FINAL MASTER DRAINAGE REPORT

FOR

REDTAIL RIDGE PRELIMINARY PLAT

&

REDTAIL RIDGE SUBDIVISION FILING NO. 1 & NO.2

CITY OF LOUISVILLE
BOULDER COUNTY
STATE OF COLORADO

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Prepared for:

BRUE BAUKOL CAPITAL PARTNERS
1555 Blake Street
Suite 210
Denver, CO 80202
720-930-4711

Prepared by:

HARRIS KOCHER SMITH

1120 Lincoln Street, Suite 1000
Denver, CO 80203
Ph: 303-623-6300, Fax: 303-623-6311

Contacts:
Mark A. West, PE, CFM, LEEDAP
Kent Steinhaus, PE, CFM
Michael Walton, EI, CFM

Harris Kocher Smith Project No. 190108

Table of Contents

Table of Contents ii

ENGINEER CERTIFICATION iv
I. EXECUTIVE SUMMARY 1
A. FINAL MASTER DRAINAGE REPORT FOR REDTAIL RIDGE 1
II. GENERAL LOCATION AND DESCRIPTION 2
A. Location 2
B. Description of Property 2
C. Historic Drainage 3
1. Major Basin Description 3
2. Sub-Basin Description 4
III. DRAINAGE DESIGN CRITERIA 5
A. Regulations 5
B. Development Criteria References and Constraints 5
C. Hydrologic Criteria 5
D. Hydraulic Criteria 6
E. Waivers from Criteria 7
IV. DRAINAGE FACILITY DESIGN 7
A. General Concept 7
B. Specific Details 8
C. Goodhue Ditch 12
D. Stormwater Detention and Water Quality 13
E. Off-site Flows 14
F. Rock Creek Tributary I 15
1. Tributary Watershed 15
2. CUHP and SWMM 16
3. Hydrology Data 16
4. Channel Geometry 17
5. HECRAS Modeling 18
6. Revegetation 19
7. MHFD Maintenance Eligibility 19
8. Culverts 23
G. Site Phasing 23
H. Construction Best Management Practices (BMP) Plan 23
I. Project Schedule 25
J. BMP Maintenance 25
V. CONCLUSIONS 26
A. Compliance with Standards 26
B. Drainage Concept 26
VI. REFERENCES 27

APPENDIX A – Vicinity Map, FIRM Map, and NRCS Web Soil Survey
APPENDIX B – Reference Material and Supporting Documents
APPENDIX C – Hydrologic and Hydraulic Computations
APPENDIX D – Existing and Preliminary Master Drainage and Grading Plans
APPENDIX E – HECRAS Model

ENGINEER CERTIFICATION

"I hereby certify that this Final Master Drainage Report for the final drainage design of the Redtail Ridge project was prepared by me (or under my direct supervision) in accordance with the provisions of the City of Louisville Storm Drainage Design and Technical Criteria for the owners thereof."

Mark A. West, PE, CFM, LEEDAP
Licensed Professional Engineer
State of Colorado
No. 38561
On behalf of Harris Kocher Smith

I. EXECUTIVE SUMMARY

A. FINAL MASTER DRAINAGE REPORT FOR REDTAIL RIDGE

The purpose of this report is to outline the proposed overall project stormwater and drainage characteristics for the sustainable redevelopment of the former Storage Tek and ConocoPhillips property. It is the intent of this Final Master Drainage Report to act as the master report for the entire Site. Future Development's preliminary plats, final plats, and individual Site Plans shall be required to submit their own Preliminary and Final Drainage Reports, as applicable, with subsequent development applications.

This report provides design of Master Plan stormwater and drainage infrastructure to support the proposed major roadways of Campus Drive, Rockcress Drive (formerly Tape Dr.), Sorrel Avenue (formerly Street B), and Yucca Avenue (formerly Street A) as well as utility infrastructure to create developable Parcels within the overall Site.

These improvements consist of roadway storm sewer, full spectrum detention ponds and Rock Creek Tributary I (hereinafter referred to as "Tributary I"). The construction of the overall Site is broken in to two phases that generally correlate with planned Redtail Ridge platting of Filing No. 1 and Filing No. 2. A Phasing line is included in the drainage plans for the project, included in Appendix D.

Filing No. 1 is currently proposed to include the construction of Campus Drive, Sorrel Avenue, the east segment of Rockcress Drive, Tributary I, and Full Spectrum Detention Ponds C-1 and C-2. With Filing No. 1, all runoff from developed infrastructure is routed to either Pond C-1 or C-2.

Filing No. 2 is currently proposed to include the construction of the west segment of Rockcress Drive and Full Spectrum Detention Ponds A-2, A-3, B, and E.

All proposed development within the Site will be required to follow the guidelines in this Master Study or provide alternative designs or methods that do not cause adverse impact to adjacent facilities or property owners.

II. GENERAL LOCATION AND DESCRIPTION

A. Location

The proposed Redtail Ridge Filing 1 development by Brue Baukol Capital Partners on the former Storage Tek / ConocoPhillips Site property (hereinafter referred to as "Site" or "Project" is situated in the City of Louisville (hereinafter referred to as "City"); specifically the Northeast ½ and South ½ of Section 20, the North ½ of Section 29, and the Northwest ¼ of Section 28, Township 1 South, Range 69 West of the 6th P.M. Counties of Boulder and Broomfield, State of Colorado.

The Project is located east of S. 88th Street, South of Campus Drive, West of S. 96th Street and Northwest Parkway, and Northeast of Highway 36. A Vicinity Map is included in Appendix A, for reference.

There is an existing Outfall System Plan which was used as reference for the Site. The City of Louisville/Boulder County Outfall System Plan (hereinafter referred to as "Louisville OSP") dated November 1982 indicates that there are several existing ponds at low points throughout the Site. Excerpts from this report are included in Appendix B.

Surrounding the Site, the existing developments include the Monarch K-8 School Campuses north of Campus Drive, the Health Park complex west of S. 88th Street and northwest of the Site, and the Parkway Circle development east of S. 96th Street.

B. Description of Property

The Site is approximately 389 acres and was formerly a developed office campus that has been demolished and removed from the Site. The Site is currently covered with grass vegetation, remnants of building slabs, and several private roadways. A ridge bisects the Site approximately along the alignment of the existing Tape Drive.

To the north, existing runoff flows from the ridge north and east towards S. 96th Street at slopes approximately ranging from 2-3%. To the South, existing runoff flows from the ridge south and east towards Highway 36 at slopes approximately ranging from 2-45%.

The Site is shown to be in a Zone X Flood Area according to FIRM map 08013C0584J, Boulder County, Colorado, and Incorporated Areas, December 18, 2012. Zone X is described on this map as areas outside the 0.2% annual chance of flood. Runoff from the northwest portion of the Site generally flows into the existing Tributary I at slopes ranging from 5-10%. Tributary I is not a FEMA regulated floodplain. Tributary I is, and will remain, a natural channel terminating on-site into a roadway culvert at S. 96th Street that will be replaced with proposed construction on S. 96th Street. See Section IV for specific details about the Tributary I. A copy of the FIRM map is included in Appendix A for reference.

The Louisville OSP also describes several irrigation swales traversing the Site, specifically Goodhue Ditch (hereinafter referred to as "Ditch") in the northeast corner of the Site and Tributary I along the Site's northern property boundary. Specific details on the Ditch culvert crossing are provided in Section IV of this report.

According to the Request for Approved Jurisdictional Determination for Phillips 66 Site Boulder and Broomfield Counties, Colorado issued on January 24, 2019 by ERO Resources Corp., none of the existing drainage features within the Project area are jurisdictional except for the Ditch and Rock Creek. Development is not planned in the vicinity of Rock Creek, and no modifications to Rock Creek are proposed.

According to the Phillips 66 Site – Delineation of the Ditch and Rock Creek issued on September 23, 2019 by ERO Resources Corp., there are wetlands abutting the Ditch. ERO mapped approximately 0.428 acres of open water along the Ditch and approximately 0.121 acres of wetlands abutting the Ditch within the Project area during a 2019 Site visit. A copy of this report can be found in Appendix B for reference.

According to soils information provided by CTL|Thompson for the project, the soil borings for the Site consist of existing fill and/or natural sandy clay with fewer amounts of sand, gravel and cobble, which overlie claystone and interbedded claystone/sandstone bedrock of the Laramie Formation. Most of the soils on the Site are Type C soils. A copy of the geologic, bedrock, and groundwater maps is included in Appendix B for reference.

According to the Boulder Valley School District (hereinafter referred to as "BVSD") Louisville Campus PUD Drainage Report (hereinafter referred to as "School Report"), there is an existing pond at the northwest corner of the Site (hereinafter referred to as "School Pond"), that is a part of the Monarch K-8 school's drainage system. According to the School Report, the pond collects runoff from an off-site basin tributary to the school's site. This runoff is detained in the pond at the Northwest corner of the Site and then released into a drainage swale that drains to a culvert under Campus Drive and outfalls into the Bus Loop Pond on the school's site. The School Report specifies that this runoff was detained off-site because the engineer was concerned that peak flows from this basin would increase the size of the on-site systems and the size of Bus Loop Pond. A copy of the Master Drainage Plan for the BVSD Monarch School Campus is included in Appendix B for reference.

C. Historic Drainage

1. Major Basin Description

The Site is located within Basins 4-I, 5-I, 6-I, 2-J, and 10-H of the Louisville OSP. The north portion of the Site is tributary to Rock Creek Tributary I, and the balance of the Site is tributary to the Rock Creek main channel. Rock Creek eventually combines with

Coal Creek and is tributary to Boulder Creek. The following is how the Louisville OSP describes the Rock Creek and Coal Creek basins:

> *"The Rock Creek basin has a northeast aspect with the high point of the basin (elevation 5560) just southwest of U.S. 36. The upper section of the basin has slopes that range from 5 to 10% and then level out to an average of 1.5% in the lower reaches of the basin."*
>
> *"The Coal Creek basin has a West to East aspect with the high point (elevation 5670) of the basin on the Davidson Mesa. The slopes on top of the mesa are very mild, but rapidly approach 6 to 7% upon decent from the mesa. The terrain then levels out to an average grade of 2% for the remaining portion of the basin."*

The Site contains several irrigation swales and ditches that were utilized with the previous uses, but are no longer in service. The only active and defined irrigation ditch is located in the far northeast corner of the Site and is owned by the Goodhue Ditch & Reservoir Company (hereinafter referred to as "Ditch Company"). All other irrigation swales and ditches are non–binding and will be routed on a Site level basis per development plans for individual parcels.

2. Sub-Basin Description

Basin delineation, areas, and flows for the Existing Drainage Plan were derived from the Louisville OSP as the existing condition. The Site design maintains the historical drainage patterns and the allowable flow at S. 96th Street (specified by the Louisville OSP) will not be exceeded with the proposed development.

Runoff flows from the northern portion of the Site (Louisville OSP Basins 4-I and 5-I) historically drains to the existing Rock Creek Tributary I channel, which contains two existing in line ponds. The central portion of the Site (Louisville OSP Basin 6-I) historically drains from southwest to northeast in to a channel on the eastern side of the Site which conveys flows from South to North along the Northwest Parkway. The southern portion of the Site (Louisville OSP Basin 2-J) historically flows from west to east across the Site to the Northwest Parkway. As shown in the Louisville OSP, approximately half of basins 4-I and 5-I drain on-site from off-site. The flows from these basins, as well as portions of basin 10-H, are accounted for in the design of Rock Creek Tributary I. See Appendix D to reference the Existing Drainage Plan.

The southeast portion of the Site (Louisville OSP Basin 2-J) drains to an existing 48" Reinforced Concrete Pipe (hereinafter referred to as "RCP") culvert under the Northwest Parkway. This 48" RCP is associated with the Parkway Circle Filing No. 8 project on the east side of the Northwest Parkway. Details for this 48" RCP can be found in the Via Varra & West Midway Improvements construction documents prepared by Drexel Barrell & Co. and dated December 4th, 2002. The Grading Plan from this set of documents can be found in Appendix B for reference.

Off the northeast corner of the Site, at the Tributary I crossing, the Northwest Parkway Toll Authority installed the existing dual (2) 10' x 6' Reinforced Concrete Box Culvert (hereinafter referred to as "RCBC") at the intersection of the Northwest Parkway and S. 96th Street. The existing culvert under the Northwest Parkway will be maintained as the outfall for the Site flows. Since the upstream peak flows do not significantly increase as a part of the development, this culvert will not require modification to accommodate the post development flows.

III. DRAINAGE DESIGN CRITERIA

A. Regulations

The Site will comply with the City's and Mile High Flood District's, formerly known as Urban Drainage Flood Control District (hereinafter referred to as MHFD), requirements. The Site will comply with current City's and MHFD's criteria, including runoff reduction, water quality capture volume, stabilizing drainageways and source control BMPs, as applicable. The Site will also comply with the Louisville OSP as it relates to the extents of the Site.

B. Development Criteria References and Constraints

The principal design guidelines that will be sourced for this Site development are the City of Louisville Storm Drainage & Technical Criteria Manual (hereinafter referred to as "Louisville Criteria") and the current version of the MHFD Urban Storm Drainage Criteria Manual (hereinafter referred to as "District Manual").

The existing conditions of the adjacent properties and those relevant drainage studies that affect the Site in that the existing conditions were analyzed, and the appropriate measures taken to maintain historic runoff as it relates to the Site. The drainage design will be affected by the proposed grading, building outline and legal boundaries of the Site. These existing basins encompass the entirety of the Site and represent the previous drainage study the Site will be modifying per the proposed developments.

Existing Site constraints include: Rock Creek Tributary I, the Goodhue Ditch, and various irrigation ditches or swales throughout the Site, existing structural building pads, and an overhead electric line and easement.

See Section IV of this report for a discussion on how the Site will take into consideration Rock Creek Tributary I and the Goodhue Ditch.

C. Hydrologic Criteria

On a regional basis for the channel design, a hydrologic stormwater routing analysis for the watershed was completed using a combination of the Colorado Urban Hydrograph

Procedure (CUHP) v. 2.0.0 and the US Environmental Protection Agency Storm Water Management Model (EPA SWMM) v. 5.1. To create the Tributary I regional model, storm hydrographs produced by CUHP are integrated into EPA SWMM for routing and flood risk analysis

The following formula, from the District Manual, was used to determine rainfall intensities:

$$I = \frac{28.5P_1}{(10 + T_C)^{0.786}}$$

For this report, the 5-year and 100-year storm events have been analyzed. The 5-year storm is considered the minor event and the 100-year storm is considered the major event. One-hour rainfall P_1 values were taken from NOAA Atlas 14, Volume 8, and Version 2 for the Site. The P_1 values for the 5-year and 100-year storms are 1.08 inches and 2.49 inches, respectively.

For the proposed roadway storm sewer analysis, Rational Method calculations were used to determine peak flow rates as the minor basins delineated for this are less than 90 acres. Utilizing catchment area, rainfall characteristics (return period), an assumed imperviousness for all development parcels, and soil type, the Rational Method workbook calculates the basin time of concentration and peak runoff. As a conservative approach, to accommodate future developments, parcel areas are assumed to have 75% imperviousness and roadway areas are designed with 90% imperviousness. These calculation results can be found in Appendix C, for reference.

As these criteria represent all required information for development of Project hydrology, other criteria or calculation methods outside of Louisville Criteria and the District Manual were not used in the hydrologic design for the Site.

D. Hydraulic Criteria

For the proposed Site Full Spectrum Detention Facilities, the District Manual MHFD-Detention_v4.00 workbooks were used to determine required volumes and release rates for each design storm.

Per Chapter 3.0 of the District Manual; calculation of the Water Quality Capture Volume (hereinafter referred to as “WQCV”) in watershed inches is given as:

$$WQCV = a\,(0.91\,I^3 - 1.19\,I^2 + 0.78\,I) \qquad \text{Equation 3-1}$$

where:

a = 1.0 for a 40-hour drain time for extended detention;
I = Contributing Basin Imperviousness

$$V = (WQCV * A) / 12 \qquad \text{Equation 3-2}$$

where:
V = required storage volume (acre-feet)
A = watershed tributary area upstream (acres)
WQCV = Water Quality Capture Volume (watershed-inches)

Other criteria or calculation methods outside of Louisville Criteria and the District Manual were not used in the hydraulic design for the Site.

E. Waivers from Criteria

No waivers were requested or granted.

IV. DRAINAGE FACILITY DESIGN

A. General Concept

The general drainage concept for the Site is to capture storm water runoff from the Site and roadway drainage basins and route the runoff through proposed storm sewer infrastructure to existing and proposed Full Spectrum Detention Facilities. Detained runoff will be released at specified rates through outlet structures to existing or proposed drainage infrastructure. Only runoff from Basin D-2 will flow off the Site per historic conditions into the drainage system associated with U.S. Highway 36. This is referenced the Master Drainage Plan in Appendix D.

The north portion of the Site releases per historical conditions and as shown on the Existing Drainage Plan at 96th Street. From this point, Tributary I releases to the existing dual 10’ x 6’ RCBC under the Northwest Parkway. Per the Louisville OSP, the peak discharge at this location is 842 cfs for the 100-year storm event. Proposed Site releases, as described below, will not exceed the allowable 842 cfs through the existing dual 10’ x 6’ RCBC in the 100-year storm event.

SWMM element Out1 represents all the Site flows contributing to Tributary I. The OSP shows a flow of 842 cfs discharging from the Site through Tributary I, but Site detention meeting MHFD standards have significantly decreased this to slightly below pre-developed site conditions. The SWMM model 100-year storm event flows at element Out1 were found to be 441 cfs in the pre-developed condition and 440 cfs in the developed condition. This shows the Site is meeting the design criteria of MHFD to release 100-year storm events at or below the pre-developed flows from the basin.

SWMM element Out2 represents all the flows contributing to the 48” RCP shown on the Grading Plan and Basin Delineation from the Via Varra & West Midway Improvements construction documents prepared by Drexell Barrell & company which are provided in

Appendix B. The aforementioned basin delineation plan show basins DA-1A, DA-1B, and DA-1C contributing a peak flow of approximately 349 cfs to this culvert. With the addition of the Site detention features it was possible to greatly decrease the flows contributing to this structure. The SWMM model 100-year storm event flows at element Out2 were found to be 96 cfs in the pre-developed condition and 74 cfs in the developed condition. Previously the OSP had a basin which extended past Northwest parkway contributing directly to Rock Creek Tributary J for this portion of the Site, but with the changes in delineation no comparable OSP value is available.

SWMM element Out3 represents all Site flows freely flowing off-site, which fall outside of the areas delineated in the OSP. These areas are to remain Open Space and will flow to the existing storm sewer system and pond system along US Highway 36, prior to releasing to Rock Creek. The SWMM model 100-year storm event flows at element Out3 were shown to be 20 cfs for the pre-developed Site condition, and 18 cfs for the developed Site condition.

The full SWMM modeling inputs and results can be found in Appendix C.

B. Specific Details

The following section describes in detail the proposed major drainage basins for the overall Redtail Ridge Site.

Minor basins within the roadway areas are shown in the drainage plan and included in the rational calculations found in Appendix C.

Calculations for all proposed Ponds as well as their respective outlet structure design can also be found in Appendix C.

Basin A is in the northwest corner of the Site located to the north of Rockcress Drive, to the east of South 88th Street, to the south of Campus Drive, and to the west of Yucca Avenue. Tributary I splits the parcel from southwest to northeast dividing Sub-Basins A-1 and A-2. Flows from A-1 historically flow from northwest to southeast in to Tributary I and flows from Sub-Basin A-2 historically flow from southwest to northeast in to Tributary I. Sub-Basin A-3 consists of a portion of Rockcress Drive which must be discharged in to Basin A.

Sub-Basin A-1 is northwest of Tributary I. Sub-Basin A-1 is proposed to be and open space area dedicated to the City of Louisville. Stormwater runoff from Sub-Basin A-1 will flow as it historically does in to Tributary I.

Sub-Basin A-2 is southeast of Tributary I. Sub-Basin A-2 is proposed as a Senior Living facility. Stormwater runoff from Sub-Basin A-2 is proposed to drain to future curb, gutter, inlet, and storm sewer system that will release to the proposed full

spectrum detention pond (hereinafter referred to as "Pond A-2") at a location in the downgradient area of the basin. Pond A-2 is proposed to release flows to Tributary I.

Sub-Basin A-3 is along the western extents of Rockcress Drive. Stormwater runoff from Sub-Basin A-3 is proposed to drain to future curb, gutter, inlet, and storm sewer system along Rockcress Drive that will release to the proposed full spectrum detention pond (hereinafter referred to as "Pond A-3") at a down gradient location in the southwestern corner of Sub-Basin A-2. Flows from Pond A-2 are proposed to release to the Rock Creek Tributary I channel.

West of Basin A, the Health Park subdivision and the S. 88th Street roadway contributes 84 cfs to the School Pond at the northwest corner of Basin A. The School Pond releases up to a maximum of 56 cfs, as shown on the BVSD Drainage plan provided in Appendix B, which is then routed north through a 30-inch RCP storm sewer pipe in to the Bus Loop Pond on the School Site, where it continues north. The balance of flow will overtop the 30-inch RCP in the manhole and continue east through the proposed Campus Drive storm sewer system connected to the same manhole to Pond C-1.

In the existing condition, School Site Basin X releases 1.9 cfs in the 10-year event and 4.2 cfs in the 100-year event into Basin A. School Site Detention Pond D releases 1.1 cfs in the 10-year event and 4.8 cfs in the 100-year event into Basin A. With the construction of Campus Drive, these outfalls will be collected by the proposed storm sewer main in Campus Drive. These flows will be routed to the storm sewer in Campus drive beginning at the existing flared end section at the northwest corner of the parcel and be released into Pond C-1.

Basin B is in the central portion of the Site located to the north of Rockcress Drive, to the east of Yucca Avenue, to the south of Campus Drive, and to the west of Sorrel Avenue. A natural ridge in the southern portion of the parcel splits the basin into Sub-Basins B-1 draining north and B-2 draining south.

Sub-Basin B-1 will be developed to drain to a curb, gutter, inlet and storm sewer system that will release to a proposed Full Spectrum Detention Facility Pond B (hereinafter referred to as "Pond B") located at the northeast corner of Basin B. Pond B is planned to release east across Parcel C into Tributary I. Preliminary calculations for the design of Pond B as well as outlet structure design are included in Appendix C. The final design of Pond B is the responsibility of the developer of Parcel B, and the final design of Pond B will require adequate conformance to the pond as designed with this Master Report.

Sub-Basin B-2 drains south and is contributory to proposed Full Spectrum Detention Facility Pond C-2. A storm sewer outfall stub is provided to the southeast corner of Basin B2 to collect developed stormwater runoff from Basin B-2 and route to Pond C-2 which will be constructed with Filing No. 1.

Basin C is in the eastern portion of the Site and generally lies east of Sorrel Avenue and west of S. 96th Street. A natural ridge in the south portion of the parcel splits the basin into Sub-Basins C-1 draining north and C-2 draining south. Basin C Sub-Basins include the portions of Campus Drive, Rockcress Drive, Sorrel Avenue, and Yucca Avenue which are Tributary to Ponds C-1 and C-2.

Sub-Basin C-1 is in the northeastern portion of Basin C between Sorrel Avenue and S. 96th Street. This Sub-Basin is proposed to be developed as a mix of Commercial and Residential Development. Sub-Basin C-1 contains the Full Spectrum Detention Facility Pond C-1 (hereinafter referred to as "Pond C-1"). Basin C-1 will be developed to drain to a curb, gutter, inlet and storm sewer system that will release to Pond C-1, located at the northeast corner of the basin. Pond C-1 is a planned permanent water surface facility with stormwater detention provided above the permanent water surface. The outlet of Pond C-1 will release east into Tributary I.

Sub-Basin C-2 is the southeastern portion of Basin C between Sorrel Avenue and Northwest Parkway. This area is proposed to be developed as a mix of Commercial and Residential Development. Runoff from Sub-Basin C-2 will be routed south through a proposed curb, gutter, inlet, and storm sewer system to Pond C-2 where it will be combined with flows from Sub-Basin C-5. The combined flows will then be detained for both the WQCV event and the major storm event. The outfall for Pond C-2 will be routed to the existing 48" RCP storm sewer releasing east under the Northwest Parkway.

Sub-Basin C-3 is composed of the area routed to Basin C from Campus Drive, Yucca Avenue and Sorrel Avenue. Stormwater runoff in Sub-Basin C-3 will be developed to drain to a curb, gutter, inlet, and storm sewer system that will release to Pond C-1.

Sub-Basin C-4 is composed of the northwestern portion of Campus Drive which grades preclude from being routed to Pond C-1. Stormwater runoff in Sub-Basin C-4 is to be collected by proposed curb, gutter, inlets and storm sewer which will be routed to Tributary I.

Sub-Basin C-5 is composed of the area routed to Basin C from Rockcress Drive and Sorrel Avenue. Stormwater runoff in Sub-Basin C-5 will be developed to drain to a curb, gutter, inlet, and storm sewer system that will release to Pond C-2.

Sub-Basin C-6 is composed of the southeastern portion of Rockcress Drive which grades preclude from being routed to Pond C-2. Stormwater runoff in Sub-Basin C-6 is to be collected by proposed curb, gutter, inlets, and storm sewer which will be routed to the existing 48" RCP storm sewer releasing east under Northwest Parkway.

Basin D is in the southern portion of the Site and generally lies south of Rockcress Drive and Basin E. Extents of proposed development and an existing ridge in Parcel E split Sub-Basins D-1, D-2, and E. Sub-Basin D-1 drains from both northwest and southeast to meet approximately in the center of the sub-basin. Sub-Basin D-2 generally drains along the existing ridge in Parcel E from northeast to southwest.

Sub-Basin D-1 contains the southeast corner of the Site, an area bounded by Rockcress Drive to the north, by property boundary to the south and east, and by an existing ridge to the west. Flows from Sub-Basin D-1 shall be routed to storm sewer at the intersection of Rockcress Drive and Sorrel Avenue through curb, gutter, inlets, and storm sewer. Flows will then be routed to the Full Spectrum Detention Facility Pond C-2, where flows will be detained for both the WQCV event and the major storm event. In order for the parcel to drain to Pond C-2 fill will required to be placed on the Site. If alternate parcel development plans are desired, this area may be released south to Rock Creek with the proper Jurisdictional approvals.

Sub-Basin D-2 is proposed as open space and will drain as it does historically. The historical flows for Basin D-2 generally flow from northeast to southwest into an empty field within the City and County of Broomfield. There appears to be an outfall crossing Northwest Parkway and Storage Tek Drive approximately 800' south from the southeast corner of the Site where runoff from D-2 eventually ends and continues downstream.

Basin E is in the southwest portion of the Site and generally lies south of Basin A and west of Sub-Basin D-2. Stormwater runoff in Basin E is proposed to drain to a curb, gutter, inlet and storm sewer system that will release to a proposed Full Spectrum Detention Facility Pond E (hereinafter referred to as "Pond E") located in the downgradient portion of Basin E. Pond E is planned to release northeast in to the proposed storm sewer for Yucca Avenue. Flows will then be routed through storm sewer to Pond C-1 where they will be detained for the WQCV event and then released to Tributary I.

Basin F is in the northern portion of the Site and is existing open space and will drain as it does historically. Basin F is bound on the north by the property line and on the east, west, and south by Campus Drive. The historical flows for Basin F generally flow from the extents of the basin to the center where they meet Tributary I.

Basin OS-1 is located generally west of the Site and is existing open space and roadway areas. Basin OS-1 will drain as it does historically. The historical flows for Basin OS-1 generally flow east to S. 88th Street. Flows are conveyed via culverts or overtopping of S. 88th Street to Tributary I in Basin A.

Basin OS-2 is located generally north of the Site and is existing farm and residential land. Basin OS-2 will be left to drain as it does historically. The historical flows for Basin OS-2 generally flow southeast into Basin F and then Tributary I.

TABLE 2: POND SUMMARY TABLE

POND	WATERSHED AREA (ACRE)	CONTRIBUTING BASINS	WATERSHED IMPERVIOUSNESS (%)	100 YR STORAGE PROVIDED (AC-FT)
A-2	65.1	A-2	75.00%	11.2
A-3	1.9	A-3	90.00%	0.4
B	69.2	B-1	75.00%	12.8
C-1	74.5	C-1, C-3	79.58%	16.7
C-2	79.1	B-2, C-2, C-5, D-1	77.23%	14.1
E	30.5	E	75.00%	5.4

TABLE 3: BASIN SUMMARY TABLE

BASIN	AREA (AC)	Q5 (CFS)	Q100 (CFS)
A-1	36.53	43.47	123.29
A-2	64.97	76.59	217.24
A-3	1.97	4.46	11.59
B-1	69.26	72.86	206.66
B-2	21.19	27.45	77.86
C-1	48.45	55.30	156.85
C-2	19.75	27.10	76.88
C-3	25.26	41.51	200.96
C-4	2.57	5.65	14.58
C-5	11.71	81.61	226.94
C-6	1.82	3.86	9.95
D-1	26.75	35.02	99.33
D-2	18.64	6.57	47.11
E	30.61	36.88	104.62
F	17.07	5.52	39.60
OS-1	77.38	21.33	152.93
OS-2	49.08	16.13	105.81

C. Goodhue Ditch

The Ditch traverses the far northeast corner of the Site and is owned by the Ditch Company. The Ditch contains a defined bed and bank with fringe wetlands along portions of the banks. The Ditch is shown on the U.S. Geological Survey (USGS) Louisville topographic quadrangle and on the National Hydrography Dataset (NHD) as a canal/ditch and intermittent stream.

A crossing of the Ditch by Campus Drive is planned, subject to Ditch Company's approval, with the proposed development. The Ditch will continue to outfall per historic conditions at the existing location on northeast property boundary. The Ditch Company has been contacted regarding the requirements of the proposed Ditch revisions. The proposed Ditch crossing has been designed and included in a separate plan set for approval by the Ditch Company according to the Ditch Company requirements.

Decreed flows in this section of the Ditch range between 30 cfs and 40 cfs. We have requested additional information on the specific decreed flow from the Ditch Company. Based on the Ditch crossing at the intersection of Via Varra and Northwest Parkway just north of the Broomfield Business center, a 54" RCP has been sized for the Ditch crossing. Preliminary calculations indicate that a 54" RCP conveys 40 cfs, which was used for design on the Site. A maintenance road with a minimum 15-feet wide easement is required, and the roadway crossing will also incorporate the ability for maintenance equipment to cross.

As the Ditch crossing will disturb waters of the US, the Project team has engaged the services of ERO Resources Corporation to assist in obtaining the required permitting. A copy of ERO's Preconstruction Notification (hereinafter referred to as "PCN") can be found in Appendix B. Per correspondence with the Army Corps of Engineers, the Goodhue Ditch Crossing, (NWO-2020-00467-DEN) will be issued an exemption for this project. It will be considered construction of an irrigation ditch, which is exempt under Section 404(f), and does not require a permit, which is referenced in Regulatory Guidance Letter 07-02.

The Site contains several other minor irrigation swales and ditches that are internal to the Site and do not flow off-site. All other irrigation swales and ditches in the Project are non–binding and will be routed on a Site level basis per development plans for individual parcels. See Appendix D for the Existing Drainage Plan sheet.

D. Stormwater Detention and Water Quality

All Detention and water quality ponds other than Pond C-1 on-site are designed to be Extended Detention Basins (EDBs) per the Criteria of the District Manual Volume 3. Construction Documents detail the required forebay, upper stage area, lower stage area and micro-pool area of these EDBs. Each Basin design will incorporate an outlet feature that is intended to delay the release of the WQCV over a 40-hour period. This outlet feature will also allow the major 100-year storm event to be detained and released through the top of the outlet feature. The overflow has been designed with 1.0' of freeboard to the top of the detention berm. The spillway is sized to accommodate the 100-year event total inflows to the pond and will be protected with Type L buried soil riprap outlet protection.

Pond C-1 on-site is designed to be a Retention Pond per the Criteria of the District Manual Volume 3. Construction Documents detail the required forebay, upper stage area, lower stage area and permanent pool area of this Retention Pond. This pond will incorporate an outlet feature that is intended to delay the release of the WQCV over a 12-hour period. This outlet feature will also allow the major 100-year storm event to be detained and released through the top of the outlet feature. The overflow has been designed with 1.0' of freeboard to the top of the detention berm. The spillway is sized to accommodate the 100-year event total inflows to the pond and will be protected with Type L buried soil riprap outlet protection. Pond C-1 will serve as a permanent, post-construction BMP to treat the WQCV in accordance with Louisville Criteria for the pond's tributary area. Pond C-1 will be modified as necessary to convert it to a Full Spectrum Detention Facility to detain developed flows associated with Basin C-1. Pond C-1 will outfall through storm sewer to Tributary I, just upstream of the location of the proposed culvert under S. 96th Street.

To further the MHFD goal of watershed level runoff control, this Final Master Drainage Report encourages the implementation of Low Impact Development practices and alternative water quality features per the District Manual Volume 3, Chapter 4.

The WQCV treatment system and release rate will be designed in accordance with Volume 3 of the District Manual and Chapter 6 of Louisville Criteria. The Full Spectrum Detention Facilities are designed as permanent, post-construction Best Management Practice (BMP) to treat the WQCV in accordance with Louisville Criteria for each of the facilities' tributary areas.

E. Off-site Flows

Basin D-2, which is to be left undeveloped, is the only on-site basin which will be left to flow freely off-site. This basin contains primarily landscaped areas and will continue to flow off-site per historical conditions. Off-site Basins OS-1 and OS-2 will be left to drain freely on-site as they historically do into Tributary I.

The existing pond in the northwest corner of Parcel A, known as the "School Pond", is associated with BVSD Monarch School Campuses. This pond will be removed at the time that the Campus Drive storm sewer is installed. Contributing flows to the School Pond will be rerouted from the existing flared end section and into the proposed storm sewer in Campus Drive. Currently a 30-inch diameter RCP releases a maximum flow of 56 cfs (maximum pipe capacity) from the School Pond into the BVSD Monarch School Site to the north. In the proposed condition, this pipe will connect the storm sewer main In Campus Drive to the Bus Loop Pond on the School Site. The invert of the 30-inch RCP to the Bus Loop Pond is set lower than the invert of the main, ensuring that the 30-inch continues to release 56 cfs north matching the existing condition.

Currently there are two storm sewer pipes that release historical flow into vacant land south of Campus Drive. Basin X releases 4.2 cfs in the 100-year event and Pond D releases 4.8 cfs in the 100-year event. Both of these pipes will be connected to the storm sewer main in the proposed condition of Campus Drive.

The existing inlets at the intersection of Rockcress Drive and Via Varra Road are contributory to the storm sewer system in Via Varra Road. This system connects to storm sewer in West Midway Blvd and ultimately releases south of Rock Creek. The proposed development will not add additional flows to this intersection, and the existing inlets are to be reset at the new curb locations in the intersection.

Stormwater drainage in Sub-Basin C-4 at the eastern section of Campus Drive will be routed by a curb, gutter, inlet, and storm sewer system south to Tributary I. Flows at and near the intersection of Campus Drive and S. 96th Street will release into the roadside ditch fronting Fire Station 67, and travel southeast within the roadside ditch ultimately discharge into Tributary I.

Pond C-2 and Sub-Basin C-6 release flows to an existing 48" HDPE storm sewer discharging east under E-470. In the Final Drainage Report for Parkway Circle, 96th Street & Carbon Road, the Existing Off-site Facilities Section delineates Basins DA-1A, DA-1B, and DA-1C that are tributary to the 48" HDPE with a peak flow of 349 cfs. This report also indicates that the 48" HDPE is routed within the North Storm System which runs north and then east at Carbon Drive. The grading plan with the storm sewer plan and a drainage basin map from this report can be found in Appendix B.

No other minor or major flows besides those listed above are anticipated to enter or exit the Site boundary. All flows exiting the Site, with the exception of the undeveloped Sub-Basin D-2, will be routed through proposed drainage infrastructure to existing drainage infrastructure which has the capacity available to convey said flows.

F. Rock Creek Tributary I

1. Tributary Watershed

The Tributary I Watershed is approximately 586 acres. Tributary I drains the area along U.S. Highway 36 from just West of U.S. Highway 36 to S. 96th Street, then through a narrow section from S. 96th Street to Rock Creek. The watercourse throughout consists of a well-defined channel.

The majority of the channel has a relatively wide and shallow floodplain with bank slopes which are densely vegetated with native grasses that provide significantly increased channel stability. Soils within the upper watershed vary but are considered Hydrologic soil group C.

2. CUHP and SWMM

The hydrologic stormwater routing analysis for the watershed was completed using a combination of the Colorado Urban Hydrograph Procedure (CUHP) v. 2.0.0 and the US Environmental Protection Agency Storm Water Management Model (EPA SWMM) v. 5.1. To create the Tributary I Basin regional model, storm hydrographs produced by CUHP were integrated into EPA SWMM for routing and flood risk analysis. The SWMM has been developed utilizing the proposed Site development planning areas routed to respective full-spectrum water quality and detention facilities. In general, Site areas drain to full spectrum detention facilities, which then release flows at rates that mimic historic flows into Tributary I.

The outlet structures from the regional detention facilities are designed to be concrete structures with weir controls and an outfall pipe sized to accommodate the 100-year release rate. The outlet structures will be designed per MHFD criteria. The spillway weir overflow was sized to route pond overflows. The overflow has been designed with 1.0' of freeboard to the top of the detention berm. The spillway is sized to accommodate the 100-year event total inflows to the pond and will be protected with Type L buried soil riprap outlet protection.

To understand the effects that the proposed development and regional detention ponds have on the overall Tributary I flood control system, hydrographs were compared at several locations within the Project. A summary of SWMM Hydrographs results were compared at specific nodes for the 2, 10, and 100-year events and have been included in Appendix C. Results shown in these hydrographs indicate closely matched peaks and timing for all events.

3. Hydrology Data

A detailed analysis of the OSP basin delineation was conducted in order to make comparisons of proposed to historical flow conditions. This analysis indicated a discrepancy in the Area of Basin 6-I (148-acres to 184-acres). Additionally, Basin 2-J in the OSP contained areas of the Northwest Parkway which no longer drain in the manner described in the OSP (23 acres).

Due to these discrepancies, a pre-developed CUHP/SWMM model was created to create a more accurate representation of the Site-specific historical flow conditions. The creation of this model provides a more direct comparison for acceptable release rates of developed flows from the Site's proposed detention structures, and was the hydrologic flow condition selected to represent existing conditions for the design of Tributary I.

A summary table detailing these changes and a comparison of the 100 year pre-developed flows from these basins to existing conditions from the Louisville OSP can be found in Table 1 below.

TABLE 1: EXISTING BASIN SUMMARY TABLE

BASIN	OSP AREA (AC)	PRE-DEVELOPED BASIN DELINEATION AREA (AC)	OSP EXISTING PERCENT IMPERVIOUS	PRE-DEVELOPED PERCENT IMPERVIOUS	OSP EXISTING Q100 (CFS)	PRE-DEVELOPED BASIN Q100 (CFS)
4 - I	110	110	13	2	213	128
5 - I	142	142	3	2	235	126
6 - I	148	184	57	2	382	176
2 - J	104	81	44	2	306	96

See Appendix D for the Louisville OSP Existing Drainage Plan sheet.

4. Channel Geometry

Tributary I as it exists within the Site extends from the existing culvert at S. 88th Street to the downstream culvert at S. 96th Street. The design for Tributary I is broken into three reaches. Tributary I will conform to a high functioning low maintenance (HFLM) stream design approach and will seek to armor the low-flow portion of the channel as needed. The design of the typical sections of this HFLM was based on MHFD criteria for natural streams.

Three typical channel sections for Tributary I were investigated within the Project extents and titled Reach 1, Reach 2, and Reach 3. Reach 1 will be left undisturbed in the existing channel condition. Reach 2 will maintain the existing channel's planform geometry, but will incorporate a new typical section with an armored low flow channel and minimal grading. Reach 3 will be realigned to mimic a portion of Reach 2's planform geometry, and will incorporate a new proposed cross section with an armored low flow channel. Tributary I typical sections are included in the construction documents for Redtail Ridge Filing No. 1.

Reach 1 is to be left in existing conditions because low velocities and shear stresses were evaluated within this reach. With the available spread for flow through this section it was determined that native grasses would be sufficient to maintain stability of the channel following development.

Reach 2 is proposed to include a new armored low flow channel section to accommodate for the increased volume of flows which will be introduced to the channel following development. The low flow channel is comprised of a 1.0' foot channel bottom width with 3:1 H:V side slopes designed to carry the approximate 2-year flow at a depth of 1.0'.

Reach 3 is a proposed channel between the eastern culvert under Campus Drive and the culvert under S. 96th Street. Reach 3 was designed to mimic the natural planform of Reach 2. The low flow channel is comprised of a 2.0' foot channel bottom width with 4:1 H:V side slopes designed to carry the approximate 2-year flow at a depth of 1.0'.

Flow values in the table below are taken from the SWMM model prepared for Tributary I.

TABLE 4: SWMM Tributary I Reach Flows

Rock Creek Tributary I Reach	2 YR Pre - Developed Flows (CFS)	2 YR Developed Flows (CFS)	10 YR Pre - Developed Flows (CFS)	10 YR Developed Flows (CFS)	100 YR Pre - Developed Flows (CFS)	100 YR Developed Flows (CFS)	100 YR OSP Flows* (CFS)
Reach 1	0.5	2	21	18	124	93	170
Reach 2	0.8	4	38	38	239	269	345
Reach 3	2	10	68	49	441	440	842**

*OSP values are approximate from Design Peak Flow Diagrams Drawing 6 of the OSP
**Flow includes portions of Northwest Parkway and Via Varra Subdivision

5. HECRAS Modeling

One-dimensional steady flow models were prepared for existing and proposed Tributary I configurations using a series of input parameters including flowrate, channel cross-section geometry, roughness coefficients, and main channel bank stations.

Cross-sections were sampled in regular intervals (roughly every 50') and at areas that were determined to have complex or important geometry. The geometry of the existing channel was modeled using topography extracted from ground survey provided by LIDAR data that was collected for the Site. Cross-sections were created in AutoCAD, which were then exported into HEC-RAS for analysis. The Manning's n roughness was chosen based on MHFD suggested values for native grasses and to represent the existing topography of natural grasses within Tributary I.

The following Manning's n values were used for native grasses within the channel:

- 0.032 when assessing Velocity, Froude No., Shear Stress
- 0.050 when assessing Water Surface Elevation and Water Depth

The development does not plan to introduce new or different vegetative communities that would alter these coefficients.

Table 5 provides the calculated hydraulic parameters for the three proposed typical cross-sections indicating low velocities and shear stress.

Flow for the major storm event was quantified within the CUHP/EPASWMM model. Flows as listed in Table 4 of this report were used as input values within the model as steady-state flow to represent the 100-year event within Tributary I.

Boundary conditions of the HEC-RAS model were based on normal depth and the average slope of the channel. A mixed-flow analysis was performed based on the mild slopes within the existing channel geometry that are expected to have sub-critical flow and the proposed drop structure where super critical flow and hydraulic jumps are predicted to occur.

The results of the model were used to represent the proposed and existing flooding extents of the 2, 10, and 100-year events, flooding depths, and flow velocities to determine channel stability. A Floodplain Workmap indicating cross-section locations and proposed floodplain limits as well as a copy of the HEC-RAS model results are included in Appendix E. It is noted that the resulting flow velocities and depths indicated a stable stream section except within the bankfull channel. A natural stream design, while accounting for higher velocities and shear stresses in the bankfull section will be used to mimic the current stream conditions.

6. Revegetation

The disturbed areas of Tributary I will be seeded with a seeding plan consisting of two main seed mixes, an Upland Seed Mix and a Riparian Seed Mix.

To further encourage the development of well-established vegetation, soil amendments may be incorporated along Tributary I channel slopes. Depending on growing conditions, a temporary irrigation system may be needed.

Details on the percentage of each grass in each mix, locations, and areas where the different seed mixes are to be applied will be included in the Rock Creek Tributary I Channel and Detention Pond Seeding and Vegetation Management Plan to be submitted with Filing No. 1 Drainage Report. This report is currently being prepared, in coordination with the MHFD. Fieldwork required to complete the study has been accelerated to April 2020 to take advantage of warmer weather to complete an assessment of existing vegetation and complete the vegetation management plan prior to approval.

7. MHFD Maintenance Eligibility

The Tributary I improvements and all drainage improvements impacting Tributary I have been designed to meet MHFD maintenance eligibility requirements.

TABLE 5: TRIBUTARY I CHANNEL HYDRAULIC RESULTS SUMMARY

REACH 1 TYPICAL SECTION	**Q2**	**Q10**	**Q100**
Discharge (cfs)	1.82	18.04	93.17
Total Depth (ft)	0.09	0.26	0.59
Area (sf)	1.99	9.04	28.99
Slope (ft/ft)	0.015	0.018	0.016
Velocity (ft/s)	0.91	1.99	3.21
Wp (wetted perimeter - ft.)	31.55	49.3	71.41
Top Width (ft)	31.55	49.4	71.40
Hydraulic Radius (A / Wp)	0.06	0.18	0.41
Shear Stress (lb/sf)	0.06	0.20	0.40
REACH 2 TYPICAL SECTION	**Q2**	**Q10**	**Q100**
Discharge (cfs)	4.22	37.95	270.8
Total Depth (ft)	0.85	1.58	2.32
Area (sf)	2.34	15.08	77.76
Slope (ft/ft)	0.007	0.011	0.008
Velocity (ft/s)	1.81	2.52	3.48
Wp (wetted perimeter - ft.)	5.77	53.49	109.17
Top Width (ft)	5.51	53.13	108.78
Hydraulic Radius (A / Wp)	0.41	0.28	0.71
Shear Stress (lb/sf)	0.18	0.48	0.72
REACH 3 TYPICAL SECTION	**Q2**	**Q10**	**Q100**
Discharge (cfs)	10.53	51.57	439.06
Total Depth (ft)	0.86	1.47	2.26
Area (sf)	5.31	19.41	99.1
Slope (ft/ft)	0.006	0.007	0.012
Velocity (ft/s)	1.98	2.66	4.43
Wp (wetted perimeter - ft.)	10.36	41.69	129.68
Top Width (ft)	10.17	41.47	129.43
Hydraulic Radius (A / Wp)	0.51	0.47	0.77
Shear Stress (lb/sf)	0.20	0.44	0.54

TABLE 6: FROM DISTRICT TABLE 8-3. DESIGN PARAMETERS FOR NATURALIZED CHANNELS

Design Parameters for Naturalized Channels					
Design Parameter	**MHFD Recommended Value**	**Rock Creek Tributary I Design Value**			**Comment**
Maximum 100-year Depth Outside of Bankfull Channel	5 ft	4.66 ft			Meets Criteria
Roughness Values	Per Table 8-5	Flooding Extents - n = 0.05 overbanks, n = 0.04 channel; Velocity/Shear Stress/Froude - n = 0.03 overbanks, n - 0.035 main channel			Meets Criteria
Maximum 5-year Velocity, Main Channel (Within Bankfull Channel Width) (ft./s)	5 ft/s	**Reach 1**	**Reach 2**	**Reach 3**	Channel is Lined in Reach 2 & 3 to Account for Excess Velocity
		2.98 ft/s (10-YR)	5.05 ft/s (10-YR)	4.8 ft/s (10-YR)	
Maximum 100-year Velocity, Main Channel (Within Bankfull Channel Width) (ft./s)	7 ft/s	4.34 ft/s	7.69 ft/s	7.60 ft/s	Channel is Lined in Reach 2 & 3 to Account for Excess Velocity
Froude No., 5-year, Main Channel (Within Bankfull Channel Width)	0.7	0.99 (10-YR)	0.94 (10-YR)	0.92 (10-YR)	Channel is lined in Reach 2 & # to Account for Excess Froude #
Froude No., 100-year, Main Channel (Within Bankfull Channel Width)	0.8	1.3	1.14	1.05	Channel is Generally Stable in Existing Condition
Maximum Shear Stress, 100-year, Main Channel (Within Bankfull Channel Width)	1.2 lb/sf	0.78 lb/sf	2.15 lb/sf	1.96 lb/sf	Channel is Lined in Reach 2 & 3 to Account for Excess Shear Stress
Minimum Bankfull Capacity of Bankfull Channel (Based on Future Development Conditions)	70% of 2-year discharge or 10% of 100-yr discharge, whichever is greater (see above)	100% 2-year discharge	100% 2-year discharge	100% 2-year discharge	Does not meet 100-yr criteria, but designed to mimic existing geometry.

TABLE 6: FROM DISTRICT TABLE 8-3. DESIGN PARAMETERS FOR NATURALIZED CHANNELS CONT.

Design Parameters for Naturalized Channels					
Minimum Bankfull Channel Geometry	Per Table 8-2	Depth = 0.1', Width = 47', Terrace = 51'	Depth = 1', Width = 9', Terrace = 70'	Depth = 1', Width = 10', Terrace = 70'	Meets Criteria
Minimum Bankfull Channel Width/Depth Ratio (Equation 8-3)	9	470.0	9.3	12.5	Meets Criteria
Minimum Entrenchment Ratio (Equation 8-4)	3	3.2	16.7	15.0	Meets Criteria
Maximum Longitudinal Slope of Low Flow Channel (Assuming Unlined, Unvegetated Low Flow Channel)	0.2 percent	1.68%	2.07%	1.59%	Low Flow Channel is Lined and Vegetated
Bankfull Channel Sinuosity (Equation 8-5)	1.1 to 1.3	1.02	1.04	1.05	Designed to Match Existing Channel Sinuosity
Maximum Overbank Side Slope	4(H):1(V)	10(H):1(V)	33(H):1(V)	33(H):1(V)	Meets Criteria
Maximum Bankfull Side Slope	2.5(H):1(V)	100(H):1(V)	3(H):1(V)	4(H):1(V)	Meets Criteria
Minimum Radius of Curvature	2.5 times top width, Reach 1 = 100', Reach 2 = 22.5', Reach 3 = 25'	161' = 3.4x	65' = 7.2x	65' = 6.5x	Meets Criteria

- Manning's n=0.032 When Assessing Velocity, Froude No., Shear Stress
- Manning's n=0.050 When Assessing Water Surface Elevation and Water Depth

8. Culverts

Several culverts are proposed with the Project and the culvert calculating program HY-8 was used to analyze these culverts. In HY-8 the tailwater was determined through a normal depth calculation based on downstream channel geometry inputs.

Two culverts have been designed for crossing the proposed Campus Drive at Tributary I reach stations 30+00 and 7+00.

Both crossings are composed of a dual box system which includes one lower structure solely for flow conveyance and another raised structure which doubles as a trail underpass for vehicle and pedestrian access during storms up to the 10-year event. The lower RCBC will have a span of 8' with a rise of 5' and the raised trail underpass RCBC will have a span of 10' and rise of 8'.

A culvert is proposed to cross under S. 96th Street on the downstream end of Tributary I project extents. The RCBC will also be a dual barrel culvert approximately 80' long and have a span of 8' with a rise of 5'. This culvert does not include a trail underpass.

G. Site Phasing

The overall Site storm sewer and detention pond improvement phasing is broken out by Filing No. below:

<u>Redtail Ridge Subdivision Filing No. 1 – Parcels B, C, and F</u>

- Campus Drive storm sewer in its entirety
- Rockcress Drive storm sewer built from Via Varra to Sorrel Avenue
- Sorrel Avenue storm sewer
- Pond C-1 and Pond C-2
- Rock Creek Tributary I in its entirety

<u>Redtail Ridge Subdivision Filing No. 2 – Parcels A, D, and E</u>

- Pond A-2, Pond A-3, Pond B, and Pond E
- Rockcress Drive storm sewer in its entirety

H. Construction Best Management Practices (BMP) Plan

<u>Erosion and Sediment Control Measures Discussion</u>

All areas considered for development and any disturbed areas will be included in the Stormwater Management Plan (SWMP) design. The proposed grading design for this Site will consist of both cut and fill. The predominant Construction BMP (CBMP) control measure will be several sedimentation basins located throughout the Project

area to be installed as the Project phasing occurs. These basins have been sized to account for sediment yield from the basins adjacent to that area.

Initial SWMP ~ Utilizes a combination of the following:

- Stabilized staging area (SSA)
- Construction Entrance and Vehicle Tracking Control (CE) (VTC)
- Concrete Washout Area (CWA)
- Silt fence (SF) installation on the downstream portions of the Site
- Inlet protection (IP) for the existing storm drain system located adjacent to the Site
- Check Dam (CD) for open channels
- Temporary Stream Crossing (SC)
- Temporary Sediment Basin (TSB)
- Sediment Control Log (SCL)
- Project phasing to minimize the amount of open acreage.

Interim SWMP ~ Within phasing limits utilizes a combination of the following:

- Stabilized staging area (SSA)
- Construction Entrance and Vehicle Tracking Control (CE) (VTC)
- Concrete Washout Area (CWA)
- Surface roughening (SR)
- Temporary Stream Crossing (SC)
- Inlet protection (IP) for the existing storm drain system located adjacent to the Site
- Sediment Control Log (SCL)
- Silt fence (SF) installation on the downstream portions of the Site
- Maintenance of the previously installed measures

Interim SWMP ~ Utilizes a combination of sediment control measures, after the storm system has been installed, of the following:

- On-site Inlet Protection (IP)
- Check Dams within swales (CD)
- Additional Silt Fencing (SF)
- Surface roughening (SR)
- Outlet Protection (OP) for newly installed storm drain system
- Sediment Control Log (SCL)
- Maintenance of all new and previously installed measures.

Final SWMP ~ Utilizes a combination of sediment control measures, after the storm system has been installed, of the following:

- On-site Inlet Protection (IP) to remain until all disturbed areas have been re-established with 80% vegetation.
- Outlet Protection (OP)
- Erosion Control Blanket (ECB) on slopes greater than 4:1
- Seeding, Mulching, and Crimping (SMC)
- Surface Roughening (SF)
- Temporary Irrigation (TI)
- Silt Fence (SF) to remain until all disturbed areas have been re-established with 80% vegetation.
- Maintenance of all installed measures.
- Upon acceptance by the City, all temporary measures are to be removed and any disturbance caused by these removals shall be brought into compliance to achieve restoration of the area.

I. Project Schedule

The start of the project schedule is determined on the approval of the project Grading, Erosion and Sediment Control plan and supportive construction documents. At the time of approval it is anticipated that the Initial SWMP measures will be implemented within one week. The following time line of events is determined by the date of issuance of the Grading Permit. A pre-construction meeting will be necessary to adequately establish the final phasing areas and implementation of the SWMP measures. At the pre-construction meeting the final schedule will be determined. It is anticipated that the grading operations for the entire disturbed area will take approximately six months, weather permitting.

J. BMP Maintenance

The General Contractor will designate an on-site SWMP Manager at the time of permit issuance. The Contractor's SWMP Manager will be the responsible party for ensuring that the Site remains in compliance with the SWMP and will be the Contractor's contact person with the permitting agency for all matters pertaining to the permit. Paved areas, including streets, will be kept clean throughout build-out and will be cleaned at first notice of accidental tracking. At a minimum, the SWMP Manager will inspect all BMP's weekly and after runoff events. All necessary maintenance and repair activities will be performed within 24-hours or as directed by the permitting agency.

V. CONCLUSIONS

A. Compliance with Standards

Drainage design for the Site was performed in accordance with Louisville and MHFD Criteria. The District Manual was used for the design of the Site only when instructed to by Louisville Criteria. The control measures identified in this report are in compliance with part I.E.4.a.iv of the CDPHE Municipal Storm Sewer Systems General permit.

It is the intent of this Final Master Drainage Report to act as the master report for the entire Site. Future Development's preliminary plats, final plats, and individual Site Plans shall be required to submit their own Preliminary and Final Drainage Reports, as applicable, with subsequent development applications.

B. Drainage Concept

The proposed drainage design for the Site will effectively control and minimize any damage from storm runoff associated with the design storms. As stated, runoff will be routed through proposed curb and gutter within roadways, to proposed storm sewer inlets and pipes, and then to one of six Full Spectrum Detention Facilities. All these systems will be adequately sized for the flows associated with the Site and off-site discharges will be managed in a manner which causes no negative effects downstream.

VI. REFERENCES

1. *Boulder Valley School District Louisville Campus PUD Drainage Report*, Charles Keim & Associates, May 31, 1996
2. *City of Louisville/Bounder County Outfall System Plan*, Water Resources Consultants, INC. November 1982
3. *Executive Summary of Previous Investigations, Former ConocoPhillips Site (Storage Tek Campus),* CTL|Thompson, April 19, 2019.
4. *Flood Insurance Rate Map*, Boulder County, Colorado, Map #08013C0584J, FEMA, revised December 18, 2012.
5. Storm Drainage Design & Technical Criteria Manual, City of Louisville, August 2013
6. *Phase I Environmental Site Assessment Former Conoco Phillips Site*, CTL|Thompson, February 25, 2019.
7. MHFD / Urban Storm Drainage Criteria Manual, Volumes 1, 2, and 3 by Urban Drainage and Flood Control District, Current Version.

APPENDIX A – Vicinity Map, FIRM Map, and NRCS Web Soil Survey

CITY OF LOUISVILLE
DRAINAGE REPORT SUBMITTAL CHECKLIST

PREPARED BY: _____ DATE: OCTOBER 2, 2019

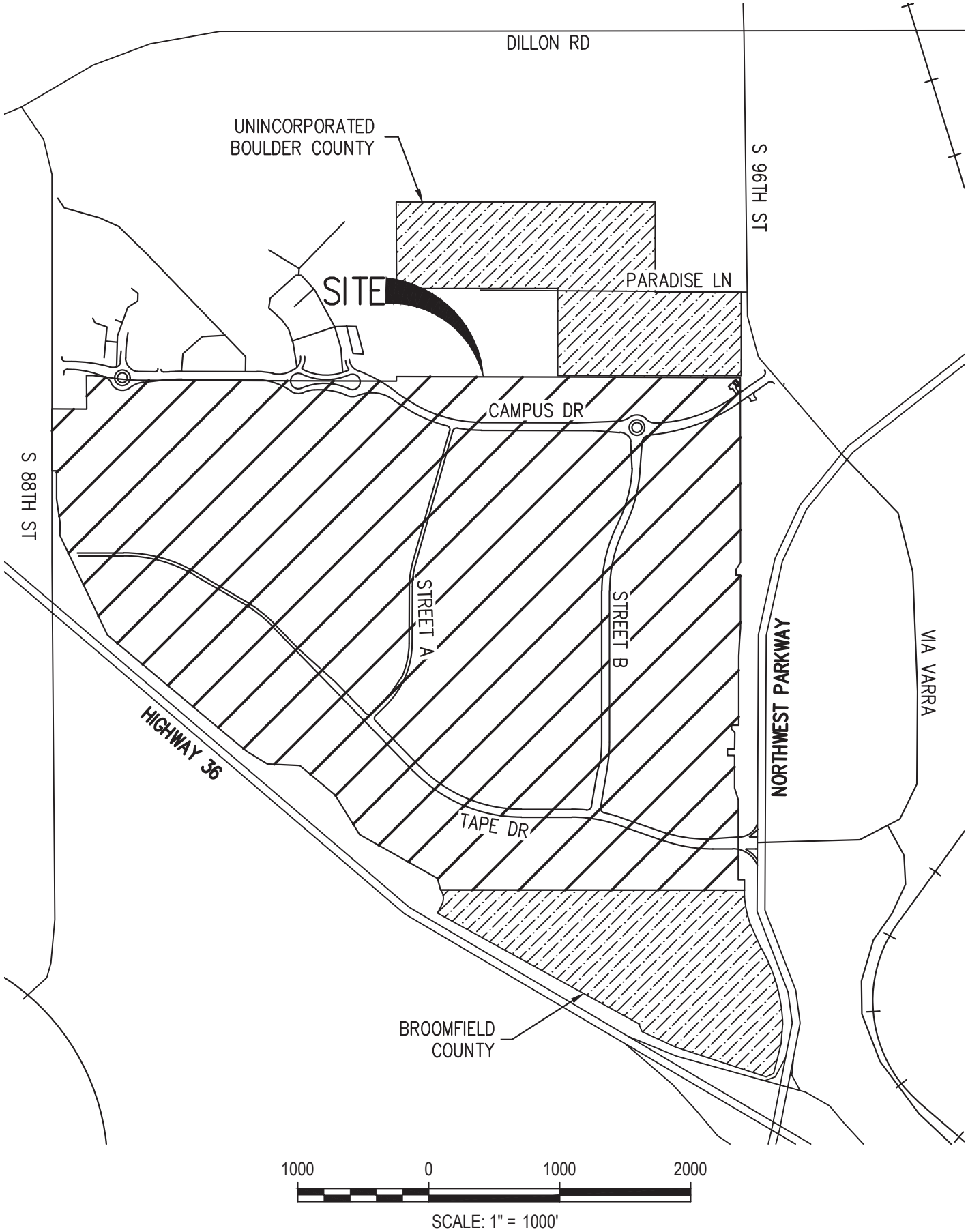
The drainage report for the development as noted below has been received and found to lack the information noted. This information must be submitted before the report will be accepted for review. Please provide the required information.

DEVELOPMENT: NAWATNY RIDGE
LOCATION: S OF CAMPUS DRIVE, W OF 96TH STREET, N OF HIGHWAY 36
DATE SUBMITTED: OCTOBVER 2, 2019
SUBMITTED BY: FIRM HARRIS KOCHER SMITH
CONTACT MARK A WEST
PHONE 303-623-6300 FAX _____

☐ Preliminary Report ☐ Final Report

CHECKLIST

ITEM	DESCRIPTION	RECEIVED OR NOT APPLICABLE	TO BE SUBMITTED
1.	Typed, Bound Report with Cover Letter	X	
2.	Professional Engineer's Certificate	X	
3.	General Location and Description		
	(a) Location Map	X	
	(b) Existing Site Description	X	
	(c) Description of Existing Drainage Patterns and Facilities	X	
4.	Drainage Basins and Sub-Basins		
	(a) Major Basin Description	X	
	(b) Sub-Basin Description	X	
5.	Design Criteria		
	(a) Discussion of Basinwide Planning Studies	X	
	(b) Hydrologic Criteria Discussion	X	
	(c) Hydraulic Criteria Discussion	X	
	(d) Hydrologic/Hydraulic Computations	X	
6.	Drainage Facility Design		
	(a) Discussion of proposed Facilities	X	
	(b) Discussion of Drainage Patterns	X	
	(c) Impact on Offsite Facilities	X	
	(d) Impact on Master Plan	X	
7.	Drainage Plan		
	(a) Topographic Contours	X	
	(b) ROW and Easements	X	
	(c) Delineation of Basin and Sub-Basins	X	
	(d) Existing Drainage Patterns and Facilities	X	
	(e) Proposed Drainage Patterns and Facilities	X	
	(f) Proposed Outfall Points	X	
	(g) Routing of Offsite Drainage	X	
8.	Other As Stated:		



Plotted: TUE 01/21/20 1:58:27P By: Jeffrey Nye Filepath: p:\190108\engineering\xref\vic map.dwg Layout: layout1

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH.

ISSUE DATE: 06-06-2019 | PROJECT #: 190108

DATE	REVISION COMMENTS
-	-
-	-
-	-
-	-
-	-
-	-

BRUE BAUKOL PARTNERS

REDTAIL RIDGE
VICINITY MAP

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

DSN'D BY: TJS
CHK'D BY: TJS
DRAWN BY: SJA

SHEET NO.
1
1 OF 1

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 provided by the FEMA Map Service Center and the Boulder Area Spatial Data Cooperative (BASDC). Additional input was provided by the Town of Erie and the City of Longmont. These data are current as of 2004.

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.

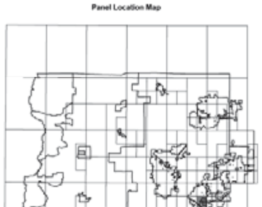
If you have **questions about this map**, how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

Boulder County Vertical Datum Offset Table

Flooding Source	Vertical Datum Offset (ft)	Flooding Source	Vertical Datum Offset (ft)
Coal Creek	3.3	Rock Creek	3.2

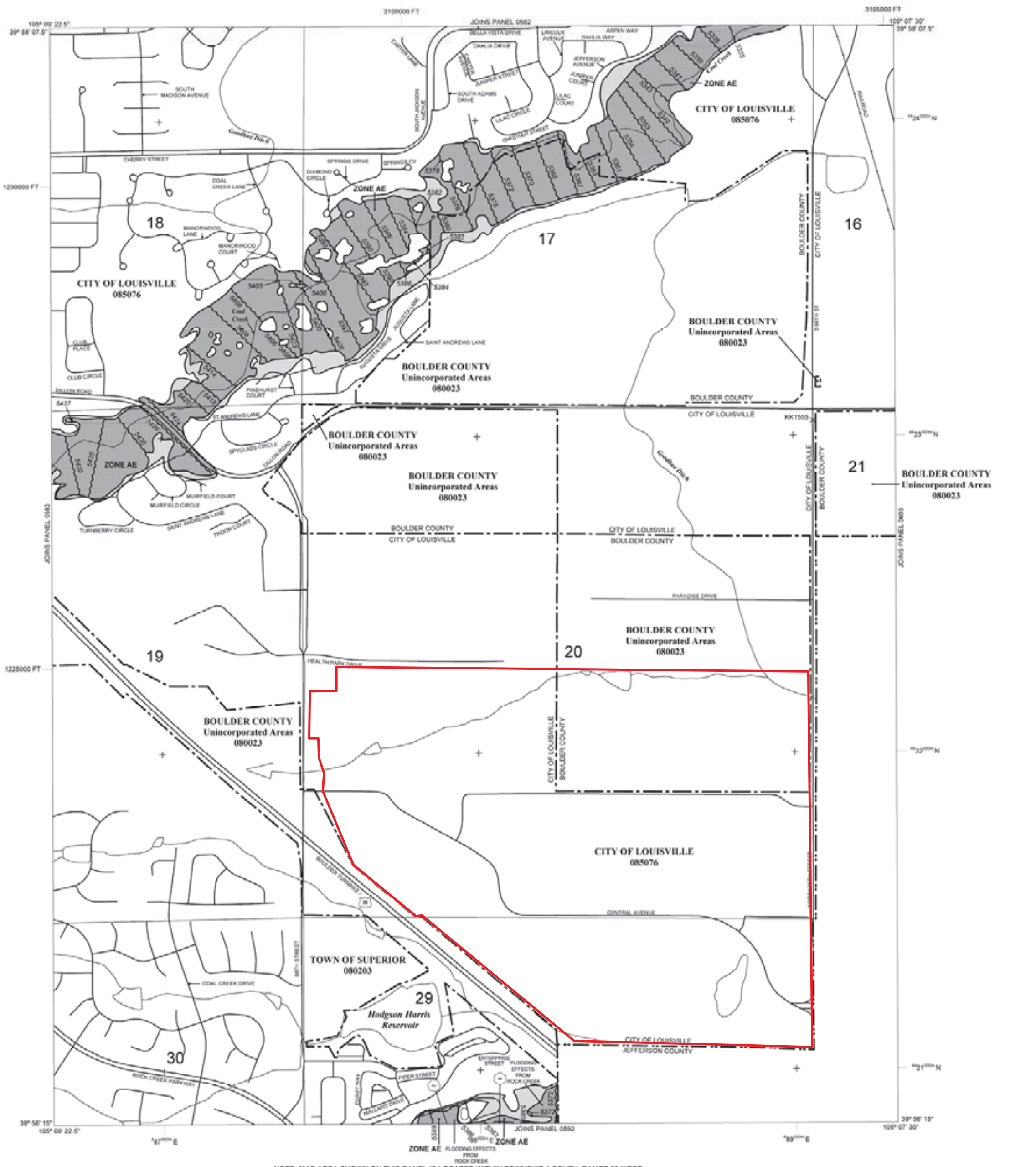
Example: To convert Coal Creek elevations to NAVD 88, 3.3 feet were added to the NGVD 29 elevations.

Panel Location Map



This digital Flood Insurance Rate map (FIRM) was produced through a cooperative partnership between the State of Colorado Water Conservation Board, the Urban Drainage and Flood Control District, and the Federal Emergency Management Agency (FEMA). The State of Colorado Water Conservation Board and the Urban Drainage and Flood Control District have implemented a long-term approach of floodplain management to reduce the costs associated with flooding. As part of this effort, both the State of Colorado and the Urban Drainage and Flood Control District have joined in Cooperating Technical Partner agreements with FEMA to produce this digital FIRM.

Additional Flood Hazard Information and resources are available from local communities, the Colorado Water Conservation Board, and the Urban Drainage and Flood Control District.



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

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

*Referenced to the North American Vertical Datum of 1988

A — A: Cross section line
23 - - - 23: Transect line
45° 02' 08", 93° 02' 12": Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
$^{45}89^{000m}$ N: 1000-meter Universal Transverse Mercator grid values, zone 13
3100000 FT: 5000-foot ticks: Colorado State Plane North Zone (FIPS Zone 0501), Lambert Conformal Conic projection
DX5510 ×: Bench mark (see explanation in Notes to Users section of this FIRM panel)
•M1.5: River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 2, 1995

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
May 6, 1996 - to incorporate previously issued Letters of Map Revision; to add roads and road names; and to update corporate limits.
October 4, 2002 - to change base flood elevations, to change special flood hazard areas, to change zone designations, to update roads and road names, to reflect updated topographic information; to incorporate previously issued Letters of Map Revision; and to change floodway.
December 18, 2012 - to update corporate limits; to update roads and road names; to add Special Flood Hazard Areas previously shown on Town of Erie, Colorado Flood Insurance Rate Map dated December 2, 2004; and to incorporate previously issued Letters of Map Revision.

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

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

MAP SCALE 1" = 500'

250 0 500 1000 FEET
150 0 150 300 METERS

NFIP — NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0584J

FIRM
FLOOD INSURANCE RATE MAP
BOULDER COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 584 OF 615

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BOULDER COUNTY	080023	0584	J
LOUISVILLE, CITY OF	085076	0584	J
SUPERIOR, TOWN OF	080203	0584	J

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

MAP NUMBER
08013C0584J

MAP REVISED
DECEMBER 18, 2012

Federal Emergency Management Agency

United States Department of Agriculture

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 Boulder County Area, Colorado

January 6, 2020

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).

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.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

Preface.....2
How Soil Surveys Are Made.....5
Soil Map.....8
Soil Map.....9
Legend.....10
Map Unit Legend.....11
Map Unit Descriptions.....11
Boulder County Area, Colorado.....13
CoC—Colby silty clay loam, 3 to 5 percent slopes.....13
KuD—Kutch clay loam, 3 to 9 percent slopes.....14
NuB—Nunn clay loam, 1 to 3 percent slopes.....15
NuC—Nunn clay loam, 3 to 5 percent slopes.....16
Te—Terrace escarpments.....18
VaB—Valmont clay loam, 1 to 3 percent slopes.....18
VaC—Valmont clay loam, 3 to 5 percent slopes.....20
VcC—Valmont cobbly clay loam, 1 to 5 percent slopes.....21
VcE—Valmont cobbly clay loam, 5 to 25 percent slopes.....22
W—Water.....23
References.....24
Glossary.....26

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.

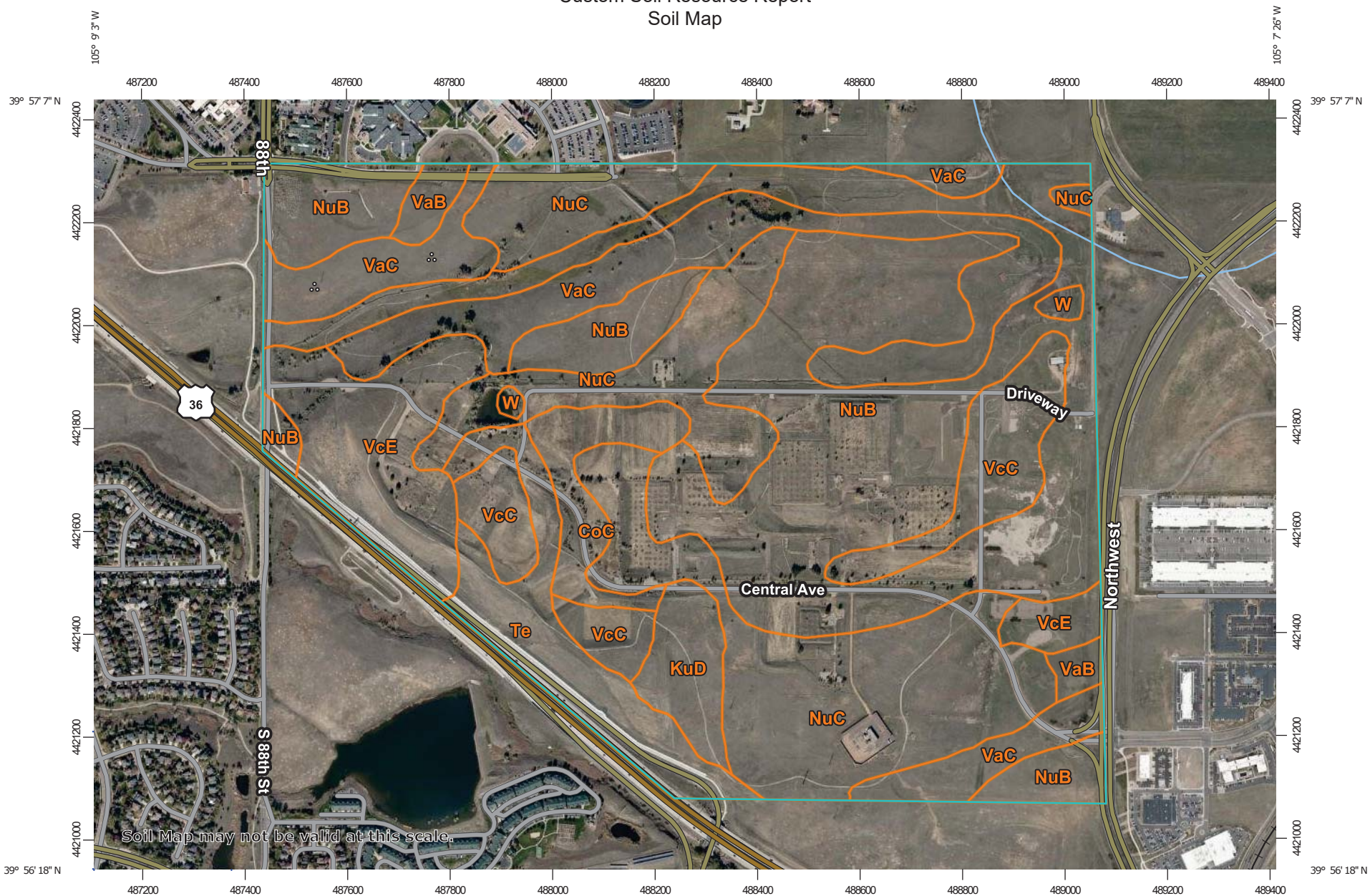
After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

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

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: 1:10,500 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 150 300 600 900

Feet: 0 500 1000 2000 3000

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

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 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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: Boulder County Area, Colorado
Survey Area Data: Version 16, Sep 13, 2019

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

Date(s) aerial images were photographed: Sep 25, 2018—Apr 9, 2019

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
CoC	Colby silty clay loam, 3 to 5 percent slopes	12.7	2.9%
KuD	Kutch clay loam, 3 to 9 percent slopes	10.6	2.4%
NuB	Nunn clay loam, 1 to 3 percent slopes	154.9	35.8%
NuC	Nunn clay loam, 3 to 5 percent slopes	97.4	22.5%
Te	Terrace escarpments	25.3	5.8%
VaB	Valmont clay loam, 1 to 3 percent slopes	5.7	1.3%
VaC	Valmont clay loam, 3 to 5 percent slopes	62.6	14.5%
VcC	Valmont cobbly clay loam, 1 to 5 percent slopes	27.7	6.4%
VcE	Valmont cobbly clay loam, 5 to 25 percent slopes	34.3	7.9%
W	Water	1.7	0.4%
Totals for Area of Interest		**432.9**	**100.0%**

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.

Boulder County Area, Colorado

CoC—Colby silty clay loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: jprf
Elevation: 4,900 to 5,500 feet
Mean annual precipitation: 14 to 18 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 140 to 155 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Colby and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Colby

Setting

Landform: Upland slopes
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Uniform eolian deposits

Typical profile

H1 - 0 to 12 inches: silty clay loam
H2 - 12 to 43 inches: silty clay loam
H3 - 43 to 60 inches: clay loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Available water storage in profile: High (about 11.4 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

Minor Components

Gaynor

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

Weld

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

KuD—Kutch clay loam, 3 to 9 percent slopes

Map Unit Setting

National map unit symbol: jprx
Elevation: 4,900 to 5,500 feet
Mean annual precipitation: 12 to 18 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 140 to 155 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

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

Description of Kutch

Setting

Landform: Valley sides
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Clayey residuum weathered from sedimentary rock

Typical profile

H1 - 0 to 7 inches: clay loam
H2 - 7 to 22 inches: clay
H3 - 22 to 30 inches: clay
H4 - 30 to 34 inches: unweathered bedrock

Properties and qualities

Slope: 3 to 9 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Available water storage in profile: Low (about 4.8 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e

Hydrologic Soil Group: D
Ecological site: Clayey Foothill (R049BY208CO)
Hydric soil rating: No

Minor Components

Renohill
Percent of map unit: 6 percent
Hydric soil rating: No

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

Samsil
Percent of map unit: 2 percent
Hydric soil rating: No

Shingle
Percent of map unit: 2 percent
Hydric soil rating: No

NuB—Nunn clay loam, 1 to 3 percent slopes

Map Unit Setting
National map unit symbol: 2tlpl
Elevation: 3,900 to 5,840 feet
Mean annual precipitation: 13 to 17 inches
Mean annual air temperature: 50 to 54 degrees F
Frost-free period: 135 to 160 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Nunn and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nunn

Setting
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Pleistocene aged alluvium and/or eolian deposits

Typical profile
Ap - 0 to 9 inches: clay loam
Bt - 9 to 13 inches: clay loam
Btk - 13 to 25 inches: clay loam
Bk1 - 25 to 38 inches: clay loam
Bk2 - 38 to 80 inches: clay loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 7 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 0.5
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: Clayey Plains (R067BY042CO)
Hydric soil rating: No

Minor Components

Heldt

Percent of map unit: 10 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Clayey Plains (R067BY042CO)
Hydric soil rating: No

Satanta

Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

NuC—Nunn clay loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2tlpm
Elevation: 5,000 to 5,750 feet
Mean annual precipitation: 12 to 17 inches
Mean annual air temperature: 46 to 54 degrees F

Frost-free period: 100 to 160 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

Nunn and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Nunn

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Pleistocene aged alluvium and/or eolian deposits

Typical profile

A - 0 to 6 inches: clay loam
Bt - 6 to 18 inches: clay
Btk - 18 to 30 inches: clay
Bk - 30 to 47 inches: clay loam
BCk - 47 to 80 inches: clay loam

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 7 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.1 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 0.5
Available water storage in profile: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: Clayey Plains (R067BY042CO)
Hydric soil rating: No

Minor Components

Satanta

Percent of map unit: 10 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: Loamy Plains (R067BY002CO)
Hydric soil rating: No

Te—Terrace escarpments

Map Unit Setting

National map unit symbol: jpsv
Elevation: 4,400 to 5,500 feet
Mean annual precipitation: 10 to 16 inches
Mean annual air temperature: 46 to 54 degrees F
Frost-free period: 120 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Terrace Escarpments

Setting

Landform: Paleoterraces, fan remnants
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Base slope, riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Cobbly and stony colluvium over sandstone and shale

Typical profile

H1 - 0 to 6 inches: gravelly sand
H2 - 6 to 60 inches: gravelly sand, very gravelly sand, gravelly coarse sand
H2 - 6 to 60 inches:
H2 - 6 to 60 inches:

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Hydric soil rating: No

VaB—Valmont clay loam, 1 to 3 percent slopes

Map Unit Setting

National map unit symbol: jpsw
Elevation: 4,900 to 5,500 feet
Mean annual precipitation: 12 to 18 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 140 to 155 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Valmont

Setting

Landform: Terraces, fan remnants
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Gravelly and cobbly loamy alluvium

Typical profile

H1 - 0 to 9 inches: clay loam
H2 - 9 to 29 inches: clay loam, clay
H2 - 9 to 29 inches: very gravelly loam, very gravelly sandy loam
H3 - 29 to 60 inches:
H3 - 29 to 60 inches:

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Very high (about 12.4 inches)

Interpretive groups

Land capability classification (irrigated): 2e
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: C
Ecological site: Clayey Foothill (R049BY208CO)
Hydric soil rating: No

Minor Components

Nunn

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

Fluventic haplaquolls

Percent of map unit: 4 percent
Landform: Terraces
Hydric soil rating: Yes

Heldt

Percent of map unit: 3 percent
Hydric soil rating: No

VaC—Valmont clay loam, 3 to 5 percent slopes

Map Unit Setting

National map unit symbol: jpsx
Elevation: 4,900 to 5,500 feet
Mean annual precipitation: 12 to 18 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 140 to 155 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition

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

Description of Valmont

Setting

Landform: Terraces, fan remnants
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Gravelly and cobbly loamy alluvium

Typical profile

H1 - 0 to 7 inches: clay loam
H2 - 7 to 24 inches: clay loam, clay
H2 - 7 to 24 inches: very gravelly loam, very gravelly sandy loam
H3 - 24 to 60 inches:
H3 - 24 to 60 inches:

Properties and qualities

Slope: 3 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.8 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C

Ecological site: Clayey Foothill (R049BY208CO)
Hydric soil rating: No

Minor Components

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

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

Fluventic haplaquolls
Percent of map unit: 2 percent
Landform: Flood plains
Hydric soil rating: Yes

VcC—Valmont cobbly clay loam, 1 to 5 percent slopes

Map Unit Setting
National map unit symbol: jpsy
Elevation: 4,900 to 5,500 feet
Mean annual precipitation: 12 to 18 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 140 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition
Valmont and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Valmont

Setting
Landform: Terraces, fan remnants
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Gravelly and cobbly loamy alluvium

Typical profile
H1 - 0 to 8 inches: cobbly clay loam
H2 - 8 to 22 inches: clay loam, clay
H2 - 8 to 22 inches: very gravelly loam, very gravelly sandy loam
H3 - 22 to 60 inches:
H3 - 22 to 60 inches:

Properties and qualities
Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained

Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 11.0 inches)

Interpretive groups
Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: Cobbly Foothills (R048AY346CO)
Hydric soil rating: No

VcE—Valmont cobbly clay loam, 5 to 25 percent slopes

Map Unit Setting
National map unit symbol: jpsz
Elevation: 4,900 to 5,500 feet
Mean annual precipitation: 12 to 18 inches
Mean annual air temperature: 48 to 52 degrees F
Frost-free period: 140 to 155 days
Farmland classification: Not prime farmland

Map Unit Composition
Valmont and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Valmont

Setting
Landform: Terraces, fan remnants
Landform position (three-dimensional): Base slope, riser
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Gravelly and cobbly loamy alluvium

Typical profile
H1 - 0 to 6 inches: cobbly clay loam
H2 - 6 to 18 inches: clay loam, clay
H2 - 6 to 18 inches: very gravelly loam, very gravelly sandy loam
H3 - 18 to 60 inches:
H3 - 18 to 60 inches:

Properties and qualities
Slope: 5 to 10 percent
Depth to restrictive feature: More than 80 inches

Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 10.6 inches)

Interpretive groups
Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: Cobbly Foothills (R048AY346CO)
Hydric soil rating: No

Minor Components

Dacono
Percent of map unit: 9 percent
Hydric soil rating: No

Fluventic haplaquolls
Percent of map unit: 1 percent
Landform: Flood plains
Hydric soil rating: Yes

W—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

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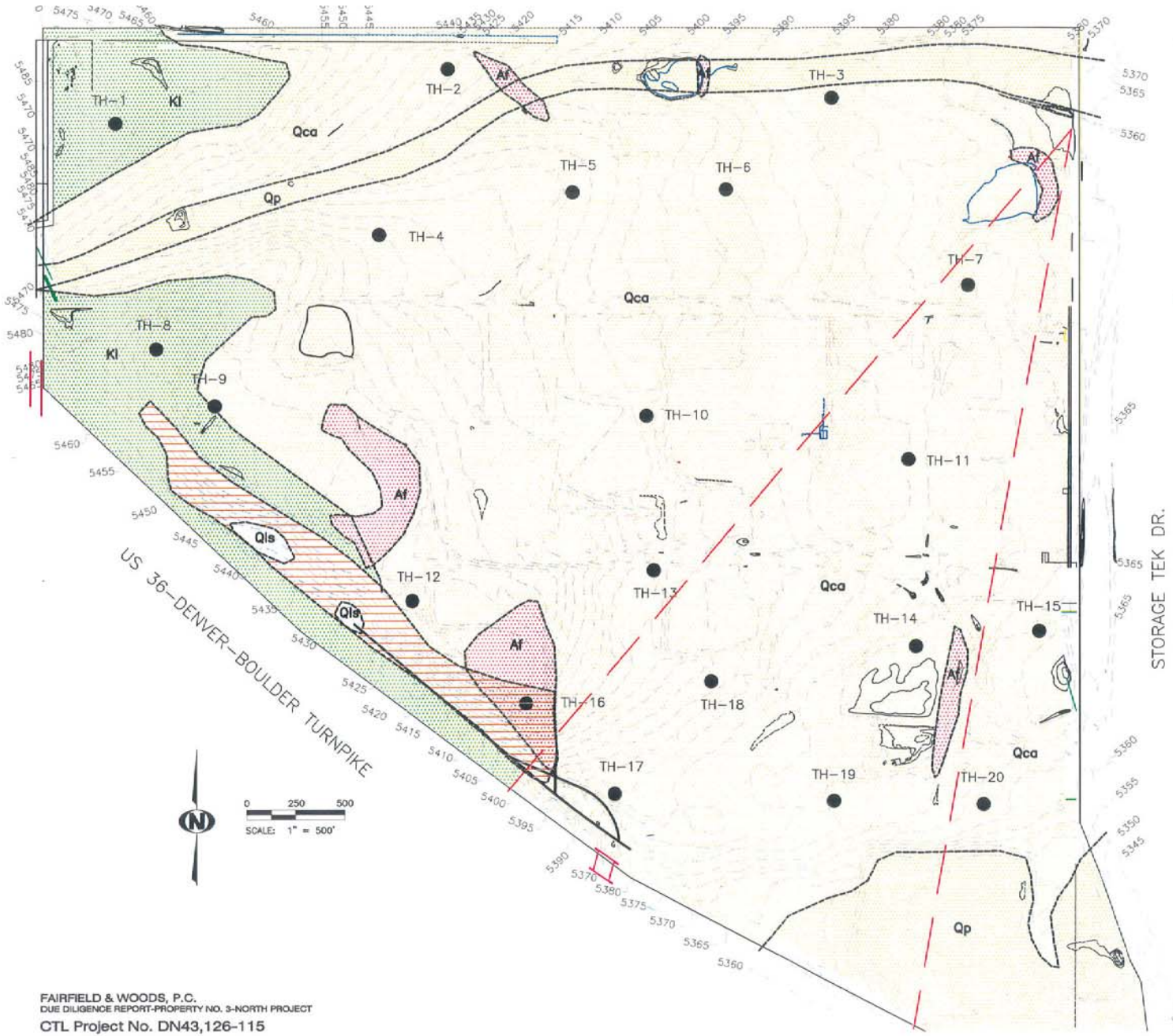
APPENDIX B – Reference Material and Supporting Documents



LEGEND:

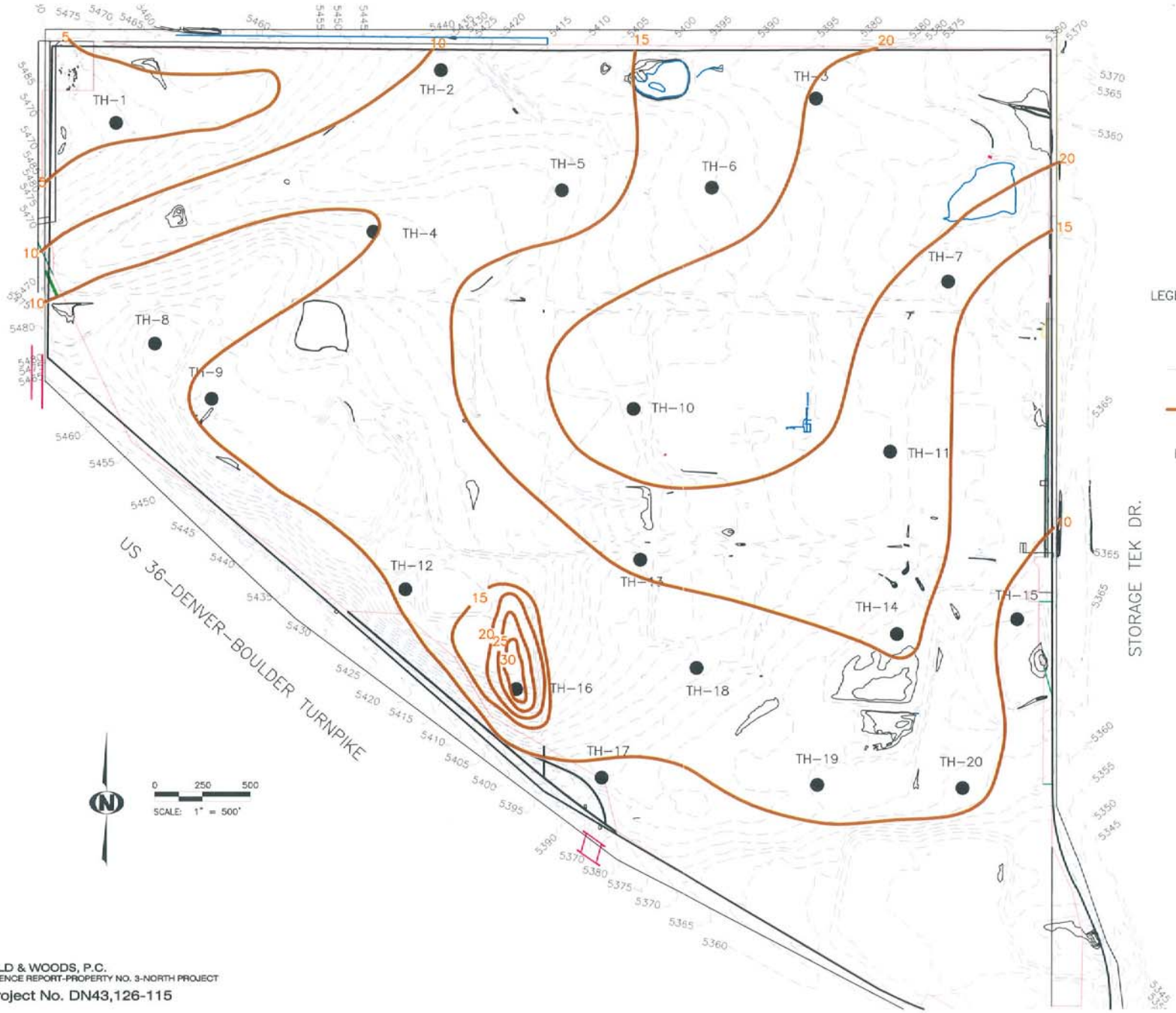
TH-1 ●	INDICATES APPROXIMATE LOCATION OF EXPLORATORY BORING
5365	INDICATES EXISTING GROUND SURFACE ELEVATION (FEET)
Af	LARGER DEPOSITS OF MAN-PLACED FILL, LIKELY PLACED DURING DEVELOPMENT OF SITE; ALSO POND EMBANKMENTS.
	UNSTABLE AND POTENTIALLY UNSTABLE SLOPES; INCLUDES POSSIBLE LANDSLIDES. GENERALLY CLASSIFIED DUE TO STEEPNESS OF ABOUT 25 PERCENT OR MORE.
Qls	POSSIBLE OLD, RELICT LANDSLIDES, MAY CONTAIN SEASONAL SEEPS.
Qp	PINEY CREEK AND YOUNGER ALLUVIUM DEPOSITS OF SAND AND CLAY.
Qca	COLLUVIUM (SLOPEWASH, WIND AND GRAVITY DEPOSITS) GENERALLY OVERLYING OLDER ALLUVIUAL SAND WITH GRAVEL.
Kl	CRETACEOUS-AGE LARAMIE FORMATION; CLAYSTONE AND FINE-GRAINED SANDSTONE.
------	CONTACT BETWEEN GEOLOGIC UNITS, APPROXIMATELY SHOWN.
------	APPROXIMATE LOCATION OF ANCIENT, INACTIVE FAULT TRACE

Geologic Map

Fig. 4-2

FAIRFIELD & WOODS, P.C.
DUE DILIGENCE REPORT-PROPERTY NO. 3-NORTH PROJECT
CTL Project No. DN43,126-115

S:\PROJECTS\DN 43,12 ,1512. Reports\R31\DN43126-115-R1-01.dwg, FIG. 4-2, 11/9/2007 9:02:06 AM



LEGEND:

TH-1 ● INDICATES APPROXIMATE LOCATION OF EXPLORATORY BORING

5365 INDICATES EXISTING GROUND SURFACE ELEVATION (FEET)

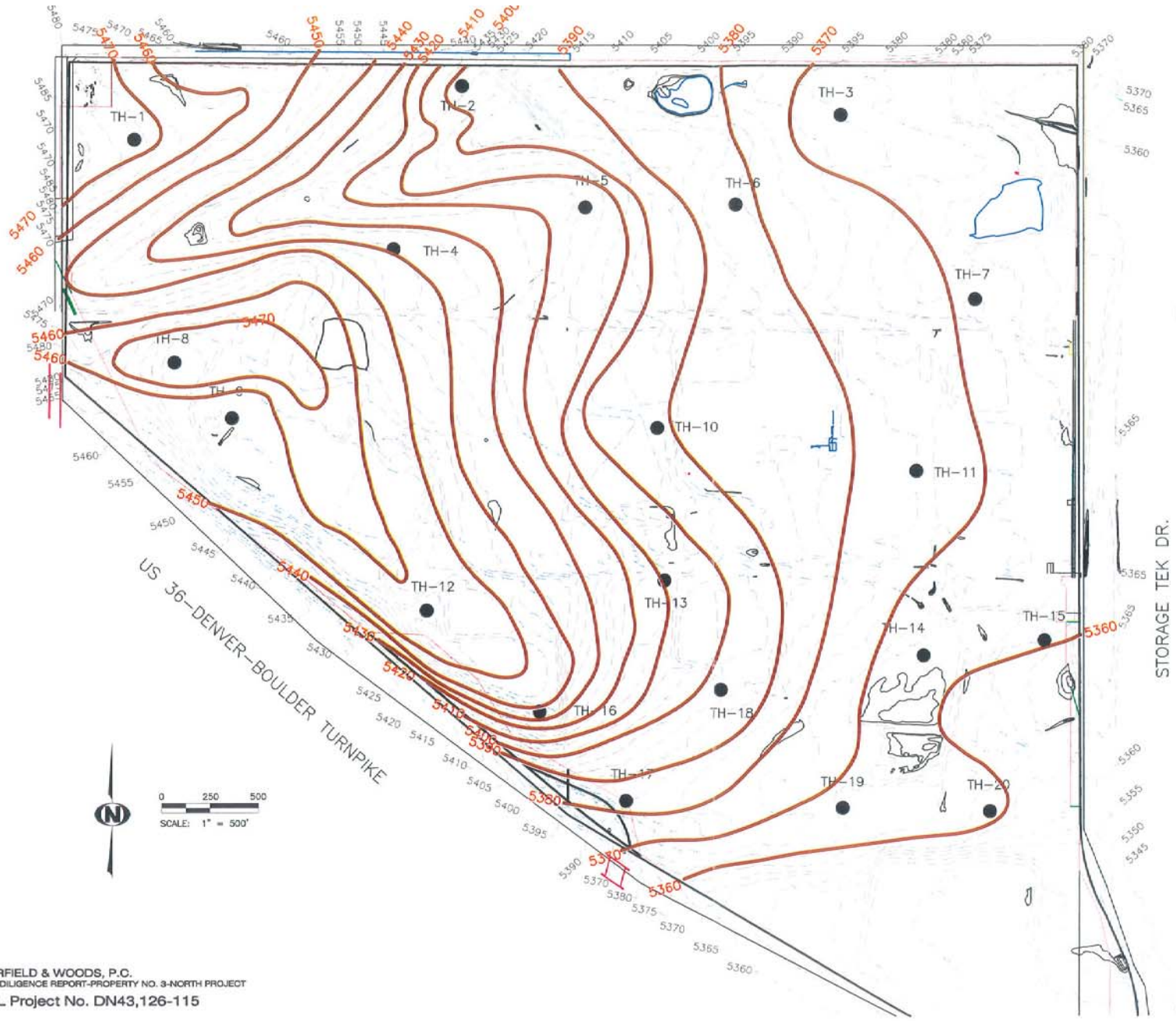
10 INDICATES ESTIMATED DEPTH TO BEDROCK (FEET)

NOTE: THIS ESTIMATE WAS BASED UPON A SUBJECTIVE ANALYSIS OF DRILL HOLE DATA AND MAY NOT REFLECT LOCAL VARIATIONS.

