

# Phase I Master Drainage Report

for

## Pioneer Village

Planning Areas 1-4, 17, and 21

*Town of Keenesburg, Weld County, Colorado*



SDD Project Number: 1919-001

Drainage Report Prepared for:  
**Pioneer Community Authority Board**  
450 E. 17<sup>th</sup> Ave., Suite 400  
Denver, CO 80203-1254  
Contact: Joel Farkas  
(720) 362-5995

Prepared by:  
**Strategic Site Designs, LLC**  
88 Inverness Circle East, Suite E101  
Englewood, CO 80112  
Contact: Christopher Perdue  
(720) 206-6931

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For Signatures:

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# Certifications

## Engineer Certification

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"This report and plan for the Phase I drainage design of Pioneer Village was prepared under my direct supervision in accordance with the provisions of the Town of Keenesburg, the Pioneer Community Authority Board and Weld County. I understand that this jurisdiction does not and will not assume liability for drainage facilities designed by others."



Signature: \_\_\_\_\_  
Christopher L Perdue, P.E.  
Registered Professional Engineer State of  
Colorado No. 50745

## Developer/Owner Certification

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"\_\_\_\_\_ hereby certifies that the drainage facilities for Pioneer Village shall be constructed according to the design presented in this report. I understand that the Town of Keenesburg, the Pioneer Community Authority Board and Weld County does not and will not assume liability for the drainage facilities designed and/or certified by my engineer and that each jurisdiction reviews drainage plans pursuant to Colorado Revised Statutes, Title 30, Article 28; but cannot, on behalf of Pioneer Village, guarantee that final drainage design review will absolve \_\_\_\_\_ and/or their successors and/or assigns of future liability for improper design."

\_\_\_\_\_  
Name of Developer/Owner

\_\_\_\_\_  
Authorized Representative

# Section I – General Location and Description

## 1.1 Site Location

Pioneer Village will be a large and complex development located at the northwest corner of County Roads 22 and 49. The project will encompass all of Sections 5, 7, 8, 9 and the southern half of Section 4 within Township 2 North of Range 64 West. Later phases of the Project will also propose development in portions of Section 12 of 2 North, 65 West and Section 32 of 3 North, 64 West. Sections 7, 8 and 9 along with a portion of



Section 4 was annexed into the Town of Keenesburg in the fall of 2019. The remaining Sections outlined above will be annexed into the Town in the coming months.

A copy of the Annexation Zoning Map has been provided in the appendices for reference.

As of now, the Project is primarily bounded by residential and agricultural uses. Residential uses are typically large lots in this area with an estimated impervious coverage less than 10% of the overall property.

The primary road network serving the property is Weld County Road 49 to the west and Weld County Road 51 to the southwest. Weld County Road 49 is a major arterial highway and was expanded in recent years to include two north and south lanes and an auxiliary lane. The highway currently aligns with a rural section meaning there is no curb and gutter along this segment. All runoff drains to a roadside ditch where culverts collect the runoff and convey it west towards Box Elder Creek. County Road 51 is a gravel road from the intersection with County Road 18 north to the southeast corner of Pioneer Village. From there a narrower improved surface drive makes up County Road 22 at the moment. The small segment of 22 currently supports local oil and gas activity within the subject property. As part of this Project, over time County Roads 22, 24 and 51 will be improved to their master planned sections within the limits of the Project. The timeline of such improvements hinge upon the overall success of the Project and the transportation needs associated with such success.

Due to the overall size of Pioneer Village, our team has drafted this report with a specific focus on Sections 7 through 9. Those sections lie within the first 30-years of master planned permitting and construction. In the case of most master plans of this magnitude, this study will need to be continually revisited to ensure compliance as well

as proper long-range planning and revisions as required to address the on-going deviation from the Project's vision as of this draft.

## 1.2 Description of Property

The entire Pioneer Development region spans approximately 3,150 acres zoned for commercial, residential, and industrial development. Currently, this area is comprised of open space and agricultural land with a few well pads and associated gravel access roads. The existing landscape primarily consists of gentle, rolling topography covered in native grasses with surface elevations ranging from approximately 4,800 to 4,950. The only structures currently within the development area are oil and gas infrastructure, some active and some abandoned over the last 10 or so years thereby allowing the current development plan to come to fruition.

In general, Pioneer slopes gradually from south to north with most of Section 7, 8 and half of 9 bearing in a westerly direction. The east half of Section 9 will flow northeast towards the Section corner. Currently, there is a portion of Section 8 encumbered by the 100-year floodplain. The area dissects Section 8 and is listed as Zone "A" meaning no base flood elevation has been determined at this time. Reference Map Number 08123C1975E with an effective date of January 20<sup>th</sup>, 2016.

Our research and site investigation have confirmed that no existing irrigation canals or ditches lie within the property.

The geotechnical report available to us during the design process did not allude to any significant geological hazards within the property. A summary of the on-site soils is provided in the table below based on NRCS information made publicly available. Additional soil information is available in the custom soils report in the appendices.

Map Unit Symbol	Map Unit Name	% of AOI	Hydrologic Soil Group
35	Loup-Boel Loamy Sands, 0 to 3% slopes	4.0	A/D
44	Olney Loamy Sand, 1 to 3% slopes	4.7	B
49	Osgood Sand, 0 to 3% slopes	26.6	A
69	Valent Sand, 0 to 3% slopes	1.0	A
70	Valent Sand, 3 to 9% slopes	60.6	A
72	Vona Loamy Sand, 0 to 3% slopes	2.7	A
84	Playas	0.2	---
85	Water	0.2	---
88	Ellicott-Glenberg Complex, 0 to 3% slopes, occasionally flooded	0.0	A

The predominant soil type for each of the Sections included in the development area is Hydrologic Group Type "A".

The proposed development consists of thirty-eight residential planning areas, including approximately 5,900 units, a school and mixed-use/commercial pad sites. The development will include all necessary infrastructure, including wet and dry utilities, parking facilities, connections to existing roadways, storm drainage, and drainage control facilities. Nine extended detention basins (EDB) are proposed within

the development area to capture runoff while still respecting the natural drainage divides in the area to the extent feasible based on existing constraints.

## **Section II – Drainage Basins and Sub-Basins**

### **2.1 Major Drainage Basins**

Generally speaking, Sections 7, 8 and 9 are broken down into three distinct drainage divides. As outlined in the previous section, there is an “un-named” stream that flows south to north through the center of Section 8. This stream receives the largest volume of runoff from Pioneer Village. All of Section 8, approximately two-thirds of Section 7 and Section 9 will outfall into the stream. At the southern boundary of Pioneer Village, approximately 8.816 square miles of tributary area will flow into Pioneer. An additional 2.206 square miles of area within Pioneer Village is tributary to the stream immediately north of Section 8 along the flow path. A map depicting the basin(s) is included in the appendices along with our CUHP Summary and Hydrograph Routing for the existing and proposed conditions.

The second basin within Pioneer Village lies on the west side of the site adjacent to County Road 49. This basin is created by a grade break within Pioneer approximately 1,000 feet west of 49. Runoff will ultimately flow west as sheet and shallow concentrated low into a series of existing ditches along the highway. Once reaching the highway’s ditch, the southern half will flow north (south half) and south (north half) to an existing culvert conveying runoff west beneath 49 to Box Elder Creek. The northern half of the basin will drain north along 49 north of Pioneer Villages limits to an outfall with Box Elder Creek immediately prior to the creek crossing west beneath 49.

The last major basin lies within the northeast corner of Section 9. This basin is created by a grade break running from the southeast corner to the northwest corner. Rainfall landing in the northeast half of Section 9 will ultimately flow off-site to the northeast.

All three of these existing major basins are primarily open spaces covered in native grasses. There are some graveled access roads and well pads on the subject property which we estimate are approximately two to three percent of the basin’s overall makeup.

In order to successfully develop the subject property and honor the existing outfalls, our team has prepared an overall drainage design that aligns with the existing condition. Through strategic on-site grading and the location of regional drainage infrastructure, the four outfalls described within these three basins will be preserved, and in all cases, improved.

As outlined in the following section, our overall approach to developing Pioneer Village is to design and construct drainage collection and conveyance infrastructure in alignment with existing drainage features. Our street design and associated overlot grading will target existing high and low topographic points within the project where geometric design criteria allow. This will preserve the existing outfalls.

We’ll demonstrate herein that we’ve proposed ponds at all four existing outfall points. Those ponds will work harmoniously to reduce runoff from the proposed development to 90% of historic values.

The ultimate outfall for the Project will be the South Platte River via Box Elder Creek.

## **2.2 Regional Drainage Basins**

At this time our team has described the characteristics of the existing basins and their proposed outfall locations. In this section, we'll begin to elaborate on the specific on-site basins we've created to capture, detain and release runoff from the proposed development in accordance with the accepted principles throughout the region. These regional basins will lie within the existing major basins outlined in the previous section hence little elaboration on the existing condition is required in this section.

Since our team has developed this overall master plan concurrently with the Construction Drawings for Planning Areas 1 through 4, 17 and 21, we'll have specific design information for Ponds A through C. Based on our master planning in the remainder of the development, we're able to accurately predict the basin location, size and elevations in the remaining areas. Those variables were then input into the UD-Detention Spreadsheet which generated the outflow hydrographs which were utilized to size the regional infrastructure conveying flows off-site.

Based on the existing topography throughout the Village and the master planned land uses, roadway locations, etc. we have broken the three existing major basins into nine smaller scale regional basins located within open space areas currently encumbered by easements and such. Each of these regional basins will include an extended detention basin (EDB) sized to provide the Water Quality Capture Volume (WQCV), the excess urban runoff volume (EURV) and the detention for the 100-year event. Each pond's outlet structure will be configured to release 90% of the historic flow rate calculated to reach the facility. A detailed summary of each regional basin is provided in Section IV in the following pages.

One of the major focal points of this design is to amend the existing "un-named" stream limits running through Section 8. A significant effort was placed on grading a new stream (*referred to as the "Pioneer Regional Drainageway" hereafter*) which will accept EDB treated runoff from Planning Areas 5 through 9 and 16 through 21 on the west side and future master planned areas on the east side. A realignment of the stream will also allow for streamlined construction which alleviate current grade issues within the existing floodplain and increased acreage for parks, trails and other public use areas for the residents of the community and adjacent neighborhoods to enjoy. We will elaborate more on this design in Section 4.1.

## **Section III – Existing Stormwater Conveyance**

### **3.1 Existing Infrastructure**

There is very limited existing storm infrastructure at the project location. There is a single drainage ditch running south to north on the east side of WCR 49 that contains two culverts. The first culvert allows the ditch to flow under WCR 22, in the southwest corner of the development area, and a second culver that allows the ditch to flow under WCR 24, in the northwest corner of the development area.

The remainder of the site lacks any existing engineered infrastructure. There is a fam pond located in the center of Section 8 along the Un-named Stream adjacent to the

floodplain. As outlined previously, the 100-year Floodplain (Zone A) also encumbers a portion of Section 8. There are no other existing conveyance or storage facilities on site that could be incorporated into this design, modified, or abandoned.

## **Section IV – Proposed Stormwater Management Design**

### **4.1 Stormwater Conveyance Facilities**

The primary collection and conveyance infrastructure for collecting flows within the proposed planning areas and transporting them to a treatment facility will be a series of open channels and buried pipe infrastructure. Those individual system components will be addressed in future Phase III Drainage Reports for specific infrastructure.

The design concept used for this site was simple: grade the site to the extent possible to honor the natural drainage divides. To honor these existing drainage paths discussed in detail in Section 2 of this report to the greatest extent possible, this design proposes the construction of nine separate EBDs. Stormwater will be conveyed to each of these facilities through 10 conduit systems (Pond C has been separated into two conduit systems to reduce the size of the infrastructure). Each conduit system shall be comprised of Type “R” and Type “C” inlets, as well as a combination of Corrugated High-Density Polyethylene (HDPE) pipe, Pre-cast Box Culverts, or Class III Reinforced Concrete Pipe (RCP). These conduit systems shall be sized to convey runoff generated during the 100-year event, and in accordance with Mile High Flood District’s (MHFD) Technical Criteria Manuals.

The major infrastructure proposed herein is the reconfiguration of the floodplain within Section 8. Our design will honor the natural alignment of the floodplain as it transitions north toward Box Elder Creek. In the existing condition, the floodplain is a wide (2,000 ft+) in locations. Our field investigation suggests that this un-named stream does not receive constant flows. During major storm events it will pass runoff from a large basin south of County Road 22. Our design for County Road 22 has proposed a roadway elevation high enough to support construction of a bridge or culvert. Our current design for the WCR 22 crossing is a Contech Pre-Fabricated Metal Bridge with a span ranging from 120 to 130 feet pending our final design and manufacturers recommendations. In future phases, two additional bridges will be required on the segment between the north and south end of Section 8.

As indicated in Section 2.1 and 2.2, Pioneer Village will accept runoff from approximately 8.816 square miles of off-site drainage south of County Road 22. In order to determine these flow rates, our team has broken the overall basin into four smaller basins. Basins Offsite 1 through Off-site 4 combine upstream of the WCR 22 crossing and net a total flow of 4,506 CFS at 1.58 hours. In our existing and proposed analysis, this flow will remain unchanged based on our current projections of development south of Pioneer Village. Should additional development occur south of WCR 22, applicants should be required to provide stormwater management consistent with our approach herein and therefore no increases in runoff south of 22 are anticipated at this time.

In order to complete our design of the Pioneer Regional Drainage Way, we have prepared a HEC-RAS Model with three scenarios:



1. Existing Condition Model
  - a. This model was created to analyze the off-site flows extent flowing through the reach during the major event. This analysis was completed with the same stationing as our proposed modeling so we can access the existing WSE versus the Proposed WSE.
    - i. Note that we also analyzed the on-site basin tributary to the drainage. Refer to Basin Onsite 1 for details.
2. Proposed Condition with Three Bridges
  - a. Because Pioneer will ultimately propose and construct three bridge structures along this segment, our team has analyzed our proposed channel section with three structures in this reach.
  - b. The flow rates used to size the stream consist of the overall off-site basin as well as the outflow from each EDB located along the drainage. A detailed summary of our hydrograph routing has been provided in the appendices.
3. Proposed Condition with one Bridge
  - a. This condition was analyzed to support our current Plat Submittal. Our initial development plan will propose construction of the WCR 22 bridge only. As shown in the model profiles, the anticipated impacts to the floodplain by installed the two additional bridges is localized at each structure. We experience a net increase of approximately 0.30 feet when the additional structure(s) are complete. Based on the minimal rise, the major event will remain within the limits of the channel.

As shown in the plans and calculations in the appendices, the proposed design will convey the major event through the reach without overtopping the proposed channel section. Our team has also included construction drawings for the stream herein to provide specific detail.

The only issue outlined in the models worth noting is the water surface elevation on the upstream end of the reach. As shown in the HEC RAS model at Station 72+50, there is a rise of approximately 2.46 feet. This rise is largely attributed to the top width of the flood plain immediately south of County Road 22. Based on the lack of existing topography, the top width exceeds 4,000 feet in width. SSD plans to work with the Town/County Engineer to address this issue. Our principle solution at this time is to acquire either a right of way or additional property to complete some regrading on the neighboring property to the south to reshape the floodplain and expand the limits of the study to demonstrate no rise on the upstream end of the reach.

## **4.2 Stormwater Storage Facilities**

There are nine EBD stormwater management facilities proposed for construction as part of this project, identified as Ponds A-I. The location of these ponds are described in detail below:

### **Pond A**

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The contributing drainage area to Pond A is 66.46 acres and primarily consists of a mixture of proposed single-family residential housing and open space/park areas in the NW1/4 and SW1/4 of Section 7. Based on the land cover condition(s), the

impervious land cover condition is 48.87%. For reference, Pond A will treat the bulk of runoff generated within Planning Area's 1 and 2. Pond A will be located in the northwesternmost portion of Section 7, immediately southeast of the intersection of WCRs 49 and 24. This pond shall outfall into the existing ditch paralleling 49. Once entering the ditch, flows will pass through a series of culverts before traveling due north and ultimately outfalling into Box Elder Creek.

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### **Pond B**

The second regional basin identified is Basin Pond B. The delineation of Pond B includes 51.64 acres of proposed single-family residential development as well as a large open space north of Planning Area 3. The impervious land cover condition of regional basin Pond B is 58%. Basin Pond B will collect drainage from the NE1/4 and SE1/4 of the NW1/4 of Section 7. Pond B's proposed location is in the NW1/4 of the NE1/4 of Section 7. Pond B shall outfall into a ditch that runs eastward, south of WCR 22, until ultimately out falling to the tributary running through Section 8.

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### **Pond C**

Basin Pond C contains 144.88 acres that lies within the SE1/4 of Section 7 and the SW1/4 of Section 8. The land cover condition for Basin Pond C is 49% imperviousness and is proposed to consist of single-family residential. Pond C will collect runoff the portion of WCR 22 that lies west of the proposed bridge. The proposed location for Pond C is in the NE1/4 of the SE1/4 of Section 8. Pond C shall outfall directly into the tributary running through Section 8.

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### **Pond D**

The delineation for basin Pond D contains 298.7 acres of proposed single-family residential development as well as parks and open space. The imperviousness of this regional basin is 41.7%. Pond D will collect runoff from the NE1/4 of Section 7, the NW1/4 of Section 8, and a small portion of flow from the NE1/4 of the SW1/4 of Section 7. The proposed location for Pond D is in the NW1/4 of the NW1/4 of Section 8, just south of WCR 24. Pond D will also outfall to the ditch running eastward, south of WCR 24, ultimately out falling to the tributary in Section 8.

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### **Pond E**

Basin Pond E consists of 89.88 acres of proposed single-family residential development as well as commercial. The land cover condition for this regional basin is 70.71%. Pond E shall collect runoff from the NW1/4 and SW1/4 of the SW1/4 of Section 7. This pond is proposed to go in the NW1/4 of the SW1/4 of Section 7. This pond will outfall to the existing drainage ditch running east along WCR 49.

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### **Pond F**

The delineation for Basin Pond F encompasses 180.22 acres of proposed single-family residential, some commercial, as well as a school. The land cover condition for Basin Pond F is 58.29% imperviousness. Pond F shall collect runoff from the SE1/4 of the SW1/4 of Section 7, the north half of the SE1/4 of Section 7, and the north half of the SW1/4 of Section 8. Pond F's proposed location is in the SE1/4 of the NW1/4 of Section 8. This pond will outfall directly in the tributary in Section 8.

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### **Pond G**

Basin Pond G contains 364.2 acres of proposed single-family residential development as well as a portion of the proposed school on the east side of the tributary. This regional basin has a land cover of 45.36% imperviousness. Pond G shall collect runoff from the NE1/4 of Section 8, the NW1/4 of Section 9 (excluding the NE1/4), as well as portions of the SW1/4 and SE1/4 of Section 8 that follow the major arterial road through the proposed development. Pond G is proposed to go in the NW1/4 of the NE1/4 of Section 8. Outfall from this pond will discharge directly into the tributary in Section 8.

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### **Pond H**

Basin Pond H contains 259.3 acres of proposed single-family residential development with a land cover of 55.28% imperviousness. The proposed location for Pond H is in the NW1/4 of the SE1/4 of Section 8. This pond will collect runoff from the SE1/4 of Section 8 as well as the majority of the SW1/4 of Section 9. Pond H shall outfall directly into the tributary in Section 8.

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### **Pond I**

Basin Pond I's delineation includes 304.9 acres of single-family residential development as well as the majority of a school site. The resulting land cover condition for this basin is 50.71%. Pond I shall collect runoff from the NE1/4 of Section 9, the NE1/4 of the NW1/4 of Section 9, as well as parts of the SE1/4 of Section 9 that naturally drain north. The proposed location for Pond I is in the NE1/4 of Section 9. Pond I shall out fall into an existing swale currently conveying flows to the northeast.

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In the appendices of this report, you will find the completed UD-Detention Spreadsheets for each facility. A summary of each is also provided in the table below.

<b>Pond</b>	<b>Contributing Area (ac)</b>	<b>Impervious %</b>	<b>100-Year Volume Required (ac-ft)</b>	<b>100-Year Volume Provided (ac-ft)</b>	<b>100-Year Inflow (Historic) (CFS)</b>	<b>100-Year Outflow (CFS)</b>
A	66.46	47.9	12.046	12.467	81.9	24.2
B	51.6	58.0	5.754	5.863	96.5	31.2
C	144.6	49.0	13.730	14.071	203.4	50.1
D	298.7	41.7	24.106	26.365	295.2	62.9
E	89.88	70.71	12.467	12.570	226.9	42.6
F	89.88	58.29	20.402	21.822	219.3	35.7
G	180.22	45.36	31.943	34.060	316.1	64.4

H	259.3	55.28	27.789	28.918	317.2	63.2
I	304.9	50.71	29.916	30.749	447.4	105.5

Based on the information above, the proposed facilities are adequately sized to capture, detain, and release the required storm events in compliance with local jurisdictional requirements.

The required Initial Surge Volume (ISV) shall be provided in the outlet structure and trickle channel. Given the Water Quality Capture volume, no additional infrastructure is required to keep the ISV over a hardened surface as recommended by UDFCD.

An energy dissipation structure will be installed where each conduit system enters the corresponding pond. The dissipation structures will each have a headwall or “seal” immediately upstream of the trickle channel with a notch sized to release 2% of the peak un-detained 100-year event.

Each energy dissipation structure will have the minimum forebay volume integrated into the structure. Per UDFCD Table EDB-4, the minimum forebay volume shall be 3% of the WQCV for drainage areas with greater than 20 impervious acres.

Each of these ponds shall be equipped with a low flow or “trickle” channel is provided from the inflow point to the outlet structure for each of the three ponds. The trickle channels shall all designed to have adequate capacity to convey 1% of the 100-year un-detained event.

Please note that like the outlet structure piping and emergency overflow, the notch and the trickle channel shall be evaluated based on the CUHP Calculations performed within the UD-Detention Spreadsheet when the final sizing is completed as part of the Phase III report for that respective area. In our opinion, this alternative mitigates mixing methodologies (*i.e. CUHP vs Rationale*) and yields the best results.

Maintenance operations for these ponds are anticipated to be typical and will not require and special equipment or practices.

#### **4.3 Water Quality Enhancement Best Management Practices**

The proposed EBDs were designed in accordance with MHFD requirements with respect to water quality treatment. A Water Quality Control Plate will be provided within the outlet structure for each pond that will slowly release flow as described below:

The facilities have also been designed to ensure that the proposed release rates are equal to or less than 90% of the pre-development peak flow rate as determined by UD-Detention.

The previous section outlined requirements for the implementation of a sediment forebay at each concentrated pond inflow point which will release 2% of the 100-year un-detained event.

A separate operation and maintenance plan will be prepared for the facility per MHFD standards are part of the facility as-built process. As such, detailed operation and

maintenance information will be provided therein. For purposes of this report, the facility's operation and maintenance plan will be consistent with other facilities of this nature. Maintenance information is available from the Mile High Flood Control District should the facility specific operation and maintenance manual be misplaced.

#### **4.4 Floodplain Modification**

As outlined in Section 4.1, a floodplain modification will be required. SSD has prepared the proposed channel design in HEC RAS and is prepared to work with the Town of Keenesburg, Weld County or other local floodplain management body to address permit specific requirements to allow construction of the proposed modifications.

#### **4.5 Additional Permitting Requirements**

Based on background information available and existing site features, no additional permits aside from the local jurisdiction's required applications typical for this type of project.

#### **4.6 General**

At the back of this report, maps and supporting calculations have been provided which support the design concepts and conclusions outlined in this report. A summary of the Appendices is provided on the following page:

<b>Appendix</b>	<b>Title</b>	<b>Included Material</b>
Appendix A	Hydrology	<ul style="list-style-type: none"><li>• CHUP Summary for Existing Major Basins</li><li>• Hydrograph Summary</li></ul>
Appendix B	Hydraulics	<ul style="list-style-type: none"><li>• HEC-RAS Models</li><li>• Pioneer Regional Drainage CD's</li><li>• Inlet Spreadsheets</li></ul>
Appendix C	EDB Pond Details	<ul style="list-style-type: none"><li>• Impervious Percentage Calcs</li><li>• Proposed Pond Worksheets</li></ul>
Appendix D	Reference Material	<ul style="list-style-type: none"><li>• FIRM Map Index – Weld County Un-incorporated</li></ul>
Appendix E	Drainage Maps	<ul style="list-style-type: none"><li>• Drainage Maps</li></ul>
Appendix F	Soils Information	<ul style="list-style-type: none"><li>• Web Soil Survey Report</li></ul>

## **Section V – Conclusions**

### **5.1 Compliance with Standards**

As demonstrated throughout this report and concluded in Paragraph 5.3 below, the Stormwater Management Plan proposed for the subject property is considered

adequate based upon the analysis completed. Our drainage design for this master study was particularly focused on detention requirements, outfall locations and a channel design for the regional drainageway. The drainage design proposed in this document is in compliance with water quality and runoff reduction requirements outlined in the Weld County Standards and Specifications as well as Volume's One through Three of UDFCD's Stormwater Criteria.

## **5.2 Variances**

Based on the current design, no variances to the criteria outlined by Weld County or MHFD are required at this time.

## **5.3 Drainage Concept**

As outlined herein and demonstrated in the appendices to follow, it is our opinion that our proposed master plan for Sections 7, 8 and 9 is adequate. Once our team is able to resolve the floodplain rise south of County Road 22, our design should perform adequately throughout development of the Sections focused on herein.

The stormwater management facilities proposed in this document are also adequately sized to provide water quality treatment for both proposed and anticipated future impervious surfaces tributary to the EDBs. The facilities will reduce runoff volumes below pre-developed levels to mitigate any potential impacts of this development on downstream neighbors and existing drainage infrastructure.

## **Section VI – References**

1. Weld County Standards and Specifications, July 2017
2. Urban Storm Drainage Criteria Manual, Urban Drainage and Flood Control District, Volume 1 revised March 2017, Volume 2 revised September 2017, Volume 3 Revised November 2010
3. Urban Drainage Technical Memo T-5, Extended Detention Basins
4. Urban Drainage Technical Memo T-12, Outlet Structure



## **Appendix A**

Hydrology

## CUHP SUBCATCHMENTS

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

								Maximum Depression Storage (Watershed inches)		Horton's Infiltration Parameters			DCIA
Subcatchment Name	EPA SWMM Target Node	Raingage	Area (mi <sup>2</sup> )	Length to Centroid (mi)	Length (mi)	Slope (ft/ft)	Percent Imperviousness	Pervious	Impervious	Initial Rate (in/hr)	Decay Coefficient (1/seconds)	Final Rate (in/hr)	Level 0, 1, or 2
Offsite 1	J1	NOAA Data	5.846	1.92	2.71	0.0098	2	0.3	0.05	4.5	0.0018	0.6	0
Offsite 2	J2	NOAA Data	1.21	1.37	2.29	0.0132	2	0.3	0.05	4.5	0.0018	0.6	0
Offsite 3	J3	NOAA Data	1.18	0.87	1.2	0.0153	2	0.3	0.05	4.5	0.0018	0.6	0
Offsite 4	J4	NOAA Data	0.58	0.68	1.7	0.0086	2	0.3	0.05	4.5	0.0018	0.6	0
Onsite 1	J5	NOAA Data	2.206	0.64	1.17	0.004	2	0.3	0.05	4.5	0.0018	0.6	0
Ex WCR 49 Culvert	J6	NOAA Data	0.102	0.38	0.68	0.0182	2	0.3	0.05	4.5	0.0018	0.6	0

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.1)

		Unit Hydrograph Parameters and Results									Excess Precip.		Storm Hydrograph			
Catchment Name/ID	User Comment for Catchment	CT	Cp	W50 (min.)	W50 Before Peak	W75 (min.)	W75 Before Peak	Time to Peak (min.)	Peak (cfs)	Volume (c.f)	Excess (inches)	Excess (c.f.)	Time to Peak (min.)	Peak Flow (cfs)	Total Volume (c.f.)	Runoff per Unit Area (cfs/acre)
Offsite 1		0.157	0.612	80.3	28.11	41.8	18.79	65.4	2,184	13,581,427	1.56	21,178,030	100.0	3,160	21,175,841	0.84
Offsite 2		0.157	0.381	94.1	29.06	48.9	20.54	48.4	386	2,811,072	1.56	4,383,410	85.0	569	4,383,406	0.73
Offsite 3		0.157	0.379	53.9	17.19	28.1	12.14	28.6	656	2,741,376	1.56	4,274,731	60.0	867	4,272,817	1.15
Offsite 4		0.157	0.306	80.5	20.42	41.9	14.43	34.0	216	1,347,456	1.56	2,101,139	70.0	308	2,100,787	0.83
Onsite 1		0.157	0.457	52.6	18.41	27.4	12.31	33.3	1,258	5,124,979	1.56	7,991,573	65.0	1,682	7,991,547	1.19
Ex WCR 49 Culvert		0.157	0.168	59.8	9.20	31.1	6.50	15.3	51	236,966	1.56	369,511	55.0	67	369,255	1.02

# Table of Contents

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Hydrology Studio v 3.0.0.18

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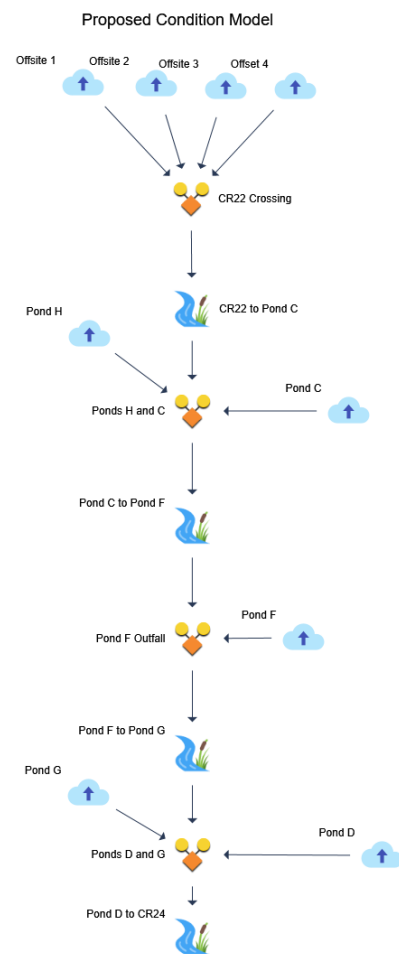
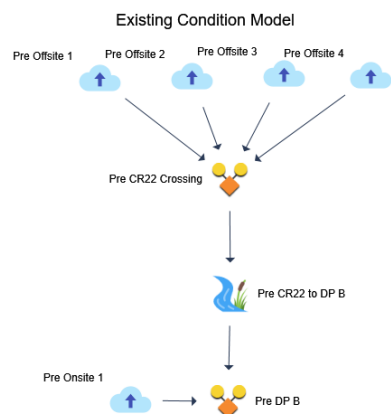
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# Basin Model

Hydrology Studio v 3.0.0.18

Project Name:

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All offsite hydrographs and the Existing Condition On-Site basin were developed using CUHP.  
All pond hydrographs were exported Outflow Hydrographs from the UD-Detention workbook.

# Hydrograph by Return Period

Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Outflow (cfs)							
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
1	Manual	Pond C		0.000			0.000			50.07
2	Manual	Offsite 1		0.000			0.000			3159.5
3	Manual	Offsite 2		0.000			0.000			568.6
4	Manual	Offsite 3		0.000			0.000			867.2
5	Manual	Offset 4		0.000			0.000			308.1
6	Junction	CR22 Crossing		0.000			0.000			4505.8
7	Reach	CR22 to Pond C		0.000			0.000			4265.5
8	Manual	Pond G		0.000			0.000			64.40
9	Manual	Pond D		0.000			0.000			62.86
10	Manual	Pond F		0.000			0.000			35.73
11	Manual	Pond H		0.000			0.000			63.18
12	Junction	Ponds H and C		0.000			0.000			4375.5
13	Reach	Pond C to Pond F		0.000			0.000			4307.3
14	Junction	Pond F Outfall		0.000			0.000			4341.3
15	Reach	Pond F to Pond G		0.000			0.000			2782.5
16	Junction	Ponds D and G		0.000			0.000			2909.3
17	Reach	Pond D to CR24		0.000			0.000			2910.7
18	Manual	Pre Offsite 1		0.000			0.000			3159.5
19	Manual	Pre Offsite 2		0.000			0.000			568.6
20	Manual	Pre Offsite 3		0.000			0.000			867.2
21	Manual	Pre Offsite 4		0.000			0.000			308.1
22	Junction	Pre CR22 Crossing		0.000			0.000			4505.8
23	Reach	Pre CR22 to DP B		0.000			0.000			3561.4
24	Manual	Pre Onsite 1		0.000			0.000			1682.2
25	Junction	Pre DP B		0.000			0.000			4301.0



# Hydrograph 100-yr Summary

Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

Hyd. No.	Hydrograph Type	Hydrograph Name	Peak Flow (cfs)	Time to Peak (hrs)	Hydrograph Volume (cuft)	Inflow Hyd(s)	Maximum Elevation (ft)	Maximum Storage (cuft)
1	Manual	Pond C	50.07	2.08	588,072	---		
2	Manual	Offsite 1	3159.5	1.67	21,175,850	---		
3	Manual	Offsite 2	568.6	1.42	4,383,399	---		
4	Manual	Offsite 3	867.2	1.00	4,272,813	---		
5	Manual	Offset 4	308.1	1.17	2,100,780	---		
6	Junction	CR22 Crossing	4505.8	1.58	31,932,840	2, 3, 4, 5		
7	Reach	CR22 to Pond C	4265.5	1.83	31,932,830	6		
8	Manual	Pond G	64.40	3.25	1,723,089	---		
9	Manual	Pond D	62.86	2.75	1,370,526	---		
10	Manual	Pond F	35.73	3.00	987,558	---		
11	Manual	Pond H	63.18	2.75	1,394,457	---		
12	Junction	Ponds H and C	4375.5	1.83	33,915,380	1, 7, 11		
13	Reach	Pond C to Pond F	4307.3	2.00	33,915,370	12		
14	Junction	Pond F Outfall	4341.3	2.00	34,902,860	10, 13		
15	Reach	Pond F to Pond G	2782.5	2.83	34,902,930	14		
16	Junction	Ponds D and G	2909.3	2.83	37,996,580	8, 9, 15		
17	Reach	Pond D to CR24	2910.7	2.92	37,996,590	16		
18	Manual	Pre Offsite 1	3159.5	1.67	21,175,850	---		
19	Manual	Pre Offsite 2	568.6	1.42	4,383,399	---		
20	Manual	Pre Offsite 3	867.2	1.00	4,272,813	---		
21	Manual	Pre Offsite 4	308.1	1.17	2,100,780	---		
22	Junction	Pre CR22 Crossing	4505.8	1.58	31,932,840	18, 19, 20, 21		
23	Reach	Pre CR22 to DP B	3561.4	2.08	31,932,820	22		
24	Manual	Pre Onsite 1	1682.2	1.08	17,940,040	---		
25	Junction	Pre DP B	4301.0	1.92	49,872,890	23, 24		

# Hydrograph Report

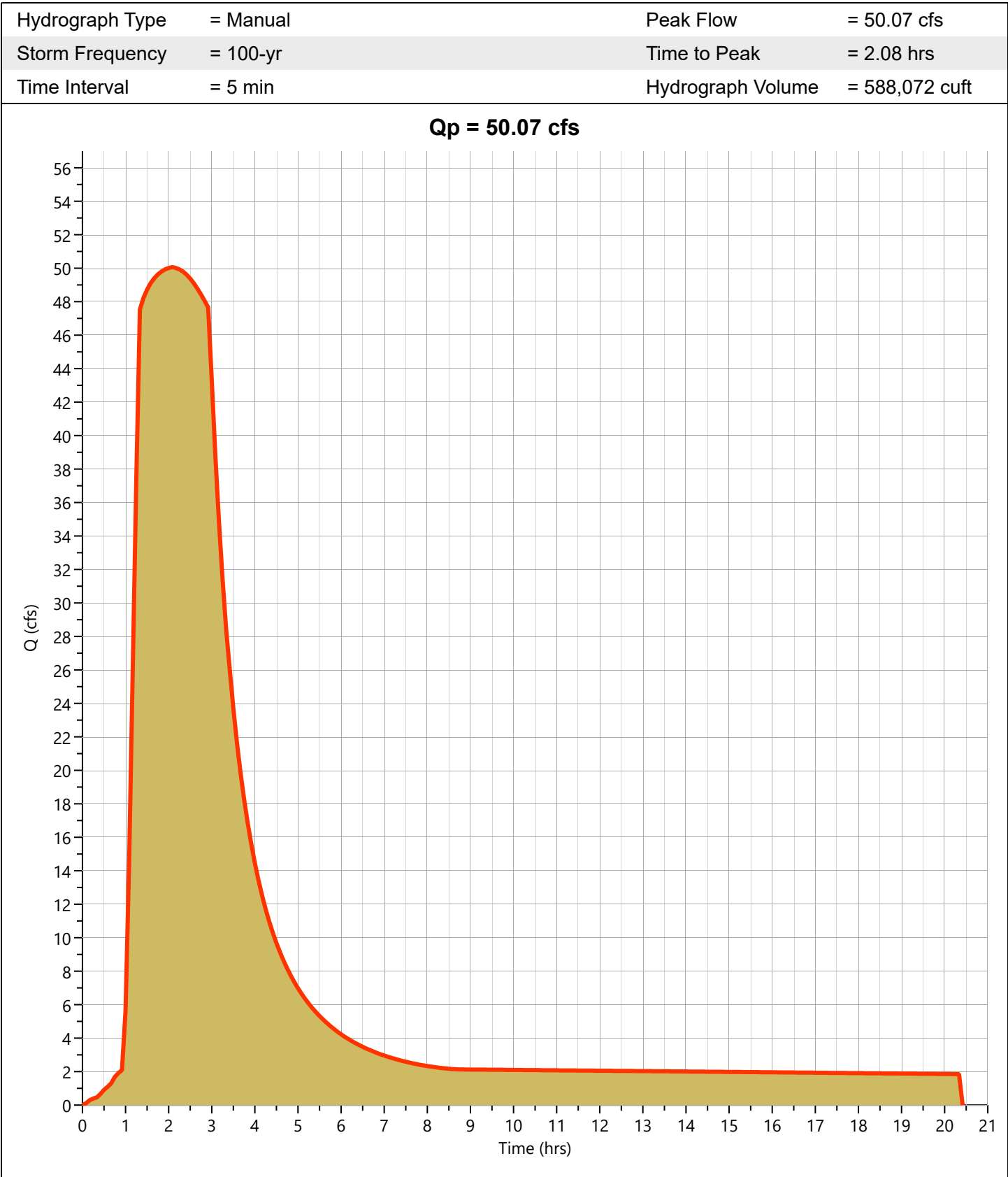
Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

## Pond C

## Hyd. No. 1



# Hydrograph Report

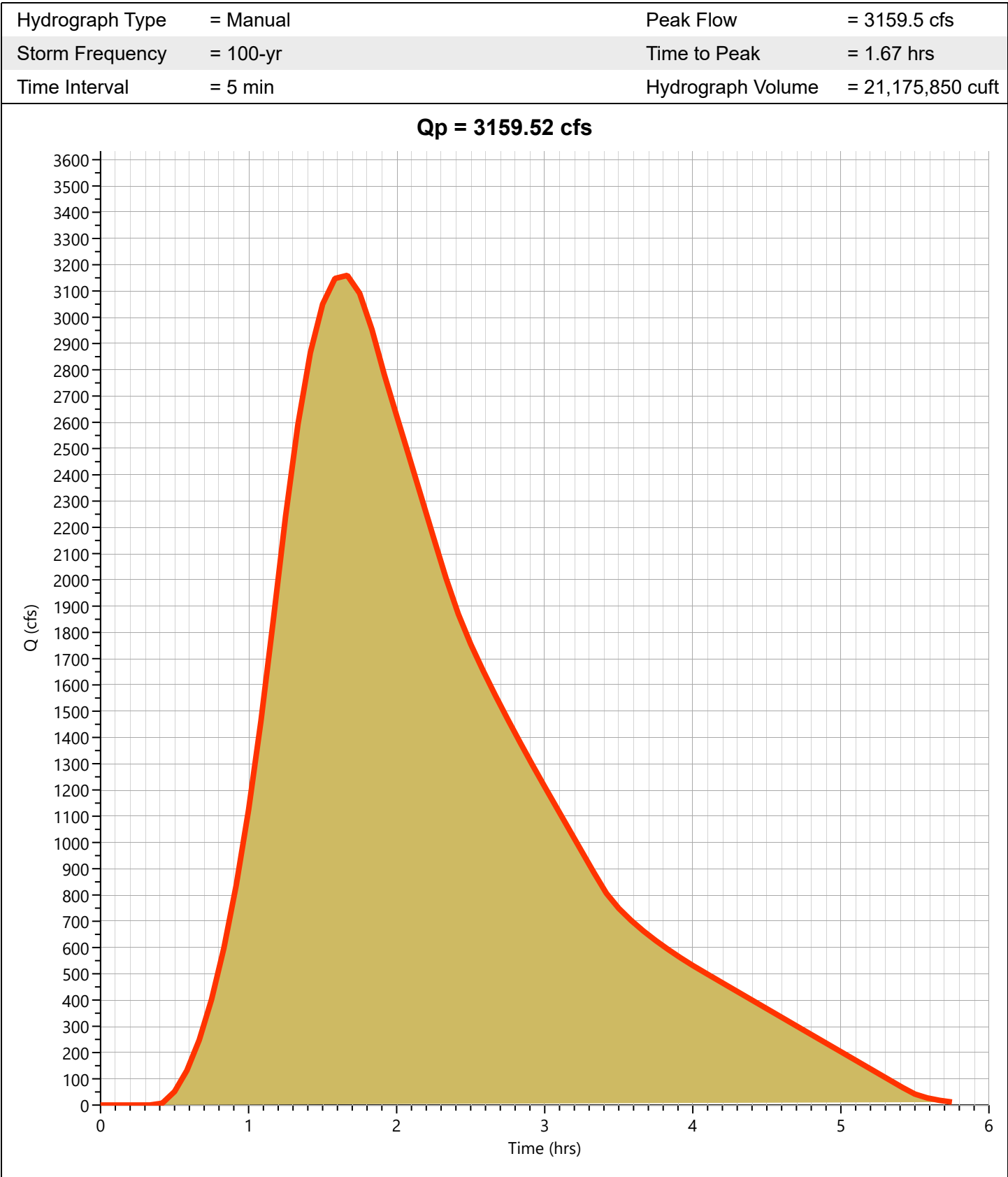
Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

## Offsite 1

## Hyd. No. 2



# Hydrograph Report

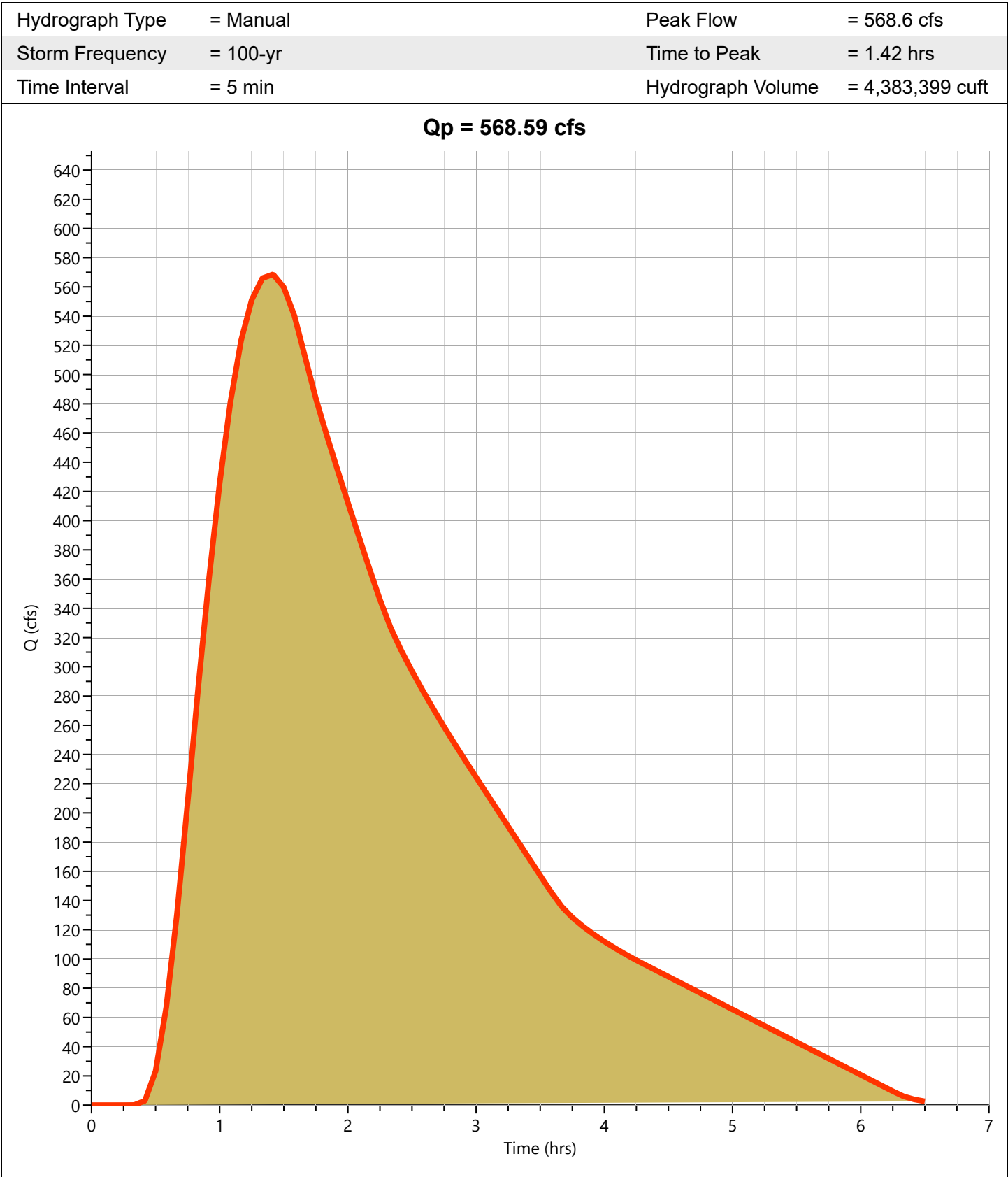
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Hydrology Studio v 3.0.0.18

04-09-2021

## Offsite 2

## Hyd. No. 3



# Hydrograph Report

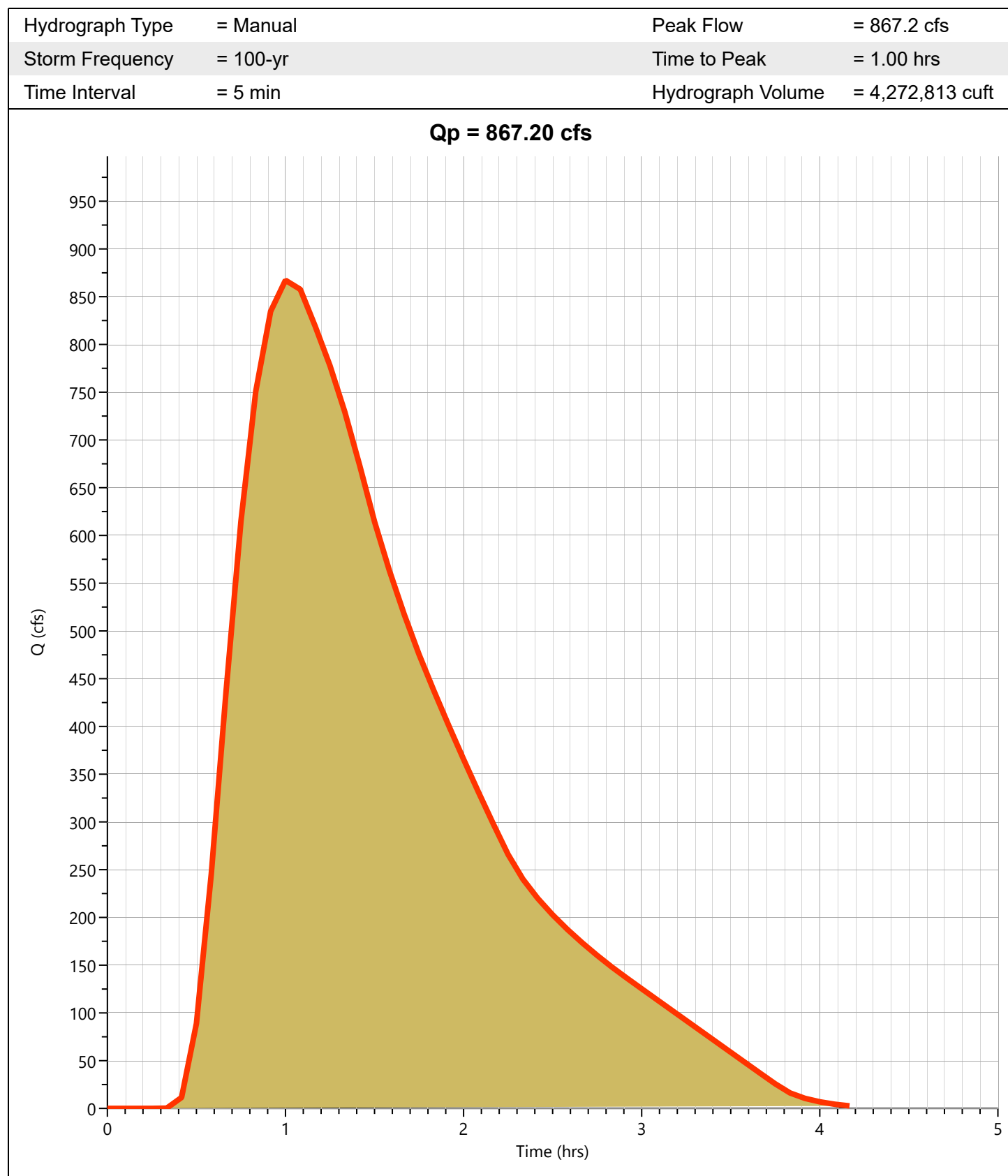
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Hydrology Studio v 3.0.0.18

04-09-2021

## Offsite 3

## Hyd. No. 4



# Hydrograph Report

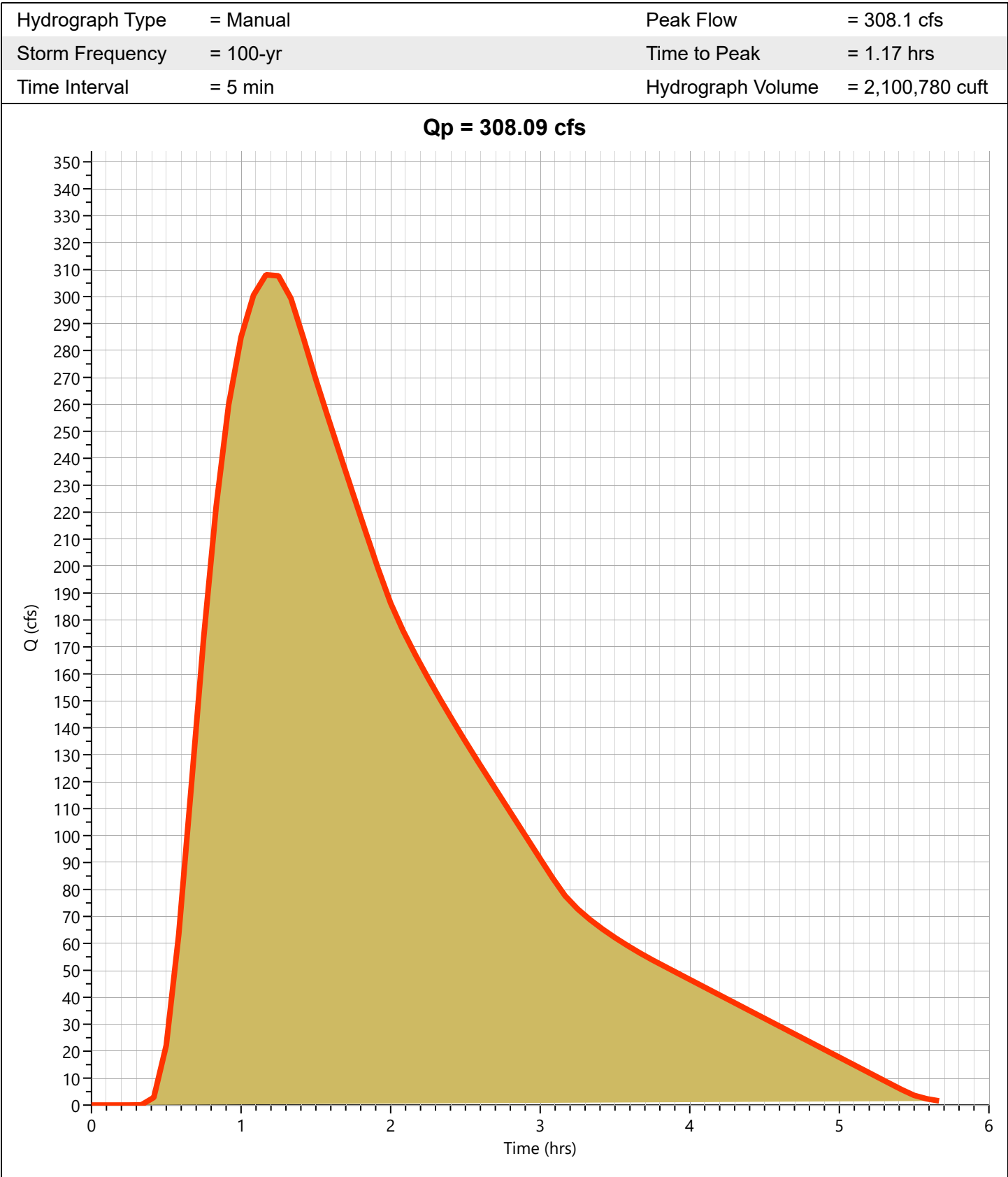
Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

Offset 4

Hyd. No. 5



# Hydrograph Report

Project Name:

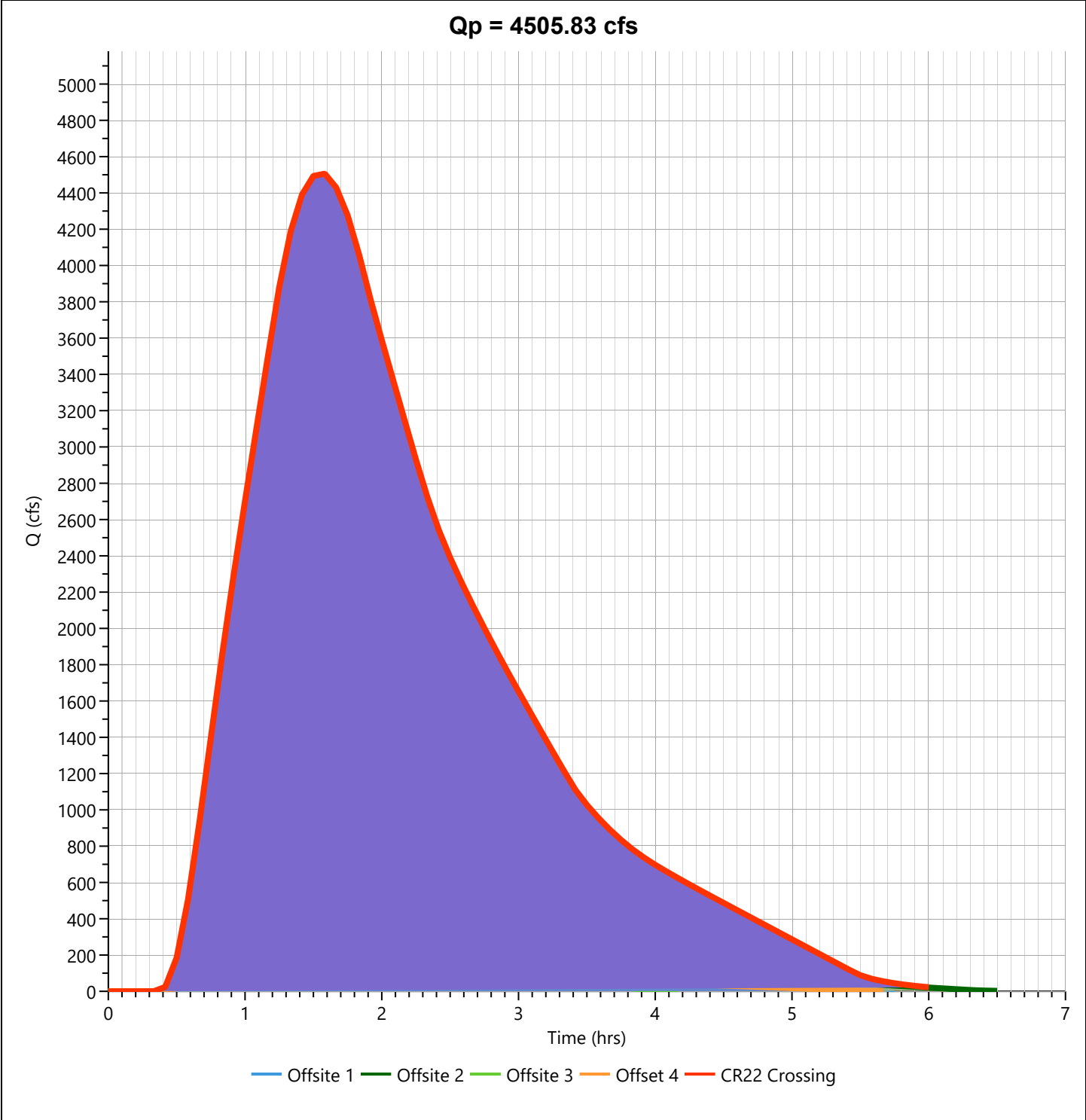
Hydrology Studio v 3.0.0.18

04-09-2021

## CR22 Crossing

Hyd. No. 6

Hydrograph Type	= Junction	Peak Flow	= 4505.8 cfs
Storm Frequency	= 100-yr	Time to Peak	= 1.58 hrs
Time Interval	= 5 min	Hydrograph Volume	= 31,932,840 cuft
Inflow Hydrographs	= 2, 3, 4, 5	Total Contrib. Area	= 0.0 ac



# Hydrograph Report

Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

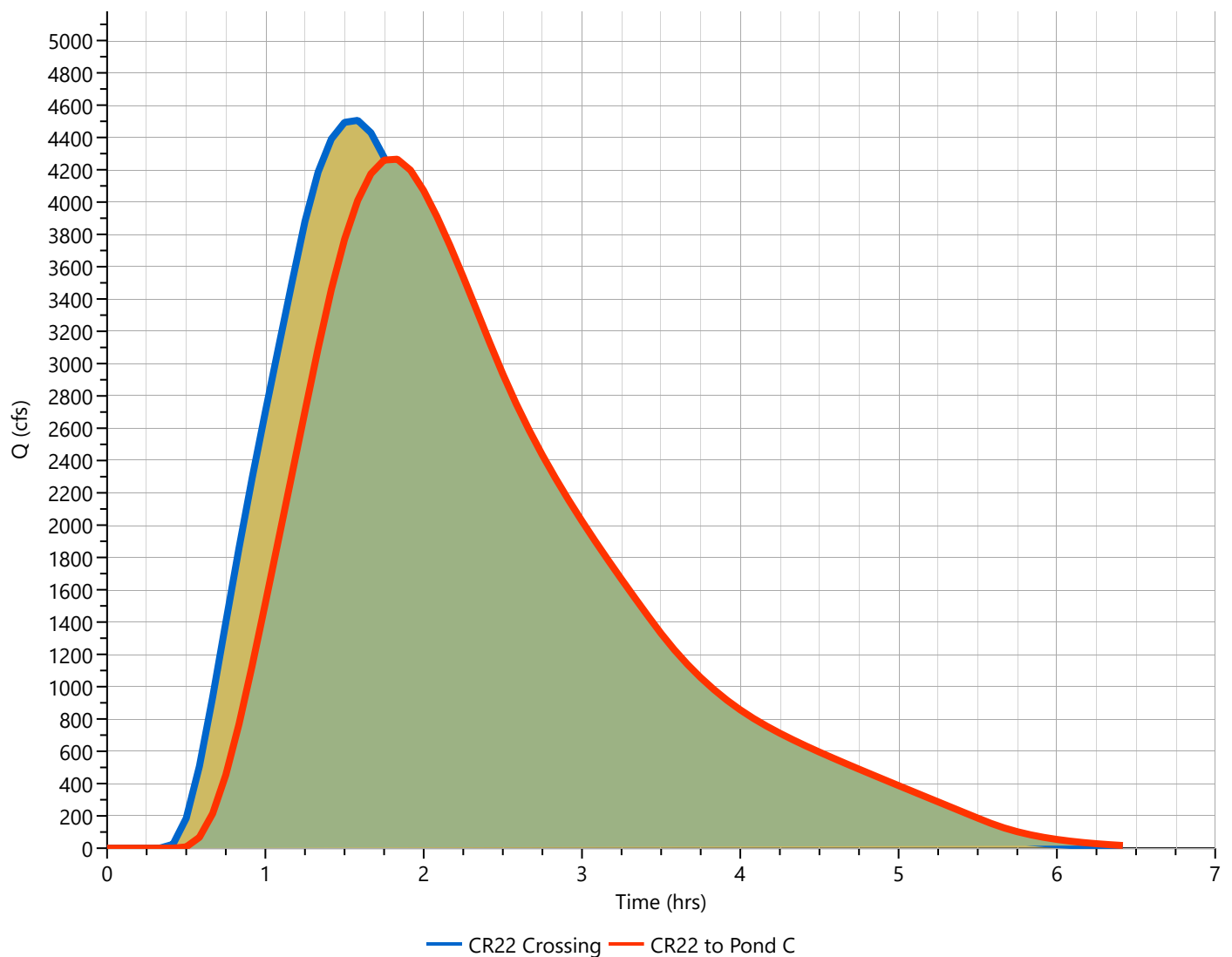
## CR22 to Pond C

Hyd. No. 7

Hydrograph Type	= Reach	Peak Flow	= 4265.5 cfs
Storm Frequency	= 100-yr	Time to Peak	= 1.83 hrs
Time Interval	= 5 min	Hydrograph Volume	= 31,932,830 cuft
Inflow Hydrograph	= 6 - CR22 Crossing	Section Type	= Trapezoidal
Reach Length	= 2300 ft	Channel Slope	= 0.30 %
Manning's n	= 0.000	Bottom Width	= 142.00 ft
Side Slope (h:v)	= 13.00:1	Maximum Depth	= 4.00 ft
Rating Curve X	= 0.100	Average Velocity	= 2.18 ft/s
Rating Curve m	= 1.404	Routing Coeff.	= 0.333

Modified Att-Kin routing method

**Qp = 4265.46 cfs**





# Hydrograph Report

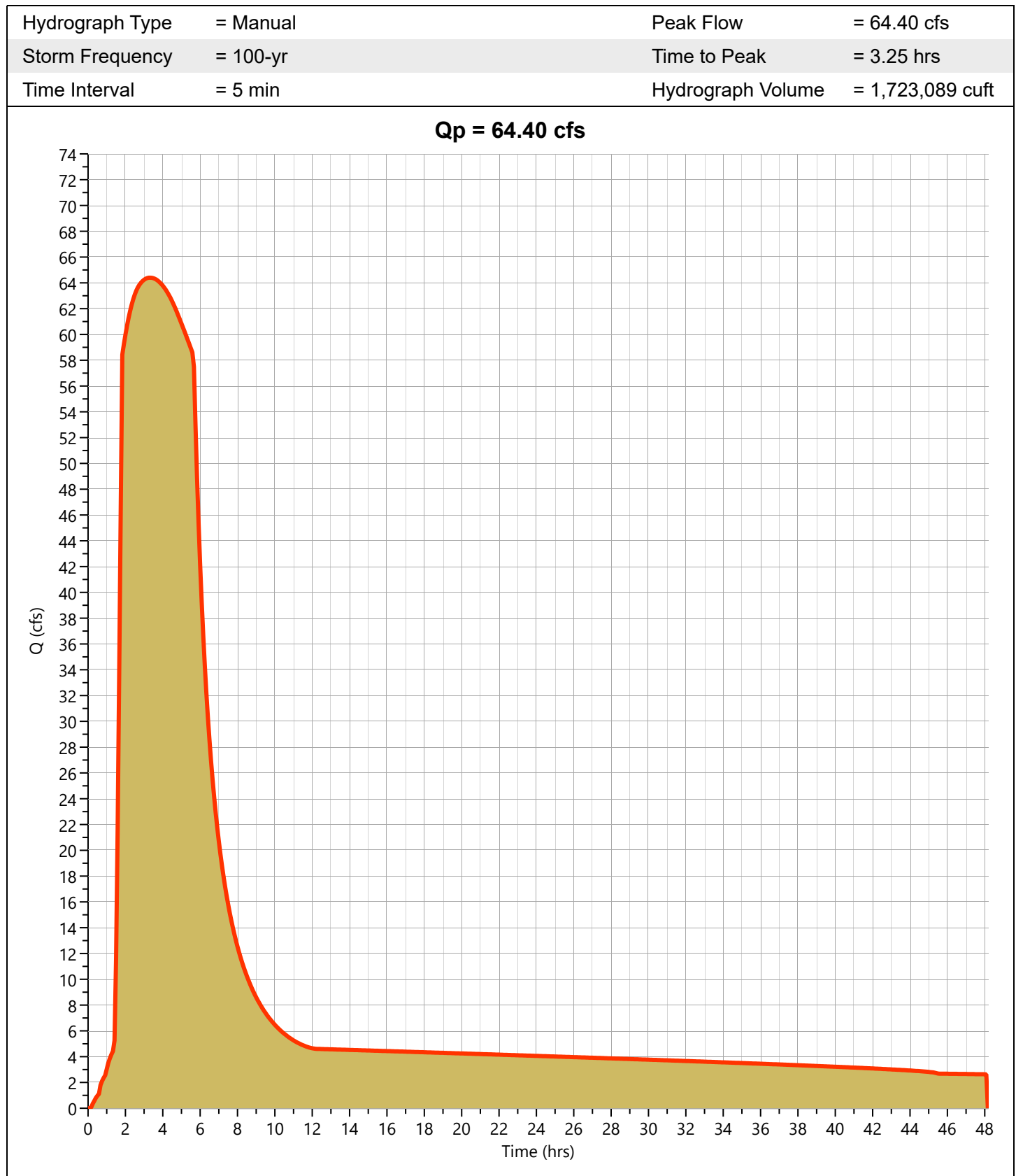
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Hydrology Studio v 3.0.0.18

04-09-2021

## Pond G

Hyd. No. 8



# Hydrograph Report

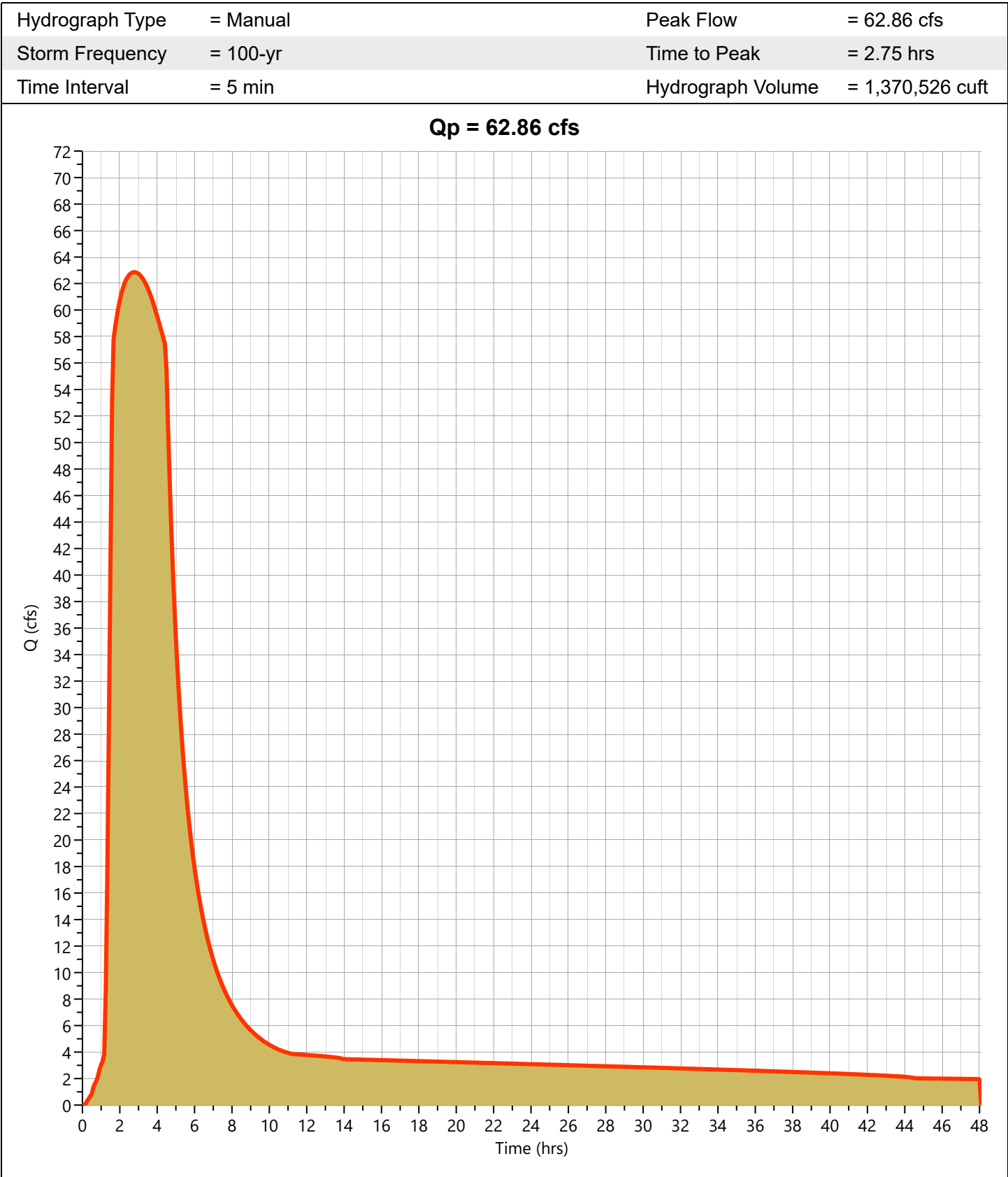
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Hydrology Studio v 3.0.0.18

04-09-2021

## Pond D

## Hyd. No. 9



# Hydrograph Report

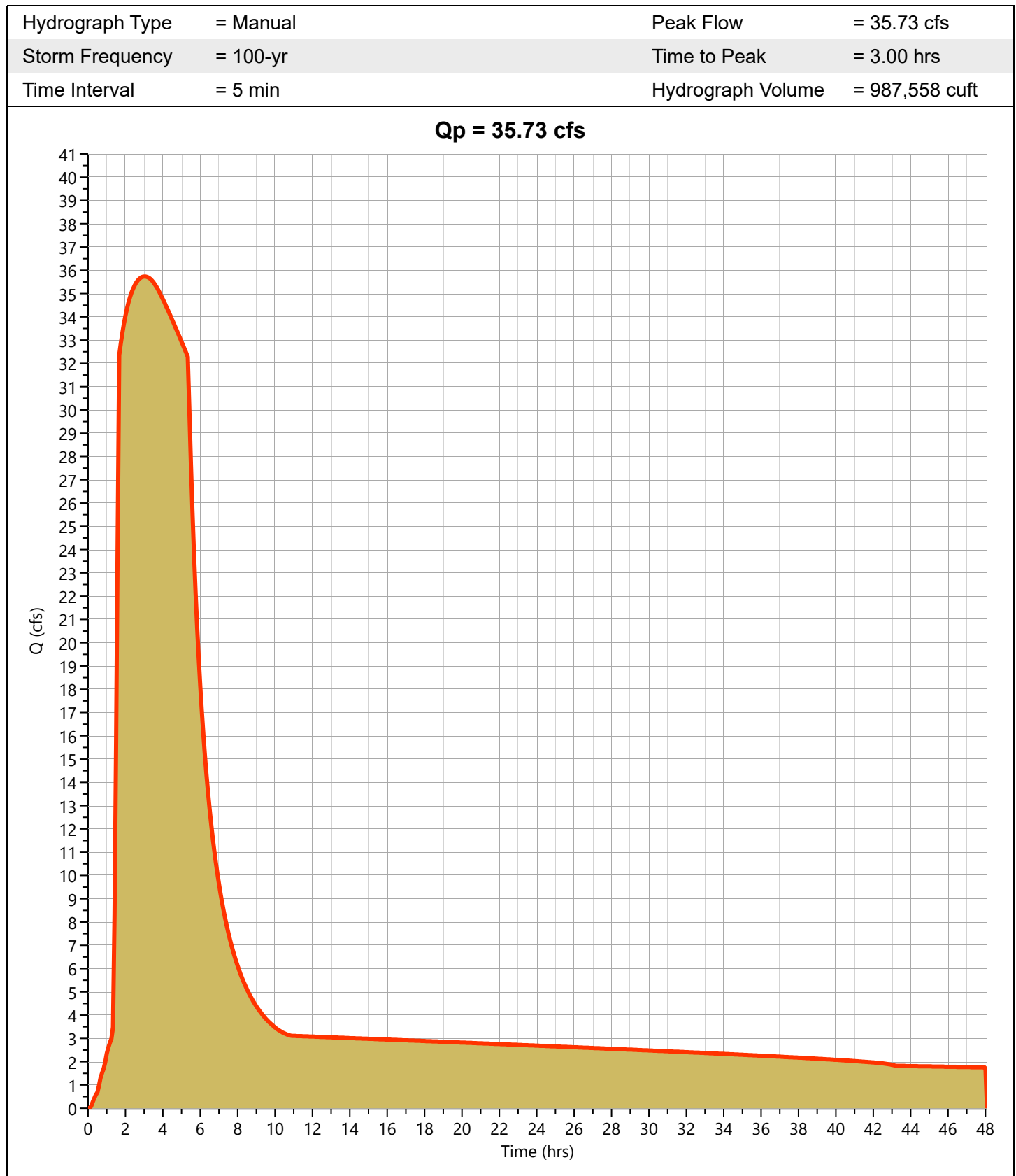
Project Name:

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04-09-2021

## Pond F

Hyd. No. 10



# Hydrograph Report

Project Name:

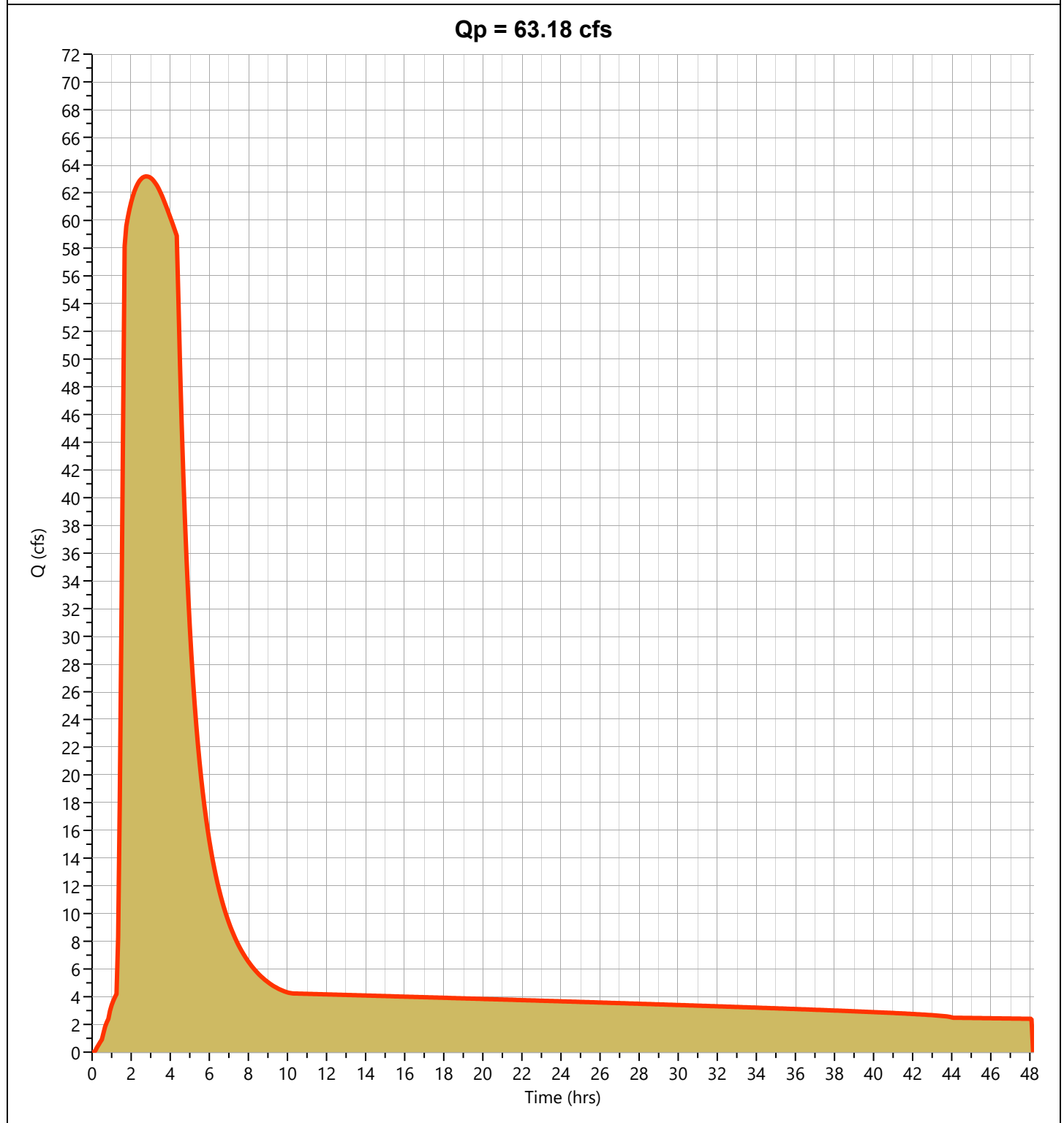
Hydrology Studio v 3.0.0.18

04-09-2021

## Pond H

Hyd. No. 11

Hydrograph Type	= Manual	Peak Flow	= 63.18 cfs
Storm Frequency	= 100-yr	Time to Peak	= 2.75 hrs
Time Interval	= 5 min	Hydrograph Volume	= 1,394,457 cuft



# Hydrograph Report

Project Name:

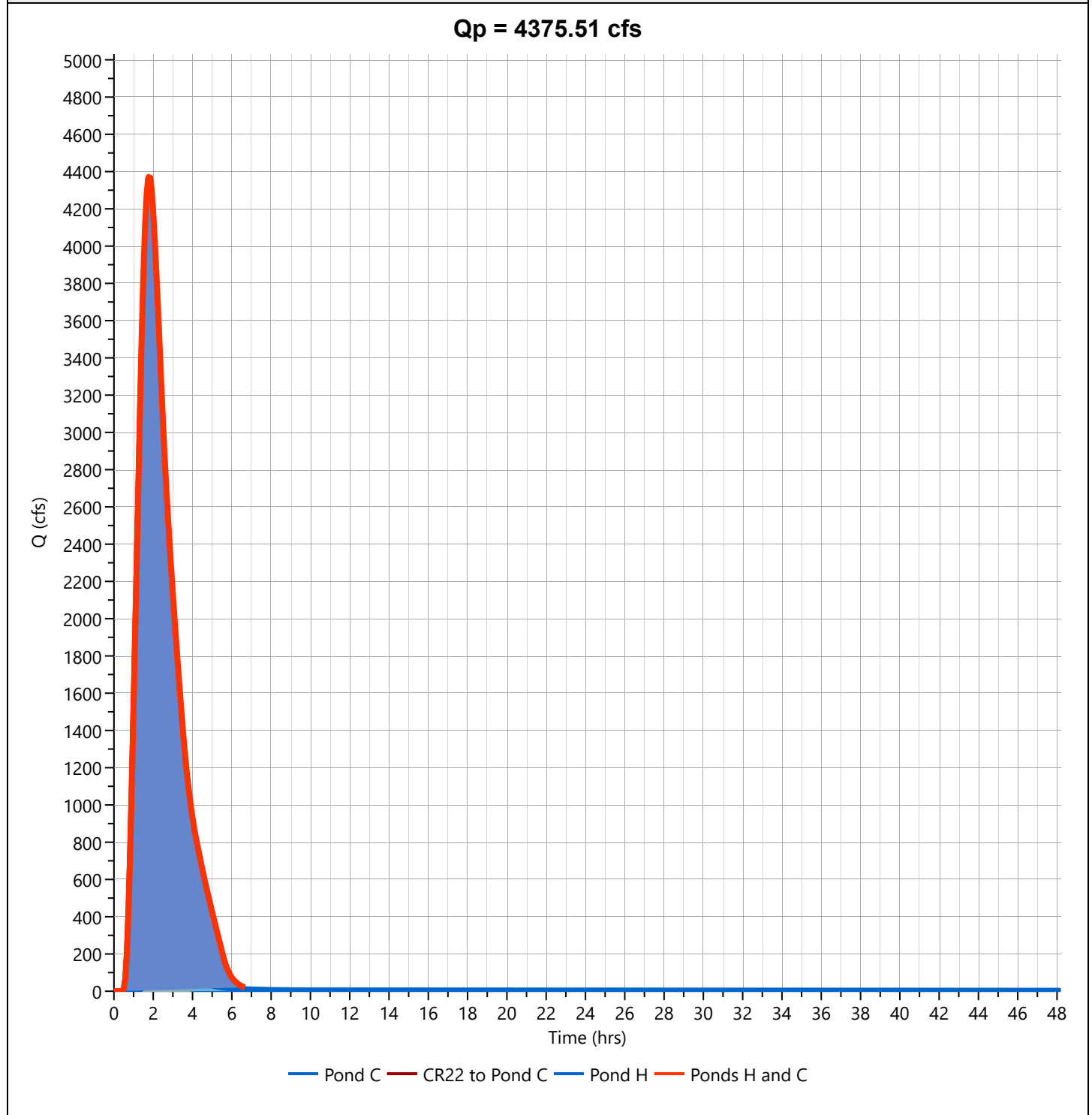
Hydrology Studio v 3.0.0.18

04-09-2021

## Ponds H and C

Hyd. No. 12

Hydrograph Type	= Junction	Peak Flow	= 4375.5 cfs
Storm Frequency	= 100-yr	Time to Peak	= 1.83 hrs
Time Interval	= 5 min	Hydrograph Volume	= 33,915,380 cuft
Inflow Hydrographs	= 1, 7, 11	Total Contrib. Area	= 4.0 ac



# Hydrograph Report

Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

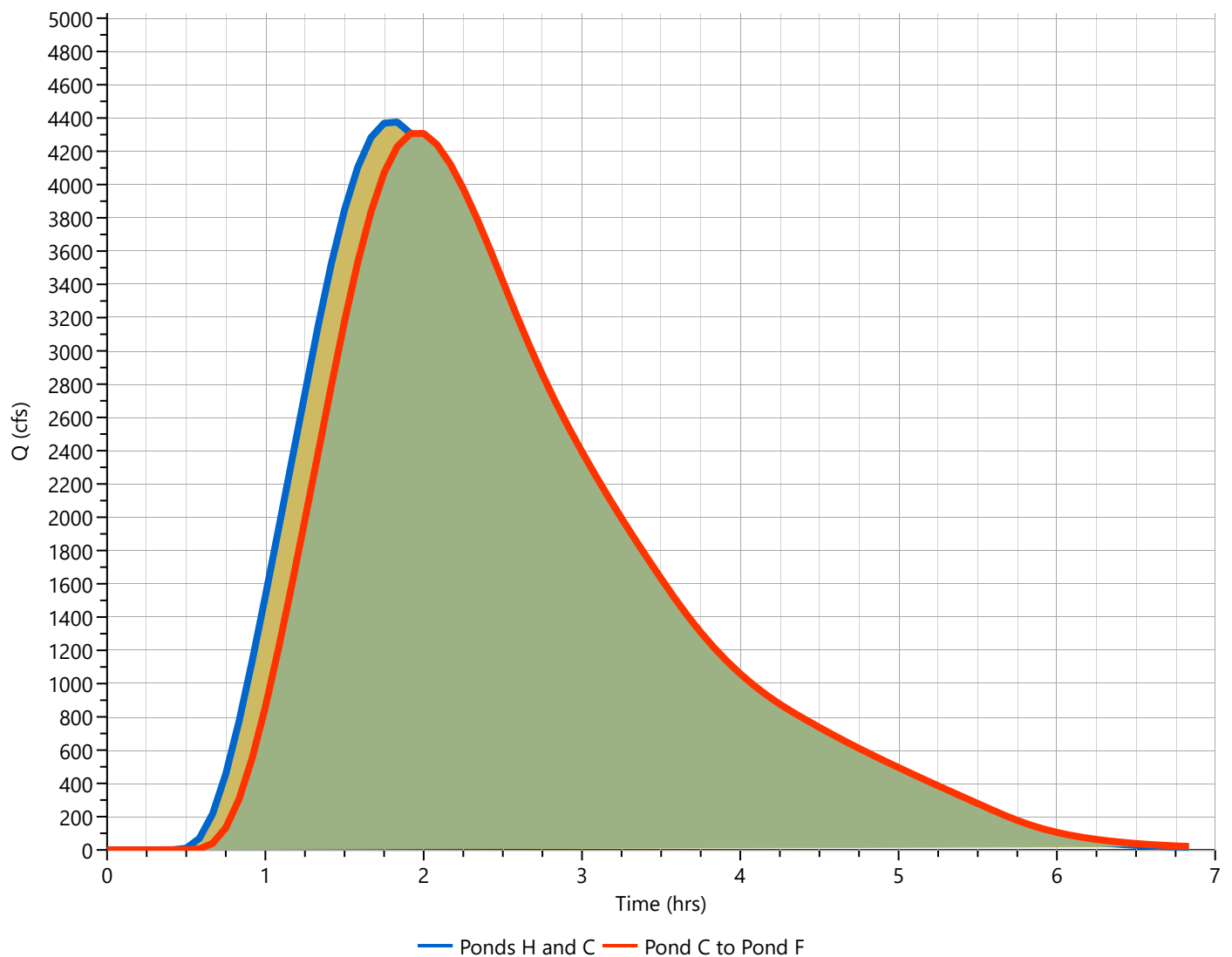
## Pond C to Pond F

Hyd. No. 13

Hydrograph Type	= Reach	Peak Flow	= 4307.3 cfs
Storm Frequency	= 100-yr	Time to Peak	= 2.00 hrs
Time Interval	= 5 min	Hydrograph Volume	= 33,915,370 cuft
Inflow Hydrograph	= 12 - Ponds H and C	Section Type	= Trapezoidal
Reach Length	= 1270 ft	Channel Slope	= 0.30 %
Manning's n	= 0.000	Bottom Width	= 142.00 ft
Side Slope (h:v)	= 13.00:1	Maximum Depth	= 4.00 ft
Rating Curve X	= 0.100	Average Velocity	= 2.16 ft/s
Rating Curve m	= 1.404	Routing Coeff.	= 0.528

