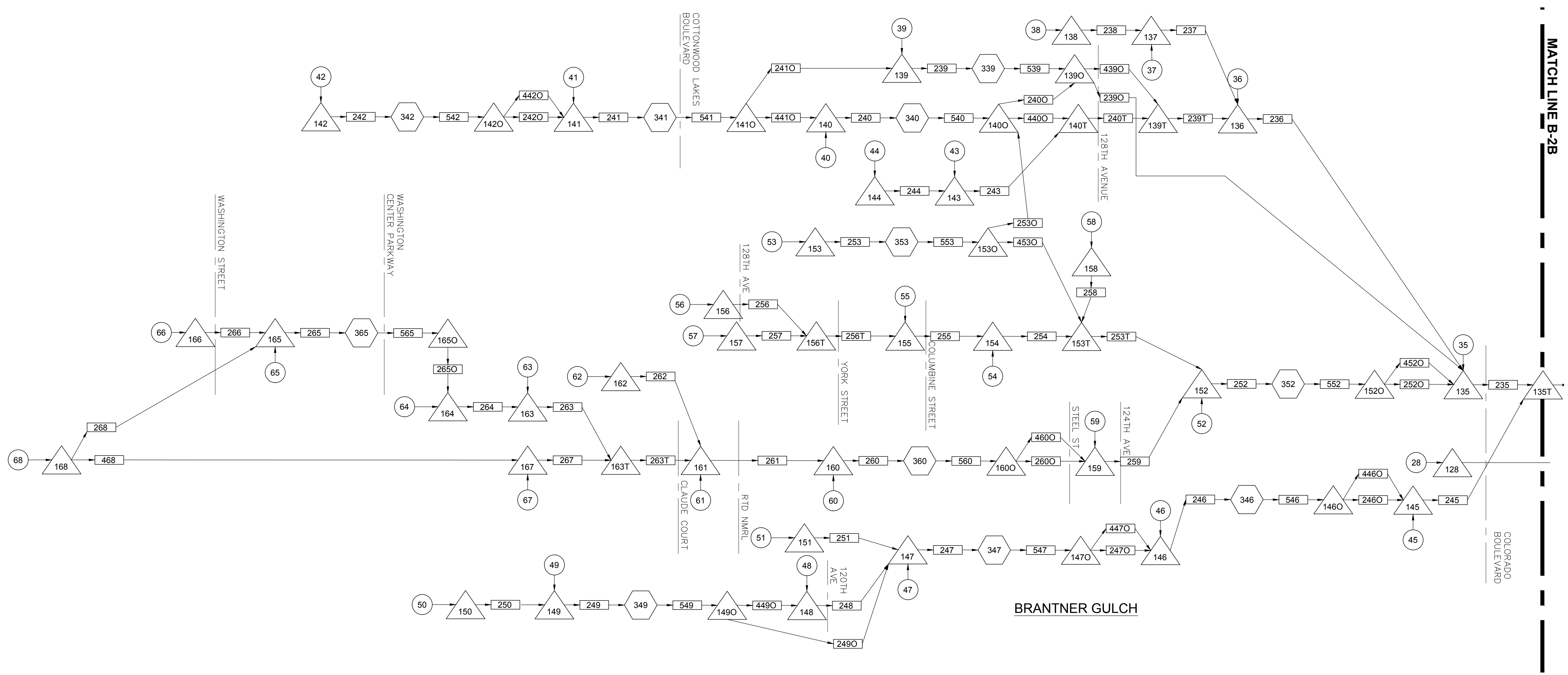
APPENDIX B

HYDROLOGIC ANALYSIS

PROJECT: 018-2897 DRAWN BY: HP DATE: 10/2021	MILE HIGH FLOOD DISTRICT, CITY OF THORNTON, NORTHGLENN, AND ADAMS COUNTY	BRANTNER GULCH MDP AND FHAD HYDROLOGY WORKMAP	olsson 1525 Raleigh Street Suite 400 Denver, CO 80204 TEL: 303.237.2072 FAX: 303.237.2659 www.olsson.com	FIGURE B-1

LEGEND

- (XX) SUBWATERSHED ID
- △ 1XX DESIGN POINT ID
- [2XX] CONVEYANCE ELEMENT ID
- ⬡ 3XX DETENTION BASIN ID
- [4XX] OVERFLOW CONVEYANCE ELEMENT ID
- [5XX] DETENTION BASIN OUTLET ID



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DATE: Oct 14, 2021 4:16pm XREFS: W_TBLK_018-2897

REV NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

olsson

1525 Raleigh Street
Suite 400
Denver, CO 80204
TEL 303.237.2072
FAX 303.237.2659

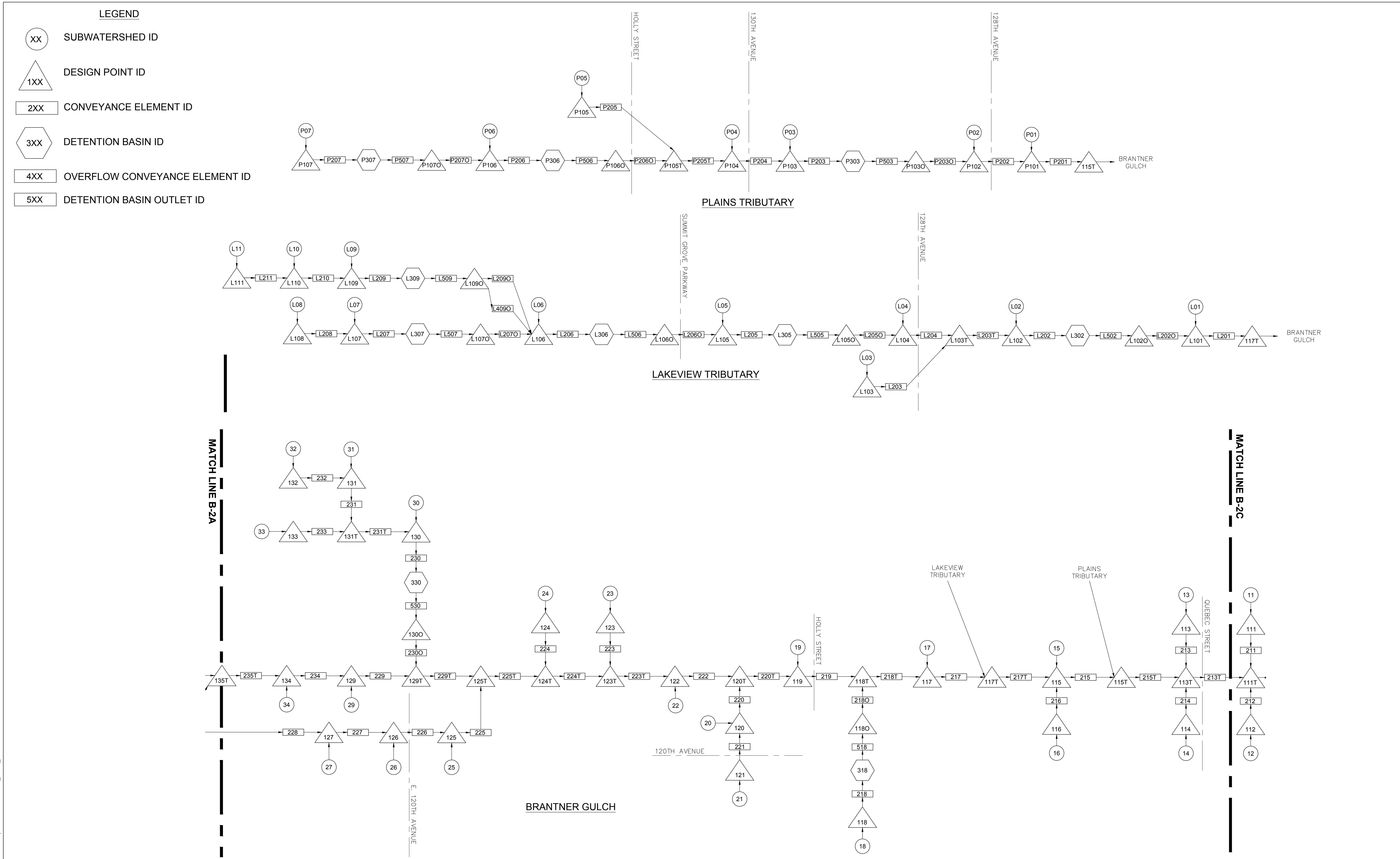
designed by: DO
drawn by: HP
checked by: DK
project no.: 018-2897
date: 10/2021

MILE HIGH FLOOD DISTRICT, CITY OF THORNTON, NORTHGLENN, AND ADAMS COUNTY

BRANTNER GULCH MDP AND FHAD

SWMM ROUTING SCHEMATIC

FIGURE B-2A



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MILE HIGH FLOOD DISTRICT, CITY OF THORNTON, NORTHGLENN, AND ADAMS COUNTY

BRANTNER GULCH MDP AND FHAD

BRANTNER GULCH AND TRIBUTARIES SWMM ROUTING SCHEMATIC

FIGURE B-2B

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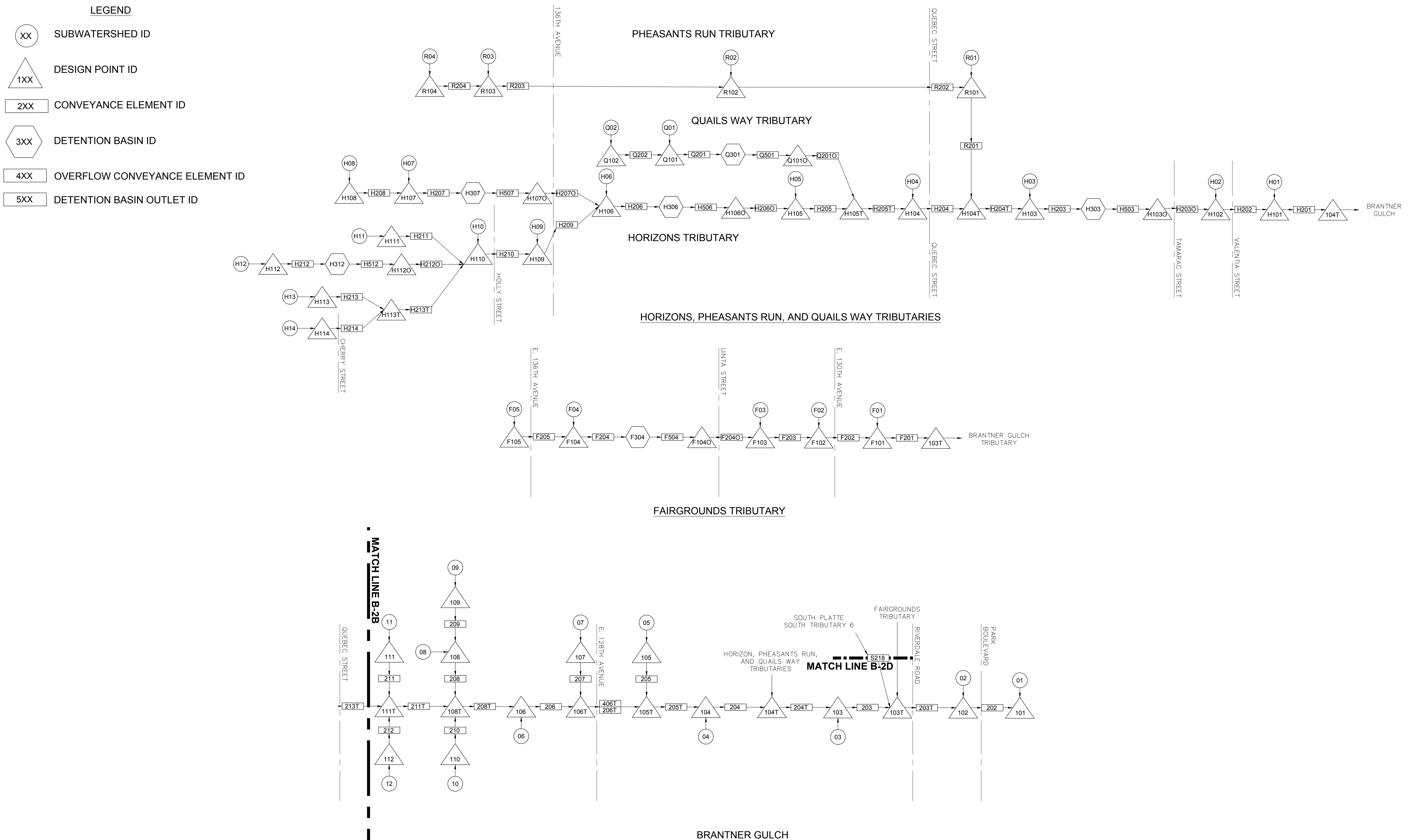

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MILE HIGH FLOOD DISTRICT, CITY OF THORNTON, NORTHGLENN, AND ADAMS COUNTY

BRANTNER GULCH MDP AND FHAD

BRANTNER GULCH AND TRIBUTARIES SWMM ROUTING SCHEMATIC

FIGURE B-2C

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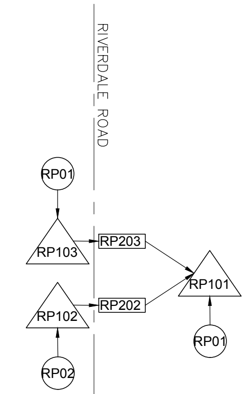
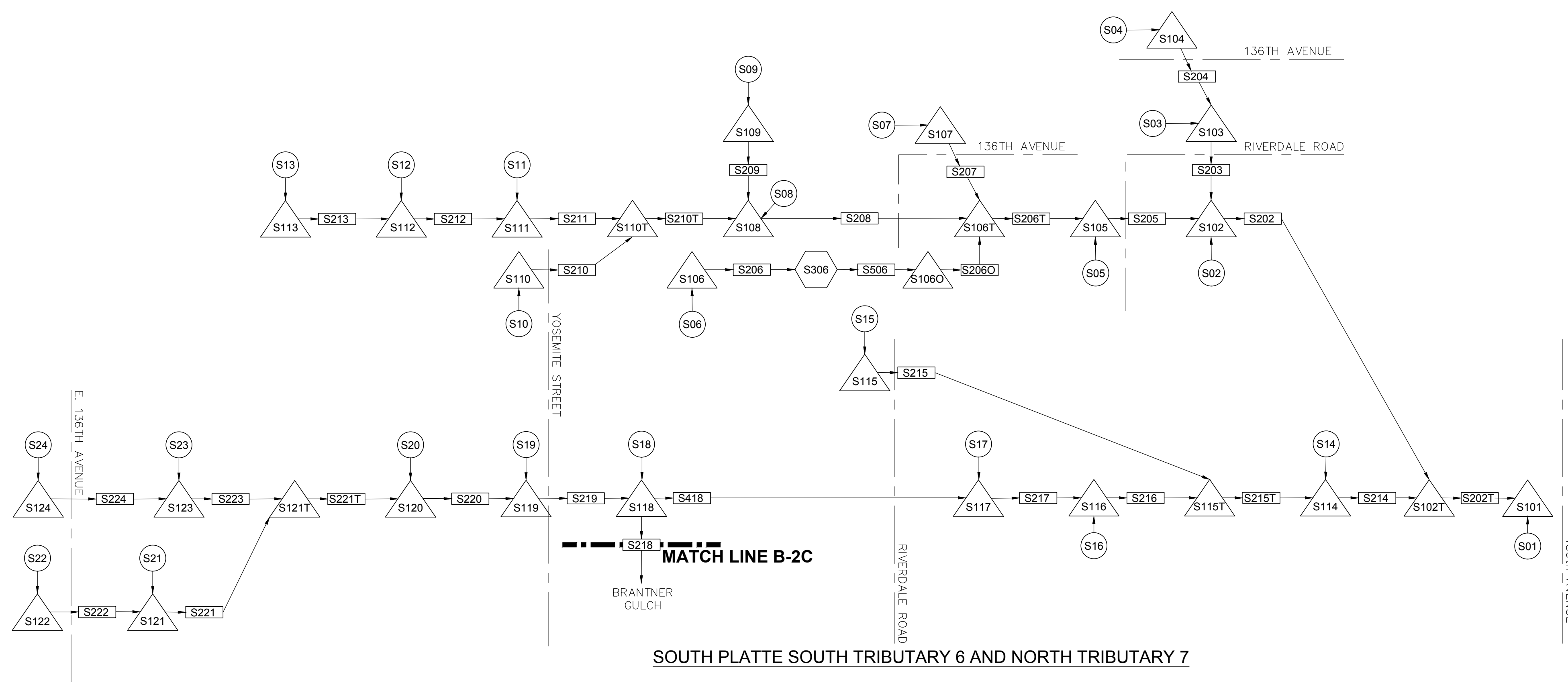
LEGEND

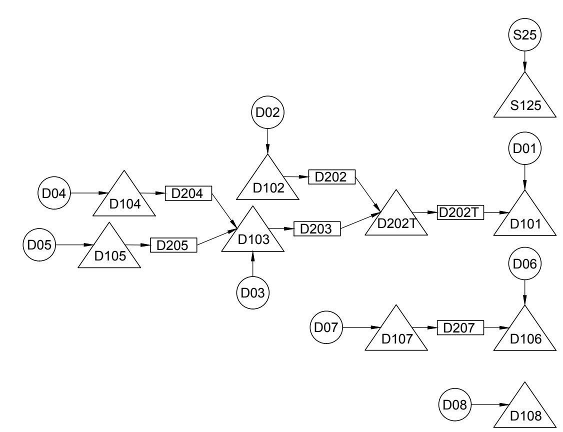
- XX — SUBWATERSHED ID
- 1XX — DESIGN POINT ID
- 2XX — CONVEYANCE ELEMENT ID
- 3XX — DETENTION BASIN ID
- 4XX — OVERFLOW CONVEYANCE ELEMENT ID
- 5XX — DETENTION BASIN OUTLET ID



REGIONAL PARK



SOUTH PLATTE SOUTH TRIBUTARY 6 AND NORTH TRIBUTARY 7



SOUTH PLATTE DIRECT
FLOW AREAS

REV NO.	DATE	REVISIONS DESCRIPTION

REVISIONS

olsson

1525 Raleigh Street
Suite 400
Denver, CO 80204
TEL 303.237.2072
FAX 303.237.2659

designed by: DO
drawn by: HP
checked by: DK
project no.: 018-2897
date: 10/2021

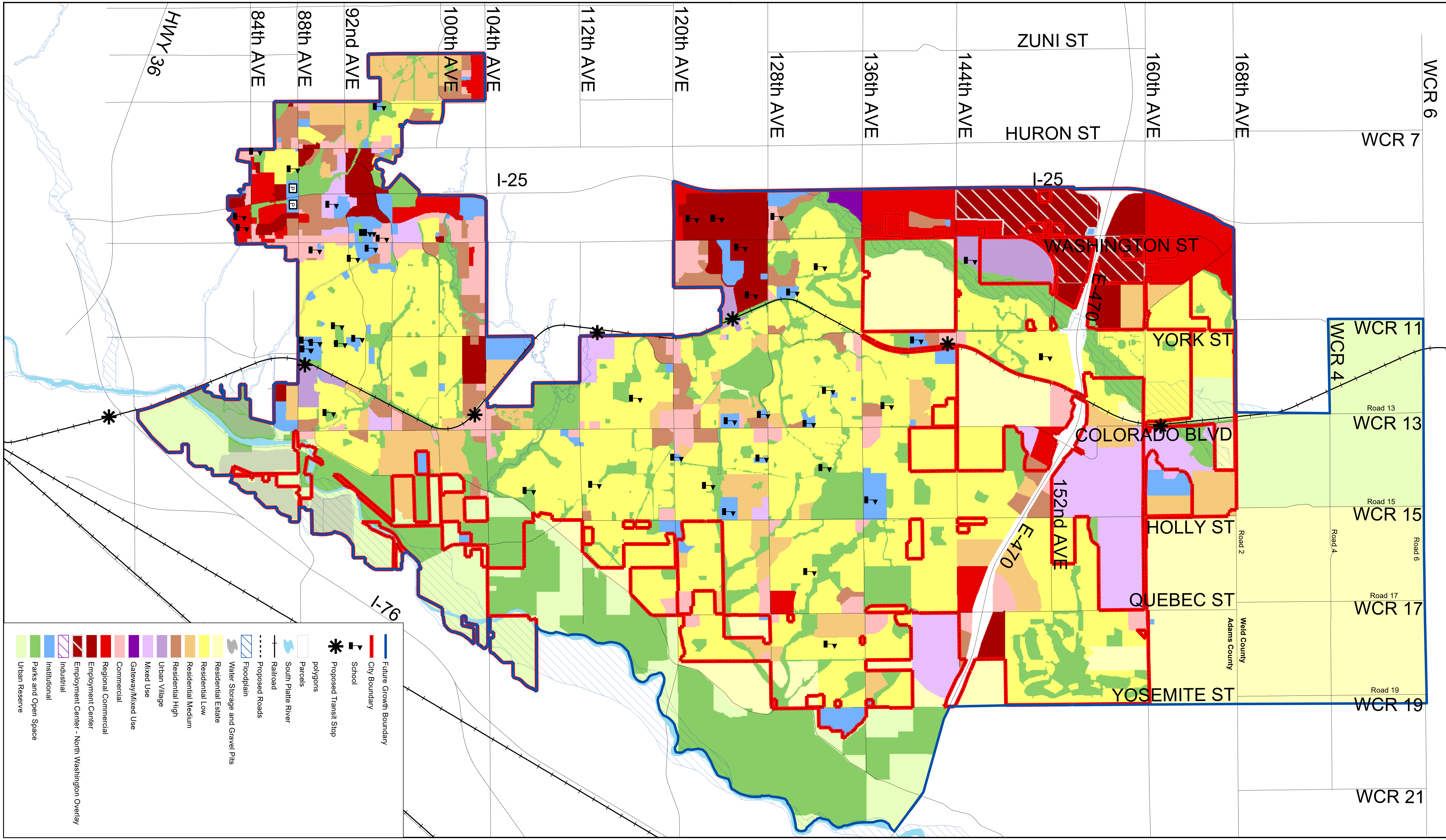
MILE HIGH FLOOD DISTRICT, CITY OF THORNTON, NORTHGLENN, AND ADAMS COUNTY

BRANTNER GULCH MDP AND FHAD

SOUTH PLATTE TRIBUTARIES
SWMM ROUTING SCHEMATIC

FIGURE
B-2D

LAND USE MAPS



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City of Thornton, Colorado

9500 Civic Center Dr. Thornton CO. 80229-4326 (303) 538-7295

Future Land Use Map

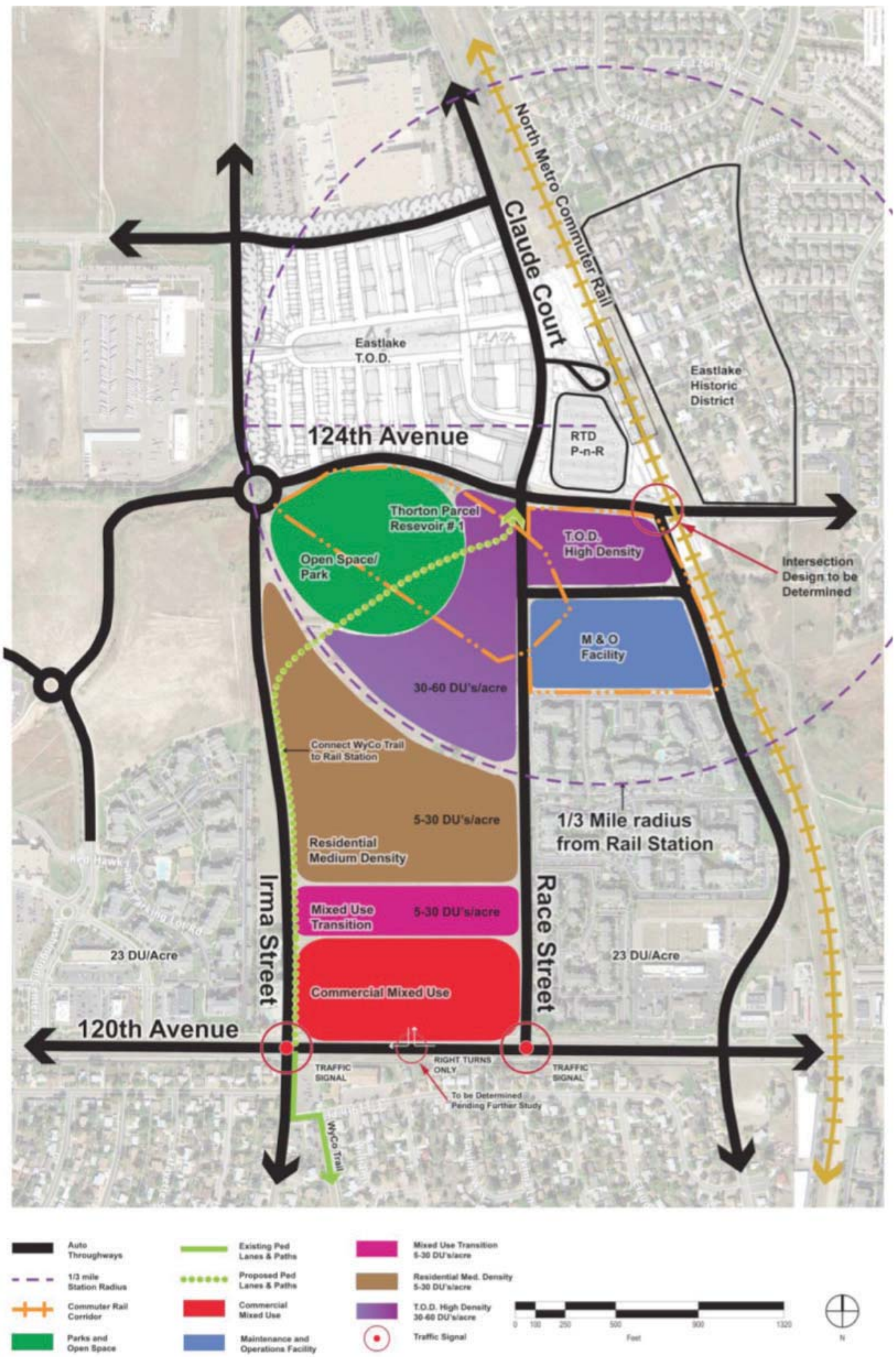
Adopted by Thornton City Council
September 11, 2012

Revised by Resolution C.D. No. 2018-161
August 28, 2018

1 inch = 5,000 feet

S:\ArcGIS\StandardMaps\FutureLandUse_11x17.mxd

Figure 3-1: Conceptual Land Use Plan



NOAA Atlas 14, Volume 8, Version 2
Location name: Brighton, Colorado, USA*
Latitude: 39.9365°, Longitude: -104.9239°
Elevation: 5210.13 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.221** (0.171-0.287)	**0.272** (0.210-0.352)	**0.366** (0.281-0.475)	**0.454** (0.348-0.593)	**0.593** (0.447-0.823)	**0.713** (0.522-0.998)	**0.843** (0.597-1.21)	**0.988** (0.672-1.46)	**1.20** (0.783-1.81)	**1.37** (0.867-2.08)
10-min	**0.324** (0.251-0.420)	**0.398** (0.307-0.516)	**0.535** (0.412-0.696)	**0.665** (0.509-0.869)	**0.868** (0.654-1.21)	**1.04** (0.764-1.46)	**1.24** (0.874-1.77)	**1.45** (0.984-2.13)	**1.75** (1.15-2.65)	**2.00** (1.27-3.05)
15-min	**0.395** (0.306-0.512)	**0.485** (0.375-0.629)	**0.653** (0.502-0.848)	**0.811** (0.621-1.06)	**1.06** (0.798-1.47)	**1.27** (0.932-1.78)	**1.51** (1.07-2.16)	**1.76** (1.20-2.60)	**2.14** (1.40-3.24)	**2.44** (1.55-3.72)
30-min	**0.551** (0.426-0.714)	**0.674** (0.520-0.873)	**0.902** (0.694-1.17)	**1.12** (0.856-1.46)	**1.46** (1.10-2.02)	**1.75** (1.28-2.44)	**2.06** (1.46-2.96)	**2.42** (1.64-3.56)	**2.92** (1.91-4.42)	**3.34** (2.12-5.08)
60-min	**0.677** (0.523-0.876)	**0.829** (0.640-1.07)	**1.11** (0.855-1.45)	**1.38** (1.06-1.80)	**1.79** (1.35-2.49)	**2.15** (1.57-3.01)	**2.54** (1.80-3.64)	**2.96** (2.02-4.37)	**3.58** (2.34-5.42)	**4.09** (2.59-6.22)
2-hr	**0.802** (0.626-1.03)	**0.984** (0.767-1.26)	**1.32** (1.03-1.70)	**1.64** (1.27-2.12)	**2.13** (1.62-2.92)	**2.55** (1.89-3.53)	**3.01** (2.15-4.26)	**3.51** (2.41-5.11)	**4.24** (2.80-6.34)	**4.83** (3.10-7.26)
3-hr	**0.867** (0.680-1.10)	**1.06** (0.834-1.36)	**1.43** (1.11-1.82)	**1.76** (1.37-2.27)	**2.29** (1.75-3.11)	**2.74** (2.03-3.76)	**3.22** (2.32-4.53)	**3.76** (2.60-5.43)	**4.53** (3.01-6.72)	**5.16** (3.32-7.69)
6-hr	**1.03** (0.816-1.30)	**1.25** (0.989-1.57)	**1.65** (1.30-2.09)	**2.02** (1.59-2.57)	**2.60** (2.01-3.49)	**3.09** (2.32-4.19)	**3.62** (2.63-5.03)	**4.20** (2.93-5.99)	**5.04** (3.39-7.38)	**5.72** (3.73-8.43)
12-hr	**1.28** (1.02-1.59)	**1.52** (1.22-1.90)	**1.97** (1.57-2.46)	**2.38** (1.89-2.99)	**3.01** (2.34-3.98)	**3.54** (2.68-4.73)	**4.11** (3.02-5.63)	**4.74** (3.34-6.67)	**5.64** (3.83-8.14)	**6.37** (4.19-9.25)
24-hr	**1.54** (1.25-1.90)	**1.85** (1.49-2.28)	**2.37** (1.91-2.94)	**2.84** (2.28-3.53)	**3.54** (2.77-4.60)	**4.11** (3.14-5.40)	**4.72** (3.49-6.35)	**5.37** (3.81-7.42)	**6.27** (4.29-8.91)	**7.00** (4.66-10.0)
2-day	**1.78** (1.45-2.17)	**2.16** (1.76-2.63)	**2.80** (2.28-3.42)	**3.34** (2.71-4.10)	**4.11** (3.23-5.23)	**4.71** (3.62-6.08)	**5.34** (3.97-7.05)	**5.98** (4.28-8.12)	**6.85** (4.73-9.57)	**7.53** (5.07-10.7)
3-day	**1.94** (1.59-2.35)	**2.32** (1.91-2.82)	**2.97** (2.43-3.61)	**3.52** (2.87-4.30)	**4.30** (3.40-5.44)	**4.92** (3.80-6.30)	**5.55** (4.16-7.29)	**6.21** (4.47-8.37)	**7.10** (4.93-9.84)	**7.80** (5.28-10.9)
4-day	**2.07** (1.71-2.49)	**2.45** (2.02-2.95)	**3.09** (2.54-3.73)	**3.64** (2.98-4.42)	**4.42** (3.51-5.56)	**5.04** (3.92-6.43)	**5.68** (4.28-7.43)	**6.35** (4.60-8.52)	**7.27** (5.07-10.0)	**7.98** (5.43-11.1)
7-day	**2.36** (1.97-2.82)	**2.75** (2.29-3.29)	**3.41** (2.83-4.08)	**3.97** (3.28-4.78)	**4.77** (3.83-5.95)	**5.41** (4.24-6.83)	**6.07** (4.61-7.84)	**6.75** (4.93-8.96)	**7.68** (5.41-10.5)	**8.41** (5.77-11.6)
10-day	**2.61** (2.19-3.11)	**3.02** (2.53-3.60)	**3.71** (3.10-4.42)	**4.29** (3.56-5.14)	**5.11** (4.12-6.32)	**5.77** (4.55-7.22)	**6.43** (4.91-8.25)	**7.12** (5.23-9.37)	**8.05** (5.70-10.9)	**8.78** (6.06-12.0)
20-day	**3.36** (2.85-3.95)	**3.84** (3.25-4.51)	**4.61** (3.89-5.44)	**5.26** (4.42-6.23)	**6.16** (5.01-7.50)	**6.86** (5.46-8.46)	**7.56** (5.83-9.54)	**8.27** (6.13-10.7)	**9.22** (6.59-12.3)	**9.94** (6.94-13.4)
30-day	**3.96** (3.38-4.62)	**4.51** (3.84-5.27)	**5.40** (4.58-6.32)	**6.13** (5.18-7.20)	**7.12** (5.82-8.58)	**7.88** (6.31-9.63)	**8.63** (6.69-10.8)	**9.39** (7.00-12.0)	**10.4** (7.46-13.7)	**11.1** (7.81-14.9)
45-day	**4.68** (4.02-5.43)	**5.35** (4.59-6.20)	**6.41** (5.48-7.46)	**7.28** (6.19-8.49)	**8.43** (6.92-10.1)	**9.30** (7.48-11.3)	**10.1** (7.91-12.6)	**11.0** (8.23-14.0)	**12.0** (8.71-15.7)	**12.8** (9.07-17.1)
60-day	**5.27** (4.55-6.08)	**6.05** (5.22-6.99)	**7.30** (6.27-8.44)	**8.30** (7.09-9.63)	**9.62** (7.92-11.4)	**10.6** (8.56-12.7)	**11.5** (9.03-14.2)	**12.4** (9.37-15.7)	**13.6** (9.88-17.6)	**14.4** (10.3-19.1)

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

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

Please refer to NOAA Atlas 14 document for more information.

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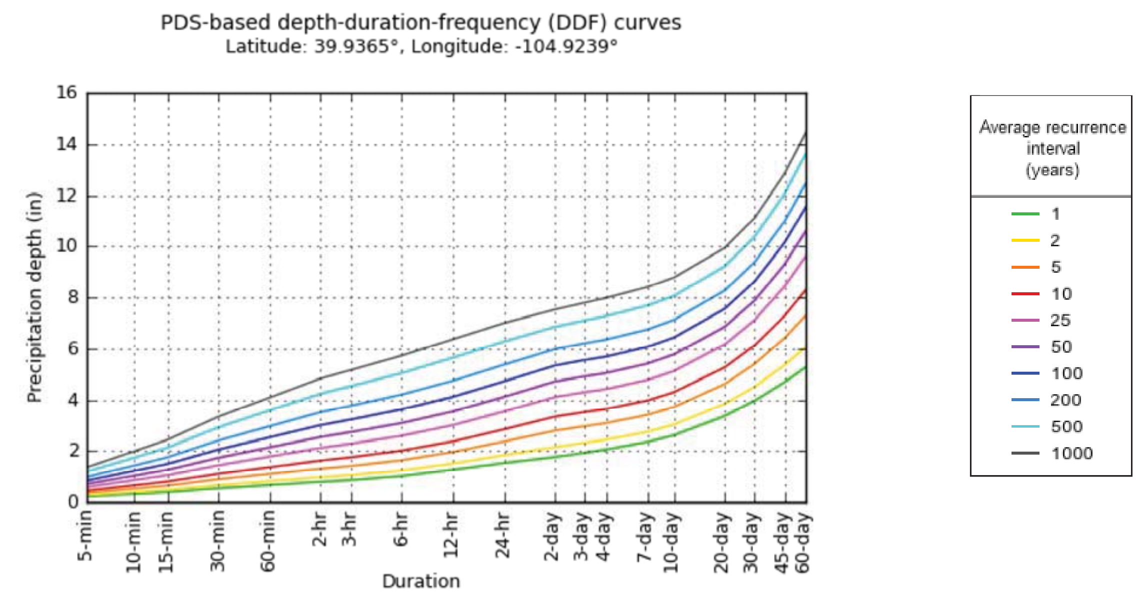
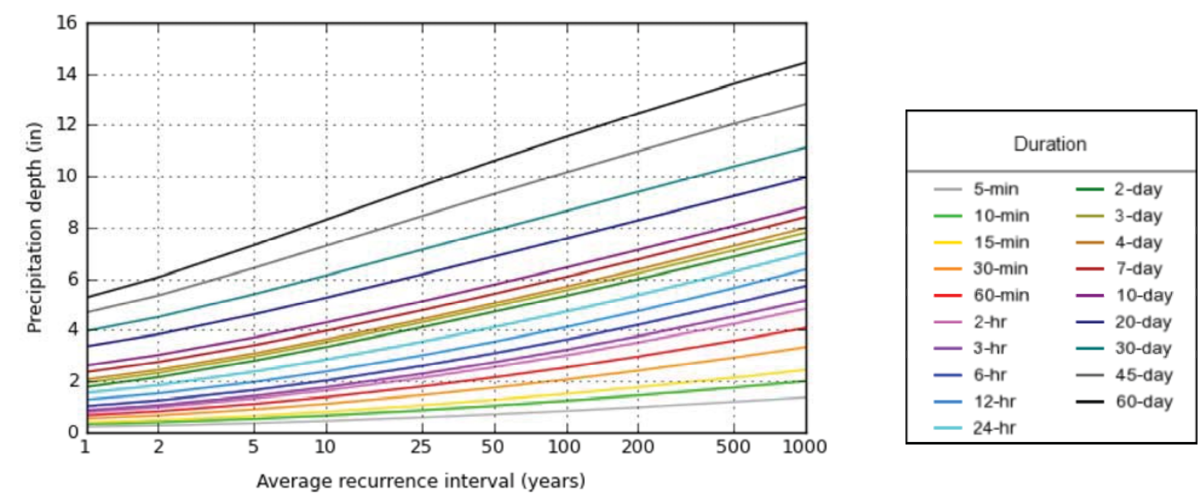
PF graphical





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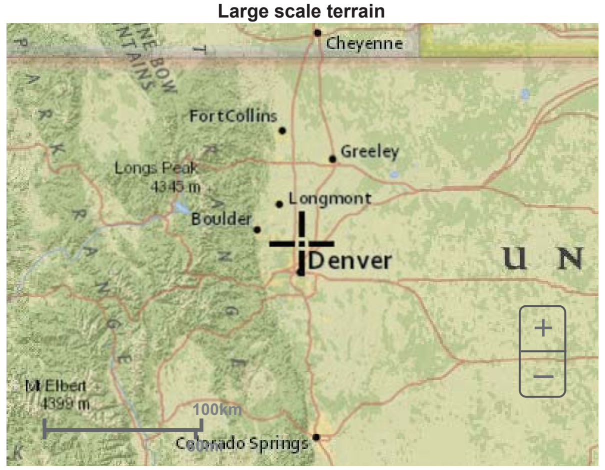
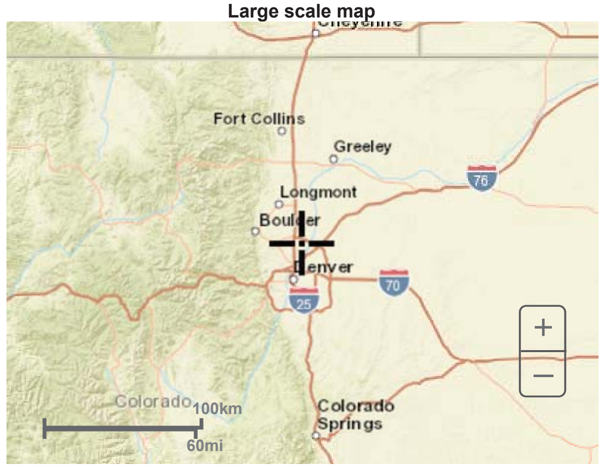
Maps & aerials

Small scale terrain

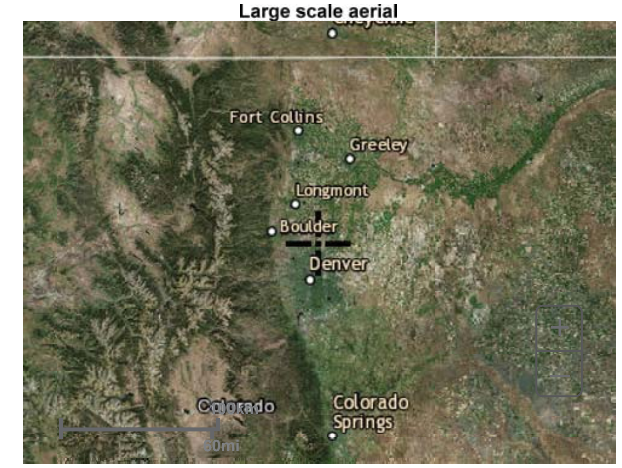
Large scale terrain



Large scale map



Large scale aerial



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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Table B-1A - Unadjusted Rainfall Distributions

1Hr Depth	0.829
Return Period	2
Time	Depth
0:05	0.0166
0:10	0.0332
0:15	0.0696
0:20	0.1326
0:25	0.2072
0:30	0.1161
0:35	0.0522
0:40	0.0415
0:45	0.0249
0:50	0.0249
0:55	0.0249
1:00	0.0249
1:05	0.0249
1:10	0.0166
1:15	0.0166
1:20	0.0166
1:25	0.0166
1:30	0.0166
1:35	0.0166
1:40	0.0166
1:45	0.0166
1:50	0.0166
1:55	0.0083
2:00	0.0083

1Hr Depth	1.11
Return Period	5
Time	Depth
0:05	0.0222
0:10	0.0411
0:15	0.0966
0:20	0.1698
0:25	0.2775
0:30	0.1443
0:35	0.0644
0:40	0.0488
0:45	0.0400
0:50	0.0400
0:55	0.0333
1:00	0.0333
1:05	0.0333
1:10	0.0333
1:15	0.0278
1:20	0.0244
1:25	0.0244
1:30	0.0244
1:35	0.0244
1:40	0.0166
1:45	0.0166
1:50	0.0166
1:55	0.0166
2:00	0.0144

1Hr Depth	1.38
Return Period	10
Time	Depth
0:05	0.0276
0:10	0.0511
0:15	0.1132
0:20	0.2070
0:25	0.3450
0:30	0.1656
0:35	0.0773
0:40	0.0593
0:45	0.0524
0:50	0.0442
0:55	0.0442
1:00	0.0442
1:05	0.0442
1:10	0.0442
1:15	0.0442
1:20	0.0345
1:25	0.0262
1:30	0.0262
1:35	0.0262
1:40	0.0262
1:45	0.0262
1:50	0.0262
1:55	0.0235
2:00	0.0179

1Hr Depth	1.79
Return Period	25
Time	Depth
0:05	0.0233
0:10	0.0626
0:15	0.0895
0:20	0.1432
0:25	0.2685
0:30	0.4475
0:35	0.2148
0:40	0.1432
0:45	0.0895
0:50	0.0895
0:55	0.0573
1:00	0.0573
1:05	0.0573
1:10	0.0430
1:15	0.0430
1:20	0.0322
1:25	0.0322
1:30	0.0251
1:35	0.0251
1:40	0.0251
1:45	0.0251
1:50	0.0251
1:55	0.0251
2:00	0.0251

1Hr Depth	2.15
Return Period	50
Time	Depth
0:05	0.0280
0:10	0.0753
0:15	0.1075
0:20	0.1720
0:25	0.3225
0:30	0.5375
0:35	0.2580
0:40	0.1720
0:45	0.1075
0:50	0.1075
0:55	0.0688
1:00	0.0688
1:05	0.0688
1:10	0.0516
1:15	0.0516
1:20	0.0387
1:25	0.0387
1:30	0.0301
1:35	0.0301
1:40	0.0301
1:45	0.0301
1:50	0.0301
1:55	0.0301
2:00	0.0301

1Hr Depth	2.54
Return Period	100
Time	Depth
0:05	0.0254
0:10	0.0762
0:15	0.1168
0:20	0.2032
0:25	0.3556
0:30	0.6350
0:35	0.3556
0:40	0.2032
0:45	0.1575
0:50	0.1270
0:55	0.1016
1:00	0.1016
1:05	0.1016
1:10	0.0508
1:15	0.0508
1:20	0.0305
1:25	0.0305
1:30	0.0305
1:35	0.0305
1:40	0.0305
1:45	0.0305
1:50	0.0305
1:55	0.0305
2:00	0.0305

1Hr Depth	3.58
Return Period	500
Time	Depth
0:05	0.0358
0:10	0.1074
0:15	0.1647
0:20	0.2864
0:25	0.5012
0:30	0.8950
0:35	0.5012
0:40	0.2864
0:45	0.2220
0:50	0.1790
0:55	0.1432
1:00	0.1432
1:05	0.1432
1:10	0.0716
1:15	0.0716
1:20	0.0430
1:25	0.0430
1:30	0.0430
1:35	0.0430
1:40	0.0430
1:45	0.0430
1:50	0.0430
1:55	0.0430
2:00	0.0430

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

1Hr Depth	0.829
Return Period	2
Time	Depth
0:05	0.0166
0:10	0.0332
0:15	0.0675
0:20	0.1141
0:25	0.1782
0:30	0.0998
0:35	0.0507
0:40	0.0402
0:45	0.0249
0:50	0.0249
0:55	0.0249
1:00	0.0249
1:05	0.0249
1:10	0.0166
1:15	0.0166
1:20	0.0166
1:25	0.0166
1:30	0.0166
1:35	0.0166
1:40	0.0166
1:45	0.0166
1:50	0.0166
1:55	0.0083
2:00	0.0083

1Hr Depth	1.11
Return Period	5
Time	Depth
0:05	0.0222
0:10	0.0411
0:15	0.0937
0:20	0.1461
0:25	0.2387
0:30	0.1241
0:35	0.0624
0:40	0.0474
0:45	0.0400
0:50	0.0400
0:55	0.0333
1:00	0.0333
1:05	0.0333
1:10	0.0333
1:15	0.0278
1:20	0.0244
1:25	0.0244
1:30	0.0244
1:35	0.0244
1:40	0.0166
1:45	0.0166
1:50	0.0166
1:55	0.0166
2:00	0.0144

1Hr Depth	1.38
Return Period	10
Time	Depth
0:05	0.0276
0:10	0.0511
0:15	0.1098
0:20	0.1780
0:25	0.2967
0:30	0.1424
0:35	0.0750
0:40	0.0576
0:45	0.0524
0:50	0.0442
0:55	0.0442
1:00	0.0442
1:05	0.0442
1:10	0.0442
1:15	0.0442
1:20	0.0345
1:25	0.0262
1:30	0.0262
1:35	0.0262
1:40	0.0262
1:45	0.0262
1:50	0.0262
1:55	0.0235
2:00	0.0179

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

1Hr Depth	0.829
Return Period	2
Time	Depth
0:05	0.0166
0:10	0.0332
0:15	0.0655
0:20	0.0995
0:25	0.1554
0:30	0.0870
0:35	0.0491
0:40	0.0390
0:45	0.0249
0:50	0.0249
0:55	0.0249
1:00	0.0249
1:05	0.0249
1:10	0.0166
1:15	0.0166
1:20	0.0166
1:25	0.0166
1:30	0.0166
1:35	0.0166
1:40	0.0166
1:45	0.0166
1:50	0.0166
1:55	0.0083
2:00	0.0083

1Hr Depth	1.11
Return Period	5
Time	Depth
0:05	0.0222
0:10	0.0411
0:15	0.0908
0:20	0.1274
0:25	0.2081
0:30	0.1082
0:35	0.0605
0:40	0.0459
0:45	0.0400
0:50	0.0400
0:55	0.0333
1:00	0.0333
1:05	0.0333
1:10	0.0333
1:15	0.0278
1:20	0.0244
1:25	0.0244
1:30	0.0244
1:35	0.0244
1:40	0.0166
1:45	0.0166
1:50	0.0166
1:55	0.0166
2:00	0.0144

1Hr Depth	1.38
Return Period	10
Time	Depth
0:05	0.0276
0:10	0.0511
0:15	0.1064
0:20	0.1553
0:25	0.2587
0:30	0.1242
0:35	0.0726
0:40	0.0558
0:45	0.0524
0:50	0.0442
0:55	0.0442
1:00	0.0442
1:05	0.0442
1:10	0.0442
1:15	0.0442
1:20	0.0345
1:25	0.0262
1:30	0.0262
1:35	0.0262
1:40	0.0262
1:45	0.0262
1:50	0.0262
1:55	0.0235
2:00	0.0179

Table B-2 - Detention Basin Stage-Storage-Discharge Information

*Red values indicate flows at or above the spillway. Tables without red values are from other reports and the spillway flows were not identified separate from the outlet structure flows.

Design Point 318 - Brantner Gulch: Wright Farms Park

Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5117.93	0	0	0	0
5118.43	0.5	2613.6	0.0	12.17
5118.93	1	5662.8	0.1	17.21
5119.43	1.5	10890.0	0.2	21.08
5119.93	2	23086.8	0.4	24.34
5120.43	2.5	35283.6	0.7	27.22
5120.93	3	53578.8	1.2	29.81
5121.43	3.5	62726.4	1.9	32.2
5121.93	4	76230.0	2.7	34.43
5122.43	4.5	89733.6	3.6	36.52
5122.93	5	100188.0	4.7	38.49
5123.43	5.5	110206.8	5.9	39.25
5123.93	6	115869.6	7.2	46.24
5124.43	6.5	121096.8	8.6	67.71
5124.93	7	123710.4	10.0	96.80
5125.43	7.5	125888.4	11.4	131.76
5126.33*	8.4*	129808.8*	14.0*	729.65*

Values from *Final Drainage Report: Wright Farms, Filing No. 3, First Plat*. Converted elevations to NAVD 88 (+2.93')
*Additional point added based on extrapolated area and discharge, plus spillway flow at stage 8.4' from design report

Design Point 330 - Brantner Gulch: SE of 125th Avenue and Dexter Way Intersection

Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5157	0	5	0.00	0.08**
5158	1	4325	0.05	1.74**
5159	2	17888	0.30	2.64**
5160	3	31450	0.87	3.31**
5161	4	37325	1.66	3.86**
5162	5	43200	2.58	5.81**
5164	7	51075	4.75	93.17**
5165.5	8.5	57075	6.61	538.23**
5166*	9*	59347*	7.28	794.04**

Stage-area values from *Final Drainage Study for Meadow Park*
*Additional point added based on area from LiDAR
**Stage-discharge calcualted using UD_Detention-v2.34 using as-built drawings and City of Thornton survey and measurements

Design Point 339 - Brantner Gulch: NE of Monroe Street and E. 128th

Storage (ac-ft)	Discharge (cfs)
0.00	0
0.26	6
0.48	10
1.06	11
2.16	13
3.32	300
3.99	600

Values from 2005 MDP

Design Point 340 - Brantner Gulch: Cottonwood Park

Storage (ac-ft)	Discharge (cfs)
0.00	0
0.07	2
0.63	2
1.69	2
3.19	2
3.64	200
5.02	600

Values from 2005 MDP

Design Point 341 - Brantner Gulch: NE of Cottonwood Lakes Boulevard and Garfield Drive

Storage (ac-ft)	Discharge (cfs)
0.00	0
0.01	4.4
0.61	16
2.00	22
2.90	450

Values from 2005 MDP

Design Point 342 - Brantner Gulch: E of E. 135th Avenue and Cottonwood Lakes Boulevard

Storage (ac-ft)	Discharge (cfs)
0.00	0
0.01	86.6
1.01	150
4.61	943

Values from 2005 MDP

Design Point 353 - Brantner Gulch: S of E 131st Way and Milwaukee Street

Storage (ac-ft)	Discharge (cfs)
0.00	0.0
0.19	8.7
1.10	17.5
1.58	60.0
1.59*	100.0*

Values from 2005 MDP
*Additional point to represent no storage above last storage-discharge point from 2005 MDP. Based on LiDAR, a large portion of detention basin would overtop beyond the last storage point.

Design Point 346 - Brantner Gulch: SW of 124th Avenue and Monroe Drive

Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5204	0	29870	0.00	0.04
5205	1	39334	0.79	2.88
5206	2	42911	1.74	4.8
5207	3	46025	2.76	6.13
5208	4	49069	3.85	7.25
5209	5	52212	5.01	8.21
5210	6	55556	6.25	9.07
5211	7	59229	7.57	9.85
5212	8	63790	8.98	471.34
5213	9	77308	10.60	2286.81

Stage-area based on LiDAR. Stage-discharge calculated using UD_Detention-v.2.34 using details from *Phase III Drainaeg Report for Eastlake Village III Development-Phase I* and LiDAR spillway dimensions

Design Point 347 - Brantner Gulch: N of 121st Avenue and Madison Street

Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5221.82	0	300.00	0.00	0
5222	0.18	11068.88	0.02	0.17
5223	1.18	74488.40	1.01	5.5
5224	2.18	141171.92	3.48	14
5225	3.18	211119.44	7.52	21
5226	4.18	284330.96	13.21	26
5226.82	5	346800.00	19.15	30
5227	5.18*	348760.47	20.59	30.88*
5227.7	5.88*	356923.70	26.26	34.29*
5229*	7.18*	398314.78*	37.53	194.13*
5230*	8.18*	525050.75*	48.13	835.46*

Values from *Phase III Drainage Report: Madison Park Phase*
*Additional points added based on LiDAR area and extrapolated discharge points plus spillway discharge calculated using UD-Detention-v2.34 and LiDAR

Design Point 349- Brantner Gulch: Brookshire Park

Storage (ac-ft)	Discharge (cfs)
0.00	0.0
0.03	4.9
0.75	28.2
2.47	250.0
2.60	310.0
2.73	324.0
3.049*	1214.51*

Values from 2005 MDP
*Additional points obtained from UD-Detention_v2.34 calculations using LiDAR areas for volume and spillway dimensions.

Design Point 352-Brantner Gulch: Eastlake Reservoir Number 3

Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5221.34	0	0.00	0.00	0.00
5222	0.66	1234661.00	9.35	2.50
5223	1.66	1745128.67	43.56	14.00
5224	2.66	2326389.42	90.29	29.70
5225	3.66	2657371.07	147.50	45.70
5226	4.66	2907598.14	211.37	58.20
5227	5.66	3151919.27	280.93	66.12
5227.5	6.16	3254271.46	317.69	66.62
5228	6.66	3356623.65	355.64	284.59

Stage-area values from LiDAR. Stage-discharge calculated using UD-Detention-v2.34 and survey.

Table B-2 - Detention Basin Stage-Storage-Discharge Information

*Red values indicate flows at or above the spillway. Tables without red values are from other reports and the spillway flows were not identified separate from the outlet structure flows.

Design Point 360 - Brantner Gulch: Eastlake Number 2

Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5252.08	0.00	0.0	0.0	0.0
5253.00	0.92	1133.3	0.0	5.1
5254.00	1.92	34428.0	0.4	26.0
5255.00	2.92	248937.8	3.7	54.3
5256.00	3.92	424911.6	11.4	87.3
5257.00	4.92	557573.8	22.7	124.1
5258.00	5.92	691668.1	37.0	158.0
5259.00	6.92	823988.7	54.4	187.1
5260.00	7.92	973891.0	75.1	212.0
5261.00	8.92	1097228.4	98.8	309.1
5262.00	9.92	1202987.1	125.2	541.2
5263.00	10.92	1285291.3	153.8	949.5

Stage-area values from LiDAR. Stage-discharge calculated using UD-Detention-v2.34 and survey.

Design Point 365 - Brantner Gulch: Ohio Lake

Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5305.17	0.00	0	0.00	0.00
5306.00	0.83	84	0.00	13.61
5307.00	1.83	1606	0.02	24.82
5308.00	2.83	12098	0.18	32.36
5309.00	3.83	49245	0.88	38.44
5310.00	4.83	113232	2.75	43.69
5311.00	5.83	173884	6.04	48.37
5312.00	6.83	201738	10.35	52.63
5313.00	7.83	217133	15.16	56.58
5313.52	8.35	226186	17.81	58.52
5314.00	8.83	234543	20.35	87.08
5314.50	9.33	248793	23.12	140.27
5314.72	9.55	255063	24.39	170.34
5315.00	9.83	263043	26.06	244.64
5315.10	9.93	269051	26.67	312.28
5315.25	10.08	278063	27.61	452.52

Stage-storage based on LiDAR, stage-discharge calculated in UD_Detention-v.2.34 using survey provided by City of Thornton.

Design Point F304 - Fairgrounds Tributary: Villages at Riverdale Filing 3

Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5109.45	0	0	0.00	0
5110	0.55	602	0.00	3
5112	2.55	6054	0.16	33
5113	3.55	19300	0.45	50
5114	4.55	32913	1.05	60
5115	5.55	46129	1.95	70
5116	6.55	56213	3.13	78
5117	7.55	63683	4.51	85
5117.77	8.32	68770	5.68	90
5118	8.55	70290	6.04	102
5119	9.55	76466	7.73	168
5120	10.55	82569	9.55	175
5121	11.55	89748	11.53	181
5121.83	12.38	96410	13.30	186
5122	12.55	97774	13.68	197
5123	13.55	108182	16.05	594

Stage-area values from LiDAR. Stage-discharge calculated using UD-Detention-v2.34 and survey and supplemented with restrictor plate information from Villages at Riverdale Filing No. 3 Drainage Report. Values from 2010 Hydrology Update - Appendix D tables (Pond 913) not used, spillway elevation did not match survey.

Design Point H306 - Horizon Tributary: Marshall Reservoir

Elevation	Stage (ft)	Storage (ac-ft)	Discharge (cfs)
5175.4	0	0	0
5176	0.6	5.3	38
5177	1.6	13.4	162
UNAVAIL.	---	17.8	244
5178	2.6	22.1	325
5179	3.6	31.6	513
5179.8	4.4	38.9	676
5180	4.6	41.9	731
5181	5.6	53.1	1101
5182	6.6	65	1796

Values from 2010 Hydrology Update - Appendix D tables (Pond 906)

Design Point H303 - Horizons Tributary: Villages at Riverdale Filing 1 & 2

Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5086	0	37206	0.00	0
5088	2	87388	2.86	2
5088.5	2.5	103086	3.95	3
5089.55	3.55	136053	6.84	208
5090	4	150181	8.31	320
5092	6	211321	16.61	650
5094	8	297182	28.29	1300
5096	10	378752	43.80	3500

Values from 2010 Hydrology Update - Appendix D tables (Pond 912)

Design Point H307 - Horizon Tributary: Springvale Detention Pond

Elevation	Stage (ft)	Area (sf)	Storage (ac-ft)	Discharge (cfs)
5190	0	50	0.00	0
5192	2	881	0.02	13
5194	4	26750	0.66	26
5196	6	81299	3.14	35
5198	8	97665	7.24	40
5198.48	8.48	100029	8.33	42
5200	10	107403	11.95	66
5201	11	113854	14.49	92
5202	12	121037	17.19	306
5203*	13*	128517*	20.05*	520*

Values from 2010 Hydrology Update - Appendix D tables (Pond 901)
*Additional point added based on area from LiDAR and extrapolating discharge (2010 Hydrology Update stage-discharge points included outlet and spillway discahrges)

Design Point H312- Horizon Tributary: Northbrook Subdivision

Elevation	Stage (ft)	Area (sf)	Storage (ac-ft)	Discharge (cfs)
5250.1	0	71	0.00	0
5251	0.9	20641	0.21	0
5252	1.9	29682	0.79	0.1
5253	2.9	32820	1.51	0.2
5254	3.9	36057	2.30	6.6
5255	4.9	39394	3.17	18.1
5255.25	5.15	42830	3.40	21.6
5256	5.9	46365	4.17	54.5
5257.5	7.4	50466	5.84	121.3
5258.25	8.15	53000	6.73	295
5259.5*	9.4*	84541*	8.70*	492.6*
5260*	9.9*	97158*	9.74*	571.64*

Values from Phase III Drainage Report for Northbrook Subdivision

*Additional points added based on area from LiDAR. Spillway discharges added to outlet dicharges

Design Point L302 - Lakeview Tributary: Sage Creek Retention Pond

Elevation	Stage (ft)	Area (sf)	Storage (ac-ft)	Discharge (cfs)
5124.15	0	63063	0.00	0
5126	1.85	119940	3.89	3.9
5126.55	2.4	127177	5.45	5.3
5128	3.85	146258	10.00	320
5128.55	4.4	154977	11.90	620
5130	5.85	177962	17.44	1500

Values from 2010 Hydrology Update - Appendix D tables (Pond 911)

Design Point L305 - Lakeview Tributary: Woodbridge Station Pond 4

Elevation	Stage (ft)	Area (sf)	Storage (ac-ft)	Discharge (cfs)
5161.43	0	0	0.00	0
5162	0.57	337	0.00	6
5163	1.57	3455	0.05	34
5164	2.57	10587	0.21	63
5165	3.57	15658	0.51	73
5166	4.57	25877	0.98	81
5167	5.57	51105	1.87	89
5167.08	5.65	52292.2	1.96	90
5168	6.57	65945	3.21	96
5169	7.57	81299	4.90	103
5169.26	7.83	84635	5.40	105
5170	8.57	94129	6.92	402
5171	9.57	118228	9.35	1710

Stage-area values from LiDAR. Stage-discharge calculated using UD-Detention-v2.34 and survey. Values from 2010 Hydrology Update - Appendix D tables (Pond 909) not used,

Design Point L306 - Lakeview Tributary: Woodbridge Station Pond 3

Elevation	Stage (ft)	Area (sf)	Storage (ac-ft)	Discharge (cfs)
5199.21	0	50	0.00	0
5200	0.79	13680	0.12	8
5202	2.79	42966	1.42	33
5204	4.79	65238	3.91	58
5205.31	6.1	79498	6.09	71
5206	6.79	87711	7.41	75
5207	7.79	99777	9.56	84
5207.2	7.99	100845	10.02	85
5208	8.79	109121	11.95	228
5210	10.79	138819	17.64	1008

Values from 2010 Hydrology Update - Appendix D tables (Pond 908)

Design Point L307 -Lakeview Tributary: Woodbridge Station Pond 2

Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5216.54	0	0	0	0
5218	1.46	26188	0.44	8
5220	3.46	52058	2.24	17
5222	5.46	65342	4.93	23
5222.94	6.4	71906	6.41	26
5224	7.46	82145	8.29	190
5225*	8.46*	89834*	10.26	1126*

Values from 2010 Hydrology Update - Appendix D tables (Pond
*Additional point added based on area from LiDAR and extrapolating discharge and adding secondary spillway discharge calculated using LiDAR dimensions and UD-Detention _v.2.34

Design Point L309 - Lakeview Tributary: Parkridge Park Pond

Elevation	Stage (ft)	Area (sf)	Storage (ac-ft)	Discharge (cfs)
5234	0	50	0.00	0
5236	2	37253	0.86	9
5238	4	78616	3.52	15
5240	6	112598	7.91	20
5241.75	7.75	135547	12.89	23
5242	8	138875	13.68	39
5244	10	162093	20.59	786

Values from 2010 Hydrology Update - Appendix D tables (Pond 904)

Table B-2 - Detention Basin Stage-Storage-Discharge Information

*Red values indicate flows at or above the spillway. Tables without red values are from other reports and the spillway flows were not identified separate from the outlet structure flows.