Estimated Depth to Bedrock

Fig. 4-3

FAIRFIELD & WOODS, P.C.
DUE DILIGENCE REPORT-PROPERTY NO. 3-NORTH PROJECT
CTL Project No. DN43,126-115



LEGEND:

TH-1 ● INDICATES APPROXIMATE LOCATION OF EXPLORATORY BORING

5365 INDICATES EXISTING GROUND SURFACE ELEVATION (FEET)

5370 INDICATES ESTIMATED BEDROCK ELEVATION (FEET)

NOTE: THIS ESTIMATE WAS BASED UPON A SUBJECTIVE ANALYSIS OF DRILL HOLE DATA AND MAY NOT REFLECT LOCAL VARIATIONS.

Estimated Elevation of Bedrock

Fig. 4-4

FAIRFIELD & WOODS, P.C.
DUE DILIGENCE REPORT-PROPERTY NO. 3-NORTH PROJECT
CTL Project No. DN43,126-115

S:\PROJECTS\DN431 11512. Reports\R1\DN43126-115-R1-01.dwg, FIG. 4-4, 11/9/2007 6:52:29 AM

LEGEND:

TH-1 ● INDICATES APPROXIMATE LOCATION OF EXPLORATORY BORING

5365 INDICATES EXISTING GROUND SURFACE ELEVATION (FEET)

20 INDICATES ESTIMATED DEPTH TO GROUND WATER (FEET)

NOTE: THIS ESTIMATE WAS BASED UPON A SUBJECTIVE ANALYSIS OF DRILL HOLE DATA AND MAY NOT REFLECT LOCAL VARIATIONS AND SEASONAL FLUCTUATIONS.

APPROXIMATE AREA OF SHALLOW GROUND WATER (LESS THAN 10')

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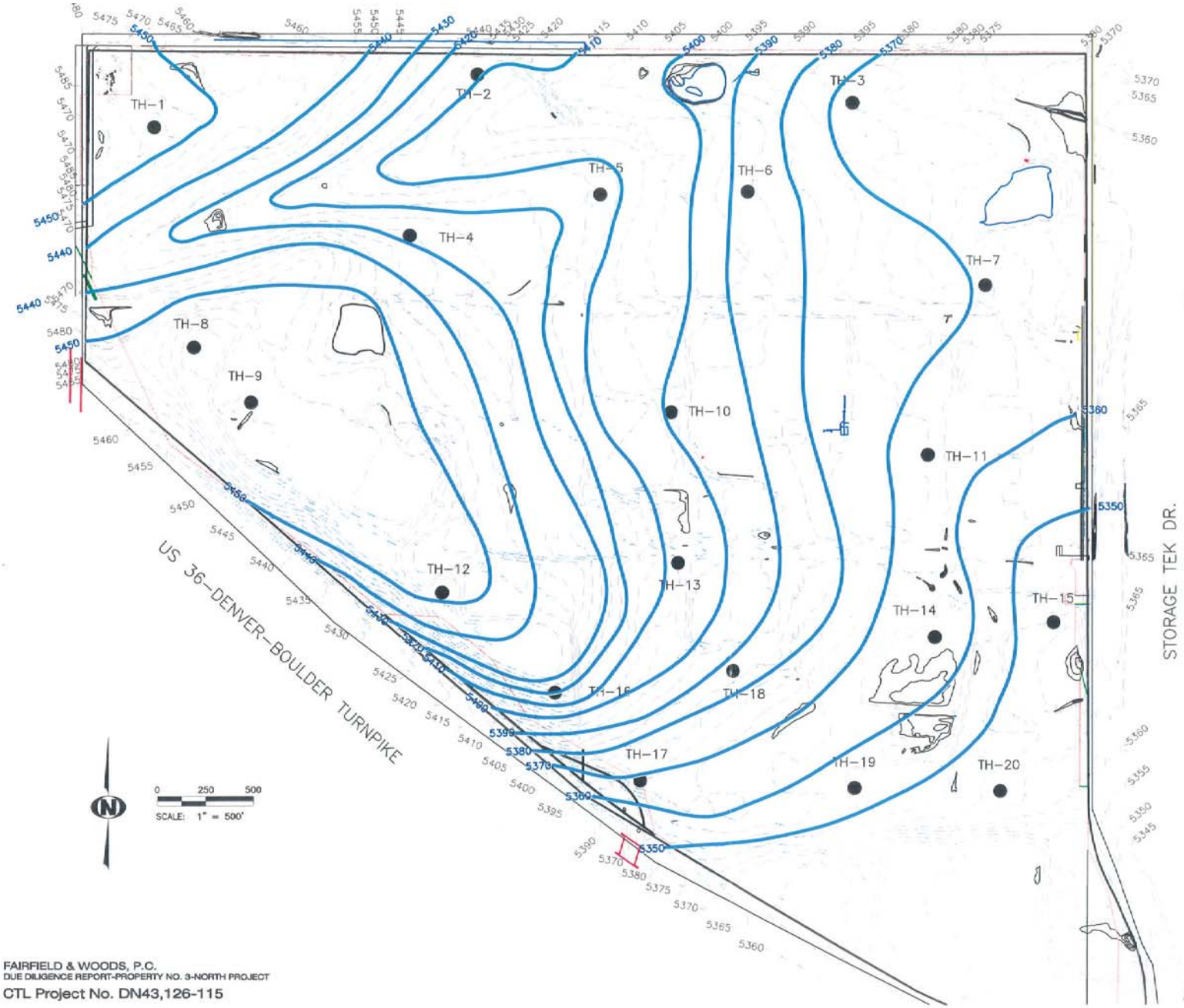
CTL Project No. DN43,126-115

Estimated Depth to Ground Water

Fig. 4-5

S:\PROJECTS\DN4312 '15\2. Reports\R1\DN43126-115-R1-01.dwg, FIG. 4-5, 11/9/2007 6:52:38 AM



LEGEND:

TH-1 ● INDICATES APPROXIMATE LOCATION OF EXPLORATORY BORING

5365 INDICATES EXISTING GROUND SURFACE ELEVATION (FEET)

5350 INDICATES ESTIMATED DEPTH TO GROUND WATER (FEET)

NOTE: THIS ESTIMATE WAS BASED UPON A SUBJECTIVE ANALYSIS OF DRILL HOLE DATA AND MAY NOT REFLECT LOCAL VARIATIONS AND SEASONAL FLUCTUATIONS.

FAIRFIELD & WOODS, P.C.
DUE DILIGENCE REPORT-PROPERTY NO. 3-NORTH PROJECT
CTL Project No. DN43,126-115

Estimated Elevation of Ground Water

Fig. 4-6

S:\PROJECTS\DN4312' 1512 Reports\R1\DN43126-115-R1-01.dwg, FIG. 4-6, 11/9/2007 6:52:45 AM

ERO Resources Corp.

September 23, 2019

To: Mrs. Jordan Swisher, Brue Baukol Capital Partners

From: Heidi Gerstung, ERO Resources Corporation

Re: Phillips 66 Site – Delineation of the Goodhue Ditch and Rock Creek

Background

Brue Baukol Capital Partners retained ERO Resources Corporation (ERO) to conduct a wetland delineation along the Goodhue Ditch and Rock Creek within portions of the Phillips 66 Site (property) in Boulder and Broomfield Counties, Colorado (project area; Figure 1). ERO reviewed the entirety of the property on January 17 and 21, 2019 to determine if any areas within the property had characteristics of a water of the U.S. (WUS) and had a defined surface connection to the South Platte River, the closest traditionally navigable water. An approved Jurisdictional Determination was subsequently completed for the property, and the U.S. Army Corps of Engineers (Corps) determined that portions of the property (the Goodhue Ditch and its abutting wetlands and Rock Creek and its abutting wetlands) were jurisdictional (Corps File No. NWO-2019-00148-DEN, attached).

On August 23, 2019, Heidi Gerstung and Anna Wistrom with ERO surveyed the project area for wetlands, streambeds, and open water (2019 site visit).

The natural resources and associated regulations described in this memo are valid as of the date of this memo and may be relied upon for the specific use for which it was prepared by ERO under contract to Brue Baukol Capital Partners. Because of their dynamic natures, site conditions and regulations should be reconfirmed by a qualified consultant before relying on this memo for a use other than that for which ERO was contracted. ERO assumes the landowner or municipality is responsible for obtaining all federal, state, and local permits for construction of the project.

General Description of Project Area

Project Location

The project area is along the Goodhue Ditch and Rock Creek within the Phillips 66 Site (property) located northwest of U.S. Highway 36 and 96th Street (Northwest Parkway) in Sections 20, 21, and 29, Township 1 South, Range 69 West of the 6th Principal Meridian in Boulder and Broomfield Counties, Colorado. The UTM coordinates for the approximate center of the property are Zone 13 488402mE and 4421737mN (Figure 1). The

Denver
1842 Clarkson Street
Denver, CO 80218
303.830.1188

Durango
1015 ½ Main Avenue
Durango, CO 81301
970.422.2136

Hotchkiss
P.O. Box 932
161 South 2nd Street
Hotchkiss, CO 81419
970.872.3020

Idaho
4001 East Main Street
Emmett, ID 83617
208.365.7684

www.eroresources.com

longitude/latitude of the property is 105.135760°W/39.945675°N. The elevation of the property ranges from 5,330 to 5,490 feet above sea level.

Site Description

The project area consists of the Goodhue Ditch and Rock Creek within the property (Figure 2a and Figure 2b). The Goodhue Ditch is approximately 2 to 6 feet wide within the project area and flows generally southeast (Photo 1; Figure 2a). Wetlands occur along the southern portion of the Goodhue Ditch (Photo 2). Vegetation along the banks of the Goodhue Ditch consists primarily of smooth brome (*Bromus inermis*) and plains cottonwood (*Populus deltoides*) with abutting wetlands dominated by peachleaf willow (*Salix amygdaloides*), sandbar willow (*Salix exigua*), reed canarygrass (*Phalaris arundinacea*), and marshpepper knotweed (*Polygonum hydropiper*) (Photo 2). Rock Creek is an intermittent drainage, is approximately 6 to 8 feet wide within the project area and flows generally northeast (Figure 2b). Wetlands occur along much of Rock Creek within the project area (Photos 3 and 4). Vegetation along Rock Creek consists primarily of plains cottonwood, peachleaf willow, sandbar willow, narrowleaf cattail (*Typha angustifolia*), Emory's sedge (*Carex emoryi*), and softstem bulrush (*Schoenoplectus tabernaemontani*).

Methods

ERO conducted the wetland delineation following the methods for routine on-site wetland determinations in areas less than 5 acres as described in the 1987 *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) and used methods in the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region (Version 2.0)* (Corps 2010) to record data on vegetation, soils, and hydrology on routine determination forms. The Corps defines wetlands as "areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 Code of Federal Regulations (CFR) 328.3(c)). Wetland boundaries were determined by a visible change in vegetation community, soils, topographic changes, and other visible distinctions between wetlands and uplands.

The wetland indicator status of plant species was identified using the *National Wetland Plant List* (Lichvar et al. 2016), taxonomy was determined using *Colorado Flora: Eastern Slope* (Weber and Wittmann 2012), and nomenclature was determined using *The PLANTS Database* (U.S. Department of Agriculture, Natural Resources Conservation Service 2019). If present, hydric soils were identified using field observation for hydric soil indicators accepted by the Corps. Soil data were not always collected if hydrophytic vegetation and hydrology were present and did not appear altered (Environmental Laboratory 1987). In addition, soil data were not collected in conditions where there was a clear lack of hydrology and hydrophytic vegetation indicators. Where soil data were collected, a Munsell soil color chart was used to determine soil color.

Intermittent, ephemeral, and perennial drainages with characteristics of a defined streambed, streambank, ordinary high water mark (OHWM), and other erosional features also were identified. The OHWM identifies the lateral jurisdictional limits of nonwetland WUS. Federal jurisdiction over nonwetland WUS extends to the OHWM, defined in 33 CFR 328.3 as "the line on the shore established by fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of the soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas." The Corps defines "stream bed" as "the substrate of the stream channel between the OHWMs. The substrate may be bedrock or inorganic particles that range in size from clay to boulders."

Project Area Conditions

ERO mapped approximately 0.635 acre of open water and 0.357 acre of wetlands along the Goodhue Ditch and Rock Creek in the project area during the 2019 site visit (Figure 2a and Figure 2b). The project area conditions along the Goodhue Ditch and Rock Creek are discussed individually in more detail below.

Goodhue Ditch

Streams and Open Water

The Goodhue Ditch is in the northeast corner of the property and contains a defined bed and bank with fringe wetlands along portions of the banks. The Goodhue Ditch is shown on the U.S. Geological Survey (USGS) Louisville topographic quadrangle and on the National Hydrography Dataset (NHD) as a canal/ditch and intermittent stream (Figure 1 and Figure 2a). ERO mapped approximately 0.428 acre of open water along the Goodhue Ditch in the project area during the 2019 site visit.

Wetlands

During the 2019 site visit, ERO mapped approximately 0.121 acre of wetlands abutting the Goodhue Ditch within the project area. ERO collected data from three data points (DP) near the Goodhue Ditch (DP1, DP2, and DP3).

Vegetation

The wetland fringe vegetation within the Goodhue Ditch is dominated by sandbar willow (facultative wetland (FACW)), peachleaf willow (FACW), marshpepper knotweed (obligate (OBL)), and reed canary grass (FACW). Upland vegetation is dominated by smooth brome, Canada thistle (*Cirsium arvense*), and Scotch thistle (*Onopordum acanthium*). At DP1 and DP2, the vegetation met the rapid test for hydrophytic vegetation. DP3 consisted primarily of smooth brome (upland (UPL)) and did not meet the dominance test or prevalence index for hydrophytic vegetation.

Soils

Soil data were collected from two locations in the Goodhue Ditch portion of the project area (DP1 and DP2) (Figure 2a). Soils at DP1 had a matrix color of 10YR 3/2 from 0 to 2 inches with no redox features observed and a matrix color of 10YR 4/2 from 2 to 12 inches with 10 percent faint redox features of 7.5YR 4/4. No hydric soils were observed at DP1. Soils at DP2 had a matrix color of 10YR 4/2 from 0 to 6 inches with 5 percent prominent redox features of 7.5YR 4/6 observed and a matrix color of 10YR 3/2 from 6 to 12 inches with 5 percent distinct redox features of 7.5YR 4/4 observed. The hydric soil indicator at DP2 was depleted matrix. Soils were not collected within the adjacent upland (DP3) due to the lack of hydrophytic vegetation and hydrologic indicators.

Hydrology

Hydrologic indicators observed at DP1 and DP2 included the presence of surface water, saturation, geomorphic position, and the FAC-Neutral test. No hydrologic indicators were observed at DP3.

Rock Creek

Streams and Open Water

Rock Creek, shown on the USGS topographic quadrangle and on the NHD as an intermittent stream, occurs within the project area (Figure 1 and Figure 2b). ERO mapped approximately 0.207 acre of open water along Rock Creek in the project area during the 2019 site visit.

Wetlands

During the 2019 site visit, ERO mapped approximately 0.236 acre of wetlands abutting Rock Creek within the project area. ERO collected data from four DPs near Rock Creek (DP4, DP5, DP6, and DP7).

Vegetation

Wetland vegetation along Rock Creek is dominated by plains cottonwood (FAC), peachleaf willow (FACW), sandbar willow (FACW), narrowleaf cattail (OBL), Emory's sedge (OBL), watercress (*Nasturtium officinale* - OBL)), curlytop knotweed (*Polygonum lapathifolium* - OBL), and common spikerush (*Eleocharis palustris* - OBL). Vegetation at DP4 met the rapid test for hydrophytic vegetation, and vegetation at DP5 met the dominance test for hydrophytic vegetation. Vegetation at DP5 and DP7 consisted primarily of the upland species including smooth brome (UPL) and Canada thistle (facultative upland (FACU)), with an overstory of plains cottonwood (facultative (FAC)), and did not meet the dominance test or prevalence index for hydrophytic vegetation.

Soils

Soil data were collected from two locations in the Rock Creek portion of project area (DP4 and DP6) (Figure 2b). Soils at DP4 had a matrix color of 10YR 4/2 from 0 to 6 inches with 15 percent prominent redox features of 7.5YR 4/6 and 7 percent depletion of Gley 1 2.5/N

observed. From 6 to 12 inches, soils at DP4 had a matrix color of 10YR 4/1 with 10 percent prominent redox features of 7.5YR 4/4 and 20 percent depletions of Gley 1 2.5/N observed. The hydric soil indicator met at DP4 was depleted matrix. Soils at DP6 had a matrix color of 10YR 4/2 from 0 to 3 inches with 25 percent depletions of Gley 1 2.5/N observed. DP6 is located within a wetland mitigation site and met the criteria for problematic hydric soils due to recently developed wetlands. Soils were not collected within the adjacent uplands (DP5 and DP7) due to the lack of hydrophytic vegetation and hydrologic indicators.

Hydrology

Hydrologic indicators observed at DP4 included high water table, saturation, oxidized rhizospheres on living roots, geomorphic position, and the FAC-Neutral test. Hydrologic indicators observed at DP6 included surface water, high water table, saturation, geomorphic position, and the FAC-Neutral test. No hydrologic indicators were observed at DP5 or DP7.

Recommendations

The Goodhue Ditch and its abutting wetlands and Rock Creek and its abutting wetlands were previously determined jurisdictional (Corps 2019). If work is planned within these areas, a Section 404 permit would be required for the placement of dredged or fill material below the OHWM. If no work is planned within these areas, no action would be necessary.

References

Environmental Laboratory. 1987. *Corps of Engineers Wetland Delineation Manual*. Technical Report 7-87-1, U.S. Army Engineer Waterways Experiment Station. Vicksburg, MS.

Lichvar, R.W., D.L. Banks, W.N. Kirchner, and N.C. Melvin. 2016. *The National Wetland Plant List*: 2016 wetland ratings. *Phytoneuron* 2016-30:1-17. Published April 28, 2016. ISSN 2153 733X. Last accessed July 11, 2018.

U.S. Army Corps of Engineers (Corps). 2010. *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Great Plains Region (Version 2.0)*. J.S. Wakeley, R.W. Lichvar, and C.V. Noble (eds.). ERDC/EL TR-10-1. Vicksburg, MS: U.S. Army Engineer Research and Development.

U.S. Army Corps of Engineers (Corps). 2019. NWO-2019-00148-DEN, Phillips 66 Site (JD). April 4.

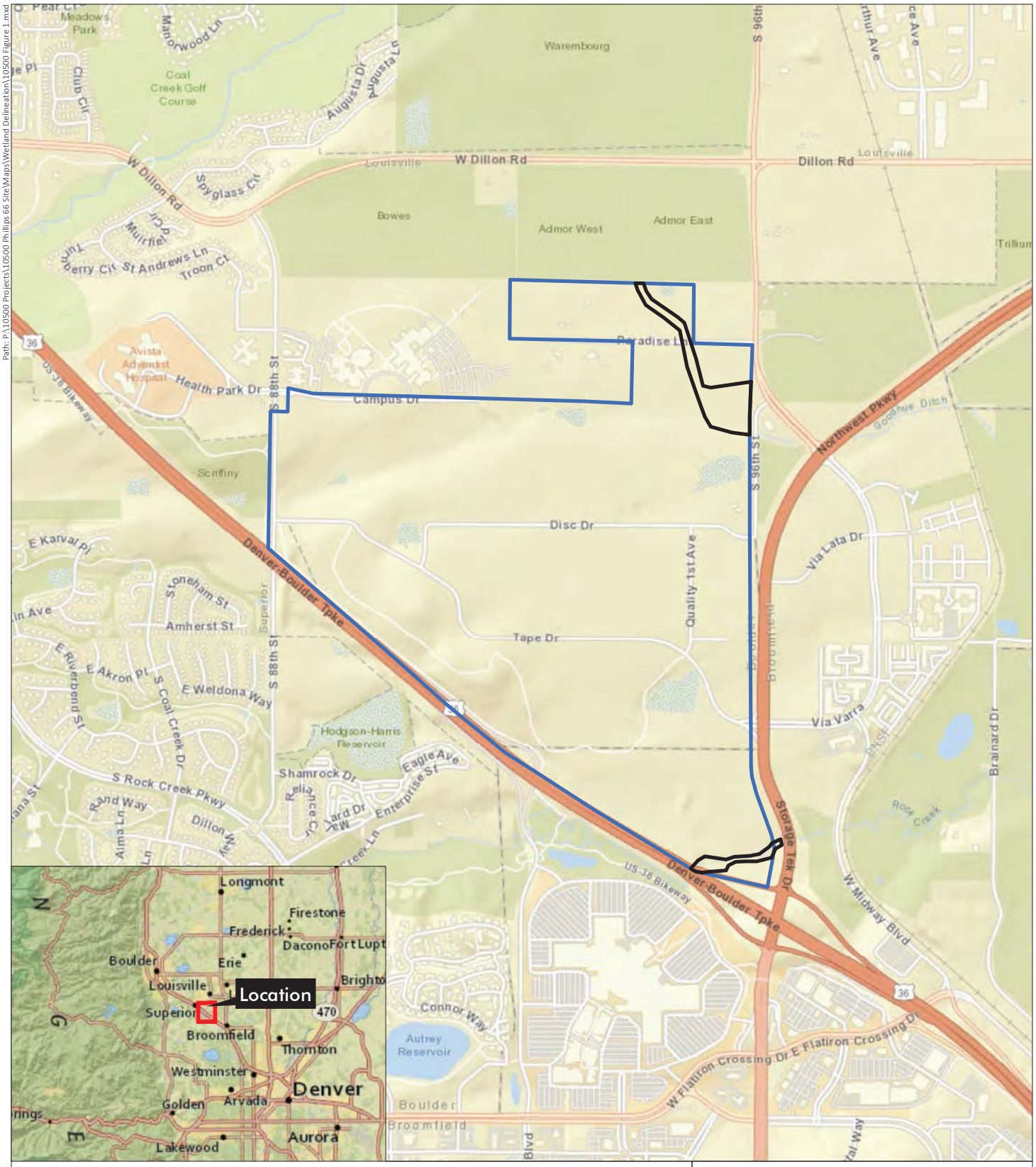
U.S. Department of Agriculture, Natural Resources Conservation Service. 2019. *The PLANTS Database*. http://plants.usda.gov. National Plant Data Team, Greensboro, NC 27401-4901 USA. September 19.

Weber, W.A. and R.C. Wittmann. 2012. *Colorado Flora: Eastern Slope.* 4th edition. University Press of Colorado. Boulder, CO.

Attachments

Figure 1 – Vicinity Map
Figure 2a – Goodhue Ditch Existing Conditions
Figure 2b – Rock Creek Existing Conditions
Photo log
Wetland delineation datasheets
Jurisdictional Determination

Path: P:\10500 Projects\10500 Phillips 66 Site\Maps\Wetland Delineation\10500 Figure 1.mxd



Phillips 66 Site Delineation

Sections 20, 21, and 29, T1S, R69W; 6th PM

UTM NAD 83: Zone 13N; 488402mE, 4421737mN

Longitude 105.135760°W, Latitude 39.945675°N

USGS Louisville, CO Quadrangle

Boulder and Broomfield Counties, Colorado

Project Area

Property Boundary

0 750 1,500 Feet

N

Figure 1
Vicinity Map

Prepared for: Brue Baukol

File: 10500 Figure 1.mxd (GS)

September 19, 2019

ERO Resources Corp.

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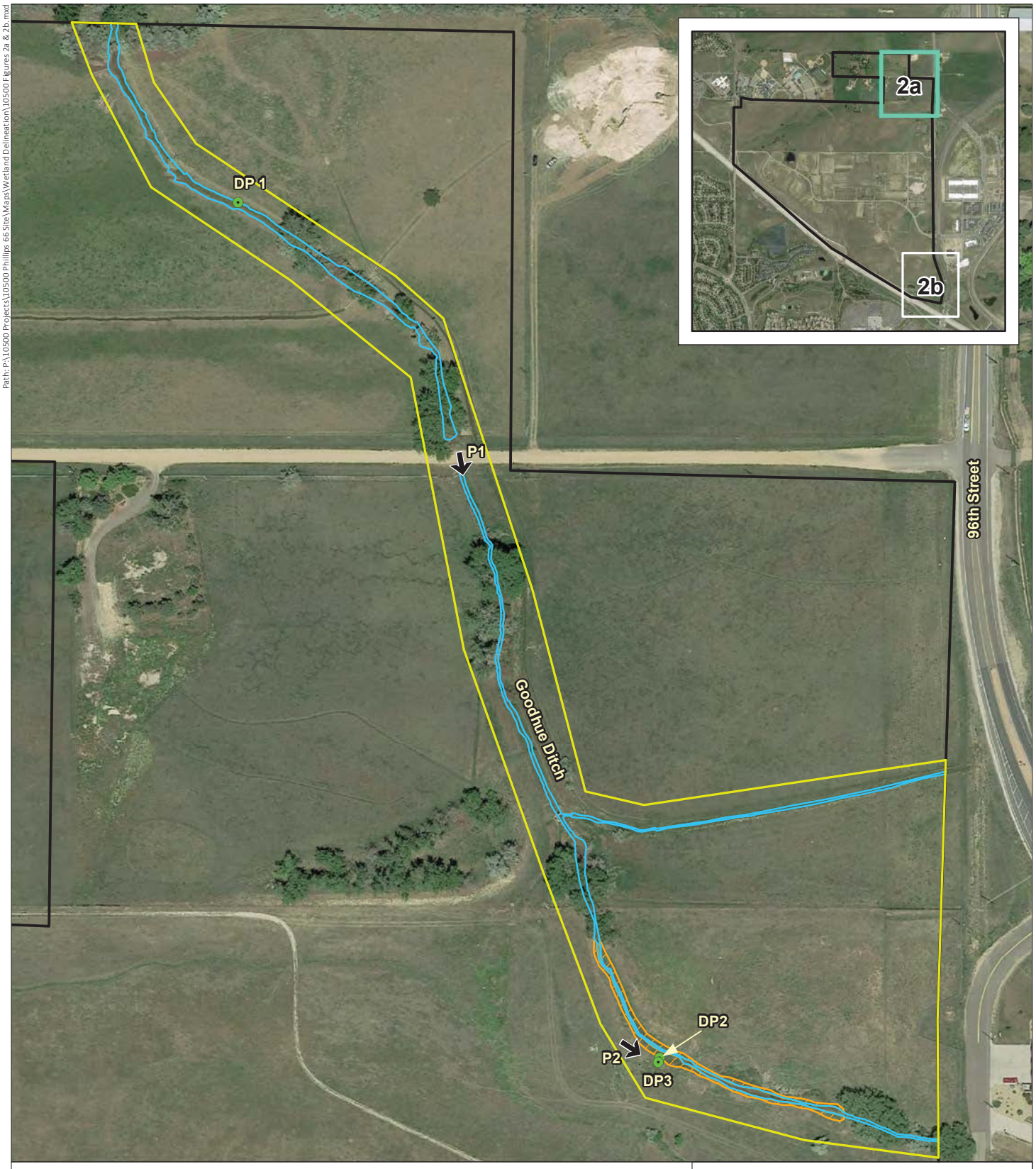

Phillips 66 Site Delineation

- Data Point
- Photo Point
- Ordinary High Water Mark (0.635 ac)
- Wetland (0.357 ac)
- Property Boundary
- Project Area

0 100 200 Feet

N

Image Source: Google Earth©, May 2018

Figure 2a
Goodhue Ditch Existing Conditions

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File: 10500 Figures 2a & 2b.mxd (GS)
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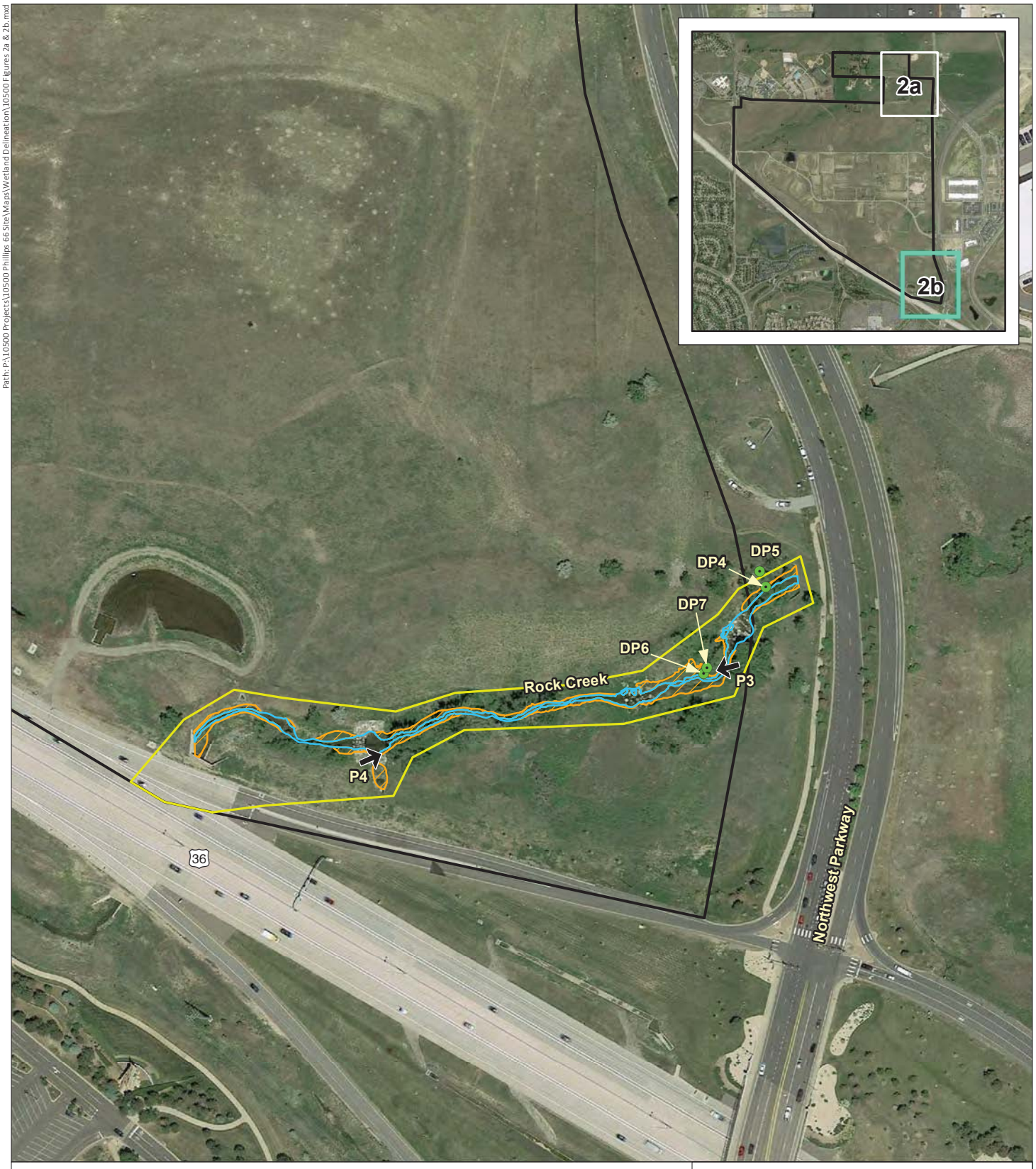

Phillips 66 Site Delineation

- Data Point
- Photo Point
- Ordinary High Water Mark (0.635 ac)
- Wetland (0.357 ac)
- Property Boundary
- Project Area

0 100 200 Feet

N

Image Source: Google Earth©, May 2018

Figure 2b
Rock Creek Existing Conditions

Prepared for: Brue Baukol
File: 10500 Figures 2a & 2b.mxd (GS)
September 19, 2019

ERO
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Photo 1 - Overview of Goodhue Ditch. View is to the southeast.

Photo 2 - Overview of wetlands abutting Goodhue Ditch. View is to the southeast.

Photo 3 - Overview of Rock Creek and abutting wetlands. View is to the southwest.

Photo 4 - Overview of Rock Creek and abutting wetlands. View is to the northeast.

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Louisville/Broomfield &Boulder Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP1

Investigator(s): H.Gerstung, A.Wistrom Section, Township, Range: 20, 21, and 29, T1S, R69W

Landform (hillslope, terrace, etc.): drainageway Local relief (concave, convex, none): concave Slope (%): <1

Subregion (LRR): G Lat: 39.953435°N Long: 105.131959°W Datum: NAD83

Soil Map Unit Name: Nunn clay loam, 1 to 3 percent slopes NWI classification: R5UBFx

Are climatic / hydrologic conditions on the site typical for this time of year? Yes [X] No [ ] (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes [X] No [ ]

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes [X]	No [ ]	**Is the Sampled Area within a Wetland?** Yes [ ] No [X]
Hydric Soil Present?	Yes [ ]	No [X]	
Wetland Hydrology Present?	Yes [X]	No [ ]	

Remarks:

within Goodhue Ditch

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		

Sapling/Shrub Stratum (Plot size: 15')			
1.			
2.			
3.			
4.			
5.			
	= Total Cover		

Herb Stratum (Plot size: 5')			
1. Carex emoryi	20	Yes	OBL
2. Polygonum hydropiper	12	Yes	OBL
3. Cirsium arvense	1	No	FACU
4. Pascopyrum smithii	4	No	FACU
5. Amorpha fruticosa	3	No	FACW
6.			
7.			
8.			
9.			
10.			
	40	= Total Cover	

Woody Vine Stratum (Plot size:)			
1.			
2.			
	= Total Cover		

% Bare Ground in Herb Stratum 60

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 2 (A)

Total Number of Dominant Species Across All Strata: 2 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- [X] 1 - Rapid Test for Hydrophytic Vegetation
- [ ] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes [X] No [ ]

Remarks:

SOIL

Sampling Point: DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-2	10YR 3/2	100	-	0	-	-	clay loam	
2-12	10YR 4/2	90	7.5YR 4/3	10	C	M	clay loam	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☐ No ☒

Remarks:

refusal after 12"; faint redox observed

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☒ Surface Water (A1)
- ☐ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☒ Geomorphic Position (D2)
- ☒ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☒ No ☐ Depth (inches): Surface

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): Surface

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Louisville/Broomfield &Boul Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP2

Investigator(s): H.Gerstung, A,Wistrom Section, Township, Range: 20, 21, and 29, T1S, R69W

Landform (hillslope, terrace, etc.): drainageway Local relief (concave, convex, none): concave Slope (%): <1

Subregion (LRR): G Lat: 39.949979°N Long: 105.129768°W Datum: NAD83

Soil Map Unit Name: Nunn clay loam, 1 to 3 percent slopes NWI classification: R4SBC

Are climatic / hydrologic conditions on the site typical for this time of year? Yes [X] No [ ] (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes [X] No [ ]

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes [X]	No [ ]	**Is the Sampled Area within a Wetland?** **Yes** [X] **No** [ ]
Hydric Soil Present?	Yes [X]	No [ ]	
Wetland Hydrology Present?	Yes [X]	No [ ]	

Remarks:

In drainageway

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1. Populus angustifolia	20	Yes	FACW
2. Salix exigua	30	Yes	FACW
3.			
4.			
5.			
	50 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Phalaris arundinacea	25	Yes	FACW
2. Polygonum hydropiper	10	Yes	OBL
3. Dipsacus fullonum	5	No	FACU
4. Echinochloa crus-galli	2	No	FAC
5.			
6.			
7.			
8.			
9.			
10.			
	42 = Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
	0 = Total Cover		

% Bare Ground in Herb Stratum 58

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 4 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- [X] 1 - Rapid Test for Hydrophytic Vegetation
- [ ] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** [X] **No** [ ]

Remarks:

SOIL

Sampling Point: DP2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 4/2	95	7.5YR 4/6	5	C	M	SCL	
6-12	10YR 3/2	95	7.5YR 4/4	5	C	M	SCL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☒ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☒ No ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☒ Surface Water (A1)
- ☐ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☒ Geomorphic Position (D2)
- ☒ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☒ No ☐ Depth (inches): Surface

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): Surface

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Louisville/Broomfield &Boul Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP3

Investigator(s): H. Gerstung, A. Wistrom Section, Township, Range: 20, 21, and 29, T1S, R69W

Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): nonr Slope (%): 1

Subregion (LRR): G Lat: 39.949960°N Long: 105.129775°W Datum: NAD83

Soil Map Unit Name: Nunn clay loam, 1 to 3 percent slopes NWI classification: R4SBC

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes ☐ No ☒

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐	No ☒	**Is the Sampled Area within a Wetland?** Yes ☐ No ☒
Hydric Soil Present?	Yes ☐	No ☒	
Wetland Hydrology Present?	Yes ☐	No ☒	

Remarks:

Terrace above drainage

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1. Salix exigua	10	Yes	FACW
2.			
3.			
4.			
5.			
	10 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Onopordum acanthium	20	Yes	UPL
2. Bromus inermis	35	Yes	UPL
3. Cirsium arvense	20	Yes	FACU
4. Dipsacus fullonum	10	No	FACU
5.			
6.			
7.			
8.			
9.			
10.			
	85 = Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
	= Total Cover		

% Bare Ground in Herb Stratum 15

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 1 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 25 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species	10	x 2 = 20
FAC species		x 3 =
FACU species	30	x 4 = 120
UPL species	55	x 5 = 275
Column Totals:	95 (A)	415 (B)

Prevalence Index = B/A = 4.37

Hydrophytic Vegetation Indicators:

☐ 1 - Rapid Test for Hydrophytic Vegetation

☐ 2 - Dominance Test is >50%

☐ 3 - Prevalence Index is ≤3.0[1]

☐ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes ☐ No ☒

Remarks:

SOIL

Sampling Point: DP3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☐ No ☒

Remarks:

Soil not sampled due to upland vegetation and lack of hydrology indicators.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? Yes ☐ No ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

no wetland hydrology indicators observed

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Broomfield &Boulder Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP4

Investigator(s): H. Gerstung, A. Wistrom Section, Township, Range: 20, 21, and 29, T1S, R69W

Landform (hillslope, terrace, etc.): bench Local relief (concave, convex, none): none Slope (%): <1

Subregion (LRR): G Lat: 39.937224°N Long: 105.127267°W Datum: NAD83

Soil Map Unit Name: Heldt clay, 0 to 3 percent slopes NWI classification: R4SBC

Are climatic / hydrologic conditions on the site typical for this time of year? Yes [X] No [ ] (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes [X] No [ ]

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes [X]	No [ ]	**Is the Sampled Area within a Wetland?** **Yes** [X] **No** [ ]
Hydric Soil Present?	Yes [X]	No [ ]	
Wetland Hydrology Present?	Yes [X]	No [ ]	

Remarks:

Wetland fringe abutting Rock Creek

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Populus deltoides	30	Yes	FAC
2. Salix amygdaloides	20	Yes	FACW
3.			
4.			
	50	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1. Salix exigua	20	Yes	FACW
2. Salix amygdaloides	30	Yes	FACW
3. Ribes aureum	2	No	FACU
4.			
5.			
	52	= Total Cover	
Herb Stratum (Plot size: 5')			
1. Poa palustris	3	No	FACW
2. Typha angustifolia	20	Yes	OBL
3. Cirsium arvense	10	No	FACU
4. Chenopodium album	2	No	FACU
5. Carex emoryi	40	Yes	OBL
6. Bromus inermis	15	No	UPL
7.			
8.			
9.			
10.			
	90	= Total Cover	
Woody Vine Stratum (Plot size:)			
1.			
2.			
		= Total Cover	

% Bare Ground in Herb Stratum 10

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 6 (A)

Total Number of Dominant Species Across All Strata: 6 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [X] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** [X] **No** [ ]

Remarks:

SOIL

Sampling Point: DP4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 4/2	78	7.5YR 4/6	15	C	M&PL	CL	prominent
	10YR 4/2	-	Gley1 2.5/N	7	D	PL	CL	
6-12	10YR 4/1	70	7.5YR 4/4	10	C	M	CL	
	10YR 4/1	-	Gley1 2.5/N	20	D	M	CL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☒ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☒ No ☐

Remarks:

Depleted matrix

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☒ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☒ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☒ Geomorphic Position (D2)
- ☒ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____

Water Table Present? Yes ☒ No ☐ Depth (inches): 6

Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): Surface

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Broomfield &Boulder Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP5

Investigator(s): H. Gerstung, A. Wistrom Section, Township, Range: 20, 21, and 29, T1S, R69W

Landform (hillslope, terrace, etc.): hillslope Local relief (concave, convex, none): none Slope (%): 2

Subregion (LRR): G Lat: 39.937287°N Long: 105.127300°W Datum: NAD83

Soil Map Unit Name: Heldt clay, 0 to 3 percent slopes NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes [X] No [ ] (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes [X] No [ ]

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes [ ]	No [X]	**Is the Sampled Area within a Wetland?** Yes [ ] No [X]
Hydric Soil Present?	Yes [ ]	No [X]	
Wetland Hydrology Present?	Yes [ ]	No [X]	

Remarks:

Upland adjacent to wetland bench on Rock Creek.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Populus deltoides	30	Yes	FAC
2. Salix amygdaloides	10	Yes	FACW
3.			
4.			
	40	= Total Cover	
Sapling/Shrub Stratum (Plot size: 15')			
1. Populus deltoides	5	Yes	FAC
2.			
3.			
4.			
5.			
	5	= Total Cover	
Herb Stratum (Plot size: 5')			
1. Bromus inermis	85	Yes	UPL
2. Lactuca serriola	5	No	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	90	= Total Cover	
Woody Vine Stratum (Plot size:)			
1.			
2.			
	0	= Total Cover	

% Bare Ground in Herb Stratum 10

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 3 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 75 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	0	x 1 = 0
FACW species	10	x 2 = 20
FAC species	40	x 3 = 120
FACU species	0	x 4 = 0
UPL species	85	x 5 = 425
Column Totals:	135 (A)	565 (B)

Prevalence Index = B/A = 4.19

Hydrophytic Vegetation Indicators:

[ ] 1 - Rapid Test for Hydrophytic Vegetation

[ ] 2 - Dominance Test is >50%

[ ] 3 - Prevalence Index is ≤3.0[1]

[ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)

[ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes [ ] No [X]

Remarks:

SOIL

Sampling Point: DP5

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☐ No ☒

Remarks:

Soil not sampled due to upland vegetation and lack of hydrological indicators.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? Yes ☐ No ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

No indicators observed.

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Broomfield &Boulder Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP6

Investigator(s): H. Gerstung, A. Wistrom Section, Township, Range: 20, 21, and 29, T1S, R69W

Landform (hillslope, terrace, etc.): drainageway Local relief (concave, convex, none): none Slope (%): ,1

Subregion (LRR): G Lat: 39.936876°N Long: 105.127595°W Datum: NAD83

Soil Map Unit Name: Heldt clay, 0 to 3 percent slopes NWI classification: R4SBC

Are climatic / hydrologic conditions on the site typical for this time of year? Yes [X] No [ ] (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes [X] No [ ]

Are Vegetation N, Soil Y, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes [X]	No [ ]	**Is the Sampled Area within a Wetland?** **Yes** [X] **No** [ ]
Hydric Soil Present?	Yes [X]	No [ ]	
Wetland Hydrology Present?	Yes [X]	No [ ]	

Remarks:

wetland mitigation area within Rock Creek drainageway

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Populus deltoides	10	Yes	FAC
2.			
3.			
4.			
	10 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1. Salix exigua	2	Yes	FACW
2.			
3.			
4.			
5.			
	2 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Typha angustifolia	15	No	OBL
2. Schoenoplectus tabernaemontani	8	No	OBL
3. Polypogon monspeliensis	2	No	FACW
4. Nasturtium officinale	20	Yes	OBL
5. Epilobium ciliatum	3	No	FACW
6. Cirsium arvense	1	No	FACU
7. Polygonum lapathifolium	20	Yes	OBL
8. Eleocharis palustris	20	Yes	OBL
9. Echinochloa crus-galli	1	No	FAC
10.			
	90 = Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
	= Total Cover		

% Bare Ground in Herb Stratum 10

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 5 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [X] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** [X] **No** [ ]

Remarks:

SOIL

Sampling Point: DP6

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-3	10YR 4/2	75	Gley1 2.5/N	25	D	M	Cobble	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☒ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☒ No ☐

Remarks:

Unable to dig past 2";Problematic soils - recently developed alluvium in floodplain. Restoration project work apparent.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☒ Surface Water (A1)
- ☒ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☒ Geomorphic Position (D2)
- ☒ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☒ No ☐ Depth (inches): 0

Water Table Present? Yes ☒ No ☐ Depth (inches): 0

Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): 0

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Broomfield &Boulder Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP7

Investigator(s): H. Gerstung, A. Wistrom Section, Township, Range: 20, 21, and 29, T1S, R69W

Landform (hillslope, terrace, etc.): upland Local relief (concave, convex, none): none Slope (%): 1

Subregion (LRR): G Lat: 39.936900°N Long: 105.127579°W Datum: NAD83

Soil Map Unit Name: Heldt clay, 0 to 3 percent slopes NWI classification: none

Are climatic / hydrologic conditions on the site typical for this time of year? Yes [X] No [ ] (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes [X] No [ ]

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes [ ]	No [X]	**Is the Sampled Area within a Wetland?** Yes [ ] No [X]
Hydric Soil Present?	Yes [ ]	No [X]	
Wetland Hydrology Present?	Yes [ ]	No [X]	

Remarks:

Upland adjacent to wetland bench.

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Populus deltoides	12	Yes	FAC
2.			
3.			
4.			
	12 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1. Salix exigua	10	Yes	FACW
2.			
3.			
4.			
5.			
	10 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Cirsium arvense	30	Yes	FACU
2. Rumex crispus	5	No	FAC
3. Conium maculatum	5	No	FACW
4. Conyza canadensis	10	Yes	FACU
5. Chenopodium album	5	No	FACU
6. Pascopyrum smithii	5	No	FACU
7. Dipsacus fullonum	10	Yes	FACU
8.			
9.			
10.			
	70 = Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
	= Total Cover		

% Bare Ground in Herb Stratum 30

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 2 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 40 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species	0	x 1 = 0
FACW species	15	x 2 = 30
FAC species	17	x 3 = 51
FACU species	60	x 4 = 240
UPL species	0	x 5 = 0
Column Totals:	92 (A)	321 (B)

Prevalence Index = B/A = 3.5

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [ ] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes [ ] No [X]

Remarks:

SOIL

Sampling Point: DP7

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☐ No ☒

Remarks:

Soil not sampled due to upland vegetation and lack of hydrological indicators.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? Yes ☐ No ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

no hydrology indicators observed

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, OMAHA DISTRICT
DENVER REGULATORY OFFICE, 9307 SOUTH WADSWORTH BOULEVARD
LITTLETON, COLORADO 80128-6901

April 4, 2019

SUBJECT: Approved Jurisdictional Determination, Phillips 66 Site, Corps File No. NWO-2019-00148-DEN, Broomfield City/County, CO

Ms. Jordan Swisher
Brue Baukol Capital Partners
1555 Blake Street, Suite 210
Denver, CO 80202

Dear Ms. Swisher:

Reference is made to the above-mentioned project centered at approximately 39.945675°N, -105.135760°W, in the City and County of Broomfield, Colorado. You have requested an Approved Jurisdictional Determination (JD) for all aquatic resources found at the project location.

The project area has been reviewed in accordance with Section 404 of the Clean Water Act under which the U.S. Army Corps of Engineers regulates the discharge of dredged and fill material, and any excavation activity associated with a dredge and fill project in waters of the United States.

We have determined that the following aquatic resources are jurisdictional waters of the U.S., and a Department of the Army permit will be required for any work that impacts these resources:

- Goodhue Ditch and its abutting wetlands
- Rock Creek and its abutting wetlands

We have determined the following aquatic resources are *not* jurisdictional waters of the U.S.:

- Community Ditch Lateral
- South Boulder Coal Creek First Extension Lateral
- Stock Ponds 1, 2, 3, and 4, and their abutting wetlands
- Detention Ponds 1 and 2, and their abutting wetlands
- Duck Pond
- Ephemeral Drainage 1 Wetlands
- Ephemeral Drainage 2 Wetlands

At your request, an approved JD has been completed for two aquatic resources in this area. The approved JD is attached to this letter. If you are not in agreement with the JD decision, you may request an administrative appeal under regulation 33 CFR 331, by using the attached Appeal Form and Administrative Appeal Process form. The request for appeal must be received within 60 days from the date of this letter. If you would like more information on the jurisdictional appeal process, contact this office. It is not necessary to submit a Request for Appeal if you do not object to the JD.

This JD is valid for a period of five years from the date of this letter, unless new information warrants revisions of the JDs before the expiration date, or unless the Corps has identified, after a possible public notice and comment, that specific geographic areas with rapidly changing environmental conditions merit re-verification on a more frequent basis.

If there are any additional questions or concerns, please contact **Mr. Nicholas Franke** of my office at **303-979-4120** or by email at Nicholas.A.Franke@usace.army.mil and reference **Corps File No. NWO-2019-00148-DEN**.

Sincerely,

John Urbanic
Chief, Denver Regulatory Office

Attachments:

Approved Jurisdictional Determination (April 4, 2019)
Approved Jurisdictional Determination Appeal Form
Approved Jurisdictional Determination Appeal Form Instruction Sheet

Copies Furnished:
Heidi Gerstung, ERO Resources Corp., 1842 Clarkson Street, Denver, CO/80218

ERO Resources Corp.

February 24, 2020

Mr. Kiel Downing
U.S. Army Corps of Engineers
Denver Regulatory Office
9307 South Wadsworth Boulevard
Littleton, CO 80128-6901

RE: Preconstruction Notification Redtail Ridge Development Goodhue Ditch Crossing
Boulder County, Colorado

Dear Mr. Downing:

On behalf of Brue Baukol Capital Partners, ERO Resources Corporation (ERO) is requesting authorization for impacts on waters of the U.S. and abutting wetlands that would result from construction of a road crossing over the Goodhue Ditch in Boulder County, Colorado. ERO believes the project meets the criteria for authorization under the Nationwide Permit (NWP) system (33 CFR 330.6) – specifically, NWP 14 for Linear Transportation Projects and/or NWP 46 for Discharges in Ditches.

The attached Preconstruction Notification includes a description of the proposed project and associated impacts, along with figures, photos of the site, and plan sheets. If you have any questions or need further information, please do not hesitate to call. I look forward to hearing from you.

Sincerely,

Heidi Gerstung
Natural Resources Specialist

Attachments

cc via email: Jordan Swisher – Brue Baukol Capital Partners
Mark West – Harris Kocher Smith

Denver
1842 Clarkson St.
Denver, CO 80218
303.830.1188

Durango
1015 ½ Main Avenue
Durango, CO 81301
970.422.2136

Hotchkiss
P.O. Box 932
161 South 2nd St.
Hotchkiss, CO 81419
970.872.3020

Idaho
4001 East Main Street
Emmett, ID 83617
208.365.7684

www.eroresources.com

Consultants in Natural Resources and the Environment

Preconstruction Notification

Redtail Ridge Development – Goodhue Ditch Crossing

Boulder County, Colorado

Prepared for—

Brue Baukol Capital Partners
1555 Blake Street, Suite 210
Denver, Colorado 80202

Prepared by—

ERO Resources Corporation
1842 Clarkson Street
Denver, Colorado 80218
(303) 830-1188
ERO Project #10500

February 24, 2020

Contents

Project Description **1**

Location **1**

Site Description **1**

Land Use and Vegetation 1

Soils Classification 4

Wetlands and Other Waters **4**

Methods 4

Streams and Open Water 5

Wetlands 6

Vegetation *6*

Soils *6*

Hydrology *6*

Endangered Species Act Compliance **7**

National Historic Preservation Act Compliance **9**

Activity to be Authorized **9**

Avoidance and Minimization 10

Mitigation 10

Compliance with Nationwide and Regional Permit Conditions **12**

Project Contacts **12**

References **13**

Tables

Table 1. Wetlands and open water within the project area. 6

Table 2. Federally threatened, endangered, and candidate species potentially found in the project area or potentially affected by projects in the project area. 7

Table 3. Summary of impacts on wetlands and waters of the U.S. 10

Figures

Figure 1. Vicinity Map 2
Figure 2. Existing Conditions 3
Figure 3. Proposed Impacts 11

Appendices

Appendix A Photo Log
Appendix B Routine Wetland Determination Datasheets
Appendix C Cultural Resource Survey Report
Appendix D Project Plan Sheets

Preconstruction Notification
Redtail Ridge Development – Goodhue Ditch Crossing

Boulder County, Colorado

February 24, 2020

Project Description

Brue Baukol Capital Partners (BBCP) is proposing to construct a road crossing over the Goodhue Ditch in Boulder County, Colorado (project area; Figure 1). The proposed road crossing is associated with Campus Drive and the Redtail Ridge residential development located in Boulder County, Colorado. The crossing over the Goodhue Ditch would provide road access to the proposed development, and project activities would include the installation of a culvert constructed of approximately 400 linear feet of reinforced concrete pipe. BBCP retained ERO Resources Corporation (ERO) to assist in requesting authorization for the project under Nationwide Permit (NWP) 14 for Linear Transportation or NWP 46 for Discharges in Diches.

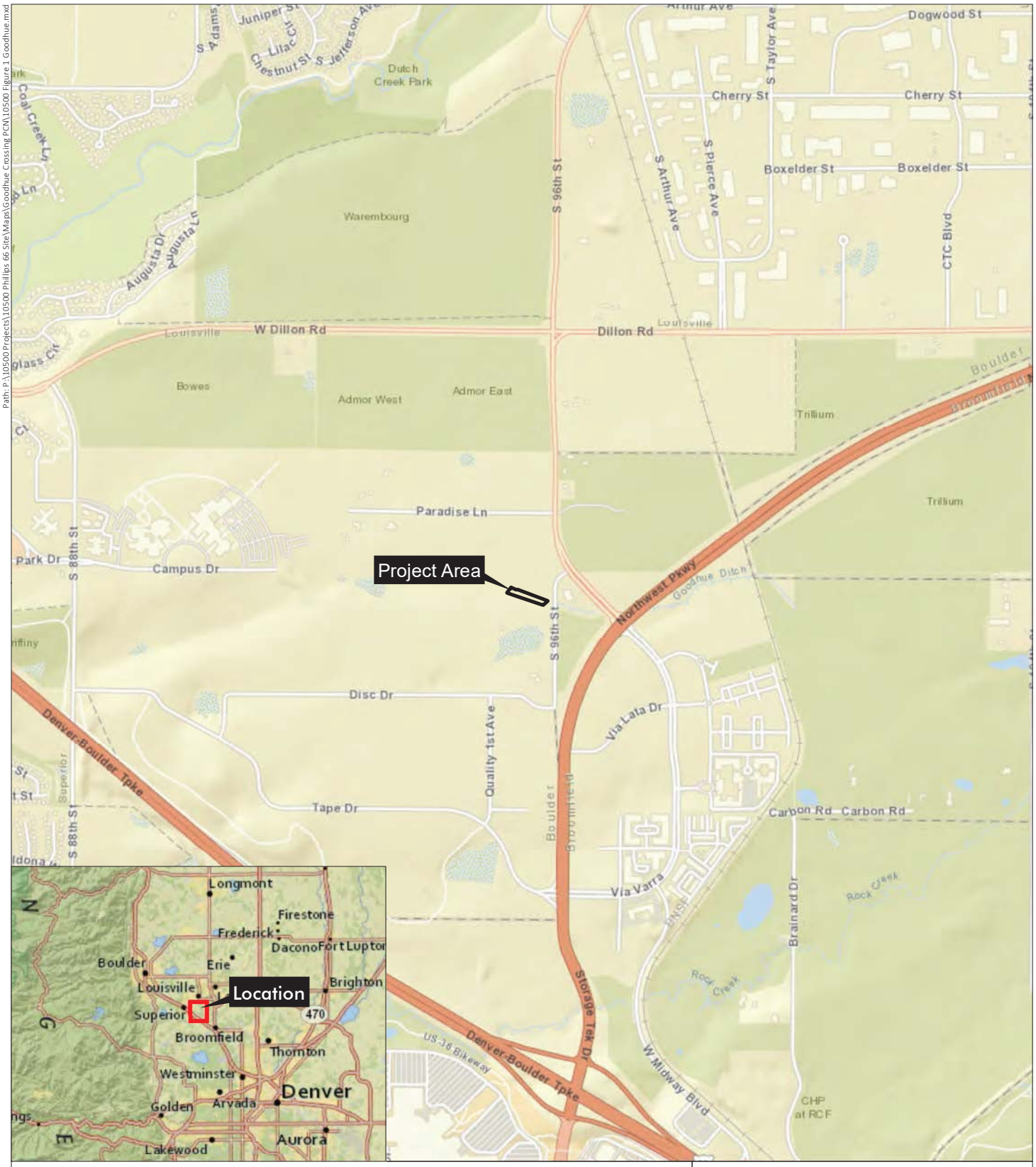
Location

The project area is generally southwest of the intersection of Paradise Lane and South 96th Street in Boulder County, Colorado. The legal description of the project area is Section 20, Township 1 South, Range 69 West of the 6th Principal Meridian in Boulder County, Colorado (Figure 1). The UTM coordinates for the approximate center of the project area are 488963mE, 4422198mN, Zone 13 North. The longitude/latitude of the project area is 105.129202°W/39.949841°N. The elevation of the project area is approximately 5,391 feet above sea level. Photo points of the project area are shown on Figure 2, and the photo log is in Appendix A.

Site Description

Land Use and Vegetation

The project area is southwest of the intersection of Paradise Lane and South 96th Street in Boulder County, Colorado (Figure 1). The project area is surrounded by agricultural lands to the north, undeveloped grazed lands to the south and west that were part of the former StorageTek campus, and South 96th Street and the North Metro Fire Station 67 to the east. The Goodhue Ditch generally flows north to southeast in the project area.



Goodhue Ditch Crossing PCN

Section 20, T1S, R69W; 6th PM

UTM NAD 83: Zone 13N; 488963mE, 4422198mN

Longitude 105.129202°W, Latitude 39.949841°N

USGS Louisville, CO Quadrangle

Boulder and Broomfield Counties, Colorado

0 750 1,500 Feet

N

Figure 1
Vicinity Map

Prepared for: Brue Baukol
Capital Partners
File: 10500 Figure 1 Goodhue.mxd (GS)
January 31, 2020

ERO Resources Corp.

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Path: P:\10500 Projects\10500 Phillips 66 Site\Maps\Goodhue Crossing PCN\10500 Figure 1 Goodhue.mxd

Path: P:\10500 Projects\10500 Phillips 66 Site\Maps\Goodhue Crossing PCN\10500 Figure 2 Goodhue.mxd

Goodhue Ditch Crossing PCN

- Data Point
- Photo Point
- Limit of Delineation

Wetlands and Waters (Total Acres, Project Area Acres)

- Ordinary High Water Mark (0.071, 0.052)
- Wetland (0.121, 0.080)

Project Area

Image Source: Google Earth©, September 2019

0 100 200 Feet

N

Figure 2
Existing Conditions

Prepared for: Brue Baukol
Capital Partners
File: 10500 Figure 2 Goodhue.mxd (GS)
February 24, 2020

ERO
ERO Resources Corp.

The Goodhue Ditch is approximately 2 to 6 feet wide within the project area (Photo 1; Figure 2). Wetlands occur along most of the length of the Goodhue Ditch (Figure 2). Vegetation along the banks of the Goodhue Ditch within the project area is dominated by sandbar willow (*Salix exigua*), peachleaf willow (*Salix amygdaloides*), reed canarygrass (*Phalaris arundinacea*), and marshpepper knotweed (*Polygonum hydropiper*) (Photos 1 and 2). Uplands adjacent to the Goodhue Ditch in the project area are dominated by Scotch thistle (*Onopordum acanthium*), smooth brome (*Bromus inermis*), and Canada thistle (*Cirsium arvense*) (Photos 1 and 2).

Soils Classification

The Natural Resources Conservation Service (NRCS) mapped two primary soil associations in the project area (U.S. Department of Agriculture (USDA)/NRCS 2020). Within the project area, the soil is predominately mapped as Nunn clay loam, 1 to 3 percent slopes and Valmont clay loam, 3 to 5 percent slopes. Nunn clay loam is typically found on terraces and consists of well-drained Pleistocene aged alluvium or eolian deposits. Valmont clay loam is typically found on terraces and fan remnants and consists of well-drained gravelly and cobbly loamy alluvium.

Wetlands and Other Waters

Methods

On August 23, 2019, Heidi Gerstung and Anna Wistrom with ERO assessed the project area for potential waters of the U.S., including abutting and adjacent wetlands (2019 site visit). Before the 2019 site visit, ERO reviewed U.S. Geological Survey (USGS) quadrangle topographic maps and aerial photography to identify mapped streams and areas of open water that could indicate wetlands or waters of the U.S.

ERO conducted the wetland delineation following the methods for routine on-site wetland determinations in areas of less than 5 acres as described in the 1987 Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) and used methods in the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual*: Great Plains Region (Version 2.0) (U.S. Army Corps of Engineers (Corps) 2010) to record data on vegetation, soils, and hydrology on routine determination forms (Appendix B). The Corps defines wetlands as “areas that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas” (33 Code of Federal Regulations (CFR) 328.2(c)). Wetland boundaries were determined by a visible change in vegetation community, soils, topographic changes, and other visible distinctions between wetlands and uplands.

The wetland indicator status of plant species was identified using the National Wetland Plant List (Lichvar et al. 2016), taxonomy was determined using Flora of Colorado (Ackerfield 2015) and Colorado Flora: Eastern Slope (Weber and Wittmann 2012), and nomenclature was determined using *The PLANTS*

Database (USDA/NRCS 2019). Soil data were not always collected if hydrophytic vegetation and hydrology were present and did not appear altered (Environmental Laboratory 1987). In addition, soil data were not collected in conditions where there was a clear lack of hydrology and hydrophytic vegetation indicators. Where soil data were collected, a Munsell soil color chart was used to determine soil color.

Intermittent, ephemeral, and perennial drainages with characteristics of a defined streambed, streambank, ordinary high water mark (OHWM), and other erosional features also were identified. The OHWM identifies the lateral jurisdictional limits of nonwetland waters of the U.S. Federal jurisdiction over nonwetland waters of the U.S. extends to the OHWM, defined in 33 CFR 328.3 as "the line on the shore established by fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of the soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas." The Corps defines stream bed as "the substrate of the stream channel between the OHWMs. The substrate may be bedrock or inorganic particles that range in size from clay to boulders."

The boundaries of identified wetlands and other characteristics of a potential waters of the U.S. were mapped using a Trimble ProXR Global Positioning System (GPS) unit and TBC1 data logger. GPS data were differentially corrected using the CompassCom base station. All differential correction was completed using Trimble Pathfinder Office 5.90 software. GPS data were incorporated onto base mapping using ARC Geographic Information System (GIS) software. Additionally, where appropriate, wetlands were drawn on georectified aerials and then digitized. Delineated wetlands were also classified according to the U.S. Fish and Wildlife Service's (Service) Cowardin classification system (Cowardin et al. 1979) combined with a hydrogeomorphic (HGM) approach (Brinson 1993).

ERO also reviewed the proximity and potential surface water connection of wetlands to known jurisdictional waters of the U.S. using aerial photo interpretation, landowner information, and information from the wetland survey. Potential waters of the U.S., including adjacent wetlands, identified in the project area are shown on Figure 2. Data were collected from various locations in the project area to document the characteristics of uplands and wetlands and the transition areas between them. Each data point was given a label that corresponds to a location shown on Figure 2 and routine wetland determination forms (Appendix B). The following sections contain information on potential surface water connections of wetlands and other waters within the project area.

Streams and Open Water

Under existing regulations, waters tributary to navigable waters are considered waters of the U.S. and are subject to the Corps' jurisdiction (jurisdictional). The Goodhue Ditch is shown on the USGS Louisville topographic quadrangle and on the National Hydrography Dataset as a canal/ditch and intermittent

stream (Figure 1, Figure 2). The Goodhue Ditch is a tributary of Coal Creek, which is a tributary to the South Platte River. The Goodhue Ditch contains a defined bed and bank with fringe wetlands along portions of the banks. ERO mapped approximately 0.052 acre of open water along the Goodhue Ditch in the project area during the 2019 site visit. The Goodhue Ditch has been determined jurisdictional by the Corps (Corps File No. NWO-2019-00148-DEN, Corps 2019).

Wetlands

Jurisdictional wetlands meet the Corps' definition of wetlands and are adjacent, neighboring, or have a surface tributary connection to interstate or navigable waters of the U.S. During the 2019 site visit, ERO mapped approximately 0.08 acre of wetlands abutting the Goodhue Ditch within the project area (Table 1). ERO collected data from two data points (DP) near the Goodhue Ditch (DP1 and DP2).

Vegetation

The wetland fringe vegetation within the Goodhue Ditch is dominated by sandbar willow (facultative wetland (FACW)), peachleaf willow (FACW), marshpepper knotweed (obligate (OBL)), and reed canarygrass (FACW). Upland (UPL) vegetation is dominated by Scotch thistle, smooth brome, and Canada thistle. At DP2, the vegetation met the rapid test for hydrophytic vegetation. DP1 consisted primarily of smooth brome and did not meet the dominance test or prevalence index for hydrophytic vegetation. See Appendix B for additional information for each data point.

Soils

Soil data were collected from one location within the project area (DP2) (Figure 2). Soils at DP2 had a matrix color of 10YR 4/2 from 0 to 6 inches with 5 percent prominent redox features of 7.5YR 4/6 observed and a matrix color of 10YR 3/2 from 6 to 12 inches with 5 percent distinct redox features of 7.5YR 4/4 observed. The hydric soil indicator at DP2 was depleted matrix. Soils were not collected within the adjacent upland (DP1) due to the lack of hydrophytic vegetation and hydrologic indicators.

Hydrology

Hydrologic indicators observed at DP2 included the presence of surface water, saturation, geomorphic position, and the FAC-Neutral test. No hydrologic indicators were observed at DP1.

Table 1. Wetlands and open water within the project area.

Feature	Cowardin Type	HGM	Size (acres)
Open Water	Riverine, intermittent, streambed	Riverine	0.052
Wetland	Palustrine emergent, palustrine scrub-shrub	Riverine	0.08

Endangered Species Act Compliance

During the 2019 site visit, ERO assessed the project area for habitat for federally listed threatened and endangered species protected under the Endangered Species Act (ESA). The project area does not fall within Service habitat or survey guidelines developed by the Service for the majority of the species listed by the Service as potentially being present in the project area (Table 2).

Table 2. Federally threatened, endangered, and candidate species potentially found in the project area or potentially affected by projects in the project area.

Common Name	Scientific Name	Status*	Habitat	Habitat Present
Mammals				
Canada lynx	*Lynx Canadensis*	T	Climax boreal forest with a dense understory of thickets and windfalls	No
Preble's meadow jumping mouse (Preble's)	*Zapus hudsonius preblei*	T	Shrub riparian/wet meadows	Yes, but not likely to support Preble's
Birds				
Interior least tern**	*Sterna antillarum athalassos*	E	Sandy/pebble beaches on lakes, reservoirs, and rivers	No habitat; no depletions anticipated
Mexican spotted owl	*Strix occidentalis*	T	Closed canopy forests in steep canyons	No
Piping plover**	*Charadrius melodus*	T	Sandy lakeshore beaches and river sandbars	No habitat; no depletions anticipated
Whooping crane**	*Grus americana*	E	Mudflats around reservoirs and in agricultural areas	No habitat; no depletions anticipated
Fish				
Greenback cutthroat trout	*Oncorhynchus clarki stomias*	T	Clear, swift-flowing mountain streams with cover such as overhanging banks and vegetation and mountain lakes	No
Pallid sturgeon**	*Scaphirhynchus albus*	E	Large, turbid, free-flowing rivers with a strong current and gravel or sandy substrate	No habitat; no depletions anticipated

Common Name	Scientific Name	Status*	Habitat	Habitat Present
Plants				
Ute ladies'-tresses orchid (ULTO)	*Spiranthes diluvialis*	T	Moist to wet alluvial meadows, floodplains of perennial streams, and around springs and lakes below 7,800 feet in elevation	No, habitat on-site not conducive to establishment of this species
Western prairie fringed orchid**	*Platanthera praeclara*	T	Moist to wet prairies and meadows	No habitat; no depletions anticipated

*T = Federally Threatened Species; E = Federally Endangered Species.

**Water depletions in the South Platte River may affect the species and/or critical habitat in downstream reaches in other counties or states.

Source: Service 2020.

There is no likelihood for the proposed project to affect the Canada lynx, Mexican spotted owl, or greenback cutthroat trout because of the lack of habitat in the project area. The interior least tern, piping plover, whooping crane, pallid sturgeon, and western prairie fringed orchid are species that are affected by continued or ongoing water depletions to the Platte River system. Based on ERO's current knowledge of the project, the project activities would not result in any depletions to the South Platte River and, therefore, would not likely result in any changes to historic patterns of natural depletions to the South Platte River watershed. Because of the lack of depletions, the proposed project would not affect these species.

The project area falls within the general guidelines for a Preble's survey because the project area is within Boulder County below 7,600 feet in elevation. However, the project area is approximately 1 mile north of the Denver metro block clearance zone border marked by U.S. Highway 36, which is located south of the project area (Service 2016). While the project area does contain a small amount of woody wetland vegetation and wetlands along the Goodhue Ditch, the ditch upstream and downstream of the project area loses this shrub component. Additionally, numerous trapping surveys conducted in the vicinity of the project area, along Rock Creek and Coal Creek, have been negative for Preble's (Boulder County Parks and Open Space 1998 and 1999; Stoecker Ecological 1998). The closest known Preble's population is approximately 4.38 miles west of the project area (Beane 1999), with substantial development, human disturbance, and roads between this location and the project area. Because of these reasons, the project is unlikely to support a population of Preble's.

The project area is located in Boulder County, an area where ULTO habitat surveys are required if suitable habitat is present (Service 1992); however, the project area lacks suitable ULTO habitat. The project area around the Goodhue Ditch consists of a narrow riparian wetland adjacent to the ditch, which is heavily vegetated with sandbar willows and lacks the open wet meadow characteristics typical

of ULTO habitat. Additionally, the banks are fairly steep and there is an abrupt transition to grazed uplands dominated by smooth brome. The small areas of emergent wetlands abutting the Goodhue Ditch also lack any of the plant species commonly found with ULTO, and the soils are predominantly clay loam. For these reasons, ERO has determined that suitable ULTO habitat is not present in the project area, and the proposed project is not likely to affect this species.

National Historic Preservation Act Compliance

To assist with the Corps' consultation obligations under Section 106 of the National Historic Preservation Act (NHPA), ERO archaeologist Abigail Sanocki conducted a Class I file search of the project area using the Colorado Office of Archaeology and Historic Preservation online COMPASS database on January 20, 2020. COMPASS identified two overlapping segments of the Goodhue Ditch within the project area: 5BL2719.42 (determined officially not eligible in 1995) and 5BL2719.50 (evaluated as needs data in 2011). In an email to ERO on January 24, 2020, Nicholas Franke determined a formal evaluation of project effects on historic resources is necessary for the Goodhue Ditch (Franke, pers. comm. 2020), and defined the area of potential effects (APE) for a Class III survey as the extent of project construction limits overlapping jurisdictional waters.

ERO conducted the Class III pedestrian survey on February 2, 2020. The survey resulted in reevaluation and expansion of segment 5BL2719.50; no new resources were identified. Because the Goodhue Ditch (5BL2719) has not yet been evaluated in its entirety, the State Historic Preservation Officer considers the entire resource eligible for listing in the National Register of Historic Places for management purposes. However, ERO recommends segment 5BL2719.50 as nonsupporting of the eligibility of the entire resource because it is a part of a lateral system and has poor overall historic integrity. Therefore, ERO recommends a determination of "no adverse effect to historic properties" pursuant to 36 CFR 800.5 of the NHPA.

A survey report detailing the results of ERO's Class I and Class III surveys, methodology, and survey results is included for Section 106 NHPA consultation as Appendix C.

Activity to be Authorized

BBCP is proposing to construct a crossing over the Goodhue Ditch in the project area. The ditch crossing is associated with the Redtail Ridge proposed residential development. BBCP is proposing constructing a crossing for Campus Drive over the Goodhue Ditch to provide vehicular access to the development. The new structure installed would consist of approximately 400 linear feet of 54-inch reinforced concrete piping. See Appendix D for Project Plan Sheets for more detail.

The proposed project would permanently impact 0.049 acre of open water and 0.075 acre of adjacent wetlands (Figure 3; Table 3). Additional impacts from construction access would occur along the

Goodhue Ditch surrounding the project area, temporarily impacting approximately 0.003 acre of open water and 0.005 acre of adjacent wetlands, but these areas would be restored to preexisting conditions.

Table 3. Summary of impacts on wetlands and waters of the U.S.

Water/Wetland	Permanent Impacts (acres)	Temporary Impacts (acres)
Open Water	0.049	0.003
Wetland	0.075	0.005
Total Impacts	**0.124**	**0.008**

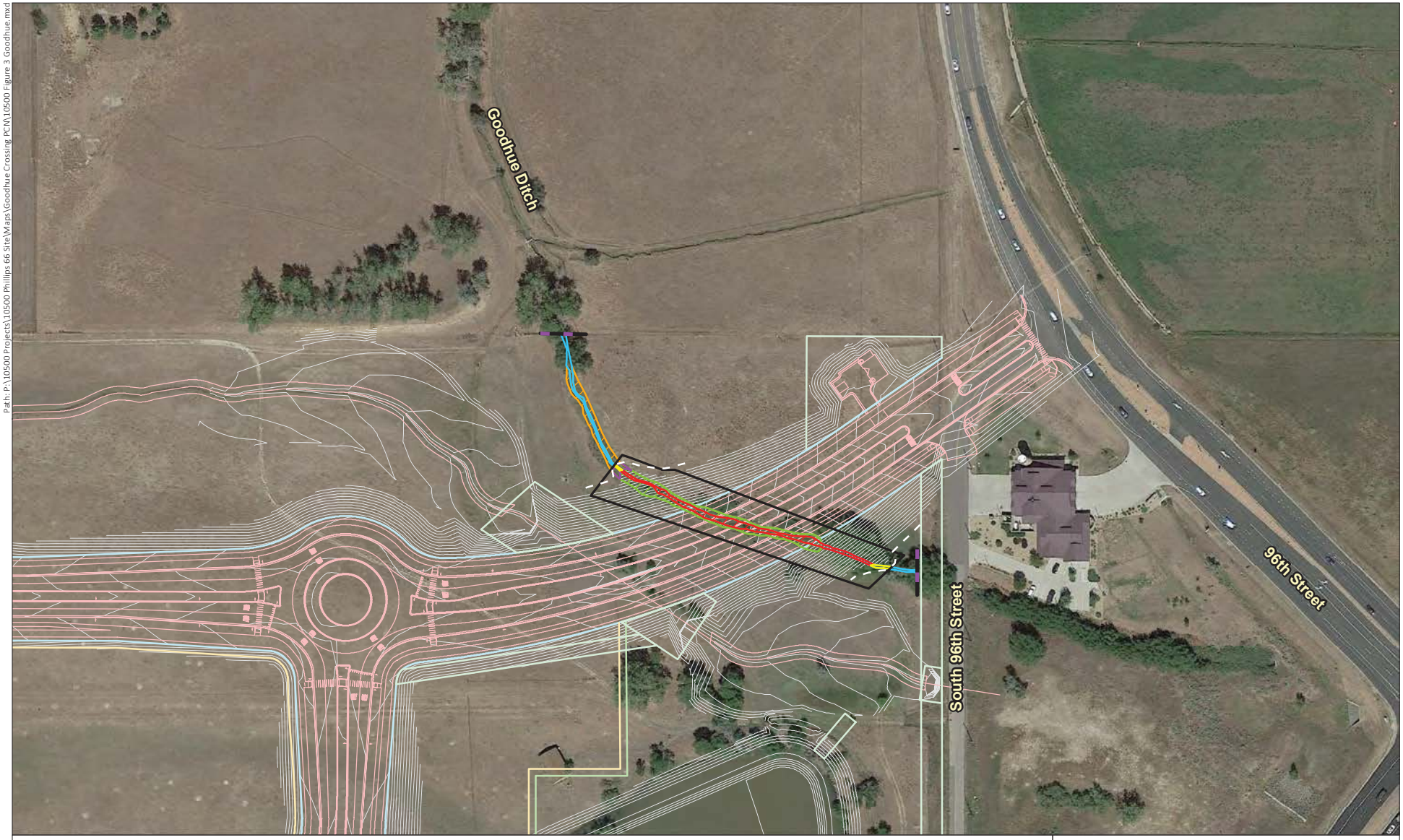
Avoidance and Minimization

The project has been designed to minimize impacts on waters of the U.S. and wetlands in the project area to the maximum extent possible, including minimizing the size of the culvert to reduce impacts on the Goodhue Ditch. The project has been designed to avoid and minimize impacts on areas outside of the project area limits. All temporary impacts associated with the project would be returned to pre-project conditions following completion of the proposed activities. In addition to the avoidance and minimization measures listed above, Best Management Practices (BMPs) would be implemented during construction to minimize indirect impacts on the adjacent wetlands abutting the Goodhue Ditch. These BMPs include installing temporary fencing to deter access to areas outside the project area limits, staging vehicles and equipment in upland areas, and installing sediment- and erosion-control devices, including erosion-control blankets, to minimize surface runoff in disturbed areas.

Mitigation

BBCP is not proposing specific compensatory wetland mitigation because less than 0.10 acre of wetlands would be impacted by the proposed project and the project would result in minimal adverse effects on the aquatic environment. All temporarily disturbed areas in the project area would be planted with native seed mixes appropriate for the site conditions and mulched directly after completion of construction.

Path: P:\10500 Projects\10500 Phillips 66 Site\Maps\Goodhue Crossing PCN\10500 Figure 3 Goodhue.mxd



Goodhue Ditch Crossing PCN

- Limit of Delineation
- Ordinary High Water Mark (0.071 ac)
- Wetland (0.121 ac)
- Project Area
- Permanent Ordinary High Water Mark Impact (0.049 ac)
- Permanent Wetland Impact (0.075 ac)
- Temporary Ordinary High Water Mark Impact (0.003 ac)
- Temporary Wetland Impact (0.005 ac)

0 100 200 Feet

N

Figure 3
Proposed Impacts

Image Source: Google Earth©, September 2019

Prepared for: Brue Baukol
Capital Partners
File: 10500 Figure 3 Goodhue.mxd (GS)
February 6, 2020

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Compliance with Nationwide and Regional Permit Conditions

ERO believes this work is authorized under NWP 14 for Linear Transportation, NWP 46 for Discharges in Ditches, or other appropriate NWPs as determined by the Corps. As currently designed, the proposed project complies with all applicable NWP general and Colorado regional conditions associated with current NWPs. All temporary and permanent impacts have been limited to the minimum amount necessary to construct the project.

Before commencing work in the project area, if construction would occur during the active nesting season, the project area would be surveyed for active nests in compliance with general condition 4 and the Migratory Bird Treaty Act. The project area was evaluated for threatened and endangered species habitat, and ERO recommends the project area is unlikely to support any federally threatened or endangered species and, therefore, would have no effect on threatened and endangered species in compliance with general condition 18 and the ESA. The project area was evaluated for historic resources, and ERO recommends the project does not have potential to affect historic properties in compliance with general condition 20 and the NHPA.

Project Contacts

Permitting Consultant
Heidi Gerstung

ERO Resources Corporation

1842 Clarkson Street

Denver, Colorado 80218

303-830-1188

hgerstung@eroresources.com

Entity Requesting Authorization
Mrs. Jordan Swisher
Brue Baukol Capital Partners
1555 Blake Street, Suite 210
Denver, Colorado 80202
720-930-4711
jordan.swisher@bruebaukol.com

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Appendix A Photo Log

Photo Log
Goodhue Ditch Crossing
Boulder County, Colorado
August 23, 2019

Photo 1 - Overview of Goodhue Ditch just outside of the northern project area boundary. View is to the north.

Photo 2 - Overview of wetlands abutting Goodhue Ditch. View is to the southeast.

Appendix B Routine Wetland Determination Datasheets

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Louisville/ Boulder Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP1

Investigator(s): H. Gerstung, A. Wistrom Section, Township, Range: 20, T1S, R69W

Landform (hillslope, terrace, etc.): terrace Local relief (concave, convex, none): none Slope (%): 1

Subregion (LRR): G Lat: 39.949960°N Long: 105.129775°W Datum: NAD83

Soil Map Unit Name: Nunn clay loam, 1 to 3 percent slopes NWI classification: R4SBC

Are climatic / hydrologic conditions on the site typical for this time of year? Yes [X] No [ ] (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes [ ] No [X]

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes [ ]	No [X]	**Is the Sampled Area within a Wetland?** Yes [ ] No [X]
Hydric Soil Present?	Yes [ ]	No [X]	
Wetland Hydrology Present?	Yes [ ]	No [X]	

Remarks:

Terrace above drainage

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	= Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1. Salix exigua	10	Yes	FACW
2.			
3.			
4.			
5.			
	10 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Onopordum acanthium	20	Yes	UPL
2. Bromus inermis	35	Yes	UPL
3. Cirsium arvense	20	Yes	FACU
4. Dipsacus fullonum	10	No	FACU
5.			
6.			
7.			
8.			
9.			
10.			
	85 = Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
	= Total Cover		

% Bare Ground in Herb Stratum 15

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 1 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 25 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species	10	x 2 = 20
FAC species		x 3 =
FACU species	30	x 4 = 120
UPL species	55	x 5 = 275
Column Totals:	95 (A)	415 (B)

Prevalence Index = B/A = 4.37

Hydrophytic Vegetation Indicators:

- [ ] 1 - Rapid Test for Hydrophytic Vegetation
- [ ] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes [ ] No [X]

Remarks:

SOIL

Sampling Point: DP1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☐ No ☒

Remarks:

Soil not sampled due to upland vegetation and lack of hydrology indicators.

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☐ No ☒ Depth (inches): _____

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☐ No ☒ Depth (inches): _____

Wetland Hydrology Present? Yes ☐ No ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

no wetland hydrology indicators observed

WETLAND DETERMINATION DATA FORM – Great Plains Region

Project/Site: Phillips 66 Site City/County: Louisville/Boulder Sampling Date: 8/23/2019

Applicant/Owner: Brue Baukol Capital Partners State: CO Sampling Point: DP2

Investigator(s): H.Gerstung, A,Wistrom Section, Township, Range: 20, T1S, R69W

Landform (hillslope, terrace, etc.): drainageway Local relief (concave, convex, none): concave Slope (%): <1

Subregion (LRR): G Lat: 39.949979°N Long: 105.129768°W Datum: NAD83

Soil Map Unit Name: Nunn clay loam, 1 to 3 percent slopes NWI classification: R4SBC

Are climatic / hydrologic conditions on the site typical for this time of year? Yes [X] No [ ] (If no, explain in Remarks.)

Are Vegetation N, Soil N, or Hydrology N significantly disturbed? Are "Normal Circumstances" present? Yes [X] No [ ]

Are Vegetation N, Soil N, or Hydrology N naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes [X]	No [ ]
Hydric Soil Present?	Yes [X]	No [ ]
Wetland Hydrology Present?	Yes [X]	No [ ]

Is the Sampled Area within a Wetland? Yes [X] No [ ]

Remarks:

In drainageway

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1.			
2.			
3.			
4.			
	0 = Total Cover		
Sapling/Shrub Stratum (Plot size: 15')			
1. Populus angustifolia	20	Yes	FACW
2. Salix exigua	30	Yes	FACW
3.			
4.			
5.			
	50 = Total Cover		
Herb Stratum (Plot size: 5')			
1. Phalaris arundinacea	25	Yes	FACW
2. Polygonum hydropiper	10	Yes	OBL
3. Dipsacus fullonum	5	No	FACU
4. Echinochloa crus-galli	2	No	FAC
5.			
6.			
7.			
8.			
9.			
10.			
	42 = Total Cover		
Woody Vine Stratum (Plot size:)			
1.			
2.			
	0 = Total Cover		

% Bare Ground in Herb Stratum 58

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC−): 4 (A)

Total Number of Dominant Species Across All Strata: 4 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A =

Hydrophytic Vegetation Indicators:

- [X] 1 - Rapid Test for Hydrophytic Vegetation
- [ ] 2 - Dominance Test is >50%
- [ ] 3 - Prevalence Index is ≤3.0[1]
- [ ] 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- [ ] Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? Yes [X] No [ ]

Remarks:

SOIL

Sampling Point: DP2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-6	10YR 4/2	95	7.5YR 4/6	5	C	M	SCL	
6-12	10YR 3/2	95	7.5YR 4/4	5	C	M	SCL	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☒ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16) (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16) (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if present):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☒ No ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☒ Surface Water (A1)
- ☐ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water-Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface (C7)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage Patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3) (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☒ Geomorphic Position (D2)
- ☒ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes ☒ No ☐ Depth (inches): Surface

Water Table Present? Yes ☐ No ☒ Depth (inches): _____

Saturation Present? (includes capillary fringe) Yes ☒ No ☐ Depth (inches): Surface

Wetland Hydrology Present? Yes ☒ No ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

Appendix C Cultural Resource Survey Report

ERO

Consultants in Natural Resources and the Environment

Cultural Resource Survey
Redtail Ridge Development-Goodhue Ditch Crossing
Boulder County, Colorado

Prepared for—

Brue Baukol Capital Partners
1555 Blake Street #210
Denver, Colorado 80202

Submitted to—

U.S. Army Corps of Engineers
Denver Regulatory Office
9307 South Wadsworth Boulevard
Littleton, Colorado 80128

Prepared by—

ERO Resources Corporation
1842 Clarkson Street
Denver, Colorado 80218

Written by—

Matthew Howryla
Abigail Sanocki

Prepared under the supervision of—

Sean Larmore, Principal Investigator

State Permit No. 2019-75573
SHPO Report ID BL.AE.R23
ERO Project No. 10500

February 2020

For Official Use Only: Disclosure of site locations prohibited (43 CFR 7.18)

Abstract

Brue Baukol Capital Partners contracted ERO Resources Corporation (ERO) to conduct a cultural resource survey for construction of a new road crossing over the Goodhue Ditch in association with the proposed Redtail Ridge housing development. The proposed crossing would include blading and paving a new road and installing an approximately 400-foot-long reinforced concrete pipe. Because the project would impact waters of the U.S., the U.S. Army Corps of Engineers (Corps) will be issuing a Clean Water Act permit for the project. As part of the Corps' review of the permit application, the Corps will evaluate potential effects of the undertaking on historic properties pursuant to Appendix C of the Clean Water Act and Section 106 (54 United States Code (U.S.C.) § 306108) of the National Historic Preservation Act (54 U.S.C. § 300101 et seq.) (NHPA, 1966, as amended).

The Corps defined the area of potential effect (APE) for the cultural resource survey as all areas of impacts on waters of the U.S. with a 20-foot buffer (0.636 acre). Within or overlapping the APE, ERO reevaluated segment 5BL2719.50 of the Goodhue Ditch. ERO recommends 5BL2719.50 as nonsupporting the eligibility of the entire resource for listing in the National Register of Historic Places. Therefore, ERO recommends a determination of "no adverse effect to historic properties" pursuant to 36 Code of Federal Regulations 800.5 of the NHPA.

Contents

Abstract i
Project Description 1
Natural Environment 1
Cultural Overview 3
Methods 6
Historic Property Identification 6
Cultural Resource Documentation 7
Historic Period Sites 7
Criteria for Evaluation 8
File and Literature Review 10
Survey Results 11
Resource Description 11
5BL2719.50 11
References Cited 14

Figures

Figure 1. Project location. 2
Figure 2. APE overview, view to the northwest. 3
Figure 3. Alignment of Goodhue Ditch and a natural unnamed drainage; APE in red (USGS 1942). 11
Figure 4. Overview of AC1, concrete footer and beam visible in mid-ground, view to the north northwest. 12

Appendices

Appendix A Cultural Resource Location Map
Appendix B OAHP Cultural Resource Documentation Forms

Cultural Resource Survey
Redtail Ridge Development-Goodhue Ditch Crossing
Boulder County, Colorado

February 2020

Project Description

Brue Baukol Capital Partners contracted ERO Resources Corporation (ERO) to conduct a cultural resource survey for construction of a new road crossing over the Goodhue Ditch in association with the proposed Redtail Ridge housing development. The proposed crossing would include blading and paving a new road and installing an approximately 400-foot-long reinforced concrete pipe. Because the project would impact waters of the U.S., the U.S. Army Corps of Engineers (Corps) will be issuing a Clean Water Act (CWA) permit for the project. As part of the Corps' review of the permit application, the Corps will evaluate potential effects of the undertaking on historic properties pursuant to Appendix C of the CWA and Section 106 (54 United States Code (U.S.C.) § 306108) of the National Historic Preservation Act (54 U.S.C. § 300101 et seq.) (NHPA, 1966, as amended).

