First Creek Tributaries (Upstream of I-70) Master Drainageway Plan

ALTERNATIVES ANALYSIS REPORT

NOVEMBER 2019

PREPARED FOR: UDFCD, CITY OF AURORA, SEMSWA, & ARAPAHOE COUNTY

PREPARED BY:

MERRICK®

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November 25, 2019

Ms. Teresa Patterson, P.E., C.F.M.
Urban Drainage and Flood Control District
2480 West 26th Avenue, 156-B
Denver, CO 80211

RE: First Creek Tributaries Upstream of I-70 Master Drainageway Plan
Draft Alternatives Analysis Report

Dear Ms. Patterson:

Enclosed is the draft Alternatives Analysis Report for the First Creek Tributaries Upstream of I-70 Master Drainageway Plan (MDP). This alternatives analysis builds on the baseline hydrology for this study and provides alternative plans to size drainage improvements to manage the developed condition runoff for each tributary of this MDP. The purpose of this project is to address any potential drainage, stability, and water quality issues within the study area. The First Creek drainageway was previously master planned in the *First Creek (Upstream of Buckley Road) Major Drainageway Plan Conceptual Design Report* by Moser and Associates (2010), however, the tributary outfalls were not master planned in detail.

Very truly yours,

Jeanne M. Boyle, P.E., C.F.M.
Project Manager

Clare Steninger, P.E.
Project Engineer

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1.0 INTRODUCTION

1.1 Authorization

This First Creek Tributaries Upstream of I-70 Master Drainageway Plan was authorized by the Urban Drainage and Flood Control District (District), with sponsorship by the City of Aurora (City) and Southeast Metro Stormwater Authority (SEMSWA). Arapahoe County is included as a Project Stakeholder. Agreement Number 18-04.08, dated May 3, 2018, serves as a contract between Merrick and Company (Merrick) and the District for this project.

1.2 Purpose and Scope

The purpose of this study is to provide a master plan for tributaries to First Creek that are upstream of I-70 which provides guidance for future construction projects. The purpose of this study is to provide hydrologic analysis and to develop alternatives and recommendations for stormwater infrastructure improvements that will be needed as development occurs. Key project goals include:

- Clearly define intent of stormwater improvement goals and objectives for future implementation.
- Inform, guide, and provide expectations to manage development effects on stormwater quality, drainageway stabilization, flood risk, etc.
- Integrate proposed improvements with realistic location of future trails, open space, traffic master plans, and development planning.
- Define stream management corridors to provide stormwater conveyance.
- Develop guidance for future vegetation and provide reference for roughness coefficients for maintenance purposes.

The Major Drainageway Plan (MDP) scope includes three phases: 1) the Baseline Hydrology Phase, 2) the Alternatives Evaluation Phase, and 3) the Conceptual Design Phase. The Baseline Hydrology section summarizes the hydrology of the study area including subwatershed delineation, subwatershed characteristics, and flow routing. The Alternatives Analysis section summarizes the alternatives development and analysis and it addresses any potential drainage, stability, and ecological issues within the project site. The Conceptual Design section includes conceptual design for the selected alternatives for the reaches studied under the Alternatives Analysis, as agreed upon by the project sponsors.

This report summarizes the hydrologic study for the existing and future land-use conditions for the First Creek Tributaries Upstream of I-70 Master Drainageway Plan. Specific tasks required for the MDP include the following:

- Gather information on existing and proposed drainage features, existing and future land uses, soils, and topography for the study area.
- Conduct field work to verify gathered data and acquire any missing information.
- Complete existing and future land-use hydrologic models for the 2-, 5-, 10-, 50-, and 100-year events for the study area using CUHP 2005 Version 2.0.0 and EPA SWMM 5.1.012.
- Evaluate the hydraulic capacity of the existing drainage system.
- Develop and analyze alternative outfall systems sketch plans to address any drainage, stability or water quality problems.
- Prepare conceptual plans for the alternatives selected by the project sponsors.

1.3 Planning Process

First Creek upstream of I-70 has been studied several times and the master plans have been updated as the years have passed. However, the tributaries themselves have not been master planned to the same level as First Creek itself.
A kickoff meeting was held with the project sponsors and other stakeholders on June 13, 2018, to establish initial project priorities and discuss project status and areas of difficulty. A progress meeting was held on August 30, 2018, to discuss preliminary tributary delineations and land use values. A progress meeting was held on January 23, 2019, to review and discuss comments for the draft hydrology report and overall discussion for the alternatives phase. A progress meeting was held on June 20th, 2019, to discuss potential alternatives that would be considered by stakeholders. Minutes from these meetings can be found in Appendix A.

1.4 Mapping and Surveys

GIS basemaps, including the existing storm drainage infrastructure, roads, pavement, building footprints, land use descriptions, zoning, jurisdictional boundaries, horizontal and vertical controls were provided by the City of Aurora and Arapahoe County through online download. The District supplied topographic mapping in the form of a digital elevation model (DEM) and 1-foot contours based on 2013 LiDAR information. Aerial imaging (dated June 14, 2017 for Baseline Hydrology and October 30, 2019 for Alternatives Analysis) was acquired from ESRI Online database through ArcGIS applications. Soils mapping was acquired from the Natural Resources Conservation Service (NRCS) Web Soil Survey on July 26, 2018.

The mapping is on the Colorado State Plane, Central Coordinate System in U.S. feet. The vertical datum is North American Vertical Datum of 1988. No survey was done for the baseline hydrology or alternatives analysis.

1.5 Data Collection

Existing drainage studies, master plans, and construction documents were collected from project stakeholders. Digital geographic information systems (GIS) data was downloaded from the Open Data websites for UDFCD, City of Aurora, Arapahoe County, and the Natural Resources Conservation Service. The primary references used for this study are shown in Table 1-1 below. A complete list of references can be found in Section 4 – References.

Table 1-1 Data Collected

Title	Author	Date
Adonea Master Drainage Report	Nolte Associates, Inc	October 2003
Arapahoe County Comprehensive Plan 2018	Arapahoe County Planning Commission	May 2018
ArcGIS files: Basins, District Boundary	Urban Drainage and Flood Control District	July 31, 2018
ArcGIS files: Building Rooftops, City Limits, Driveways, Edge of Pavement, Parcels, Parks Open Space, Ponds, Sidewalks, Storm Fittings, Storm Inlets, Storm Mains, Storm Manholes, Zoning	City of Aurora	July 12, 2018 & August 9, 2018
ArcGIS files: County Boundary, Parks Open Space, Zoning, 2018_CompPlan	Arapahoe County	July 31, 2018 & September 24, 2018
ArcGIS files: Soils	Natural Resources Conservation Service	July 26, 2018
City of Aurora 2016 Zoning Map	City of Aurora Planning and Development Services	March 8, 2016
Drainage Basin Plan for Annexation Study Area: Phase I Development of Alternatives, Volume III Upper South Platte River Basin including First Creek	Simons & Li	1986
First Creek (Upstream of Buckley Road) Major Drainageway Plan - Conceptual Design Report	Moser & Associates	August 2010
First Creek and DFA 0055 Outfall Systems Masterplan Preliminary Design Report	Wright Water Engineers	1990
Master Drainage Report for Harmony	CVL Consultants of Colorado, Inc.	May 2016
Master Drainage Study The Traditions Framework Development Plan	CVL Consultants of Colorado, Inc.	December 11, 2003
Phase II Drainage Report for Sky Ranch II	CVL Consultants of Colorado, Inc.	September 8, 2006
Sky Ranch Filing 1 Phase 1 & 2 Road & Drainage Construction Plans	CVL Consultants of Colorado, Inc.	May 2018
Sky Ranch Filing 2 Phase I Drainage Report Draft	CVL Consultants of Colorado, Inc.	May 2019
Sky Ranch General Development Plan – Draft	PCS Group, Inc.	November 2018
Sky Ranch Neighborhood B Phase III Drainage Report (E 6th Ave. and Monaghan Rd.)	CVL Consultants of Colorado, Inc.	May 2018
Draft Sky Ranch Neighborhood B Floodplain Modification Study	CVL Consultants of Colorado, Inc.	2018
Topographic Contours and Digital Elevation Model (DEM)	Urban Drainage and Flood Control District	May 30, 2018

1.6 Acknowledgements

This report was prepared with the cooperation of the Urban Drainage and Flood Control District, the City of Aurora, Southeast Metro Stormwater Authority, and Arapahoe County. The representatives who were involved with this study are listed in the following table:

Table 1-2 Project Participants

Participant Name	Organization	Title
Teresa Patterson	UDFCD	Project Manager – Watershed Services
Jonathan Villines	UDFCD	Project Engineer
Janet Bender	City of Aurora	Principal Engineer
Sam Miller	City of Aurora	Engineer
George Slovensky	City of Aurora	Public Works Project Manager
Craig Perl	City of Aurora	Senior Engineer
Sarah Young	City of Aurora	Planning Services Manager
Jon Nelson	SEMSWA	Capital Improvements Project Manager
Stacey Thompson	SEMSWA	Floodplain Program Manager
Sue Liu	Arapahoe County	Public Works and Development
Jeanne Boyle, P.E., CFM	Merrick & Company	Project Manager
Jennifer Goldman, P.E.	Merrick & Company	Design Engineer
Rebecca Hutchinson, E.I.	Merrick & Company	Design Engineer
Clare Steninger, P.E.	Merrick & Company	Project Engineer

2.0 STUDY AREA

2.1 Project Area

The First Creek watershed consists of approximately 47.2 square miles and is largely comprised of agricultural and open space land uses with only about 33 percent of the area developed. First Creek is an east bank tributary of the South Platte River that generally flows northwest. Its headwaters are in Arapahoe County, south of Interstate Highway 70 (I-70) and east of Express Highway 470 (E-470).

The study area for this project is in the upper portion of the First Creek watershed upstream of I-70, within the City of Aurora and unincorporated Arapahoe County. The study area is approximately 7.4 square miles and consists of tributaries that are greater than 130 acres at the outfall to First Creek. The study area is roughly bounded by I-70 to the north, East Jewell Ave to the south, E-470 to the west, and South Watkins Road to the east as can be seen on the Watershed and Vicinity Map in Figure 2-1 on the next page and the Study Area Map in Figure B-1 in Appendix B. The historic surface drainage patterns have been influenced by farming and agricultural practices, residential and industrial developments, highways, embankments, and natural channels. I-70 and E-470 interrupt basin continuity, concentrate flow patterns and create, in some cases, inadvertent detention.

The tributaries that are the focus of this study flow generally northwesterly and southwesterly into First Creek at an average slope of approximately 1.4 percent. The highest estimated elevation in the study area is approximately 5,850 feet above mean sea level, located in the southeast corner of Subwatershed 1110 and the lowest point occurs in the northwest corner of the study area in Subwatershed 100 at elevation 5,511 feet.

2.2 Land Use

The study area for the tributaries is approximately 17 percent developed. The majority of the developed area is zoned for Medium Density Residential. The undeveloped areas are currently Agricultural and Open Space. Much of the undeveloped areas are slated for development based on future zoning and master plans in the area.

Land use categories were primarily determined using zoning and comprehensive plans from the currently available City of Aurora zoning GIS shapefiles and the 2018 Arapahoe County Comprehensive Plan. The City of Aurora's Zoning Map (2016) was the basis for the GIS shapefiles, but the shapefiles have been updated to include recently annexed areas and slight zoning updates. See Appendix B for the Zoning Maps for Aurora and Arapahoe County. This zoning data, in conjunction with Table 6-3 from the Urban Storm Drainage Criteria Manual (USDCM), was used to create compatible land use categories and corresponding percent imperviousness values. A summary table of land uses and percent imperviousness values is found in Table 2-1 below. Only the land uses for this study's area of interest were included.

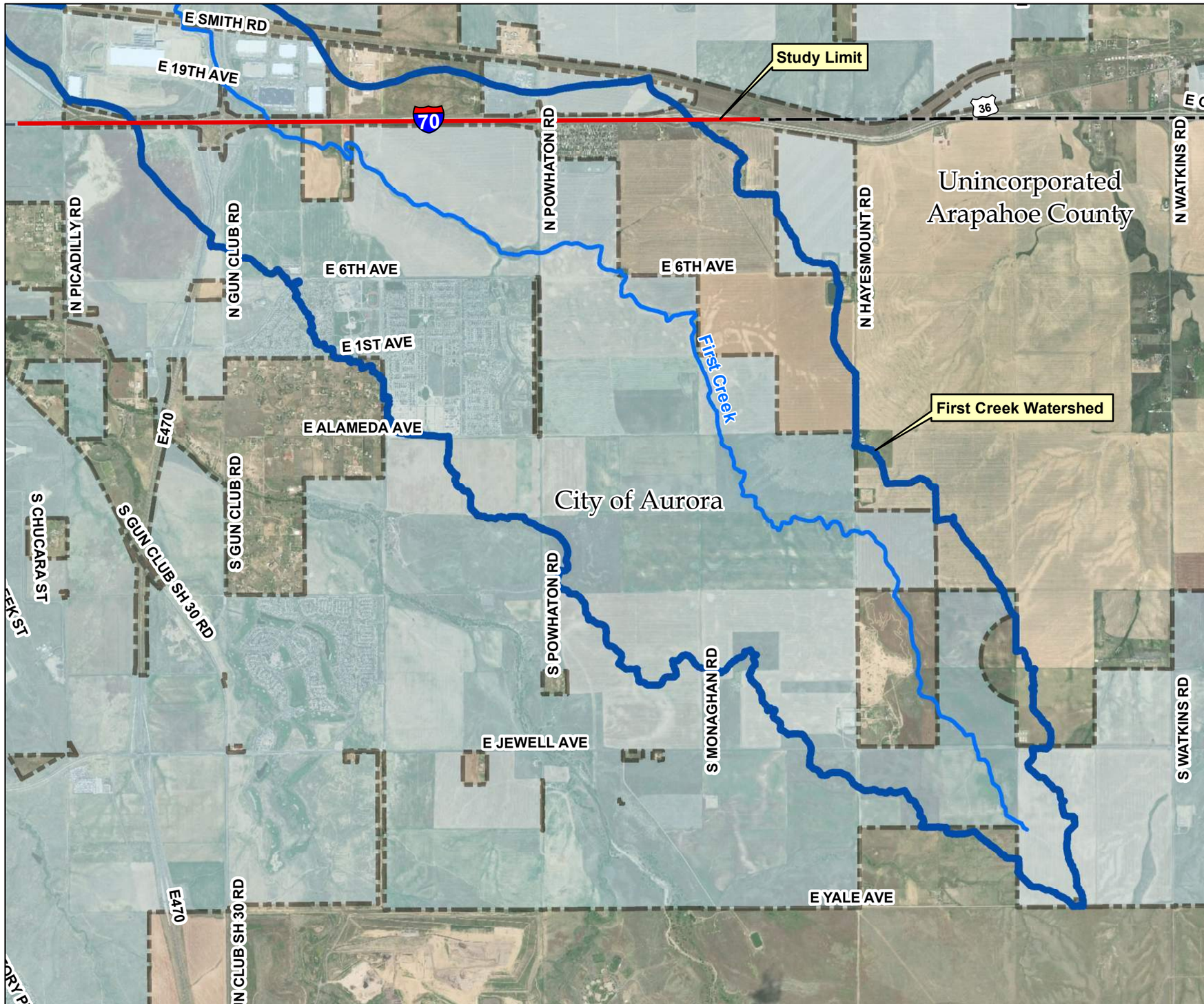
Table 2-1 Land Uses

UDFCD Code	Description	Percent Impervious	Aurora Zoning Code	Arapahoe County Zoning Code
AG	Agricultural	2	-	A-1
OS	Open Space	2	-	O
RR	Rural Residential (2.41+ acre lot size)	10	-	R-A
LDR	Low Density Residential (0.4 - 4 dwellings/acre)	30	-	-
GAS_UTILITY	Natural Gas Well/ Utility Site	50	-	-
MDR	Medium Density Residential (4 - 11 dwellings/acre)	50	E-470 rmed, nep-mres	R-M
SCHOOL	School/Recreation	55	-	-
HDR	High Density Residential (11+ dwellings/acre)	75	-	-
O	Office/Church	85	-	-
COM	Business/Commercial	95	E-470 rac, E-470 r&c, NEP-I70	B-5
MU	Mixed Use	95	-	MU
FR	Freeway	100	-	-

Existing land use was determined using aerial imaging and existing development drainage reports and assigning appropriate land use categories. The percent imperviousness was verified using existing GIS planimetric data that was acquired from City of Aurora's Open Data website on 7/12/2018 and from Arapahoe County's website on 7/31/2018. This data included polygons of building rooftops, sidewalks, driveways, parking areas, and pavement areas. This data was used to verify that the imperviousness assumed in master drainage plans and drainage reports were reasonable for existing development. Other areas not covered by planimetric or existing development were assigned land use categories based on the aerial imaging. Existing land uses are shown on the Existing Land Use Map within the Interactive Hydrology Map (Figure B-1) in Appendix B.

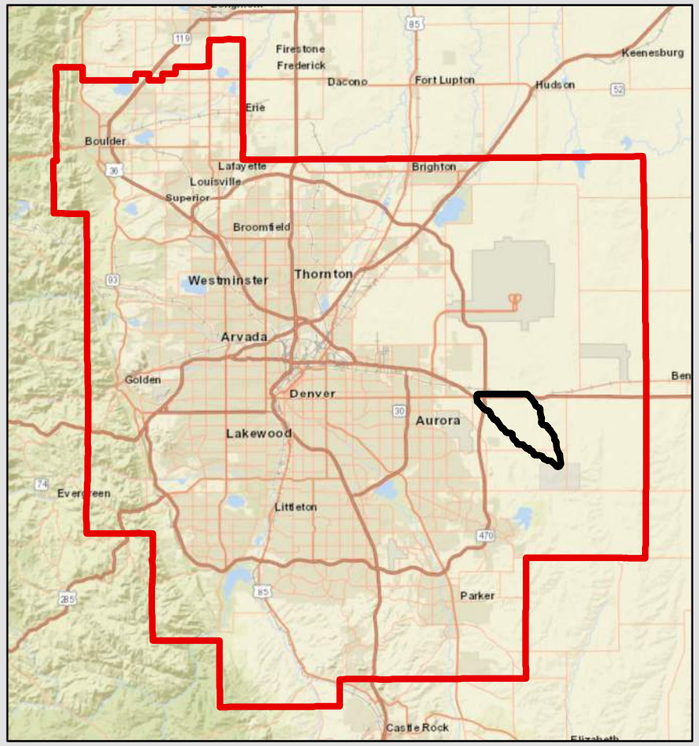
Future land use was primarily assigned based on the zoning and comprehensive plan codes as explained above. Shapefiles of zoning were acquired from City of Aurora's OpenData website on 7/12/2018 and from Arapahoe County's website on 7/31/2018. Where master development plans were available, the overall built-out imperviousness was utilized. Future land uses are shown on the Future Land Use Map within the Interactive Hydrology Map (Figure B-1) in Appendix B.

Additional information regarding subwatershed parameters is provided in detail in Section 3.0 of this report.



Legend

- First Creek
- First Creek Watershed
- City of Aurora
- Arapahoe County



VICINITY MAP

N
W E
S

1 inch = 3,500 feet

0 1,750 3,500

Feet

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FIRST CREEK TRIBUTARIES (UPSTREAM OF I-70)
MASTER DRAINAGEWAY PLAN

WATERSHED AND VICINTY MAP

FEBRUARY 2019

FIGURE
2-1

2.3 Reach Description

As a Major Drainageway Plan, the scope of this study is to focus on the major tributaries of First Creek within the study area. Eleven basins were identified within the study area that are tributary to First Creek with tributary area greater than 130 acres. Each tributary basin was further divided into subwatersheds based on natural and constructed hydraulic breaks or features. The Tributary Map within the Interactive Hydrology Map (Figure B-1) shows the 11 tributaries and 55 subwatersheds. Subwatersheds that flow directly to First Creek were not included as part of this study's scope.

The tributaries were originally identified and named in the *Drainage Basin Plan for Annexation Study Area: Phase I Development of Alternative, Volume III Upper South Platte River Basin including First Creek* (Simons & Li, 1986). Tributaries were named with a "T#" convention sequentially from I-70 moving upstream. These tributaries were also documented in the *First Creek and DFA 0055 Outfall Systems Masterplan Preliminary Design Report* (Wright Water Engineers, 1990). However, the project partners for this study decided that a more distinguishable naming convention was desired. Therefore, each tributary was assigned a name based on notable roadways that bisect or are near each tributary basin. In some cases, the naming convention refers to future roadways proposed in the area.

There are several existing culverts and storm sewer systems in the study area. The City of Aurora's storm GIS data (accessed on 7/12/18) and approved construction plans were used to determine the sizes, lengths, slopes, and materials of the existing culverts and storm sewers. These major structures were included in the hydrology model to simulate actual routed flow conditions, except for the newly constructed culvert at Monaghan Road. Table 2-2 summarizes the existing major road crossing structures inventory within the study area.

Table 2-2 Major Structure Inventory

Tributary	Street Name	Street Classification	Existing Structure	Condition
Harvest	Along Little River Street	Local	48-inch RCP System	Unknown
Harvest	Little River, 1st Avenue, Kellerman Street, Kewaunee Way, 6th Avenue	Local and Minor Arterial	60-inch RCP System	Unknown
Harvest	6th Avenue, E of Harvest Road	Minor Arterial	Twin 12x5-foot RCBC	Good
Harvest	Parallel to 6th Avenue, E of Harvest Road	Minor Arterial	42-inch RCP	Unknown
Harvest	6th Avenue, W of Harvest Road	Minor Arterial	42-inch RCP	Unknown
Harvest	6th Avenue, W of Harvest Road	Minor Arterial	30x19-inch HERCP	Unknown
Powhaton South	Powhaton Road	Major Arterial	Twin 10x6-foot RCBC	Unknown
Powhaton South	Future Alameda Avenue	Minor Arterial	Triple 54-inch RCP	Unknown
Powhaton South	Future 1st Avenue	Local	Twin 54-inch RCP	Unknown
Powhaton South	3rd Avenue	Local	Triple 14x8-foot RCBC	Unknown
Powhaton South	6th Avenue	Major Arterial	Triple 14x8-foot RCBC	Unknown
Monaghan	Monaghan Road	Major Arterial	6x4-foot RCBC	Newly Constructed
Monaghan	N/A	Sky Ranch Pond D Outlet	8x4-foot RCBC	Newly Constructed

The following narrative provides a description of the existing conditions for each tributary.

Gun Club Tributary (100 Series Subwatersheds)

The tributary furthest downstream is the Gun Club Tributary. The Gun Club Tributary consists of 155 contributing acres along the east side of Gun Club Road, just southeast of the E-470/I-70 interchange. This area was originally part of Tributary T2 (Simons & Li, 1986). In existing conditions, runoff from this area flows north through agricultural fields to a channel south of the Gun Club road embankment. The runoff in the channel flows east to the First Creek main channel. The outfall of this tributary is just upstream of the large First Creek culvert under I-70.

Gun Club Tributary Outfall at First Creek

Harvest Tributary (200 Series Subwatersheds)

The Harvest Tributary is confluence to the First Creek main channel north of 6th Avenue and slightly east of Harvest Road. The Harvest Tributary has a tributary area of 773 acres and generally flows north and west. This area was originally part of Tributary T4 (Simons & Li, 1986). The upstream end of the tributary path is located at Little River Street and 1st Avenue. Flow from upstream of Alameda Avenue and southwest portions the Adonea development combines in a 48-inch and 60-inch Reinforced Concrete Pipe (RCP) sewer system and continues north and west along 1st Avenue, Kellerman Street, Kewaunee Way, and 6th Avenue. This storm sewer system does not collect any additional flow from street inlets and it outfalls to the tributary on the north side of 6th Avenue just east of Harvest Road (Design Point 219).

Harvest Tributary Culvert Outfall at 6th Avenue

A stormwater detention facility at the southeast corner of 6th Avenue and Harvest Road (Design Point 240) detains runoff from the Traditions development before discharging north through double 12x5-foot Reinforced Concrete Box Culverts (RCBC) under 6th Avenue. However, since this pond is a local pond and not regional, it was not included in the hydrologic modeling. Runoff from the Traditions development combines with the tributary north of 6th Avenue (Design Point 219). This runoff and additional runoff from part of the Cross Creek development and Vista Peak School area combines and flows northwest in a natural channel to the confluence with First Creek. There are several existing local detention ponds in the Traditions development that were also not included in hydrologic modeling.

Powhaton South and Exposition Tributaries (300 Series Subwatersheds)

The Powhaton South Tributary has 1,402 contributing acres and is located along Powhaton Road south of First Creek. This area was originally part of Tributary T7 (Simons & Li, 1986). This tributary has two branches: a main alignment and an additional branch in the upper reaches called the Exposition Tributary.

The main tributary originates south of the future Mississippi Avenue east of Powhaton Road. In existing conditions, runoff flows northwest through agricultural land until it combines with runoff from the Exposition Tributary southeast of Powhaton Road and Alameda Avenue in the Harmony development area. The headwaters of the Exposition branch are east of Monaghan Road at about the future Mississippi Avenue. Runoff from this branch flows north and west to confluence with the main stem of the tributary (Design Point 345).

The Harmony development is proposed southeast of Powhaton Road and future Alameda Avenue. This development proposes naturalized channels with 100-year storm event capacity that convey runoff north on the east side of Powhaton Road instead of following existing topography to the west. Runoff then crosses under Powhaton via double 10x6-foot RCBC and enters the Adonea residential development. A 100-year storm event capacity channel continues north through the Adonea development and crosses under 3rd Avenue and 6th Avenue through triple 14x8-foot RCBC at each crossing. Runoff continues north to the confluence with First Creek.

Powhaton South Tributary at 6th Avenue

There are several existing local detention ponds in the Harmony and Adonea developments that were not included in hydrologic modeling as they are not regional.

Powhaton North Tributary (400 Series Subwatersheds)

The Powhaton North Tributary has 162 acres tributary to the outfall and is located east of Powhaton Road north of First Creek. This area was originally part of Tributary T6 (Simons & Li, 1986). Runoff from a mobile home development and agricultural fields generally flows to the southwest to a roadside ditch along the east side of Powhaton Road. Runoff continues south in this grass-lined ditch to a sump at a low point. Runoff ponds at the sump and eventually overflows to the south and outfalls to First Creek.

Powhaton North Tributary at Sump Location

Riverwood Tributary (500 Series Subwatersheds)

The Riverwood Tributary has 175 contributing acres and is located southwest of the I-70 and Airpark Road interchange. This area was originally part of Tributary T8 (Simons & Li, 1986). The tributary area is divided between the City of Aurora and unincorporated Arapahoe County. In existing conditions, runoff flows southwest across agricultural open space until it outfalls to First Creek.

Monaghan Tributary (600 Series Subwatersheds)

The Monaghan Tributary has 369 contributing acres and is bisected by Monaghan Road south of I-70. This area was originally part of Tributary T9 (Simons & Li, 1986). In existing conditions, the majority of the tributary area is agricultural land and runoff generally flows to the southwest. However, this area has been master planned in the *2018 Arapahoe County Comprehensive Plan* (Arapahoe County, 2018) to be mixed residential and commercial. A portion of the Sky Ranch development is currently being constructed in the lower portions of the tributary. A regional detention pond, Pond D, was newly constructed and has been included in this study's model (Pond 1). Runoff from this tributary flows to Pond D before being released through an 8x4-foot RCBC to First Creek.

Example of Terrain in Northeast Portion of Study Area

Titus Tributary (700 Series Subwatersheds)

The Titus Tributary has 222 contributing acres and is generally located south of First Creek, from Alameda Avenue to future 6th Avenue, east of Powhaton Road. This area was originally part of Tributary T10 (Simons & Li, 1986). In existing conditions, runoff flows north through agricultural land until it reaches the confluence with First Creek.

1st Avenue Tributary (800 Series Subwatersheds)

The 1st Avenue Tributary has 448 contributing acres and is approximately bounded east and west by Hayesmount Road and future Monaghan Road, respectively, and bounded north and south by future 6th Avenue and future Alameda Avenue, respectively. This tributary is named 1st Avenue because the main stem of the tributary is approximately parallel to 1st Avenue to the west. This area was originally part of Tributary T12 (Simons & Li, 1986). In existing conditions, runoff generally flows west through agricultural land until it reaches the confluence with First Creek. This area is included in the drainage planning for the Sky Ranch development in Arapahoe County.

Example of Terrain in Southeast Portion of Study Area

Hayesmount Tributary (900 Series Subwatersheds)

The Hayesmount Tributary has 587 contributing acres and is so named because the tributary area is adjacent to Hayesmount Road on the west. The tributary is south of First Creek and is generally bounded to the north and south by future Mississippi Avenue and East Jewell Avenue, respectively. This area was originally part of Tributary T13 (Simons & Li, 1986). In existing conditions, runoff from this tributary generally flows north through agricultural land until it reaches the confluence with First Creek.

Mississippi Tributary (1000 Series Subwatersheds)

The Mississippi Tributary has 217 contributing acres and is located east of First Creek and east of Hayesmount Road. Based on the City of Aurora Street grid plan, future Mississippi Avenue will cross the tributary area. This area was originally part of Tributary T14 (Simons & Li, 1986). In existing conditions, runoff from this tributary flows northwest through agricultural land until it reaches the confluence with First Creek.

Florida Tributary (1100 Series Subwatersheds)

The Florida Tributary has 253 contributing acres and is located east of First Creek and east of Hayesmount Road. Based on the City of Aurora Street grid plan, future Florida Avenue will cross the tributary area. This area was originally part of Tributary T15 (Simons & Li, 1986). In existing conditions, runoff from this tributary flows northwest through agricultural land. At East Jewell Avenue, flow overtops the roadway and continues northwest until it reaches the confluence with First Creek.

2.4 Flood History

The Flood Insurance Study (FIS) for Arapahoe County (FEMA, 2018) states that major flooding has occurred on the South Platte River and its tributaries since 1844. Periodic flooding occurs along First Creek and tributaries within the study area in the spring and summer when heavy thunderstorms follow either rapid snowmelt or prolonged rainy weather. A major regional flood event of September 2013 caused street flooding and threatened houses across the City of Aurora and within the District. Other recent floods in Aurora occurred on June 16, 1965 and May 6, 1973.

2.5 Environmental Assessment

Environmental assessments will be completed in future submittals of the report.

3.0 HYDROLOGIC ANALYSIS

3.1 Overview

This Baseline Hydrology study was conducted in accordance with the provisions of the *City of Aurora Standards and Specifications* and the *Urban Storm Drainage Criteria Manual (USDCM)* to generate existing and future peak flows for the First Creek Tributaries (Upstream of I-70) Major Drainageway Plan (MDP). The study area was limited to the tributaries to First Creek upstream of I-70 and does not include the main stem of First Creek. The study area is approximately 7.4 square miles and is located generally between East Jewell Avenue to the South, E-470 to the west, I-70 to the north, and Watkins Road to the east. The purpose of this study is to identify and address any potential drainage, stability, and water quality issues for the tributaries to First Creek upstream of I-70 and to provide a master plan for the tributaries which provides guidance for future land development activities and construction projects.

Hydrologic data was collected from UDFCD, City of Aurora, SEMSWA, and Arapahoe County and is discussed in more detail in the following sections. Once the hydrologic data was collected, the *Colorado Urban Hydrograph Procedure* (CUHP) 2005 Version 2.0.0 modeling software was used to generate subwatershed hydrographs for the 2-, 5-, 10-, 25-, 50-, 100-, and 500-year design storms for existing and future land uses. The Environmental Protection Agency's *Stormwater Management Model* (SWMM) 5.1.012 modeling software was used to combine and route individual subwatershed hydrographs through the storm drainage system.

3.2 Design Rainfall

This hydrology study modeled the two-hour storm events for the 2-, 5-, 10-, 25-, 50-, and 100-year return periods. The 500-year return period was analyzed for the hydrology study but will not be used for subsequent phases of this MDP and is only used as a reference.

One-hour rainfall depths for the specified return periods were determined from NOAA Atlas 14 and are included in Table 3-0 in Appendix B. CUHP was utilized to create a two-hour rainfall distribution from the one-hour rainfall depths.

3.3 Subwatershed Characteristics

Eleven major watersheds were identified within the study area that are tributary to First Creek and are greater than 130 acres. Each tributary watershed was further divided into subwatersheds based on natural and constructed hydraulic breaks or features, such as roadways or berms. Subwatershed characteristics used with CUHP were determined from reports and data from UDFCD, City of Aurora, and Arapahoe County. These characteristics are discussed further in the following sections. A summary of these characteristics can be found in Table B-1 in Appendix B.

3.3.1 Subwatershed Delineation

Subwatersheds were initially defined using automated techniques and the digital elevation model (DEM) provided by UDFCD. Adjustments to delineations were verified using 1-foot contours (2013 LIDAR), local drainage reports, master drainage plans, and field investigation. The study area was divided into 11 tributary watersheds and 56 subwatersheds. Subwatersheds were generally delineated so that the subwatershed area was approximately 130 acres and the average area was no more than 100 acres (per standard guidance from UDFCD). Twelve of the subwatersheds exceeded the 130-acre maximum size. In general, these subwatersheds are very uniform in character. More recent versions of CUHP and SWMM have been less sensitive to maximum subwatershed size, and these subwatersheds are very homogenous. Therefore, the slightly larger subwatersheds were not subdivided further. The subwatershed delineation parameters are summarized in Table 3-1 below. Tributaries and subwatersheds can be seen on the Tributaries Map within the Interactive Hydrology Map Figure B-1 in Appendix B.

Table 3-1 Subwatershed Delineation Summary

Watershed	Total Area	Average Subwatershed Area	Minimum Subwatershed Area	Maximum Subwatershed Area	Total No. of Subwatersheds
	(Sq. Mi.)	(Acre)	(Acre)	(Acre)	(Unit)
First Creek Tributaries	7.4	86.2	6.5	175	56

The average slope of the study area is 1.41 percent. The highest elevation of 5849.6 feet is at the upper end of First Creek in the Florida tributary in Subwatershed 1110 and the lowest elevation was in the Gun Club Tributary in Subwatershed 100 at 5511.1 feet.

3.3.2 Subwatershed Imperviousness

A GIS-based approach was used to determine the land-use and percent imperviousness within each subwatershed. The existing and future land use data described in Section 2.2 were used to create percent imperviousness values for each land use type. Table 2-1 describes the land use zoning categories and corresponding percent imperviousness and are shown on the Land Use Maps within the Interactive Hydrology Map (Figure B-1) in Appendix B.

GIS data representing existing and future land use were intersected with subwatershed polygons in ArcMap (version 10.0) to calculate the area-weighted or composite percent imperviousness value for each subwatershed. Composite imperviousness for each subwatershed, both existing and future land uses, are shown on the Subwatershed Map within the Interactive Hydrology Map (Figure B-1) and the CUHP Input Parameters (Table B-1) in Appendix B.

A historic condition was also considered in this hydrology model. The historic condition assumes all areas within the study area are open space or agricultural land uses with an imperviousness of 2 percent to approximate the condition of the study area prior to any development occurring. This condition was only analyzed for the 100-year storm event. The results are presented in Appendix B and provides a baseline for comparison to the existing and future conditions.

3.3.3 Soil Classification

The soil classification and hydrologic soil group of each subwatershed influences the Horton's infiltration parameters that are inputs for CUHP. The hydrologic soil groups were found from the Natural Resources Conservation Service Web Soil Survey (July 2018). The study area is primarily Type B and C soils, with some Type A in the Powhaton North and Hayesmount Tributaries, and Type D soils in the Monaghan and 1st Avenue Tributaries. The hydrologic soil groups are shown on the Soils Map within the Interactive Hydrology Map (Figure B-1) in Appendix B.

3.3.4 Infiltration and Depression Losses

The Horton's infiltration parameters were determined by weighted interpolation from Table 6-7 in the USDCM based on the percentage of each soil type within each subwatershed.

Depression losses are based on land cover. Referencing Table 6-6 in the USDCM, each subwatershed was given a pervious depression storage value of either 0.35 inches for subwatershed imperviousness values greater than 15%, or 0.4 inches for less than 15%.

3.4 Detention

In existing conditions, the majority of the study area is undeveloped, irrigated farmland, with some light industrial and residential developments. There are several existing development areas, including the Cross Creek, Vista Pointe School, Traditions and Adonea developments. Although local stormwater detention and water quality facilities have been constructed within these developments to reduce discharge to historic rates, they are not regional and therefore not considered in this hydrologic analysis. There are proposed developments, such as Harmony, Sand Creek Ranch, and Sky Ranch, that will be required to have local detention and water quality facilities, they will also not be included in this study.

Additionally, no inadvertent storage has been considered, such as that caused by road embankments or low depression areas. Inadvertent detention areas occur at several locations in existing conditions, but future development will likely eliminate these by regrading the area and/or adding culverts; therefore, inadvertent detention was not included in the models.

However, there is a newly constructed regional detention facility within the Sky Ranch subdivision (Pond D) that is considered existing and included in the models. The storage volume stage-storage curve and stage-discharge curve from the *Sky Ranch Neighborhood B Phase III Drainage Report (E 6th Ave. and Monaghan Rd.)* (CVL Consultants, 2018) was included in the hydrologic models for both existing and future conditions. The stage-storage curve and stage-discharge curve for Pond D (i.e. Pond 1 in models) can be found in Table B-3 in Appendix B. The pond location is near the downstream end of the Monaghan Tributary and can be seen on the SWMM Routing Map within the Interactive Hydrology Map (Figure B-1) and the SWMM Routing Schematic (Figure B-2) in Appendix B. There are additional future regional detention basins in the Sky Ranch development that will considered in the Alternatives Analysis section of this study.

3.5 Hydrograph Routing

EPA SWMM 5.1.012 was used to route the individual subwatershed hydrographs through the storm drainage system. The system is represented by subwatersheds, design points, conduits (open channels and pipes), and storage units. The SWMM Routing Map within the Interactive Hydrology Map (Figure B-1) shows the modeled elements graphically within the study area while the SWMM Routing Schematic (Figure B-2) shows the routing elements linearly. These figures illustrate how the system is connected and how runoff is routed. The kinematic wave routing method was used in the SWMM model.

The major routing inputs in the model include conduit geometry, length, slope, Manning's n roughness factor, junction inverts, and detention facility stage-storage and stage-discharge curves. Conduit geometry was defined from City of Aurora stormwater pipe data, master plan information, as-constructed plans, topographic information, and field investigation. Overflow links (diversions) were used to prevent loss of runoff due to flooding of culverts or pipe systems.

Typical Manning's n roughness values for conduits and gutters were increased by 25% as recommended in the USCDM. The resulting Manning's n values used in the model were: 0.016 for concrete pipes and gutters, 0.03 for corrugated metal pipes, 0.014 for high-density polyethylene pipes, and 0.015 for street flow, and 0.05 for natural channels. Example of SWMM parameters and results for the 100-year storm event for the existing and future conditions are shown in Figures B-4 and B-5, respectively, in Appendix B.

3.6 Previous Studies

The First Creek watershed has been studied several times for master planning purposes. The following is a summary of major studies in the First Creek watershed upstream of I-70:

- In 1986, Simons and Li completed an Annexation Drainage Basin Plan for the City of Aurora where the tributaries upstream of I-70 were initially named.
- In 1990, Wright Water Engineers updated the master plan for First Creek in an Outfall Systems Masterplan.
- In 2010, Moser and Associates studied the main stem of First Creek in *First Creek (Upstream of Buckley Road) Major Drainageway Plan Conceptual Design Report*. This MDP included master plans for the main channel of First Creek but did not include master planning for the tributaries.

While the previous studies analyzed First Creek, they did not provide specific improvement recommendations along the tributaries. Each of the previous studies has updated basin delineations and characteristics including land use for more refined subwatershed definitions. With each update, each study used the latest methodologies and software versions available.

3.7 Results of Analysis

The existing, future, and 100-year historic peak discharges and volumes at each design point for the 2-, 5-, 10-, 25-, 50-, 100- and 500-year storm events can be found in Table B-2 in Appendix B. Hydrographs for the 2-, 10-, and 100-year storm events at key design points can be found in Figure B-3 in Appendix B. Peak flow profiles along the length of each tributary for the 2-, 5-, 10-, 25-, 50-, 100-, and historic 100-year storm events are presented in Figure B-4 in Appendix B. The SWMM output results for both the existing and future 100-year conditions is provided in Figures B-5 and B-6, respectively, in Appendix B.

As expected, the future conditions peak flows are typically greater than the peak flows for existing conditions. This increase is primarily due to the increase in land development across the study area without accounting for future local detention or water quality. For the purposes of the baseline hydrology, overflow links were provided when the capacity of existing culverts and storm sewer systems were reached. Further analysis of the hydrology model will be completed as a part of the Alternatives Analysis.

Table 3-2 below compares the 100-year storm event flows between the 2010 Moser MDP and this study. One significant difference between the two studies is that the CUHP 2.0.0 for this study utilizes the NOAA Atlas 14 one-hour point rainfall depth that typically decreased from what was used in the previous studies. As expected, the runoff in this study decreased from previous studies in most cases. However, some anomalies did occur:

- Powhaton South and Titus Tributaries - The runoff from these tributaries increased from the previous study due to changes in future land use and imperviousness in the tributaries, thus increasing the flow.
- Powhaton South Tributary – additionally, adjustments to the subwatershed divides created a larger tributary area, increasing the flow from the previous study.
- Monaghan Tributary – The Moser (2010) MDP did not include detention in the hydrology analysis for this tributary. The addition of Pond D lowers the peak runoff to the outfall compared to the previous study.
- Mississippi and Florida Tributaries – Both of these tributaries plus other areas were included in the Moser DP 1650 outfall peak runoff. Adjustments to subwatershed divides made for the current study do not provide a direct peak runoff correlation for comparison.

Table 3-2 Peak Flow Comparison to Previous Master Plan

Tributary Outfall	Moser (2010)				Merrick (2019)			
	Location	Trib. Area (ac)	Ex. 100-yr Flow (cfs)	Fut. 100-yr Flow (cfs)	Location	Trib. Area (ac)	Ex. 100-yr Flow (cfs)	Fut. 100-yr Flow (cfs)
Gun Club	Basin 150	179	168	685	DP 100	155	169	431
Harvest	DP 7000	737	1,050	1,680	DP 200	773	969	1,383
Powhaton South	Link 7115 & Basin 710	1,248	783	1,602	DP 300	1,402	811	1,741
Powhaton North	Basin 153	198	203	570	DP 400	162	147	216
Riverwood	DP 7200	224	260	700	DP 500	175	150	374
Monaghan	Basin 160	365	384	1,120	DP 600	369	285	602
Titus	Link 7315 & Basin 730	224	159	210	DP 700	222	191	392
1st Avenue	DP 7400	403	540	1,390	DP 800	448	468	981
Hayes-mount	DP 7500	608	650	1,450	DP 900	587	474	873
Mississippi	N/A				DP 1000	217	227	291
Florida	N/A				DP 1100	253	218	261

* Note: DP= Design Point

4.0 HYDRAULICS ANALYSIS

4.1 Evaluation of Existing Facilities

Hydraulic analyses were performed to evaluate the capacity of existing drainage components including storm sewer systems, culverts, open channels, streets, and detention ponds. The capacities of each were assessed by the following methods:

1. Storm Sewer Systems and Culverts. Existing storm sewer characteristics were obtained from City of Aurora's GIS database and from as-constructed plans. The existing storm sewer system along the main Harvest Tributary was included in the baseline hydrology model for this tributary. Existing culverts along the main tributary alignments were included in the baseline hydrology models for all tributaries. Storm peak flows were compared to pipe capacities and assessed to determine if pipes have an adequate capacity or not for the 100-year future flows. The capacity of existing storm sewer systems and culverts were analyzed using SWMM routing methods and Bentley's FlowMaster. Storm sewers and culverts with a capacity less than the future condition 100-year storm event flow were marked for improvement. The results are shown in the Crossing Structure Capacities table (Table 4-1).
2. Open Channels and Streets. The majority of the study area is undeveloped and flow paths are typically comprised of natural open channels or open channels that have been modified by agricultural practices. However, there are several engineered open channels in the Adonea, Harmony, and Sky Ranch developments. All open channel capacities were analyzed using HEC-RAS methods to determine if they contained the future condition 100-year storm event based on peak flows derived from the hydrology models. Those that did not meet the study criteria were identified for improvements.

   Additionally, street cross sections along the Harvest Tributary through the Traditions development were modeled in HEC-RAS with the flows that exceed the existing 48- and 60-inch storm sewer system. Street capacities were further evaluated using street cross sections from *Construction Plans for Traditions – Filing No. 2* by CVL Consultants (September 2004). Cross sections from the plans were input to Bentley FlowMaster to determine the actual capacity of the streets along the Harvest Tributary.
3. Detention Ponds. One existing detention pond (Pond D from Sky Ranch development) was included in the baseline hydrology model. The resulting pond depth, volume, and release rates from the Monaghan Tributary SWMM model was compared to the design for Pond D from the *Sky Ranch Neighborhood B Phase III Drainage Report* by CVL Consultants (May 2018) to verify that the pond was functioning as designed.

Table 4-1 Crossing Structure Capacities

Tributary	Location	Crossing Type	Structure Description	Type/ Size of Structure	Estimated Capacity (cfs)	100-year Future Flow to Upstream Design Point	Level of Service (Future Flows)
Harvest	Alameda Ave., Little River St.	Roadway	Storm Sewer	48-inch RCP	94.4	185	< 25-yr
Harvest	Little River St., 1st Ave., Kellerman St., Kewaunee Wy., 6th Ave.	Roadway	Storm Sewer	60-inch RCP	183.1	358	< 25-yr
Harvest	6th Ave. – east of Harvest Rd.	Roadway	Storm Sewer	Double 12x5-foot RCBC	536.9	4	> 100-yr
Harvest	Parallel to 6th Ave. – east of Harvest Rd.	Roadway	Culvert/ Outlet	42-inch RCP	133.1	53	> 100-yr
Harvest	6th Ave. – west of Harvest Rd.	Roadway	Culvert	42-inch RCP	106.5	143	< 100-yr
Harvest	6th Ave. – west of Harvest Rd.	Roadway	Culvert	30x19-inch HERCP	14.6	206	< 2-yr
Powhaton South	Powhaton Rd.	Roadway	Culvert	Double 10x6-foot RCBC	1,198.3	1,327	< 100-yr
Powhaton South	Future Alameda Ave.	Roadway	Culvert	Triple 54-inch RCP	339.3	282	> 100-yr
Powhaton South	Future 1st Ave.	Roadway	Culvert	Double 54-inch RCP	337.7	413	< 100-yr
Powhaton South	3rd Ave.	Roadway	Culvert	Triple 14x8-foot RCBC	3,418.6	1,620	> 100-yr
Powhaton South	6th Ave.	Roadway	Culvert	Triple 14x8-foot RCBC	3,457.3	1,732	> 100-yr
Monaghan	Sky Ranch Pond D	Earthen Embank-ment	Outlet	8x4-foot RCBC	351	584	> 100-yr

4.2 Flood Hazards

Floodplain limits based on existing topography and conditions were created using one-dimensional (1D) hydraulic models in GeoHEC-RAS which uses HEC-RAS (version 5.0.7) as the analysis engine. Table 4-2 below provides a summary of the HEC-RAS geometric input by tributary.

Table 4-2 Summary of HEC-RAS Geometric Input

Tributary	Reach Length (ft)	Manning's N		No. of Cross Sections	Average Spacing (ft)	No. of Culverts	No. of Drop Structures	Average Slope (ft/ft)
		Overbank	Channel					
Gun Club	253	0.032	0.032	3	127	-	-	0.024
Harvest	10,165	0.032	0.020	32	327	-	-	0.009
Powhaton South	24,279	0.045	0.032	85	289	4	12	0.008
Powhaton North	3,268	0.032	0.032	14	251	-	-	0.009
Riverwood	1,482	0.032	0.032	6	296	-	-	0.012
Monaghan	3,866	0.032	0.032	13	322	-	-	0.015
Titus	4,489	0.032	0.032	17	280	-	-	0.010
1st Avenue	4,363	0.032	0.032	17	272	-	-	0.011
Hayesmount	6,629	0.032	0.032	23	301	-	-	0.013
Mississippi	2,233	0.032	0.032	9	279	-	-	0.014
Florida	3,582	0.032	0.032	12	325	-	-	0.016

Cross section geometry was defined using 1-foot contours based on 2013 LiDAR information provided by the District. Cross sections are cut approximately every 300 feet along the defined channel flow paths, as well as upstream and downstream of culverts and at the toe and crest of each drop structure. Bank stations are placed at apparent top of banks where changes in topography occur across the cross section. Peak flow data from the hydrology analysis of this study was used for the hydraulic modeling, and downstream boundary conditions were set using normal depth calculations.

Drop structures and culverts modeled in HEC-RAS for the Powhaton South Tributary are defined in the model using *Adonea – Filing No. 1, Channel STA 0+00.00 – 10+50.00 Storm Plan and Profile* by Nolte Associates (2004) and *Harmony Subdivision Filing 1, Drainage Channel A Plan & Profile (Private)* by CVL Consultants of Colorado, Inc. (2017). A culvert currently under construction crossing future E Alameda Avenue is included in the HEC-RAS model per the plans specified by CVL Consultants.

Aerial imaging was used to define roughness coefficients for all the reaches. The project site generally consists of native grasses with undefined channel and overbank areas. Per USDCM criteria, a Manning's n-value of 0.032 was used for both channel and overbank in nine of the eleven reaches. For the portion of Harvest Tributary where street flow was modeled, a roughness value of 0.02 was used to represent street asphalt. This is a conservative value for asphalt and was used since the flow in this reach is shallow, so roughness has a greater effect on conveyance. A roughness value of 0.045 was used for the overbank areas downstream of the culvert crossing at future E. Alameda Avenue in Powhaton South Tributary due to thicker vegetation in the overbank area. Several iterations of n-value sensitivity were modeled, and it was determined that the HEC-RAS modeling is not significantly sensitive to changes in n-values between 0.032 and 0.045. A roughness value of 0.013 was used for concrete culverts in the HEC-RAS models. A summary of Manning's roughness values used for each tributary is listed in Table 4-2 above.

The floodplain limits for the existing and future condition peak flows that are the results of the HEC-RAS modeling are shown on the 100-year Floodplain Layers in the Interactive Alternatives Map (Figures D-1 to D-11) in Appendix D. HEC-RAS cross sections showing the 100-year existing and future conditions water surface elevations are presented in Figure C-1 in Appendix C.

4.3 Hydraulic Modeling Results

Culverts that have been identified as undersized for conveyance of 100-year future condition flows are identified on the Problem Areas Layer in the Interactive Alternatives Maps in Appendix D. Additionally, floodplains with excessive width or that would be at risk of being uncontained in the natural channel are identified on the Problem Areas Layer. Problem Areas are identified in five of the eleven tributaries. The remaining six tributaries have contained 100-year future condition floodplains based on existing condition channel geometry. The problem areas determination is based on existing topography where a rise in the 100-year water surface would result in excess ponding or escaping flow.

There are problem areas within the Harvest Tributary due to the inadequate capacity of the existing 42- and 60-inch RCP storm sewer system that runs from Little River Street, through 1st Avenue, N. Kellerman Street, 2nd Place/3rd Avenue, N. Kewaunee Way, and 6th Avenue and daylights on the north side of 6th Avenue to an open channel. These storm sewers were designed with the assumption of detention upstream, specifically at Eastern Hills south of Alameda Avenue and at Adonea Filing 2 West Pond. For the baseline hydrology, these ponds were not considered since they are not regional facilities. Therefore, the 42- and 60-inch storm sewer system does not have the capacity to convey developed conditions without detention upstream. The capacity of the 60-inch RCP is 183 cfs, leaving the future condition peak flow of 175 cfs to flow in the street corridors. Using the street sections from *Construction Plans for Traditions – Filing No. 2* by CVL Consultants (September 2004), the street capacities have been calculated using Bentley FlowMaster, and are listed in Table 4-3 below. Along 1st Avenue between Little River Street and Kellerman Street, the actual grading conditions indicate that the depth available is less than the Aurora criteria of 12" above the gutter flow line. For this street, the most limiting depth to back of walk was used. The available depths used are indicated in Table 4-3. Since a couple of the street capacities are less than the future condition peak flow (175 cfs), approximately 46 properties in the Harvest Tributary are within the 100-year future condition floodplain, as seen on the 100-year Floodplain Layer in Figure D-2.

Table 4-3 Harvest Tributary Street Capacities

Street Name and Type	Street Capacity [cfs]	Available Depth (in)
6th Avenue – Six Lane Arterial	141	12
N. Kewaunee Way – Local Street Type I	179	12
2nd Place/3rd Avenue – Local Street Type I	179	12
N. Kellerman Street – Local Street Type I	179	12
1st Avenue – Two Lane Collector	68	9.4

There are problem areas within the Powhaton South Tributary due to undersized culverts and floodplain risk for uncontained flow in the upstream portion of the tributary. The existing double 10 x 6-foot RCBC culvert that crosses northwest under Powhaton Road and the future 1st Avenue intersection has a full flow capacity of 1,198 cfs. The 100-year future condition peak flow in this location is 1,327 cfs without considering non-regional detention, therefore the culvert is considered undersized for this study. Even though this culvert is undersized for future flow conditions, the results of the HEC-RAS modeling do not show excessive ponding behind the crossing. Per the *Master Drainage Report for Harmony* by CVL Consultants (May 2016), the culvert that is currently under construction that runs northwest under future Alameda Avenue is a 10 x 6-foot RCBC with a full flow capacity of 553 cfs. The design of this culvert assumed detention upstream which was not included in the regional hydrology for this study. Therefore, this culvert will be undersized compared to the 100-year future condition peak flow at this location (1,278 cfs). Based on the HEC-RAS modeling results, excessive ponding would occur upstream of this undersized culvert which could create a wide floodplain upstream of the crossing that could affect the proposed Harmony development adjacent to the floodplain.

The Powhaton North, Titus, and Hayesmount Tributaries have problem areas due to risk of escaping flow in the 100-year future condition storm event. Along these three tributaries, the existing topography does not contain the floodplain to the natural channel flow path. The Powhaton North Tributary future condition floodplain spreads across two access roads to the Foxridge Farm mobile home park and is directly adjacent to Powhaton Road. The Titus Tributary floodplain is uncontained in the upstream portion of the tributary where it could affect future development plans. The Hayesmount

Tributary future condition floodplain is wide at the upstream end of the tributary due to ponding behind existing ridges. Additionally, the future condition floodplain has risk of escaping flow which could affect future development plans.

Tributaries that are currently undeveloped have average longitudinal slopes between 0.9 to 2.4 percent. These slopes are relatively steep and could promote erosion and head-cutting in the channel bottom and undermining of bank slopes with additional flow. Additionally, no stormwater quality improvements exist within many of the tributaries. Developing within these watersheds without stormwater quality treatment before releasing to First Creek has the potential to disrupt downstream ecosystems.

4.4 Previous Analyses

There are three previous studies for the reach of First Creek located upstream of I-70 which are listed in Section 3.6. The floodplains for the tributaries were not delineated as part of these studies, and only the main stem has previously been hydraulically analyzed. This is the first study to map the floodplains for the tributaries to First Creek located upstream of I-70.

5.0 ALTERNATIVE ANALYSIS

5.1 Alternative Development Process

The purpose of the alternatives section is to address flooding and capacity issues, stream health and erosion potential problems, and provide a holistic solution to flooding and drainage problems along the tributaries.

After hydrologic and preliminary hydraulic analyses were completed, a meeting was held on June 20th, 2019, to discuss potential alternatives that would be considered. Input was provided by the project sponsors about the feasibility and constructability of the potential alternatives. Alternative categories include naturalized channels per UDFCD criteria, regional detention and water quality, both for new ponds and formalization of existing ponds as regional, and capacity upgrades including upsizing existing storm sewers and channels.

5.2 Criteria and Constraints

The design and evaluation of the alternatives are based on criteria from the UDFCD *Urban Storm Drainage Criteria Manual* (USDCM), City of Aurora's *Storm Drainage Design and Technical Criteria*, and the *SEMSWA Stormwater Management Manual*. The following are the general criteria and assumptions for the alternative design:

- The major design storm is the 100-year storm event for fully-developed (future) conditions.
- Culverts and Storm Sewer Systems:
  - A headwater to culvert diameter ratio of 1.5 or less for the future 100-year storm event was assumed.
  - Storm sewer laterals are not examined. Main storm sewer mains along the tributary path, generally greater than 36-inches in diameter, were analyzed
- Channels:
  - USDCM Natural Stream Management Corridor is proposed for all new channels throughout the study area. This includes a meandering bankfull channel, a floodplain terrace, and overbanks to contain runoff from the 100-year future condition storm event.
  - The maximum shear stress in the floodplain terrace is 1.2 pounds per square foot.
  - The minimum bankfull channel geometry was designed per Table 8-2 of the USDCM.
  - The longitudinal slope of 0.2% was set for bankfull channels.
  - Historic drainage patterns were followed, including existing slopes for the corridor overbanks.
  - The design assumed native grasses and a roughness value of 0.032 across the entire cross-section.
  - The maximum allowable depth in the 100-year storm event is 5 feet.
  - A minimum of 2-foot of freeboard was assumed to determine corridor top width.
  - A 12-foot maintenance access trail is included in the corridor.
  - A typical section of a natural stream management corridor design is presented in Figure D-12 in Appendix D.
- Detention:
  - All new regional detention ponds with tributary area less than 1 square mile were sized to be full-spectrum detention and include water quality capture volume (WQCV) and Excess Urban Runoff Volume (EURV). Ponds with tributary area greater than or equal to 1 square mile were designed as flood control ponds only, and water quality must be provided offline.
  - Regional detention ponds must have a tributary area of at least 130 acres to be eligible for maintenance assistance, unless otherwise approved by the governing agencies.
  - A WQCV release time of 40-hours or more was assumed.
  - Release of at least 97% of all runoff for rainfall events less than or equal to a 5-year storm within 72 hours after the end of the event.
  - Release at least 99% of all runoff within 120 hours after the end of events greater than a 5-year storm.
  - Maximum 100-year release rates are the historic flow rates.
  - All proposed ponds and outlet structures were sized and designed based on a combination of UD-Detention v3.07 for WQCV and EURV sizing and SWMM routing for 100-year detention sizing.

Additional constraints include master plans for the proposed Sky Ranch and Harmony developments, as well as existing developments such as Traditions and Adonea.

5.3 Alternative Categories

The purpose of the alternatives analysis is to contain or reduce flood hazards for the 100-year storm event. In addition, this master drainage plan study provides opportunities to preserve and enhance existing natural stream corridors and provide regional detention as guidance for future development. Each tributary was evaluated to determine which alternative category(s) would be considered. The categories of improvements for the study are:

- Natural Channel/Stream Management Corridor – Where applicable, natural channel design is preferred by the project sponsors instead of engineered or structural improvements. The natural channel design consists of high functioning, low maintenance streams and incorporate geomorphic principles that mimic natural channel processes. The geometry includes a bankfull channel, wide floodplain terraces, and overbanks to contain the 100-year storm event. The overall channel geometry develops a "stream management corridor" (SMC) that reduces the potential for channel erosion. Preserving a SMC will allow the stream to be a self-maintaining system and adapt naturally without significant risk to infrastructure. In addition, SMC's provide passive water quality treatment that improves stream health. The SMC provides a geographic boundary as guidance for incorporating the tributaries into future developments. For this study, the limits of the corridor are defined as the top width of the proposed channel including 2-foot of freeboard above the 100-year water surface level plus a 12-feet wide maintenance trail.
- Detention – Analyze locations and sizing for proposed regional detention ponds within the watershed, including reducing the 100-year peak release rates to historic rates. Regional detention ponds with tributary area of less than 1 square mile will also provide water quality storage to help maintain stream health.
- Conveyance – To reduce flooding concerns, improvements are proposed to increase capacity for undersized culverts and storm sewer systems to the 100-year design storm flows.
- Conveyance with Detention – Analyze the effects of existing or proposed non-regional detention ponds on undersized culverts or storm sewer systems.
- No Improvements Recommended – System has future 100-year capacity.

Alternative development considered multiple categories of improvements for each tributary. The Pre-Screening Matrix (Table 5-1) provides a list of incorporated categories in each tributary area. The Harvest Tributary alternatives include the comparison of upsizing existing storm sewer infrastructure versus formalizing non-regional ponds for detention. While a "No Improvements" option is available, it was not utilized for any alternative due to the potential for erosion of the existing channel with proposed development, especially where steep slopes exist.

Table 5-1 Alternative Pre-Screening Matrix

Tributary	Natural Stream Management Corridor	Detention	Conveyance	Conveyance with Detention	No Improvements
Gun Club	X	X			
Harvest	X	X	X	X	
Powhaton South	X	X			
Powhaton North	X	X			
Riverwood	X	X			
Monaghan	X	X		X	
Titus	X	X			
1st Avenue	X	X		X	
Hayesmount	X	X			
Mississippi	X	X			
Florida	X	X			

5.4 Alternative Hydrology and Hydraulics

Based on the preliminary drainage plan for Sky Ranch Filing 2, there are a few areas that were not previously included in the baseline hydrology tributary area for the Monaghan and 1st Avenue Tributaries that are now planned to be routed to these tributaries. Several subwatersheds (620, 802, and 812) were added or altered for the alternatives hydrology to better represent the proposed Sky Ranch Filing 2 conditions. In addition, several subwatersheds (805, 810, and 375) were subdivided to represent proposed drainage barriers at roadways, including future F Street and Exposition Avenue. These changes in subwatershed delineation are reflected on Figure D-0 in Appendix D.

The natural channel designs were developed using a floodplain corridor approximation spreadsheet provided by UDFCD and further designed in detail using an extensive spreadsheet developed to meet each of the natural channel design criteria depicted in Chapter 8 of the USDCM. Bankfull channel slopes were set to a slope of 0.2% and floodplain terrace slopes were set to approximately the existing channel slopes. Refer to Section 5.2 for additional design parameters for channel design. No grade control structures were included in the design. Engineers designing the actual channel improvements at the time of development will need to provide additional geomorphic analysis to provide the geometry that will support a high functioning, low maintenance stream. The natural channel designs have been tested in SWMM to ensure the 100-year storm event is contained with adequate freeboard. Determining the flows used for the channel designs was an iterative process which resulted from incorporating the natural channel sections in the SWMM modeling and reassessing the peak flows at designated design points. In Appendix D, Figure D-12 presents a typical section of the natural channel corridor and Table D-1 shows the natural channel design and specific design flows for each reach.

Since the channels in Sky Ranch Filing 1 are currently under construction, the channel geometries for Reaches 602 and 605 in the Monaghan Tributary were obtained from *Sky Ranch Filing 1 Phase 1 & 2 Road & Drainage Construction Plans* (May 2018), Sections G-G and F-F, respectively.

Storm sewer capacities for the Harvest Tributary alternatives were determined using Bentley FlowMaster. The existing slope of the storm sewers and a roughness coefficient of 0.016 (to match SWMM roughness values) were used to calculate the capacity of various proposed RCP pipe sizes.

Detention required for each of the tributaries was initially determined using UD-Detention v3.07. The stage-storage and stage-discharge curves were then tested using the SWMM model and adjusted until a result of the historic discharge rate was achieved in the SWMM model.

The proposed stage-storage-discharge curve from the draft *Sky Ranch Filing 2 Phase I Drainage Report* (CVL, 2019) was used for proposed Pond C in the Monaghan Tributary. See Appendix D for locations of Sky Ranch Ponds. In the 1st Avenue Tributary, proposed Ponds H and J from the draft Filing 2 report do not individually meet the criteria for regional detention eligibility (i.e., tributary area is less than 130 acres). For this MDP, a representative pond at the approximate location of Pond H was sized for all proposed Sky Ranch development area east of proposed F Street on the 1st Avenue Tributary. An additional representative pond was sized for the remaining Sky Ranch development area west of proposed F Street that is proposed to be routed to the 1st Avenue Tributary. The stage-storage-discharge curves for each of the proposed alternative ponds (Ponds 800 and 812) are found in Table D-2 in Appendix D.

All regional detention ponds proposed in this study should be considered as representative and future development plans may reasonably subdivide the ponds and tributary areas within the watersheds as long as the tributary flow to the main stem of First Creek as determined by this study is not exceeded. If ponds are subdivided, corresponding adjustments of stream management corridor design flows must also be made. Note that regional detention ponds with less than 130 acres of tributary area may not be eligible for maintenance assistance. Subdivision of detention ponds and maintenance assistance will need to be approved by the governing agencies through the land development process.

5.5 Alternative Costs

The costs for each alternative were estimated using the UD-MP Cost Version 2.2 spreadsheet. Unit costs per the UD-MP Cost spreadsheet are based on unit cost data from 2012. This study used a Construction Cost Index (CCI) of 1.2778 to update unit costs to reflect 2019 Quarter 1 prices. See Table D-3 in Appendix D for a list of UD-MP unit costs. Unit costs for special/user-defined items that were not embedded in the UD-MP spreadsheet are shown in Table 5-2. The following were also included as a percentage of the subtotal capital improvement costs: dewatering (5%), mobilization (5%), traffic control (2%), utility coordination (5%), and stormwater management (5%). Additional costs were included as a percentage of the total construction costs at the following percentages: contingencies (25%), engineering (15%), legal and administration (5%), and construction management (10%). See Appendix D for detailed alternatives cost estimates.

Table 5-2 Unit Costs for Special Items

User Defined Special Item	Unit	Unit Cost
Regional Detention Outlet Works (WQCV, EURV and 100-year appurtenances for ponds with tributary area less than 1 sq. mi., 100-year only control for tributary area greater than 1 sq. mi.)	EA	$25,000
Stream Management Corridor*	LF	$214.70-$595.70
12-feet Wide Gravel Maintenance Trail	LF	$16.80
Junction Box for Flow Split in Storm Sewer Systems	EA	$25,000

* Relative to top width at 2-feet of freeboard

Per discussion with project sponsors, it was assumed no right-of-way or easement costs would be needed for the proposed alternatives with the exception of converting private detention to public regional detention in the Harvest Tributary Alternative 1B.

Regional detention facilities were costed as complete-in-place with a unit cost of $58,268 per acre-foot. Additional costs for outlet works for ponds with tributary area less than 1 square mile include WQCV, EURV, and 100-year appurtenances were added separately at a unit cost of $25,000 per pond. For detention facilities with greater than 1 square mile that are flood control only, a cost for 100-year appurtenances were added at a unit cost of $25,000 per pond.

Stream Management Corridor unit costs are per linear foot of the 100-year floodplain corridor. The unit cost is based on converting high-range excavation costs ($40/CY) and the corridor's cross-sectional area to a cost per linear foot of channel per foot of top width. The average of $4.38/LF/ft of top width resulted in a unit cost ranging between $214.70-$595.70/LF relative to the top width of the channel (at two feet of freeboard). Each corridor width presented on the plans includes an additional 12 feet for a gravel maintenance trail along the entire length of the tributary. However, the cost for the maintenance trail is accounted for separately from the stream management corridor costs. The maintenance trail unit cost ($16.80/LF) is prorated based on the unit costs for a 10-feet wide crusher fines trail ($14/LF) from the UD-MP spreadsheet. Native seeding costs were based on the area of impact of the proposed corridors and the proposed detention ponds. This is a separate line item from the capital costs for stream management corridors and ponds.

Operation and Maintenance (O&M) costs were based on the assumptions that storm sewers, manholes, and channels would be maintained every 5 years, detention and water quality ponds maintained every 10 years, and vegetation management of detention and channel grasses would be performed every year.

Detailed cost breakdowns for each tributary alternative are presented in Table D-4 in Appendix D.

5.6 Alternative Plans

Only one alternative was analyzed for each tributary, except the Harvest Tributary. After discussions with sponsors it was decided that since the study area is mainly undeveloped, one alternative per tributary meets the level of detail expected. Each alternative described below contains the 100-year future condition floodplain within a designated stream management corridor and includes a regional detention pond near the outfall of each tributary to release runoff to the First Creek main stem at approximately the historic rates. Additional regional detention ponds are included for larger tributaries. The proposed improvements for each tributary reduce the risk of flooding for existing structures and provides guidance for future development drainage improvements. Alternatives for each tributary are shown on the Alternatives Layer in the Interactive Alternatives Map (Figures D-1 to D-11) in Appendix D.

For all alternatives, stream management corridors are located along natural stream flow patterns since it is important to maintain the natural stream networks. For several of the tributaries, the hydraulic modeling identified reaches where the 100-year future condition flows are not contained within the existing natural channels. The proposed channel improvements will reshape the natural channels as needed to contain the 100-year design flows within the stream management corridors.

Existing wetlands are located mainly along the tributary alignments, with a few wetland areas located where water ponds in sumps at low points in the topography. The proposed alternatives do not appear to negatively impact wetland areas. No existing recreation is impacted by the proposed alternatives.

Gun Club Tributary (Figure D-1)

Gun Club Tributary is located adjacent to Gun Club Road (and E470) and outfalls to First Creek just before the waterway crosses underneath I-70. The watershed area for Gun Club Tributary is generally undeveloped and future land use in this area will increase imperviousness and pose a potential for erosion along existing drainage patterns. The proposed alternative for this tributary is to reshape the channel to provide a healthy stream management corridor and contain the 100-year storm event downstream of a regional detention pond. The Alternative Layer on Figure D-1 shows the proposed alternative with the following specifications:

Stream Management Corridor - Reach 100	61-foot width
100-year Detention Pond Volume	23.4 acre-feet
100-year Maximum Inflow to Pond	431 cfs
100-year Release Rate to First Creek	134 cfs

The total capital improvement cost for the proposed alternative for Gun Club Tributary is $2,758,756 with an annual operation and maintenance cost for the detention pond and channel of $2,408. See Table 5-3 for a summary of alternative cost estimates and Table D-4 for detailed cost calculations.

Harvest Tributary (Figure D-2)

The Harvest Tributary is partially developed with the Traditions and Adonea developments in the upstream portions of the watershed. The existing storm sewer system along Little River Street, Kellerman Street, Kewaunee Way and 6th Avenue is undersized for the 100-year future condition storm event. Several alternatives are proposed to solve the undersized infrastructure issues within the development, including:

1A. Formalize Eastern Hills Pond E1, south of Alameda Avenue, as a regional detention pond
1B. Formalize both Eastern Hills Pond E1 and Adonea Filing 2 West Pond as regional detention ponds
2. Install additional storm sewer pipes to convey the remaining 100-year storm event

The Traditions master drainage plan proposed Eastern Hills Pond E1 to reduce offsite runoff from south of E. Alameda Ave to the historic flow rate (91 cfs). Proposed Eastern Hills Pond E1 is located south of Alameda Avenue and east of Little River Street. Alternative 1A involves formalizing the proposed Eastern Hills Pond E1 as a regional detention pond once constructed, even though the tributary area is less than 130 acres. The pond would detain the 100-year storm event from Subwatershed 250 (8.2 acre-feet) and would release 91 cfs to the existing 48-inch RCP storm sewer. This release rate was the flow assumed by the Traditions development for accepting offsite runoff and to size the storm sewer system for the development. Inclusion of Eastern Hills Pond E1 decreases the flow at Design Point 245 (Little River Street and 1st Avenue) to 198 cfs. Since the storm sewer capacity at this point is 183 cfs, approximately 15 cfs would overflow into the street. The limiting street capacity is 68 cfs, therefore the overflow would be contained within the street right-of-way and be routed to 6th Avenue. Downstream of 6th Avenue, stream management corridors and a regional detention pond (68.3 acre-feet) near the tributary outfall are proposed for this alternative.

The Harvest 1A Alternative Layer on Figure D-2 shows the proposed Alternative 1A improvements. The total capital improvements cost for Alternative 1A for Harvest Tributary is $13,631,951 with an annual operation and maintenance cost of $8,312.

Alternative 1B involves formalizing both the proposed Eastern Hills Pond E1 and the existing Adonea Filing 2 West Pond as regional detention ponds, even though the individual tributary area for each pond is less than 130 acres. Both ponds would detain the 100-year storm event and reduce the flow to the existing storm sewer system capacity, so the existing storm sewer system is able to convey the 100-year flow through the Adonea and Traditions developments without any street conveyance. This alternative would take advantage of an existing detention pond (Adonea) to better mimic designed hydraulic conditions of the system. Downstream of 6th Avenue, stream management corridors and a regional detention pond (58.7 acre-feet) near the tributary outfall are also proposed for this alternative.

The Harvest 1B Alternative Layer on Figure D-2 shows the proposed Alternative 1B improvements. The total capital improvement cost for Alternative 1B for Harvest Tributary is $12,402,5573 with an annual operation and maintenance cost of $9,213. There are no capital costs associated with formalizing the Adonea West Pond as a regional pond since it is already constructed.

Alternative 2 for Harvest Tributary includes the installment of additional storm sewer pipes to convey the remaining flow for the 100-year storm event without street flooding and without upstream ponds. The additional storm sewer system includes a 48-inch RCP upstream of Design Point 245 and a 60-inch RCP downstream of Design Point 245. This alternative also includes approximately 23 storm manholes along the new system and junction boxes at the outlets of the Adonea and Eastern Hills ponds to split flow between the new and existing storm sewer pipes. Downstream of 6th Avenue, stream management corridors and a regional detention pond (77.8 acre-feet) near the tributary outfall are proposed for this alternative.

The Harvest 2 Alternative Map on Figure D-2 shows the proposed Alternative 2 improvements. The total capital improvement cost for Alternative 2 for Harvest Tributary is $18,510,985 with an annual operation and maintenance cost of $9,955.

See Table 5-3 for a summary of each alternative cost estimate and Table D-4 for detailed cost calculations.

Powhaton South Tributary (Figure D-3)

The Powhaton South Tributary is partially developed with the existing Adonea development in the lower portions of the watershed. The preliminary plans for the Harmony development are being designed for the area upstream (southeast) of future Alameda Avenue. Since a large portion of the Harmony development is still in the preliminary design stage, this study proposes a regional online detention pond located south of future Alameda Avenue to represent the multiple offline ponds proposed by the *Master Drainage Report for Harmony* by CVL Consultants (May 2016). The release rate of 553 cfs from the representative Harmony regional detention pond (74.9 acre-feet) is the design flow for the Alameda Avenue culvert crossing (recently constructed) and influences the design flow of Channel A downstream of Alameda Avenue.

A regional detention pond was identified by the Harmony drainage report and the *First Creek (Upstream of Buckley Road) Major Drainageway Plan - Conceptual Design Report* by Moser and Associates (August 2010) generally located south of future Exposition Avenue on the Exposition Tributary. A regional pond (29.7 acre-feet) was included in the alternative plan in this location as Regional Detention Pond 8715.

Lastly, a regional detention pond (26.2 acre-feet) at the tributary outfall is proposed for this alternative. Stream management corridors are proposed upstream of Alameda Avenue and downstream of 6th Avenue and are designed for flows assuming all regional detention is in place.

The Alternative Layer on Figure D-3 shows the proposed alternative for the Powhaton South Tributary. The total capital improvement cost is $26,815,926 with an annual operation and maintenance cost for the detention ponds and channels of $21,722. See Table 5-3 for a summary of the alternative cost estimate and Table D-4 for detailed cost calculations.

Powhaton North Tributary (Figure D-4)

The Powhaton North Tributary is generally undeveloped except for the Foxridge Farm mobile home park at the upper end of the tributary. Future development will increase imperviousness and runoff which will increase potential for erosion within existing drainage patterns. The proposed alternative for the Powhaton North Tributary includes a stream management corridor along the east side of Powhaton Road to stabilize the channel and convey the 100-year storm event and includes a regional detention pond at the tributary outfall to First Creek. The Alternative Map on Figure D-4 shows the proposed alternative with the following specifications:

Stream Management Corridor - Reach 400	76-foot width
100-year Detention Pond Volume	17.1 acre-feet
100-year Maximum Inflow to Pond	251 cfs
100-year Release Rate to First Creek	77 cfs

The total capital improvement cost for the proposed alternative for the Powhaton North Tributary is $3,796,754 with an annual operation and maintenance cost for the detention pond and channel of $3,904. See Table 5-3 for a summary of the alternative cost estimate and Table D-4 for detailed cost calculations.

Riverwood Tributary (Figure D-5)

The Riverwood Tributary is generally undeveloped and future development will increase imperviousness and runoff which will increase potential for erosion within existing drainage patterns. The proposed alternative for the Riverwood Tributary includes a stream management corridor to stabilize the channel and convey the 100-year storm event and includes a regional detention pond at the tributary outfall to First Creek. The Alternative Map on Figure D-5 shows the proposed alternative with the following specifications:

Stream Management Corridor - Reach 500	91-foot width
100-year Detention Pond Volume	19.9 acre-feet
100-year Maximum Inflow to Pond	374 cfs
100-year Release Rate to First Creek	148 cfs

The total capital improvement cost for the proposed alternative for the Riverwood Tributary is $3,285,712 with an annual operation and maintenance cost for the detention pond and channel of $3,264. See Table 5-3 for a summary of the alternative cost estimate and Table D-4 for detailed cost calculations.

Monaghan Tributary (Figure D-6)

The Monaghan Tributary is included in a master drainage plan for the Sky Ranch development. The construction of Sky Ranch Filing 1 (west of Monaghan Road) is nearly completed and Filing 2 (east of Monaghan Road) is currently being planned. Sky Ranch Pond D located about 750 feet upstream of the outfall to First Creek was under construction and assumed to be existing for the baseline hydrology and was also included in the alternatives analysis as an existing regional detention pond. No capital cost was included for this existing detention pond, but operation and maintenance costs were included. The proposed alternative includes stream management corridors and another regional detention pond based on the proposed Sky Ranch construction plans and master drainage plan for this area. The stream management corridors for reaches 602 and 605 are based on cross sections G-G and F-F, respectively, from the *Sky Ranch Filing 1 Phase 1 & 2 Road & Drainage Construction Plans* (May 2019). Since these channels are nearly completed, the capital costs were not included for the Alternative Plan, but operation and maintenance costs were included. The stage-storage-discharge curves for proposed Pond C from the *Sky Ranch Filing 2 Phase I Drainage Report* (CVL, 2019) was utilized to model the proposed alternative pond upstream of Monaghan Road. The pond release rate to the channel in Reach 605 is 133 cfs which is similar to the design flow (135 cfs) for this newly constructed channel.

The only proposed stream management corridor that wasn't designed and constructed by the Sky Ranch development is Reach 600. This channel is west of the Arapahoe County / City of Aurora boundary and located downstream of existing Pond D at the outfall to First Creek. Since Pond D reduces the runoff significantly for this tributary, an additional regional detention pond at the tributary outfall was not included with this alternative. The Alternative Map on Figure D-6 shows the proposed alternative for the Monaghan Tributary with the following specifications:

Stream Management Corridor - Reach 600	89-foot width
Stream Management Corridor - Reach 602	99-foot width (no capital costs)
Stream Management Corridor - Reach 605	99-foot width (no capital costs)
100-year Detention Pond Volume (Pond C)	20.4 acre-feet
100-year Maximum Inflow (Pond C)	402 cfs
100-year Release Rate (Pond C)	133 cfs
100-year Release Rate to First Creek	366 cfs

The total capital improvement cost for the proposed alternative for the Monaghan Tributary is $2,772,622 with an annual operation and maintenance cost for the detention ponds and channels of $2,701. See Table 5-3 for a summary of alternative cost estimates and Table D-4 for detailed cost calculations.

Titus Tributary (Figure D-7)

The Titus Tributary is currently undeveloped and future development, such as in the Harmony development, will increase imperviousness and runoff which will increase potential for erosion within existing drainage patterns. The proposed alternative for the Titus Tributary includes a stream management corridor to stabilize the channel and convey the 100-year storm event and includes a regional detention pond at the outfall to First Creek. The Alternative Map on Figure D-7 shows the proposed alternative with the following specifications:

Stream Management Corridor - Reach 700	90-foot width
100-year Detention Pond Volume	23.2 acre-feet
100-year Maximum Inflow to Pond	420 cfs
100-year Release Rate to First Creek	191 cfs

The total capital improvement cost for the proposed alternative for the Titus Tributary is $5,621,455 with an annual operation and maintenance cost for the detention pond and channel of $5,319. See Table 5-3 for a summary of alternative cost estimates and Table D-4 for detailed cost calculations.

1st Avenue Tributary (Figure D-8)

The 1st Avenue Tributary is generally undeveloped. A large portion of Sky Ranch Filing 2 is proposed to be located within this tributary. When developed, increased imperviousness and runoff will increase potential for erosion within existing drainage patterns. After discussions with the project sponsors, two regional detention ponds are included in the alternative for the 1st Avenue Tributary. These are representative ponds that are close to the proposed locations for Sky Ranch Ponds G and H that are included in the *Sky Ranch Filing 2 Phase I Drainage Report* (CVL, 2019). Ponds H and J from this report do not individually meet the requirement for regional pond recognition (i.e. tributary area greater than 130 acres), so a representative pond (Pond 812) was designed to provide detention for all tributary area located east of future F Street. Additionally, a representative pond (Pond 800) is located at the outfall to First Creek and was designed for the remaining tributary area located west of future F Street.

The proposed alternative for the 1st Avenue Tributary includes stream management corridors to stabilize the channel and convey the 100-year storm event and the regional detention ponds described above. The Alternative Map on Figure D-8 shows the proposed alternative with the following specifications:

Stream Management Corridors	Range between 93 and 123-foot width
100-year Detention Volume (812 Pond)	30.5 acre-feet
100-year Maximum Inflow (812 Pond)	917 cfs
100-year Release Rate (812 Pond)	420 cfs
100-year Detention Volume (800 Pond)	35.7 acre-feet
100-year Maximum Inflow (800 Pond)	700 cfs
100-year Release Rate (800 Pond) to First Creek	468 cfs

The total capital improvement cost for the proposed alternative for the 1st Avenue Tributary is $10,659,317 with an annual operation and maintenance cost for the detention ponds and channels of $6,714. See Table 5-3 for a summary of alternative cost estimates and Table D-4 for detailed cost calculations.

Hayesmount Tributary (Figure D-9)

The Hayesmount Tributary is currently undeveloped and future development will increase imperviousness and runoff which will increase potential for erosion within existing drainage patterns. The proposed alternative for the Hayesmount Tributary includes stream management corridors to stabilize the channel and convey the 100-year storm event and includes a regional detention pond at the outfall to First Creek. The Alternative Map on Figure D-9 shows the proposed alternative with the following specifications:

Stream Management Corridors	Range between 111 and 138-foot width
100-year Detention Pond Volume	51.9 acre-feet
100-year Maximum Inflow to Pond	926 cfs
100-year Release Rate to First Creek	474 cfs

The total capital improvement cost for the proposed alternative for the Hayesmount Tributary is $12,064,721 with an annual operation and maintenance cost for the detention pond and channels of $9,326. See Table 5-3 for a summary of alternative cost estimates and Table D-4 for detailed cost calculations.

Mississippi Tributary (Figure D-10)

The Mississippi Tributary is currently undeveloped and future development will increase imperviousness and runoff which will increase potential for erosion within existing drainage patterns. The proposed alternative for the Mississippi Tributary includes stream management corridors to stabilize the channel and convey the 100-year storm event and includes a regional detention pond at the outfall to First Creek. The Alternative Map on Figure D-10 shows the proposed alternative with the following specifications:

Stream Management Corridors	Range between 71 and 79-foot width
100-year Detention Pond Volume	10.8 acre-feet
100-year Maximum Inflow to Pond	300 cfs
100-year Release Rate to First Creek	227 cfs

The total capital improvement cost for the proposed alternative for the Mississippi Tributary is $2,489,909 with an annual operation and maintenance cost for the detention pond and channels of $2,779. See Table 5-3 for a summary of alternative cost estimates and Table D-4 for detailed cost calculations.

Florida Tributary (Figure D-11)

The Florida Tributary is currently undeveloped and future development will increase imperviousness and runoff which will increase potential for erosion within existing drainage patterns. The proposed alternative for the Mississippi Tributary includes stream management corridors to stabilize the channel and convey the 100-year storm event and includes a regional detention pond at the outfall to First Creek. The Alternative Map on Figure D-11 shows the proposed alternative with the following specifications:

Stream Management Corridors	Range between 68 and 77-foot width
100-year Detention Pond Volume	10.8 acre-feet
100-year Maximum Inflow to Pond	272 cfs
100-year Release Rate to First Creek	218 cfs

The total capital improvement cost for the proposed alternative for the Florida Tributary is $3,232,637 with an annual operation and maintenance cost for the detention pond and channels of $3,770. See Table 5-3 for a summary of alternative cost estimates and Table D-4 for detailed cost calculations.

Alternative Plan Costs

Table 5-3 below presents a summary of the total capital improvement costs and associated annual operations and maintenance costs for each of the proposed tributary alternatives. Detailed cost calculations for individual alternative plans are presented in Table D-4 in Appendix D.

Table 5-3 Alternative Plan Cost Estimate Summary

Tributary	Capital	Easement/ ROW	Engineering	Legal/ Administrative	Construction Management	Contingency	Total Capital Improvements Cost	Annual O&M Cost	50-Year O&M Cost	Proposed Improvements
Gun Club	$1,779,843	$0	$266,976	$88,992	$177,984	$444,961	**$2,758,756**	$2,408	$120,400	• Stream Management Corridor • Regional Detention Pond at Outfall
Harvest (1A)	$8,794,807	$0	$1,319,221	$439,740	$879,481	$2,198,702	**$13,631,951**	$8,312	$415,600	• Formalize Eastern Hills Pond E1 as a regional detention pond • Stream Management Corridors • Regional Detention Pond at Outfall
Harvest (1B)	$8,001,660	$0	$1,200,249	$400,083	$800,166	$2,000,415	**$12,402,573**	$9,213	$460,650	• Formalize Adonea Filing 2 West Pond and Eastern Hills Pond E1 as regional detention ponds • Stream Management Corridors • Regional Detention Pond at Outfall
Harvest (2)	$11,942,570	$0	$1,791,386	$597,129	$1,194,257	$2,985,643	**$18,510,985**	$9,955	$497,750	• Install additional parallel storm sewer system • Stream Management Corridors • Regional Detention Pond at Outfall
Powhaton South	$17,300,597	$0	$2,595,090	$865,030	$1,730,060	$4,325,149	**$26,815,926**	$21,722	$1,086,100	• Stream Management Corridors • Regional Detention Pond at Outfall, Harmony Pond, and Regional Pond 8715
Powhaton North	$2,449,518	$0	$367,428	$122,476	$244,952	$612,380	**$3,796,754**	$3,904	$195,200	• Stream Management Corridors • Regional Detention Pond at Outfall
Riverwood	$2,119,814	$0	$317,972	$105,991	$211,981	$529,954	**$3,285,712**	$3,264	$163,200	• Stream Management Corridors • Regional Detention Pond at Outfall
Monaghan	$1,788,789	$0	$268,318	$89,439	$178,879	$447,197	**$2,772,622**	$2,701	$135,050	• Stream Management Corridor for Reach 600 only • Sky Ranch Pond C • Maintenance for Sky Ranch Pond D
Titus	$3,626,745	$0	$544,012	$181,337	$362,675	$906,686	**$5,621,455**	$5,319	$265,950	• Stream Management Corridors • Regional Detention Pond at Outfall
1st Avenue	$6,876,978	$0	$1,031,547	$343,849	$687,698	$1,719,245	**$10,659,317**	$6,714	$335,700	• Stream Management Corridors • Sky Ranch Ponds H/J and G
Hayesmount	$7,783,690	$0	$1,167,554	$389,185	$778,369	$1,945,923	**$12,064,721**	$9,326	$466,300	• Stream Management Corridors • Regional Detention Pond at Outfall
Mississippi	$1,606,393	$0	$240,959	$80,320	$160,639	$401,598	**$2,489,909**	$2,779	$138,950	• Stream Management Corridors • Regional Detention Pond at Outfall
Florida	$2,085,572	$0	$312,836	$104,279	$208,557	$521,393	**$3,232,637**	$3,770	$188,500	• Stream Management Corridors • Regional Detention Pond at Outfall

5.7 Evaluation of Alternatives

As discussed with the project sponsors, since the majority of the tributaries are currently undeveloped or master planned, a single alternative was analyzed to determine stream management corridor cross sections and widths and regional detention pond volumes and release rates. Therefore, these tributaries do not have multiple alternatives to evaluate.

The Harvest Tributary is the only tributary with multiple alternatives to resolve flooding issues. Several evaluation parameters were considered in evaluating these alternatives, including capital and O&M costs, inconvenience to the public during construction, and size of downstream proposed improvements. Table 5-4 below shows a comparison of the Harvest Tributary alternatives relative to each other.

Table 5-4 Harvest Tributary Alternative Evaluation Matrix

Alternative	Advantages	Disadvantages
1A	• Only 1 sub-regional pond needs to be formalized for maintenance eligibility. • Utilizes existing infrastructure. • No impacts to existing roadways in Traditions. • No inconveniences to the public.	• Minor street flow in 100-year storm event. • Larger stream management corridors than Alt 1B. • Larger detention pond at outfall than Alt 1B.
1B	• No street flow in 100-year storm event. • Utilizes existing infrastructure. • No impacts to existing roadways in Traditions. • Smallest stream management corridors. • Smallest detention pond at outfall. • Lowest capital and O&M costs. • No inconveniences to the public.	• Need to formalize 2 sub-regional ponds for maintenance eligibility.
2	• No street flow in 100-year storm event. • No sub-regional ponds included.	• Major impacts to existing roadways / ROW in Traditions • Significant inconveniences for the public. • Existing infrastructure not utilized. • Highest peak flows. • Largest stream management corridors. • Largest detention pond at outfall. • Highest capital and O&M costs.

5.8 Recommended Plan

Each tributary is independent from each other and therefore, the proposed improvements for each tributary can be constructed separately, depending on the timing and phasing of future development. However, within each tributary, regional detention ponds should be considered and constructed prior to or concurrently with development to minimize impacts to downstream drainageways created by increased imperviousness and runoff.

With the exception of the Harvest tributary, only one alternative was analyzed and recommended for all tributaries. The recommended alternative for each tributary typically includes stream management corridors to safely route and contain the 100-year future condition storm event and to minimize the potential for erosion, and regional detention ponds to reduce 100-year future condition flows to match historic flows at the tributary outfalls to the First Creek main stem. These recommended alternatives are shown on the Recommended Plan Maps on Figures D-1 to D-11 in Appendix D.

For the Harvest Tributary, Alternative 1B is recommended since it will safely provide 100-year conveyance through existing subdivisions while utilizing existing storm sewer infrastructure, cause the least disruption to the public, has the smallest stream management corridors and detention pond at the outfall, and would be the least costly to implement.

All recommended alternatives achieve the project goals of minimizing flood risk, identifying natural stream management corridors along existing drainage pathways to promote stabile, adaptable streams, determine necessary detention to release flows to the main stem of First Creek at historic rates, promote water quality opportunities, and provide recommendations for future implementation.

6.0 REFERENCES

1. *Adonea – Filing No. 1, Channel STA 0+00.00 – 10+50.00 Storm Plan and Profile* by Nolte Associates, May 2004
2. *Adonea Master Drainage Report* by Nolte Associates, Inc. Revised October 2003
3. *Arapahoe County Comprehensive Plan 2018* by Arapahoe County Planning Commission, May 2018
4. ArcGIS files: Basins, District Boundary by Urban Drainage and Flood Control District, July 31st, 2018
5. ArcGIS files: Building Rooftops, City Limits, Driveways, Edge of Pavement, Parcels, Parks Open Space, Ponds, Sidewalks, Storm Fittings, Storm Inlets, Storm Mains, Storm Manholes, Zoning by City of Aurora, July 12th, 2018 & August 9, 2018
6. ArcGIS files: County Boundary, Parks Open Space, Zoning, 2018_CompPlan by Arapahoe County, July 31st, 2018, and September 24th, 2018
7. ArcGIS files: Soils by Natural Resources Conservation Service, July 26th, 2018
8. *Aurora Data Center Subdivision Filing No. 1 – Sycamore Aurora Site Plans* by CH2M, Revised June 5th, 2018
9. *City of Aurora 2016 Zoning Map* by City of Aurora Planning and Development Services, March 8, 2016
10. *Construction Plans for Traditions Subdivision Filing 2* by CVL Consultants of Colorado, Inc., September 2004
11. *Drainage Basin Plan for Annexation Study Area: Phase I Development of Alternatives, Volume III Upper South Platte River Basin including First Creek* by Simons & Li, 1986
12. *Final Drainage Report for APS Educational Campus – Filing 1* by JVA Consulting Engineers, January 21st, 2009.
13. *Final Drainage Study Aurora Pumping Station No. 3, Subdivision Filing No.1* by MWH, February 11th, 2008. COA #208031
14. *First Creek (Upstream of Buckley Road) Major Drainageway Plan - Conceptual Design Report* by Moser & Associates, August 2010
15. *First Creek and DFA 0055 Outfall Systems Masterplan Preliminary Design Report* by Wright Water Engineers, 1990
16. *Harmony Subdivision Filing 1, Drainage Channel A Plan & Profile (Private)* by CVL Consultants of Colorado, Inc., November 2017
17. *Horizon City Center Framework Development Plan* by Lend Lease Horizon LLC, September 9th, 2008
18. *Horizon City Center Master Drainage Report* by Nolte Associates, Revised June 2005. COA #205179
19. *Horizon City Center Preliminary Utility Report* by URS Corporation, October 2007. COA #472007
20. *Master Drainage Report for Harmony* by CVL Consultants of Colorado, Inc., May 2016. COA #216065
21. *Master Drainage Study for The Traditions Framework Development Plan* by CVL Consultants of Colorado, Inc., December 11th, 2003
22. *Phase II Drainage Report for Sky Ranch II* by CVL Consultants of Colorado, Inc., Revised September 8th, 2006
23. *Sky Ranch Filing 1 Phase 1 & 2 Road & Drainage Construction Plans* by CVL Consultants of Colorado, Inc., May 2018
24. *Sky Ranch Filing 2 Phase I Drainage Report Draft*, CVL Consultants of Colorado, Inc., May 2019.
25. *Sky Ranch Neighborhood B Phase III Drainage Report (E 6th Ave. and Monaghan Rd.)* by CVL Consultants of Colorado, Inc., May 2018
26. *Sandy Creek Subdivision* by CVL Consultants of Colorado, Inc., Revised July 3rd, 2013. COA #213082
27. *SEMSWA Stormwater Management Manual*, SEMSWA, Revised January 2017.
28. *Sun Meadow Master Drainage Report* by CVL of Colorado, Inc., Revised April 5th, 2006. COA #206123
29. *Sunset & Grimm Motocross Oil & Gas Well* by CVL Consultants of Colorado, Inc., October 1st, 2013. COA #214009
30. *Topographic Contours and Digital Elevation Model (DEM)* by Urban Drainage and Flood Control District, May 30th, 2018
31. *Urban Storm Drainage Criteria Manual, Volume 1, 2, and 3* by Urban Drainage and Flood Control District, revised 2017.

APPENDIX A – PROJECT CORRESPONDENCE

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MINUTES

First Creek Tributaries

Master Drainage Plan

Kickoff Meeting, Wednesday, June 13th, 2018, 10:30 pm – at City of Aurora

Attendees:

Name	Organization	Phone	Email
Teresa Patterson	UDFCD	303 455 6277	tpatterson@udfcd.org
Sarah Young	City of Aurora	303 739 7279	syoung@auroragov.org
Craig Perl	City of Aurora	303 739 7532	cperl@auroragov.com
Stacey Thompson	SEMSWA	303 858 8844	sthompson@semswa.org
Sue Liu	Arapahoe County	720 874 6546	sliu@arapahoegov.com
Jeanne Boyle	Merrick	303 800 9036	jeanne.boyle@merrick.com
Colin McKernan	Merrick	303 800 9030	colin.mckernan@merrick.com
Clare Steninger	Merrick	303 800 9074	clare.steninger@merrick.com

1. Introductions
   a. Merrick project team: Jeanne, Colin, and Clare attendees. Other employees will be a part of the project team as necessary.
   b. Sponsors: UDFCD, Aurora, and SEMSWA.
      i. Arapahoe County, development stakeholders, and others as necessary to provide input.
   c. Project communication
      i. Website – launch page should be set up before next progress meeting. Meeting notices will be posted to provide notice to stakeholders.
2. Project Scope – area of interest is tributaries to First Creek upstream of I-70
   a. Phases: hydrology, hydraulics, alternatives analysis, and conceptual design.
   b. Not updating hydrology for the main stem, just the tributaries indicated in the original scope
   c. Naming tributaries – Aurora will check with Open Space and Maintenance if any naming conventions are currently used. Team will decide prior to submitting the hydrology report.
3. Available Data
   a. Mapping, GIS data
      i. Contours – 2013 Lidar.
      ii. COA Open Portal – has GIS data available for download including stormwater, ponds, wastewater, boundaries, planimetrics, etc.
      iii. Arapahoe County – urban land use plan and county transportation system mapping are available
   b. Previous Master Plans and On-going developments
      i. No FHAD has been done for these tributaries, only for the main stem of First Creek. The City and SEMSWA may be interested in adding a FHAD for this area in the future.
      ii. Aurora will send (or direct Merrick to) the MDPs or FDPs for Sky Ranch, Eastern Hills, Harmony.
      iii. IGA for First Creek main channel should be referenced and considered in this study.
   c. Land Use – Existing and Proposed Imperviousness
      i. City has existing imperviousness surface data as GIS layer. Future imperviousness layer not developed. City will send anticipated future development map when finished.
      ii. Use zoning categories, 2018 County Comprehensive Plan, MDPs, and FDPs for future imperviousness values.
         1. County may have GIS for land-use zones.
      iii. Compare Aurora and SEMSWA values for land uses and imperviousness and discuss at next progress meeting.
   d. Regional detention
      i. Pond inventory is available on COA Open Portal. Indicates private vs. public ponds. Private ponds will not be included in baseline hydrology but may be considered for retrofitting in alternatives analysis.
      ii. Regional ponds currently or soon to be built (within the next year) will be included in baseline hydrology. This includes Pond D in Sky Ranch.
      iii. Merrick will determine the ponds within the study limit and the team will discuss at the next progress meeting.
      iv. Other master planned ponds (i.e. Sky Ranch T9 and T12) may be considered in alternatives analysis.
4. Models to Use and Storm Events
   a. CUHP 2005 Version 2.0.0, EPA SWMM 5.0 models
   b. Storm events studied: 2-year to 500-year
5. Project Specifics
   a. Channel improvements near Powhaton Road has redirected a tributary further north.
   b. Neighborhood near Adonea may have major conveyance underground.
   c. Mississippi and Hayesmount area may annex into the City. More information about land use will be in this area is to be determined.
6. Deliverables for Baseline Hydrology
   a. CUHP/SWMM models
   b. Hydrology Report

c. Other deliverables to be discussed for following phases.

7. Billing information
   a. Invoicing – Merrick will send to Teresa
8. Schedule
   a. Anticipated Schedule – see attached anticipated schedule
   b. Next progress meeting – 8 weeks. Approximately week of August 6th
      i. Tributary alignments
      ii. Watershed delineation
      iii. Land use and percent imperviousness values
      iv. Ponds to be included in baseline hydrology
9. Project Goals:
   a. Clearly define intent of improvement goals and objectives.
   b. Inform, guide, and provide expectations of development effects on water quality, stabilization, flood risk, etc.
   c. Potentially provide stream management corridors for more natural stormwater conveyance
   d. Integrate proposed improvements with realistic location of future trails, open space, traffic master plans, and developments

Action Items:

- Aurora – research naming conventions for these tributaries
- Aurora – provide existing impervious surface data
- Aurora – provide MDPs and FDPs for Sky Ranch, Eastern Hills, Harmony, and other developments
- SEMSWA/ Arapahoe County – Plans for Pond D at Sky Ranch. To be used for baseline hydrology model.
- Merrick – set up project website and send link to Teresa
- Merrick – collect data
- Merrick – delineate watersheds, subbasins, and stream network. Verify stream network shown in Appendix A of RFP
- Merrick – determine land use and imperviousness values
- Merrick – determine private, public, and regional detention ponds to be discussed at the next meeting.

FIRST CREEK MDP

Anticipated Schedule

Phase	Task	Weeks to Complete	Approximate Date	Assumptions
Baseline Hydrology	Next Progress Meeting	7	8/6/2018	Starting date is June 18, 2018
	Draft Hydrology Report	10	8/24/2018	Starting date is June 18, 2018
	Sponsor review of Hydrology Report	3	8/27/2018	
	Finalize Hydrology Report	3	9/17/2018	
Alternatives Analysis	Draft Alternatives Report	8	11/12/2018	No work on alternatives until Hydrology is finalized
	Sponsor review of Alternatives Report	3	12/3/2018	
	Finalize Alternatives Report	3	12/31/2018	No work during the week between Christmas and New Years
	Arrange and Hold Public Meeting	3	1/21/2019	Not started until after Alternatives report has been finalized
	Select Best Alternative Plan	3	2/11/2019	
Conceptual Design	Draft Conceptual Design	8	4/8/2019	No work on Conceptual until Best Alternative Plan selected
	Sponsor review of Conceptual Report	3	4/29/2019	
	Final Conceptual Design	3	5/20/2019	

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MINUTES

First Creek Tributaries

Master Drainage Plan

Progress Meeting, Thursday, August 30th, 2018, 3:30 pm – at Merrick

Attendees:

Name	Organization	Phone	Email
Teresa Patterson	UDFCD	303 455 6277	tpatterson@udfcd.org
Craig Perl	City of Aurora	303 739 7532	cperl@auroragov.org
Jon Villines	City of Aurora	303 739 7646	jvilline@auroragov.org
Stacey Thompson	SEMSWA	303 858 8844	sthompson@semswa.org
Jeanne Boyle	Merrick	303 800 9036	jeanne.boyle@merrick.com
Clare Steninger	Merrick	303 800 9074	clare.steninger@merrick.com

A memo was sent to the project team on August 9th, 2018, describing the tributary delineation and land use categories Merrick will base the hydrology on. This meeting was to discuss the items presented in that memo.

1. Tributary Delineation
   a. The tributaries Merrick delineated were similar to the tributaries presented in UDFCD's draft flow paths for tributaries greater than 130 acres. This confirms the main tributary paths are reasonable.
   b. Some of the subcatchments that were delineated were small or had interesting shapes. Merrick will investigate the sizes and shapes based on contours and edit as appropriate.
   c. The upper limits of each tributary should have a subcatchment about 130 acres. The scope of the study dictates that improvements for the tributary will only be investigated when cumulative area meets or exceeds 130 acres. Merrick will revise subcatchment boundaries that were previously split at roadways and edit tributary paths at the upstream reaches of the tributaries to be where 130 acres actually comes together.
   d. Merrick will perform a site visit to clarify determine the actual flow path for several potential split flow locations. If it is not obvious, then the topo data should be used to determine the flow path.
   e. Additional information about the Harmony development and proposed flow paths can be found in the Harmony Master Drainage Study. This may influence subcatchment divides in the Powhaton and Alameda area.
2. Tributary Names
   a. Merrick initially named the tributaries numerically based on the 1986 Simons and Li Drainage Basin Plan. Existing developments did not use these names in their drainage reports. The project team would prefer more descriptive names than numeric values. However, these numbered tributary names will be referenced in the report.
   b. After some discussion, the project team agreed that tributary names should reference major roadways names instead of development names as developments can go through many names before being built.
   c. Merrick will develop names base on streets and send to the project team for review. Teresa will ask Shea about other naming conventions in the area.
3. Land Use
   a. There was a typo in the memo. "OS" should refer to Open Space not Office Space. The percent impervious for this land use is 2%.
   b. The Road land use would likely include the right-of-way (ROW) area and not just the pavement. The 100% imperviousness would be too high if all the ROW area was included. Teresa will investigate typical values for ROW. However, this land use is only found along I-70 and E-470, so this land use could be changed to "Freeway" instead of "Road".
   c. For areas that had both City and County zoning categories, the areas that are currently incorporated into the City used City zoning over County.
   d. The "Mixed Use" from Arapahoe County's Comprehensive Plan does not have specifics as to what the typical density will be. For the Sky Ranch and Prosper development areas, the May 2018 Comprehensive Map land uses will be used. Merrick will digitize the boundaries if GIS data is not available from Arapahoe County.
   e. From aerial imagery, there appears to be an existing oil well site east of Hayesmount. The team decided to include this site in existing and future land use calculations. The Lone Tree well (planned for across the street) will only be used in future land use calculations.
4. Other
   a. The aerial imaging that will be used is 2017 World Imagery from the ESRI (ArcMap) database. This will be referenced in the report.
   b. The regional detention pond southeast of Alameda and Hayesmount originally proposed in the 2010 First Creek MDP was an inline pond and therefore wouldn't influence any of this study's tributaries. An area for the pond will not be made for future land use as it would not be a permanent pool pond.
   c. In the hydrology report, document dates of retrieval for shapefiles used in the bibliography.
   d. For final maps, include labels for jurisdiction.
   e. On final tributary may, show the major basin for First Creek (watershed divide).
5. Anticipated Schedule
   a. Draft report mid-October

Action Items:

- UDFCD – ask Shea about naming conventions
- UDFCD – investigate typical right-of-way imperviousness values
- SEMSWA – investigate if the May 2018 Arapahoe County Comprehensive Plan is available in GIS format.
- Merrick – revise watershed and subcatchment delineations.
- Merrick – continue baseline hydrology model development

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MINUTES

First Creek Tributaries

Master Drainage Plan

Progress Meeting, Wednesday, January 23rd, 2019, 11:00 am – at UDFCD

Attendees:

Name	Organization	Phone	Email
Teresa Patterson	UDFCD	303 455 6277	tpatterson@udfcd.org
Craig Perl	City of Aurora	303 739 7532	cperl@auroragov.org
Jon Villines	City of Aurora	303 739 7646	jvilline@auroragov.org
Stacey Thompson	SEMSWA	303 858 8844	sthompson@semswa.org
Sue Liu	Arapahoe County	720 874 6500	sliu@arapahoegov.com
Jeanne Boyle	Merrick	303 800 9036	jeanne.boyle@merrick.com
Clare Steninger	Merrick	303 800 9074	clare.steninger@merrick.com

Review of Hydrology Comments

Overall, review comments were reasonable and made sense to Merrick. We will update the report and modeling based on these comments. Below is more in-depth discussion of several comments:

1. Sue Liu's (Arapahoe County) comments were not included in the complied list. They will be resent to Teresa and Merrick to be included in the comment response matrix.
2. Sensitivity Analysis - A roughness (Manning's n) or culvert blockage (sedimentation) analysis of hydraulic models to provide information of which reaches are more sensitive to changes could provide helpful information for long term O&M. However, it is not as critical for this study since most of the area is undeveloped. Could be included in future MDPs but won't be part of this scope.
3. Historic run (I=2%) – for studies in developing watersheds, a historic flow condition (i.e. I=2%) illustrates effect of development and helps future developers adhere to discharging at historic rates. A historic run will be included in this study for only the 100-year storm event per sponsor discussion.
4. 500-year storm event – this MDP will not have a FHAD associated with it so the 500-year event hydrology is not required. The 500-year scenario will be run but not used for subsequent phases of this MDP.
    a. For Baseline Hydrology, Merrick will provide the 500-year results in the peak flow and volume table but remove it from the peak flow profiles for clarity.
5. Sky Ranch Zoning – a Phase II drainage report for Sky Ranch shows different zoning/land use in the Monaghan tributary. This report has not been published yet.
    a. Merrick will look at the differences in land use to determine if there are significant changes for what was used in this study (based on Arapahoe County Comp Plan). If there are significant changes, this will be discussed with the sponsors before changing in the modeling.
6. Sky Ranch Pond D –
    a. a comment mentioned that the stage-storage and discharge curves for Pond D were not the ones from the Phase III drainage report. This is incorrect. The curves used were the correct curves from the Phase III report – no changes needed for the model.
    b. Subwatershed 600 has greater area than what Pond D was sized for. Subwatershed 600 will be split into two subwatersheds about at the jurisdictional boundary (depending on development boundaries) so only the area tributary to Pond D will be included in the pond routing.
7. Sky Ranch culvert – there is an existing 4x6 RCBC culvert under Monaghan in the Sky Ranch area. This culvert will be added to the table of existing infrastructure but will not be modeled in the baseline hydrology SWMM model.
8. Future Sky Ranch Ponds – there are other proposed ponds in Sky Ranch that may be regional (Ponds C, G, H). Since they are not existing infrastructure, they aren't included in the baseline hydrology. They will be considered in the alternatives analysis.
9. Depression Storage – for existing and future conditions, subwatersheds with imperviousness less than 15% a value of 0.4 was used for depression storage and for greater than 15% 0.35 was used.
10. Tributary naming – some sponsors are not thrilled with naming tributaries after adjacent roadways as the alignments of the roads could change in the future and would not be unique to this watershed.
    a. A theme (native grasses, trees, crops, animals, etc.) with alphabetical names could make the tributary names more unique.
    b. For now, tributary names shall remain as they are (road based).

Alternatives Analysis Considerations

1. The target storm event for the alternatives is the 100-year.
2. Existing ponds – existing ponds could be considered to be included for maintenance eligibility/ publicly owned, it must show that including them significantly improves the existing infrastructure capacity.
3. Future ponds – include regional detention from Sky Ranch in alternatives. Also look at if there are any regional ponds from the First Creek (main channel) MDP that should be considered.
4. Harmony development – the channels and ponds proposed in Harmony's plans are not eligible for District maintenance. The channels may be too small because they rely on local detention.
    a. Merrick will look at reports and flows assumed as part of the alternatives analysis.
    b. Goal would be to give guidance for this area.

5. Traditions pipe system – since existing local ponds are not included in the hydrology model, it is likely that the pipe system through the Traditions development are undersized. The pipes may have been sized assuming a future detention pond upstream of the development (subwatershed 250). Merrick will analyze:
    a. The capacity of the pipe system (pipe and street flow) without existing or future ponds and what the cost and size pipe would be needed to convey the undetained flow.
        i. Identify sensitive areas for excessive street depths or impacts to properties, etc.
    b. Include existing ponds and how that impacts the alternative design of the pipe system.
    c. Include existing and future ponds (even if not regional) and impacts for the alternative design of the pipe system.

Schedule

1. Finalize Hydrology Report – mid-February 2019
    a. Will be posted on the project website after approval.
2. Alternatives – proposal for budget is almost completed and will be sent to UDFCD. Before Merrick begins work on alternatives, a discussion of approach and categories will be conducted with UDFCD and then distributed to the other sponsors.

MINUTES

First Creek Tributaries

Master Drainage Plan - Alternatives

Progress Meeting, Thursday, June 20th, 2019, 10:00 am – at Merrick

Attendees:

Name	Organization	Phone	Email
Teresa Patterson	UDFCD	303-455-6277	tpatterson@udfcd.org
Janet Bender	City of Aurora	303-739-7512	jbender@auroragov.org
Sam Miller	City of Aurora	303-739-7368	samiller@auroragov.org
George Slovensky	City of Aurora	303-739-7431	jsolvens@auroragov.org
Sarah Young	City of Aurora	303-379-7279	syoung@auroragov.org
Jon Nelson	SEMSWA	303-858-8844	jnelson@semswa.org
Stacey Thompson	SEMSWA	303-858-8844	sthompson@semswa.org
Jeanne Boyle	Merrick	303-800-9036	jboyle@merrick.com
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Jennifer Goldman	Merrick	303-353-3712	jennifer.goldman@merrick.com

1. Project Overview

The project includes 11 tributaries to First Creek, all of which have tributary drainage areas greater than 130 acres. The project location is south of I-70 and east of E-470. The hydrology for the project has been completed and tributaries have been given official names based on their proximity to specific roads. The next phase of the project is to identify alternatives for each tributary, then ultimately to provide a recommended alternative for conceptual design.

2. Alternative Categories

a. Naturalized Channels
- The purpose of the naturalized channel design is to define a floodplain corridor to inform future development. The channel must be wide enough so that the shear stress is below 1.2 psf per criteria. Teresa suggested using 1.0 psf for this project. Historic longitudinal slopes and grassy side slopes for the naturalized channels will be assumed for this study. Any armoring needed will be determined by developers with future designs.
- The District would like a section included in the report discussing natural stream networks and how the corridors should follow the historic drainage patterns and not reroute tributaries.
- Teresa will provide the spreadsheet she uses to design naturalized channels.
- If the channels are naturally too steep to design stable channel slopes, grade control can be accomplished using step pools or riffle sections. The cost of grade control items will be investigated using other master plans with similar items.

b. Regional Detention
- Each tributary alternative will include online regional detention to release to the First Creek mainstem at historic flow rates. At a minimum, a pond near the outfall to the mainstem will be provided. Other potential pond locations will be dependent on property lines and roadways. Merrick will identify locations for proposed ponds and send to the team for approval. Pond locations will be noted as "general" in the master plan.
- Water quality will be identified for the tributaries as part of detention, but this does not mean future development will not be required to provide on-site water quality.
- Regional detention is defined as 130 acres contributing, minimum, but if future ponds need to be split due to multiple developments/property owners, this will be addressed by the developer at the time of design, so long as the divided ponds meet the intent of the regional facility. Dividing regional detention will be determined on a case by case basis for each of the proposed developments. Stacey will verify if these assumptions are acceptable or not. If ponds serve less than 130 acres of tributary area, they would not be eligible for maintenance assistance. Also, if the tributary area is less than 130 acres, ponds may not be allowed for hydrologic analysis to reduce downstream design flows, depending on their impact. This would be decided by the governing entity (i.e., City of Aurora, SEMSWA, Arapahoe County).

c. Capacity upgrades
- Upsizing existing storm sewers or channels, specifically in the Harvest and Powhaton South Tributaries, will be determined and included as an alternative.

d. Additional detention
- Recognizing existing detention ponds in the master plan will be part of the alternatives, specifically the detention ponds on the Harvest tributary and other developed reaches. Since these ponds are existing, the alternative costs will be those associated with maintaining the ponds. A field visit may be necessary to investigate the existing conditions of the ponds that have potential for becoming maintained by the City of Aurora.
- Cost differences between the capacity upgrades to the storm sewer or channel system alternative versus the additional detention alternative will be included as part of the alternatives analysis.
- The ponds at the upstream end of Harvest tributary can be found in the Adonea Filing 2 drainage report.

3. Sky Ranch Regional Ponds

- Merrick will base the alternative design for regional detention in Sky Ranch on the May 2019 Phase 2 Drainage Report for Sky Ranch Filing 2 by CVL Consultants.

- Pond C will be included in the Monaghan Tributary and have a 100-year release rate of 135 cfs per design assumptions for the downstream channel in Neighborhood B.
- Pond G will be included in the 1st Avenue Tributary. Merrick will add a subbasin to the hydrology that will be tributary to this pond that was not previously in the baseline hydrology to match the proposed tributary area per the Sky Ranch design.
- The previous master plan for Sky Ranch showed a pond (HK) east of the future F Street in the 1st Avenue Tributary. However, the May 2019 report shows two ponds: Pond J and Pond H.
    - Pond J only has 77 acres contributing and therefore it will not be included in the master plan on its own.
    - Pond H re-delineates drainage boundaries so the contributing area would be approximately 206 acres.
    - Merrick will propose one regional pond upstream of proposed F Street for master planning purposes. The developer may subdivide this pond, but the smaller ponds may not be eligible for maintenance assistance or for peak flow reduction. As mentioned in 2b above, Stacey will verify if this assumption is acceptable or not.

4. Hydraulic Modeling

a. Existing Topography with Future Flows
    - The existing topography has been modeled with future condition flows, and problem areas have been identified by Merrick.

b. Harvest (Traditions) Tributary
    - The street sections along the Harvest Tributary cut from the LiDAR topography appear to have several sump areas. These areas appear to be places where basements were being excavated. Based on the low precision of the topography in this area, Merrick will use typical street sections to calculate street capacities in this reach and adjacent to the detention pond and determine if future flows are contained within the streets or not.

5. Other/General

- A schedule to finish the alternatives phase will be prepared so that a public meeting can be scheduled. It is important to begin scheduling the public meeting as soon as possible.
- Third Creek and Second Creek MDPs are available on the District's website and should be referenced for alternatives costing, especially for the naturalized channel designs.
- Later this year it is expected that the hydrology for the entirety of the First Creek watershed will be updated.
- Merrick will provide locations of proposed regional ponds for team approval prior to analysis.
- Merrick will submit a draft of the alternatives analysis to the team for review prior to the public meeting.
- The alternatives section of the report will be finalized after the recommended alternatives are selected based on input from the public meeting.

TABLE A-1
Response to Draft Hydrology Report Comments

The following are responses to comment received from the project sponsors regarding the draft Baseline Hydrology report for the First Creek Tributaries (Upstream of I-70) Master Drainageway Plan.

Comment Number	Page Label	Subject	Author	Comments	Merrick Action	Merrick Response	Date Changed
1	1	Text Box	SLiu	and Arapahoe County	Agree	Added "Arapahoe County" to the cover.	2/13/2019
2	1	Text Box	SLiu	County Logo	Agree	Added Arapahoe County logo to the cover.	2/13/2019
3	4	Text Box	jvilline	It would probably require a scope change (and maybe a separate contract with RESPEC), but I am curious about the possibility of doing a roughness/sedimentation/culvert blockage sensitivity analysis as part of this and other MDPs going forward. It would provide very useful information at a relatively minor cost. If it doesn't make sense at this stage for this MDP, I understand.	No action	After discussion with the project sponsors, this sensitivity analysis will not be completed as part of this MDP. However sponsors did agree that having something like this in the future would provide useful operations and maintenance information for sensitive reaches.	1/24/2019
4	4	Line	jvilline		Disagree	Didn't omit comma after "June 13, 2018," because sentence continues after date.	N/A
5	5	Note	sthompson	new title: Group Manager, Floodplain and Master Planning	Agree	Changed in text	1/17/2019
6	5	Callout	tclark	there is now a new Phase II Drainage Report for Sly Ranch Filing 2. Only the initial review has been completed as of January 2019.	Agree	Added as a data source to Table 1-1	2/13/2019
7	5	Text Box	ahoward	Angela Howard, P.E., CFM - SEMSWA - Master Plan Coordinator	Agree	Added to text	1/17/2019
8	5	Text Box	SLiu	Draft Sky Ranch Neighborhood B Floodplain Modification Study CVL Consultants of Colorado, Inc	Agree	This study was added to the Data Collected in Table 1-1.	2/13/2019
9	6	Cross-Out	TPatterson		Agree	Deleted sentence.	
10	6	Inserted Text	TPatterson	for this project	Agree	Changed in text	1/17/2019
11	6	Inserted Text	TPatterson	upstream of I-70	Agree	Changed in text	1/17/2019
12	6	Highlight	TPatterson	move I-70 to first boundary in list	Agree	Changed in text	1/17/2019
13	6	Inserted Text	TPatterson	farming and agricultural practices,	Agree	Added to text	1/17/2019
14	6	Highlight	TPatterson	at the I-70 roadway crossing?	No action	Yes, the lowest point in the study area is in Subwatershed 100 at First Creek near the I-70 crossing.	2/7/2019
15	6	Highlight	TPatterson	Is the UPPER First Creek (Study area) really 33% developed? Or is this the entire FC watershed that is 33% developed. Is this based on aerials from a particular date or is it based on aerials plus approved development plans? I would like to focus this discussion to the Study Area (FC U/S of I-70).	Agree	Focusing on the study area, specifically the areas that were delineated for the studied tributaries, the study area is approximately 17% developed. This is based on existing aerial (June 2017) and verified with City of Aurora GIS planimetric data. The percentage was changed in the text.	2/15/2019
16	6	Ellipse	sthompson		Agree	Fixed tense of verb from "concentrates" to "concentrate"	1/17/2019
17	6	Ellipse	sthompson		Agree	Fixed tense of verb from "creates" to "create"	1/17/2019
18	6	Ellipse	sthompson		Agree	Fixed tense of verb from "was" to "were".	1/17/2019
19	6	Callout	jvilline	Future	Disagree	Land Use categories were determined for both existing and future conditions.	N/A
20	6	Callout	jvilline	Is this paragraph a little redundant with the second paragraph in 2.2?	Agree	The second paragraph describes what the basis for determining land use and percent imperviousness was, and the future land use paragraph specifies the date that those data sources were accessed. We have added language to clarify that zoning and resulting land uses were used for the future condition.	2/10/2019

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Comment Number	Page Label	Subject	Author	Comments	Merrick Action	Merrick Response	Date Changed
21	6	Callout	jvilline	Just for my own clarification, this means tributaries that have drainage areas of 130 acres or greater at the outfall to First Creek, not those that have a point-of-origin with 130 acres of tributary area, correct? In other words the point-of-origin would typically have significantly less than 130 acres tributary area, but any discernible channel in the basin would still be considered a 'major drainageway' because it eventually becomes a channel with greater than 130 acres of tributary area prior to the confluence with First Creek. Or is it the case that only channel reaches with greater than 130 acres of tributary area are considered major drainageways?	No action	The tributaries are based on having at least 130 acres tributary at the outfall. To be considered a major drainageway that will be considered for improvements in subsequent phases of this study, a channel would have greater than 130 acres tributary to it. Typically, the upper-most subwatershed is approximately 130 acres, so condutis downstream would be considered a major drainageway.	1/17/2019
22	7	Text Box	SLiu	Include Legend for Arapahoe County	Agree	The Arapahoe County Boundary was added to Figure 2-1.	2/13/2019
23	7	Callout	TPatterson	Thicken the watershed boundary line and remove the black line. The double line is confusing.	Agree	Removed black area of interest line and thickened watershed boundary.	1/17/2019
24	7	Callout	TPatterson	Label as I-70 instead of Colfax	Agree	Labeled as "I-70" instead of "E Colfax Ave"	1/17/2019
25	7	Line	TPatterson	Add and label I-70 as the Study Limit.	Agree	Added line and label with I-70 as Study Limit	1/17/2019
26	7	Line	TPatterson	Cross out Study Area Boundary on Legend	Agree	Removed Study Area Boundary from Watershed Map	1/17/2019
27	7	Text Box	TPatterson	Unincorporated	Agree	Added "Unincorporated" to Arapahoe County on the Watershed Map	1/17/2019
28	8	Text Box	SLiu	under construction	Agree	The 8'x4' RCBC Pond D outlet pipe was labeled as "Newly Constructed" in Table 2-2.	2/13/2019
29	8	Inserted Text	TPatterson	As a Major Drainageway Plan, the scope of this study is to focus on the major tributaries of First Creek within the study area.	Agreed	Added to text	1/17/2019
30	8	Inserted Text	TPatterson	with tributary areas	Agreed	Changed in text	1/17/2019
31	8	Inserted Text	TPatterson	with	Agreed	Changed "in the Interactive Hydrology Map" to "within the Interactive Hydrology Map" throughout the report.	1/17/2019
32	8	Rectangle	TPatterson	Rearrange "The following narrative provides a description…"	Agreed	This sentence was moved to the second column on page 2-2.	2/10/2019
33	8	Inserted Text	TPatterson	Within	Agreed	Changed "for" to "within"	1/17/2019
34	8	Inserted Text	TPatterson	existing	Agreed	Added to text. Also changed Table 2-2 to Existing Major Structure Inventory"	1/17/2019
35	8	Inserted Text	TPatterson	s	Agreed	Added to text.	1/17/2019
36	8	Highlight	TPatterson	What resource did you use for this information? And discuss how this information was used in the hydrology. If it wasn't, maybe this is better suited in the future Hydraulic Analysis Section of the report.	Agree	The City of Aurora's existing storm sewer GIS layer and approved construction plans from the City and Arapahoe County were used to set the sizes, lengths, slopes, and materials of the culverts and storm sewer systems that were modeled for the baseline hydrology. Text was added to the report in section 2.3 to clarify.	2/10/2019
37	8	Cross-Out	TPatterson		Agree	Crossed out "to the outfall"	1/17/2019
38	8	Highlight	TPatterson	Please round these areas to the ones for all reach descriptions.	Agree	Rounded tributary areas to the one's place for all tributary descriptions.	1/17/2019
39	8	Note	sthompson	I didn't see that this tributary was shown/labeled on the hydrology maps.	Agree	This tributary has been labeled on the Interactive Hydrology Map. This tributary only a single subwatershed (ID 100 - 155 ac) so the length of the tributary is limited.	2/10/2019

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Comment Number	Page Label	Subject	Author	Comments	Merrick Action	Merrick Response	Date Changed
40	8	Callout	tclark	there is also a 4x6 RCBC (proposed with Sky Ranch Neighborhood B) crossing Monaghan Rd	Agree	This culvert was added to the list of existing structures in Table 2-2. Since this culvert was built after this project kicked off, it is not modeled in the SWMM routing. It will be considered in Alternative Analysis.	2/13/2019
41	8	Callout	tclark	Under Construction/Not yet accepted	Agree	Pond not accepted yet. Teresa said to mark as newly constructed. Changed in table 2-2	1/17/2019
42	8	Callout	TPatterson	List as "Newly Constructed"	Agree	Added to table 2-2	1/17/2019
43	8	Callout	TPatterson	List as "Newly Constructed"	Agree	Added to table 2-2	1/17/2019
44	8	Callout	TPatterson	6'x4' RCBC. There is another culvert for pedestrians only that is set higher.	Agree	The newly constructed 6'x4' drainage culvert was added to Table 2-2. However, the culvert was not included in the SWMM routing because it was not built at the start of this project.	2/13/2019
45	9	Cross-Out	TPatterson	Delete comma	Agree	Deleted comma	1/17/2019
46	9	Inserted Text	TPatterson	and Exposition Tributary	Agree	Added "and Exposistion Tributary" to the reach description title	1/17/2019
47	9	Rectangle	Tpatterson	Rogue picture label?	Agree	Removed label from text	1/17/2019
48	9	Ellipse	ahoward	Delete comma	Agree	Deleted comma	1/17/2019
49	9	Text Box	jvilline	combines	Agree	Fixed tense of verb from "combine to "combines"	1/17/2019
50	10	Highlight	TPatterson	Let's say "major regional flood event" so it's not thought that it was a major event on First Creek.	Agree	Changed in text	1/17/2019
51	10	Text Box	SLiu	a detention pond (Pond G) is proposed at the downstream end of the 1st Avenue Tributary, before in reaches the confluence with First Creek for the Sky Ranch Development. The tributary to this pond is 208-ac – can this pond function as a regional facility and should it be included in the study's model?	No Action	Future regional ponds in Sky Ranch are not included in the baseline hydrology. They will be included in the alternatives analysis.	2/1/2019
52	10	Note	sthompson	Add information about future conditions? This area is included in the Sky Ranch development plans under Arapahoe County land use review.	Agree	A sentence was added to the 1st Avenue tributary description to specify that this area is planned as part of the Sky Ranch development in Arapahoe County.	2/10/2019
53	10	Callout	ahoward	newly constructed	Agree	Added "newly" to text	1/17/2019
54	10	Ellipse	ahoward		Agree	Typo. Changed "in" to "it"	
55	10	Ellipse	ahoward		Agree	Removed extra space before comma.	1/17/2019
56	10	Ellipse	ahoward		Agree	Removed extra space before comma.	1/17/2019
57	11	Cross-Out	TPatterson	500-year only included in studies with FHAD.	Noted	The 500-year CUHP/SWMM was performed for existing and future conditions and peak runoff and volume was included in Table B-2 as a reference. The 500-year will not be included in future phases of this study and text was added to Section 3.2 to specify this.	2/10/2019
58	11	Inserted Text	TPatterson	and	Agree	"and" was added before 100-year.	2/10/2019
59	11	Sticky Note	TPatterson	For studies in developing watersheds we have started adding a historic flow condition (I=2% for all subwatersheds) to illustrate the effect of development. I recognize that it isn't written in the scope, but can you please add it to the hydrology report.	Agree	The historic (I=2%) 100-year storm condition was added to the modeling, appendices and report text.	2/10/2019
60	11	Cross-Out	TPatterson	500-year	Agree	Text was added to the report specifying that the 500-year was run for hydrology but will not be used in future phases of the study.	2/10/2019

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Comment Number	Page Label	Subject	Author	Comments	Merrick Action	Merrick Response	Date Changed
61	11	Text Box	SLiu	A zoning document for the major portion of the Sky Ranch Development was submitted recently, the % imperviousness for the Sky Ranch property may need to be updated per the proposed zones/land uses. This document is attached.	No Action	After review of the Sky Ranch Filing 2 zoning/ land use, the zoning meets the general intent of the 2018 Arapahoe County Comprehensive Plan. The slight changes in land use would not significantly affect the runoff in the tributary outfall channel. Therefore, the comp plan land uses remained in the CUHP analysis.	2/1/2019
62	11	Note	sthompson	and land development activities	Agree	Added "and land development activites" to text.	1/17/2019
63	11	Highlight	TPatterson	Add this table to Appendix B and reference it here.	Agree	The One-Hour Point Rainfall depth table was added to Appendix B as Table B-0.	2/7/2019
64	11	Highlight	TPatterson		No Action	Header was not highlighted for a purpose.	1/24/2019
65	12	Text Box	SLiu	More detention facilities proposed within the Sky Ranch Development - need to determine if they are functioning as regional facility and should they be included in the hydrologic analysis.	No Action	Future regional ponds in Sky Ranch are not included in the baseline hydrology. They will be included in the alternatives analysis.	2/1/2019
66	12	Inserted Text	TPatterson	wave	Agree	Added to text.	1/17/2019
67	12	Inserted Text	TPatterson	stage	Agree	Changed "storage-storage" to "stage-storage"	1/17/2019
68	12	Note	sthompson	Please see comments in the appendix -- it was noted that the stage-storage-discharge curve does not match the design information from the Phase III Drainage Report for Sky Ranch Neighborhood B. Status of construction is not known, but as-built information may be available from the County.	Disagree	The stage-storage and stage-discharge curves that were used in the model were the exact curves from the PhIII report. Subwatershed 600 was split into 600 and 602 to have the tributary area to the pond be closer to what the pond was designed for.	1/24/2019
69	12	Note	sthompson	It is understood that the future Sky Ranch ponds will be included in the Alternatives Analysis, assuming public ownership and maintenance, either by SEMSWA or the Metro District.	Agree	The other proposed ponds within the Sky Ranch development that could be considered regional/sub-regional were not included in the baseline hydrology as they are not existing infrastructure. These ponds will be included in the Alternatives Analysis assuming public ownership.	2/10/2019
70	12	Callout	tclark	There are multiple other ponds proposed within the Sky Ranch Development, three of which will have a tributary area greater than 130 acres (Pond C, G, H) and could be considered regional/sub-regional	No action	See response #69 above	2/10/2019
71	12	Callout	TPatterson	Note in the text that there are future regional detention basins planned in the Sky Ranch Development that will be considered in the Alternatives Analysis.	Agree	Text was added to Section 3.4 specifying that the proposed regional ponds in Sky Ranch will be considered in the Alternatives Analysis.	2/10/2019
72	13	Text Box	SLiu	369, see page 2-4	Disagree	The area of the Monaghan Tributary in Table 3-3 that was highlighted (365 acres) was originally from the Moser 2010 MDP. This study's tributary area (369 acres) is to the right in the table.	2/13/2019
73	13	Text Box	SLiu	448, see page 2-4	Disagree	The area of the 1st Avenue Tributary in Table 3-3 that was highlighted (403 acres) was originally from the Moser 2010 MDP. This study's tributary area (448 acres) is to the right in the table.	2/13/2019
74	13	Cross-Out	TPatterson		Disagree	The 500-year peak flows and volumes are still presented in Table B-2.	
75	13	Inserted Text	TPatterson	and	Disagree	The 500-year peak flows and volumes are still presented in Table B-2.	2/13/2019
76	13	Sticky Note	TPatterson	So many things are changing between the two studies (Trib size, percent imperviousness, and rainfall) it is hard to pinpoint it to one thing. I think that it is better to eliminate the this column and add a paragraph to Section 3.7 that	Agree	The Comparison column from Table 3-3 was removed and text was added to Section 3.7 that discusses the lower rainfall due to using CUHP 2.0.0. Anomalies were also discussed in this section instead of in the table.	2/13/2019

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Comment Number	Page Label	Subject	Author	Comments	Merrick Action	Merrick Response	Date Changed
				discusses the trend (decrease due to lower rainfall) and notes the anomalies that occur.			
77	20	Text Box	TPatterson	Please verify slopes of the conveyance elements listed below. They are either very flat or could potentially be steeper than actual conditions.	Agree	The model was reviewed and slopes were altered based on topographic information or construction plans.	2/7/2019
78	20	Text Box	TPatterson	Even though the lines in SWMM representing the conveyance links is purely graphical, the following conveyance element lines are confusing because they geographically backtrack. Please revise the vertices so at least they are not crossing. Simplifying the line is acceptable. Elements: C8, C32, and C65.	Agree	There was an error when the model was converted between PCSWMM and EPASWMM. The nodes have been corrected so they do not geographically backtrack.	2/15/2019
79	20	Text Box	TPatterson	Please include: - Rainfall Distribution table - Overall grading plan from CDs for Sky Ranch Pond D	Agree	The rainfall distribution table was added to Appendix B as Table B-0. The overall grading plan for Sky Ranch Neighborhood B and Pond D are included in Appendix B.	2/7/2019
80	21	Callout	SLiu	Arapahoe County Staff will proivde the latest Zoning documents for this portion of the Sky Ranch	No Action	See response to comment #61 above.	2/7/2019
81	21	Callout	SLiu	change the use to Commercial and Business Park per the recent submitted zoning document	No Action	See response to comment #61 above.	2/7/2019
82	21	Callout	tclark	there are three other ponds with have a greater than 130 acre tributary area that are proposed with the Sky Ranch Development	Disagree	Per UDFCD, don't show future Sky Ranch Ponds on Hydrology Map. They will be included in the Alternatives Analysis	2/10/2019
83	21	Text Box	tclark	Sky Ranch has recently submitted a second filing, The draft General Development Plan (zoning documents) conflicts slightly with the zoning shown in this map.	No Action	See response to comment #61 above.	2/1/2019
84	21	Callout	TPatterson	Do not show these here. We will address these in the alternatives analysis.	Agree	Future Sky Ranch Ponds are not shown on the Hydrology Map as they are not existing infrastructure. They will be included in the Alternatives Analysis.	1/18/2019
85	21	Line	TPatterson	How big is the area D/S of the County boundary? Should this be subdivided? Detention Basin Pond D is U/S of the boundary.	Agree	The area downstream of Pond D and the county boundary is approximately 18 acres. Subwatershed 600 was divided near the county boundary into subwatersheds 600 (downstream) and 602 (tributary to pond). This division was made to better model the actual performance of the pond.	2/7/2019
86	21	Sticky Note	TPatterson	Suggestion: Can controls be added to the map for the Tributary_Paths and Street labels that allow the user to toggle the street and tributary labels on and off? It is hard to geographically place things in this study area without these labels. I originally was going to suggest that they stay on for all layers, but then they cover too much information.	Agree	Links have been created to toggle the street and tributary labels on/off within the Interactive Map Controls.	2/10/2019
87	21	Text Box	TPatterson	Label Gun Club Trib	Agree	Gun Club label was added to Figure B-1.	2/7/2019
88	21	Text Box	TPatterson	Add an additional First Creek label	Agree	Added an additional First Creek label to map	2/7/2019
89	21	Text Box	TPatterson	Label Mississippi Trib	Agree	Added Mississippi Trib label to map	2/7/2019

TABLE A-1
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Comment Number	Page Label	Subject	Author	Comments	Merrick Action	Merrick Response	Date Changed
90	22	Callout	SLiu	unclear what conveyance 15 is.	Agree	Originally, conveyance element 15 was an overflow pipe from Pond 1 (Sky Ranch Pond D) because more area was tributary to the pond than the pond was designed for. However, the subwatershed has been divided to better model this Pond and so an overflow element is not needed. Conveyance element 15 is now a channel connecting the outlet of Pond D to the outfall of the Monaghan tributary at Design Point 600.	2/6/2019
91	22	Callout	TPatterson	since the channel downstream of the detention basin is open channel, I don't understand the need for the overflow. Is this just modeling the pond outfall pipe and overflow separately? I think this should change once the basin is subdivided properly because there will be a conveyance channel downstream of Pond 1.	Agree	The overflow element was removed and element 15 is now an open channel downstream of Pond 1	2/6/2019
92	22	Callout	SLiu	need to determine if the proposed pond in Sky Ranch be included in the model.	No Action	The proposed Sky Ranch ponds will be considered in the alternatives phase of the study but not included in the baseline hydrology.	2/6/2019
93	22	Polygonal Line	TPatterson	Line overflow 30 at future Alameda on SWMM Schematic	Agree	Added overflow link 30 to SWMM Schematic	1/18/2019
94	22	Text Box	TPatterson	30	Agree	Added overflow link 30 to SWMM Schematic	1/18/2019
95	22	Rectangle	TPatterson	May need to modify if Subwatershed 600 is subdivided.	Agree	The SWMM Routing schematic was updated to show the split subwatersheds 600 and 602 and the changes in routing.	2/10/2019
96	22	Callout	tclark	there is another pond with a tributary area greater than 130 acres on this tributary that Sky Ranch is considering sub-regional, this pond MAY be maintained by SEMSWA, however maintenance responsibility has not yet been determined.	No action	Proposed regional ponds in Sky Ranch will be included in the alternatives analysis.	2/10/2019
97	22	Text Box	tclark	there are two other ponds with a tributary area greater than 130 acres on this tributary that Sky Ranch is considering sub-regional, these ponds MAY be maintained by SEMSWA, however maintenance responsibility has not yet been determined.	No action	Proposed regional ponds in Sky Ranch will be included in the alternatives analysis.	2/10/2019
98	22	Callout	TPatterson	Do not show these here. We will address these in the alternatives analysis.	Agree	Proposed regional ponds in Sky Ranch will be included in the alternatives analysis.	2/10/2019
99	23	Sticky Note	TPatterson	Please add tributary names and land mark locations if pertinent to hydrographs. Suggestion: Far more than needed to illustrate hydrograph patterns and changes due to land use changes. Can we limit this to 1 for most with 2 or 3 for the larger tribs at key locations? I would recommend shortening the timeline to 5 hours to provide more value to the page.	Agree	Tributary names and land mark locations were added to the titles of each hydrograph. The number of hydrographs were reduced to 1 for most and 3 for the Monaghan and Powhaton South (larger) tributaries. The timeline for all hydrographs were also shortened to 5 hours for clarity.	2/6/2019
100	31	Line	TPatterson	Cross out 500-year	Agree	The 500-year was removed from all peak flow profiles.	2/10/2019
101	31	Line	TPatterson	No 500-year	Agree	The 500-year was removed from all peak flow profiles.	2/10/2019
102	31	Sticky Note	TPatterson	Add historic 100-year once run.	Agree	The historic (I=2%) 100-year flows were added to the peak flow profiles.	2/10/2019
103	32	Sticky Note	TPatterson	Same comments for this one and the rest.	Agree	The 500-year was removed from all peak flow profiles and the historic 100-year was added.	2/10/2019
104	40	Highlight	TPatterson	This is an improvement channel. The imperviousness will not change in the future.	Agree	The imperviousness of 2.0% was maintained in existing and future conditions for subwatershed 305.	1/29/2019
105	40	Highlight	TPatterson	This is an improvement channel. The imperviousness will not change in the future.	Agree	The imperviousness of 4.9% was maintained in existing and future conditions for subwatershed 320.	1/29/2019

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106	40	Rectangle	TPatterson	Values should be between 0.0007 and 0.0018 depending on the soil type.	Agree	All subwatershed have been updated to have decay coefficients between 0.0007 and 0.0018.	1/29/2019
107	41	Callout	SLiu	may need to update	No Action	See response to comment #61 above.	2/7/2019
108	41	Rectangle	TPatterson	Why isn't this one 0.035, too?	Disagree	For subwatershed 1105, the future imperviousness is less than 15% (12.3%) so the future pervious value is 0.4 instead of 0.35.	1/29/2019
109	41	Rectangle	TPatterson	Same comment	Agree	All subwatershed have been updated to have decay coefficients between 0.0007 and 0.0018.	1/29/2019
110	41	Text Box	tclark	I compared to Sky Ranch filing 2, there is conflicting information between this CUHP model and the existing conditions as shown in the Phase II Drainage report.	No Action	See response to comment #61 above.	2/7/2019
111	41	Callout	TPatterson	You determine if this needs updating based on the what's been decided with updating/not updating the land use.	No Action	See response to comment #61 above.	2/7/2019
112	42	Rectangle	TPatterson	Round to nearest integer	Agree	Table B-2: Rounded Contributing Area to the nearest acre.	2/1/2019
113	43	Callout	tclark	the future impervious percentage when compared to the draft Phase II Drainage report for Sky Ranch filing 2 is low	No Action	See response to comment #61 above.	2/7/2019
114	48	Highlight	TPatterson	Even though this is a dummy link, the slope should not be negative.	Agree	Links have been updated so that no slope is negative	1/30/2019

MINUTES

First Creek Tributaries

Master Drainage Plan - Alternatives

Progress Meeting, Thursday, October 24th, 2019, 2:00 pm – at Merrick

Attendees:

Name	Organization	Phone	Email
Teresa Patterson	MHFD	303-455-6277	tpatterson@udfcd.org
Sam Miller	City of Aurora	303-739-7368	samiller@auroragov.org
Craig Perl	City of Aurora	303-739-7532	cperl@auroragov.org
Sue Liu	Arapahoe County	720-874-6500	sliu@arapahoegov.com
Stacey Thompson	SEMSWA	303-858-8844	sthompson@semswa.org
Jeanne Boyle	Merrick	303-800-9036	jboyle@merrick.com
Clare Steninger	Merrick	303-800-9074	clare.steninger@merrick.com
Jennifer Goldman	Merrick	303-353-3712	jennifer.goldman@merrick.com

Meeting Objective : To discuss and clarify comments made on the draft Alternatives Analysis report.

1. Alternative Review Comment Discussion
   a. Naturalized Channels
      i. The text of the report stated that the maximum average velocity must be 7 ft/s or less but a recommendation of 5 ft/s or less is preferred since there is erosive soils in this area.
      ii. However, the natural channel designs focused on getting the shear stress to be below 1.2 psf which is the more restrictive criteria. Any armoring needed for higher velocities will be determined by developers with future designs. Therefore, the natural channel designs do not need to be altered for the velocity criteria.
      iii. The reference to the velocity criteria will be removed from the text.
   b. Water Quality in large watersheds
      i. A comment was made that water quality should not be included in regional ponds with tributary areas greater than 1 square mile.
      ii. Merrick will not change the stage-storage-discharge curves but will remove reference in the text and on the plans about water quality for these ponds. Merrick will add a note to the plans that they are flood-control ponds only and water quality must be provided offline.
   c. Detention Release Rates
      i. Merrick designed proposed ponds to release at 90% of historic flows. However, the criteria to release at 90% of this historic rate is for offline detention ponds, not for ones on the main stem. Releasing at 90% from offline ponds typically models the historic flows on the main stem.
      ii. For this study, the detention ponds should release at historic flows. Merrick will change the release rates from all proposed detention ponds.
   d. Sky Ranch Reports
      i. Merrick used the *Sky Ranch Filing 2 Phase I Drainage Report* (May, 2019) by CVL Consultants to inform the alternative designs for the Monaghan and 1st Avenue Tributaries. There has since been an updated report entitled *Sky Ranch Neighborhoods A, C, D, E, & F Phase I Drainage Report*.
      ii. Merrick recognizes that there is a newer report, but for the Alternatives phase, we will proceed with the information that was provided at the outset of this phase (i.e. use the May 2019 report).
      iii. The new report may be considered during the conceptual design phase.
   e. Sky Ranch Ponds
      i. Pond C – the stage-storage and stage-discharge curves that accompanied the May 2019 report was used in the proposed alternative design.
      ii. Pond H – the May 2019 report showed two ponds east of proposed road F Street: Pond J and Pond H.
         1. Per previous project sponsor discussions, Ponds H and J were combined for this MDP into a single representative pond east of F Street. Merrick did not use the stage-storage-discharge curves from the May 2019 report. Rather new curves were developed to account for all tributary area east of F Street.
         2. From sponsor knowledge, Sky Ranch has changed its plans and will also have a single pond east of F Street.
         3. To avoid confusion, Merrick will not reference Sky Ranch pond names on the Alternatives Maps. The ponds designed for this MDP will be renamed to match the naming convention in the other tributaries.
         4. Merrick will increase the area of subwatershed 812 to be similar to the tributary area assumed for Sky Ranch.
   f. Harvest Tributary Alternatives
      i. Alternatives 1A and 1B include recognizing ponds with tributary area less than 130 acres.
         1. Aurora criteria may not allow these ponds to be eligible for City assistance/ maintenance due to tributary size being less than 130 acres.
         2. The Eastern Hills pond may be easier to adopt since it has not been built yet.

3. With only recognizing the Eastern Hills pond, there would be some street flow in the 100-year event, but it would be within the allowable street capacity.
4. The sponsors asked Merrick to compare Alt 1A versus 1B to determine if adopting the Adonea pond provides more benefit other than reducing street flow and cost. The recommended plan may be changed to Alternative 1A depending on these findings.

ii. Alternative 2 involves upsizing the pipe system in the Traditions development

1. Currently, the alternative assumes remove and replace existing pipe. This alternative is not desired since sponsors would prefer to use acceptable existing infrastructure in the right-of-way.
2. The project sponsors agreed that the pipe alternative should be changed to show an additional parallel pipe and new structures instead of remove/ replace existing.

g. Unit Costs

i. Naturalized Stream Corridor

1. A comment was made that the unit cost for the naturalized stream corridor seemed low. It was suggested to use the high-range excavation as the basis for unit cost instead of mid-range.
2. The higher unit cost for the excavation would likely offset the cost of rock armoring. Merrick will not include additional cost for rock.
3. Teresa will send examples of some naturalized channel cost from other fee-in-lieu projects for Merrick to compare unit costs.
4. Merrick will add a 12-foot maintenance trail to the stream corridors for maintenance access. This will be reflected in the text, on the maps, and in the costs.

ii. Recognizing non-regional ponds

1. The unit cost for formalizing non-regional ponds in an alternative was unclear.
2. No cost for land acquisition will be applied to the Eastern Hills ponds because they will be required to put detention onsite anyway.
3. The potential conversion of the Adonea pond from private to public may be more costly. Aurora may already have an agreement about this pond since it discharges to City pipes. Unless there is an existing drainage easement and maintenance agreement with the metro district, the $500/acre to convert private to public pond will be maintained for the Alternatives. However, this cost may be adjusted for conceptual design if this alternative is selected.