Design Point P303 - Plains Tributary: Riverdale Park Detention Pond

Elevation	Stage (ft)	Storage (ac-ft)	Discharge (cfs)
5149	0	0	0
5153.49	4.49	2.79	0
5154	5	5.29	75
5155	6	9.39	289
5156	7	13.69	583
5156.4	7.4	15.59	725
UNAVAIL.	---	22.09	955
UNAVAIL.	---	33.59	1424

Values from 2010 Hydrology Update - Appendix D tables (Pond 910)

2010 Hydrology Update shows spillway elevation of 5158.0 in Table 2-6

Design Point P306 - Plains Tributary: Trail Winds Park Pond

Elevation	Stage (ft)	Area (sf)	Storage (ac-ft)	Discharge (cfs)
5197	0	50	0.00	0
5198	1	2640	0.03	2
5199	2	12975	0.21	5
5200	3	39850	0.82	6
5201	4	80936	2.20	31
5202	5	93173	4.20	35
5203	6	106976	6.50	39
5204	7	125748	9.17	44
5204.15	7.15	131789	9.61	45
5205	8	165499	12.51	255

Values from 2010 Hydrology Update - Appendix D tables (Pond 905)

Design Point P307 - Plains Tributary: Adams 12 Aquatic Center

Elevation	Stage (ft)	Storage (ac-ft)	Discharge (cfs)
5245.3	0	0	0
5246.4	1.1	0.249	0.4
5247	1.7	0.393	2
5248	2.7	0.781	4.2
5248.9	3.6	1.24	5
5249	3.7	1.296	23.7
5249.9	4.6	1.908	25
5250	4.7	1.977	75
5251	5.7	2.85	80

Values from 2010 Hydrology Update - Appendix D tables (Pond 903)

Design Point Q301- Quails Way Tributary: Amber Creek Subdivision Pond C

Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5131.8	0	0	0.00	0
5132	0.2	500	0.00	0
5133	1.2	3250	0.04	0.07
5134	2.2	7500	0.17	0.18
5135	3.2	11250	0.38	0.31
5136	4.2	19250	0.73	0.47
5137	5.2	25000	1.24	0.65
5138	6.2	34500	1.92	5.22
5139	7.2	37500	2.75	26.01
5140	8.2	48000	3.73	256.4

Stage-area values from *Addendum to Phase III Drainage Study for The Northwesterly 153 Single Family Lots of Amber Creek Subdivision*

Stage-discharge values calculated using UD_Detention-2.34 based on values and details in drainage study

Design Point S306- South Platte Tributary 7 : Brantner Gulch Pond #3

Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5065.55	0	0	0.00	0
5066	0.45	1193	0.01	0.04
5067	1.45	9296	0.13	0.16
5068	2.45	22150	0.49	0.33
5069	3.45	35115	1.14	0.53
5070	4.45	45111	2.07	0.76
5071	5.45	53393	3.20	4.000
5072	6.45	60551	4.50	33.91
5073	7.45	67225	5.97	36.68
5073.6	8.05	69995	6.92	57.25
5074.8*	9.25*	75535*	8.92	416.9

Stage-area values based on *Final Drainage Report: High School No. 3 - Onsite Improvements.*
*Additional point added by extrapolating area from drainage
Stage-discharge values calculated using UD_Detention-v2.34 based on values and details in drainage report and construction drawings

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 (ft^2)	Length to Centroid (ft)	Length (ft)	Slope (ft/ft)	Existing Percent Imperviousness	Future Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Level 0, 1, or 2
1	101	Raingage	5153730	3111.219971	4659.83	0.000464772	61.5132	61.5132	0.4	0.1	3.80089232	0.00135951	0.7	0
2	102	Raingage	1902770	1948.550049	3432.6	0.012639963	18.1794	18.1794	0.35	0.1	3.19964876	0.00169019	0.55	0
3	103	Raingage	181418	142.3399963	692.54	0.033435951	14.8793	14.8793	0.4	0.1	3	0.0018	0.5	0
4	104	Raingage	794283	1427.550049	2855.36	0.017968971	18.4063	18.4063	0.4	0.09	3	0.0018	0.5	0
5	105	Raingage	461990	656.7390137	1871.75	0.021561495	45.6049	45.6049	0.35	0.07	3	0.0018	0.5	0
6	106	Raingage	3583580	1838.719971	3945.1	0.022728335	18.2438	32.4595	0.38	0.08	3.07982749	0.00175609	0.52	0
7	107	Raingage	2498200	1282.589966	2569.8	0.038027911	29.4816	29.4816	0.35	0.07	3.69971503	0.00141516	0.675	0
8	108	Raingage	3569850	1051.650024	2594.86	0.019035512	6.86315	15.6838	0.4	0.09	3	0.0018	0.5	0
9	109	Raingage	2498100	2899.389893	4187.67	0.013102046	48.7767	48.7767	0.35	0.07	3	0.0018	0.5	0
10	110	Raingage	2206150	1228.869995	2645.55	0.027269334	31.1229	32.3174	0.35	0.07	3.00179327	0.00179901	0.5	0
11	111	Raingage	498615	1619.069946	2804.53	0.01547389	6.32007	6.32007	0.4	0.09	3	0.0018	0.5	0
12	112	Raingage	4030230	1749.810059	3604.14	0.026378594	35.305	40.5015	0.35	0.09	3.05649353	0.00176893	0.514	0
13	113	Raingage	2151290	1236.51001	3579.23	0.013570356	4.86117	53.7489	0.37	0.08	3	0.0018	0.5	0
14	114	Raingage	1097420	1028.23999	2166.844	0.025749957	52.9305	66.187	0.35	0.08	3	0.0018	0.5	0
15	115	Raingage	1887720	1626.939941	3020.13	0.021849145	2.0688	21.1684	0.37	0.08	3	0.0018	0.5	0
16	116	Raingage	4320650	3017.4065	4017.025	0.020977515	45.923	53.0469	0.35	0.07	3	0.0018	0.5	0
17	117	Raingage	4537730	2343.889893	4377.19	0.015999865	43.1572	43.1572	0.35	0.07	3	0.0018	0.5	0
18	118	Raingage	5231440	1823.660034	4116.37	0.018037594	49.0362	49.0362	0.35	0.07	3	0.0018	0.5	0
19	119	Raingage	3362440	1778.52002	4028.44	0.013871206	33.3971	42.5689	0.35	0.07	3	0.0018	0.5	0
20	120	Raingage	3321180	1473.209961	3738.94	0.022021537	42.0659	42.0659	0.35	0.07	3	0.0018	0.5	0
21	121	Raingage	1149780	1251.790039	1915.69	0.010493913	41.8023	41.8023	0.35	0.07	3	0.0018	0.5	0
22	122	Raingage	3108680	2308.800049	4435.93	0.015255757	34.2561	34.2561	0.35	0.07	3	0.0018	0.5	0
23	123	Raingage	3086230	1614.439941	4045.15	0.014719152	39.3297	39.3297	0.35	0.07	3	0.0018	0.5	0
24	124	Raingage	425020	1333.930054	2723.27	0.020963756	43.9892	43.9892	0.35	0.07	3	0.0018	0.5	0
25	125	Raingage	4870380	1556.51001	6277.89	0.010140968	48.2064	48.2064	0.35	0.09	3	0.0018	0.5	0
26	126	Raingage	3119540	2273.169922	2717.82	0.007858495	39.0043	39.0043	0.35	0.07	3	0.0018	0.5	0
27	127	Raingage	3359590	2123.26001	3105.29	0.007024373	38.0654	38.0654	0.35	0.08	3	0.0018	0.5	0
28	128	Raingage	3469100	547.4589844	3134.56	0.010151548	47.562	47.562	0.35	0.07	3	0.0018	0.5	0
29	129	Raingage	2331550	2327.360107	3948.96	0.021183012	38.126	38.126	0.35	0.07	3	0.0018	0.5	0
30	130	Raingage	4141760	2057.469971	5021.439	0.012792584	39.4321	39.4321	0.35	0.07	3	0.0018	0.5	0
31	131	Raingage	3688680	3353.439941	4712.43	0.013973056	48.5291	48.5291	0.35	0.07	3	0.0018	0.5	0
32	132	Raingage	82958.9	831.6129761	1666.29	0.011897731	48.7931	48.7931	0.35	0.1	3	0.0018	0.5	0
33	133	Raingage	2447820	1595.469971	3306.66	0.011167878	45.732	45.732	0.35	0.08	3	0.0018	0.5	0
34	134	Raingage	390439	755.8280029	2023.75	0.026380994	44.6859	44.6859	0.35	0.07	3	0.0018	0.5	0
35	135	Raingage	3689280	2375.2997	3684.54	0.011356162	37.9043	44.0202	0.4	0.09	3	0.0018	0.5	0
36	136	Raingage	3969400	1802.51001	3852.82	0.013110827	47.4843	47.4843	0.35	0.09	3	0.0018	0.5	0

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Subcatchment Name	EPA SWMM Target Node	Raingage	Area (ft^2)	Length to Centroid (ft)	Length (ft)	Slope (ft/ft)	Existing Percent Imperviousness	Future Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Level 0, 1, or 2
37	137	Raingage	217883	789.6170044	1600.08	0.023174886	53.8904	53.8904	0.35	0.08	3	0.0018	0.5	0
38	138	Raingage	339857	854.625	2239.03	0.017210493	44.2017	44.2017	0.35	0.07	3	0.0018	0.5	0
39	139	Raingage	1017900	1109	1692.59	0.016187115	45.0466	45.0466	0.35	0.07	3	0.0018	0.5	0
40	140	Raingage	1805890	1198.579956	2968.79	0.009108063	37.3073	37.3073	0.35	0.07	3	0.0018	0.5	0
41	141	Raingage	3289340	1987.979981	3253.73	0.01216091	38.6495	38.6495	0.35	0.07	3	0.0018	0.5	0
42	142	Raingage	1206800	858.0029907	1700.36	0.01971999	42.411	42.411	0.35	0.09	3	0.0018	0.5	0
43	143	Raingage	171147	410.6870117	865.9	0.016984237	37.0559	37.0559	0.35	0.07	3	0.0018	0.5	0
44	144	Raingage	308593	477.7940063	1714.38	0.017414229	45.766	45.766	0.35	0.07	3	0.0018	0.5	0
45	145	Raingage	2310300	813.9990234	3001.56	0.011969019	45.7701	45.7701	0.35	0.09	3	0.0018	0.5	0
46	146	Raingage	1058160	1493.420044	2262.34	0.009468194	47.6434	47.6434	0.35	0.07	3	0.0018	0.5	0
47	147	Raingage	3750370	628.0859985	3391.03	0.012270821	52.543	52.543	0.35	0.08	3	0.0018	0.5	0
48	148	Raingage	3011140	2249.879883	3740.71	0.006007352	40.857	40.857	0.35	0.07	3	0.0018	0.5	0
49	149	Raingage	1267160	985.7280273	2511.38	0.007468244	30.8673	30.8673	0.35	0.07	3	0.0018	0.5	0
50	150	Raingage	4266990	640.5449829	3866.54	0.013117689	45.96405	45.96405	0.35	0.09	3	0.0018	0.5	0
51	151	Raingage	1220280	1298.209961	3396.03	0.014887347	44.0169	46.3205	0.35	0.07	3	0.0018	0.5	0
52	152	Raingage	5425480	1528.150024	3930.38	0.00176269	35.096	35.096	0.4	0.09	3	0.0018	0.5	0
53	153	Raingage	972086	1141.890015	2100.43	0.014610718	43.2385	43.2385	0.35	0.07	3	0.0018	0.5	0
54	154	Raingage	2792160	1360.959961	2967.88	0.006619408	32.5809	32.5809	0.35	0.09	3	0.0018	0.5	0
55	155	Raingage	2057990	1613.900024	2803.88	0.006761654	50.0559	50.0559	0.35	0.07	3	0.0018	0.5	0
56	156	Raingage	1800590	1348.069946	2295.74	0.004176386	46.0914	46.0914	0.35	0.07	3	0.0018	0.5	0
57	157	Raingage	3035630	2050.8489	3208.205	0.015581226	33.65397	63.68981	0.4	0.1	3	0.0018	0.5	0
58	158	Raingage	3802670	2985.399902	4370.161	0.007441017	51.1627	51.1627	0.35	0.09	3	0.0018	0.5	0
59	159	Raingage	2306120	661.6469727	3367.23	0.012242576	32.2623	37.5529	0.38	0.09	3	0.0018	0.5	0
60	160	Raingage	2873400	768.9500122	3771.62	0.012526799	22.6403	23.229	0.38	0.09	3	0.0018	0.5	0
61	161	Raingage	5962370	1580.030029	6119.3	0.011644289	35.6982	61.9255	0.35	0.1	3	0.0018	0.5	0
62	162	Raingage	1108590	679.8189697	2153.27	0.016030261	14.2708	32.1399	0.4	0.1	3	0.0018	0.5	0
63	163	Raingage	1626770	694.1599731	1995.47	0.01062432	3.82423	38.5098	0.38	0.09	3	0.0018	0.5	0
64	164	Raingage	3431000	1454.959961	3328.84	0.009117394	22.5066	75.4384	0.35	0.09	3	0.0018	0.5	0
65	165	Raingage	3020100	1668.229981	3030.24	0.013299382	60.1328	75.7833	0.38	0.09	3	0.0018	0.5	0
66	166	Raingage	2876420	1779.8578	3073.84	0.009773748	50.8691	63.7986	0.35	0.1	3	0.0018	0.5	0
67	167	Raingage	4914790	3012.189941	5175.14	0.00884346	45.2526	45.2526	0.35	0.1	3	0.0018	0.5	0
68	168	Raingage	5108720	2754.860107	4936.14	0.009568366	57.9038	57.9038	0.35	0.09	3	0.0018	0.5	0
F01	F101	Raingage	1082450	896.0487	2250.961	0.018227142	19.7803	19.7803	0.37	0.09	3	0.0018	0.5	0
F02	F102	Raingage	1486690	967.9060059	2467.65	0.02134406	21.0217	21.0217	0.38	0.09	3	0.0018	0.5	0
F03	F103	Raingage	1556340	1559.969971	2961.49	0.024061064	4.16679	13.5729	0.38	0.08	3	0.0018	0.5	0
F04	F104	Raingage	3823670	1044.040039	3481.91	0.018524852	30.4143	43.181	0.35	0.07	3	0.0018	0.5	0

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Subcatchment Name	EPA SWMM Target Node	Raingage	Area (ft^2)	Length to Centroid (ft)	Length (ft)	Slope (ft/ft)	Existing Percent Imperviousness	Future Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Level 0, 1, or 2
F05	F105	Raingage	3389770	2375.919922	3943.586	0.022550272	16.8074	47.2463	0.35	0.08	3.50679632	0.00152126	0.627	0
H01	H101	Raingage	1437480	1623.290039	3080.88	0.014494558	18.8664	18.8664	0.37	0.09	3	0.0018	0.5	0
H02	H102	Raingage	4890120	1849.280029	4326.3	0.014639254	44.094	44.4065	0.35	0.07	3	0.0018	0.5	0
H03	H103	Raingage	1835600	1404.77002	3065.589	0.00876622	28.9441	29.1236	0.4	0.09	3	0.0018	0.5	0
H04	H104	Raingage	4838940	1470.199951	3834.23	0.030381382	38.5962	41.938	0.37	0.07	3	0.0018	0.5	0
H05	H105	Raingage	1534440	1072.479981	2127.2	0.021394216	17.4498	17.4498	0.35	0.1	3	0.0018	0.5	0
H06	H106	Raingage	4959590	700.6209717	3236.01	0.004731279	55.62	55.62	0.35	0.08	3	0.0018	0.5	0
H07	H107	Raingage	4280860	2228.409912	4351.93	0.023832379	45.1494	47.115	0.35	0.08	3.15326119	0.00171571	0.538	0
H08	H108	Raingage	1900830	1151.729981	2799.31	0.018447266	37.4106	45.2436	0.38	0.09	3.31210586	0.00162834	0.578	0
H09	H109	Raingage	694303	1766.479981	3283.62	0.032341107	20.4427	20.7094	0.35	0.07	3.0129515	0.00179288	0.503	0
H10	H110	Raingage	3400170	1670.849976	3909.208	0.017539129	28.5621	28.5621	0.4	0.1	3	0.0018	0.5	0
H11	H111	Raingage	654534	855.7150269	2492.84	0.027432027	34.66	34.66	0.35	0.07	3.76870003	0.00137721	0.692	0
H12	H112	Raingage	4957750	2360.159912	4121.109	0.026126401	33.7168	37.5911	0.35	0.07	3.11057955	0.00173918	0.528	0
H13	H113	Raingage	1741950	976.2730103	2958.31	0.024984314	42.0703	42.7699	0.35	0.08	3.45013919	0.00155242	0.613	0
H14	H114	Raingage	2590070	853.5479736	3083.25	0.013677601	53.7745	54.2891	0.35	0.08	3.12316149	0.00173226	0.531	0
L01	L101	Raingage	2249480	1499	3472.8	0.012542105	17.9184	25.2814	0.35	0.09	3	0.0018	0.5	0
L02	L102	Raingage	1891150	1476.160034	3062.31	0.012390253	49.2033	49.2033	0.35	0.09	3	0.0018	0.5	0
L03	L103	Raingage	442198	385.3670044	2168.13	0.027668776	48.7883	48.7883	0.35	0.07	3	0.0018	0.5	0
L04	L104	Raingage	2189830	1505.910034	2856.2	0.017952823	50.1462	50.1462	0.35	0.09	3	0.0018	0.5	0
L05	L105	Raingage	4701800	1626.160034	3930.08	0.015540448	44.4341	44.4341	0.35	0.07	3	0.0018	0.5	0
L06	L106	Raingage	2831940	1115.939941	2668.26	0.017273422	45.5951	45.5951	0.35	0.07	3	0.0018	0.5	0
L07	L107	Raingage	3200030	1789.930054	3537.19	0.014342247	47.3273	47.3273	0.35	0.07	3	0.0018	0.5	0
L08	L108	Raingage	1984970	1596.439941	2952.38	0.015961405	46.8174	46.8174	0.35	0.07	3	0.0018	0.5	0
L09	L109	Raingage	1366030	782.7700195	1782.71	0.015916678	33.2771	33.2771	0.35	0.07	3	0.0018	0.5	0
L10	L110	Raingage	2237150	759.6049805	2689.04	0.019058793	47.6945	47.6945	0.35	0.07	3	0.0018	0.5	0
L11	L111	Raingage	973098	555.5	1874.11	0.01861176	46.5366	46.5366	0.35	0.07	3	0.0018	0.5	0
P01	P101	Raingage	2074300	1439.979981	4093.5	0.017427751	5.13892	34.6384	0.35	0.09	3	0.0018	0.5	0
P02	P102	Raingage	2754700	1826.540039	3541.47	0.011408036	44.5191	44.5191	0.35	0.08	3	0.0018	0.5	0
P03	P103	Raingage	2838930	2830.610107	4153.99	0.009169271	53.1576	53.1576	0.35	0.07	3	0.0018	0.5	0
P04	P104	Raingage	2382680	1539.609985	3866.05	0.011546831	54.7801	54.7801	0.35	0.07	3	0.0018	0.5	0
P05	P105	Raingage	2447870	2602.129883	5251.55	0.014668368	13.9294	13.9294	0.4	0.1	3	0.0018	0.5	0
P06	P106	Raingage	2550990	2133.860107	3326.422	0.011356268	11.2243	11.2243	0.37	0.1	3	0.0018	0.5	0
P07	P107	Raingage	1188930	672.3460083	2010.88	0.021026985	23.4081	23.4081	0.4	0.1	3	0.0018	0.5	0
Q01	Q101	Raingage	2330590	1695.319946	3313.8	0.026506587	21.756	21.756	0.4	0.08	3	0.0018	0.5	0
Q02	Q102	Raingage	1154400	859.6699829	1933.99	0.021635128	16.1309	16.1309	0.37	0.08	3	0.0018	0.5	0
R01	R101	Raingage	2832830	2095.350098	4229.09	0.017071686	4.13363	36.8499	0.35	0.09	3	0.0018	0.5	0

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Subcatchment Name	EPA SWMM Target Node	Raingage	Area (ft^2)	Length to Centroid (ft)	Length (ft)	Slope (ft/ft)	Existing Percent Imperviousness	Future Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Level 0, 1, or 2
R02	R102	Raingage	2343860	1288.089966	1899.699	0.023124812	14.323	71.2014	0.37	0.08	3	0.0018	0.5	0
R03	R103	Raingage	1300810	1319.6917	2434.855	0.028903398	2	2	0.4	0.1	3	0.0018	0.5	0
R04	R104	Raingage	5229150	1782.160034	3724.007	0.014198608	5.75207	9.19566	0.4	0.35	3.12425067	0.00173166	0.531	0
RP01	RP101	Raingage	3623700	1710.4019	3436.137	0.003180093	3.354054	3.354054	0.4	0.1	3.29004262	0.00164048	0.573	0
RP02	RP102	Raingage	676527	761.0796	1592.296	0.036815105	4.619718	4.619718	0.35	0.07	4.98775095	0.00070674	0.997	0
RP03	RP103	Raingage	1926020	952.3852	2223.867	0.045215868	6.040201	6.040201	0.35	0.07	5	0.0007	1	0
S01	S101	Raingage	6804360	2413.1589	5643.273	0.002641566	22.1608	22.1608	0.35	0.1	4.70694396	0.00086118	0.927	0
S02	S102	Raingage	1355180	385.678009	2099.6	0.020313637	12.2933	13.9626	0.35	0.1	3.70049479	0.00141473	0.675	0
S03	S103	Raingage	965424	1363.680054	2490.75	0.005258701	3.61799	59.2025	0.37	0.08	3.62734159	0.00145496	0.657	0
S04	S104	Raingage	4079060	1856.410034	4729.87	0.031295577	2.607059	4.656815	0.4	0.1	3.70091813	0.0014145	0.675	0
S05	S105	Raingage	3095320	789.4227	4043.26	0.018406912	15.7763	40.6734	0.37	0.08	3	0.0018	0.5	0
S06	S106	Raingage	1697000	1900.7274	2311.104	0.014729462	54.998	54.998	0.35	0.1	3	0.0018	0.5	0
S07	S107	Raingage	431873	704.7189941	1490.35	0.022156108	7.83002	7.83002	0.35	0.07	3.5547376	0.00149489	0.639	0
S08	S108	Raingage	2567610	2055.439941	4011.23	0.0291203	9.79614	38.1003	0.35	0.07	3.01381757	0.0017924	0.503	0
S09	S109	Raingage	2504880	1364.060059	2942.41	0.024294277	2.45455	28.4905	0.35	0.07	3.02547753	0.00178599	0.506	0
S10	S110	Raingage	327621	1133.630005	1516.69	0.013341895	2.43265	35.2098	0.35	0.07	3	0.0018	0.5	0
S11	S111	Raingage	1178500	834.9019775	2033.74	0.031069504	2.05298	23.4369	0.37	0.08	3	0.0018	0.5	0
S12	S112	Raingage	3911730	2708.800049	4654.37	0.030894582	13.3469	29.1312	0.38	0.08	3.21220968	0.00168328	0.553	0
S13	S113	Raingage	1660120	722.2540283	1876.2	0.044996368	2	75	0.38	0.07	4.34435342	0.00106061	0.836	0
S14	S114	Raingage	3675700	956.7440186	3646.41	0.009501848	20.8663	20.8663	0.35	0.1	4.32097612	0.00107346	0.83	0
S15	S115	Raingage	481241	409.4515	1185.001	0.016193127	19.119	68.6591	0.35	0.08	3	0.0018	0.5	0
S16	S116	Raingage	2854630	679.9719849	2470.54	0.005889665	36.0095	36.0095	0.35	0.1	3.67912664	0.00142648	0.67	0
S17	S117	Raingage	4746340	2742.3199	4400.316	0.013619877	13.4889	16.2527	0.35	0.1	3.00727614	0.001796	0.502	0
S18	S118	Raingage	533962	1171.1509	2540.101	0.01749343	38.9591	60.2568	0.35	0.09	3	0.0018	0.5	0
S19	S119	Raingage	3563790	1526.36478	3679.679	0.025783519	3.001266	29.070127	0.4	0.1	3	0.0018	0.5	0
S20	S120	Raingage	1530340	997.725227	2477.801	0.019178243	2.101288	28.819087	0.4	0.1	3	0.0018	0.5	0
S21	S121	Raingage	586998	537.0139771	1781.339	0.029344719	2.5574	7.49423	0.4	0.1	3	0.0018	0.5	0
S22	S122	Raingage	1409050	1585.420044	2379.4	0.023225288	4.72366	27.5403	0.4	0.1	3	0.0018	0.5	0
S23	S123	Raingage	1046070	1644.729981	2862.12	0.022767077	2.35835	11.4071	0.4	0.1	3	0.0018	0.5	0
S24	S124	Raingage	2584980	1674.73999	3465.47	0.031500877	32.9642	32.9642	0.35	0.07	3.32926179	0.00161891	0.582	0
S25	S125	Raingage	2449370	1695.26001	2771.87	0.007611794	2.66791	28.1996	0.4	0.1	4.76179538	0.00083101	0.94	0
D01	D101	Raingage	4890191	2168.9914	4151.052	0.001342983	42.98911	42.98911	0.4	0.1	4.79269081	0.00081402	0.948	0
D02	D102	Raingage	3467684	1566.90043	2954.635	0.006625651	7.889727	7.889727	0.35	0.1	3.48379509	0.00153391	0.621	0
D03	D103	Raingage	3409382	1841.76006	3779.395	0.002398868	70.861126	70.861126	0.4	0.1	3.66099239	0.00143645	0.665	0
D04	D104	Raingage	3307631	1494.29529	3161.877	0.020724801	7.231711	7.231711	0.4	0.1	3.88375454	0.00131394	0.721	0
D05	D105	Raingage	1215373	1496.38286	2847.958	0.027133406	2.494048	2.494048	0.38	0.09	3.83430441	0.00134113	0.709	0

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 (ft^2)	Length to Centroid (ft)	Length (ft)	Slope (ft/ft)	Existing Percent Imperviousness	Future Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Level 0, 1, or 2
D06	D106	Raingage	3471197	2107.83131	3776.785	0.00065488	70.120104	70.120104	0.4	0.1	3.62110696	0.00145839	0.655	0
D07	D107	Raingage	4772990	1489.55753	3639.7	0.034532073	6.145152	6.145152	0.38	0.09	3.8977046	0.00130626	0.724	0
D08	D108	Raingage	2843820	1469.0406	3336.463	0.001893214	11.377841	11.377841	0.4	0.1	3.81503001	0.00135173	0.704	0

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          00:05:00
WET_STEP             00:05:00
DRY_STEP             01:00:00
ROUTING_STEP         0:00:05
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         12.557
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:\2018\2501-3000\018-2897\40-Design\Calcs\WTRS\1
HYDROLOGY\Baseline\CUHP 2016 - v. 2.0.0\Output
Files\Future\20_Fut_500yr_0mi^2_018-2897.txt"

[EVAPORATION]
;;Data Source    Parameters
;;-------------- ----------------
```



```
CONSTANT         0.0
DRY_ONLY         NO

[JUNCTIONS]
;;Name           Elevation  MaxDepth   InitDepth  SurDepth   Aponded

;;-------------- ---------- ---------- ---------- ----------
----------
102              5010       0          0          0          0

103              5035       0          0          0          0

103T             5035       0          0          0          0

104              5036       0          0          0          0

104T             5036       0          0          0          0

105              5072       0          0          0          0

105T             5044.51    0          0          0          0

106              5048       0          0          0          0

107              5052       0          0          0          0

108              5055       0          0          0          0

108T             5055       0          0          0          0

109              5109.86    0          0          0          0

110              5055       0          0          0          0

111              5069       0          0          0          0

111T             5069       0          0          0          0

112              5069       0          0          0          0

113              5073.79    0          0          0          0

113T             5073.79    0          0          0          0

114              5073.79    0          0          0          0

115              5075.51    0          0          0          0

115T             5075.51    0          0          0          0
```

116	5075.51	0	0	0	0
117	5089	0	0	0	0
117T	5089	0	0	0	0
118	5117.93	0	0	0	0
118O	5117.93	0	0	0	0
118T	5112	0	0	0	0
119	5122.65	0	0	0	0
120	5135	0	0	0	0
120T	5135	0	0	0	0
121	5216	0	0	0	0
122	5142	0	0	0	0
123	5150.74	0	0	0	0
123T	5142.8	0	0	0	0
124	5156	0	0	0	0
124T	5145	0	0	0	0
125	5161	0	0	0	0
125T	5148	0	0	0	0
126	5212	0	0	0	0
127	5209	0	0	0	0
128	5230	0	0	0	0
129	5151.24	0	0	0	0
129T	5151.24	0	0	0	0
130	5157	0	0	0	0
130O	5157	0	0	0	0
131	5217	0	0	0	0

131T	5172	0	0	0	0
132	5289.43	0	0	0	0
133	5186	0	0	0	0
134	5180.63	0	0	0	0
135	5184	0	0	0	0
135T	5181.98	0	0	0	0
136	5206.86	0	0	0	0
137	5253.55	0	0	0	0
138	5289.8	0	0	0	0
139	5245	0	0	0	0
139T	5230	0	0	0	0
140	5252	0	0	0	0
140T	5234	0	0	0	0
141	5267	0	0	0	0
142	5285.82	0	0	0	0
143	5258	0	0	0	0
144	5275.47	0	0	0	0
145	5191.57	0	0	0	0
146	5204	0	0	0	0
147	5221.82	0	0	0	0
148	5243	0	0	0	0
149	5253	0	0	0	0
150	5257	0	0	0	0
151	5235	0	0	0	0
152	5222	0	0	0	0

153	5253	0	0	0	0
153T	5222	0	0	0	0
154	5222	0	0	0	0
155	5240	0	0	0	0
156	5247	0	0	0	0
156T	5247	0	0	0	0
157	5256	0	0	0	0
158	5231	0	0	0	0
159	5225	0	0	0	0
160	5252	0	0	0	0
161	5263	0	0	0	0
162	5271	0	0	0	0
163	5276.39	0	0	0	0
163T	5268	0	0	0	0
164	5293	0	0	0	0
165	5306.12	0	0	0	0
165O	5305.01	0	0	0	0
166	5331	0	0	0	0
167	5314	0	0	0	0
F101	5035	0	0	0	0
F102	5060	0	0	0	0
F103	5078	0	0	0	0
F104	5109.45	0	0	0	0
F104O	5109.45	0	0	0	0
F105	5165	0	0	0	0

H101	5036	0	0	0	0
H102	5062.27	0	0	0	0
H103	5086	0	0	0	0
H103O	5086	0	0	0	0
H104	5100	0	0	0	0
H104T	5089	0	0	0	0
H105	5126.52	0	0	0	0
H105T	5126.52	0	0	0	0
H106	5175.4	0	0	0	0
H106O	5175.4	0	0	0	0
H107	5190	0	0	0	0
H107O	5190	0	0	0	0
H108	5242	0	0	0	0
H109	5195	0	0	0	0
H110	5213	0	0	0	0
H111	5270.43	0	0	0	0
H112	5250.1	0	0	0	0
H112O	5250.1	0	0	0	0
H113	5277	0	0	0	0
H113T	5259.9	0	0	0	0
H114	5284	0	0	0	0
L101	5089	0	0	0	0
L102	5124.15	0	0	0	0
L102O	5124.15	0	0	0	0
L103	5163	0	0	0	0

L103T	5124.89	0	0	0	0
L104	5130	0	0	0	0
L105	5161.43	0	0	0	0
L105O	5161.43	0	0	0	0
L106	5199.21	0	0	0	0
L106O	5199.21	0	0	0	0
L107	5216.54	0	0	0	0
L107O	5216.54	0	0	0	0
L108	5251	0	0	0	0
L109	5234	0	0	0	0
L110	5261	0	0	0	0
L111	5291	0	0	0	0
P101	5075.51	0	0	0	0
P102	5126	0	0	0	0
P103	5149	0	0	0	0
P103O	5149	0	0	0	0
P104	5170.99	0	0	0	0
P105	5205	0	0	0	0
P105T	5194.89	0	0	0	0
P106	5197	0	0	0	0
P106O	5197	0	0	0	0
P107	5245.3	0	0	0	0
P107O	5245.3	0	0	0	0
Q101	5131.8	0	0	0	0
Q101O	5131.8	0	0	0	0

Q102	5201	0	0	0	0
R101	5089	0	0	0	0
R102	5130	0	0	0	0
R103	5163	0	0	0	0
R104	5179	0	0	0	0
S102	5013	0	0	0	0
S102T	4998.5	0	0	0	0
S103	5021	0	0	0	0
S104	5022	0	0	0	0
S105	5030	0	0	0	0
S106	5065.55	0	0	0	0
S106O	5065.55	0	0	0	0
S106T	5056.65	0	0	0	0
S107	5095	0	0	0	0
S108	5069	0	0	0	0
S109	5100	0	0	0	0
S110	5115.15	0	0	0	0
S110T	5075.55	0	0	0	0
S111	5082	0	0	0	0
S112	5110	0	0	0	0
S113	5193	0	0	0	0
S114	5002.3	0	0	0	0
S115	5045	0	0	0	0
S115T	4999	0	0	0	0
S116	5004	0	0	0	0

```
S117               5014       0          0          0          0

S119               5057       0          0          0          0

S121               5088.63    0          0          0          0

S121T              5088.63    0          0          0          0

S122               5122       0          0          0          0

S123               5088.63    0          0          0          0

S124               5148       0          0          0          0

RP102              5018       0          0          0          0

RP103              5022       0          0          0          0

S120               5070.98    0          0          0          0

D102T              5012       0          0          0          0

D102               5016       0          0          0          0

D103               5016       0          0          0          0

D104               5019       0          0          0          0

D105               5024       0          0          0          0

D107               5025       0          0          0          0


[OUTFALLS]
;;Name             Elevation  Type       Stage Data       Gated
Route To
;;-------------- ---------- ---------- ---------------- --------
----------------
101                5001       FREE                        NO

S101               4997       FREE                        NO

S125               4997       FREE                        NO

RP101              4995       FREE                        NO

D101               5002       FREE                        NO

D106               5007       FREE                        NO
```



```
D108               5008       FREE                        NO


[DIVIDERS]
;;Name             Elevation  Diverted Link    Type       Parameters
;;-------------- ---------- ---------------- ---------- ----------
106T               5048       406T             OVERFLOW   0          0
        0          0
139O               5245       439O             OVERFLOW   0          0
        0          0
140O               5252       440O             OVERFLOW   0          0
        0          0
141O               5267       441O             OVERFLOW   0          0
        0          0
142O               5285.82    442O             OVERFLOW   0          0
        0          0
146O               5204       446O             OVERFLOW   0          0
        0          0
147O               5221.82    447O             OVERFLOW   0          0
        0          0
149O               5253       449O             OVERFLOW   0          0
        0          0
152O               5221.34    452O             OVERFLOW   0          0
        0          0
153O               5253       453O             OVERFLOW   0          0
        0          0
160O               5252.08    460O             OVERFLOW   0          0
        0          0
L109O              5234       L409O            OVERFLOW   0          0
        0          0
168                5355.67    468              OVERFLOW   0          0
        0          0
S118               5052.70    S418             TABULAR
S118_Diversion     0          0          0          0

[STORAGE]
;;Name             Elev.    MaxDepth   InitDepth  Shape      Curve
Name/Params           N/A      Fevap    Psi      Ksat      IMD
;;-------------- -------- ---------- ----------- ----------
---------------------------- -------- --------          --------
--------
318                5117.93  8.4        0          TABULAR    Pond318
                    0        0
330                5157     9          0          TABULAR    Pond330
                    0        0
;Detention pond is modeled using storage-discharge information from
2005 MDP. Depth value actually reflects storage, not depth.
339                5245     3.99       0          FUNCTIONAL 0
0        43560     0        0
;Detention pond is modeled using storage-discharge information from
```

```
2005 MDP. Depth value actually reflects storage, not depth.
340              5252     5.02       0          FUNCTIONAL 0
0         43560    0        0
;Detention pond is modeled using storage-discharge information from
2005 MDP. Depth value actually reflects storage, not depth.
341              5267     2.9        0          FUNCTIONAL 0
0         43560    0        0
;Detention pond is modeled using storage-discharge information from
2005 MDP. Depth value actually reflects storage, not depth.
342              5285.82  4.61       0          FUNCTIONAL 0
0         43560    0        0
346              5204     9          0          TABULAR    Pond346
                  0        0
347              5221.82  8.18       0          TABULAR    Pond347
                  0        0
;Detention pond is modeled using storage-discharge information from
2005 MDP. Depth value actually reflects storage, not depth.
349              5253     3.049      0          FUNCTIONAL 0
0         43560    0        0
352              5221.34  6.66       0          TABULAR    Pond352
                  0        0
;Detention pond is modeled using storage-discharge information from
2005 MDP. Depth value actually reflects storage, not depth.
353              5253     1.59       0          FUNCTIONAL 0
0         43560    0        0
360              5252.08  10.9       0          TABULAR    Pond360
                  0        0
365              5305.17  10.08      0          TABULAR    Pond365
                  0        0
F304             5109.45  13.55      0          TABULAR    PondF304
                  0        0
H303             5086     10         0          TABULAR    PondH303
                  0        0
;Detention pond is modeled using storage-discharge information from
2010 Hydrology Update. Depth value actually reflects storage, not
depth.
H306             5175.4   65         0          FUNCTIONAL 0
0         43560    0        0
H307             5190     13         0          TABULAR    PondH307
                  0        0
H312             5250.1   9.9        0          TABULAR    PondH312
                  0        0
L302             5124.15  5.85       0          TABULAR    PondL302
                  0        0
L305             5161.43  9.57       0          TABULAR    PondL305
                  0        0
L306             5199.21  10.79      0          TABULAR    PondL306
                  0        0
L307             5216.54  8.46       0          TABULAR    PondL307
                  0        0
```



```
L309             5234     10         0          TABULAR    PondL309
                  0        0
;Detention pond is modeled using storage-discharge information from
2010 Hydrology Update. Depth value actually reflects storage, not
depth.
P303             5149     33.59      0          FUNCTIONAL 0
0         43560    0        0
P306             5197     8          0          TABULAR    PondP306
                  0        0
;Detention pond is modeled using storage-discharge information from
2010 Hydrology Update. Depth value actually reflects storage, not
depth.
P307             5245.3   2.85       0          FUNCTIONAL 0
0         43560    0        0
Q301             5131.8   8.2        0          TABULAR    PondQ301
                  0        0
S306             5065.55  9.25       0          TABULAR    PondS306
                  0        0

[CONDUITS]
;;Name           From Node        To Node          Length
Roughness  InOffset   OutOffset  InitFlow   MaxFlow
;;-------------- ---------------- ---------------- ----------
---------- ---------- ---------- ---------- ----------
202              102              101              4240.3635  .045
   0          4          0          0
203              103              103T             .1         0.01
   0          0          0          0
203T             103T             102              2944.7752  .045
   0          0          0          0
204              104              104T             .1         0.01
   0          0          0          0
204T             104T             103              508.1516   .045
   0          0          0          0
205              105              105T             611.4132   .045
   0          11         0          0
205T             105T             104              1943.8953  .045
   0          2          0          0
206              106              106T             .1         0.01
   0          0          0          0
206T             106T             105T             90.7218    0.01875
   0          0          0          0
207              107              106T             489.6636   .045
   0          3          0          0
208              108              108T             .1         0.01
   0          0          0          0
208T             108T             106              2337.0097  .045
   0          0          0          0
209              109              108              1890.9462  .045
   0          8          0          0
```

```
210                 110                 108T                .1          0.01
   0          0           0           0
211                 111                 111T                .1          .045
   0          0           0           0
211T                111T                108T                2846.5149   .045
   0          0           0           0
212                 112                 111T                .1          .045
   0          0           0           0
213                 113                 113T                .1          0.01
   0          0           0           0
213T                113T                111T                615.8973    .045
   0          0           0           0
214                 114                 113T                .1          0.01
   0          0           0           0
215                 115                 115T                .1          0.01
   0          0           0           0
215T                115T                113T                765.6657    .045
   0          0           0           0
216                 116                 115                 .1          0.01
   0          0           0           0
217                 117                 117T                .1          0.01
   0          0           0           0
217T                117T                115                 2149.2064   .045
   0          0           0           0
218                 118                 318                 .1          0.01
   0          0           0           0
218O                118O                118T                0.1         0.01
   0          0           0           0
218T                118T                117                 1413.4868   .045
   0          9           0           0
219                 119                 118T                1832.6634   .045
   0          0           0           0
220                 120                 120T                .1          0.01
   0          0           0           0
220T                120T                119                 474.2676    .045
   0          5           0           0
221                 121                 120                 2882.5819   0.02
   0          11          0           0
222                 122                 120T                806.4729    .045
   0          0           0           0
223                 123                 123T                80.5047     .045
   0          0           0           0
223T                123T                122                 570.5641    .045
   0          0           0           0
224                 124                 124T                109.5383    .045
   1.5        5           0           0
224T                124T                123T                650.7889    .045
   0          0           0           0
225                 125                 125T                182.31      .045
   4          8           0           0
```



```
225T                125T                124T                228.777     .045
   0          1           0           0
226                 126                 125                 2818.4498   .045
   0          12          0           0
227                 127                 126                 941.6604    0.02
   10         0           0           0
228                 128                 127                 1457.5035   0.02
   3          8           0           0
229                 129                 129T                .1          0.01
   0          0           0           0
229T                129T                125T                33.6461     .045
   0          3           0           0
230                 130                 330                 .1          0.01
   0          0           0           0
230O                130O                129T                143.4532    0.01
   0          0           0           0
231                 131                 131T                2869.9539   0.02
   0          0           0           0
231T                131T                130                 345.9346    .045
   0          0           0           0
232                 132                 131                 4688.7054   0.02
   0          0           0           0
233                 133                 131T                1740.8421   0.02
   0          0           0           0
234                 134                 129                 2081.7427   .045
   0          9           0           0
235                 135                 135T                230.8152    0.02
   8          8           0           0
235T                135T                134                 378.5377    .045
   0          0           0           0
236                 136                 135                 1274.1831   0.02
   0          8           0           0
237                 137                 136                 2359.8359   0.02
   0          0           0           0
238                 138                 137                 1562.5851   0.02
   0          0           0           0
239                 139                 339                 .1          0.01
   0          0           0           0
239O                139O                135                 4161.2759   0.01875
   0          0           0           0
239T                139T                136                 1821.0354   0.02
   0          0           0           0
240                 140                 340                 .1          .01
   0          0           0           0
240O                140O                139O                954.2879    0.01875
   0          0           0           0
240T                140T                139T                646.9258    0.02
   0          0           0           0
241                 141                 341                 .1          0.01
   0          0           0           0
```

```
2410            1410            139             1376.579   .01875
   0        9          0          0
242             142             342             .1         0.01
   0        0          0          0
2420            1420            141             1442.349   .01875
   0        7          0          0
243             143             140T            1481.6601  0.02
   0        0          0          0
244             144             143             865.9005   0.02
   0        0          0          0
245             145             135T            168.198    0.02
   0        7          0          0
246             146             346             .1         0.01
   0        0          0          0
2460            1460            145             1504.9612  .01875
   0        0          0          0
247             147             347             .1         0.01
   0        0          0          0
2470            1470            146             1281.4658  .01875
   0        0          0          0
248             148             147             1665.0052  0.02
   0        5          0          0
249             149             349             .1         0.01
   0        0          0          0
2490            1490            147             2611.7548  .01875
   0        0          0          0
250             150             149             744.6435   0.02
   6        3          0          0
251             151             147             1594.0119  0.02
   0        6          0          0
252             152             352             .1         0.01
   0        0          0          0
2520            1520            135             2855.9963  0.01875
   0        0          0          0
253             153             353             .1         0.01
   0        0          0          0
2530            1530            1400            754.0506   .01875
   0        0          0          0
253T            153T            152             672.8941   0.01
   0        0          0          0
254             154             153T            1203.958   0.01
   0        0          0          0
255             155             154             1176.9069  .045
   0        0          0          0
256             156             156T            100.3933   0.02
   1        0          0          0
256T            156T            155             983.237    .045
   0        4          0          0
257             157             156T            1683.4899  0.02
   6        0          0          0
```



```
258             158             153T            931.2345   .045
   0        0          0          0
259             159             152             998.8231   0.045
   0        0          0          0
260             160             360             .1         0.01
   0        0          0          0
2600            1600            159             2601.3874  0.01875
   0        0          0          0
261             161             160             1764.2901  .045
   0        0          0          0
262             162             161             901.1829   .045
   0        0          0          0
263             163             163T            504.9543   .045
   0        4          0          0
263T            163T            161             648.283    .045
   0        1          0          0
264             164             163             1577.0004  .045
   0        0          0          0
265             165             365             .1         0.01
   0        0          0          0
2650            1650            164             1715.2069  .045
   0        2          0          0
266             166             165             1864.4361  .045
   0        2          0          0
267             167             163T            2464.0709  .045
   0        4          0          0
468             168             167             3141.2452  0.02
   0        0          0          0
406T            106T            105T            90.7218    .02
   0        0          0          0
4390            1390            139T            1090.0089  .045
   0        0          0          0
4400            1400            140T            1075.9782  .045
   5        0          0          0
4410            1410            140             1767.2148  0.02
   8        6          0          0
4420            1420            141             1471.7676  0.02
   1        7          0          0
4460            1460            145             1525.4556  0.02
   5        0          0          0
4470            1470            146             1313.5679  0.02
  10        5          0          0
4490            1490            148             1049.8107  0.02
   3        0          0          0
4520            1520            135             2855.9963  .02
   0        0          0          0
4530            1530            153T            1230.2512  0.02
   4        0          0          0
4600            1600            159             1816.0131  .02
  11        7          0          0
```

```
F201            F101            103T            .1          0.01
  0          0          0          0
F202            F102            F101            1703.2809   .045
  0          0          0          0
F203            F103            F102            1152.0405   .045
  0          0          0          0
F204            F104            F304            .1          0.01
  0          0          0          0
F204O           F104O           F103            1791.2231   .045
  0          0          0          0
F205            F105            F104            2619.7769   .045
  0          12.55      0          0
H201            H101            104T            .1          0.01
  0          0          0          0
H202            H102            H101            2278.939    .045
  0          4          0          0
H203            H103            H303            .1          0.01
  0          0          0          0
H203O           H103O           H102            1914.6132   .045
  0          3          0          0
H204            H104            H104T           1506.5733   .045
  0          2          0          0
H204T           H104T           H103            644.7832    0.01
  0          0          0          0
H205            H105            H105T           .1          0.01
  0          0          0          0
H205T           H105T           H104            2134.9248   .045
  0          3          0          0
H206            H106            H306            .1          0.01
  0          0          0          0
H206O           H106O           H105            2041.3484   .045
  0          1          0          0
H207            H107            H307            .1          0.01
  0          0          0          0
H207O           H107O           H106            1933.7005   .045
  0          0          0          0
H208            H108            H107            1478.4259   .045
  0          0          0          0
H209            H109            H106            2203.3206   .045
  0          4          0          0
H210            H110            H109            953.6393    .045
  0          0          0          0
H211            H111            H110            1329.9975   0.02
  0          19         0          0
H212            H112            H312            .1          0.01
  0          0          0          0
H212O           H112O           H110            1159.6307   .045
  0          2          0          0
H213            H113            H113T           1402.7938   .045
  7          0          0          0
```



```
H213T           H113T           H110            2198.3835   0.02
  0          21         0          0
H214            H114            H113T           1634.653    0.02
  7          0          0          0
L201            L101            117T            .1          0.01
  0          0          0          0
L202            L102            L302            .1          0.01
  0          0          0          0
L202O           L102O           L101            2434.997    .045
  0          11         0          0
L203            L103            L103T           1316.7819   0.02
  5          26         0          0
L203T           L103T           L102            802.7569    0.01
  0          0          0          0
L204            L104            L103T           504.6649    0.02
  0          0          0          0
L205            L105            L305            .1          0.01
  0          0          0          0
L205O           L105O           L104            1238.5648   .045
  0          11.34      0          0
L206            L106            L306            .1          0.01
  0          0          0          0
L206O           L106O           L105            1763.1623   .045
  0          2.34       0          0
L207            L107            L307            .1          0.01
  0          0          0          0
L207O           L107O           L106            741.1105    .045
  0          5          0          0
L208            L108            L107            2003.3637   0.02
  5          5          0          0
L209            L109            L309            .1          0.01
  0          0          0          0
L209O           L109O           L106            2327.0497   .01875
  0          0          0          0
L210            L110            L109            1465.5898   .045
  3          0          0          0
L211            L111            L110            1304.0591   .045
  3          0          0          0
L409O           L109O           L106            2341.3689   0.02
  7          5          0          0
P201            P101            115T            .1          0.01
  0          0          0          0
P202            P102            P101            3199.1447   .045
  0          0          0          0
P203            P103            P303            .1          0.01
  0          0          0          0
P203O           P103O           P102            1090.3406   .045
  0          12         0          0
P204            P104            P103            1294.4691   .045
  0          14         0          0
```

```
P205             P105             P105T            355.5289   0.02
   2         11          0          0
P205T            P105T            P104             1989.3091  .045
   0         14          0          0
P206             P106             P306             .1         0.01
   0          0          0          0
P206O            P106O            P105T            313.1226   0.02
   0          0          0          0
P207             P107             P307             .1         0.01
   0          0          0          0
P207O            P107O            P106             3325.6874  .045
   0         13          0          0
Q201             Q101             Q301             .1         0.01
   0          0          0          0
Q201O            Q101O            H105T            .1         0.01
   0          0          0          0
Q202             Q102             Q101             2844.8716  .045
   5          0          0          0
R201             R101             H104T            .1         0.01
   0          0          0          0
R202             R102             R101             2893.6459  .045
   0          0          0          0
R203             R103             R102             1761.9431  .045
   0          0          0          0
R204             R104             R103             174.4019   0.045
   9          0          0          0
S202             S102             S102T            1917.7185  .045
   4          0          0          0
S202T            S102T            S101             3046.0523  .045
   0          0          0          0
S203             S103             S102             1150.8161  .045
   0          0          0          0
S204             S104             S103             54.8297    0.02
   0          0          0          0
S205             S105             S102             1959.9199  .045
   5          0          0          0
S206             S106             S306             .1         0.01
   0          0          0          0
S206O            S106O            S106T            257.5189   .045
   0          0          0          0
S206T            S106T            S105             1716.4446  .045
   0          0          0          0
S207             S107             S106T            663.6463   .045
   2          0          0          0
S208             S108             S106T            740.3113   .045
   1          0          0          0
S209             S109             S108             983.0275   .045
   0          0          0          0
S210             S110             S110T            352.179    .045
   0          0          0          0
```



```
S210T            S110T            S108             571.8217   .045
   0          0          0          0
S211             S111             S110T            326.4764   .045
   0          0          0          0
S212             S112             S111             1455.2326  .045
   0          0          0          0
S213             S113             S112             2403.2458  .045
   0          3          0          0
S214             S114             S102T            316.7795   .045
   0          0          0          0
S215             S115             S115T            2927.134   .045
   0          0          0          0
S215T            S115T            S114             639.0982   .045
   3.5        0          0          0
S216             S116             S115T            1394.317   .045
   0          0          0          0
S217             S117             S116             1584.8634  .045
   0          0          0          0
S418             S118             S117             3521.7289  0.045
   1.94       0          0          0
S219             S119             S118             211.1342   0.045
   0          0          0          0
S221             S121             S121T            .1         0.01
   0          0          0          0
S221T            S121T            S120             1557.76    .045
   0          0          0          0
S222             S122             S121             1036.9735  .045
   2          4          0          0
S223             S123             S121T            .1         0.01
   0          0          0          0
S224             S124             S123             2302.0966  .045
   8          5          0          0
268              168              165              1604.40    0.01875
   0          22.8       0          0
RP203            RP103            RP101            2378.43    .045
   0          2          0          0
RP202            RP102            RP101            3232.36    0.045
   0          3          0          0
S220             S120             S119             709.42     0.045
   0          0          0          0
S218             S118             103T             2174.02    0.013
   0          0          0          0
D207             D107             D106             3550.4509  0.045
   0          8          0          0
D205             D105             D103             3634.8295  0.045
   0          0          0          0
D203             D103             D102T            60.6336    0.01
   0          0          0          0
D202T            D102T            D101             2435.3387  0.045
   0          6          0          0
```

```
D204            D104            D103            1899.9567  0.045
   0          0          0          0
D202            D102            D102T           114.3819   0.01
   0          0          0          0

[OUTLETS]
;;Name           From Node        To Node          Offset     Type
        QTable/Qcoeff    Qexpon     Gated
;;-------------- ---------------- ---------------- ----------
-------------- ---------------- ---------- --------
518             318             118O            0
TABULAR/DEPTH   PondOutlet518             NO
530             330             130O            0
TABULAR/DEPTH   PondOutlet530             NO
;Detention pond is modeled using storage-discharge information from
2005 MDP. Depth value actually reflects storage, not depth.
539             339             139O            0
TABULAR/DEPTH   PondOutlet539             NO
;Detention pond is modeled using storage-discharge information from
2005 MDP. Depth value actually reflects storage, not depth.
540             340             140O            0
TABULAR/DEPTH   PondOutlet540             NO
;Detention pond is modeled using storage-discharge information from
2005 MDP. Depth value actually reflects storage, not depth.
541             341             141O            0
TABULAR/DEPTH   PondOutlet541             NO
;Detention pond is modeled using storage-discharge information from
2005 MDP. Depth value actually reflects storage, not depth.
542             342             142O            0
TABULAR/DEPTH   PondOutlet542             NO
546             346             146O            0
TABULAR/DEPTH   PondOutlet546             NO
547             347             147O            0
TABULAR/DEPTH   PondOutlet547             NO
;Detention pond is modeled using storage-discharge information from
2005 MDP. Depth value actually reflects storage, not depth.
549             349             149O            0
TABULAR/DEPTH   PondOutlet549             NO
552             352             152O            0
TABULAR/DEPTH   PondOutlet552             NO
;Detention pond is modeled using storage-discharge information from
2005 MDP. Depth value actually reflects storage, not depth.
553             353             153O            0
TABULAR/DEPTH   PondOutlet553             NO
560             360             160O            0
TABULAR/DEPTH   PondOutlet560             NO
565             365             165O            0
TABULAR/DEPTH   PondOutlet565             NO
F504            F304            F104O           0
TABULAR/DEPTH   PondOutletF504            NO
```



```
H503            H303            H103O           0
TABULAR/DEPTH   PondOutletH503            NO
;Detention pond is modeled using storage-discharge information from
2010 Hydrology Update. Depth value actually reflects storage, not
depth.
H506            H306            H106O           0
TABULAR/DEPTH   PondOutletH506            NO
H507            H307            H107O           0
TABULAR/DEPTH   PondOutletH507            NO
H512            H312            H112O           0
TABULAR/DEPTH   PondOutletH512            NO
L502            L302            L102O           0
TABULAR/DEPTH   PondOutletL502            NO
L505            L305            L105O           0
TABULAR/DEPTH   PondOutletL505            NO
L506            L306            L106O           0
TABULAR/DEPTH   PondOutletL506            NO
L507            L307            L107O           0
TABULAR/DEPTH   PondOutletL507            NO
L509            L309            L109O           0
TABULAR/DEPTH   PondOutletL509            NO
;Detention pond is modeled using storage-discharge information from
2010 Hydrology Update. Depth value actually reflects storage, not
depth.
P503            P303            P103O           0
TABULAR/DEPTH   PondOutletP503            NO
P506            P306            P106O           0
TABULAR/DEPTH   PondOutletP506            NO
;Detention pond is modeled using storage-discharge information from
2010 Hydrology Update. Depth value actually reflects storage, not
depth.
P507            P307            P107O           0
TABULAR/DEPTH   PondOutletP507            NO
Q501            Q301            Q101O           0
TABULAR/DEPTH   PondOutletQ501            NO
S506            S306            S106O           0
TABULAR/DEPTH   PondOutletS506            NO

[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3
Geom4      Barrels    Culvert
;;-------------- ------------ ---------------- ---------- ----------
---------- ---------- ----------
202             TRAPEZOIDAL  8                678        5.25
4.33       1
203             DUMMY        0                0          0
0          1
203T            IRREGULAR    203T             0          0
0          1
204             DUMMY        0                0          0
```

```
0          1
204T                IRREGULAR    204T             0          0
0          1
205                 IRREGULAR    205              0          0
0          1
205T                IRREGULAR    205T             0          0
0          1
206                 DUMMY        0                0          0
0          1
206T                CIRCULAR     3.5              0          0
0          1
207                 IRREGULAR    207              0          0
0          1
208                 DUMMY        0                0          0
0          1
208T                IRREGULAR    208T             0          0
0          1
209                 TRAPEZOIDAL  4                33         9.5
8.25       1
210                 DUMMY        0                0          0
0          1
211                 DUMMY        0                0          0
0          1
211T                IRREGULAR    211T             0          0
0          1
212                 DUMMY        0                0          0
0          1
213                 DUMMY        0                0          0
0          1
213T                IRREGULAR    213T             0          0
0          1
214                 DUMMY        0                0          0
0          1
215                 DUMMY        0                0          0
0          1
215T                IRREGULAR    215T             0          0
0          1
216                 DUMMY        0                0          0
0          1
217                 DUMMY        0                0          0
0          1
217T                IRREGULAR    217T             0          0
0          1
218                 DUMMY        0                0          0
0          1
218O                DUMMY        0                0          0
0          1
218T                IRREGULAR    218T             0          0
0          1
219                 TRAPEZOIDAL  6                72.5       8.66
```



```
6.5        1
220                 DUMMY        0                0          0
0          1
220T                TRAPEZOIDAL  7                159        7
15         1
221                 TRAPEZOIDAL  5                1          20
20         1
222                 TRAPEZOIDAL  6                130        10.25
7.75       1
223                 TRAPEZOIDAL  6                8          3.33
3.66       1
223T                IRREGULAR    223T             0          0
0          1
224                 TRAPEZOIDAL  3.5              11         4.33
4.25       1
224T                IRREGULAR    224T             0          0
0          1
225                 TRAPEZOIDAL  1.5              71.5       141.5
30.66      1
225T                IRREGULAR    225T             0          0
0          1
226                 IRREGULAR    226              0          0
0          1
227                 TRAPEZOIDAL  5                1          20
20         1
228                 TRAPEZOIDAL  5                1          20
20         1
229                 DUMMY        0                0          0
0          1
229T                IRREGULAR    229T             0          0
0          1
230                 DUMMY        0                0          0
0          1
230O                DUMMY        0                0          0
0          1
231                 TRAPEZOIDAL  5                1          20
20         1
231T                TRAPEZOIDAL  4                10         4
6.25       1
232                 TRAPEZOIDAL  5                1          20
20         1
233                 TRAPEZOIDAL  5                1          20
20         1
234                 TRAPEZOIDAL  5                8.5        13
14         1
235                 TRAPEZOIDAL  5                1          20
20         1
235T                IRREGULAR    235T             0          0
0          1
236                 TRAPEZOIDAL  5                1          20
```

```
20          1
237                 TRAPEZOIDAL  5                1          20
20          1
238                 TRAPEZOIDAL  5                1          20
20          1
239                 DUMMY        0                0          0
0           1
239O                CIRCULAR     2                0          0
0           1
239T                TRAPEZOIDAL  5                1          20
20          1
240                 DUMMY        0                0          0
0           1
240O                CIRCULAR     2                0          0
0           1
240T                TRAPEZOIDAL  5                1          20
20          1
241                 DUMMY        0                0          0
0           1
241O                CIRCULAR     2.5              0          0
0           1
242                 DUMMY        0                0          0
0           1
242O                CIRCULAR     2                0          0
0           1
243                 TRAPEZOIDAL  5                1          20
20          1
244                 TRAPEZOIDAL  5                1          20
20          1
245                 TRAPEZOIDAL  5                1          20
20          1
246                 DUMMY        0                0          0
0           1
246O                CIRCULAR     2                0          0
0           1
247                 DUMMY        0                0          0
0           1
247O                CIRCULAR     4.5              0          0
0           1
248                 TRAPEZOIDAL  5                1          20
20          1
249                 DUMMY        0                0          0
0           1
249O                CIRCULAR     3                0          0
0           1
250                 TRAPEZOIDAL  5                1          20
20          1
251                 TRAPEZOIDAL  5                1          20
20          1
252                 DUMMY        0                0          0
```



```
0           1
252O                CIRCULAR     4.5              0          0
0           1
253                 DUMMY        0                0          0
0           1
253O                CIRCULAR     2                0          0
0           1
253T                DUMMY        0                0          0
0           1
254                 DUMMY        0                0          0
0           1
255                 TRAPEZOIDAL  3.5              15         8.75
25          1
256                 TRAPEZOIDAL  5                1          20
20          1
256T                IRREGULAR    256T             0          0
0           1
257                 TRAPEZOIDAL  5                1          20
20          1
258                 IRREGULAR    258              0          0
0           1
259                 TRAPEZOIDAL  6                20         10
20          1
260                 DUMMY        0                0          0
0           1
260O                CIRCULAR     5                0          0
0           1
261                 TRAPEZOIDAL  14               10         1.66
3.66        1
262                 TRAPEZOIDAL  3                40.5       5.75
9           1
263                 TRAPEZOIDAL  6                8          10
5.25        1
263T                IRREGULAR    263T             0          0
0           1
264                 IRREGULAR    264              0          0
0           1
265                 DUMMY        0                0          0
0           1
265O                TRAPEZOIDAL  9                6          4
4           1
266                 TRAPEZOIDAL  6                35.5       10.33
6.5         1
267                 TRAPEZOIDAL  3                20         38
50.5        1
468                 TRAPEZOIDAL  5                1          20
20          1
406T                TRAPEZOIDAL  5                1          20
20          1
439O                IRREGULAR    239O             0          0
```

```
0           1
440O                 IRREGULAR    240O           0          0
0           1
441O                 TRAPEZOIDAL  5              1          20
20          1
442O                 TRAPEZOIDAL  5              1          20
20          1
446O                 TRAPEZOIDAL  5              1          20
20          1
447O                 TRAPEZOIDAL  5              1          20
20          1
449O                 TRAPEZOIDAL  5              1          20
20          1
452O                 TRAPEZOIDAL  5              1          20
20          1
453O                 TRAPEZOIDAL  5              1          20
20          1
460O                 TRAPEZOIDAL  5              1          20
20          1
F201                 DUMMY        0              0          0
0           1
F202                 TRAPEZOIDAL  7              48.5       12.5
8.75        1
F203                 TRAPEZOIDAL  10             28         5.25
6.33        1
F204                 DUMMY        0              0          0
0           1
F204O                TRAPEZOIDAL  14             25         8
6           1
F205                 TRAPEZOIDAL  4              21         7
4.75        1
H201                 DUMMY        0              0          0
0           1
H202                 TRAPEZOIDAL  5              12         19.66
12.33       1
H203                 DUMMY        0              0          0
0           1
H203O                TRAPEZOIDAL  17             30         8
9           1
H204                 TRAPEZOIDAL  9              25.5       13
6.25        1
H204T                DUMMY        0              0          0
0           1
H205                 DUMMY        0              0          0
0           1
H205T                TRAPEZOIDAL  9              18         5
6           1
H206                 DUMMY        0              0          0
0           1
H206O                TRAPEZOIDAL  15             30         6
```



```
9           1
H207                 DUMMY        0              0          0
0           1
H207O                TRAPEZOIDAL  4              9          9
9           1
H208                 TRAPEZOIDAL  6              17.5       5.75
7.75        1
H209                 TRAPEZOIDAL  7              8          5.33
5.75        1
H210                 TRAPEZOIDAL  5              28         6.5
6           1
H211                 TRAPEZOIDAL  5              1          20
20          1
H212                 DUMMY        0              0          0
0           1
H212O                TRAPEZOIDAL  15             65         4
4           1
H213                 TRAPEZOIDAL  3              5          12.75
9.5         1
H213T                TRAPEZOIDAL  5              1          20
20          1
H214                 TRAPEZOIDAL  5              1          20
20          1
L201                 DUMMY        0              0          0
0           1
L202                 DUMMY        0              0          0
0           1
L202O                TRAPEZOIDAL  15.00          15         5
5           1
L203                 TRAPEZOIDAL  5              1          20
20          1
L203T                DUMMY        0              0          0
0           1
L204                 TRAPEZOIDAL  5              1          20
20          1
L205                 DUMMY        0              0          0
0           1
L205O                TRAPEZOIDAL  14.00          15         7
5           1
L206                 DUMMY        0              0          0
0           1
L206O                TRAPEZOIDAL  5              15         8
4           1
L207                 DUMMY        0              0          0
0           1
L207O                TRAPEZOIDAL  10.00          15         14
10          1
L208                 TRAPEZOIDAL  5              1          20
20          1
L209                 DUMMY        0              0          0
```

```
0           1
L209O             CIRCULAR     1.5              0           0
0           1
L210              TRAPEZOIDAL  8                15          10
5           1
L211              TRAPEZOIDAL  2                36          4.33
4           1
L409O             TRAPEZOIDAL  5                1           20
20          1
P201              DUMMY        0                0           0
0           1
P202              TRAPEZOIDAL  12               74          15
14.25       1
P203              DUMMY        0                0           0
0           1
P203O             TRAPEZOIDAL  10               6           4
6           1
P204              TRAPEZOIDAL  4                15          4.5
7.66        1
P205              TRAPEZOIDAL  5                1           20
20          1
P205T             TRAPEZOIDAL  6                6.5         4.25
5           1
P206              DUMMY        0                0           0
0           1
P206O             TRAPEZOIDAL  5                1           20
20          1
P207              DUMMY        0                0           0
0           1
P207O             TRAPEZOIDAL  6.00             6           10
4           1
Q201              DUMMY        0                0           0
0           1
Q201O             DUMMY        0                0           0
0           1
Q202              TRAPEZOIDAL  6                11          6
5.66        1
R201              DUMMY        0                0           0
0           1
R202              TRAPEZOIDAL  12               33.5        4
11.25       1
R203              TRAPEZOIDAL  10               10          5
4           1
R204              TRAPEZOIDAL  1                10          165
115         1
S202              TRAPEZOIDAL  4                34          8.5
8.75        1
S202T             IRREGULAR    S202T            0           0
0           1
S203              IRREGULAR    S203             0           0
```



```
0           1
S204              TRAPEZOIDAL  5                1           20
20          1
S205              TRAPEZOIDAL  5                10          14
10          1
S206              DUMMY        0                0           0
0           1
S206O             TRAPEZOIDAL  1.25             70          4
4           1
S206T             TRAPEZOIDAL  3                12          16
15          1
S207              TRAPEZOIDAL  1                48.5        12
34.5        1
S208              TRAPEZOIDAL  10               75.5        13.33
11.33       1
S209              TRAPEZOIDAL  15               63.5        7.33
8.33        1
S210              TRAPEZOIDAL  1                154         5.66
27.66       1
S210T             TRAPEZOIDAL  10               25          8
8           1
S211              TRAPEZOIDAL  10               25          8
8           1
S212              TRAPEZOIDAL  10               25          8
8           1
S213              TRAPEZOIDAL  8                14          7.33
7.5         1
S214              TRAPEZOIDAL  3                51.5        6
10.25       1
S215              TRAPEZOIDAL  1                21.5        9
7.25        1
S215T             IRREGULAR    S215T            0           0
0           1
S216              TRAPEZOIDAL  5                130         10
15          1
S217              IRREGULAR    S217             0           0
0           1
S418              TRAPEZOIDAL  5                105         10
10          1
S219              TRAPEZOIDAL  10               50          4
4           1
S221              DUMMY        0                0           0
0           1
S221T             TRAPEZOIDAL  4                16.5        7.25
27.5        1
S222              TRAPEZOIDAL  9                31.5        5
5           1
S223              DUMMY        0                0           0
0           1
S224              TRAPEZOIDAL  9                22          5.25
```

```
8.5         1
268                 CIRCULAR     4                0          0
0           1
RP203               TRAPEZOIDAL  2                100        50
50          1
RP202               TRAPEZOIDAL  2                60         100
100         1
S220                TRAPEZOIDAL  4                16.5       7.25
27.5        1
S218                CIRCULAR     3                0          0
0           1
D207                TRAPEZOIDAL  6                20         4
4           1
D205                TRAPEZOIDAL  7                100        6
5           1
D203                DUMMY        0                0          0
0           1
D202T               TRAPEZOIDAL  6                4          2
14          1
D204                TRAPEZOIDAL  4                6          30
3           1
D202                DUMMY        0                0          0
0           1

[TRANSECTS]
;;Transect Data in HEC-2 format
;
;203T
NC .045     .045     .045
X1 203T              9        256      275.5    0.0      0.0      0.0
     0.0      0.0
GR 11       0        6        122      5        164.5    5
219.5    2        256
GR 0        261.5    0        267.5    3        275.5    11       351

;
;204T
NC .045     .045     .045
X1 204T              11       129.5    164.5    0.0      0.0      0.0
     0.0      0.0
GR 16       0        11       48       5        129.5    1        148
     0        151.5
GR 1        155      3        158.5    4        164.5    11       324
     11       424
GR 16       577
;
;205
NC .045     .045     .045
X1 205               5        13       26.5     0.0      0.0      0.0
     0.0      0.0
```



```
GR 3        0        2        13       0        18       2
26.5     3        70.5
;
;205T
NC .045     .045     .045
X1 205T              8        128.65   187.24   0.0      0.0      0.0
     0.0      0.0
GR 15       0        5        119.89   4        128.65   0
143.88   0        151.08
GR 0        161.56   3        187.24   10.5     336.7
;
;207
NC 0.045    0.045    .045
X1 207               6        82.5     105.5    0.0      0.0      0.0
     0.0      0.0
GR 5        0        3        82.5     0        92       0        96
     4        105.5
GR 5        119
;
;208T
NC .045     .045     .045
X1 208T              12       177      213      0.0      0.0      0.0
     0.0      0.0
GR 16       0        8        126.5    7        167.5    5        177
     4        189.5
GR 1        195.5    0        198      1        202      4        207
     5        213
GR 10       353      16       487
;
;211T
NC 0.045    .045     .045
X1 211T              9        238      265.5    0.0      0.0      0.0
     0.0      0.0
GR 14       0        9        133      5        218.5    4        238
     0        249
GR 0        254      7        265.5    8        286.5    14
321.5
;
;213T
NC .045     .045     .045
X1 213T              12       182.5    261.5    0.0      0.0      0.0
     0.0      0.0
GR 13       0        10       31.5     9        53.5     5
182.5    2        229
GR 0        234      0        243.5    2        247      6
261.5    8        286.5
GR 9        320      13       375
;
;215T
NC .045     .045     .045
```

```
X1 215T          9        250      288.5    0.0      0.0      0.0
     0.0      0.0
GR 15      0        11       64       9        162.5    8        250
     0        267
GR 0       274      6        288.5    11       416.5    15       498

;
;217T
NC .045    .045     .045
X1 217T          8        50.02    101.85   0.0      0.0      0.0
     0.0      0.0
GR 12      0        11       22.46    10       50.02    4
62.44    0        78.7
GR 0       90.47    6        101.85   13       143.86
;
;218T
NC .045    .045     .045
X1 218T          8        83.5     332      0.0      0.0      0.0
     0.0      0.0
GR 13      0        6        52       5        83.5     1
100.5    0        260
GR 0       281      7        332      13       349
;
;223T
NC .045    0.045    .045
X1 223T          17       360      546.5    0.0      0.0      0.0
     0.0      0.0
GR 23      0        21       16.5     20       74       18       119
     18       256.5
GR 16      271      16       360      2        396.5    0        401
     2        405.5
GR 3       444      6        452      10       495.5    11
516.5    18       546.5
GR 20      565.5    23       714
;
;224T
NC .045    .045     .045
X1 224T          9        90.5     164.5    0.0      0.0      0.0
     0.0      0.0
GR 20      0        18       71       16       90.5     1
150.5    0        153
GR 1       156      6        164.5    18       297      20       386

;
;225T
NC .045    .045     .045
X1 225T          16       418.5    475      0.0      0.0      0.0
     0.0      0.0
GR 24      0        22       17.5     21       58.5     21
235.5    20       281.5
```



```
GR 19      291.5    18       369.5    13       418.5    1        436
     0        440
GR 1       443      11       457.5    12       475      18       537
     21       588.5
GR 24      758
;
;226
NC .045    .045     .045
X1 226           6        32       87       0.0      0.0      0.0
     0.0      0.0
GR 8       0        4        32       0        58       0        63
     7        87
GR 8       101
;
;229T
NC .045    .045     .045
X1 229T          16       418.5    475      0.0      0.0      0.0
     0.0      0.0
GR 24      0        22       17.5     21       58.5     21
235.5    20       281.5
GR 19      291.5    18       369.5    13       418.5    1        436
     0        440
GR 1       443      11       457.5    12       475      18       537
     21       588.5
GR 24      758
;
;235T
NC .045    .045     .045
X1 235T          7        23       83.5     0.0      0.0      0.0
     0.0      0.0
GR 11      0        6        23       3        44       0
54.5     2        70.5
GR 4       83.5     11       115.5
;
;239O
NC .045    .045     .045
X1 239O          6        28       55.5     0.0      0.0      0.0
     0.0      0.0
GR 4       0        3        28       0        41       0
44.5     3        55.5
GR 4       69
;
;240O
NC .045    .045     .045
X1 240O          5        0.0      113      0.0      0.0      0.0
     0.0      0.0
GR 2.5     0        1        36.5     0        60       0        72
     2.5      113
;
;256T
```