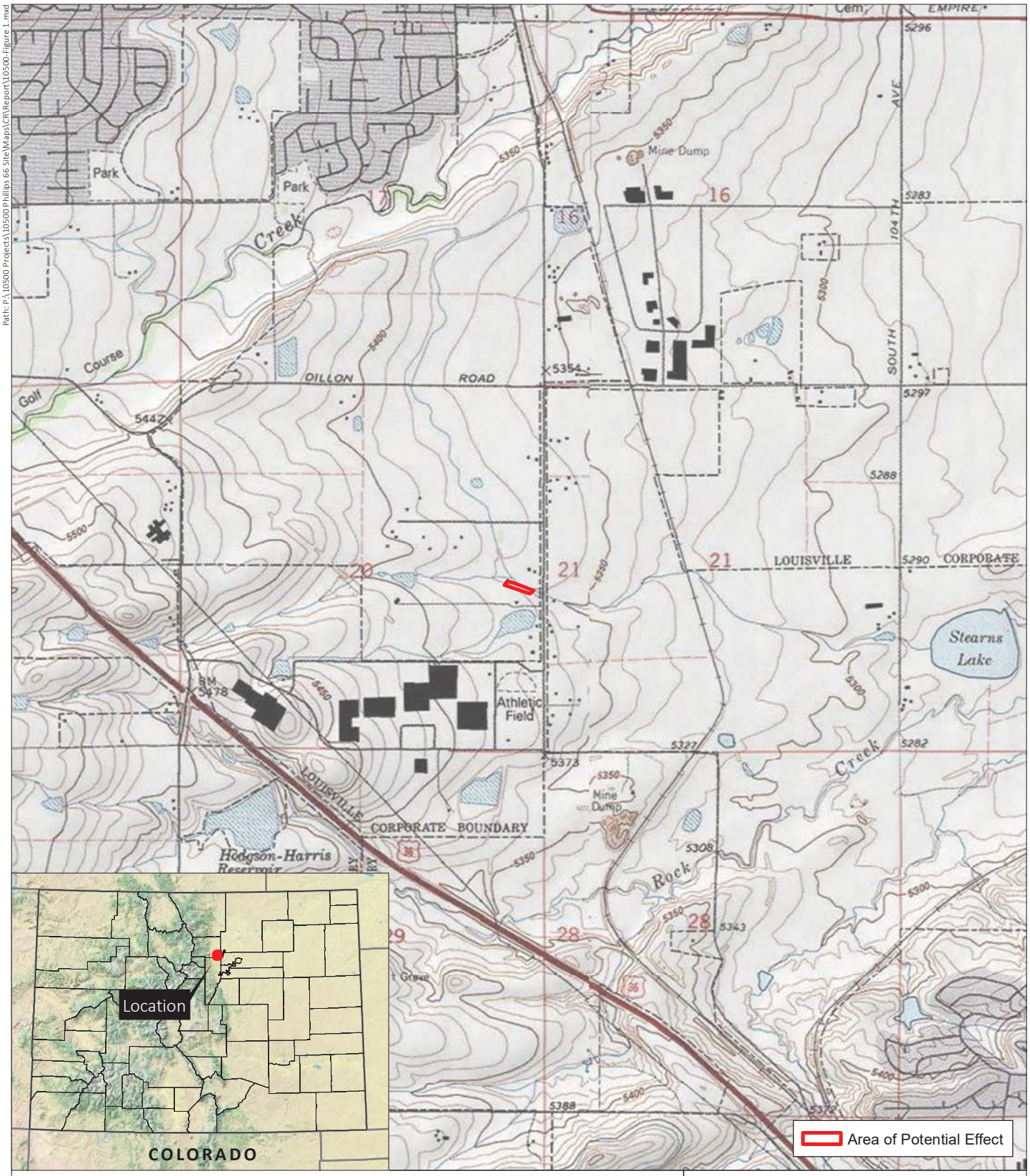
The Corps defined the area of potential effect (APE) for the cultural resource survey as all areas of Corps-permitted impacts on waters of the U.S. with a 20-foot buffer (0.636 acre). Land within the APE is owned by the Phillips 66 Company. The APE is located on the Louisville 7.5-minute U.S. Geological Survey (USGS) quadrangle (Figure 1). The legal location is the northeast quarter of the southeast quarter of Section 20, Township 1 South, Range 69 West of the 6th Principal Meridian in Boulder County, Colorado.

ERO archaeologist Abigail Sanocki conducted a Class III cultural resource survey of the APE on February 2, 2020.

Natural Environment

Contained within the Colorado Piedmont geological province, the APE is located in the open valley of Coal Creek; the creek is about 1.25 miles to the northwest. The area is characterized as a broad valley surrounded by rolling hills and mesas with shallow ephemeral drainages (Figure 2). The elevation of the APE ranges from 5,365 feet (ft) above sea level (asl) to 5,370 ft asl. Moderately dense grasses allowed for 60 to 90 percent ground visibility at the time of survey. The surface geology consists of Laramie and Fox Hills Sandstone formations comprised of sedimentary sandstone, shale, and claystone (Green 1992).

Path: P:\10500 Projects\10500 Phillips 66 Site\Maps\CR\Report\10500-Figure 1.mxd



Cultural Resource Survey
Redtail Ridge Development-Goodhue Ditch Crossing
Boulder County, Colorado

Section 20, Township 1S, Range 69W; 6th PM
USGS Louisville, CO Qudranlge (1:24,000, 1980)
Boulder County, Colorado

N

0 1,000 2,000 Feet
1:24,000

Figure 1
Project Location

Prepared for: Brue Baukol
Capital Partners
File: 10500-Figure 1.mxd (MH)
February 5, 2020

ERO
ERO Resources Corp.

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Based on the Web Soil Survey data compiled by the Natural Resources Conservation Service (NRCS), soils within the APE consist of Nunn Clay Loam 1 to 3 percent slope and Valmont Clay Loam, 1 to 3 percent slope. Nunn Clay Loams are typically found on terraces and are derived from Pleistocene age alluvium or eolian deposits. Valmont Clay Loams are typically found on terraces and alluvial fans and are derived from gravelly and cobbly alluvium (NRCS 2020).

Vegetation along the banks of the Goodhue Ditch is predominantly sandbar willow (*Salix exigua*), peachleaf willow (*Salix amygdaloides*), reed canarygrass (*Phalaris arundinacea*), and marshpepper knotweed (*Polygonum hydropiper*). Uplands adjacent to the Goodhue Ditch are dominated by smooth brome (*Bromus inermis*). Fauna includes coyotes, cottontails, jackrabbits, foxes, rodents, and various bird species.

Figure 2. APE overview, view to the northwest.

Cultural Overview

The overview provided here is regional and intended to provide a context for the historical development and construction of resources identified in the APE. Because no prehistoric resources were identified during ERO's survey, an intensive cultural overview of the prehistory of the region is unnecessary; refer to *Colorado Prehistory: A Context for the Platte River Basin* (Gilmore et al. 1999) for a complete overview.

The earliest settlements in the eastern plains of Colorado were established by Hispanic settlers. Until the end of the Mexican-American War and the transfer of control of large areas of the West to the

United States in 1848, most American contact with the area was in the form of exploratory and military parties. A second period of agricultural settlement was initiated by the discovery of gold in Colorado in 1858 (Church et al. 2007). Large numbers of individuals left the economically depressed Mississippi Valley to travel to Colorado in the hopes of wealth. While many failed and returned to the east, a number stayed to occupy mining communities or establish agricultural or commercial venues in the Colorado plains to supply miners and travelers. The United States government began to encourage western expansion and settlement following the Civil War by establishing a series of acts. The Homestead Act of 1862 encouraged the settlement of Colorado's plains for agricultural purposes by ensuring settlers could obtain cheap land.

Originally a prospector camp in 1858, the city of Boulder grew as a jumping-off point and supply center for gold seekers and early territorial settlers. In early 1859, A.A. Brookfield organized the Boulder City Town Company. As president, he platted the first subdivision along Pearl Street and sold lots to settlers for building cabins, stores, and cultivation. This subdivision quickly grew into a busy commercial district with mercantile, hardware, mining supply stores, banks, gambling establishments, and boarding houses (Baldwin 1978; Stone 1918). During the territorial days, these businesses were primarily directed at providing supplies and services to miners. As the mountain mining industry declined and after Colorado obtained statehood in 1876, the City's industries diversified when the University of Colorado was established and agricultural development on the high plains became important for subsistence and economic survival (Abbott et al. 2005; Baldwin 1978).

By the 1880s, waves of settlers were arriving in the plains and claiming the land Congress set aside for settlement. The settlers' migration and the establishment of agriculture further aided in the growth of Boulder and other Front Range towns, and prompted the construction of grain mills in the area (Baldwin 1978). The success of agriculture was further aided by the construction of railroad spurs across the Front Range by railroad companies organized by Colorado financiers and, later, state and federal government projects to improve highways across the plains (Fraser and Strand 1997). By 1889, permanent agricultural and ranching operations had been established throughout the plains, and the sustainability of these settlement efforts was increased by the establishment of irrigation systems and reservoirs (Church et al. 2007; Mehls 1982).

Due to Colorado's semiarid climate, agricultural development and permanent settlement would not have been possible without the construction of advanced water irrigation and conveyance systems. Irrigation ditches and canals across the state divert water from rivers and streams and carry it to agricultural areas and reservoirs. The era of historical agricultural irrigation in Colorado began in the south-central part of the state, in the San Luis Valley, with the construction of the San Luis People's Ditch in 1852 (Colorado Irrigation Centennial Committee 1952).

Typically, the first ditches constructed in an area, known as pioneer ditches, were used to irrigate low-lying areas in the floodplains and bottomlands by drawing water off of existing sources such as creeks, rivers, and streams. These early irrigation systems required little engineering or technology (King 1984). The best land in the immediate vicinity of rivers was claimed early on, so later settlers of lands further from the river sought a way to carry water through ditch systems for a greater distance (Colorado

Irrigation Centennial Committee 1952). In 1861, at the first session of the Colorado Territorial Legislature, an act was passed that allowed a landowner who was not adjacent to a stream to construct a ditch through land lying between his land and the stream to gain access to irrigation water (City of Boulder 2009). By the early 1860s, settlers were constructing much larger and longer ditch irrigation systems that required more sophisticated engineering and construction techniques. Some of these new systems expanded or replaced the early pioneer ditches, and some were entirely new enterprises.

Many of the early pioneer ditches were constructed by individuals, and some were constructed by several irrigators who banded together to form a mutual ditch company; larger ditches were almost always constructed by mutual ditch companies (Holleran 2005). Mutual ditch companies are legal entities in Colorado that allow ditches to be used by multiple individuals who are shareholders in the ditch company that operates the facility on their behalf. A share in a mutual ditch company represents an actual pro rata ownership interest in all of the water rights, ditches, facilities, and other assets of the company. The shareholders are, in essence, the company (Hobbs 1997).

In the late 19th and early 20th centuries, development of new irrigation ditches in Colorado began to be viewed as an investment opportunity, with speculators often enticing investors from the eastern United States with promises of quick wealth. Investors living in commercial centers on the East Coast and in Western Europe provided large sums of money for constructing irrigation systems to reach more remote areas of land in the hopes of creating a profit by selling water rights or, in many cases, just a contractual right to use water from water rights owned by another (Holleran 2005). Colorado's water laws are based on the appropriation doctrine, which protects the water rights of earlier users from diminishment by later users. Therefore, many of these later ditch investment companies were less successful than originally planned because of the limited quantity of water available to them (Holleran 2005). While many of the investment-style water companies tried to incorporate older systems or buy out senior water rights, it was soon realized that the maintenance costs of the irrigation ditches would prevent water companies from making a profit (Holleran 2005).

Many of the investment water companies' irrigation systems were not as profitable as anticipated and were later taken over by their users in the form of mutual ditch companies or irrigation districts. Irrigation districts were developed as a method to help diffuse the cost of developing a ditch system. The districts could be organized by a majority of the landowners within their boundaries, with acquisitions and construction paid through bonds paid off by assessments on all irrigated lands in the district. Irrigation districts were soon developed in some regions of Colorado as a means to acquire earlier failed irrigation companies and develop reservoirs and new canals to support existing systems (Holleran 2005).

As the demand on Colorado's water resources increased, it became necessary for the state to implement laws overseeing water rights and monitoring the amount of water diverted by each ditch system (Mehls and Mehls 2006). In 1889, state law mandated the installation of headgates to control and measure water flow. Most early attempts at water measurement tended to be unreliable as these methods were based on the calibration of laterals and headgates. Accurate flow measurements required the development of a measurement structure separate from the control gate. The need for

accurate measurements led to the development of several devices, including the Cipolletti weir, a measured opening across the flow of the ditch, and the Parshall flume, which is precalibrated to give a true flow measurement at a range of volumes (Holleran 2005).

The technology available for the construction of irrigation ditch systems has also improved, and many historical ditches have undergone modifications and improvements that help conserve water and monitor flow allotments. One significant change in ditch construction is the increased use of concrete, which began in the late 19th and early 20th centuries, when the cost decreased. Concrete can be seen in ditch features such as headgates and weirs and also as a channel liner in sections of a canal particularly susceptible to erosion or seepage. Another improvement was the development of patent iron or steel headgates in the 1890s. These iron and steel headgates replaced wooden gates, which had short life spans. Manufactured gates are usually set in concrete headwalls, although some earlier constructions were stone. Lastly, the most significant improvement to irrigation ditches was the use of electric-powered pumps to force water into field ditches or irrigation sprinklers (Holleran 2005), which began in the 1930s.

Methods

Historic Property Identification

This cultural resource survey provides compliance under Section 106 of the NHPA and its implementing regulations under 36 Code of Federal Regulations (CFR) Part 800 by undertaking a "reasonable and good faith effort" to identify historic properties (defined as listed in or eligible for listing in the National Register of Historic Places (NRHP)) within the defined APE. Identification and documentation standards conform to federal land managing agency requirements and secondly to guidelines provided by the State Historic Preservation Officer (SHPO). In doing so, the standards imposed by the *Secretary of the Interior for the Identification, Documentation, and Evaluation of Historic Properties* are also met. All personnel supervising survey and documentation are listed in applicable federal and state permits and meet or exceed the *Secretary of the Interior's Professional Qualification Standards* (36 CFR 61).

Historic properties may consist of buildings, structures, objects, or sites and can include districts, landscapes, and traditional cultural properties. The National Park Service has established an age criterion of 50 years for historic property evaluation and to be listed in the NRHP (but see criteria consideration (g) for an exception to the age guideline); in some instances, a federal agency will establish the age criterion at 45 years to account for the duration of the undertaking.

Cultural resources not identified in the Office of Archaeology and Historic Preservation (OAHP) file search and historical records were identified during pedestrian survey. This project used standard pedestrian survey transects spaced 15 to 20 meters (m) apart to identify unknown cultural resources within the APE. The APE is defined by the lead federal agency, generally in consultation with the SHPO, and means "the geographic area or areas within which an undertaking may directly or indirectly cause alterations in the character of use of historic properties, if any such properties exist" (36 CFR 800.16).

Cultural Resource Documentation

ERO documents cultural resources according to a standardized approach to ensure consistency and accuracy. Sites are digitally documented from multiple perspectives, and all significant tools, diagnostic artifacts, and features are photographed to scale. The site datum is also photographed if physically established and directed by the land managing agency. Individual site maps are produced using a mapping grade (submeter- and subcentimeter-capable) Trimble GeoXH Explorer global positioning system (GPS) unit. Elements of the site map include all cultural features, diagnostic and point provenience artifacts (designated as field specimens (FS)), artifact concentrations, major vegetation breaks and contour topography, modern features and disturbances, and the site datum (whether physically established or for location purposes).

All required forms are completed digitally in the field using a tablet. Archaeological resources and newly defined segments of linear resources such as ditches and railroads were documented using a Management Data Form (OAHP1400) and appropriate component form (prehistoric archaeology, historical archaeology, or linear); the boundaries of newly defined linear resource segments are limited to the extent of the resource within the APE. Newly identified historical buildings and structures were documented on an Architectural Inventory Form (OAHP1403). Previously recorded cultural resources identified during the OAHP file search were revisited and reevaluated on OAHP form 1405; if the resource has not been reevaluated within the last 10 years or substantial changes have occurred to the property since the previous evaluation, ERO rerecorded and reevaluated the resource by completing new state documentation forms. Location maps (Appendix A) and OAHP resource documentation forms (Appendix B) are included only for agency consultation and reside permanently with the OAHP.

Historic Period Sites

Historic period sites include such purposeful activities as homestead, ranching, or agricultural complexes; mining complexes; federal work programs; timber harvesting; and industry, among other site types. Age criteria is established for potential historic sites by referencing general land office (GLO) patents, county assessor records, state water division records, historical maps, and 15’ USGS maps. Historical dumps and artifact scatters without features are evaluated on a case-by-case basis. A single artifact class within a dump, such as sanitary cans, is recorded as an isolated occurrence; conversely, dumps that exhibit diverse artifact classes and date prior to the early part of the 20th century may be documented as archaeological sites, given their information potential.

Linear structures such as water conveyance systems, transmission lines, trails, and roads are documented as sites. An isolated fence line is generally not recorded as a resource unless it demarcates a boundary significant to the history of the area and can be physically linked with a purposeful activity; an isolated fence line may also be documented as a feature of a larger resource. Depending on their cultural context, single or small clusters of mining prospect pits with no associated artifacts are documented as isolated finds (IFs) due to general ubiquity and limited information potential.

Criteria for Evaluation

Documented cultural resources are evaluated for their eligibility to be listed in the NRHP. Significance criteria are codified under 36 CFR 60.4, summarized below:

The quality of significance in American history, architecture, archaeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and

a) that are associated with events that have made a significant contribution to the broad patterns of our history [Criterion A]; or
b) that are associated with the lives of persons significant in the past [Criterion B]; or
c) that embody the distinctive characteristics of a type, period, or method of construction, or that represents the work of a master, or that possess high artistic value, or that represent a significant or distinguishable entity whose components may lack individual distinction [Criterion C]; or
d) that have yielded, or are likely to yield, information important in prehistory or history [Criterion D].

Cultural resources that do not meet the 50-year age criterion but that are integral parts of a historic district or carry exceptional importance to the history of the region are considered for eligibility under criteria consideration (g).

Certain kinds of properties are not usually considered for listing in the NRHP: religious properties, moved properties, birthplaces and graves, cemeteries, reconstructed properties, commemorative properties, and properties achieving significance within the past fifty years" (U.S. Department of the Interior, National Park Service 1997). In order for a property to be eligible under a criteria consideration, the property must qualify for one of the four criteria and must possess integrity. Regional contexts and multiproperty nominations are used to evaluate significance under Criteria A, B, and C by defining a period of significance in which the cultural resource achieved significance given events important to the interpretation of history.

Regional contexts (e.g., Church et al. 2007; Gilmore et al. 1999) are used to evaluate significance under Criterion D by determining whether a potential property has the potential to answer defined research questions and/or date to a defined period of significance. Historical sites representative of the built environment (i.e., buildings, structures, and engineered features) typically qualify for listing in the NRHP under at least one of the first three criteria (A–C). Archaeological sites typically qualify exclusively under Criterion D, with notable exceptions. An otherwise heavily disturbed site may still retain information potential from intact features (potential chronometric or subsistence data) or discrete areas of the site that retain physical integrity. Archaeological sites with significant sediment deposition remain potentially eligible for listing in the NRHP even without evaluative testing.

Sites evaluated as "needs data" may be eligible under one or more criteria but require further work to determine NRHP eligibility. Cultural resources recommended "needs data" are predominantly archaeological sites (either prehistoric or historical) suspected of containing buried cultural deposits or historical sites where additional research is necessary to ascertain significance. Sites that are evaluated

as not eligible for listing in the NRHP do not meet any of the eligibility criteria and/or have lost physical integrity. Cultural resources are assessed for integrity only if the site meets one or more eligibility criteria. Eroded or otherwise heavily disturbed archaeological sites are typically not considered eligible since the ability to convey significance in the form of intact cultural deposits (i.e., information potential) has been lost through natural or modern disturbance.

For a property to be eligible under one or more criteria, the property must possess physical integrity and retain most if not all aspects of integrity: *location, design, setting, materials, workmanship, feeling, and association*. Most important of these for any building or structure are the aspects of location, design, and setting. Any property or linear resource that has been relocated/realigned no longer retains integrity of location, perhaps the most important aspect of integrity. The aspect of design is important for demonstrating a building or structure's association with significant historical trends, and is required for a property to qualify under Criterion A or C. Considering most historical properties are still in use, a resource can maintain integrity of design if materials have been maintained in-kind to the design of the original structure or building; for example, in-kind replacement of materials such as wood siding or railroad hardware with modern materials does not diminish integrity of design. However, modern maintenance and upgrades to earthen ditches such as the placement of modern diversion structures and concrete lining does diminish the ditch segment's ability to support eligibility under Criterion A or C. The aspects of feeling and association are intrinsically linked to the aspect of setting; suburban development and modern intrusions on the setting of a potential historic property diminish its ability to convey significance.

ERO uses the following generalized approach to assess integrity under Criterion D. Most archaeological sites are considered to be in their original *location* unless post-depositional processes, such as erosion, have transported artifacts away from their original context. Artifacts can move both vertically and horizontally in subsurface contexts. The site retains *location* if no significant post-depositional processes have altered the primary context of the artifacts. The aspect of *design* is present if the relationship between features or activity loci is apparent and the spatial organization of the site is discernible; *design* may also be present in highly formalized tools such as projectile points, ceramic vessels, architectural elements, or individual features. *Setting* refers to the surrounding physical environment of a site, which may be affected by modern development or changes to the natural environment (such as important biotic species) through climate change or modern development. *Setting* is considered intact if the surrounding environment is similar to the environment during the time of occupation. The aspect of *materials* is almost always retained due to the nature of the archaeological record and the material culture inherent to archaeological sites: If there were no physical artifacts or features (i.e., *materials*) present, there would not be a site. *Workmanship* is retained by the presence of artifacts, architecture, or features emblematic of a particular culture or people, such as a Puebloan kiva or a Clovis projectile point. The aspect of *feeling* is difficult to ascertain for archaeological sites and is often dependent on Native American perspective. Very few of the physical features present during occupation of a prehistoric site still exist in the present to convey a property's character. A site that retains *association* can be linked to a particular cultural-historical period through the presence of diagnostic artifacts or architectural elements or by chronometric means.

Each documented cultural resource described in the Survey Results section, below, is provided a recommendation of NRHP eligibility and evaluated for project effects. Based on this documentation, the lead agency will provide a determination of eligibility for each documented cultural resource based on ERO's recommendation and will provide a determination of project effect on historic properties. The lead agency will then provide the SHPO an opportunity to review and provide comment regarding NRHP eligibility and project effects per 36 CFR 800.4 through 800.5. If, during consultation between the lead agency and SHPO, a determination of "adverse effects to historic properties" occurs, further consultation is required to resolve adverse effects.

File and Literature Review

ERO conducted a file review of the APE using the OAHP's online COMPASS database on January 20, 2020. The database indicates that one previously conducted survey overlaps the entire APE: Lois Berger Group conducted the survey in 2010 on behalf of the Conoco Phillips Company and Boulder County (BL.PA.R29). COMPASS identified two overlapping segments of the Goodhue Ditch within the APE: 5BL2719.42 (determined officially not eligible in 1995) and 5BL2719.50 (evaluated as needs data in 2011). ERO reevaluated and expanded segment 5BL2719.50 during the current survey.

Additionally, ERO reviewed historical maps and aerial photographs. USGS topographic maps since 1899 depict the alignment of the Goodhue Ditch and demonstrate how the ditch builders advantageously appropriated a natural unnamed drainage into the ditch system within the APE (Figure 3) (USGS 1899, 1942, 1950, 1965). Additionally, the sinuous alignment of the natural drainage channel is visible in aerial photographs from 1963, 1964, and 1971. The 1965 USGS map and 1963-1971 aerial photographs depict a corral with small outbuildings located along the north side of the Goodhue Ditch and APE. The corral appears to have been abandoned by 1971 and all structures were removed between 1993 and 1999 (Nationwide Environmental Title Research (NETR) 2020). During the current reevaluation of 5BL2719.50, ERO documented an artifact concentration (AC1) and concrete riprap of various ages; some of these materials may be related to the corral structures.

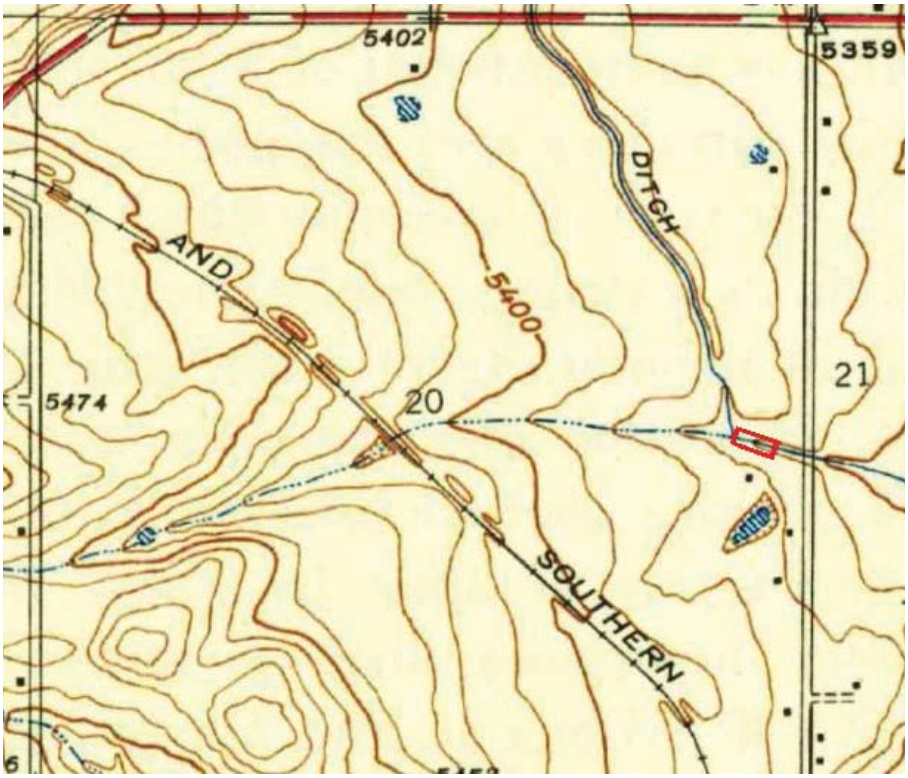

Figure 3. Alignment of Goodhue Ditch and a natural unnamed drainage; APE in red (USGS 1942).

Survey Results

ERO's pedestrian survey resulted in reevaluation and expansion of segment 5BL2719.50. OAHP documentation forms for the segment are included as Appendix B.

Resource Description

5BL2719.50

Goodhue Ditch lateral (segment)

Description: Segment 5BL2719.50 is a roughly 730-ft-long earthen ditch that generally trends northwest to southeast. It is located centrally within a southern lateral of the main Goodhue Ditch; the lateral begins in the Warembourg Open Space approximately 1 mile north of the subject segment and drains into Stearns Reservoir about 0.9 mile southeast of 5BL2709.50. The width of the recorded segment varies from 8 to 20 ft due to erosional slumping along the ditch banks. The depth varies from 6 to 12 ft due to erosion and incision of a central channel in the bottom of the ditch. The entire segment is lined by various types and ages of broken concrete and asphalt riprap, and is also littered with wood, metal, and other modern trash debris that has been washed or blown into the ditch, including PVC pipe, plywood, metal housing for a water pump, fragments of a porcelain toilet, golf and tennis balls, and various types of sheet metal. The ditch has no integrity of materials and design due to a lack of maintenance and the multiple episodes of dumping concrete and asphalt riprap onto its banks for ad hoc erosion control.

ERO documented AC1 on the northeast side of the segment (Figure 4). The concentration contains various types of broken concrete (a board-formed concrete beam with rebar, a prefabricated concrete beam with metal plates, broken concrete sidewalk slabs, and about 20 pieces of broken concrete ranging in size from 4 to 18 inches in diameter); asphalt fragments; broken sandstone flagstone pieces; about 5 common red brick fragments; about 5 wood fence posts; a milk glass fragment; a barrel hoop; aluminum straps; and 4 tennis balls (likely washed or blown into the area from nearby neighborhoods and parks). While some materials are likely associated with the corral that was historically located on the north side of the segment, the variety of concrete types and other materials indicates that AC1 is the result of later maintenance on the ditch and/or use of the area for dumping or storing construction materials.

Abner Goodhue and neighboring farmers began construction on the main Goodhue Ditch in 1873. The 20-mile-long main ditch drew water from South Boulder Creek and drained into Rock Creek. According to research conducted for the Boulder County Ditch Project, local irrigators constructed the south lateral on which segment 5BL2719.50 is located in 1875 or 1885 (Black 2007). Topographic maps and 1960s aerial photographs demonstrate that the builders advantageously incorporated an unnamed natural drainage into the south lateral system and within segment 5BL2719.50 (see Figure 3 above) (NETR 2020; USGS 1942). The Goodhue Ditch & Reservoir Company has continually maintained the ditch throughout the 1900s and for use today. Court records from the Colorado Decision Support System (CDSS) state that between 1970 and 1991 municipalities started allocating ditch water to provide water for the surrounding commercial and residential suburban developments (CDSS 2020).

Figure 4. Overview of AC1, concrete footer and beam visible in mid-ground, view to the northwest.

NRHP Eligibility: Because the Goodhue Ditch has not been evaluated in its entirety, the SHPO considers it NRHP-eligible for management purposes. The ditch is significant under Criterion A for its association

with settlement and development of dryland agriculture. The ditch is not known to be associated with any important people (Criterion B) or to convey any distinctive aspects of design or engineering (Criterion C). Additional research is unlikely to yield important information under Criterion D.

ERO recommends segment 5BL2719.50 as nonsupporting of the eligibility of the entire resource because it is part of a southern lateral and not the main ditch, a portion of the segment is a natural drainage, and the segment has poor overall integrity. The entire segment resembles a natural drainage channel and does not convey any integrity of design, materials, or workmanship due to slumping of the banks, the bottom being heavily incised, and the various types of riprap and modern debris within and along the segment. The segment has poor integrity of setting, feeling, and association due to modern highway expansion and construction of commercial, residential, and recreation developments in the surrounding area. The segment retains integrity of location.

Management Recommendations: No further work.

Summary and Management Recommendations

ERO reevaluated segment 5BL2719.50 of the Goodhue Ditch overlapping the APE and recommends it as nonsupporting of the eligibility of the entire resource for listing in the NRHP. ERO recommends no further work and a determination of “no adverse effect to historic properties” pursuant to 36 Code of Federal Regulations 800.5 of the NHPA.

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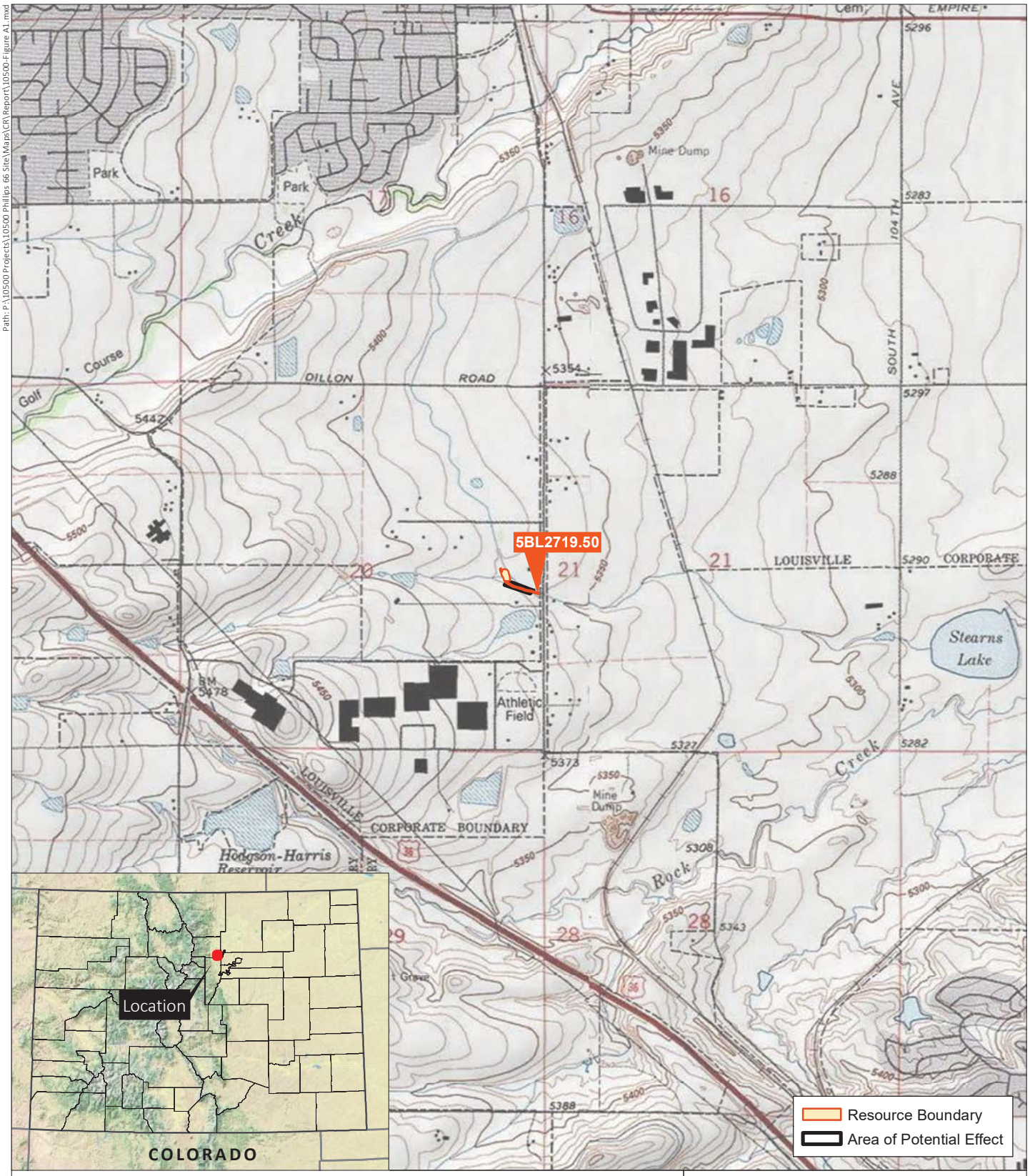
1942 *Louisville, Colorado* [topographic map]. 1:31,680. U.S. Department of the Interior, Washington DC.
1950 *Louisville, Colorado* [topographic map]. 1:24,000. U.S. Department of the Interior, Washington DC.
1965 *Louisville, Colorado* [topographic map]. 1:31,680. U.S. Department of the Interior, Washington DC.

Appendix A Cultural Resource Location Map
For Official Use Only: Disclosure of Site Locations Prohibited (43 CFR 7.18)



Cultural Resource Survey
Redtail Ridge Development-Goodhue Ditch Crossing
Boulder County, Colorado

Section 20, Township 1S, Range 69W; 6th PM
USGS Louisville, CO Qudranlge (1:24,000, 1980)
Boulder County, Colorado

N

0 1,000 2,000 Feet
1:24,000

Figure A1
Resource Location

Prepared for: Brue Baukol
Capital Partners
File: 10500-Figure A1.mxd (MH)
February 5, 2020

ERO
ERO Resources Corp.

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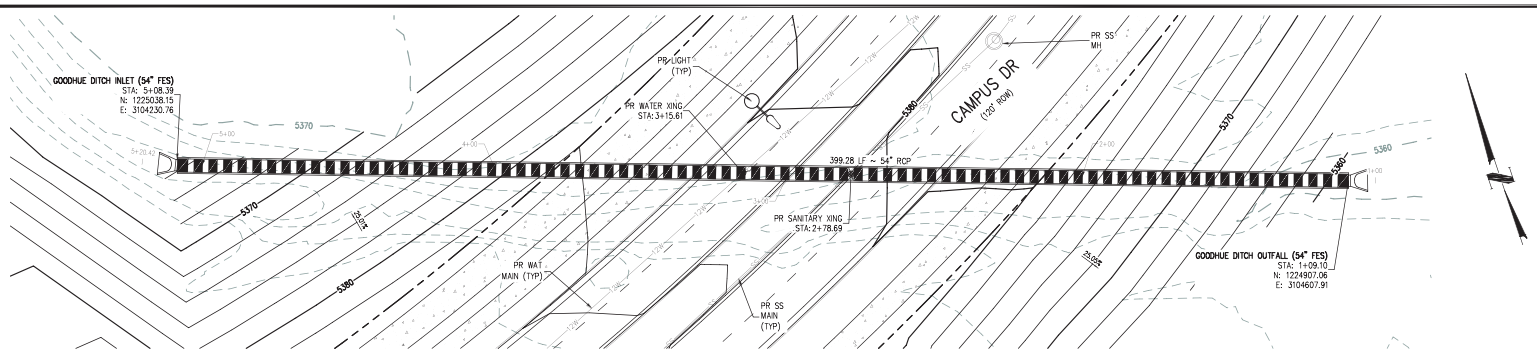
Path: P:\10500 Projects\10500 Phillips 66 Site\Maps\CR\Report\10500-Figure A1.mxd

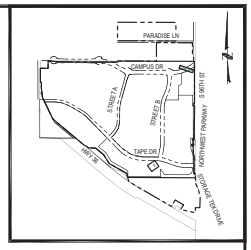
Appendix B OAHP Cultural Resource Documentation Forms
For Official Use Only: Disclosure of Site Locations Prohibited (43 CFR 7.18)

Appendix D Project Plan Sheets



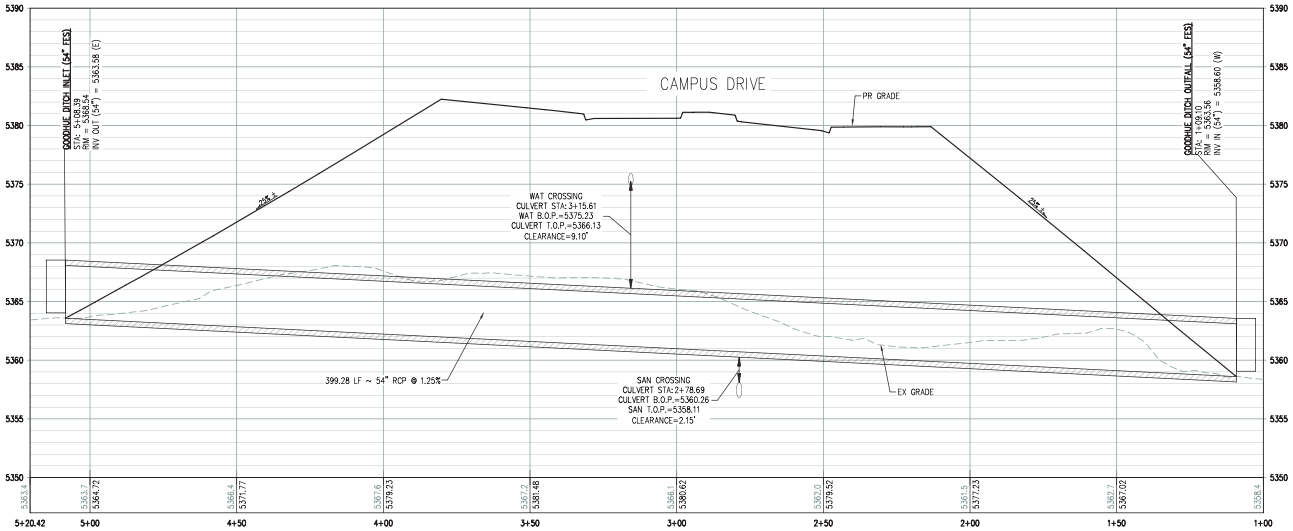
GOODHUE IRRIGATION DITCH CULVERT PLAN

SCALE: 1" = 20'



KEY MAP

SCALE: 1"=2000'



GOODHUE IRRIGATION DITCH CULVERT PROFILE

HORIZONTAL SCALE: 1" = 20'
VERTICAL SCALE: 1" = 5'

NOTES:

1. REFER TO CDOT DETAILS ON SHEETS 68–70 FOR CONSTRUCTION DETAILS.
2. CONCRETE MATERIAL PROPERTIES INDICATED IN STANDARD CDOT DETAILS ON SHEETS 68–70.
3. REFER TO REPORT BY CTL THOMPSON GEOTECHNICAL FOR BORING INFORMATION.
4. CONTRACTOR TO CONFIRM PROJECT RECEIPT OF 404 PERMIT AND CONDITIONS PRIOR TO CONSTRUCTION IN GOODHUE DITCH.

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH

FILE PATH: P:\190108\ENGINEERING\DRAWINGS\CD SHEETS\GOODHUE DITCH IRRIGATION CULVERT PAP.DWG LAYOUT: LAYOUT1
8 XREFs: ccd-f1, stamp, mv, e-base, e-topo, e-util, key map, p-base-f1, p-grad-f1, p-util
PLOTTED: THU 11/14/19 8:03:33 AM BY: TIM SAVLEER

811 Know what's below. Call before you dig.

CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

20 0 20 40
SCALE: 1" = 20'

DESIGNED BY: JMN
CHECKED BY: MAW
DRAWN BY: JMN

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

BRUE BAUKOL CAPITAL PARTNERS

NAWATNY RIDGE FILING #1
GOODHUE IRRIGATION DITCH - CULVERT PLAN & PROFILE

ISSUE DATE: 11-15-2019 PROJECT #: 190108

DATE	REVISION COMMENTS

PRELIMINARY NOT FOR CONSTRUCTION

SHEET NO.
104

Mark West

From: Heidi Gerstung <hgerstung@eroresources.com>
Sent: Friday, March 27, 2020 8:57 AM
To: Jordan Swisher; Mark West
Cc: Moneka Worah; Abigail Sanocki
Subject: FW: Update on Goodhue Ditch Crossing, NWO-2020-00467-DEN

Follow Up Flag: Follow up
Flag Status: Flagged

Good morning Jordan and Mark,

While I was preparing this email, we just got one from Nick; but here you go anyway as it provides just a bit more information on it...

Great news! Please see below for the Corps update on this project.

This has happened to us before on other ditch projects when the consultation becomes too difficult. Normally agricultural activities in ditches are what is exempt - so if the company that owned the ditch wanted to pipe it or reconstruct it, they do not need a 404 permit. But technically if it is related to development or another entity that does not own the ditch, then it is not exempt.

Please let us know if you have any questions, thanks!

Heidi Gerstung
Ecologist

ERO Resources Corporation
Consultants in Natural Resources and the Environment
1842 Clarkson Street | Denver, CO 80218
303.830.1188 O | 720.468.2103 C | hgerstung@eroresources.com | https://urldefense.proofpoint.com/v2/url?u=http-3A__www.eroresources.com&d=DwIFAg&c=euGZstcaTDllvimEN8b7jXrwqOf-v5A_CdpgnVfiiMM&r=ADCGPxPp92MbL20W0qzp3g&m=nFNZQ4D8eZasRXG5-ZDhSCj-_7k70AQnEst-L_CLxOI&s=Z69s3B0Libl3Pd2l3VrL64aS9UkDdsoI2fQQVOV-NF4&e=

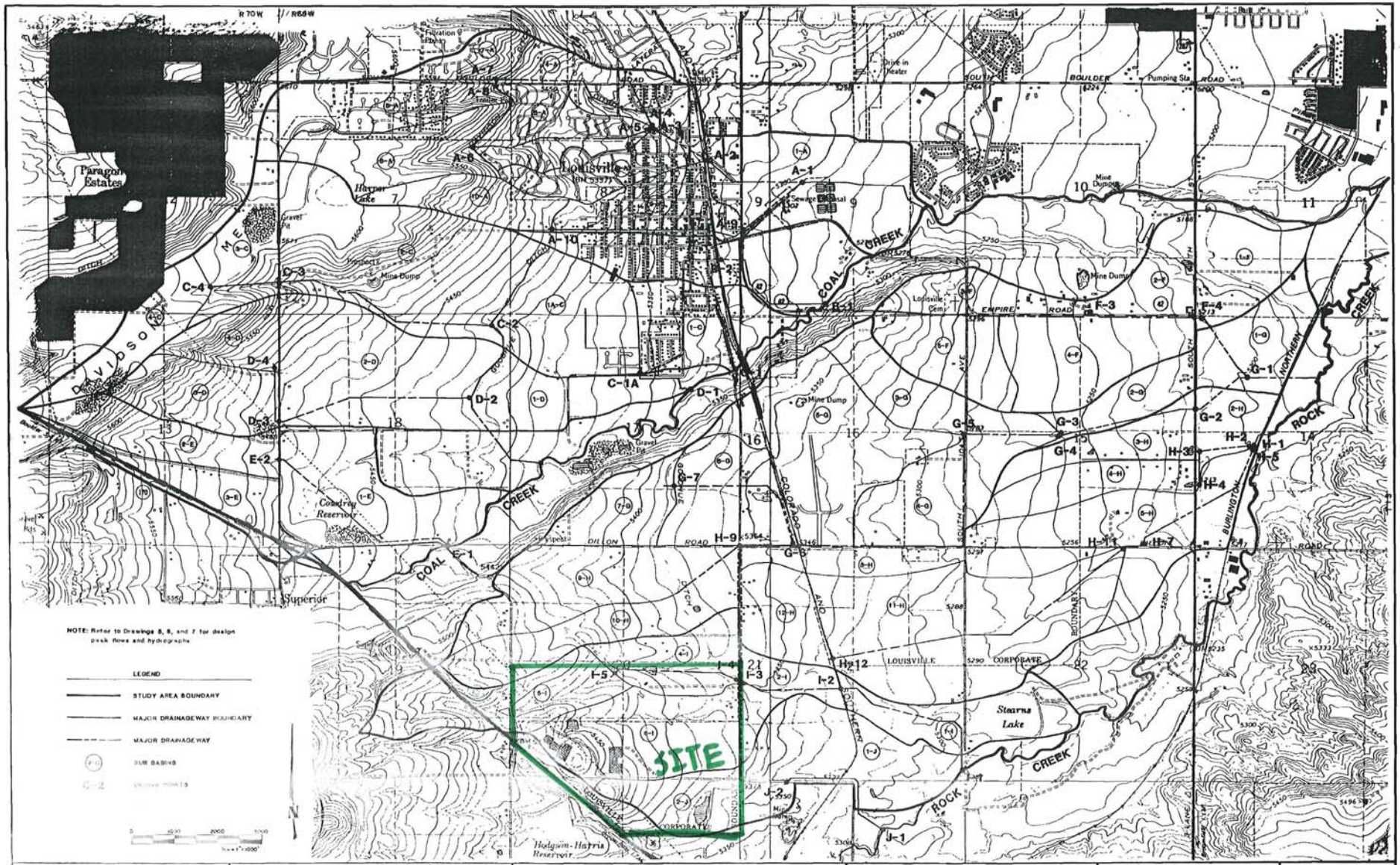
-----Original Message-----
From: Franke, Nicholas A CIV USARMY CENWO (USA) <https://urldefense.proofpoint.com/v2/url?u=http-3A__Nicholas.A.Franke-40usace.army.mil&d=DwIFAg&c=euGZstcaTDllvimEN8b7jXrwqOf-v5A_CdpgnVfiiMM&r=ADCGPxPp92MbL20W0qzp3g&m=nFNZQ4D8eZasRXG5-ZDhSCj-_7k70AQnEst-L_CLxOI&s=HUZjhj_bBWNwW_aUaqh2ppcS3gFbPyJjNLeZyjt7jB0&e=>
Sent: Thursday, March 26, 2020 2:11 PM
To: Heidi Gerstung <hgerstung@eroresources.com>
Subject: Update on Goodhue Ditch Crossing, NWO-2020-00467-DEN

Hi Heidi,

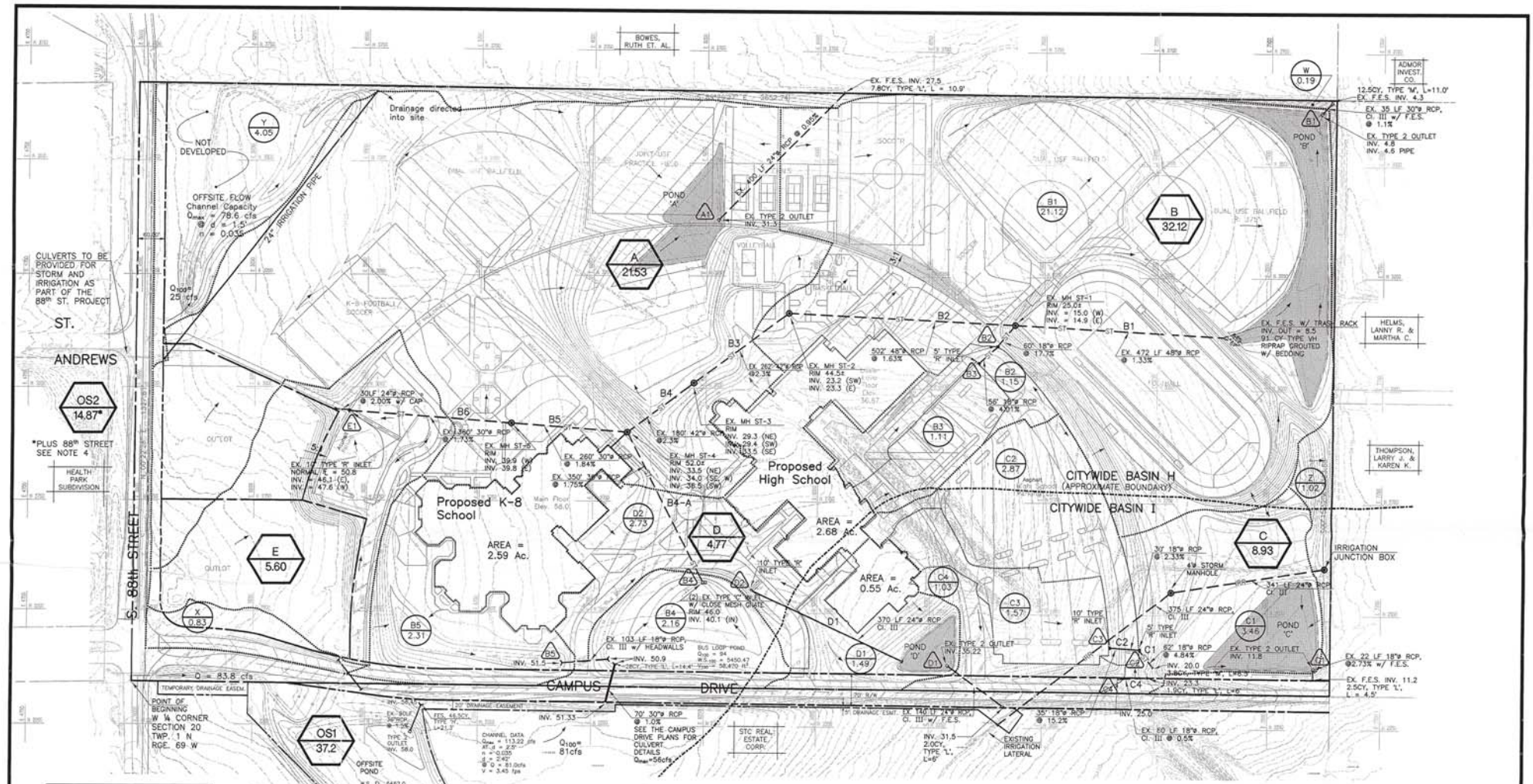
I just wanted to give you a heads-up that we heard back from SHPO; long story short the relationship isn't great, so in the interest of saving time and aggravation for everyone, we are going to go ahead and issue an exemption for this project. It will be considered construction of an irrigation ditch, which is exempt under Section 404(f), and won't require

a permit. You can reference Regulatory Guidance Letter 07-02, which goes into some more technical detail about what is and is not considered construction of an irrigation ditch.

Please let me know if you have any questions or concerns on this. And of course, stay healthy and safe!

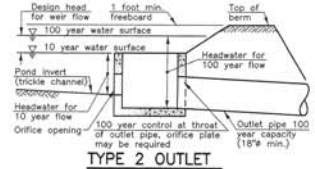


BASE MAP UNITED STATES GEOLOGICAL SURVEY MAP LOUISVILLE QUAD - LAFAYETTE QUAD PHOTOREVISED 1970	WRC Water Resources Consultants, Inc. 2765 South Colorado Boulevard Suite 218 Denver, Colorado 80222	DESIGNED A.J.L. DATE 6-82 DRAWN B.K.H. DATE 6-82 CHECKED W.P.R. DATE 6-82 REVISED DATE	URBAN DRAINAGE AND FLOOD CONTROL DISTRICT CITY OF LOUISVILLE BOULDER COUNTY	BASINWIDE MAJOR DRAINAGEWAY PLANNING SELECTED ALTERNATIVE OUTFALL DESIGN	DRAINAGE BASINS	DRAWING 2



CITYWIDE vs. SITE BASIN COMPARISON			
MAJOR** BASIN	AREA	SITE TRIBUTARY BASINS	AREA
H	66.02	A,B,E,W,X,Y,Z* OS1*, OS2*	65.65
I	13.84	C,D,Z*	14.21

*PORTION OF BASIN TRIBUTARY
**APPROXIMATE



TYPE 2 OUTLET
N.T.S.

NOTES:

1. Drainage basins, characteristics, inlets, and concentration points are identified in the Master Drainage report.
2. Existing storm drains and inlets were constructed as part of the Phase I — Overlot Grading contract.
3. Citywide basins are approximate. The boundary shown is taken from the Basinwide Major Drainageway Planning, Drawing 2, prepared by WRC, Inc., Denver, CO.
4. 88th St. design is underway at the time of preparing this report. The 100-year flow at St. Andrews is taken from the preliminary 88th St. drainage analysis, as prepared by Charles Keim & Associates.
5. Offsite tributary drainage analysis is included in the appendix of the drainage report.

LEGEND:

- BASIN ACRES — MAJOR ONSITE BASIN
- BASIN ACRES — MINOR ONSITE BASIN
- A1 — DESIGN POINT
- MAJOR BASIN BOUNDARY
- MINOR BASIN BOUNDARY
- CITYWIDE BASIN BOUNDARY (APPROX.)
- EXISTING STORM DRAIN
- OVERLAND FLOW DIRECTION

DETENTION POND SUMMARY

POND	V_{10} (cfs)	V_{100} (ac. ft.)	$Q_{R_{10}}$ (cfs)	$Q_{R_{100}}$ (cfs)	WS_{10}	WS_{100}
DETAINED BASINS:						
A	0.232	0.426	5.2	21.5	5433.92	5434.34
B	1.039	1.867	7.1	28.2	5407.92	5408.62
C	0.367	0.651	2.1	8.9	5414.60	5415.42
D	1.039	0.250	1.1	4.8	5439.96	5440.45
TOTAL DETENTION RELEASE RATES:			15.5	63.4		
FREE RELEASE BASINS:						
W	—	—	0.3	0.8	—	—
X	—	—	1.9	4.2	—	—
Y	—	—	4.9	15.2	—	—
Z	—	—	2.0	4.5	—	—
TOTAL FREE RELEASE:			9.0	24.6	—	—

TOTAL SITE AREA = 79.86
DEVELOPED AREA = 75.81 (BASIN 'Y' NOT DEVELOPED)
RELEASE FROM DEVELOPED AREA = 72.90 cfs

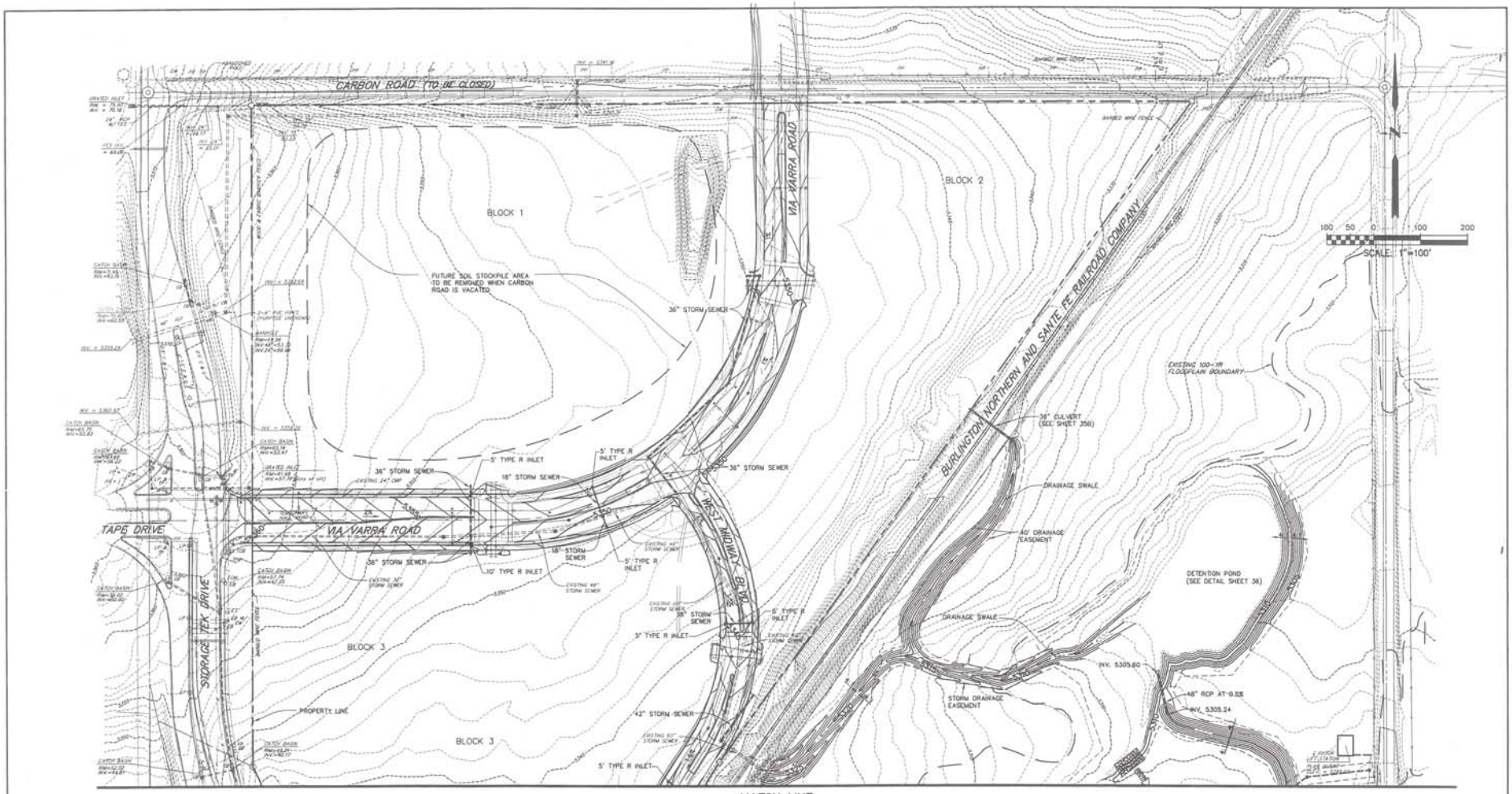
SCALE: 1" = 100'
100 50 0 100 200 400

BVSD LOUISVILLE K-12 CAMPUS
LOUISVILLE, COLORADO
MASTER DRAINAGE PLAN

Charles Keim & Associates
Consulting Engineers
1711 15th St., Suite 200
Boulder, Colorado 80302
(303) 447-0090

Revisions - Date	Date	Designed by	Job No.
	6/24/96	JLB	95-214
	Scale	Drawn by CJC	Sheet of
	1" = 100'	Checked by CRK	Drawing No. D164

C:\Drawings 6/24/96 2:18 pm C:\DRAWINGS\95-214\DRAIN.AN



MATCH LINE
SEE SHEET 4

LEGEND

RAILROAD TRACKS	
EX. INTERMEDIATE CONTOUR	
EX. INDEX CONTOUR	7862
EX. SPOT ELEVATION	+ 54.67
PROPOSED CONTOUR	5350
OPEN CHANNEL	
FLOOD PLAIN BOUNDARY	
STORM DRAIN LINE	
PROPOSED MANHOLE	

All work shall be constructed to City and County of Broomfield STANDARDS AND SPECIFICATIONS. This drawing has been reviewed and found to be in general compliance with these STANDARDS AND SPECIFICATIONS and other City and County requirements. THE ENGINEERING DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER WHOSE STAMP AND SIGNATURE APPEAR HEREON.

Accepted by: City and County of Broomfield

Job No.

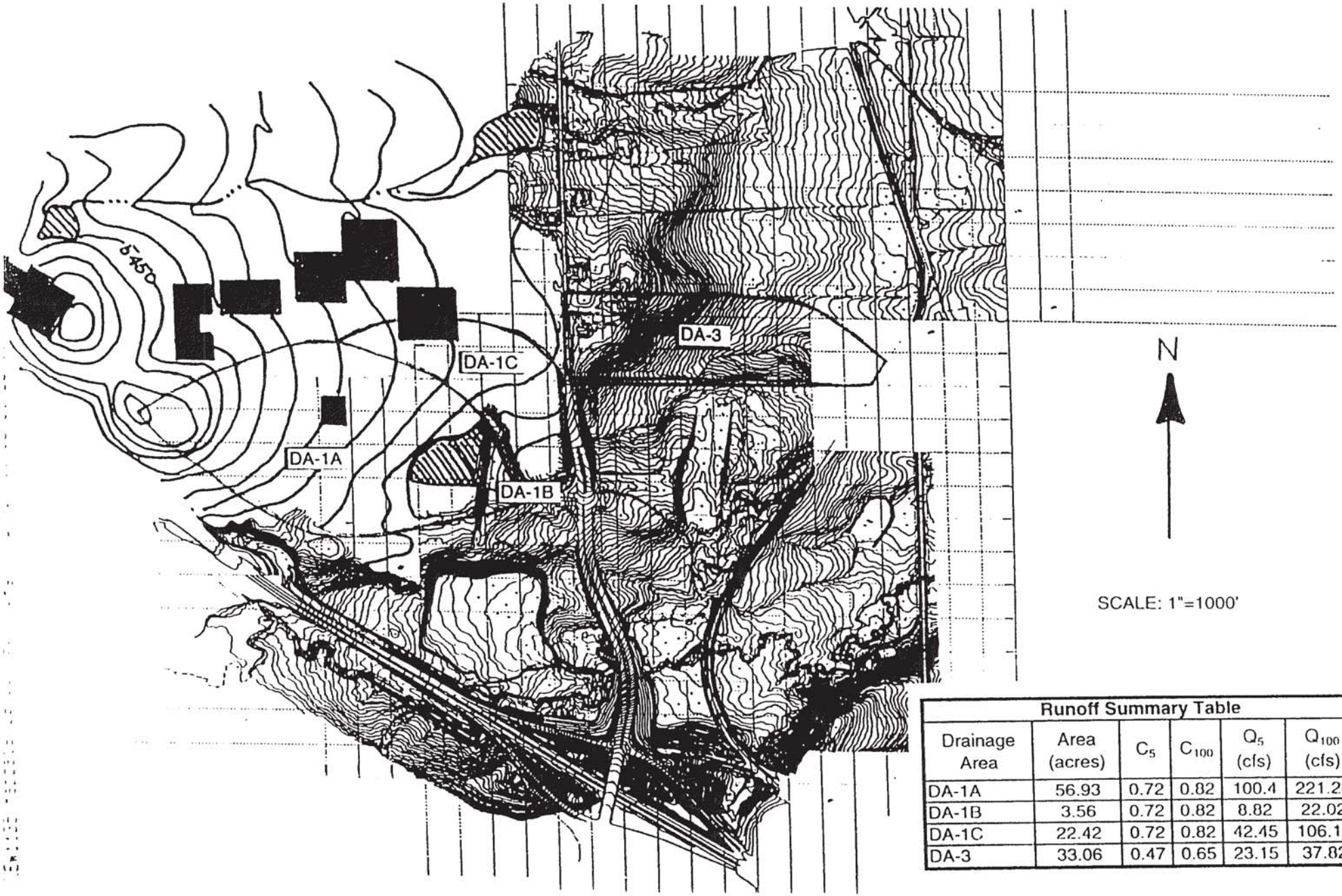
4/30/03

COLORADO REGISTERED PROFESSIONAL ENGINEER 31609 11-12-03

NOT VALID WITHOUT ORIGINAL SIGNATURE AND DATE

PREPARED BY: Drexel Barrell & Co. Engineers Surveyors 4840 PEARL EAST CIRCLE, SUITE 114 BOULDER, COLORADO 80301 (303) 442-4338 5365 CORPORATE DRIVE COLORADO SPRINGS, COLORADO 80919 (719) 260-0887 5401 W. 10TH STREET, SUITE 100A GREELEY, COLORADO 80634 (970) 351-0645 CONTACT: JOHN EWY	PREPARED FOR: NJD LIMITED 3300 E FIRST AVE. SUITE 510 DENVER, COLORADO 80206 CONTACT: KIM SCOTT (303) 399-6177	PROJECT INFO: VIA VARRA & WEST MIDWAY IMPROVEMENTS 96TH STREET AND CARBON ROAD BROOMFIELD, COLORADO	DESIGNED BY: JE/AP DRAWN BY: JJW CHECKED BY:	REVISION DESCRIPTIONS / DATE REVISED PER CITY COMMENTS — 8 MARCH 2002 REVISED PER CITY COMMENTS — 15 MAY 2002 REVISED PER CITY COMMENTS — 14 OCTOBER 2002 REVISED PER CLIENT COMMENTS — 04 DEC 2002	DRAWING INFO: GRADING PLAN (SHEET 1 OF 2)	DATE: 17 DEC 2001 SCALE: H: 1" = 100' V: N/A	JOB NO: EW 1135.3 DRAWING NO: 5D 780	SHEET 3 SHEETS 39

OFFSITE DRAINAGE AREA MAP



Runoff Summary Table					
Drainage Area	Area (acres)	C_5	C_{100}	Q_5 (cfs)	Q_{100} (cfs)
DA-1A	56.93	0.72	0.82	100.4	221.28
DA-1B	3.56	0.72	0.82	8.82	22.02
DA-1C	22.42	0.72	0.82	42.45	106.13
DA-3	33.06	0.47	0.65	23.15	37.82

APPENDIX C – Hydrologic and Hydraulic Computations

Project Name:	Nawatny Ridge
	Composite C-Value Computations
	Post-Development
Project No:	190108
Date:	06/20/19
Revised:	04/06/20
Design by:	JMR
Checked by:	MAW

BASIN	TOTAL AREA (ACRES)	ROOFS (90%)	DRIVES & WALKS (90%)	GARAGE & STREETS (100%)	LANDSCAPE AREA (2%)	PERCENT IMPERVIOUS	C_2=	C_5=	C_{10}=	C_{100}=
A-1	36.53	0.00	0.00	0.00	0.00	75.00%	0.54	0.58	0.62	0.71
A-2	64.97	0.00	0.00	0.00	0.00	75.00%	0.54	0.58	0.62	0.71
A-3	1.97	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
A-3-1	0.57	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
A-3-2	0.59	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
A-3-3	0.41	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
A-3-4	0.40	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
B-1	69.26	0.00	0.00	0.00	0.00	75.00%	0.54	0.58	0.62	0.71
B-2	21.19	0.00	0.00	0.00	0.00	75.00%	0.54	0.58	0.62	0.71
C-1	48.45	0.00	0.00	0.00	0.00	75.00%	0.54	0.58	0.62	0.71
C-2	19.75	0.00	0.00	0.00	0.00	75.00%	0.54	0.58	0.62	0.71
C-3	25.26	0.00	0.00	0.00	0.00	88.00%	0.70	0.72	0.75	0.81
C-3-1	1.57	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-2	1.52	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-3	0.64	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-4	0.66	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-5	0.91	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-6	0.96	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-7	1.45	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-8	1.43	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-9	0.68	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-10	0.71	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-11	0.88	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-12	0.87	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-13	0.50	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-14	0.50	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-15	1.22	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-16	1.00	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-17	0.97	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-18	0.99	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-19	0.87	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-20	2.49	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-21	1.80	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-3-22	1.61	0.00	0.00	0.00	0.00	74.00%	0.53	0.57	0.61	0.70
C-3-23	1.04	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-4	2.57	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-4-1	1.16	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-4-2	1.41	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-5	11.71	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-5-1	0.80	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-5-2	0.82	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-5-3	0.80	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-5-4	0.80	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-5-5	0.95	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-5-6	0.97	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-5-7	1.10	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-5-8	1.04	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-5-9	1.34	0.00	0.00	0.00	0.00	84.00%	0.64	0.67	0.70	0.78
C-5-10	1.17	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-5-11	0.87	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-5-12	1.06	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-6	1.82	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-6-1	0.67	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-6-2	0.81	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
C-6-3	0.34	0.00	0.00	0.00	0.00	90.00%	0.73	0.75	0.77	0.83
D-1	26.75	0.00	0.00	0.00	0.00	75.00%	0.54	0.58	0.62	0.71
D-2	18.64	0.00	0.00	0.00	0.00	2.00%	0.06	0.16	0.26	0.51
E	30.61	0.00	0.00	0.00	0.00	75.00%	0.54	0.58	0.62	0.71
F	17.07	0.00	0.00	0.00	0.00	2.00%	0.06	0.16	0.26	0.51
OS-1	77.38	0.00	0.00	0.00	0.00	2.00%	0.06	0.16	0.26	0.51
OS-2	49.08	0.00	0.00	0.00	0.00	5.00%	0.08	0.18	0.28	0.52
Total On-Site	523.01	0.00	0.00	0.00	0.00	51.95%	0.35	0.41	0.47	0.61
Total Detained	322.49	0.00	0.00	0.00	0.00	84.55%	0.65	0.68	0.71	0.78
Total	523.01	0.00	0.00	0.00	0.00	54.04%	0.36	0.42	0.48	0.61

TYPE C/D HYDRAULIC SOIL		
2 YR - K_{CD} =	0	< Table RO-4 USDCM
5 YR - K_{CD} =	-0.10i+0.11	< Table RO-4 USDCM
100 YR - K_{CD} =	-0.39i+0.46	< Table RO-4 USDCM
$C_{CD} = K_{CD} + (0.858i^3 - 0.786i^2 + 0.774i + 0.04)$		< RO-7 from USDCM

Project Name: Nawatny Ridge
Project No: 190108
Date: 6/20/2019

Revised: 4/6/2020

STANDARD FORM SF-2
TIME OF CONCENTRATION

Designed By: JMR
Checked By: MAW

SUB-BASIN DATA			INITIAL/OVERLAND TIME (Ti)			TRAVEL TIME (Tt)					Tc CHECK (URBANIZED BASINS)			FINAL	REMARKS
BASIN	AREA (AC)	C_5	LENGTH (FT)	SLOPE %	Ti (MIN)	LENGTH (FT)	SLOPE %	C_v	VELOCITY (FPS)	Tt (MIN)	COMPOS. Tc (MIN)	TOTAL LENGTH	Tc = (L/180) + 10 (MIN)	Tc (MIN)	
A-1	36.53	0.58	300	4.05	10.45	1688.01	3.26	7.00	1.26	22.27	32.72	1,988	21.04	21.04	
A-2	64.97	0.58	300	1.14	15.93	1754.82	3.24	20.00	3.60	8.12	24.06	2,055	21.42	21.42	
A-3															Null Basin
A-3-1	0.57	0.75	34.93	1.50	3.36	581.91	1.02	20.00	2.02	4.80	8.16	617	13.43	8.16	
A-3-2	0.59	0.75	32.28	1.50	3.23	602.71	0.98	20.00	1.98	5.07	8.30	635	13.53	8.30	
A-3-3	0.41	0.75	80.91	1.69	4.91	198	0.74	20.00	1.72	1.92	6.83	279	11.55	6.83	
A-3-4	0.40	0.75	80.32	1.50	5.09	195.52	0.76	20.00	1.75	1.87	6.96	276	11.53	6.96	
B-1	69.26	0.58	300	1.02	16.55	2636.29	1.88	15.00	2.06	21.36	37.91	2,936	26.31	26.31	
B-2	21.19	0.58	300	2.62	12.09	1414.76	4.16	20.00	4.08	5.78	17.86	1,715	19.53	17.86	
C-1	48.45	0.58	300	2.22	12.77	1992	0.81	20.00	1.80	18.49	31.26	2,292	22.73	22.73	
C-2	19.75	0.58	300	2.53	12.23	760.72	2.36	20.00	3.07	4.13	16.36	1,061	15.89	15.89	
C-3															Null Basin
C-3-1	1.57	0.75	55.26	3.80	3.10	973.76	1.67	20.00	2.58	6.28	9.38	1,029	15.72	9.38	
C-3-2	1.52	0.75	54.18	2.95	3.34	937.97	1.78	20.00	2.67	5.85	9.19	992	15.51	9.19	
C-3-3	0.64	0.75	24.23	3.96	2.02	458.42	1.71	20.00	2.62	2.92	5.00	483	12.68	5.00	
C-3-4	0.66	0.75	24.55	3.79	2.07	459.47	1.71	20.00	2.62	2.93	5.00	484	12.69	5.00	
C-3-5	0.91	0.75	36.3	4.44	2.38	521.98	3.76	20.00	3.88	2.24	5.00	558	13.10	5.00	
C-3-6	0.96	0.75	34.82	4.19	2.38	545.16	3.51	20.00	3.75	2.42	5.00	580	13.22	5.00	
C-3-7	1.45	0.75	152.67	4.40	4.90	703.47	3.27	20.00	3.62	3.24	8.15	856	14.76	8.15	
C-3-8	1.43	0.75	102.87	3.72	4.25	765.74	3.09	20.00	3.52	3.63	7.88	869	14.83	7.88	
C-3-9	0.68	0.75	35.31	2.52	2.84	692.06	2.55	20.00	3.20	3.61	6.45	727	14.04	6.45	
C-3-10	0.71	0.75	37.85	1.50	3.49	717.45	2.46	20.00	3.14	3.81	7.31	755	14.20	7.31	
C-3-11	0.88	0.75	41.11	3.65	2.71	905.57	1.91	20.00	2.76	5.47	8.17	947	15.26	8.17	
C-3-12	0.87	0.75	41.11	2.70	2.99	895.91	1.90	20.00	2.75	5.42	8.42	937	15.21	8.42	
C-3-13	0.50	0.75	28.24	1.35	3.13	510.47	0.77	20.00	1.75	4.85	7.98	539	12.99	7.98	
C-3-14	0.50	0.75	28.56	1.37	3.13	510.47	0.77	20.00	1.75	4.85	7.99	539	12.99	7.99	
C-3-15	1.22	0.75	45.62	3.79	2.82	721.63	0.85	20.00	1.85	6.51	9.32	767	14.26	9.32	
C-3-16	1.00	0.75	44.81	3.95	2.75	685.2	0.89	20.00	1.89	6.04	8.79	730	14.06	8.79	
C-3-17	0.97	0.75	53.79	3.44	3.16	686.7	1.82	20.00	2.70	4.24	7.40	740	14.11	7.40	
C-3-18	0.99	0.75	53.79	3.44	3.16	686.7	1.81	20.00	2.69	4.26	7.42	740	14.11	7.42	
C-3-19	0.87	0.75	38.01	3.42	2.66	480.13	0.60	20.00	1.55	5.17	7.83	518	12.88	7.83	
C-3-20	2.49	0.75	54.63	6.46	2.58	989.71	0.77	20.00	1.75	9.41	11.99	1,044	15.80	11.99	
C-3-21	1.80	0.75	34.93	4.04	2.41	989.05	0.77	20.00	1.75	9.40	11.82	1,024	15.69	11.82	
C-3-22	1.61	0.57	64.4	1.50	6.86	727.42	0.75	20.00	1.73	7.01	13.87	792	14.40	13.87	
C-3-23	1.04	0.75	41.42	3.40	2.78	724.73	0.75	20.00	1.73	6.98	9.76	766	14.26	9.76	
C-4															Nul Basin
C-4-1	1.16	0.75	42.17	4.72	2.52	871.1	1.94	20.00	2.79	5.21	7.72	913	15.07	7.72	
C-4-2	1.41	0.75	71.89	3.19	3.75	969.02	1.80	20.00	2.68	6.02	9.77	1,041	15.78	9.77	
C-5															Null Basin
C-5-1	0.80	0.75	34.27	1.87	3.09	820.11	1.19	20.00	2.19	6.26	9.35	854	14.75	9.35	
C-5-2	0.82	0.75	35.47	1.89	3.13	830.41	1.18	20.00	2.17	6.37	9.51	866	14.81	9.51	
C-5-3	0.80	0.75	34.4	1.57	3.28	842.17	1.87	20.00	2.73	5.14	8.42	877	14.87	8.42	
C-5-4	0.80	0.75	34.4	1.57	3.28	842.17	1.88	20.00	2.74	5.12	8.40	877	14.87	8.40	
C-5-5	0.95	0.75	56.23	2.12	3.80	981.62	3.52	20.00	3.75	4.36	8.16	1,038	15.77	8.16	
C-5-6	0.97	0.75	56.23	2.15	3.78	968.27	3.55	20.00	3.77	4.28	8.06	1,025	15.69	8.06	
C-5-7	1.10	0.75	50.63	4.46	2.81	978.95	3.33	20.00	3.65	4.47	7.28	1,030	15.72	7.28	
C-5-8	1.04	0.75	48.16	4.63	2.71	971.61	3.33	20.00	3.65	4.44	7.15	1,020	15.67	7.15	
C-5-9	1.34	0.67	68.85	1.50	5.71	842.39	2.09	20.00	2.89	4.86	10.57	911	15.06	10.57	
C-5-10	1.17	0.75	41.35	3.58	2.73	847.93	2.06	20.00	2.87	4.93	7.66	889	14.94	7.66	
C-5-11	0.87	0.75	53.24	1.50	4.14	647.69	1.77	20.00	2.66	4.05	8.20	701	13.89	8.20	
C-5-12	1.06	0.75	47.89	1.50	3.93	664.41	1.57	20.00	2.50	4.43	8.36	712	13.96	8.36	
C-6															Null Basin
C-6-1	0.67	0.75	28.99	3.59	2.29	455.01	1.44	20.00	2.40	3.16	5.44	484	12.69	5.44	
C-6-2	0.81	0.75	44.8	3.86	2.77	475.31	1.58	20.00	2.52	3.15	5.92	520	12.89	5.92	
C-6-3	0.34	0.75	57	3.21	3.33	146.36	2.05	20.00	2.86	0.85	5.00	203	11.13	5.00	
D-1	26.75	0.58	300	2.50	12.28	1048.55	2.50	20.00	3.16	5.53	17.80	1,349	17.49	17.49	
D-2	18.64	0.16	300	6.49	15.95	1384.97	1.46	7.00	0.85	27.31	43.26	1,685	19.36	19.36	
E	30.61	0.58	300	5.77	9.29	1599.27	1.04	20.00	2.04	13.09	22.38	1,899	20.55	20.55	
F	17.07	0.16	300	4.30	18.30	1993.61	1.57	15.00	1.88	17.67	35.97	2,294	22.74	22.74	
OS-1	77.38	0.16	300	3.89	18.92	3326.96	2.94	15.00	2.57	21.57	40.49	3,627	30.15	30.15	
OS-2	49.08	0.18	300	2.35	21.92	2732.47	1.46	15.00	1.81	25.13	47.05	3,032	26.85	26.85	

Table RO-2—Conveyance Coefficient, C_v

Type of Land Surface	Conveyance Coefficient, C_v
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

*http://udfcd.org/downloads/pdf/critmanual/Volume%201%20PDFs/050%20Chapter%2005%20Runoff%202008-04%20Rev.pdf#page=8

NOAA Atlas 14, Volume 8, Version 2
Location name: Louisville, Colorado, USA*
Latitude: 39.9455°, Longitude: -105.1359°
Elevation: 5420.91 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

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

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.213 (0.168-0.271)	0.264 (0.208-0.335)	0.357 (0.280-0.456)	0.446 (0.348-0.571)	0.583 (0.446-0.791)	0.702 (0.520-0.958)	0.832 (0.594-1.16)	0.975 (0.666-1.39)	1.18 (0.774-1.73)	1.35 (0.855-1.98)
10-min	0.313 (0.246-0.397)	0.386 (0.304-0.491)	0.523 (0.410-0.667)	0.652 (0.509-0.836)	0.854 (0.653-1.16)	1.03 (0.762-1.40)	1.22 (0.870-1.70)	1.43 (0.975-2.04)	1.73 (1.13-2.53)	1.98 (1.25-2.90)
15-min	0.381 (0.300-0.485)	0.471 (0.371-0.599)	0.638 (0.500-0.814)	0.796 (0.621-1.02)	1.04 (0.796-1.41)	1.25 (0.929-1.71)	1.49 (1.06-2.07)	1.74 (1.19-2.49)	2.11 (1.38-3.08)	2.41 (1.53-3.54)
30-min	0.528 (0.416-0.671)	0.649 (0.511-0.826)	0.877 (0.688-1.12)	1.09 (0.852-1.40)	1.43 (1.09-1.94)	1.72 (1.27-2.34)	2.04 (1.45-2.84)	2.38 (1.63-3.40)	2.89 (1.89-4.22)	3.30 (2.09-4.84)
60-min	0.650 (0.512-0.826)	0.801 (0.631-1.02)	1.08 (0.849-1.38)	1.35 (1.05-1.72)	1.76 (1.34-2.38)	2.11 (1.56-2.87)	2.49 (1.78-3.47)	2.91 (1.99-4.16)	3.52 (2.30-5.14)	4.02 (2.54-5.89)
2-hr	0.772 (0.614-0.970)	0.953 (0.758-1.20)	1.29 (1.02-1.62)	1.60 (1.26-2.02)	2.08 (1.61-2.79)	2.50 (1.87-3.36)	2.95 (2.12-4.06)	3.44 (2.37-4.85)	4.15 (2.75-5.99)	4.73 (3.03-6.86)
3-hr	0.842 (0.675-1.05)	1.04 (0.831-1.30)	1.40 (1.12-1.75)	1.73 (1.37-2.18)	2.25 (1.74-2.98)	2.69 (2.02-3.59)	3.17 (2.30-4.32)	3.69 (2.56-5.15)	4.43 (2.95-6.35)	5.05 (3.25-7.25)
6-hr	1.02 (0.827-1.26)	1.25 (1.01-1.54)	1.65 (1.33-2.05)	2.03 (1.63-2.52)	2.61 (2.04-3.41)	3.10 (2.35-4.08)	3.63 (2.66-4.88)	4.20 (2.95-5.80)	5.03 (3.38-7.11)	5.70 (3.71-8.10)
12-hr	1.30 (1.06-1.58)	1.55 (1.27-1.90)	2.02 (1.65-2.47)	2.45 (1.99-3.01)	3.11 (2.46-4.01)	3.67 (2.82-4.77)	4.26 (3.16-5.67)	4.92 (3.49-6.69)	5.85 (3.98-8.15)	6.60 (4.35-9.26)
24-hr	1.57 (1.30-1.89)	1.91 (1.57-2.30)	2.49 (2.05-3.01)	3.01 (2.46-3.65)	3.78 (3.00-4.78)	4.41 (3.41-5.63)	5.07 (3.78-6.62)	5.78 (4.13-7.74)	6.77 (4.65-9.30)	7.57 (5.04-10.5)
2-day	1.79 (1.50-2.13)	2.23 (1.86-2.66)	2.97 (2.47-3.54)	3.59 (2.97-4.30)	4.47 (3.57-5.53)	5.16 (4.02-6.47)	5.86 (4.41-7.52)	6.59 (4.75-8.67)	7.58 (5.25-10.2)	8.34 (5.62-11.4)
3-day	1.96 (1.64-2.31)	2.40 (2.02-2.84)	3.15 (2.64-3.73)	3.78 (3.15-4.50)	4.68 (3.76-5.75)	5.39 (4.22-6.70)	6.11 (4.62-7.77)	6.85 (4.97-8.94)	7.86 (5.48-10.5)	8.65 (5.87-11.7)
4-day	2.09 (1.77-2.46)	2.53 (2.13-2.97)	3.26 (2.74-3.84)	3.88 (3.24-4.60)	4.77 (3.86-5.85)	5.48 (4.32-6.79)	6.21 (4.73-7.87)	6.97 (5.08-9.06)	8.01 (5.61-10.7)	8.81 (6.01-11.9)
7-day	2.42 (2.06-2.81)	2.83 (2.41-3.30)	3.54 (3.00-4.12)	4.15 (3.49-4.86)	5.02 (4.10-6.10)	5.73 (4.57-7.03)	6.46 (4.97-8.11)	7.23 (5.33-9.31)	8.29 (5.87-10.9)	9.13 (6.28-12.2)
10-day	2.71 (2.32-3.13)	3.12 (2.67-3.61)	3.83 (3.27-4.44)	4.45 (3.77-5.17)	5.33 (4.38-6.42)	6.04 (4.84-7.35)	6.77 (5.24-8.44)	7.54 (5.59-9.63)	8.60 (6.13-11.3)	9.43 (6.53-12.5)
20-day	3.54 (3.06-4.03)	4.03 (3.49-4.60)	4.85 (4.18-5.55)	5.54 (4.74-6.36)	6.49 (5.38-7.68)	7.24 (5.86-8.67)	8.00 (6.25-9.79)	8.77 (6.57-11.0)	9.81 (7.06-12.6)	10.6 (7.44-13.9)
30-day	4.21 (3.66-4.76)	4.80 (4.18-5.43)	5.76 (4.99-6.54)	6.54 (5.64-7.46)	7.61 (6.33-8.89)	8.42 (6.85-9.98)	9.23 (7.25-11.2)	10.0 (7.55-12.5)	11.1 (8.03-14.1)	11.9 (8.38-15.4)
45-day	5.02 (4.40-5.64)	5.75 (5.04-6.46)	6.92 (6.04-7.79)	7.86 (6.82-8.89)	9.11 (7.60-10.5)	10.0 (8.20-11.8)	10.9 (8.63-13.1)	11.8 (8.94-14.5)	12.9 (9.41-16.3)	13.7 (9.76-17.7)
60-day	5.68 (5.01-6.35)	6.55 (5.76-7.32)	7.91 (6.94-8.86)	8.99 (7.84-10.1)	10.4 (8.73-12.0)	11.5 (9.41-13.4)	12.5 (9.88-14.8)	13.4 (10.2-16.4)	14.6 (10.7-18.3)	15.5 (11.1-19.8)

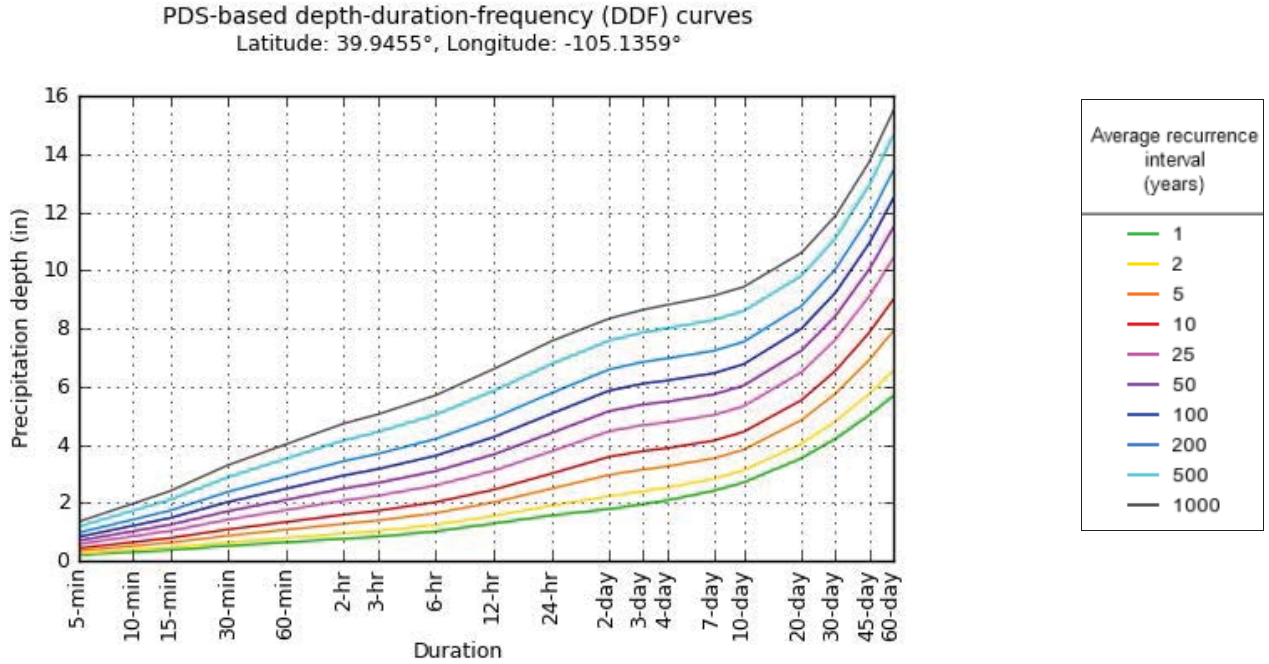
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

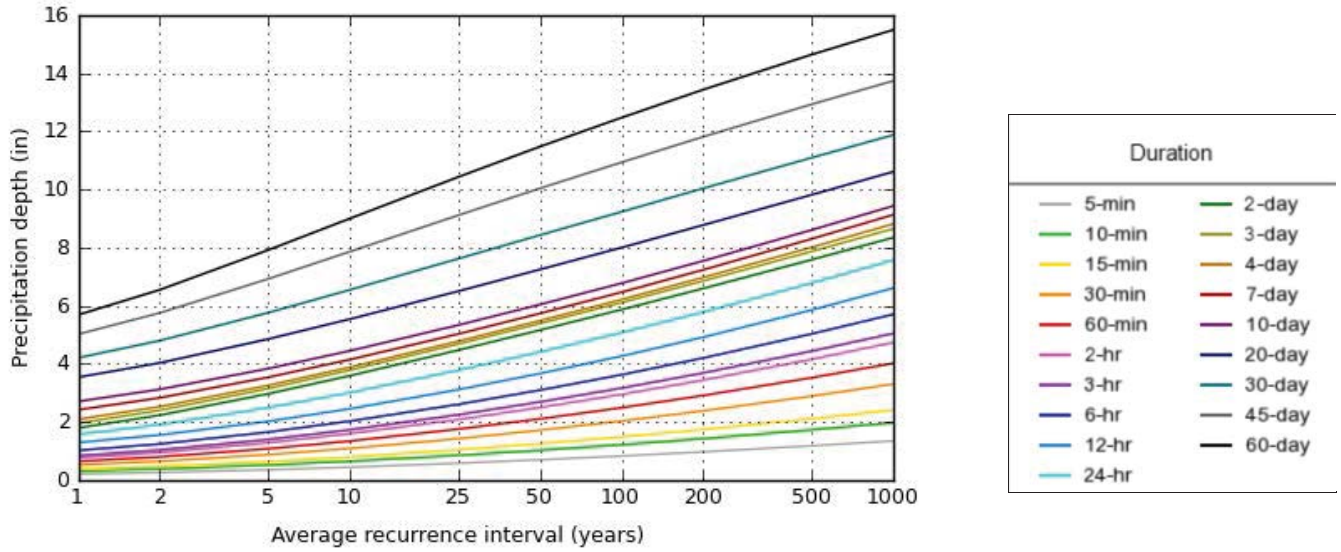
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper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

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical





NOAA Atlas 14, Volume 8, Version 2

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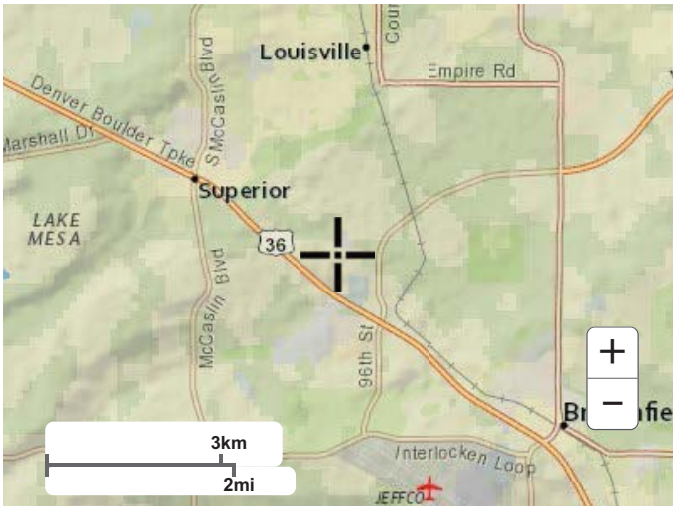
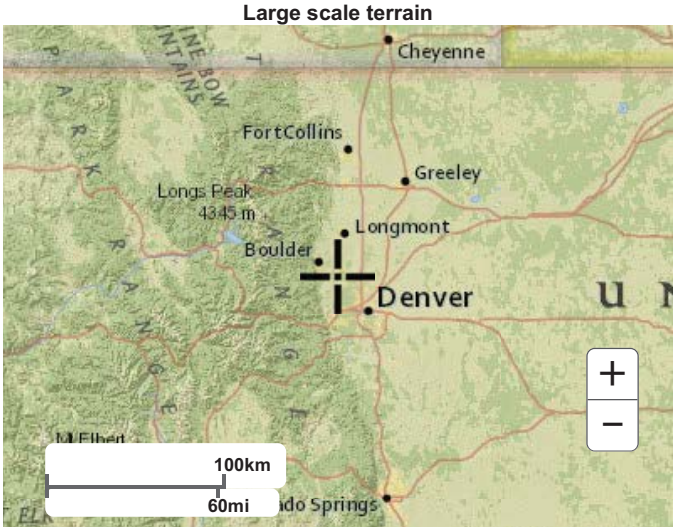
Back to Top

Maps & aerials

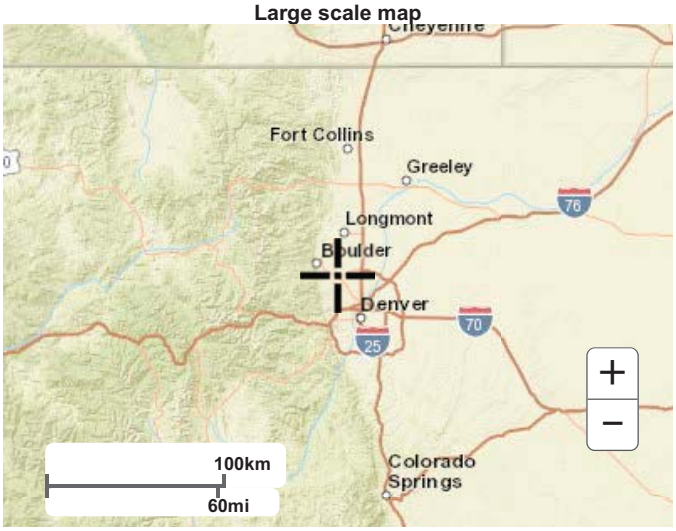
Small scale terrain



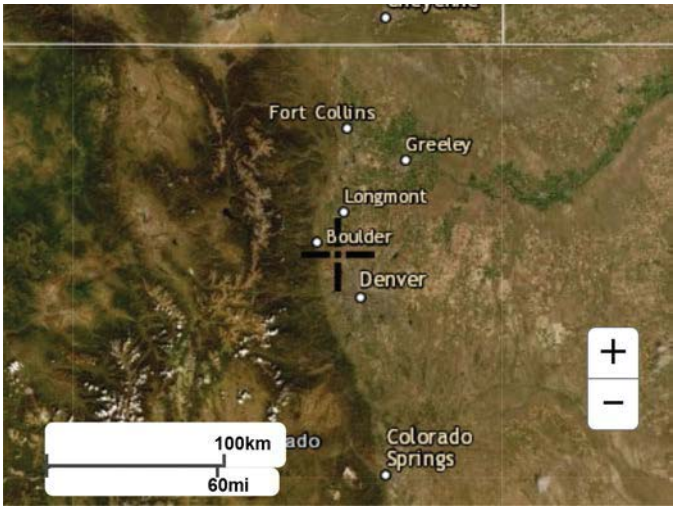
Large scale terrain



Large scale map



Large scale aerial



Back to Top

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

Disclaimer

1-HR Rainfall

Return Interval (YR)	1-hour Rainfall
WQ	0.6
2	0.8
5	1.09
10	1.35
100	2.54

tc	WQ	2yr	5yr	5yr	100yr
5	2.035	2.713	3.697	4.579	8.615
6	1.934	2.579	3.514	4.353	8.189
7	1.844	2.459	3.351	4.150	7.808
8	1.763	2.351	3.204	3.968	7.465
9	1.690	2.253	3.070	3.803	7.154
10	1.623	2.164	2.949	3.652	6.872
11	1.562	2.083	2.838	3.515	6.613
12	1.506	2.008	2.736	3.389	6.376
13	1.454	1.939	2.642	3.272	6.157
14	1.407	1.875	2.555	3.165	5.954
15	1.362	1.816	2.475	3.065	5.766
16	1.321	1.761	2.399	2.972	5.591
17	1.282	1.710	2.329	2.885	5.428
18	1.246	1.661	2.264	2.804	5.275
19	1.212	1.616	2.202	2.727	5.131
20	1.180	1.574	2.144	2.656	4.996