Modified Att-Kin routing method

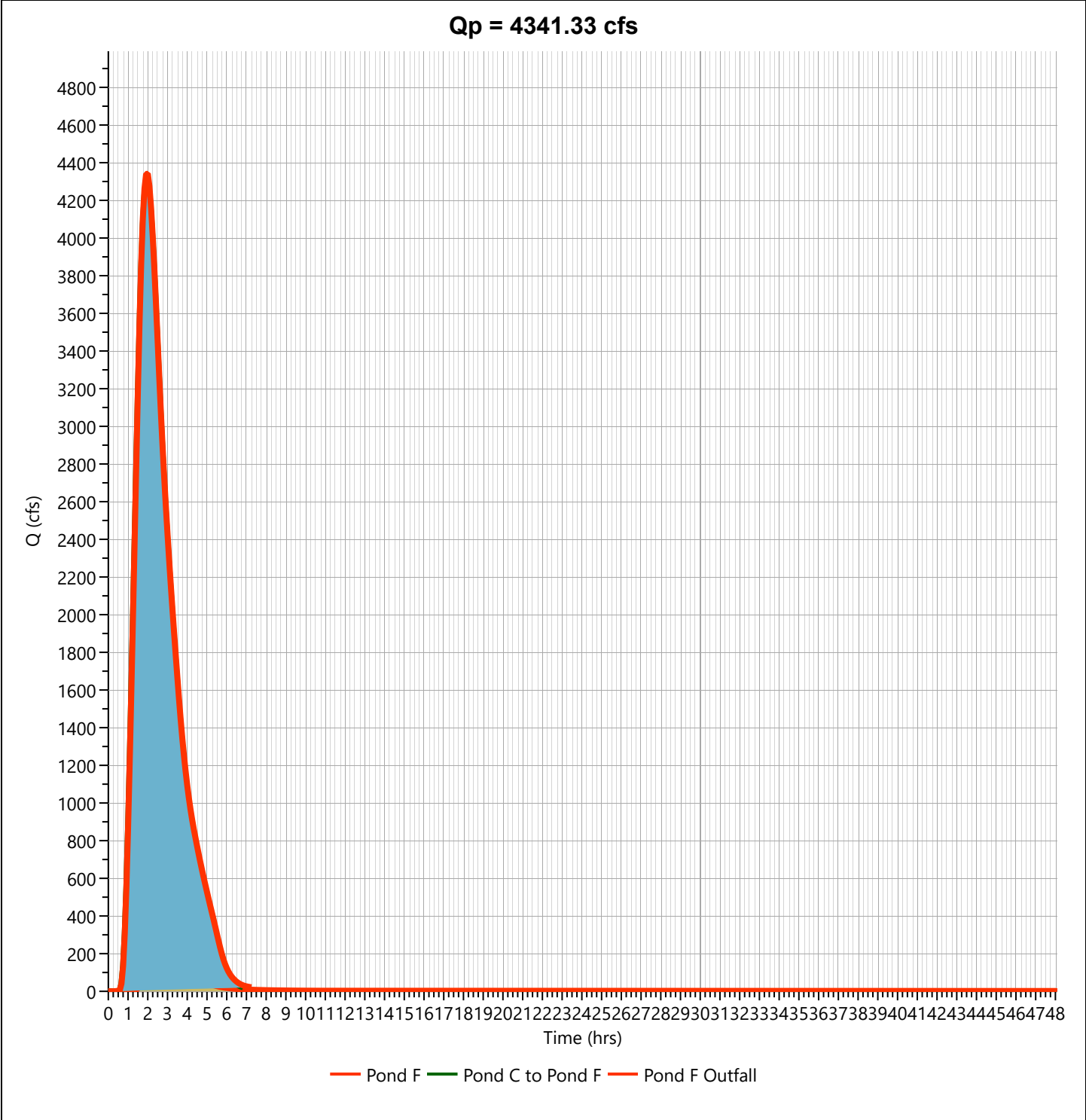
**Qp = 4307.28 cfs**



Pond F Outfall

Hyd. No. 14

Hydrograph Type	= Junction	Peak Flow	= 4341.3 cfs
Storm Frequency	= 100-yr	Time to Peak	= 2.00 hrs
Time Interval	= 5 min	Hydrograph Volume	= 34,902,860 cuft
Inflow Hydrographs	= 10, 13	Total Contrib. Area	= 4.0 ac



# Hydrograph Report

Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

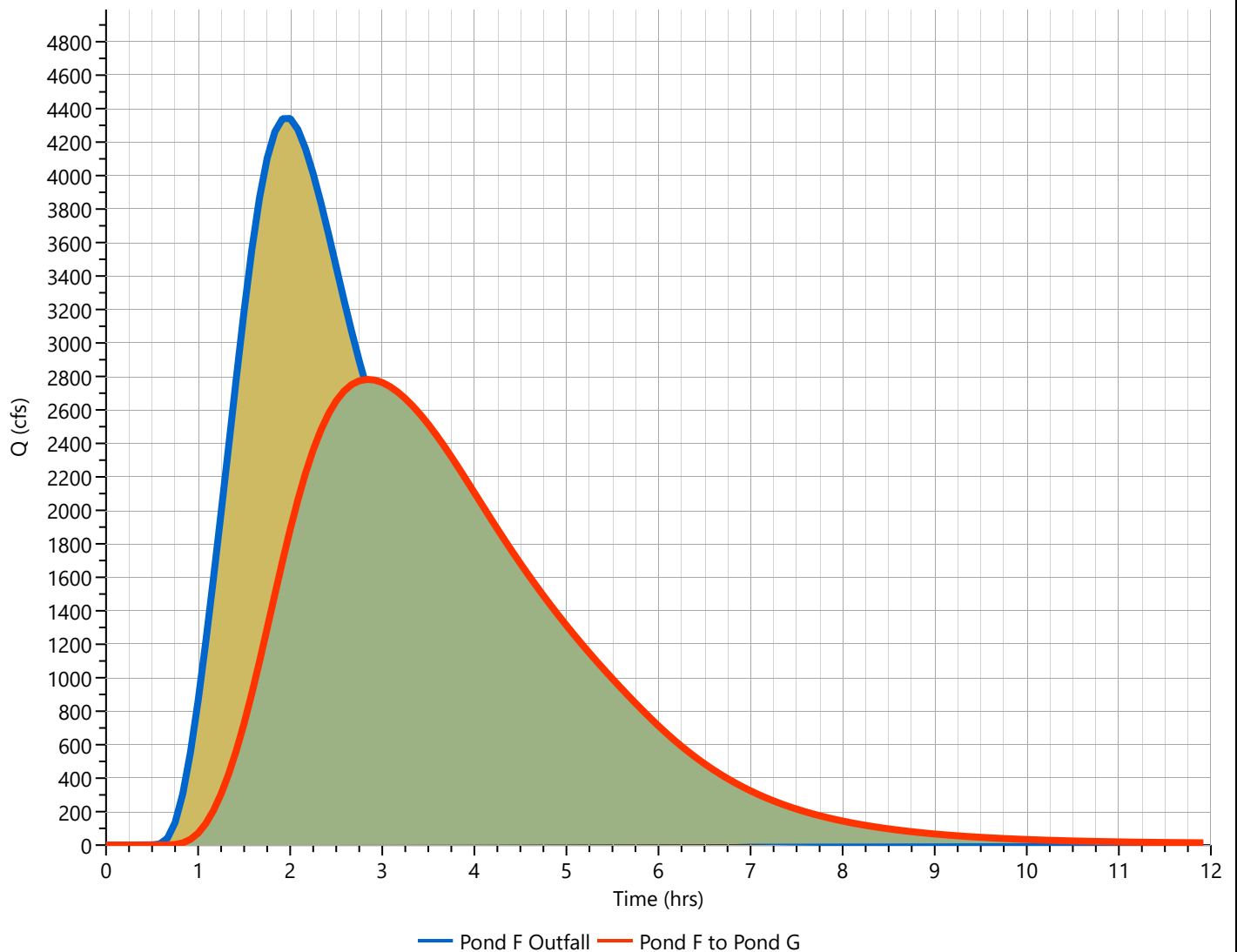
## Pond F to Pond G

Hyd. No. 15

Hydrograph Type	= Reach	Peak Flow	= 2782.5 cfs
Storm Frequency	= 100-yr	Time to Peak	= 2.83 hrs
Time Interval	= 5 min	Hydrograph Volume	= 34,902,930 cuft
Inflow Hydrograph	= 14 - Pond F Outfall	Section Type	= Trapezoidal
Reach Length	= 11216 ft	Channel Slope	= 0.30 %
Manning's n	= 0.000	Bottom Width	= 142.00 ft
Side Slope (h:v)	= 13.00:1	Maximum Depth	= 3.00 ft
Rating Curve X	= 0.100	Average Velocity	= 2.00 ft/s
Rating Curve m	= 1.391	Routing Coeff.	= 0.0719

Modified Att-Kin routing method

**Qp = 2782.46 cfs**





# Hydrograph Report

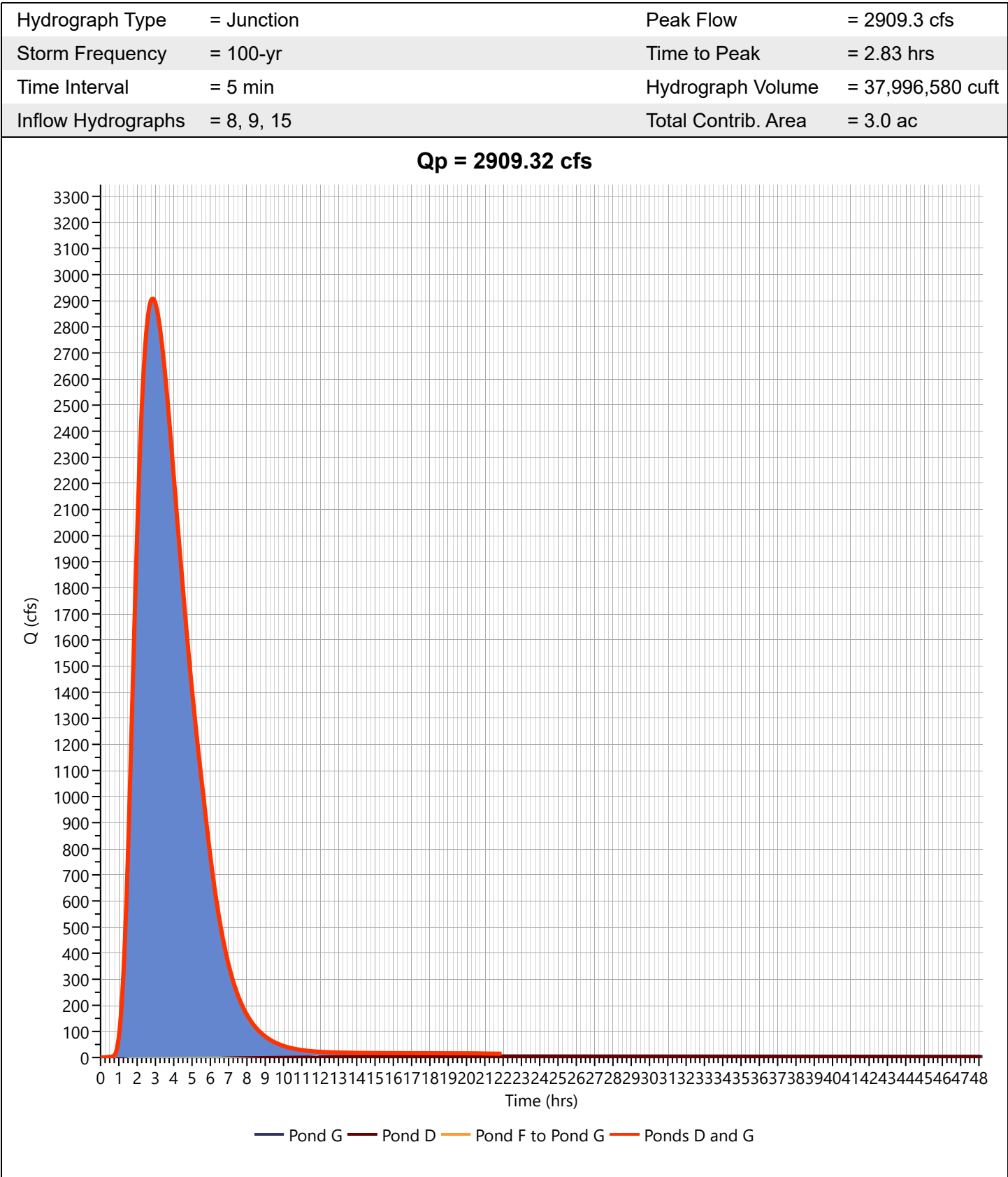
Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

## Ponds D and G

Hyd. No. 16



# Hydrograph Report

Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

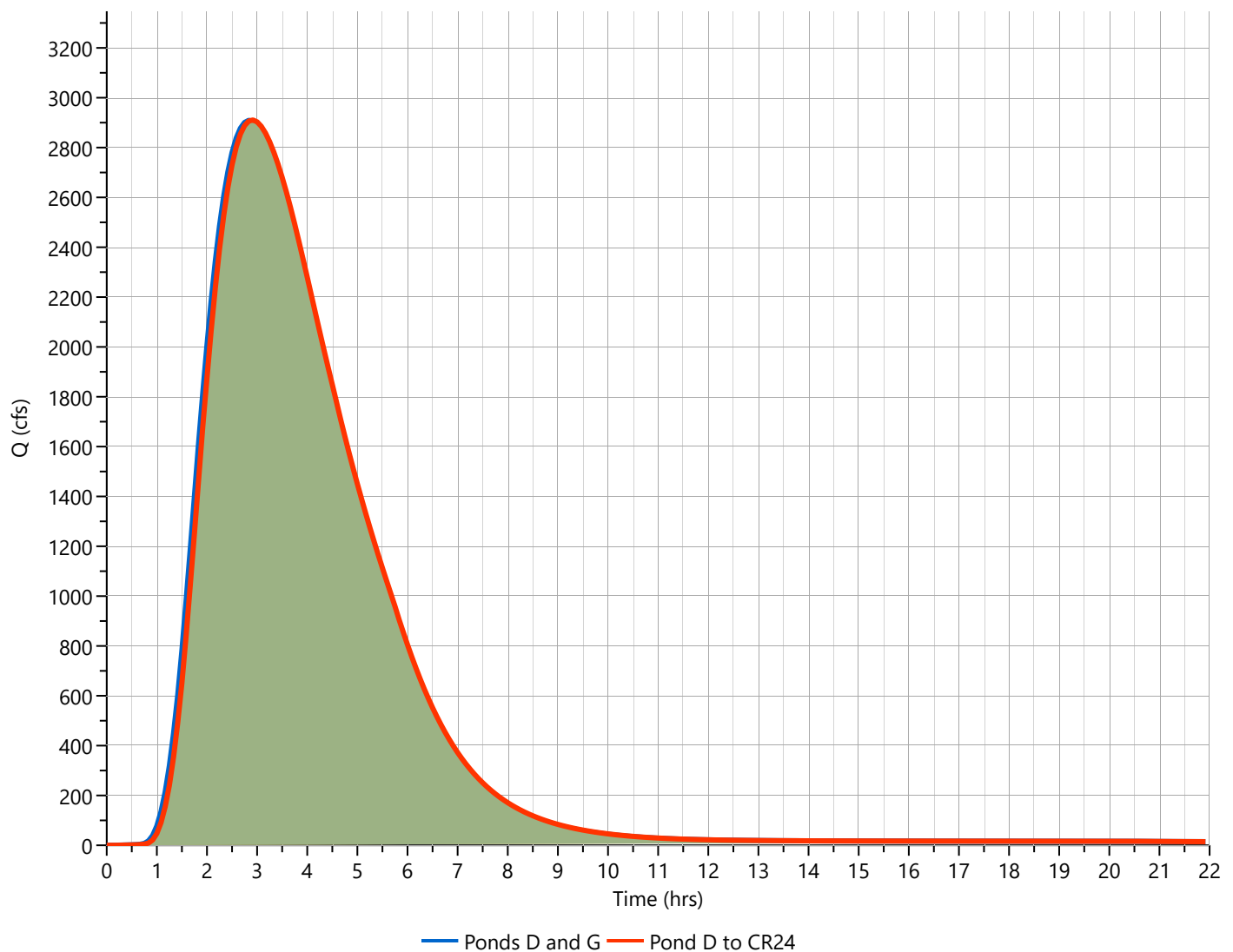
## Pond D to CR24

Hyd. No. 17

Hydrograph Type	= Reach	Peak Flow	= 2910.7 cfs
Storm Frequency	= 100-yr	Time to Peak	= 2.92 hrs
Time Interval	= 5 min	Hydrograph Volume	= 37,996,590 cuft
Inflow Hydrograph	= 16 - Ponds D and G	Section Type	= Trapezoidal
Reach Length	= 140 ft	Channel Slope	= 0.30 %
Manning's n	= 0.000	Bottom Width	= 142.00 ft
Side Slope (h:v)	= 13.00:1	Maximum Depth	= 3.00 ft
Rating Curve X	= 0.100	Average Velocity	= 1.79 ft/s
Rating Curve m	= 1.391	Routing Coeff.	= 1.4549

Modified Att-Kin routing method

**Qp = 2910.69 cfs**



# Hydrograph Report

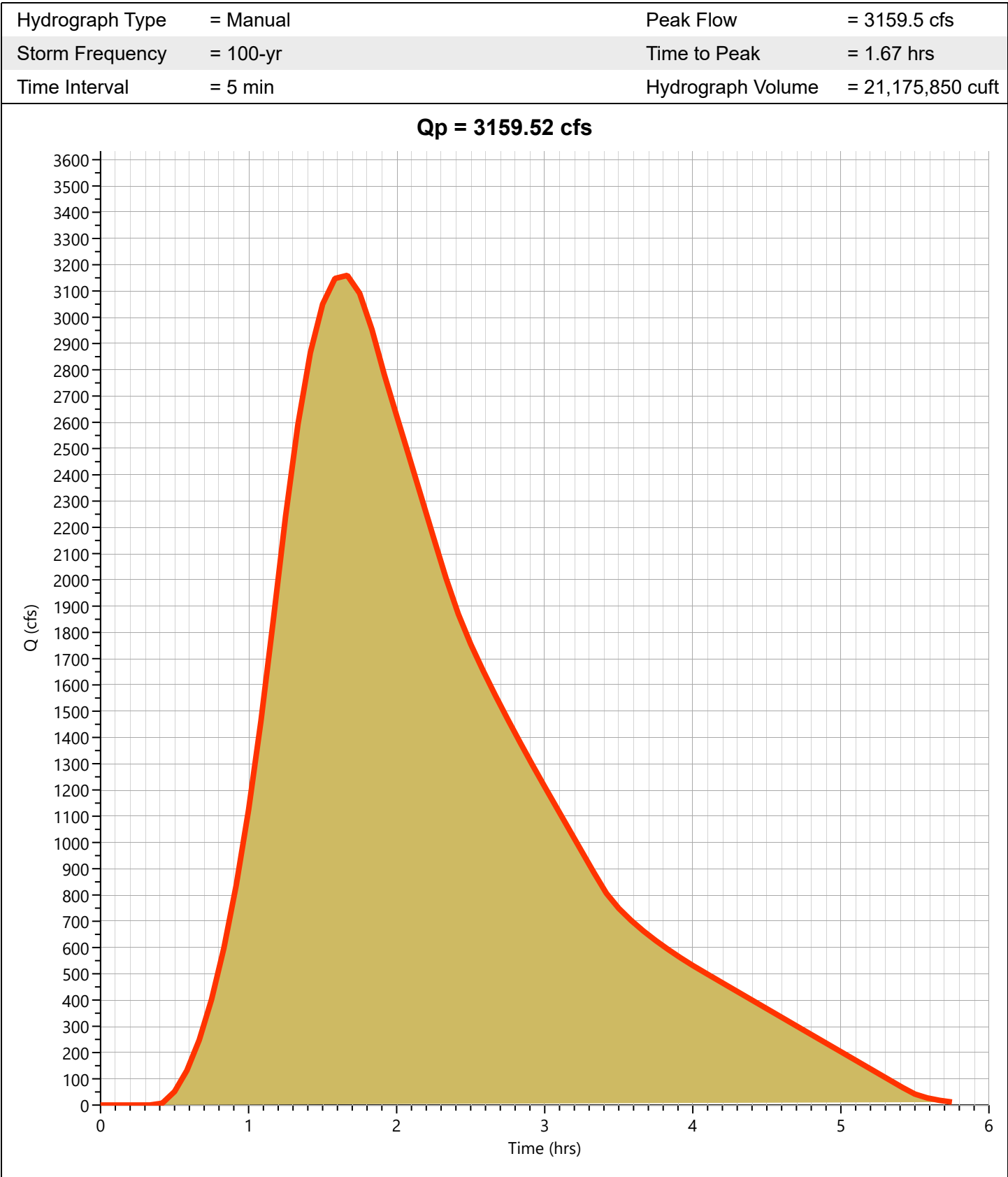
Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

## Pre Offsite 1

Hyd. No. 18



# Hydrograph Report

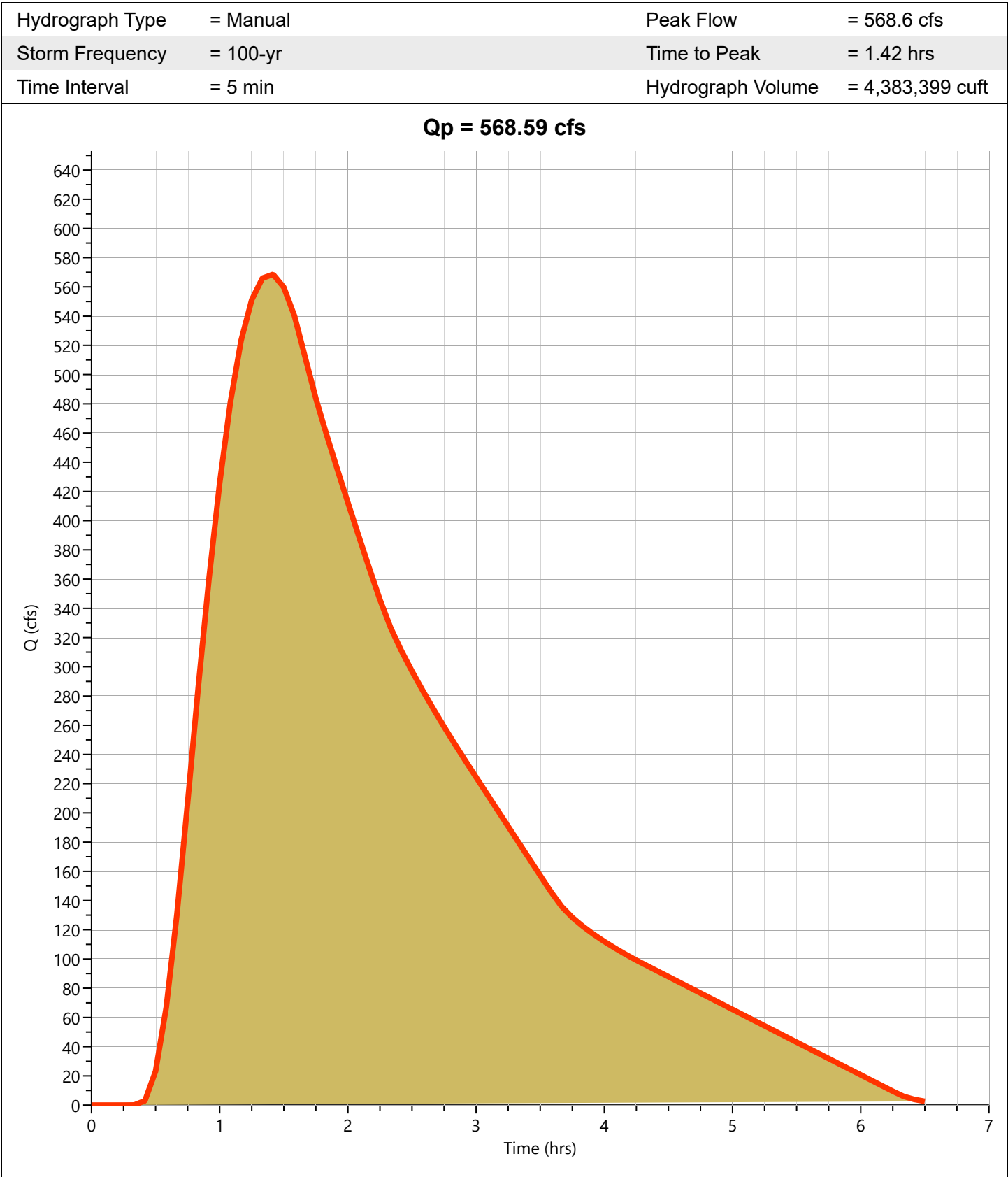
Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

## Pre Offsite 2

Hyd. No. 19



# Hydrograph Report

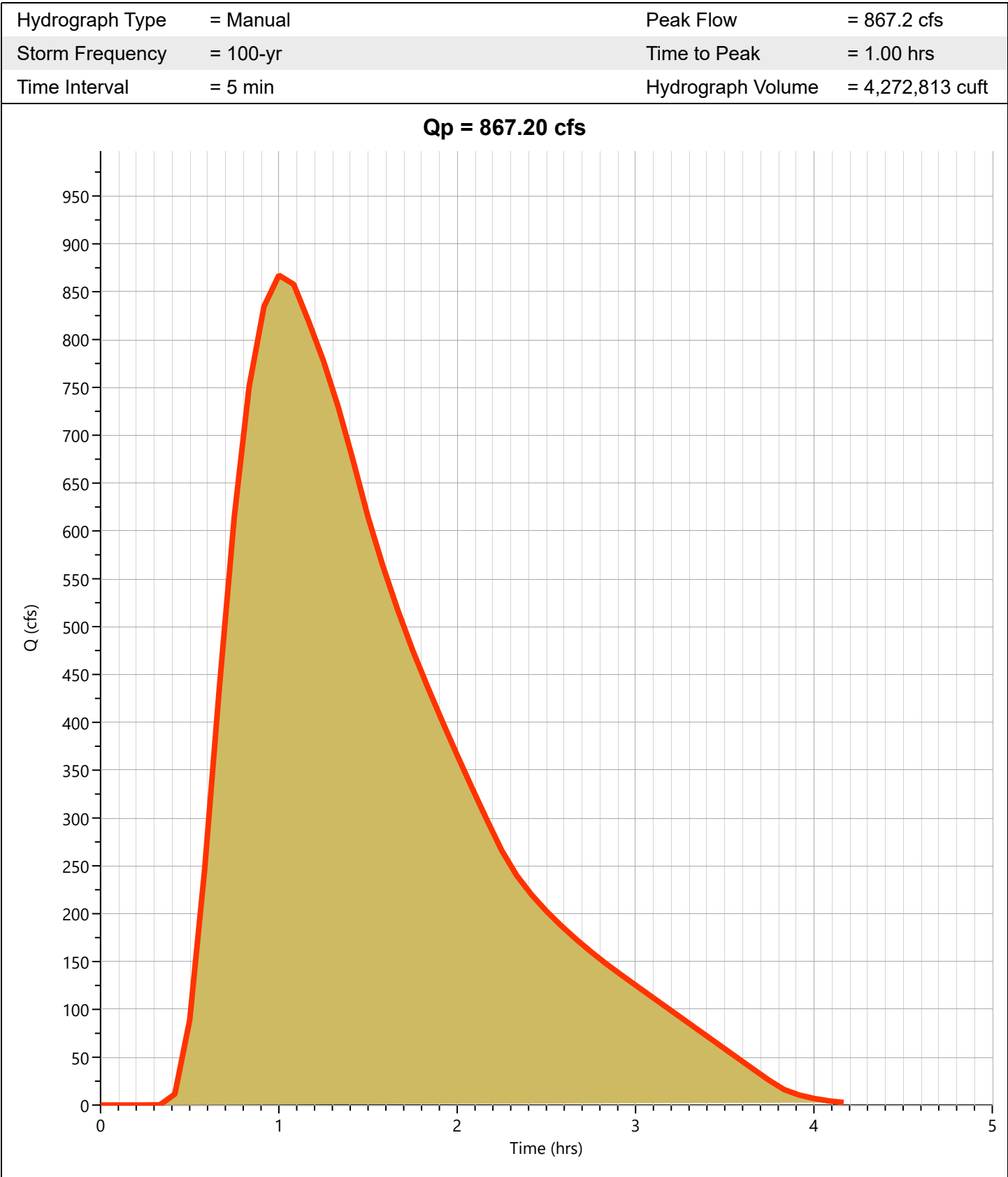
Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

## Pre Offsite 3

## Hyd. No. 20



# Hydrograph Report

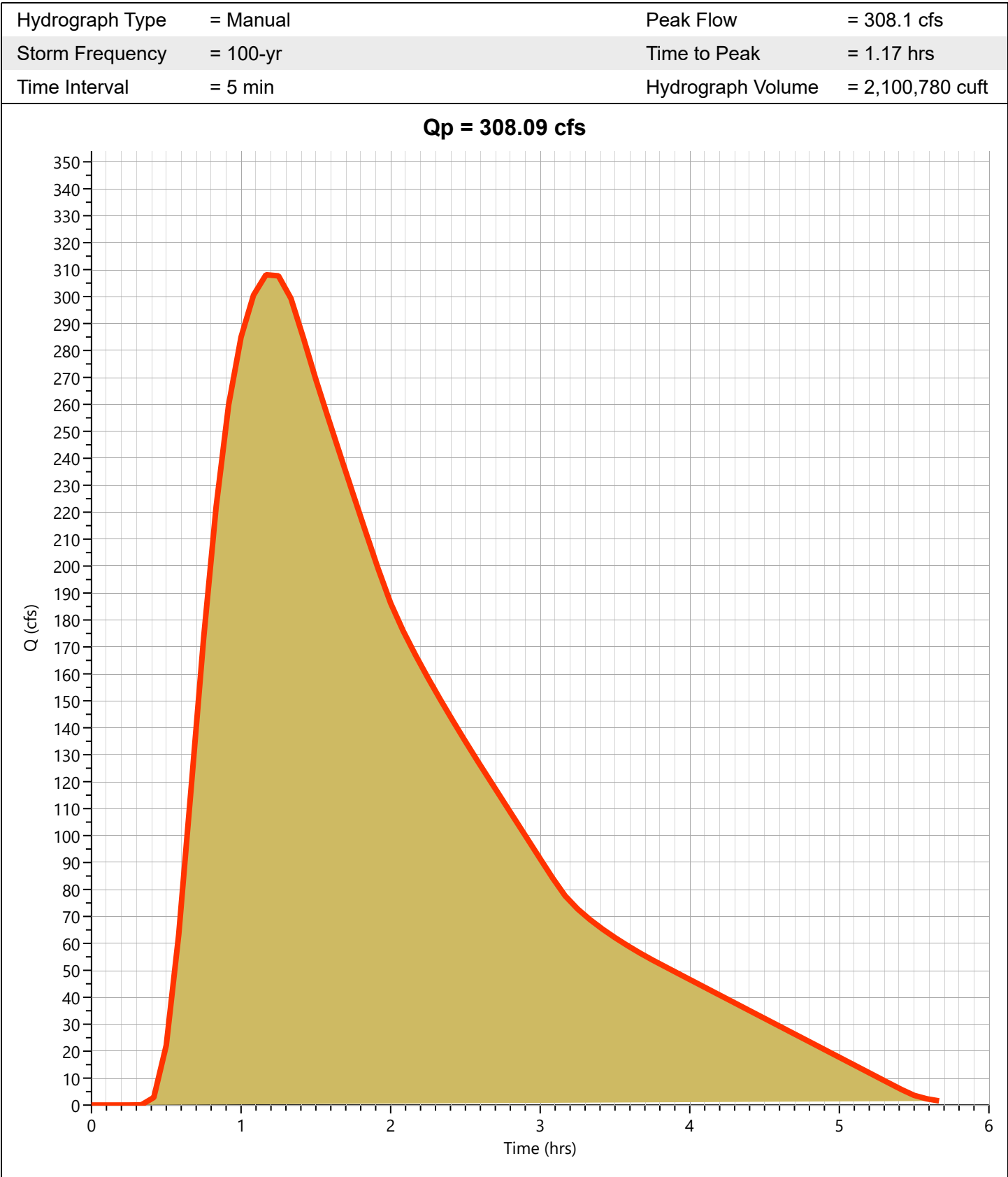
Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

## Pre Offsite 4

## Hyd. No. 21



# Hydrograph Report

Project Name:

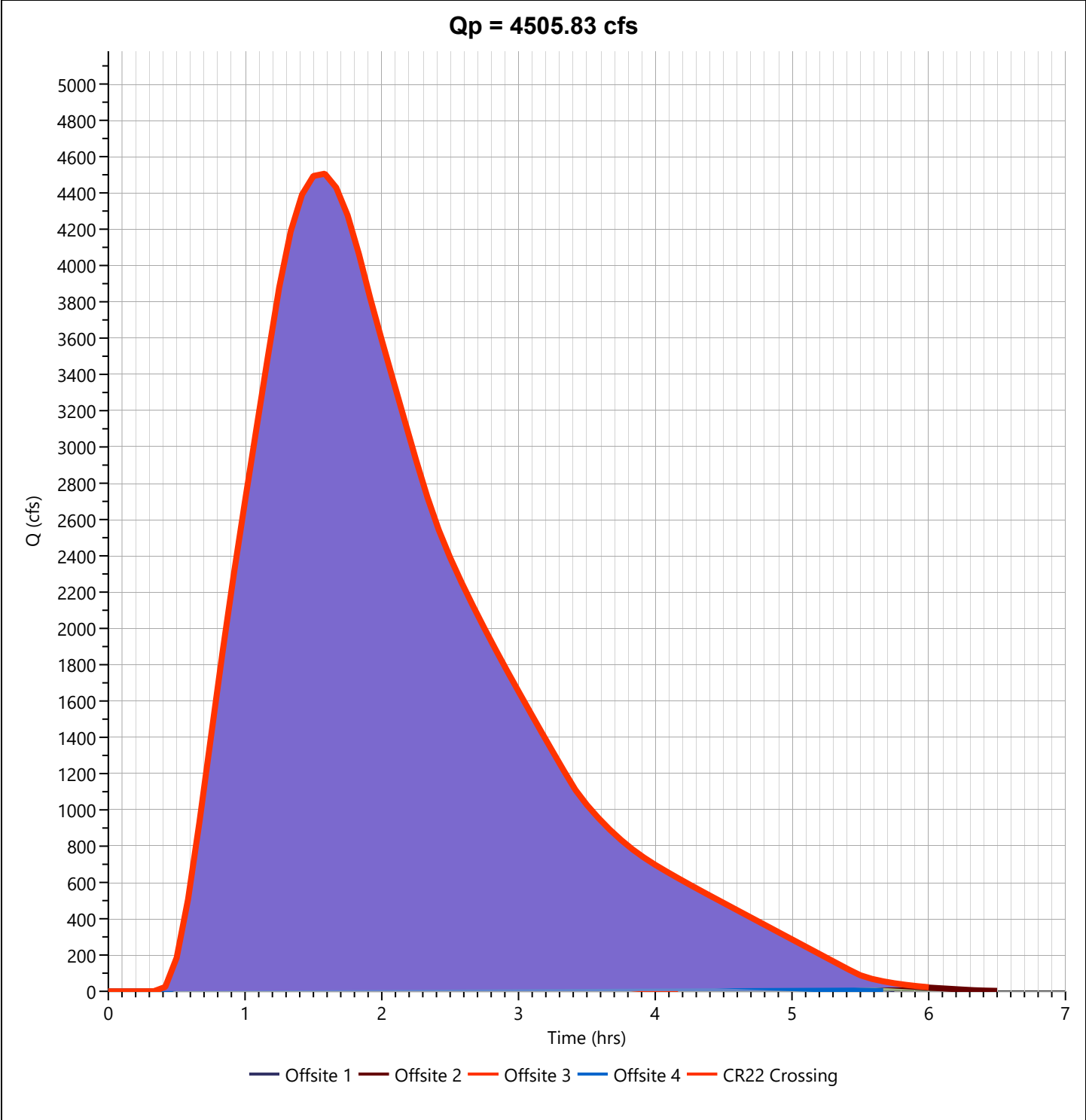
Hydrology Studio v 3.0.0.18

04-09-2021

## Pre CR22 Crossing

Hyd. No. 22

Hydrograph Type	= Junction	Peak Flow	= 4505.8 cfs
Storm Frequency	= 100-yr	Time to Peak	= 1.58 hrs
Time Interval	= 5 min	Hydrograph Volume	= 31,932,840 cuft
Inflow Hydrographs	= 18, 19, 20, 21	Total Contrib. Area	= 0.0 ac



# Hydrograph Report

Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

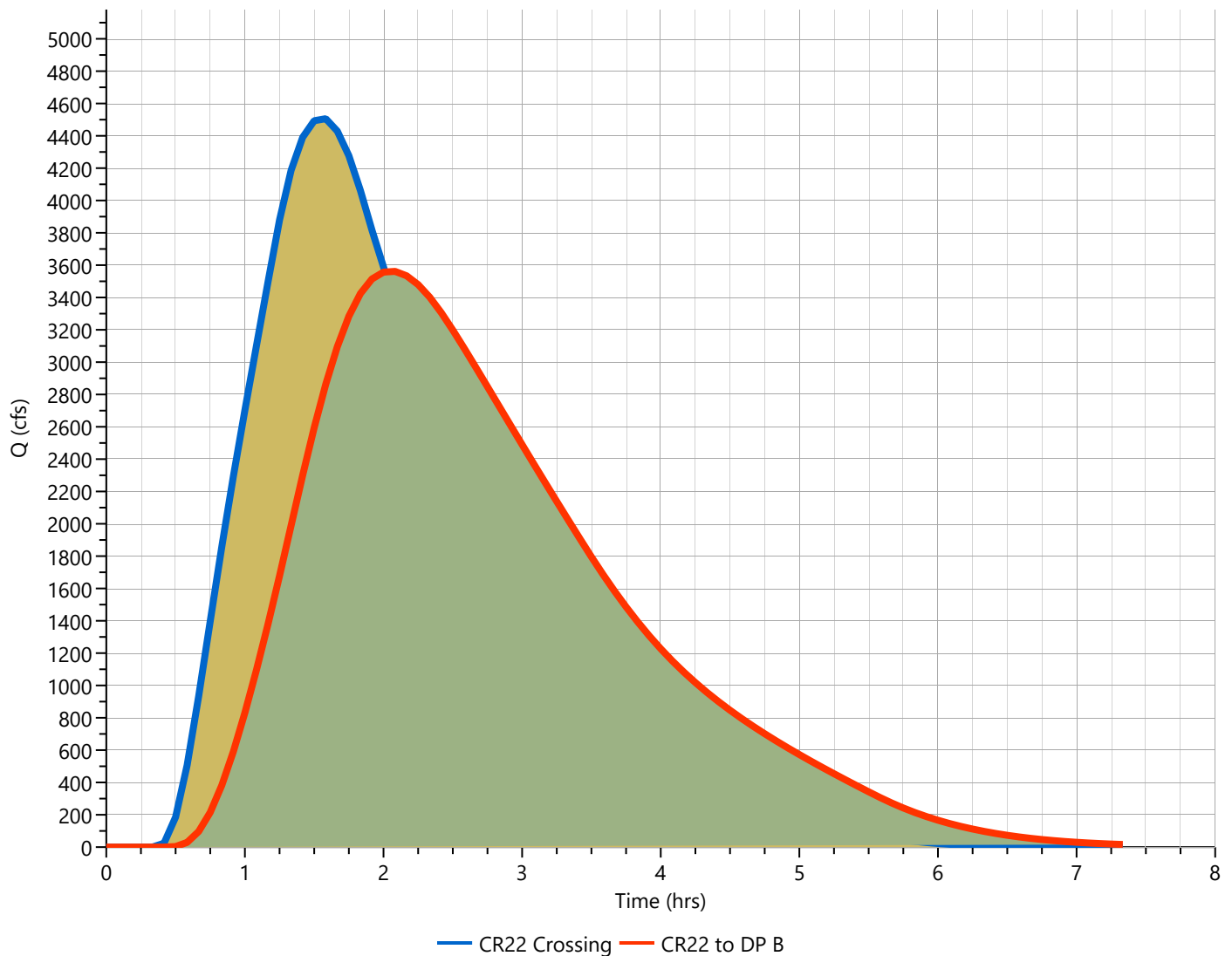
## Pre CR22 to DP B

Hyd. No. 23

Hydrograph Type	= Reach	Peak Flow	= 3561.4 cfs
Storm Frequency	= 100-yr	Time to Peak	= 2.08 hrs
Time Interval	= 5 min	Hydrograph Volume	= 31,932,820 cuft
Inflow Hydrograph	= 22 - CR22 Crossing	Section Type	= Trapezoidal
Reach Length	= 6179 ft	Channel Slope	= 0.40 %
Manning's n	= 0.000	Bottom Width	= 300.00 ft
Side Slope (h:v)	= 20.00:1	Maximum Depth	= 20.00 ft
Rating Curve X	= 0.070	Average Velocity	= 2.16 ft/s
Rating Curve m	= 1.449	Routing Coeff.	= 0.1413

Modified Att-Kin routing method

**Qp = 3561.43 cfs**





# Hydrograph Report

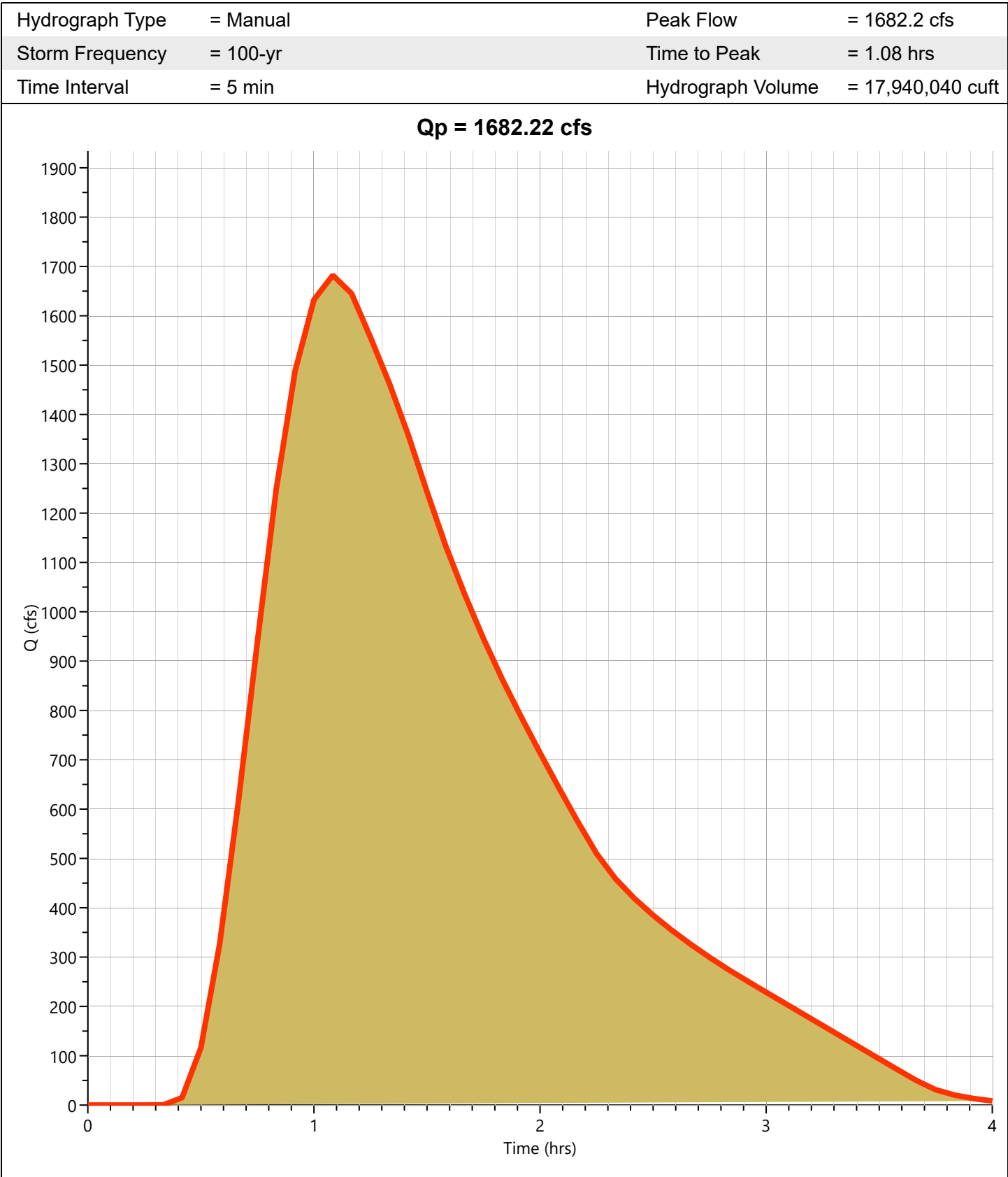
Project Name:

Hydrology Studio v 3.0.0.18

04-09-2021

## Pre Onsite 1

## Hyd. No. 24



# Hydrograph Report

Project Name:

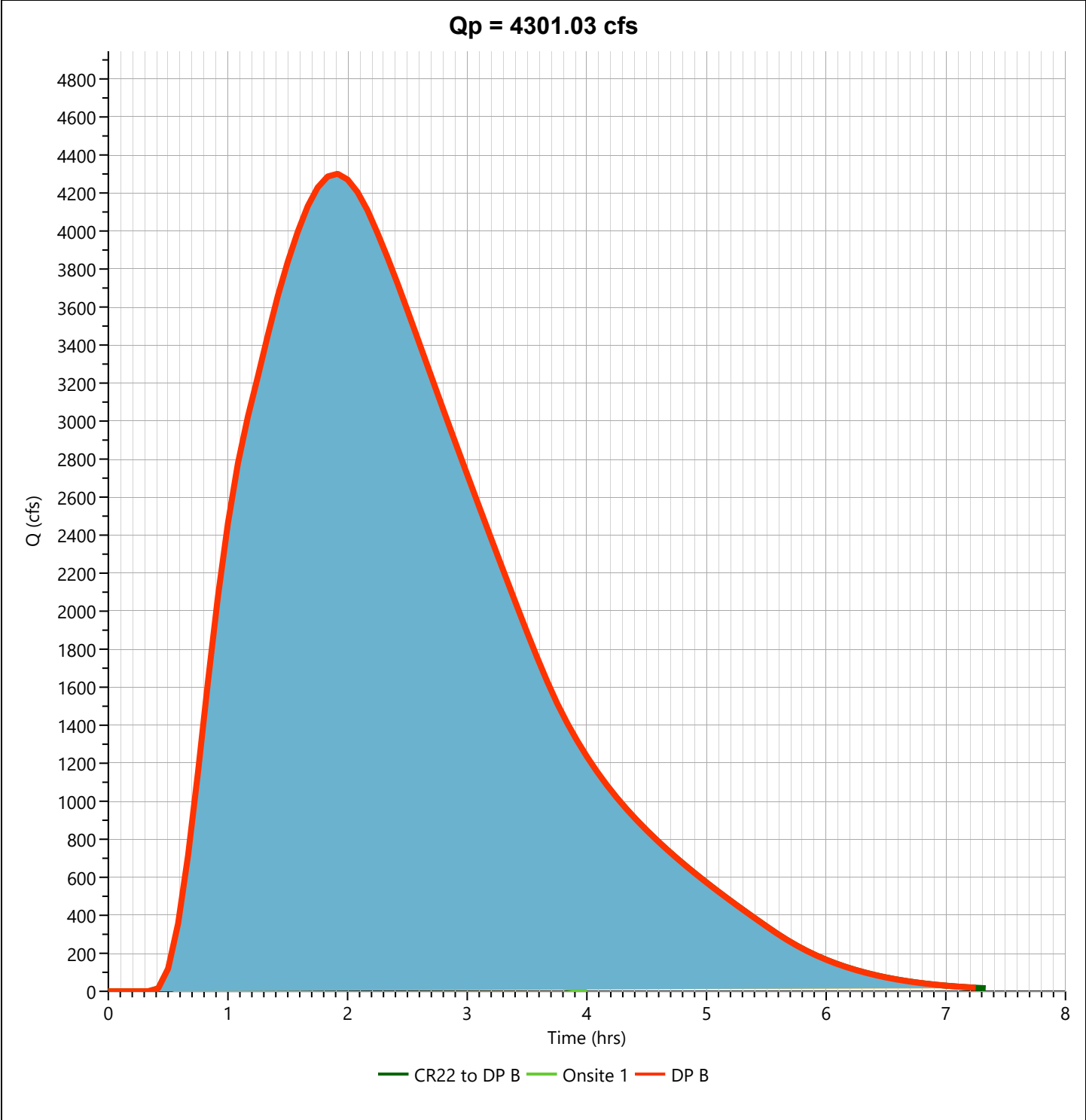
Hydrology Studio v 3.0.0.18

04-09-2021

## Pre DP B

## Hyd. No. 25

Hydrograph Type	= Junction	Peak Flow	= 4301.0 cfs
Storm Frequency	= 100-yr	Time to Peak	= 1.92 hrs
Time Interval	= 5 min	Hydrograph Volume	= 49,872,890 cuft
Inflow Hydrographs	= 23, 24	Total Contrib. Area	= 25.0 ac



## **Appendix B**

Hydraulics

HEC-RAS River: Pioneer Regional Reach: Revised Tributary Profile: PF 1

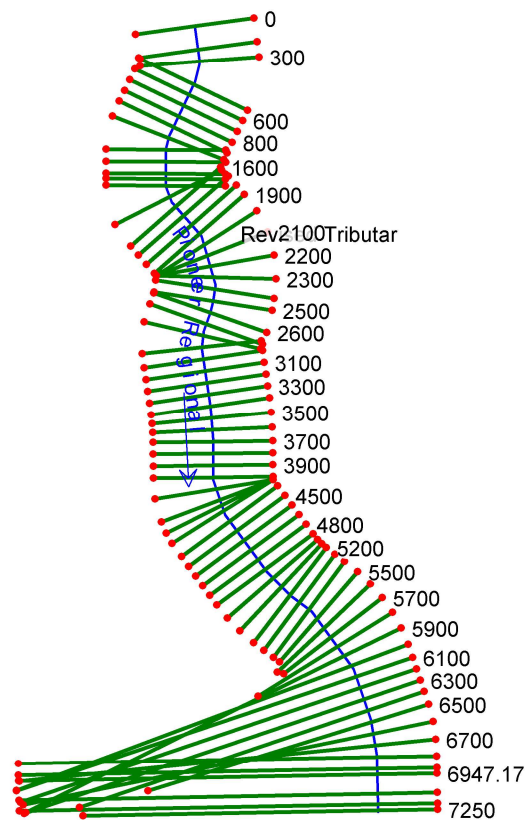
Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Revised Tributary	7250	PF 1	PROP	4505.00	4869.00	4872.16	4871.23	4872.34	0.001960	3.45	1306.68	662.58	0.43
Revised Tributary	7250	PF 1	EX	4505.00	4868.00	4869.88	4869.36	4869.98	0.002219	2.46	1832.71	1694.80	0.42
Revised Tributary	7200	PF 1	PROP	4505.00	4869.00	4872.06		4872.24	0.002068	3.41	1320.66	708.49	0.44
Revised Tributary	7200	PF 1	EX	4505.00	4868.00	4869.80		4869.88	0.001639	2.19	2054.56	1797.00	0.36
Revised Tributary	7109.35	PF 1	PROP	4505.00	4865.84	4872.00	4870.46	4872.10	0.000894	2.63	1712.04	720.23	0.30
Revised Tributary	7109.35	PF 1	EX	4505.00	4868.00	4869.55		4869.66	0.003445	2.71	1665.19	1854.98	0.50
Revised Tributary	6980			Bridge									
Revised Tributary	6947.17	PF 1	PROP	4505.00	4864.19	4870.70		4871.38	0.003537	6.58	684.66	204.58	0.63
Revised Tributary	6947.17	PF 1	EX	4505.00	4866.52	4869.53		4869.54	0.000219	0.97	4648.95	3060.83	0.14
Revised Tributary	6900	PF 1	PROP	4505.00	4863.92	4870.61		4871.20	0.002974	6.17	730.72	211.34	0.58
Revised Tributary	6900	PF 1	EX	4505.00	4865.00	4869.52		4869.53	0.000134	0.82	5481.55	3183.53	0.11
Revised Tributary	6800	PF 1	PROP	4505.00	4863.62	4870.29		4870.90	0.003074	6.23	722.73	210.69	0.59
Revised Tributary	6800	PF 1	EX	4505.00	4865.00	4869.51		4869.52	0.000109	0.76	5900.55	3275.94	0.10
Revised Tributary	6700	PF 1	PROP	4505.00	4863.32	4869.99		4870.59	0.003065	6.23	723.14	210.53	0.59
Revised Tributary	6700	PF 1	EX	4505.00	4866.13	4869.49		4869.51	0.000199	0.93	4819.20	3113.90	0.13
Revised Tributary	6600	PF 1	PROP	4505.00	4863.01	4869.69		4870.28	0.003018	6.20	726.39	210.50	0.59
Revised Tributary	6600	PF 1	EX	4505.00	4867.00	4869.45		4869.48	0.000422	1.28	3518.70	2493.37	0.19
Revised Tributary	6500	PF 1	PROP	4505.00	4862.69	4869.38		4869.98	0.003005	6.19	727.32	210.47	0.59
Revised Tributary	6500	PF 1	EX	4505.00	4867.00	4869.36		4869.41	0.000941	1.81	2484.89	1905.92	0.28
Revised Tributary	6400	PF 1	PROP	4505.00	4862.38	4869.07		4869.68	0.003102	6.26	720.07	210.02	0.60
Revised Tributary	6400	PF 1	EX	4505.00	4867.00	4869.28		4869.32	0.000800	1.64	2745.07	2165.05	0.26
Revised Tributary	6300	PF 1	PROP	4505.00	4862.06	4868.79		4869.37	0.002891	6.12	735.85	210.52	0.58
Revised Tributary	6300	PF 1	EX	4505.00	4867.00	4869.24		4869.27	0.000348	1.23	3669.88	2396.47	0.17
Revised Tributary	6200	PF 1	PROP	4505.00	4861.75	4868.47		4869.07	0.003021	6.21	725.35	209.91	0.59
Revised Tributary	6200	PF 1	EX	4505.00	4867.00	4869.20		4869.23	0.000470	1.35	3343.85	2377.67	0.20
Revised Tributary	6100	PF 1	PROP	4505.00	4861.45	4868.15		4868.77	0.003109	6.27	718.61	209.45	0.60
Revised Tributary	6100	PF 1	EX	4505.00	4866.00	4869.14		4869.17	0.000650	1.46	3076.43	2462.65	0.23
Revised Tributary	6000	PF 1	PROP	4505.00	4861.15	4867.84		4868.46	0.003111	6.27	718.00	209.16	0.60
Revised Tributary	6000	PF 1	EX	4505.00	4866.00	4869.07		4869.10	0.000673	1.47	3057.64	2490.29	0.23
Revised Tributary	5900	PF 1	PROP	4505.00	4860.84	4867.54		4868.14	0.003086	6.26	719.40	208.94	0.59
Revised Tributary	5900	PF 1	EX	4505.00	4866.00	4869.00		4869.04	0.000630	1.59	2825.87	1946.86	0.23
Revised Tributary	5800	PF 1	PROP	4505.00	4860.51	4867.24		4867.84	0.003001	6.21	725.65	209.01	0.59
Revised Tributary	5800	PF 1	EX	4505.00	4865.96	4868.64		4868.91	0.002419	4.15	1084.38	486.75	0.49
Revised Tributary	5700	PF 1	PROP	4505.00	4860.20	4866.91		4867.53	0.003136	6.30	715.10	208.10	0.60
Revised Tributary	5700	PF 1	EX	4505.00	4865.00	4868.42		4868.67	0.002236	4.04	1114.12	491.00	0.47
Revised Tributary	5600	PF 1	PROP	4505.00	4859.85	4866.64		4867.22	0.002824	6.10	738.70	208.88	0.57
Revised Tributary	5600	PF 1	EX	4505.00	4865.00	4868.14		4868.40	0.003156	4.14	1087.09	598.06	0.54
Revised Tributary	5500	PF 1	PROP	4505.00	4859.54	4866.31		4866.92	0.003086	6.27	718.46	208.12	0.59
Revised Tributary	5500	PF 1	EX	4505.00	4865.00	4867.65		4868.00	0.005063	4.78	942.32	596.27	0.67
Revised Tributary	5400	PF 1	PROP	4505.00	4859.25	4866.00		4866.62	0.003118	6.29	715.71	207.75	0.60
Revised Tributary	5400	PF 1	EX	4505.00	4864.00	4866.73	4866.68	4867.26	0.011075	5.87	767.28	640.72	0.95
Revised Tributary	5300	PF 1	PROP	4505.00	4858.93	4865.72		4866.31	0.002918	6.17	730.49	208.17	0.58
Revised Tributary	5300	PF 1	EX	4505.00	4863.00	4866.02		4866.37	0.006572	4.74	950.44	739.61	0.74
Revised Tributary	5200	PF 1	PROP	4505.00	4858.60	4865.40		4866.01	0.003032	6.24	721.88	207.77	0.59
Revised Tributary	5200	PF 1	EX	4505.00	4862.42	4865.51		4865.78	0.004970	4.18	1078.68	823.95	0.64
Revised Tributary	5100	PF 1	PROP	4505.00	4858.31	4865.08		4865.70	0.003145	6.32	713.03	206.92	0.60
Revised Tributary	5100	PF 1	EX	4505.00	4861.70	4865.27		4865.44	0.002066	3.30	1365.18	768.83	0.44
Revised Tributary	5000	PF 1	PROP	4505.00	4857.99	4864.80		4865.39	0.002884	6.15	732.15	207.48	0.58
Revised Tributary	5000	PF 1	EX	4505.00	4861.00	4865.10		4865.26	0.001611	3.14	1434.68	722.31	0.39
Revised Tributary	4900	PF 1	PROP	4505.00	4857.66	4864.48		4865.09	0.003048	6.26	719.42	206.91	0.59
Revised Tributary	4900	PF 1	EX	4505.00	4861.00	4864.82		4865.04	0.002746	3.80	1185.80	668.80	0.50
Revised Tributary	4800	PF 1	PROP	4505.00	4857.36	4864.14		4864.77	0.003205	6.36	707.82	206.05	0.61
Revised Tributary	4800	PF 1	EX	4505.00	4862.00	4864.43		4864.69	0.004508	4.13	1091.41	789.12	0.62
Revised Tributary	4700	PF 1	PROP	4505.00	4857.06	4863.83		4864.45	0.003183	6.36	708.38	205.59	0.60
Revised Tributary	4700	PF 1	EX	4505.00	4862.00	4864.01		4864.26	0.004079	4.02	1119.71	780.57	0.59
Revised Tributary	4600	PF 1	PROP	4505.00	4856.73	4863.55		4864.14	0.002910	6.19	728.22	206.10	0.58
Revised Tributary	4600	PF 1	EX	4505.00	4861.81	4863.33		4863.71	0.007583	4.91	916.99	754.31	0.79
Revised Tributary	4500	PF 1	PROP	4375.00	4856.42	4863.29		4863.83	0.002937	5.90	741.70	226.54	0.57

HEC-RAS River: Pioneer Regional Reach: Revised Tributary Profile: PF 1 (Continued)

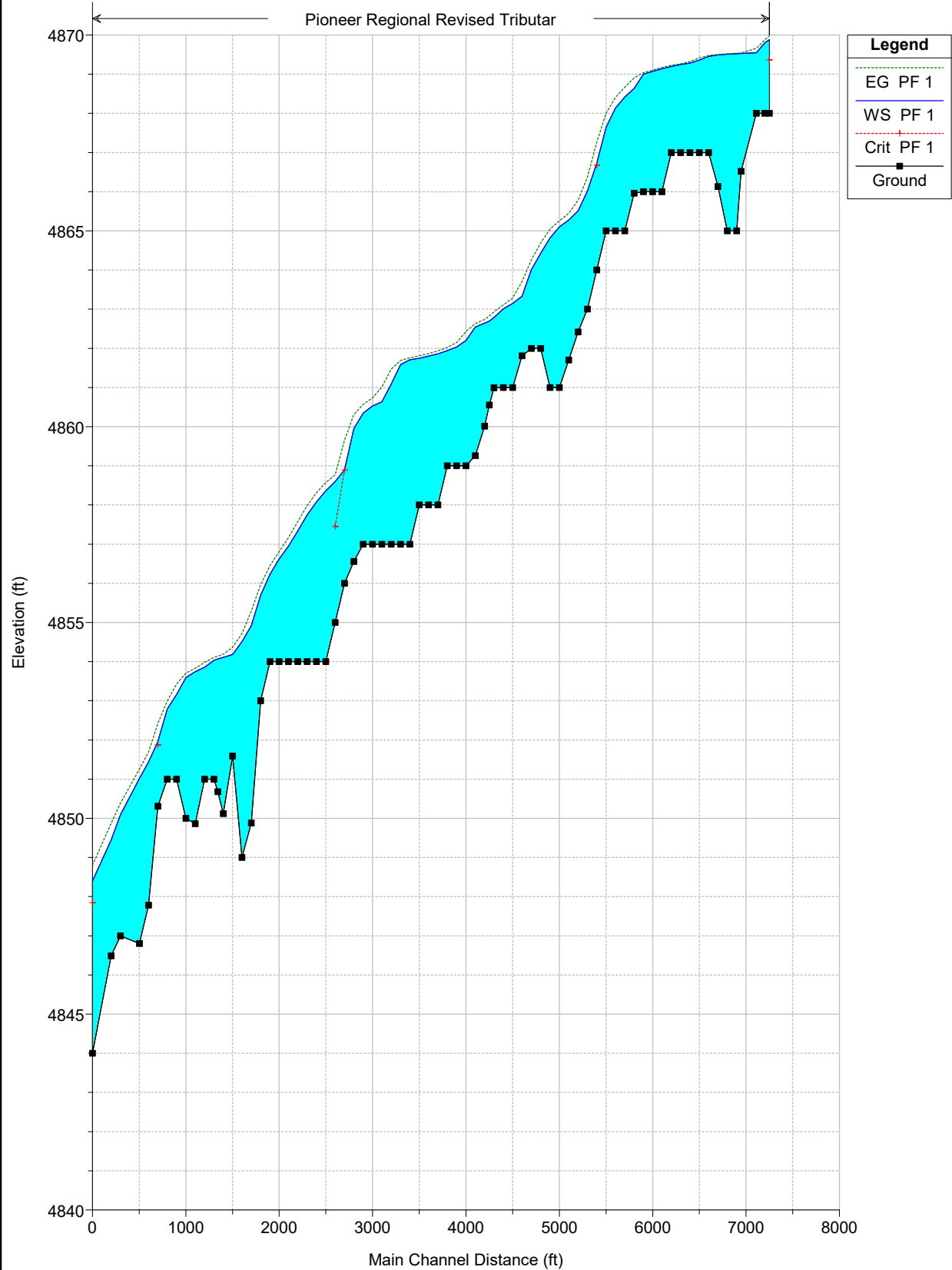
Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Revised Tributary	4500	PF 1	EX	4430.00	4861.00	4863.15		4863.29	0.001983	2.94	1505.36	976.64	0.42
Revised Tributary	4400	PF 1	PROP	4375.00	4856.17	4863.03		4863.56	0.002469	5.80	754.65	208.14	0.54
Revised Tributary	4400	PF 1	EX	4430.00	4861.00	4863.01		4863.11	0.001386	2.62	1692.82	1000.00	0.35
Revised Tributary	4300	PF 1	PROP	4375.00	4855.89	4862.72		4863.29	0.002838	6.05	723.47	207.76	0.57
Revised Tributary	4300	PF 1	EX	4430.00	4860.99	4862.79		4862.93	0.002258	3.03	1462.51	1000.00	0.44
Revised Tributary	4250	PF 1	PROP	4375.00	4855.76	4862.57		4863.15	0.002884	6.07	720.17	207.85	0.58
Revised Tributary	4250	PF 1	EX	4430.00	4860.55	4862.70		4862.83	0.001938	2.89	1531.20	1000.00	0.41
Revised Tributary	4200	PF 1	PROP	4375.00	4855.63	4862.46		4863.00	0.002649	5.91	739.70	208.68	0.55
Revised Tributary	4200	PF 1	EX	4430.00	4860.01	4862.64		4862.74	0.001205	2.51	1765.67	1000.00	0.33
Revised Tributary	4100	PF 1	PROP	4375.00	4855.36	4862.17		4862.73	0.002772	5.99	730.25	209.04	0.57
Revised Tributary	4100	PF 1	EX	4430.00	4859.26	4862.55		4862.63	0.000948	2.33	1898.28	1000.00	0.30
Revised Tributary	4000	PF 1	PROP	4375.00	4855.14	4861.86		4862.44	0.002932	6.10	717.54	208.66	0.58
Revised Tributary	4000	PF 1	EX	4430.00	4859.00	4862.20		4862.43	0.005066	3.86	1147.28	999.72	0.64
Revised Tributary	3900	PF 1	PROP	4375.00	4854.89	4861.60		4862.15	0.002734	5.96	733.87	209.56	0.56
Revised Tributary	3900	PF 1	EX	4430.00	4859.00	4862.04		4862.15	0.001466	2.66	1664.83	999.72	0.36
Revised Tributary	3800	PF 1	PROP	4375.00	4854.63	4861.35		4861.88	0.002596	5.86	747.17	210.77	0.55
Revised Tributary	3800	PF 1	EX	4430.00	4859.00	4861.94		4862.03	0.000915	2.31	1918.22	1000.00	0.29
Revised Tributary	3700	PF 1	PROP	4375.00	4854.36	4861.03		4861.60	0.002888	6.05	723.25	210.43	0.58
Revised Tributary	3700	PF 1	EX	4430.00	4858.00	4861.86		4861.94	0.000846	2.26	1964.00	1000.00	0.28
Revised Tributary	3600	PF 1	PROP	4375.00	4854.12	4860.75		4861.31	0.002813	6.00	729.63	210.99	0.57
Revised Tributary	3600	PF 1	EX	4430.00	4858.00	4861.81		4861.86	0.000530	1.96	2260.27	1000.00	0.23
Revised Tributary	3500	PF 1	PROP	4341.00	4853.85	4860.48		4861.03	0.002789	5.95	729.13	211.67	0.57
Revised Tributary	3500	PF 1	EX	4380.00	4858.00	4861.75		4861.81	0.000560	1.98	2207.70	1000.00	0.24
Revised Tributary	3400	PF 1	PROP	4341.00	4853.60	4860.24		4860.75	0.002506	5.75	754.62	212.99	0.54
Revised Tributary	3400	PF 1	EX	4380.00	4857.00	4861.71		4861.76	0.000424	1.82	2401.13	1000.00	0.21
Revised Tributary	3300	PF 1	PROP	4341.00	4853.33	4859.95		4860.49	0.002749	5.91	734.35	213.17	0.56
Revised Tributary	3300	PF 1	EX	4380.00	4857.00	4861.58		4861.69	0.000952	2.65	1655.72	724.68	0.31
Revised Tributary	3200	PF 1	PROP	4341.00	4853.10	4859.66		4860.21	0.002851	5.97	726.90	213.41	0.57
Revised Tributary	3200	PF 1	EX	4380.00	4857.00	4861.08		4861.47	0.005983	4.98	879.17	591.74	0.72
Revised Tributary	3100	PF 1	PROP	4341.00	4852.85	4859.40		4859.93	0.002636	5.82	745.52	214.58	0.55
Revised Tributary	3100	PF 1	EX	4380.00	4857.00	4860.64		4861.01	0.003601	4.91	892.45	420.35	0.59
Revised Tributary	3000	PF 1	PROP	4341.00	4852.60	4859.11		4859.66	0.002826	5.94	730.26	214.68	0.57
Revised Tributary	3000	PF 1	EX	4380.00	4857.00	4860.53		4860.74	0.001510	3.66	1198.12	457.60	0.40
Revised Tributary	2900	PF 1	PROP	4341.00	4852.36	4858.83		4859.37	0.002779	5.91	734.76	215.33	0.56
Revised Tributary	2900	PF 1	EX	4301.00	4857.00	4860.35		4860.57	0.001780	3.80	1130.88	460.35	0.43
Revised Tributary	2800	PF 1	PROP	4341.00	4852.11	4858.56		4859.09	0.002730	5.87	739.39	215.80	0.56
Revised Tributary	2800	PF 1	EX	4301.00	4856.56	4859.95		4860.31	0.003793	4.79	897.81	456.01	0.60
Revised Tributary	2700	PF 1	PROP	4341.00	4851.88	4858.25		4858.81	0.002903	5.98	725.79	215.70	0.57
Revised Tributary	2700	PF 1	EX	4301.00	4856.00	4858.90	4858.90	4859.65	0.011592	6.99	615.10	409.47	1.01
Revised Tributary	2600	PF 1	PROP	4341.00	4851.61	4858.02		4858.53	0.002508	5.71	760.55	217.38	0.54
Revised Tributary	2600	PF 1	EX	4301.00	4855.00	4858.60	4857.45	4858.77	0.001650	3.36	1278.86	591.31	0.40
Revised Tributary	2500	PF 1	PROP	4341.00	4851.38	4857.70		4858.25	0.002912	5.97	726.61	216.79	0.58
Revised Tributary	2500	PF 1	EX	4301.00	4854.00	4858.36		4858.57	0.002310	3.69	1164.64	602.35	0.47
Revised Tributary	2400	PF 1	PROP	4341.00	4851.11	4857.43		4857.96	0.002704	5.83	744.10	217.74	0.56
Revised Tributary	2400	PF 1	EX	4301.00	4854.00	4858.08		4858.32	0.002833	3.90	1102.53	612.09	0.51
Revised Tributary	2300	PF 1	PROP	4341.00	4850.86	4857.12		4857.68	0.002978	6.01	722.04	217.03	0.58
Revised Tributary	2300	PF 1	EX	4301.00	4854.00	4857.75		4857.98	0.004009	3.88	1107.97	804.26	0.58
Revised Tributary	2200	PF 1	PROP	4341.00	4850.60	4856.83		4857.38	0.002907	5.97	727.55	217.31	0.57
Revised Tributary	2200	PF 1	EX	4301.00	4854.00	4857.34		4857.58	0.004071	3.93	1093.41	787.01	0.59
Revised Tributary	2100	PF 1	PROP	4341.00	4850.34	4856.51		4857.08	0.003030	6.05	718.10	216.95	0.59
Revised Tributary	2100	PF 1	EX	4301.00	4854.00	4856.95		4857.16	0.003999	3.73	1151.80	883.79	0.58
Revised Tributary	2000	PF 1	PROP	4341.00	4850.13	4856.16		4856.76	0.003339	6.24	695.65	215.48	0.61
Revised Tributary	2000	PF 1	EX	4301.00	4854.00	4856.62		4856.81	0.003053	3.45	1246.26	879.77	0.51
Revised Tributary	1900	PF 1	PROP	4341.00	4849.89	4855.81		4856.42	0.003391	6.28	690.80	214.29	0.62
Revised Tributary	1900	PF 1	EX	4301.00	4854.00	4856.23		4856.45	0.004127	3.79	1135.92	873.79	0.59
Revised Tributary	1800	PF 1	PROP	4341.00	4849.62	4855.31		4856.03	0.004280	6.80	638.17	209.20	0.69
Revised Tributary	1800	PF 1	EX	4301.00	4853.00	4855.70		4855.97	0.005622	4.18	1028.49	858.80	0.67
Revised Tributary	1700	PF 1	PROP	4341.00	4849.36	4854.36	4854.13	4855.44	0.007560	8.36	519.50	191.79	0.90

HEC-RAS River: Pioneer Regional Reach: Revised Tributar Profile: PF 1 (Continued)

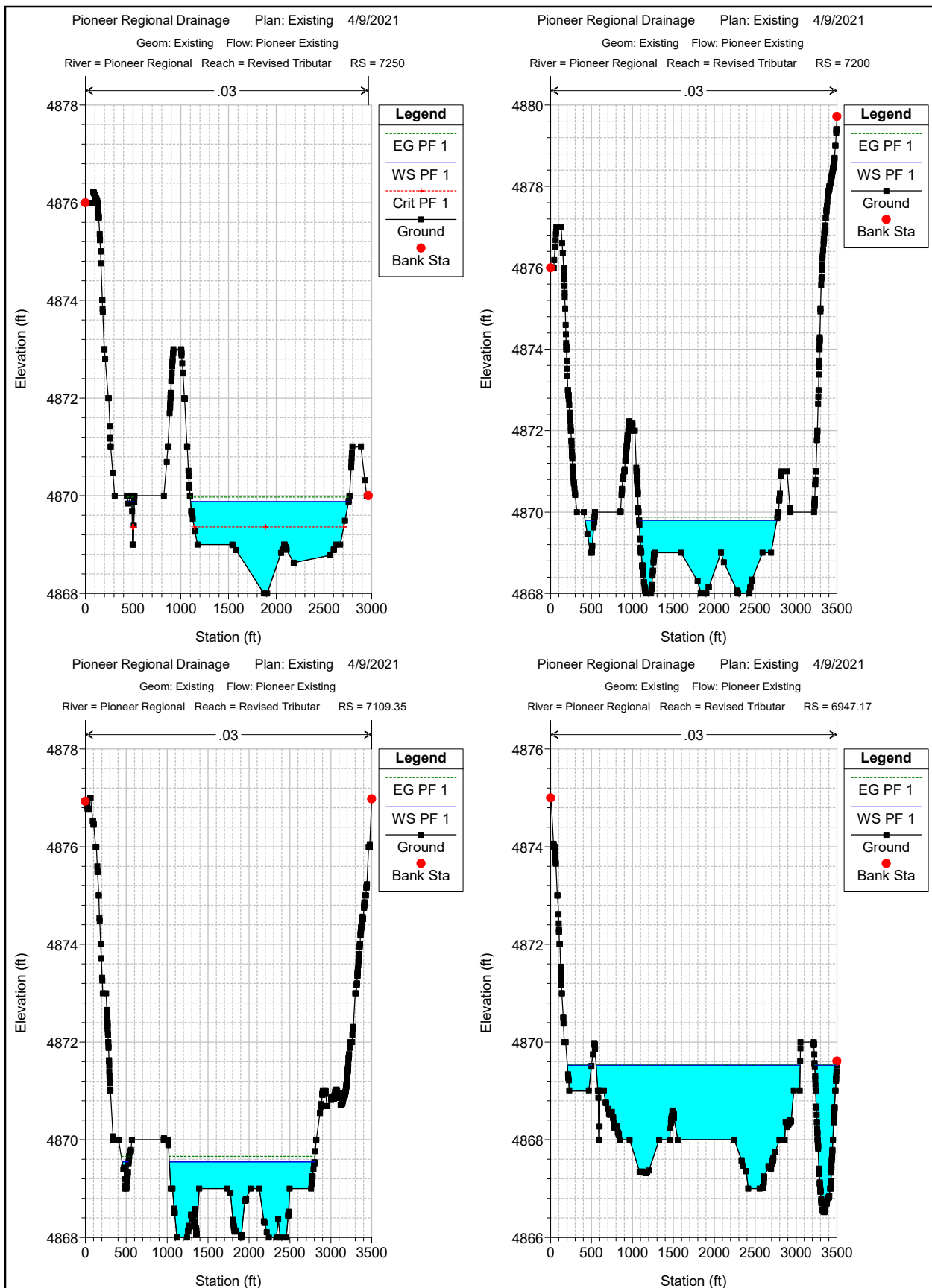
Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Revised Tributar	1700	PF 1	EX	4301.00	4849.88	4854.92		4855.29	0.008083	4.90	878.54	758.03	0.80
Revised Tributar	1600	PF 1	PROP	2909.00	4849.11	4854.31		4854.75	0.003027	5.34	544.98	198.30	0.57
Revised Tributar	1600	PF 1	EX	4301.00	4849.00	4854.51		4854.72	0.003628	3.65	1178.54	865.62	0.55
Revised Tributar	1500	PF 1	PROP	2909.00	4848.86	4853.99		4854.44	0.003115	5.39	539.81	197.86	0.58
Revised Tributar	1500	PF 1	EX	4301.00	4851.59	4854.19		4854.37	0.003263	3.39	1266.94	961.39	0.52
Revised Tributar	1400	PF 1	PROP	2909.00	4848.63	4853.61		4854.10	0.003563	5.63	516.33	195.80	0.61
Revised Tributar	1400	PF 1	EX	4301.00	4850.12	4854.11		4854.19	0.000821	2.25	1912.92	954.62	0.28
Revised Tributar	1343.61	PF 1	PROP	2909.00	4848.50	4853.54		4853.90	0.002472	4.78	608.22	222.22	0.51
Revised Tributar	1343.61	PF 1	EX	4301.00	4850.68	4854.07		4854.14	0.000790	2.18	1971.38	1000.00	0.27
Revised Tributar	1300	PF 1	PROP	2909.00	4848.39	4853.18		4853.74	0.004246	6.00	485.13	191.11	0.66
Revised Tributar	1300	PF 1	EX	4301.00	4851.00	4854.03		4854.11	0.000813	2.20	1954.87	1000.00	0.28
Revised Tributar	1200	PF 1	PROP	2909.00	4848.14	4852.66		4853.27	0.004965	6.30	461.75	189.98	0.71
Revised Tributar	1200	PF 1	EX	4301.00	4851.00	4853.86		4853.98	0.001920	2.85	1509.78	1000.00	0.41
Revised Tributar	1100	PF 1	PROP	2909.00	4847.81	4852.35		4852.82	0.003473	5.49	530.30	205.38	0.60
Revised Tributar	1100	PF 1	EX	4301.00	4849.86	4853.75		4853.83	0.001029	2.36	1819.09	1000.00	0.31
Revised Tributar	1000	PF 1	PROP	2909.00	4847.43	4852.01		4852.47	0.003421	5.46	532.95	205.60	0.60
Revised Tributar	1000	PF 1	EX	4301.00	4850.00	4853.59		4853.71	0.001519	2.74	1568.94	925.48	0.37
Revised Tributar	900	PF 1	PROP	2909.00	4847.13	4851.65		4852.12	0.003525	5.51	528.30	205.73	0.61
Revised Tributar	900	PF 1	EX	4301.00	4851.00	4853.16		4853.43	0.005494	4.16	1033.03	854.99	0.67
Revised Tributar	800	PF 1	PROP	2909.00	4846.75	4851.33		4851.78	0.003250	5.37	542.04	206.47	0.58
Revised Tributar	800	PF 1	EX	4301.00	4851.00	4852.79		4852.99	0.003267	3.60	1194.10	831.03	0.53
Revised Tributar	700	PF 1	PROP	2909.00	4846.43	4850.98		4851.44	0.003414	5.44	534.59	206.85	0.60
Revised Tributar	700	PF 1	EX	4301.00	4850.31	4851.96	4851.88	4852.43	0.010677	5.48	784.63	707.48	0.92
Revised Tributar	600	PF 1	PROP	2909.00	4846.07	4850.68		4851.11	0.003104	5.27	551.50	208.26	0.57
Revised Tributar	600	PF 1	EX	4301.00	4847.78	4851.44		4851.69	0.004604	4.02	1069.38	813.02	0.62
Revised Tributar	503.03	PF 1	PROP	2909.00	4845.87	4850.31		4850.78	0.003622	5.54	525.25	206.93	0.61
Revised Tributar	503.03	PF 1	EX	4301.00	4846.80	4851.02		4851.26	0.004181	3.92	1097.20	805.85	0.59
Revised Tributar	300	PF 1	PROP	2909.00	4845.51	4849.69		4849.94	0.004000	4.03	721.95	494.56	0.59
Revised Tributar	300	PF 1	EX	4301.00	4847.00	4850.10		4850.39	0.004330	4.35	989.18	638.74	0.62
Revised Tributar	200	PF 1	PROP	2909.00	4845.34	4849.27	4848.60	4849.54	0.003966	4.21	691.38	440.96	0.59
Revised Tributar	200	PF 1	EX	4301.00	4846.49	4849.45		4849.87	0.005963	5.22	824.56	514.59	0.73
Revised Tributar	0	PF 1	PROP	2909.00	4845.00	4848.32	4847.81	4848.67	0.004808	4.75	612.11	375.95	0.66
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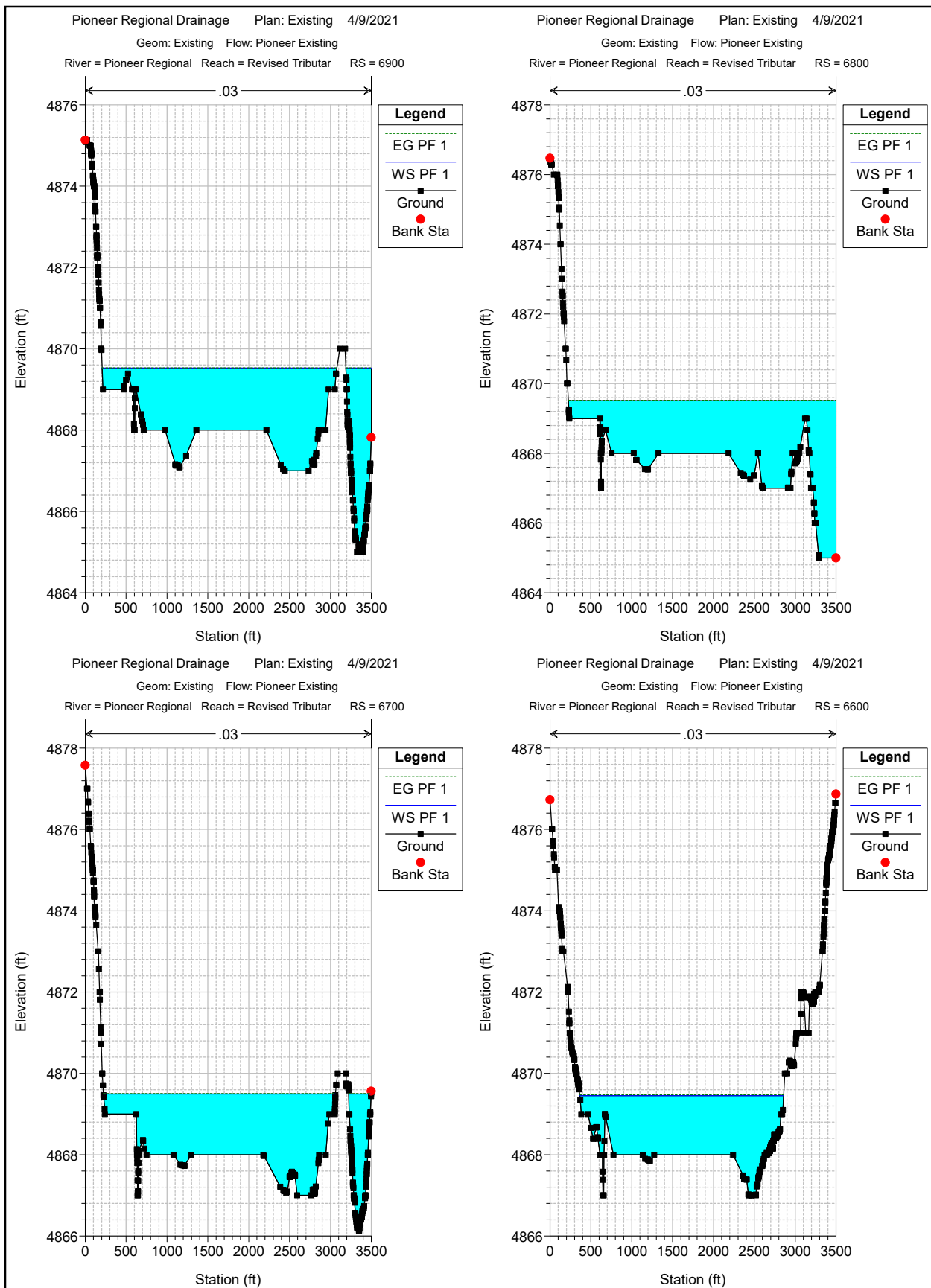


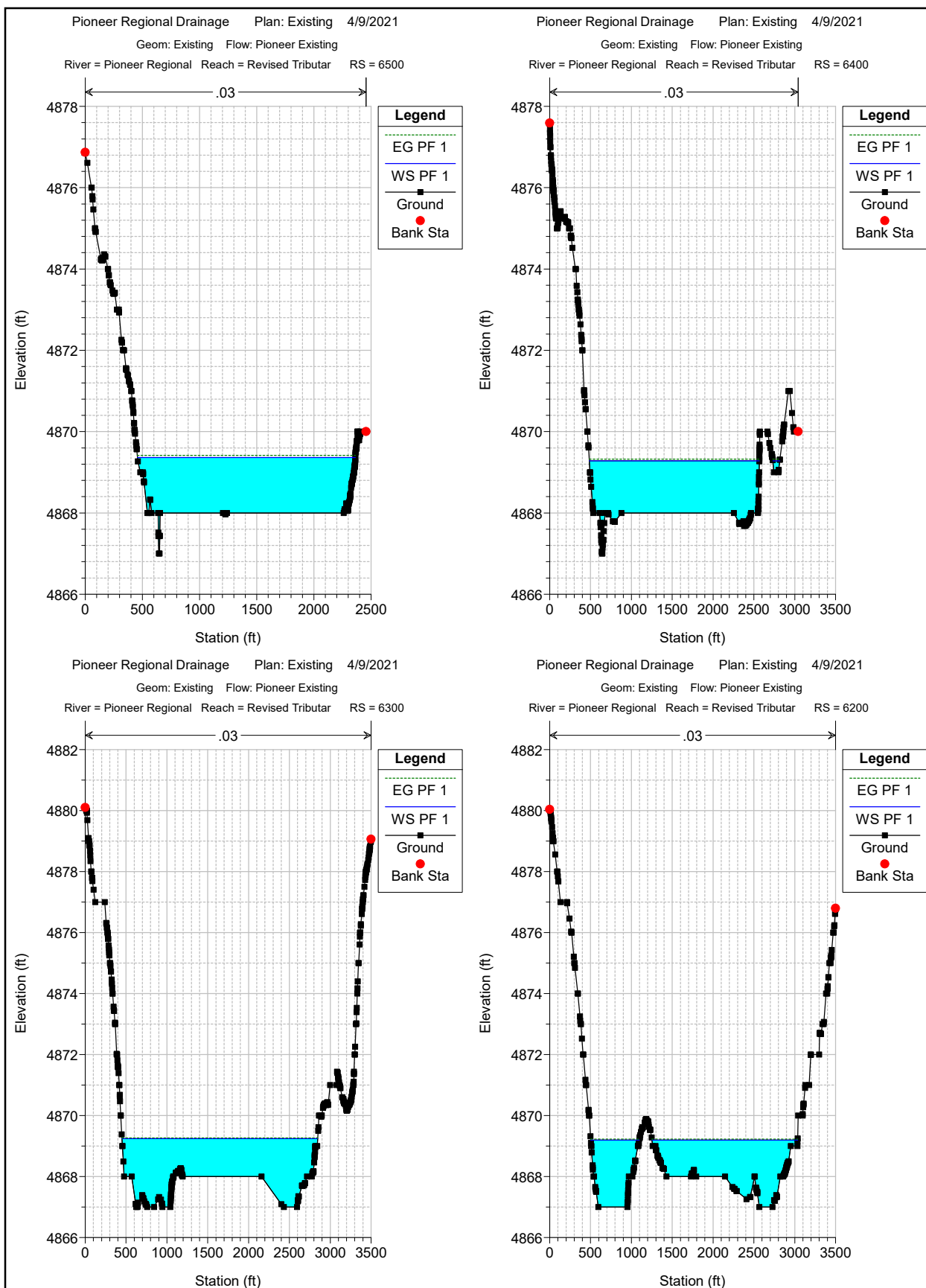
Pioneer Regional Drainage Plan: Existing 4/9/2021  
Geom: Existing Flow: Pioneer Existing