```
NC .045     .045     .045
X1 256T              8        156      241      0.0      0.0      0.0
     0.0      0.0
GR 6        0        5        8.5      5        60       5        156
     3        190.5
GR 0        212.5    0        227      6        241
;
;258
NC .045     .045     .045
X1 258               7        376.5    1318     0.0      0.0      0.0
     0.0      0.0
GR 5        0        3        92       2        376.5    0
1060.5   0        1070
GR 1        1318     5        1362
;
;263T
NC .045     .045     .045
X1 263T              8        109      197.5    0.0      0.0      0.0
     0.0      0.0
GR 9        0        5        109      0        146.5    0
175.5    3        197.5
GR 6        259.5    7        421.5    9        455
;
;264
NC .045     .045     .045
X1 264               6        134      626.5    0.0      0.0      0.0
     0.0      0.0
GR 7        0        1        134      0        433      0        447
     4        626.5
GR 7        639
;
;S202T
NC .045     .045     .045
X1 S202T             9        202      490.5    0.0      0.0      0.0
     0.0      0.0
GR 17       0        13       11       13       77       12
150.5    5        202
GR 0        215.5    0        479      7        490.5    17
612.5
;
;S203
NC .045     .045     .045
X1 S203              5        0        208      0.0      0.0      0.0
     0.0      0.0
GR 5        0        0        9        0        157      4
165.5    5        208
;
;S215T
NC .045     .045     .045
X1 S215T             8        123.5    230      0.0      0.0      0.0
```



```
     0.0      0.0
GR 8        0        3.5      41.5     3.5      123.5    0.5
142.5    0        170
GR 0.5      199      2.5      230      8        284.5
;
;S217
NC .045     .045     .045
X1 S217              6        0        300      0.0      0.0      0.0
     0.0      0.0
GR 5        0        0        21       0        44       4        219
     4        270
GR 5        300

[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
;Low Flow Diversion
S118_Diversion   Diversion  0          0
S118_Diversion              9.6        0
S118_Diversion              31         0
S118_Diversion              104        58
S118_Diversion              158.4      108.4
S118_Diversion              211.8      158.8
S118_Diversion              264.2      209.2
S118_Diversion              321        266
S118_Diversion              365        310
S118_Diversion              600        545
;
;PondOutlet539 - Detention pond is modeled using storage-discharge
information from 2005 MDP. Head value actually reflects storage, not
head.
PondOutlet539    Rating     0          0
PondOutlet539               .26        6.2
PondOutlet539               .48        9.8
PondOutlet539               1.06       11
PondOutlet539               2.16       13
PondOutlet539               3.32       300
PondOutlet539               3.99       600
;
;PondOutlet540 - Detention pond is modeled using storage-discharge
information from 2005 MDP. Head value actually reflects storage, not
head.
PondOutlet540    Rating     0          0
PondOutlet540               .07        2
PondOutlet540               .63        2
PondOutlet540               1.69       2
PondOutlet540               3.19       2
PondOutlet540               3.64       200
PondOutlet540               5.02       600
;
```

```
;PondOutlet541 - Detention pond is modeled using storage-discharge
information from 2005 MDP. Head value actually reflects storage, not
head.
PondOutlet541    Rating     0          0
PondOutlet541               .01        4.4
PondOutlet541               .61        16
PondOutlet541               2          22
PondOutlet541               2.9        450
;
;PondOutlet542 - Detention pond is modeled using storage-discharge
information from 2005 MDP. Head value actually reflects storage, not
head.
PondOutlet542    Rating     0          0
PondOutlet542               .01        86.6
PondOutlet542               1.01       150
PondOutlet542               4.61       943
;
;PondOutlet552
PondOutlet552    Rating     0.00       0.00
PondOutlet552               0.66       2.50
PondOutlet552               1.66       14.00
PondOutlet552               2.66       29.70
PondOutlet552               3.66       45.70
PondOutlet552               4.66       58.20
PondOutlet552               5.66       66.12
PondOutlet552               6.16       66.62
PondOutlet552               6.66       284.59
;
;PondOutlet546
PondOutlet546    Rating     0          0.04
PondOutlet546               1          2.88
PondOutlet546               2          4.8
PondOutlet546               3          6.13
PondOutlet546               4          7.25
PondOutlet546               5          8.21
PondOutlet546               6          9.07
PondOutlet546               7          9.85
PondOutlet546               8          471.34
PondOutlet546               9          2286.81
;
;PondOutlet547
PondOutlet547    Rating     0          0
PondOutlet547               0.18       0.17
PondOutlet547               1.18       5.5
PondOutlet547               2.18       14
PondOutlet547               3.18       21
PondOutlet547               4.18       26
PondOutlet547               5          30
PondOutlet547               5.18       30.88
PondOutlet547               5.88       34.29
```



```
PondOutlet547               7.18       194.13
PondOutlet547               8.18       835.46
;
;PondOutlet549 - Detention pond is modeled using storage-discharge
information from 2005 MDP. Head value actually reflects storage, not
head.
PondOutlet549    Rating     0          0
PondOutlet549               .03        4.9
PondOutlet549               .75        28.2
PondOutlet549               2.47       250
PondOutlet549               2.6        310
PondOutlet549               2.73       324
PondOutlet549               3.049      1214.51
;
;PondOutlet553 - PondOutlet549 - Detention pond is modeled using
storage-discharge information from 2005 MDP. Head value actually
reflects storage, not head.
PondOutlet553    Rating     0          0
PondOutlet553               .19        8.7
PondOutlet553               1.1        17.5
PondOutlet553               1.58       60
PondOutlet553               1.59       100
;
;PondOutlet560
PondOutlet560    Rating     0.0        0.0
PondOutlet560               0.9        5.1
PondOutlet560               1.9        26.0
PondOutlet560               2.9        54.3
PondOutlet560               3.9        87.3
PondOutlet560               4.9        124.1
PondOutlet560               5.9        158.0
PondOutlet560               6.9        187.1
PondOutlet560               7.9        212.0
PondOutlet560               8.9        309.1
PondOutlet560               9.9        541.2
PondOutlet560               10.9       949.5
;
;PondOutlet565
PondOutlet565    Rating     0.00       0.00
PondOutlet565               0.83       13.61
PondOutlet565               1.83       24.82
PondOutlet565               2.83       32.36
PondOutlet565               3.83       38.44
PondOutlet565               4.83       43.69
PondOutlet565               5.83       48.37
PondOutlet565               6.83       52.63
PondOutlet565               7.83       56.58
PondOutlet565               8.35       58.52
PondOutlet565               8.83       87.08
PondOutlet565               9.33       140.27
```

```
PondOutlet565                9.55       170.34
PondOutlet565                9.83       244.64
PondOutlet565                9.93       312.28
PondOutlet565                10.08      452.52
;
;PondOutletF504
PondOutletF504   Rating      0          0
PondOutletF504               0.55       3.33
PondOutletF504               2.55       33.21
PondOutletF504               3.55       49.54
PondOutletF504               4.55       60.43
PondOutletF504               5.55       69.64
PondOutletF504               6.55       77.76
PondOutletF504               7.55       85.11
PondOutletF504               8.32       90.36
PondOutletF504               8.55       102.03
PondOutletF504               9.55       167.72
PondOutletF504               10.55      174.5
PondOutletF504               11.55      181.01
PondOutletF504               12.38      186.25
PondOutletF504               12.55      196.82
PondOutletF504               13.55      594.16
;
;PondOutletH503
PondOutletH503   Rating      0.00       0
PondOutletH503               2.00       2
PondOutletH503               2.50       3
PondOutletH503               3.55       208
PondOutletH503               4.00       320
PondOutletH503               6.00       650
PondOutletH503               8.00       1300
PondOutletH503               10.00      3500
;
;PondOutletQ501
PondOutletQ501   Rating      0          0
PondOutletQ501               0.2        0
PondOutletQ501               1.2        0.07
PondOutletQ501               2.2        0.18
PondOutletQ501               3.2        0.31
PondOutletQ501               4.2        0.47
PondOutletQ501               5.2        0.65
PondOutletQ501               6.2        5.22
PondOutletQ501               7.2        26.01
PondOutletQ501               8.2        256.4
;
;PondOutletH506 - Detention pond is modeled using storage-discharge
information from 2010 Hydrology Update. Head value actually reflects
storage, not head.
PondOutletH506   Rating      0          0
PondOutletH506               5.3        38
```



```
PondOutletH506               13.4       162
PondOutletH506               17.8       244
PondOutletH506               22.1       325
PondOutletH506               31.6       513
PondOutletH506               38.9       676
PondOutletH506               41.9       731
PondOutletH506               53.1       1101
PondOutletH506               65         1796
;
;PondOutletH507
PondOutletH507   Rating      0.00       0
PondOutletH507               2.00       13
PondOutletH507               4.00       26
PondOutletH507               6.00       35
PondOutletH507               8.00       40
PondOutletH507               8.48       42
PondOutletH507               10.00      66
PondOutletH507               11.00      92
PondOutletH507               12.00      306
PondOutletH507               13.00      520
;
;PondOutletH512
PondOutletH512   Rating      0          0
PondOutletH512               0.9        0
PondOutletH512               1.9        0.1
PondOutletH512               2.9        0.2
PondOutletH512               3.9        6.6
PondOutletH512               4.9        18.1
PondOutletH512               5.15       21.6
PondOutletH512               5.9        54.5
PondOutletH512               7.4        121.3
PondOutletH512               8.15       295
PondOutletH512               9.4        492.6
PondOutletH512               9.9        571.64
;
;PondOutletP503 - Detention pond is modeled using storage-discharge
information from 2010 Hydrology Update. Head value actually reflects
storage, not head.
PondOutletP503   Rating      0.00       0
PondOutletP503               2.79       0
PondOutletP503               5.29       75
PondOutletP503               9.39       289
PondOutletP503               13.69      583
PondOutletP503               15.59      725
PondOutletP503               22.09      955
PondOutletP503               33.59      1424
;
;PondOutletP507 - Detention pond is modeled using storage-discharge
information from 2010 Hydrology Update. Head value actually reflects
storage, not head.
```

```
PondOutletP507   Rating     0.000      0.0
PondOutletP507              0.249      0.4
PondOutletP507              0.393      2.0
PondOutletP507              0.781      4.2
PondOutletP507              1.240      5.0
PondOutletP507              1.296      23.7
PondOutletP507              1.908      25.0
PondOutletP507              1.977      75.0
PondOutletP507              2.850      80.0
;
;PondOutletP506
PondOutletP506   Rating     0.00       0
PondOutletP506              1.00       2
PondOutletP506              2.00       5
PondOutletP506              3.00       6
PondOutletP506              4.00       31
PondOutletP506              5.00       35
PondOutletP506              6.00       39
PondOutletP506              7.00       44
PondOutletP506              7.15       45
PondOutletP506              8.00       255
;
;PondOutletL506
PondOutletL506   Rating     0.00       0
PondOutletL506              0.79       8
PondOutletL506              2.79       33
PondOutletL506              4.79       58
PondOutletL506              6.10       71
PondOutletL506              6.79       75
PondOutletL506              7.79       84
PondOutletL506              7.99       85
PondOutletL506              8.79       228
PondOutletL506              10.79      1008
;
;PondOutletL505
PondOutletL505   Rating     0          0.00
PondOutletL505              0.57       6.00
PondOutletL505              1.57       34.00
PondOutletL505              2.57       63.07
PondOutletL505              3.57       72.82
PondOutletL505              4.57       81.43
PondOutletL505              5.57       89.15
PondOutletL505              5.65       89.74
PondOutletL505              6.57       96.33
PondOutletL505              7.57       102.98
PondOutletL505              7.83       104.60
PondOutletL505              8.57       401.56
PondOutletL505              9.57       1709.57
;
;PondOutletL502
```



```
PondOutletL502   Rating     0.00       0
PondOutletL502              1.85       3.9
PondOutletL502              2.40       5.3
PondOutletL502              3.85       320
PondOutletL502              4.40       620
PondOutletL502              5.85       1500
;
;PondOutletL509
PondOutletL509   Rating     0.00       0
PondOutletL509              2.00       9
PondOutletL509              4.00       15
PondOutletL509              6.00       20
PondOutletL509              7.75       23
PondOutletL509              8.00       39
PondOutletL509              10.00      786
;
;PondOutletL507
PondOutletL507   Rating     0.00       0
PondOutletL507              1.46       8
PondOutletL507              3.46       17
PondOutletL507              5.46       23
PondOutletL507              6.40       26
PondOutletL507              7.46       190
PondOutletL507              8.46       1126
;
;PondOutletS518
PondOutletS518   Rating     0          0
PondOutletS518              0.4        0.01
PondOutletS518              1.4        0.06
PondOutletS518              2.4        0.12
PondOutletS518              3.4        0.17
PondOutletS518              4.4        10.54
PondOutletS518              5.4        25.87
PondOutletS518              6.4        63.3
PondOutletS518              7.4        78.58
PondOutletS518              8.4        842.72
;
;PondOutlet530
PondOutlet530    Rating     0          0.08
PondOutlet530               1          1.74
PondOutlet530               2          2.64
PondOutlet530               3          3.31
PondOutlet530               4          3.86
PondOutlet530               5          5.81
PondOutlet530               7          93.17
PondOutlet530               8.5        538.23
PondOutlet530               9          794.04
;
;PondOutletR503
PondOutletR503   Rating     0          0
```

```
PondOutletR503              0.02        13
PondOutletR503              0.51        26
PondOutletR503              2.88        35
PondOutletR503              6.98        40
PondOutletR503              8.07        42
PondOutletR503              11.69       66
PondOutletR503              14.23       92
PondOutletR503              16.93       306
;
;PondOutletS506
PondOutletS506   Rating     0           0
PondOutletS506              0.45        0.04
PondOutletS506              1.45        0.16
PondOutletS506              2.45        0.33
PondOutletS506              3.45        0.53
PondOutletS506              4.45        0.76
PondOutletS506              5.45        4.00
PondOutletS506              6.45        33.91
PondOutletS506              7.45        36.68
PondOutletS506              8.05        57.25
PondOutletS506              9.25        416.9
;
;PondOutlet518
PondOutlet518    Rating     0           0
PondOutlet518               0.5         12.17
PondOutlet518               1           17.21
PondOutlet518               1.5         21.08
PondOutlet518               2           24.34
PondOutlet518               2.5         27.22
PondOutlet518               3           29.81
PondOutlet518               3.5         32.2
PondOutlet518               4           34.43
PondOutlet518               4.5         36.52
PondOutlet518               5           38.49
PondOutlet518               5.2         39.25
PondOutlet518               5.5         46.24
PondOutlet518               6           67.71
PondOutlet518               6.5         96.8
PondOutlet518               7           131.76
PondOutlet518               8.4         729.648
;
;Pond346
Pond346          Storage    0           29870
Pond346                     1           39334
Pond346                     2           42911
Pond346                     3           46025
Pond346                     4           49069
Pond346                     5           52212
Pond346                     6           55556
Pond346                     7           59229
```



```
Pond346                     8           63790
Pond346                     9           77308
;
;Pond347
Pond347          Storage    0           300.00
Pond347                     0.18        11068.88
Pond347                     1.18        74488.40
Pond347                     2.18        141171.92
Pond347                     3.18        211119.44
Pond347                     4.18        284330.96
Pond347                     5           346800.00
Pond347                     5.18        348760.47
Pond347                     5.88        356923.70
Pond347                     7.18        398314.78
Pond347                     8.18        525050.75
;
;PondQ301
PondQ301         Storage    0           0
PondQ301                    0.2         500
PondQ301                    1.2         3250
PondQ301                    2.2         7500
PondQ301                    3.2         11250
PondQ301                    4.2         19250
PondQ301                    5.2         25000
PondQ301                    6.2         34500
PondQ301                    7.2         37500
PondQ301                    8.2         48000
;
;PondH312
PondH312         Storage    0           71
PondH312                    0.9         20641
PondH312                    1.9         29682
PondH312                    2.9         32820
PondH312                    3.9         36057
PondH312                    4.9         39394
PondH312                    5.9         42830
PondH312                    6.9         46365
PondH312                    7.9         50466
PondH312                    8.9         53000
PondH312                    9.9         97158
;
;PondS318
PondS318         Storage    0           10
PondS318                    0.4         320
PondS318                    1.4         4911
PondS318                    2.4         7178
PondS318                    3.4         9089
PondS318                    4.4         11162
PondS318                    5.4         13757
PondS318                    6.4         42621
```

```
PondS318                7.4         79155
PondS318                8.4         112260
;
;Pond318
Pond318         Storage 0           0.0
Pond318                 0.5         2613.6
Pond318                 1           5662.8
Pond318                 1.5         10890.0
Pond318                 2           23086.8
Pond318                 2.5         35283.6
Pond318                 3           53578.8
Pond318                 3.5         62726.4
Pond318                 4           76230.0
Pond318                 4.5         89733.6
Pond318                 5           100188.0
Pond318                 5.5         110206.8
Pond318                 6           115869.6
Pond318                 6.5         121096.8
Pond318                 7           123710.4
Pond318                 7.5         125888.4
Pond318                 8.4         129808.8
;
Pond330         Storage 0           5
Pond330                 1           4325
Pond330                 2           17888
Pond330                 3           31450
Pond330                 4           37325
Pond330                 5           43200
Pond330                 7           51075
Pond330                 8.5         57075
Pond330                 9           59347
;
PondF304        Storage 0           0
PondF304                0.55        602
PondF304                2.55        6054
PondF304                3.55        19300
PondF304                4.55        32913
PondF304                5.55        46129
PondF304                6.55        56213
PondF304                7.55        63683
PondF304                8.32        68770
PondF304                8.55        70290
PondF304                9.55        76466
PondF304                10.55       82569
PondF304                11.55       89748
PondF304                12.38       96410
PondF304                12.55       97774
PondF304                13.55       108182
;
PondH303        Storage 0.00        37206
```



```
PondH303                2.00        87388
PondH303                2.50        103086
PondH303                3.55        136053
PondH303                4.00        150181
PondH303                6.00        211321
PondH303                8.00        297182
PondH303                10.00       378752
;
PondH307        Storage 0.00        50
PondH307                2.00        881
PondH307                4.00        26750
PondH307                6.00        81299
PondH307                8.00        97665
PondH307                8.48        100029
PondH307                10.00       107403
PondH307                11.00       113854
PondH307                12.00       121037
PondH307                13.00       128517
;
PondL302        Storage 0.00        63063
PondL302                1.85        119940
PondL302                2.40        127177
PondL302                3.85        146258
PondL302                4.40        154977
PondL302                5.85        177962
;
PondL305        Storage 0           0
PondL305                0.57        337
PondL305                1.57        3455
PondL305                2.57        10587
PondL305                3.57        15658
PondL305                4.57        25877
PondL305                5.57        51105
PondL305                5.65        52292.2
PondL305                6.57        65945
PondL305                7.57        81299
PondL305                7.83        84634.8
PondL305                8.57        94129
PondL305                9.57        118228
;
PondL306        Storage 0.00        50
PondL306                0.79        13680
PondL306                2.79        42966
PondL306                4.79        65238
PondL306                6.10        79498
PondL306                6.79        87711
PondL306                7.79        99777
PondL306                7.99        100845
PondL306                8.79        109121
PondL306                10.79       138819
```

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;
PondL307        Storage    0.00      0
PondL307                   1.46      26188
PondL307                   3.46      52058
PondL307                   5.46      65342
PondL307                   6.40      71906
PondL307                   7.46      82145
PondL307                   8.46      89834
;
PondL309        Storage    0.00      50
PondL309                   2.00      37253
PondL309                   4.00      78616
PondL309                   6.00      112598
PondL309                   7.75      135547
PondL309                   8.00      138875
PondL309                   10.00     162093
;
PondP306        Storage    0.00      50
PondP306                   1.00      2640
PondP306                   2.00      12975
PondP306                   3.00      39850
PondP306                   4.00      80936
PondP306                   5.00      93173
PondP306                   6.00      106976
PondP306                   7.00      125748
PondP306                   7.15      131789
PondP306                   8.00      165499
;
PondS306        Storage    0         0
PondS306                   0.45      1193
PondS306                   1.45      9296
PondS306                   2.45      22150
PondS306                   3.45      35115
PondS306                   4.45      45111
PondS306                   5.45      53393
PondS306                   6.45      60551
PondS306                   7.45      67225
PondS306                   8.05      69995
PondS306                   9.25      75535
;
Pond365         Storage    0.00      0
Pond365                    0.83      84
Pond365                    1.83      1606
Pond365                    2.83      12098
Pond365                    3.83      49245
Pond365                    4.83      113232
Pond365                    5.83      173884
Pond365                    6.83      201738
Pond365                    7.83      217133
Pond365                    8.35      226186
```



```
Pond365                    8.83      234543
Pond365                    9.33      248793
Pond365                    9.55      255063
Pond365                    9.83      263043
Pond365                    9.93      269051
Pond365                    10.08     278063.15
;
Pond352         Storage    0         0.00
Pond352                    0.66      1234661.00
Pond352                    1.66      1745128.67
Pond352                    2.66      2326389.42
Pond352                    3.66      2657371.07
Pond352                    4.66      2907598.14
Pond352                    5.66      3151919.27
Pond352                    6.16      3254271.46
Pond352                    6.66      3356623.65
;
Pond360         Storage    0.0       0.0
Pond360                    0.9       1133.3
Pond360                    1.9       34428.0
Pond360                    2.9       248937.8
Pond360                    3.9       424911.6
Pond360                    4.9       557573.8
Pond360                    5.9       691668.1
Pond360                    6.9       823988.7
Pond360                    7.9       973891.0
Pond360                    8.9       1097228.4
Pond360                    9.9       1202987.1
Pond360                    10.9      1285291.3

[REPORT]
;;Reporting Options
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]

[MAP]
DIMENSIONS -2727.273 0.000 12727.273 10000.000
Units      None

[COORDINATES]
;;Node          X-Coord            Y-Coord
;;-------------- ------------------ ------------------
102             10673.572          4623.359
103             9567.639           4841.293
103T            9629.441           4880.326
104             9414.760           4870.568
104T            9440.782           4912.853
```

105	8689.398	4766.480
105T	8946.365	4782.744
106	8932.987	4712.037
107	9138.277	4730.700
108	8227.508	4246.041
108T	8289.310	4246.041
109	7713.575	4750.216
110	8286.058	4213.513
111	7580.212	3670.305
111T	7625.751	3660.547
112	7629.003	3631.272
113	7368.784	3689.821
113T	7388.300	3647.536
114	7365.531	3618.261
115	7125.399	3661.651
115T	7180.125	3667.052
116	7111.817	3628.019
117	6406.194	3662.750
117T	6431.993	3663.799
118	5849.752	3442.613
118O	5853.518	3529.412
118T	5885.532	3621.514
119	5140.654	3481.646
120	4922.720	3439.360
120T	4958.500	3481.646
121	4782.852	2444.020
122	4629.973	3494.657
123	4408.786	3536.942
123T	4405.533	3481.646
124	4145.314	3569.470
124T	4158.325	3510.921
125	4034.721	3445.866
125T	4073.753	3527.184
126	3764.743	2434.262
127	3377.666	2398.482
128	2964.568	2125.251
129	4026.794	3533.600
129T	4042.651	3518.888
130	3999.024	3615.626
130O	4017.032	3568.866
131	3891.600	4691.667
131T	3899.125	3608.039
132	2980.831	5778.083
133	3172.743	3572.723
134	3189.007	3507.668
135	2964.568	3562.964
135T	3036.128	3510.921
136	2972.211	4102.693
137	2957.857	5105.669
138	2952.474	5774.918

139	2667.191	5087.727
139T	2546.978	4601.490
140	2285.020	5127.200
140T	2324.493	4594.313
141	2593.628	5547.051
142	2186.337	5941.782
143	2155.835	5035.694
144	2067.917	5322.772
145	2954.809	3510.921
146	2301.008	3455.624
147	2216.436	3006.745
148	2206.678	2395.229
149	1780.569	2261.867
150	1630.942	2235.845
151	1858.634	2954.701
152	1927.967	3885.591
153	1913.613	5066.196
153T	1789.811	4084.751
154	1398.668	4427.449
155	1009.320	4441.803
156	680.975	4680.436
156T	724.037	4662.494
157	8.138	4624.815
158	1457.878	3873.031
159	1899.260	3512.390
160	1258.718	3035.124
161	666.621	3171.486
162	492.581	3517.773
163	194.738	3271.963
163T	379.544	3194.811
164	-356.092	3542.892
165	-817.210	3058.449
165O	-601.583	3282.885
166	-1500.812	3015.388
167	-138.989	2416.114
F101	9573.285	4931.686
F102	9154.300	5412.505
F103	8861.890	5758.964
F104	8288.911	6257.906
F104O	8388.700	6225.716
F105	7764.217	6995.053
H101	9383.365	4951.000
H102	8636.561	5105.511
H103	7902.634	5343.715
H103O	7989.546	5314.745
H104	7358.626	5552.949
H104T	7909.072	5478.913
H105	6579.632	5855.533
H105T	6627.917	5839.439
H106	5893.989	6383.446

H106O	5935.836	6254.687
H107	5604.731	7053.662
H107O	5701.420	6969.584
H108	5306.257	7339.525
H109	5434.475	6952.769
H110	5117.083	7158.758
H111	5108.675	7690.548
H112	4690.391	7558.126
H112O	4751.347	7459.335
H113	3975.733	7146.147
H113T	4417.139	6935.954
H114	3748.725	6963.279
L101	6433.984	3759.400
L102	5862.737	4537.914
L102O	5938.566	4459.557
L103	5119.611	4727.487
L103T	5635.249	4631.437
L104	5554.365	4724.959
L105	5036.198	5147.075
L105O	5139.832	5093.995
L106	4409.343	5366.980
L106O	4507.921	5331.593
L107	4035.253	5402.367
L107O	4133.831	5374.563
L108	3726.880	5923.061
L109	4095.916	6132.855
L110	3635.885	6380.564
L111	3185.965	6597.941
P101	7144.251	3736.652
P102	6423.873	4730.015
P103	5956.260	5040.915
P103O	6054.838	4960.030
P104	5612.501	5286.096
P105	5084.224	6074.720
P105T	5210.606	5986.252
P106	5048.837	5915.478
P106O	5089.279	5996.363
P107	4113.609	6453.866
P107O	4131.303	6370.454
Q101	6544.223	6016.483
Q101O	6615.041	5894.161
Q102	6302.800	6962.863
R101	7902.634	5527.197
R102	7348.969	6338.381
R103	7149.392	7043.338
R104	7133.297	7149.564
S102	11127.656	6541.635
S102T	11663.757	6043.828
S103	11113.297	6977.217
S104	11089.364	7025.083

S105	10467.104	6163.493
S106	9926.217	6584.715
S106O	10041.096	6690.020
S106T	10103.322	6766.606
S107	10160.761	7001.150
S108	9907.070	6982.004
S109	9696.460	7355.359
S110	9552.861	7001.150
S110T	9682.100	7082.522
S111	9572.008	7144.748
S112	9069.413	7537.251
S113	8341.848	8111.644
S114	11620.677	5900.229
S115	10285.704	5926.663
S115T	11375.615	5811.066
S116	11188.459	5409.230
S117	10858.183	5563.359
S119	9559.096	5992.718
S121	9206.802	6664.280
S121T	9261.848	6548.683
S122	9019.645	7005.565
S123	9157.260	6598.224
S124	8436.157	7033.088
RP102	11362.512	7375.650
RP103	11719.228	8015.130
S120	9495.842	6116.285
D102T	11605.817	4045.184
D102	11538.768	4082.433
D103	11538.768	4011.659
D104	10879.453	4123.407
D105	10812.404	3538.591
D107	10793.779	3262.945
101	11843.531	5191.063
S101	12376.962	6259.225
S125	12194.164	5925.926
RP101	12715.425	7993.379
D101	12344.718	3795.052
D106	12057.287	3270.346
D108	11996.936	2994.749
106T	8923.596	4737.205
139O	2592.775	4794.289
140O	2307.594	4812.113
141O	2378.889	5296.921
142O	2450.185	5696.175
146O	2671.200	3510.973
147O	2254.122	3236.486
149O	2050.301	2330.828
152O	2336.112	3764.072
153O	1799.760	4685.916
160O	1622.453	3309.866

```
L109O           4181.856          6046.916
168             -1472.105         2416.114
S118            9663.684          5899.140
318             5859.209          3485.755
330             4009.121          3594.575
339             2628.423          4958.268
340             2300.464          4986.786
341             2496.527          5453.771
342             2293.335          5831.636
346             2446.620          3475.326
347             2225.604          3086.766
349             1911.540          2292.283
352             2157.874          3813.978
353             1857.577          4886.349
360             1410.457          3163.396
365             -705.654          3174.959
F304            8333.977          6245.030
H303            7928.385          5314.745
H306            5907.410          6320.087
H307            5640.464          7013.725
H312            4719.818          7503.476
L302            5895.596          4497.472
L305            5099.390          5139.493
L306            4449.786          5344.231
L307            4088.333          5387.201
L309            4133.831          6092.413
P303            6001.757          4995.417
P306            5064.003          5960.976
P307            4098.444          6405.841
Q301            6592.508          5958.541
S306            9978.870          6627.794

[VERTICES]
;;Link          X-Coord           Y-Coord
;;-------------- ------------------ ------------------
213T            7576.381          3628.371
217T            7054.099          3657.280
239O            2591.036          4059.917
239O            2952.371          4078.352
242O            2562.409          5608.071
246O            2839.785          3477.841
247O            2237.760          3369.088
249O            2181.768          2404.410
253O            2122.774          4756.778
406T            8951.611          4756.554
452O            2733.384          3579.000
460O            1613.955          3495.791
L209O           4460.045          5779.915
P207O           4889.595          5832.066
```

EPA SWMM 5.1

100-YEAR FUTURE CONDITIONS OUTPUT

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

WARNING 04: minimum elevation drop used for Conduit 203
WARNING 04: minimum elevation drop used for Conduit 204
WARNING 04: minimum elevation drop used for Conduit 206
WARNING 04: minimum elevation drop used for Conduit 208
WARNING 04: minimum elevation drop used for Conduit 210
WARNING 04: minimum elevation drop used for Conduit 211
WARNING 04: minimum elevation drop used for Conduit 212
WARNING 04: minimum elevation drop used for Conduit 213
WARNING 04: minimum elevation drop used for Conduit 214
WARNING 04: minimum elevation drop used for Conduit 215
WARNING 04: minimum elevation drop used for Conduit 216
WARNING 04: minimum elevation drop used for Conduit 217
WARNING 04: minimum elevation drop used for Conduit 218
WARNING 08: elevation drop exceeds length for Conduit 218O
WARNING 04: minimum elevation drop used for Conduit 220
WARNING 04: minimum elevation drop used for Conduit 229
WARNING 04: minimum elevation drop used for Conduit 230
WARNING 04: minimum elevation drop used for Conduit 239
WARNING 04: minimum elevation drop used for Conduit 240
WARNING 04: minimum elevation drop used for Conduit 241
WARNING 04: minimum elevation drop used for Conduit 242
WARNING 04: minimum elevation drop used for Conduit 246
WARNING 04: minimum elevation drop used for Conduit 247
WARNING 04: minimum elevation drop used for Conduit 249
WARNING 08: elevation drop exceeds length for Conduit 252
WARNING 04: minimum elevation drop used for Conduit 253
WARNING 04: minimum elevation drop used for Conduit 253T
WARNING 04: minimum elevation drop used for Conduit 254
WARNING 08: elevation drop exceeds length for Conduit 265
WARNING 04: minimum elevation drop used for Conduit F201
WARNING 04: minimum elevation drop used for Conduit F204
WARNING 04: minimum elevation drop used for Conduit H201
WARNING 04: minimum elevation drop used for Conduit H203
WARNING 04: minimum elevation drop used for Conduit H205
WARNING 04: minimum elevation drop used for Conduit H206
WARNING 04: minimum elevation drop used for Conduit H207
WARNING 04: minimum elevation drop used for Conduit H212
WARNING 04: minimum elevation drop used for Conduit L201
WARNING 04: minimum elevation drop used for Conduit L202
WARNING 04: minimum elevation drop used for Conduit L205
WARNING 04: minimum elevation drop used for Conduit L206
WARNING 04: minimum elevation drop used for Conduit L207
WARNING 04: minimum elevation drop used for Conduit L209
WARNING 04: minimum elevation drop used for Conduit P201
WARNING 04: minimum elevation drop used for Conduit P203
WARNING 04: minimum elevation drop used for Conduit P206

WARNING 04: minimum elevation drop used for Conduit P207
WARNING 04: minimum elevation drop used for Conduit Q201
WARNING 08: elevation drop exceeds length for Conduit Q201O
WARNING 04: minimum elevation drop used for Conduit R201
WARNING 04: minimum elevation drop used for Conduit S206
WARNING 04: minimum elevation drop used for Conduit S221
WARNING 04: minimum elevation drop used for Conduit S223

****
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 ......... 00:05:00
Routing Time Step ........ 5.00 sec
```

************************** 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	1346.009	438.617
External Outflow	1298.131	423.015
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	90.805	29.590
Continuity Error (%)	-3.189	

****
Highest Flow Instability Indexes
****
Link F504 (9)
Link L505 (6)
Link L205O (4)
Link L203T (4)
Link L202 (4)

****
Routing Time Step Summary
****
Minimum Time Step : 5.00 sec
Average Time Step : 5.00 sec
Maximum Time Step : 5.00 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	hr:min	Reported Max Depth Feet
102	JUNCTION	2.14	8.03	5018.03	0	01:49	8.03
103	JUNCTION	3.58	11.65	5046.65	0	01:43	11.64
103T	JUNCTION	2.15	8.04	5043.04	0	01:42	8.03
104	JUNCTION	3.61	10.15	5046.15	0	01:41	10.15
104T	JUNCTION	3.59	11.65	5047.65	0	01:41	11.65
105	JUNCTION	0.05	1.26	5073.26	0	00:40	1.26

Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days	hr:min	Reported Max Depth Feet
105T	JUNCTION	11.05	12.26	5056.77	0	00:42	12.26
106	JUNCTION	3.44	10.39	5058.39	0	01:35	10.39
107	JUNCTION	0.10	3.66	5055.66	0	00:40	3.66
108	JUNCTION	8.03	8.64	5063.64	0	00:55	8.64
108T	JUNCTION	3.45	10.43	5065.43	0	01:26	10.43
109	JUNCTION	0.02	0.64	5110.50	0	00:50	0.64
110	JUNCTION	0.00	0.00	5055.00	0	00:00	0.00
111	JUNCTION	0.00	0.00	5069.00	0	00:00	0.00
111T	JUNCTION	2.54	9.97	5078.97	0	01:18	9.96
112	JUNCTION	0.00	0.00	5069.00	0	00:00	0.00
113	JUNCTION	0.00	0.00	5073.79	0	00:00	0.00
113T	JUNCTION	2.77	11.19	5084.98	0	01:18	11.18
114	JUNCTION	0.00	0.00	5073.79	0	00:00	0.00
115	JUNCTION	1.66	9.26	5084.77	0	01:15	9.25
115T	JUNCTION	2.77	11.19	5086.70	0	01:15	11.19
116	JUNCTION	0.00	0.00	5075.51	0	00:00	0.00
117	JUNCTION	9.59	11.60	5100.60	0	01:08	11.60
117T	JUNCTION	1.66	9.27	5098.27	0	01:11	9.25
118	JUNCTION	0.00	0.00	5117.93	0	00:00	0.00
118O	JUNCTION	0.00	0.00	5117.93	0	00:00	0.00
118T	JUNCTION	0.63	3.89	5115.89	0	01:05	3.89
119	JUNCTION	5.27	6.88	5129.53	0	01:00	6.88
120	JUNCTION	11.03	11.62	5146.62	0	00:51	11.62
120T	JUNCTION	0.36	2.38	5137.38	0	01:00	2.38
121	JUNCTION	0.02	0.63	5216.63	0	00:45	0.63

122	JUNCTION	3.29	9.37	5151.37	0	00:58	9.36
123	JUNCTION	0.04	1.13	5151.87	0	00:45	1.13
123T	JUNCTION	3.35	9.94	5152.74	0	00:56	9.93
124	JUNCTION	1.51	1.79	5157.79	0	00:50	1.79
124T	JUNCTION	5.19	10.98	5155.98	0	00:54	10.98
125	JUNCTION	12.13	15.41	5176.41	0	00:51	15.41
125T	JUNCTION	8.11	11.66	5159.66	0	01:16	11.66
126	JUNCTION	0.12	3.46	5215.46	0	00:44	3.46
127	JUNCTION	10.06	11.70	5220.70	0	00:41	11.70
128	JUNCTION	3.04	4.38	5234.38	0	00:35	4.37
129	JUNCTION	10.04	11.95	5163.19	0	01:17	11.94
129T	JUNCTION	2.54	8.66	5159.90	0	01:16	8.66
130	JUNCTION	0.07	1.69	5158.69	0	00:53	1.69
130O	JUNCTION	0.00	0.00	5157.00	0	00:00	0.00
131	JUNCTION	0.05	1.04	5218.04	0	00:50	1.04
131T	JUNCTION	0.07	1.69	5173.69	0	00:53	1.69
132	JUNCTION	0.01	0.19	5289.62	0	01:00	0.19
133	JUNCTION	0.04	1.06	5187.06	0	00:45	1.06
134	JUNCTION	2.18	5.46	5186.09	0	01:12	5.43
135	JUNCTION	8.76	9.99	5193.99	0	01:11	9.99
135T	JUNCTION	8.75	9.99	5191.97	0	01:11	9.99
136	JUNCTION	0.07	1.69	5208.55	0	01:09	1.69
137	JUNCTION	0.02	0.47	5254.02	0	00:49	0.47
138	JUNCTION	0.02	0.36	5290.16	0	00:45	0.36
139	JUNCTION	9.16	11.50	5256.50	0	00:40	11.50

139T	JUNCTION	0.07	1.59	5231.59	0	01:09	1.59
140	JUNCTION	6.03	7.20	5259.20	0	00:53	7.20
140T	JUNCTION	0.05	1.48	5235.48	0	01:03	1.48
141	JUNCTION	7.07	9.00	5276.00	0	00:27	9.00
142	JUNCTION	0.00	0.00	5285.82	0	00:00	0.00
143	JUNCTION	0.02	0.49	5258.49	0	00:43	0.49
144	JUNCTION	0.01	0.40	5275.87	0	00:40	0.40
145	JUNCTION	1.02	2.00	5193.57	0	01:33	2.00
146	JUNCTION	5.00	5.33	5209.33	0	01:51	5.33
147	JUNCTION	6.04	6.86	5228.68	0	00:53	6.86
148	JUNCTION	0.06	1.62	5244.62	0	00:46	1.61
149	JUNCTION	3.04	4.50	5257.50	0	00:37	4.50
150	JUNCTION	6.04	7.51	5264.51	0	00:35	7.51
151	JUNCTION	0.04	0.87	5235.87	0	00:45	0.87
152	JUNCTION	0.40	2.08	5224.08	0	01:34	2.04
153	JUNCTION	0.00	0.00	5253.00	0	00:00	0.00
153T	JUNCTION	0.03	0.56	5222.56	0	00:58	0.56
154	JUNCTION	0.06	1.72	5223.72	0	00:52	1.72
155	JUNCTION	4.10	6.92	5246.92	0	00:49	6.92
156	JUNCTION	1.04	1.88	5248.88	0	00:45	1.88
156T	JUNCTION	0.09	2.94	5249.94	0	00:45	2.94
157	JUNCTION	6.04	7.26	5263.26	0	00:40	7.26
158	JUNCTION	0.03	0.56	5231.56	0	00:50	0.56
159	JUNCTION	7.03	7.50	5232.50	0	02:47	7.50
160	JUNCTION	0.39	5.73	5257.73	0	01:01	5.73

161	JUNCTION	1.26	5.74	5268.74	0	00:57	5.73
162	JUNCTION	0.02	0.53	5271.53	0	00:40	0.52
163	JUNCTION	0.25	2.68	5279.07	0	00:50	2.68
163T	JUNCTION	4.25	6.68	5274.68	0	00:52	6.67
164	JUNCTION	2.28	4.98	5297.98	0	01:42	4.98
165	JUNCTION	22.94	26.80	5332.92	0	00:34	26.80
165O	JUNCTION	0.28	3.00	5308.01	0	01:36	2.99
166	JUNCTION	0.03	1.06	5332.06	0	00:40	1.06
167	JUNCTION	0.04	1.16	5315.16	0	00:52	1.15
F101	JUNCTION	0.06	1.08	5036.08	0	01:17	1.08
F102	JUNCTION	0.07	1.33	5061.33	0	01:16	1.33
F103	JUNCTION	0.07	1.33	5079.33	0	01:13	1.33
F104	JUNCTION	12.59	13.77	5123.22	0	00:52	13.76
F104O	JUNCTION	0.06	1.22	5110.67	0	01:21	1.22
F105	JUNCTION	0.04	1.24	5166.24	0	00:45	1.24
H101	JUNCTION	4.41	7.15	5043.15	0	01:41	7.15
H102	JUNCTION	3.30	5.88	5068.15	0	01:39	5.88
H103	JUNCTION	0.00	0.00	5086.00	0	00:00	0.00
H103O	JUNCTION	0.30	2.88	5088.88	0	01:34	2.88
H104	JUNCTION	3.29	5.94	5105.94	0	01:37	5.94
H104T	JUNCTION	2.30	4.91	5093.91	0	01:33	4.91
H105	JUNCTION	1.16	2.74	5129.26	0	01:38	2.74
H105T	JUNCTION	0.29	2.94	5129.46	0	01:32	2.94
H106	JUNCTION	4.22	7.72	5183.12	0	01:08	7.72
H106O	JUNCTION	0.16	1.74	5177.14	0	01:34	1.74

H107	JUNCTION	0.02	0.83	5190.83	0	00:44	0.83
H107O	JUNCTION	0.14	1.49	5191.49	0	01:39	1.49
H108	JUNCTION	0.02	0.83	5242.83	0	00:40	0.83
H109	JUNCTION	0.21	3.74	5198.74	0	01:03	3.73
H110	JUNCTION	21.05	22.34	5235.34	0	00:47	22.34
H111	JUNCTION	0.02	0.44	5270.87	0	00:45	0.44
H112	JUNCTION	0.00	0.00	5250.10	0	00:00	0.00
H112O	JUNCTION	0.03	0.63	5250.73	0	01:02	0.63
H113	JUNCTION	7.04	8.27	5285.27	0	00:40	8.27
H113T	JUNCTION	0.05	1.35	5261.25	0	00:42	1.35
H114	JUNCTION	7.03	8.06	5292.06	0	00:35	8.06
L101	JUNCTION	11.36	13.67	5102.67	0	01:20	13.67
L102	JUNCTION	0.00	0.00	5124.15	0	00:00	0.00
L102O	JUNCTION	0.36	2.69	5126.84	0	01:14	2.69
L103	JUNCTION	5.02	5.55	5168.55	0	00:35	5.55
L103T	JUNCTION	26.02	26.54	5151.43	0	00:43	26.54
L104	JUNCTION	11.56	13.30	5143.30	0	01:38	13.30
L105	JUNCTION	2.52	3.93	5165.36	0	01:36	3.93
L105O	JUNCTION	0.22	1.96	5163.39	0	01:35	1.96
L106	JUNCTION	5.10	6.38	5205.59	0	01:13	6.38
L106O	JUNCTION	0.18	1.59	5200.80	0	01:31	1.59
L107	JUNCTION	5.03	5.86	5222.40	0	00:47	5.85
L107O	JUNCTION	0.08	1.38	5217.92	0	01:11	1.38
L108	JUNCTION	5.03	5.86	5256.86	0	00:40	5.86
L109	JUNCTION	0.04	1.49	5235.49	0	00:43	1.49

L110	JUNCTION	3.04	4.50	5265.50	0	00:40	4.50
L111	JUNCTION	3.01	3.49	5294.49	0	00:35	3.48
P101	JUNCTION	0.07	0.89	5076.40	0	01:30	0.89
P102	JUNCTION	12.24	14.56	5140.56	0	01:27	14.55
P103	JUNCTION	14.16	15.80	5164.80	0	01:12	15.80
P103O	JUNCTION	0.23	2.56	5151.56	0	01:24	2.56
P104	JUNCTION	14.21	15.85	5186.84	0	01:25	15.85
P105	JUNCTION	2.07	2.90	5207.90	0	01:05	2.90
P105T	JUNCTION	11.07	11.90	5206.79	0	01:10	11.90
P106	JUNCTION	13.08	13.94	5210.94	0	02:01	13.90
P106O	JUNCTION	0.12	0.72	5197.72	0	02:21	0.72
P107	JUNCTION	0.00	0.00	5245.30	0	00:00	0.00
P107O	JUNCTION	0.08	0.87	5246.17	0	01:23	0.87
Q101	JUNCTION	0.03	0.67	5132.47	0	00:58	0.67
Q101O	JUNCTION	0.00	0.00	5131.80	0	00:00	0.00
Q102	JUNCTION	5.02	5.69	5206.69	0	00:45	5.69
R101	JUNCTION	0.06	1.48	5090.48	0	00:55	1.48
R102	JUNCTION	0.08	1.82	5131.82	0	00:56	1.82
R103	JUNCTION	0.07	1.83	5164.83	0	00:50	1.83
R104	JUNCTION	9.02	9.43	5188.43	0	00:50	9.43
S102	JUNCTION	4.15	6.69	5019.69	0	00:59	6.69
S102T	JUNCTION	0.17	2.87	5001.37	0	01:21	2.86
S103	JUNCTION	0.04	0.86	5021.86	0	00:50	0.86
S104	JUNCTION	0.04	0.86	5022.86	0	00:50	0.86
S105	JUNCTION	5.20	7.87	5037.87	0	00:53	7.87

S106	JUNCTION	0.00	0.00	5065.55	0	00:00	0.00
S106O	JUNCTION	0.03	0.21	5065.76	0	01:31	0.21
S106T	JUNCTION	0.16	2.20	5058.85	0	00:49	2.20
S107	JUNCTION	2.00	2.11	5097.11	0	00:50	2.11
S108	JUNCTION	1.04	2.18	5071.18	0	00:47	2.18
S109	JUNCTION	0.01	0.43	5100.43	0	00:45	0.43
S110	JUNCTION	0.00	0.04	5115.19	0	00:50	0.04
S110T	JUNCTION	0.06	1.76	5077.31	0	00:46	1.75
S111	JUNCTION	0.05	1.50	5083.50	0	00:45	1.50
S112	JUNCTION	3.02	4.13	5114.13	0	00:39	4.13
S113	JUNCTION	0.02	1.17	5194.17	0	00:35	1.17
S114	JUNCTION	0.30	4.41	5006.71	0	01:30	4.41
S115	JUNCTION	0.01	0.55	5045.55	0	00:35	0.55
S115T	JUNCTION	3.79	7.93	5006.93	0	01:22	7.93
S116	JUNCTION	0.10	1.94	5005.94	0	01:18	1.94
S117	JUNCTION	0.09	1.95	5015.95	0	01:11	1.95
S119	JUNCTION	0.06	1.34	5058.34	0	01:00	1.34
S121	JUNCTION	4.02	4.41	5093.04	0	00:52	4.41
S121T	JUNCTION	0.06	1.37	5090.00	0	00:52	1.36
S122	JUNCTION	2.02	2.41	5124.41	0	00:50	2.41
S123	JUNCTION	5.03	5.82	5094.45	0	00:51	5.82
S124	JUNCTION	8.03	8.83	5156.83	0	00:45	8.83
RP102	JUNCTION	0.00	0.17	5018.17	0	00:40	0.17
RP103	JUNCTION	0.01	0.24	5022.24	0	00:40	0.24
S120	JUNCTION	0.06	1.36	5072.34	0	00:59	1.36

D102T	JUNCTION	0.26	3.78	5015.78	0	00:59	3.78
D102	JUNCTION	0.00	0.00	5016.00	0	00:00	0.00
D103	JUNCTION	0.09	1.67	5017.67	0	01:14	1.67
D104	JUNCTION	0.07	1.76	5020.76	0	00:50	1.76
D105	JUNCTION	0.01	0.31	5024.31	0	00:55	0.31
D107	JUNCTION	0.06	2.04	5027.04	0	00:45	2.04
101	OUTFALL	4.37	6.89	5007.89	0	02:09	6.82
S101	OUTFALL	0.18	2.71	4999.71	0	01:44	2.71
S125	OUTFALL	0.00	0.00	4997.00	0	00:00	0.00
RP101	OUTFALL	3.01	3.13	4998.13	0	01:37	3.13
D101	OUTFALL	6.28	9.73	5011.73	0	01:17	9.73
D106	OUTFALL	8.08	9.86	5016.86	0	01:10	9.86
D108	OUTFALL	0.00	0.00	5008.00	0	00:00	0.00
106T	DIVIDER	3.15	6.62	5054.62	0	00:47	6.62
139O	DIVIDER	0.39	2.00	5247.00	0	00:42	2.00
140O	DIVIDER	5.03	6.32	5258.32	0	00:58	6.32
141O	DIVIDER	8.03	9.22	5276.22	0	00:47	9.21
142O	DIVIDER	1.03	2.00	5287.82	0	00:23	2.00
146O	DIVIDER	5.14	6.21	5210.21	0	01:49	6.21
147O	DIVIDER	10.00	10.34	5232.16	0	01:45	10.34
149O	DIVIDER	3.03	4.37	5257.37	0	00:43	4.36
152O	DIVIDER	1.48	1.78	5223.12	0	11:08	1.78
153O	DIVIDER	4.02	4.47	5257.47	0	01:12	4.46
160O	DIVIDER	11.03	11.50	5263.58	0	02:41	11.50
L109O	DIVIDER	7.08	7.62	5241.62	0	01:43	7.62

168	DIVIDER	0.14	4.00	5359.67	0	00:31	4.00
S118	DIVIDER	1.97	2.82	5055.52	0	00:57	2.81
318	STORAGE	0.43	7.05	5124.98	0	01:13	7.05
330	STORAGE	1.09	7.96	5164.96	0	00:57	7.96
339	STORAGE	0.22	2.37	5247.37	0	01:04	2.37
340	STORAGE	0.82	3.69	5255.69	0	00:58	3.69
341	STORAGE	0.12	2.36	5269.36	0	00:47	2.35
342	STORAGE	0.00	0.01	5285.83	0	00:40	0.01
346	STORAGE	3.64	7.39	5211.39	0	01:49	7.39
347	STORAGE	1.55	6.98	5228.80	0	01:45	6.98
349	STORAGE	0.07	2.58	5255.58	0	00:43	2.58
352	STORAGE	3.13	4.12	5225.46	0	11:08	4.12
353	STORAGE	0.05	1.23	5254.23	0	01:12	1.23
360	STORAGE	1.28	7.65	5259.73	0	02:41	7.65
365	STORAGE	1.06	9.65	5314.82	0	01:36	9.65
F304	STORAGE	0.49	10.86	5120.31	0	01:21	10.86
H303	STORAGE	2.03	6.62	5092.62	0	01:34	6.62
H306	STORAGE	1.92	28.88	5204.28	0	01:34	28.88
H307	STORAGE	0.95	10.95	5200.95	0	01:39	10.95
H312	STORAGE	2.78	7.64	5257.74	0	01:02	7.63
L302	STORAGE	1.37	3.95	5128.10	0	01:14	3.95
L305	STORAGE	0.89	8.24	5169.67	0	01:35	8.24
L306	STORAGE	0.97	8.63	5207.84	0	01:31	8.63
L307	STORAGE	0.64	7.36	5223.90	0	01:11	7.35
L309	STORAGE	1.25	8.02	5242.02	0	01:43	8.02

P303	STORAGE	3.04	7.85	5156.85	0	01:24	7.85
P306	STORAGE	0.59	5.14	5202.14	0	02:21	5.13
P307	STORAGE	0.15	1.69	5246.99	0	01:23	1.69
Q301	STORAGE	3.73	7.50	5139.30	0	01:06	7.50
S306	STORAGE	3.69	6.40	5071.95	0	01:31	6.40

****
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	39.79	4711.15	0	01:49	1.97	324	0.000
103	JUNCTION	8.37	4424.54	0	01:42	0.181	305	0.000
103T	JUNCTION	0.00	4716.42	0	01:42	0	323	0.000
104	JUNCTION	15.84	3477.45	0	01:41	0.84	240	0.000
104T	JUNCTION	0.00	4425.26	0	01:41	0	305	0.000
105	JUNCTION	20.88	20.88	0	00:40	0.591	0.591	0.000
105T	JUNCTION	0.00	3491.02	0	01:34	0	239	0.000
106	JUNCTION	133.05	3447.14	0	01:34	4.15	236	0.000
107	JUNCTION	100.33	100.33	0	00:40	2.57	2.57	0.000
108	JUNCTION	133.92	212.82	0	00:50	3.69	6.98	0.000

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
108T	JUNCTION	0.00	3449.01	0	01:26	0	232	-0.000
109	JUNCTION	87.94	87.94	0	00:50	3.27	3.27	0.000
110	JUNCTION	95.49	95.49	0	00:40	2.61	2.61	0.000
111	JUNCTION	7.03	7.03	0	01:10	0.483	0.483	0.000
111T	JUNCTION	0.00	3344.37	0	01:18	0	223	0.000
112	JUNCTION	200.79	200.79	0	00:40	4.97	4.97	0.000
113	JUNCTION	107.97	107.97	0	00:40	2.87	2.87	0.000
113T	JUNCTION	0.00	3242.33	0	01:17	0	217	0.000
114	JUNCTION	70.73	70.73	0	00:35	1.57	1.57	0.000
115	JUNCTION	51.59	2872.75	0	01:14	2.06	194	0.000
115T	JUNCTION	0.00	3163.56	0	01:15	0	213	0.000
116	JUNCTION	208.53	208.53	0	00:45	5.8	5.8	0.000
117	JUNCTION	195.10	2354.80	0	01:08	5.75	156	0.000
117T	JUNCTION	0.00	2704.73	0	01:11	0	186	0.000
118	JUNCTION	289.79	289.79	0	00:40	6.86	6.86	0.000
118O	JUNCTION	0.00	153.68	0	01:13	0	6.86	0.000
118T	JUNCTION	0.00	2208.87	0	01:06	0	150	0.000
119	JUNCTION	142.59	2096.93	0	01:00	4.25	143	0.000
120	JUNCTION	163.21	201.28	0	00:45	4.17	5.61	0.000
120T	JUNCTION	0.00	1974.89	0	00:59	0	139	0.000
121	JUNCTION	46.36	46.36	0	00:45	1.44	1.44	0.000
122	JUNCTION	97.51	1805.47	0	00:58	3.73	134	0.000
123	JUNCTION	124.90	124.90	0	00:45	3.82	3.82	0.000
123T	JUNCTION	0.00	1715.47	0	00:56	0	130	0.000
124	JUNCTION	12.56	12.56	0	00:50	0.54	0.54	0.000

124T		JUNCTION	0.00	1603.56	0	00:54
0	126	0.000				
125		JUNCTION	218.47	653.52	0	00:50
6.33	18.9	0.000				
125T		JUNCTION	0.00	1591.26	0	00:54
0	126	0.000				
126		JUNCTION	115.06	457.38	0	00:44
3.86	12.5	0.000				
127		JUNCTION	119.24	345.21	0	00:41
4.12	8.62	0.000				
128		JUNCTION	240.52	240.52	0	00:35
4.49	4.49	-0.000				
129		JUNCTION	79.23	701.38	0	01:17
2.87	93.8	0.000				
129T		JUNCTION	0.00	1024.59	0	01:16
0	107	-0.000				
130		JUNCTION	154.17	387.01	0	00:52
5.13	13.2	0.000				
130O		JUNCTION	0.00	379.15	0	00:57
0	13.2	0.000				
131		JUNCTION	136.25	136.89	0	00:50
4.82	4.93	0.000				
131T		JUNCTION	0.00	236.23	0	00:53
0	8.09	0.000				
132		JUNCTION	1.93	1.93	0	01:00
0.108	0.108	0.000				
133		JUNCTION	104.90	104.90	0	00:45
3.14	3.14	0.000				
134		JUNCTION	15.76	655.01	0	01:11
0.497	91	0.000				
135		JUNCTION	146.71	566.90	0	01:11
4.61	68.9	0.000				
135T		JUNCTION	0.00	643.89	0	01:10
0	90.6	0.000				
136		JUNCTION	190.77	423.92	0	01:09
5.14	12.6	0.000				
137		JUNCTION	8.72	19.60	0	00:49
0.291	0.724	0.000				
138		JUNCTION	11.28	11.28	0	00:45
0.432	0.432	0.000				
139		JUNCTION	48.72	78.28	0	00:40
1.3	3.52	0.000				
139T		JUNCTION	0.00	275.99	0	01:06
0	6.76	0.000				
140		JUNCTION	66.32	222.17	0	00:53
2.21	5.64	0.000				
140T		JUNCTION	0.00	220.37	0	01:03
0	4.8	0.000				
141		JUNCTION	130.27	192.90	0	00:45
4.06	5.57	0.000				

142		JUNCTION	64.05	64.05	0	00:40
1.5	1.5	0.000				
143		JUNCTION	6.95	20.32	0	00:43
0.206	0.599	0.000				
144		JUNCTION	13.55	13.55	0	00:40
0.394	0.394	0.000				
145		JUNCTION	125.45	203.59	0	01:49
2.95	21.7	0.000				
146		JUNCTION	40.15	191.84	0	02:01
1.37	18.7	0.000				
147		JUNCTION	273.74	638.81	0	00:48
4.99	17.3	0.000				
148		JUNCTION	97.99	344.90	0	00:46
3.76	7.97	0.000				
149		JUNCTION	38.92	314.26	0	00:38
1.49	6.93	0.000				
150		JUNCTION	283.62	283.62	0	00:35
5.44	5.44	0.000				
151		JUNCTION	46.90	46.90	0	00:45
1.57	1.57	0.000				
152		JUNCTION	167.53	894.32	0	00:55
6.42	70.3	0.000				
153		JUNCTION	40.07	40.07	0	00:45
1.23	1.23	0.000				
153T		JUNCTION	0.00	553.43	0	00:54
0	18.4	0.000				
154		JUNCTION	96.35	412.02	0	00:52
3.31	12.6	0.000				
155		JUNCTION	86.47	319.60	0	00:49
2.71	9.29	0.000				
156		JUNCTION	71.36	71.36	0	00:45
2.32	2.32	0.000				
156T		JUNCTION	0.00	238.17	0	00:45
0	6.57	0.000				
157		JUNCTION	170.79	170.79	0	00:40
4.24	4.24	0.000				
158		JUNCTION	141.16	141.16	0	00:50
5.02	5.02	0.000				
159		JUNCTION	111.78	219.67	0	02:38
2.78	45.4	-0.000				
160		JUNCTION	100.39	939.53	0	01:01
3.16	42	0.000				
161		JUNCTION	340.49	853.24	0	00:57
8.33	38.8	-0.000				
162		JUNCTION	44.60	44.60	0	00:40
1.28	1.28	0.000				
163		JUNCTION	81.65	313.19	0	00:50
1.97	21.3	0.000				
163T		JUNCTION	0.00	554.27	0	00:59
0	29.2	0.000				

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  164                      JUNCTION    223.28    263.21      0  00:40
 5.12         19.2          0.000
  165                      JUNCTION    195.77    459.49      0  00:44
 4.49         14.1          0.000
  165O                     JUNCTION      0.00    197.64      0  01:36
   0            14          0.000
  166                      JUNCTION    158.39    158.39      0  00:40
 4.05         4.05          0.000
  167                      JUNCTION    176.18    271.87      0  00:52
 6.27         7.87          0.000
  F101                     JUNCTION     31.83    269.38      0  01:15
 1.17         13.4          0.000
  F102                     JUNCTION     47.59    245.52      0  01:10
 1.61         12.2          0.000
  F103                     JUNCTION     37.94    208.01      0  01:13
 1.61         10.6          0.000
  F104                     JUNCTION    218.49    332.72      0  00:46
 4.82            9          0.000
  F104O                    JUNCTION      0.00    176.54      0  01:21
   0             9          0.000
  F105                     JUNCTION    146.33    146.33      0  00:45
 4.15         4.15          0.000
  H101                     JUNCTION     32.06    947.86      0  01:40
 1.55         65.4          0.000
  H102                     JUNCTION    233.09    928.52      0  01:34
 6.24         63.8          0.000
  H103                     JUNCTION     50.67    900.84      0  01:19
 2.09         57.7          0.000
  H103O                    JUNCTION      0.00    852.07      0  01:34
   0          57.4          0.000
  H104                     JUNCTION    274.64    610.45      0  01:28
 6.03         42.5          0.000
  H104T                    JUNCTION      0.00    860.26      0  01:20
   0          55.6          0.000
  H105                     JUNCTION     49.35    482.40      0  01:36
 1.65         32.7          0.000
  H105T                    JUNCTION      0.00    549.56      0  01:32
   0          36.4          0.000
  H106                     JUNCTION    342.91    703.38      0  01:06
 6.69         31.1          0.000
  H106O                    JUNCTION      0.00    459.16      0  01:34
   0            31          0.000
  H107                     JUNCTION    204.70    292.86      0  00:42
 5.44         7.76          0.000
  H107O                    JUNCTION      0.00     90.78      0  01:39
   0          7.76          0.000
  H108                     JUNCTION     91.35     91.35      0  00:40
 2.31         2.31          0.000
  H109                     JUNCTION     13.60    496.68      0  01:03
0.762         16.5          0.000
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  H110                     JUNCTION    110.91    483.96      0  01:01
 3.85         15.7          0.000
  H111                     JUNCTION     21.06     21.06      0  00:45
0.698        0.698         -0.000
  H112                     JUNCTION    214.82    214.82      0  00:45
 5.99         5.99          0.000
  H112O                    JUNCTION      0.00    176.16      0  01:02
   0          5.66          0.000
  H113                     JUNCTION     84.71     84.71      0  00:40
 2.07         2.07          0.000
  H113T                    JUNCTION      0.00    238.54      0  00:42
   0          5.51          0.000
  H114                     JUNCTION    160.64    160.64      0  00:35
 3.43         3.43          0.000
  L101                     JUNCTION     61.27    415.83      0  01:20
 2.55         30.6          0.000
  L102                     JUNCTION     83.46    404.48      0  01:05
 2.47           28          0.000
  L102O                    JUNCTION      0.00    373.85      0  01:14
   0            28          0.000
  L103                     JUNCTION     23.96     23.96      0  00:35
0.569        0.569          0.000
  L103T                    JUNCTION      0.00    337.91      0  01:06
   0          25.6          0.000
  L104                     JUNCTION    111.77    321.16      0  01:05
 2.87           25          0.000
  L105                     JUNCTION    242.62    276.75      0  00:45
   6          22.1          0.000
  L105O                    JUNCTION      0.00    269.26      0  01:35
   0          22.1          0.000
  L106                     JUNCTION    160.93    279.66      0  01:08
 3.62         16.1          0.000
  L106O                    JUNCTION      0.00    199.16      0  01:31
   0          16.1          0.000
  L107                     JUNCTION    149.94    235.47      0  00:45
 4.15         6.72          0.000
  L107O                    JUNCTION      0.00    173.77      0  01:11
   0          6.72          0.000
  L108                     JUNCTION     88.49     88.49      0  00:40
 2.56         2.56          0.000
  L109                     JUNCTION     63.04    251.73      0  00:42
 1.62         5.78          0.000
  L110                     JUNCTION    141.38    192.23      0  00:40
 2.9          4.15          0.000
  L111                     JUNCTION     57.69     57.69      0  00:35
 1.24         1.24          0.000
  P101                     JUNCTION     70.44    315.54      0  01:27
 2.49         18.8          0.000
  P102                     JUNCTION    113.14    276.04      0  01:19
 3.51         16.2          0.000
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P103	JUNCTION	105.70	232.99	0	01:05	3.81	13.5	0.000
P103O	JUNCTION	0.00	208.71	0	01:24	0	12.6	0.000
P104	JUNCTION	110.81	142.00	0	01:08	3.22	9.72	0.000
P105	JUNCTION	42.98	42.98	0	01:05	2.51	2.51	0.000
P105T	JUNCTION	0.00	73.48	0	01:13	0	6.47	0.000
P106	JUNCTION	54.55	69.54	0	01:15	2.6	3.96	0.000
P106O	JUNCTION	0.00	35.54	0	02:21	0	3.96	0.000
P107	JUNCTION	43.42	43.42	0	00:45	1.3	1.3	0.000
P107O	JUNCTION	0.00	24.55	0	01:23	0	1.3	0.000
Q101	JUNCTION	67.09	100.61	0	00:53	2.52	3.77	0.000
Q101O	JUNCTION	0.00	95.85	0	01:06	0	3.74	0.000
Q102	JUNCTION	36.93	36.93	0	00:45	1.22	1.22	0.000
R101	JUNCTION	97.36	383.76	0	00:55	3.45	13.1	0.000
R102	JUNCTION	187.08	297.30	0	00:47	3.42	9.61	0.000
R103	JUNCTION	32.08	174.24	0	00:50	1.22	6.17	0.000
R104	JUNCTION	142.33	142.33	0	00:50	4.95	4.95	0.000
S102	JUNCTION	50.96	768.50	0	00:59	1.21	26.5	0.000
S102T	JUNCTION	0.00	1119.93	0	01:21	0	47.9	0.000
S103	JUNCTION	35.81	127.16	0	00:50	1.26	4.49	0.000
S104	JUNCTION	91.96	91.96	0	00:50	3.23	3.23	0.000
S105	JUNCTION	165.83	614.47	0	00:53	3.82	20.7	-0.000
S106	JUNCTION	81.42	81.42	0	00:40	2.28	2.28	0.000
S106O	JUNCTION	0.00	32.49	0	01:31	0	2.14	0.000
S106T	JUNCTION	0.00	487.21	0	00:49	0	16.9	0.000
S107	JUNCTION	9.93	9.93	0	00:50	0.379	0.379	0.000

S108	JUNCTION	98.65	477.51	0	00:47	3.15	14.4	0.000
S109	JUNCTION	93.82	93.82	0	00:45	2.88	2.88	0.000
S110	JUNCTION	8.94	8.94	0	00:50	0.395	0.395	0.000
S110T	JUNCTION	0.00	287.49	0	00:46	0	8.32	0.000
S111	JUNCTION	43.14	278.96	0	00:45	1.31	7.93	0.000
S112	JUNCTION	117.21	238.56	0	00:40	4.33	6.61	0.000
S113	JUNCTION	142.22	142.22	0	00:35	2.26	2.26	0.000
S114	JUNCTION	94.28	505.49	0	01:28	2.94	21.3	0.000
S115	JUNCTION	35.63	35.63	0	00:35	0.673	0.673	0.000
S115T	JUNCTION	0.00	462.07	0	01:22	0	18.3	0.000
S116	JUNCTION	130.08	451.44	0	01:15	3.11	17.5	0.000
S117	JUNCTION	113.74	393.38	0	01:11	5.06	14.3	0.000
S119	JUNCTION	134.92	342.17	0	00:57	4.05	12	0.000
S121	JUNCTION	17.54	59.04	0	00:51	0.572	2.16	0.000
S121T	JUNCTION	0.00	174.60	0	00:52	0	6.14	0.000
S122	JUNCTION	42.13	42.13	0	00:50	1.58	1.58	0.000
S123	JUNCTION	21.22	115.60	0	00:52	1.05	3.99	0.000
S124	JUNCTION	97.15	97.15	0	00:45	2.92	2.92	0.000
RP102	JUNCTION	9.14	9.14	0	00:40	0.244	0.244	0.000
RP103	JUNCTION	33.32	33.32	0	00:40	0.714	0.714	0.000
S120	JUNCTION	54.62	221.61	0	00:57	1.73	7.91	0.000
D102T	JUNCTION	0.00	272.56	0	00:59	0	11.7	0.000
D102	JUNCTION	78.66	78.66	0	00:55	3.1	3.1	0.000
D103	JUNCTION	150.15	195.90	0	01:02	4.77	8.6	0.000
D104	JUNCTION	78.54	78.54	0	00:50	2.53	2.53	0.000

D105		JUNCTION	21.62	21.62	0	00:55
0.916	0.916	0.000				
D107		JUNCTION	135.05	135.05	0	00:45
3.65	3.65	0.000				
101		OUTFALL	136.02	4599.06	0	02:09
6.7	334	0.000				
S101		OUTFALL	84.02	1078.59	0	01:44
4.62	55.2	0.000				
S125		OUTFALL	43.82	43.82	0	00:50
1.74	1.74	0.000				
RP101		OUTFALL	65.26	92.64	0	01:05
3.17	4.33	0.000				
D101		OUTFALL	105.07	354.26	0	01:13
4.43	16.3	0.000				
D106		OUTFALL	117.52	223.55	0	01:05
4.85	8.78	0.000				
D108		OUTFALL	42.85	42.85	0	01:05
2.33	2.33	0.000				
106T		DIVIDER	0.00	3482.79	0	01:34
0	239	0.000				
139O		DIVIDER	0.00	77.75	0	01:04
0	5.5	0.000				
140O		DIVIDER	0.00	219.65	0	00:58
0	6.11	-0.000				
141O		DIVIDER	0.00	191.11	0	00:47
0	5.57	0.000				
142O		DIVIDER	0.00	64.04	0	00:40
0	1.5	-0.000				
146O		DIVIDER	0.00	188.62	0	01:49
0	18.7	0.000				
147O		DIVIDER	0.00	169.10	0	01:45
0	17.3	-0.000				
149O		DIVIDER	0.00	302.54	0	00:43
0	6.93	0.000				
152O		DIVIDER	0.00	51.50	0	11:08
0	48.1	-0.000				
153O		DIVIDER	0.00	29.19	0	01:12
0	1.23	0.000				
160O		DIVIDER	0.00	205.72	0	02:41
0	42	0.000				
L109O		DIVIDER	0.00	45.71	0	01:43
0	5.78	0.000				
168		DIVIDER	235.61	235.61	0	00:45
6.99	6.99	0.000				
S118		DIVIDER	22.13	362.33	0	00:57
0.74	12.7	0.000				
318		STORAGE	0.00	289.79	0	00:40
0	6.86	0.010				
330		STORAGE	0.00	387.01	0	00:52
0	13.2	0.036				

339		STORAGE	0.00	78.28	0	00:40
0	3.52	0.003				
340		STORAGE	0.00	222.17	0	00:53
0	5.64	0.042				
341		STORAGE	0.00	192.90	0	00:45
0	5.57	0.030				
342		STORAGE	0.00	64.05	0	00:40
0	1.5	0.000				
346		STORAGE	0.00	191.84	0	02:01
0	18.7	0.007				
347		STORAGE	0.00	638.81	0	00:48
0	17.3	0.004				
349		STORAGE	0.00	314.26	0	00:38
0	6.93	0.048				
352		STORAGE	0.00	894.32	0	00:55
0	70.3	-0.001				
353		STORAGE	0.00	40.07	0	00:45
0	1.23	-0.000				
360		STORAGE	0.00	939.53	0	01:01
0	42	0.004				
365		STORAGE	0.00	459.49	0	00:44
0	14.1	0.005				
F304		STORAGE	0.00	332.72	0	00:46
0	9	0.012				
H303		STORAGE	0.00	900.84	0	01:19
0	57.7	0.013				
H306		STORAGE	0.00	703.38	0	01:06
0	31.1	0.010				
H307		STORAGE	0.00	292.86	0	00:42
0	7.76	0.008				
H312		STORAGE	0.00	214.82	0	00:45
0	5.99	0.033				
L302		STORAGE	0.00	404.48	0	01:05
0	28	0.007				
L305		STORAGE	0.00	276.75	0	00:45
0	22.1	0.010				
L306		STORAGE	0.00	279.66	0	01:08
0	16.1	0.010				
L307		STORAGE	0.00	235.47	0	00:45
0	6.72	0.023				
L309		STORAGE	0.00	251.73	0	00:42
0	5.78	0.005				
P303		STORAGE	0.00	232.99	0	01:05
0	13.5	0.019				
P306		STORAGE	0.00	69.54	0	01:15
0	3.96	0.002				
P307		STORAGE	0.00	43.42	0	00:45
0	1.3	-0.000				
Q301		STORAGE	0.00	100.61	0	00:53
0	3.77	0.019				