Project Name: Nawatny Ridge
Project No: 190108
Date: 06/20/19
Revised: 04/03/20

STANDARD FORM SF-2
Post-Development
Rational Method Procedure

Designed By: JMR
Checked By: MAW
Design Storm: 5 YR

		DIRECT RUNOFF						TOTAL RUNOFF				STREET/INLET					STORM SEWER PIPE				TRAVEL TIME			CARRYOVER FLOWS					
BASIN (s)	DESIGN POINT	AREA (AC)	RUNOFF COEFF	Tc (min)	C x A (AC)	I (IN/HR)	DIRECT RUNOFF, Q (CFS)	Tc (MAX)	Σ(C x A) (AC)	I (IN/HR)	TOTAL RUNOFF, Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	INLET DESIGN FLOW (CFS)	STREET OR INLET INTERCEPTION (CFS)	CARRYOVER (CFS)	DESIGN FLOW (CFS)	PIPE SLOPE (%)	PIPE SIZE (IN)	80% OF QFULL (CFS)	LENGTH (FT)	VELOCITY (FPS)	Tt (min)	BYPASS RUNOFF, Q (CFS)	LENGTH (FT)	SLOPE (%)	VELOCITY (FPS)	Tt (min)	REMARKS
A-1		36.53	0.58	21.04	21.02	2.07	43.47																						
A-2		64.97	0.58	21.42	37.38	2.05	76.59																						
A-3-1		0.57	0.75	8.16	0.42	3.15	1.34										1.34	0.30	15	2.83	6.66	2.31	0.05						
A-3-2		0.59	0.75	8.30	0.44	3.13	1.38										1.38	0.46	15	3.50	30.68	2.86	0.18						
A-3-1 & A-3-2	1							8.48	0.86	3.11	2.69						2.69	1.50	18	10.29	132.28	5.82	0.38						L3
A-3-3		0.41	0.75	6.83	0.31	3.35	1.02										1.02	0.30	15	2.83	6.67	2.31	0.05						
DP 1 & A-3-3	2							8.86	1.17	3.06	3.58						3.58	0.46	18	5.70	30.67	3.23	0.16						L2
A-3-4		0.40	0.75	6.96	0.30	3.33	0.99																						
DP 2 & A-3-4	**3**							**9.01**	**1.47**	**3.04**	**4.46**						**4.46**	**0.49**	**18**	5.88	**29.61**	**3.33**	**0.15**						**L1, To Pond A-3**
B-1		69.26	0.58	26.31	39.85	1.83	72.86																						
120% Pond B-1 Release Rate							4.00										**4.00**	**1.00**	**42**	80.49	**559.15**	**8.37**	**1.11**						**To Tirbutary I**
B-2		21.19	0.58	17.86	12.19	2.25	27.45										27.45	0.30	36	29.23	45.82	4.13	0.18						
C-1		48.45	0.58	22.73	27.88	1.98	55.30																						
C-2		19.75	0.58	15.89	11.36	2.39	27.10																						
EX S 88th Street Culvert							28.00										28.00	1.84	24	24.55	445.59	7.81	0.95						
EX School Culvert West							1.90																						
88th St Culvert & School West Culvert	4							0.95	0.00	4.69	29.90						29.90	0.50	30	23.20	561.38	4.73	1.98						A20
C-3-1		1.57	0.75	9.38	1.17	3.00	3.51										3.51	1.00	15	5.17	11.03	4.21	0.04						
C-3-2		1.52	0.75	9.19	1.13	3.02	3.42										3.42	1.00	15	5.17	64.31	4.21	0.25						
DP 4 & C-3-1 & C-3-2	5							9.44	2.30	2.99	36.78						36.78	1.65	30	42.15	84.67	8.59	0.16						A18
Flow Lost to School Detention Pond							-56.00																						A portion of flow from 88th St Culvert is let into School Pond
DP 5 & School Pond Bypass	6							0.00	0.00	0.00	0.00						0.00	1.60	30	41.51	382.72	8.46	0.75						A17
C-3-3		0.64	0.75	5.00	0.48	3.66	1.75										1.75	1.00	15	5.17	12.51	4.21	0.05						
C-3-4		0.66	0.75	5.00	0.49	3.66	1.80										1.80	1.00	15	5.17	62.83	4.21	0.25						
DP 6 & C-3-3 & C-3-4	7							5.25	0.97	3.62	3.50						3.50	4.00	30	65.63	415.50	13.37	0.52						A15
EX School Culvert East							1.10																						
DP 7 & School East Culvert	8							5.25	0.97	3.62	4.60						4.60	4.00	30	65.63	112.83	13.37	0.14						A14
C-3-5		0.91	0.75	5.00	0.68	3.66	2.48										2.48	2.00	15	7.31	74.82	5.96	0.21						
C-3-6		0.96	0.75	5.00	0.72	3.66	2.62										2.62	5.50	15	12.12	44.54	9.88	0.08						
DP 8 & C-3-5 & C-3-6	9							5.39	2.36	3.59	9.58						9.58	1.74	36	70.38	704.07	9.96	1.18						A13
C-3-7		1.45	0.75	8.15	1.08	3.15	3.41										3.41	10.00	18	26.57	10.76	15.04	0.01						
C-3-8		1.43	0.75	7.88	1.07	3.19	3.40										3.40	1.00	18	8.40	64.64	4.76	0.23						
DP 9 & C-3-7 & C-3-8	10							8.16	4.51	3.15	15.32						15.32	0.50	36	37.73	318.93	5.34	1.00						A10
120% Pond E Release Rate							2.50										2.50	1.50	30	40.19	1200.00	8.19	2.44						
C-3-9		0.68	0.75	6.45	0.51	3.41	1.73										1.73	2.00	15	7.31	12.00	5.96	0.03						
C-3-10		0.71	0.75	7.31	0.53	3.27	1.73										1.73	2.00	15	7.31	60.00	5.96	0.17						
Pond E Release & C-3-9 & C-3-10	11							7.48	1.04	3.25	5.87						5.87	1.50	30	40.19	900.00	8.19	1.83						J6
C-3-11		0.88	0.75	8.17	0.66	3.15	2.07										2.07	2.00	15	7.31	12.00	5.96	0.03						
C-3-12		0.87	0.75	8.42	0.65	3.12	2.02										2.02	2.00	15	7.31	60.00	5.96	0.17						
DP 11 & C-3-11 & C-3-12	12							9.31	2.34	3.00	9.53						9.53	1.50	36	65.35	400.00	9.25	0.72						J3
C-3-13		0.50	0.75	7.98	0.37	3.18	1.18										1.18	2.00	15	7.31	12.00	5.96	0.03						
C-3-14		0.50	0.75	7.99	0.37	3.18	1.18										1.18	2.00	15	7.31	60.00	5.96	0.17						
DP 12 & C-3-13 & C-3-14	13							10.03	3.09	2.92	11.51						11.51	5.00	36	119.31	200.00	16.88	0.20						J1
DP 10 & DP 13	14							10.23	7.60	2.90	25.60						25.60	0.50	48	81.26	489.24	6.47	1.26						A8
C-3-15		1.22	0.75	9.32	0.91	3.00	2.73										2.73	12.81	15	18.50	10.66	15.07	0.01						
C-3-16		1.00	0.75	8.79	0.75	3.07	2.29										2.29	10.46	15	16.71	64.67	13.62	0.08						
DP 14 & C-3-15 & C-3-16	15							11.49	9.25	2.76	29.15						29.15	0.50	48	81.26	628.20	6.47	1.62						A6
C-3-17		0.97	0.75	7.40	0.72	3.26	2.36										2.36	10.00	15	16.34	10.65	13.32	0.01						
C-3-18		0.99	0.75	7.42	0.74	3.26	2.40										2.40	3.00	15	8.95	64.68	7.29	0.15						
DP 15 & C-3-17 & C-3-18	16							13.11	10.71	2.61	31.54						31.54	2.28	48	173.52	290.30	13.81	0.35						A4
C-3-19		0.87	0.75	7.83	0.65	3.20	2.07										2.07	0.75	18	7.28	244.45	4.12	0.99						
DP 16 & C-3-19	17							13.46	11.36	2.58	32.88						32.88	0.20	54	70.36	252.95	4.42	0.95						A3
C-3-20		2.49	0.75	11.99	1.86	2.71	5.03										5.03	10.00	15	16.34	9.74	13.32	0.01						
C-3-21		1.80	0.75	11.82	1.34	2.73	3.66										3.66	10.00	15	16.34	65.77	13.32	0.08						
DP 17 & C-3-20 & C-3-21	18							14.41	14.56	2.50	39.97						39.97	0.20	54	70.36	227.14	4.42	0.86						A2
C-3-22		1.61	0.57	13.87	0.91	2.54	2.32										2.32	1.00	15	5.17	8.03	4.21	0.03						
C-3-23		1.04	0.75	9.76	0.78	2.95	2.29										2.29	0.50	15	3.65	67.30	2.98	0.38						
C-3-22 & C-3-23	19							13.90	1.69	2.54	4.28						4.28	1.00	18	8.40	775.04	4.76	2.72						B5
DP 18 & DP19	**20**							**16.62**	**16.24**	**2.33**	**41.51**						**41.51**	**0.20**	**54**	70.36	**251.71**	**4.42**	**0.95**						**A1, To Pond C-1**
120% Pond C-1 Release Rate							8.00										**8.00**	**0.50**	**48**	81.26	**46.72**	**6.47**	**0.12**						**To Tributary I**
C-4-1		1.16	0.75	7.72	0.86	3.21	2.78										2.78	0.78	18	7.42	79.63	4.20	0.32						
C-4-2		1.41	0.75	9.77	1.05	2.95	3.10																						
C-4-1 & C-4-2	**21**							**9.77**	**1.92**	**2.95**	**5.65**						**5.65**	**1.50**	**18**	10.29	**54.65**	**5.82**	**0.16**						**OS-A2, To EX Northwest Pkwy Roadside Ditch**
C-5-1		0.80	0.75	9.35	0.60	3.00	1.79										1.79	2.00	15	7.31	12.00	5.96	0.03						
C-5-2		0.82	0.75	9.51	0.61	2.98	1.82										1.82	2.00	15	7.31	40.00	5.96	0.11						
C-5-1 & C-5-2	22							9.62	1.21	2.97	3.58						3.58	1.50	30	40.19	500.00	8.19	1.02						K13
C-5-3		0.80	0.75	8.42	0.60	3.12	1.86																						
C-5-4		0.80	0.75	8.40	0.60	3.12	1.86										1.86	2.00	15	7.31	40.00	5.96	0.11						
C-5-3 & C-5-4	23							8.51	1.19	3.10	3.70						3.70	2.00	15	7.31	6.00	5.96	0.02						KC1
DP 22 & DP 23	24							10.64	2.40	2.85	6.84						6.84	1.50	30	40.19	500.00	8.19	1.02						K12
C-5-5		0.95	0.75	8.16	0.71	3.15	2.23																						
C-5-6		0.97	0.75	8.06	0.72	3.17	2.29										2.29	2.00	15	7.31	40.00	5.96	0.11						
C-5-5 & C-5-6	25							8.17	1.43	3.15	4.51						4.51	2.00	15	7.31	6.00	5.96	0.02						KB1
DP 24 & DP 25	26							11.65	3.83	2.75	10.52						10.52	1.50	30	40.19	500.00	8.19	1.02						K5
C-5-7		1.10	0.75	7.28	0.82	3.28	2.69										2.69	2.00	15	7.31	6.00	5.96	0.02						
C-5-8		1.04	0.75	7.15	0.78	3.30	2.56										2.56	2.00	15	7.31	40.00	5.96	0.11						
DP 26 & C-5-7 & C-5-8	27							12.67	5.43	2.65	14.37						14.37	1.50	30	40.19	40.00	8.19	0.08						K1
C-5-9		1.34	0.67	10.57	0.90	2.86	2.57																						
B-2 & C-5-9	28							18.05	13.09	2.24	29.32						29.32	0.50	36	37.73	76.00	5.34	0.24						I5
C-5-10		1.17	0.75	7.66	0.87	3.22	2.81																						
DP 28 & C-5-10	**29**							**18.28**	**13.96**	**2.23**	**31.07**						**31.07**	**0.39**	**36**	33.32	**629.46**	**4.71**	**2.23**						**I4, To Pond C-2**
C-5-11		0.87	0.75	8.20	0.65	3.15	2.04										2.04	0.62	18	6.62	9.39	3.74	0.04						
C-5-12		1.06	0.75	8.36	0.79	3.13	2.47										2.47	0.45	18	5.64	66.02	3.19	0.34						
DP 27 & C-5-11 & C-5-12	30							12.75	6.87	2.64	18.13						18.13	0.50	30	23.20	40.60	4.73	0.14						E2
C-6-1		0.67	0.75	5.44	0.50	3.58	1.79										1.79	1.28	18	9.51	87.91	5.38	0.27						
C-6-2		0.81	0.75	5.92	0.60	3.50	2.11																						
C-6-1 & C-6-2	31							5.92	1.10	3.50	3.86						3.86	1.00	21	12.68	308.14	5.27	0.97						OS-B2
120% Pond C-2 Release Rate							3.00										3.00	0.50	42	56.91	540.97	5.92	1.52						
Pond C-2 Release & DP 31	**32**							**6.90**	**1.10**	**3.34**	**6.68**						**6.68**	**0.50**	**48**	81.26	**54.71**	**6.47**	**0.14**						**G1, To EX Northwest Pkwy Culvert**
C-6-3		0.34	0.75	5.00	0.25	3.66	0.93																						
D-1		26.75	0.58	17.49	15.39	2.28	35.02										35.02	1.31	42	92.12	36.64	9.58	0.06						
DP 30 & D-1	**33**							**17.56**	**22.26**	**2.27**	**50.55**						**50.55**	**0.20**	**48**	51.39	**129.79**	**4.09**	**0.53**						**E1, To Pond C-2**
D-2		18.64	0.16	19.36	3.04	2.16	6.57																						
E		30.61	0.58	20.55	17.61	2.09	36.88																						
F		17.07	0.16	22.74	2.79	1.98	5.52																						
OS-1		77.38	0.16	30.15	12.63	1.69	21.33																						
OS-2		49.08	0.18	26.85	8.92	1.81	16.13																						

Project Name: Nawatny Ridge
Project No: 190108
Date: 06/20/19
Revised: 04/03/20

STANDARD FORM SF-2
Post-Development
Rational Method Procedure

Designed By: JMR
Checked By: MAW
Design Storm: 100 YR

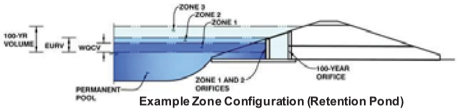
		DIRECT RUNOFF						TOTAL RUNOFF				STREET/INLET					STORM SEWER PIPE				TRAVEL TIME			CARRYOVER FLOWS					
BASIN (s)	DESIGN POINT	AREA (AC)	RUNOFF COEFF	T_c (min)	C x A (AC)	I (IN/HR)	DIRECT RUNOFF, Q (CFS)	T_c (MAX)	Σ(C x A) (AC)	I (IN/HR)	TOTAL RUNOFF, Q (CFS)	SLOPE (%)	STREET FLOW (CFS)	INLET DESIGN FLOW (CFS)	STREET OR INLET INTERCEPTION (CFS)	CARRYOVER (CFS)	DESIGN FLOW (CFS)	PIPE SLOPE (%)	PIPE SIZE (IN)	QFULL (CFS)	LENGTH (FT)	VELOCITY (FPS)	T_t (min)	BY-PASS RUNOFF, Q (CFS)	LENGTH (FT)	SLOPE (%)	VELOCITY (FPS)	T_t (min)	REMARKS
A-1		36.53	0.71	21.04	25.86	4.77	123.29																						
A-2		64.97	0.71	21.42	45.99	4.72	217.24																						
A-3-1		0.57	0.83	8.16	0.48	7.27	3.46										3.46	0.30	15	3.54	6.66	2.88	0.04						
A-3-2		0.59	0.83	8.30	0.49	7.22	3.56										3.56	0.46	15	4.38	30.68	3.57	0.14						
A-3-1 & A-3-2	1							8.44	0.97	7.18	6.95						6.95	1.50	18	12.87	132.28	7.28	0.30						L3
A-3-3		0.41	0.83	6.83	0.34	7.72	2.64										2.64	0.30	15	3.54	6.67	2.88	0.04						
DP 1 & A-3-3	2							8.74	1.31	7.09	9.29						9.29	0.46	18	7.12	30.67	4.03	0.13						L2
A-3-4		0.40	0.83	6.96	0.33	7.67	2.56																						
DP 2 & A-3-4	**3**							**8.87**	**1.64**	**7.05**	**11.59**						**11.59**	**0.49**	**18**	7.35	**29.61**	**4.16**	**0.12**						**L1, To Pond A-3**
B-1		69.26	0.71	26.31	49.03	4.22	206.66																						
120% Pond B-1 Release Rate							92.50										**92.50**	**1.00**	**42**	100.61	**559.15**	**10.46**	**0.89**						**To Tirbutary I**
B-2		21.19	0.71	17.86	15.00	5.19	77.86										77.86	0.30	36	36.53	45.82	5.17	0.15						
C-1		48.45	0.71	22.73	34.30	4.57	156.85																						
C-2		19.75	0.71	15.89	13.98	5.50	76.88																						
EX S 88th Street Culvert							83.80										83.80	1.84	24	30.69	445.59	9.77	0.76						
EX School Culvert West							4.20																						
88th St Culvert & School West Culvert	4							0.76	0.00	10.97	88.00						88.00	0.50	30	29.00	561.38	5.91	1.58						A20
C-3-1		1.57	0.83	9.38	1.31	6.91	9.05										9.05	1.00	15	6.46	11.03	5.26	0.03						
C-3-2		1.52	0.83	9.19	1.27	6.96	8.83										8.83	1.00	15	6.46	64.31	5.26	0.20						
DP 4 & C-3-1 & C-3-2	5							9.42	2.58	6.90	105.78						105.78	1.65	30	52.69	84.67	10.73	0.13						A18
Flow Lost to School Detention Pond							-56.00																						A portion of flow from 88th St Culvert is let into School Pond
DP 5 & School Pond Bypass	6							9.42	2.58	6.90	49.78						49.78	1.60	30	51.88	382.72	10.57	0.60						A17
C-3-3		0.64	0.83	5.00	0.53	8.45	4.51										4.51	1.00	15	6.46	12.51	5.26	0.04						
C-3-4		0.66	0.83	5.00	0.55	8.45	4.65										4.65	1.00	15	6.46	62.83	5.26	0.20						
DP 6 & C-3-3 & C-3-4	7							10.02	3.66	6.73	56.66						56.66	4.00	30	82.03	415.50	16.71	0.41						A15
EX School Culvert East							4.80																						
DP 7 & School East Culvert	8							10.02	3.66	6.73	61.46						61.46	4.00	30	82.03	112.83	16.71	0.11						A14
C-3-5		0.91	0.83	5.00	0.76	8.45	6.41										6.41	2.00	15	9.14	74.82	7.44	0.17						
C-3-6		0.96	0.83	5.00	0.80	8.45	6.77										6.77	5.50	15	15.15	44.54	12.34	0.06						
DP 8 & C-3-5 & C-3-6	9							10.13	5.22	6.70	71.81						71.81	1.74	36	87.98	704.07	12.45	0.94						A13
C-3-7		1.45	0.83	8.15	1.21	7.27	8.80										8.80	10.00	18	33.22	10.76	18.80	0.01						
C-3-8		1.43	0.83	7.88	1.19	7.36	8.78										8.78	1.00	18	10.50	64.64	5.94	0.18						
DP 9 & C-3-7 & C-3-8	10							11.07	7.63	6.47	86.11						86.11	0.50	36	47.16	318.93	6.67	0.80						A10
120% Pond E Release Rate							50.00										50.00	1.50	30	50.24	1200.00	10.23	1.95						
C-3-9		0.68	0.83	6.45	0.57	7.86	4.46										4.46	2.00	15	9.14	12.00	7.44	0.03						
C-3-10		0.71	0.83	7.31	0.59	7.55	4.47										4.47	2.00	15	9.14	60.00	7.44	0.13						
Pond E Release & C-3-9 & C-3-10	11							7.44	1.16	7.50	58.70						58.70	1.50	30	50.24	900.00	10.23	1.47						J6
C-3-11		0.88	0.83	8.17	0.73	7.26	5.33										5.33	2.00	15	9.14	12.00	7.44	0.03						
C-3-12		0.87	0.83	8.42	0.73	7.19	5.22										5.22	2.00	15	9.14	60.00	7.44	0.13						
DP 11 & C-3-11 & C-3-12	12							8.91	2.62	7.04	68.45						68.45	1.50	36	81.69	400.00	11.56	0.58						J3
C-3-13		0.50	0.83	7.98	0.42	7.33	3.06										3.06	2.00	15	9.14	12.00	7.44	0.03						
C-3-14		0.50	0.83	7.99	0.42	7.32	3.06										3.06	2.00	15	9.14	60.00	7.44	0.13						
DP 12 & C-3-13 & C-3-14	13							9.48	3.45	6.88	73.75						73.75	5.00	36	149.14	200.00	21.10	0.16						J1
DP 10 & DP 13	14							11.87	11.08	6.28	156.38						156.38	0.50	48	101.57	489.24	8.08	1.01						A8
C-3-15		1.22	0.83	9.32	1.02	6.92	7.05										7.05	12.81	15	23.12	10.66	18.84	0.01						
C-3-16		1.00	0.83	8.79	0.83	7.08	5.90										5.90	10.46	15	20.89	64.67	17.02	0.06						
DP 14 & C-3-15 & C-3-16	15							12.88	12.93	6.06	165.19						165.19	0.50	48	101.57	628.20	8.08	1.30						A6
C-3-17		0.97	0.83	7.40	0.81	7.52	6.08										6.08	10.00	15	20.43	10.65	16.65	0.01						
C-3-18		0.99	0.83	7.42	0.83	7.51	6.20										6.20	3.00	15	11.19	64.68	9.12	0.12						
DP 15 & C-3-17 & C-3-18	16							14.17	14.57	5.80	171.36						171.36	2.28	48	216.90	290.30	17.26	0.28						A4
C-3-19		0.87	0.83	7.83	0.73	7.37	5.35										5.35	0.75	18	9.10	244.45	5.15	0.79						
DP 16 & C-3-19	17							14.46	15.29	5.75	174.77						174.77	0.20	54	87.94	252.95	5.53	0.76						A3
C-3-20		2.49	0.83	11.99	2.08	6.25	12.99										12.99	10.00	15	20.43	9.74	16.65	0.01						
C-3-21		1.80	0.83	11.82	1.50	6.29	9.45										9.45	10.00	15	20.43	65.77	16.65	0.07						
DP 17 & C-3-20 & C-3-21	18							15.22	18.87	5.61	192.77						192.77	0.20	54	87.94	227.14	5.53	0.68						A2
C-3-22		1.61	0.70	13.87	1.13	5.86	6.62										6.62	1.00	15	6.46	8.03	5.26	0.03						
C-3-23		1.04	0.83	9.76	0.87	6.80	5.90										5.90	0.50	15	4.57	67.30	3.72	0.30						
C-3-22 & C-3-23	19							13.90	2.00	5.88	11.70						11.70	1.00	18	10.50	775.04	5.94	2.17						B5
DP 18 & DP19	**20**							**16.07**	**20.87**	**5.47**	**200.96**						**200.96**	**0.20**	**54**	**87.94**	**251.71**	**5.53**	**0.76**						**A1, To Pond C-1**
120% Pond C-1 Release Rate							115.00										**115.00**	**0.50**	**48**	**101.57**	**46.72**	**8.08**	**0.10**						**To Tributary I**
C-4-1		1.16	0.83	7.72	0.97	7.41	7.17										7.17	0.78	18	9.28	79.63	5.25	0.25						
C-4-2		1.41	0.83	9.77	1.18	6.80	8.00																						
C-4-1 & C-4-2	**21**							**9.77**	**2.14**	**6.80**	**14.58**						**14.58**	**1.50**	**18**	**12.87**	**54.65**	**7.28**	**0.13**						**OS-A2, To EX Northwest Pkwy Roadside Ditch**
C-5-1		0.80	0.83	9.35	0.67	6.92	4.62										4.62	2.00	15	9.14	12.00	7.44	0.03						
C-5-2		0.82	0.83	9.51	0.68	6.87	4.70										4.70	2.00	15	9.14	40.00	7.44	0.09						
C-5-1 & C-5-2	22							9.59	1.35	6.85	9.25						9.25	1.50	30	50.24	500.00	10.23	0.81						K13
C-5-3		0.80	0.83	8.42	0.67	7.19	4.80																						
C-5-4		0.80	0.83	8.40	0.67	7.19	4.80										4.80	2.00	15	9.14	40.00	7.44	0.09						
C-5-3 & C-5-4	23							8.49	1.34	7.16	9.57						9.57	2.00	15	9.14	6.00	7.44	0.01						KC1
DP 22 & DP 23	24							10.41	2.69	6.63	17.81						17.81	1.50	30	50.24	500.00	10.23	0.81						K12
C-5-5		0.95	0.83	8.16	0.79	7.27	5.76																						
C-5-6		0.97	0.83	8.06	0.81	7.30	5.91										5.91	2.00	15	9.14	40.00	7.44	0.09						
C-5-5 & C-5-6	25							8.16	1.60	7.27	11.64						11.64	2.00	15	9.14	6.00	7.44	0.01						KB1
DP 24 & DP 25	26							11.22	4.29	6.43	27.57						27.57	1.50	30	50.24	500.00	10.23	0.81						K5
C-5-7		1.10	0.83	7.28	0.92	7.56	6.94										6.94	2.00	15	9.14	6.00	7.44	0.01						
C-5-8		1.04	0.83	7.15	0.87	7.60	6.60										6.60	2.00	15	9.14	40.00	7.44	0.09						
DP 26 & C-5-7 & C-5-8	27							12.04	6.07	6.24	37.92						37.92	1.50	30	50.24	40.00	10.23	0.07						K1
C-5-9		1.34	0.78	10.57	1.04	6.59	6.86																						
B-2 & C-5-9	28							18.01	16.04	5.17	82.92						82.92	0.50	36	47.16	76.00	6.67	0.19						I5
C-5-10		1.17	0.83	7.66	0.98	7.43	7.25																						
DP 28 & C-5-10	**29**							**18.20**	**17.02**	**5.14**	**87.50**						**87.50**	**0.39**	**36**	**41.65**	**629.46**	**5.89**	**1.78**						**I4, To Pond C-2**
C-5-11		0.87	0.83	8.20	0.73	7.26	5.27										5.27	0.62	18	8.27	9.39	4.68	0.03						
C-5-12		1.06	0.83	8.36	0.88	7.21	6.37										6.37	0.45	18	7.05	66.02	3.99	0.28						
DP 27 & C-5-11 & C-5-12	30							12.10	7.69	6.23	47.86						47.86	0.50	30	29.00	40.60	5.91	0.11						E2
C-6-1		0.67	0.83	5.44	0.56	8.26	4.62										4.62	1.28	18	11.88	87.91	6.73	0.22						
C-6-2		0.81	0.83	5.92	0.68	8.06	5.45																						
C-6-1 & C-6-2	31							5.92	1.23	8.06	9.95						9.95	1.00	21	15.85	308.14	6.59	0.78						OS-B2
120% Pond C-2 Release Rate							90.00										90.00	0.50	42	71.14	540.97	7.39	1.22						
Pond C-2 Release & DP 31	**32**							**6.70**	**1.23**	**7.76**	**99.59**						**99.59**	**0.50**	**48**	**101.57**	**54.71**	**8.08**	**0.11**						**G1, To EX Northwest Pkwy Culvert**
C-6-3		0.34	0.83	5.00	0.28	8.45	2.40																						
D-1		26.75	0.71	17.49	18.93	5.25	99.33										99.33	1.31	42	115.15	36.64	11.97	0.05						
DP 30 & D-1	**33**							**17.54**	**26.62**	**5.24**	**139.44**						**139.44**	**0.20**	**48**	**64.24**	**129.79**	**5.11**	**0.42**						**E1, To Pond C-2**
D-2		18.64	0.51	19.36	9.46	4.98	47.11																						
E		30.61	0.71	20.55	21.67	4.83	104.62																						
F		17.07	0.51	22.74	8.66	4.57	39.60																						
OS-1		77.38	0.51	30.15	39.26	3.90	152.93																						
OS-2		49.08	0.52	26.85	25.39	4.17	105.81																						

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.00 (December 2019)

Project: Redtail Ridge

Basin ID: Pond A-2



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	65.00	acres
Watershed Length =	2,055	ft
Watershed Length to Centroid =	1,084	ft
Watershed Slope =	0.030	ft/ft
Watershed Imperviousness =	75.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Louisville - City Hall	

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

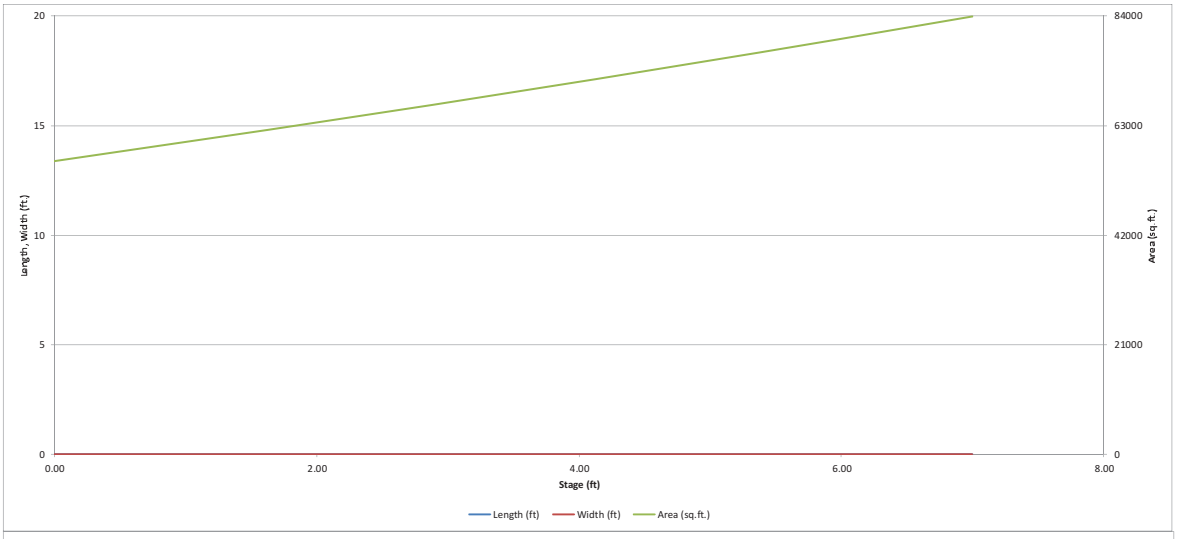
			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.622	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	4.764	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.8 in.) =	3.015	acre-feet		inches
5-yr Runoff Volume (P1 = 1.09 in.) =	4.399	acre-feet		inches
10-yr Runoff Volume (P1 = 1.35 in.) =	5.782	acre-feet		inches
25-yr Runoff Volume (P1 = 1.78 in.) =	8.299	acre-feet		inches
50-yr Runoff Volume (P1 = 2.14 in.) =	10.348	acre-feet		inches
100-yr Runoff Volume (P1 = 2.54 in.) =	12.725	acre-feet		inches
500-yr Runoff Volume (P1 = 3.63 in.) =	19.005	acre-feet		inches
Approximate 2-yr Detention Volume =	2.900	acre-feet		
Approximate 5-yr Detention Volume =	4.303	acre-feet		
Approximate 10-yr Detention Volume =	5.248	acre-feet		
Approximate 25-yr Detention Volume =	6.427	acre-feet		
Approximate 50-yr Detention Volume =	7.043	acre-feet		
Approximate 100-yr Detention Volume =	7.971	acre-feet		

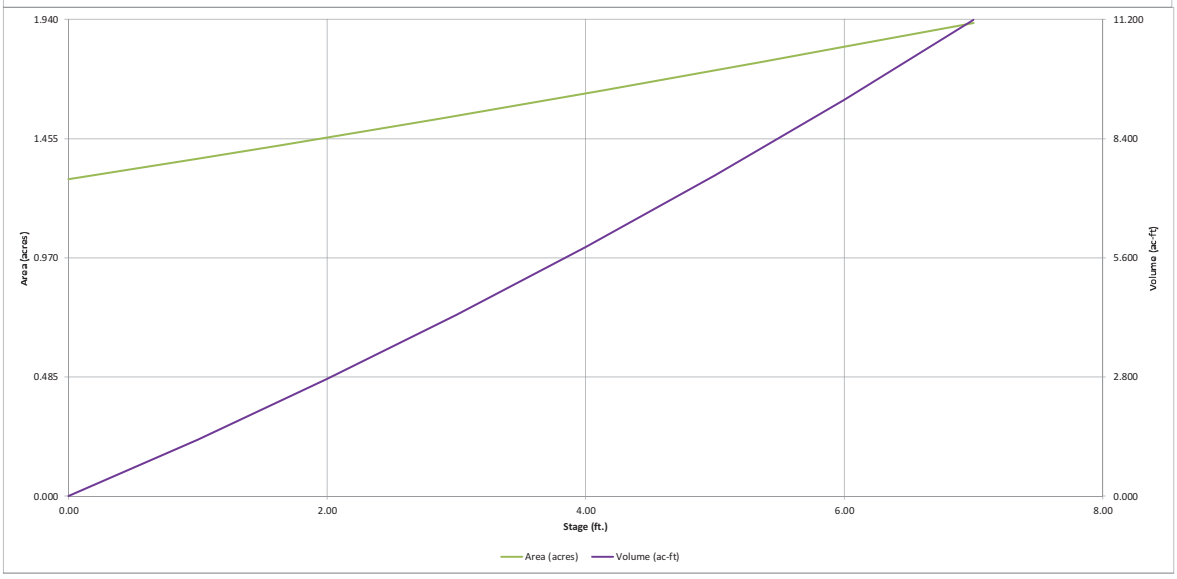
Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	1.622	acre-feet
Zone 2 Volume (EURV - Zone 1) =	3.142	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	3.207	acre-feet
Total Detention Basin Volume =	7.971	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
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^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	56,199	1.290		
	--	1.00	--	--	--	59,854	1.374	58,026	1.332
	--	2.00	--	--	--	63,609	1.460	119,757	2.749
	--	3.00	--	--	--	67,464	1.549	185,294	4.254
	--	4.00	--	--	--	71,420	1.640	254,736	5.848
	--	5.00	--	--	--	75,477	1.733	328,184	7.534
	--	6.00	--	--	--	79,634	1.828	405,739	9.314
	--	7.00	--	--	--	83,891	1.926	487,501	11.191


20
15
10
5
0
84000
63000
42000
21000
0
0.00
2.00
4.00
6.00
8.00
Stage (ft)
Length, Width (ft.)
Area (sq. ft.)
Length (ft)
Width (ft)
Area (sq.ft.)

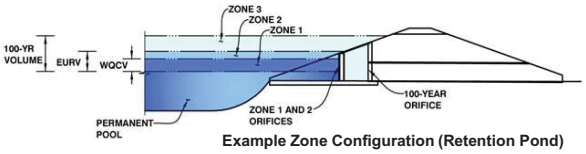

1.940
1.455
0.970
0.485
0.000
11.200
8.400
5.600
2.800
0.000
0.00
2.00
4.00
6.00
8.00
Stage (ft.)
Area (acres)
Volume (ac-ft)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

Project: **Redtail Ridge**

Basin ID: **Pond A-2**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.21	1.622	Orifice Plate
Zone 2 (EURV)	3.33	3.142	Orifice Plate
Zone 3 (100-year)	5.26	3.207	Weir&Pipe (Restrict)
Total (all zones)		7.971	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.33	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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	1.10	2.20					
Orifice Area (sq. inches)	23.00	23.00	50.00					

	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)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.33	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	9.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	9.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.33	N/A	feet
Overflow Weir Slope Length =	9.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	9.98	N/A	
Overflow Grate Open Area w/o Debris =	56.70	N/A	ft^2
Overflow Grate Open Area w/ Debris =	28.35	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	42.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	24.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	5.68	N/A	ft^2
Outlet Orifice Centroid =	1.14	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.71	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.25	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	125.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.75	feet
Stage at Top of Freeboard =	7.00	feet
Basin Area at Top of Freeboard =	1.93	acres
Basin Volume at Top of Freeboard =	11.19	acre-ft

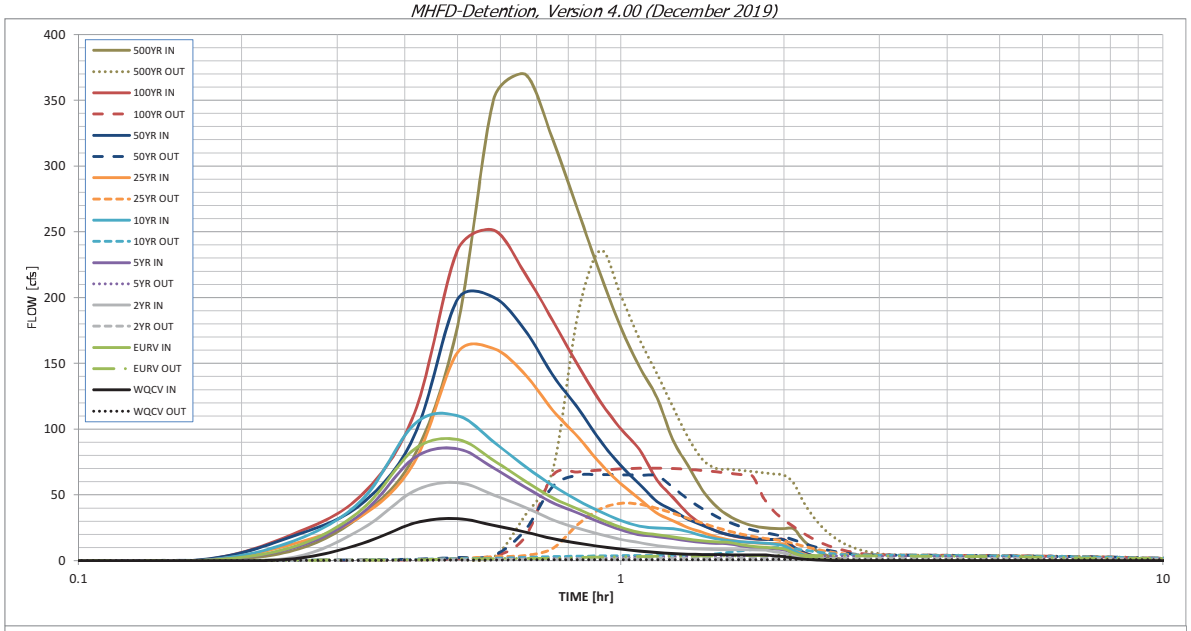
Routed Hydrograph Results

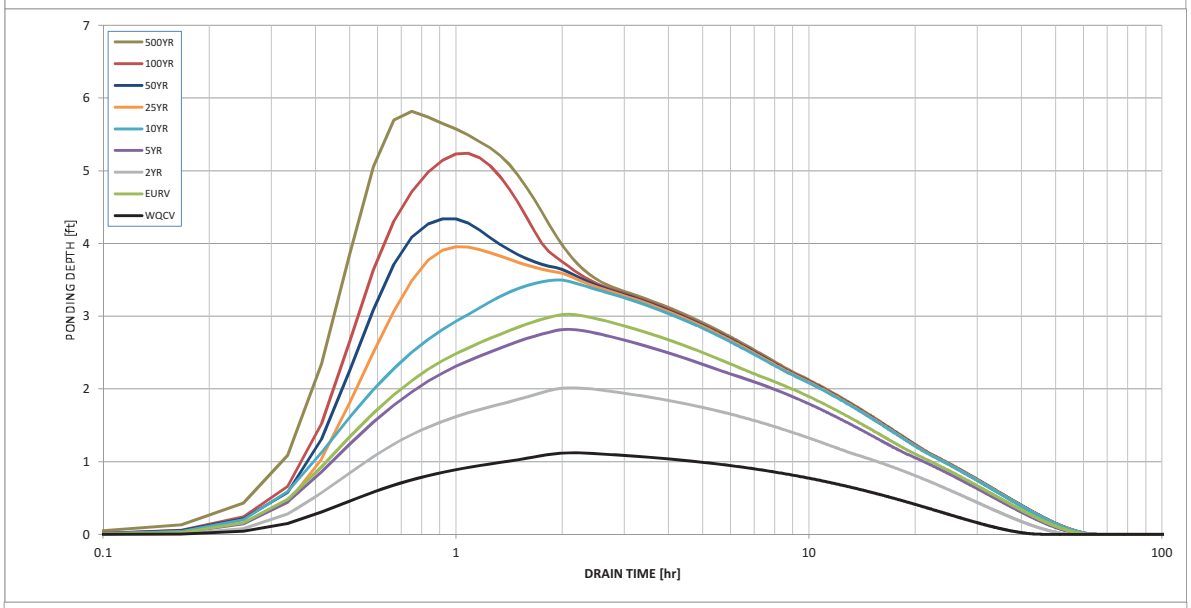
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

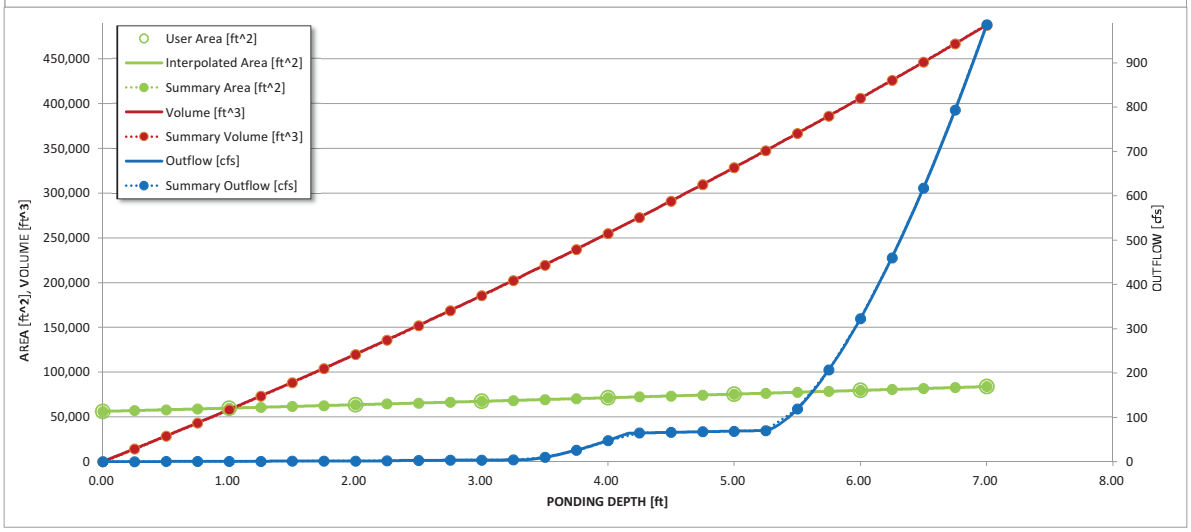
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	0.80	1.09	1.35	1.78	2.14	2.54	3.63
CUHP Runoff Volume (acre-ft) =	1.622	4.764	3.015	4.399	5.782	8.299	10.348	12.725	19.005
Inflow Hydrograph Volume (acre-ft) =	1.622	4.764	3.015	4.399	5.782	8.299	10.348	12.725	19.005
CUHP Predevelopment Peak Q (cfs) =	0.0	0.0	0.7	6.9	20.6	54.8	78.1	106.5	176.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	0.0	0.0							
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.11	0.32	0.84	1.20	1.64	2.71
Peak Inflow Q (cfs) =	31.9	92.1	59.4	85.0	110.2	161.2	200.2	251.2	369.7
Peak Outflow Q (cfs) =	0.9	3.9	1.8	3.6	9.9	43.6	65.3	70.3	235.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.5	0.5	0.8	0.8	0.7	1.3
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.7	1.1	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	50	46	50	51	48	46	44	39
Time to Drain 99% of Inflow Volume (hours) =	**42**	56	51	55	57	55	54	53	50
Maximum Ponding Depth (ft) =	1.12	3.03	2.02	2.82	3.50	3.96	4.34	5.24	5.82
Area at Maximum Ponding Depth (acres) =	1.38	1.55	1.46	1.53	1.59	1.64	1.67	1.76	1.81
Maximum Volume Stored (acre-ft) =	1.498	4.285	2.764	3.961	5.024	5.766	6.394	7.953	8.969

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	0.47	0.28	7.89
	0:15:00	1.45	10.69	2.70	9.87	15.22	12.95	18.98	20.57	34.84
	0:20:00	12.99	39.05	24.15	36.05	46.17	34.13	43.49	50.26	80.07
	0:25:00	28.59	84.78	53.14	78.28	103.85	75.02	95.26	112.14	177.94
	0:30:00	31.95	92.10	59.39	85.04	110.23	158.12	198.54	235.79	350.93
	0:35:00	26.83	76.17	49.87	70.34	90.29	161.19	200.21	251.24	369.71
	0:40:00	21.77	60.47	40.47	55.84	71.65	141.50	174.98	218.02	319.77
	0:45:00	16.65	47.60	30.95	43.95	57.07	114.09	140.86	182.17	266.63
	0:50:00	13.27	39.32	24.67	36.31	45.86	94.21	116.17	148.84	218.03
	0:55:00	10.77	31.60	20.01	29.17	37.34	73.96	91.36	121.07	177.52
	1:00:00	8.69	25.37	16.16	23.43	30.54	58.55	72.43	100.43	147.26
	1:05:00	7.40	21.45	13.76	19.81	26.29	47.00	58.23	84.35	123.93
	1:10:00	6.11	19.82	11.35	18.30	24.73	36.06	44.97	61.42	91.18
	1:15:00	5.38	18.04	10.01	16.66	24.23	30.36	38.12	47.90	71.88
	1:20:00	4.98	16.23	9.25	14.98	22.02	24.95	31.23	35.45	53.35
	1:25:00	4.74	15.05	8.81	13.89	18.82	21.54	26.86	27.39	41.31
	1:30:00	4.60	14.30	8.55	13.21	16.67	18.12	22.55	22.63	34.19
	1:35:00	4.50	13.86	8.36	12.80	15.25	15.88	19.72	19.47	29.45
	1:40:00	4.44	12.14	8.24	11.21	14.35	14.48	17.95	17.56	26.59
	1:45:00	4.41	10.91	8.20	10.07	13.76	13.61	16.86	16.57	25.09
	1:50:00	4.41	10.14	8.20	9.36	13.36	13.15	16.27	16.20	24.50
	1:55:00	3.66	9.67	6.81	8.93	12.69	12.89	15.94	16.06	24.29
	2:00:00	3.12	8.99	5.81	8.30	11.36	12.77	15.80	16.06	24.30
	2:05:00	2.02	5.84	3.76	5.39	7.41	8.39	10.38	10.58	15.99
	2:10:00	1.25	3.60	2.32	3.33	4.62	5.26	6.50	6.63	10.01
	2:15:00	0.75	2.18	1.40	2.01	2.81	3.23	3.99	4.06	6.13
	2:20:00	0.42	1.27	0.78	1.17	1.62	1.88	2.32	2.36	3.56
	2:25:00	0.21	0.71	0.40	0.66	0.88	1.07	1.32	1.34	2.01
	2:30:00	0.09	0.32	0.16	0.29	0.37	0.48	0.59	0.60	0.90
	2:35:00	0.02	0.08	0.04	0.08	0.09	0.13	0.16	0.16	0.23
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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 4.00 (December 2019)

Summary Stage-Area-Volume-Discharge Relationships

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

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

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	56,199	1.290	0	0.000	0.00
	0.25	57,113	1.311	14,164	0.325	0.38
	0.50	58,026	1.332	28,556	0.656	0.54
	0.75	58,940	1.353	43,177	0.991	0.67
	1.00	59,854	1.374	58,026	1.332	0.77
	1.25	60,792	1.396	73,107	1.678	1.16
	1.50	61,731	1.417	88,423	2.030	1.43
	1.75	62,670	1.439	103,973	2.387	1.64
	2.00	63,609	1.460	119,757	2.749	1.82
	2.25	64,572	1.482	135,780	3.117	2.35
	2.50	65,536	1.505	152,044	3.490	3.04
	2.75	66,500	1.527	168,548	3.869	3.50
	3.00	67,464	1.549	185,294	4.254	3.89
	3.25	68,453	1.571	202,283	4.644	4.23
	3.50	69,442	1.594	219,520	5.039	9.98
	3.75	70,431	1.617	237,004	5.441	25.95
	4.00	71,420	1.640	254,736	5.848	47.66
	4.25	72,434	1.663	272,717	6.261	64.80
	4.50	73,448	1.686	290,953	6.679	66.23
	4.75	74,462	1.709	309,442	7.104	67.63
	5.00	75,477	1.733	328,184	7.534	69.00
	5.25	76,516	1.757	347,183	7.970	70.34
	5.50	77,555	1.780	366,442	8.412	118.84
	5.75	78,594	1.804	385,961	8.860	207.24
	6.00	79,634	1.828	405,739	9.314	322.47
	6.25	80,698	1.853	425,781	9.775	460.08
	6.50	81,762	1.877	446,088	10.241	617.56
	6.75	82,827	1.901	466,662	10.713	793.29
	7.00	83,891	1.926	487,501	11.191	986.14

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

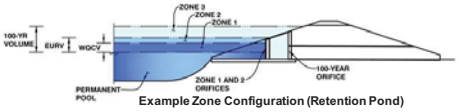
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.00 (December 2019)

Project: **Redtail Ridge**

Basin ID: **Pond A-3**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	2.00	acres
Watershed Length =	632	ft
Watershed Length to Centroid =	500	ft
Watershed Slope =	0.015	ft/ft
Watershed Imperviousness =	90.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Louisville - City Hall	

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

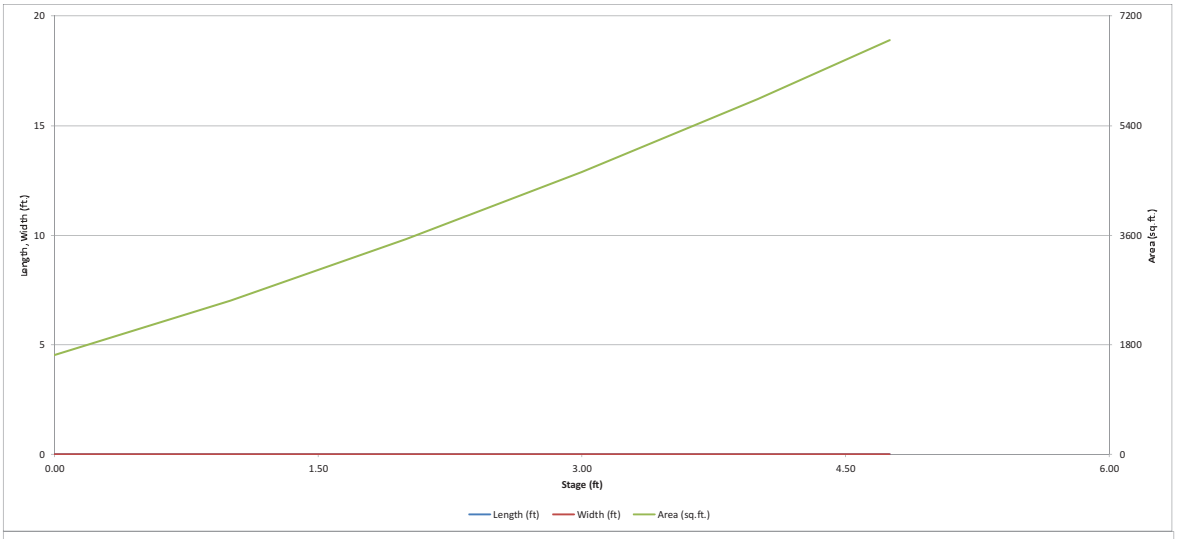
			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.067	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	0.178	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.8 in.) =	0.113	acre-feet		inches
5-yr Runoff Volume (P1 = 1.09 in.) =	0.160	acre-feet		inches
10-yr Runoff Volume (P1 = 1.35 in.) =	0.205	acre-feet		inches
25-yr Runoff Volume (P1 = 1.78 in.) =	0.281	acre-feet		inches
50-yr Runoff Volume (P1 = 2.14 in.) =	0.345	acre-feet		inches
100-yr Runoff Volume (P1 = 2.54 in.) =	0.416	acre-feet		inches
500-yr Runoff Volume (P1 = 3.63 in.) =	0.609	acre-feet		inches
Approximate 2-yr Detention Volume =	0.110	acre-feet		
Approximate 5-yr Detention Volume =	0.158	acre-feet		
Approximate 10-yr Detention Volume =	0.194	acre-feet		
Approximate 25-yr Detention Volume =	0.237	acre-feet		
Approximate 50-yr Detention Volume =	0.258	acre-feet		
Approximate 100-yr Detention Volume =	0.284	acre-feet		

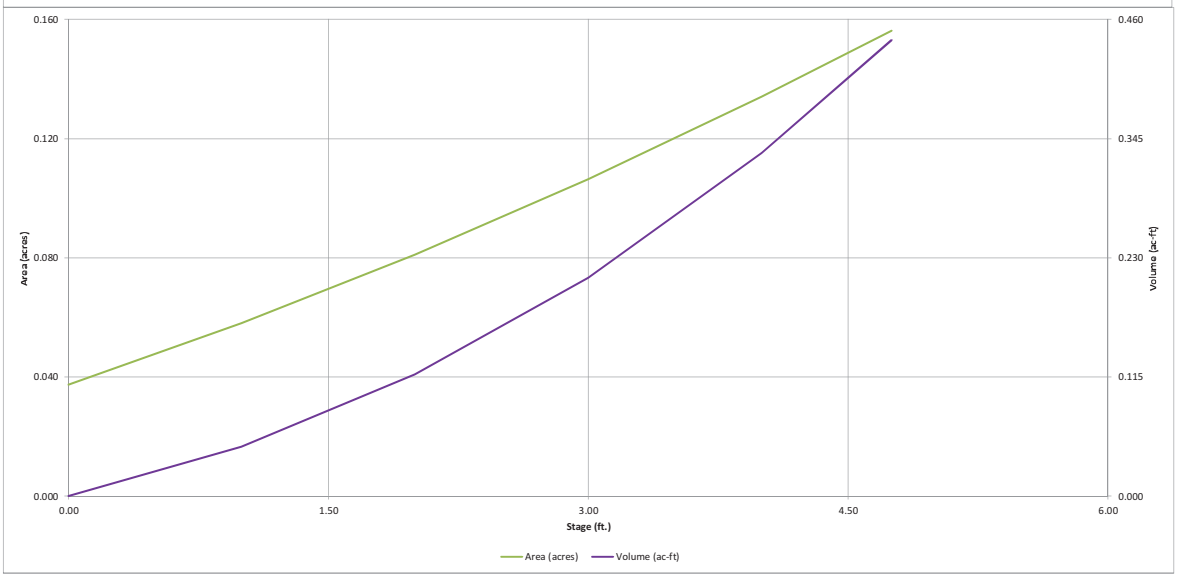
Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.067	acre-feet
Zone 2 Volume (EURV - Zone 1) =	0.112	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.105	acre-feet
Total Detention Basin Volume =	0.284	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
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^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	1,626	0.037		
	--	1.00	--	--	--	2,528	0.058	2,077	0.048
	--	2.00	--	--	--	3,531	0.081	5,107	0.117
	--	3.00	--	--	--	4,635	0.106	9,190	0.211
	--	4.00	--	--	--	5,840	0.134	14,427	0.331
	--	4.75	--	--	--	6,809	0.156	19,171	0.440


20
15
10
5
0
7200
5400
3600
1800
0
0.00
1.50
3.00
4.50
6.00
Stage (ft)
Length, Width (ft.)
Area (sq. ft.)
Length (ft)
Width (ft)
Area (sq.ft.)

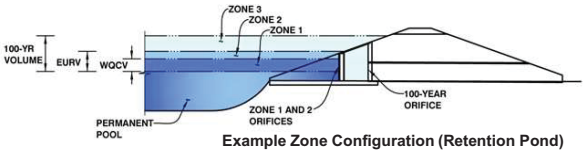

0.160
0.120
0.080
0.040
0.000
0.460
0.345
0.230
0.115
0.000
0.00
1.50
3.00
4.50
6.00
Stage (ft.)
Area (acres)
Volume (ac-ft)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

Project: **Redtail Ridge**

Basin ID: **Pond A-3**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.32	0.067	Orifice Plate
Zone 2 (EURV)	2.69	0.112	Orifice Plate
Zone 3 (100-year)	3.64	0.105	Weir&Pipe (Restrict)
Total (all zones)		0.284	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.69	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	9.20	inches
Orifice Plate: Orifice Area per Row =	0.80	sq. inches (diameter = 1 inch)

Calculated Parameters for Plate

WQ Orifice Area per Row =	5.556E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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	0.90	1.79					
Orifice Area (sq. inches)	0.80	0.80	0.80					

	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)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	2.69	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	4.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	4.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	2.69	N/A	feet
Overflow Weir Slope Length =	4.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	77.60	N/A	
Overflow Grate Open Area w/o Debris =	11.20	N/A	ft^2
Overflow Grate Open Area w/ Debris =	5.60	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	18.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	2.45		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	0.14	N/A	ft^2
Outlet Orifice Centroid =	0.12	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	0.76	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.50	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	11.50	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.25	feet
Stage at Top of Freeboard =	4.75	feet
Basin Area at Top of Freeboard =	0.16	acres
Basin Volume at Top of Freeboard =	0.44	acre-ft

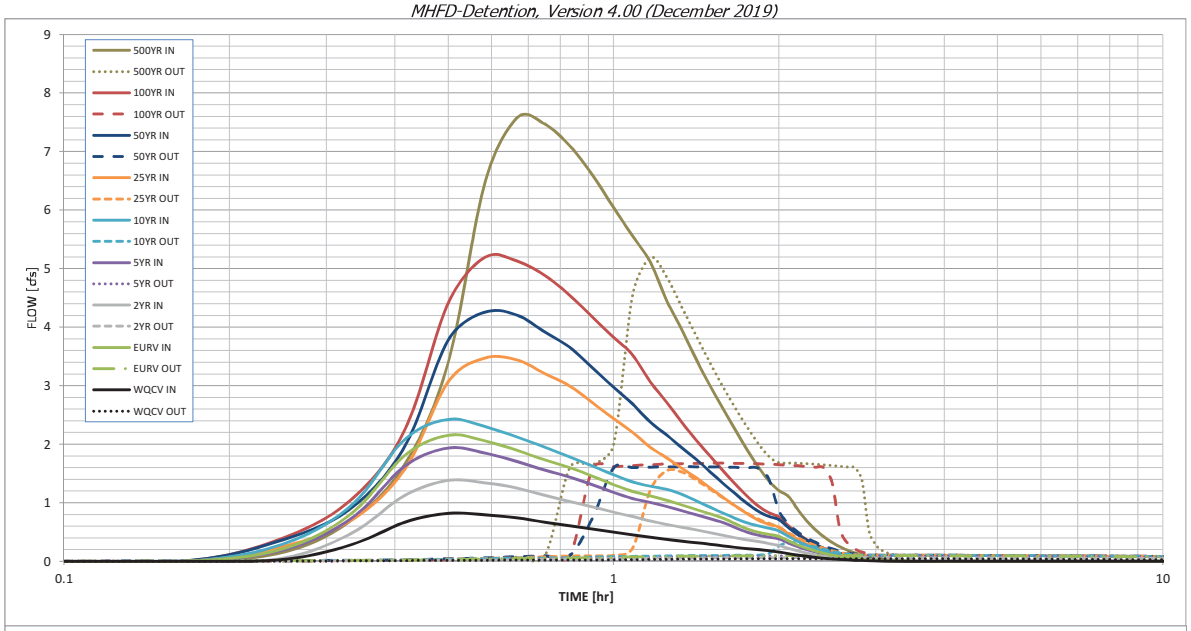
Routed Hydrograph Results

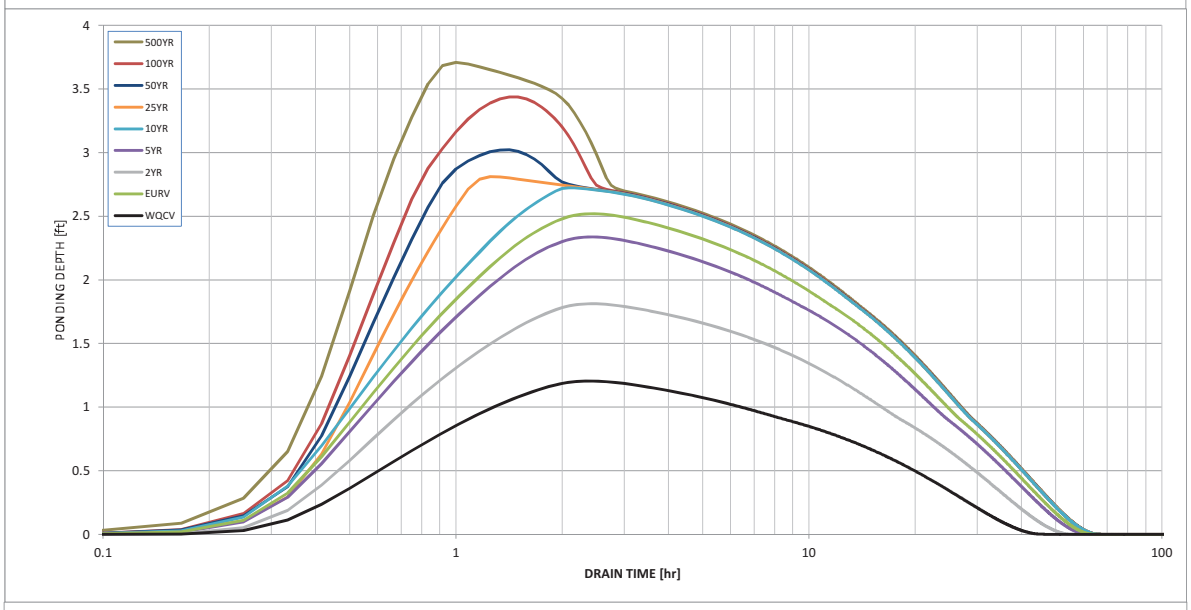
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

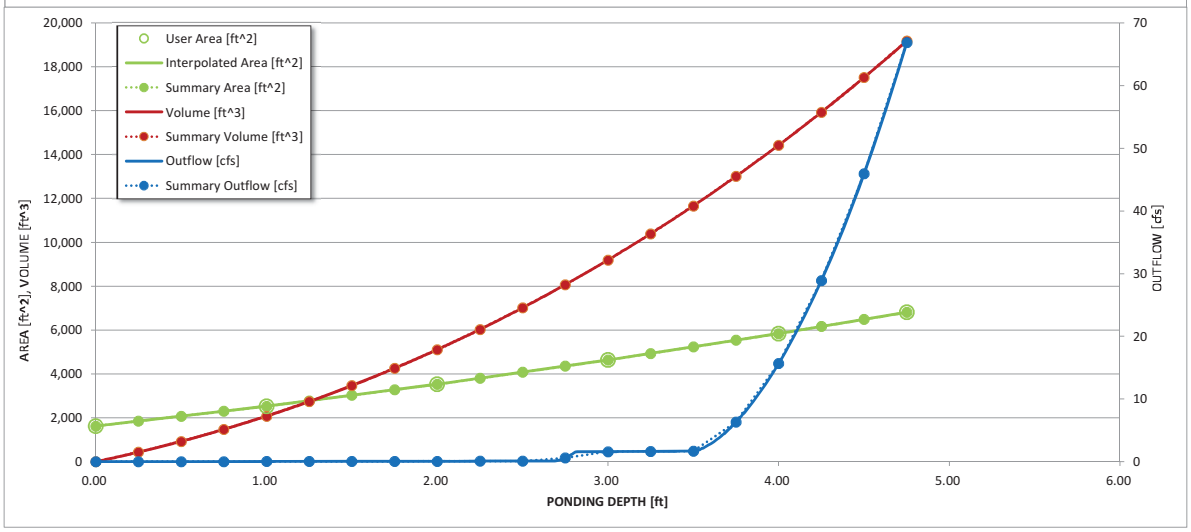
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	0.80	1.09	1.35	1.78	2.14	2.54	3.63
CUHP Runoff Volume (acre-ft) =	0.067	0.178	0.113	0.160	0.205	0.281	0.345	0.416	0.609
Inflow Hydrograph Volume (acre-ft) =	0.067	0.178	0.113	0.160	0.205	0.281	0.345	0.416	0.609
CUHP Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.1	0.3	0.9	1.3	1.8	3.0
OPTIONAL Override Predevelopment Peak Q (cfs) =	0.0	0.0							
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.05	0.16	0.45	0.64	0.89	1.48
Peak Inflow Q (cfs) =	0.8	2.2	1.4	1.9	2.4	3.5	4.3	5.2	7.6
Peak Outflow Q (cfs) =	0.0	0.1	0.1	0.1	0.3	1.5	1.6	1.7	5.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.9	1.0	1.7	1.3	0.9	1.8
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.1	0.1	0.1	0.1
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	51	46	50	53	50	49	47	43
Time to Drain 99% of Inflow Volume (hours) =	**42**	57	50	55	59	57	56	55	53
Maximum Ponding Depth (ft) =	1.21	2.52	1.81	2.34	2.72	2.81	3.02	3.44	3.71
Area at Maximum Ponding Depth (acres) =	0.06	0.09	0.08	0.09	0.10	0.10	0.11	0.12	0.13
Maximum Volume Stored (acre-ft) =	0.060	0.162	0.102	0.145	0.182	0.191	0.213	0.259	0.292

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	0.01	0.01	0.15
	0:15:00	0.03	0.21	0.05	0.19	0.29	0.25	0.37	0.40	0.70
	0:20:00	0.28	0.81	0.48	0.73	0.96	0.71	0.91	1.06	1.65
	0:25:00	0.67	1.81	1.12	1.62	2.08	1.57	1.96	2.24	3.39
	0:30:00	0.82	2.15	1.38	1.93	2.42	3.06	3.77	4.40	6.47
	0:35:00	0.79	2.06	1.34	1.85	2.30	3.47	4.25	5.19	7.57
	0:40:00	0.74	1.90	1.25	1.71	2.12	3.44	4.21	5.13	7.47
	0:45:00	0.67	1.73	1.12	1.56	1.95	3.21	3.92	4.88	7.09
	0:50:00	0.61	1.60	1.02	1.44	1.78	2.99	3.65	4.54	6.59
	0:55:00	0.55	1.45	0.93	1.31	1.63	2.71	3.30	4.17	6.05
	1:00:00	0.50	1.31	0.84	1.18	1.48	2.44	2.98	3.83	5.56
	1:05:00	0.45	1.19	0.76	1.07	1.36	2.20	2.69	3.52	5.11
	1:10:00	0.41	1.12	0.69	1.00	1.28	1.95	2.38	3.07	4.45
	1:15:00	0.37	1.04	0.63	0.94	1.23	1.77	2.16	2.72	3.95
	1:20:00	0.34	0.96	0.58	0.86	1.14	1.58	1.93	2.37	3.44
	1:25:00	0.32	0.88	0.53	0.79	1.03	1.42	1.74	2.06	2.99
	1:30:00	0.29	0.81	0.49	0.73	0.92	1.25	1.53	1.79	2.60
	1:35:00	0.26	0.74	0.44	0.66	0.82	1.09	1.33	1.54	2.24
	1:40:00	0.24	0.64	0.40	0.57	0.73	0.95	1.15	1.32	1.91
	1:45:00	0.22	0.55	0.36	0.50	0.66	0.81	0.99	1.11	1.62
	1:50:00	0.20	0.50	0.34	0.45	0.61	0.70	0.86	0.95	1.38
	1:55:00	0.18	0.46	0.30	0.41	0.57	0.63	0.77	0.83	1.21
	2:00:00	0.16	0.43	0.27	0.38	0.52	0.58	0.71	0.76	1.10
	2:05:00	0.13	0.35	0.22	0.31	0.42	0.47	0.57	0.60	0.88
	2:10:00	0.10	0.28	0.18	0.25	0.34	0.37	0.45	0.47	0.69
	2:15:00	0.08	0.22	0.14	0.20	0.27	0.29	0.36	0.37	0.53
	2:20:00	0.07	0.17	0.11	0.16	0.21	0.23	0.28	0.28	0.41
	2:25:00	0.05	0.14	0.09	0.12	0.17	0.18	0.22	0.22	0.32
	2:30:00	0.04	0.11	0.07	0.10	0.13	0.14	0.17	0.17	0.25
	2:35:00	0.03	0.08	0.05	0.07	0.10	0.11	0.13	0.13	0.19
	2:40:00	0.02	0.06	0.04	0.06	0.08	0.08	0.10	0.10	0.15
	2:45:00	0.02	0.05	0.03	0.04	0.06	0.06	0.08	0.08	0.11
	2:50:00	0.01	0.04	0.02	0.03	0.04	0.05	0.06	0.06	0.09
	2:55:00	0.01	0.02	0.02	0.02	0.03	0.04	0.04	0.04	0.06
	3:00:00	0.01	0.02	0.01	0.02	0.02	0.02	0.03	0.03	0.04
	3:05:00	0.00	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.03
	3:10:00	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.02
	3:15:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	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 4.00 (December 2019)

Summary Stage-Area-Volume-Discharge Relationships

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

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

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	1,626	0.037	0	0.000	0.00
	0.25	1,851	0.042	435	0.010	0.01
	0.50	2,077	0.048	926	0.021	0.02
	0.75	2,303	0.053	1,473	0.034	0.02
	1.00	2,528	0.058	2,077	0.048	0.04
	1.25	2,779	0.064	2,740	0.063	0.05
	1.50	3,030	0.070	3,466	0.080	0.05
	1.75	3,281	0.075	4,255	0.098	0.06
	2.00	3,531	0.081	5,107	0.117	0.08
	2.25	3,807	0.087	6,024	0.138	0.09
	2.50	4,083	0.094	7,010	0.161	0.10
	2.75	4,359	0.100	8,066	0.185	0.61
	3.00	4,635	0.106	9,190	0.211	1.61
	3.25	4,936	0.113	10,387	0.238	1.65
	3.50	5,237	0.120	11,658	0.268	1.69
	3.75	5,538	0.127	13,005	0.299	6.33
	4.00	5,840	0.134	14,427	0.331	15.65
	4.25	6,163	0.141	15,928	0.366	28.87
	4.50	6,486	0.149	17,509	0.402	45.92
	4.75	6,809	0.156	19,171	0.440	66.84

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

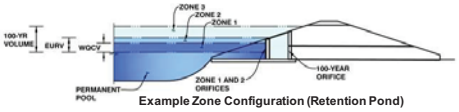
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.00 (December 2019)

Project: **Redtail Ridge**

Basin ID: **Pond B**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	69.30	acres
Watershed Length =	2,936	ft
Watershed Length to Centroid =	1,715	ft
Watershed Slope =	0.018	ft/ft
Watershed Imperviousness =	75.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Louisville - City Hall	

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

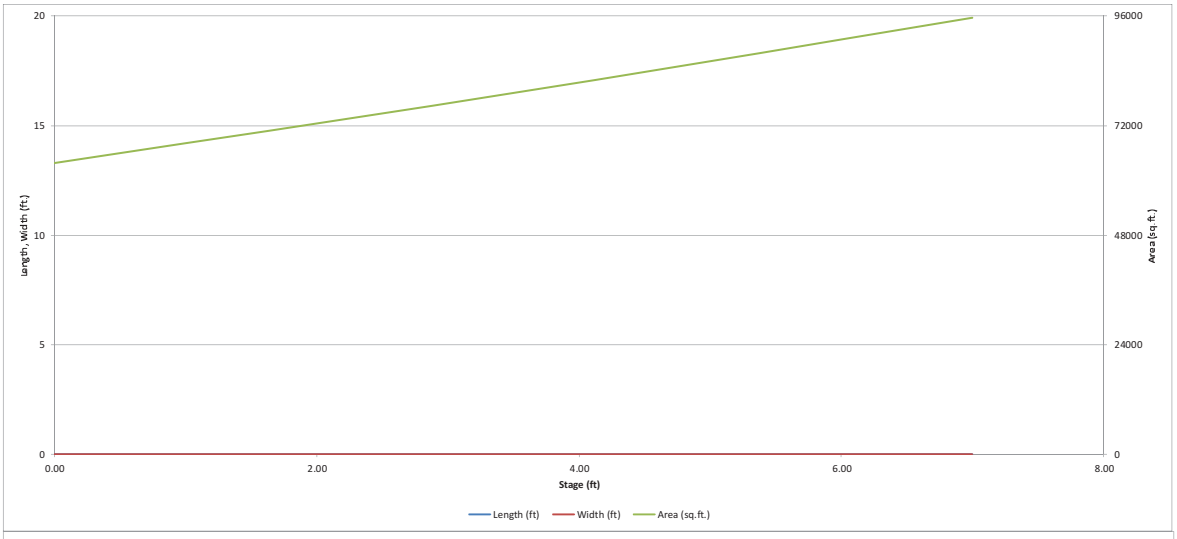
			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.730	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	5.079	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.8 in.) =	3.262	acre-feet		inches
5-yr Runoff Volume (P1 = 1.09 in.) =	4.759	acre-feet		inches
10-yr Runoff Volume (P1 = 1.35 in.) =	6.255	acre-feet		inches
25-yr Runoff Volume (P1 = 1.78 in.) =	8.977	acre-feet		inches
50-yr Runoff Volume (P1 = 2.14 in.) =	11.193	acre-feet		inches
100-yr Runoff Volume (P1 = 2.54 in.) =	13.764	acre-feet		inches
500-yr Runoff Volume (P1 = 3.63 in.) =	20.557	acre-feet		inches
Approximate 2-yr Detention Volume =	3.092	acre-feet		
Approximate 5-yr Detention Volume =	4.588	acre-feet		
Approximate 10-yr Detention Volume =	5.595	acre-feet		
Approximate 25-yr Detention Volume =	6.852	acre-feet		
Approximate 50-yr Detention Volume =	7.509	acre-feet		
Approximate 100-yr Detention Volume =	8.499	acre-feet		

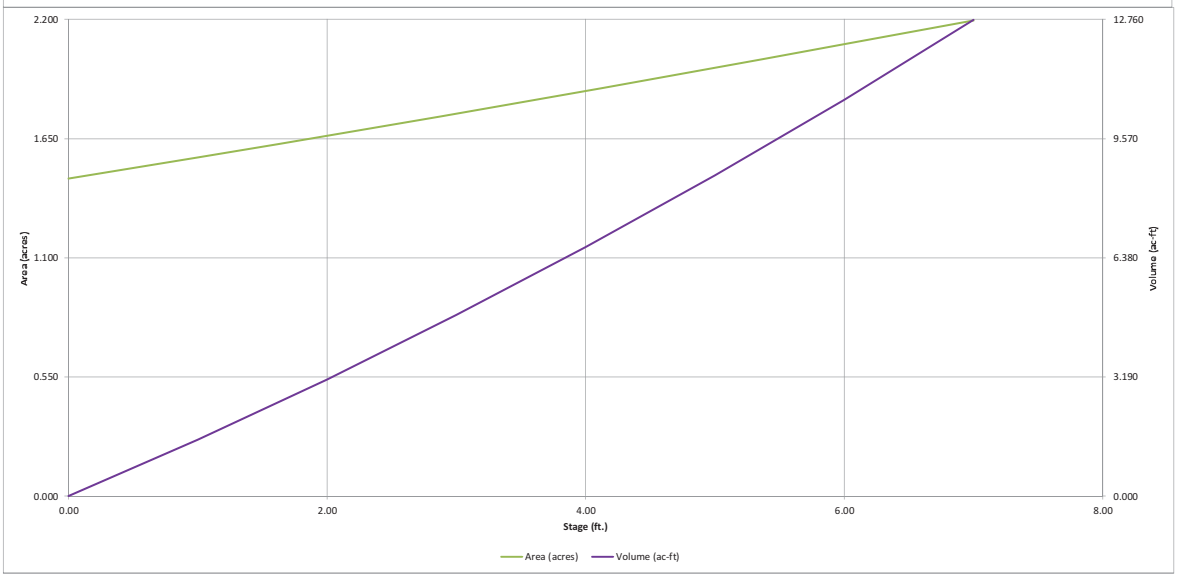
Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	1.730	acre-feet
Zone 2 Volume (EURV - Zone 1) =	3.349	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	3.420	acre-feet
Total Detention Basin Volume =	8.499	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
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^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	63,865	1.466		
5390.61	--	1.00	--	--	--	68,110	1.564	65,988	1.515
5391.61	--	2.00	--	--	--	72,455	1.663	136,270	3.128
5392.61	--	3.00	--	--	--	76,901	1.765	210,949	4.843
5393.61	--	4.00	--	--	--	81,448	1.870	290,123	6.660
5394.61	--	5.00	--	--	--	86,095	1.976	373,894	8.583
5365.61	--	6.00	--	--	--	90,842	2.085	462,363	10.614
5396.61	--	7.00	--	--	--	95,690	2.197	555,629	12.755


20
15
10
5
0
96000
72000
48000
24000
0
0.00
2.00
4.00
6.00
8.00
Stage (ft)
Length, Width (ft.)
Area (sq. ft.)
Length (ft)
Width (ft)
Area (sq.ft.)

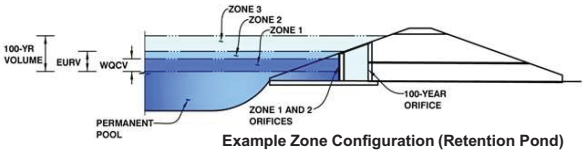

2.200
1.650
1.100
0.550
0.000
12.760
9.570
6.380
3.190
0.000
0.00
2.00
4.00
6.00
8.00
Stage (ft.)
Area (acres)
Volume (ac-ft)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

Project: **Redtail Ridge**

Basin ID: **Pond B**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.14	1.730	Orifice Plate
Zone 2 (EURV)	3.14	3.349	Orifice Plate
Zone 3 (100-year)	4.96	3.420	Weir&Pipe (Restrict)
Total (all zones)		8.499	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.14	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	12.70	inches
Orifice Plate: Orifice Area per Row =	25.50	sq. inches (use rectangular openings)

Calculated Parameters for Plate

WQ Orifice Area per Row =	1.771E-01	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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	1.05	2.09					
Orifice Area (sq. inches)	25.50	25.50	25.50					

	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)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.14	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	8.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	8.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.14	N/A	feet
Overflow Weir Slope Length =	8.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	6.94	N/A	
Overflow Grate Open Area w/o Debris =	44.80	N/A	ft^2
Overflow Grate Open Area w/ Debris =	22.40	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	42.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	26.70		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	6.45	N/A	ft^2
Outlet Orifice Centroid =	1.26	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.85	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	4.82	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	100.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.78	feet
Stage at Top of Freeboard =	6.60	feet
Basin Area at Top of Freeboard =	2.15	acres
Basin Volume at Top of Freeboard =	11.89	acre-ft

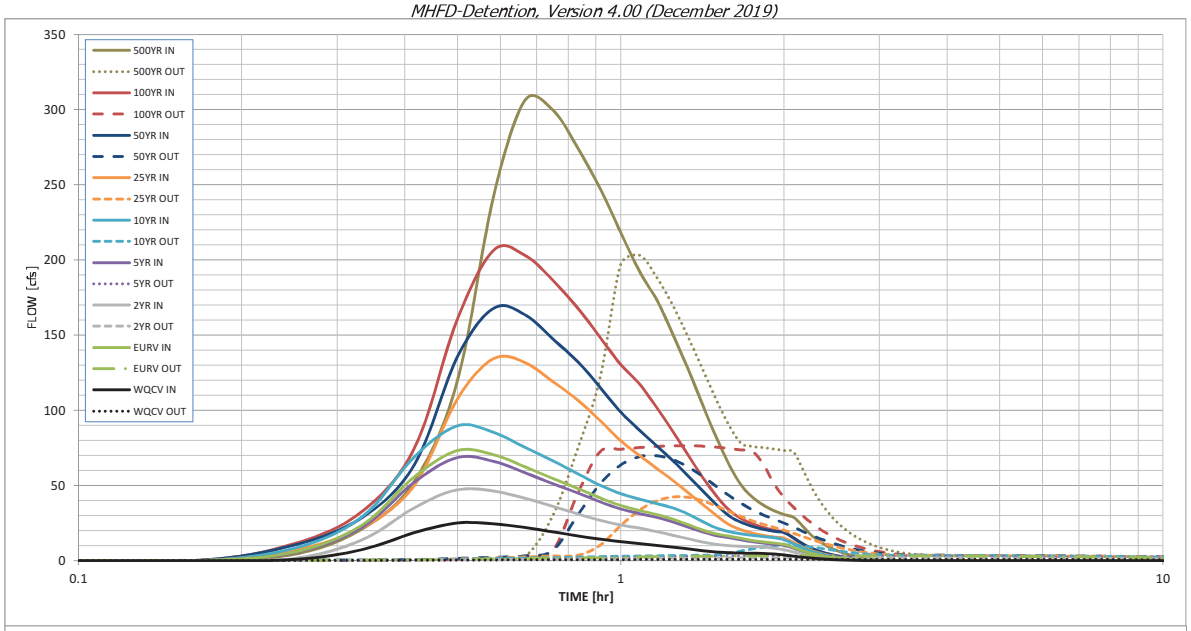
Routed Hydrograph Results

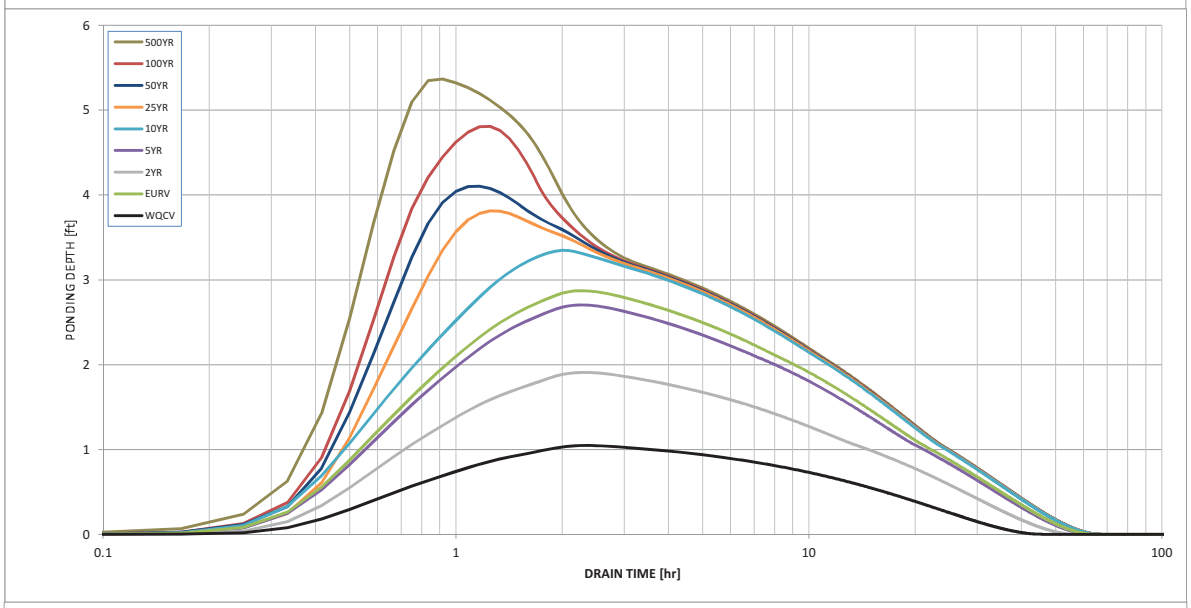
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

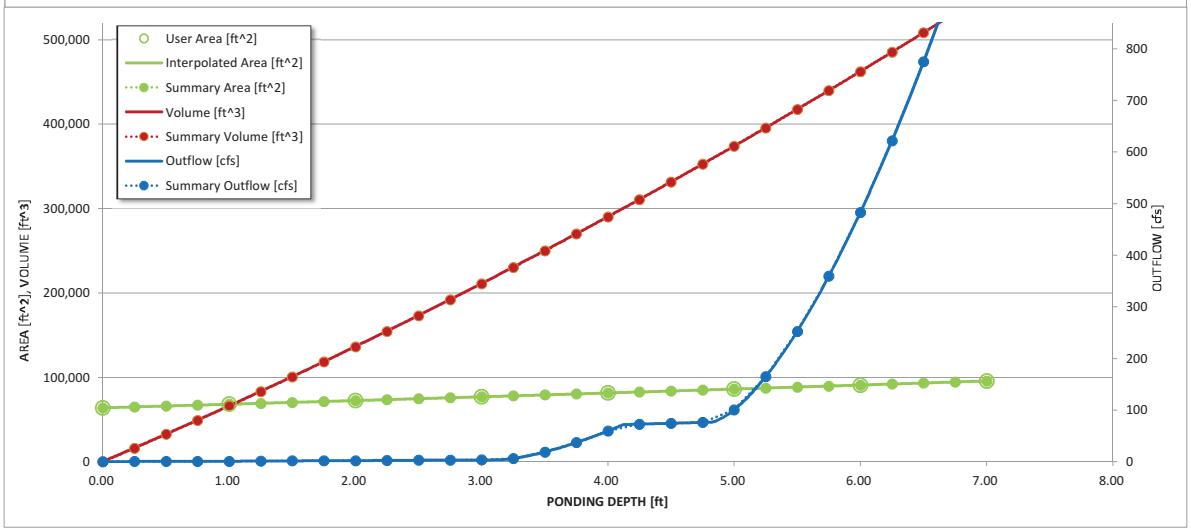
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	0.80	1.09	1.35	1.78	2.14	2.54	3.63
CUHP Runoff Volume (acre-ft) =	1.730	5.079	3.262	4.759	6.255	8.977	11.193	13.764	20.557
Inflow Hydrograph Volume (acre-ft) =	1.730	5.079	3.262	4.759	6.255	8.977	11.193	13.764	20.557
CUHP Predevelopment Peak Q (cfs) =	0.0	0.0	0.5	4.7	14.8	41.1	58.3	80.6	134.1
OPTIONAL Override Predevelopment Peak Q (cfs) =	0.0	0.0							
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.07	0.21	0.59	0.84	1.16	1.93
Peak Inflow Q (cfs) =	25.1	73.3	47.3	68.6	89.7	134.5	167.9	206.6	306.4
Peak Outflow Q (cfs) =	0.9	3.3	2.0	3.2	10.4	42.4	69.8	76.4	203.2
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.7	0.7	1.0	1.2	0.9	1.5
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.8	1.4	1.6	1.7
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	51	47	51	52	49	47	45	40
Time to Drain 99% of Inflow Volume (hours) =	**42**	57	51	56	58	57	56	55	52
Maximum Ponding Depth (ft) =	1.05	2.87	1.91	2.71	3.35	3.81	4.10	4.81	5.37
Area at Maximum Ponding Depth (acres) =	1.57	1.75	1.65	1.73	1.80	1.85	1.88	1.96	2.02
Maximum Volume Stored (acre-ft) =	1.577	4.614	2.963	4.318	5.449	6.307	6.848	8.190	9.302

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	0.26	0.15	4.29
	0:15:00	0.78	5.72	1.47	5.36	8.27	7.04	10.44	11.26	21.02
	0:20:00	7.33	23.66	13.82	22.17	29.07	21.94	28.63	32.73	53.00
	0:25:00	18.71	55.88	35.27	52.36	69.14	50.24	63.98	75.00	119.58
	0:30:00	25.06	73.26	47.25	68.64	89.71	107.64	135.64	160.69	242.94
	0:35:00	24.47	70.46	46.15	66.02	85.31	134.47	167.93	206.57	306.41
	0:40:00	22.03	62.38	41.53	58.45	75.32	131.64	163.46	203.03	299.66
	0:45:00	19.17	54.66	36.14	51.22	66.37	119.00	147.48	186.35	274.59
	0:50:00	16.47	48.06	31.06	45.03	57.81	106.88	132.35	167.99	247.41
	0:55:00	14.24	41.74	26.84	39.11	50.16	93.11	115.33	148.38	218.45
	1:00:00	12.59	36.72	23.73	34.41	44.58	79.74	98.83	130.57	192.35
	1:05:00	11.49	33.39	21.66	31.29	40.93	69.96	86.81	117.48	173.27
	1:10:00	10.22	30.73	19.26	28.79	37.95	61.22	76.11	101.53	150.04
	1:15:00	8.92	27.54	16.81	25.80	35.03	53.25	66.32	85.68	126.93
	1:20:00	7.73	23.82	14.58	22.32	30.98	45.07	56.07	69.88	103.63
	1:25:00	6.61	20.40	12.47	19.12	26.01	37.42	46.48	55.44	82.19
	1:30:00	5.75	17.80	10.85	16.67	21.80	30.14	37.38	43.29	64.26
	1:35:00	5.29	16.39	9.97	15.35	19.38	24.10	29.90	33.78	50.46
	1:40:00	5.06	14.87	9.55	13.93	17.89	20.59	25.56	28.12	42.19
	1:45:00	4.94	13.46	9.31	12.61	16.83	18.33	22.76	24.56	36.94
	1:50:00	4.86	12.45	9.16	11.67	16.07	16.83	20.89	22.07	33.27
	1:55:00	4.40	11.69	8.29	10.95	15.28	15.77	19.56	20.32	30.69
	2:00:00	3.87	10.89	7.30	10.20	14.04	15.07	18.68	19.06	28.82
	2:05:00	3.08	8.74	5.81	8.19	11.20	12.20	15.11	15.19	22.97
	2:10:00	2.31	6.50	4.35	6.09	8.31	9.01	11.15	11.08	16.76
	2:15:00	1.73	4.85	3.27	4.54	6.16	6.69	8.27	8.24	12.45
	2:20:00	1.29	3.59	2.42	3.36	4.53	4.95	6.11	6.12	9.24
	2:25:00	0.94	2.61	1.78	2.44	3.30	3.62	4.47	4.52	6.82
	2:30:00	0.68	1.85	1.28	1.73	2.38	2.59	3.20	3.26	4.92
	2:35:00	0.48	1.30	0.90	1.21	1.71	1.87	2.31	2.35	3.54
	2:40:00	0.32	0.90	0.61	0.84	1.19	1.33	1.64	1.67	2.51
	2:45:00	0.20	0.59	0.38	0.55	0.77	0.88	1.09	1.10	1.66
	2:50:00	0.11	0.35	0.20	0.33	0.44	0.52	0.65	0.66	0.98
	2:55:00	0.05	0.17	0.09	0.16	0.20	0.26	0.32	0.32	0.48
	3:00:00	0.02	0.05	0.03	0.05	0.06	0.08	0.10	0.10	0.15
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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
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	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
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	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 4.00 (December 2019)

Summary Stage-Area-Volume-Discharge Relationships

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

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

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	63,865	1.466	0	0.000	0.00
	0.25	64,926	1.491	16,099	0.370	0.43
	0.50	65,988	1.515	32,463	0.745	0.60
	0.75	67,049	1.539	49,093	1.127	0.74
	1.00	68,110	1.564	65,988	1.515	0.85
	1.25	69,196	1.589	83,151	1.909	1.33
	1.50	70,283	1.613	100,586	2.309	1.62
	1.75	71,369	1.638	118,292	2.716	1.84
	2.00	72,455	1.663	136,270	3.128	2.04
	2.25	73,567	1.689	154,523	3.547	2.55
	2.50	74,678	1.714	173,054	3.973	2.92
	2.75	75,790	1.740	191,862	4.405	3.22
	3.00	76,901	1.765	210,949	4.843	3.48
	3.25	78,038	1.792	230,316	5.287	6.24
	3.50	79,175	1.818	249,968	5.738	18.85
	3.75	80,311	1.844	269,903	6.196	37.02
	4.00	81,448	1.870	290,123	6.660	59.38
	4.25	82,609	1.896	310,630	7.131	72.82
	4.50	83,771	1.923	331,428	7.609	74.46
	4.75	84,933	1.950	352,516	8.093	76.06
	5.00	86,095	1.976	373,894	8.583	100.67
	5.25	87,282	2.004	395,566	9.081	164.93
	5.50	88,468	2.031	417,535	9.585	252.56
	5.75	89,655	2.058	439,801	10.096	359.23
	6.00	90,842	2.085	462,363	10.614	482.68
	6.25	92,054	2.113	485,225	11.139	621.53
	6.50	93,266	2.141	508,390	11.671	774.83
	6.75	94,478	2.169	531,858	12.210	941.89
	7.00	95,690	2.197	555,629	12.755	1,122.18

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

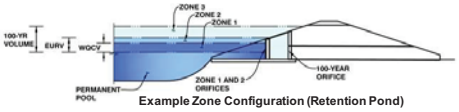
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.00 (December 2019)

Project: **Redtail Ridge**

Basin ID: **Pond C-1**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**RP**	
Watershed Area =	73.80	acres
Watershed Length =	4,748	ft
Watershed Length to Centroid =	2,564	ft
Watershed Slope =	0.019	ft/ft
Watershed Imperviousness =	79.47%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	12.0	hours
Location for 1-hr Rainfall Depths =	Louisville - City Hall	

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

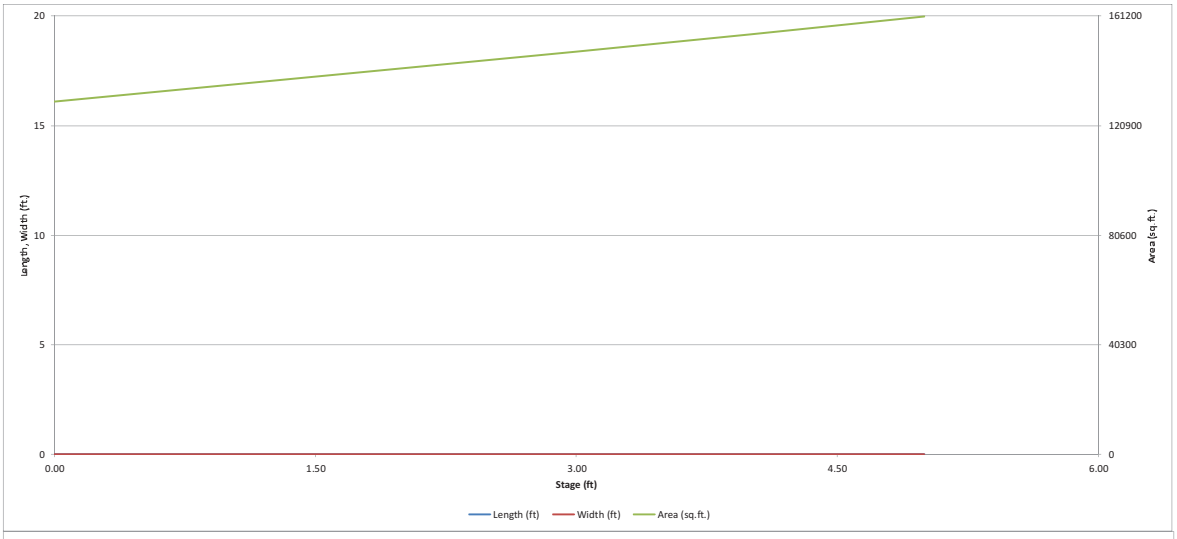
			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	1.773	acre-feet	1.773	acre-feet
Excess Urban Runoff Volume (EURV) =	5.758	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.8 in.) =	3.717	acre-feet		inches
5-yr Runoff Volume (P1 = 1.09 in.) =	5.381	acre-feet		inches
10-yr Runoff Volume (P1 = 1.35 in.) =	7.011	acre-feet		inches
25-yr Runoff Volume (P1 = 1.78 in.) =	9.915	acre-feet		inches
50-yr Runoff Volume (P1 = 2.14 in.) =	12.298	acre-feet		inches
100-yr Runoff Volume (P1 = 2.54 in.) =	15.036	acre-feet		inches
500-yr Runoff Volume (P1 = 3.63 in.) =	22.313	acre-feet		inches
Approximate 2-yr Detention Volume =	3.516	acre-feet		
Approximate 5-yr Detention Volume =	5.163	acre-feet		
Approximate 10-yr Detention Volume =	6.312	acre-feet		
Approximate 25-yr Detention Volume =	7.718	acre-feet		
Approximate 50-yr Detention Volume =	8.447	acre-feet		
Approximate 100-yr Detention Volume =	9.471	acre-feet		

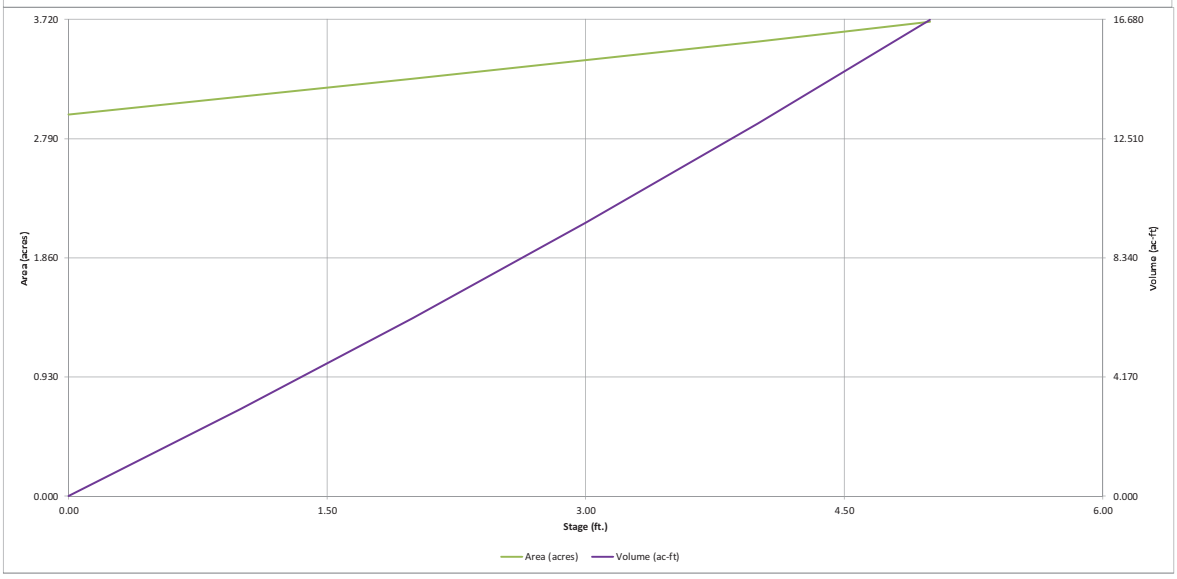
Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	1.773	acre-feet
Zone 2 Volume (EURV - Zone 1) =	3.985	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	3.713	acre-feet
Total Detention Basin Volume =	9.471	acre-feet
Initial Surcharge Volume (ISV) =	N/A	ft^3
Initial Surcharge Depth (ISD) =	N/A	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	N/A	ft
Slope of Trickle Channel (S_{TC}) =	N/A	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Permanent Pool	--	0.00	--	--	--	129,664	2.977		
5370	--	1.00	--	--	--	135,797	3.117	132,731	3.047
5371	--	2.00	--	--	--	141,912	3.258	271,585	6.235
5372	--	3.00	--	--	--	148,134	3.401	416,608	9.564
5373	--	4.00	--	--	--	154,503	3.547	567,927	13.038
5374	--	5.00	--	--	--	161,184	3.700	725,771	16.661


20
15
10
5
0
161200
120900
80600
40300
0
0.00
1.50
3.00
4.50
6.00
Stage (ft)
Length, Width (ft.)
Area (sq. ft.)
Length (ft)
Width (ft)
Area (sq.ft.)