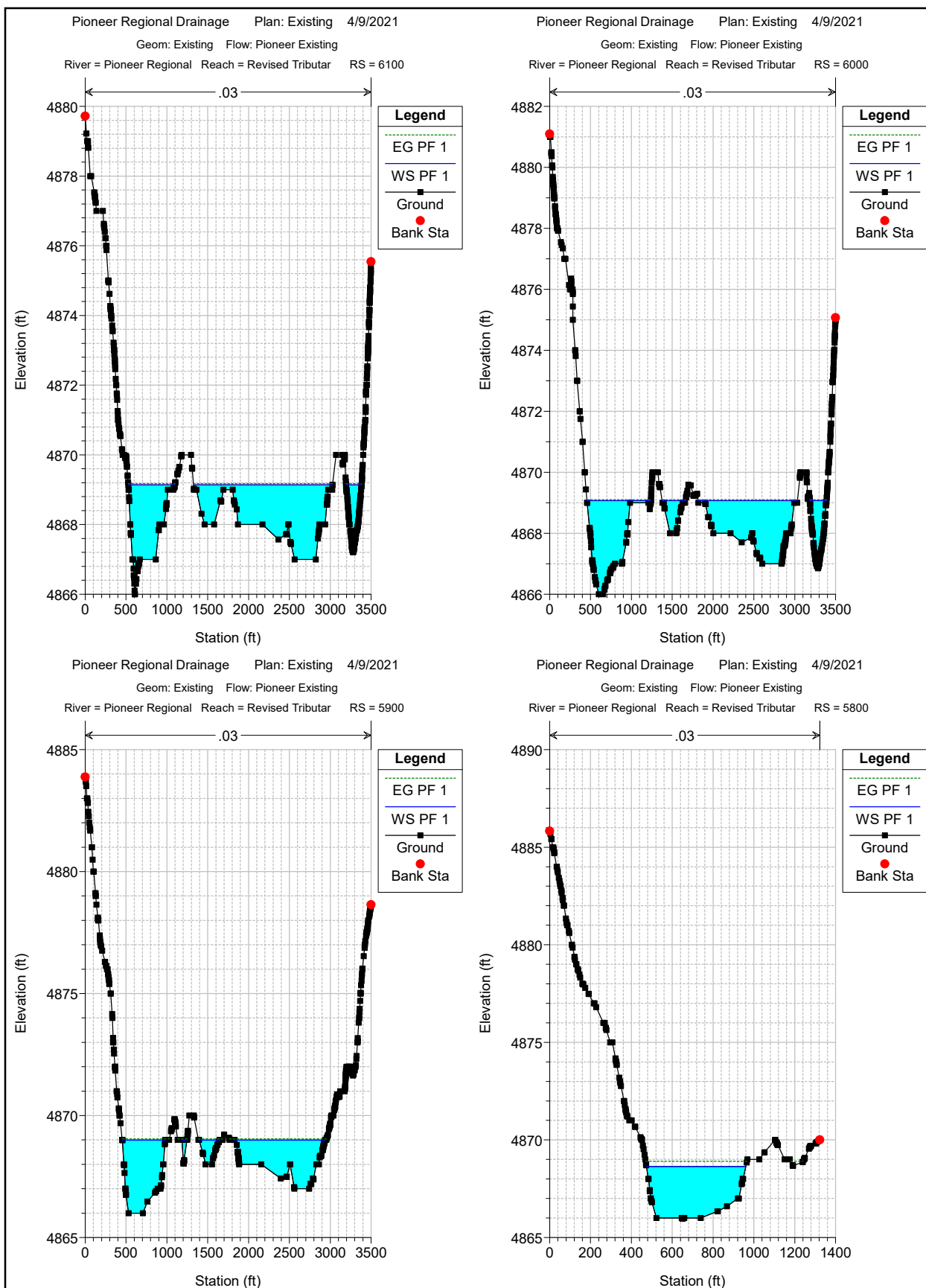


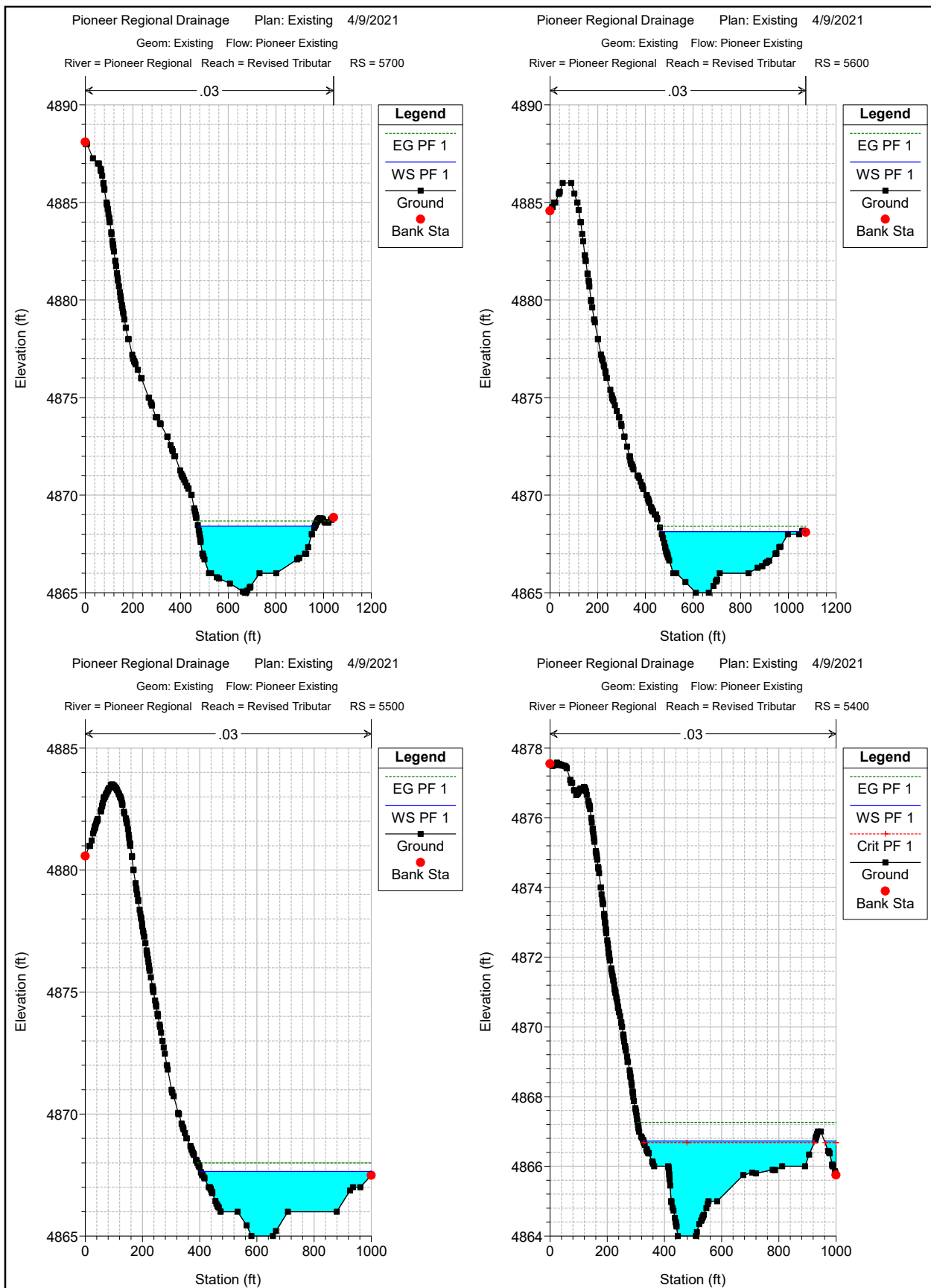


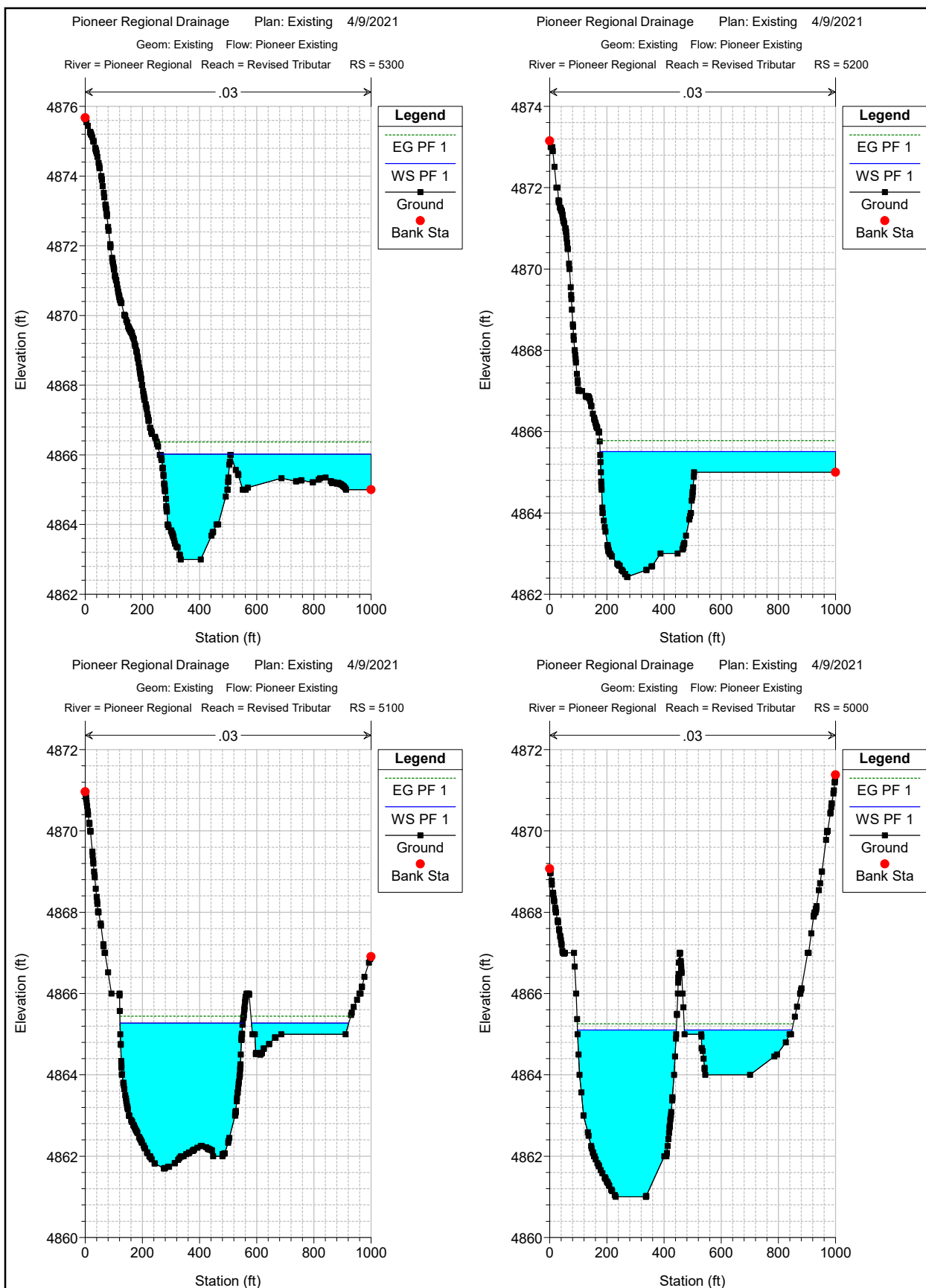


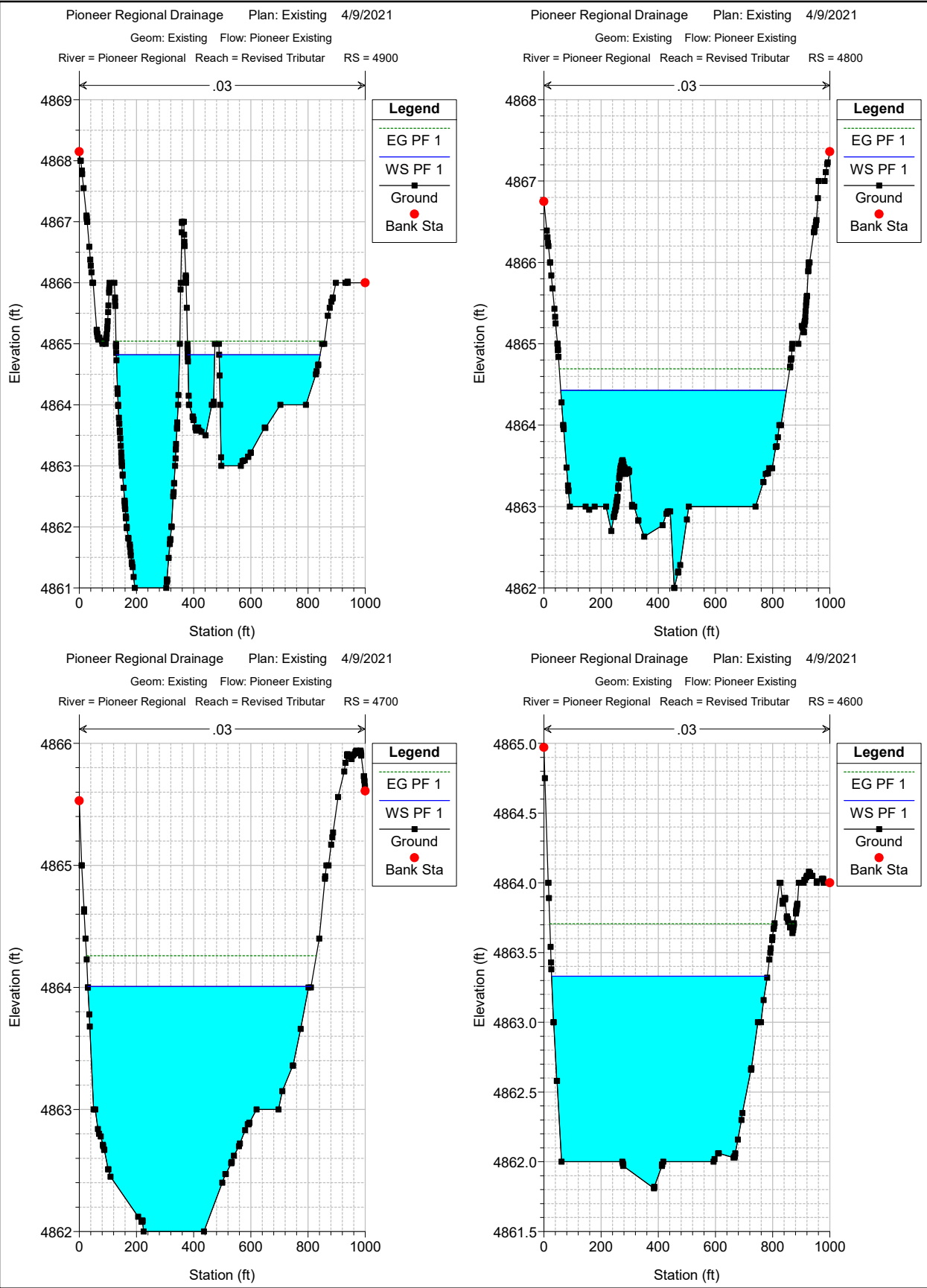


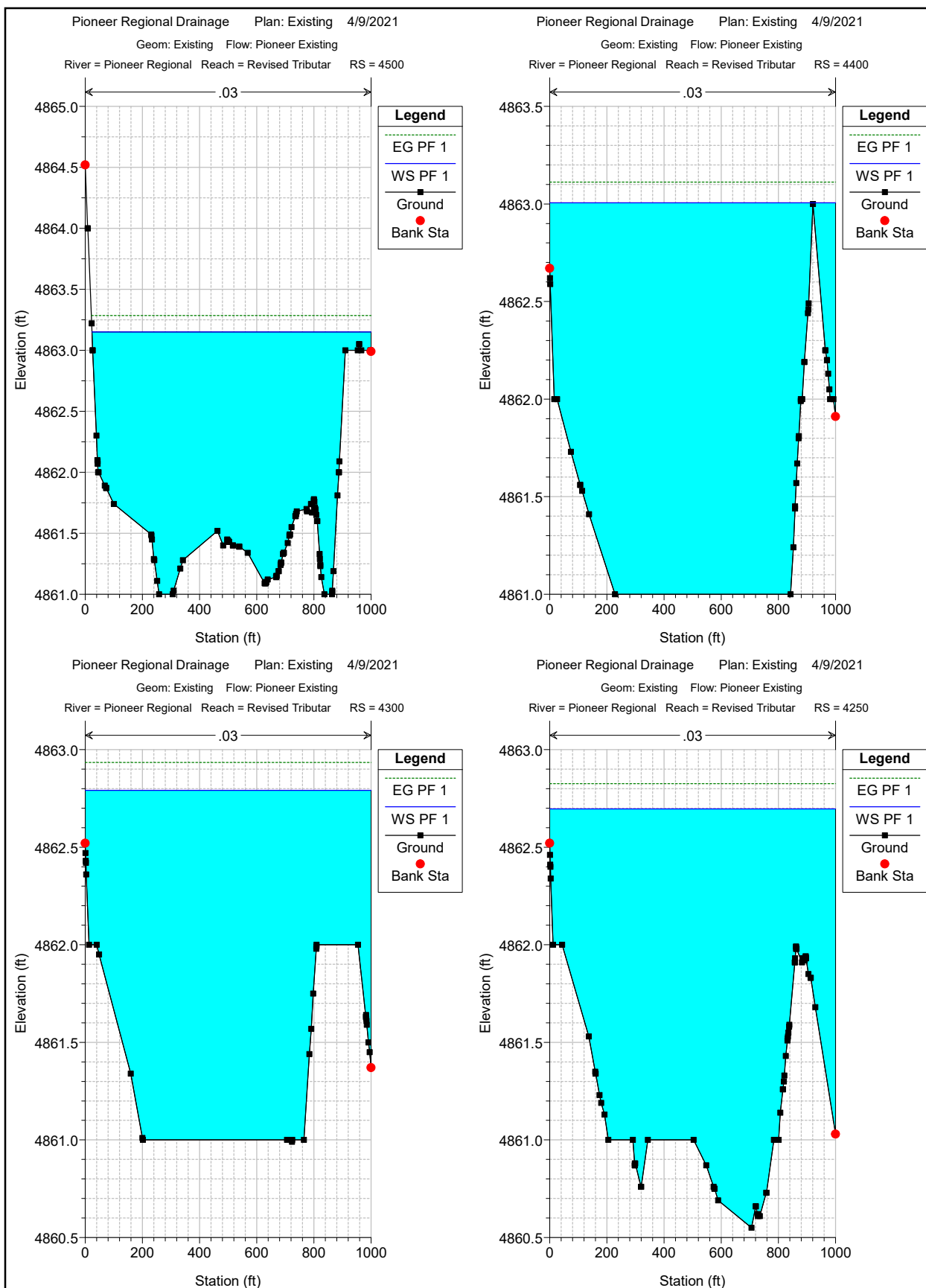




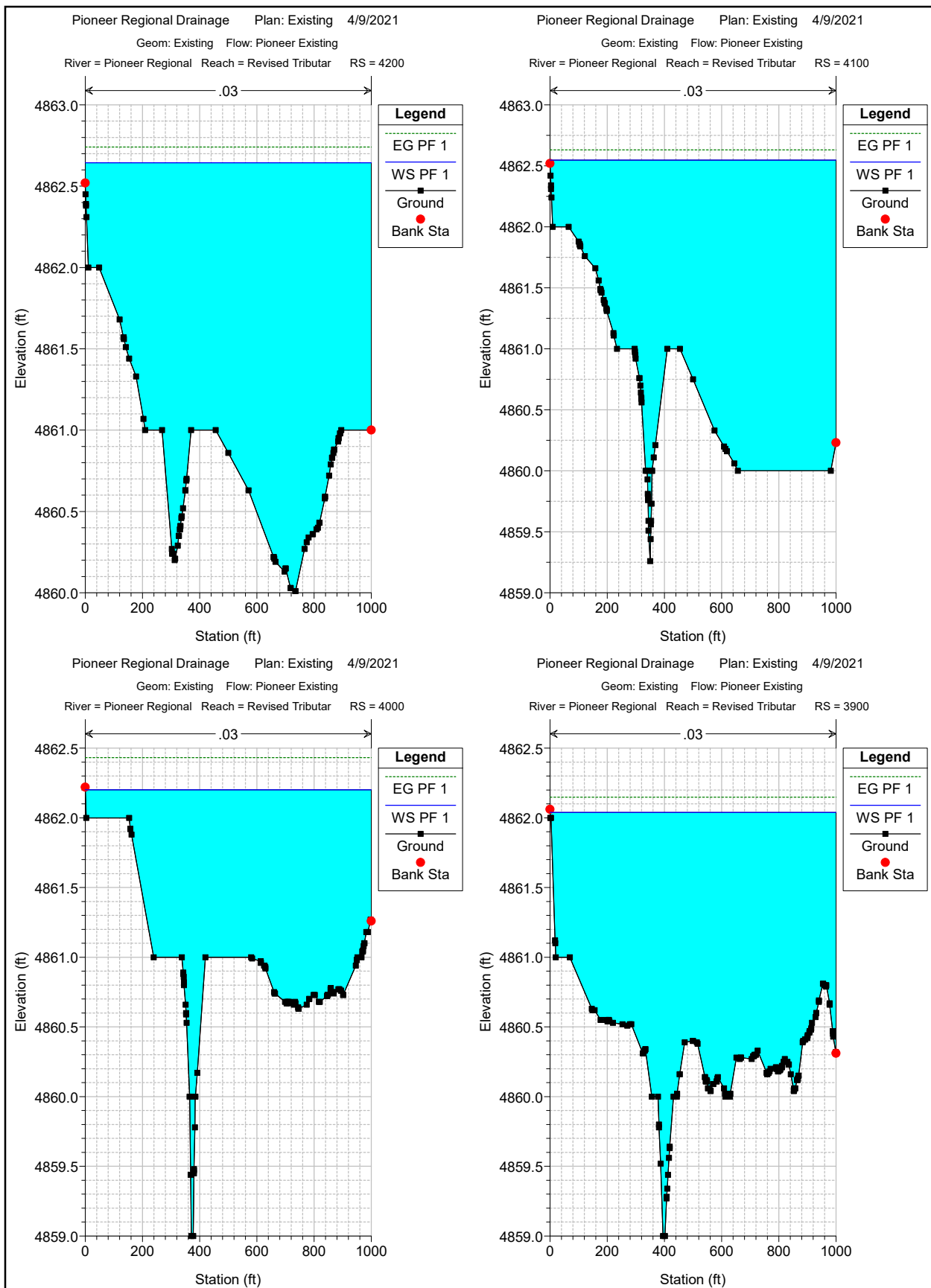


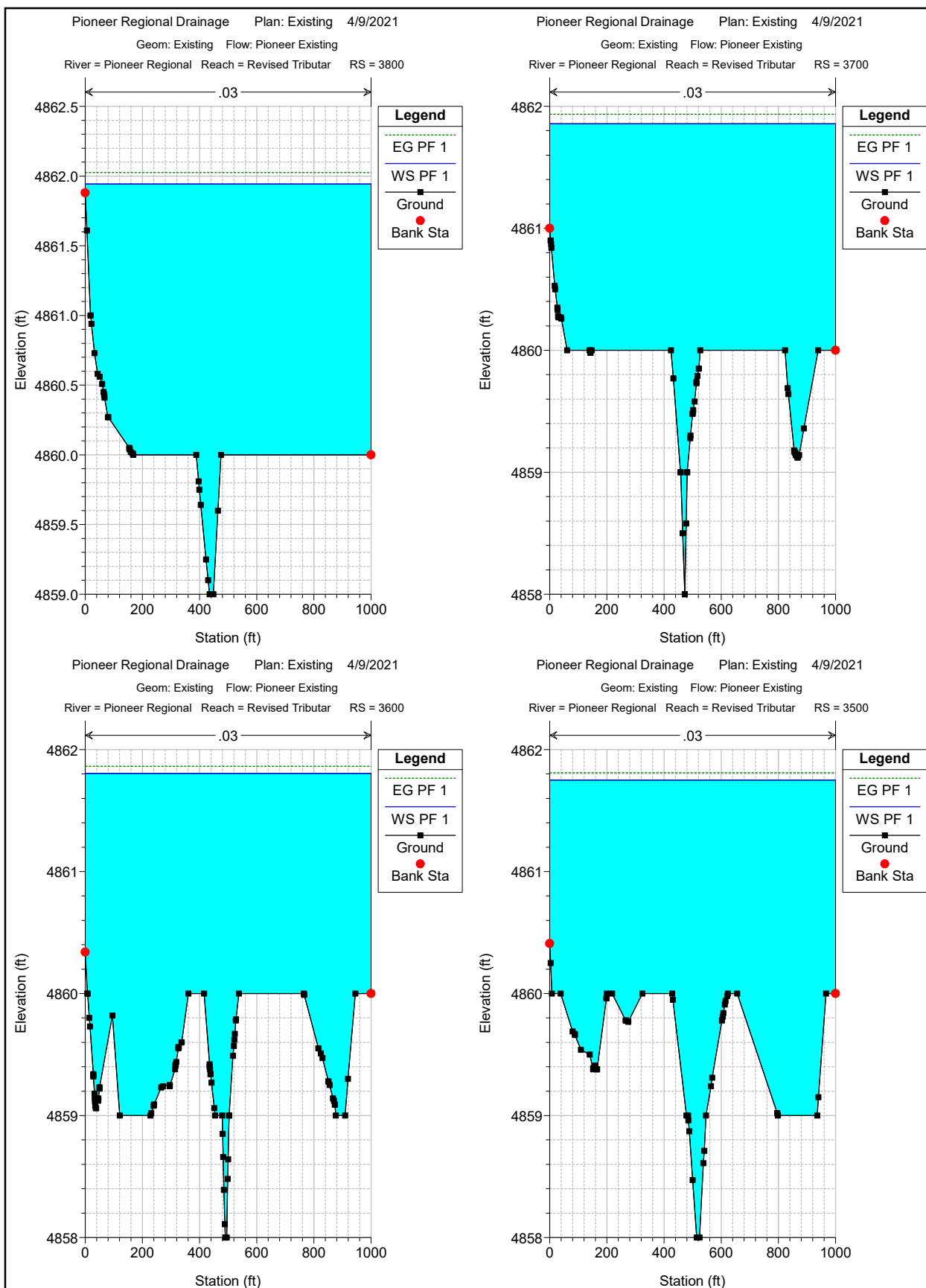


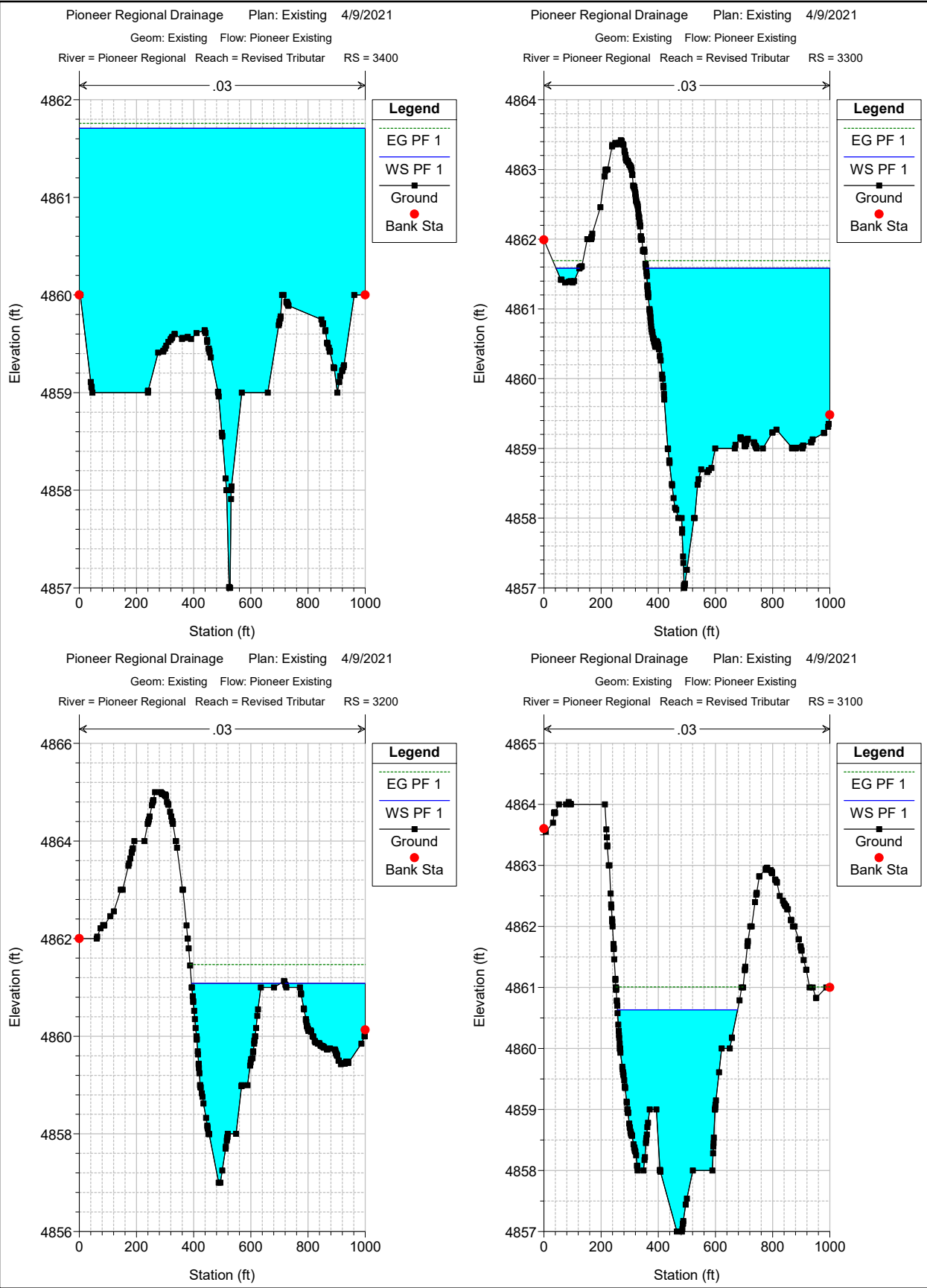


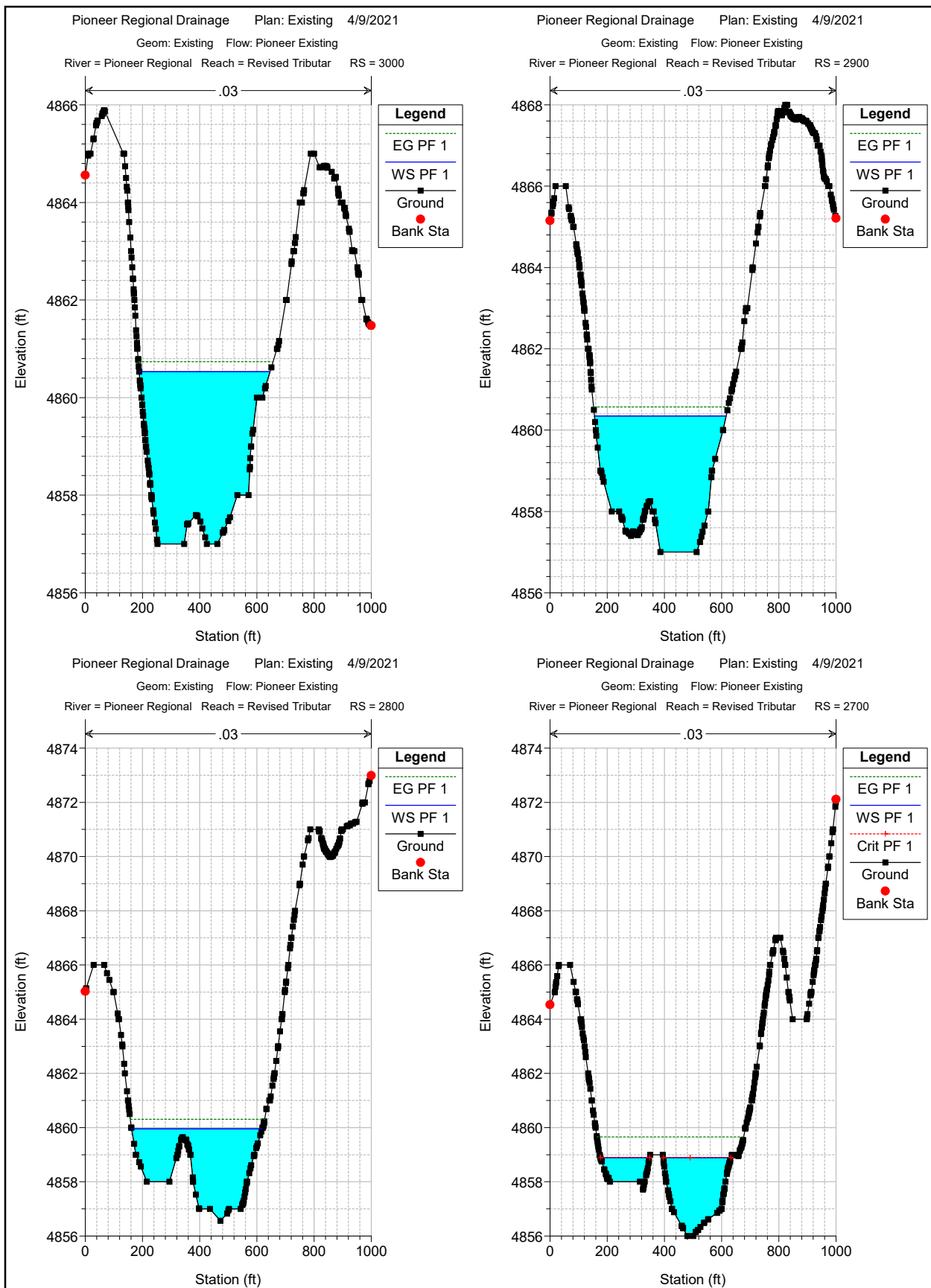


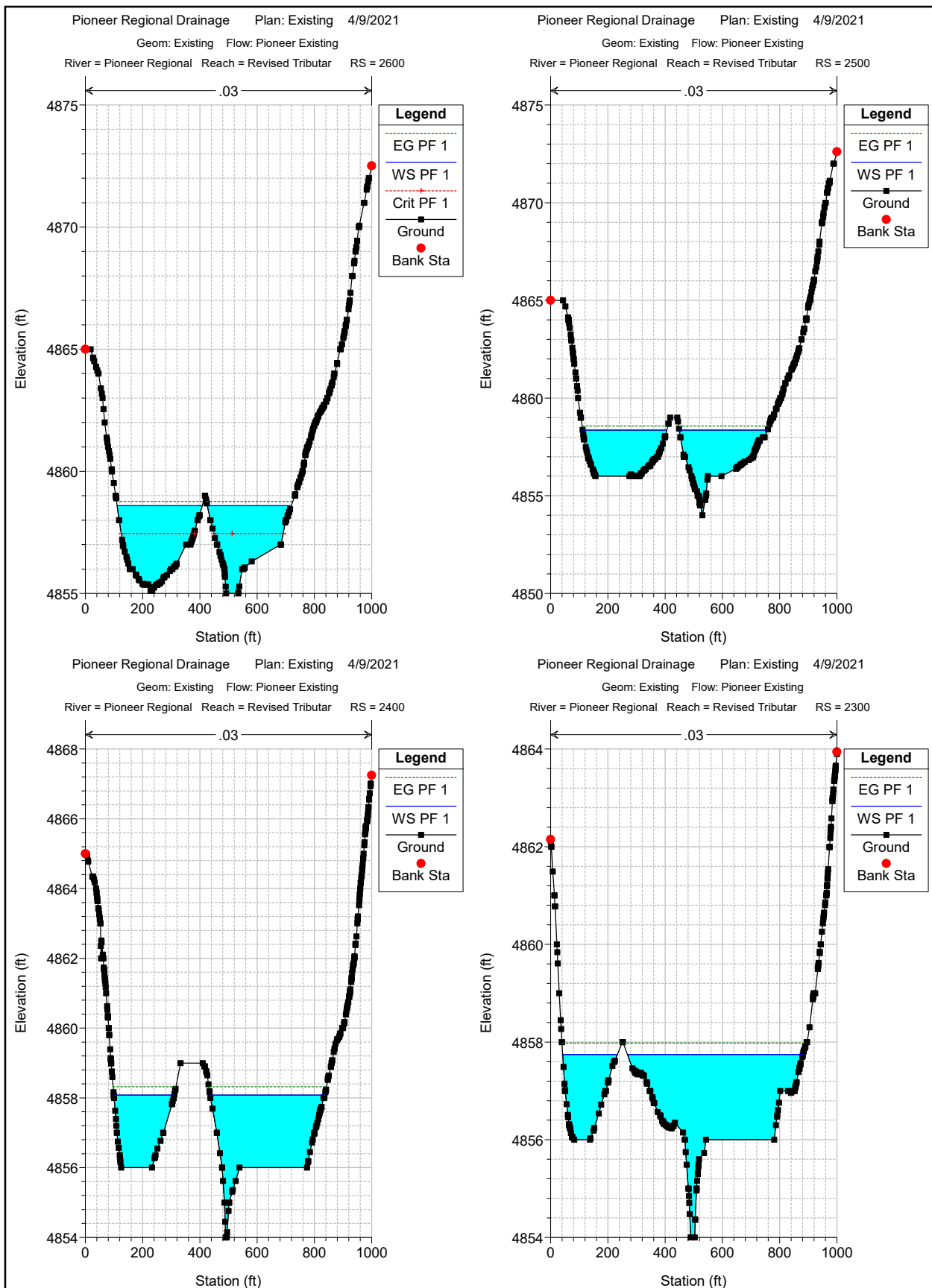


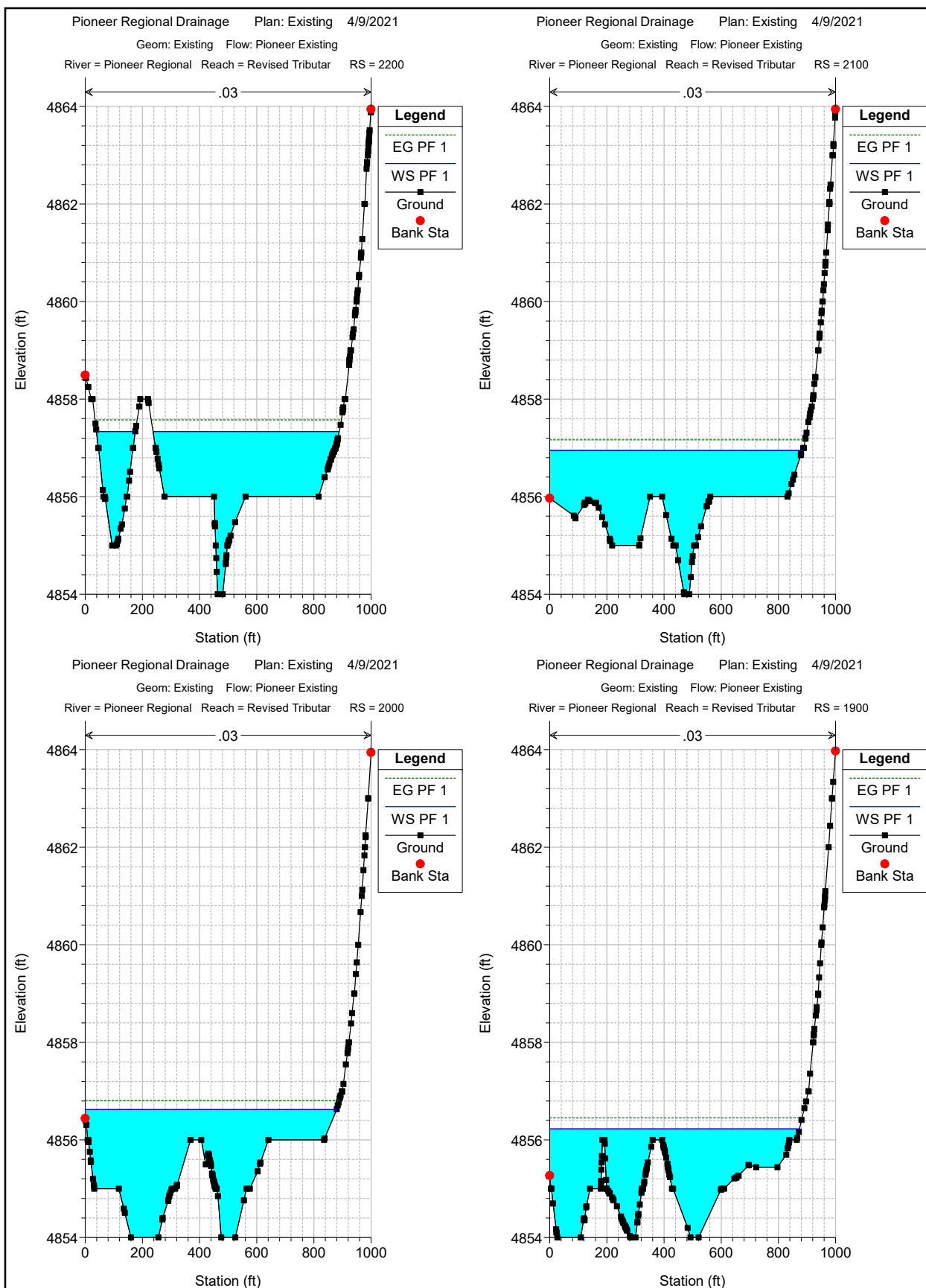


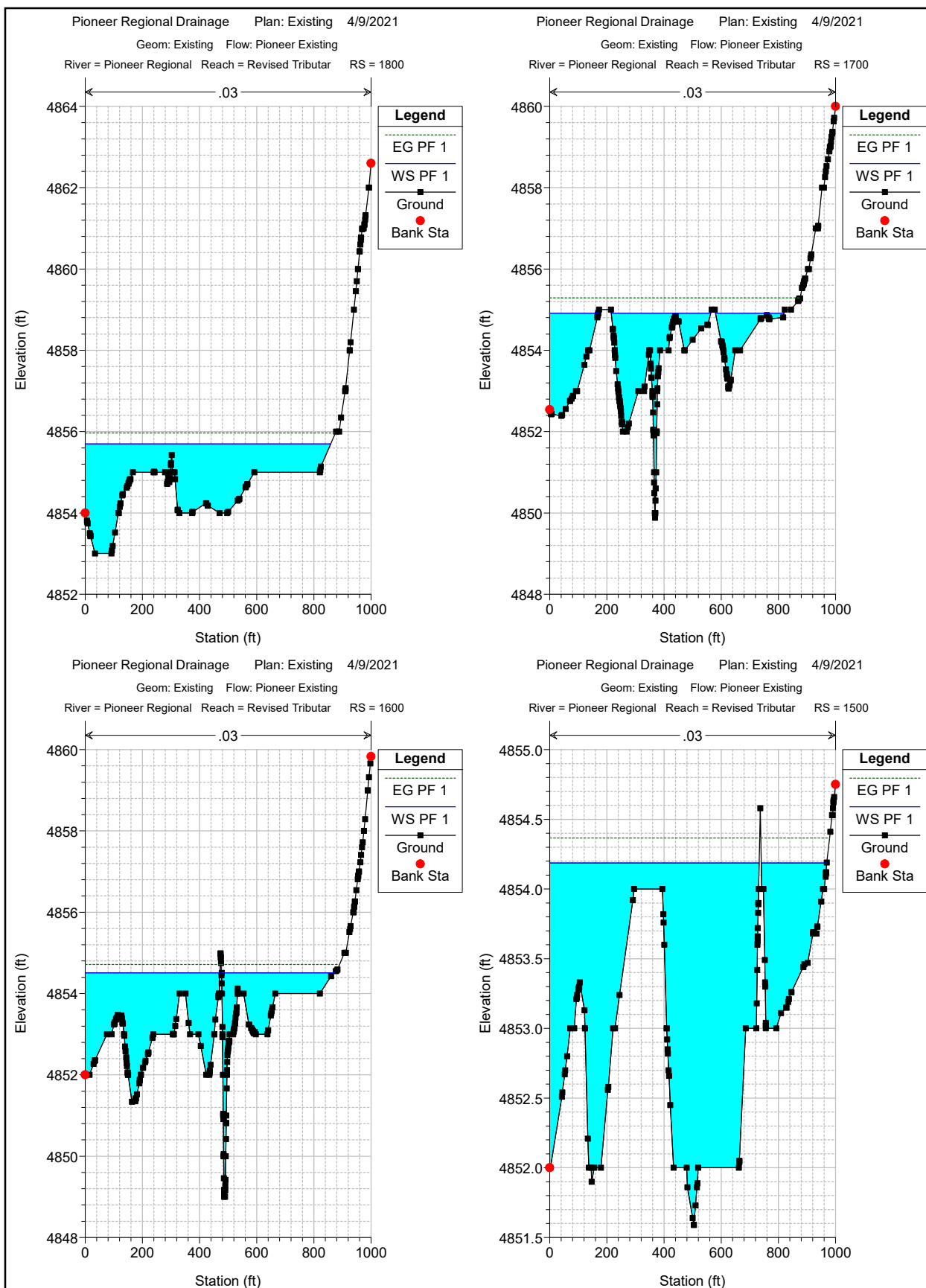


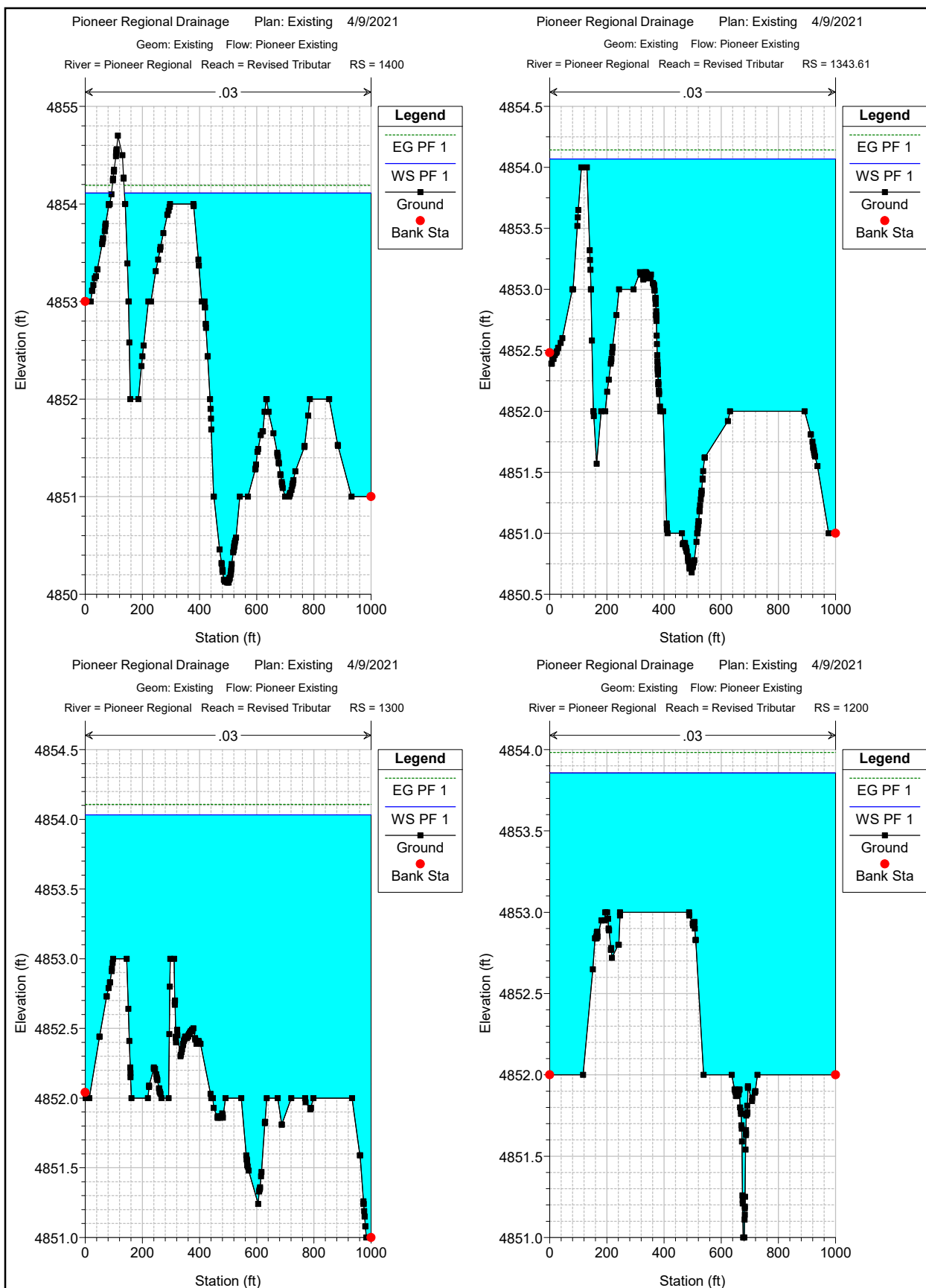




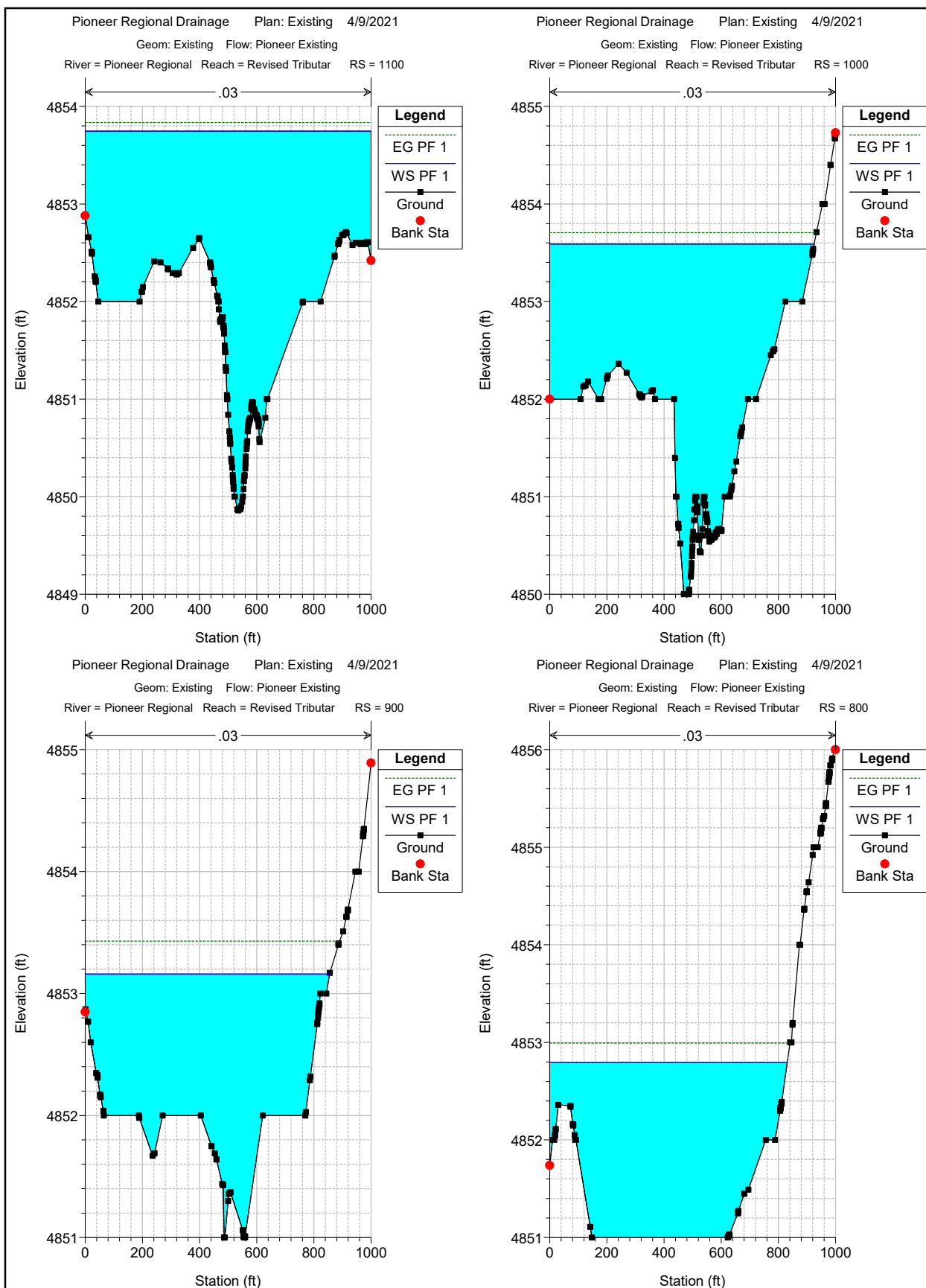


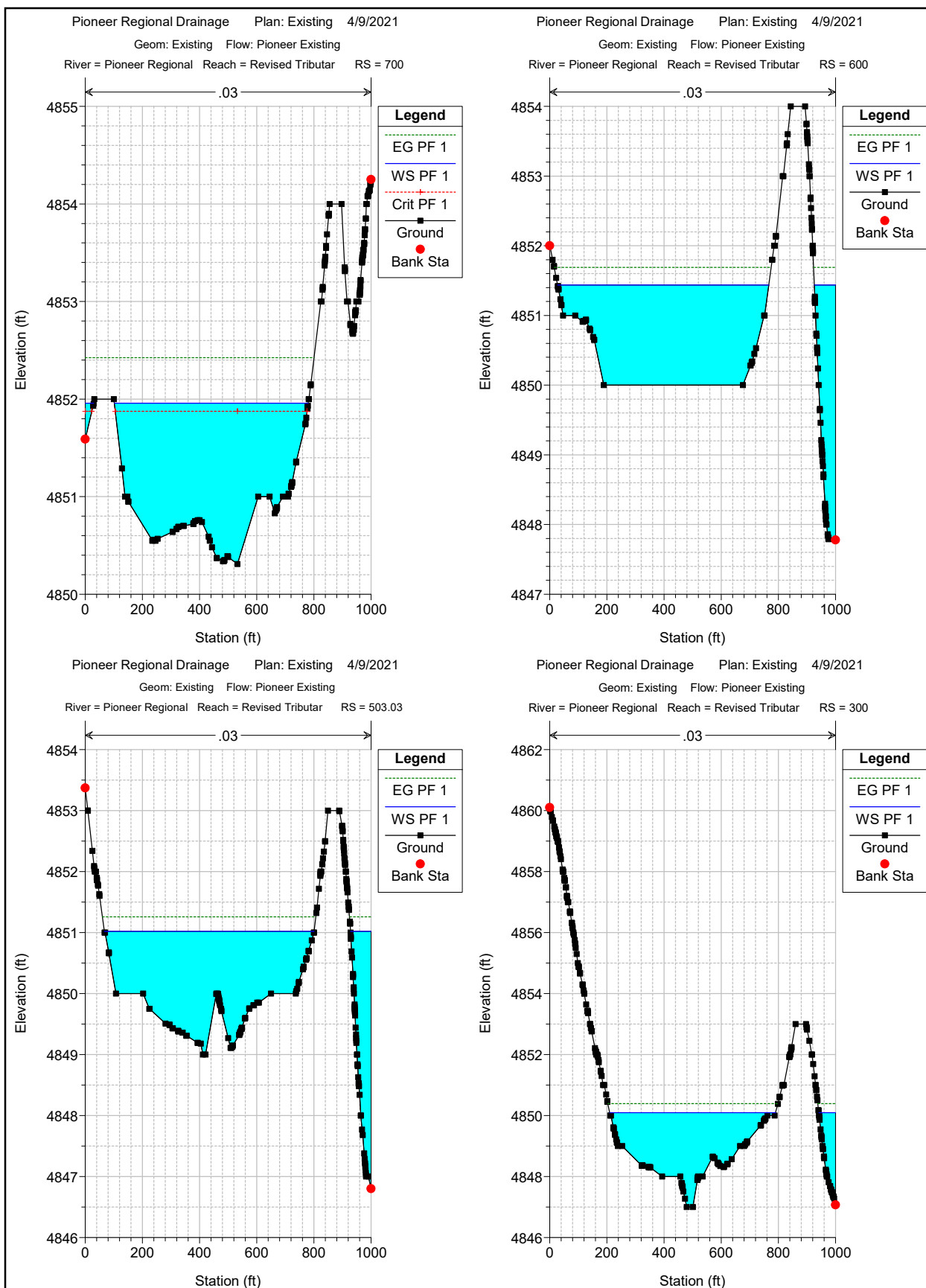


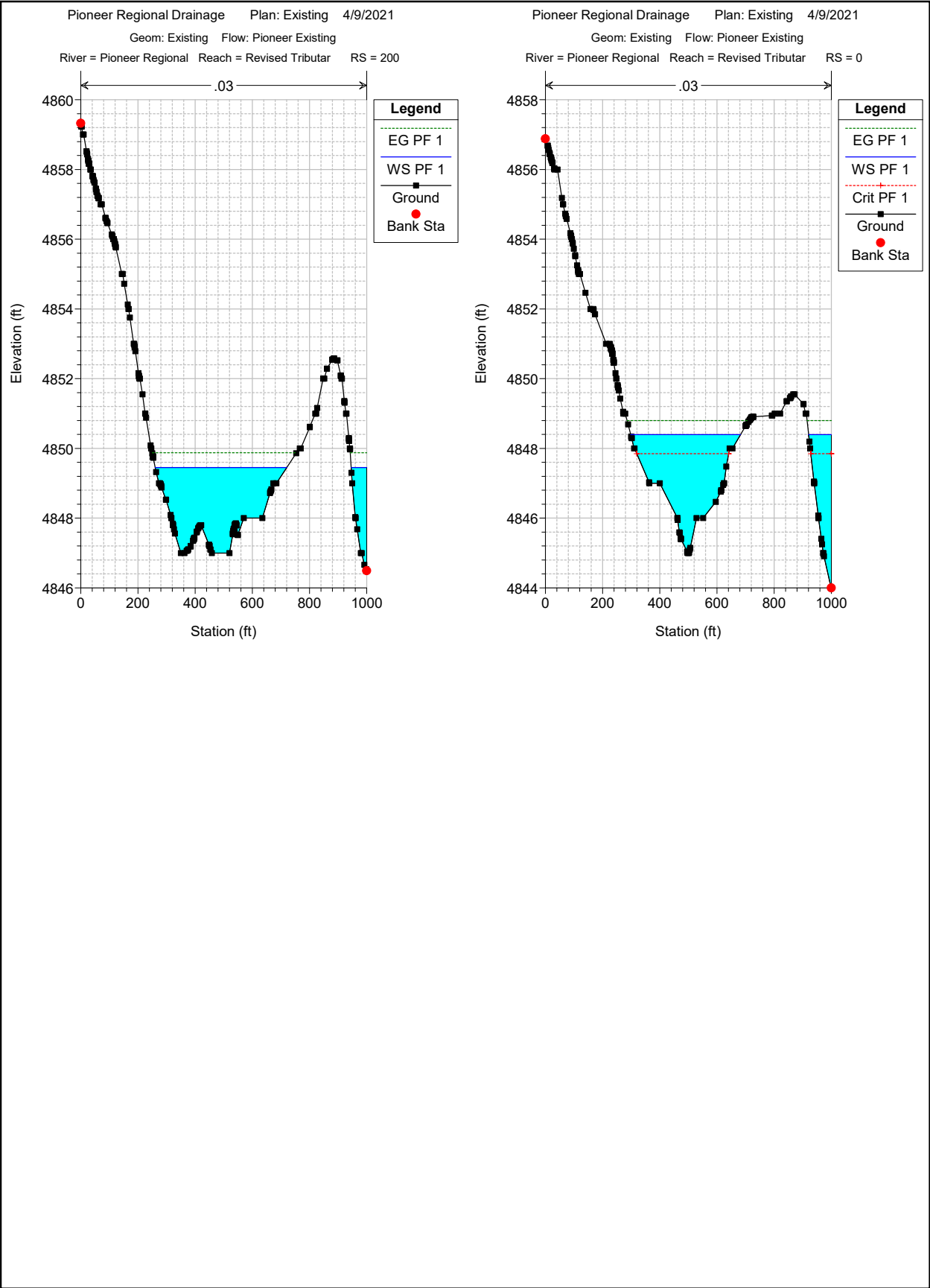


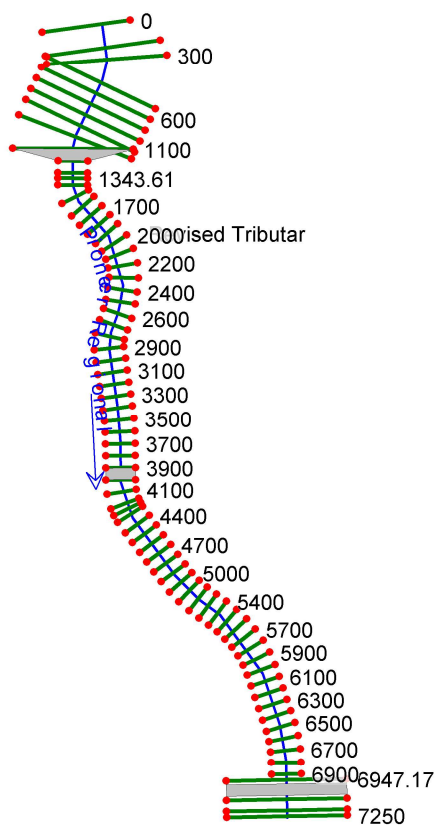






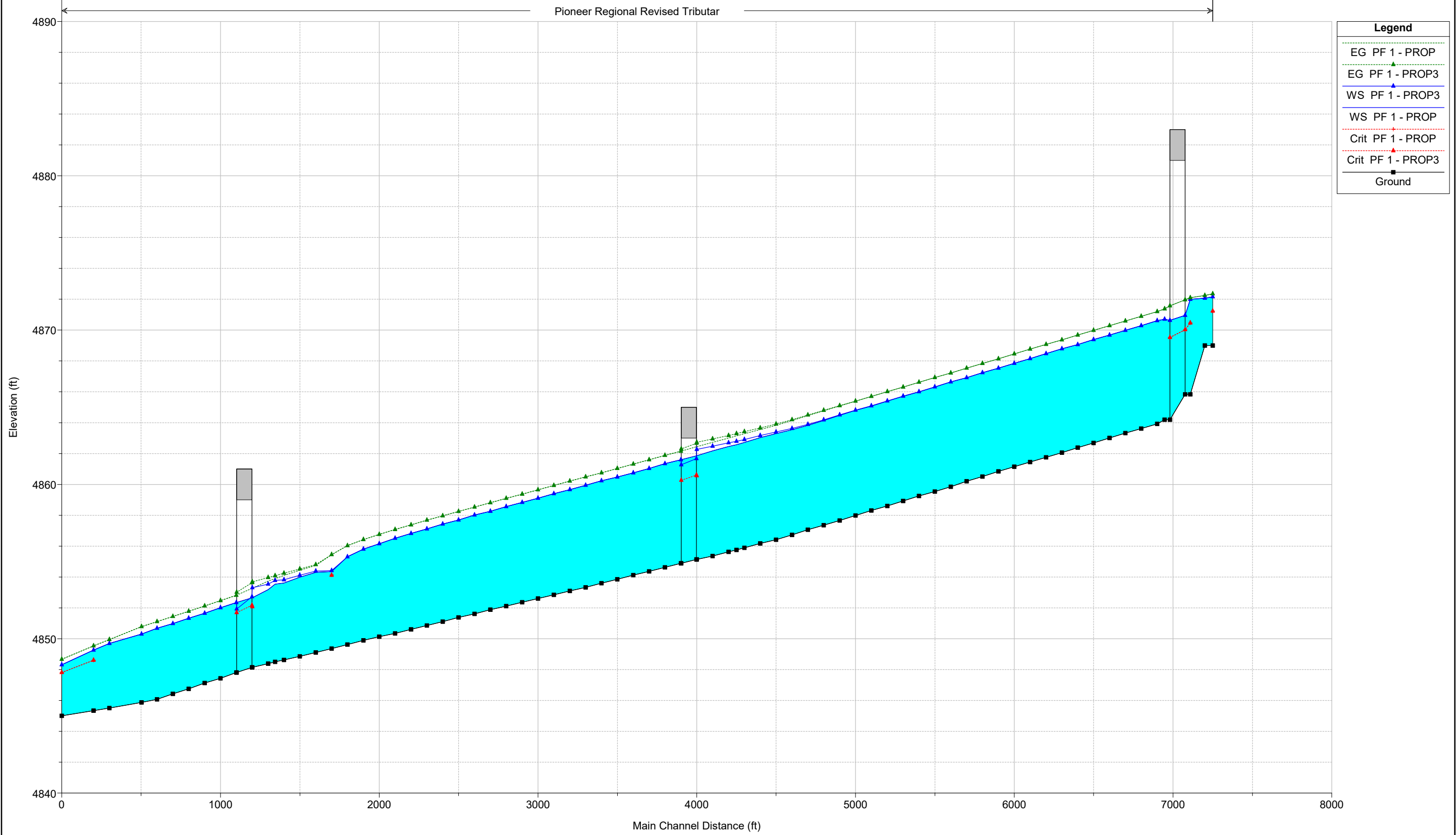


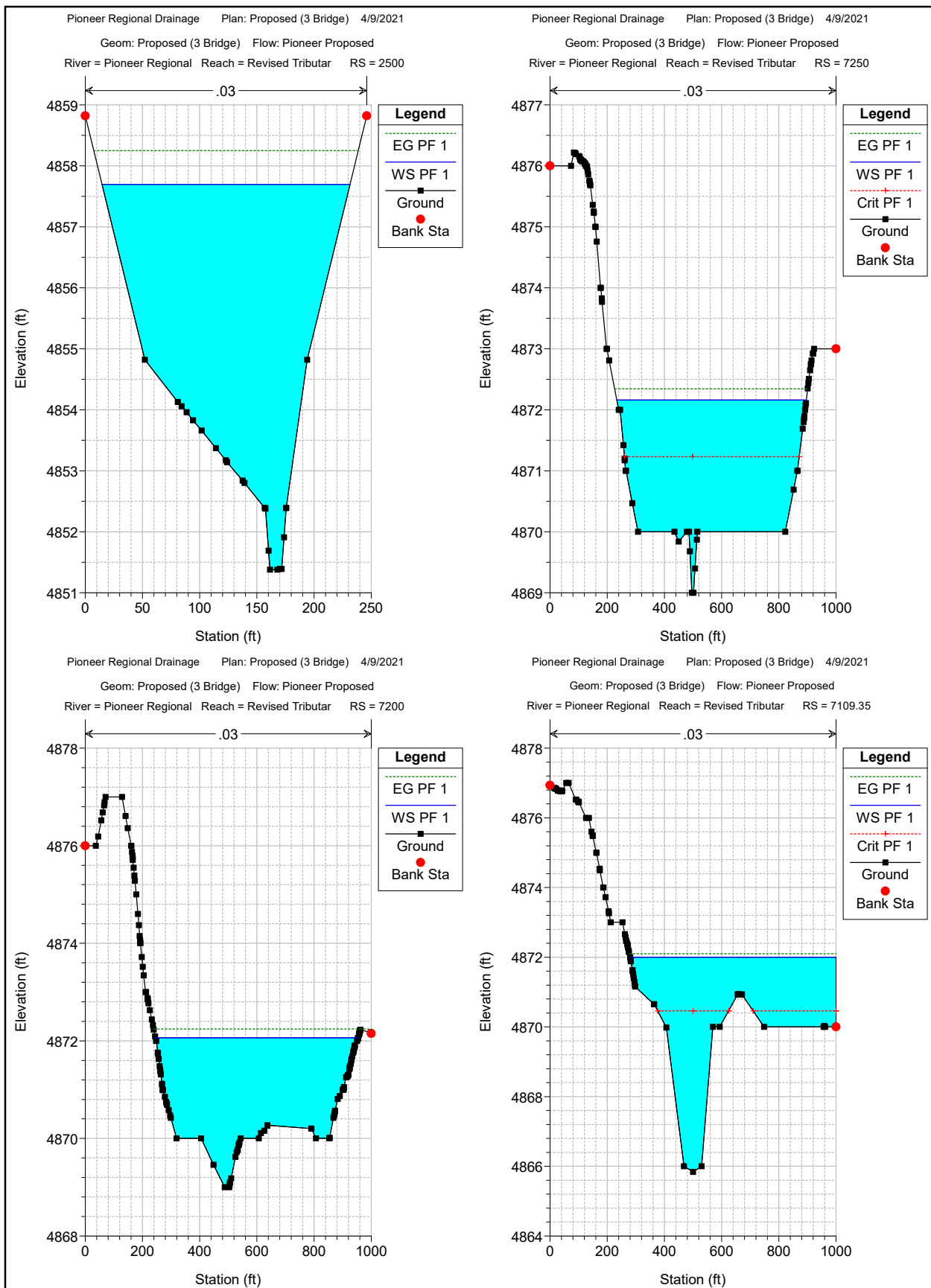


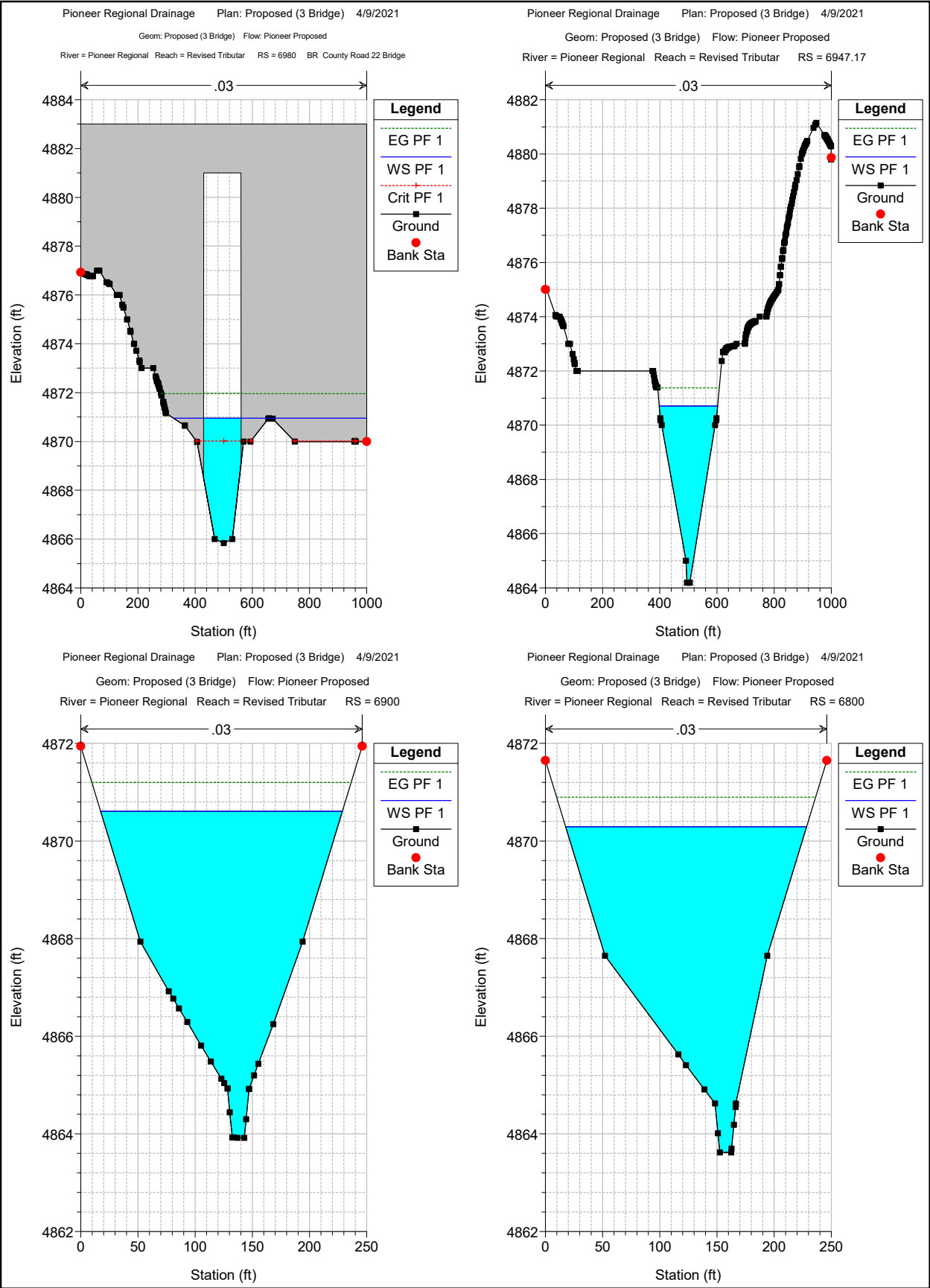


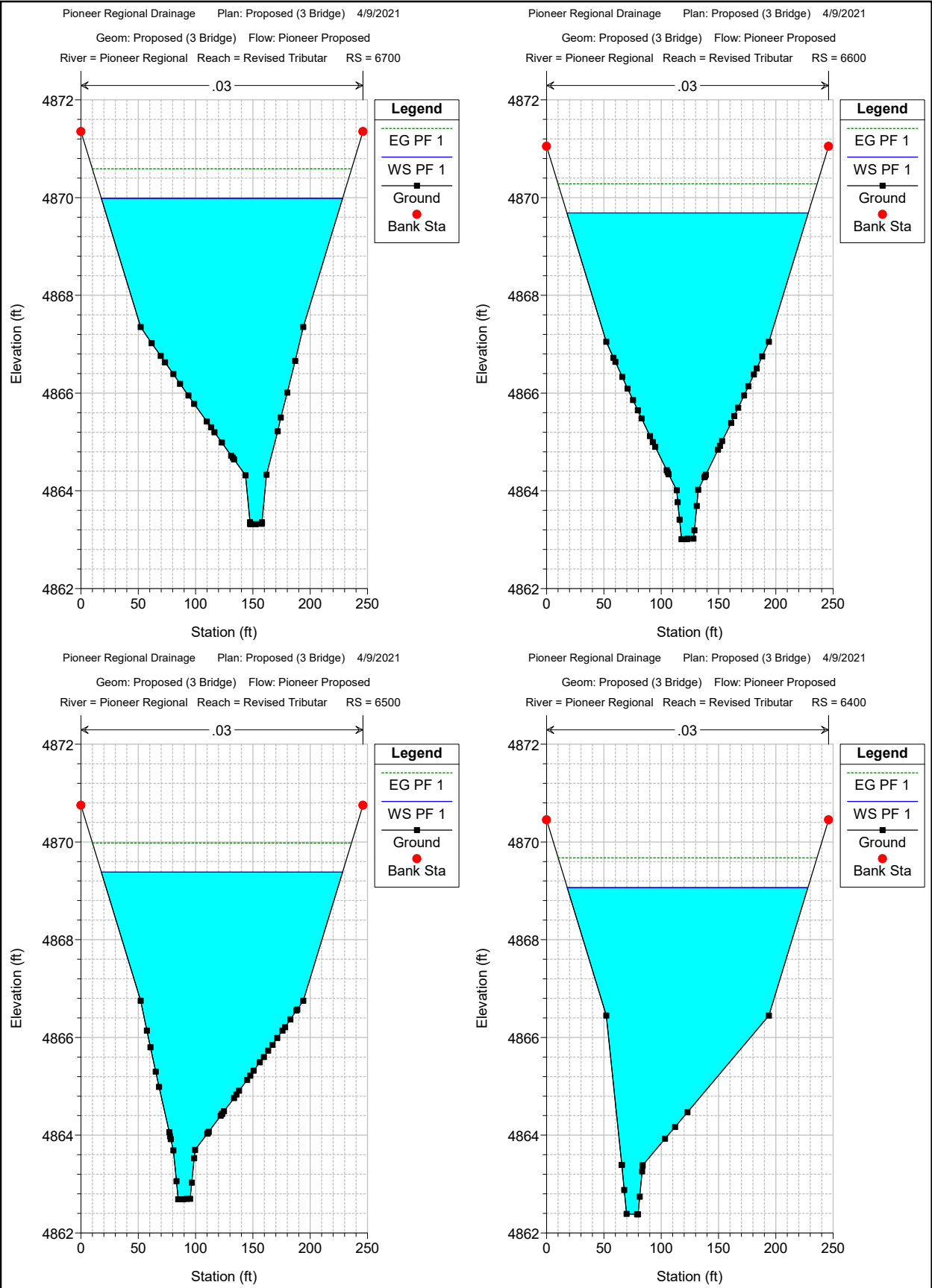
Pioneer Regional Drainage Plan: 1) PROP 4/9/2021 2) PROP3 4/9/2021  
Geom: Proposed (3 Bridge) Flow: Pioneer Proposed