2. Recommended Plan

a. For the majority of the tributaries, there is a single alternative, so these will be the recommended alternatives.
b. The benefits of the different alternatives for the Harvest tributary will be reevaluated before finalizing the recommended plan.

3. Public Meeting

a. With the holidays coming up, project sponsors agreed to hold the public meeting in January 2020 to hopefully get more attendance.
b. Sam will investigate locations to hold the public meeting somewhat near the study location.
c. Teresa will organize the mailing list to send notice postcards. Merrick will post information on the project website

4. Schedule

a. Alternatives Report – Merrick will finalize the alternatives report as soon as possible.
b. Selected Plan – project sponsors will select a plan after the public meeting is held. This will be presented in the Conceptual Design Report.
c. Conceptual Design – a kickoff meeting with all sponsors was deemed unnecessary. Teresa will work with Merrick about what deliverables are expected for this phase.

5. Other/ Action Items

a. Merrick will add a newer aerial image to the alternatives maps. The aerial for the baseline hydrology will remain unchanged.
b. Sue will send latest Sky Ranch report to Merrick.
c. Teresa will send unit costs for naturalized channel construction to Merrick.
d. Teresa will organize the mailing list for the public meeting.
e. Sam will investigate potential locations for the public meeting

TABLE A-2
Response to Draft Alternatives Report Comments

The following are responses to comments received from the project sponsors regarding the draft Alternatives Analysis report for the First Creek Tributaries (Upstream of I-70) Master Drainageway Plan.

Comment Number	Page Label	Subject	Author	Comments	Merrick Action	Merrick Response	Date Changed
1	5	Text Box	SPL	Cross out Sky Ranch Filing 2 Phase I Drainage Report Draft, replace with Sky Ranch Neighborhoods A, C, D, E & F Phase I Drainage Report	No Action	While reports may have been updated, Sky Ranch Filing 2 Phase I Drainage Report (dated May 2019) was used to inform the alternatives analysis. Therefore, the reference remains unchanged.	10/18/2019
2	8	Text Box	SPL	Cross out Minor, replace with Major	Agree	Changed in text	10/18/2019
3	14	Sticky Note	TPatterson	Include level of service (i.e., 10-yr, 50-yr).	Agree	A column was added to Table 4-1 describing the level of service (i.e. storm event) for future flow conditions.	11/19/2019
4	15	Highlight	TPatterson	I'm assuming it's because the drainage report included detention and we do not when considering baseline hydrology.	Agree	Yes, the design of the 10'x6' culvert under the future Alameda in the Harmony development assumed there would be detention upstream that we did not consider for this regional study. Text was added to clarify the assumption of no detention upstream of this culvert.	11/19/2019
5	15	Sticky Note	TPatterson	Do you have reason/theory why they were designed under capacity during development? Did they have much different hydrology?...perhaps existing flows instead of fully-developed flows. Or were the detention basins included in their fully developed condition hydrology and now our analysis without them falls short? I'm not saying anything is wrong in this report, just trying to gain a larger picture understanding of why this happens. Either way, we should probably discuss in the text why capacity is insufficient.	Agree	The master drainage plan for the Traditions development assumed there would be detention upstream so the design flows for these storm sewers are lower than what is shown in the baseline hydrology. It was assumed detention in Eastern Hills development south of Alameda Avenue would release at 91 cfs and detention from Adonea Filing 2 West Pond would release at 85 cfs. The storm sewer was sized based on these detained flows. Discussion was added to Section 4.3 of the text.	11/19/2019
6	15	Highlight	TPatterson	Omit this text. There is no reason to include short roadway culverts in the hydrology model for an MDP.	Agree	Removed from text.	10/18/2019
7	15	Highlight	TPatterson	change to "Layers"	Agree	Changed in text	10/18/2019
8	15	Highlight	TPatterson	Layer	Agree	Changed in text	10/18/2019
9	15	Highlight	TPatterson	Layer	Agree	Changed in text	10/18/2019
10	15	Sticky Note	TPatterson	What is the street capacity based on? Aurora Criteria of allowable street gutter flow (12"?)? Or something else? Need to discuss the basis of determining street capacity. If it differs for the different areas, then consider adding a column to this table indicating what determines the capacity.	Agree	Aurora criteria allows street gutter flow up to 12" above the flow line. Street capacity calculations and values in Table 4-3 were changed to reflect this depth. However, along 1st Avenue between Little River and Kellerman Street, the actual grading would not allow for 12" depth in the street without impacting structures. The limiting depth for this street was chosen as the back of walk (9.4 inches) so structures would not be impacted. This depth was added to Table 4-3 with corresponding street capacity flow. Street cross sections and slopes that were analyzed were taken from the *Construction Plans for Traditions - Filing No. 2* by CVL Consultants (September 2004).	11/21/2019
11	15	Highlight	TPatterson	Layer	Agree	Changed in text	10/18/2019
12	15	Highlight	TPatterson	Doesn't match Figure D-3A	Agree	Figure D-3 was changed to match the correct flow at this location of 1,327 cfs.	10/18/2019
13	15	Highlight	TPatterson	I'm assuming it's because the drainage report included detention and we do not when considering baseline hydrology.	Agree	Yes, the culvert under Powhaton Road was designed assuming there was detention upstream. Since this study did not include non-regional detention in the baseline hydrology, the culvert is shown as undersized. Text was added to clarify this in Section 4.3.	11/19/2019
14	15	Highlight	TPatterson	Doesn't match Figure D-3A	Agree	Figure D-3 was changed to match the correct capacity of this culvert of 553 cfs.	10/18/2019
15	15	Highlight	TPatterson	Doesn't match Figure D-3A	Agree	Figure D-3 was changed to match the correct flow at this location of 1,278 cfs.	10/18/2019
16	15	Highlight	TPatterson	Developing within these watersheds without stormwater quality treatment…	Agree	Changed in text.	10/18/2019

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Comment Number	Page Label	Subject	Author	Comments	Merrick Action	Merrick Response	Date Changed
17	16	Highlight	TPatterson	historic peak flows. 90% pertains to smaller basins with less tributary area and not at this level of regional flow control.	Agree	Per discussion with project sponsors, proposed detention will be released at historic rates. The design and text have been adjusted to release at historic peak flows to First Creek.	11/19/2019
18	16	Highlight	TPatterson	Needs to be 5 ft/s or less with the highly erosive soils in the FC watershed.	Agree	Per sponsor discussion this criterion has been removed because the controlling criteria for the natural channel design is shear stress.	10/28/2019
19	16	Highlight	TPatterson	Aurora requires 2-ft of freeboard	Agree	The stream management corridors were widened to include 2 feet of freeboard above the 100-year water surface and a 12-foot maintenance trail. Reference in Section 5.2 of the text was changed to 2 feet of freeboard.	10/28/2019
20	16	Highlight	TPatterson	Regional detention basins larger than 1 sq. mile should not include WQ and EURV, but be designed for 100-year flood control only. WQ and EURV will need to be provided offline from the tributary when the stream tributary area exceeds 1 sq. mile.	Agree	Per sponsor discussion, the stage-storage curves for ponds with contributing area greater than 1 square mile was not changed, but reference in the text and on the plans about water quality for these ponds was removed. Notes were added to the alternative plans and in the text that regional ponds with tributary area greater than 1 square mile will be flood-control ponds only and water quality must be provided offline.	10/28/2019
21	16	Highlight	TPatterson	Again, no WQ and EURV should be included for detention with tributary area greater than 1 sq. mile.	Agree	See comment 20 response.	10/28/2019
22	16	Highlight	TPatterson	High functioning, low maintenance streams incorporate geomorphic principles that mimic natural channel processes.	Agree	Added in text	10/28/2019
23	16	Highlight	TPatterson	required freeboard	Agree	The freeboard requirement of 2 feet above the 100-year water surface was changed in Section 5.3 of the text.	10/28/2019
24	16	Highlight	TPatterson	Again, only when less than 1 sq. mile trib area. Otherwise water quality needs to be provided offline.	Agree	See comment 20 response.	10/28/2019
25	17	Highlight	TPatterson	Replace with "Engineers designing the actual channel improvements at the time of development will need to provide additional geomorphic analysis to provide the geometry that will support a high functioning, low maintenance stream."	Agree	Changed in text.	10/28/2019
26	17	Highlight	TPatterson	Highlights WQCV, EURV, and 100-year storage volumes	Agree	See comment 20 response.	10/28/2019
27	17	Highlight	TPatterson	historic peak flow	Agree	Changed in text.	10/28/2019
28	17	Sticky Note	TPatterson	Is there a figure in the report that someone could reference when reading this paragraph?	Agree	The overall drainage map from the *Sky Ranch Filing 2 Phase I Drainage Report* by CVL Consultants (May 2019) is included in Appendix D for reference.	11/20/2019
29	17	Highlight	TPatterson	change text if not applicable	Agree	The text describing the Outlet Works unit costs were changed to clarify that WQCV/EURV are not included for tributary areas greater than 1 square mile.	11/20/2019
30	17	Highlight	TPatterson	Highlights WQCV, EURV	Agree	See comment 20 response.	10/28/2019
31	17	Highlight	TPatterson	This unit price is really low. Does it account for any rock import or revegetation? For narrower SMC, may need to increase the percentages on incidentals to be more in line with actual project costs.	Agree	The unit price for Stream Management Corridors presented in the draft report were based on mid-range excavation and did not include rock import or revegetation. Per discussions with the project sponsors, unit costs for the final alternatives report are based on high-range excavation and no additional costs were included for rock. Unit costs in the text and the appendices were updated.	10/28/2019
32	17	Highlight	TPatterson	for narrow corridors, consider using a high-range excavation cost instead of mid because most stream contractors are not equipped to move large quantities of dirt and there is a fair amount of fine grading.	Agree	Per discussion with project sponsors, the unit cost for the stream management corridors were changed to be based on high-range excavation costs.	10/28/2019

TABLE A-2
Response to Draft Alternatives Report Comments

Comment Number	Page Label	Subject	Author	Comments	Merrick Action	Merrick Response	Date Changed
33	17	Callout	SPL	Pond H has tributary area greater than 130-ac	Disagree	*Sky Ranch Filing 2 Phase I Drainage Report* (May 2019) is the report that was used as reference for the alternative phase of this report. From this drainage report, Ponds H and J do not have tributary area of 130 acres or greater individually. This MDP therefore proposes a representative pond east of future F Street (Pond 812). The proposed ponds designed for this MDP have been renamed to match the naming convention in the other tributaries and not use the Sky Ranch naming convention.	10/28/2019
34	17	Ellipse	SPL	References comment 33	No Action	See comment 33 response.	10/28/2019
35	17	Text Box	SPL	Sky Ranch Neighborhoods A, C, D, E & F	No Action	While we understand there are updated reports, the referenced report that was used to inform the Alternatives Analysis is named *Sky Ranch Filing 2 Phase I Drainage Report* by CVL Consultants (May 2019)	10/28/2019
36	17	Ellipse	SPL	Circles report name	No Action	See comment 35 response.	10/28/2019
37	17	Line	SPL	Crosses out report name	No Action	See comment 35 response.	10/28/2019
38	17	Ellipse	SPL	Circles report name	No Action	See comment 35 response.	10/28/2019
39	18	Highlight	TPatterson	replace with "vegetation management"	Agree	Changed "mowing" to "vegetation management" in text.	10/28/2019
40	18	Highlight	TPatterson	revise	Agree	Changed "90% of the historic rates" to "historic rates" in text.	10/28/2019
41	18	Highlight	TPatterson	Layer	Agree	Changed "Map" to "Layer" in text.	10/28/2019
42	18	Highlight	TPatterson	reshape the channel to provide a healthy stream management corridor and contain the 100-year storm event	Agree	Changed in text.	10/28/2019
44	18	Highlight	TPatterson	Layer	Agree	Changed "Map" to "Layer" in text.	10/28/2019
45	18	Highlight	TPatterson	This seems really narrow. Can you provide the backup for these?	No Action	The cross-section design can be found in Table D-1 in Appendix D. The Gun Club channel appears narrow because it is downstream of a proposed detention pond, so the flows are smaller creating a smaller channel footprint required.	10/28/2019
46	18	Sticky Note	TPatterson	Add Qin	Agree	Inflows to each proposed pond were included in the text and the alternative maps.	10/28/2019
47	18	Sticky Note	TPatterson	It would be helpful to provide links to the figures for each of these tributary Alternatives Maps.		Links have been provided in the text to connect to the Alternative Maps in Appendix D.	11/22/2019
48	18	Highlight	TPatterson	was	Agree	Changed in text	10/28/2019
49	18	Sticky Note	TPatterson	Did you also look at adding a second pipe instead of replacing the existing pipe? Difference in cost would just be the pipe cost difference because the street would still be torn up and the manholes replaced.	Agree	The cost for adding additional pipes, manholes, and junction structures was more advantageous than removing and upsizing existing pipe. Therefore, Alternative 2 on the Harvest Tributary has been changed to be addition of parallel storm pipes.	10/28/2019
50	19	Highlight	TPatterson	recently constructed	Agree	Changed "under construction" to "recently constructed" in text.	10/28/2019
51	19	Sticky Note	TPatterson	Add Qin	Agree	Inflows to each proposed pond were included in the text and the alternative maps.	10/28/2019
52	19	Sticky Note	TPatterson	Add Qin	Agree	Inflows to each proposed pond were included in the text and the alternative maps.	10/28/2019
53	19	Sticky Note	TPatterson	Add Qin	Agree	Inflows to each proposed pond were included in the text and the alternative maps.	10/28/2019
54	19	Text Box	SPL	Sky Ranch Neighborhoods A, C, D, E & F	No Action	See comment 35 response.	10/28/2019
55	19	Ellipse	SPL	Circles report name	No Action	See comment 35 response.	10/28/2019

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Response to Draft Alternatives Report Comments

Comment Number	Page Label	Subject	Author	Comments	Merrick Action	Merrick Response	Date Changed
56	19	Callout	SPL	Need to verify - 20.66 ac-ft shows on Phase I study	No Action	The stage-storage and stage-discharge curves for Sky Ranch Pond C were taken directly from the Filing 2 (May 2019) SWMM model. However, the CUHP inputs for our study are slightly different than what was assumed for the Filing 2 model which is the cause for the slightly different volumes. We based the MDP design on what we observed in our SWMM model.	11/20/2019
57	19	Ellipse	SPL	References comment 56		See comment 56 response	11/20/2019
58	19	Ellipse	SPL	References comment 59		See comment 59 response.	11/20/2019
59	19	Text Box	SPL	verify with Figure D-6 - shows Q=649cfs		649 cfs refers to the inflow to Pond D. The maps were revised to include both the inflow and the outflow to the existing pond.	11/20/2019
60	20	Sticky Note	TPatterson	Add Qin	Agree	Inflows to each proposed pond were included in the text and the alternative maps.	10/28/2019
61	20	Sticky Note	TPatterson	Add Qin	Agree	Inflows to each proposed pond were included in the text and the alternative maps.	10/28/2019
62	20	Highlight	TPatterson	Trib Area to H should be big enough. J is not.	Agree	The text has been revised. The ponds designed for this MDP were renamed to match the naming convention in the other tributaries.	10/28/2019
63	20	Sticky Note	TPatterson	Add Qin	Agree	Inflows to each proposed pond were included in the text and the alternative maps.	10/28/2019
64	20	Sticky Note	TPatterson	Add Qin	Agree	Inflows to each proposed pond were included in the text and the alternative maps.	10/28/2019
65	20	Sticky Note	TPatterson	Add Qin	Agree	Inflows to each proposed pond were included in the text and the alternative maps.	10/28/2019
66	20	Text Box	SPL	Sky Ranch Neighborhoods A, C, D, E & F	No Action	See comment 35 response.	10/28/2019
67	20	Line	SPL	Crosses out report name	No Action	See comment 35 response.	10/28/2019
68	20	Ellipse	SPL	Circles "Ponds H and J do not individually meet the requirement for regional pond recognition (i.e. tributary area greater than 130 acres)"	No Action	See comment 33 response.	10/28/2019
69	20	Text Box	SPL	May need to verify - Does Pond G WQCV include Pond J (assume Pond H is the regional facility)? or Pond G WQCV should be the sum of entire tributary to it (including tributary to pond H and J)?	No Action	New representative ponds (800 and 812) were designed for this MDP. Curves and characteristics from the Sky Ranch ponds were not used for the design of the ponds on the 1st Avenue Tributary. WQCV was included for only the direct tributary area for each pond.	11/19/2019
70	20	Text Box	SPL	Sky Ranch Neighborhoods A, C, D, E & F	No Action	See comment 35 response.	10/28/2019
71	20	Line	SPL	Crosses out report name	No Action	See comment 35 response.	10/28/2019
72	20	Text Box	SPL	Pond H has tributary area greater than 130-ac. Please revise the statement.	No Action	See comment 33 response.	10/28/2019
73	20	Ellipse	SPL	References comment 72	No Action	See comment 33 response.	10/28/2019
74	22	Highlight	TPatterson	Remove	Agree	Reference to 90% of historic has been removed from the text.	10/28/2019
75	22	Highlight	TPatterson	historic	Agree	Changed text to "at historic rates" instead of "at less than existing".	10/28/2019
76	41	Callout	SPL	Subbasin Boundaries Map - Basin missing	Disagree	Subbasin 620 was not included as part of the Baseline Hydrology since it did not follow existing drainage patterns to the Monaghan Tributary. Therefore, it is not shown on Figure B-1. However, subbasin 620 was added as part of the alternatives hydrology to better mimic planned development. See Figure D-0 for the delineation.	11/11/2019
77	41	Callout	SPL	Land Use Map - The land use map of Sky Ranch should be updated	No Action	Since the Sky Ranch plans (specifically land use) continue to change, it was decided after discussion with project sponsors not to continue to update the baseline hydrology.	11/11/2019

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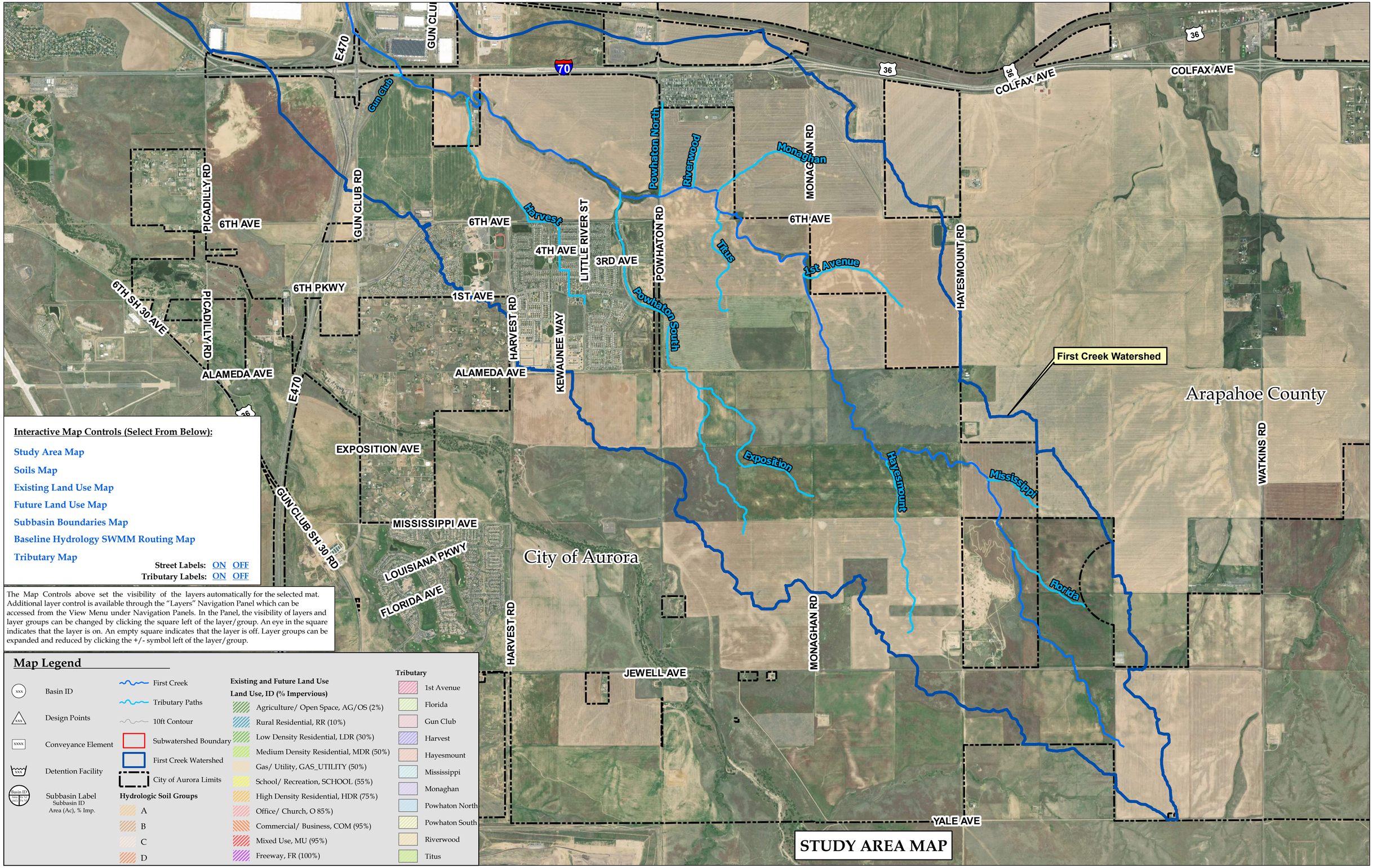
Comment Number	Page Label	Subject	Author	Comments	Merrick Action	Merrick Response	Date Changed
78	41	Ellipse	SPL	References comment 76	No Action	See comment 76 response.	10/28/2019
79	41	Ellipse	SPL	References comment 77	No Action	See comment 77 response.	10/28/2019
80	42	Highlight	SPL	References comment 82	No Action	See comment 76 response.	10/28/2019
81	42	Highlight	SPL	References comment 83	No Action	See comment 83 response.	10/28/2019
82	42	Text Box	SPL	Include basin 620- see Figure D-0	No Action	See comment 76 response.	11/11/2019
83	42	Text Box	SPL	Include basins 807, 812, 802 - see Figure D-0	No Action	Subcatchments 802, 807 and 812 were created as part of the alternatives hydrology to mimic planned development. They are not part of the Baseline Hydrology and therefore are not included on the Baseline Hydrology SWMM Routing Schematic (Figure B-2).	11/11/2019
84	409	Sticky Note	TPatterson	- Can you shade Aurora, so we know which jurisdiction is which? - Please label the tributaries in the study	Agree	The City of Aurora is shaded in light blue to distinguish jurisdictions more clearly. Tributaries have been labeled and have a toggle to switch labels on/ off.	11/11/2019
85	409	Callout	SPL	this portion should included within 812	Agree	The alternatives hydrology has been updated to include this area in subcatchment 812.	10/28/2019
86	409	Ellipse	SPL	References comment 85	No Action	See comment 85 response.	10/28/2019
87	410	Sticky Note	TPatterson	- Please add a key map to each of the tributary figures. It is hard to understand the system when there is no context to the bigger picture. - Can we add the First Creek effective 1% SFHA to the tributary maps to give context to the First Creek/tributary interface?	Agree	A key map was added to each tributary figure. The 1% SFHA Floodplain was added to the alternative maps.	11/13/2019
88	410	Rectangle	TPatterson	These only apply to Harvest Trib. Please remove from other tributary maps.	Agree	The options for the Harvest Alternatives were removed from other tributary maps. The Alternatives are only presented on Figure D-2 for the Harvest Tributary.	11/13/2019
89	410	Sticky Note	TPatterson	Add Qin for all detention basin labels	Agree	Qin and Qout have been added to all detention alternatives.	11/11/2019
90	411	Sticky Note	TPatterson	Label Traditions and Adonea since they are referred to so often in the text.	Agree	Labels for all developments mentioned in the text were added to the Alternative Maps.	11/11/2019
91	412	Sticky Note	TPatterson	Add development labels when they are referenced in the text.	Agree	Labels for all developments mentioned in the text were added to the Alternative Maps.	11/11/2019
92	412	Sticky Note	TPatterson	Can D-3A and D-3B combined into one long sheet? It's hard to understand the big picture when they're broken up.	Agree	The Powhaton South tributary has been combined into one sheet (D-3) at 1"=1000' scale	11/11/2019
93	413	Sticky Note	TPatterson	- Add development labels when they are referenced in the text. - Label tribs	Agree	Labels for all developments mentioned in the text were added to the Alternative Maps. Labels for each tributary were added to the maps.	11/11/2019
94	414	Sticky Note	TPatterson	Add development labels when they are referenced in the text.	Agree	Labels for all developments mentioned in the text were added to the Alternative Maps.	11/11/2019
95	415	Sticky Note	TPatterson	Add development labels when they are referenced in the text.	Agree	Labels for all developments mentioned in the text were added to the Alternative Maps.	11/11/2019
96	416	Callout	Sam Miller	WHAT ARE V, Qin, AND Qout WITH THIS ALTERNATIVE?	Agree	The Sky Ranch Pond D was previously constructed and was included in the Baseline Hydrology. The volume, Qin, and Qout for this pond have been added to the Figure D-6 assuming the upstream improvements were made.	10/28/2019
97	416	Text Box	Sam Miller	ARE POND D AND C IN THIS HYDROLOGY PER THE SKY RANCH REPORT OR DID IT NEED TO BE MODIFIED?	No Action	Both the existing Pond D and proposed Pond C stage-storage-discharge curves are per the Sky Ranch report. References have been added to the alternatives callouts.	10/28/2019

TABLE A-2
Response to Draft Alternatives Report Comments

Comment Number	Page Label	Subject	Author	Comments	Merrick Action	Merrick Response	Date Changed
98	418	Text Box	TPatterson	I KNOW POND J SHOULDN'T HAVE BEEN INCLUDED, BUT ARE H AND G MODELED PER THE CHARACTERISTICS IN THE SKY RANCH REPORT? OR WERE MODIFICATIONS NEEDED TO MEET THE GOALS?	Agree	New representative ponds were designed for this MDP (Ponds 800 and 812). Pond curves and characteristics from the Sky Ranch ponds were not used for the design of the ponds on the 1st Avenue Tributary. References to Ponds G, H, and J have been removed from the maps and text.	10/28/2019
99	422	Highlight	TPatterson	REVISE FOR CONSISTENCY	Agree	The typical section for the natural stream management corridor (Figure D-12) has been updated to show the required 2 feet of freeboard.	10/28/2019
100	424	Text Box	TPatterson	For detention basins with more than 1 sq. mile, remove WQCV and EURV from basin design.	Agree	See comment 20 response.	10/28/2019
101	425	Text Box	SPL	600 pond - Where is Sky Ranch Pond C upstream Monaghan Trib?	Agree	Design of Sky Ranch Pond C for the alternative plan is referenced from the *Sky Ranch Filing 2 Phase I Drainage Report* (May 2019). The stage-storage-discharge curves for this pond were taken directly from the SWMM routing model associated with this report. These curves were included for reference in Table D-2.	11/18/2019
102	425	Line	SPL	Pond H/J	Agree	Reference to the Sky Ranch Ponds H/J have been removed from Table D-2. Ponds designed for this MDP were renamed to match the naming convention in the other tributaries.	10/28/2019
103	425	Ellipse	SPL	Pond H/J	Agree	See comment 102 response.	10/28/2019
104	426	Text Box	SPL	Unclear if Pond G WQCV includes Pond J (assume Pond H is the regional facility), or Pond G WQCV includes the entire tributary to it (including tributary to pond H and J)	Agree	New representative ponds (800 and 812) were designed for this MDP. Curves and characteristics from the Sky Ranch ponds were not used for the design of the ponds on the 1st Avenue Tributary. WQCV was included for only the direct tributary area for each pond.	10/28/2019
105	426	Highlight	SPL	References comment 104.	No Action	See comment 104 response.	10/28/2019
106	409		Meeting	Add newer aerial to Alternatives maps	Agree	Aerial from October 30, 2019 was added to all Alternative Maps. Some grading has occurred since the Baseline Hydrology, however, the existing percent imperviousness for these basins were not changed for the Alternatives analysis.	11/11/2019

APPENDIX B – HYDROLOGIC ANALYSIS



MERRICK®
Merrick and Company
2480 W 26th Ave, Unit B225
Denver, CO 80211
Phone: 303-964-3333

FIRST CREEK TRIBUTARIES (UPSTREAM OF I-70)
MASTER DRAINAGEWAY PLAN

HYDROLOGY MAP

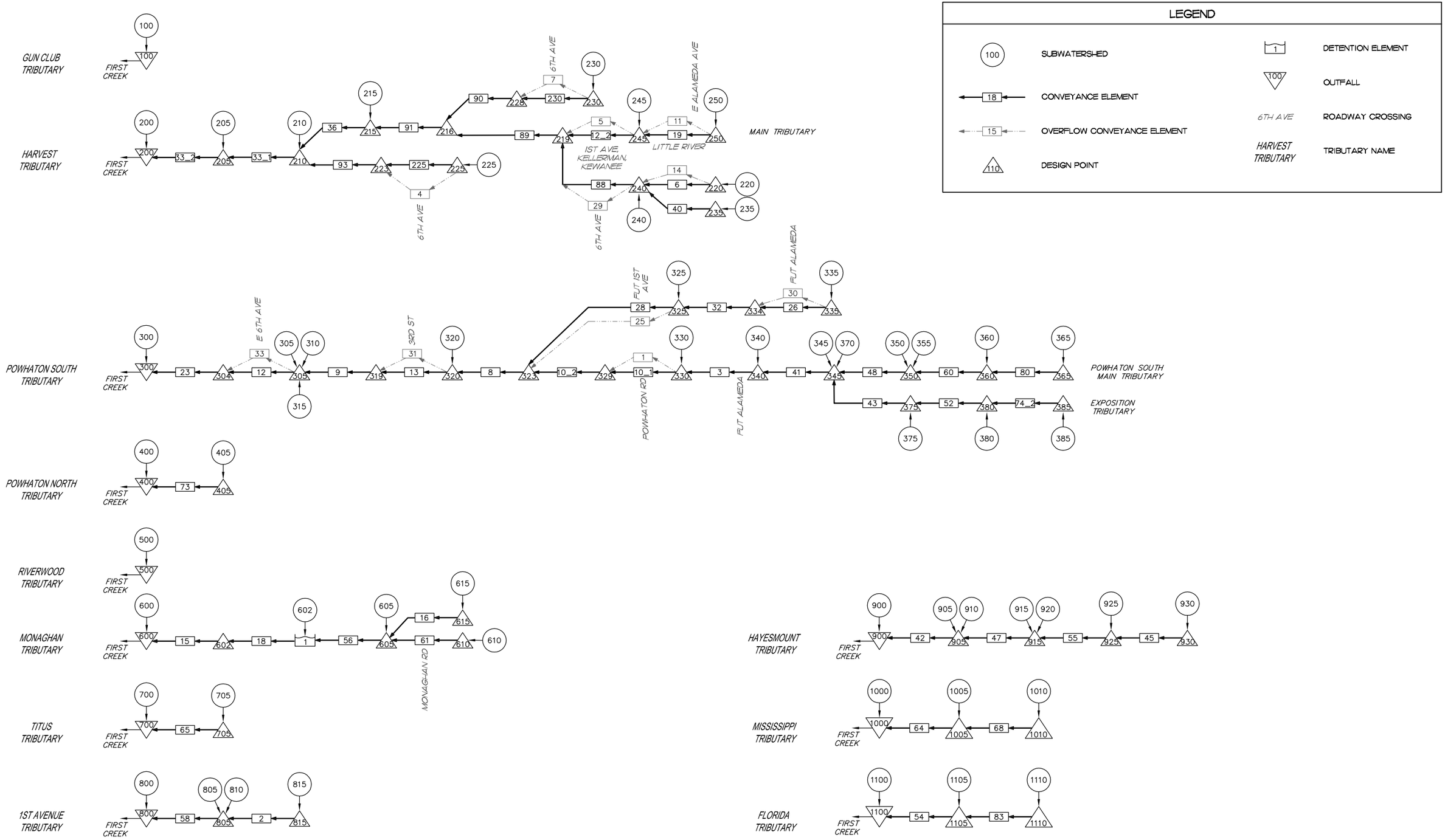
FEBRUARY 2019

1 inch =1,500 feet
0 750 1,500 Feet

N W E S

FIGURE
B-1

SWMM ROUTING SCHEMATIC



Number	Revision Description	By	Date

UDFCS, CITY OF AURORA, SEMSWA, ARAPAHOE COUNTY

FIRST CREEK TRIBUTARIES (Upstream of I-70) MAJOR DRAINAGEWAY PLAN

SWMM ROUTING SCHEMATIC

MERRICK
2480 W. 26th Ave Unit B225 Denver, CO 80211 T303.964.3333 F303.964.3355

DESIGN:CS
DETAIL:RH
CHECK:JB
DATE:FEBRUARY, 2019

PROJECT NUMBER 65419888

Figure Number: B-2

TABLE B-0
One Hour Point Rainfall (inches)

Watershed	2-Year	5-Year	10-Year	25-Year	50-Year	100-Year	500-Year
First Creek	0.853	1.14	1.40	1.79	2.13	2.49	3.43

TABLE B-1
CUHP Input Parameters

Subcatchment Name	Area (acre)	Length to Centroid (ft)	Length (ft)	Slope (ft/ft)	Percent Imperviousness			Depression Storage				Horton's Infiltration Parameters		
					Historic Land Use	Existing Land Use	Future Land Use	Historic Pervious	Existing Pervious	Future Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)
100	155	2,851	5,586	0.0125	2.0	25.2	95.3	0.4	0.35	0.35	0.1	3.00	0.0018	0.50
200	23	1,096	2,126	0.0150	2.0	2.5	35.3	0.4	0.4	0.35	0.1	3.03	0.0018	0.50
205	64	1,691	3,880	0.0136	2.0	3.8	94.6	0.4	0.4	0.35	0.1	3.00	0.0018	0.50
210	39	756	1,844	0.0195	2.0	2.8	93.1	0.4	0.4	0.35	0.1	3.00	0.0018	0.50
215	44	1,063	2,395	0.0133	2.0	2.2	90.0	0.4	0.4	0.35	0.1	3.00	0.0018	0.50
220	27	960	1,900	0.0065	2.0	50.2	50.5	0.4	0.35	0.35	0.1	3.00	0.0018	0.50
225	84	1,248	3,465	0.0134	2.0	52.1	52.3	0.4	0.35	0.35	0.1	3.45	0.0018	0.53
230	62	1,467	3,131	0.0131	2.0	54.8	55.1	0.4	0.35	0.35	0.1	3.17	0.0018	0.51
235	91	2,751	5,208	0.0080	2.0	29.9	46.5	0.4	0.35	0.35	0.1	3.32	0.0018	0.52
240	171	3,176	6,741	0.0077	2.0	26.5	50.4	0.4	0.35	0.35	0.1	3.02	0.0018	0.50
245	81	1,012	3,144	0.0093	2.0	49.6	50.2	0.4	0.35	0.35	0.1	3.23	0.0018	0.52
250	86	1,581	3,168	0.0088	2.0	2.1	50.0	0.4	0.4	0.35	0.1	3.43	0.0018	0.53
300	19	755	1,796	0.0217	2.0	2.0	50.0	0.4	0.4	0.35	0.1	3.63	0.0018	0.54
305	7	637	1,384	0.0113	2.0	2.0	2.0	0.4	0.4	0.4	0.1	4.44	0.0018	0.60
310	104	1,652	3,648	0.0102	2.0	45.6	50.0	0.4	0.35	0.35	0.1	3.47	0.0018	0.53
315	75	1,222	3,372	0.0142	2.0	2.0	50.2	0.4	0.4	0.35	0.1	3.22	0.0018	0.51
320	16	1,071	2,453	0.0151	2.0	4.9	4.9	0.4	0.4	0.4	0.1	3.49	0.0018	0.53
325	73	1,502	2,802	0.0105	2.0	6.8	50.0	0.4	0.4	0.35	0.1	3.29	0.0018	0.52
330	68	1,252	2,458	0.0074	2.0	2.0	50.1	0.4	0.4	0.35	0.1	3.01	0.0018	0.50
335	125	2,442	4,480	0.0102	2.0	2.1	64.7	0.4	0.4	0.35	0.1	3.94	0.0018	0.56
340	34	322	1,452	0.0146	2.0	2.0	68.3	0.4	0.4	0.35	0.1	3.88	0.0018	0.56
345	75	1,768	3,680	0.0082	2.0	2.0	53.6	0.4	0.4	0.35	0.1	3.82	0.0018	0.56
350	45	1,739	3,460	0.0118	2.0	2.0	50.0	0.4	0.4	0.35	0.1	3.23	0.0018	0.52
355	69	1,662	3,722	0.0116	2.0	2.0	52.6	0.4	0.4	0.35	0.1	4.50	0.0016	0.68
360	93	2,085	4,892	0.0148	2.0	2.0	50.0	0.4	0.4	0.35	0.1	3.28	0.0018	0.53
365	154	2,582	4,732	0.0147	2.0	2.0	50.0	0.4	0.4	0.35	0.1	3.90	0.0018	0.57
370	62	1,745	3,440	0.0140	2.0	2.0	50.8	0.4	0.4	0.35	0.1	3.46	0.0018	0.53
375	149	1,441	3,992	0.0073	2.0	2.0	50.0	0.4	0.4	0.35	0.1	3.58	0.0018	0.54
380	102	2,153	3,768	0.0100	2.0	2.0	50.5	0.4	0.4	0.35	0.1	3.39	0.0018	0.53
385	132	1,880	4,232	0.0167	2.0	2.0	59.9	0.4	0.4	0.35	0.1	3.30	0.0018	0.52

TABLE B-1
CUHP Input Parameters

Subcatchment Name	Area (acre)	Length to Centroid (ft)	Length (ft)	Slope (ft/ft)	Percent Imperviousness			Depression Storage				Horton's Infiltration Parameters		
					Historic Land Use	Existing Land Use	Future Land Use	Historic Pervious	Existing Pervious	Future Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)
400	93	2,105	4,718	0.0107	2.0	6.6	50.0	0.4	0.4	0.35	0.1	4.73	0.0009	0.92
405	69	1,615	3,388	0.0124	2.0	51.4	51.9	0.4	0.35	0.35	0.1	3.83	0.0013	0.71
500	175	3,052	6,395	0.0146	2.0	4.6	62.8	0.4	0.4	0.35	0.1	3.09	0.0018	0.51
600	18	302	1,305	0.0240	2.0	2.0	29.4	0.4	0.4	0.35	0.1	3.76	0.0018	0.55
602	90	1,238	3,446	0.0192	2.0	2.0	46.0	0.4	0.4	0.35	0.1	3.00	0.0018	0.50
605	72	840	3,147	0.0181	2.0	2.5	69.0	0.4	0.4	0.35	0.1	3.00	0.0018	0.50
610	136	2,801	4,855	0.0138	2.0	2.0	59.9	0.4	0.4	0.35	0.1	3.00	0.0018	0.50
615	53	478	1,889	0.0134	2.0	2.0	82.2	0.4	0.4	0.35	0.1	3.00	0.0018	0.50
700	59	1,975	4,145	0.0121	2.0	2.0	58.0	0.4	0.4	0.35	0.1	3.51	0.0018	0.53
705	163	1,901	4,520	0.0107	2.0	2.0	50.0	0.4	0.4	0.35	0.1	3.52	0.0018	0.54
800	82	2,573	5,283	0.0161	2.0	2.0	42.0	0.4	0.4	0.35	0.1	3.09	0.0018	0.51
805	156	2,247	4,110	0.0167	2.0	2.0	58.5	0.4	0.4	0.35	0.1	3.00	0.0018	0.50
810	69	1,956	4,190	0.0185	2.0	2.0	47.3	0.4	0.4	0.35	0.1	3.00	0.0018	0.50
815	142	1,455	3,625	0.0202	2.0	2.0	58.8	0.4	0.4	0.35	0.1	3.00	0.0018	0.50
900	78	1,627	3,645	0.0203	2.0	2.0	50.0	0.4	0.4	0.35	0.1	4.06	0.0018	0.57
905	38	837	2,255	0.0250	2.0	2.0	50.0	0.4	0.4	0.35	0.1	3.17	0.0018	0.51
910	41	1,703	3,764	0.0108	2.0	2.0	49.1	0.4	0.4	0.35	0.1	3.12	0.0018	0.51
915	84	1,711	3,511	0.0164	2.0	2.0	50.0	0.4	0.4	0.35	0.1	3.83	0.0018	0.56
920	88	1,741	3,539	0.0164	2.0	2.0	49.7	0.4	0.4	0.35	0.1	3.50	0.0018	0.55
925	123	3,055	5,043	0.0147	2.0	2.0	32.7	0.4	0.4	0.35	0.1	4.26	0.0017	0.62
930	134	2,690	5,078	0.0165	2.0	2.0	36.3	0.4	0.4	0.35	0.1	4.67	0.0014	0.75
1000	34	1,131	2,353	0.0195	2.0	2.0	49.8	0.4	0.4	0.35	0.1	3.36	0.0018	0.52
1005	48	957	2,314	0.0209	2.0	2.0	24.7	0.4	0.4	0.35	0.1	3.31	0.0018	0.52
1010	134	2,227	4,231	0.0158	2.0	2.0	18.8	0.4	0.4	0.35	0.1	3.35	0.0018	0.52
1100	85	1,810	3,310	0.0221	2.0	2.0	21.8	0.4	0.4	0.35	0.1	3.94	0.0018	0.56
1105	40	1,450	2,924	0.0139	2.0	2.0	12.3	0.4	0.4	0.4	0.1	3.62	0.0018	0.54
1110	128	2,372	5,780	0.0145	2.0	2.0	19.7	0.4	0.4	0.35	0.1	3.11	0.0018	0.51

TABLE B-2
Peak Discharge and Total Inflow Volume at Design Points

Design Point	Contributing Area (ac)	Imperviousness (%)			Peak Inflow Discharge (cfs)															Peak Inflow Volume (ac-ft)													
					Historic	Existing Conditions							Future Conditions							Historic	Existing Conditions							Future Conditions						
		Historic	Existing	Future	Q_{100}	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}	V_{100}	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}
B100	**155**	**2.0**	**25.2**	**95.3**	134	15	31	50	97	129	169	258	131	177	216	300	361	431	601	6.1	2.2	4.4	7.2	12.9	17.3	22.7	35.3	10.3	14.2	17.9	23.4	28.2	33.1	46.7
B1000	**34**	**2.0**	**2.0**	**49.8**	36	0	1	6	18	26	36	59	13	21	29	48	61	76	112	1.3	0.0	0.1	0.6	1.9	2.8	4.0	6.8	1.1	1.7	2.3	3.6	4.6	5.7	8.6
B1005	**48**	**2.0**	**2.0**	**24.7**	63	0	2	11	32	45	63	101	7	14	24	46	61	78	120	1.9	0.0	0.2	0.9	2.7	4.0	5.7	9.5	0.7	1.3	2.1	3.9	5.2	7.0	10.9
B1010	**134**	**2.0**	**2.0**	**18.8**	138	1	4	23	69	99	138	224	11	24	43	92	123	162	252	5.2	0.1	0.5	2.3	7.4	11.0	15.8	26.4	1.3	2.8	5.0	10.0	13.7	18.5	29.3
B1100	**85**	**2.0**	**2.0**	**21.8**	91	1	1	12	45	65	91	150	9	17	30	63	85	112	174	3.1	0.1	0.1	1.1	4.3	6.5	9.5	16.2	1.0	1.8	3.1	6.3	8.6	11.5	18.4
B1105	**40**	**2.0**	**2.0**	**12.3**	34	0	1	5	17	25	34	57	2	3	7	20	27	37	60	1.5	0.0	0.1	0.6	2.1	3.2	4.6	7.7	0.2	0.4	1.0	2.5	3.6	5.0	8.2
B1110	**128**	**2.0**	**2.0**	**19.7**	114	1	5	19	57	81	114	184	10	21	37	76	102	135	209	5.0	0.1	0.6	2.5	7.3	10.8	15.4	25.5	1.4	2.9	5.1	9.9	13.5	18.0	28.4
B200	**23**	**2.0**	**2.5**	**35.3**	22	0	1	4	11	16	22	36	5	8	12	22	28	36	54	0.9	0.0	0.1	0.5	1.4	2.0	2.8	4.7	0.5	0.9	1.3	2.2	2.8	3.7	5.6
B205	**64**	**2.0**	**3.8**	**94.6**	58	1	3	11	30	42	59	94	55	74	92	126	152	182	254	2.5	0.1	0.4	1.4	3.8	5.5	7.8	12.9	4.2	5.8	7.3	9.5	11.5	13.6	19.0
B210	**39**	**2.0**	**2.8**	**93.1**	56	1	3	11	29	41	56	89	48	64	78	106	129	153	213	1.5	0.0	0.2	0.8	2.3	3.3	4.8	7.9	2.5	3.4	4.3	5.7	6.9	8.1	11.4
B215	**44**	**2.0**	**2.2**	**90.0**	50	0	3	9	26	36	50	80	44	60	75	102	124	149	208	1.7	0.0	0.2	0.9	2.6	3.8	5.4	8.9	2.7	3.8	4.8	6.4	7.8	9.2	13.0
B220	**27**	**2.0**	**50.2**	**50.5**	25	9	15	20	33	42	53	77	9	15	21	34	43	53	78	1.1	0.9	1.3	1.9	2.8	3.6	4.5	6.8	0.9	1.4	1.9	2.8	3.6	4.5	6.8
B225	**84**	**2.0**	**52.1**	**52.3**	96	38	58	80	130	165	206	302	38	58	80	131	165	206	303	3.2	2.8	4.3	5.9	9.0	11.4	14.3	21.3	2.9	4.3	5.9	9.0	11.4	14.3	21.3
B230	**62**	**2.0**	**54.8**	**55.1**	63	27	42	57	91	114	142	207	27	42	57	91	115	143	208	2.4	2.2	3.4	4.6	6.9	8.7	10.8	16.0	2.2	3.4	4.6	6.9	8.7	10.8	16.0
B235	**91**	**2.0**	**29.9**	**46.5**	63	9	17	27	53	69	92	141	21	33	47	81	104	132	196	3.5	1.6	2.8	4.4	7.8	10.4	13.6	21.0	2.7	4.2	6.0	9.3	11.9	15.1	22.6
B240	**171**	**2.0**	**26.5**	**50.4**	124	15	29	47	92	122	162	250	47	74	103	171	217	273	402	6.8	2.6	5.0	8.1	14.5	19.3	25.4	39.3	5.6	8.7	12.1	18.4	23.4	29.3	43.6
B245	**81**	**2.0**	**49.6**	**50.2**	96	35	54	76	124	157	197	289	35	55	77	125	159	198	291	3.1	2.6	4.0	5.6	8.5	10.8	13.6	20.3	2.6	4.0	5.6	8.5	10.9	13.7	20.3
B250	**86**	**2.0**	**2.1**	**50.0**	87	1	3	14	44	62	87	141	33	51	71	117	148	185	274	3.3	0.1	0.3	1.4	4.7	7.0	10.1	16.9	2.8	4.2	5.9	9.0	11.5	14.5	21.6
B300	**19**	**2.0**	**2.0**	**50.0**	20	0	0	3	10	15	20	33	8	12	17	27	34	43	63	0.7	0.0	0.0	0.3	1.0	1.5	2.1	3.6	0.6	0.9	1.2	1.9	2.5	3.1	4.6
B305	**7**	**2.0**	**2.0**	**2.0**	5	0	0	1	2	3	5	8	0	0	1	2	3	5	8	0.2	0.0	0.0	0.1	0.3	0.5	0.7	1.2	0.0	0.0	0.1	0.3	0.5	0.7	1.2
B310	**104**	**2.0**	**45.6**	**50.0**	108	35	55	79	133	171	214	319	41	63	88	145	185	231	341	4.0	3.0	4.7	6.6	10.5	13.5	17.1	25.7	3.4	5.1	7.1	11.0	14.0	17.6	26.2
B315	**75**	**2.0**	**2.0**	**50.2**	86	1	3	15	44	62	86	139	32	50	69	113	144	179	263	2.9	0.1	0.3	1.4	4.2	6.2	9.0	14.9	2.4	3.8	5.2	7.9	10.2	12.7	19.0
B320	**16**	**2.0**	**4.9**	**4.9**	13	0	1	2	7	9	13	21	0	1	2	7	9	13	21	0.6	0.0	0.1	0.3	0.9	1.4	2.0	3.3	0.0	0.1	0.3	0.9	1.4	2.0	3.3
B325	**73**	**2.0**	**6.8**	**50.0**	76	2	5	15	41	57	79	126	29	45	62	102	130	162	238	2.8	0.2	0.5	1.6	4.4	6.3	8.9	14.7	2.3	3.6	5.0	7.6	9.8	12.2	18.3
B330	**68**	**2.0**	**2.0**	**50.1**	75	1	4	14	38	55	75	121	28	44	61	99	126	157	230	2.7	0.1	0.4	1.4	4.0	5.8	8.3	13.7	2.2	3.4	4.8	7.3	9.3	11.6	17.3
B335	**125**	**2.0**	**2.1**	**64.7**	107	1	1	14	51	75	107	176	62	90	119	184	230	282	410	4.6	0.1	0.2	1.7	6.4	9.7	14.1	24.0	5.4	7.8	10.3	14.8	18.5	22.7	33.1
B340	**34**	**2.0**	**2.0**	**68.3**	60	0	1	10	31	44	60	98	33	46	61	93	117	137	198	1.3	0.0	0.0	0.5	1.8	2.6	3.8	6.5	1.5	2.2	2.8	4.0	5.0	6.1	8.9
B345	**75**	**2.0**	**2.0**	**53.6**	62	0	1	8	30	44	62	103	27	40	55	91	115	144	212	2.8	0.0	0.1	1.0	3.9	5.8	8.5	14.3	2.6	3.8	5.3	8.0	10.2	12.7	18.9
B350	**45**	**2.0**	**2.0**	**50.0**	36	0	1	6	18	25	36	58	13	21	29	49	62	78	115	1.7	0.0	0.2	0.8	2.5	3.7	5.3	8.9	1.5	2.2	3.1	4.8	6.1	7.6	11.4
B355	**69**	**2.0**	**2.0**	**52.6**	54	0	1	3	23	37	54	92	24	35	48	82	105	133	197	2.2	0.0	0.1	0.4	2.7	4.4	6.9	12.0	2.3	3.3	4.5	6.9	8.8	11.2	16.8
B360	**93**	**2.0**	**2.0**	**50.0**	83	1	3	13	41	59	83	135	31	48	67	111	142	178	263	3.6	0.1	0.3	1.6	5.2	7.6	11.0	18.4	3.0	4.6	6.4	9.8	12.5	15.7	23.5
B365	**154**	**2.0**	**2.0**	**50.0**	141	1	2	18	68	99	141	232	54	81	114	191	244	309	456	5.6	0.1	0.2	2.0	7.8	11.8	17.2	29.3	4.9	7.3	10.2	15.8	20.2	25.4	38.4
B370	**62**	**2.0**	**2.0**	**50.8**	56	0	2	9	28	40	56	91	22	34	47	77	98	122	180	2.3	0.0	0.2	1.0	3.4	5.0	7.2	12.1	2.0	3.1	4.3	6.5	8.3	10.4	15.5
B375	**149**	**2.0**	**2.0**	**50.0**	161	1	4	24	80	115	161	261	61	93	131	215	275	343	507	5.6	0.1	0.4	2.3	8.0	11.9	17.2	28.9	4.8	7.3	10.1	15.6	19.9	25.0	37.4

TABLE B-2
Peak Discharge and Total Inflow Volume at Design Points

Design Point	Contributing Area (ac)	Imperviousness (%)			Peak Inflow Discharge (cfs)																Peak Inflow Volume (ac-ft)															
					Historic	Existing Conditions							Future Conditions							Historic	Existing Conditions							Future Conditions						
		Historic	Existing	Future	Q_{100}	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}	V_{100}	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}
B380	**102**	**2.0**	**2.0**	**50.5**	94	1	3	15	47	67	94	153	36	56	77	127	162	203	300	3.9	0.1	0.3	1.7	5.6	8.3	12.0	20.1	3.3	5.1	7.0	10.8	13.7	17.3	25.8
B385	**132**	**2.0**	**2.0**	**59.9**	145	1	5	24	73	104	145	235	72	107	143	224	280	346	502	5.1	0.1	0.5	2.3	7.3	10.8	15.6	26.0	5.2	7.8	10.4	15.2	19.1	23.6	34.7
B400	**93**	**2.0**	**6.6**	**50.0**	40	0	1	2	11	24	44	91	26	35	45	78	104	137	217	1.7	0.1	0.2	0.3	1.4	3.1	5.8	12.5	2.8	3.9	5.0	7.4	9.7	12.6	19.9
B405	**69**	**2.0**	**51.4**	**51.9**	55	24	35	47	82	107	136	204	25	36	48	83	108	137	205	2.1	2.2	3.2	4.2	6.6	8.5	10.9	16.4	2.2	3.2	4.3	6.6	8.5	10.9	16.5
B500	**175**	**2.0**	**4.6**	**62.8**	148	2	8	27	75	107	150	242	80	117	155	242	302	374	541	6.9	0.3	1.1	3.8	10.4	15.1	21.4	35.3	7.3	10.8	14.5	20.8	26.0	31.9	46.7
B600	**18**	**2.0**	**2.0**	**29.4**	30	0	0	5	15	22	30	48	4	8	13	24	32	41	63	0.7	0.0	0.0	0.3	0.9	1.4	2.0	3.4	0.3	0.5	0.8	1.4	1.9	2.5	4.0
B602	**90**	**2.0**	**2.0**	**46.0**	116	1	6	22	60	84	116	186	36	60	84	138	177	221	326	3.6	0.1	0.5	1.9	5.2	7.7	11.0	18.1	2.7	4.2	6.0	9.3	11.9	15.0	22.5
B605	**72**	**2.0**	**2.5**	**69.0**	100	1	5	19	52	73	100	160	59	86	112	162	201	246	352	2.8	0.1	0.4	1.5	4.2	6.1	8.7	14.4	3.3	4.8	6.4	9.0	11.1	13.5	19.6
B610	**136**	**2.0**	**2.0**	**59.9**	123	1	6	22	62	89	123	199	61	91	123	190	239	296	429	5.4	0.1	0.7	2.8	7.9	11.6	16.5	27.4	5.5	8.1	11.0	15.9	19.9	24.6	36.2
B615	**53**	**2.0**	**2.0**	**82.2**	90	1	5	18	47	67	90	144	62	86	111	155	190	221	312	2.1	0.0	0.3	1.1	3.1	4.5	6.4	10.5	2.9	4.1	5.2	7.1	8.7	10.4	14.7
B700	**59**	**2.0**	**2.0**	**58.0**	46	0	1	7	22	32	46	75	22	33	45	71	90	112	164	2.2	0.0	0.2	0.9	3.2	4.8	6.9	11.5	2.3	3.3	4.5	6.7	8.4	10.4	15.4
B705	**163**	**2.0**	**2.0**	**50.0**	168	1	4	26	84	120	168	273	63	97	136	223	285	355	526	6.2	0.1	0.4	2.6	8.8	13.1	18.9	31.9	5.2	8.0	11.0	17.0	21.7	27.3	40.8
B800	**82**	**2.0**	**2.0**	**42.0**	65	0	3	11	32	46	65	105	18	29	43	74	95	122	182	3.2	0.1	0.4	1.6	4.7	6.9	9.9	16.4	2.2	3.5	5.1	8.1	10.5	13.3	20.1
B805	**156**	**2.0**	**2.0**	**58.5**	173	1	8	32	88	125	173	277	82	124	167	259	325	402	583	6.1	0.1	0.8	3.2	9.0	13.2	18.8	31.3	6.0	9.1	12.3	17.9	22.5	27.9	40.8
B810	**69**	**2.0**	**2.0**	**47.3**	63	0	3	11	32	46	63	102	21	34	48	80	102	129	190	2.7	0.1	0.4	1.4	4.0	5.9	8.3	13.8	2.1	3.3	4.7	7.2	9.2	11.6	17.3
B815	**142**	**2.0**	**2.0**	**58.8**	193	1	10	37	99	141	193	309	89	136	184	279	352	433	629	5.6	0.1	0.7	2.9	8.2	12.1	17.2	28.4	5.5	8.3	11.2	16.3	20.5	25.3	37.1
B900	**78**	**2.0**	**2.0**	**50.0**	80	1	1	11	39	57	80	132	31	46	65	109	139	174	258	2.8	0.0	0.1	1.0	4.0	6.0	8.7	14.9	2.5	3.7	5.2	8.0	10.3	12.9	19.4
B905	**38**	**2.0**	**2.0**	**50.0**	49	0	2	9	25	36	49	80	18	29	40	63	81	101	149	1.5	0.0	0.2	0.7	2.1	3.1	4.5	7.5	1.2	1.9	2.6	4.0	5.1	6.4	9.5
B910	**41**	**2.0**	**2.0**	**49.1**	31	0	1	5	15	22	31	51	11	18	25	41	53	66	98	1.6	0.0	0.2	0.8	2.4	3.5	5.0	8.2	1.3	2.0	2.9	4.4	5.6	7.0	10.4
B915	**84**	**2.0**	**2.0**	**50.0**	86	1	1	12	42	61	86	141	33	50	70	117	149	187	276	3.1	0.1	0.1	1.2	4.4	6.6	9.6	16.2	2.7	4.1	5.6	8.7	11.1	14.0	21.0
B920	**88**	**2.0**	**2.0**	**49.7**	92	1	2	14	46	66	92	150	35	53	75	124	158	197	292	3.3	0.1	0.2	1.3	4.7	7.0	10.2	17.2	2.8	4.3	5.9	9.2	11.7	14.7	22.1
B925	**123**	**2.0**	**2.0**	**32.7**	94	1	1	9	42	64	94	157	17	26	42	86	115	150	232	4.3	0.1	0.2	1.1	5.6	8.7	13.1	22.5	2.3	3.5	5.5	9.9	13.3	17.6	27.5
B930	**134**	**2.0**	**2.0**	**36.3**	95	0	1	2	35	61	95	168	22	34	47	98	133	179	279	3.9	0.0	0.1	0.2	4.1	7.2	11.9	21.8	2.7	4.0	5.5	9.9	13.4	18.0	28.5
DP100	**155**	**2.0**	**25.2**	**95.3**	134	15	31	50	97	129	169	258	131	177	216	300	361	431	601	6.1	2.2	4.4	7.2	12.9	17.3	22.7	35.3	10.3	14.2	17.9	23.4	28.2	33.1	46.7
DP1000	**217**	**2.0**	**2.0**	**49.8**	227	1	6	34	111	160	227	371	24	48	81	165	220	291	450	8.4	0.2	0.8	3.8	12.1	17.8	25.7	43.0	3.1	5.8	9.5	17.6	23.6	31.3	48.8
DP1005	**183**	**2.0**	**2.0**	**24.7**	194	1	6	30	97	138	194	317	17	36	63	132	177	234	362	7.0	0.1	0.7	3.2	10.2	15.0	21.6	35.9	2.0	4.1	7.1	14.0	19.0	25.5	40.2
DP1100	**253**	**2.0**	**2.0**	**21.8**	218	1	5	29	101	151	218	363	15	33	62	139	191	261	415	9.7	0.2	0.8	4.3	14.0	20.6	29.7	49.7	2.6	5.2	9.4	18.9	25.9	34.7	55.2
DP1105	**168**	**2.0**	**2.0**	**12.3**	147	1	5	24	72	104	147	239	11	24	44	94	128	171	267	6.5	0.1	0.7	3.1	9.5	14.0	20.0	33.1	1.6	3.4	6.2	12.4	17.1	23.0	36.5
DP200	**773**	**2.0**	**2.5**	**35.3**	682	107	181	288	563	746	969	1,489	255	394	541	873	1,096	1,383	2,070	30.3	13.3	22.5	35.9	64.5	86.9	114.2	177.7	29.8	44.5	60.2	89.0	112.0	138.4	203.2
DP205	**749**	**2.0**	**3.8**	**94.6**	667	111	185	291	558	738	952	1,462	255	393	539	862	1,079	1,358	2,034	29.3	13.1	22.2	35.3	62.9	84.7	111.1	172.5	29.2	43.6	58.6	86.5	109.0	134.7	197.3
DP210	**686**	**2.0**	**2.8**	**93.1**	617	113	186	284	533	700	896	1,372	225	349	484	778	977	1,234	1,856	26.8	13.0	21.7	33.8	59.2	79.2	103.4	159.6	25.0	37.7	51.3	77.0	97.3	120.9	178.3
DP215	**562**	**2.0**	**2.2**	**90.0**	492	82	136	211	402	539	695	1,050	176	274	382	619	783	996	1,490	22.0	10.0	17.1	27.0	47.9	64.1	84.1	130.4	19.6	29.8	41.1	62.3	79.2	98.5	145.5
DP216	**518**	**2.0**	**2.2**	**90.0**	452	82	134	203	379	507	650	977	154	242	341	561	714	912	1,365	20.3	10.0	16.9	26.1	45.1	60.5	78.9	121.5	16.9	26.0	36.2	55.9	71.2	89.3	132.6
DP219	**456**	**2.0**	**2.2**	**90.0**	396	59	101	158	307	425	534	810	132	208	294	486	619	788	1,182	17.8	7.7	13.5	21.4	38.4	51.6	67.8	105.6	14.6	22.6	31.6	49.1	62.6	78.3	116.6

TABLE B-2
Peak Discharge and Total Inflow Volume at Design Points

Design Point	Contributing Area (ac)	Imperviousness (%)			Peak Inflow Discharge (cfs)															Peak Inflow Volume (ac-ft)														
					Historic	Existing Conditions							Future Conditions							Historic	Existing Conditions							Future Conditions						
		Historic	Existing	Future	Q_{100}	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}	V_{100}	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}
DP223	**84**	**2.0**	**2.8**	**93.1**	96	38	58	80	130	165	206	302	38	58	80	131	165	206	303	3.2	2.8	4.3	5.9	9.0	11.4	14.3	21.3	2.9	4.3	5.9	9.0	11.4	14.3	21.3
DP228	**62**	**2.0**	**2.2**	**90.0**	63	27	41	57	90	120	141	207	27	42	57	91	120	142	208	2.4	2.2	3.4	4.6	6.9	8.7	10.8	16.0	2.2	3.4	4.6	6.9	8.7	10.9	16.1
DP240	**289**	**2.0**	**26.5**	**50.4**	209	30	56	88	168	223	295	452	72	114	161	276	353	446	662	11.3	5.1	9.2	14.5	25.1	33.5	43.6	67.2	9.2	14.3	20.0	30.5	39.0	49.1	73.0
DP245	**167**	**2.0**	**49.6**	**50.2**	178	35	54	78	146	193	252	380	64	99	140	228	280	358	538	6.4	2.7	4.3	7.0	13.2	17.8	23.7	37.4	5.4	8.3	11.4	17.8	22.7	28.5	42.4
DP300	**1402**	**2.0**	**2.0**	**50.0**	817	34	56	93	326	523	811	1,496	220	365	531	931	1,254	1,741	2,698	54.3	3.9	8.6	28.3	82.9	120.6	171.6	283.9	50.9	75.8	103.4	155.6	196.7	247.7	365.2
DP304	**1383**	**2.0**	**2.0**	**50.0**	811	35	58	92	324	520	805	1,483	219	363	529	927	1,247	1,732	2,680	53.6	3.9	8.6	28.0	81.9	119.4	169.7	280.5	50.6	74.9	102.2	153.8	194.6	244.6	362.2
DP305	**1383**	**2.0**	**2.0**	**2.0**	811	35	58	92	324	520	805	1,483	219	363	529	927	1,247	1,732	2,680	53.6	3.9	8.6	28.1	81.9	119.4	169.7	280.5	50.6	74.9	102.2	153.8	194.6	244.6	362.2
DP319	**1197**	**2.0**	**2.0**	**50.0**	742	2	8	68	304	481	744	1,351	211	344	497	870	1,162	1,620	2,467	46.5	0.9	3.7	20.1	66.9	99.1	143.0	238.8	44.5	66.0	89.6	134.1	169.4	213.3	313.0
DP320	**1197**	**2.0**	**4.9**	**4.9**	742	2	8	68	304	481	744	1,351	211	344	497	870	1,162	1,620	2,467	46.5	0.9	3.7	20.1	67.2	99.1	143.0	238.8	44.5	66.0	89.6	134.1	169.4	213.3	313.0
DP323	**1181**	**2.0**	**4.9**	**4.9**	738	2	8	69	303	478	739	1,342	212	346	498	870	1,161	1,621	2,452	45.8	1.0	3.7	19.8	66.0	97.6	140.9	235.1	44.5	65.7	89.0	132.9	167.6	210.5	310.0
DP325	**198**	**2.0**	**6.8**	**50.0**	173	2	5	23	83	121	175	289	77	115	157	260	329	413	610	7.5	0.3	0.8	3.4	10.9	16.1	23.2	39.0	7.9	11.5	15.5	22.6	28.5	35.3	51.9
DP329	**983**	**2.0**	**4.9**	**4.9**	633	1	8	60	262	411	633	1,142	183	297	426	751	999	1,404	2,081	38.3	0.7	3.0	16.5	55.2	81.6	117.5	196.1	36.5	54.0	73.7	110.2	139.0	175.2	258.1
DP330	**983**	**2.0**	**2.0**	**50.1**	633	1	8	60	262	411	633	1,142	183	297	426	751	999	1,327	2,081	38.3	0.7	3.0	16.5	55.2	81.6	117.5	196.1	36.5	54.0	73.7	110.2	139.0	173.4	256.3
DP334	**125**	**2.0**	**6.8**	**50.0**	107	1	1	14	51	75	107	176	62	90	119	184	230	282	414	4.6	0.1	0.2	1.7	6.4	9.6	14.1	23.9	5.4	7.8	10.3	14.8	18.5	22.7	33.5
DP335	**125**	**2.0**	**2.1**	**64.7**	107	1	1	14	51	75	107	176	62	90	119	184	230	282	410	4.6	0.1	0.2	1.7	6.4	9.7	14.1	24.0	5.4	7.8	10.3	14.8	18.5	22.7	33.1
DP340	**914**	**2.0**	**2.0**	**68.3**	604	1	8	59	252	394	604	1,083	179	288	411	726	963	1,278	1,994	35.5	0.7	2.7	15.0	50.9	75.5	109.0	182.0	34.1	50.3	68.4	102.5	129.5	161.4	238.8
DP345	**880**	**2.0**	**2.0**	**53.6**	598	2	8	59	252	392	598	1,066	175	283	405	719	953	1,267	1,971	34.2	0.7	2.7	14.5	49.1	72.7	105.0	175.6	32.5	48.2	65.4	98.5	124.6	155.3	229.9
DP350	**361**	**2.0**	**2.0**	**50.0**	268	1	3	27	115	178	268	463	81	129	185	334	436	571	872	13.5	0.3	0.9	5.2	18.9	28.4	41.4	70.0	12.4	18.4	25.3	38.7	49.1	61.7	92.1
DP360	**247**	**2.0**	**2.0**	**50.0**	220	1	4	28	105	154	220	363	76	118	169	291	373	473	705	9.2	0.2	0.6	3.7	13.1	19.5	28.4	47.9	8.1	12.1	16.7	25.7	32.8	41.4	62.0
DP375	**383**	**2.0**	**2.0**	**50.0**	269	1	4	28	113	176	269	482	79	128	185	322	426	567	878	15.4	0.4	1.4	7.2	22.6	32.8	47.3	78.0	15.0	22.2	30.0	44.5	56.2	69.7	102.2
DP380	**234**	**2.0**	**2.0**	**50.5**	202	1	4	25	91	137	202	343	71	111	154	265	340	436	656	9.4	0.2	1.0	4.6	13.9	20.3	28.9	47.9	9.6	14.1	18.9	27.7	34.7	43.0	62.6
DP400	**162**	**2.0**	**6.6**	**50.0**	77	17	26	35	72	102	147	255	36	52	68	122	160	216	349	4.0	2.6	3.8	5.1	8.7	12.5	17.6	30.1	5.3	7.5	9.8	14.8	19.1	24.5	37.4
DP500	**175**	**2.0**	**4.6**	**62.8**	148	2	8	27	75	107	150	242	80	117	155	242	302	374	541	6.9	0.3	1.1	3.8	10.4	15.1	21.4	35.3	7.3	10.8	14.5	20.8	26.0	31.9	46.7
DP600	**369**	**2.0**	**2.0**	**29.4**	284	1	1	5	54	151	285	502	6	72	149	332	382	602	1,073	10.7	0.3	1.0	2.2	9.6	19.6	32.8	62.0	3.5	10.4	18.0	31.3	42.0	54.6	85.3
DP602	**351**	**2.0**	**2.0**	**46.0**	277	1	1	3	54	148	277	487	6	71	146	323	371	584	1,035	10.1	0.3	1.0	2.0	8.7	18.2	31.0	58.6	3.3	10.0	17.2	29.8	40.2	52.2	81.3
DP605	**261**	**2.0**	**2.5**	**69.0**	290	2	13	51	146	210	290	468	156	229	299	454	564	692	998	10.4	0.2	1.4	5.5	15.3	22.4	31.9	52.5	11.8	17.2	22.7	31.9	39.9	48.5	70.6
DP700	**222**	**2.0**	**2.0**	**58.0**	191	1	3	24	88	131	191	320	62	96	136	237	305	392	592	8.7	0.2	0.7	3.8	12.6	18.6	26.7	44.5	8.1	12.0	16.4	24.8	31.3	39.0	57.7
DP800	**448**	**2.0**	**2.0**	**42.0**	468	2	18	76	228	331	468	765	167	263	365	608	777	981	1,460	17.9	0.4	2.4	9.5	26.5	38.7	54.9	90.5	16.3	24.7	33.8	50.0	63.2	78.6	116.0
DP805	**366**	**2.0**	**2.0**	**58.5**	413	2	17	71	206	296	413	671	164	255	348	563	714	894	1,318	14.6	0.3	2.0	7.8	21.5	31.6	44.8	74.0	13.9	21.0	28.5	41.7	52.5	65.1	95.8
DP900	**587**	**2.0**	**2.0**	**50.0**	474	2	6	45	206	318	474	807	120	190	274	508	668	873	1,342	20.7	0.4	1.1	6.5	27.6	42.4	63.5	109.0	15.8	23.8	33.5	54.3	70.9	91.2	139.0
DP905	**508**	**2.0**	**2.0**	**50.0**	411	2	6	40	179	275	411	697	102	161	232	435	574	749	1,153	17.8	0.3	1.0	5.5	23.5	36.2	54.6	93.9	13.2	19.9	28.2	46.3	60.5	78.0	119.4
DP915	**429**	**2.0**	**2.0**	**50.0**	343	1	4	29	146	228	343	585	81	128	186	357	474	622	961	14.7	0.3	0.6	3.9	19.0	29.6	45.1	78.0	10.6	16.0	22.7	38.1	49.7	64.8	99.4
DP925	**257**	**2.0**	**2.0**	**32.7**	188	1	2	10	77	124	188	324	39	59	88	183	248	329	512	8.2	0.1	0.3	1.3	9.7	15.8	25.0	44.2	4.9	7.5	11.0	19.8	26.6	35.6	55.9
Pond 1	**351**	**2.0**	**2.0**	**46.0**	390	2	15	64	192	278	390	635	173	262	351	558	702	872	1,276	14.0	0.3	1.9	7.5	20.7	30.3	43.0	70.9	14.6	21.6	28.9	41.4	51.9	63.8	93.0

FIGURE B-3
2-, 10-, 100-Year Hydrographs

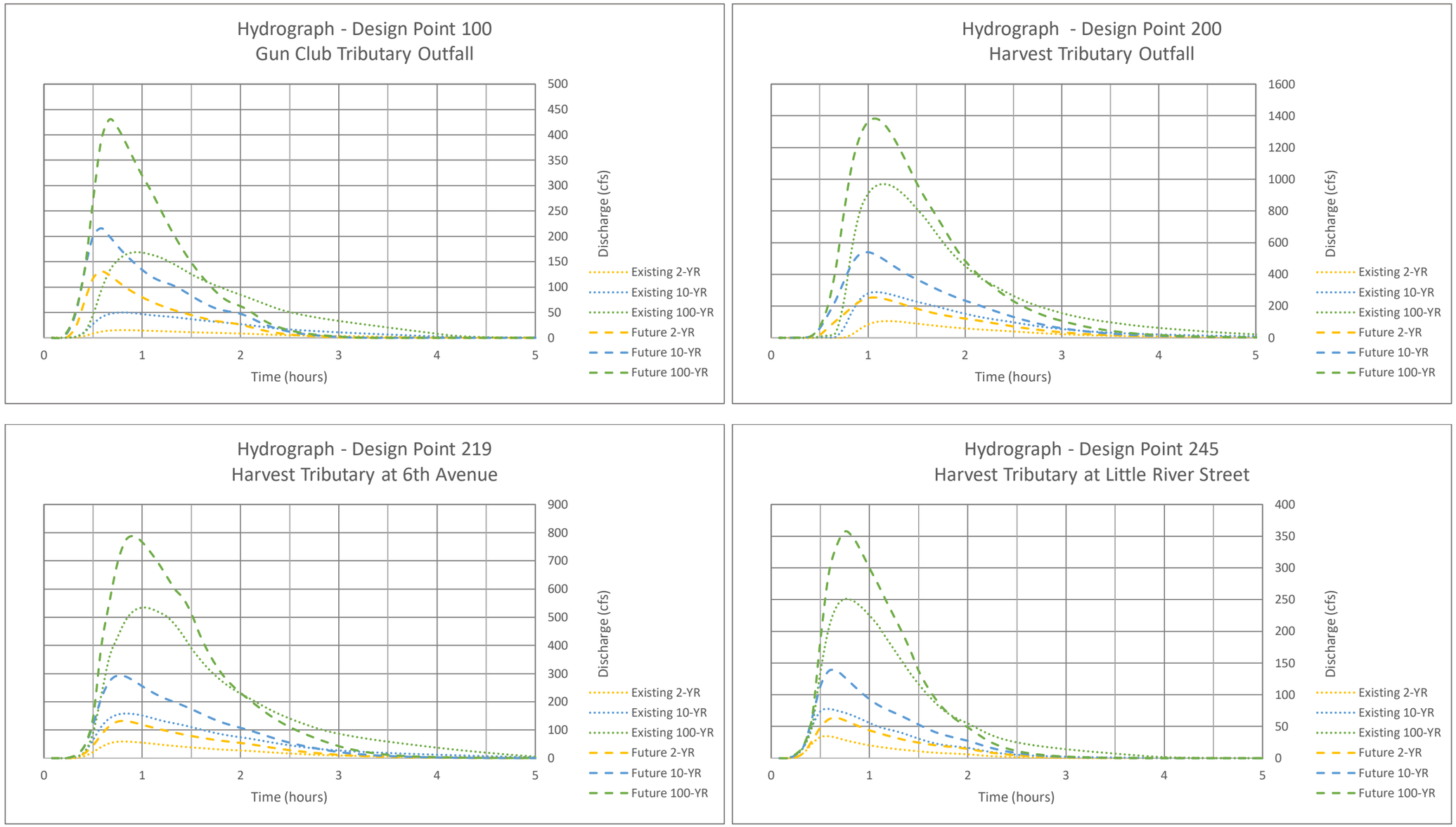
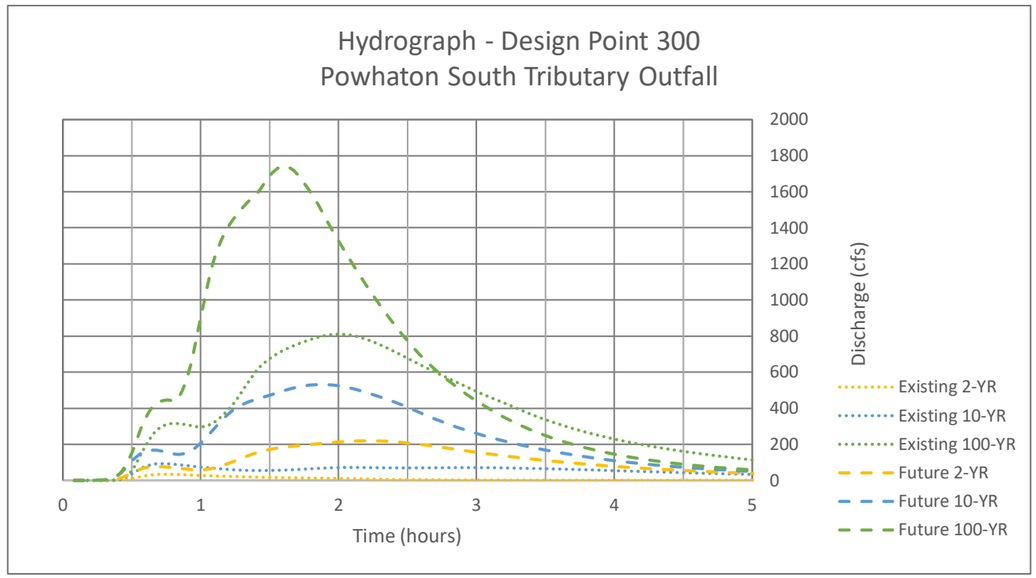
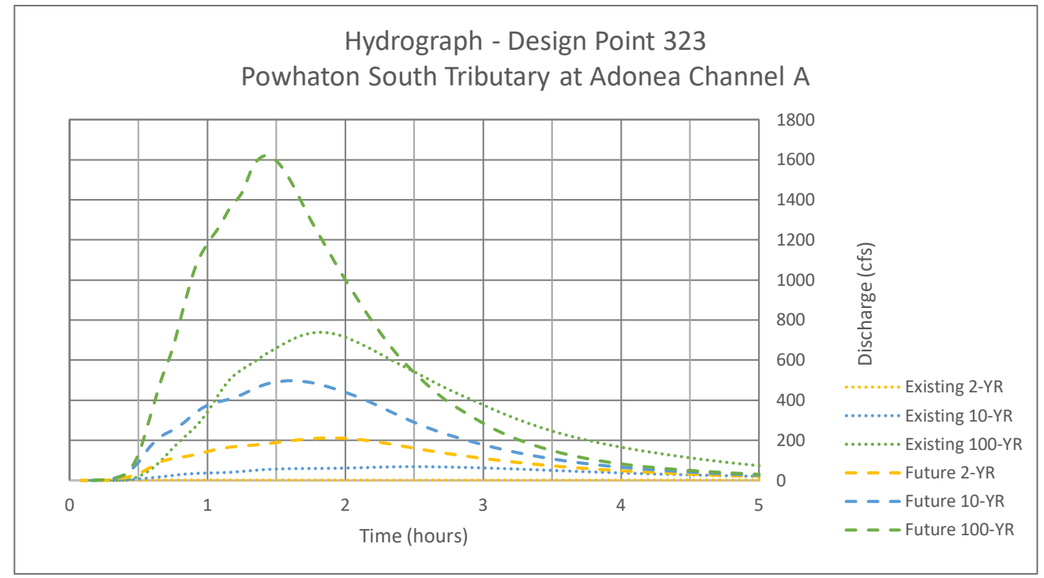
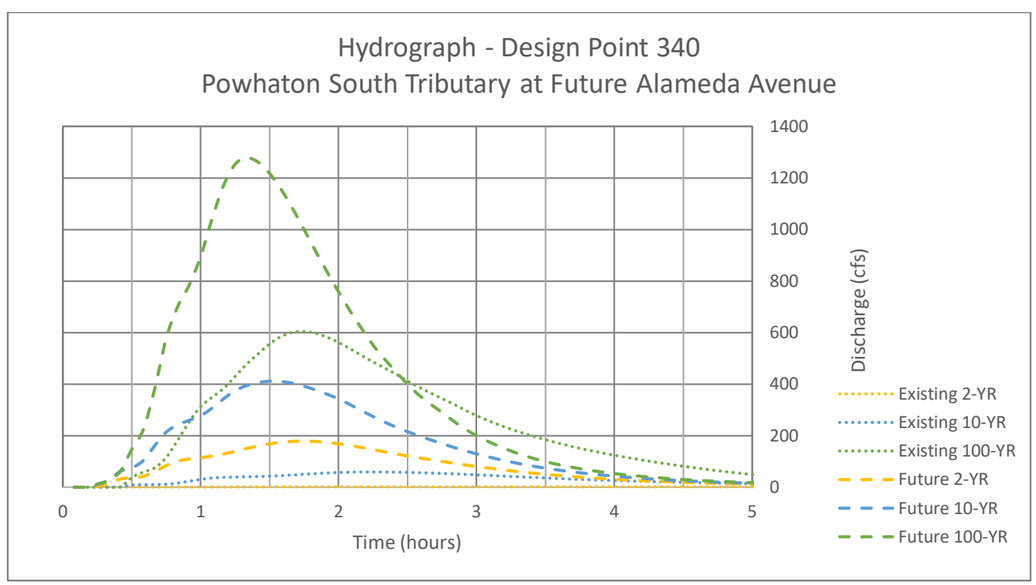


FIGURE B-3
2-, 10-, 100-Year Hydrographs







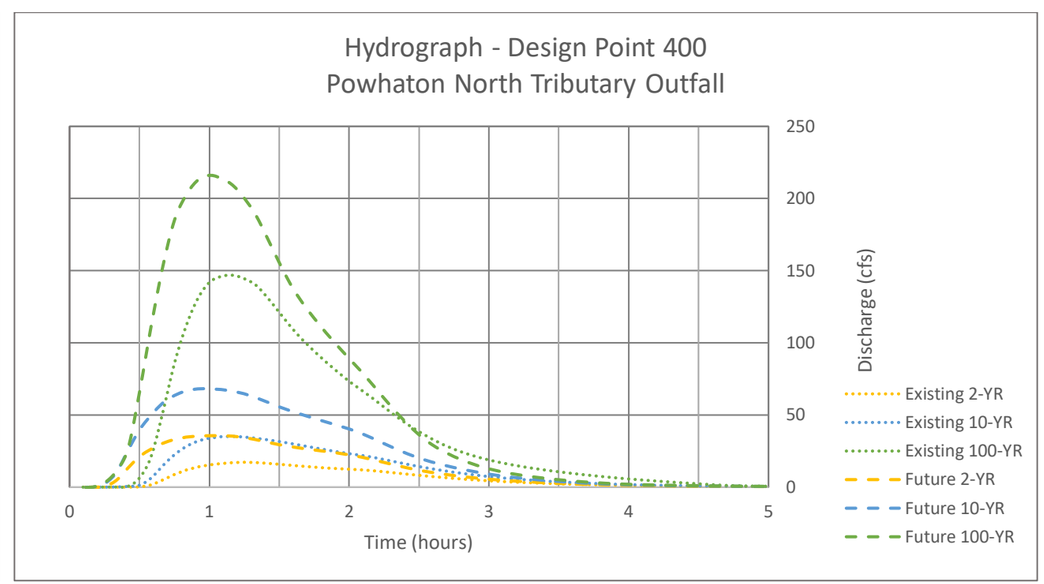
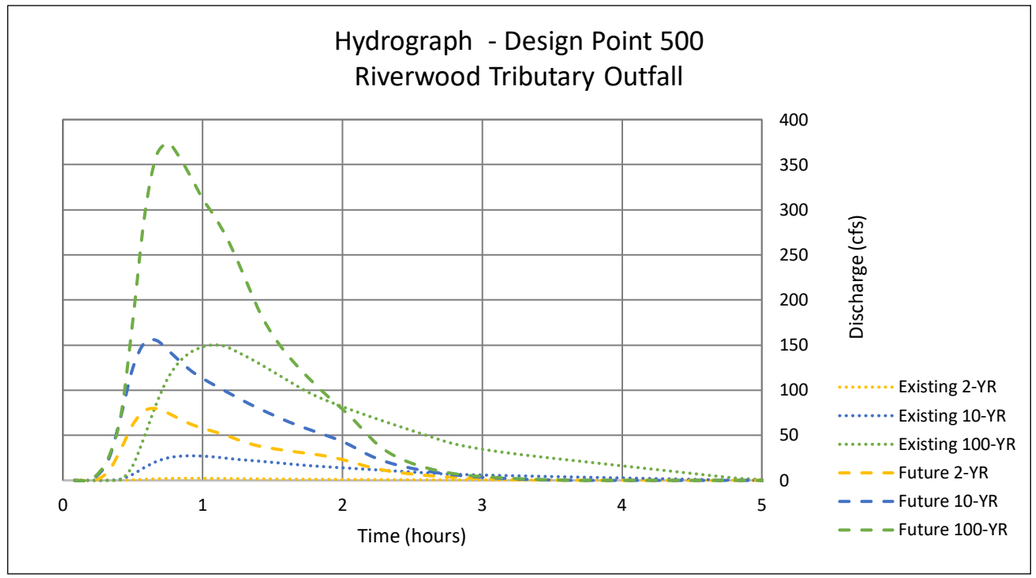
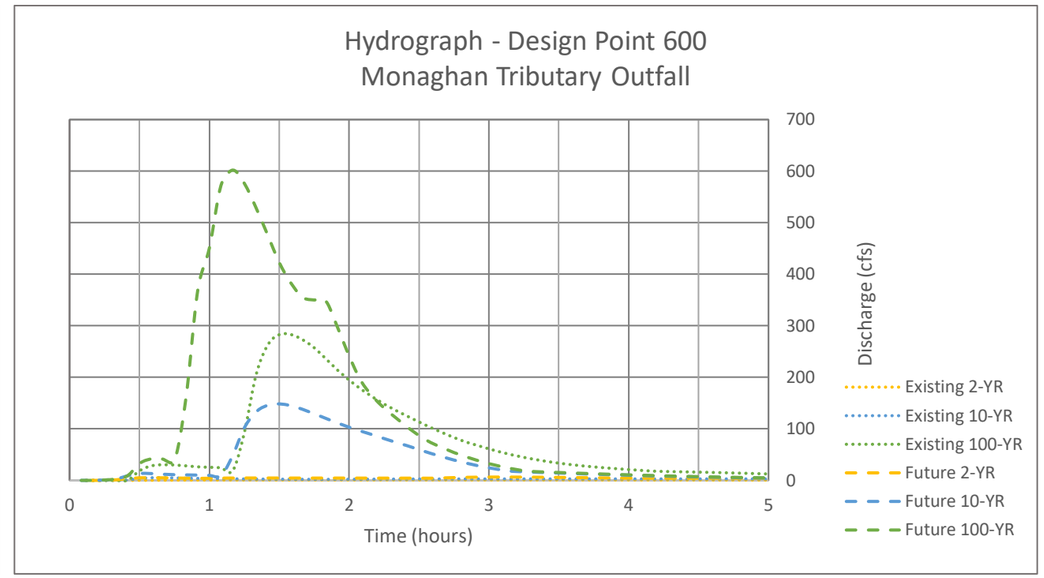


FIGURE B-3
2-, 10-, 100-Year Hydrographs





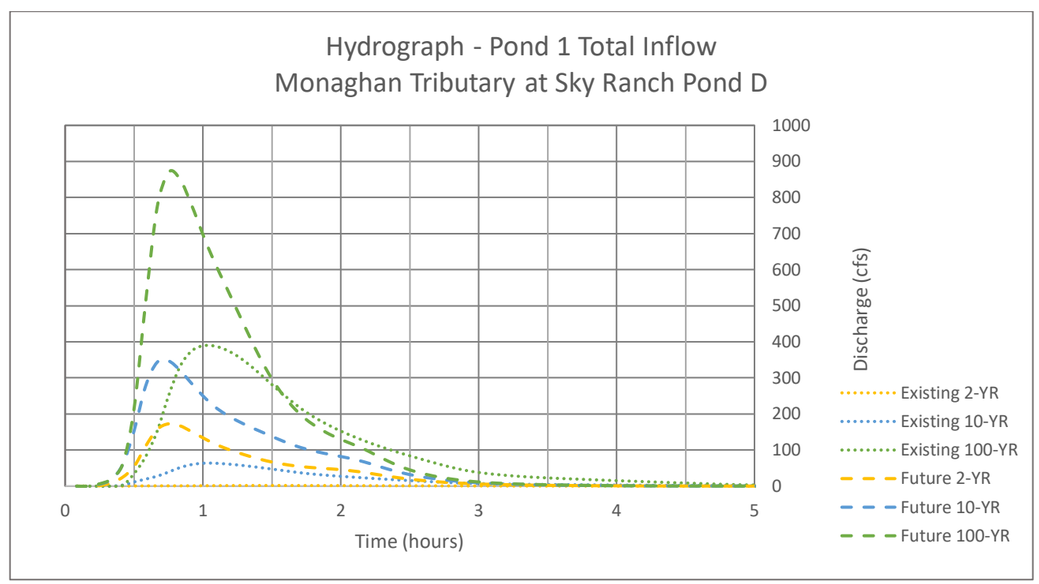
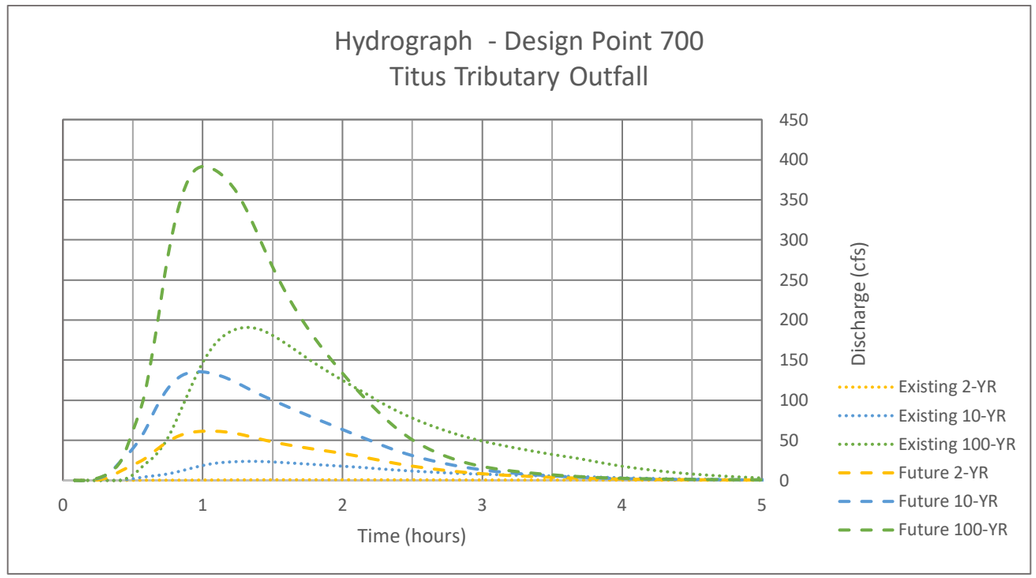
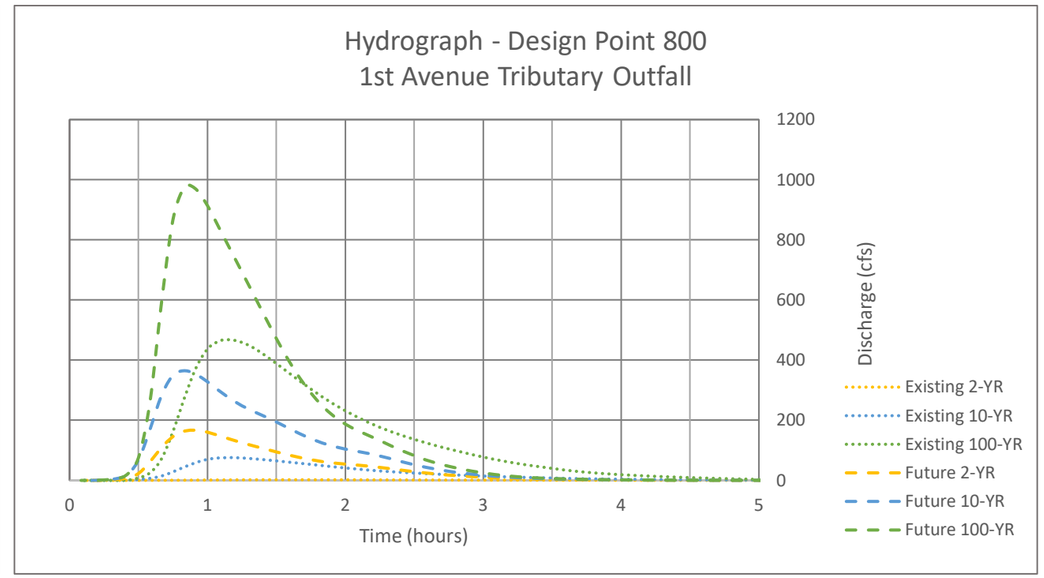
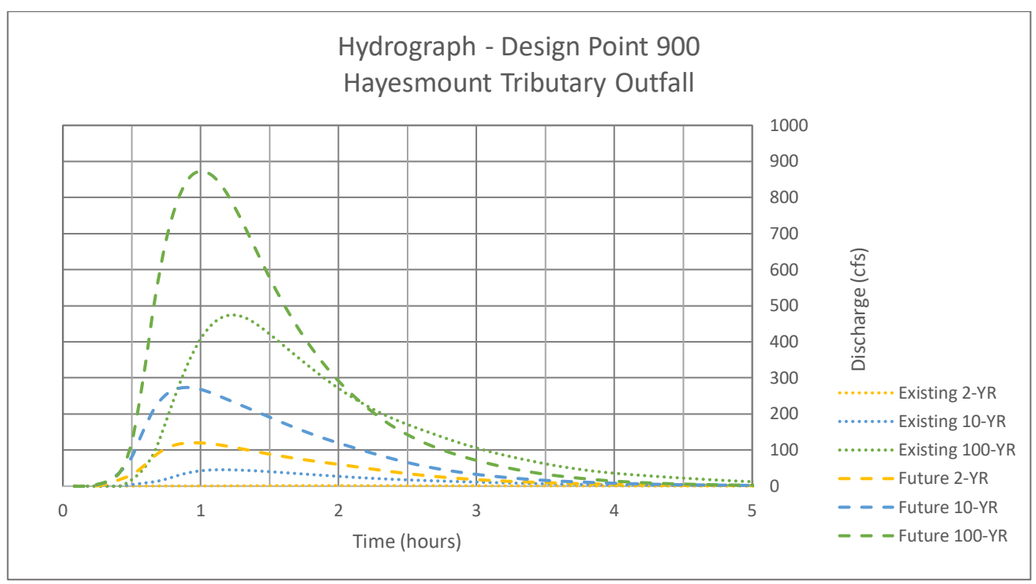
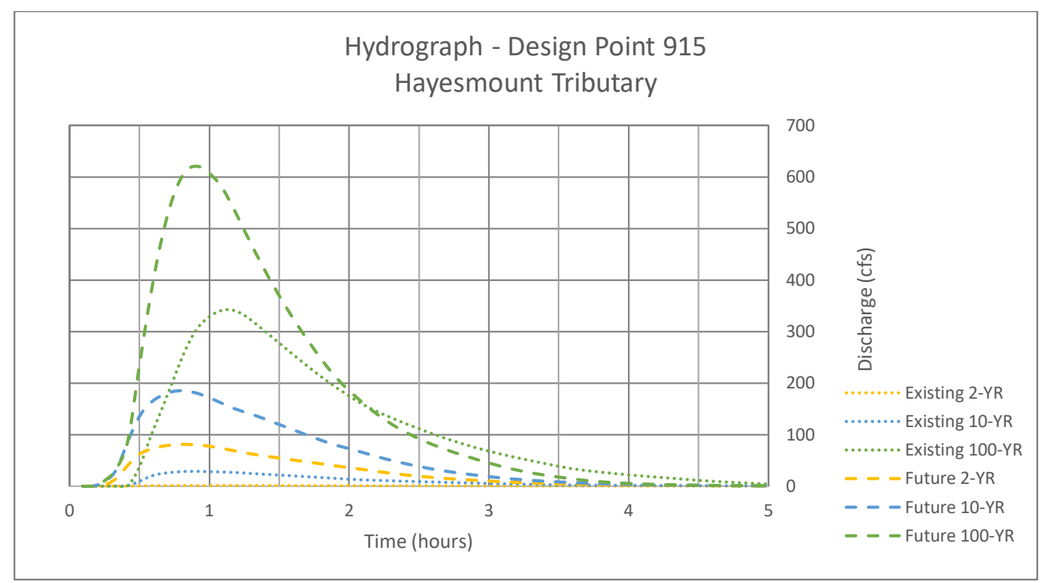


FIGURE B-3
2-, 10-, 100-Year Hydrographs









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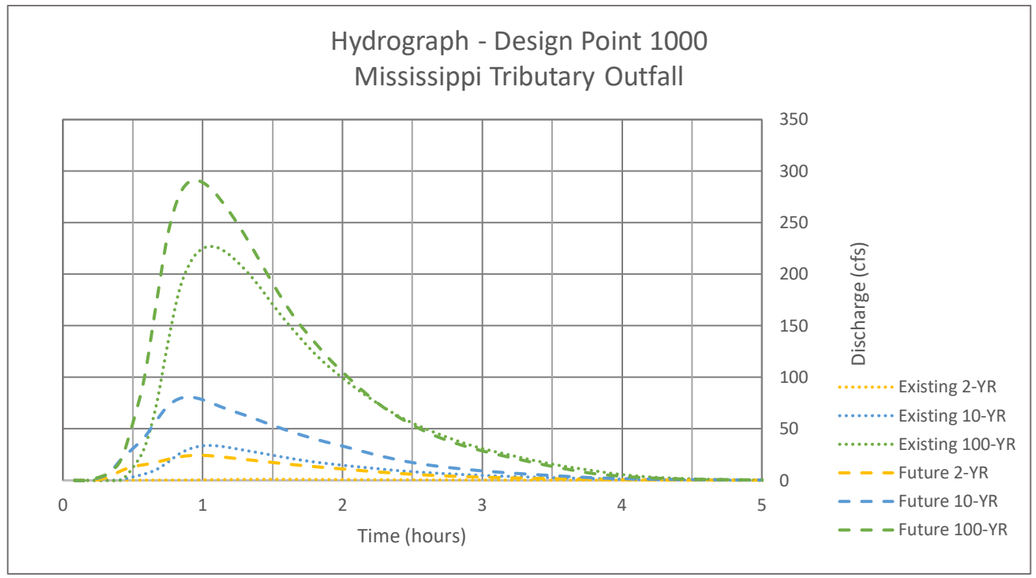
2-, 10-, 100-Year Hydrographs



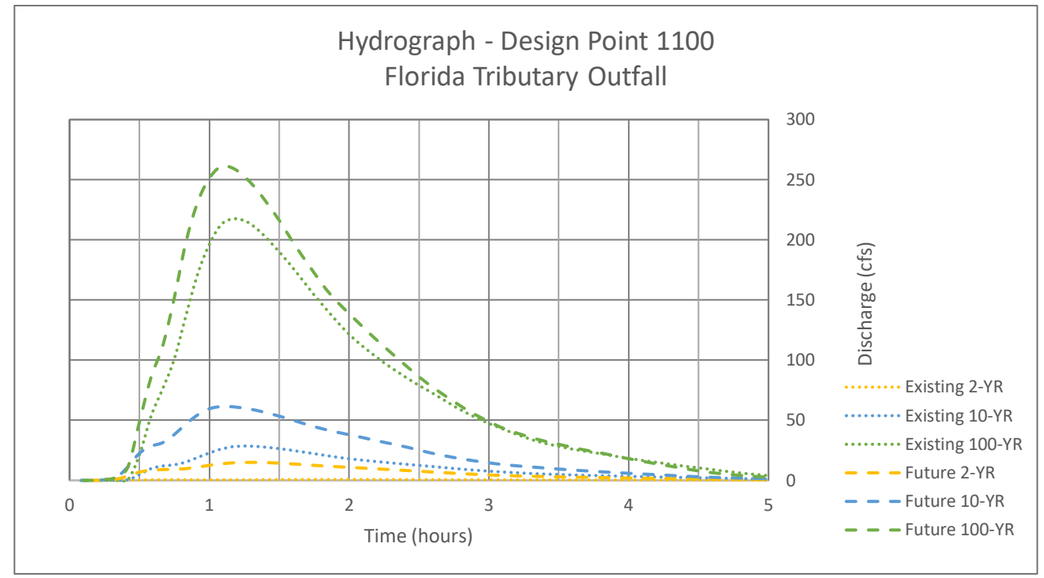


FIGURE B-4
Peak Flow Profiles

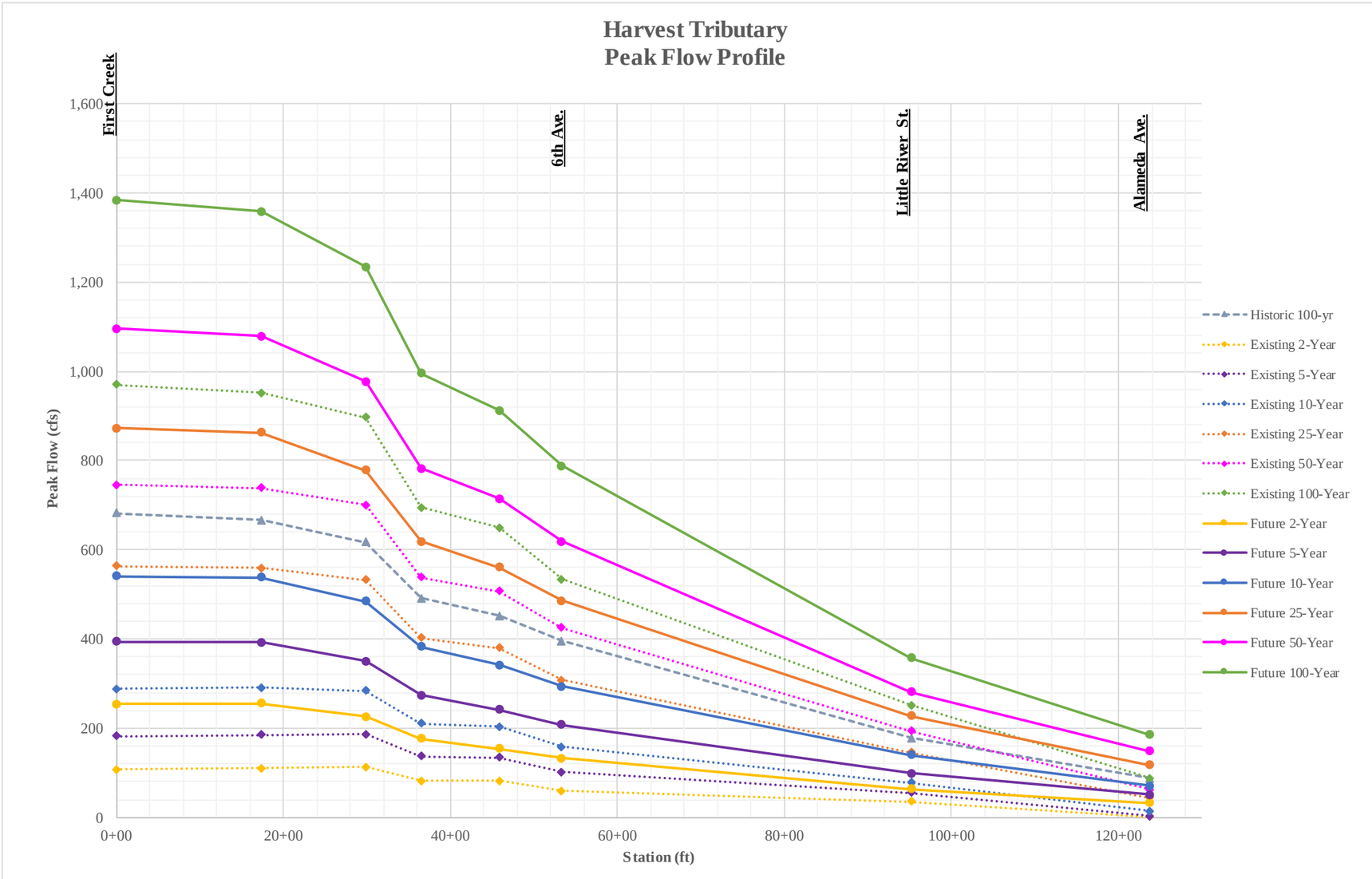


FIGURE B-4
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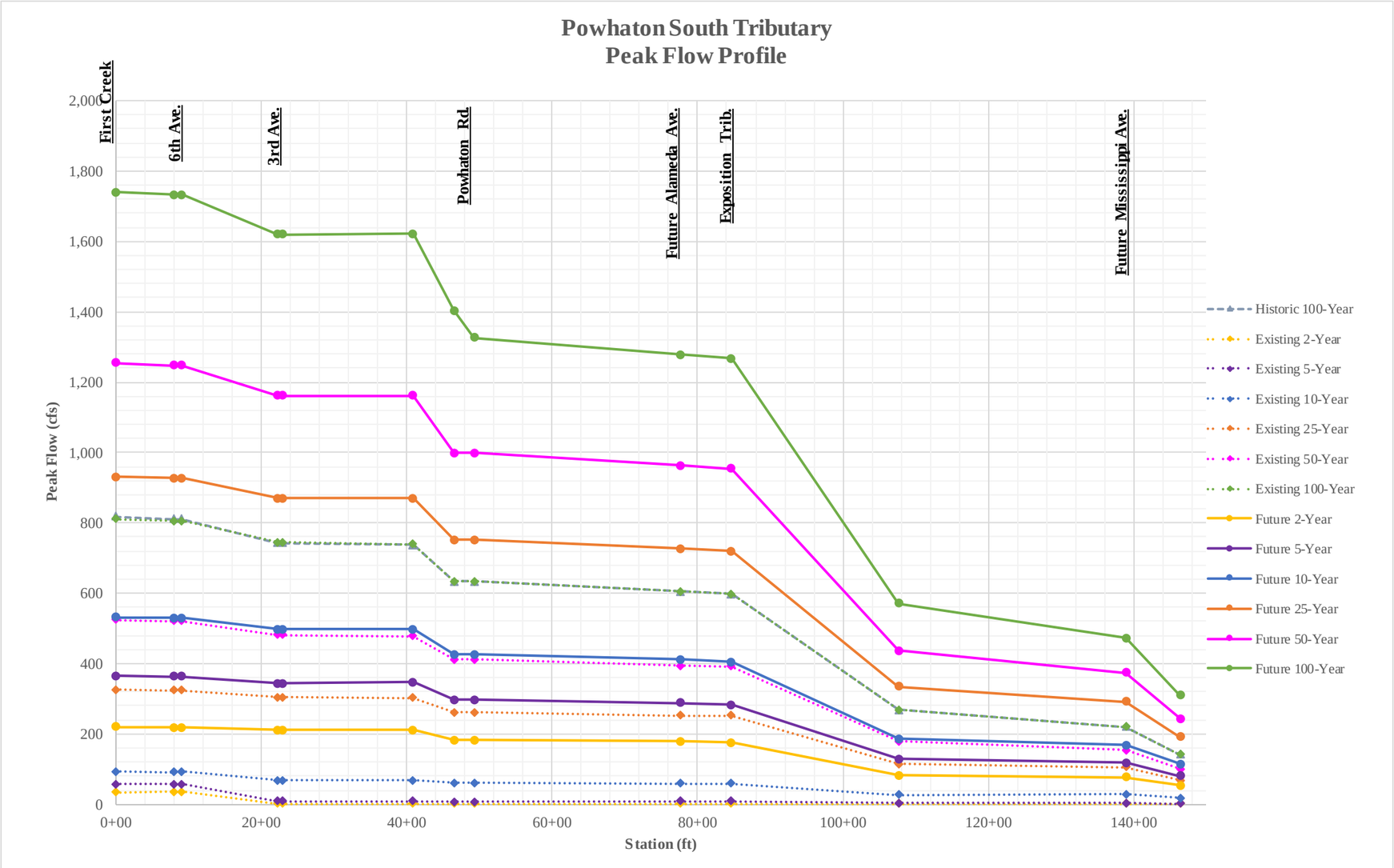


FIGURE B-4
Peak Flow Profiles

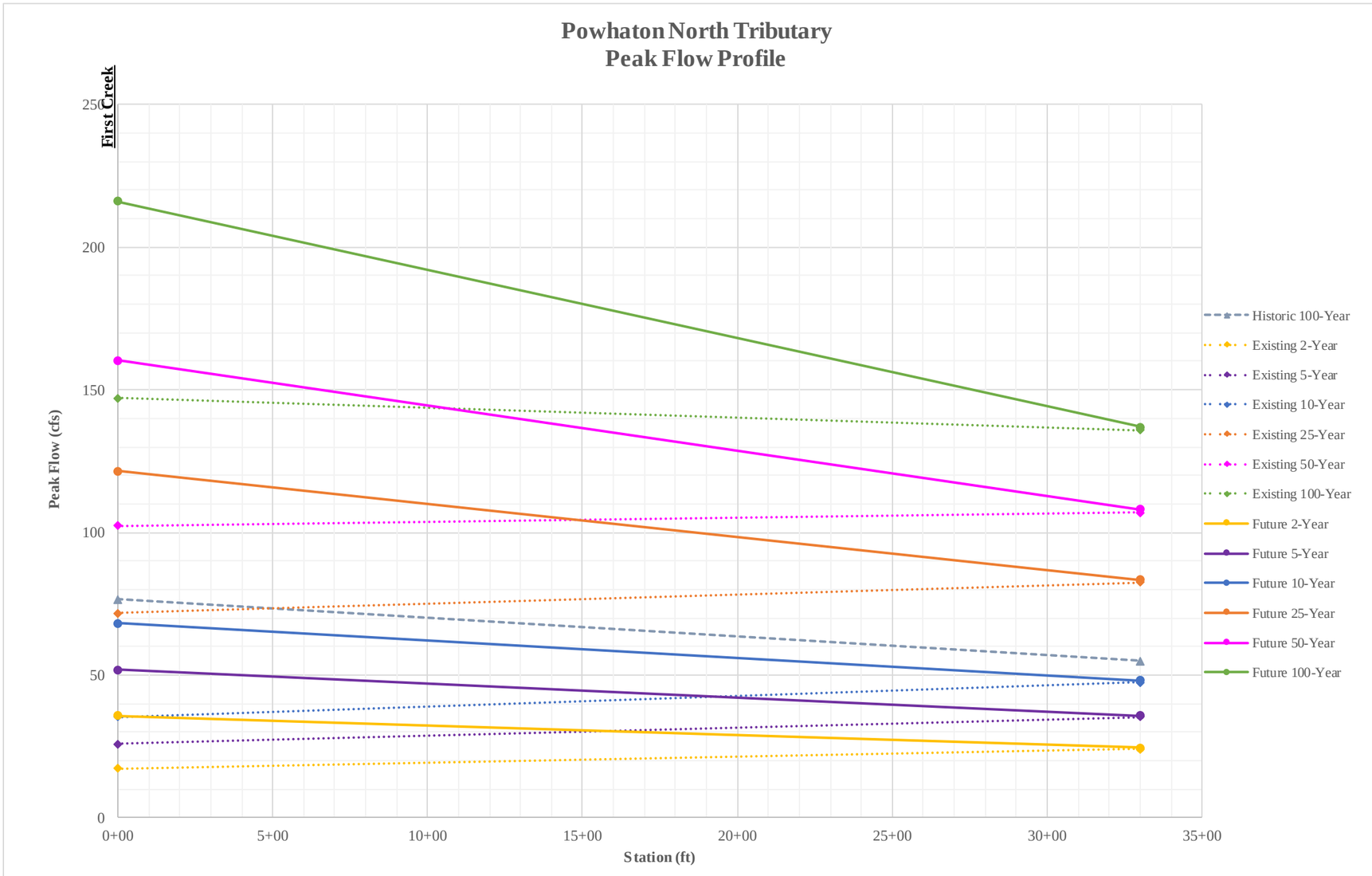
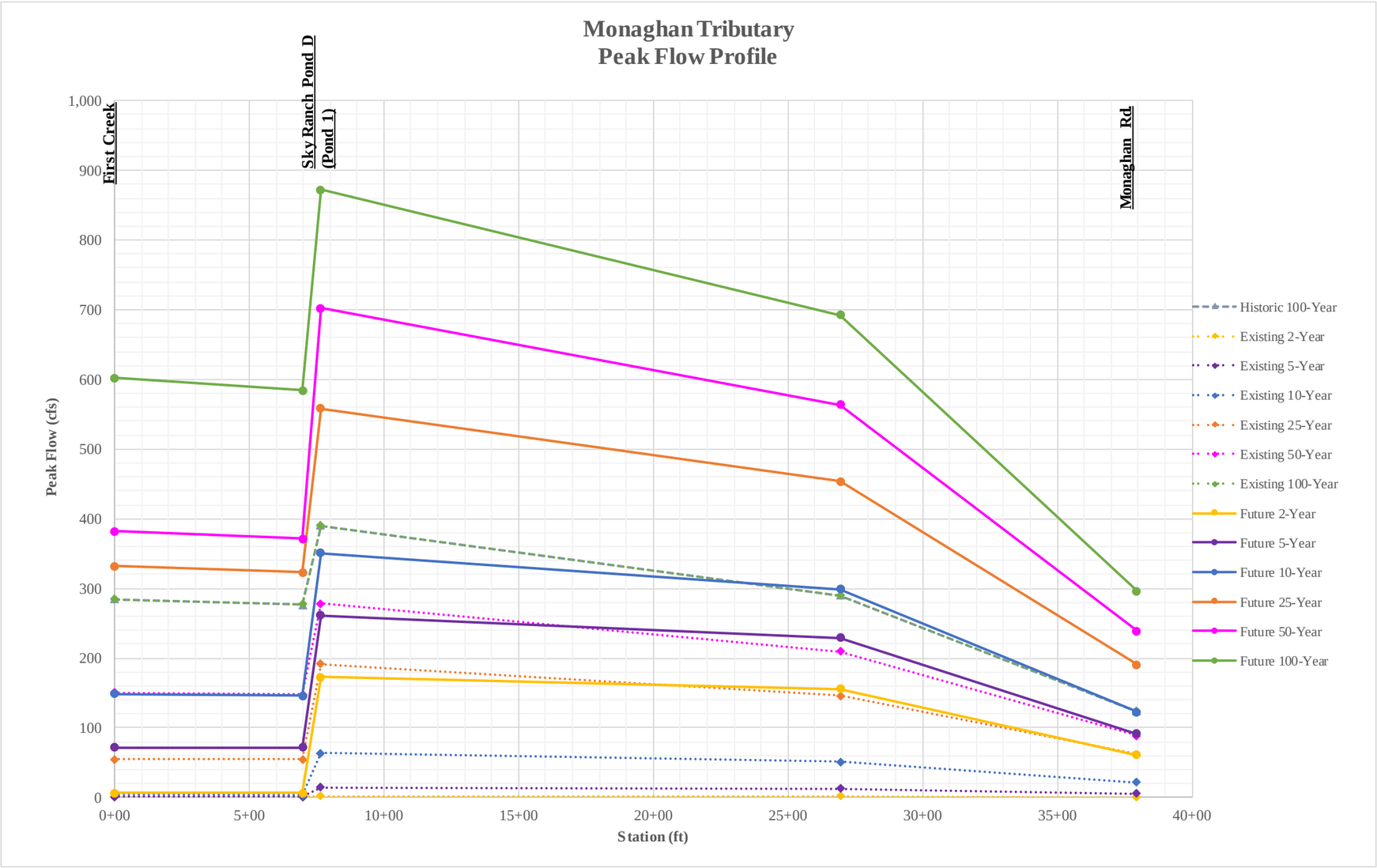


FIGURE B-4
Peak Flow Profiles



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Peak Flow Profiles

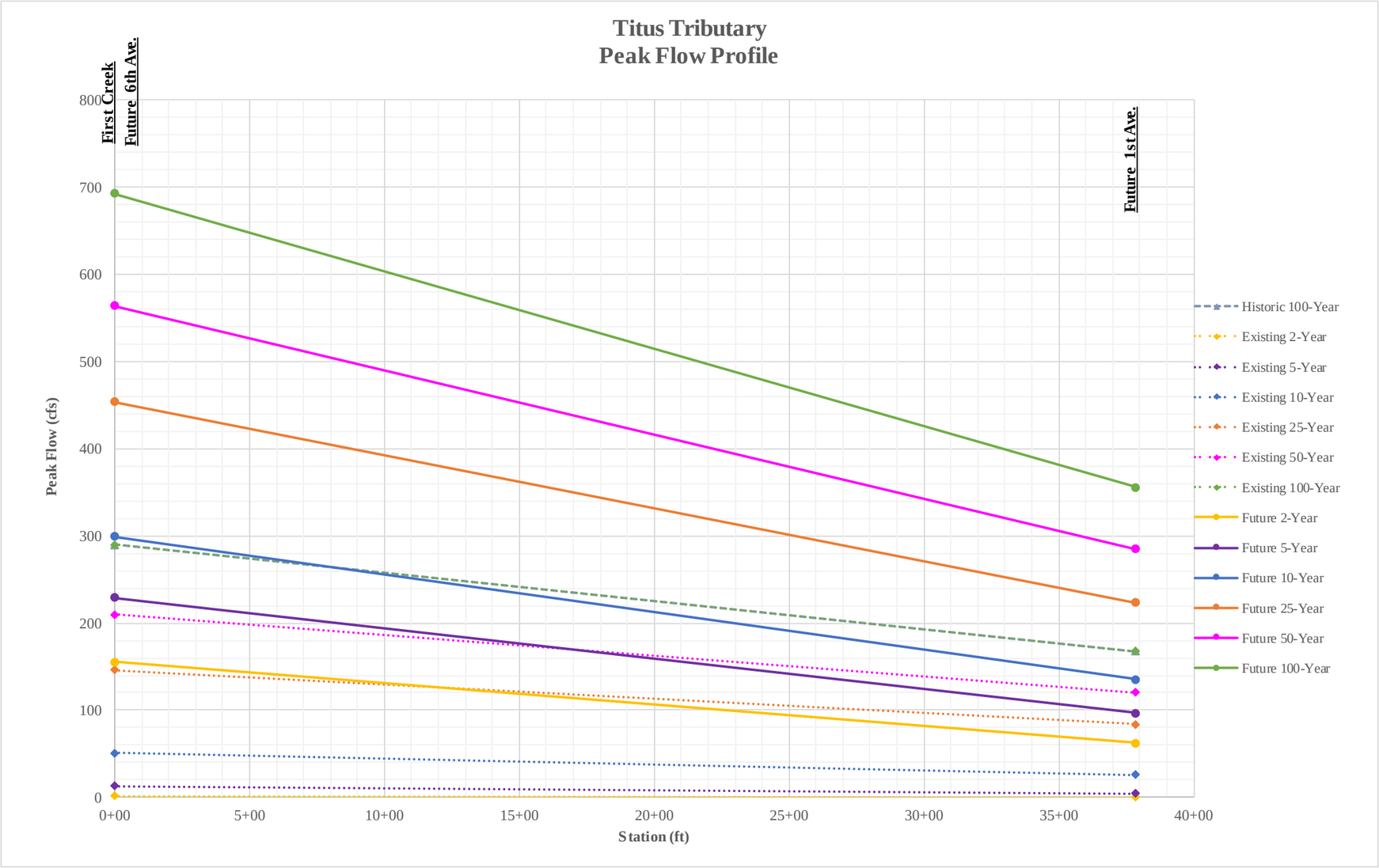


FIGURE B-4
Peak Flow Profiles

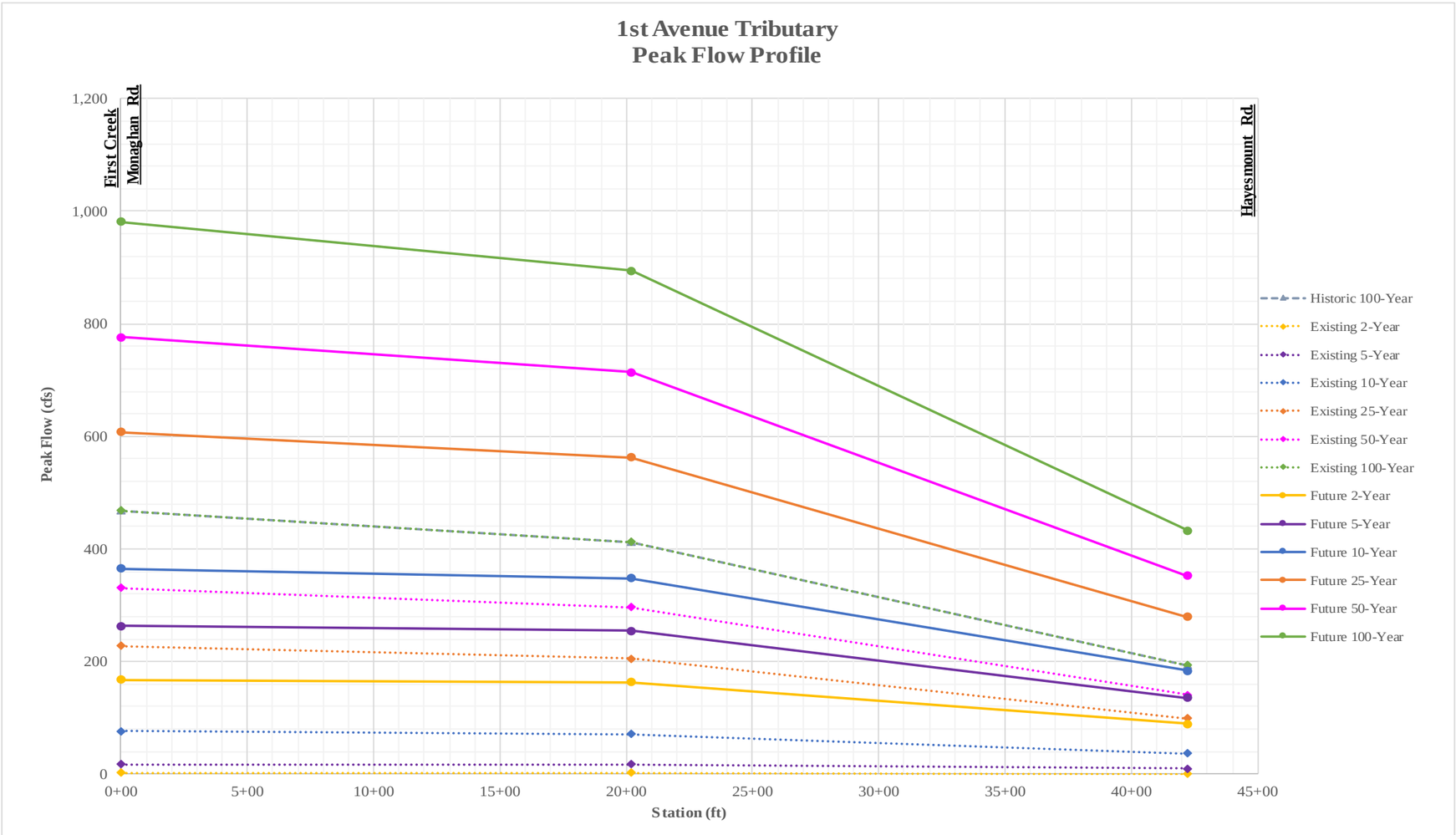


FIGURE B-4
Peak Flow Profiles

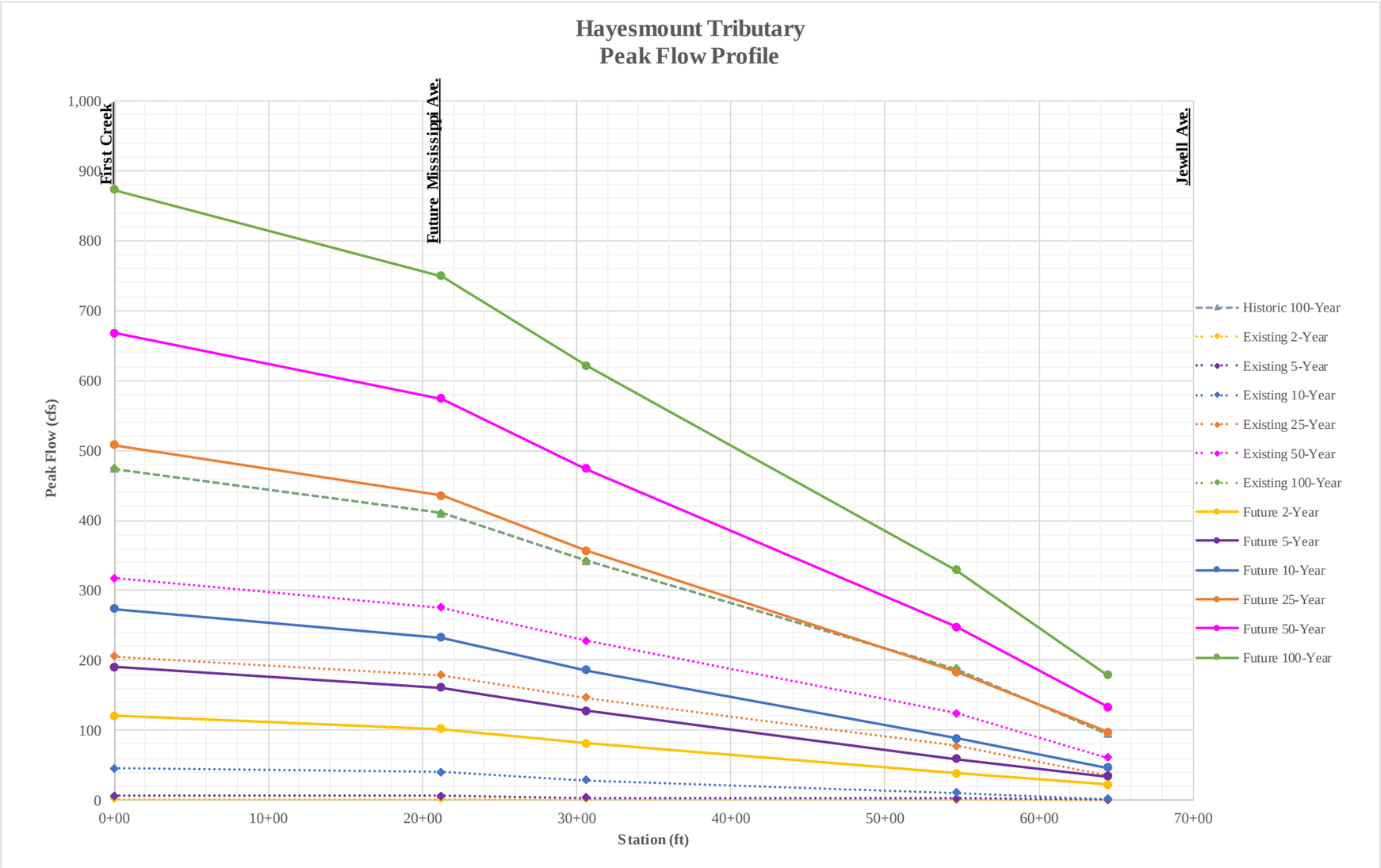


FIGURE B-4
Peak Flow Profiles

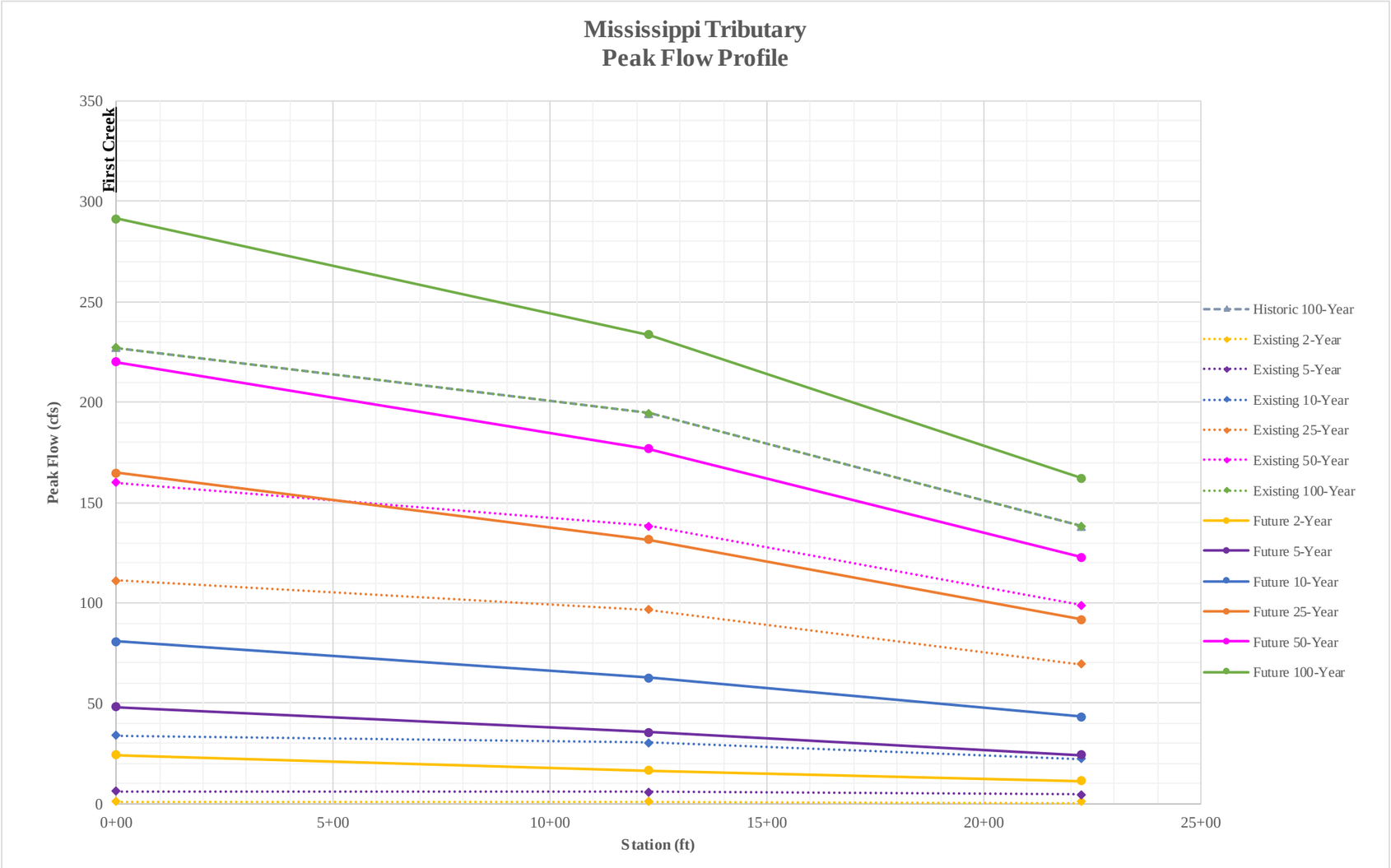
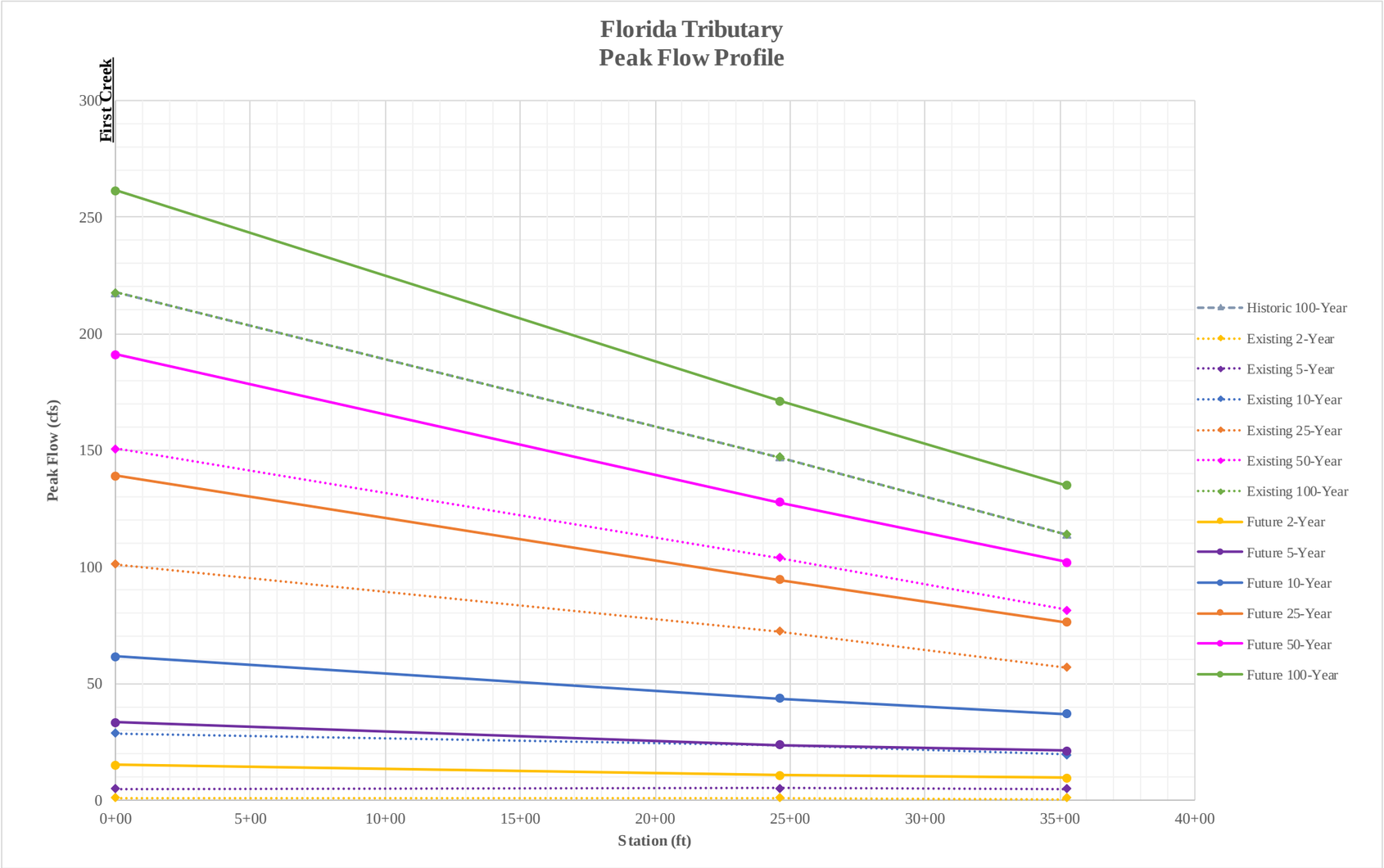


FIGURE B-4
Peak Flow Profiles



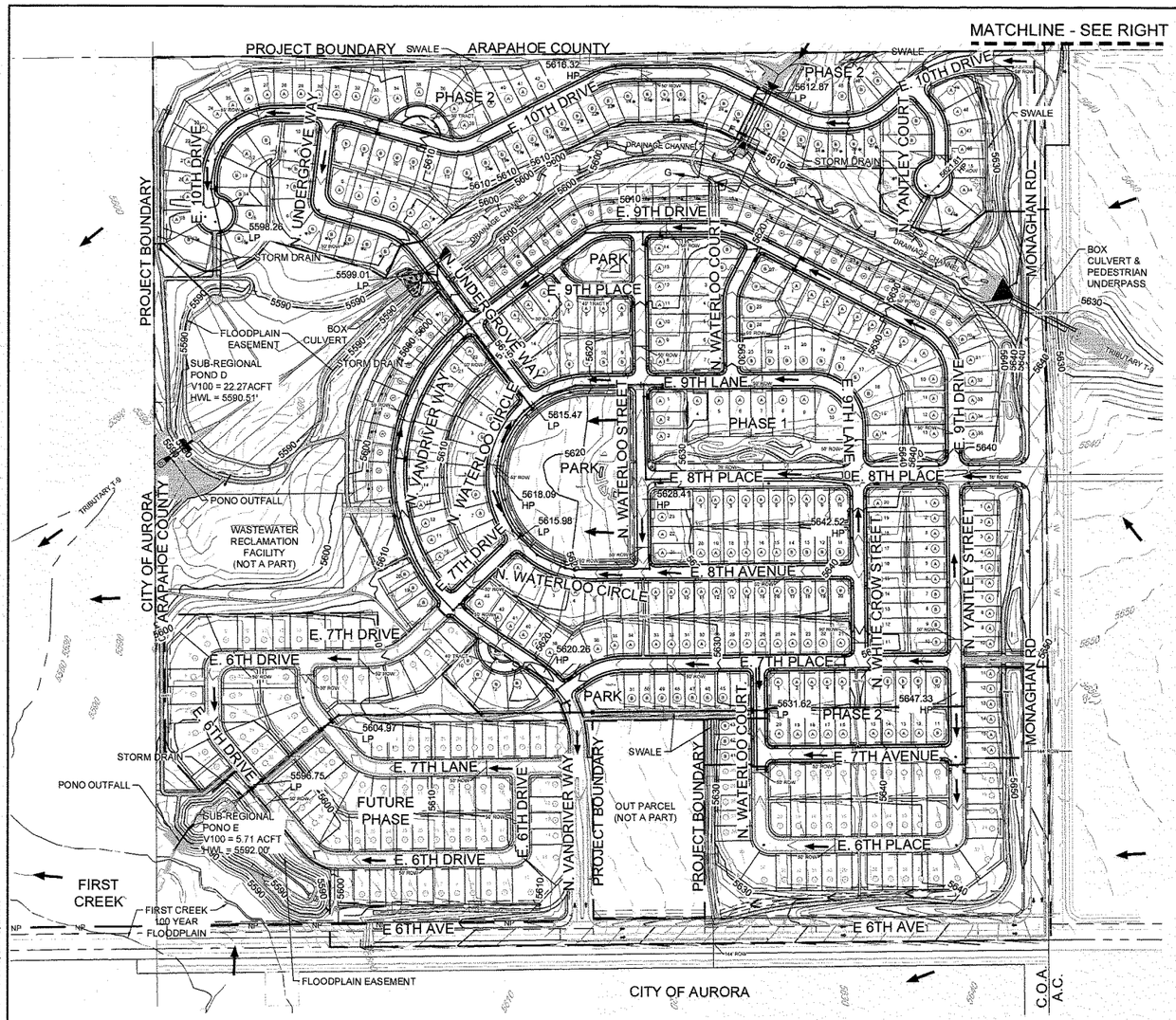
Note: Gun Club and Riverwood Tributaries do not have profiles since they each have a single discharge design point.

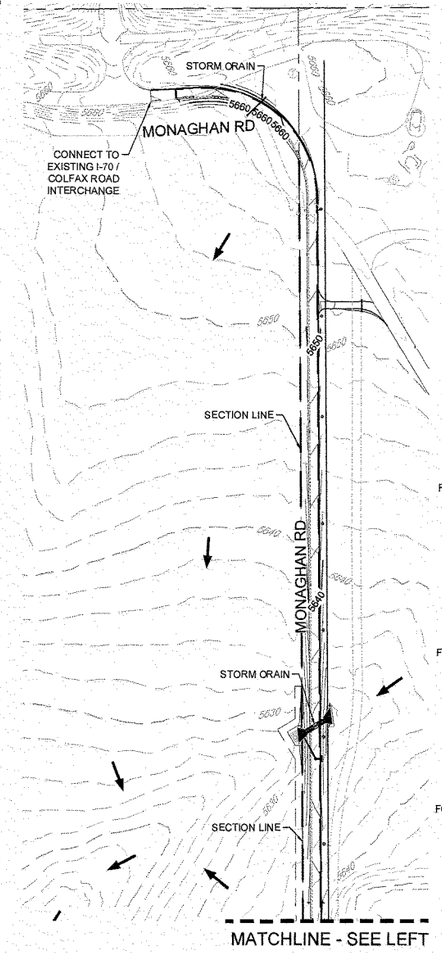
TABLE B-3
Existing Detention Stage-Storage-Discharge Curves

Sky Ranch Pond D		
Stage-Storage Curve		
Stage (ft)	Surface Area (ft^2)	Total Volume (ac-ft)
5,582	308	0
5,583	4,565	0.05
5,584	21,305	0.32
5,585	56,123	1.18
5,586	107,274	3.02
5,587	151,619	5.98
5,588	185,520	9.84
5,589	212,162	14.4
5,590	231,449	19.49
5,591	243,011	24.94
5,592	252,146	30.62

Sky Ranch Pond D										
Stage-Discharge Curve										
Stage		Grate Design Release Rates								
	Elevation (ft)	Stage (ft)	WQCV Orifice (cfs)	EURV Orifice (cfs)	100-yr Grate Orifice (cfs)	100-yr Grate Weir (cfs)	100-yr Control (cfs)	Orifice Design Release (cfs)	100-yr Restrictor Plate (cfs)	Spillway Design (cfs)	Total Release (cfs)
	5,582	0	0					0	82.76		**0.00**
	5,582.25	0.25	0.6					0.6	101.35		**0.60**
	5,582.50	0.5	0.69					0.69	117.03		**0.69**
	5,582.75	0.75	0.77					0.77	130.85		**0.77**
	5,583	1	0.84					0.84	143.34		**0.84**
	5,583.25	1.25	0.91					0.91	154.82		**0.91**
	5,583.50	1.5	0.98					0.98	165.51		**0.98**
	5,583.75	1.75	1.03					1.03	175.55		**1.03**
	5,584	2	1.09					1.09	185.05		**1.09**
	5,584.25	2.25	1.14					1.14	194.08		**1.14**
	5,584.50	2.5	1.19					1.19	202.71		**1.19**
	5,584.75	2.75	1.24					1.24	210.98		**1.24**
	5,585	3	1.29					1.29	218.95		**1.29**
	5,585.25	3.25	1.34					1.34	226.63		**1.34**
	5,585.50	3.5	1.38					1.38	234.07		**1.38**
	5,585.75	3.75	1.42					1.42	241.27		**1.42**
	5,586	4	1.46					1.46	248.27		**1.46**
	5,586.25	4.25	1.5					1.5	255.07		**1.50**
WQCV	5,586.50	4.5	1.54	0				1.54	261.69		**1.54**
	5,586.75	4.75	1.58	0.7				2.28	268.16		**2.28**
	5,587	5	1.62	1.06				2.68	274.47		**2.68**
	5,587.25	5.25	1.65	1.33				2.98	280.64		**2.98**
	5,587.50	5.5	1.69	1.55				3.24	286.67		**3.24**
	5,587.75	5.75	1.72	1.74				3.46	292.58		**3.46**
	5,588	6	1.76	1.92				3.68	298.38		**3.68**
	5,588.25	6.25	1.79	2.08				3.87	304.06		**3.87**
	5,588.50	6.5	1.82	2.23				4.05	309.64		**4.05**
EURV	5,588.75	6.75	1.86	2.37				4.23	315.12		**4.23**
	5,589	7	1.89	2.5	191.11	12.97	12.97	17.36	320.51		**17.36**
	5,589.25	7.25	1.92	2.62	335.59	70.22	70.22	74.76	325.81		**74.76**
	5,589.50	7.5	1.95	2.74	434.41	152.31	152.31	157	331.02		**157.00**
	5,589.75	7.75	1.98	2.86	514.59	253.18	253.18	258.02	336.15		**258.02**
	5,590	8	2.01	2.97	583.86	369.81	369.81	374.79	341.21		**341.21**
	5,590.25	8.25	2.04	3.07	645.75	500.31	500.31	505.42	346.19		**346.19**
100-yr	5,590.50	8.5	2.07	3.17	702.2	643.32	643.32	648.56	351.10		**351.10**
	5,590.75	8.75	2.1	3.27	754.44	797.84	754.44	759.81	355.94	65.80	**421.74**
	5,591	9	2.13	3.37	803.29	963.07	803.29	808.79	360.72	193.90	**554.62**
	5,591.25	9.25	2.15	3.46	849.33	1138.35	849.33	854.94	365.44	363.60	**729.04**
	5,591.50	9.5	2.18	3.55	893	1323.14	893	898.73	370.09	568.60	**938.69**
	5,591.75	9.75	2.21	3.64	934.64	1516.97	934.64	940.49	374.69	805.40	**1180.09**
	5,592	10	2.23	3.73	974.5	1719.44	974.5	980.46	379.23	1071.70	**1450.93**

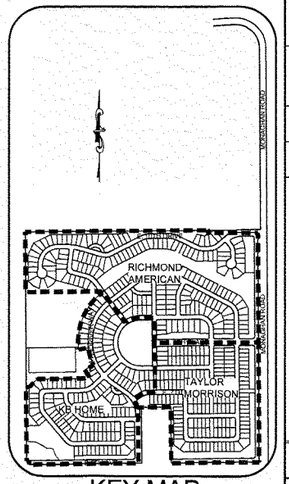
Data from *Sky Ranch Neighborhood B Phase III Drainage Report (E. 6th Ave. and Monaghan Rd.)* by CVL Consultants of Colorado (May, 2018)



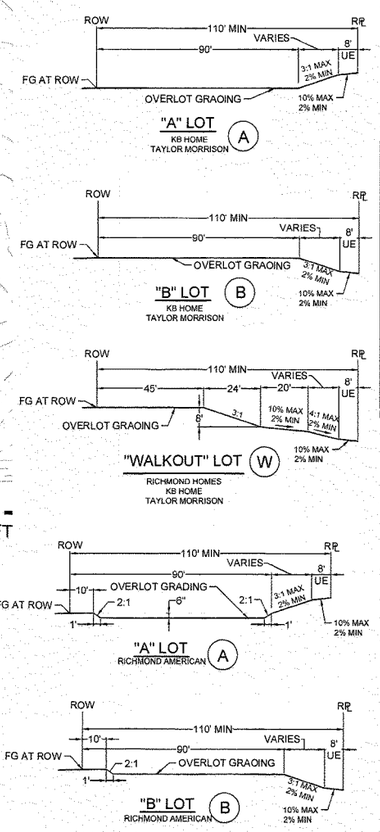


200 100 0 200 400

SCALE: 1" = 200'



KEY MAP
N.T.S.