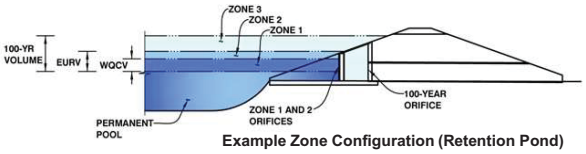

3.720
2.790
1.860
0.930
0.000
16.680
12.510
8.340
4.170
0.000
0.00
1.50
3.00
4.50
6.00
Stage (ft.)
Area (acres)
Volume (ac-ft)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

Project: **Redtail Ridge**

Basin ID: **Pond C-1**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	0.59	1.773	Orifice Plate
Zone 2 (EURV)	1.86	3.985	Orifice Plate
Zone 3 (100-year)	2.98	3.713	Weir&Pipe (Restrict)
Total (all zones)		9.471	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	1.86	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	N/A	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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	1.25						
Orifice Area (sq. inches)	125.00	75.00						

	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)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	1.86	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	8.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	8.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	1.86	N/A	feet
Overflow Weir Slope Length =	8.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	4.61	N/A	
Overflow Grate Open Area w/o Debris =	44.80	N/A	ft^2
Overflow Grate Open Area w/ Debris =	22.40	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	48.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	34.67		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	9.72	N/A	ft^2
Outlet Orifice Centroid =	1.61	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	2.03	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	3.25	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	95.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.75	feet
Stage at Top of Freeboard =	5.00	feet
Basin Area at Top of Freeboard =	3.70	acres
Basin Volume at Top of Freeboard =	16.66	acre-ft

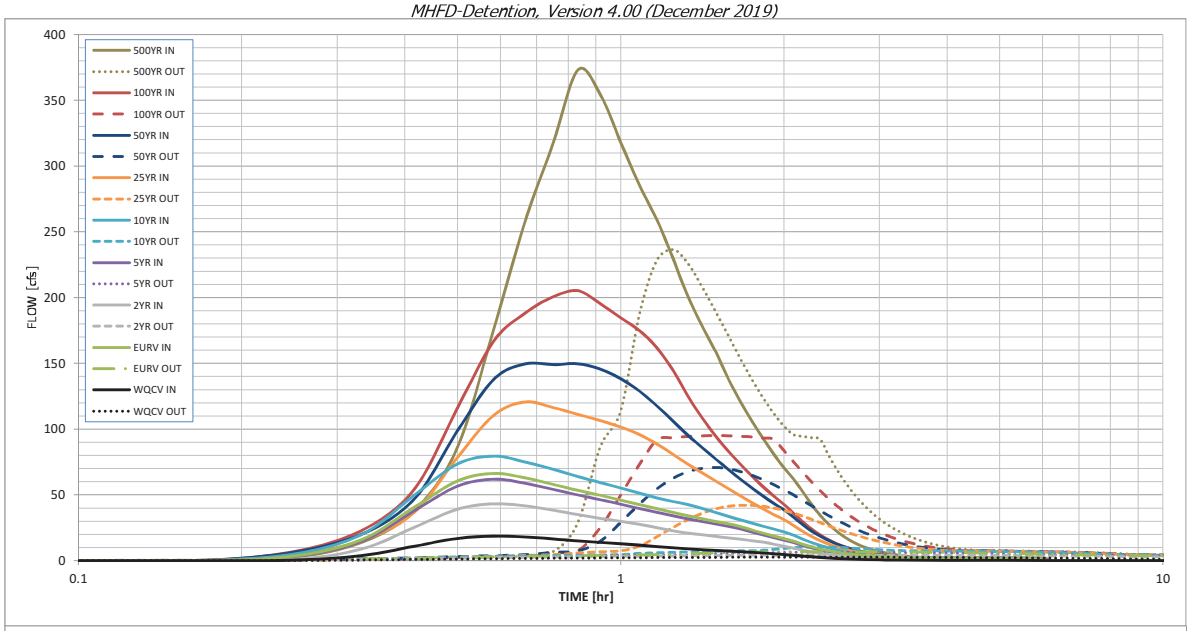
Routed Hydrograph Results

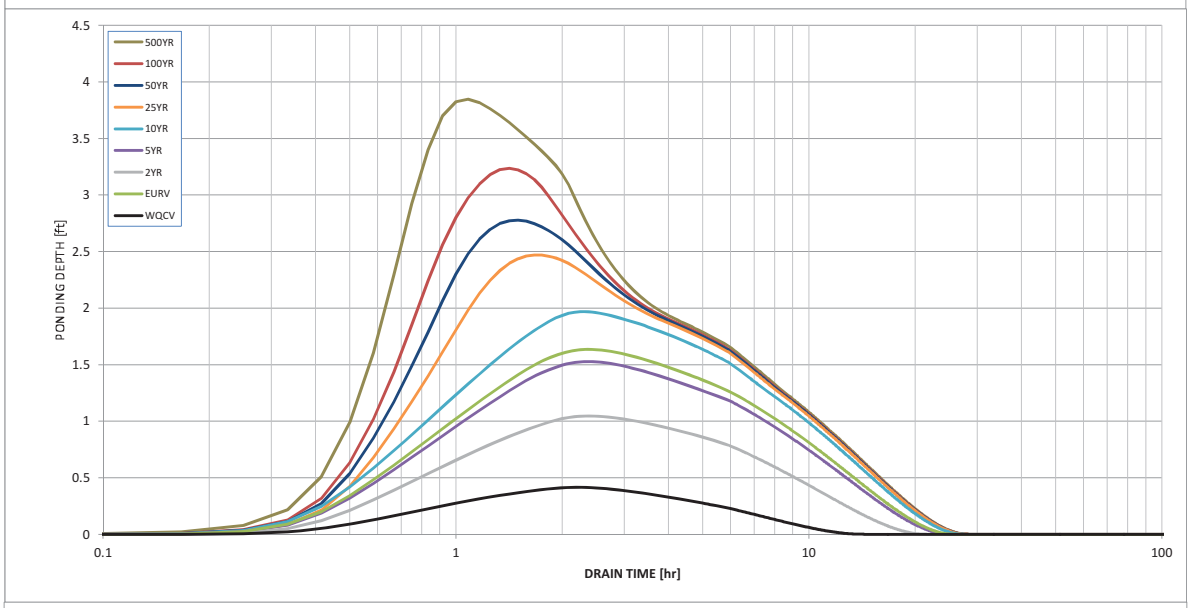
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

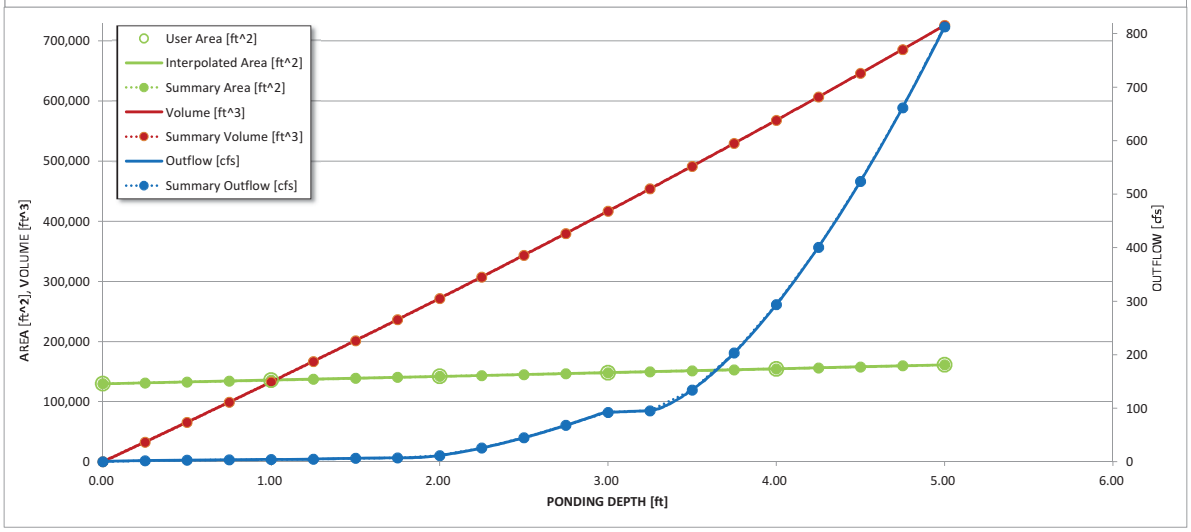
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	N/A	1.07	0.80	1.09	1.35	1.78	2.14	2.54	3.63
CUHP Runoff Volume (acre-ft) =	1.773	5.758	3.717	5.381	7.011	9.915	12.298	15.036	22.313
User Override Inflow Hydrograph Volume (acre-ft) =	1.773	6.556	4.169	6.083	8.010	11.997	15.313	19.149	29.317
CUHP Predevelopment Peak Q (cfs) =	0.0	0.0	0.4	3.5	11.1	31.9	45.6	64.4	107.6
OPTIONAL Override Predevelopment Peak Q (cfs) =	0.0	0.0							
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.05	0.15	0.43	0.62	0.87	1.46
Peak Inflow Q (cfs) =	18.7	66.3	43.2	61.9	79.5	120.7	149.7	205.2	372.9
Peak Outflow Q (cfs) =	2.7	6.9	4.3	6.5	10.5	42.2	70.8	95.1	236.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	1.8	0.9	1.3	1.6	1.5	2.2
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.1	0.7	1.4	1.9	2.0
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) =	12	21	18	21	23	22	21	21	19
Time to Drain 99% of Inflow Volume (hours) =	**13**	23	19	23	25	25	24	24	23
Maximum Ponding Depth (ft) =	0.42	1.63	1.05	1.53	1.97	2.47	2.78	3.24	3.85
Area at Maximum Ponding Depth (acres) =	3.03	3.21	3.12	3.19	3.25	3.32	3.37	3.43	3.52
Maximum Volume Stored (acre-ft) =	1.232	5.039	3.172	4.687	6.105	7.748	8.786	10.350	12.472

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	USER	USER	USER	USER	USER	USER	USER	USER	USER
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
5.00 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.10	2.68
	0:15:00	0.40	3.57	0.93	3.34	5.13	4.37	6.53	7.01	14.06
	0:20:00	3.87	16.10	8.93	15.05	20.03	15.34	20.33	23.12	38.12
	0:25:00	10.99	40.75	25.41	38.09	49.87	36.92	47.05	54.52	86.13
	0:30:00	16.93	60.60	39.14	56.64	73.52	78.48	98.72	116.00	175.91
	0:35:00	18.69	66.28	43.19	61.90	79.52	110.52	137.83	166.94	258.06
	0:40:00	18.00	62.93	41.65	58.79	75.01	120.68	149.55	188.19	316.69
	0:45:00	16.54	58.00	38.43	54.19	69.52	116.41	149.02	200.48	372.87
	0:50:00	15.03	53.49	35.00	49.99	64.03	111.24	149.72	205.19	354.55
	0:55:00	13.81	49.76	32.21	46.35	59.38	106.51	145.63	195.41	318.04
	1:00:00	12.81	46.19	29.92	42.92	55.26	101.56	138.27	184.59	285.37
	1:05:00	11.83	42.62	27.66	39.65	51.29	95.82	128.84	174.86	258.91
	1:10:00	10.72	39.38	25.09	36.67	47.66	88.69	117.69	161.77	229.47
	1:15:00	9.69	36.48	22.70	33.99	44.89	80.72	105.92	144.46	199.91
	1:20:00	8.93	34.03	20.95	31.72	42.54	73.08	94.93	124.51	177.47
	1:25:00	8.36	31.85	19.62	29.69	39.63	66.59	85.65	107.97	158.14
	1:30:00	7.84	29.87	18.43	27.85	36.47	60.36	76.98	94.19	137.30
	1:35:00	7.36	28.02	17.33	26.13	33.54	54.47	68.96	82.77	120.23
	1:40:00	6.89	25.78	16.23	24.03	30.89	48.97	61.63	72.79	105.47
	1:45:00	6.41	23.27	15.14	21.69	28.46	43.96	55.04	63.94	92.49
	1:50:00	5.94	20.81	14.04	19.39	26.17	39.25	48.94	55.95	80.88
	1:55:00	5.37	18.65	12.55	17.38	23.99	34.97	43.48	48.91	70.71
	2:00:00	4.75	16.86	11.04	15.71	21.89	31.24	38.74	42.89	62.07
	2:05:00	4.09	14.78	9.47	13.77	19.27	26.73	33.08	36.13	52.29
	2:10:00	3.44	12.51	7.96	11.64	16.36	22.21	27.40	29.60	42.67
	2:15:00	2.88	10.49	6.65	9.76	13.74	18.30	22.48	24.04	34.42
	2:20:00	2.43	8.89	5.63	8.26	11.59	15.21	18.58	19.61	27.85
	2:25:00	2.05	7.56	4.76	7.02	9.76	12.64	15.35	16.00	22.50
	2:30:00	1.73	6.49	4.04	6.01	8.24	10.57	12.75	13.11	18.23
	2:35:00	1.46	5.57	3.44	5.15	6.94	8.83	10.56	10.74	14.74
	2:40:00	1.24	4.79	2.95	4.42	5.87	7.39	8.77	8.87	11.99
	2:45:00	1.05	4.16	2.57	3.83	5.04	6.25	7.34	7.44	9.91
	2:50:00	0.89	3.67	2.25	3.37	4.43	5.36	6.23	6.34	8.30
	2:55:00	0.76	3.29	1.99	3.01	3.96	4.66	5.36	5.48	7.06
	3:00:00	0.67	2.95	1.76	2.69	3.56	4.07	4.62	4.73	5.98
	3:05:00	0.58	2.66	1.56	2.42	3.21	3.58	4.01	4.09	5.05
	3:10:00	0.51	2.43	1.40	2.20	2.91	3.17	3.49	3.55	4.27
	3:15:00	0.46	2.25	1.26	2.03	2.66	2.84	3.06	3.11	3.62
	3:20:00	0.42	2.10	1.17	1.89	2.47	2.61	2.73	2.76	3.11
	3:25:00	0.39	1.99	1.10	1.78	2.33	2.45	2.50	2.51	2.72
	3:30:00	0.38	1.91	1.06	1.70	2.24	2.35	2.37	2.38	2.46
	3:35:00	0.37	1.87	1.04	1.66	2.20	2.29	2.31	2.32	2.34
	3:40:00	0.37	1.86	1.04	1.65	2.19	2.28	2.30	2.30	2.32
	3:45:00	0.37	1.84	1.03	1.63	2.17	2.27	2.28	2.29	2.31
	3:50:00	0.37	1.82	1.02	1.61	2.16	2.25	2.27	2.28	2.30
	3:55:00	0.37	1.81	1.02	1.59	2.15	2.24	2.26	2.26	2.28
	4:00:00	0.37	1.79	1.01	1.57	2.13	2.23	2.24	2.25	2.27
	4:05:00	0.37	1.78	1.01	1.55	2.12	2.21	2.23	2.23	2.26
	4:10:00	0.37	1.76	1.00	1.53	2.10	2.20	2.22	2.22	2.24
	4:15:00	0.36	1.74	1.00	1.51	2.09	2.18	2.20	2.21	2.23
	4:20:00	0.36	1.73	0.99	1.48	2.07	2.17	2.19	2.19	2.22
	4:25:00	0.36	1.71	0.98	1.46	2.06	2.16	2.17	2.18	2.20
	4:30:00	0.36	1.69	0.98	1.43	2.05	2.14	2.16	2.16	2.19
	4:35:00	0.36	1.67	0.97	1.40	2.03	2.13	2.15	2.15	2.17
	4:40:00	0.36	1.66	0.97	1.37	2.02	2.11	2.13	2.14	2.16
	4:45:00	0.36	1.64	0.96	1.32	2.00	2.10	2.12	2.12	2.15
	4:50:00	0.36	1.62	0.96	1.26	1.99	2.08	2.10	2.11	2.13
	4:55:00	0.36	1.60	0.95	1.26	1.97	2.07	2.09	2.09	2.12
	5:00:00	0.36	1.58	0.94	1.25	1.96	2.06	2.07	2.08	2.10
	5:05:00	0.36	1.56	0.94	1.25	1.94	2.04	2.06	2.07	2.09
	5:10:00	0.36	1.54	0.93	1.24	1.93	2.03	2.05	2.05	2.07
	5:15:00	0.36	1.52	0.93	1.24	1.91	2.01	2.03	2.04	2.06
	5:20:00	0.36	1.50	0.92	1.23	1.90	2.00	2.02	2.02	2.04
	5:25:00	0.35	1.47	0.91	1.22	1.88	1.98	2.00	2.01	2.03
	5:30:00	0.35	1.45	0.91	1.22	1.87	1.97	1.99	1.99	2.02
	5:35:00	0.35	1.42	0.90	1.21	1.85	1.95	1.97	1.98	2.00
	5:40:00	0.35	1.39	0.90	1.21	1.83	1.94	1.96	1.96	1.99
	5:45:00	0.35	1.35	0.89	1.20	1.82	1.92	1.94	1.95	1.97
	5:50:00	0.35	1.28	0.88	1.20	1.80	1.91	1.93	1.93	1.96
	5:55:00	0.35	1.26	0.88	1.19	1.79	1.89	1.91	1.92	1.94
	6:00:00	0.35	1.25	0.87	1.19	1.77	1.88	1.90	1.90	1.93

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

Summary Stage-Area-Volume-Discharge Relationships

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

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

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	129,664	2.977	0	0.000	0.00
	0.25	131,198	3.012	32,608	0.749	2.09
	0.50	132,731	3.047	65,599	1.506	2.96
	0.75	134,264	3.082	98,973	2.272	3.62
	1.00	135,797	3.117	132,731	3.047	4.18
	1.25	137,326	3.153	166,871	3.831	4.67
	1.50	138,855	3.188	201,394	4.623	6.37
	1.75	140,383	3.223	236,299	5.425	7.30
	2.00	141,912	3.258	271,585	6.235	11.70
	2.25	143,467	3.294	307,258	7.054	25.58
	2.50	145,023	3.329	343,319	7.882	44.74
	2.75	146,579	3.365	379,769	8.718	67.93
	3.00	148,134	3.401	416,608	9.564	92.35
	3.25	149,727	3.437	453,841	10.419	95.27
	3.50	151,319	3.474	491,472	11.283	134.02
	3.75	152,911	3.510	529,501	12.156	203.31
	4.00	154,503	3.547	567,927	13.038	293.32
	4.25	156,173	3.585	606,762	13.929	400.74
	4.50	157,844	3.624	646,014	14.830	523.76
	4.75	159,514	3.662	685,684	15.741	661.21
	5.00	161,184	3.700	725,771	16.661	812.29

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

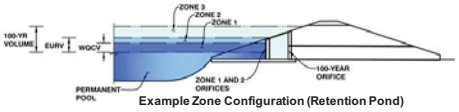
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.00 (December 2019)

Project: **Redtail Ridge**

Basin ID: **Pond C-2**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	79.84	acres
Watershed Length =	4,482	ft
Watershed Length to Centroid =	2,441	ft
Watershed Slope =	0.023	ft/ft
Watershed Imperviousness =	77.20%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Louisville - City Hall	

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

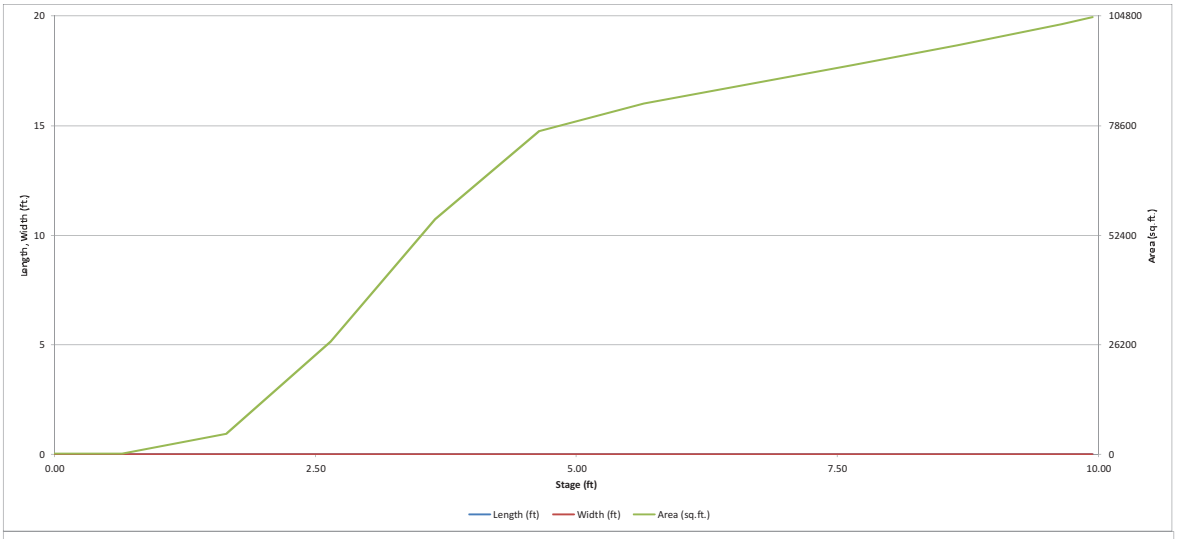
			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	2.073	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	6.037	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.8 in.) =	3.905	acre-feet		inches
5-yr Runoff Volume (P1 = 1.09 in.) =	5.675	acre-feet		inches
10-yr Runoff Volume (P1 = 1.35 in.) =	7.426	acre-feet		inches
25-yr Runoff Volume (P1 = 1.78 in.) =	10.579	acre-feet		inches
50-yr Runoff Volume (P1 = 2.14 in.) =	13.156	acre-feet		inches
100-yr Runoff Volume (P1 = 2.54 in.) =	16.131	acre-feet		inches
500-yr Runoff Volume (P1 = 3.63 in.) =	24.013	acre-feet		inches
Approximate 2-yr Detention Volume =	3.681	acre-feet		
Approximate 5-yr Detention Volume =	5.433	acre-feet		
Approximate 10-yr Detention Volume =	6.634	acre-feet		
Approximate 25-yr Detention Volume =	8.118	acre-feet		
Approximate 50-yr Detention Volume =	8.890	acre-feet		
Approximate 100-yr Detention Volume =	10.015	acre-feet		

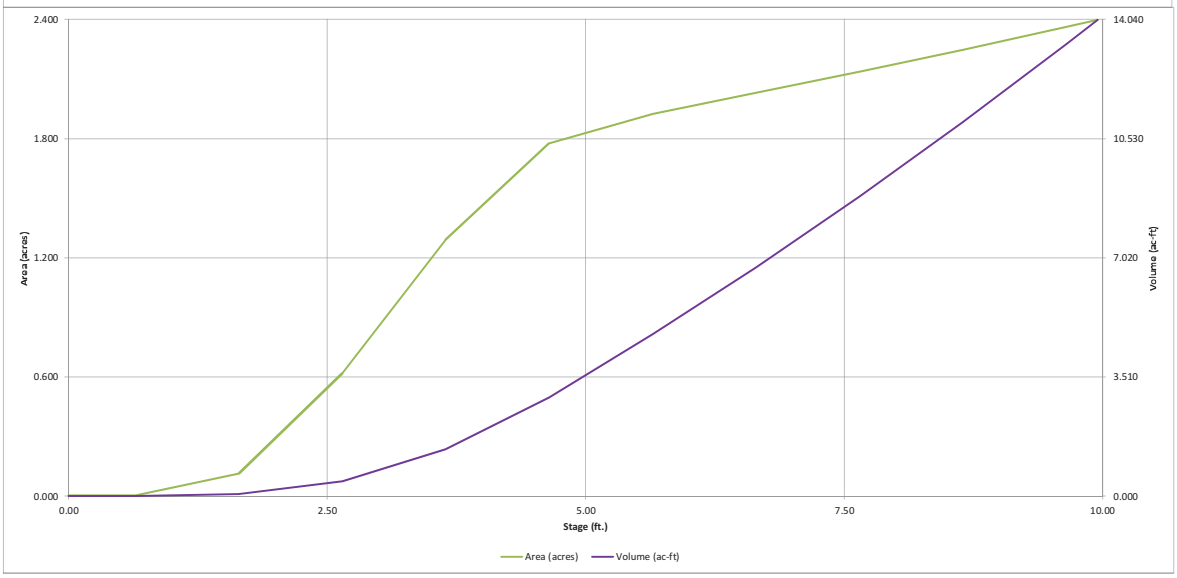
Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	2.073	acre-feet
Zone 2 Volume (EURV - Zone 1) =	3.964	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	3.978	acre-feet
Total Detention Basin Volume =	10.015	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
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^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	148	0.003		
5364	--	0.65	--	--	--	150	0.003	97	0.002
5365	--	1.65	--	--	--	4,914	0.113	2,629	0.060
5366	--	2.65	--	--	--	26,969	0.619	18,570	0.426
5367	--	3.65	--	--	--	56,153	1.289	60,131	1.380
5368	--	4.65	--	--	--	77,350	1.776	126,883	2.913
5369	--	5.65	--	--	--	83,873	1.925	207,494	4.763
5370	--	6.65	--	--	--	88,416	2.030	293,639	6.741
5371	--	7.65	--	--	--	93,068	2.137	384,381	8.824
5372	--	8.65	--	--	--	97,875	2.247	479,853	11.016
5373	--	9.65	--	--	--	102,886	2.362	580,234	13.320
5373.3	--	9.95	--	--	--	104,516	2.399	611,344	14.035


20
15
10
5
0
104800
78600
52400
26200
0
0.00
2.50
5.00
7.50
10.00
Stage (ft)
Length, Width (ft.)
Area (sq. ft.)
Length (ft)
Width (ft)
Area (sq.ft.)

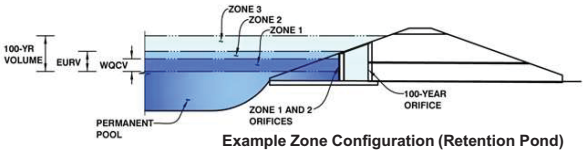

2.400
1.800
1.200
0.600
0.000
14.040
10.530
7.020
3.510
0.000
0.00
2.50
5.00
7.50
10.00
Stage (ft.)
Area (acres)
Volume (ac-ft)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

Project: **Redtail Ridge**

Basin ID: **Pond C-2**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	4.15	2.073	Orifice Plate
Zone 2 (EURV)	6.31	3.964	Orifice Plate
Zone 3 (100-year)	8.20	3.978	Weir&Pipe (Restrict)
Total (all zones)		10.015	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	6.31	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	25.16	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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	2.10	4.20					
Orifice Area (sq. inches)	7.00	7.00	30.00					

	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)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	6.31	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	8.00	N/A	feet
Overflow Weir Grate Slope =	0.00	N/A	H:V
Horiz. Length of Weir Sides =	8.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	6.31	N/A	feet
Overflow Weir Slope Length =	8.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	8.78	N/A	
Overflow Grate Open Area w/o Debris =	44.80	N/A	ft^2
Overflow Grate Open Area w/ Debris =	22.40	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	1.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	42.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	22.00		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	5.10	N/A	ft^2
Outlet Orifice Centroid =	1.05	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.62	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	8.20	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	105.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.75	feet
Stage at Top of Freeboard =	9.95	feet
Basin Area at Top of Freeboard =	2.40	acres
Basin Volume at Top of Freeboard =	14.03	acre-ft

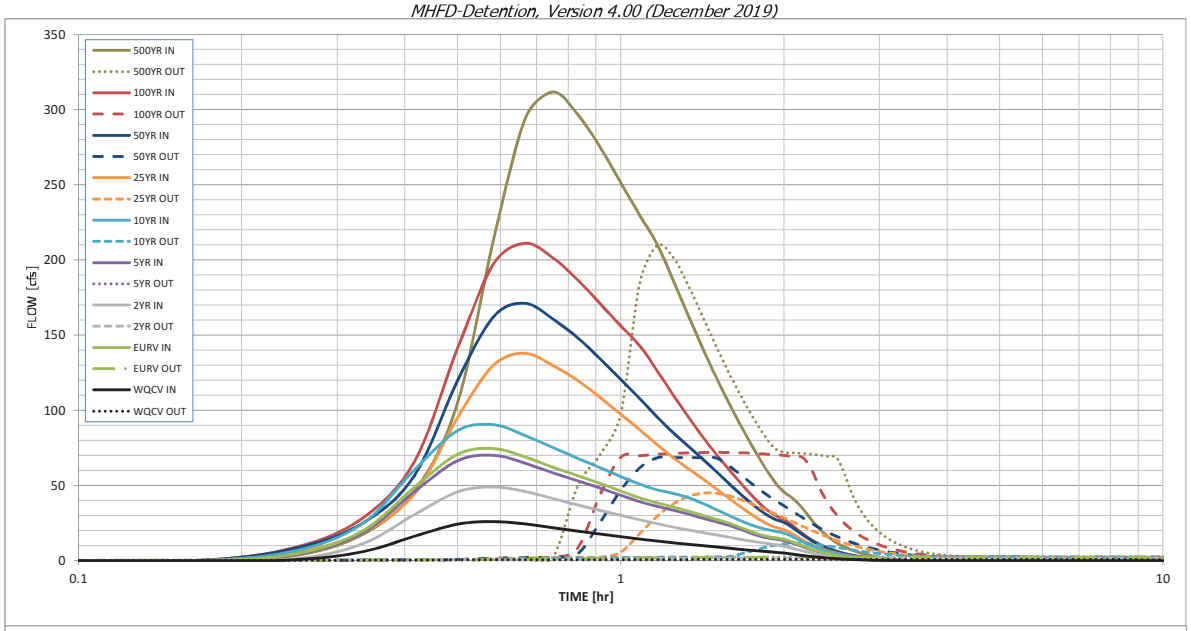
Routed Hydrograph Results

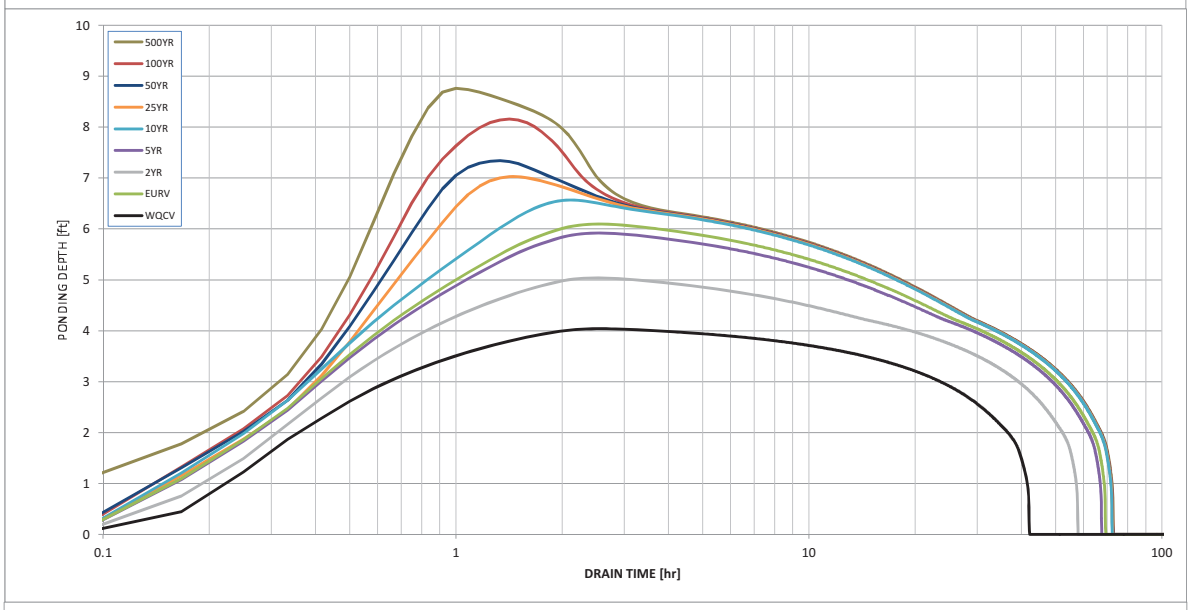
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

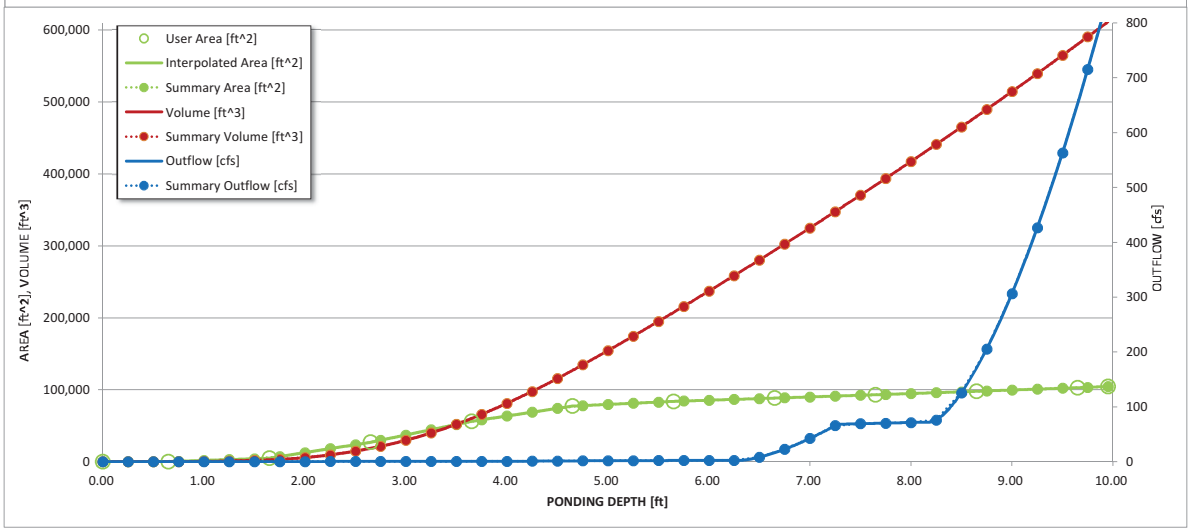
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	0.80	1.09	1.35	1.78	2.14	2.54	3.63
CUHP Runoff Volume (acre-ft) =	2.073	6.037	3.905	5.675	7.426	10.579	13.156	16.131	24.013
Inflow Hydrograph Volume (acre-ft) =	2.073	6.037	3.905	5.675	7.426	10.579	13.156	16.131	24.013
CUHP Predevelopment Peak Q (cfs) =	0.0	0.0	0.5	4.3	13.6	38.7	55.0	77.1	128.5
OPTIONAL Override Predevelopment Peak Q (cfs) =	0.0	0.0							
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.05	0.17	0.48	0.69	0.97	1.61
Peak Inflow Q (cfs) =	26.0	74.6	49.0	70.1	90.4	137.9	171.1	211.1	311.7
Peak Outflow Q (cfs) =	0.8	2.4	1.8	2.3	11.7	44.9	68.6	72.1	209.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.5	0.9	1.2	1.2	0.9	1.6
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.2	0.9	1.5	1.5	1.6
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) =	39	62	53	61	64	62	60	58	54
Time to Drain 99% of Inflow Volume (hours) =	**41**	67	56	65	69	68	67	66	64
Maximum Ponding Depth (ft) =	4.04	6.10	5.04	5.92	6.57	7.03	7.34	8.16	8.76
Area at Maximum Ponding Depth (acres) =	1.47	1.97	1.83	1.95	2.02	2.07	2.10	2.19	2.26
Maximum Volume Stored (acre-ft) =	1.905	5.621	3.598	5.268	6.559	7.499	8.167	9.906	11.264

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	0.20	0.12	3.32
	0:15:00	0.60	4.41	1.13	4.15	6.39	5.44	8.13	8.74	17.26
	0:20:00	5.86	19.58	11.03	18.41	24.43	18.63	24.62	28.03	46.13
	0:25:00	16.27	48.89	30.66	45.96	60.45	44.42	56.68	65.97	104.70
	0:30:00	24.29	70.71	45.76	66.47	86.50	95.08	119.63	141.07	214.00
	0:35:00	26.01	74.59	48.99	70.11	90.41	130.10	162.38	197.58	293.88
	0:40:00	24.42	68.97	46.00	64.83	83.19	137.87	171.15	211.11	311.74
	0:45:00	21.94	62.15	41.33	58.43	75.24	129.79	160.73	201.37	296.71
	0:50:00	19.64	56.52	36.99	53.13	68.08	119.83	148.23	186.77	274.92
	0:55:00	17.72	51.36	33.38	48.28	61.76	108.50	134.20	170.88	251.53
	1:00:00	16.02	46.32	30.18	43.54	55.97	97.40	120.52	156.21	229.95
	1:05:00	14.49	41.78	27.29	39.28	50.89	87.28	108.05	143.14	210.65
	1:10:00	13.04	38.44	24.57	36.13	47.17	77.21	95.67	126.52	186.51
	1:15:00	11.82	35.73	22.27	33.59	44.77	68.56	85.12	110.19	162.92
	1:20:00	10.82	32.93	20.38	30.95	41.97	61.16	75.96	95.48	141.36
	1:25:00	9.94	30.12	18.73	28.32	38.09	54.46	67.56	82.38	121.95
	1:30:00	9.12	27.50	17.18	25.85	33.95	47.85	59.28	70.87	104.83
	1:35:00	8.31	25.00	15.66	23.50	30.07	41.51	51.36	60.68	89.72
	1:40:00	7.51	22.03	14.16	20.71	26.53	35.63	44.04	51.34	75.94
	1:45:00	6.79	19.03	12.78	17.89	23.50	30.34	37.48	42.94	63.57
	1:50:00	6.28	16.74	11.83	15.73	21.29	25.82	31.89	35.83	53.17
	1:55:00	5.71	15.35	10.76	14.43	19.82	22.55	27.88	30.67	45.73
	2:00:00	5.11	14.27	9.62	13.42	18.34	20.59	25.48	27.49	41.10
	2:05:00	4.30	12.23	8.09	11.50	15.65	17.49	21.65	23.04	34.51
	2:10:00	3.45	9.79	6.50	9.20	12.55	13.85	17.14	18.00	26.98
	2:15:00	2.73	7.69	5.14	7.23	9.89	10.76	13.31	13.75	20.63
	2:20:00	2.16	6.07	4.06	5.70	7.79	8.41	10.40	10.53	15.81
	2:25:00	1.69	4.77	3.19	4.48	6.09	6.53	8.07	8.04	12.08
	2:30:00	1.32	3.70	2.49	3.48	4.70	5.05	6.23	6.16	9.25
	2:35:00	1.03	2.83	1.94	2.66	3.58	3.85	4.75	4.72	7.08
	2:40:00	0.79	2.14	1.49	2.01	2.72	2.92	3.60	3.61	5.41
	2:45:00	0.60	1.62	1.14	1.52	2.08	2.23	2.75	2.79	4.18
	2:50:00	0.45	1.21	0.85	1.14	1.58	1.70	2.10	2.14	3.21
	2:55:00	0.32	0.87	0.60	0.81	1.15	1.26	1.55	1.58	2.36
	3:00:00	0.21	0.59	0.40	0.56	0.78	0.88	1.08	1.10	1.64
	3:05:00	0.13	0.38	0.24	0.36	0.49	0.57	0.70	0.71	1.05
	3:10:00	0.07	0.22	0.12	0.20	0.27	0.32	0.40	0.40	0.60
	3:15:00	0.03	0.10	0.05	0.09	0.12	0.15	0.18	0.18	0.27
	3:20:00	0.01	0.03	0.01	0.02	0.03	0.04	0.05	0.05	0.07
	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 4.00 (December 2019)

Summary Stage-Area-Volume-Discharge Relationships

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

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

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	148	0.003	0	0.000	0.00
	0.25	149	0.003	37	0.001	0.12
	0.50	149	0.003	74	0.002	0.17
	0.75	626	0.014	136	0.003	0.20
	1.00	1,817	0.042	441	0.010	0.23
	1.25	3,009	0.069	1,044	0.024	0.26
	1.50	4,200	0.096	1,945	0.045	0.29
	1.75	7,120	0.163	3,231	0.074	0.31
	2.00	12,633	0.290	5,700	0.131	0.33
	2.25	18,147	0.417	9,547	0.219	0.44
	2.50	23,661	0.543	14,773	0.339	0.52
	2.75	29,887	0.686	21,413	0.492	0.58
	3.00	37,183	0.854	29,797	0.684	0.63
	3.25	44,479	1.021	40,005	0.918	0.67
	3.50	51,775	1.189	52,037	1.195	0.71
	3.75	58,273	1.338	65,852	1.512	0.75
	4.00	63,572	1.459	81,083	1.861	0.79
	4.25	68,871	1.581	97,638	2.241	1.05
	4.50	74,171	1.703	115,519	2.652	1.41
	4.75	78,002	1.791	134,650	3.091	1.64
	5.00	79,633	1.828	154,355	3.543	1.82
	5.25	81,264	1.866	174,467	4.005	1.98
	5.50	82,895	1.903	194,987	4.476	2.12
	5.75	84,328	1.936	215,905	4.956	2.26
	6.00	85,463	1.962	237,128	5.444	2.38
	6.25	86,599	1.988	258,636	5.937	2.50
	6.50	87,735	2.014	280,428	6.438	8.32
	6.75	88,881	2.040	302,504	6.945	22.85
	7.00	90,044	2.067	324,870	7.458	42.36
	7.25	91,207	2.094	347,526	7.978	65.80
	7.50	92,370	2.121	370,473	8.505	69.26
	7.75	93,549	2.148	393,712	9.038	70.34
	8.00	94,750	2.175	417,250	9.579	71.40
	8.25	95,952	2.203	441,087	10.126	75.98
	8.50	97,154	2.230	465,226	10.680	125.72
	8.75	98,376	2.258	489,666	11.241	205.14
	9.00	99,629	2.287	514,416	11.809	306.40
	9.25	100,882	2.316	539,480	12.385	426.27
	9.50	102,134	2.345	564,857	12.967	562.88
	9.75	103,429	2.374	590,549	13.557	715.03
	9.95	104,516	2.399	611,344	14.035	847.34

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

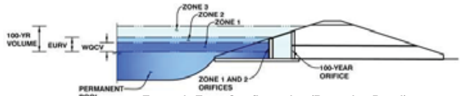
Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

MHFD-Detention, Version 4.00 (December 2019)

Project: **Redtail Ridge**

Basin ID: **Pond E**



Example Zone Configuration (Retention Pond)

Watershed Information

Selected BMP Type =	**EDB**	
Watershed Area =	30.60	acres
Watershed Length =	1,899	ft
Watershed Length to Centroid =	372	ft
Watershed Slope =	0.018	ft/ft
Watershed Imperviousness =	75.00%	percent
Percentage Hydrologic Soil Group A =	0.0%	percent
Percentage Hydrologic Soil Group B =	0.0%	percent
Percentage Hydrologic Soil Groups C/D =	100.0%	percent
Target WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	Louisville - City Hall	

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

			Optional User Overrides	
Water Quality Capture Volume (WQCV) =	0.764	acre-feet		acre-feet
Excess Urban Runoff Volume (EURV) =	2.243	acre-feet		acre-feet
2-yr Runoff Volume (P1 = 0.8 in.) =	1.399	acre-feet		inches
5-yr Runoff Volume (P1 = 1.09 in.) =	2.041	acre-feet		inches
10-yr Runoff Volume (P1 = 1.35 in.) =	2.683	acre-feet		inches
25-yr Runoff Volume (P1 = 1.78 in.) =	3.850	acre-feet		inches
50-yr Runoff Volume (P1 = 2.14 in.) =	4.800	acre-feet		inches
100-yr Runoff Volume (P1 = 2.54 in.) =	5.902	acre-feet		inches
500-yr Runoff Volume (P1 = 3.63 in.) =	8.815	acre-feet		inches
Approximate 2-yr Detention Volume =	1.365	acre-feet		
Approximate 5-yr Detention Volume =	2.026	acre-feet		
Approximate 10-yr Detention Volume =	2.471	acre-feet		
Approximate 25-yr Detention Volume =	3.026	acre-feet		
Approximate 50-yr Detention Volume =	3.316	acre-feet		
Approximate 100-yr Detention Volume =	3.753	acre-feet		

Define Zones and Basin Geometry

Zone 1 Volume (WQCV) =	0.764	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.479	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	1.510	acre-feet
Total Detention Basin Volume =	3.753	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
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^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

Depth Increment = ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	23,198	0.533		
	--	1.00	--	--	--	25,995	0.597	24,596	0.565
	--	2.00	--	--	--	28,892	0.663	52,040	1.195
	--	3.00	--	--	--	31,891	0.732	82,431	1.892
	--	4.00	--	--	--	34,990	0.803	115,872	2.660
	--	5.00	--	--	--	38,189	0.877	152,461	3.500
	--	6.00	--	--	--	41,489	0.952	192,299	4.415
	--	7.00	--	--	--	44,889	1.031	235,488	5.406
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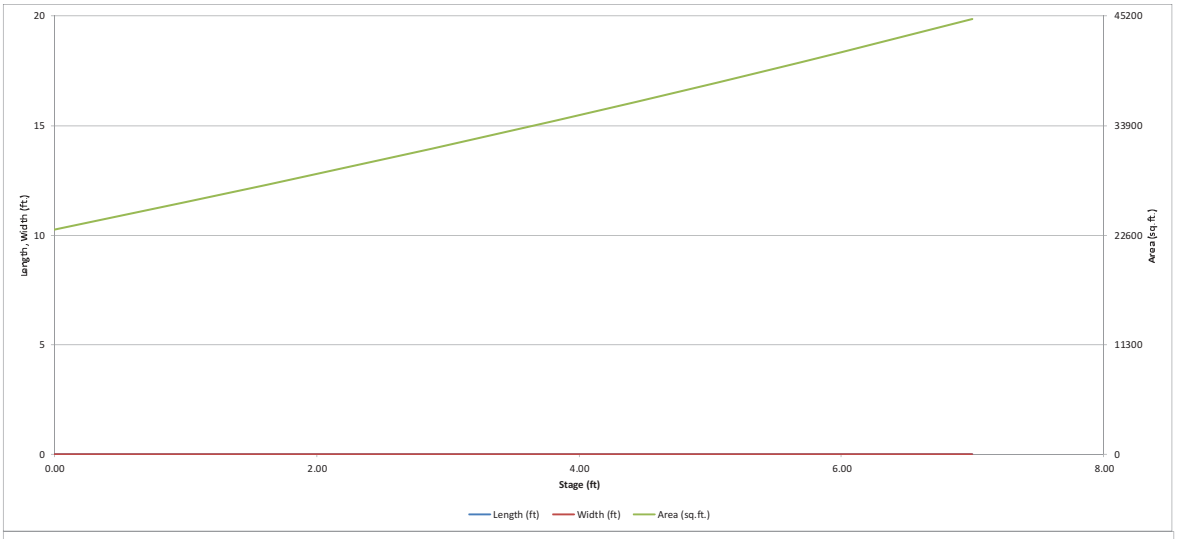
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22600
11300
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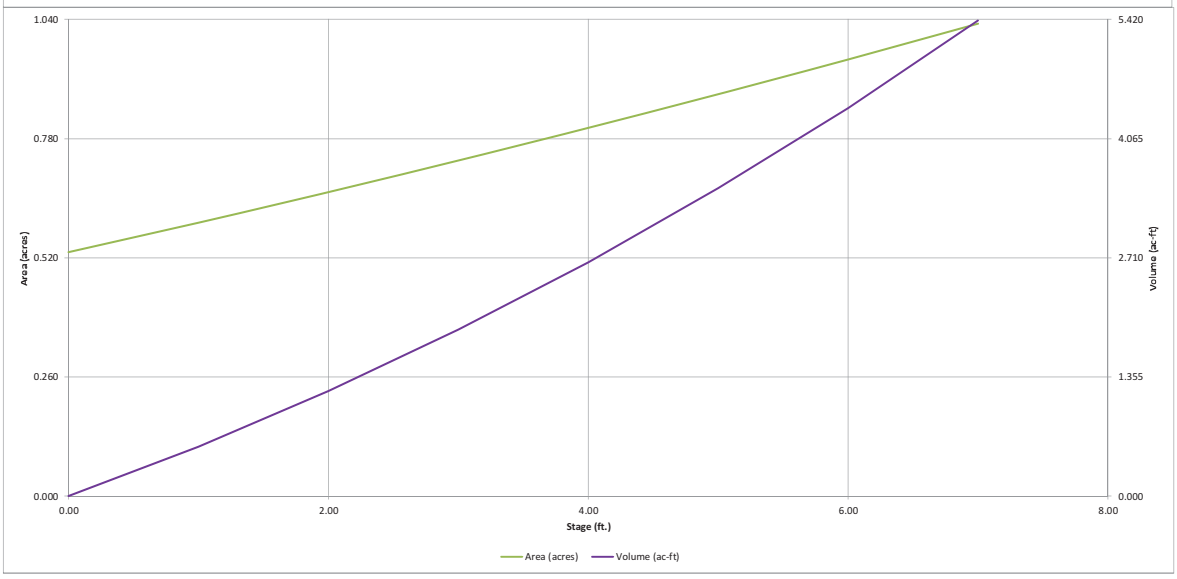
8.00
Stage (ft)
Length, Width (ft.)
Area (sq. ft.)
Length (ft)
Width (ft)
Area (sq.ft.)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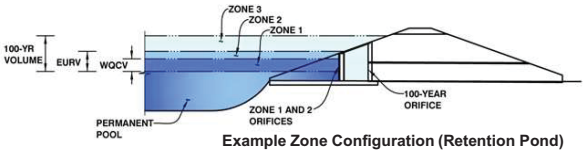
6.00
8.00
Stage (ft.)
Area (acres)
Volume (ac-ft)
Area (acres)
Volume (ac-ft)

DETENTION BASIN OUTLET STRUCTURE DESIGN

MHFD-Detention, Version 4.00 (December 2019)

Project: **Redtail Ridge**

Basin ID: **Pond E**



Example Zone Configuration (Retention Pond)

	Estimated Stage (ft)	Estimated Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	1.33	0.764	Orifice Plate
Zone 2 (EURV)	3.47	1.479	Orifice Plate
Zone 3 (100-year)	5.29	1.510	Weir&Pipe (Restrict)
Total (all zones)		3.753	

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

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

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	3.47	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	13.84	inches
Orifice Plate: Orifice Area per Row =	N/A	inches

Calculated Parameters for Plate

WQ Orifice Area per Row =	N/A	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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					
Orifice Area (sq. inches)	10.25	20.00	20.00					

	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)

	Not Selected	Not Selected	
Invert of Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	N/A	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Diameter =	N/A	N/A	inches

Calculated Parameters for Vertical Orifice

	Not Selected	Not Selected	
Vertical Orifice Area =	N/A	N/A	ft^2
Vertical Orifice Centroid =	N/A	N/A	feet

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

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.47	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	8.00	N/A	feet
Overflow Weir Grate Slope =	4.00	N/A	H:V
Horiz. Length of Weir Sides =	8.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	5.47	N/A	feet
Overflow Weir Slope Length =	8.25	N/A	feet
Grate Open Area / 100-yr Orifice Area =	13.88	N/A	
Overflow Grate Open Area w/o Debris =	46.18	N/A	ft^2
Overflow Grate Open Area w/ Debris =	23.09	N/A	ft^2

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

	Zone 3 Restrictor	Not Selected	
Depth to Invert of Outlet Pipe =	2.50	N/A	ft (distance below basin bottom at Stage = 0 ft)
Outlet Pipe Diameter =	30.00	N/A	inches
Restrictor Plate Height Above Pipe Invert =	19.25		inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Restrictor	Not Selected	
Outlet Orifice Area =	3.33	N/A	ft^2
Outlet Orifice Centroid =	0.90	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	1.86	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.12	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	60.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

Spillway Design Flow Depth=	0.75	feet
Stage at Top of Freeboard =	6.87	feet
Basin Area at Top of Freeboard =	1.02	acres
Basin Volume at Top of Freeboard =	5.27	acre-ft

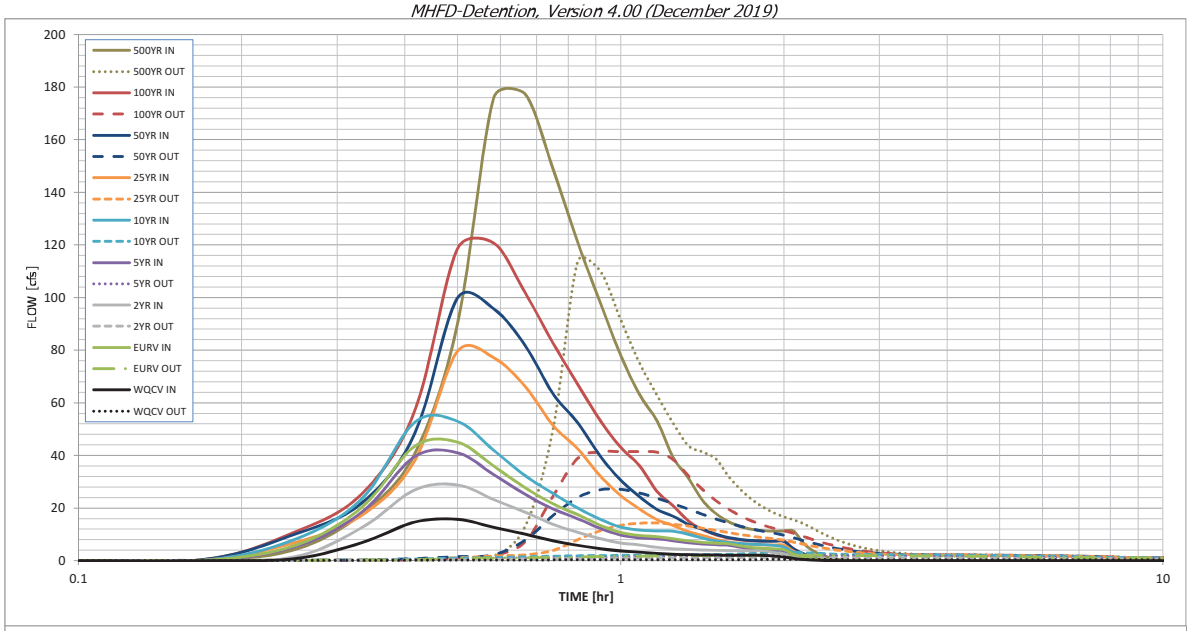
Routed Hydrograph Results

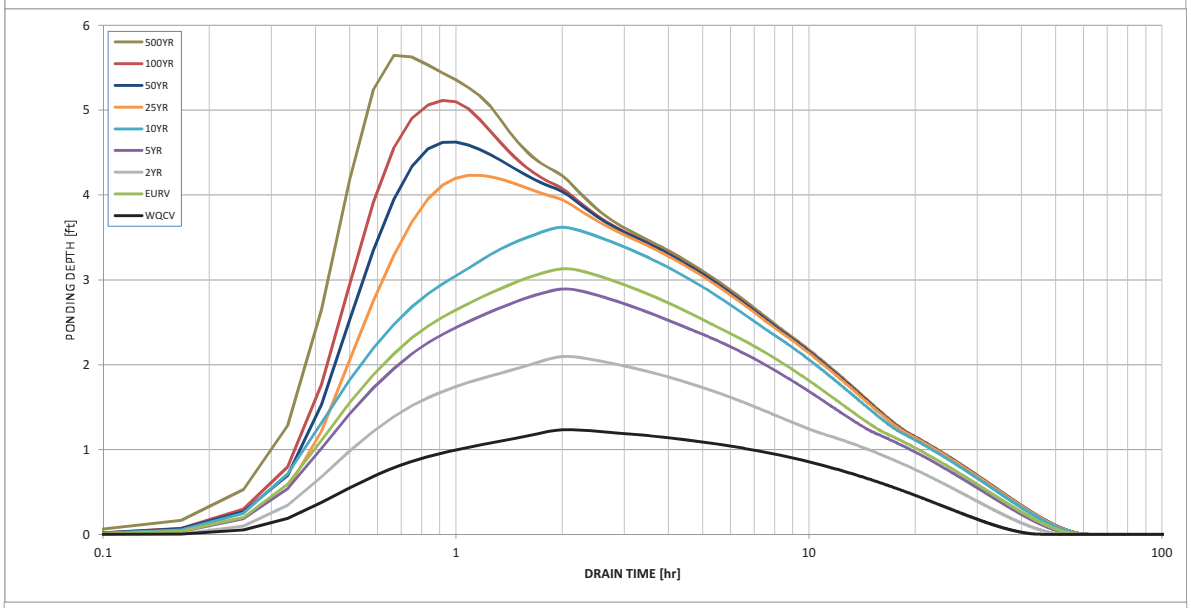
The user can override the default CUHP hydrographs and runoff volumes by entering new values in the Inflow Hydrographs table (Columns W through AF).

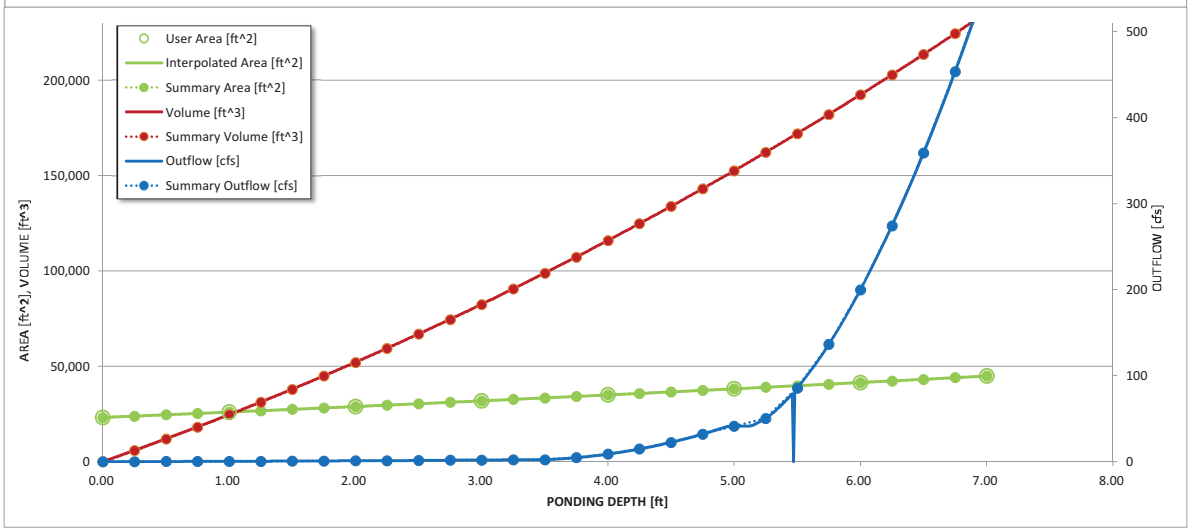
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	0.80	1.09	1.35	1.78	2.14	2.54	3.63
CUHP Runoff Volume (acre-ft) =	0.764	2.243	1.399	2.041	2.683	3.850	4.800	5.902	8.815
Inflow Hydrograph Volume (acre-ft) =	0.764	2.243	1.399	2.041	2.683	3.850	4.800	5.902	8.815
CUHP Predevelopment Peak Q (cfs) =	0.0	0.0	0.4	3.5	10.5	27.8	39.4	53.3	88.2
OPTIONAL Override Predevelopment Peak Q (cfs) =	0.0	0.0							
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.01	0.11	0.34	0.91	1.29	1.74	2.88
Peak Inflow Q (cfs) =	15.7	45.1	28.8	41.0	53.0	79.5	99.8	120.7	177.4
Peak Outflow Q (cfs) =	0.5	2.1	1.1	1.9	3.3	14.3	27.1	41.5	113.8
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	0.6	0.3	0.5	0.7	0.8	1.3
Structure Controlling Flow =	Plate	Plate	Plate	Plate	Overflow Weir 1	Overflow Weir 1	Overflow Weir 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	N/A	N/A	N/A	0.0	0.2	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	46	43	46	47	44	43	40	36
Time to Drain 99% of Inflow Volume (hours) =	**42**	52	48	51	53	52	51	50	47
Maximum Ponding Depth (ft) =	1.24	3.13	2.10	2.89	3.62	4.23	4.63	5.11	5.65
Area at Maximum Ponding Depth (acres) =	0.61	0.74	0.67	0.72	0.78	0.82	0.85	0.89	0.93
Maximum Volume Stored (acre-ft) =	0.704	1.988	1.255	1.812	2.360	2.847	3.172	3.597	4.077

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: *..\Hydrographs\Outflow Hydrograph\Pond E Outflow Hydrograph 80.xlsx*

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	0.25	0.15	4.15
	0:15:00	0.78	5.71	1.42	5.20	8.01	6.81	9.96	10.80	17.95
	0:20:00	6.87	20.35	12.59	18.52	23.59	17.35	22.00	25.48	40.50
	0:25:00	14.67	43.45	26.86	39.54	52.52	37.90	48.10	56.67	89.78
	0:30:00	15.72	45.07	28.79	41.01	53.00	79.54	99.77	118.55	175.91
	0:35:00	12.68	35.93	23.21	32.69	41.94	77.14	95.71	120.75	177.37
	0:40:00	10.07	27.75	18.44	25.25	32.31	66.19	81.74	101.83	149.03
	0:45:00	7.56	21.63	13.84	19.68	25.59	51.48	63.48	82.76	121.00
	0:50:00	5.89	17.51	10.79	15.93	19.99	42.53	52.40	67.06	98.15
	0:55:00	4.57	13.49	8.36	12.28	15.74	32.21	39.77	53.31	78.06
	1:00:00	3.68	10.74	6.73	9.77	12.77	24.75	30.60	43.09	63.17
	1:05:00	3.29	9.56	6.02	8.70	11.65	19.63	24.36	36.08	53.15
	1:10:00	2.76	9.16	5.06	8.34	11.30	15.58	19.49	26.35	39.24
	1:15:00	2.46	8.34	4.51	7.59	11.17	13.40	16.86	20.85	31.39
	1:20:00	2.30	7.48	4.21	6.81	10.06	11.01	13.78	15.14	22.84
	1:25:00	2.20	6.95	4.03	6.33	8.51	9.60	11.97	11.83	17.87
	1:30:00	2.14	6.65	3.92	6.05	7.52	8.06	10.02	9.77	14.78
	1:35:00	2.10	6.46	3.84	5.87	6.90	7.09	8.80	8.50	12.88
	1:40:00	2.08	5.57	3.81	5.06	6.52	6.50	8.06	7.81	11.83
	1:45:00	2.08	5.01	3.81	4.56	6.27	6.20	7.67	7.56	11.44
	1:50:00	2.08	4.68	3.81	4.26	6.13	6.02	7.44	7.45	11.27
	1:55:00	1.68	4.50	3.08	4.09	5.84	5.94	7.35	7.45	11.27
	2:00:00	1.43	4.16	2.61	3.78	5.18	5.91	7.30	7.45	11.27
	2:05:00	0.86	2.52	1.58	2.29	3.17	3.62	4.48	4.57	6.90
	2:10:00	0.51	1.49	0.94	1.35	1.89	2.18	2.69	2.74	4.14
	2:15:00	0.28	0.85	0.52	0.78	1.07	1.25	1.54	1.57	2.37
	2:20:00	0.14	0.47	0.26	0.43	0.58	0.70	0.86	0.88	1.33
	2:25:00	0.06	0.23	0.11	0.20	0.26	0.34	0.42	0.42	0.64
	2:30:00	0.02	0.07	0.04	0.06	0.08	0.11	0.13	0.13	0.20
	2:35:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:40:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:45:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:50:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	2:55:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:05:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	3:10:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	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 4.00 (December 2019)

Summary Stage-Area-Volume-Discharge Relationships

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

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

Stage - Storage Description	Stage [ft]	Area [ft^2]	Area [acres]	Volume [ft^3]	Volume [ac-ft]	Total Outflow [cfs]
	0.00	23,198	0.533	0	0.000	0.00
	0.25	23,897	0.549	5,887	0.135	0.17
	0.50	24,596	0.565	11,948	0.274	0.24
	0.75	25,295	0.581	18,185	0.417	0.30
	1.00	25,995	0.597	24,596	0.565	0.34
	1.25	26,719	0.613	31,185	0.716	0.53
	1.50	27,444	0.630	37,956	0.871	0.79
	1.75	28,168	0.647	44,907	1.031	0.95
	2.00	28,892	0.663	52,040	1.195	1.08
	2.25	29,642	0.680	59,357	1.363	1.20
	2.50	30,392	0.698	66,861	1.535	1.52
	2.75	31,141	0.715	74,552	1.711	1.80
	3.00	31,891	0.732	82,431	1.892	2.01
	3.25	32,665	0.750	90,501	2.078	2.19
	3.50	33,440	0.768	98,764	2.267	2.43
	3.75	34,215	0.785	107,221	2.461	4.70
	4.00	34,990	0.803	115,872	2.660	8.86
	4.25	35,789	0.822	124,719	2.863	14.78
	4.50	36,589	0.840	133,766	3.071	22.50
	4.75	37,389	0.858	143,013	3.283	32.09
	5.00	38,189	0.877	152,461	3.500	41.15
	5.25	39,014	0.896	162,111	3.722	50.42
	5.50	39,839	0.915	171,968	3.948	85.70
	5.75	40,664	0.934	182,030	4.179	136.46
	6.00	41,489	0.952	192,299	4.415	199.73
	6.25	42,339	0.972	202,778	4.655	274.13
	6.50	43,189	0.991	213,469	4.901	358.87
	6.75	44,039	1.011	224,372	5.151	453.44
	7.00	44,889	1.031	235,488	5.406	557.49

For best results, include the stages of all grade slope changes (e.g. ISV and Floor) from the S-A-V table on Sheet 'Basin'.

Also include the inverts of all outlets (e.g. vertical orifice, overflow grate, and spillway, where applicable).

HY-8 Culvert Analysis Report

Crossing Notes: Station 30+00 10-Year Culvert

* Full Flow Headwater elevation is below inlet invert.

****

Straight 8'x5' Concrete Box Culvert

Inlet Elevation (invert): 5399.18 ft, Outlet Elevation (invert): 5398.72 ft

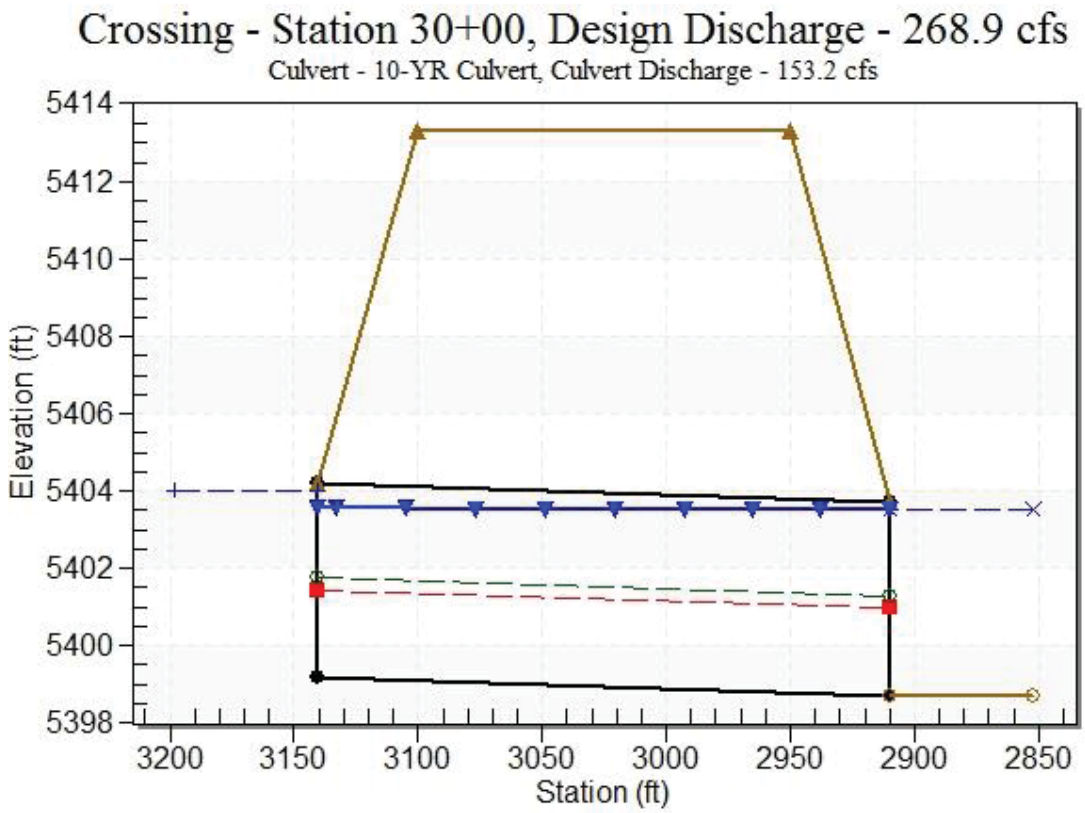
Culvert Length: 230.41 ft, Culvert Slope: 0.0020

****

Culvert Summary Table: 10-YR Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
38.19	37.11	5401.06	1.499	1.882	3-M1t	0.980	0.874	2.150	2.150	2.158	2.102
61.47	49.53	5401.55	1.817	2.374	3-M1t	1.185	1.060	2.626	2.626	2.357	2.370
84.75	61.13	5401.95	2.090	2.769	3-M1t	1.363	1.219	3.000	3.000	2.547	2.568
108.03	72.75	5402.29	2.347	3.111	3-M1t	1.532	1.369	3.314	3.314	2.744	2.730
131.31	84.50	5402.60	2.591	3.417	3-M1t	1.695	1.513	3.588	3.588	2.943	2.867
154.60	96.24	5402.87	2.817	3.695	3-M1t	1.853	1.650	3.834	3.834	3.138	2.986
177.88	107.81	5403.13	3.031	3.952	3-M1t	2.004	1.780	4.058	4.058	3.321	3.093
201.16	119.45	5403.37	3.239	4.192	3-M1t	2.152	1.906	4.264	4.264	3.502	3.190
224.44	131.05	5403.60	3.440	4.419	3-M1t	2.297	2.027	4.455	4.455	3.677	3.278
268.90	153.16	5404.00	3.807	4.822	3-M1t	2.564	2.249	4.790	4.790	3.997	3.430
271.00	154.16	5404.02	3.823	4.840	3-M1t	2.576	2.259	4.804	4.804	4.011	3.437

Water Surface Profile Plot for Culvert: 10-YR Culvert



Crossing Notes: Station 30+00 Pedestrian Culvert

* Full Flow Headwater elevation is below inlet invert.

****

Straight 10'x8' Concrete Box Culvert

Inlet Elevation (invert): 5400.93 ft, Outlet Elevation (invert): 5400.47 ft

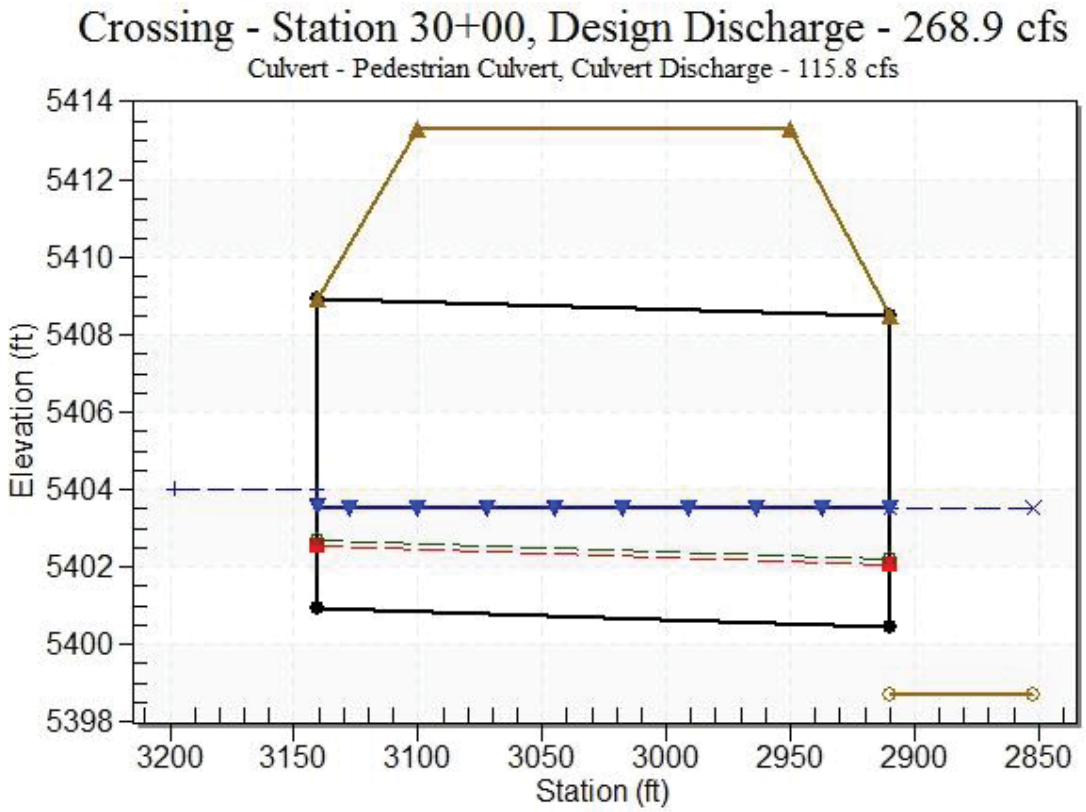
Culvert Length: 230.41 ft, Culvert Slope: 0.0020

****

Culvert Summary Table: Pedestrian Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
38.19	1.23	5401.06	0.133	0.0*	1-S2n	0.065	0.078	0.065	2.150	1.877	2.102
61.47	12.03	5401.55	0.609	0.624	3-M1t	0.412	0.356	0.876	2.626	1.373	2.370
84.75	23.79	5401.95	0.960	1.019	3-M1t	0.630	0.560	1.250	3.000	1.904	2.568
108.03	35.33	5402.29	1.250	1.360	3-M1t	0.810	0.729	1.564	3.314	2.259	2.730
131.31	47.03	5402.60	1.512	1.668	3-M1t	0.971	0.882	1.838	3.588	2.558	2.867
154.60	58.52	5402.87	1.750	1.945	3-M1t	1.118	1.021	2.084	3.834	2.808	2.986
177.88	70.15	5403.13	1.974	2.203	3-M1t	1.259	1.152	2.308	4.058	3.040	3.093
201.16	81.77	5403.37	2.187	2.443	3-M1t	1.392	1.276	2.514	4.264	3.253	3.190
224.44	93.42	5403.60	2.390	2.670	3-M1t	1.519	1.394	2.705	4.455	3.453	3.278
268.90	115.81	5404.00	2.758	3.073	3-M1t	1.753	1.609	3.040	4.790	3.810	3.430
271.00	116.84	5404.02	2.774	3.091	3-M1t	1.764	1.618	3.054	4.804	3.825	3.437

Water Surface Profile Plot for Culvert: Pedestrian Culvert



Crossing Notes: Station 7+00 10-Year Culvert

* Full Flow Headwater elevation is below inlet invert.

****

Straight 8'x5' Concrete Box Culvert

Inlet Elevation (invert): 5372.82 ft, Outlet Elevation (invert): 5370.42 ft

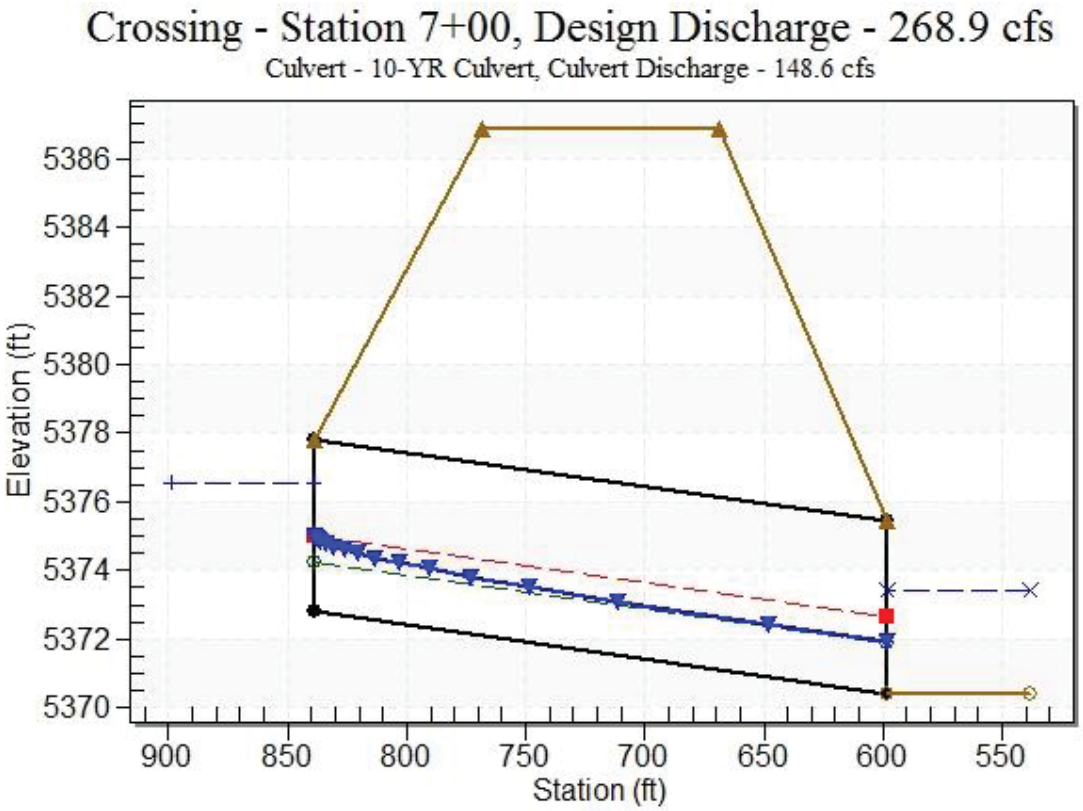
Culvert Length: 240.13 ft, Culvert Slope: 0.0100

****

Culvert Summary Table: 10-YR Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
38.19	38.16	5374.33	1.514	0.0*	1-JS1t	0.594	0.891	1.369	1.369	3.484	4.307
61.47	56.78	5374.79	1.973	0.0*	1-S2n	0.767	1.161	0.767	1.659	9.250	4.853
84.75	69.19	5375.07	2.251	0.0*	1-S2n	0.871	1.324	0.871	1.886	9.933	5.259
108.03	80.30	5375.31	2.486	0.0*	1-S2n	0.959	1.463	0.966	2.077	10.386	5.589
131.31	90.98	5375.52	2.697	0.009	1-S2n	1.041	1.590	1.061	2.244	10.714	5.868
154.60	101.27	5375.71	2.891	0.198	1-S2n	1.116	1.707	1.146	2.393	11.044	6.113
177.88	111.27	5375.89	3.074	0.376	1-S2n	1.188	1.818	1.217	2.528	11.426	6.331
201.16	121.05	5376.07	3.247	0.547	1-S2n	1.256	1.923	1.287	2.653	11.756	6.528
224.44	130.67	5376.23	3.413	0.712	1-S2n	1.322	2.024	1.362	2.769	11.993	6.710
268.90	148.64	5376.53	3.713	1.015	1-S2n	1.441	2.205	1.490	2.972	12.472	7.021
271.00	149.47	5376.55	3.727	1.029	1-S2n	1.446	2.213	1.495	2.981	12.493	7.034

Water Surface Profile Plot for Culvert: 10-YR Culvert



Crossing Notes: Station 7+00 Pedestrian Culvert

* Full Flow Headwater elevation is below inlet invert.