Pioneer Regional Revised Tributar

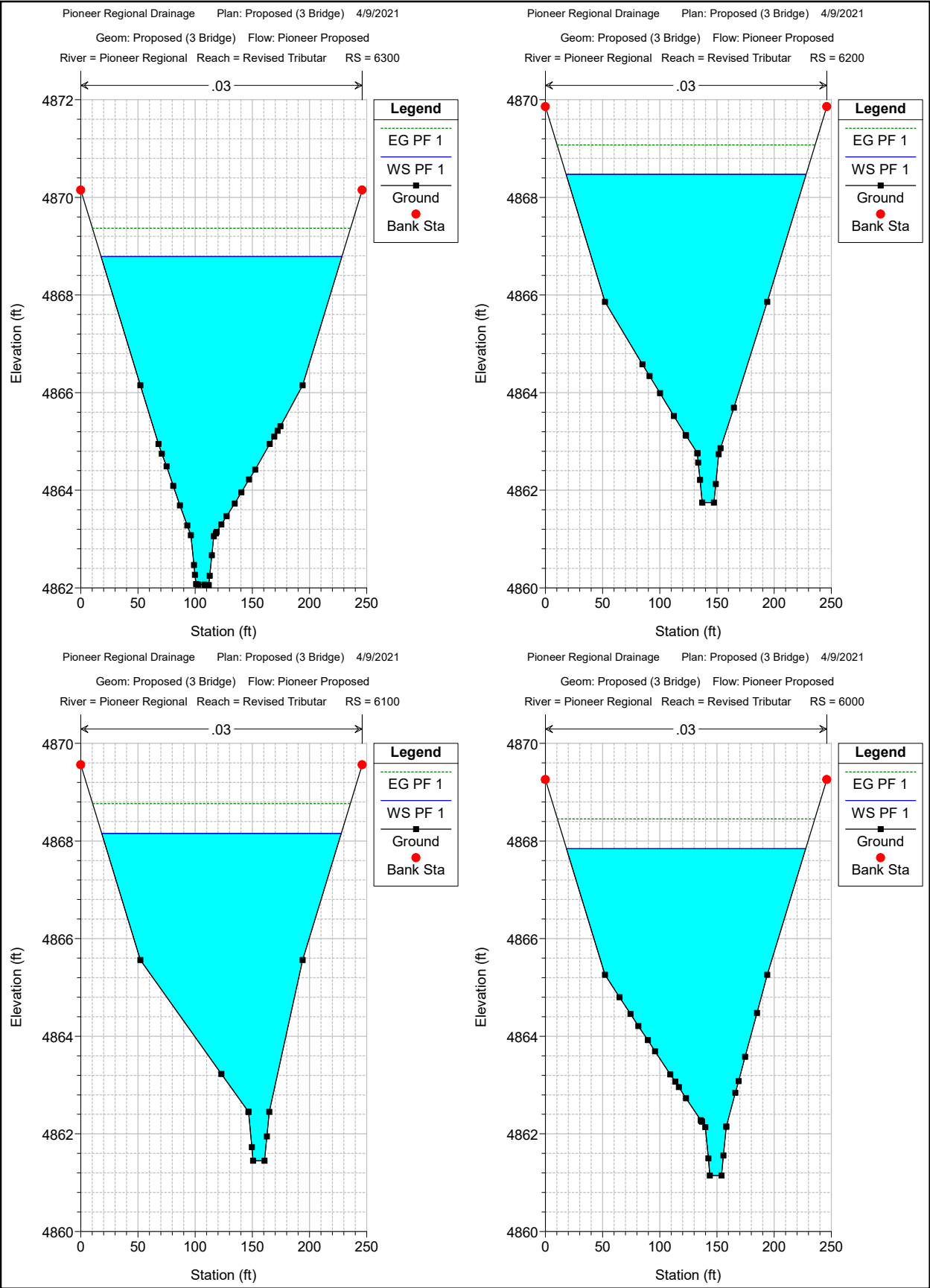


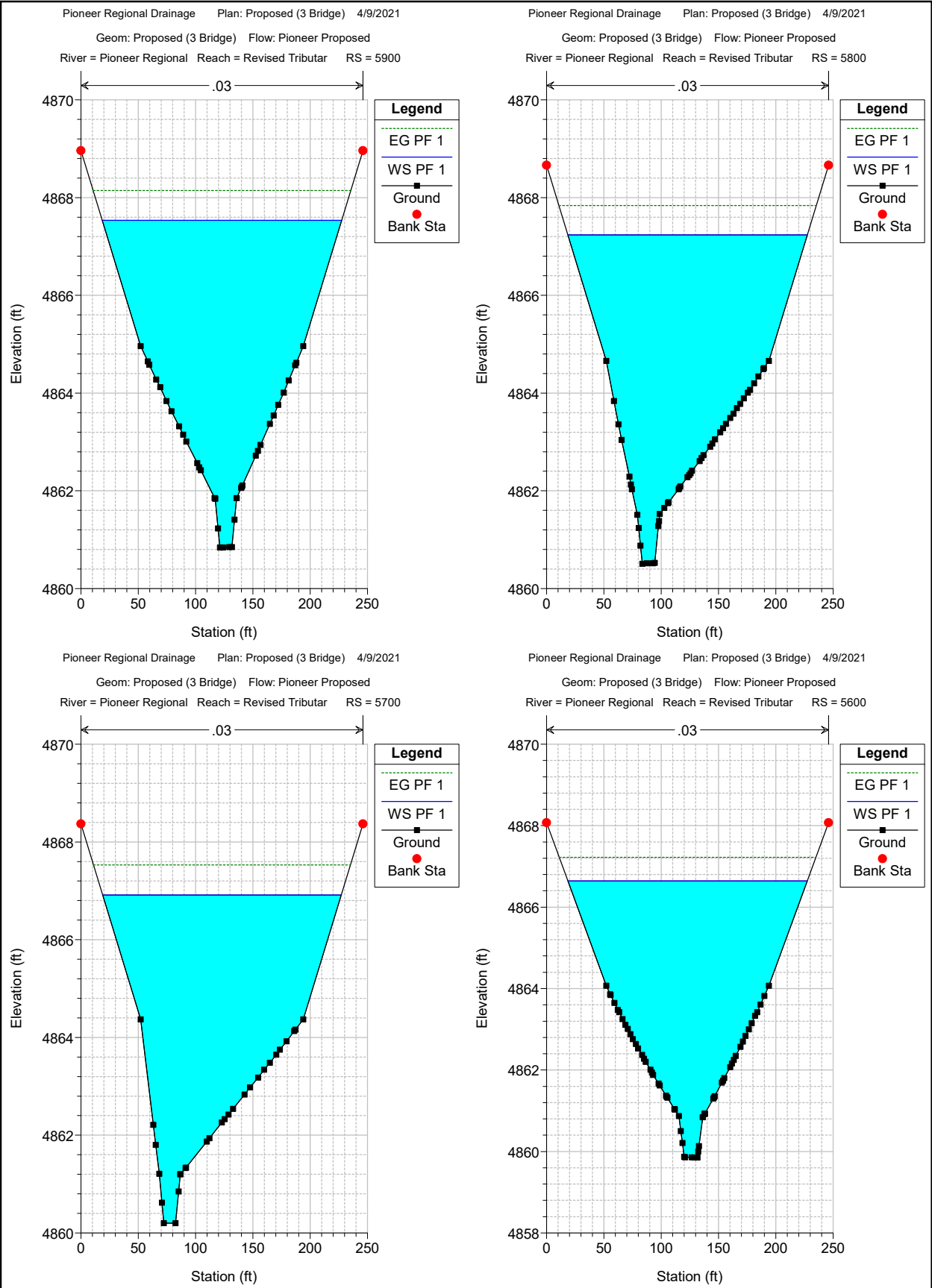


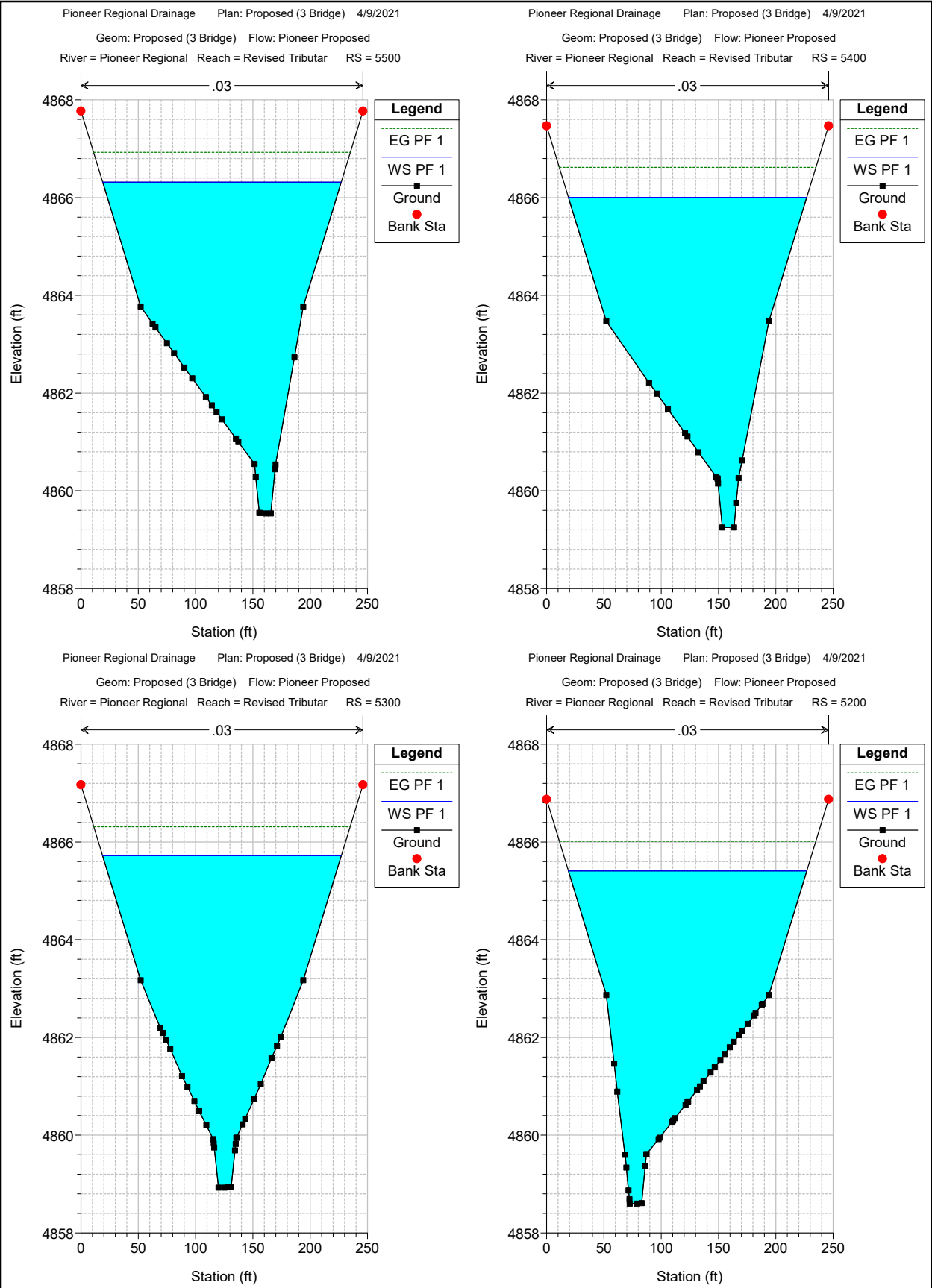


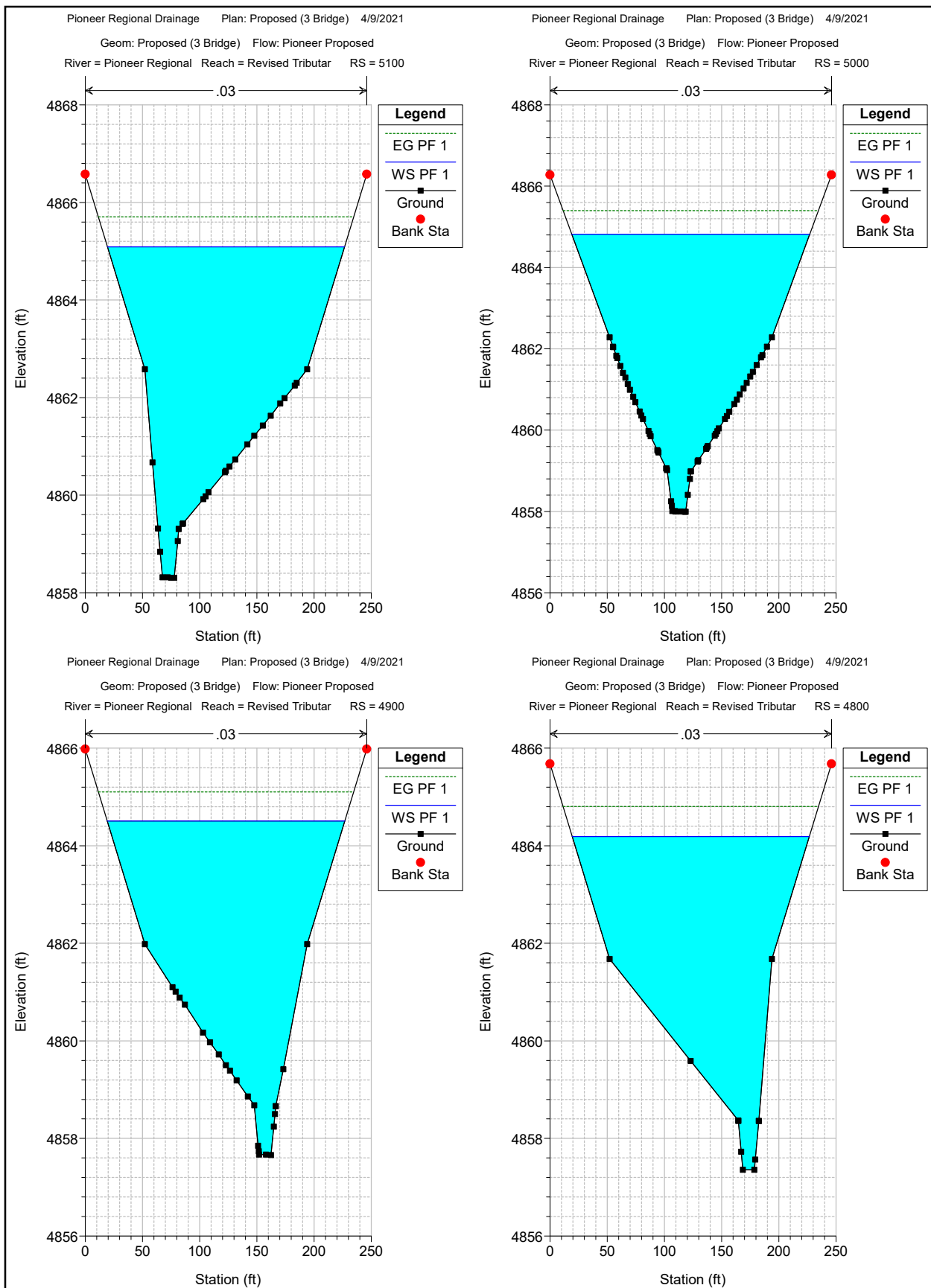


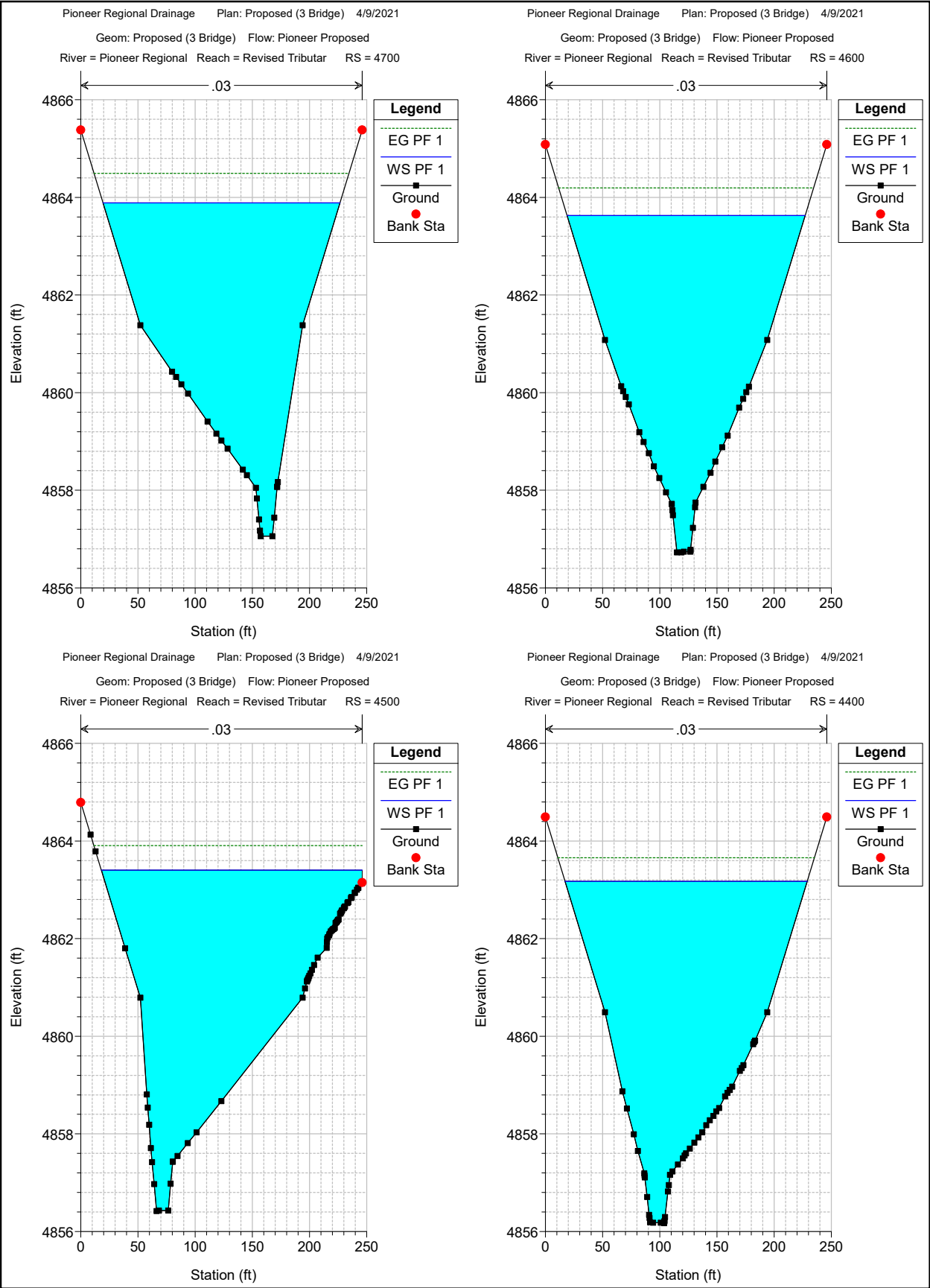


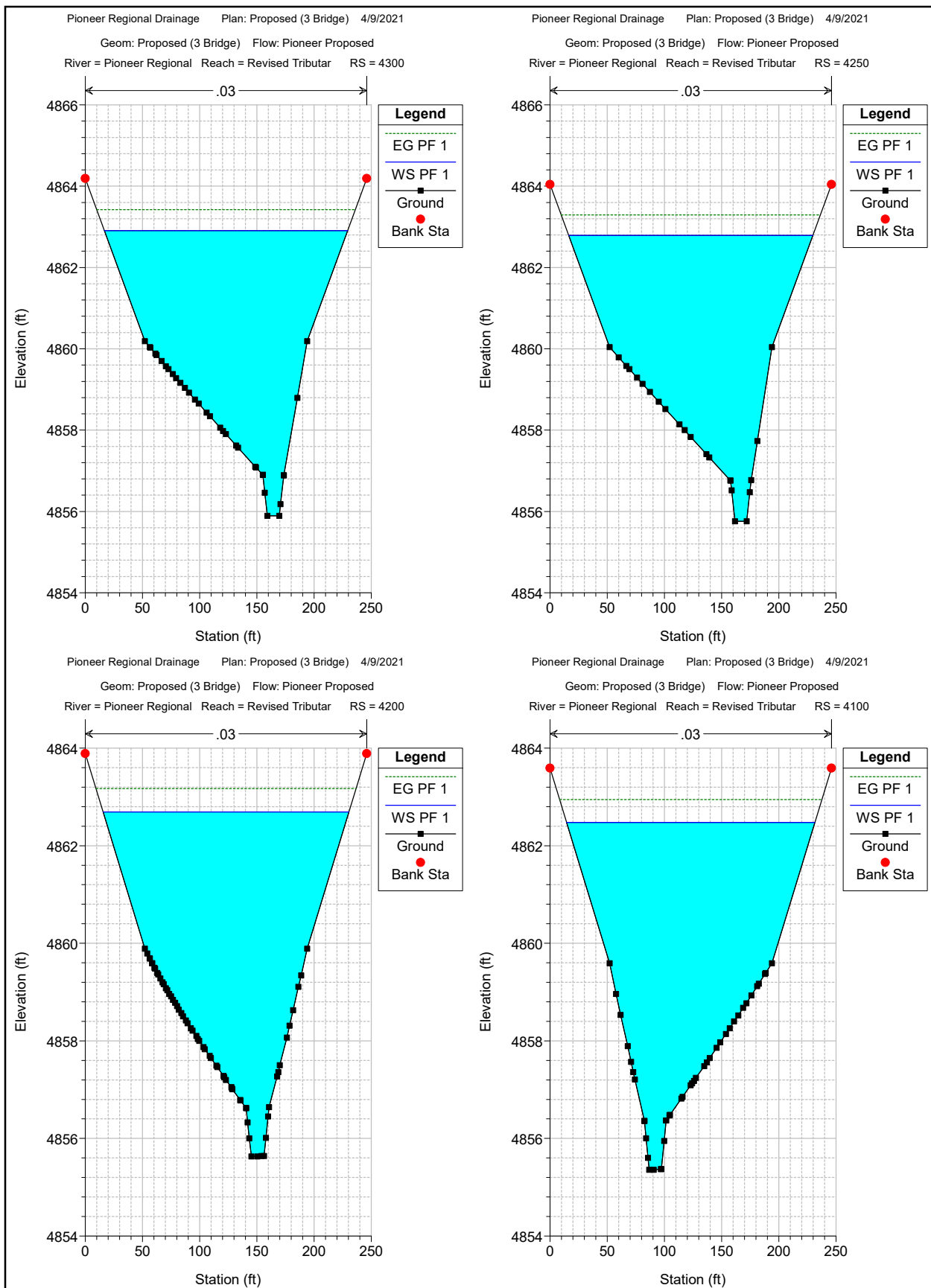


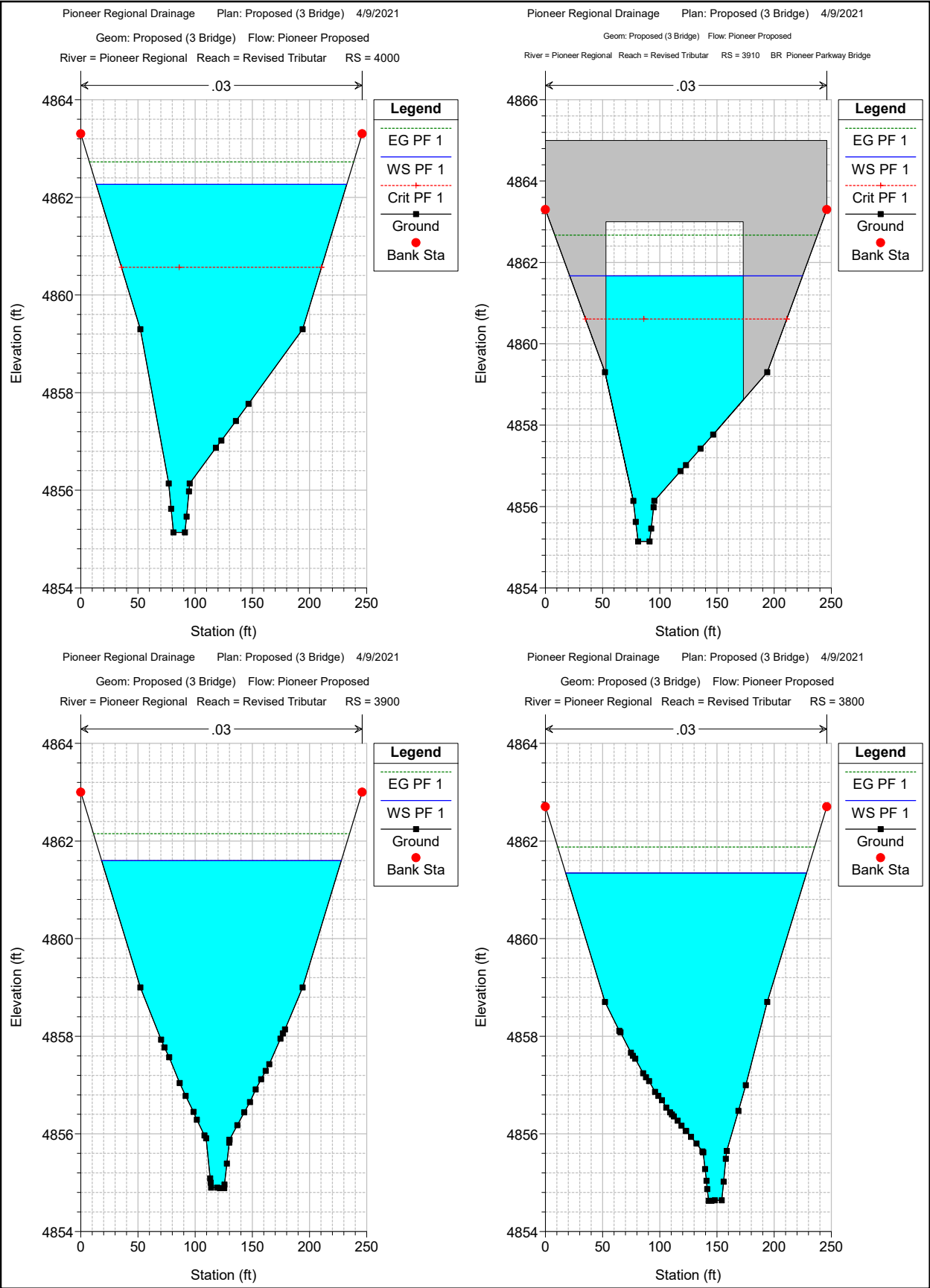


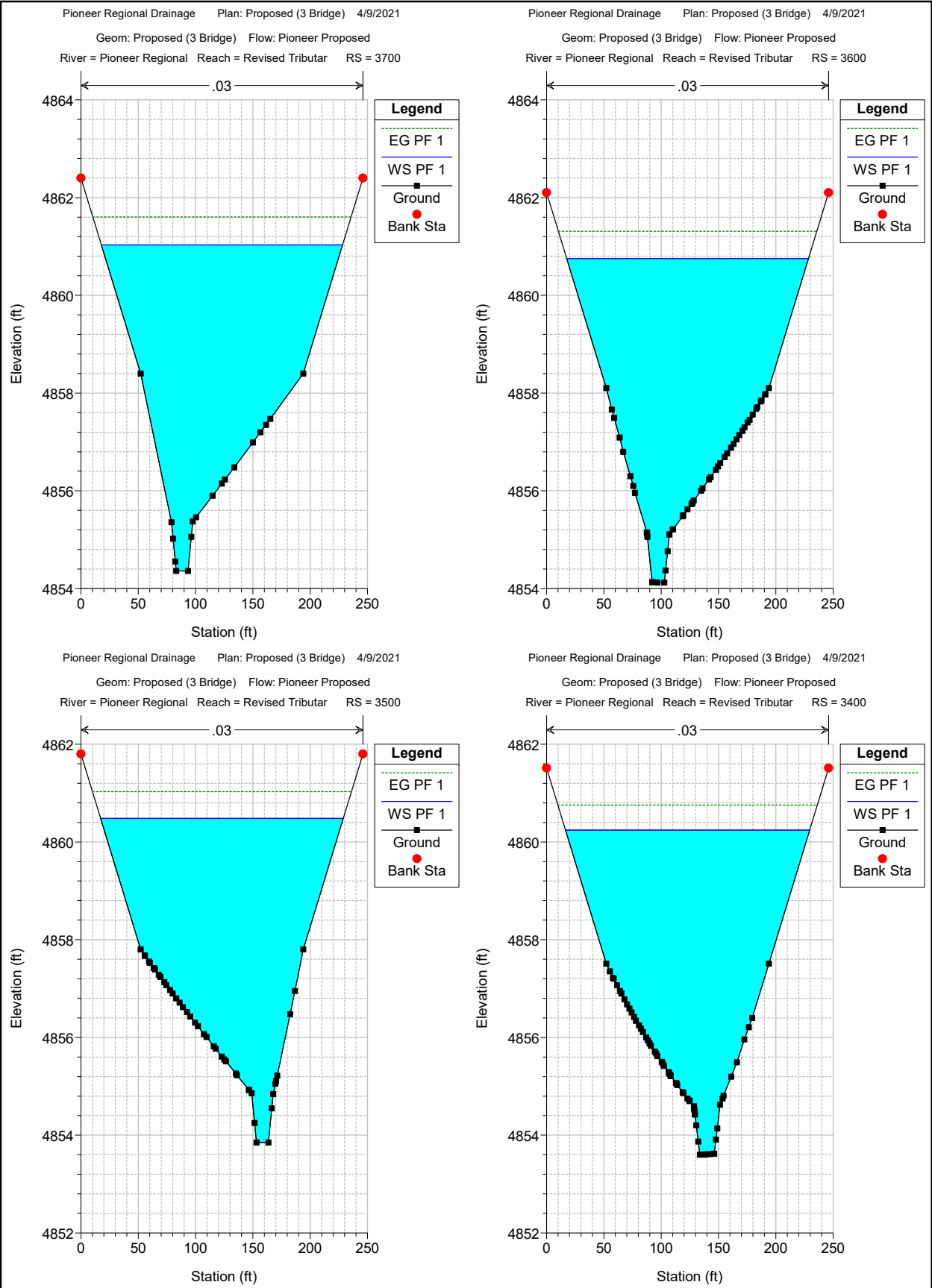




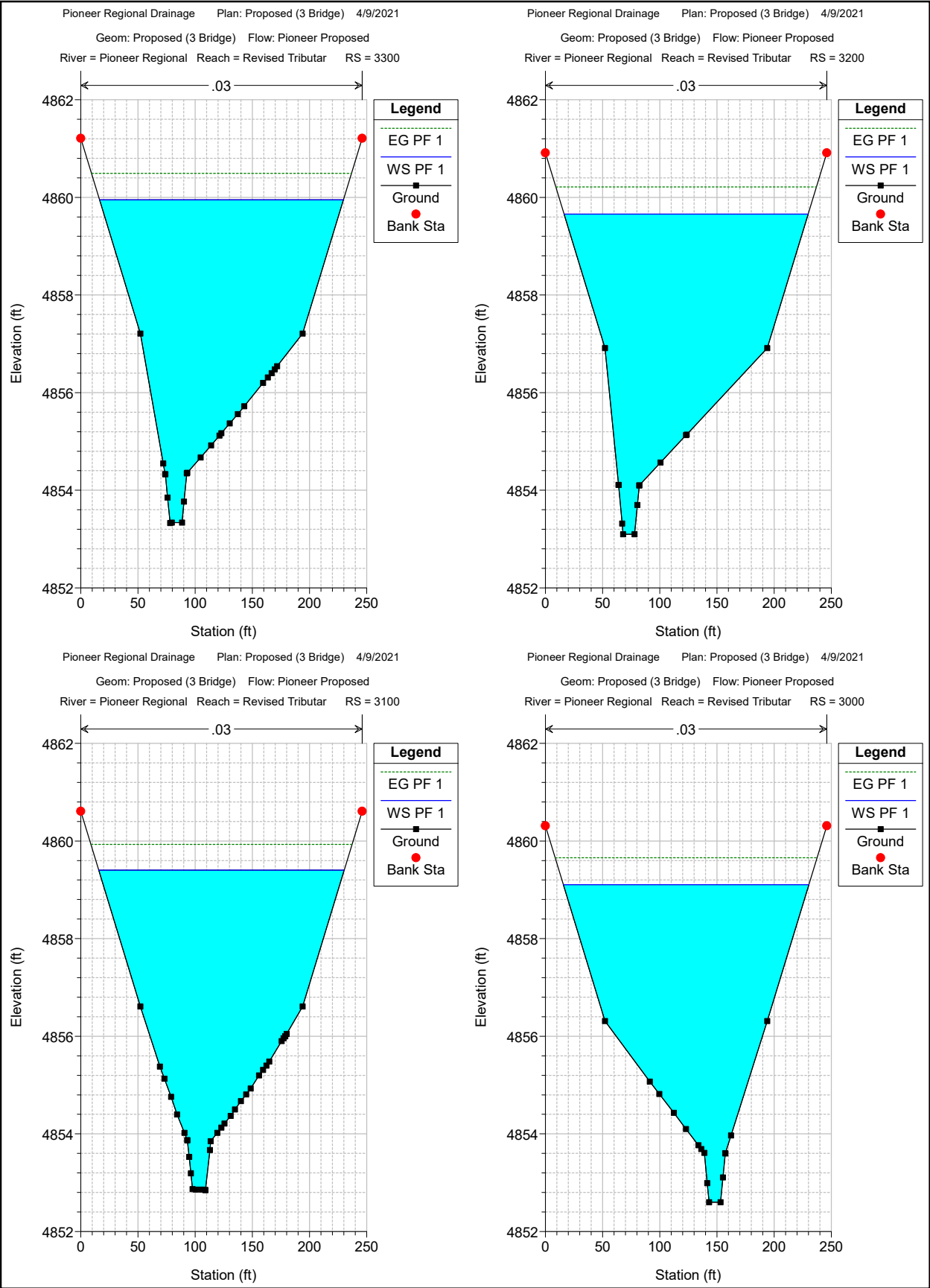


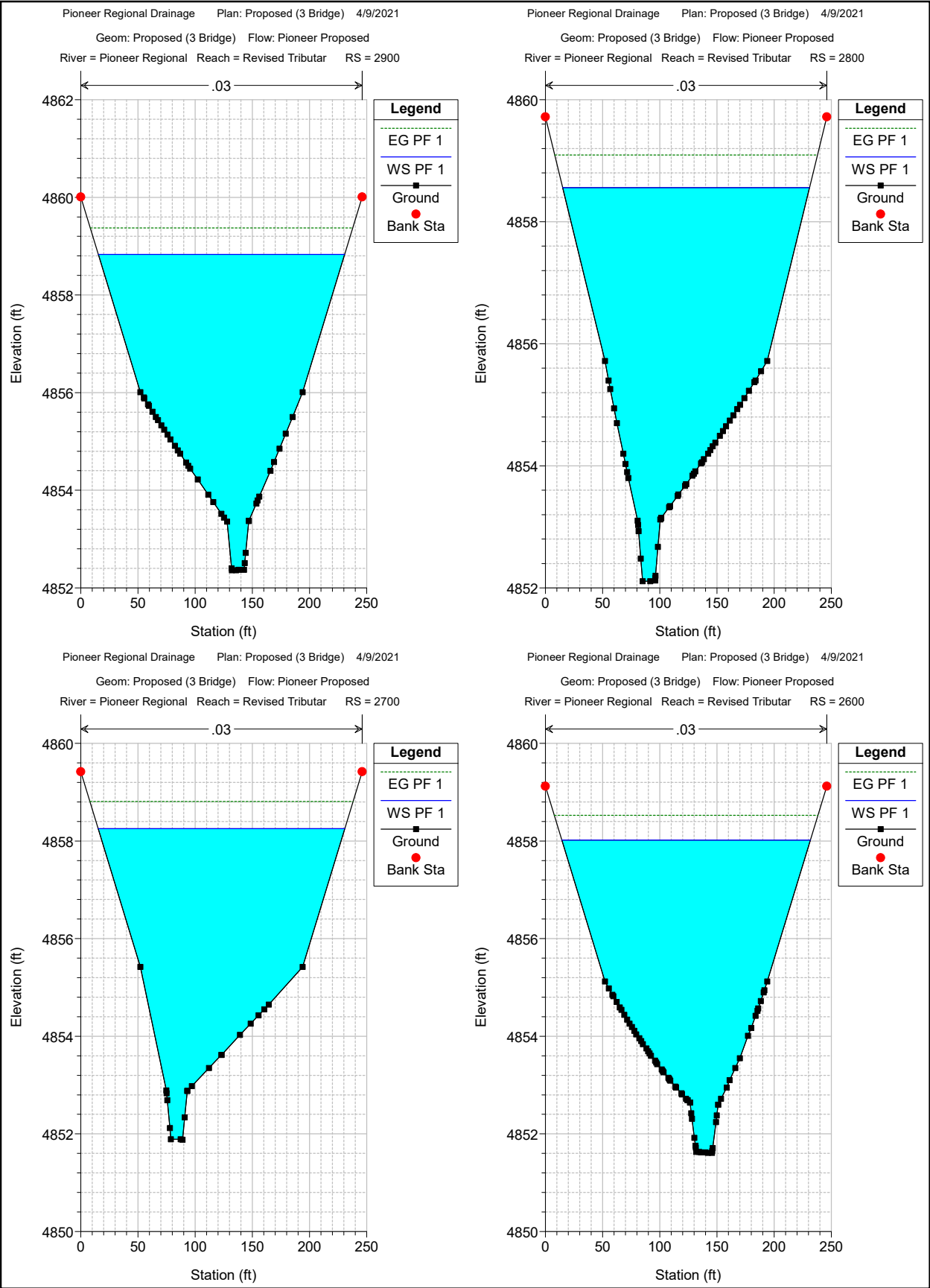


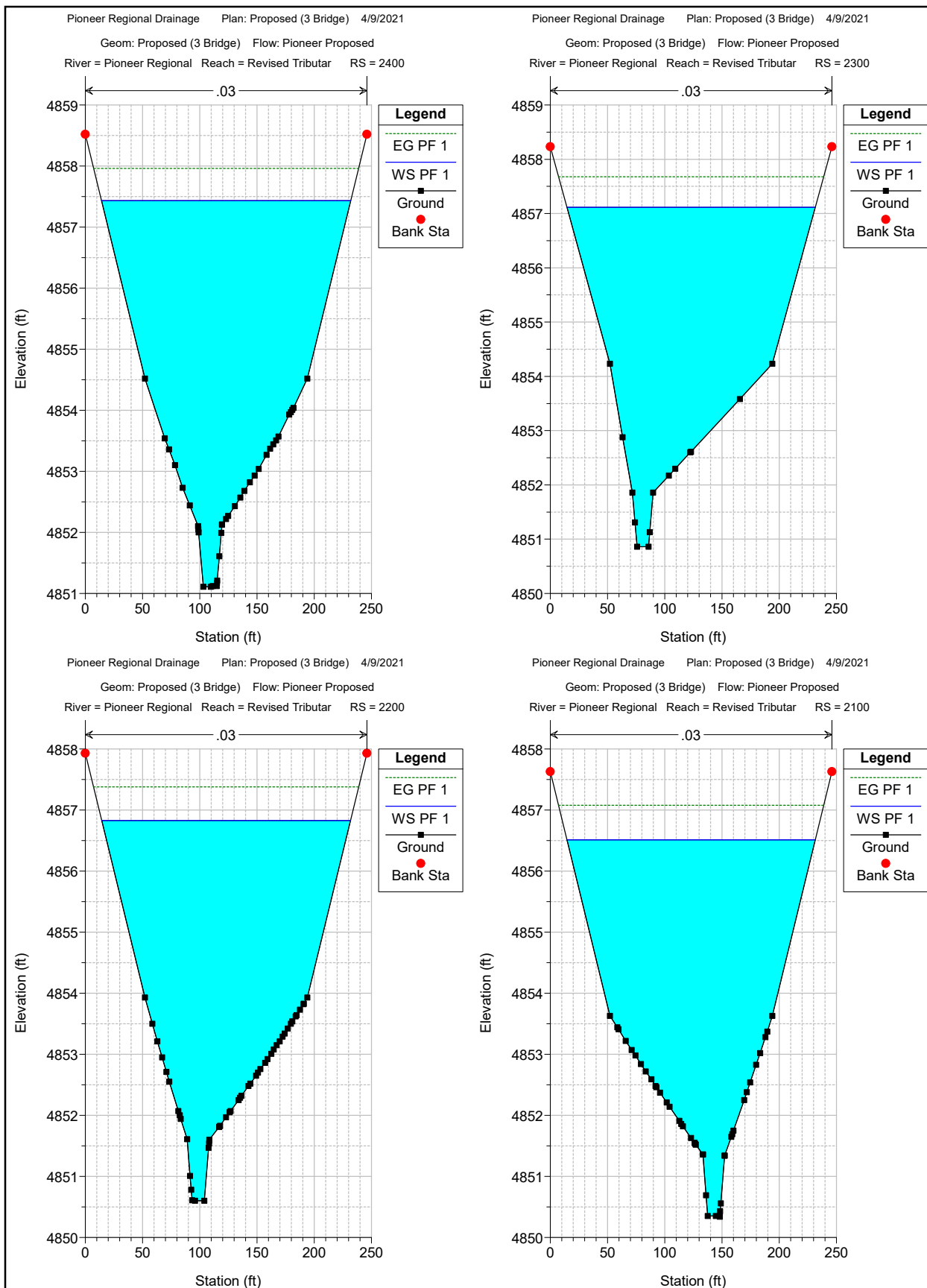


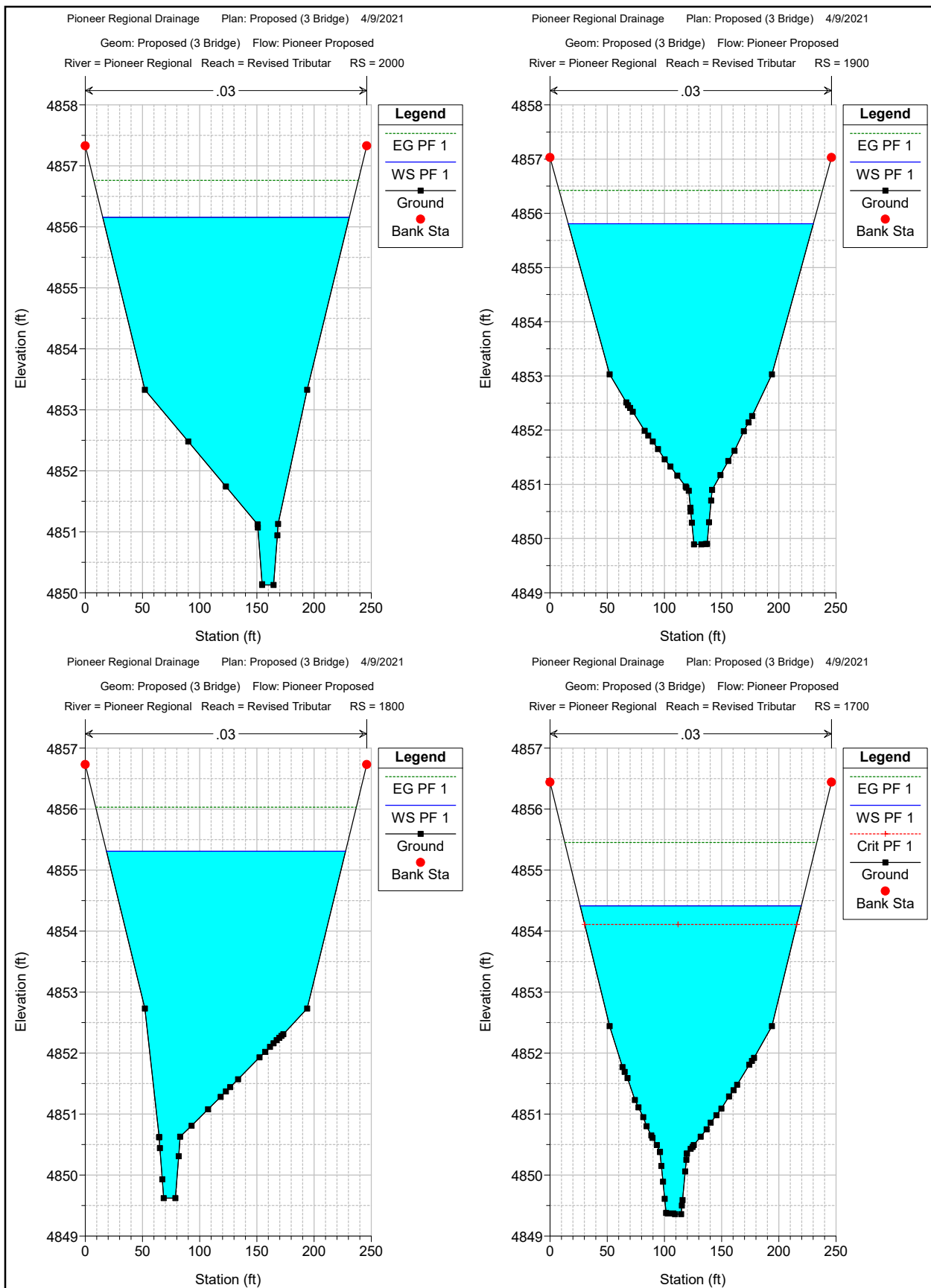


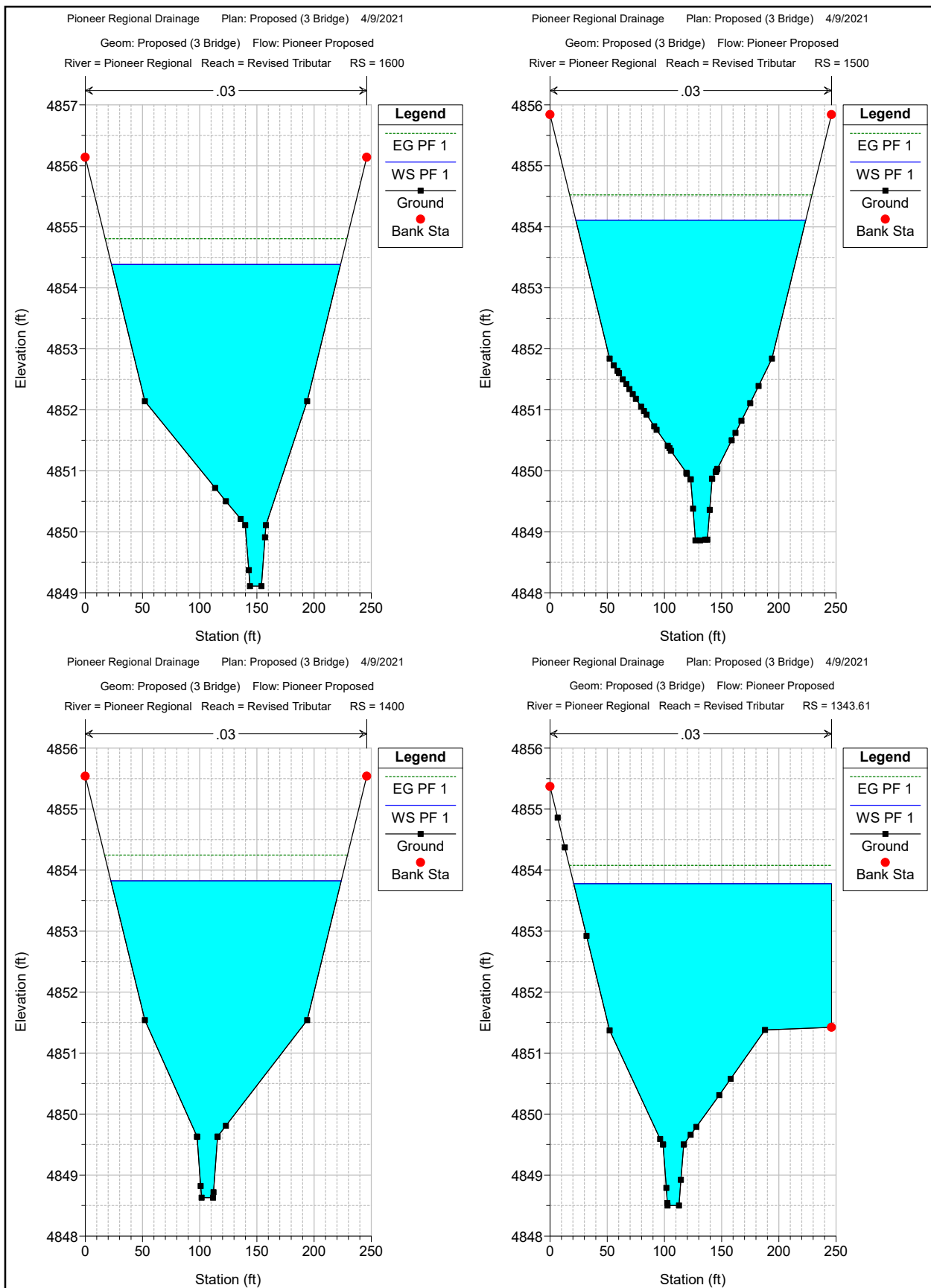


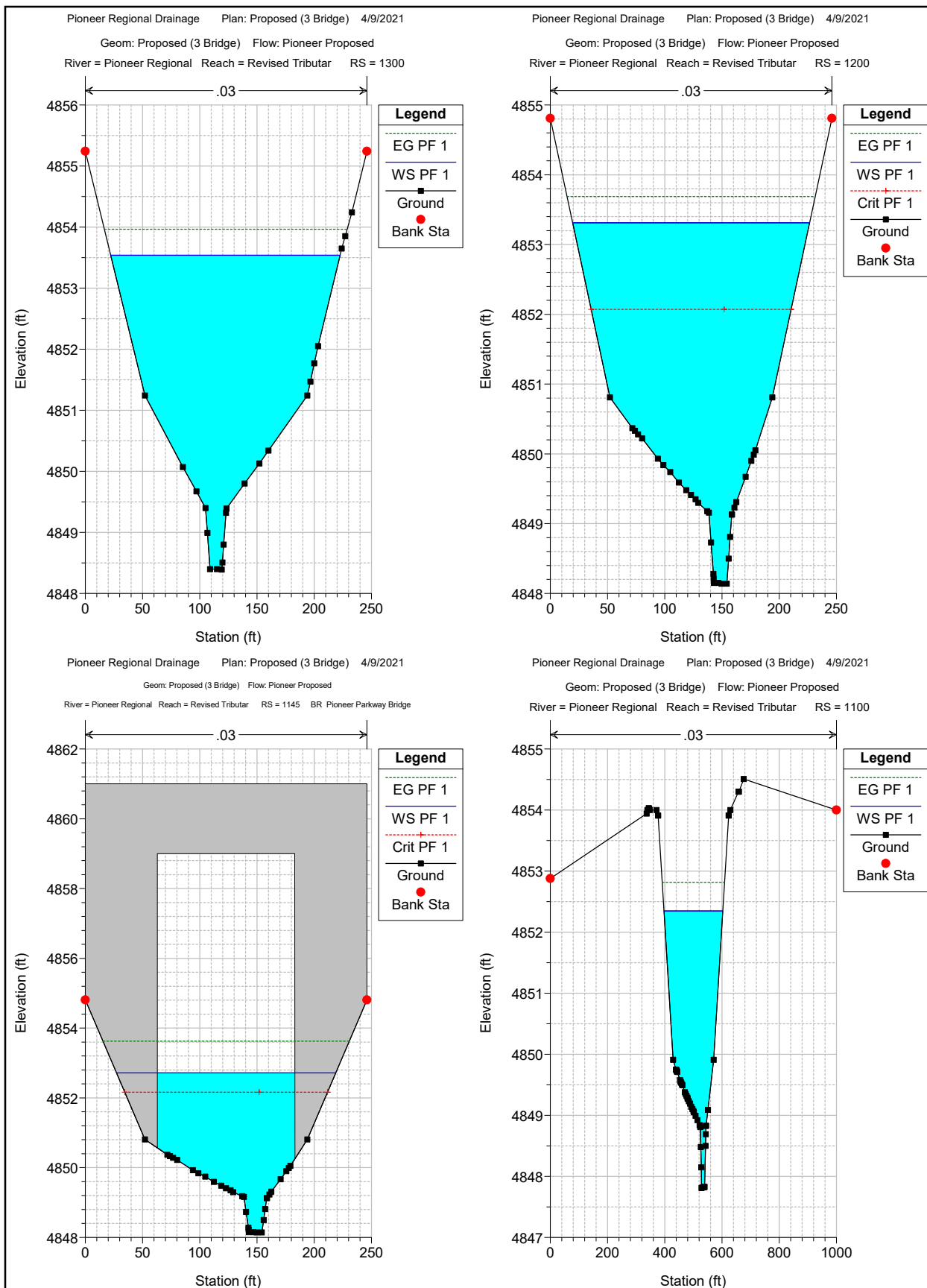


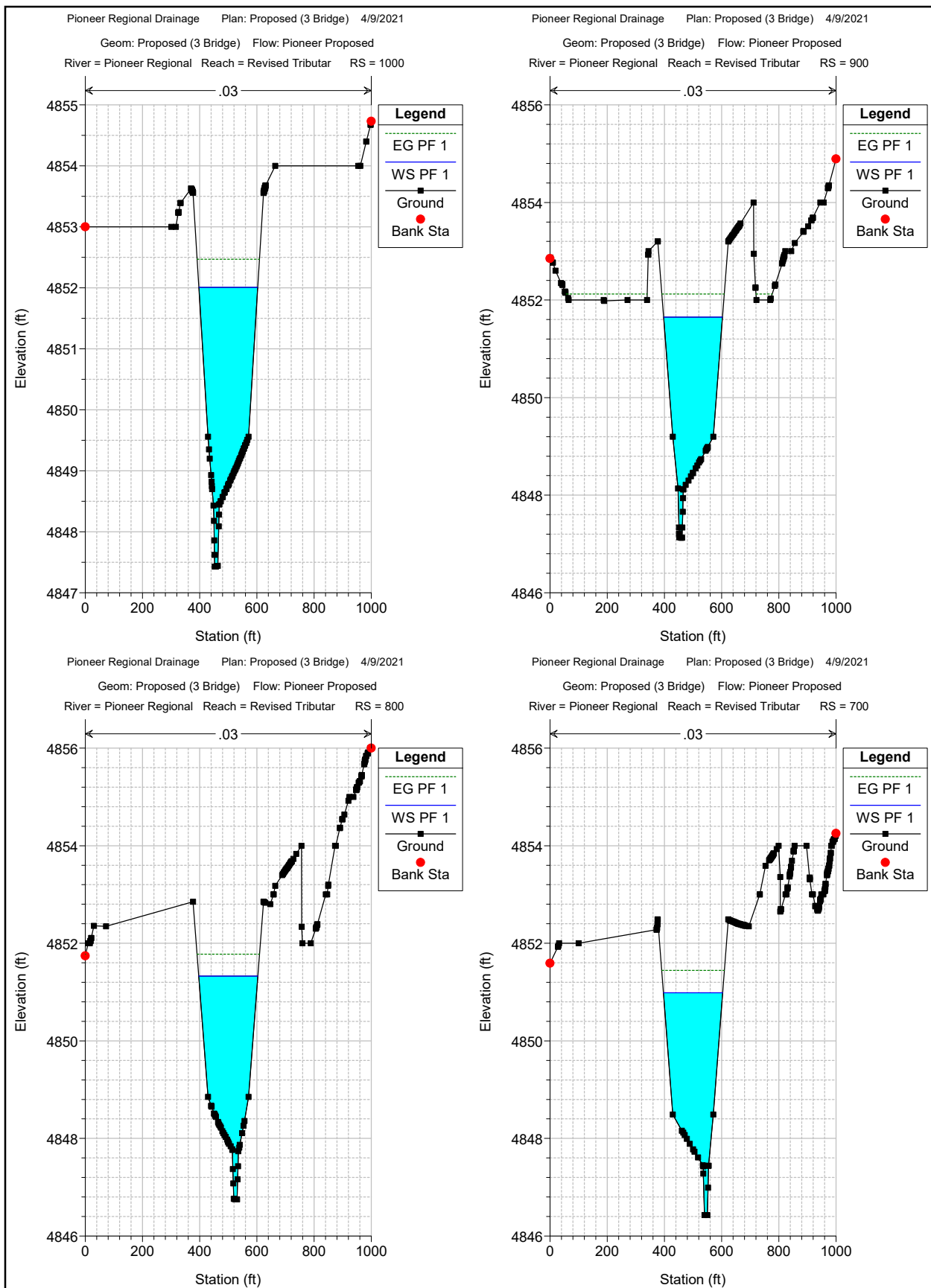


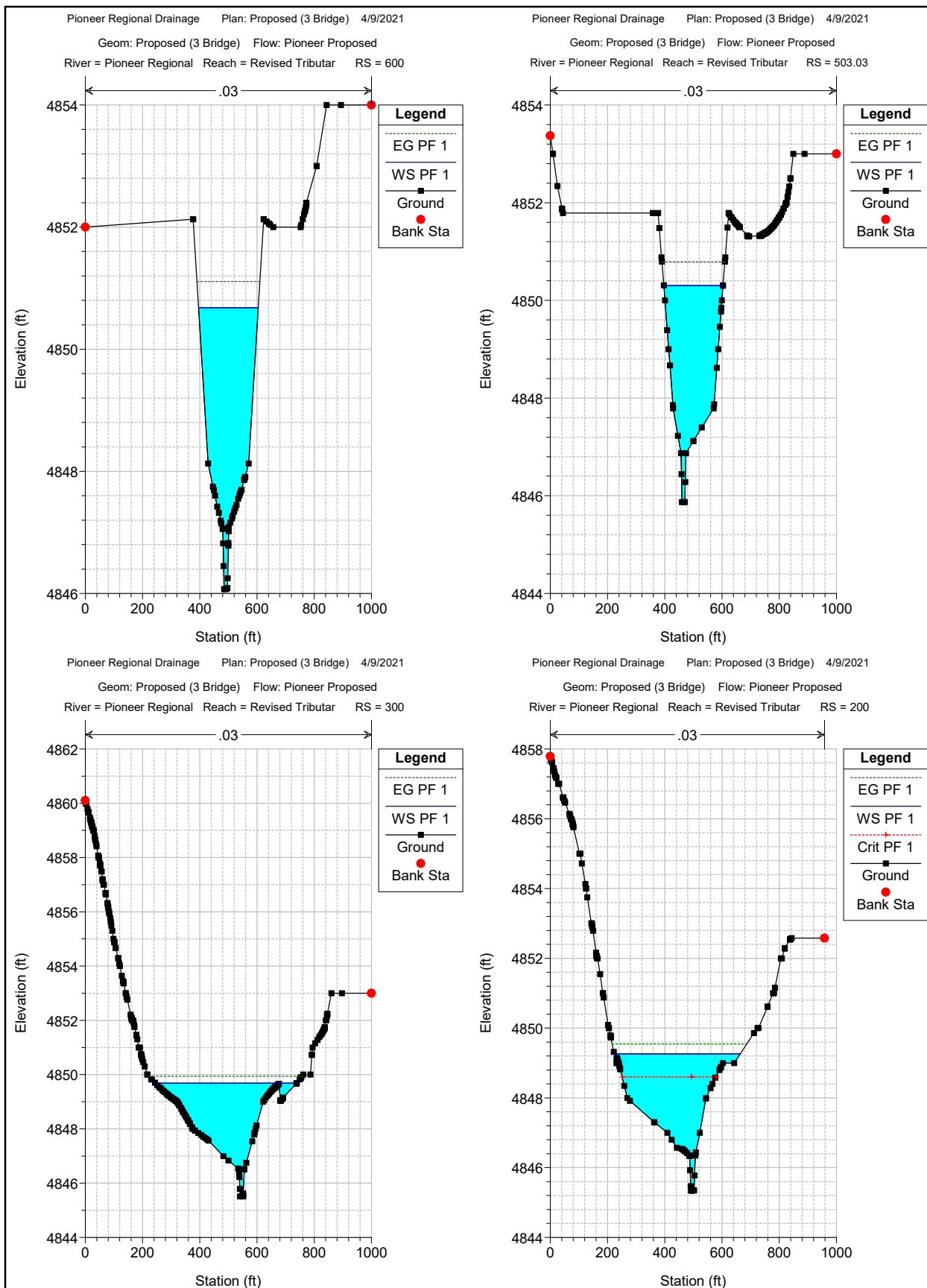










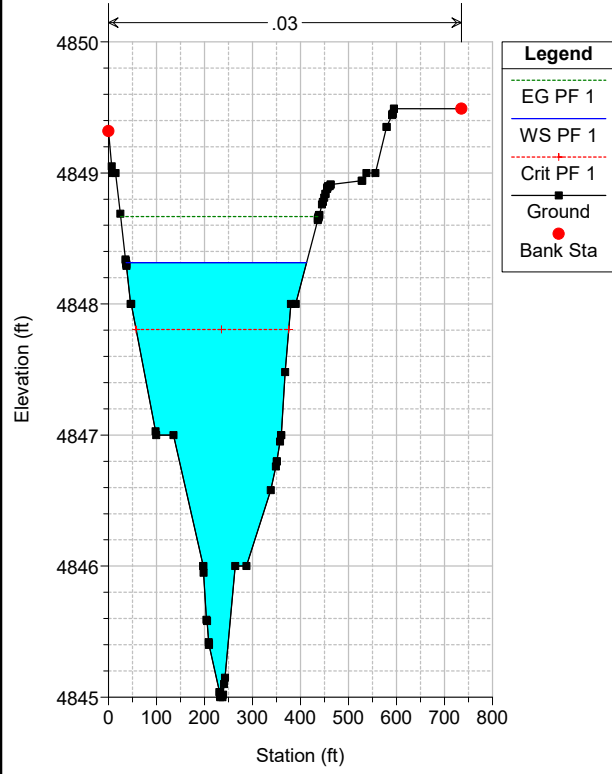


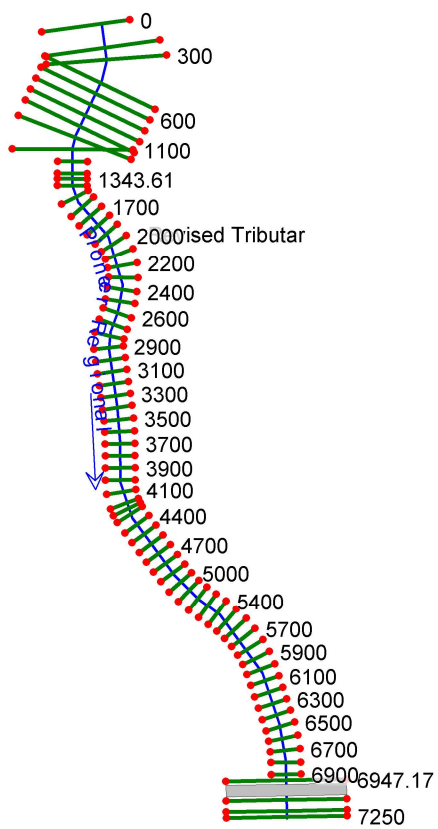


Pioneer Regional Drainage Plan: Proposed (3 Bridge) 4/9/2021

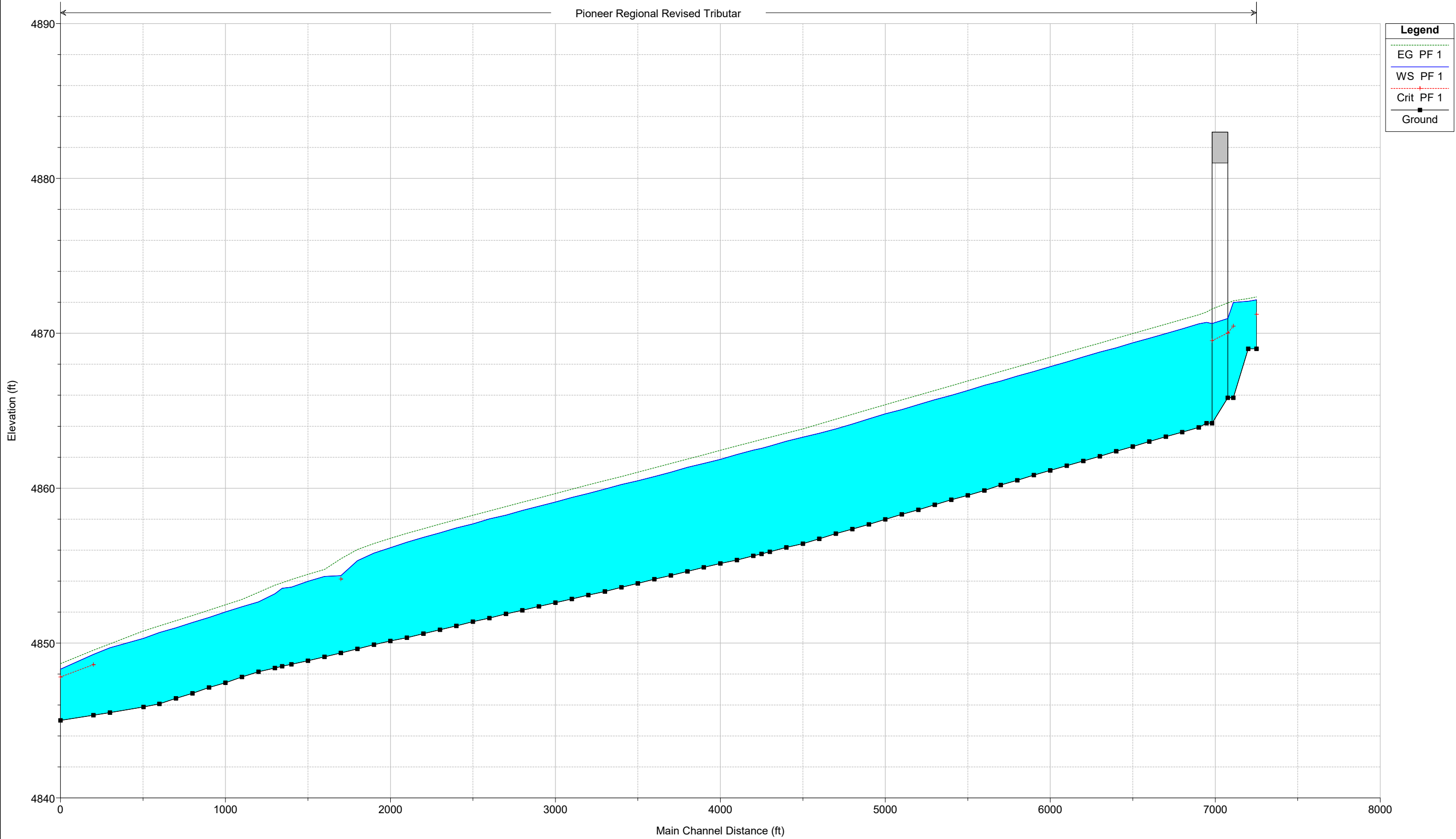
Geom: Proposed (3 Bridge) Flow: Pioneer Proposed

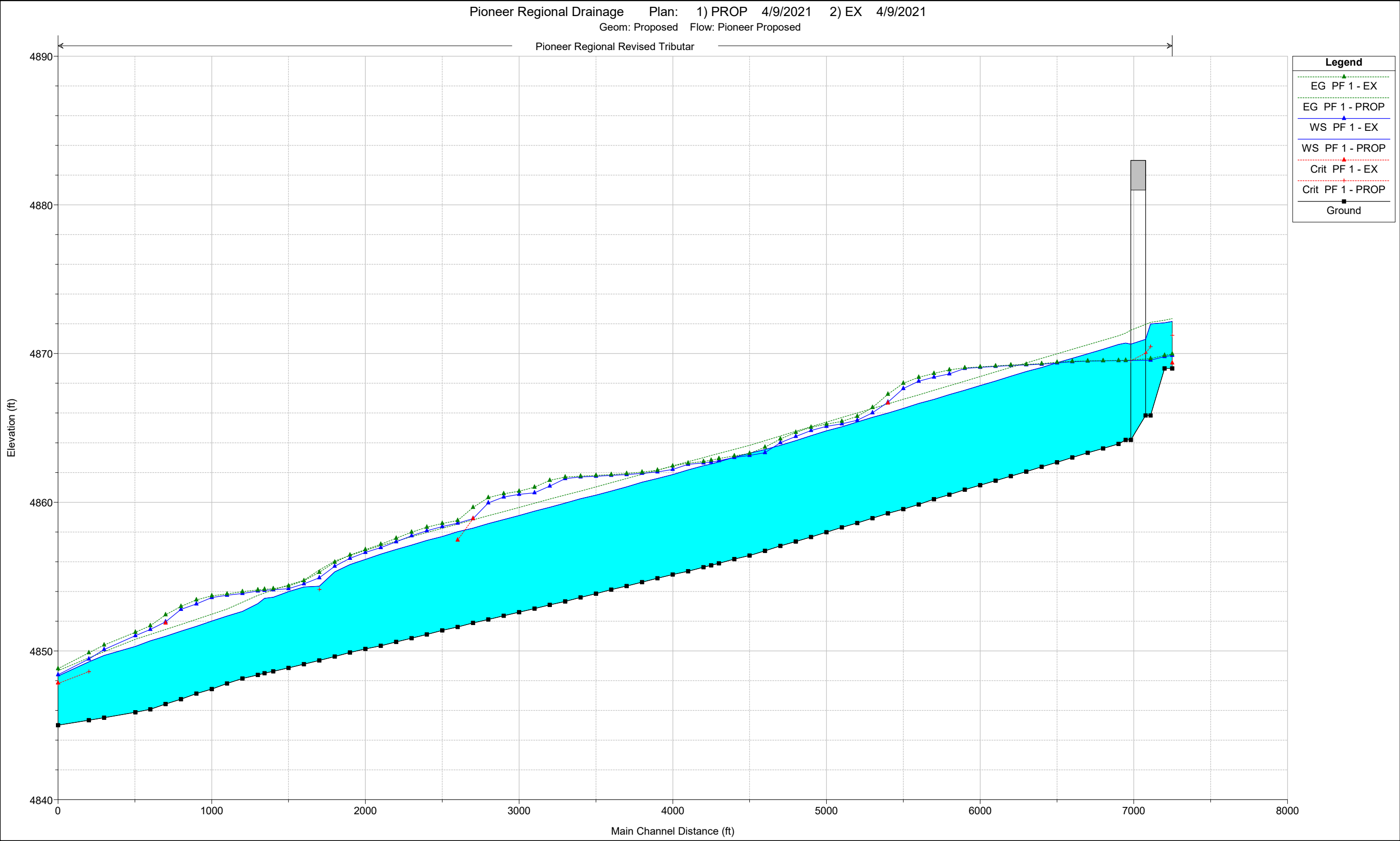
River = Pioneer Regional Reach = Revised Tributary RS = 0