```
  S306                 STORAGE       0.00    81.42     0  00:40
    0        2.28       0.004
```

****
Node Flooding Summary
****

No nodes were flooded.

****
Storage Volume Summary
****

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days	Time of Max Occurrence hr:min	Maximum Outflow CFS
318	19.283	3	0	0	440.867	72	0	01:13	153.68
330	22.838	7	0	0	257.953	81	0	00:57	379.15
339	9.399	5	0	0	103.125	59	0	01:04	64.32
340	35.853	16	0	0	160.654	73	0	00:58	213.94
341	5.260	4	0	0	102.610	81	0	00:47	191.11
342	0.008	0	0	0	0.322	0	0	00:40	64.04
346	165.670	36	0	0	352.942	76	0	01:49	188.62
347	229.850	11	0	0	1554.339	74	0	01:45	169.10
349	2.869	2	0	0	112.554	85	0	00:43	302.54
352	5178.747	33	0	0	7685.507	50	0	11:08	51.50
353	1.983	3	0	0	53.669	77	0	01:12	29.19
360	346.870	5	0	0	3028.846				

Storage Unit	Average Volume 1000 ft3	Avg Pcnt Full	Evap Pcnt Loss	Exfil Pcnt Loss	Maximum Volume 1000 ft3	Max Pcnt Full	Time of Max Occurrence days	Time of Max Occurrence hr:min	Maximum Outflow CFS
						45	0	02:41	205.72
365	80.359	7	0	0	1088.933	91	0	01:36	197.64
F304	14.359	2	0	0	442.374	63	0	01:21	176.54
H303	144.982	8	0	0	863.352	45	0	01:34	852.07
H306	83.749	3	0	0	1257.977	44	0	01:34	459.16
H307	38.218	4	0	0	625.943	72	0	01:39	90.78
H312	63.247	16	0	0	258.885	65	0	01:02	176.16
L302	128.625	17	0	0	449.993	59	0	01:14	373.85
L305	17.426	4	0	0	270.921	66	0	01:35	269.26
L306	38.160	5	0	0	503.083	65	0	01:31	199.16
L307	23.648	5	0	0	352.357	79	0	01:11	173.77
L309	68.349	8	0	0	598.312	67	0	01:43	45.71
P303	132.246	9	0	0	342.018	23	0	01:24	208.71
P306	12.676	2	0	0	195.747	36	0	02:21	35.54
P307	6.629	5	0	0	73.785	59	0	01:23	24.55
Q301	31.067	19	0	0	131.650	81	0	01:06	95.85
S306	63.305	16	0	0	193.335	50	0	01:31	32.49

****
Outfall Loading Summary
****

Outfall Node	Flow Freq Pcnt	Avg Flow CFS	Max Flow CFS	Total Volume 10^6 gal
101	99.81	259.11	4599.06	334.285
S101	99.76	42.79	1078.59	55.182
S125	10.84	12.44	43.82	1.744
RP101	70.50	4.76	92.64	4.333
D101	99.81	12.66	354.26	16.338
D106	71.27	9.53	223.55	8.777

D108	14.16	12.71	42.85	2.326
System	66.59	354.01	42.85	422.984

****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days	Time of Max Occurrence hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
202	CONDUIT	4524.16	0	02:09	2.37	0.18	0.35
203	DUMMY	4424.54	0	01:42			
203T	CHANNEL	4686.40	0	01:49	6.31	0.34	0.73
204	DUMMY	3477.45	0	01:41			
204T	CHANNEL	4423.47	0	01:43	3.80	0.26	0.73
205	CHANNEL	20.77	0	00:42	3.87	0.08	0.42
205T	CHANNEL	3466.23	0	01:41	4.57	0.17	0.54
206	DUMMY	3447.14	0	01:34			
206T	CONDUIT	146.85	0	07:39	16.65	1.07	1.00
207	CHANNEL	97.44	0	00:47	2.30	0.30	0.72
208	DUMMY	212.82	0	00:50			
208T	CHANNEL	3386.76	0	01:35	3.93	0.19	0.65
209	CONDUIT	86.57	0	00:55	3.54	0.03	0.16
210	DUMMY	95.49	0	00:40			
211	DUMMY	7.03	0	01:10			
211T	CHANNEL	3276.47	0	01:26	5.20	0.28	0.71
212	DUMMY	200.79	0	00:40			
213	DUMMY	107.97	0	00:40			
213T	CHANNEL	3240.55	0	01:19	5.78		

						0.17	0.61
214	DUMMY	70.73	0	00:35			
215	DUMMY	2872.75	0	01:14			
215T	CHANNEL	3157.03	0	01:18	3.61	0.25	0.75
216	DUMMY	208.53	0	00:45			
217	DUMMY	2354.80	0	01:08			
217T	CHANNEL	2696.23	0	01:15	7.57	0.45	0.71
218	DUMMY	289.79	0	00:40			
218O	DUMMY	153.68	0	01:13			
218T	CHANNEL	2203.24	0	01:08	5.28	0.04	0.20
219	CONDUIT	2081.69	0	01:05	5.30	0.44	0.65
220	DUMMY	201.28	0	00:45			
220T	CONDUIT	1974.41	0	01:00	5.83	0.10	0.27
221	CONDUIT	45.35	0	00:51	5.53	0.00	0.12
222	CONDUIT	1803.36	0	01:00	5.02	0.19	0.40
223	CONDUIT	124.87	0	00:45	9.22	0.03	0.19
223T	CHANNEL	1711.52	0	00:58	3.36	0.08	0.41
224	CONDUIT	12.56	0	00:50	3.54	0.01	0.08
224T	CHANNEL	1601.21	0	00:56	4.56	0.12	0.50
225	CONDUIT	653.43	0	00:50	5.09	0.31	0.58
225T	CHANNEL	1591.15	0	00:54	8.66	0.05	0.42
226	CHANNEL	444.16	0	00:51	6.05	0.13	0.43
227	CONDUIT	344.01	0	00:43	5.82	0.06	0.34
228	CONDUIT	233.47	0	00:39	6.18	0.03	0.27
229	DUMMY	701.38	0	01:17			
229T	CHANNEL	1024.58	0	01:16	7.19	0.04	0.36
230	DUMMY	387.01	0	00:52			
230O	DUMMY	379.15	0	00:57			
231	CONDUIT	134.69	0	00:55	6.12	0.02	0.21
231T	CONDUIT	236.21	0	00:53	7.50	0.16	0.42
232	CONDUIT	1.75	0	01:30	2.16		

```
0.00     0.04
  233                    CONDUIT    103.40     0  00:49      4.47
0.02     0.21
  234                    CONDUIT    640.82     0  01:17      4.60
0.27     0.59
  235                    CONDUIT    566.84     0  01:11      6.98
0.09     0.40
  235T                   CHANNEL    643.29     0  01:12      3.78
0.15     0.50
  236                    CONDUIT    422.29     0  01:11      7.27
0.06     0.34
  237                    CONDUIT     19.26     0  00:58      4.12
0.00     0.09
  238                    CONDUIT     11.20     0  00:52      3.80
0.00     0.07
  239                    DUMMY       78.28     0  00:40
  239O                   CONDUIT     20.55     0  03:48      7.52
1.08     1.00
  239T                   CONDUIT    272.62     0  01:11      6.76
0.03     0.28
  240                    DUMMY      222.17     0  00:53
  240O                   CONDUIT     14.53     0  02:41      5.16
1.08     1.00
  240T                   CONDUIT    219.82     0  01:05      4.85
0.04     0.30
  241                    DUMMY      192.90     0  00:45
  241O                   CONDUIT     29.90     0  02:18      7.89
1.08     1.00
  242                    DUMMY       64.05     0  00:40
  242O                   CONDUIT     15.36     0  01:40      8.83
1.08     1.00
  243                    CONDUIT     20.09     0  00:49      3.86
0.00     0.10
  244                    CONDUIT     13.43     0  00:43      3.76
0.00     0.08
  245                    CONDUIT    203.59     0  01:49      6.68
0.02     0.24
  246                    DUMMY      191.84     0  02:01
  246O                   CONDUIT     15.42     0  15:00      5.37
1.08     1.00
  247                    DUMMY      638.81     0  00:48
  247O                   CONDUIT    173.89     0  02:01     11.88
1.08     0.93
  248                    CONDUIT    338.85     0  00:50      6.46
0.05     0.32
  249                    DUMMY      314.26     0  00:38
  249O                   CONDUIT     54.67     0  01:50      8.79
1.08     1.00
  250                    CONDUIT    280.11     0  00:37      6.04
0.04     0.30
```



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  251                    CONDUIT     45.74     0  00:53      2.94
0.01     0.17
  252                    DUMMY      894.32     0  00:55
  252O                   CONDUIT     51.50     0  11:12      8.79
0.33     0.40
  253                    DUMMY       40.07     0  00:45
  253O                   CONDUIT      6.18     0  00:34      2.34
1.08     1.00
  253T                   DUMMY      553.43     0  00:54
  254                    DUMMY      412.02     0  00:52
  255                    CONDUIT    317.60     0  00:52      4.21
0.19     0.49
  256                    CONDUIT     71.32     0  00:45      4.36
0.01     0.18
  256T                   CHANNEL    235.31     0  00:49      2.84
0.19     0.49
  257                    CONDUIT    166.89     0  00:44      5.25
0.03     0.25
  258                    CHANNEL    136.55     0  00:58      1.43
0.00     0.11
  259                    CONDUIT    227.25     0  01:34      2.26
0.09     0.34
  260                    DUMMY      939.53     0  01:01
  260O                   CONDUIT    199.30     0  04:40     11.26
1.08     0.95
  261                    CONDUIT    850.28     0  01:01      5.91
0.13     0.41
  262                    CONDUIT     43.80     0  00:48      1.92
0.04     0.17
  263                    CONDUIT    312.98     0  00:52      4.12
0.14     0.45
  263T                   CHANNEL    553.82     0  01:01      4.04
0.06     0.31
  264                    CHANNEL    242.28     0  00:52      2.05
0.01     0.12
  265                    DUMMY      459.49     0  00:44
  265O                   CONDUIT    195.90     0  01:42      7.23
0.07     0.33
  266                    CONDUIT    151.55     0  00:48      3.38
0.03     0.17
  267                    CONDUIT    258.98     0  01:03      3.39
0.10     0.38
  468                    CONDUIT     98.01     0  00:53     15.50
0.01     0.19
  406T                   CONDUIT   3345.92     0  01:34     18.96
0.25     0.59
  439O                   CHANNEL     57.97     0  01:09      3.80
0.13     0.40
  440O                   CHANNEL    202.45     0  01:03      4.10
0.22     0.52
```

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  441O                CONDUIT    158.65     0  00:53       9.37
0.02    0.24
  442O                CONDUIT     48.50     0  00:44       7.92
0.01    0.16
  446O                CONDUIT    174.09     0  01:53       5.77
0.02    0.24
  447O                CONDUIT      7.93     0  01:51       9.75
0.00    0.07
  449O                CONDUIT    249.22     0  00:45      10.32
0.03    0.27
  452O                CONDUIT      0.00     0  00:00       0.00
0.00    0.00
  453O                CONDUIT     23.38     0  01:15       9.03
0.00    0.09
  460O                CONDUIT     21.46     0  02:47       8.10
0.00    0.10
  F201                DUMMY      269.38     0  01:15
  F202                CONDUIT    244.37     0  01:17       3.77
0.03    0.15
  F203                CONDUIT    207.94     0  01:16       4.37
0.02    0.13
  F204                DUMMY      332.72     0  00:46
  F204O               CONDUIT    176.48     0  01:26       4.38
0.01    0.09
  F205                CONDUIT    141.13     0  00:52       4.21
0.10    0.30
  H201                DUMMY      947.86     0  01:40
  H202                CONDUIT    926.41     0  01:41       4.75
0.32    0.63
  H203                DUMMY      900.84     0  01:19
  H203O               CONDUIT    851.12     0  01:39       5.43
0.02    0.17
  H204                CONDUIT    609.55     0  01:33       3.93
0.08    0.32
  H204T               DUMMY      860.26     0  01:20
  H205                DUMMY      482.40     0  01:36
  H205T               CONDUIT    548.64     0  01:37       5.48
0.09    0.33
  H206                DUMMY      703.38     0  01:06
  H206O               CONDUIT    458.71     0  01:38       6.13
0.01    0.12
  H207                DUMMY      292.86     0  00:42
  H207O               CONDUIT     90.43     0  01:49       5.20
0.10    0.37
  H208                CONDUIT     89.78     0  00:44       4.75
0.02    0.14
  H209                CONDUIT    490.89     0  01:08       4.70
0.22    0.53
  H210                CONDUIT    483.09     0  01:03       6.00
0.16    0.40
```



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  H211                CONDUIT     20.91     0  00:47       4.81
0.00    0.09
  H212                DUMMY      214.82     0  00:45
  H212O               CONDUIT    175.10     0  01:05       4.14
0.00    0.04
  H213                CONDUIT     82.46     0  00:46       3.53
0.12    0.42
  H213T               CONDUIT    234.14     0  00:47       6.35
0.03    0.27
  H214                CONDUIT    158.91     0  00:41       6.87
0.02    0.21
  L201                DUMMY      415.83     0  01:20
  L202                DUMMY      404.48     0  01:05
  L202O               CONDUIT    366.90     0  01:20       4.95
0.02    0.18
  L203                CONDUIT     23.53     0  00:43       3.71
0.00    0.11
  L203T               DUMMY      337.91     0  01:06
  L204                CONDUIT    321.00     0  01:06       6.40
0.05    0.31
  L205                DUMMY      276.75     0  00:45
  L205O               CONDUIT    268.69     0  01:38       5.16
0.01    0.14
  L206                DUMMY      279.66     0  01:08
  L206O               CONDUIT    198.06     0  01:36       5.13
0.09    0.32
  L207                DUMMY      235.47     0  00:45
  L207O               CONDUIT    173.52     0  01:13       4.00
0.01    0.14
  L208                CONDUIT     87.70     0  00:47       5.70
0.01    0.17
  L209                DUMMY      251.73     0  00:42
  L209O               CONDUIT      9.64     0  11:15       8.09
1.08    1.00
  L210                CONDUIT    189.74     0  00:43       4.91
0.02    0.19
  L211                CONDUIT     55.90     0  00:42       3.13
0.09    0.24
  L409O               CONDUIT     35.45     0  01:50       5.44
0.00    0.12
  P201                DUMMY      315.54     0  01:27
  P202                CONDUIT    272.06     0  01:30       3.56
0.01    0.07
  P203                DUMMY      232.99     0  01:05
  P203O               CONDUIT    208.51     0  01:27       4.35
0.04    0.26
  P204                CONDUIT    141.67     0  01:12       3.05
0.19    0.45
  P205                CONDUIT     42.97     0  01:10       2.49
0.01    0.18
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  P205T                 CONDUIT     71.98     0  01:25       2.59
0.07    0.31
  P206                  DUMMY       69.54     0  01:15
  P206O                 CONDUIT     35.54     0  02:22       3.17
0.01    0.14
  P207                  DUMMY       43.42     0  00:45
  P207O                 CONDUIT     28.81     0  02:01       3.27
0.01    0.14
  Q201                  DUMMY      100.61     0  00:53
  Q201O                 DUMMY       95.85     0  01:06
  Q202                  CONDUIT     35.21     0  00:58       3.58
0.01    0.11
  R201                  DUMMY      383.76     0  00:55
  R202                  CONDUIT    289.47     0  00:55       4.46
0.01    0.12
  R203                  CONDUIT    172.98     0  00:56       5.24
0.02    0.18
  R204                  CONDUIT    142.19     0  00:50       4.73
0.12    0.43
  S202                  CONDUIT    759.77     0  01:04       5.02
0.45    0.67
  S202T                 CHANNEL   1018.18     0  01:44       1.49
0.04    0.16
  S203                  CHANNEL    124.50     0  00:59       1.72
0.02    0.10
  S204                  CONDUIT     91.95     0  00:50       5.83
0.01    0.17
  S205                  CONDUIT    604.48     0  00:59       4.86
0.26    0.57
  S206                  DUMMY       81.42     0  00:40
  S206O                 CONDUIT     32.48     0  01:33       2.16
0.05    0.17
  S206T                 CONDUIT    480.40     0  00:55       4.85
0.47    0.73
  S207                  CONDUIT      9.87     0  00:52       1.80
0.02    0.11
  S208                  CONDUIT    476.71     0  00:49       4.49
0.02    0.12
  S209                  CONDUIT     93.18     0  00:47       3.25
0.00    0.03
  S210                  CONDUIT      8.91     0  00:52       1.35
0.01    0.04
  S210T                 CONDUIT    287.04     0  00:48       4.19
0.02    0.18
  S211                  CONDUIT    278.86     0  00:46       5.03
0.02    0.15
  S212                  CONDUIT    236.01     0  00:45       4.80
0.02    0.14
  S213                  CONDUIT    134.42     0  00:39       5.54
0.01    0.14
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  S214                  CONDUIT    505.43     0  01:29       4.53
0.36    0.57
  S215                  CONDUIT     28.39     0  00:52       2.51
0.27    0.47
  S215T                 CHANNEL    455.53     0  01:30       1.19
0.20    0.55
  S216                  CONDUIT    446.61     0  01:23       2.28
0.10    0.27
  S217                  CHANNEL    388.98     0  01:18       2.94
0.11    0.39
  S418                  CONDUIT    287.49     0  01:13       3.14
0.04    0.17
  S219                  CONDUIT    342.15     0  00:57       5.08
0.02    0.12
  S221                  DUMMY       59.04     0  00:51
  S221T                 CONDUIT    171.99     0  00:59       3.19
0.08    0.34
  S222                  CONDUIT     41.98     0  00:52       3.06
0.00    0.05
  S223                  DUMMY      115.60     0  00:52
  S224                  CONDUIT     94.76     0  00:51       4.24
0.01    0.09
  268                   CONDUIT    139.13     0  00:34      12.27
1.08    1.00
  RP203                 CONDUIT     23.55     0  01:05       1.22
0.01    0.10
  RP202                 CONDUIT      5.50     0  01:37       0.90
0.00    0.06
  S220                  CONDUIT    221.38     0  01:00       4.15
0.08    0.34
  S218                  CONDUIT     55.06     0  01:26       9.69
0.91    0.75
  D207                  CONDUIT    113.78     0  01:10       2.45
0.10    0.30
  D205                  CONDUIT     14.37     0  01:57       0.71
0.00    0.03
  D203                  DUMMY      195.90     0  01:02
  D202T                 CONDUIT    264.26     0  01:17       2.20
0.30    0.62
  D204                  CONDUIT     69.29     0  01:14       1.39
0.11    0.41
  D202                  DUMMY       78.66     0  00:55
  518                   DUMMY      153.68     0  01:13
  530                   DUMMY      379.15     0  00:57
  539                   DUMMY       64.32     0  01:04
  540                   DUMMY      213.94     0  00:58
  541                   DUMMY      191.11     0  00:47
  542                   DUMMY       64.04     0  00:40
  546                   DUMMY      188.62     0  01:49
  547                   DUMMY      169.10     0  01:45
```

549	DUMMY	302.54	0	00:43
552	DUMMY	51.50	0	11:08
553	DUMMY	29.19	0	01:12
560	DUMMY	205.72	0	02:41
565	DUMMY	197.64	0	01:36
F504	DUMMY	176.54	0	01:21
H503	DUMMY	852.07	0	01:34
H506	DUMMY	459.16	0	01:34
H507	DUMMY	90.78	0	01:39
H512	DUMMY	176.16	0	01:02
L502	DUMMY	373.85	0	01:14
L505	DUMMY	269.26	0	01:35
L506	DUMMY	199.16	0	01:31
L507	DUMMY	173.77	0	01:11
L509	DUMMY	45.71	0	01:43
P503	DUMMY	208.71	0	01:24
P506	DUMMY	35.54	0	02:21
P507	DUMMY	24.55	0	01:23
Q501	DUMMY	95.85	0	01:06
S506	DUMMY	32.49	0	01:31

****

Conduit Surcharge Summary

****

Conduit	--------- Hours Full --------			Hours Above Full	Hours Capacity Limited
	Both Ends	Upstream	Dnstream	Normal Flow	
206T	7.38	7.38	7.38	7.38	7.38
2390	2.96	2.96	2.96	0.15	2.96
2400	1.80	1.80	1.80	1.86	1.80
2410	1.61	1.61	1.61	0.06	1.61
2420	1.23	1.23	1.23	0.07	1.23
2460	13.37	13.37	13.37	0.15	13.37

19_Fut_100yr_0mi^2_018-2897.rpt

2470	0.48	0.48	0.48	0.48	0.48
2490	1.27	1.27	1.27	0.07	1.27
2530	2.70	2.70	2.70	0.08	2.70
2600	3.10	3.10	3.10	3.12	3.10
L2090	10.62	10.62	10.62	10.70	10.62
268	0.89	0.89	0.89	0.92	0.89

Analysis begun on: Tue Oct 26 16:31:49 2021
Analysis ended on: Tue Oct 26 16:31:52 2021
Total elapsed time: 00:00:03

Table B-3A - 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}
101	6463	10.1	37	42	223	434	704	2,090	2,974	4,364	7,538	278	520	795	2,213	3,117	4,599	7,734
102	6345	9.9	36	42	301	675	946	2,336	3,224	4,563	7,861	368	675	1,060	2,440	3,375	4,711	8,078
103	6041	9.4	37	42	292	544	905	2,203	3,056	4,313	7,494	340	598	976	2,286	3,158	4,425	7,626
103T	6301	9.8	37	42	302	567	952	2,344	3,234	4,569	7,844	371	639	1,063	2,447	3,385	4,716	8,059
104	4776	7.5	39	44	251	456	748	1,767	2,437	3,407	5,850	277	490	795	1,825	2,506	3,477	5,930
104T	6037	9.4	37	42	292	545	905	2,204	3,057	4,314	7,494	340	599	976	2,287	3,159	4,425	7,625
105	11	0.0	46	46	3	5	8	13	17	21	32	3	5	8	13	17	21	32
105T	4758	7.4	39	44	251	458	751	1,780	2,456	3,418	5,847	279	490	798	1,839	2,526	3,491	5,926
106	4690	7.3	39	44	248	455	744	1,762	2,427	3,376	5,773	276	487	791	1,819	2,496	3,447	5,849
106T	4747	7.4	39	44	251	457	749	1,776	2,450	3,410	5,834	278	490	796	1,834	2,520	3,483	5,913
107	57	0.1	29	29	10	15	25	54	75	100	161	10	15	25	54	75	100	161
108	139	0.2	24	29	15	27	52	113	154	206	327	19	33	58	119	160	213	335
108T	4608	7.2	40	44	256	457	752	1,779	2,446	3,376	5,696	281	484	791	1,834	2,509	3,449	5,769
109	57	0.1	49	49	14	22	31	54	69	88	133	14	22	31	54	69	88	133
110	51	0.1	31	32	10	18	29	54	72	93	144	11	19	30	56	74	95	149
111	11	0.0	6	6	0	0	1	3	5	7	12	0	0	1	3	5	7	12
111T	4418	6.9	40	45	254	447	730	1,748	2,378	3,276	5,450	279	470	766	1,797	2,437	3,344	5,515
112	93	0.1	35	41	21	37	58	106	140	179	278	27	45	69	120	157	201	308
113	49	0.1	5	54	1	3	10	26	37	51	83	19	29	41	67	86	108	162
113T	4314	6.7	40	45	247	438	712	1,701	2,307	3,175	5,304	271	463	748	1,749	2,365	3,242	5,366
114	25	0.0	53	66	11	17	23	38	48	60	90	16	23	30	45	57	71	104
115	3866	6.0	42	46	234	412	660	1,546	2,078	2,834	4,698	247	425	680	1,574	2,113	2,873	4,736
115T	4239	6.6	41	45	244	434	705	1,675	2,266	3,112	5,204	261	452	731	1,712	2,310	3,164	5,255
116	99	0.2	46	53	29	47	67	115	148	189	287	37	57	80	129	166	209	312
117	3171	5.0	42	46	255	430	659	1,287	1,740	2,325	3,743	264	442	673	1,306	1,764	2,355	3,790
117T	3724	5.8	42	46	223	396	630	1,472	1,970	2,675	4,471	232	405	642	1,493	1,996	2,705	4,503
118	120	0.2	49	49	49	76	108	179	230	290	437	49	76	108	179	230	290	437
118T	3067	4.8	42	47	244	406	619	1,216	1,639	2,180	3,509	253	417	633	1,235	1,663	2,209	3,556
318	120	0.2	49	49	49	76	108	179	230	290	437	49	76	108	179	230	290	437
118O	120	0.2	49	49	28	32	36	61	93	154	330	28	32	36	61	93	154	330
119	2947	4.6	41	46	223	376	588	1,173	1,571	2,066	3,211	232	387	602	1,192	1,596	2,097	3,257
120	103	0.2	42	42	28	45	68	120	156	201	309	28	45	68	120	156	201	309
120T	2870	4.5	41	47	213	359	560	1,117	1,493	1,959	3,040	218	364	567	1,127	1,506	1,975	3,064
121	26	0.0	42	42	7	11	16	28	36	46	71	7	11	16	28	36	46	71
122	2767	4.3	41	47	194	329	512	1,028	1,370	1,789	2,811	199	335	520	1,039	1,383	1,805	2,827
123	71	0.1	39	39	17	28	42	74	97	125	191	17	28	42	74	97	125	191
123T	2696	4.2	42	47	184	314	487	981	1,304	1,699	2,678	189	319	494	991	1,317	1,715	2,694
124	10	0.0	44	44	2	3	4	8	10	13	19	2	3	4	8	10	13	19
124T	2625	4.1	42	47	172	294	455	921	1,221	1,588	2,527	176	299	462	932	1,234	1,604	2,542
125	340	0.5	44	44	91	149	221	390	508	654	1,001	91	149	221	390	508	654	1,001
125T	2615	4.1	42	47	170	291	451	914	1,212	1,575	2,509	175	296	458	924	1,225	1,591	2,524
126	228	0.4	42	42	67	109	161	277	359	457	697	67	109	161	277	359	457	697
127	157	0.2	43	43	52	85	124	210	272	345	525	52	85	124	210	272	345	525
128	80	0.1	48	48	40	63	91	147	190	241	363	40	63	91	147	190	241	363
129	2037	3.2	41	48	80	127	188	334	469	693	1,440	84	133	195	344	475	701	1,449
129T	2275	3.6	41	48	100	173	261	548	724	1,015	1,864	103	178	267	558	736	1,025	1,875
130	238	0.4	44	44	55	89	131	231	301	387	592	55	89	131	231	301	387	592
330	238	0.4	44	44	55	89	131	231	301	387	592	55	89	131	231	301	387	592

Table B-3A - 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}
130O	238	0.4	44	44	31	60	95	217	290	379	588	31	60	95	217	290	379	588
131	87	0.1	49	49	22	34	49	83	107	137	207	22	34	49	83	107	137	207
131T	143	0.2	47	47	36	57	83	143	185	236	359	36	57	83	143	185	236	359
132	2	0.0	49	49	0	0	1	1	1	2	3	0	0	1	1	1	2	3
133	56	0.1	46	46	16	26	37	63	82	105	159	16	26	37	63	82	105	159
134	1984	3.1	41	48	73	114	170	297	439	646	1,385	77	120	177	307	445	655	1,395
135	1587	2.5	40	49	56	87	126	248	382	558	920	60	92	133	251	388	567	933
135T	1975	3.1	41	48	71	111	165	288	432	635	1,372	75	117	172	298	438	644	1,382
136	115	0.2	47	47	31	50	72	176	283	424	709	31	50	72	176	283	424	709
137	13	0.0	48	48	3	5	7	12	15	20	30	3	5	7	12	15	20	30
138	8	0.0	44	44	2	3	4	7	9	11	17	2	3	4	7	9	11	17
139	127	0.2	41	41	20	27	41	57	67	78	102	20	27	41	57	67	78	102
139T	11	0.0	43	43	3	5	25	120	188	276	456	3	5	25	120	188	276	456
339	127	0.2	41	41	20	27	41	57	67	78	102	20	27	41	57	67	78	102
139O	190	0.3	40	40	17	21	42	56	65	78	104	17	21	42	56	65	78	104
140	41	0.1	37	37	8	14	30	110	160	222	359	8	14	30	110	160	222	359
140T	11	0.0	43	43	3	5	7	86	147	220	373	3	5	7	86	147	220	373
340	41	0.1	37	37	8	14	30	110	160	222	359	8	14	30	110	160	222	359
140O	64	0.1	39	39	7	8	8	97	154	220	360	7	8	8	97	154	220	360
141	103	0.2	40	40	26	45	65	115	150	193	291	26	45	65	115	150	193	291
341	103	0.2	40	40	26	45	65	115	150	193	291	26	45	65	115	150	193	291
141O	103	0.2	40	40	16	20	46	109	146	191	290	16	20	46	109	146	191	290
142	28	0.0	42	42	9	15	23	39	50	64	98	9	15	23	39	50	64	98
342	28	0.0	42	42	9	15	23	39	50	64	98	9	15	23	39	50	64	98
142O	28	0.0	42	42	9	15	23	39	50	64	92	9	15	23	39	50	64	92
143	11	0.0	43	43	3	5	7	12	16	20	31	3	5	7	12	16	20	31
144	7	0.0	46	46	2	3	5	8	11	14	21	2	3	5	8	11	14	21
145	388	0.6	45	45	20	31	46	78	105	202	621	20	31	46	78	106	204	623
146	335	0.5	45	45	21	27	34	47	105	192	552	21	27	34	47	105	192	554
346	335	0.5	45	45	21	27	34	47	105	192	552	21	27	34	47	105	192	554
146O	335	0.5	45	45	8	13	25	34	102	187	552	8	14	25	34	103	189	554
147	310	0.5	45	45	74	134	199	365	478	637	1,009	75	135	200	366	479	639	1,012
347	310	0.5	45	45	74	134	199	365	478	637	1,009	75	135	200	366	479	639	1,012
147O	310	0.5	45	45	18	23	27	34	94	168	511	18	23	27	34	95	169	513
148	69	0.1	41	41	13	32	77	177	247	345	563	13	32	77	177	247	345	563
149	127	0.2	43	43	47	76	113	190	248	314	479	47	76	113	190	248	314	479
349	127	0.2	43	43	47	76	113	190	248	314	479	47	76	113	190	248	314	479
149O	127	0.2	43	43	32	62	96	170	222	303	479	32	62	96	170	222	303	479
150	98	0.2	46	46	44	71	105	172	224	284	430	44	71	105	172	224	284	430
151	28	0.0	44	46	7	11	16	27	35	45	69	7	12	17	28	37	47	71
152	1197	1.9	40	51	109	174	263	477	622	808	1,259	146	219	314	543	699	894	1,375
352	1197	1.9	40	51	109	174	263	477	622	808	1,259	146	219	314	543	699	894	1,375
152O	1197	1.9	40	51	9	14	21	32	40	49	63	12	17	24	35	43	52	65
153	22	0.0	43	43	6	10	14	24	32	40	61	6	10	14	24	32	40	61
153T	310	0.5	43	49	63	104	158	288	378	491	779	85	133	194	334	432	553	860
353	22	0.0	43	43	6	10	14	24	32	40	61	6	10	14	24	32	40	61
153O	22	0.0	43	43	5	8	10	14	17	29	51	5	8	10	14	17	29	51
154	222	0.3	39	49	41	69	106	199	263	345	534	64	99	144	249	322	412	624

Table B-3A - 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}
155	158	0.2	42	55	33	53	81	149	195	254	391	55	84	118	197	252	320	479
156	41	0.1	46	46	11	17	25	43	56	71	108	11	17	25	43	56	71	108
156T	111	0.2	38	57	21	34	54	101	134	175	270	44	65	91	148	189	238	356
157	70	0.1	34	64	12	19	31	60	81	106	166	35	50	68	108	137	171	254
158	87	0.1	51	51	23	36	51	86	111	141	213	23	36	51	86	111	141	213
159	763	1.2	39	54	59	75	96	137	166	202	373	77	97	119	157	185	220	439
160	710	1.1	40	56	89	135	203	391	543	753	1,229	154	227	315	537	708	940	1,485
360	710	1.1	40	56	89	135	203	391	543	753	1,229	154	227	315	537	708	940	1,485
160O	710	1.1	40	56	59	75	95	133	164	195	370	76	95	116	151	179	206	433
161	644	1.0	41	59	85	127	185	351	487	672	1,096	149	217	295	492	645	853	1,346
162	25	0.0	14	32	2	3	8	18	25	34	54	5	8	13	26	34	45	70
163	369	0.6	44	64	48	59	75	118	150	230	487	81	108	136	207	254	313	534
163T	482	0.8	44	60	68	92	127	228	321	446	777	104	144	189	311	415	554	886
164	331	0.5	49	67	54	60	70	102	143	219	462	81	105	130	183	220	263	505
165	253	0.4	57	64	90	137	193	314	354	416	565	111	163	222	348	393	459	621
365	253	0.4	57	64	90	137	193	314	354	416	565	111	163	222	348	393	459	621
165O	253	0.4	57	64	43	48	52	66	113	170	358	45	50	54	79	129	198	394
166	66	0.1	51	64	22	35	50	83	107	134	203	32	48	65	101	128	158	234
167	113	0.2	45	45	26	41	60	118	185	272	479	26	41	60	118	185	272	479
168	117	0.2	58	58	44	66	91	148	187	236	351	44	66	91	148	187	236	351
D101	374	0.6	31	31	43	62	88	178	251	354	597	43	62	88	178	251	354	597
D102T	262	0.4	26	26	35	49	71	143	198	273	448	35	49	71	143	198	273	448
D102	80	0.1	8	8	2	3	12	38	56	79	131	2	3	12	38	56	79	131
D103	182	0.3	34	34	33	46	59	104	143	196	320	33	46	59	104	143	196	320
D104	76	0.1	7	7	1	3	5	33	53	79	137	1	3	5	33	53	79	137
D105	28	0.0	2	2	0	0	1	9	14	22	38	0	0	1	9	14	22	38
D106	189	0.3	33	33	25	35	47	110	158	224	371	25	35	47	110	158	224	371
D107	110	0.2	6	6	2	4	8	57	91	135	234	2	4	8	57	91	135	234
D108	65	0.1	11	11	1	2	4	18	28	43	74	1	2	4	18	28	43	74
F101	260	0.4	20	35	20	40	70	120	150	222	334	46	67	90	136	212	269	523
F102	235	0.4	21	37	20	38	65	107	131	204	293	45	64	85	123	197	246	490
F103	201	0.3	20	39	17	33	55	89	106	175	233	42	60	76	106	174	208	432
F104	166	0.3	24	45	18	33	55	120	165	223	360	44	71	107	195	256	333	515
F304	166	0.3	24	45	18	33	55	120	165	223	360	44	71	107	195	256	333	515
F104O	166	0.3	24	45	18	32	50	76	88	150	191	41	57	69	93	153	177	382
F105	78	0.1	17	47	4	7	16	41	58	80	131	23	34	49	87	114	146	224
H101	1261	2.0	31	37	58	111	204	438	624	909	1,647	74	134	231	462	653	948	1,696
H102	1228	1.9	31	37	58	110	200	429	611	892	1,616	73	132	226	452	639	929	1,664
H103	1115	1.7	30	37	58	103	184	415	613	875	1,517	85	134	206	430	632	901	1,548
H303	1115	1.7	30	37	58	103	184	415	613	875	1,517	85	134	206	430	632	901	1,548
H103O	1115	1.7	30	37	57	102	180	396	564	824	1,497	70	119	201	415	587	852	1,530
H104	804	1.3	38	40	54	91	146	303	428	600	1,093	56	95	151	308	434	610	1,125
H104T	1073	1.7	30	37	56	99	175	397	586	837	1,454	80	126	195	412	604	860	1,482
H105	613	1.0	40	42	50	83	128	243	335	469	887	53	87	133	250	344	482	921
H105T	693	1.1	38	40	51	84	136	274	381	535	996	53	87	140	281	390	550	1,033
H106	578	0.9	42	44	96	143	207	369	484	663	1,158	98	145	209	371	504	703	1,221
H306	578	0.9	42	44	96	143	207	369	484	663	1,158	98	145	209	371	504	703	1,221
H106O	578	0.9	42	44	49	82	124	233	320	446	847	52	85	129	240	329	459	880

Table B-3A - 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}
H107	142	0.2	43	47	38	60	90	163	213	275	422	45	68	101	176	229	293	448
H307	142	0.2	43	47	38	60	90	163	213	275	422	45	68	101	176	229	293	448
H107O	142	0.2	43	47	26	30	35	41	58	86	270	27	32	36	42	61	91	286
H108	44	0.1	37	45	10	15	24	45	60	78	123	14	20	30	54	71	91	141
H109	322	0.5	37	38	49	77	119	227	326	464	823	50	78	120	243	343	497	856
H110	306	0.5	37	39	49	76	116	220	317	452	803	49	77	117	236	334	484	836
H111	15	0.0	35	35	2	4	5	11	16	21	34	2	4	5	11	16	21	34
H112	114	0.2	34	38	23	38	61	115	152	198	308	28	45	70	126	165	215	331
H312	114	0.2	34	38	23	38	61	115	152	198	308	28	45	70	126	165	215	331
H112O	114	0.2	34	38	4	11	24	71	101	161	282	5	14	30	78	110	176	303
H113	40	0.1	42	43	12	17	27	49	65	84	129	12	18	28	50	66	85	131
H113T	99	0.2	49	50	38	58	84	143	186	236	361	39	59	85	145	188	239	364
H114	59	0.1	54	54	29	44	62	99	127	159	240	29	44	63	100	128	161	242
L101	553	0.9	43	44	50	90	129	195	270	413	959	51	91	131	197	272	416	961
L102	501	0.8	46	46	75	114	146	214	263	404	915	75	114	146	214	263	404	915
L302	501	0.8	46	46	75	114	146	214	263	404	915	75	114	146	214	263	404	915
L102O	501	0.8	46	46	50	86	121	174	243	374	897	50	86	121	174	243	374	897
L103	10	0.0	49	49	4	6	9	15	19	24	36	4	6	9	15	19	24	36
L103T	457	0.7	46	46	63	94	118	164	222	338	840	63	94	118	164	222	338	840
L104	447	0.7	46	46	60	89	110	150	212	321	823	60	89	110	150	212	321	823
L105	397	0.6	45	45	46	71	102	171	219	277	745	46	71	102	171	219	277	745
L305	397	0.6	45	45	46	71	102	171	219	277	745	46	71	102	171	219	277	745
L105O	397	0.6	45	45	46	68	84	102	168	269	744	46	68	84	102	168	269	744
L106	289	0.5	45	45	36	52	72	118	189	280	595	36	52	72	118	189	280	595
L306	289	0.5	45	45	36	52	72	118	189	280	595	36	52	72	118	189	280	595
L106O	289	0.5	45	45	29	38	47	70	85	199	568	29	38	47	70	85	199	568
L107	119	0.2	47	47	37	58	84	143	184	235	357	37	58	84	143	184	235	357
L307	119	0.2	47	47	37	58	84	143	184	235	357	37	58	84	143	184	235	357
L107O	119	0.2	47	47	14	19	22	69	116	174	331	14	19	22	69	116	174	331
L108	46	0.1	47	47	14	22	32	54	70	88	134	14	22	32	54	70	88	134
L109	105	0.2	43	43	35	57	86	150	197	252	386	35	57	86	150	197	252	386
L309	105	0.2	43	43	35	57	86	150	197	252	386	35	57	86	150	197	252	386
L109O	105	0.2	43	43	11	13	16	20	22	46	219	11	13	16	20	22	46	219
L110	74	0.1	47	47	29	47	68	117	151	192	292	29	47	68	117	151	192	292
L111	22	0.0	47	47	9	15	22	35	45	58	88	9	15	22	35	45	58	88
P101	373	0.6	31	35	19	44	75	154	219	307	508	21	47	80	161	227	316	521
P102	325	0.5	35	35	20	43	72	143	200	276	451	20	43	72	143	200	276	451
P103	262	0.4	33	33	37	57	80	139	180	233	366	37	57	80	139	180	233	366
P303	262	0.4	33	33	37	57	80	139	180	233	366	37	57	80	139	180	233	366
P103O	262	0.4	33	33	16	33	55	109	152	209	335	16	33	55	109	152	209	335
P104	197	0.3	26	26	20	31	43	78	102	142	225	20	31	43	78	102	142	225
P105	56	0.1	14	14	2	4	9	22	31	43	70	2	4	9	22	31	43	70
P105T	142	0.2	15	15	4	7	14	36	56	73	104	4	7	14	36	56	73	104
P106	86	0.1	15	15	2	5	12	29	50	70	134	2	5	12	29	50	70	134
P306	86	0.1	15	15	2	5	12	29	50	70	134	2	5	12	29	50	70	134
P106O	86	0.1	15	15	2	4	6	22	32	36	45	2	4	6	22	32	36	45
P107	27	0.0	23	23	3	6	11	24	33	43	69	3	6	11	24	33	43	69
P307	27	0.0	23	23	3	6	11	24	33	43	69	3	6	11	24	33	43	69

Table B-3A - Baseline Peak Flows

Design Point	Drainage Area	Drainage Area	Existing Percent	Future Percent	Existing Conditions Peak Flow (cfs)							Future Conditions Peak Flow (cfs)						
	(acres)	(sm)	Imperviousness	Imperviousness	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}
P107O	27	0.0	23	23	1	2	4	12	24	25	62	1	2	4	12	24	25	62
Q101	80	0.1	20	20	6	12	24	54	74	101	162	6	12	24	54	74	101	162
Q301	80	0.1	20	20	6	12	24	54	74	101	162	6	12	24	54	74	101	162
Q101O	80	0.1	20	20	0	2	8	37	64	96	158	0	2	8	37	64	96	158
Q102	27	0.0	16	16	2	5	9	20	27	37	59	2	5	9	20	27	37	59
R101	269	0.4	7	28	4	14	50	148	213	301	498	45	68	104	212	287	384	611
R102	204	0.3	7	25	4	11	43	124	177	247	407	44	63	83	163	222	297	474
R103	150	0.2	5	8	1	4	27	85	122	171	285	2	6	30	87	125	174	288
R104	120	0.2	6	9	1	3	22	69	100	139	232	2	5	24	71	102	142	235
RP101	143	0.2	4	4	1	1	8	32	57	93	182	1	1	8	32	57	93	182
RP102	16	0.0	5	5	0	0	0	1	5	9	21	0	0	0	1	5	9	21
RP103	44	0.1	6	6	0	1	2	4	17	33	74	0	1	2	4	17	33	74
S101	1230	1.9	15	28	17	42	102	339	556	870	1,642	61	108	196	483	714	1,079	1,930
S102	546	0.9	11	32	9	28	75	240	363	534	932	77	127	200	417	570	769	1,236
S102T	1074	1.7	14	29	23	57	128	373	588	908	1,668	93	156	250	542	781	1,120	1,965
S103	116	0.2	3	15	1	2	6	44	70	103	180	8	12	19	61	90	127	213
S104	94	0.1	3	5	1	1	5	38	61	90	158	1	2	6	40	63	92	160
S105	399	0.6	14	39	8	26	69	192	283	407	703	73	120	186	352	468	614	967
S106	39	0.1	55	55	15	22	31	51	65	81	122	15	22	31	51	65	81	122
S306	39	0.1	55	55	15	22	31	51	65	81	122	15	22	31	51	65	81	122
S106O	39	0.1	55	55	1	1	2	11	21	32	45	1	1	2	11	21	32	45
S106T	328	0.5	13	38	6	19	52	150	221	322	558	64	102	154	284	374	487	764
S107	10	0.0	8	8	0	0	1	5	7	10	17	0	0	1	5	7	10	17
S108	279	0.4	7	37	6	19	51	145	213	303	509	64	102	154	279	368	478	742
S109	58	0.1	2	28	1	5	14	37	52	72	117	9	17	28	53	71	94	147
S110	8	0.0	2	35	0	0	1	3	4	6	9	1	2	3	5	7	9	14
S110T	162	0.3	8	39	4	9	25	78	119	173	295	44	66	96	170	223	287	445
S111	155	0.2	9	39	4	9	24	76	115	167	286	43	64	93	165	216	279	432
S112	128	0.2	10	43	4	7	19	60	91	134	231	42	61	85	143	186	239	369
S113	38	0.1	2	75	0	0	1	15	28	45	86	36	49	63	91	115	142	211
S114	528	0.8	17	27	16	30	55	173	283	432	806	20	36	78	221	329	505	906
S115	11	0.0	19	69	1	3	5	10	13	17	27	8	12	16	23	29	36	52
S115T	444	0.7	16	28	14	26	48	160	256	394	717	18	31	73	206	311	462	809
S116	433	0.7	16	27	15	26	47	156	250	385	700	15	27	71	202	304	451	789
S117	367	0.6	12	25	5	13	33	135	217	334	599	6	21	59	178	267	393	676
S118	258	0.4	12	28	12	23	59	156	222	309	507	29	50	91	195	268	362	580
S119	246	0.4	10	27	10	20	55	147	210	294	483	26	45	84	183	252	342	549
S120	164	0.3	14	26	9	18	41	103	145	199	325	17	30	55	120	164	222	355
S121	46	0.1	4	22	0	2	8	24	35	49	81	4	7	14	32	44	59	94
S121T	129	0.2	17	25	10	18	37	87	120	163	263	14	24	44	96	131	175	278
S122	32	0.1	5	28	0	1	6	16	24	33	54	4	6	11	23	32	42	67
S123	83	0.1	24	27	10	16	29	63	85	114	182	10	17	30	64	87	116	184
S124	59	0.1	33	33	11	17	28	55	74	97	153	11	17	28	55	74	97	153
S125	56	0.1	3	28	0	0	1	4	12	25	57	4	6	9	18	29	44	82

Table B-3B - Historic Peak Flows and Volumes

Design Point	Drainage Area (acres)	Drainage Area (sm)	Historic Percent Imperviousness	Historic Conditions Peak Flow (cfs)							Historic Conditions Runoff Volume (acre-feet)						
				Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_{500}
101	6463	10.1	2	3	12	116	1,975	3,083	4,852	8,371	3	9	43	417	608	862	1442
102	6345	9.9	2	8	25	382	2,173	3,326	4,946	8,737	4	10	87	399	583	832	1396
103	6041	9.4	2	8	25	370	2,086	3,192	4,745	8,384	4	9	81	374	546	783	1317
103T	6301	9.8	2	8	26	385	2,180	3,332	4,947	8,731	4	10	86	396	580	826	1387
104	4776	7.5	2	7	20	313	1,708	2,591	3,833	6,692	3	7	66	297	436	620	1043
104T	6037	9.4	2	8	25	370	2,087	3,193	4,746	8,384	4	9	81	371	546	779	1317
105	11	0.0	2	0	1	2	6	8	11	18	0	0	0	1	1	1	2
105T	4758	7.4	2	7	20	315	1,716	2,597	3,834	6,696	3	7	66	296	433	617	1040
106	4690	7.3	2	7	20	314	1,707	2,581	3,807	6,639	3	7	66	293	430	611	1028
106T	4747	7.4	2	7	20	314	1,713	2,593	3,828	6,685	3	7	66	296	433	617	1037
107	57	0.1	2	0	1	7	32	50	72	122	0	0	0	2	4	6	11
108	139	0.2	2	1	4	23	71	104	147	246	0	1	3	8	12	18	30
108T	4608	7.2	2	7	21	321	1,717	2,579	3,785	6,592	3	7	65	288	420	602	1010
109	57	0.1	2	0	3	8	21	30	43	70	0	0	1	4	5	7	13
110	51	0.1	2	0	5	14	34	48	66	108	0	0	1	3	5	7	11
111	11	0.0	2	0	0	1	3	5	7	11	0	0	0	1	1	1	2
111T	4418	6.9	2	7	21	323	1,697	2,534	3,701	6,427	3	7	62	276	405	574	967
112	93	0.1	2	1	7	22	60	85	117	191	0	1	2	6	8	12	20
113	49	0.1	2	0	3	9	25	36	50	82	0	0	1	3	4	6	11
113T	4314	6.7	2	7	21	320	1,670	2,489	3,636	6,302	3	6	61	270	396	562	945
114	25	0.0	2	0	2	6	15	21	29	48	0	0	1	2	2	3	5
115	3866	6.0	2	7	19	293	1,516	2,255	3,297	5,714	2	6	55	242	353	503	847
115T	4239	6.6	2	7	21	316	1,651	2,458	3,588	6,214	3	6	60	265	387	552	930
116	99	0.2	2	1	7	19	50	71	98	161	0	1	2	6	9	13	22
117	3171	5.0	2	9	114	420	1,234	1,837	2,702	4,664	3	23	73	198	290	414	694
117T	3724	5.8	2	7	19	286	1,474	2,189	3,204	5,540	2	5	53	233	341	485	816
118	120	0.2	2	1	10	29	75	106	146	238	0	1	3	7	11	16	26
118T	3067	4.8	2	9	114	411	1,203	1,789	2,630	4,532	3	22	71	192	280	399	672
318	120	0.2	2	1	10	29	75	106	146	238	0	1	3	7	11	16	26
118O	120	0.2	2	1	10	29	75	106	146	238	0	1	3	7	11	16	26
119	2947	4.6	2	10	113	399	1,164	1,729	2,544	4,371	2	21	68	184	269	384	644
120	103	0.2	2	1	7	22	59	83	115	189	0	1	2	6	9	13	22
120T	2870	4.5	2	9	110	389	1,137	1,690	2,486	4,267	2	21	66	179	262	374	629
121	26	0.0	2	0	2	5	13	19	26	42	0	0	1	2	2	3	6
122	2767	4.3	2	9	106	375	1,099	1,635	2,405	4,121	2	20	64	173	253	359	605
123	71	0.1	2	1	5	14	37	53	73	119	0	1	2	4	6	9	15
123T	2696	4.2	2	9	104	366	1,075	1,600	2,354	4,031	2	19	62	168	246	350	589
124	10	0.0	2	0	0	1	3	5	7	11	0	0	0	1	1	1	2
124T	2625	4.1	2	9	101	357	1,049	1,562	2,298	3,932	2	19	60	164	240	341	574
125	340	0.5	2	2	22	68	184	262	365	598	0	3	8	21	31	44	75
125T	2615	4.1	2	9	100	355	1,046	1,558	2,292	3,922	2	19	60	163	239	341	574
126	228	0.4	2	2	18	52	134	189	260	423	0	2	5	14	21	30	50
127	157	0.2	2	1	14	39	100	141	193	315	0	1	4	10	14	20	34
128	80	0.1	2	1	10	27	67	94	128	208	0	1	2	5	7	10	17
129	2037	3.2	2	6	71	265	808	1,219	1,792	3,065	2	14	47	127	186	265	445
129T	2275	3.6	2	7	81	297	893	1,345	1,978	3,386	2	16	52	142	208	296	497
130	238	0.4	2	1	12	38	103	147	207	340	0	2	6	15	22	31	52
330	238	0.4	2	1	12	38	103	147	207	340	0	2	6	15	22	31	52

Table B-3B - Historic Peak Flows and Volumes

Design Point	Drainage Area (acres)	Drainage Area (sm)	Historic Percent Imperviousness	Historic Conditions Peak Flow (cfs)							Historic Conditions Runoff Volume (acre-feet)						
				Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_{500}
130O	238	0.4	2	1	12	38	103	147	207	340	0	2	6	15	22	31	52
131	87	0.1	2	0	4	12	33	47	67	111	0	1	2	5	8	11	19
131T	143	0.2	2	1	7	22	59	85	119	197	0	1	3	9	13	19	31
132	2	0.0	2	0	0	0	0	1	1	1	0	0	0	0	0	0	0
133	56	0.1	2	0	4	11	28	40	55	90	0	0	1	3	5	7	12
134	1984	3.1	2	6	70	259	791	1,196	1,757	3,003	2	14	45	123	181	258	433
135	1587	2.5	2	4	49	204	622	936	1,374	2,344	1	11	36	99	144	206	347
135T	1975	3.1	2	6	69	258	788	1,191	1,751	2,991	2	14	45	123	180	257	433
136	115	0.2	2	1	7	39	128	191	276	464	0	1	4	14	22	33	58
137	13	0.0	2	0	1	2	5	7	10	16	0	0	0	1	1	2	3
138	8	0.0	2	0	0	1	3	4	6	10	0	0	0	0	1	1	2
139	127	0.2	2	1	9	27	41	47	54	70	0	1	3	6	8	9	12
139T	11	0.0	2	0	1	22	81	121	175	295	0	0	1	8	13	19	35
339	127	0.2	2	1	9	27	41	47	54	70	0	1	3	6	8	9	12
139O	190	0.3	2	1	13	39	55	60	67	84	0	1	4	9	11	13	16
140	41	0.1	2	0	3	8	49	82	125	222	0	0	1	4	8	13	25
140T	11	0.0	2	0	1	2	47	82	128	232	0	0	0	3	7	12	25
340	41	0.1	2	0	3	8	49	82	125	222	0	0	1	4	8	13	25
140O	64	0.1	2	0	4	12	55	88	130	228	0	0	1	5	9	14	26
141	103	0.2	2	1	8	22	58	82	113	185	0	1	2	6	9	13	23
341	103	0.2	2	1	8	22	58	82	113	185	0	1	2	6	9	13	23
141O	103	0.2	2	1	8	22	58	82	113	185	0	1	2	6	9	13	23
142	28	0.0	2	0	3	8	19	27	37	60	0	0	1	2	3	4	6
342	28	0.0	2	0	3	8	19	27	37	60	0	0	1	2	3	4	6
142O	28	0.0	2	0	3	8	19	27	37	60	0	0	1	2	3	4	6
143	11	0.0	2	0	1	2	6	8	11	19	0	0	0	1	1	1	2
144	7	0.0	2	0	0	1	4	5	7	12	0	0	0	0	1	1	2
145	388	0.6	2	3	28	87	229	329	457	751	0	3	9	24	36	51	85
146	335	0.5	2	2	25	76	200	285	394	646	0	3	8	21	31	44	73
346	335	0.5	2	2	25	76	200	285	394	646	0	3	8	21	31	44	73
146O	335	0.5	2	2	25	76	200	285	394	646	0	3	8	21	31	44	73
147	310	0.5	2	2	24	73	190	272	375	615	0	2	7	19	28	41	68
347	310	0.5	2	2	24	73	190	272	375	615	0	2	7	19	28	41	68
147O	310	0.5	2	2	24	73	190	272	375	615	0	2	7	19	28	41	68
148	69	0.1	2	0	3	10	69	118	179	324	0	1	2	6	11	17	33
149	127	0.2	2	1	13	38	94	133	182	295	0	1	3	8	12	16	28
349	127	0.2	2	1	13	38	94	133	182	295	0	1	3	8	12	16	28
149O	127	0.2	2	1	13	38	94	133	182	295	0	1	3	8	12	16	28
150	98	0.2	2	1	12	33	81	115	156	253	0	1	2	6	9	13	21
151	28	0.0	2	0	2	5	12	17	24	39	0	0	1	2	3	4	6
152	1197	1.9	2	3	38	154	471	711	1,043	1,779	1	8	27	74	109	157	265
352	1197	1.9	2	3	38	154	471	711	1,043	1,779	1	8	27	74	109	157	265
152O	1197	1.9	2	3	38	154	471	711	1,043	1,779	1	8	27	74	109	157	265
153	22	0.0	2	0	1	4	11	16	22	36	0	0	1	1	2	3	5
153T	310	0.5	2	1	12	45	136	199	285	476	0	2	7	19	29	41	71
353	22	0.0	2	0	1	4	11	16	22	36	0	0	1	1	2	3	5
153O	22	0.0	2	0	1	4	11	16	22	36	0	0	1	1	2	3	5
154	222	0.3	2	1	9	34	101	146	208	344	0	1	5	14	20	29	48

Table B-3B - Historic Peak Flows and Volumes

Design Point	Drainage Area (acres)	Drainage Area (sm)	Historic Percent Imperviousness	Historic Conditions Peak Flow (cfs)							Historic Conditions Runoff Volume (acre-feet)						
				Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_{500}
155	158	0.2	2	1	6	25	72	104	147	242	0	1	3	10	14	20	34
156	41	0.1	2	0	2	7	18	26	37	60	0	0	1	3	4	5	9
156T	111	0.2	2	1	4	18	52	75	106	175	0	1	2	7	10	14	24
157	70	0.1	2	0	2	11	34	50	70	115	0	0	1	4	6	9	15
158	87	0.1	2	0	4	12	33	47	66	109	0	1	2	5	8	11	19
159	763	1.2	2	2	27	105	317	472	686	1,161	1	5	17	48	69	99	167
160	710	1.1	2	2	27	100	299	442	641	1,078	1	5	16	44	65	92	155
360	710	1.1	2	2	27	100	299	442	641	1,078	1	5	16	44	65	92	155
160O	710	1.1	2	2	27	100	299	442	641	1,078	1	5	16	44	65	92	155
161	644	1.0	2	2	26	93	275	404	583	974	1	5	15	40	59	84	141
162	25	0.0	2	0	1	5	15	22	31	51	0	0	0	1	2	3	5
163	369	0.6	2	1	15	56	165	241	347	549	0	3	9	23	34	48	79
163T	482	0.8	2	2	20	71	208	304	435	721	0	4	11	30	44	63	106
164	331	0.5	2	1	16	54	155	224	317	488	0	2	8	21	30	43	71
165	253	0.4	2	1	12	42	117	169	238	354	0	2	6	16	23	33	53
365	253	0.4	2	1	12	42	117	169	238	354	0	2	6	16	23	33	53
165O	253	0.4	2	1	12	42	117	169	238	354	0	2	6	16	23	33	53
166	66	0.1	2	0	4	13	33	47	66	107	0	0	2	4	6	9	14
167	113	0.2	2	1	6	17	45	64	91	186	0	1	3	7	10	15	27
168	117	0.2	2	1	7	19	51	73	103	169	0	1	3	7	11	15	26
D101	374	0.6	31	31	1	10	70	127	209	405	0	0	2	12	22	35	66
D102T	262	0.4	26	26	2	12	73	120	188	338	0	0	2	11	18	29	51
D102	80	0.1	8	8	1	9	35	53	76	128	0	0	1	4	6	9	16
D103	182	0.3	34	34	1	3	43	75	121	222	0	0	1	7	12	19	35
D104	76	0.1	7	7	1	1	29	49	75	133	0	0	0	3	4	7	14
D105	28	0.0	2	2	0	1	9	14	22	38	0	0	0	1	2	3	5
D106	189	0.3	33	33	1	4	53	91	145	262	0	0	1	8	13	20	36
D107	110	0.2	6	6	1	4	52	87	130	229	0	0	0	4	7	11	20
D108	65	0.1	11	11	0	1	15	25	39	70	0	0	0	2	4	6	12
F101	260	0.4	2	1	10	39	128	190	274	461	0	1	5	15	23	33	56
F102	235	0.4	2	1	10	37	118	174	250	420	0	1	5	14	20	29	50
F103	201	0.3	2	1	9	32	101	149	213	358	0	1	4	12	17	25	43
F104	166	0.3	2	1	9	27	85	126	179	302	0	1	3	9	14	20	35
F304	166	0.3	2	1	9	27	85	126	179	302	0	1	3	9	14	20	35
F104O	166	0.3	2	1	9	27	85	126	179	302	0	1	3	9	14	20	35
F105	78	0.1	2	0	1	8	33	49	70	120	0	0	1	4	6	9	15
H101	1261	2.0	2	3	35	176	591	888	1,300	2,216	1	7	26	75	111	160	272
H102	1228	1.9	2	3	35	175	588	881	1,286	2,186	1	7	25	73	108	156	264
H103	1115	1.7	2	3	32	162	546	814	1,186	2,007	1	6	22	66	98	141	240
H303	1115	1.7	2	3	32	162	546	814	1,186	2,007	1	6	22	66	98	141	240
H103O	1115	1.7	2	3	32	162	546	814	1,186	2,007	1	6	22	66	98	141	240
H104	804	1.3	2	2	26	123	407	605	876	1,480	1	4	16	48	71	102	173
H104T	1073	1.7	2	3	31	158	530	791	1,151	1,948	1	6	22	64	94	136	230
H105	613	1.0	2	2	22	98	319	469	672	1,128	0	3	12	36	53	77	131
H105T	693	1.1	2	2	24	110	358	527	756	1,269	1	4	14	41	60	87	149
H106	578	0.9	2	2	21	94	304	446	636	1,065	0	3	11	34	50	72	123
H306	578	0.9	2	2	21	94	304	446	636	1,065	0	3	11	34	50	72	123
H106O	578	0.9	2	2	21	94	304	446	636	1,065	0	3	11	34	50	72	123

Table B-3B - Historic Peak Flows and Volumes

Design Point	Drainage Area (acres)	Drainage Area (sm)	Historic Percent Imperviousness	Historic Conditions Peak Flow (cfs)							Historic Conditions Runoff Volume (acre-feet)						
				Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_{500}
H107	142	0.2	2	1	5	23	74	107	151	251	0	1	2	8	12	17	30
H307	142	0.2	2	1	5	23	74	107	151	251	0	1	2	8	12	17	30
H107O	142	0.2	2	1	5	23	74	107	151	251	0	1	2	8	12	17	30
H108	44	0.1	2	0	1	6	22	33	47	79	0	0	1	2	3	5	9
H109	322	0.5	2	2	13	56	174	253	355	590	0	2	6	19	28	40	68
H110	306	0.5	2	2	13	55	169	245	344	572	0	1	6	18	26	38	65
H111	15	0.0	2	0	0	1	5	9	13	22	0	0	0	1	1	2	3
H112	114	0.2	2	1	7	24	66	94	130	214	0	1	2	7	10	14	24
H312	114	0.2	2	1	7	24	66	94	130	214	0	1	2	7	10	14	24
H112O	114	0.2	2	1	7	24	66	94	130	214	0	1	2	7	10	14	24
H113	40	0.1	2	0	1	6	22	32	45	76	0	0	1	2	3	5	8
H113T	99	0.2	2	1	4	19	60	86	121	201	0	0	2	6	8	12	21
H114	59	0.1	2	1	4	14	39	55	77	126	0	0	1	3	5	7	13
L101	553	0.9	2	2	33	106	305	440	621	1,026	0	4	13	35	51	72	121
L102	501	0.8	2	2	32	101	286	412	577	952	0	4	12	31	46	65	110
L302	501	0.8	2	2	32	101	286	412	577	952	0	4	12	31	46	65	110
L102O	501	0.8	2	2	32	101	286	412	577	952	0	4	12	31	46	65	110
L103	10	0.0	2	0	1	3	6	9	12	20	0	0	0	1	1	1	2
L103T	457	0.7	2	2	30	94	266	383	536	884	0	4	11	29	42	60	100
L104	447	0.7	2	2	29	92	260	375	524	865	0	3	11	28	41	58	98
L105	397	0.6	2	2	27	84	235	338	472	778	0	3	9	25	36	52	87
L305	397	0.6	2	2	27	84	235	338	472	778	0	3	9	25	36	52	87
L105O	397	0.6	2	2	27	84	235	338	472	778	0	3	9	25	36	52	87
L106	289	0.5	2	2	21	63	174	250	347	570	0	2	7	18	26	38	63
L306	289	0.5	2	2	21	63	174	250	347	570	0	2	7	18	26	38	63
L106O	289	0.5	2	2	21	63	174	250	347	570	0	2	7	18	26	38	63
L107	119	0.2	2	1	8	23	62	88	122	200	0	1	3	7	11	15	26
L307	119	0.2	2	1	8	23	62	88	122	200	0	1	3	7	11	15	26
L107O	119	0.2	2	1	8	23	62	88	122	200	0	1	3	7	11	15	26
L108	46	0.1	2	0	3	9	23	33	46	75	0	0	1	3	4	6	10
L109	105	0.2	2	1	8	27	73	104	144	237	0	1	2	7	10	14	23
L309	105	0.2	2	1	8	27	73	104	144	237	0	1	2	7	10	14	23
L109O	105	0.2	2	1	8	27	73	104	144	237	0	1	2	7	10	14	23
L110	74	0.1	2	1	6	20	53	75	103	170	0	1	2	5	7	10	16
L111	22	0.0	2	0	2	6	16	23	31	50	0	0	1	1	2	3	5
P101	373	0.6	2	1	11	44	136	204	297	505	0	3	9	23	34	48	82
P102	325	0.5	2	1	10	42	125	185	267	449	0	2	7	20	29	42	71
P103	262	0.4	2	1	8	33	101	149	214	359	0	2	6	16	24	34	57
P303	262	0.4	2	1	8	33	101	149	214	359	0	2	6	16	24	34	57
P103O	262	0.4	2	1	8	33	101	149	214	359	0	2	6	16	24	34	57
P104	197	0.3	2	1	6	26	79	117	168	281	0	1	4	12	18	25	43
P105	56	0.1	2	0	1	6	19	27	39	66	0	0	1	3	5	7	12
P105T	142	0.2	2	1	4	19	59	86	123	204	0	1	3	9	13	18	31
P106	86	0.1	2	0	3	13	40	59	84	139	0	0	2	5	8	11	19
P306	86	0.1	2	0	3	13	40	59	84	139	0	0	2	5	8	11	19
P106O	86	0.1	2	0	3	13	40	59	84	139	0	0	2	5	8	11	19
P107	27	0.0	2	0	1	6	18	26	36	60	0	0	1	2	2	3	6
P307	27	0.0	2	0	1	6	18	26	36	60	0	0	1	2	2	3	6