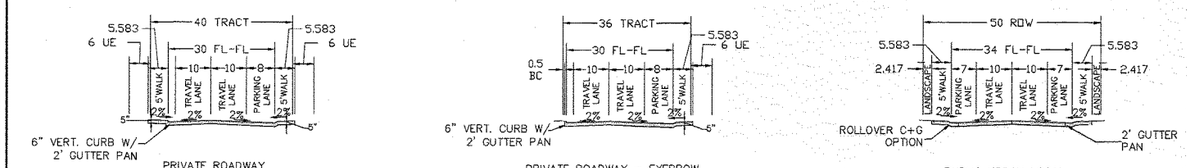


LEGEND

1	BLOCK NUMBER
10	LOT NUMBER
A	LOT TYPE
	EXISTING MAJOR CONTOUR
	EXISTING MINOR CONTOUR
	PROPOSED MAJOR CONTOUR
	PROPOSED MINOR CONTOUR
	PROPOSED STORM DRAIN (SD)
	PROPOSED STORM DRAIN INLET
4 5 6	PROPOSED STORM DRAIN MANHOLE
1.0%	PROPOSED SLOPE AND DIRECTION
	PROPOSED OVERLAND FLOW
	PHASING LINE
	SIGHT TRIANGLES (30' x 30')

NOTES:

1. ALL TRAILS ARE 6' CRUSHER FINES UNLESS OTHERWISE NOTED.
2. PROPOSEO CONTOURS REPRESENT OVERLOT GRAOING IN LOTS AND FINISH GRADE WITH STREET ROW.
3. NO MORE THAN THREE LOTS SHALL DRAIN THROUGH OOWNHILL LOT. REAR AND SIOE YARO SWALES SHALL BE DESIGNED ACCOROINGLY DURING DEVELOPMENT OF PLOT PLANS, FOLLOWING THE PROPERTY CORNER ELEVATIONS IOENTIFIED HEREIN AND ON THE AOMINISTRATIVE SITE PLAN.
4. SLOPES ON SIOEWALKS AND TRAILS MUST MEET ADA STANDARDS. SLOPES ON SIOEWALKS SHALL BE 5% MAX UNLESS OTHERWISE INDICATED. IF THE ADJACENT ROAOWAY SLOPE EXCEEDS 5%, THE SIDEWALK SLOPE CAN MATCH THE ROADWAY SLOPE, UP TO 7%. SLOPES ON TRAILS, UP TO 8.3%, ARE SHOWN FOR UP TO 200 FEET.
5. LOTS AOJACENT TO THE DRAINAGE CHANNEL ANO PONO O SHALL PROVIDE 2 FEET OF CLEARANCE ABOVE THE 100 YEAR WATER SURFACE ELEVATION FOR THE LOWEST FINISHED FLOOR. LOTS TO BE CONSIDERED ARE INDICATEO WITH AN ASTERISK " (*). PLOT PLANS SHALL VERIFY THAT CRITERIA IS MET.
6. ONSITE ORAINAGE AND UTILITY EASEMENTS SHOWN ARE TO BE OEOICATEO BY THE SKY RANCH FILING 1 PLAT. OFFSITE EASEMENTS ARE TO BE OEOICATEO BY SEPARATE OOCUMENT.



PRIVATE ROADWAY
40' TRACT
NOTE: FLOWLINE OF CURB ELEVATION (PARKING LANE SIDE) = FG CENTERLINE - 0.49'
NOTE: FLOWLINE OF CURB ELEVATION = FG CENTERLINE - 0.37'

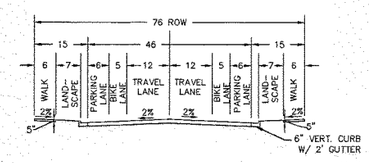
E. 9TH PLACE & N. VANDRIVER WAY EYEBROW

PRIVATE ROADWAY – EYEBROW
36' TRACT
FLOWLINE OF CURB ELEVATION (PARKING LANE SIOE) = FG CENTERLINE - 0.49'
NOTE: FLOWLINE OF CURB ELEVATION = FG CENTERLINE - 0.37'

E. 10TH DRIVE EYEBROW

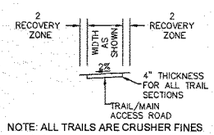
PUBLIC URBAN LOCAL
50' ROW
NOTE: FLOWLINE OF CURB ELEVATION = FG CENTERLINE - 0.47'

ALL STREETS UNLESS OTHERWISE NOTED

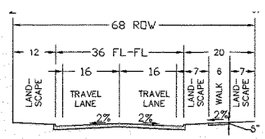


TWO LANE COLLECTOR
76' ROW
NOTE: FLOWLINE OF CURB ELEVATION = FG CENTERLINE - 0.63'

N. VANDRIVER WAY & E. 8TH PLACE

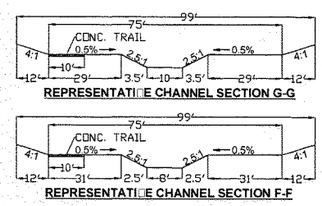


NOTE: ALL TRAILS ARE CRUSHER FINES UNLESS OTHERWISE STATEO.



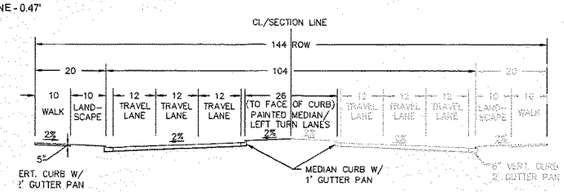
2 LANE COLLECTOR
68' ROW
NOTE: FLOWLINE OF CURB ELEVATION = FG CENTERLINE - 0.49'

E. 10TH DRIVE



REPRESENTATIOE CHANNEL SECTION G-G

REPRESENTATIOE CHANNEL SECTION F-F



SIX LANE PRINCIPAL ARTERIAL
144' ROW
NOTE: FLOWLINE OF CURB ELEVATION = FG CENTERLINE - 1.17'

MONAGHAN ROAD & 6TH AVENUE
THE WEST HALF OF MONAGHAN ROAD &
THE NORTH HALF OF 6TH AVENUE (FROM MONAGHAN ROAD TO APPROX. 615 LF WEST OF N. VANORIVER WAY) WILL BE CONSTRUCTEO WITH FILING 1

CASE NO. P17-014 (A.C.)

Arapahoe County
VALID ONLY IF FIRST PAGE IS SIGNED
JUL 19 2018
REVIEW AND ACCEPTANCE OF CONSTRUCTION PLANS AND SPECIFICATIONS

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No.	Revisions	Date	Init.	Appr.	Date

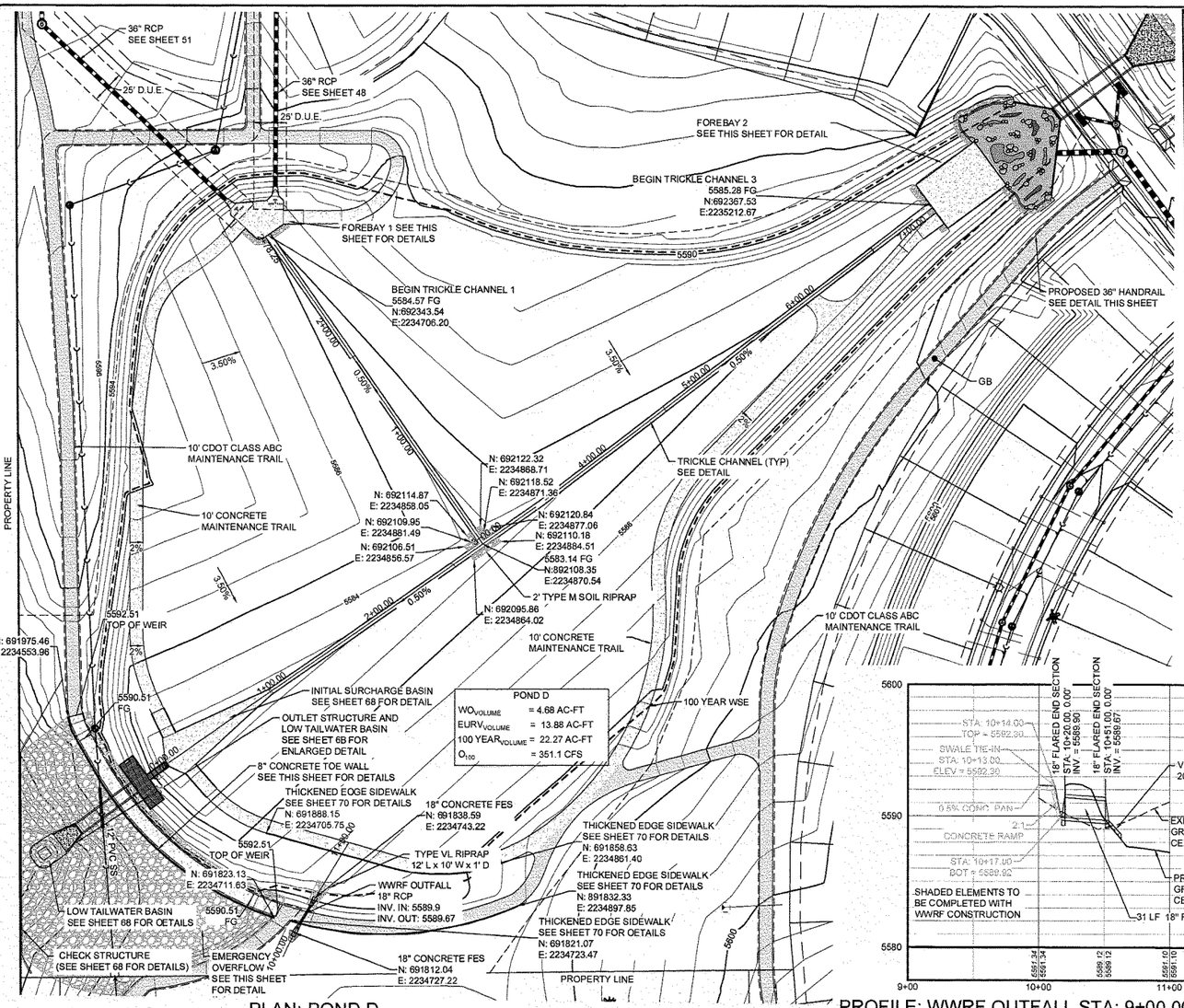
CVL CONSULTANTS
10333 E. Dry Creek Rd
Suite 240
Englewood, CO 80112
Tel: (720) 482-9526
Fax: (720) 482-9546
Contact: Melinda Lundquist, PE

SKY RANCH COMMUNITY AUTHORITY BOARD
Attn: Mark Harding
3450N. EAST QUINCY AVE.
BLDG. 34, BOX 10
WATKINS, CO. 80137

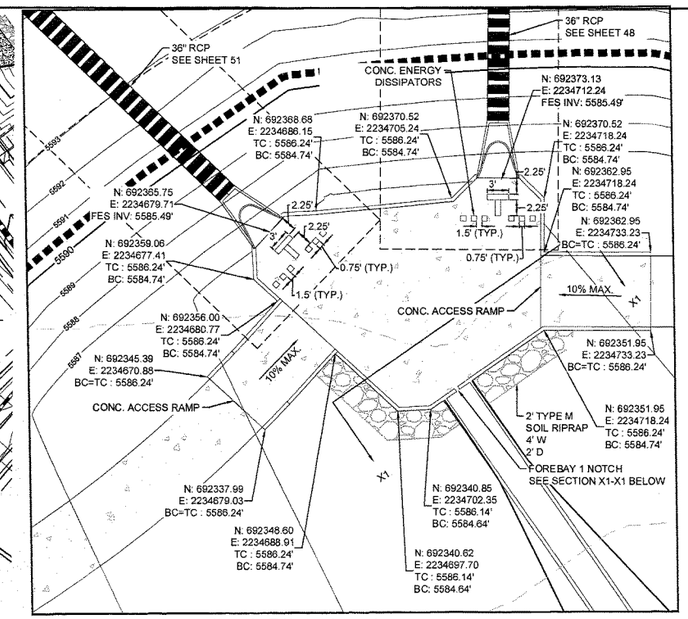
SKY RANCH - FILING 1 - PHASE 1 & 2
ROAD & DRAINAGE CONSTRUCTION PLANS
OVERALL GRADING PLAN

SCALE: AS SHOWN
FILE NO: 8.13.0107307
DRAWN BY: RHR
CHECKED BY: MEL
DATE: JUNE 26, 2018
SHEET NUMBER: 3

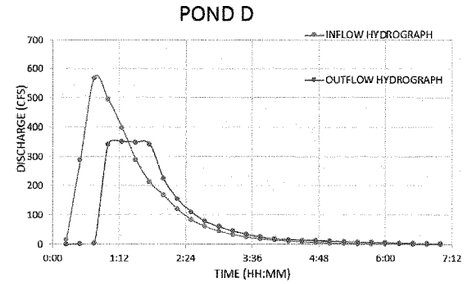
N:\PROJECTS\8\10705 SKY RANCH\CAD\ENGINEERING\SHEET SETS\CONSTRUCTION PLANS - NEIGHBORHOOD B\PHASE 1&2\OVERALL GRADING PLAN.DWG, CLAY0, 7/11/18



PLAN: POND D
HORIZONTAL SCALE: 1" = 50'

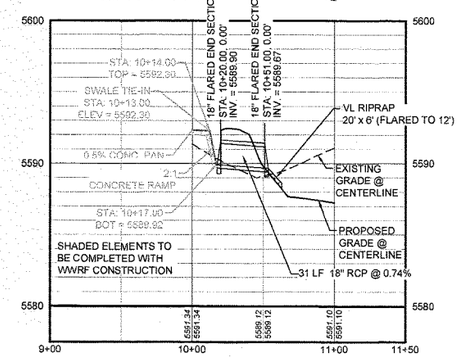


PLAN: FOREBAY 1
HORIZONTAL SCALE: 1" = 10'

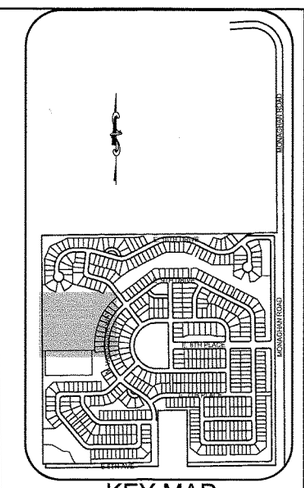


NOTE:
1. SEE DRAINAGE REPORT FOR MORE DETAILS.

Pond D		
Stage (ft)	Storage (Ac-ft)	Discharge (cfs)
5582	0.00	0.00
5583	0.06	0.84
5584	0.35	1.09
5585	1.24	1.29
5586	3.11	1.46
5587	6.08	2.68
5588	9.95	3.68
5589	14.52	17.36
5590	19.61	338.33
5591	25.05	363.42



PROFILE: WWRF OUTFALL STA: 9+00.00 TO 11+50.00
HORIZONTAL: 1" = 50'
VERTICAL: 1" = 5'

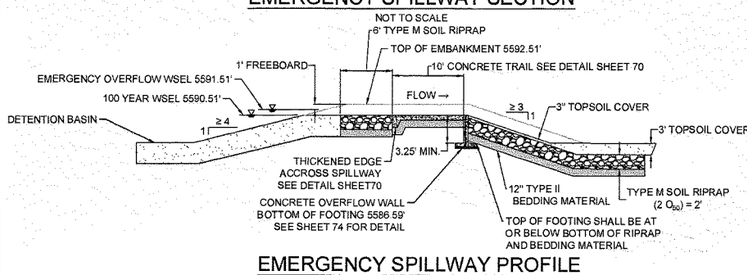


KEY MAP
NTS

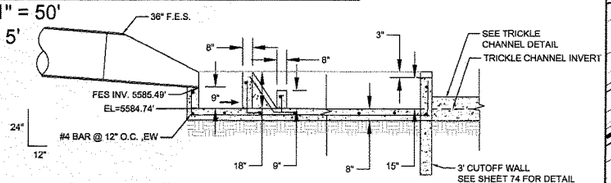
LEGEND

1	BLOCK NUMBER
10	LOT NUMBER
A	LOT TYPE
	EXISTING MAJOR CONTOUR
	EXISTING MINOR CONTOUR
	PROPOSED MAJOR CONTOUR
	PROPOSED MINOR CONTOUR
	PROPOSED STORM DRAIN (SD)
	PROPOSED STORM DRAIN INLET
	PROPOSED STORM DRAIN MANHOLE
1.0%	PROPOSED SLOPE AND DIRECTION
	PROPOSED OVERLAND FLOW
	PHASING LINE
	AGGREGATE SURFACE TRAIL (W = 30')

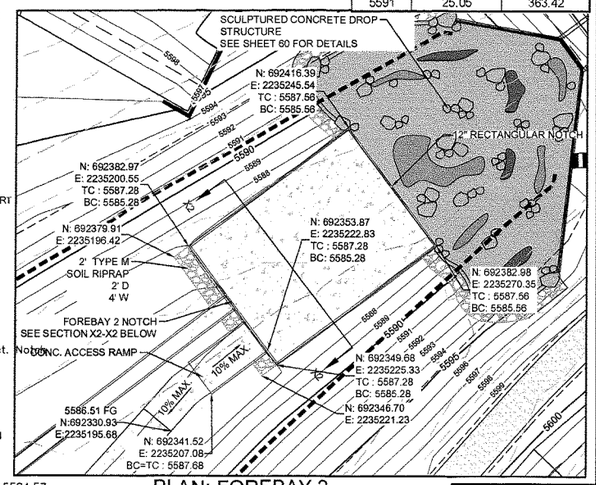
EMERGENCY SPILLWAY SECTION



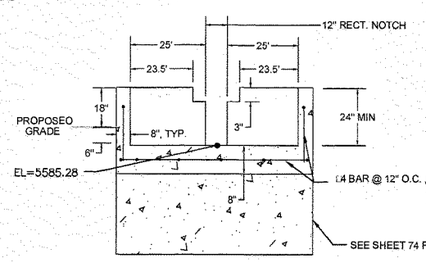
EMERGENCY SPILLWAY PROFILE
NOT TO SCALE



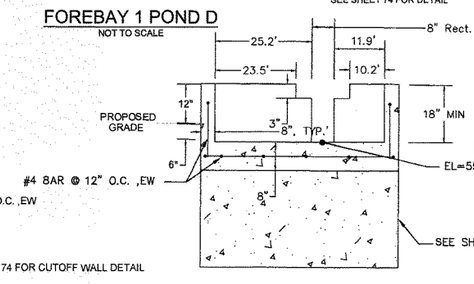
FOREBAY 1 POND D
NOT TO SCALE



PLAN: FOREBAY 2
HORIZONTAL SCALE: 1" = 20'



SECTION X2-X2 (RECT. - NOTCH DETAILS)
NOT TO SCALE



SECTION X1-X1 (RECT. - NOTCH DETAILS)
NOT TO SCALE

PREPARED UNDER THE SUPERVISION OF
COLORADO REGISTERED PROFESSIONAL ENGINEER 49988 6/28/2018
MARK SCHEURER
COLORADO P.E. 49988
VALID ONLY IF FIRST PAGE IS SIGNED
JUL 19 2018

UNCC UTILITY NOTIFICATION CENTER OF COLORADO
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No.	Revisions	Date	Init.	Appr.	Date

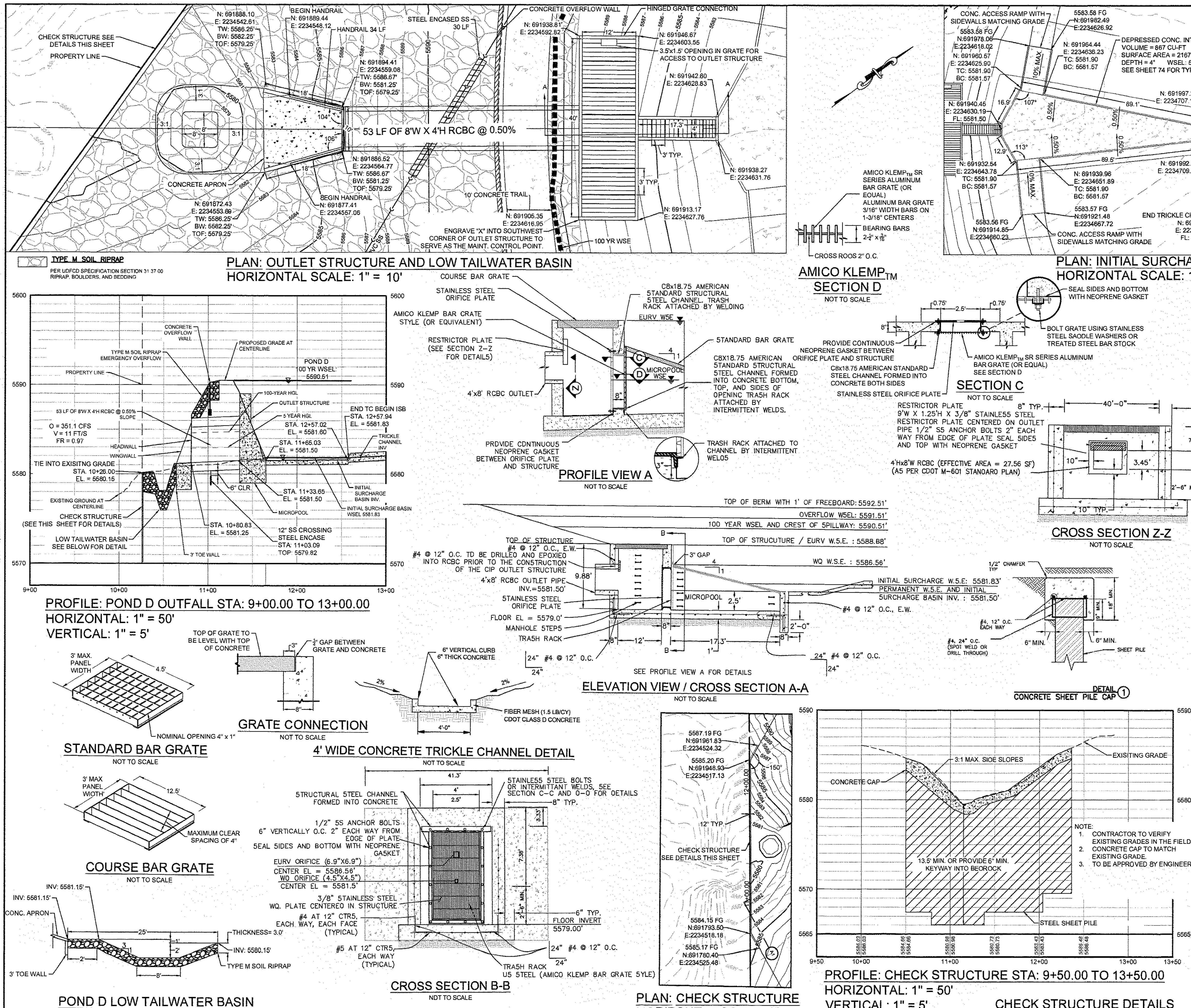
CVL CONSULTANTS
10333 E. Dry Creek Rd.
Suite 240
Englewood, CO 80112
Tel: (720) 482-9526
Fax: (720) 482-9546
Contact:
Melinda Lundquist, PE

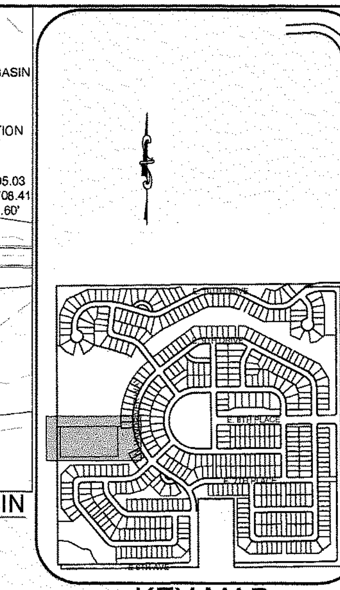
PCY HOLDINGS, LLC.
ATTN: MARK HARDING
34591 EAST QUINCY AVE.
BLDG. 34, BOX 10
WATKINS, CO. 80137

SKY RANCH - FILING 1 - PHASE 1&2
ROAD & DRAINAGE CONSTRUCTION PLANS
POND D PLAN

SCALE: AS SHOWN
FILE NO: 8.13.0107307
DRAWN BY: TPC
CHECKED BY: MS
DATE: MAY 2018
SHEET NUMBER 67

N:\PROJECTS\3010\7305 SKY RANCH\CAD\ENGINEERING\SHEET SETS\CONSTRUCTION PLANS - NEIGHBORHOOD B\PHASE 1&2\STORM PLAN AND PROFILE\POND D PLAN AND DETAILS.DWG, CLAYG, 6/20/18





KEY MAP
N.T.S.

LEGEND

- BLOCK NUMBER
- LOT NUMBER
- LOT TYPE
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- PROPOSED STORM DRAIN (SD)
- PROPOSED STORM DRAIN INLET
- PROPOSED STORM DRAIN MANHOLE
- PROPOSED SLOPE AND DIRECTION
- PROPOSED OVERLAND FLOW
- PHASING LINE
- SIGHT TRIANGLES (30' x 30')
- AGGREGATE BASE COURSE TRAIL

Arapahoe County
VALID ONLY IF FIRST PAGE IS SIGNED
JUL 19 2018
REVIEWED ACCEPTANCE OF CONSTRUCTION PLANS AND SPECIFICATIONS

ORIFICE PLATE NOTES:
1. PROVIDE CONTINUOUS NEOPRENE GASKET MATERIAL BETWEEN THE ORIFICE PLATE AND CONCRETE.
2. BOLT PLATE TO CONCRETE 12" MAX. ON CENTER.
3. ALL METAL PIECES SHALL BE STAINLESS STEEL UNLESS NOTED OTHERWISE.

EURV AND WOCV TRASH RACKS:
1. TRASH RACKS SHALL BE STAINLESS STEEL AND SHALL BE ATTACHED BY INTERMITTENT WELDS ALONG THE EDGE OF THE MOUNTING FRAME.
2. ALL METAL PIECES SHALL BE STAINLESS STEEL UNLESS NOTED OTHERWISE.

BAR GRATES:
1. ALL SAFETY GRATES SHALL BE MOUNTED USING STAINLESS STEEL HARDWARE AND PROVIDED WITH HINGED AND LOCKABLE OR BOLTABLE ACCESS PANELS.
2. SAFETY GRATES SHALL BE STAINLESS STEEL, ALUMINUM, OR STEEL. STEEL GRATES SHALL BE HOT DIP GALVANIZED AND MAY BE HOT POWDER COATED AFTER GALVANIZING.
3. COARSE BAR GRATING REFERS TO METAL BAR GRATING WITH MAXIMUM CLEAR SPACING OF 4".
4. STANDARD BAR GRATING REFERS TO METAL BAR GRATING WITH A NOMINAL OPENING OF 1 INCH BY 4 INCH. BEARING BARS FOR STANDARD BAR SHALL BEAR A UNIFORM LOAD OF 150 POUNDS PER SQUARE FOOT.
5. 3" GAP TO BE PROVIDED ABOVE TRASH RACK BETWEEN CONCRETE AND BAR GRATE TO FACILITATE CLEANING.
6. BAR GRATES OVER MANHOLE STEPS TO BE ATTACHED WITH A HINGED CONNECTION.

CHECK STRUCTURE NOTES:
1. CHECK STRUCTURE TO EXTEND ACROSS THE FULL WIDTH OF THE EMERGENCY SPILLWAY.
2. CHECK STRUCTURE LOCATED AT THE TERMINATION OF RIPRAP FOR EMERGENCY SPILLWAY.

WINGWALL NOTES:
1. CONSTRUCT WINGWALLS PER CDOT DETAILS M-601-1, M-601-10, AND M-601-20. SEE SHEET 74

OUTFALL STRUCTURE NOTES:
1. CONTRACTOR TO VERIFY OUTLET RCBC INVERT IS EQUAL TO THE INITIAL SURCHARGE BASIN INVERT.

MAINTENANCE PATH NOTES:
1. SEE SHEET 70 FOR CROSS SECTION DETAILS.

GENERAL NOTES:
1. SEE COVER SHEET FOR ADDITIONAL NOTES ON UDFCD CONSTRUCTION OBSERVATION.

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PREPARED UNDER THE SUPERVISION OF
MARK SCHEURER
COLORADO P.E. 48988

CVL CONSULTANTS
10333 E. Dry Creek Rd. Suite 240
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Tel: (720) 482-9526
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PCY HOLDINGS, LLC.
ATTN: MARK HARDING
34501 EAST QUINCY AVE. BLDG. 34, BOX 10
WATKINS, CO, 80137

SKY RANCH - FILING 1 - PHASE 1&2
ROAD & DRAINAGE CONSTRUCTION PLANS
POND D DETAIL

SCALE:	AS SHOWN
FILE NO:	3.13.D1D7307
DRAWN BY:	TPC
CHECKED BY:	MS
DATE:	MAY 2018
SHEET NUMBER	68

FIGURE B-5
Existing Conditions 100-Year SWMM Output

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)
--------------------------------------------------------------

FIRST CREEK TRIBUTARIES MDP
BASELINE HYDROLOGY SWMM MODEL
100-YR, EXISTING


*************
Element Count
*************
Number of rain gages ...... 1
Number of subcatchments ... 57
Number of nodes ........... 102
Number of links ........... 102
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                  Data       Recording
Name                 Data Source                  Type       Interval
-----------------------------------------------------------------------
California_Type_1_1in California_Type_1_1in        INTENSITY    6 min.


********************
Subcatchment Summary
********************
Name                        Area     Width   %Imperv    %Slope Rain Gage            Outlet
-----------------------------------------------------------------------------------------------
-------
100                       154.77   1206.87     95.27    1.9160 California_Type_1_1in B100
1000                       34.21    633.19     49.82    3.6020 California_Type_1_1in B1000
1005                       48.48    912.77     24.73    3.0360 California_Type_1_1in B1005
1010                      134.08   1380.51     18.76    2.8070 California_Type_1_1in B1010
1100                       84.78   1115.60     21.79    3.7800 California_Type_1_1in B1100
1105                       39.65    590.76     12.34    2.3970 California_Type_1_1in B1105
1110                      128.07    965.26     19.65    2.2590 California_Type_1_1in B1110
200                        23.41    479.69     35.27    3.2800 California_Type_1_1in B200
205                        63.55    713.35     94.57    3.2800 California_Type_1_1in B205
210                        39.05    922.35     93.06    3.6980 California_Type_1_1in B210
215                        44.10    802.10     90.03    3.2590 California_Type_1_1in B215
220                        26.63    610.48     50.50    4.0730 California_Type_1_1in B220
225                        84.22   1058.87     52.28    3.6980 California_Type_1_1in B225
230                        62.05    863.38     55.14    3.9450 California_Type_1_1in B230
235                        91.12    762.19     46.46    3.8200 California_Type_1_1in B235
240                       171.44   1107.78     50.36    1.4720 California_Type_1_1in B240
245                        80.85   1120.24     50.22    3.4570 California_Type_1_1in B245
250                        86.18   1184.99     50.00    2.7920 California_Type_1_1in B250
300                        18.67    452.95     50.00    0.5000 California_Type_1_1in B300
305                         6.51    204.73      2.01    7.6490 California_Type_1_1in B305
310                       104.43   1246.91     50.02    4.0900 California_Type_1_1in B310
315                        75.26    972.24     50.22    5.0300 California_Type_1_1in B315
320                        16.37    290.72      4.92    0.5000 California_Type_1_1in B320
325                        72.58   1128.17     50.00    3.4970 California_Type_1_1in B325
330                        68.14   1207.53     50.11    3.4710 California_Type_1_1in B330
335                       125.39   1219.23     64.73    2.5240 California_Type_1_1in B335
340                        34.29   1028.66     68.28    2.0960 California_Type_1_1in B340
345                        74.60    883.04     53.61    2.2660 California_Type_1_1in B345
350                        44.97    566.09     50.00    2.1640 California_Type_1_1in B350
355                        69.00    807.53     52.60    3.0160 California_Type_1_1in B355
360                        93.29    830.66     50.00    2.1620 California_Type_1_1in B360
365                       153.84   1416.18     50.00    2.3800 California_Type_1_1in B365
370                        61.66    780.72     50.84    2.0720 California_Type_1_1in B370
375                       148.86   1624.22     50.00    2.3120 California_Type_1_1in B375
380                       102.12   1180.64     50.47    2.4420 California_Type_1_1in B380
385                       131.80   1356.65     59.95    2.4610 California_Type_1_1in B385
400                        92.70    855.88     50.00    2.2110 California_Type_1_1in B400
405                        69.28    890.75     51.87    3.2540 California_Type_1_1in B405
500                       175.00   1191.94     62.84    2.3860 California_Type_1_1in B500
600                        17.88    596.80     29.39    3.8290 California_Type_1_1in B600
602                        90.36   1142.37     45.99    3.8290 California_Type_1_1in B602
605                        71.84    994.31     69.05    3.0090 California_Type_1_1in B605
610                       136.46   1224.43     59.92    2.4820 California_Type_1_1in B610
615                        52.66   1214.43     82.20    3.0610 California_Type_1_1in B615
700                        59.09    620.93     57.98    2.8110 California_Type_1_1in B700
705                       162.98   1570.75     50.02    2.2830 California_Type_1_1in B705
800                        81.92    675.40     41.96    3.1530 California_Type_1_1in B800
805                       155.55   1648.82     58.48    2.5420 California_Type_1_1in B805
810                        68.87    715.98     47.31    3.2040 California_Type_1_1in B810
815                       141.73   1702.91     58.81    2.7200 California_Type_1_1in B815
900                        78.20    934.68     50.00    3.9870 California_Type_1_1in B900
905                        37.72    728.74     50.00    2.7060 California_Type_1_1in B905
910                        41.31    478.01     49.09    2.6320 California_Type_1_1in B910
915                        84.39   1046.83     50.00    3.1260 California_Type_1_1in B915
920                        88.42   1088.43     49.69    2.8320 California_Type_1_1in B920
925                       123.01   1062.57     32.75    3.9830 California_Type_1_1in B925
930                       133.54   1145.51     36.32    3.5300 California_Type_1_1in B930


************
Node Summary
************
                                                Invert      Max.    Ponded    External
Name                 Type                        Elev.     Depth      Area    Inflow
-----------------------------------------------------------------------------------------
B100                 JUNCTION                  5511.01      0.00       0.0
B1000                JUNCTION                  5686.08      0.00       0.0
B1005                JUNCTION                  5700.10      0.00       0.0
B1010                JUNCTION                  5717.19      3.45       0.0
B1100                JUNCTION                  5708.80      0.00       0.0
B1105                JUNCTION                  5749.60      0.00       0.0
B1110                JUNCTION                  5765.81      3.65       0.0
B200                 JUNCTION                  5516.13      0.00       0.0
B205                 JUNCTION                  5531.84      0.00       0.0
B210                 JUNCTION                  5543.12      0.00       0.0
B215                 JUNCTION                  5551.33      0.00       0.0
B235                 JUNCTION                  5571.48     10.55       0.0
B240                 JUNCTION                  5570.52      0.00       0.0
B245                 JUNCTION                  5600.91      0.00       0.0
B300                 JUNCTION                  5554.12      0.00       0.0
B305                 JUNCTION                  5563.78      0.00       0.0
B310                 JUNCTION                  5563.78      0.00       0.0
B315                 JUNCTION                  5563.78      0.00       0.0
B320                 JUNCTION                  5575.36      0.00       0.0
B325                 JUNCTION                  5600.62      0.00       0.0
```

FIGURE B-5
Existing Conditions 100-Year SWMM Output

B330	JUNCTION	5601.85	0.00	0.0
B335	JUNCTION	5612.56	0.00	0.0
B340	JUNCTION	5610.04	0.00	0.0
B345	JUNCTION	5632.10	0.00	0.0
B350	JUNCTION	5643.98	0.00	0.0
B355	JUNCTION	5643.98	0.00	0.0
B360	JUNCTION	5669.91	0.00	0.0
B365	JUNCTION	5672.97	4.10	0.0
B370	JUNCTION	5632.10	0.00	0.0
B375	JUNCTION	5645.12	0.00	0.0
B380	JUNCTION	5659.42	0.00	0.0
B385	JUNCTION	5677.36	2.59	0.0
B400	JUNCTION	5565.43	0.00	0.0
B405	JUNCTION	5593.96	2.92	0.0
B500	JUNCTION	5567.09	0.00	0.0
B600	JUNCTION	5568.84	0.00	0.0
B602	JUNCTION	5582.10	0.00	0.0
B605	JUNCTION	5603.51	0.00	0.0
B610	JUNCTION	5626.02	4.19	0.0
B615	JUNCTION	5635.11	4.43	0.0
B700	JUNCTION	5573.79	0.00	0.0
B705	JUNCTION	5615.99	3.73	0.0
B800	JUNCTION	5605.06	0.00	0.0
B805	JUNCTION	5626.11	0.00	0.0
B810	JUNCTION	5626.11	0.00	0.0
B815	JUNCTION	5650.94	8.71	0.0
B900	JUNCTION	5648.06	0.00	0.0
B905	JUNCTION	5688.47	0.00	0.0
B910	JUNCTION	5688.47	0.00	0.0
B915	JUNCTION	5695.99	0.00	0.0
B920	JUNCTION	5695.99	0.00	0.0
B925	JUNCTION	5740.06	0.00	0.0
B930	JUNCTION	5740.06	0.00	0.0
DP100	JUNCTION	5510.91	0.00	0.0
DP1000	JUNCTION	5685.98	3.11	0.0
DP1005	JUNCTION	5700.00	3.45	0.0
DP1100	JUNCTION	5708.70	1.64	0.0
DP1105	JUNCTION	5749.50	3.65	0.0
DP200	JUNCTION	5516.03	13.59	0.0
DP205	JUNCTION	5531.74	16.24	0.0
DP210	JUNCTION	5543.02	16.24	0.0
DP215	JUNCTION	5551.23	12.16	0.0
DP216	JUNCTION	5563.26	12.16	0.0
DP219	JUNCTION	5569.45	11.00	0.0
DP223	JUNCTION	5572.72	5.75	0.0
DP228	JUNCTION	5569.11	4.75	0.0
DP300	JUNCTION	5554.02	10.19	0.0
DP304	JUNCTION	5562.30	15.00	0.0
DP319	JUNCTION	5566.31	22.70	0.0
DP323	JUNCTION	5578.90	28.23	0.0
DP329	JUNCTION	5596.56	15.77	0.0
DP334	JUNCTION	5604.55	12.95	0.0
DP340	JUNCTION	5609.94	23.08	0.0
DP345	JUNCTION	5632.00	6.92	0.0
DP350	JUNCTION	5643.88	6.92	0.0
DP360	JUNCTION	5669.81	4.10	0.0
DP375	JUNCTION	5645.02	3.56	0.0
DP380	JUNCTION	5659.31	2.59	0.0
DP400	JUNCTION	5565.33	2.92	0.0
DP500	JUNCTION	5566.99	0.00	0.0
DP600	JUNCTION	5568.74	14.67	0.0
DP602	JUNCTION	5580.15	14.67	0.0
DP605	JUNCTION	5603.41	6.49	0.0
DP700	JUNCTION	5573.69	3.73	0.0
DP800	JUNCTION	5604.96	11.71	0.0
DP805	JUNCTION	5626.01	11.71	0.0
DP900	JUNCTION	5647.96	13.33	0.0
DP905	JUNCTION	5688.37	13.33	0.0
DP915	JUNCTION	5695.89	8.49	0.0
DP925	JUNCTION	5739.96	4.65	0.0
B220	DIVIDER	5582.69	4.50	0.0
B225	DIVIDER	5573.55	4.58	0.0
B230	DIVIDER	5579.02	4.50	0.0
B250	DIVIDER	5619.48	5.00	0.0
DP240	DIVIDER	5570.43	11.00	0.0
DP245	DIVIDER	5600.81	8.00	0.0
DP305	DIVIDER	5563.68	14.00	0.0
DP320	DIVIDER	5575.26	14.00	0.0
DP325	DIVIDER	5600.52	10.50	0.0
DP330	DIVIDER	5601.75	12.00	0.0
DP335	DIVIDER	5612.46	5.50	0.0
SU1	STORAGE	5582.00	11.00	0.0

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************
Link Summary
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Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	DP330	DP329	CONDUIT	284.0	0.5000	0.0150
C10	B925	DP925	CONDUIT	10.0	1.0001	0.0100
C10_1	DP330	DP329	CONDUIT	284.0	0.5000	0.0160
C10_2	DP329	DP323	CONDUIT	489.6	0.1999	0.0500
C1000	B1000	DP1000	CONDUIT	10.0	1.0001	0.0100
C1005	B1005	DP1005	CONDUIT	10.0	1.0001	0.0100
C11	B250	DP245	CONDUIT	2856.0	0.6537	0.0150
C1100	B1100	DP1100	CONDUIT	10.0	1.0001	0.0100
C111	B605	DP605	CONDUIT	10.0	1.0001	0.0100
C12	DP305	DP304	CONDUIT	107.6	0.3532	0.0160
C12_2	DP245	DP219	CONDUIT	4818.2	0.6509	0.0160
C13	DP320	DP319	CONDUIT	72.4	0.3453	0.0160
C14	B220	DP240	CONDUIT	463.0	2.6495	0.0150
C15	DP602	DP600	CONDUIT	697.6	1.6356	0.0500
C16	B615	DP605	CONDUIT	1481.2	2.1406	0.0500
C17	B400	DP400	CONDUIT	10.0	1.0001	0.0100
C19	B250	DP245	CONDUIT	2856.0	0.6537	0.0160
C2	B815	DP805	CONDUIT	2203.8	1.1313	0.0500
C20	B210	DP210	CONDUIT	10.0	1.0001	0.0100
C200	B200	DP200	CONDUIT	10.0	1.0001	0.0100
C205	B205	DP205	CONDUIT	10.0	1.0001	0.0100
C21	B1105	DP1105	CONDUIT	10.0	1.0001	0.0100
C22	B100	DP100	CONDUIT	10.0	1.0001	0.0100
C225	B225	DP223	CONDUIT	215.0	0.3884	0.0130
C23	DP304	DP300	CONDUIT	878.8	0.9415	0.0500
C230	B230	DP228	CONDUIT	584.0	1.6971	0.0160
C24	B215	DP215	CONDUIT	10.0	1.0001	0.0100
C240	B240	DP240	CONDUIT	10.0	1.0001	0.0100
C245	B245	DP245	CONDUIT	10.0	1.0001	0.0100
C25	DP325	DP323	CONDUIT	349.0	1.1165	0.0150
C26	DP335	DP334	CONDUIT	91.8	0.5012	0.0160
C27	B300	DP300	CONDUIT	10.0	1.0001	0.0100
C28	DP325	DP323	CONDUIT	349.0	1.1165	0.0160

FIGURE B-5
Existing Conditions 100-Year SWMM Output

C29	DP240	DP219	CONDUIT	224.0	0.4353	0.0150
C3	DP340	DP330	CONDUIT	2728.7	0.3001	0.0500
C30	DP335	DP334	CONDUIT	91.8	0.5012	0.0150
C305	B305	DP305	CONDUIT	10.0	1.0001	0.0100
C31	DP320	DP319	CONDUIT	72.4	0.3453	0.0150
C310	B310	DP305	CONDUIT	10.0	1.0001	0.0100
C315	B315	DP305	CONDUIT	10.0	1.0001	0.0100
C32	DP334	DP325	CONDUIT	2012.8	0.2000	0.0500
C320	B320	DP320	CONDUIT	10.0	1.0001	0.0100
C325	B325	DP325	CONDUIT	10.0	1.0001	0.0100
C33	DP305	DP304	CONDUIT	107.6	0.3532	0.0150
C33_1	DP210	DP205	CONDUIT	1253.0	0.9003	0.0500
C33_2	DP205	DP200	CONDUIT	1738.4	0.9039	0.0500
C330	B330	DP330	CONDUIT	10.0	1.0001	0.0100
C335	B335	DP335	CONDUIT	10.0	1.0001	0.0100
C340	B340	DP340	CONDUIT	10.0	1.0001	0.0100
C345	B345	DP345	CONDUIT	10.0	1.0001	0.0100
C350	B350	DP350	CONDUIT	10.0	1.0001	0.0100
C355	B355	DP350	CONDUIT	10.0	1.0001	0.0100
C36	DP215	DP210	CONDUIT	661.7	1.2399	0.0500
C360	B360	DP360	CONDUIT	10.0	1.0001	0.0100
C370	B370	DP345	CONDUIT	10.0	1.0001	0.0100
C375	B375	DP375	CONDUIT	10.0	1.0001	0.0100
C380	B380	DP380	CONDUIT	10.0	1.0001	0.0100
C4	B225	DP223	CONDUIT	215.0	0.3884	0.0150
C40	B235	DP240	CONDUIT	551.2	0.1907	0.0500
C41	DP345	DP340	CONDUIT	695.2	0.3645	0.0500
C42	DP905	DP900	CONDUIT	2138.8	1.8898	0.0500
C43	DP375	DP345	CONDUIT	1483.6	0.8776	0.0500
C45	B930	DP925	CONDUIT	10.0	1.0001	0.0500
C47	DP915	DP905	CONDUIT	932.8	0.8059	0.0500
C48	DP350	DP345	CONDUIT	2298.8	0.5169	0.0500
C5	DP245	DP219	CONDUIT	4814.0	0.6515	0.0150
C500	B500	DP500	CONDUIT	10.0	1.0001	0.0100
C52	DP380	DP375	CONDUIT	2912.3	0.4909	0.0500
C54	DP1105	DP1100	CONDUIT	2525.6	1.6158	0.0500
C55	DP925	DP915	CONDUIT	2403.2	1.8341	0.0500
C56	DP605	SU1	CONDUIT	1930.9	1.1087	0.0500
C58	DP805	DP800	CONDUIT	2017.8	1.0429	0.0500
C6	B220	DP240	CONDUIT	463.0	2.6495	0.0160
C60	DP360	DP350	CONDUIT	3128.7	0.8288	0.0500
C600	B600	DP600	CONDUIT	10.0	1.0001	0.0100
C602	B602	SU1	CONDUIT	10.0	1.0001	0.0100
C61	B610	DP605	CONDUIT	1099.8	2.0570	0.0500
C64	DP1005	DP1000	CONDUIT	1227.6	1.1423	0.0500
C65	B705	DP700	CONDUIT	3786.0	1.1173	0.0500
C68	B1010	DP1005	CONDUIT	987.3	1.7410	0.0500
C7	B230	DP228	CONDUIT	600.2	1.6514	0.0160
C700	B700	DP700	CONDUIT	10.0	1.0001	0.0100
C73	B405	DP400	CONDUIT	3267.8	0.8762	0.0500
C74_2	B385	DP380	CONDUIT	2902.1	0.6218	0.0500
C8	DP323	DP320	CONDUIT	1819.4	0.2000	0.0500
C80	B365	DP360	CONDUIT	747.2	0.4227	0.0500
C800	B800	DP800	CONDUIT	10.0	1.0001	0.0100
C805	B805	DP805	CONDUIT	10.0	1.0001	0.0100
C810	B810	DP805	CONDUIT	10.0	1.0001	0.0100
C83	B1110	DP1105	CONDUIT	1066.2	1.5301	0.0500
C88	DP240	DP219	CONDUIT	224.0	0.4353	0.0160
C89	DP219	DP216	CONDUIT	744.9	0.8309	0.0500
C9	DP319	DP305	CONDUIT	1316.5	0.2000	0.0500
C90	DP228	DP216	CONDUIT	448.2	1.3057	0.0500
C900	B900	DP900	CONDUIT	10.0	1.0001	0.0100
C905	B905	DP905	CONDUIT	10.0	1.0001	0.0100
C91	DP216	DP215	CONDUIT	935.4	1.2866	0.0500
C910	B910	DP905	CONDUIT	10.0	1.0001	0.0100
C915	B915	DP915	CONDUIT	10.0	1.0001	0.0100
C920	B920	DP915	CONDUIT	10.0	1.0001	0.0100
C93	DP223	DP210	CONDUIT	1626.4	1.8261	0.0500
C18	SU1	DP602	OUTLET			

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Cross Section Summary
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Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	TRAPEZOIDAL	6.00	480.00	4.32	110.00	1	8914.80
C10	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C10_1	RECT_CLOSED	6.00	60.00	1.88	10.00	2	599.15
C10_2	Adonea_A	7.00	861.00	6.69	151.00	1	4063.56
C1000	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C1005	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C11	TRAPEZOIDAL	1.00	35.00	0.87	40.00	1	255.61
C1100	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C111	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C12	RECT_CLOSED	8.00	112.00	2.55	14.00	3	1152.43
C12_2	CIRCULAR	5.00	19.63	1.25	5.00	1	170.73
C13	RECT_CLOSED	8.00	112.00	2.55	14.00	3	1139.54
C14	TRAPEZOIDAL	1.00	35.00	0.87	40.00	1	514.62
C15	C15	4.67	397.00	2.67	148.00	1	2901.03
C16	C16	4.43	449.04	2.98	150.00	1	4041.29
C17	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C19	CIRCULAR	4.00	12.57	1.00	4.00	1	94.36
C2	T-C2	8.71	1845.88	5.12	358.60	1	17336.81
C20	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C200	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C205	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C21	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C22	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C225	HORIZ_ELLIPSE	1.58	3.30	0.49	2.50	1	14.61
C23	T-C23	10.19	2349.09	4.61	507.12	1	18760.66
C230	CIRCULAR	3.50	9.62	0.88	3.50	1	106.49
C24	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C240	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C245	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C25	TRAPEZOIDAL	6.00	480.00	4.32	110.00	1	13321.73
C26	CIRCULAR	4.50	15.90	1.13	4.50	3	113.11
C27	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C28	CIRCULAR	4.50	15.90	1.13	4.50	2	168.83
C29	TRAPEZOIDAL	1.00	35.00	0.87	40.00	1	208.59
C3	Harmony_ChannelA	8.18	507.76	8.69	97.00	1	3494.71
C30	TRAPEZOIDAL	1.00	35.00	0.87	40.00	1	223.81
C305	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C31	TRAPEZOIDAL	6.00	480.00	4.32	110.00	1	7408.42
C310	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C315	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C32	Adonea_B	6.45	280.33	5.92	78.84	1	1219.28
C320	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C325	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C33	TRAPEZOIDAL	6.00	480.00	4.32	110.00	1	7492.22
C33_1	T-C33_1	16.24	5187.03	8.89	575.42	1	62758.59

FIGURE B-5
Existing Conditions 100-Year SWMM Output

C33_2	T-C33_2	13.59	3268.65	5.87	549.88	1	30055.45
C330	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C335	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C340	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C345	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C350	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C355	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C36	C36	7.06	463.83	2.91	158.00	1	3125.16
C360	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C370	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C375	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C380	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C4	TRAPEZOIDAL	3.00	135.00	2.23	60.00	1	1421.75
C40	T-C40	10.55	3282.51	7.91	412.31	1	16914.18
C41	T-C41	3.56	1714.56	2.46	693.42	1	5610.08
C42	T-C42	13.33	3200.48	7.71	407.50	1	51037.72
C43	T-C43	3.56	892.97	1.81	523.83	1	3686.15
C45	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C47	T-C47	8.49	2254.13	4.47	501.65	1	16326.72
C48	T-C48	6.92	2340.46	4.14	560.17	1	12897.75
C5	TRAPEZOIDAL	3.00	135.00	2.23	60.00	1	1841.45
C500	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C52	T-C52	2.31	551.95	1.27	433.50	1	1346.45
C54	C54	1.64	78.55	0.92	85.00	1	280.38
C55	T-C55	4.65	990.82	2.63	375.00	1	7600.11
C56	C56	6.49	697.78	3.92	177.00	1	5426.12
C58	T-C58	11.71	3500.55	6.86	508.00	1	38349.31
C6	CIRCULAR	3.50	9.62	0.88	3.50	1	133.06
C60	T-C60	2.95	695.15	1.88	368.35	1	2864.44
C600	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C602	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C61	T-C61	4.19	425.39	2.67	157.00	1	3490.37
C64	C64	3.11	306.56	1.77	172.00	1	1424.04
C65	T-C65	3.73	584.98	2.26	258.00	1	3162.58
C68	C68	3.45	376.19	2.22	169.00	1	2506.83
C7	TRAPEZOIDAL	1.00	35.00	0.87	40.00	1	380.89
C700	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C73	T-C73	2.92	544.57	1.59	339.00	1	2063.80
C74_2	T-C74_2	2.59	781.89	1.84	421.91	1	2751.66
C8	Adonea_A	7.00	861.00	6.69	151.00	1	4064.24
C80	T-C80	4.10	1502.69	2.82	529.80	1	5801.01
C800	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C805	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C810	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C83	C83	3.65	305.10	2.32	131.00	1	1963.78
C88	RECT_CLOSED	5.00	60.00	1.76	12.00	2	536.88
C89	C89	6.26	318.03	3.46	90.00	1	1970.83
C9	Adonea_A	7.00	861.00	6.69	151.00	1	4064.09
C90	C90	4.75	201.01	2.28	87.00	1	1182.92
C900	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C905	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C91	T-C91	12.16	2858.33	4.95	574.81	1	27969.80
C910	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C915	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C920	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C93	T-C93	5.75	981.83	1.79	544.78	1	5822.45

```
*********************************************************
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
Infiltration Method ...... HORTON
Flow Routing Method ...... KINWAVE
Starting Date ............ 09/01/2018 00:00:00
Ending Date .............. 09/01/2018 10:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec

**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......         0.000         0.000
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.000         0.000
Surface Runoff ...........         0.000         0.000
Final Storage ............         0.000         0.000
Continuity Error (%) .....         0.000


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.000         0.000
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........       583.280       190.071
External Outflow .........       581.179       189.386
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 ......        13.636         4.443
Continuity Error (%) .....        -1.978


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

FIGURE B-5
Existing Conditions 100-Year SWMM Output

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*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     4.00 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
```

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******************
Node Depth Summary
******************
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Node	Type	Average Depth Feet	Maximum Depth Feet	Maximum HGL Feet	Time of Max Occurrence days	hr:min	Reported Max Depth Feet
B100	JUNCTION	0.00	0.00	5511.01	0	00:00	0.00
B1000	JUNCTION	0.00	0.00	5686.08	0	00:00	0.00
B1005	JUNCTION	0.00	0.00	5700.10	0	00:00	0.00
B1010	JUNCTION	0.22	1.03	5718.22	0	00:55	1.03
B1100	JUNCTION	0.00	0.00	5708.80	0	00:00	0.00
B1105	JUNCTION	0.00	0.00	5749.60	0	00:00	0.00
B1110	JUNCTION	0.28	1.09	5766.90	0	01:05	1.09
B200	JUNCTION	0.00	0.00	5516.13	0	00:00	0.00
B205	JUNCTION	0.00	0.00	5531.84	0	00:00	0.00
B210	JUNCTION	0.00	0.00	5543.12	0	00:00	0.00
B215	JUNCTION	0.00	0.00	5551.33	0	00:00	0.00
B235	JUNCTION	0.32	1.13	5572.60	0	01:00	1.13
B240	JUNCTION	0.00	0.00	5570.52	0	00:00	0.00
B245	JUNCTION	0.00	0.00	5600.91	0	00:00	0.00
B300	JUNCTION	0.00	0.00	5554.12	0	00:00	0.00
B305	JUNCTION	0.00	0.00	5563.78	0	00:00	0.00
B310	JUNCTION	0.00	0.00	5563.78	0	00:00	0.00
B315	JUNCTION	0.00	0.00	5563.78	0	00:00	0.00
B320	JUNCTION	0.00	0.00	5575.36	0	00:00	0.00
B325	JUNCTION	0.00	0.00	5600.62	0	00:00	0.00
B330	JUNCTION	0.00	0.00	5601.85	0	00:00	0.00
B335	JUNCTION	0.00	0.00	5612.56	0	00:00	0.00
B340	JUNCTION	0.00	0.00	5610.04	0	00:00	0.00
B345	JUNCTION	0.00	0.00	5632.10	0	00:00	0.00
B350	JUNCTION	0.00	0.00	5643.98	0	00:00	0.00
B355	JUNCTION	0.00	0.00	5643.98	0	00:00	0.00
B360	JUNCTION	0.00	0.00	5669.91	0	00:00	0.00
B365	JUNCTION	0.17	0.73	5673.70	0	01:00	0.73
B370	JUNCTION	0.00	0.00	5632.10	0	00:00	0.00
B375	JUNCTION	0.00	0.00	5645.12	0	00:00	0.00
B380	JUNCTION	0.00	0.00	5659.42	0	00:00	0.00
B385	JUNCTION	0.13	0.67	5678.03	0	00:55	0.67
B400	JUNCTION	0.00	0.00	5565.43	0	00:00	0.00
B405	JUNCTION	0.16	0.99	5594.95	0	00:40	0.99
B500	JUNCTION	0.00	0.00	5567.09	0	00:00	0.00
B600	JUNCTION	0.00	0.00	5568.84	0	00:00	0.00
B602	JUNCTION	0.00	0.00	5582.10	0	00:00	0.00
B605	JUNCTION	0.00	0.00	5603.51	0	00:00	0.00
B610	JUNCTION	0.26	1.00	5627.02	0	01:00	1.00
B615	JUNCTION	0.11	0.84	5635.94	0	00:40	0.84
B700	JUNCTION	0.00	0.00	5573.79	0	00:00	0.00
B705	JUNCTION	0.24	1.13	5617.11	0	00:55	1.13
B800	JUNCTION	0.00	0.00	5605.06	0	00:00	0.00
B805	JUNCTION	0.00	0.00	5626.11	0	00:00	0.00
B810	JUNCTION	0.00	0.00	5626.11	0	00:00	0.00
B815	JUNCTION	0.23	1.41	5652.34	0	00:50	1.41
B900	JUNCTION	0.00	0.00	5648.06	0	00:00	0.00
B905	JUNCTION	0.00	0.00	5688.47	0	00:00	0.00
B910	JUNCTION	0.00	0.00	5688.47	0	00:00	0.00
B915	JUNCTION	0.00	0.00	5695.99	0	00:00	0.00
B920	JUNCTION	0.00	0.00	5695.99	0	00:00	0.00
B925	JUNCTION	0.00	0.00	5740.06	0	00:00	0.00
B930	JUNCTION	0.00	0.00	5740.06	0	00:00	0.00
DP100	JUNCTION	0.00	0.00	5510.91	0	00:10	0.00
DP1000	JUNCTION	3.06	3.11	5689.09	0	00:10	3.11
DP1005	JUNCTION	0.30	1.39	5701.39	0	00:57	1.38
DP1100	JUNCTION	1.61	1.64	5710.34	0	00:10	1.64
DP1105	JUNCTION	0.33	1.25	5750.75	0	01:06	1.25
DP200	JUNCTION	13.35	13.59	5529.62	0	00:10	13.59
DP205	JUNCTION	1.01	3.84	5535.58	0	01:03	3.84
DP210	JUNCTION	1.13	4.32	5547.35	0	01:05	4.32
DP215	JUNCTION	1.11	4.33	5555.55	0	01:04	4.32
DP216	JUNCTION	1.04	4.11	5567.37	0	01:02	4.10
DP219	JUNCTION	10.00	10.00	5579.45	0	00:00	10.00
DP223	JUNCTION	1.68	2.57	5575.28	0	00:40	2.56
DP228	JUNCTION	3.51	3.74	5572.86	0	00:41	3.74
DP300	JUNCTION	10.01	10.19	5564.21	0	00:10	10.19
DP304	JUNCTION	9.00	9.00	5571.30	0	00:00	9.00
DP319	JUNCTION	16.70	16.70	5583.01	0	00:00	16.70
DP323	JUNCTION	22.23	22.23	5601.13	0	00:00	22.23
DP329	JUNCTION	9.77	9.77	5606.33	0	00:00	9.77
DP334	JUNCTION	11.95	11.95	5616.50	0	00:00	11.95
DP340	JUNCTION	19.95	20.70	5630.64	0	01:45	20.70
DP345	JUNCTION	0.51	1.44	5633.43	0	01:42	1.44
DP350	JUNCTION	0.46	1.46	5645.34	0	01:25	1.46
DP360	JUNCTION	0.24	0.96	5670.77	0	01:05	0.96
DP375	JUNCTION	0.43	1.15	5646.17	0	01:34	1.15
DP380	JUNCTION	0.33	1.03	5660.35	0	01:18	1.03
DP400	JUNCTION	2.87	2.92	5568.25	0	00:10	2.92
DP500	JUNCTION	0.00	0.00	5566.99	0	00:10	0.00
DP600	JUNCTION	14.59	14.67	5583.41	0	00:10	14.67
DP602	JUNCTION	10.54	11.82	5591.97	0	01:30	11.82
DP605	JUNCTION	0.45	1.96	5605.37	0	00:55	1.96
DP700	JUNCTION	3.66	3.73	5577.41	0	00:10	3.73
DP800	JUNCTION	10.68	11.71	5616.68	0	00:10	11.71
DP805	JUNCTION	0.45	2.01	5628.01	0	00:58	2.01
DP900	JUNCTION	13.11	13.33	5661.30	0	00:10	13.33
DP905	JUNCTION	0.54	2.01	5690.39	0	01:11	2.01
DP915	JUNCTION	0.53	2.02	5697.91	0	01:07	2.01
DP925	JUNCTION	0.29	1.11	5741.07	0	01:00	1.11
B220	DIVIDER	3.50	3.50	5586.19	0	00:00	3.50
B225	DIVIDER	1.68	2.57	5576.12	0	00:40	2.57
B230	DIVIDER	3.51	3.75	5582.77	0	00:40	3.75
B250	DIVIDER	4.00	4.00	5623.48	0	00:00	4.00
DP240	DIVIDER	10.00	10.00	5580.43	0	00:00	10.00
DP245	DIVIDER	5.03	5.51	5606.32	0	00:46	5.51
DP305	DIVIDER	8.00	8.00	5571.68	0	00:00	8.00
DP320	DIVIDER	8.00	8.00	5583.26	0	00:00	8.00
DP325	DIVIDER	4.50	4.50	5605.02	0	00:00	4.50
DP330	DIVIDER	6.00	6.00	5607.75	0	00:00	6.00
DP335	DIVIDER	4.50	4.50	5616.96	0	00:00	4.50
SU1	STORAGE	6.42	7.81	5589.81	0	01:30	7.81

FIGURE B-5
Existing Conditions 100-Year SWMM Output

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Node Inflow Summary
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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
B100	JUNCTION	168.69	168.69	0	00:55	7.41	7.41	0.000
B1000	JUNCTION	36.39	36.39	0	00:50	1.31	1.31	0.000
B1005	JUNCTION	62.86	62.86	0	00:45	1.86	1.86	0.000
B1010	JUNCTION	138.27	138.27	0	00:55	5.15	5.15	0.000
B1100	JUNCTION	91.21	91.21	0	00:50	3.11	3.11	0.000
B1105	JUNCTION	34.47	34.47	0	00:55	1.49	1.49	0.000
B1110	JUNCTION	113.80	113.80	0	01:05	5.02	5.02	0.000
B200	JUNCTION	22.28	22.28	0	00:55	0.927	0.927	0.000
B205	JUNCTION	58.60	58.60	0	01:00	2.55	2.55	0.000
B210	JUNCTION	55.87	55.87	0	00:45	1.55	1.55	0.000
B215	JUNCTION	49.90	49.90	0	00:50	1.75	1.75	0.000
B235	JUNCTION	91.66	91.66	0	01:00	4.42	4.42	0.000
B240	JUNCTION	162.31	162.31	0	01:05	8.27	8.27	0.000
B245	JUNCTION	196.60	196.60	0	00:40	4.43	4.43	0.000
B300	JUNCTION	20.42	20.42	0	00:50	0.699	0.699	0.000
B305	JUNCTION	4.86	4.86	0	00:55	0.23	0.23	0.000
B310	JUNCTION	214.26	214.26	0	00:40	5.56	5.56	0.000
B315	JUNCTION	86.04	86.04	0	00:50	2.92	2.92	0.000
B320	JUNCTION	12.95	12.95	0	01:00	0.636	0.636	0.000
B325	JUNCTION	78.70	78.70	0	00:50	2.91	2.91	0.000
B330	JUNCTION	75.16	75.16	0	00:50	2.69	2.69	0.000
B335	JUNCTION	106.87	106.87	0	01:00	4.6	4.6	0.000
B340	JUNCTION	60.40	60.40	0	00:40	1.25	1.25	0.000
B345	JUNCTION	62.47	62.47	0	01:00	2.76	2.76	0.000
B350	JUNCTION	35.92	35.92	0	01:05	1.74	1.74	0.000
B355	JUNCTION	54.39	54.39	0	00:55	2.24	2.24	0.000
B360	JUNCTION	82.74	82.74	0	01:00	3.58	3.58	0.000
B365	JUNCTION	141.01	141.01	0	01:00	5.61	5.61	0.000
B370	JUNCTION	55.99	55.99	0	00:55	2.34	2.34	0.000
B375	JUNCTION	160.69	160.69	0	00:55	5.6	5.6	0.000
B380	JUNCTION	94.38	94.38	0	01:00	3.91	3.91	0.000
B385	JUNCTION	145.45	145.45	0	00:55	5.08	5.08	0.000
B400	JUNCTION	43.50	43.50	0	00:55	1.88	1.88	0.000
B405	JUNCTION	135.74	135.74	0	00:40	3.54	3.54	0.000
B500	JUNCTION	150.23	150.23	0	01:05	6.98	6.98	0.000
B600	JUNCTION	29.66	29.66	0	00:40	0.658	0.658	0.000
B602	JUNCTION	116.08	116.08	0	00:50	3.57	3.57	0.000
B605	JUNCTION	100.16	100.16	0	00:45	2.85	2.85	0.000
B610	JUNCTION	123.36	123.36	0	01:00	5.39	5.39	0.000
B615	JUNCTION	89.98	89.98	0	00:40	2.08	2.08	0.000
B700	JUNCTION	45.91	45.91	0	01:05	2.24	2.24	0.000
B705	JUNCTION	167.67	167.67	0	00:55	6.16	6.16	0.000
B800	JUNCTION	64.62	64.62	0	01:05	3.21	3.21	0.000
B805	JUNCTION	173.02	173.02	0	00:55	6.14	6.14	0.000
B810	JUNCTION	63.20	63.20	0	01:00	2.72	2.72	0.000
B815	JUNCTION	192.99	192.99	0	00:50	5.6	5.6	0.000
B900	JUNCTION	80.01	80.01	0	00:50	2.84	2.84	0.000
B905	JUNCTION	49.47	49.47	0	00:45	1.47	1.47	0.000
B910	JUNCTION	31.13	31.13	0	01:05	1.62	1.62	0.000
B915	JUNCTION	86.27	86.27	0	00:55	3.12	3.12	0.000
B920	JUNCTION	92.28	92.28	0	00:55	3.31	3.31	0.000
B925	JUNCTION	93.70	93.70	0	01:05	4.26	4.26	0.000
B930	JUNCTION	94.59	94.59	0	01:00	3.89	3.89	0.000
DP100	JUNCTION	0.00	168.69	0	00:55	0	7.41	0.000
DP1000	JUNCTION	0.00	226.92	0	01:03	0	8.37	0.000
DP1005	JUNCTION	0.00	194.45	0	00:57	0	7.03	0.000
DP1100	JUNCTION	0.00	217.72	0	01:11	0	9.69	0.000
DP1105	JUNCTION	0.00	146.98	0	01:06	0	6.52	0.000
DP200	JUNCTION	0.00	969.48	0	01:10	0	37.2	0.000
DP205	JUNCTION	0.00	951.99	0	01:03	0	36.2	0.000
DP210	JUNCTION	0.00	896.47	0	01:00	0	33.7	0.000
DP215	JUNCTION	0.00	694.77	0	01:04	0	27.4	0.000
DP216	JUNCTION	0.00	649.81	0	01:02	0	25.7	0.000
DP219	JUNCTION	0.00	534.32	0	01:00	0	22.1	0.000
DP223	JUNCTION	0.00	205.74	0	00:40	0	4.66	0.000
DP228	JUNCTION	0.00	141.08	0	00:41	0	3.53	0.000
DP300	JUNCTION	0.00	810.62	0	02:00	0	55.9	0.000
DP304	JUNCTION	0.00	804.80	0	01:57	0	55.3	0.000
DP319	JUNCTION	0.00	743.57	0	01:56	0	46.6	0.000
DP323	JUNCTION	0.00	739.07	0	01:49	0	45.9	0.000
DP329	JUNCTION	0.00	633.39	0	01:50	0	38.3	0.000
DP334	JUNCTION	0.00	106.85	0	01:00	0	4.6	0.000
DP340	JUNCTION	0.00	604.36	0	01:44	0	35.5	0.000
DP345	JUNCTION	0.00	598.38	0	01:40	0	34.2	0.000
DP350	JUNCTION	0.00	268.46	0	01:25	0	13.5	0.000
DP360	JUNCTION	0.00	220.42	0	01:05	0	9.24	0.000
DP375	JUNCTION	0.00	269.43	0	01:34	0	15.4	0.000
DP380	JUNCTION	0.00	201.89	0	01:18	0	9.42	0.000
DP400	JUNCTION	0.00	147.47	0	01:08	0	5.73	0.000
DP500	JUNCTION	0.00	150.23	0	01:05	0	6.98	0.000
DP600	JUNCTION	0.00	284.58	0	01:32	0	10.7	0.000
DP602	JUNCTION	0.00	276.99	0	01:30	0	10.1	0.000
DP605	JUNCTION	0.00	289.82	0	00:55	0	10.4	0.000
DP700	JUNCTION	0.00	190.88	0	01:18	0	8.7	0.000
DP800	JUNCTION	0.00	468.19	0	01:08	0	17.9	0.000
DP805	JUNCTION	0.00	412.83	0	00:58	0	14.6	0.000
DP900	JUNCTION	0.00	474.27	0	01:14	0	20.7	0.000
DP905	JUNCTION	0.00	410.61	0	01:10	0	17.8	0.000
DP915	JUNCTION	0.00	342.52	0	01:07	0	14.7	0.000
DP925	JUNCTION	0.00	187.54	0	01:00	0	8.15	0.000
B220	DIVIDER	52.62	52.62	0	00:40	1.48	1.48	0.000
B225	DIVIDER	205.98	205.98	0	00:40	4.66	4.66	0.000
B230	DIVIDER	141.89	141.89	0	00:40	3.52	3.52	0.000
B250	DIVIDER	87.06	87.06	0	00:55	3.29	3.29	0.000
DP240	DIVIDER	0.00	294.67	0	01:03	0	14.2	0.000
DP245	DIVIDER	0.00	251.61	0	00:46	0	7.72	0.000
DP305	DIVIDER	0.00	804.81	0	01:57	0	55.3	0.000
DP320	DIVIDER	0.00	743.57	0	01:56	0	46.6	0.000
DP325	DIVIDER	0.00	175.06	0	01:08	0	7.57	0.000
DP330	DIVIDER	0.00	633.40	0	01:50	0	38.3	0.000
DP335	DIVIDER	0.00	106.87	0	01:00	0	4.6	0.000
SU1	STORAGE	0.00	389.96	0	01:02	0	14	0.009

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Node Flooding Summary
****

No nodes were flooded.

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FIGURE B-5
Existing Conditions 100-Year SWMM Output

Storage Volume Summary
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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 hr:min	Maximum Outflow CFS
SU1	561.336	35	0	0	810.137	51	0 01:30	276.99

****
Link Flow Summary
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Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
C10	DUMMY	93.70	0 01:05			
C10_1	CONDUIT	633.39	0 01:50	10.15	0.53	0.52
C10_2	CHANNEL	633.13	0 01:52	2.41	0.16	0.36
C1000	DUMMY	36.39	0 00:50			
C1005	DUMMY	62.86	0 00:45			
C11	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
C1100	DUMMY	91.21	0 00:50			
C111	DUMMY	100.16	0 00:45			
C12	CONDUIT	804.80	0 01:57	8.08	0.23	0.30
C12_2	CONDUIT	184.71	0 00:42	10.84	1.08	1.00
C13	CONDUIT	743.57	0 01:56	7.81	0.22	0.28
C14	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
C15	CHANNEL	276.70	0 01:33	3.88	0.10	0.39
C16	CHANNEL	86.23	0 00:50	2.82	0.02	0.19
C17	DUMMY	43.50	0 00:55			
C19	CONDUIT	86.27	0 00:59	8.61	0.91	0.75
C2	CHANNEL	181.59	0 01:01	2.71	0.01	0.16
C20	DUMMY	55.87	0 00:45			
C200	DUMMY	22.28	0 00:55			
C205	DUMMY	58.60	0 01:00			
C21	DUMMY	34.47	0 00:55			
C22	DUMMY	168.69	0 00:55			
C225	CONDUIT	16.33	0 00:19	5.50	1.12	1.00
C23	CHANNEL	804.44	0 02:00	3.67	0.04	0.28
C230	CONDUIT	115.17	0 00:34	13.05	1.08	1.00
C24	DUMMY	49.90	0 00:50			
C240	DUMMY	162.31	0 01:05			
C245	DUMMY	196.60	0 00:40			
C25	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
C26	CONDUIT	106.85	0 01:00	6.30	0.31	0.39
C27	DUMMY	20.42	0 00:50			
C28	CONDUIT	175.06	0 01:08	10.71	0.52	0.51
C29	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
C3	CHANNEL	601.05	0 01:51	3.95	0.17	0.45
C30	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
C305	DUMMY	4.86	0 00:55			
C31	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
C310	DUMMY	214.26	0 00:40			
C315	DUMMY	86.04	0 00:50			
C32	CHANNEL	104.44	0 01:12	2.39	0.09	0.28
C320	DUMMY	12.95	0 01:00			
C325	DUMMY	78.70	0 00:50			
C33	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
C33_1	CHANNEL	894.13	0 01:03	3.88	0.01	0.21
C33_2	CHANNEL	948.93	0 01:10	4.55	0.03	0.28
C330	DUMMY	75.16	0 00:50			
C335	DUMMY	106.87	0 01:00			
C340	DUMMY	60.40	0 00:40			
C345	DUMMY	62.47	0 01:00			
C350	DUMMY	35.92	0 01:05			
C355	DUMMY	54.39	0 00:55			
C36	CHANNEL	694.08	0 01:05	5.17	0.22	0.61
C360	DUMMY	82.74	0 01:00			
C370	DUMMY	55.99	0 00:55			
C375	DUMMY	160.69	0 00:55			
C380	DUMMY	94.38	0 01:00			
C4	CONDUIT	191.13	0 00:40	5.58	0.13	0.33
C40	CHANNEL	91.20	0 01:06	0.98	0.01	0.11
C41	CHANNEL	597.26	0 01:45	1.60	0.11	0.33
C42	CHANNEL	408.44	0 01:16	4.43	0.01	0.14
C43	CHANNEL	268.06	0 01:42	2.16	0.07	0.32
C45	DUMMY	94.59	0 01:00			
C47	CHANNEL	341.84	0 01:11	2.97	0.02	0.24
C48	CHANNEL	256.58	0 01:42	1.84	0.02	0.21
C5	CONDUIT	69.75	0 00:59	8.80	0.04	0.15
C500	DUMMY	150.23	0 01:05			
C52	CHANNEL	182.35	0 01:44	1.48	0.14	0.43
C54	CHANNEL	143.30	0 01:18	3.12	0.51	0.75
C55	CHANNEL	182.92	0 01:13	2.89	0.02	0.24
C56	CHANNEL	285.68	0 01:04	3.44	0.05	0.30
C58	CHANNEL	404.04	0 01:09	3.06	0.01	0.17
C6	CONDUIT	52.54	0 00:40	13.02	0.39	0.44
C60	CHANNEL	198.98	0 01:29	1.98	0.07	0.31
C600	DUMMY	29.66	0 00:40			
C602	DUMMY	116.08	0 00:50			
C61	CHANNEL	123.27	0 01:06	3.03	0.04	0.24
C64	CHANNEL	192.89	0 01:04	2.73	0.14	0.44
C65	CHANNEL	150.08	0 01:21	2.51	0.05	0.28
C68	CHANNEL	137.08	0 01:00	2.80	0.05	0.30
C7	CONDUIT	34.59	0 00:41	4.72	0.09	0.24
C700	DUMMY	45.91	0 01:05			
C73	CHANNEL	107.81	0 01:11	2.08	0.05	0.31
C74_2	CHANNEL	122.83	0 01:24	1.63	0.04	0.24
C8	CHANNEL	736.30	0 01:56	2.57	0.18	0.39
C80	CHANNEL	138.99	0 01:06	1.19	0.02	0.18
C800	DUMMY	64.62	0 01:05			
C805	DUMMY	173.02	0 00:55			
C810	DUMMY	63.20	0 01:00			
C83	CHANNEL	113.74	0 01:07	2.77	0.06	0.30
C88	CONDUIT	294.67	0 01:03	7.33	0.27	0.33
C89	CHANNEL	534.02	0 01:02	4.50	0.27	0.55
C9	CHANNEL	742.12	0 02:01	2.57	0.18	0.39
C90	CHANNEL	140.66	0 00:43	3.72	0.12	0.39
C900	DUMMY	80.01	0 00:50			
C905	DUMMY	49.47	0 00:45			
C91	CHANNEL	648.51	0 01:04	5.18	0.02	0.34
C910	DUMMY	31.13	0 01:05			
C915	DUMMY	86.27	0 00:55			
C920	DUMMY	92.28	0 00:55			
C93	CHANNEL	198.42	0 00:46	3.97	0.03	0.31
C18	DUMMY	276.99	0 01:30			

FIGURE B-5
Existing Conditions 100-Year SWMM Output

```
*************************
Conduit Surcharge Summary
*************************

-------------------------------------------------------------------------------
                                                          Hours        Hours
                      --------- Hours Full --------   Above Full   Capacity
Conduit               Both Ends  Upstream  Dnstream   Normal Flow   Limited
-------------------------------------------------------------------------------
C12_2                      0.71      0.71      0.71      0.74         0.71
C225                       1.78      1.78      1.78      1.79         1.78
C230                       0.48      0.48      0.48      0.50         0.48
```

FIGURE B-6
Future Conditions 100-Year SWMM Output

```
EPA STORM WATER MANAGEMENT MODEL - VERSION 5.1 (Build 5.1.012)
--------------------------------------------------------------

FIRST CREEK TRIBUTARIES MDP
BASELINE HYDROLOGY SWMM MODEL
100-YR, FUTURE


*************
Element Count
*************
Number of rain gages ...... 1
Number of subcatchments ... 57
Number of nodes ........... 102
Number of links ........... 102
Number of pollutants ...... 0
Number of land uses ....... 0


****************
Raingage Summary
****************
                                                  Data       Recording
Name                 Data Source                  Type       Interval
-----------------------------------------------------------------------
California_Type_1_1in California_Type_1_1in        INTENSITY    6 min.


********************
Subcatchment Summary
********************
Name                        Area     Width   %Imperv    %Slope Rain Gage            Outlet
-----------------------------------------------------------------------------------------------
-------
100                       154.77   1206.87     95.27    1.9160 California_Type_1_1in B100
1000                       34.21    633.19     49.82    3.6020 California_Type_1_1in B1000
1005                       48.48    912.77     24.73    3.0360 California_Type_1_1in B1005
1010                      134.08   1380.51     18.76    2.8070 California_Type_1_1in B1010
1100                       84.78   1115.60     21.79    3.7800 California_Type_1_1in B1100
1105                       39.65    590.76     12.34    2.3970 California_Type_1_1in B1105
1110                      128.07    965.26     19.65    2.2590 California_Type_1_1in B1110
200                        23.41    479.69     35.27    3.2800 California_Type_1_1in B200
205                        63.55    713.35     94.57    3.2800 California_Type_1_1in B205
210                        39.05    922.35     93.06    3.6980 California_Type_1_1in B210
215                        44.10    802.10     90.03    3.2590 California_Type_1_1in B215
220                        26.63    610.48     50.50    4.0730 California_Type_1_1in B220
225                        84.22   1058.87     52.28    3.6980 California_Type_1_1in B225
230                        62.05    863.38     55.14    3.9450 California_Type_1_1in B230
235                        91.12    762.19     46.46    3.8200 California_Type_1_1in B235
240                       171.44   1107.78     50.36    1.4720 California_Type_1_1in B240
245                        80.85   1120.24     50.22    3.4570 California_Type_1_1in B245
250                        86.18   1184.99     50.00    2.7920 California_Type_1_1in B250
300                        18.67    452.95     50.00    0.5000 California_Type_1_1in B300
305                         6.51    204.73      2.01    7.6490 California_Type_1_1in B305
310                       104.43   1246.91     50.02    4.0900 California_Type_1_1in B310
315                        75.26    972.24     50.22    5.0300 California_Type_1_1in B315
320                        16.37    290.72      4.92    0.5000 California_Type_1_1in B320
325                        72.58   1128.17     50.00    3.4970 California_Type_1_1in B325
330                        68.14   1207.53     50.11    3.4710 California_Type_1_1in B330
335                       125.39   1219.23     64.73    2.5240 California_Type_1_1in B335
340                        34.29   1028.66     68.28    2.0960 California_Type_1_1in B340
345                        74.60    883.04     53.61    2.2660 California_Type_1_1in B345
350                        44.97    566.09     50.00    2.1640 California_Type_1_1in B350
355                        69.00    807.53     52.60    3.0160 California_Type_1_1in B355
360                        93.29    830.66     50.00    2.1620 California_Type_1_1in B360
365                       153.84   1416.18     50.00    2.3800 California_Type_1_1in B365
370                        61.66    780.72     50.84    2.0720 California_Type_1_1in B370
375                       148.86   1624.22     50.00    2.3120 California_Type_1_1in B375
380                       102.12   1180.64     50.47    2.4420 California_Type_1_1in B380
385                       131.80   1356.65     59.95    2.4610 California_Type_1_1in B385
400                        92.70    855.88     50.00    2.2110 California_Type_1_1in B400
405                        69.28    890.75     51.87    3.2540 California_Type_1_1in B405
500                       175.00   1191.94     62.84    2.3860 California_Type_1_1in B500
600                        17.88    596.80     29.39    3.8290 California_Type_1_1in B600
602                        90.36   1142.37     45.99    3.8290 California_Type_1_1in B602
605                        71.84    994.31     69.05    3.0090 California_Type_1_1in B605
610                       136.46   1224.43     59.92    2.4820 California_Type_1_1in B610
615                        52.66   1214.43     82.20    3.0610 California_Type_1_1in B615
700                        59.09    620.93     57.98    2.8110 California_Type_1_1in B700
705                       162.98   1570.75     50.02    2.2830 California_Type_1_1in B705
800                        81.92    675.40     41.96    3.1530 California_Type_1_1in B800
805                       155.55   1648.82     58.48    2.5420 California_Type_1_1in B805
810                        68.87    715.98     47.31    3.2040 California_Type_1_1in B810
815                       141.73   1702.91     58.81    2.7200 California_Type_1_1in B815
900                        78.20    934.68     50.00    3.9870 California_Type_1_1in B900
905                        37.72    728.74     50.00    2.7060 California_Type_1_1in B905
910                        41.31    478.01     49.09    2.6320 California_Type_1_1in B910
915                        84.39   1046.83     50.00    3.1260 California_Type_1_1in B915
920                        88.42   1088.43     49.69    2.8320 California_Type_1_1in B920
925                       123.01   1062.57     32.75    3.9830 California_Type_1_1in B925
930                       133.54   1145.51     36.32    3.5300 California_Type_1_1in B930


************
Node Summary
************
                                              Invert      Max.    Ponded    External
Name                 Type                      Elev.     Depth      Area    Inflow
-----------------------------------------------------------------------------------
B100                 JUNCTION                5511.01      0.00       0.0
B1000                JUNCTION                5686.08      0.00       0.0
B1005                JUNCTION                5700.10      0.00       0.0
B1010                JUNCTION                5717.19      3.45       0.0
B1100                JUNCTION                5708.80      0.00       0.0
B1105                JUNCTION                5749.60      0.00       0.0
B1110                JUNCTION                5765.81      3.65       0.0
B200                 JUNCTION                5516.13      0.00       0.0
B205                 JUNCTION                5531.84      0.00       0.0
B210                 JUNCTION                5543.12      0.00       0.0
B215                 JUNCTION                5551.33      0.00       0.0
B235                 JUNCTION                5571.48     10.55       0.0
B240                 JUNCTION                5570.52      0.00       0.0
B245                 JUNCTION                5600.91      0.00       0.0
B300                 JUNCTION                5554.12      0.00       0.0
B305                 JUNCTION                5563.78      0.00       0.0
B310                 JUNCTION                5563.78      0.00       0.0
B315                 JUNCTION                5563.78      0.00       0.0
B320                 JUNCTION                5575.36      0.00       0.0
B325                 JUNCTION                5600.62      0.00       0.0
```

FIGURE B-6
Future Conditions 100-Year SWMM Output

B330	JUNCTION	5601.85	0.00	0.0
B335	JUNCTION	5612.56	0.00	0.0
B340	JUNCTION	5610.04	0.00	0.0
B345	JUNCTION	5632.10	0.00	0.0
B350	JUNCTION	5643.98	0.00	0.0
B355	JUNCTION	5643.98	0.00	0.0
B360	JUNCTION	5669.91	0.00	0.0
B365	JUNCTION	5672.97	4.10	0.0
B370	JUNCTION	5632.10	0.00	0.0
B375	JUNCTION	5645.12	0.00	0.0
B380	JUNCTION	5659.42	0.00	0.0
B385	JUNCTION	5677.36	2.59	0.0
B400	JUNCTION	5565.43	0.00	0.0
B405	JUNCTION	5593.96	2.92	0.0
B500	JUNCTION	5567.09	0.00	0.0
B600	JUNCTION	5568.84	0.00	0.0
B602	JUNCTION	5582.10	0.00	0.0
B605	JUNCTION	5603.51	0.00	0.0
B610	JUNCTION	5626.02	4.19	0.0
B615	JUNCTION	5635.11	4.43	0.0
B700	JUNCTION	5573.79	0.00	0.0
B705	JUNCTION	5615.99	3.73	0.0
B800	JUNCTION	5605.06	0.00	0.0
B805	JUNCTION	5626.11	0.00	0.0
B810	JUNCTION	5626.11	0.00	0.0
B815	JUNCTION	5650.94	8.71	0.0
B900	JUNCTION	5648.06	0.00	0.0
B905	JUNCTION	5688.47	0.00	0.0
B910	JUNCTION	5688.47	0.00	0.0
B915	JUNCTION	5695.99	0.00	0.0
B920	JUNCTION	5695.99	0.00	0.0
B925	JUNCTION	5740.06	0.00	0.0
B930	JUNCTION	5740.06	0.00	0.0
DP100	JUNCTION	5510.91	0.00	0.0
DP1000	JUNCTION	5685.98	3.11	0.0
DP1005	JUNCTION	5700.00	3.45	0.0
DP1100	JUNCTION	5708.70	1.64	0.0
DP1105	JUNCTION	5749.50	3.65	0.0
DP200	JUNCTION	5516.03	13.59	0.0
DP205	JUNCTION	5531.74	16.24	0.0
DP210	JUNCTION	5543.02	16.24	0.0
DP215	JUNCTION	5551.23	12.16	0.0
DP216	JUNCTION	5563.26	12.16	0.0
DP219	JUNCTION	5569.45	11.00	0.0
DP223	JUNCTION	5572.72	5.75	0.0
DP228	JUNCTION	5569.11	4.75	0.0
DP300	JUNCTION	5554.02	10.19	0.0
DP304	JUNCTION	5562.30	15.00	0.0
DP319	JUNCTION	5566.31	22.70	0.0
DP323	JUNCTION	5578.90	28.23	0.0
DP329	JUNCTION	5596.56	15.77	0.0
DP334	JUNCTION	5604.55	12.95	0.0
DP340	JUNCTION	5609.94	23.08	0.0
DP345	JUNCTION	5632.00	6.92	0.0
DP350	JUNCTION	5643.88	6.92	0.0
DP360	JUNCTION	5669.81	4.10	0.0
DP375	JUNCTION	5645.02	3.56	0.0
DP380	JUNCTION	5659.31	2.59	0.0
DP400	JUNCTION	5565.33	2.92	0.0
DP500	JUNCTION	5566.99	0.00	0.0
DP600	JUNCTION	5568.74	14.67	0.0
DP602	JUNCTION	5580.15	14.67	0.0
DP605	JUNCTION	5603.41	6.49	0.0
DP700	JUNCTION	5573.69	3.73	0.0
DP800	JUNCTION	5604.96	11.71	0.0
DP805	JUNCTION	5626.01	11.71	0.0
DP900	JUNCTION	5647.96	13.33	0.0
DP905	JUNCTION	5688.37	13.33	0.0
DP915	JUNCTION	5695.89	8.49	0.0
DP925	JUNCTION	5739.96	4.65	0.0
B220	DIVIDER	5582.69	4.50	0.0
B225	DIVIDER	5573.55	4.58	0.0
B230	DIVIDER	5579.02	4.50	0.0
B250	DIVIDER	5619.48	5.00	0.0
DP240	DIVIDER	5570.43	11.00	0.0
DP245	DIVIDER	5600.81	8.00	0.0
DP305	DIVIDER	5563.68	14.00	0.0
DP320	DIVIDER	5575.26	14.00	0.0
DP325	DIVIDER	5600.52	10.50	0.0
DP330	DIVIDER	5601.75	12.00	0.0
DP335	DIVIDER	5612.46	5.50	0.0
SU1	STORAGE	5582.00	11.00	0.0

****
Link Summary
****

Name	From Node	To Node	Type	Length	%Slope	Roughness
C1	DP330	DP329	CONDUIT	284.0	0.5000	0.0150
C10	B925	DP925	CONDUIT	10.0	1.0001	0.0100
C10_1	DP330	DP329	CONDUIT	284.0	0.5000	0.0160
C10_2	DP329	DP323	CONDUIT	489.6	0.1999	0.0500
C1000	B1000	DP1000	CONDUIT	10.0	1.0001	0.0100
C1005	B1005	DP1005	CONDUIT	10.0	1.0001	0.0100
C11	B250	DP245	CONDUIT	2856.0	0.6537	0.0150
C1100	B1100	DP1100	CONDUIT	10.0	1.0001	0.0100
C111	B605	DP605	CONDUIT	10.0	1.0001	0.0100
C12	DP305	DP304	CONDUIT	107.6	0.3532	0.0160
C12_2	DP245	DP219	CONDUIT	4818.2	0.6509	0.0160
C13	DP320	DP319	CONDUIT	72.4	0.3453	0.0160
C14	B220	DP240	CONDUIT	463.0	2.6495	0.0150
C15	DP602	DP600	CONDUIT	697.6	1.6356	0.0500
C16	B615	DP605	CONDUIT	1481.2	2.1406	0.0500
C17	B400	DP400	CONDUIT	10.0	1.0001	0.0100
C19	B250	DP245	CONDUIT	2856.0	0.6537	0.0160
C2	B815	DP805	CONDUIT	2203.8	1.1313	0.0500
C20	B210	DP210	CONDUIT	10.0	1.0001	0.0100
C200	B200	DP200	CONDUIT	10.0	1.0001	0.0100
C205	B205	DP205	CONDUIT	10.0	1.0001	0.0100
C21	B1105	DP1105	CONDUIT	10.0	1.0001	0.0100
C22	B100	DP100	CONDUIT	10.0	1.0001	0.0100
C225	B225	DP223	CONDUIT	215.0	0.3884	0.0130
C23	DP304	DP300	CONDUIT	878.8	0.9415	0.0500
C230	B230	DP228	CONDUIT	584.0	1.6971	0.0160
C24	B215	DP215	CONDUIT	10.0	1.0001	0.0100
C240	B240	DP240	CONDUIT	10.0	1.0001	0.0100
C245	B245	DP245	CONDUIT	10.0	1.0001	0.0100
C25	DP325	DP323	CONDUIT	349.0	1.1165	0.0150
C26	DP335	DP334	CONDUIT	91.8	0.5012	0.0160
C27	B300	DP300	CONDUIT	10.0	1.0001	0.0100
C28	DP325	DP323	CONDUIT	349.0	1.1165	0.0160

FIGURE B-6
Future Conditions 100-Year SWMM Output

C29	DP240	DP219	CONDUIT	224.0	0.4353	0.0150
C3	DP340	DP330	CONDUIT	2728.7	0.3001	0.0500
C30	DP335	DP334	CONDUIT	91.8	0.5012	0.0150
C305	B305	DP305	CONDUIT	10.0	1.0001	0.0100
C31	DP320	DP319	CONDUIT	72.4	0.3453	0.0150
C310	B310	DP305	CONDUIT	10.0	1.0001	0.0100
C315	B315	DP305	CONDUIT	10.0	1.0001	0.0100
C32	DP334	DP325	CONDUIT	2012.8	0.2000	0.0500
C320	B320	DP320	CONDUIT	10.0	1.0001	0.0100
C325	B325	DP325	CONDUIT	10.0	1.0001	0.0100
C33	DP305	DP304	CONDUIT	107.6	0.3532	0.0150
C33_1	DP210	DP205	CONDUIT	1253.0	0.9003	0.0500
C33_2	DP205	DP200	CONDUIT	1738.4	0.9039	0.0500
C330	B330	DP330	CONDUIT	10.0	1.0001	0.0100
C335	B335	DP335	CONDUIT	10.0	1.0001	0.0100
C340	B340	DP340	CONDUIT	10.0	1.0001	0.0100
C345	B345	DP345	CONDUIT	10.0	1.0001	0.0100
C350	B350	DP350	CONDUIT	10.0	1.0001	0.0100
C355	B355	DP350	CONDUIT	10.0	1.0001	0.0100
C36	DP215	DP210	CONDUIT	661.7	1.2399	0.0500
C360	B360	DP360	CONDUIT	10.0	1.0001	0.0100
C370	B370	DP345	CONDUIT	10.0	1.0001	0.0100
C375	B375	DP375	CONDUIT	10.0	1.0001	0.0100
C380	B380	DP380	CONDUIT	10.0	1.0001	0.0100
C4	B225	DP223	CONDUIT	215.0	0.3884	0.0150
C40	B235	DP240	CONDUIT	551.2	0.1907	0.0500
C41	DP345	DP340	CONDUIT	695.2	0.3645	0.0500
C42	DP905	DP900	CONDUIT	2138.8	1.8898	0.0500
C43	DP375	DP345	CONDUIT	1483.6	0.8776	0.0500
C45	B930	DP925	CONDUIT	10.0	1.0001	0.0500
C47	DP915	DP905	CONDUIT	932.8	0.8059	0.0500
C48	DP350	DP345	CONDUIT	2298.8	0.5169	0.0500
C5	DP245	DP219	CONDUIT	4814.0	0.6515	0.0150
C500	B500	DP500	CONDUIT	10.0	1.0001	0.0100
C52	DP380	DP375	CONDUIT	2912.3	0.4909	0.0500
C54	DP1105	DP1100	CONDUIT	2525.6	1.6158	0.0500
C55	DP925	DP915	CONDUIT	2403.2	1.8341	0.0500
C56	DP605	SU1	CONDUIT	1930.9	1.1087	0.0500
C58	DP805	DP800	CONDUIT	2017.8	1.0429	0.0500
C6	B220	DP240	CONDUIT	463.0	2.6495	0.0160
C60	DP360	DP350	CONDUIT	3128.7	0.8288	0.0500
C600	B600	DP600	CONDUIT	10.0	1.0001	0.0100
C602	B602	SU1	CONDUIT	10.0	1.0001	0.0100
C61	B610	DP605	CONDUIT	1099.8	2.0570	0.0500
C64	DP1005	DP1000	CONDUIT	1227.6	1.1423	0.0500
C65	B705	DP700	CONDUIT	3786.0	1.1173	0.0500
C68	B1010	DP1005	CONDUIT	987.3	1.7410	0.0500
C7	B230	DP228	CONDUIT	600.2	1.6514	0.0160
C700	B700	DP700	CONDUIT	10.0	1.0001	0.0100
C73	B405	DP400	CONDUIT	3267.8	0.8762	0.0500
C74_2	B385	DP380	CONDUIT	2902.1	0.6218	0.0500
C8	DP323	DP320	CONDUIT	1819.4	0.2000	0.0500
C80	B365	DP360	CONDUIT	747.2	0.4227	0.0500
C800	B800	DP800	CONDUIT	10.0	1.0001	0.0100
C805	B805	DP805	CONDUIT	10.0	1.0001	0.0100
C810	B810	DP805	CONDUIT	10.0	1.0001	0.0100
C83	B1110	DP1105	CONDUIT	1066.2	1.5301	0.0500
C88	DP240	DP219	CONDUIT	224.0	0.4353	0.0160
C89	DP219	DP216	CONDUIT	744.9	0.8309	0.0500
C9	DP319	DP305	CONDUIT	1316.5	0.2000	0.0500
C90	DP228	DP216	CONDUIT	448.2	1.3057	0.0500
C900	B900	DP900	CONDUIT	10.0	1.0001	0.0100
C905	B905	DP905	CONDUIT	10.0	1.0001	0.0100
C91	DP216	DP215	CONDUIT	935.4	1.2866	0.0500
C910	B910	DP905	CONDUIT	10.0	1.0001	0.0100
C915	B915	DP915	CONDUIT	10.0	1.0001	0.0100
C920	B920	DP915	CONDUIT	10.0	1.0001	0.0100
C93	DP223	DP210	CONDUIT	1626.4	1.8261	0.0500
C18	SU1	DP602	OUTLET			

****
Cross Section Summary
****

Conduit	Shape	Full Depth	Full Area	Hyd. Rad.	Max. Width	No. of Barrels	Full Flow
C1	TRAPEZOIDAL	6.00	480.00	4.32	110.00	1	8914.80
C10	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C10_1	RECT_CLOSED	6.00	60.00	1.88	10.00	2	599.15
C10_2	Adonea_A	7.00	861.00	6.69	151.00	1	4063.56
C1000	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C1005	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C11	TRAPEZOIDAL	1.00	35.00	0.87	40.00	1	255.61
C1100	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C111	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C12	RECT_CLOSED	8.00	112.00	2.55	14.00	3	1152.43
C12_2	CIRCULAR	5.00	19.63	1.25	5.00	1	170.73
C13	RECT_CLOSED	8.00	112.00	2.55	14.00	3	1139.54
C14	TRAPEZOIDAL	1.00	35.00	0.87	40.00	1	514.62
C15	C15	4.67	397.00	2.67	148.00	1	2901.03
C16	C16	4.43	449.04	2.98	150.00	1	4041.29
C17	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C19	CIRCULAR	4.00	12.57	1.00	4.00	1	94.36
C2	T-C2	8.71	1845.88	5.12	358.60	1	17336.81
C20	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C200	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C205	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C21	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C22	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C225	HORIZ_ELLIPSE	1.58	3.30	0.49	2.50	1	14.61
C23	T-C23	10.19	2349.09	4.61	507.12	1	18760.66
C230	CIRCULAR	3.50	9.62	0.88	3.50	1	106.49
C24	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C240	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C245	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C25	TRAPEZOIDAL	6.00	480.00	4.32	110.00	1	13321.73
C26	CIRCULAR	4.50	15.90	1.13	4.50	3	113.11
C27	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C28	CIRCULAR	4.50	15.90	1.13	4.50	2	168.83
C29	TRAPEZOIDAL	1.00	35.00	0.87	40.00	1	208.59
C3	Harmony_ChannelA	8.18	507.76	8.69	97.00	1	3494.71
C30	TRAPEZOIDAL	1.00	35.00	0.87	40.00	1	223.81
C305	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C31	TRAPEZOIDAL	6.00	480.00	4.32	110.00	1	7408.42
C310	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C315	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C32	Adonea_B	6.45	280.33	5.92	78.84	1	1219.28
C320	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C325	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C33	TRAPEZOIDAL	6.00	480.00	4.32	110.00	1	7492.22
C33_1	T-C33_1	16.24	5187.03	8.89	575.42	1	62758.59

FIGURE B-6
Future Conditions 100-Year SWMM Output

C33_2	T-C33_2	13.59	3268.65	5.87	549.88	1	30055.45
C330	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C335	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C340	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C345	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C350	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C355	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C36	C36	7.06	463.83	2.91	158.00	1	3125.16
C360	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C370	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C375	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C380	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C4	TRAPEZOIDAL	3.00	135.00	2.23	60.00	1	1421.75
C40	T-C40	10.55	3282.51	7.91	412.31	1	16914.18
C41	T-C41	3.56	1714.56	2.46	693.42	1	5610.08
C42	T-C42	13.33	3200.48	7.71	407.50	1	51037.72
C43	T-C43	3.56	892.97	1.81	523.83	1	3686.15
C45	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C47	T-C47	8.49	2254.13	4.47	501.65	1	16326.72
C48	T-C48	6.92	2340.46	4.14	560.17	1	12897.75
C5	TRAPEZOIDAL	3.00	135.00	2.23	60.00	1	1841.45
C500	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C52	T-C52	2.31	551.95	1.27	433.50	1	1346.45
C54	C54	1.64	78.55	0.92	85.00	1	280.38
C55	T-C55	4.65	990.82	2.63	375.00	1	7600.11
C56	C56	6.49	697.78	3.92	177.00	1	5426.12
C58	T-C58	11.71	3500.55	6.86	508.00	1	38349.31
C6	CIRCULAR	3.50	9.62	0.88	3.50	1	133.06
C60	T-C60	2.95	695.15	1.88	368.35	1	2864.44
C600	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C602	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C61	T-C61	4.19	425.39	2.67	157.00	1	3490.37
C64	C64	3.11	306.56	1.77	172.00	1	1424.04
C65	T-C65	3.73	584.98	2.26	258.00	1	3162.58
C68	C68	3.45	376.19	2.22	169.00	1	2506.83
C7	TRAPEZOIDAL	1.00	35.00	0.87	40.00	1	380.89
C700	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C73	T-C73	2.92	544.57	1.59	339.00	1	2063.80
C74_2	T-C74_2	2.59	781.89	1.84	421.91	1	2751.66
C8	Adonea_A	7.00	861.00	6.69	151.00	1	4064.24
C80	T-C80	4.10	1502.69	2.82	529.80	1	5801.01
C800	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C805	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C810	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C83	C83	3.65	305.10	2.32	131.00	1	1963.78
C88	RECT_CLOSED	5.00	60.00	1.76	12.00	2	536.88
C89	C89	6.26	318.03	3.46	90.00	1	1970.83
C9	Adonea_A	7.00	861.00	6.69	151.00	1	4064.09
C90	C90	4.75	201.01	2.28	87.00	1	1182.92
C900	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C905	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C91	T-C91	12.16	2858.33	4.95	574.81	1	27969.80
C910	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C915	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C920	DUMMY	0.00	0.00	0.00	0.00	1	0.00
C93	T-C93	5.75	981.83	1.79	544.78	1	5822.45

```
**********************************************************
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
Infiltration Method ...... HORTON
Flow Routing Method ...... KINWAVE
Starting Date ............ 09/01/2018 00:00:00
Ending Date .............. 09/01/2018 10:00:00
Antecedent Dry Days ...... 0.0
Report Time Step ......... 00:05:00
Wet Time Step ............ 00:05:00
Dry Time Step ............ 00:05:00
Routing Time Step ........ 5.00 sec

**************************        Volume         Depth
Runoff Quantity Continuity     acre-feet        inches
**************************     ---------       -------
Total Precipitation ......         0.000         0.000
Evaporation Loss .........         0.000         0.000
Infiltration Loss ........         0.000         0.000
Surface Runoff ...........         0.000         0.000
Final Storage ............         0.000         0.000
Continuity Error (%) .....         0.000


**************************        Volume        Volume
Flow Routing Continuity        acre-feet      10^6 gal
**************************     ---------     ---------
Dry Weather Inflow .......         0.000         0.000
Wet Weather Inflow .......         0.000         0.000
Groundwater Inflow .......         0.000         0.000
RDII Inflow ..............         0.000         0.000
External Inflow ..........       801.245       261.098
External Outflow .........       805.204       262.388
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 ......        12.896         4.202
Continuity Error (%) .....        -2.104


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

FIGURE B-6
Future Conditions 100-Year SWMM Output

```
*************************
Routing Time Step Summary
*************************
Minimum Time Step           :     4.00 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
B100	JUNCTION	0.00	0.00	5511.01	0	00:00	0.00
B1000	JUNCTION	0.00	0.00	5686.08	0	00:00	0.00
B1005	JUNCTION	0.00	0.00	5700.10	0	00:00	0.00
B1010	JUNCTION	0.24	1.10	5718.29	0	00:50	1.10
B1100	JUNCTION	0.00	0.00	5708.80	0	00:00	0.00
B1105	JUNCTION	0.00	0.00	5749.60	0	00:00	0.00
B1110	JUNCTION	0.29	1.17	5766.99	0	00:55	1.17
B200	JUNCTION	0.00	0.00	5516.13	0	00:00	0.00
B205	JUNCTION	0.00	0.00	5531.84	0	00:00	0.00
B210	JUNCTION	0.00	0.00	5543.12	0	00:00	0.00
B215	JUNCTION	0.00	0.00	5551.33	0	00:00	0.00
B235	JUNCTION	0.29	1.30	5572.78	0	00:50	1.30
B240	JUNCTION	0.00	0.00	5570.52	0	00:00	0.00
B245	JUNCTION	0.00	0.00	5600.91	0	00:00	0.00
B300	JUNCTION	0.00	0.00	5554.12	0	00:00	0.00
B305	JUNCTION	0.00	0.00	5563.78	0	00:00	0.00
B310	JUNCTION	0.00	0.00	5563.78	0	00:00	0.00
B315	JUNCTION	0.00	0.00	5563.78	0	00:00	0.00
B320	JUNCTION	0.00	0.00	5575.36	0	00:00	0.00
B325	JUNCTION	0.00	0.00	5600.62	0	00:00	0.00
B330	JUNCTION	0.00	0.00	5601.85	0	00:00	0.00
B335	JUNCTION	0.00	0.00	5612.56	0	00:00	0.00
B340	JUNCTION	0.00	0.00	5610.04	0	00:00	0.00
B345	JUNCTION	0.00	0.00	5632.10	0	00:00	0.00
B350	JUNCTION	0.00	0.00	5643.98	0	00:00	0.00
B355	JUNCTION	0.00	0.00	5643.98	0	00:00	0.00
B360	JUNCTION	0.00	0.00	5669.91	0	00:00	0.00
B365	JUNCTION	0.16	1.04	5674.01	0	00:45	1.04
B370	JUNCTION	0.00	0.00	5632.10	0	00:00	0.00
B375	JUNCTION	0.00	0.00	5645.12	0	00:00	0.00
B380	JUNCTION	0.00	0.00	5659.42	0	00:00	0.00
B385	JUNCTION	0.13	1.00	5678.36	0	00:40	1.00
B400	JUNCTION	0.00	0.00	5565.43	0	00:00	0.00
B405	JUNCTION	0.16	0.99	5594.95	0	00:40	0.99
B500	JUNCTION	0.00	0.00	5567.09	0	00:00	0.00
B600	JUNCTION	0.00	0.00	5568.84	0	00:00	0.00
B602	JUNCTION	0.00	0.00	5582.10	0	00:00	0.00
B605	JUNCTION	0.00	0.00	5603.51	0	00:00	0.00
B610	JUNCTION	0.23	1.45	5627.47	0	00:45	1.45
B615	JUNCTION	0.13	1.24	5636.35	0	00:30	1.24
B700	JUNCTION	0.00	0.00	5573.79	0	00:00	0.00
B705	JUNCTION	0.23	1.54	5617.53	0	00:40	1.54
B800	JUNCTION	0.00	0.00	5605.06	0	00:00	0.00
B805	JUNCTION	0.00	0.00	5626.11	0	00:00	0.00
B810	JUNCTION	0.00	0.00	5626.11	0	00:00	0.00
B815	JUNCTION	0.24	1.95	5652.88	0	00:35	1.95
B900	JUNCTION	0.00	0.00	5648.06	0	00:00	0.00
B905	JUNCTION	0.00	0.00	5688.47	0	00:00	0.00
B910	JUNCTION	0.00	0.00	5688.47	0	00:00	0.00
B915	JUNCTION	0.00	0.00	5695.99	0	00:00	0.00
B920	JUNCTION	0.00	0.00	5695.99	0	00:00	0.00
B925	JUNCTION	0.00	0.00	5740.06	0	00:00	0.00
B930	JUNCTION	0.00	0.00	5740.06	0	00:00	0.00
DP100	JUNCTION	0.00	0.00	5510.91	0	00:10	0.00
DP1000	JUNCTION	3.06	3.11	5689.09	0	00:10	3.11
DP1005	JUNCTION	0.32	1.50	5701.50	0	00:52	1.49
DP1100	JUNCTION	1.61	1.64	5710.34	0	00:10	1.64
DP1105	JUNCTION	0.34	1.34	5750.84	0	01:01	1.34
DP200	JUNCTION	12.47	13.59	5529.62	0	00:10	13.59
DP205	JUNCTION	0.96	4.43	5536.18	0	00:59	4.43
DP210	JUNCTION	1.06	4.98	5548.00	0	00:59	4.98
DP215	JUNCTION	1.04	4.98	5556.21	0	00:57	4.97
DP216	JUNCTION	0.94	4.77	5568.03	0	00:54	4.77
DP219	JUNCTION	10.00	10.00	5579.45	0	00:00	10.00
DP223	JUNCTION	1.68	2.57	5575.28	0	00:40	2.57
DP228	JUNCTION	3.51	3.75	5572.86	0	00:41	3.74
DP300	JUNCTION	10.02	10.19	5564.21	0	00:10	10.19
DP304	JUNCTION	9.00	9.00	5571.30	0	00:00	9.00
DP319	JUNCTION	16.70	16.70	5583.01	0	00:00	16.70
DP323	JUNCTION	22.24	22.54	5601.44	0	00:50	22.54
DP329	JUNCTION	9.79	10.31	5606.87	0	01:26	10.31
DP334	JUNCTION	11.95	11.95	5616.50	0	00:00	11.95
DP340	JUNCTION	19.97	21.21	5631.15	0	01:20	21.21
DP345	JUNCTION	0.52	1.91	5633.91	0	01:20	1.91
DP350	JUNCTION	0.46	1.95	5645.83	0	01:05	1.95
DP360	JUNCTION	0.24	1.35	5671.16	0	00:48	1.35
DP375	JUNCTION	0.45	1.57	5646.59	0	01:11	1.57
DP380	JUNCTION	0.33	1.40	5660.71	0	00:58	1.40
DP400	JUNCTION	2.87	2.92	5568.25	0	00:10	2.92
DP500	JUNCTION	0.00	0.00	5566.99	0	00:10	0.00
DP600	JUNCTION	14.59	14.67	5583.41	0	00:10	14.67
DP602	JUNCTION	10.60	12.50	5592.65	0	01:07	12.49
DP605	JUNCTION	0.43	2.83	5606.24	0	00:41	2.83
DP700	JUNCTION	3.66	3.73	5577.41	0	00:10	3.73
DP800	JUNCTION	10.00	11.71	5616.68	0	00:10	11.71
DP805	JUNCTION	0.44	2.66	5628.66	0	00:44	2.66
DP900	JUNCTION	12.63	13.33	5661.30	0	00:10	13.33
DP905	JUNCTION	0.57	2.63	5691.00	0	00:58	2.63
DP915	JUNCTION	0.55	2.64	5698.53	0	00:53	2.63
DP925	JUNCTION	0.29	1.39	5741.35	0	00:50	1.39
B220	DIVIDER	3.50	3.50	5586.19	0	00:00	3.50
B225	DIVIDER	1.68	2.57	5576.12	0	00:40	2.57
B230	DIVIDER	3.51	3.75	5582.77	0	00:40	3.75
B250	DIVIDER	4.03	4.55	5624.03	0	00:40	4.55
DP240	DIVIDER	10.00	10.00	5580.43	0	00:00	10.00
DP245	DIVIDER	5.05	5.84	5606.65	0	00:45	5.83
DP305	DIVIDER	8.00	8.00	5571.68	0	00:00	8.00
DP320	DIVIDER	8.00	8.00	5583.26	0	00:00	8.00
DP325	DIVIDER	4.51	4.81	5605.33	0	00:49	4.81
DP330	DIVIDER	6.02	6.54	5608.29	0	01:25	6.54
DP335	DIVIDER	4.50	4.50	5616.96	0	00:00	4.50
SU1	STORAGE	6.61	9.04	5591.04	0	01:07	9.03

FIGURE B-6
Future Conditions 100-Year SWMM Output

****
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
B100	JUNCTION	430.97	430.97	0 00:40	10.8	10.8	0.000
B1000	JUNCTION	76.19	76.19	0 00:40	1.87	1.87	0.000
B1005	JUNCTION	78.29	78.29	0 00:45	2.27	2.27	0.000
B1010	JUNCTION	162.30	162.30	0 00:50	6.02	6.02	0.000
B1100	JUNCTION	111.82	111.82	0 00:50	3.76	3.76	0.000
B1105	JUNCTION	37.42	37.42	0 00:55	1.62	1.62	0.000
B1110	JUNCTION	134.91	134.91	0 00:55	5.87	5.87	0.000
B200	JUNCTION	36.18	36.18	0 00:45	1.19	1.19	0.000
B205	JUNCTION	182.06	182.06	0 00:40	4.43	4.43	0.000
B210	JUNCTION	153.08	153.08	0 00:35	2.65	2.65	0.000
B215	JUNCTION	148.54	148.54	0 00:35	3.01	3.01	0.000
B235	JUNCTION	131.87	131.87	0 00:50	4.91	4.91	-0.000
B240	JUNCTION	272.67	272.67	0 00:50	9.55	9.55	0.000
B245	JUNCTION	198.12	198.12	0 00:40	4.45	4.45	0.000
B300	JUNCTION	42.59	42.59	0 00:35	1.01	1.01	0.000
B305	JUNCTION	4.86	4.86	0 00:55	0.23	0.23	0.000
B310	JUNCTION	230.85	230.85	0 00:40	5.72	5.72	0.000
B315	JUNCTION	179.18	179.18	0 00:40	4.15	4.15	0.000
B320	JUNCTION	12.95	12.95	0 01:00	0.636	0.636	0.000
B325	JUNCTION	161.82	161.82	0 00:40	3.99	3.99	0.000
B330	JUNCTION	156.86	156.86	0 00:40	3.79	3.79	0.000
B335	JUNCTION	282.44	282.44	0 00:40	7.4	7.4	0.000
B340	JUNCTION	137.47	137.47	0 00:30	1.99	1.99	0.000
B345	JUNCTION	144.49	144.49	0 00:45	4.14	4.14	0.000
B350	JUNCTION	77.87	77.87	0 00:45	2.48	2.48	0.000
B355	JUNCTION	132.56	132.56	0 00:40	3.64	3.64	0.000
B360	JUNCTION	178.38	178.38	0 00:45	5.13	5.13	0.000
B365	JUNCTION	308.63	308.63	0 00:45	8.29	8.29	0.000
B370	JUNCTION	121.61	121.61	0 00:40	3.39	3.39	0.000
B375	JUNCTION	343.06	343.06	0 00:40	8.13	8.13	0.000
B380	JUNCTION	203.42	203.42	0 00:45	5.63	5.63	0.000
B385	JUNCTION	346.13	346.13	0 00:40	7.69	7.69	0.000
B400	JUNCTION	137.15	137.15	0 00:45	4.1	4.1	0.000
B405	JUNCTION	136.92	136.92	0 00:40	3.56	3.56	0.000
B500	JUNCTION	374.15	374.15	0 00:45	10.4	10.4	0.000
B600	JUNCTION	40.92	40.92	0 00:35	0.826	0.826	0.000
B602	JUNCTION	221.23	221.23	0 00:40	4.89	4.89	0.000
B605	JUNCTION	246.38	246.38	0 00:35	4.4	4.4	0.000
B610	JUNCTION	296.24	296.24	0 00:45	8.02	8.02	-0.000
B615	JUNCTION	221.02	221.02	0 00:30	3.38	3.38	0.000
B700	JUNCTION	112.24	112.24	0 00:45	3.39	3.39	0.000
B705	JUNCTION	355.44	355.44	0 00:40	8.89	8.89	0.000
B800	JUNCTION	121.81	121.81	0 00:50	4.33	4.33	0.000
B805	JUNCTION	401.96	401.96	0 00:40	9.08	9.08	0.000
B810	JUNCTION	128.79	128.79	0 00:45	3.77	3.77	0.000
B815	JUNCTION	432.82	432.82	0 00:35	8.25	8.25	0.000
B900	JUNCTION	174.46	174.46	0 00:40	4.21	4.21	0.000
B905	JUNCTION	101.30	101.30	0 00:35	2.07	2.07	0.000
B910	JUNCTION	66.37	66.37	0 00:45	2.28	2.28	0.000
B915	JUNCTION	186.66	186.66	0 00:40	4.57	4.57	0.000
B920	JUNCTION	197.17	197.17	0 00:40	4.8	4.8	0.000
B925	JUNCTION	150.45	150.45	0 00:50	5.72	5.72	0.000
B930	JUNCTION	178.61	178.61	0 00:50	5.88	5.88	0.000
DP100	JUNCTION	0.00	430.97	0 00:40	0	10.8	0.000
DP1000	JUNCTION	0.00	291.35	0 00:56	0	10.2	0.000
DP1005	JUNCTION	0.00	233.63	0 00:52	0	8.3	0.000
DP1100	JUNCTION	0.00	261.31	0 01:06	0	11.3	0.000
DP1105	JUNCTION	0.00	171.13	0 01:01	0	7.5	0.000
DP200	JUNCTION	0.00	1383.34	0 01:04	0	45.1	0.000
DP205	JUNCTION	0.00	1357.92	0 00:59	0	43.9	0.000
DP210	JUNCTION	0.00	1234.23	0 00:56	0	39.4	0.000
DP215	JUNCTION	0.00	995.73	0 00:57	0	32.1	0.000
DP216	JUNCTION	0.00	911.89	0 00:54	0	29.1	0.000
DP219	JUNCTION	0.00	788.44	0 00:54	0	25.5	0.000
DP223	JUNCTION	0.00	206.13	0 00:40	0	4.66	0.000
DP228	JUNCTION	0.00	141.70	0 00:41	0	3.54	0.000
DP300	JUNCTION	0.00	1740.64	0 01:36	0	80.7	0.000
DP304	JUNCTION	0.00	1732.28	0 01:34	0	79.7	0.000
DP319	JUNCTION	0.00	1619.57	0 01:31	0	69.5	0.000
DP323	JUNCTION	0.00	1620.82	0 01:25	0	68.6	0.000
DP329	JUNCTION	0.00	1403.80	0 01:26	0	57.1	0.000
DP334	JUNCTION	0.00	282.26	0 00:40	0	7.4	0.000
DP340	JUNCTION	0.00	1277.59	0 01:20	0	52.6	0.000
DP345	JUNCTION	0.00	1267.23	0 01:16	0	50.6	0.000
DP350	JUNCTION	0.00	571.14	0 01:05	0	20.1	0.000
DP360	JUNCTION	0.00	473.08	0 00:48	0	13.5	0.000
DP375	JUNCTION	0.00	567.10	0 01:11	0	22.7	0.000
DP380	JUNCTION	0.00	436.19	0 00:58	0	14	0.000
DP400	JUNCTION	0.00	216.84	0 01:00	0	7.97	0.000
DP500	JUNCTION	0.00	374.15	0 00:45	0	10.4	0.000
DP600	JUNCTION	0.00	602.25	0 01:09	0	17.8	0.000
DP602	JUNCTION	0.00	583.81	0 01:07	0	17	0.000
DP605	JUNCTION	0.00	692.40	0 00:41	0	15.8	0.000
DP700	JUNCTION	0.00	391.75	0 01:00	0	12.7	0.000
DP800	JUNCTION	0.00	981.29	0 00:51	0	25.6	0.000
DP805	JUNCTION	0.00	893.92	0 00:44	0	21.2	0.000
DP900	JUNCTION	0.00	872.58	0 01:00	0	29.7	0.000
DP905	JUNCTION	0.00	749.40	0 00:55	0	25.4	0.000
DP915	JUNCTION	0.00	621.58	0 00:53	0	21.1	0.000
DP925	JUNCTION	0.00	329.05	0 00:50	0	11.6	0.000
B220	DIVIDER	52.87	52.87	0 00:40	1.48	1.48	0.000
B225	DIVIDER	206.37	206.37	0 00:40	4.66	4.66	0.000
B230	DIVIDER	142.50	142.50	0 00:40	3.53	3.53	0.000
B250	DIVIDER	185.15	185.15	0 00:40	4.72	4.72	0.000
DP240	DIVIDER	0.00	446.39	0 00:52	0	16	0.000
DP245	DIVIDER	0.00	357.58	0 00:45	0	9.27	0.000
DP305	DIVIDER	0.00	1732.28	0 01:33	0	79.7	0.000
DP320	DIVIDER	0.00	1619.58	0 01:31	0	69.5	0.000
DP325	DIVIDER	0.00	412.53	0 00:49	0	11.5	0.000
DP330	DIVIDER	0.00	1326.84	0 01:25	0	56.5	0.000
DP335	DIVIDER	0.00	282.44	0 00:40	0	7.4	0.000
SU1	STORAGE	0.00	872.36	0 00:46	0	20.8	0.029

****
Node Flooding Summary
****

No nodes were flooded.

****

FIGURE B-6
Future Conditions 100-Year SWMM Output

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 hr:min	Maximum Outflow CFS
SU1	590.217	37	0	0	1101.855	69	0 01:07	583.81

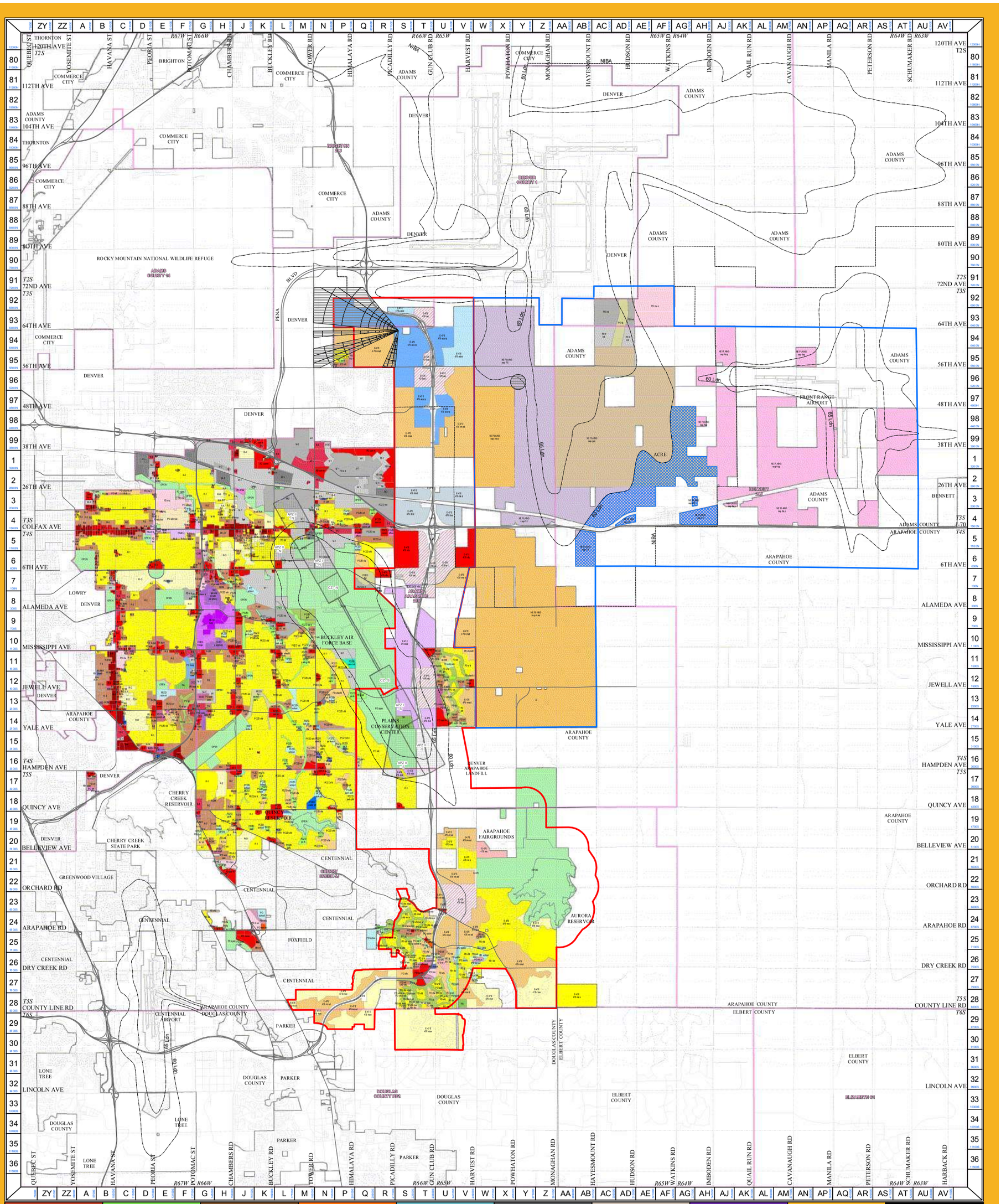
****
Link Flow Summary
****

Link	Type	Maximum |Flow| CFS	Time of Max Occurrence days hr:min	Maximum |Veloc| ft/sec	Max/ Full Flow	Max/ Full Depth
C1	CONDUIT	128.46	0 01:26	4.56	0.01	0.09
C10	DUMMY	150.45	0 00:50			
C10_1	CONDUIT	1374.11	0 01:40	13.13	1.15	0.93
C10_2	CHANNEL	1403.08	0 01:27	3.31	0.35	0.56
C1000	DUMMY	76.19	0 00:40			
C1005	DUMMY	78.29	0 00:45			
C11	CONDUIT	82.79	0 00:49	7.25	0.32	0.51
C1100	DUMMY	111.82	0 00:50			
C111	DUMMY	246.38	0 00:35			
C12	CONDUIT	1732.28	0 01:34	10.30	0.50	0.50
C12_2	CONDUIT	184.71	0 00:36	11.11	1.08	1.00
C13	CONDUIT	1619.57	0 01:31	10.01	0.47	0.48
C14	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
C15	CHANNEL	582.43	0 01:10	4.66	0.20	0.53
C16	CHANNEL	210.23	0 00:37	3.73	0.05	0.27
C17	DUMMY	137.15	0 00:45			
C19	CONDUIT	102.10	0 01:22	9.24	1.08	1.00
C2	CHANNEL	388.09	0 00:46	3.38	0.02	0.21
C20	DUMMY	153.08	0 00:35			
C200	DUMMY	36.18	0 00:45			
C205	DUMMY	182.06	0 00:40			
C21	DUMMY	37.42	0 00:55			
C22	DUMMY	430.97	0 00:40			
C225	CONDUIT	16.33	0 00:19	5.51	1.12	1.00
C23	CHANNEL	1730.72	0 01:36	4.63	0.09	0.37
C230	CONDUIT	115.14	0 00:34	13.06	1.08	1.00
C24	DUMMY	148.54	0 00:35			
C240	DUMMY	272.67	0 00:50			
C245	DUMMY	198.12	0 00:40			
C25	CONDUIT	74.78	0 00:50	4.70	0.01	0.05
C26	CONDUIT	282.26	0 00:40	7.95	0.83	0.70
C27	DUMMY	42.59	0 00:35			
C28	CONDUIT	365.28	0 00:43	12.46	1.08	1.00
C29	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
C3	CHANNEL	1269.20	0 01:26	5.06	0.36	0.63
C30	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
C305	DUMMY	4.86	0 00:55			
C31	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
C310	DUMMY	230.85	0 00:40			
C315	DUMMY	179.18	0 00:40			
C32	CHANNEL	268.47	0 00:52	3.16	0.22	0.45
C320	DUMMY	12.95	0 01:00			
C325	DUMMY	161.82	0 00:40			
C33	CONDUIT	0.00	0 00:00	0.00	0.00	0.00
C33_1	CHANNEL	1230.50	0 01:00	4.21	0.02	0.23
C33_2	CHANNEL	1351.93	0 01:04	4.94	0.04	0.33
C330	DUMMY	156.86	0 00:40			
C335	DUMMY	282.44	0 00:40			
C340	DUMMY	137.47	0 00:30			
C345	DUMMY	144.49	0 00:45			
C350	DUMMY	77.87	0 00:45			
C355	DUMMY	132.56	0 00:40			
C36	CHANNEL	994.78	0 00:59	5.29	0.32	0.70
C360	DUMMY	178.38	0 00:45			
C370	DUMMY	121.61	0 00:40			
C375	DUMMY	343.06	0 00:40			
C380	DUMMY	203.42	0 00:45			
C4	CONDUIT	191.52	0 00:40	5.58	0.13	0.33
C40	CHANNEL	130.21	0 00:57	1.11	0.01	0.12
C41	CHANNEL	1264.41	0 01:20	2.07	0.23	0.47
C42	CHANNEL	743.77	0 01:02	5.09	0.01	0.18
C43	CHANNEL	562.52	0 01:18	2.68	0.15	0.44
C45	DUMMY	178.61	0 00:50			
C47	CHANNEL	619.36	0 00:58	3.34	0.04	0.31
C48	CHANNEL	547.29	0 01:20	2.30	0.04	0.28
C5	CONDUIT	172.49	0 00:55	10.09	0.09	0.26
C500	DUMMY	374.15	0 00:45			
C52	CHANNEL	395.12	0 01:20	1.93	0.29	0.57
C54	CHANNEL	167.26	0 01:13	3.23	0.60	0.80
C55	CHANNEL	315.25	0 01:01	3.29	0.04	0.29
C56	CHANNEL	670.32	0 00:47	4.36	0.12	0.43
C58	CHANNEL	860.88	0 00:52	3.79	0.02	0.22
C6	CONDUIT	52.80	0 00:40	13.04	0.40	0.44
C60	CHANNEL	411.34	0 01:10	2.49	0.14	0.42
C600	DUMMY	40.92	0 00:35			
C602	DUMMY	221.23	0 00:40			
C61	CHANNEL	294.89	0 00:46	3.92	0.08	0.35
C64	CHANNEL	231.67	0 00:58	2.86	0.16	0.48
C65	CHANNEL	296.46	0 01:02	3.04	0.09	0.38
C68	CHANNEL	161.35	0 00:56	2.93	0.06	0.32
C7	CONDUIT	35.21	0 00:41	4.67	0.09	0.25
C700	DUMMY	112.24	0 00:45			
C73	CHANNEL	108.59	0 01:11	2.08	0.05	0.31
C74_2	CHANNEL	267.04	0 01:02	1.92	0.10	0.34
C8	CHANNEL	1609.75	0 01:31	3.60	0.40	0.60
C80	CHANNEL	300.78	0 00:50	1.53	0.05	0.25
C800	DUMMY	121.81	0 00:50			
C805	DUMMY	401.96	0 00:40			
C810	DUMMY	128.79	0 00:45			
C83	CHANNEL	134.37	0 01:01	2.90	0.07	0.32
C88	CONDUIT	446.38	0 00:52	8.43	0.42	0.44
C89	CHANNEL	788.03	0 00:55	5.03	0.40	0.65
C9	CHANNEL	1614.23	0 01:35	3.47	0.40	0.60
C90	CHANNEL	141.27	0 00:42	3.73	0.12	0.39
C900	DUMMY	174.46	0 00:40			
C905	DUMMY	101.30	0 00:35			
C91	CHANNEL	908.48	0 00:58	5.25	0.03	0.39
C910	DUMMY	66.37	0 00:45			
C915	DUMMY	186.66	0 00:40			
C920	DUMMY	197.17	0 00:40			
C93	CHANNEL	198.81	0 00:46	3.97	0.03	0.31
C18	DUMMY	583.81	0 01:07			

FIGURE B-6
Future Conditions 100-Year SWMM Output