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Straight 10'x8' Concrete Box Culvert

Inlet Elevation (invert): 5374.57 ft, Outlet Elevation (invert): 5372.17 ft

Culvert Length: 240.13 ft, Culvert Slope: 0.0100

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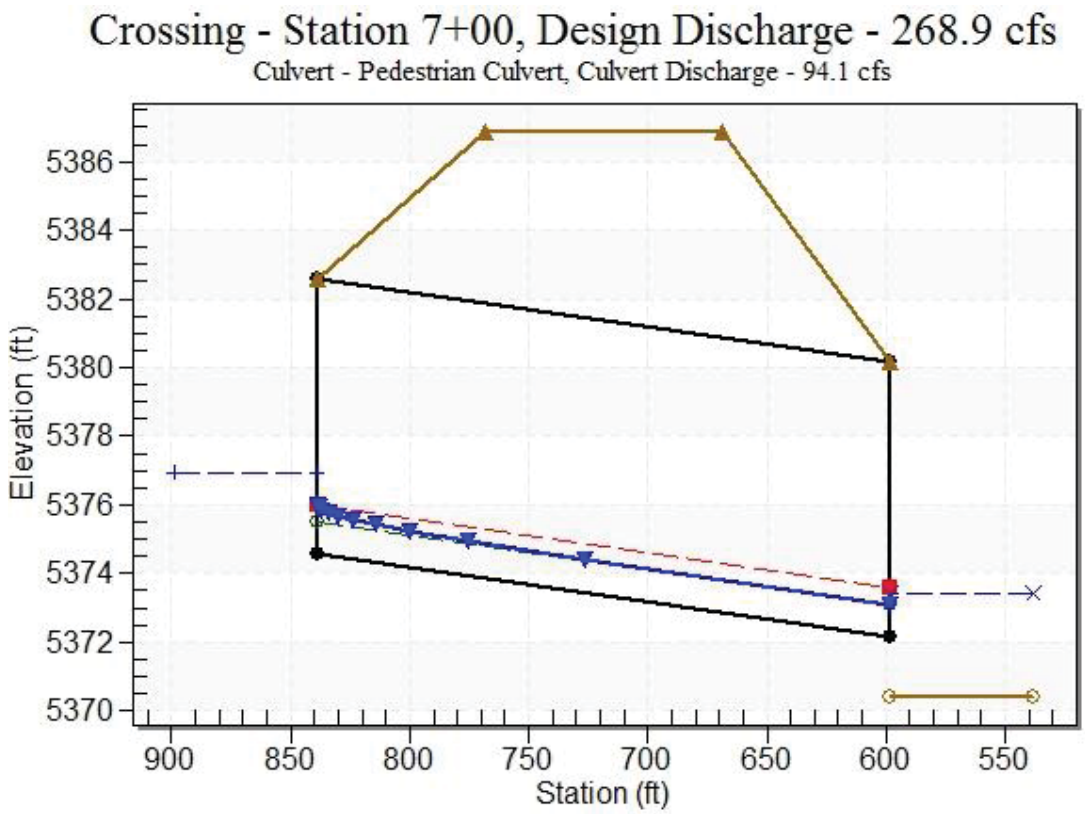
Culvert Summary Table: Pedestrian Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
38.19	0.00	5374.33	0.000	0.000	0-NF	0.000	0.000	0.000	1.369	0.000	4.307
61.47	3.30	5374.82	0.255	0.0*	1-S2n	0.079	0.150	0.079	1.659	4.201	4.853
84.75	11.52	5375.16	0.587	0.0*	1-S2n	0.238	0.345	0.238	1.886	4.838	5.259
108.03	20.87	5375.44	0.873	0.0*	1-S2n	0.344	0.513	0.344	2.077	6.060	5.589
131.31	30.71	5375.70	1.129	0.0*	1-S2n	0.444	0.664	0.444	2.244	6.913	5.868
154.60	40.91	5375.94	1.367	0.0*	1-S2n	0.530	0.804	0.530	2.393	7.722	6.113
177.88	51.40	5376.16	1.591	0.0*	1-S2n	0.617	0.936	0.617	2.528	8.326	6.331
201.16	62.06	5376.37	1.804	0.0*	1-S2n	0.691	1.061	0.691	2.653	8.975	6.528
224.44	72.91	5376.58	2.009	0.0*	1-S2n	0.767	1.182	0.767	2.769	9.507	6.710
268.90	94.06	5376.95	2.381	0.0*	1-S2n	0.902	1.401	0.920	2.972	10.222	7.021
271.00	95.11	5376.97	2.399	0.0*	1-S2n	0.909	1.411	0.923	2.981	10.309	7.034

Water Surface Profile Plot for Culvert: Pedestrian Culvert



Crossing Notes: 96th Street

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Straight Dual Barrel 8'x5' Concrete Box Culvert

Inlet Elevation (invert): 5363.99 ft, Outlet Elevation (invert): 5363.59 ft

Culvert Length: 80.00 ft, Culvert Slope: 0.0050

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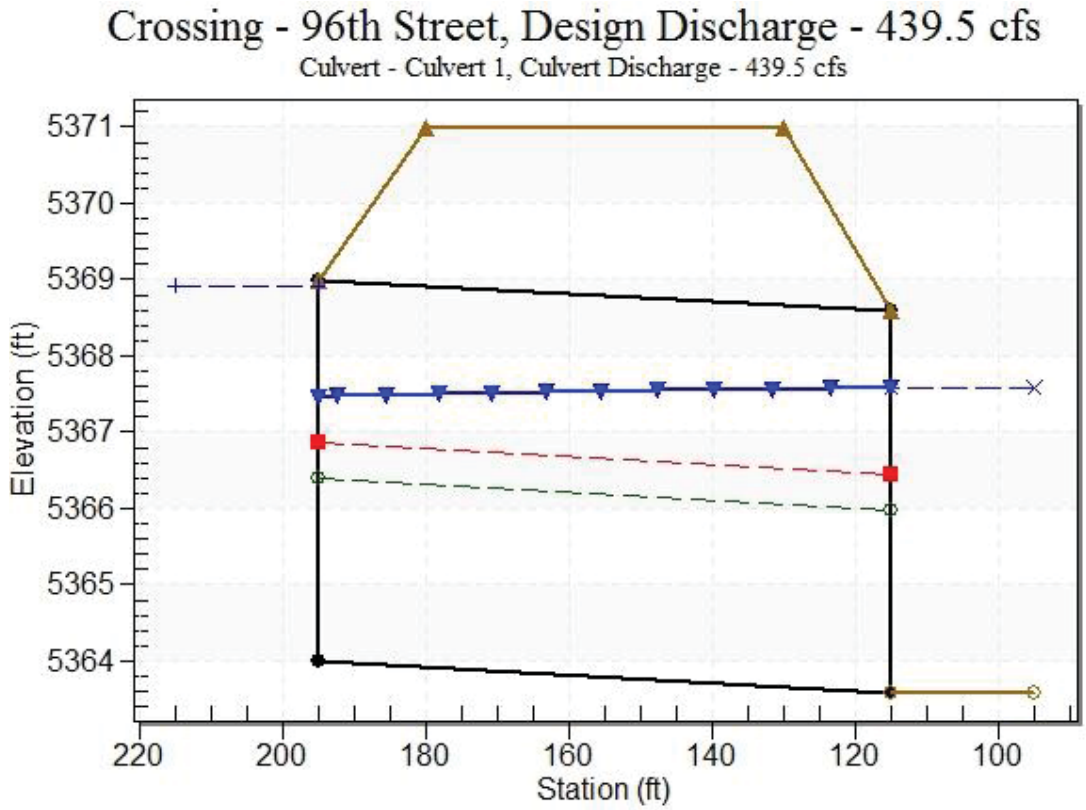
Culvert Summary Table: 96th Street Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5363.99	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
44.00	44.00	5365.31	1.054	1.321	1-S1t	0.523	0.617	1.615	1.615	1.702	3.650
88.00	88.00	5365.94	1.674	1.945	1-S1t	0.813	0.979	2.129	2.129	2.583	4.342
132.00	132.00	5366.42	2.193	2.435	1-S1t	1.058	1.283	2.498	2.498	3.302	4.806
176.00	176.00	5366.85	2.652	2.860	1-S1t	1.280	1.555	2.797	2.797	3.933	5.164
220.00	220.00	5367.24	3.063	3.249	1-S1t	1.485	1.804	3.051	3.051	4.506	5.460
264.00	264.00	5367.60	3.448	3.613	1-S1t	1.681	2.037	3.276	3.276	5.037	5.715
308.00	308.00	5367.95	3.813	3.959	1-S1t	1.867	2.258	3.478	3.478	5.535	5.940
352.00	352.00	5368.28	4.163	4.293	1-S1t	2.048	2.468	3.662	3.662	6.007	6.141
439.53	439.53	5368.92	4.838	4.931	1-S1t	2.392	2.862	3.991	3.991	6.883	6.492
440.00	440.00	5368.92	4.842	4.935	1-S1t	2.394	2.864	3.993	3.993	6.888	6.494

Water Surface Profile Plot for Culvert: 96th Street Culvert



Crossing Notes: Goodhue Ditch

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Straight Culvert

Inlet Elevation (invert): 5363.58 ft, Outlet Elevation (invert): 5358.98 ft

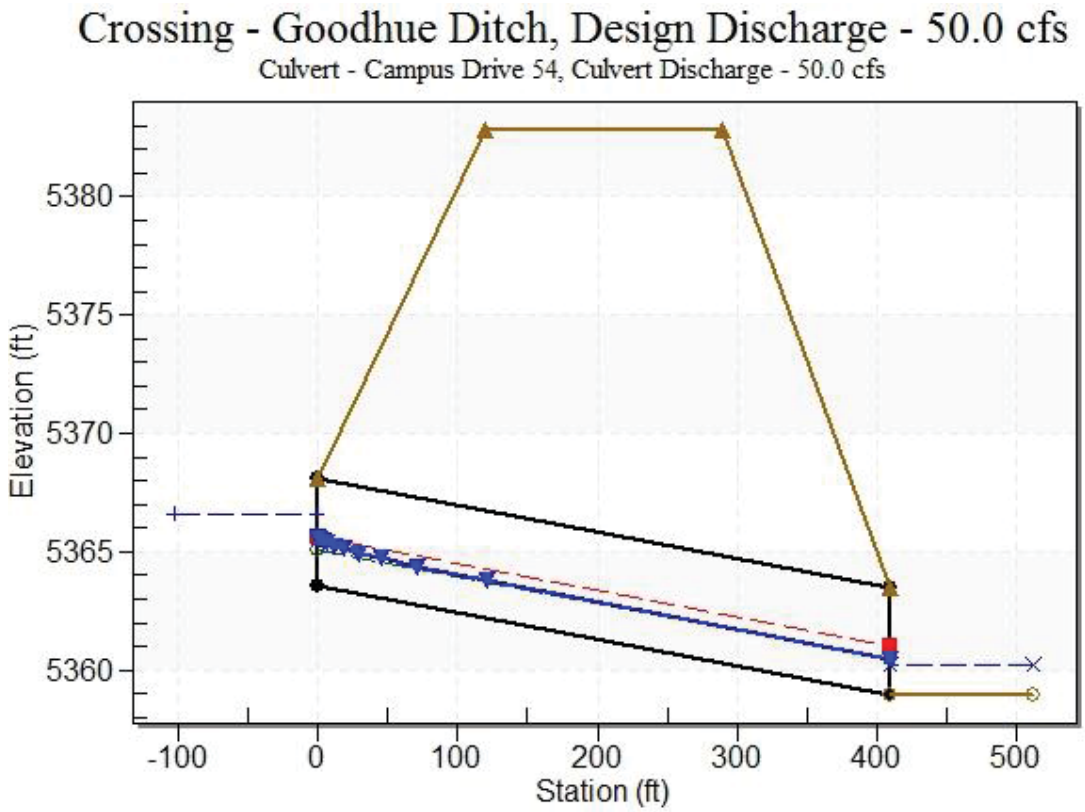
Culvert Length: 409.37 ft, Culvert Slope: 0.0112

****

Culvert Summary Table: Goodhue Ditch Culvert

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	5363.58	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
5.00	5.00	5364.47	0.891	0.0*	1-S2n	0.478	0.626	0.478	0.388	5.509	2.324
10.00	10.00	5364.85	1.275	0.0*	1-S2n	0.668	0.891	0.668	0.561	6.771	2.852
15.00	15.00	5365.15	1.575	0.0*	1-S2n	0.816	1.097	0.816	0.692	7.624	3.200
20.00	20.00	5365.41	1.833	0.0*	1-S2n	0.940	1.272	0.940	0.801	8.298	3.465
25.00	25.00	5365.64	2.064	0.0*	1-S2n	1.051	1.427	1.051	0.895	8.854	3.684
30.00	30.00	5365.86	2.278	0.0*	1-S2n	1.152	1.568	1.152	0.979	9.329	3.870
35.00	35.00	5366.07	2.486	0.0*	1-S2n	1.245	1.698	1.245	1.055	9.756	4.033
40.00	40.00	5366.26	2.679	0.0*	1-S2n	1.334	1.821	1.334	1.126	10.133	4.179
45.00	45.00	5366.44	2.860	0.0*	1-S2n	1.418	1.936	1.418	1.191	10.477	4.312
50.00	50.00	5366.61	3.033	0.0*	1-S2n	1.499	2.046	1.499	1.252	10.786	4.433

Water Surface Profile Plot for Culvert: Goodhue Ditch Culvert



HY-8 Culvert Analysis Report
Existing Dual 10'x6' Box Culvert at E470

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

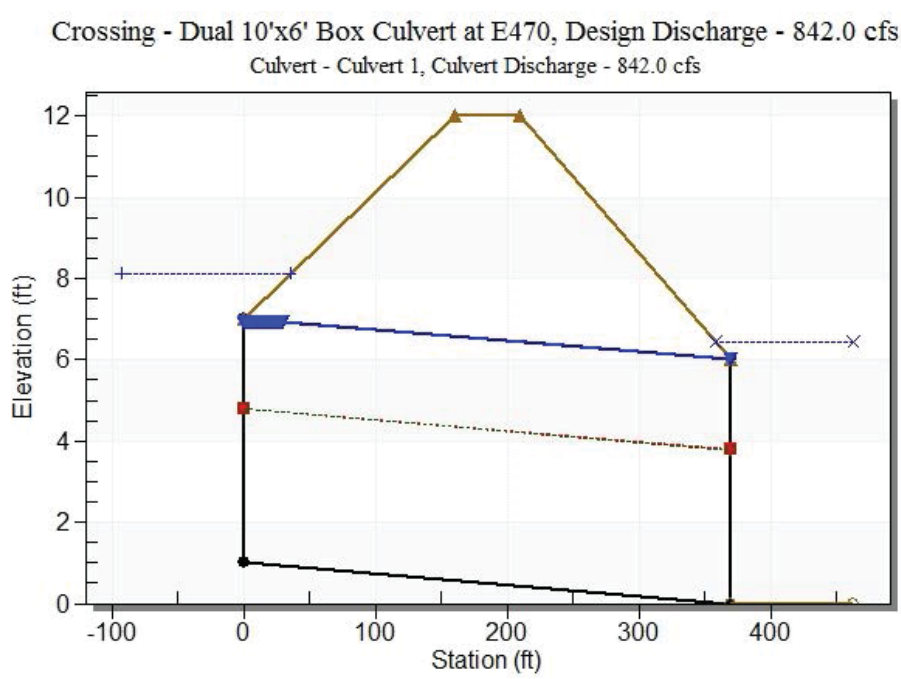
Design Flow: 842 cfs

Maximum Flow: 842 cfs

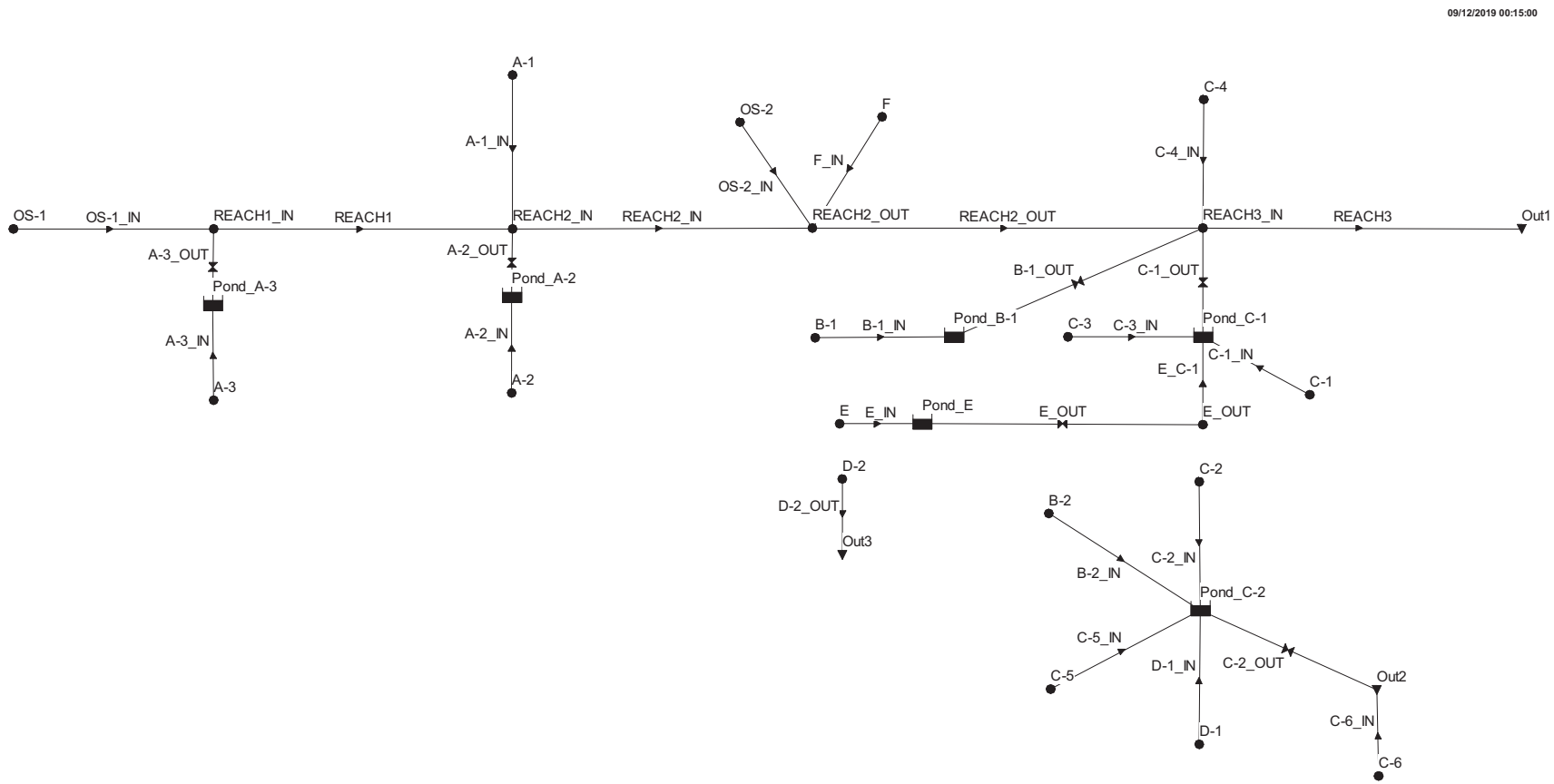
Summary of Culvert Flows at Crossing: Dual 10'x6' Box Culvert at E470

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
84.20	84.20	2.40	1.404	0.415	1-S2n	0.800	0.820	0.800	1.398	5.260	3.010
168.40	168.40	3.23	2.228	1.243	1-JS1t	1.252	1.301	2.176	2.176	3.869	3.869
252.60	252.60	3.95	2.920	2.947	1-S1t	1.637	1.705	2.835	2.835	4.455	4.455
336.80	336.80	4.55	3.518	3.549	1-S1t	1.987	2.065	3.431	3.431	4.909	4.909
421.00	421.00	5.15	4.065	4.148	1-S1t	2.314	2.396	3.986	3.986	5.281	5.281
505.20	505.20	5.73	4.577	4.729	1-S1t	2.626	2.706	4.513	4.513	5.597	5.597
589.40	589.40	6.29	5.066	5.290	1-S1t	2.926	2.999	5.019	5.019	5.872	5.872
673.60	673.60	6.83	5.541	5.834	1-S1t	3.217	3.278	5.508	5.508	6.115	6.115
757.80	757.80	7.36	6.011	6.362	1-S1t	3.500	3.546	5.983	5.983	6.333	6.333
842.00	842.00	8.10	6.485	7.102	1-S1f	3.778	3.804	6.000	6.447	7.017	6.531

Water Surface Profile Plot for Culvert



Redtail Ridge



SWMM 5.1 Proposed Model

SWMM Storage Node Input Tables

Pond A-2 Stage Summary Table		
Stage	Storage Area (FT^2)	Discharge (CFS)
0	56199.00	0
0.25	57113.00	0.38
0.5	58026.00	0.54
0.75	58940.00	0.67
1	59854.00	0.77
1.25	60792.00	1.16
1.5	61731.00	1.43
1.75	62670.00	1.64
2	63609.00	1.82
2.25	64572.00	2.35
2.5	65536.00	3.04
2.75	66500.00	3.5
3	67464.00	3.89
3.25	68453.00	4.23
3.5	69442.00	9.98
3.75	70431.00	25.95
4	71420.00	47.66
4.25	72434.00	64.8
4.5	73448.00	66.23
4.75	74462.00	67.63
5	75477.00	69
5.25	76516.00	70.34
5.5	77555.00	118.84
5.75	78594.00	207.24
6	79634.00	322.47
6.25	80698.00	460.08
6.5	81762.00	617.56
6.75	82827.00	793.29
7	83891.00	986.14

Pond A-3 Stage Summary Table		
Stage	Storage Area (FT^2)	Discharge (CFS)
0	1626.00	0
0.25	1851.00	0.01
0.5	2077.00	0.02
0.75	2303.00	0.02
1	2528.00	0.04
1.25	2779.00	0.05
1.5	3030.00	0.05
1.75	3281.00	0.06
2	3531.00	0.08
2.25	3807.00	0.09
2.5	4083.00	0.1
2.75	4359.00	0.61
3	4635.00	1.61
3.25	4936.00	1.65
3.5	5237.00	1.69
3.75	5538.00	6.33
4	5840.00	15.65
4.25	6163.00	28.87
4.5	6486.00	45.92
4.75	6809.00	66.84

Pond B Stage Summary Table		
Stage	Storage Area (FT^2)	Discharge (CFS)
0	63865.00	0.00
0.25	64926.00	0.43
0.5	65988.00	0.60
0.75	67049.00	0.74
1	68110.00	0.85
1.25	69196.00	1.33
1.5	70283.00	1.62
1.75	71369.00	1.84
2	72455.00	2.04
2.25	73567.00	2.55
2.5	74678.00	2.92
2.75	75790.00	3.22
3	76901.00	3.48
3.25	78038.00	6.24
3.5	79175.00	18.85
3.75	80311.00	37.02
4	81448.00	59.38
4.25	82609.00	72.82
4.5	83771.00	74.46
4.75	84933.00	76.06
5	86095.00	100.67
5.25	87282.00	164.93
5.5	88468.00	252.56
5.75	89655.00	359.23
6	90842.00	482.68
6.25	92054.00	621.53
6.5	93266.00	774.83
6.75	94478.00	941.89
7	95690.00	1122.18

Pond C-1 Stage Summary Table		
Stage	Storage Area (FT^2)	Discharge (CFS)
0	129664.00	0
0.25	131198.00	2.09
0.5	132731.00	2.96
0.75	134264.00	3.62
1	135797.00	4.18
1.25	137326.00	4.67
1.5	138855.00	6.37
1.75	140383.00	7.3
2	141912.00	11.7
2.25	143467.00	25.58
2.5	145023.00	44.74
2.75	146579.00	67.93
3	148134.00	92.35
3.25	149727.00	95.27
3.5	151319.00	134.02
3.75	152911.00	203.31
4	154503.00	293.32
4.25	156173.00	400.74
4.5	157844.00	523.76
4.75	159514.00	661.21
5	161184.00	812.29

Pond C-2 Stage Summary Table		
Stage	Storage Area (FT^2)	Discharge (CFS)
0	148.00	0
0.25	149.00	0.12
0.5	149.00	0.17
0.75	626.00	0.21
1	1817.00	0.24
1.25	3009.00	0.27
1.5	4200.00	0.29
1.75	7120.00	0.32
2	12633.00	0.34
2.25	18147.00	0.45
2.5	23661.00	0.53
2.75	29887.00	0.59
3	37183.00	0.64
3.25	44479.00	0.69
3.5	51775.00	0.73
3.75	58273.00	0.77
4	63572.00	0.81
4.25	68871.00	1.07
4.5	74171.00	1.43
4.75	78002.00	1.66
5	79633.00	1.84
5.25	81264.00	2
5.5	82895.00	2.15
5.75	84328.00	2.28
6	85463.00	2.41
6.25	86599.00	2.52
6.5	87735.00	9.27
6.75	88881.00	24.27
7	90044.00	44.12
7.25	91207.00	67.84
7.5	92370.00	69.26
7.75	93549.00	70.34
8	94750.00	71.4
8.25	95952.00	75.98

Pond C-2 Stage Summary Table		
Stage	Storage Area (FT^2)	Discharge (CFS)
8.5	97154.00	125.72
8.75	98376.00	205.14
9	99629.00	306.4
9.25	100882.00	426.27
9.5	102134.00	562.88
9.75	103429.00	715.03
9.95	104516.00	847.34

Pond E Stage Summary Table		
Stage	Storage Area (FT^2)	Discharge (CFS)
0	23198.00	0
0.25	23897.00	0.17
0.5	24596.00	0.24
0.75	25295.00	0.3
1	25995.00	0.34
1.25	26719.00	0.53
1.5	27444.00	0.79
1.75	28168.00	0.95
2	28892.00	1.08
2.25	29642.00	1.2
2.5	30392.00	1.52
2.75	31141.00	1.8
3	31891.00	2.01
3.25	32665.00	2.19
3.5	33440.00	2.43
3.75	34215.00	4.7
4	34990.00	8.86
4.25	35789.00	14.78
4.5	36589.00	22.5
4.75	37389.00	32.09
5	38189.00	41.15
5.25	39014.00	50.42
5.5	39839.00	85.7
5.75	40664.00	136.46
6	41489.00	199.73
6.25	42339.00	274.13
6.5	43189.00	358.87
6.75	44039.00	453.44
7	44889.00	557.49

SWMM Results Summary Tables

SWMM Node 100-yr Inflow Summary Table					
Node	Type	Maximum Total Inflow (CFS)	Hour of Maximum Total Inflow	Total Inflow Volume (10^6 gal)	Flow Balance Error Percent
A-1	JUNCTION	48.04	0:45	1.50	0
A-2	JUNCTION	222.47	0:35	4.12	0
A-3	JUNCTION	5.1	0:35	0.13	0
B-1	JUNCTION	202.89	0:35	4.40	0
B-2	JUNCTION	71.17	0:35	1.32	0
C-1	JUNCTION	146.84	0:35	3.08	0
C-2	JUNCTION	79.83	0:30	1.19	0
C-3	JUNCTION	52.61	0:45	1.74	0
C-4	JUNCTION	7.45	0:35	0.17	0
C-5	JUNCTION	17	0:50	0.80	0
C-6	JUNCTION	9.14	0:35	0.16	0
D-1	JUNCTION	92	0:35	1.66	0
D-2	JUNCTION	17.53	0:55	0.77	0
E	JUNCTION	118.65	0:35	1.89	0
E_OUT	JUNCTION	43.19	1:00	1.72	0
F	JUNCTION	16.52	0:55	0.70	0
OS-1	JUNCTION	96.04	0:50	3.33	0
OS-2	JUNCTION	50.57	0:55	2.07	0
Out1	OUTFALL	439.53	1:11	21.80	0
Out2	OUTFALL	73.77	1:04	4.26	0
Out3	OUTFALL	17.53	0:55	0.77	0
Pond_A-2	STORAGE	222.47	0:35	4.12	0.08
Pond_A-3	STORAGE	5.1	0:35	0.13	0.083
Pond_B-1	STORAGE	202.89	0:35	4.40	0.084
Pond_C-1	STORAGE	194.49	0:35	6.53	0.088
Pond_C-2	STORAGE	254.94	0:35	4.98	0.084
Pond_E	STORAGE	118.65	0:35	1.89	0.104
REACH1_IN	JUNCTION	96.35	0:50	3.45	0
REACH2_IN	JUNCTION	205.29	1:00	8.65	0
REACH2_OUT	JUNCTION	269.57	1:03	11.40	0
REACH3_IN	JUNCTION	439.54	1:11	21.80	0

SWMM Link 100-yr Inflow Summary Table			
Link	Type	Maximum Flow (CFS)	Hour of Maximum Flow
REACH1	CHANNEL	93.18	1:02
REACH2_IN	CHANNEL	204.78	1:05
REACH2_OUT	CHANNEL	268.9	1:08
REACH3	CHANNEL	439.53	1:11
E_C-1	CONDUIT	42.57	1:07
A-1_IN	DUMMY	48.04	0:45
A-2_IN	DUMMY	222.47	0:35
A-2_OUT	DUMMY	69.77	1:14
A-3_IN	DUMMY	5.1	0:35
A-3_OUT	DUMMY	1.68	1:32
B-1_IN	DUMMY	202.89	0:35
B-1_OUT	DUMMY	76.02	1:18
B-2_IN	DUMMY	71.17	0:35
C-1_IN	DUMMY	146.84	0:35
C-1_OUT	DUMMY	94.37	1:26
C-2_IN	DUMMY	79.83	0:30
C-2_OUT	DUMMY	70.93	1:15
C-3_IN	DUMMY	52.61	0:45
C-4_IN	DUMMY	7.45	0:35
C-5_IN	DUMMY	17	0:50
C-6_IN	DUMMY	9.14	0:35
D-1_IN	DUMMY	92	0:35
D-2_OUT	DUMMY	17.53	0:55
E_IN	DUMMY	118.65	0:35
E_OUT	DUMMY	43.19	1:00
F_IN	DUMMY	16.52	0:55
OS-1_IN	DUMMY	96.04	0:50
OS-2_IN	DUMMY	50.57	0:55

SWMM 100-yr Storage Summary Table								
Unit	Average Volume (1000 ft3)	Average Percent Full	Evap Percent Loss	Exfil Percent Loss	Maximum Volume (1000 ft3)	Maximum Percent Full	Hour of Maximum Volume	Maximum Outflow (CFS)
Pond_A-2	124.49	26	0	0	339.071	70	1:13	69.77
Pond_A-3	4.75	23	0	0	11.208	54	1:32	1.68
Pond_B-1	141.57	25	0	0	352.035	63	1:18	76.02
Pond_C-1	148.22	20	0	0	442.38	61	1:26	94.37
Pond_C-2	198.33	32	0	0	406.811	67	1:15	70.93
Pond_E	55.77	24	0	0	154.586	66	1:00	43.19

SWMM Reach 1 2-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
0:15:00	0
0:30:00	0
0:45:00	0.34
1:00:00	1.34
1:15:00	1.8
1:30:00	1.8
1:45:00	1.63
2:00:00	1.39
2:15:00	1.16
2:30:00	0.96
2:45:00	0.8
3:00:00	0.8
3:15:00	0.62
3:30:00	0.45
3:45:00	0.34
4:00:00	0.27
4:15:00	0

SWMM Reach 1 10-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
0:15:00	0
0:30:00	0
0:45:00	10.59
1:00:00	18.02
1:15:00	16.25
1:30:00	13.72
1:45:00	11.19
2:00:00	8.74
2:15:00	6.88
2:30:00	5.56
2:45:00	4.43
3:00:00	3.43
3:15:00	2.5
3:30:00	1.55
3:45:00	1.11
4:00:00	0.74
4:15:00	0.52
4:30:00	0.39
4:45:00	0.3
5:00:00	0.24
5:15:00	0

SWMM Reach 1 100-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
0:15:00	0
0:30:00	0.01
0:45:00	60.9
1:00:00	92.96
1:15:00	87.89
1:30:00	71.43
1:45:00	54.8
2:00:00	40.49
2:15:00	30.71
2:30:00	23.93
2:45:00	18.25
3:00:00	13.61
3:15:00	9.52
3:30:00	5.43
3:45:00	2.95
4:00:00	1.75
4:15:00	1.03
4:30:00	0.67
4:45:00	0.47
5:00:00	0.35
5:15:00	0.28
5:30:00	0

SWMM Reach 2 2-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
0:15:00	0
0:30:00	0.04
0:45:00	1.51
1:00:00	2.76
1:15:00	3.91
1:30:00	4.22
1:45:00	4.11
2:00:00	3.87
2:15:00	3.57
2:30:00	3.3
2:45:00	3.03
3:00:00	2.75
3:15:00	2.68
3:30:00	2.47
3:45:00	2.27
4:00:00	2.11
4:15:00	1.99
4:30:00	1.74
4:45:00	1.7
5:00:00	1.68
5:15:00	1.66
5:30:00	1.64
5:45:00	1.62
6:00:00	1.61
6:15:00	1.59
6:30:00	1.57
6:45:00	1.55
7:00:00	1.53
7:15:00	1.51
7:30:00	1.49
7:45:00	1.47
8:00:00	1.46
8:15:00	1.44

SWMM Reach 2 2-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
8:30:00	1.42
8:45:00	1.4
9:00:00	1.38
9:15:00	1.35
9:30:00	1.33
9:45:00	1.31
10:00:00	1.29
10:15:00	1.27
10:30:00	1.25
10:45:00	1.23
11:00:00	1.21
11:15:00	1.19
11:30:00	1.17
11:45:00	1.15
12:00:00	1.13
12:15:00	1.1
12:30:00	1.08
12:45:00	1.05
13:00:00	1.03
13:15:00	1
13:30:00	0.98
13:45:00	0.96
14:00:00	0.94
14:15:00	0.92
14:30:00	0.89
14:45:00	0.87
15:00:00	0.85
15:15:00	0.83
15:30:00	0.81
15:45:00	0.8
16:00:00	0.78
16:15:00	0.77
16:30:00	0.76

SWMM Reach 2 2-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
16:45:00	0.76
17:00:00	0.75
17:15:00	0.75
17:30:00	0.74
17:45:00	0.74
18:00:00	0.74
18:15:00	0.73
18:30:00	0.73
18:45:00	0.72
19:00:00	0.72
19:15:00	0.71
19:30:00	0.71
19:45:00	0.71
20:00:00	0.7
20:15:00	0.7
20:30:00	0.69
20:45:00	0.69
21:00:00	0.68
21:15:00	0.68
21:30:00	0.68
21:45:00	0.67
22:00:00	0.67
22:15:00	0.66
22:30:00	0.66
22:45:00	0.65
23:00:00	0.65
23:15:00	0.64
23:30:00	0.64
23:45:00	0.63
0:00:00	0.63

SWMM Reach 2 10-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
0:15:00	0
0:30:00	2.58
0:45:00	21.08
1:00:00	34.67
1:15:00	37.64
1:30:00	33.72
1:45:00	30.23
2:00:00	27.7
2:15:00	24.52
2:30:00	20.5
2:45:00	16.01
3:00:00	11.69
3:15:00	9.06
3:30:00	7.52
3:45:00	6.32
4:00:00	5.31
4:15:00	4.69
4:30:00	4.37
4:45:00	4.15
5:00:00	3.98
5:15:00	3.69
5:30:00	3.54
5:45:00	3.45
6:00:00	3.37
6:15:00	3.29
6:30:00	3.21
6:45:00	3.13
7:00:00	3.05
7:15:00	2.94
7:30:00	2.83
7:45:00	2.73
8:00:00	2.62
8:15:00	2.53

SWMM Reach 2 10-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
8:30:00	2.43
8:45:00	2.35
9:00:00	2.28
9:15:00	2.21
9:30:00	2.15
9:45:00	2.08
10:00:00	2.02
10:15:00	1.96
10:30:00	1.9
10:45:00	1.85
11:00:00	1.81
11:15:00	1.79
11:30:00	1.77
11:45:00	1.76
12:00:00	1.74
12:15:00	1.72
12:30:00	1.7
12:45:00	1.69
13:00:00	1.67
13:15:00	1.65
13:30:00	1.63
13:45:00	1.61
14:00:00	1.6
14:15:00	1.58
14:30:00	1.56
14:45:00	1.54
15:00:00	1.52
15:15:00	1.5
15:30:00	1.48
15:45:00	1.47
16:00:00	1.45
16:15:00	1.43
16:30:00	1.41

SWMM Reach 2 10-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
16:45:00	1.39
17:00:00	1.36
17:15:00	1.34
17:30:00	1.32
17:45:00	1.3
18:00:00	1.28
18:15:00	1.26
18:30:00	1.24
18:45:00	1.22
19:00:00	1.2
19:15:00	1.18
19:30:00	1.16
19:45:00	1.14
20:00:00	1.11
20:15:00	1.09
20:30:00	1.06
20:45:00	1.04
21:00:00	1.02
21:15:00	0.99
21:30:00	0.97
21:45:00	0.95
22:00:00	0.93
22:15:00	0.9
22:30:00	0.88
22:45:00	0.86
23:00:00	0.84
23:15:00	0.82
23:30:00	0.8
23:45:00	0.79
0:00:00	0.77

SWMM Reach 2 100-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
0:15:00	0
0:30:00	1.92
0:45:00	92.31
1:00:00	258.24
1:15:00	263.96
1:30:00	229.27
1:45:00	191.79
2:00:00	148.42
2:15:00	102.84
2:30:00	74.22
2:45:00	54.88
3:00:00	41.47
3:15:00	30.41
3:30:00	21.2
3:45:00	14.23
4:00:00	9.16
4:15:00	6.38
4:30:00	5.09
4:45:00	4.51
5:00:00	4.22
5:15:00	4.02
5:30:00	3.93
5:45:00	3.56
6:00:00	3.45
6:15:00	3.37
6:30:00	3.29
6:45:00	3.2
7:00:00	3.12
7:15:00	3.05
7:30:00	2.94
7:45:00	2.83
8:00:00	2.73
8:15:00	2.62

SWMM Reach 2 100-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
8:30:00	2.53
8:45:00	2.43
9:00:00	2.34
9:15:00	2.27
9:30:00	2.21
9:45:00	2.14
10:00:00	2.08
10:15:00	2.02
10:30:00	1.96
10:45:00	1.9
11:00:00	1.85
11:15:00	1.81
11:30:00	1.79
11:45:00	1.77
12:00:00	1.76
12:15:00	1.74
12:30:00	1.72
12:45:00	1.7
13:00:00	1.69
13:15:00	1.67
13:30:00	1.65
13:45:00	1.63
14:00:00	1.61
14:15:00	1.59
14:30:00	1.58
14:45:00	1.56
15:00:00	1.54
15:15:00	1.52
15:30:00	1.5
15:45:00	1.48
16:00:00	1.46
16:15:00	1.45
16:30:00	1.43

SWMM Reach 2 100-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
16:45:00	1.41
17:00:00	1.39
17:15:00	1.36
17:30:00	1.34
17:45:00	1.32
18:00:00	1.3
18:15:00	1.28
18:30:00	1.26
18:45:00	1.24
19:00:00	1.22
19:15:00	1.2
19:30:00	1.18
19:45:00	1.16
20:00:00	1.14
20:15:00	1.11
20:30:00	1.09
20:45:00	1.06
21:00:00	1.04
21:15:00	1.01
21:30:00	0.99
21:45:00	0.97
22:00:00	0.95
22:15:00	0.93
22:30:00	0.9
22:45:00	0.88
23:00:00	0.86
23:15:00	0.84
23:30:00	0.82
23:45:00	0.8
0:00:00	0.79

SWMM Reach 3 2-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
0:15:00	0
0:30:00	3.58
0:45:00	6.55
1:00:00	8.43
1:15:00	9.98
1:30:00	10.43
1:45:00	10.46
2:00:00	10.34
2:15:00	9.96
2:30:00	9.61
2:45:00	9.28
3:00:00	8.93
3:15:00	8.8
3:30:00	8.53
3:45:00	8.26
4:00:00	8.03
4:15:00	7.87
4:30:00	7.53
4:45:00	7.43
5:00:00	7.34
5:15:00	7.26
5:30:00	7.18
5:45:00	7.1
6:00:00	7.02
6:15:00	6.94
6:30:00	6.86
6:45:00	6.77
7:00:00	6.69
7:15:00	6.6
7:30:00	6.51
7:45:00	6.42
8:00:00	6.34
8:15:00	6.25

SWMM Reach 3 2-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
8:30:00	6.16
8:45:00	6.07
9:00:00	5.98
9:15:00	5.89
9:30:00	5.81
9:45:00	5.72
10:00:00	5.64
10:15:00	5.55
10:30:00	5.44
10:45:00	5.34
11:00:00	5.23
11:15:00	5.13
11:30:00	5.03
11:45:00	4.92
12:00:00	4.82
12:15:00	4.72
12:30:00	4.61
12:45:00	4.51
13:00:00	4.42
13:15:00	4.32
13:30:00	4.23
13:45:00	4.14
14:00:00	4.05
14:15:00	3.96
14:30:00	3.87
14:45:00	3.75
15:00:00	3.62
15:15:00	3.51
15:30:00	3.4
15:45:00	3.3
16:00:00	3.2
16:15:00	3.11
16:30:00	3.04

SWMM Reach 3 2-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
16:45:00	2.96
17:00:00	2.9
17:15:00	2.83
17:30:00	2.77
17:45:00	2.71
18:00:00	2.65
18:15:00	2.6
18:30:00	2.54
18:45:00	2.49
19:00:00	2.45
19:15:00	2.4
19:30:00	2.36
19:45:00	2.32
20:00:00	2.28
20:15:00	2.24
20:30:00	2.2
20:45:00	2.17
21:00:00	2.13
21:15:00	2.1
21:30:00	2.07
21:45:00	2.04
22:00:00	2
22:15:00	1.98
22:30:00	1.95
22:45:00	1.92
23:00:00	1.89
23:15:00	1.86
23:30:00	1.84
23:45:00	1.81
0:00:00	1.79

SWMM Reach 3 10-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
0:15:00	0.25
0:30:00	8.34
0:45:00	28.78
1:00:00	43.4
1:15:00	48.65
1:30:00	46.25
1:45:00	45.29
2:00:00	48.32
2:15:00	45.87
2:30:00	39.02
2:45:00	32.43
3:00:00	26.73
3:15:00	22.71
3:30:00	19.94
3:45:00	17.57
4:00:00	16.04
4:15:00	15.24
4:30:00	14.75
4:45:00	14.37
5:00:00	14.04
5:15:00	13.61
5:30:00	13.29
5:45:00	13.05
6:00:00	12.78
6:15:00	12.46
6:30:00	12.14
6:45:00	11.84
7:00:00	11.54
7:15:00	11.21
7:30:00	10.88
7:45:00	10.56
8:00:00	10.25
8:15:00	9.95

SWMM Reach 3 10-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
8:30:00	9.72
8:45:00	9.54
9:00:00	9.38
9:15:00	9.2
9:30:00	9.04
9:45:00	8.87
10:00:00	8.71
10:15:00	8.55
10:30:00	8.39
10:45:00	8.24
11:00:00	8.11
11:15:00	8.01
11:30:00	7.92
11:45:00	7.84
12:00:00	7.76
12:15:00	7.67
12:30:00	7.59
12:45:00	7.51
13:00:00	7.43
13:15:00	7.35
13:30:00	7.27
13:45:00	7.19
14:00:00	7.11
14:15:00	7.02
14:30:00	6.94
14:45:00	6.85
15:00:00	6.77
15:15:00	6.68
15:30:00	6.59
15:45:00	6.51
16:00:00	6.43
16:15:00	6.34
16:30:00	6.26

SWMM Reach 3 10-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
16:45:00	6.17
17:00:00	6.08
17:15:00	5.99
17:30:00	5.9
17:45:00	5.81
18:00:00	5.72
18:15:00	5.62
18:30:00	5.52
18:45:00	5.43
19:00:00	5.33
19:15:00	5.24
19:30:00	5.15
19:45:00	5.05
20:00:00	4.95
20:15:00	4.84
20:30:00	4.74
20:45:00	4.63
21:00:00	4.53
21:15:00	4.44
21:30:00	4.34
21:45:00	4.24
22:00:00	4.15
22:15:00	4.06
22:30:00	3.94
22:45:00	3.8
23:00:00	3.66
23:15:00	3.53
23:30:00	3.41
23:45:00	3.29
0:00:00	3.19

SWMM Reach 3 100-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
0:15:00	0.36
0:30:00	10.2
0:45:00	105.26
1:00:00	387.41
1:15:00	436.92
1:30:00	401.62
1:45:00	354.81
2:00:00	264.61
2:15:00	185.2
2:30:00	131.13
2:45:00	94.64
3:00:00	69.91
3:15:00	52.86
3:30:00	38.67
3:45:00	29.56
4:00:00	22.99
4:15:00	19.14
4:30:00	17
4:45:00	15.69
5:00:00	14.83
5:15:00	14.47
5:30:00	14.21
5:45:00	13.68
6:00:00	13.41
6:15:00	13.16
6:30:00	12.92
6:45:00	12.68
7:00:00	12.43
7:15:00	12.1
7:30:00	11.76
7:45:00	11.41
8:00:00	11.07
8:15:00	10.74

SWMM Reach 3 100-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
8:30:00	10.43
8:45:00	10.12
9:00:00	9.82
9:15:00	9.55
9:30:00	9.34
9:45:00	9.17
10:00:00	9
10:15:00	8.84
10:30:00	8.68
10:45:00	8.52
11:00:00	8.37
11:15:00	8.24
11:30:00	8.13
11:45:00	8.05
12:00:00	7.97
12:15:00	7.89
12:30:00	7.8
12:45:00	7.72
13:00:00	7.64
13:15:00	7.56
13:30:00	7.47
13:45:00	7.39
14:00:00	7.31
14:15:00	7.23
14:30:00	7.14
14:45:00	7.06
15:00:00	6.98
15:15:00	6.9
15:30:00	6.81
15:45:00	6.73
16:00:00	6.64
16:15:00	6.56
16:30:00	6.47

SWMM Reach 3 100-YR Time Series Table	
Time	Flow
(15 min)	(CFS)
16:45:00	6.38
17:00:00	6.29
17:15:00	6.2
17:30:00	6.11
17:45:00	6.02
18:00:00	5.93
18:15:00	5.84
18:30:00	5.76
18:45:00	5.67
19:00:00	5.58
19:15:00	5.48
19:30:00	5.38
19:45:00	5.29
20:00:00	5.19
20:15:00	5.09
20:30:00	4.98
20:45:00	4.87
21:00:00	4.76
21:15:00	4.66
21:30:00	4.56
21:45:00	4.46
22:00:00	4.36
22:15:00	4.27
22:30:00	4.18
22:45:00	4.08
23:00:00	3.99
23:15:00	3.91
23:30:00	3.76
23:45:00	3.63
0:00:00	3.5

Summary of CUHP Input Parameters (Version 2.0.0)

								Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	SWMM Node/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
4-I	4-I	100 YEAR	0.159	0.355	0.753	0.018	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.79
5-I	5-I	100 YEAR	0.248	0.631	1.236	0.024	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.79
6-I	6-I	100 YEAR	0.287	0.642	1.135	0.023	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.79
2-J	2-J	100 YEAR	0.127	0.357	0.731	0.035	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.79
EX-1	EX-1	100 YEAR	0.027	0.329	0.356	0.067	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.79
EX-2	EX-2	100 YEAR	0.003	0.048	0.138	0.023	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.00	0.02	1.79

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.0)

		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)
4-I	100 YEAR	0.156	0.205	49.6	9.30	25.8	6.57	15.5	96	369,861	1.52	560,462	55.0	115	559,933	1.13
5-I	100 YEAR	0.156	0.237	67.3	13.75	35.0	9.72	22.9	111	577,170	1.52	874,604	65.0	145	874,474	0.91
6-I	100 YEAR	0.156	0.248	62.8	13.45	32.7	9.50	22.4	137	667,847	1.52	1,012,011	60.0	176	1,011,804	0.96
2-J	100 YEAR	0.156	0.185	46.4	8.09	24.2	5.72	13.5	82	294,502	1.52	446,268	50.0	96	446,088	1.19
EX-1	100 YEAR	0.156	0.092	54.4	5.35	28.3	3.78	8.9	15	62,981	1.52	95,436	50.0	18	95,352	1.03
EX-2	100 YEAR	0.156	0.034	48.2	2.75	25.0	1.94	4.6	2	6,752	1.52	10,231	50.0	2	10,138	1.11

Summary of CUHP Input Parameters (Version 2.0.0)

								Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	SWMM Node/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
A-1	A-1	2 YEAR	0.057	0.217	0.343	0.029	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.42
A-2	A-2	2 YEAR	0.102	0.344	0.205	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
A-3	A-3	2 YEAR	0.003	0.095	0.142	0.015	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	88.92
B-1	B-1	2 YEAR	0.108	0.325	0.556	0.021	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
B-2	B-2	2 YEAR	0.033	0.153	0.325	0.042	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-1	C-1	2 YEAR	0.075	0.203	0.434	0.012	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-2	C-2	2 YEAR	0.031	0.078	0.201	0.025	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
C-3	C-3	2 YEAR	0.041	0.400	0.760	0.019	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	88.92
C-4	C-4	2 YEAR	0.004	0.070	0.130	0.012	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	88.92
C-5	C-5	2 YEAR	0.018	0.520	0.881	0.023	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	88.92
C-6	C-6	2 YEAR	0.004	0.040	0.062	0.008	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	88.92
D-1	D-1	2 YEAR	0.042	0.178	0.255	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
D-2	D-2	2 YEAR	0.029	0.303	0.319	0.047	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.42
E	E	2 YEAR	0.048	0.070	0.288	0.013	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.24
F	F	2 YEAR	0.026	0.170	0.459	0.021	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.42
OS-1	OS-1	2 YEAR	0.121	0.330	0.687	0.030	8.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.17	0.09	6.48
OS-2	OS-2	2 YEAR	0.077	0.299	0.598	0.018	5.9	0.35	0.10	3.00	0.50	0.0018	0.00	0.12	0.06	4.28

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.0)

		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)
A-1	2 YEAR	0.158	0.130	38.3	5.32	19.9	3.76	8.9	44	131,696	0.01	1,148	40.0	0	1,145	0.01
A-2	2 YEAR	0.079	0.224	14.0	3.91	7.3	2.76	6.5	218	236,240	0.57	133,812	30.0	54	132,919	0.83
A-3	2 YEAR	0.075	0.048	25.3	2.43	13.1	1.72	4.1	4	7,042	0.69	4,885	30.0	1	4,763	0.64
B-1	2 YEAR	0.079	0.231	17.9	4.66	9.3	3.29	7.8	182	251,160	0.57	142,263	30.0	49	141,564	0.70
B-2	2 YEAR	0.079	0.135	13.9	2.94	7.2	2.08	4.9	71	76,121	0.57	43,117	30.0	17	41,861	0.80
C-1	2 YEAR	0.079	0.196	17.0	4.07	8.9	2.87	6.8	133	175,329	0.57	99,311	30.0	35	98,645	0.73
C-2	2 YEAR	0.079	0.131	9.3	2.44	4.8	1.72	4.1	99	71,620	0.57	40,567	30.0	19	38,329	0.96
C-3	2 YEAR	0.075	0.155	33.0	5.44	17.2	3.84	9.1	37	95,251	0.69	66,078	35.0	14	65,997	0.55
C-4	2 YEAR	0.075	0.057	18.7	2.32	9.7	1.64	3.9	7	10,200	0.69	7,076	30.0	2	6,829	0.80
C-5	2 YEAR	0.075	0.108	55.2	6.08	28.7	4.30	10.1	10	42,616	0.69	29,564	45.0	4	29,556	0.37
C-6	2 YEAR	0.075	0.052	12.2	1.98	6.3	1.40	3.3	9	8,204	0.69	5,691	30.0	2	5,304	1.00
D-1	2 YEAR	0.079	0.150	14.3	3.15	7.4	2.23	5.3	87	96,703	0.57	54,775	30.0	21	53,709	0.80
D-2	2 YEAR	0.158	0.096	52.3	5.36	27.2	3.78	8.9	17	67,591	0.01	589	40.0	0	589	0.01
E	2 YEAR	0.079	0.160	10.1	2.74	5.3	1.94	4.6	141	110,751	0.57	62,732	30.0	29	60,499	0.95
F	2 YEAR	0.158	0.092	59.9	5.72	31.1	4.04	9.5	13	60,984	0.01	532	45.0	0	531	0.01
OS-1	2 YEAR	0.139	0.162	45.6	7.19	23.7	5.08	12.0	80	281,071	0.04	11,508	40.0	3	11,503	0.03
OS-2	2 YEAR	0.147	0.139	56.9	7.58	29.6	5.35	12.6	40	178,160	0.03	4,754	45.0	1	4,754	0.02

Summary of CUHP Input Parameters (Version 2.0.0)

								Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	SWMM Node/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
A-1	A-1	10 YEAR	0.057	0.217	0.343	0.029	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.63
A-2	A-2	10 YEAR	0.102	0.344	0.205	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
A-3	A-3	10 YEAR	0.003	0.095	0.142	0.015	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	89.31
B-1	B-1	10 YEAR	0.108	0.325	0.556	0.021	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
B-2	B-2	10 YEAR	0.033	0.153	0.325	0.042	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-1	C-1	10 YEAR	0.075	0.203	0.434	0.012	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-2	C-2	10 YEAR	0.031	0.078	0.201	0.025	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
C-3	C-3	10 YEAR	0.041	0.400	0.760	0.019	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	89.31
C-4	C-4	10 YEAR	0.004	0.070	0.130	0.012	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	89.31
C-5	C-5	10 YEAR	0.018	0.520	0.881	0.023	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	89.31
C-6	C-6	10 YEAR	0.004	0.040	0.062	0.008	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	89.31
D-1	D-1	10 YEAR	0.042	0.178	0.255	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
D-2	D-2	10 YEAR	0.029	0.303	0.319	0.047	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.63
E	E	10 YEAR	0.048	0.070	0.288	0.013	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	73.88
F	F	10 YEAR	0.026	0.170	0.459	0.021	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.63
OS-1	OS-1	10 YEAR	0.121	0.330	0.687	0.030	8.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.17	0.09	7.28
OS-2	OS-2	10 YEAR	0.077	0.299	0.598	0.018	5.9	0.35	0.10	3.00	0.50	0.0018	0.00	0.12	0.06	4.85

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.0)

		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)
A-1	10 YEAR	0.157	0.129	38.3	5.30	19.9	3.74	8.8	44	131,696	0.25	33,128	40.0	9	33,049	0.26
A-2	10 YEAR	0.079	0.225	13.9	3.90	7.2	2.76	6.5	219	236,240	1.09	257,313	30.0	102	255,541	1.56
A-3	10 YEAR	0.075	0.048	25.2	2.43	13.1	1.72	4.1	4	7,042	1.27	8,929	30.0	2	8,704	1.13
B-1	10 YEAR	0.079	0.231	17.8	4.65	9.2	3.29	7.8	182	251,160	1.09	273,563	30.0	92	272,191	1.33
B-2	10 YEAR	0.079	0.135	13.9	2.94	7.2	2.08	4.9	71	76,121	1.09	82,911	30.0	31	80,437	1.50
C-1	10 YEAR	0.079	0.197	16.9	4.06	8.8	2.87	6.8	134	175,329	1.09	190,968	30.0	67	189,786	1.38
C-2	10 YEAR	0.079	0.131	9.3	2.44	4.8	1.72	4.1	100	71,620	1.09	78,008	25.0	36	73,661	1.82
C-3	10 YEAR	0.075	0.155	33.0	5.44	17.1	3.84	9.1	37	95,251	1.27	120,772	35.0	25	120,614	0.96
C-4	10 YEAR	0.075	0.057	18.7	2.32	9.7	1.64	3.9	7	10,200	1.27	12,933	30.0	4	12,479	1.39
C-5	10 YEAR	0.075	0.108	55.1	6.08	28.6	4.30	10.1	10	42,616	1.27	54,034	45.0	8	54,024	0.65
C-6	10 YEAR	0.075	0.052	12.2	1.98	6.3	1.40	3.3	9	8,204	1.27	10,402	30.0	4	9,693	1.72
D-1	10 YEAR	0.079	0.150	14.3	3.15	7.4	2.22	5.2	88	96,703	1.09	105,329	30.0	40	103,255	1.50
D-2	10 YEAR	0.157	0.096	52.3	5.34	27.2	3.77	8.9	17	67,591	0.25	17,002	40.0	4	16,985	0.20
E	10 YEAR	0.079	0.160	10.1	2.74	5.2	1.94	4.6	142	110,751	1.09	120,630	25.0	53	116,299	1.75
F	10 YEAR	0.157	0.091	59.9	5.70	31.1	4.03	9.5	13	60,984	0.25	15,340	45.0	3	15,335	0.18
OS-1	10 YEAR	0.136	0.159	45.5	7.07	23.7	5.00	11.8	80	281,071	0.32	90,162	45.0	21	90,119	0.27
OS-2	10 YEAR	0.145	0.137	56.8	7.49	29.5	5.29	12.5	41	178,160	0.29	51,884	45.0	10	51,877	0.21

Summary of CUHP Input Parameters (Version 2.0.0)

								Depression Storage		Horton's Infiltration Parameters			DCIA Level and Fractions			
Catchment Name/ID	SWMM Node/ID	Raingage Name/ID	Area (sq.mi.)	Dist. to Centroid (miles)	Length (miles)	Slope (ft./ft.)	Percent Imperv.	Pervious (inches)	Imperv. (inches)	Initial Rate (in./hr.)	Final Rate (in.hr.)	Decay Coeff. (1/sec.)	DCIA Level	Dir. Con'ct Imperv. Fraction	Receiv. Perv. Fraction	Percent Eff. Imperv.
A-1	A-1	100 YEAR	0.057	0.217	0.343	0.029	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.79
A-2	A-2	100 YEAR	0.102	0.344	0.205	0.010	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
A-3	A-3	100 YEAR	0.003	0.095	0.142	0.015	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	89.61
B-1	B-1	100 YEAR	0.108	0.325	0.556	0.021	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
B-2	B-2	100 YEAR	0.033	0.153	0.325	0.042	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-1	C-1	100 YEAR	0.075	0.203	0.434	0.012	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-2	C-2	100 YEAR	0.031	0.078	0.201	0.025	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
C-3	C-3	100 YEAR	0.041	0.400	0.760	0.019	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	89.61
C-4	C-4	100 YEAR	0.004	0.070	0.130	0.012	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	89.61
C-5	C-5	100 YEAR	0.018	0.520	0.881	0.023	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	89.61
C-6	C-6	100 YEAR	0.004	0.040	0.062	0.008	90.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.96	0.37	89.61
D-1	D-1	100 YEAR	0.042	0.178	0.255	0.020	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
D-2	D-2	100 YEAR	0.029	0.303	0.319	0.047	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.79
E	E	100 YEAR	0.048	0.070	0.288	0.013	75.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.93	0.32	74.34
F	F	100 YEAR	0.026	0.170	0.459	0.021	2.0	0.35	0.10	3.00	0.50	0.0018	0.00	0.04	0.02	1.79
OS-1	OS-1	100 YEAR	0.121	0.330	0.687	0.030	8.7	0.35	0.10	3.00	0.50	0.0018	0.00	0.17	0.09	7.89
OS-2	OS-2	100 YEAR	0.077	0.299	0.598	0.018	5.9	0.35	0.10	3.00	0.50	0.0018	0.00	0.12	0.06	5.28

Summary of Unit Hydrograph Parameters Used By Program and Calculated Results (Version 2.0.0)

		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)
A-1	100 YEAR	0.156	0.129	38.3	5.28	19.9	3.73	8.8	44	131,696	1.52	199,564	45.0	49	199,083	1.35
A-2	100 YEAR	0.079	0.225	13.9	3.90	7.2	2.75	6.5	220	236,240	2.35	555,912	35.0	228	551,977	3.50
A-3	100 YEAR	0.075	0.048	25.2	2.43	13.1	1.72	4.1	4	7,042	2.53	17,824	40.0	5	17,374	2.39
B-1	100 YEAR	0.079	0.231	17.7	4.65	9.2	3.29	7.7	183	251,160	2.35	591,020	35.0	208	587,991	3.01
B-2	100 YEAR	0.079	0.135	13.8	2.93	7.2	2.07	4.9	71	76,121	2.35	179,125	35.0	71	173,681	3.37
C-1	100 YEAR	0.079	0.197	16.9	4.05	8.8	2.87	6.8	134	175,329	2.35	412,578	35.0	151	410,168	3.12
C-2	100 YEAR	0.079	0.132	9.2	2.43	4.8	1.72	4.1	100	71,620	2.35	168,533	30.0	79	159,105	4.03
C-3	100 YEAR	0.075	0.155	32.9	5.43	17.1	3.84	9.1	37	95,251	2.53	241,080	45.0	55	240,761	2.09
C-4	100 YEAR	0.075	0.057	18.6	2.31	9.7	1.64	3.9	7	10,200	2.53	25,817	35.0	8	24,906	2.93
C-5	100 YEAR	0.075	0.108	55.0	6.07	28.6	4.29	10.1	10	42,616	2.53	107,861	50.0	17	107,843	1.45
C-6	100 YEAR	0.075	0.052	12.2	1.98	6.3	1.40	3.3	9	8,204	2.53	20,764	35.0	8	19,349	3.58
D-1	100 YEAR	0.079	0.151	14.2	3.14	7.4	2.22	5.2	88	96,703	2.35	227,558	35.0	90	223,031	3.37
D-2	100 YEAR	0.156	0.095	52.2	5.32	27.2	3.76	8.9	17	67,591	1.52	102,422	50.0	20	102,319	1.07
E	100 YEAR	0.079	0.160	10.1	2.74	5.2	1.93	4.6	142	110,751	2.35	260,616	35.0	119	251,190	3.91
F	100 YEAR	0.156	0.091	59.9	5.68	31.1	4.01	9.5	13	60,984	1.52	92,411	55.0	16	92,378	0.96
OS-1	100 YEAR	0.134	0.157	45.4	6.98	23.6	4.93	11.6	80	281,071	1.59	445,892	50.0	96	445,644	1.24
OS-2	100 YEAR	0.143	0.136	56.7	7.42	29.5	5.25	12.4	41	178,160	1.56	277,239	55.0	51	277,208	1.03

Pond C-1 Outfall Riprap Apron Sizing for Circular Conduit

Variables			Calculations			
Q =	95.1	ft^3/s	**L_p**	118.6	ft	Length of riprap apron protection
***V =**	1.9	ft/s	**A_t**	50.05263	ft^2	
D =	4	ft	**Expansion Factor**	6.5		Determined from Fig 9-35
Y_t =	2.25	ft	**Θ**	0.076772		Expansion angle of culvert flow
			Q/D^5/2	2.971875		Froude parameter
***5 ft/s for A and B soils, 7 ft/s for C and D soils**			**T**	10.2	ft	Width of Riprap apron protection
			Y_t/D	0.5625		

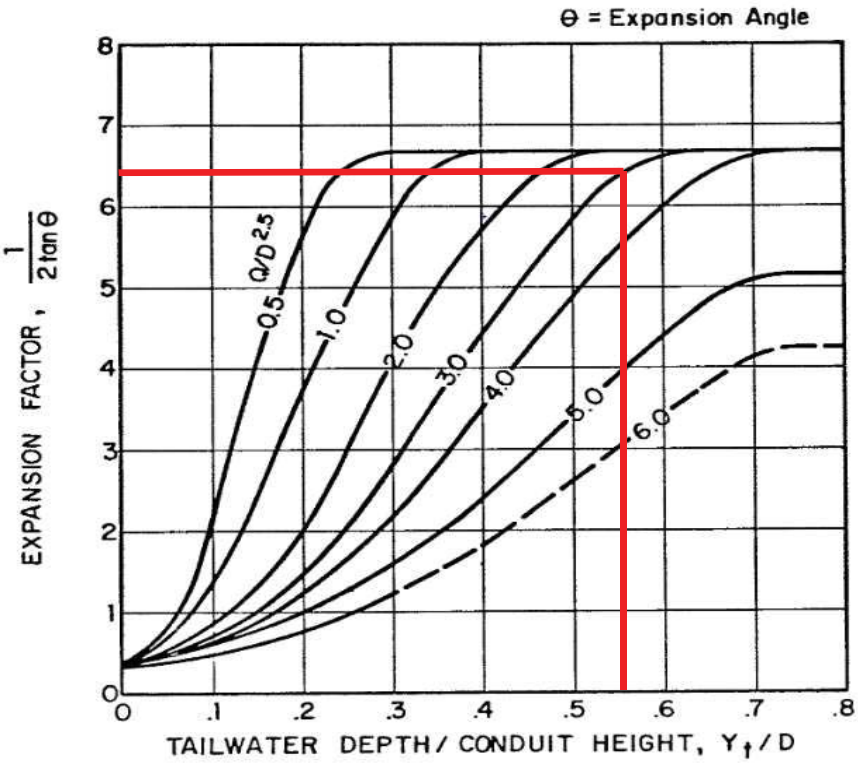


Figure 9-35. Expansion factor for circular conduits

$$L_p = \left(\frac{1}{2\tan\theta}\right)\left(\frac{A_t}{Y_t} - W\right)$$ Equation 9-11

Where:

L_p = length of protection (ft)

W = width of the conduit (ft, use diameter for circular conduits)

Y_t = tailwater depth (ft)

θ = the expansion angle of the culvert flow

and:

$$A_t = \frac{Q}{V} \qquad \text{Equation 9-12}$$

Where:

Q = design discharge (cfs)

V = the allowable non-eroding velocity in the downstream channel (ft/sec)

A_t = required area of flow at allowable velocity (ft²)

$$\theta = \tan^{-1}\left(\frac{1}{2(\text{ExpansionFactor})}\right) \qquad \text{Equation 9-13}$$

Where:

Expansion Factor = determined using Figure 9-35 or 9-36

T is then calculated using the following equation:

$$T = 2(L_p \tan\theta) + W \qquad \text{Equation 9-14}$$

In certain circumstances, Equation 9-11 may yield unreasonable results. Therefore, in no case should L_p be less than $3H$ or $3D$, nor does L_p need to be greater than $10H$ or $10D$ whenever the Froude parameter, $Q/WH^{1.5}$ or $Q/D^{2.5}$, is less than 8.0 or 6.0, respectively. Whenever the Froude parameter is greater than these maximums, increase the maximum L_p required by ¼ D_c or ¼ H for circular or rectangular (box) culverts, respectively, for each whole number by which the Froude parameter is greater than 8.0 or 6.0, respectively.

Once L_p has been determined, the width of the riprap protection at the furthest downstream point should be verified. This dimension is labeled "T" on Figure 9-34. The first step is to solve for ϑ using the results from Figure 9-35 or 9-36:

Is L_p less than 3D:	NO
Is L_p greater than 10D and the Froude number less than 6:	YES
Is the Froude number greater than 6:	NO
If YES, then by how many whole numbers:	

New L_p 40 ft

Pond C-1 Outfall Riprap Type Selection for Circular Conduits

Variables			Calculations		
D =	4	ft	**D_a**	2	ft
Q =	95.1	ft^3/s	**Q/(D^1.5)**	11.9	
Y_t =	2.25	ft	**Riprap Size =**	L	Using Figure 9-38
Y_t/D =	0.5625				
Y_n =		ft	(normal depth of supercritical flow)		

3.2.3 Rock Sizing for Riprap Apron and Low Tailwater Basin

Scour resulting from highly turbulent, rapidly decelerating flow is a common problem at conduit outlets. The following section summarizes the method for sizing riprap protection for both riprap aprons (Section 3.2.1) and low tailwater basins (Section 3.2.2).

Use Figure 9-38 to determine the required rock size for circular conduits and Figure 9-39 for rectangular conduits. Figure 9-38 is valid for $Q/D_c^{2.5}$ of 6.0 or less and Figure 9-39 is valid for $Q/WH^{1.5}$ of 8.0 or less. The parameters in these two figures are:

1. $Q/D^{1.5}$ or $Q/WH^{0.5}$ in which Q is the design discharge in cfs, D_c is the diameter of a circular conduit in feet, and W and H are the width and height of a rectangular conduit in feet.

2. Y_t/D_c or Y_t/H in which Y_t is the tailwater depth in feet, D_c is the diameter of a circular conduit in feet, and H is the height of a rectangular conduit in feet. In cases where Y_t is unknown or a hydraulic jump is suspected downstream of the outlet, use $Y_t/D_t = Y_t/H = 0.40$ when using Figures 9-38 and 9-39.

3. The riprap size requirements in Figures 9-38 and 9-39 are based on the non-dimensional parametric Equations 9-16 and 9-17 (Steven, Simons, and Watts 1971 and Smith 1975).

Circular culvert:

$$d_{50} = \frac{0.023Q}{Y_t^{1.2} D_c^{0.3}} \qquad \text{Equation 9-16}$$

Can use figure 9-38:	YES	
Is a hydraulic jump expected downstream:	NO	(Type "YES" or "NO")

Is the flow in the culvert supercritical: NO (Type "YES" or "NO")

New Y_t/D = 0.5625

These rock size requirements assume that the flow in the culvert is subcritical. It is possible to use Equations 9-16 and 9-17 when the flow in the culvert is supercritical (and less than full) if the value of D_c or H is modified for use in Figures 9-38 and 9-39. Note that rock sizes referenced in these figures are defined in the *Open Channels* chapter. Whenever the flow is supercritical in the culvert, substitute D_a for D_c and H_a for H, in which D_a is defined as:

$$D_a = \frac{(D_c + Y_n)}{2} \qquad \text{Equation 9-18}$$

Where the maximum value of D_a shall not exceed D_c, and

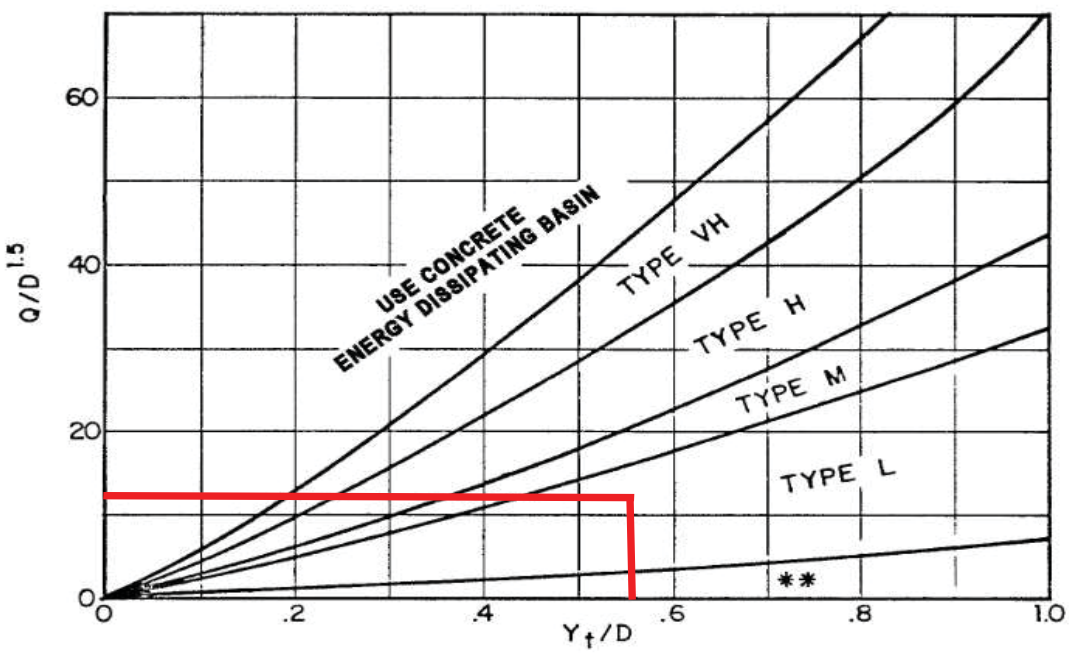
D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

Y_n = normal depth of supercritical flow in the culvert (ft)



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

Storm Line F Riprap Apron Sizing for Circular Conduit

Variables			Calculations			
Q =	12.5	ft^3/s	**L_p**	0.7	ft	Length of riprap apron protection
***V =**	7	ft/s	**A_t**	1.785714	ft^2	
D =	2	ft	**Expansion Factor**	5.8		Determined from Fig 9-35
Y_t =	0.84	ft	**Θ**	0.085994		Expansion angle of culvert flow
			Q/D^5/2	2.209709		Froude parameter
***5 ft/s for A and B soils, 7 ft/s for C and D soils**			**T**	3.0	ft	Width of Riprap apron protection
			Y_t/D	0.42		

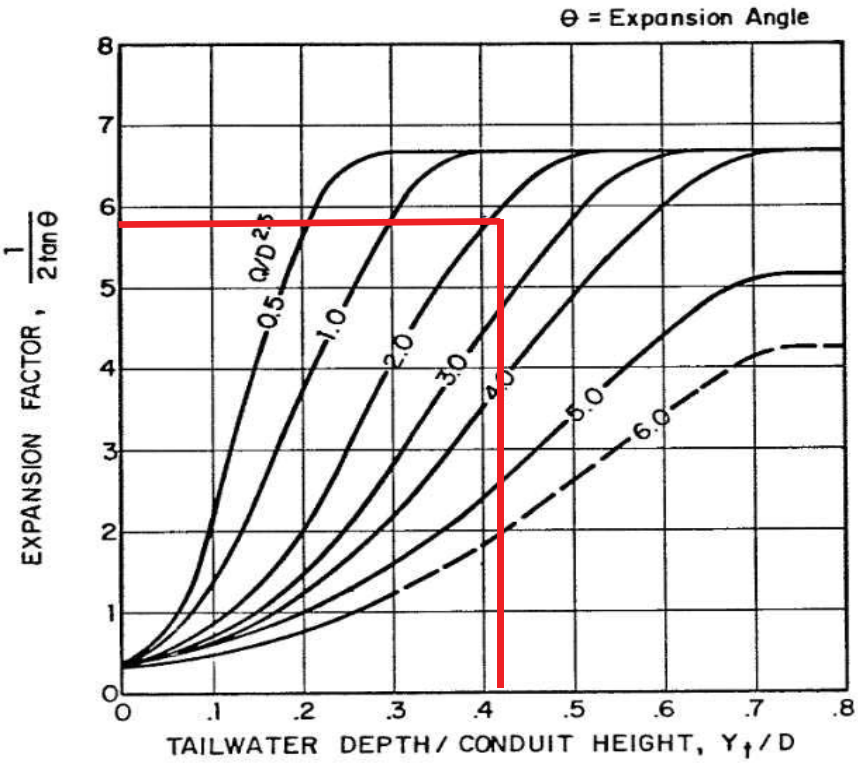


Figure 9-35. Expansion factor for circular conduits

$$L_p = \left(\frac{1}{2\tan\theta}\right)\left(\frac{A_t}{Y_t} - W\right)$$ Equation 9-11

Where:

L_p = length of protection (ft)

W = width of the conduit (ft, use diameter for circular conduits)

Y_t = tailwater depth (ft)

θ = the expansion angle of the culvert flow

and:

$$A_t = \frac{Q}{V} \qquad \text{Equation 9-12}$$

Where:

Q = design discharge (cfs)

V = the allowable non-eroding velocity in the downstream channel (ft/sec)

A_t = required area of flow at allowable velocity (ft²)

$$\theta = \tan^{-1}\left(\frac{1}{2(\text{ExpansionFactor})}\right) \qquad \text{Equation 9-13}$$

Where:

Expansion Factor = determined using Figure 9-35 or 9-36

T is then calculated using the following equation:

$$T = 2(L_p \tan\theta) + W \qquad \text{Equation 9-14}$$

In certain circumstances, Equation 9-11 may yield unreasonable results. Therefore, in no case should L_p be less than $3H$ or $3D$, nor does L_p need to be greater than $10H$ or $10D$ whenever the Froude parameter, $Q/WH^{1.5}$ or $Q/D^{2.5}$, is less than 8.0 or 6.0, respectively. Whenever the Froude parameter is greater than these maximums, increase the maximum L_p required by ¼ D_c or ¼ H for circular or rectangular (box) culverts, respectively, for each whole number by which the Froude parameter is greater than 8.0 or 6.0, respectively.

Once L_p has been determined, the width of the riprap protection at the furthest downstream point should be verified. This dimension is labeled "T" on Figure 9-34. The first step is to solve for ϑ using the results from Figure 9-35 or 9-36:

Is L_p less than 3D:	YES
Is L_p greater than 10D and the Froude number less than 6:	NO
Is the Froude number greater than 6:	NO
If YES, then by how many whole numbers:	NO

New L_p	6 ft

Storm Line F Riprap Type Selection for Circular Conduits

Variables			Calculations		
D =	2	ft	**D_a**	1.52	ft
Q =	12.5	ft^3/s	**Q/(D^1.5)**	4.4	
Y_t =	0.84	ft	**Riprap Size =**	L	Using Figure 9-38
Y_t/D =	0.42				
Y_n =	1.04	ft	(normal depth of supercritical flow)		

3.2.3 Rock Sizing for Riprap Apron and Low Tailwater Basin

Scour resulting from highly turbulent, rapidly decelerating flow is a common problem at conduit outlets. The following section summarizes the method for sizing riprap protection for both riprap aprons (Section 3.2.1) and low tailwater basins (Section 3.2.2).

Use Figure 9-38 to determine the required rock size for circular conduits and Figure 9-39 for rectangular conduits. Figure 9-38 is valid for $Q/D_c^{2.5}$ of 6.0 or less and Figure 9-39 is valid for $Q/WH^{1.5}$ of 8.0 or less. The parameters in these two figures are:

1. $Q/D^{1.5}$ or $Q/WH^{0.5}$ in which Q is the design discharge in cfs, D_c is the diameter of a circular conduit in feet, and W and H are the width and height of a rectangular conduit in feet.

2. Y_t/D_c or Y_t/H in which Y_t is the tailwater depth in feet, D_c is the diameter of a circular conduit in feet, and H is the height of a rectangular conduit in feet. In cases where Y_t is unknown or a hydraulic jump is suspected downstream of the outlet, use $Y_t/D_t = Y_t/H = 0.40$ when using Figures 9-38 and 9-39.

3. The riprap size requirements in Figures 9-38 and 9-39 are based on the non-dimensional parametric Equations 9-16 and 9-17 (Steven, Simons, and Watts 1971 and Smith 1975).

Circular culvert:

$$d_{50} = \frac{0.023Q}{Y_t^{1.2} D_c^{0.3}} \qquad \text{Equation 9-16}$$

Can use figure 9-38:	YES	
Is a hydraulic jump expected downstream:	NO	(Type "YES" or "NO")

Is the flow in the culvert supercritical: YES (Type "YES" or "NO")

New Y_t/D = 0.552632

These rock size requirements assume that the flow in the culvert is subcritical. It is possible to use Equations 9-16 and 9-17 when the flow in the culvert is supercritical (and less than full) if the value of D_c or H is modified for use in Figures 9-38 and 9-39. Note that rock sizes referenced in these figures are defined in the *Open Channels* chapter. Whenever the flow is supercritical in the culvert, substitute D_a for D_c and H_a for H, in which D_a is defined as:

$$D_a = \frac{(D_c + Y_n)}{2} \qquad \text{Equation 9-18}$$

Where the maximum value of D_a shall not exceed D_c, and

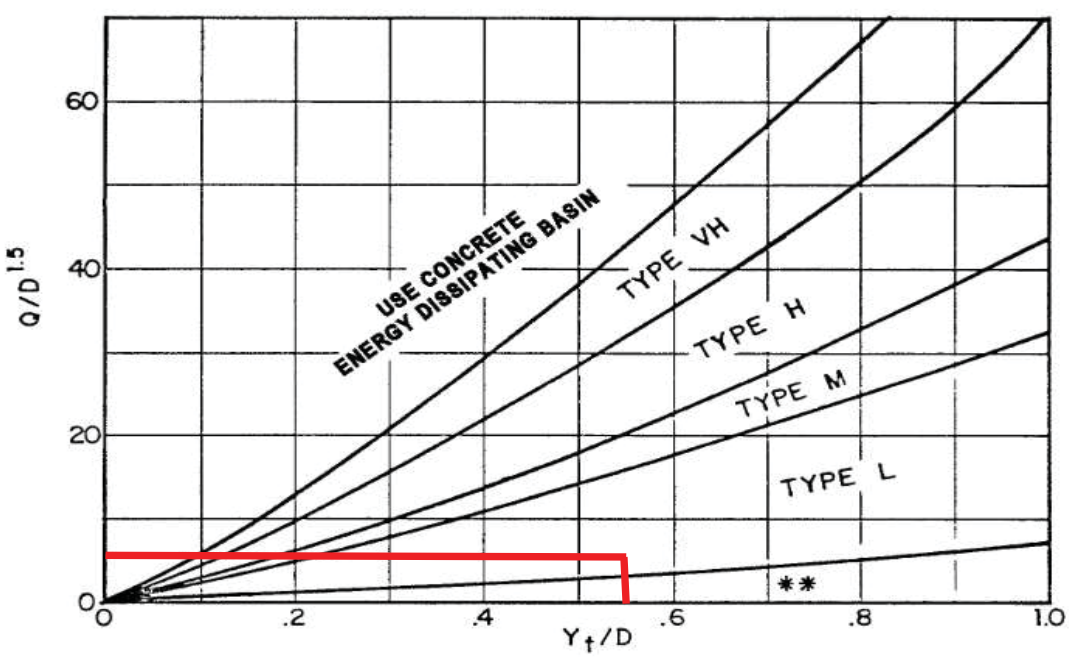
D_a = parameter to use in place of D in Figure 9-38 when flow is supercritical (ft)

D_c = diameter of circular culvert (ft)

H_a = parameter to use in place of H in Figure 9-39 when flow is supercritical (ft)

H = height of rectangular culvert (ft)

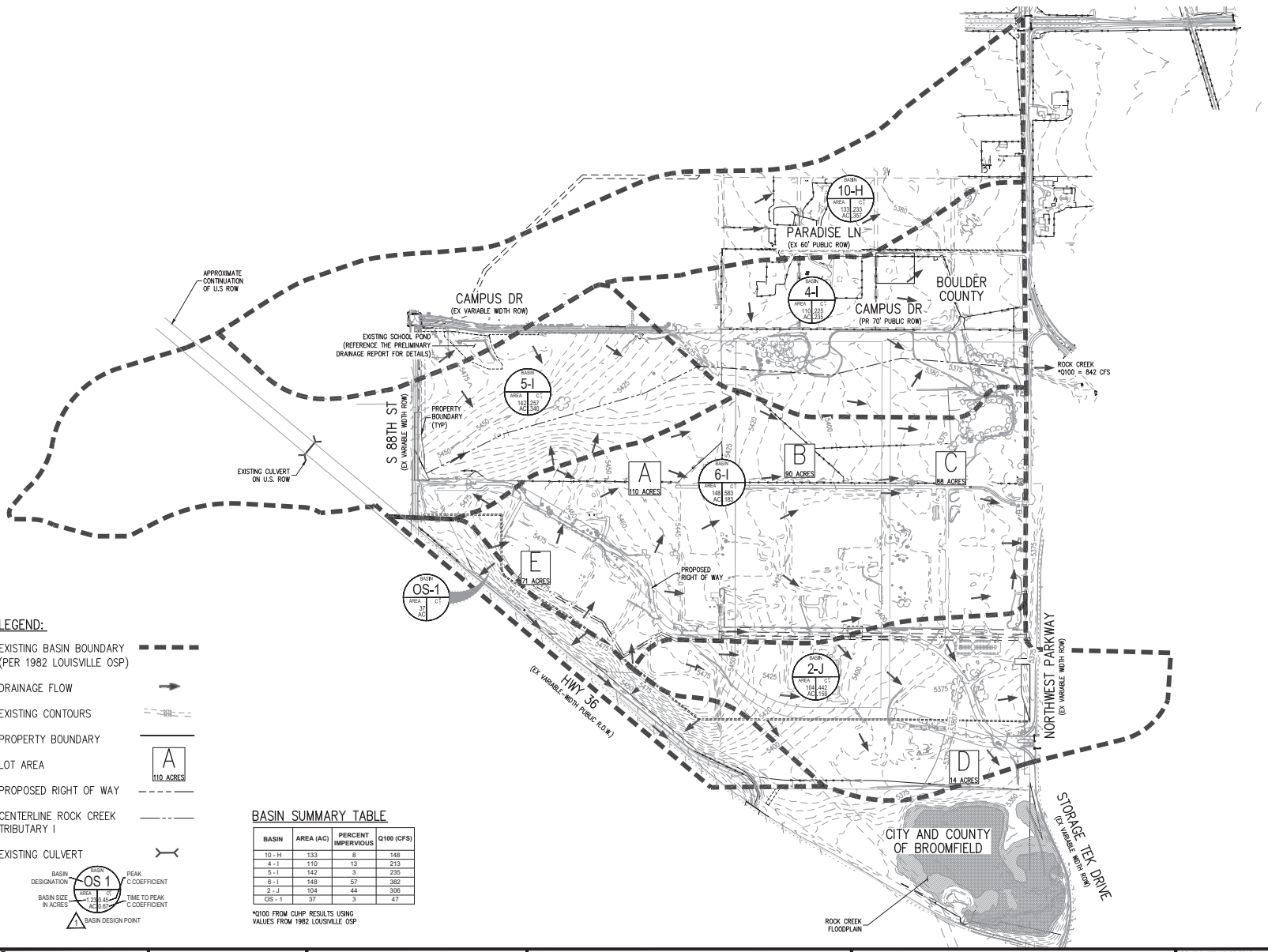
Y_n = normal depth of supercritical flow in the culvert (ft)



Use D_a instead of D whenever flow is supercritical in the barrel.
** Use Type L for a distance of 3D downstream.

Figure 9-38. Riprap erosion protection at circular conduit outlet (valid for Q/D2.5 ≤ 6.0)

APPENDIX D – Existing and Preliminary Master Drainage and Grading Plans



LEGEND:

- EXISTING BASIN BOUNDARY (PER 1982 LOUISVILLE OSP)
- DRAINAGE FLOW
- EXISTING CONTOURS
- PROPERTY BOUNDARY
- LOT AREA (A, 110 ACRES)
- PROPOSED RIGHT OF WAY
- CENTERLINE ROCK CREEK TRIBUTARY I
- EXISTING CULVERT

BASIN DESIGNATION — BASIN OS 1 — PEAK C COEFFICIENT; BASIN SIZE IN ACRES — AREA 1.23 AC 6.63 — TIME TO PEAK C COEFFICIENT; 1 BASIN DESIGN POINT

BASIN SUMMARY TABLE

BASIN	AREA (AC)	PERCENT IMPERVIOUS	Q100 (CFS)
10 - H	133	8	148
4 - I	110	13	213
5 - I	142	3	235
6 - I	148	57	382
2 - J	104	44	306
OS - 1	37	3	47

*Q100 FROM CUHP RESULTS USING VALUES FROM 1982 LOUISVILLE OSP

811 Know what's below. Call before you dig.

CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

400 0 400 800
SCALE: 1" = 400'

DESIGNED BY: TMW
CHECKED BY: MAW
DRAWN BY: TMW

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

BRUE·BAUKOL CAPITAL PARTNERS

NATWATNY RIDGE
EXISTING DRAINAGE PLAN

ISSUE DATE: 10-02-2019 PROJECT #: 190108

DATE	REVISION COMMENTS
-	-
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SHEET NO. 1

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH

FILE PATH: P:\190108\ENGINEERING\CD\PDCDP - EXISTING DRAINAGE PLAN.DWG LAYOUT: HKS TITLE SHEET
6 XREFs: clientlogo, e-base, e-legal, logos, p-base[UF], p-legal[UF]
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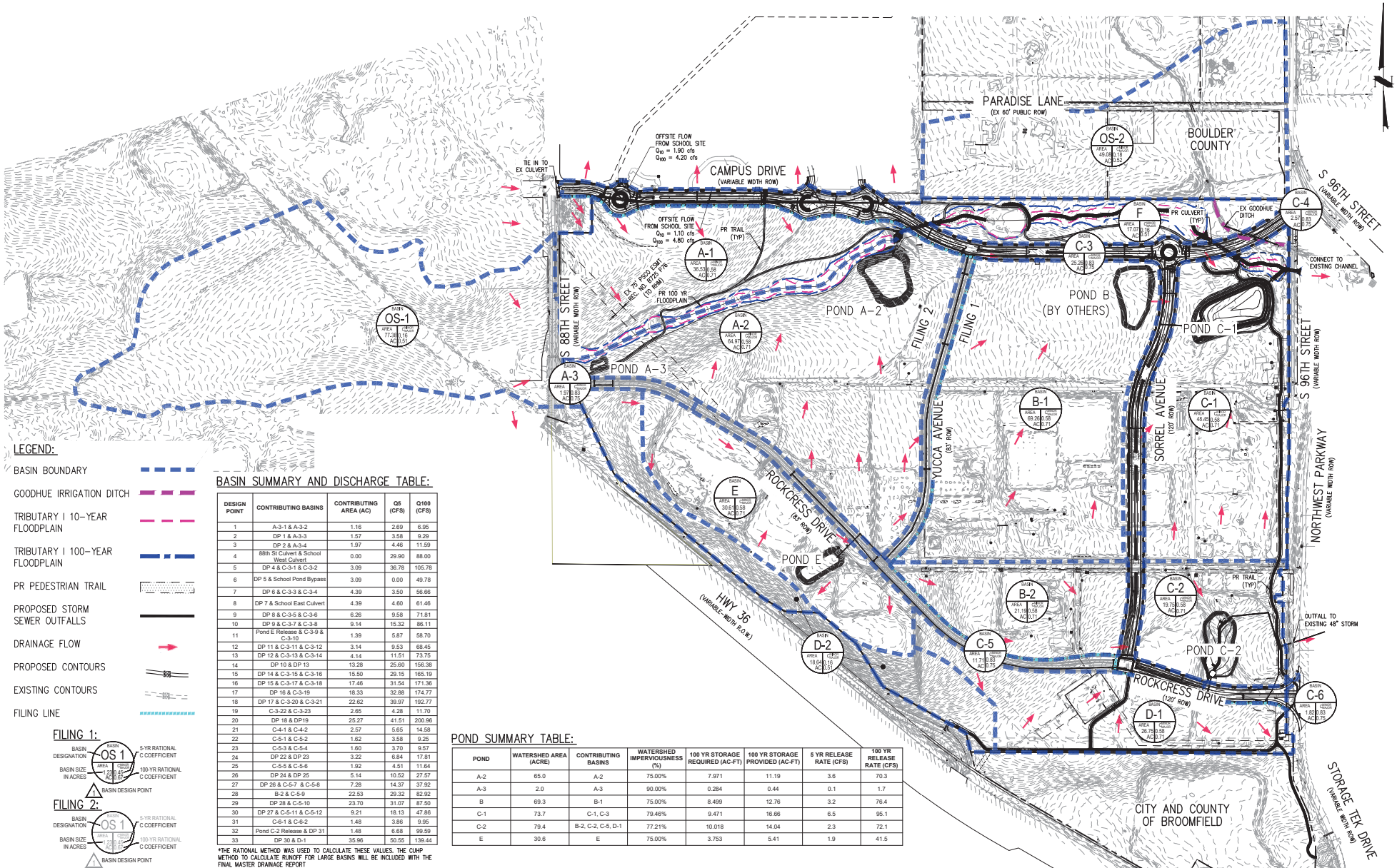

LEGEND:

- BASIN BOUNDARY
- GOODHUE IRRIGATION DITCH
- TRIBUTARY I 10-YEAR FLOODPLAIN
- TRIBUTARY I 100-YEAR FLOODPLAIN
- PR PEDESTRIAN TRAIL
- PROPOSED STORM SEWER OUTFALLS
- DRAINAGE FLOW
- PROPOSED CONTOURS
- EXISTING CONTOURS
- FILING LINE

FILING 1:

BASIN DESIGNATION — BASIN OS 1 — 5-YR RATIONAL C COEFFICIENT
BASIN SIZE IN ACRES — AREA 1.23 | CONTRIB. AREA 0.45 | AC 0.67 — 100-YR RATIONAL C COEFFICIENT
BASIN DESIGN POINT

FILING 2:

BASIN DESIGNATION — BASIN OS 1 — 5-YR RATIONAL C COEFFICIENT
BASIN SIZE IN ACRES — AREA 1.23 | CONTRIB. AREA 0.45 | AC 0.67 — 100-YR RATIONAL C COEFFICIENT
BASIN DESIGN POINT

BASIN SUMMARY AND DISCHARGE TABLE:

DESIGN POINT	CONTRIBUTING BASINS	CONTRIBUTING AREA (AC)	Q5 (CFS)	Q100 (CFS)
1	A-3-1 & A-3-2	1.16	2.69	6.95
2	DP 1 & A-3-3	1.57	3.58	9.29
3	DP 2 & A-3-4	1.97	4.46	11.59
4	88th St Culvert & School West Culvert	0.00	29.90	88.00
5	DP 4 & C-3-1 & C-3-2	3.09	36.78	105.78
6	DP 5 & School Pond Bypass	3.09	0.00	49.78
7	DP 6 & C-3-3 & C-3-4	4.39	3.50	56.66
8	DP 7 & School East Culvert	4.39	4.60	61.46
9	DP 8 & C-3-5 & C-3-6	6.26	9.58	71.81
10	DP 9 & C-3-7 & C-3-8	9.14	15.32	86.11
11	Pond E Release & C-3-9 & C-3-10	1.39	5.87	58.70
12	DP 11 & C-3-11 & C-3-12	3.14	9.53	68.45
13	DP 12 & C-3-13 & C-3-14	4.14	11.51	73.75
14	DP 10 & DP 13	13.28	25.60	156.38
15	DP 14 & C-3-15 & C-3-16	15.50	29.15	165.19
16	DP 15 & C-3-17 & C-3-18	17.46	31.54	171.36
17	DP 16 & C-3-19	18.33	32.88	174.77
18	DP 17 & C-3-20 & C-3-21	22.62	39.97	192.77
19	C-3-22 & C-3-23	2.65	4.28	11.70
20	DP 18 & DP19	25.27	41.51	200.96
21	C-4-1 & C-4-2	2.57	5.65	14.58
22	C-5-1 & C-5-2	1.62	3.58	9.25
23	C-5-3 & C-5-4	1.60	3.70	9.57
24	DP 22 & DP 23	3.22	6.84	17.81
25	C-5-5 & C-5-6	1.92	4.51	11.64
26	DP 24 & DP 25	5.14	10.52	27.57
27	DP 26 & C-5-7 & C-5-8	7.28	14.37	37.92
28	B-2 & C-5-9	22.53	29.32	82.92
29	DP 28 & C-5-10	23.70	31.07	87.50
30	DP 27 & C-5-11 & C-5-12	9.21	18.13	47.86
31	C-6-1 & C-6-2	1.48	3.86	9.95
32	Pond C-2 Release & DP 31	1.48	6.68	99.59
33	DP 30 & D-1	35.96	50.55	139.44

*THE RATIONAL METHOD WAS USED TO CALCULATE THESE VALUES. THE CUHP METHOD TO CALCULATE RUNOFF FOR LARGE BASINS WILL BE INCLUDED WITH THE FINAL MASTER DRAINAGE REPORT

POND SUMMARY TABLE:

POND	WATERSHED AREA (ACRE)	CONTRIBUTING BASINS	WATERSHED IMPERVIOUSNESS (%)	100 YR STORAGE REQUIRED (AC-FT)	100 YR STORAGE PROVIDED (AC-FT)	5 YR RELEASE RATE (CFS)	100 YR RELEASE RATE (CFS)
A-2	65.0	A-2	75.00%	7.971	11.19	3.6	70.3
A-3	2.0	A-3	90.00%	0.284	0.44	0.1	1.7
B	69.3	B-1	75.00%	8.499	12.76	3.2	76.4
C-1	73.7	C-1, C-3	79.46%	9.471	16.66	6.5	95.1
C-2	79.4	B-2, C-2, C-5, D-1	77.21%	10.018	14.04	2.3	72.1
E	30.6	E	75.00%	3.753	5.41	1.9	41.5

811 Know what's below. Call before you dig.

CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

300 0 300 600
SCALE: 1" = 300'

DESIGNED BY: TMW, JMR
CHECKED BY: MAW
DRAWN BY: TMW, JMR

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

BRUE·BAUKOL CAPITAL PARTNERS

REDTAIL RIDGE - FILING NO. 1
FINAL DRAINAGE PLAN

ISSUE DATE: 03-03-2020 | PROJECT #: 190108

DATE	REVISION COMMENTS
04-06-2020	SECOND SUBMITTAL PER CITY COMMENTS
-	-
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-	-

SHEET NO. 1

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH

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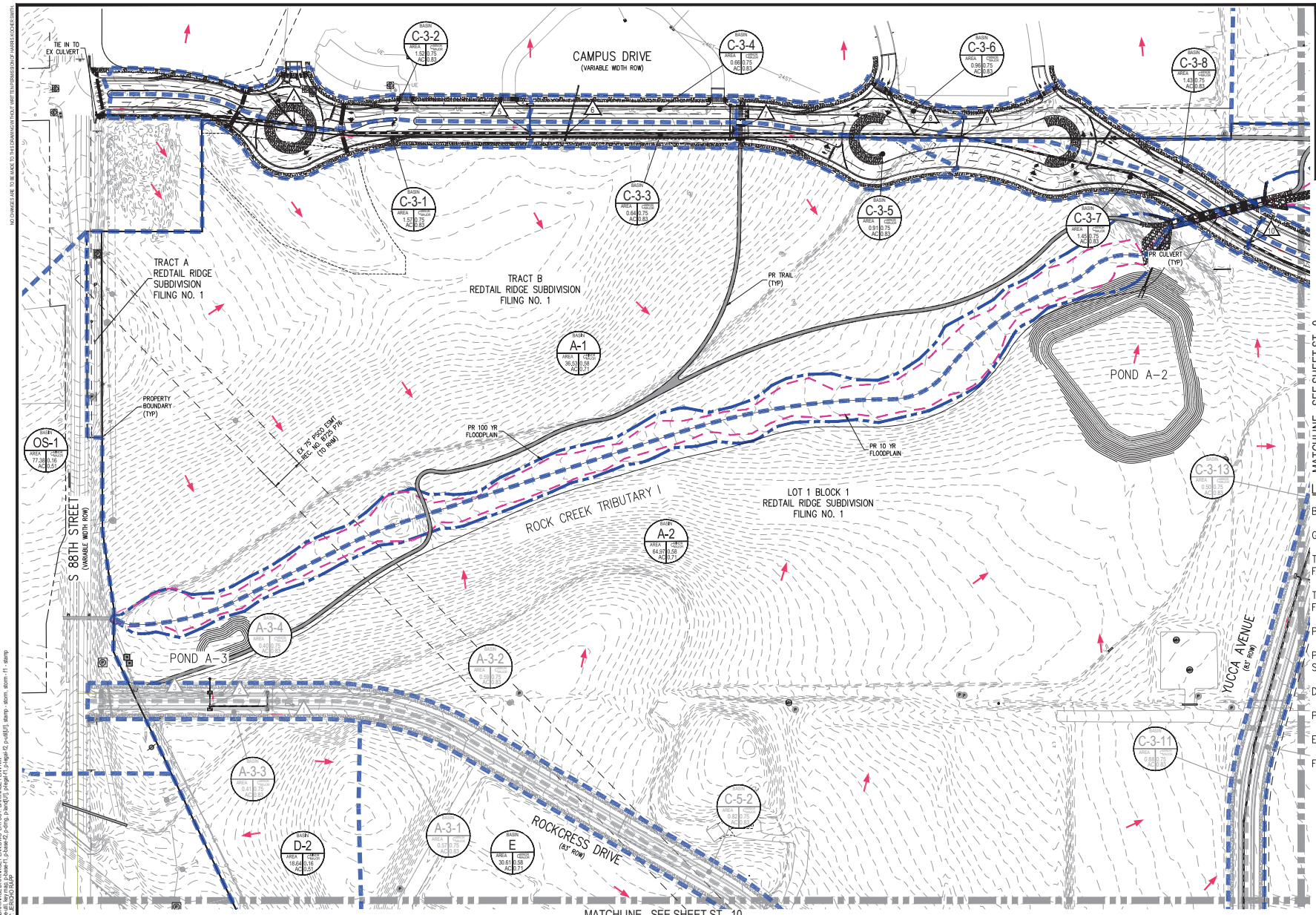

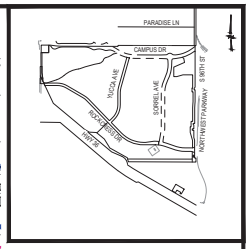

KEY MAP
SCALE: 1"=2000'

LEGEND:

- BASIN BOUNDARY
- GOODHUE IRRIGATION DITCH
- TRIBUTARY I 10-YEAR FLOODPLAIN
- TRIBUTARY I 100-YEAR FLOODPLAIN
- PR PEDESTRIAN TRAIL
- PROPOSED STORM SEWER OUTFALLS
- DRAINAGE FLOW
- PROPOSED CONTOURS
- EXISTING CONTOURS
- FILING LINE

FILING 1:

BASIN DESIGNATION — OS 1 — 5-YR RATIONAL C COEFFICIENT
BASIN SIZE IN ACRES — AREA 1.23 — 100-YR RATIONAL C COEFFICIENT AC 0.83
BASIN DESIGN POINT

FILING 2:

BASIN DESIGNATION — OS 1 — 5-YR RATIONAL C COEFFICIENT
BASIN SIZE IN ACRES — AREA 1.23 — 100-YR RATIONAL C COEFFICIENT AC 0.83
BASIN DESIGN POINT

811 Know what's below. Call before you dig.

CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

SCALE: 1" = 100'

DESIGNED BY: TMW, JMR
CHECKED BY: MAW
DRAWN BY: TMW, JMR

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

BRUE·BAUKOL CAPITAL PARTNERS

REDTAIL RIDGE - FILING NO. 1
DRAINAGE PLAN NW

ISSUE DATE: 03-03-2020	PROJECT #: 190108
DATE	REVISION COMMENTS
04-06-2020	SECOND SUBMITTAL PER CITY COMMENTS
-	-
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PRELIMINARY NOT FOR CONSTRUCTION

SHEET NO.
2
2 OF 5

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH

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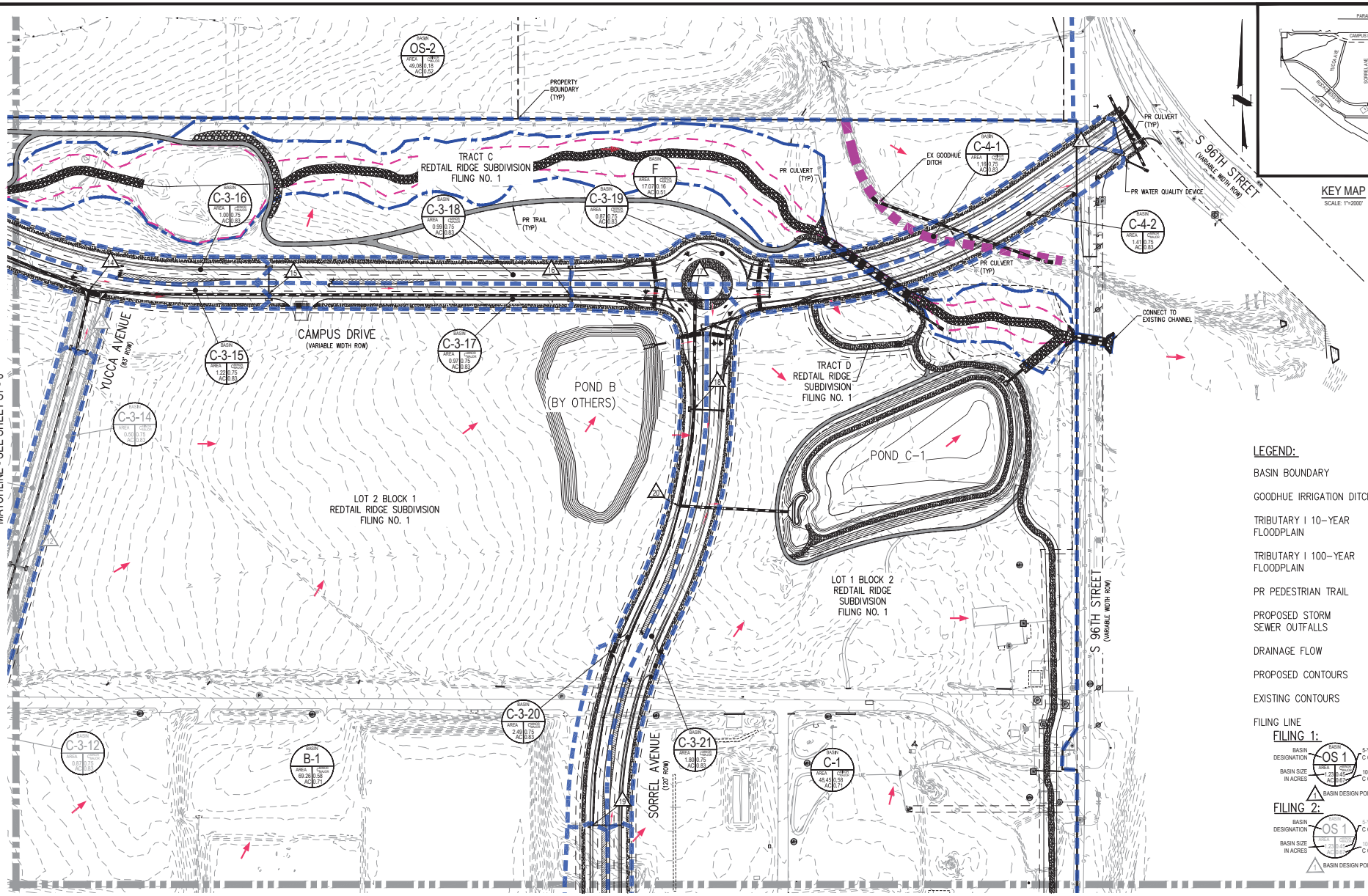

Know what's below. Call before you dig.

CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

SCALE: 1" = 100'

DESIGNED BY: TMW, JMR
CHECKED BY: MAW
DRAWN BY: TMW, JMR

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

BRUE·BAUKOL CAPITAL PARTNERS

REDTAIL RIDGE - FILING NO. 1
DRAINAGE PLAN NE

ISSUE DATE: 03-03-2020	PROJECT #: 190108
DATE	REVISION COMMENTS
04-06-2020	SECOND SUBMITTAL PER CITY COMMENTS
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PRELIMINARY NOT FOR CONSTRUCTION

SHEET NO.
3
3 OF 5

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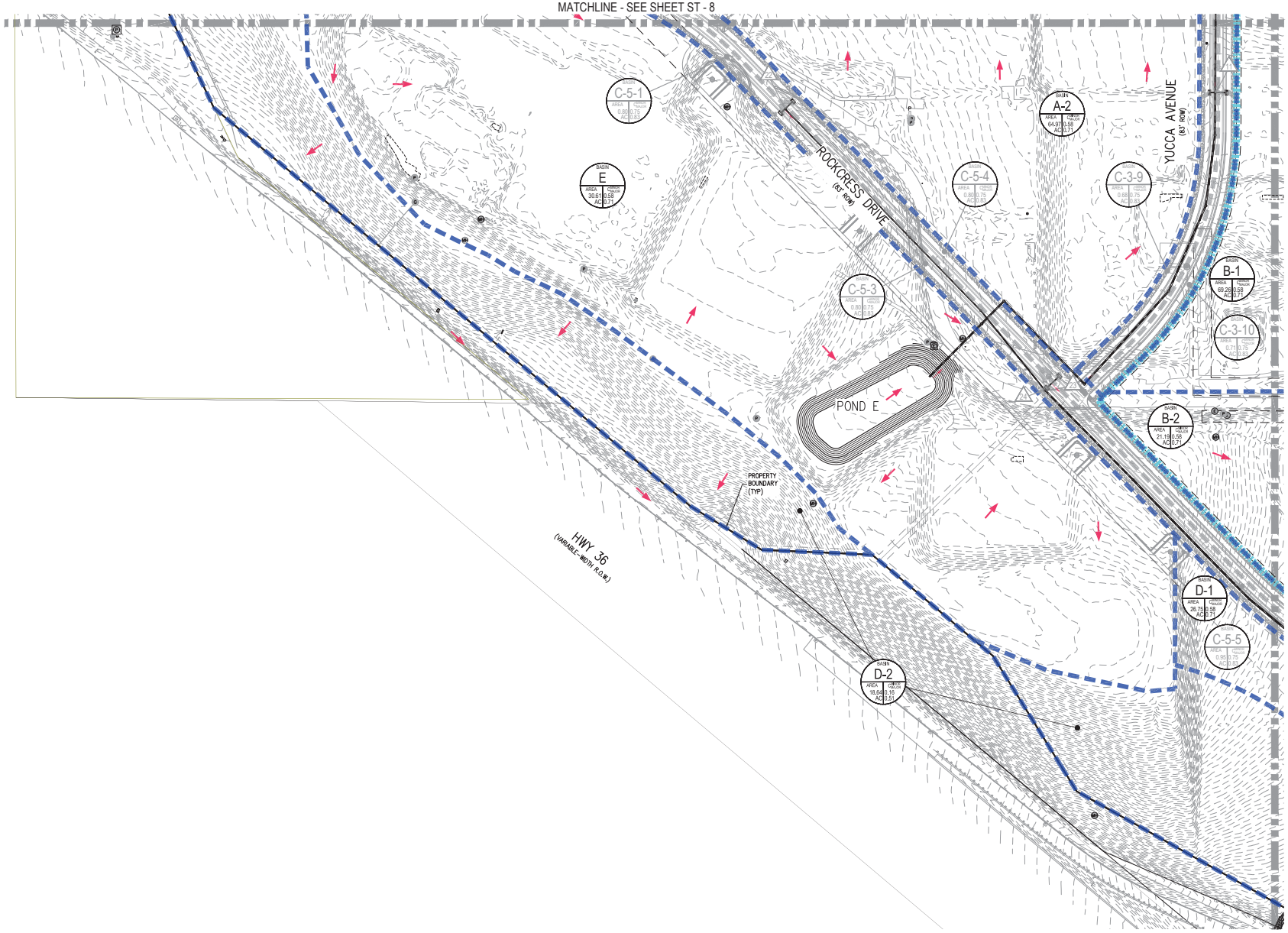

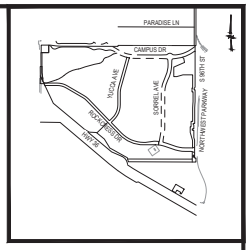

KEY MAP
SCALE: 1"=2000'

LEGEND:

- BASIN BOUNDARY
- GOODHUE IRRIGATION DITCH
- TRIBUTARY I 10-YEAR FLOODPLAIN
- TRIBUTARY I 100-YEAR FLOODPLAIN
- PR PEDESTRIAN TRAIL
- PROPOSED STORM SEWER OUTFALLS
- DRAINAGE FLOW
- PROPOSED CONTOURS
- EXISTING CONTOURS
- FILING LINE

FILING 1:

BASIN DESIGNATION — BASIN OS 1 — 5-YR RATIONAL C COEFFICIENT
BASIN SIZE IN ACRES — AREA 1.23 RUNOFF 0.42 AC 0.61 — 100-YR RATIONAL C COEFFICIENT
1 BASIN DESIGN POINT

FILING 2:

BASIN DESIGNATION — BASIN OS 1 — 5-YR RATIONAL C COEFFICIENT
BASIN SIZE IN ACRES — AREA 1.23 RUNOFF 0.42 AC 0.61 — 100-YR RATIONAL C COEFFICIENT
1 BASIN DESIGN POINT

NO CHANGES ARE TO BE MADE TO THE DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH

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PLOTTED: THU JAN 09, 2020 4:05:48 PM, JERICO YAP

811 Know what's below. Call before you dig.
CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

SCALE: 1" = 100'

DESIGNED BY: TMW, JRM
CHECKED BY: MAW
DRAWN BY: TMW, JMR

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

BRUE·BAUKOL CAPITAL PARTNERS

REDTAIL RIDGE - FILING NO. 1
DRAINAGE PLAN SW

ISSUE DATE: 03-03-2020 PROJECT #: 190108

DATE	REVISION COMMENTS
04-06-2020	SECOND SUBMITTAL PER CITY COMMENTS
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PRELIMINARY NOT FOR CONSTRUCTION

SHEET NO.
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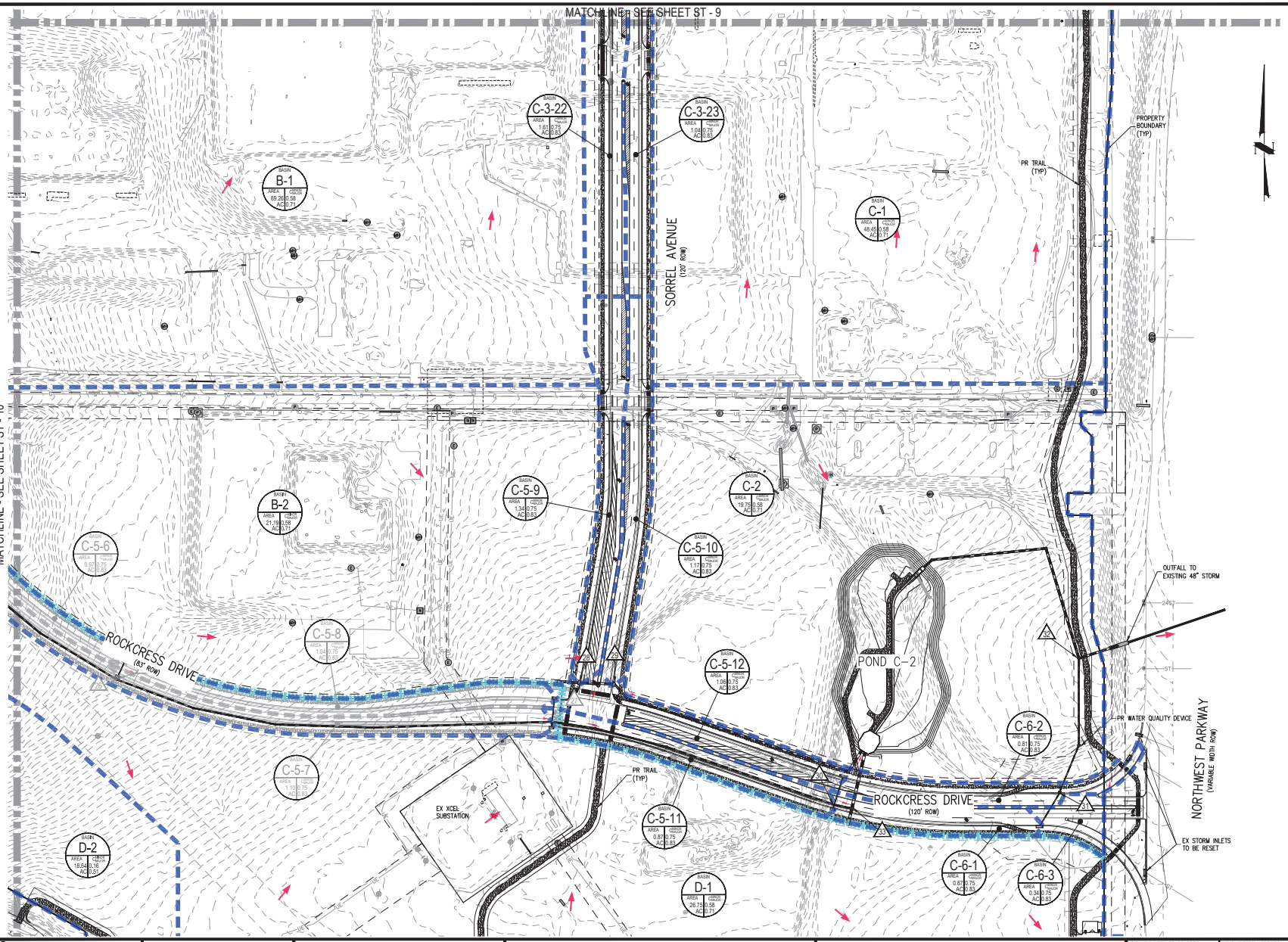
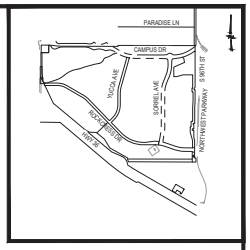
4 OF 5





KEY MAP
SCALE: 1"=2000'

LEGEND:

- BASIN BOUNDARY
- GOODHUE IRRIGATION DITCH
- TRIBUTARY I 10-YEAR FLOODPLAIN
- TRIBUTARY I 100-YEAR FLOODPLAIN
- PR PEDESTRIAN TRAIL
- PROPOSED STORM SEWER OUTFALLS
- DRAINAGE FLOW
- PROPOSED CONTOURS
- EXISTING CONTOURS
- FILING LINE

FILING 1:

BASIN DESIGNATION — BASIN OS 1 — 5-YR RATIONAL C COEFFICIENT
BASIN SIZE IN ACRES — AREA 1.23 | AC 0.42 — 100-YR RATIONAL C COEFFICIENT
BASIN DESIGN POINT

FILING 2:

BASIN DESIGNATION — BASIN OS 1 — 5-YR RATIONAL C COEFFICIENT
BASIN SIZE IN ACRES — AREA 1.23 | AC 0.42 — 100-YR RATIONAL C COEFFICIENT
BASIN DESIGN POINT

811 Know what's below. Call before you dig.

CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

SCALE: 1" = 100'

DESIGNED BY: TMW, JMR
CHECKED BY: MAW
DRAWN BY: TMW, JMR

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

BRUE·BAUKOL CAPITAL PARTNERS

REDTAIL RIDGE - FILING NO. 1
DRAINAGE PLAN SE

ISSUE DATE: 03-03-2020 | PROJECT #: 190108

DATE	REVISION COMMENTS
04-06-2020	SECOND SUBMITTAL PER CITY COMMENTS
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PRELIMINARY NOT FOR CONSTRUCTION

SHEET NO.
5
5 OF 5

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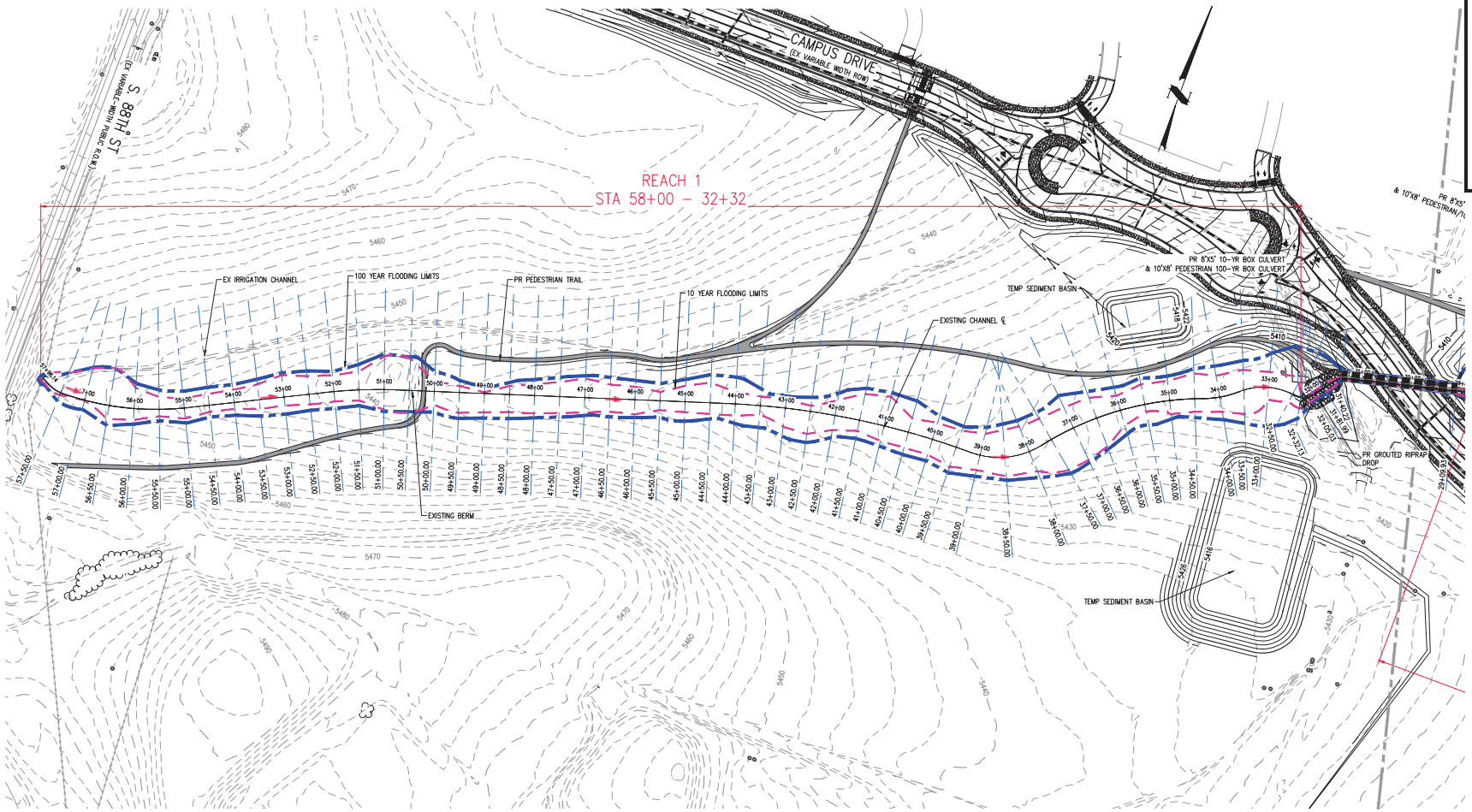
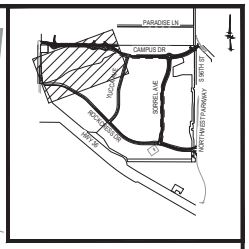
APPENDIX E – HECRAS Model





KEY MAP
SCALE: 1"=2000'

LEGEND:

- PROPOSED 100-YR FLOODPLAIN
- PROPOSED 10-YR FLOODPLAIN
- CHANNEL CENTERLINE
- CHANNEL CROSS SECTION — STA
- DRAINAGE FLOW
- PROPOSED CONTOURS
- EXISTING CONTOURS

Know what's below. Call before you dig.

CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

SCALE: 1" = 100'

DESIGNED BY: KAS
CHECKED BY: MAW
DRAWN BY: KAS

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

BRUE BAUKOL CAPITOL PARTNERS

REDTAIL RIDGE FILING NO. 1
FLOODPLAIN WORKMAP

ISSUE DATE: 11-15-2019 PROJECT #: 190108

DATE:	REVISION COMMENTS
04-06-2020	PER CITY COMMENTS
04-22-2020	PER MHFD COMMENTS
-	-
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PRELIMINARY NOT FOR CONSTRUCTION

SHEET NO.
1
1 OF 2

NO CHANGES ARE TO BE MADE TO THIS DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH

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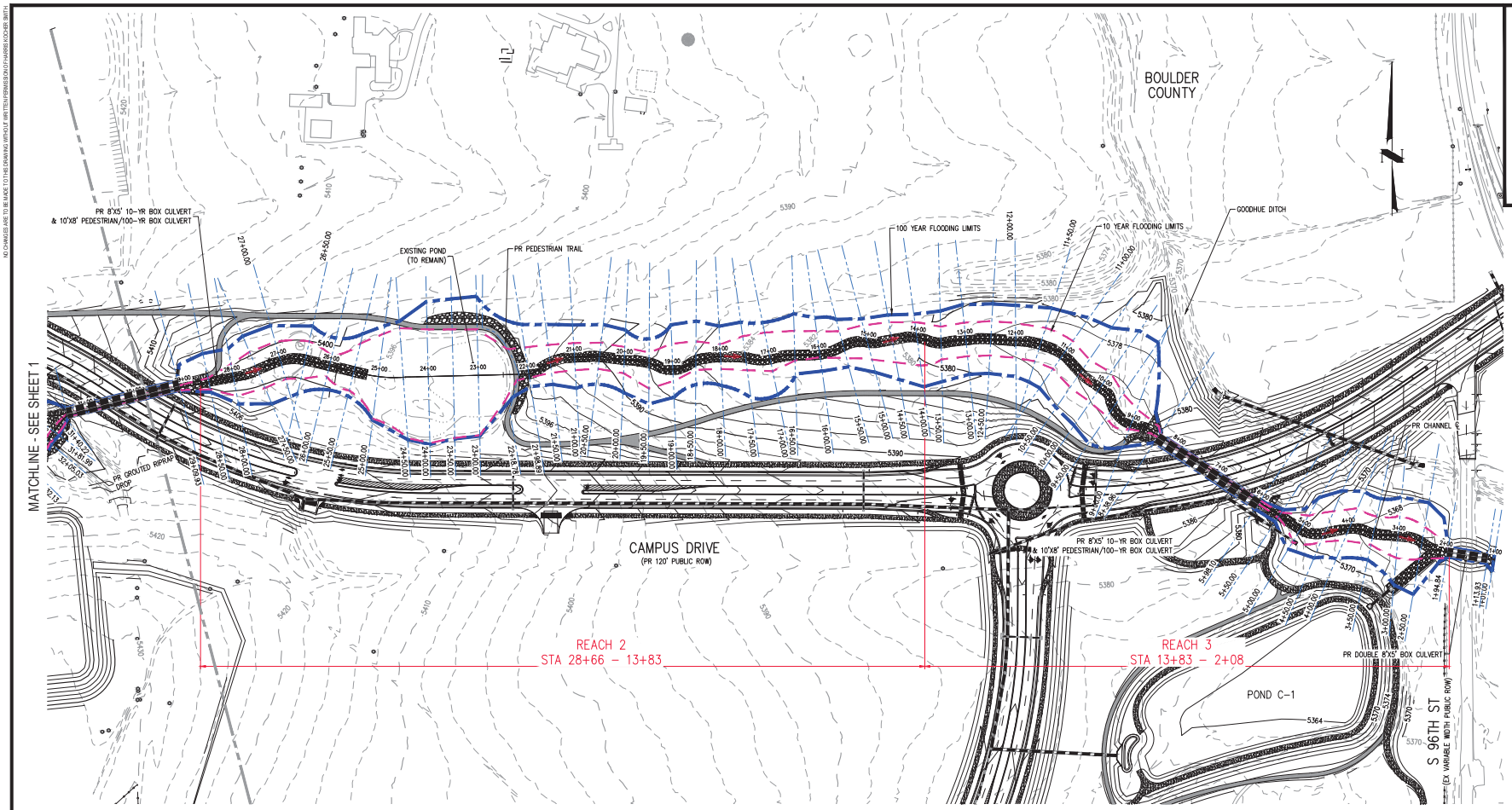

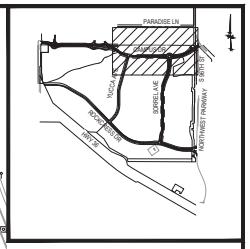

KEY MAP
SCALE: 1"=2000'

LEGEND:

- PROPOSED 100-YR FLOODPLAIN
- PROPOSED 10-YR FLOODPLAIN
- CHANNEL CENTERLINE
- CHANNEL CROSS SECTION — STA
- DRAINAGE FLOW
- PROPOSED CONTOURS — 5378
- EXISTING CONTOURS — 5378

811 Know what's below. Call before you dig.

CALL 3 BUSINESS DAYS IN ADVANCE BEFORE YOU DIG, GRADE, OR EXCAVATE FOR THE MARKING OF UNDERGROUND MEMBER UTILITIES.

100 0 100 200
SCALE: 1" = 100'

DESIGNED BY: KAS
CHECKED BY: MAW
DRAWN BY: KAS

HARRIS KOCHER SMITH
1120 Lincoln Street, Suite 1000
Denver, Colorado 80203
P: 303.623.6300 F: 303.623.6311
HarrisKocherSmith.com

BRUE BAUKOL CAPITOL PARTNERS

REDTAIL RIDGE FILING NO. 1
FLOODPLAIN WORKMAP

ISSUE DATE: 11-15-2019 PROJECT #: 190108

DATE	REVISION COMMENTS
04-06-2020	PER CITY COMMENTS
04-22-2020	PER MHFD COMMENTS
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PRELIMINARY NOT FOR CONSTRUCTION

SHEET NO.
2
2 OF 2

NO CHANGES ARE TO BE MADE TO THE DRAWING WITHOUT WRITTEN PERMISSION OF HARRIS KOCHER SMITH

F:\ERP\Tr P:\190108\ENGINEERING\DRAINAGE\FLOODPLAN WORKMAP.DWG LAYOUT: LAYOUT2
5 XREFs: e-base, key map, p-base-f1, p-base-f2(1), p-dmg
PLOTTED: TUE 04/21/20 2:56:08 PM BY: MICHAEL VALTON

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR Channel w EX	5800	2 YR	0.52	5451.37	5451.60	5451.60	5451.67	0.032569	2.04	0.26	2.03	1.01	0.24
PR Channel w EX	5800	10 YR	20.67	5451.37	5452.60		5452.72	0.008134	2.85	7.25	12.50	0.66	0.29
PR Channel w EX	5800	100 YR	124.43	5451.37	5453.46	5453.46	5454.08	0.015228	6.34	19.61	15.91	1.01	1.11
PR Channel w EX	5750	2 YR	0.52	5450.60	5451.01		5451.03	0.003348	0.91	0.57	2.76	0.35	0.04
PR Channel w EX	5750	10 YR	20.67	5450.60	5452.00	5451.77	5452.13	0.019188	2.91	7.10	22.70	0.92	0.37
PR Channel w EX	5750	100 YR	124.43	5450.60	5452.50	5452.50	5452.79	0.020681	4.28	29.09	55.92	1.05	0.66
PR Channel w EX	5700	2 YR	0.52	5450.44	5450.72	5450.67	5450.75	0.010675	1.29	0.40	2.71	0.59	0.09
PR Channel w EX	5700	10 YR	20.67	5450.44	5451.06	5451.04	5451.13	0.019671	2.13	9.72	51.56	0.86	0.23
PR Channel w EX	5700	100 YR	124.43	5450.44	5451.43	5451.43	5451.65	0.019853	3.81	32.67	72.79	1.00	0.55
PR Channel w EX	5650	2 YR	0.52	5449.59	5449.67	5449.67	5449.68	0.059947	0.94	0.55	23.04	1.07	0.09
PR Channel w EX	5650	10 YR	20.67	5449.59	5449.87	5449.87	5449.93	0.030473	2.03	10.16	80.66	1.01	0.24
PR Channel w EX	5650	100 YR	124.43	5449.59	5450.15	5450.15	5450.34	0.021004	3.44	36.17	98.65	1.00	0.48
PR Channel w EX	5600	2 YR	0.52	5448.20	5448.26	5448.26	5448.26	0.008355	0.45	1.17	34.28	0.43	0.02
PR Channel w EX	5600	10 YR	20.67	5448.20	5448.44	5448.43	5448.52	0.023735	2.23	9.27	53.27	0.94	0.26
PR Channel w EX	5600	100 YR	124.43	5448.20	5448.79	5448.79	5449.01	0.019744	3.72	33.47	77.79	1.00	0.53
PR Channel w EX	5550	2 YR	0.52	5446.73	5446.84	5446.84	5446.86	0.026149	1.13	0.46	7.91	0.82	0.10
PR Channel w EX	5550	10 YR	20.67	5446.73	5447.18	5447.18	5447.29	0.025411	2.55	8.11	40.14	1.00	0.32
PR Channel w EX	5550	100 YR	124.43	5446.73	5447.62	5447.62	5447.87	0.019269	4.06	30.63	61.19	1.01	0.60
PR Channel w EX	5500	2 YR	0.52	5445.70	5445.82	5445.78	5445.82	0.005298	0.57	0.92	13.35	0.38	0.02
PR Channel w EX	5500	10 YR	20.67	5445.70	5446.21		5446.27	0.008514	1.91	10.85	36.57	0.62	0.16
PR Channel w EX	5500	100 YR	124.43	5445.70	5446.78		5446.94	0.009065	3.24	38.39	61.11	0.72	0.36
PR Channel w EX	5450	2 YR	0.52	5445.18	5445.24	5445.24	5445.26	0.038968	1.09	0.48	11.74	0.95	0.10
PR Channel w EX	5450	10 YR	20.67	5445.18	5445.56	5445.54	5445.66	0.019402	2.47	8.35	35.29	0.90	0.29
PR Channel w EX	5450	100 YR	124.43	5445.18	5446.02	5446.02	5446.29	0.019177	4.17	29.85	57.15	1.02	0.62
PR Channel w EX	5400	2 YR	0.52	5444.02	5444.14	5444.12	5444.15	0.012529	0.83	0.63	9.93	0.58	0.05
PR Channel w EX	5400	10 YR	20.67	5444.02	5444.46	5444.46	5444.57	0.024450	2.71	7.62	33.40	1.00	0.35
PR Channel w EX	5400	100 YR	124.43	5444.02	5444.95	5444.95	5445.22	0.019165	4.15	29.96	57.64	1.02	0.62
PR Channel w EX	5350	2 YR	0.52	5443.50	5443.55	5443.53	5443.56	0.010873	0.52	1.00	28.36	0.49	0.02
PR Channel w EX	5350	10 YR	20.67	5443.50	5443.85		5443.89	0.008027	1.69	12.25	47.43	0.59	0.13
PR Channel w EX	5350	100 YR	124.43	5443.50	5444.30		5444.46	0.010052	3.15	39.53	71.10	0.74	0.35
PR Channel w EX	5300	2 YR	0.52	5443.06	5443.12	5443.11	5443.13	0.006775	0.43	1.22	32.71	0.39	0.02
PR Channel w EX	5300	10 YR	20.67	5443.06	5443.35		5443.40	0.012474	1.80	11.48	56.10	0.70	0.16
PR Channel w EX	5300	100 YR	124.43	5443.06	5443.75		5443.91	0.012234	3.18	39.18	80.54	0.80	0.37
PR Channel w EX	5250	2 YR	0.52	5442.30	5442.36	5442.36	5442.37	0.059968	0.93	0.56	24.17	1.07	0.09
PR Channel w EX	5250	10 YR	20.67	5442.30	5442.57	5442.55	5442.64	0.019134	2.04	10.15	56.78	0.85	0.21
PR Channel w EX	5250	100 YR	124.43	5442.30	5442.92	5442.92	5443.14	0.019806	3.76	33.13	76.00	1.00	0.54
PR Channel w EX	5200	2 YR	0.52	5441.16	5441.19	5441.19	5441.22	0.124750	1.32	0.39	17.26	1.54	0.18
PR Channel w EX	5200	10 YR	20.67	5441.16	5441.44	5441.44	5441.53	0.026188	2.47	8.36	44.32	1.00	0.31
PR Channel w EX	5200	100 YR	124.43	5441.16	5441.84	5441.84	5442.07	0.019319	3.83	32.50	71.10	1.00	0.55
PR Channel w EX	5150	2 YR	0.52	5440.47	5440.84		5440.84	0.000004	0.04	14.20	58.62	0.01	0.00
PR Channel w EX	5150	10 YR	20.67	5440.47	5441.22		5441.23	0.000288	0.52	40.13	75.89	0.12	0.01
PR Channel w EX	5150	100 YR	124.43	5440.47	5441.85		5441.88	0.000846	1.29	96.18	102.55	0.24	0.05
PR Channel w EX	5100	2 YR	0.52	5438.22	5440.84		5440.84	0.000000	0.00	151.41	97.17	0.00	0.00
PR Channel w EX	5100	10 YR	20.67	5438.22	5441.22		5441.22	0.000003	0.11	191.21	109.57	0.01	0.00
PR Channel w EX	5100	100 YR	124.43	5438.22	5441.86		5441.87	0.000038	0.47	266.50	126.99	0.06	0.00
PR Channel w EX	5050	2 YR	0.52	5440.75	5440.82	5440.82	5440.84	0.028382	0.92	0.57	14.08	0.81	0.07
PR Channel w EX	5050	10 YR	20.67	5440.75	5441.10	5441.10	5441.21	0.024340	2.67	7.75	34.64	0.99	0.34
PR Channel w EX	5050	100 YR	124.43	5440.75	5441.59	5441.59	5441.84	0.019034	3.94	31.59	65.50	1.00	0.57
PR Channel w EX	5000	2 YR	0.52	5438.11	5438.27	5438.26	5438.30	0.032005	1.53	0.34	4.26	0.96	0.16
PR Channel w EX	5000	10 YR	20.67	5438.11	5438.75	5438.75	5438.86	0.024373	2.70	7.65	33.61	1.00	0.35
PR Channel w EX	5000	100 YR	124.43	5438.11	5439.22	5439.22	5439.42	0.018591	3.62	34.36	79.35	0.97	0.50
PR Channel w EX	4950	2 YR	0.52	5437.46	5437.58	5437.55	5437.59	0.007884	0.67	0.77	11.77	0.46	0.03
PR Channel w EX	4950	10 YR	20.67	5437.46	5437.90	5437.84	5437.97	0.013139	2.07	9.99	41.19	0.74	0.20
PR Channel w EX	4950	100 YR	124.43	5437.46	5438.32	5438.27	5438.52	0.015473	3.59	34.70	70.94	0.90	0.47
PR Channel w EX	4900	2 YR	0.52	5436.63	5436.70	5436.70	5436.73	0.063975	1.25	0.42	11.98	1.18	0.14
PR Channel w EX	4900	10 YR	20.67	5436.63	5436.97	5436.97	5437.07	0.025069	2.55	8.11	39.72	0.99	0.32
PR Channel w EX	4900	100 YR	124.43	5436.63	5437.41	5437.41	5437.66	0.019189	4.00	31.11	63.41	1.01	0.59
PR Channel w EX	4850	2 YR	0.52	5435.74	5435.85	5435.81	5435.85	0.004148	0.47	1.11	18.04	0.33	0.02
PR Channel w EX	4850	10 YR	20.67	5435.74	5436.19		5436.23	0.006371	1.55	13.32	49.17	0.53	0.11
PR Channel w EX	4850	100 YR	124.43	5435.74	5436.67		5436.80	0.007685	2.88	43.27	72.86	0.66	0.28
PR Channel w EX	4800	2 YR	0.52	5435.30	5435.38	5435.38	5435.40	0.032500	0.99	0.53	13.06	0.86	0.08
PR Channel w EX	4800	10 YR	20.67	5435.30	5435.67	5435.64	5435.73	0.016860	1.99	10.39	54.84	0.81	0.20
PR Channel w EX	4800	100 YR	124.43	5435.30	5436.04	5436.02	5436.25	0.016768	3.60	34.53	74.40	0.93	0.49
PR Channel w EX	4750	2 YR	0.52	5434.70	5434.78	5434.76	5434.78	0.005828	0.36	1.45	44.92	0.35	0.01
PR Channel w EX	4750	10 YR	20.67	5434.70	5434.98	5434.93	5435.02	0.011963	1.73	11.97	60.34	0.68	0.15
PR Channel w EX	4750	100 YR	124.43	5434.70	5435.35		5435.52	0.012631	3.26	38.13	77.06	0.82	0.39
PR Channel w EX	4700	2 YR	0.52	5434.00	5434.09	5434.09	5434.11	0.055068	0.98	0.53	19.58	1.05	0.09
PR Channel w EX	4700	10 YR	20.67	5434.00	5434.31	5434.27	5434.35	0.014669	1.79	11.56	64.43	0.74	0.16

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR Channel w EX	4700	100 YR	124.43	5434.00	5434.65	5434.61	5434.83	0.015376	3.42	36.36	79.33	0.89	0.44
PR Channel w EX	4650	2 YR	0.52	5433.19	5433.24	5433.23	5433.25	0.020470	0.65	0.81	26.60	0.65	0.04
PR Channel w EX	4650	10 YR	20.67	5433.19	5433.46	5433.44	5433.53	0.018127	2.11	9.80	50.02	0.84	0.22
PR Channel w EX	4650	100 YR	124.43	5433.19	5433.87	5433.83	5434.06	0.015616	3.51	35.49	75.53	0.90	0.46
PR Channel w EX	4600	2 YR	0.52	5432.42	5432.49		5432.49	0.011303	0.52	1.00	29.06	0.50	0.02
PR Channel w EX	4600	10 YR	20.67	5432.42	5432.73		5432.78	0.012674	1.89	10.93	50.20	0.71	0.17
PR Channel w EX	4600	100 YR	124.43	5432.42	5433.14		5433.32	0.013679	3.43	36.24	72.07	0.85	0.43
PR Channel w EX	4550	2 YR	0.52	5431.42	5431.50	5431.50	5431.52	0.040694	1.19	0.44	9.58	0.99	0.12
PR Channel w EX	4550	10 YR	20.67	5431.42	5431.81	5431.81	5431.92	0.024791	2.59	7.98	37.82	0.99	0.33
PR Channel w EX	4550	100 YR	124.43	5431.42	5432.26	5432.26	5432.50	0.019447	3.95	31.50	66.06	1.01	0.58
PR Channel w EX	4500	2 YR	0.52	5430.16	5430.65		5430.65	0.000020	0.10	5.31	16.49	0.03	0.00
PR Channel w EX	4500	10 YR	20.67	5430.16	5431.11		5431.14	0.001807	1.43	14.48	23.43	0.32	0.07
PR Channel w EX	4500	100 YR	124.43	5430.16	5431.74		5431.84	0.005590	2.56	48.57	76.47	0.57	0.22
PR Channel w EX	4450	2 YR	0.52	5430.58	5430.63	5430.63	5430.64	0.044418	0.86	0.61	23.29	0.94	0.07
PR Channel w EX	4450	10 YR	20.67	5430.58	5430.83	5430.83	5430.90	0.029449	2.22	9.30	63.07	1.02	0.27
PR Channel w EX	4450	100 YR	124.43	5430.58	5431.16	5431.16	5431.35	0.020292	3.54	35.17	89.90	1.00	0.50
PR Channel w EX	4400	2 YR	0.52	5428.93	5429.02		5429.03	0.010423	0.70	0.75	13.22	0.52	0.04
PR Channel w EX	4400	10 YR	20.67	5428.93	5429.32	5429.30	5429.40	0.018901	2.32	8.91	40.66	0.87	0.26
PR Channel w EX	4400	100 YR	124.43	5428.93	5429.74	5429.74	5429.94	0.021151	3.59	34.68	89.51	1.02	0.51
PR Channel w EX	4350	2 YR	0.52	5427.79	5427.87	5427.86	5427.89	0.053029	1.25	0.42	10.50	1.10	0.13
PR Channel w EX	4350	10 YR	20.67	5427.79	5428.18	5428.18	5428.29	0.026218	2.74	7.53	34.14	1.03	0.36
PR Channel w EX	4350	100 YR	124.43	5427.79	5428.62	5428.62	5428.84	0.020020	3.80	32.74	74.39	1.01	0.55
PR Channel w EX	4300	2 YR	0.52	5426.79	5426.90		5426.90	0.010321	0.66	0.78	14.86	0.51	0.03
PR Channel w EX	4300	10 YR	20.67	5426.79	5427.18		5427.25	0.015691	2.06	10.02	47.45	0.79	0.21
PR Channel w EX	4300	100 YR	124.43	5426.79	5427.59	5427.54	5427.77	0.015120	3.40	36.54	79.34	0.88	0.43
PR Channel w EX	4250	2 YR	0.52	5426.01	5426.07	5426.07	5426.09	0.030405	0.83	0.63	19.09	0.81	0.06
PR Channel w EX	4250	10 YR	20.67	5426.01	5426.34	5426.31	5426.41	0.018014	2.08	9.92	51.33	0.84	0.22
PR Channel w EX	4250	100 YR	124.43	5426.01	5426.68	5426.68	5426.89	0.020942	3.60	34.54	87.99	1.01	0.51
PR Channel w EX	4200	2 YR	0.52	5425.01	5425.11		5425.12	0.010796	0.66	0.79	15.83	0.52	0.03
PR Channel w EX	4200	10 YR	20.67	5425.01	5425.38	5425.35	5425.44	0.020663	2.10	9.83	55.63	0.88	0.23
PR Channel w EX	4200	100 YR	124.43	5425.01	5425.74	5425.71	5425.92	0.017221	3.40	36.62	87.94	0.93	0.45
PR Channel w EX	4150	2 YR	0.52	5424.35	5424.44	5424.42	5424.44	0.017783	0.67	0.78	21.89	0.63	0.04
PR Channel w EX	4150	10 YR	20.67	5424.35	5424.66		5424.69	0.011251	1.58	13.08	72.01	0.65	0.13
PR Channel w EX	4150	100 YR	124.43	5424.35	5424.98	5424.93	5425.12	0.014509	3.07	40.55	99.75	0.85	0.37
PR Channel w EX	4100	2 YR	0.52	5423.68	5423.75		5423.75	0.011209	0.57	0.91	23.18	0.51	0.03
PR Channel w EX	4100	10 YR	20.67	5423.68	5423.94	5423.92	5423.98	0.018992	1.71	12.11	87.87	0.81	0.16
PR Channel w EX	4100	100 YR	124.43	5423.68	5424.23	5424.19	5424.37	0.015343	3.03	41.03	107.16	0.86	0.37
PR Channel w EX	4050	2 YR	0.52	5422.77	5422.84	5422.84	5422.85	0.034147	0.86	0.60	18.78	0.85	0.07
PR Channel w EX	4050	10 YR	20.67	5422.77	5423.12	5423.08	5423.18	0.014017	1.88	11.00	54.99	0.74	0.17
PR Channel w EX	4050	100 YR	124.43	5422.77	5423.52	5423.46	5423.65	0.013395	2.91	42.78	107.45	0.81	0.33
PR Channel w EX	4000	2 YR	0.52	5422.17	5422.25		5422.26	0.005995	0.44	1.17	26.91	0.38	0.02
PR Channel w EX	4000	10 YR	20.67	5422.17	5422.48		5422.52	0.012141	1.70	12.19	63.89	0.68	0.14
PR Channel w EX	4000	100 YR	124.43	5422.17	5422.85		5423.00	0.012655	3.11	39.99	86.98	0.81	0.36
PR Channel w EX	3950	2 YR	0.52	5421.53	5421.60	5421.60	5421.62	0.043328	1.00	0.52	15.61	0.97	0.09
PR Channel w EX	3950	10 YR	20.67	5421.53	5421.90	5421.84	5421.94	0.011052	1.59	13.02	70.18	0.65	0.13
PR Channel w EX	3950	100 YR	124.43	5421.53	5422.24	5422.18	5422.38	0.012144	2.98	41.78	94.08	0.79	0.34
PR Channel w EX	3900	2 YR	0.52	5420.98	5421.03	5421.03	5421.04	0.026495	0.76	0.68	21.41	0.75	0.05
PR Channel w EX	3900	10 YR	20.67	5420.98	5421.27		5421.31	0.014266	1.70	12.14	71.37	0.73	0.15
PR Channel w EX	3900	100 YR	124.43	5420.98	5421.61		5421.75	0.013007	3.01	41.27	96.07	0.81	0.35
PR Channel w EX	3850	2 YR	0.52	5420.39	5420.54	5420.49	5420.54	0.005229	0.50	1.04	18.21	0.37	0.02
PR Channel w EX	3850	10 YR	20.67	5420.39	5420.80	5420.73	5420.82	0.007133	1.26	16.42	90.27	0.52	0.08
PR Channel w EX	3850	100 YR	124.43	5420.39	5421.14		5421.23	0.008001	2.47	50.46	110.29	0.64	0.23
PR Channel w EX	3800	2 YR	0.52	5419.85	5419.95	5419.95	5419.97	0.040081	1.10	0.47	11.62	0.96	0.10
PR Channel w EX	3800	10 YR	20.67	5419.85	5420.18	5420.17	5420.25	0.022015	1.98	10.43	67.57	0.89	0.21
PR Channel w EX	3800	100 YR	124.43	5419.85	5420.50	5420.48	5420.64	0.018906	3.06	40.63	122.29	0.94	0.39
PR Channel w EX	3750	2 YR	0.52	5418.83	5418.95	5418.92	5418.96	0.012145	0.78	0.66	11.07	0.56	0.05
PR Channel w EX	3750	10 YR	20.67	5418.83	5419.30	5419.25	5419.35	0.014535	1.88	11.02	56.76	0.75	0.18
PR Channel w EX	3750	100 YR	124.43	5418.83	5419.66	5419.61	5419.80	0.015270	3.03	41.03	106.75	0.86	0.37
PR Channel w EX	3700	2 YR	0.52	5417.94	5418.05	5418.04	5418.07	0.027984	1.14	0.46	8.07	0.85	0.10
PR Channel w EX	3700	10 YR	20.67	5417.94	5418.42	5418.40	5418.48	0.020644	2.03	10.16	60.31	0.87	0.22
PR Channel w EX	3700	100 YR	124.43	5417.94	5418.74	5418.74	5418.89	0.022492	3.10	40.08	134.62	1.00	0.42
PR Channel w EX	3650	2 YR	0.52	5416.94	5417.02		5417.03	0.016076	0.69	0.75	18.57	0.61	0.04
PR Channel w EX	3650	10 YR	20.67	5416.94	5417.23	5417.21	5417.28	0.027732	1.82	11.36	99.62	0.95	0.20
PR Channel w EX	3650	100 YR	124.43	5416.94	5417.47	5417.47	5417.64	0.022557	3.26	38.14	119.20	1.02	0.45
PR Channel w EX	3600	2 YR	0.52	5415.54	5415.61	5415.61	5415.64	0.060437	1.26	0.41	11.17	1.16	0.14
PR Channel w EX	3600	10 YR	20.67	5415.54	5415.83	5415.83	5415.90	0.027141	2.19	9.44	61.64	0.99	0.26
PR Channel w EX	3600	100 YR	124.43	5415.54	5416.16	5416.16	5416.35	0.021106	3.51	35.41	94.16	1.01	0.50

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR Channel w EX	3550	2 YR	0.52	5414.52	5414.58		5414.58	0.007885	0.45	1.17	32.75	0.42	0.02
PR Channel w EX	3550	10 YR	20.67	5414.52	5414.82	5414.76	5414.87	0.011680	1.84	11.23	50.50	0.69	0.16
PR Channel w EX	3550	100 YR	124.43	5414.52	5415.18	5415.16	5415.37	0.017312	3.48	35.79	83.33	0.94	0.46
PR Channel w EX	3500	2 YR	0.52	5413.69	5413.75	5413.75	5413.76	0.052504	0.89	0.58	23.98	1.01	0.08
PR Channel w EX	3500	10 YR	20.67	5413.69	5413.91	5413.91	5413.98	0.029114	2.15	9.63	68.35	1.01	0.26
PR Channel w EX	3500	100 YR	124.43	5413.69	5414.23	5414.23	5414.43	0.020444	3.57	34.87	88.48	1.00	0.50
PR Channel w EX	3450	2 YR	0.52	5412.61	5412.70	5412.67	5412.70	0.004997	0.45	1.15	22.32	0.35	0.02
PR Channel w EX	3450	10 YR	20.67	5412.61	5412.99		5413.02	0.007461	1.42	14.51	68.57	0.55	0.10
PR Channel w EX	3450	100 YR	124.43	5412.61	5414.14		5414.15	0.000405	0.98	126.54	117.07	0.17	0.03
PR Channel w EX	3400	2 YR	0.84	5411.86	5411.91	5411.91	5411.92	0.056470	1.07	0.78	25.73	1.09	0.11
PR Channel w EX	3400	10 YR	38.19	5411.86	5412.20	5412.20	5412.30	0.023396	2.51	15.19	72.11	0.97	0.31
PR Channel w EX	3400	100 YR	239.44	5411.86	5414.12		5414.14	0.000254	1.02	233.84	143.56	0.14	0.03
PR Channel w EX	3350	2 YR	0.84	5411.23	5411.34	5411.30	5411.34	0.004398	0.41	2.04	41.58	0.33	0.01
PR Channel w EX	3350	10 YR	38.19	5411.23	5411.67		5411.71	0.006725	1.63	23.47	84.00	0.54	0.12
PR Channel w EX	3350	100 YR	239.44	5411.23	5414.12		5414.13	0.000083	0.68	354.48	175.04	0.08	0.01
PR Channel w EX	3300	2 YR	0.84	5410.86	5410.92	5410.92	5410.93	0.020386	0.80	1.05	24.88	0.69	0.05
PR Channel w EX	3300	10 YR	38.19	5410.86	5411.38		5411.42	0.005267	1.54	24.76	79.92	0.49	0.10
PR Channel w EX	3300	100 YR	239.44	5410.86	5414.12		5414.13	0.000049	0.54	442.82	205.96	0.07	0.01
PR Channel w EX	3250	2 YR	0.84	5408.73	5410.02	5410.02	5410.08	0.031382	2.05	0.41	35.11	1.02	0.24
PR Channel w EX	3250	10 YR	38.19	5408.73	5410.74	5410.74	5410.93	0.021639	3.41	11.20	68.06	1.01	0.48
PR Channel w EX	3250	100 YR	239.44	5408.73	5414.12	5411.50	5414.12	0.000064	0.68	349.85	209.81	0.08	0.01
PR Channel w EX	3225		Culvert										
PR Channel w EX	3150	2 YR	0.84	5408.50	5408.66	5408.66	5408.70	0.037853	1.71	0.49	5.98	1.05	0.19
PR Channel w EX	3150	10 YR	38.19	5408.50	5409.28	5409.28	5409.58	0.019755	4.44	8.60	14.70	1.02	0.69
PR Channel w EX	3150	100 YR	239.44	5408.50	5410.72	5410.72	5411.72	0.015296	8.00	29.93	14.79	0.99	1.57
PR Channel w EX	3100	2 YR	0.84	5407.06	5407.22		5407.22	0.000880	0.34	2.48	20.36	0.17	0.01
PR Channel w EX	3100	10 YR	38.19	5407.06	5407.81		5407.84	0.005171	1.40	27.33	100.90	0.47	0.09
PR Channel w EX	3100	100 YR	239.44	5407.06	5408.42		5408.52	0.003765	2.44	98.26	124.14	0.48	0.19
PR Channel w EX	3050	2 YR	0.84	5407.04	5407.14		5407.15	0.004073	0.48	1.74	26.49	0.33	0.02
PR Channel w EX	3050	10 YR	38.19	5407.04	5407.54		5407.58	0.005276	1.56	24.46	77.63	0.49	0.10
PR Channel w EX	3050	100 YR	239.44	5407.04	5408.16		5408.29	0.005297	2.92	81.98	101.98	0.57	0.27
PR Channel w EX	3000	2 YR	0.84	5406.60	5406.66	5406.66	5406.68	0.040104	0.98	0.86	25.29	0.93	0.09
PR Channel w EX	3000	10 YR	38.19	5406.60	5406.96	5406.96	5407.08	0.024526	2.80	13.64	57.13	1.01	0.37
PR Channel w EX	3000	100 YR	239.44	5406.60	5407.52	5407.52	5407.83	0.017844	4.50	53.19	85.99	1.01	0.69
PR Channel w EX	2950	2 YR	0.84	5404.92	5405.09	5405.08	5405.12	0.024281	1.41	0.60	6.90	0.85	0.13
PR Channel w EX	2950	10 YR	38.19	5404.92	5405.61	5405.59	5405.73	0.018444	2.78	13.76	47.08	0.91	0.34
PR Channel w EX	2950	100 YR	239.44	5404.92	5406.21	5406.21	5406.50	0.018606	4.36	54.92	96.11	1.02	0.66
PR Channel w EX	2900	2 YR	0.84	5403.66	5403.90	5403.88	5403.94	0.023293	1.65	0.51	4.50	0.87	0.16
PR Channel w EX	2900	10 YR	38.19	5403.66	5404.51	5404.51	5404.68	0.024056	3.36	11.36	35.57	1.05	0.48
PR Channel w EX	2900	100 YR	239.44	5403.66	5405.17	5405.17	5405.47	0.017954	4.41	54.34	91.06	1.01	0.67
PR Channel w EX	2850	2 YR	0.84	5402.27	5402.52	5402.52	5402.59	0.031734	2.00	0.42	3.47	1.02	0.24
PR Channel w EX	2850	10 YR	38.19	5402.27	5403.35	5403.35	5403.53	0.022015	3.45	11.06	31.04	1.02	0.49
PR Channel w EX	2850	100 YR	239.44	5402.27	5404.05	5404.05	5404.33	0.018471	4.20	56.95	104.48	1.00	0.63
PR Channel w EX	2800	2 YR	0.84	5400.99	5401.26	5401.24	5401.31	0.020942	1.83	0.46	3.16	0.85	0.19
PR Channel w EX	2800	10 YR	38.19	5400.99	5401.94	5401.94	5402.09	0.025467	3.02	12.64	48.28	1.04	0.41
PR Channel w EX	2800	100 YR	239.44	5400.99	5402.51	5402.51	5402.82	0.018147	4.46	53.73	88.92	1.01	0.68
PR Channel w EX	2750	2 YR	0.84	5399.72	5399.85	5399.85	5399.88	0.040239	1.30	0.65	12.40	1.00	0.13
PR Channel w EX	2750	10 YR	38.19	5399.72	5400.37	5400.37	5400.59	0.019664	3.77	10.12	22.89	1.00	0.54
PR Channel w EX	2750	100 YR	239.44	5399.72	5401.38	5401.38	5401.79	0.016168	5.17	46.29	56.29	1.01	0.83
PR Channel w EX	2700	2 YR	0.84	5399.21	5399.34		5399.34	0.000207	0.14	6.03	63.14	0.08	0.00
PR Channel w EX	2700	10 YR	38.19	5399.21	5399.81		5399.82	0.001108	1.01	37.84	71.64	0.24	0.04
PR Channel w EX	2700	100 YR	239.44	5399.21	5400.65		5400.74	0.001876	2.30	104.03	84.78	0.37	0.14
PR Channel w EX	2650	2 YR	0.84	5399.21	5399.30	5399.29	5399.31	0.017785	0.76	1.11	26.11	0.65	0.05
PR Channel w EX	2650	10 YR	38.19	5399.21	5399.57	5399.55	5399.68	0.017405	2.54	15.02	56.15	0.87	0.29
PR Channel w EX	2650	100 YR	239.44	5399.21	5400.12	5400.12	5400.50	0.016834	4.92	48.71	65.90	1.01	0.77
PR Channel w EX	2600	2 YR	0.84	5398.06	5398.15	5398.14	5398.17	0.029658	1.13	0.74	13.85	0.87	0.10
PR Channel w EX	2600	10 YR	38.19	5398.06	5398.53	5398.53	5398.65	0.024343	2.88	13.25	52.79	1.01	0.38
PR Channel w EX	2600	100 YR	239.44	5398.06	5399.06	5399.06	5399.34	0.018996	4.28	55.98	102.33	1.02	0.65
PR Channel w EX	2550	2 YR	0.84	5396.34	5396.44	5396.44	5396.46	0.039839	1.20	0.70	15.00	0.98	0.12
PR Channel w EX	2550	10 YR	38.19	5396.34	5396.89	5396.89	5397.06	0.021836	3.34	11.42	33.56	1.01	0.46
PR Channel w EX	2550	100 YR	239.44	5396.34	5397.63	5397.63	5397.94	0.018563	4.45	53.84	91.27	1.02	0.68
PR Channel w EX	2500	2 YR	0.84	5394.48	5394.65	5394.59	5394.65	0.003959	0.46	1.83	29.27	0.32	0.02
PR Channel w EX	2500	10 YR	38.19	5394.48	5395.10		5395.15	0.004664	1.72	22.17	55.27	0.48	0.12
PR Channel w EX	2500	100 YR	239.44	5394.48	5395.60	5395.53	5395.90	0.013066	4.42	54.22	71.21	0.89	0.62
PR Channel w EX	2450	2 YR	0.84	5394.37	5394.42	5394.42	5394.42	0.005570	0.46	1.84	38.38	0.37	0.02
PR Channel w EX	2450	10 YR	38.19	5394.37	5394.82		5394.85	0.007456	1.53	24.95	105.65	0.56	0.11
PR Channel w EX	2450	100 YR	239.44	5394.37	5395.43		5395.51	0.003947	2.29	104.37	149.43	0.48	0.17

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX (Continued)

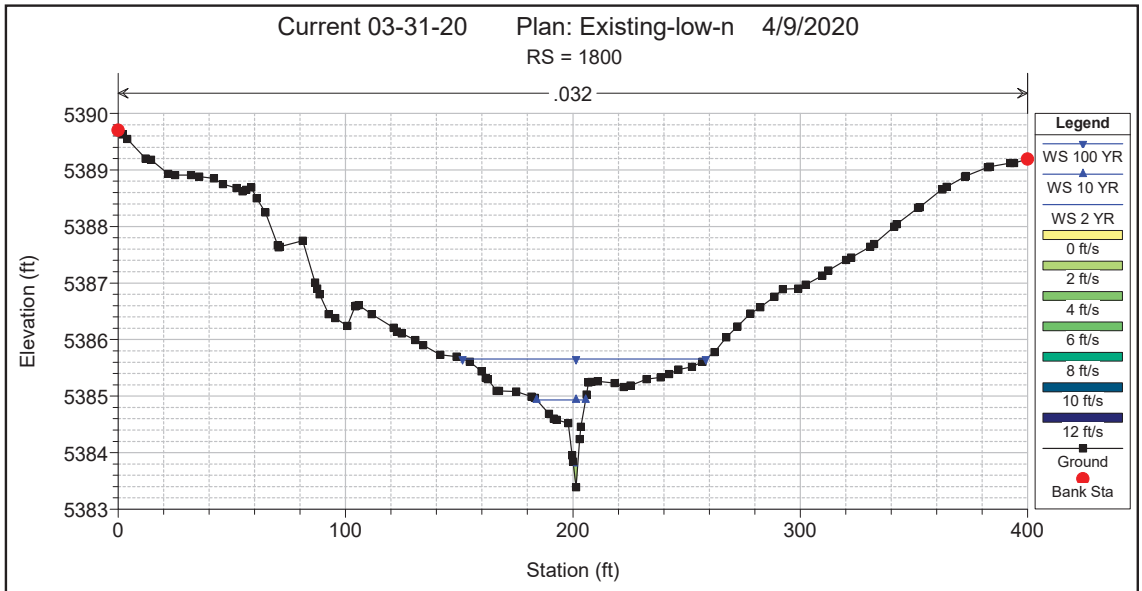
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR Channel w EX	2400	2 YR	0.84	5394.18	5394.31		5394.31	0.000185	0.15	5.52	46.63	0.08	0.00
PR Channel w EX	2400	10 YR	38.19	5394.18	5394.69		5394.70	0.001558	0.89	42.89	126.59	0.27	0.03
PR Channel w EX	2400	100 YR	239.44	5394.18	5395.32		5395.37	0.001861	1.77	135.11	162.12	0.34	0.10
PR Channel w EX	2350	2 YR	0.84	5394.18	5394.30		5394.30	0.000537	0.17	4.89	76.53	0.12	0.00
PR Channel w EX	2350	10 YR	38.19	5394.18	5394.63		5394.63	0.001068	0.72	53.07	162.46	0.22	0.02
PR Channel w EX	2350	100 YR	239.44	5394.18	5395.25		5395.29	0.001210	1.50	159.54	178.06	0.28	0.07
PR Channel w EX	2300	2 YR	0.84	5394.18	5394.22	5394.21	5394.22	0.012734	0.49	1.72	60.84	0.51	0.02
PR Channel w EX	2300	10 YR	38.19	5394.18	5394.57		5394.58	0.001204	0.75	50.61	157.92	0.23	0.02
PR Channel w EX	2300	100 YR	239.44	5394.18	5395.19		5395.22	0.001378	1.57	152.23	174.43	0.30	0.07
PR Channel w EX	2250	2 YR	0.84	5393.01	5393.38	5393.35	5393.44	0.019577	1.98	0.42	2.41	0.83	0.21
PR Channel w EX	2250	10 YR	38.19	5393.01	5394.31	5394.31	5394.41	0.029729	2.53	15.12	85.01	1.06	0.33
PR Channel w EX	2250	100 YR	239.44	5393.01	5394.76	5394.76	5395.03	0.018482	4.20	57.05	104.72	1.00	0.63
PR Channel w EX	2200	2 YR	0.84	5391.94	5392.07	5392.07	5392.10	0.038325	1.26	0.67	12.95	0.98	0.12
PR Channel w EX	2200	10 YR	38.19	5391.94	5392.38	5392.38	5392.48	0.025766	2.61	14.66	70.87	1.01	0.33
PR Channel w EX	2200	100 YR	239.44	5391.94	5392.83	5392.83	5393.10	0.019824	4.16	57.55	113.28	1.03	0.63
PR Channel w EX	2150	2 YR	0.84	5389.65	5389.98		5390.00	0.008120	1.24	0.68	4.10	0.54	0.08
PR Channel w EX	2150	10 YR	38.19	5389.65	5390.79	5390.79	5391.04	0.020483	4.03	9.47	19.86	1.03	0.60
PR Channel w EX	2150	100 YR	239.44	5389.65	5391.59	5391.59	5391.85	0.021175	4.14	57.83	120.30	1.05	0.63
PR Channel w EX	2100	2 YR	0.84	5388.87	5389.99		5389.99	0.000005	0.07	11.80	21.33	0.02	0.00
PR Channel w EX	2100	10 YR	38.19	5388.87	5390.51		5390.54	0.001442	1.35	28.20	41.70	0.29	0.06
PR Channel w EX	2100	100 YR	239.44	5388.87	5391.19		5391.29	0.005616	2.65	90.35	135.74	0.57	0.23
PR Channel w EX	2050	2 YR	0.84	5389.86	5389.97	5389.97	5389.99	0.021605	0.99	0.85	15.51	0.74	0.07
PR Channel w EX	2050	10 YR	38.19	5389.86	5390.27	5390.27	5390.35	0.027864	2.24	17.05	109.72	1.00	0.27
PR Channel w EX	2050	100 YR	239.44	5389.86	5390.60	5390.60	5390.79	0.021643	3.55	67.50	180.36	1.02	0.51
PR Channel w EX	2000	2 YR	0.84	5386.96	5387.26	5387.26	5387.33	0.029511	2.20	0.38	2.58	1.01	0.27
PR Channel w EX	2000	10 YR	38.19	5386.96	5388.29	5388.26	5388.49	0.017524	3.54	10.79	24.42	0.94	0.48
PR Channel w EX	2000	100 YR	239.44	5386.96	5388.97	5388.97	5389.21	0.020045	3.89	61.61	135.26	1.02	0.57
PR Channel w EX	1950	2 YR	0.84	5385.84	5386.21	5386.16	5386.26	0.013447	1.69	0.50	2.71	0.70	0.15
PR Channel w EX	1950	10 YR	38.19	5385.84	5387.36	5387.36	5387.53	0.020740	3.32	11.50	32.37	0.98	0.45
PR Channel w EX	1950	100 YR	239.44	5385.84	5387.95	5387.94	5388.17	0.020976	3.79	63.22	149.11	1.03	0.55
PR Channel w EX	1900	2 YR	0.84	5385.10	5385.37	5385.35	5385.42	0.021444	1.84	0.46	3.21	0.86	0.19
PR Channel w EX	1900	10 YR	38.19	5385.10	5386.61		5386.68	0.007099	2.15	17.73	43.19	0.59	0.18
PR Channel w EX	1900	100 YR	239.44	5385.10	5387.40		5387.54	0.007936	2.97	80.70	132.59	0.67	0.30
PR Channel w EX	1850	2 YR	0.84	5384.15	5384.63	5384.56	5384.68	0.010748	1.70	0.49	2.05	0.61	0.14
PR Channel w EX	1850	10 YR	38.19	5384.15	5385.91	5385.88	5386.14	0.017189	3.87	9.86	18.66	0.94	0.54
PR Channel w EX	1850	100 YR	239.44	5384.15	5386.66	5386.66	5386.93	0.019997	4.16	57.54	113.27	1.03	0.63
PR Channel w EX	1800	2 YR	0.84	5383.39	5383.77	5383.76	5383.85	0.027717	2.40	0.35	1.87	0.98	0.30
PR Channel w EX	1800	10 YR	38.19	5383.39	5384.94	5384.94	5385.18	0.022078	3.96	9.63	21.61	1.05	0.60
PR Channel w EX	1800	100 YR	239.44	5383.39	5385.66	5385.66	5385.94	0.019570	4.23	56.57	106.98	1.03	0.64
PR Channel w EX	1750	2 YR	0.84	5382.66	5383.10		5383.14	0.008333	1.48	0.57	2.56	0.56	0.11
PR Channel w EX	1750	10 YR	38.19	5382.66	5384.20		5384.28	0.010507	2.25	16.97	51.74	0.69	0.21
PR Channel w EX	1750	100 YR	239.44	5382.66	5384.83	5384.73	5385.01	0.011839	3.40	70.39	126.93	0.81	0.41
PR Channel w EX	1700	2 YR	0.84	5381.94	5382.32	5382.32	5382.42	0.029933	2.50	0.34	1.78	1.01	0.32
PR Channel w EX	1700	10 YR	38.19	5381.94	5383.53	5383.49	5383.62	0.016775	2.38	16.02	63.70	0.84	0.26
PR Channel w EX	1700	100 YR	239.44	5381.94	5384.00	5384.00	5384.28	0.018052	4.22	56.74	101.49	0.99	0.63
PR Channel w EX	1650	2 YR	0.84	5381.09	5381.53		5381.55	0.007041	1.37	0.61	2.83	0.52	0.09
PR Channel w EX	1650	10 YR	38.19	5381.09	5382.65	5382.61	5382.76	0.017459	2.62	14.56	51.73	0.87	0.30
PR Channel w EX	1650	100 YR	239.44	5381.09	5383.34		5383.52	0.009203	3.40	70.39	105.10	0.73	0.38
PR Channel w EX	1600	2 YR	0.84	5380.66	5381.08	5381.01	5381.13	0.010835	1.65	0.51	2.40	0.63	0.13
PR Channel w EX	1600	10 YR	38.19	5380.66	5382.08		5382.15	0.008919	2.13	17.97	52.79	0.64	0.19
PR Channel w EX	1600	100 YR	239.44	5380.66	5382.66	5382.59	5382.94	0.014380	4.26	56.18	83.40	0.92	0.60
PR Channel w EX	1550	2 YR	0.84	5379.85	5380.19	5380.19	5380.28	0.028929	2.33	0.36	2.11	1.00	0.29
PR Channel w EX	1550	10 YR	38.19	5379.85	5381.25	5381.25	5381.39	0.031282	3.03	12.60	55.72	1.12	0.44
PR Channel w EX	1550	100 YR	239.44	5379.85	5381.83	5381.83	5382.12	0.019352	4.28	55.92	103.09	1.03	0.65
PR Channel w EX	1500	2 YR	0.84	5379.19	5379.62		5379.64	0.004996	1.16	0.73	3.33	0.44	0.07
PR Channel w EX	1500	10 YR	38.19	5379.19	5380.67		5380.71	0.006121	1.72	22.20	67.79	0.53	0.12
PR Channel w EX	1500	100 YR	239.44	5379.19	5381.31		5381.48	0.006643	3.29	72.88	89.72	0.64	0.34
PR Channel w EX	1450	2 YR	0.84	5378.72	5379.08	5379.08	5379.16	0.024539	2.23	0.38	2.09	0.93	0.26
PR Channel w EX	1450	10 YR	38.19	5378.72	5380.26		5380.34	0.009105	2.26	16.90	46.01	0.66	0.21
PR Channel w EX	1450	100 YR	239.44	5378.72	5381.14		5381.21	0.003644	2.14	112.05	167.85	0.46	0.15
PR Channel w EX	1400	2 YR	1.93	5377.94	5378.60		5378.65	0.006645	1.73	1.12	3.34	0.53	0.13
PR Channel w EX	1400	10 YR	67.96	5377.94	5379.66		5379.77	0.013048	2.63	25.79	73.16	0.78	0.29
PR Channel w EX	1400	100 YR	441.42	5377.94	5380.35	5380.35	5380.74	0.016910	5.02	87.89	115.30	1.01	0.80
PR Channel w EX	1350	2 YR	1.93	5377.74	5378.35	5378.25	5378.36	0.004718	0.91	2.12	13.69	0.41	0.04
PR Channel w EX	1350	10 YR	67.96	5377.74	5379.06		5379.14	0.012190	2.27	29.93	101.10	0.74	0.22
PR Channel w EX	1350	100 YR	441.42	5377.74	5379.65		5379.88	0.012008	3.89	113.48	169.30	0.84	0.50
PR Channel w EX	1300	2 YR	1.93	5377.72	5377.84	5377.84	5377.87	0.032287	1.40	1.38	23.00	0.94	0.14
PR Channel w EX	1300	10 YR	67.96	5377.72	5378.42	5378.35	5378.50	0.012916	2.32	29.25	115.91	0.76	0.24

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR Channel w EX	1300	100 YR	441.42	5377.72	5379.02	5378.95	5379.26	0.012928	3.93	112.20	195.55	0.86	0.52
PR Channel w EX	1250	2 YR	1.93	5375.82	5376.46	5376.36	5376.53	0.010657	2.10	0.92	2.85	0.65	0.19
PR Channel w EX	1250	10 YR	67.96	5375.82	5377.54	5377.54	5377.70	0.020321	3.28	20.73	78.16	0.97	0.44
PR Channel w EX	1250	100 YR	441.42	5375.82	5378.23	5378.23	5378.51	0.017819	4.25	103.90	208.43	0.99	0.63
PR Channel w EX	1200	2 YR	1.93	5375.37	5375.99	5375.88	5376.05	0.008718	1.90	1.02	10.76	0.60	0.16
PR Channel w EX	1200	10 YR	67.96	5375.37	5376.89	5376.79	5376.97	0.008622	2.21	30.71	103.46	0.64	0.20
PR Channel w EX	1200	100 YR	441.42	5375.37	5377.68	5377.50	5377.81	0.007519	2.92	151.35	271.66	0.65	0.29
PR Channel w EX	1150	2 YR	1.93	5373.83	5375.53	5375.44	5375.59	0.009824	1.84	1.05	41.49	0.63	0.16
PR Channel w EX	1150	10 YR	67.96	5373.83	5376.19	5376.19	5376.33	0.020942	2.90	23.42	127.72	0.96	0.37
PR Channel w EX	1150	100 YR	441.42	5373.83	5376.85	5376.85	5377.22	0.018869	4.94	89.37	183.45	1.05	0.80
PR Channel w EX	1100	2 YR	1.93	5374.53	5374.70	5374.70	5374.74	0.036070	1.46	1.32	19.66	0.99	0.15
PR Channel w EX	1100	10 YR	67.96	5374.53	5375.15	5375.15	5375.28	0.021068	2.80	24.27	90.39	0.95	0.35
PR Channel w EX	1100	100 YR	441.42	5374.53	5375.73	5375.73	5376.06	0.017377	4.60	96.04	147.34	1.00	0.71
PR Channel w EX	1050	2 YR	1.93	5372.62	5372.84		5372.85	0.005208	0.79	2.44	21.30	0.41	0.04
PR Channel w EX	1050	10 YR	67.96	5372.62	5373.43		5373.53	0.007359	2.43	27.93	58.47	0.62	0.22
PR Channel w EX	1050	100 YR	441.42	5372.62	5374.36	5374.22	5374.58	0.010359	3.70	119.18	170.67	0.78	0.45
PR Channel w EX	1000	2 YR	1.93	5372.05	5372.28	5372.28	5372.33	0.030241	1.86	1.04	9.41	0.98	0.21
PR Channel w EX	1000	10 YR	67.96	5372.05	5372.78	5372.78	5372.93	0.022078	3.11	21.84	72.10	1.00	0.42
PR Channel w EX	1000	100 YR	441.42	5372.05	5373.48	5373.48	5373.90	0.016894	5.20	84.92	105.82	1.02	0.84
PR Channel w EX	950	2 YR	1.93	5363.66	5370.75		5370.75	0.000000	0.02	98.60	100.50	0.00	0.00
PR Channel w EX	950	10 YR	67.96	5363.66	5371.46		5371.46	0.000046	0.39	174.98	117.93	0.06	0.00
PR Channel w EX	950	100 YR	441.42	5363.66	5372.42		5372.46	0.000385	1.49	295.98	130.97	0.17	0.05
PR Channel w EX	900	2 YR	1.93	5370.50	5370.70	5370.70	5370.75	0.034567	1.82	1.06	11.01	1.03	0.21
PR Channel w EX	900	10 YR	67.96	5370.50	5371.26	5371.26	5371.43	0.022413	3.29	20.65	63.37	1.02	0.46
PR Channel w EX	900	100 YR	441.42	5370.50	5372.00	5372.00	5372.36	0.017029	4.87	90.72	125.41	1.01	0.77
PR Channel w EX	850	2 YR	1.93	5363.67	5364.32		5364.34	0.003257	1.22	1.58	4.90	0.38	0.06
PR Channel w EX	850	10 YR	67.96	5363.67	5365.96		5366.18	0.005132	3.69	18.42	15.02	0.59	0.37
PR Channel w EX	850	100 YR	441.42	5363.67	5368.60		5369.15	0.004719	5.90	74.79	27.93	0.64	0.74
PR Channel w EX	800	2 YR	1.93	5363.51	5364.05		5364.09	0.007697	1.66	1.16	4.30	0.57	0.13
PR Channel w EX	800	10 YR	67.96	5363.51	5365.71		5365.92	0.005257	3.68	18.48	15.51	0.59	0.37
PR Channel w EX	800	100 YR	441.42	5363.51	5368.41		5368.91	0.004237	5.70	77.37	27.99	0.60	0.69
PR Channel w EX	750	2 YR	1.93	5363.16	5363.90		5363.92	0.001790	1.00	1.92	5.01	0.29	0.04
PR Channel w EX	750	10 YR	67.96	5363.16	5365.64		5365.73	0.001927	2.46	27.58	19.66	0.37	0.16
PR Channel w EX	750	100 YR	441.42	5363.16	5368.34		5368.65	0.003928	4.49	98.22	48.59	0.56	0.47
PR Channel w EX	700	2 YR	1.93	5363.03	5363.86		5363.86	0.000733	0.72	2.69	5.98	0.19	0.02
PR Channel w EX	700	10 YR	67.96	5363.03	5365.55		5365.64	0.001706	2.38	28.57	19.64	0.35	0.15
PR Channel w EX	700	100 YR	441.42	5363.03	5368.18		5368.49	0.002554	4.44	99.42	36.28	0.47	0.41
PR Channel w EX	650	2 YR	1.93	5363.27	5363.78		5363.80	0.002570	0.98	1.97	7.26	0.33	0.04
PR Channel w EX	650	10 YR	67.96	5363.27	5365.24		5365.48	0.005527	3.91	17.36	13.53	0.61	0.42
PR Channel w EX	650	100 YR	441.42	5363.27	5367.79		5368.28	0.005976	5.65	78.14	37.55	0.69	0.74
PR Channel w EX	600	2 YR	1.93	5363.06	5363.76		5363.77	0.000256	0.41	4.72	11.47	0.11	0.01
PR Channel w EX	600	10 YR	67.96	5363.06	5365.20		5365.29	0.001798	2.39	28.43	20.68	0.36	0.15
PR Channel w EX	600	100 YR	441.42	5363.06	5367.77		5367.98	0.003424	3.64	121.24	76.82	0.51	0.33
PR Channel w EX	550	2 YR	1.93	5361.10	5363.76		5363.76	0.000002	0.08	24.62	17.17	0.01	0.00
PR Channel w EX	550	10 YR	67.96	5361.10	5365.22		5365.24	0.000259	1.24	55.00	24.34	0.14	0.03
PR Channel w EX	550	100 YR	441.42	5361.10	5367.75		5367.85	0.001145	2.47	178.98	87.62	0.30	0.14
PR Channel w EX	500	2 YR	1.93	5361.07	5363.76		5363.76	0.000001	0.06	29.87	15.49	0.01	0.00
PR Channel w EX	500	10 YR	67.96	5361.07	5365.21		5365.23	0.000231	1.25	54.44	18.60	0.13	0.03
PR Channel w EX	500	100 YR	441.42	5361.07	5367.70		5367.79	0.001139	2.35	187.62	94.67	0.29	0.13
PR Channel w EX	450	2 YR	1.93	5363.05	5363.76		5363.76	0.000703	0.63	3.05	7.66	0.18	0.02
PR Channel w EX	450	10 YR	67.96	5363.05	5364.63	5364.63	5365.14	0.018358	5.76	11.80	11.86	1.02	1.00
PR Channel w EX	450	100 YR	441.42	5363.05	5367.15	5367.15	5367.61	0.018098	5.42	81.46	95.77	1.04	0.91
PR Channel w EX	400	2 YR	1.93	5360.98	5363.76		5363.76	0.000001	0.07	29.23	19.09	0.01	0.00
PR Channel w EX	400	10 YR	67.96	5360.98	5364.43		5364.47	0.000519	1.58	43.14	22.47	0.20	0.06
PR Channel w EX	400	100 YR	441.42	5360.98	5364.85	5364.85	5365.93	0.012494	8.32	53.03	24.69	1.00	1.58
PR Channel w EX	350	2 YR	1.93	5360.77	5363.76		5363.76	0.000000	0.04	54.32	31.80	0.00	0.00
PR Channel w EX	350	10 YR	67.96	5360.77	5364.44		5364.44	0.000258	0.74	92.11	92.34	0.13	0.02
PR Channel w EX	350	100 YR	441.42	5360.77	5365.29		5365.37	0.001452	2.26	195.17	132.97	0.33	0.13
PR Channel w EX	300	2 YR	1.93	5359.06	5363.76		5363.76	0.000000	0.02	92.55	84.64	0.00	0.00
PR Channel w EX	300	10 YR	67.96	5359.06	5364.44		5364.44	0.000051	0.39	173.58	134.01	0.06	0.00
PR Channel w EX	300	100 YR	441.42	5359.06	5365.29		5365.32	0.000472	1.40	314.91	189.52	0.19	0.05
PR Channel w EX	250	2 YR	1.93	5363.39	5363.74		5363.76	0.007490	1.24	1.56	9.14	0.53	0.08
PR Channel w EX	250	10 YR	67.96	5363.39	5364.36	5364.28	5364.42	0.010529	1.95	34.83	132.77	0.67	0.17
PR Channel w EX	250	100 YR	441.42	5363.39	5365.16		5365.26	0.003572	2.53	174.49	200.31	0.48	0.19
PR Channel w EX	200	2 YR	1.93	5362.85	5363.02	5363.02	5363.06	0.035289	1.51	1.28	17.85	0.99	0.16
PR Channel w EX	200	10 YR	67.96	5362.85	5363.49	5363.49	5363.69	0.020158	3.60	18.86	46.64	1.00	0.51
PR Channel w EX	200	100 YR	441.42	5362.85	5364.56	5364.56	5364.89	0.018267	4.62	95.59	151.29	1.02	0.72

HEC-RAS Plan: EX-low-n River: PR Channel w EX Reach: PR Channel w EX (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR Channel w EX	150	2 YR	1.93	5355.69	5356.30	5356.20	5356.36	0.009995	2.00	0.96	3.16	0.64	0.18
PR Channel w EX	150	10 YR	67.96	5355.69	5358.04	5357.81	5358.46	0.010004	5.18	13.12	9.98	0.80	0.74
PR Channel w EX	150	100 YR	441.42	5355.69	5360.76	5360.49	5361.87	0.010008	8.42	52.42	18.71	0.89	1.52


Current 03-31-20 Plan: Existing-low-n 4/9/2020
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.032
Elevation (ft)
Station (ft)
Legend
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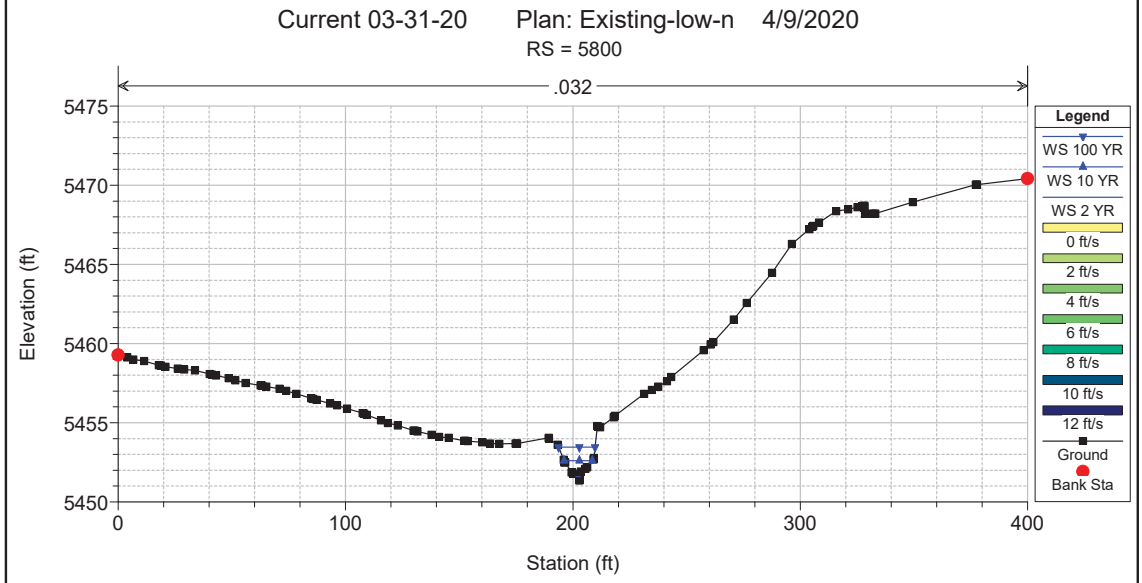
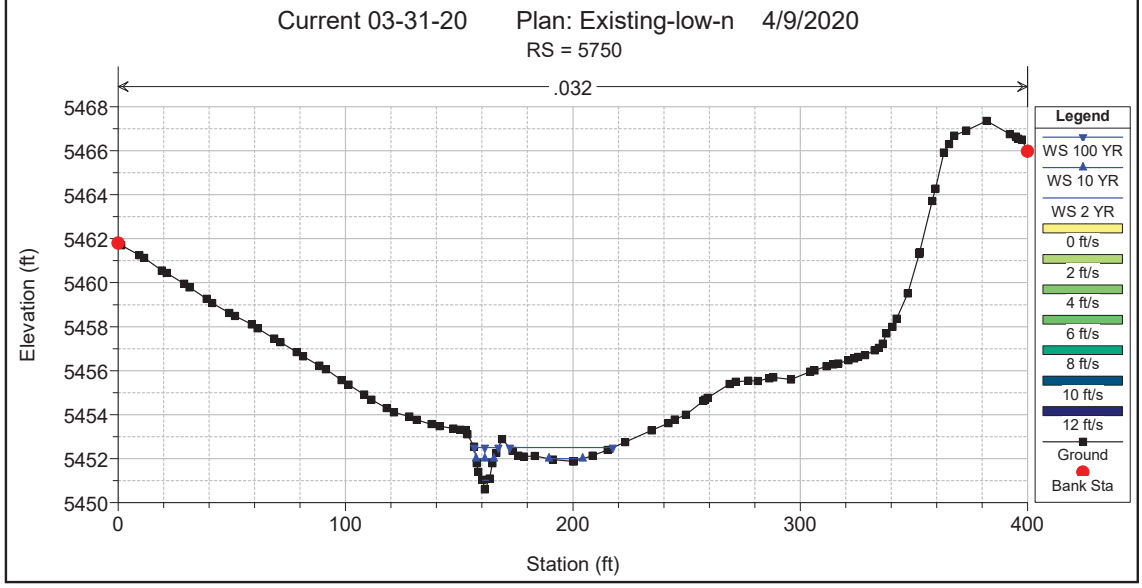
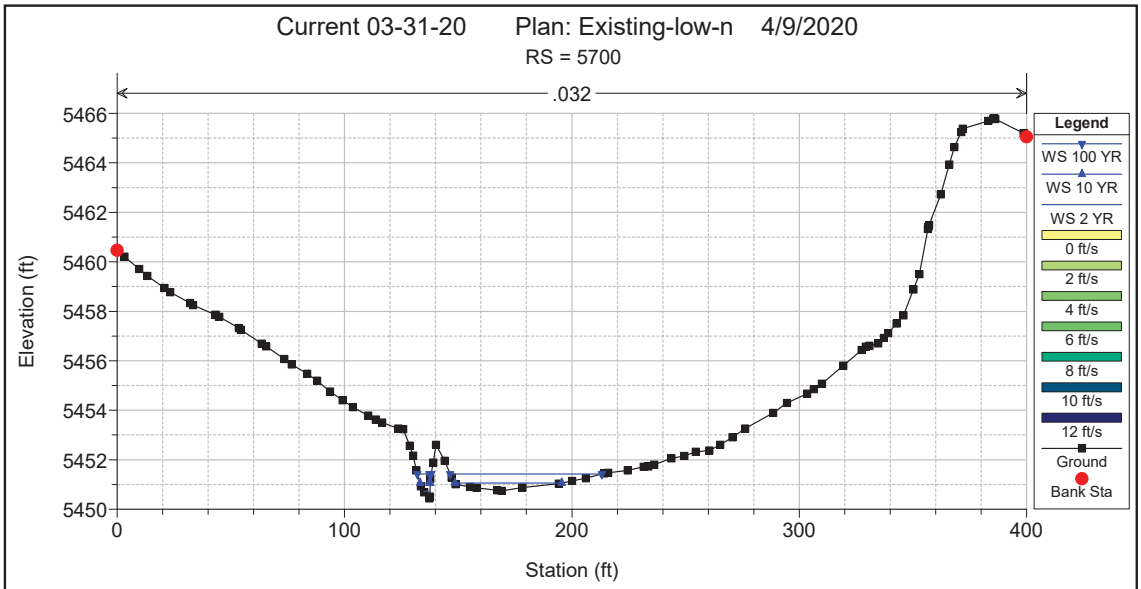
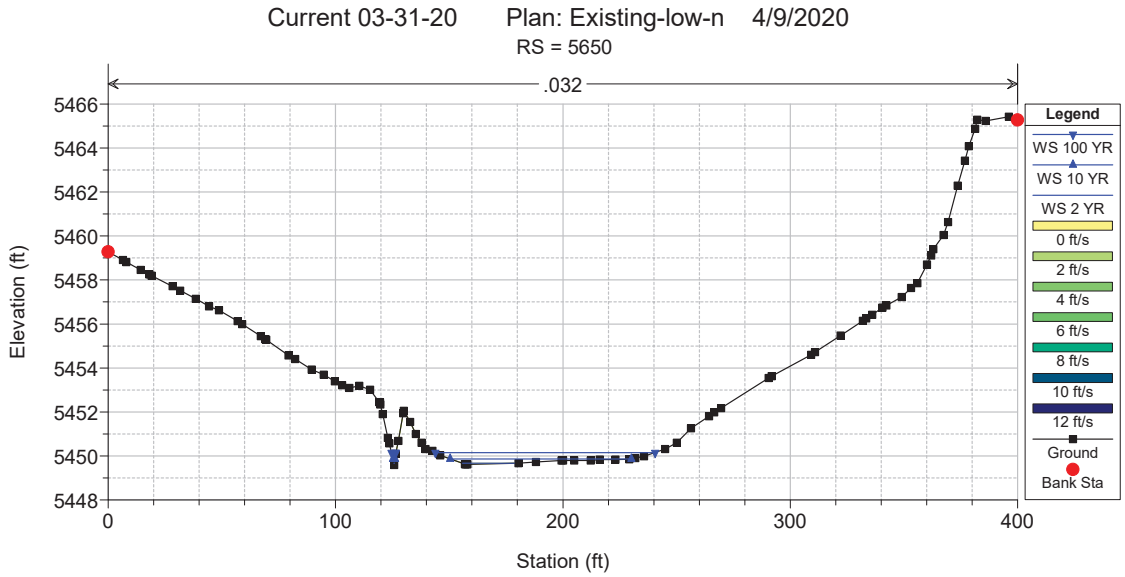
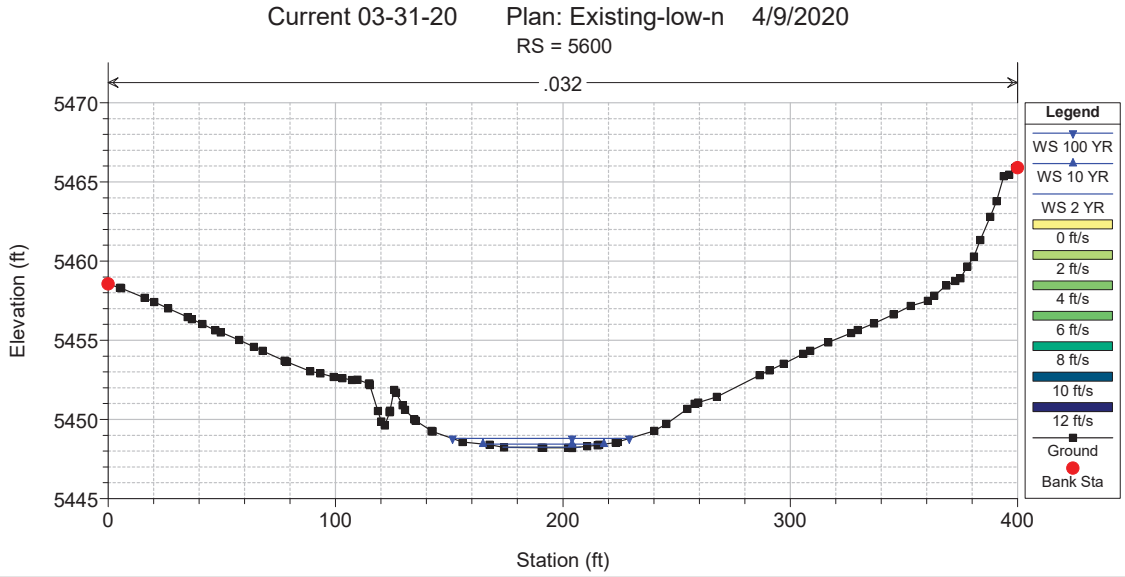
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