Table B-3B - Historic Peak Flows and Volumes

Design Point	Drainage Area (acres)	Drainage Area (sm)	Historic Percent Imperviousness	Historic Conditions Peak Flow (cfs)							Historic Conditions Runoff Volume (acre-feet)						
				Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}	Q_{500}	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}	V_{500}
P107O	27	0.0	2	0	1	6	18	26	36	60	0	0	1	2	2	3	6
Q101	80	0.1	2	0	3	14	43	63	88	146	0	0	2	5	7	10	17
Q301	80	0.1	2	0	3	14	43	63	88	146	0	0	2	5	7	10	17
Q101O	80	0.1	2	0	3	14	43	63	88	146	0	0	2	5	7	10	17
Q102	27	0.0	2	0	2	6	17	24	33	55	0	0	1	2	2	3	6
R101	269	0.4	2	1	7	42	139	205	292	489	0	1	5	16	24	34	58
R102	204	0.3	2	1	5	36	116	170	239	398	0	1	4	12	17	25	43
R103	150	0.2	2	1	2	25	82	120	169	282	0	0	2	8	12	18	31
R104	120	0.2	2	0	1	20	66	97	137	229	0	0	2	7	10	15	25
RP101	143	0.2	2	0	1	7	30	54	89	178	0	0	1	5	8	13	25
RP102	16	0.0	2	0	0	0	1	4	9	21	0	0	0	0	0	1	2
RP103	44	0.1	2	0	0	1	2	15	30	71	0	0	0	0	1	2	5
S101	1230	1.9	2	1	10	52	265	465	761	1,512	1	5	15	55	87	132	238
S102	546	0.9	2	1	15	62	237	366	544	939	0	2	8	29	44	64	112
S102T	1074	1.7	2	2	16	77	313	515	820	1,545	1	4	13	48	76	116	208
S103	116	0.2	2	0	1	5	43	69	103	180	0	0	1	5	8	12	22
S104	94	0.1	2	0	1	4	38	61	90	158	0	0	0	4	6	10	18
S105	399	0.6	2	1	14	59	193	289	420	711	0	2	7	22	33	49	84
S106	39	0.1	2	0	2	7	19	27	37	61	0	0	1	2	4	5	9
S306	39	0.1	2	0	2	7	19	27	37	61	0	0	1	2	4	5	9
S106O	39	0.1	2	0	2	7	19	27	37	61	0	0	1	2	4	5	9
S106T	328	0.5	2	1	12	48	157	234	337	571	0	2	6	18	27	40	68
S107	10	0.0	2	0	0	1	4	7	10	16	0	0	0	0	1	1	2
S108	279	0.4	2	1	10	41	135	202	291	494	0	1	5	15	23	33	58
S109	58	0.1	2	1	5	14	37	52	72	116	0	0	1	4	5	7	12
S110	8	0.0	2	0	0	1	3	4	6	9	0	0	0	0	1	1	2
S110T	162	0.3	2	1	3	18	71	111	164	285	0	0	2	8	12	18	32
S111	155	0.2	2	1	3	17	68	107	159	276	0	0	2	7	11	17	31
S112	128	0.2	2	1	2	12	53	84	126	221	0	0	1	6	9	14	25
S113	38	0.1	2	0	0	1	15	28	45	86	0	0	0	1	2	3	6
S114	528	0.8	2	0	5	21	122	220	360	709	0	1	4	20	33	52	95
S115	11	0.0	2	0	1	3	8	11	15	25	0	0	0	1	1	1	2
S115T	444	0.7	2	1	5	22	117	206	336	638	0	1	4	17	28	44	82
S116	433	0.7	2	1	6	22	114	201	328	622	0	1	3	16	27	42	79
S117	367	0.6	2	1	7	20	102	179	287	536	0	1	3	13	22	35	66
S118	258	0.4	2	1	5	36	124	185	267	448	0	1	5	15	22	32	55
S119	246	0.4	2	1	5	35	120	178	258	433	0	1	5	14	21	31	52
S120	164	0.3	2	1	3	23	78	116	167	280	0	1	3	9	14	20	35
S121	46	0.1	2	0	1	8	24	34	48	80	0	0	1	3	4	6	10
S121T	129	0.2	2	1	3	19	63	92	131	219	0	0	2	7	11	16	27
S122	32	0.1	2	0	1	5	16	23	32	53	0	0	1	2	3	4	7
S123	83	0.1	2	0	2	11	40	58	83	139	0	0	1	5	7	10	17
S124	59	0.1	2	0	2	10	32	46	64	108	0	0	1	3	5	7	12
S125	56	0.1	2	0	0	0	3	12	24	57	0	0	0	0	1	3	7

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}
101	6463	10.1	37	42	109	170	244	580	767	994	1538	130	198	278	611	798	1,025	1568
102	6345	9.9	36	42	115	178	276	562	743	967	1498	136	207	310	592	773	994	1525
103	6041	9.4	37	42	110	171	263	531	703	911	1415	127	194	289	555	727	936	1439
103T	6301	9.8	37	42	114	177	275	559	740	961	1488	136	207	307	589	770	991	1516
104	4776	7.5	39	44	91	140	214	420	555	718	1105	104	157	233	439	574	737	1123
104T	6037	9.4	37	42	110	171	263	528	700	911	1415	127	194	289	555	727	936	1436
105	11	0.0	46	46	0	0	1	1	1	2	3	0	0	1	1	1	2	3
105T	4758	7.4	39	44	91	140	214	420	552	715	1102	104	157	233	439	571	733	1117
106	4690	7.3	39	44	90	139	212	414	546	706	1086	103	155	231	433	565	724	1102
106T	4747	7.4	39	44	91	140	213	417	552	715	1099	103	157	232	436	571	733	1117
107	57	0.1	29	29	1	1	2	4	6	8	13	1	1	2	4	6	8	13
108	139	0.2	24	29	2	3	6	11	15	21	33	2	4	7	12	16	21	34
108T	4608	7.2	40	44	90	137	210	408	537	694	1068	102	153	228	427	555	712	1083
109	57	0.1	49	49	2	3	4	6	8	10	15	2	3	4	6	8	10	15
110	51	0.1	31	32	1	2	3	5	6	8	13	1	2	3	5	6	8	13
111	11	0.0	6	6	0	0	0	1	1	1	3	0	0	0	1	1	1	3
111T	4418	6.9	40	45	87	133	203	393	516	666	1022	99	149	220	411	534	684	1037
112	93	0.1	35	41	2	3	5	8	11	15	23	2	4	5	9	12	15	24
113	49	0.1	5	54	0	0	1	3	5	6	11	2	3	4	5	7	9	13
113T	4314	6.7	40	45	85	131	199	384	503	651	997	96	146	215	399	522	666	1010
114	25	0.0	53	66	1	1	2	3	4	4	7	1	2	2	3	4	5	7
115	3866	6.0	42	46	81	122	184	347	454	583	890	90	134	196	359	466	595	899
115T	4239	6.6	41	45	85	130	196	377	497	638	979	94	142	211	393	509	654	991
116	99	0.2	46	53	3	5	7	10	13	17	26	3	5	7	11	14	18	27
117	3171	5.0	42	46	73	117	172	279	365	466	709	81	126	183	289	374	479	718
117T	3724	5.8	42	46	79	119	177	335	439	562	853	86	129	189	347	448	571	862
118	120	0.2	49	49	4	6	8	13	17	21	32	4	6	8	13	17	21	32
118T	3067	4.8	42	47	71	112	166	269	350	451	684	79	122	177	279	362	460	690
318	120	0.2	49	49	4	6	8	13	17	21	32	4	6	8	13	17	21	32
118O	120	0.2	49	49	4	6	8	13	17	21	32	4	6	8	13	17	21	32
119	2947	4.6	41	46	67	106	158	256	335	430	651	75	117	169	267	347	439	660
120	103	0.2	42	42	3	4	6	10	13	17	27	3	4	6	10	13	17	27
120T	2870	4.5	41	47	65	104	154	249	325	417	632	73	113	164	259	335	427	641
121	26	0.0	42	42	1	1	2	3	3	4	7	1	1	2	3	3	4	7
122	2767	4.3	41	47	63	100	148	239	313	402	608	70	109	158	249	322	411	614
123	71	0.1	39	39	2	3	4	7	9	12	18	2	3	4	7	9	12	18
123T	2696	4.2	42	47	61	97	144	233	304	390	589	69	107	154	242	313	399	595
124	10	0.0	44	44	0	0	1	1	1	2	3	0	0	1	1	1	2	3
124T	2625	4.1	42	47	59	95	140	226	295	377	571	67	104	150	236	305	387	577
125	340	0.5	44	44	9	15	22	35	45	58	89	9	15	22	35	45	58	89
125T	2615	4.1	42	47	59	94	139	225	294	377	568	67	103	149	235	304	387	577
126	228	0.4	42	42	6	10	14	23	30	38	59	6	10	14	23	30	38	59
127	157	0.2	43	43	4	7	10	16	21	26	41	4	7	10	16	21	26	41
128	80	0.1	48	48	2	4	5	8	11	14	21	2	4	5	8	11	14	21
129	2037	3.2	41	48	43	69	102	166	217	278	417	51	78	112	176	227	288	424
129T	2275	3.6	41	48	50	79	117	190	249	319	479	57	89	128	200	258	328	488
130	238	0.4	44	44	7	11	15	24	32	41	63	7	11	15	24	32	41	63
330	238	0.4	44	44	7	11	15	24	32	41	63	7	11	15	24	32	41	63

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}
130O	238	0.4	44	44	7	11	15	24	32	41	63	7	11	15	24	32	41	63
131	87	0.1	49	49	3	4	6	9	12	15	23	3	4	6	9	12	15	23
131T	143	0.2	47	47	4	7	10	15	19	25	38	4	7	10	15	19	25	38
132	2	0.0	49	49	0	0	0	0	0	0	1	0	0	0	0	0	0	1
133	56	0.1	46	46	2	3	4	6	8	10	15	2	3	4	6	8	10	15
134	1984	3.1	41	48	42	67	99	161	211	269	402	49	76	109	171	220	279	411
135	1587	2.5	40	49	30	49	73	120	157	202	299	38	58	83	130	167	211	307
135T	1975	3.1	41	48	41	66	99	160	209	268	402	49	76	109	170	219	278	408
136	115	0.2	47	47	3	5	9	19	28	39	65	3	5	9	19	28	39	65
137	13	0.0	48	48	0	1	1	1	2	2	3	0	1	1	1	2	2	3
138	8	0.0	44	44	0	0	1	1	1	1	2	0	0	1	1	1	1	2
139	127	0.2	41	41	3	5	7	9	10	11	13	3	5	7	9	10	11	13
139T	11	0.0	43	43	0	1	2	9	14	21	37	0	1	2	9	14	21	37
339	127	0.2	41	41	3	5	7	9	10	11	13	3	5	7	9	10	11	13
139O	190	0.3	40	40	5	8	11	14	16	17	20	5	8	11	14	16	17	20
140	41	0.1	37	37	1	2	3	8	12	17	30	1	2	3	8	12	17	30
140T	11	0.0	43	43	0	0	1	5	9	15	29	0	0	1	5	9	15	29
340	41	0.1	37	37	1	2	3	8	12	17	30	1	2	3	8	12	17	30
140O	64	0.1	39	39	2	2	4	9	13	19	32	2	2	4	9	13	19	32
141	103	0.2	40	40	3	4	6	10	13	17	27	3	4	6	10	13	17	27
341	103	0.2	40	40	3	4	6	10	13	17	27	3	4	6	10	13	17	27
141O	103	0.2	40	40	3	4	6	10	13	17	27	3	4	6	10	13	17	27
142	28	0.0	42	42	1	1	2	3	4	5	7	1	1	2	3	4	5	7
342	28	0.0	42	42	1	1	2	3	4	5	7	1	1	2	3	4	5	7
142O	28	0.0	42	42	1	1	2	3	4	5	7	1	1	2	3	4	5	7
143	11	0.0	43	43	0	0	1	1	1	2	3	0	0	1	1	1	2	3
144	7	0.0	46	46	0	0	0	1	1	1	2	0	0	0	1	1	1	2
145	388	0.6	45	45	11	17	25	40	52	67	102	11	17	25	40	52	67	103
146	335	0.5	45	45	10	15	22	34	45	57	88	10	15	22	35	45	57	88
346	335	0.5	45	45	10	15	22	34	45	57	88	10	15	22	35	45	57	88
146O	335	0.5	45	45	10	15	22	34	45	57	88	10	15	22	35	45	57	88
147	310	0.5	45	45	9	14	20	32	41	53	82	9	14	20	32	41	53	82
347	310	0.5	45	45	9	14	20	32	41	53	82	9	14	20	32	41	53	82
147O	310	0.5	45	45	9	14	20	32	41	53	82	9	14	20	32	41	53	82
148	69	0.1	41	41	2	3	6	12	18	24	41	2	3	6	12	18	24	41
149	127	0.2	43	43	3	5	8	13	17	21	33	3	5	8	13	17	21	33
349	127	0.2	43	43	3	5	8	13	17	21	33	3	5	8	13	17	21	33
149O	127	0.2	43	43	3	5	8	13	17	21	33	3	5	8	13	17	21	33
150	98	0.2	46	46	3	4	6	10	13	17	26	3	4	6	10	13	17	26
151	28	0.0	44	46	1	1	2	3	4	5	7	1	1	2	3	4	5	7
152	1197	1.9	40	51	29	47	71	117	154	201	313	39	59	84	131	168	216	325
352	1197	1.9	40	51	29	47	71	117	154	201	313	39	59	84	131	168	216	325
152O	1197	1.9	40	51	20	33	50	83	108	138	202	27	42	60	92	117	148	209
153	22	0.0	43	43	1	1	1	2	3	4	6	1	1	1	2	3	4	6
153T	310	0.5	43	49	8	13	20	32	42	54	85	10	15	22	34	44	56	87
353	22	0.0	43	43	1	1	1	2	3	4	6	1	1	1	2	3	4	6
153O	22	0.0	43	43	1	1	1	2	3	4	6	1	1	1	2	3	4	6
154	222	0.3	39	49	5	9	13	21	28	37	57	7	11	15	24	30	39	59

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}
155	158	0.2	42	55	4	6	10	16	20	26	41	6	8	12	18	23	29	43
156	41	0.1	46	46	1	2	3	4	6	7	11	1	2	3	4	6	7	11
156T	111	0.2	38	57	3	4	6	10	14	18	28	4	6	8	13	16	20	30
157	70	0.1	34	64	1	2	3	6	8	11	17	3	4	6	8	10	13	20
158	87	0.1	51	51	3	4	6	9	12	15	23	3	4	6	9	12	15	23
159	763	1.2	39	54	19	30	45	74	97	127	196	27	40	56	85	109	139	208
160	710	1.1	40	56	18	28	42	69	91	118	183	26	38	53	80	103	129	195
360	710	1.1	40	56	18	28	42	69	91	118	183	26	38	53	80	103	129	195
160O	710	1.1	40	56	18	28	42	69	91	118	183	26	38	53	80	103	129	195
161	644	1.0	41	59	17	27	39	64	84	108	167	25	37	51	75	95	119	179
162	25	0.0	14	32	0	0	1	2	3	3	6	0	1	1	2	3	4	6
163	369	0.6	44	64	10	16	24	37	47	58	84	16	23	31	44	55	65	91
163T	482	0.8	44	60	14	21	31	50	64	83	127	19	28	38	57	72	90	134
164	331	0.5	49	67	10	16	23	35	44	53	76	15	21	29	41	50	59	82
165	253	0.4	57	64	9	14	19	29	35	41	57	11	16	21	30	37	43	59
365	253	0.4	57	64	9	14	19	29	35	41	57	11	16	21	30	37	43	59
165O	253	0.4	57	64	9	14	19	29	35	41	57	11	16	21	30	37	43	59
166	66	0.1	51	64	2	3	5	7	9	12	18	3	4	5	8	10	12	19
167	113	0.2	45	45	3	5	7	12	17	24	42	3	5	7	12	17	24	42
168	117	0.2	58	58	4	7	9	13	17	21	32	4	7	9	13	17	21	32
D101	374	0.6	31	31	7	10	14	26	37	50	83	7	10	14	26	37	50	83
D102T	262	0.4	26	26	4	6	9	18	26	36	59	4	6	9	18	26	36	59
D102	80	0.1	8	8	0	0	1	4	6	10	16	0	0	1	4	6	10	16
D103	182	0.3	34	34	4	5	7	14	19	26	43	4	5	7	14	19	26	43
D104	76	0.1	7	7	0	0	0	3	5	8	14	0	0	0	3	5	8	14
D105	28	0.0	2	2	0	0	0	1	2	3	5	0	0	0	1	2	3	5
D106	189	0.3	33	33	4	5	7	14	20	27	44	4	5	7	14	20	27	44
D107	110	0.2	6	6	0	0	1	4	7	11	20	0	0	1	4	7	11	20
D108	65	0.1	11	11	0	0	1	3	5	7	13	0	0	1	3	5	7	13
F101	260	0.4	20	35	3	5	10	20	27	37	60	6	9	14	24	32	41	65
F102	235	0.4	21	37	3	5	9	18	25	33	55	5	8	13	22	29	37	59
F103	201	0.3	20	39	2	4	7	15	21	28	47	5	8	11	19	25	33	51
F104	166	0.3	24	45	2	4	7	13	18	24	39	5	7	10	16	21	28	43
F304	166	0.3	24	45	2	4	7	13	18	24	39	5	7	10	16	21	28	43
F104O	166	0.3	24	45	2	4	7	13	18	24	39	5	7	10	16	21	28	43
F105	78	0.1	17	47	1	1	2	5	7	10	17	2	3	5	8	10	13	20
H101	1261	2.0	31	37	22	37	60	108	146	194	307	27	43	67	115	153	201	316
H102	1228	1.9	31	37	22	36	59	106	143	189	300	27	42	66	113	150	196	307
H103	1115	1.7	30	37	19	32	52	95	128	170	272	24	38	59	102	135	177	279
H303	1115	1.7	30	37	19	32	52	95	128	170	272	24	38	59	102	135	177	279
H103O	1115	1.7	30	37	19	31	51	94	127	169	271	23	37	58	101	134	176	278
H104	804	1.3	38	40	18	29	44	75	99	129	202	19	30	45	76	100	130	204
H104T	1073	1.7	30	37	19	31	50	91	123	164	261	23	37	57	98	130	171	269
H105	613	1.0	40	42	14	23	34	58	76	99	155	15	24	36	59	77	100	157
H105T	693	1.1	38	40	15	24	37	64	85	111	174	16	25	39	65	86	112	175
H106	578	0.9	42	44	14	22	33	55	73	94	147	15	23	34	56	74	95	148
H306	578	0.9	42	44	14	22	33	55	73	94	147	15	23	34	56	74	95	148
H106O	578	0.9	42	44	14	22	33	55	73	94	147	15	23	34	56	74	95	148

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}
H107	142	0.2	43	47	4	6	8	14	18	23	36	4	6	9	14	19	24	37
H307	142	0.2	43	47	4	6	8	14	18	23	36	4	6	9	14	19	24	37
H107O	142	0.2	43	47	4	6	8	14	18	23	36	4	6	9	14	19	24	37
H108	44	0.1	37	45	1	1	2	4	5	7	11	1	2	3	4	5	7	11
H109	322	0.5	37	38	6	10	16	28	38	50	79	6	11	17	29	39	51	80
H110	306	0.5	37	39	6	10	15	27	36	48	76	6	10	16	28	37	48	76
H111	15	0.0	35	35	0	0	1	1	2	2	3	0	0	1	1	2	2	3
H112	114	0.2	34	38	2	4	6	10	14	18	28	3	4	6	11	14	18	29
H312	114	0.2	34	38	2	4	6	10	14	18	28	3	4	6	11	14	18	29
H112O	114	0.2	34	38	1	3	5	9	13	17	27	2	3	5	10	13	17	28
H113	40	0.1	42	43	1	1	2	4	5	6	10	1	2	2	4	5	6	10
H113T	99	0.2	49	50	3	5	6	10	13	17	26	3	5	7	10	13	17	26
H114	59	0.1	54	54	2	3	4	6	8	10	16	2	3	4	7	8	11	16
L101	553	0.9	43	44	15	24	35	56	73	94	145	15	24	35	56	73	94	145
L102	501	0.8	46	46	15	23	33	52	68	86	132	15	23	33	52	68	86	132
L302	501	0.8	46	46	15	23	33	52	68	86	132	15	23	33	52	68	86	132
L102O	501	0.8	46	46	15	23	33	52	67	86	132	15	23	33	52	67	86	132
L103	10	0.0	49	49	0	0	1	1	1	2	3	0	0	1	1	1	2	3
L103T	457	0.7	46	46	13	21	30	47	61	79	121	13	21	30	47	61	79	121
L104	447	0.7	46	46	13	20	29	46	60	77	118	13	20	29	46	60	77	118
L105	397	0.6	45	45	12	18	26	41	53	68	104	12	18	26	41	53	68	104
L305	397	0.6	45	45	12	18	26	41	53	68	104	12	18	26	41	53	68	104
L105O	397	0.6	45	45	12	18	26	41	53	68	104	12	18	26	41	53	68	104
L106	289	0.5	45	45	8	13	19	30	39	49	76	8	13	19	30	39	49	76
L306	289	0.5	45	45	8	13	19	30	39	49	76	8	13	19	30	39	49	76
L106O	289	0.5	45	45	8	13	19	30	39	49	76	8	13	19	30	39	49	76
L107	119	0.2	47	47	4	6	8	12	16	21	32	4	6	8	12	16	21	32
L307	119	0.2	47	47	4	6	8	12	16	21	32	4	6	8	12	16	21	32
L107O	119	0.2	47	47	4	6	8	12	16	21	32	4	6	8	12	16	21	32
L108	46	0.1	47	47	1	2	3	5	6	8	12	1	2	3	5	6	8	12
L109	105	0.2	43	43	3	5	7	11	14	18	27	3	5	7	11	14	18	27
L309	105	0.2	43	43	3	5	7	11	14	18	27	3	5	7	11	14	18	27
L109O	105	0.2	43	43	3	5	7	11	14	18	27	3	5	7	11	14	18	27
L110	74	0.1	47	47	2	3	5	8	10	13	19	2	3	5	8	10	13	19
L111	22	0.0	47	47	1	1	1	2	3	4	6	1	1	1	2	3	4	6
P101	373	0.6	31	35	5	9	16	31	42	56	90	5	10	18	32	44	58	92
P102	325	0.5	35	35	4	9	15	27	37	50	79	4	9	15	27	37	50	79
P103	262	0.4	33	33	5	9	14	24	32	41	65	5	9	14	24	32	41	65
P303	262	0.4	33	33	5	9	14	24	32	41	65	5	9	14	24	32	41	65
P103O	262	0.4	33	33	2	6	11	21	29	39	63	2	6	11	21	29	39	63
P104	197	0.3	26	26	3	5	9	16	22	30	48	3	5	9	16	22	30	48
P105	56	0.1	14	14	0	1	2	4	6	8	13	0	1	2	4	6	8	13
P105T	142	0.2	15	15	1	2	5	10	14	20	33	1	2	5	10	14	20	33
P106	86	0.1	15	15	1	1	3	6	9	12	20	1	1	3	6	9	12	20
P306	86	0.1	15	15	1	1	3	6	9	12	20	1	1	3	6	9	12	20
P106O	86	0.1	15	15	1	1	3	6	9	12	20	1	1	3	6	9	12	20
P107	27	0.0	23	23	0	1	1	2	3	4	6	0	1	1	2	3	4	6
P307	27	0.0	23	23	0	1	1	2	3	4	6	0	1	1	2	3	4	6

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}
P107O	27	0.0	23	23	0	1	1	2	3	4	6	0	1	1	2	3	4	6
Q101	80	0.1	20	20	1	2	3	6	9	12	19	1	2	3	6	9	12	19
Q301	80	0.1	20	20	1	2	3	6	9	12	19	1	2	3	6	9	12	19
Q101O	80	0.1	20	20	1	2	3	6	8	11	19	1	2	3	6	8	11	19
Q102	27	0.0	16	16	0	0	1	2	3	4	6	0	0	1	2	3	4	6
R101	269	0.4	7	28	1	2	6	17	25	35	59	4	7	12	22	30	40	64
R102	204	0.3	7	25	1	1	5	12	18	26	44	3	4	8	16	22	29	48
R103	150	0.2	5	8	0	0	3	9	13	19	32	0	1	3	9	13	19	32
R104	120	0.2	6	9	0	0	2	7	10	15	25	0	1	2	7	11	15	26
RP101	143	0.2	4	4	0	0	1	5	8	13	25	0	0	1	5	8	13	25
RP102	16	0.0	5	5	0	0	0	0	0	1	2	0	0	0	0	0	1	2
RP103	44	0.1	6	6	0	0	0	0	1	2	5	0	0	0	0	1	2	5
S101	1230	1.9	15	28	8	15	29	70	103	149	257	18	29	46	89	124	169	279
S102	546	0.9	11	32	3	6	13	33	48	69	117	11	16	25	45	61	81	130
S102T	1074	1.7	14	29	6	12	24	60	89	129	222	14	24	39	77	107	147	242
S103	116	0.2	3	15	0	0	1	5	8	12	22	1	1	2	6	9	14	24
S104	94	0.1	3	5	0	0	0	4	6	10	18	0	0	1	4	6	10	18
S105	399	0.6	14	39	3	6	11	26	37	53	88	9	15	22	37	49	64	100
S106	39	0.1	55	55	1	2	3	4	6	7	11	1	2	3	4	6	7	11
S306	39	0.1	55	55	1	2	3	4	6	7	11	1	2	3	4	6	7	11
S106O	39	0.1	55	55	1	2	2	4	5	7	10	1	2	2	4	5	7	10
S106T	328	0.5	13	38	2	4	9	21	30	43	72	8	12	18	30	40	52	82
S107	10	0.0	8	8	0	0	0	1	1	1	2	0	0	0	1	1	1	2
S108	279	0.4	7	37	1	2	6	16	24	35	59	6	10	15	25	34	44	69
S109	58	0.1	2	28	0	0	1	4	5	7	12	1	2	3	5	7	9	14
S110	8	0.0	2	35	0	0	0	0	1	1	2	0	0	0	1	1	1	2
S110T	162	0.3	8	39	1	1	3	9	13	19	33	4	6	9	15	20	26	40
S111	155	0.2	9	39	1	1	3	8	13	18	32	4	6	8	14	19	24	38
S112	128	0.2	10	43	1	1	2	7	10	15	26	3	5	7	12	16	20	32
S113	38	0.1	2	75	0	0	0	1	2	3	6	2	3	3	4	6	7	10
S114	528	0.8	17	27	3	5	11	27	41	60	106	4	7	14	32	46	65	112
S115	11	0.0	19	69	0	0	0	1	1	2	3	0	1	1	1	2	2	3
S115T	444	0.7	16	28	2	4	9	23	35	51	89	3	6	13	28	40	56	95
S116	433	0.7	16	27	2	4	8	22	33	49	86	2	5	11	26	38	54	91
S117	367	0.6	12	25	1	2	5	17	26	39	71	1	3	8	21	31	44	76
S118	258	0.4	12	28	2	3	7	17	25	35	58	4	7	12	21	29	39	62
S119	246	0.4	10	27	1	3	7	16	23	33	55	4	6	11	20	27	37	59
S120	164	0.3	14	26	1	2	5	11	16	22	37	2	4	7	13	18	24	39
S121	46	0.1	4	22	0	0	1	3	4	6	10	1	1	2	3	5	7	11
S121T	129	0.2	17	25	1	2	4	9	13	18	29	2	3	5	10	14	19	31
S122	32	0.1	5	28	0	0	1	2	3	4	7	0	1	1	3	4	5	8
S123	83	0.1	24	27	1	2	3	6	9	12	20	1	2	3	7	9	12	20
S124	59	0.1	33	33	1	2	3	5	7	9	14	1	2	3	5	7	9	14
S125	56	0.1	3	28	0	0	0	0	1	3	8	1	1	1	2	4	5	10

Table B-5 - Baseline Peak Flows Along Regional Park

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}
RP101	---	Confluence with South Platte River	143	0.2	0	0	1	1	8	32	57	93	182	1	1	8	32	57	93	182
RP102	RP202	Riverdale Road	16	0.0	3,232	3,232	0	0	0	1	5	9	21	0	0	0	1	5	9	21

Table B-6 - Baseline Runoff Volumes Along Regional Park

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}
RP101	---	Confluence with South Platte River	143	0.2	0	0	0	0	0	2	3	4	8	0	0	1	5	8	13	25
RP102	RP202	Riverdale Road	16	0.0	3,232	3,232	0	0	0	0	0	0	1	0	0	0	0	0	1	2

Table B-7 - Baseline Peak Flows Along South Platte River Direct Flow Areas

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}
D101	---	South Platte River	374	0.6	0	0	43	62	88	178	251	354	597	43	62	88	178	251	354	597
D106	---	South Platte River	189	0.3	0	0	25	35	47	110	158	224	371	25	35	47	110	158	224	371
D108	---	South Platte River	65	0.1	0	0	1	2	4	18	28	43	74	1	2	4	18	28	43	74
S125	---	South Platte River	56	0.1	0	0	0	0	1	4	12	25	57	4	6	9	18	29	44	82

Table B-8 - Baseline Runoff Volumes Along South Platte River Direct Flow Areas

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}
D101	---	South Platte River	374	0.6	0	0	7	10	14	26	37	50	83	7	10	14	26	37	50	83
D106	---	South Platte River	189	0.3	0	0	4	5	7	14	20	27	44	4	5	7	14	20	27	44
D108	---	South Platte River	65	0.1	0	0	0	0	1	3	5	7	13	0	0	1	3	5	7	13
S125	---	South Platte River	56	0.1	0	0	0	0	0	0	1	3	8	1	1	1	2	4	5	10

Table B-9 - Baseline Peak Flows Along South Platte River Northern Tributary 7

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}
S101	---	Confluence with South Platte River	1,230	1.9	0	0	17	42	102	339	556	870	1,642	61	108	196	483	714	1,079	1,930
S102T	S202T	Confluence with South Platte Tributary 6	1,074	1.7	3,046	3,046	23	57	128	373	588	908	1,668	93	156	250	542	781	1,120	1,965
S102	S202		546	0.9	1,918	4,964	9	28	75	240	363	534	932	77	127	200	417	570	769	1,236
S105	S205	Riverdale Road	399	0.6	1,960	6,924	8	26	69	192	283	407	703	73	120	186	352	468	614	967
S106T	S206T		328	0.5	1,716	8,640	6	19	52	150	221	322	558	64	102	154	284	374	487	764
S108	S208	136th Avenue	279	0.4	740	9,380	6	19	51	145	213	303	509	64	102	154	279	368	478	742
S110T	S210T		162	0.3	572	9,952	4	9	25	78	119	173	295	44	66	96	170	223	287	445
S111	S211	Yosemite Street	155	0.2	326	10,279	4	9	24	76	115	167	286	43	64	93	165	216	279	432
S112	S212		128	0.2	1,455	11,734	4	7	19	60	91	134	231	42	61	85	143	186	239	369
S113	S213		38	0.1	2,403	14,137	0	0	1	15	28	45	86	36	49	63	91	115	142	211

Table B-10 - Baseline Runoff Volumes Along South Platte River Northern Tributary 7

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}
S101	---	Confluence with South Platte River	1,230	1.9	0	0	8	15	29	70	103	149	257	18	29	46	89	124	169	279
S102T	S202T	Confluence with South Platte Tributary 6	1,074	1.7	3,046	3,046	6	12	24	60	89	129	222	14	24	39	77	107	147	242
S102	S202		546	0.9	1,918	4,964	3	6	13	33	48	69	117	11	16	25	45	61	81	130
S105	S205	Riverdale Road	399	0.6	1,960	6,924	3	6	11	26	37	53	88	9	15	22	37	49	64	100
S106T	S206T		328	0.5	1,716	8,640	2	4	9	21	30	43	72	8	12	18	30	40	52	82
S108	S208	136th Avenue	279	0.4	740	9,380	1	2	6	16	24	35	59	6	10	15	25	34	44	69
S110T	S210T		162	0.3	572	9,952	1	1	3	9	13	19	33	4	6	9	15	20	26	40
S111	S211	Yosemite Street	155	0.2	326	10,279	1	1	3	8	13	18	32	4	6	8	14	19	24	38
S112	S212		128	0.2	1,455	11,734	1	1	2	7	10	15	26	3	5	7	12	16	20	32
S113	S213		38	0.1	2,403	14,137	0	0	0	1	2	3	6	2	3	3	4	6	7	10

Table B-11 - Baseline Peak Flows Along South Platte River Southern Tributary 6

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}
S102T	S202T	Confluence with South Platte Tributary 6	1,074	1.7	0	0	23	57	128	373	588	908	1,668	93	156	250	542	781	1,120	1,965
S114	S214		528	0.8	317	317	16	30	55	173	283	432	806	20	36	78	221	329	505	906
S115T	S215T		444	0.7	639	956	14	26	48	160	256	394	717	18	31	73	206	311	462	809
S116	S216		433	0.7	1,394	2,350	15	26	47	156	250	385	700	15	27	71	202	304	451	789
S117	S217	Riverdale Road	367	0.6	1,585	3,935	5	13	33	135	217	334	599	6	21	59	178	267	393	676
S118	S218		258	0.4	2,174	6,109	12	23	59	156	222	309	507	29	50	91	195	268	362	580
S119	S219	Yosemite Street	246	0.4	211	6,320	10	20	55	147	210	294	483	26	45	84	183	252	342	549
S120	S220		164	0.3	709	7,030	9	18	41	103	145	199	325	17	30	55	120	164	222	355
S121T	S221T		129	0.2	1,558	8,587	10	18	37	87	120	163	263	14	24	44	96	131	175	278
S123	S223		83	0.1	0	8,587	10	16	29	63	85	114	182	10	17	30	64	87	116	184
S124	S224	136th Avenue	59	0.1	2,302	10,890	11	17	28	55	74	97	153	11	17	28	55	74	97	153

Table B-12 - Baseline Runoff Volumes Along South Platte River Southern Tributary 6

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}
S102T	S202T	Confluence with South Platte Tributary 6	1,074	1.7	0	0	6	12	24	60	89	129	222	14	24	39	77	107	147	242
S114	S214		528	0.8	317	317	3	5	11	27	41	60	106	4	7	14	32	46	65	112
S115T	S215T		444	0.7	639	956	2	4	9	23	35	51	89	3	6	13	28	40	56	95
S116	S216		433	0.7	1,394	2,350	2	4	8	22	33	49	86	2	5	11	26	38	54	91
S117	S217	Riverdale Road	367	0.6	1,585	3,935	1	2	5	17	26	39	71	1	3	8	21	31	44	76
S118	S218		258	0.4	2,174	6,109	2	3	7	17	25	35	58	4	7	12	21	29	39	62
S119	S219	Yosemite Street	246	0.4	211	6,320	1	3	7	16	23	33	55	4	6	11	20	27	37	59
S120	S220		164	0.3	709	7,030	1	2	5	11	16	22	37	2	4	7	13	18	24	39
S121T	S221T		129	0.2	1,558	8,587	1	2	4	9	13	18	29	2	3	5	10	14	19	31
S123	S223		83	0.1	0	8,587	1	2	3	6	9	12	20	1	2	3	7	9	12	20
S124	S224	136th Avenue	59	0.1	2,302	10,890	1	2	3	5	7	9	14	1	2	3	5	7	9	14

Table B-13 - Baseline Peak Flows Along Brantner Gulch

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}
101	--		6,463	10.1	0	0	223	434	704	2,090	2,974	4,364	7,538	278	520	795	2,213	3,117	4,599	7,734
102	202	Park Boulevard	6,345	9.9	4,240	4,240	301	675	946	2,336	3,224	4,563	7,861	368	675	1,060	2,440	3,375	4,711	8,078
103T	203T	Riverdale Road	6,301	9.8	2,945	7,185	302	567	952	2,344	3,234	4,569	7,844	371	639	1,063	2,447	3,385	4,716	8,059
103	203		6,041	9.4	0	7,185	292	544	905	2,203	3,056	4,313	7,494	340	598	976	2,286	3,158	4,425	7,626
104T	204T		6,037	9.4	508	7,693	292	545	905	2,204	3,057	4,314	7,494	340	599	976	2,287	3,159	4,425	7,625
104	204		4,776	7.5	0	7,693	251	456	748	1,767	2,437	3,407	5,850	277	490	795	1,825	2,506	3,477	5,930
105T	205T		4,758	7.4	1,944	9,637	251	458	751	1,780	2,456	3,418	5,847	279	490	798	1,839	2,526	3,491	5,926
106T	206T	128th Avenue	4,747	7.4	91	9,728	251	457	749	1,776	2,450	3,410	5,834	278	490	796	1,834	2,520	3,483	5,913
106	206		4,690	7.3	0	9,728	248	455	744	1,762	2,427	3,376	5,773	276	487	791	1,819	2,496	3,447	5,849
108T	208T		4,608	7.2	2,337	12,065	256	457	752	1,779	2,446	3,376	5,696	281	484	791	1,834	2,509	3,449	5,769
111T	211T		4,418	6.9	2,847	14,912	254	447	730	1,748	2,378	3,276	5,450	279	470	766	1,797	2,437	3,344	5,515
113T	213T	Quebec Street	4,314	6.7	616	15,528	247	438	712	1,701	2,307	3,175	5,304	271	463	748	1,749	2,365	3,242	5,366
115T	215T		4,239	6.6	766	16,293	244	434	705	1,675	2,266	3,112	5,204	261	452	731	1,712	2,310	3,164	5,255
115	215		3,866	6.0	0	16,293	234	412	660	1,546	2,078	2,834	4,698	247	425	680	1,574	2,113	2,873	4,736
117T	217T		3,724	5.8	2,149	18,443	223	396	630	1,472	1,970	2,675	4,471	232	405	642	1,493	1,996	2,705	4,503
117	217		3,171	5.0	0	16,293	255	430	659	1,287	1,740	2,325	3,743	264	442	673	1,306	1,764	2,355	3,790
118T	218T		3,067	4.8	1,413	19,856	244	406	619	1,216	1,639	2,180	3,509	253	417	633	1,235	1,663	2,209	3,556
119	219	Holly Street	2,947	4.6	1,833	21,689	223	376	588	1,173	1,571	2,066	3,211	232	387	602	1,192	1,596	2,097	3,257
120T	220T		2,870	4.5	474	22,163	213	359	560	1,117	1,493	1,959	3,040	218	364	567	1,127	1,506	1,975	3,064
122	222		2,767	4.3	806	22,969	194	329	512	1,028	1,370	1,789	2,811	199	335	520	1,039	1,383	1,805	2,827
123T	223		2,696	4.2	81	23,050	184	314	487	981	1,304	1,699	2,678	189	319	494	991	1,317	1,715	2,694
124T	224T		2,625	4.1	651	23,701	172	294	455	921	1,221	1,588	2,527	176	299	462	932	1,234	1,604	2,542
125T	225T		2,615	4.1	229	23,929	170	291	451	914	1,212	1,575	2,509	175	296	458	924	1,225	1,591	2,524
129T	229T		2,275	3.6	34	23,963	100	173	261	548	724	1,015	1,864	103	178	267	558	736	1,025	1,875
129	229		2,037	3.2	0	23,963	80	127	188	334	469	693	1,440	84	133	195	344	475	701	1,449
134	234		1,984	3.1	2,082	26,045	73	114	170	297	439	646	1,385	77	120	177	307	445	655	1,395
135T	235T		1,975	3.1	379	26,423	71	111	165	288	432	635	1,372	75	117	172	298	438	644	1,382
135	235	Colorado Boulevard	1,587	2.5	231	26,654	56	87	126	248	382	558	920	60	92	133	251	388	567	933
152O	252O		1,197	1.9	2,856	29,510	9	14	21	32	40	49	63	12	17	24	35	43	52	65
152	252		1,197	1.9	0	29,510	109	174	263	477	622	808	1,259	146	219	314	543	699	894	1,375
159	259	124th Avenue	763	1.2	999	30,509	59	75	96	137	166	202	373	77	97	119	157	185	220	439
160O	260O	Steel Street	710	1.1	2,601	33,111	59	75	95	133	164	195	370	76	95	116	151	179	206	433
160	260		710	1.1	0	33,111	89	135	203	391	543	753	1,229	154	227	315	537	708	940	1,485
161	261	RTD NMRL	644	1.0	1,764	34,875	85	127	185	351	487	672	1,096	149	217	295	492	645	853	1,346
163T	263T	Claude Court	482	0.8	648	35,523	68	92	127	228	321	446	777	104	144	189	311	415	554	886
163	263		369	0.6	505	36,028	48	59	75	118	150	230	487	81	108	136	207	254	313	534
164	264		331	0.5	1,577	37,605	54	60	70	102	143	219	462	81	105	130	183	220	263	505
165O	265O		253	0.4	1,715	39,320	43	48	52	66	113	170	358	45	50	54	79	129	198	394
165	265	Washington Center Parkway	253	0.4	0	39,321	90	137	193	314	354	416	565	111	163	222	348	393	459	621
166	266	Washington Street	66	0.1	1,864	41,185	22	35	50	83	107	134	203	32	48	65	101	128	158	234

Table B-14 - Baseline Runoff Volumes Along Brantner Gulch

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 Peak Flows (cfs)						
							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}
101	--		6,463	10.1	0	0	109	170	244	580	767	994	1,538	130	198	278	611	798	1,025	1,568
102	202	Park Boulevard	6,345	9.9	4,240	4,240	115	178	276	562	743	967	1,498	136	207	310	592	773	994	1,525
103T	203T	Riverdale Road	6,301	9.8	2,945	7,185	114	177	275	559	740	961	1,488	136	207	307	589	770	991	1,516
103	203		6,041	9.4	0	7,185	110	171	263	531	703	911	1,415	127	194	289	555	727	936	1,439
104T	204T		6,037	9.4	508	7,693	110	171	263	528	700	911	1,415	127	194	289	555	727	936	1,436
104	204		4,776	7.5	0	7,693	91	140	214	420	555	718	1,105	104	157	233	439	574	737	1,123
105T	205T		4,758	7.4	1,944	9,637	91	140	214	420	552	715	1,102	104	157	233	439	571	733	1,117
106T	206T	128th Avenue	4,747	7.4	91	9,728	91	140	213	417	552	715	1,099	103	157	232	436	571	733	1,117
106	206		4,690	7.3	0	9,728	90	139	212	414	546	706	1,086	103	155	231	433	565	724	1,102
108T	208T		4,608	7.2	2,337	12,065	90	137	210	408	537	694	1,068	102	153	228	427	555	712	1,083
111T	211T		4,418	6.9	2,847	14,912	87	133	203	393	516	666	1,022	99	149	220	411	534	684	1,037
113T	213T	Quebec Street	4,314	6.7	616	15,528	85	131	199	384	503	651	997	96	146	215	399	522	666	1,010
115T	215T		4,239	6.6	766	16,293	85	130	196	377	497	638	979	94	142	211	393	509	654	991
115	215		3,866	6.0	0	16,293	81	122	184	347	454	583	890	90	134	196	359	466	595	899
117T	217T		3,724	5.8	2,149	18,443	79	119	177	335	439	562	853	86	129	189	347	448	571	862
117	217		3,171	5.0	0	18,443	73	117	172	279	365	466	709	81	126	183	289	374	479	718
118T	218T		3,067	4.8	1,413	19,856	71	112	166	269	350	451	684	79	122	177	279	362	460	690
119	219	Holly Street	2,947	4.6	1,833	21,689	67	106	158	256	335	430	651	75	117	169	267	347	439	660
120T	220T		2,870	4.5	474	22,163	65	104	154	249	325	417	632	73	113	164	259	335	427	641
122	222		2,767	4.3	806	22,969	63	100	148	239	313	402	608	70	109	158	249	322	411	614
123T	223		2,696	4.2	81	23,050	61	97	144	233	304	390	589	69	107	154	242	313	399	595
124T	224T		2,625	4.1	651	23,701	59	95	140	226	295	377	571	67	104	150	236	305	387	577
125T	225T		2,615	4.1	229	23,930	59	94	139	225	294	377	568	67	103	149	235	304	387	577
129T	229T		2,275	3.6	34	23,963	50	79	117	190	249	319	479	57	89	128	200	258	328	488
129	229		2,037	3.2	0	23,963	43	69	102	166	217	278	417	51	78	112	176	227	288	424
134	234		1,984	3.1	2,082	26,045	42	67	99	161	211	269	402	49	76	109	171	220	279	411
135T	235T		1,975	3.1	379	26,424	41	66	99	160	209	268	402	49	76	109	170	219	278	408
135	235	Colorado Boulevard	1,587	2.5	231	26,654	30	49	73	120	157	202	299	38	58	83	130	167	211	307
152O	252O		1,197	1.9	2,856	29,510	20	33	50	83	108	138	202	27	42	60	92	117	148	209
152	252		1,197	1.9	0	29,511	29	47	71	117	154	201	313	39	59	84	131	168	216	325
159	259	124th Avenue	763	1.2	999	30,509	19	30	45	74	97	127	196	27	40	56	85	109	139	208
160O	260O	Steel Street	710	1.1	2,601	33,111	18	28	42	69	91	118	183	26	38	53	80	103	129	195
160	260		710	1.1	0	33,111	18	28	42	69	91	118	183	26	38	53	80	103	129	195
161	261	RTD NMRL	644	1.0	1,764	34,875	17	27	39	64	84	108	167	25	37	51	75	95	119	179
163T	263T	Claude Court	482	0.8	648	35,523	14	21	31	50	64	83	127	19	28	38	57	72	90	134
163	263		369	0.6	505	36,028	10	16	24	37	47	58	84	16	23	31	44	55	65	91
164	264		331	0.5	1,577	37,605	10	16	23	35	44	53	76	15	21	29	41	50	59	82
165O	265O		253	0.4	1,715	39,321	9	14	19	29	35	41	57	11	16	21	30	37	43	59
165	265	Washington Center Parkway	253	0.4	0	39,321	9	14	19	29	35	41	57	11	16	21	30	37	43	59
166	266	Washington Street	66	0.1	1,864	41,185	2	3	5	7	9	12	18	3	4	5	8	10	12	19

Table B-15 - Baseline Peak Flows Along Fairgrounds Tributary

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}
F101	F201	Brantner Gulch Tributary Confluence	260	0.4	0	0	20	40	70	120	150	222	334	46	67	90	136	212	269	523
F102	F202	130th Avenue	235	0.4	1,703	1,703	20	38	65	107	131	204	293	45	64	85	123	197	246	490
F103	F203		201	0.3	1,152	2,855	17	33	55	89	106	175	233	42	60	76	106	174	208	432
F104O	F204O	Unita Street	166	0.3	1,791	4,647	18	32	50	76	88	150	191	41	57	69	93	153	177	382
F104	F204		166	0.3	0	4,647	18	33	55	120	165	223	360	44	71	107	195	256	333	515
F105	F205	136th Avenue	78	0.1	2,620	7,266	4	7	16	41	58	80	131	23	34	49	87	114	146	224

Table B-16 - Baseline Runoff Volumes Along Fairgrounds Tributary

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}
F101	F201	Brantner Gulch Tributary Confluence	260	0.4	0	0	3	5	10	20	27	37	60	6	9	14	24	32	41	65
F102	F202	130th Avenue	235	0.4	1,703	1,703	3	5	9	18	25	33	55	5	8	13	22	29	37	59
F103	F203		201	0.3	1,152	2,855	2	4	7	15	21	28	47	5	8	11	19	25	33	51
F104O	F204O	Unita Street	166	0.3	1,791	4,647	2	4	7	13	18	24	39	5	7	10	16	21	28	43
F104	F204		166	0.3	0	4,647	2	4	7	13	18	24	39	5	7	10	16	21	28	43
F105	F205	136th Avenue	78	0.1	2,620	7,266	1	1	2	5	7	10	17	2	3	5	8	10	13	20

Table B-17 - Baseline Peak Flows Along Horizon Tributary

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}
H101	H201	Brantner Gulch Tributary Confluence	1,261	2.0	0	0	58	111	204	438	624	909	1,647	74	134	231	462	653	948	1,696
H102	H202	Valentina Street	1,228	1.9	2,279	2,279	58	110	200	429	611	892	1,616	73	132	226	452	639	929	1,664
H103O	H203O	Tamarac Street	1,115	1.7	1,915	4,194	57	102	180	396	564	824	1,497	70	119	201	415	587	852	1,530
H103	H203		1,115	1.7	0	4,194	58	103	184	415	613	875	1,517	85	134	206	430	632	901	1,548
H104T	H204T		1,073	1.7	645	4,838	56	99	175	397	586	837	1,454	80	126	195	412	604	860	1,482
H104	H204	Quebec Street	804	1.3	1,507	6,345	54	91	146	303	428	600	1,093	56	95	151	308	434	610	1,125
H105T	H205T		693	1.1	2,135	8,480	51	84	136	274	381	535	996	53	87	140	281	390	550	1,033
H105	H205		613	1.0	0	8,480	50	83	128	243	335	469	887	53	87	133	250	344	482	921
H106O	H206O		578	0.9	2,041	10,521	49	82	124	233	320	446	847	52	85	129	240	329	459	880
H106	H206		578	0.9	0	10,521	96	143	207	369	484	663	1,158	98	145	209	371	504	703	1,221
H109	H209	136th Avenue	322	0.5	2,203	12,725	49	77	119	227	326	464	823	50	78	120	243	343	497	856
H110	H210	Holly Street	306	0.5	954	13,678	49	76	116	220	317	452	803	49	77	117	236	334	484	836
H112O	H212O		114	0.2	1,160	14,838	4	11	24	71	101	161	282	5	14	30	78	110	176	303
H112	H212		114	0.2	0	14,838	23	38	61	115	152	198	308	28	45	70	126	165	215	331

Table B-18 - Baseline Runoff Volumes Along Horizon Tributary

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}
H101	H201	Brantner Gulch Tributary Confluence	1,261	2.0	0	0	22	37	60	108	146	194	307	27	43	67	115	153	201	316
H102	H202	Valentina Street	1,228	1.9	2,279	2,279	22	36	59	106	143	189	300	27	42	66	113	150	196	307
H103O	H203O	Tamarac Street	1,115	1.7	1,915	4,194	19	31	51	94	127	169	271	23	37	58	101	134	176	278
H103	H203		1,115	1.7	0	4,194	19	32	52	95	128	170	272	24	38	59	102	135	177	279
H104T	H204T		1,073	1.7	645	4,838	19	31	50	91	123	164	261	23	37	57	98	130	171	269
H104	H204	Quebec Street	804	1.3	1,507	6,345	18	29	44	75	99	129	202	19	30	45	76	100	130	204
H105T	H205T		693	1.1	2,135	8,480	15	24	37	64	85	111	174	16	25	39	65	86	112	175
H105	H205		613	1.0	0	8,480	14	23	34	58	76	99	155	15	24	36	59	77	100	157
H106O	H206O		578	0.9	2,041	10,521	14	22	33	55	73	94	147	15	23	34	56	74	95	148
H106	H206		578	0.9	0	10,521	14	22	33	55	73	94	147	15	23	34	56	74	95	148
H109	H209	136th Avenue	322	0.5	2,203	12,725	6	10	16	28	38	50	79	6	11	17	29	39	51	80
H110	H210	Holly Street	306	0.5	954	13,678	6	10	15	27	36	48	76	6	10	16	28	37	48	76
H112O	H212O		114	0.2	1,160	14,838	1	3	5	9	13	17	27	2	3	5	10	13	17	28
H112	H212		114	0.2	0	14,838	2	4	6	10	14	18	28	3	4	6	11	14	18	29

Table B-19 - Baseline Peak Flows Along Pheasants Run Tributary

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	Horizons Tributary Confluence	269	0.4	0	0	4	14	50	148	213	301	498	45	68	104	212	287	384	611
R102	R202	Quebec Street	204	0.3	2,894	2,894	4	11	43	124	177	247	407	44	63	83	163	222	297	474
R103	R203	136th Avenue	150	0.2	1,762	4,656	1	4	27	85	122	171	285	2	6	30	87	125	174	288
R104	R204		120	0.2	174	4,830	1	3	22	69	100	139	232	2	5	24	71	102	142	235

Table B-20 - Baseline Runoff Volumes Along Pheasants Run Tributary

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	Horizons Tributary Confluence	269	0.4	0	0	1	2	6	17	25	35	59	4	7	12	22	30	40	64
R102	R202	Quebec Street	204	0.3	2,894	2,894	1	1	5	12	18	26	44	3	4	8	16	22	29	48
R103	R203	136th Avenue	150	0.2	1,762	4,656	0	0	3	9	13	19	32	0	1	3	9	13	19	32
R104	R204		120	0.2	174	4,830	0	0	2	7	10	15	25	0	1	2	7	11	15	26

Table B-21 - Baseline Peak Flows Along Quails Way Tributary

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}
Q101O	Q201O	Horizons Tributary Confluence	80	0.1	0	0	0	2	8	37	64	96	158	0	2	8	37	64	96	158
Q101	Q201		80	0.1	0	0	6	12	24	54	74	101	162	6	12	24	54	74	101	162
Q102	Q202		27	0.0	2,845	2,845	2	5	9	20	27	37	59	2	5	9	20	27	37	59

Table B-22 - Baseline Runoff Volumes Along Quails Way Tributary

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}
Q101O	Q201O	Horizons Tributary Confluence	80	0.1	0	0	1	2	3	6	8	11	19	1	2	3	6	8	11	19
Q101	Q201		80	0.1	0	0	1	2	3	6	9	12	19	1	2	3	6	9	12	19
Q102	Q202		27	0.0	2,845	2,845	0	0	1	2	3	4	6	0	0	1	2	3	4	6

Table B-23 - Baseline Peak Flows Along Plains Tributary

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}
P101	P201	Brantner Gulch Tributary Confluence	373	0.6	0	0	19	44	75	154	219	307	508	21	47	80	161	227	316	521
P102	P202	128th Avenue	325	0.5	3,199	3,199	20	43	72	143	200	276	451	20	43	72	143	200	276	451
P103O	P203O		262	0.4	1,090	4,289	16	33	55	109	152	209	335	16	33	55	109	152	209	335
P103	P203		262	0.4	0	4,290	37	57	80	139	180	233	366	37	57	80	139	180	233	366
P104	P204	130th Avenue	197	0.3	1,294	5,584	20	31	43	78	102	142	225	20	31	43	78	102	142	225
P105T	P205T		142	0.2	1,989	7,573	4	7	14	36	56	73	104	4	7	14	36	56	73	104
P106O	P206O	Holly Street	86	0.1	313	7,886	2	4	6	22	32	36	45	2	4	6	22	32	36	45
P106	P206		86	0.1	0	7,887	2	5	12	29	50	70	134	2	5	12	29	50	70	134
P107O	P207O		27	0.0	3,326	11,212	1	2	4	12	24	25	62	1	2	4	12	24	25	62
P107	P207		27	0.0	0	11,212	3	6	11	24	33	43	69	3	6	11	24	33	43	69

Table B-24 - Baseline Runoff Volumes Along Plains Tributary

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}
P101	P201	Brantner Gulch Tributary Confluence	373	0.6	0	0	5	9	16	31	42	56	90	5	10	18	32	44	58	92
P102	P202	128th Avenue	325	0.5	3,199	3,199	4	9	15	27	37	50	79	4	9	15	27	37	50	79
P103O	P203O		262	0.4	1,090	4,289	2	6	11	21	29	39	63	2	6	11	21	29	39	63
P103	P203		262	0.4	0	4,290	5	9	14	24	32	41	65	5	9	14	24	32	41	65
P104	P204	130th Avenue	197	0.3	1,294	5,584	3	5	9	16	22	30	48	3	5	9	16	22	30	48
P105T	P205T		142	0.2	1,989	7,573	1	2	5	10	14	20	33	1	2	5	10	14	20	33
P106O	P206O	Holly Street	86	0.1	313	7,886	1	1	3	6	9	12	20	1	1	3	6	9	12	20
P106	P206		86	0.1	0	7,887	1	1	3	6	9	12	20	1	1	3	6	9	12	20
P107O	P207O		27	0.0	3,326	11,212	0	1	1	2	3	4	6	0	1	1	2	3	4	6
P107	P207		27	0.0	0	11,212	0	1	1	2	3	4	6	0	1	1	2	3	4	6

Table B-25 - Baseline Peak Flows Along Lakeview Tributary

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}
L101	L201	Brantner Gulch Tributary Confluence	553	0.9	0	0	50	90	129	195	270	413	959	51	91	131	197	272	416	961
L102O	L202O		501	0.8	2,435	2,435	50	86	121	174	243	374	897	50	86	121	174	243	374	897
L102	L202		501	0.8	0	2,435	75	114	146	214	263	404	915	75	114	146	214	263	404	915
L103T	L203T		457	0.7	803	3,238	63	94	118	164	222	338	840	63	94	118	164	222	338	840
L104	L204	128th Avenue	447	0.7	505	3,743	60	89	110	150	212	321	823	60	89	110	150	212	321	823
L105O	L205O		397	0.6	1,239	4,981	46	68	84	102	168	269	744	46	68	84	102	168	269	744
L105	L205		397	0.6	0	4,981	46	71	102	171	219	277	745	46	71	102	171	219	277	745
L106O	L206O	Summit Grove Parkway	289	0.5	1,763	6,744	29	38	47	70	85	199	568	29	38	47	70	85	199	568
L106	L206		289	0.5	0	6,744	36	52	72	118	189	280	595	36	52	72	118	189	280	595
L109O	L209O		105	0.2	2,327	9,071	11	13	16	20	22	46	219	11	13	16	20	22	46	219
L109	L209		105	0.2	0	9,072	35	57	86	150	197	252	386	35	57	86	150	197	252	386
L110	L210		74	0.1	1,466	10,537	29	47	68	117	151	192	292	29	47	68	117	151	192	292
L111	L211		22	0.0	1,304	11,841	9	15	22	35	45	58	88	9	15	22	35	45	58	88

Table B-26 - Baseline Runoff Volumes Along Lakeview Tributary

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}
L101	L201	Brantner Gulch Tributary Confluence	553	0.9	0	0	15	24	35	56	73	94	145	15	24	35	56	73	94	145
L102O	L202O		501	0.8	2,435	2,435	15	23	33	52	67	86	132	15	23	33	52	67	86	132
L102	L202		501	0.8	0	2,435	15	23	33	52	68	86	132	15	23	33	52	68	86	132
L103T	L203T		457	0.7	803	3,238	13	21	30	47	61	79	121	13	21	30	47	61	79	121
L104	L204	128th Avenue	447	0.7	505	3,743	13	20	29	46	60	77	118	13	20	29	46	60	77	118
L105O	L205O		397	0.6	1,239	4,981	12	18	26	41	53	68	104	12	18	26	41	53	68	104
L105	L205		397	0.6	0	4,981	12	18	26	41	53	68	104	12	18	26	41	53	68	104
L106O	L206O	Summit Grove Parkway	289	0.5	1,763	6,744	8	13	19	30	39	49	76	8	13	19	30	39	49	76
L106	L206		289	0.5	0	6,744	8	13	19	30	39	49	76	8	13	19	30	39	49	76
L109O	L209O		105	0.2	2,327	9,071	3	5	7	11	14	18	27	3	5	7	11	14	18	27
L109	L209		105	0.2	0	9,072	3	5	7	11	14	18	27	3	5	7	11	14	18	27
L110	L210		74	0.1	1,466	10,537	2	3	5	8	10	13	19	2	3	5	8	10	13	19
L111	L211		22	0.0	1,304	11,841	1	1	1	2	3	4	6	1	1	1	2	3	4	6

Figure B-3
Regional Park
Baseline Peak Discharge vs. Drainageway Station

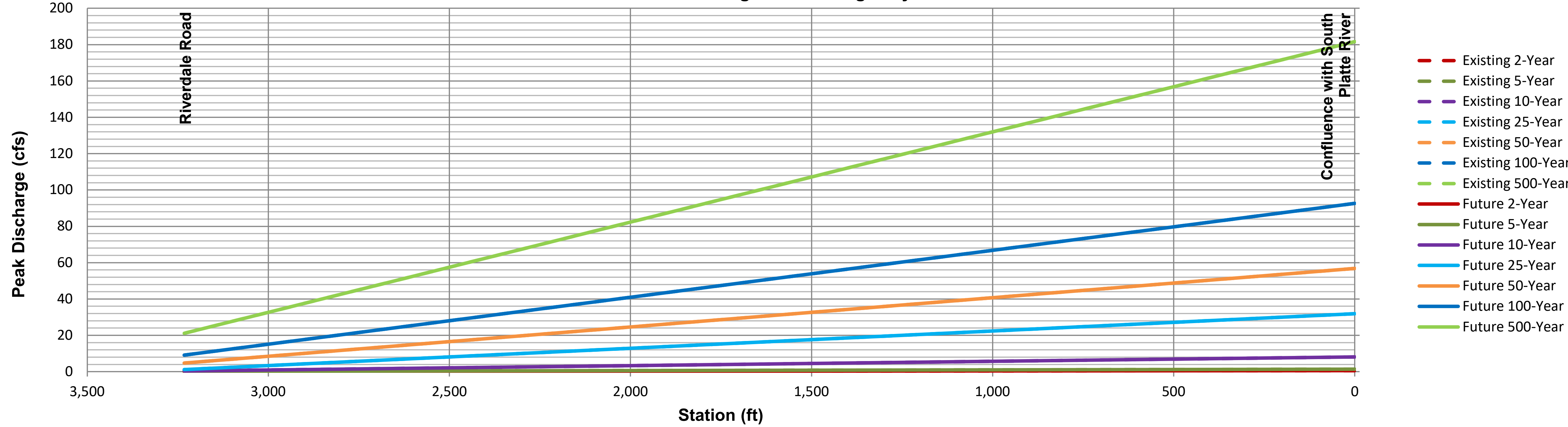
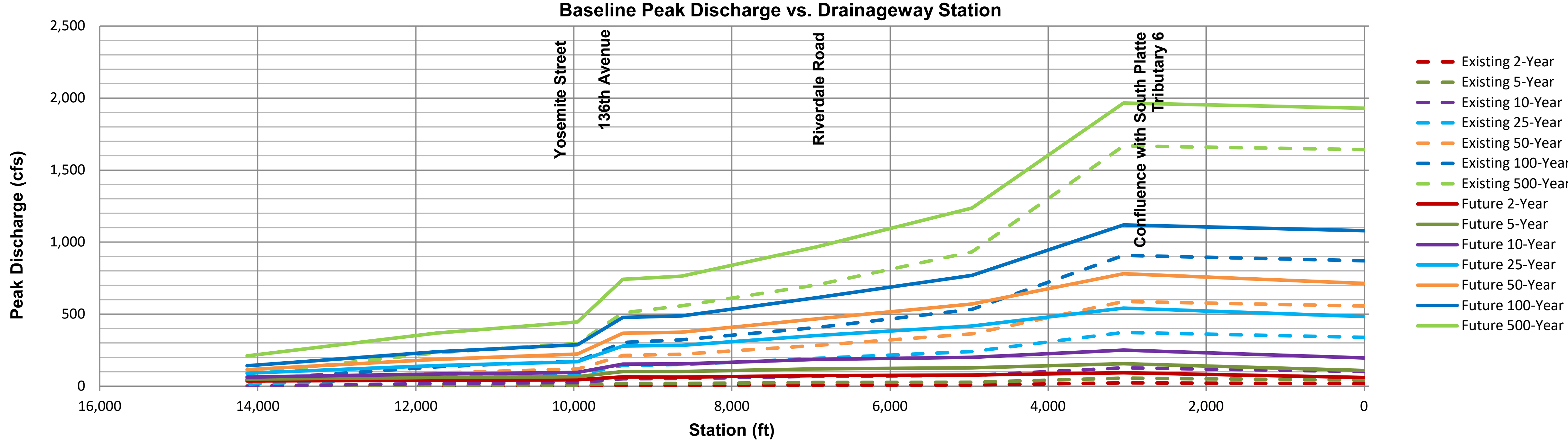


Figure B-4
South Platte Tributary 7
Baseline Peak Discharge vs. Drainageway Station



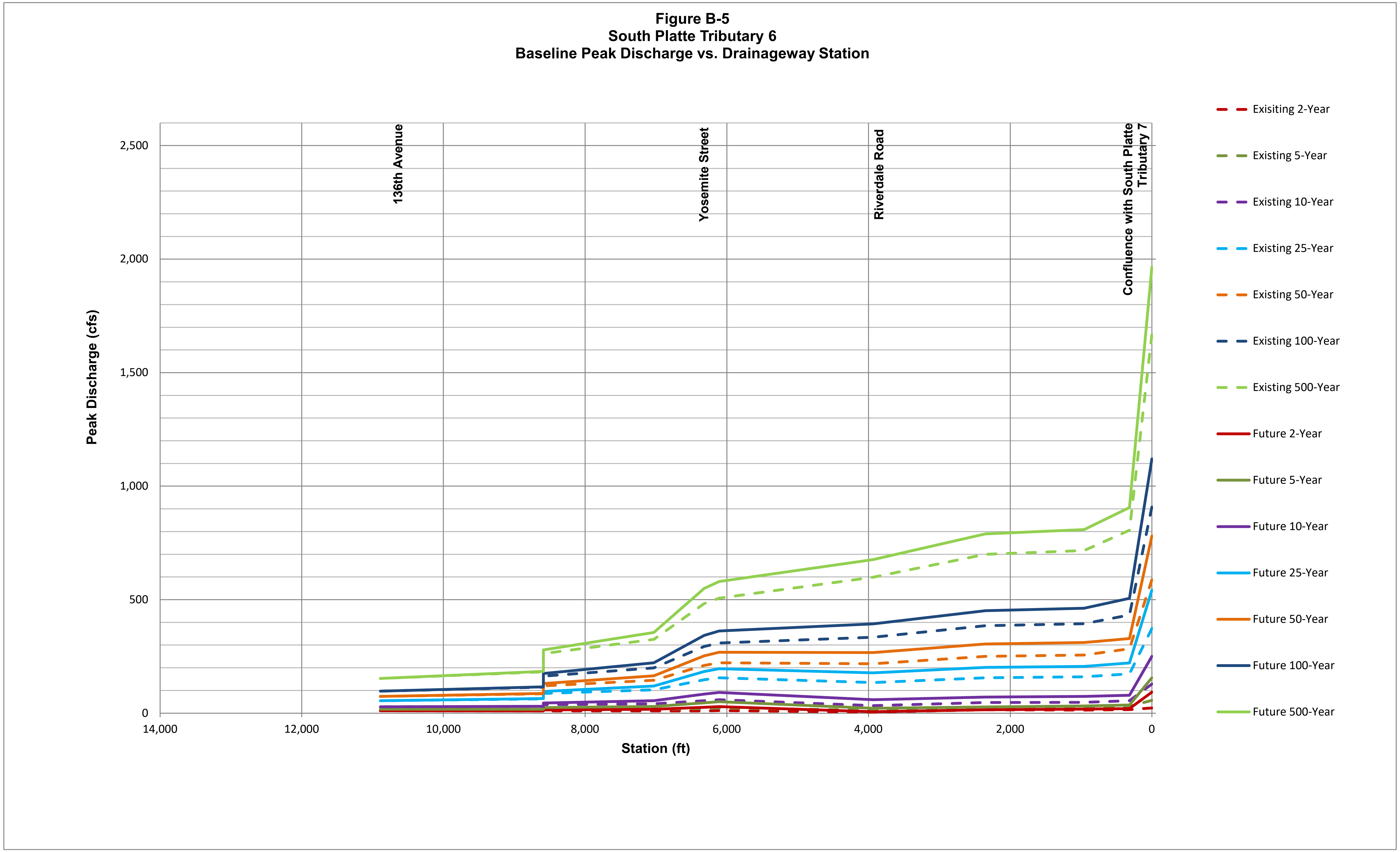


Figure B-5
South Platte Tributary 6
Baseline Peak Discharge vs. Drainageway Station
Peak Discharge (cfs)
Station (ft)
0
500
1,000
1,500
2,000
2,500
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
136th Avenue
Yosemite Street
Riverdale Road
Confluence with South Platte Tributary 7
Exisiting 2-Year
Existing 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