```
*************************
Conduit Surcharge Summary
*************************
```

Conduit	Hours Full Both Ends	Hours Full Upstream	Hours Full Dnstream	Hours Above Full Normal Flow	Hours Capacity Limited
C10_1	0.44	0.44	0.44	0.44	0.44
C12_2	0.92	0.92	0.92	0.94	0.92
C19	0.83	0.83	0.83	0.10	0.83
C225	1.78	1.78	1.78	1.79	1.78
C230	0.49	0.49	0.49	0.50	0.49
C28	0.45	0.45	0.45	0.46	0.45



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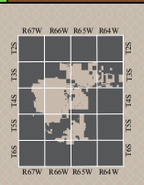

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Miles
0 0.5 1 2

City of Aurora, Colorado

2016 Zoning Map

March 8, 2016

Aurora
Worth Discovering!

N
W E
S

Legend

Buckley APZ
School District Boundary
E-470 Boundary Area
NE Plains Boundary Area
Airport Noise LDN
Airport Influence Area
Restricted Building Height

Zoning Classifications

P-1
B-1, comm
B-2
B-3
B-4, B-R
AOD,COD, comm/ off/showrm
day care
lodging
self storage, kennel
office
mixed use, mu-comm
mu residential
mu industrial
mu office
MOD, light ind
M-1
M-2, ind
M-3
R-A,R-E,R-O,low den
R-1, M-H, sfd
R-1A, sfa
R-2, mf, assisted lvg
FBAD
PD, ed-med
CCZD, core
CCZD, fringe
CCZD, periphery
well, other
fire station, esmt
water treatment
cemetery
church
hospital
recreation ctr
school
SIR
TOD
floodplain
landscape buffer
open space
golf course
park, greenbelt
park maintenance
pvt open,pvt park
park/school
Natural Area
NE PLAINS nep-resover
NE PLAINS, nep-frap
NE PLAINS, nep-gen
NE PLAINS, nep-i70
NE PLAINS, nep-mres
E-470, 470-acorp
E-470, 470-adist
E-470, 470-ltind
E-470, 470-r&c
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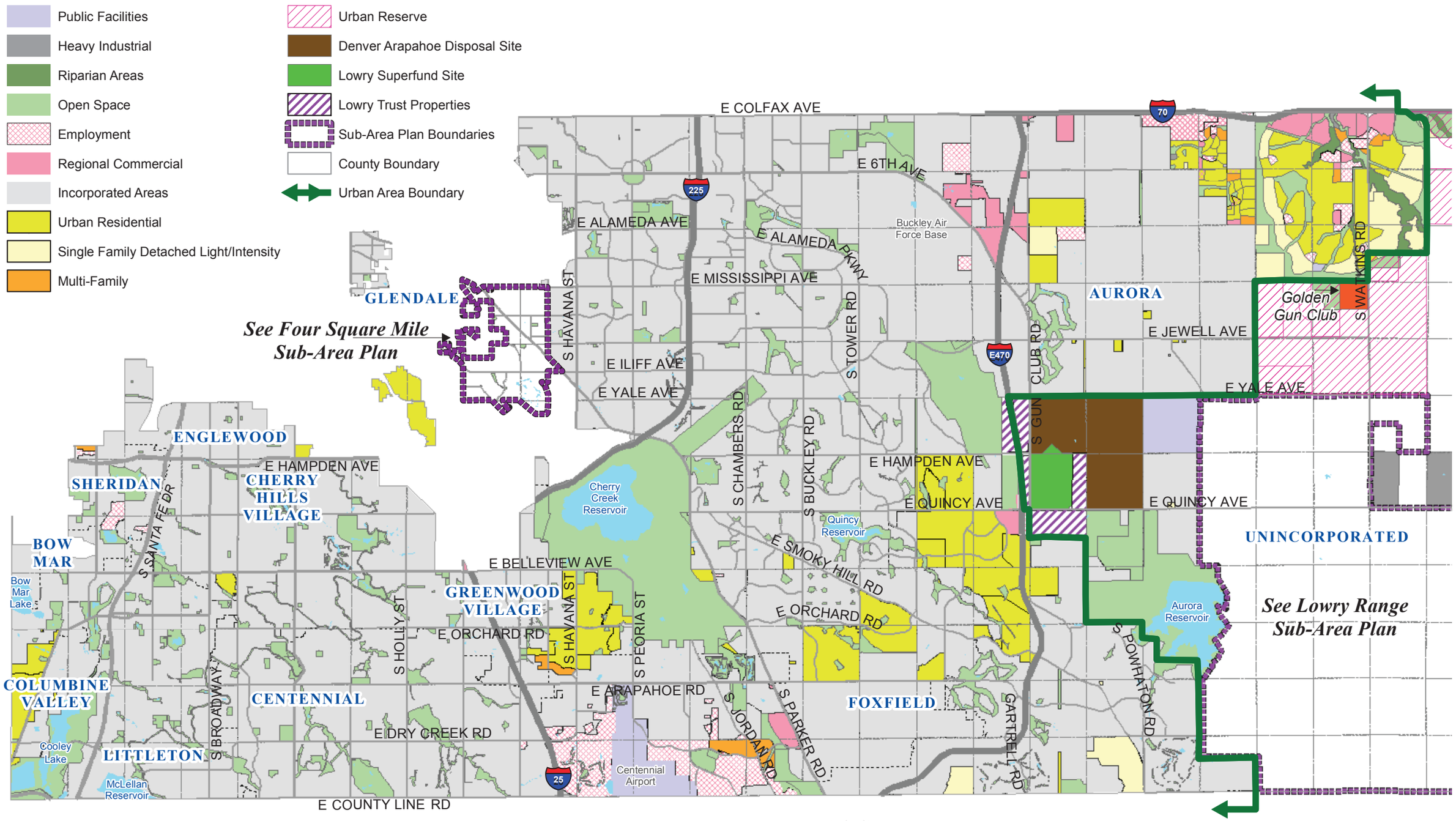

MAP 3 URBAN AREA LAND USE PLAN

ARAPAHOE COUNTY
COLORADO'S FIRST

Produced By:
Arapahoe County Mapping Division
6924 S. Lima St
Centennial, Co. 80112
Ph. 720-874-6686

Last Updated:
May 2018

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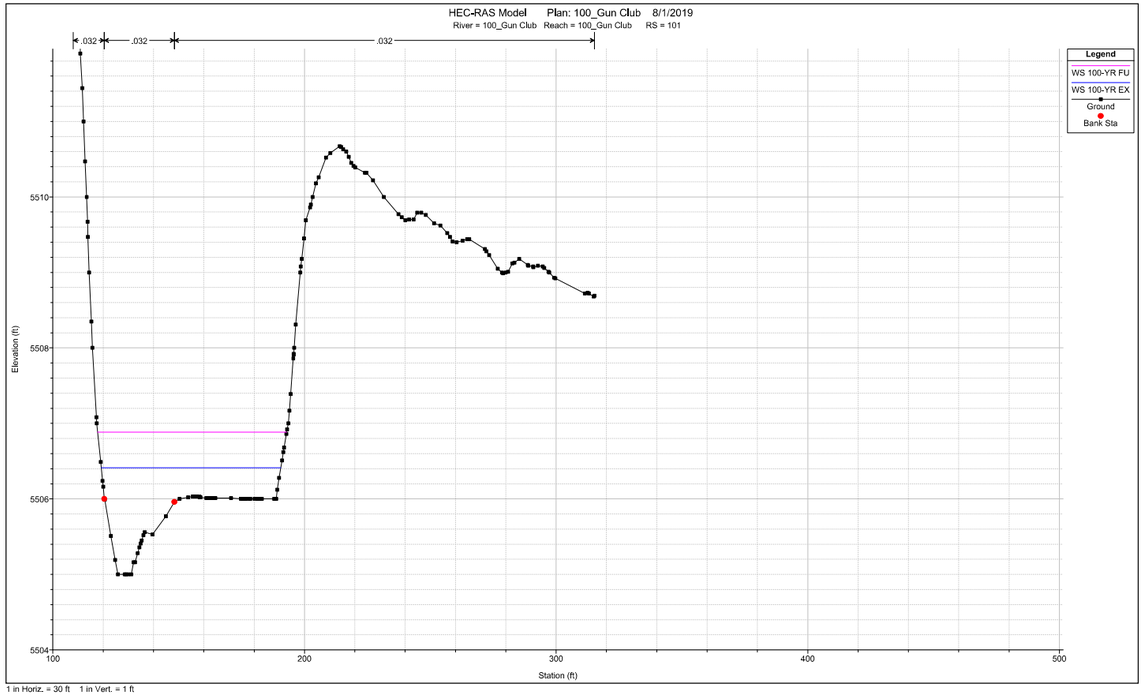
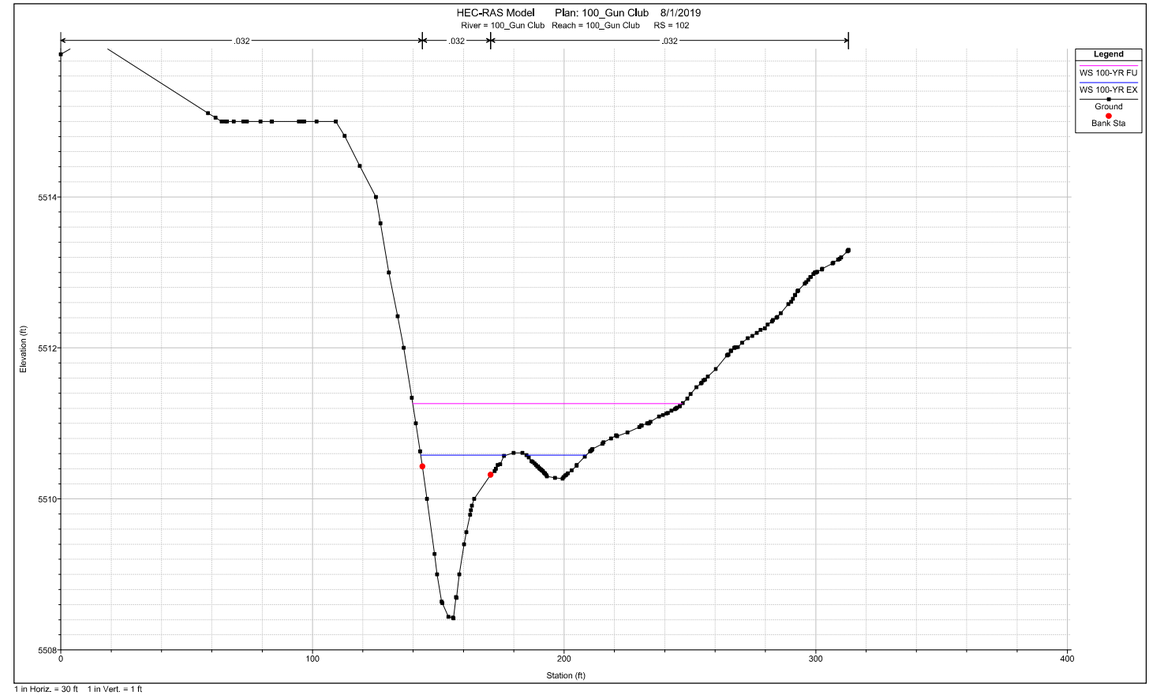
APPENDIX C – HYDRAULIC ANALYSIS

FIGURE C-1
HEC-RAS Cross Sections

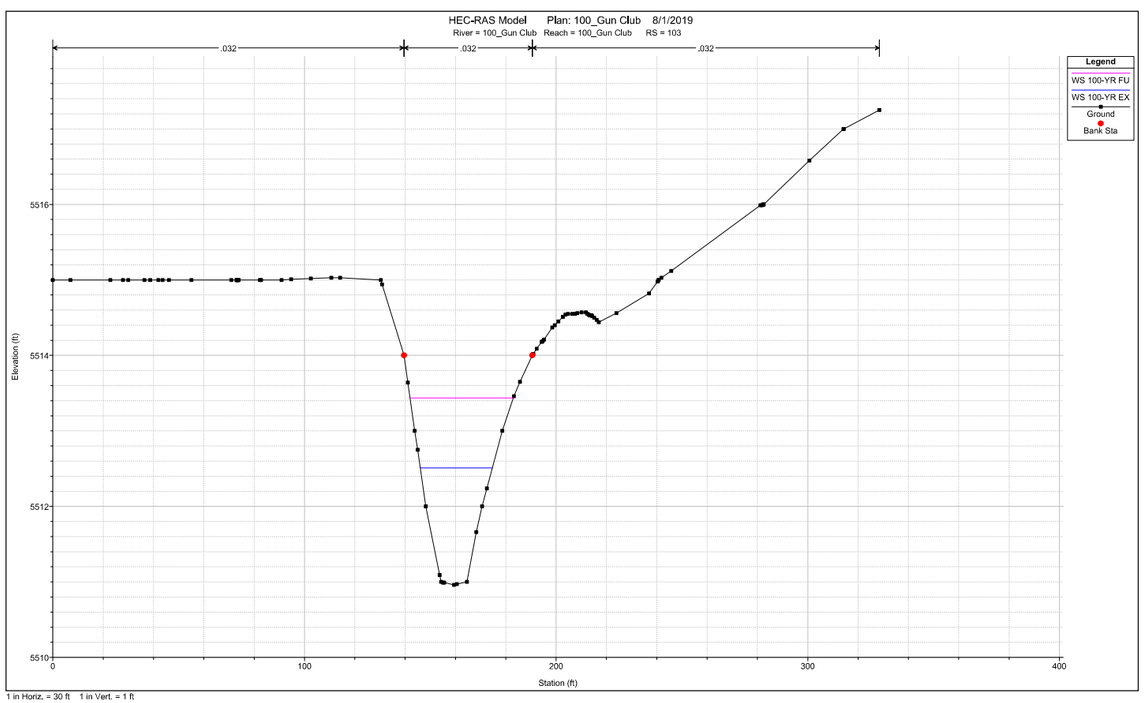
GUN CLUB TRIBUTARY
Series 100 Cross Sections



1 in Horiz. = 30 ft 1 in Vert. = 1 ft

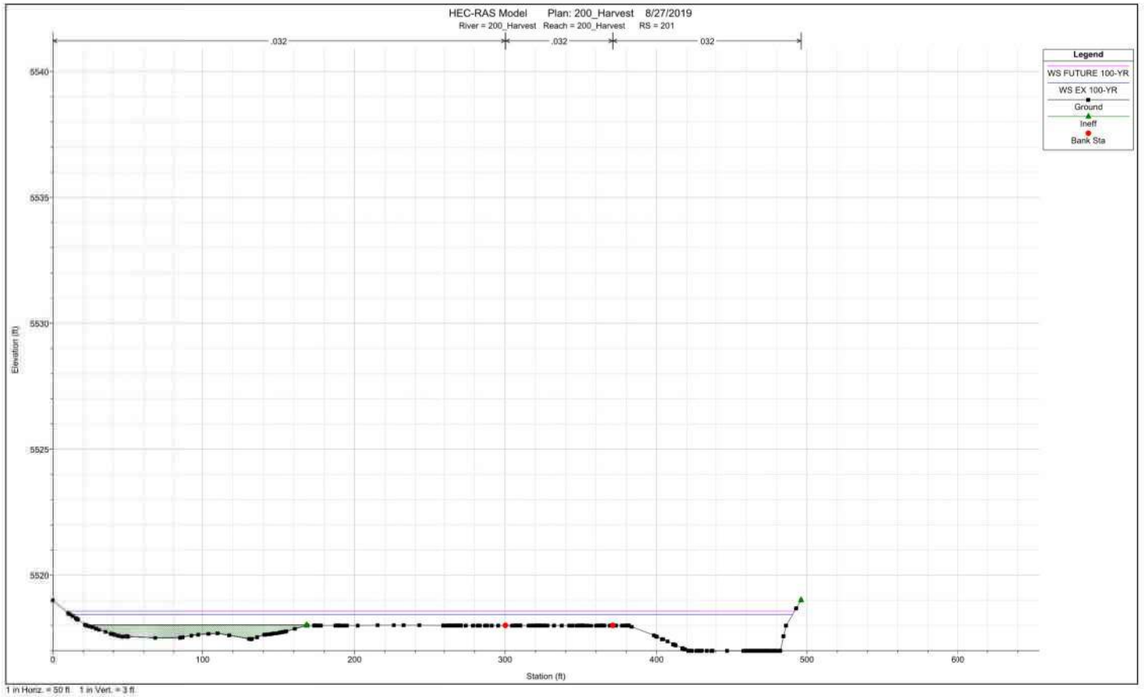


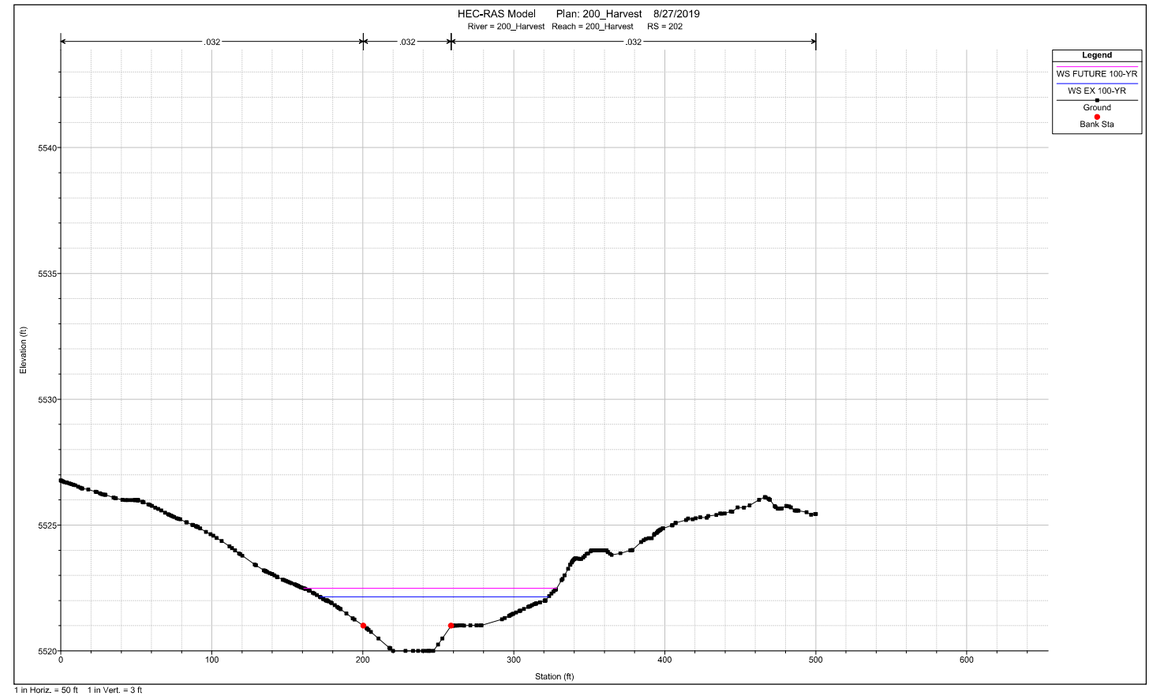
1 in Horiz. = 30 ft 1 in Vert. = 1 ft



1 in Horiz. = 30 ft 1 in Vert. = 1 ft

HARVEST TRIBUTARY
Series 200 Cross Sections


HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 201
.032
.032
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 3 ft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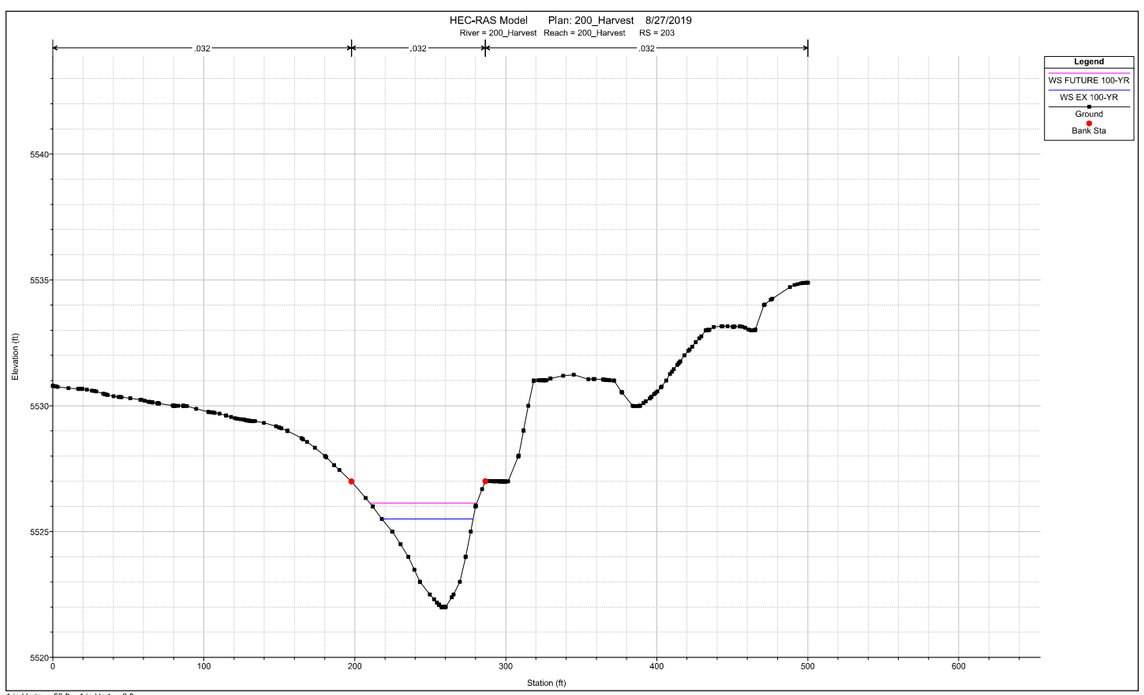
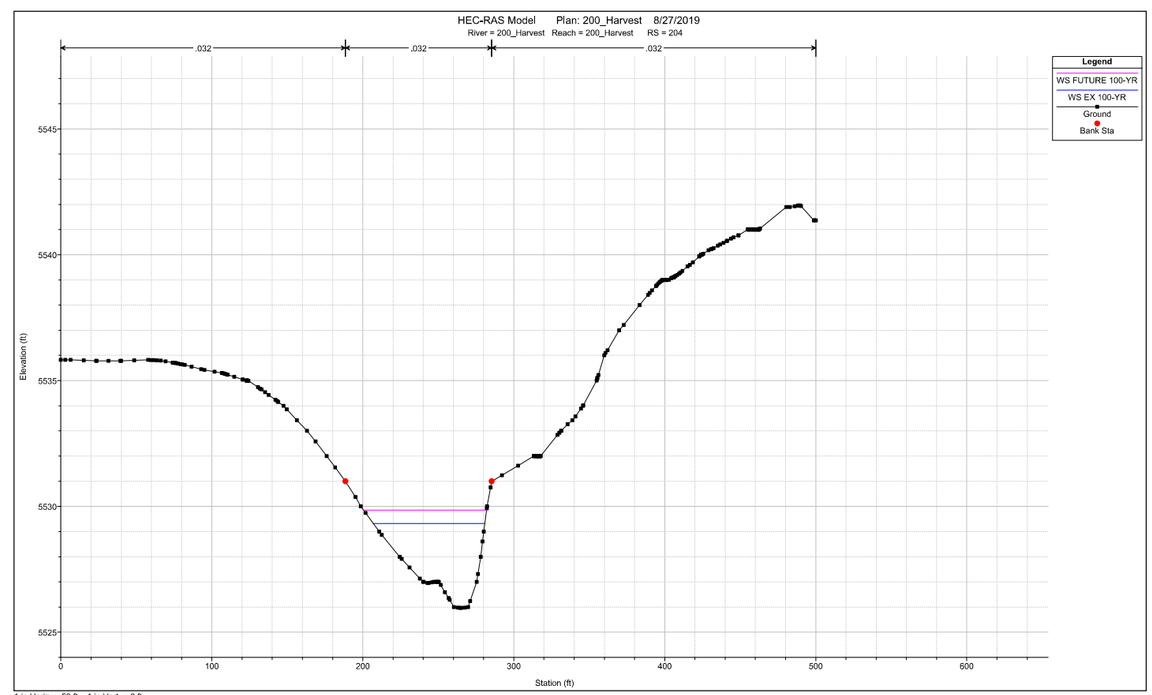
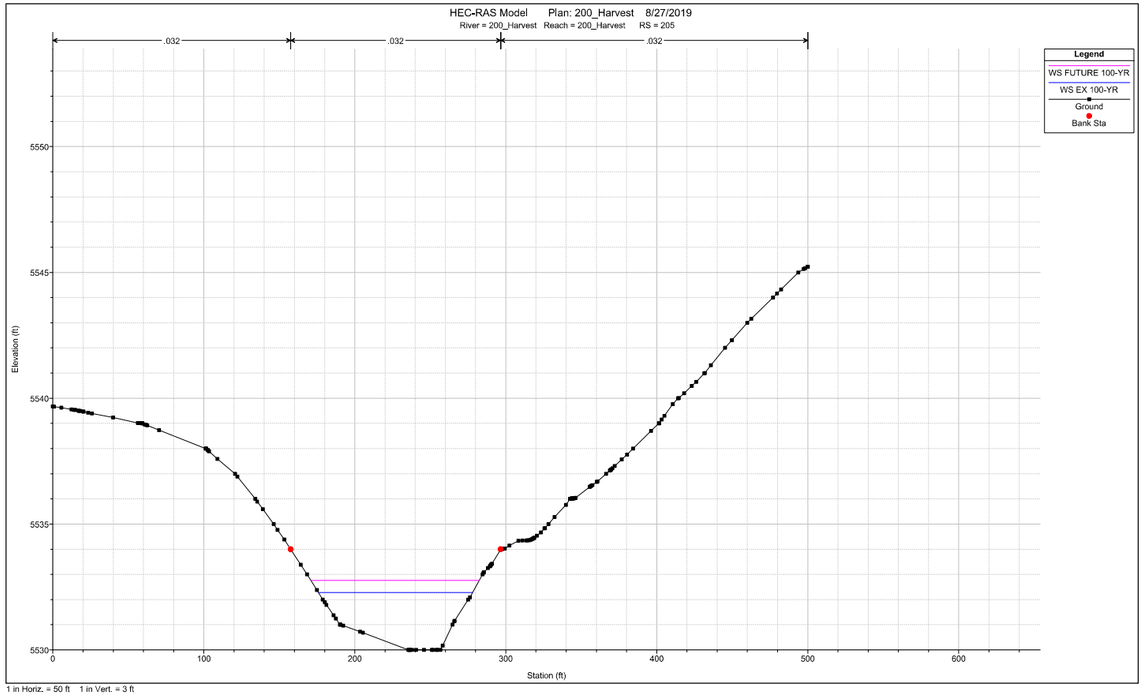
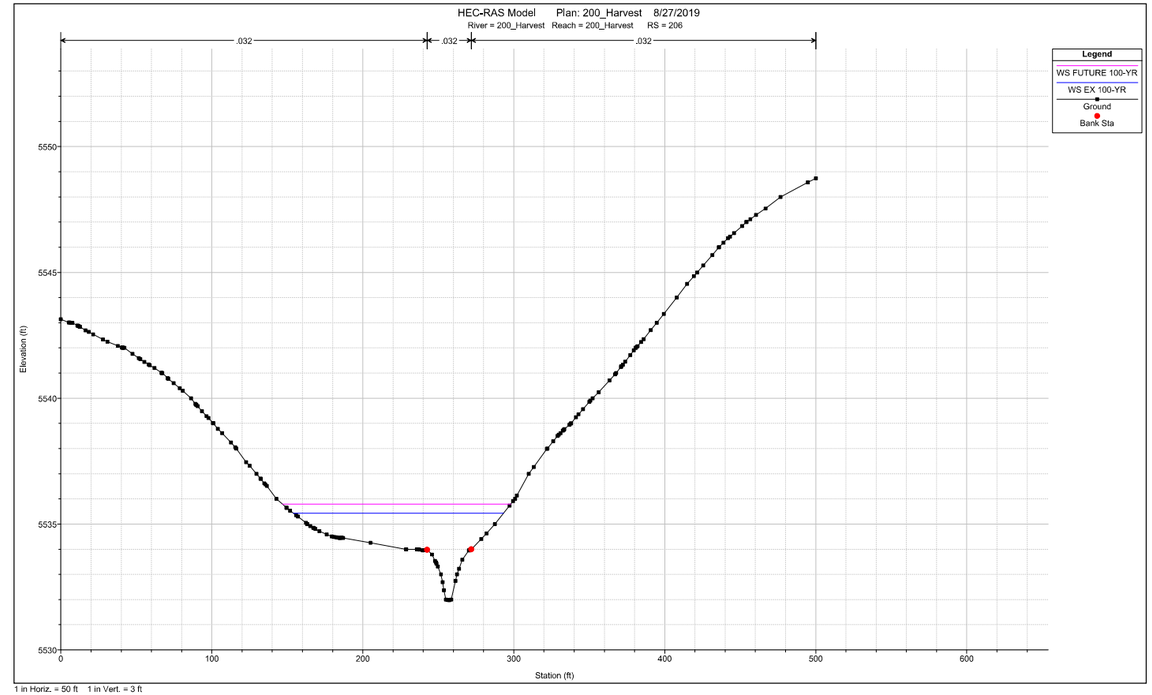
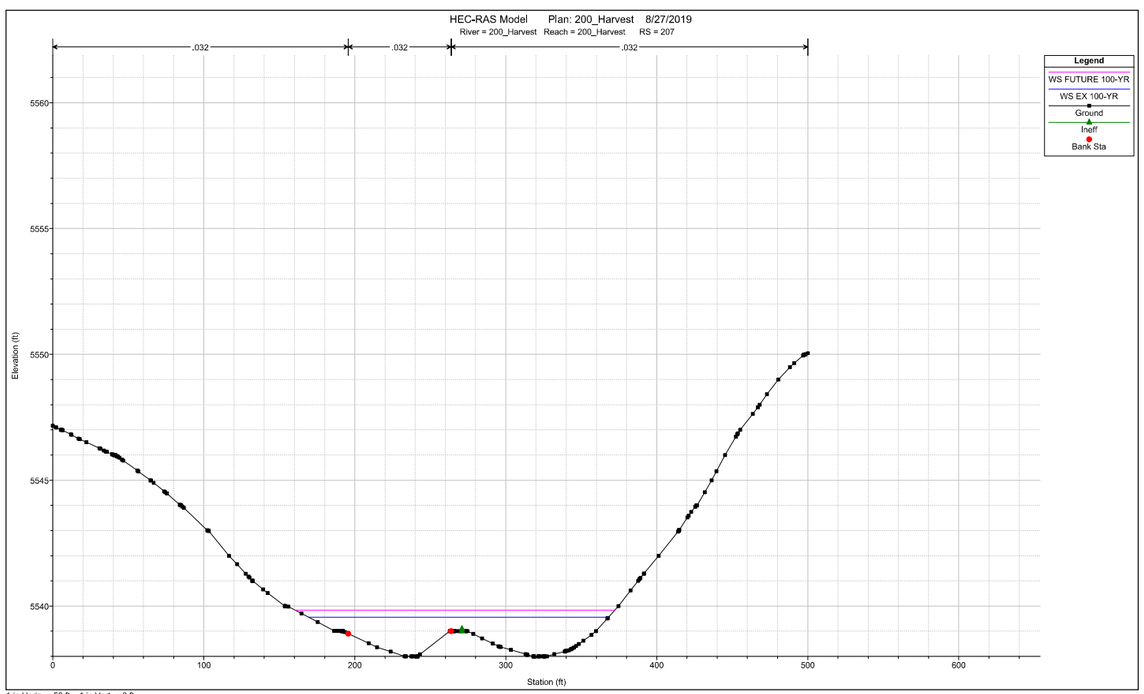
River = 200_Harvest Reach = 200_Harvest RS = 202
.032
.032
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 3 ft

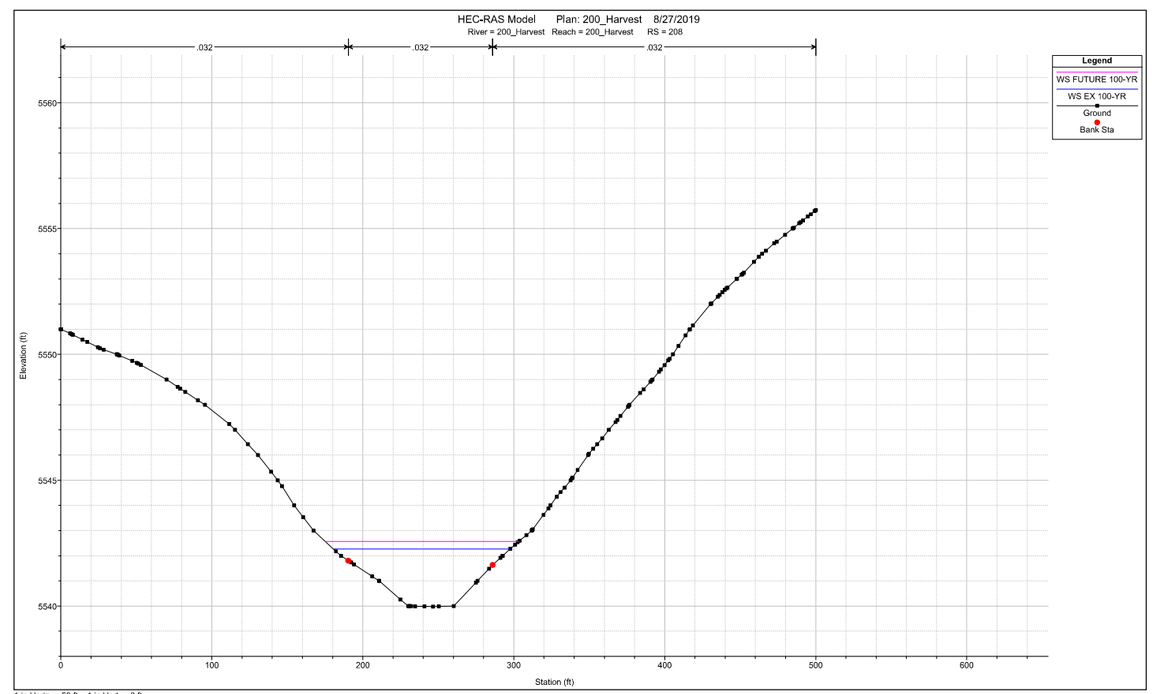

HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 203
.032
.032
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 3 ft

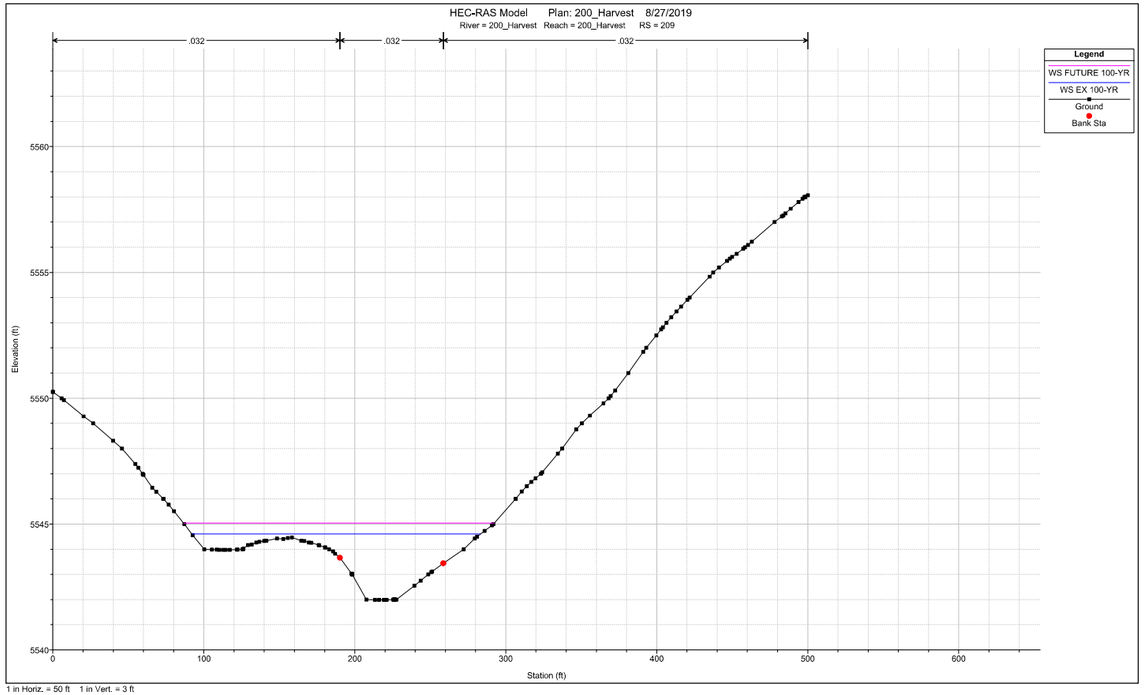

HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 204
.032
.032
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 3 ft

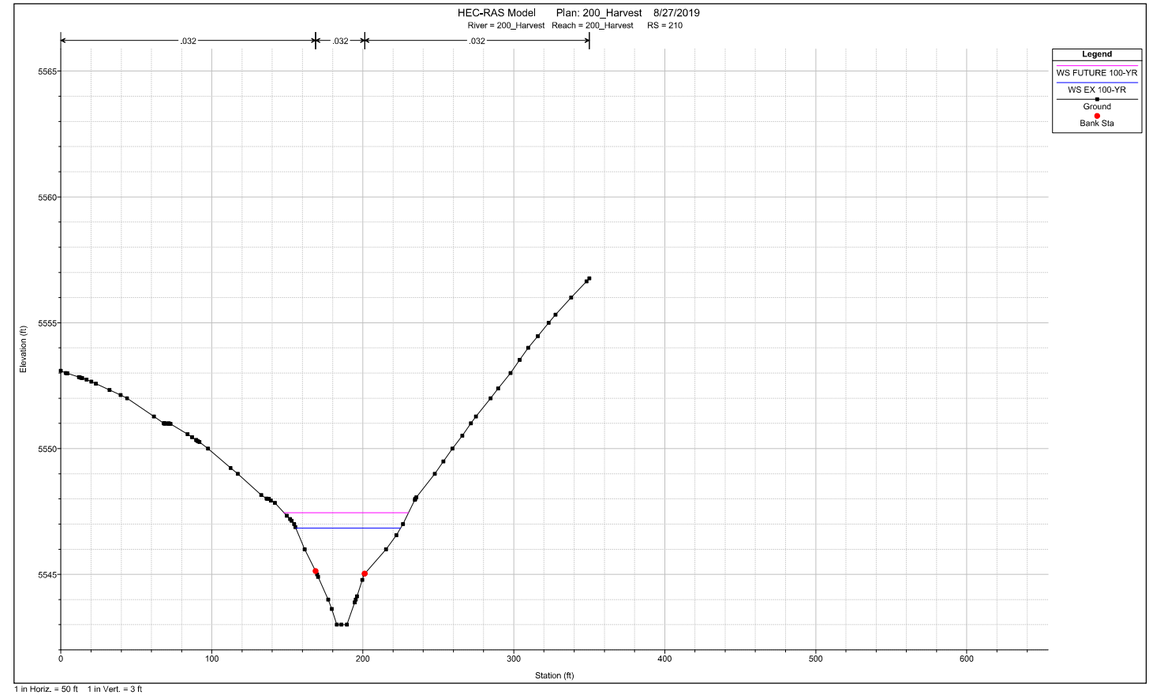

HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 205
.032
.032
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 3 ft

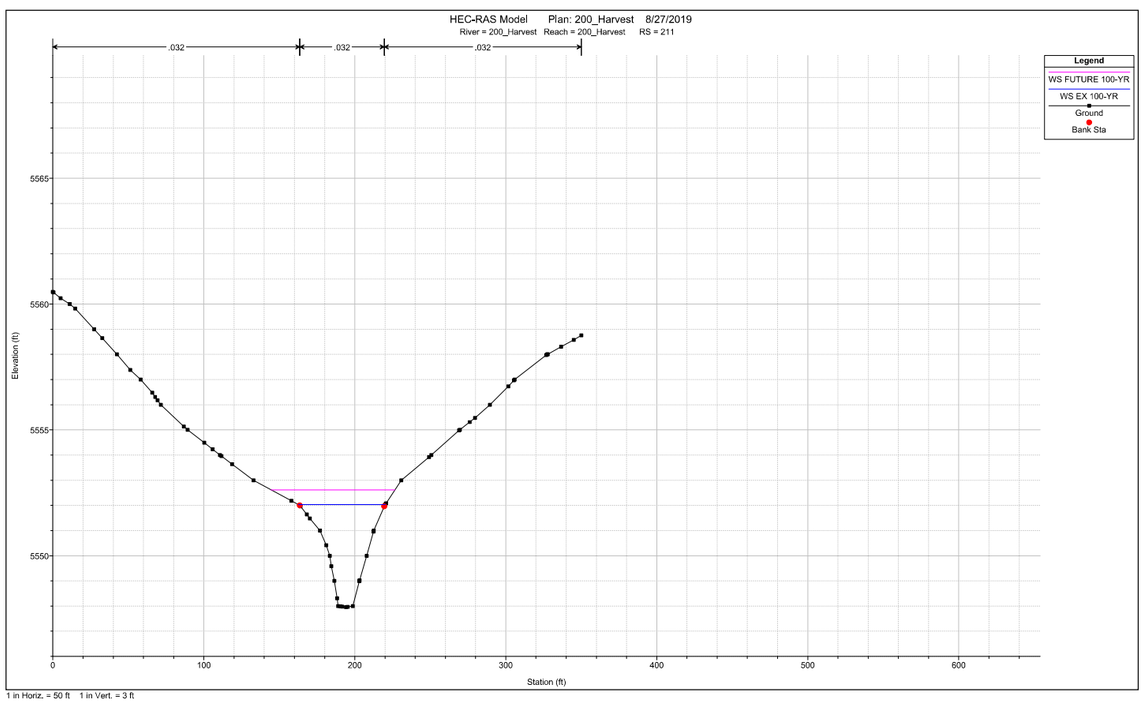

HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 206
.032
.032
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 3 ft

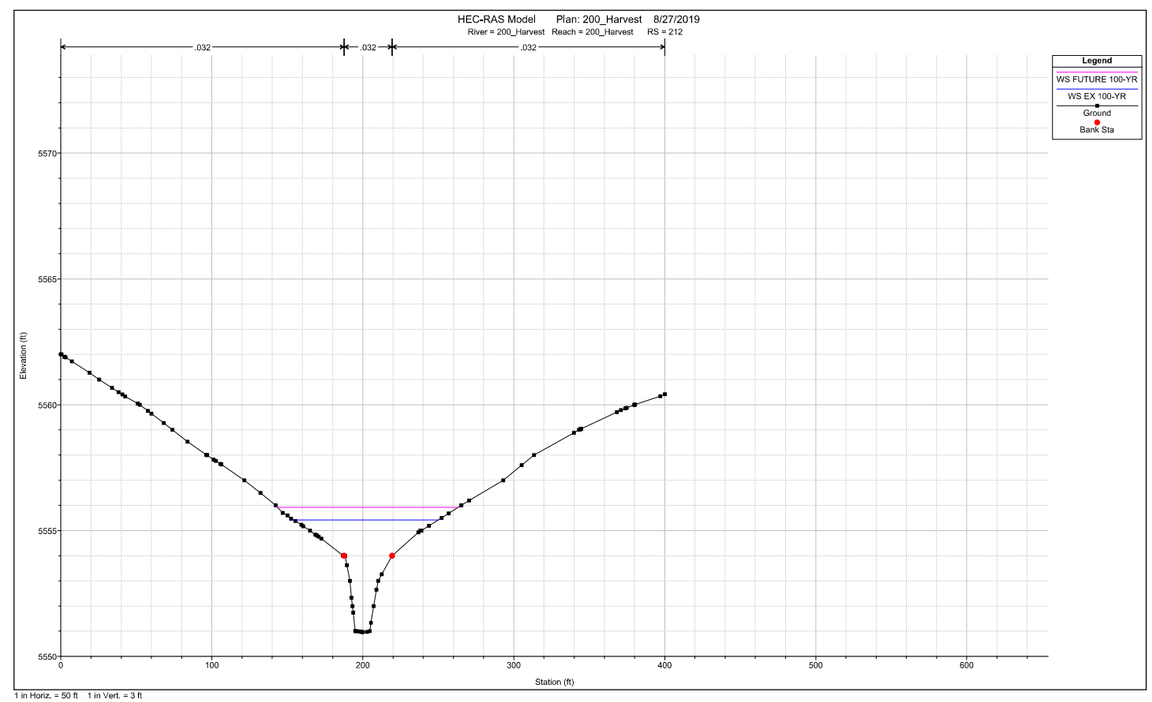

HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 207
.032
.032
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 3 ft

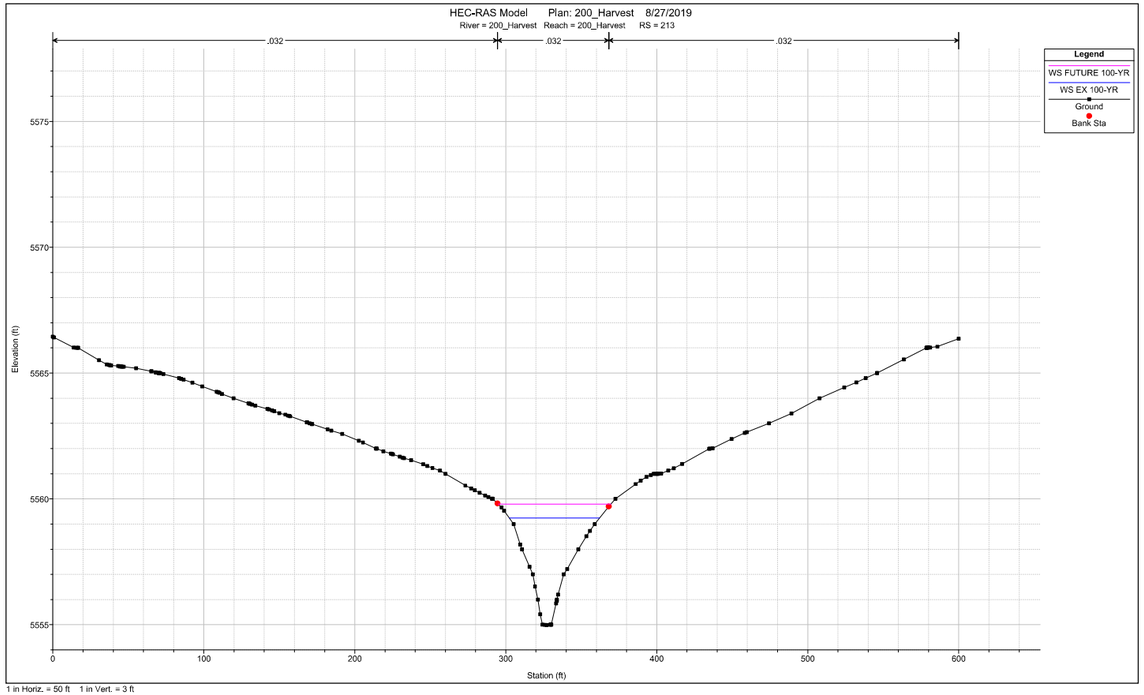

HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 208
.032
.032
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 3 ft


HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 209
.032
.032
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 3 ft

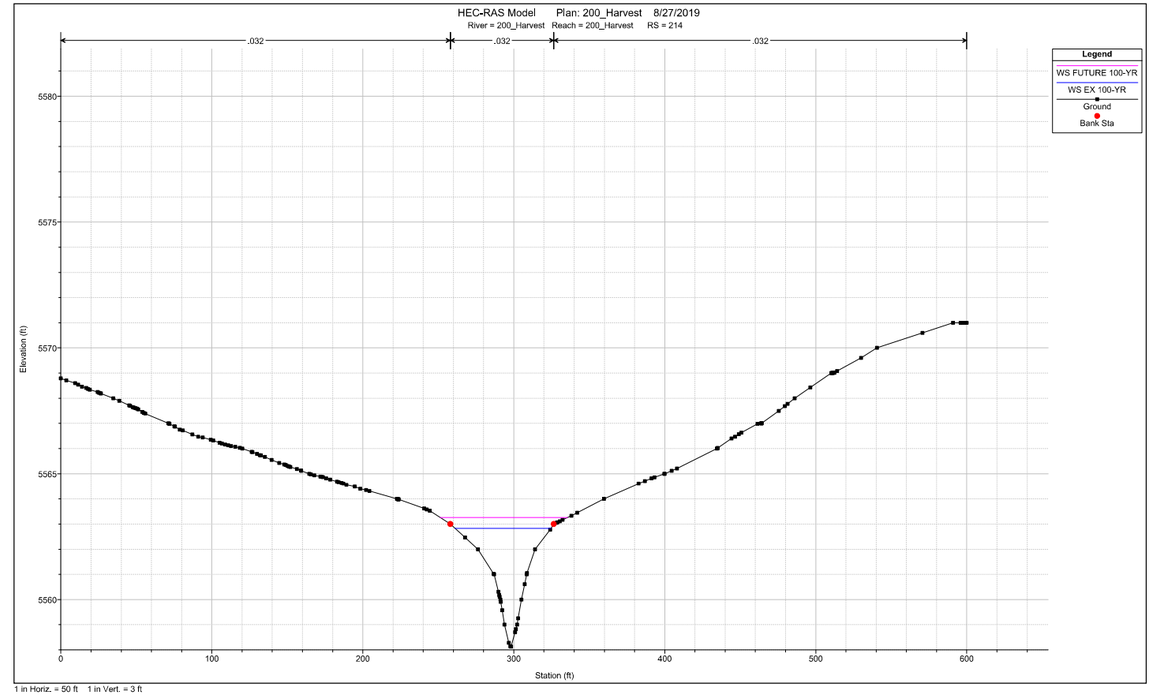

HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 210
.032
.032
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 3 ft


HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 211
.032
.032
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 3 ft

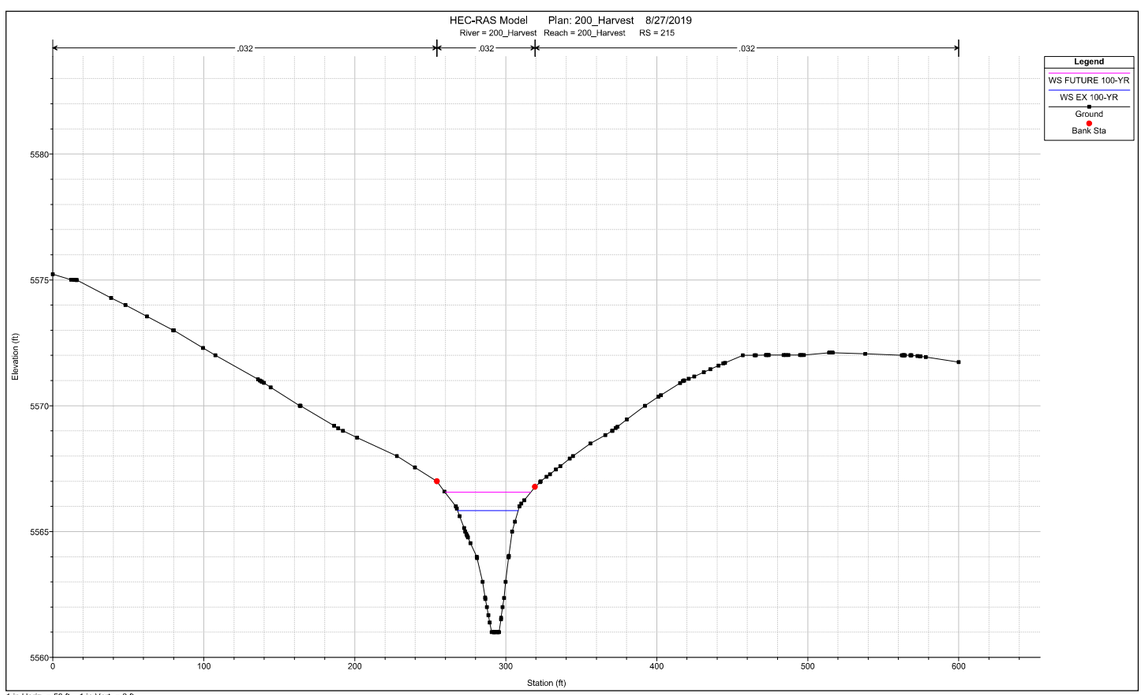

HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 212
.032
.032
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 3 ft



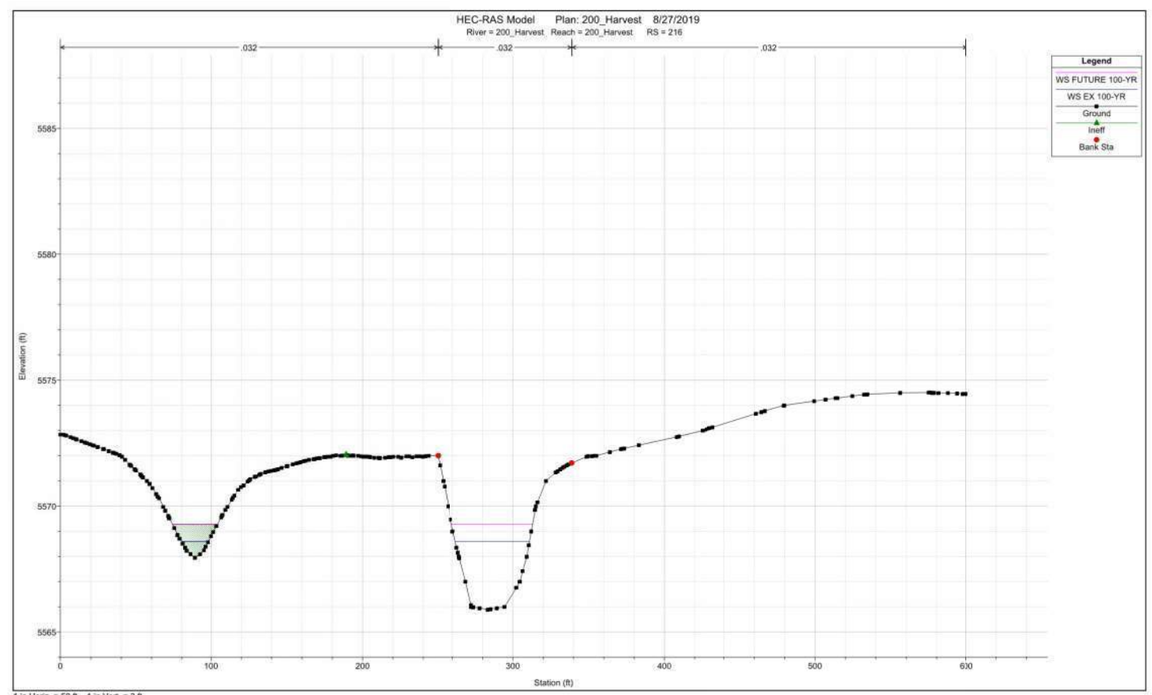
1 in Horiz. = 50 ft 1 in Vert. = 3 ft



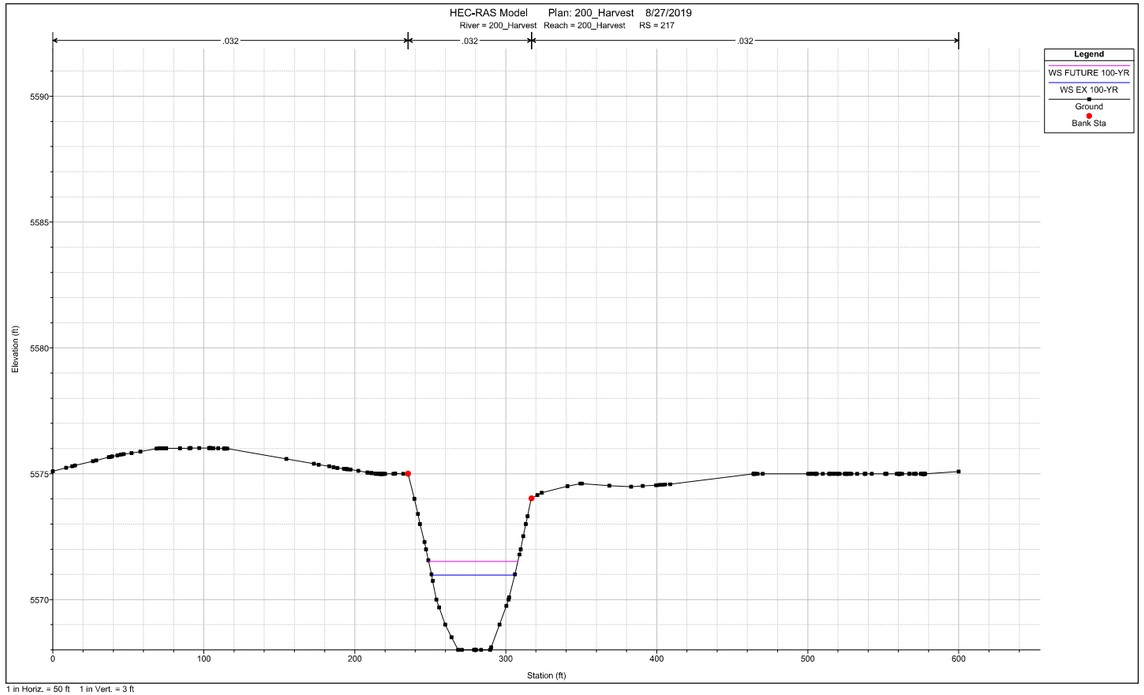
1 in Horiz. = 50 ft 1 in Vert. = 3 ft



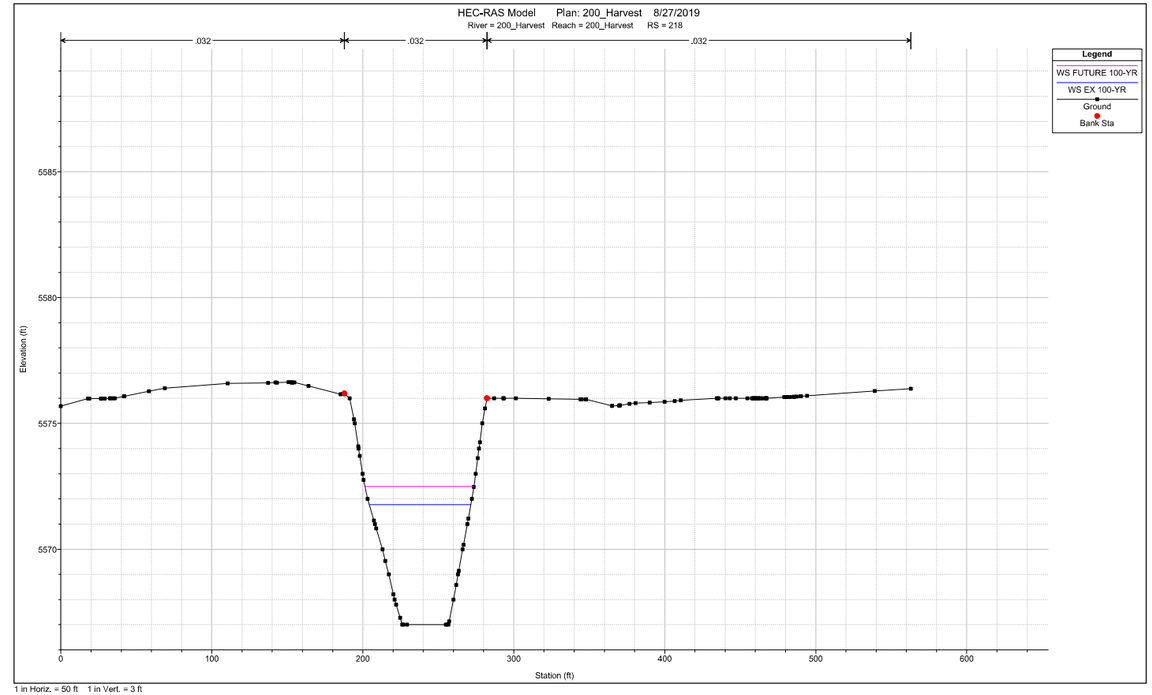
1 in Horiz. = 50 ft 1 in Vert. = 3 ft



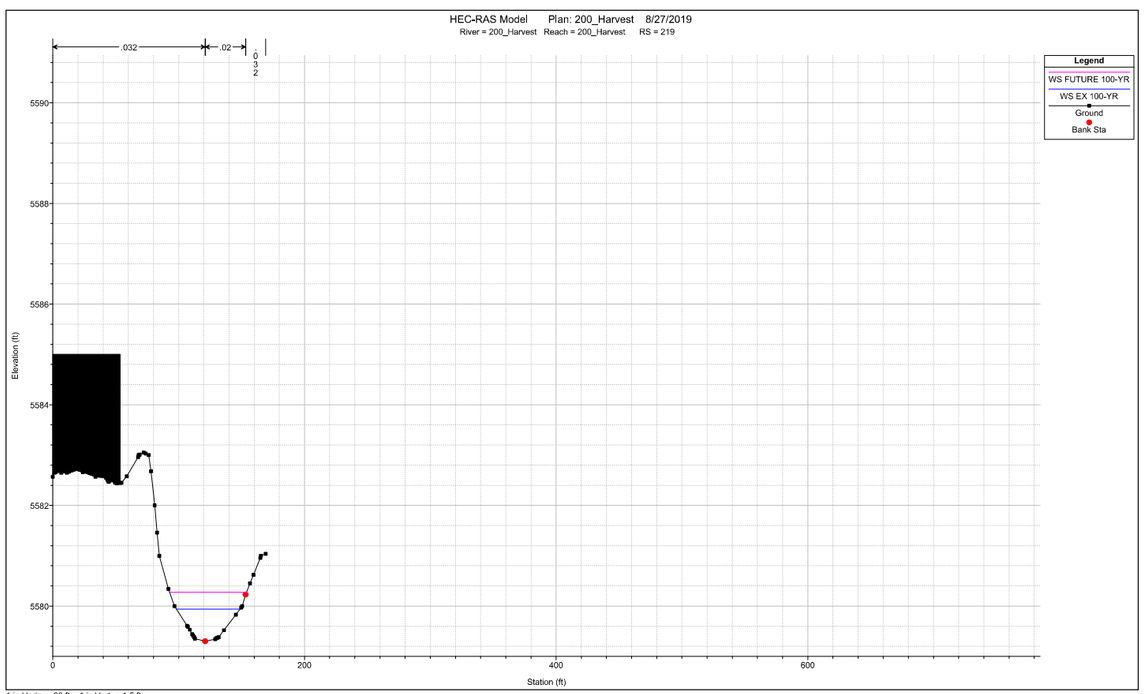
1 in Horiz. = 50 ft 1 in Vert. = 3 ft



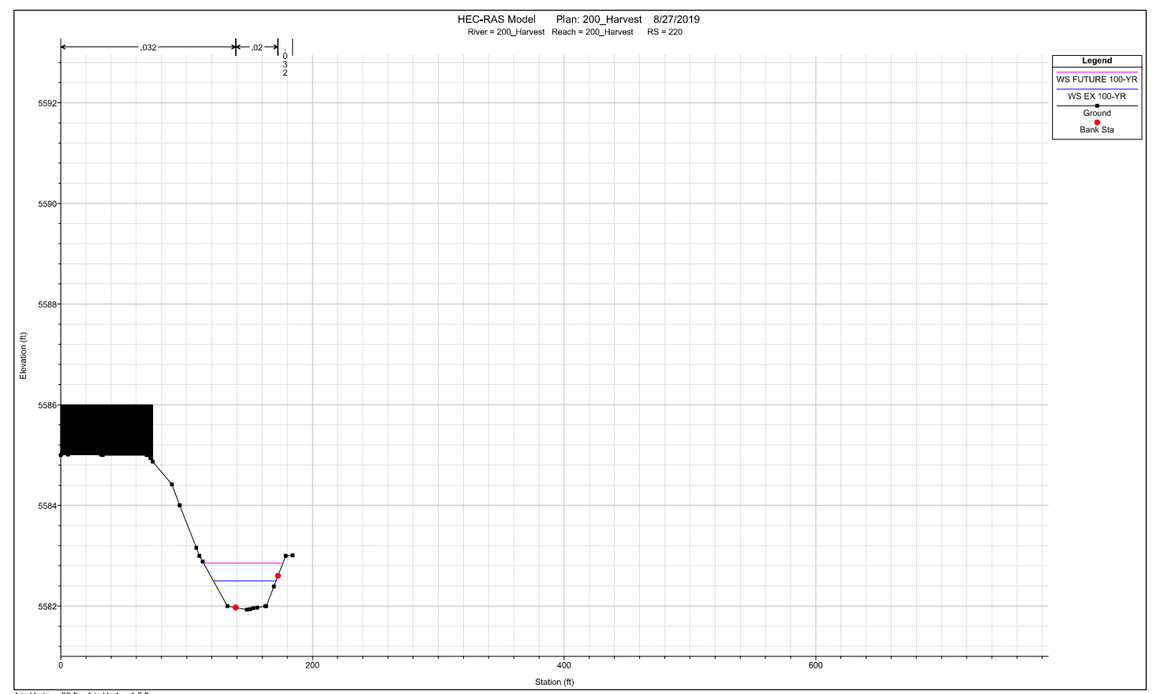
1 in Horiz. = 50 ft 1 in Vert. = 3 ft



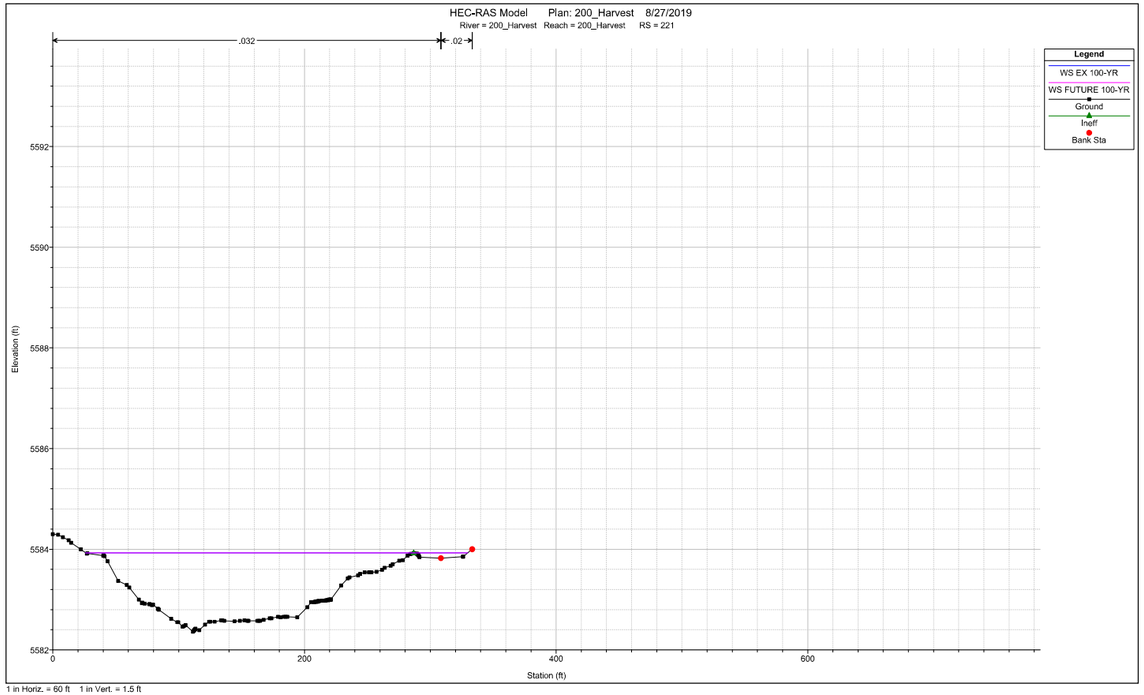
1 in Horiz. = 50 ft 1 in Vert. = 3 ft



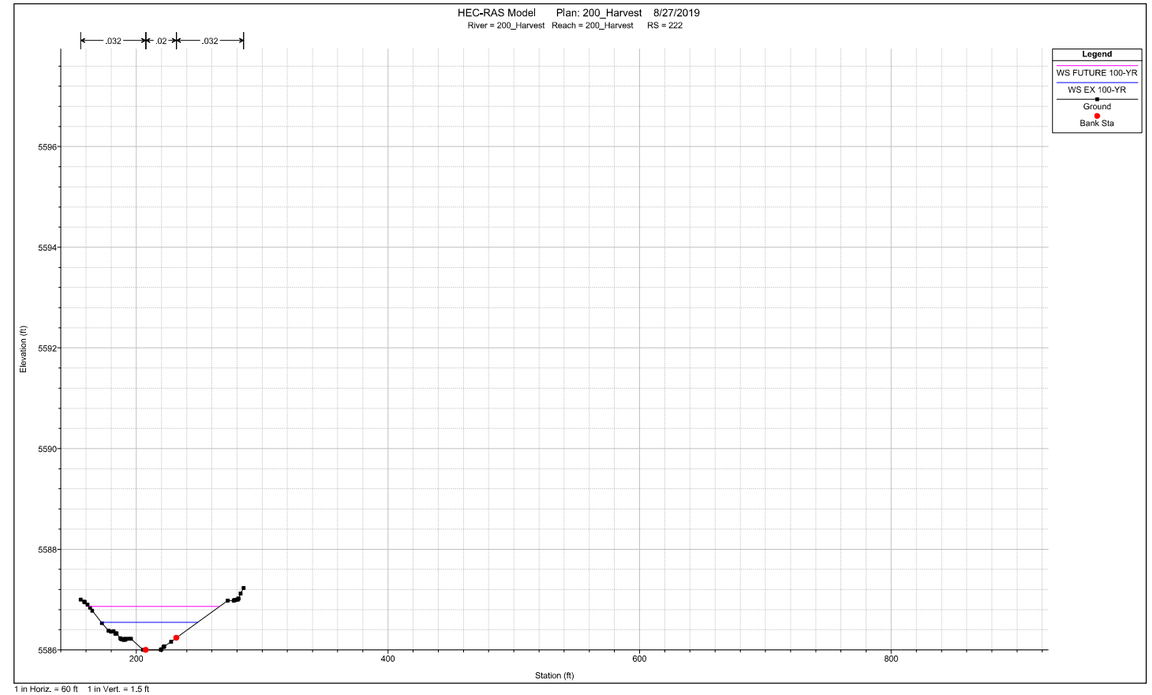
1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft



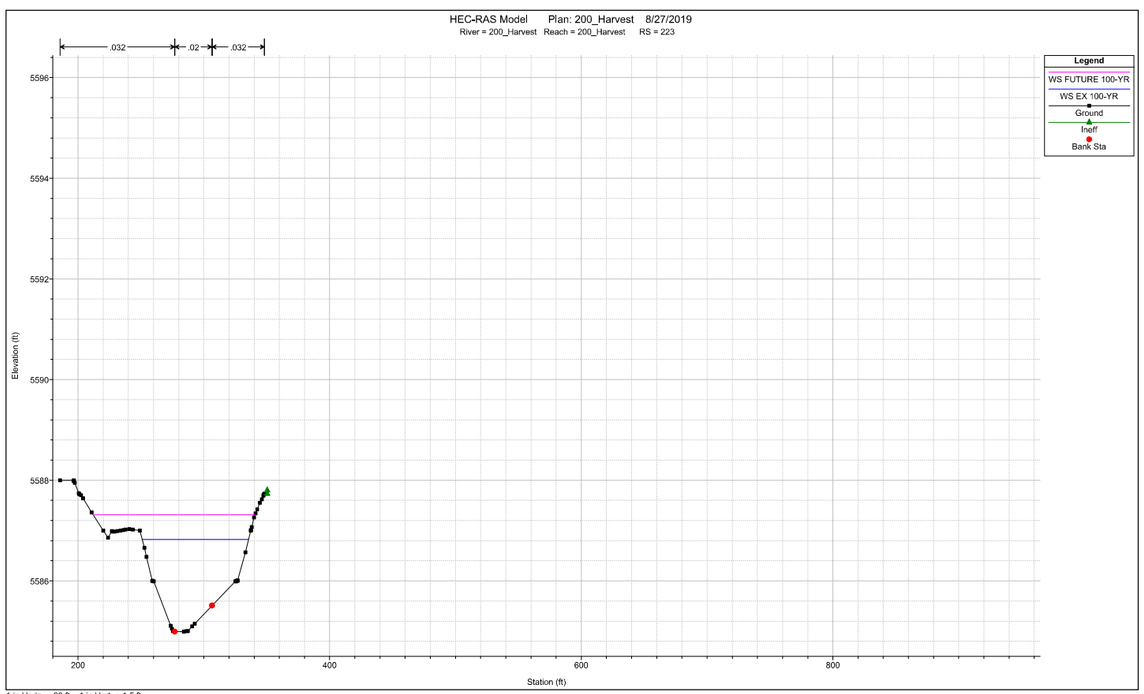
1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft



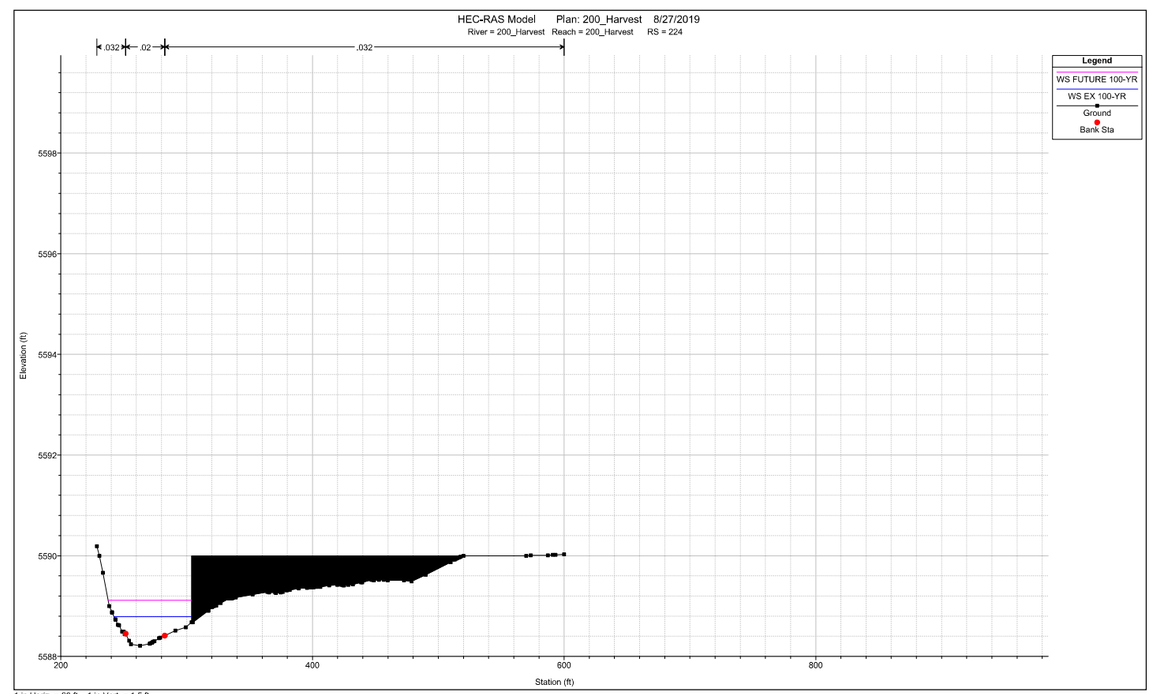
1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft



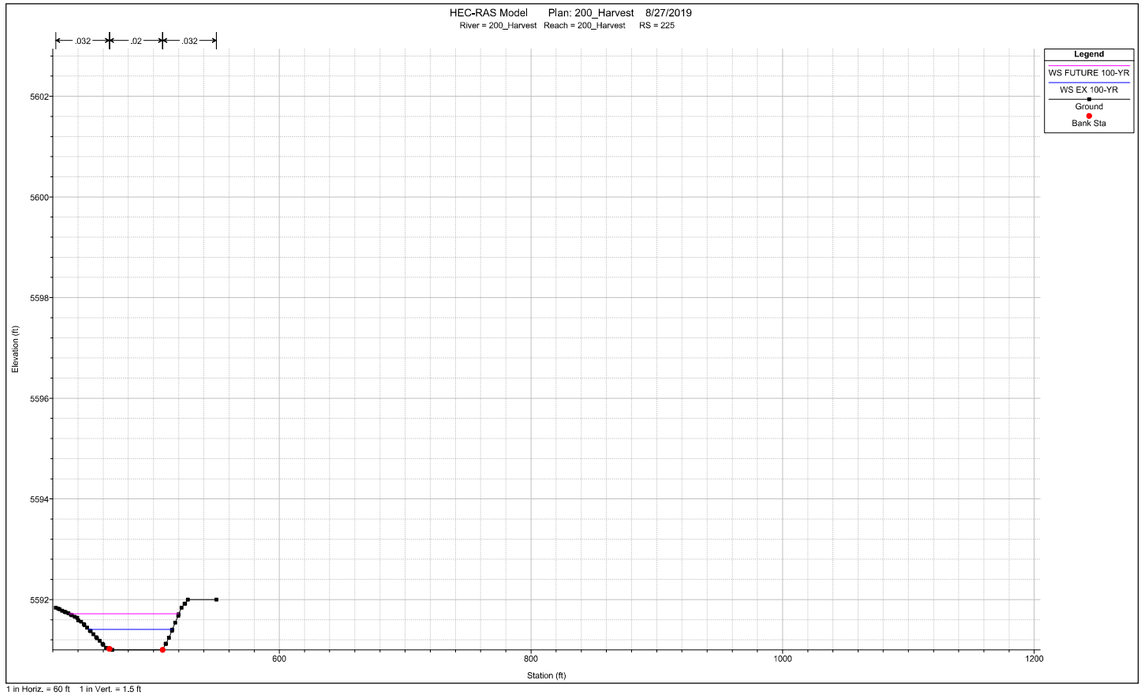
1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft

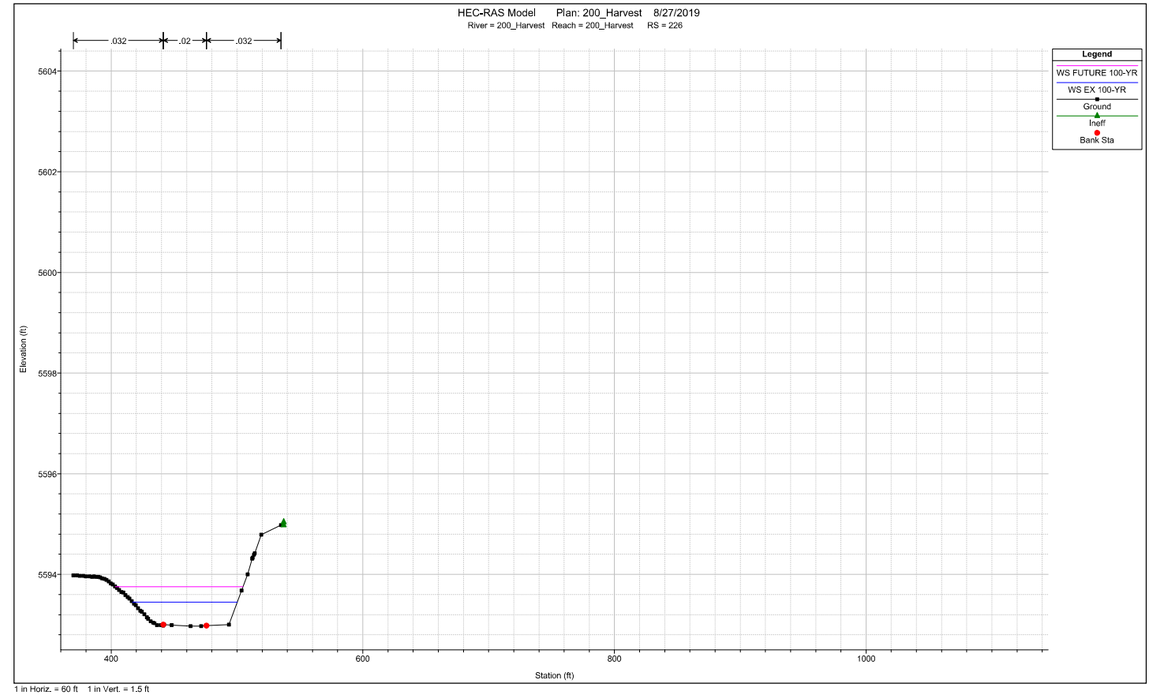


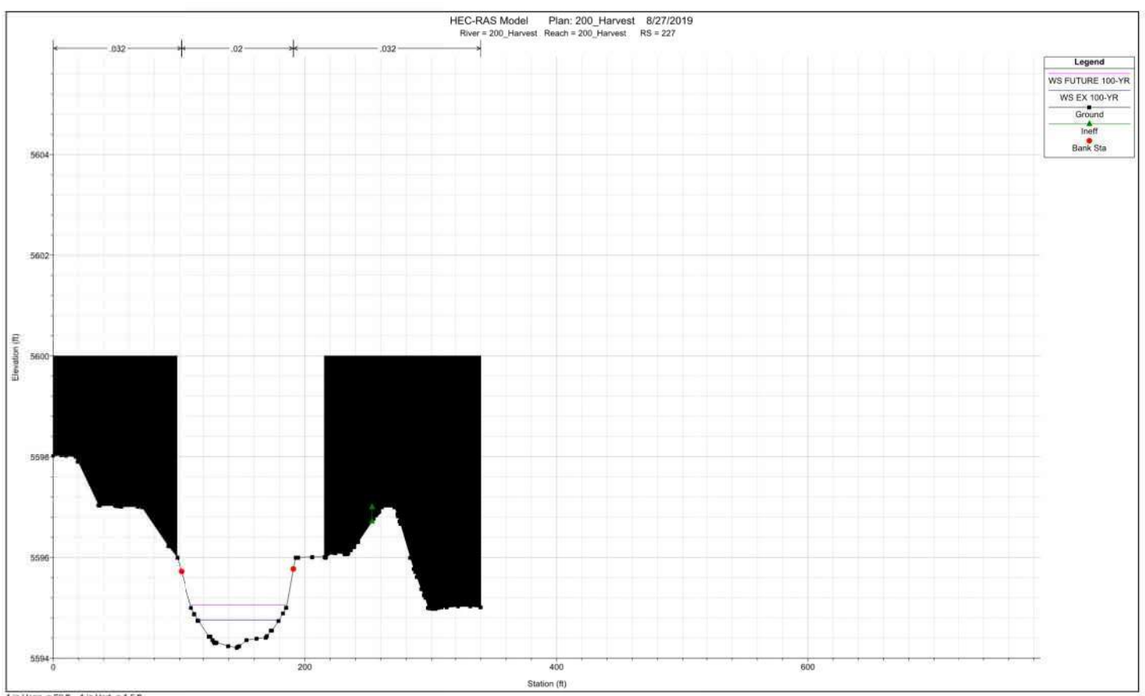
1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft

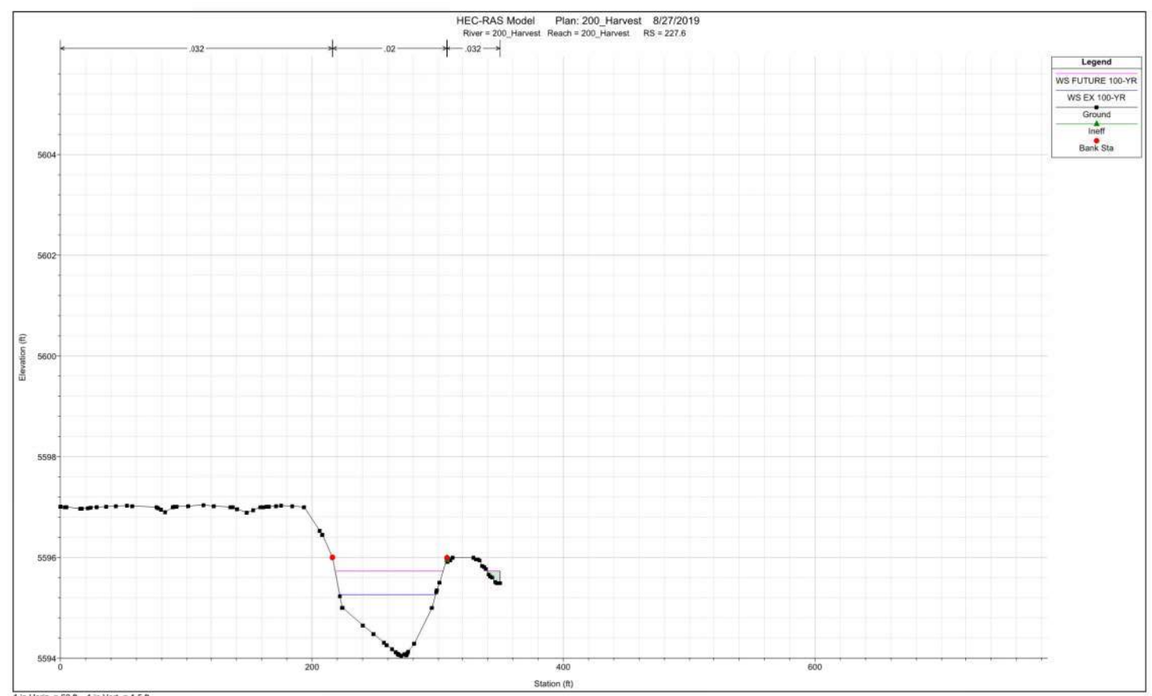


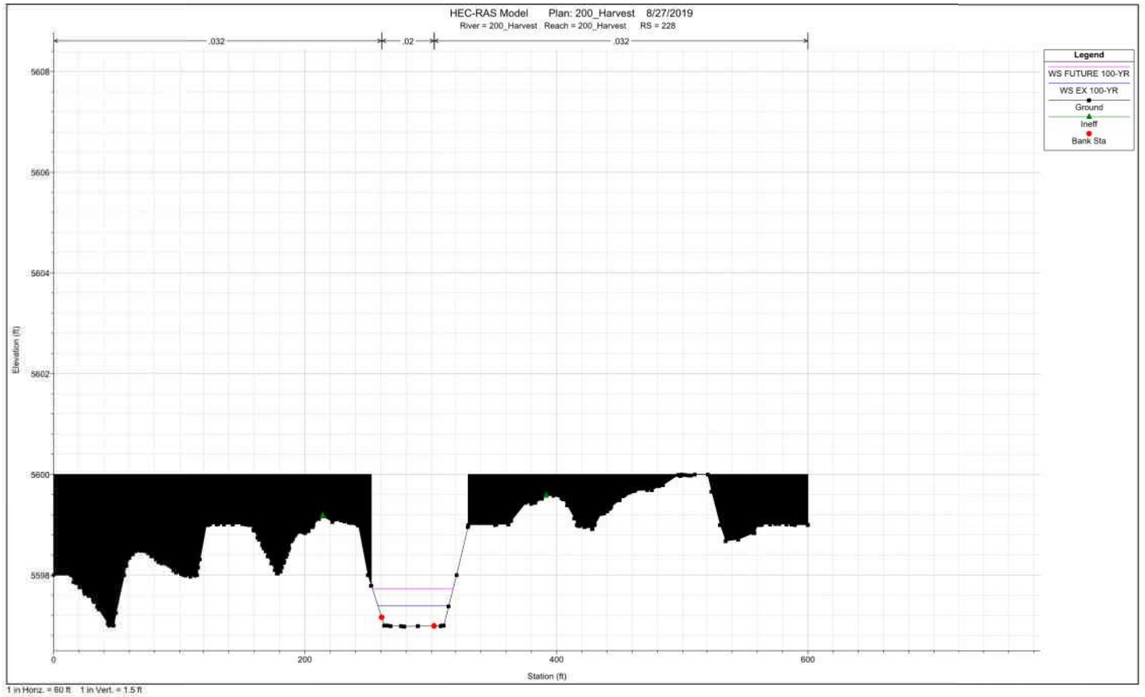
1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft


HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 225
.032
.02
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
5592
5594
5596
5598
5600
5602
600
800
1000
1200
Station (ft)
1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft

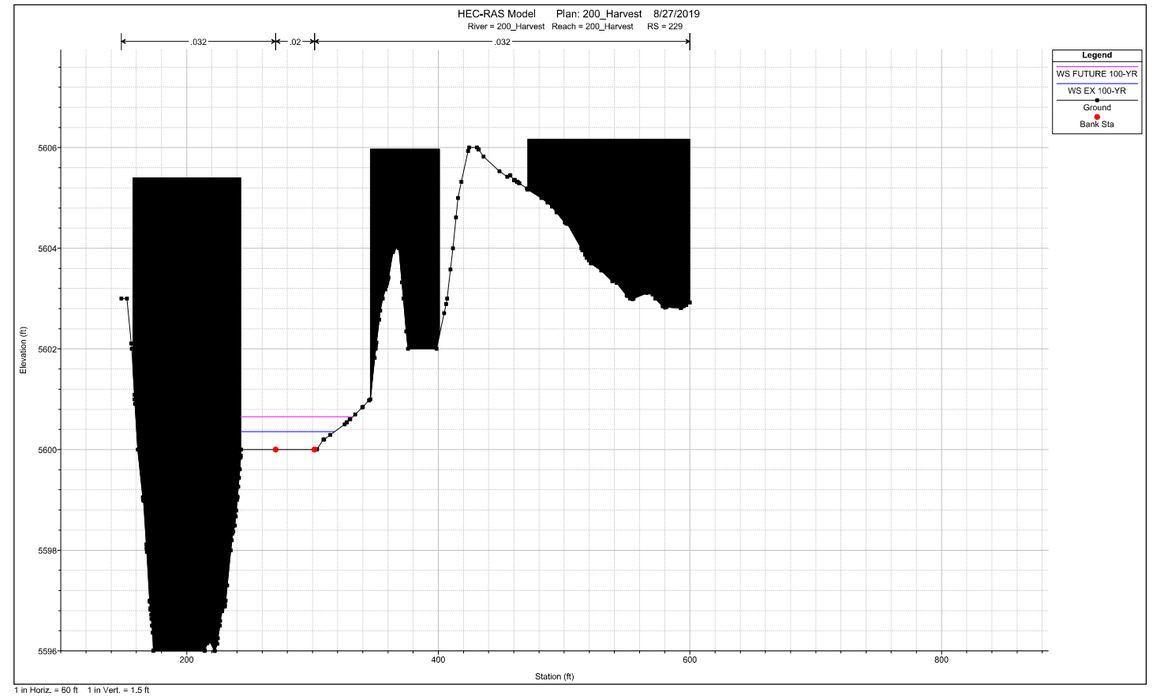

HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 226
.032
.02
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
5594
5596
5598
5600
5602
5604
400
600
800
1000
Station (ft)
1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft


HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 227
.032
.02
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
5594
5596
5598
5600
5602
5604
0
200
400
600
Station (ft)
1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft

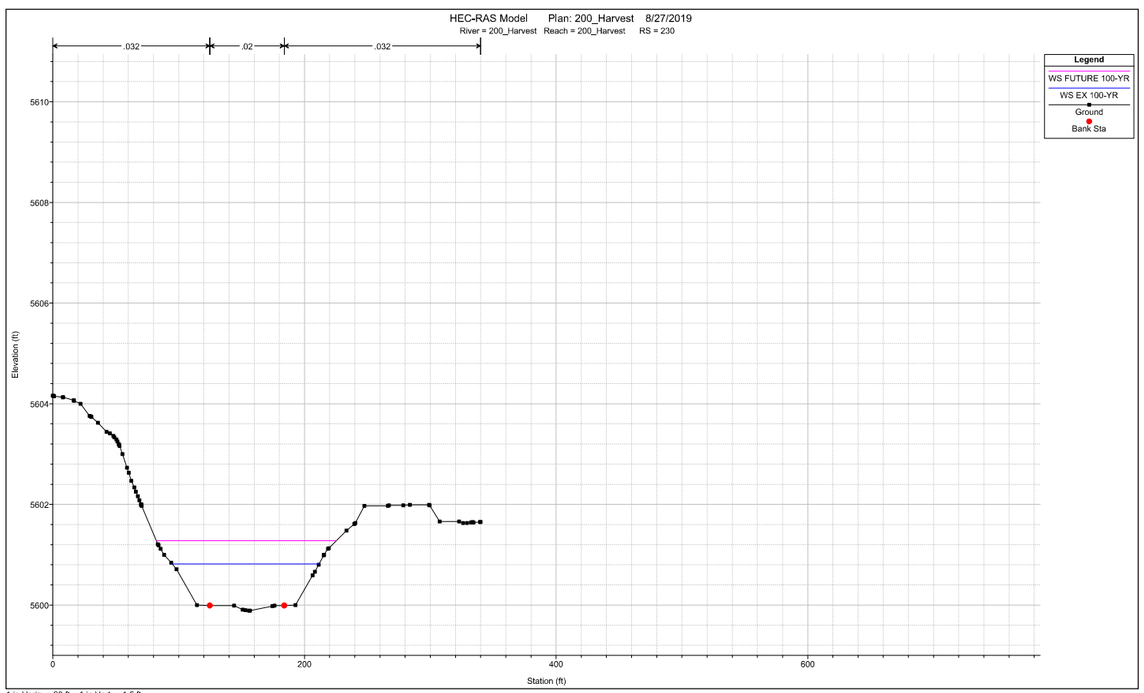

HEC-RAS Model Plan: 200_Harvest 8/27/2019
River = 200_Harvest Reach = 200_Harvest RS = 227.6
.032
.02
.032
Legend
WS FUTURE 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
5594
5596
5598
5600
5602
5604
0
200
400
600
Station (ft)
1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft



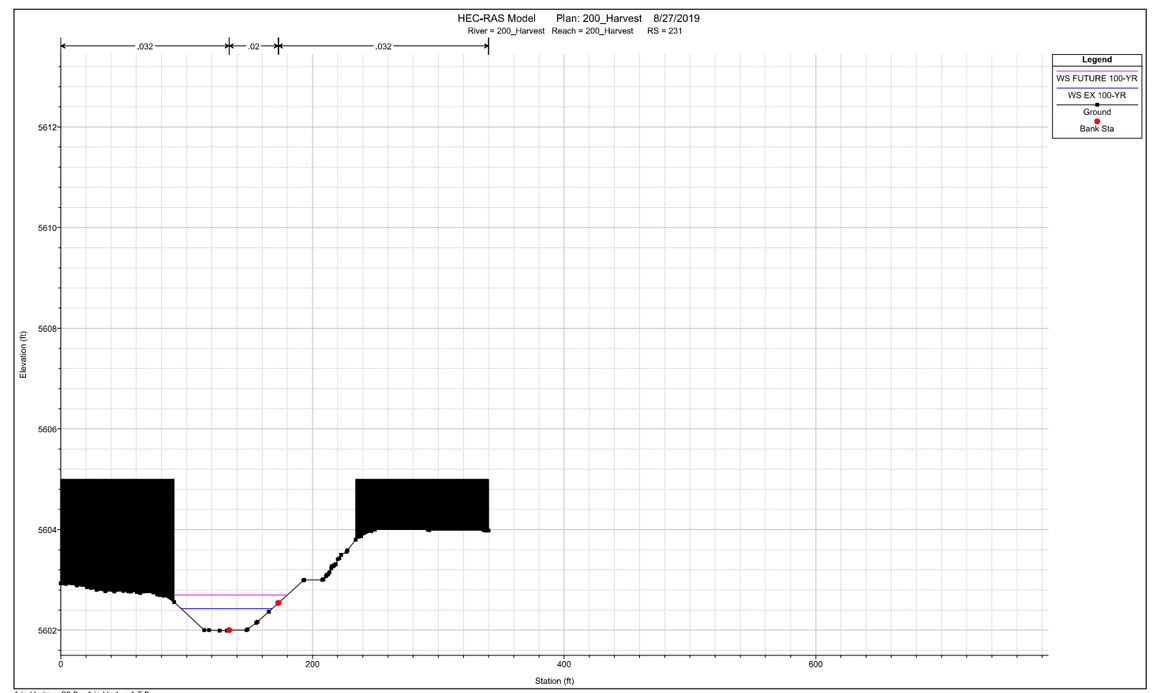
1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft



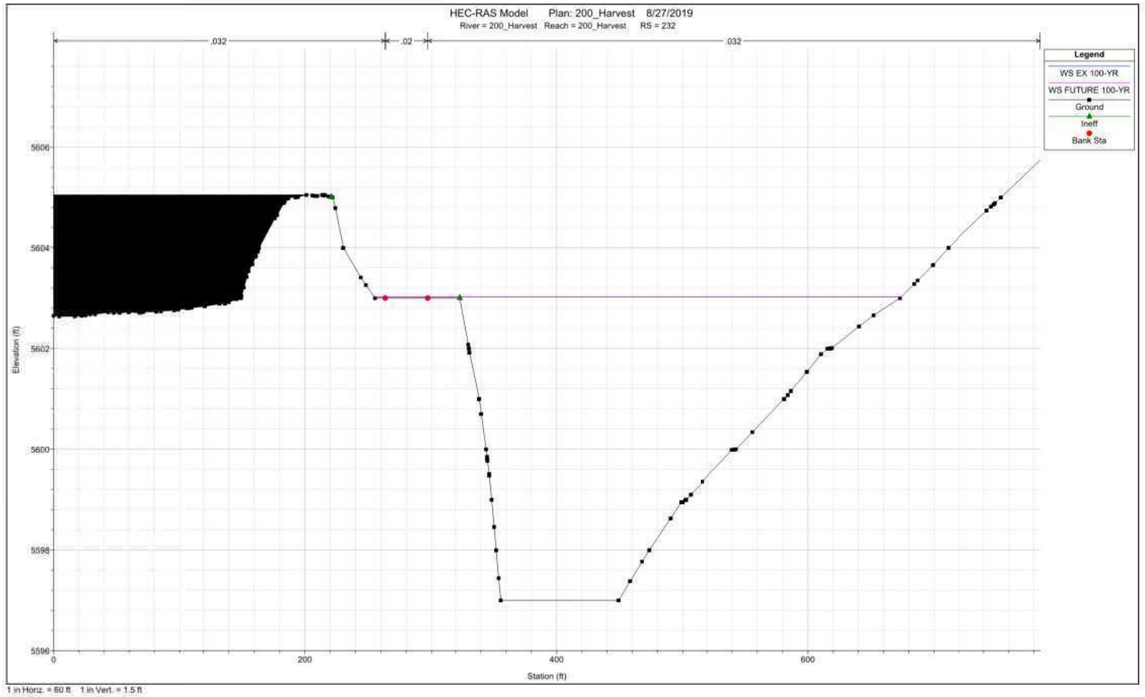
1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft



1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft

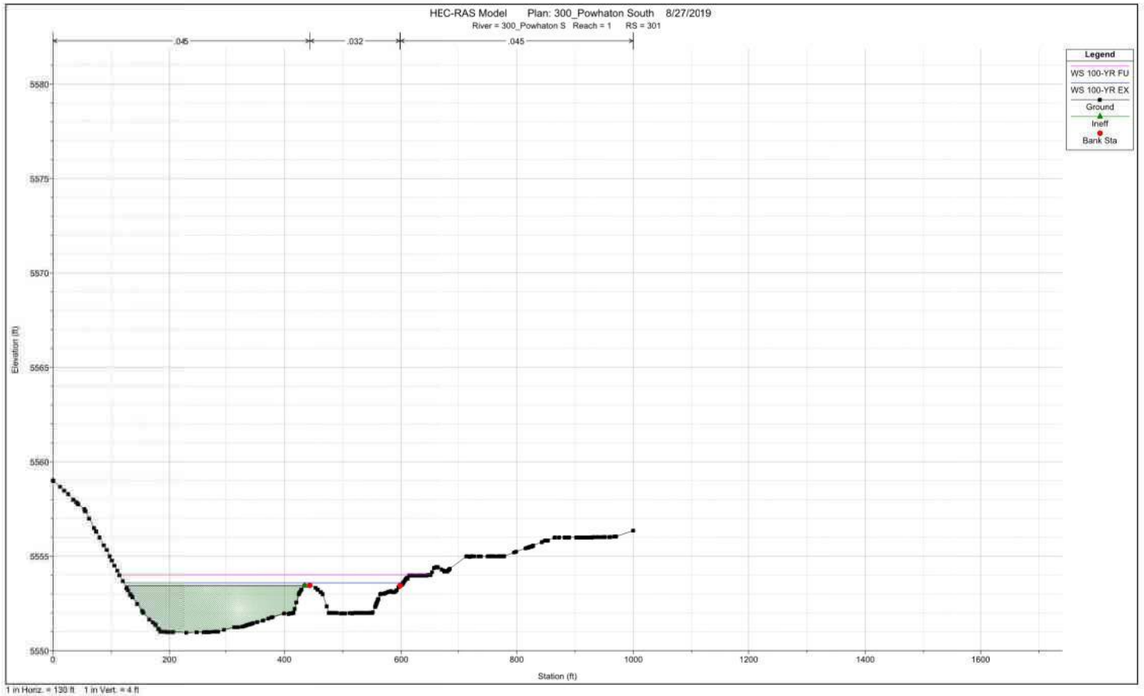


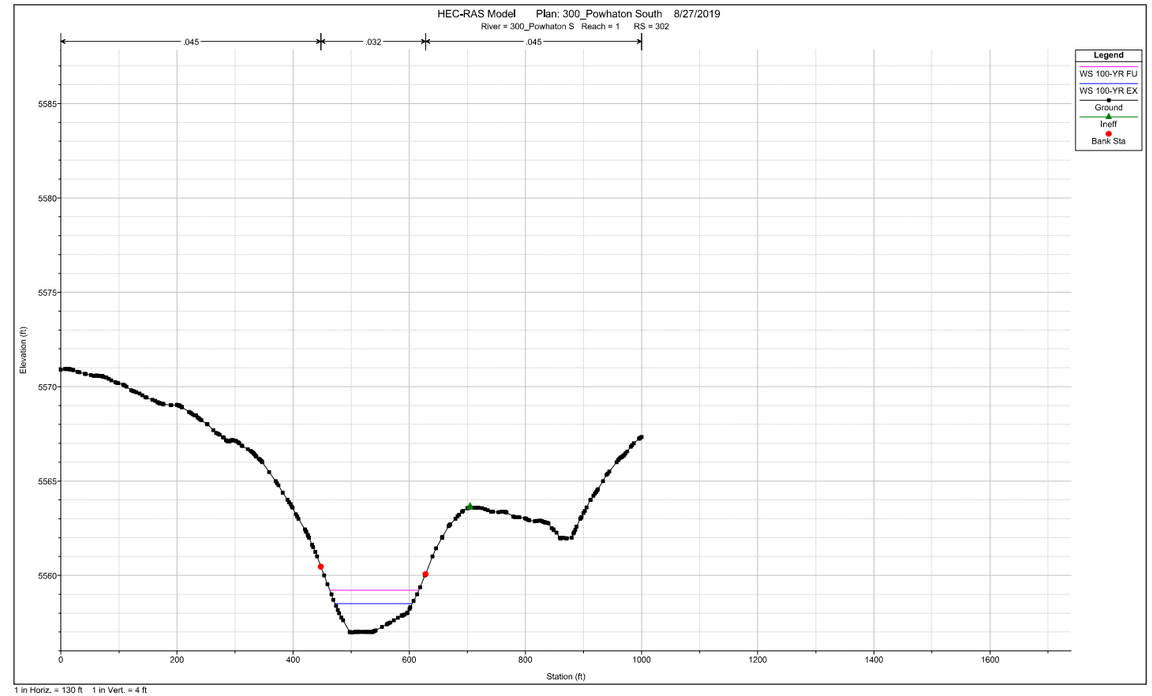
1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft

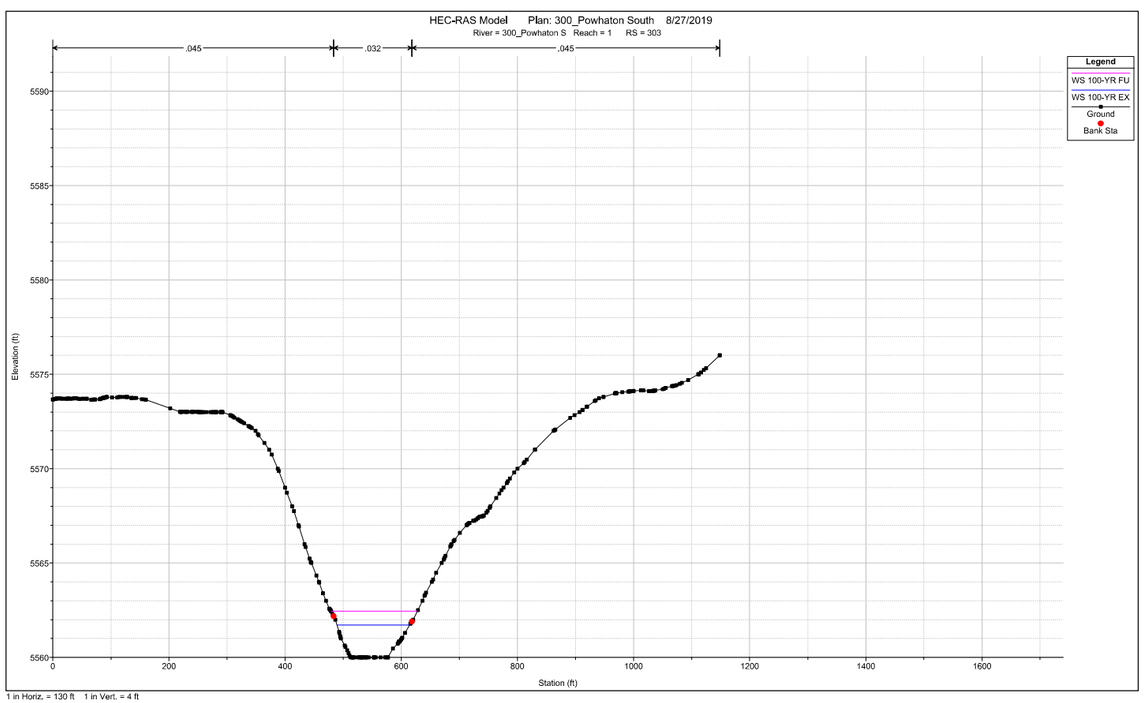


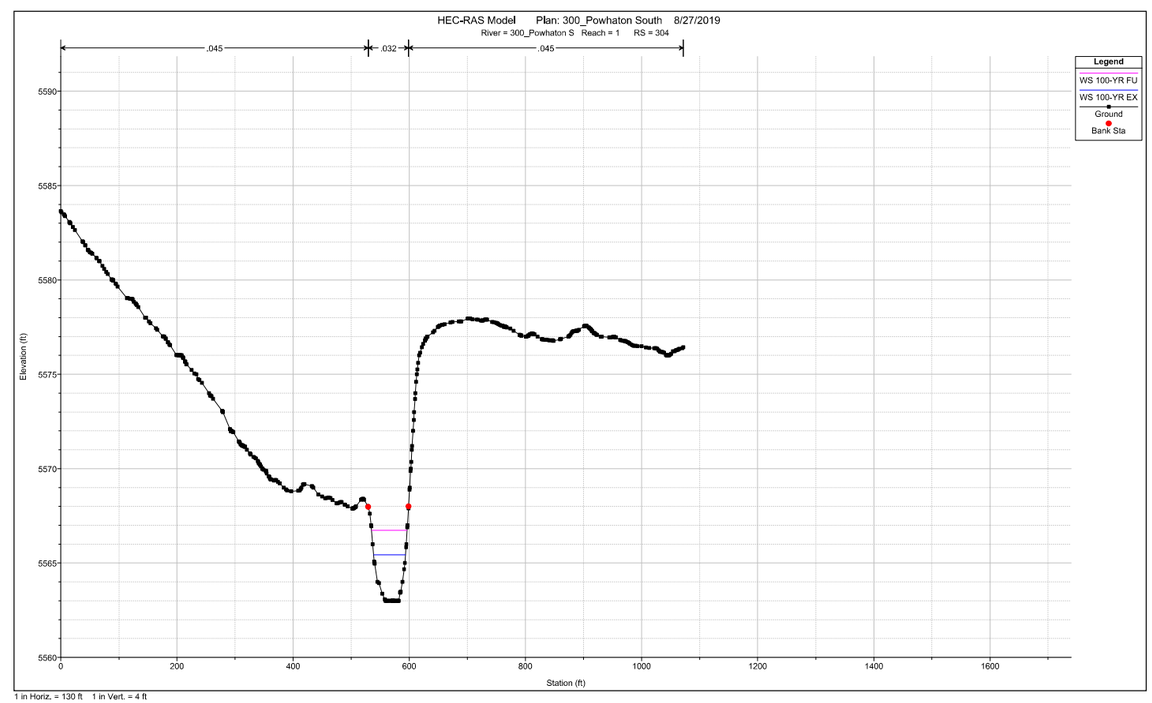
1 in Horiz. = 60 ft 1 in Vert. = 1.5 ft

POWHATON SOUTH TRIBUTARY
Series 300 Cross Sections

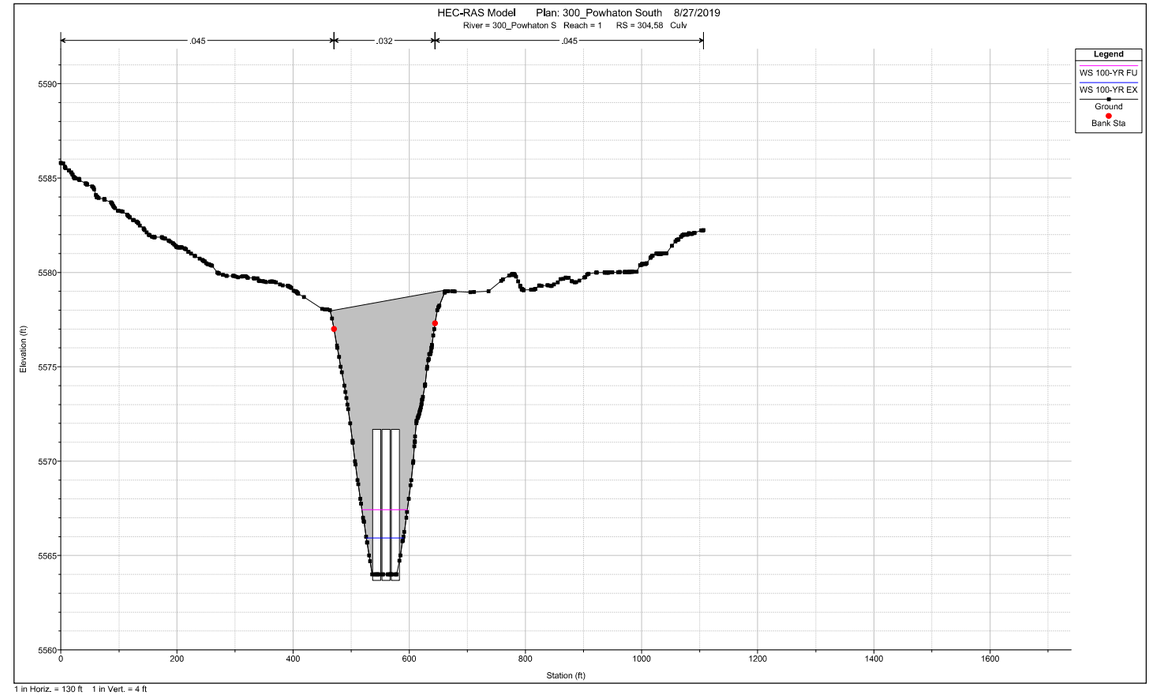

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 301
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

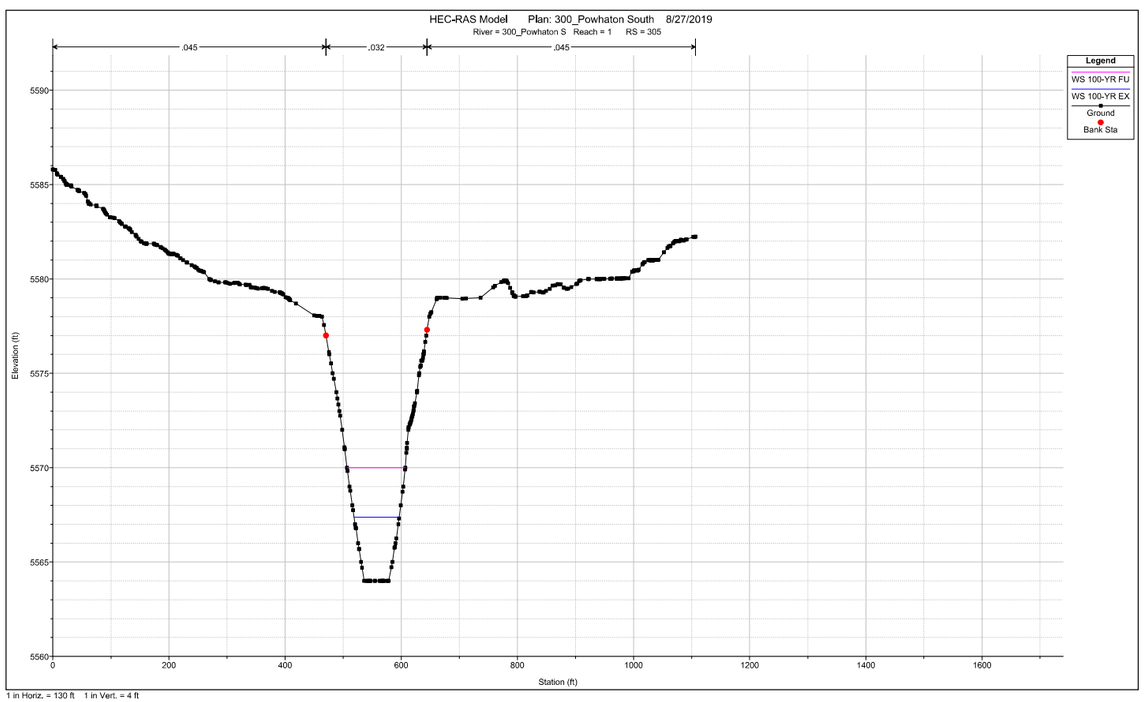

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 302
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

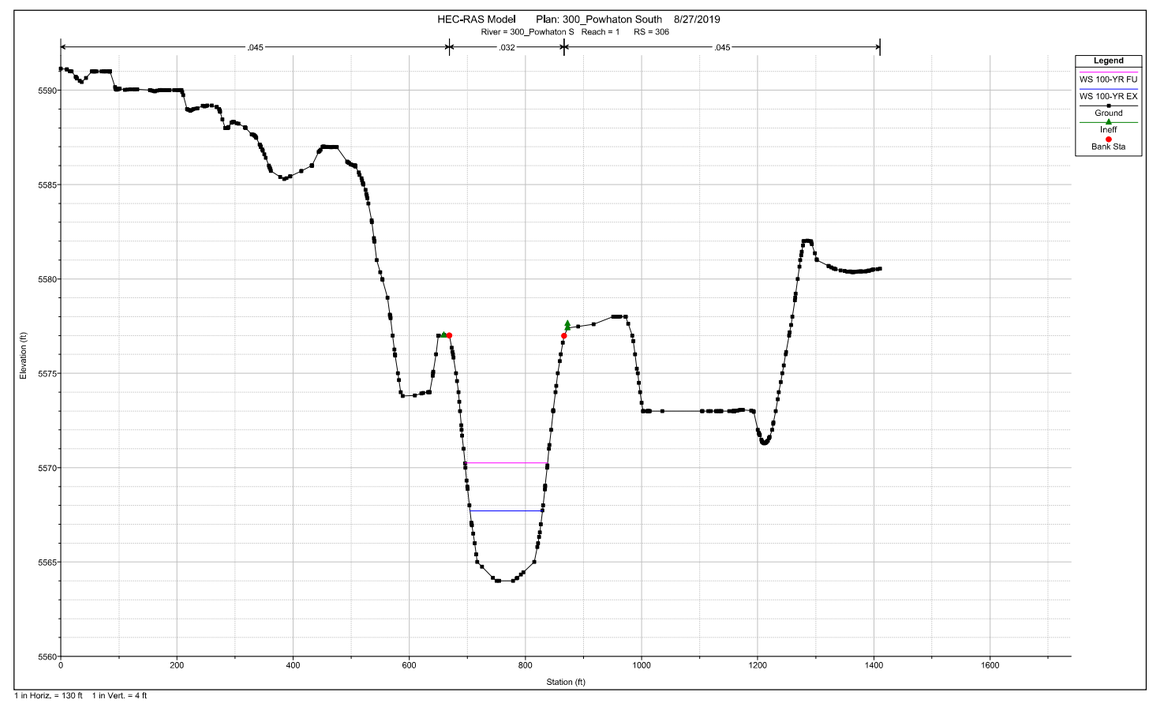

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 303
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

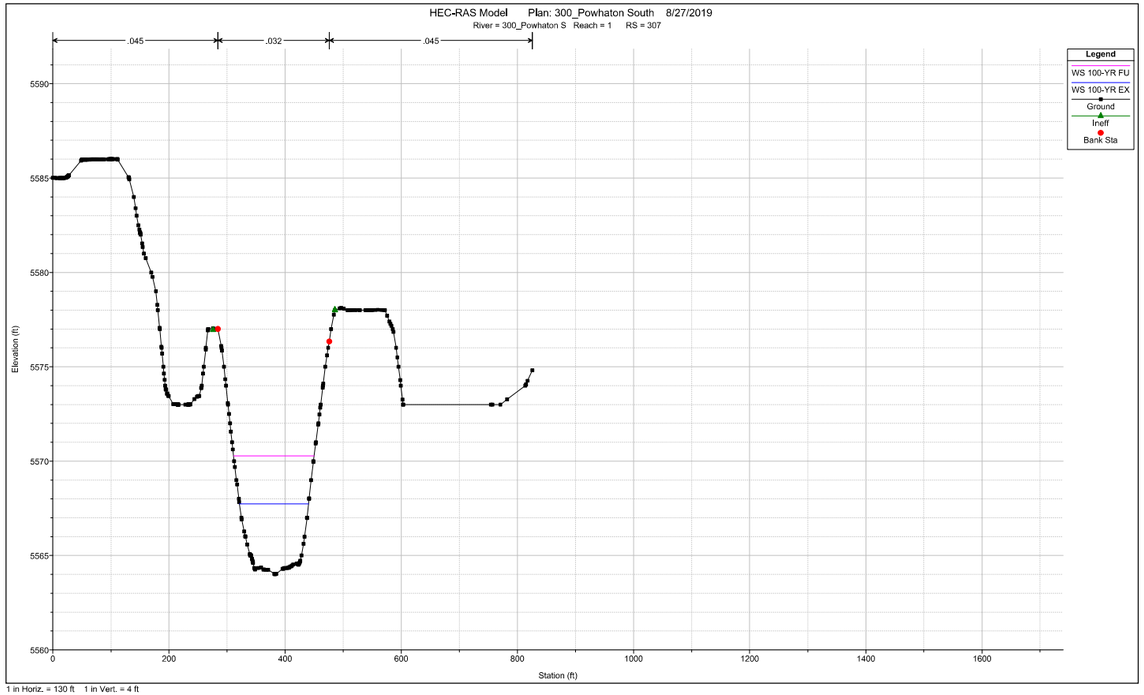

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 304
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

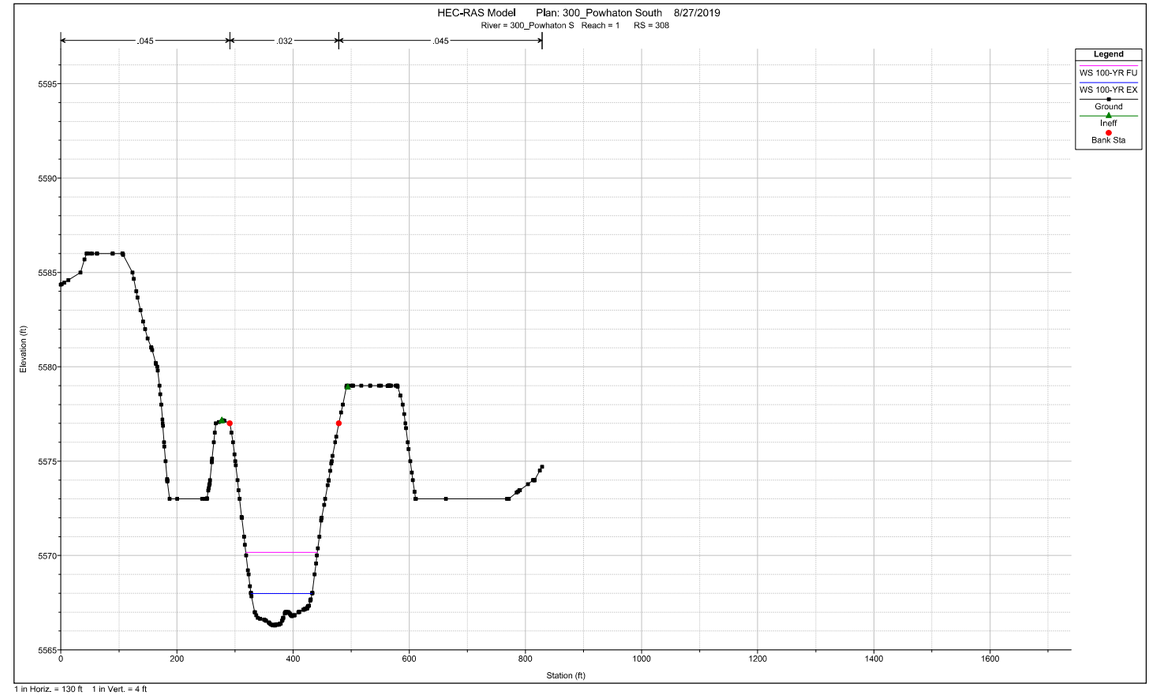
HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 304.58 Culv
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

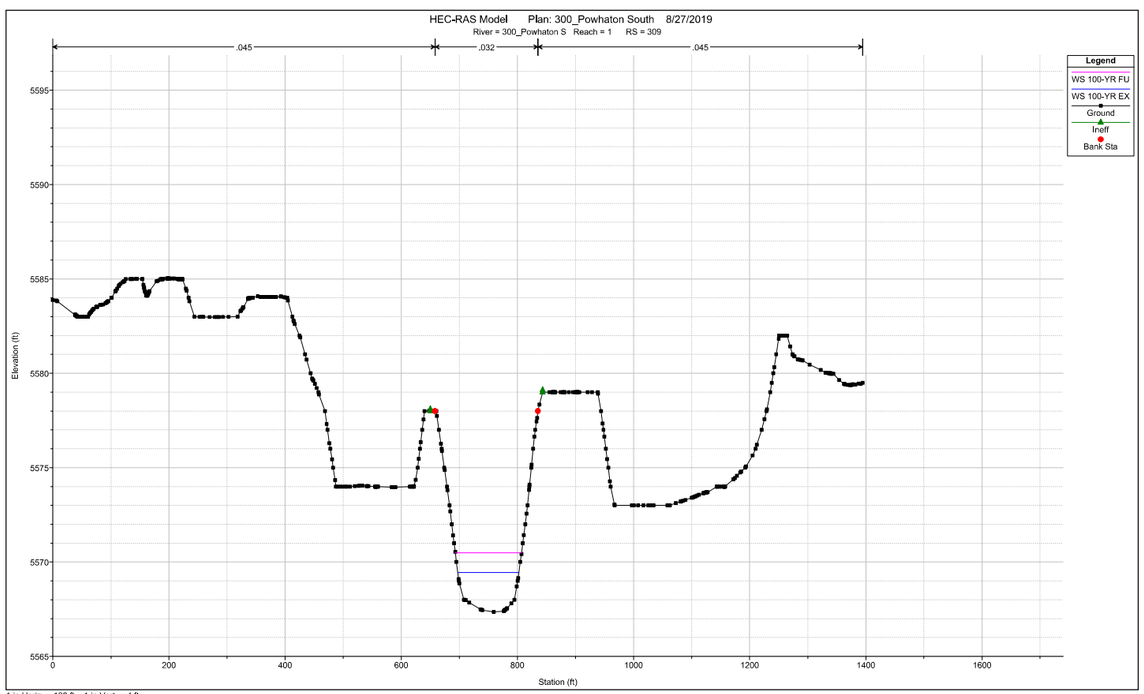

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 304.58 Culv
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

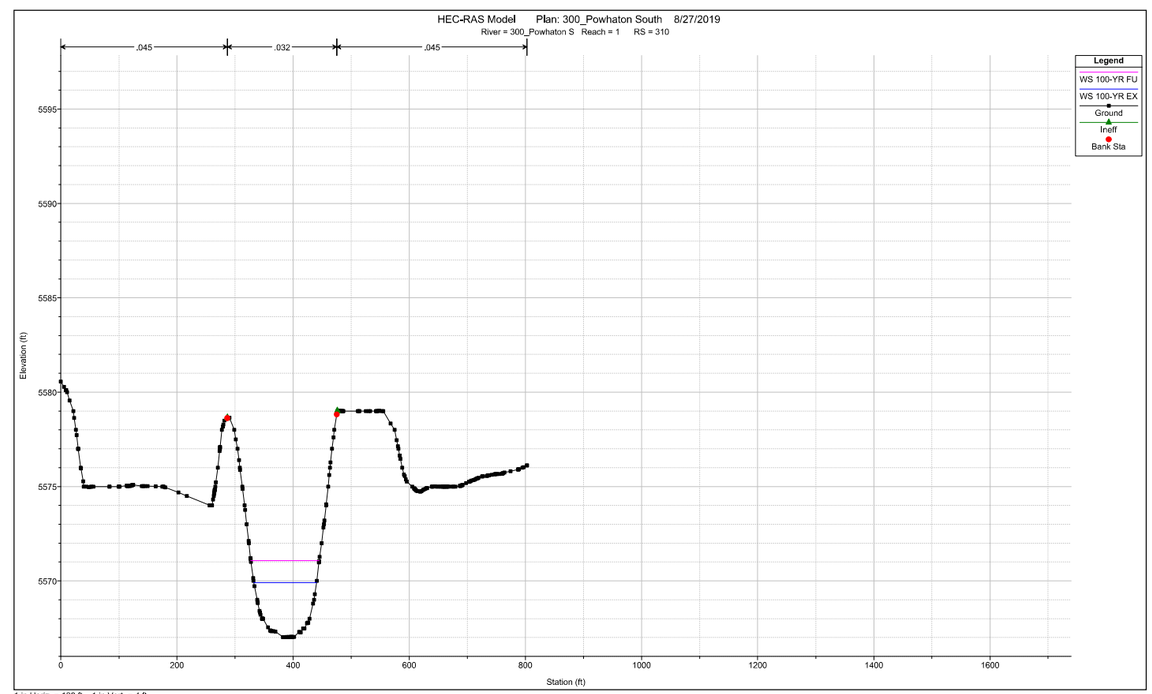

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 305
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

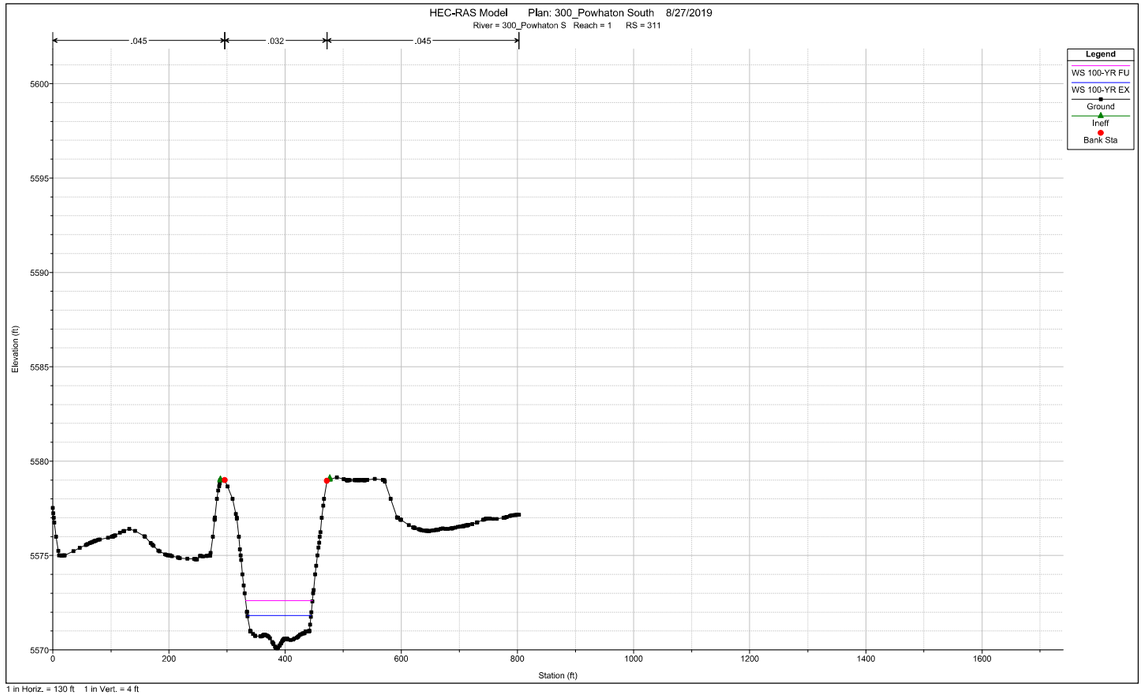

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 306
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

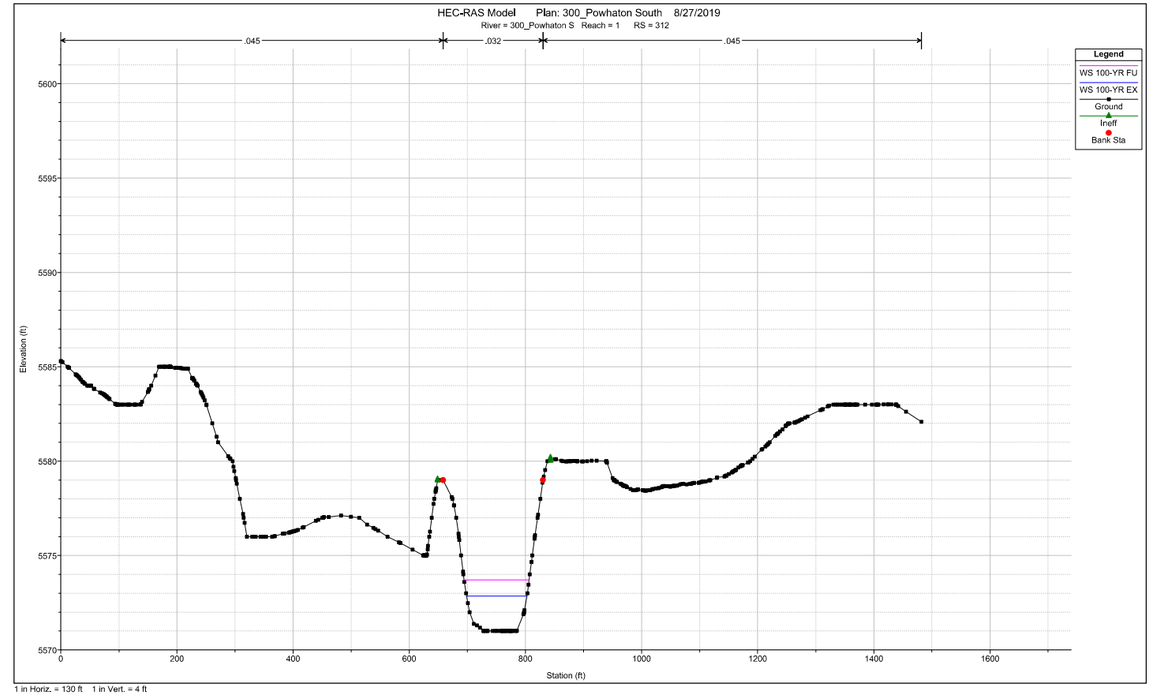

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 307
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

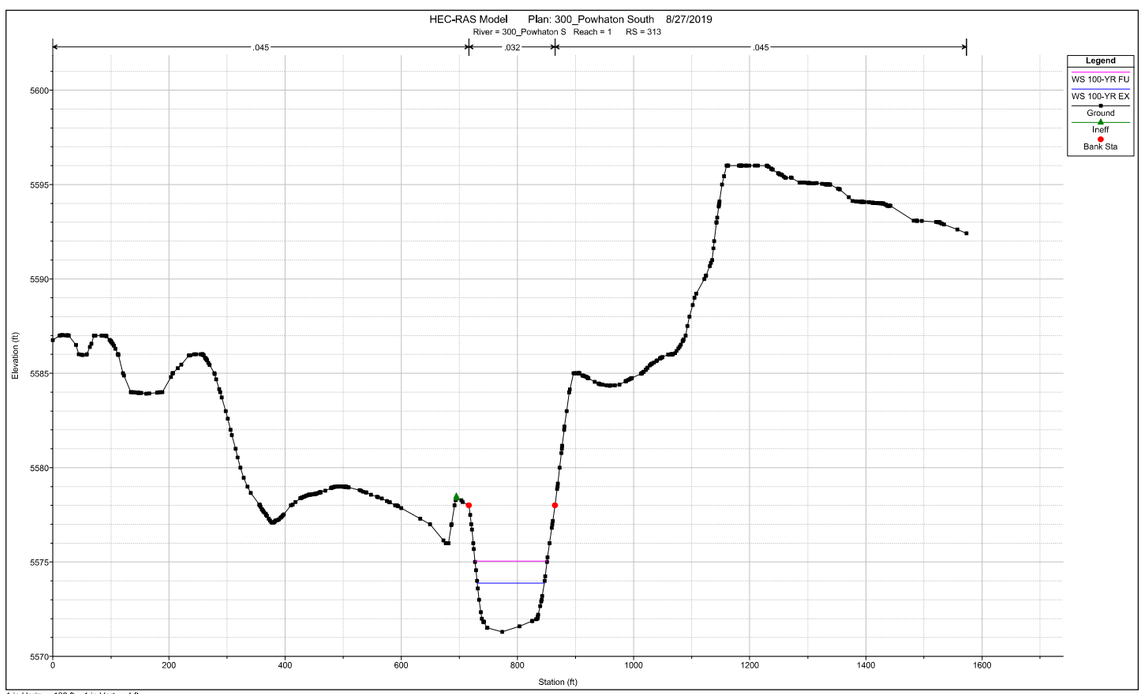

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 308
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

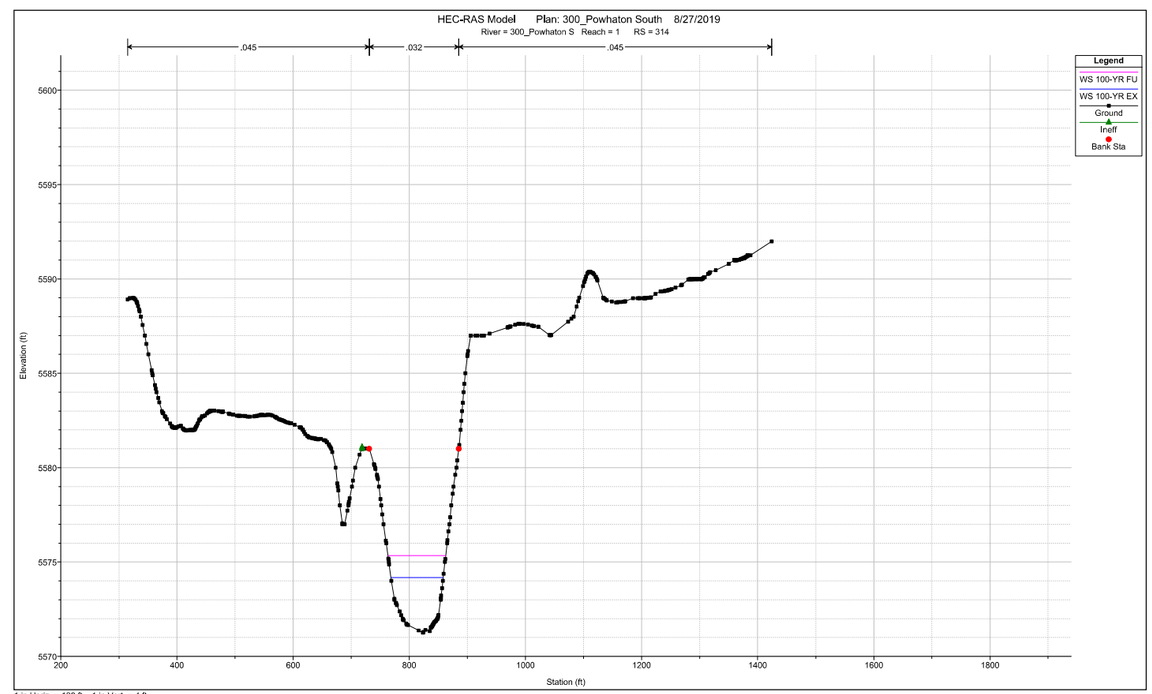

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 309
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

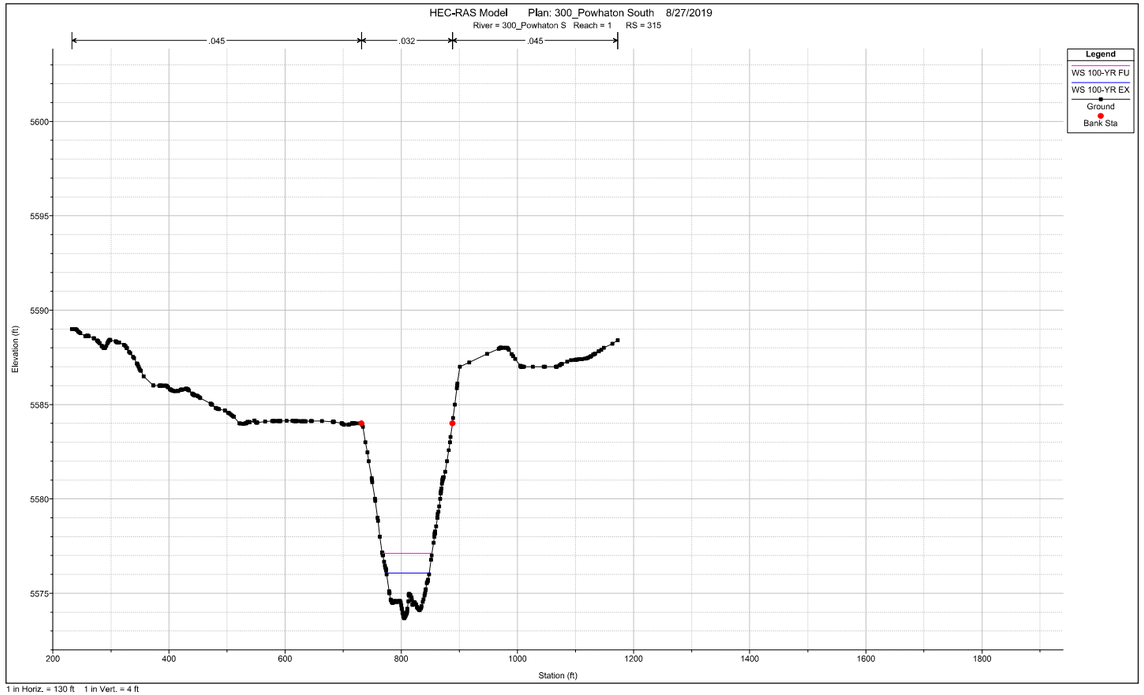

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 310
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

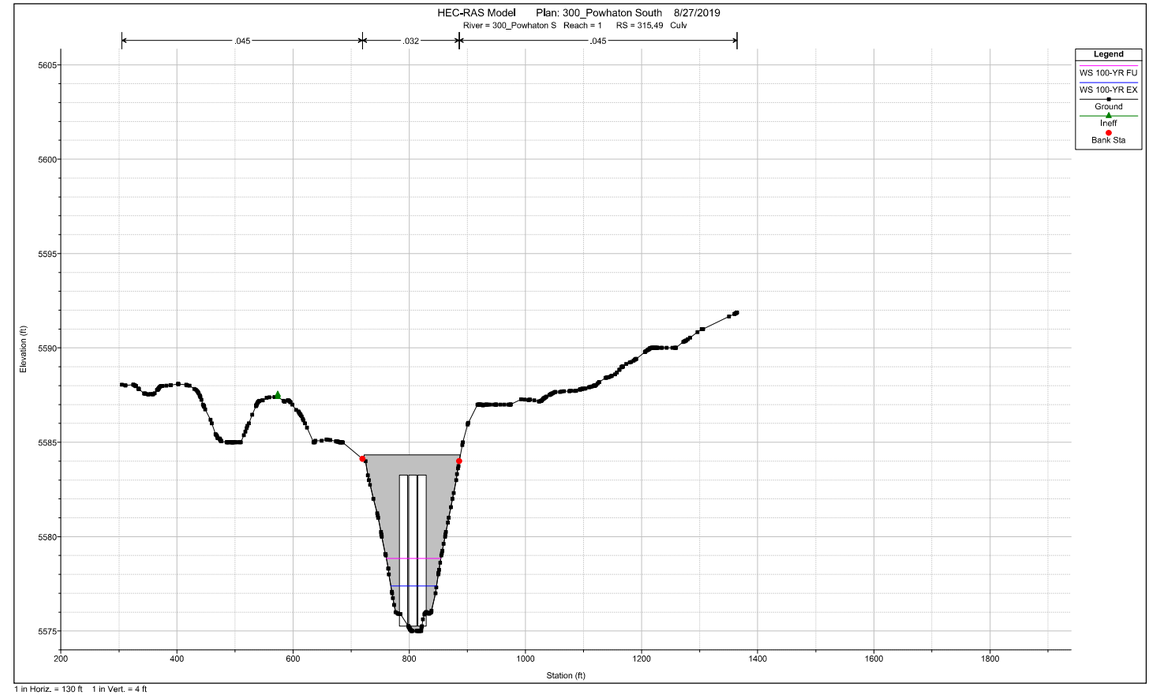

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 311
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

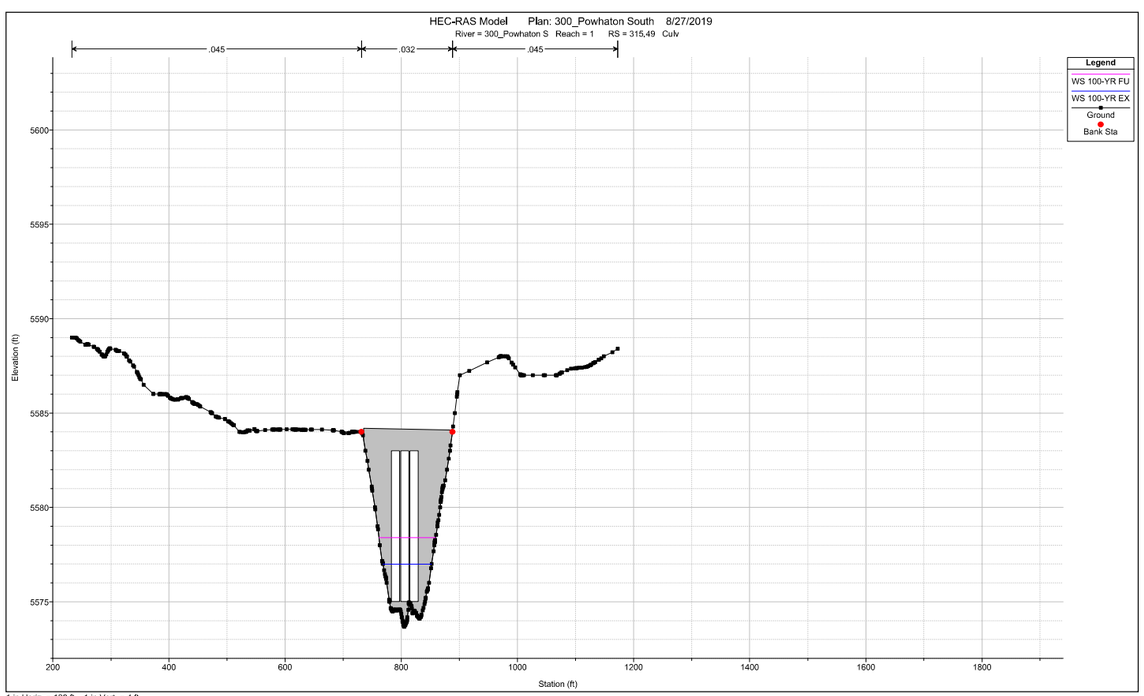

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 312
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

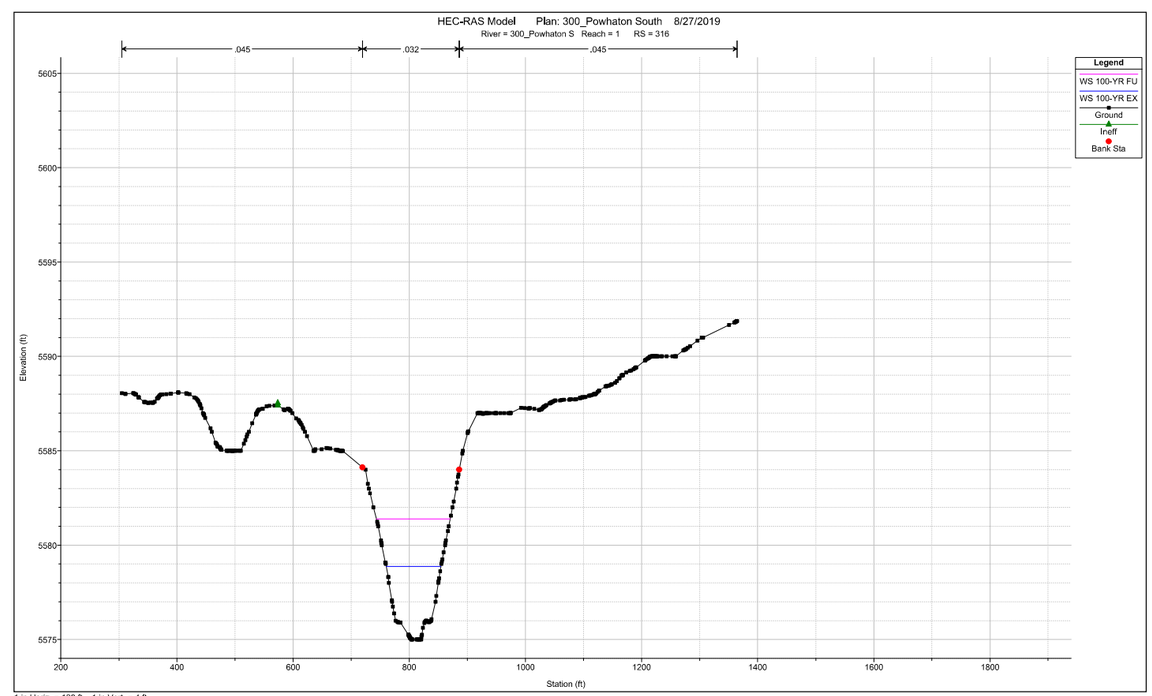

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 313
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

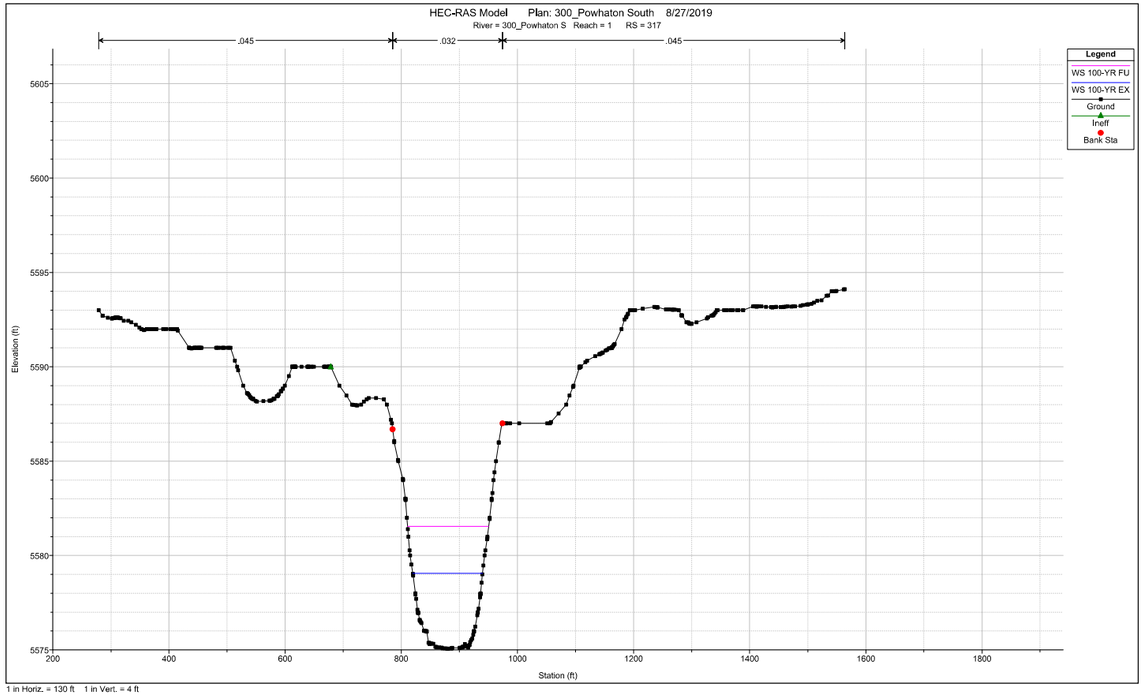

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 314
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

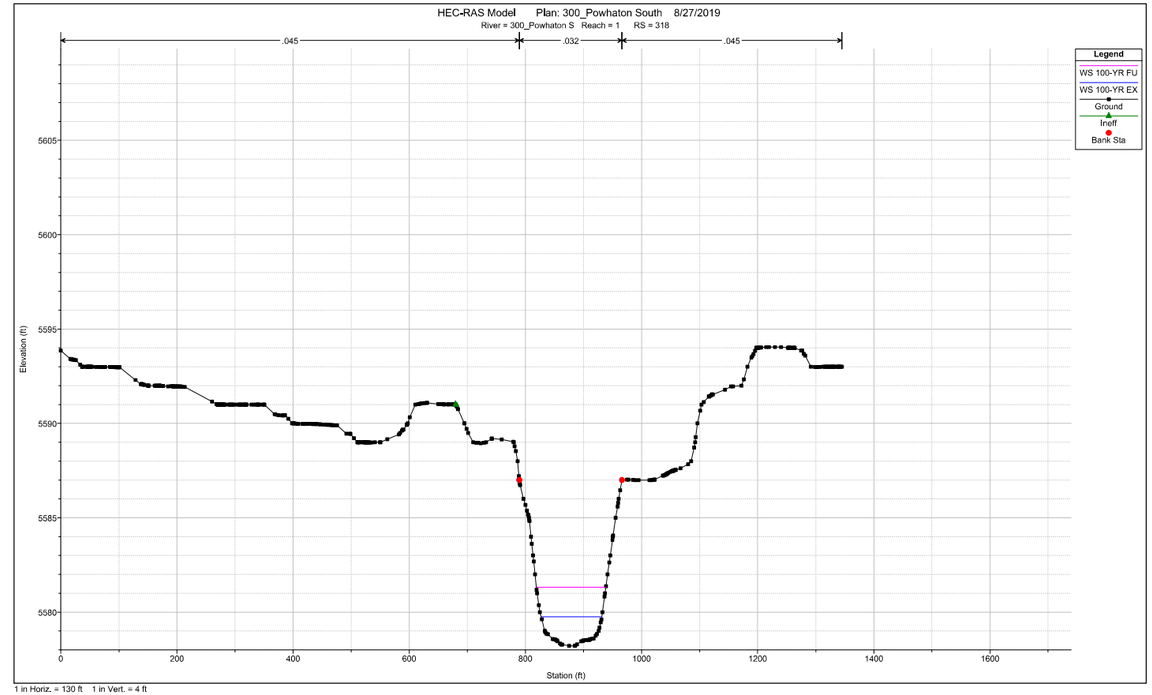

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 315
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

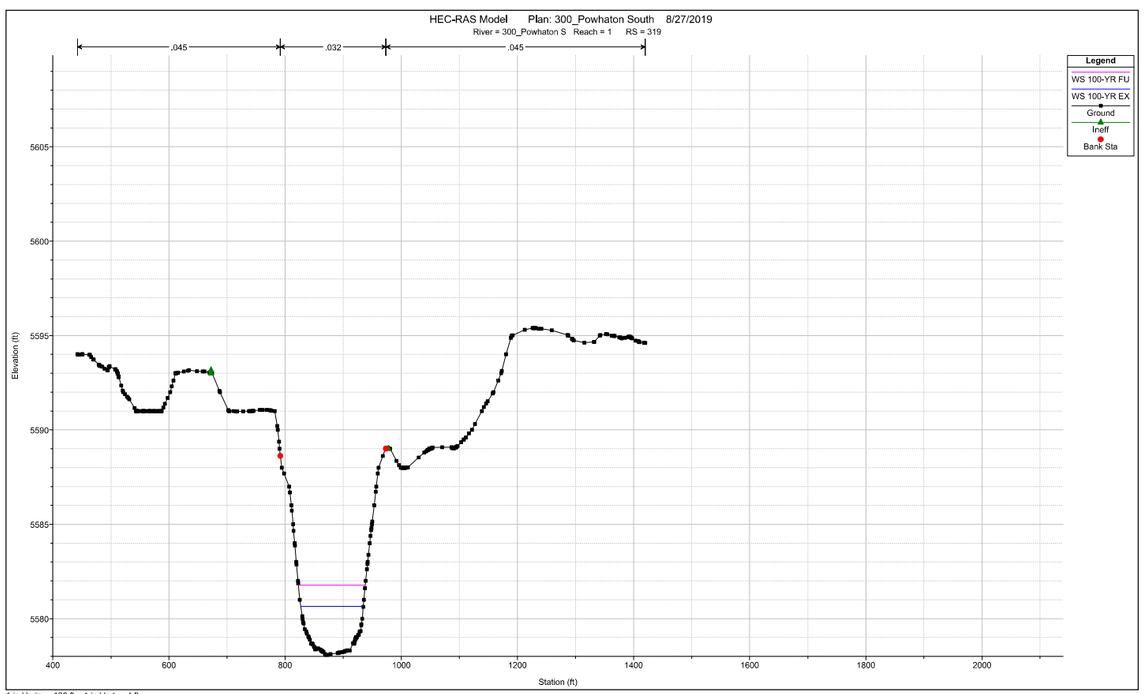

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 315.49 Culv
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

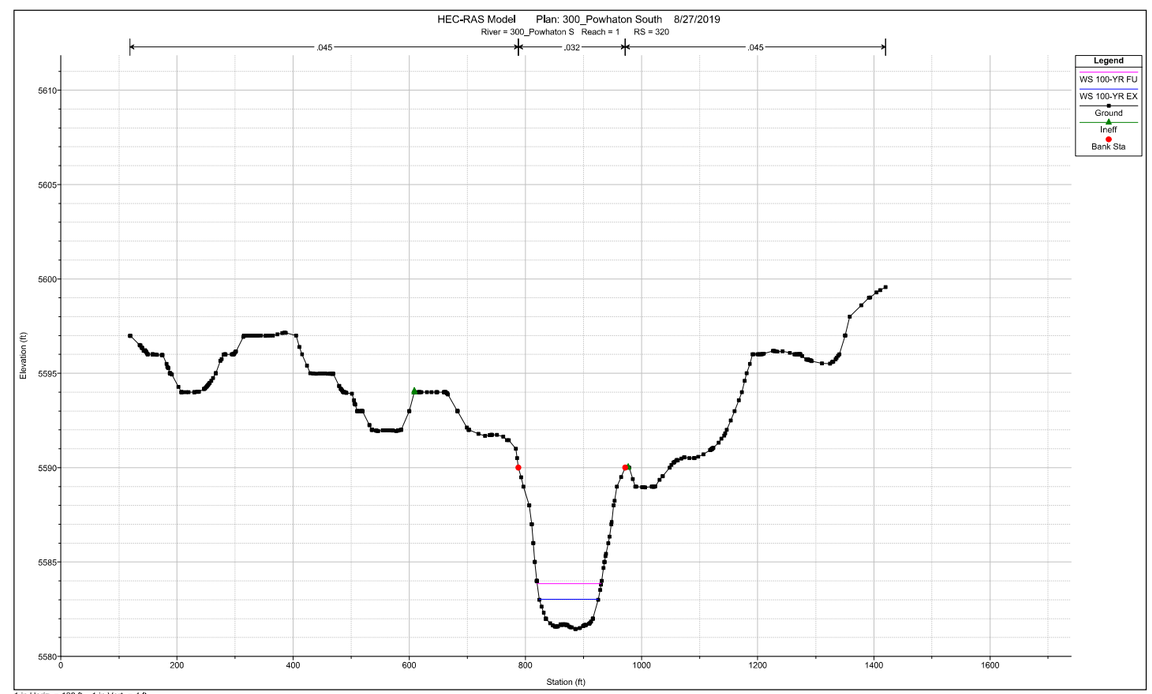

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 315.49 Culv
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

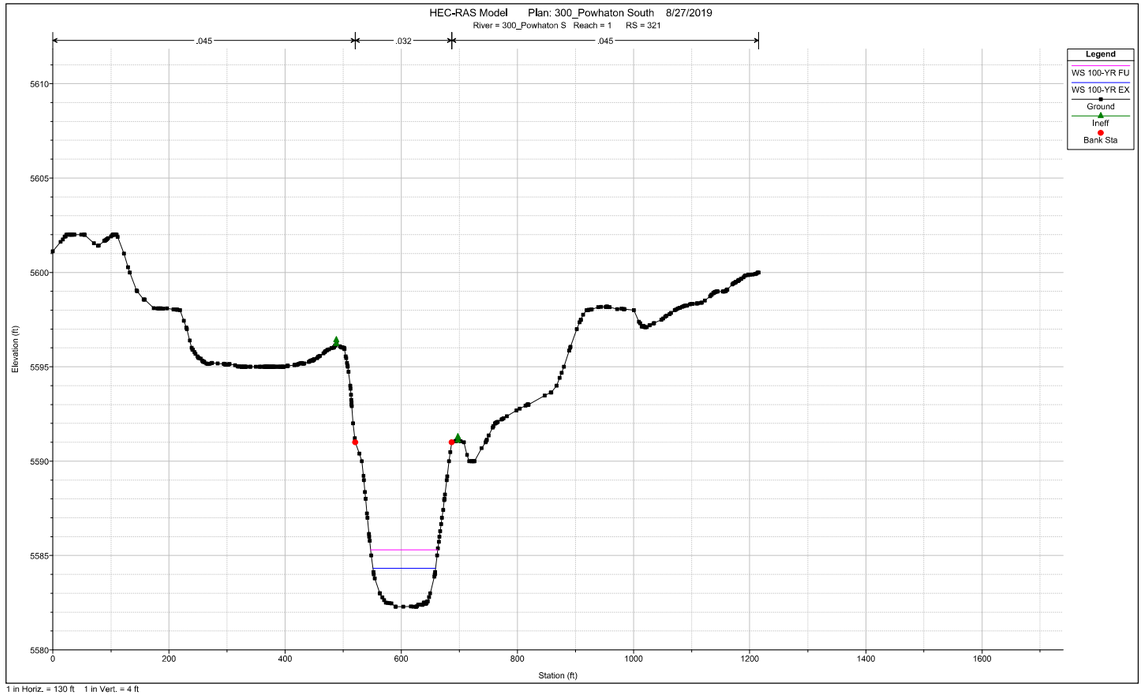

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 316
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

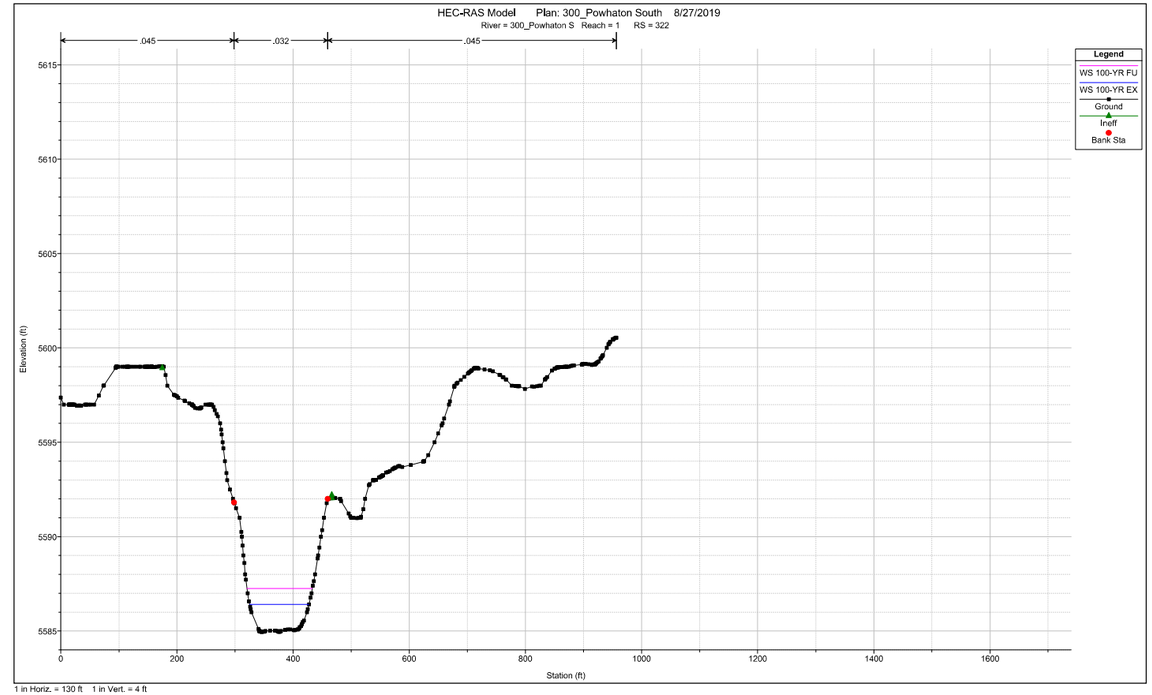

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 317
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

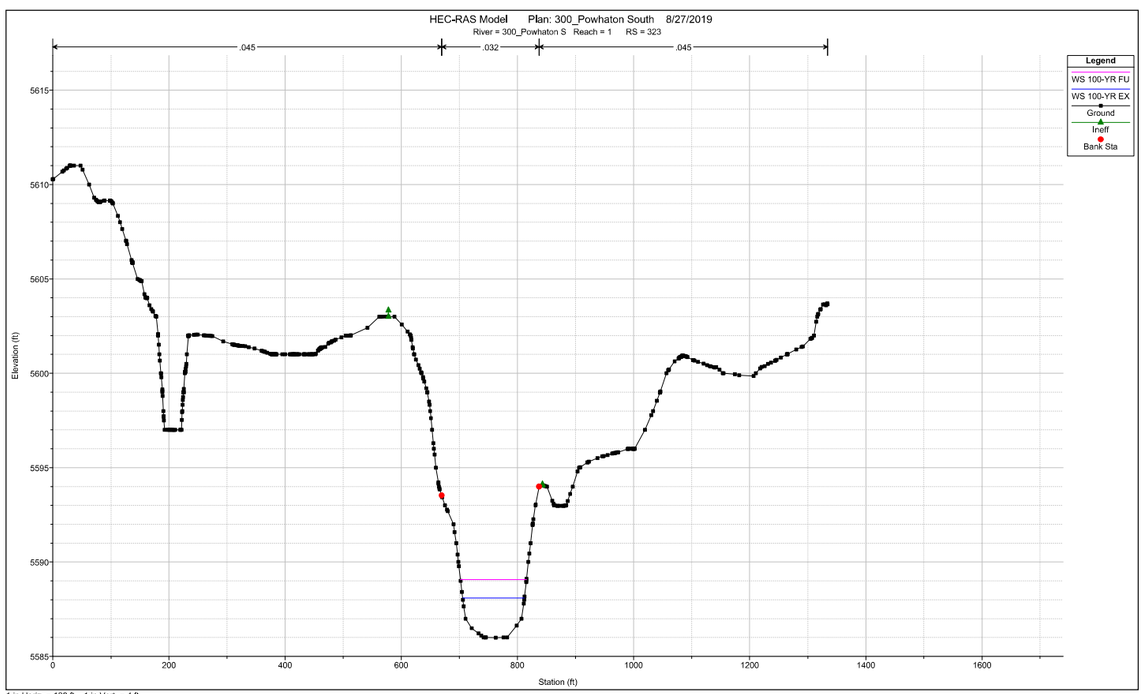

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 318
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

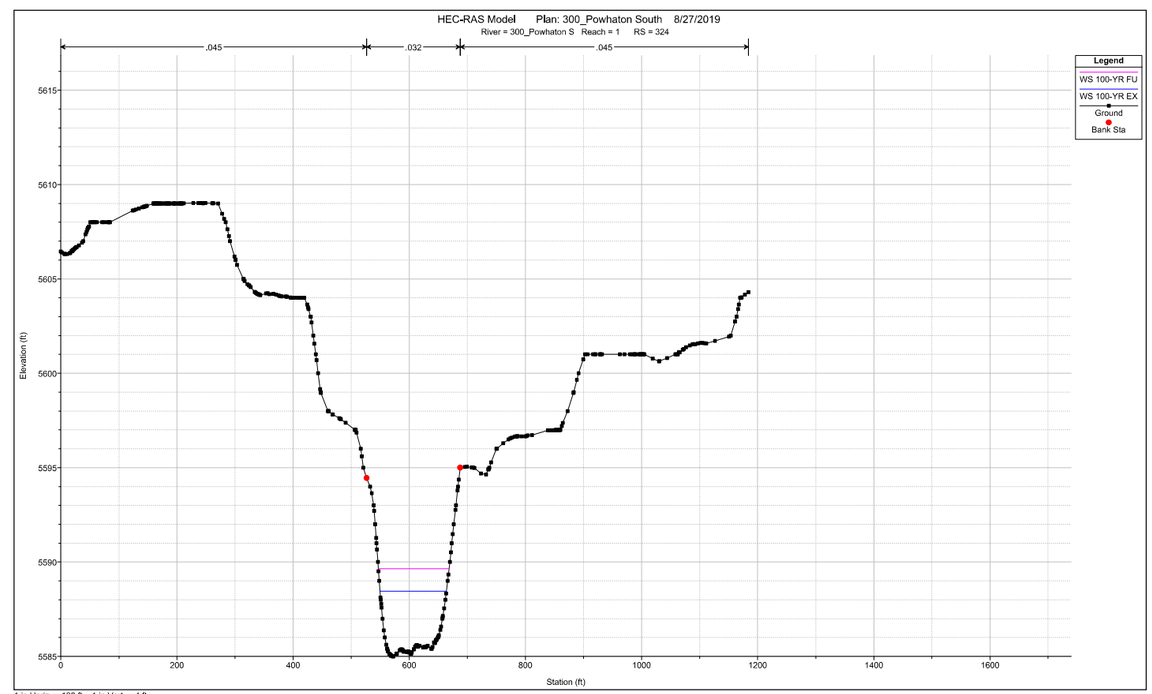

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 319
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 320
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 321
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 322
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 323
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 324
.045
.032
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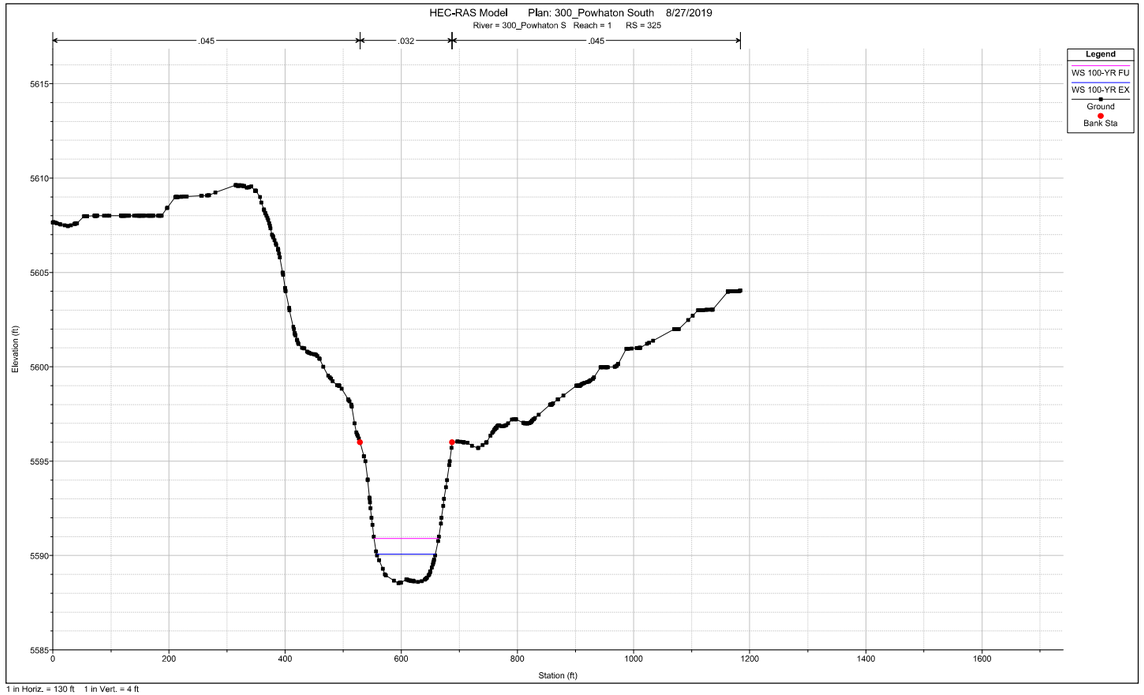
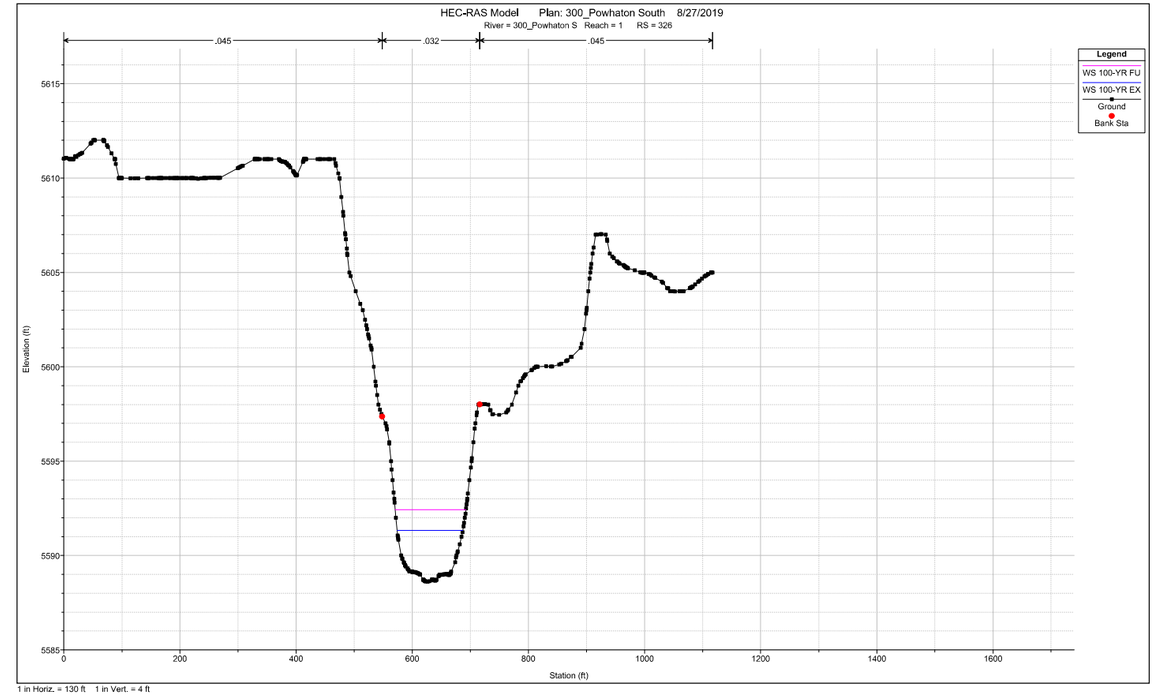
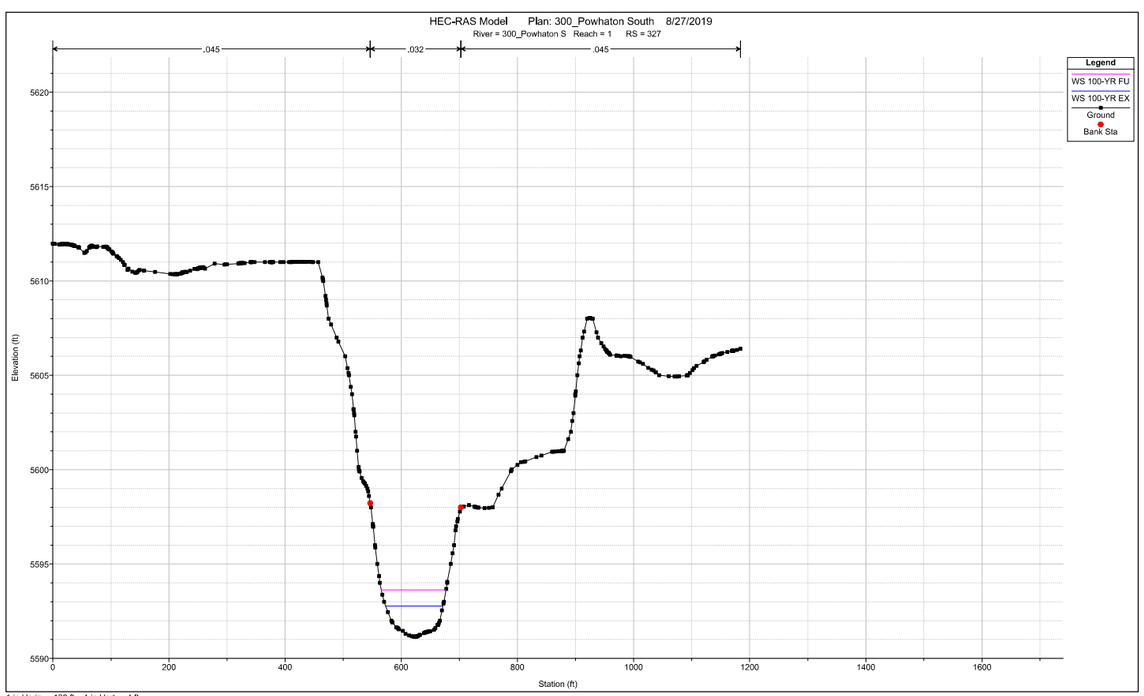
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 325
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 326
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 327
.045
.032
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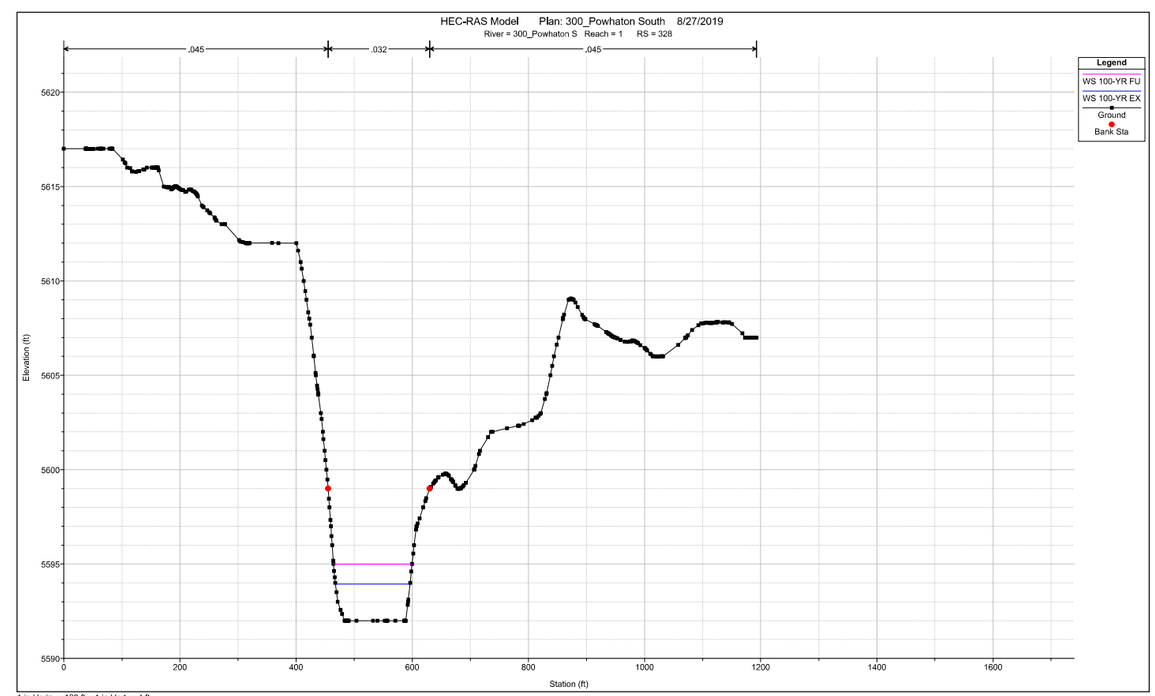
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 328
.045
.032
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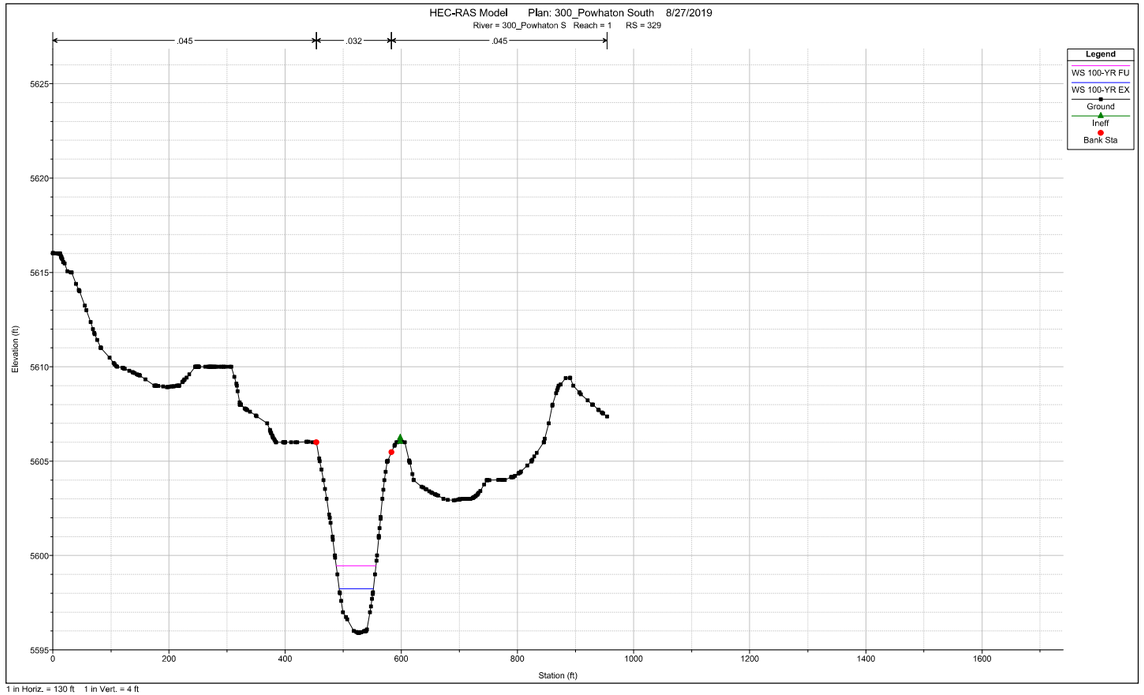
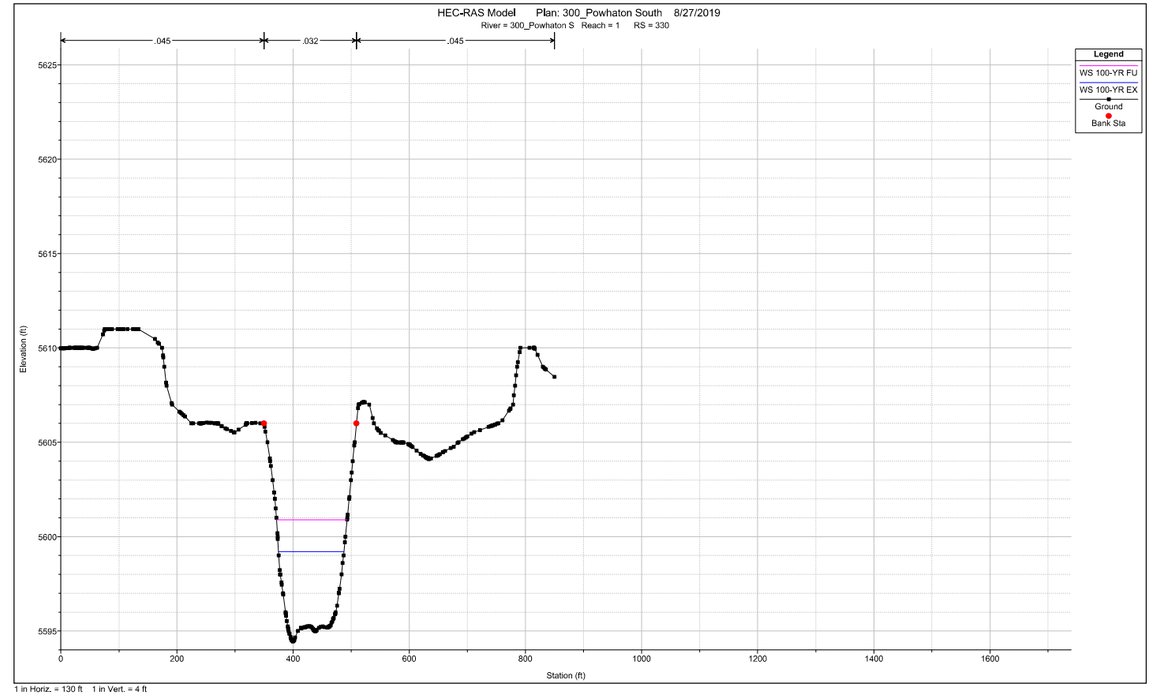
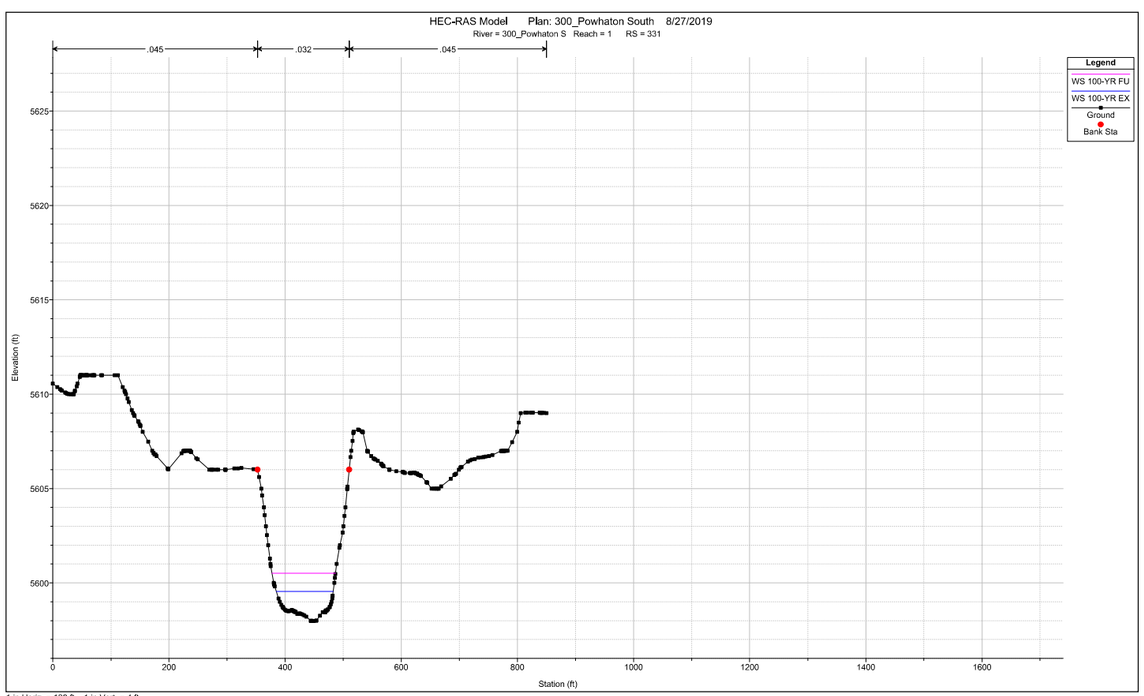
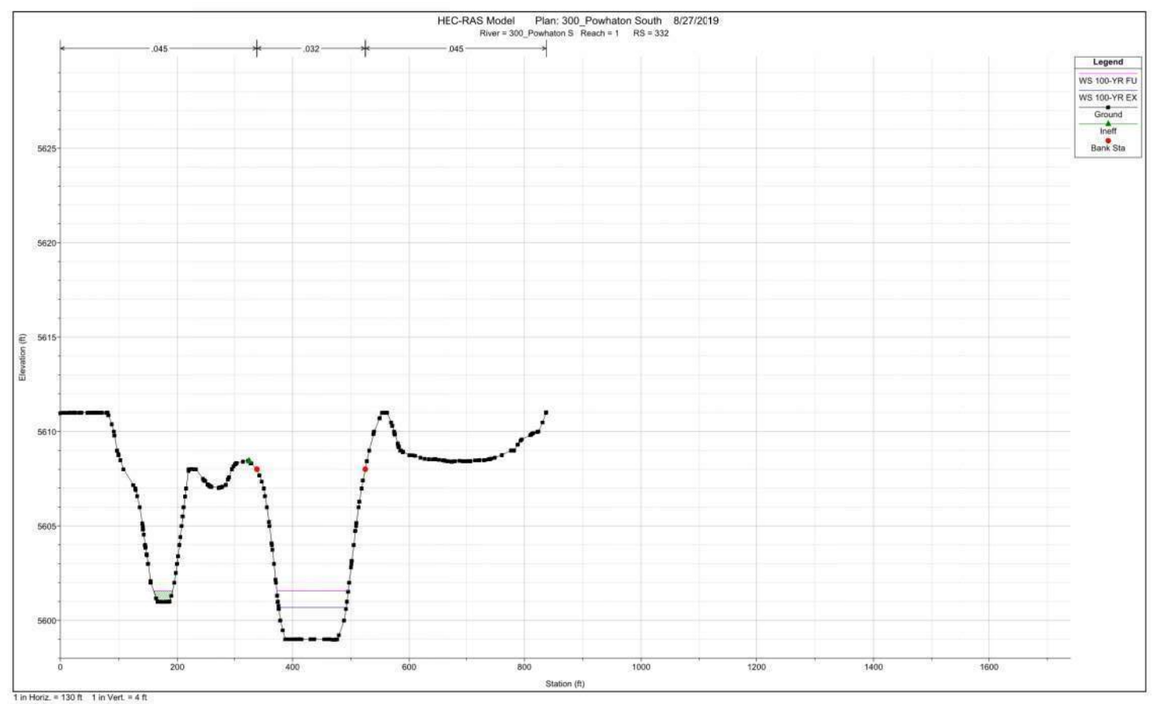
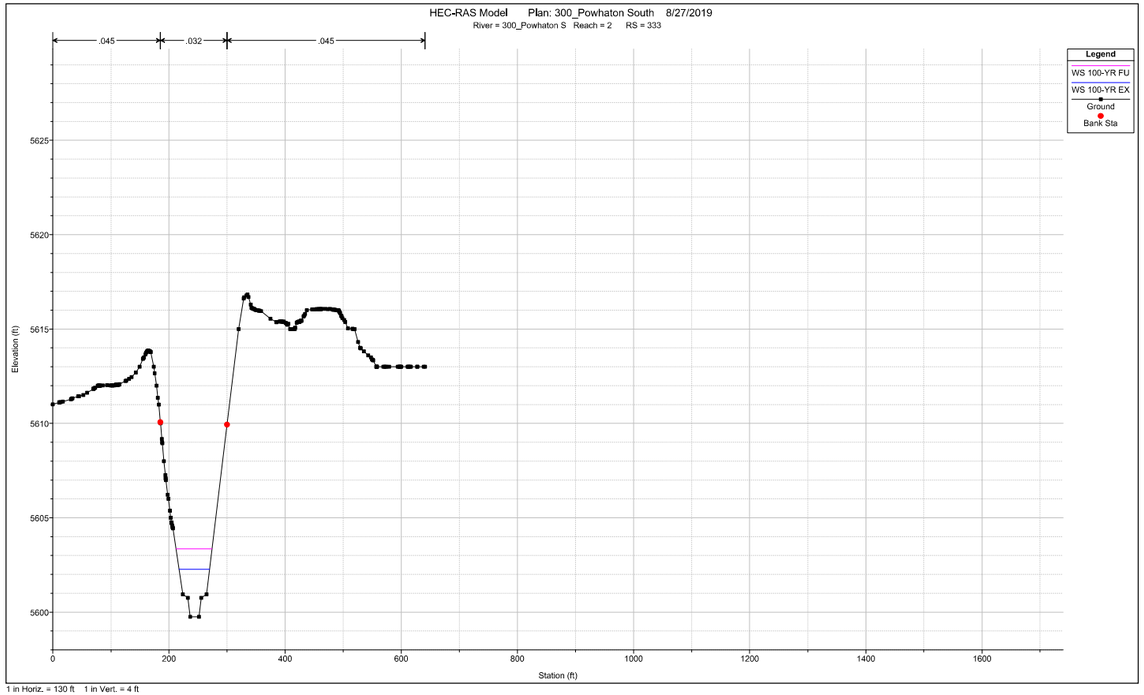
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

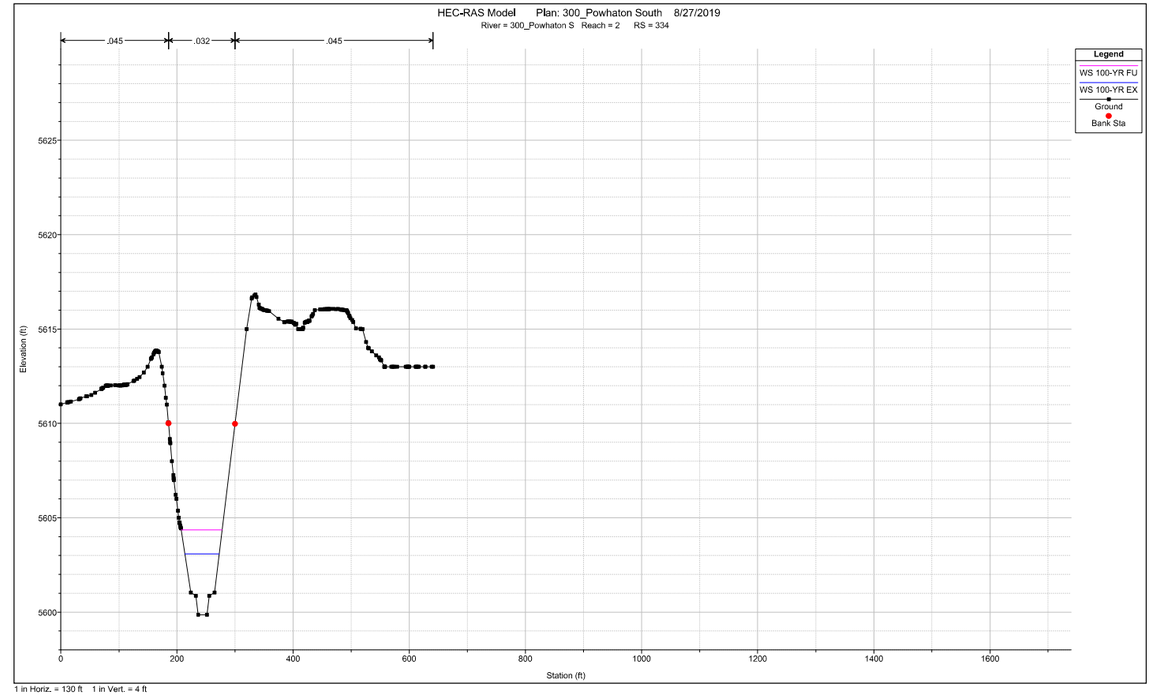

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 329
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

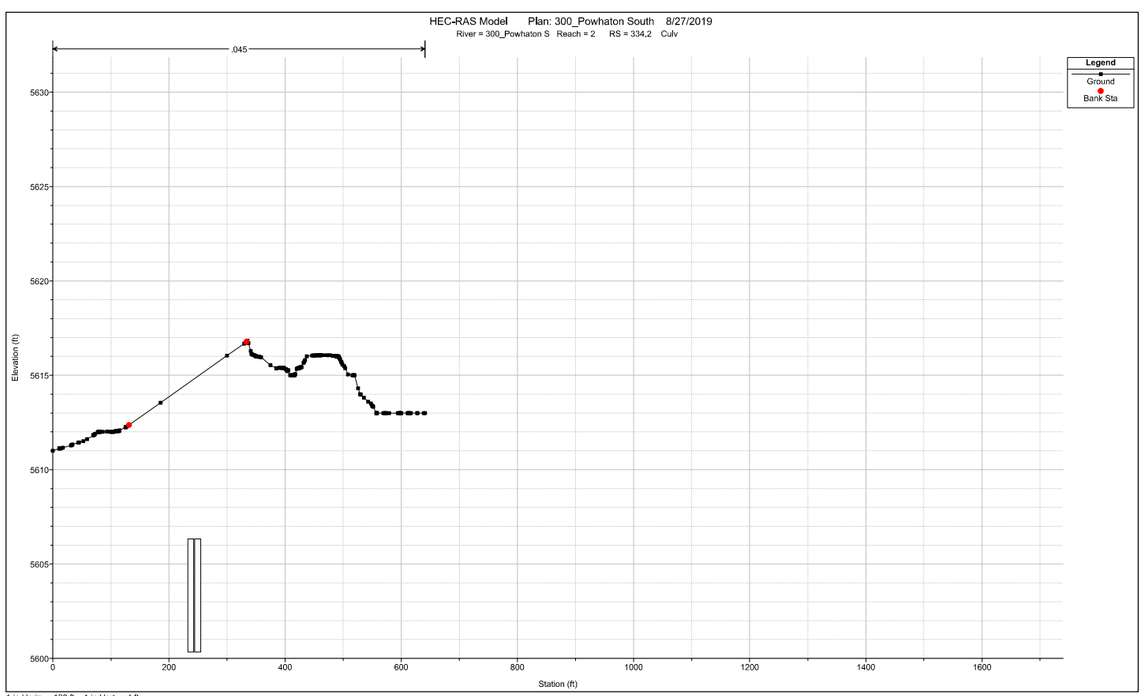

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 330
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

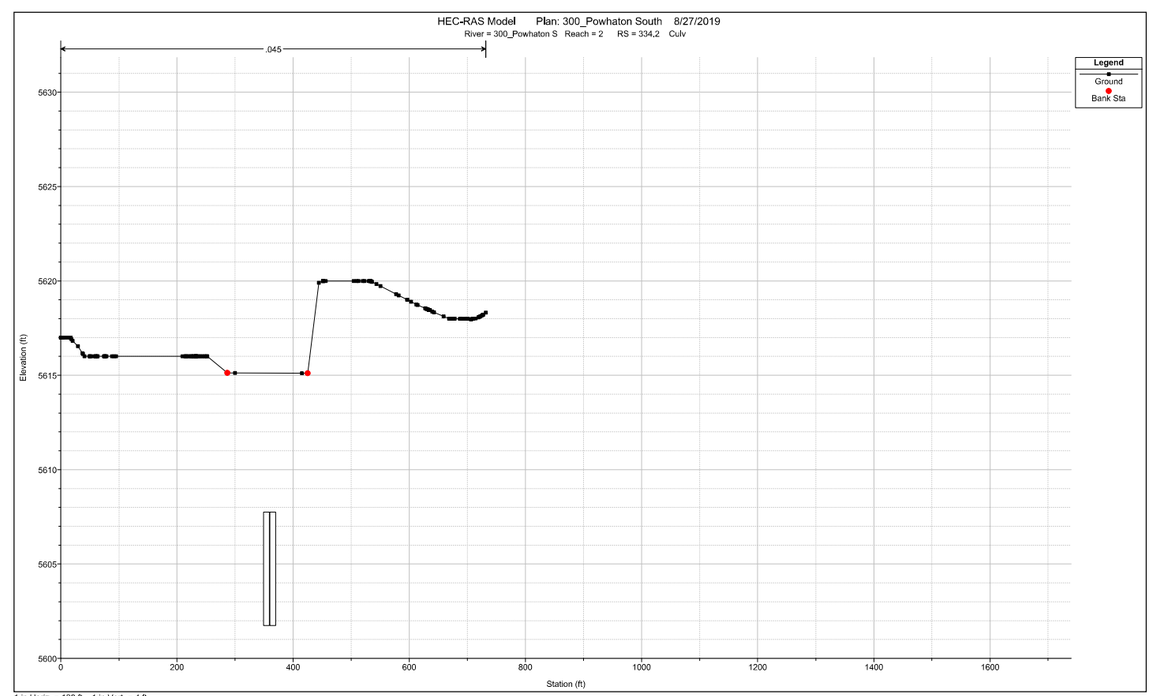

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 331
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

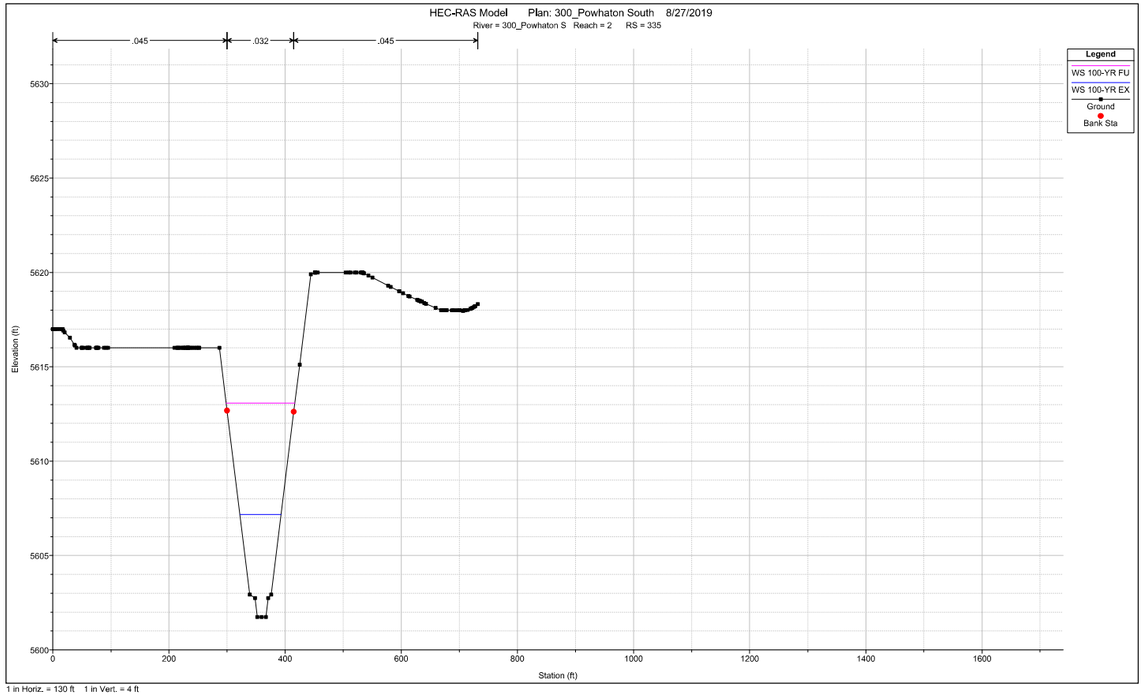

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 1 RS = 332
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

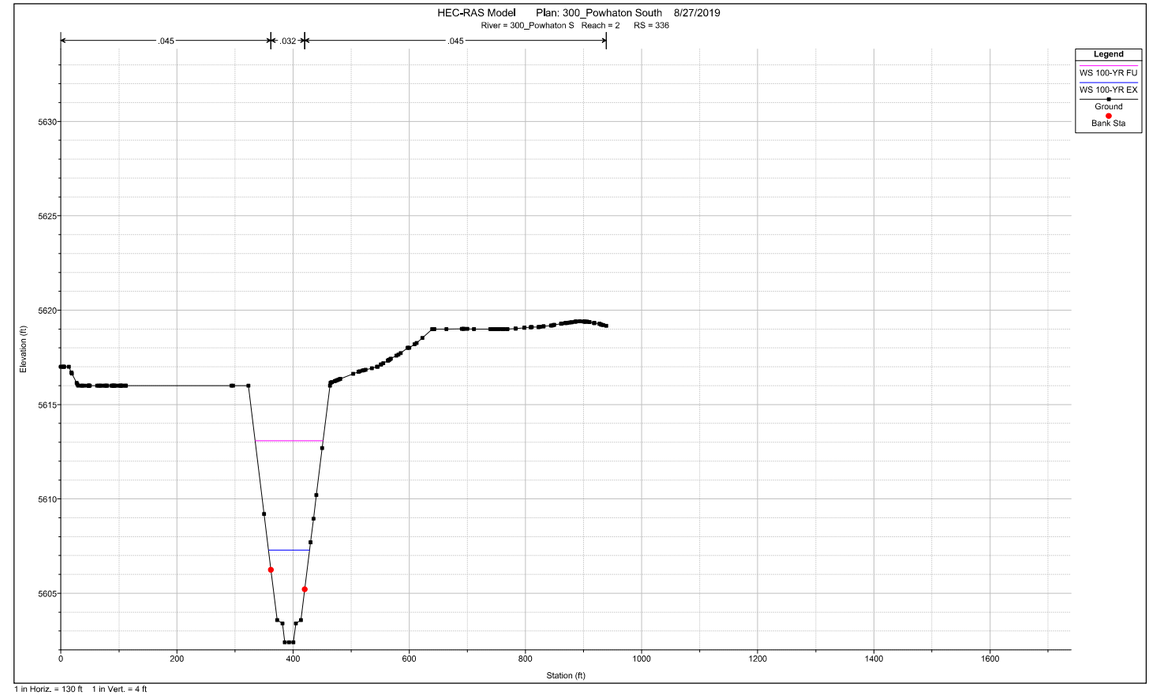

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 333
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

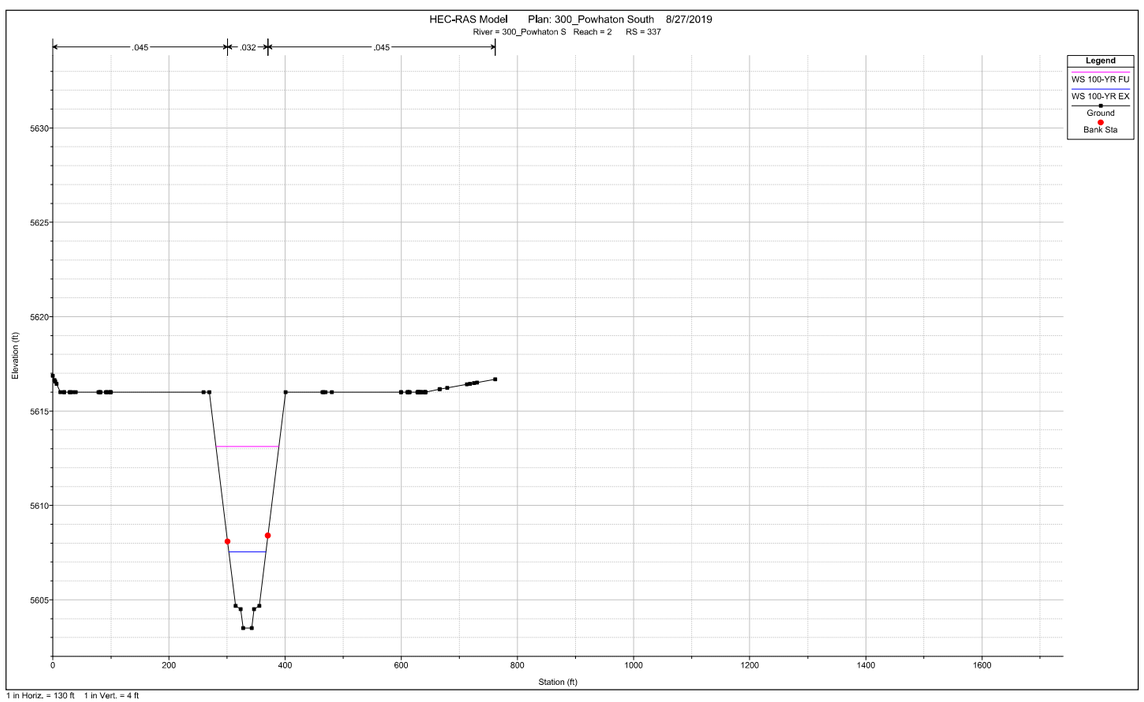

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 334
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

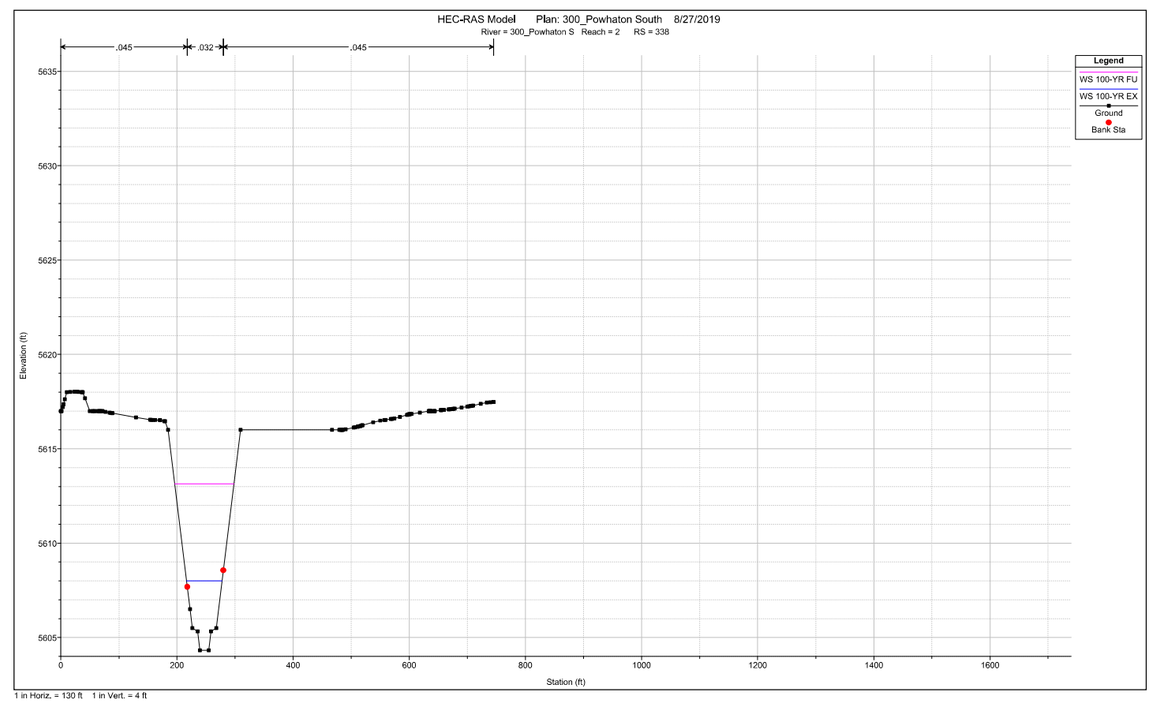

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 334,2 Culv
.045
Legend
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

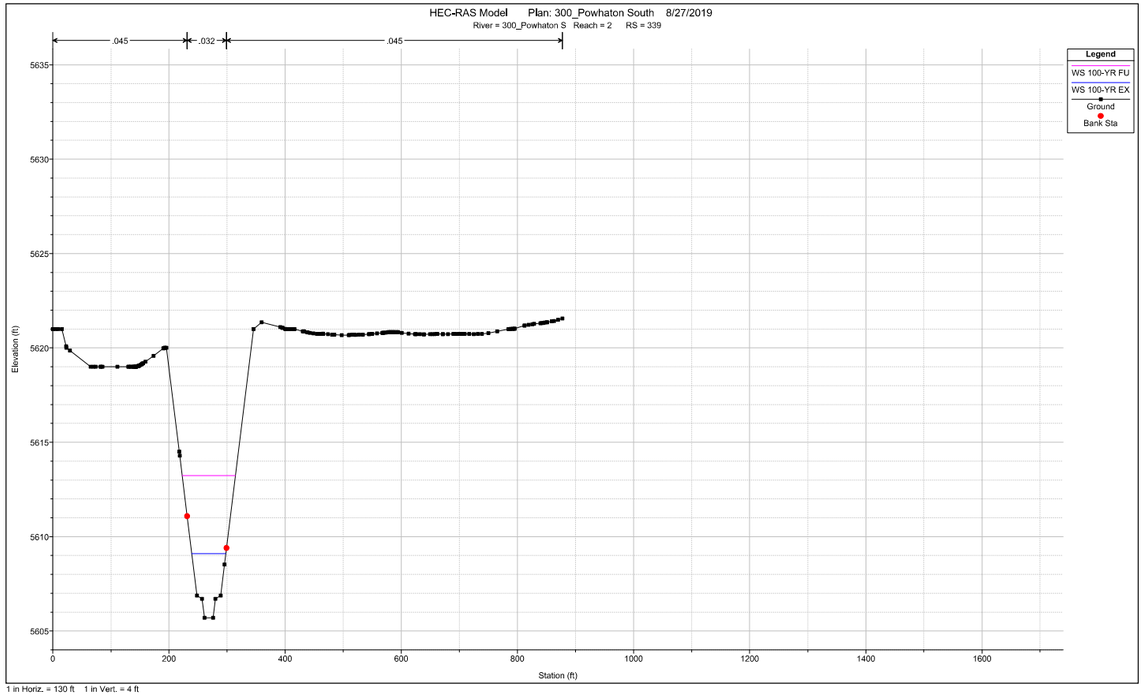

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 334,2 Culv
.045
Legend
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

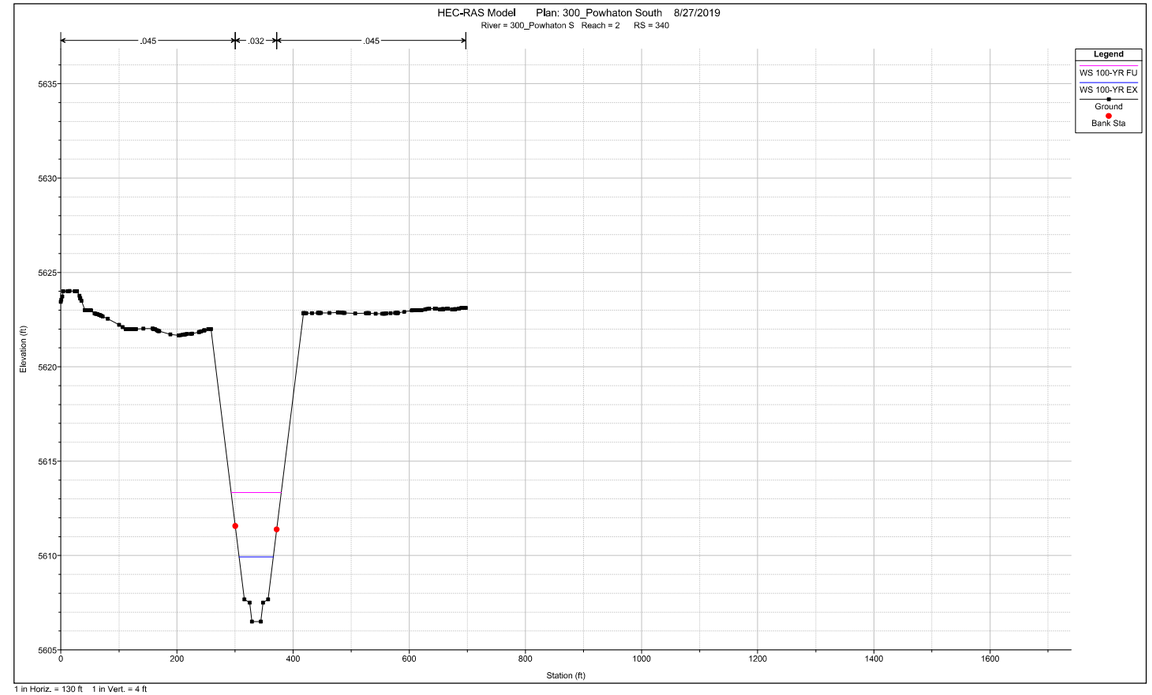

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 335
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

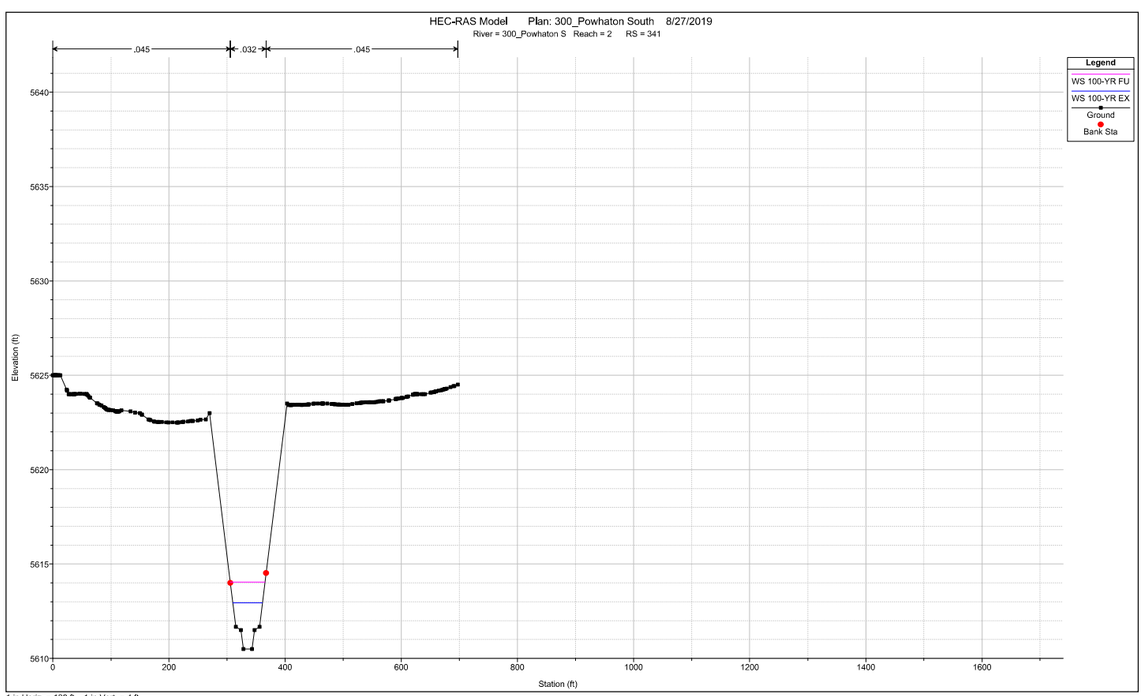

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 336
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

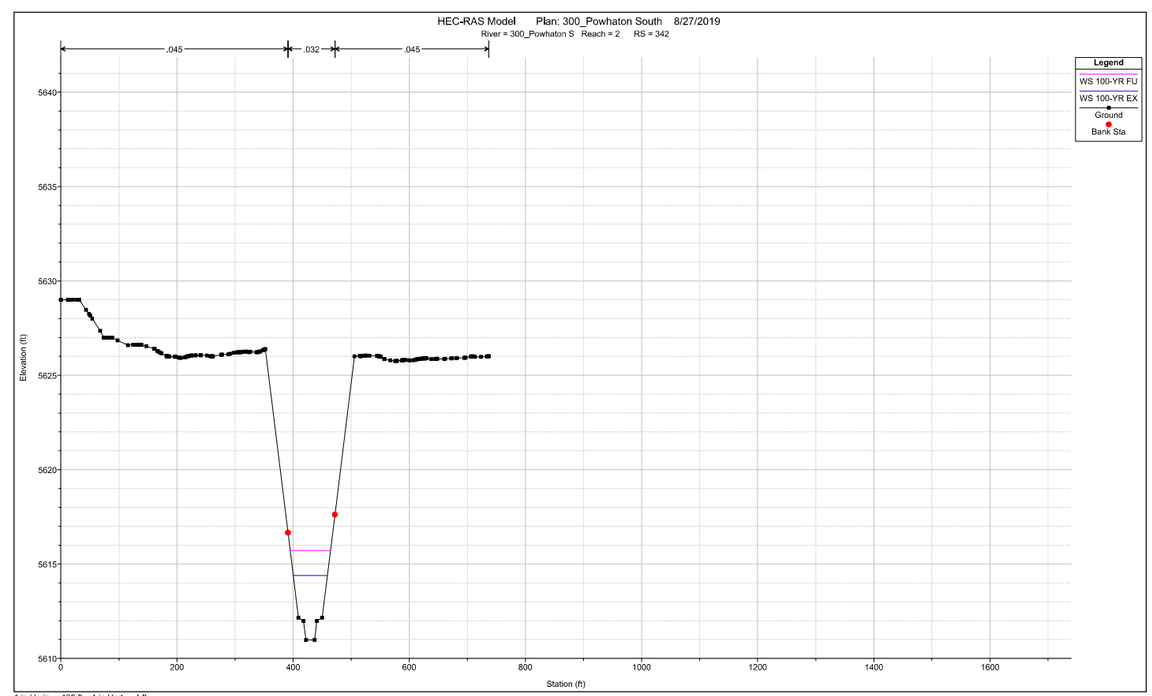

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 337
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

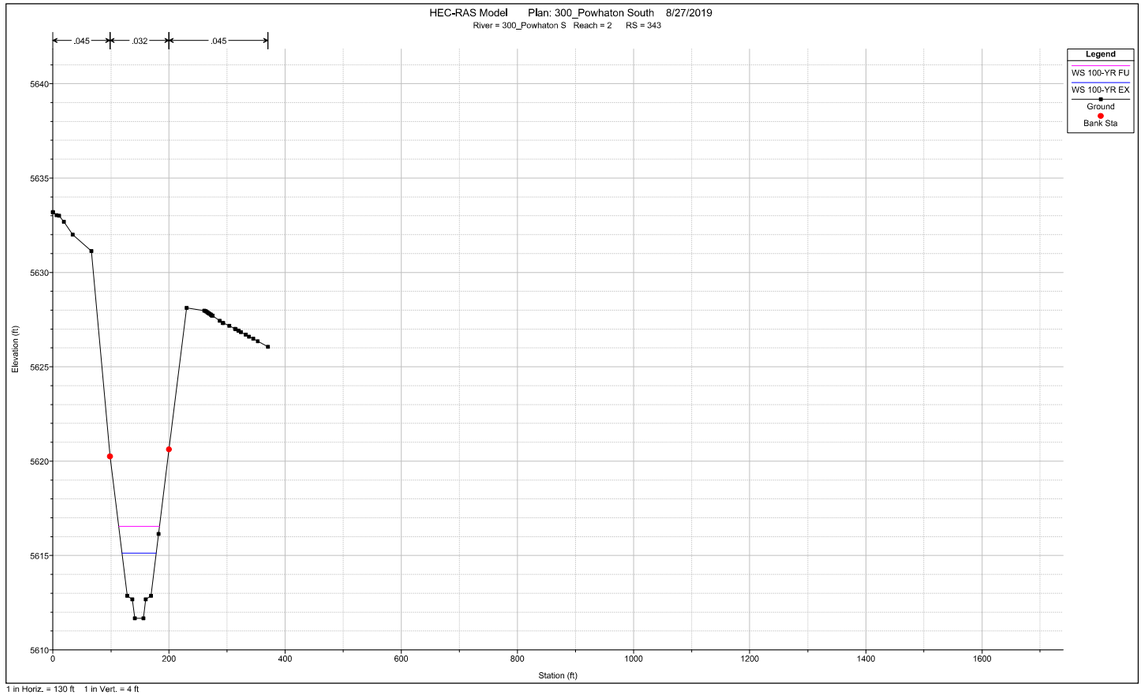

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 338
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

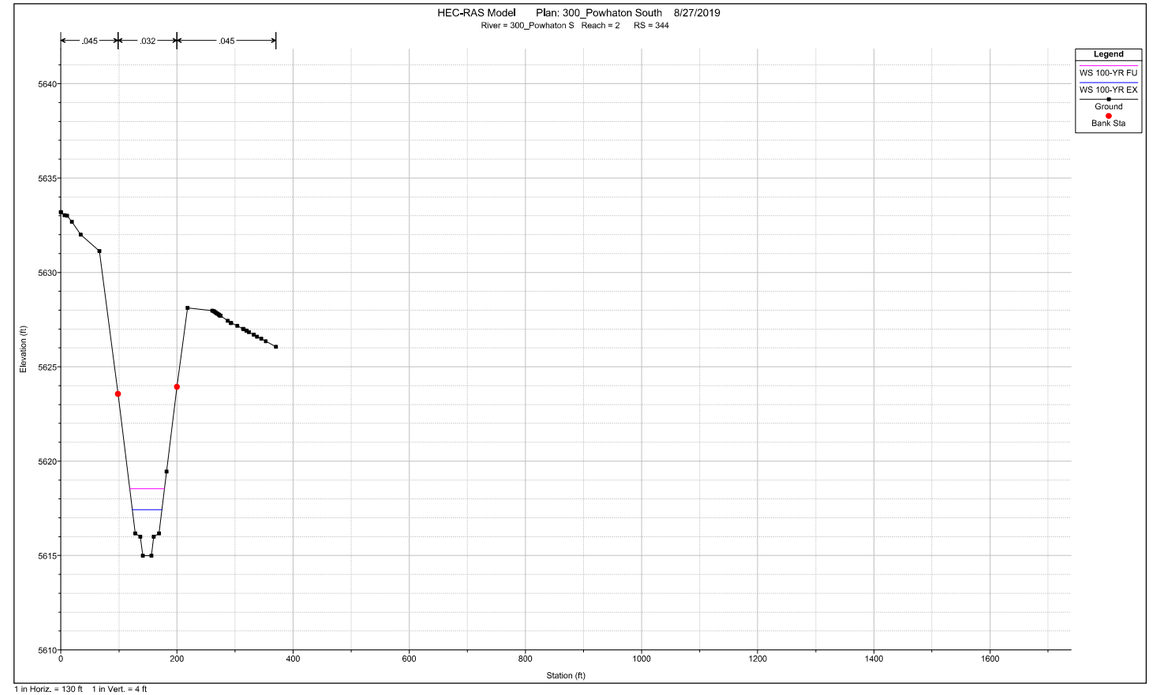

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 339
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

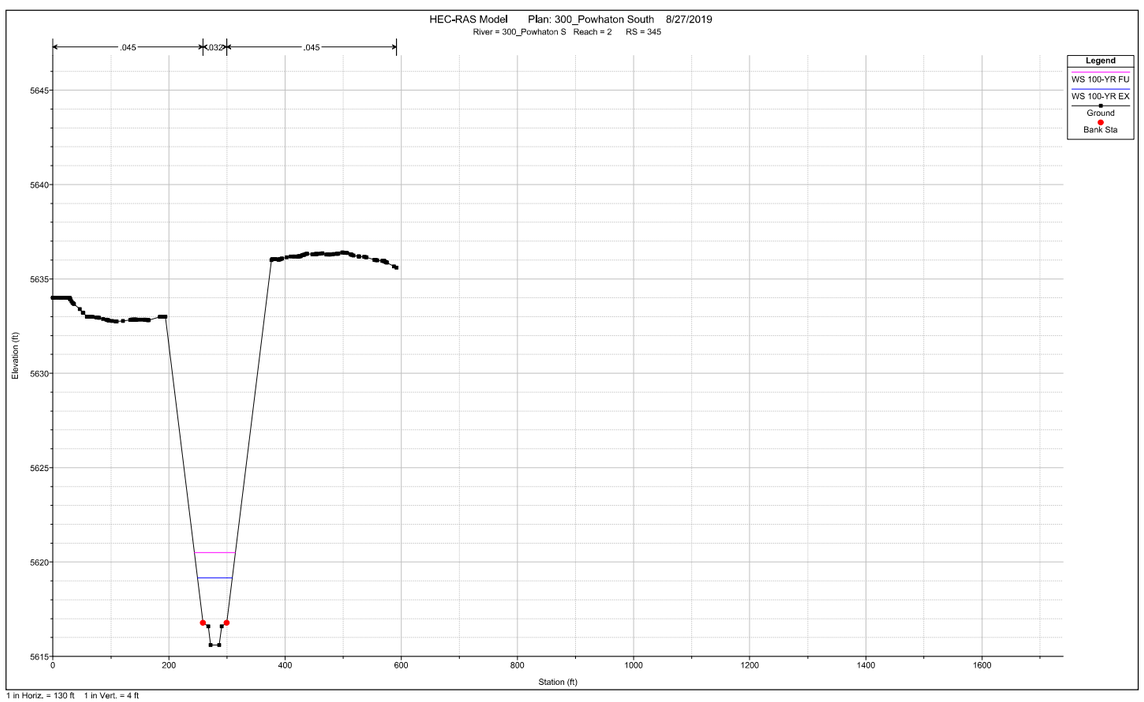

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 340
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

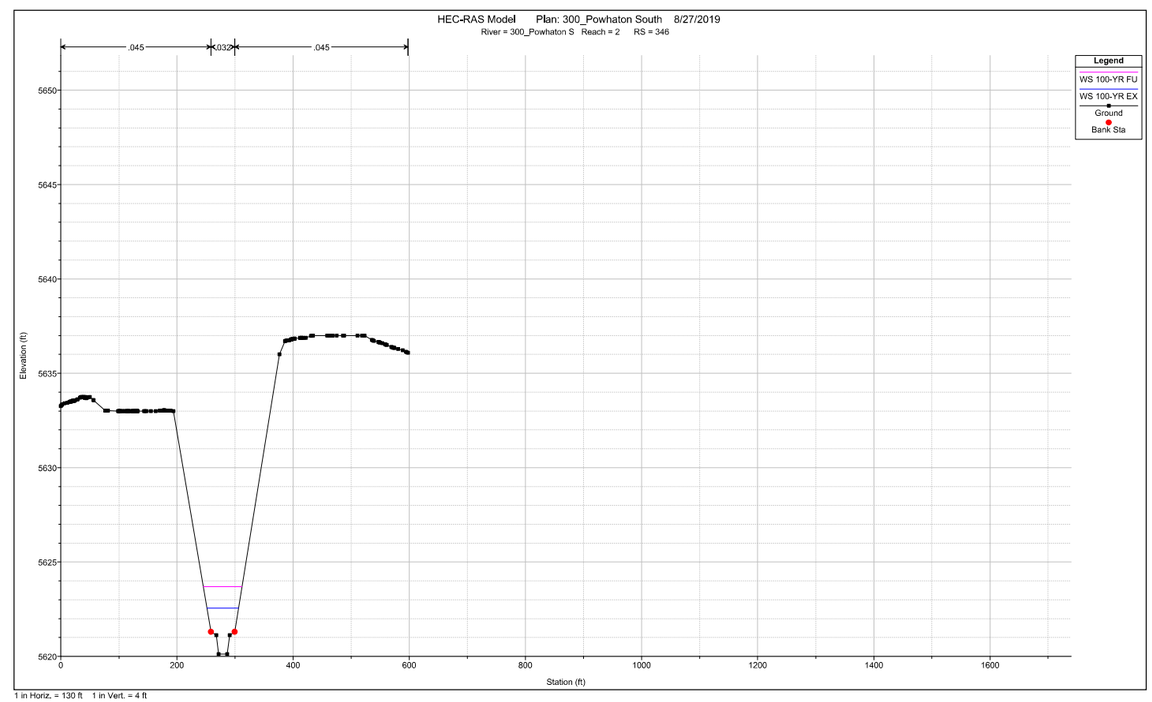

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 341
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

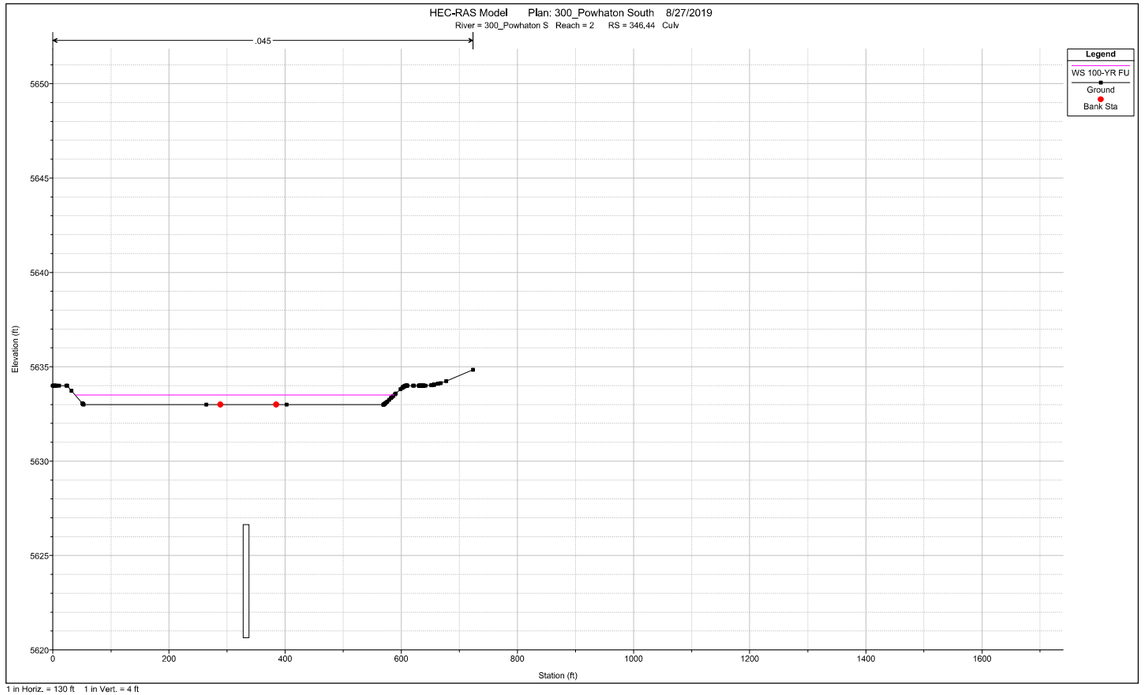

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 342
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

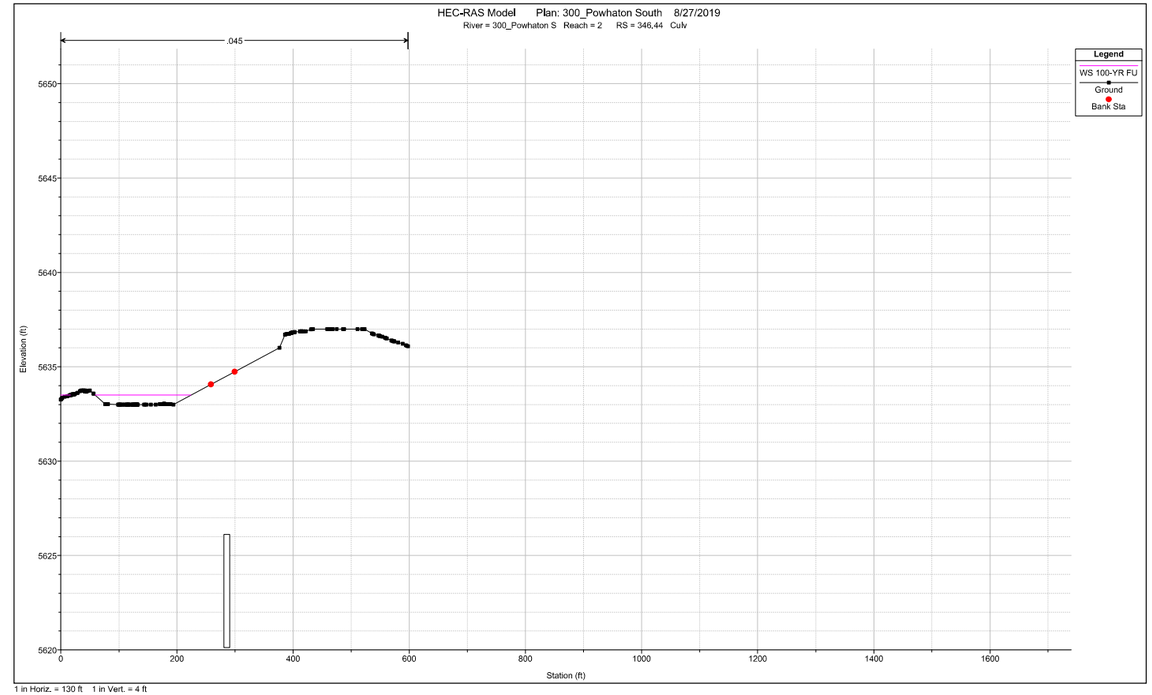

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 343
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

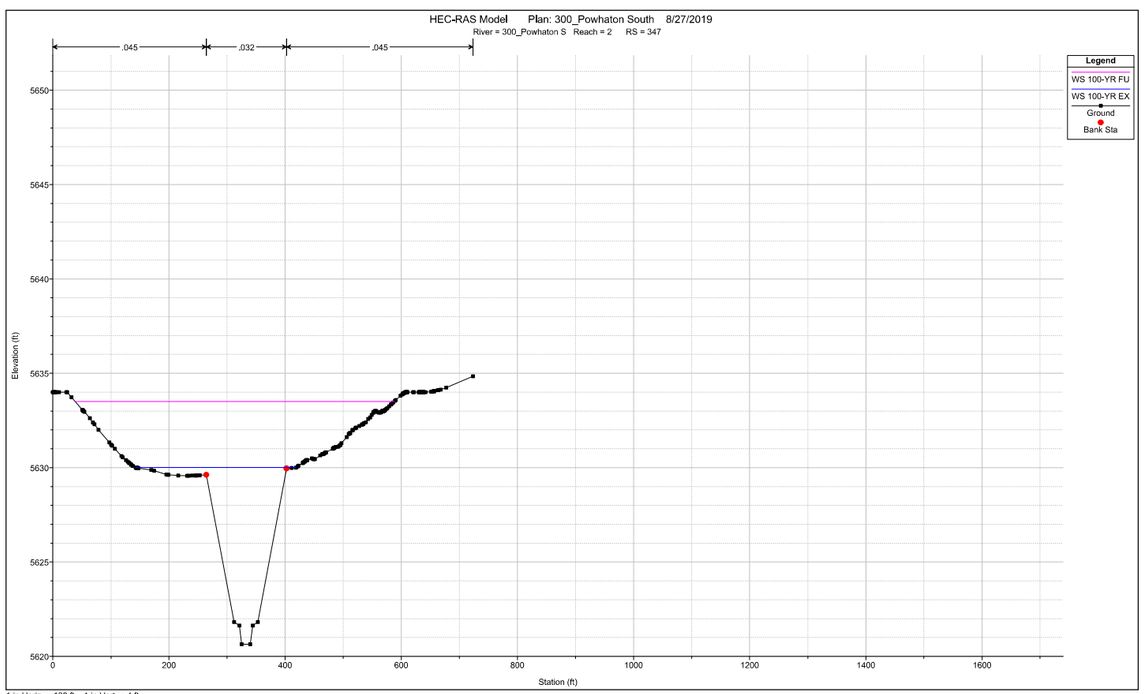

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 344
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

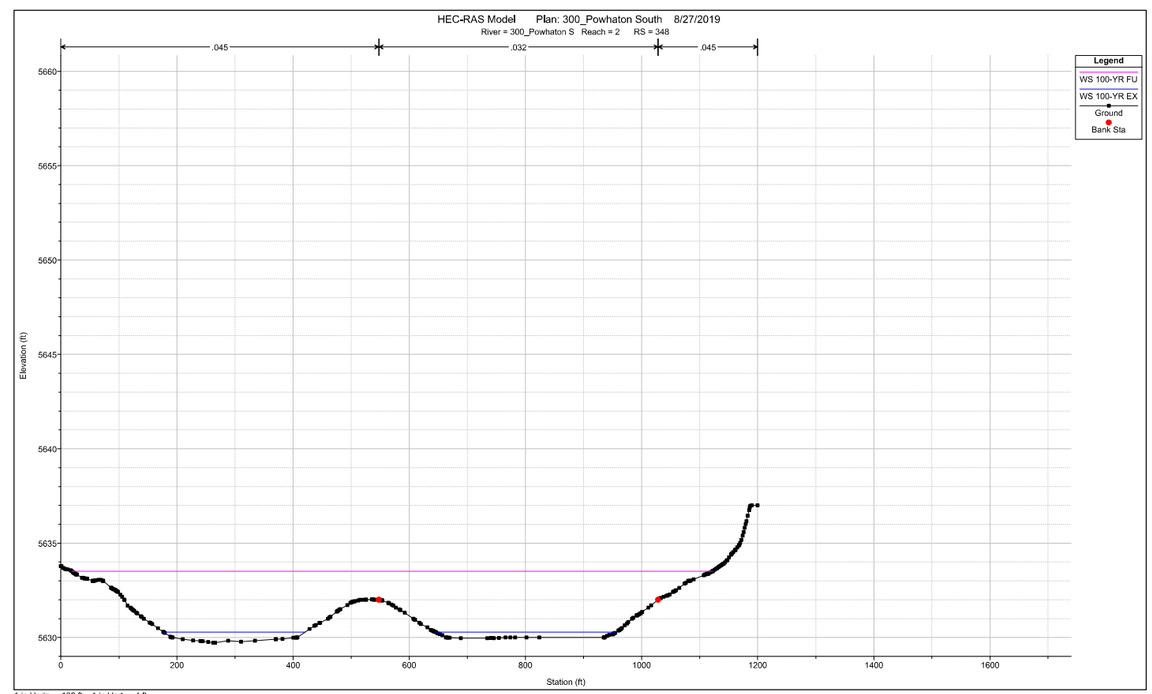

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 345
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

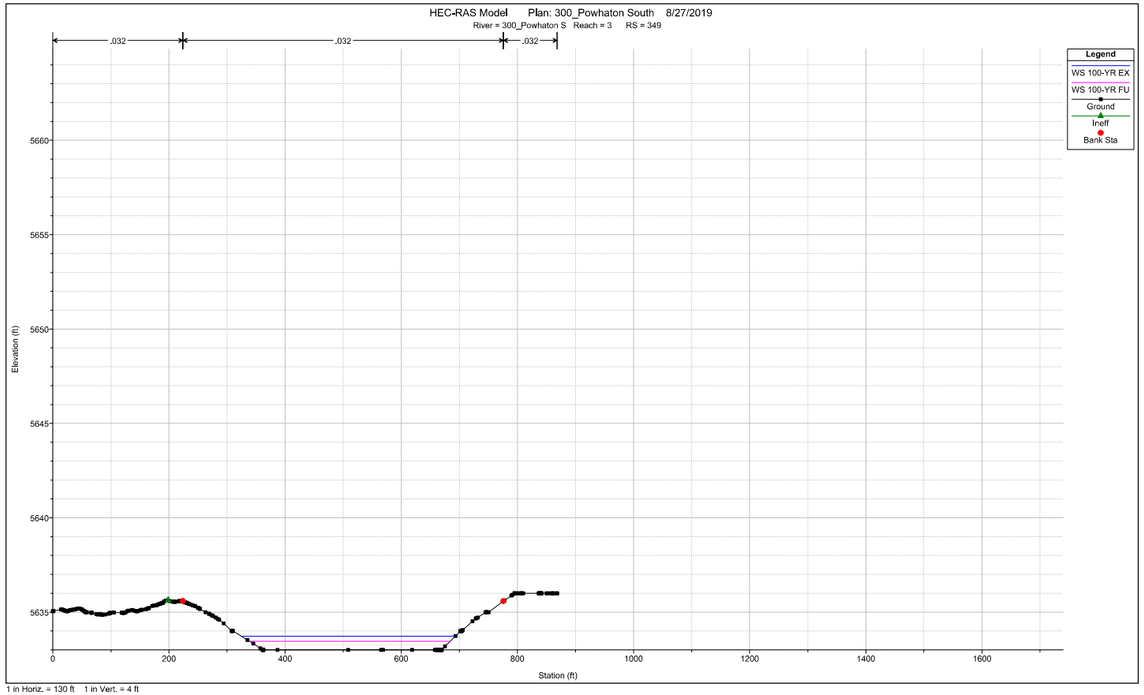

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 346
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

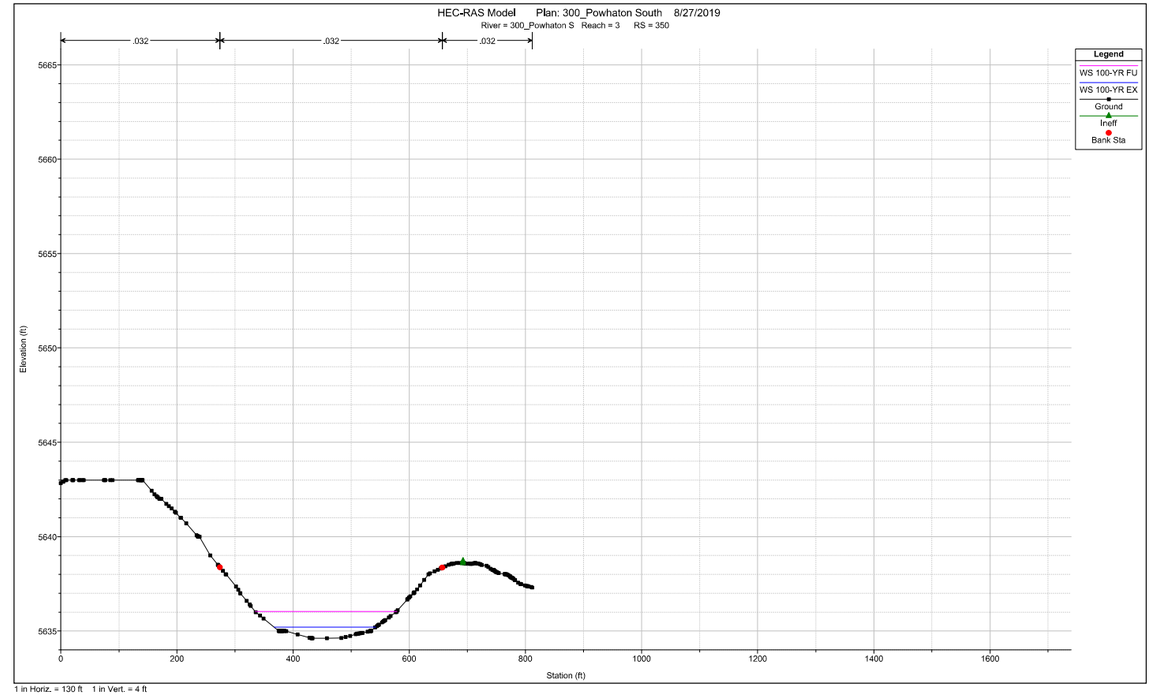

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 346.44 Culv
.045
Legend
WS 100-YR FU
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

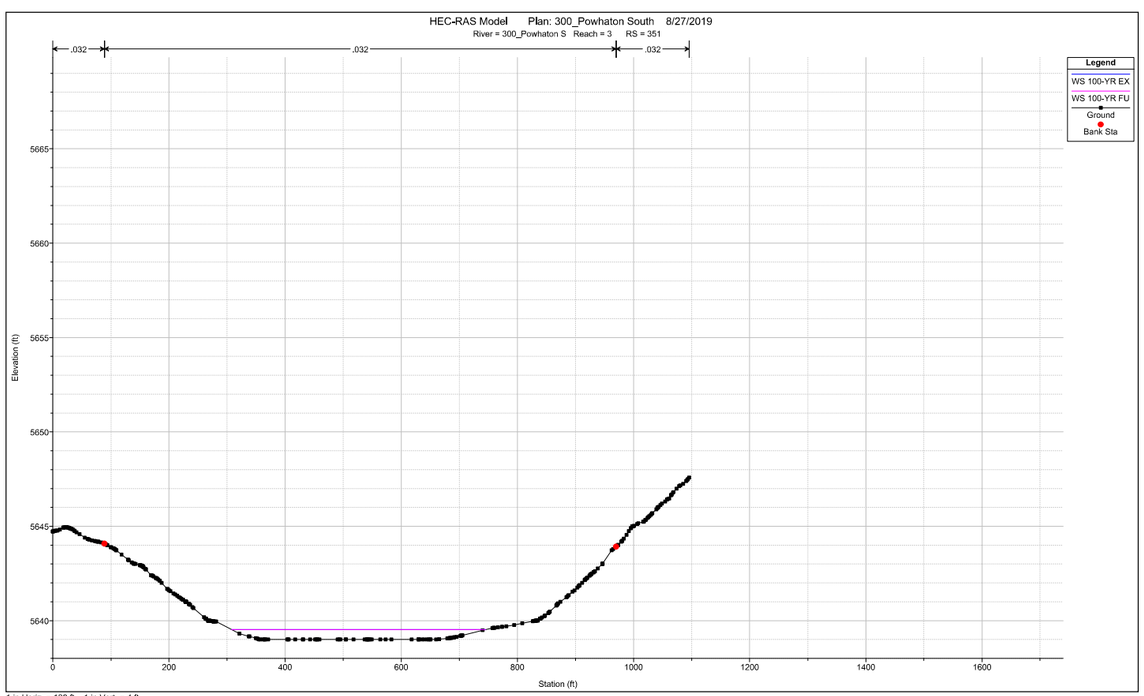

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 346.44 Culv
.045
Legend
WS 100-YR FU
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

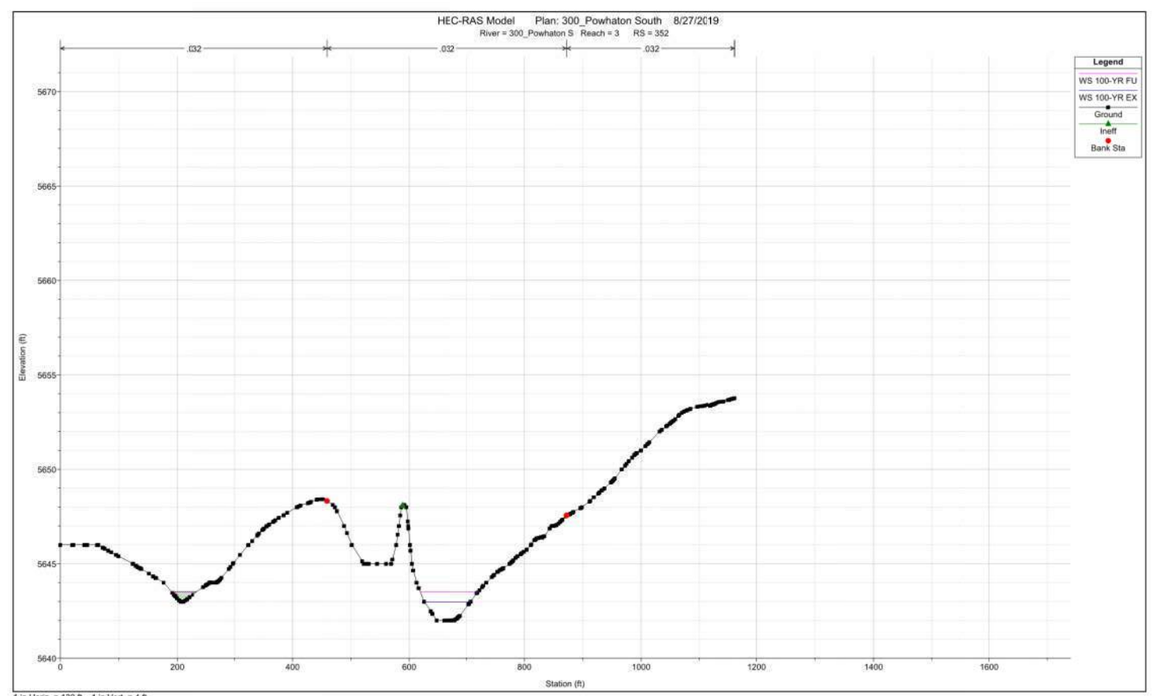

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 347
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

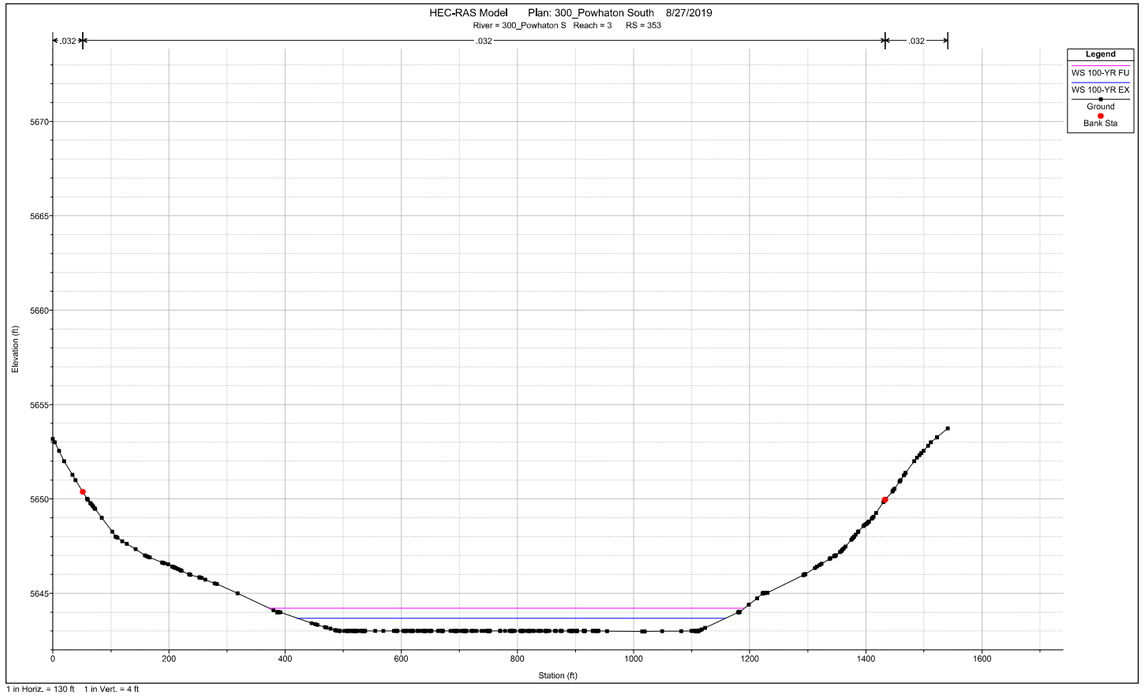

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 2 RS = 348
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

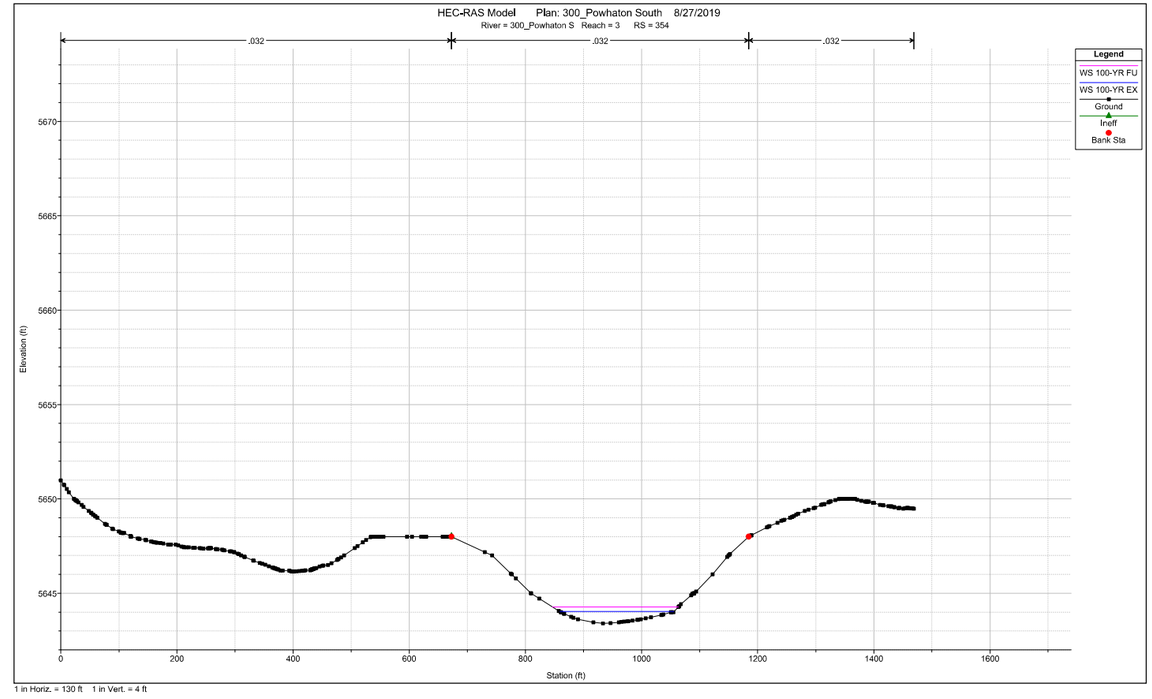

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 349
.032
.032
.032
Legend
WS 100-YR EX
WS 100-YR FU
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

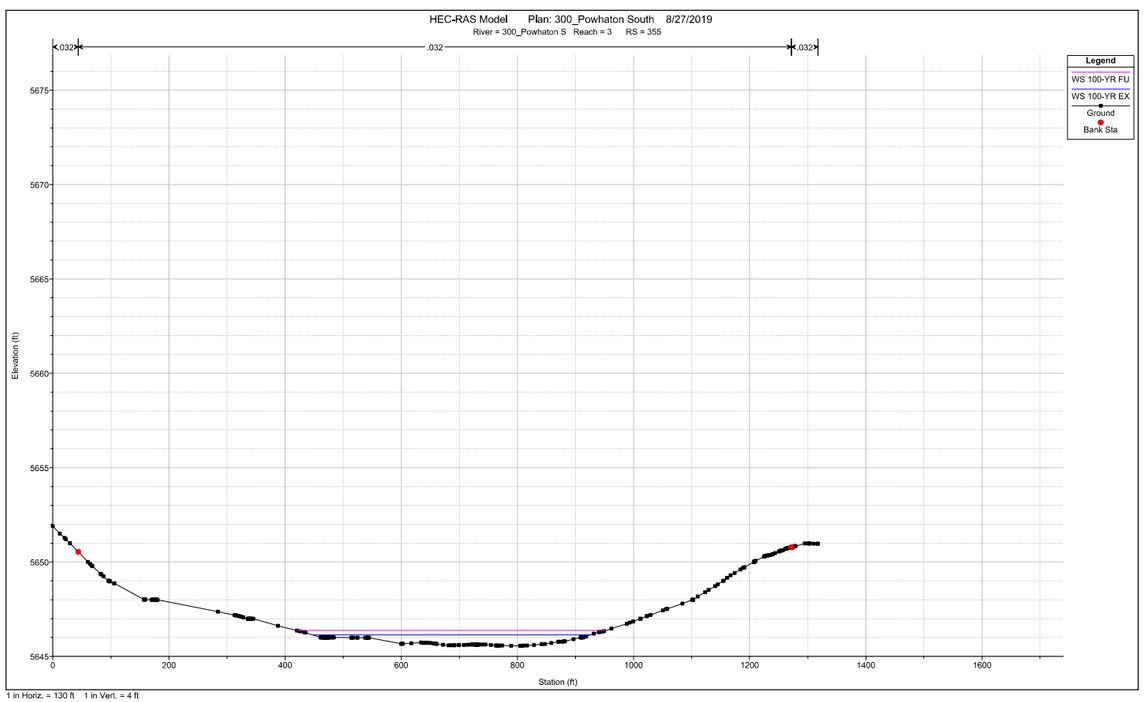

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 350
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

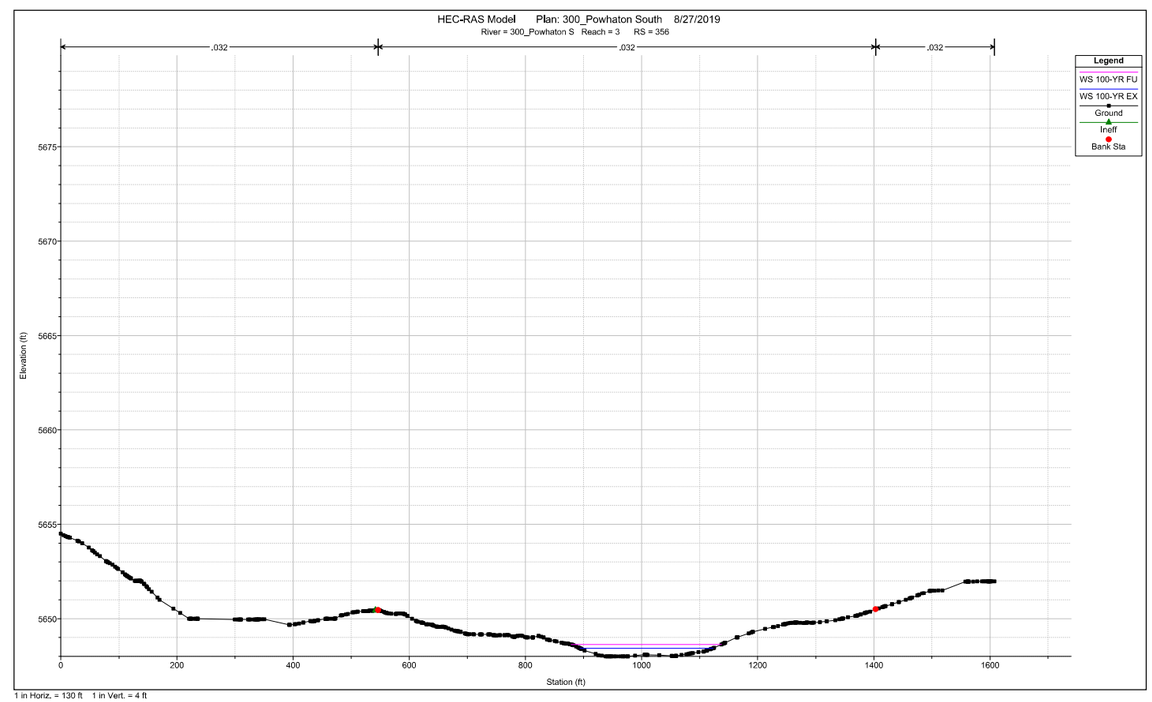

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 351
.032
.032
.032
Legend
WS 100-YR EX
WS 100-YR FU
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

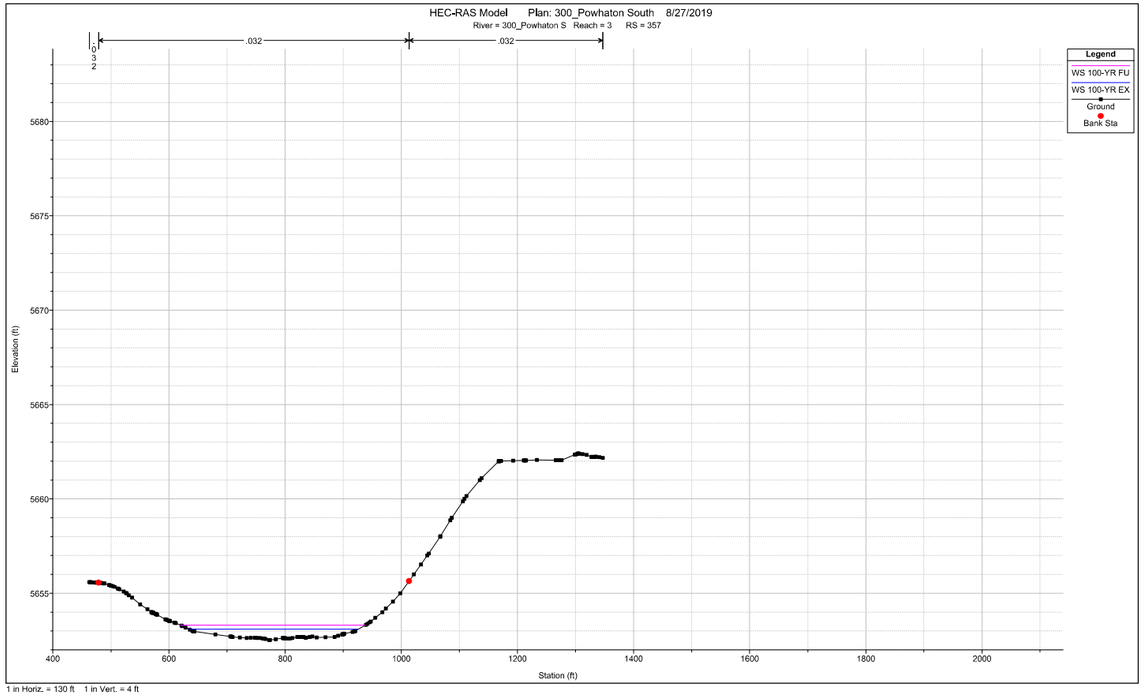

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 352
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

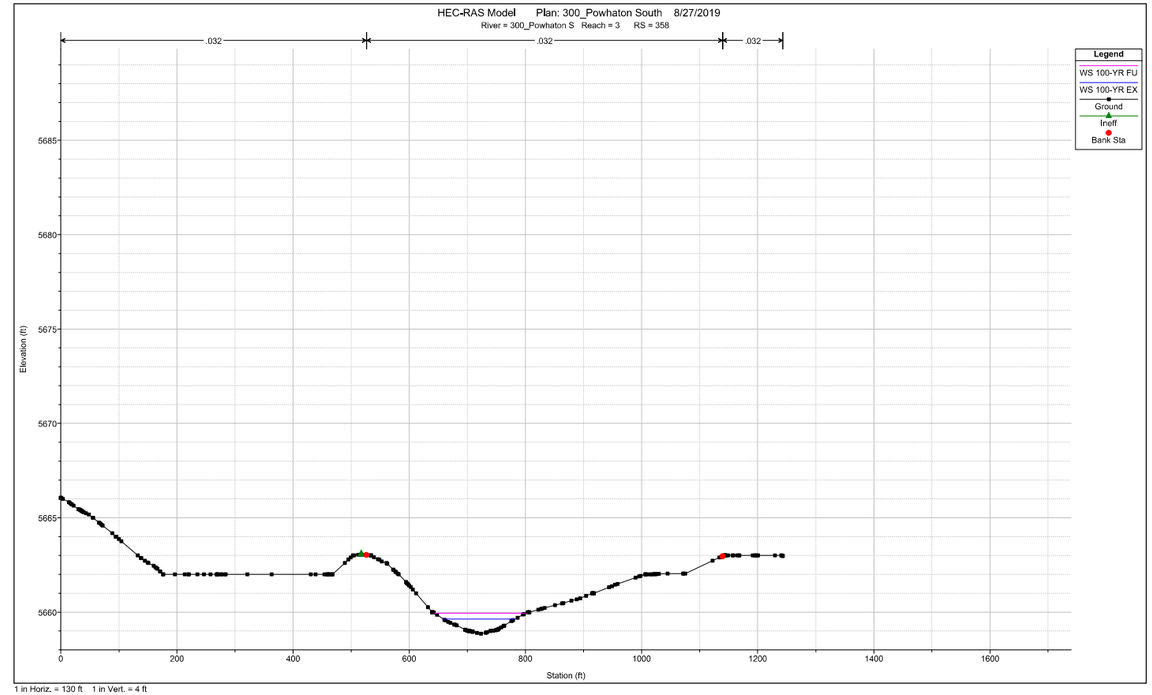

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 353
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
5670
5665
5660
5655
5650
5645
0
200
400
600
800
1000
1200
1400
1600
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

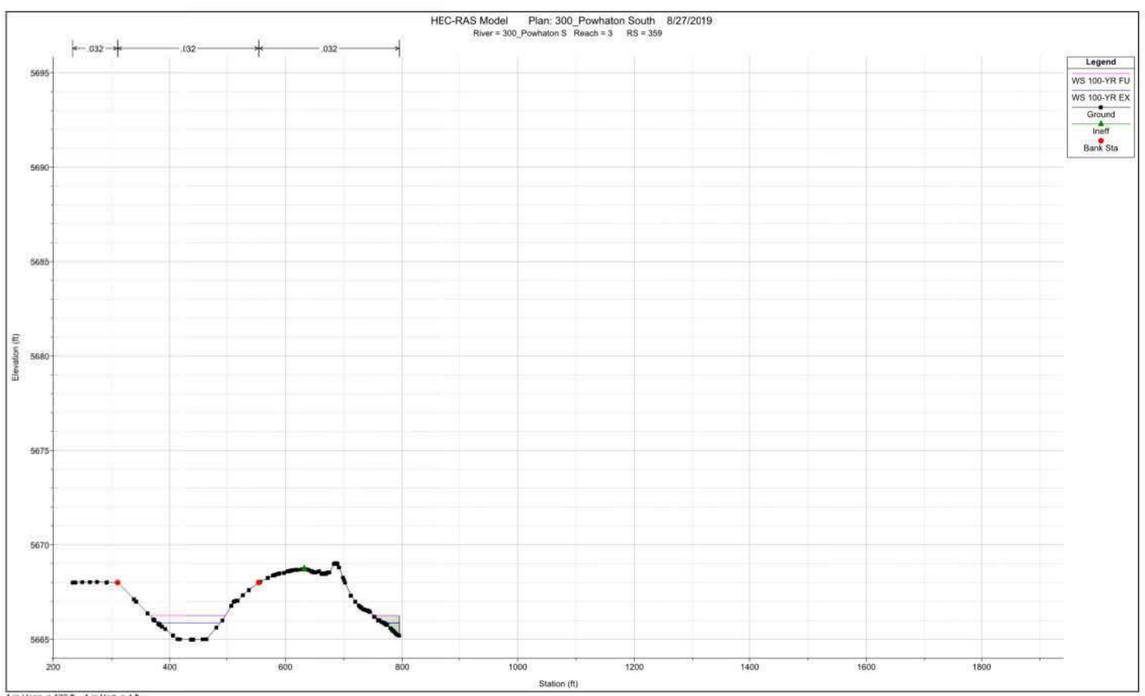

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 354
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
5670
5665
5660
5655
5650
5645
0
200
400
600
800
1000
1200
1400
1600
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

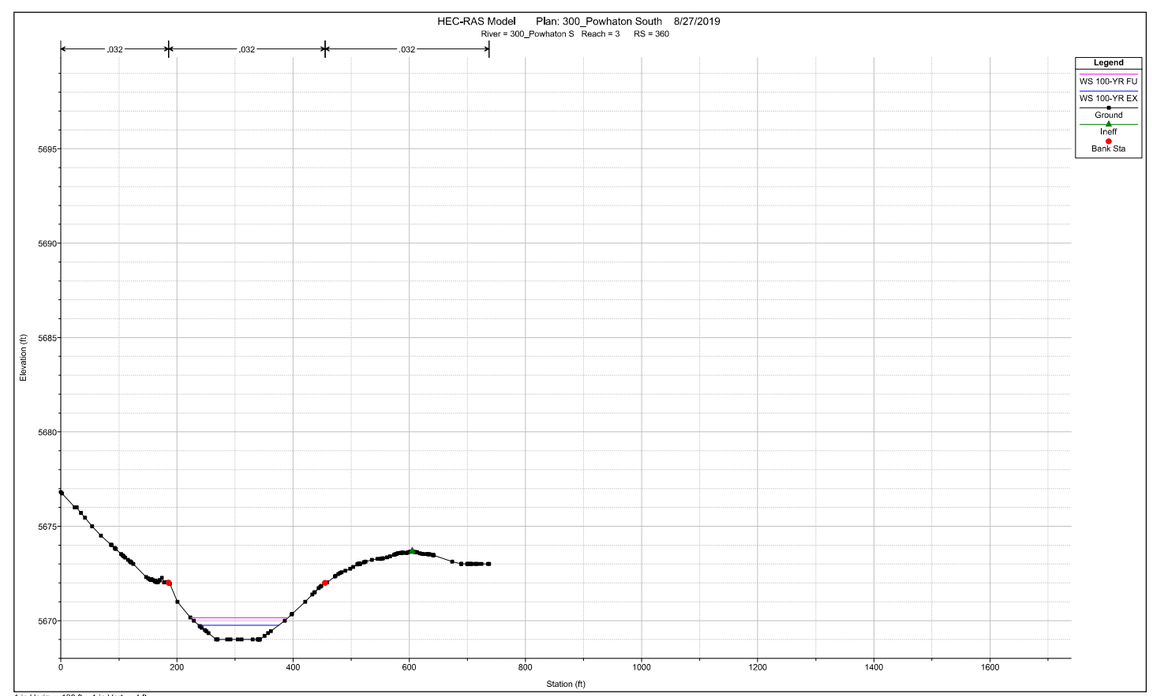

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 355
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
5675
5670
5665
5660
5655
5650
5645
0
200
400
600
800
1000
1200
1400
1600
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

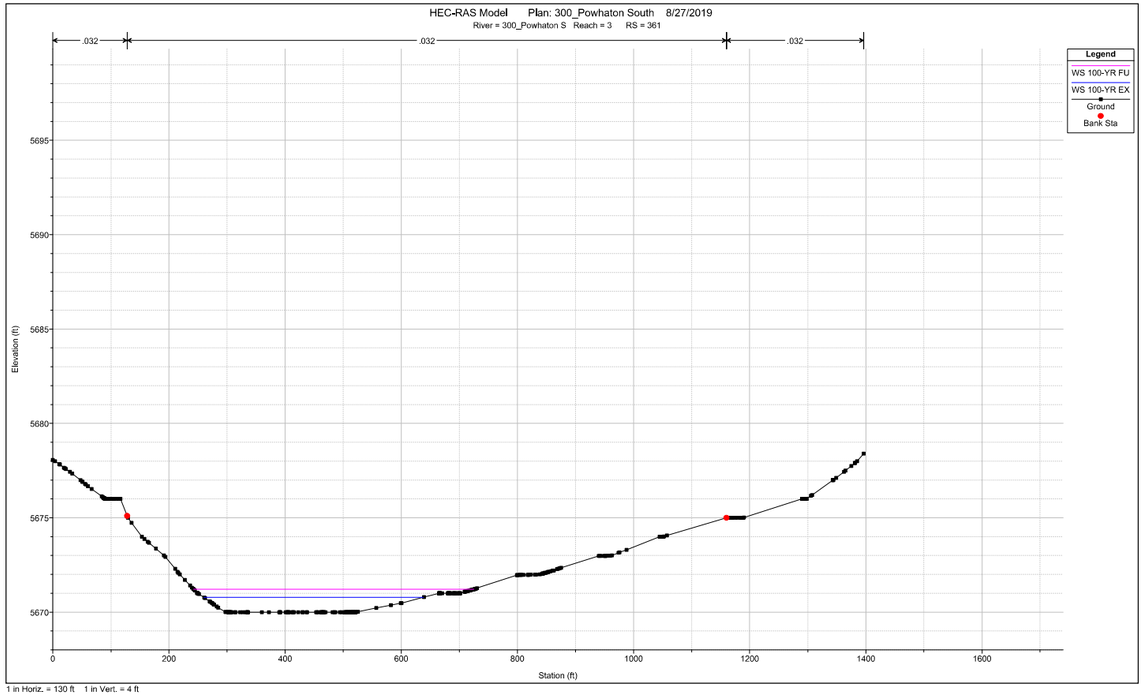

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 356
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
5675
5670
5665
5660
5655
5650
0
200
400
600
800
1000
1200
1400
1600
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

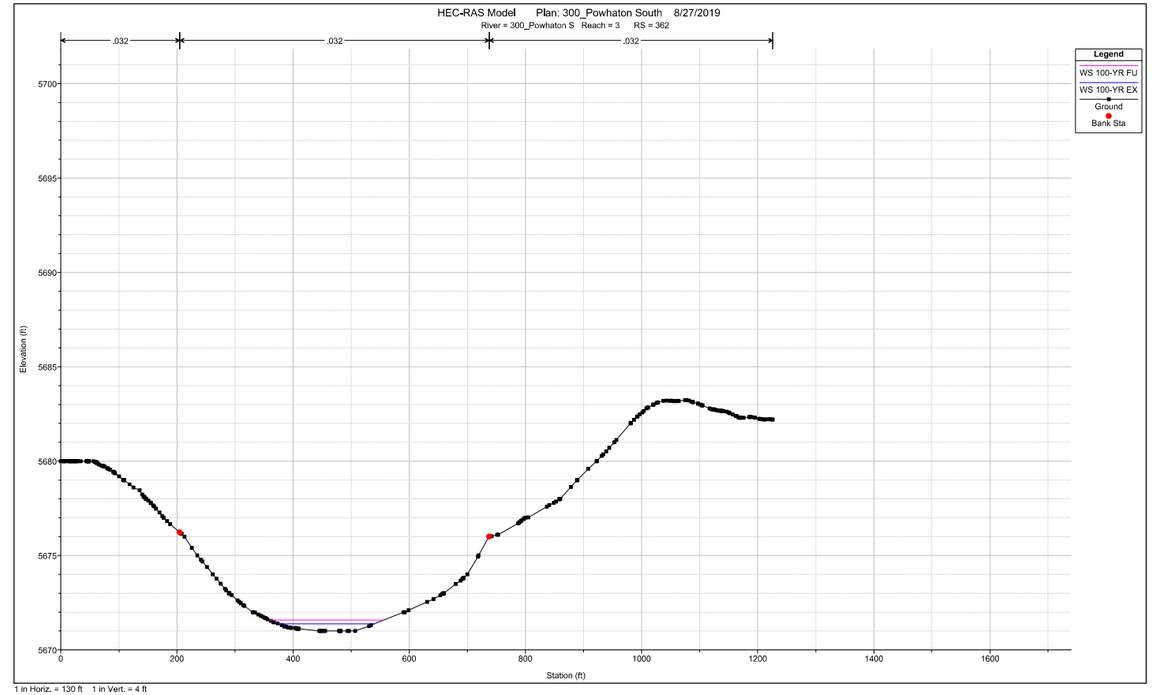

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 357
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

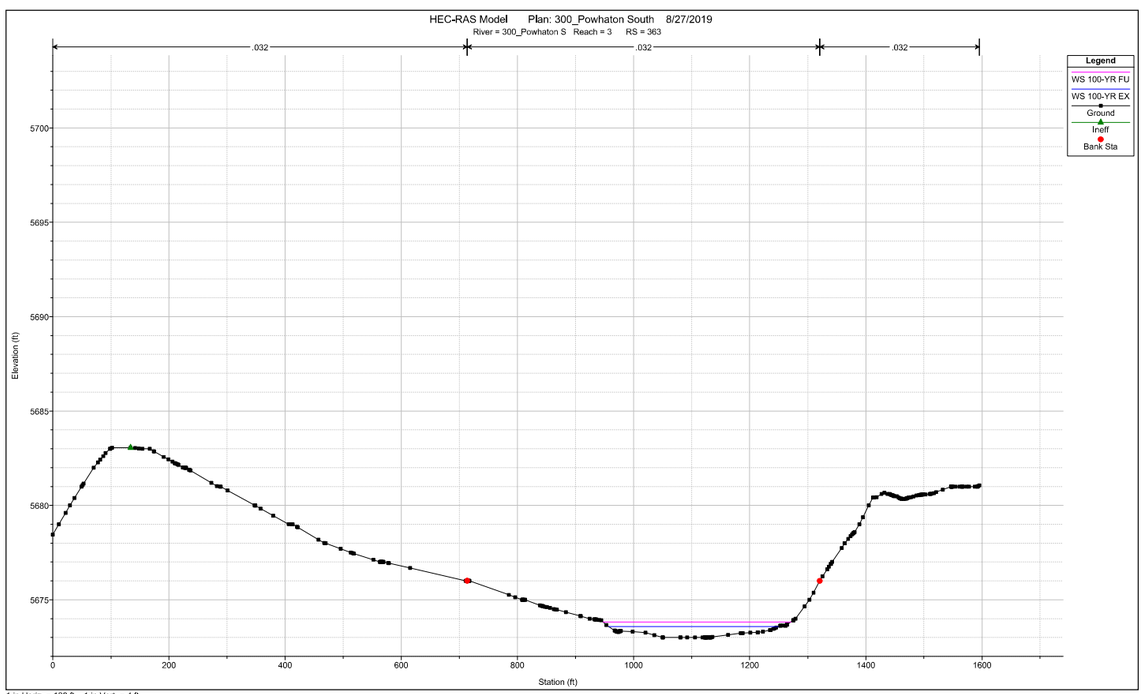

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 358
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

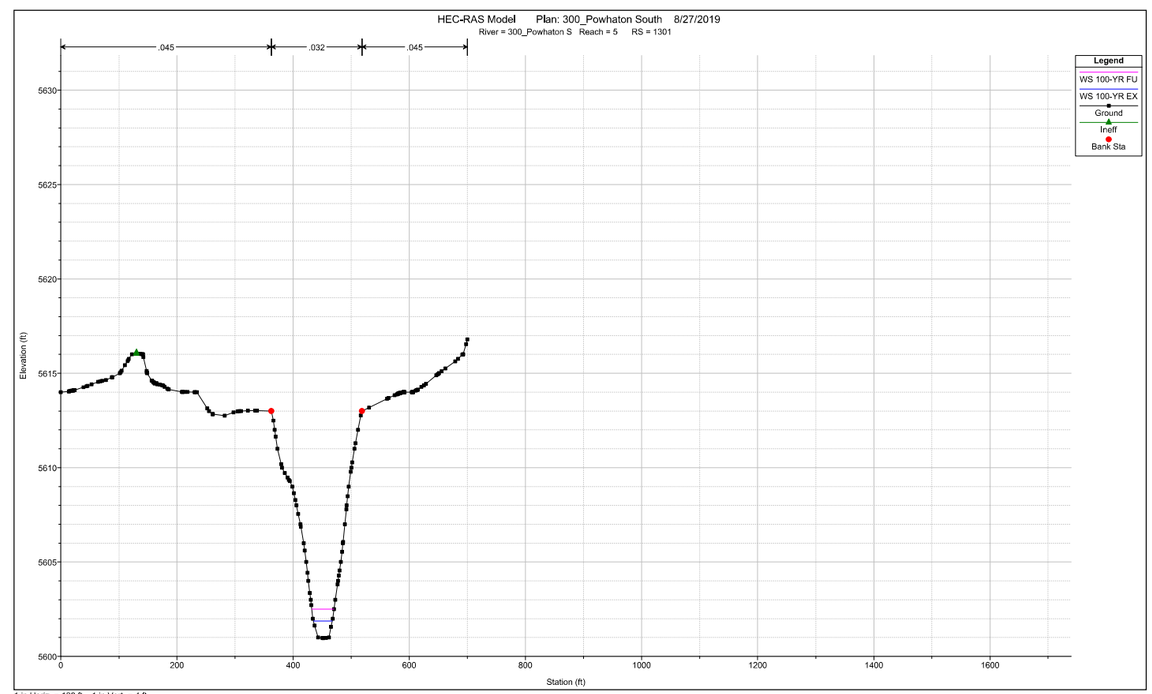

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 359
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

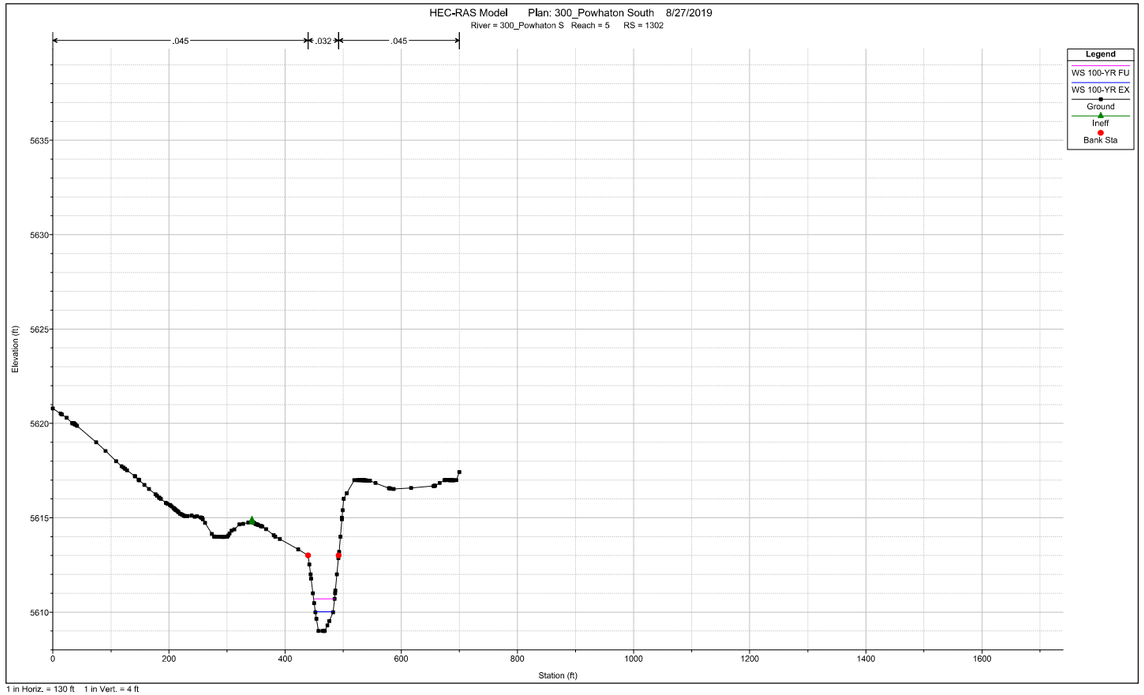

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 360
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

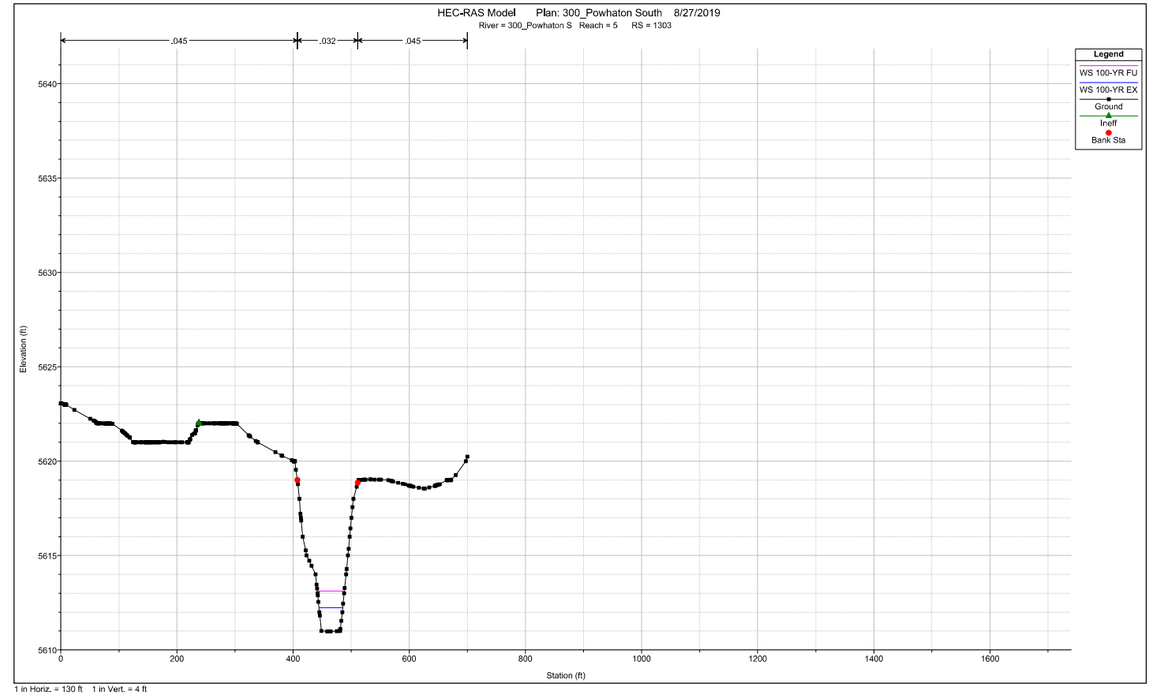

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 361
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

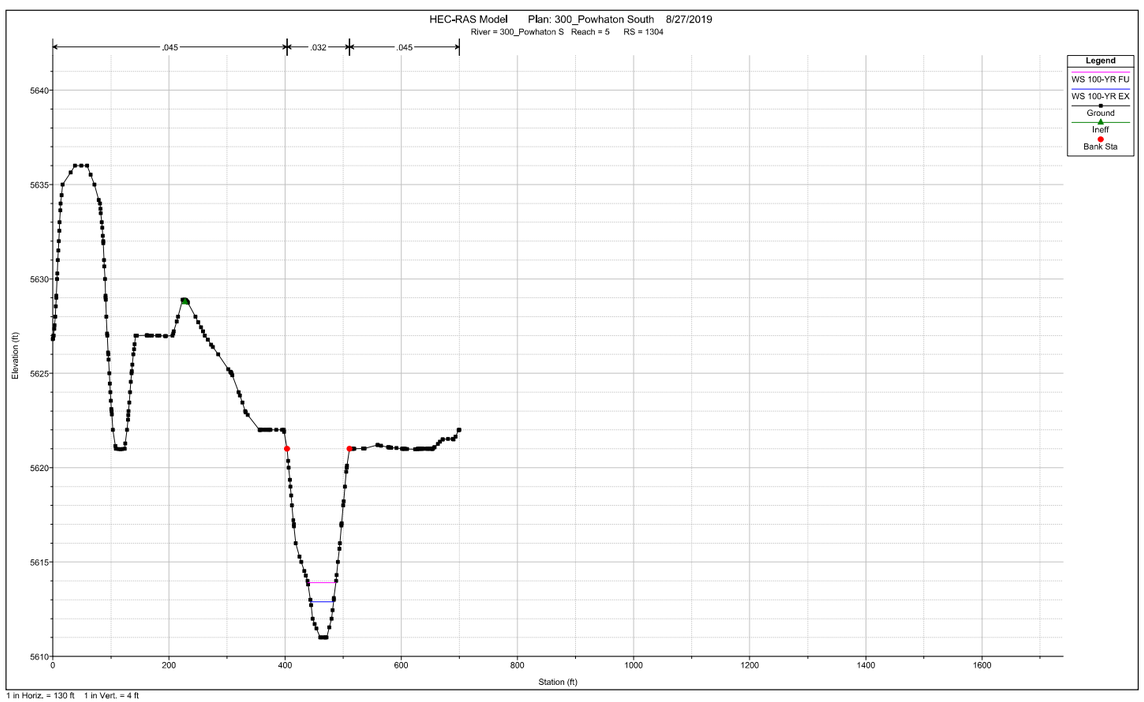

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 362
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

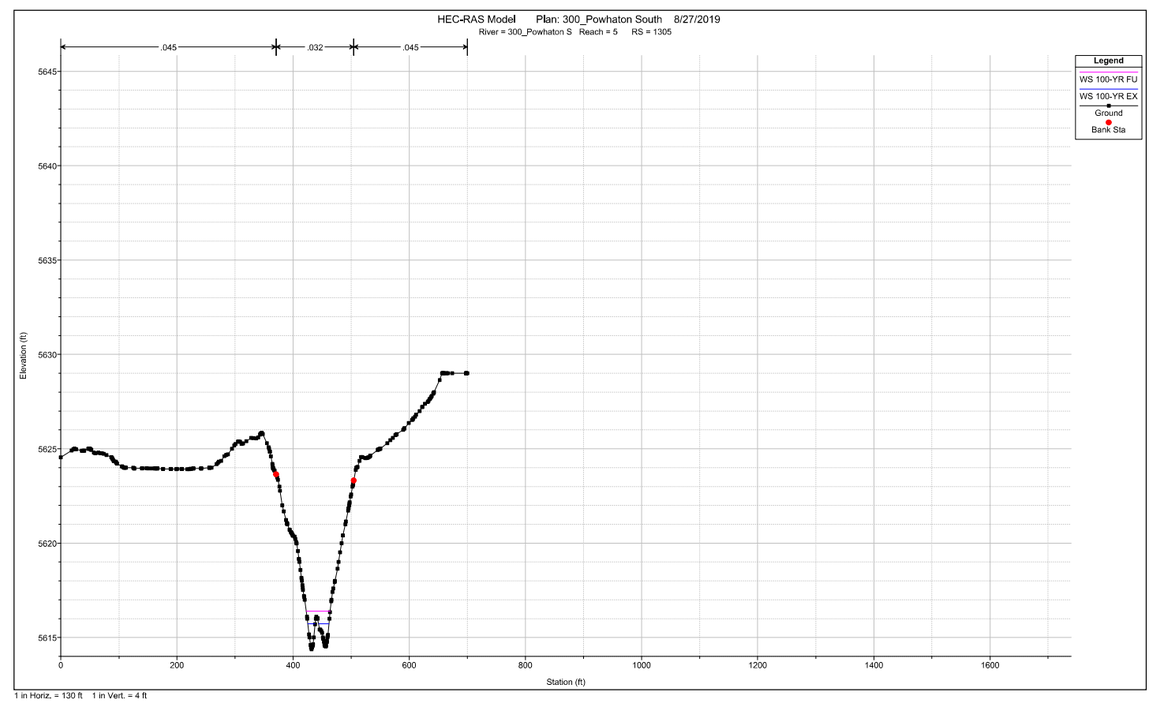

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 3 RS = 363
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

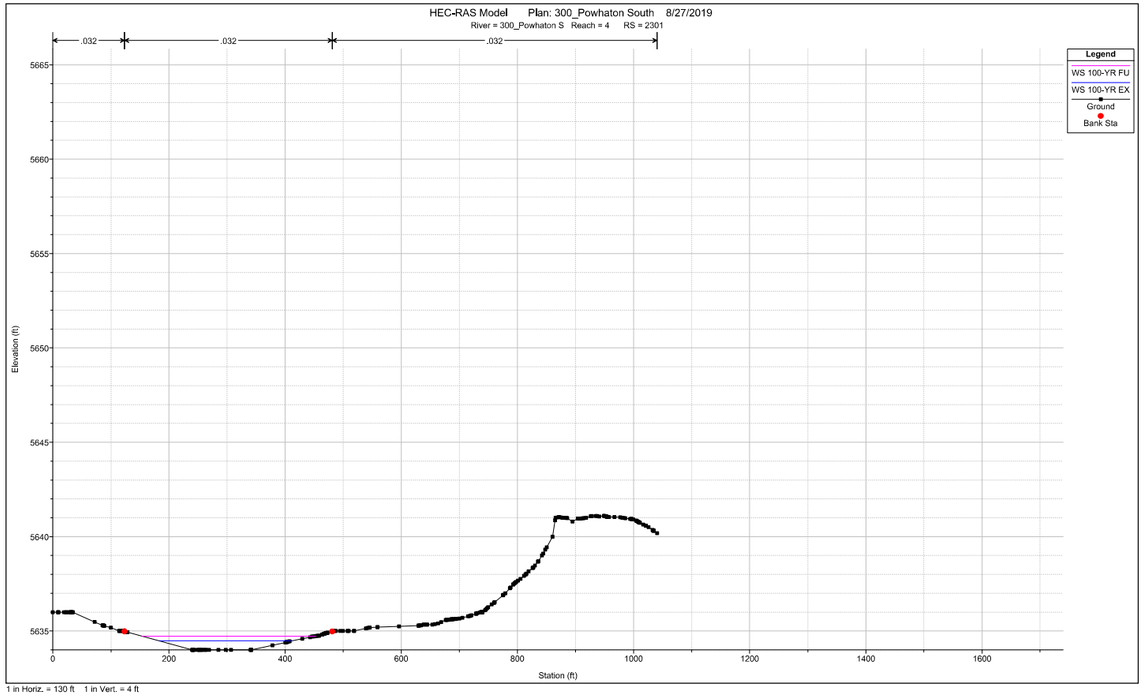

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 5 RS = 1301
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

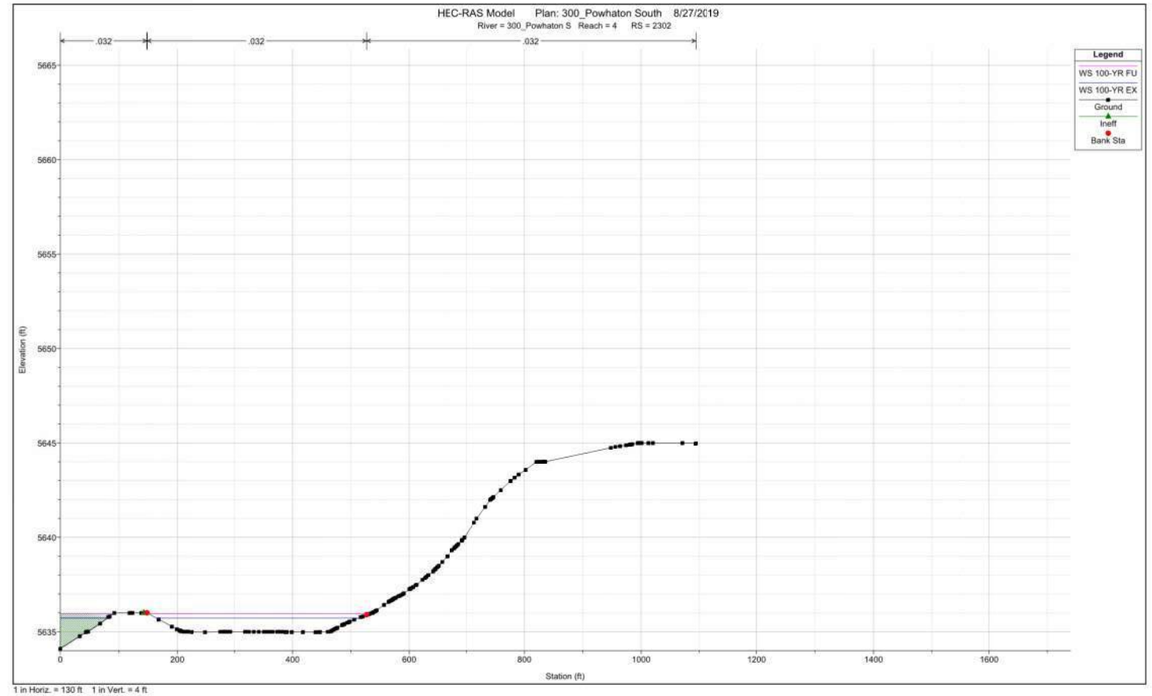

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 5 RS = 1302
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

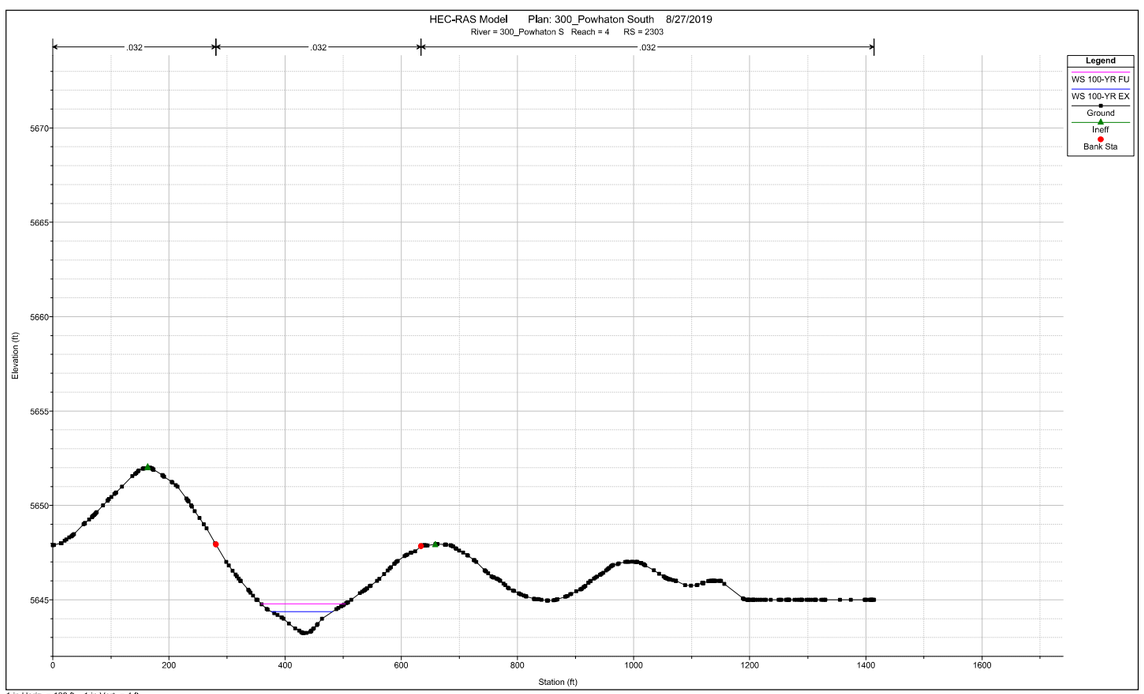

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 5 RS = 1303
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