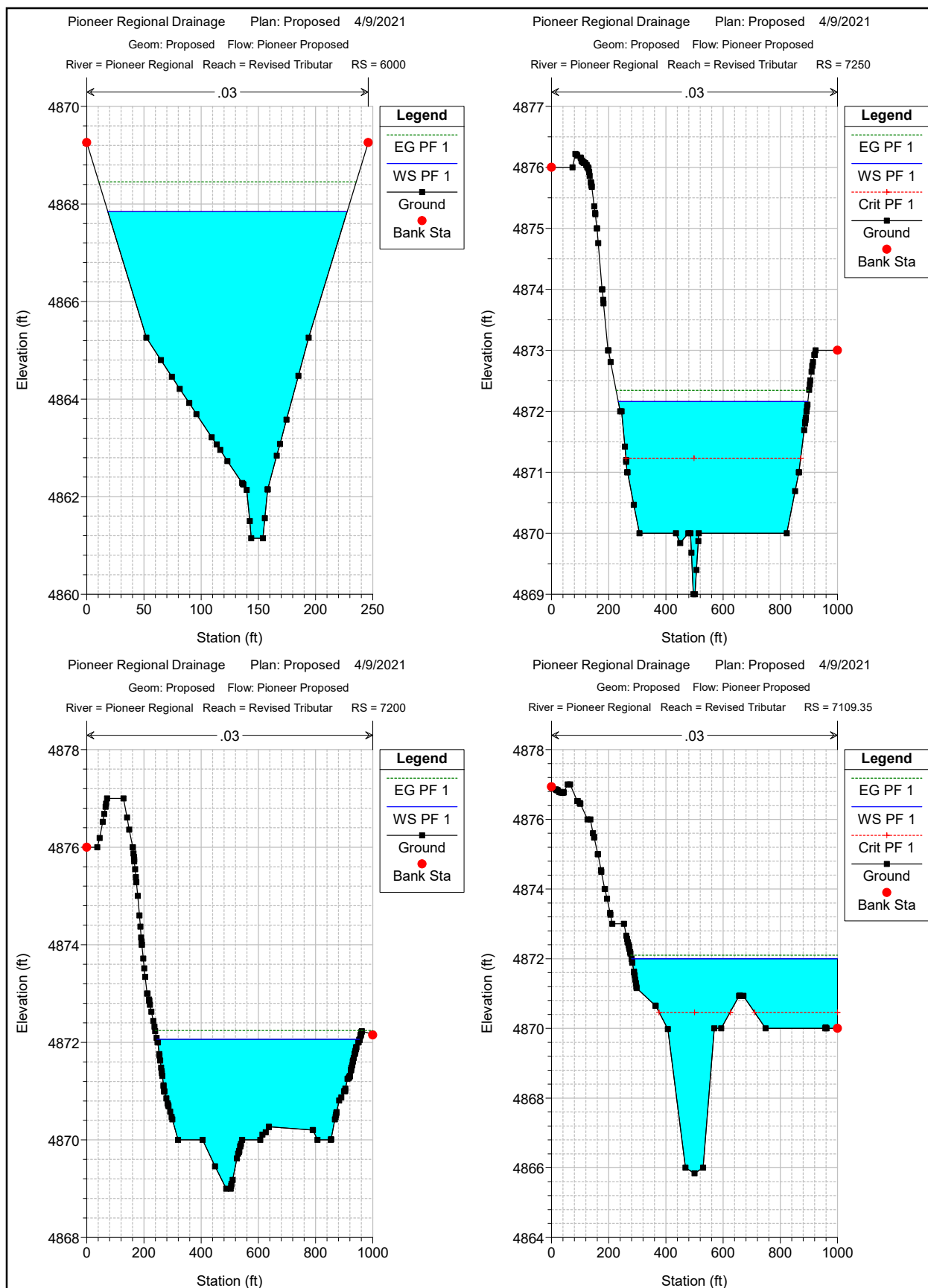


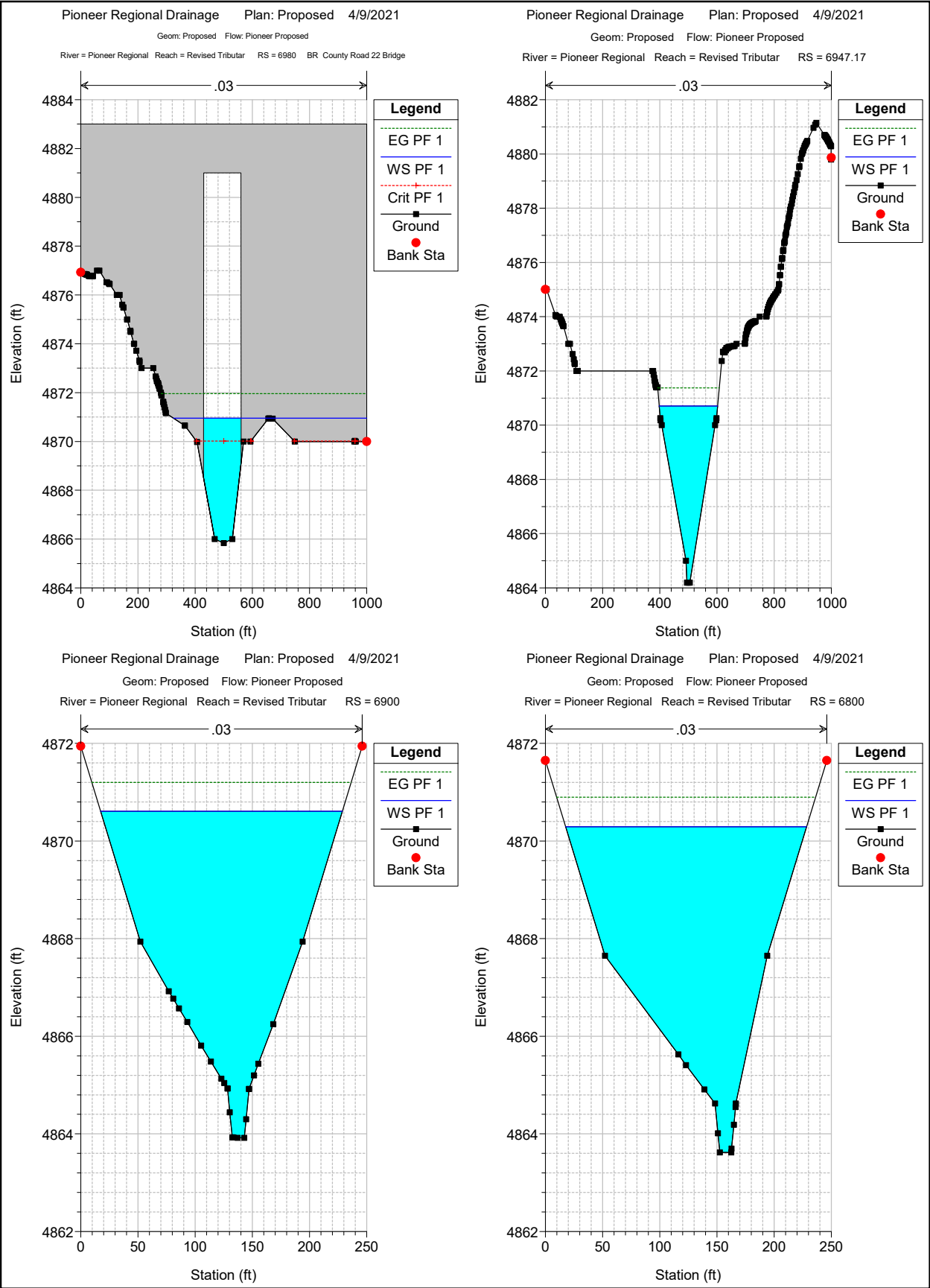


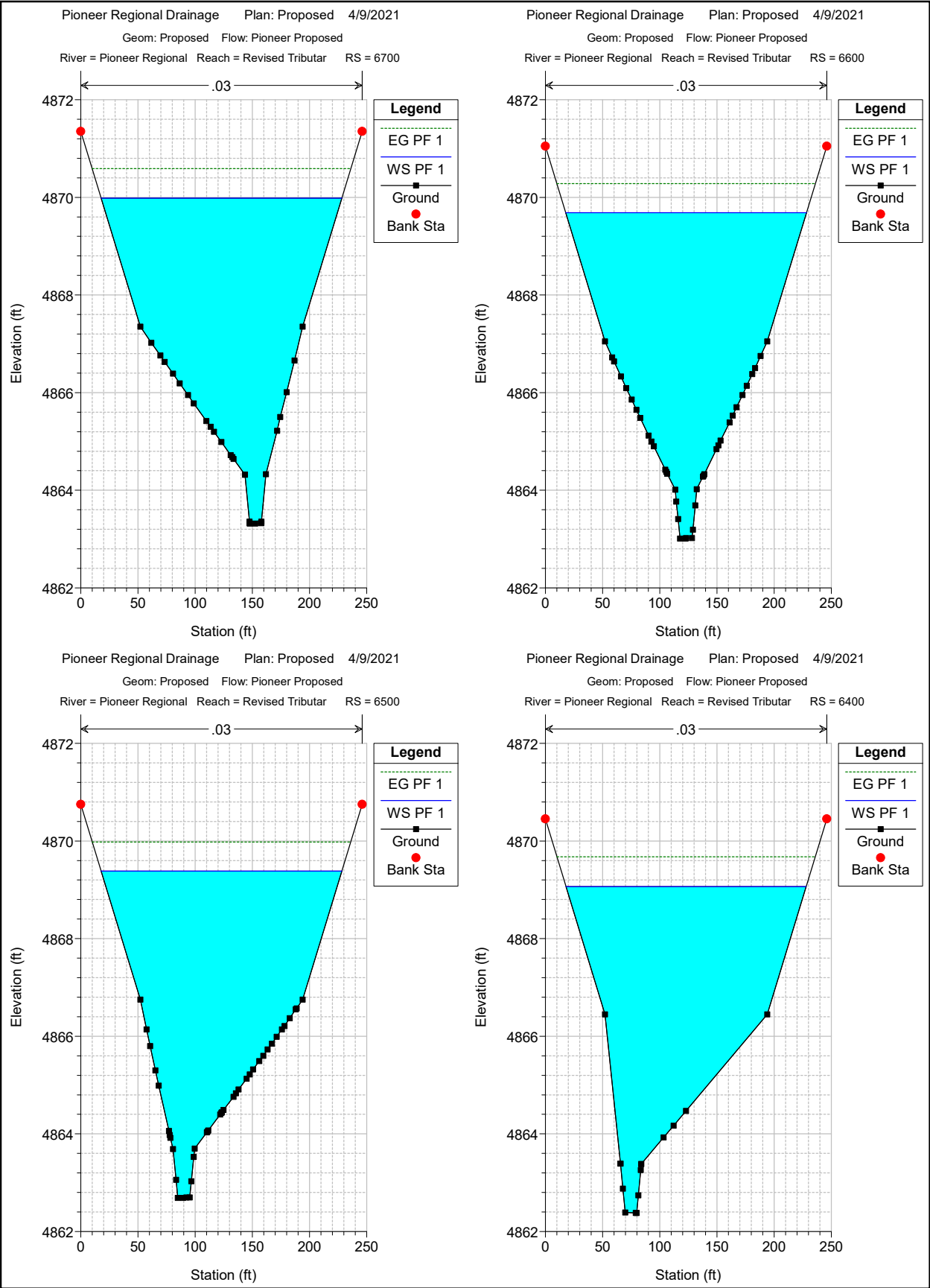
Pioneer Regional Revised Tributary

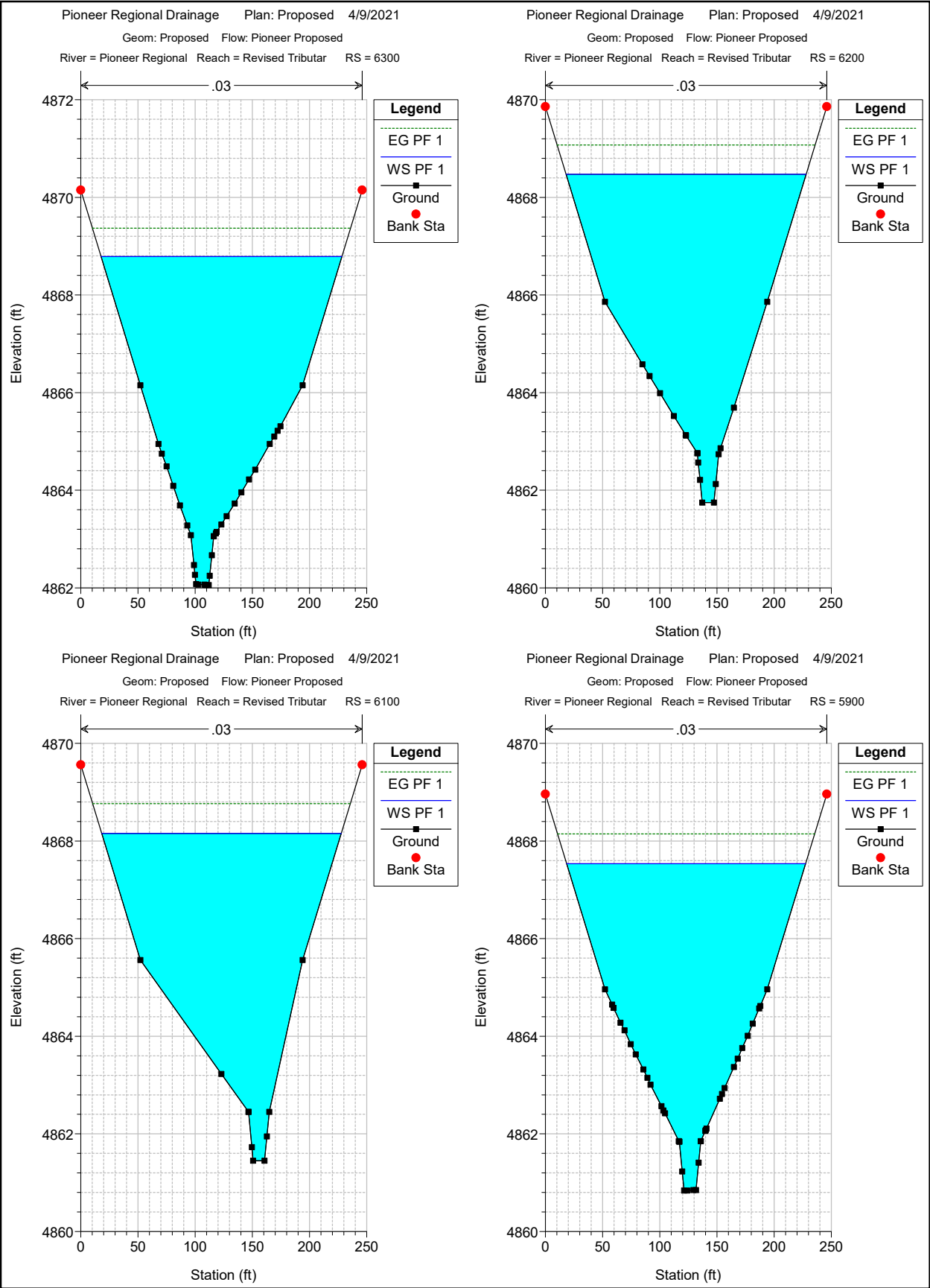




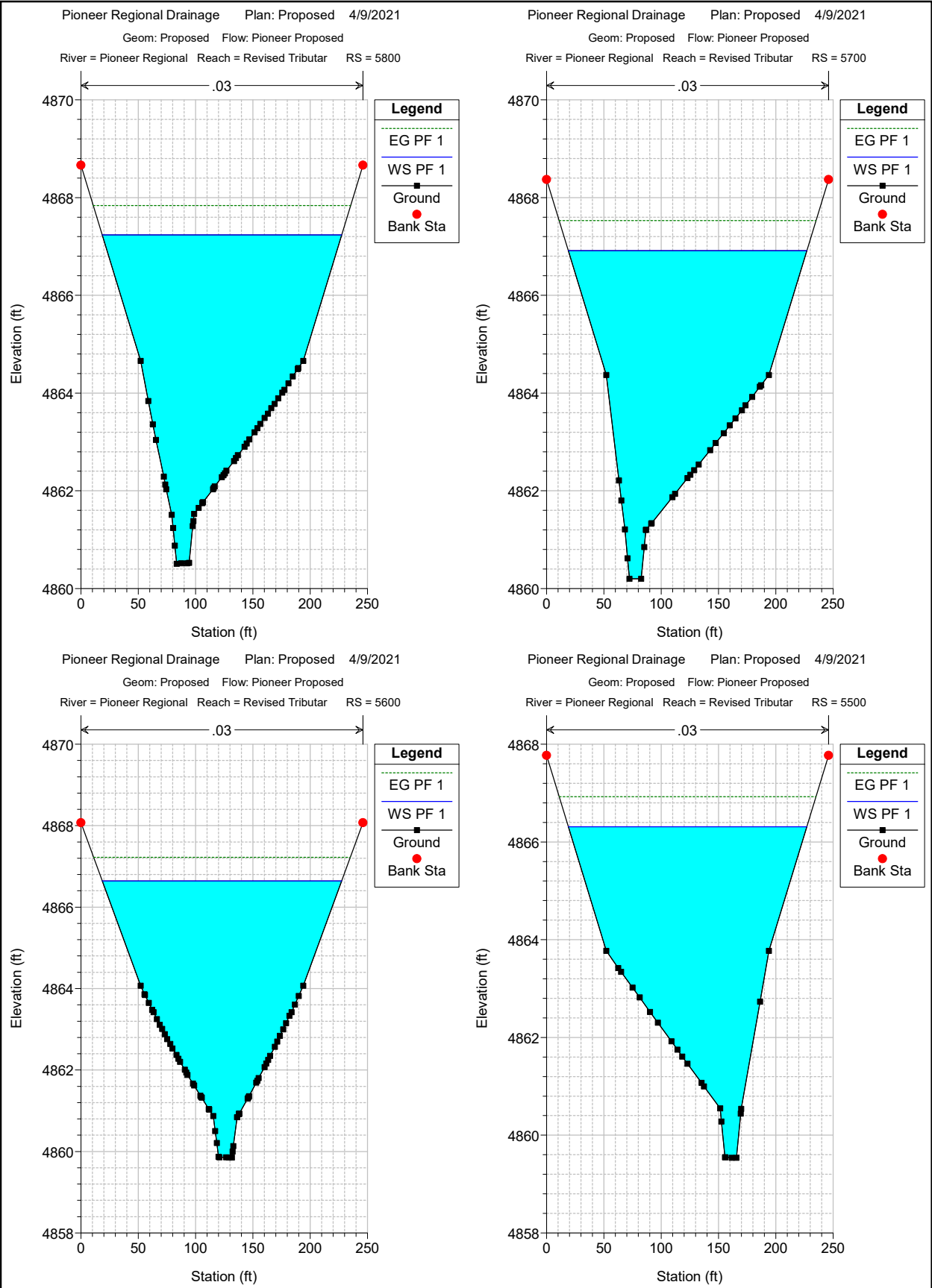


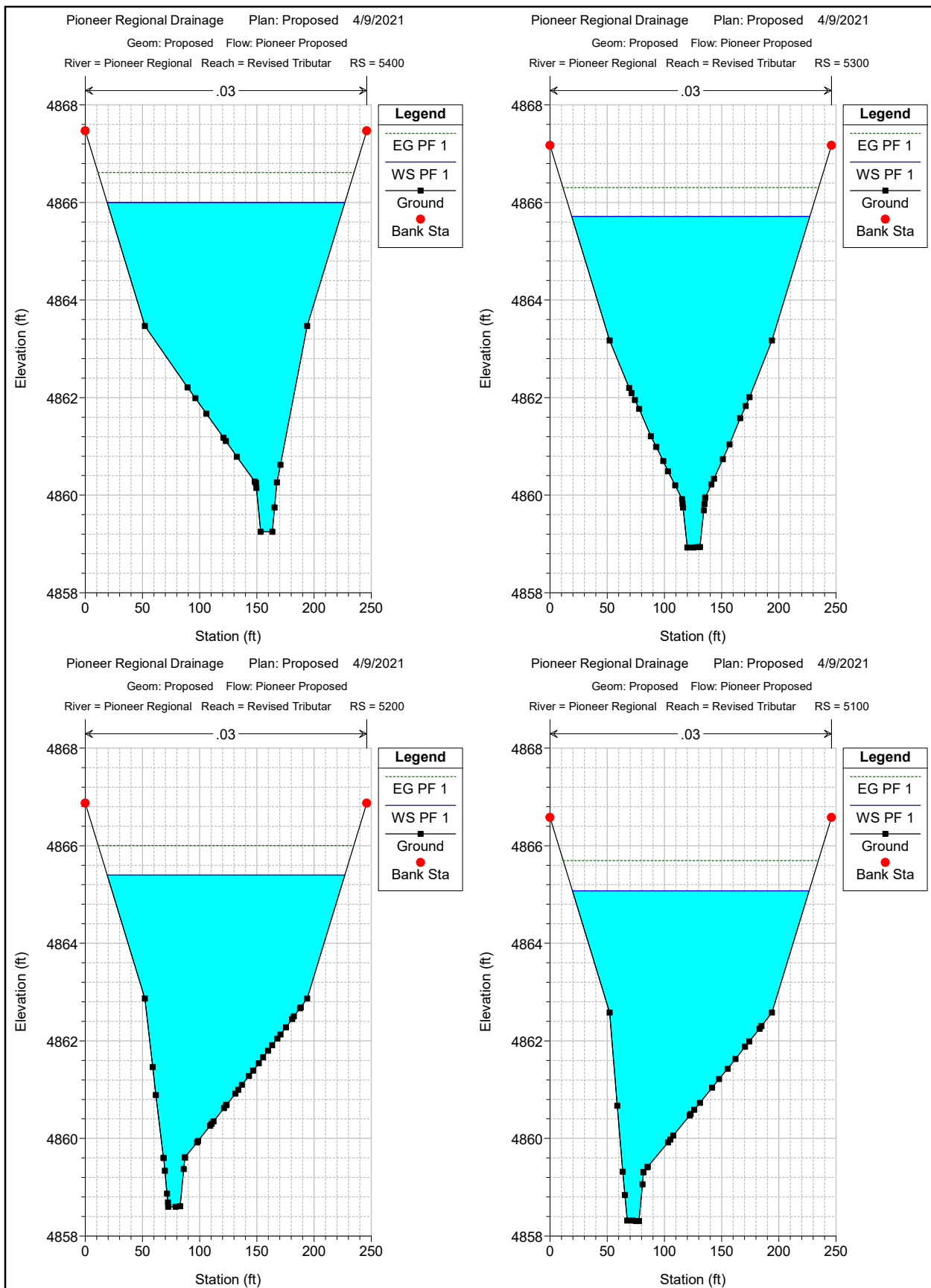


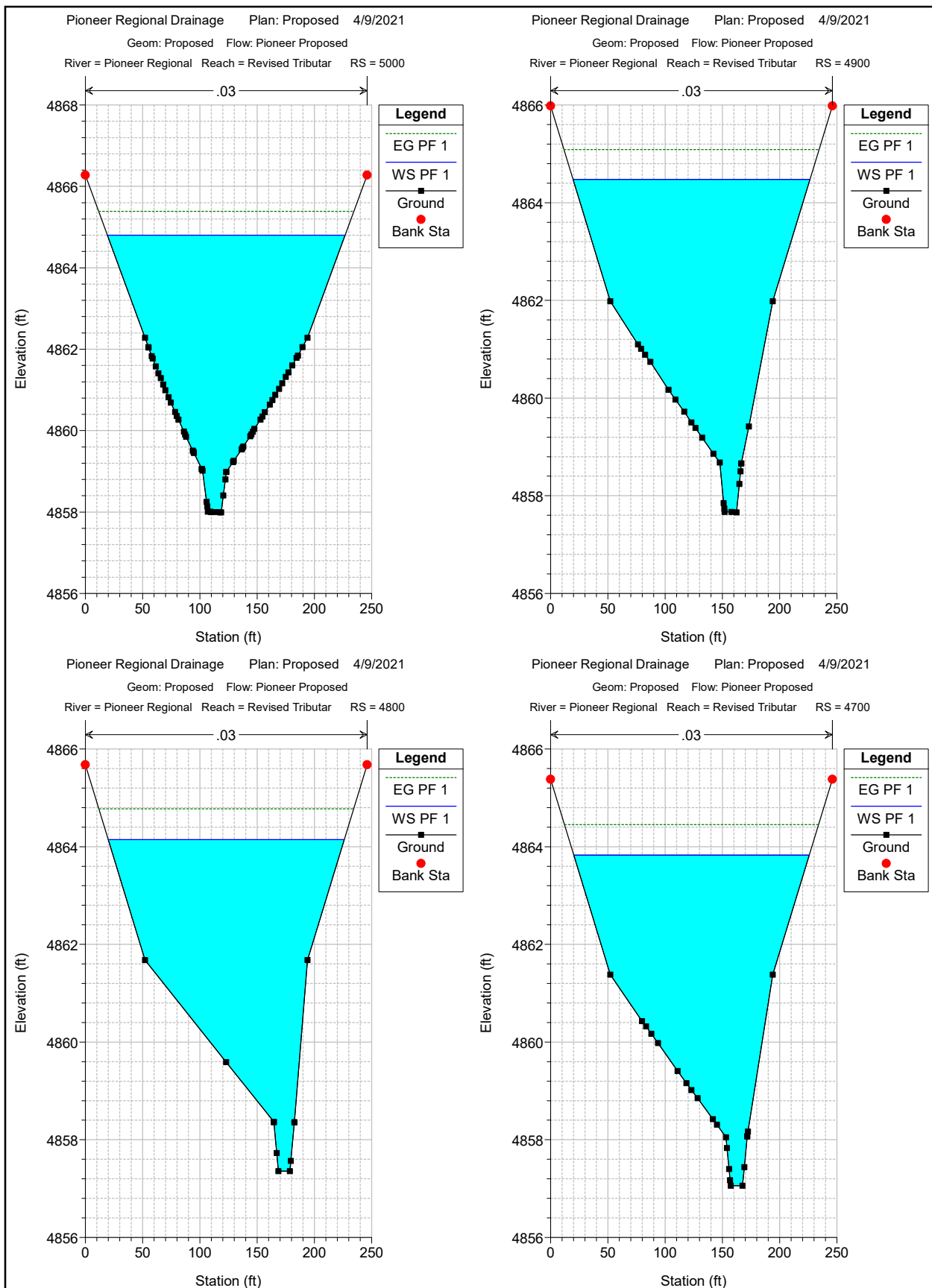


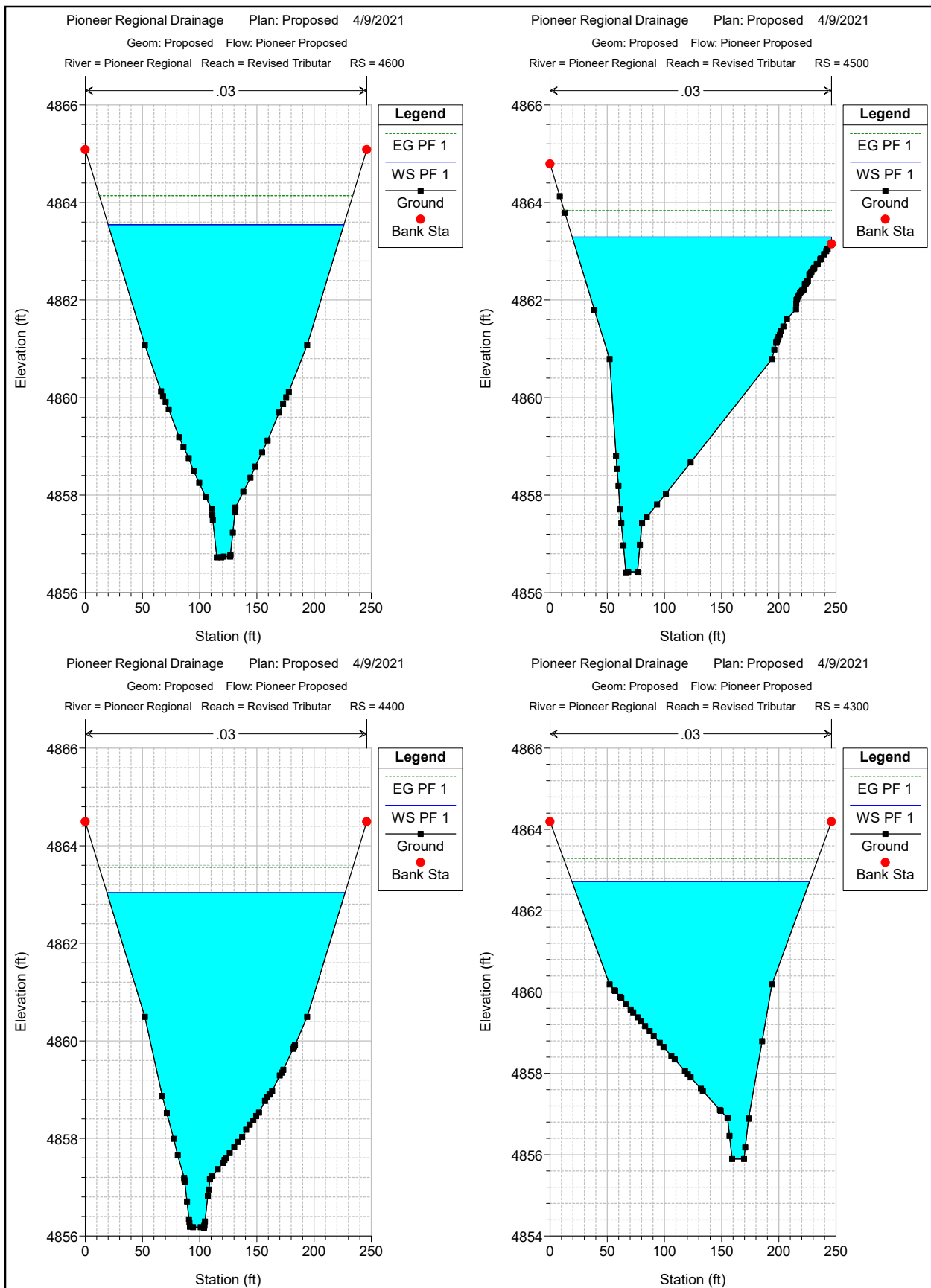


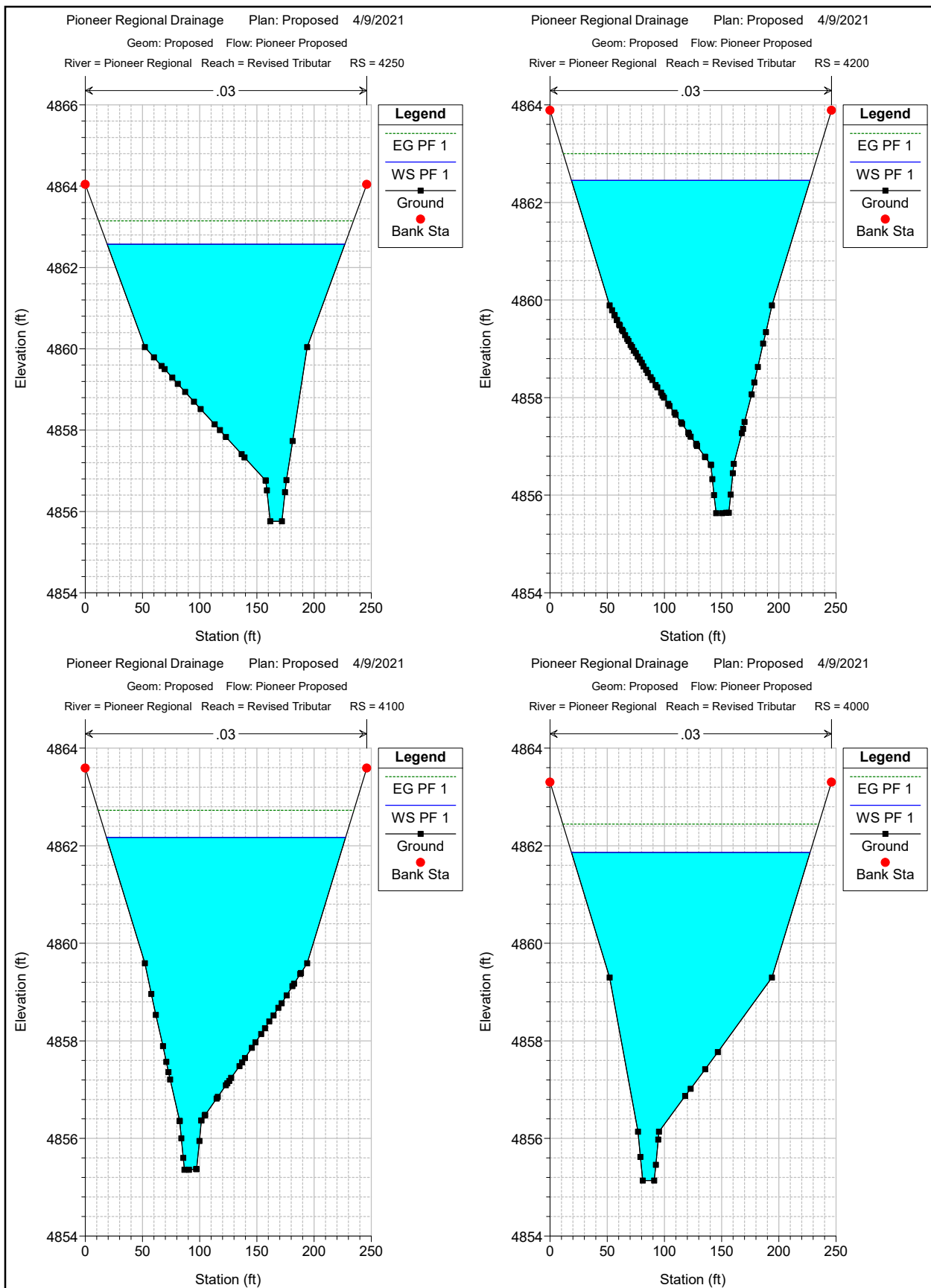


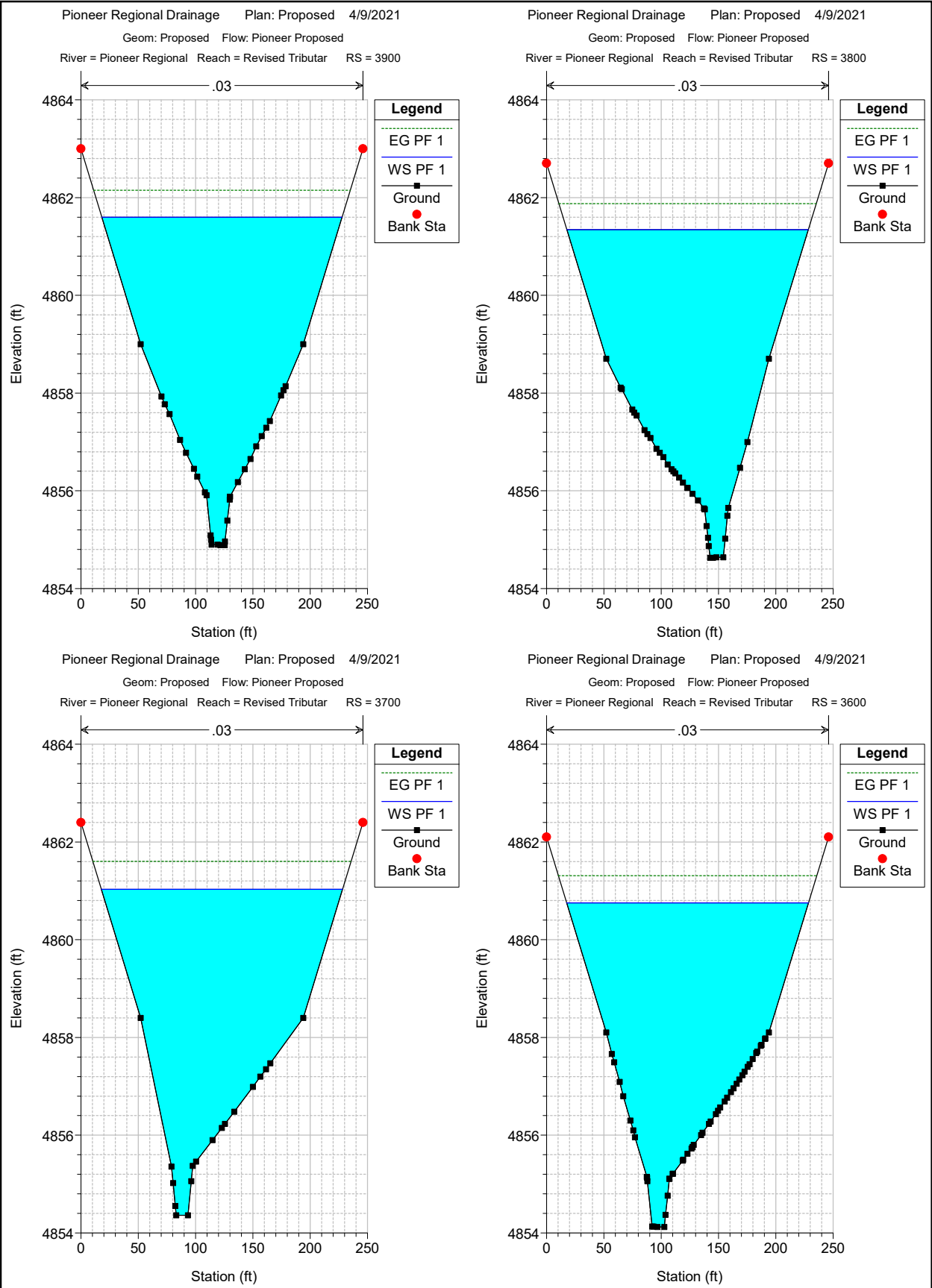












Elevation (ft)

Station (ft)

Legend

EG PF 1

WS PF 1

Ground

Bank Sta

Elevation (ft)

Station (ft)

Legend

EG PF 1

WS PF 1

Ground

Bank Sta

Pioneer Regional Drainage

Plan: Proposed

4/9/2021

Geom: Proposed

Flow: Pioneer Proposed

River = Pioneer Regional

Reach = Revised Tributary

RS = 3700

Elevation (ft)

Station (ft)

Legend

EG PF 1

WS PF 1

Ground

Bank Sta

Elevation (ft)

Station (ft)

Legend

EG PF 1

WS PF 1

Ground

Bank Sta

Pioneer Regional Drainage

Plan: Proposed

4/9/2021

Geom: Proposed

Flow: Pioneer Proposed

River = Pioneer Regional

Reach = Revised Tributary

RS = 3600

Elevation (ft)

Station (ft)

Legend

EG PF 1

WS PF 1

Ground

Bank Sta

Elevation (ft)

Station (ft)

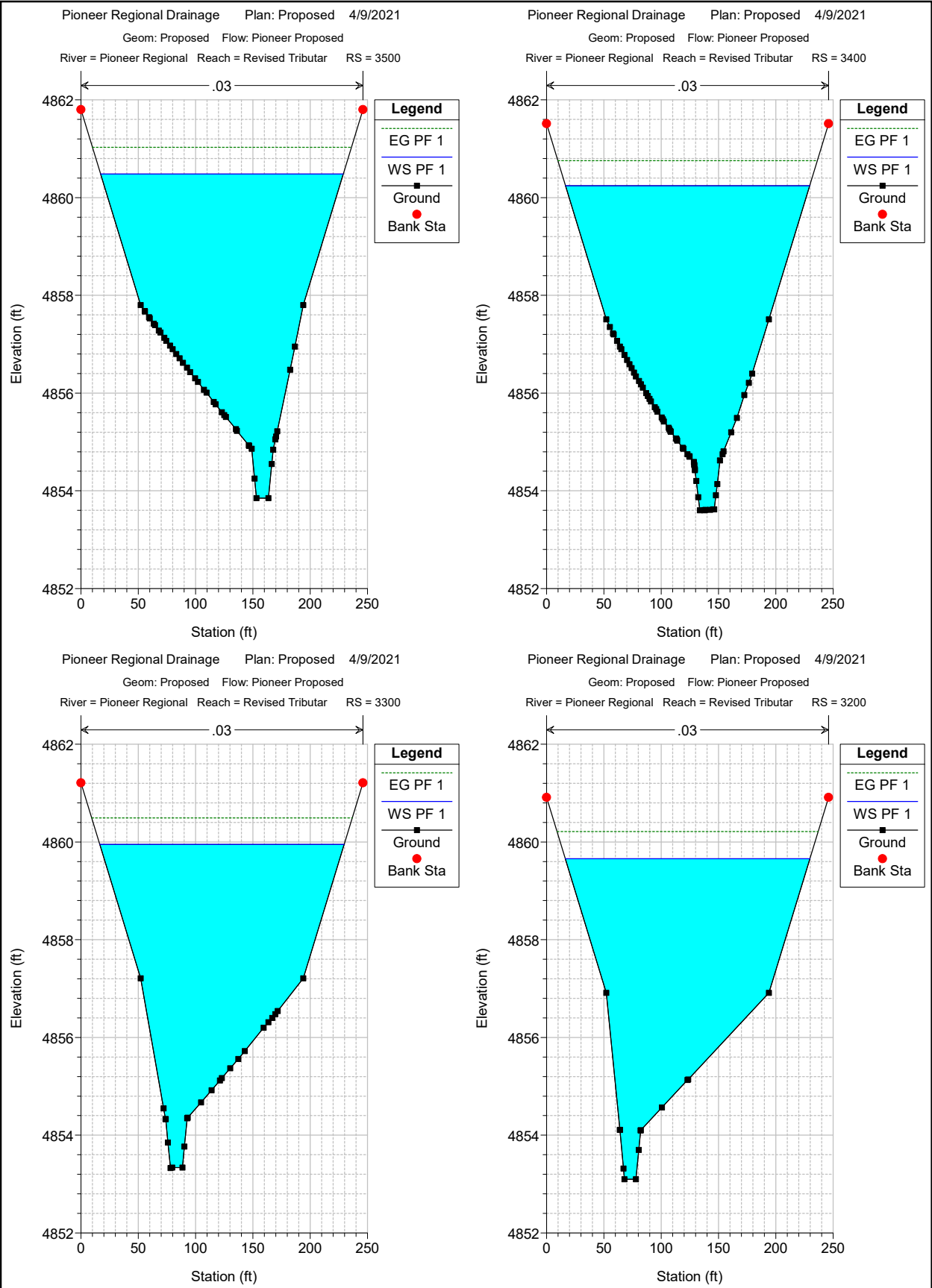
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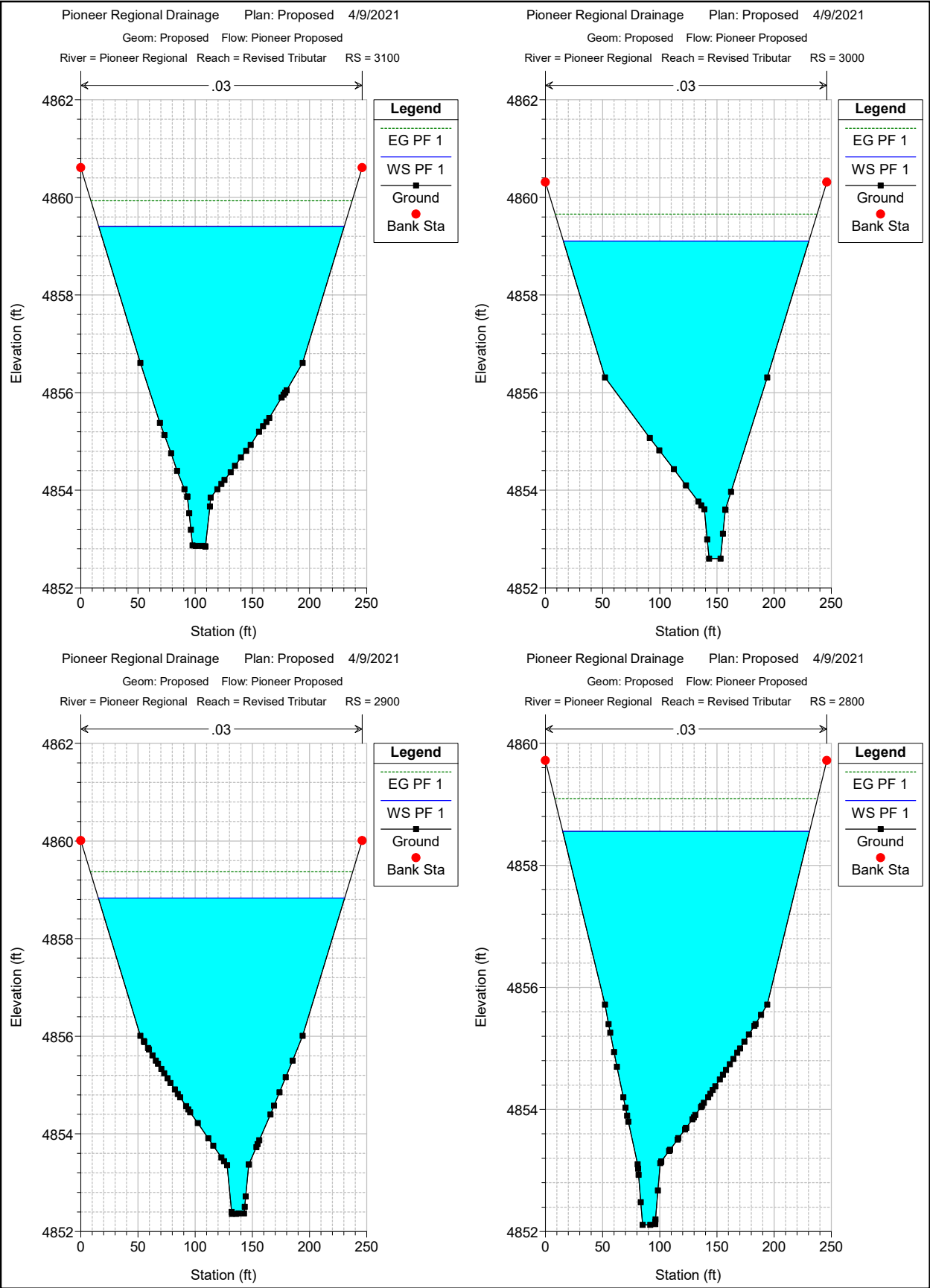
EG PF 1

WS PF 1

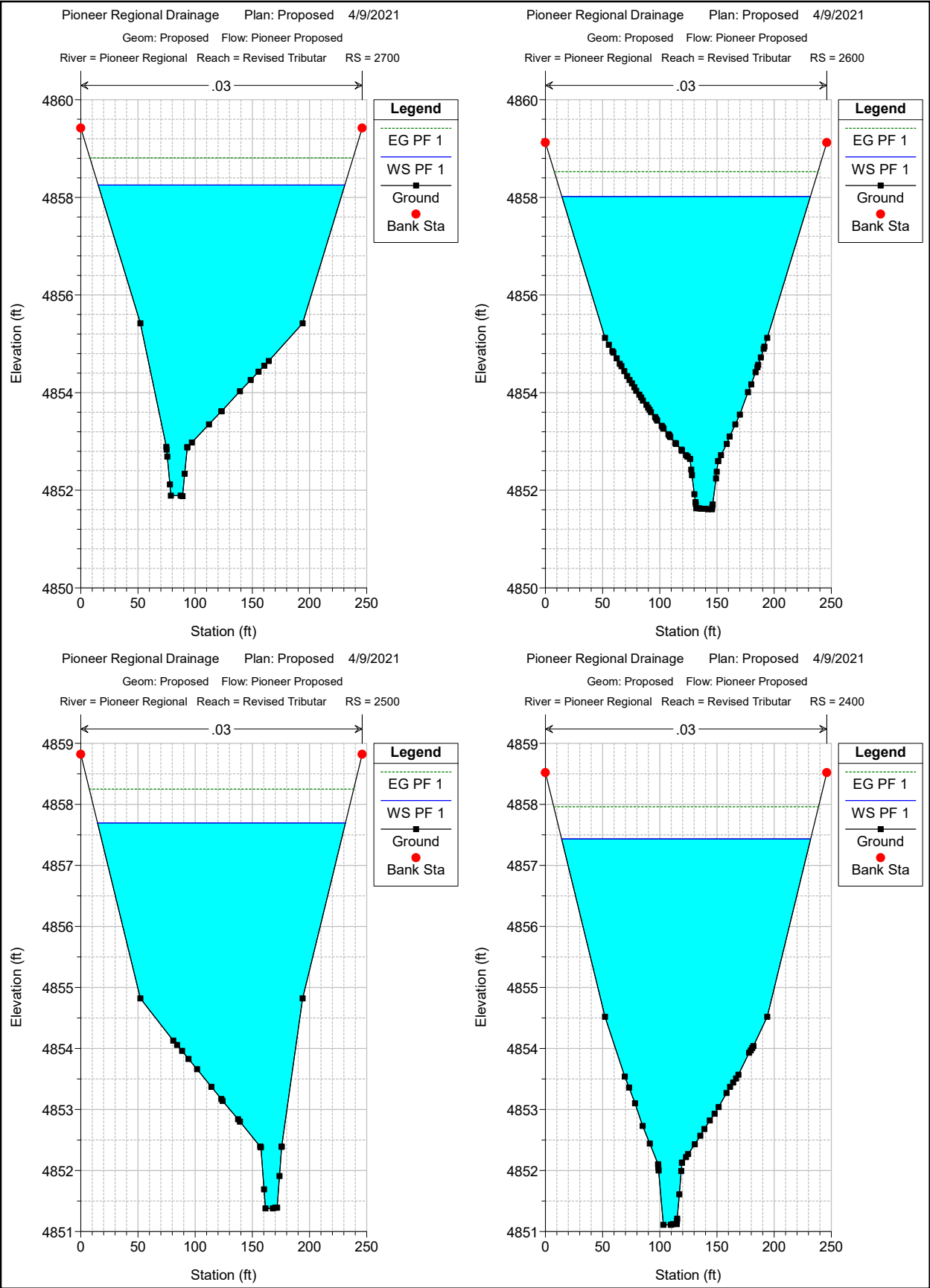
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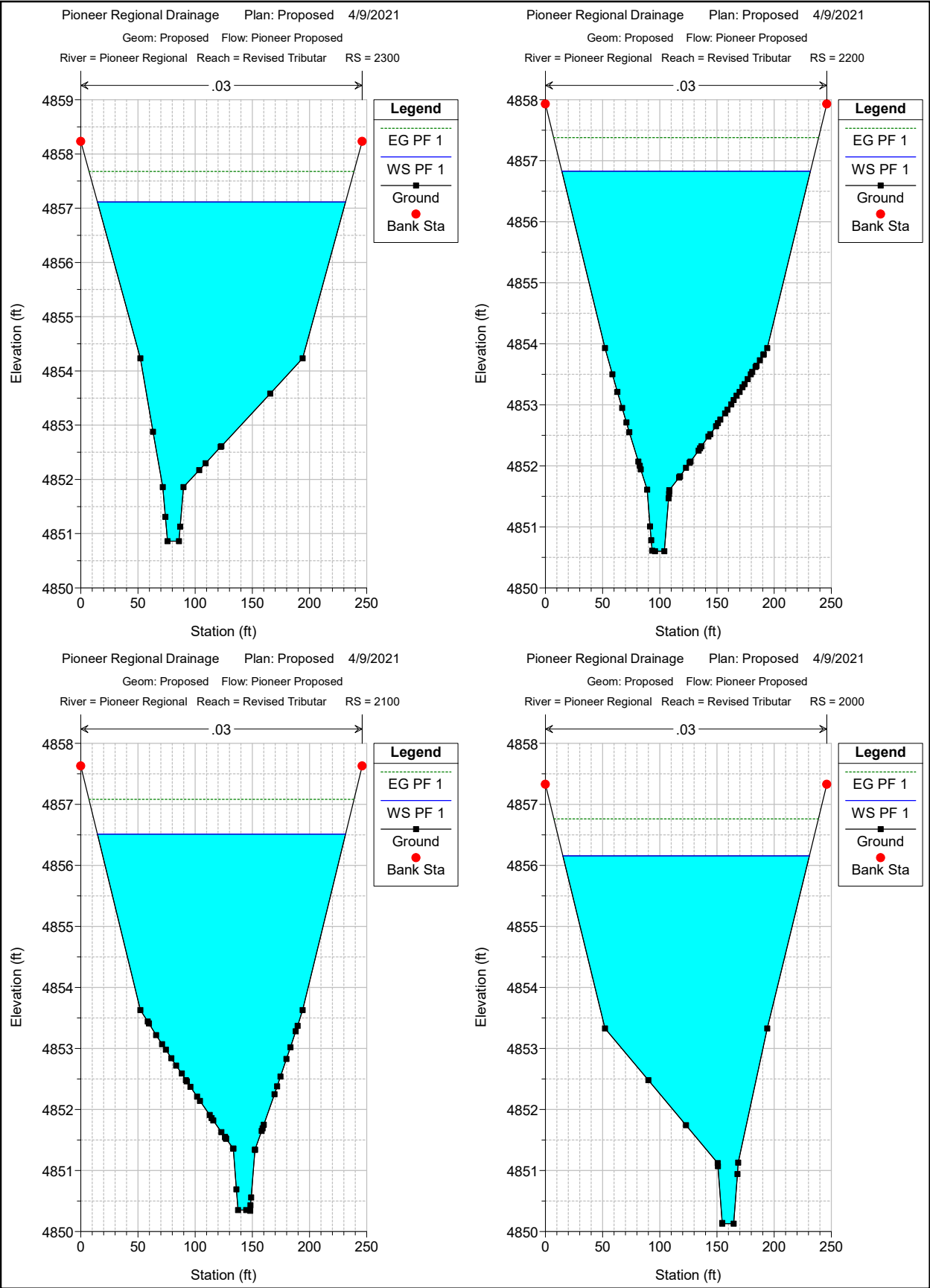
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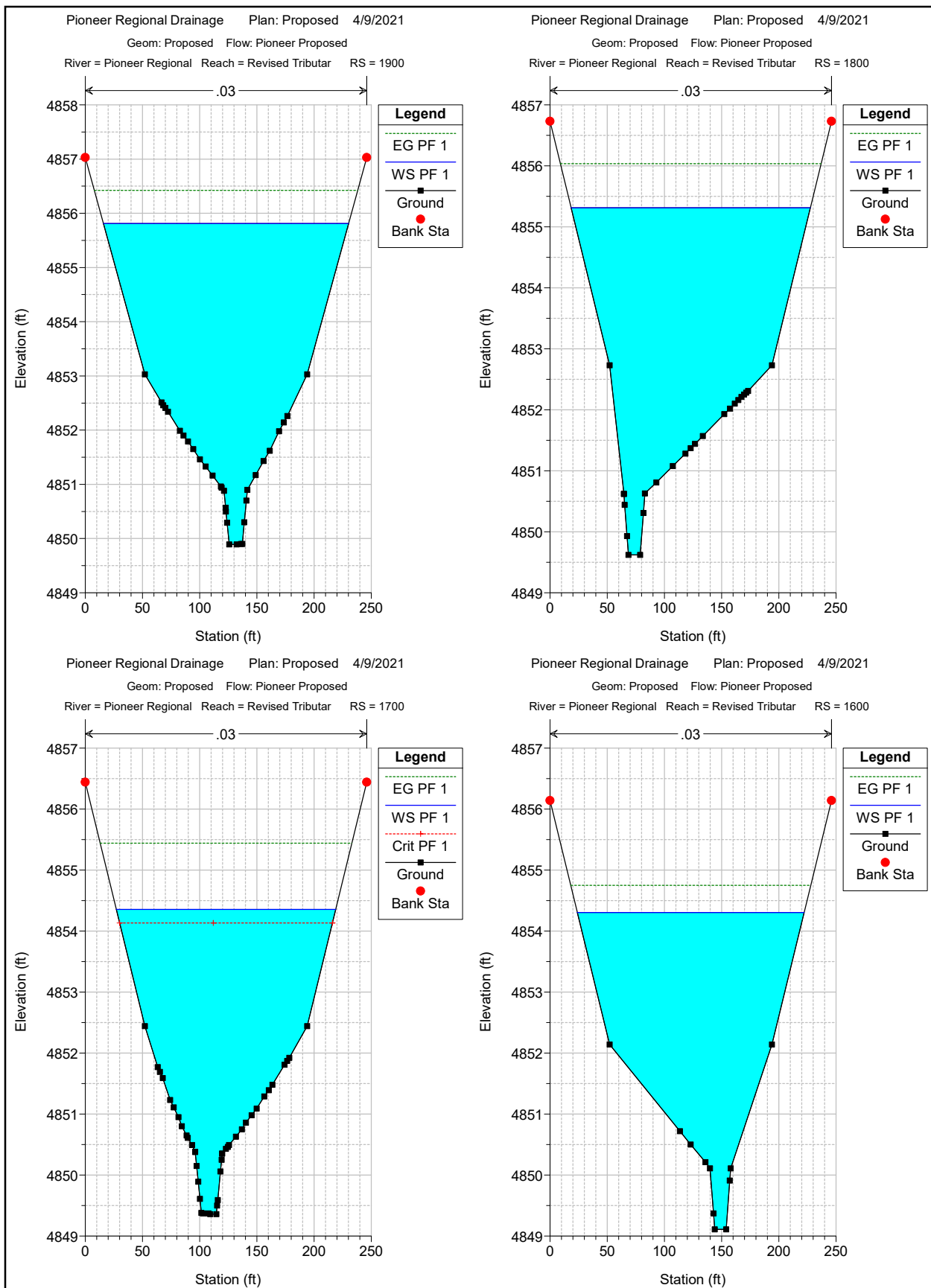


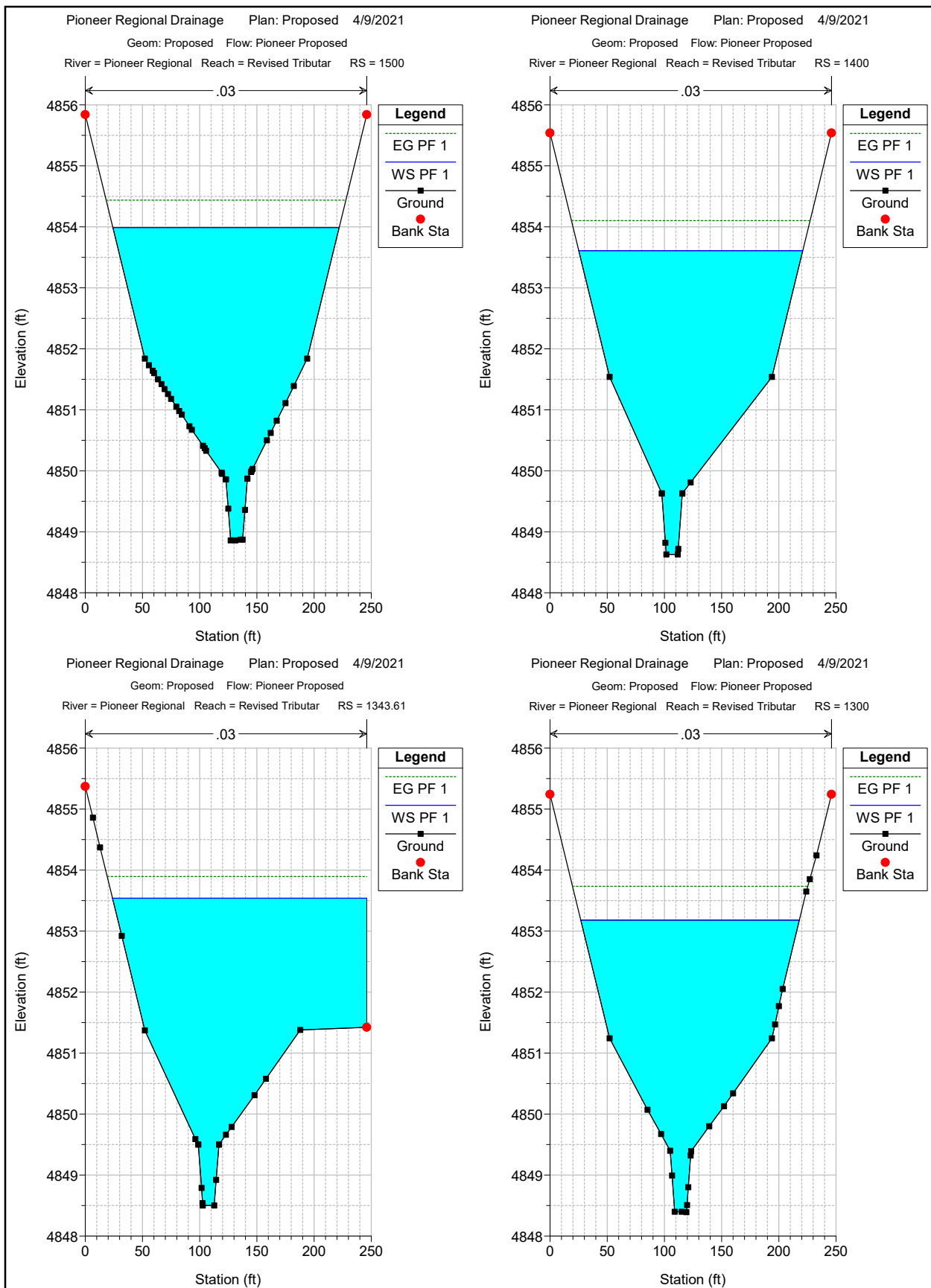


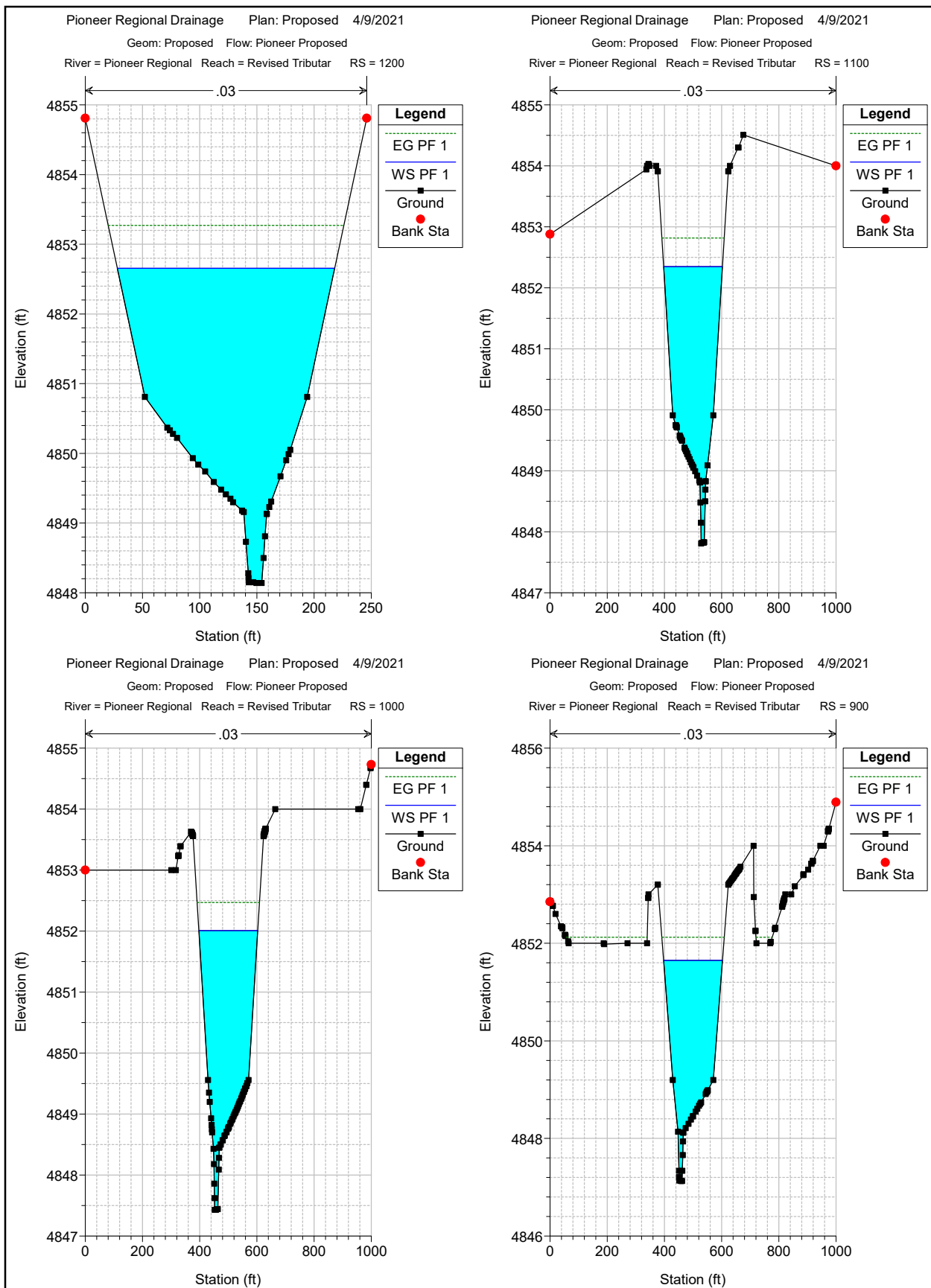


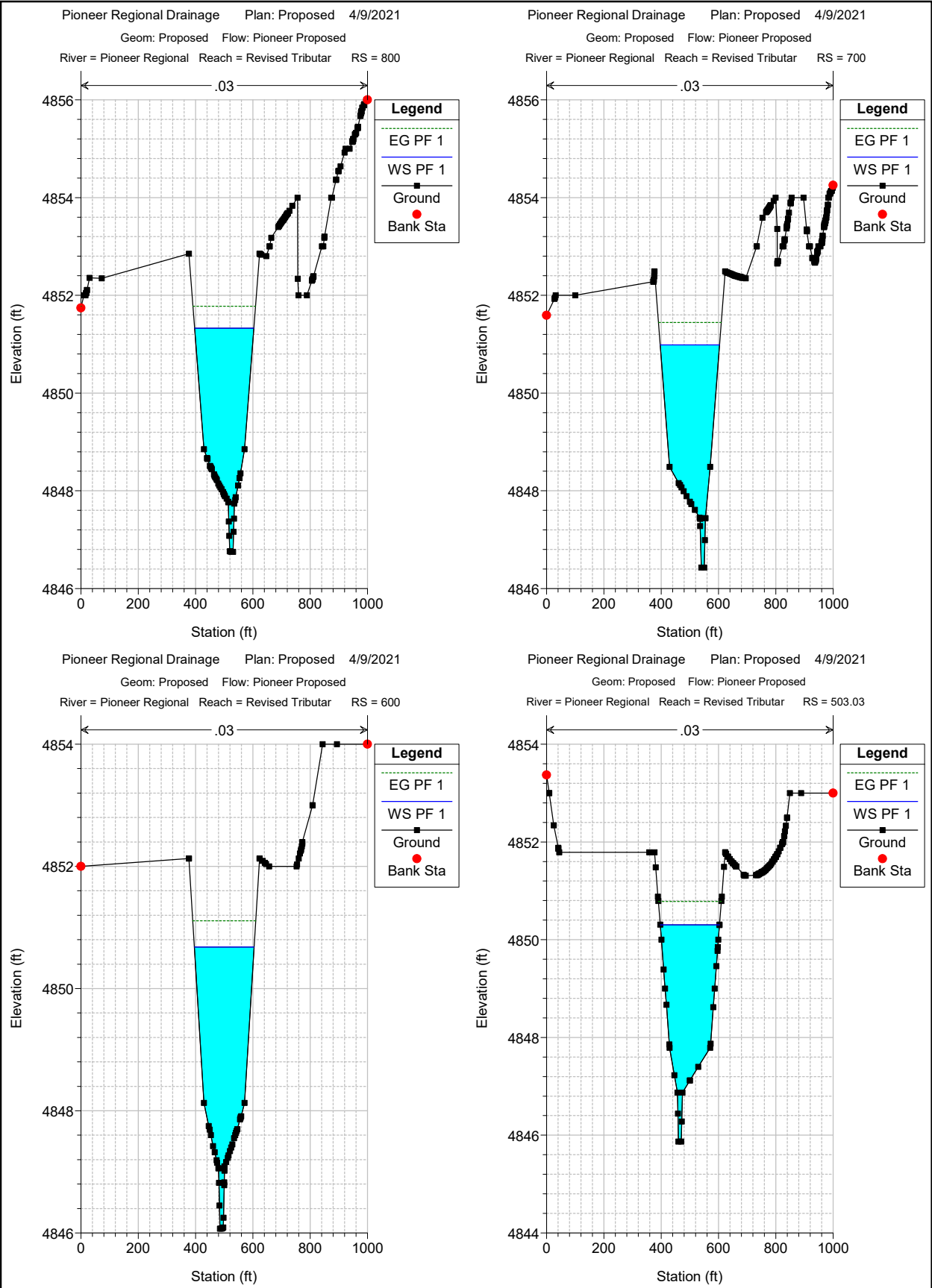


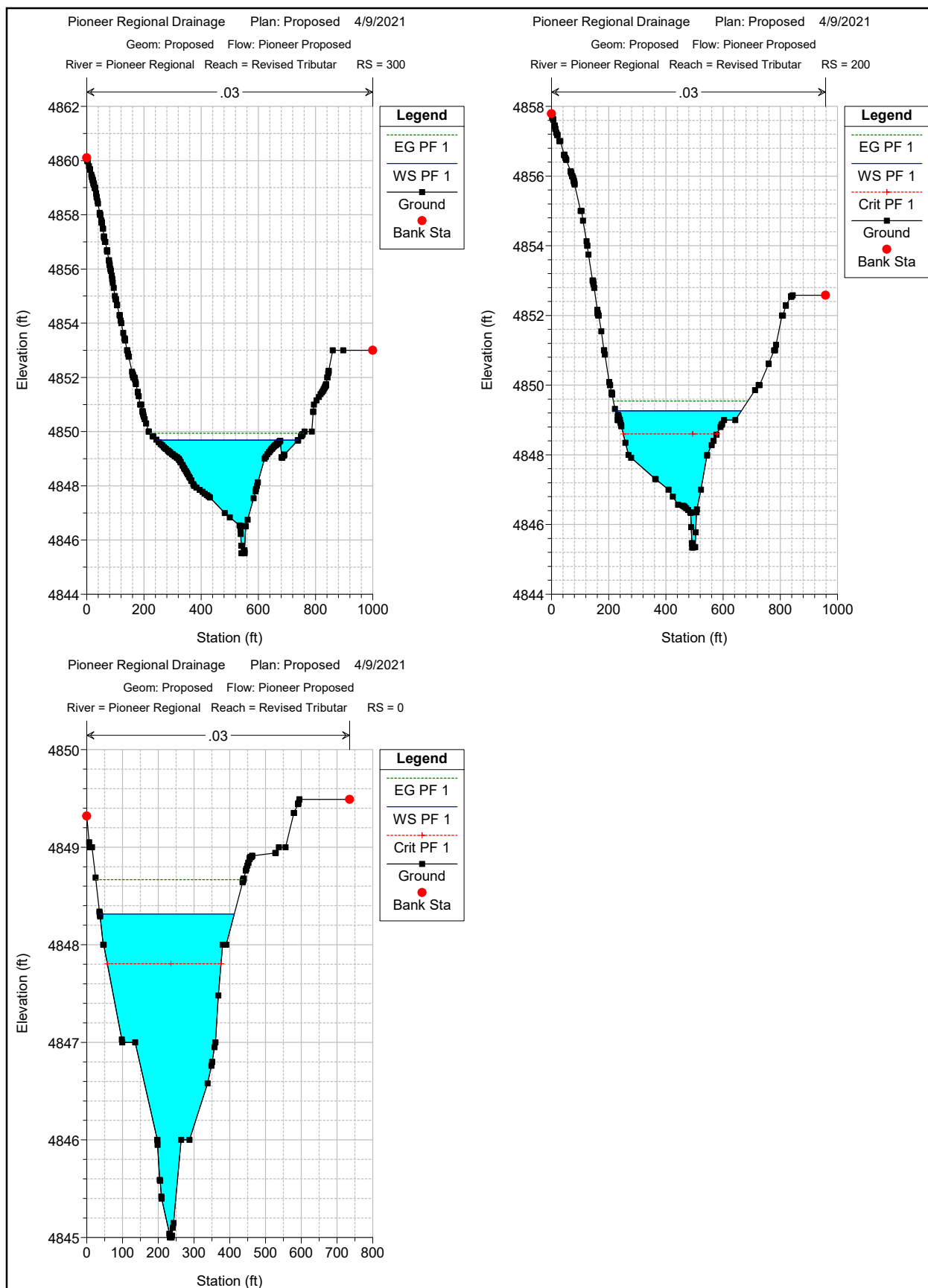




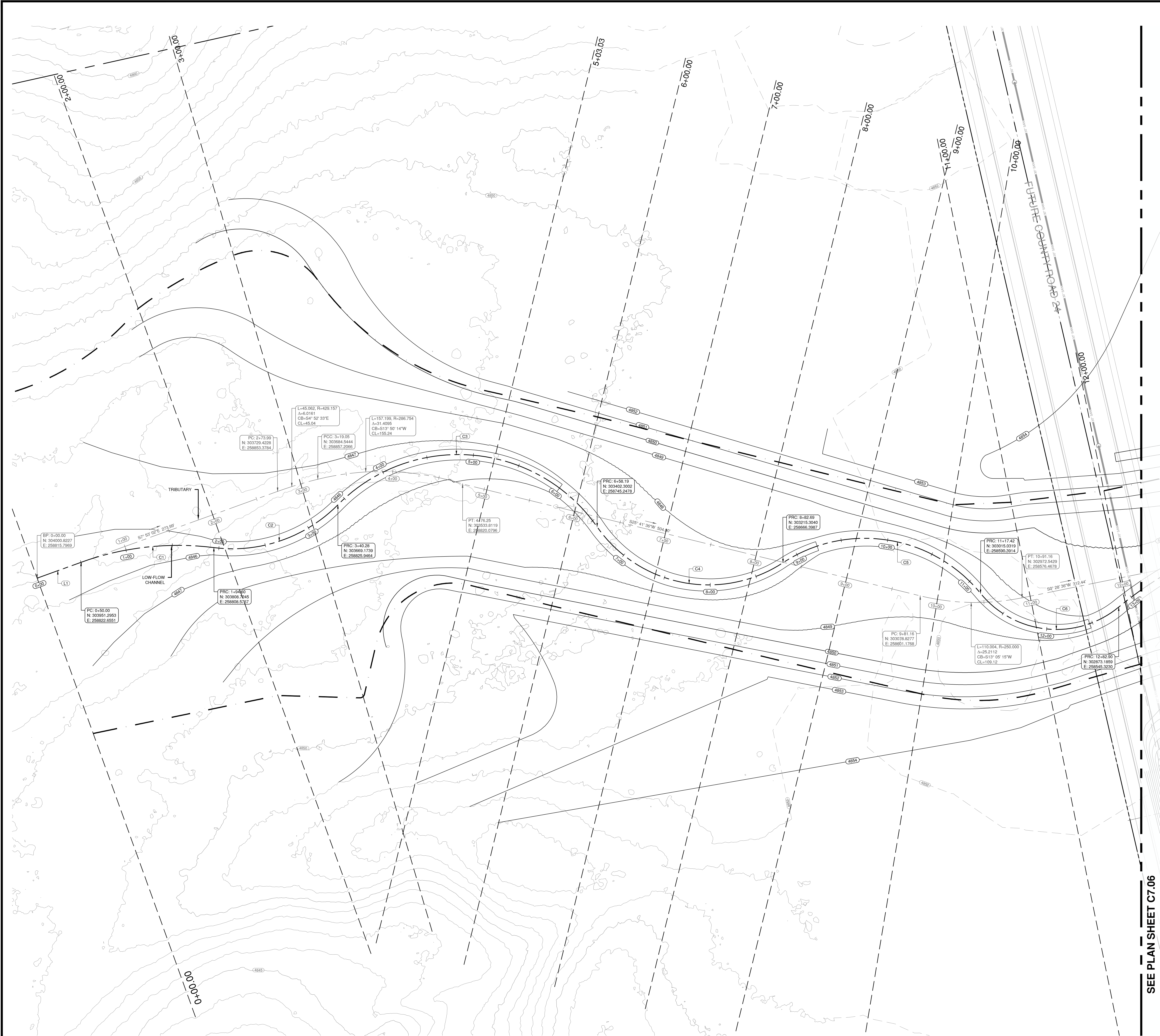




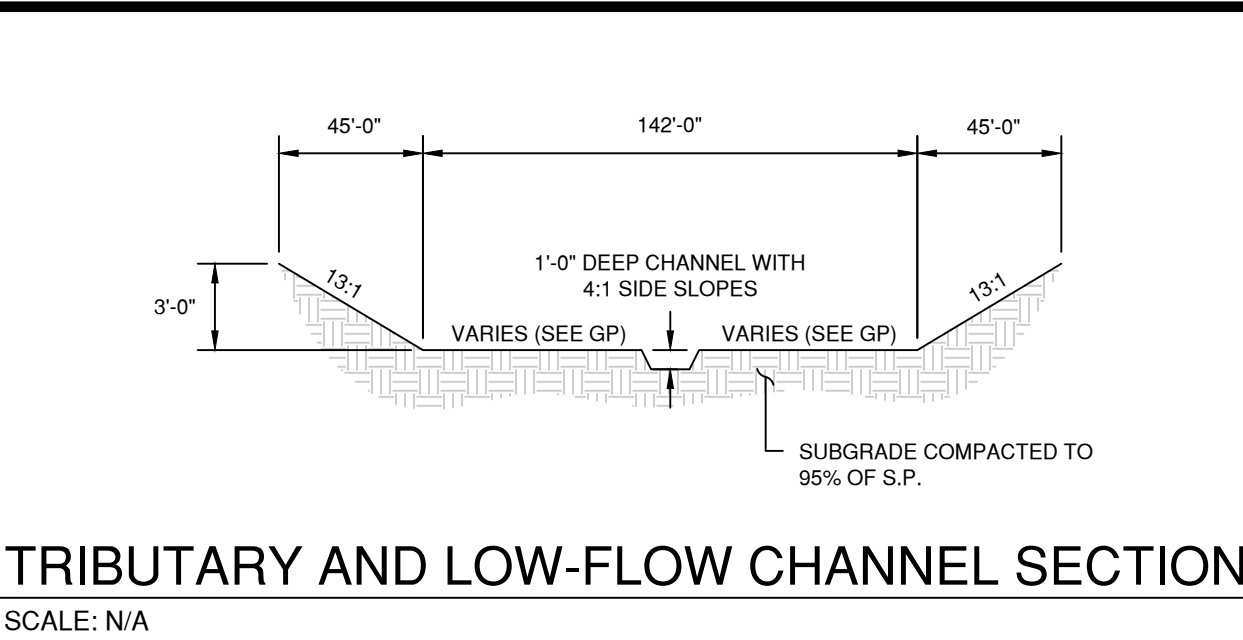








TRIBUTARY AND LOW-FLOW CHANNEL - STATION 0+00 TO 12+00 PLAN VIEW  
SCALE: 1" = 40'



- TRIBUTARY PLAN AND PROFILE NOTES**
- REFER TO ROADWAY PLAN AND PROFILES FOR ALL ROADWAY AND UTILITY DESIGN INFORMATION (SERIES C5.XX DRAWINGS)
  - SEE PLAN SHEET C5.00 FOR STANDARD ROADWAY CROSS SECTIONS.
  - REFER TO PLAN SHEET C6.00 FOR OVERLOT GRADING TEMPLATE(S)

**LEGEND**

---	RIGHT OF WAY / PROPERTY LINE
---	36" W
---	EXISTING WATERMAINS
---	PROPOSED WATERMAINS
---	WATER
---	SSWR
---	PROPOSED GRAVITY SEWER
---	SS-FM
---	PROPOSED SANITARY SEWER FORCEMAIN
---	X' HDPE (TYPE S) STORM DRAIN
---	VERTICAL CURB AND GUTTER
---	LIGHT DUTY ASPHALT PAVEMENT
---	PROPOSED CONCRETE
---	EXISTING MAJOR CONTOUR
---	EXISTING MINOR CONTOUR
---	PROPOSED MAJOR CONTOUR
---	PROPOSED MINOR CONTOUR
---	100-YEAR STORM WATER SURFACE ELEVATION

**Line Table: Alignments**

Line #	Length	Direction	Start Point	End Point
L1	50.00	S7° 53' 01.57"E	(258815.80,304000.82)	(258822.66,303951.30)

**Curve Table: Alignments**

Curve #	Radius	Length	Chord Direction	Start Point	End Point
C1	306.33	144.60	S5° 38' 22.17"W	(258822.66,303951.30)	(258808.58,303808.72)
C2	158.93	145.67	S7° 05' 42.15"E	(258808.58,303808.72)	(258825.95,303669.17)
C3	181.51	317.92	S16° 49' 28.24"W	(258825.95,303669.17)	(258745.25,303402.30)
C4	145.71	224.50	S22° 51' 47.88"W	(258745.25,303402.30)	(258666.40,303215.30)
C5	159.89	234.73	S20° 46' 57.88"W	(258666.40,303215.30)	(258590.39,303015.03)
C6	104.85	165.48	S17° 37' 35.46"W	(258590.39,303015.03)	(258545.32,302873.19)

ENGINEER IN CHARGE:

CONTACT INFORMATION

88 INVERNESS CIRCLE EAST, SUITE E-101

ENGLEWOOD, CO 80112

(720) 206-6831

CPERDUE@STRATEGICDESIGNS.COM

ATTENTION: CHRISTOPHER PERDUE, P.E., M.B.A.

**STRATEGIC**

SITE DESIGNS

**BASIS OF BEARINGS:**

BEARINGS SHOWN HEREON ARE GRID BEARINGS DERIVED FROM GPS OBSERVATION BASED UPON THE COLORADO COORDINATE SYSTEM OF 1983 NORTH ZONE (NAD 83, 2011) REFERENCED TO THE WEST LINE OF THE NORTHWEST QUARTER OF SECTION 7, TOWNSHIP 2 NORTH, RANGE 64 WEST, 80TH PRINCIPAL MERIDIAN, TAKEN TO BEAR SOUTH 00°30'28" EAST, A DISTANCE OF 2,612.70 FEET.

**BENCHMARK**

NOS ROGGEN RM 1: RECOVERED A 3 1/2" BRASS CAP LOCATED 200' SOUTH OF FRONTAGE RD 176 AND 2500' WEST OF COUNTY RD 73.

ELEVATION = 4721.56 (NAVD 88)

**PIONEER VILLAGE**

**PA'S 1-4, 17 AND 21**

**TOWN OF KEENESBURG**

**WELD COUNTY, COLORADO**

**TRIBUTARY AND LOW-FLOW CHANNEL PLAN**

REV	DESCRIPTION	BY	DATE

JOB NO: 1903-001

ORIGINAL ISSUE: 03/15/2021

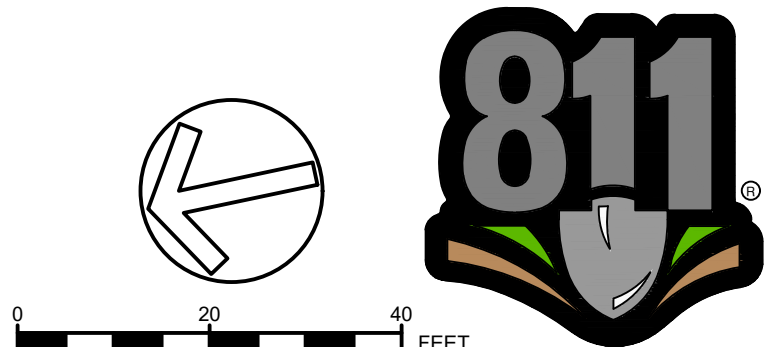
DESIGN BY: CLP

CHECKED BY: CLP

SCALE: VARIES

SHEET NUMBER

**C7.05**







1. REFER TO ROADWAY PLAN AND PROFILES FOR ALL ROADWAY AND UTILITY DESIGN INFORMATION (SERIES C5.XX DRAWINGS)
2. SEE PLAN SHEET C5.00 FOR STANDARD ROADWAY CROSS SECTIONS.
3. REFER TO PLAN SHEET C6.00 FOR OVERLOT GRADING TEMPLATE(S)

	RIGHT OF WAY / PROPERTY LINE
	EXISTING WATERMAINS
	PROPOSED WATERMAINS
	EXISTING GRAVITY SEWER
	PROPOSED SANITARY SEWER FORCEMAIN
	X' HDPE (TYPE S) STORM DRAIN
	VERTICAL CURB AND GUTTER
	LIGHT DUTY ASPHALT PAVEMENT
	PROPOSED CONCRETE
	EXISTING MAJOR CONTOUR
	EXISTING MINOR CONTOUR
	PROPOSED MAJOR CONTOUR
	PROPOSED MINOR CONTOUR
	100-YEAR STORM WATER SURFACE ELEVATION

Curve Table: Alignments					
Curve #	Radius	Length	Chord Direction	Start Point	End Point
C7	401.32	255.40	S9° 21' 23.78"E	(258545.52,3020873.19)	(258586.15,3026265.42)
C8	170.16	289.27	S37° 54' 03.00"E	(258586.15,3026265.42)	(258744.75,302421.69)
C9	105.66	153.87	S42° 57' 27.53"E	(258744.75,302421.69)	(258840.59,302318.77)
C10	310.63	200.06	S19° 41' 23.09"E	(258840.59,302318.77)	(258906.83,302133.66)
C11	234.25	136.44	S39° 49' 17.70"E	(258906.83,302133.66)	(258994.20,302028.86)
C12	178.29	290.35	S5° 09' 43.83"W	(258994.20,302028.86)	(258970.67,301770.62)



**STRATEGIC**  
SITE DESIGNS

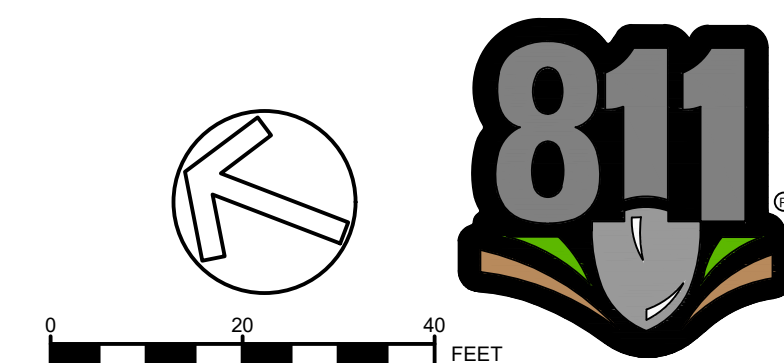
**BENCHMARK**  
NGS ROGGEN RM 1: RECOVERED  
A 3 1/2" BRASS CAP LOCATED  
200' SOUTH OF FRONTAGE ROAD  
I-76 AND 2500' WEST OF COUNTY  
RD 73.  
ELEVATION = 4721.56 (NAVD 88)

**PIONEER VILLAGE  
PA'S 1-4, 17 AND 21  
TOWN OF KEENESBURG  
WELD COUNTY, COLORADO**

# TRIBUTARY AND LOW-FLOW CHANNEL PLAN

[illegible]

C7.06



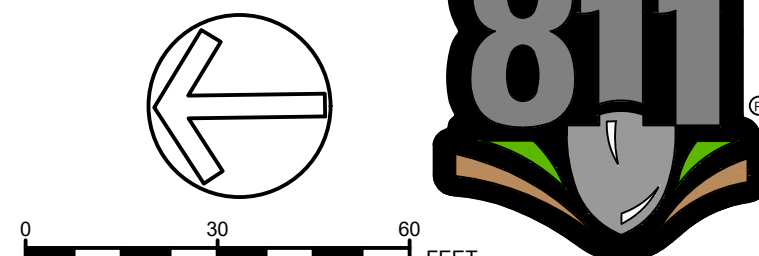




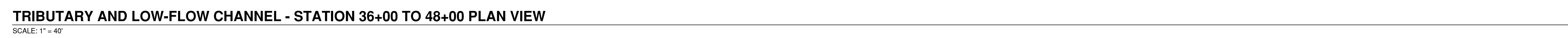
1. REFER TO ROADWAY PLAN AND PROFILES FOR ALL ROADWAY AND UTILITY DESIGN INFORMATION (SERIES C5.XX DRAWINGS)
2. SEE PLAN SHEET C5.00 FOR STANDARD ROADWAY CROSS SECTIONS.
3. REFER TO PLAN SHEET C6.00 FOR OVERLOT GRADING TEMPLATE(S)

	RIGHT OF WAY / PROPERTY LINE
	EXISTING WATERMAINS
	PROPOSED WATERMAINS
	EXISTING GRAVITY SEWER
	PROPOSED GRAVITY SEWER
	EXISTING SANITARY SEWER FORCEMAIN
	PROPOSED SANITARY SEWER FORCEMAIN
	X' HDPE (TYPE S) STORM DRAIN
	VERTICAL CURB AND GUTTER
	LIGHT DUTY ASPHALT PAVEMENT
	PROPOSED CONCRETE
	EXISTING MAJOR CONTOUR
	EXISTING MINOR CONTOUR
	PROPOSED MAJOR CONTOUR
	PROPOSED MINOR CONTOUR
	100-YEAR STORM WATER SURFACE ELEVATION

Curve Table: Alignments					
Curve #	Radius	Length	Chord Direction	Start Point	End Point
C13	134.61	181.48	S13° 12' 13.91"N	(258907.87,301770.62)	(258932.48,301607.01)
C14	192.85	224.67	S7° 57' 20.79"W	(258902.48,301607.01)	(258903.11,301396.88)
C15	190.62	279.51	S0° 40' 34.06"E	(258903.11,301396.88)	(258906.13,301141.77)
C16	255.97	341.67	S0° 01' 52.67"E	(258906.13,301141.77)	(258933.98,300825.38)
C17	116.90	163.66	S7° 29' 07.82"E	(258933.98,300825.38)	(258955.60,300676.05)
C18	162.97	267.65	S0° 32' 35.4"E	(258955.60,300676.05)	(258963.66,300437.49)







- ## LEGEND
- |  |  |
|--|--|
|  | RIGHT OF WAY / PROPERTY LINE           |
|  | EXISTING WATERMAINS                    |
|  | PROPOSED WATERMAINS                    |
|  | PROPOSED GRAVITY SEWER                 |
|  | PROPOSED SANITARY SEWER FORCEMAIN      |
|  | X" HDPE (TYPE S) STORM DRAIN           |
|  | VERTICAL CURB AND GUTTER               |
|  | LIGHT DUTY ASPHALT PAVEMENT            |
|  | PROPOSED CONCRETE                      |
|  | EXISTING MAJOR CONTOUR                 |
|  | EXISTING MINOR CONTOUR                 |
|  | PROPOSED MAJOR CONTOUR                 |
|  | PROPOSED MINOR CONTOUR                 |
|  | 100-YEAR STORM WATER SURFACE ELEVATION |

Curve Table: Alignments					
Curve #	Radius	Length	Chord Direction	Start Point	End Point
C19	162.97	267.65	S0° 32' 32.54"E	(258951.66,300676.05)	(258955.86,300437.44)
C20	58.19	352.48	S4° 25' 32.70"W	(258955.86,300437.44)	(258949.84,300359.97)
C21	304.77	82.93	S7° 18' 03.84"E	(258949.84,300359.97)	(258988.99,300054.14)
C22	127.56	242.77	S31° 28' 12.66"E	(258988.99,300054.14)	(259097.45,299867.07)
C23	139.22	210.80	S42° 37' 01.94"E	(259097.45,299867.07)	(259226.93,299736.22)
C24	370.73	481.36	S7° 27' 44.08"E	(259226.93,299736.22)	(259497.47,299375.55)

SEE SHEET C7.02  
FOR POND C DETAILS

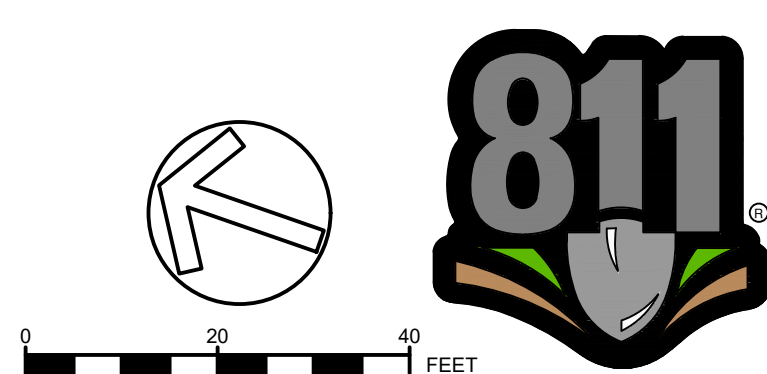
**BASIS OF BEARINGS:**  
BEARINGS SHOWN HEREIN ARE  
GRID BEARINGS DERIVED FROM  
GPS OBSERVATIONS BASED UPON  
THE COLORADO COORDINATE  
SYSTEM OF 1983 NORTH ZONE  
(NAD 83, 2011) REFERENCED TO  
THE WEST LINE OF THE  
NORTHWEST QUARTER OF  
SECTION 7, TOWNSHIP 2 NORTH,  
RANGE 64 WEST, SIXTH  
PRINCIPAL MERIDIAN, TAKEN TO  
BEAR SOUTH 00°30'28" EAST, A  
DISTANCE OF 2,612.70 FEET.

**BENCHMARK**  
NGS ROGGEN RM 1: RECOVERED  
A 1 1/2" BRASS CAP LOCATED  
200' SOUTH OF FRONTAGE RM  
1-76 AND 2500' WEST OF COUNT  
RD 73.

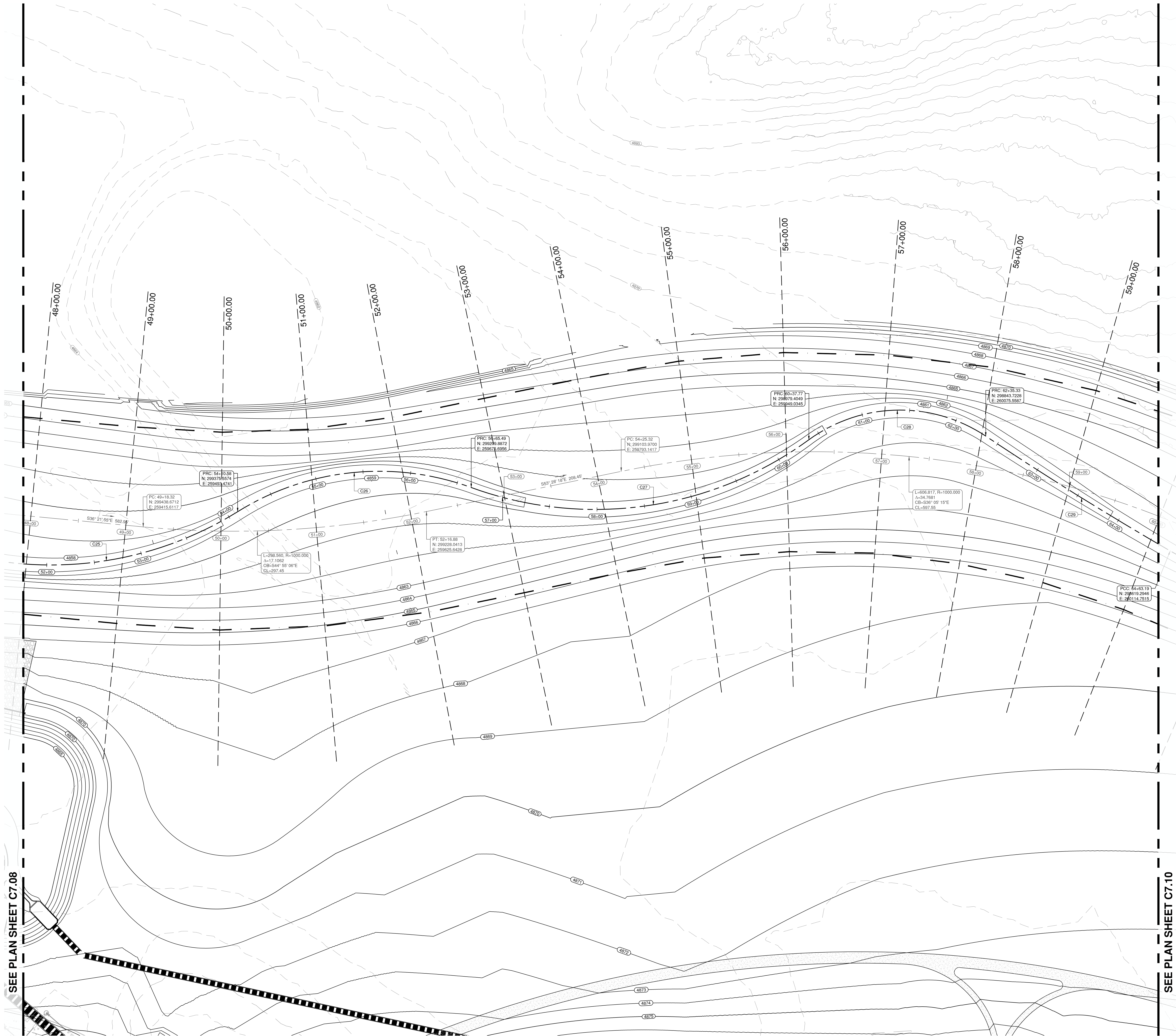
EL ELEVATION = 4721.56 (NAVD 83)

**PIONEER VILLAGE  
PA'S 1-4, 17 AND 21  
TOWN OF KEENESBURG  
WELD COUNTY, COLORADO**

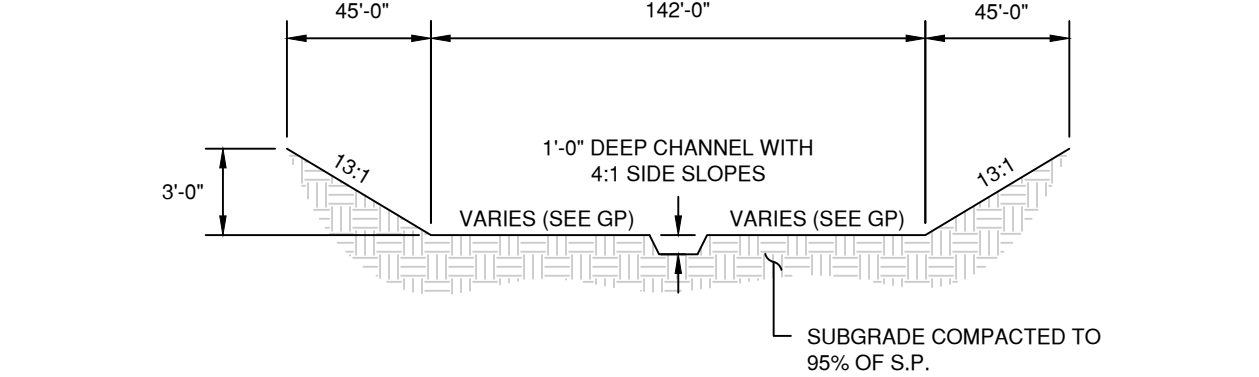
# TRIBUTARY AND LOW-FLOW CHANNEL PLAN

[illegible]





TRIBUTARY AND LOW-FLOW CHANNEL - STATION 48+00 TO 60+00 PLAN VIEW  
SCALE: 1" = 40'



TRIBUTARY AND LOW-FLOW CHANNEL SECTION  
SCALE: N/A

- TRIBUTARY PLAN AND PROFILE NOTES**
- REFER TO ROADWAY PLAN AND PROFILES FOR ALL ROADWAY AND UTILITY DESIGN INFORMATION (SERIES C5.XX DRAWINGS)
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  - REFER TO PLAN SHEET C6.00 FOR OVERLOT GRADING TEMPLATE(S)

**LEGEND**

- RIGHT OF WAY / PROPERTY LINE
- EXISTING WATERMAINS
- PROPOSED WATERMAINS
- SSWR
- PROPOSED GRAVITY SEWER
- PROPOSED SANITARY SEWER FORCEMAIN
- X' HDPE (TYPE S) STORM DRAIN
- VERTICAL CURB AND GUTTER
- LIGHT DUTY ASPHALT PAVEMENT
- PROPOSED CONCRETE
- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR
- 100-YEAR STORM WATER SURFACE ELEVATION

Curve Table: Alignments					
Curve #	Radius	Length	Chord Direction	Start Point	End Point
C25	370.73	481.68	S36° 27' 44.08"E	(259226.93,299736.27)	(259493.47,299375.56)
C26	281.30	254.91	S47° 43' 25.84"E	(259493.47,299375.56)	(259675.70,299209.89)
C27	379.57	372.29	S49° 51' 43.36"E	(259675.70,299209.89)	(259949.03,298979.40)
C28	161.88	197.55	S42° 59' 58.84"E	(259949.03,298979.40)	(260075.56,298843.72)
C29	3497.08	227.86	S9° 54' 21.26"E	(260075.56,298843.72)	(260114.75,298619.29)

ENGINEER IN CHARGE:

CONTACT INFORMATION  
88 INVERNESS CIRCLE EAST, SUITE E-101  
ENGLEWOOD, CO 80112  
(720) 206-6831  
CPEDUE@STRATEGICDESIGNS.COM  
ATTENTION: CHRISTOPHER PEDUE, P.E., M.B.A.

**STRATEGIC**  
SITE DESIGNS

**BASIS OF BEARINGS:**  
BEARINGS SHOWN HEREON ARE GRID BEARINGS DERIVED FROM GPS OBSERVATION BASED UPON THE COLORADO COORDINATE SYSTEM OF 1983 NORTH ZONE (NAD 83, 2011) REFERENCED TO THE WEST LINE OF THE NORTHWEST QUARTER OF SECTION 7, TOWNSHIP 2 NORTH, RANGE 64 WEST, SIXTH PRINCIPAL MERIDIAN, TAKEN TO BEAR SOUTH 00°30'28" EAST, A DISTANCE OF 2,612.70 FEET.

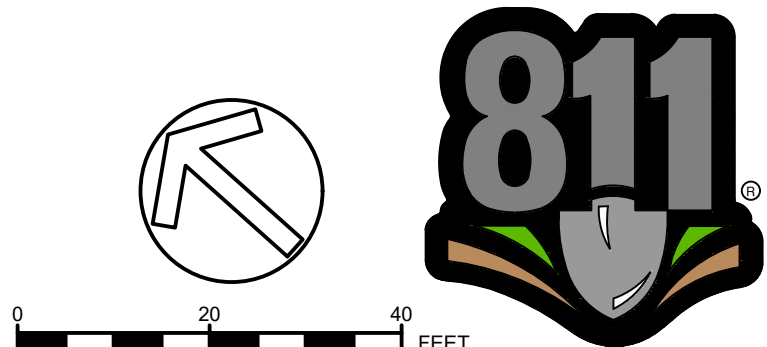
**BENCHMARK**  
NGS ROGEN RM 1: RECOVERED A 3 1/2" BRASS CAP LOCATED 200' SOUTH OF FRONTAGE RD 176 AND 2500' WEST OF COUNTY RD 73.  
ELEVATION = 4721.56 (NAVD 88)

**PIONEER VILLAGE**  
PA'S 1-4, 17 AND 21  
TOWN OF KEENESBURG  
WELD COUNTY, COLORADO

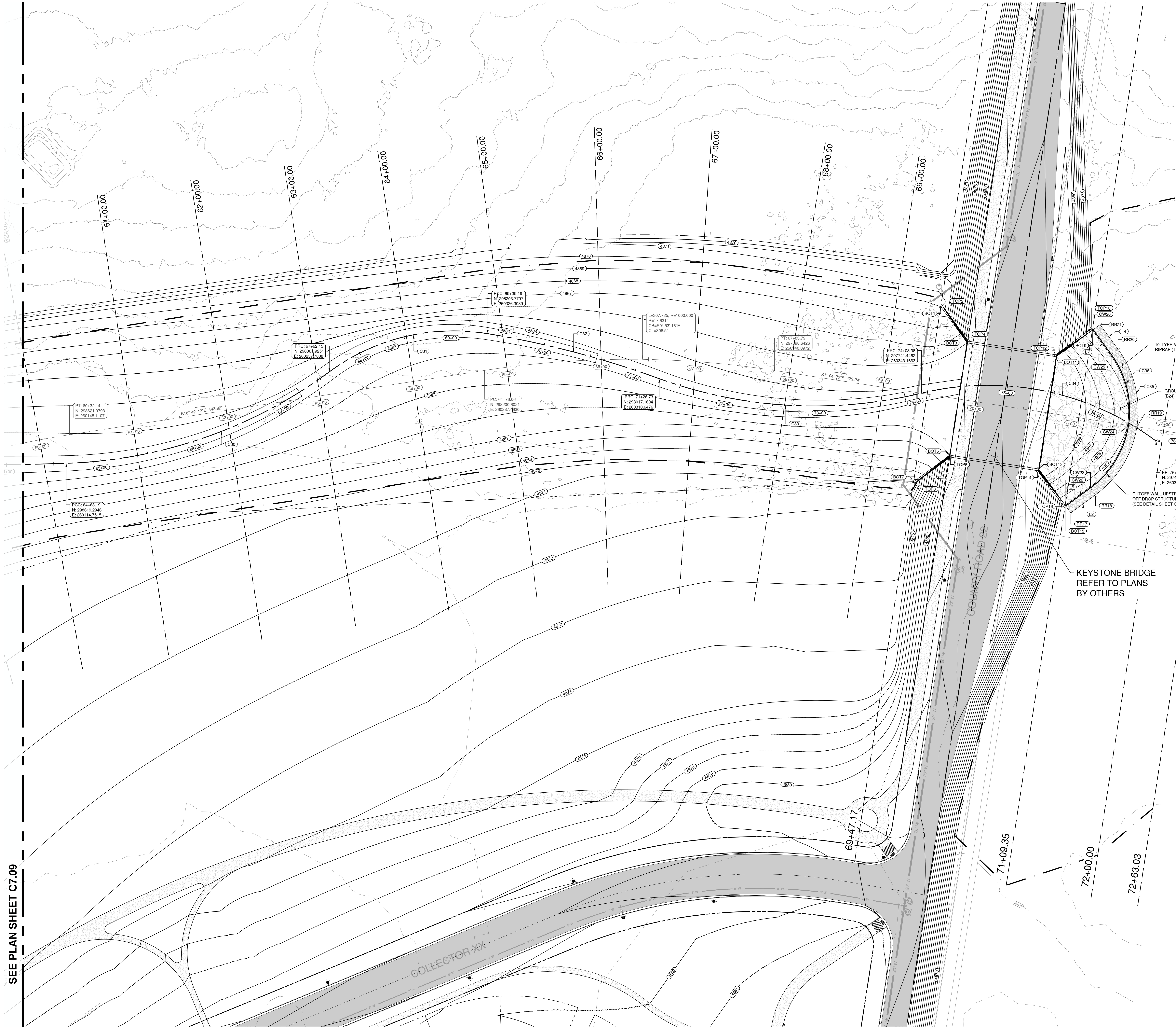
**TRIBUTARY AND LOW-FLOW CHANNEL PLAN**

REV	DESCRIPTION	BY	DATE

JOB NO: 1903-001  
ORIGINAL ISSUE: 03/15/2021  
DESIGN BY: CLP  
CHECKED BY: CLP  
SCALE: VARIES  
SHEET NUMBER  
**C7.09**







TRIBUTARY AND LOW-FLOW CHANNEL SECTION  
SCALE: N/A

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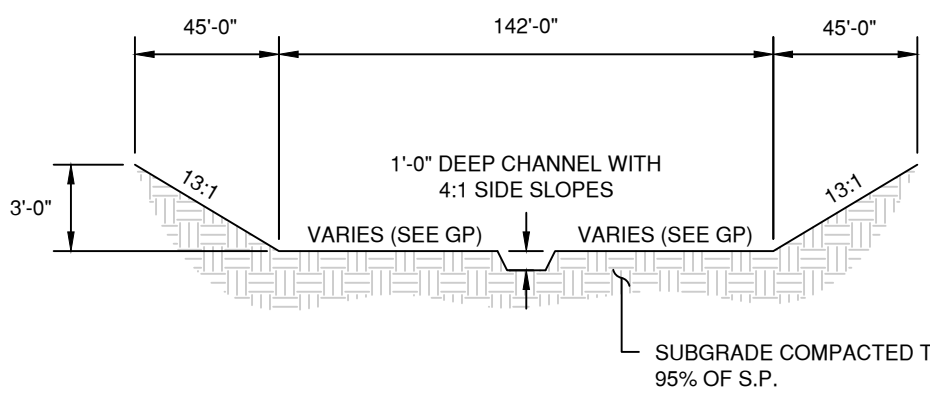
**LEGEND**

- 36" W --- RIGHT OF WAY / PROPERTY LINE
- EXISTING WATERMAINS --- EXISTING WATERMAINS
- WATER --- PROPOSED WATERMAINS
- SSWR --- PROPOSED GRAVITY SEWER
- SS-FM --- PROPOSED SANITARY SEWER FORCEMAIN
- X' HOPE (TYPE S) STORM DRAIN --- X' HOPE (TYPE S) STORM DRAIN
- VERTICAL CURB AND GUTTER --- VERTICAL CURB AND GUTTER
- LIGHT DUTY ASPHALT PAVEMENT --- LIGHT DUTY ASPHALT PAVEMENT
- PROPOSED CONCRETE --- PROPOSED CONCRETE
- EXISTING MAJOR CONTOUR --- EXISTING MAJOR CONTOUR
- EXISTING MINOR CONTOUR --- EXISTING MINOR CONTOUR
- PROPOSED MAJOR CONTOUR --- PROPOSED MAJOR CONTOUR
- PROPOSED MINOR CONTOUR --- PROPOSED MINOR CONTOUR
- 100-YEAR STORM WATER SURFACE ELEVATION --- 100-YEAR STORM WATER SURFACE ELEVATION

Point Table				
Point #	Elevation	Northing	Easting	Description
1	9763.72	297737.04	260436.73	BOT1
2	4893.72	297735.65	260438.17	TOP2
3	9763.72	297702.83	260403.77	BOT3
4	9763.72	297702.04	260405.79	TOP4
5	9763.72	297699.72	260281.81	TOP6
6	14612.03	297700.67	260283.53	BOT5
7	14633.72	297732.10	260248.20	TOP8
8	9763.72	297733.54	260249.58	BOT7
9	9763.72	297574.89	260439.76	BOT9
10	14635.88	297576.24	260441.09	TOP10
11	0.00	297607.85	260405.55	BOT11
12	9763.72	297608.71	260407.53	TOP12
13	9763.72	297572.78	260251.18	TOP16
14	9763.72	297571.39	260252.62	BOT15
15	9763.72	297606.39	260283.56	TOP14
16	9763.72	297605.60	260285.57	BOT13
17	9763.72	297564.19	260245.68	RR17
18	9763.72	297541.74	260268.98	RR18
19	9763.72	297510.99	260347.35	RR19
20	9763.72	297544.65	260424.52	RR20
21	9763.72	297567.95	260446.96	RR21
22	9763.72	297574.20	260440.48	CW26
23	9763.72	297550.90	260418.04	CW25
24	9763.72	297519.98	260347.18	CW24
25	9763.72	297548.22	260275.22	CW23
26	9763.72	297570.67	260251.92	CW22

Line Table						
Line #	Length	Direction	Start Northing	End Northing	Start Easting	End Easting
L2	32.35	N46° 04' 19.45"W	297541.74	297564.19	260268.98	260245.68
L4	32.35	S43° 55' 39.82"W	297567.95	297544.65	260446.96	260424.52
L5	32.35	N46° 04' 19.45"W	297548.22	297570.67	260275.22	260251.92
L7	32.35	S43° 55' 39.82"W	297574.20	297550.90	260440.48	260418.04

Curve Table: Alignments					
Curve #	Radius	Length	Chord Direction	Start Point	End Point
C30	495.34	298.96	S29° 03' 46.72"E	(260114.75,298619.29)	(260257.76,298361.93)
C31	221.21	177.04	S23° 25' 32.75"E	(260257.78,298361.93)	(260326.30,298203.78)
C32	1014.92	187.54	S4° 47' 43.97"W	(260326.30,298203.78)	(260310.65,298017.16)
C33	479.83	281.65	S6° 43' 35.72"E	(260310.65,298017.16)	(260343.17,297741.45)
C34	297.55	261.47	S1° 37' 56.08"W	(260343.17,297741.45)	(260335.96,297488.41)



ENGINEER IN CHARGE:

CONTACT INFORMATION  
88 INVERNESS CIRCLE EAST, SUITE E-101  
ENGLEWOOD, CO 80112  
(720) 206-8831  
CPERDUE@STRATEGICDESIGNS.COM  
ATTENTION: CHRISTOPHER PERDUE, P.E., M.B.A.