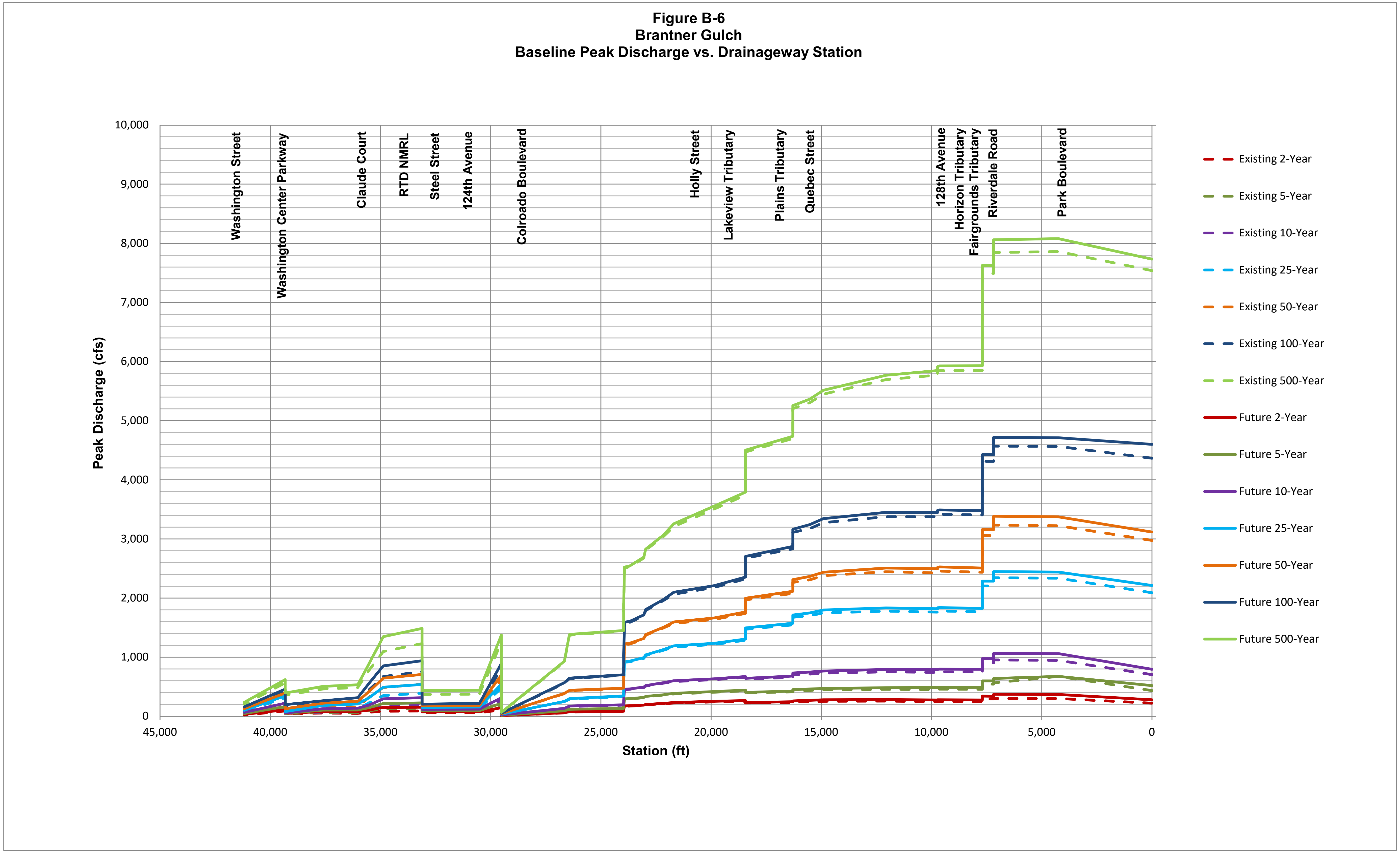


Figure B-6
Brantner Gulch
Baseline Peak Discharge vs. Drainageway Station
Peak Discharge (cfs)
Station (ft)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
Washington Street
Washington Center Parkway
Claude Court
RTD NMRL
Steel Street
124th Avenue
Colroado Boulevard
Holly Street
Lakeview Tributary
Plains Tributary
Quebec Street
128th Avenue
Horizon Tributary
Fairgrounds Tributary
Riverdale Road
Park Boulevard
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

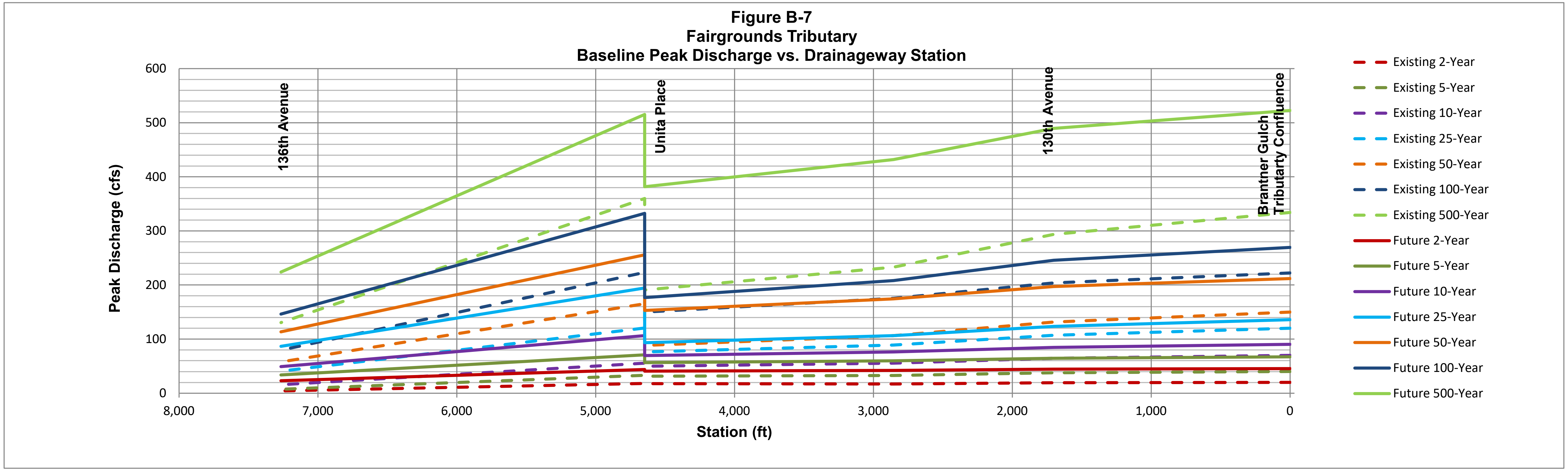


Figure B-7
Fairgrounds Tributary
Baseline Peak Discharge vs. Drainageway Station
Peak Discharge (cfs)
Station (ft)
136th Avenue
Unita Place
130th Avenue
Brantner Gulch Tributarty Confluence
0
100
200
300
400
500
600
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Existing 2-Year
Existing 5-Year
Existing 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

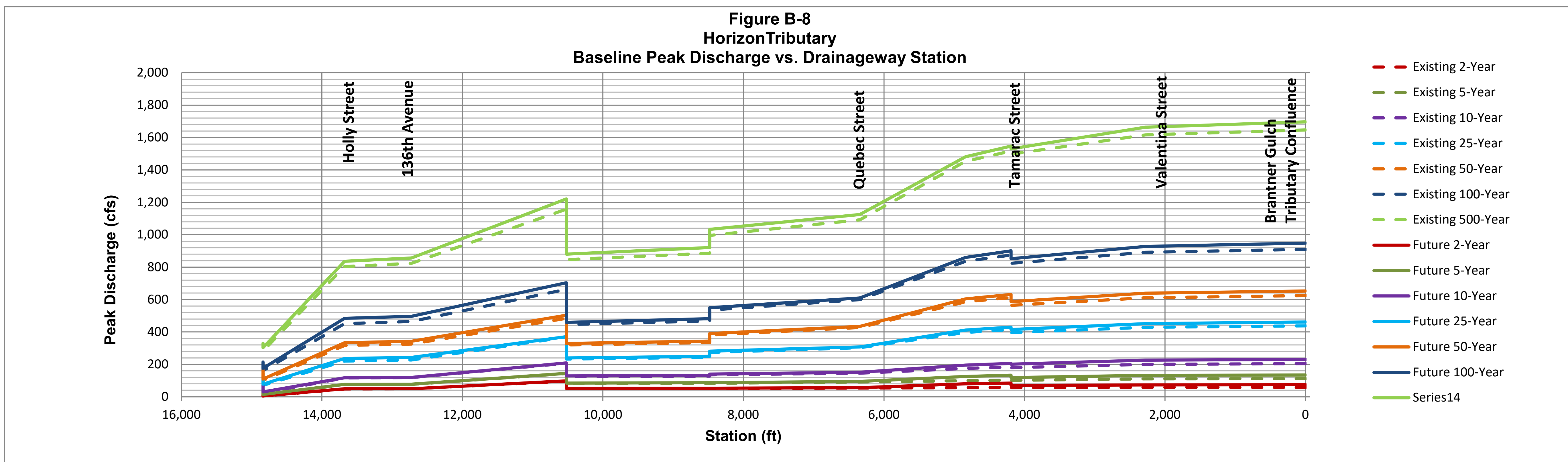


Figure B-8
HorizonTributary
Baseline Peak Discharge vs. Drainageway Station
Peak Discharge (cfs)
Station (ft)
Holly Street
136th Avenue
Quebec Street
Tamarac Street
Valentina Street
Brantner Gulch Tributary Confluence
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
2,000
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
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
Series14

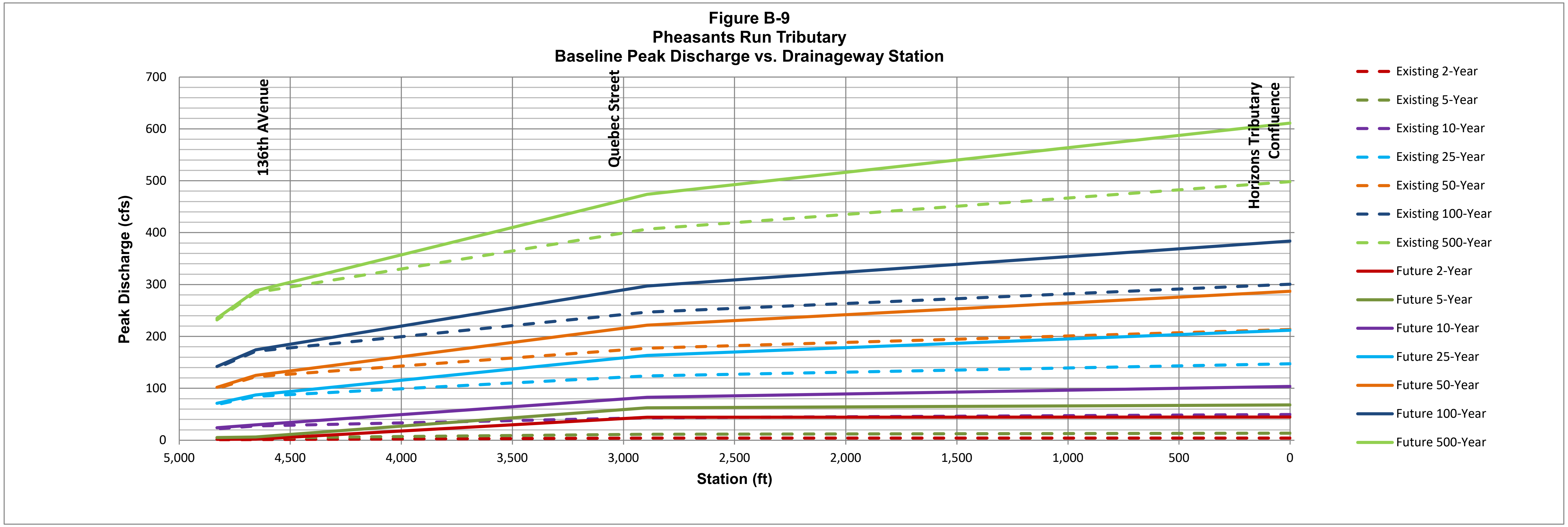


Figure B-9
Pheasants Run Tributary
Baseline Peak Discharge vs. Drainageway Station
Peak Discharge (cfs)
Station (ft)
136th AVenue
Quebec Street
Horizons Tributary Confluence
Existing 2-Year
Existing 5-Year
Existing 10-Year
Existing 25-Year
Existing 50-Year
Existing 100-Year
Existing 500-Year
Future 2-Year
Future 5-Year
Future 10-Year
Future 25-Year
Future 50-Year
Future 100-Year
Future 500-Year

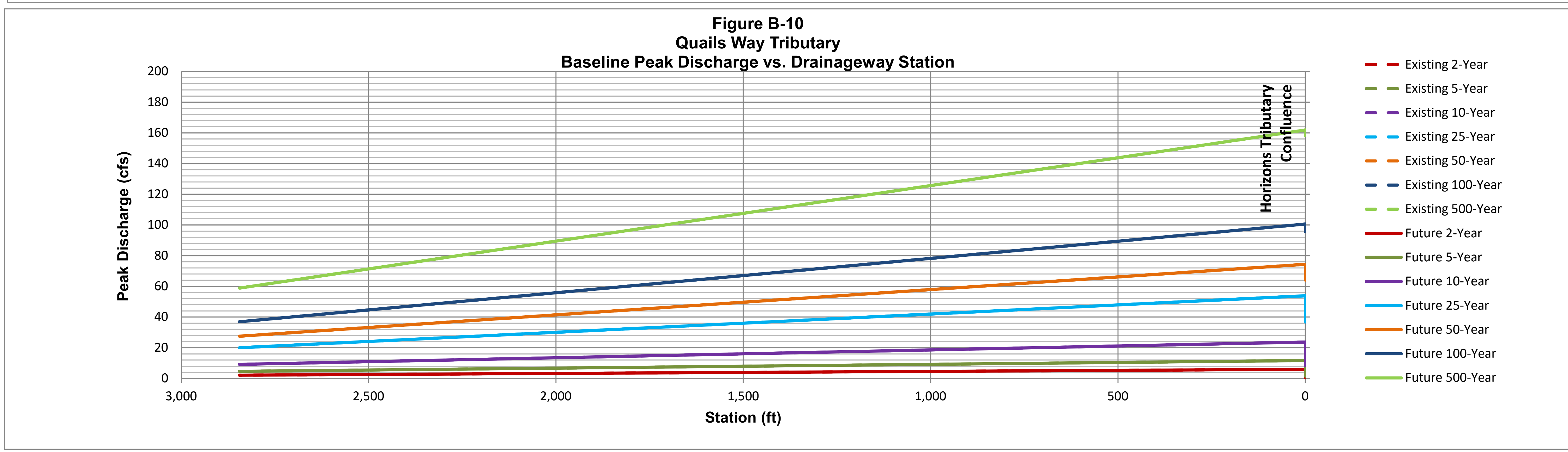


Figure B-10
Quails Way Tributary
Baseline Peak Discharge vs. Drainageway Station
Peak Discharge (cfs)
Station (ft)
Horizons Tributary Confluence
Existing 2-Year
Existing 5-Year
Existing 10-Year
Existing 25-Year
Existing 50-Year
Existing 100-Year
Existing 500-Year
Future 2-Year
Future 5-Year
Future 10-Year
Future 25-Year
Future 50-Year
Future 100-Year
Future 500-Year

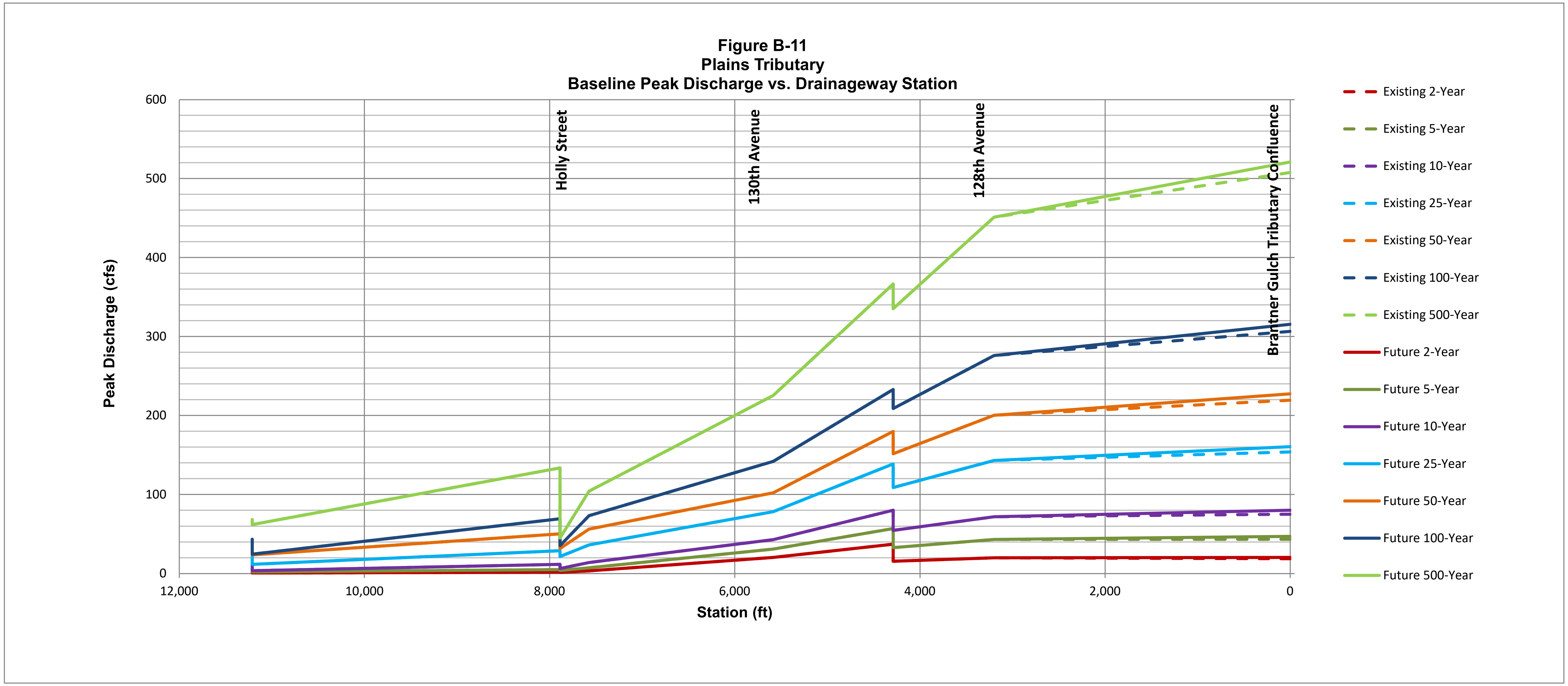


Figure B-11
Plains Tributary
Baseline Peak Discharge vs. Drainageway Station
Peak Discharge (cfs)
Station (ft)
600
500
400
300
200
100
0
12,000
10,000
8,000
6,000
4,000
2,000
0
Holly Street
130th Avenue
128th Avenue
Brantner Gulch Tributary Confluence
Existing 2-Year
Existing 5-Year
Existing 10-Year
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

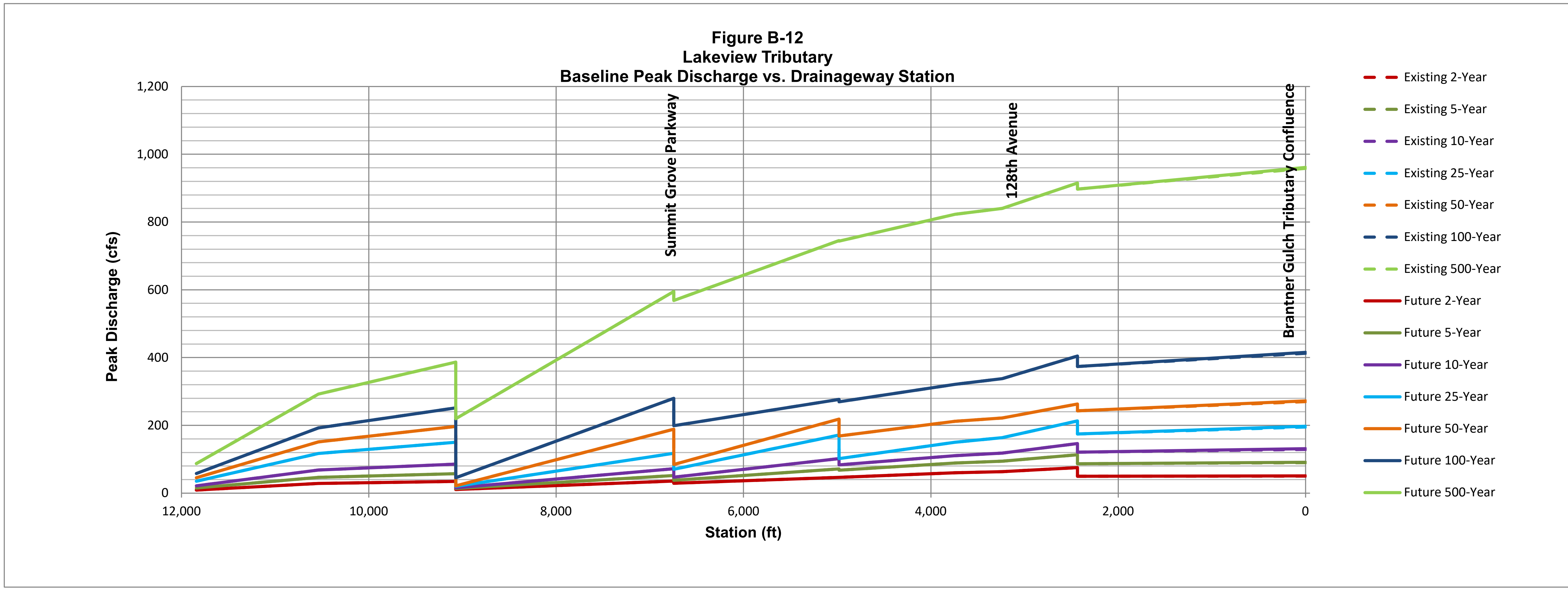


Figure B-12
Lakeview Tributary
Baseline Peak Discharge vs. Drainageway Station
Peak Discharge (cfs)
1,200
1,000
800
600
400
200
0
12,000
10,000
8,000
6,000
4,000
2,000
0
Station (ft)
Summit Grove Parkway
128th Avenue
Brantner Gulch Tributary Confluence
Existing 2-Year
Existing 5-Year
Existing 10-Year
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-13 - Baseline Hydrographs

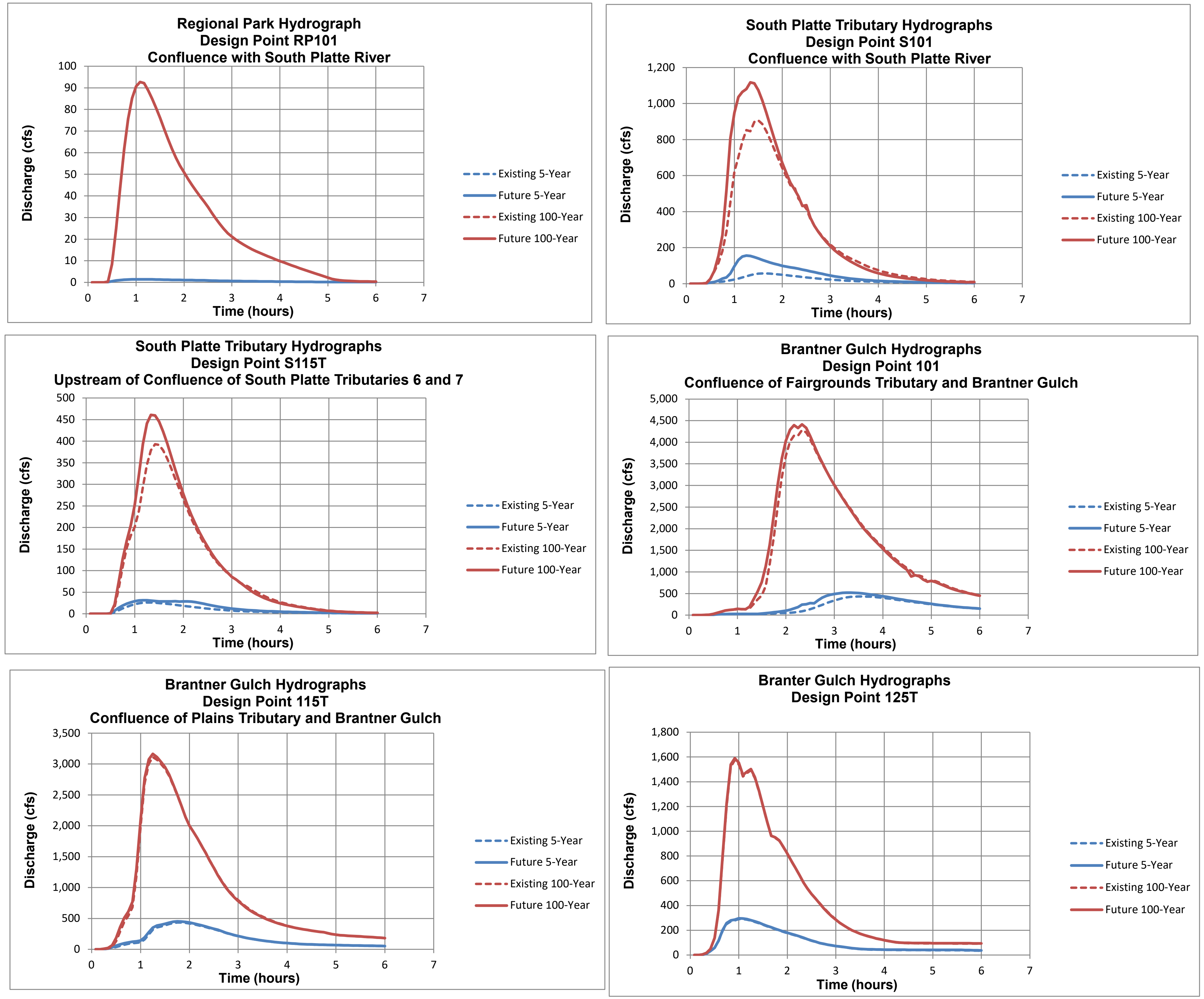
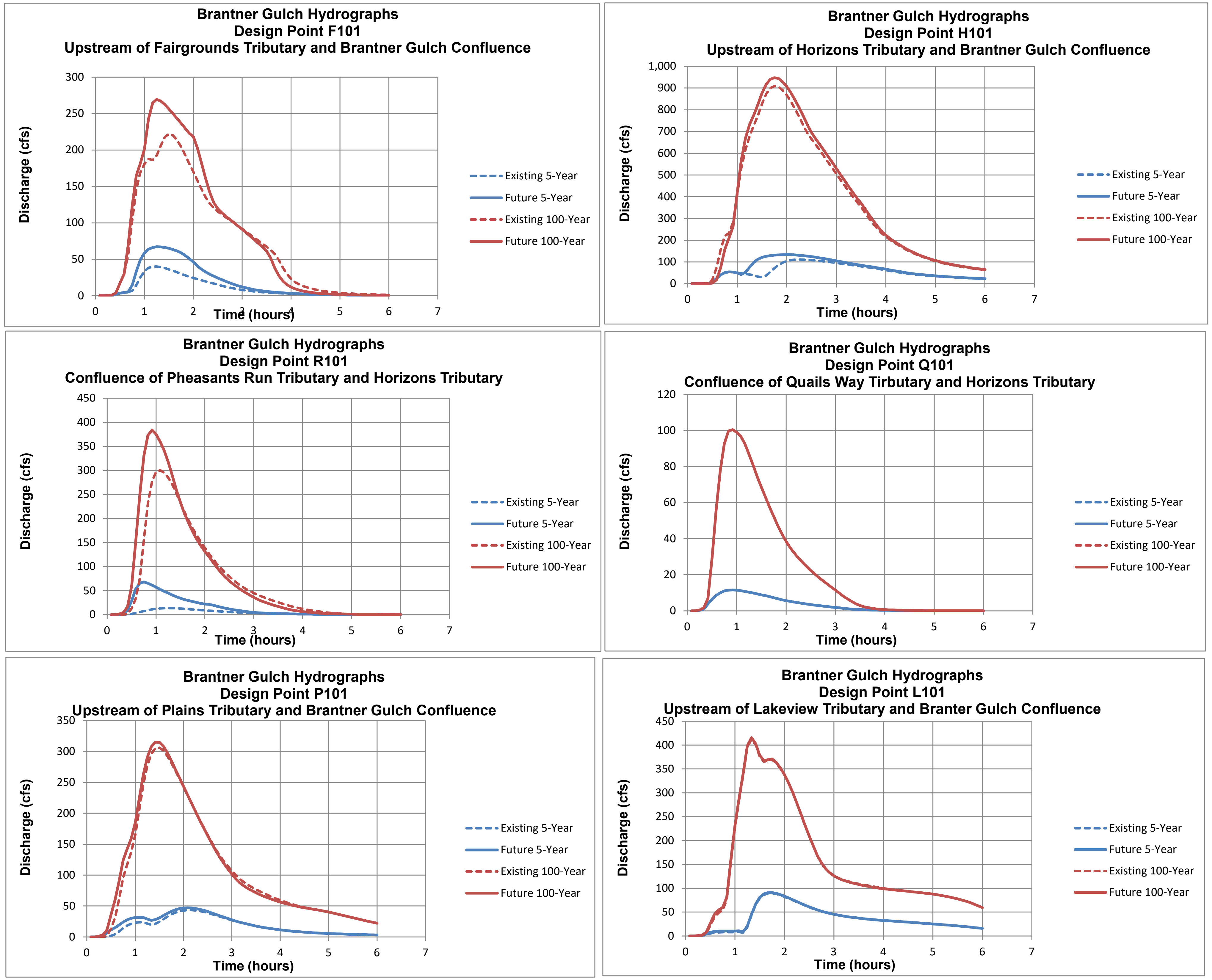


Figure B-13 - Baseline Hydrographs



APPENDIX C

HYDRAULIC ANALYSIS

Table C-1: Summary of HEC-RAS Flows

River Name	Reach Name	New Cross Section ID	Design Point	Future Peak Flow						
				2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	500 yr
Brantner Gulch	Brantner 5	43231	165	111	163	222	348	393	459	621
Brantner Gulch	Brantner 5	41356	165O	45	50	54	79	129	198	394
Brantner Gulch	Brantner 5	40732	164	81	105	130	183	220	263	505
Brantner Gulch	Brantner 5	39030	163	81	108	136	207	254	313	534
Brantner Gulch	Brantner 5	37931	163T	104	144	189	311	415	554	886
Brantner Gulch	Brantner 5	37531	161	149	217	295	492	645	853	1346
Brantner Gulch	Brantner 5	36301	160	154	227	315	537	708	940	1485
Brantner Gulch	Brantner 5	32439	159	77	97	119	157	185	220	439
Brantner Gulch	Brantner 5	31293	152	146	219	314	543	699	894	1375
Brantner Gulch	Brantner 5	28637	135	60	92	133	251	388	567	933
Brantner Gulch	Brantner 5	27762	134	77	120	177	307	445	655	1395
Brantner Gulch	Brantner 5	26895	129	84	133	195	344	475	701	1449
Brantner Gulch	Brantner 5	25245	124T	176	299	462	932	1234	1604	2542
Brantner Gulch	Brantner 5	24356	123T	189	319	494	991	1317	1715	2694
Brantner Gulch	Brantner 5	23880	122	199	335	520	1039	1383	1805	2827
Brantner Gulch	Brantner 5	22776	120T	218	364	567	1127	1506	1975	3064
Brantner Gulch	Brantner 5	22372	119	232	387	602	1192	1596	2097	3257
Brantner Gulch	Brantner 5	20178	118T	253	417	633	1235	1663	2209	3556
Brantner Gulch	Brantner 4	18737	117T (2- and 5-year are at 118T to avoid reduction in flows)	253	417	642	1493	1996	2705	4503
Brantner Gulch	Brantner 3	16588	115T	261	452	731	1712	2310	3164	5255
Brantner Gulch	Brantner 3	16033	113T	271	463	748	1749	2365	3242	5366
Brantner Gulch	Brantner 3	15287	111T	279	470	766	1797	2437	3344	5515
Brantner Gulch	Brantner 3	13288	108T	281	484	791	1834	2509	3449	5769
Brantner Gulch	Brantner 3	10027	105T	279	490	798	1839	2526	3491	5926
Brantner Gulch	Brantner 2	7884	104T	340	599	976	2287	3159	4425	7625
Brantner Gulch	Brantner 1	7632	103T	371	639	1063	2447	3385	4716	8059
Brantner Gulch	Eastlake 2 O.F.	126823	Detention Basin 360 (Eastlake Number 2) 500-year overflow	0.1	0.1	0.1	0.1	0.1	0.1	194
Fairgrounds Trib	Fairgrounds Trib	97529	F105	23	34	49	87	114	146	224
Fairgrounds Trib	Fairgrounds Trib	95500	F104	44	71	107	195	256	333	515
Fairgrounds Trib	Fairgrounds Trib	94294	F104O	41	57	69	93	153	177	382
Fairgrounds Trib	Fairgrounds Trib	93338	F103	42	60	76	106	174	208	432
Fairgrounds Trib	Fairgrounds Trib	91927	F102	45	64	85	123	197	246	490
Fairgrounds Trib	Fairgrounds Trib	90907	F101	46	67	90	136	212	269	523
Horizons Tributa	Horizon Trib 2	84280	H112O	5	14	30	78	110	176	303
Horizons Tributa	Horizon Trib 2	83870	H110	49	77	117	236	334	484	836
Horizons Tributa	Horizon Trib 2	83217	H109	50	78	120	243	343	497	856
Horizons Tributa	Horizon Trib 2	81567	H106	98	145	209	371	504	703	1221
Horizons Tributa	Horizon Trib 2	80389	H106O	52	85	129	240	329	459	880
Horizons Tributa	Horizon Trib 2	79842	H105	53	87	133	250	344	482	921
Horizons Tributa	Horizon Trib 2	78542	H105T	53	87	140	281	390	550	1033
Horizons Tributa	Horizon Trib 2	77572	H104	56	95	151	308	434	610	1125

Table C-1: Summary of HEC-RAS Flows

River Name	Reach Name	New Cross Section ID	Design Point	Future Peak Flow						
				2 yr	5 yr	10 yr	25 yr	50 yr	100 yr	500 yr
Horizons Tributa	Horizon Trib 1	74828	H104T	80	126	195	412	604	860	1482
Horizons Tributa	Horizon Trib 1	74428	H103	85	134	206	430	632	901	1548
Horizons Tributa	Horizon Trib 1	74173	H103O	70	119	201	415	587	852	1530
Horizons Tributa	Horizon Trib 1	73333	H102	73	132	226	452	639	929	1664
Horizons Tributa	Horizon Trib 1	71360	H101	74	134	231	462	653	948	1696
Lakeview Tributa	Lakeview Trib	55510	L105	46	71	102	171	219	277	745
Lakeview Tributa	Lakeview Trib	54746	L105O	46	68	84	102	168	269	744
Lakeview Tributa	Lakeview Trib	54215	L104	60	89	110	150	212	321	823
Lakeview Tributa	Lakeview Trib	53283	L102	75	114	146	214	263	404	915
Lakeview Tributa	Lakeview Trib	52396	L102O	50	86	121	174	243	374	897
Lakeview Tributa	Lakeview Trib	51738	L101	51	91	131	197	272	416	961
Ohio Lake O.F.	Ohio Lake O.F.	132252	Detention Basin 365 (Ohio Lake) 100-year and 500-year overflow	0.1	0.1	0.1	0.1	0.1	9	134
Pheasants Run Tr	Pheasants Run Tr	89647	R102	44	63	83	163	222	297	474
Pheasants Run Tr	Pheasants Run Tr	88906	R101	45	68	104	212	287	384	611
Plains Tributary	Plains Trib	67604	P105T	4	7	14	36	56	73	104
Plains Tributary	Plains Trib	66429	P104	20	31	43	78	102	142	225
Plains Tributary	Plains Trib	64826	P103	37	57	80	139	180	233	366
Plains Tributary	Plains Trib	64193	P103O	16	33	55	109	152	209	335
Plains Tributary	Plains Trib	63607	P102	20	43	72	143	200	276	451
Plains Tributary	Plains Trib	62007	P101	21	47	80	161	227	316	521
Quails Way Tributary	Quails Way Trib	86428	Q102	2	5	9	20	27	37	59
SPR North Trib 7	SPR North Trib 7	123571	S112	42	61	85	143	186	239	369
SPR North Trib 7	SPR North Trib 7	121302	S111	43	64	93	165	216	279	432
SPR North Trib 7	SPR North Trib 7	120489	S110T	44	66	96	170	223	287	445
SPR North Trib 7	SPR North Trib 7	119839	S108	64	102	154	279	368	478	742
SPR North Trib 7	SPR North Trib 7	118937	S106T	64	102	154	284	374	487	764
SPR North Trib 7	SPR North Trib 7	118543	S105	73	120	186	352	468	614	967
SPR North Trib 7	SPR North Trib 7	115367	S102	77	127	200	417	570	769	1236
SPR North Trib 7	SPR N Trib DS	113331	S102T and Brantner Overflows	108	225	398	993	1727	2755	5421
SPR South Trib 6	SPR South 6 DS	108647	S120	17	30	55	120	164	222	355
SPR South Trib 6	SPR South 6 DS	107753	S119 500-year Overflow in Yosemite Storm Drain System	0.1	0.1	0.1	0.1	0.1	0.1	207.2
SPR South Trib 6	SPR South 6 DS	107147	S118	29	50	91	195	268	362	580
SPR South Trib6	SPR South 6 DS	105606	S118 and Brantner Overflows	44	119	239	646	1214	1997	4036
SPR South Trib 6	SPR South 6 DS	105160	S117 and Brantner Overflows	21	90	207	629	1213	2028	4132
SPR South Trib 6	SPR South 6 DS	102817	S116 and Brantner Overflows	30	96	219	653	1250	2086	4245
SPR South Trib 6	SPR South 6 DS	100924	S115T and Brantner Overflows	33	100	221	657	1257	2097	4265
SPR South Trib 6	SPR South 6 DS	100524	S114 and Brantner Overflows	35	105	226	672	1275	2140	4362

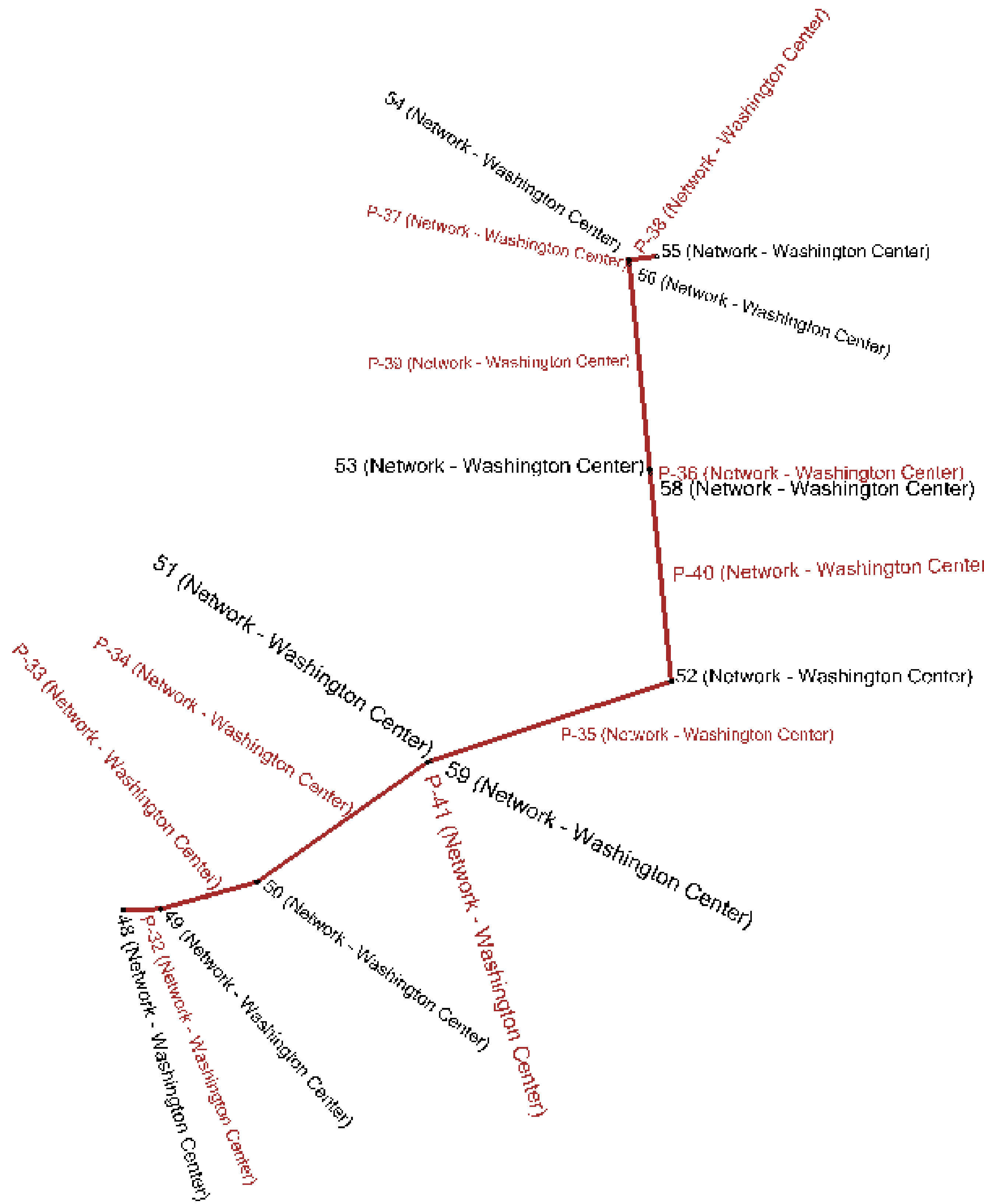
Table C-2 - Set Water Surface Elevations Summary

Cross Section	EPA SWMM Design Point	Storm Event	Peak Flow (cfs)	WSE	WSE Source	Overtops?	SWMM Model Spillway Elevation	Survey Spillway Elevation	Spillway Notes	SWMM Bottom Elevation	SWMM Source	HEC-RAS XS Elevation	HEC-RAS Source	Notes
Brantner Gulch - Cross Section 41162	365	500-Year	394	5315.19	EPA SWMM	Overtops	5314.72	Survey SW: 5314.72	SWMM model and survey match - OK	5305.17	Thornton Survey	5305.14	MHFD Survey 1	Elevations very similar - do not update to match in order to keep data sources consistent in each model
		100-Year	198	5314.82										
		50-Year	129	5314.39		No overtopping								
		25-Year	79	5313.87										
		10-Year	54	5312.32										
		5-Year	50	5311.32										
		2-Year	45	5310.32										
Brantner Gulch - Cross Section 34346	360	500-Year	433	5261.53	EPA SWMM	Overtops	5260	Survey SW: 5260.12	Survey and SWMM model are close, slightly conservative in SWMM model - OK	5252.08	MHFD Survey	5252.2	MHFD Survey 6	SWMM calcs use culvert invert, HEC-RAS uses upstream cross section points. Same data, so no changes
		100-Year	206	5259.75		No overtopping								
		50-Year	179	5258.71										
		25-Year	151	5257.80										
		10-Year	116	5256.79										
		5-Year	95	5256.21										
		2-Year	76	5255.66										
Brantner Gulch - Cross Section 30445	352	500-Year	65	5226.82	EPA SWMM	No overtopping	5227.5	Survey SW: 5227.58	SW survey point on end of survey, used slightly conservative value in hydrology - OK	5221.34	MHFD Survey	5221.34	MHFD Survey 11	Matches - OK
		100-Year	52	5225.36										
		50-Year	43	5224.86										
		25-Year	35	5224.35										
		10-Year	24	5223.66										
		5-Year	17	5223.29										
		2-Year	12	5222.79										
Fairgrounds Tributary - Cross Section 94495	F304	500-Year	382	5122.47	EPA SWMM	Overtops	5121.83	Survey SW: 5121.83	2010 Hydrology Update Table 2-6 spillway elevation = 5120, which did not match survey - used survey data instead	5109.45	MHFD Survey 82	5109.61	MHFD Survey 82	U/S ground, culvert = 5109.45, matches - OK
		100-Year	177	5120.31		No overtopping								
		50-Year	153	5118.78										
		25-Year	93	5117.83										
		10-Year	69	5114.98										
		5-Year	57	5113.64										
		2-Year	41	5112.49										
Horizon Tributary - Cross Section 80569	H306	500-Year	880	5180.54	EPA SWMM	Overtops	5179.8 SW, 5182 dam	Survey SW: 5179.82, 5182.02 dam	Survey and SWMM model from 2010 Hydrology Update Table 2-6 elevations are close - OK	5175.4	Functional: 2010 Hydrology Update - Appendix D tables (Pond 906)	5174.91	MHFD Survey 63	HEC-RAS is ledge elevation, SWMM is based on as-built drawings, not in the same location. Elevations on as-builts compare well where there is survey to compare - OK
		100-Year	459	5178.71		No overtopping								
		50-Year	329	5178.02										
		25-Year	240	5177.48										
		10-Year	129	5176.73										
		5-Year	85	5176.38										
		2-Year	52	5176.11										
Horizon Tributary - Cross Section 74217	H303	500-Year	1530	5094.21	EPA SWMM	Overtops	5092	Survey SW: 5092.15	Survey and SWMM model from 2010 Hydrology Update Table 2-6 elevations are close, slightly conservative in SWMM model - OK	5086	2010 Hydrology Update - Appendix D tables (Pond 912)	5085.37	MHFD Survey 74	U/S ground elevation, culvert = 5085.82. Top of drop = 5088.39 survey vs. 5088.5 in hydrology. Elevations match closely - OK
		100-Year	852	5092.62										
		50-Year	587	5091.62		No overtopping								
		25-Year	415	5090.57										
		10-Year	201	5089.51										
		5-Year	119	5089.09										
		2-Year	70	5088.84										
Lakeview Tributary - Cross Section 54978	L305	500-Year	744	5170.26	EPA SWMM	Overtops	5169.26	Survey SW: 5169.26	Survey and SWMM model from 2010 Hydrology Update Table 2-6 elevations of 5169.35 are close - OK	5161.43	MHFD Survey 42	5159.89, 5161.43	MHFD Survey 42	Ground lower than culvert inverts - blocked off in HEC-RAS. Used survey instead of 2010 Hydrology Update since bottom elevation did not match.
		100-Year	269	5169.67										
		50-Year	168	5169.42										
		25-Year	102	5168.86		No overtopping								
		10-Year	84	5166.28										
		5-Year	68	5164.46										
		2-Year	46	5163.42										
Lakeview Tributary - Cross Section 52430	L302	500-Year	897	5129.01	EPA SWMM	Overtops	5128	Survey SW: 5127.98	2010 Hydrology Update Table 2-6 spillway elevation = 5128.55, but stage-discharge curve checked and spillway is at 5128	5124.15	2010 Hydrology Update - Appendix D tables (Pond 911)	5123.46	MHFD Survey 44	Upstream ground shot - lower than outlet structure - 5123.88 (plate) 5123.74 (culvert), outlet structure wall = 5123.99 - 5124.16 vs. 5124.15 in SWMM - OK. Overflow box = 5126.55 in survey and SWMM - OK
		100-Year	374	5128.10										
		50-Year	243	5127.64		No overtopping								
		25-Year	174	5127.33										
		10-Year	121	5127.08										
		5-Year	86	5126.92										
		2-Year	50	5126.75										
Plains Tributary - Cross Section 64301	P303	500-Year	335	5155.16	EPA SWMM	No overtopping	5158	Survey SW Berm (outside of notch) = 5157.98	Survey and SWMM model from 2010 Hydrology Update Table 2-6 elevations are close - OK	5149	Functional: 2010 Hydrology Update - Appendix D tables (Pond 910)	5146.18	MHFD Survey 54	Upstream ground, WQ Plate inv = 5148.45 vs. 5149 in hydrology, culvert invert 5143.91. Checked stage-discharge with survey and similar results as model - OK
		100-Year	209	5154.62										
		50-Year	152	5154.36										
		25-Year	109	5154.16										
		10-Year	55	5153.86										
		5-Year	33	5153.71										
		2-Year	16	5153.60										
South Platte River Tributary 6 - Cross Section 108207	S119	500-Year	355	5084.63	MHFD-Culvert, Version 4.00/ StormCAD	No overtopping	Water surface elevations were determined using a culvert invert calculation, with inverts based on the Timberleaf Filing No. 1 construction documents.							
		100-Year	222	5079.62										
		50-Year	164	5078.17										
		25-Year	120	5077.23										
		10-Year	55	5075.76										
		5-Year	30	5075.05										
		2-Year	17	5074.61										