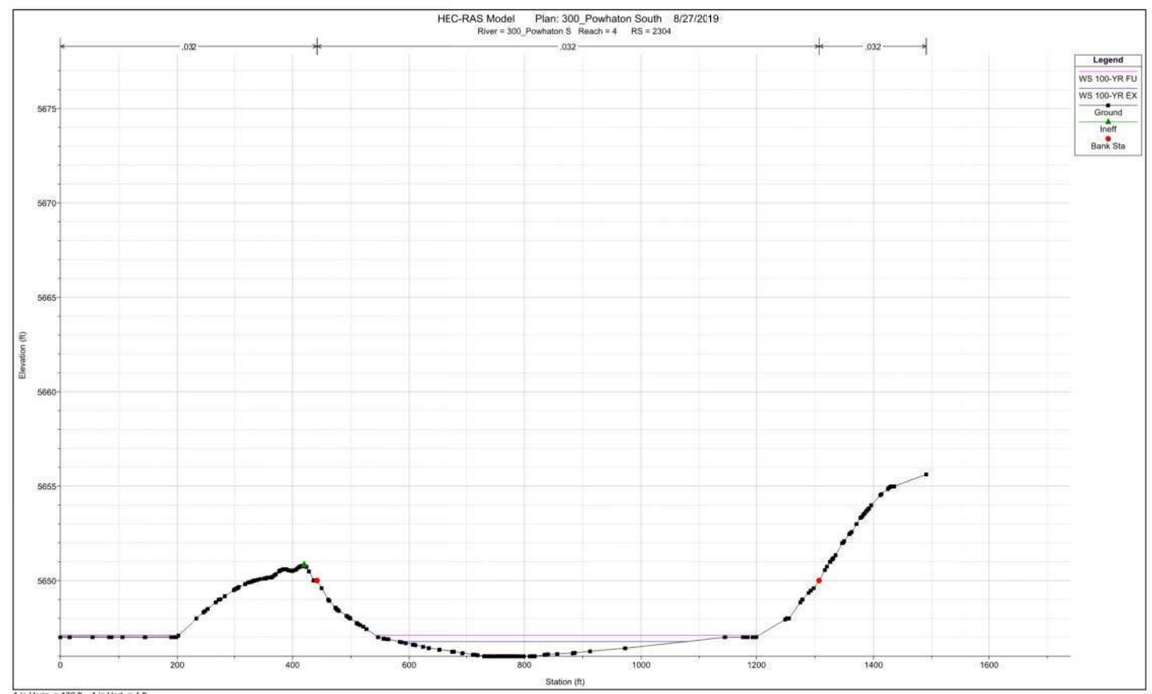

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 5 RS = 1304
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

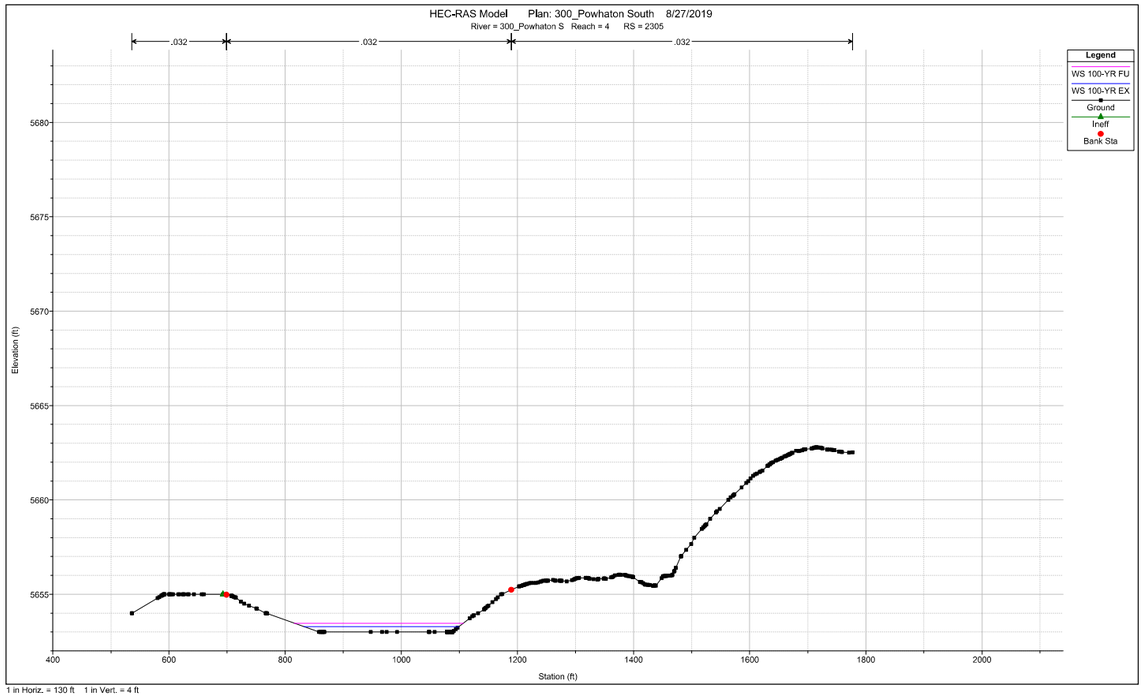

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 5 RS = 1305
.045
.032
.045
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

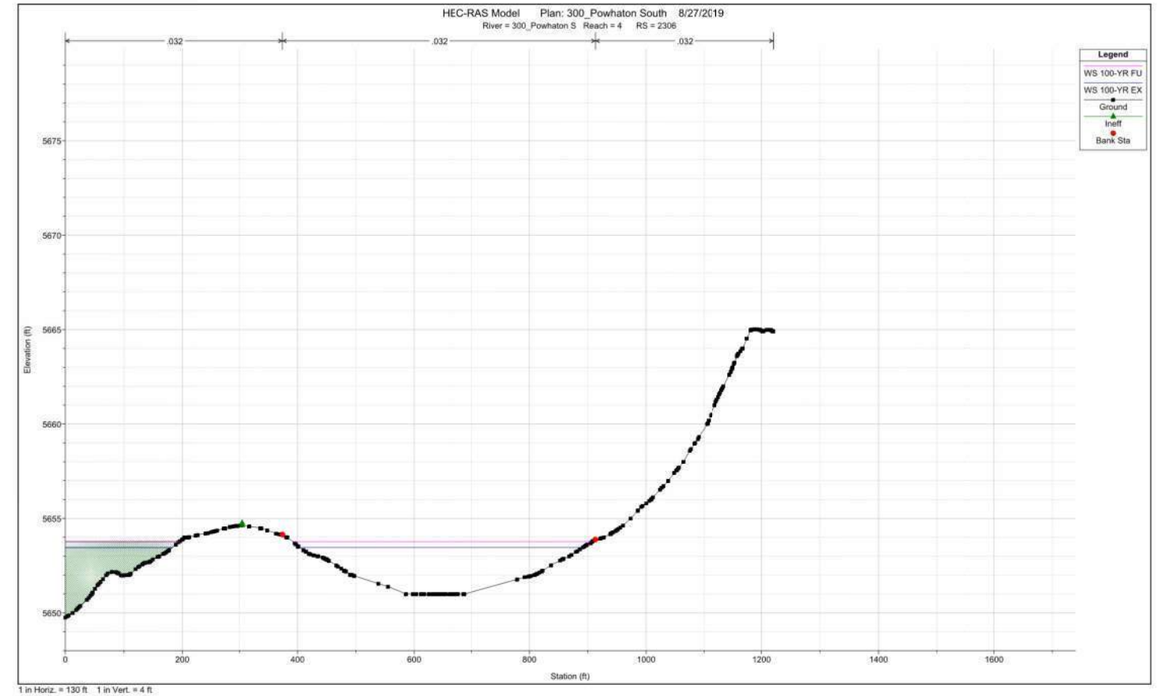

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2301
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

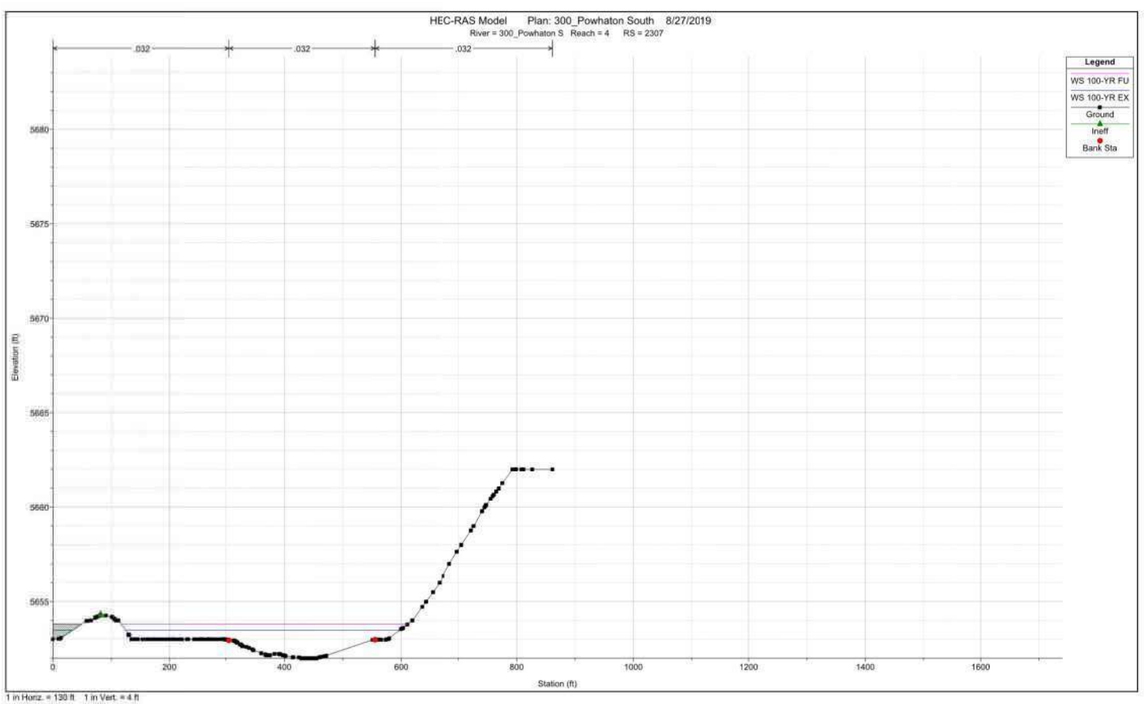

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2302
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

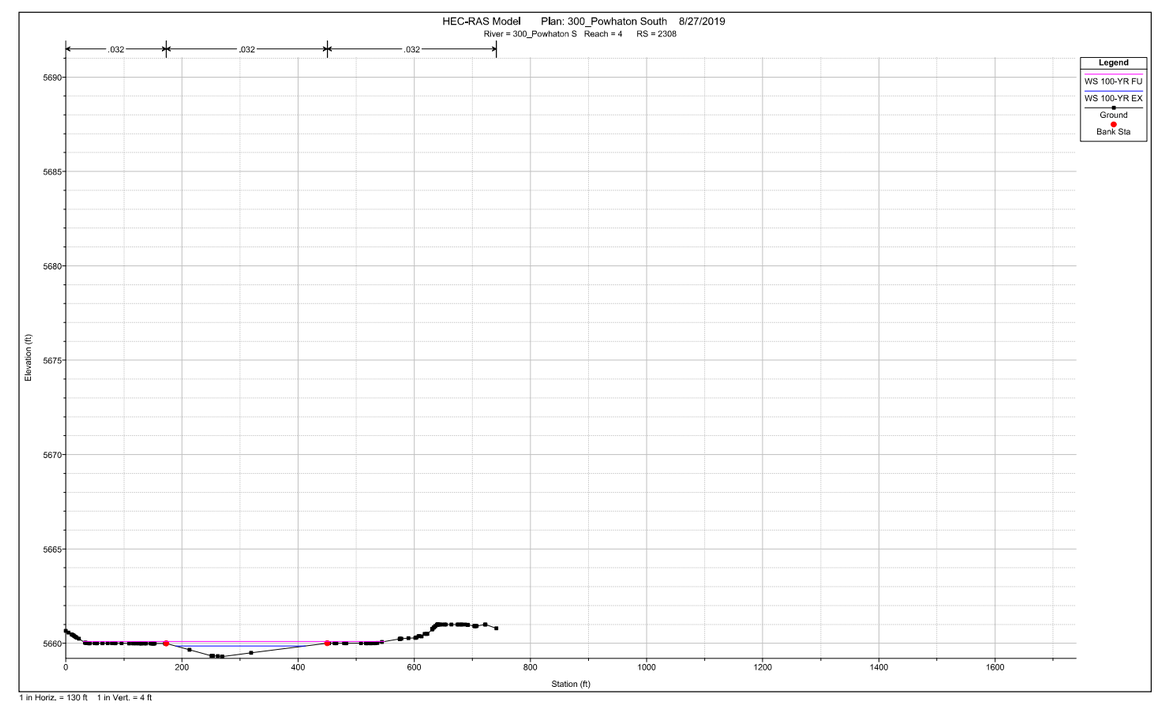

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2303
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

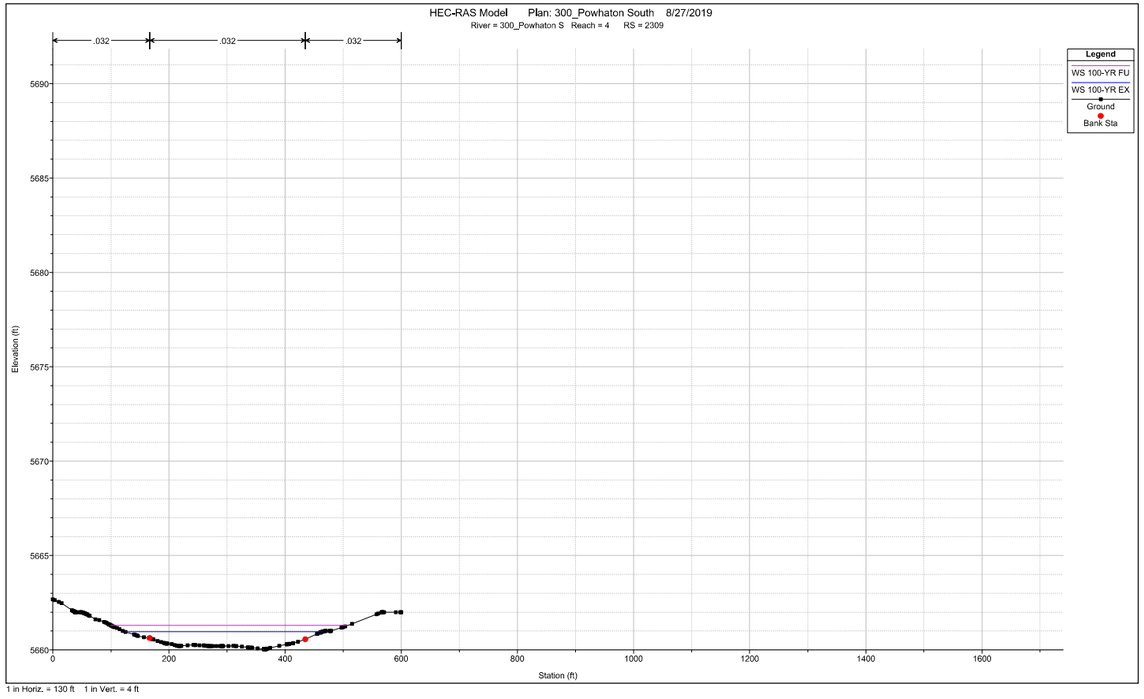

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2304
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

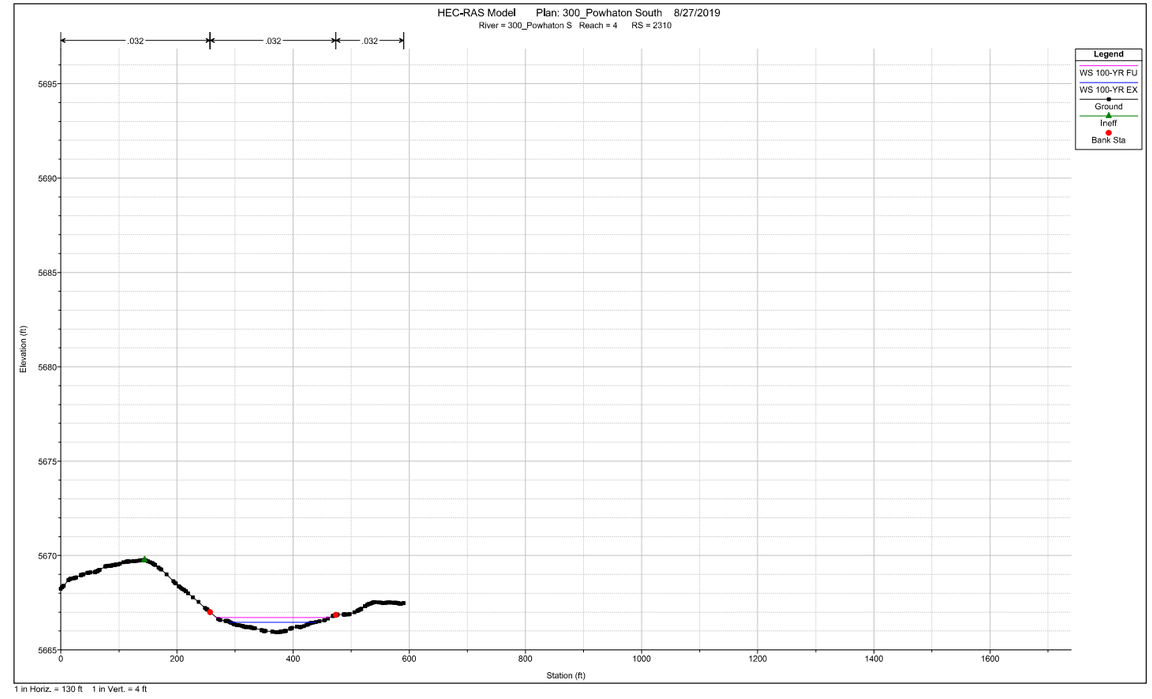

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2305
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

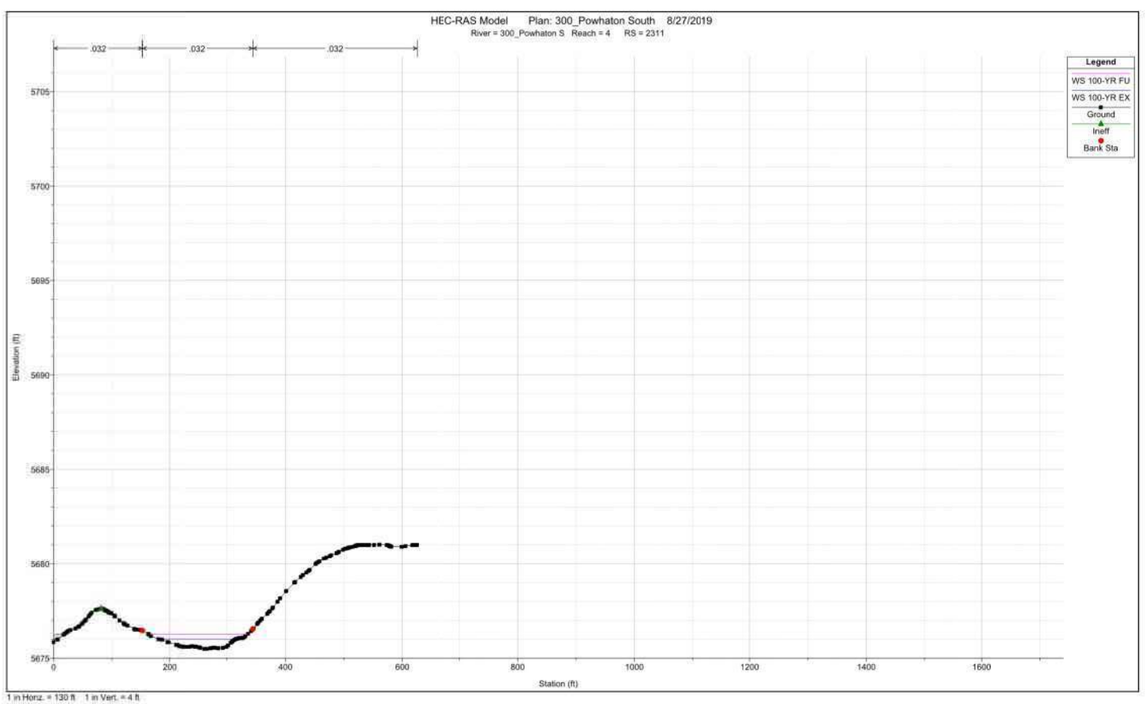

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2306
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

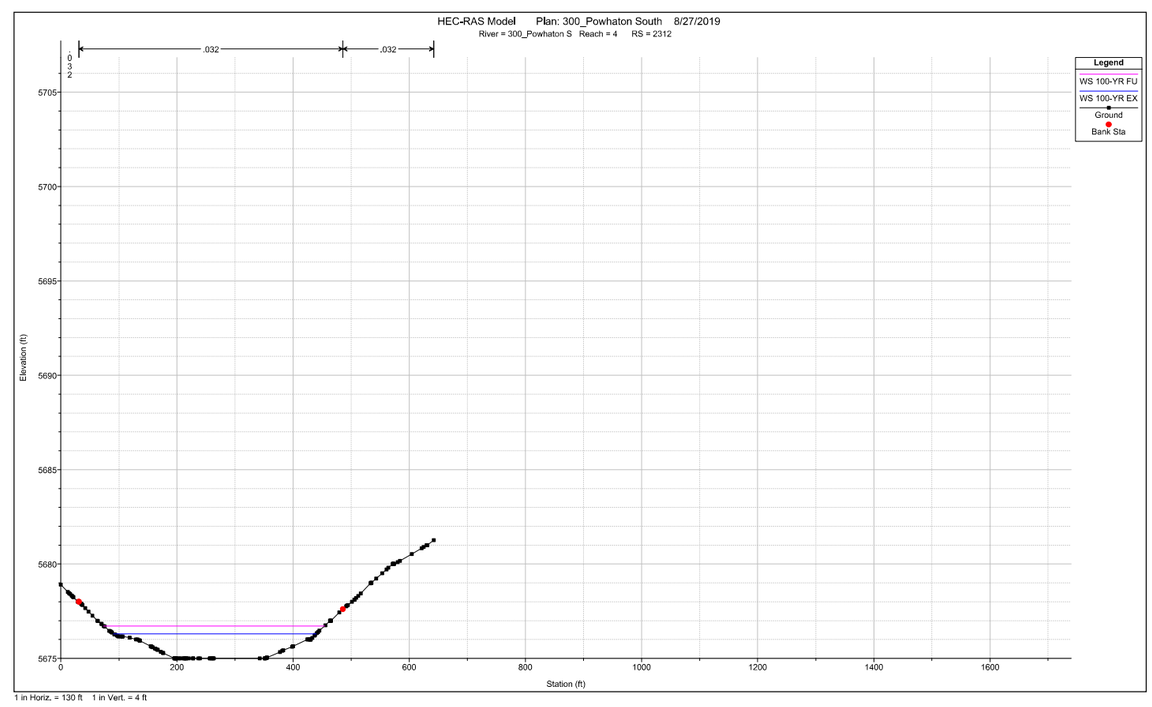

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2307
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

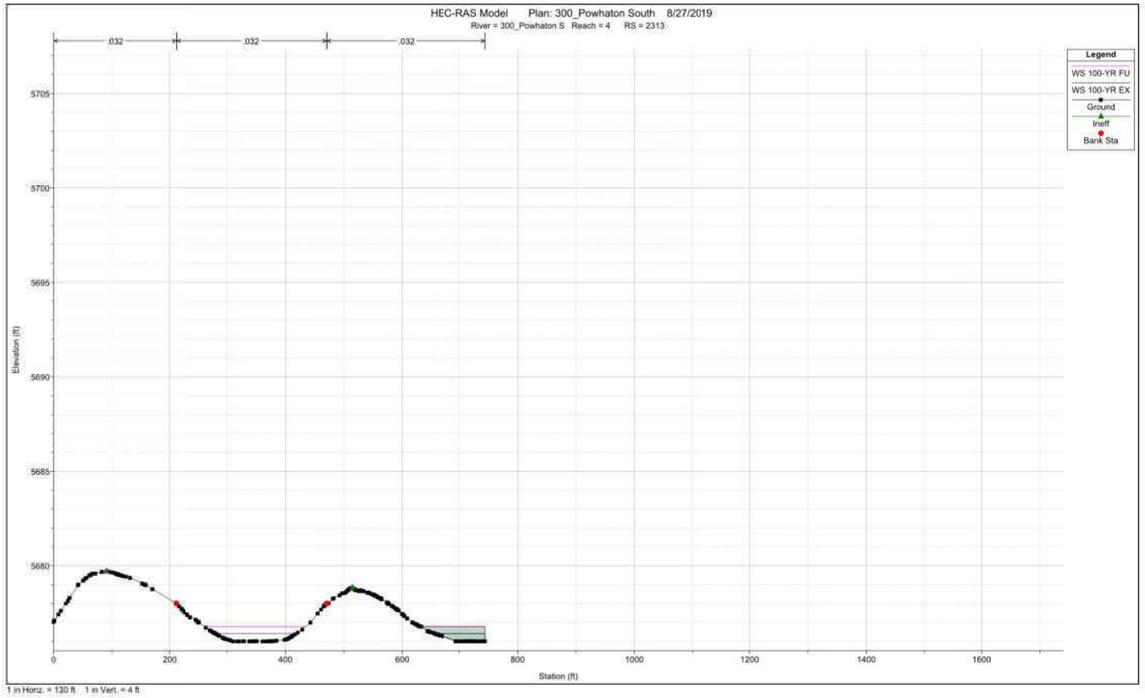

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2308
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

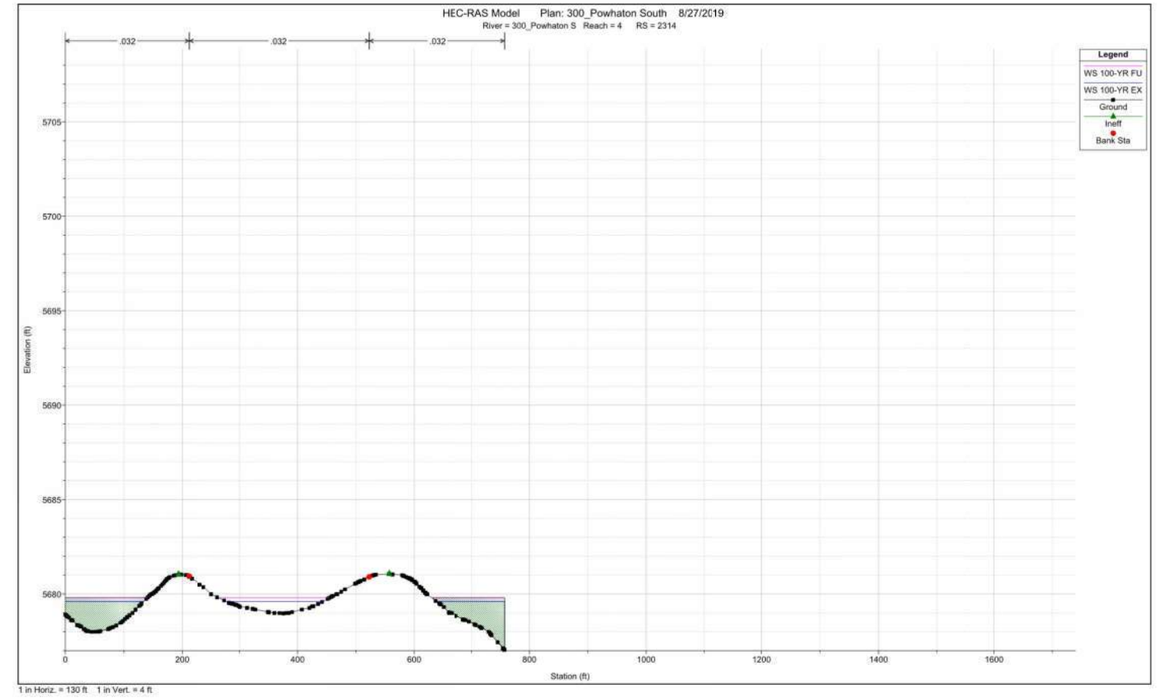

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2309
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

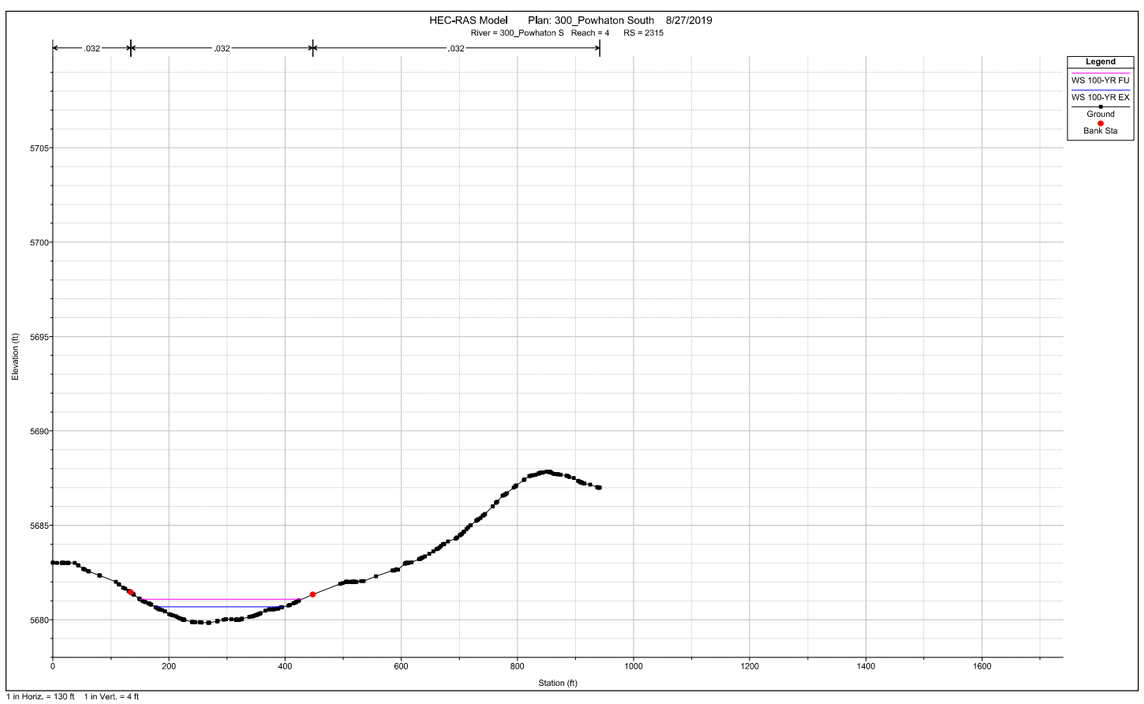

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2310
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

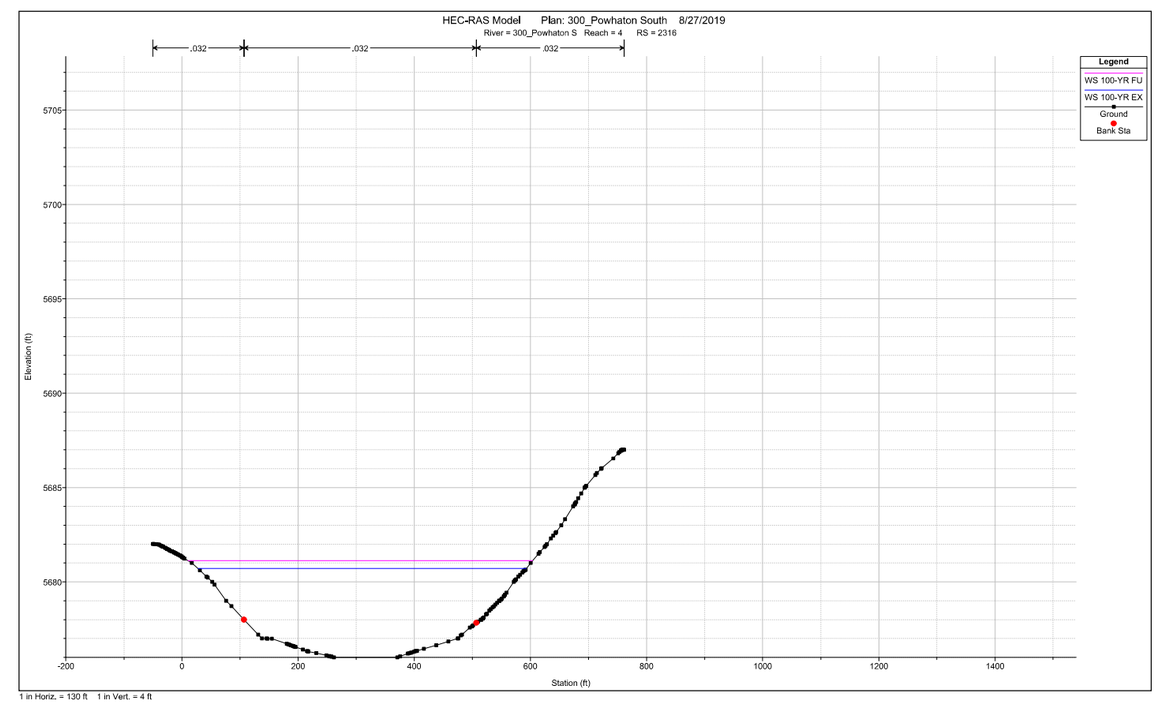

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2311
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

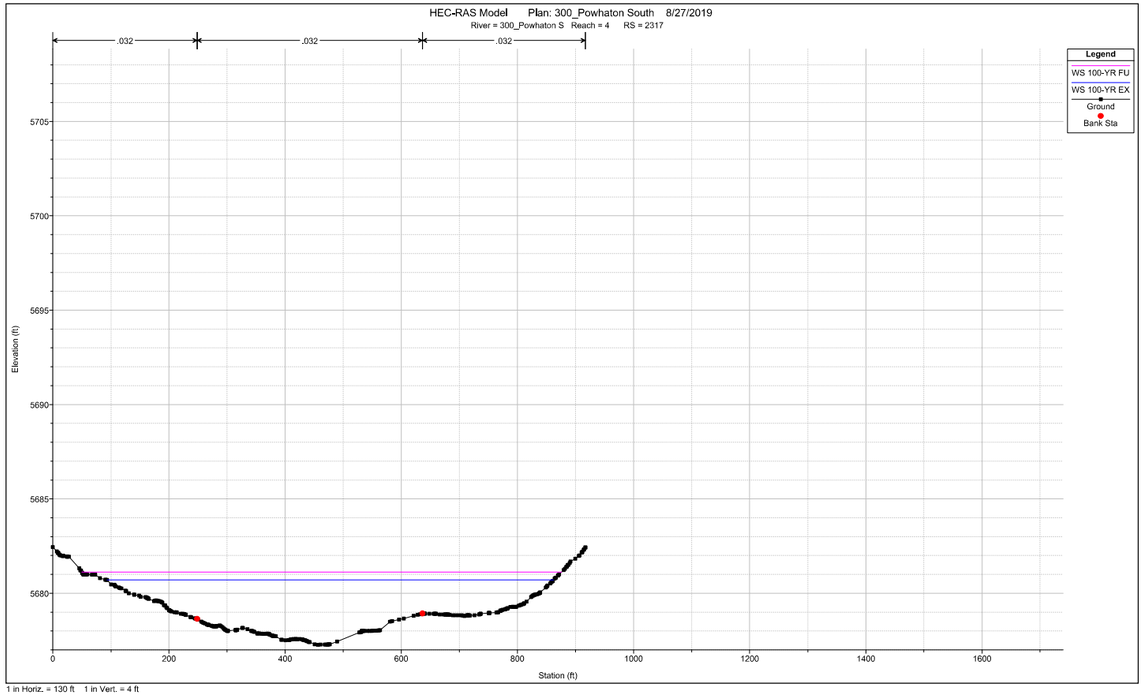

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2312
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2313
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2314
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

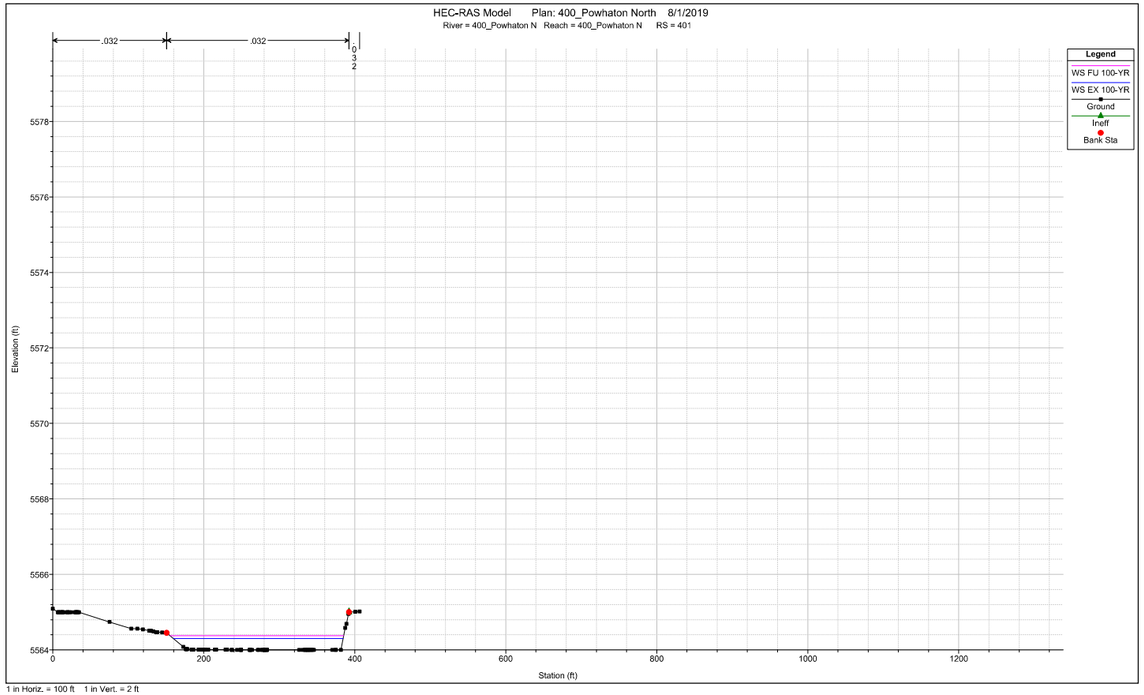

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2315
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

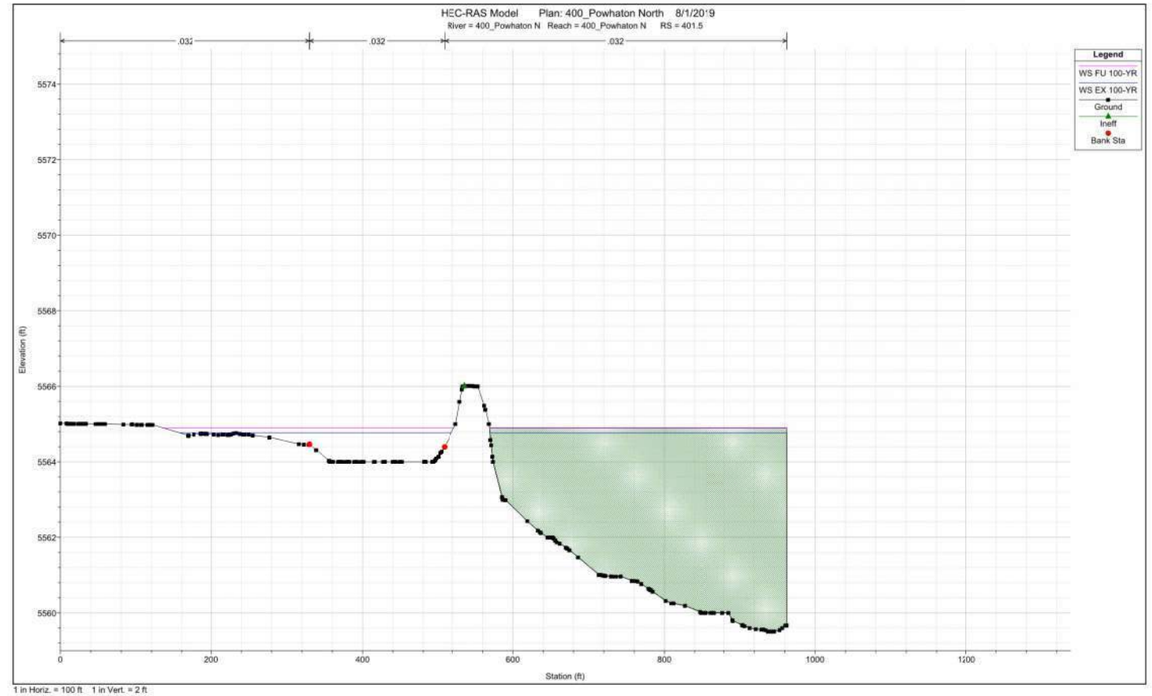

HEC-RAS Model Plan: 300_Powhaton South 8/27/2019
River = 300_Powhaton S Reach = 4 RS = 2316
.032
.032
.032
Legend
WS 100-YR FU
WS 100-YR EX
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

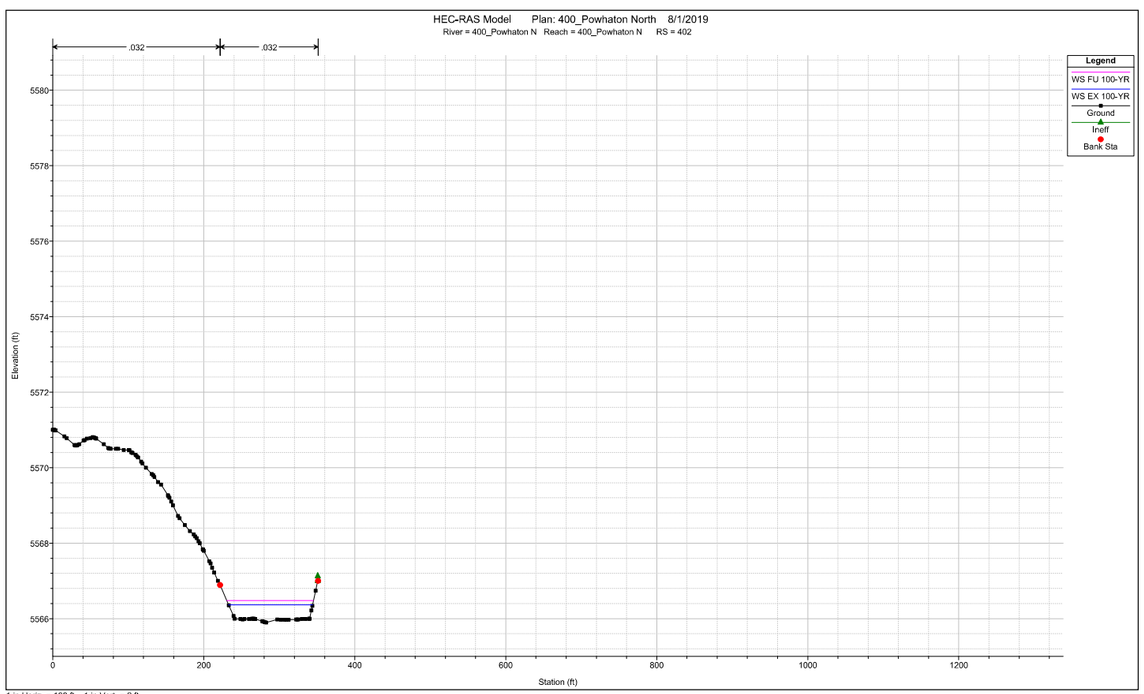


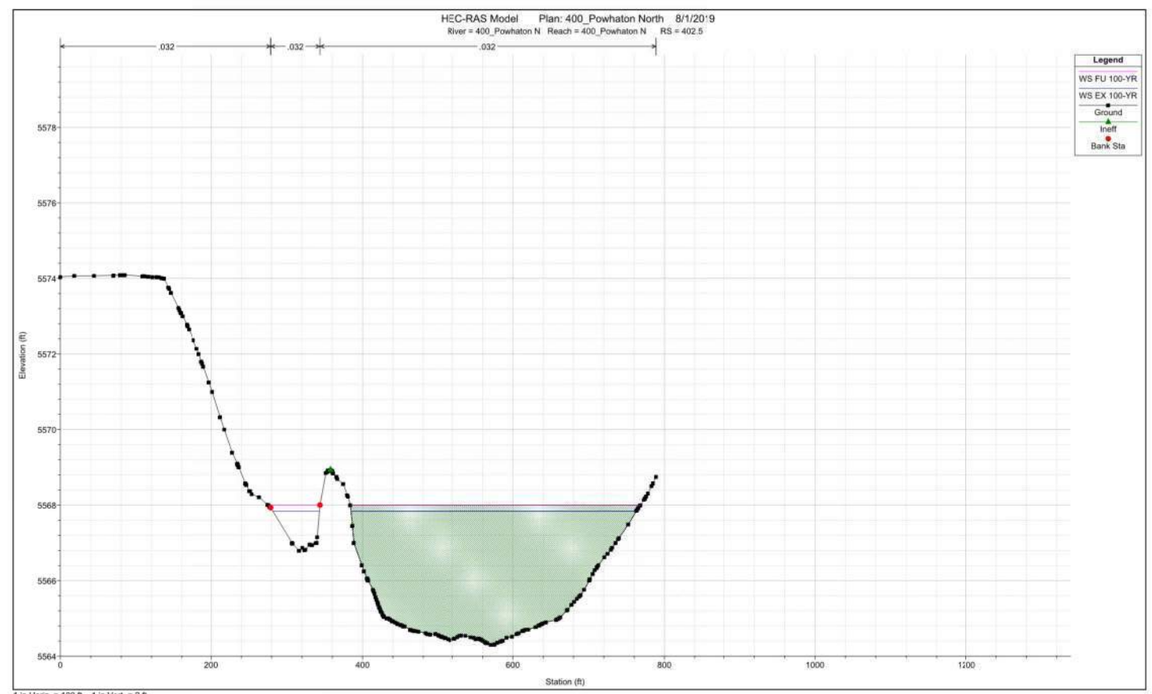
1 in Horiz. = 130 ft 1 in Vert. = 4 ft

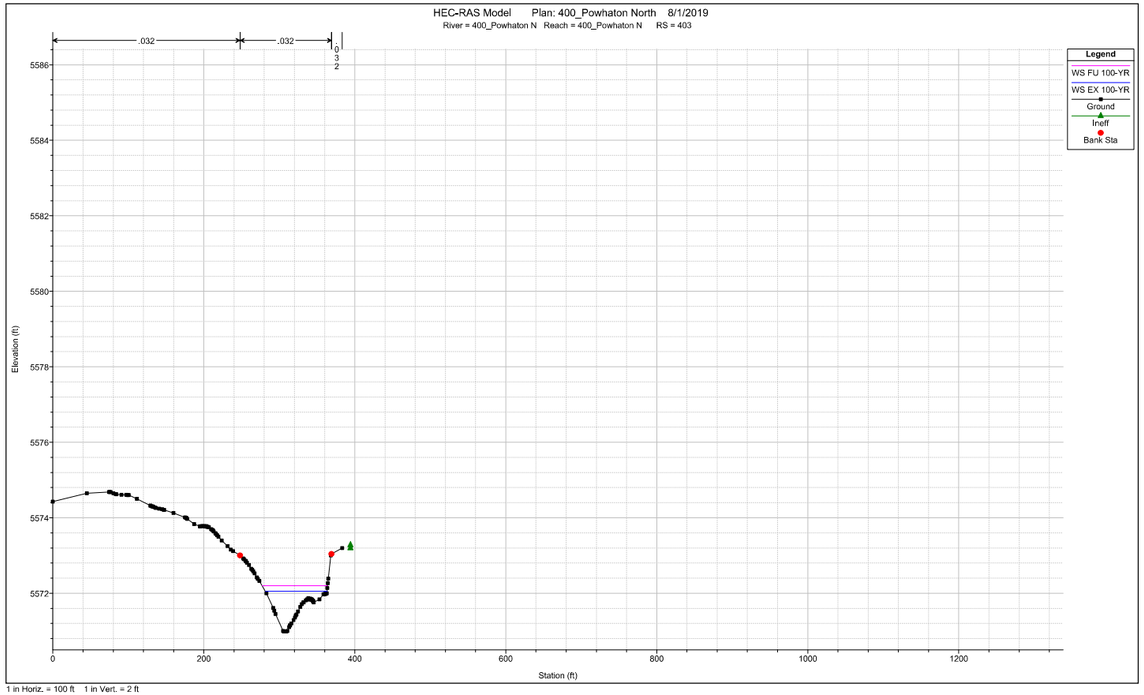
POWHATON NORTH TRIBUTARY
Series 400 Cross Sections

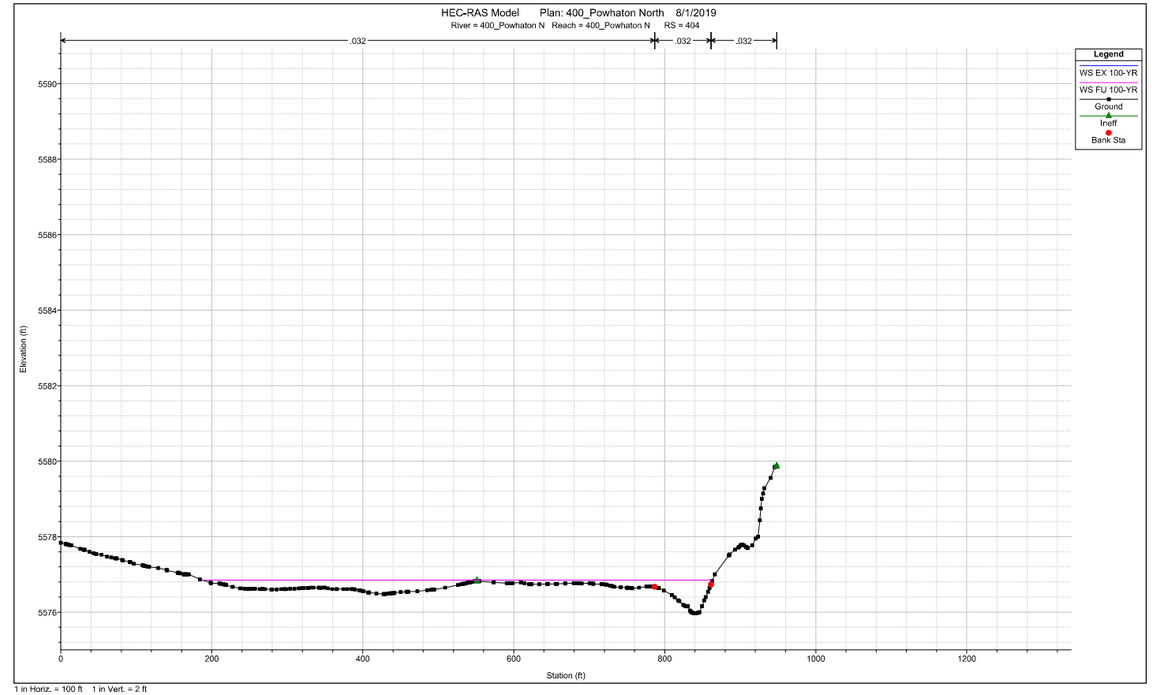

HEC-RAS Model Plan: 400_Powhaton North 8/1/2019
River = 400_Powhaton N Reach = 400_Powhaton N RS = 401
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

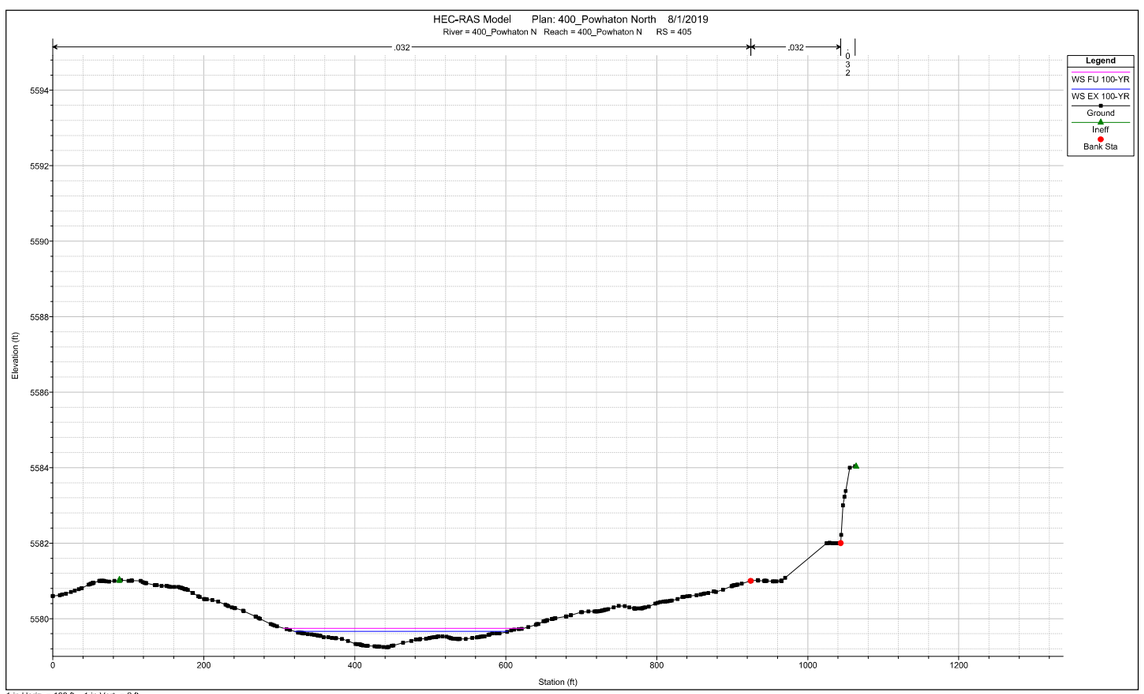

HEC-RAS Model Plan: 400_Powhaton North 8/1/2019
River = 400_Powhaton N Reach = 400_Powhaton N RS = 401.5
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

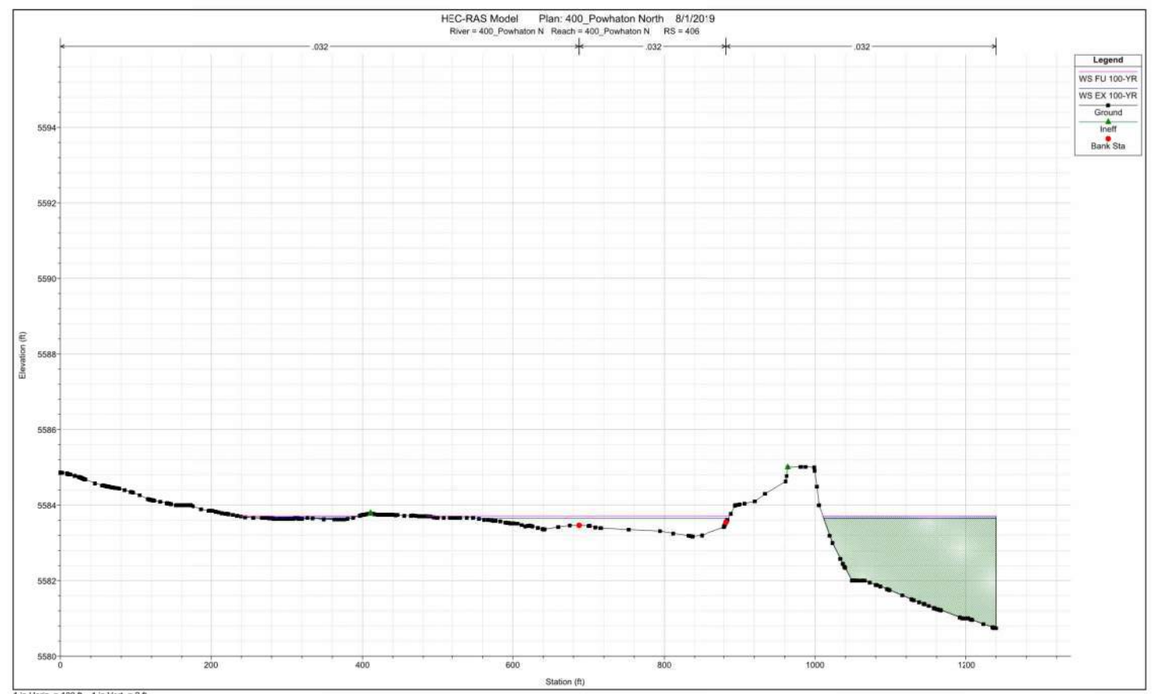

HEC-RAS Model Plan: 400_Powhaton North 8/1/2019
River = 400_Powhaton N Reach = 400_Powhaton N RS = 402
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

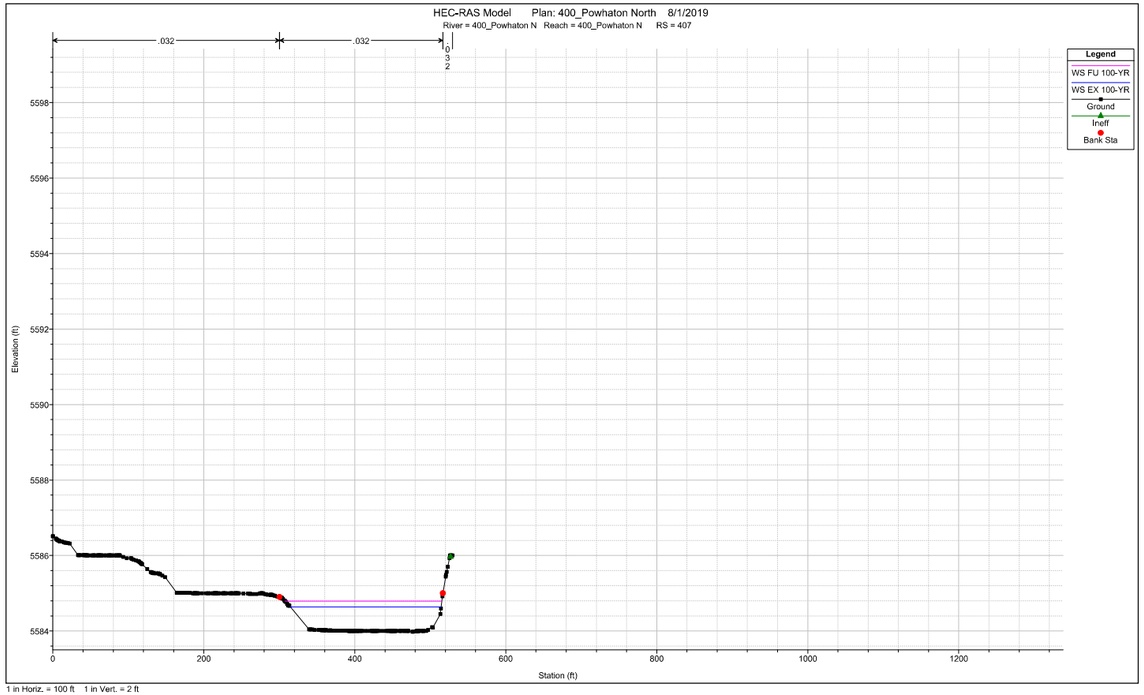

HEC-RAS Model Plan: 400_Powhaton North 8/1/2019
River = 400_Powhaton N Reach = 400_Powhaton N RS = 402.5
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

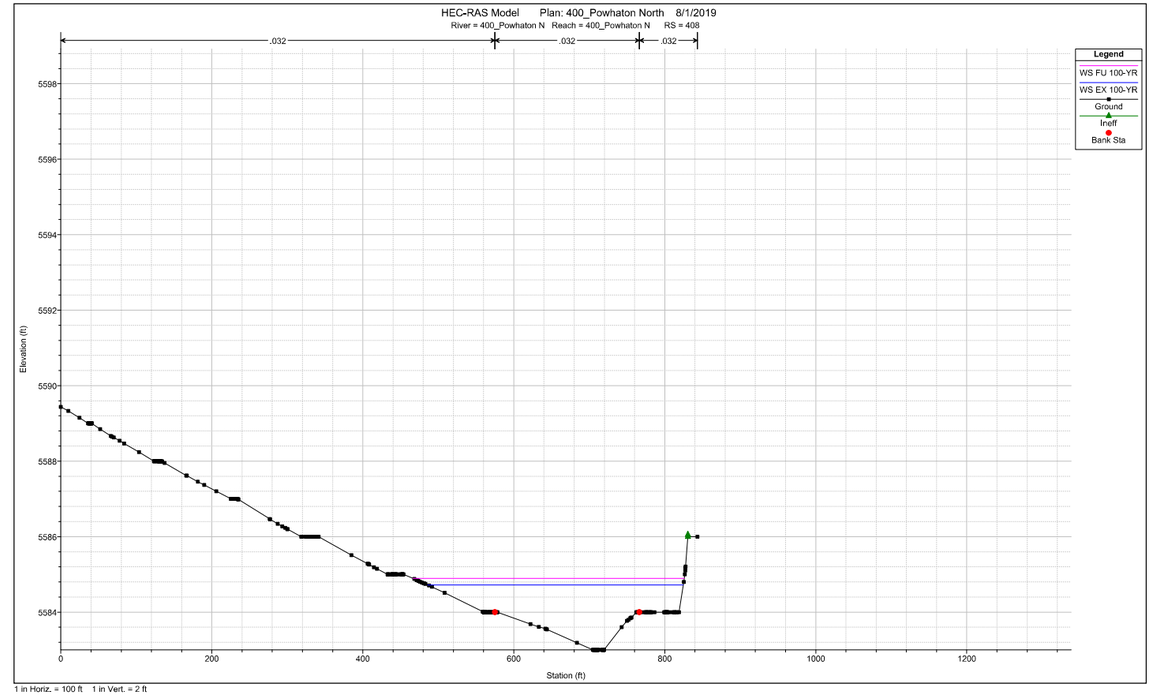

HEC-RAS Model Plan: 400_Powhaton North 8/1/2019
River = 400_Powhaton N Reach = 400_Powhaton N RS = 403
.032
.032
0
3
2
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

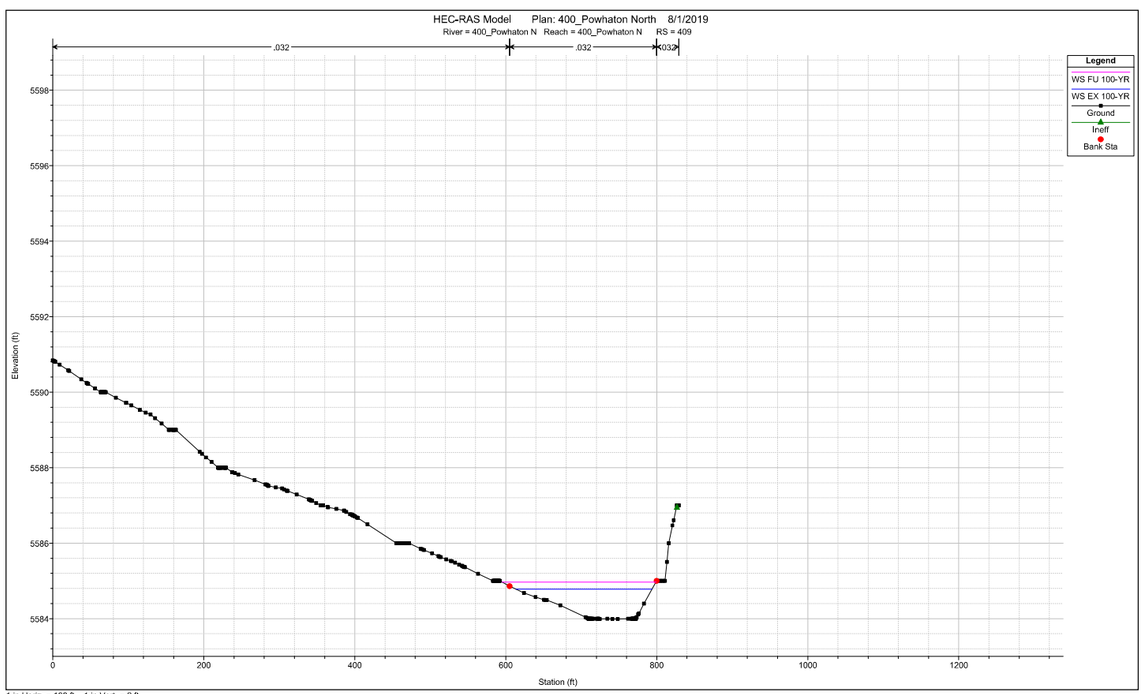

HEC-RAS Model Plan: 400_Powhaton North 8/1/2019
River = 400_Powhaton N Reach = 400_Powhaton N RS = 404
.032
.032
.032
Legend
WS EX 100-YR
WS FU 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

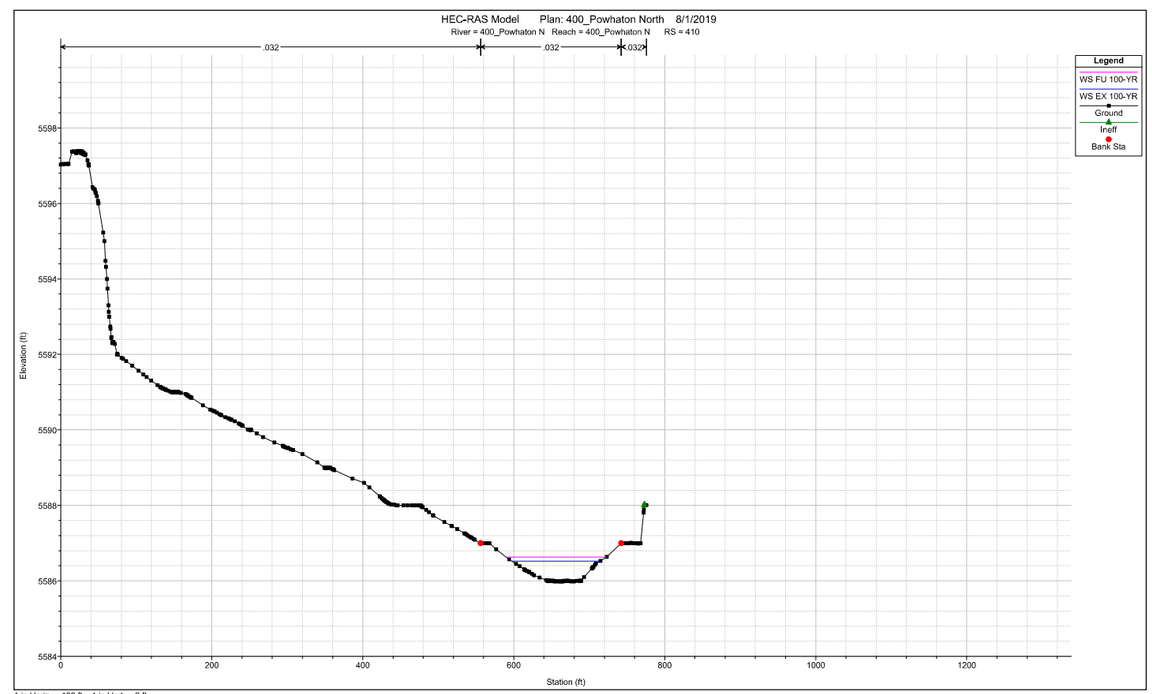

HEC-RAS Model Plan: 400_Powhaton North 8/1/2019
River = 400_Powhaton N Reach = 400_Powhaton N RS = 405
.032
.032
0
3
2
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

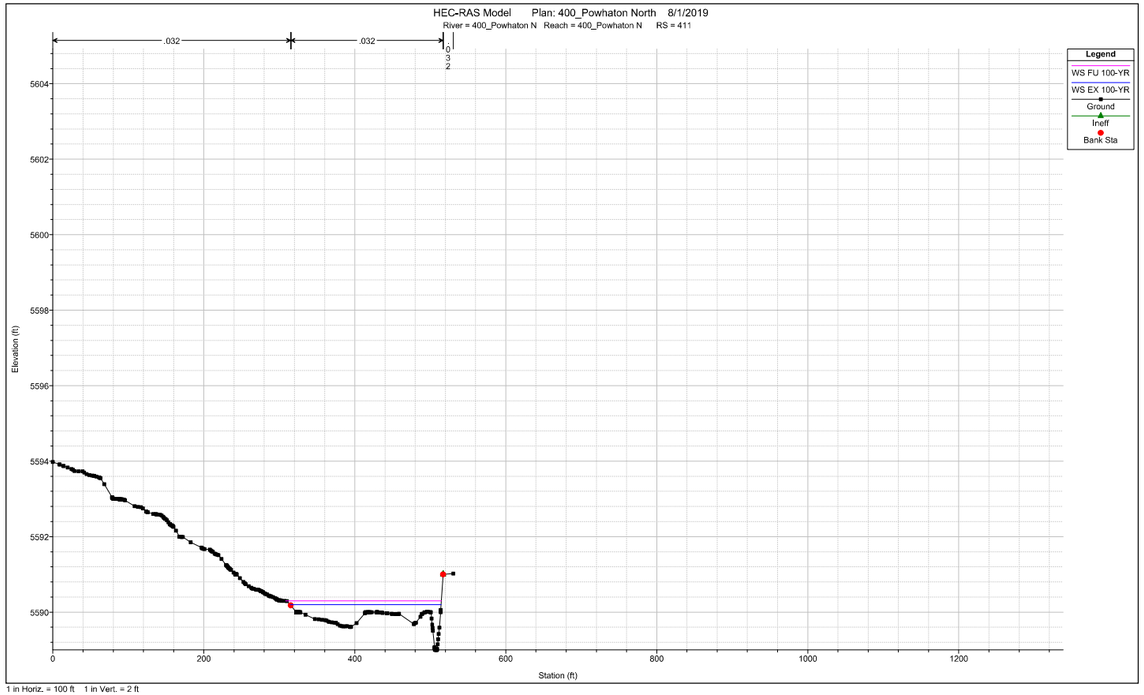

HEC-RAS Model Plan: 400_Powhaton North 8/1/2019
River = 400_Powhaton N Reach = 400_Powhaton N RS = 406
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft


HEC-RAS Model Plan: 400_Powhaton North 8/1/2019
River = 400_Powhaton N Reach = 400_Powhaton N RS = 407
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

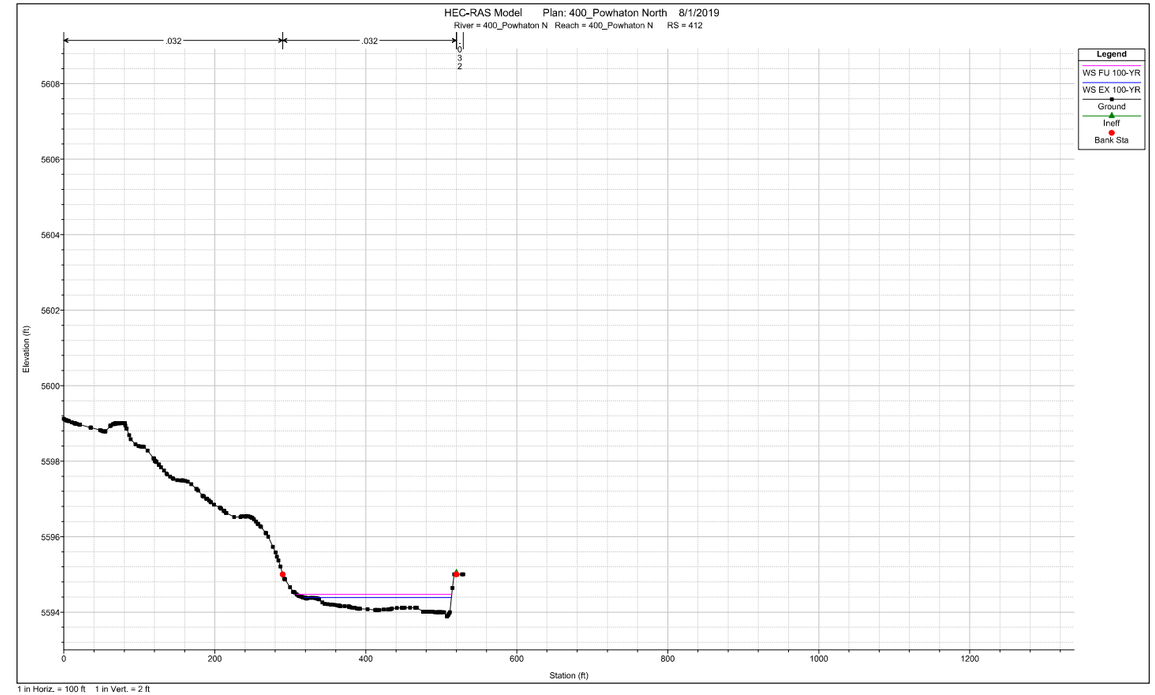

HEC-RAS Model Plan: 400_Powhaton North 8/1/2019
River = 400_Powhaton N Reach = 400_Powhaton N RS = 408
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft


HEC-RAS Model Plan: 400_Powhaton North 8/1/2019
River = 400_Powhaton N Reach = 400_Powhaton N RS = 409
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft


HEC-RAS Model Plan: 400_Powhaton North 8/1/2019
River = 400_Powhaton N Reach = 400_Powhaton N RS = 410
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

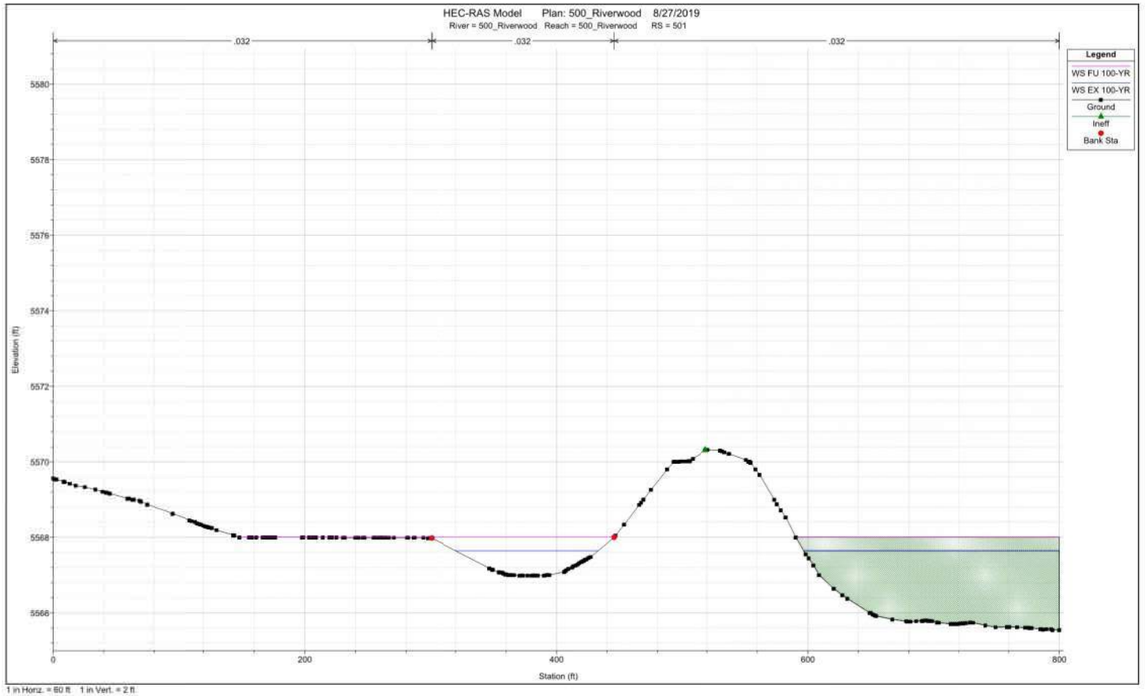


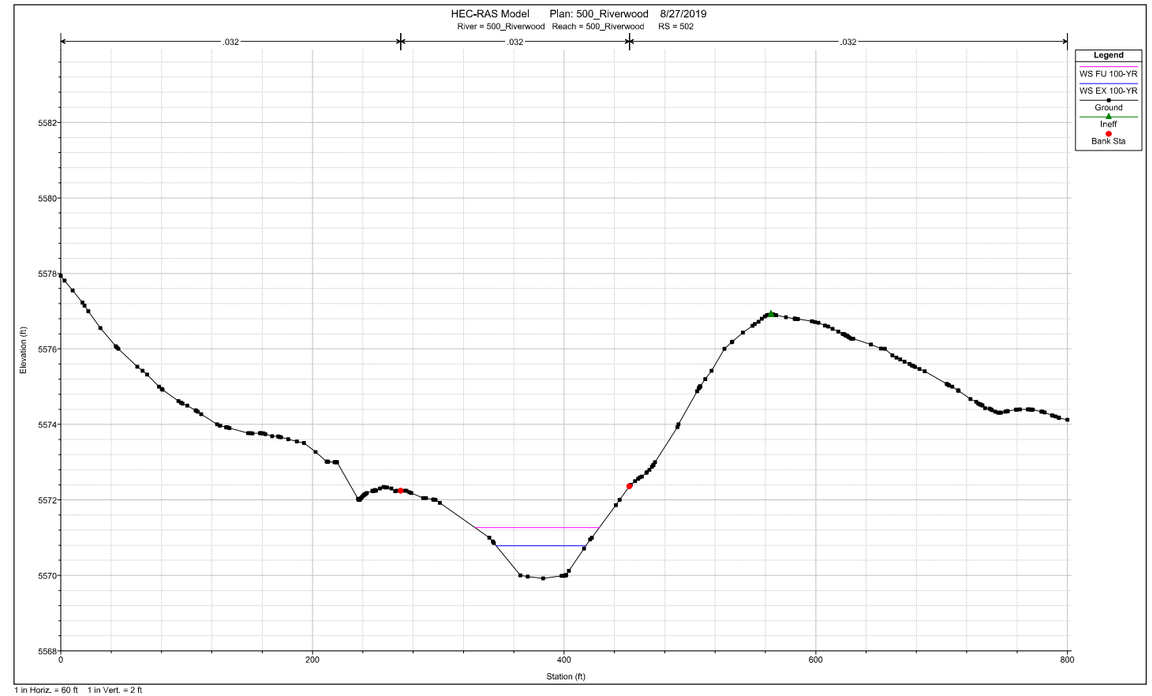
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

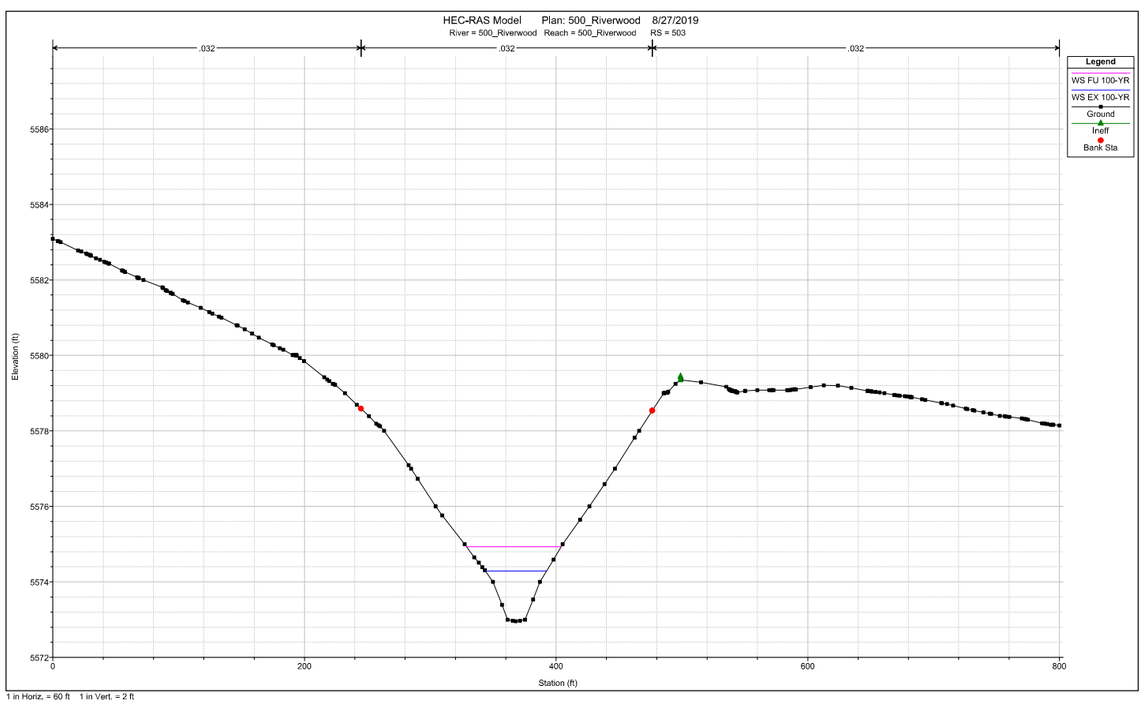


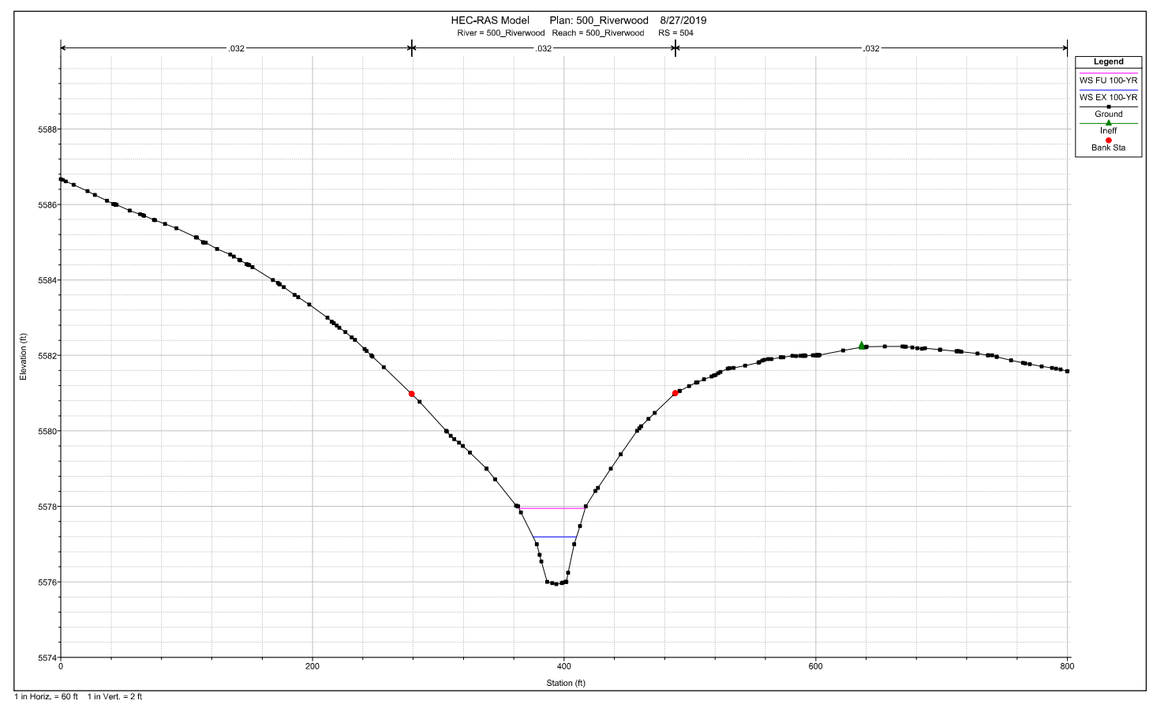
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

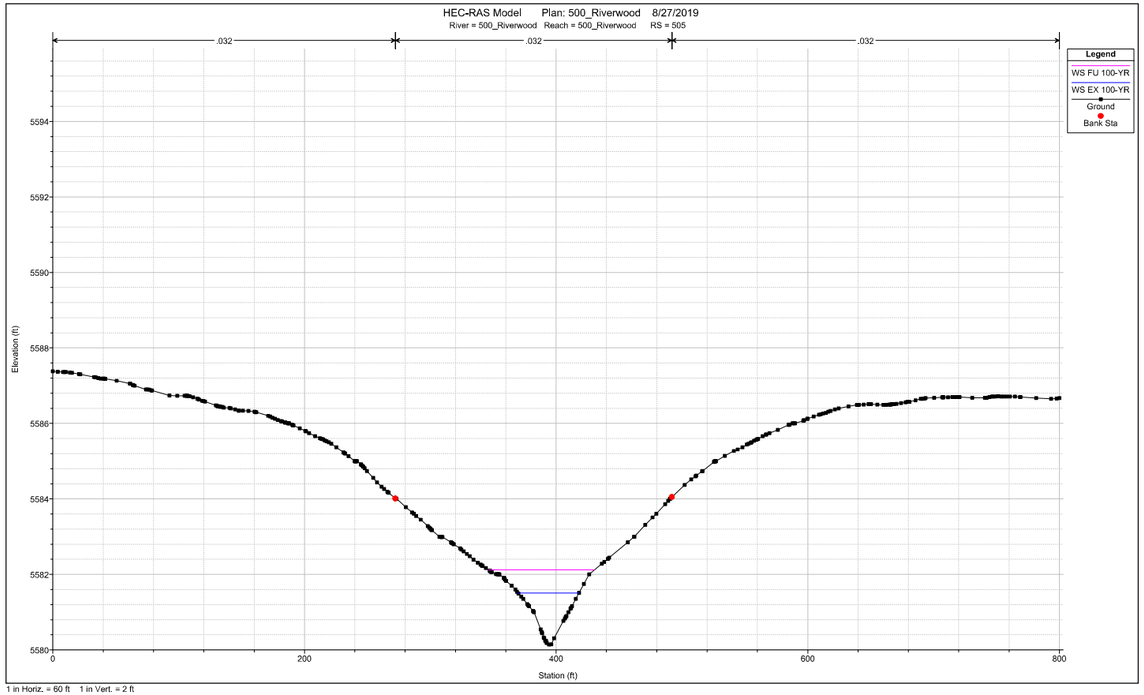
RIVERWOOD TRIBUTARY
Series 500 Cross Sections


HEC-RAS Model Plan: 500_Riverwood 8/27/2019
River = 500_Riverwood Reach = 500_Riverwood RS = 501
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 60 ft 1 in Vert. = 2 ft

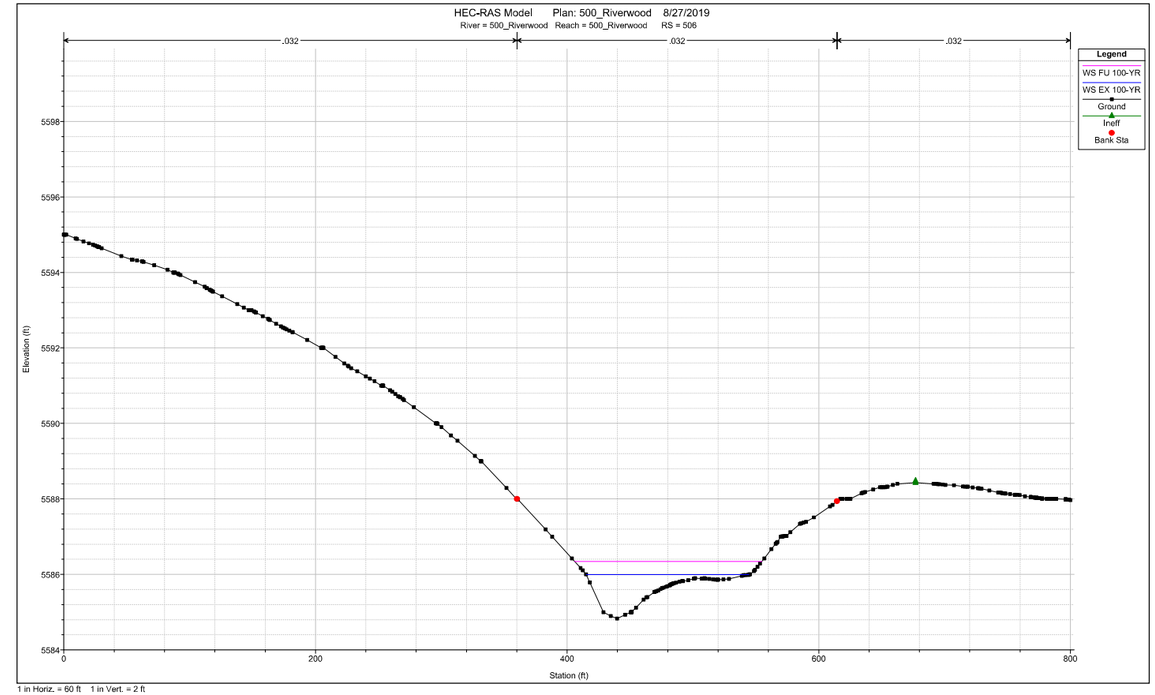

HEC-RAS Model Plan: 500_Riverwood 8/27/2019
River = 500_Riverwood Reach = 500_Riverwood RS = 502
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 60 ft 1 in Vert. = 2 ft


HEC-RAS Model Plan: 500_Riverwood 8/27/2019
River = 500_Riverwood Reach = 500_Riverwood RS = 503
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 60 ft 1 in Vert. = 2 ft


HEC-RAS Model Plan: 500_Riverwood 8/27/2019
River = 500_Riverwood Reach = 500_Riverwood RS = 504
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 60 ft 1 in Vert. = 2 ft

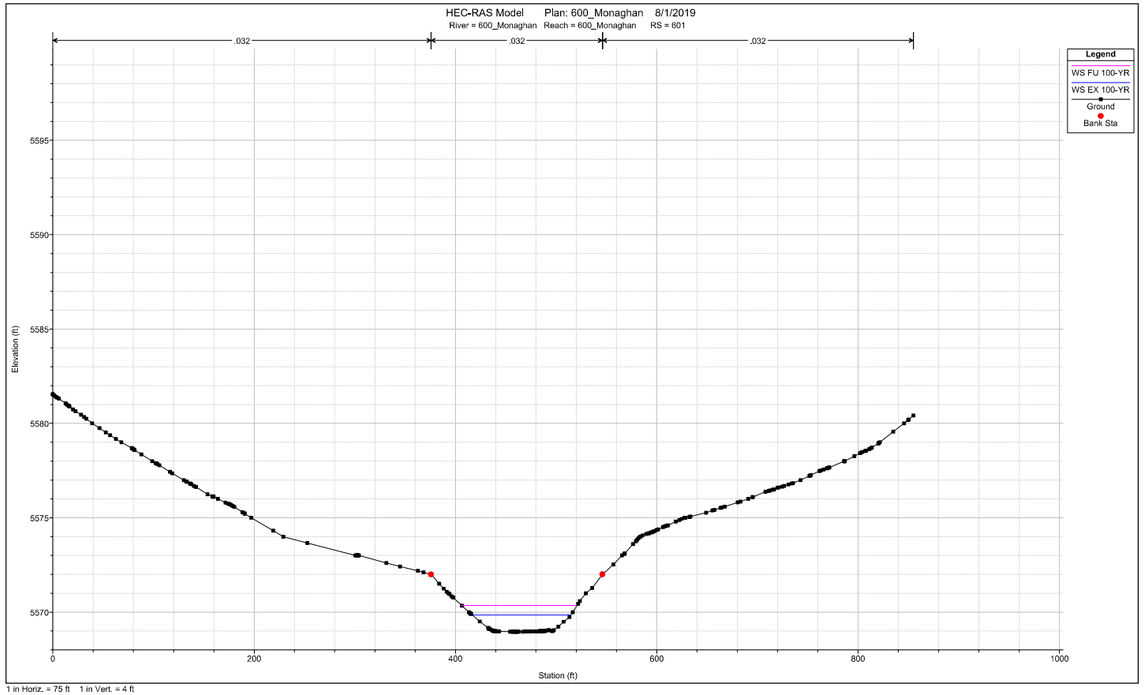


1 in Horiz. = 60 ft 1 in Vert. = 2 ft

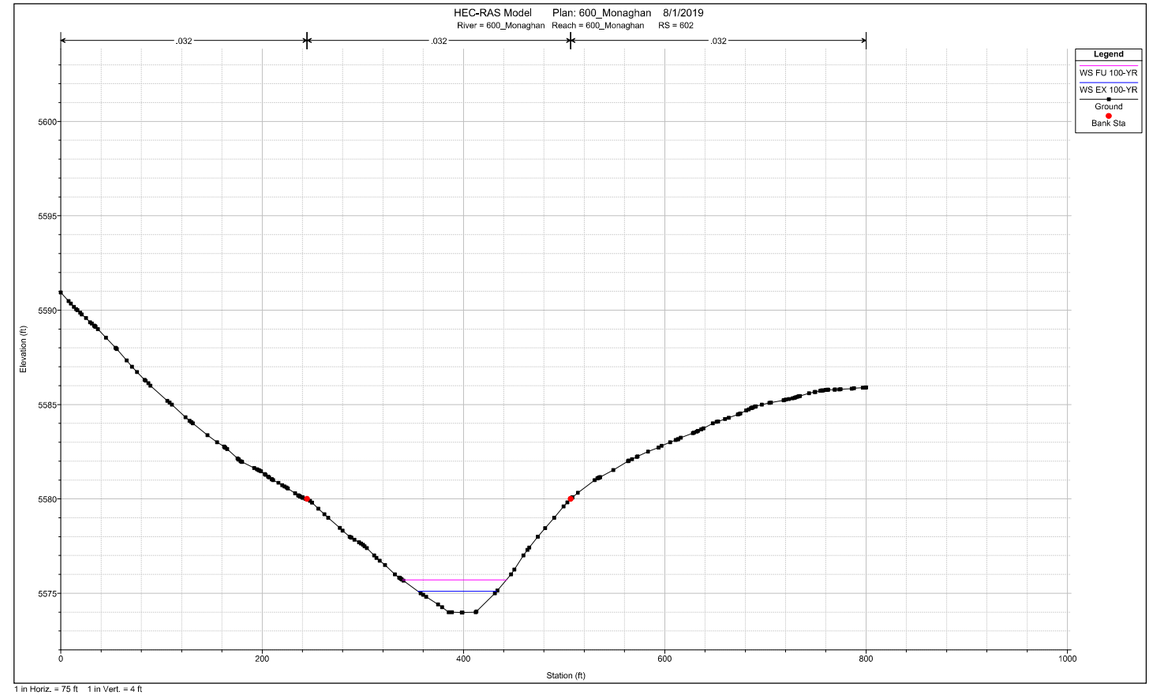


1 in Horiz. = 60 ft 1 in Vert. = 2 ft

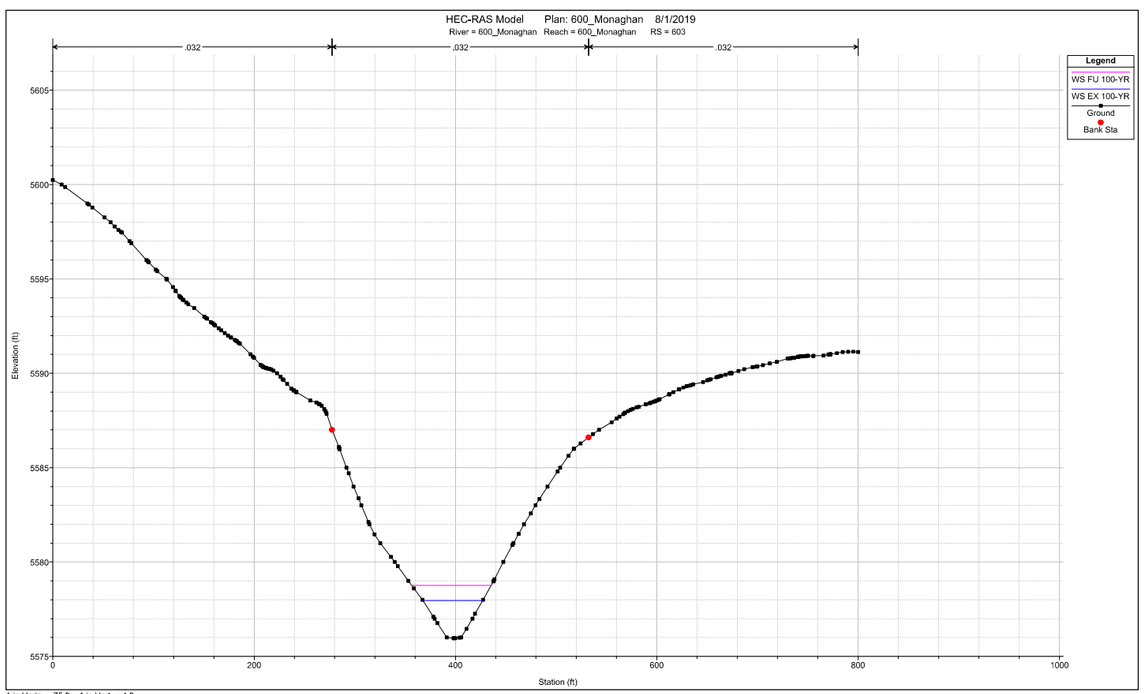
MONAGHAN TRIBUTARY
Series 600 Cross Sections



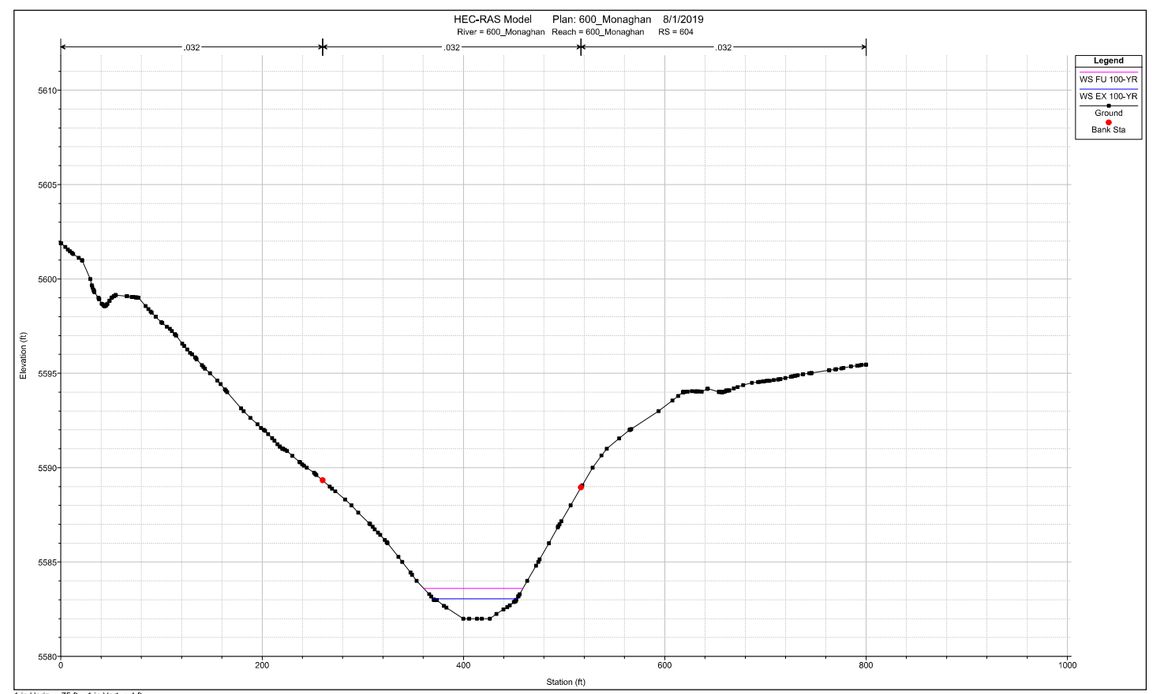
1 in Horiz. = 75 ft 1 in Vert. = 4 ft



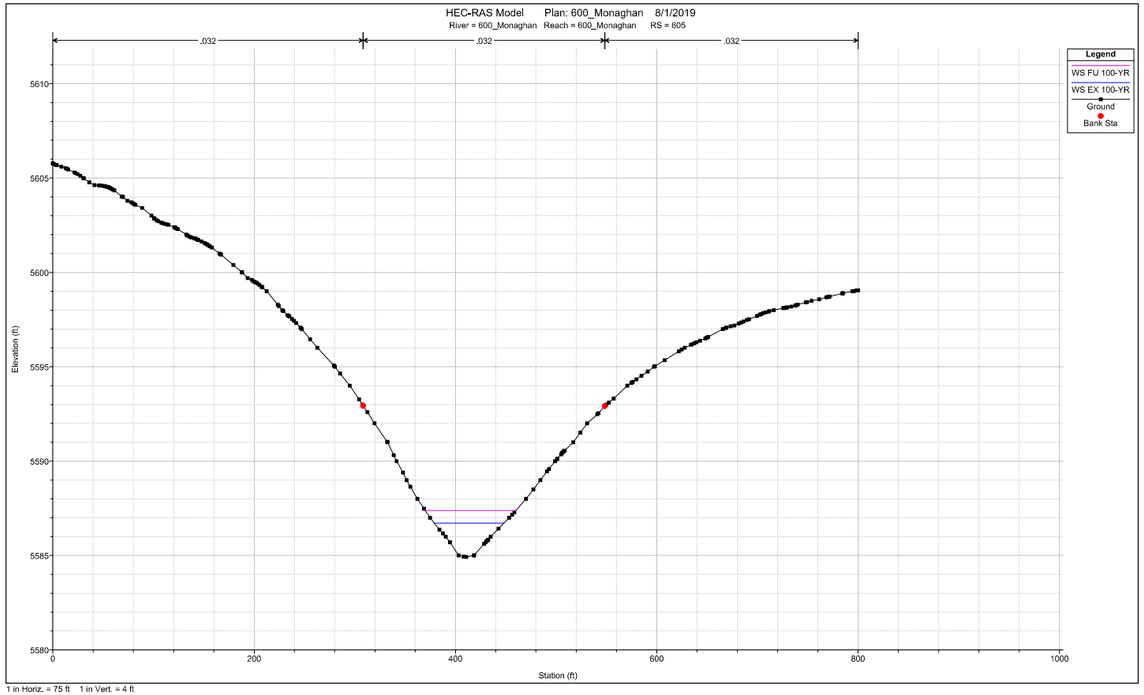
1 in Horiz. = 75 ft 1 in Vert. = 4 ft

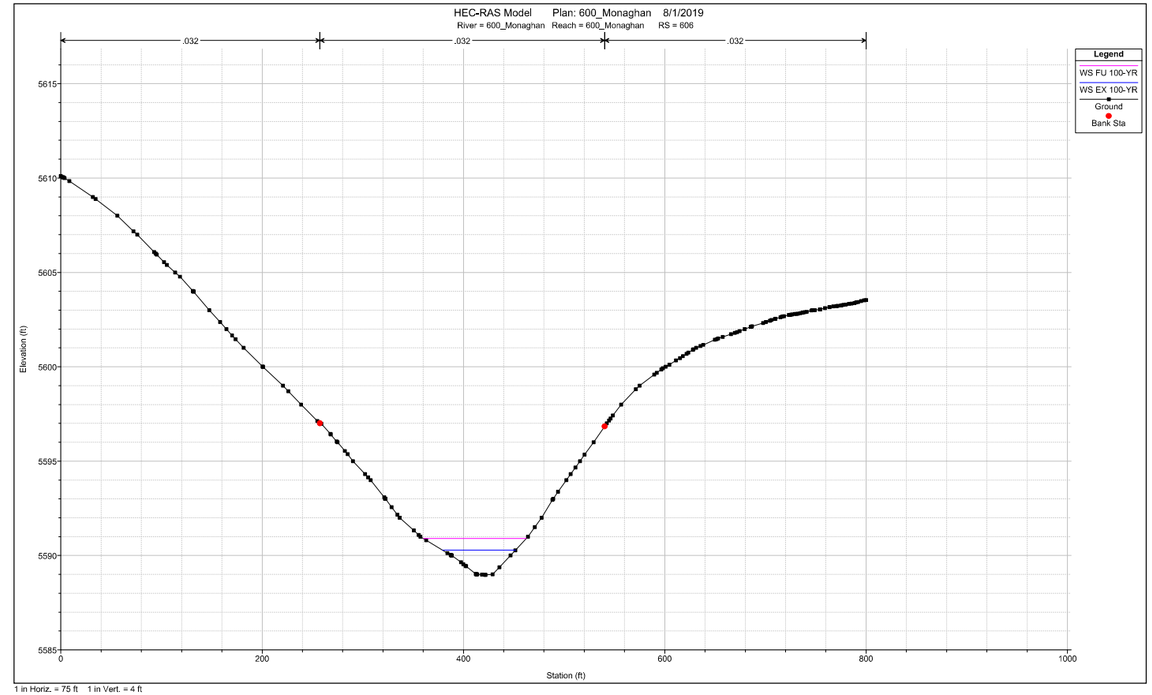


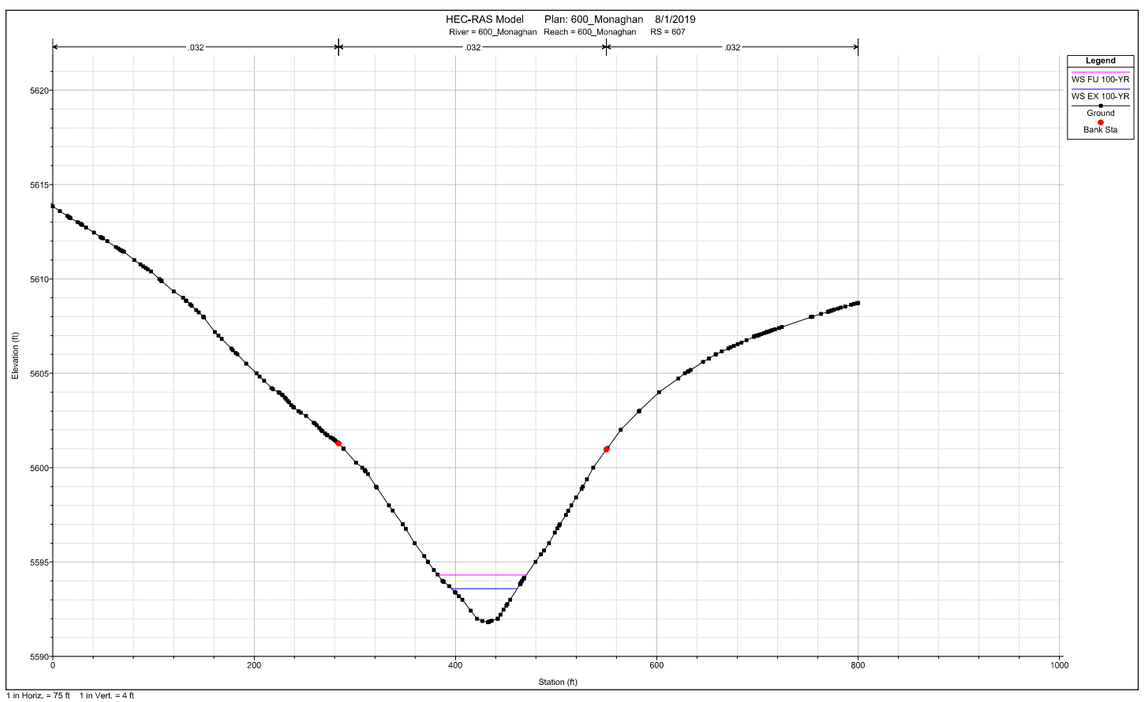
1 in Horiz. = 75 ft 1 in Vert. = 4 ft

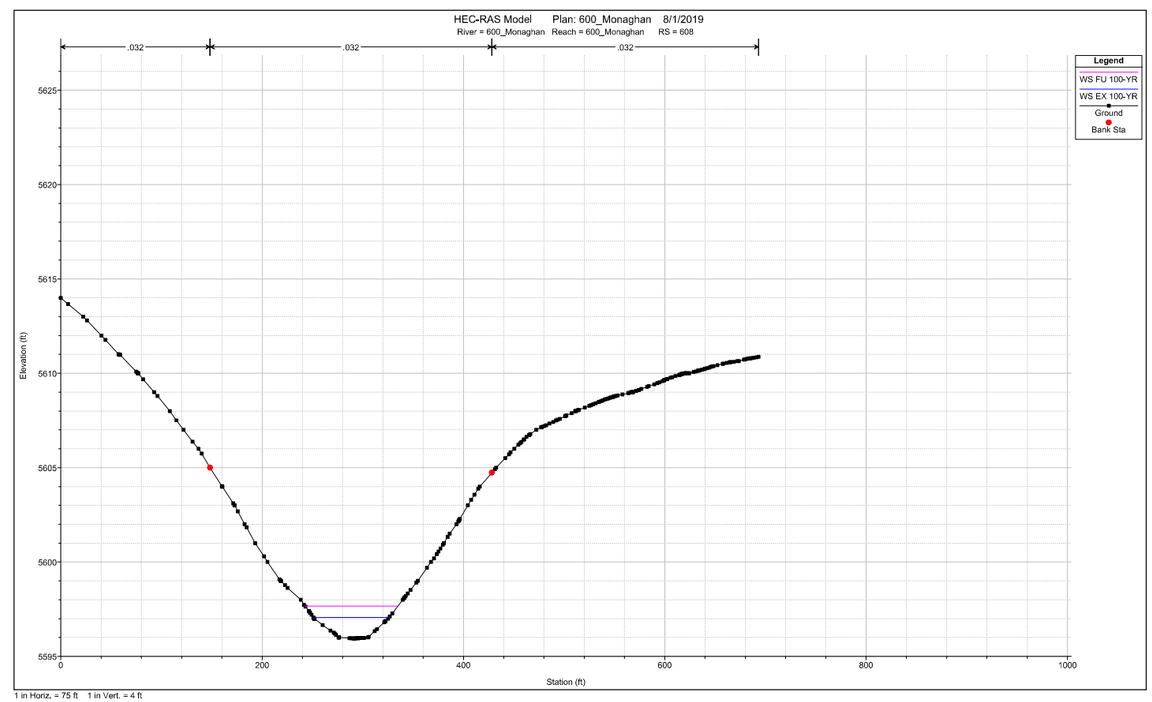


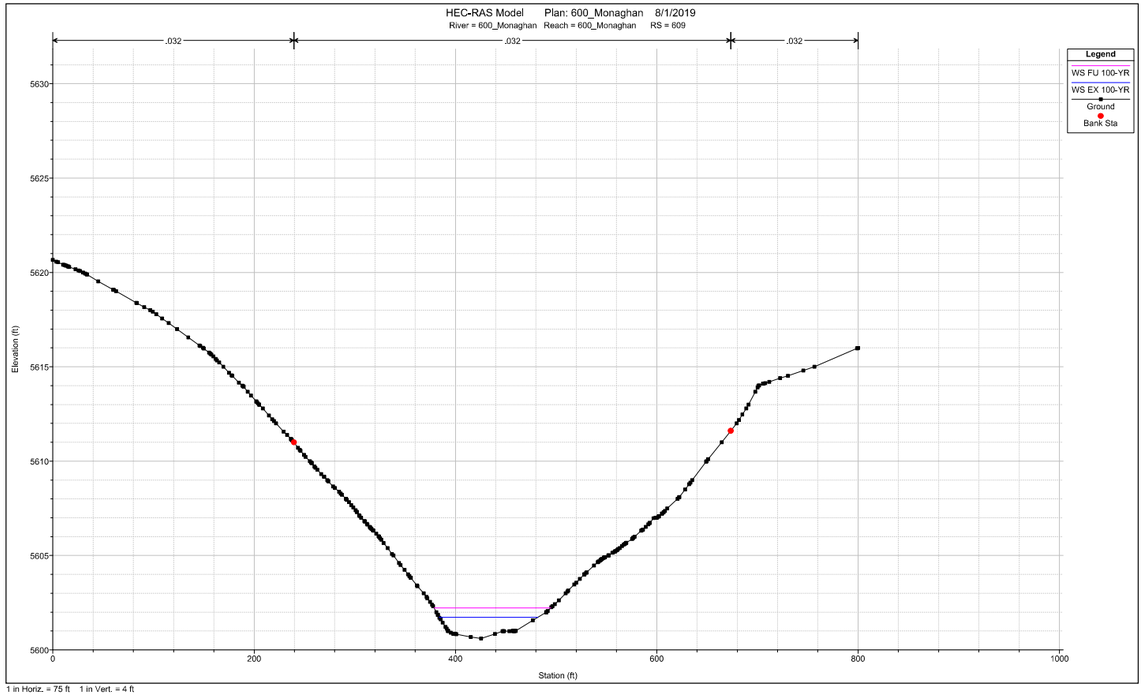
1 in Horiz. = 75 ft 1 in Vert. = 4 ft

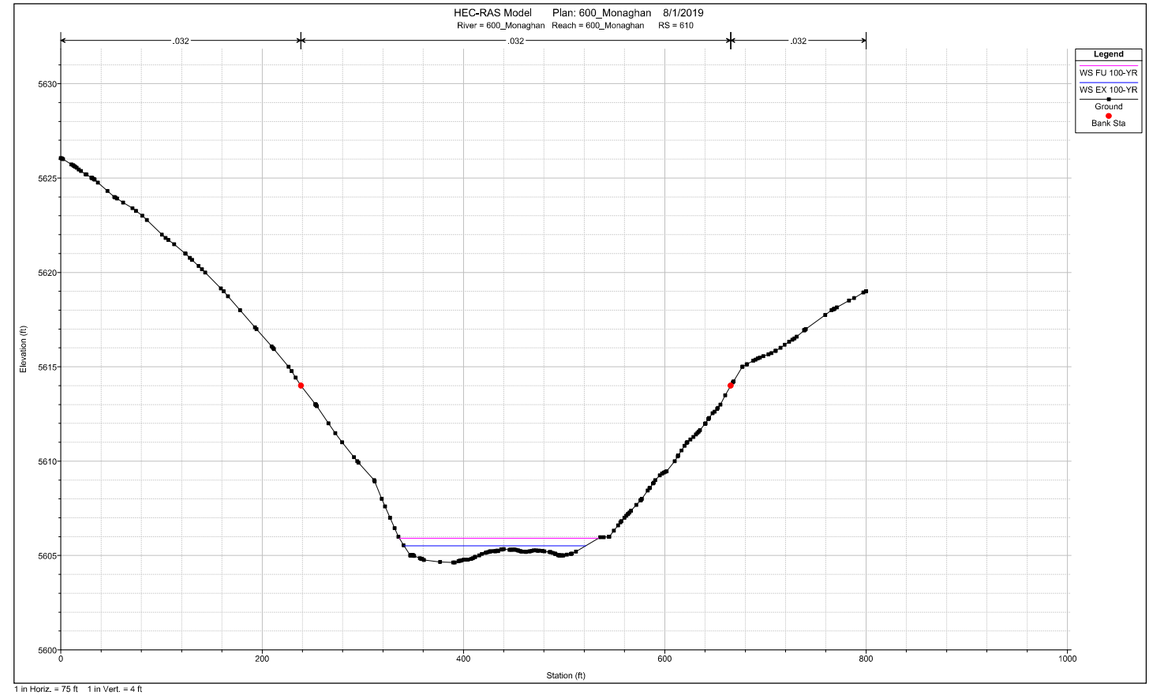

HEC-RAS Model Plan: 600_Monaghan 8/1/2019
River = 600_Monaghan Reach = 600_Monaghan RS = 605
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 75 ft 1 in Vert. = 4 ft

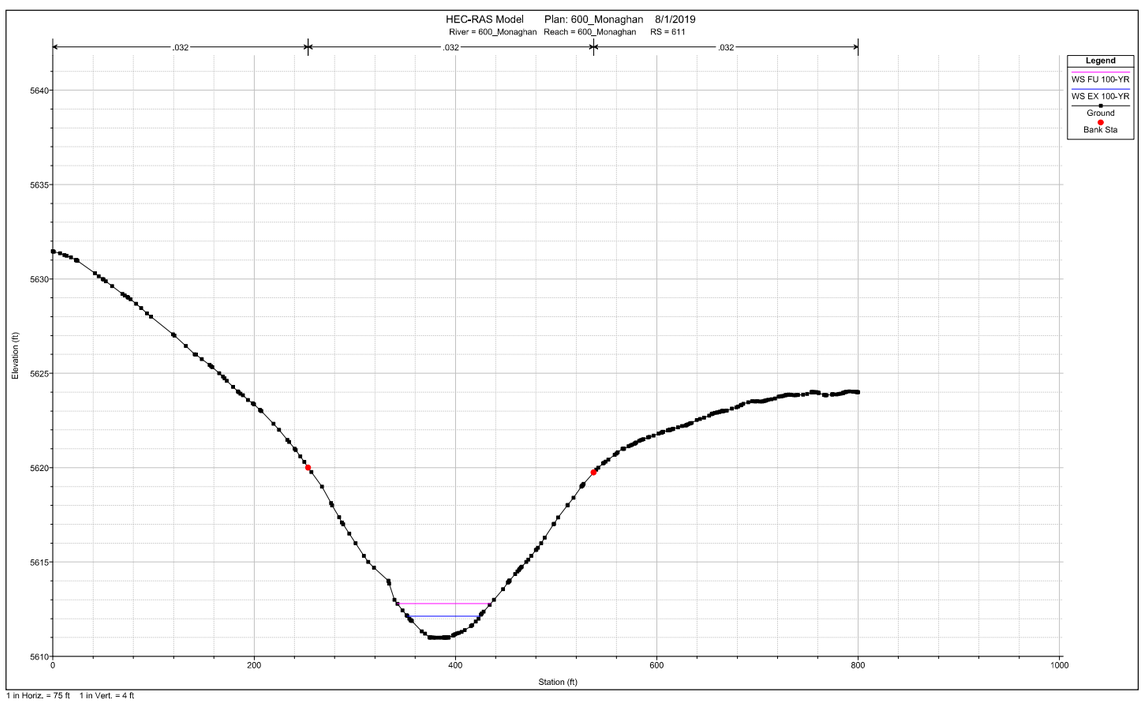

HEC-RAS Model Plan: 600_Monaghan 8/1/2019
River = 600_Monaghan Reach = 600_Monaghan RS = 606
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 75 ft 1 in Vert. = 4 ft

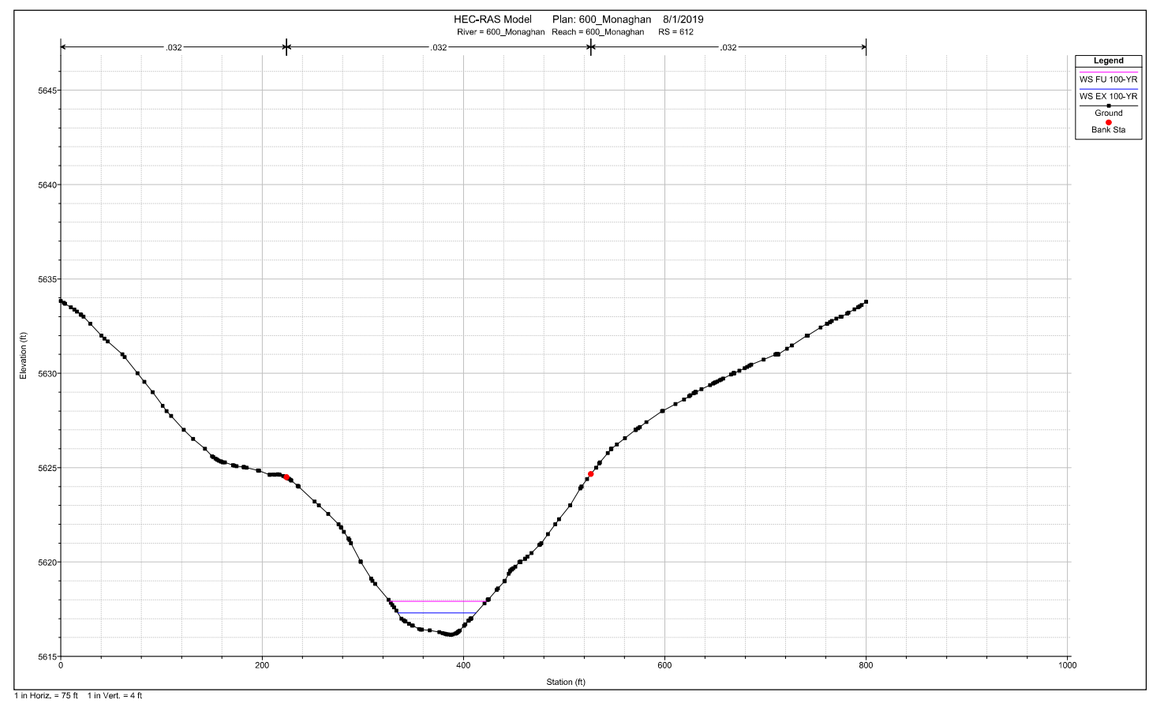

HEC-RAS Model Plan: 600_Monaghan 8/1/2019
River = 600_Monaghan Reach = 600_Monaghan RS = 607
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 75 ft 1 in Vert. = 4 ft

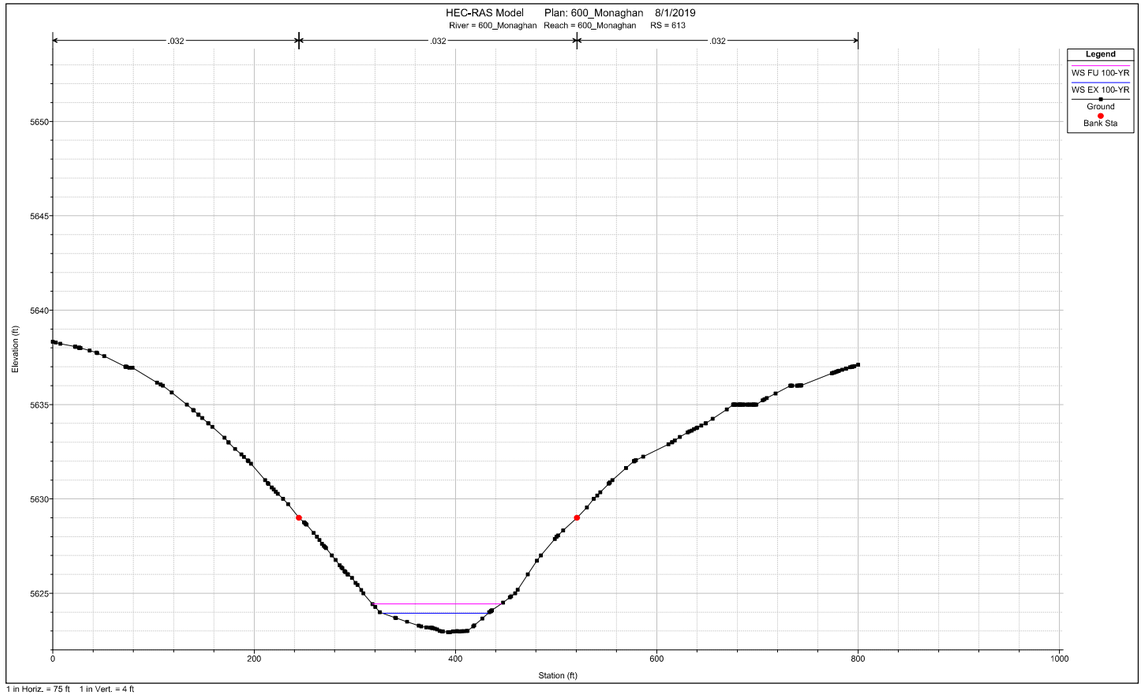

HEC-RAS Model Plan: 600_Monaghan 8/1/2019
River = 600_Monaghan Reach = 600_Monaghan RS = 608
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 75 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 600_Monaghan 8/1/2019
River = 600_Monaghan Reach = 600_Monaghan RS = 609
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 75 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 600_Monaghan 8/1/2019
River = 600_Monaghan Reach = 600_Monaghan RS = 610
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 75 ft 1 in Vert. = 4 ft

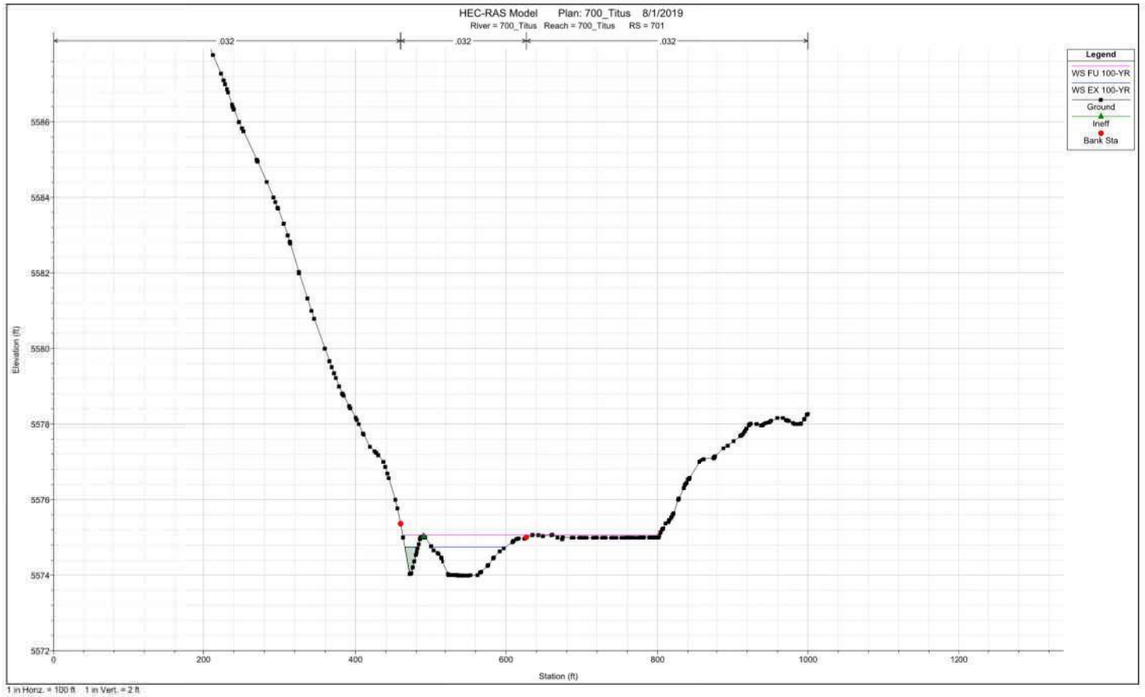

HEC-RAS Model Plan: 600_Monaghan 8/1/2019
River = 600_Monaghan Reach = 600_Monaghan RS = 611
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 75 ft 1 in Vert. = 4 ft

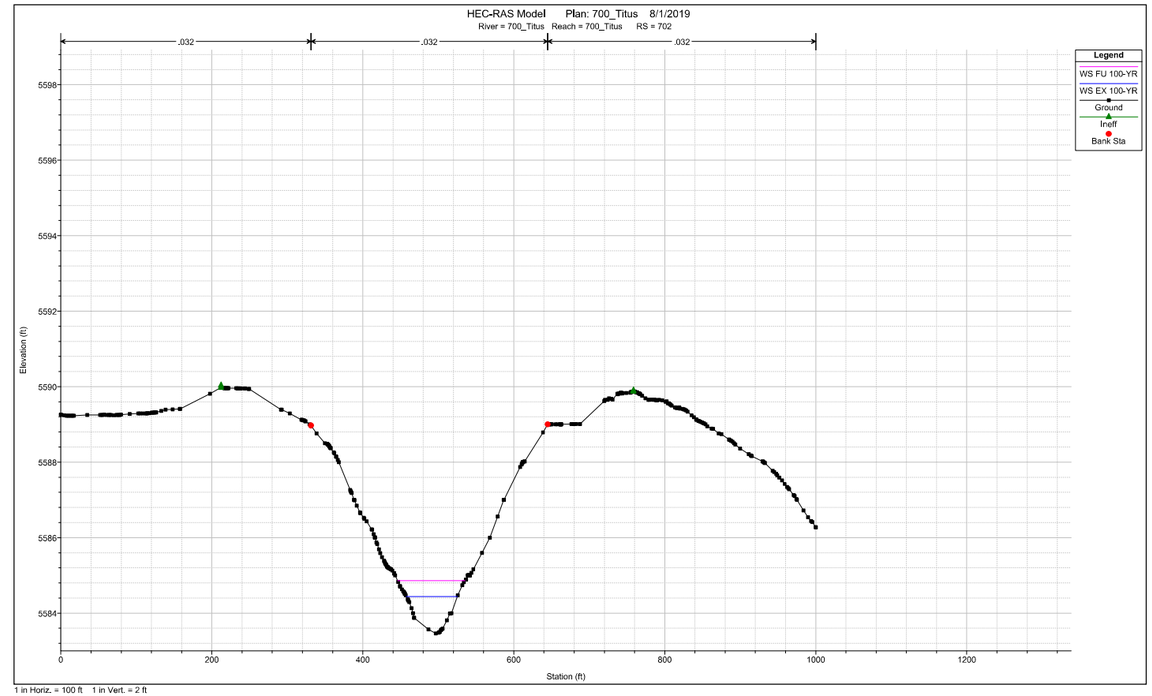

HEC-RAS Model Plan: 600_Monaghan 8/1/2019
River = 600_Monaghan Reach = 600_Monaghan RS = 612
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 75 ft 1 in Vert. = 4 ft

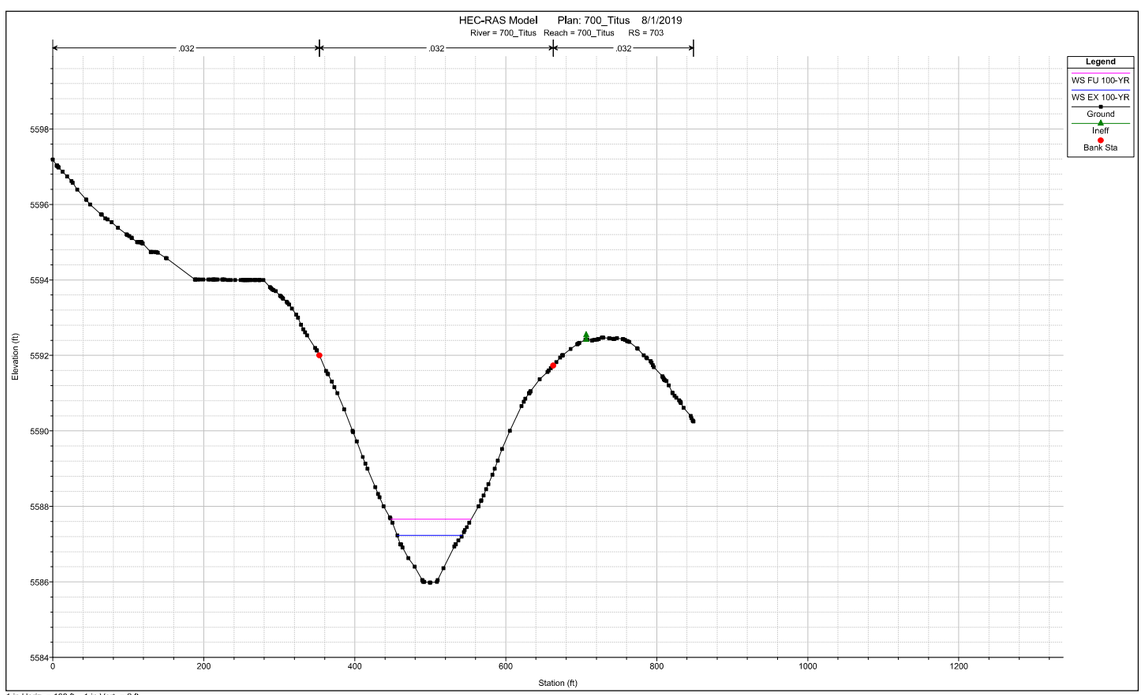


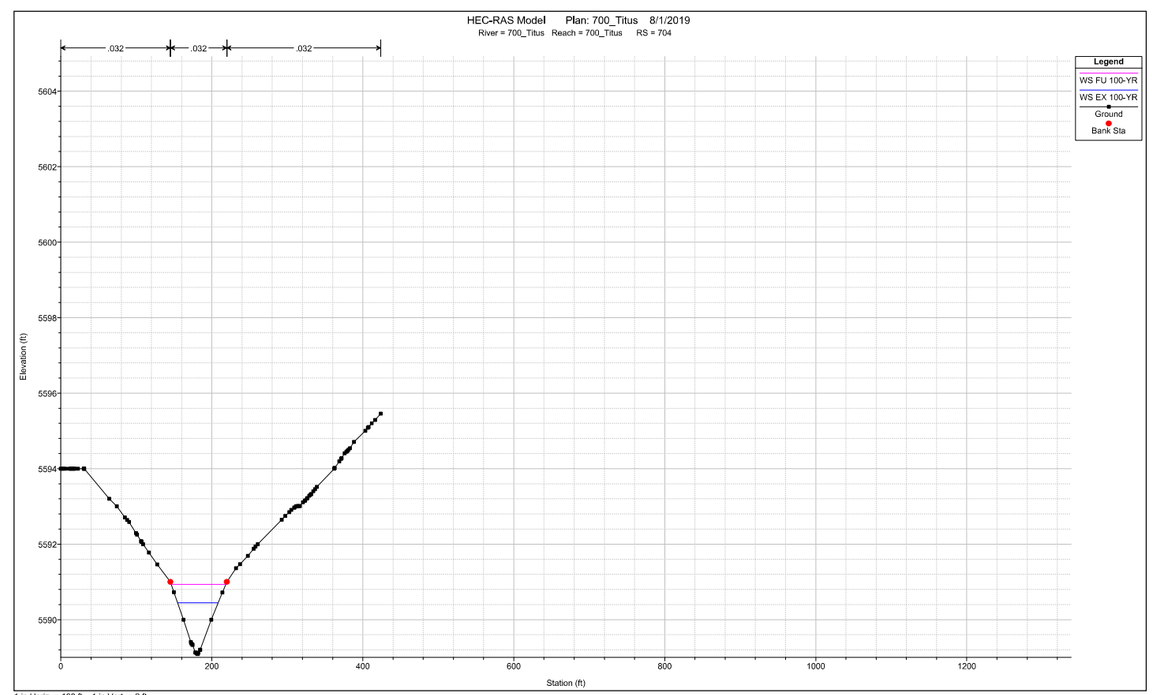
1 in Horiz. = 75 ft 1 in Vert. = 4 ft

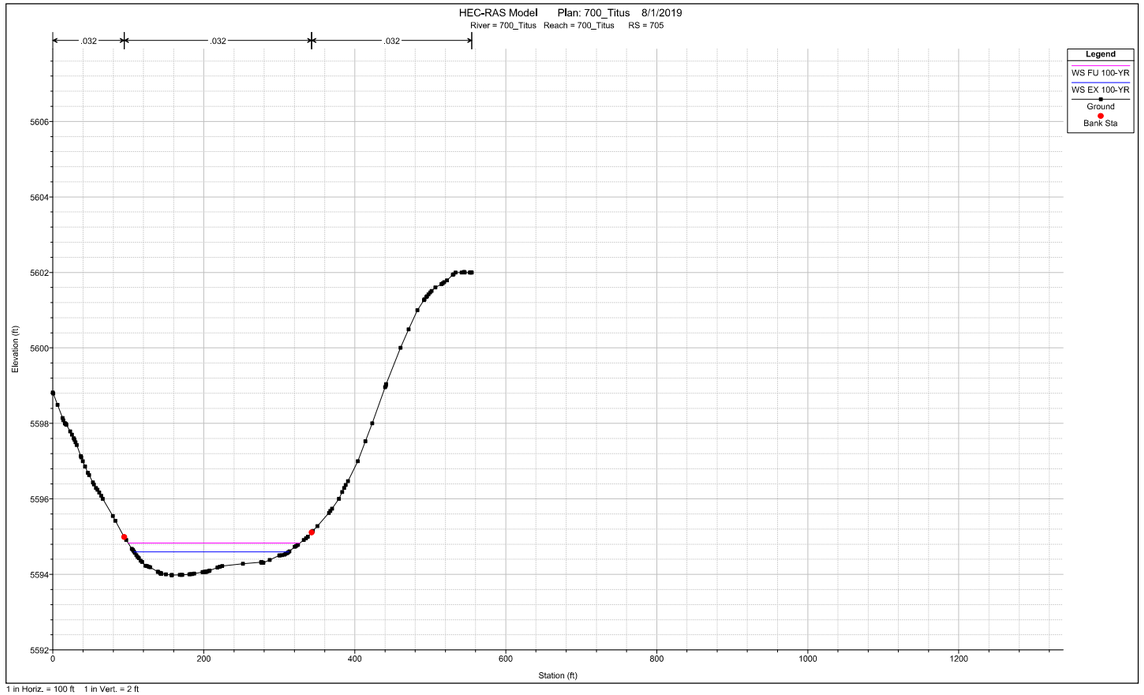
TITUS TRIBUTARY
Series 700 Cross Sections

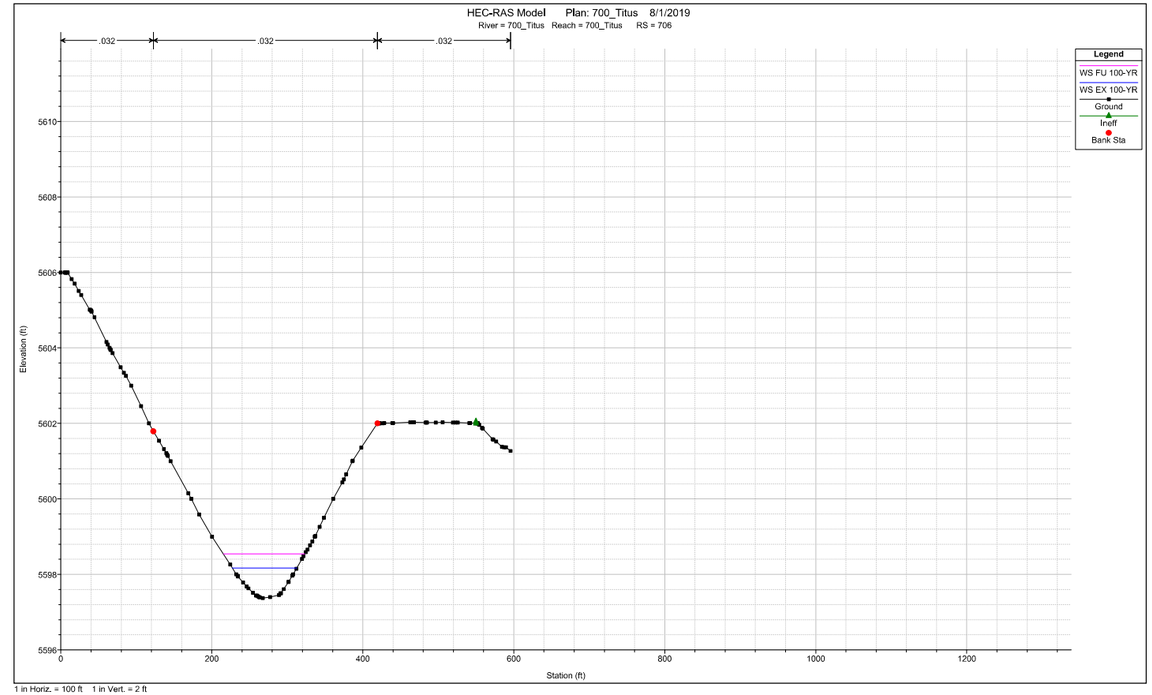

HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 701
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

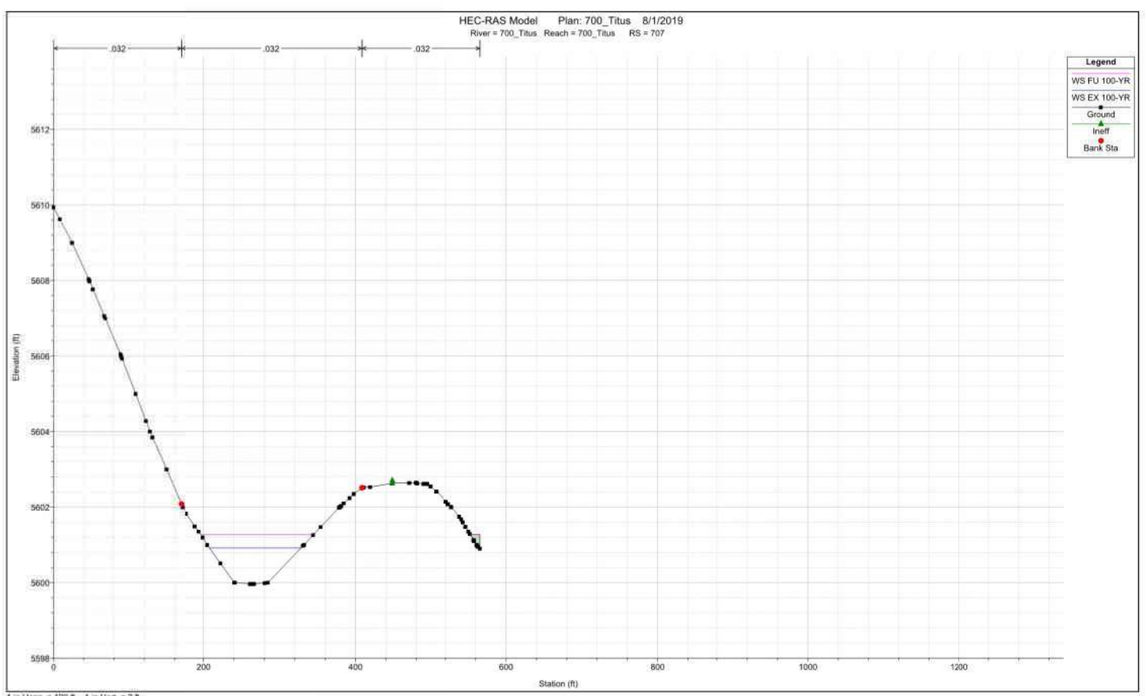

HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 702
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

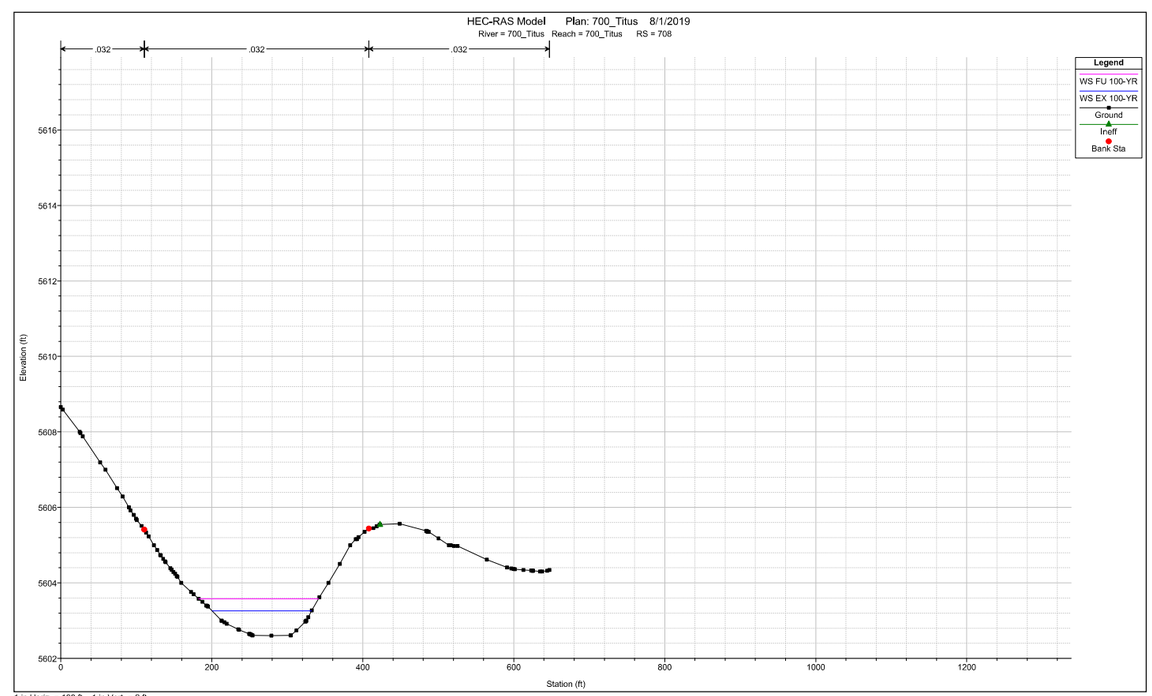

HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 703
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

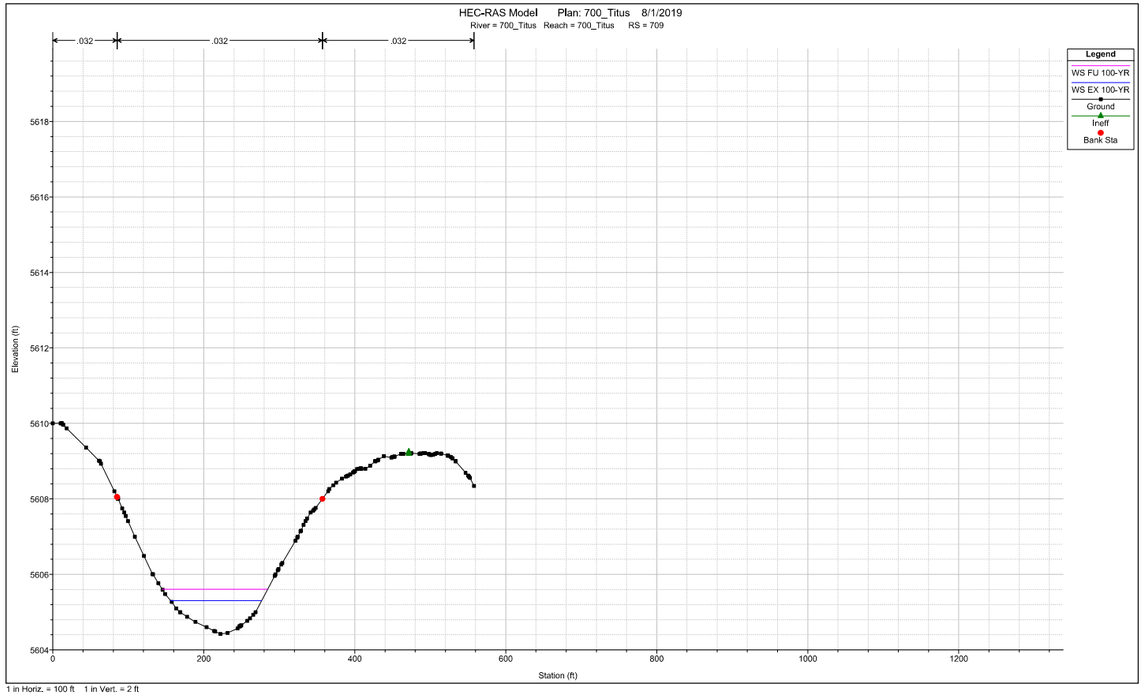

HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 704
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

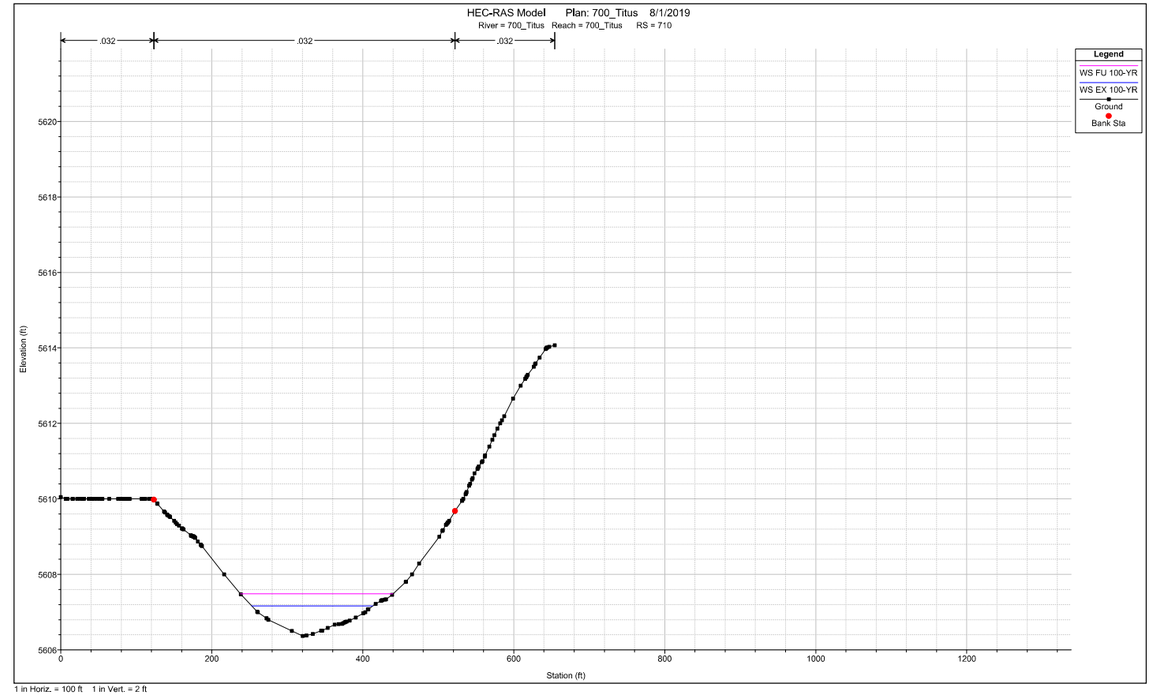

HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 705
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

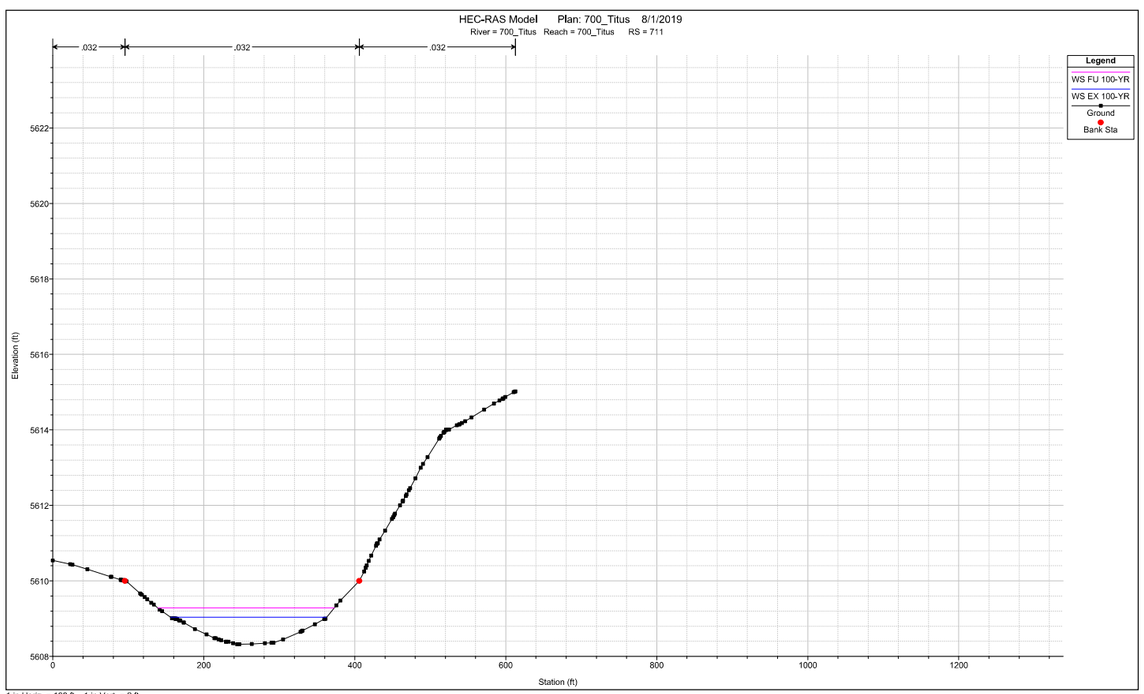

HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 706
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

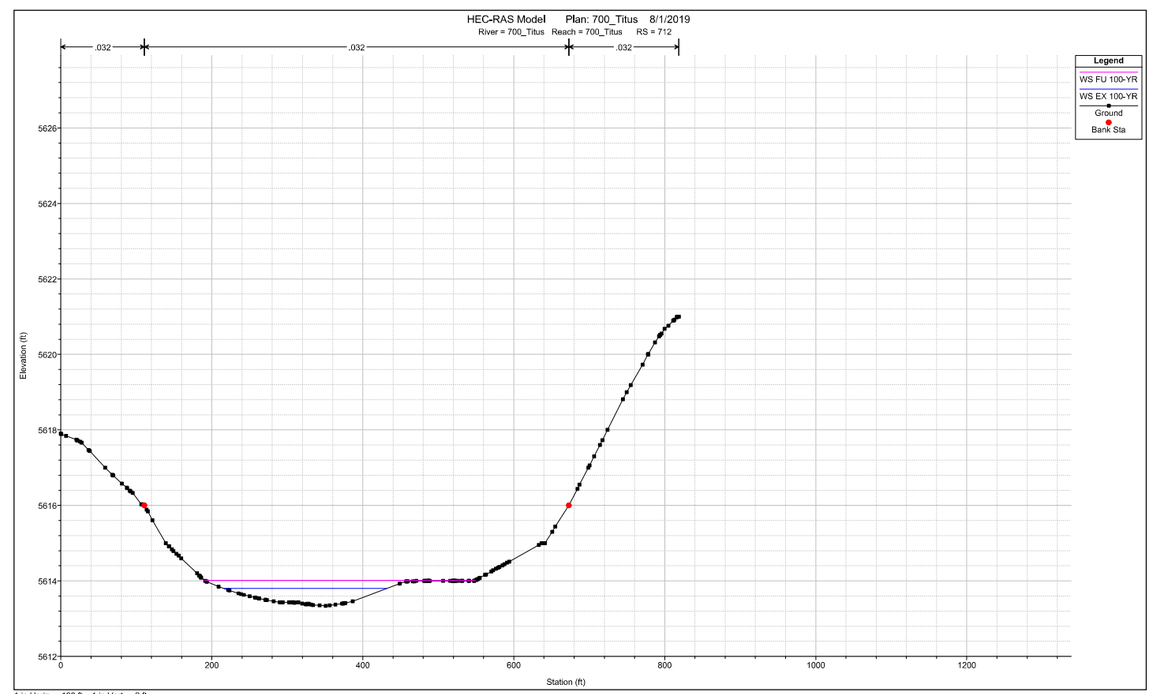

HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 707
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

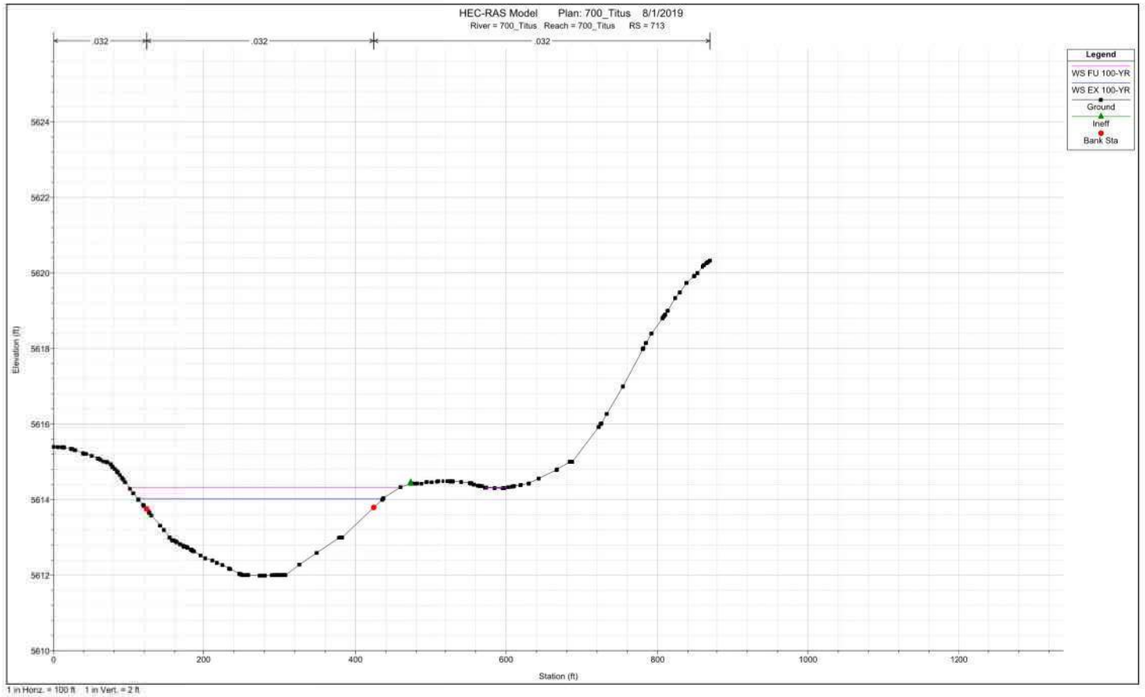

HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 708
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

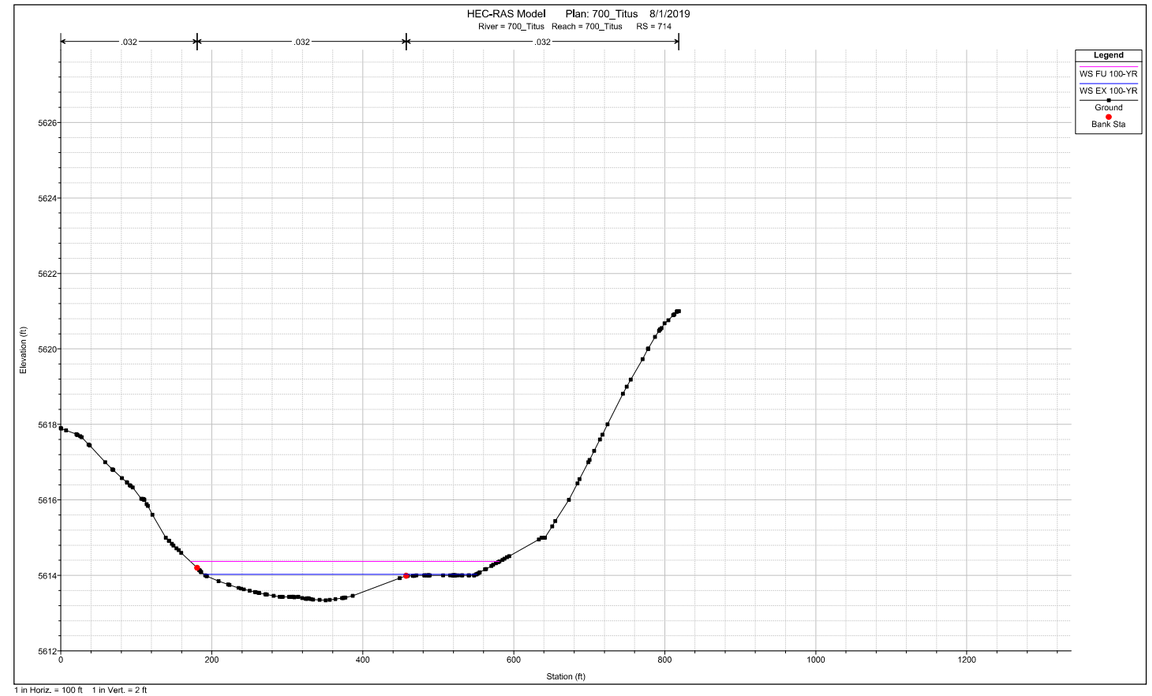

HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 709
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

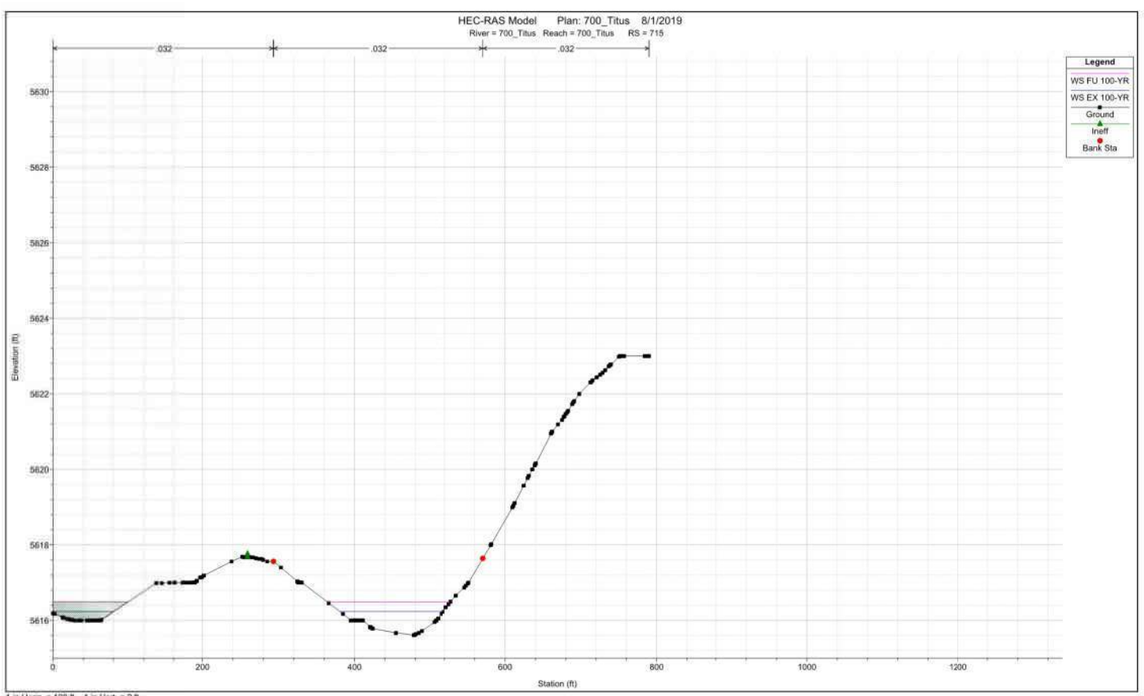

HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 710
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

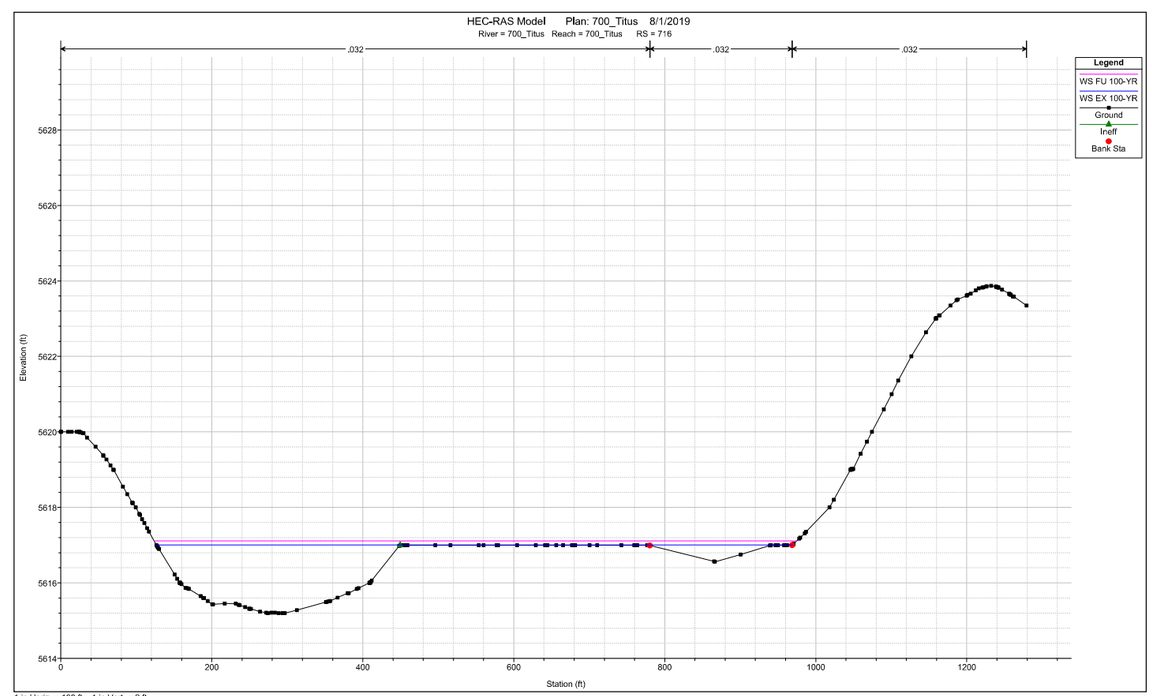

HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 711
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

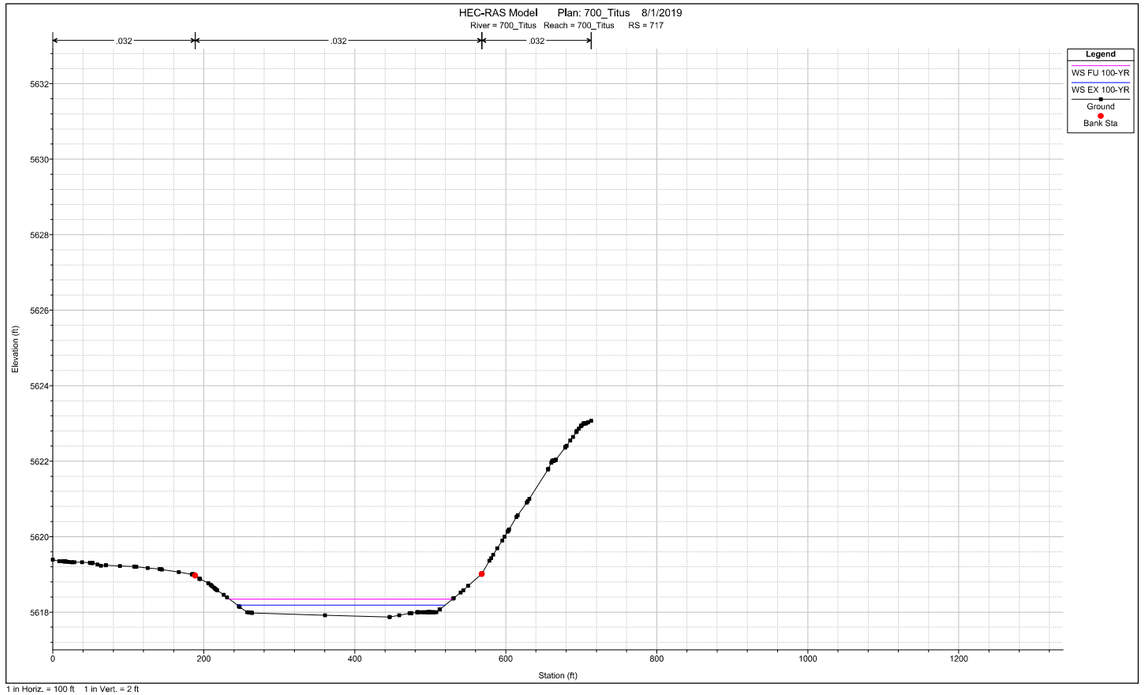

HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 712
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft


HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 713
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft


HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 714
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

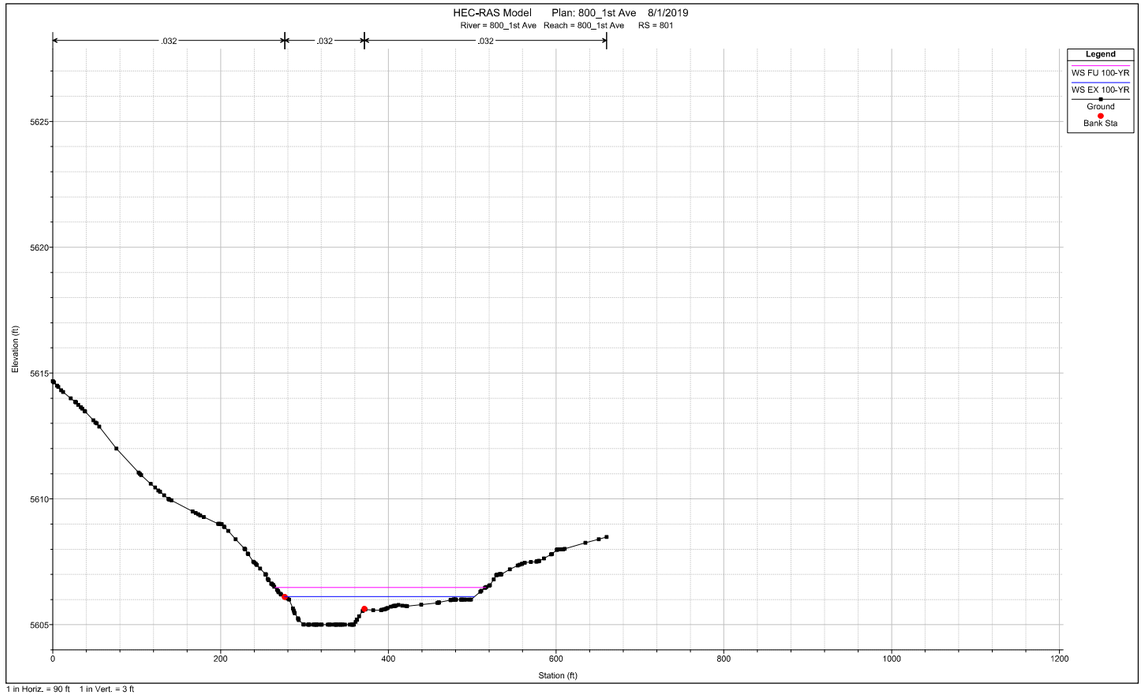

HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 715
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft


HEC-RAS Model Plan: 700_Titus 8/1/2019
River = 700_Titus Reach = 700_Titus RS = 716
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 2 ft

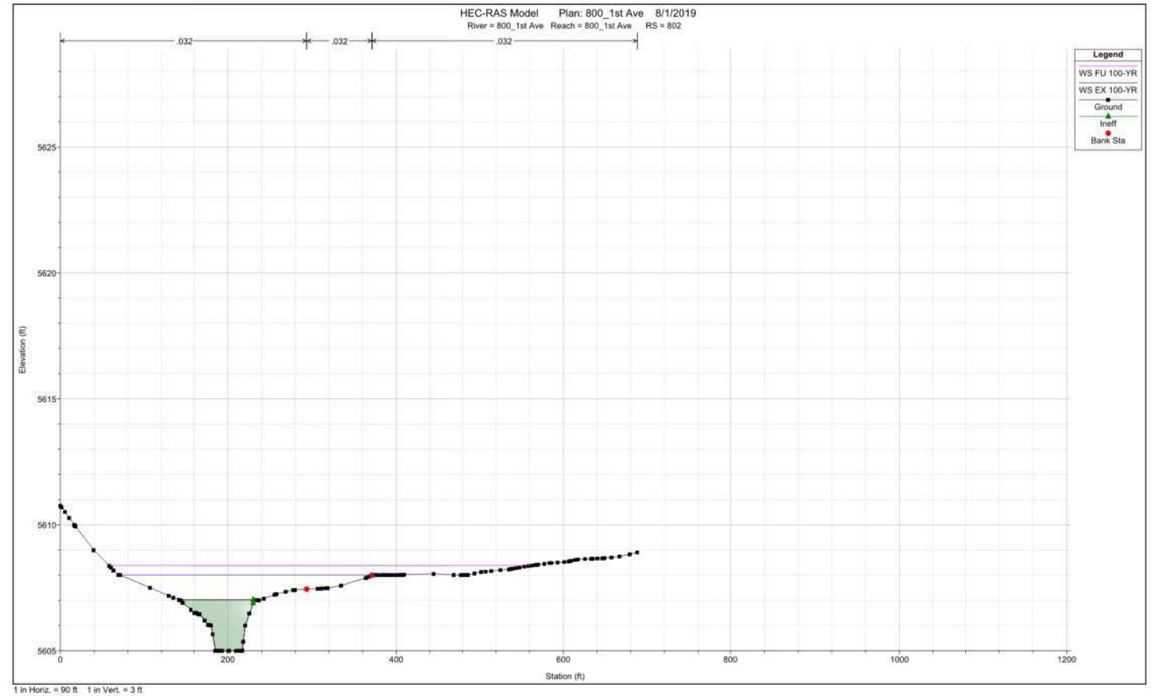


1 in Horiz. = 100 ft 1 in Vert. = 2 ft

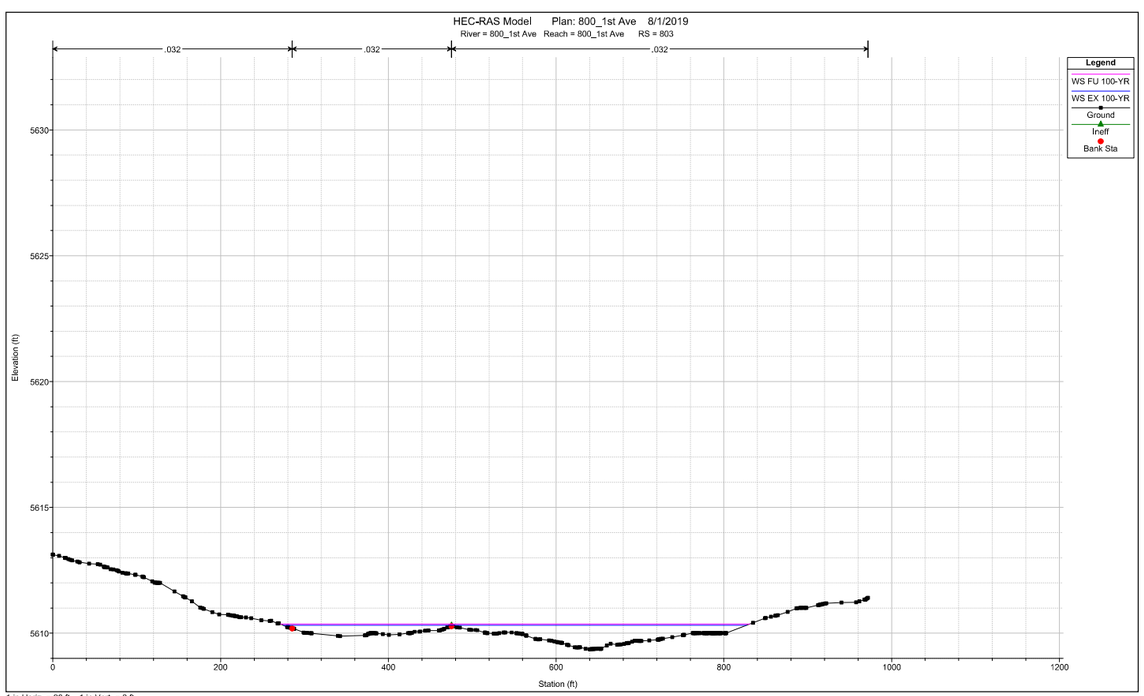
1ST AVENUE TRIBUTARY
Series 800 Cross Sections



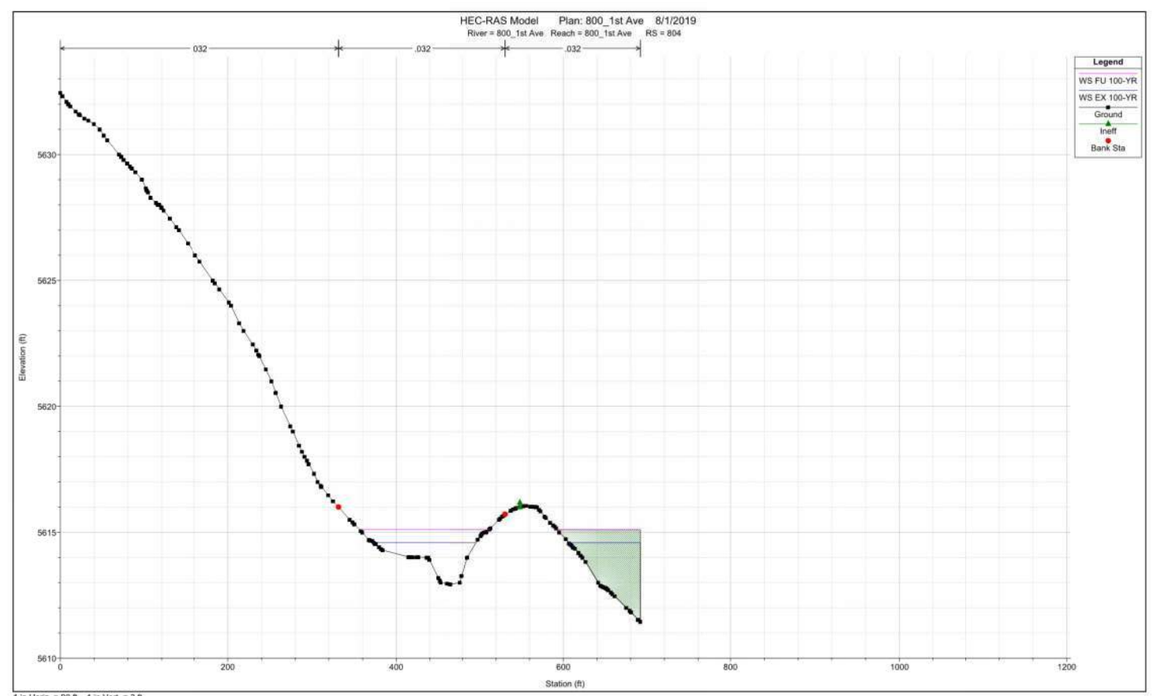
1 in Horiz. = 90 ft 1 in Vert. = 3 ft



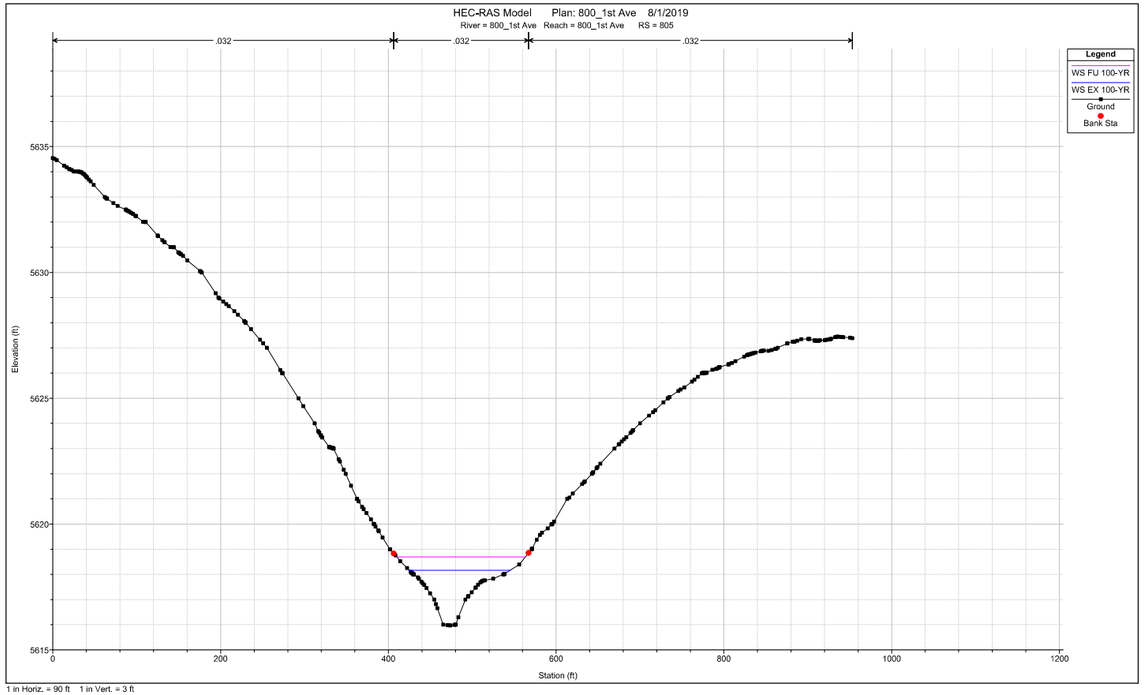
1 in Horiz. = 90 ft 1 in Vert. = 3 ft



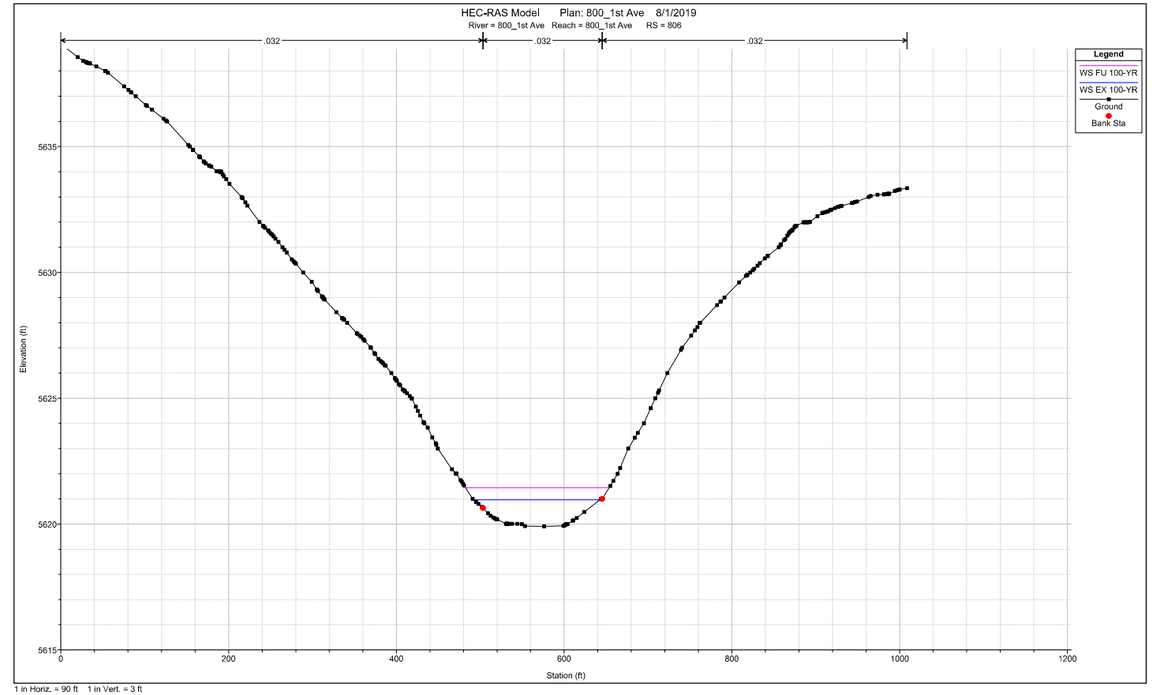
1 in Horiz. = 90 ft 1 in Vert. = 3 ft



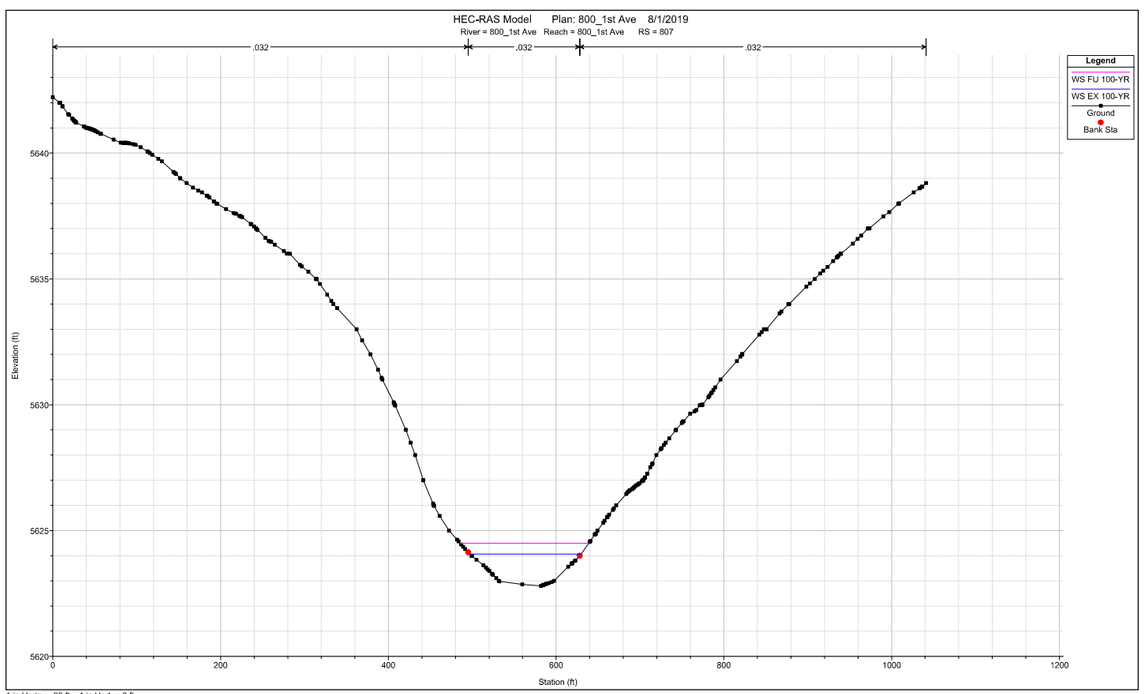
1 in Horiz. = 90 ft 1 in Vert. = 3 ft



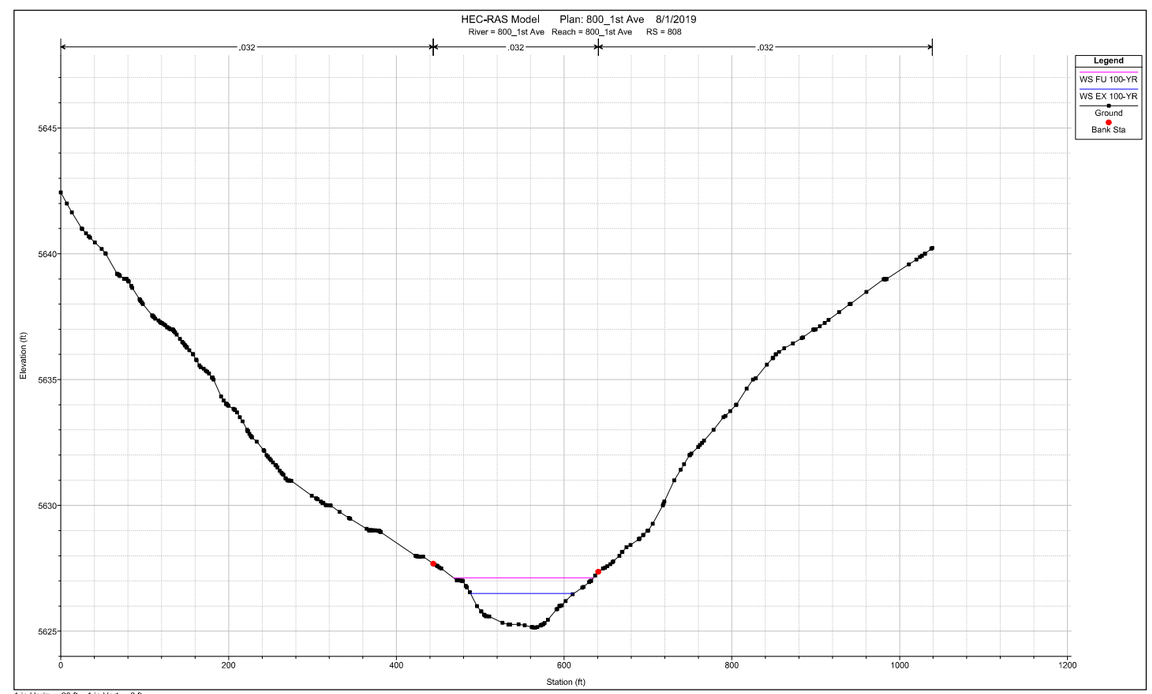
1 in Horiz. = 90 ft 1 in Vert. = 3 ft



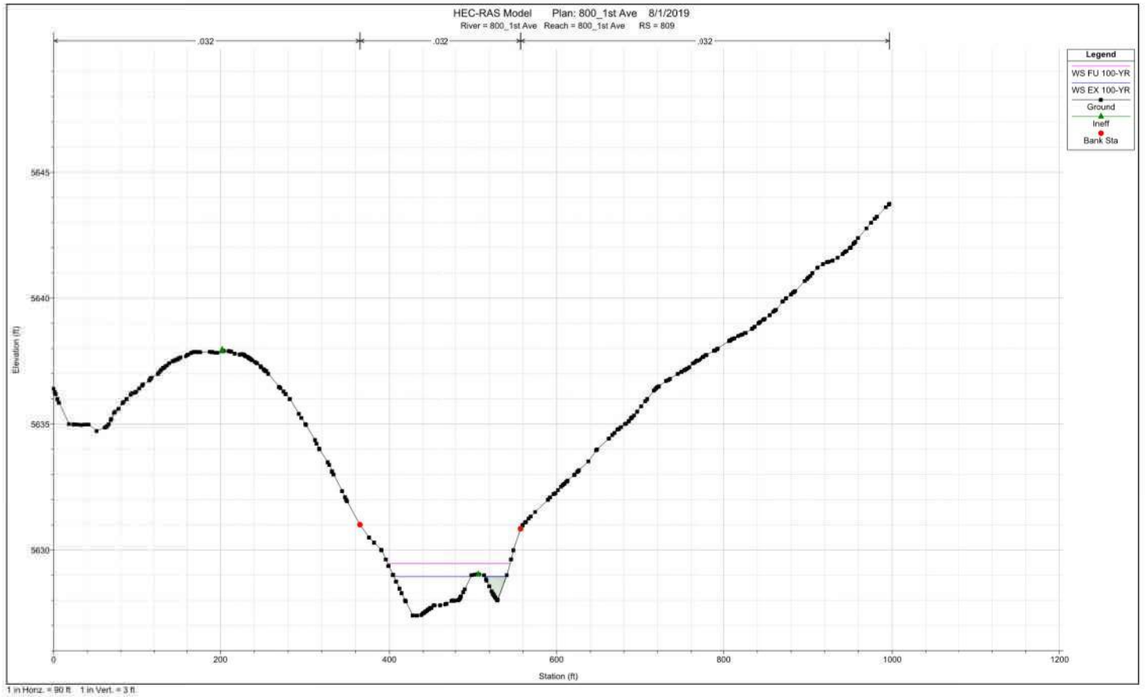
1 in Horiz. = 90 ft 1 in Vert. = 3 ft



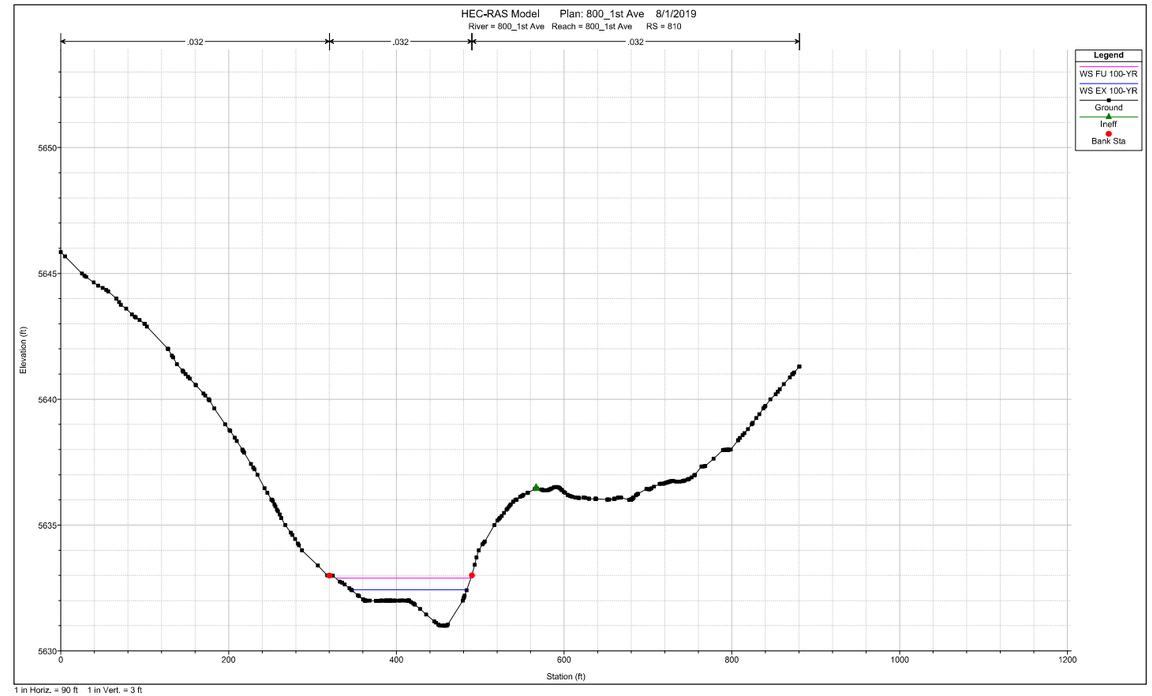
1 in Horiz. = 90 ft 1 in Vert. = 3 ft



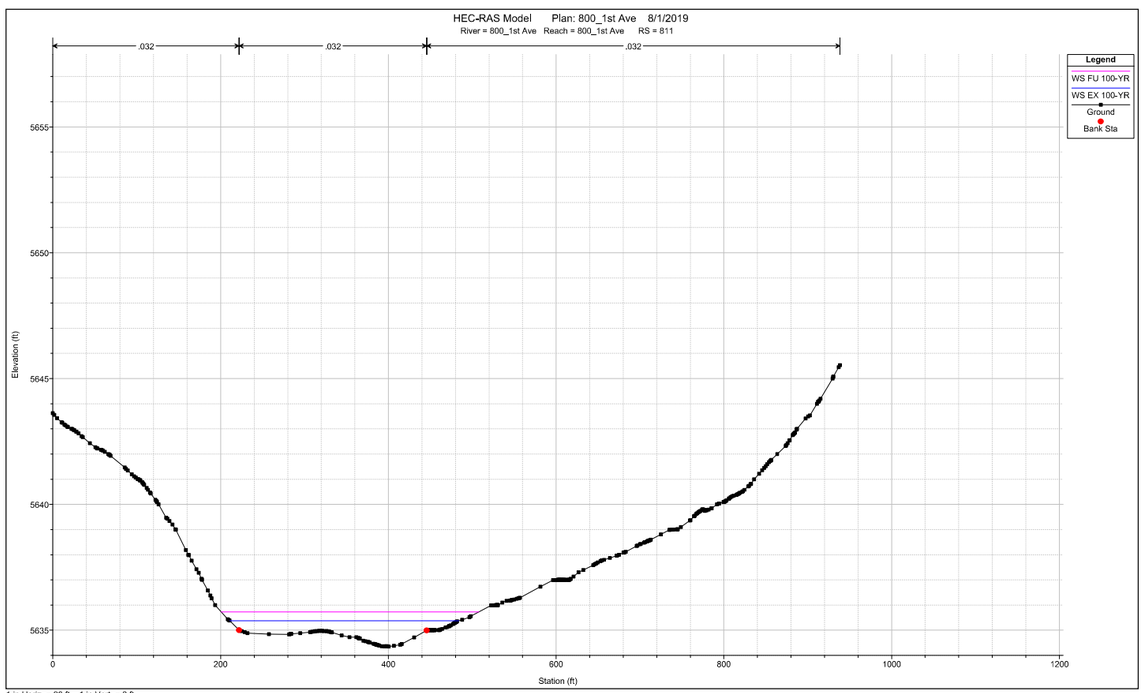
1 in Horiz. = 90 ft 1 in Vert. = 3 ft



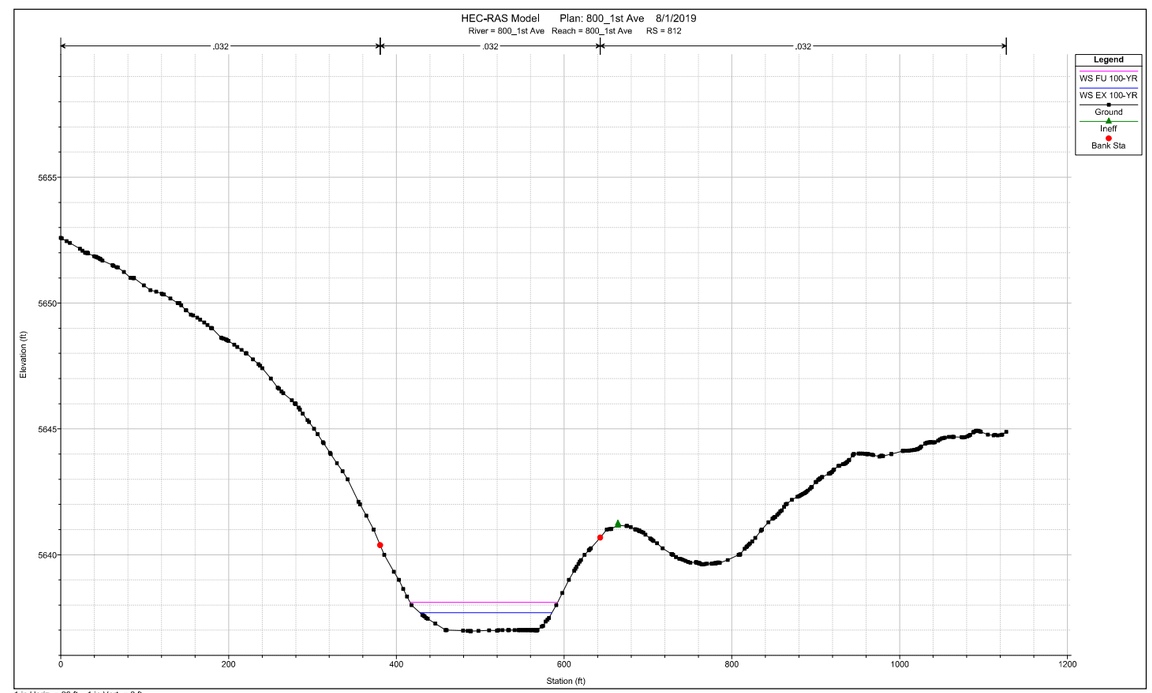
1 in Horiz. = 90 ft 1 in Vert. = 3 ft



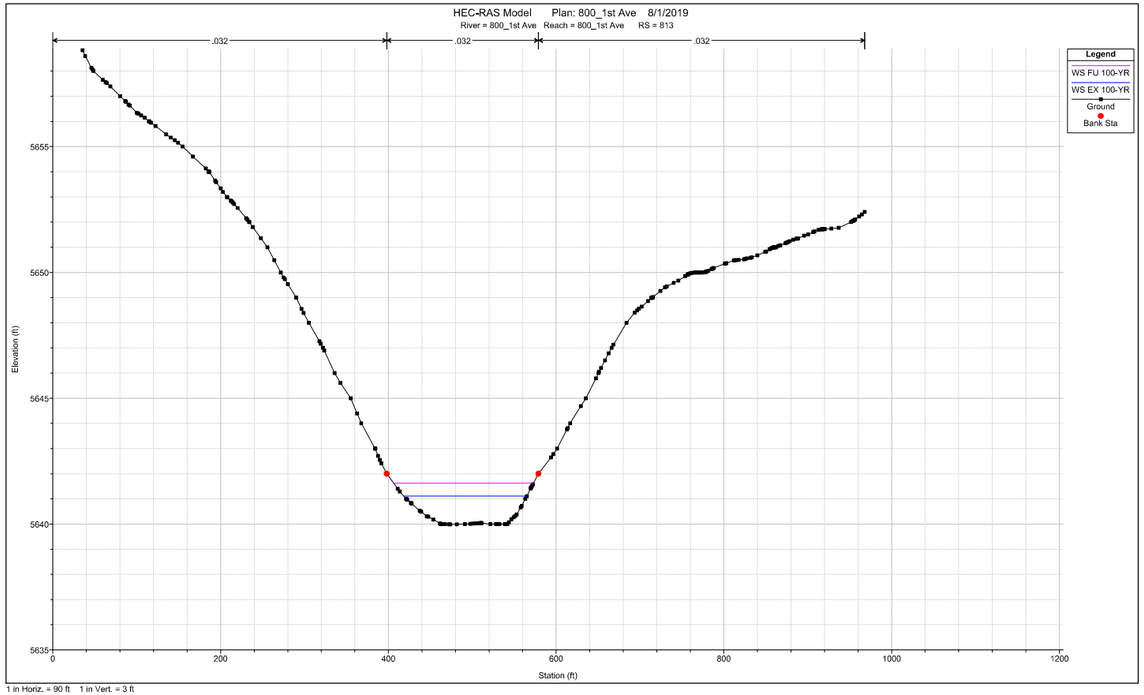
1 in Horiz. = 90 ft 1 in Vert. = 3 ft



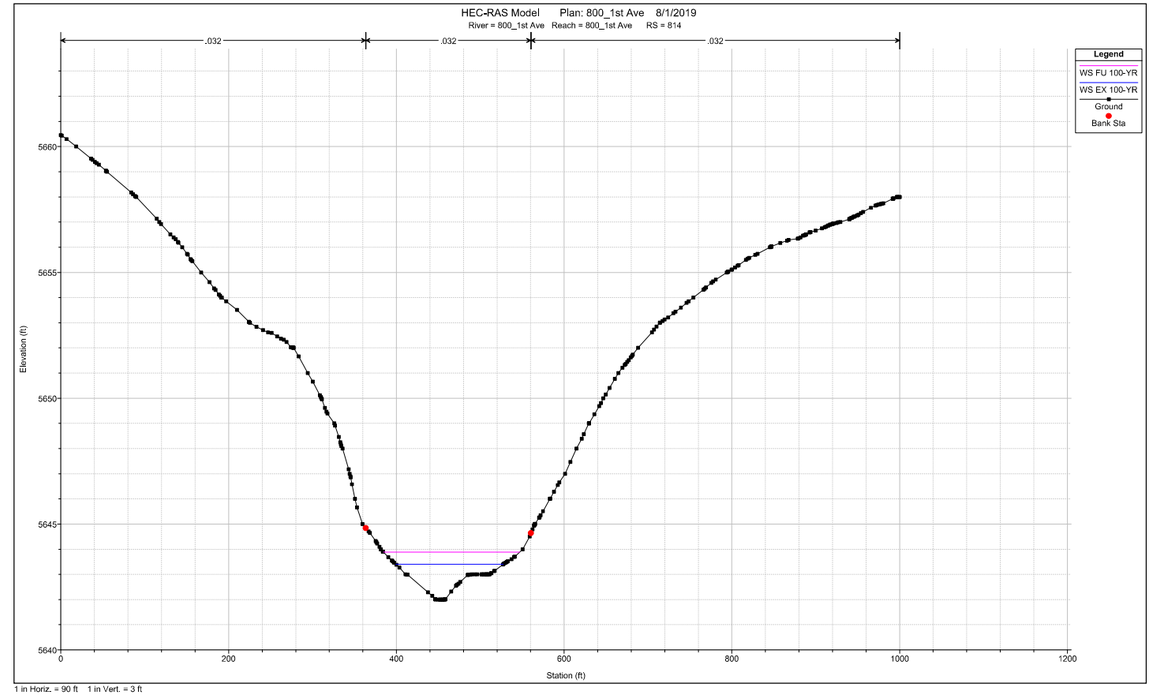
1 in Horiz. = 90 ft 1 in Vert. = 3 ft



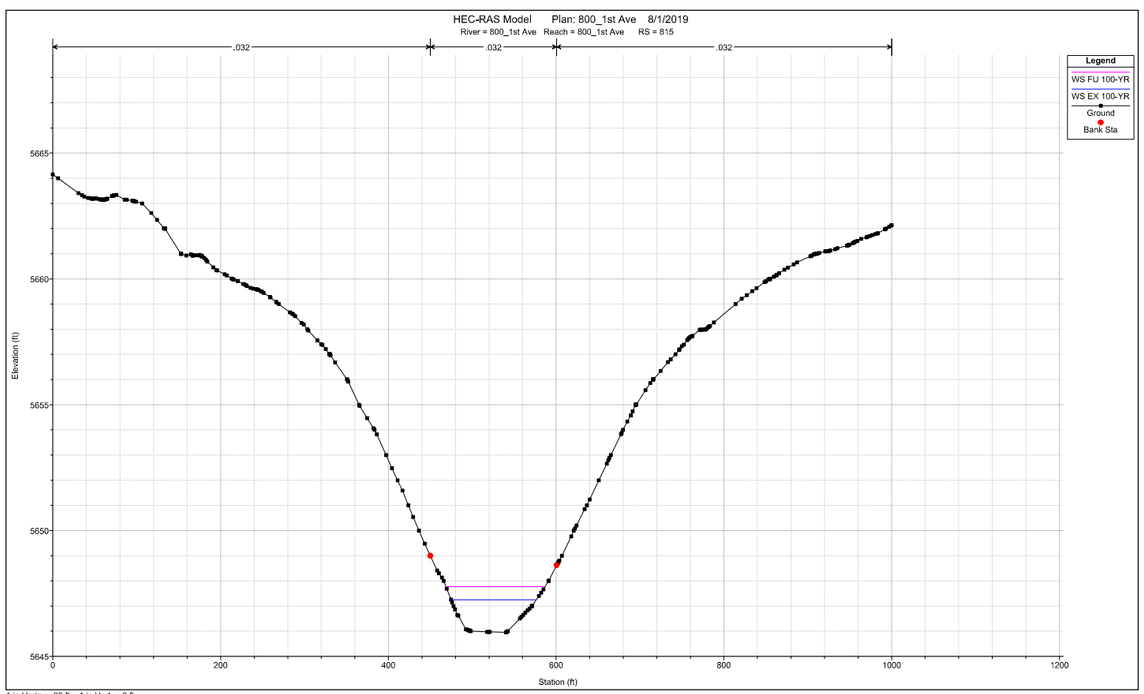
1 in Horiz. = 90 ft 1 in Vert. = 3 ft



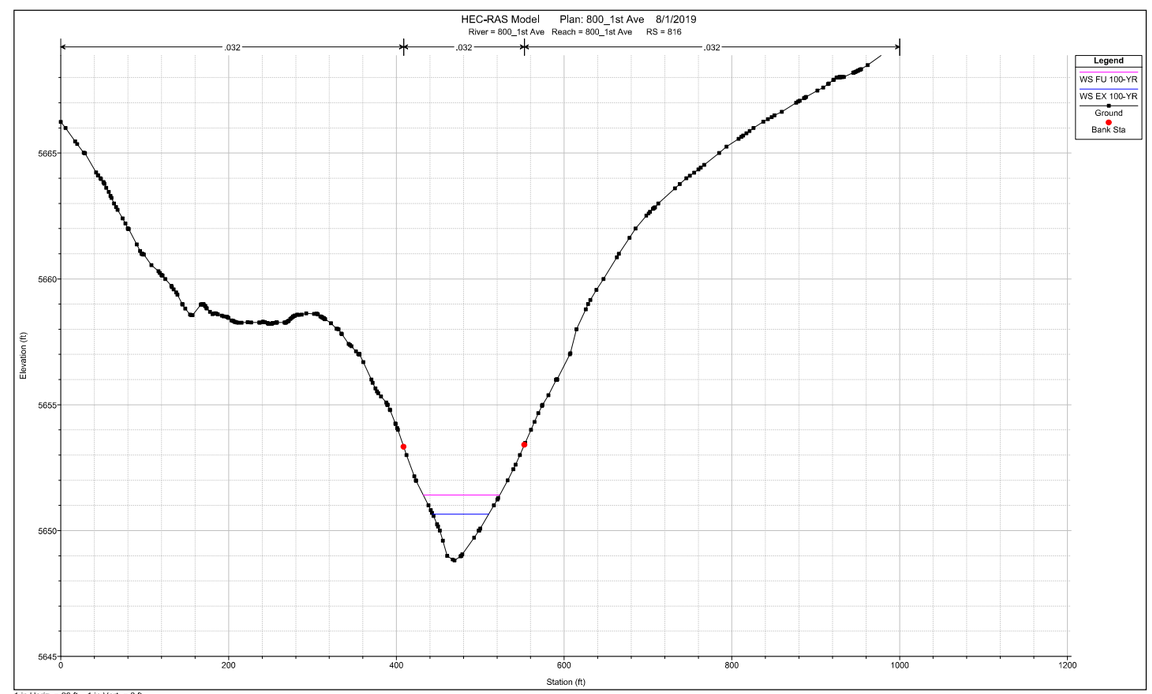
1 in Horiz. = 90 ft 1 in Vert. = 3 ft



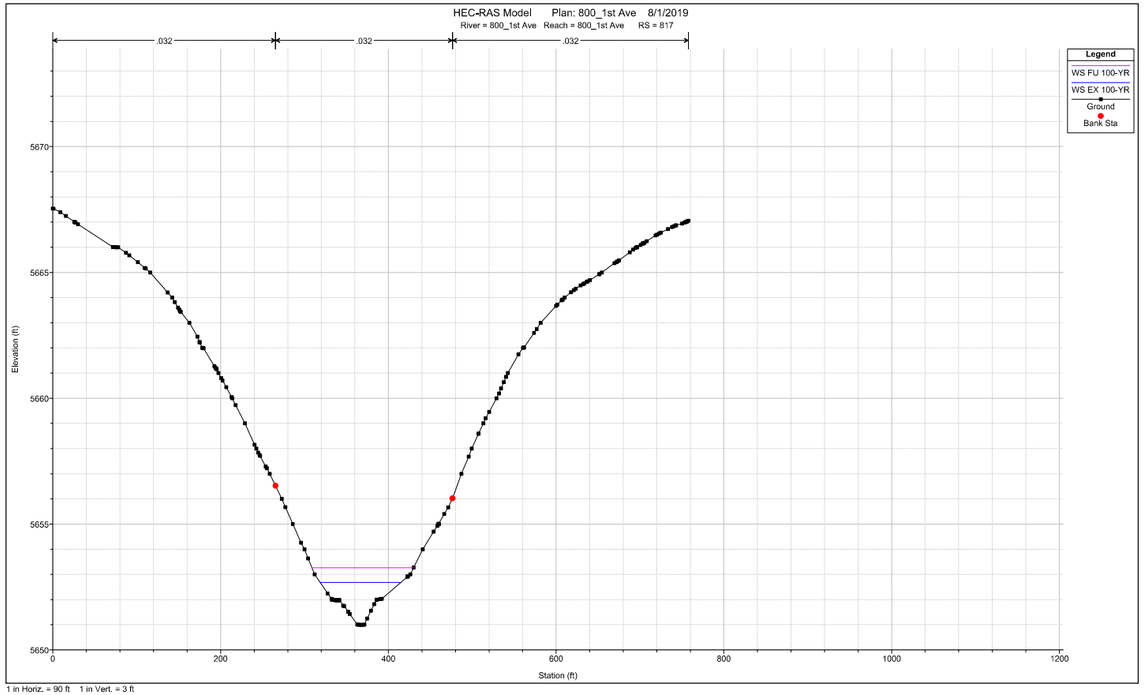
1 in Horiz. = 90 ft 1 in Vert. = 3 ft



1 in Horiz. = 90 ft 1 in Vert. = 3 ft

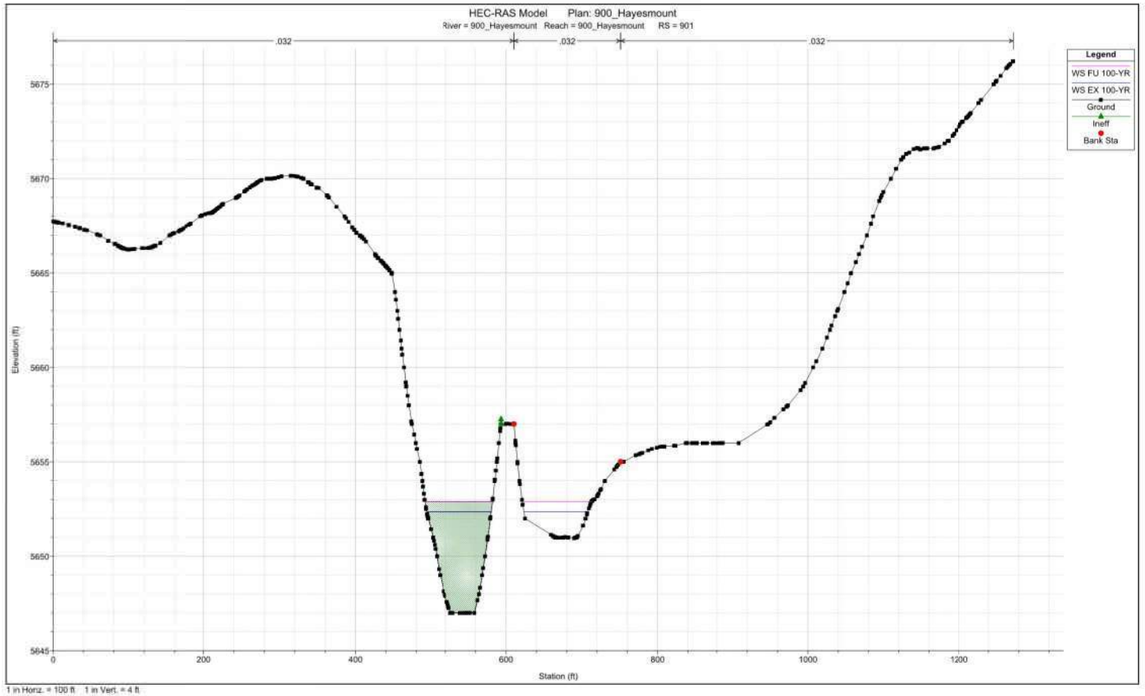


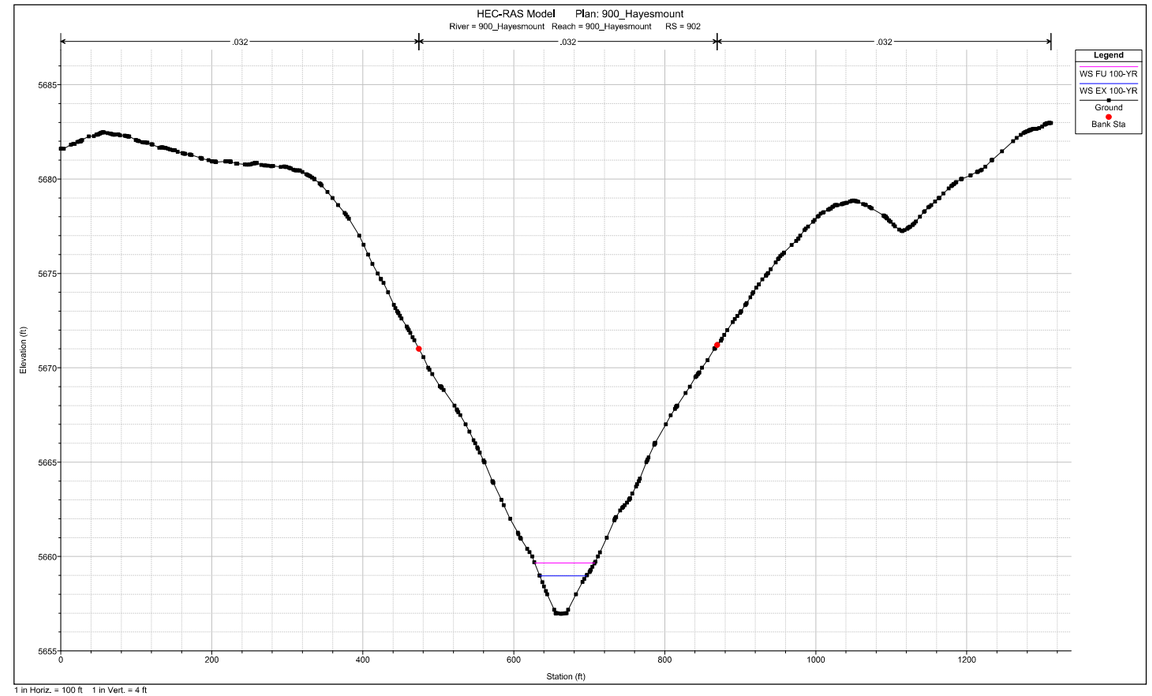
1 in Horiz. = 90 ft 1 in Vert. = 3 ft

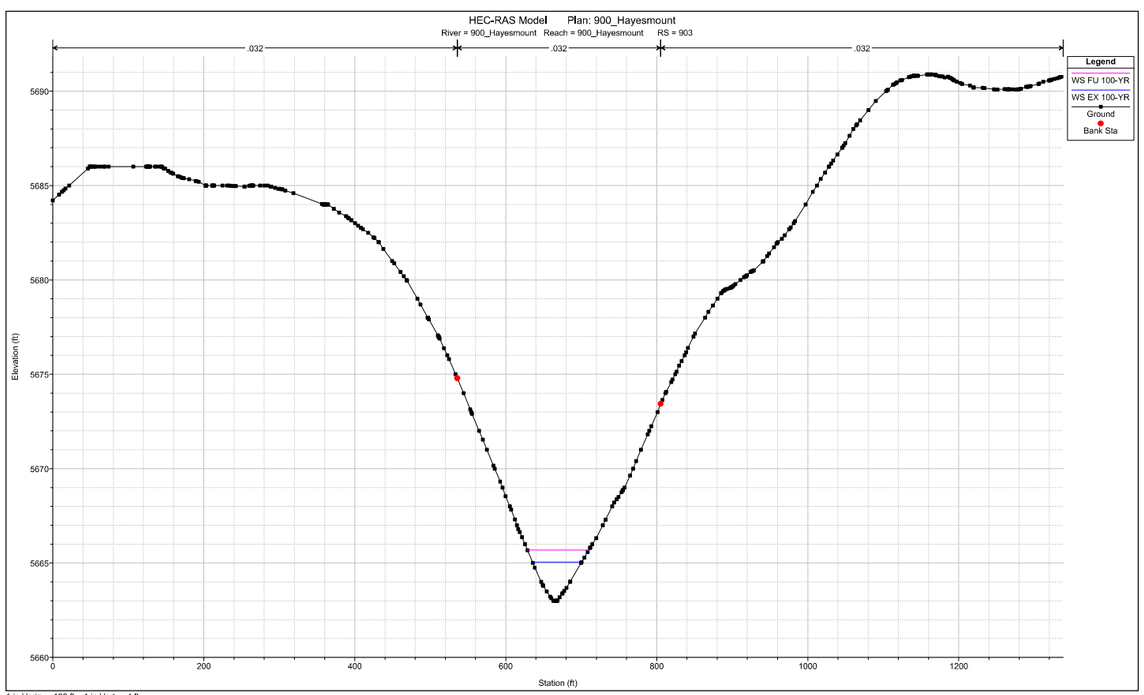


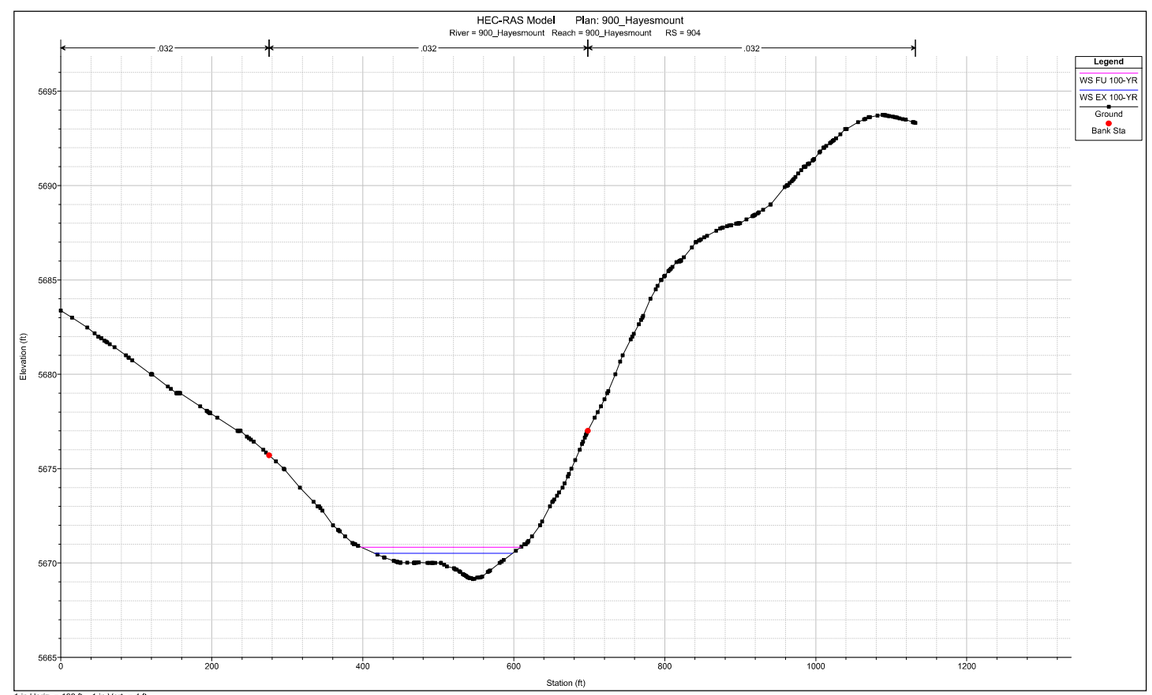
1 in Horiz. = 90 ft 1 in Vert. = 3 ft

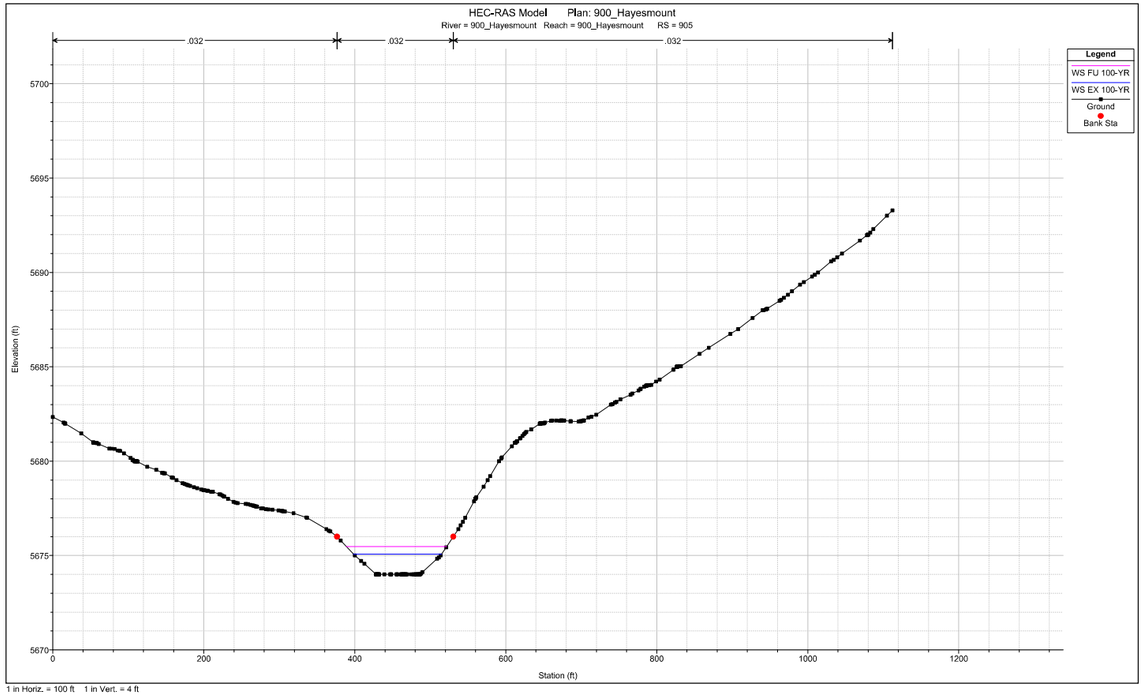
HAYESMOUNT TRIBUTARY
Series 900 Cross Sections

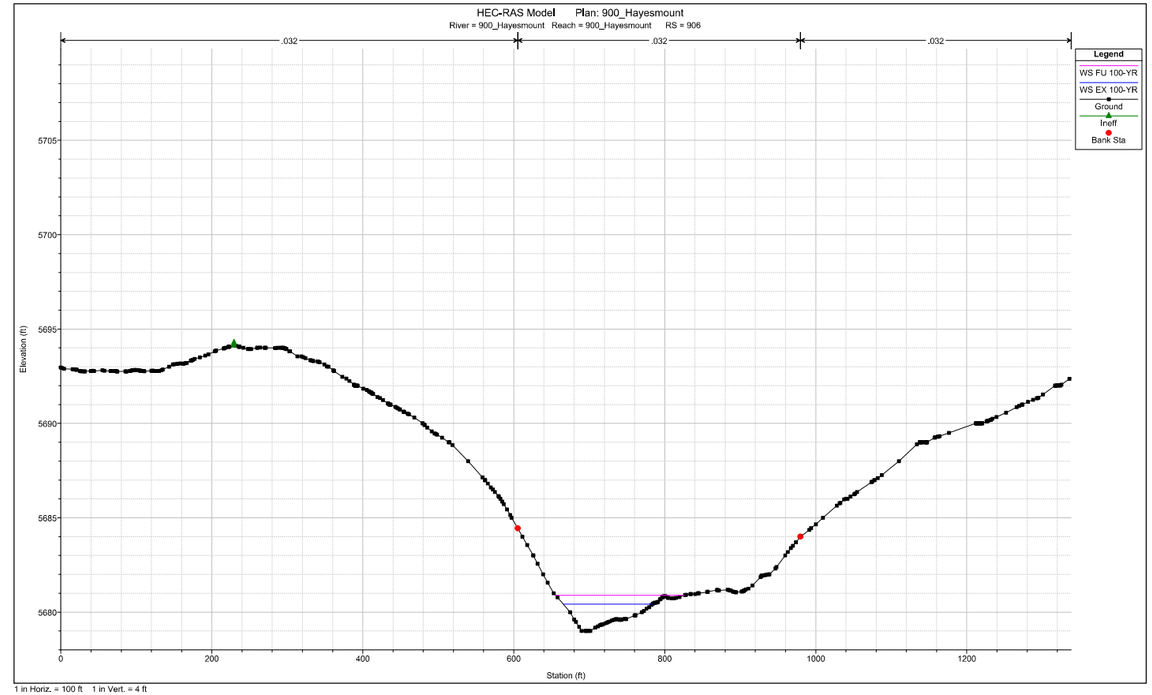

HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 901
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

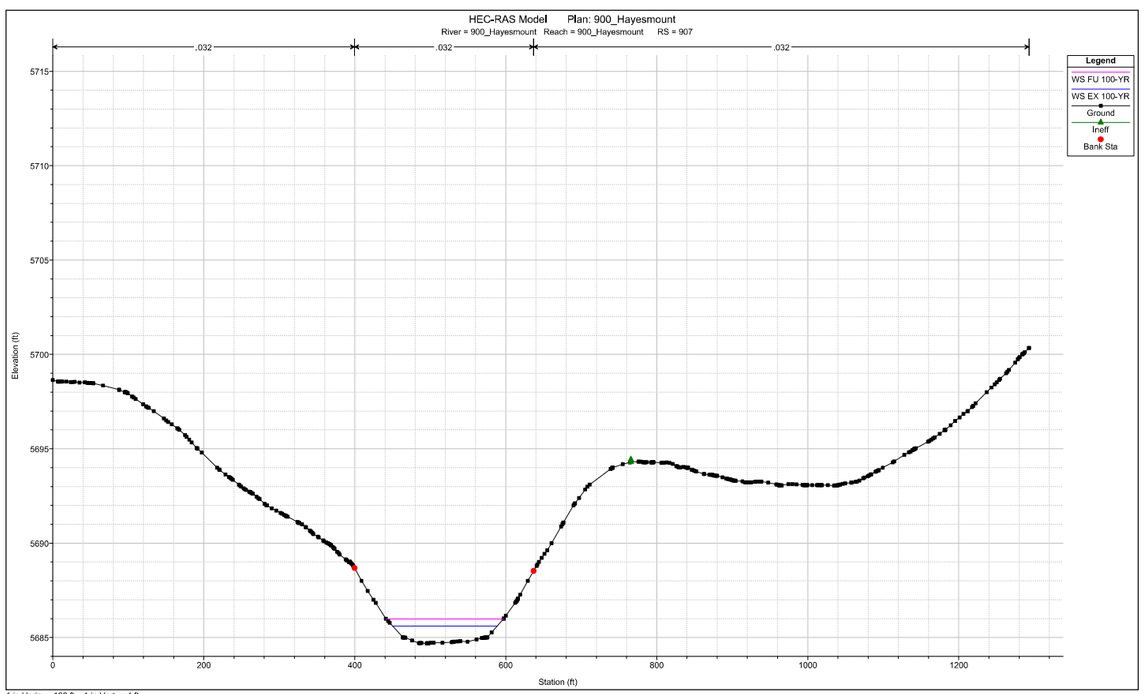

HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 902
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

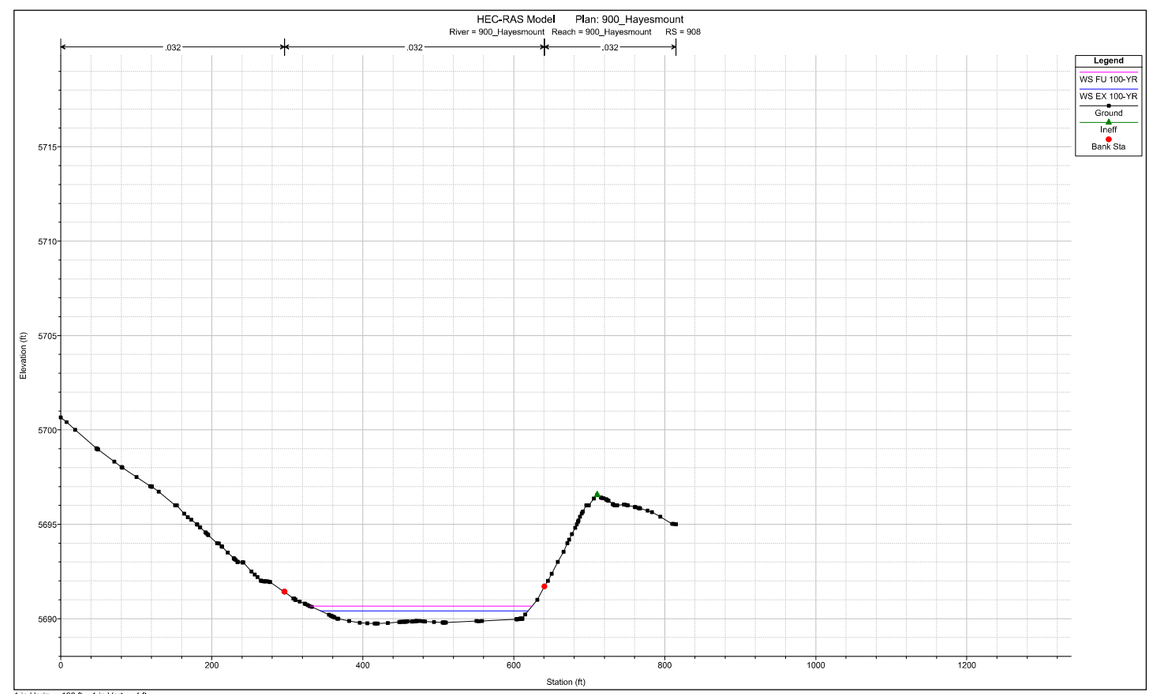

HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 903
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

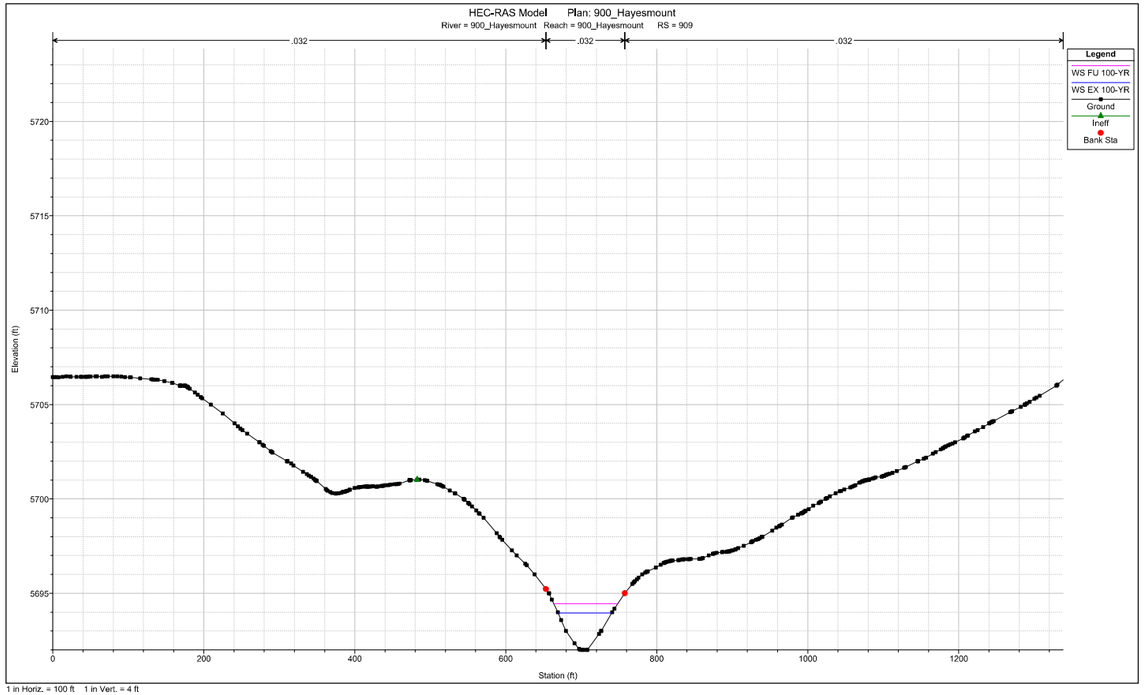

HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 904
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 905
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

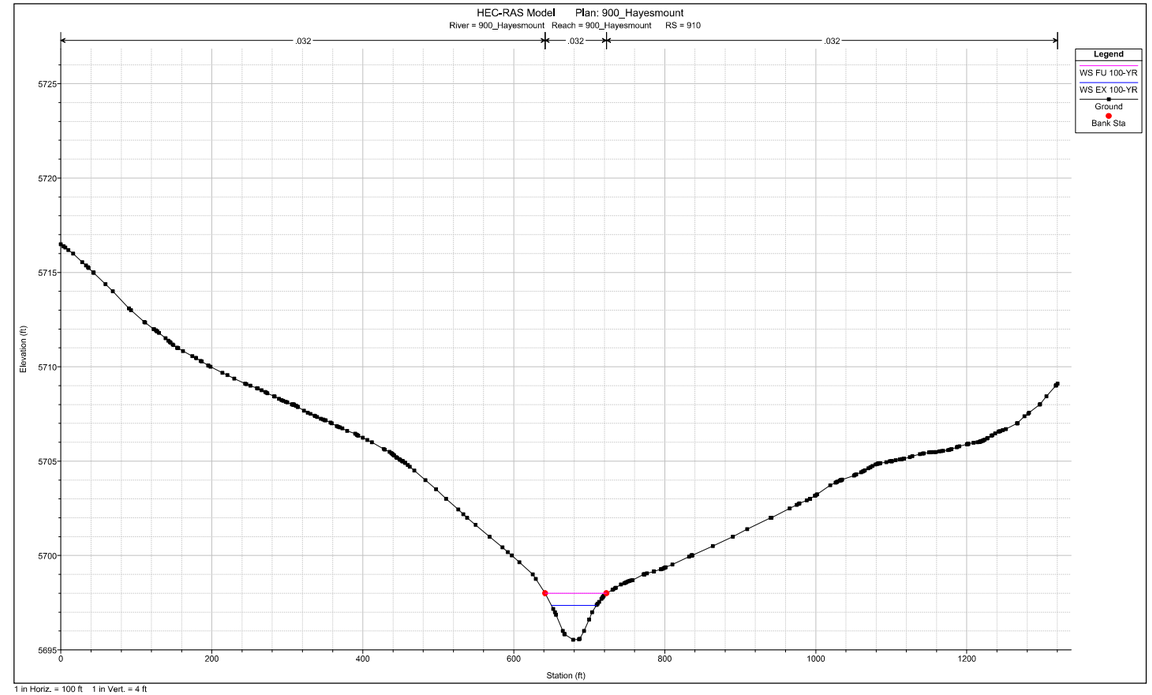

HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 906
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 907
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

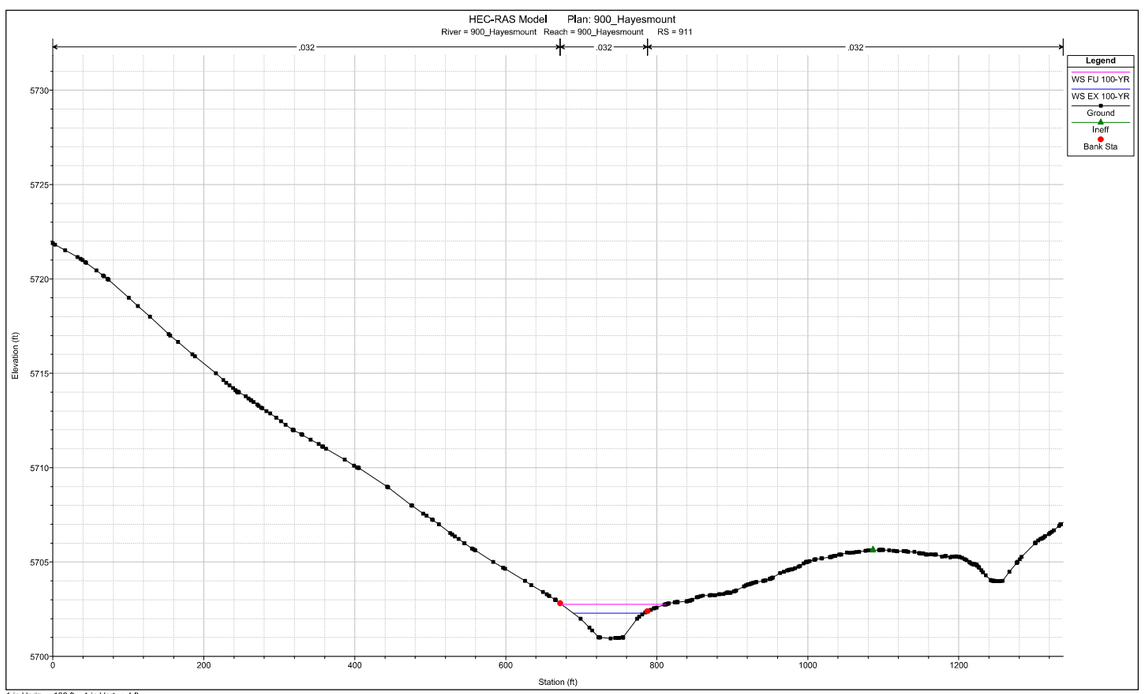

HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 908
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft



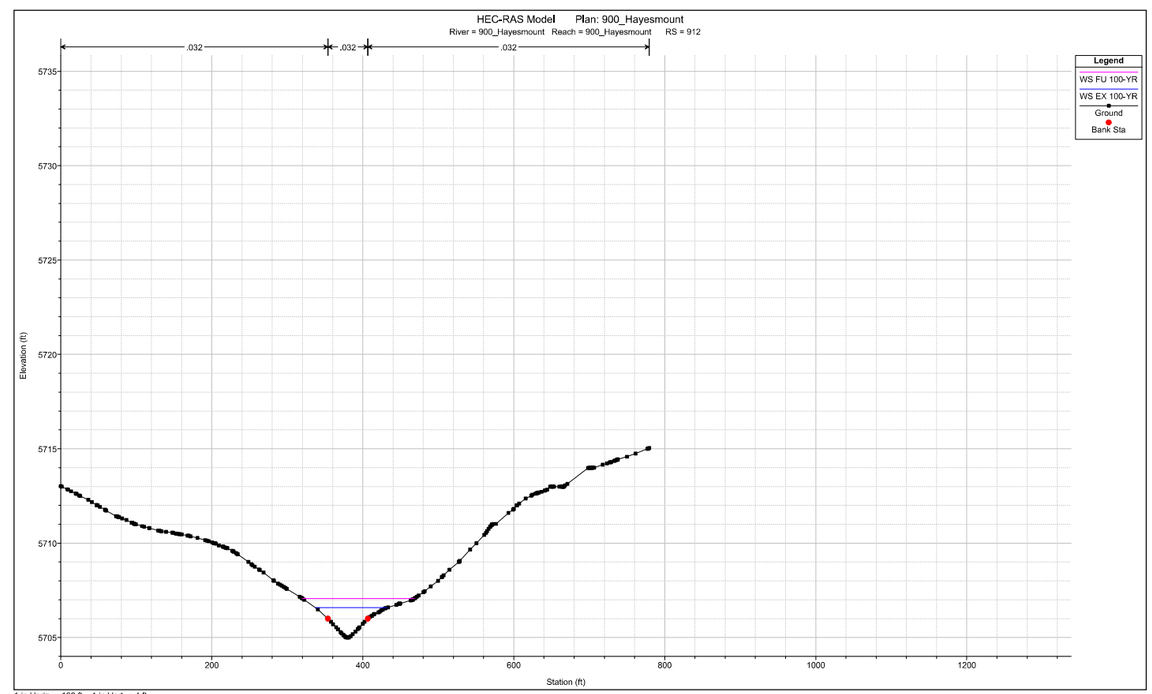
1 in Horiz. = 100 ft 1 in Vert. = 4 ft



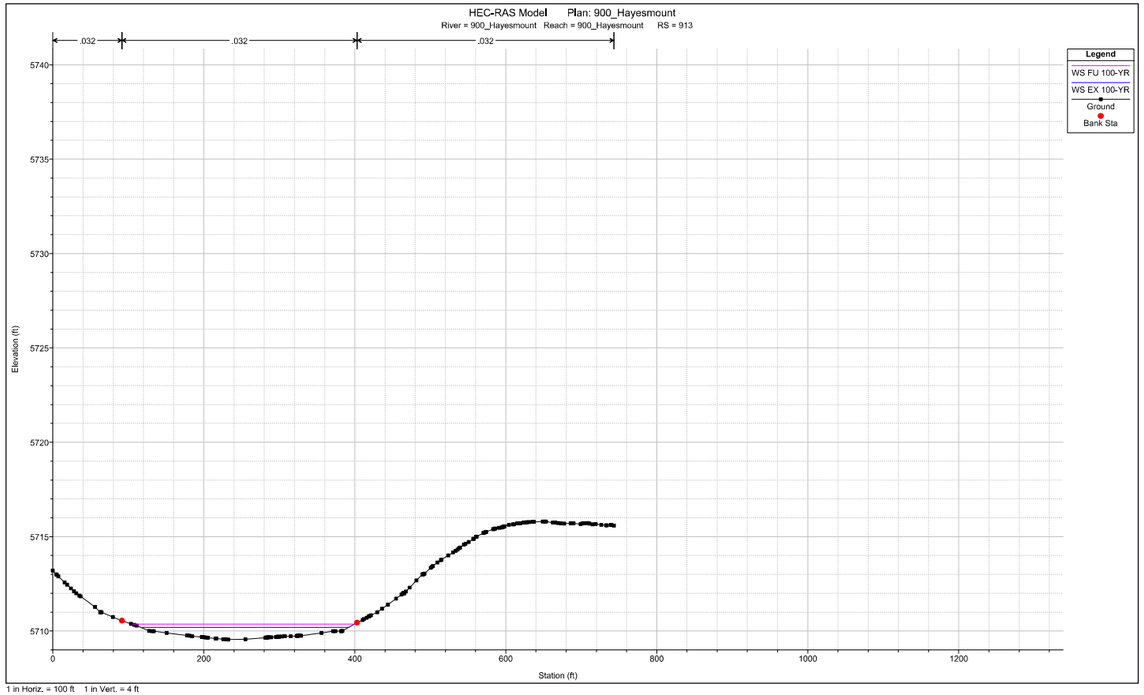
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

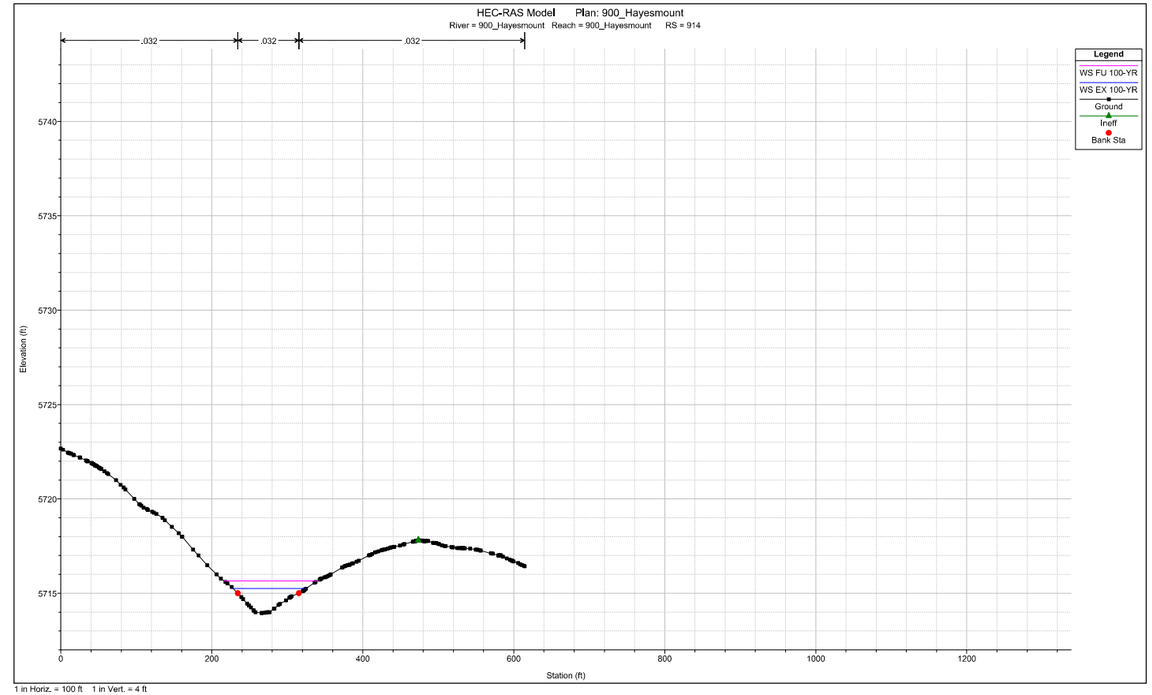


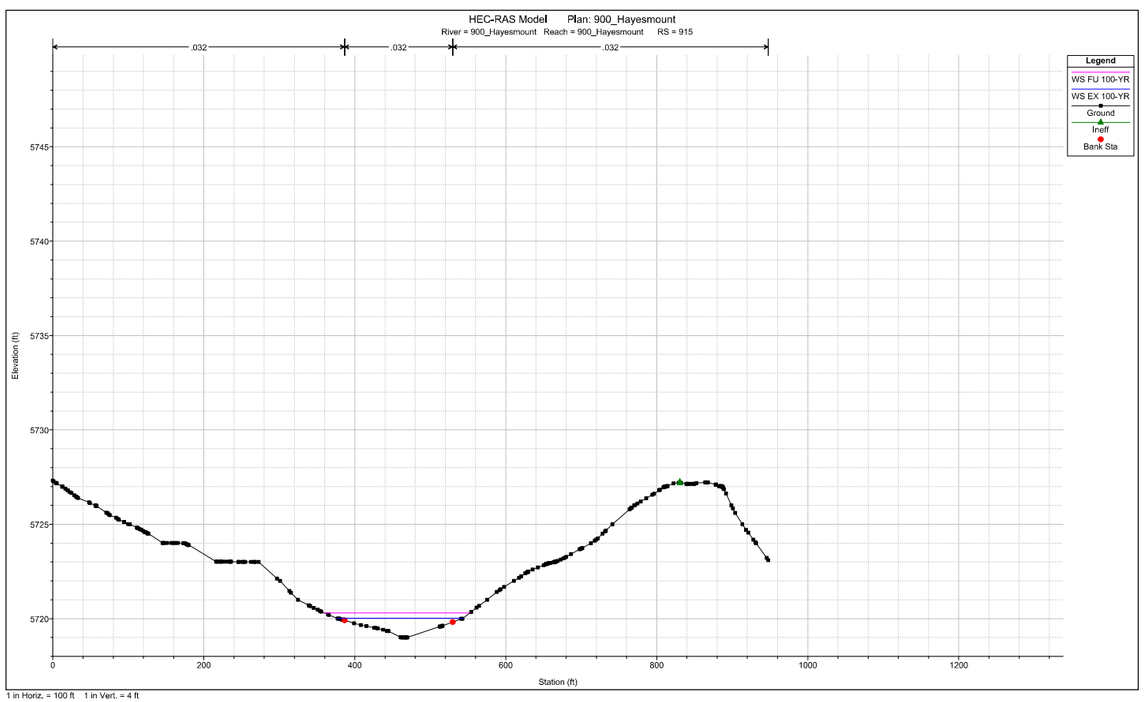
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

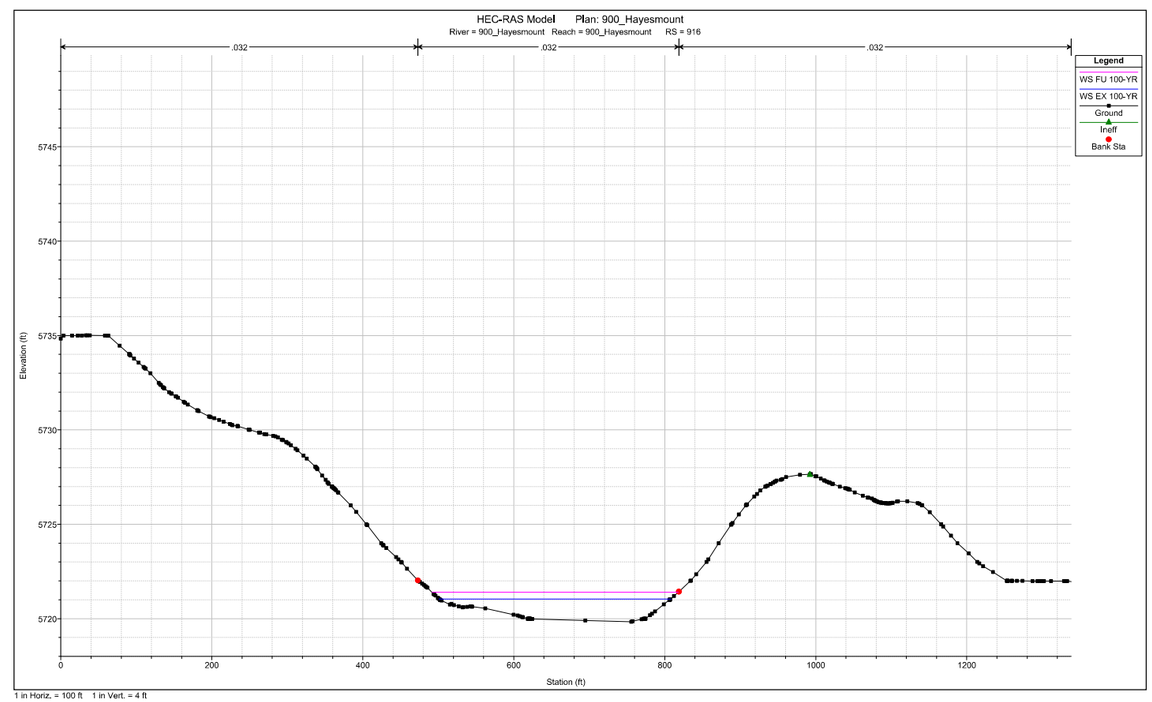


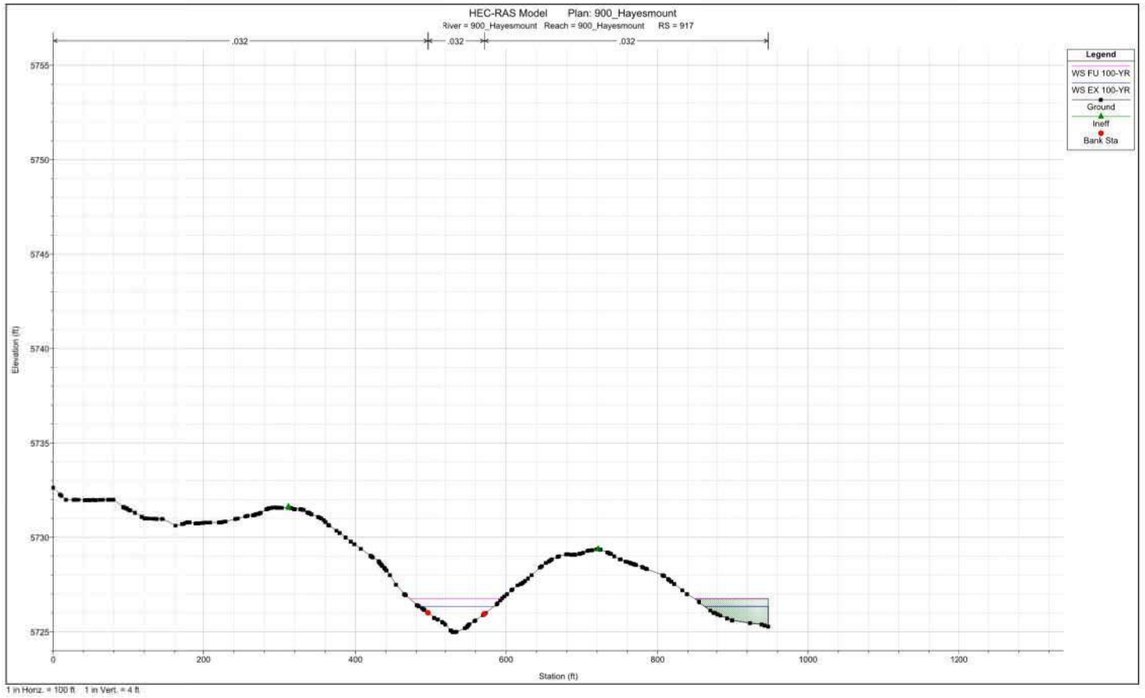
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

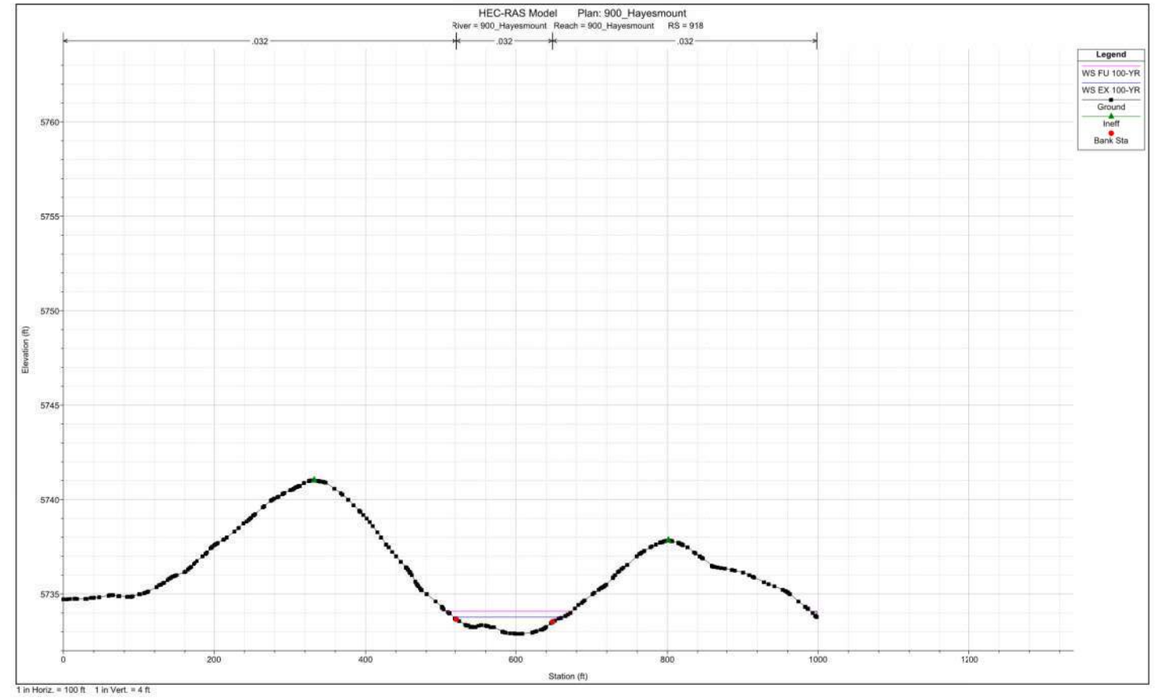

HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 913
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

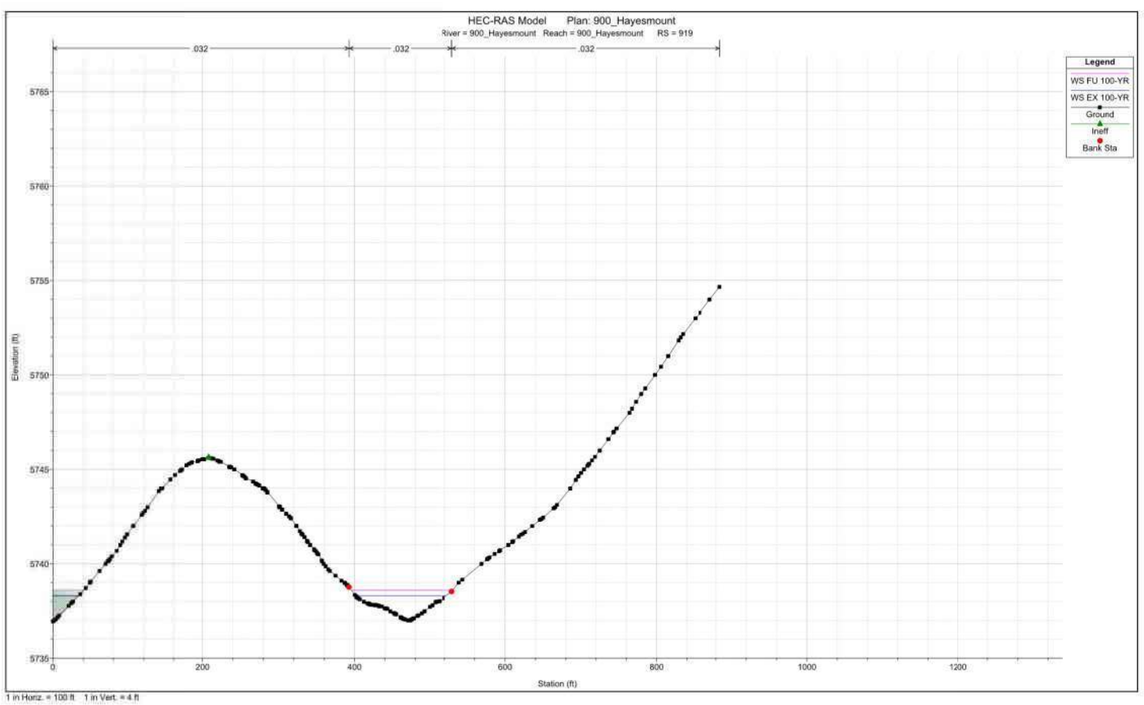

HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 914
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

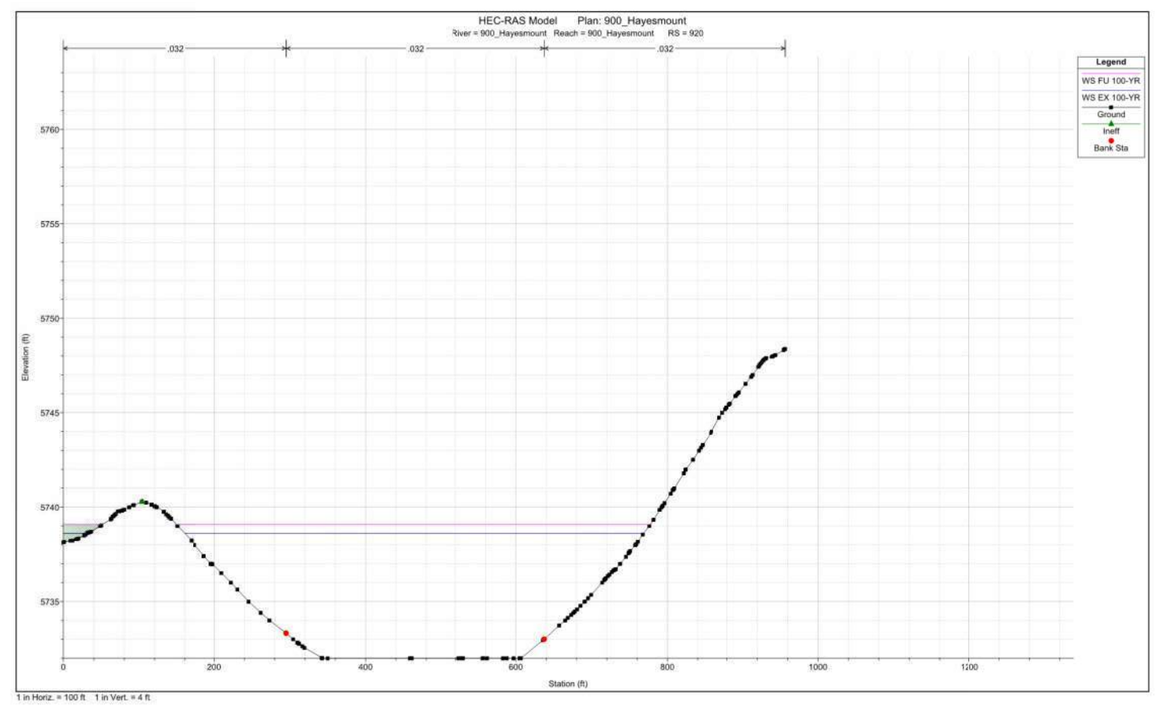

HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 915
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

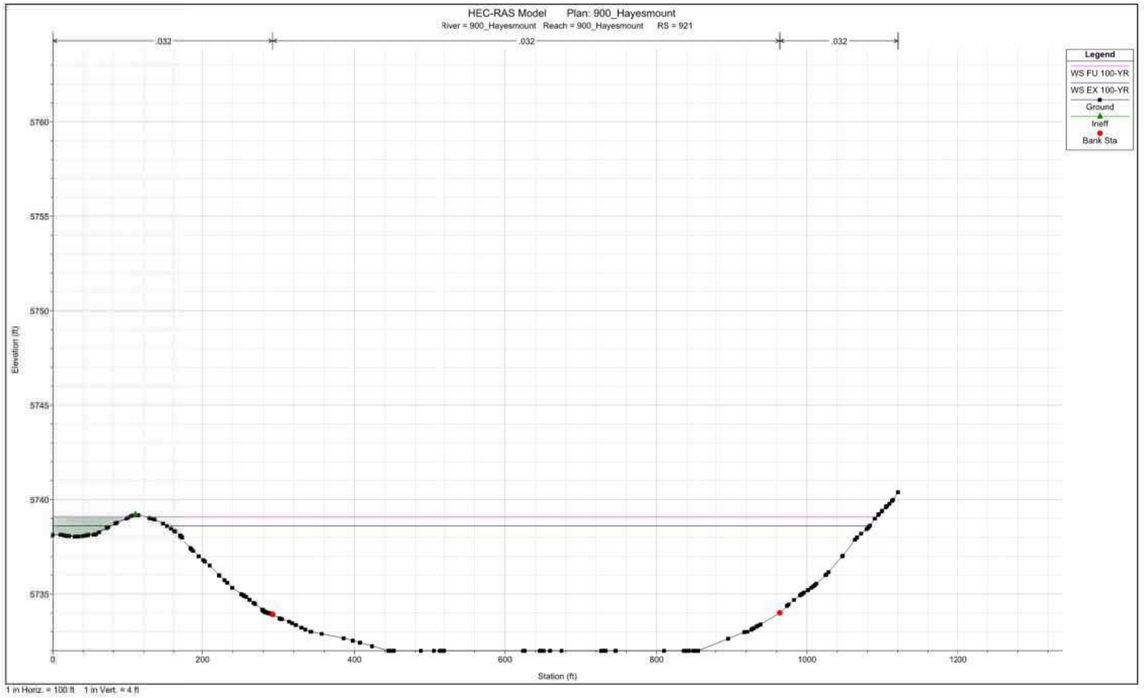

HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 916
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

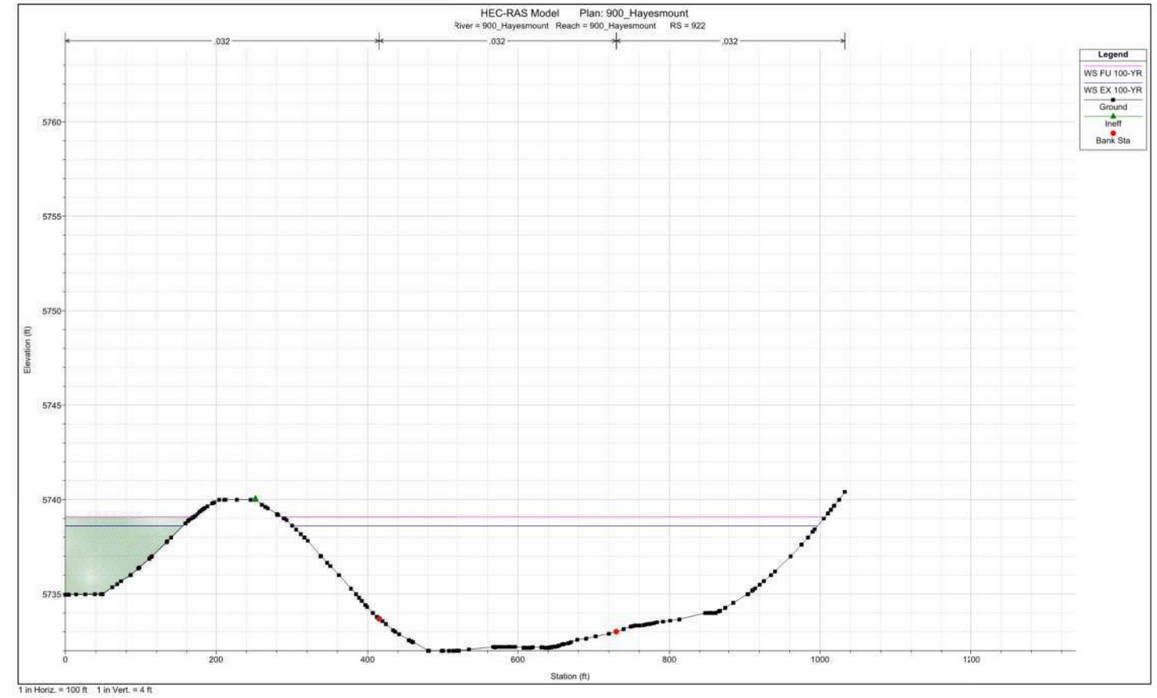

HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 917
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

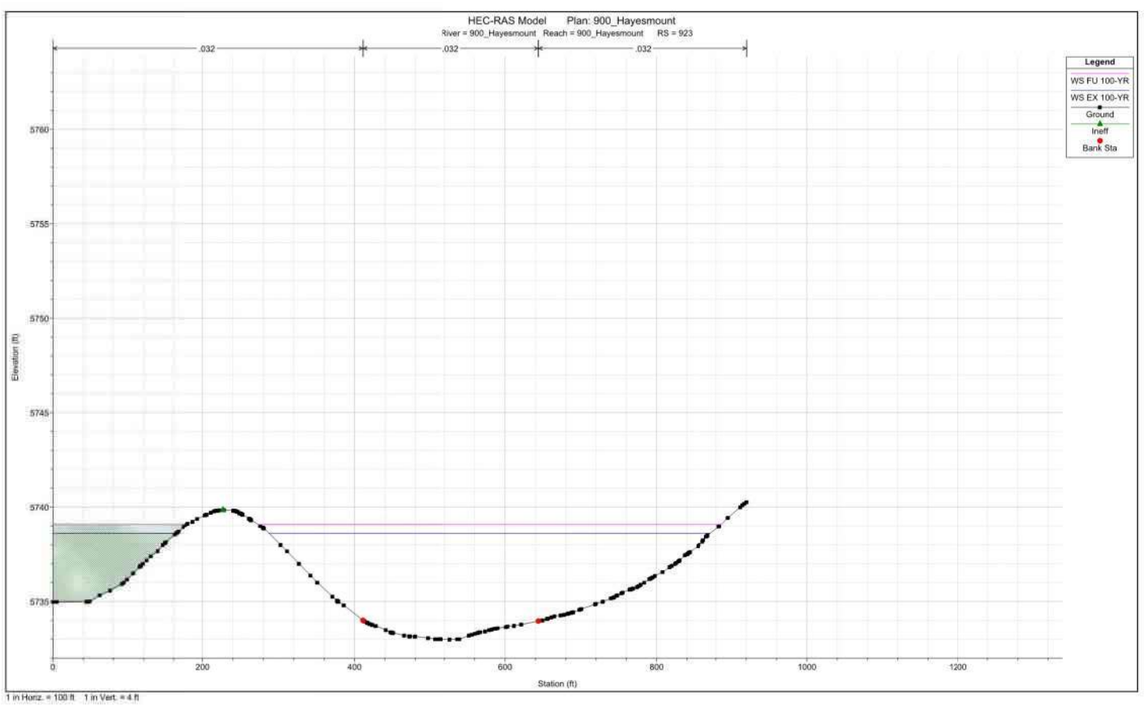

HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 918
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 919
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

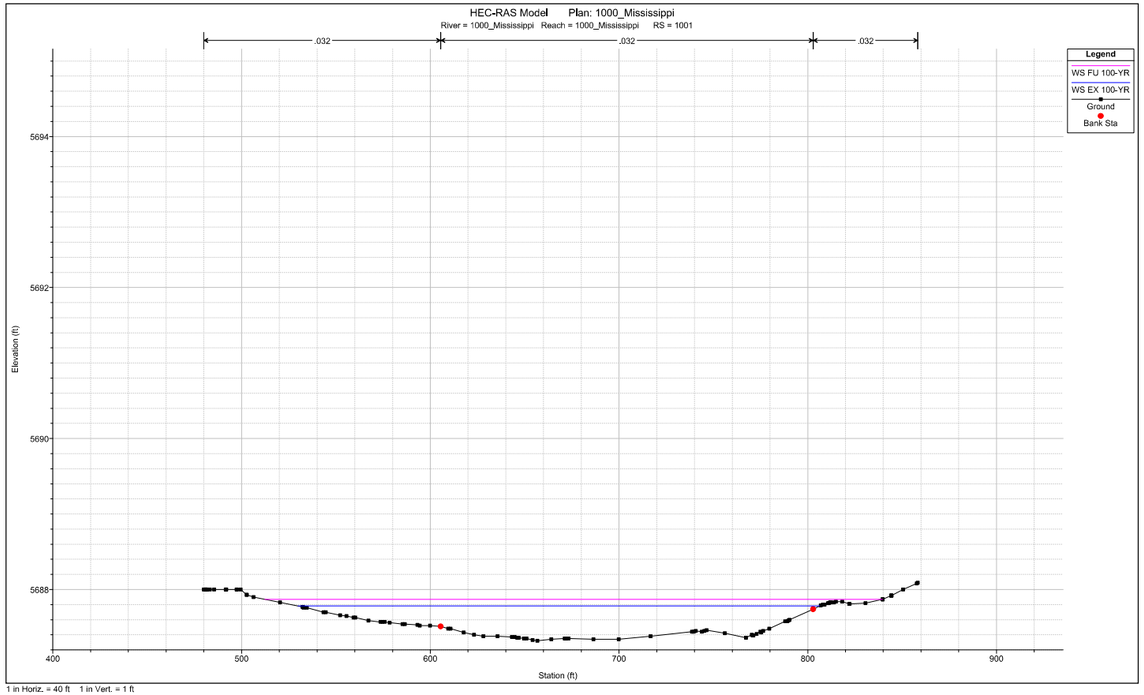

HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 920
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 921
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
5760
5755
5750
5745
5740
5735
0
200
400
600
800
1000
1200
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

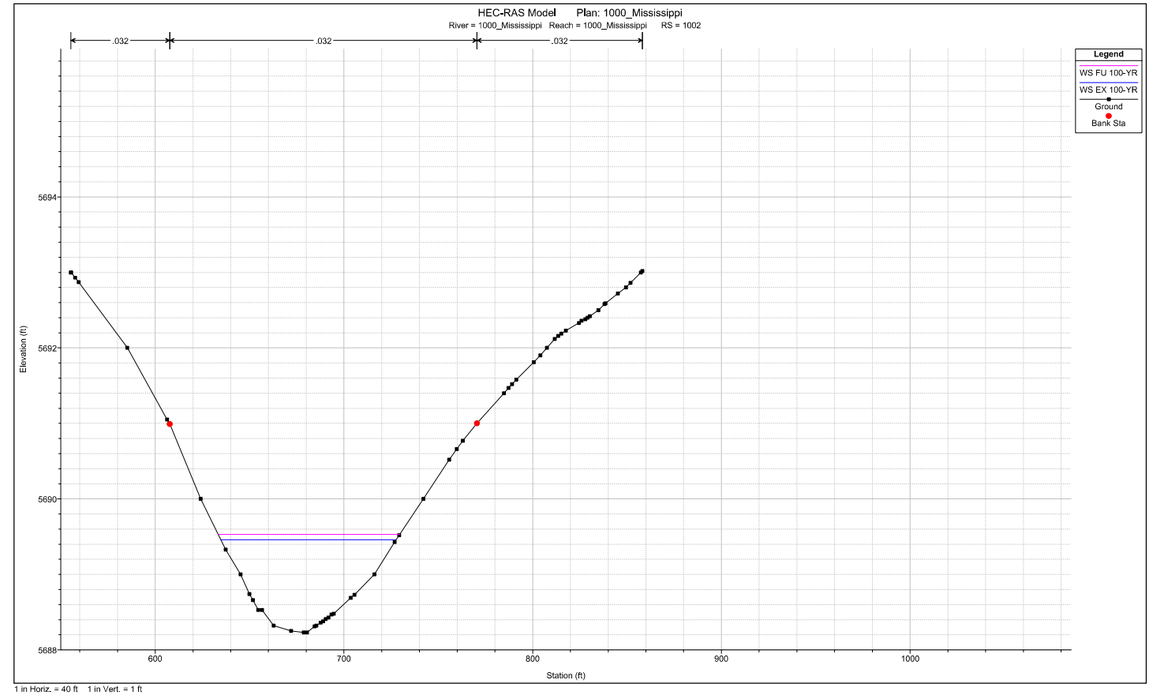

HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 922
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
5760
5755
5750
5745
5740
5735
0
200
400
600
800
1000
1200
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft


HEC-RAS Model Plan: 900_Hayesmount
River = 900_Hayesmount Reach = 900_Hayesmount RS = 923
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
5760
5755
5750
5745
5740
5735
0
200
400
600
800
1000
1200
Station (ft)
1 in Horiz. = 100 ft 1 in Vert. = 4 ft

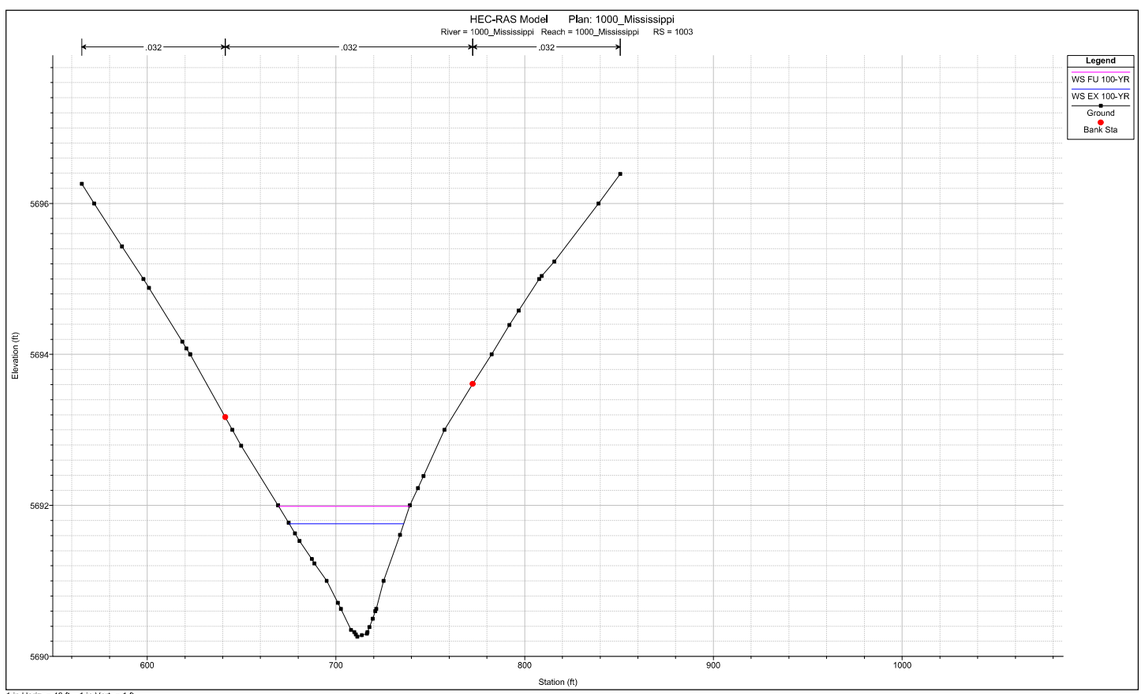
MISSISSIPPI TRIBUTARY
Series 1000 Cross Sections



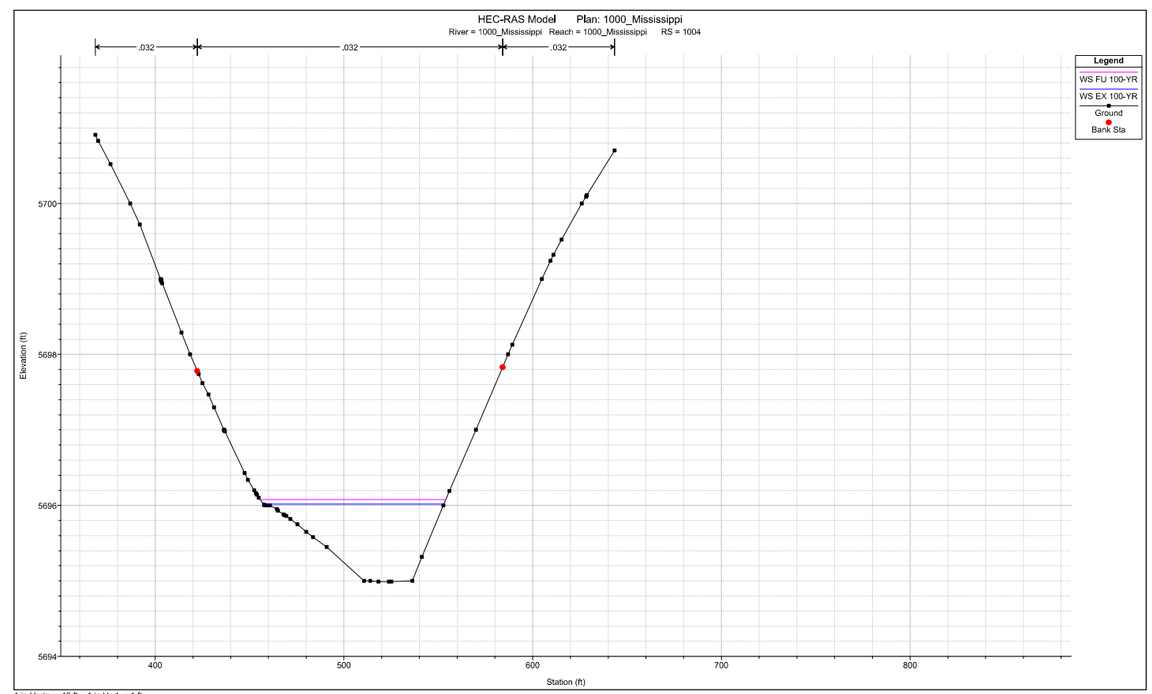
1 in Horiz. = 40 ft 1 in Vert. = 1 ft



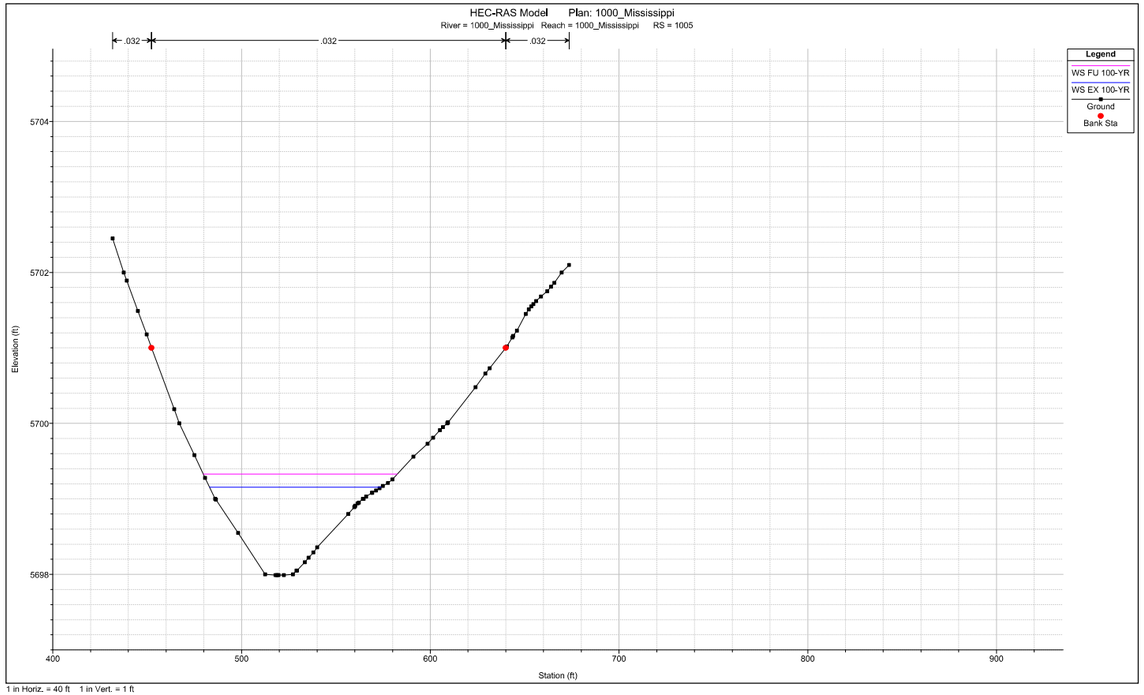
1 in Horiz. = 40 ft 1 in Vert. = 1 ft



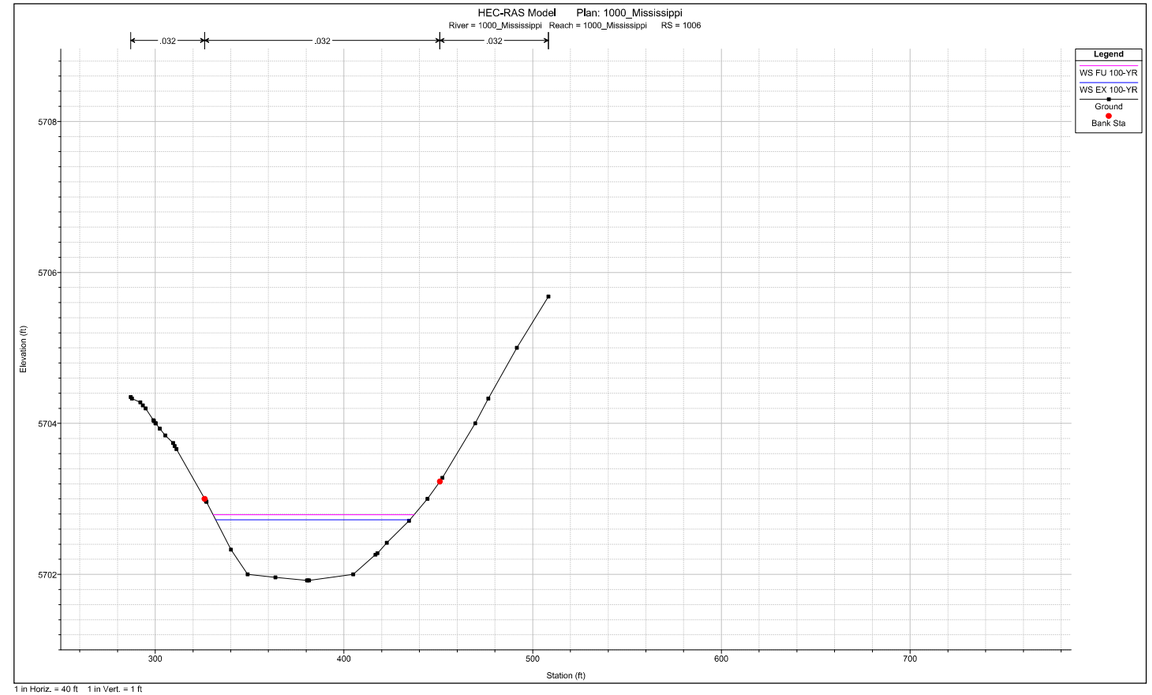
1 in Horiz. = 40 ft 1 in Vert. = 1 ft



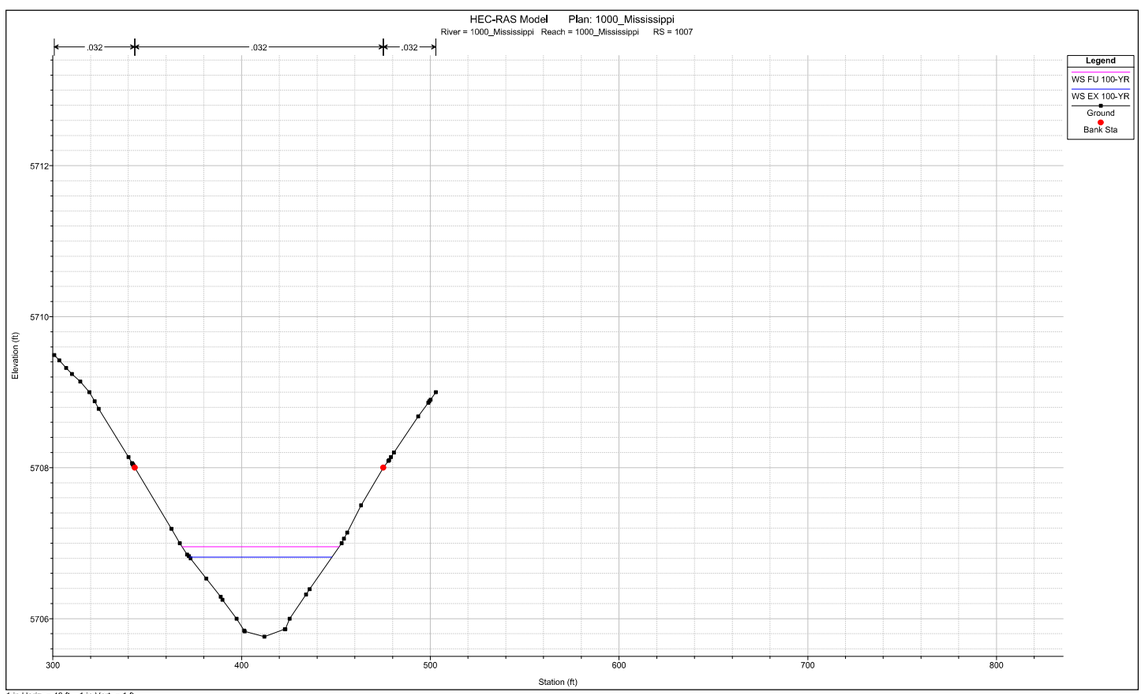
1 in Horiz. = 40 ft 1 in Vert. = 1 ft



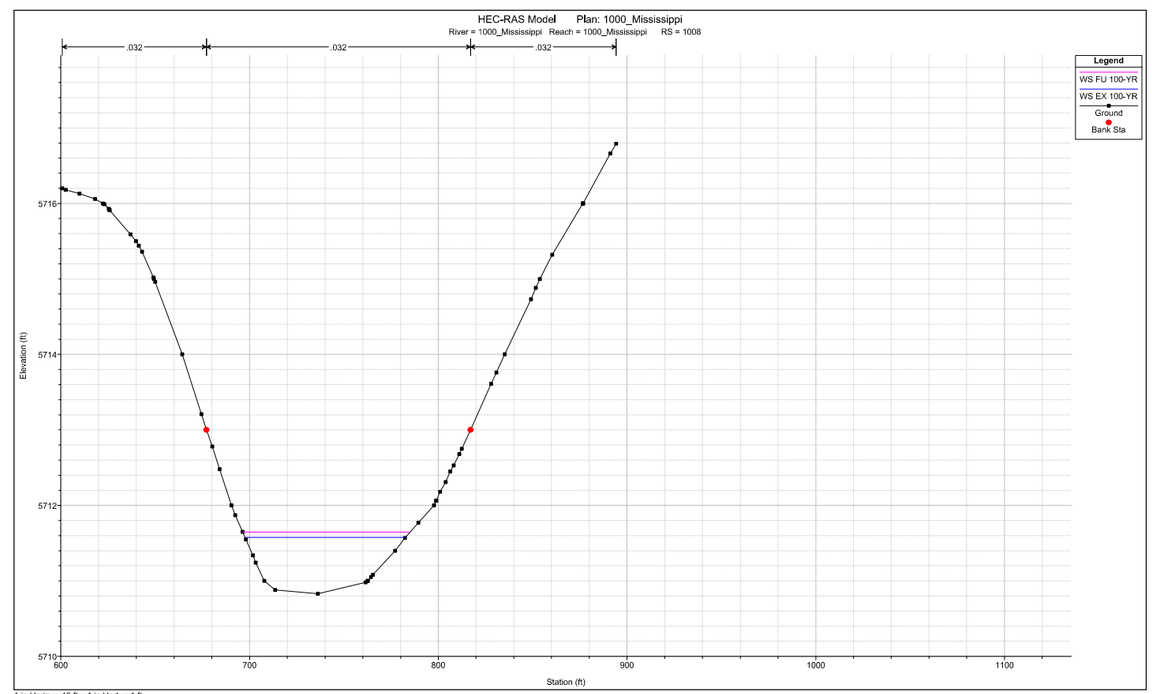
1 in Horiz. = 40 ft 1 in Vert. = 1 ft



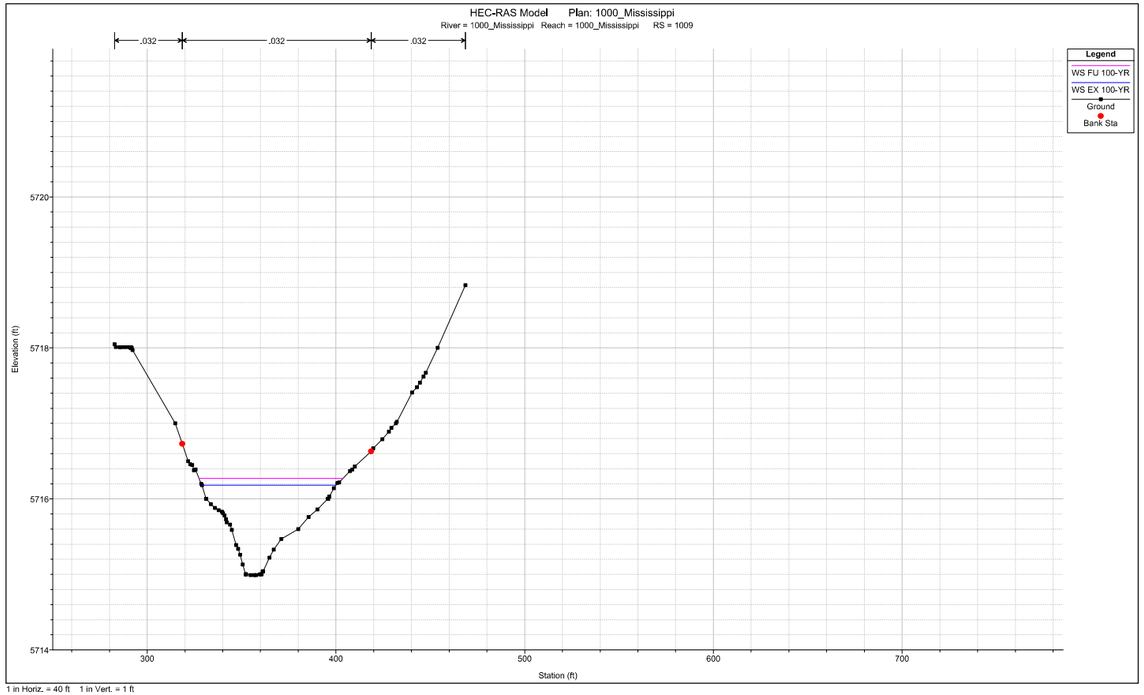
1 in Horiz. = 40 ft 1 in Vert. = 1 ft



1 in Horiz. = 40 ft 1 in Vert. = 1 ft

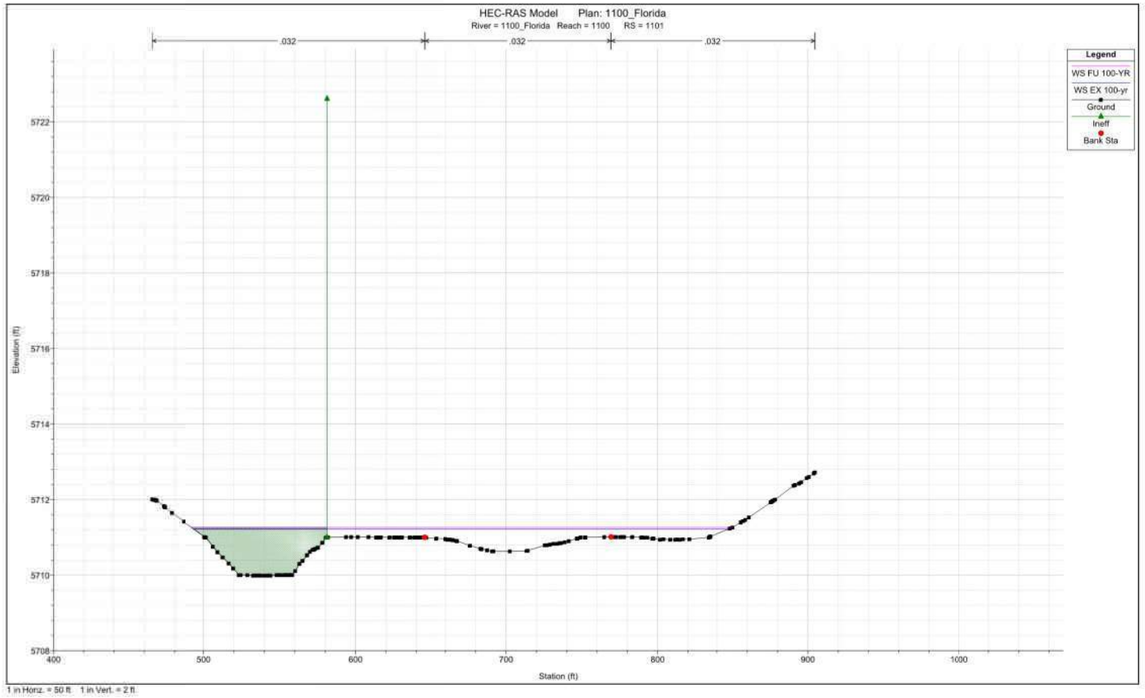


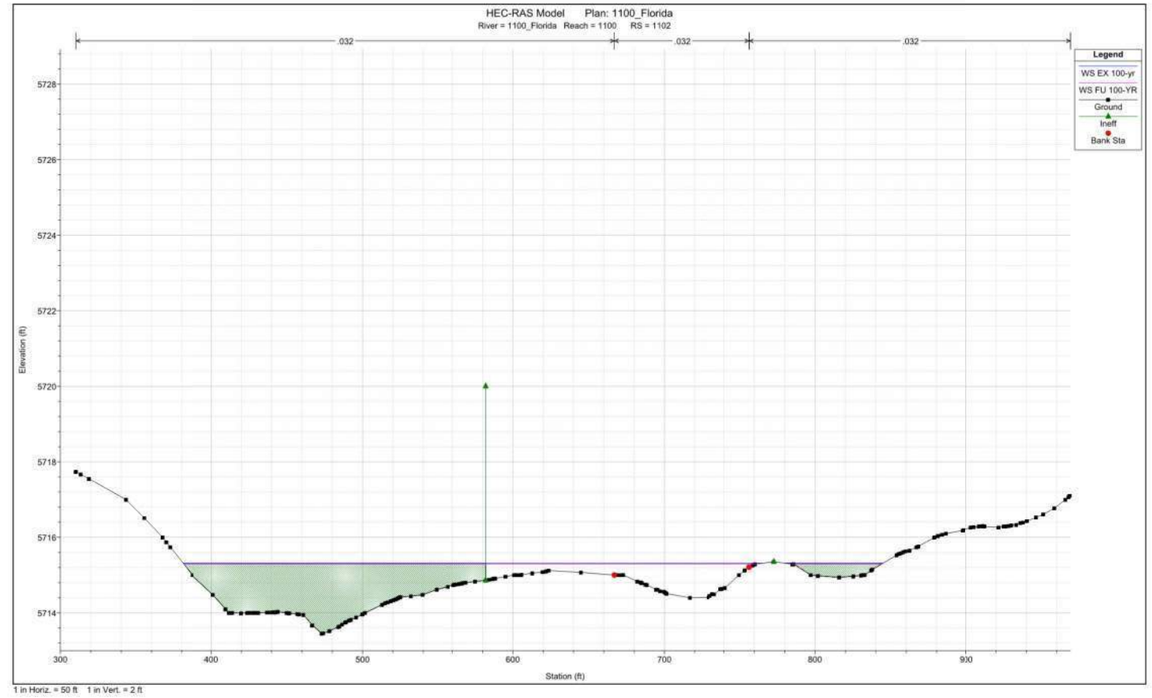
1 in Horiz. = 40 ft 1 in Vert. = 1 ft

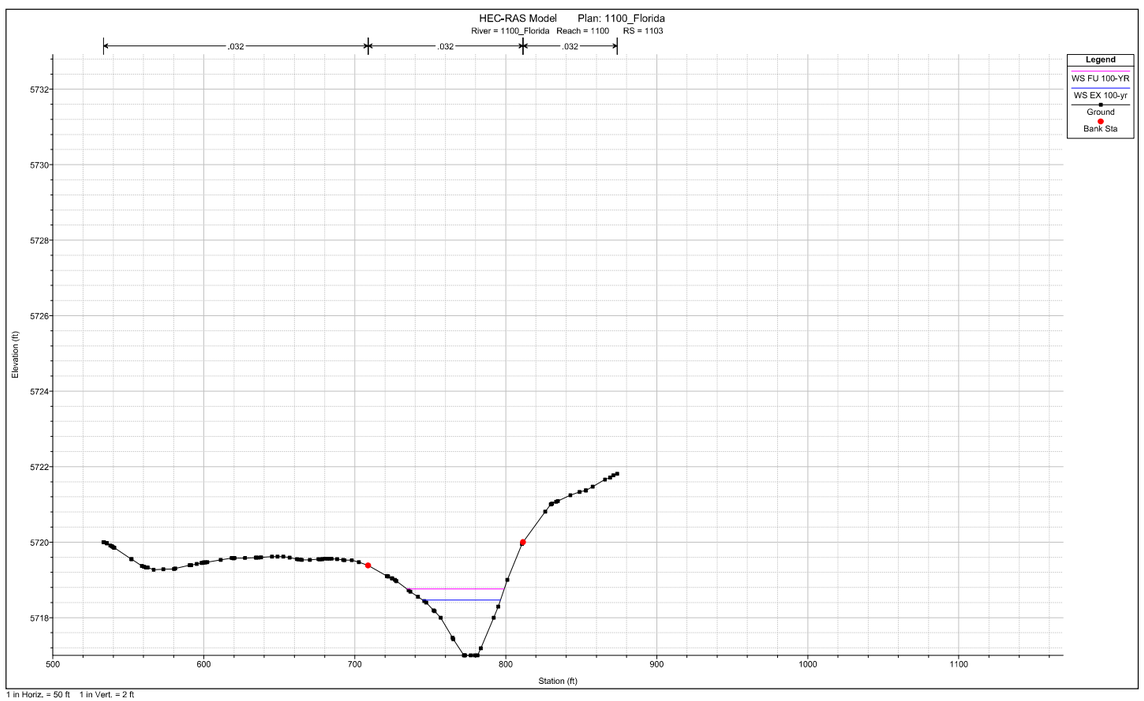


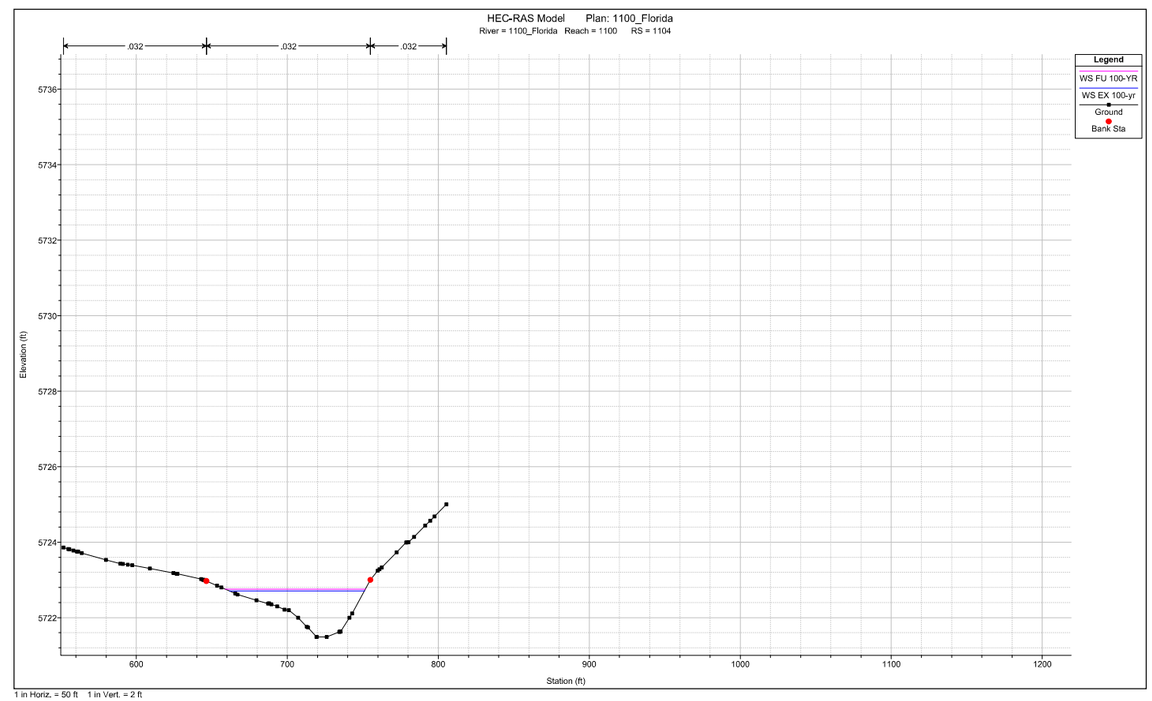
1 in Horiz. = 40 ft 1 in Vert. = 1 ft

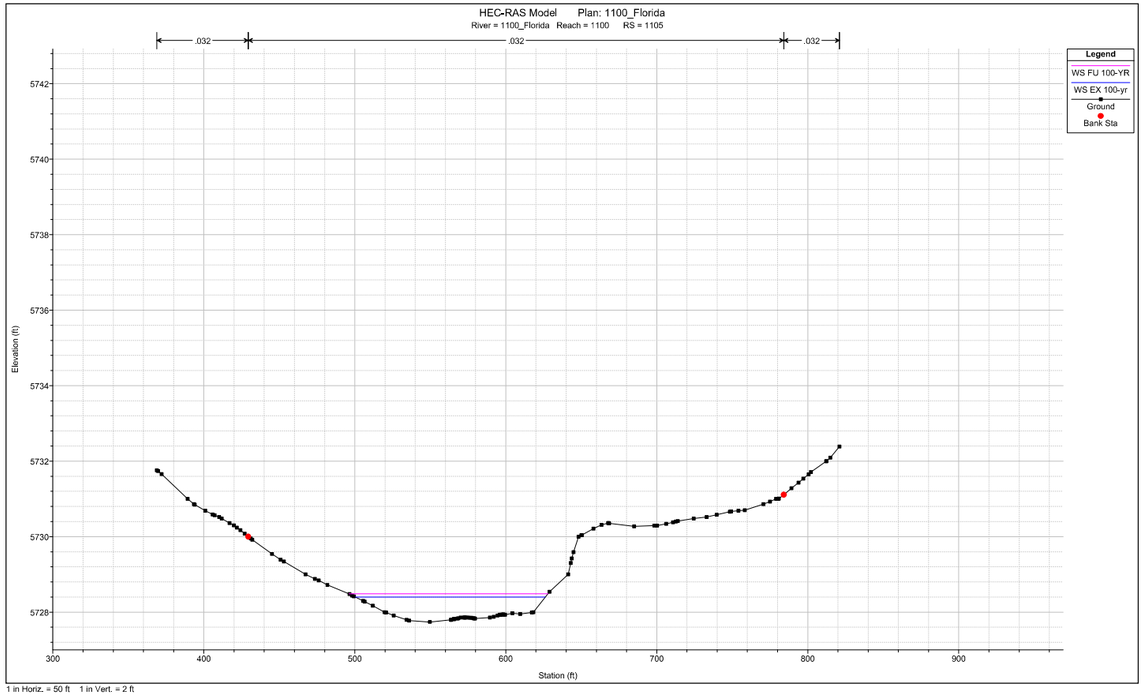
FLORIDA TRIBUTARY
Series 1100 Cross Sections

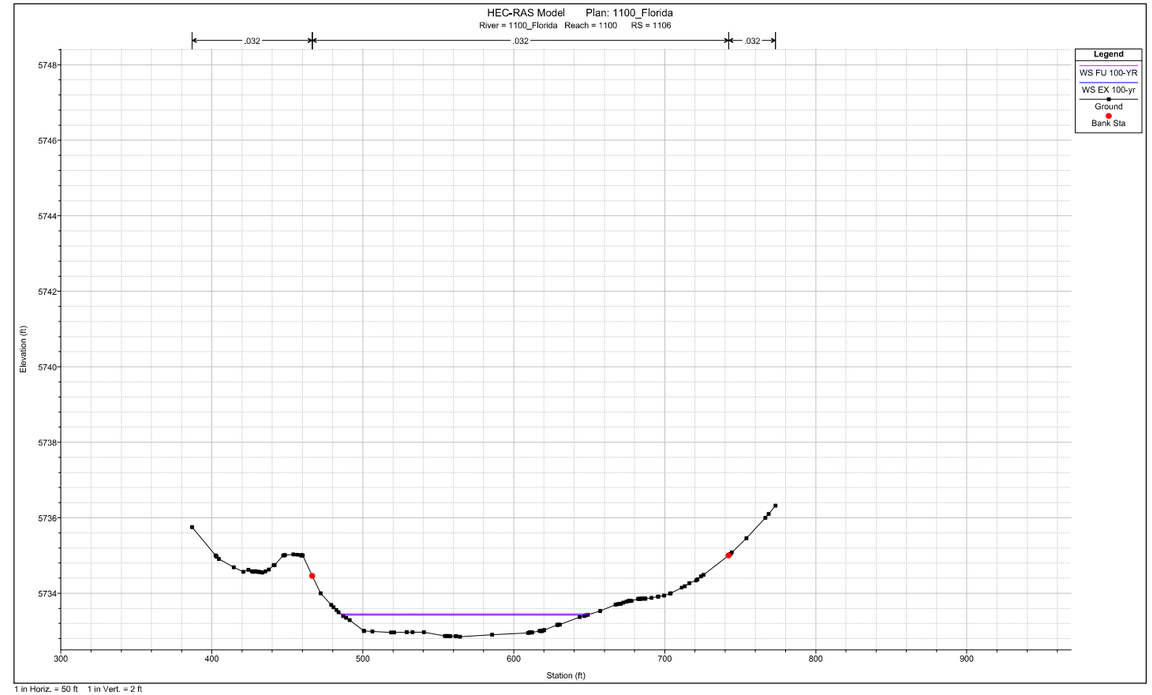

HEC-RAS Model Plan: 1100_Florida
River = 1100_Florida Reach = 1100 RS = 1101
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 2 ft

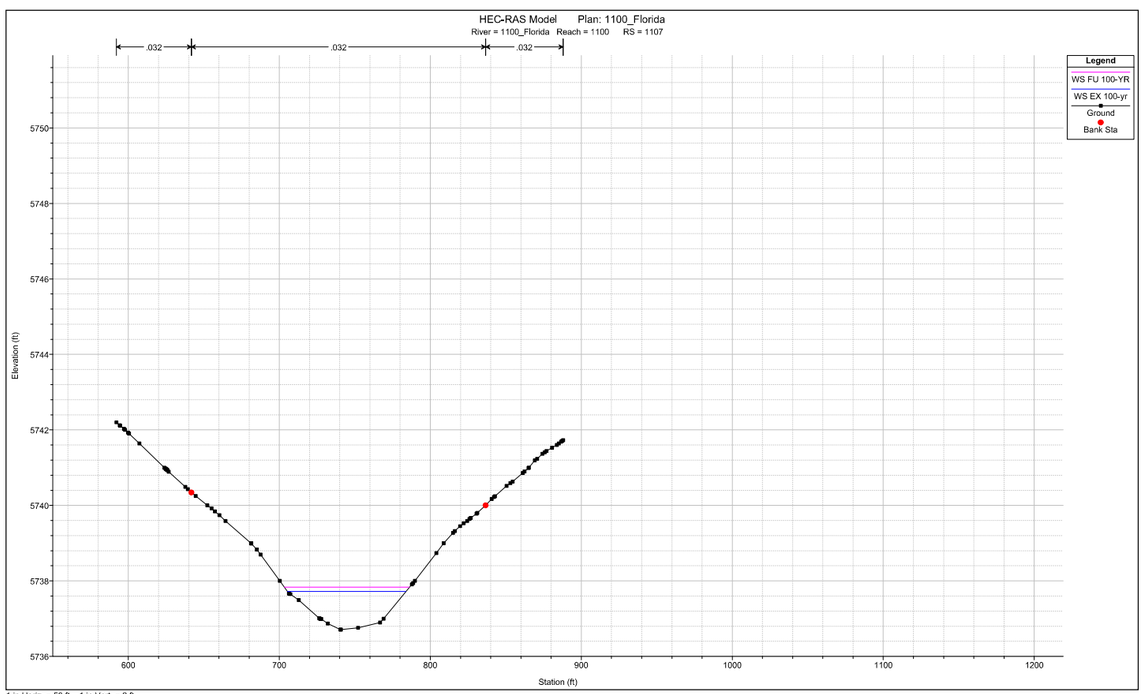

HEC-RAS Model Plan: 1100_Florida
River = 1100_Florida Reach = 1100 RS = 1102
.032
.032
.032
Legend
WS EX 100-yr
WS FU 100-YR
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 2 ft

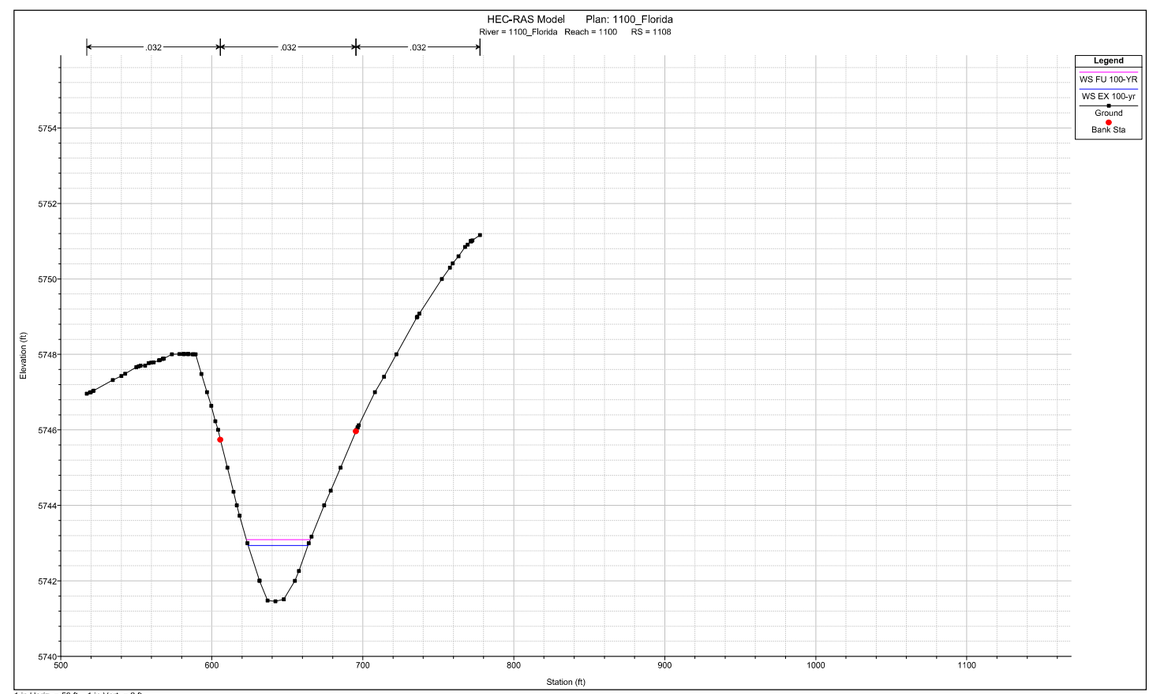

HEC-RAS Model Plan: 1100_Florida
River = 1100_Florida Reach = 1100 RS = 1103
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 2 ft

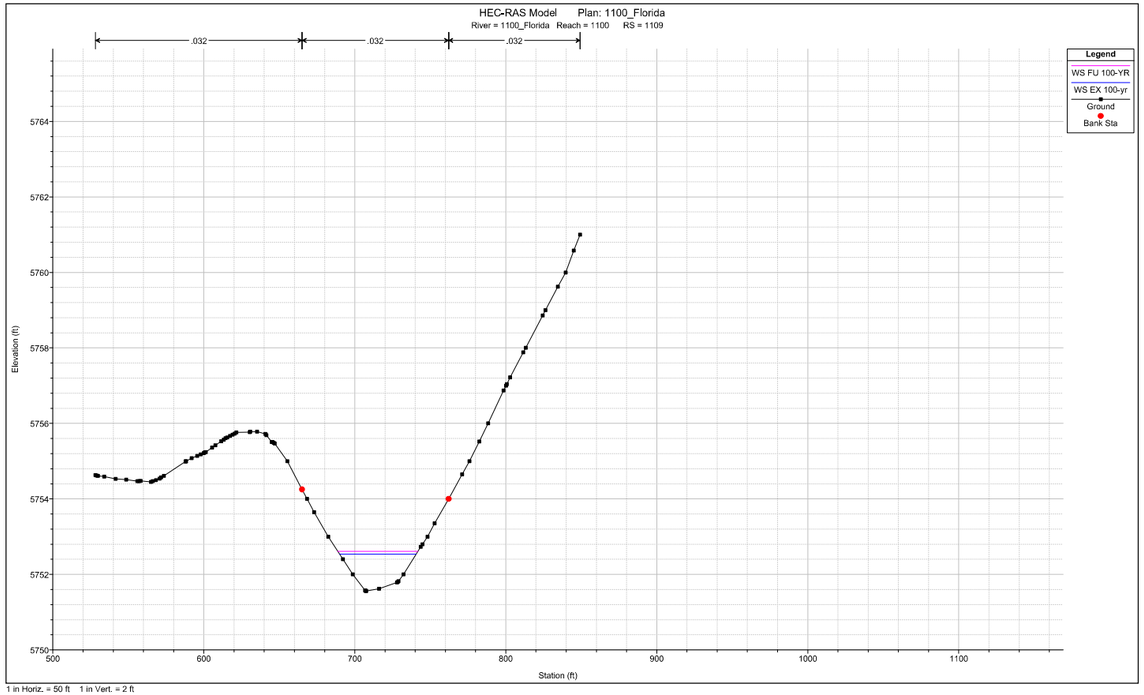

HEC-RAS Model Plan: 1100_Florida
River = 1100_Florida Reach = 1100 RS = 1104
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 2 ft

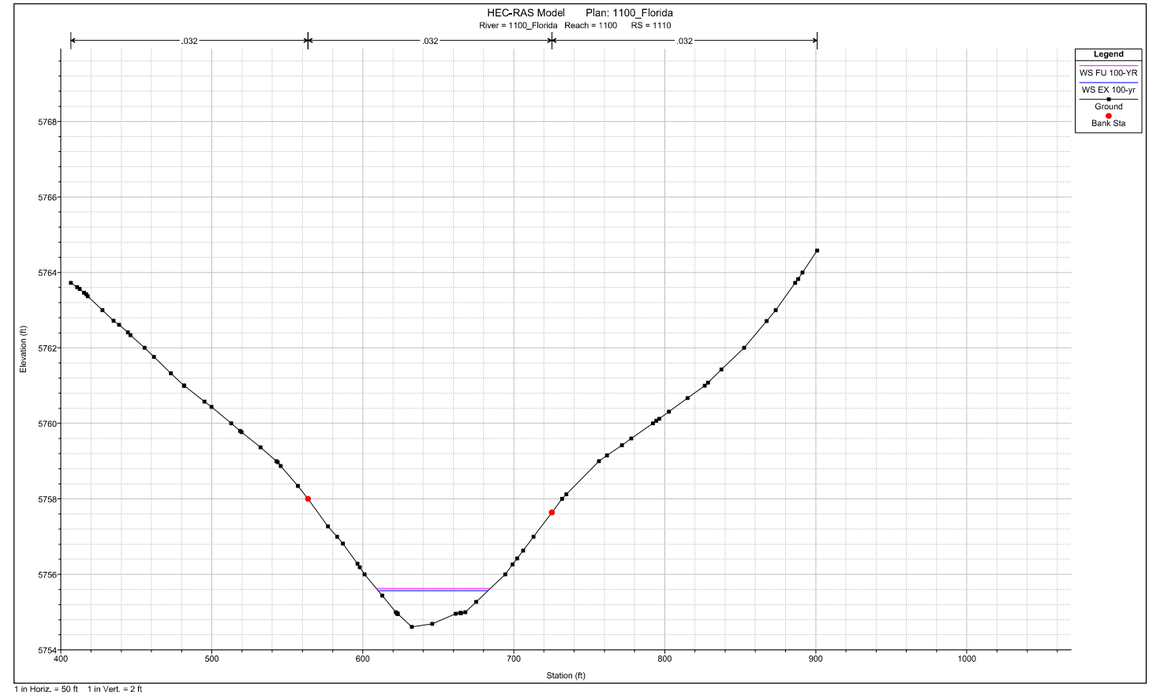

HEC-RAS Model Plan: 1100_Florida
River = 1100_Florida Reach = 1100 RS = 1105
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 2 ft

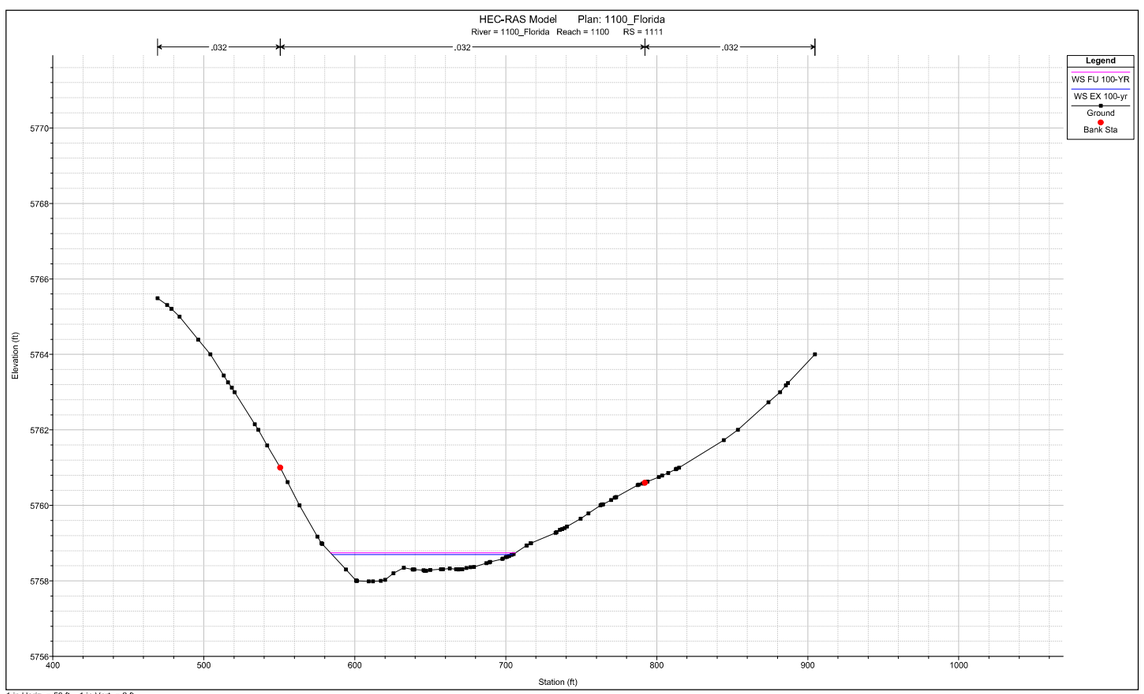

HEC-RAS Model Plan: 1100_Florida
River = 1100_Florida Reach = 1100 RS = 1106
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 2 ft

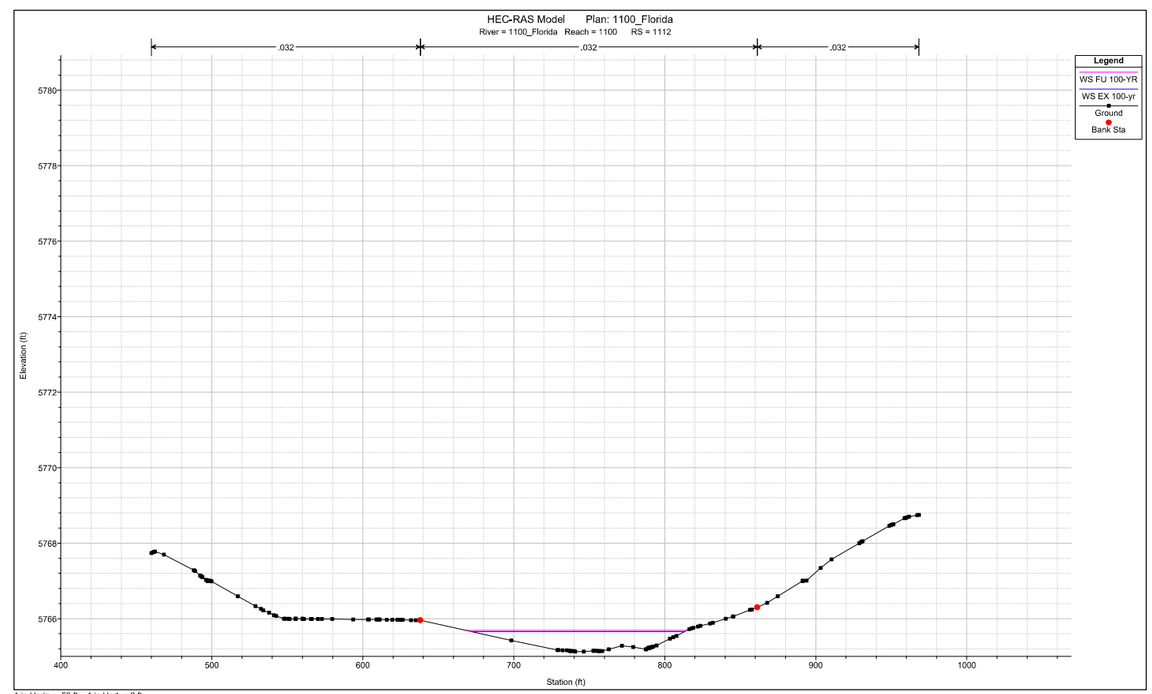

HEC-RAS Model Plan: 1100_Florida
River = 1100_Florida Reach = 1100 RS = 1107
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 2 ft


HEC-RAS Model Plan: 1100_Florida
River = 1100_Florida Reach = 1100 RS = 1108
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 2 ft

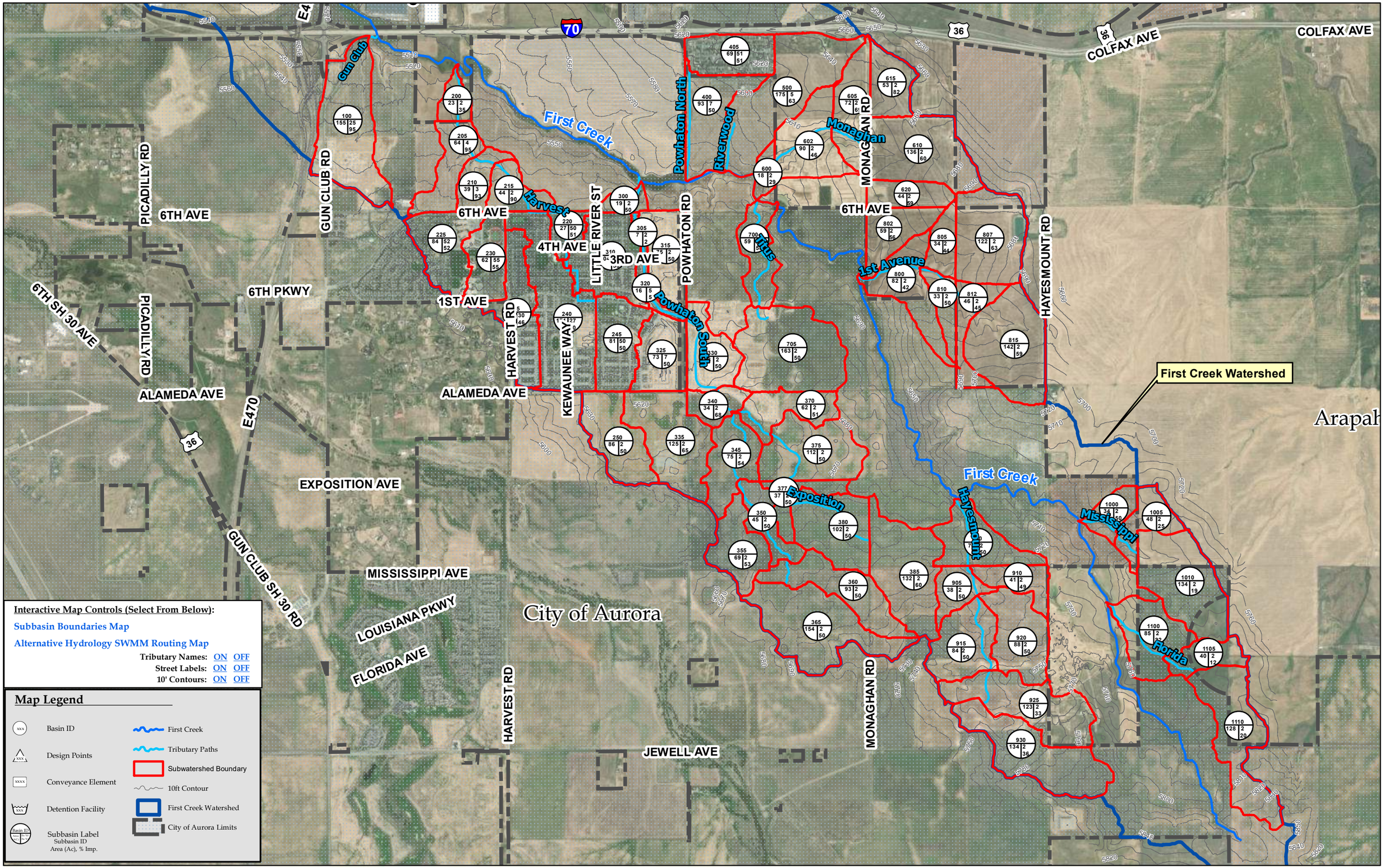

HEC-RAS Model Plan: 1100_Florida
River = 1100_Florida Reach = 1100 RS = 1109
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 2 ft


HEC-RAS Model Plan: 1100_Florida
River = 1100_Florida Reach = 1100 RS = 1110
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 2 ft


HEC-RAS Model Plan: 1100_Florida
River = 1100_Florida Reach = 1100 RS = 1111
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 2 ft


HEC-RAS Model Plan: 1100_Florida
River = 1100_Florida Reach = 1100 RS = 1112