**STRATEGIC**  
DESIGNS  
SITE DESIGN

**BASIS OF BEARINGS:**  
BEARINGS SHOWN HEREON ARE GRID BEARINGS DERIVED FROM GPS OBSERVATION BASED UPON THE COLORADO COORDINATE SYSTEM OF 1983 NORTH ZONE (NAD 83, 2011) REFERENCED TO THE WEST LINE OF THE NORTHWEST QUARTER OF SECTION 7, TOWNSHIP 2 NORTH, RANGE 64 WEST, SIXTH PRINCIPAL MERIDIAN, TAKEN TO BEAR SOUTH 90°30'28" EAST, A DISTANCE OF 2,612.70 FEET.

**BENCHMARK**  
NOS ROGGEN RM 1 - RECOVERED A 3 1/2" BRASS CAP LOCATED 200' SOUTH OF FRONTAGE RD 176 AND 2500' WEST OF COUNTY RD 73.  
ELEVATION = 4721.56 (NAVD 88)

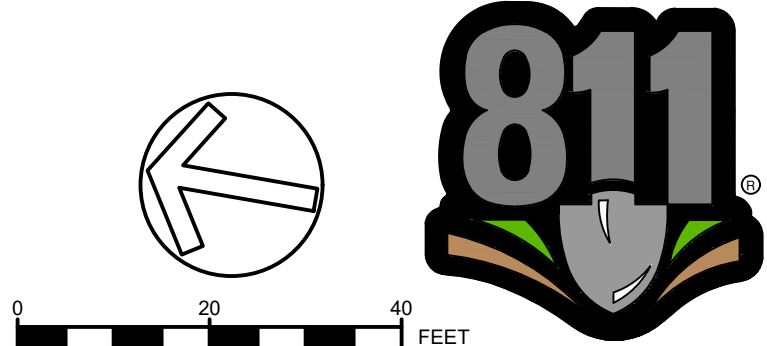
**PIONEER VILLAGE**  
PA'S 1-4, 17 AND 21  
TOWN OF KEENESBURG  
WELD COUNTY, COLORADO

**TRIBUTARY AND LOW-FLOW CHANNEL PLAN**

REV	DESCRIPTION	BY	DATE

JOB NO: 1903-001  
ORIGINAL ISSUE: 03/15/2021  
DESIGN BY: CLP  
CHECKED BY: CLP  
SCALE: VARIES  
SHEET NUMBER  
**C7.10**

TRIBUTARY AND LOW-FLOW CHANNEL - STATION 60+00 TO 72+63 PLAN VIEW  
SCALE: 1" = 40'





## **Appendix C**

EDB Pond Details

**Pioneer Village Phase 1  
Town of Keenesburg**

**Designer**  
**Company**  
**Date**  
**Project**  
**Location**

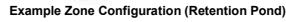
SSD  
11/11/2020  
Pioneer Village  
Keenesburg, CO

Overall Inputs	
Land Use	% Impervious
Open Space/Lawn	2%
Hardscape/Pavement	100%
School	55%
Residential	55%
Commercial	95%

Future Pond	Total Area (ac)	NRCS Hydrologic Soil Group	Open Space/Lawn		Hardscape/Pavement		School		Residential		Commercial		% Check	Percent Impervious
			Area (ac)	Imp (ac)	Area (ac)	Imp (ac)	Area (ac)	Imp (ac)	Area (ac)	Imp (ac)	Area (ac)	Imp (ac)		
Future Pond D	298.70	A	96.10	1.922	24.90	24.90	0.00	0.00	177.70	97.74	0.00	0.00	100.00%	41.70%
Future Pond E	89.88	A	8.47	0.169	4.48	4.48	0.00	0.00	35.45	19.50	41.48	39.41	100.00%	70.71%
Future Pond F	180.22	A	22.14	0.443	13.10	13.10	29.68	16.32	85.90	47.25	29.40	27.93	100.00%	58.29%
Future Pond G	364.20	A	74.95	1.499	10.25	10.25	8.00	4.40	271.00	149.05	0.00	0.00	100.00%	45.36%
Future Pond H	259.30	A	14.10	0.282	18.20	18.20	0.00	0.00	227.00	124.85	0.00	0.00	100.00%	55.28%
Future Pond I	304.90	A	28.60	0.572	4.60	4.60	28.70	15.79	243.00	133.65	0.00	0.00	100.00%	50.71%
Pond A	66.42	A	10.15	0.203	1.43	1.43	0.00	0.00	54.84	30.16	0.00	0.00	100.00%	48.00%
Pond B	51.64	A	7.64	0.153	4.04	4.04	0.00	0.00	39.96	21.98	0.00	0.00	100.00%	58.00%
Pond C	144.88	A	15.98	0.320	29.42	29.42	0.00	0.00	99.48	54.71	0.00	0.00	100.00%	49.00%

## MHFD-Detention, Version 4.03 (May 2020)

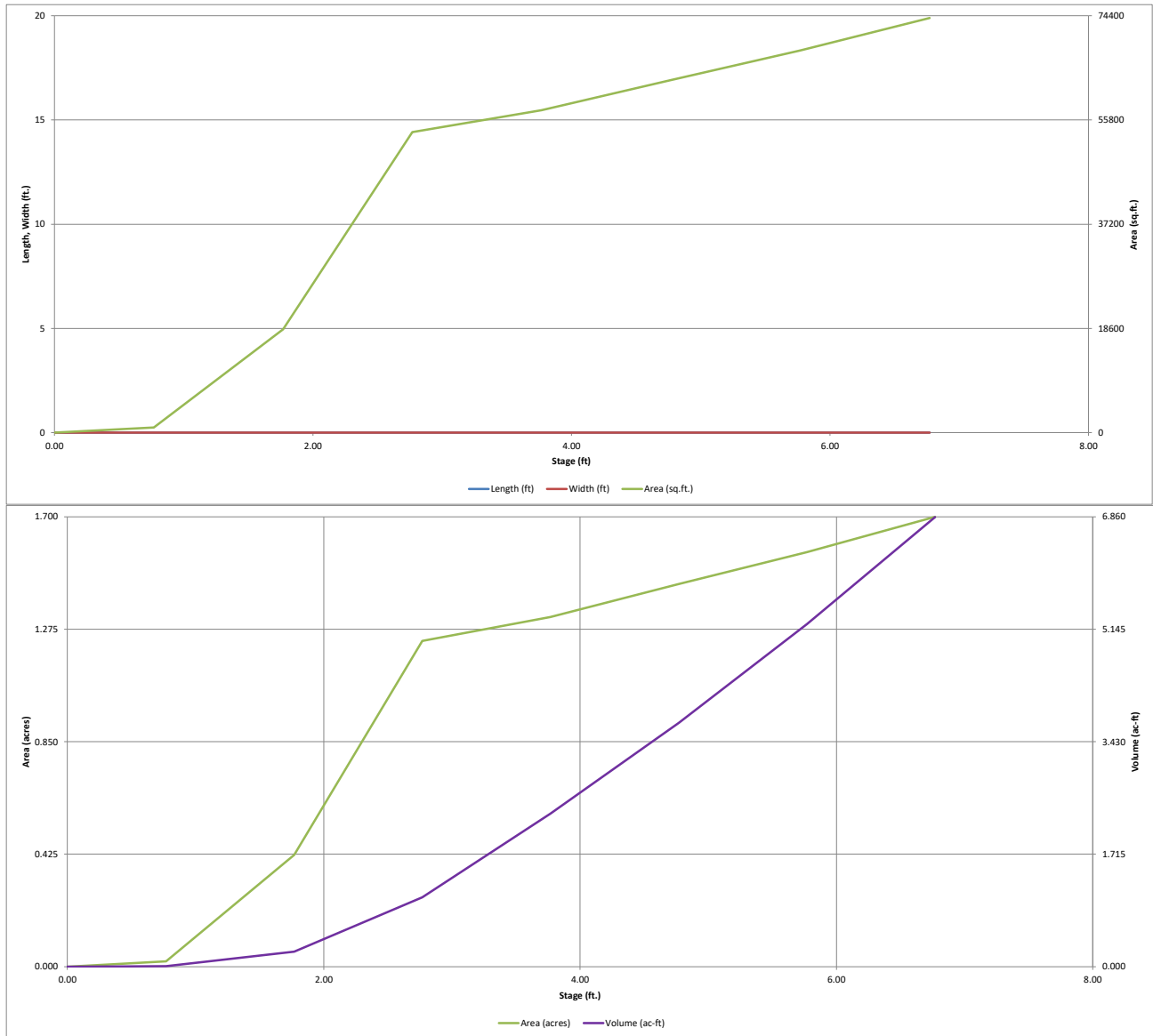
**Basin ID:** Pond 1 and 2





# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

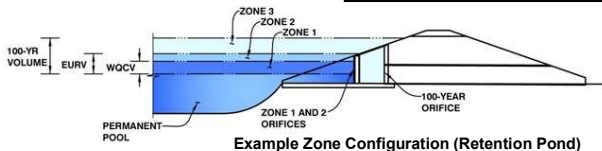
MHFD-Detention, Version 4.03 (May 2020)



# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.03 (May 2020)

Project: **Pioneer Village**  
Basin ID: **Pond 1 and 2**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.82	1.111	Orifice Plate
Zone 2 (EURV)	4.71	2.513	Orifice Plate
Zone 3 (100-year)	6.36	2.528	Weir&Pipe (Restrict)
Total (all zones)		6.152	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain  
Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (use rectangular openings)

Calculated Parameters for Plate  
WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	<input type="text" value="0.00"/>	<input type="text" value="1.60"/>	<input type="text" value="3.20"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Orifice Area (sq. inches)	<input type="text" value="5.00"/>	<input type="text" value="5.00"/>	<input type="text" value="5.00"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Orifice Area (sq. inches)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice  
Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Grate Slope =  H:V  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Open Area % =  %  
Debris Clogging % =  %

Calculated Parameters for Overflow Weir  
Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =   
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  inches  
Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway  
Spillway Design Flow Depth =  feet  
Stage at Top of Freeboard =  feet  
Basin Area at Top of Freeboard =  acres  
Basin Volume at Top of Freeboard =  acre-ft

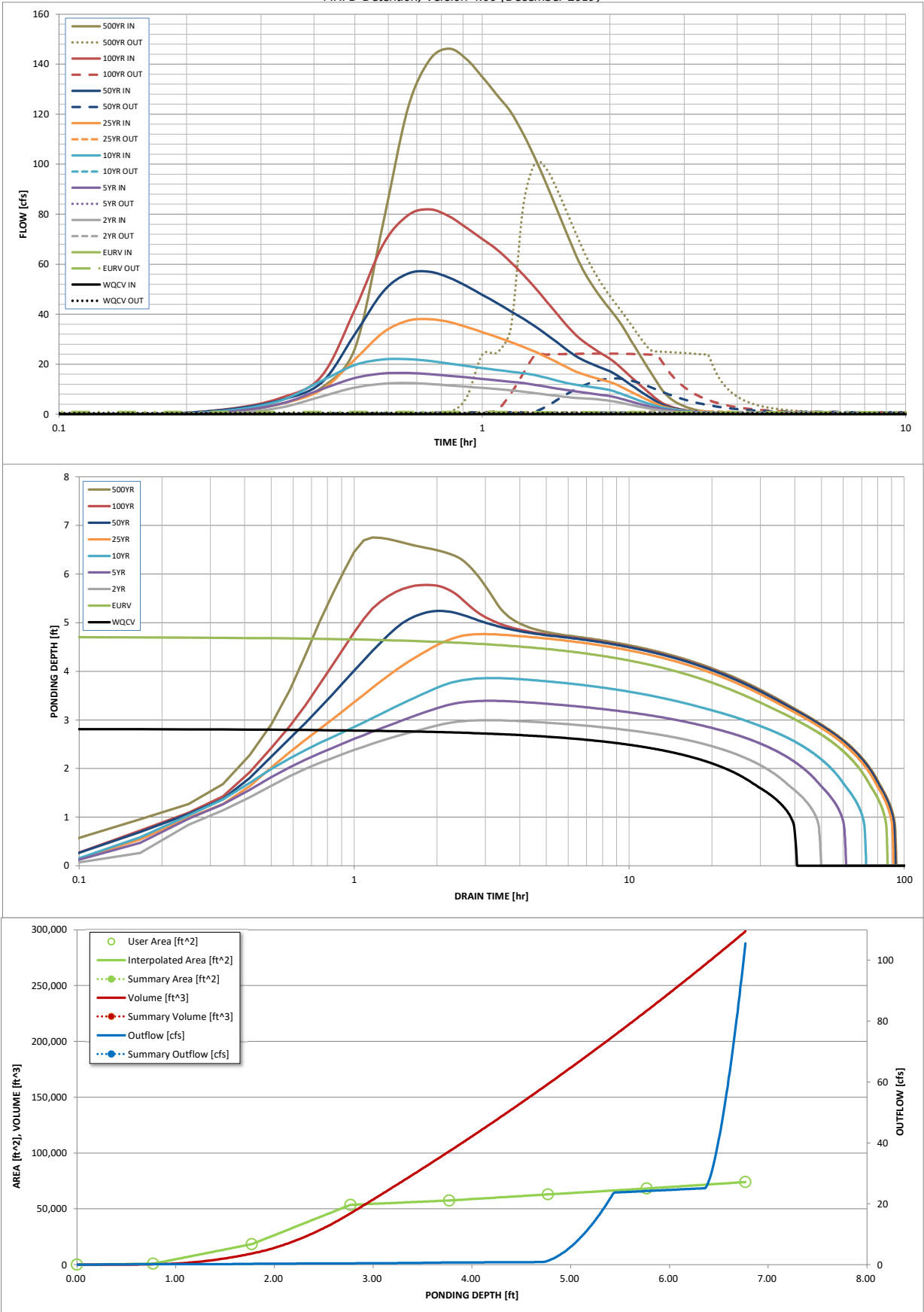
## Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
One-Hour Rainfall Depth (in) =	1.111	3.624	1.448	1.973	2.612	3.910	5.523	7.670	13.699
CUHP Runoff Volume (acre-ft) =	N/A	N/A	1.448	1.973	2.612	3.910	5.523	7.670	13.699
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.0	0.2	0.4	3.1	14.0	29.1	71.4
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A							
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.00	0.01	0.05	0.21	0.44	1.07
Peak Inflow Q (cfs) =	N/A	N/A	12.5	16.5	22.0	38.0	57.0	81.9	146.2
Peak Outflow Q (cfs) =	0.5	0.9	0.5	0.6	0.7	1.2	14.3	24.2	100.6
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	3.0	1.6	0.4	1.0	0.8	1.4
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.0	0.5	0.8	0.9
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	80	47	57	67	83	82	79	73
Time to Drain 99% of Inflow Volume (hours) =	40	84	49	60	71	88	89	87	84
Maximum Ponding Depth (ft) =	2.82	4.71	2.99	3.39	3.86	4.76	5.24	5.78	6.75
Area at Maximum Ponding Depth (acres) =	1.24	1.44	1.25	1.29	1.33	1.44	1.50	1.57	1.70
Maximum Volume Stored (acre-ft) =	1.118	3.628	1.329	1.837	2.451	3.700	4.407	5.221	6.820

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.10	0.84
	0:15:00	0.00	0.00	0.36	0.96	1.44	1.24	1.90	2.07	4.12
	0:20:00	0.00	0.00	2.63	4.15	5.46	4.23	5.66	6.50	10.56
	0:25:00	0.00	0.00	7.07	9.94	13.30	9.75	12.59	15.12	26.25
	0:30:00	0.00	0.00	10.68	14.52	19.67	21.92	32.00	41.86	76.61
	0:35:00	0.00	0.00	12.19	16.27	21.91	32.67	49.08	67.96	122.26
	0:40:00	0.00	0.00	12.51	16.49	22.02	37.39	56.24	79.48	141.63
	0:45:00	0.00	0.00	12.13	16.01	21.28	38.02	56.97	81.93	146.22
	0:50:00	0.00	0.00	11.54	15.39	20.27	36.89	54.68	79.19	142.07
	0:55:00	0.00	0.00	11.00	14.75	19.34	34.95	51.29	74.56	134.91
	1:00:00	0.00	0.00	10.50	14.09	18.47	32.84	47.75	70.05	127.65
	1:05:00	0.00	0.00	10.06	13.49	17.68	30.87	44.48	65.85	120.91
	1:10:00	0.00	0.00	9.56	12.99	17.03	28.82	41.18	60.85	112.00
	1:15:00	0.00	0.00	9.01	12.42	16.41	26.91	38.15	55.72	102.26
	1:20:00	0.00	0.00	8.45	11.73	15.61	24.94	35.08	50.49	92.14
	1:25:00	0.00	0.00	7.88	10.99	14.55	22.90	31.95	45.21	81.94
	1:30:00	0.00	0.00	7.32	10.27	13.44	20.81	28.80	40.19	72.31
	1:35:00	0.00	0.00	6.86	9.65	12.46	18.78	25.75	35.49	63.36
	1:40:00	0.00	0.00	6.53	9.12	11.75	17.00	23.14	31.52	56.13
	1:45:00	0.00	0.00	6.29	8.61	11.22	15.70	21.26	28.60	50.68
	1:50:00	0.00	0.00	6.08	8.14	10.73	14.67	19.76	26.25	46.11
	1:55:00	0.00	0.00	5.75	7.69	10.23	13.75	18.42	24.15	42.00
	2:00:00	0.00	0.00	5.35	7.24	9.64	12.90	17.16	22.21	38.20
	2:05:00	0.00	0.00	4.83	6.57	8.73	11.69	15.47	19.85	33.86
	2:10:00	0.00	0.00	4.24	5.78	7.67	10.28	13.54	17.27	29.27
	2:15:00	0.00	0.00	3.67	5.01	6.64	8.89	11.63	14.78	24.89
	2:20:00	0.00	0.00	3.15	4.28	5.67	7.56	9.80	12.40	20.69
	2:25:00	0.00	0.00	2.65	3.60	4.76	6.31	8.08	10.13	16.71
	2:30:00	0.00	0.00	2.18	2.97	3.94	5.15	6.48	7.99	12.93
	2:35:00	0.00	0.00	1.77	2.42	3.21	4.08	5.01	6.02	9.50
	2:40:00	0.00	0.00	1.45	1.99	2.64	3.16	3.77	4.41	7.01
	2:45:00	0.00	0.00	1.20	1.66	2.21	2.50	2.97	3.37	5.35
	2:50:00	0.00	0.00	1.00	1.40	1.86	2.03	2.39	2.64	4.13
	2:55:00	0.00	0.00	0.84	1.17	1.56	1.66	1.95	2.08	3.18
	3:00:00	0.00	0.00	0.70	0.97	1.30	1.35	1.58	1.65	2.45
	3:05:00	0.00	0.00	0.59	0.81	1.08	1.10	1.29	1.30	1.87
	3:10:00	0.00	0.00	0.49	0.67	0.89	0.90	1.05	1.03	1.45
	3:15:00	0.00	0.00	0.41	0.55	0.74	0.74	0.86	0.83	1.16
	3:20:00	0.00	0.00	0.33	0.45	0.60	0.60	0.70	0.68	0.94
	3:25:00	0.00	0.00	0.27	0.36	0.48	0.49	0.56	0.55	0.75
	3:30:00	0.00	0.00	0.22	0.28	0.38	0.39	0.44	0.44	0.59
	3:35:00	0.00	0.00	0.17	0.22	0.30	0.30	0.34	0.34	0.45
	3:40:00	0.00	0.00	0.12	0.16	0.23	0.22	0.25	0.25	0.33
	3:45:00	0.00	0.00	0.09	0.12	0.16	0.16	0.18	0.17	0.23
	3:50:00	0.00	0.00	0.06	0.08	0.11	0.11	0.12	0.11	0.14
	3:55:00	0.00	0.00	0.03	0.05	0.07	0.07	0.07	0.07	0.08
	4:00:00	0.00	0.00	0.02	0.03	0.04	0.03	0.03	0.03	0.03
	4:05:00	0.00	0.00	0.01	0.01	0.02	0.01	0.01	0.01	0.01
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.03 (May 2020)*

### Summary Stage-Area-Volume-Discharge Relationships

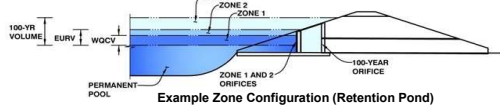
The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

[illegible]

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

**Basin ID:** Pond B



### Example Zone Configuration (Retention Pond)

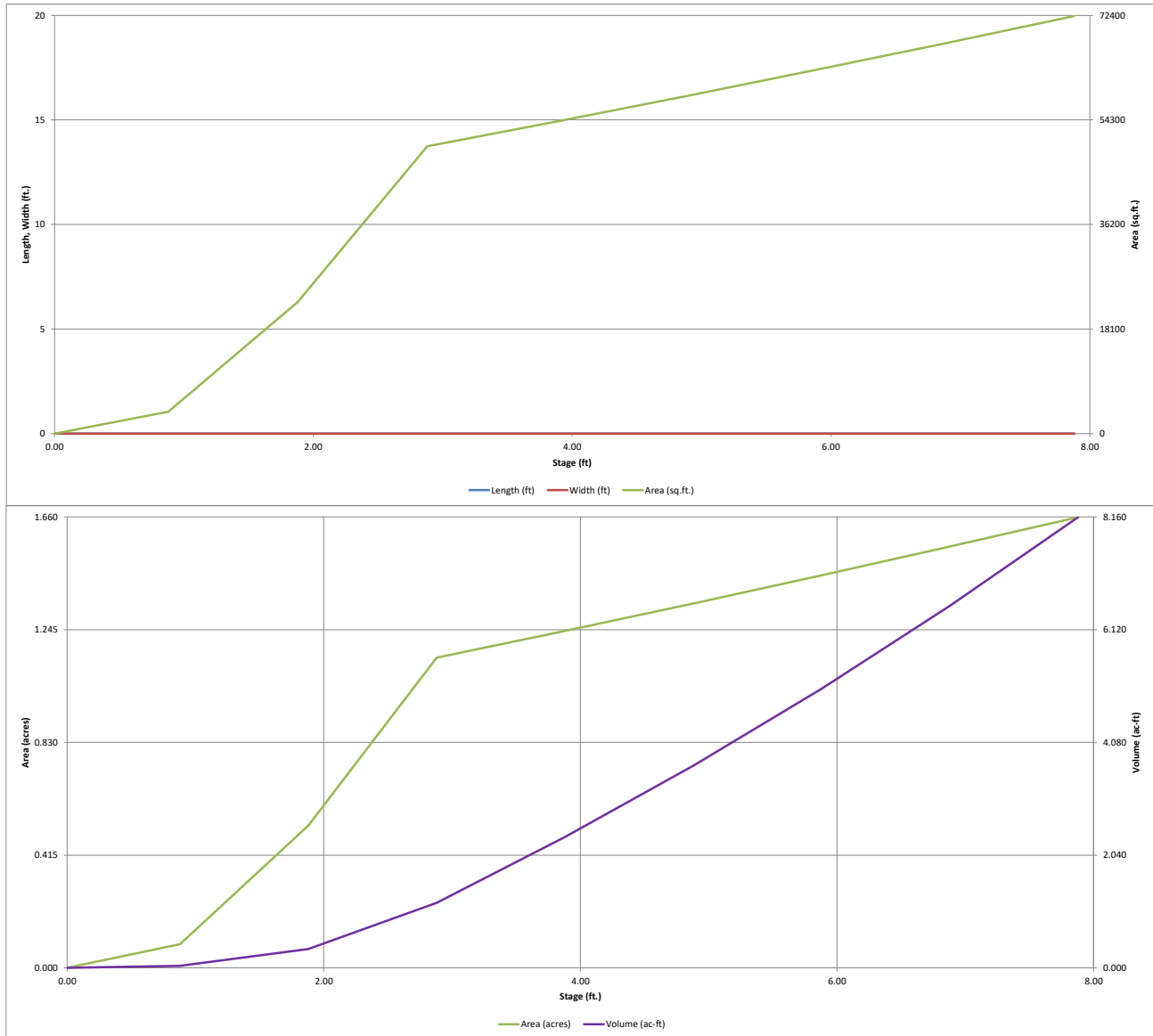
After providing required inputs above including 1-hour rainfall depths, click 'Run CUHP' to generate runoff hydrographs using the embedded Colorado Urban Hydrograph Procedure.

Initial Surcharge Area ( $A_{ISV}$ )	=	user	ft <sup>2</sup>
Surcharge Volume Length ( $L_{ISV}$ )	=	user	ft
Surcharge Volume Width ( $W_{ISV}$ )	=	user	ft
Depth of Basin Floor ( $H_{LFLOOR}$ )	=	user	ft
Length of Basin Floor ( $L_{LFLOOR}$ )	=	user	ft
Width of Basin Floor ( $W_{LFLOOR}$ )	=	user	ft
Area of Basin Floor ( $A_{LFLOOR}$ )	=	user	ft <sup>2</sup>
Volume of Basin Floor ( $V_{LFLOOR}$ )	=	user	ft <sup>3</sup>
Depth of Main Basin ( $H_{MAIN}$ )	=	user	ft
Length of Main Basin ( $L_{MAIN}$ )	=	user	ft
Width of Main Basin ( $W_{MAIN}$ )	=	user	ft
Area of Main Basin ( $A_{MAIN}$ )	=	user	ft <sup>2</sup>
Volume of Main Basin ( $V_{MAIN}$ )	=	user	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TOTAL}$ )	=	user	acre-feet

4/1/2021, 10:00 AM

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

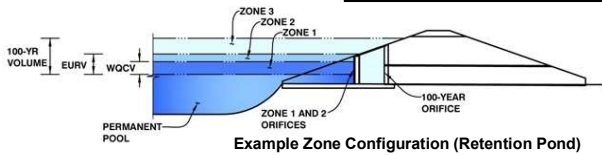


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Pioneer Village ~ PA's 3 and 4**

Basin ID: **Pond B**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.71	0.988	Orifice Plate
Zone 2 (EURV)	4.71	2.432	Orifice Plate
Zone 3 (100-year)	6.36	2.334	Weir&Pipe (Restrict)
Total (all zones)		5.754	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain  
Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (use rectangular openings)

Calculated Parameters for Plate  
WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.57	3.14					
Orifice Area (sq. inches)	4.85	4.85	4.85					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice  
Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Grate Slope =  H:V  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Type =   
Debris Clogging % =  %

Calculated Parameters for Overflow Weir  
Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =   
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  inches  
Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway  
Spillway Design Flow Depth =  feet  
Stage at Top of Freeboard =  feet  
Basin Area at Top of Freeboard =  acres  
Basin Volume at Top of Freeboard =  acre-ft

Routed Hydrograph Results

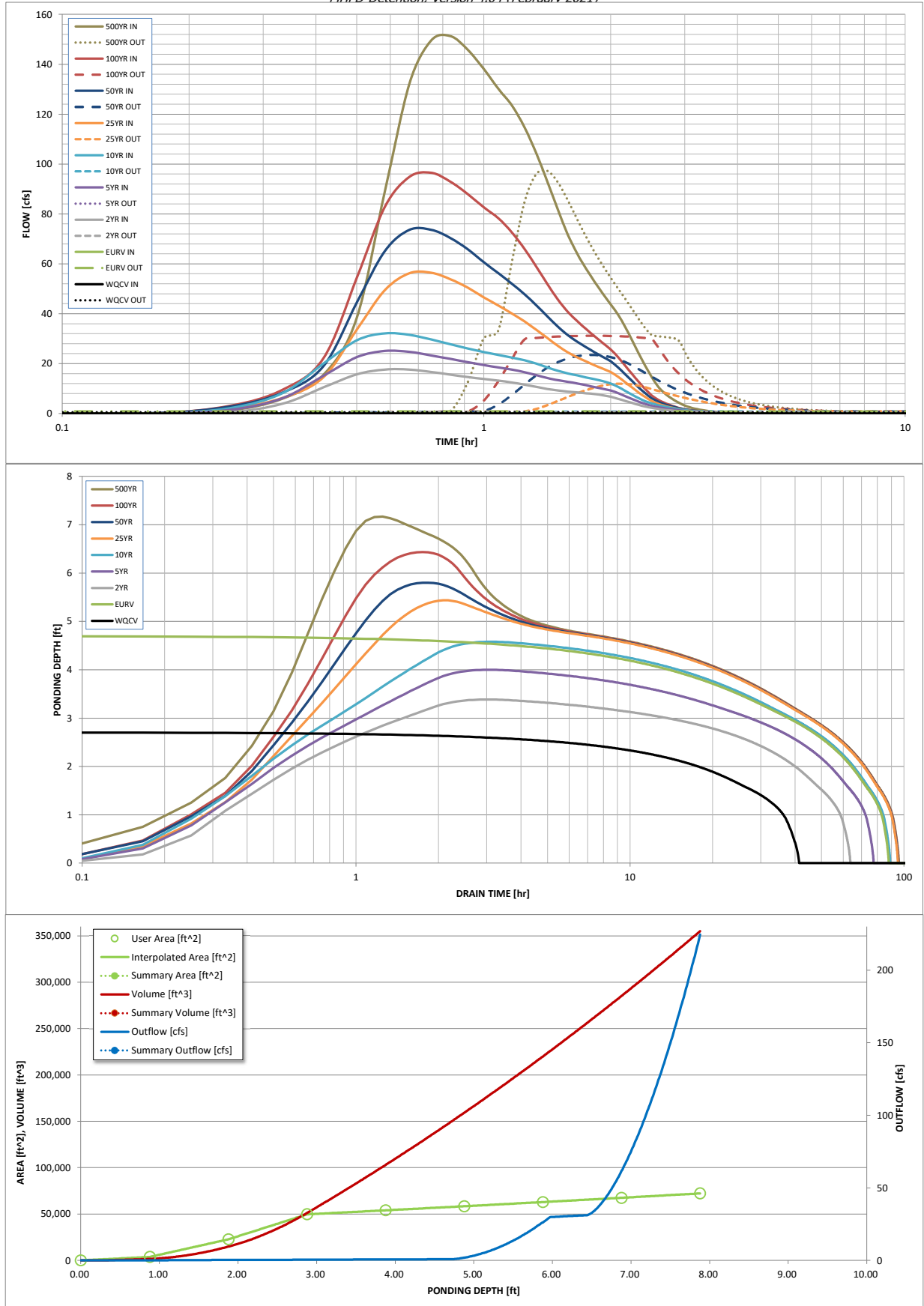
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
One-Hour Rainfall Depth (in) =	0.988	3.420	1.890	2.671	3.438	5.370	6.941	9.020	14.217
CUHP Runoff Volume (acre-ft) =	N/A	N/A	1.890	2.671	3.438	5.370	6.941	9.020	14.217
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.1	0.3	0.5	12.2	21.2	34.2	64.3
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A							
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.01	0.01	0.24	0.41	0.66	1.25
Peak Inflow Q (cfs) =	N/A	N/A	17.6	25.1	32.1	56.4	73.7	96.5	151.3
Peak Outflow Q (cfs) =	0.4	0.8	0.6	0.7	0.8	11.9	23.4	31.2	97.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	2.3	1.6	1.0	1.1	0.9	1.5
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.4	0.8	1.1	1.2
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	79	58	70	80	83	80	77	72
Time to Drain 99% of Inflow Volume (hours) =	40	84	61	74	85	90	89	88	85
Maximum Ponding Depth (ft) =	2.71	4.71	3.38	4.00	4.58	5.44	5.80	6.44	7.17
Area at Maximum Ponding Depth (acres) =	1.04	1.32	1.19	1.25	1.31	1.40	1.44	1.50	1.58
Maximum Volume Stored (acre-ft) =	0.991	3.432	1.760	2.505	3.248	4.413	4.937	5.863	6.989



# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.15	1.23
	0:15:00	0.00	0.00	0.53	1.43	2.16	1.85	2.80	3.03	5.99
	0:20:00	0.00	0.00	3.91	6.17	8.19	6.28	8.33	9.51	15.53
	0:25:00	0.00	0.00	10.46	15.13	20.01	14.56	18.97	22.06	38.26
	0:30:00	0.00	0.00	15.70	22.56	29.30	33.58	44.44	54.28	89.28
	0:35:00	0.00	0.00	17.63	25.06	32.14	49.50	65.18	82.94	132.23
	0:40:00	0.00	0.00	17.61	24.67	31.51	56.25	73.59	94.87	149.50
	0:45:00	0.00	0.00	16.67	23.26	29.66	56.42	73.67	96.49	151.32
	0:50:00	0.00	0.00	15.58	21.89	27.78	53.87	70.36	92.96	145.83
	0:55:00	0.00	0.00	14.61	20.59	26.05	50.43	65.84	87.95	138.14
	1:00:00	0.00	0.00	13.82	19.42	24.62	46.56	60.65	82.66	130.13
	1:05:00	0.00	0.00	13.21	18.47	23.48	43.28	56.27	78.27	123.54
	1:10:00	0.00	0.00	12.45	17.58	22.41	40.07	52.02	72.60	114.71
	1:15:00	0.00	0.00	11.56	16.55	21.30	36.88	47.82	65.94	104.26
	1:20:00	0.00	0.00	10.66	15.36	19.97	33.55	43.38	58.87	92.96
	1:25:00	0.00	0.00	9.84	14.22	18.43	30.24	38.96	51.90	81.70
	1:30:00	0.00	0.00	9.22	13.34	17.11	27.09	34.77	45.66	71.75
	1:35:00	0.00	0.00	8.78	12.73	16.10	24.52	31.40	40.78	64.04
	1:40:00	0.00	0.00	8.43	12.05	15.24	22.53	28.78	37.02	58.01
	1:45:00	0.00	0.00	8.12	11.30	14.47	20.85	26.55	33.81	52.81
	1:50:00	0.00	0.00	7.81	10.58	13.74	19.35	24.55	30.91	48.11
	1:55:00	0.00	0.00	7.31	9.89	12.97	17.95	22.70	28.24	43.76
	2:00:00	0.00	0.00	6.70	9.20	12.06	16.62	20.93	25.70	39.64
	2:05:00	0.00	0.00	5.91	8.16	10.66	14.73	18.49	22.56	34.65
	2:10:00	0.00	0.00	5.04	6.96	9.05	12.54	15.69	19.13	29.27
	2:15:00	0.00	0.00	4.21	5.79	7.50	10.39	12.94	15.78	24.05
	2:20:00	0.00	0.00	3.44	4.72	6.11	8.39	10.41	12.65	19.18
	2:25:00	0.00	0.00	2.78	3.81	4.95	6.61	8.14	9.81	14.78
	2:30:00	0.00	0.00	2.27	3.11	4.07	5.07	6.19	7.35	11.13
	2:35:00	0.00	0.00	1.88	2.58	3.41	4.01	4.89	5.69	8.63
	2:40:00	0.00	0.00	1.57	2.17	2.86	3.23	3.93	4.48	6.78
	2:45:00	0.00	0.00	1.31	1.81	2.39	2.62	3.18	3.52	5.30
	2:50:00	0.00	0.00	1.09	1.50	1.98	2.11	2.55	2.75	4.12
	2:55:00	0.00	0.00	0.90	1.24	1.63	1.71	2.06	2.15	3.19
	3:00:00	0.00	0.00	0.75	1.01	1.33	1.38	1.66	1.67	2.46
	3:05:00	0.00	0.00	0.62	0.83	1.09	1.13	1.35	1.33	1.95
	3:10:00	0.00	0.00	0.51	0.68	0.89	0.92	1.10	1.08	1.58
	3:15:00	0.00	0.00	0.41	0.54	0.71	0.74	0.88	0.87	1.27
	3:20:00	0.00	0.00	0.33	0.43	0.56	0.58	0.69	0.70	1.01
	3:25:00	0.00	0.00	0.25	0.33	0.43	0.45	0.54	0.54	0.78
	3:30:00	0.00	0.00	0.19	0.24	0.32	0.34	0.40	0.41	0.58
	3:35:00	0.00	0.00	0.13	0.17	0.23	0.24	0.29	0.29	0.41
	3:40:00	0.00	0.00	0.08	0.12	0.15	0.16	0.19	0.19	0.27
	3:45:00	0.00	0.00	0.05	0.07	0.09	0.10	0.11	0.11	0.16
	3:50:00	0.00	0.00	0.02	0.04	0.05	0.05	0.06	0.06	0.08
	3:55:00	0.00	0.00	0.01	0.02	0.02	0.02	0.02	0.02	0.02
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## DETENTION BASIN OUTLET STRUCTURE DESIGN

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

### Summary Stage-Area-Volume-Discharge Relationships

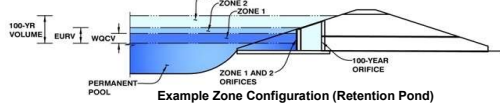
The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

[illegible]

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

**Basin ID:** Pond C (PA's 17 and 21)



### Example Zone Configuration (Retention Pond)

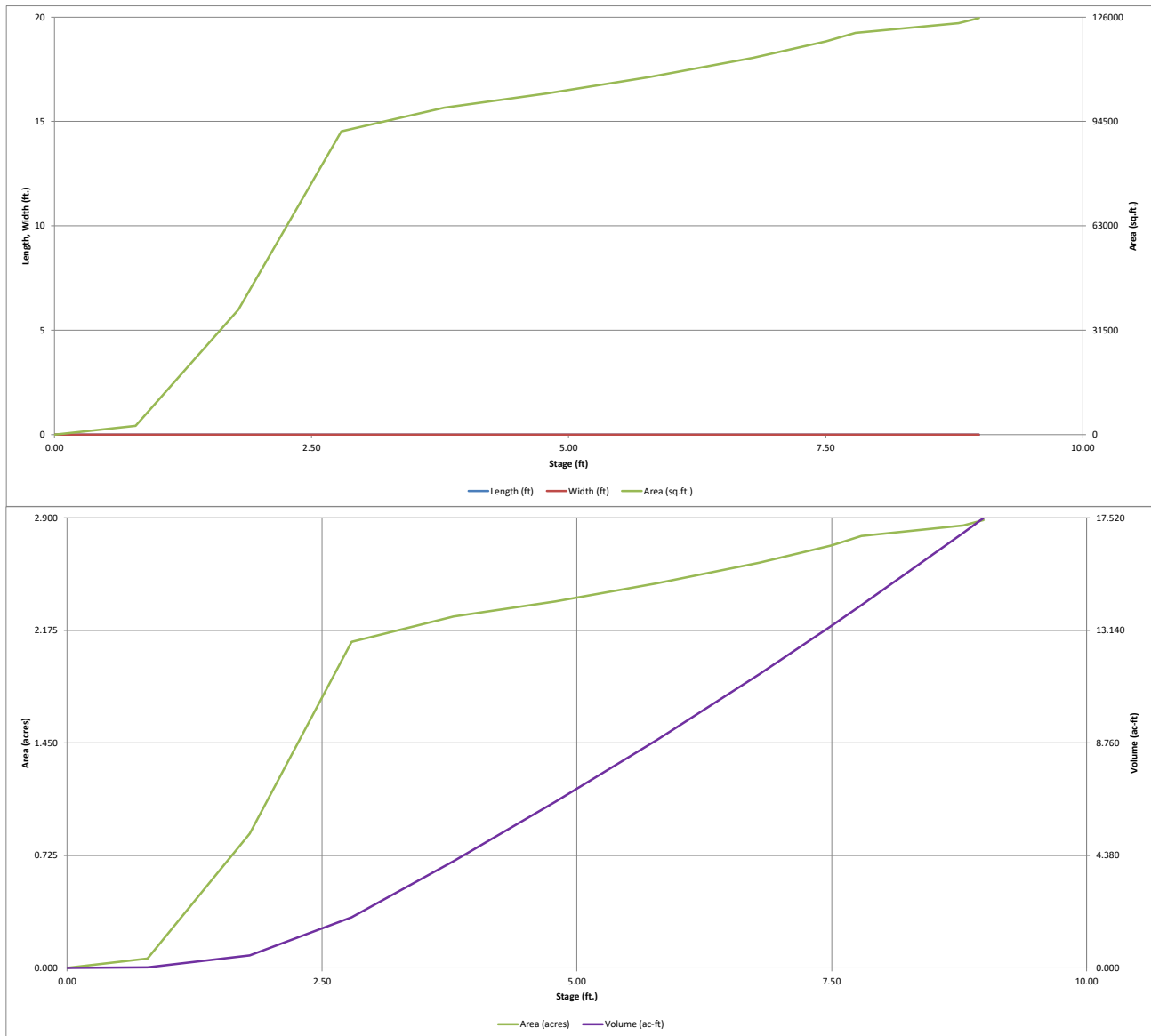
### Optional User Overrides

Initial Surcharge Area ( $A_{ISV}$ )	=	user	ft <sup>2</sup>
Surcharge Volume Length ( $L_{ISV}$ )	=	user	ft
Surcharge Volume Width ( $W_{ISV}$ )	=	user	ft
Depth of Basin Floor ( $H_{FLOOR}$ )	=	user	ft
Length of Basin Floor ( $L_{FLOOR}$ )	=	user	ft
Width of Basin Floor ( $W_{FLOOR}$ )	=	user	ft
Area of Basin Floor ( $A_{FLOOR}$ )	=	user	ft <sup>2</sup>
Volume of Basin Floor ( $V_{FLOOR}$ )	=	user	ft <sup>3</sup>
Depth of Main Basin ( $H_{MAIN}$ )	=	user	ft
Length of Main Basin ( $L_{MAIN}$ )	=	user	ft
Width of Main Basin ( $W_{MAIN}$ )	=	user	ft
Area of Main Basin ( $A_{MAIN}$ )	=	user	ft <sup>2</sup>
Volume of Main Basin ( $V_{MAIN}$ )	=	user	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TOTAL}$ )	=	user	acre-feet

4/1/2021, 10:00 AM

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.04 (February 2021)

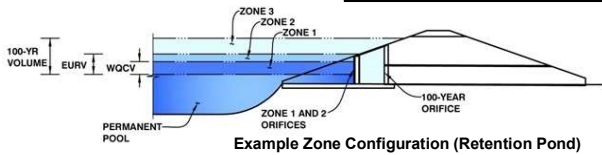


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)

Project: **Pioneer Village**

Basin ID: **Pond C (PA's 17 and 21)**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.02	2.457	Orifice Plate
Zone 2 (EURV)	5.49	5.682	Orifice Plate
Zone 3 (100-year)	7.65	5.591	Weir&Pipe (Restrict)
Total (all zones)		13.730	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain  
Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (use rectangular openings)

Calculated Parameters for Plate  
WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.83	3.66					
Orifice Area (sq. inches)	11.35	11.35	11.35					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice  
Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Grate Slope =  H:V  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Type =   
Debris Clogging % =

Calculated Parameters for Overflow Weir  
Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =   
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  inches  
Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway  
Spillway Design Flow Depth =  feet  
Stage at Top of Freeboard =  feet  
Basin Area at Top of Freeboard =  acres  
Basin Volume at Top of Freeboard =  acre-ft

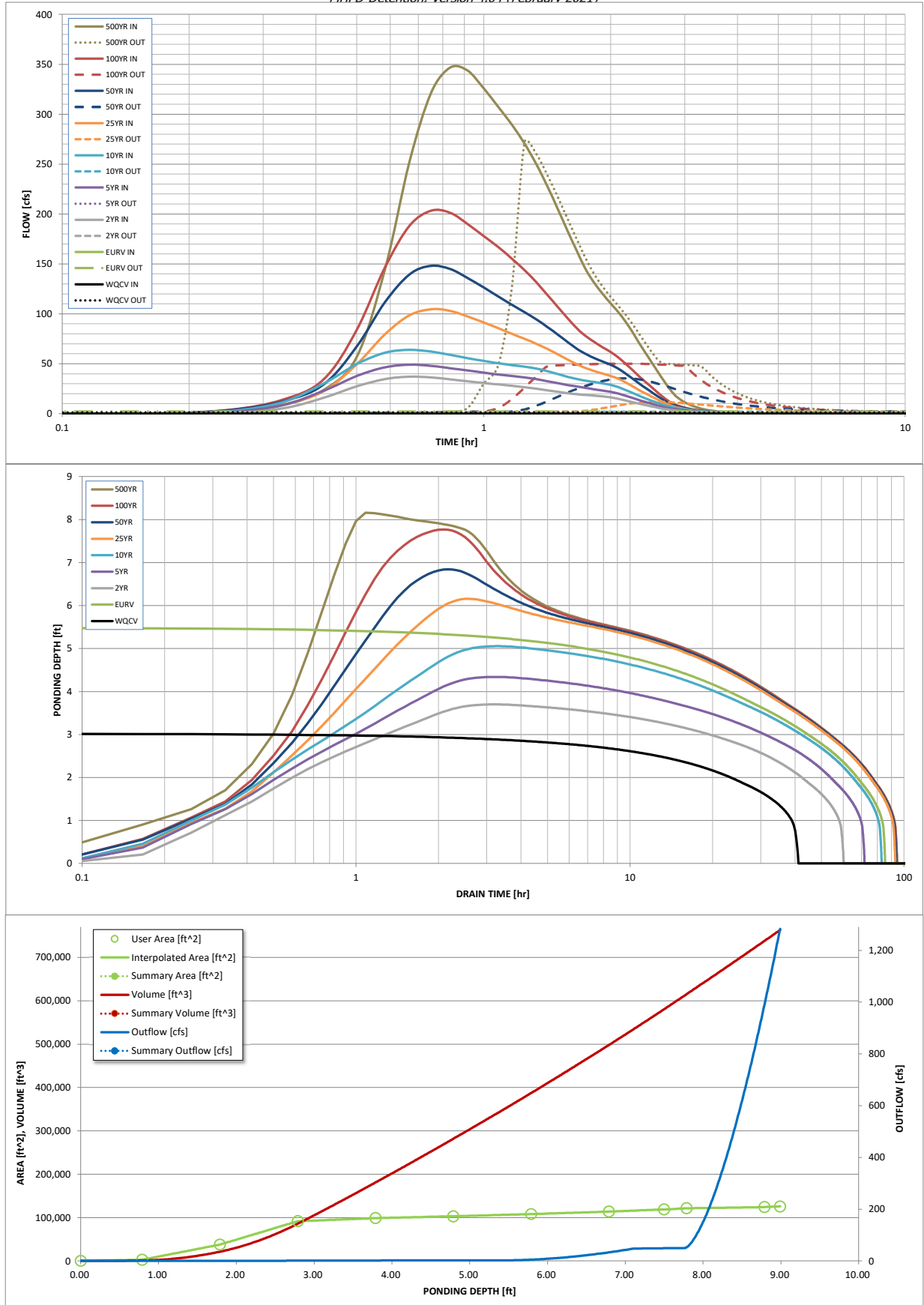
## Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
One-Hour Rainfall Depth (in) =	2.457	8.139	4.248	5.786	7.539	10.932	14.760	19.737	33.551
CUHP Runoff Volume (acre-ft) =	N/A	N/A	4.248	5.786	7.539	10.932	14.760	19.737	33.551
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.0	0.4	0.8	5.8	26.5	55.0	138.2
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A							
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.00	0.01	0.04	0.18	0.38	0.95
Peak Inflow Q (cfs) =	N/A	N/A	37.0	48.9	63.8	104.6	148.1	203.4	346.7
Peak Outflow Q (cfs) =	1.1	2.1	1.3	1.7	2.0	11.8	35.4	50.1	272.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.5	2.4	2.0	1.3	0.9	2.0
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Spillway	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.4	1.2	1.8	1.8
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	78	56	66	76	83	81	78	72
Time to Drain 99% of Inflow Volume (hours) =	40	82	59	70	80	89	89	88	85
Maximum Ponding Depth (ft) =	3.02	5.49	3.70	4.34	5.06	6.16	6.85	7.77	8.16
Area at Maximum Ponding Depth (acres) =	2.14	2.44	2.25	2.32	2.39	2.53	2.62	2.78	2.81
Maximum Volume Stored (acre-ft) =	2.459	8.150	3.928	5.391	7.086	9.790	11.565	14.071	15.161

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.04 (February 2021)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.18	1.53
	0:15:00	0.00	0.00	0.65	1.76	2.63	2.26	3.56	3.86	8.35
	0:20:00	0.00	0.00	5.20	8.62	11.53	9.03	12.31	14.00	23.58
	0:25:00	0.00	0.00	15.79	22.74	29.92	22.44	28.95	34.05	56.65
	0:30:00	0.00	0.00	27.44	37.70	49.67	49.39	67.25	83.96	144.60
	0:35:00	0.00	0.00	34.59	46.44	60.98	79.57	111.75	146.69	252.30
	0:40:00	0.00	0.00	37.02	48.92	63.83	98.51	139.45	188.12	321.34
	0:45:00	0.00	0.00	36.35	47.86	62.20	104.64	148.09	203.39	346.75
	0:50:00	0.00	0.00	34.36	45.51	58.77	102.95	144.86	201.18	343.61
	0:55:00	0.00	0.00	32.40	43.26	55.59	97.36	135.82	189.81	325.86
	1:00:00	0.00	0.00	30.64	41.09	52.77	91.31	126.40	177.88	307.14
	1:05:00	0.00	0.00	29.19	39.19	50.37	85.45	117.33	166.82	289.51
	1:10:00	0.00	0.00	27.91	37.73	48.61	79.94	109.00	155.34	270.53
	1:15:00	0.00	0.00	26.47	36.27	47.04	74.97	101.61	143.73	250.00
	1:20:00	0.00	0.00	24.92	34.51	45.14	70.04	94.38	131.59	227.85
	1:25:00	0.00	0.00	23.33	32.51	42.57	64.83	86.85	118.97	204.84
	1:30:00	0.00	0.00	21.76	30.47	39.61	59.43	79.17	106.73	182.64
	1:35:00	0.00	0.00	20.38	28.65	36.79	54.12	71.64	95.34	162.03
	1:40:00	0.00	0.00	19.35	27.09	34.57	49.23	64.68	84.99	143.60
	1:45:00	0.00	0.00	18.63	25.67	32.96	45.45	59.52	77.38	130.40
	1:50:00	0.00	0.00	18.04	24.32	31.61	42.53	55.52	71.51	119.83
	1:55:00	0.00	0.00	17.27	23.05	30.28	40.07	52.13	66.40	110.47
	2:00:00	0.00	0.00	16.23	21.80	28.79	37.81	48.99	61.74	101.92
	2:05:00	0.00	0.00	14.86	20.15	26.61	34.99	45.17	56.44	92.59
	2:10:00	0.00	0.00	13.24	18.05	23.81	31.40	40.42	50.27	82.08
	2:15:00	0.00	0.00	11.59	15.83	20.85	27.57	35.39	43.92	71.45
	2:20:00	0.00	0.00	10.05	13.69	18.01	23.86	30.50	37.84	61.33
	2:25:00	0.00	0.00	8.61	11.71	15.40	20.38	25.89	32.04	51.64
	2:30:00	0.00	0.00	7.27	9.89	13.01	17.15	21.59	26.57	42.51
	2:35:00	0.00	0.00	6.03	8.19	10.80	14.11	17.57	21.38	33.82
	2:40:00	0.00	0.00	4.89	6.68	8.85	11.34	13.89	16.57	25.79
	2:45:00	0.00	0.00	3.98	5.48	7.26	8.92	10.67	12.33	19.03
	2:50:00	0.00	0.00	3.30	4.58	6.09	7.04	8.37	9.43	14.59
	2:55:00	0.00	0.00	2.77	3.87	5.14	5.69	6.74	7.44	11.39
	3:00:00	0.00	0.00	2.33	3.25	4.32	4.66	5.51	5.91	8.91
	3:05:00	0.00	0.00	1.97	2.72	3.63	3.82	4.50	4.71	6.97
	3:10:00	0.00	0.00	1.66	2.28	3.04	3.15	3.70	3.77	5.47
	3:15:00	0.00	0.00	1.39	1.90	2.55	2.61	3.07	3.04	4.33
	3:20:00	0.00	0.00	1.16	1.58	2.12	2.15	2.52	2.45	3.44
	3:25:00	0.00	0.00	0.96	1.29	1.73	1.76	2.06	2.00	2.80
	3:30:00	0.00	0.00	0.78	1.04	1.40	1.42	1.66	1.62	2.26
	3:35:00	0.00	0.00	0.63	0.82	1.11	1.13	1.32	1.30	1.80
	3:40:00	0.00	0.00	0.48	0.64	0.87	0.89	1.02	1.01	1.39
	3:45:00	0.00	0.00	0.36	0.48	0.66	0.67	0.77	0.76	1.04
	3:50:00	0.00	0.00	0.26	0.34	0.48	0.49	0.56	0.55	0.74
	3:55:00	0.00	0.00	0.17	0.24	0.33	0.34	0.38	0.37	0.48
	4:00:00	0.00	0.00	0.10	0.15	0.21	0.22	0.24	0.22	0.29
	4:05:00	0.00	0.00	0.05	0.09	0.12	0.12	0.13	0.11	0.14
	4:10:00	0.00	0.00	0.02	0.04	0.05	0.05	0.05	0.04	0.04
	4:15:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



## DETENTION BASIN OUTLET STRUCTURE DESIGN

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

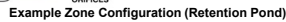
### Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

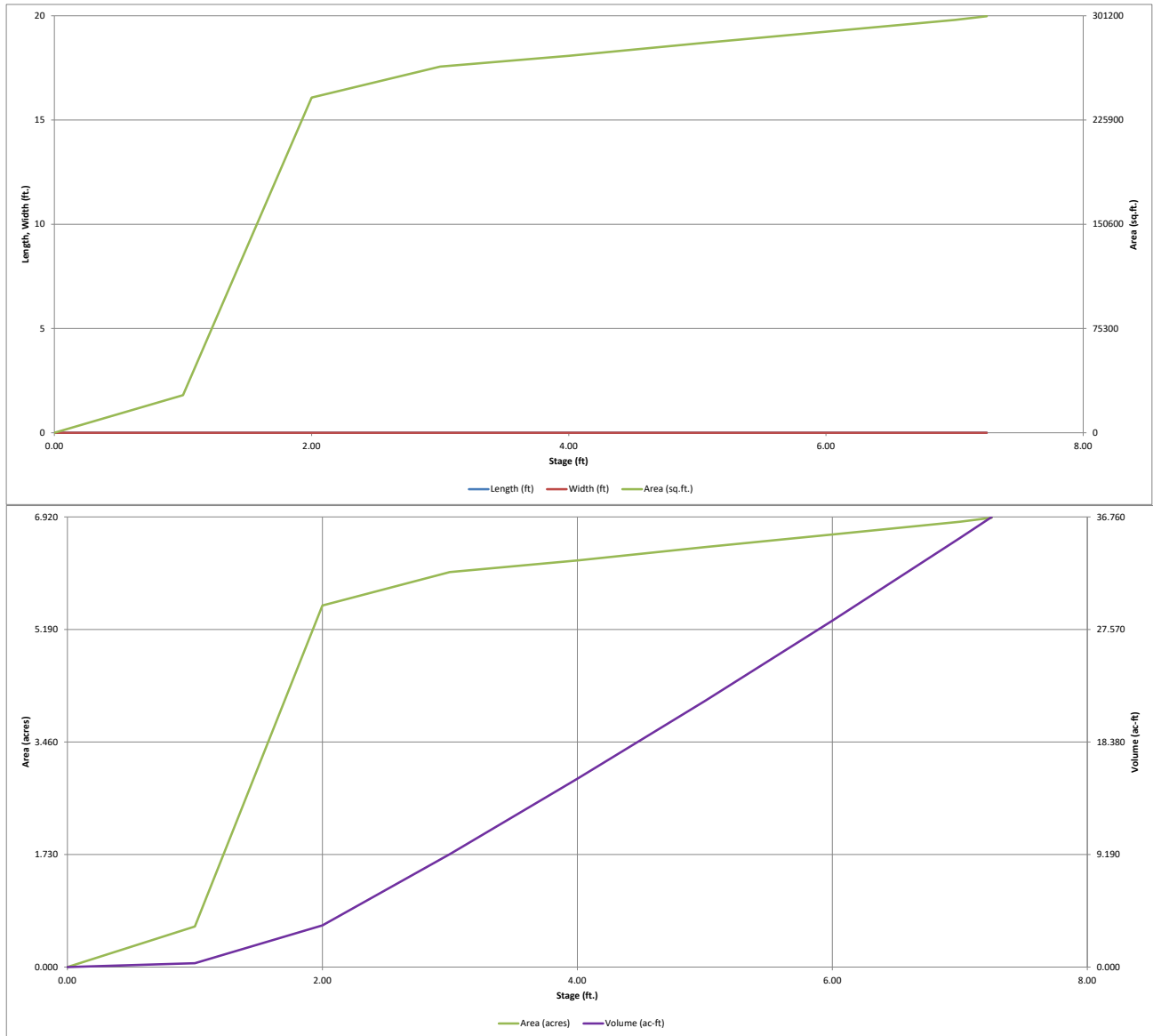
[illegible]

MHFD-Detention, Version 4.03 (May 2020)

Basin ID: Future Pond D

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

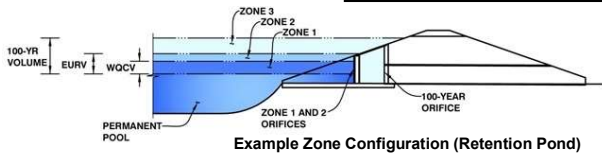


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-DETENTION, Version 4.03 (May 2020)

Project: **Pioneer Village**

Basin ID: **Future Pond D**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.22	4.588	Orifice Plate
Zone 2 (EURV)	3.73	9.062	Orifice Plate
Zone 3 (100-year)	5.37	10.456	Weir&Pipe (Restrict)
Total (all zones)		24.106	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain  
Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (use rectangular openings)

Calculated Parameters for Plate  
WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.20	2.40	3.60				
Orifice Area (sq. inches)	22.83	22.83	22.83	22.83				

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice  
Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Grate Slope =  H:V  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Open Area % =  %  
Debris Clogging % =  %

Calculated Parameters for Overflow Weir  
Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =  ft<sup>2</sup>  
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  inches  
Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway  
Spillway Design Flow Depth =  feet  
Stage at Top of Freeboard =  feet  
Basin Area at Top of Freeboard =  acres  
Basin Volume at Top of Freeboard =  acre-ft

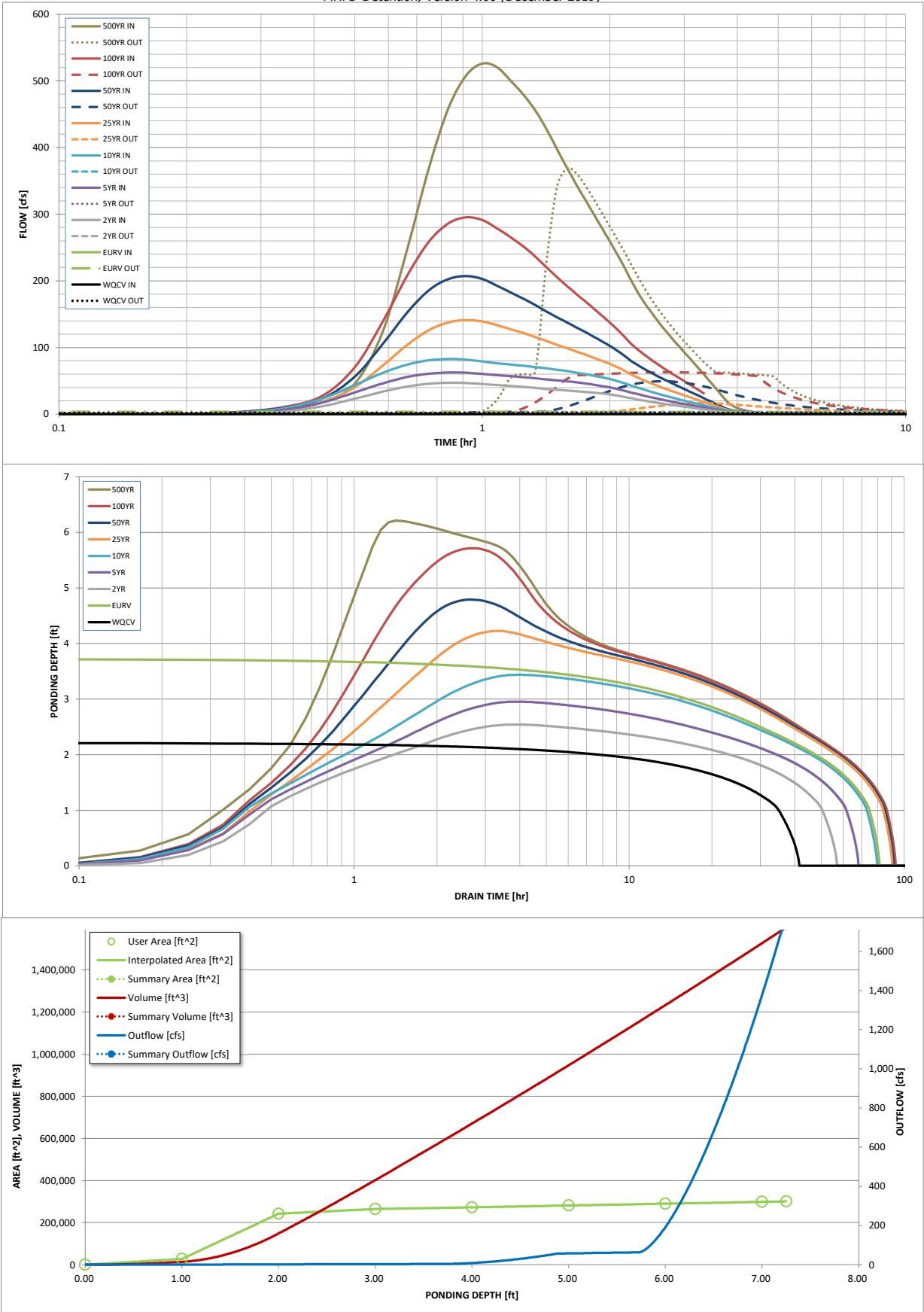
## Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
One-Hour Rainfall Depth (in) =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
CUHP Runoff Volume (acre-ft) =	4.588	13.650	7.135	9.718	12.809	19.020	26.566	36.566	64.570
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	7.135	9.718	12.809	19.020	26.566	36.566	64.570
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.6	1.4	9.6	43.7	91.5	236.4
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.00	0.00	0.03	0.15	0.31	0.79
Peak Inflow Q (cfs) =	N/A	N/A	47.1	62.6	82.8	141.2	207.1	295.2	525.9
Peak Outflow Q (cfs) =	1.9	3.8	2.4	2.9	3.3	16.5	49.4	62.9	368.7
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.6	2.4	1.7	1.1	0.7	1.6
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.4	1.5	2.0	2.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	73	52	62	72	80	79	77	70
Time to Drain 99% of Inflow Volume (hours) =	40	78	55	66	76	86	86	85	82
Maximum Ponding Depth (ft) =	2.22	3.73	2.54	2.95	3.44	4.23	4.79	5.72	6.21
Area at Maximum Ponding Depth (acres) =	5.67	6.20	5.84	6.05	6.15	6.30	6.41	6.59	6.69
Maximum Volume Stored (acre-ft) =	4.639	13.698	6.480	8.915	11.845	16.759	20.381	26.365	29.686

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: Pond D Outflow

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.11	0.94
	0:15:00	0.00	0.00	0.40	1.07	1.61	1.39	2.26	2.44	5.69
	0:20:00	0.00	0.00	3.40	5.87	7.95	6.32	8.85	10.00	17.76
	0:25:00	0.00	0.00	11.55	17.17	22.89	17.28	22.81	26.81	46.09
	0:30:00	0.00	0.00	23.20	32.62	43.65	40.60	56.36	70.74	125.71
	0:35:00	0.00	0.00	34.05	46.52	62.28	73.51	106.17	140.47	250.83
	0:40:00	0.00	0.00	41.65	55.96	74.70	104.59	153.52	209.48	372.33
	0:45:00	0.00	0.00	45.73	60.88	80.91	126.42	186.56	259.80	460.54
	0:50:00	0.00	0.00	47.14	62.59	82.75	137.67	202.82	286.52	508.52
	0:55:00	0.00	0.00	46.66	62.10	81.71	141.19	207.13	295.21	525.93
	1:00:00	0.00	0.00	45.16	60.33	79.06	139.13	202.73	291.25	520.48
	1:05:00	0.00	0.00	43.70	58.51	76.47	133.56	192.65	278.74	500.09
	1:10:00	0.00	0.00	42.40	57.01	74.49	127.45	182.49	265.29	479.29
	1:15:00	0.00	0.00	40.92	55.48	72.64	121.69	173.08	251.56	455.77
	1:20:00	0.00	0.00	39.31	53.78	70.72	115.88	163.75	236.51	428.04
	1:25:00	0.00	0.00	37.83	52.11	68.69	109.85	154.20	220.52	397.87
	1:30:00	0.00	0.00	36.60	50.70	66.74	104.12	145.41	205.60	370.04
	1:35:00	0.00	0.00	35.51	49.36	64.64	98.99	137.68	192.46	344.91
	1:40:00	0.00	0.00	34.44	47.87	62.37	94.11	130.34	180.41	321.53
	1:45:00	0.00	0.00	33.41	46.13	60.04	89.34	123.21	169.19	299.97
	1:50:00	0.00	0.00	32.38	44.21	57.67	84.64	116.19	158.37	279.21
	1:55:00	0.00	0.00	31.17	42.18	55.28	80.04	109.29	147.82	259.10
	2:00:00	0.00	0.00	29.68	40.07	52.73	75.46	102.44	137.46	239.55
	2:05:00	0.00	0.00	27.85	37.68	49.72	70.59	95.31	126.93	219.99
	2:10:00	0.00	0.00	25.80	35.02	46.26	65.20	87.57	115.94	200.09
	2:15:00	0.00	0.00	23.80	32.42	42.83	59.64	79.77	105.32	182.06
	2:20:00	0.00	0.00	21.96	29.99	39.64	54.76	73.33	96.59	167.12
	2:25:00	0.00	0.00	20.25	27.70	36.62	50.48	67.68	89.06	153.91
	2:30:00	0.00	0.00	18.67	25.52	33.75	46.58	62.50	82.17	141.78
	2:35:00	0.00	0.00	17.21	23.50	31.08	42.95	57.66	75.82	130.60
	2:40:00	0.00	0.00	15.86	21.65	28.62	39.65	53.25	69.98	120.32
	2:45:00	0.00	0.00	14.61	19.93	26.33	36.57	49.07	64.46	110.63
	2:50:00	0.00	0.00	13.43	18.31	24.17	33.64	45.09	59.25	101.54
	2:55:00	0.00	0.00	12.33	16.77	22.14	30.87	41.31	54.32	92.90
	3:00:00	0.00	0.00	11.28	15.33	20.23	28.23	37.68	49.54	84.52
	3:05:00	0.00	0.00	10.27	13.96	18.43	25.70	34.19	44.89	76.30
	3:10:00	0.00	0.00	9.30	12.64	16.70	23.24	30.77	40.30	68.17
	3:15:00	0.00	0.00	8.35	11.36	15.01	20.83	27.42	35.77	60.12
	3:20:00	0.00	0.00	7.43	10.12	13.38	18.48	24.12	31.29	52.15
	3:25:00	0.00	0.00	6.54	8.93	11.79	16.16	20.88	26.87	44.28
	3:30:00	0.00	0.00	5.68	7.77	10.24	13.90	17.70	22.51	36.54
	3:35:00	0.00	0.00	4.85	6.64	8.74	11.67	14.61	18.28	29.06
	3:40:00	0.00	0.00	4.06	5.56	7.31	9.56	11.69	14.27	21.99
	3:45:00	0.00	0.00	3.34	4.59	6.05	7.62	9.03	10.62	15.85
	3:50:00	0.00	0.00	2.78	3.84	5.05	5.95	6.92	7.95	12.07
	3:55:00	0.00	0.00	2.38	3.29	4.35	4.81	5.59	6.23	9.48
	4:00:00	0.00	0.00	2.05	2.85	3.78	4.00	4.64	5.02	7.49
	4:05:00	0.00	0.00	1.78	2.46	3.27	3.37	3.89	4.07	5.92
	4:10:00	0.00	0.00	1.53	2.10	2.81	2.82	3.25	3.30	4.67
	4:15:00	0.00	0.00	1.30	1.79	2.39	2.37	2.71	2.67	3.65
	4:20:00	0.00	0.00	1.10	1.50	2.01	1.97	2.24	2.15	2.88
	4:25:00	0.00	0.00	0.92	1.24	1.67	1.62	1.84	1.74	2.34
	4:30:00	0.00	0.00	0.76	1.02	1.36	1.32	1.49	1.42	1.89
	4:35:00	0.00	0.00	0.62	0.82	1.10	1.06	1.19	1.14	1.51
	4:40:00	0.00	0.00	0.49	0.65	0.87	0.84	0.94	0.90	1.17
	4:45:00	0.00	0.00	0.38	0.50	0.68	0.65	0.72	0.68	0.87
	4:50:00	0.00	0.00	0.28	0.37	0.52	0.49	0.53	0.50	0.62
	4:55:00	0.00	0.00	0.20	0.27	0.38	0.35	0.37	0.34	0.41
	5:00:00	0.00	0.00	0.13	0.18	0.26	0.24	0.24	0.22	0.25
	5:05:00	0.00	0.00	0.08	0.12	0.16	0.14	0.14	0.12	0.12
	5:10:00	0.00	0.00	0.04	0.07	0.09	0.07	0.07	0.05	0.04
	5:15:00	0.00	0.00	0.02	0.03	0.04	0.03	0.02	0.01	0.00
	5:20:00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.03 (May 2020)*

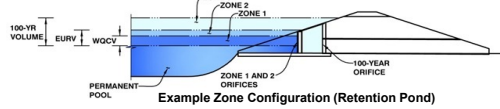
### Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

[illegible]

## MHFD-Detention, Version 4.03 (May 2020)

Basin ID: Future Pond E

### Example Zone Configuration (Retention Pond)

Selected BMP Type =	<b>EDB</b>	
Watershed Area =	89.88	acres
Watershed Length =	2,825	ft
Watershed Length to Centroid =	1,933	ft
Watershed Slope =	0.009	ft/ft
Watershed Imperviousness =	70.71%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Group C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths = User Input		

### Optional User Overrides

Water Quality Capture Volume (WQCV) =	2.084	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	8.075	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.86 in.) =	4.140		0.86	inches
5-yr Runoff Volume (P1 = 1.14 in.) =	5.639	acre-feet	1.14	inches
10-yr Runoff Volume (P1 = 1.41 in.) =	7.199	acre-feet	1.41	inches
25-yr Runoff Volume (P1 = 1.85 in.) =	9.971	acre-feet	1.85	inches
50-yr Runoff Volume (P1 = 2.23 in.) =	12.659	acre-feet	2.23	inches
100-yr Runoff Volume (P1 = 2.66 in.) =	15.962	acre-feet	2.66	inches
500-yr Runoff Volume (P1 = 3.83 in.) =	24.957	acre-feet	3.83	inches
Approximate 2-yr Detention Volume =	3.810	acre-feet		
Approximate 5-yr Detention Volume =	5.227	acre-feet		
Approximate 10-yr Detention Volume =	6.654	acre-feet		
Approximate 25-yr Detention Volume =	9.143	acre-feet		
Approximate 50-yr Detention Volume =	10.755	acre-feet		
Approximate 100-yr Detention Volume =	12.467	acre-feet		

Zone 1 Volume (WQCV) =	2.084	acre-feet
Zone 2 Volume (EURV - Zone 1) =	5.990	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	4.393	acre-feet
Total Detention Basin Volume =	12.467	
Initial Surcharge Volume (ISV) =	user	ft <sup>3</sup>
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth ( $H_{total}$ ) =	user	ft
Depth of Trickle Channel ( $H_{TC}$ ) =	user	ft
Slope of Trickle Channel ( $S_{TC}$ ) =	user	ft/ft
Slopes of Main Basin Sides ( $S_{main}$ ) =	user	H:V
Basin Length-to-Width Ratio ( $R_{L/W}$ ) =	user	

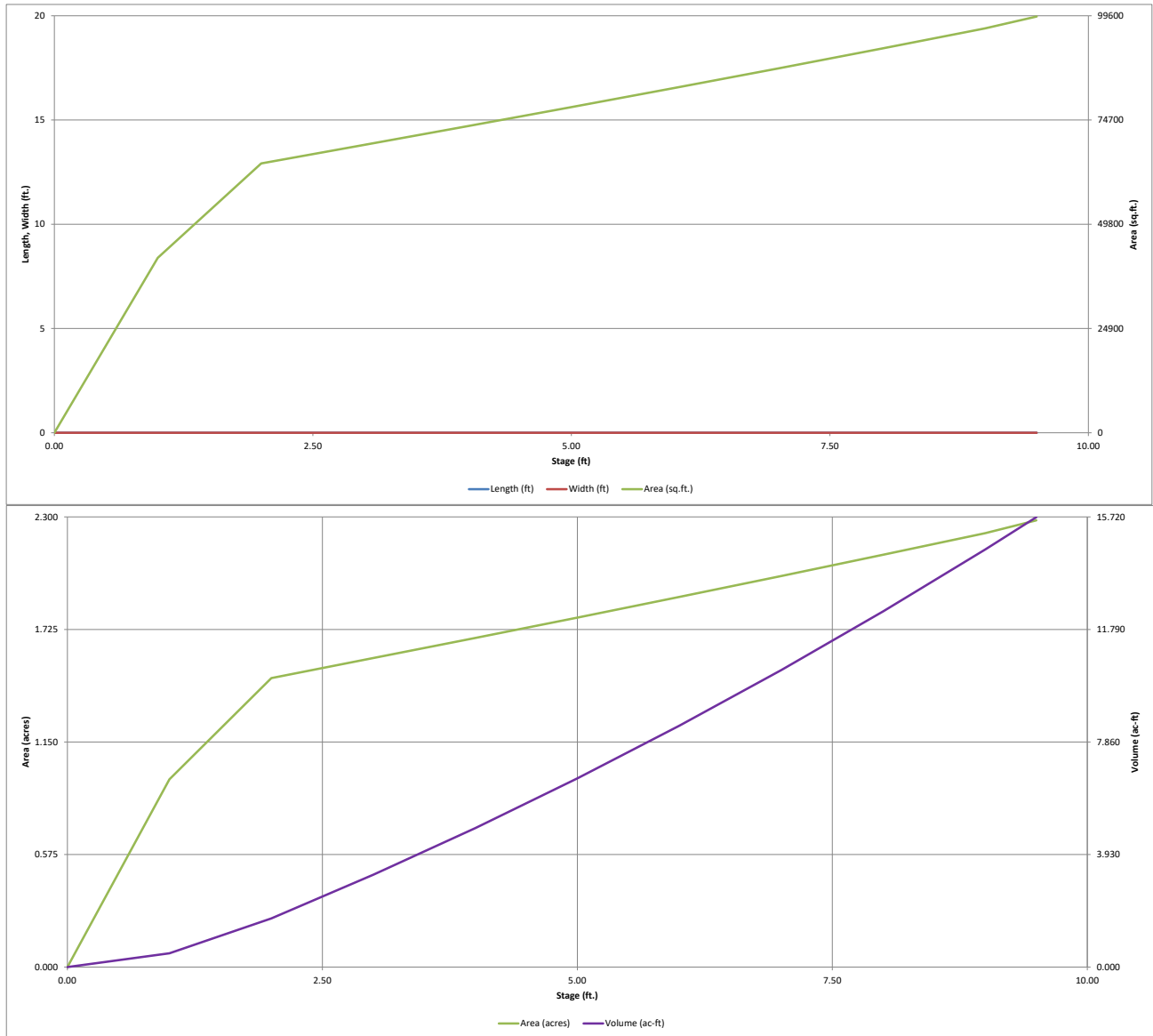
Initial Surcharge Area ( $A_{ISV}$ )	=	user	ft <sup>2</sup>
Surcharge Volume Length ( $L_{ISV}$ )	=	user	ft
Surcharge Volume Width ( $W_{ISV}$ )	=	user	ft
Depth of Basin Floor ( $H_{LFloor}$ )	=	user	ft
Length of Basin Floor ( $L_{LFloor}$ )	=	user	ft
Width of Basin Floor ( $W_{LFloor}$ )	=	user	ft
Area of Basin Floor ( $A_{LFloor}$ )	=	user	ft <sup>2</sup>
Volume of Basin Floor ( $V_{LFloor}$ )	=	user	ft <sup>3</sup>
Depth of Main Basin ( $H_{Main}$ )	=	user	ft
Length of Main Basin ( $L_{Main}$ )	=	user	ft
Width of Main Basin ( $W_{Main}$ )	=	user	ft
Area of Main Basin ( $A_{Main}$ )	=	user	ft <sup>2</sup>
Volume of Main Basin ( $V_{Main}$ )	=	user	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{Total}$ )	=	user	acre-feet

[illegible]



# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

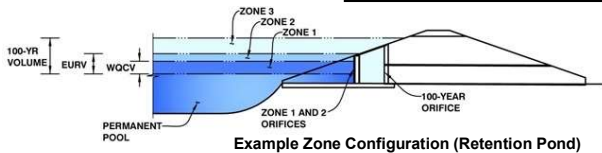


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.03 (May 2020)

Project: **Pioneer Village**

Basin ID: **Future Pond E**



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.26	2.084	Orifice Plate
Zone 2 (EURV)	5.82	5.990	Orifice Plate
Zone 3 (100-year)	8.03	4.393	Weir&Pipe (Restrict)
Total (all zones)		12.467	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain  
Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (use rectangular openings)

Calculated Parameters for Plate  
WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.90	3.80	5.70				
Orifice Area (sq. inches)	15.93	15.93	15.93	15.93				

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice  
Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Grate Slope =  H:V  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Open Area % =  %  
Debris Clogging % =  %

Calculated Parameters for Overflow Weir  
Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =  ft<sup>2</sup>  
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  inches  
Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway  
Spillway Design Flow Depth =  feet  
Stage at Top of Freeboard =  feet  
Basin Area at Top of Freeboard =  acres  
Basin Volume at Top of Freeboard =  acre-ft

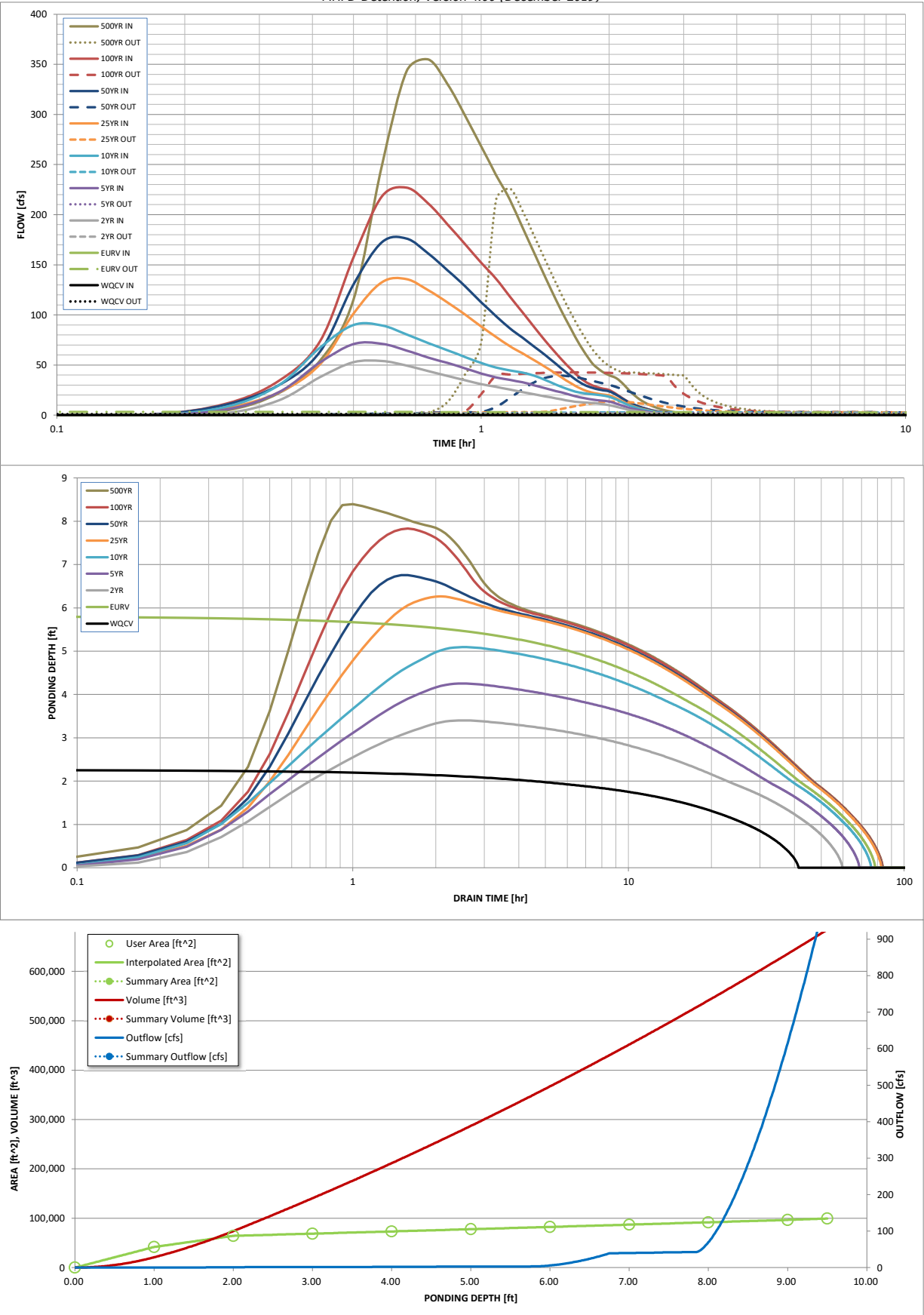
## Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
One-Hour Rainfall Depth (in) =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
CUHP Runoff Volume (acre-ft) =	2.084	8.075	4.140	5.639	7.199	9.971	12.659	15.962	24.957
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	4.140	5.639	7.199	9.971	12.659	15.962	24.957
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.0	0.3	0.7	4.8	21.8	45.3	110.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.00	0.01	0.05	0.24	0.50	1.22
Peak Inflow Q (cfs) =	N/A	N/A	54.1	71.2	89.9	135.7	176.2	226.9	354.7
Peak Outflow Q (cfs) =	1.1	3.3	1.6	2.3	2.8	13.7	39.2	42.6	226.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	7.3	4.0	2.8	1.8	0.9	2.1
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Plate	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.4	1.2	1.3	1.4
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	70	55	62	68	73	71	69	63
Time to Drain 99% of Inflow Volume (hours) =	40	75	57	66	72	78	78	77	75
Maximum Ponding Depth (ft) =	2.26	5.82	3.40	4.25	5.09	6.27	6.76	7.83	8.39
Area at Maximum Ponding Depth (acres) =	1.50	1.87	1.62	1.71	1.79	1.92	1.97	2.09	2.15
Maximum Volume Stored (acre-ft) =	2.085	8.088	3.865	5.279	6.750	8.922	9.875	12.046	13.254