StormCAD Plan

Design Point 165O Ohio Lake: Washington Center

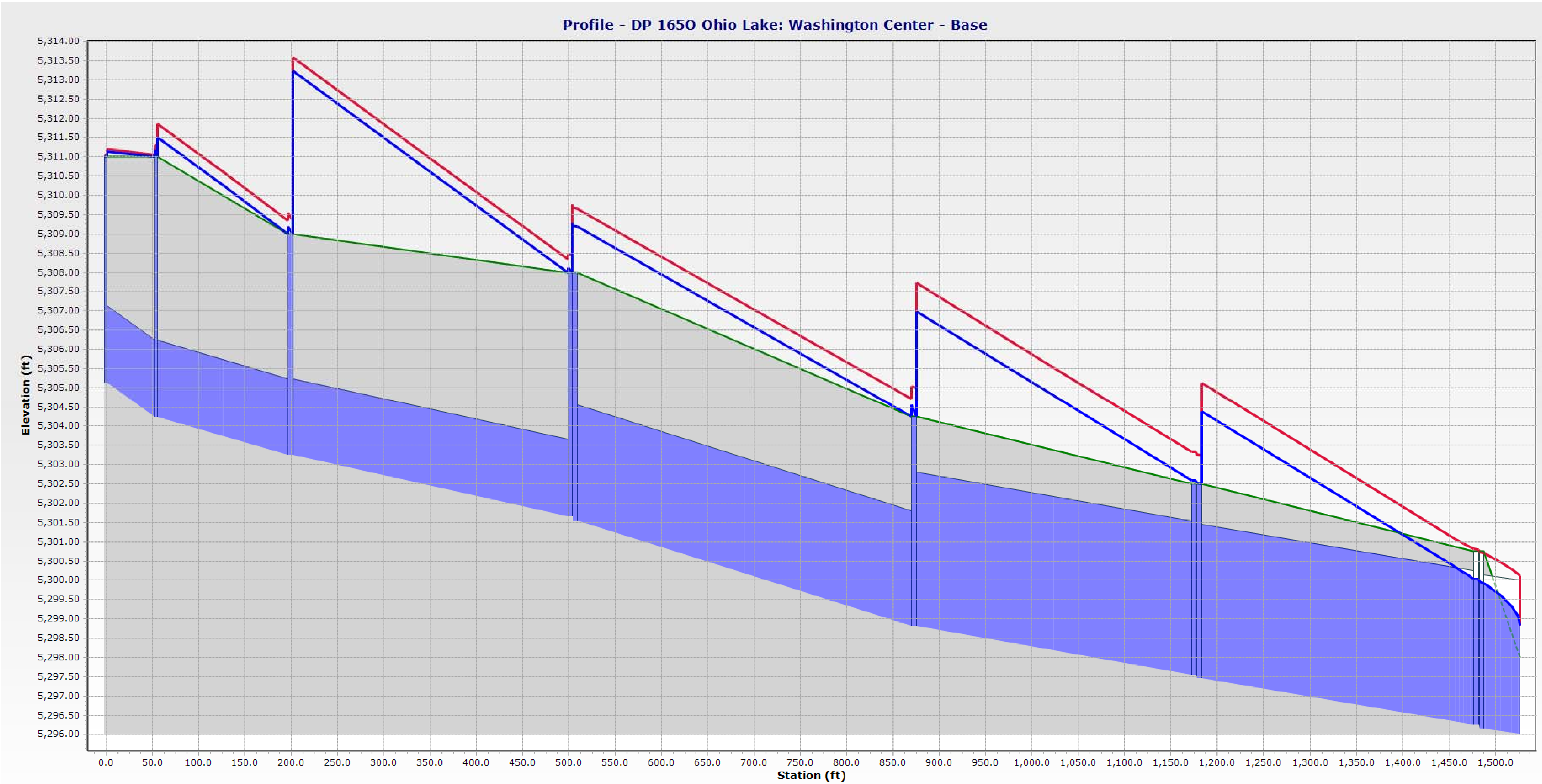
Design Flows



StormCAD Profile

Design Point 165O Ohio Lake: Washington Center

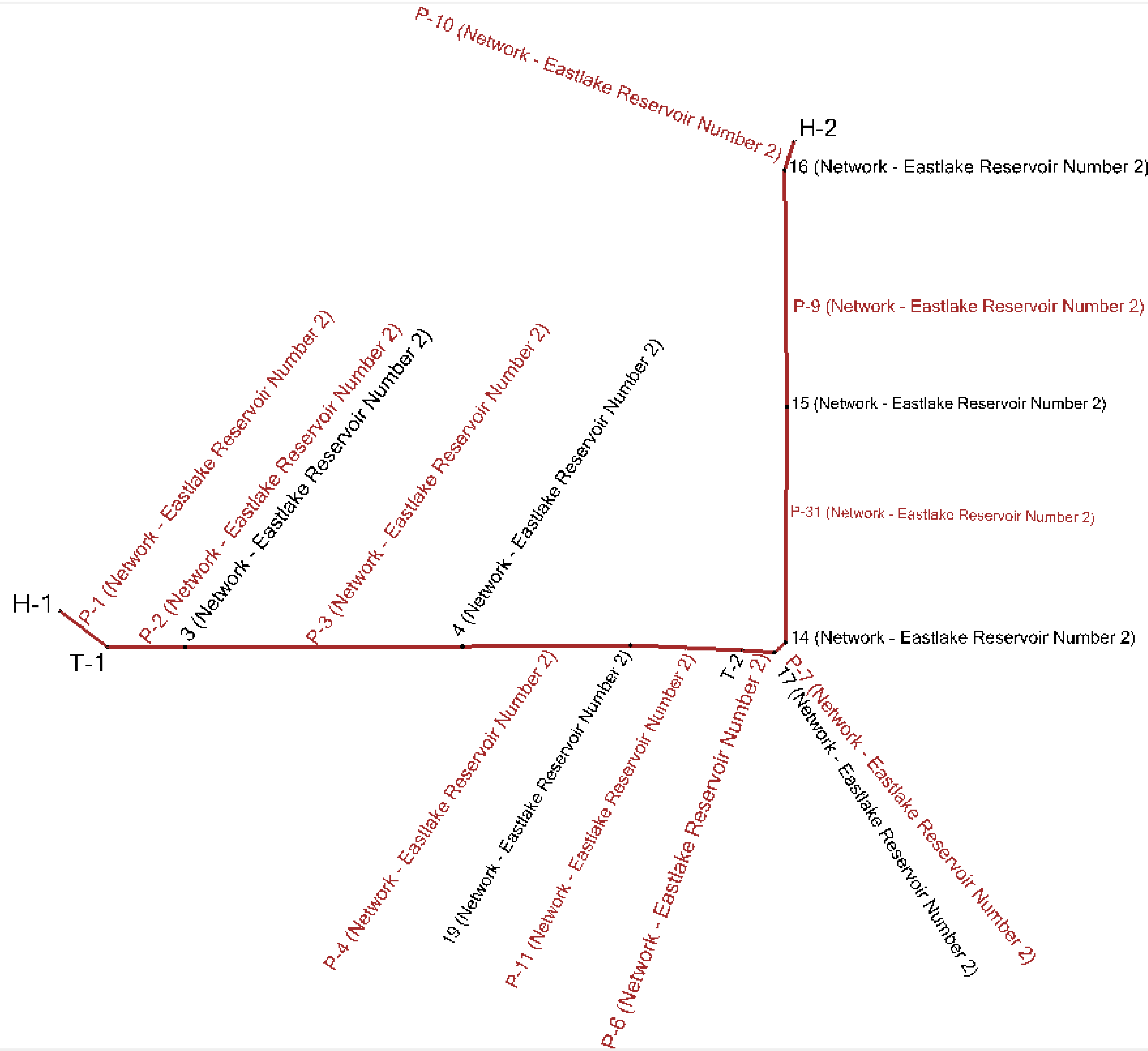
Design Flows



StormCAD Plan

Design Point 160O Eastlake Number 2

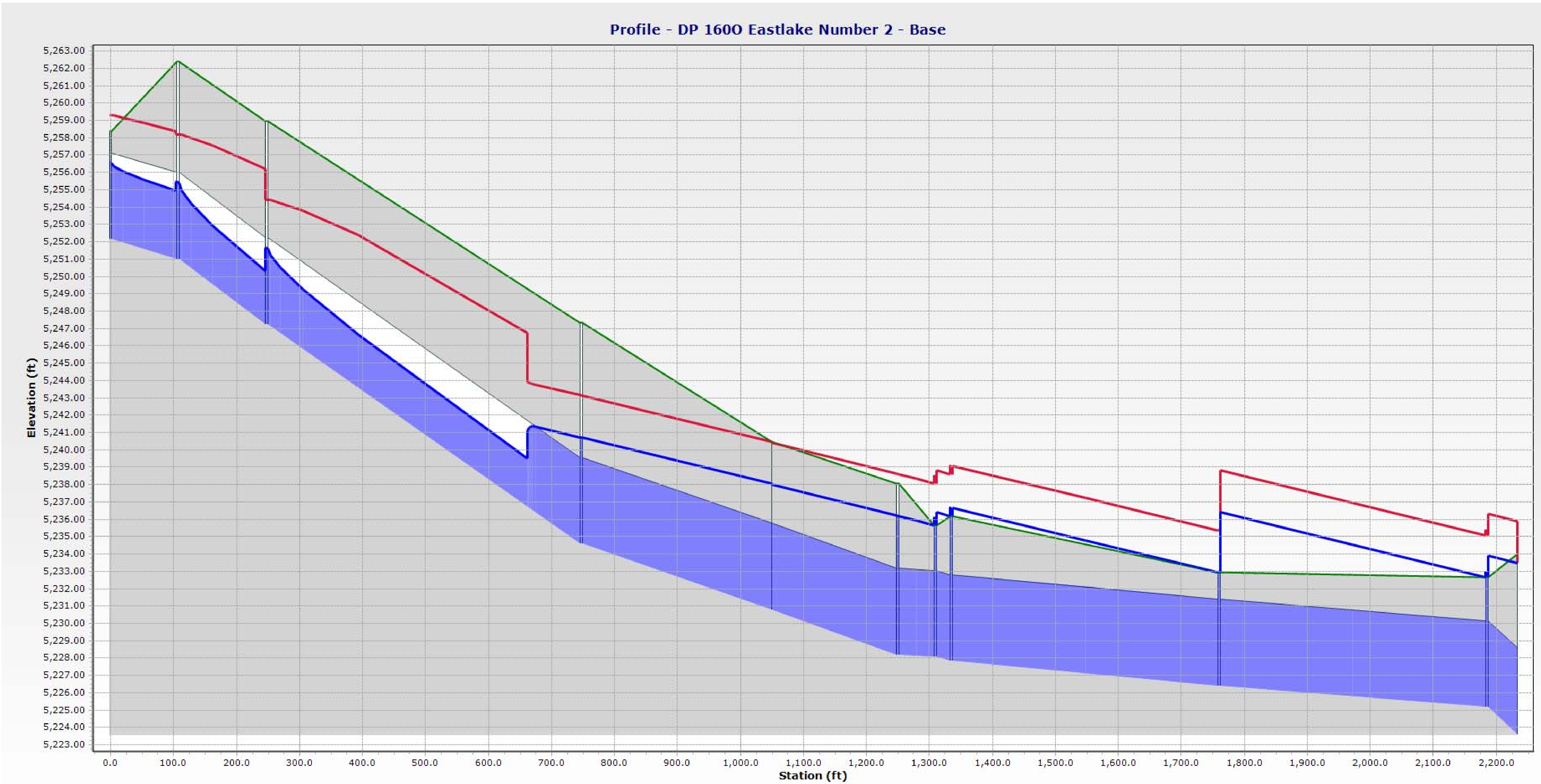
500-Year Flows



StormCAD Profile

Design Point 160O Eastlake Number 2

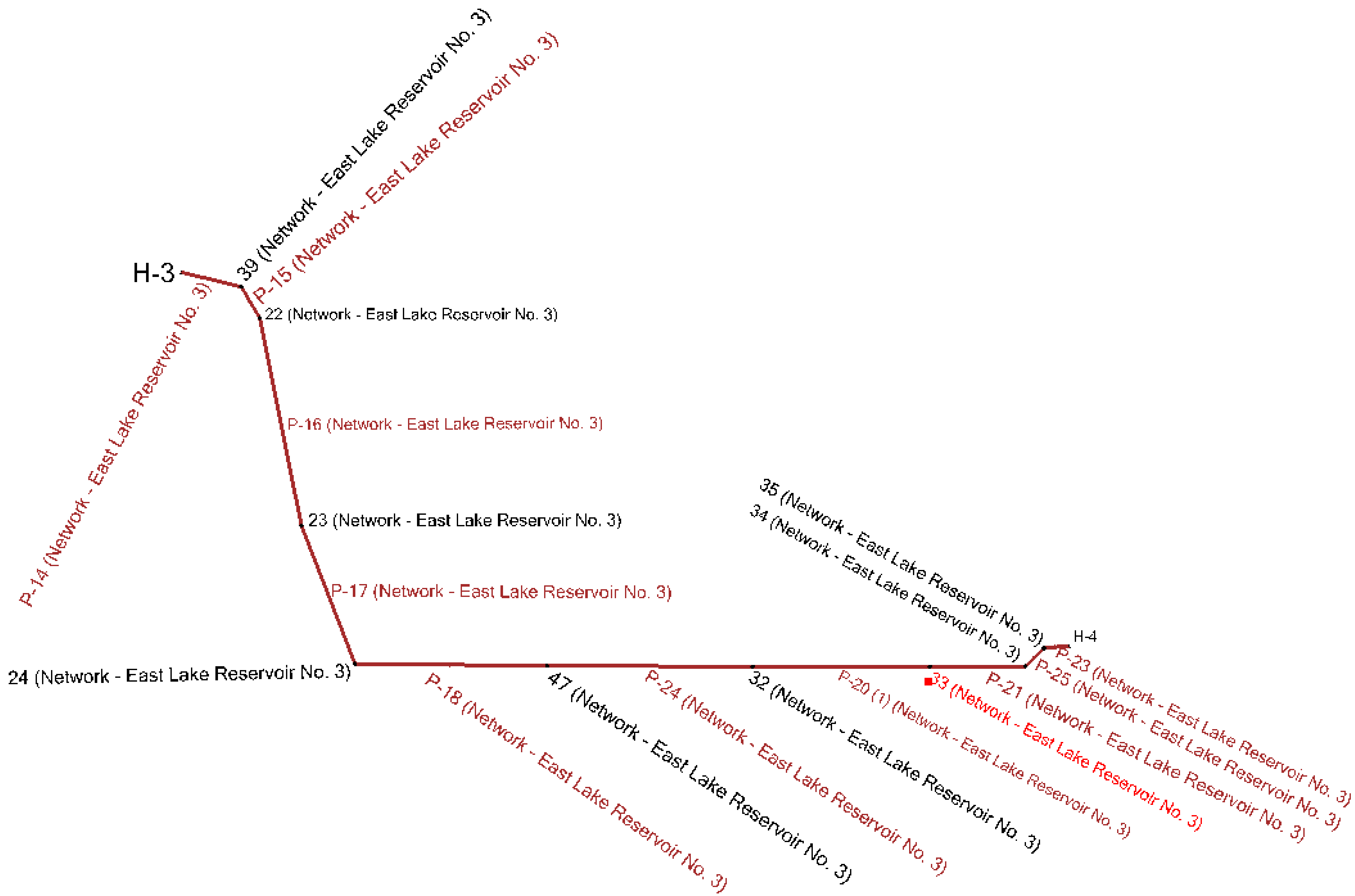
500-Year Flows



StormCAD Plan

Design Point 152O Eastlake Number 3

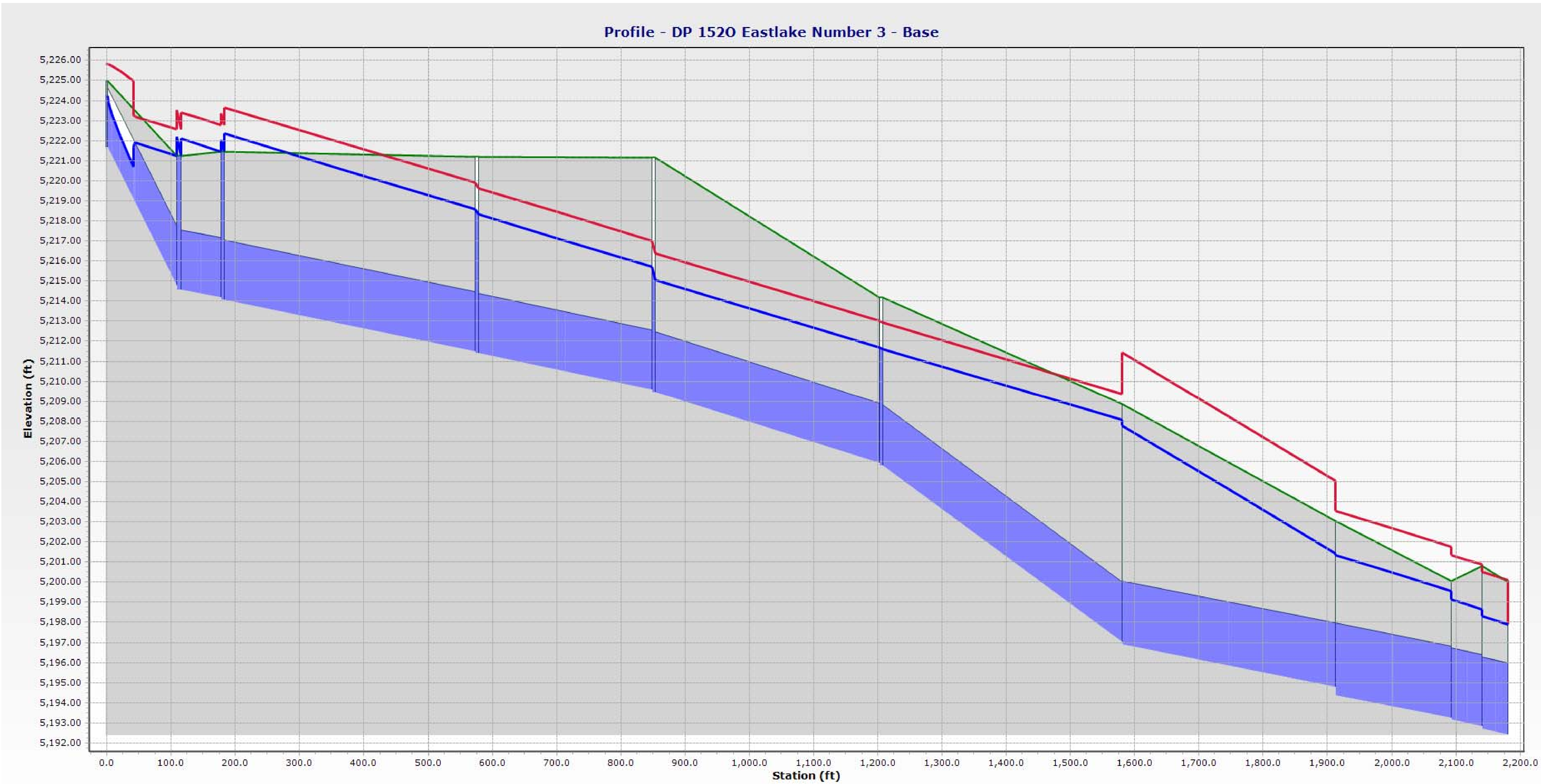
500-Year Flows



StormCAD Profile

Design Point 152O Eastlake Number 3

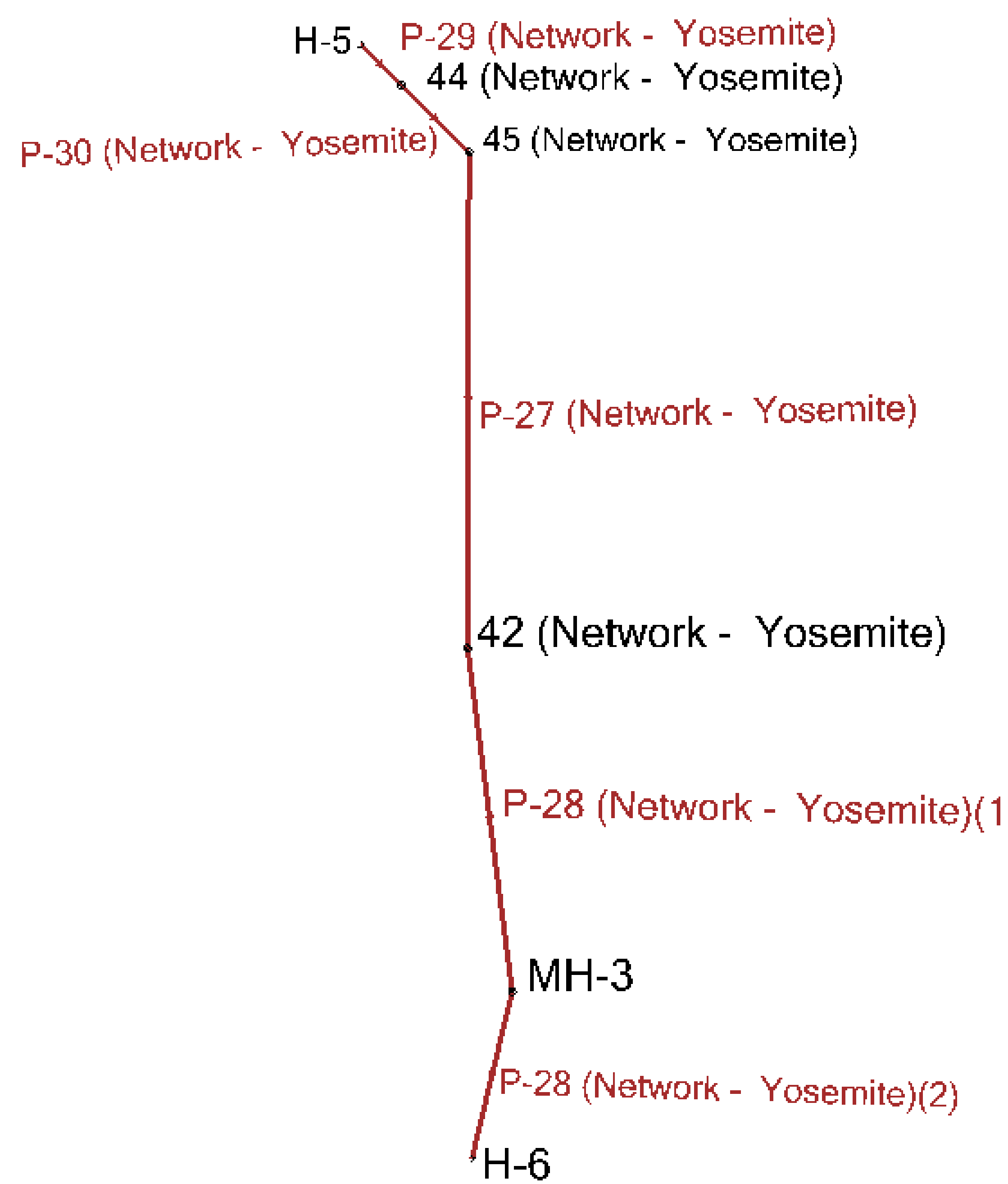
500-Year Flows



StormCAD Plan

Design Point S119 Yosemite Street Pipe

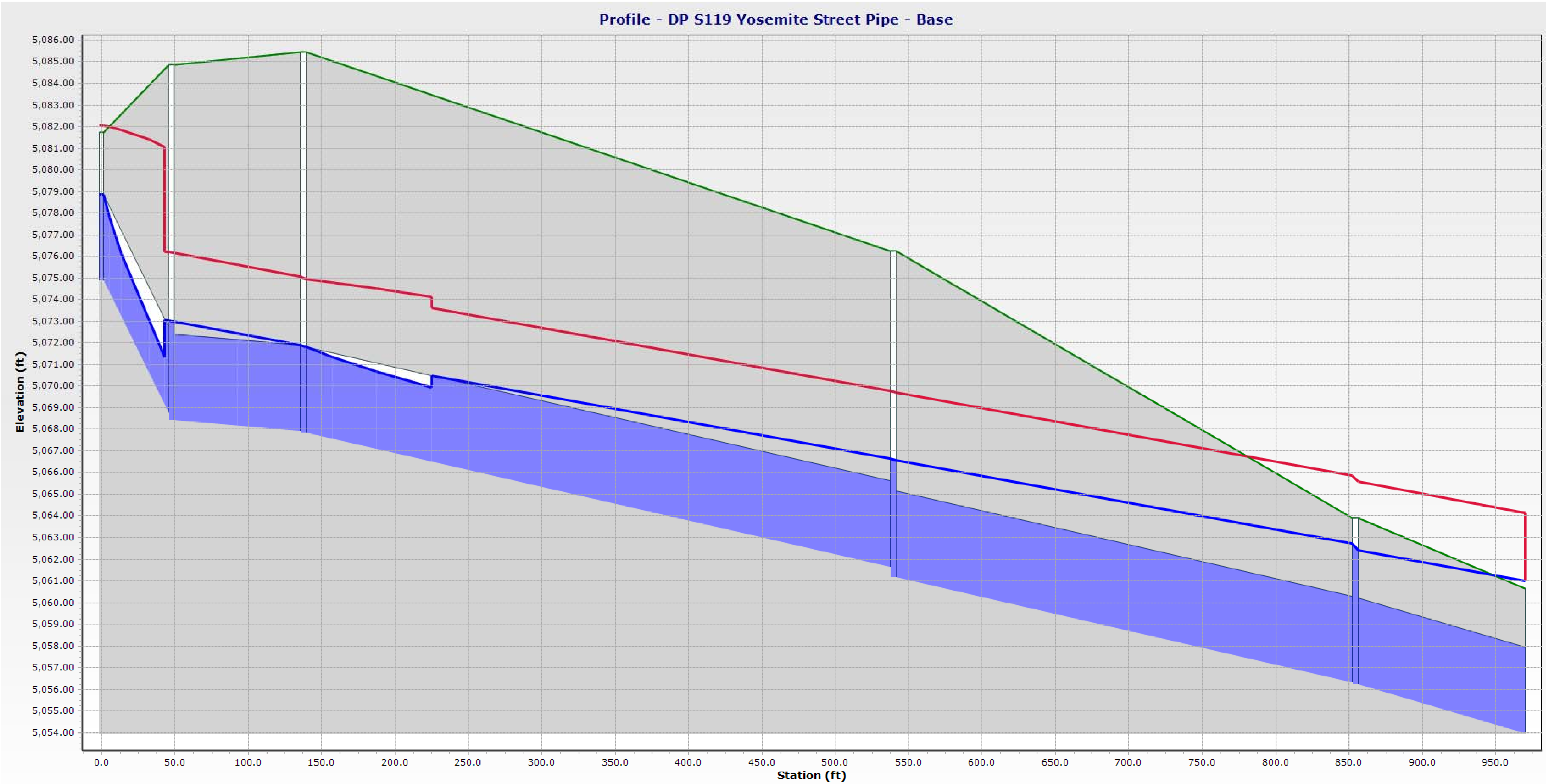
100-Year Flows



StormCAD Profile

Design Point S119 Yosemite Street Pipe

100-Year Flows



Conduit FlexTable: Combined Pipe/Node Report

Label	Notes	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Length (Unified) (ft)	Slope (Calculated) (ft/ft)	Flow (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)
P-29 (Network - Yosemite)	72" x 48" RCBC	H-5	44 (Network - Yosemite)	5,074.87	5,068.72	47.6	0.129	342.00	40.10	5,078.87	5,073.03	5,082.03	5,076.19
P-30 (Network - Yosemite)	72" x 48" RCBC	44 (Network - Yosemite)	45 (Network - Yosemite)	5,068.42	5,067.90	90.0	0.006	342.00	14.25	5,073.01	5,071.91	5,076.17	5,075.07
P-27 (Network - Yosemite)	72" x 48" RCBC	45 (Network - Yosemite)	42 (Network - Yosemite)	5,067.80	5,061.64	402.0	0.015	342.00	18.65	5,071.80	5,066.59	5,074.96	5,069.75
P-14 (Network - East Lake Reservoir No. 3)	36" RCP	H-3	39 (Network - East Lake Reservoir No. 3)	5,221.66	5,214.76	112.0	0.062	65.00	22.01	5,224.25	5,221.26	5,225.81	5,222.57
P-15 (Network - East Lake Reservoir No. 3)	36" RCP	39 (Network - East Lake Reservoir No. 3)	22 (Network - East Lake Reservoir No. 3)	5,214.56	5,214.16	68.0	0.006	65.00	9.20	5,222.11	5,221.46	5,223.42	5,222.77
P-16 (Network - East Lake Reservoir No. 3)	36" RCP	22 (Network - East Lake Reservoir No. 3)	23 (Network - East Lake Reservoir No. 3)	5,214.06	5,211.48	396.0	0.007	65.00	9.20	5,222.46	5,218.70	5,223.77	5,220.01
P-17 (Network - East Lake Reservoir No. 3)	36" RCP	23 (Network - East Lake Reservoir No. 3)	24 (Network - East Lake Reservoir No. 3)	5,211.38	5,209.56	275.0	0.007	65.00	9.20	5,218.42	5,215.81	5,219.74	5,217.12
P-18 (Network - East Lake Reservoir No. 3)	36" RCP	24 (Network - East Lake Reservoir No. 3)	47 (Network - East Lake Reservoir No. 3)	5,209.46	5,205.90	354.0	0.010	65.00	9.20	5,215.14	5,211.78	5,216.46	5,213.09
P-24 (Network - East Lake Reservoir No. 3)	36" RCP	47 (Network - East Lake Reservoir No. 3)	32 (Network - East Lake Reservoir No. 3)	5,205.80	5,197.01	375.0	0.023	65.00	9.20	5,211.70	5,208.14	5,213.01	5,209.45
P-20 (1) (Network - East Lake Reservoir No. 3)	60" x 38" HERCP	32 (Network - East Lake Reservoir No. 3)	33 (Network - East Lake Reservoir No. 3)	5,196.89	5,194.79	332.0	0.006	190.00	15.28	5,207.88	5,201.49	5,211.51	5,205.12
P-21 (Network - East Lake Reservoir No. 3)	68" x 43" HERCP	33 (Network - East Lake Reservoir No. 3)	34 (Network - East Lake Reservoir No. 3)	5,194.38	5,193.25	181.0	0.006	190.00	11.91	5,201.44	5,199.64	5,203.64	5,201.85
P-25 (Network - East Lake Reservoir No. 3)	68" x 43" HERCP	34 (Network - East Lake Reservoir No. 3)	35 (Network - East Lake Reservoir No. 3)	5,193.15	5,192.81	48.0	0.007	190.00	11.91	5,199.21	5,198.73	5,201.41	5,200.94
P-23 (Network - East Lake Reservoir No. 3)	68" x 43" HERCP	35 (Network - East Lake Reservoir No. 3)	H-4	5,192.71	5,192.41	40.0	0.008	190.00	11.91	5,198.37	5,197.97	5,200.57	5,200.18
P-1 (Network - Eastlake Reservoir Number 2)	60" RCP	H-1	T-1	5,252.13	5,251.01	106.5	0.011	239.00	15.38	5,256.48	5,255.43	5,259.18	5,258.06
P-2 (Network - Eastlake Reservoir Number 2)	60" RCP	T-1	3 (Network - Eastlake Reservoir Number 2)	5,251.01	5,247.25	140.8	0.027	239.00	22.30	5,255.36	5,251.61	5,258.06	5,254.30
P-3 (Network - Eastlake Reservoir Number 2)	60" RCP	3 (Network - Eastlake Reservoir Number 2)	4 (Network - Eastlake Reservoir Number 2)	5,247.25	5,234.57	500.0	0.025	239.00	21.87	5,251.60	5,240.48	5,254.30	5,242.79
P-4 (Network - Eastlake Reservoir Number 2)	60" RCP	4 (Network - Eastlake Reservoir Number 2)	19 (Network - Eastlake Reservoir Number 2)	5,234.57	5,230.78	302.0	0.013	239.00	12.17	5,240.47	5,237.93	5,242.77	5,240.23

Conduit FlexTable: Combined Pipe/Node Report

Label	Notes	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Length (Unified) (ft)	Slope (Calculated) (ft/ft)	Flow (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)
P-11 (Network - Eastlake Reservoir Number 2)	60" RCP	19 (Network - Eastlake Reservoir Number 2)	T-2	5,230.78	5,228.17	200.0	0.013	239.00	12.17	5,237.88	5,236.19	5,240.18	5,238.50
P-7 (Network - Eastlake Reservoir Number 2)	60" RCP	17 (Network - Eastlake Reservoir Number 2)	14 (Network - Eastlake Reservoir Number 2)	5,228.05	5,227.82	26.4	0.009	239.00	12.17	5,236.39	5,236.17	5,238.69	5,238.47
P-6 (Network - Eastlake Reservoir Number 2)	60" RCP	T-2	17 (Network - Eastlake Reservoir Number 2)	5,228.17	5,228.05	59.7	0.002	239.00	12.17	5,236.16	5,235.66	5,238.46	5,237.96
P-31 (Network - Eastlake Reservoir Number 2)	60" RCP	14 (Network - Eastlake Reservoir Number 2)	15 (Network - Eastlake Reservoir Number 2)	5,227.82	5,226.39	424.2	0.003	239.00	12.17	5,236.49	5,232.92	5,238.79	5,235.22
P-9 (Network - Eastlake Reservoir Number 2)	60" RCP	15 (Network - Eastlake Reservoir Number 2)	16 (Network - Eastlake Reservoir Number 2)	5,226.39	5,225.15	425.8	0.003	239.00	12.17	5,236.24	5,232.65	5,238.54	5,234.95
P-10 (Network - Eastlake Reservoir Number 2)	60" RCP	16 (Network - Eastlake Reservoir Number 2)	H-2	5,225.15	5,223.58	48.4	0.032	239.00	12.17	5,233.90	5,233.49	5,236.20	5,235.79
P-28 (Network - Yosemite)(1)	72" x 48" RCBC	42 (Network - Yosemite)	MH-3	5,061.14	5,056.31	314.5	0.015	342.00	14.25	5,066.52	5,062.69	5,069.68	5,065.85
P-28 (Network - Yosemite)(2)	72" x 48" RCBC	MH-3	H-6	5,056.21	5,053.95	116.0	0.019	342.00	14.25	5,062.38	5,060.97	5,065.54	5,064.13
P-35 (Network - Washington Center)	36" HDPE	59 (Network - Washington Center)	52 (Network - Washington Center)	5,301.55	5,298.80	366.4	0.008	38.70	5.47	5,309.18	5,304.25	5,309.65	5,304.72
P-41 (Network - Washington Center)	36" HDPE	51 (Network - Washington Center)	59 (Network - Washington Center)	5,301.65	5,301.55	5.0	0.020	38.70	5.47	5,309.29	5,309.22	5,309.75	5,309.69
P-36 (Network - Washington Center)	48" HDPE	58 (Network - Washington Center)	53 (Network - Washington Center)	5,297.55	5,297.45	6.0	0.017	86.60	6.89	5,302.59	5,302.50	5,303.33	5,303.24
P-40 (Network - Washington Center)	48" HDPE	52 (Network - Washington Center)	58 (Network - Washington Center)	5,298.80	5,297.55	302.0	0.004	86.60	6.89	5,306.99	5,302.60	5,307.72	5,303.33
P-37 (Network - Washington Center)	48" HDPE	56 (Network - Washington Center)	54 (Network - Washington Center)	5,296.25	5,296.15	6.0	0.017	86.60	8.38	5,300.04	5,299.97	5,300.81	5,300.73
P-39 (Network - Washington Center)	48" HDPE	53 (Network - Washington Center)	56 (Network - Washington Center)	5,297.45	5,296.25	299.0	0.004	86.60	6.89	5,304.39	5,300.04	5,305.13	5,300.81
P-38 (Network - Washington Center)	48" HDPE	54 (Network - Washington Center)	55 (Network - Washington Center)	5,296.15	5,296.01	41.2	0.003	86.60	6.89	5,299.93	5,298.83	5,300.70	5,300.13
P-32 (Network - Washington Center)	24" RCP	48 (Network - Washington Center)	49 (Network - Washington Center)	5,305.13	5,304.23	54.3	0.017	5.80	1.85	5,311.14	5,311.00	5,311.20	5,311.05

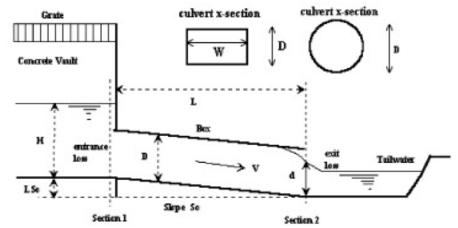
Conduit FlexTable: Combined Pipe/Node Report

Label	Notes	Start Node	Stop Node	Invert (Start) (ft)	Invert (Stop) (ft)	Length (Unified) (ft)	Slope (Calculated) (ft/ft)	Flow (cfs)	Velocity (ft/s)	Hydraulic Grade Line (In) (ft)	Hydraulic Grade Line (Out) (ft)	Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)
P-33 (Network - Washington Center)	24" HDPE	49 (Network - Washington Center)	50 (Network - Washington Center)	5,304.23	5,303.24	145.1	0.007	14.90	4.74	5,311.52	5,309.00	5,311.87	5,309.35
P-34 (Network - Washington Center)	24" HDPE	50 (Network - Washington Center)	51 (Network - Washington Center)	5,303.24	5,301.65	301.7	0.005	14.90	4.74	5,313.24	5,308.00	5,313.59	5,308.35

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Brantner Gulch 018-2897**
ID: **SPRS Trib 6 - Yosemite Storm Drain System Inlet**



Design Information (Input):

Circular Culvert: Barrel Diameter in Inches — D = [ ] inches
Inlet Edge Type (Choose from pull-down list)

OR:

Box Culvert:

Barrel Height (Rise) in Feet	H (Rise) =	4.00	ft
Barrel Width (Span) in Feet	W (Span) =	6.00	ft
Inlet Edge Type (Choose from pull-down list)	Square Edge w/ 30-75 deg. Flared Wingwall		
Number of Barrels	# Barrels =	1	
Inlet Elevation at Culvert Invert	Elev IN =	5073.64	ft
Outlet Elevation **OR** Slope	Elev OUT =	5073.5	ft
Culvert Length	L =	30.36	ft
Manning's Roughness	n =	0.013	
Bend Loss Coefficient	K_b =	0	
Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	0.12
Sum of All Loss Coefficients	K_s =	1.32
Minimum Energy Condition Coefficient	KE_{low} =	0.0618
Orifice Inlet Condition Coefficient	C_d =	0.62

Calculations of Culvert Capacity (output):

Backwater calculations required to obtain Outlet Control Flowrate when HWo < 0.75 * Culvert Rise

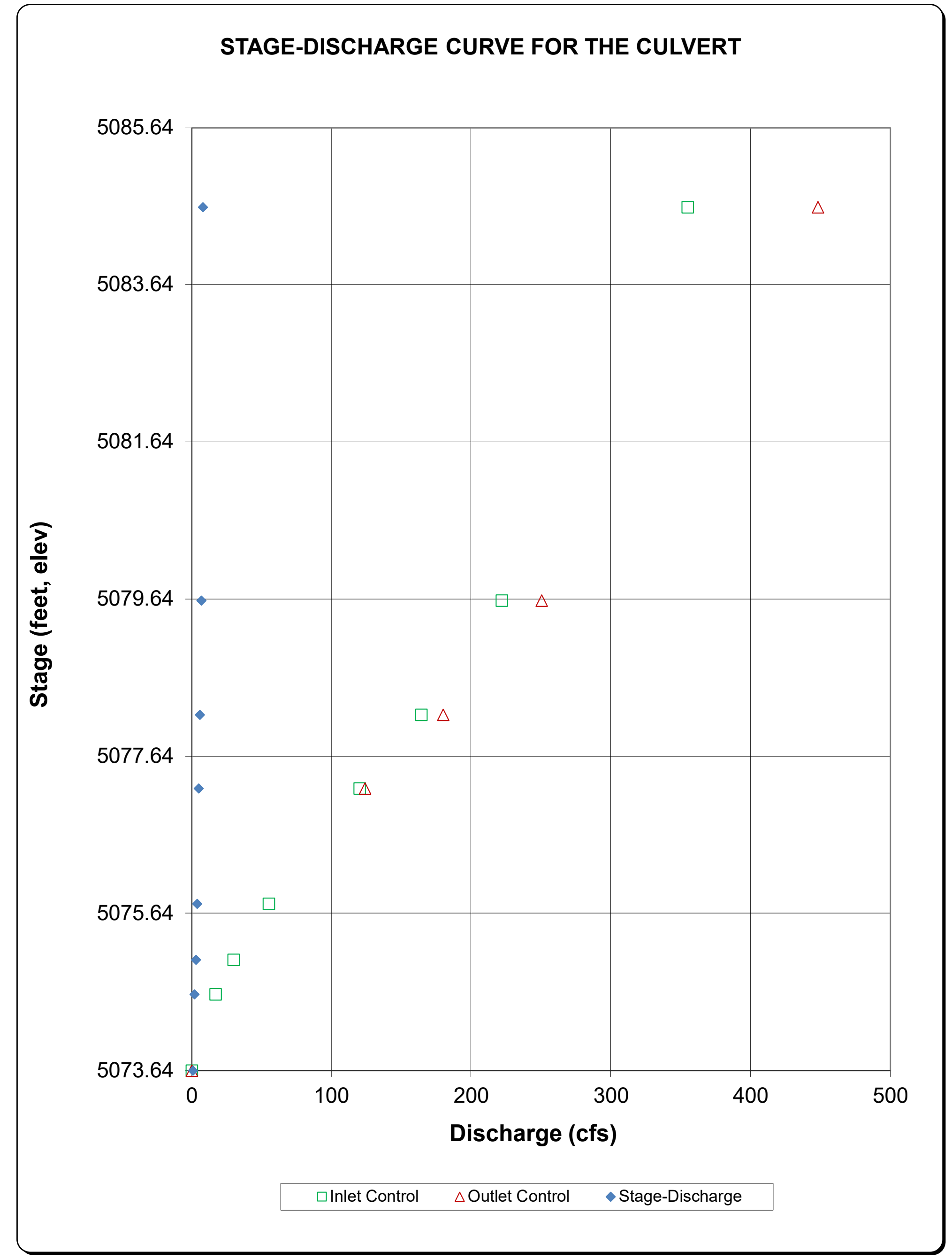
Headwater Surface Elevation (ft)	Tailwater Surface Elevation (ft)	Inlet Control Equation Used	Inlet Control Flowrate (cfs)	Outlet Control Flowrate (cfs)	Controlling Culvert Flowrate (cfs)	Flow Control Used
5073.64		No Flow (WS < inlet)	0.00	0.00	**0.00**	N/A
5074.61		Min. Energy. Eqn.	17.21	#N/A	#N/A	#N/A
5075.05		Min. Energy. Eqn.	30.11	#N/A	#N/A	#N/A
5075.76		Regression Eqn.	55.33	#N/A	#N/A	#N/A
5077.23		Regression Eqn.	120.36	124.02	**120.36**	INLET
5078.17		Regression Eqn.	164.41	180.12	**164.41**	INLET
5079.62		Regression Eqn.	222.03	250.54	**222.03**	INLET
5084.63		Regression Eqn.	355.01	448.18	**355.01**	INLET

Processing Time: **78.13 ms**

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: **Brantner Gulch 018-2897**
ID: **SPRS Trib 6 - Yosemite Storm Drain System Inlet**



Worksheet for Crossing 56

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.020 ft/ft
Discharge	175.00 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	5,137.00
0+02	5,136.66
0+05	5,136.00
0+08	5,135.00
0+09	5,134.91
0+25	5,132.27
0+32	5,132.10
0+51	5,132.30
0+69	5,136.33
0+78	5,135.00
0+98	5,135.00
1+03	5,136.00
1+10	5,137.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 5,137.00)	(0+09, 5,134.91)	0.040
(0+09, 5,134.91)	(0+69, 5,136.33)	0.040
(0+69, 5,136.33)	(0+78, 5,135.00)	0.040
(0+78, 5,135.00)	(0+98, 5,135.00)	0.040
(0+98, 5,135.00)	(1+10, 5,137.00)	0.040

Options

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

Results

Normal Depth	14.7 in
Elevation Range	5,132.1 to 5,137.0 ft
Flow Area	34.7 ft²
Wetted Perimeter	37.0 ft

Worksheet for Crossing 56

Results

Hydraulic Radius	11.3 in
Top Width	36.82 ft
Normal Depth	14.7 in
Critical Depth	14.0 in
Critical Slope	0.024 ft/ft
Velocity	5.04 ft/s
Velocity Head	0.39 ft
Specific Energy	1.62 ft
Froude Number	0.914
Flow Type	Subcritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

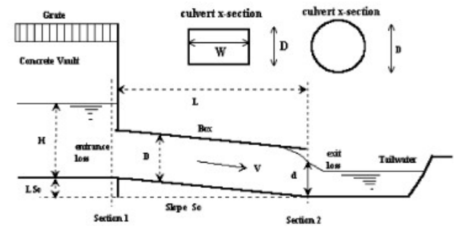
GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	14.7 in
Critical Depth	14.0 in
Channel Slope	0.020 ft/ft
Critical Slope	0.024 ft/ft

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Brantner Gulch 018-2897
ID: Crossing 56



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =		inches
	Inlet Edge Type (Choose from pull-down list)			
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	H (Rise) =	10.00	ft
	Barrel Width (Span) in Feet	W (Span) =	10.00	ft
	Inlet Edge Type (Choose from pull-down list)	Square Edge w/ 30-75 deg. Flared Wingwall		
	Number of Barrels	# Barrels =	1	
	Inlet Elevation at Culvert Invert	Elev IN =	5128.82	ft
	Outlet Elevation **OR** Slope	Elev OUT =	5126.07	ft
	Culvert Length	L =	141.78	ft
	Manning's Roughness	n =	0.015	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	0.27
Sum of All Loss Coefficients	K_s =	1.47
Minimum Energy Condition Coefficient	KE_{low} =	0.0187
Orifice Inlet Condition Coefficient	C_d =	0.62

Calculations of Culvert Capacity (output): **Backwater calculations required to obtain Outlet Control Flowrate when HWo < 0.75 * Culvert Rise**

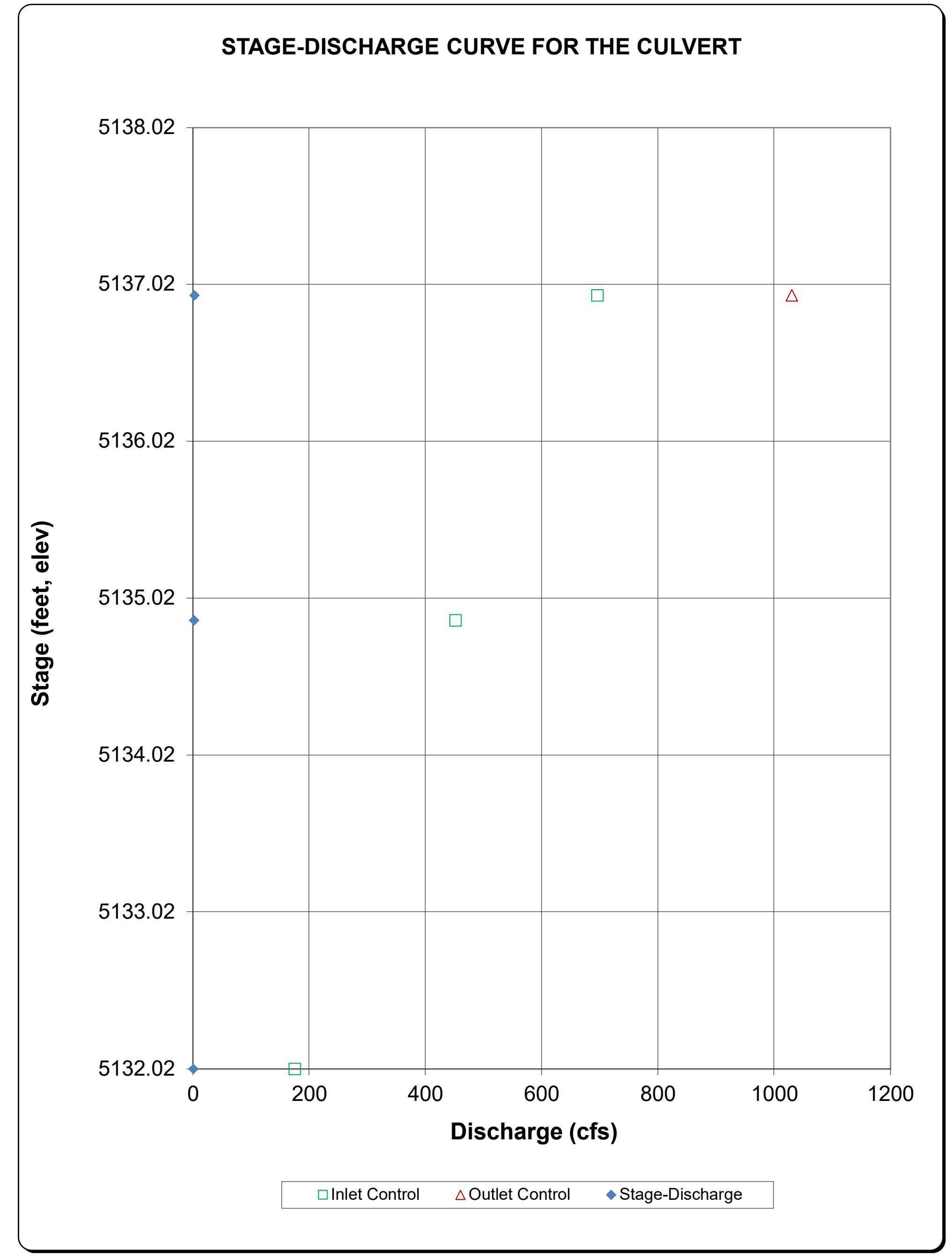
Headwater Surface Elevation (ft)	Tailwater Surface Elevation (ft)	Inlet Control Equation Used	Inlet Control Flowrate (cfs)	Outlet Control Flowrate (cfs)	Controlling Culvert Flowrate (cfs)	Flow Control Used
5132.02	5127.49	Min. Energy. Eqn.	175.21	#N/A	#N/A	#N/A
5134.88	5127.49	Regression Eqn.	451.63	#N/A	#N/A	#N/A
5136.95	5127.49	Regression Eqn.	695.81	1,030.17	**695.81**	INLET

Processing Time: **66.41 ms**

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Brantner Gulch 018-2897
ID: Crossing 56



Worksheet for Crossing 60 - 100YR

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.080 ft/ft
Discharge	154.00 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	5,217.00
0+04	5,216.00
0+08	5,215.00
0+12	5,214.00
0+17	5,213.00
0+21	5,212.00
0+25	5,211.00
0+28	5,210.00
0+32	5,209.00
0+35	5,208.00
0+40	5,207.00
0+46	5,206.00
0+53	5,205.00
0+61	5,204.00
0+72	5,203.00
0+96	5,203.00
1+16	5,203.00
1+23	5,204.00
1+29	5,205.00
1+38	5,206.00
1+83	5,207.00
2+02	5,208.00
2+50	5,209.00
2+77	5,210.00
3+03	5,211.00
3+30	5,212.00
3+55	5,213.00
3+80	5,214.00
4+01	5,215.00
4+18	5,216.00
4+40	5,217.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 5,217.00)	(4+40, 5,217.00)	0.040

Worksheet for Crossing 60 - 100YR

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

Results	
Normal Depth	6.1 in
Elevation Range	5,203.0 to 5,217.0 ft
Flow Area	24.5 ft²
Wetted Perimeter	53.1 ft
Hydraulic Radius	5.5 in
Top Width	53.04 ft
Normal Depth	6.1 in
Critical Depth	8.3 in
Critical Slope	0.027 ft/ft
Velocity	6.28 ft/s
Velocity Head	0.61 ft
Specific Energy	1.12 ft
Froude Number	1.628
Flow Type	Supercritical

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

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	6.1 in
Critical Depth	8.3 in
Channel Slope	0.080 ft/ft
Critical Slope	0.027 ft/ft

Worksheet for Crossing 60 - 500YR

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.080 ft/ft
Discharge	513.00 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	5,217.00
0+04	5,216.00
0+08	5,215.00
0+12	5,214.00
0+17	5,213.00
0+21	5,212.00
0+25	5,211.00
0+28	5,210.00
0+32	5,209.00
0+35	5,208.00
0+40	5,207.00
0+46	5,206.00
0+53	5,205.00
0+61	5,204.00
0+72	5,203.00
0+96	5,203.00
1+16	5,203.00
1+23	5,204.00
1+29	5,205.00
1+38	5,206.00
1+83	5,207.00
2+02	5,208.00
2+50	5,209.00
2+77	5,210.00
3+03	5,211.00
3+30	5,212.00
3+55	5,213.00
3+80	5,214.00
4+01	5,215.00
4+18	5,216.00
4+40	5,217.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 5,217.00)	(4+40, 5,217.00)	0.040

Worksheet for Crossing 60 - 500YR

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

Results	
Normal Depth	12.2 in
Elevation Range	5,203.0 to 5,217.0 ft
Flow Area	53.8 ft²
Wetted Perimeter	62.2 ft
Hydraulic Radius	10.4 in
Top Width	62.11 ft
Normal Depth	12.2 in
Critical Depth	17.4 in
Critical Slope	0.022 ft/ft
Velocity	9.54 ft/s
Velocity Head	1.41 ft
Specific Energy	2.43 ft
Froude Number	1.806
Flow Type	Supercritical

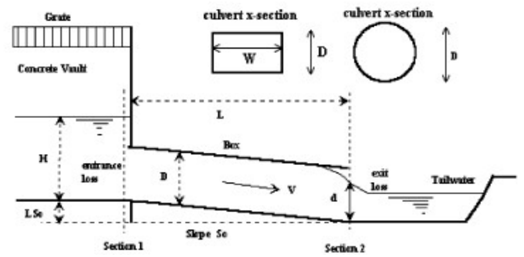
GVF Input Data	
Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	12.2 in
Critical Depth	17.4 in
Channel Slope	0.080 ft/ft
Critical Slope	0.022 ft/ft

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Brantner Gulch 018-2897
ID: Crossing 60



Design Information (Input):

Circular Culvert:	Barrel Diameter in Inches	D =		inches
	Inlet Edge Type (Choose from pull-down list)			
OR:				
Box Culvert:	Barrel Height (Rise) in Feet	H (Rise) =	10.00	ft
	Barrel Width (Span) in Feet	W (Span) =	10.00	ft
	Inlet Edge Type (Choose from pull-down list)		Square Edge w/ 30-75 deg. Flared Wingwall	
	Number of Barrels	# Barrels =	1	
	Inlet Elevation at Culvert Invert	Elev IN =	5195.81	ft
	Outlet Elevation **OR** Slope	Elev OUT =	5194.61	ft
	Culvert Length	L =	209.84	ft
	Manning's Roughness	n =	0.015	
	Bend Loss Coefficient	K_b =	0	
	Exit Loss Coefficient	K_x =	1	

Design Information (calculated):

Entrance Loss Coefficient	K_e =	0.20
Friction Loss Coefficient	K_f =	0.40
Sum of All Loss Coefficients	K_s =	1.60
Minimum Energy Condition Coefficient	KE_{low} =	0.0586
Orifice Inlet Condition Coefficient	C_d =	0.62

Calculations of Culvert Capacity (output):

Backwater calculations required to obtain Outlet Control Flowrate when HWo < 0.75 * Culvert Rise

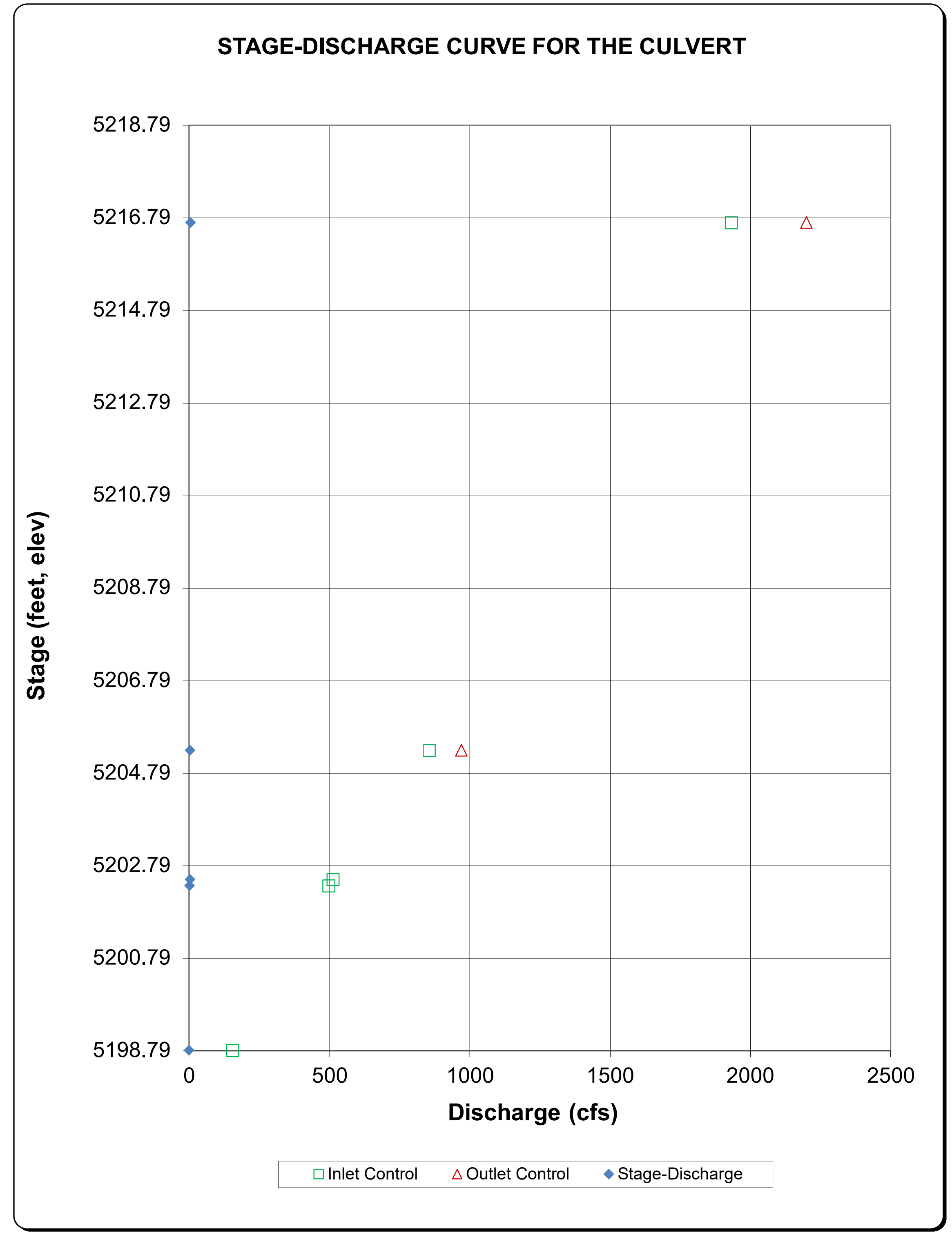
Headwater Surface Elevation (ft)	Tailwater Surface Elevation (ft)	Inlet Control Equation Used	Inlet Control Flowrate (cfs)	Outlet Control Flowrate (cfs)	Controlling Culvert Flowrate (cfs)	Flow Control Used
5198.79		Min. Energy. Eqn.	154.36	#N/A	#N/A	#N/A
5202.35		Regression Eqn.	497.25	#N/A	#N/A	#N/A
5202.49		Regression Eqn.	513.15	#N/A	#N/A	#N/A
5205.28		Regression Eqn.	856.31	970.76	**856.31**	INLET
5216.68		Regression Eqn.	1,932.21	2,201.34	**1,932.21**	INLET

Processing Time: **00.10 Seconds**

CULVERT SIZING (INLET vs. OUTLET CONTROL WITH TAILWATER EFFECTS)

MHFD-Culvert, Version 4.00 (May 2020)

Project: Brantner Gulch 018-2897
ID: Crossing 60



Worksheet for H306 SW Channel - 500YR

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.050
Channel Slope	0.063 ft/ft
Left Side Slope	4.000 H:V
Right Side Slope	4.000 H:V
Bottom Width	20.00 ft
Discharge	133.00 cfs

Results

Normal Depth	10.8 in
Flow Area	21.2 ft²
Wetted Perimeter	27.4 ft
Hydraulic Radius	9.3 in
Top Width	27.20 ft
Critical Depth	12.4 in
Critical Slope	0.038 ft/ft
Velocity	6.27 ft/s
Velocity Head	0.61 ft
Specific Energy	1.51 ft
Froude Number	1.250
Flow Type	Supercritical

GVF Input Data

Downstream Depth	0.0 in
Length	0.0 ft
Number Of Steps	0

GVF Output Data

Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	10.8 in
Critical Depth	12.4 in
Channel Slope	0.063 ft/ft
Critical Slope	0.038 ft/ft

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.005 ft/ft
Discharge	154.00 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	5,151.72
0+02	5,151.23
0+02	5,151.18
0+02	5,150.95
0+03	5,150.72
0+05	5,150.25
0+06	5,149.91
0+07	5,149.47
0+09	5,148.95
0+10	5,148.77
0+12	5,148.09
0+13	5,147.90
0+13	5,147.81
0+14	5,147.69
0+14	5,147.54
0+15	5,147.28
0+16	5,147.10
0+17	5,146.89
0+18	5,146.66
0+19	5,146.38
0+19	5,146.21
0+21	5,145.77
0+22	5,145.59
0+23	5,145.07
0+24	5,144.78
0+26	5,144.38
0+27	5,143.89
0+28	5,143.67
0+29	5,143.47
0+30	5,143.15
0+30	5,143.07
0+30	5,143.01
0+31	5,142.93
0+32	5,142.80
0+32	5,142.73
0+33	5,142.65
0+34	5,142.49
0+35	5,142.34

Section Definitions

Station (ft)	Elevation (ft)
0+37	5,142.10
0+37	5,142.05
0+38	5,142.01
0+38	5,142.03
0+38	5,142.00
0+63	5,142.00
0+65	5,142.15
0+66	5,142.22
0+69	5,142.52
0+71	5,142.68
0+71	5,142.75
0+72	5,142.83
0+73	5,142.90
0+74	5,142.99
0+75	5,143.23
0+76	5,143.37
0+77	5,143.51
0+78	5,143.64
0+79	5,143.77
0+79	5,143.91
0+80	5,144.04
0+81	5,144.29
0+82	5,144.65
0+84	5,145.12
0+84	5,145.29
0+86	5,145.85
0+88	5,146.51
0+89	5,146.93
0+92	5,147.69
0+93	5,148.21
0+94	5,148.63
0+95	5,148.86
0+95	5,149.08
0+95	5,149.19
0+97	5,149.85
0+98	5,150.17
0+99	5,150.50
0+99	5,150.64
1+00	5,151.14
1+01	5,151.50
1+02	5,151.74
1+03	5,152.04
1+03	5,152.23
1+04	5,152.60
1+05	5,152.99
1+06	5,153.13
1+09	5,154.19

Section Definitions

Station (ft)	Elevation (ft)
1+10	5,154.83
1+11	5,154.87
1+11	5,155.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 5,151.72)	(1+11, 5,155.00)	0.035

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

Results	
Normal Depth	15.9 in
Roughness Coefficient	0.035
Elevation	5,143.33 ft
Elevation Range	5,142.0 to 5,155.0 ft
Flow Area	49.4 ft²
Wetted Perimeter	46.8 ft
Hydraulic Radius	12.7 in
Top Width	46.59 ft
Normal Depth	15.9 in
Critical Depth	11.1 in
Critical Slope	0.020 ft/ft
Velocity	3.12 ft/s
Velocity Head	0.15 ft
Specific Energy	1.48 ft
Froude Number	0.533
Flow Type	Subcritical

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

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	0.00 ft/s

GVF Output Data	
Upstream Velocity	0.00 ft/s
Normal Depth	15.9 in
Critical Depth	11.1 in
Channel Slope	0.005 ft/ft
Critical Slope	0.020 ft/ft

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.018 ft/ft
Discharge	15.00 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	5,226.05
0+01	5,226.00
0+26	5,226.00
0+27	5,225.96
0+28	5,225.87
0+29	5,225.84
0+30	5,225.71
0+31	5,225.59
0+31	5,225.54
0+32	5,225.49
0+33	5,225.40
0+33	5,225.32
0+34	5,225.22
0+35	5,225.12
0+37	5,225.04
0+38	5,225.00
0+38	5,225.01
0+38	5,225.00
0+43	5,225.00
0+43	5,224.95
0+45	5,224.79
0+45	5,224.78
0+46	5,224.69
0+48	5,224.61
0+48	5,224.56
0+50	5,224.44
0+51	5,224.33
0+52	5,224.24
0+52	5,224.24
0+53	5,224.13
0+54	5,224.05
0+54	5,224.05
0+54	5,224.00
0+63	5,224.00
0+63	5,223.99
0+64	5,223.99
0+64	5,223.97
0+65	5,223.95

Section Definitions

Station (ft)	Elevation (ft)
0+66	5,223.92
0+66	5,223.92
0+67	5,223.88
0+69	5,223.85
0+70	5,223.83
0+70	5,223.82
0+72	5,223.77
0+72	5,223.76
0+73	5,223.76
0+74	5,223.77
0+75	5,223.77
0+75	5,223.78
0+77	5,223.78
0+79	5,223.80
0+80	5,223.80
0+80	5,223.81
0+82	5,223.81
0+82	5,223.82
0+84	5,223.82
0+86	5,223.84
0+88	5,223.84
0+89	5,223.85
0+89	5,223.85
0+90	5,223.86
0+91	5,223.86
0+91	5,223.87
0+93	5,223.87
0+93	5,223.88
0+94	5,223.88
0+95	5,223.90
0+96	5,223.91
0+97	5,223.93
0+97	5,223.93
0+98	5,223.94
0+99	5,223.98
0+99	5,223.98
0+99	5,224.00
1+01	5,224.00
1+01	5,224.01
1+02	5,224.00
1+02	5,224.01
1+03	5,224.00
1+04	5,224.02
1+05	5,224.06
1+05	5,224.06
1+06	5,224.11
1+06	5,224.12

Section Definitions

Station (ft)	Elevation (ft)
1+07	5,224.17
1+07	5,224.19
1+08	5,224.21
1+09	5,224.31
1+12	5,224.49
1+13	5,224.59
1+14	5,224.62
1+15	5,224.71
1+16	5,224.74
1+16	5,224.78
1+17	5,224.87
1+18	5,224.91
1+19	5,224.95
1+19	5,224.95
1+20	5,225.00
1+23	5,225.00
1+25	5,225.02
1+25	5,225.01
1+25	5,225.02
1+26	5,225.01
1+27	5,225.01
1+27	5,225.00
1+32	5,225.00
1+33	5,225.02
1+33	5,225.00
1+33	5,225.04
1+34	5,225.01
1+34	5,225.04
1+35	5,225.04
1+35	5,225.06
1+36	5,225.09
1+37	5,225.10
1+38	5,225.12
1+40	5,225.12
1+41	5,225.11
1+41	5,225.13
1+42	5,225.11
1+42	5,225.11
1+43	5,225.09
1+44	5,225.09
1+45	5,225.08
1+46	5,225.12
1+46	5,225.12
1+47	5,225.19
1+47	5,225.20
1+47	5,225.24
1+48	5,225.25

Section Definitions

Station (ft)	Elevation (ft)
1+49	5,225.35
1+49	5,225.41
1+50	5,225.48
1+50	5,225.45
1+50	5,225.52
1+51	5,225.61
1+52	5,225.68
1+53	5,225.75
1+54	5,225.80
1+55	5,225.95
1+56	5,225.96
1+56	5,225.99
1+57	5,226.00
1+57	5,225.98
1+57	5,226.00
1+65	5,226.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 5,226.05)	(0+63, 5,224.00)	0.030
(0+63, 5,224.00)	(0+99, 5,224.00)	0.015
(0+99, 5,224.00)	(1+65, 5,226.00)	0.030

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

Results	
Normal Depth	2.5 in
Roughness Coefficient	0.015
Elevation	5,223.97 ft
Elevation Range	5,223.8 to 5,226.1 ft
Flow Area	4.4 ft²
Wetted Perimeter	34.6 ft
Hydraulic Radius	1.5 in
Top Width	34.54 ft
Normal Depth	2.5 in
Critical Depth	3.3 in
Critical Slope	0.006 ft/ft
Velocity	3.38 ft/s
Velocity Head	0.18 ft

Worksheet for Brantner Reach 5 Lateral Structure - 100 year

Results	
Specific Energy	0.39 ft
Froude Number	1.664
Flow Type	Supercritical

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

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	2.5 in
Critical Depth	3.3 in
Channel Slope	0.018 ft/ft
Critical Slope	0.006 ft/ft

Worksheet for Brantner Reach 5 Lateral Structure - 500 year

Project Description	
Friction Method	Manning Formula
Solve For	Normal Depth

Input Data	
Channel Slope	0.018 ft/ft
Discharge	220.00 cfs

Section Definitions

Station (ft)	Elevation (ft)
0+00	5,226.05
0+01	5,226.00
0+26	5,226.00
0+27	5,225.96
0+28	5,225.87
0+29	5,225.84
0+30	5,225.71
0+31	5,225.59
0+31	5,225.54
0+32	5,225.49
0+33	5,225.40
0+33	5,225.32
0+34	5,225.22
0+35	5,225.12
0+37	5,225.04
0+38	5,225.00
0+38	5,225.01
0+38	5,225.00
0+43	5,225.00
0+43	5,224.95
0+45	5,224.79
0+45	5,224.78
0+46	5,224.69
0+48	5,224.61
0+48	5,224.56
0+50	5,224.44
0+51	5,224.33
0+52	5,224.24
0+52	5,224.24
0+53	5,224.13
0+54	5,224.05
0+54	5,224.05
0+54	5,224.00
0+63	5,224.00
0+63	5,223.99
0+64	5,223.99
0+64	5,223.97
0+65	5,223.95

Worksheet for Brantner Reach 5 Lateral Structure - 500 year

Section Definitions

Station (ft)	Elevation (ft)
0+66	5,223.92
0+66	5,223.92
0+67	5,223.88
0+69	5,223.85
0+70	5,223.83
0+70	5,223.82
0+72	5,223.77
0+72	5,223.76
0+73	5,223.76
0+74	5,223.77
0+75	5,223.77
0+75	5,223.78
0+77	5,223.78
0+79	5,223.80
0+80	5,223.80
0+80	5,223.81
0+82	5,223.81
0+82	5,223.82
0+84	5,223.82
0+86	5,223.84
0+88	5,223.84
0+89	5,223.85
0+89	5,223.85
0+90	5,223.86
0+91	5,223.86
0+91	5,223.87
0+93	5,223.87
0+93	5,223.88
0+94	5,223.88
0+95	5,223.90
0+96	5,223.91
0+97	5,223.93
0+97	5,223.93
0+98	5,223.94
0+99	5,223.98
0+99	5,223.98
0+99	5,224.00
1+01	5,224.00
1+01	5,224.01
1+02	5,224.00
1+02	5,224.01
1+03	5,224.00
1+04	5,224.02
1+05	5,224.06
1+05	5,224.06
1+06	5,224.11
1+06	5,224.12

Worksheet for Brantner Reach 5 Lateral Structure - 500 year

Section Definitions

Station (ft)	Elevation (ft)
1+07	5,224.17
1+07	5,224.19
1+08	5,224.21
1+09	5,224.31
1+12	5,224.49
1+13	5,224.59
1+14	5,224.62
1+15	5,224.71
1+16	5,224.74
1+16	5,224.78
1+17	5,224.87
1+18	5,224.91
1+19	5,224.95
1+19	5,224.95
1+20	5,225.00
1+23	5,225.00
1+25	5,225.02
1+25	5,225.01
1+25	5,225.02
1+26	5,225.01
1+27	5,225.01
1+27	5,225.00
1+32	5,225.00
1+33	5,225.02
1+33	5,225.00
1+33	5,225.04
1+34	5,225.01
1+34	5,225.04
1+35	5,225.04
1+35	5,225.06
1+36	5,225.09
1+37	5,225.10
1+38	5,225.12
1+40	5,225.12
1+41	5,225.11
1+41	5,225.13
1+42	5,225.11
1+42	5,225.11
1+43	5,225.09
1+44	5,225.09
1+45	5,225.08
1+46	5,225.12
1+46	5,225.12
1+47	5,225.19
1+47	5,225.20
1+47	5,225.24
1+48	5,225.25

Section Definitions

Station (ft)	Elevation (ft)
1+49	5,225.35
1+49	5,225.41
1+50	5,225.48
1+50	5,225.45
1+50	5,225.52
1+51	5,225.61
1+52	5,225.68
1+53	5,225.75
1+54	5,225.80
1+55	5,225.95
1+56	5,225.96
1+56	5,225.99
1+57	5,226.00
1+57	5,225.98
1+57	5,226.00
1+65	5,226.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 5,226.05)	(0+63, 5,224.00)	0.030
(0+63, 5,224.00)	(0+99, 5,224.00)	0.015
(0+99, 5,224.00)	(1+65, 5,226.00)	0.030

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

Results	
Normal Depth	9.4 in
Roughness Coefficient	0.023
Elevation	5,224.54 ft
Elevation Range	5,223.8 to 5,226.1 ft
Flow Area	36.5 ft²
Wetted Perimeter	64.4 ft
Hydraulic Radius	6.8 in
Top Width	64.37 ft
Normal Depth	9.4 in
Critical Depth	11.3 in
Critical Slope	0.009 ft/ft
Velocity	6.02 ft/s
Velocity Head	0.56 ft

Results	
Specific Energy	1.35 ft
Froude Number	1.409
Flow Type	Supercritical

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

GVF Output Data	
Upstream Depth	0.0 in
Profile Description	N/A
Profile Headloss	0.00 ft
Downstream Velocity	Infinity ft/s
Upstream Velocity	Infinity ft/s
Normal Depth	9.4 in
Critical Depth	11.3 in
Channel Slope	0.018 ft/ft
Critical Slope	0.009 ft/ft

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.

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

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

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

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS1980 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, MD 20910-3282

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

Base map information shown on this FIRM was provided by the Adams County and Commerce City GIS departments. The coordinate system used for the production of the digital FIRM is Universe Transverse Mercator, Zone 13N, referenced to North American Datum of 1983 and the GRS 80 spheroid, Western Hemisphere.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *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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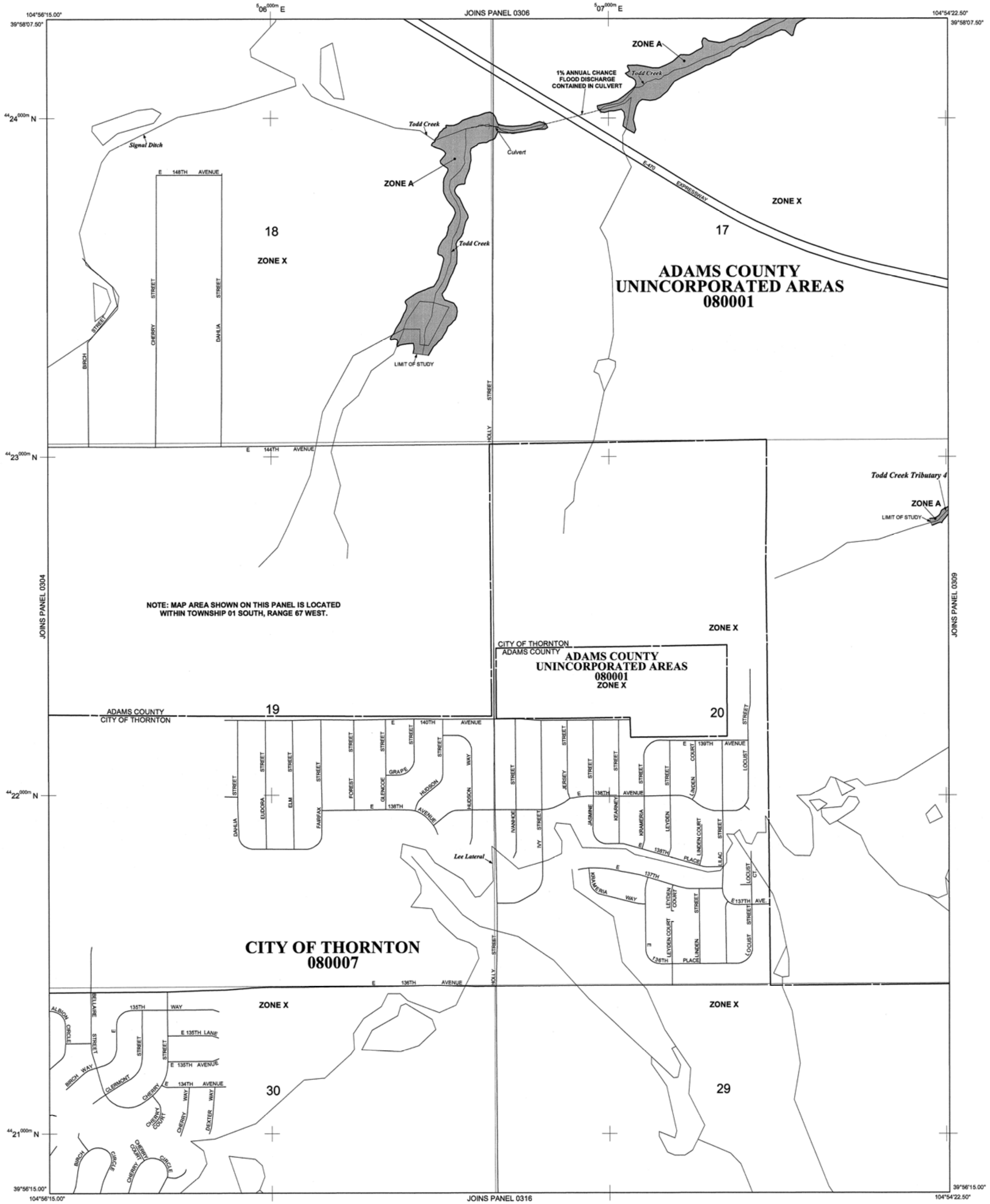
Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

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

This digital Flood Insurance Rate Map (FIRM) was produced through a cooperative partnership between the State of Colorado Water Conservation Board, the Urban Drainage and Flood Control District, and the Federal Emergency Management Agency (FEMA). The State of Colorado Water Conservation Board and the Urban Drainage and Flood Control District have implemented a long-term approach of floodplain management to reduce the costs associated with flooding. As part of this effort, both the State of Colorado and the Urban Drainage and Flood Control District have joined in Cooperating Technical Partner agreements with FEMA to produce this digital FIRM.

Additional flood hazard information and resources are available from local communities, the Colorado Water Conservation Board, and the Urban Drainage and Flood Control District.



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 Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

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

(A)——(A)	Cross section line
(23)- - - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 M	5000-foot grid ticks: Alabama State Plane coordinate system, east zone (FIPSZONE 0101), Transverse Mercator
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
August 16, 1995
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
March 5, 2007 - to update map format.

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

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

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

PANEL 0308H

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP
ADAMS COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 308 OF 1150
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ADAMS COUNTY	080001	0308	H
THORNTON, CITY OF	080007	0308	H

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 08001C0308H

MAP REVISED MARCH 5, 2007

Federal Emergency Management Agency

NOTES TO USERS

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

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Silver Spring, MD 20910- 3282

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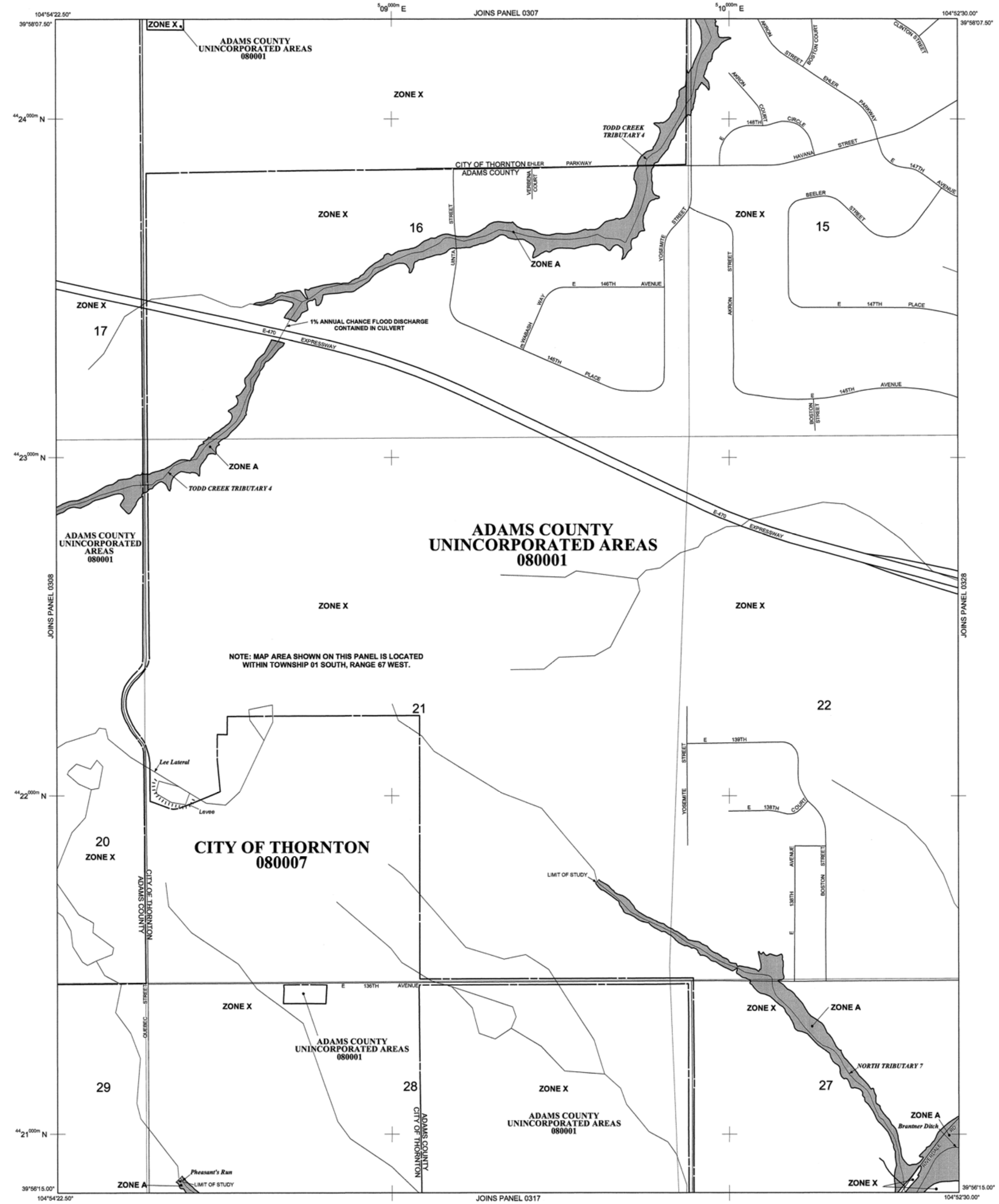

LEGEND

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

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

A — A	Cross section line
23 - - - 23	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN	1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 M	5000-foot grid ticks: Alabama State Plane coordinate system, east zone (FIPSZONE 0101), Transverse Mercator
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
August 16, 1995
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
March 5, 2007 - to update map format.

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

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

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0309H

FIRM

FLOOD INSURANCE RATE MAP

ADAMS COUNTY, COLORADO

AND INCORPORATED AREAS

PANEL 309 OF 1150
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ADAMS COUNTY	080001	0309	H
THORNTON, CITY OF	080007	0309	H

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
08001C0309H

MAP REVISED
MARCH 5, 2007

Federal Emergency Management Agency

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The **projection** used in the preparation of this map was Colorado State Plane North Zone (FIPS ZONE 0501). The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane 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.

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SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

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Base map information shown on this FIRM was provided in digital format by the Adams County GIS Department.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables *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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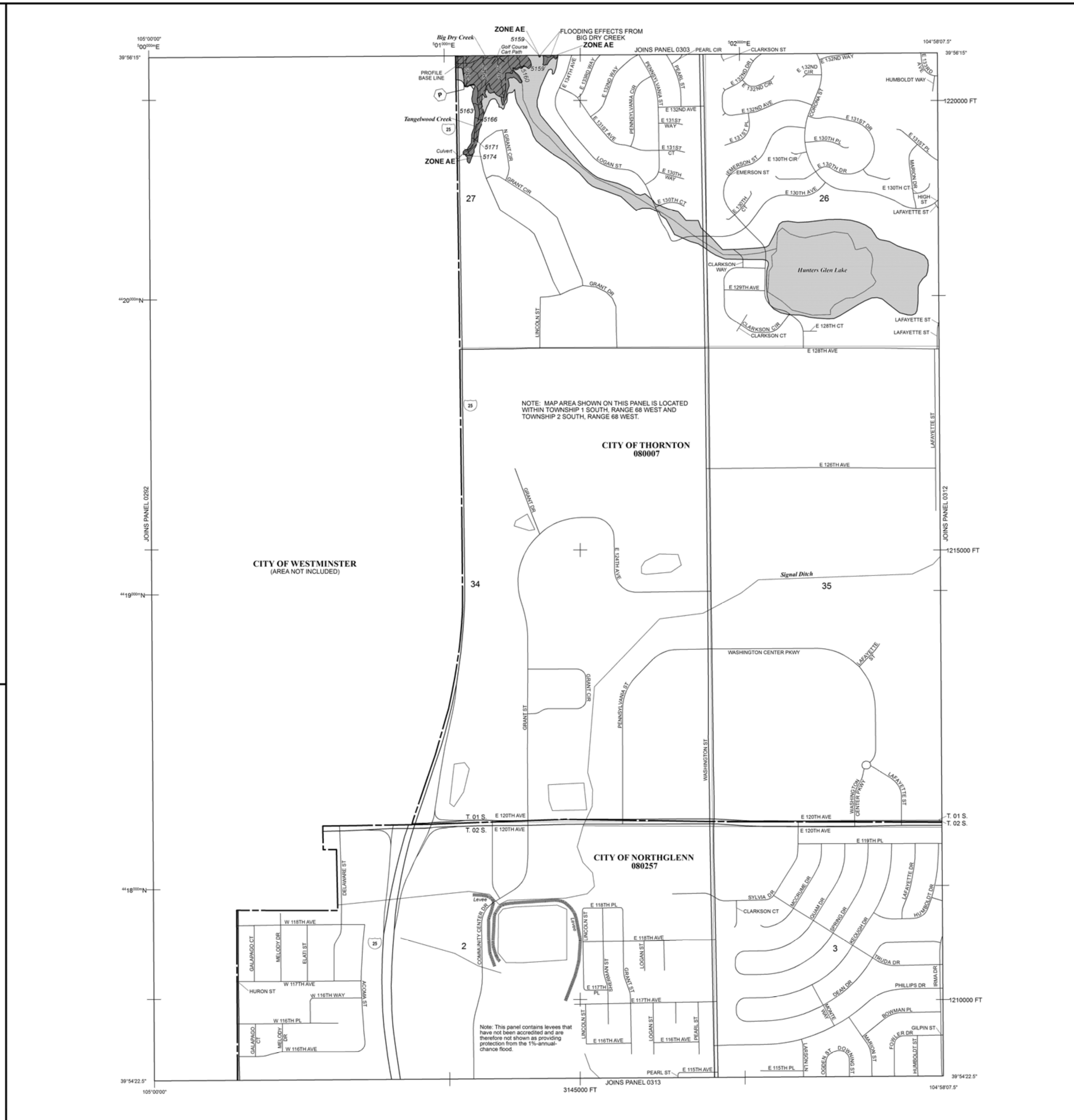
For information and questions about this map, available products associated with this FIRM including historic versions of this FIRM, how to order products or the National Flood Insurance Program in general, please call the FEMA Map Information eXchange at 1-877-FEMA-MAP (1-877-336-2627) or visit the FEMA Map Service Center website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the webiste. Users may determine the current map date for each FIRM panel by visiting the FEMA Map Service Center webiste or by calling the FEMA Map Information eXchange.