.032
.032
.032
Legend
WS FU 100-YR
WS EX 100-yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
1 in Horiz. = 50 ft 1 in Vert. = 2 ft

APPENDIX D – ALTERNATIVE ANALYSIS



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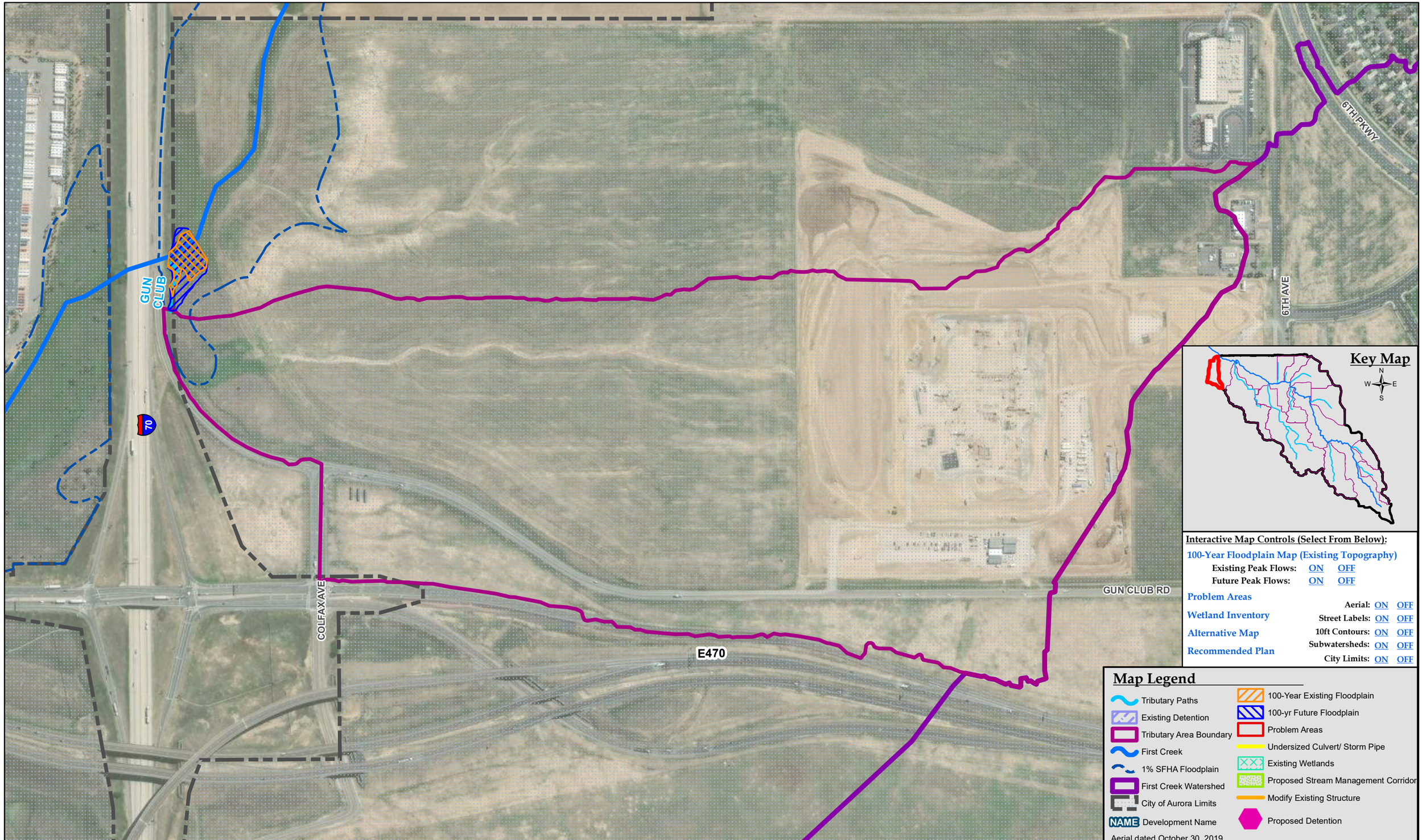
FIRST CREEK TRIBUTARIES (UPSTREAM OF I-70)
MASTER DRAINAGEWAY PLAN

ALTERNATIVES
HYDROLOGY MAP

NOVEMBER 2019

1 inch =2,500 feet
0 1,250 2,500 Feet

FIGURE
D-0



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FIRST CREEK TRIBUTARIES
(UPSTREAM OF I-70)
MASTER DRAINAGEWAY PLAN

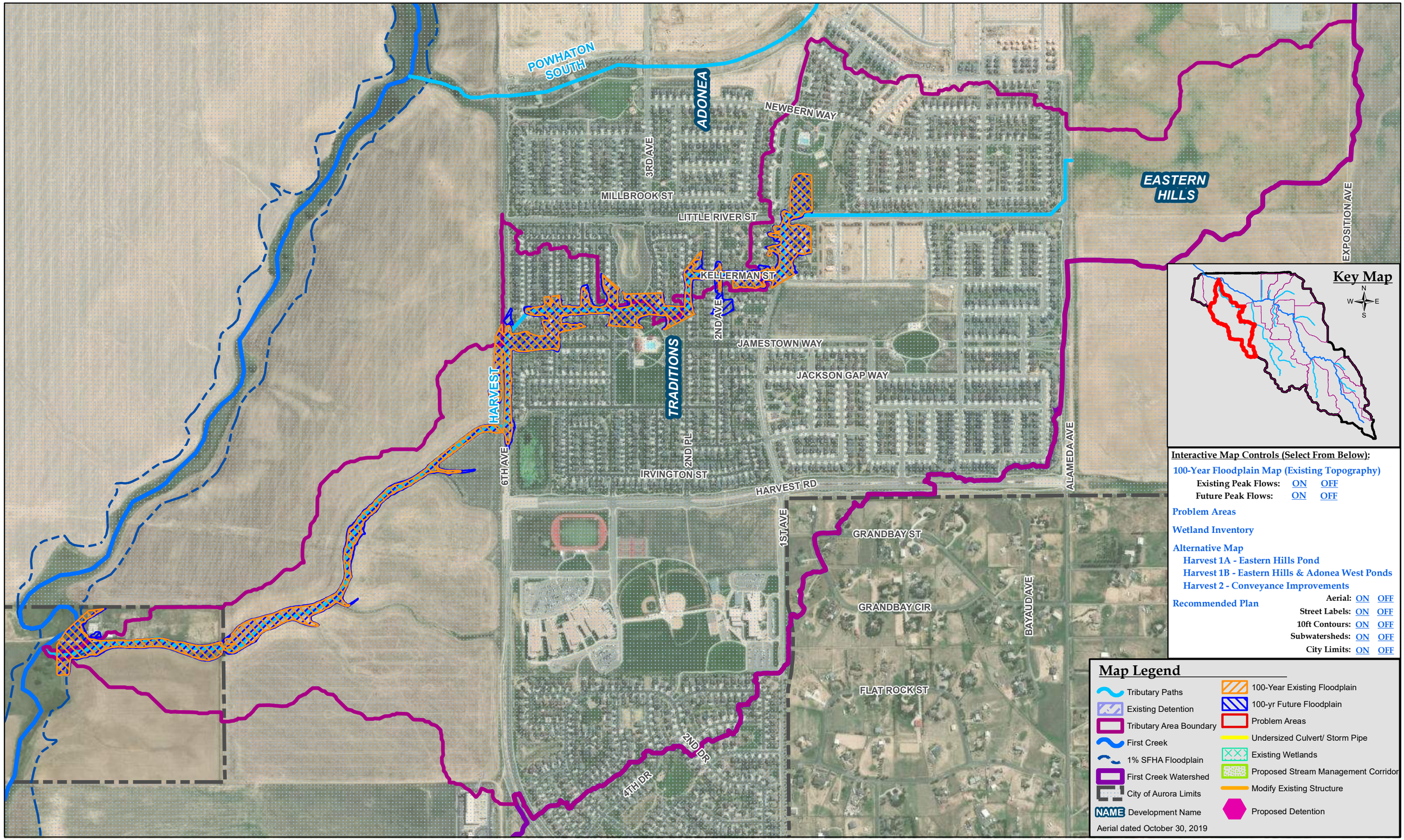
ALTERNATIVES MAP
GUN CLUB TRIBUTARY

N W E S

1 inch = 400 feet
0 200 400 Feet

NOVEMBER 2019

FIGURE D-1



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FIRST CREEK TRIBUTARIES
(UPSTREAM OF I-70)
MASTER DRAINAGEWAY PLAN

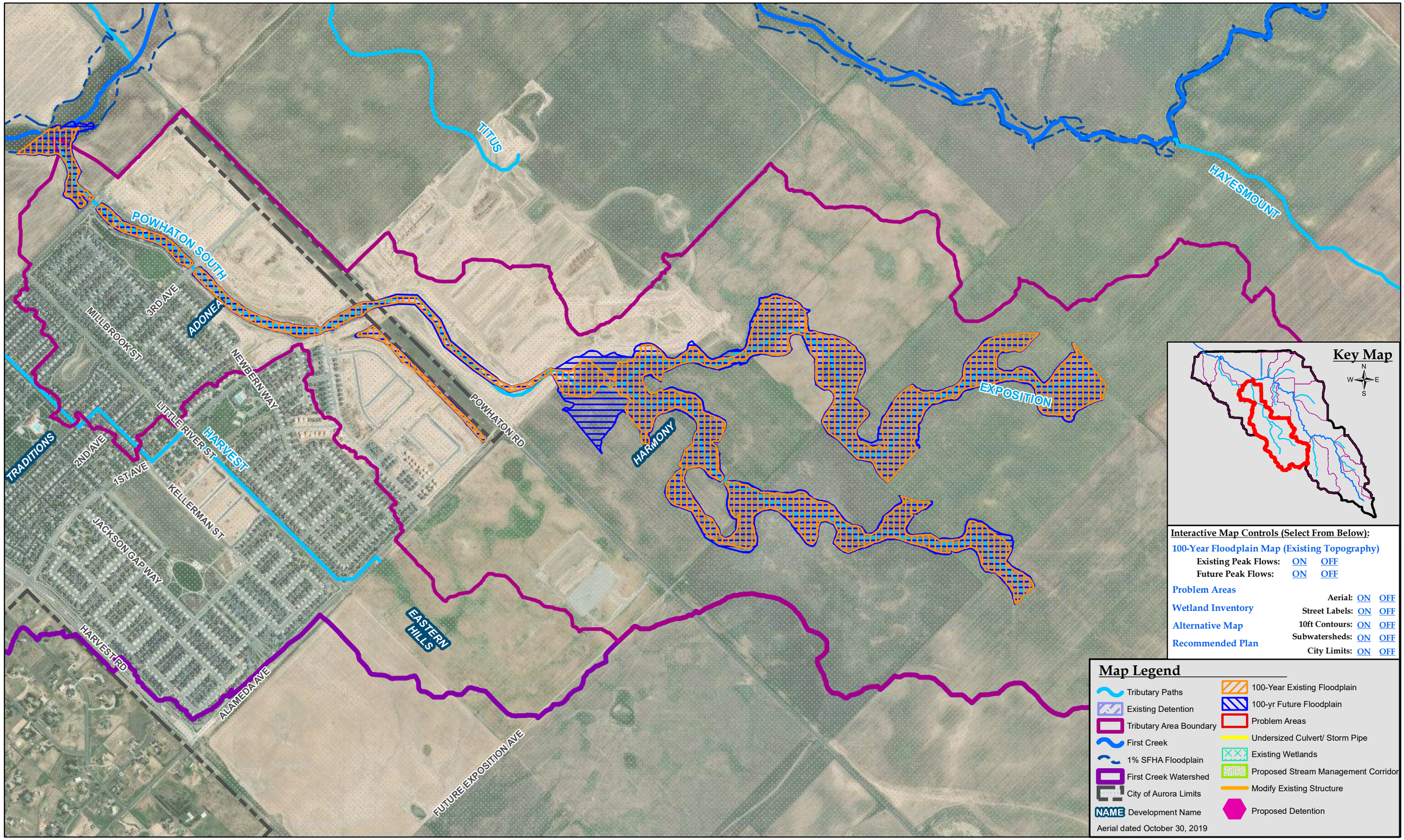
ALTERNATIVES MAP
HARVEST TRIBUTARY

N W E S

1 inch = 800 feet
0 400 800
Feet

NOVEMBER 2019

FIGURE D-2



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FIRST CREEK TRIBUTARIES
(UPSTREAM OF I-70)
MASTER DRAINAGEWAY PLAN

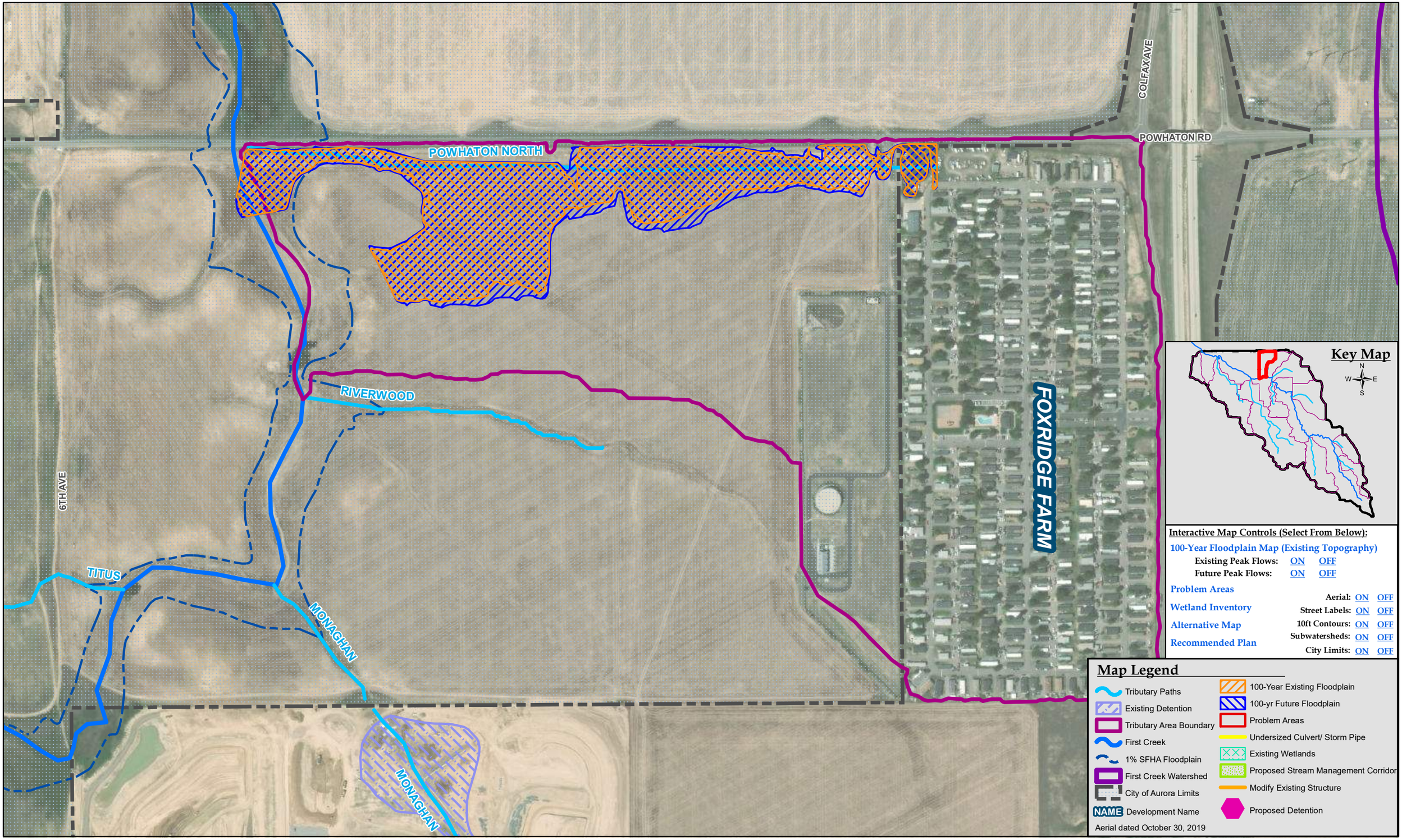
ALTERNATIVES MAP
POWHATON SOUTH TRIBUTARY

N W E S

1 inch = 1000 feet
0 500 1,000 Feet

NOVEMBER 2019

FIGURE D-3



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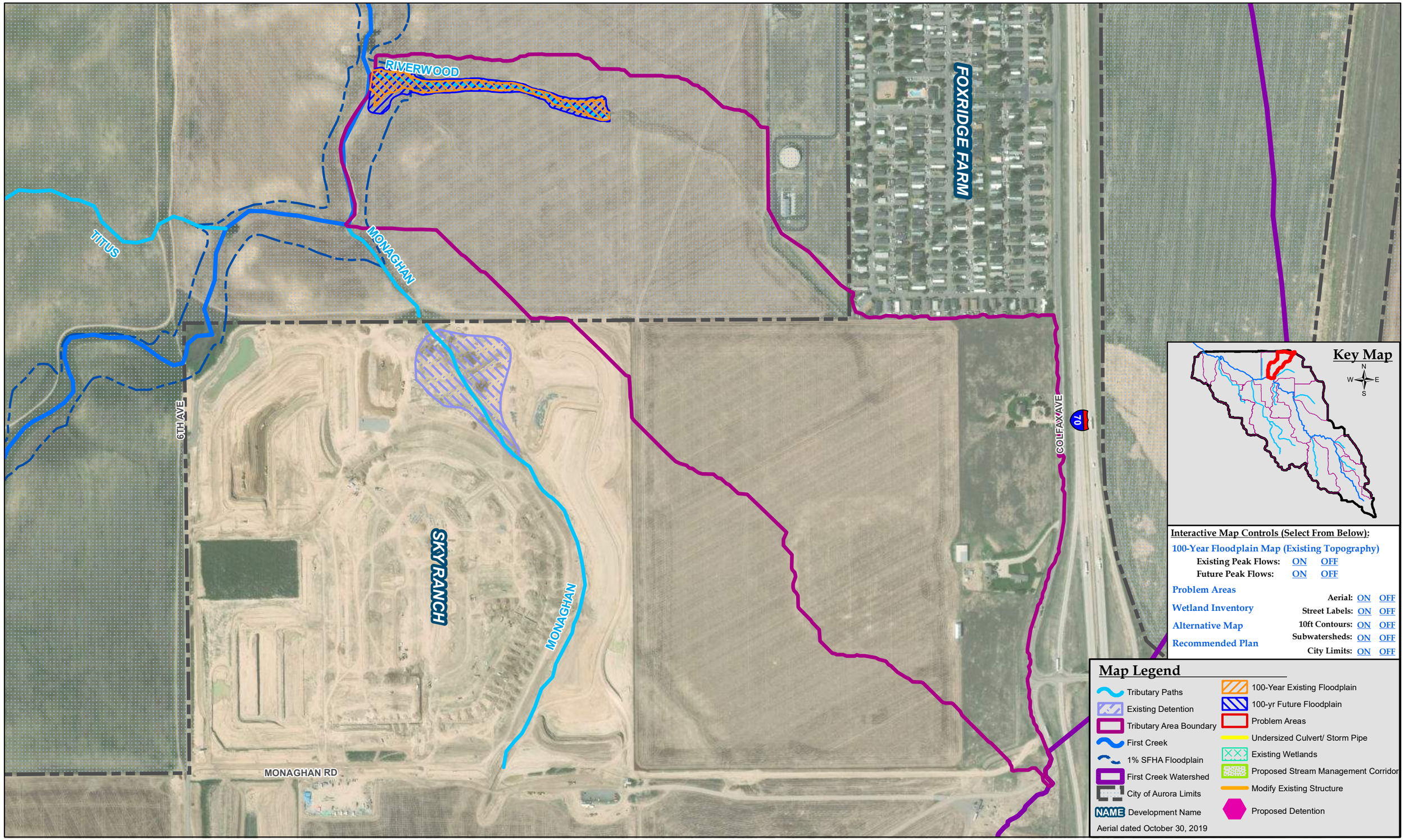
FIRST CREEK TRIBUTARIES
(UPSTREAM OF I-70)
MASTER DRAINAGEWAY PLAN

ALTERNATIVES MAP
POWHATON NORTH TRIBUTARY

1 inch = 400 feet
0 200 400 Feet

NOVEMBER 2019

FIGURE D-4



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FIRST CREEK TRIBUTARIES
(UPSTREAM OF I-70)
MASTER DRAINAGEWAY PLAN

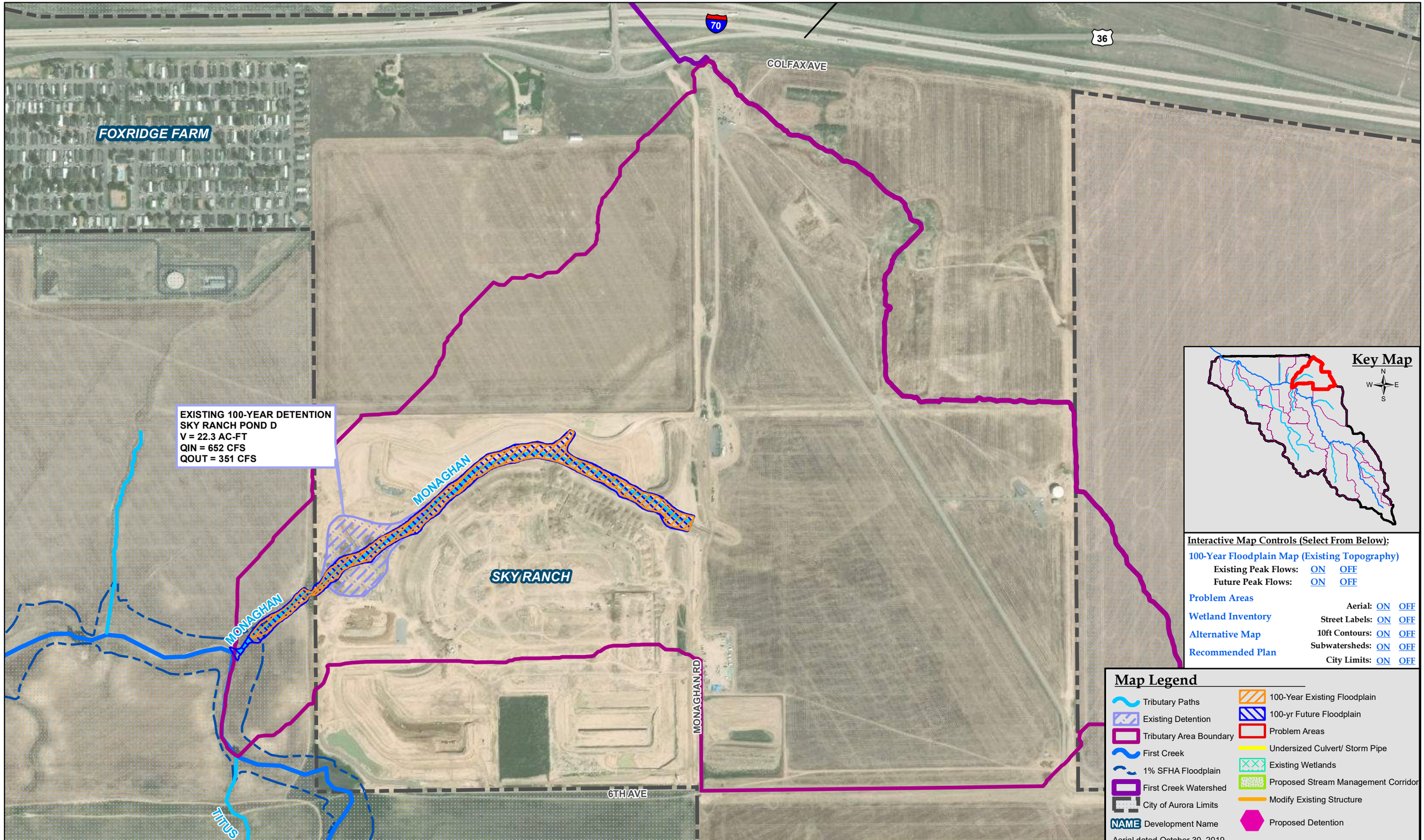
ALTERNATIVES MAP
RIVERWOOD TRIBUTARY

W S N E

1 inch = 500 feet
0 250 500 Feet

NOVEMBER 2019

FIGURE D-5



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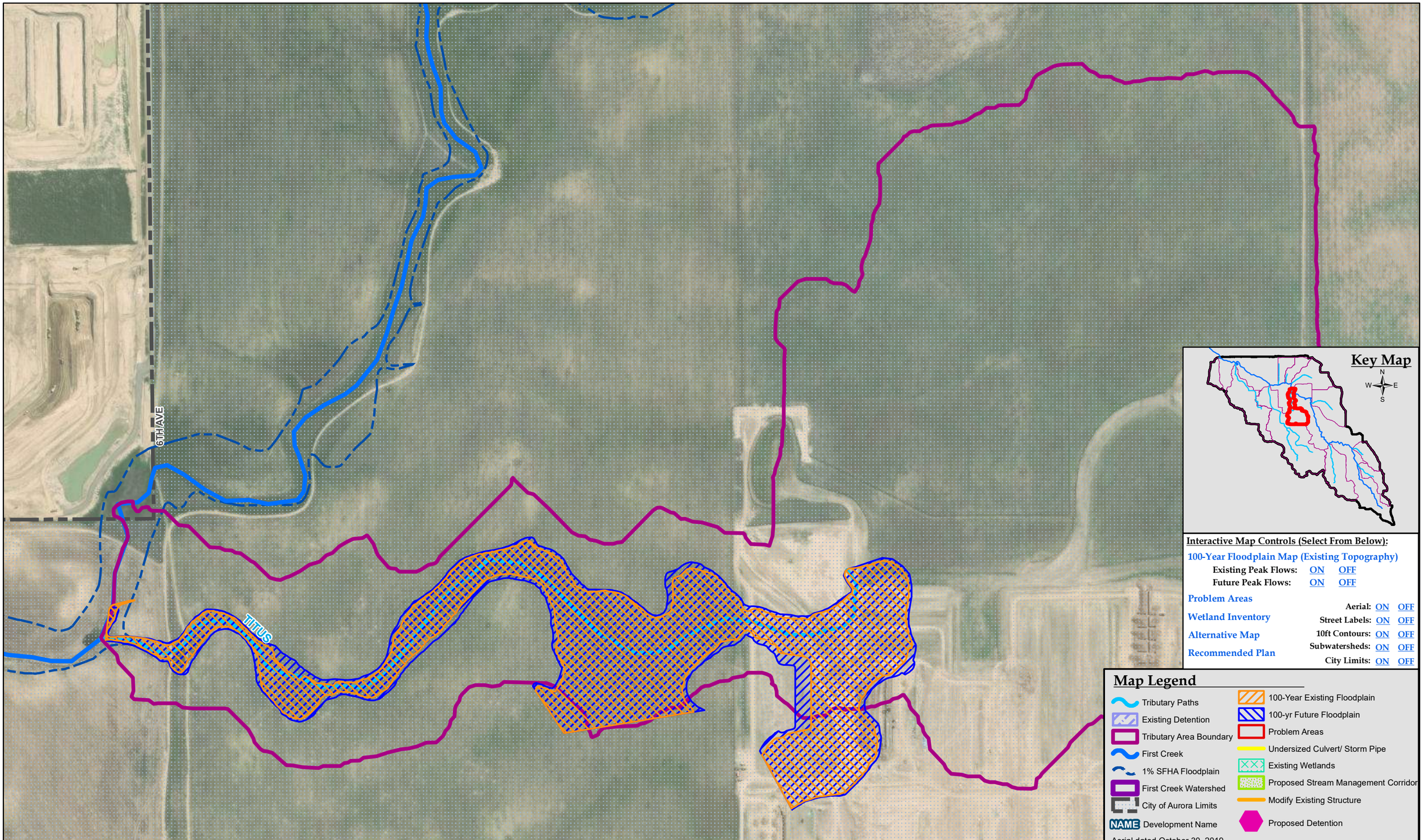
FIRST CREEK TRIBUTARIES
(UPSTREAM OF I-70)
MASTER DRAINAGEWAY PLAN

ALTERNATIVES MAP
MONAGHAN TRIBUTARY

N W E S
1 inch = 600 feet
0 300 600 Feet

NOVEMBER 2019

FIGURE D-6



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FIRST CREEK TRIBUTARIES
(UPSTREAM OF I-70)
MASTER DRAINAGEWAY PLAN

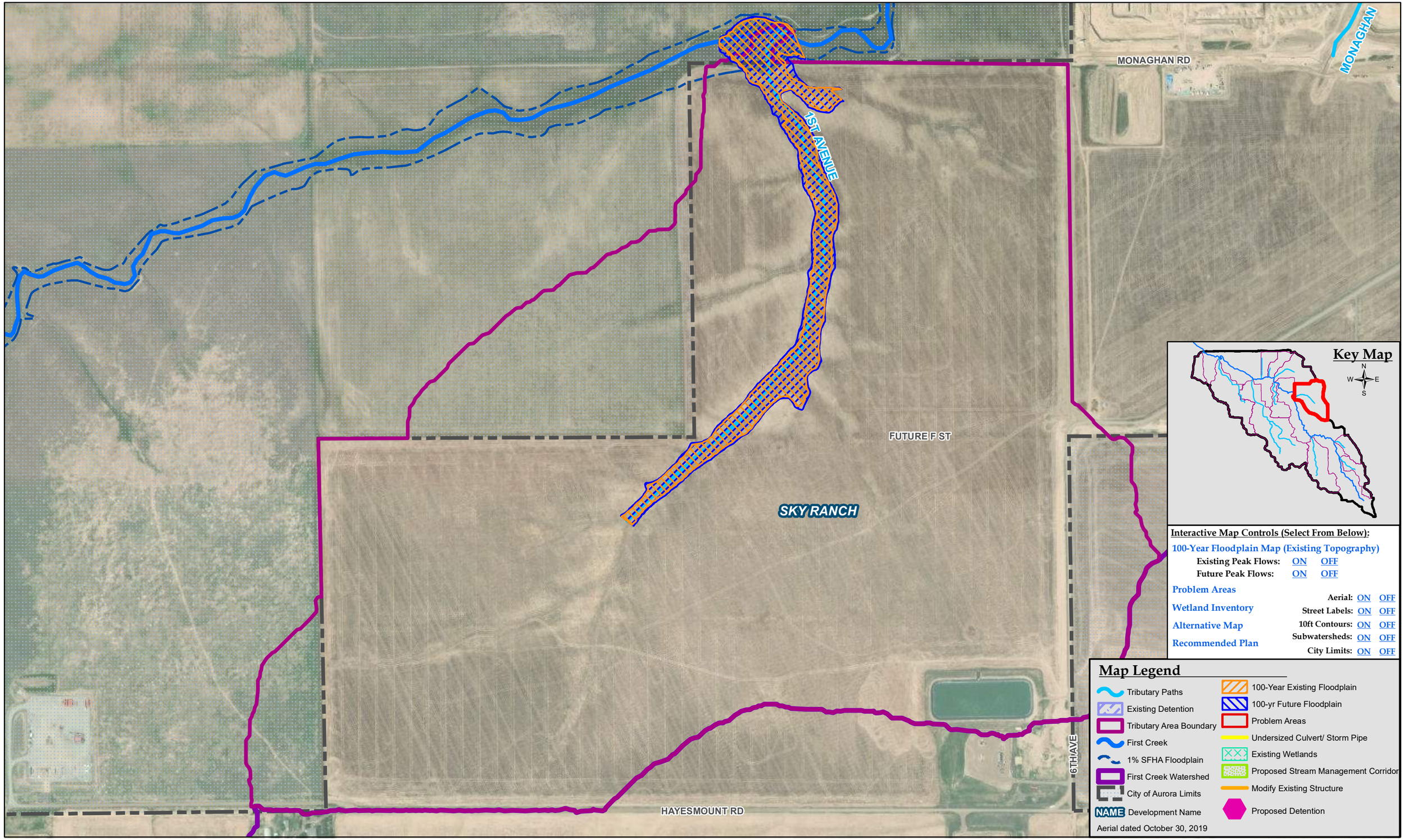
ALTERNATIVES MAP
TITUS TRIBUTARY

N W E S

1 inch = 400 feet
0 200 400 Feet

NOVEMBER 2019

FIGURE D-7



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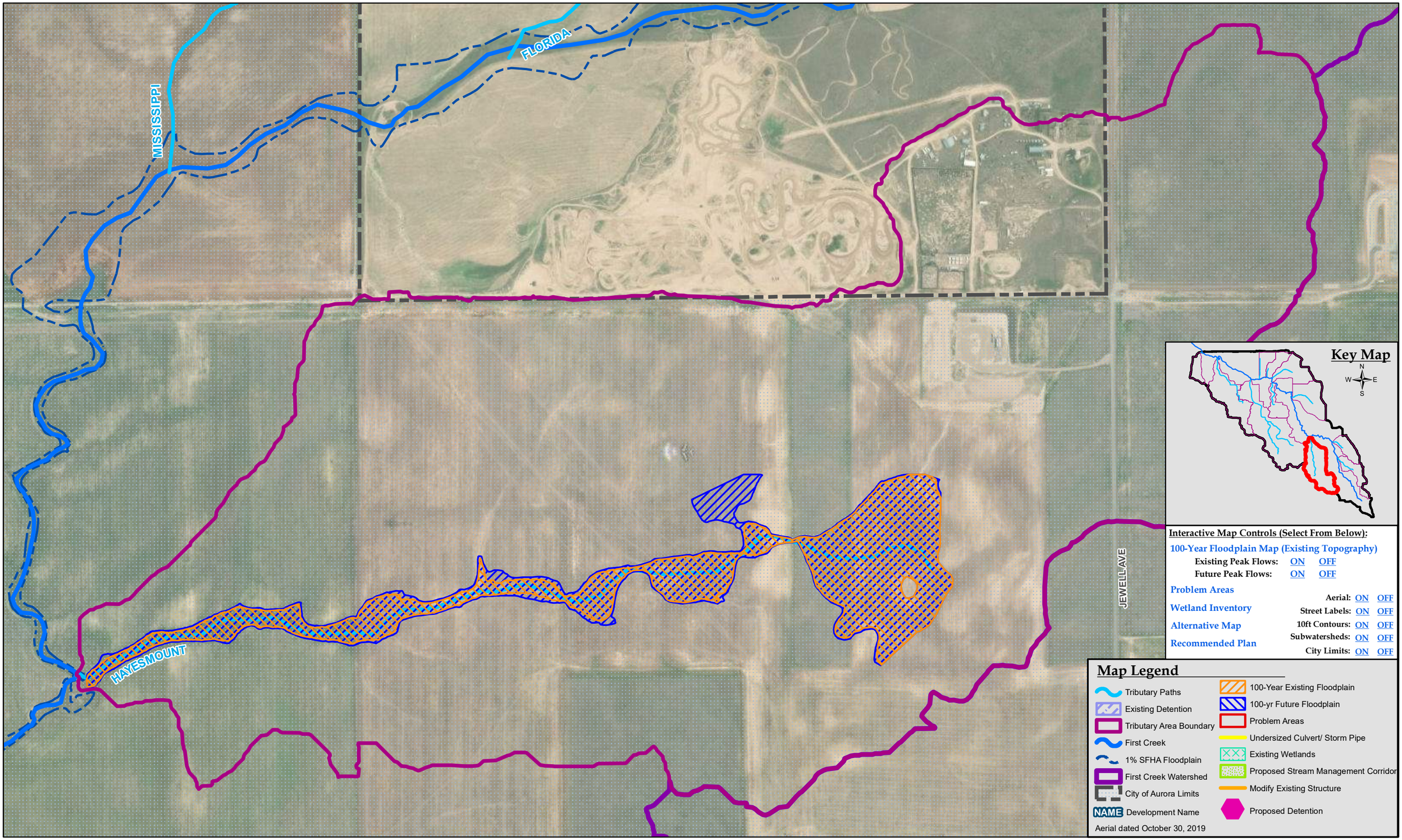
FIRST CREEK TRIBUTARIES
(UPSTREAM OF I-70)
MASTER DRAINAGEWAY PLAN

ALTERNATIVES MAP
1ST AVENUE TRIBUTARY

1 inch = 600 feet
0 300 600 Feet

NOVEMBER 2019

FIGURE D-8



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Denver, CO 80211
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FIRST CREEK TRIBUTARIES
(UPSTREAM OF I-70)
MASTER DRAINAGEWAY PLAN

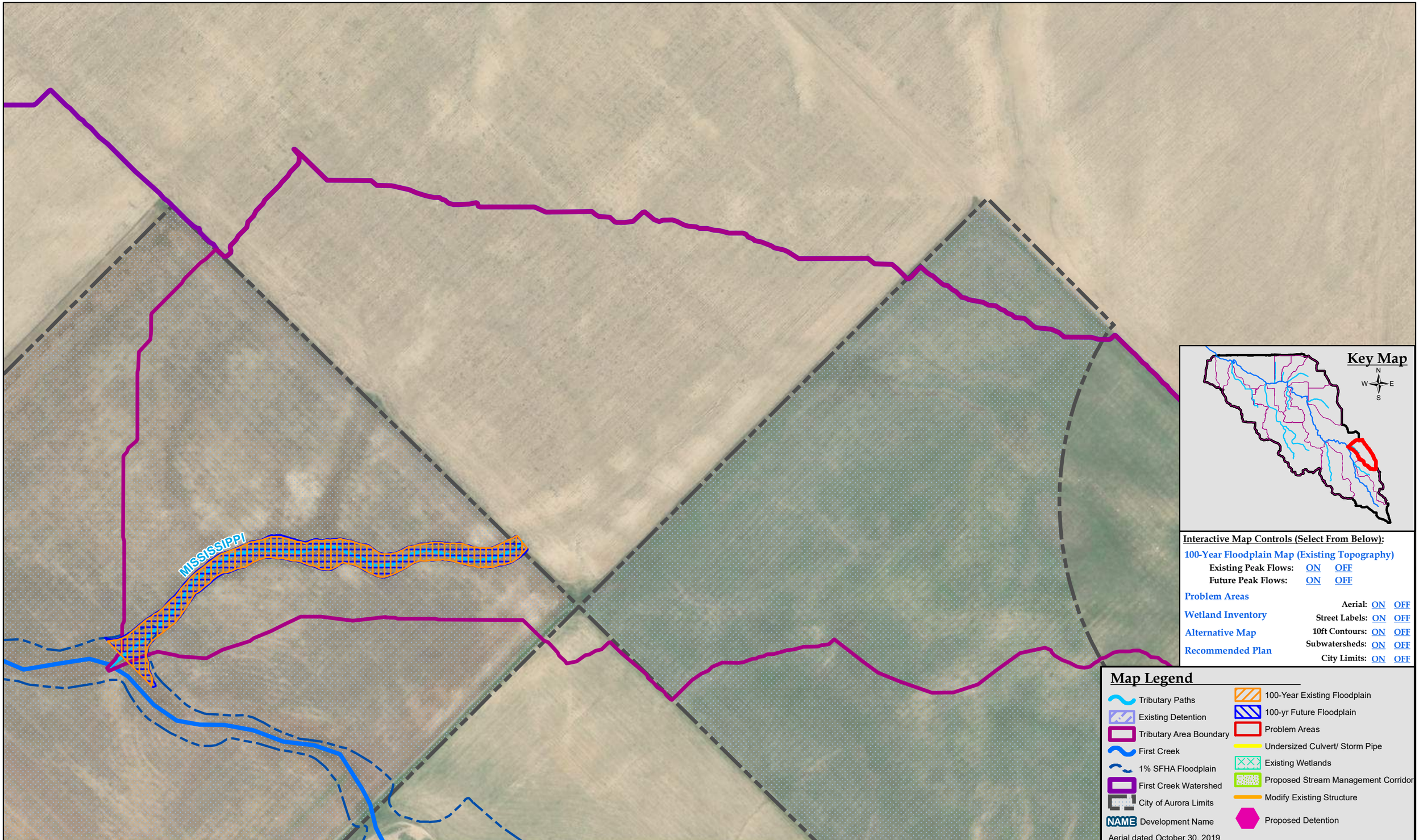
ALTERNATIVES MAP
HAYESMOUNT TRIBUTARY

N W E S

1 inch = 600 feet
0 300 600 Feet

NOVEMBER 2019

FIGURE D-9



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FIRST CREEK TRIBUTARIES
(UPSTREAM OF I-70)
MASTER DRAINAGEWAY PLAN

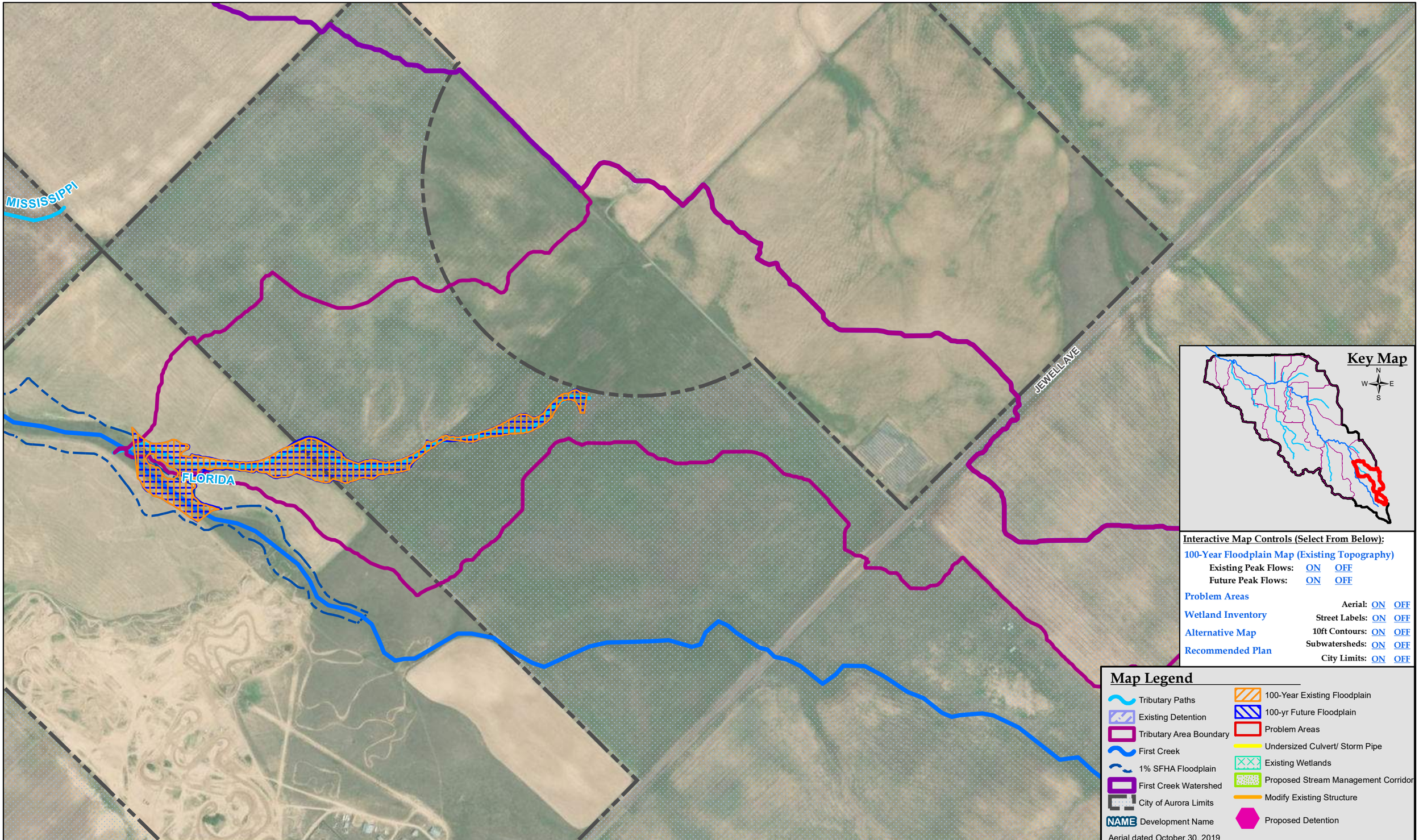
ALTERNATIVES MAP
MISSISSIPPI TRIBUTARY

N E S W

1 inch = 400 feet
0 200 400 Feet

NOVEMBER 2019

FIGURE D-10



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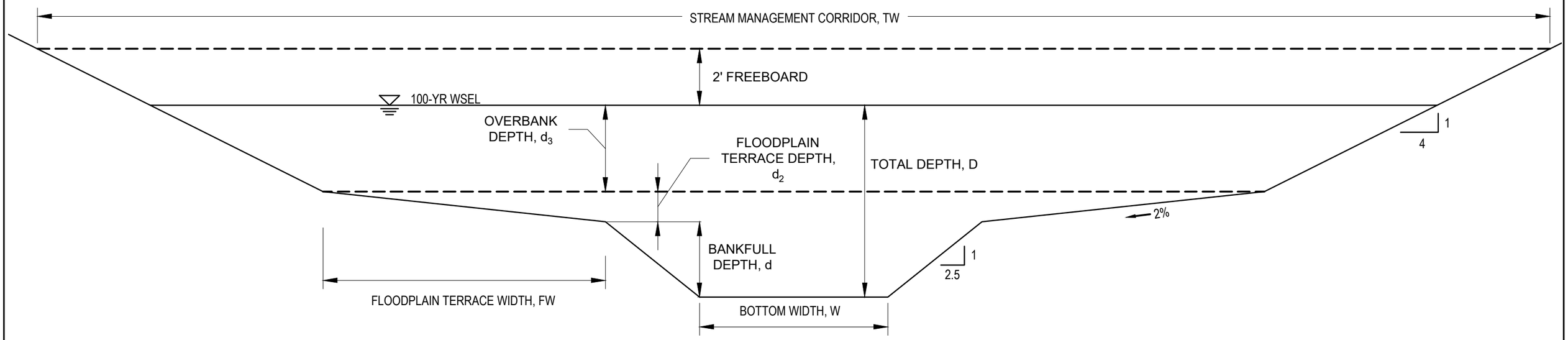
FIRST CREEK TRIBUTARIES
(UPSTREAM OF I-70)
MASTER DRAINAGEWAY PLAN

ALTERNATIVES MAP
FLORIDA TRIBUTARY

1 inch = 600 feet
0 300 600 Feet

NOVEMBER 2019

FIGURE D-11



UDFCD, CITY OF AURORA, SEMSWA, ARAPAHOE COUNTY	FIRST CREEK TRIBUTARIES (UPSTREAM OF I-70) MASTER DRAINAGE PLAN	TYPICAL NATURAL STREAM MANAGEMENT CORRIDOR	NOVEMBER 2019	MERRICK 2480 W. 26th Ave. Suite B225 Denver, CO 80211 T303.964.3333 F303.964.3355	FIGURE D-12

TABLE D-1
Natural Stream Management Corridor Design

		Design Flows		Bankfull			Floodplain Terrace				Overbank		Overall Conveyance								Stream Management Corridor		
	Reach Number	2-Year Flow, Q2	100-Year Flow	Bottom Width (W)	Depth (d)	Top Width	Terrace Width (FW)	Depth above bankfull (d1)	Depth (d2)	Top Width	Depth (d3)	Top Width	Total Depth (D)	Total Area	Total Wetted Perimeter	Total Hydraulic Radius	Channel Slope	Roughness Coefficient	Froude Number	Shear Stress	Total Depth with 2' of Freeboard	Top Width with 2' of Freeboard	Stream Management Corridor Top Width (TW)*
		(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(sf)	(ft)	(ft)	(ft/ft)	(-)	(-)	(lb/sf)	(ft)	(ft)	(ft)
	100	3	134	3	1.24	9.2	10	0.59	0.2	29.2	0.39	32.3	1.83	23.3	32.9	0.71	0.024	0.032	0.75	0.88	3.83	49	61
Alternative 1A	**200**	12	682	10	1.84	19.2	25	1.39	0.5	69.2	0.89	76.3	3.22	113.4	77.2	1.47	0.010	0.032	0.59	0.86	5.22	93	105
	205	252	1,291	22	2.14	32.7	33	1.65	0.66	98.7	0.99	106.6	3.78	203.1	107.7	1.89	0.008	0.032	0.58	0.82	5.78	123	135
	210	211	1,144	21	1.98	30.9	36	1.37	0.72	102.9	0.65	108.1	3.35	168.1	109.0	1.54	0.012	0.032	0.66	1.03	5.35	125	137
	215	153	876	19	1.74	27.7	33	1.19	0.66	93.7	0.53	97.9	2.93	131.4	98.7	1.33	0.014	0.032	0.69	1.04	4.93	114	126
	216	127	779	17	1.65	25.3	32	1.12	0.64	89.3	0.48	93.1	2.77	115.3	93.9	1.23	0.016	0.032	0.71	1.12	4.77	110	122
Alternative 1B	**200**	12	682	10	1.84	19.2	25	1.39	0.5	69.2	0.89	76.3	3.22	113.4	77.2	1.47	0.010	0.032	0.59	0.86	5.22	93	105
	205	225	1,101	22	2.00	32.0	33	1.51	0.66	98.0	0.85	104.8	3.51	183.3	105.8	1.73	0.008	0.032	0.56	0.75	5.51	121	133
	210	182	952	20	1.87	29.3	35	1.26	0.7	99.3	0.56	103.8	3.13	148.1	104.7	1.41	0.012	0.032	0.64	0.94	5.13	120	132
	215	122	678	16	1.67	24.3	30	1.09	0.6	84.3	0.49	88.2	2.75	108.1	89.0	1.21	0.014	0.032	0.67	0.95	4.75	105	117
	216	95	587	15	1.50	22.5	30	1.01	0.6	82.5	0.41	85.8	2.51	94.2	86.5	1.09	0.016	0.032	0.69	1.01	4.51	102	114
Alternative 2	**200**	12	680	10	1.84	19.2	25	1.38	0.5	69.2	0.88	76.3	3.22	113.2	77.2	1.47	0.010	0.032	0.59	0.86	5.22	93	105
	205	272	1,436	23	2.18	33.9	34	1.73	0.68	101.9	1.05	110.3	3.91	219.4	111.4	1.97	0.008	0.032	0.58	0.86	5.91	127	139
	210	234	1,299	22	2.05	32.2	38	1.45	0.76	108.2	0.69	113.7	3.50	185.1	114.7	1.61	0.012	0.032	0.66	1.08	5.50	130	142
	215	180	1,047	20	1.85	29.3	34	1.28	0.68	97.3	0.60	102.1	3.14	148.7	103.0	1.44	0.014	0.032	0.70	1.12	5.14	119	131
	216	155	956	19	1.75	27.7	35	1.20	0.7	97.7	0.50	101.8	2.95	135.1	102.6	1.32	0.016	0.032	0.73	1.20	4.95	118	130
	300	113	847	14	1.77	22.9	34	1.92	0.68	90.9	1.24	100.8	3.69	189.8	101.8	1.87	0.004	0.032	0.41	0.48	5.69	117	129
	340	195	1,142	20	1.94	29.7	43	1.34	0.86	115.7	0.48	119.5	3.28	166.8	120.4	1.39	0.014	0.032	0.67	1.17	5.28	136	148
	345	135	791	18	1.66	26.3	30	1.35	0.6	86.3	0.75	92.3	3.02	137.9	93.2	1.48	0.009	0.032	0.58	0.76	5.02	109	121
	350	111	658	14	1.69	22.5	23	1.38	0.46	68.5	0.92	75.8	3.07	118.3	76.7	1.54	0.008	0.032	0.56	0.69	5.07	92	104
	360	84	485	10	1.70	18.5	19	1.63	0.38	56.5	1.25	66.5	3.33	115.2	67.5	1.71	0.004	0.032	0.41	0.41	5.33	83	95
	370	71	399	10	1.55	17.7	20	1.10	0.4	57.7	0.70	63.3	2.65	78.7	64.1	1.23	0.009	0.032	0.55	0.62	4.65	80	92
	375	50	282	8	1.41	15.1	16	1.22	0.32	47.1	0.90	54.3	2.63	71.8	55.0	1.30	0.005	0.032	0.43	0.38	4.63	71	83
	377	107	594	12	1.78	20.9	21	1.49	0.42	62.9	1.07	71.4	3.27	118.5	72.4	1.64	0.006	0.032	0.49	0.56	5.27	88	100
	380	99	515	12	1.71	20.5	21	1.37	0.42	62.5	0.95	70.1	3.07	108.0	71.0	1.52	0.006	0.032	0.48	0.51	5.07	87	99
	400	45	251	6	1.51	13.5	14	0.97	0.28	41.5	0.69	47.1	2.48	53.0	47.8	1.11	0.009	0.032	0.53	0.55	4.48	64	76
	500	80	374	10	1.65	18.3	20	0.90	0.4	58.3	0.50	62.3	2.56	69.0	63.1	1.09	0.012	0.032	0.60	0.68	4.56	79	91
	600	5	366	10	1.31	16.5	20	0.91	0.4	56.5	0.51	60.6	2.22	61.8	61.3	1.01	0.016	0.032	0.70	0.91	4.22	77	89
	700	72	420	10	1.56	17.8	19	1.10	0.38	55.8	0.72	61.5	2.66	77.8	62.3	1.25	0.010	0.032	0.58	0.69	4.66	78	90
	800	62	700	10	1.86	13.3	20	1.45	0.4	59.3	1.05	67.7	3.32	109.9	68.7	1.60	0.010	0.032	0.62	0.91	5.32	84	96
	805	22	511	10	1.57	17.9	20	1.21	0.4	57.9	0.81	64.4	2.78	86.6	65.2	1.33	0.011	0.032	0.62	0.83	4.78	81	93
	812	191	919	20	1.92	29.6	30	1.25	0.6	89.6	0.65	94.8	3.17	143.6	95.7	1.50	0.011	0.032	0.63	0.86	5.17	111	123
	900	144	926	28	1.36	34.8	36	1.07	0.72	106.8	0.35	109.6	2.43	131.7	110.2	1.19	0.018	0.032	0.79	1.20	4.43	126	138
	905	120	786	22	1.40	29.0	32	1.05	0.64	93.0	0.41	96.3	2.45	113.3	96.9	1.17	0.018	0.032	0.78	1.18	4.45	113	125
	915	95	648	15	1.50	22.5	28	1.03	0.56	78.5	0.47	82.3	2.53	94.3	83.0	1.14	0.018	0.032	0.76	1.18	4.53	99	111
	1000	29	300	8	1.30	14.5	15	1.01	0.3	44.5	0.71	50.2	2.31	57.0	50.8	1.12	0.011	0.032	0.61	0.69	4.31	67	79
	1005	18	236	6	1.30	12.5	13	0.82	0.26	38.5	0.56	43.0	2.12	41.4	43.6	0.95	0.016	0.032	0.69	0.82	4.12	59	71
	1100	18	272	8	1.24	14.2	15	0.84	0.3	44.2	0.54	48.5	2.07	47.3	49.1	0.96	0.016	0.032	0.70	0.84	4.07	65	77
	1105	11	172	6	1.09	11.5	12	0.72	0.24	35.5	0.48	39.3	1.81	33.1	39.8	0.83	0.016	0.032	0.68	0.72	3.81	56	68

*Stream Management Corridor Top Width includes 12' wide gravel maintenance trail

Note: Channels in Reaches 602 and 605 were designed as part of Sky Ranch Filing 1 (Neighborhood B). See Sky Ranch Road and Drainage Construction Plans in Appendix for typical sections G-G and F-F.

TABLE D-2
Alternative Stage-Storage-Discharge Curves

100 Pond

	Stage (ft)	Surface Area (sf)	Total Volume(ac-ft)	Release (cfs)
	0	2,297	0	0.00
	1	5,150	0.09	0.64
	2	46,648	0.68	1.37
	3	129,975	2.71	1.88
WQCV	3.71	213,464	5.51	2.16
	4	253,481	7.06	2.67
EURV	4.95	358,436	13.73	3.85
	5	358,940	14.15	3.90
	6	369,103	22.50	100.42
100-YR	6.1	370,132	23.35	134.00
	7	379,394	31.09	237.79
	8	389,812	39.92	857.84
	9	400,359	48.99	1,863.15
	10	411,034	58.31	3,249.13

200 Pond – Alternative 1A

	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	5,206	0	0.00
	1	12,464	0.20	1.43
	2	123,042	1.76	3.09
	3	348,863	7.17	4.24
	3.66	543,079	13.93	4.83
	4	547,298	18.19	9.16
	5	559,795	30.90	15.49
	5.63	567,733	39.05	18.15
	6	572,419	43.89	32.64
	7	585,172	57.18	215.52
100-YR	7.82	595,747	68.31	667.00
	8	598,052	70.76	740.00
	9	611,061	84.64	1,222.75
	10	624,197	98.82	3,034.14

200 Pond – Alternative 1B

	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	5,206	0	0.00
	1	12,464	0.20	1.43
	2	123,042	1.76	3.09
	3	348,863	7.17	4.24
	3.48	494,622	11.82	4.68
	4	500,785	17.76	9.78
	5	512,733	29.40	15.76
	5.19	515,018	31.64	16.60
	6	524,809	41.31	86.81
	7	537,014	53.49	371.53
100-YR	7.42	542,169	58.67	667.00
	8	549,346	65.96	775.78
	9	561,806	78.72	2,141.06
	10	574,395	91.76	4,522.23

200 Pond – Alternative 2

	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	5,206	0	0.00
	1	12,464	0.20	1.43
	2	123,042	1.76	3.09
	3	348,863	7.17	4.24
	3.64	551,328	13.79	4.81
	4	598,348	18.54	8.32
	5	611,420	32.42	15.17
	5.51	618,136	39.62	17.41
	6	624,620	46.61	32.40
	7	637,948	61.10	215.32
	8	651,404	75.90	503.87
100-YR	8.13	653,116	77.80	667.00
	9	664,988	91.01	867.28
	10	678,700	106.44	2,144.56

Eastern Hills Pond

	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	586	0	0.00
	1	2,286	0.03	0.20
	2	36,576	0.48	0.43
WQCV	2.72	77,184	1.42	0.55
	3	78,500	1.92	0.69
	4	83,279	3.78	1.01
EURV	4.15	84,007	4.06	1.04
	5	88,186	5.74	12.55
	6	93,222	7.83	77.75
100-YR	6.18	94,151	8.21	91.00
	7	98,385	10.03	151.84
	8	103,677	12.35	512.11
	9	109,096	14.79	1,147.74
	10	114,643	17.36	2,080.71

Adonea Filing 2 West Pond

Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
0	0	0	0.00
0.5	7,302	0.04	0.00
1	11,210	0.15	0.00
1.5	19,169	0.32	0.00
2	37,704	0.65	0.00
2.5	59,601	1.21	0.00
2.83	71,594	1.70	0.00
3	78,535	2.00	0.65
3.5	106,468	3.06	5.05
4	125,732	4.39	11.66
4.5	145,464	5.95	19.89
4.67	149,591	6.52	23.00
5	161,342	7.70	61.90
5.5	179,444	9.66	71.20
5.72	190,035	10.59	74.00
6	201,194	11.85	105.25
6.8	227,108	15.78	310.71
7	233,586	16.84	379.42
7.5	251,822	19.62	574.85

Note: Referenced from *Adonea Filing 2 Final Drainage Report* (November 2004) by Nolte Associates

TABLE D-2
Alternative Stage-Storage-Discharge Curves

	300 Pond			
	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	5,206	0	0.00
	1	17,136	0.26	1.27
	2	237,860	3.18	2.76
	3	480,579	11.43	3.78
	3.11	481,860	12.65	3.87
	4	492,277	22.60	6.76
	4.14	493,925	24.18	7.04
100-YR	4.32	497,182	26.23	817.00
	5	504,104	34.04	1,263.72
	6	516,058	45.75	4,040.29
	7	528,140	57.74	7,717.59
	8	540,351	70.00	12,112.04
	9	552,689	82.55	18,780.57
	10	565,155	95.38	27,861.36

	8715 Pond			
	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	1,721	0	0.00
	1	5,050	0.08	0.59
	2	62,684	0.86	1.28
	3	185,349	3.70	1.76
WQCV	3.24	224,023	4.83	1.85
	4	370,618	10.02	3.84
EURV	4.41	464,933	13.95	4.48
	5	502,367	20.50	41.75
100-YR	5.79	511,873	29.70	230.00
	6	514,400	32.17	264.53
	7	526,561	44.12	705.76
	8	538,851	56.35	1,687.57
	9	551,268	68.86	3,107.58
	10	563,813	81.66	4,959.57

	500 Pond			
	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	1,421	0	0.00
	1	3,777	0.06	0.42
	2	42,166	0.59	0.91
	3	122,352	2.48	1.25
WQCV	3.31	155,311	3.46	1.34
	4	242,749	6.62	2.68
EURV	4.55	326,358	10.21	3.31
	5	352,953	13.72	21.98
100-YR	5.76	360,627	19.94	148.00
	6	363,051	21.94	150.00
	7	373,277	30.39	465.35
	8	383,631	39.08	1,209.05
	9	394,113	48.00	2,320.13
	10	404,723	57.17	3,806.53

	Representative Harmony Pond			
	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	5,342	0	0.00
	1	17,386	0.26	1.67
	2	238,817	3.20	3.61
	2.93	652,876	12.72	4.87
	3	653,827	13.77	4.95
	4	667,488	28.94	8.72
	4.18	669,960	31.70	9.16
	5	681,276	44.42	10.86
	6	695,193	60.22	254.72
100-YR	6.91	708,032	74.88	553.00
	8	723,410	92.78	1,383.37
	9	737,710	109.56	3,491.17
	10	752,139	126.66	6,506.90

	400 Pond			
	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	1,115	0	0.00
	1	3,262	0.05	0.34
	2	40,341	0.55	0.75
	3	119,206	2.38	1.02
WQCV	3.12	131,342	2.73	1.05
	4	238,294	6.46	2.60
EURV	4.38	247,458	8.58	3.00
	5	252,688	12.14	11.64
100-YR	5.85	259,947	17.14	77.00
	6	261,228	18.04	80.00
	7	269,896	24.13	293.61
	8	278,693	30.43	831.23
	9	287,617	36.93	1,673.30
	10	296,669	43.64	2,840.34

Sky Ranch Pond C			
Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
0	75,477	0.00	0.00
0.5	77,437	0.88	0.91
1	79,423	1.78	1.29
1.5	81,433	2.70	1.58
2	83,469	3.65	1.83
2.5	85,530	4.62	2.25
3	87,616	5.61	2.53
3.5	89,727	6.63	2.77
4	91,863	7.67	2.99
4.5	94,025	8.74	3.19
5	96,211	9.83	3.38
5.5	98,423	10.95	3.56
6	100,660	12.09	3.73
6.5	102,922	13.26	74.42
7	105,209	14.45	87.79
7.5	107,521	15.67	99.34
8	109,858	16.92	109.66
8.5	112,221	18.20	119.07
9	114,608	19.50	127.78
9.5	117,021	20.83	135.93
10	119,459	22.18	143.61

TABLE D-2
Alternative Stage-Storage-Discharge Curves

700 Pond

	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	1,555	0	0.00
	1	4,758	0.07	0.41
	2	61,612	0.83	0.95
	3	183,489	3.65	1.61
WQCV	3.03	188,100	3.78	1.62
	4	331,185	9.56	3.59
EURV	4.26	333,714	11.54	3.92
	5	340,959	17.27	14.03
100-YR	5.75	348,386	23.21	191.00
	6	350,861	25.21	200.00
	7	360,891	33.38	408.61
	8	371,049	41.78	1,071.47
	9	381,335	50.42	2,099.12
	10	391,749	59.29	3,496.48

Representative 812 Pond

	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	2,288	0	0.00
	1	6,001	0.10	0.67
	2	66,039	0.92	1.46
	3	191,134	3.87	2.00
WQCV	3.36	251,381	5.72	2.15
2-YR	4.21	285,277	10.96	3.99
EURV	4.95	291,959	15.84	13.40
5-YR	5.00	292,413	16.18	18.05
10-YR	5.41	296,056	18.93	73.48
25-YR	5.99	301,468	22.95	196.21
50-YR	6.37	304,977	25.59	294.62
100-YR	7.07	311,405	30.48	420.00
500-YR	7.63	316,651	34.55	754.68
	8	320,239	37.26	1,176.85
	9	329,771	44.72	2,795.92
	10	339,430	52.40	5,050.88

1000 Pond

	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	964	0	0.00
	1	2,997	0.05	0.24
	2	39,366	0.53	0.57
	3	117,513	2.33	0.97
WQCV	3.02	119,481	2.39	0.98
EURV	3.76	188,379	5.00	1.59
	4	190,141	6.04	11.66
	5	197,561	10.49	196.12
100-YR	5.07	198,089	10.81	227.00
	6	205,108	15.12	231.58
	7	212,784	19.91	567.24
	8	220,588	24.89	1,334.37
	9	228,519	30.04	2,473.37
	10	236,579	35.38	3,991.25

Representative 800 Pond

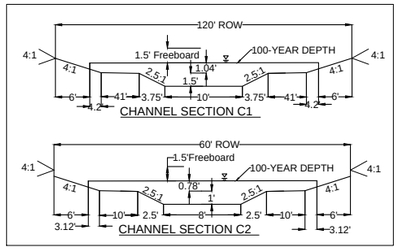
	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	1,982	0	0.00
	1	5,494	0.09	0.60
	2	64,276	0.89	1.29
	3	188,102	3.78	1.76
WQCV	3.24	227,051	4.93	1.86
EURV	3.99	243,921	8.98	2.22
	4	244,005	9.04	2.23
	5	252,374	14.74	2.59
	6	260,872	20.63	2.90
	7	269,498	26.71	123.93
	8	278,252	33.00	344.96
100-YR	8.42	281,982	35.70	468.00
	9	287,134	39.49	573.61
	10	296,144	46.19	1,513.44

900 Pond

	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	3,642	0	0.00
	1	9,947	0.16	1.05
	2	114,575	1.59	2.27
	3	334,386	6.74	3.52
WQCV	3.25	406,505	8.86	3.97
	4	665,027	18.09	6.63
EURV	4.49	674,632	25.62	7.74
	5	681,707	33.56	8.71
	6	695,675	49.37	312.18
100-YR	6.15	697,832	51.82	474.00
	7	709,772	65.51	865.48
	8	723,997	81.96	2,318.60
	9	738,349	98.75	4,784.40
	10	752,830	115.87	8,009.44

1100 Pond

	Stage (ft)	Surface Area (sf)	Total Volume (ac-ft)	Release (cfs)
	0	937	0	0.00
	1	2,948	0.04	0.23
	2	39,180	0.53	0.55
WQCV	2.99	116,212	2.29	0.95
	3	117,188	2.32	0.95
EURV	3.64	188,162	4.56	1.25
	4	192,773	6.14	20.54
	5	200,245	10.65	189.01
100-YR	5.04	200,511	10.81	218.00
	6	207,846	15.33	253.21
	7	215,574	20.19	559.91
	8	223,430	25.23	1,265.14
	9	231,414	30.45	2,322.18
	10	239,526	35.86	3,742.04



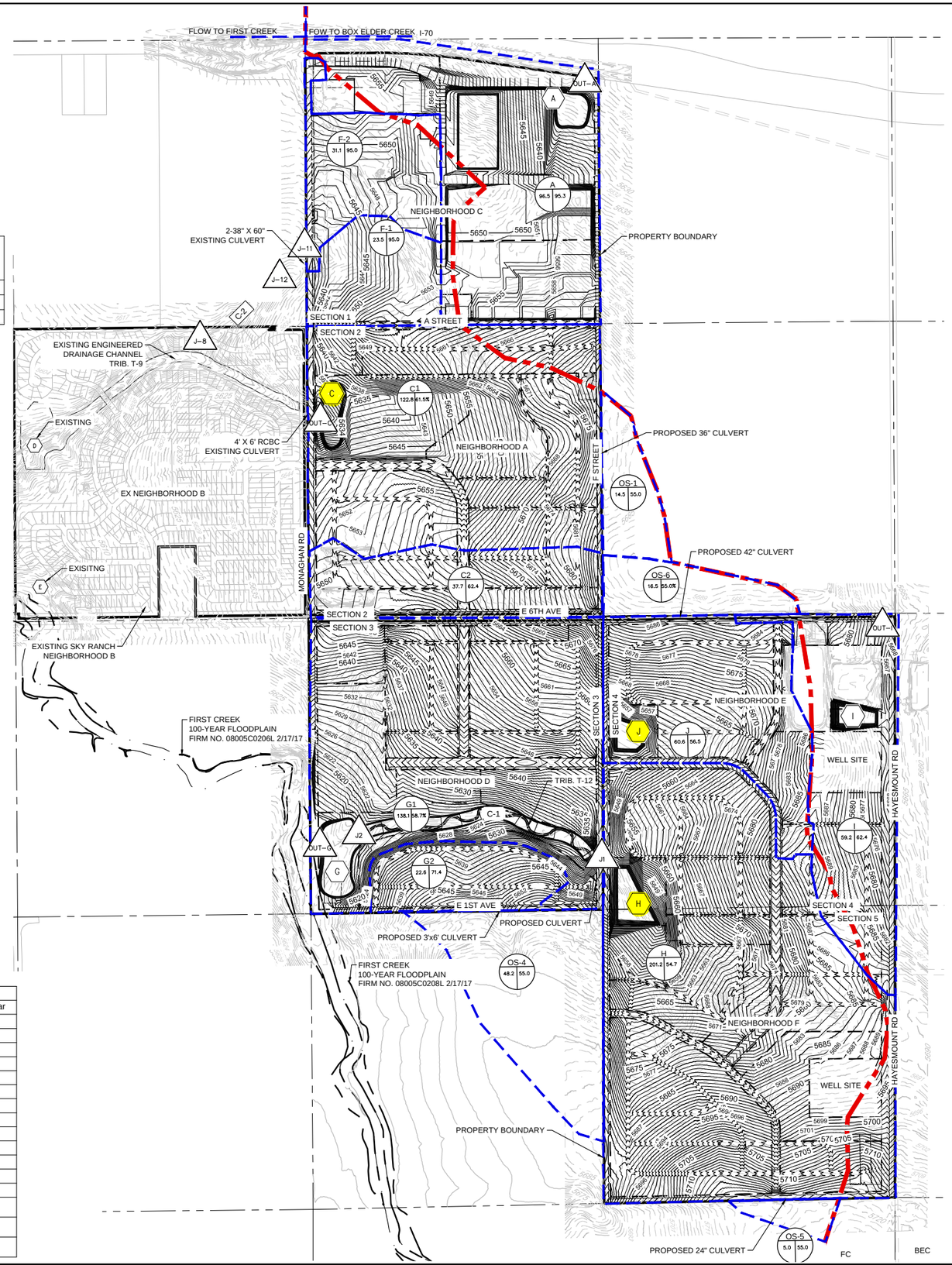
CHANNEL ID	LOW FLOW CHANNEL DEPTH	OVERBANK FLOW DEPTH	BOTTOM WIDTH	LEFT OVERBANK BOTTOM WIDTH	RIGHT OVERBANK BOTTOM WIDTH	TOP WIDTH W/ 1.5' FREEBOARD	Q100-Year
	FT	FT	FT	FT	FT	FT	CFS
C1	1.5	1.04	10	41	41	120	689.6
C2	1	0.78	8	10	10	52	194.3

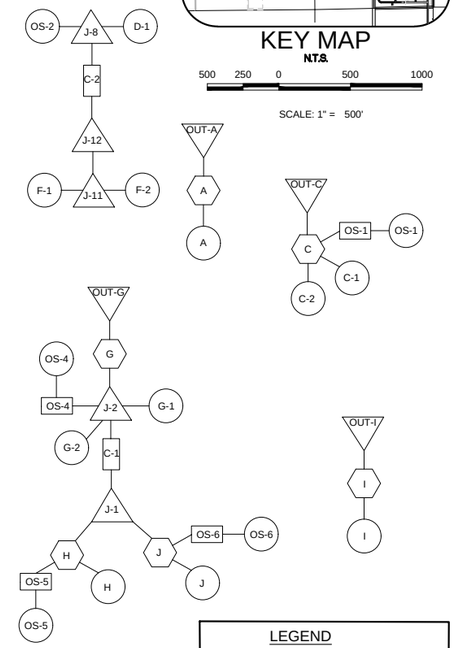
POND SUMMARY TABLE						
Pond	Tributary	WQCV	EURV	100-YEAR SWMM	UDFCD Allowable Release	Design Release
ID	Area	VWQCV	VEURV	V100-Yr	Q100	Q100
	(AC)	(AC-FT)	(AC-FT)	(AC-FT)	(CFS)	(CFS)
Pond A	96.51	3.62	9.16	12.94	125.22	121.27
Pond C	174.94	3.50	10.29	20.60	232.87	134.98
Pond G	208.89	4.07	11.86	22.05	553.13	547.05
Pond H	206.20	3.77	10.75	17.92	289.50	288.78
Pond I	59.17	1.42	4.23	6.82	51.65	47.42
Pond J	77.09	1.44	4.14	7.94	73.80	72.54

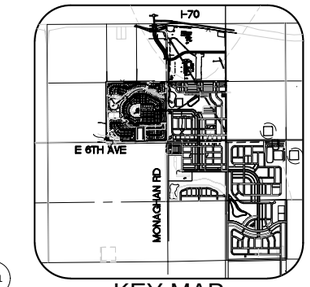
DESIGN POINT SUMMARY TABLE				
Design Point	Q2-Year	Q5-Year	Q10-Year	Q100-Year
ID	(cfs)	(cfs)	(cfs)	(cfs)
J-1	3.58	4.48	58.45	359.19
J-2	107.44	157.32	214.78	689.59
J-3	2.76	3.36	30.76	134.98
J-5	78.61	113.01	145.42	322.87
J-6	76.54	110.55	143.35	325.09
J-7	102.71	150.56	198.86	460.60
J-8	78.47	112.48	143.59	307.44
J-10	8.97	13.13	17.81	44.27
J-11	61.49	82.63	100.83	197.93
J-12	61.20	82.38	100.65	197.33

CONCEPTUAL CULVERT SIZES		
Basin ID	Q100-Year	Culvert Size
F-1/F-2	197.93	EX 2-38"x60" RCP
C-1	134.98	EX 4'X6' RCBC
OS-1	42.63	36" RCP
OS-4	139.80	3'X6' RCBC
OS-5	17.54	24" RCP
OS-6	60.43	42" RCP

BASIN SUMMARY TABLE						
Basin ID	Area	Imperviousness	Q2-Year	Q5-Year	Q10-Year	Q100-Year
	(acres)	(%)	(cfs)	(cfs)	(cfs)	(cfs)
A	96.51	95.26	117.96	158.43	193.35	376.03
C-1	122.81	61.49	83.18	120.78	164.02	391.57
C-2	37.67	62.41	15.80	22.98	30.87	75.16
F-1	23.53	95.00	26.48	35.56	43.37	85.17
F-2	31.05	95.00	35.02	47.07	57.46	112.76
G-1	138.12	58.68	68.48	100.51	137.49	341.75
G-2	22.62	71.35	13.11	18.66	24.40	55.49
H	201.17	54.68	107.11	159.42	222.73	564.87
J	60.63	56.53	29.56	43.46	60.05	151.82
I	59.17	62.36	28.34	41.16	55.36	134.58
OS-1	14.45	55.00	8.28	12.22	17.15	42.63
OS-4	48.15	55.00	26.83	39.84	55.83	139.80
OS-5	5.03	55.00	3.47	5.06	7.14	17.54
OS-6	16.46	55.00	11.99	17.45	24.66	60.43







KEY MAP
N.T.S.

500 250 0 500 1000

SCALE: 1" = 500'

LEGEND

- XX-X BASIN DESIGNATION (X.X = AREA IN ACRES, %I = % IMPERVIOUS)
- DESIGN POINT
- CONDUIT/CHANNEL
- DETENTION POND
- OUTFALL
- PROPOSED BASIN BOUNDARY
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR

NOTE:
1. DRAINAGE FACILITIES SHOWN ALONG MONAGHAN RD AND IN NEIGHBORHOOD B ARE CURRENTLY UNDER CONSTRUCTION AS OF JANUARY 2019. FOR THE PURPOSE OF THIS DRAINAGE REPORT THEY ARE CALLED OUT AS EXISTING
2. STORM SEWER LAYOUT IS CONCEPTUAL AND WILL BE DESIGNED IN THE PH III DRAINAGE REPORT

CALL 811
TWO WORKING DAYS
BEFORE YOU DIG
1-800-922-1987

PREPARED UNDER THE SUPERVISION OF

MARK SCHEURER
COLORADO P.E. 48988

No.	Revisions	Date	Init.	Appr.	Date

10333 E. Dry Creek Rd.
Suite 240
Englewood, CO 80112
Tel: (720) 482-9526
Fax: (720) 482-9546
Contact:
Melinda Lundquist, PE

PCY HOLDINGS, LLC.
ATTN: MARK HARDING
34501 EAST QUINCY AVE.
BLDG. 34, BOX 10
WATKINS, CO. 80137

SKY RANCH - FILING 2 DRAINAGE
F2 Proposed Drainage Map

SCALE: AS SHOWN
FILE NO: 8.13.01007307
DRAWN BY: KAM
CHECKED BY: MS
DATE: MAY 2018
SHEET NUMBER 2

N:\PROJECTS\301\07320 SKY RANCH F2\DOCS\ENGINEERING\DRAINAGE\PHASE I DRAINAGE REPORT\DRAINAGE MAPS\F2 PROPOSED DRAINAGE MAP OVERALL.DWG, LAURAH, 5/15/19

DPR18-0081/D18-0089

TABLE D-3
UD-MP Unit Costs

Cost Data

Item	Unit	Unit Cost 2012 Q1	Adjusted Unit Cost 2019 Q1
Circular Pipes			
12-inch	L.F.	$36.00	$46.00
18-inch	L.F.	$54.00	$69.00
24-inch	L.F.	$72.00	$92.00
30-inch	L.F.	$90.00	$115.00
36-inch	L.F.	$108.00	$138.00
42-inch	L.F.	$126.00	$161.00
48-inch	L.F.	$144.00	$184.00
54-inch	L.F.	$216.00	$276.00
60-inch	L.F.	$240.00	$307.00
66-inch	L.F.	$264.00	$337.00
72-inch	L.F.	$360.00	$460.00
78-inch	L.F.	$390.00	$498.00
84-inch	L.F.	$420.00	$537.00
90-inch	L.F.	$450.00	$575.00
96-inch	L.F.	$480.00	$613.00
102-inch	L.F.	$714.00	$912.00
108-inch	L.F.	$756.00	$966.00
120-inch	L.F.	$840.00	$1,073.00
Flared End Sections			
12-inch	EA	$710.00	$907.00
18-inch	EA	$920.00	$1,176.00
24-inch	EA	$970.00	$1,239.00
30-inch	EA	$1,570.00	$2,006.00
36-inch	EA	$1,610.00	$2,057.00
42-inch	EA	$1,700.00	$2,172.00
48-inch	EA	$2,060.00	$2,632.00
Manholes and Inlets			
Manhole, 4' Dia. (Pipe Dia. < 36"), Depth > 15-feet)	EA	$2,900.00	$3,706.00
Manhole, 5' Dia. (Pipe Dia. 36" - 42"), Depth > 15-feet)	EA	$3,900.00	$4,983.00
Manhole, 6' Dia. (Pipe Dia. , Depth > 15-feet)	EA	$4,300.00	$5,495.00
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)	EA	$12,000.00	$15,334.00
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)	EA	$15,000.00	$19,167.00
Storm Inlet, Type R/Type 14, 5-foot, 10-foot deep avg.	EA	$4,600.00	$5,878.00
Headwalls for Circular Pipes			
See Headwall Table			See Headwall Table
Wingwalls for Circular Pipes			
See Wingwall Table			See Wingwall Table
Box Culverts			
See Box Culvert Table			See Box Culvert Table
Hydraulic Structures			
Grouted Boulders, 36-inch	C.Y.	$190.00	$243.00
Soil Riprap, Type M	C.Y.	$70.00	$89.00
Excavation, Complete-in-Place	C.Y.	$11.00	$14.00
Bedding, Granular Type II	C.Y.	$58.00	$74.00
Grout	C.Y.	$240.00	$307.00
Check Structure, Concrete	L.F.	$270.00	$345.00
Channel Improvements			
Boulder Edging, 12" High	L.F.	$60.00	$77.00
Boulder Edging, 24" High	L.F.	$75.00	$96.00
Boulder Edging, 36" High	L.F.	$90.00	$115.00
Concrete Low Flow Channel	L.F.	$40.00	$51.00
Grouted Boulders, 12"	S.Y.	$130.00	$166.00
Grouted Boulders, 18"	S.Y.	$150.00	$192.00
Grouted Boulders, 24"	S.Y.	$170.00	$217.00
Grouted Boulders, 36"	S.Y.	$190.00	$243.00
Grouted Boulders, 48"	S.Y.	$200.00	$256.00
6-inch Riprap, Type VL	C.Y.	$45.00	$58.00
9-inch Riprap, Type L	C.Y.	$55.00	$70.00
12-inch Riprap, Type M	C.Y.	$60.00	$77.00
18-inch Riprap, Type H	C.Y.	$80.00	$102.00

24-inch Riprap, Type VH	C.Y.	$85.00	$109.00
Soil Riprap, Type VL	C.Y.	$50.00	$64.00
Soil Riprap, Type L	C.Y.	$60.00	$77.00
Soil Riprap, Type M	C.Y.	$70.00	$89.00
Soil Riprap, Type H	C.Y.	$80.00	$102.00
Soil Riprap, Type VH	C.Y.	$90.00	$115.00
Excavation, Low Range	C.Y.	$11.00	$14.00
Excavation, Mid Range	C.Y.	$24.00	$31.00
Excavation, High Range	C.Y.	$31.00	$40.00
Detention/Water Quality Facilities			
Excavation, Low Range	C.Y.	$11.00	$14.00
Excavation, Mid Range	C.Y.	$24.00	$31.00
Excavation, High Range	C.Y.	$31.00	$40.00
Outlet Works	EA	User Defined	User Defined
Water Quality Appurtenances	EA	User Defined	User Defined
Detention (Complete-in-Place)	AC-FT	$45,600.00	$58,268.00
Landscaping and Recreation Improvements			
Wetlands Plantings	ACRE	$25,000.00	$31,945.00
Reclamation & seeding (native grasses)	ACRE	$1,000.00	$1,278.00
Trail/Path, Concrete (10' Width)	L.F.	$44.00	$56.00
Trail/Path, Crusher Fines (10' Width)	L.F.	$11.00	$14.00
Removals			
Removal of culvert pipe (D<48")	L.F.	$20.00	$26.00
Removal of culvert pipe (48"<D<84")	L.F.	$50.00	$64.00
Removal of culvert pipe (D>84")	L.F.	$75.00	$96.00
Concrete Box Culvert	L.F./CELL	$100.00	$128.00
Land Acquisition			
Temporary Easements	EA	User Defined	User Defined
Easement/ROW Acquisition	ACRE	User Defined	User Defined
Concrete and Steel			
Concrete	C.Y.	$600.00	$767.00
Steel	LB.	$0.90	$1.00
Operation and Maintenance			
Culvert Maintenance	L.F.	$1.00	$1.00
Manhole and Inlet Maintenance	EA	$50.00	$64.00
Hydraulic Structure Maintenance	EA	$500.00	$639.00
Channel Maintenance	L.F.	$2.00	$3.00
Detention/WQ Maintenance	ACRE	$1,500.00	$1,917.00
Mowing	ACRE	$50.00	$64.00
Trail Maintenance	L.F.	$5.00	$6.00

TABLE D-4
Alternatives Cost Tables

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	First Creek Master Drainage Plan			
DRAINAGEWAY :	Gun Club			
REACH :	100			
JURISDICTION :	Aurora			
REACH ID:	Gun Club-Reach100	Clare Steninger & Jennifer Goldman	DATE :	11/21/2019

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		23	AC-FT	$58,268.00	$1,363,471.00	
Detention (User Entered Quantities)						
Outlet Works		1	EA	$25,000.00	$25,000.00	Includes WQCV, EURV, 100-yr appurtenances
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		9	ACRE	$1,278.00	$11,617.00	Includes Area of Impact for pond and stream management corridors
Special Items (User Defined)						
Stream Management Corridor	<----User Defined Items	254	LF	$214.70	$54,534.00	Reach 100 - 49' Top Width at freeboard. Trail not included.
12' Wide Gravel Maintenance Trail	<----User Defined Items	254	LF	$16.80	$4,267.00	12' Wide Gravel Maintenance Trail

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$1,388,471.00
Removals				$0.00
Landscaping and Maintenance Improvements				$11,617.00
Special Items (User Defined)				$58,801.00
Subtotal Capital Improvement Costs				**$1,458,889.00**
Additional Capital Improvement Costs				
Dewatering	$72,944.45	L.S.		$72,944.00
Mobilization	5%			$72,944.00
Traffic Control	$29,177.78	L.S.		$29,178.00
Utility Coordination/Relocation	$72,944.45	L.S.		$72,944.00
Stormwater Management/Erosion Control	5%			$72,944.00
Subtotal Additional Capital Improvement Costs				**$320,954.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$266,976.00
Legal/Administrative	5%			$88,992.00
Contract Admin/Construction Management	10%			$177,984.00
Contingency	25%			$444,961.00
Subtotal Other Costs				**$978,913.00**
Total Capital Improvement Costs				**$2,758,756.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	254	L.F.	$3.00	$152.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, struc	8.73	ACRE	$1,917.00	$1,674.00
Mowing (e.g. channels, ponds, etc.)	9.09	ACRE	$64.00	$582.00
Total Annual Operation and Maintenance Cost				**$2,408.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$120,400.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	First Creek Master Drainage Plan			
DRAINAGEWAY :	Harvest			
REACH :	200 1A			
JURISDICTION :	Aurora			
REACH ID:	Harvest-Reach200 1A	Clare Steninger & Jennifer Goldman	DATE :	11/21/2019

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		68	AC-FT	$58,268.00	$3,979,704.00	Pond 200 - > 1 sq. mi., 100-year control only
Detention Facility 2 (Complete-in-Place)		8	AC-FT	$58,268.00	$477,798.00	Pond 250 - Eastern Hills Pond E1
Detention (User Entered Quantities)						
Outlet Works		2	EA	$25,000.00	$50,000.00	100-yr only for tributary area > 1 sq mi. WQCV/EURV/100-yr for other ponds
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		31	ACRE	$1,278.00	$39,874.00	Includes Area of Impact for ponds (200 and Eastern Hills only) and corridors
Special Items (User Defined)						
Stream Management Corridor	<----User Defined Items	1739	LF	$407.40	$708,469.00	Reach 200 - 93' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items	1252	LF	$538.80	$674,578.00	Reach 205 - 123' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items	662	LF	$547.50	$362,445.00	Reach 210 - 125' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items	936	LF	$499.40	$467,438.00	Reach 215 - 114' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items	745	LF	$481.80	$358,941.00	Reach 216 - 110' Top Width at freeboard. Trail not included.
12' Wide Gravel Maintenance Trail	<----User Defined Items	5334	LF	$16.80	$89,611.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$4,507,502.00
Removals				$0.00
Landscaping and Maintenance Improvements				$39,874.00
Special Items (User Defined)				$2,661,482.00
Subtotal Capital Improvement Costs				**$7,208,858.00**
Additional Capital Improvement Costs				
Dewatering	$360,442.90	L.S.		$360,443.00
Mobilization	5%			$360,443.00
Traffic Control	$144,177.16	L.S.		$144,177.00
Utility Coordination/Relocation	$360,442.90	L.S.		$360,443.00
Stormwater Management/Erosion Control	5%			$360,443.00
Subtotal Additional Capital Improvement Costs				**$1,585,949.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$1,319,221.00
Legal/Administrative	5%			$439,740.00
Contract Admin/Construction Management	10%			$879,481.00
Contingency	25%			$2,198,702.00
Subtotal Other Costs				**$4,837,144.00**
Total Capital Improvement Costs				**$13,631,951.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	5334	L.F.	$3.00	$3,200.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, struc	16.25	ACRE	$1,917.00	$3,115.00
Mowing (e.g. channels, ponds, etc.)	31.2	ACRE	$64.00	$1,997.00
Total Annual Operation and Maintenance Cost				**$8,312.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$415,600.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	First Creek Master Drainage Plan			
DRAINAGEWAY :	Harvest			
REACH :	200 1B			
JURISDICTION :	Aurora			
REACH ID:	Harvest-Reach200 1B	Clare Steninger & Jennifer Goldman	DATE :	11/21/2019

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		59	AC-FT	$58,268.00	$3,420,332.00	Pond 200 - > 1 sq. mi., 100-year control only
Detention Facility 2 (Complete-in-Place)		8	AC-FT	$58,268.00	$477,798.00	Pond 250 - Eastern Hills Pond E1
Detention (User Entered Quantities)						
Outlet Works		2	EA	$25,000.00	$50,000.00	100-yr only for tributary area > 1 sq mi. WQCV/EURV/100-yr for other ponds
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		29	ACRE	$1,278.00	$37,688.00	Includes Area of Impact for ponds (200 and Eastern Hills only) and corridors
Special Items (User Defined)						
Stream Management Corridor	<----User Defined Items	1739	LF	$407.40	$708,469.00	Reach 200 - 93' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items	1252	LF	$530.00	$663,560.00	Reach 205 - 121' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items	662	LF	$525.60	$347,947.00	Reach 210 - 120' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items	936	LF	$459.90	$430,466.00	Reach 215 - 105' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items	745	LF	$446.80	$332,866.00	Reach 216 - 102' Top Width at freeboard. Trail not included.
12' Wide Gravel Maintenance Trail	<----User Defined Items	5334	LF	$16.80	$89,611.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$3,948,130.00
Removals				$0.00
Landscaping and Maintenance Improvements				$37,688.00
Special Items (User Defined)				$2,572,919.00
Subtotal Capital Improvement Costs				**$6,558,737.00**
Additional Capital Improvement Costs				
Dewatering	$327,936.85	L.S.		$327,937.00
Mobilization	5%			$327,937.00
Traffic Control	$131,174.74	L.S.		$131,175.00
Utility Coordination/Relocation	$327,936.85	L.S.		$327,937.00
Stormwater Management/Erosion Control	5%			$327,937.00
Subtotal Additional Capital Improvement Costs				**$1,442,923.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$1,200,249.00
Legal/Administrative	5%			$400,083.00
Contract Admin/Construction Management	10%			$800,166.00
Contingency	25%			$2,000,415.00
Subtotal Other Costs				**$4,400,913.00**
Total Capital Improvement Costs				**$12,402,573.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	5334	L.F.	$3.00	$3,200.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, struc	19.89	ACRE	$1,917.00	$3,813.00
Mowing (e.g. channels, ponds, etc.)	34.37	ACRE	$64.00	$2,200.00
Total Annual Operation and Maintenance Cost				**$9,213.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$460,650.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	First Creek Master Drainage Plan			
DRAINAGEWAY :	Harvest			
REACH :	200 2			
JURISDICTION :	Aurora			
REACH ID:	Harvest-Reach200 2	Clare Steninger & Jennifer Goldman	DATE :	11/21/2019

DESCRIPTION			QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Pipe Culverts and Storm Drains							
Circular Pipes							
Diameter (in)	Length (ft)	No. of Barrels					
60-inch	4820	1	4820	L.F.	$307.00	$1,479,740.00	6th Ave to 1st Ave (DP219 to DP245)
48-inch	2860	1	2860	L.F.	$184.00	$526,240.00	1st Ave to Alameda Ave (DP245 to DP250)
Manholes and Inlets							
Type B Manhole (Pipe Dia. 48" and larger, deflection < 10 degrees)			13	EA	$15,334.00	$199,342.00	6th Ave to 1st Ave (DP219 to DP245)
Type P Manhole (Pipe Dia. 48" and larger, deflection > 10 degrees)			10	EA	$19,167.00	$191,670.00	1st Ave to Alameda Ave (DP245 to DP250)
Detention/Water Quality Facilities							
Detention (Complete-in-Place)							
Detention Facility 1 (Complete-in-Place)			78	AC-FT	$58,268.00	$4,533,250.00	Pond 200 - > 1 sq. mi., 100-year control only
Detention (User Entered Quantities)							
Outlet Works			1	EA	$25,000.00	$25,000.00	100-yr only for tributary area > 1 sq mi.
Landscaping and Maintenance Improvements							
Reclamation & seeding (native grasses)			31	ACRE	$1,278.00	$39,209.00	Includes Area of Impact for pond and stream management corridors
Special Items (User Defined)							
Stream Management Corridor	<----User Defined Items		1739	LF	$407.40	$708,469.00	Reach 200 - 93' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items		1252	LF	$556.30	$696,488.00	Reach 205 - 127' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items		662	LF	$569.40	$376,943.00	Reach 210 - 130' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items		936	LF	$521.30	$487,937.00	Reach 215 - 119' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items		745	LF	$516.90	$385,091.00	Reach 216 - 118' Top Width at freeboard. Trail not included.
12' Wide Gravel Maintenance Trail	<----User Defined Items		5334	LF	$16.80	$89,611.00	
Junction Box for Flow Split	<----User Defined Items		2	EA	$25,000.00	$50,000.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains				$2,396,992.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$4,558,250.00
Removals				$0.00
Landscaping and Maintenance Improvements				$39,209.00
Special Items (User Defined)				$2,794,539.00
Subtotal Capital Improvement Costs				**$9,788,990.00**
Additional Capital Improvement Costs				
Dewatering	$489,449.50	L.S.		$489,450.00
Mobilization	5%			$489,450.00
Traffic Control	$195,779.80	L.S.		$195,780.00
Utility Coordination/Relocation	$489,449.50	L.S.		$489,450.00
Stormwater Management/Erosion Control	5%			$489,450.00
Subtotal Additional Capital Improvement Costs				**$2,153,580.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$1,791,386.00
Legal/Administrative	5%			$597,129.00
Contract Admin/Construction Management	10%			$1,194,257.00
Contingency	25%			$2,985,643.00
Subtotal Other Costs				**$6,568,415.00**
Total Capital Improvement Costs				**$18,510,985.00**

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost
Culvert Maintenance (e.g. sediment & debris removal, erosion at entrance/exit, structural repairs, etc.)	7680	L.F.	$1.00	$1,536.00
Manhole and Inlet Maintenance (e.g. sediment & debris removal, structural repairs, etc.)	25	EA	$64.00	$320.00
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	5334	L.F.	$3.00	$3,200.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, struc	15.31	ACRE	$1,917.00	$2,935.00
Mowing (e.g. channels, ponds, etc.)	30.68	ACRE	$64.00	$1,964.00
Total Annual Operation and Maintenance Cost				**$9,955.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$497,750.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	First Creek Master Drainage Plan			
DRAINAGEWAY :	Powhaton South			
REACH :	300			
JURISDICTION :	Aurora			
REACH ID:	Powhaton South-Reach300	Clare Steninger & Jennifer Goldman	DATE :	11/21/2019

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		26	AC-FT	$58,268.00	$1,526,622.00	Pond 300 - > 1 sq. mi., 100-year control only
Detention Facility 2 (Complete-in-Place)		75	AC-FT	$58,268.00	$4,364,273.00	Pond 340 - Harmony Pond, > 1 sq. mi., 100-year control only
Detention Facility 3 (Complete-in-Place)		30	AC-FT	$58,268.00	$1,730,560.00	Pond 8715
Detention (User Entered Quantities)						
Outlet Works		3	EA	$25,000.00	$75,000.00	100-yr only for tributary area > 1 sq mi. WQCV/EURV/100-yr for other ponds
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		77	ACRE	$1,278.00	$97,856.00	Includes Area of Impact for ponds and stream management corridors
Special Items (User Defined)						
Stream Management Corridor	**<----User Defined Items**	879	LF	$512.50	$450,488.00	Reach 300 - 117' Top Width at freeboard. Trail not included.
Stream Management Corridor	**<----User Defined Items**	696	LF	$595.70	$414,607.00	Reach 340 - 136' Top Width at freeboard. Trail not included.
Stream Management Corridor	**<----User Defined Items**	2299	LF	$477.50	$1,097,773.00	Reach 345 - 109' Top Width at freeboard. Trail not included.
Stream Management Corridor	**<----User Defined Items**	3129	LF	$403.00	$1,260,987.00	Reach 350 - 92' Top Wdith at freeboard. Trail not included.
Stream Management Corridor	**<----User Defined Items**	748	LF	$363.60	$271,973.00	Reach 360 - 83' Top Width at freeboard. Trail not included.
Stream Management Corridor	**<----User Defined Items**	1484	LF	$350.40	$519,994.00	Reach 370 - 80' Top Width at freeboard. Trail not included.
Stream Management Corridor	**<----User Defined Items**	2155	LF	$311.00	$670,205.00	Reach 375 - 71' Top Width at freeboard. Trail not included.
Stream Management Corridor	**<----User Defined Items**	880	LF	$385.50	$339,240.00	Reach 377 - 88' Top Width at freeboard. Trail not included.
Stream Management Corridor	**<----User Defined Items**	2903	LF	$381.10	$1,106,333.00	Reach 380 - 87' Top Width at freeboard. Trail not included.
12' Wide Gravel Maintenance Trail	**<----User Defined Items**	15173	LF	$16.80	$254,906.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains			$0.00	
Concrete Box Culverts			$0.00	
Hydraulic Structures			$0.00	
Channel Improvements			$0.00	
Detention/Water Quality Facilities			$7,696,455.00	
Removals			$0.00	
Landscaping and Maintenance Improvements			$97,856.00	
Special Items (User Defined)			$6,386,506.00	
Subtotal Capital Improvement Costs			**$14,180,817.00**	
Additional Capital Improvement Costs				
Dewatering	$709,040.85	L.S.	$709,041.00	
Mobilization	5%		$709,041.00	
Traffic Control	$283,616.34	L.S.	$283,616.00	
Utility Coordination/Relocation	$709,040.85	L.S.	$709,041.00	
Stormwater Management/Erosion Control	5%		$709,041.00	