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.56	4.65
	0:15:00	0.00	0.00	2.05	5.51	8.24	7.02	10.53	11.43	21.99
	0:20:00	0.00	0.00	14.74	22.85	29.94	22.79	29.97	34.31	54.17
	0:25:00	0.00	0.00	37.82	52.52	67.30	50.61	63.29	73.49	115.13
	0:30:00	0.00	0.00	52.86	70.85	89.93	101.20	130.32	157.37	249.21
	0:35:00	0.00	0.00	54.07	71.16	89.52	132.66	172.43	218.23	343.09
	0:40:00	0.00	0.00	49.55	64.40	80.57	135.68	176.18	226.91	354.75
	0:45:00	0.00	0.00	43.92	57.41	71.88	124.57	161.13	211.14	330.11
	0:50:00	0.00	0.00	39.02	51.98	64.66	112.24	144.41	190.23	298.48
	0:55:00	0.00	0.00	34.76	46.66	57.94	100.25	128.36	170.27	268.05
	1:00:00	0.00	0.00	30.97	41.59	51.98	88.39	112.56	152.04	239.79
	1:05:00	0.00	0.00	28.15	37.71	47.49	78.08	98.85	136.18	215.32
	1:10:00	0.00	0.00	25.56	35.20	44.66	68.86	86.70	118.57	187.40
	1:15:00	0.00	0.00	23.05	32.73	42.36	61.67	77.30	102.70	161.65
	1:20:00	0.00	0.00	20.80	29.81	39.26	54.73	68.32	87.78	137.34
	1:25:00	0.00	0.00	18.74	26.85	34.99	48.06	59.71	73.98	114.94
	1:30:00	0.00	0.00	16.75	24.03	30.50	41.27	51.05	61.78	95.39
	1:35:00	0.00	0.00	14.83	21.51	26.56	34.87	42.91	50.91	77.96
	1:40:00	0.00	0.00	13.36	18.88	23.54	29.27	35.78	41.44	62.81
	1:45:00	0.00	0.00	12.60	16.87	21.82	24.86	30.15	33.93	51.01
	1:50:00	0.00	0.00	12.23	15.50	20.77	22.36	27.02	29.58	44.17
	1:55:00	0.00	0.00	11.25	14.52	19.78	20.76	25.05	26.88	39.80
	2:00:00	0.00	0.00	10.05	13.59	18.42	19.71	23.76	25.02	36.75
	2:05:00	0.00	0.00	8.31	11.44	15.47	16.71	20.12	20.91	30.52
	2:10:00	0.00	0.00	6.48	8.92	12.07	13.01	15.65	16.00	23.23
	2:15:00	0.00	0.00	5.00	6.85	9.28	9.93	11.94	12.01	17.34
	2:20:00	0.00	0.00	3.85	5.27	7.12	7.59	9.11	9.07	13.04
	2:25:00	0.00	0.00	2.96	4.04	5.43	5.82	6.99	6.97	9.99
	2:30:00	0.00	0.00	2.25	3.04	4.08	4.38	5.25	5.26	7.54
	2:35:00	0.00	0.00	1.69	2.25	3.04	3.26	3.91	3.95	5.65
	2:40:00	0.00	0.00	1.25	1.65	2.28	2.43	2.91	2.96	4.23
	2:45:00	0.00	0.00	0.90	1.20	1.69	1.82	2.18	2.21	3.16
	2:50:00	0.00	0.00	0.62	0.83	1.18	1.30	1.55	1.57	2.24
	2:55:00	0.00	0.00	0.38	0.55	0.77	0.86	1.03	1.04	1.47
	3:00:00	0.00	0.00	0.21	0.33	0.45	0.52	0.61	0.62	0.87
	3:05:00	0.00	0.00	0.09	0.16	0.21	0.26	0.30	0.30	0.42
	3:10:00	0.00	0.00	0.03	0.05	0.07	0.09	0.10	0.10	0.13
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.03 (May 2020)*

### Summary Stage-Area-Volume-Discharge Relationships

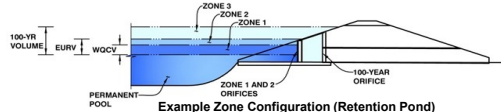
The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

[illegible]

## MHFD-Detention. Version 4.03 (May 2020)

Basin ID: Future Pond F



### Example Zone Configuration (Retention Pond)

Selected BMP Type =	<b>EDB</b>	
Watershed Area =	180.22	acres
Watershed Length =	8,212	ft
Watershed Length to Centroid =	5,139	ft
Watershed Slope =	0.008	ft/ft
Watershed Imperviousness =	58.29%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	

**Note: L / W Ratio > 8**  
**L / W Ratio = 8.59**

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

### Optional User Overrides

Water Quality Capture Volume (WQCV) =	3.463	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	12.644	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.86 in.) =	6.633	acre-feet	0.86	inches
5-yr Runoff Volume (P1 = 1.14 in.) =	9.033	acre-feet	1.14	inches
10-yr Runoff Volume (P1 = 1.41 in.) =	11.576	acre-feet	1.41	inches
25-yr Runoff Volume (P1 = 1.85 in.) =	16.383	acre-feet	1.85	inches
50-yr Runoff Volume (P1 = 2.23 in.) =	21.401	acre-feet	2.23	inches
100-yr Runoff Volume (P1 = 2.66 in.) =	27.780	acre-feet	2.66	inches
500-yr Runoff Volume (P1 = 3.83 in.) =	45.331	acre-feet	3.83	inches
Approximate 2-yr Detention Volume =	5.916	acre-feet		
Approximate 5-yr Detention Volume =	8.157	acre-feet		
Approximate 10-yr Detention Volume =	10.478	acre-feet		
Approximate 25-yr Detention Volume =	14.574	acre-feet		
Approximate 50-yr Detention Volume =	17.291	acre-feet		
Approximate 100-yr Detention Volume =	20.402	acre-feet		

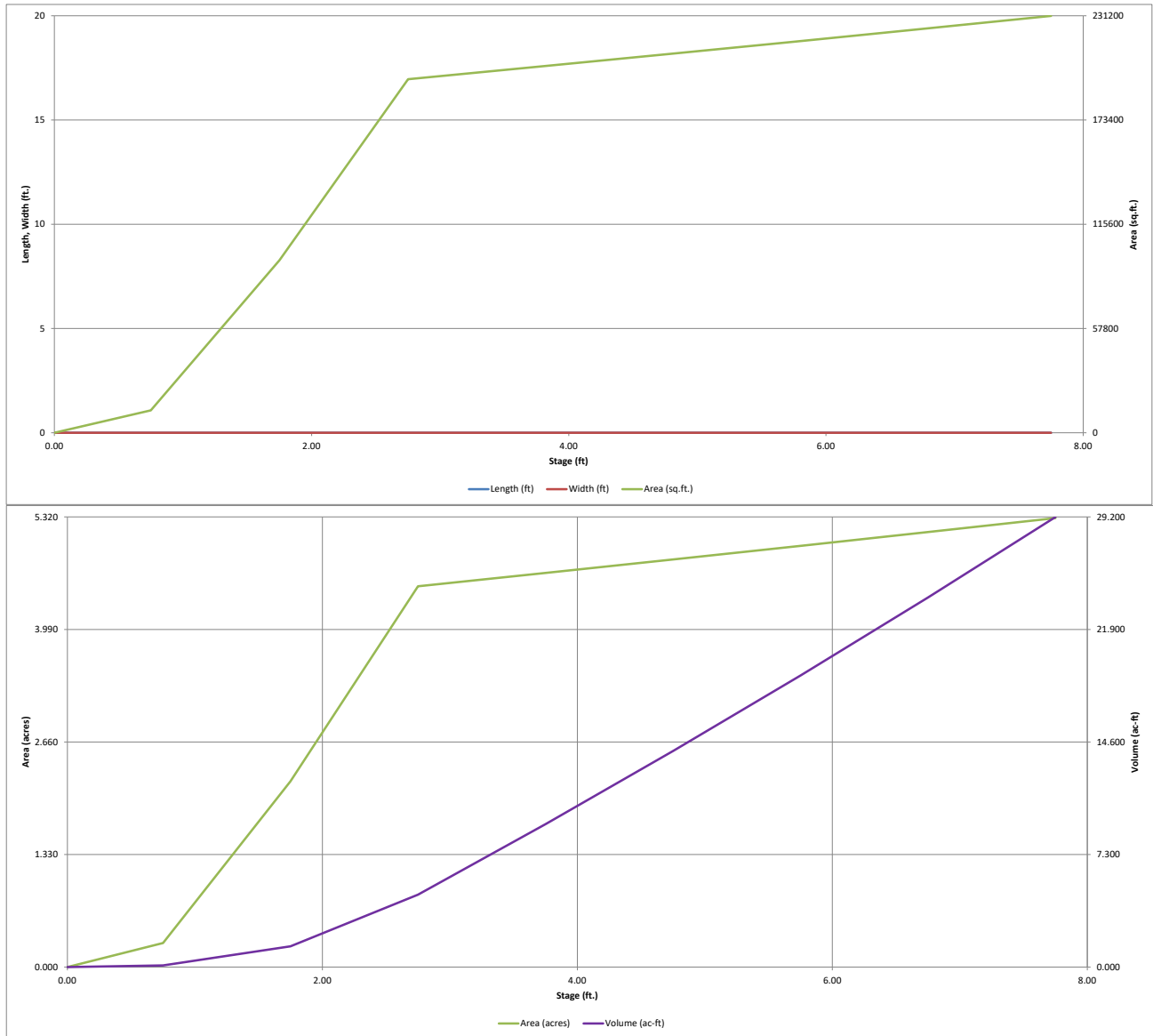
### Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	3.463	acre-feet
Zone 2 Volume (EURV - Zone 1) =	9.182	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	7.758	acre-feet
Total Detention Basin Volume =	20.402	acre-feet
Initial Surcharge Volume (ISV) =	user	ft <sup>3</sup>
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H <sub>total</sub> ) =	user	ft
Depth of Trickle Channel (H <sub>TC</sub> ) =	user	ft
Slope of Trickle Channel (S <sub>TC</sub> ) =	user	ft/ft
Slopes of Main Basin Sides (S <sub>main</sub> ) =	user	H:V
Basin Length-to-Width Ratio (R <sub>L/W</sub> ) =	user	
Initial Surcharge Area (A <sub>ISV</sub> ) =	user	ft <sup>2</sup>
Surcharge Volume Length (L <sub>ISV</sub> ) =	user	ft
Surcharge Volume Width (W <sub>ISV</sub> ) =	user	ft
Depth of Basin Floor (H <sub>FLOOR</sub> ) =	user	ft
Length of Basin Floor (L <sub>FLOOR</sub> ) =	user	ft
Width of Basin Floor (W <sub>FLOOR</sub> ) =	user	ft
Area of Basin Floor (A <sub>FLOOR</sub> ) =	user	ft <sup>2</sup>
Volume of Basin Floor (V <sub>FLOOR</sub> ) =	user	ft <sup>3</sup>
Depth of Main Basin (H <sub>MAIN</sub> ) =	user	ft
Length of Main Basin (L <sub>MAIN</sub> ) =	user	ft
Width of Main Basin (W <sub>MAIN</sub> ) =	user	ft
Area of Main Basin (A <sub>MAIN</sub> ) =	user	ft <sup>2</sup>
Volume of Main Basin (V <sub>MAIN</sub> ) =	user	ft <sup>3</sup>
Calculated Total Basin Volume (V <sub>total</sub> ) =	user	acre-feet

[illegible]

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

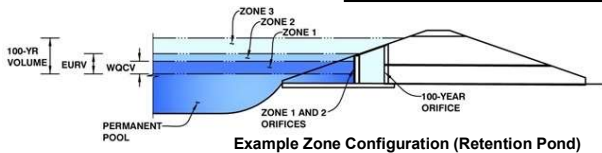


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-DETENTION, Version 4.03 (May 2020)

Project: **Pioneer Village**

Basin ID: **Future Pond F**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.46	3.463	Orifice Plate
Zone 2 (EURV)	4.47	9.182	Orifice Plate
Zone 3 (100-year)	6.05	7.758	Weir&Pipe (Restrict)
Total (all zones)		20.402	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain  
Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (use rectangular openings)

Calculated Parameters for Plate  
WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.50	3.00					
Orifice Area (sq. inches)	18.43	18.43	18.43					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice  
Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Grate Slope =  H:V  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Open Area % =  %  
Debris Clogging % =  %

Calculated Parameters for Overflow Weir  
Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =  ft<sup>2</sup>  
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  inches  
Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway  
Spillway Design Flow Depth =  feet  
Stage at Top of Freeboard =  feet  
Basin Area at Top of Freeboard =  acres  
Basin Volume at Top of Freeboard =  acre-ft

## Routed Hydrograph Results

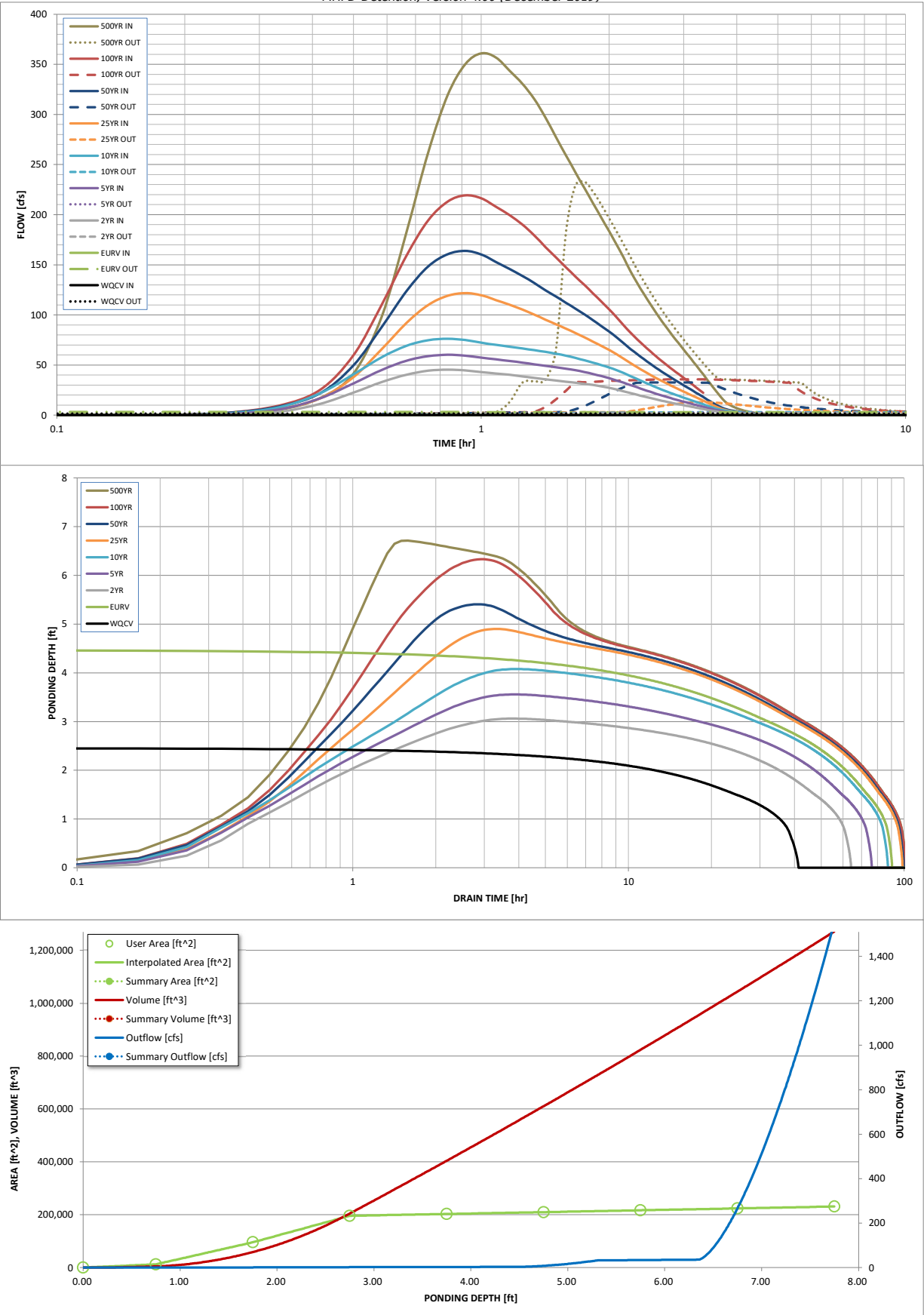
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
One-Hour Rainfall Depth (in) =	3.463	12.644	6.633	9.033	11.576	16.383	21.401	27.780	45.331
CUHP Runoff Volume (acre-ft) =	N/A	N/A	6.633	9.033	11.576	16.383	21.401	27.780	45.331
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.0	0.3	0.6	4.6	20.8	43.6	114.0
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.00	0.00	0.00	0.03	0.12	0.24	0.63
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A	45.4	60.2	76.2	121.8	163.8	219.3	360.9
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	2.0	2.5	2.9	12.8	32.6	35.7	232.9
Peak Inflow Q (cfs) =	N/A	N/A	N/A	8.4	4.4	2.8	1.6	0.8	2.0
Peak Outflow Q (cfs) =	N/A	N/A	N/A	8.4	4.4	2.8	1.6	0.8	2.0
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	8.4	4.4	2.8	1.6	0.8	2.0
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Plate	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.3	1.0	1.1	1.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	82	59	70	79	88	87	85	79
Time to Drain 99% of Inflow Volume (hours) =	40	87	62	74	84	94	94	95	92
Maximum Ponding Depth (ft) =	2.46	4.47	3.06	3.56	4.08	4.90	5.41	6.33	6.71
Area at Maximum Ponding Depth (acres) =	3.83	4.77	4.55	4.63	4.71	4.84	4.92	5.07	5.13
Maximum Volume Stored (acre-ft) =	3.487	12.668	6.098	8.345	10.772	14.735	17.176	21.822	23.762



DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: Pond F Outflow

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.11	0.90
	0:15:00	0.00	0.00	0.39	1.05	1.57	1.34	2.17	2.34	5.42
	0:20:00	0.00	0.00	3.31	5.71	7.74	6.11	8.50	9.58	16.90
	0:25:00	0.00	0.00	11.24	16.70	21.80	16.69	21.72	25.08	41.59
	0:30:00	0.00	0.00	22.55	31.69	40.89	37.83	49.66	59.74	98.94
	0:35:00	0.00	0.00	33.07	45.18	57.87	66.07	88.23	110.53	182.77
	0:40:00	0.00	0.00	40.41	54.28	69.18	91.99	123.84	159.25	262.27
	0:45:00	0.00	0.00	44.28	58.91	74.80	109.97	148.45	194.40	319.31
	0:50:00	0.00	0.00	45.42	60.24	76.21	119.10	160.60	213.10	350.16
	0:55:00	0.00	0.00	44.61	59.37	74.91	121.76	163.82	219.26	360.91
	1:00:00	0.00	0.00	42.95	57.35	72.26	119.65	160.31	216.41	356.71
	1:05:00	0.00	0.00	41.52	55.60	70.08	114.77	152.71	207.84	343.46
	1:10:00	0.00	0.00	40.19	54.05	68.27	110.03	145.74	199.39	330.56
	1:15:00	0.00	0.00	38.65	52.43	66.52	105.30	138.87	190.11	315.34
	1:20:00	0.00	0.00	37.08	50.76	64.81	100.38	131.83	179.37	297.05
	1:25:00	0.00	0.00	35.70	49.22	63.15	95.28	124.59	167.81	277.20
	1:30:00	0.00	0.00	34.50	47.82	61.34	90.66	118.22	157.25	259.17
	1:35:00	0.00	0.00	33.37	46.42	59.28	86.25	112.18	147.53	242.32
	1:40:00	0.00	0.00	32.26	44.86	57.04	81.90	106.26	138.37	226.40
	1:45:00	0.00	0.00	31.19	43.06	54.73	77.60	100.41	129.83	211.66
	1:50:00	0.00	0.00	30.09	41.08	52.39	73.35	94.65	121.53	197.35
	1:55:00	0.00	0.00	28.82	38.98	50.03	69.17	88.97	113.46	183.52
	2:00:00	0.00	0.00	27.31	36.85	47.58	65.10	83.46	105.65	170.21
	2:05:00	0.00	0.00	25.56	34.59	44.85	60.84	77.75	97.74	156.86
	2:10:00	0.00	0.00	23.74	32.24	41.90	56.22	71.62	89.53	143.30
	2:15:00	0.00	0.00	21.98	29.95	38.94	51.76	65.91	82.14	131.54
	2:20:00	0.00	0.00	20.25	27.67	35.97	47.66	60.71	75.55	120.97
	2:25:00	0.00	0.00	18.61	25.45	33.07	43.86	55.88	69.47	111.16
	2:30:00	0.00	0.00	17.09	23.34	30.32	40.28	51.33	63.82	102.05
	2:35:00	0.00	0.00	15.66	21.38	27.76	36.96	47.12	58.58	93.61
	2:40:00	0.00	0.00	14.36	19.59	25.42	33.95	43.28	53.80	85.88
	2:45:00	0.00	0.00	13.14	17.92	23.23	31.11	39.64	49.29	78.61
	2:50:00	0.00	0.00	12.00	16.33	21.17	28.43	36.19	45.06	71.82
	2:55:00	0.00	0.00	10.92	14.84	19.23	25.89	32.91	41.02	65.31
	3:00:00	0.00	0.00	9.89	13.44	17.42	23.48	29.79	37.14	59.03
	3:05:00	0.00	0.00	8.90	12.09	15.69	21.15	26.77	33.34	52.86
	3:10:00	0.00	0.00	7.93	10.79	14.02	18.88	23.81	29.60	46.77
	3:15:00	0.00	0.00	7.00	9.53	12.39	16.66	20.92	25.92	40.76
	3:20:00	0.00	0.00	6.09	8.31	10.81	14.48	18.08	22.29	34.84
	3:25:00	0.00	0.00	5.21	7.13	9.27	12.35	15.30	18.72	29.04
	3:30:00	0.00	0.00	4.37	5.98	7.79	10.29	12.63	15.29	23.48
	3:35:00	0.00	0.00	3.58	4.93	6.45	8.37	10.14	12.07	18.26
	3:40:00	0.00	0.00	2.95	4.07	5.34	6.66	7.95	9.22	13.70
	3:45:00	0.00	0.00	2.50	3.47	4.58	5.33	6.33	7.16	10.70
	3:50:00	0.00	0.00	2.16	3.00	3.98	4.41	5.22	5.77	8.58
	3:55:00	0.00	0.00	1.87	2.59	3.45	3.70	4.38	4.71	6.93
	4:00:00	0.00	0.00	1.61	2.23	2.97	3.12	3.68	3.85	5.59
	4:05:00	0.00	0.00	1.38	1.89	2.53	2.62	3.08	3.15	4.50
	4:10:00	0.00	0.00	1.17	1.60	2.14	2.19	2.57	2.55	3.60
	4:15:00	0.00	0.00	0.98	1.33	1.78	1.81	2.12	2.07	2.88
	4:20:00	0.00	0.00	0.81	1.09	1.46	1.48	1.73	1.68	2.34
	4:25:00	0.00	0.00	0.66	0.88	1.18	1.20	1.40	1.37	1.89
	4:30:00	0.00	0.00	0.53	0.70	0.94	0.96	1.12	1.10	1.52
	4:35:00	0.00	0.00	0.41	0.54	0.74	0.75	0.87	0.86	1.18
	4:40:00	0.00	0.00	0.31	0.41	0.57	0.58	0.66	0.66	0.89
	4:45:00	0.00	0.00	0.22	0.30	0.42	0.43	0.49	0.48	0.64
	4:50:00	0.00	0.00	0.15	0.20	0.29	0.30	0.34	0.33	0.43
	4:55:00	0.00	0.00	0.09	0.13	0.19	0.19	0.21	0.20	0.26
	5:00:00	0.00	0.00	0.05	0.08	0.11	0.11	0.12	0.11	0.13
	5:05:00	0.00	0.00	0.02	0.04	0.05	0.05	0.05	0.05	0.05
	5:10:00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.03 (May 2020)*

### Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

[illegible]

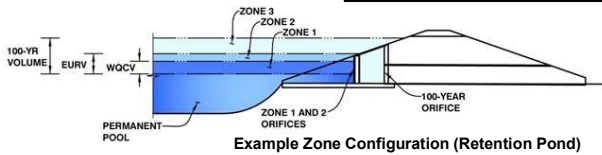


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.03 (May 2020)

Project: **Pioneer Village**

Basin ID: **Future Pond G**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.03	5.885	Orifice Plate
Zone 2 (EURV)	5.09	12.651	Orifice Plate
Zone 3 (100-year)	7.13	13.407	Weir&Pipe (Restrict)
Total (all zones)		31.943	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain  
Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (use rectangular openings)

Calculated Parameters for Plate  
WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.70	3.40					
Orifice Area (sq. inches)	25.52	25.52	25.52					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice  
Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Grate Slope =  H:V  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Open Area % =  %  
Debris Clogging % =  %

Calculated Parameters for Overflow Weir  
Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =  ft<sup>2</sup>  
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  inches  
Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway  
Spillway Design Flow Depth =  feet  
Stage at Top of Freeboard =  feet  
Basin Area at Top of Freeboard =  acres  
Basin Volume at Top of Freeboard =  acre-ft

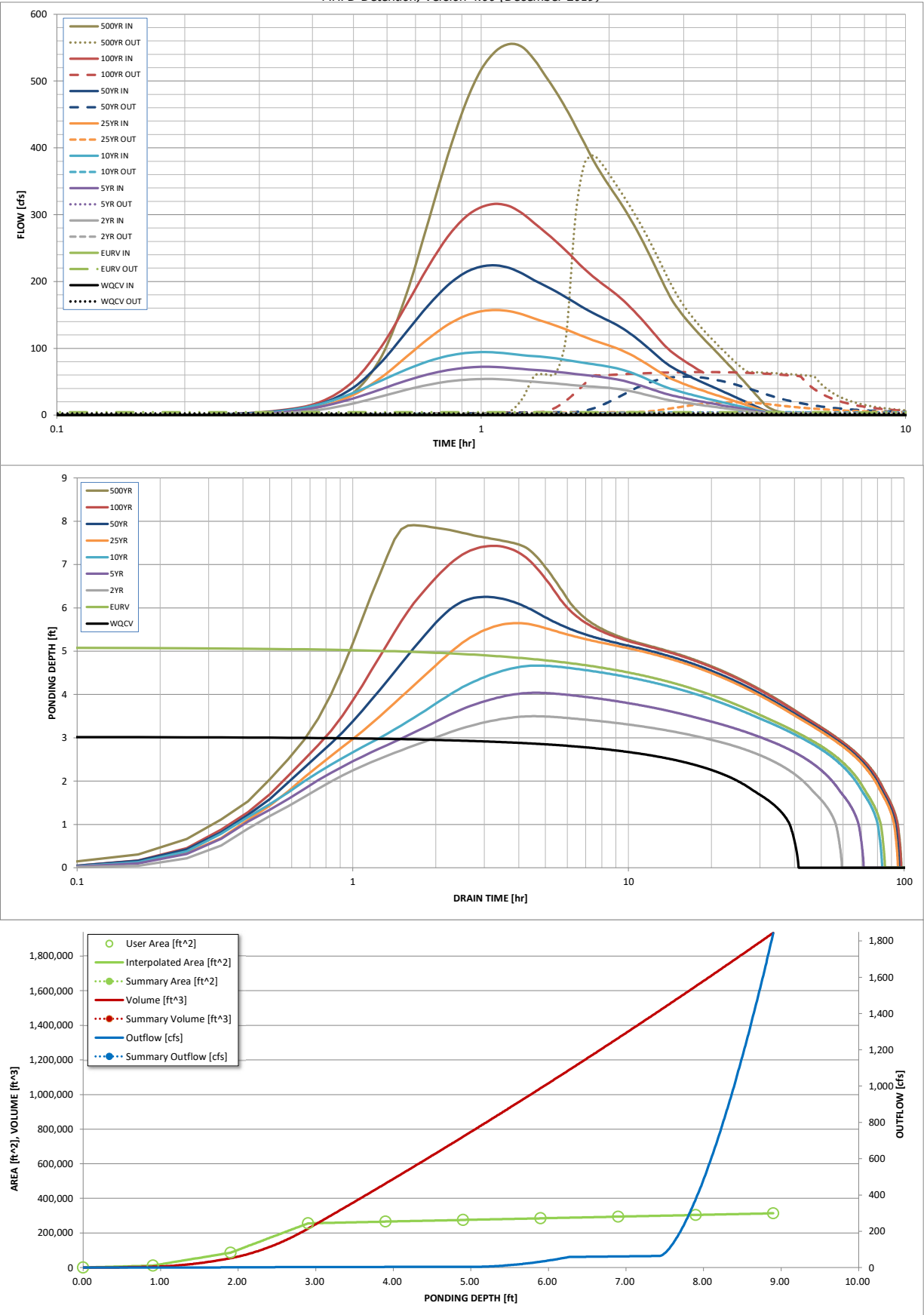
## Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
One-Hour Rainfall Depth (in) =	5.885	18.536	9.678	13.180	17.275	25.330	34.752	47.113	81.581
CUHP Runoff Volume (acre-ft) =	N/A	N/A	9.677	13.180	17.275	25.330	34.751	47.113	81.581
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	0.1	0.6	1.2	8.7	39.6	83.0	218.3
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A							
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.00	0.00	0.02	0.11	0.23	0.60
Peak Inflow Q (cfs) =	N/A	N/A	54.1	72.3	94.4	157.3	224.0	316.1	555.4
Peak Outflow Q (cfs) =	2.5	4.6	3.0	3.7	4.3	19.5	57.5	64.4	388.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	6.5	3.5	2.2	1.5	0.8	1.8
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.5	1.8	2.0	2.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	77	55	65	76	85	83	81	75
Time to Drain 99% of Inflow Volume (hours) =	40	82	58	69	80	91	91	91	87
Maximum Ponding Depth (ft) =	3.03	5.09	3.50	4.04	4.67	5.65	6.25	7.43	7.91
Area at Maximum Ponding Depth (acres) =	5.90	6.36	6.01	6.13	6.27	6.48	6.62	6.88	6.98
Maximum Volume Stored (acre-ft) =	5.932	18.571	8.670	11.949	15.856	22.104	26.099	34.060	37.387

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: Desktop

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.07	0.62
	0:15:00	0.00	0.00	0.26	0.71	1.06	0.91	1.50	1.62	3.87
	0:20:00	0.00	0.00	2.29	4.00	5.44	4.34	6.14	6.92	12.67
	0:25:00	0.00	0.00	8.15	12.34	16.46	12.55	16.71	19.47	33.65
	0:30:00	0.00	0.00	17.63	25.15	33.45	30.29	41.42	51.00	89.14
	0:35:00	0.00	0.00	28.32	39.24	52.12	57.23	80.40	103.68	181.67
	0:40:00	0.00	0.00	37.96	51.63	68.38	87.47	124.76	165.62	289.43
	0:45:00	0.00	0.00	45.41	61.04	80.59	114.36	164.09	222.30	387.68
	0:50:00	0.00	0.00	50.30	67.30	88.53	135.08	194.16	266.70	465.24
	0:55:00	0.00	0.00	53.01	70.82	92.79	148.62	213.30	296.08	517.10
	1:00:00	0.00	0.00	54.12	72.28	94.38	155.50	222.33	311.25	544.94
	1:05:00	0.00	0.00	53.94	72.04	93.84	157.34	223.97	316.11	555.45
	1:10:00	0.00	0.00	52.71	70.65	91.92	155.40	220.04	312.56	550.64
	1:15:00	0.00	0.00	51.17	68.96	89.70	150.60	211.77	301.67	532.10
	1:20:00	0.00	0.00	49.87	67.69	88.25	144.53	201.88	287.29	507.81
	1:25:00	0.00	0.00	48.62	66.42	86.82	139.16	193.37	273.71	484.04
	1:30:00	0.00	0.00	47.27	64.92	84.90	133.81	185.03	260.02	459.01
	1:35:00	0.00	0.00	45.87	63.28	82.60	128.23	176.55	245.99	432.90
	1:40:00	0.00	0.00	44.55	61.61	80.21	122.50	167.93	232.02	406.81
	1:45:00	0.00	0.00	43.48	60.10	78.09	117.00	159.65	218.64	382.24
	1:50:00	0.00	0.00	42.62	58.62	76.22	112.26	152.81	207.52	361.59
	1:55:00	0.00	0.00	41.76	57.07	74.38	108.08	146.72	197.90	343.43
	2:00:00	0.00	0.00	40.76	55.42	72.42	104.21	141.05	189.05	326.70
	2:05:00	0.00	0.00	39.45	53.54	70.11	100.16	135.17	180.22	310.18
	2:10:00	0.00	0.00	37.80	51.28	67.27	95.67	128.77	170.92	293.13
	2:15:00	0.00	0.00	35.83	48.63	63.88	90.62	121.67	160.96	275.24
	2:20:00	0.00	0.00	33.65	45.70	60.09	85.15	114.07	150.55	256.82
	2:25:00	0.00	0.00	31.36	42.62	56.05	79.40	106.13	139.89	238.18
	2:30:00	0.00	0.00	29.02	39.49	51.90	73.51	98.07	129.13	219.50
	2:35:00	0.00	0.00	26.71	36.43	47.86	67.73	90.18	118.60	201.22
	2:40:00	0.00	0.00	24.60	33.59	44.13	62.20	82.66	108.54	183.93
	2:45:00	0.00	0.00	22.82	31.18	40.98	57.17	75.97	99.74	169.57
	2:50:00	0.00	0.00	21.33	29.15	38.34	53.18	70.76	92.82	158.04
	2:55:00	0.00	0.00	20.02	27.36	35.98	49.83	66.37	86.99	148.03
	3:00:00	0.00	0.00	18.80	25.69	33.78	46.81	62.38	81.71	138.89
	3:05:00	0.00	0.00	17.66	24.11	31.70	43.98	58.65	76.81	130.42
	3:10:00	0.00	0.00	16.58	22.62	29.74	41.35	55.15	72.20	122.47
	3:15:00	0.00	0.00	15.57	21.21	27.89	38.86	51.82	67.85	114.98
	3:20:00	0.00	0.00	14.61	19.89	26.14	36.50	48.65	63.75	107.97
	3:25:00	0.00	0.00	13.69	18.62	24.46	34.24	45.60	59.80	101.18
	3:30:00	0.00	0.00	12.80	17.40	22.86	32.04	42.63	55.94	94.53
	3:35:00	0.00	0.00	11.93	16.22	21.32	29.91	39.73	52.15	87.97
	3:40:00	0.00	0.00	11.09	15.09	19.83	27.83	36.90	48.41	81.49
	3:45:00	0.00	0.00	10.28	13.99	18.39	25.80	34.12	44.71	75.08
	3:50:00	0.00	0.00	9.49	12.92	16.99	23.82	31.40	41.07	68.74
	3:55:00	0.00	0.00	8.72	11.90	15.63	21.87	28.72	37.47	62.47
	4:00:00	0.00	0.00	7.98	10.90	14.31	19.95	26.09	33.93	56.28
	4:05:00	0.00	0.00	7.27	9.93	13.02	18.08	23.50	30.43	50.15
	4:10:00	0.00	0.00	6.58	8.98	11.78	16.25	20.96	26.99	44.10
	4:15:00	0.00	0.00	5.91	8.06	10.57	14.45	18.48	23.59	38.13
	4:20:00	0.00	0.00	5.25	7.16	9.39	12.69	16.02	20.22	32.20
	4:25:00	0.00	0.00	4.60	6.27	8.22	10.94	13.58	16.86	26.36
	4:30:00	0.00	0.00	3.94	5.37	7.05	9.20	11.19	13.60	20.72
	4:35:00	0.00	0.00	3.30	4.51	5.93	7.53	8.92	10.50	15.51
	4:40:00	0.00	0.00	2.72	3.75	4.93	6.00	6.88	7.74	11.56
	4:45:00	0.00	0.00	2.29	3.17	4.17	4.73	5.42	5.98	8.99
	4:50:00	0.00	0.00	1.97	2.73	3.61	3.88	4.45	4.80	7.12
	4:55:00	0.00	0.00	1.70	2.36	3.13	3.25	3.72	3.89	5.66
	5:00:00	0.00	0.00	1.47	2.03	2.70	2.73	3.11	3.17	4.49
	5:05:00	0.00	0.00	1.26	1.73	2.32	2.29	2.61	2.57	3.55
	5:10:00	0.00	0.00	1.07	1.47	1.96	1.92	2.17	2.07	2.80
	5:15:00	0.00	0.00	0.90	1.23	1.65	1.59	1.78	1.67	2.24
	5:20:00	0.00	0.00	0.75	1.01	1.36	1.30	1.46	1.37	1.82
	5:25:00	0.00	0.00	0.62	0.83	1.11	1.06	1.18	1.11	1.46
	5:30:00	0.00	0.00	0.50	0.66	0.89	0.84	0.93	0.88	1.15
	5:35:00	0.00	0.00	0.39	0.52	0.70	0.67	0.73	0.69	0.88
	5:40:00	0.00	0.00	0.30	0.40	0.55	0.51	0.55	0.52	0.65
	5:45:00	0.00	0.00	0.22	0.29	0.41	0.38	0.40	0.37	0.45
	5:50:00	0.00	0.00	0.15	0.21	0.29	0.27	0.28	0.25	0.29
	5:55:00	0.00	0.00	0.10	0.14	0.20	0.18	0.17	0.15	0.16
	6:00:00	0.00	0.00	0.06	0.09	0.12	0.10	0.09	0.07	0.07

## DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.03 (May 2020)*

### Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

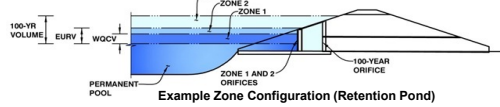
[illegible]



# MHFD-Detention Outflow Hydrographs

		WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Time [hr]	Time [min]	Outflow2 - [cfs]	Outflow2 - [cfs]	Outflow2 - [cfs]	Outflow2 - [cfs]	Outflow2 - [cfs]	Outflow2 - [cfs]	Outflow2 - [cfs]	Outflow2 - [cfs]	Outflow2 - [cfs]
0.00	0.00	2.46	4.60	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.08	5.00	2.46	4.60	0.00	0.00	0.00	0.00	0.08	0.07	0.26
0.17	10.00	2.46	4.59	0.18	0.27	0.31	0.29	0.34	0.35	0.47
0.25	15.00	2.46	4.59	0.40	0.48	0.53	0.50	0.56	0.57	0.70
0.33	20.00	2.46	4.58	0.61	0.70	0.76	0.71	0.77	0.80	0.90
0.42	25.00	2.45	4.58	0.81	0.88	0.92	0.90	0.94	0.97	1.06
0.50	30.00	2.45	4.58	0.93	0.99	1.03	1.02	1.07	1.11	1.72
0.58	35.00	2.45	4.57	1.02	1.08	1.30	1.35	1.65	1.80	2.12
0.67	40.00	2.45	4.57	1.09	1.44	1.67	1.76	1.96	2.11	2.42
0.75	45.00	2.45	4.57	1.45	1.70	1.87	2.00	2.19	2.35	2.89
0.83	50.00	2.45	4.56	1.66	1.86	2.02	2.17	2.37	2.55	3.66
0.92	55.00	2.44	4.56	1.80	1.98	2.14	2.31	2.53	3.03	4.21
1.00	60.00	2.44	4.55	1.91	2.08	2.23	2.43	2.67	3.51	5.48
1.08	65.00	2.44	4.55	1.99	2.16	2.31	2.54	3.22	3.87	24.63
1.17	70.00	2.44	4.55	2.06	2.23	2.38	2.64	3.52	4.17	58.43
1.25	75.00	2.44	4.54	2.12	2.29	2.45	2.99	3.76	4.43	60.97
1.33	80.00	2.44	4.54	2.17	2.35	2.51	3.25	3.97	5.25	63.22
1.42	85.00	2.43	4.54	2.22	2.39	2.57	3.44	4.15	11.62	116.27
1.50	90.00	2.43	4.53	2.26	2.44	2.62	3.60	4.31	21.58	295.99
1.58	95.00	2.43	4.53	2.30	2.48	2.67	3.75	4.46	33.62	376.27
1.67	100.00	2.43	4.52	2.34	2.52	2.94	3.87	4.59	46.63	388.53
1.75	105.00	2.43	4.52	2.37	2.56	3.10	3.99	6.34	58.43	377.37
1.83	110.00	2.42	4.52	2.40	2.60	3.22	4.09	9.93	59.23	360.83
1.92	115.00	2.42	4.51	2.43	2.64	3.33	4.19	14.54	59.97	343.90
2.00	120.00	2.42	4.51	2.46	2.67	3.43	4.28	19.81	60.65	327.37
2.08	125.00	2.42	4.51	2.48	2.85	3.51	4.36	25.41	61.26	310.93
2.17	130.00	2.42	4.50	2.51	2.98	3.59	4.44	31.04	61.81	294.08
2.25	135.00	2.42	4.50	2.53	3.07	3.66	4.51	36.42	62.30	276.70
2.33	140.00	2.41	4.49	2.55	3.15	3.72	4.57	41.36	62.72	258.95
2.42	145.00	2.41	4.49	2.57	3.21	3.78	4.82	45.67	63.09	241.02
2.50	150.00	2.41	4.49	2.59	3.27	3.83	5.70	49.27	63.40	223.19
2.58	155.00	2.41	4.48	2.60	3.32	3.87	6.83	52.12	63.65	205.84
2.67	160.00	2.41	4.48	2.61	3.36	3.92	8.08	54.26	63.85	189.81
2.75	165.00	2.40	4.48	2.63	3.40	3.95	9.35	55.80	64.01	175.89
2.83	170.00	2.40	4.47	2.64	3.43	3.99	10.62	56.83	64.14	164.00
2.92	175.00	2.40	4.47	2.65	3.46	4.02	11.86	57.42	64.24	153.58
3.00	180.00	2.40	4.46	2.66	3.49	4.05	13.04	57.53	64.32	144.27
3.08	185.00	2.40	4.46	2.67	3.51	4.07	14.14	57.51	64.37	135.71
3.17	190.00	2.40	4.46	2.68	3.54	4.10	15.15	57.32	64.40	127.80
3.25	195.00	2.39	4.45	2.70	3.56	4.12	16.06	56.74	64.40	120.44
3.33	200.00	2.39	4.45	2.80	3.58	4.14	16.86	55.96	64.39	113.50
3.42	205.00	2.39	4.45	2.84	3.60	4.16	17.56	55.01	64.36	106.90
3.50	210.00	2.39	4.44	2.87	3.61	4.17	18.15	53.90	64.31	100.56
3.58	215.00	2.39	4.44	2.90	3.63	4.19	18.63	52.67	64.24	94.45
3.67	220.00	2.39	4.43	2.92	3.64	4.20	19.00	51.34	64.15	88.52
3.75	225.00	2.38	4.43	2.94	3.65	4.21	19.26	49.91	64.04	82.81
3.83	230.00	2.38	4.43	2.95	3.66	4.23	19.43	48.41	63.92	77.41
3.92	235.00	2.38	4.42	2.97	3.67	4.24	19.49	46.85	63.78	72.33
4.00	240.00	2.38	4.42	2.98	3.68	4.24	19.47	45.23	63.62	67.89
4.08	245.00	2.38	4.41	2.99	3.69	4.25	19.37	43.58	63.45	64.76
4.17	250.00	2.37	4.41	2.99	3.69	4.26	19.18	41.90	63.25	64.34
4.25	255.00	2.37	4.41	3.00	3.70	4.26	18.93	40.21	63.04	64.20
4.33	260.00	2.37	4.40	3.00	3.70	4.27	18.61	38.49	62.82	64.02
4.42	265.00	2.37	4.40	3.01	3.70	4.27	18.23	36.78	62.57	63.82
4.50	270.00	2.37	4.40	3.01	3.70	4.27	17.79	35.06	62.31	63.59
4.58	275.00	2.37	4.39	3.01	3.70	4.27	17.31	33.36	62.04	63.34
4.67	280.00	2.36	4.39	3.01	3.70	4.27	16.80	31.70	61.75	63.07
4.75	285.00	2.36	4.38	3.01	3.70	4.27	16.28	30.11	61.45	62.79
4.83	290.00	2.36	4.38	3.00	3.70	4.27	15.76	28.61	61.15	62.50
4.92	295.00	2.36	4.38	3.00	3.70	4.27	15.24	27.20	60.84	62.21
5.00	300.00	2.36	4.37	3.00	3.70	4.27	14.74	25.87	60.53	61.90
5.08	305.00	2.35	4.37	2.99	3.69	4.27	14.25	24.62	60.22	61.60
5.17	310.00	2.35	4.37	2.99	3.69	4.27	13.78	23.45	59.90	61.28
5.25	315.00	2.35	4.36	2.98	3.69	4.26	13.32	22.35	59.58	60.97
5.33	320.00	2.35	4.36	2.98	3.69	4.26	12.88	21.32	59.26	60.65
5.42	325.00	2.35	4.35	2.97	3.68	4.26	12.46	20.35	58.93	60.33
5.50	330.00	2.34	4.35	2.97	3.68	4.25	12.05	19.44	58.61	60.01
5.58	335.00	2.34	4.35	2.96	3.67	4.25	11.66	18.58	57.49	59.69
5.67	340.00	2.34	4.34	2.95	3.67	4.25	11.29	17.78	53.01	59.36
5.75	345.00	2.34	4.34	2.95	3.67	4.24	10.93	17.03	48.95	59.03
5.83	350.00	2.34	4.33	2.94	3.66	4.24	10.59	16.32	45.34	58.71
5.92	355.00	2.34	4.33	2.93	3.66	4.24	10.26	15.66	42.12	58.32
6.00	360.00	2.33	4.33	2.92	3.65	4.23	9.95	15.03	39.24	54.22
6.08	365.00	2.33	4.32	2.92	3.65	4.23	9.66	14.45	36.65	49.99
6.17	370.00	2.33	4.32	2.91	3.65	4.23	9.38	13.90	34.31	46.25

## MHFD-Detention, Version 4.03 (May 2020)

Basin ID: Future Pond H

### Example Zone Configuration (Retention Pond)

Selected BMP Type =	<b>EDB</b>	
Watershed Area =	259.30	acres
Watershed Length =	8,529	ft
Watershed Length to Centroid =	4,795	ft
Watershed Slope =	0.006	ft/ft
Watershed Imperviousness =	55.28%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths = User Input		

### Optional User Overrides

Water Quality Capture Volume (WQCV) =	4.781	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	16.999	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.86 in.) =	8.891	acre-feet	0.86	inches
5-yr Runoff Volume (P1 = 1.14 in.) =	12.110	acre-feet	1.14	inches
10-yr Runoff Volume (P1 = 1.41 in.) =	15.602	acre-feet	1.41	inches
25-yr Runoff Volume (P1 = 1.85 in.) =	22.247	acre-feet	1.85	inches
50-yr Runoff Volume (P1 = 2.23 in.) =	29.352	acre-feet	2.23	inches
100-yr Runoff Volume (P1 = 2.66 in.) =	38.457	acre-feet	2.66	inches
500-yr Runoff Volume (P1 = 3.83 in.) =	63.549	acre-feet	3.83	inches
Approximate 2-yr Detention Volume =	7.935	acre-feet		
Approximate 5-yr Detention Volume =	10.956	acre-feet		
Approximate 10-yr Detention Volume =	14.108	acre-feet		
Approximate 25-yr Detention Volume =	19.689	acre-feet		
Approximate 50-yr Detention Volume =	23.421	acre-feet		
Approximate 100-yr Detention Volume =	27.789	acre-feet		

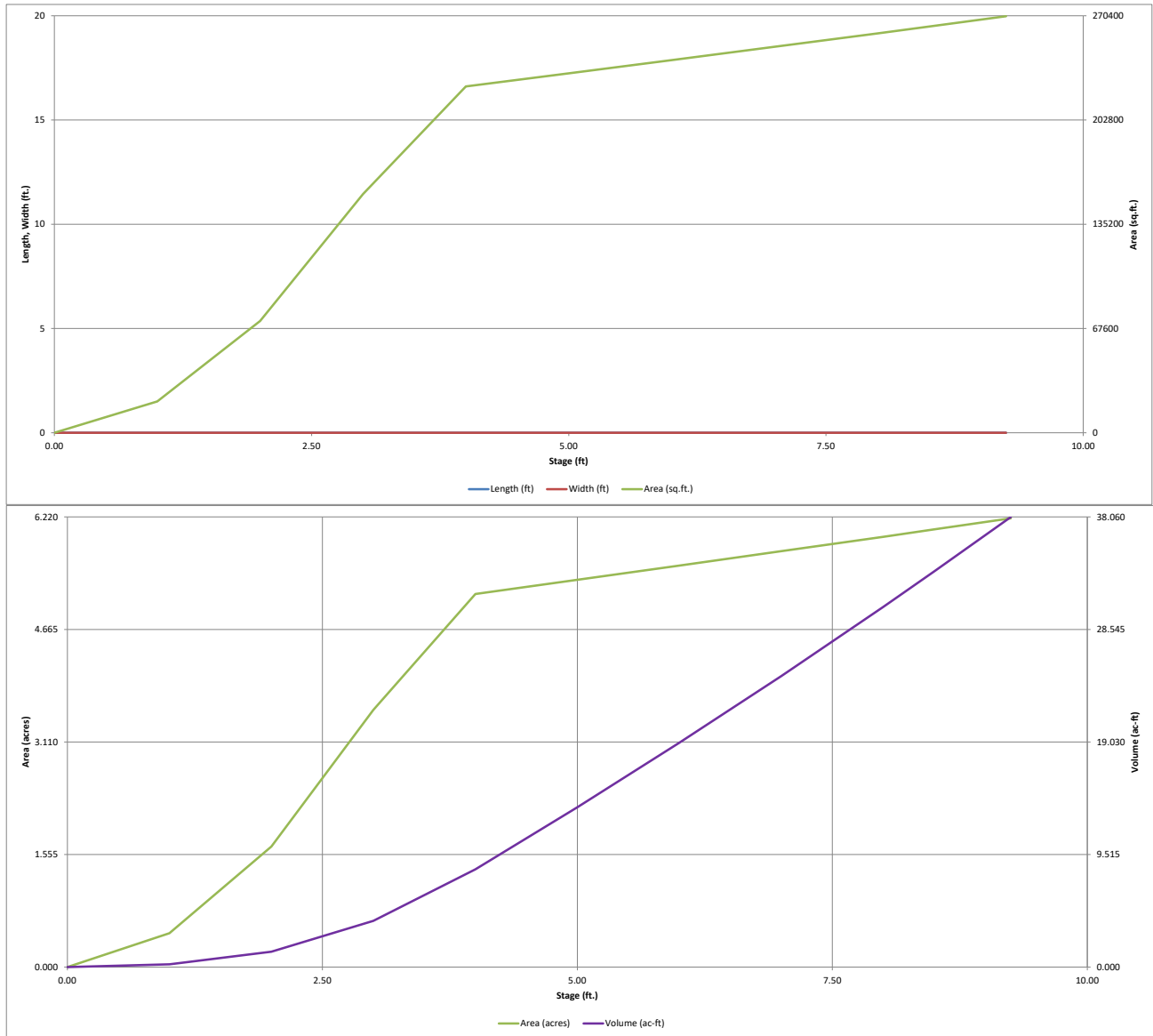
Zone 1 Volume (WQCV) =	4.781	acre-feet
Zone 2 Volume (EURV - Zone 1) =	12.218	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	10.790	acre-feet
Total Detention Basin Volume =	27.789	
Initial Surcharge Volume (ISV) =	user	ft <sup>3</sup>
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth ( $H_{total}$ ) =	user	ft
Depth of Trickle Channel ( $H_{TC}$ ) =	user	ft
Slope of Trickle Channel ( $S_{TC}$ ) =	user	ft/ft
Slopes of Main Basin Sides ( $S_{main}$ ) =	user	H:V
Basin Length-to-Width Ratio ( $R_{L/W}$ ) =	user	

Initial Surcharge Area ( $A_{ISV}$ ) =	<u>user</u>	ft <sup>2</sup>
Surcharge Volume Length ( $L_{ISV}$ ) =	<u>user</u>	ft
Surcharge Volume Width ( $W_{ISV}$ ) =	<u>user</u>	ft
Depth of Basin Floor ( $H_{FLOOR}$ ) =	<u>user</u>	ft
Length of Basin Floor ( $L_{FLOOR}$ ) =	<u>user</u>	ft
Width of Basin Floor ( $W_{FLOOR}$ ) =	<u>user</u>	ft
Area of Basin Floor ( $A_{FLOOR}$ ) =	<u>user</u>	ft <sup>2</sup>
Volume of Basin Floor ( $V_{FLOOR}$ ) =	<u>user</u>	ft <sup>3</sup>
Depth of Main Basin ( $H_{MAIN}$ ) =	<u>user</u>	ft
Length of Main Basin ( $L_{MAIN}$ ) =	<u>user</u>	ft
Width of Main Basin ( $W_{MAIN}$ ) =	<u>user</u>	ft
Area of Main Basin ( $A_{MAIN}$ ) =	<u>user</u>	ft <sup>2</sup>
Volume of Main Basin ( $V_{MAIN}$ ) =	<u>user</u>	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TOTAL}$ ) =	<b>user</b>	acre-feet

[illegible]

# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

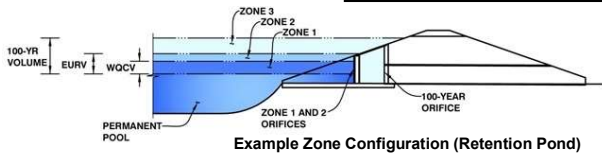


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-DETENTION, Version 4.03 (May 2020)

Project: **Pioneer Village**

Basin ID: **Future Pond G**



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.03	5.885	Orifice Plate
Zone 2 (EURV)	5.09	12.651	Orifice Plate
Zone 3 (100-year)	7.13	13.407	Weir&Pipe (Restrict)
Total (all zones)		31.943	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain  
Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (use rectangular openings)

Calculated Parameters for Plate  
WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.70	3.40					
Orifice Area (sq. inches)	25.52	25.52	25.52					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice  
Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Grate Slope =  H:V  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Open Area % =  %  
Debris Clogging % =  %

Calculated Parameters for Overflow Weir  
Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =   
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  inches  
Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway  
Spillway Design Flow Depth =  feet  
Stage at Top of Freeboard =  feet  
Basin Area at Top of Freeboard =  acres  
Basin Volume at Top of Freeboard =  acre-ft

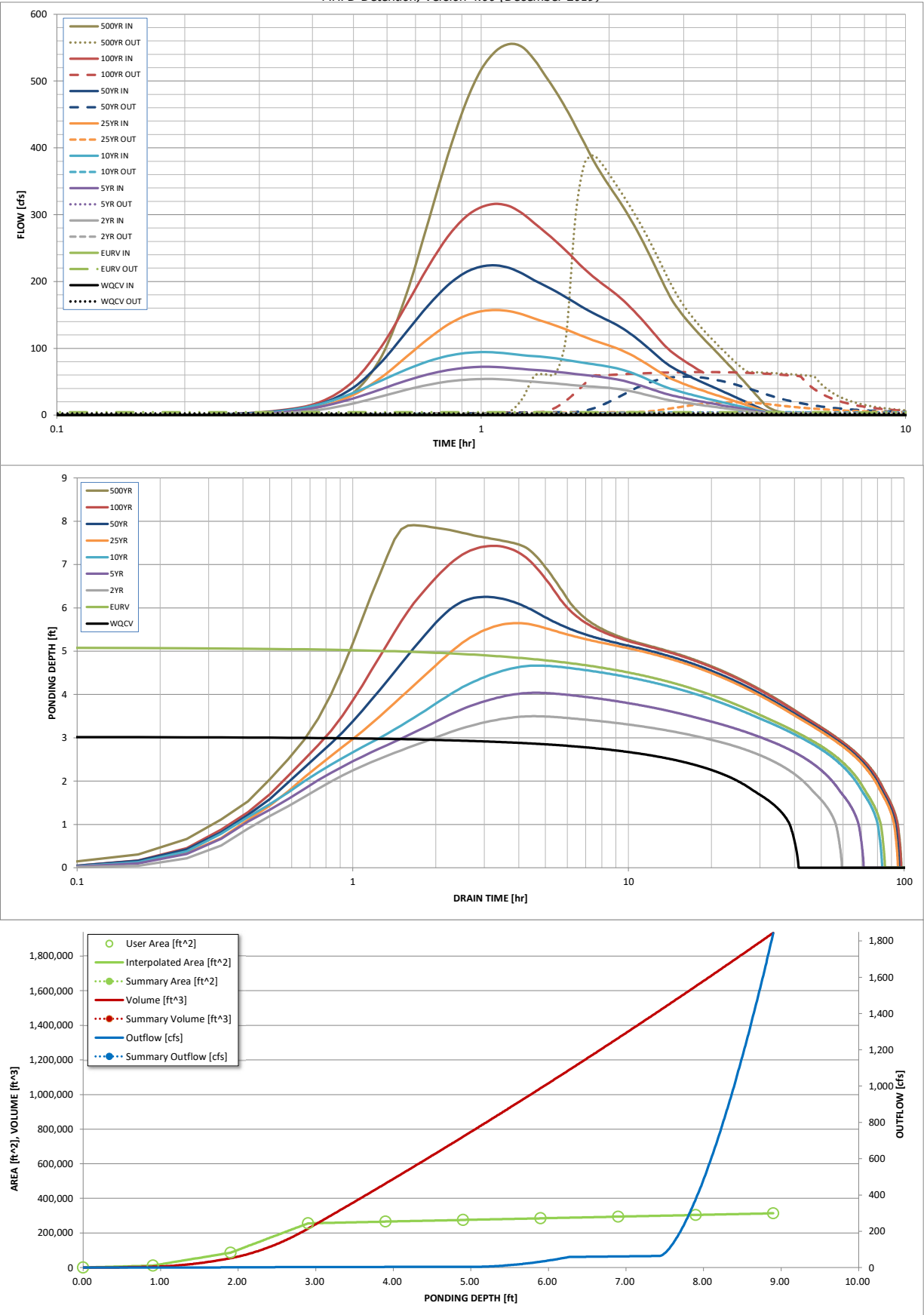
## Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
One-Hour Rainfall Depth (in) =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
CUHP Runoff Volume (acre-ft) =	5.885	18.536	9.678	13.180	17.275	25.330	34.752	47.113	81.581
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	9.677	13.180	17.275	25.330	34.751	47.113	81.581
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.6	1.2	8.7	39.6	83.0	218.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.00	0.00	0.02	0.11	0.23	0.60
Peak Inflow Q (cfs) =	N/A	N/A	54.1	72.3	94.4	157.3	224.0	316.1	555.4
Peak Outflow Q (cfs) =	2.5	4.6	3.0	3.7	4.3	19.5	57.5	64.4	388.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	6.5	3.5	2.2	1.5	0.8	1.8
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.5	1.8	2.0	2.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	77	55	65	76	85	83	81	75
Time to Drain 99% of Inflow Volume (hours) =	40	82	58	69	80	91	91	91	87
Maximum Ponding Depth (ft) =	3.03	5.09	3.50	4.04	4.67	5.65	6.25	7.43	7.91
Area at Maximum Ponding Depth (acres) =	5.90	6.36	6.01	6.13	6.27	6.48	6.62	6.88	6.98
Maximum Volume Stored (acre-ft) =	5.932	18.571	8.670	11.949	15.856	22.104	26.099	34.060	37.387

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: Desktop

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.07	0.62
	0:15:00	0.00	0.00	0.26	0.71	1.06	0.91	1.50	1.62	3.87
	0:20:00	0.00	0.00	2.29	4.00	5.44	4.34	6.14	6.92	12.67
	0:25:00	0.00	0.00	8.15	12.34	16.46	12.55	16.71	19.47	33.65
	0:30:00	0.00	0.00	17.63	25.15	33.45	30.29	41.42	51.00	89.14
	0:35:00	0.00	0.00	28.32	39.24	52.12	57.23	80.40	103.68	181.67
	0:40:00	0.00	0.00	37.96	51.63	68.38	87.47	124.76	165.62	289.43
	0:45:00	0.00	0.00	45.41	61.04	80.59	114.36	164.09	222.30	387.68
	0:50:00	0.00	0.00	50.30	67.30	88.53	135.08	194.16	266.70	465.24
	0:55:00	0.00	0.00	53.01	70.82	92.79	148.62	213.30	296.08	517.10
	1:00:00	0.00	0.00	54.12	72.28	94.38	155.50	222.33	311.25	544.94
	1:05:00	0.00	0.00	53.94	72.04	93.84	157.34	223.97	316.11	555.45
	1:10:00	0.00	0.00	52.71	70.65	91.92	155.40	220.04	312.56	550.64
	1:15:00	0.00	0.00	51.17	68.96	89.70	150.60	211.77	301.67	532.10
	1:20:00	0.00	0.00	49.87	67.69	88.25	144.53	201.88	287.29	507.81
	1:25:00	0.00	0.00	48.62	66.42	86.82	139.16	193.37	273.71	484.04
	1:30:00	0.00	0.00	47.27	64.92	84.90	133.81	185.03	260.02	459.01
	1:35:00	0.00	0.00	45.87	63.28	82.60	128.23	176.55	245.99	432.90
	1:40:00	0.00	0.00	44.55	61.61	80.21	122.50	167.93	232.02	406.81
	1:45:00	0.00	0.00	43.48	60.10	78.09	117.00	159.65	218.64	382.24
	1:50:00	0.00	0.00	42.62	58.62	76.22	112.26	152.81	207.52	361.59
	1:55:00	0.00	0.00	41.76	57.07	74.38	108.08	146.72	197.90	343.43
	2:00:00	0.00	0.00	40.76	55.42	72.42	104.21	141.05	189.05	326.70
	2:05:00	0.00	0.00	39.45	53.54	70.11	100.16	135.17	180.22	310.18
	2:10:00	0.00	0.00	37.80	51.28	67.27	95.67	128.77	170.92	293.13
	2:15:00	0.00	0.00	35.83	48.63	63.88	90.62	121.67	160.96	275.24
	2:20:00	0.00	0.00	33.65	45.70	60.09	85.15	114.07	150.55	256.82
	2:25:00	0.00	0.00	31.36	42.62	56.05	79.40	106.13	139.89	238.18
	2:30:00	0.00	0.00	29.02	39.49	51.90	73.51	98.07	129.13	219.50
	2:35:00	0.00	0.00	26.71	36.43	47.86	67.73	90.18	118.60	201.22
	2:40:00	0.00	0.00	24.60	33.59	44.13	62.20	82.66	108.54	183.93
	2:45:00	0.00	0.00	22.82	31.18	40.98	57.17	75.97	99.74	169.57
	2:50:00	0.00	0.00	21.33	29.15	38.34	53.18	70.76	92.82	158.04
	2:55:00	0.00	0.00	20.02	27.36	35.98	49.83	66.37	86.99	148.03
	3:00:00	0.00	0.00	18.80	25.69	33.78	46.81	62.38	81.71	138.89
	3:05:00	0.00	0.00	17.66	24.11	31.70	43.98	58.65	76.81	130.42
	3:10:00	0.00	0.00	16.58	22.62	29.74	41.35	55.15	72.20	122.47
	3:15:00	0.00	0.00	15.57	21.21	27.89	38.86	51.82	67.85	114.98
	3:20:00	0.00	0.00	14.61	19.89	26.14	36.50	48.65	63.75	107.97
	3:25:00	0.00	0.00	13.69	18.62	24.46	34.24	45.60	59.80	101.18
	3:30:00	0.00	0.00	12.80	17.40	22.86	32.04	42.63	55.94	94.53
	3:35:00	0.00	0.00	11.93	16.22	21.32	29.91	39.73	52.15	87.97
	3:40:00	0.00	0.00	11.09	15.09	19.83	27.83	36.90	48.41	81.49
	3:45:00	0.00	0.00	10.28	13.99	18.39	25.80	34.12	44.71	75.08
	3:50:00	0.00	0.00	9.49	12.92	16.99	23.82	31.40	41.07	68.74
	3:55:00	0.00	0.00	8.72	11.90	15.63	21.87	28.72	37.47	62.47
	4:00:00	0.00	0.00	7.98	10.90	14.31	19.95	26.09	33.93	56.28
	4:05:00	0.00	0.00	7.27	9.93	13.02	18.08	23.50	30.43	50.15
	4:10:00	0.00	0.00	6.58	8.98	11.78	16.25	20.96	26.99	44.10
	4:15:00	0.00	0.00	5.91	8.06	10.57	14.45	18.48	23.59	38.13
	4:20:00	0.00	0.00	5.25	7.16	9.39	12.69	16.02	20.22	32.20
	4:25:00	0.00	0.00	4.60	6.27	8.22	10.94	13.58	16.86	26.36
	4:30:00	0.00	0.00	3.94	5.37	7.05	9.20	11.19	13.60	20.72
	4:35:00	0.00	0.00	3.30	4.51	5.93	7.53	8.92	10.50	15.51
	4:40:00	0.00	0.00	2.72	3.75	4.93	6.00	6.88	7.74	11.56
	4:45:00	0.00	0.00	2.29	3.17	4.17	4.73	5.42	5.98	8.99
	4:50:00	0.00	0.00	1.97	2.73	3.61	3.88	4.45	4.80	7.12
	4:55:00	0.00	0.00	1.70	2.36	3.13	3.25	3.72	3.89	5.66
	5:00:00	0.00	0.00	1.47	2.03	2.70	2.73	3.11	3.17	4.49
	5:05:00	0.00	0.00	1.26	1.73	2.32	2.29	2.61	2.57	3.55
	5:10:00	0.00	0.00	1.07	1.47	1.96	1.92	2.17	2.07	2.80
	5:15:00	0.00	0.00	0.90	1.23	1.65	1.59	1.78	1.67	2.24
	5:20:00	0.00	0.00	0.75	1.01	1.36	1.30	1.46	1.37	1.82
	5:25:00	0.00	0.00	0.62	0.83	1.11	1.06	1.18	1.11	1.46
	5:30:00	0.00	0.00	0.50	0.66	0.89	0.84	0.93	0.88	1.15
	5:35:00	0.00	0.00	0.39	0.52	0.70	0.67	0.73	0.69	0.88
	5:40:00	0.00	0.00	0.30	0.40	0.55	0.51	0.55	0.52	0.65
	5:45:00	0.00	0.00	0.22	0.29	0.41	0.38	0.40	0.37	0.45
	5:50:00	0.00	0.00	0.15	0.21	0.29	0.27	0.28	0.25	0.29
	5:55:00	0.00	0.00	0.10	0.14	0.20	0.18	0.17	0.15	0.16
	6:00:00	0.00	0.00	0.06	0.09	0.12	0.10	0.09	0.07	0.07

## DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.03 (May 2020)*

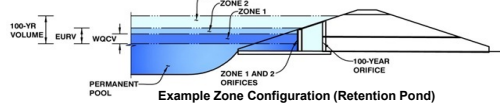
### Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

[illegible]

## MHFD-Detention, Version 4.03 (May 2020)

Basin ID: Future Pond H

### Example Zone Configuration (Retention Pond)

Selected BMP Type =	<b>EDB</b>	
Watershed Area =	259.30	acres
Watershed Length =	8,529	ft
Watershed Length to Centroid =	4,795	ft
Watershed Slope =	0.006	ft/ft
Watershed Imperviousness =	55.28%	percent
Percentage Hydrologic Soil Group A =	100.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths = User Input		

### Optional User Overrides

Water Quality Capture Volume (WQCV) =	4.781	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	16.999	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.86 in.) =	8.891	acre-feet	0.86	inches
5-yr Runoff Volume (P1 = 1.14 in.) =	12.110	acre-feet	1.14	inches
10-yr Runoff Volume (P1 = 1.41 in.) =	15.602	acre-feet	1.41	inches
25-yr Runoff Volume (P1 = 1.85 in.) =	22.247	acre-feet	1.85	inches
50-yr Runoff Volume (P1 = 2.23 in.) =	29.352	acre-feet	2.23	inches
100-yr Runoff Volume (P1 = 2.66 in.) =	38.457	acre-feet	2.66	inches
500-yr Runoff Volume (P1 = 3.83 in.) =	63.549	acre-feet	3.83	inches
Approximate 2-yr Detention Volume =	7.935	acre-feet		
Approximate 5-yr Detention Volume =	10.956	acre-feet		
Approximate 10-yr Detention Volume =	14.108	acre-feet		
Approximate 25-yr Detention Volume =	19.689	acre-feet		
Approximate 50-yr Detention Volume =	23.421	acre-feet		
Approximate 100-yr Detention Volume =	27.789	acre-feet		

Zone 1 Volume (WQCV) =	4.781	acre-feet
Zone 2 Volume (EURV - Zone 1) =	12.218	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	10.790	acre-feet
Total Detention Basin Volume =	27.789	acre-feet
Initial Surcharge Volume (ISV) =	user	ft <sup>3</sup>
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth ( $H_{total}$ ) =	user	ft
Depth of Trickle Channel ( $H_{TC}$ ) =	user	ft
Slope of Trickle Channel ( $S_{TC}$ ) =	user	ft/ft
Slopes of Main Basin Sides ( $S_{main}$ ) =	user	H:V
Basin Length-to-Width Ratio ( $R_{L/W}$ ) =	user	

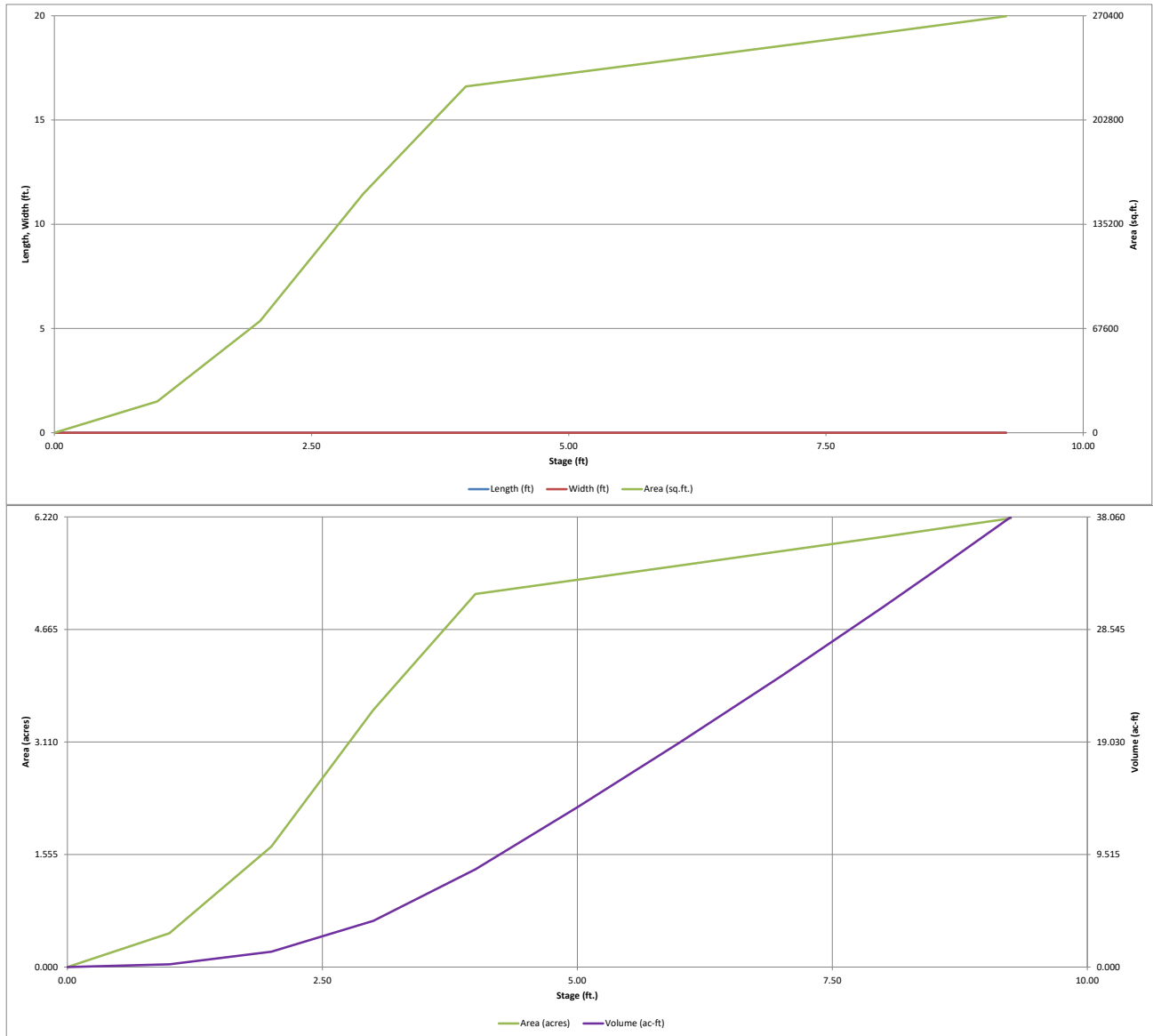
Initial Surchage Area ( $A_{ISV}$ ) =	user	ft <sup>2</sup>
Surchage Volume Length ( $L_{ISV}$ ) =	user	ft
Surchage Volume Width ( $W_{ISV}$ ) =	user	ft
Depth of Basin Floor ( $H_{FLOOR}$ ) =	user	ft
Length of Basin Floor ( $L_{FLOOR}$ ) =	user	ft
Width of Basin Floor ( $W_{FLOOR}$ ) =	user	ft
Area of Basin Floor ( $A_{FLOOR}$ ) =	user	ft <sup>2</sup>
Volume of Basin Floor ( $V_{FLOOR}$ ) =	user	ft <sup>3</sup>
Depth of Main Basin ( $H_{MAIN}$ ) =	user	ft
Length of Main Basin ( $L_{MAIN}$ ) =	user	ft
Width of Main Basin ( $W_{MAIN}$ ) =	user	ft
Area of Main Basin ( $A_{MAIN}$ ) =	user	ft <sup>2</sup>
Volume of Main Basin ( $V_{MAIN}$ ) =	user	ft <sup>3</sup>
Calculated Total Basin Volume ( $V_{TOTAL}$ ) =	user	acre-feet

[illegible]



# DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.03 (May 2020)

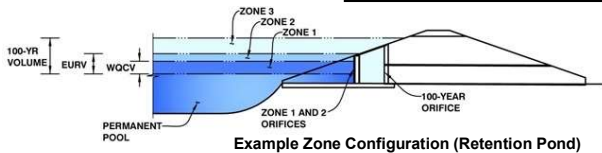


# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-DETENTION, Version 4.03 (May 2020)

Project: **Pioneer Village**

Basin ID: **Future Pond H**



	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	3.24	4.781	Orifice Plate
Zone 2 (EURV)	5.65	12.218	Orifice Plate
Zone 3 (100-year)	7.55	10.790	Weir&Pipe (Restrict)
Total (all zones)		27.789	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain  
Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (use rectangular openings)

Calculated Parameters for Plate  
WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.90	3.80					
Orifice Area (sq. inches)	22.33	22.33	22.33					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice  
Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Grate Slope =  H:V  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Open Area % =  %  
Debris Clogging % =  %

Calculated Parameters for Overflow Weir  
Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =  ft<sup>2</sup>  
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  inches  
Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway  
Spillway Design Flow Depth =  feet  
Stage at Top of Freeboard =  feet  
Basin Area at Top of Freeboard =  acres  
Basin Volume at Top of Freeboard =  acre-ft

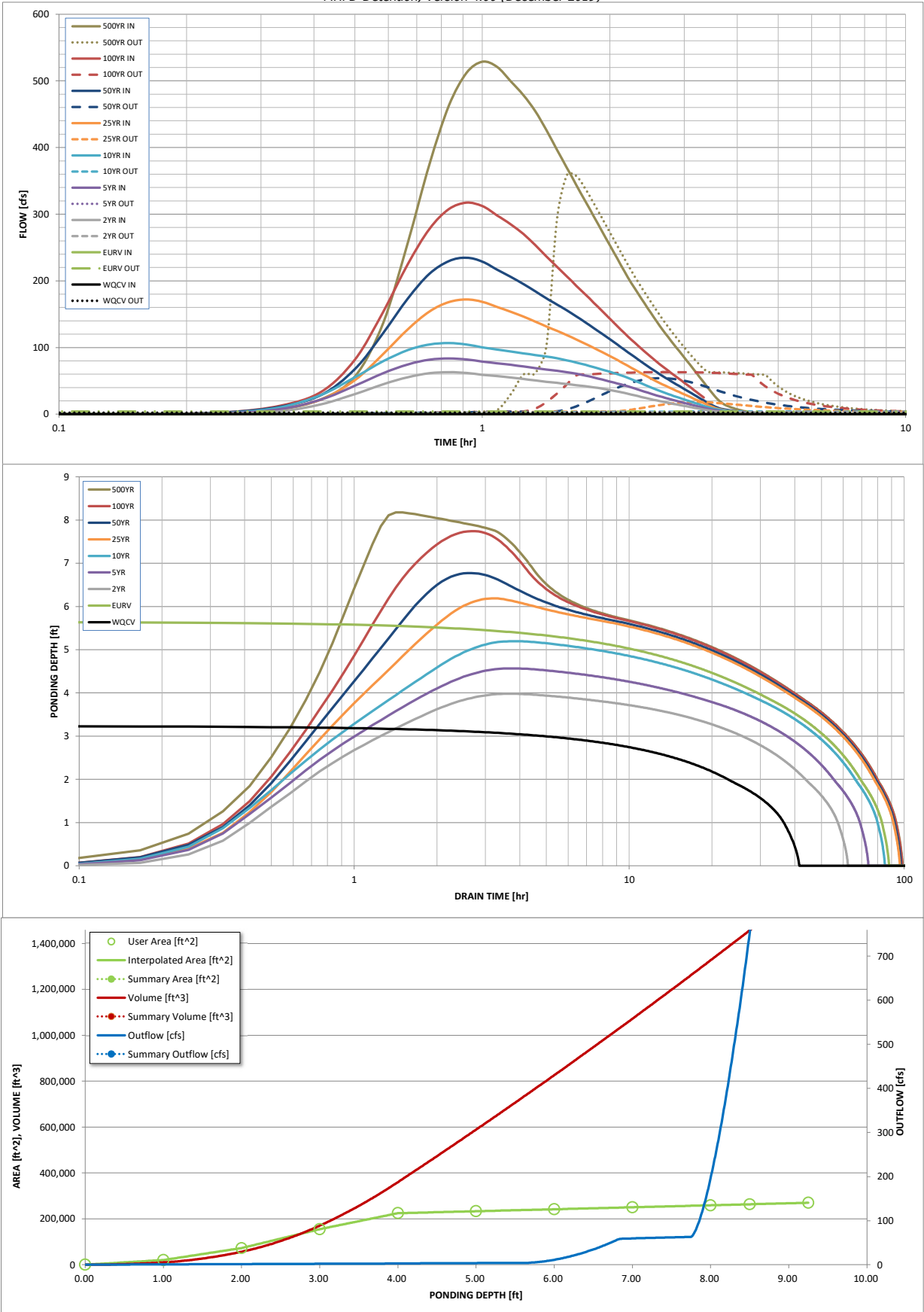
## Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
One-Hour Rainfall Depth (in) =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
CUHP Runoff Volume (acre-ft) =	4.781	16.999	8.891	12.110	15.602	22.247	29.352	38.457	63.549
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	8.891	12.110	15.602	22.247	29.352	38.457	63.549
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.5	1.0	7.1	32.5	67.9	177.3
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.00	0.00	0.03	0.13	0.26	0.68
Peak Inflow Q (cfs) =	N/A	N/A	63.1	83.6	106.7	172.1	234.7	317.2	528.6
Peak Outflow Q (cfs) =	2.2	4.2	2.9	3.5	3.9	18.2	54.0	63.2	358.3
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	7.5	3.9	2.6	1.7	0.9	2.0
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.5	1.7	2.0	2.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	79	57	67	77	85	83	81	75
Time to Drain 99% of Inflow Volume (hours) =	40	84	60	71	81	92	91	91	88
Maximum Ponding Depth (ft) =	3.24	5.65	3.98	4.57	5.20	6.19	6.77	7.74	8.18
Area at Maximum Ponding Depth (acres) =	3.94	5.48	5.11	5.26	5.39	5.58	5.70	5.89	5.98
Maximum Volume Stored (acre-ft) =	4.807	17.035	8.108	11.180	14.535	19.966	23.295	28.918	31.471

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			

# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename: Pond H Outflow

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.14	1.19
	0:15:00	0.00	0.00	0.51	1.38	2.06	1.77	2.87	3.09	7.19
	0:20:00	0.00	0.00	4.37	7.55	10.23	8.09	11.29	12.72	22.57
	0:25:00	0.00	0.00	14.91	22.22	29.15	22.27	29.06	33.70	56.30
	0:30:00	0.00	0.00	30.23	42.58	55.35	51.04	67.52	81.79	136.95
	0:35:00	0.00	0.00	44.90	61.46	79.43	90.30	121.87	153.83	257.42
	0:40:00	0.00	0.00	55.55	74.71	96.09	127.42	173.61	225.03	375.12
	0:45:00	0.00	0.00	61.39	81.70	104.68	154.03	210.60	278.10	462.47
	0:50:00	0.00	0.00	63.11	83.65	106.72	168.05	229.68	307.50	511.60
	0:55:00	0.00	0.00	61.77	82.14	104.50	172.10	234.69	317.16	528.57
	1:00:00	0.00	0.00	59.18	78.97	100.21	168.65	228.95	312.17	521.00
	1:05:00	0.00	0.00	57.06	76.38	96.91	160.90	216.85	298.27	499.44
	1:10:00	0.00	0.00	55.06	74.02	94.06	153.65	205.97	284.70	478.57
	1:15:00	0.00	0.00	52.74	71.55	91.30	146.44	195.29	270.18	454.51
	1:20:00	0.00	0.00	50.53	69.14	88.74	139.02	184.50	253.73	426.28
	1:25:00	0.00	0.00	48.64	67.06	86.49	131.50	173.71	236.58	396.70
	1:30:00	0.00	0.00	46.92	65.07	83.91	125.00	164.58	221.19	369.82
	1:35:00	0.00	0.00	45.24	62.98	80.85	118.59	155.66	206.68	344.12
	1:40:00	0.00	0.00	43.59	60.65	77.50	112.16	146.77	192.83	319.62
	1:45:00	0.00	0.00	41.97	57.98	74.01	105.74	137.93	179.83	296.79
	1:50:00	0.00	0.00	40.31	55.07	70.48	99.38	129.18	167.15	274.67
	1:55:00	0.00	0.00	38.43	52.01	66.98	93.16	120.66	154.95	253.50
	2:00:00	0.00	0.00	36.31	49.03	63.56	87.23	112.54	143.35	233.39
	2:05:00	0.00	0.00	34.09	46.10	60.02	81.29	104.44	131.99	214.02
	2:10:00	0.00	0.00	31.82	43.19	56.37	75.27	96.54	121.34	196.64
	2:15:00	0.00	0.00	29.47	40.16	52.43	69.62	89.25	111.81	181.04
	2:20:00	0.00	0.00	27.08	36.99	48.29	64.10	82.17	102.78	166.22
	2:25:00	0.00	0.00	24.77	33.86	44.18	58.78	75.36	94.19	152.16
	2:30:00	0.00	0.00	22.61	30.87	40.27	53.71	68.88	86.08	138.94
	2:35:00	0.00	0.00	20.60	28.11	36.63	49.00	62.83	78.53	126.61
	2:40:00	0.00	0.00	18.76	25.60	33.33	44.72	57.30	71.61	115.32
	2:45:00	0.00	0.00	17.05	23.23	30.23	40.66	52.05	65.10	104.75
	2:50:00	0.00	0.00	15.44	20.99	27.31	36.82	47.06	58.92	94.66
	2:55:00	0.00	0.00	13.91	18.89	24.59	33.18	42.31	52.98	84.93
	3:00:00	0.00	0.00	12.45	16.91	22.03	29.72	37.77	47.24	75.48
	3:05:00	0.00	0.00	11.03	14.99	19.56	26.34	33.33	41.58	66.14
	3:10:00	0.00	0.00	9.65	13.13	17.16	23.04	28.99	36.00	56.93
	3:15:00	0.00	0.00	8.32	11.34	14.82	19.81	24.73	30.50	47.88
	3:20:00	0.00	0.00	7.03	9.61	12.55	16.64	20.57	25.15	39.11
	3:25:00	0.00	0.00	5.80	7.97	10.42	13.63	16.66	20.07	30.79
	3:30:00	0.00	0.00	4.74	6.54	8.58	10.88	13.09	15.43	23.28
	3:35:00	0.00	0.00	3.95	5.47	7.20	8.54	10.13	11.68	17.66
	3:40:00	0.00	0.00	3.38	4.69	6.20	6.95	8.23	9.23	13.94
	3:45:00	0.00	0.00	2.92	4.05	5.38	5.82	6.87	7.50	11.19
	3:50:00	0.00	0.00	2.52	3.49	4.64	4.90	5.77	6.12	9.00
	3:55:00	0.00	0.00	2.17	2.98	3.98	4.11	4.84	5.00	7.24
	4:00:00	0.00	0.00	1.84	2.52	3.38	3.45	4.05	4.07	5.78
	4:05:00	0.00	0.00	1.55	2.11	2.83	2.86	3.35	3.29	4.61
	4:10:00	0.00	0.00	1.29	1.74	2.34	2.35	2.75	2.67	3.72
	4:15:00	0.00	0.00	1.06	1.42	1.91	1.92	2.24	2.18	3.02
	4:20:00	0.00	0.00	0.86	1.14	1.53	1.54	1.79	1.75	2.43
	4:25:00	0.00	0.00	0.68	0.89	1.21	1.22	1.41	1.39	1.91
	4:30:00	0.00	0.00	0.52	0.68	0.94	0.94	1.09	1.07	1.46
	4:35:00	0.00	0.00	0.38	0.50	0.70	0.71	0.81	0.80	1.07
	4:40:00	0.00	0.00	0.27	0.36	0.50	0.51	0.57	0.56	0.74
	4:45:00	0.00	0.00	0.17	0.24	0.34	0.34	0.38	0.36	0.47
	4:50:00	0.00	0.00	0.10	0.15	0.21	0.21	0.22	0.21	0.26
	4:55:00	0.00	0.00	0.05	0.08	0.11	0.11	0.11	0.10	0.11
	5:00:00	0.00	0.00	0.02	0.03	0.04	0.04	0.03	0.03	0.03
	5:05:00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.03 (May 2020)*

### Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

[illegible]

## DETENTION BASIN STAGE-STORAGE TABLE BUILDER

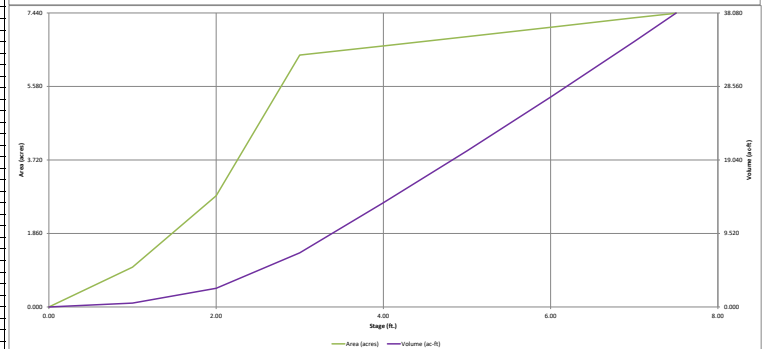
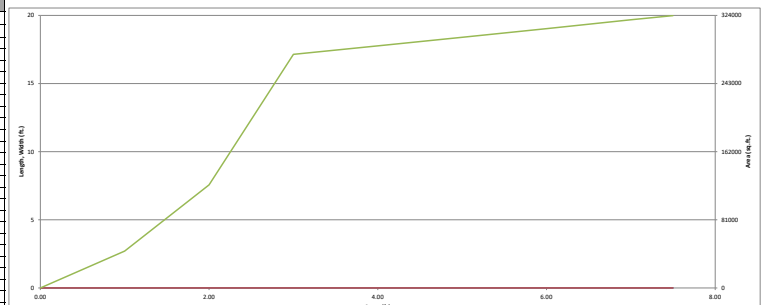
MHFD-Detention, Version 4.03 (May 2020)