LEGEND

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

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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 Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Areas to be protected from 1% annual chance flood event 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.
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COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

* Referenced to the North American Vertical Datum of 1988

(A)———(A)	Cross section line
(23)- - - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
4275000mE	1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT	5000-foot grid values: Colorado State Plane coordinate system, North Zone (FIPSZONE = 501), Lambert projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories List on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
August 16, 1995

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
March 5, 2007: to update map format.
January 20, 2016: to update special flood hazard areas.

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.

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MAP SCALE 1" = 500'

250 0 250 500 750 1,000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0311J

FIRM
FLOOD INSURANCE RATE MAP
ADAMS COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 311 OF 1150

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
NORTHGLENN, CITY OF	080257	0311	J
THORNTON, CITY OF	080007	0311	J

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
08001C0311J

MAP REVISED
JANUARY 20, 2016

Federal Emergency Management Agency

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Silver Spring, MD 20910- 3282

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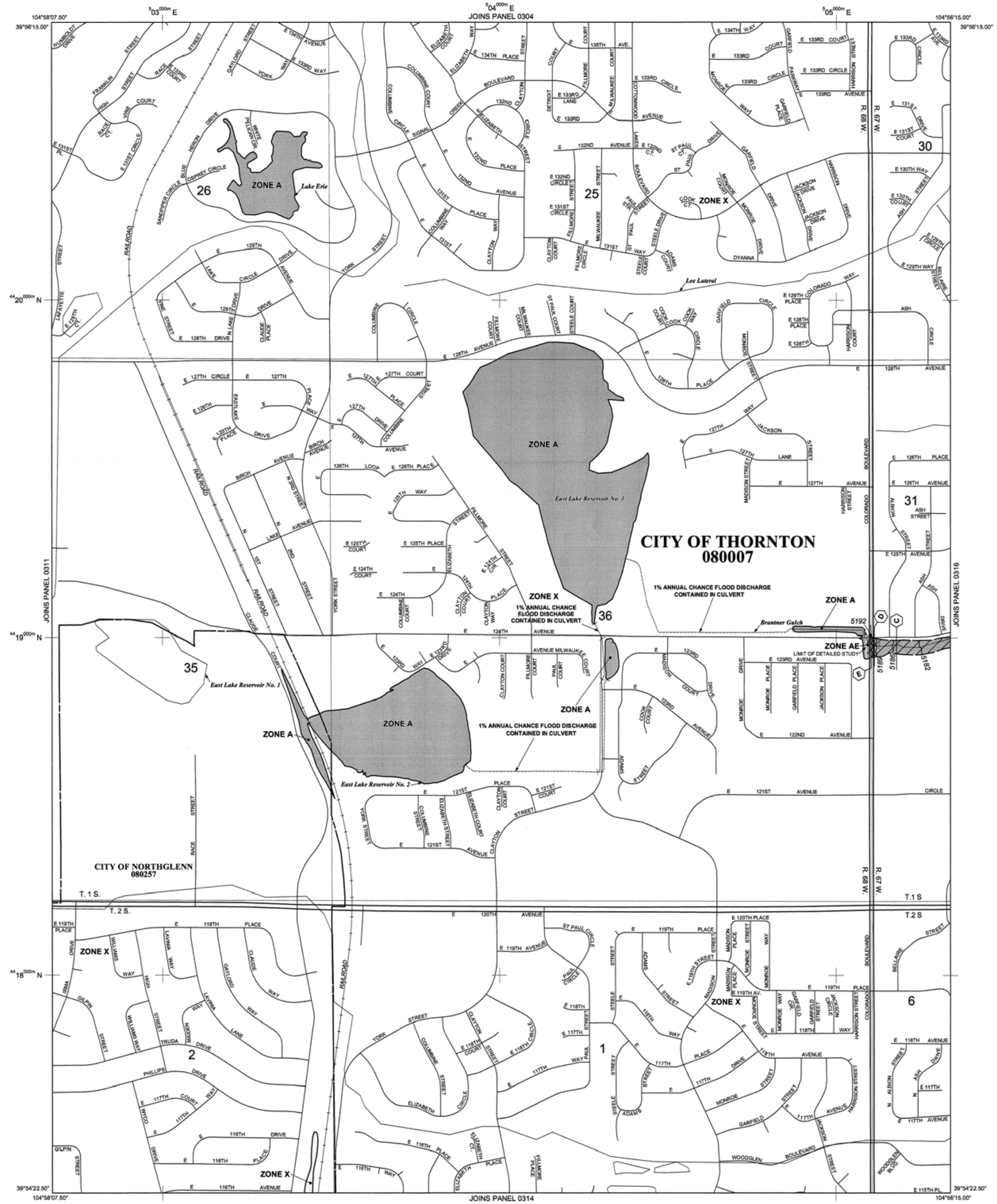

LEGEND

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 Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

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

(A)———(A)	Cross section line
(23)- - - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000mN	1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 M	5000-foot grid ticks: Alabama State Plane coordinate system, east zone (FIPSZONE 0101), Transverse Mercator
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
August 16, 1995
EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
March 5, 2007 - to update map format.

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MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0312H

FIRM
FLOOD INSURANCE RATE MAP
ADAMS COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 312 OF 1150
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
NORTHGLENN, CITY OF	080257	0312	H
THORNTON, CITY OF	080007	0312	H

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MAP NUMBER
08001C0312H

MAP REVISED
MARCH 5, 2007

Federal Emergency Management Agency

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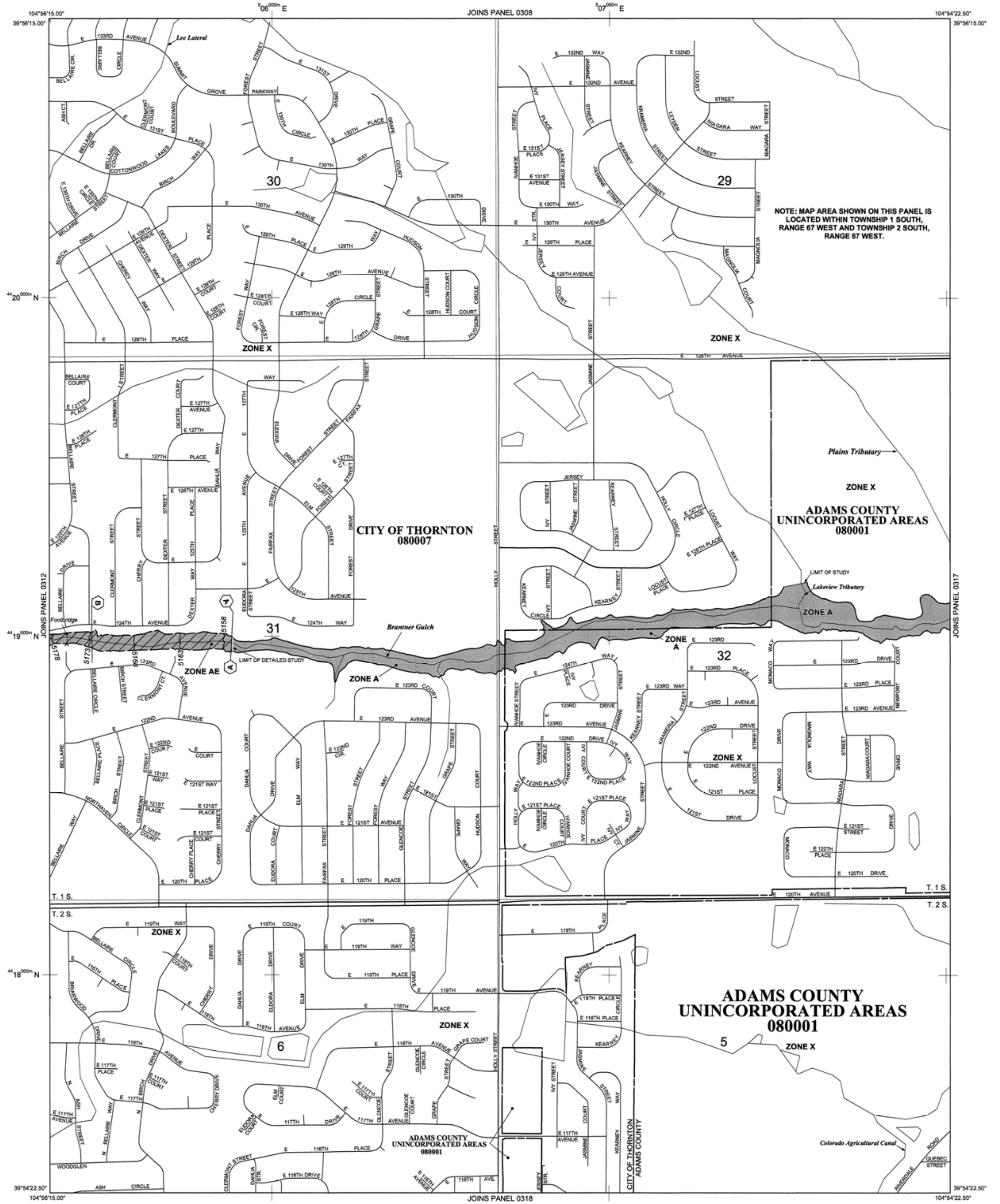

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NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0316H

FIRM

FLOOD INSURANCE RATE MAP

ADAMS COUNTY, COLORADO

AND INCORPORATED AREAS

PANEL 316 OF 1150
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ADAMS COUNTY	080001	0316	H
THORNTON, CITY OF	080007	0316	H

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MAP NUMBER
08001C0316H

MAP REVISED
MARCH 5, 2007

Federal Emergency Management Agency

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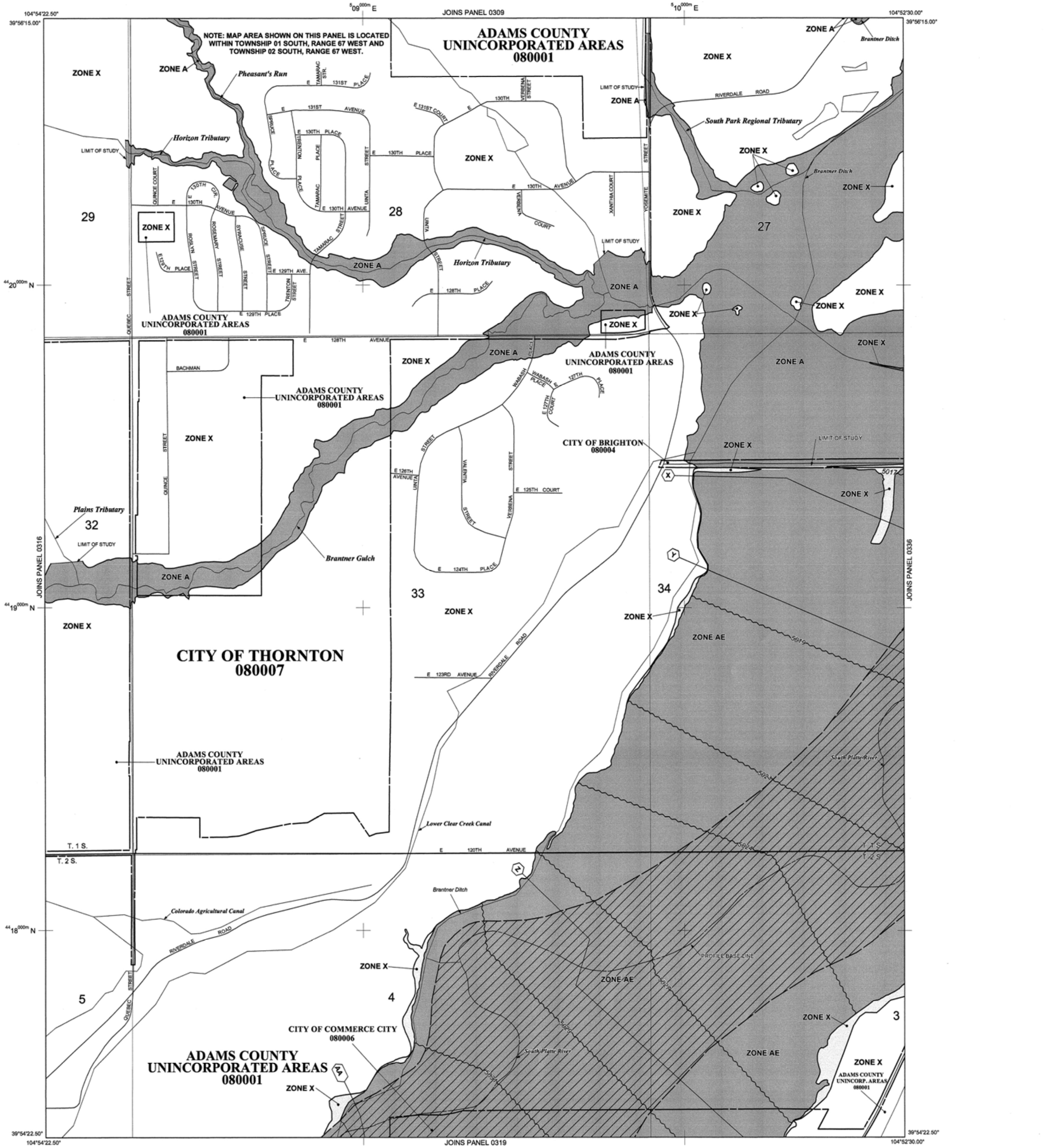

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FLOODWAY AREAS IN ZONE AE

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NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0317H

FIRM
FLOOD INSURANCE RATE MAP
ADAMS COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 317 OF 1150
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
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BRIGHTON, CITY OF	080004	0317	H
COMMERCE CITY, CITY OF	080006	0317	H
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MAP REVISED MARCH 5, 2007

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

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

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Contact the **FEMA Map Service Center** at 1- 800- 358- 9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, *a Flood Insurance Study report*, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1- 800- 358- 9620 and its website at http://www.msc.fema.gov/.

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

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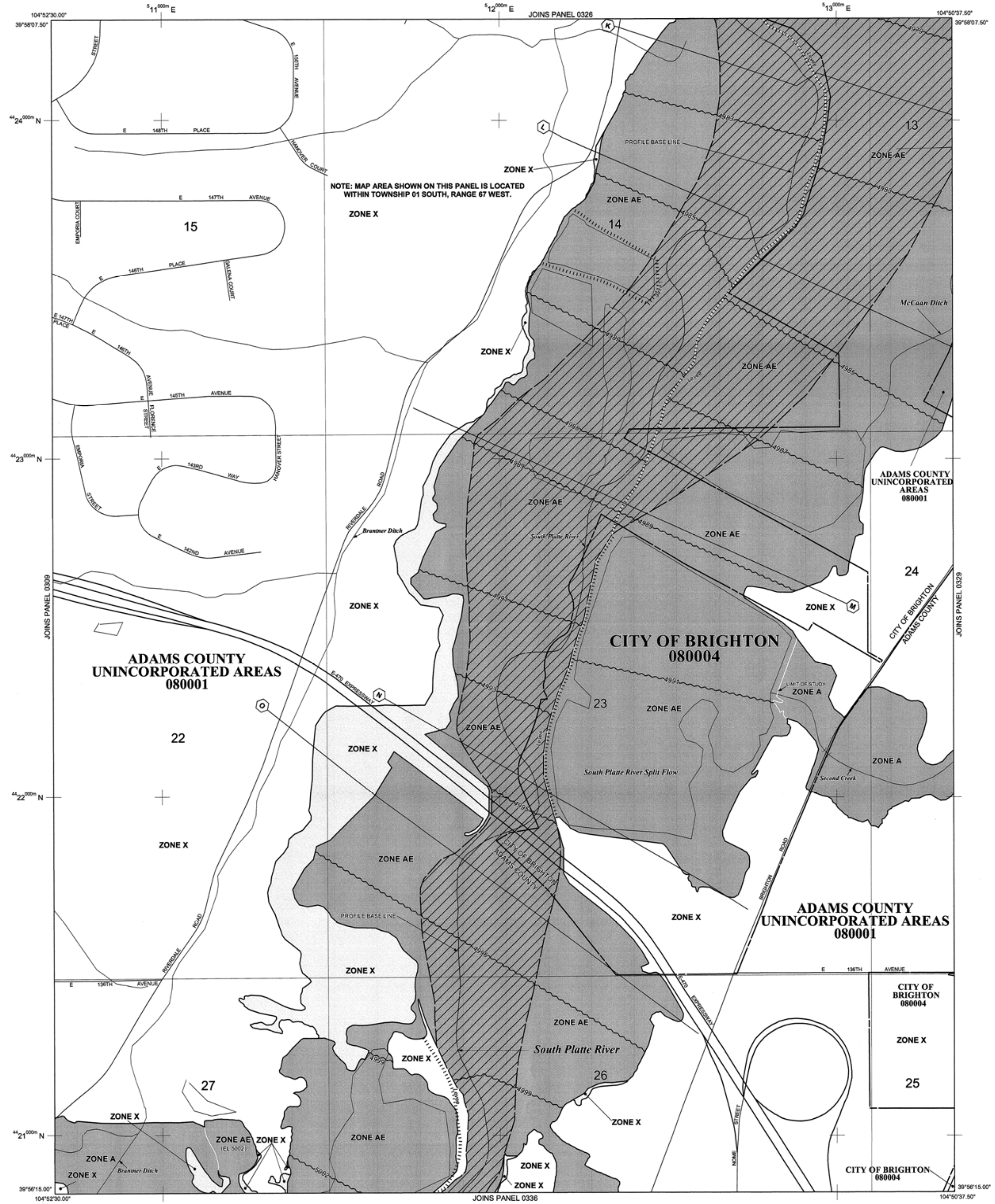

LEGEND

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

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

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

(A)———(A)	Cross section line
(23)- - - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 M	5000-foot grid ticks: Alabama State Plane coordinate system, east zone (FIPSZONE 0101), Transverse Mercator
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

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FLOOD INSURANCE RATE MAP
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EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
March 5, 2007 - to update map format.

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MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0328H

FIRM
FLOOD INSURANCE RATE MAP
ADAMS COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 328 OF 1150
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
ADAMS COUNTY	080001	0328	H
BRIGHTON, CITY OF	080004	0328	H

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
08001C0328H

MAP REVISED
MARCH 5, 2007

Federal Emergency Management Agency

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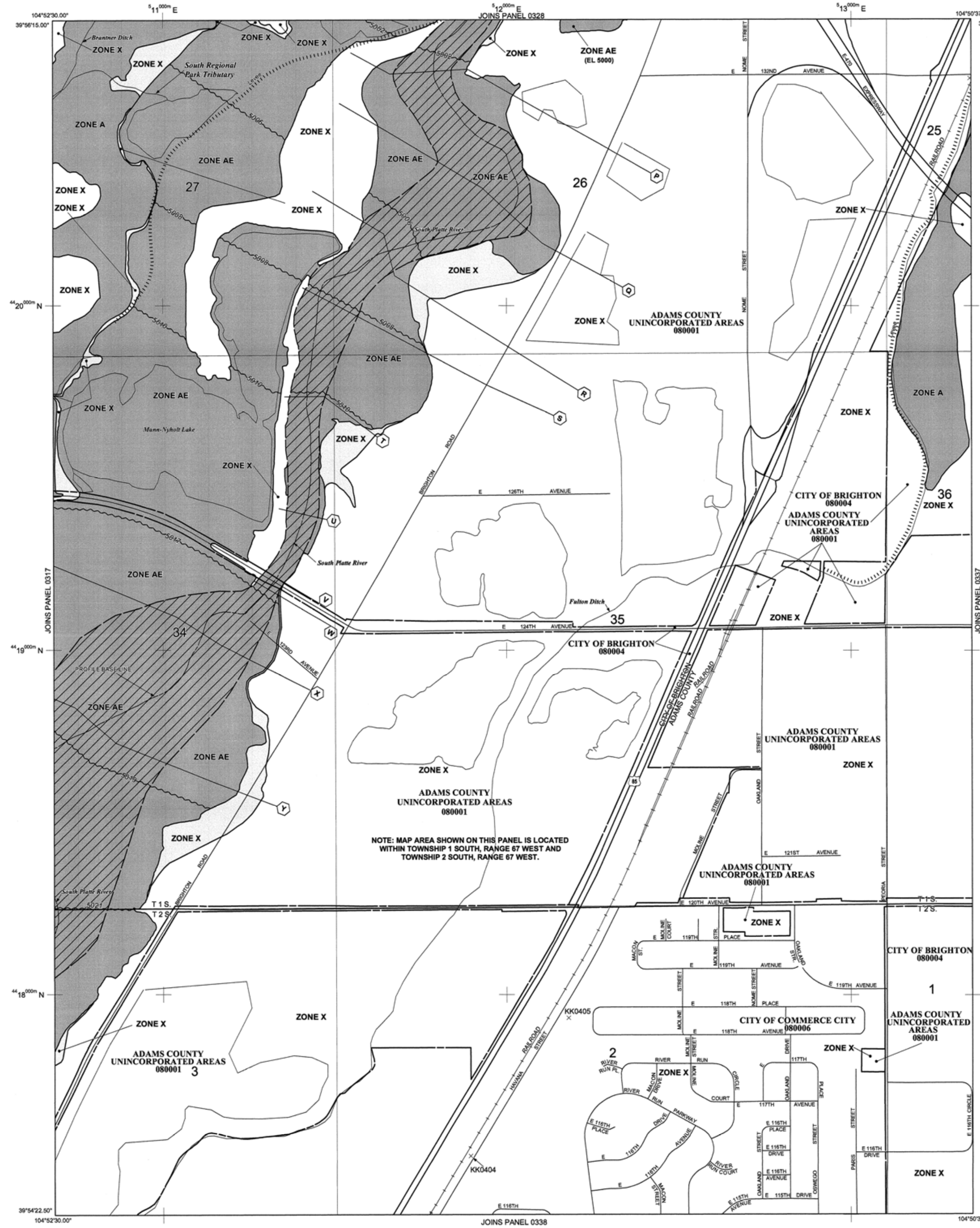

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NFIP

PANEL 0336H

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP
ADAMS COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 336 OF 1150
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
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BRIGHTON, CITY OF	080004	0336	H
COMMERCE CITY, CITY OF	080006	0336	H

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MAP NUMBER
08001C0336H

MAP REVISED
MARCH 5, 2007

Federal Emergency Management Agency

APPENDIX D

WETLAND AND RIPARIAN INVENTORY

PROJECT: 018-2897	
DRAWN BY: ELB	
DATE: 3/10/2023	

MILE HIGH FLOOD DISTRICT,
CITY OF THORNTON, NORTHGLENN, & ADAMS COUNTY

BRANTNER GULCH MDP
WETLAND INVENTORY

olsson
1525 Raleigh Street
Suite 400
Denver, CO 80204
TEL: 303.237.2072
FAX: 303.237.2659
www.olsson.com

FIGURE
D-1

APPENDIX E

ALTERNATIVES ANALYSIS

Proposed Detention Basin Summary

Existing Detention Basin

Design Point 365 - Brantner Gulch: Ohio Lake				
Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5305.17	0.00	0	0.00	0.00
5306.00	0.83	84	0.00	13.61
5307.00	1.83	1606	0.02	24.82
5308.00	2.83	12098	0.18	32.36
5309.00	3.83	49245	0.88	38.44
5310.00	4.83	113232	2.75	43.69
5311.00	5.83	173884	6.04	48.37
5312.00	6.83	201738	10.35	52.63
5313.00	7.83	217133	15.16	56.58
5313.52	8.35	226186	17.81	58.52
5314.00	8.83	234543	20.35	87.08
5314.50	9.33	248793	23.12	140.27
5314.72	9.55	255063	24.39	170.34
5315.00	9.83	263043	26.06	244.64
5315.10	9.93	269051	26.67	312.28
5315.25	10.08	278063	27.61	452.52

Stage-storage based on LiDAR, stage-discharge calculated in UD_Detention-v.2.34 using survey provided by City of Thornton.

Verify stage-storage. Lower notch and top of outlet box by 0.2-foot

Design Point 365 - Brantner Gulch: Ohio Lake				
Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5305.17	0.00	0	0.00	0.00
5306.00	0.83	84	0.00	13.61
5307.00	1.83	1606	0.02	24.82
5308.00	2.83	12098	0.18	32.36
5309.00	3.83	49245	0.88	38.44
5310.00	4.83	113232	2.75	43.69
5311.00	5.83	173884	6.04	48.37
5312.00	6.83	201738	10.35	52.63
5313.00	7.83	217133	15.16	56.58
5313.32	8.15	---	---	58.52
5313.52	8.35	226186	17.81	65.74
5314.00	8.83	234543	20.35	105.49
5314.30	9.13	---	---	140.27
5314.50	9.33	248793	23.12	166.47
5314.72	9.55	255063	24.39	204.69
5315.00	9.83	263043	26.06	285.43
5315.10	9.93	269051	26.67	355.03
5315.25	10.08	278063	27.61	498.01

Stage-storage based on LiDAR, stage-discharge calculated in UD_Detention-v.2.34 using survey provided by City of Thornton.

Existing Detention Basin

Design Point L305 - Lakeview Tributary: Woodbridge Station Pond 4				
Elevation	Stage (ft)	Area (sf)	Storage (ac-ft)	Discharge (cfs)
5161.43	0	0	0.00	0
5162	0.57	337	0.00	6
5163	1.57	3455	0.05	34
5164	2.57	10587	0.21	63
5165	3.57	15658	0.51	73
5166	4.57	25877	0.98	81
5167	5.57	51105	1.87	89
5167.08	5.65	52292.2	1.96	90
5168	6.57	65945	3.21	96
5169	7.57	81299	4.90	103
5169.26	7.83	84635	5.40	105
5170	8.57	94129	6.92	402
5171	9.57	118228	9.35	1710

Stage-area values from LiDAR. Stage-discharge calculated using UD-Detention-v2.34 and survey. Values from 2010 Hydrology Update - Appendix D tables (Pond 909) not used, bottom elevation did not

Verify outlet pipe dimensions and elevations, remove and replace to increase capacity if needed

Design Point L305 - Lakeview Tributary: Woodbridge Station Pond 4				
Elevation	Stage (ft)	Area (sf)	Storage (ac-ft)	Discharge (cfs)
5161.43	0	0	0.00	0
5162	0.57	337	0.00	7
5163	1.57	3455	0.05	38
5164	2.57	10587	0.21	69
5165	3.57	15658	0.51	88
5166	4.57	25877	0.98	104
5167	5.57	51105	1.87	117
5167.08	5.65	52292.2	1.96	118
5168	6.57	65945	3.21	254
5169	7.57	81299	4.90	285
5169.26	7.83	84635	5.40	289
5170	8.57	94129	6.92	592
5171	9.57	118228	9.35	1907

Stage-area values from LiDAR. Stage-discharge calculated using UD-Detention-v2.34 and survey. Values from 2010 Hydrology Update - Appendix D tables (Pond 909) not used, bottom elevation did not

Existing Detention Basin

Design Point H303 - Horizons Tributary: Villages at Riverdale Filing 1 & 2				
Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5086	0	37206	0.00	0
5088	2	87388	2.86	2
5088.5	2.5	103086	3.95	3
5089.55	3.55	136053	6.84	208
5090	4	150181	8.31	320
5092	6	211321	16.61	650
5094	8	297182	28.29	1300
5096	10	378752	43.80	3500

Values from 2010 Hydrology Update - Appendix D tables (Pond 912)

No significant benefit to further detain - improvements not recommended

Design Point H303 - Horizons Tributary: Villages at Riverdale Filing 1 & 2				
Elevation	Stage (ft)	Area (sf)	Storage (acre-ft)	Discharge (cfs)
5086	0	37206	0.00	0
5088	2	87388	2.86	2
5088.5	2.5	103086	3.95	3
5089.55	3.55	136053	6.84	208
5090	4	150181	8.31	320
5092	6	211321	16.61	650
5094	8	297182	28.29	1300
5096	10	378752	43.80	3500

Values from 2010 Hydrology Update - Appendix D tables (Pond 912)

Existing Detention Basin

Design Point L302 - Lakeview Tributary: Sage Creek Retention Pond				
Elevation	Stage (ft)	Area (sf)	Storage (ac-ft)	Discharge (cfs)
5124.15	0	63063	0.00	0
5126	1.85	119940	3.89	3.9
5126.55	2.4	127177	5.45	5.3
5128	3.85	146258	10.00	320
5128.55	4.4	154977	11.90	620
5130	5.85	177962	17.44	1500

Values from 2010 Hydrology Update - Appendix D tables (Pond 911)

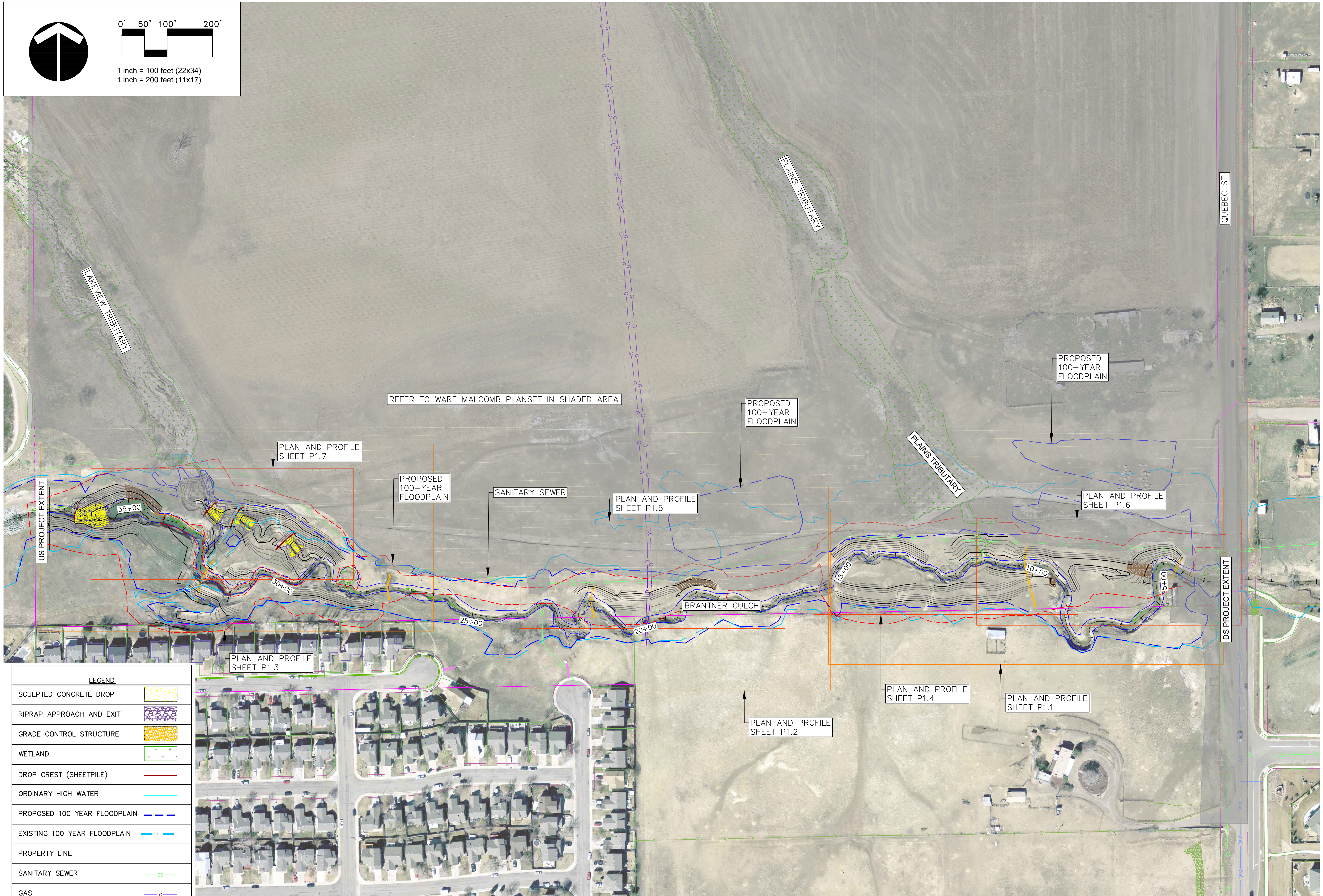
No significant benefit to further detain - improvements not recommended

Design Point L302 - Lakeview Tributary: Sage Creek Retention Pond				
Elevation	Stage (ft)	Area (sf)	Storage (ac-ft)	Discharge (cfs)
5124.15	0	63063	0.00	0
5126	1.85	119940	3.89	3.9
5126.55	2.4	127177	5.45	5.3
5128	3.85	146258	10.00	320
5128.55	4.4	154977	11.90	620
5130	5.85	177962	17.44	1500

Values from 2010 Hydrology Update - Appendix D tables (Pond 911)

Table E-1 - Proposed Crossing Structures

Reach	Structure Survey Number	Upstream Cross Section	Jurisdiction	Street Name	Street Classification	Existing Structure	Proposed Improvements
Brantner 5	1	41162	Thornton	Washington Center Parkway	Local	Outlet structure and (1) 10-foot (S) x 5-foot (R) RCBC	Verify stage-storage. Lower notch and top of outlet structure 0.2' to prevent 100-year spillway overtopping
	10	31738	Thornton	124th Ave	Local	(1) 60-inch RCP	Add (1) 48-inch RCP to meet 100-year criteria and prevent pipe surcharging upstream
	14	25221	Thornton	Pipe Aerial Crossing	Park	Lateral crossing of 6" fiber optic conduit	Raise channel and construct drop structures to protect utility
Brantner 3	20	9639	Adams County/ Thornton	E 128th Avenue	Principal Arterial	(1) 42-inch RCP and (4) 48-inch overflow RCPs	Raise E. 128th Avenue low point 4' and replace existing crossing with (2) 20-foot span by 10 -foot (H) RCBC to meet 100-year criteria
Brantner 1	21	7084	Adams County/ Thornton	Riverdale Road	Collector	(3) 16-foot (S) x 12-foot (R) RCBC partially filled in	Drop structure upstream of Riverdale Rd, remove filled bottom, channel improvements downstream to accommodate lower invert
	22	6673	Adams County	Golf Cart Path	Bridge	(1) 14.9-foot Span Bridge	(1) 250-foot span bridge
	23	6564	Adams County	Lateral Pipe	Golf Course	(1) 15-inch Lateral CMP Aerial Crossing	Protect utility
	24	6468	Adams County	Golf Cart Path	Bridge	(1) 23.2-foot Span Bridge	(1) 200-foot span bridge
	25	6110	Adams County	Golf Cart Path	Bridge	(1) 14.75-foot Span Bridge	Crossing removed
	26	5752	Adams County	Golf Cart Path	Bridge	(1) 17.8-foot Span Bridge	Crossing removed
	27	5527	Adams County	Golf Cart Path	Bridge	(1) 14.6-foot Span Bridge	Crossing removed
	28	5252	Adams County	Golf Cart Path	Bridge	(1) 15-foot Span Bridge	(3) 20-foot x 6-foot RCBC under Brantner Ditch to eliminate 100-year overtopping
	29	5035	Adams County	Golf Cart Path	Bridge	(1) 18-foot Span Bridge	Crossing removed
	30	4618	Adams County	Golf Cart Path	Bridge	(1) 33.3-foot Span Bridge	(1) 180-foot span bridge
	31	4446	Adams County	Golf Cart Path	Bridge	(1) 24.5-foot Span Bridge	Crossing removed
	32	4103	Adams County	Park Boulevard	Local	(1) 18-foot (S) x 4.7-foot (R) RCBC	(3) 16-foot (S) x 10-foot (R) RCBC to meet 100-year criteria
	33	4023	Adams County	Lateral Pipe (Park Blvd & Golf Course Way)	Private	12-inch Lateral Aerial Pipe Crossing	Protect utility
	34	3932	Adams County	Golf Cart Path	Bridge	(1) 23.3-foot Span Bridge	(1) 150-foot span bridge
	35	1973	Adams County	Pedestrian Trail	Trail	(1) 77.65-foot Span Bridge	No improvements evaluated
Lakeview Tributary	42	54978	Thornton	Holly Street	Collector	Outlet structure and (1) 18-inch RCP and (3) 24-inch RCP	Verify stage-discharge. Remove and replace outlet pipes to eliminate 100-year spill over road
Horizons Trib 2	58	83712	Thornton	Holly Street	Collector	(1) 48-inch RCP	Add (1) 72-inch RCP to meet 100-year criteria and improve safety
	59	82763	Thornton	E 136th Avenue	Principal Arterial	(1) 84-inch RCP	Add (1) 36-inch RCP to meet 100-year criteria
SPR South Tributary 6	91	107047	Adams County	Riverdale Road	Collector	(1) 8-foot (S) x 4-foot (R) RCBC	Add (1) 48-inch RCP to meet 100-year criteria
SPR North Tributary 7	92	120636	Adams County/ Thornton	Yosemite Street	Section Line Arterial	(1) 72-inch CMP	Replace with (1) 72-inch RCP to meet 100-year criteria
	93	119839	Adams County	E 136th Avenue	Collector	(1) 12-inch RCP	Raise E. 136th Avenue low point 2.2' and replace existing crossing with (1) 12-foot span by 6 -foot (H) RCBC to meet 100-year criteria
	94	117273	Adams County	Riverdale Road	Collector	(1) 48-inch CMP	Replace with (1) 10-foot (S) x 8-foot (R) RCBC lowered 6.5 feet. Drop structures upstream of Riverdale Rd, channel improvements downstream to accommodate lower invert
Regional Park	---	---	Adams County	Future Park Access	Access	---	Install (2) 36" RCP to meet 100-year capacity
	---	---	Adams County	Riverdale Road	Collector	---	Install (1) 8-foot (S) x 2-foot (R) RCBC to meet 100-year capacity



NO.	DATE	BY	REVISION COMMENTS

Design	Drawn	Checked	Date	Initial Issue Date:
KP/JEA	KP/AN	JEA	8/17/18	

PREPARED FOR:

WOODBURY CORPORATION

PROPOSED CONDITIONS OVERVIEW

BRANTNER GULCH AT CREEKSIDE
STABILIZATION PROJECT
THORNTON, CO

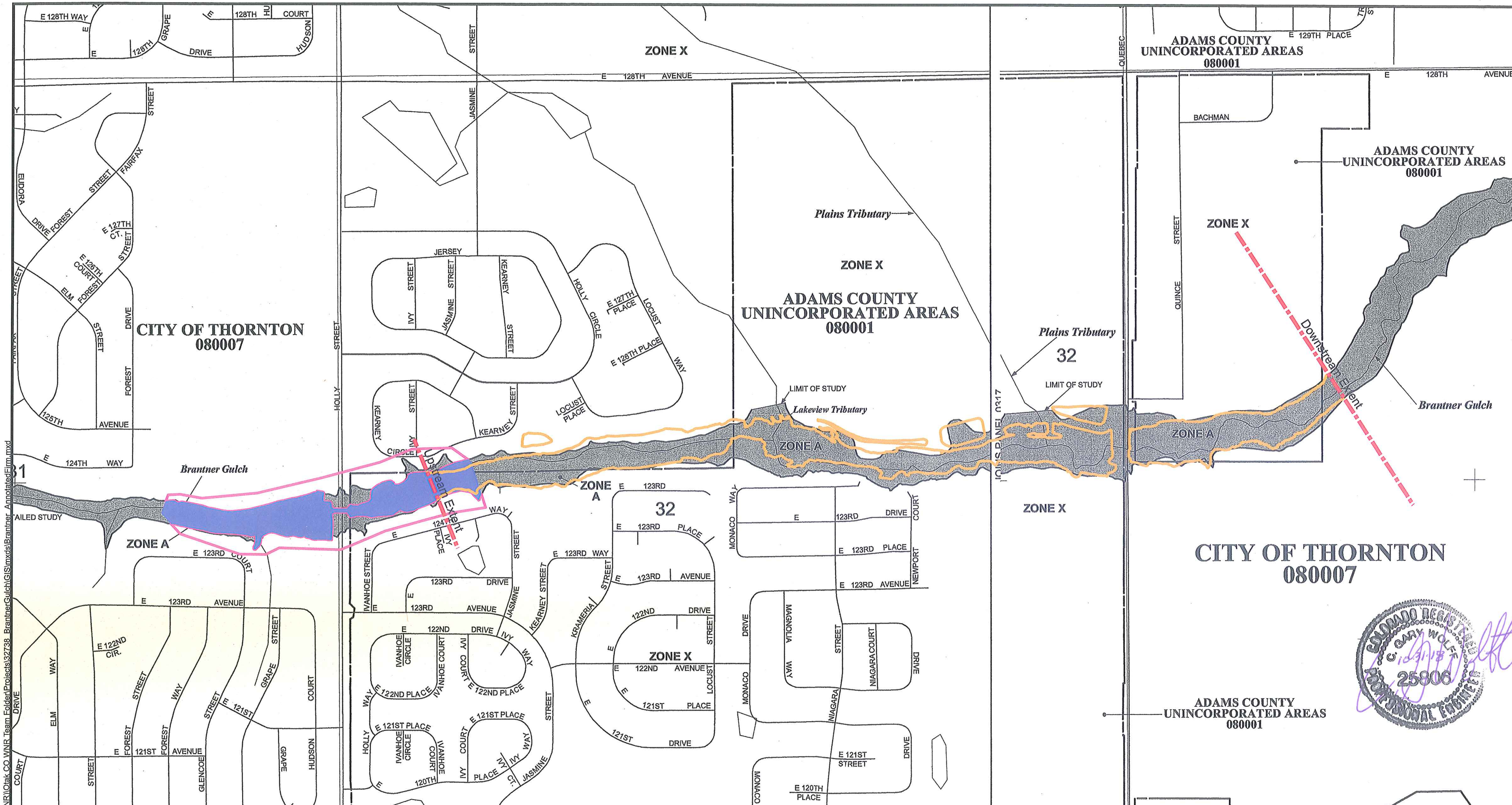
otak

5777 Central Avenue
Suite 228
Boulder, Colorado 80301
Phone: 303-296-3304
Fax: 303-296-3699

032738
Project No. Drawing No.

P1.0B
Sheet No.

Plotted: Aug 17, 2018 - 5:11pm ollisonn C:\Dropbox (Otak CO WNR)\Otak CO WNR Team Folder\Projects\32738_BrantnerGulch\CAD\Planset\32738_Overview.dwg Layout Name: PROPOSED CONDITIONS OVERVIEW



Otak

Legend

- Limit of Map Revision
- Revised 1% Annual Chance Floodplain
- Effective Zone A Holly Street LOMR
- Effective Holly Street LOMR

N

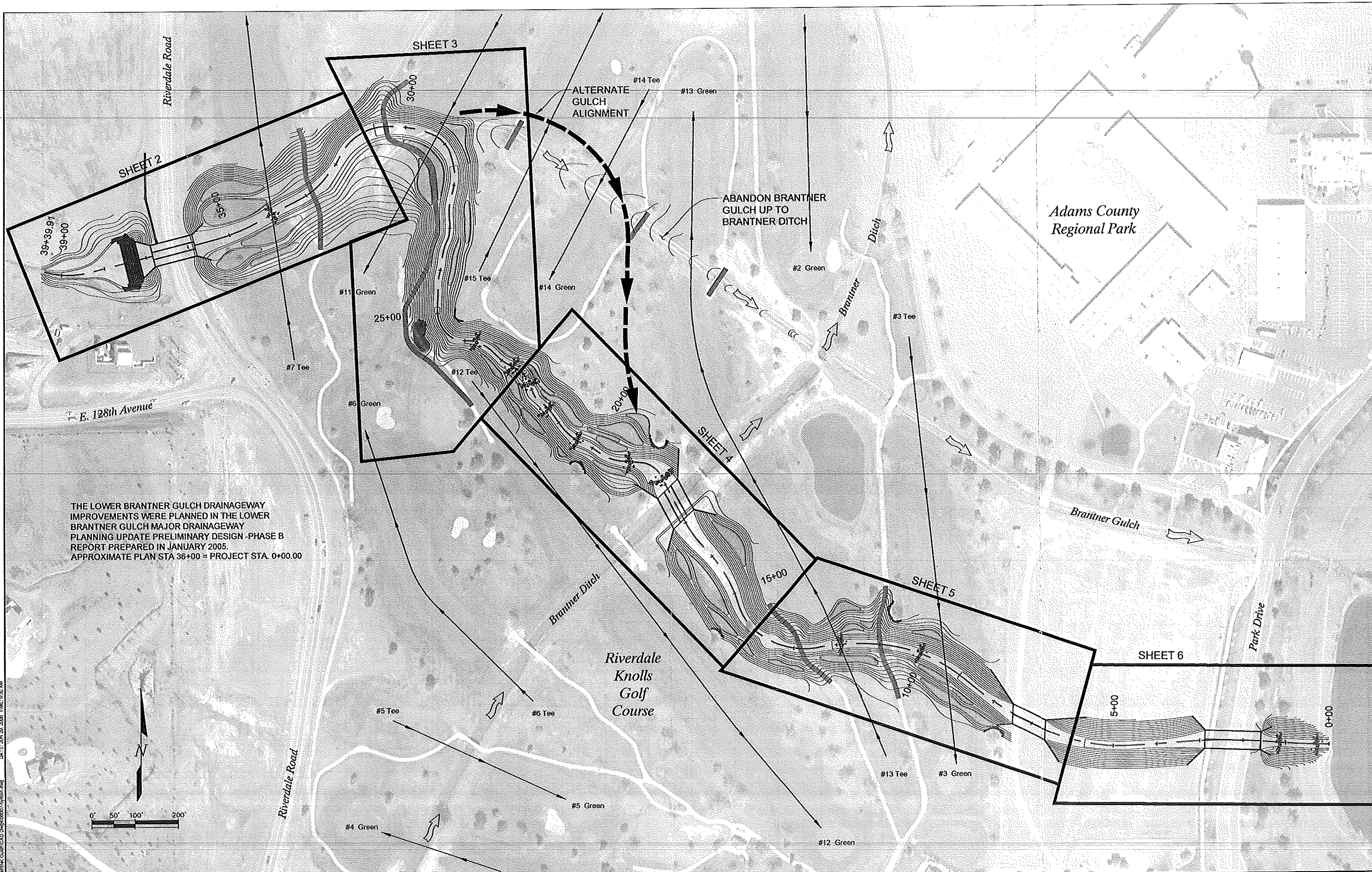
0 320 640 1,280 Feet

Vertical Datum: NAVD88
Horizontal Datum: NAD83 (1991)
Colorado North State Plane Coordinate System

FIGURE 3
ANNOTATED FIRM
BRANTNER GULCH PROJECT

Last Modified: 10/23/2018

Document Path: C:\Dropbox (Otak CO WNR)\Otak CO WNR Team Folder\Projects\32738_BrantnerGulch\GIS\mxds\Brantner_AnnotatedFirm.mxd



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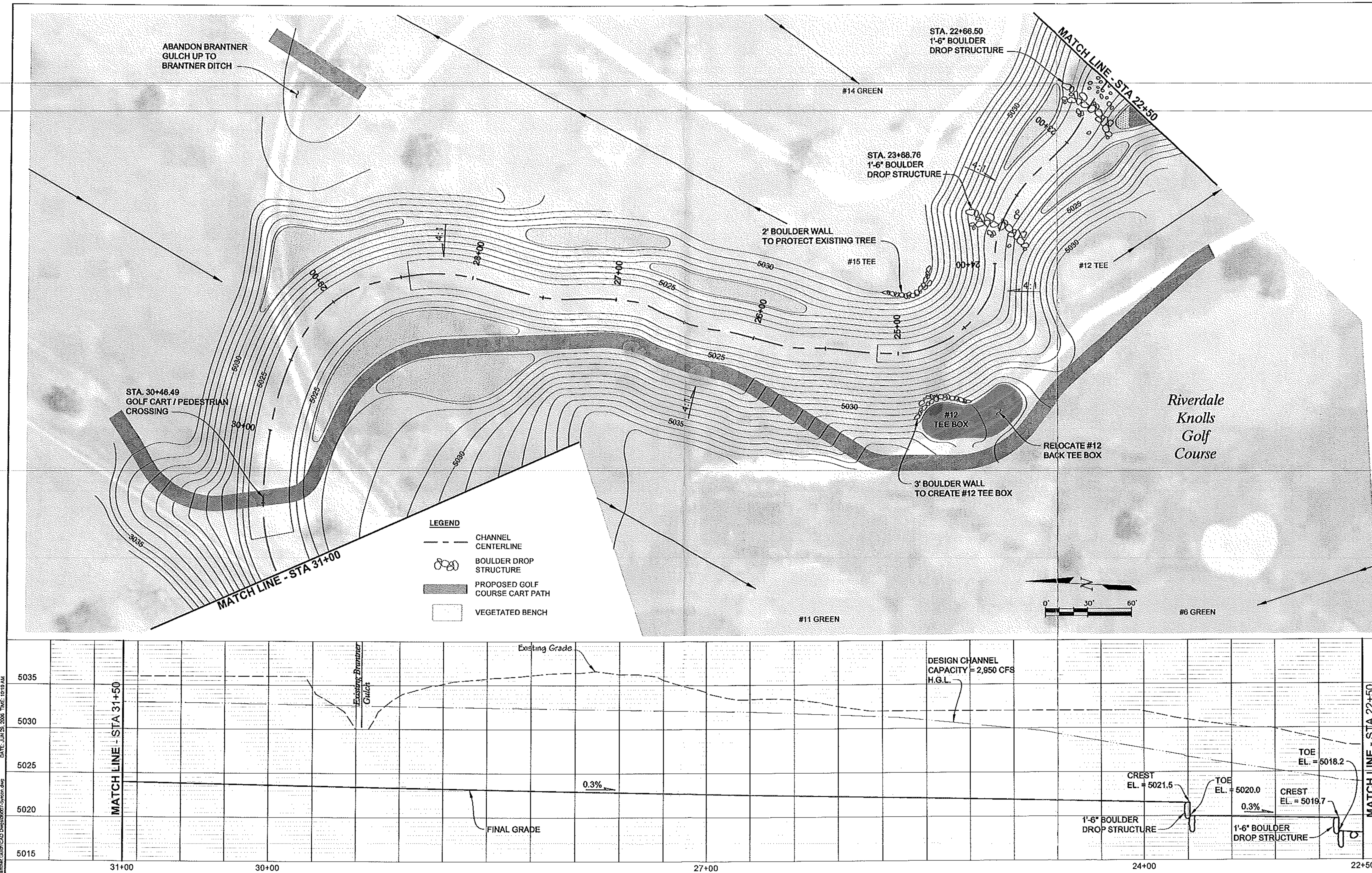

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CONSULTING ENGINEERS
PROJECT NO. 06007.01

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1719 BOULDER STREET
DENVER, COLORADO 80211

ADAMS COUNTY

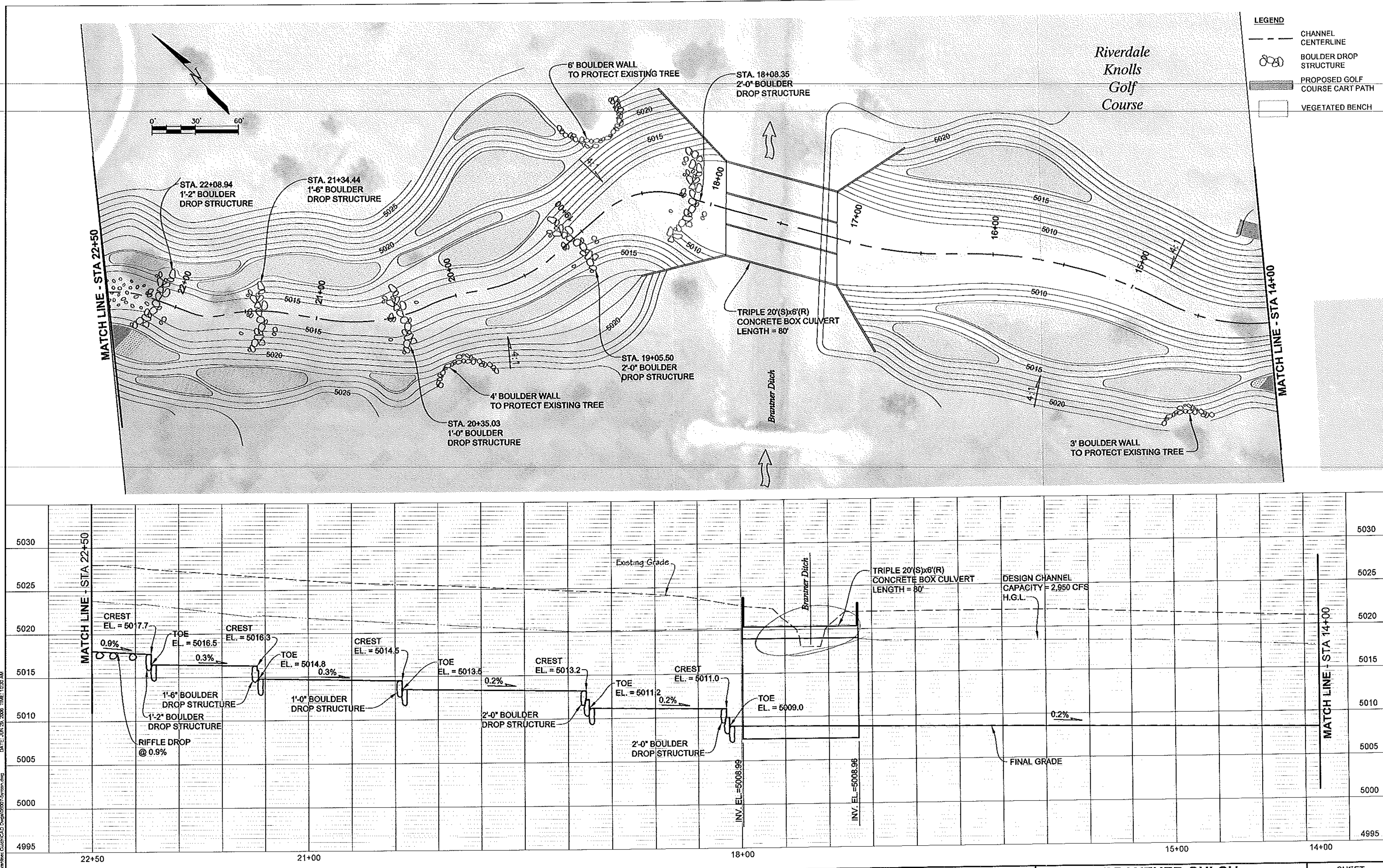
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

LOWER BRANTNER GULCH DRAINAGE IMPROVEMENTS

BRANTNER GULCH PLAN AND PROFILE

STA 31+00 TO STA 22+50

SHEET 3 OF 6



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LAKEWOOD, COLORADO 80226
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DENVER, COLORADO 80211

ADAMS COUNTY

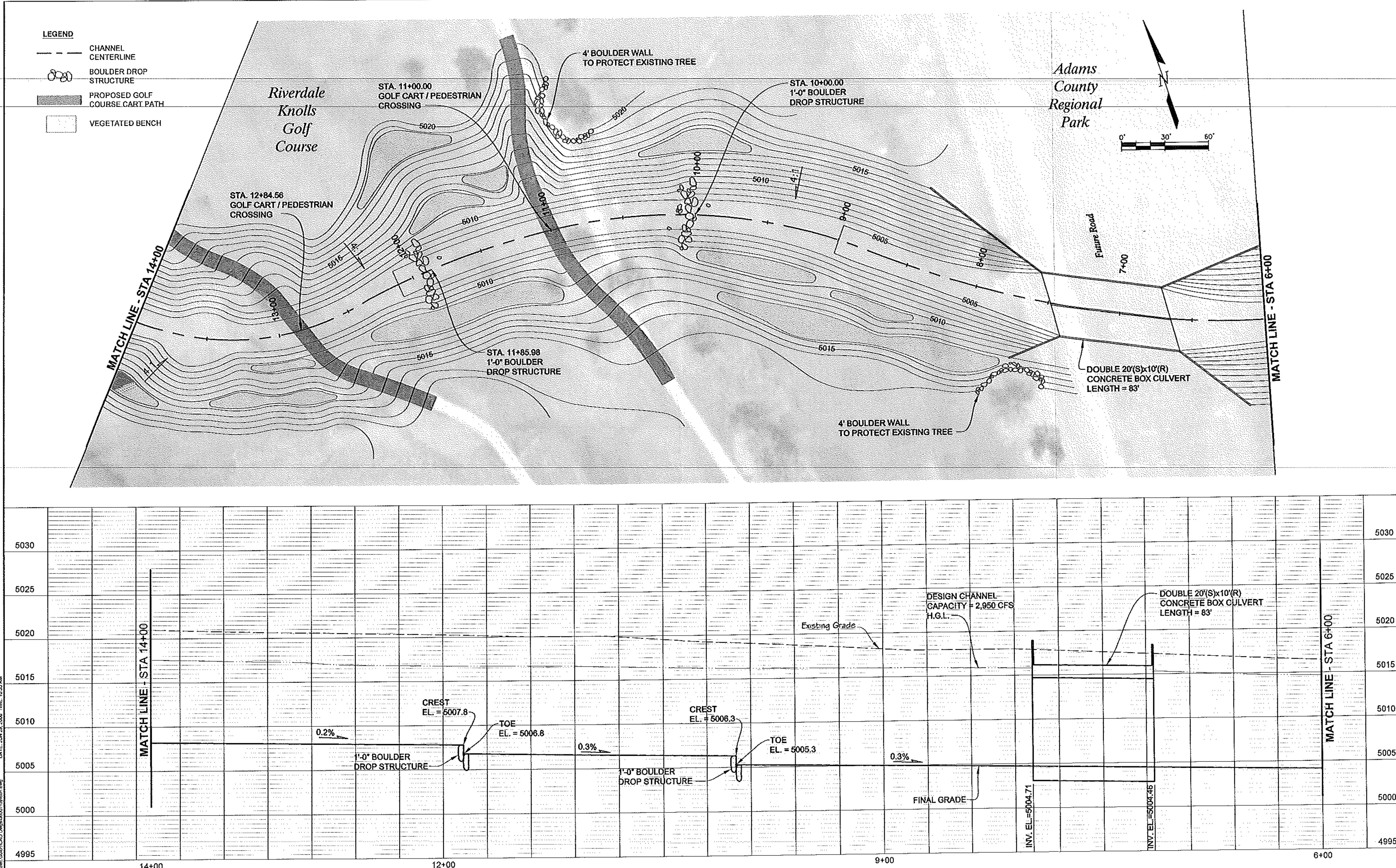
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

LOWER BRANTNER GULCH DRAINAGE IMPROVEMENTS

BRANTNER GULCH PLAN AND PROFILE

STA 22+50 TO STA 14+00

SHEET 4 OF 6



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LAKEWOOD, COLORADO

PROJECT NO. 06007.01

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ADAMS COUNTY

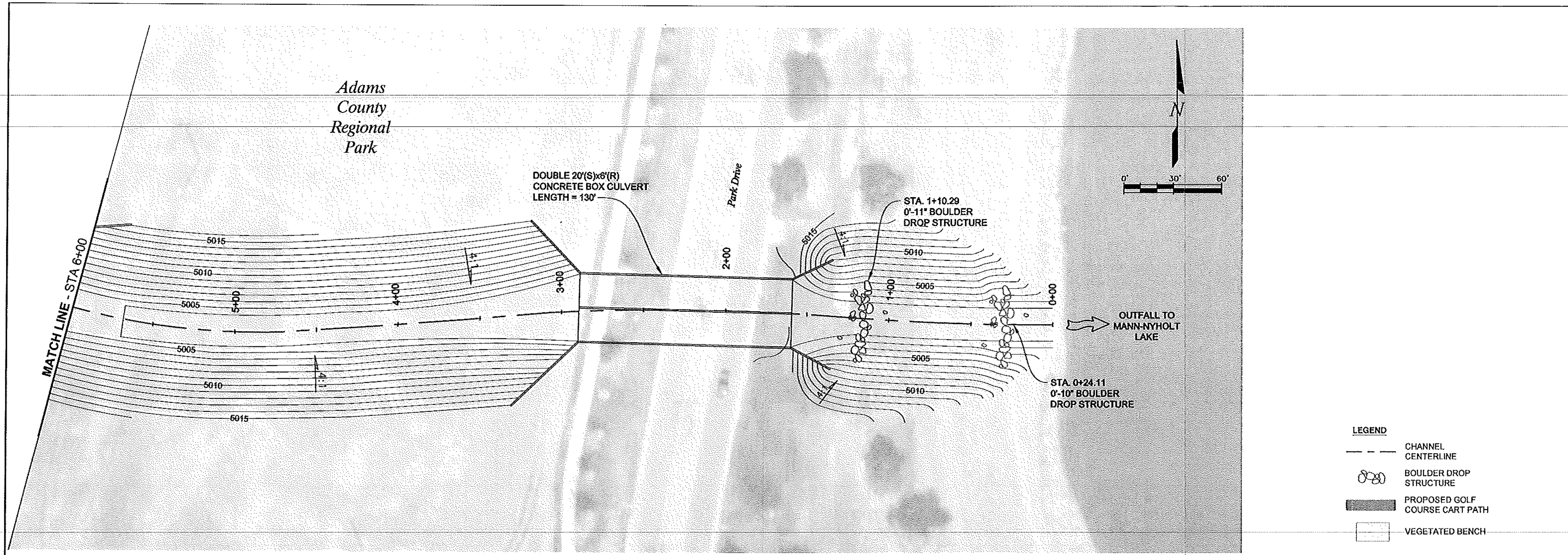
URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

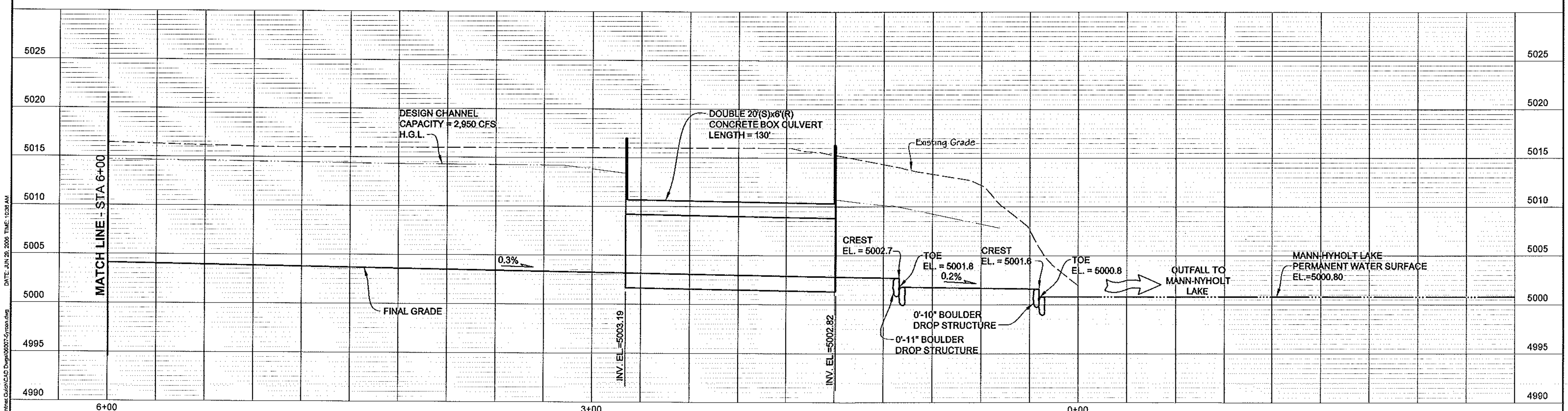
LOWER BRANTNER GULCH DRAINAGE IMPROVEMENTS

BRANTNER GULCH PLAN AND PROFILE

STA 14+00 TO STA 6+00

SHEET 5 OF 6





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MULLER

MULLER ENGINEERING CO., INC.
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(303) 988-4939

PROJECT NO. 06007.01

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ADAMS COUNTY

URBAN DRAINAGE AND FLOOD CONTROL DISTRICT

LOWER BRANTNER GULCH DRAINAGE IMPROVEMENTS

BRANTNER GULCH PLAN AND PROFILE

STA 6+00 TO STA 0+00

SHEET 6 OF 6

MASTER PLAN OVERVIEW

Map Legend

- E-470 REGIONAL TRAIL (10' WIDE CONCRETE WITH 4' SOFT SHOULDER)
- PRIMARY SOFT SURFACE TRAIL (6' TO 10' WIDE CRUSHER FINES)*
- FUTURE SOFT SURFACE TRAIL (CONCEPTUAL)
- SINGLETRACK TRAIL - MULTI-USE (2' TO 3' WIDE, EARTHEN)*
- FUTURE SINGLETRACK TRAIL (CONCEPTUAL)
- SINGLETRACK TRAIL - PEDESTRIAN ONLY (2' TO 3' WIDE, EARTHEN)
- SINGLETRACK TRAIL - BICYCLE ONLY (2' TO 3' WIDE , EARTHEN)
- BICYCLE SKILLS LOOP - BICYCLE ONLY (2' TO 3' WIDE, EARTHEN)
- STAIR-CLIMBER TRAIL - PEDESTRIAN ONLY (5' TO 6' WIDE, CONCRETE STEPS AND CRUSHER FINES)
- SOUTH PLATTE RIVER GREENWAY TRAIL
- PROPERTY LINE

1. TRAILHEAD & PARKING LOT
2. E-470 TRAIL
3. PEDESTRIAN OVERPASS OVER RIVERDALE ROAD
4. BLUFF OVERLOOK
5. REGIONAL TRAIL CONNECTION FROM BLUFFS TO SOUTH PLATTE RIVER GREENWAY
6. ADA CONNECTION TO LOCAL SCHOOLS AND SIDEWALK ALONG 136TH AVENUE TO THE WEST (SHOWN CONCEPTUALLY)
7. 136TH UNDERPASS
8. BAUMGARTNER PROPERTY
9. BAUMGARTNER PARKING LOT (SHOWN CONCEPTUALLY)
10. SOUTH PLATTE RIVER GREENWAY
11. SINGLE TRACK TRAIL - PEDESTRIAN ONLY TO NORTHWEST HIGH POINT/OVERLOOK
12. EXISTING PUBLIC ROW
13. TO BE DETERMINED IF SINGLETRACK TRAIL IS SEPARATE OR CO-LOCATED WITH PRIMARY SOFT SURFACE PATH

Equestrian use allowed on primary soft surface trails and singletrack multi-use trails, with the exception of the soft surface trails leading up to point 4, the bluff overlook area.