Subtotal Additional Capital Improvement Costs			**$3,119,780.00**	
Land Acquisition Costs				
ROW/Easements			$0.00	
Subtotal Land Acquisition Costs			**$0.00**	
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%		$2,595,090.00	
Legal/Administrative	5%		$865,030.00	
Contract Admin/Construction Management	10%		$1,730,060.00	
Contingency	25%		$4,325,149.00	
Subtotal Other Costs			**$9,515,329.00**	
Total Capital Improvement Costs			**$26,815,926.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	15173	L.F.	$3.00	$9,104.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, struc	40.26	ACRE	$1,917.00	$7,718.00	
Mowing (e.g. channels, ponds, etc.)	76.57	ACRE	$64.00	$4,900.00	
Total Annual Operation and Maintenance Cost				**$21,722.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$1,086,100.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	First Creek Master Drainage Plan			
DRAINAGEWAY :	Powhaton North			
REACH :	400			
JURISDICTION :	Aurora			
REACH ID:	Powhaton North-Reach400	Clare Steninger & Jennifer Goldman	DATE :	11/21/2019

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		17	AC-FT	$58,268.00	$996,383.00	
Detention (User Entered Quantities)						
Outlet Works		1	EA	$25,000.00	$25,000.00	Includes WQCV, EURV, 100-yr appurtenances
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		12	ACRE	$1,278.00	$15,170.00	Includes Area of Impact for pond and stream management corridors
Special Items (User Defined)						
Stream Management Corridor	**<----User Defined Items**	3268	LF	$280.40	$916,347.00	Reach 400 - 64' Top Width at freeboard. Trail not included.
12' Gravel Maintenance Trail	**<----User Defined Items**	3268	LF	$16.80	$54,902.00	

Master Plan Capital Improvement Cost Summary

Capital Improvement Costs				
Pipe Culverts and Storm Drains			$0.00	
Concrete Box Culverts			$0.00	
Hydraulic Structures			$0.00	
Channel Improvements			$0.00	
Detention/Water Quality Facilities			$1,021,383.00	
Removals			$0.00	
Landscaping and Maintenance Improvements			$15,170.00	
Special Items (User Defined)			$971,249.00	
Subtotal Capital Improvement Costs			**$2,007,802.00**	
Additional Capital Improvement Costs				
Dewatering	$100,390.10	L.S.	$100,390.00	
Mobilization	5%		$100,390.00	
Traffic Control	$40,156.04	L.S.	$40,156.00	
Utility Coordination/Relocation	$100,390.10	L.S.	$100,390.00	
Stormwater Management/Erosion Control	5%		$100,390.00	
Subtotal Additional Capital Improvement Costs			**$441,716.00**	
Land Acquisition Costs				
ROW/Easements			$0.00	
Subtotal Land Acquisition Costs			**$0.00**	
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%		$367,428.00	
Legal/Administrative	5%		$122,476.00	
Contract Admin/Construction Management	10%		$244,952.00	
Contingency	25%		$612,380.00	
Subtotal Other Costs			**$1,347,236.00**	
Total Capital Improvement Costs			**$3,796,754.00**	

Master Plan Operation and Maintenance Cost Summary

Description	Quantity	Unit	Unit Cost	Total Annual Cost	
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	3268	L.F.	$3.00	$1,961.00	
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, struc	6.17	ACRE	$1,917.00	$1,183.00	
Mowing (e.g. channels, ponds, etc.)	11.87	ACRE	$64.00	$760.00	
Total Annual Operation and Maintenance Cost				**$3,904.00**	
Effective Interest Rate				0.00%	
Total Operation and Maintenance Costs Over 50 Years				**$195,200.00**	

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	First Creek Master Drainage Plan			
DRAINAGEWAY :	Riverwood			
REACH :	500			
JURISDICTION :	Aurora			
REACH ID:	Riverwood-Reach500	Clare Steninger & Jennifer Goldman	DATE :	11/21/2019

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		20	AC-FT	$58,268.00	$1,159,533.00	
Detention (User Entered Quantities)						
Outlet Works		1	EA	$25,000.00	$25,000.00	Includes WQCV, EURV, 100-yr appurtenances
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		12	ACRE	$1,278.00	$14,838.00	Includes Area of Impact for pond and stream management corridors
Special Items (User Defined)						
Stream Management Corridor	**<----User Defined Items**	1483	LF	$346.10	$513,266.00	Reach 500 - 79' Top Width at freeboard. Trail not included.
12' Gravel Maintenance Trail	**<----User Defined Items**	1483	LF	$16.80	$24,914.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$1,184,533.00
Removals				$0.00
Landscaping and Maintenance Improvements				$14,838.00
Special Items (User Defined)				$538,180.00
Subtotal Capital Improvement Costs				**$1,737,551.00**
Additional Capital Improvement Costs				
Dewatering	$86,877.55	L.S.		$86,878.00
Mobilization	5%			$86,878.00
Traffic Control	$34,751.02	L.S.		$34,751.00
Utility Coordination/Relocation	$86,877.55	L.S.		$86,878.00
Stormwater Management/Erosion Control	5%			$86,878.00
Subtotal Additional Capital Improvement Costs				**$382,263.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$317,972.00
Legal/Administrative	5%			$105,991.00
Contract Admin/Construction Management	10%			$211,981.00
Contingency	25%			$529,954.00
Subtotal Other Costs				**$1,165,898.00**
Total Capital Improvement Costs				**$3,285,712.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	1483	L.F.	$3.00	$890.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, struc	8.51	ACRE	$1,917.00	$1,631.00
Mowing (e.g. channels, ponds, etc.)	11.61	ACRE	$64.00	$743.00
Total Annual Operation and Maintenance Cost				**$3,264.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$163,200.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	First Creek Master Drainage Plan			
DRAINAGEWAY :	Monaghan			
REACH :	600			
JURISDICTION :	Aurora			
REACH ID:	Monaghan-Reach600	Clare Steninger & Jennifer Goldman	DATE :	11/21/2019

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		20	AC-FT	$58,268.00	$1,188,667.00	Pond 610 - Sky Ranch Pond C
Detention (User Entered Quantities)						
Outlet Works		1	EA	$25,000.00	$25,000.00	Includes WQCV, EURV, 100-yr appurtenances
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		4	ACRE	$1,278.00	$5,393.00	Includes Area of Impact for pond and stream management corridors
Special Items (User Defined)						
Stream Management Corridor	**<----User Defined Items**	698	LF	$337.30	$235,435.00	Reach 600 - 77' Top Width at freeboard. Trail not included.
12' Gravel Maintenance Trail	**<----User Defined Items**	698	LF	$16.80	$11,726.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$1,213,667.00
Removals				$0.00
Landscaping and Maintenance Improvements				$5,393.00
Special Items (User Defined)				$247,161.00
Subtotal Capital Improvement Costs				**$1,466,221.00**
Additional Capital Improvement Costs				
Dewatering	$73,311.05	L.S.		$73,311.00
Mobilization	5%			$73,311.00
Traffic Control	$29,324.42	L.S.		$29,324.00
Utility Coordination/Relocation	$73,311.05	L.S.		$73,311.00
Stormwater Management/Erosion Control	5%			$73,311.00
Subtotal Additional Capital Improvement Costs				**$322,568.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$268,318.00
Legal/Administrative	5%			$89,439.00
Contract Admin/Construction Management	10%			$178,879.00
Contingency	25%			$447,197.00
Subtotal Other Costs				**$983,833.00**
Total Capital Improvement Costs				**$2,772,622.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	698	L.F.	$3.00	$419.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, struc	8.57	ACRE	$1,917.00	$1,643.00
Mowing (e.g. channels, ponds, etc.)	9.99	ACRE	$64.00	$639.00
Total Annual Operation and Maintenance Cost				**$2,701.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$135,050.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	First Creek Master Drainage Plan			
DRAINAGEWAY :	Titus			
REACH :	700			
JURISDICTION :	Aurora			
REACH ID:	Titus -Reach700	Clare Steninger & Jennifer Goldman	DATE :	11/21/2019

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		23	AC-FT	$58,268.00	$1,351,818.00	
Detention (User Entered Quantities)						
Outlet Works		1	EA	$25,000.00	$25,000.00	Includes WQCV, EURV, 100-yr appurtenances
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		17	ACRE	$1,278.00	$22,109.00	Includes Area of Impact for pond and stream management corridors
Special Items (User Defined)						
Stream Management Corridor	<----User Defined Items	4390	LF	$341.70	$1,500,063.00	Reach 700 - 78' Top Width at freeboard. Trail not included.
12' Wide Gravel Maintenance Trail	<----User Defined Items	4390	LF	$16.80	$73,752.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$1,376,818.00
Removals				$0.00
Landscaping and Maintenance Improvements				$22,109.00
Special Items (User Defined)				$1,573,815.00
Subtotal Capital Improvement Costs				**$2,972,742.00**
Additional Capital Improvement Costs				
Dewatering		$148,637.10	L.S.	$148,637.00
Mobilization		5%		$148,637.00
Traffic Control		$59,454.84	L.S.	$59,455.00
Utility Coordination/Relocation		$148,637.10	L.S.	$148,637.00
Stormwater Management/Erosion Control		5%		$148,637.00
Subtotal Additional Capital Improvement Costs				**$654,003.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering		15%		$544,012.00
Legal/Administrative		5%		$181,337.00
Contract Admin/Construction Management		10%		$362,675.00
Contingency		25%		$906,686.00
Subtotal Other Costs				**$1,994,710.00**
Total Capital Improvement Costs				**$5,621,455.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	4390	L.F.	$3.00	$2,634.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, struc	8.23	ACRE	$1,917.00	$1,578.00
Mowing (e.g. channels, ponds, etc.)	17.3	ACRE	$64.00	$1,107.00
Total Annual Operation and Maintenance Cost				**$5,319.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$265,950.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	First Creek Master Drainage Plan			
DRAINAGEWAY :	1st Ave			
REACH :	800			
JURISDICTION :	Aurora			
REACH ID:	1st Ave-Reach800	Clare Steninger & Jennifer Goldman	DATE :	11/21/2019

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		36	AC-FT	$58,268.00	$2,080,168.00	Pond 800
Detention Facility 2 (Complete-in-Place)		31	AC-FT	$58,268.00	$1,777,174.00	Pond 812
Detention (User Entered Quantities)						
Outlet Works		2	EA	$25,000.00	$50,000.00	Includes WQCV, EURV, 100-yr appurtenances
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		24	ACRE	$1,278.00	$30,327.00	Includes Area of Impact for ponds and stream management corridors
Special Items (User Defined)						
Stream Management Corridor	<----User Defined Items	2018	LF	$368.00	$742,624.00	Reach 800 - 84' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items	1216	LF	$354.80	$431,437.00	Reach 805 - 81' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items	936	LF	$486.20	$455,083.00	Reach 812 - 111' Top Width at freeboard. Trail not included.
12' Wide Gravel Maintenance Trail	<----User Defined Items	4170	LF	$16.80	$70,056.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$3,907,342.00
Removals				$0.00
Landscaping and Maintenance Improvements				$30,327.00
Special Items (User Defined)				$1,699,200.00
Subtotal Capital Improvement Costs				**$5,636,869.00**
Additional Capital Improvement Costs				
Dewatering		$281,843.45	L.S.	$281,843.00
Mobilization		5%		$281,843.00
Traffic Control		$112,737.38	L.S.	$112,737.00
Utility Coordination/Relocation		$281,843.45	L.S.	$281,843.00
Stormwater Management/Erosion Control		5%		$281,843.00
Subtotal Additional Capital Improvement Costs				**$1,240,109.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering		15%		$1,031,547.00
Legal/Administrative		5%		$343,849.00
Contract Admin/Construction Management		10%		$687,698.00
Contingency		25%		$1,719,245.00
Subtotal Other Costs				**$3,782,339.00**
Total Capital Improvement Costs				**$10,659,317.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	4170	L.F.	$3.00	$2,502.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, struc	14.05	ACRE	$1,917.00	$2,693.00
Mowing (e.g. channels, ponds, etc.)	23.73	ACRE	$64.00	$1,519.00
Total Annual Operation and Maintenance Cost				**$6,714.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$335,700.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	First Creek Master Drainage Plan			
DRAINAGEWAY :	Hayesmount			
REACH :	900			
JURISDICTION :	Aurora			
REACH ID:	Hayesmount-Reach900	Clare Steninger & Jennifer Goldman	DATE :	11/21/2019

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		52	AC-FT	$58,268.00	$3,024,109.00	
Detention (User Entered Quantities)						
Outlet Works		1	EA	$25,000.00	$25,000.00	Includes WQCV, EURV, 100-yr appurtenances
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		35	ACRE	$1,278.00	$44,487.00	Includes Area of Impact for pond and stream management corridors
Special Items (User Defined)						
Stream Management Corridor	<----User Defined Items	2139	LF	$551.90	$1,180,514.00	Reach 900 - 126' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items	933	LF	$495.00	$461,835.00	Reach 905 - 113' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items	3535	LF	$433.70	$1,533,130.00	Reach 915 - 99' Top Width at freeboard. Trail not included.
12' Wide Gravel Maintenance Trail	<----User Defined Items	6607	LF	$16.80	$110,998.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$3,049,109.00
Removals				$0.00
Landscaping and Maintenance Improvements				$44,487.00
Special Items (User Defined)				$3,286,477.00
Subtotal Capital Improvement Costs				**$6,380,073.00**
Additional Capital Improvement Costs				
Dewatering	$319,003.65	L.S.		$319,004.00
Mobilization	5%			$319,004.00
Traffic Control	$127,601.46	L.S.		$127,601.00
Utility Coordination/Relocation	$319,003.65	L.S.		$319,004.00
Stormwater Management/Erosion Control	5%			$319,004.00
Subtotal Additional Capital Improvement Costs				**$1,403,617.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$1,167,554.00
Legal/Administrative	5%			$389,185.00
Contract Admin/Construction Management	10%			$778,369.00
Contingency	25%			$1,945,923.00
Subtotal Other Costs				**$4,281,031.00**
Total Capital Improvement Costs				**$12,064,721.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	6607	L.F.	$3.00	$3,964.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, struc	16.35	ACRE	$1,917.00	$3,134.00
Mowing (e.g. channels, ponds, etc.)	34.81	ACRE	$64.00	$2,228.00
Total Annual Operation and Maintenance Cost				**$9,326.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$466,300.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	First Creek Master Drainage Plan			
DRAINAGEWAY :	Mississippi			
REACH :	1000			
JURISDICTION :	Aurora			
REACH ID:	Mississippi-Reach1000	Clare Steninger & Jennifer Goldman	DATE :	11/21/2019

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		11	AC-FT	$58,268.00	$629,294.00	
Detention (User Entered Quantities)						
Outlet Works		1	EA	$25,000.00	$25,000.00	Includes WQCV, EURV, 100-yr appurtenances
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		9	ACRE	$1,278.00	$10,927.00	Includes Area of Impact for pond and stream management corridors
Special Items (User Defined)						
Stream Management Corridor	<----User Defined Items	1223	LF	$293.50	$358,951.00	Reach 1000 - 67' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items	988	LF	$258.50	$255,398.00	Reach 1005 - 59' Top Width at freeboard. Trail not included.
12' Wide Gravel Maintenance Trail	<----User Defined Items	2211	LF	$16.80	$37,145.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$654,294.00
Removals				$0.00
Landscaping and Maintenance Improvements				$10,927.00
Special Items (User Defined)				$651,494.00
Subtotal Capital Improvement Costs				**$1,316,715.00**
Additional Capital Improvement Costs				
Dewatering	$65,835.75	L.S.		$65,836.00
Mobilization	5%			$65,836.00
Traffic Control	$26,334.30	L.S.		$26,334.00
Utility Coordination/Relocation	$65,835.75	L.S.		$65,836.00
Stormwater Management/Erosion Control	5%			$65,836.00
Subtotal Additional Capital Improvement Costs				**$289,678.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering	15%			$240,959.00
Legal/Administrative	5%			$80,320.00
Contract Admin/Construction Management	10%			$160,639.00
Contingency	25%			$401,598.00
Subtotal Other Costs				**$883,516.00**
Total Capital Improvement Costs				**$2,489,909.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	2211	L.F.	$3.00	$1,327.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, struc	4.72	ACRE	$1,917.00	$905.00
Mowing (e.g. channels, ponds, etc.)	8.55	ACRE	$64.00	$547.00
Total Annual Operation and Maintenance Cost				**$2,779.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$138,950.00**

MASTER PLAN COST ESTIMATE FOR INDIVIDUAL REACH

PROJECT :	First Creek Master Drainage Plan			
DRAINAGEWAY :	Florida			
REACH :	1100			
JURISDICTION :	Aurora			
REACH ID:	Florida -Reach1100	Clare Steninger & Jennifer Goldman	DATE :	11/21/2019

DESCRIPTION		QUANTITY	UNIT	UNIT COST	TOTAL COST	USER COMMENTS
Detention/Water Quality Facilities						
Detention (Complete-in-Place)						
Detention Facility 1 (Complete-in-Place)		11	AC-FT	$58,268.00	$629,294.00	
Detention (User Entered Quantities)						
Outlet Works		1	EA	$25,000.00	$25,000.00	Includes WQCV, EURV, 100-yr appurtenances
Landscaping and Maintenance Improvements						
Reclamation & seeding (native grasses)		11	ACRE	$1,278.00	$13,943.00	Includes Area of Impact for pond and stream management corridors
Special Items (User Defined)						
Stream Management Corridor	<----User Defined Items	2526	LF	$284.70	$719,152.00	Reach 1100 - 65' Top Width at freeboard. Trail not included.
Stream Management Corridor	<----User Defined Items	1067	LF	$245.30	$261,735.00	Reach 1105 - 56' Top Width at freeboard. Trail not included.
12' Wide Gravel Maintenance Trail	<----User Defined Items	3593	LF	$16.80	$60,362.00	

Master Plan Capital Improvement Cost Summary				
Capital Improvement Costs				
Pipe Culverts and Storm Drains				$0.00
Concrete Box Culverts				$0.00
Hydraulic Structures				$0.00
Channel Improvements				$0.00
Detention/Water Quality Facilities				$654,294.00
Removals				$0.00
Landscaping and Maintenance Improvements				$13,943.00
Special Items (User Defined)				$1,041,249.00
Subtotal Capital Improvement Costs				**$1,709,486.00**
Additional Capital Improvement Costs				
Dewatering		$85,474.30	L.S.	$85,474.00
Mobilization		5%		$85,474.00
Traffic Control		$34,189.72	L.S.	$34,190.00
Utility Coordination/Relocation		$85,474.30	L.S.	$85,474.00
Stormwater Management/Erosion Control		5%		$85,474.00
Subtotal Additional Capital Improvement Costs				**$376,086.00**
Land Acquisition Costs				
ROW/Easements				$0.00
Subtotal Land Acquisition Costs				**$0.00**
Other Costs (percentage of Capital Improvement Costs)				
Engineering		15%		$312,836.00
Legal/Administrative		5%		$104,279.00
Contract Admin/Construction Management		10%		$208,557.00
Contingency		25%		$521,393.00
Subtotal Other Costs				**$1,147,065.00**
Total Capital Improvement Costs				**$3,232,637.00**

Master Plan Operation and Maintenance Cost Summary				
Description	**Quantity**	**Unit**	**Unit Cost**	**Total Annual Cost**
Channel Maintenance (e.g. sediment & debris removal, erosion, tree & weed removal, etc.)	3593	L.F.	$3.00	$2,156.00
Detention/WQ Maintenance (e.g. sediment & debris removal, mucking out, tree & weed removal, struc	4.78	ACRE	$1,917.00	$916.00
Mowing (e.g. channels, ponds, etc.)	10.91	ACRE	$64.00	$698.00
Total Annual Operation and Maintenance Cost				**$3,770.00**
Effective Interest Rate				0.00%
Total Operation and Maintenance Costs Over 50 Years				**$188,500.00**