Basin ID: Future Pond I



Selected BMP Types		
	5.338	ft
Watershed Length =	0.964	ft
Watershed Length to Centroid =	0.852	ft
Watershed Slope =	0.000	% ft
Watershed Imperviousness =	0.000	%
Percentage Hydrologic Soil Group A =	100.0	percent
Percentage Hydrologic Soil Group B =	0.0	percent
Percentage Hydrologic Soil Group C =	0.0	percent
Target WQCV Drain Time =	40.0	hours
Location for Rain Gauge Data Entry = User Input		
<p>NOTE: The user must enter a valid location for the rain gauge. The user must enter a valid rainfall depth, click Run CLIMAP to generate runoff hydrographs using the user-defined rainfall depth, and click Run CLIMAP to generate runoff hydrographs using the user-defined rainfall depth.</p>		
Water Quality Criteria Maximum (WQCV) =	5.338	ac-ft
Excess Runoff Volume (ERV) =	17.886	ac-ft
25-cf Runoff Volume (1 = 1.141 in.)	13.339	ac-ft
10-cf Runoff Volume (1 = 1.141 in.)	16.520	ac-ft
25-cf Runoff Volume (1 = 1.141 in.)	13.339	ac-ft
10-cf Runoff Volume (1 = 1.141 in.)	16.520	ac-ft
100-cf Runoff Volume (2.6 = 2.663 in.)	42.518	ac-ft
500-cf Runoff Volume (2.6 = 2.663 in.)	42.518	ac-ft
100-cf Runoff Volume (1 = 3.833 in.)	73.765	ac-ft
Approximate 25-cf Detention Volume =	8.824	ac-ft
Approximate 10-cf Detention Volume =	11.333	ac-ft
Approximate 10-cf Detention Volume =	14.891	ac-ft
Approximate 25-cf Detention Volume =	25.896	ac-ft
Approximate 100-cf Detention Volume =	20.916	ac-ft

Zone 1 Volume ( $V_{QZC1}$ )	5,290	acre-feet
Zone 2 Volume ( $V_{QZC2}$ )	1,000	acre-feet
Zone 3 Volume ( $V_{QZC3}$ )	12,018	acre-feet
Total Detention Basin Volume ( $V_{DB}$ )	29,516	acre-feet
Total Detention Basin Volume ( $V_{DB}$ )	USCF	acre-feet
Initial Surge Depth ( $H_{ISD}$ )	USCF	ft
Total Available Storage Depth ( $H_{TASD}$ )	USCF	ft
Depth of Trickle Channel ( $H_{TC}$ )	USCF	ft
Depth of Trickle Channel ( $H_{TC}$ )	USCF	ft
Slopes of Main Basin Sides ( $S_{MB}$ )	USCF	H:V
Basin Length-to-Width Ratio ( $R_{BLW}$ )	USCF	
Initial Surge Area ( $A_{IS}$ )	USCF	acre-feet
Surge Volume Width ( $W_{SV}$ )	USCF	ft
Surge Volume Width ( $W_{SV}$ )	USCF	ft
Area of Basin Floor ( $A_{BF}$ )	USCF	acre-feet
Length of Basin Floor ( $L_{BF}$ )	USCF	ft
Width of Basin Floor ( $W_{BF}$ )	USCF	ft
Area of Basin Floor ( $A_{BF}$ )	USCF	acre-feet
Length of Basin Floor ( $L_{BF}$ )	USCF	ft
Depth of Main Basin ( $H_{MB}$ )	USCF	ft
Length of Main Basin ( $L_{MB}$ )	USCF	ft
Width of Main Basin ( $W_{MB}$ )	USCF	ft
Area of Main Basin ( $A_{MB}$ )	USCF	acre-feet
Volume of Main Basin ( $V_{MB}$ )	USCF	acre-feet
Calculated Total Basin Volume ( $V_{TB}$ )	USCF	acre-feet

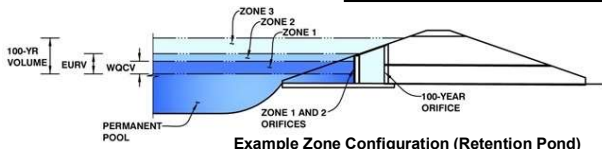
[illegible]

# DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.03 (May 2020)

Project: **Pioneer Village**

Basin ID: **Future Pond I**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.71	5.290	Orifice Plate
Zone 2 (EURV)	4.66	12.608	Orifice Plate
Zone 3 (100-year)	6.39	12.018	Weir&Pipe (Restrict)
Total (all zones)		29.916	

User Input: Orifice at Underdrain Outlet (typically used to drain WQCV in a Filtration BMP)

Underdrain Orifice Invert Depth =  ft (distance below the filtration media surface)  
Underdrain Orifice Diameter =  inches

Calculated Parameters for Underdrain  
Underdrain Orifice Area =  ft<sup>2</sup>  
Underdrain Orifice Centroid =  feet

User Input: Orifice Plate with one or more orifices or Elliptical Slot Weir (typically used to drain WQCV and/or EURV in a sedimentation BMP)

Invert of Lowest Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Orifice Plate =  ft (relative to basin bottom at Stage = 0 ft)  
Orifice Plate: Orifice Vertical Spacing =  inches  
Orifice Plate: Orifice Area per Row =  sq. inches (use rectangular openings)

Calculated Parameters for Plate  
WQ Orifice Area per Row =  ft<sup>2</sup>  
Elliptical Half-Width =  feet  
Elliptical Slot Centroid =  feet  
Elliptical Slot Area =  ft<sup>2</sup>

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	1.60	3.20					
Orifice Area (sq. inches)	28.10	28.10	28.10					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

Invert of Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Depth at top of Zone using Vertical Orifice =  ft (relative to basin bottom at Stage = 0 ft)  
Vertical Orifice Diameter =  inches

Calculated Parameters for Vertical Orifice  
Vertical Orifice Area =  ft<sup>2</sup>  
Vertical Orifice Centroid =  feet

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

Overflow Weir Front Edge Height, H<sub>o</sub> =  ft (relative to basin bottom at Stage = 0 ft)  
Overflow Weir Front Edge Length =  feet  
Overflow Weir Grate Slope =  H:V  
Horiz. Length of Weir Sides =  feet  
Overflow Grate Open Area % =  %  
Debris Clogging % =  %

Calculated Parameters for Overflow Weir  
Height of Grate Upper Edge, H<sub>u</sub> =  feet  
Overflow Weir Slope Length =  feet  
Grate Open Area / 100-yr Orifice Area =   
Overflow Grate Open Area w/o Debris =  ft<sup>2</sup>  
Overflow Grate Open Area w/ Debris =  ft<sup>2</sup>

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

Depth to Invert of Outlet Pipe =  ft (distance below basin bottom at Stage = 0 ft)  
Outlet Pipe Diameter =  inches  
Restrictor Plate Height Above Pipe Invert =  inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate  
Outlet Orifice Area =  ft<sup>2</sup>  
Outlet Orifice Centroid =  feet  
Half-Central Angle of Restrictor Plate on Pipe =  radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

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

Calculated Parameters for Spillway  
Spillway Design Flow Depth =  feet  
Stage at Top of Freeboard =  feet  
Basin Area at Top of Freeboard =  acres  
Basin Volume at Top of Freeboard =  acre-ft

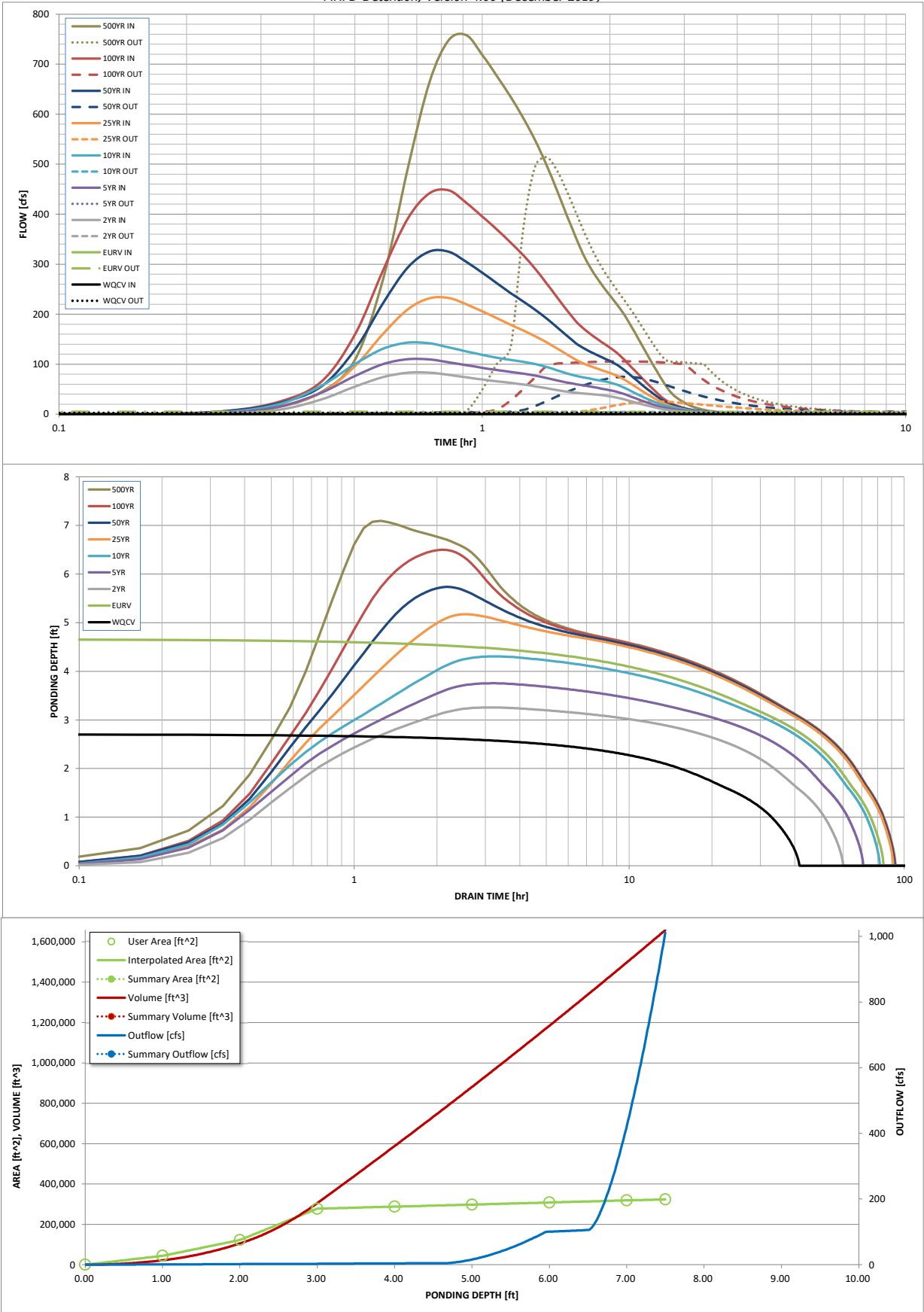
## Routed Hydrograph Results

The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
Design Storm Return Period =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
One-Hour Rainfall Depth (in) =	N/A	N/A	0.86	1.14	1.41	1.85	2.23	2.66	3.83
CUHP Runoff Volume (acre-ft) =	5.290	17.898	9.336	12.716	16.520	23.839	31.975	42.516	71.708
Inflow Hydrograph Volume (acre-ft) =	N/A	N/A	9.336	12.716	16.520	23.839	31.975	42.516	71.708
CUHP Predevelopment Peak Q (cfs) =	N/A	N/A	0.1	0.8	1.7	12.2	55.6	115.7	293.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	N/A	N/A							
Predevelopment Unit Peak Flow, q (cfs/acre) =	N/A	N/A	0.00	0.00	0.01	0.04	0.18	0.38	0.96
Peak Inflow Q (cfs) =	N/A	N/A	83.0	110.0	143.0	232.4	325.1	447.4	758.0
Peak Outflow Q (cfs) =	2.5	4.8	3.1	3.9	4.5	25.7	74.8	105.7	514.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	4.9	2.6	2.1	1.3	0.9	1.8
Structure Controlling Flow =	Plate	Overflow Weir 1	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	N/A	0.4	1.4	2.0	2.1
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	38	75	54	64	73	80	78	75	68
Time to Drain 99% of Inflow Volume (hours) =	40	80	58	68	78	87	86	85	82
Maximum Ponding Depth (ft) =	2.71	4.66	3.26	3.75	4.31	5.17	5.74	6.50	7.09
Area at Maximum Ponding Depth (acres) =	5.34	6.76	6.43	6.55	6.68	6.88	7.01	7.20	7.34
Maximum Volume Stored (acre-ft) =	5.309	17.910	8.609	11.855	15.491	21.388	25.278	30.749	35.038

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Depotion, Version 4.00 (December 2019)



S-A-V-D Chart Axis Override	X-axis	Left Y-Axis	Right Y-Axis
minimum bound			
maximum bound			



# DETENTION BASIN OUTLET STRUCTURE DESIGN

Outflow Hydrograph Workbook Filename:

## Inflow Hydrographs

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

	SOURCE	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP	CUHP
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.31	2.61
	0:15:00	0.00	0.00	1.12	3.02	4.51	3.87	6.19	6.69	15.00
	0:20:00	0.00	0.00	9.21	15.58	20.98	16.51	22.77	25.78	44.45
	0:25:00	0.00	0.00	29.56	43.23	56.86	42.95	55.73	65.17	108.41
	0:30:00	0.00	0.00	55.09	76.39	100.21	95.87	128.99	159.20	271.12
	0:35:00	0.00	0.00	74.19	100.21	131.01	161.01	222.89	288.51	491.91
	0:40:00	0.00	0.00	83.03	110.04	143.02	209.73	293.54	391.13	664.06
	0:45:00	0.00	0.00	83.04	109.41	141.73	231.74	325.14	441.79	748.39
	0:50:00	0.00	0.00	78.47	103.68	133.45	232.36	324.95	447.42	757.98
	0:55:00	0.00	0.00	73.68	98.07	125.61	219.64	304.45	422.68	718.54
	1:00:00	0.00	0.00	69.29	92.80	118.73	205.67	282.99	395.21	675.79
	1:05:00	0.00	0.00	65.59	88.07	112.73	191.79	261.74	369.30	634.48
	1:10:00	0.00	0.00	62.59	84.49	108.38	178.77	242.18	343.03	591.63
	1:15:00	0.00	0.00	59.34	81.02	104.61	167.17	225.10	317.52	547.54
	1:20:00	0.00	0.00	55.73	77.00	100.23	155.92	208.73	290.72	499.45
	1:25:00	0.00	0.00	51.99	72.38	94.53	143.99	191.66	262.27	448.20
	1:30:00	0.00	0.00	48.25	67.63	87.95	131.63	174.23	234.23	397.77
	1:35:00	0.00	0.00	45.08	63.44	81.57	119.55	157.24	208.35	351.62
	1:40:00	0.00	0.00	42.80	60.08	76.61	108.43	141.52	185.12	311.22
	1:45:00	0.00	0.00	41.16	57.00	72.89	100.08	130.29	168.44	282.03
	1:50:00	0.00	0.00	39.79	53.93	69.72	93.47	121.32	155.39	258.50
	1:55:00	0.00	0.00	38.12	50.95	66.65	87.83	113.62	143.87	237.57
	2:00:00	0.00	0.00	35.89	48.02	63.31	82.63	106.44	133.34	218.44
	2:05:00	0.00	0.00	32.93	44.45	58.69	76.53	98.21	121.83	198.19
	2:10:00	0.00	0.00	29.34	39.90	52.63	68.82	88.00	108.47	175.51
	2:15:00	0.00	0.00	25.55	34.87	45.93	60.24	76.74	94.30	151.92
	2:20:00	0.00	0.00	21.93	29.89	39.30	51.64	65.47	80.36	128.87
	2:25:00	0.00	0.00	18.52	25.20	33.12	43.43	54.69	66.93	106.70
	2:30:00	0.00	0.00	15.40	20.95	27.56	35.98	44.90	54.55	86.20
	2:35:00	0.00	0.00	12.53	17.09	22.58	29.10	35.87	42.98	66.97
	2:40:00	0.00	0.00	10.12	13.87	18.39	23.00	27.87	32.61	49.92
	2:45:00	0.00	0.00	8.36	11.54	15.35	18.02	21.61	24.69	37.89
	2:50:00	0.00	0.00	6.99	9.72	12.95	14.51	17.30	19.28	29.49
	2:55:00	0.00	0.00	5.86	8.18	10.88	11.84	14.06	15.29	23.09
	3:00:00	0.00	0.00	4.92	6.84	9.11	9.69	11.47	12.15	18.06
	3:05:00	0.00	0.00	4.12	5.69	7.60	7.92	9.36	9.67	14.12
	3:10:00	0.00	0.00	3.45	4.72	6.32	6.51	7.68	7.71	11.05
	3:15:00	0.00	0.00	2.88	3.92	5.25	5.37	6.34	6.23	8.77
	3:20:00	0.00	0.00	2.39	3.22	4.32	4.41	5.19	5.06	7.10
	3:25:00	0.00	0.00	1.96	2.61	3.50	3.58	4.20	4.12	5.74
	3:30:00	0.00	0.00	1.57	2.08	2.80	2.87	3.36	3.31	4.61
	3:35:00	0.00	0.00	1.23	1.62	2.20	2.26	2.63	2.61	3.61
	3:40:00	0.00	0.00	0.93	1.22	1.69	1.73	2.01	2.00	2.74
	3:45:00	0.00	0.00	0.67	0.89	1.25	1.29	1.49	1.46	1.98
	3:50:00	0.00	0.00	0.46	0.62	0.88	0.91	1.04	1.01	1.35
	3:55:00	0.00	0.00	0.29	0.41	0.57	0.60	0.67	0.65	0.84
	4:00:00	0.00	0.00	0.16	0.25	0.33	0.35	0.38	0.36	0.45
	4:05:00	0.00	0.00	0.07	0.12	0.16	0.17	0.18	0.16	0.18
	4:10:00	0.00	0.00	0.02	0.04	0.05	0.05	0.05	0.04	0.03
	4:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:25:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:30:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

## DETENTION BASIN OUTLET STRUCTURE DESIGN

*MHFD-Detention, Version 4.03 (May 2020)*

### Summary Stage-Area-Volume-Discharge Relationships

The user can create a summary S-A-V-D by entering the desired stage increments and the remainder of the table will populate automatically.

The user should graphically compare the summary S-A-V-D table to the full S-A-V-D table in the chart to confirm it captures all key transition points.

[illegible]

## **Appendix D**

Reference Material



## NOTES TO USERS

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

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

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

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

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

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

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

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

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

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

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

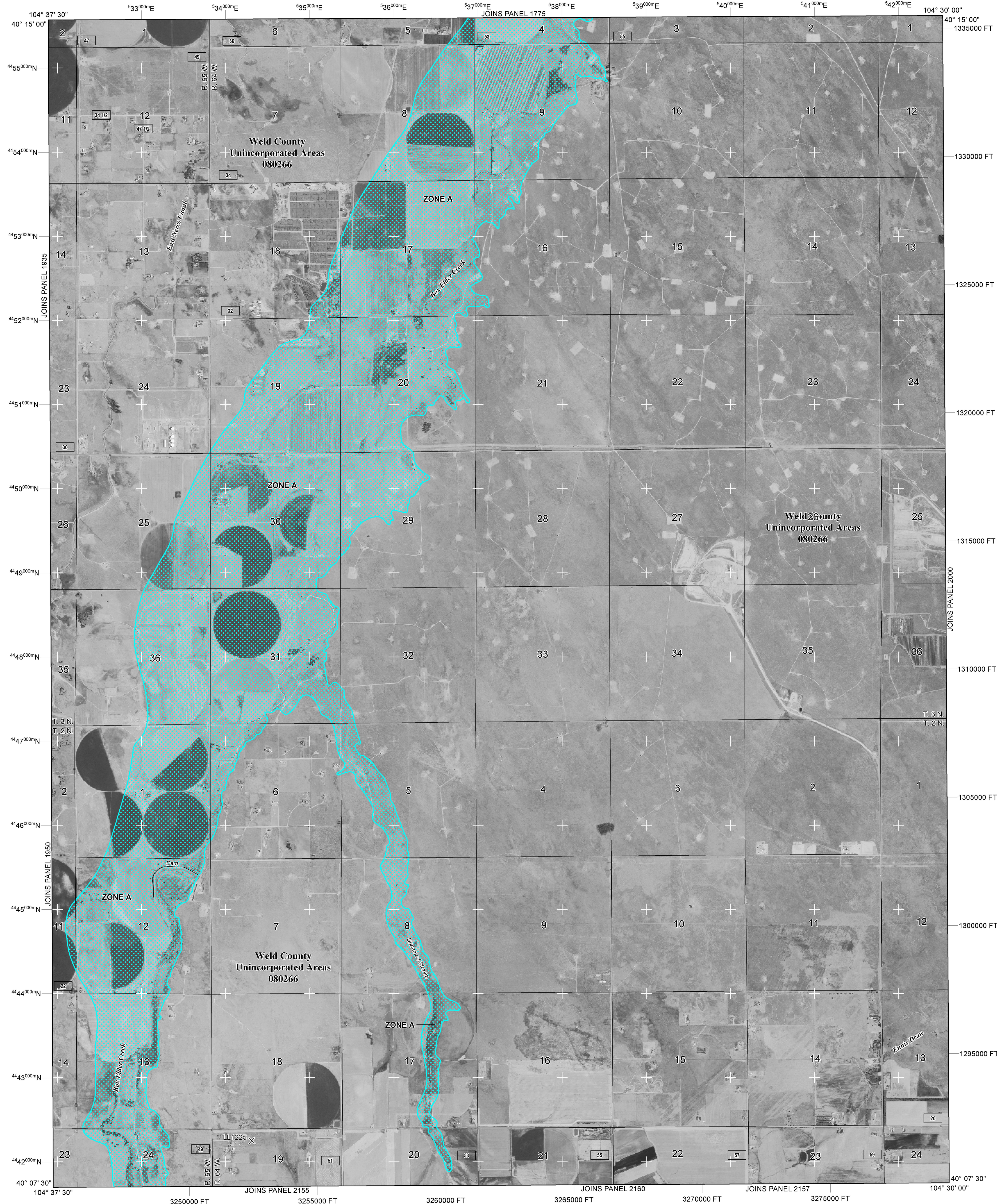
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result,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

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

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

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

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



## LEGEND

- SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD**
- The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.
- ZONE A** No Base Flood Elevations determined.
- ZONE AE** Base Flood Elevations determined.
- ZONE AH** Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
- ZONE AO** Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
- ZONE AR** Special Flood Hazard Areas formerly protected from the 1% annual chance flood by a flood control system that was subsequently derelict. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
- ZONE A99** Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
- ZONE V** Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
- ZONE VE** Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

**FLOODWAY AREAS IN ZONE AE**

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

**OTHER FLOOD AREAS**

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

**OTHER AREAS**

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

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

**COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS**

**OTHERWISE PROTECTED AREAS (OPAs)**

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

1% Annual Chance Floodplain Boundary

0.2% Annual Chance Floodplain Boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

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

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

Base Flood Elevation value where uniform within zone; elevation in feet\*

\*Referenced to the North American Vertical Datum of 1988

Cross section line

Transect line

Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere

5000-foot ticks: Colorado State Plane Central Zone (FIPS Zone 0502), Lambert Conformal Conic projection

1000-meter Universal Transverse Mercator grid values, zone 13

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

MAP REPOSITORIES

Refer to Map Repositories list on Map Index

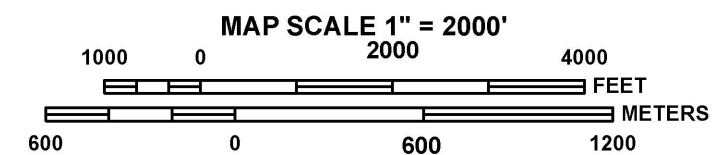
EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP

January 20, 2016

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

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

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



**NATIONAL FLOOD INSURANCE PROGRAM**

**PANEL 1975E**

**FIRM**

**FLOOD INSURANCE RATE MAP**

**WELD COUNTY, COLORADO AND INCORPORATED AREAS**

**PANEL 1975 OF 2250**  
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

**CONTAINS:**

COMMUNITY	NUMBER	PANEL	SUFFIX
WELD COUNTY	080266	1975	E

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

**MAP NUMBER**  
**08123C1975E**

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

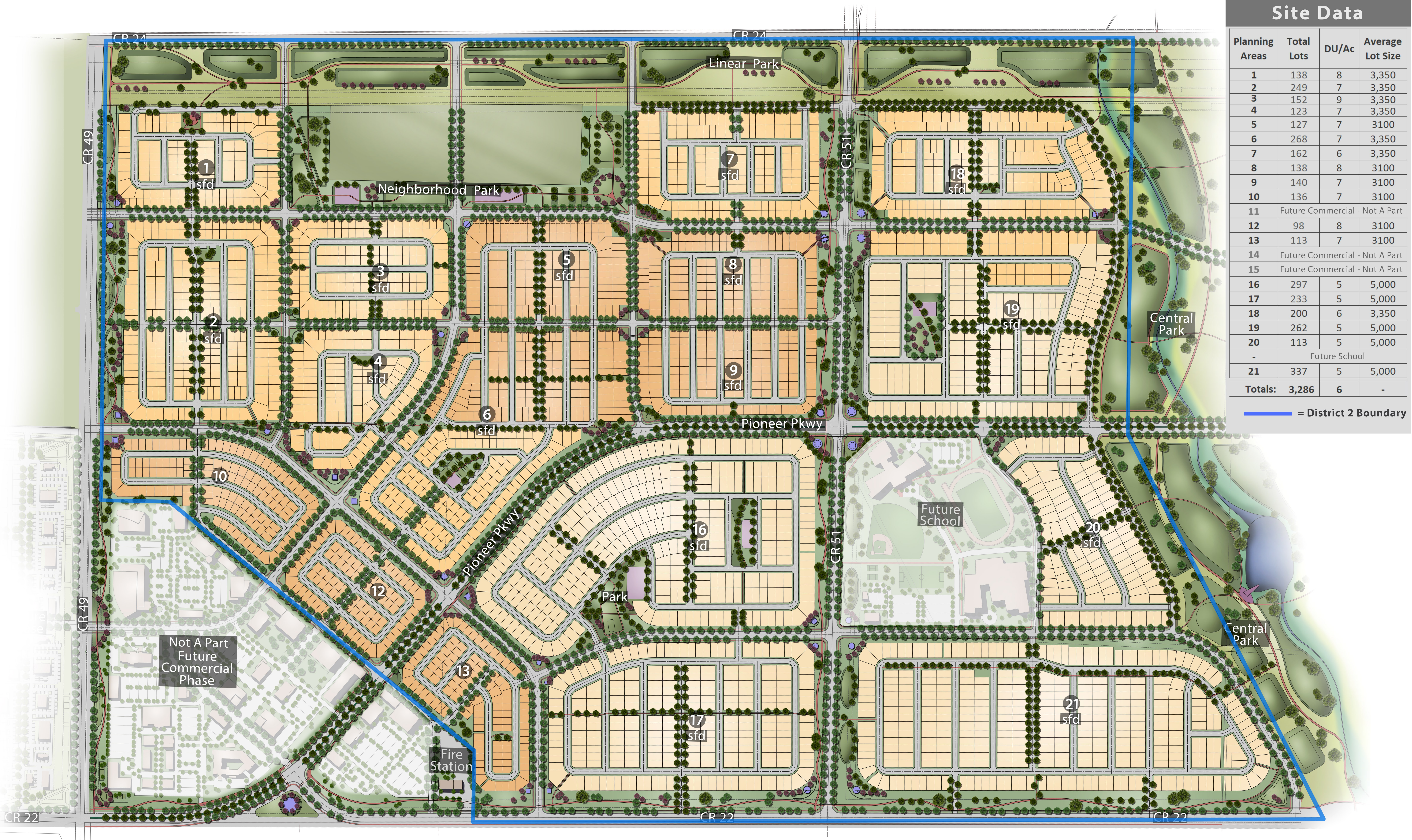
**Federal Emergency Management Agency**



Pioneer Village Site Data								
Phase One: 1-10 Years								
Phase	Years	Areas (Lot Block Plan)	Units	Acres	DU/Ac	Average Lot Size	Zoning	
1A	3	1	125	15	9	3100	R2-PUD	
		2	242	32	8	3100	R2-PUD	
		3	159	18	9	3100	R2-PUD	
1B	5	4	150	20	7	3200	R2-PUD	
		5	151	18	8	3100	R2-PUD	
		6	321	41	8	3100	R2-PUD	
1C	7	7	146	18	8	3100	R2-PUD	
		8	143	19	8	3100	R2-PUD	
		9	106	16	7	3100	R2-PUD	
1D	10	10	136	17	8	3100	R2-PUD	
		12	11	-	-	COMM	CBD-PUD	
		10	12	98	12	8	3100	R3-PUD
1E	12	12	113	15	8	3100	R3-PUD	
		12	14	-	-	COMM	CBD-PUD	
		14	15	-	-	COMM	CBD-PUD	
1G	14	16	234	42	6	5,000	R2-PUD	
1H	15	17	292	55	5	5,000	R2-PUD	
1I	16	18	230	26	9	3100	R2-PUD	
		19	249	47	5	5,000	R2-PUD	
1J	17	20	113	27	4	5,000	R2-PUD	
		-	-	-	-	School	PZ-PUD	
1K	18	21	347	68	5	5,000	R2-PUD	
Totals:		-	3,355	506	7	-	-	
Gross Totals (Zoning Plan):			4,261	515				
Phase Two: 15-25 Years								
Phase	Years	Area	Units	Acres	DU/Ac	Average Lot Size	Zoning	
2A	16	18	230	26	9	3100	R2-PUD	
		19	249	47	5	5,000	R2-PUD	
2B	17	20	113	27	4	5,000	R2-PUD	
		-	-	-	-	School	PZ-PUD	
2C	18	21	347	68	5	5,000	R2-PUD	
2E	19	22	91	29	3	6000	R2-PUD	
		20	23	86	27	3	7500	R2-PUD
2F	21	24	74	27	3	6000	R2-PUD	
		22	25	67	20	3	6000	R2-PUD
2G	23	26	-	-	-	Comm	CBD-PUD	
		24	27	128	44	3	10500	R2-PUD
		25	28	60	14	4	6500	R2-PUD
2H	25	29	93	18	5	6500	R2-PUD	
		Totals:		25	-	1,538	346	4
Gross Totals (Zoning Plan):			2,049	431				
Phase Three: 25-30 Years								
Phase	Years	Area	Units	Acres	DU/Ac	Average Lot Size	Zoning	
3A	26	30	1156	257	4	6000	R2-PUD	
3B	27	31	-	33	-	School	PZ-PUD	
3C	28	32	272	97	3	6000	R2-PUD	
3D	29	33	223	35	6	6000	R2-PUD	
3E	30	34	350	125	3	6000	R2-PUD	
Totals:		30	-	2,001	547	4	-	-
Gross Totals (Zoning Plan):			2,001	547				
Phase Four: 30-35 Years								
Phase	Years	Area	Units	Acres	DU/Ac	Average Lot Size	Zoning	
4A	31	35	-	86	-	Industrial	L1-PUD	
4B	32	36	-	61	-	Industrial	L1-PUD	
4D	33	37	-	11	-	Comm	CBD-PUD	
4E	34	38	-	105	-	Industrial	H1-PUD	
Totals:		35	-	263	-	-	-	-
Gross Totals (Zoning Plan):			-	263				
Phase Five - Annexation Two: 30-40 Years								
Phase	Years	Area	Units	Acres	DU/Ac	Average Lot Size	Zoning	
5A	30	-	69	-	-	Industrial	L1-PUD	
5B	31	-	84	-	-	Industrial	H1-PUD	
5C	32	-	11	-	-	Comm	CBD	
5D	33	-	534	89	-	5000	R2-PUD	
5E	34	-	102	-	-	Industrial	L1-PUD	
5F	35	-	80	-	-	Industrial	H1-PUD	
5G	36	-	97	-	-	Industrial	H1-PUD	
5H	37	-	1702	236	-	5000	R2-PUD	
5I	38	-	255	-	-	Industrial	H1-PUD	
5J	39	-	11	-	-	Comm	CBD	
5K	40	-	588	147	-	6000	R1-PUD	
Totals:		40	-	2,824	1181	-	-	-
Public Zone Districts								
Phase	Years	Area	Units	Acres	DU/Ac	Average Lot Size	Zoning	
6A	-	-	24	-	-	Public Zone	PZ-1	
6B	-	-	119	-	-	Public Zone	PZ-2	
6C	-	-	95	-	-	Public Zone	PZ-3	
6D	-	-	24	-	-	Public Zone	PZ-4	
6E	-	-	26	-	-	Public Zone	PZ-5	
6F	-	-	60	-	-	Public Zone	PZ-6	
6G	-	-	115	-	-	Addition ROW	ROW	
Totals:		-	-	463	-	-	-	-
Grand Totals:		-	9,718	3,306	-	-	-	-







Site Data			
Planning Areas	Total Lots	DU/Ac	Average Lot Size
1	138	8	3,350
2	249	7	3,350
3	152	9	3,350
4	123	7	3,350
5	127	7	3100
6	268	7	3,350
7	162	6	3,350
8	138	8	3100
9	140	7	3100
10	136	7	3100
11	Future Commercial - Not A Part		
12	98	8	3100
13	113	7	3100
14	Future Commercial - Not A Part		
15	Future Commercial - Not A Part		
16	297	5	5,000
17	233	5	5,000
18	200	6	3,350
19	262	5	5,000
20	113	5	5,000
-	Future School		
21	337	5	5,000
Totals:	3,286	6	-

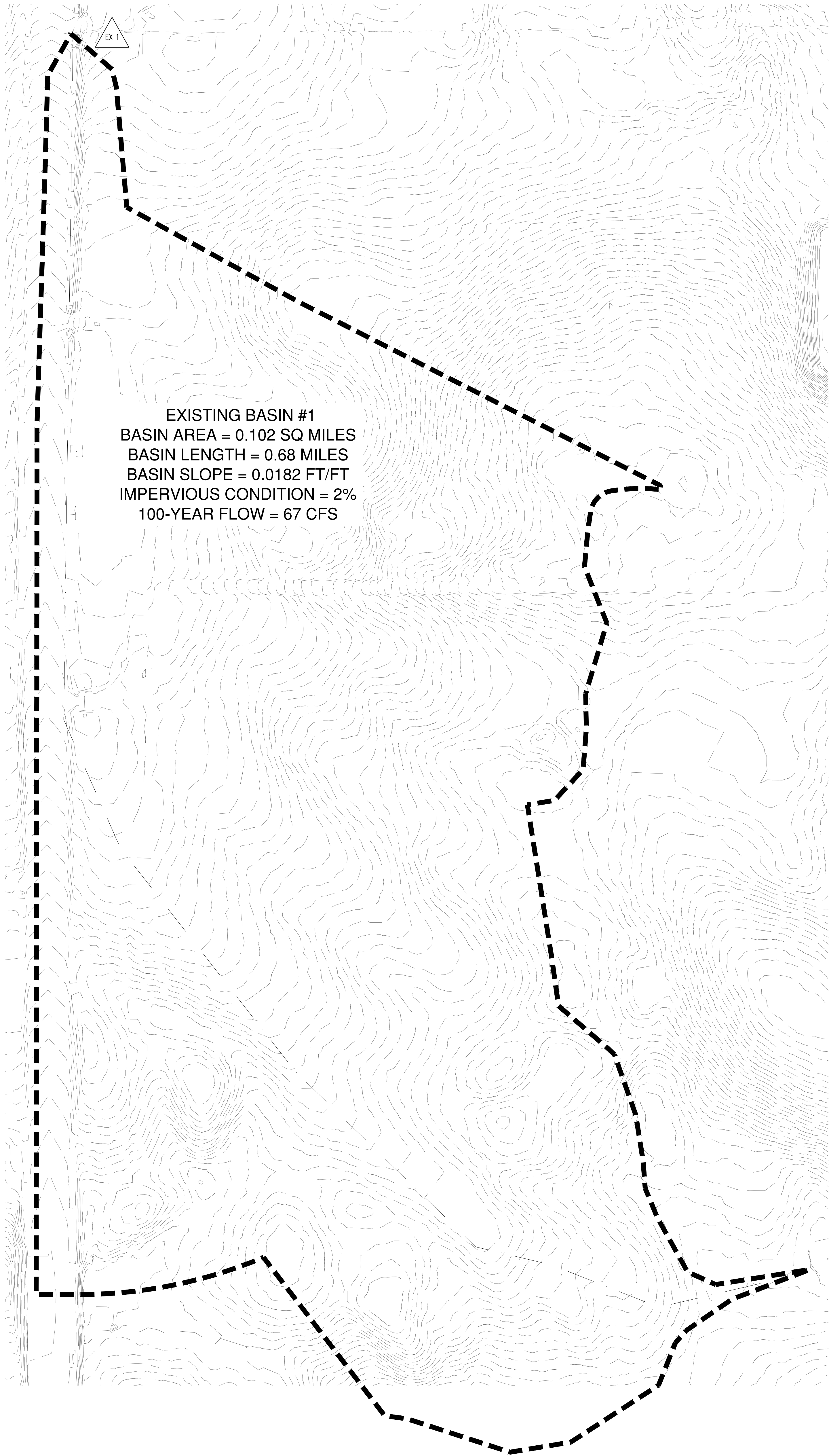
— = District 2 Boundary



## **Appendix E**

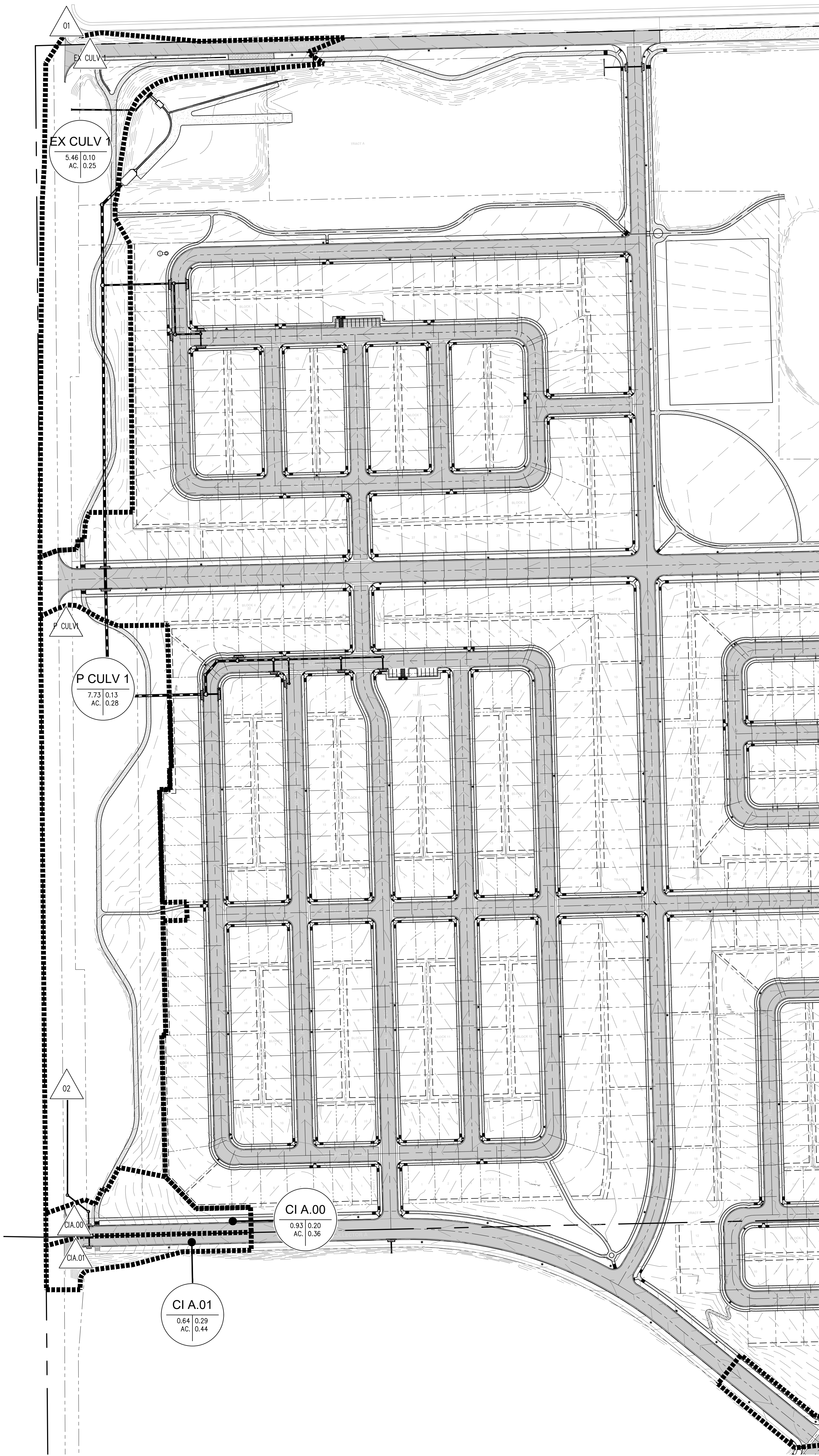
Drainage Maps



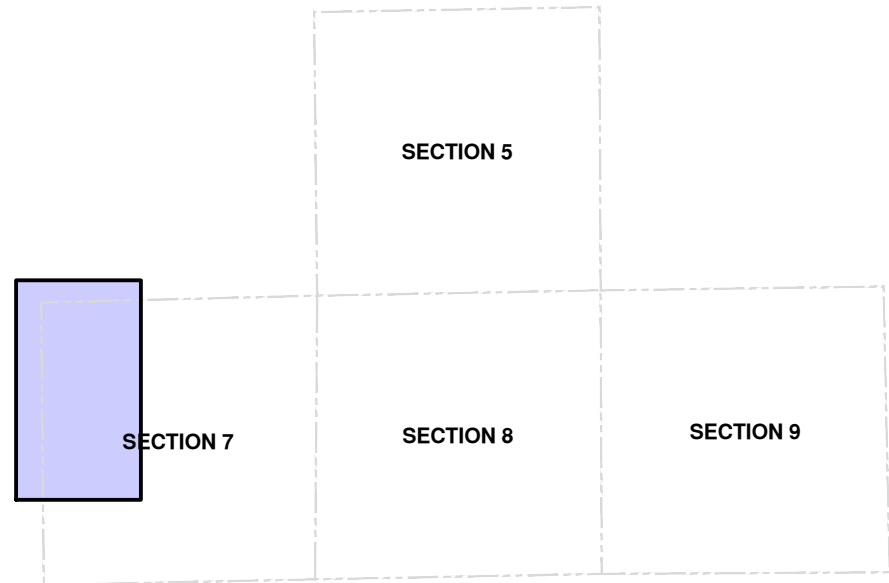


EXISTING BASIN #1  
BASIN AREA = 0.102 SQ MILES  
BASIN LENGTH = 0.68 MILES  
BASIN SLOPE = 0.0182 FT/FT  
IMPERVIOUS CONDITION = 2%  
100-YEAR FLOW = 67 CFS

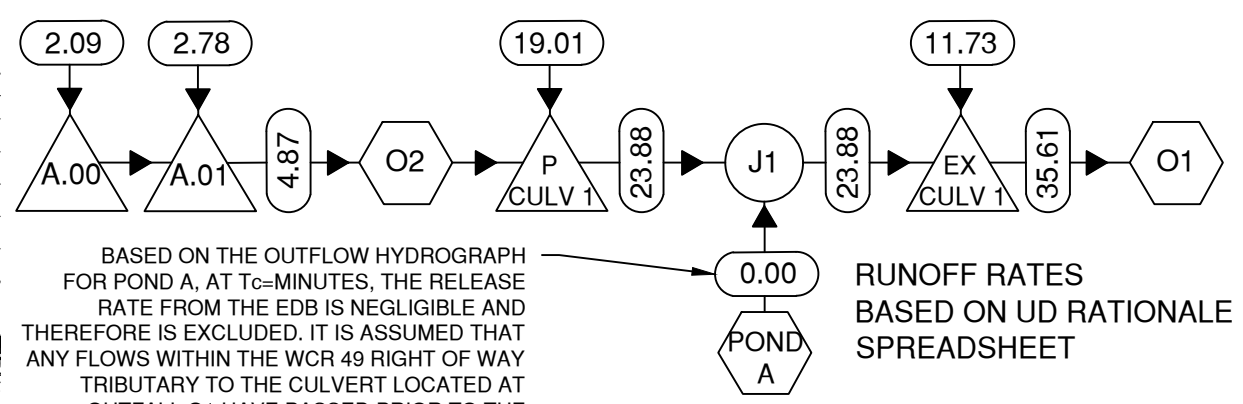
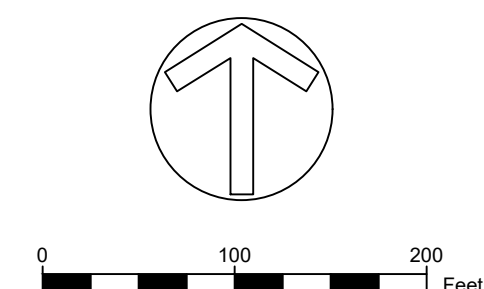
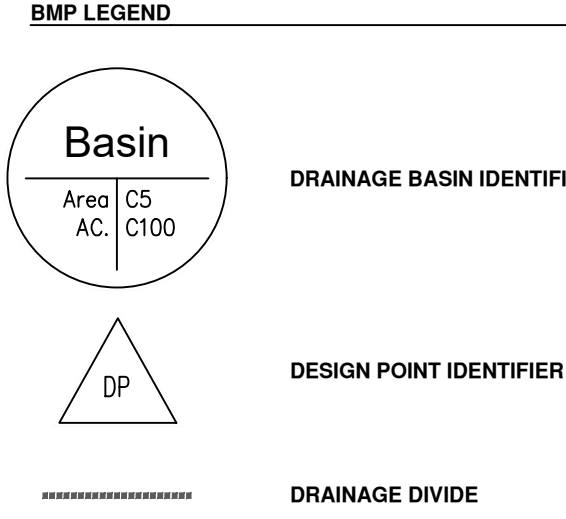
DESIGN POINT PRE A DRAINAGE MAP  
SCALE: 1"=120'



DESIGN POINT POST A DRAINAGE MAP  
SCALE: 1"=120'



KEY MAP  
SCALE: NTS



FLOW SCHEMATIC (100-YEAR EVENT)  
SCALE: NTS

ENGINEER IN CHARGE:  
  
STRATEGIC SITE DESIGNS  
ATTENTION: CHRISTOPHER PERDUE, P.E., M.B.A.

CONTACT INFORMATION  
88 INVERNESS CIRCLE EAST, SUITE E-101  
ENGLEWOOD, CO 80112  
(720) 206-6831  
CPERDUE@STRATEGICSITEDESIGNS.COM

**PIONEER VILLAGE**  
**PA'S 1-4, 17 AND 21**  
**TOWN OF KEENESBURG**  
**WELD COUNTY, COLORADO**

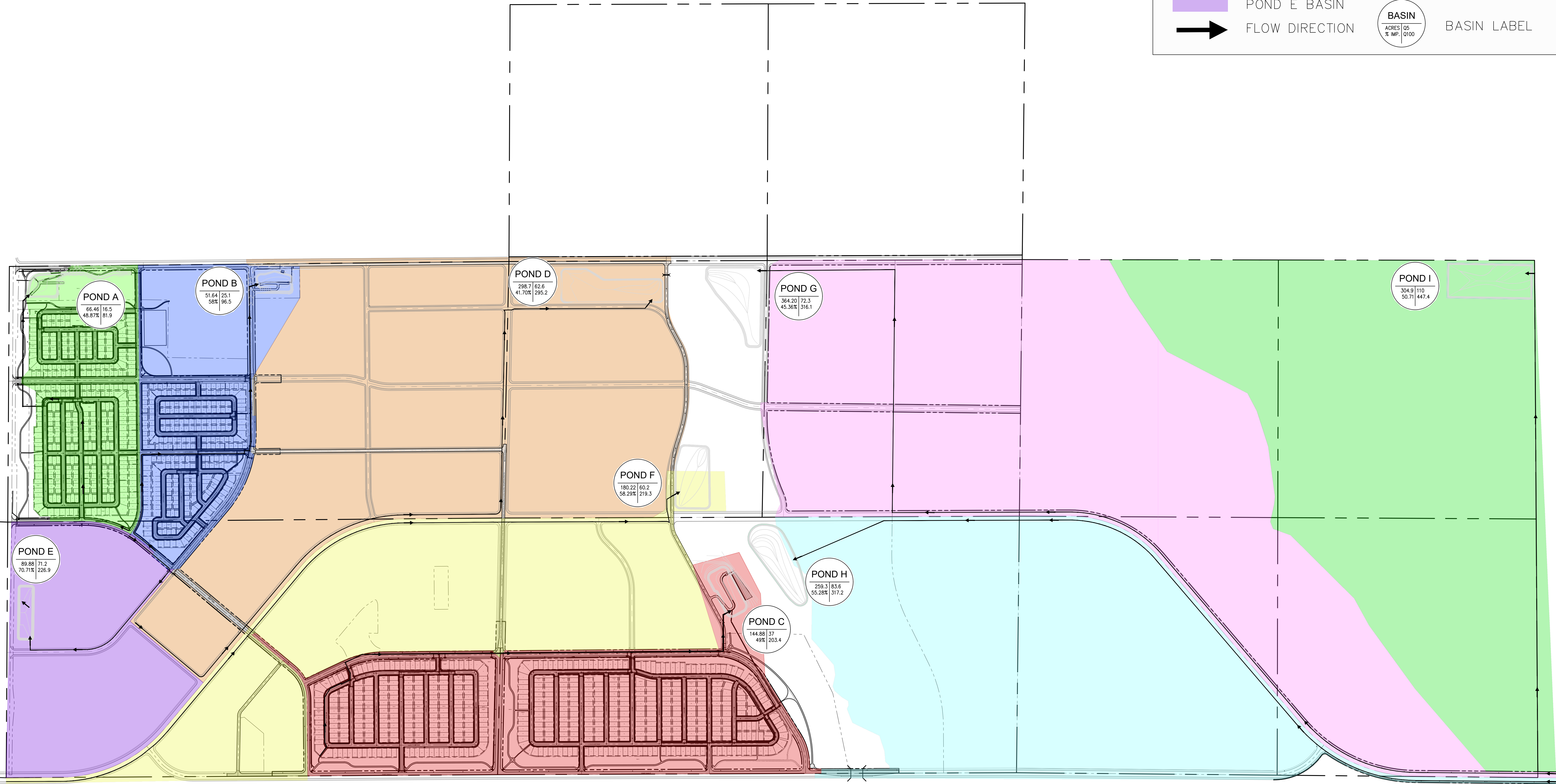
**DESIGN POINT PRE A**  
**DRAINAGE MAP**

REV	DESCRIPTION	BY	DATE

JOB NO: 1903-001  
ORIGINAL ISSUE: 03/15/2021  
DESIGN BY: CLP  
CHECKED BY: CLP  
SCALE: 1"= 70'  
SHEET NUMBER

**EXHIBIT E.02**





POND A BASIN

POND B BASIN

POND C BASIN

POND D BASIN

POND E BASIN

FLOW DIRECTION

POND F BASIN

POND G BASIN

POND H BASIN

POND I BASIN

BASIN

ACRES

Q5

Q100

BASIN LABEL

ENGINEER IN CHARGE:  
  
STRATEGIC SITE DESIGNS  
ATTENTION: CHRISTOPHER PERDUE, P.E., M.B.A.

CONTACT INFORMATION  
88 INVERNESS CIRCLE EAST, SUITE E-101  
ENGLEWOOD, CO 80112  
(720) 206-6831  
CPERDUE@STRATEGICSITEDESIGNS.COM

STRATEGIC SITE DESIGNS

STRATEGIC SITE DESIGNS

**BASIS OF BEARINGS:**  
BEARINGS SHOWN HEREON ARE GRID BEARINGS DERIVED FROM GPS OBSERVATION BASED UPON THE COLORADO COORDINATE SYSTEM OF 1983 NORTH ZONE (NAD 83, 2011) REFERENCED TO THE WEST LINE OF THE NORTHWEST QUARTER OF SECTION 7, TOWNSHIP 2 NORTH, RANGE 64 WEST, SIXTH PRINCIPAL MERIDIAN, TAKEN TO BEAR SOUTH 00°30'28" EAST, A DISTANCE OF 2,612.70 FEET.

**BENCHMARK**  
NGS ROGGEN RM 1; RECOVERED A 3 1/2" BRASS CAP LOCATED 200' SOUTH OF FRONTAGE RD 1-76 AND 2500' WEST OF COUNTY RD 73.  
ELEVATION = 4721.56 (NAVD 88)

**PIONEER VILLAGE**  
PA'S 1-4, 17 AND 21  
TOWN OF KEENESBURG  
WELD COUNTY, COLORADO

**MASTER DRAINAGE**  
MAP FOR PONDS A-I

REV	DESCRIPTION	BY	DATE

JOB NO:

1903-001

ORIGINAL ISSUE:

03/15/2021

DESIGN BY:

CLP

CHECKED BY:

CLP

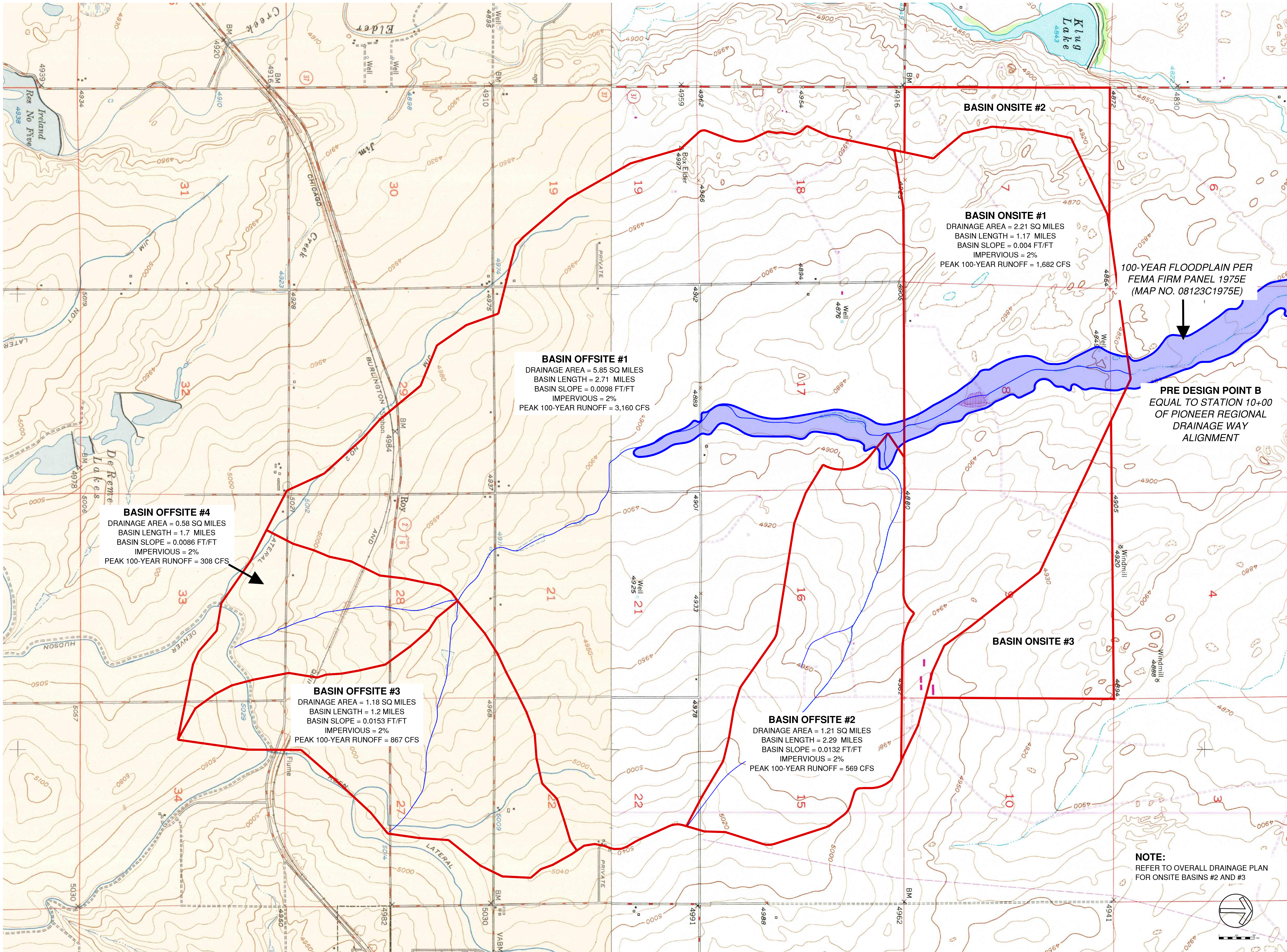
SCALE:

1" = 450'

SHEET NUMBER

**EXHIBIT**





**BASIN OFFSITE #4**  
DRAINAGE AREA = 0.58 SQ MILES  
BASIN LENGTH = 1.7 MILES  
BASIN SLOPE = 0.0086 FT/FT  
IMPERVIOUS = 2%  
PEAK 100-YEAR RUNOFF = 308 CFS

**BASIN OFFSITE #3**  
DRAINAGE AREA = 1.18 SQ MILES  
BASIN LENGTH = 1.2 MILES  
BASIN SLOPE = 0.0153 FT/FT  
IMPERVIOUS = 2%  
PEAK 100-YEAR RUNOFF = 867 CFS

**BASIN OFFSITE #1**  
DRAINAGE AREA = 5.85 SQ MILES  
BASIN LENGTH = 2.71 MILES  
BASIN SLOPE = 0.0098 FT/FT  
IMPERVIOUS = 2%  
PEAK 100-YEAR RUNOFF = 3,160 CFS

**BASIN OFFSITE #2**  
DRAINAGE AREA = 1.21 SQ MILES  
BASIN LENGTH = 2.29 MILES  
BASIN SLOPE = 0.0132 FT/FT  
IMPERVIOUS = 2%  
PEAK 100-YEAR RUNOFF = 569 CFS

**BASIN ONSITE #1**  
DRAINAGE AREA = 2.21 SQ MILES  
BASIN LENGTH = 1.17 MILES  
BASIN SLOPE = 0.004 FT/FT  
IMPERVIOUS = 2%  
PEAK 100-YEAR RUNOFF = 1,682 CFS

**BASIN ONSITE #3**

**BASIN ONSITE #2**

100-YEAR FLOODPLAIN PER  
FEMA FIRM PANEL 1975E  
(MAP NO. 08123C1975E)

**PRE DESIGN POINT B**  
EQUAL TO STATION 10+00  
OF PIONEER REGIONAL  
DRAINAGE WAY  
ALIGNMENT

**NOTE:**  
REFER TO OVERALL DRAINAGE PLAN  
FOR ONSITE BASINS #2 AND #3

ENGINEER IN CHARGE:  
STRATEGIC  
SITE DESIGN  
ATTENTION: CHRISTOPHER PERDUE, P.E., M.B.A.

CONTACT INFORMATION  
88 INVERNESS CIRCLE EAST, SUITE E-101  
ENGLEWOOD, CO 80112  
(720) 206-6831  
CPERDUE@STRATEGICSITEDESIGNS.COM

**STRATEGIC**  
SITE DESIGN

**BASIS OF BEARINGS:**  
BEARINGS SHOWN HEREON ARE  
GRID BEARINGS DERIVED FROM  
GPS OBSERVATION BASED UPON  
THE COLORADO COORDINATE  
SYSTEM OF 1983 NORTH ZONE  
(NAD 83, 2011) REFERENCED TO  
THE WEST LINE OF THE  
NORTHWEST QUARTER OF  
SECTION 7, TOWNSHIP 2 NORTH,  
RANGE 64 WEST, SIXTH  
PRINCIPAL MERIDIAN, TAKEN TO  
BEAR SOUTH 00°30'28" EAST, A  
DISTANCE OF 2,612.70 FEET.

**BENCHMARK**  
NOS ROGGEN RM 1; RECOVERED  
A 3 1/2" BRASS CAP LOCATED  
20' SOUTH OF FRONTAGE RD  
176 AND 2500'; WEST OF COUNTY  
RD 73.  
ELEVATION = 4721.56 (NAVD 88)

**PIONEER VILLAGE**  
PA'S 1-4, 17 AND 21  
TOWN OF KEENESBURG  
WELD COUNTY, COLORADO

**PRE-DEVELOPMENT**  
**DRAINAGE MAP FOR**  
**PIONEER REGIONAL**  
**DRAINAGE WAY**

REV	DESCRIPTION	BY	DATE

JOB NO: 1903-001  
ORIGINAL ISSUE: 03/15/2021  
DESIGN BY: CLP  
CHECKED BY: CLP  
SCALE: 1" = 900'  
SHEET NUMBER  
**EXHIBIT E.01**



## **Appendix F**

Web Soil Survey



United States  
Department of  
Agriculture

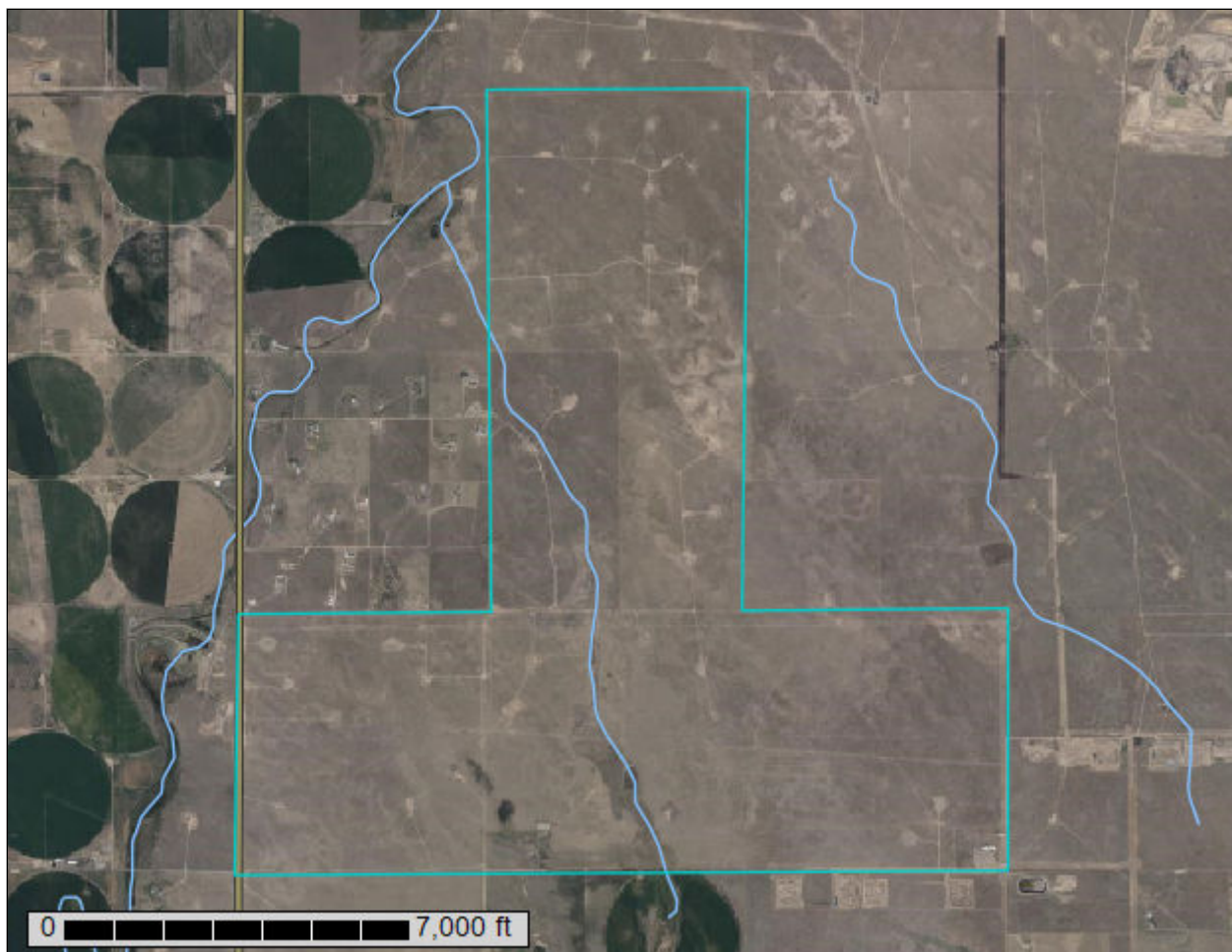
**NRCS**

Natural  
Resources  
Conservation  
Service

A product of the National  
Cooperative Soil Survey,  
a joint effort of the United  
States Department of  
Agriculture and other  
Federal agencies, State  
agencies including the  
Agricultural Experiment  
Stations, and local  
participants

# Custom Soil Resource Report for **Weld County, Colorado, Southern Part**

**Pioneer Village**



January 19, 2021

# Preface

---

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<https://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist ([http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2\\_053951](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951)).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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# How Soil Surveys Are Made

---

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

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

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

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

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



scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

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

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

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

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

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

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

## Custom Soil Resource Report

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

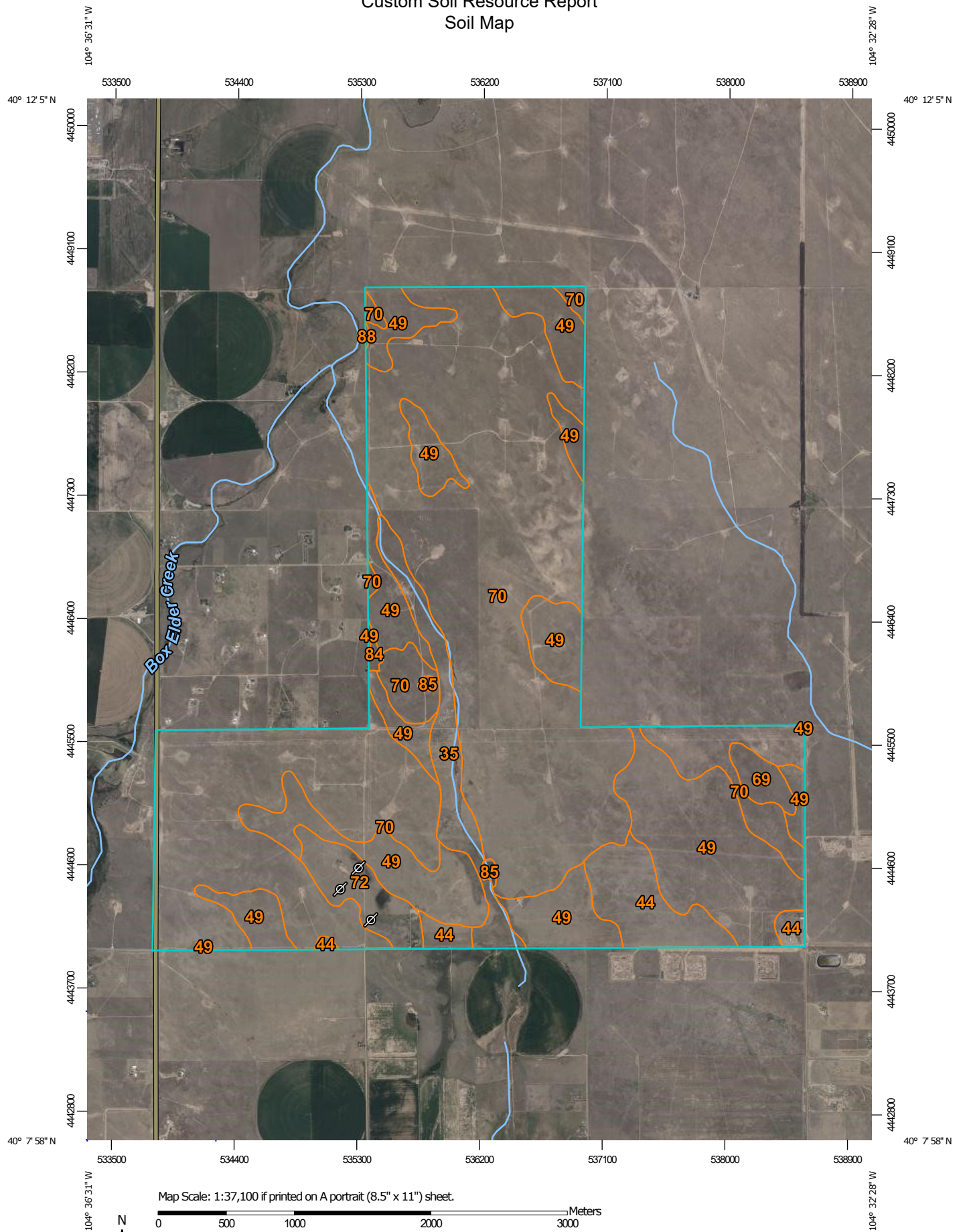
# Soil Map

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



# Custom Soil Resource Report Soil Map



Map Scale: 1:37,100 if printed on A portrait (8.5" x 11") sheet.

0 500 1000 2000 3000 Meters  
0 1500 3000 6000 9000 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge ticks: UTM Zone 13N WGS84

## Custom Soil Resource Report

### MAP LEGEND

#### Area of Interest (AOI)

 Area of Interest (AOI)

#### Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

#### Special Point Features

 Blowout

 Borrow Pit

 Clay Spot

 Closed Depression

 Gravel Pit

 Gravelly Spot

 Landfill

 Lava Flow

 Marsh or swamp

 Mine or Quarry

 Miscellaneous Water

 Perennial Water

 Rock Outcrop

 Saline Spot

 Sandy Spot

 Severely Eroded Spot


 Sinkhole

 Slide or Slip

 Sodic Spot

 Spoil Area

 Stony Spot

 Very Stony Spot

 Wet Spot

 Other

 Special Line Features

#### Water Features

 Streams and Canals

#### Transportation

 Rails


 Interstate Highways

 US Routes

 Major Roads

 Local Roads

#### Background

 Aerial Photography

### MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Weld County, Colorado, Southern Part

Survey Area Data: Version 19, Jun 5, 2020

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 19, 2018—Aug 10, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

## Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
35	Loup-Boel loamy sands, 0 to 3 percent slopes	128.4	4.0%
44	Olney loamy sand, 1 to 3 percent slopes	149.1	4.7%
49	Osgood sand, 0 to 3 percent slopes	844.1	26.6%
69	Valent sand, 0 to 3 percent slopes	32.4	1.0%
70	Valent sand, 3 to 9 percent slopes	1,926.7	60.6%
72	Vona loamy sand, 0 to 3 percent slopes	84.5	2.7%
84	Playas	5.2	0.2%
85	Water	6.5	0.2%
88	Ellicott-Glenberg complex, 0 to 3 percent slopes, occasionally flooded	0.8	0.0%
<b>Totals for Area of Interest</b>		<b>3,177.6</b>	<b>100.0%</b>

## Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the



scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

## Weld County, Colorado, Southern Part

### 35—Loup-Boel loamy sands, 0 to 3 percent slopes

#### Map Unit Setting

*National map unit symbol:* 362f  
*Elevation:* 4,550 to 4,750 feet  
*Mean annual precipitation:* 11 to 15 inches  
*Mean annual air temperature:* 46 to 52 degrees F  
*Frost-free period:* 130 to 180 days  
*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Loup and similar soils:* 55 percent  
*Boel and similar soils:* 35 percent  
*Minor components:* 10 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Loup

##### Setting

*Landform:* Swales, drainageways, streams  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Sandy alluvium

##### Typical profile

*H1 - 0 to 16 inches:* loamy sand  
*H2 - 16 to 40 inches:* loamy sand  
*H3 - 40 to 60 inches:* sandy loam

##### Properties and qualities

*Slope:* 0 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Poorly drained  
*Runoff class:* Very high  
*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)  
*Depth to water table:* About 0 to 18 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 5 percent  
*Available water capacity:* Low (about 5.2 inches)

##### Interpretive groups

*Land capability classification (irrigated):* 4w  
*Land capability classification (nonirrigated):* 6w  
*Hydrologic Soil Group:* A/D  
*Ecological site:* R067BY029CO - Sandy Meadow  
*Hydric soil rating:* Yes

#### Description of Boel

##### Setting

*Landform:* Swales, drainageways, streams  
*Down-slope shape:* Linear

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*Across-slope shape:* Linear

*Parent material:* Stratified sandy alluvium

### Typical profile

*H1 - 0 to 14 inches:* loamy sand

*H2 - 14 to 60 inches:* loamy sand

### Properties and qualities

*Slope:* 0 to 3 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Somewhat poorly drained

*Runoff class:* Very low

*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (5.95 to 19.98 in/hr)

*Depth to water table:* About 18 to 36 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Calcium carbonate, maximum content:* 5 percent

*Available water capacity:* Low (about 4.2 inches)

### Interpretive groups

*Land capability classification (irrigated):* 4w

*Land capability classification (nonirrigated):* 6w

*Hydrologic Soil Group:* A

*Ecological site:* R067BY029CO - Sandy Meadow

*Hydric soil rating:* No

### Minor Components

#### Osgood

*Percent of map unit:* 5 percent

*Hydric soil rating:* No

#### Valent

*Percent of map unit:* 5 percent

*Hydric soil rating:* No

## 44—Olney loamy sand, 1 to 3 percent slopes

### Map Unit Setting

*National map unit symbol:* 362r

*Elevation:* 4,600 to 5,200 feet

*Mean annual precipitation:* 11 to 15 inches

*Mean annual air temperature:* 46 to 54 degrees F

*Frost-free period:* 125 to 175 days

*Farmland classification:* Farmland of statewide importance

### Map Unit Composition

*Olney and similar soils:* 85 percent

*Minor components:* 15 percent



*Estimates are based on observations, descriptions, and transects of the mapunit.*

## **Description of Olney**

### **Setting**

*Landform:* Plains  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Mixed deposit outwash

### **Typical profile**

*H1 - 0 to 10 inches:* loamy sand  
*H2 - 10 to 20 inches:* sandy clay loam  
*H3 - 20 to 25 inches:* sandy clay loam  
*H4 - 25 to 60 inches:* fine sandy loam

### **Properties and qualities**

*Slope:* 1 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Low  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high  
(0.60 to 2.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 15 percent  
*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)  
*Available water capacity:* Moderate (about 6.5 inches)

### **Interpretive groups**

*Land capability classification (irrigated):* 3e  
*Land capability classification (nonirrigated):* 4c  
*Hydrologic Soil Group:* B  
*Ecological site:* R067BY024CO - Sandy Plains  
*Hydric soil rating:* No

## **Minor Components**

### **Vona**

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

### **Zigweid**

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

## **49—Osgood sand, 0 to 3 percent slopes**

### **Map Unit Setting**

*National map unit symbol:* 362x  
*Elevation:* 4,680 to 4,900 feet

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*Mean annual precipitation:* 13 to 15 inches

*Mean annual air temperature:* 46 to 55 degrees F

*Frost-free period:* 140 to 150 days

*Farmland classification:* Farmland of statewide importance

### Map Unit Composition

*Osgood and similar soils:* 85 percent

*Minor components:* 15 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Osgood

#### Setting

*Landform:* Plains

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Eolian sands

#### Typical profile

*H1 - 0 to 22 inches:* sand

*H2 - 22 to 34 inches:* sandy loam

*H3 - 34 to 60 inches:* sand

#### Properties and qualities

*Slope:* 0 to 3 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Well drained

*Runoff class:* Very low

*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Maximum salinity:* Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)

*Available water capacity:* Low (about 4.8 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 4e

*Land capability classification (nonirrigated):* 6e

*Hydrologic Soil Group:* A

*Ecological site:* R067BY015CO - Deep Sand

*Hydric soil rating:* No

### Minor Components

#### Valent

*Percent of map unit:* 10 percent

*Hydric soil rating:* No

#### Dailey

*Percent of map unit:* 5 percent

*Hydric soil rating:* No

## 69—Valent sand, 0 to 3 percent slopes

### Map Unit Setting

*National map unit symbol:* 2tczd  
*Elevation:* 3,000 to 5,210 feet  
*Mean annual precipitation:* 13 to 20 inches  
*Mean annual air temperature:* 48 to 52 degrees F  
*Frost-free period:* 130 to 166 days  
*Farmland classification:* Farmland of local importance

### Map Unit Composition

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

### Description of Valent

#### Setting

*Landform:* Interdunes  
*Landform position (two-dimensional):* Footslope, toeslope  
*Landform position (three-dimensional):* Base slope  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Noncalcareous eolian sands

#### Typical profile

*A - 0 to 5 inches:* sand  
*AC - 5 to 12 inches:* sand  
*C1 - 12 to 30 inches:* sand  
*C2 - 30 to 80 inches:* sand

#### Properties and qualities

*Slope:* 0 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Excessively drained  
*Runoff class:* Negligible  
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (6.00 to 39.96 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 1 percent  
*Maximum salinity:* Nonsaline (0.1 to 1.9 mmhos/cm)  
*Available water capacity:* Very low (about 2.4 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 4e  
*Land capability classification (nonirrigated):* 6e  
*Hydrologic Soil Group:* A



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*Ecological site:* R067BY015CO - Deep Sand, R072XA021KS - Sands (North) (PE 16-20)

*Hydric soil rating:* No

### Minor Components

#### Julesburg

*Percent of map unit:* 5 percent

*Landform:* Interdunes

*Landform position (two-dimensional):* Toeslope

*Landform position (three-dimensional):* Base slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Ecological site:* R067BY024CO - Sandy Plains, R072XA022KS - Sandy (North)

Draft (April 2010) (PE 16-20)

*Hydric soil rating:* No

#### Dailey

*Percent of map unit:* 5 percent

*Landform:* Interdunes

*Landform position (two-dimensional):* Toeslope

*Landform position (three-dimensional):* Base slope

*Down-slope shape:* Linear

*Across-slope shape:* Concave

*Ecological site:* R067BY015CO - Deep Sand, R072XA022KS - Sandy (North) Draft

(April 2010) (PE 16-20)

*Hydric soil rating:* No

#### Vona

*Percent of map unit:* 5 percent

*Landform:* Interdunes

*Landform position (two-dimensional):* Toeslope

*Landform position (three-dimensional):* Base slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Ecological site:* R067BY024CO - Sandy Plains, R072XA022KS - Sandy (North)

Draft (April 2010) (PE 16-20)

*Hydric soil rating:* No

## 70—Valent sand, 3 to 9 percent slopes

### Map Unit Setting

*National map unit symbol:* 2tczf

*Elevation:* 3,050 to 5,150 feet

*Mean annual precipitation:* 12 to 18 inches

*Mean annual air temperature:* 48 to 55 degrees F

*Frost-free period:* 130 to 180 days

*Farmland classification:* Not prime farmland

### Map Unit Composition

*Valent and similar soils:* 80 percent

*Minor components:* 20 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Valent

#### Setting

*Landform:* Hills, dunes

*Landform position (two-dimensional):* Backslope, shoulder, footslope, summit

*Landform position (three-dimensional):* Side slope, head slope, nose slope, crest

*Down-slope shape:* Linear, convex

*Across-slope shape:* Linear, convex

*Parent material:* Noncalcareous eolian sands

#### Typical profile

*A - 0 to 5 inches:* sand

*AC - 5 to 12 inches:* sand

*C1 - 12 to 30 inches:* sand

*C2 - 30 to 80 inches:* sand

#### Properties and qualities

*Slope:* 3 to 9 percent

*Depth to restrictive feature:* More than 80 inches

*Drainage class:* Excessively drained

*Runoff class:* Very low

*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (6.00 to 39.96 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Calcium carbonate, maximum content:* 1 percent

*Maximum salinity:* Nonsaline (0.0 to 1.9 mmhos/cm)

*Available water capacity:* Very low (about 2.4 inches)

#### Interpretive groups

*Land capability classification (irrigated):* 4e

*Land capability classification (nonirrigated):* 6e

*Hydrologic Soil Group:* A

*Ecological site:* R067BY015CO - Deep Sand, R072XY109KS - Rolling Sands

*Hydric soil rating:* No

### Minor Components

#### Dailey

*Percent of map unit:* 10 percent

*Landform:* Interdunes

*Landform position (two-dimensional):* Footslope, toeslope

*Landform position (three-dimensional):* Base slope

*Down-slope shape:* Linear

*Across-slope shape:* Concave

*Ecological site:* R067BY015CO - Deep Sand, R072XA021KS - Sands (North) (PE 16-20)

*Hydric soil rating:* No

**Vona**

*Percent of map unit:* 5 percent

*Landform:* Hills

*Landform position (two-dimensional):* Footslope, backslope, shoulder

*Landform position (three-dimensional):* Side slope, head slope, nose slope, base slope

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Ecological site:* R067BY024CO - Sandy Plains, R072XA022KS - Sandy (North)

Draft (April 2010) (PE 16-20)

*Hydric soil rating:* No

**Haxtun**

*Percent of map unit:* 5 percent

*Landform:* Interdunes

*Landform position (two-dimensional):* Footslope, toeslope

*Landform position (three-dimensional):* Base slope

*Down-slope shape:* Linear

*Across-slope shape:* Concave

*Ecological site:* R067BY024CO - Sandy Plains, R072XY111KS - Sandy Plains

*Hydric soil rating:* No

**72—Vona loamy sand, 0 to 3 percent slopes**

**Map Unit Setting**

*National map unit symbol:* 363r

*Elevation:* 4,600 to 5,200 feet

*Mean annual precipitation:* 13 to 15 inches

*Mean annual air temperature:* 48 to 55 degrees F

*Frost-free period:* 130 to 160 days

*Farmland classification:* Farmland of local importance

**Map Unit Composition**

*Vona and similar soils:* 85 percent

*Minor components:* 15 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Vona**

**Setting**

*Landform:* Plains, terraces

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Alluvium and/or eolian deposits

**Typical profile**

*H1 - 0 to 6 inches:* loamy sand

*H2 - 6 to 28 inches:* fine sandy loam

*H3 - 28 to 60 inches:* sandy loam



**Properties and qualities**

*Slope:* 0 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Very low  
*Capacity of the most limiting layer to transmit water (Ksat):* High (1.98 to 6.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 15 percent  
*Maximum salinity:* Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)  
*Available water capacity:* Moderate (about 6.5 inches)

**Interpretive groups**

*Land capability classification (irrigated):* 3e  
*Land capability classification (nonirrigated):* 4e  
*Hydrologic Soil Group:* A  
*Ecological site:* R067BY024CO - Sandy Plains  
*Hydric soil rating:* No

**Minor Components**

**Remmit**

*Percent of map unit:* 10 percent  
*Hydric soil rating:* No

**Valent**

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

**84—Playas**

**Map Unit Composition**

*Playas:* 100 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

**Description of Playas**

**Setting**

*Landform:* Playas  
*Landform position (three-dimensional):* Talf  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Alluvium

**Properties and qualities**

*Frequency of ponding:* Rare

**Interpretive groups**

*Land capability classification (irrigated):* None specified

*Ecological site:* R067BY010CO - Closed Upland Depression

*Hydric soil rating:* No

## **85—Water**

### **Map Unit Composition**

*Water:* 95 percent

*Minor components:* 5 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### **Minor Components**

#### **Aquolls**

*Percent of map unit:* 5 percent

*Landform:* Marshes

*Hydric soil rating:* Yes

## **88—Ellicott-Glenberg complex, 0 to 3 percent slopes, occasionally flooded**

### **Map Unit Setting**

*National map unit symbol:* 2x0j6

*Elevation:* 3,950 to 5,960 feet

*Mean annual precipitation:* 13 to 17 inches

*Mean annual air temperature:* 50 to 54 degrees F

*Frost-free period:* 135 to 165 days

### **Map Unit Composition**

*Ellicott, occasionally flooded, and similar soils:* 65 percent

*Glenberg, rarely flooded, and similar soils:* 20 percent

*Minor components:* 15 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### **Description of Ellicott, Occasionally Flooded**

#### **Setting**

*Landform:* Flood plains

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Noncalcareous, stratified sandy alluvium

#### **Typical profile**

*A - 0 to 4 inches:* sand

*AC - 4 to 13 inches:* sand

*C1 - 13 to 30 inches:* sand

*C2 - 30 to 44 inches:* sand

*C3 - 44 to 80 inches:* coarse sand

#### **Properties and qualities**

*Slope:* 0 to 3 percent

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*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Somewhat excessively drained  
*Runoff class:* Negligible  
*Capacity of the most limiting layer to transmit water (Ksat):* High to very high (6.00 to 39.96 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* Occasional  
*Frequency of ponding:* None  
*Maximum salinity:* Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)  
*Available water capacity:* Very low (about 2.1 inches)

### Interpretive groups

*Land capability classification (irrigated):* 4e  
*Land capability classification (nonirrigated):* 7s  
*Hydrologic Soil Group:* A  
*Ecological site:* R067BY031CO - Sandy Bottomland  
*Hydric soil rating:* No

### Description of Glenberg, Rarely Flooded

#### Setting

*Landform:* Ephemeral streams, flood-plain steps  
*Down-slope shape:* Linear  
*Across-slope shape:* Linear  
*Parent material:* Stratified, calcareous alluvium

#### Typical profile

*A - 0 to 6 inches:* sandy loam  
*AC - 6 to 18 inches:* sandy loam  
*C1 - 18 to 45 inches:* sandy loam  
*C2 - 45 to 80 inches:* loamy coarse sand

#### Properties and qualities

*Slope:* 0 to 3 percent  
*Depth to restrictive feature:* More than 80 inches  
*Drainage class:* Well drained  
*Runoff class:* Very low  
*Capacity of the most limiting layer to transmit water (Ksat):* High (2.00 to 6.00 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* Rare  
*Frequency of ponding:* None  
*Calcium carbonate, maximum content:* 5 percent  
*Maximum salinity:* Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)  
*Sodium adsorption ratio, maximum:* 2.0  
*Available water capacity:* Low (about 5.6 inches)

### Interpretive groups

*Land capability classification (irrigated):* 3e  
*Land capability classification (nonirrigated):* 4c  
*Hydrologic Soil Group:* A  
*Ecological site:* R067BY031CO - Sandy Bottomland  
*Hydric soil rating:* No



### **Minor Components**

#### **Las animas, occasionally flooded**

*Percent of map unit:* 10 percent

*Landform:* Flood plains, ephemeral streams

*Down-slope shape:* Linear

*Across-slope shape:* Concave, linear

*Ecological site:* R067BY038CO - Wet Meadow

*Hydric soil rating:* No

#### **Ellicott sandy-skeletal, occasionally flooded**

*Percent of map unit:* 5 percent

*Landform:* Channels, flood plains

*Down-slope shape:* Linear

*Across-slope shape:* Concave, linear

*Ecological site:* R067BY031CO - Sandy Bottomland

*Hydric soil rating:* No

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