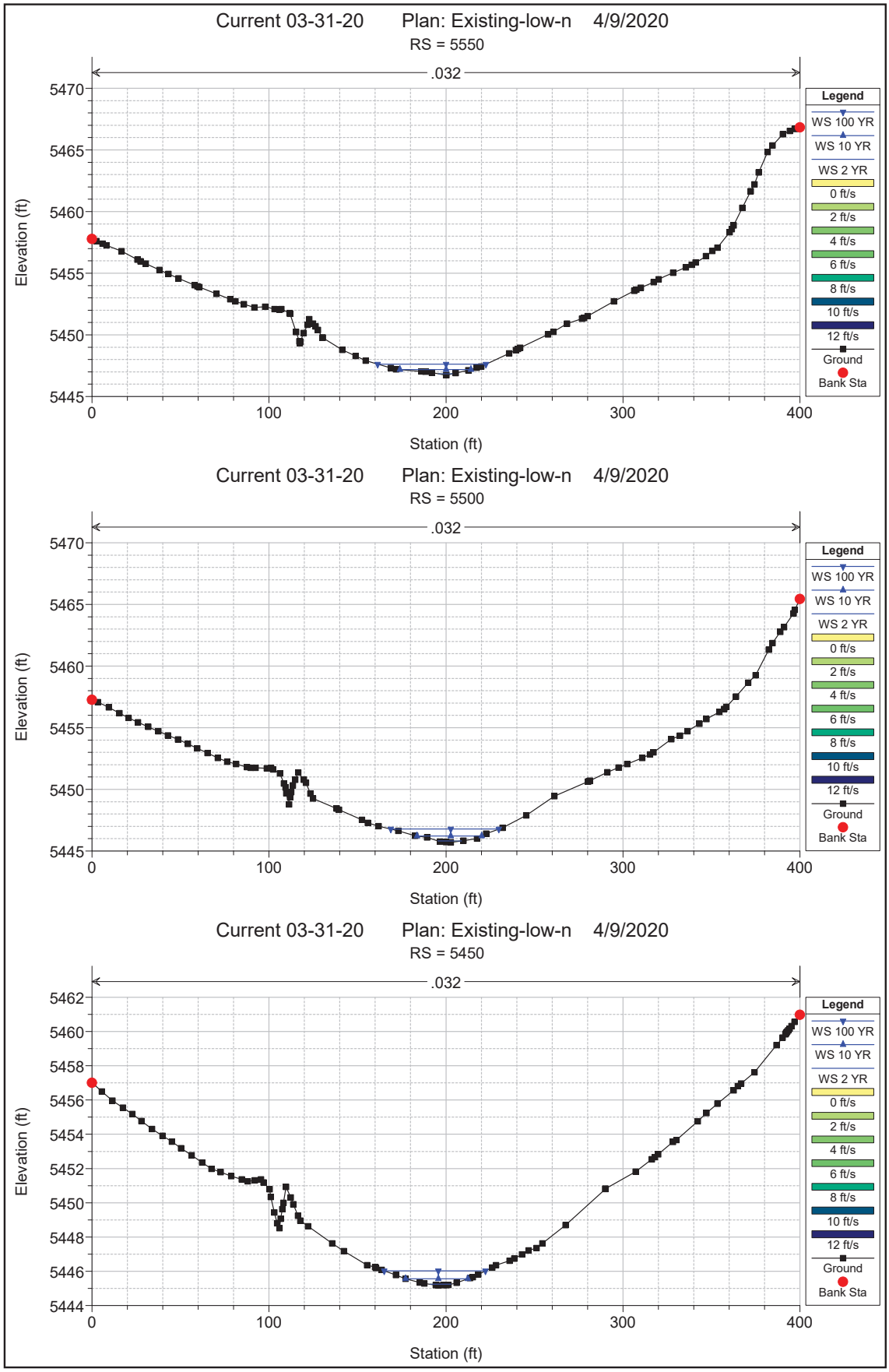

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5800
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5750
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5700
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5650
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5600
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5550
.032
Elevation (ft)
Station (ft)
Legend
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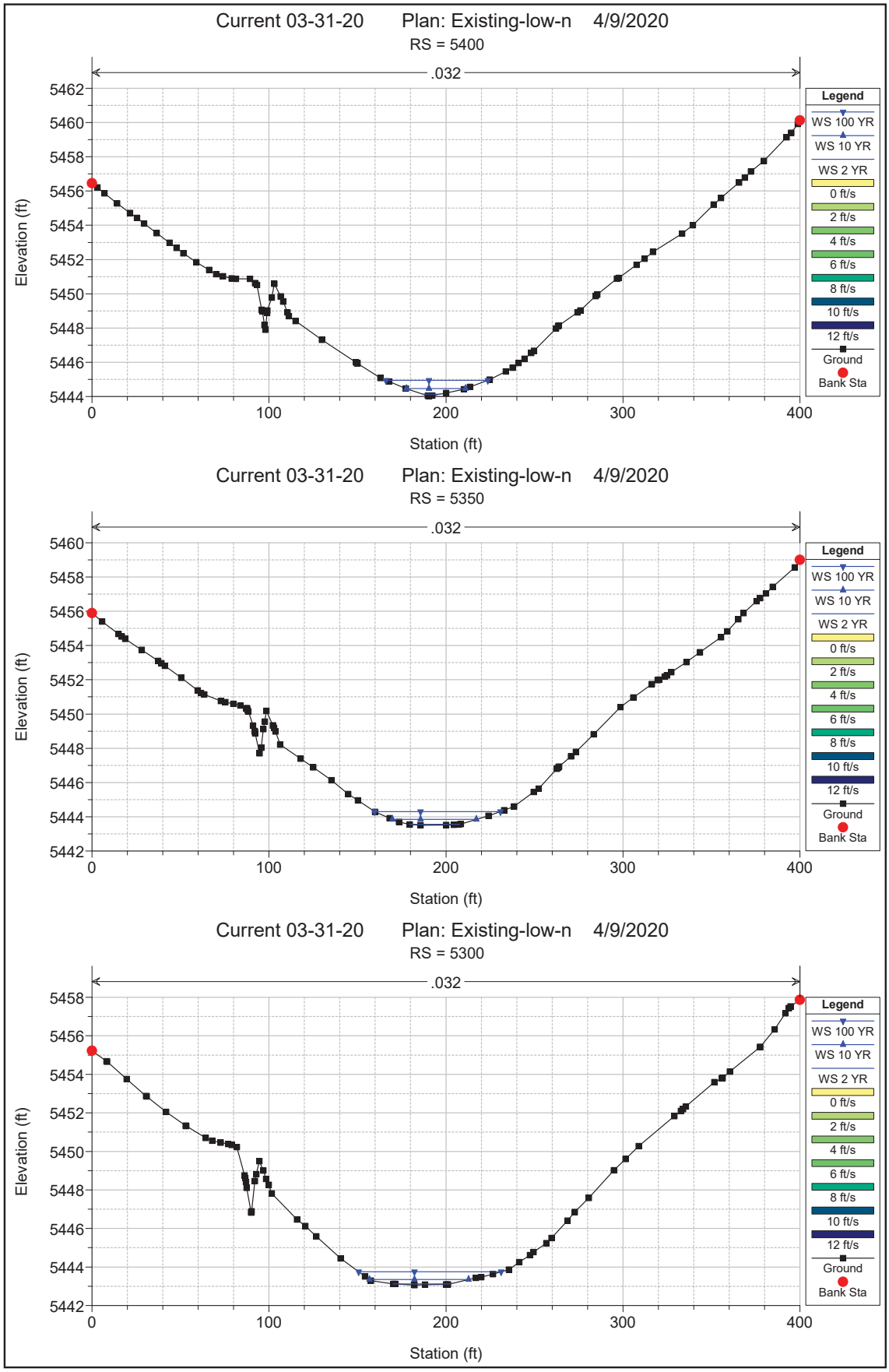
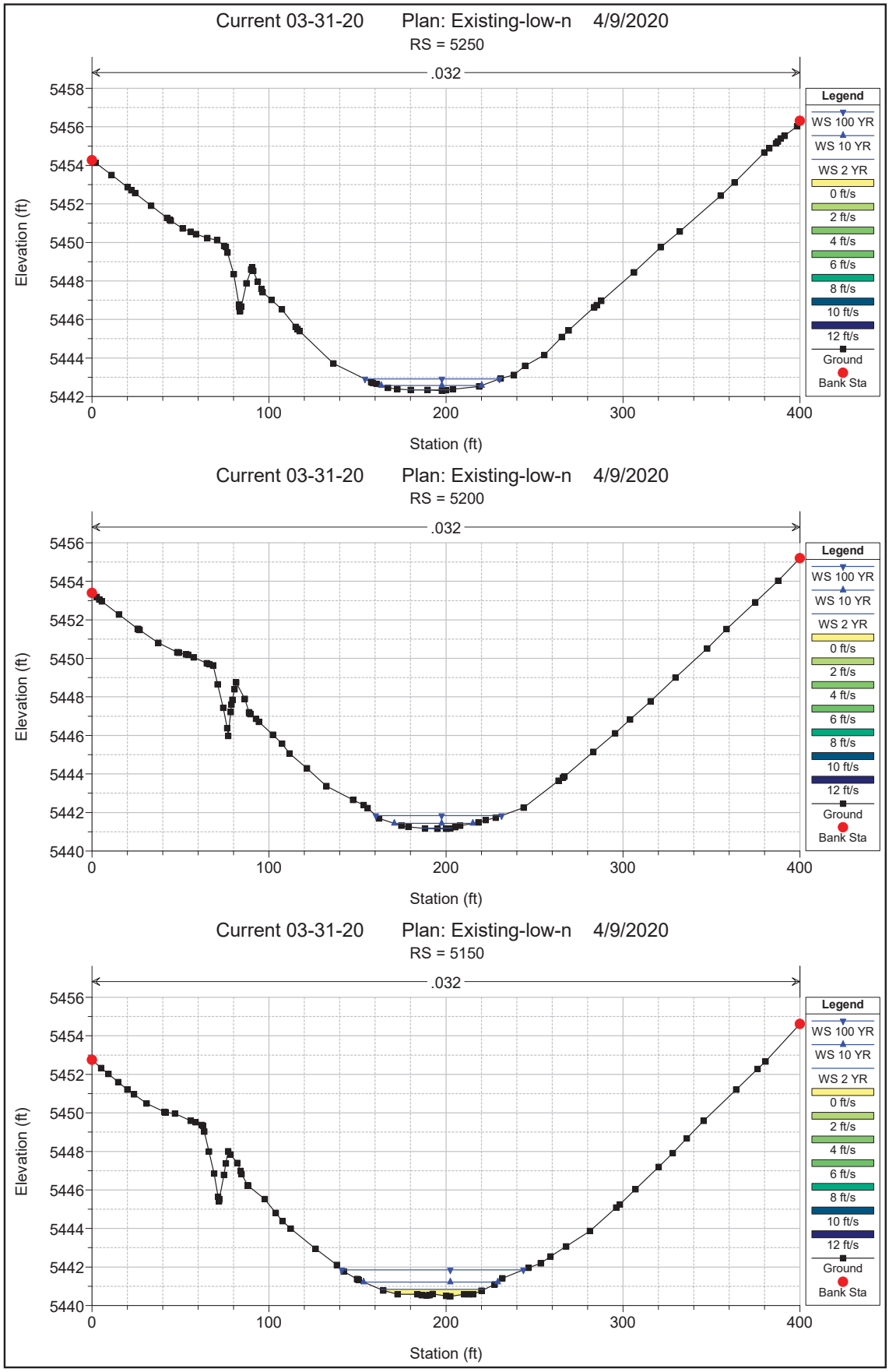
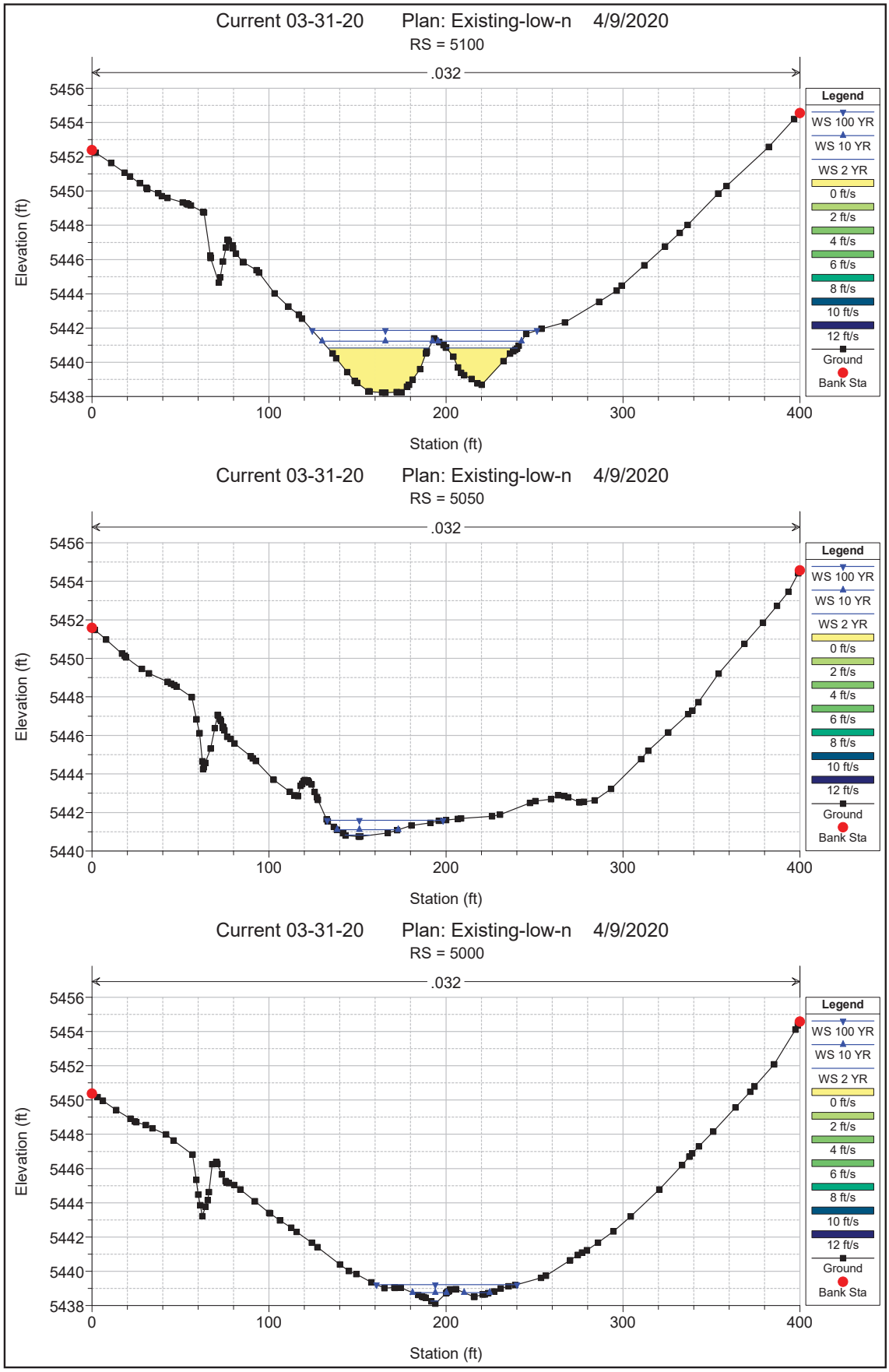
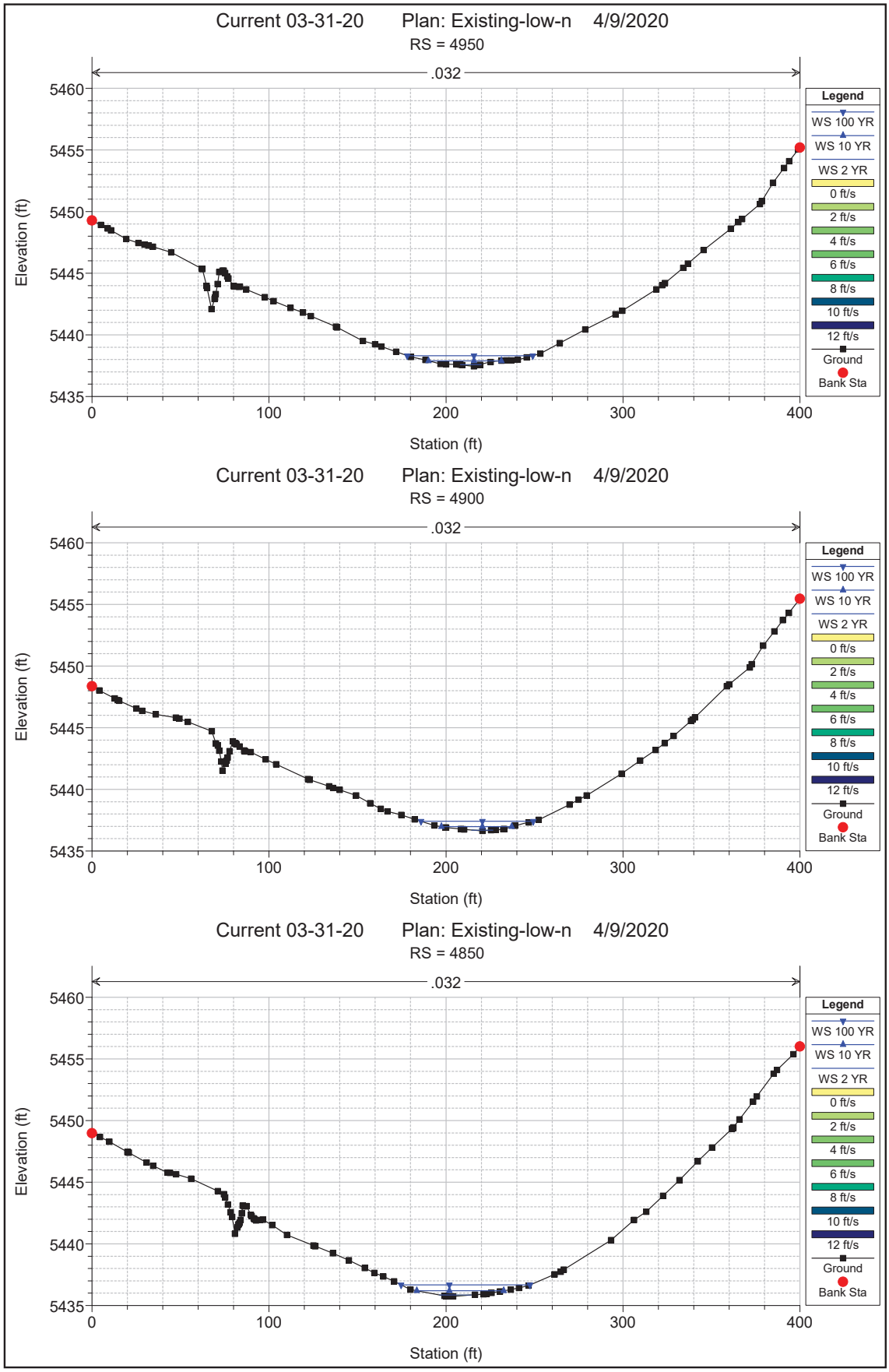
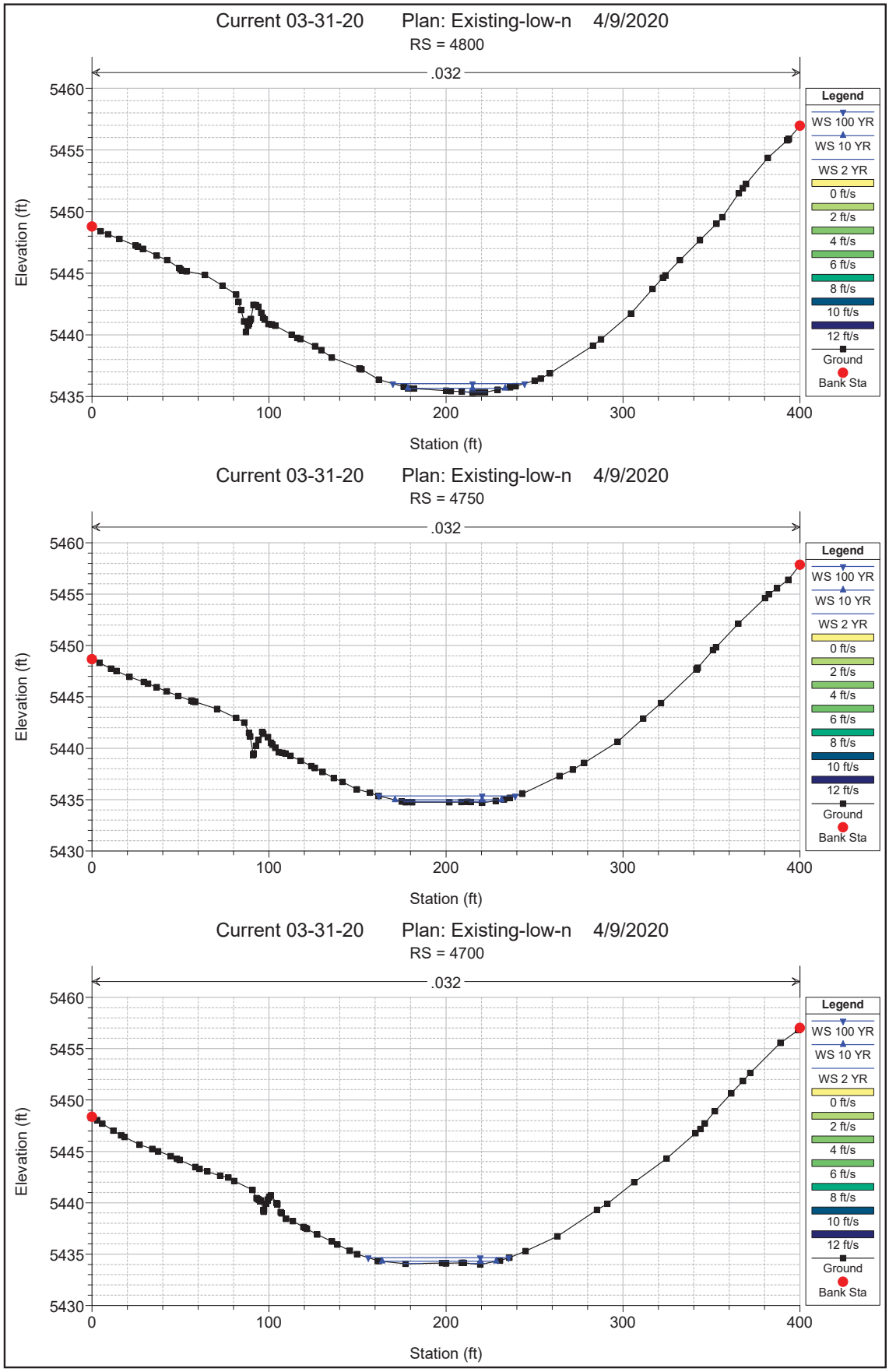
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5500
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5450
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

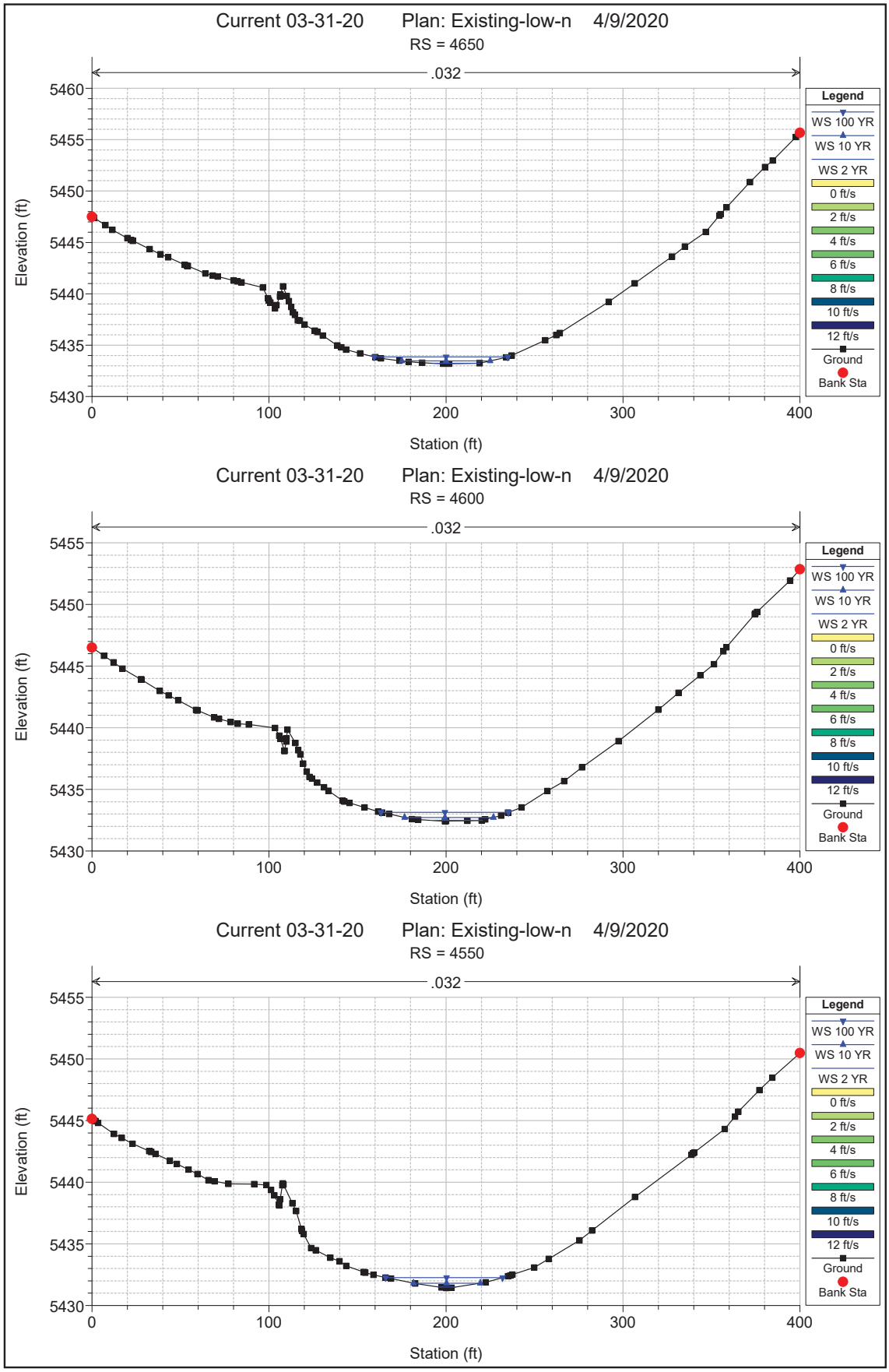

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5400
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5350
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5300
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

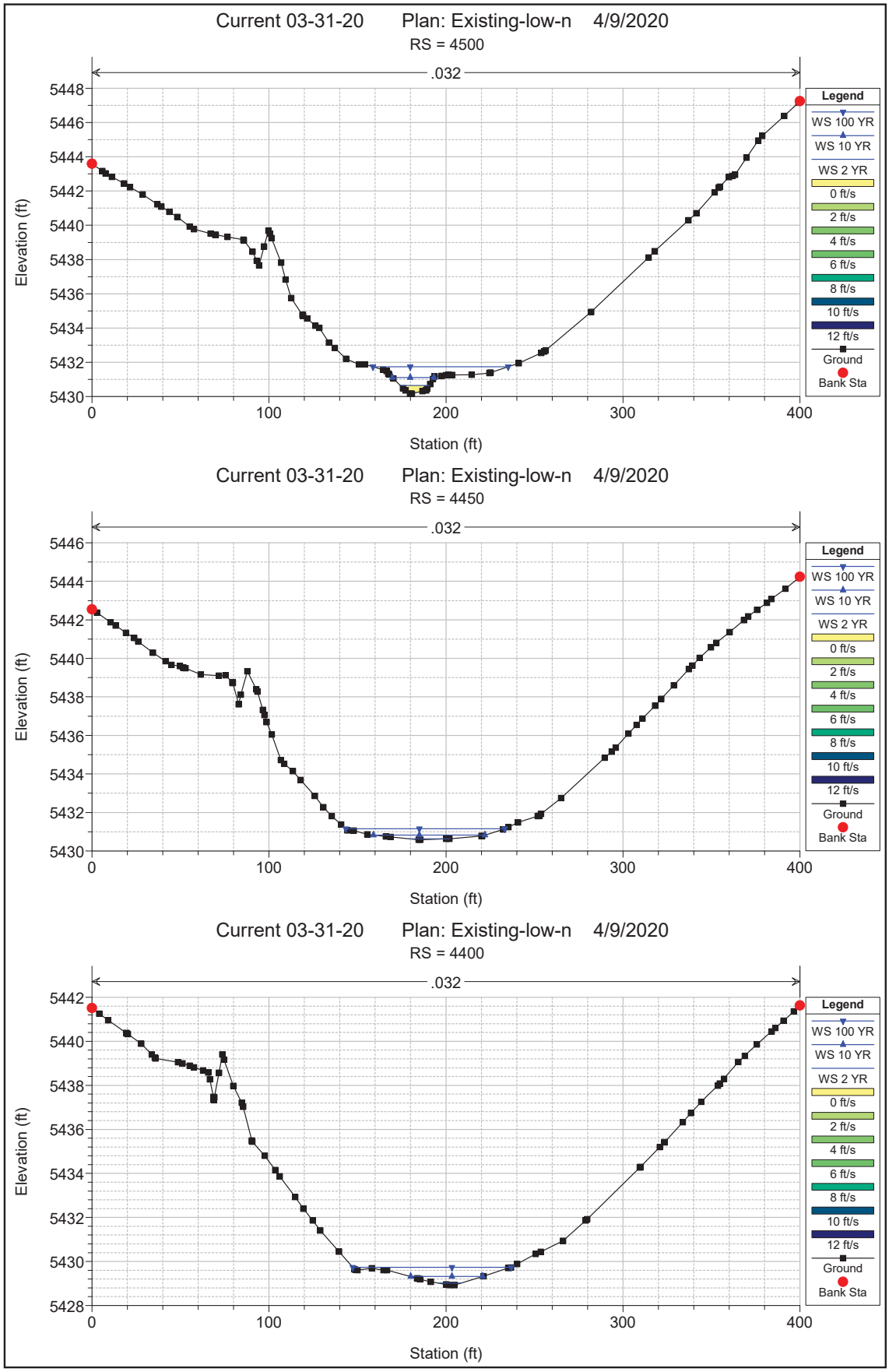

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5250
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5200
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5150
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

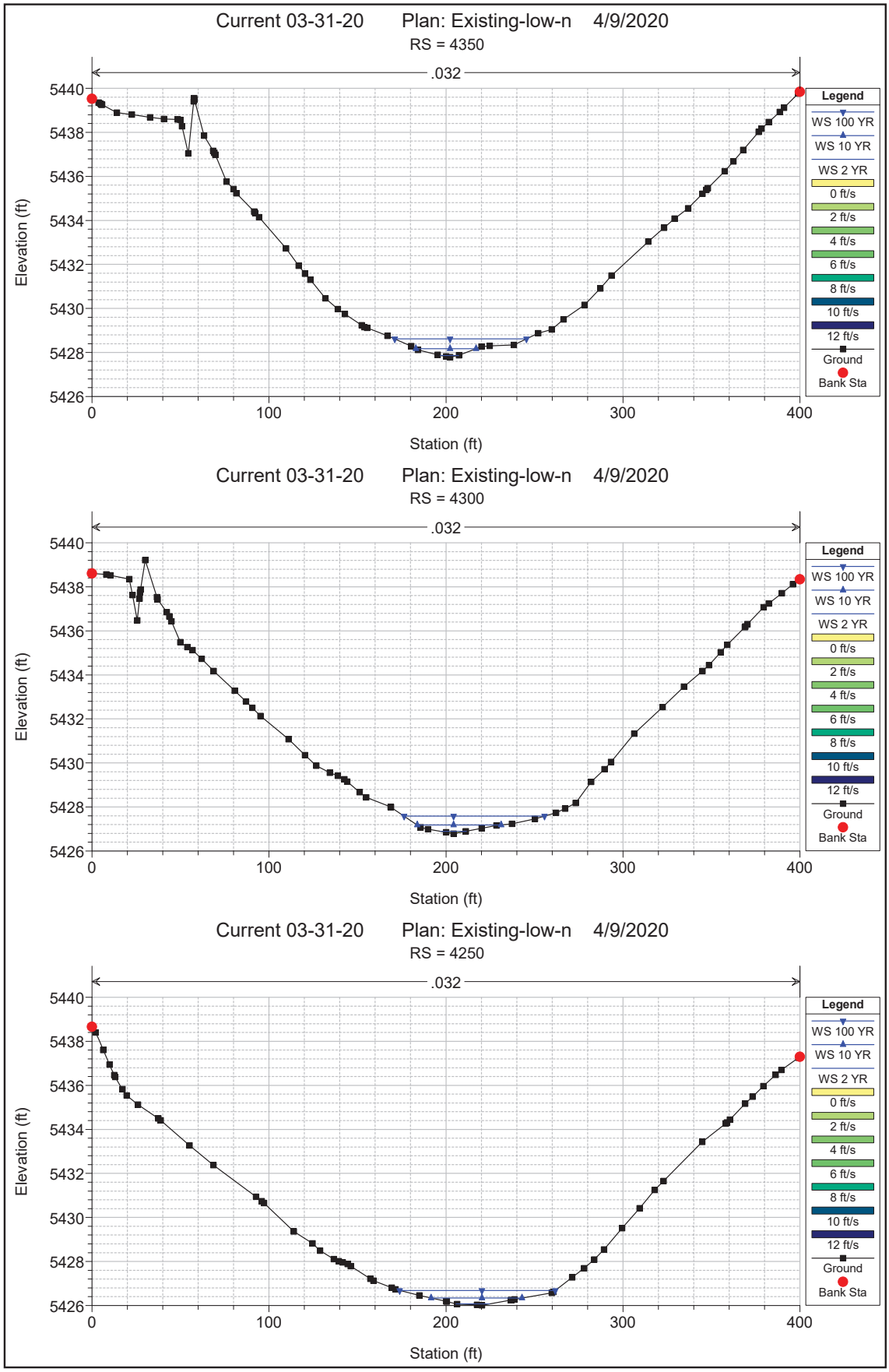

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5100
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5050
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 5000
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

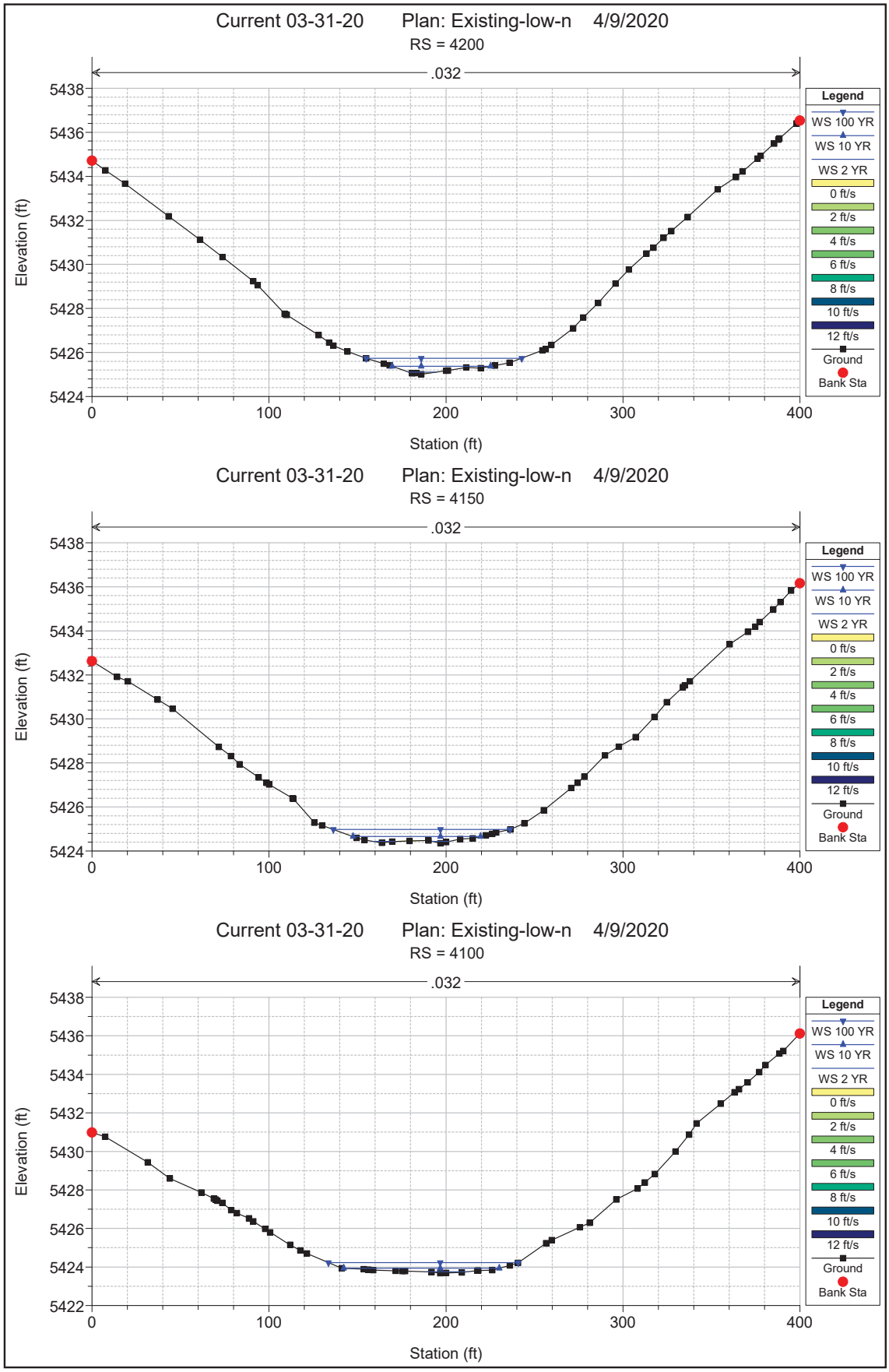

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4950
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4900
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4850
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

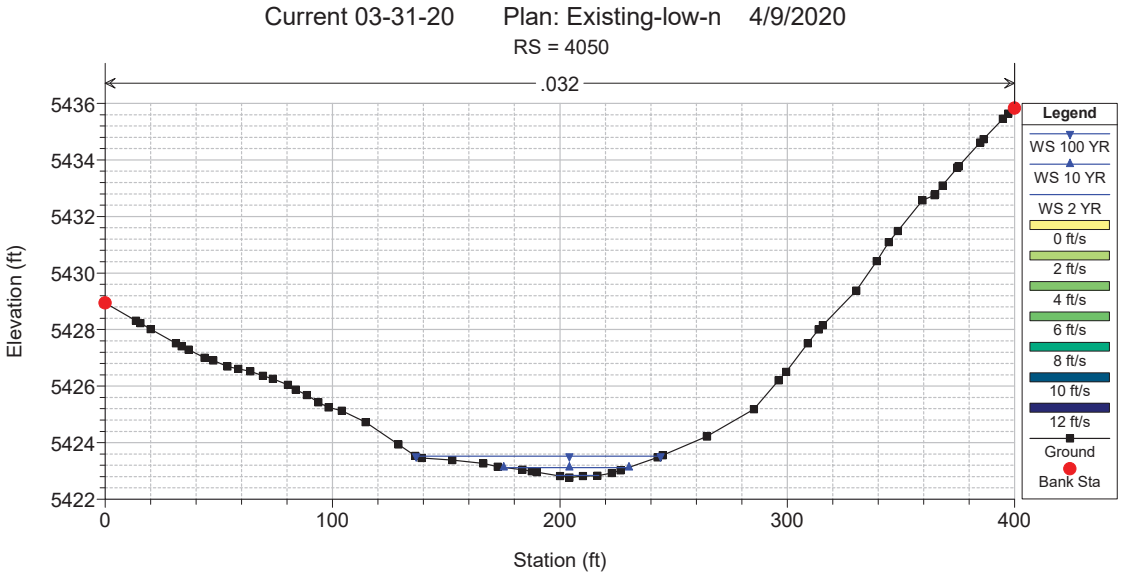

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4800
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4750
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4700
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

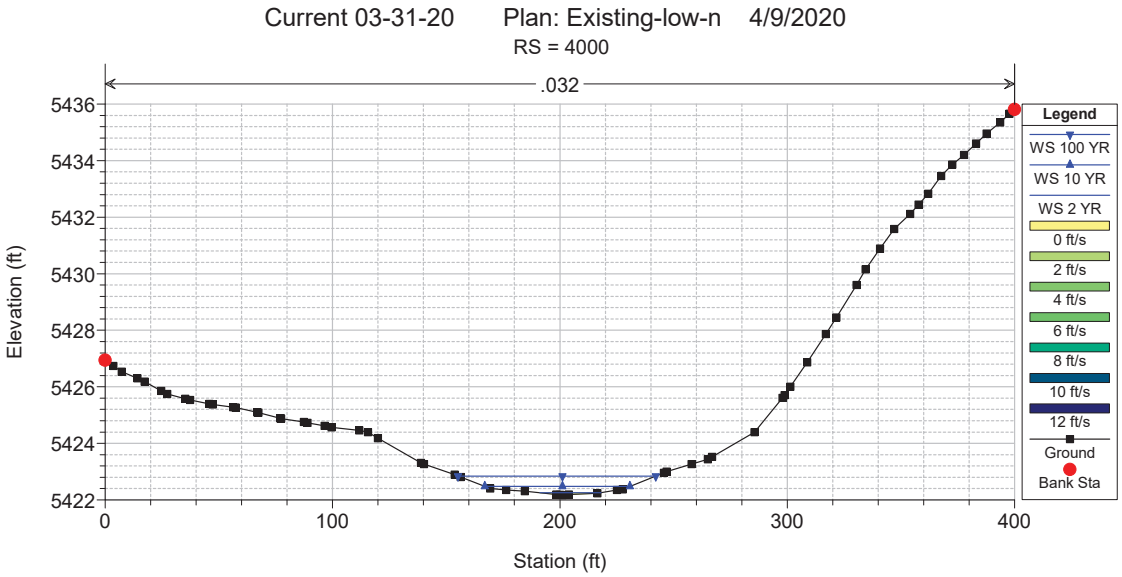

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4650
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4600
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4550
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

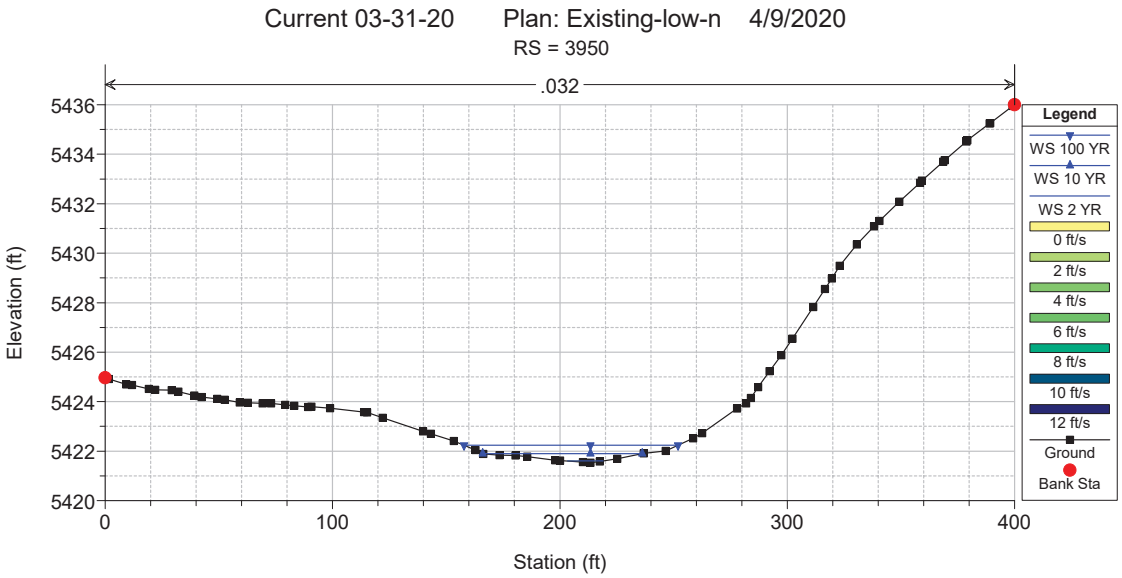

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4500
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4450
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4400
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

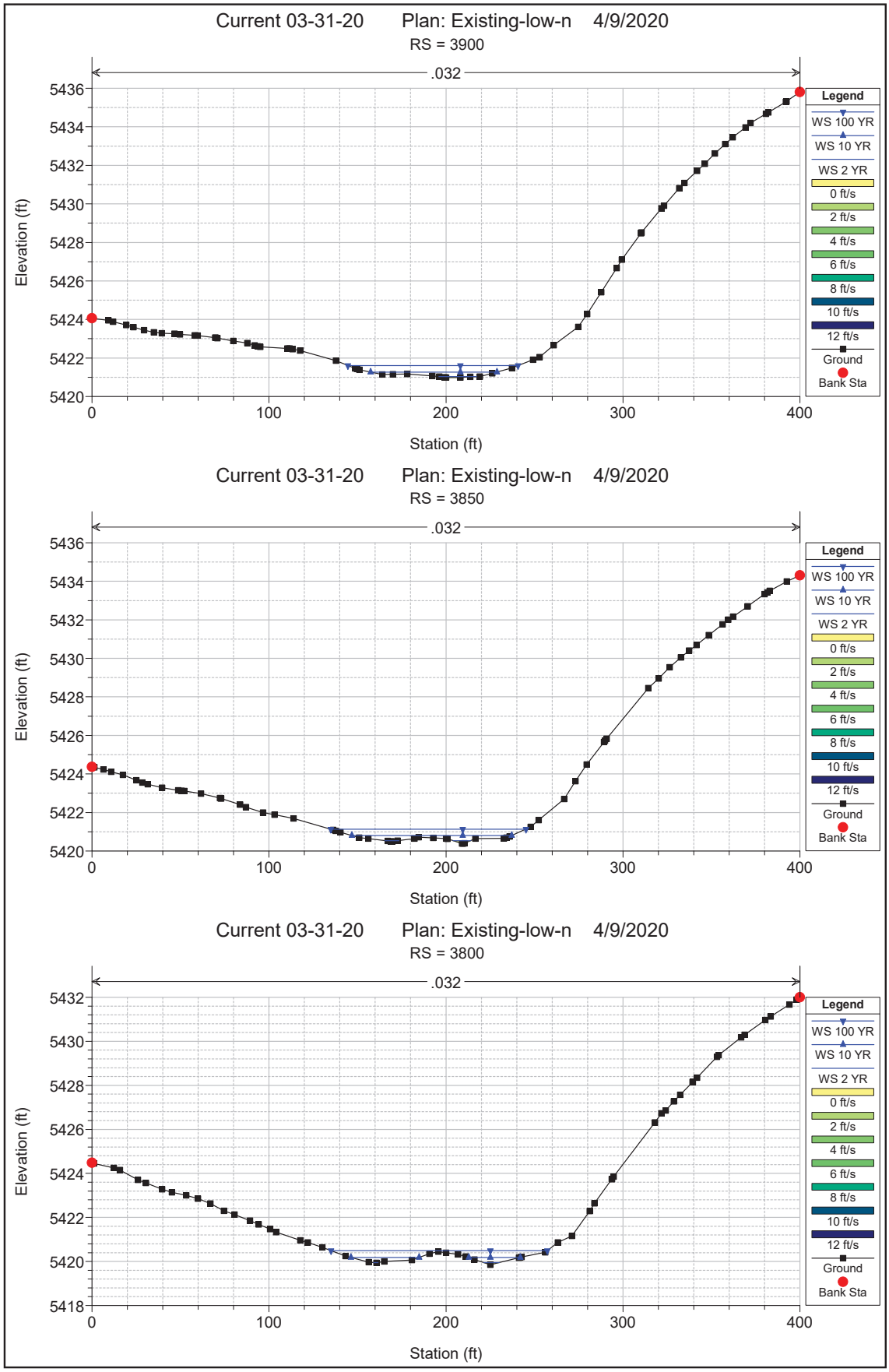

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4350
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4300
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4250
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

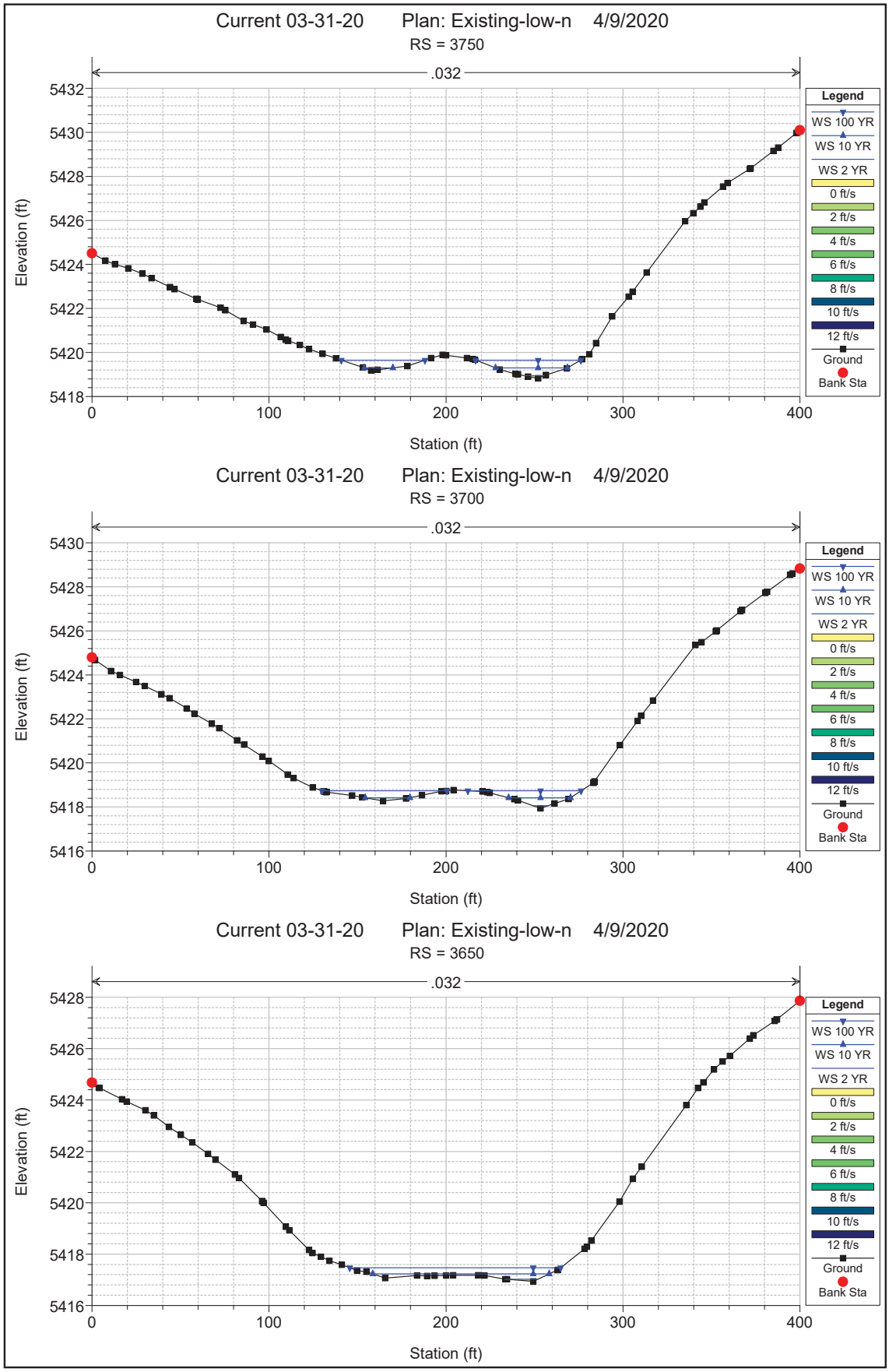

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4200
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4150
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4100
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

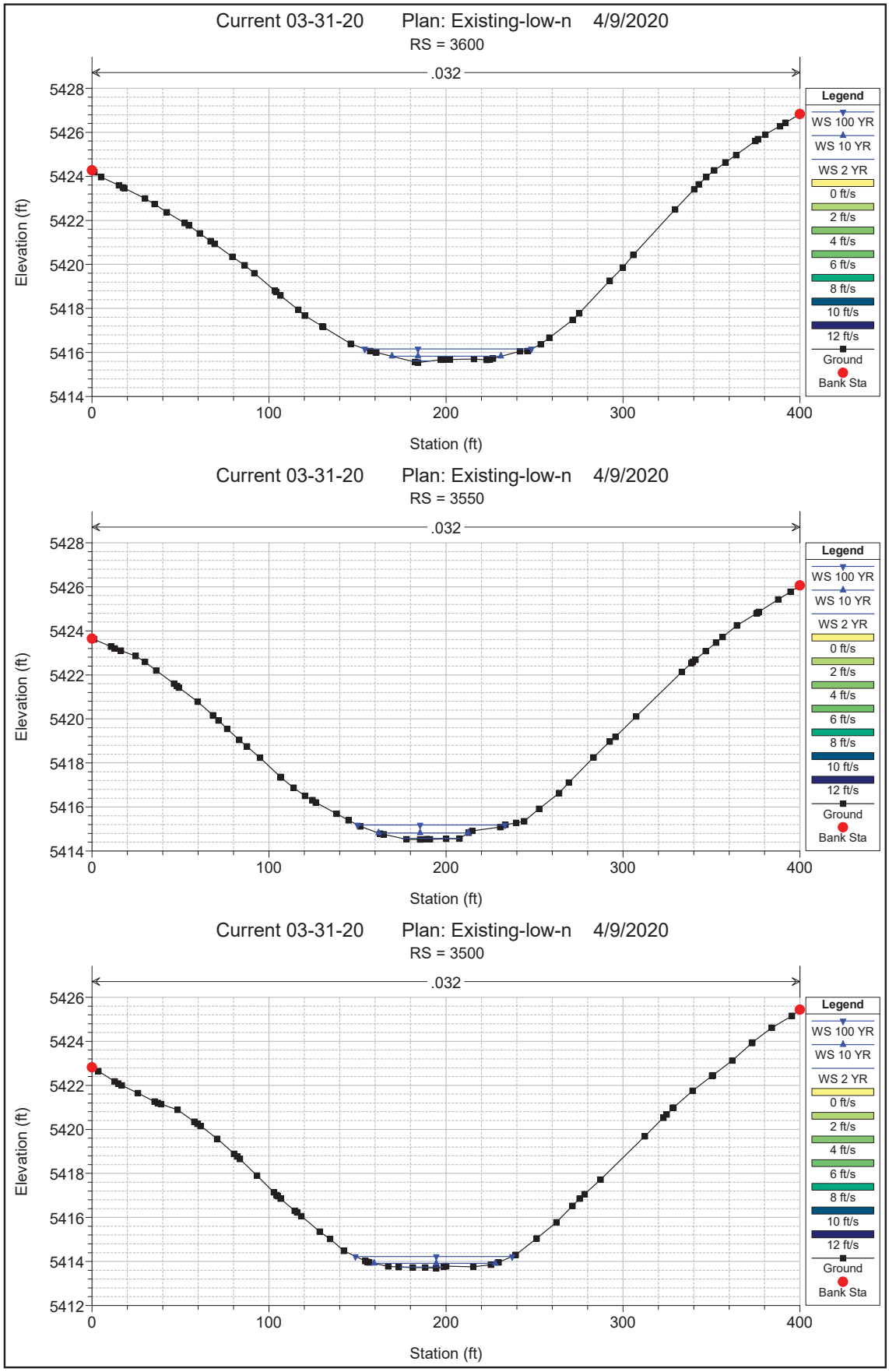

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4050
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

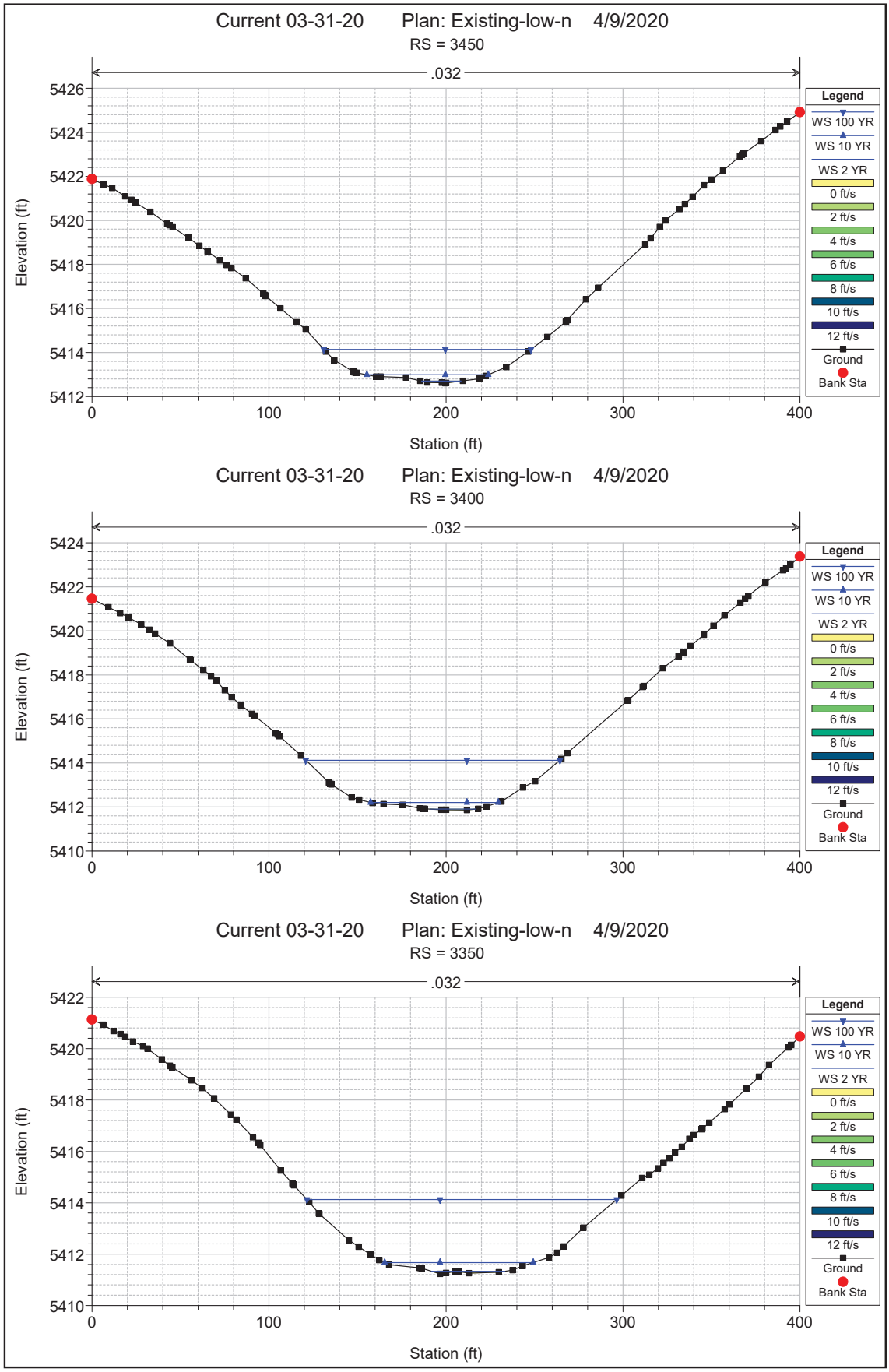

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 4000
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

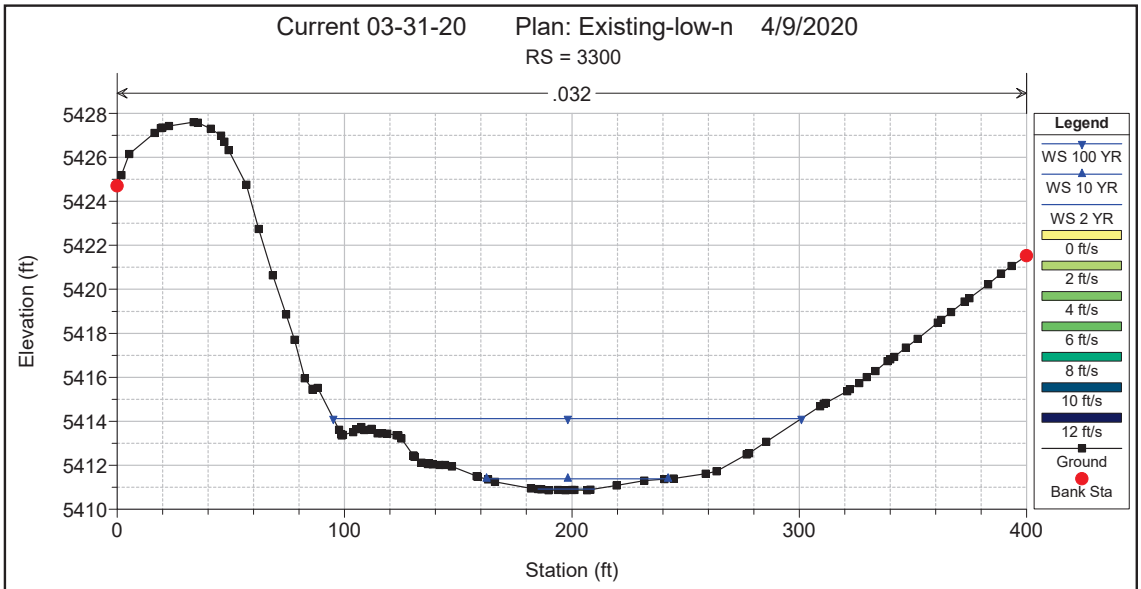

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3950
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3900
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3850
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3800
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3750
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3700
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3650
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3600
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3550
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3500
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3450
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3400
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3350
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3300
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
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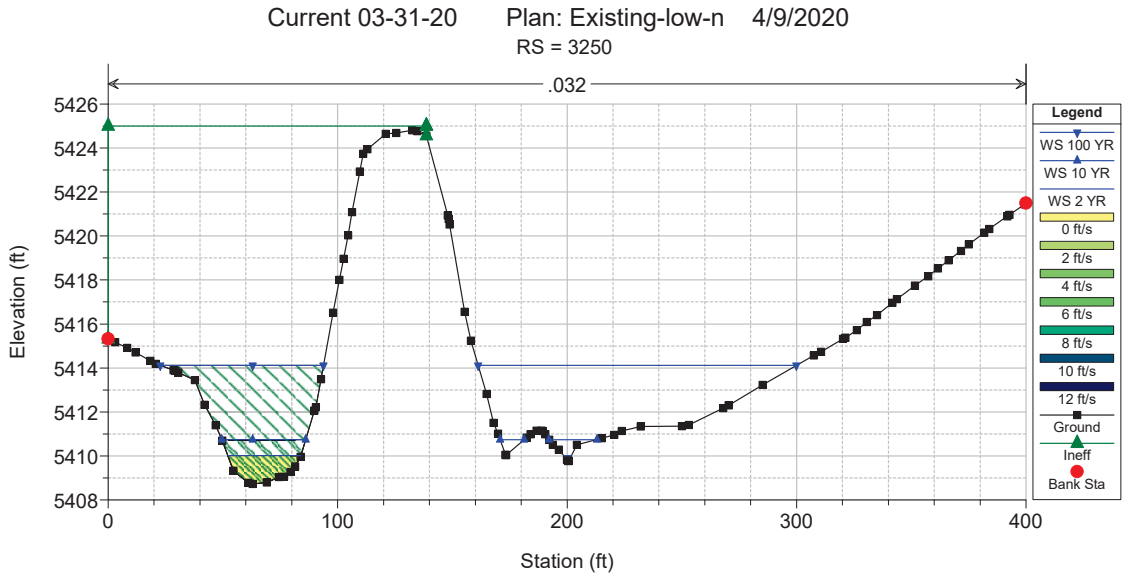
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3250
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
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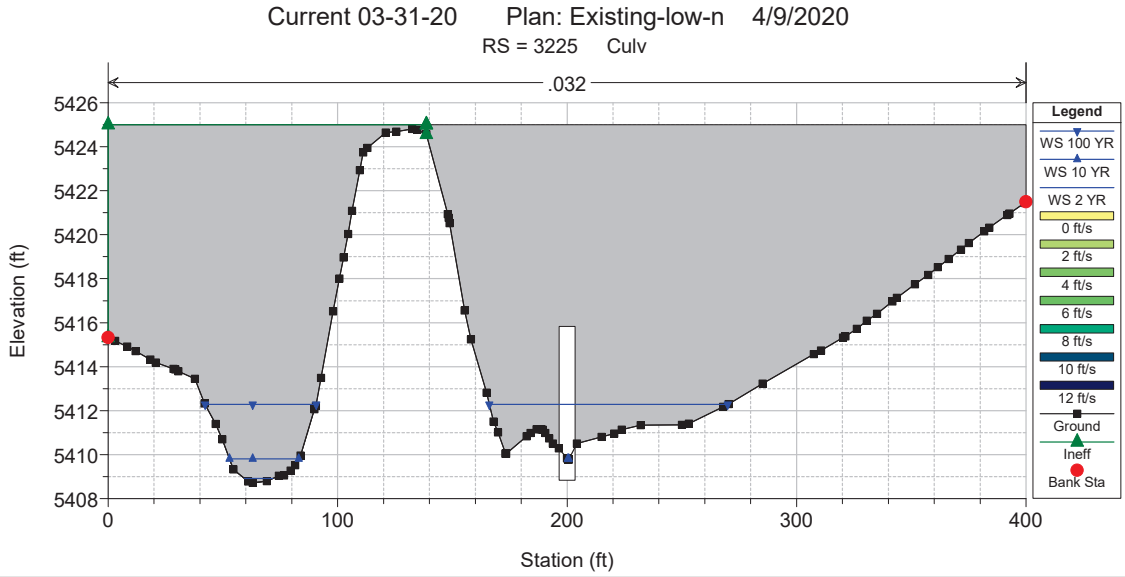
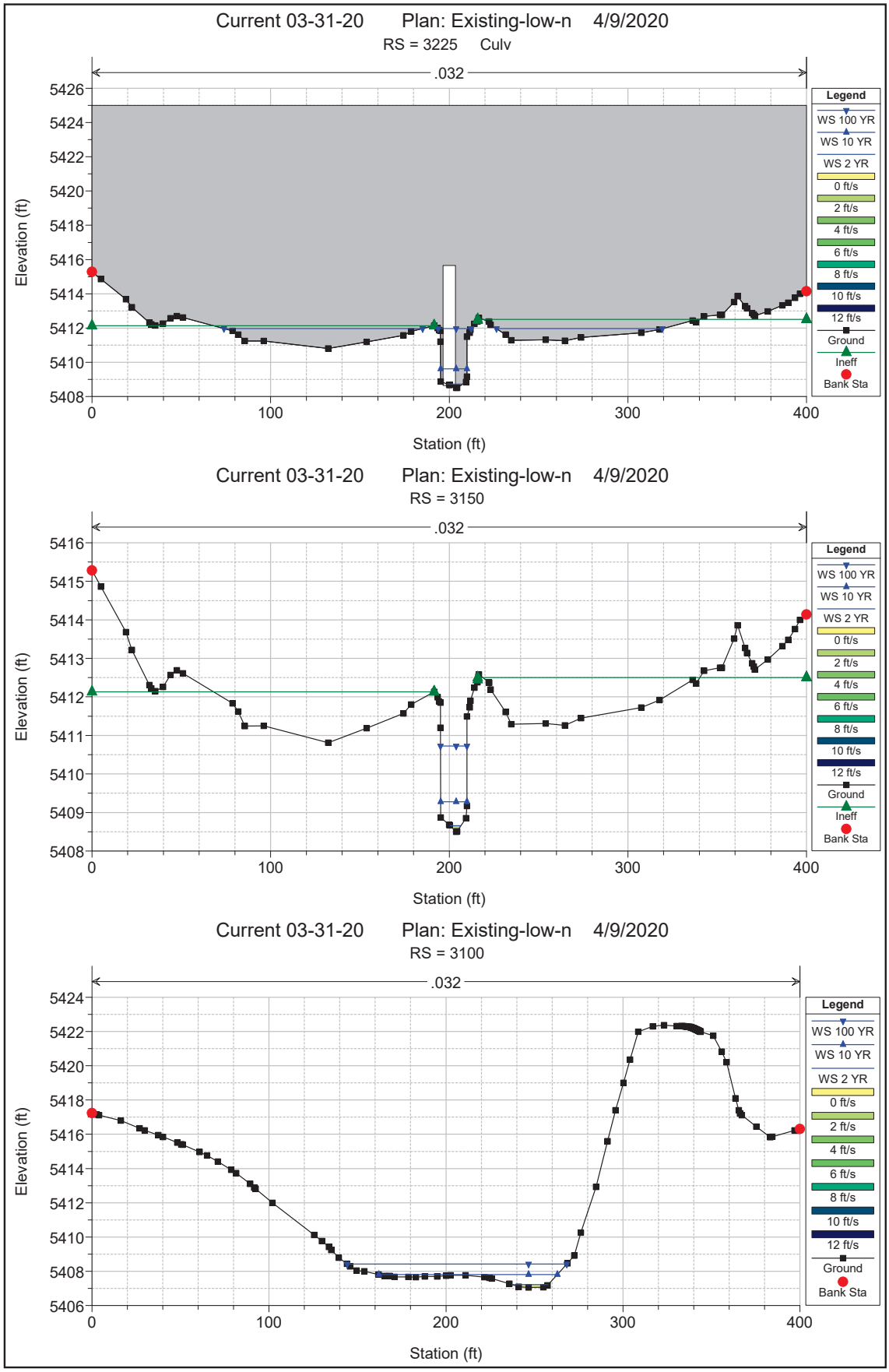
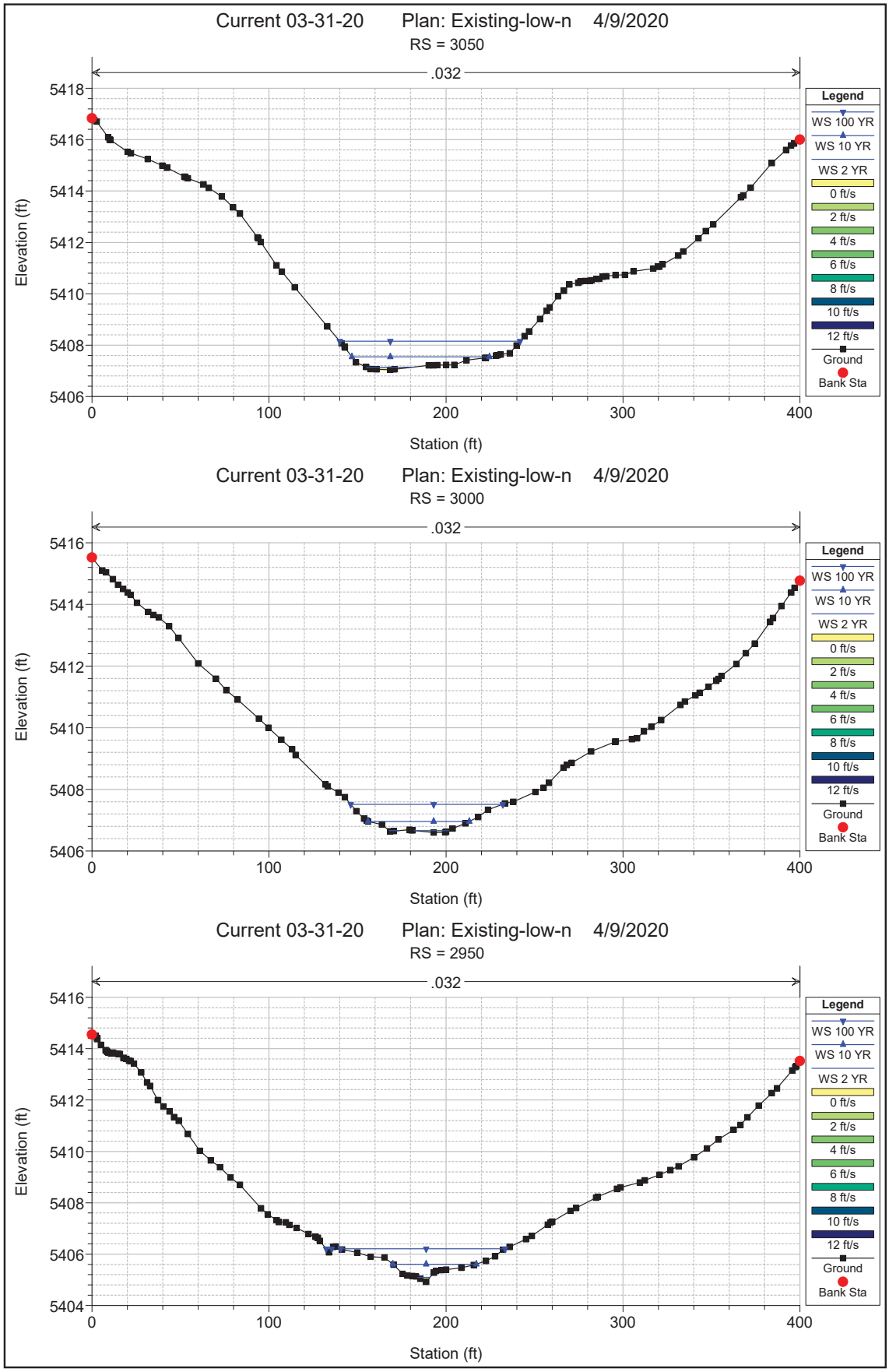
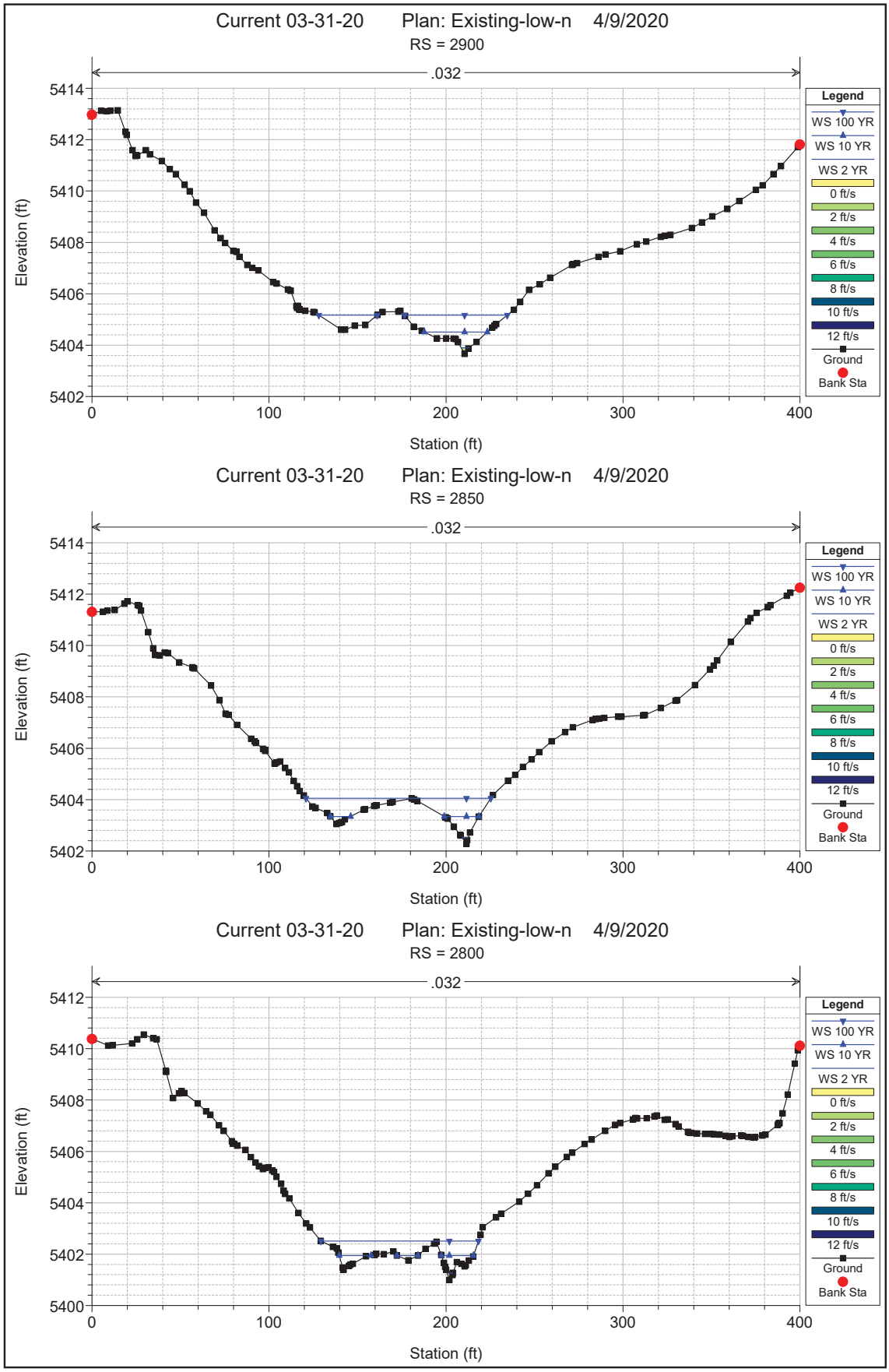
10 ft/s
12 ft/s
Ground
Ineff
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3225 Culv
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Ineff
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3225 Culv
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Ineff
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3150
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Ineff
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3100
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3050
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 3000
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2950
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2900
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2850
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2800
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
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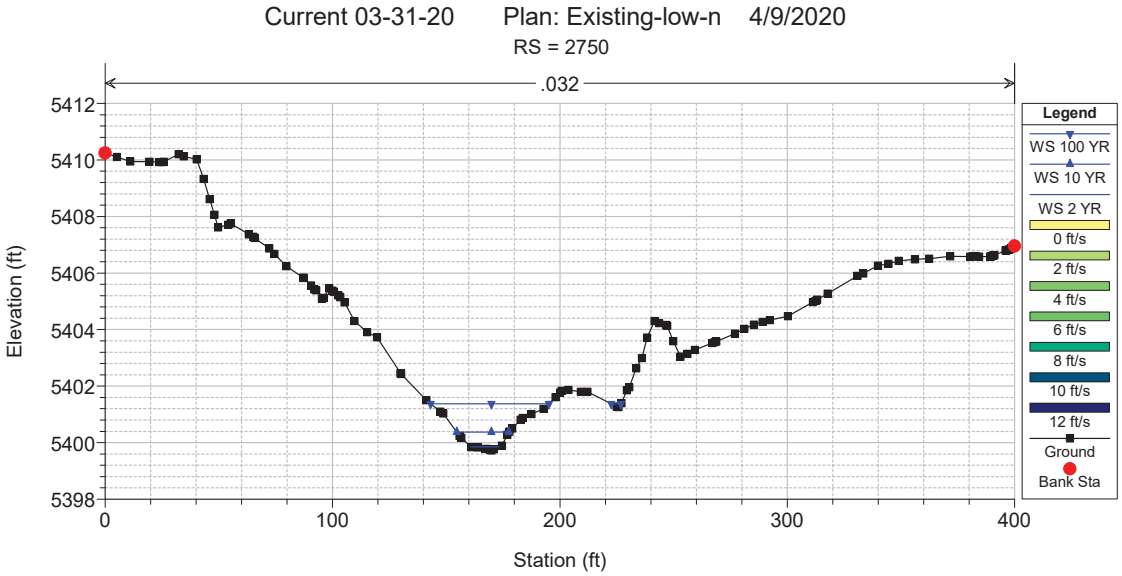
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2750
.032
Elevation (ft)
Station (ft)
Legend
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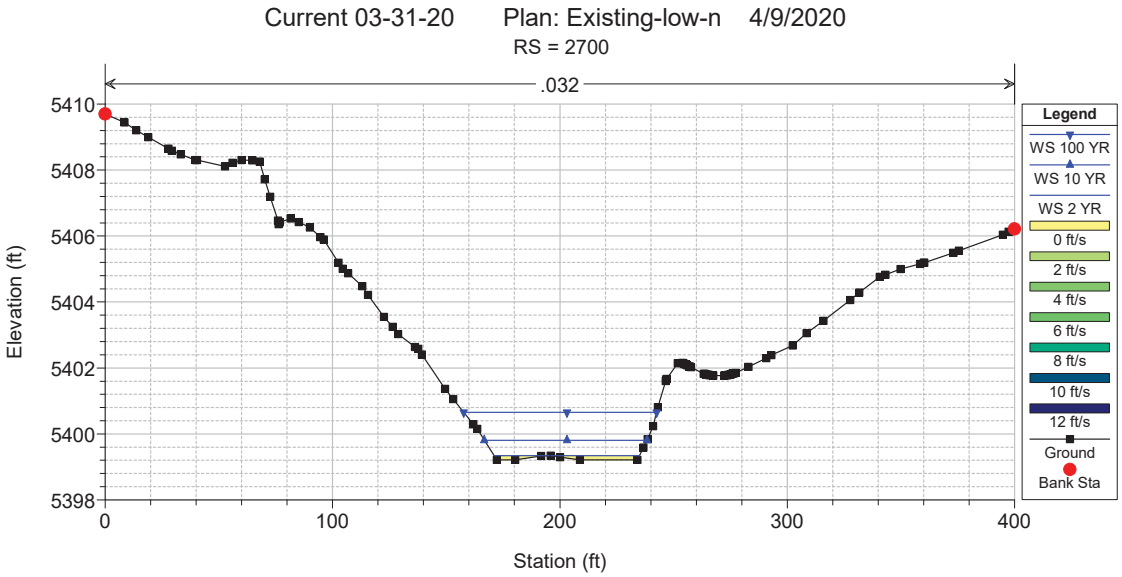
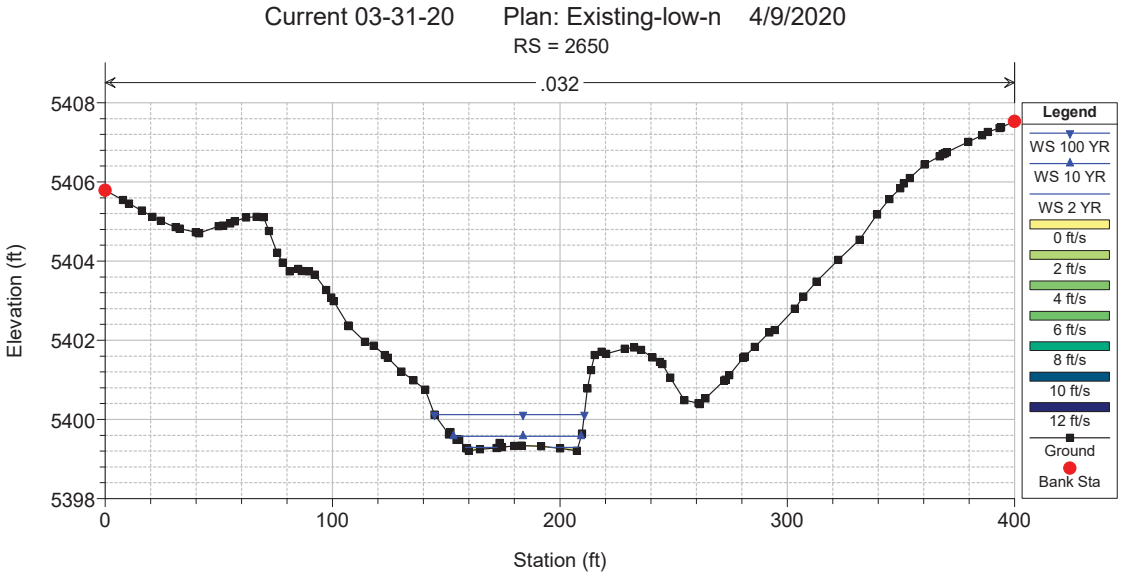
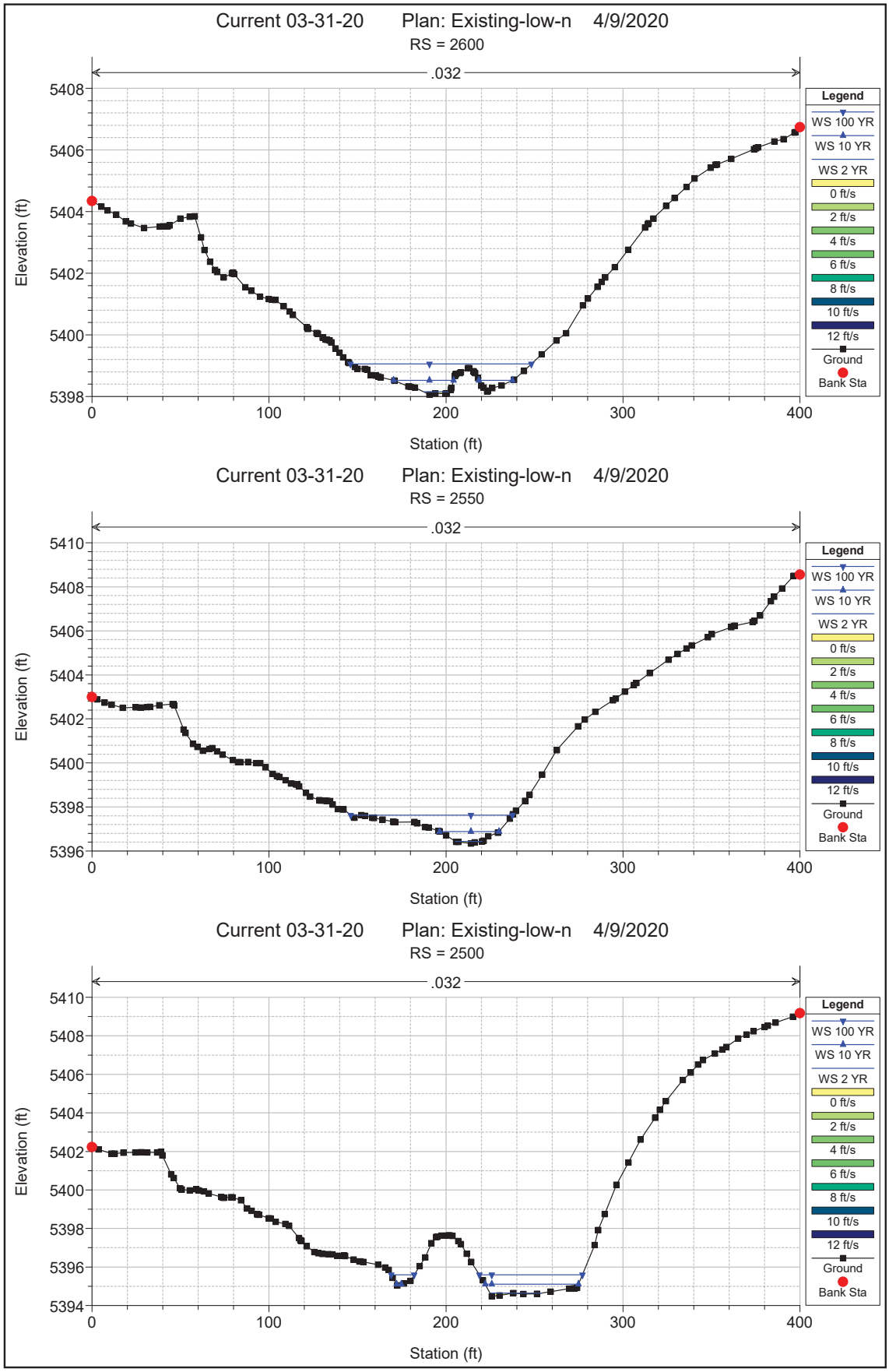
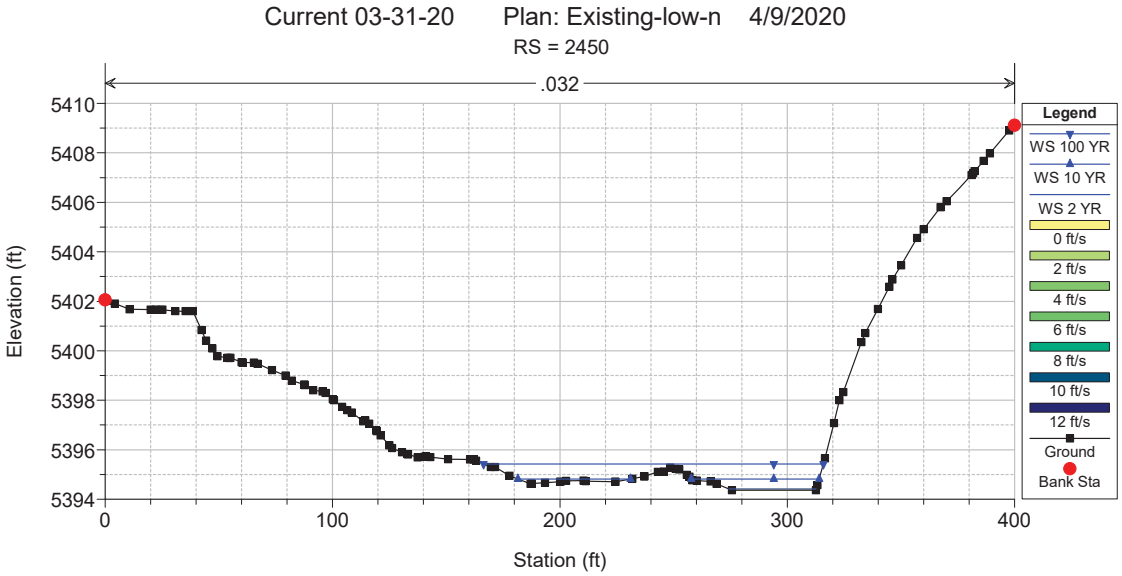
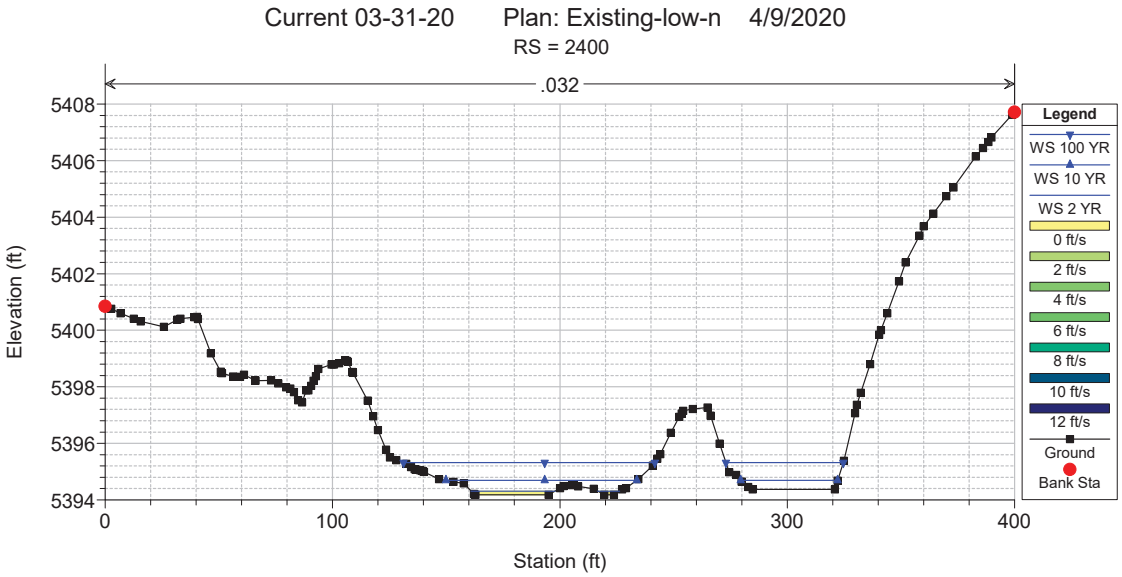
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

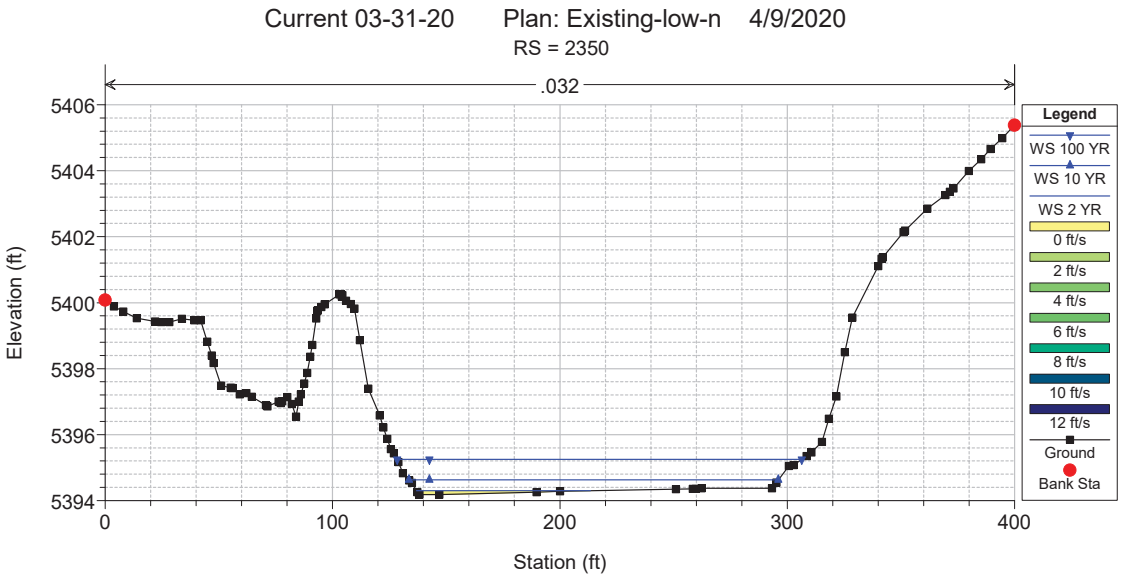

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2700
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

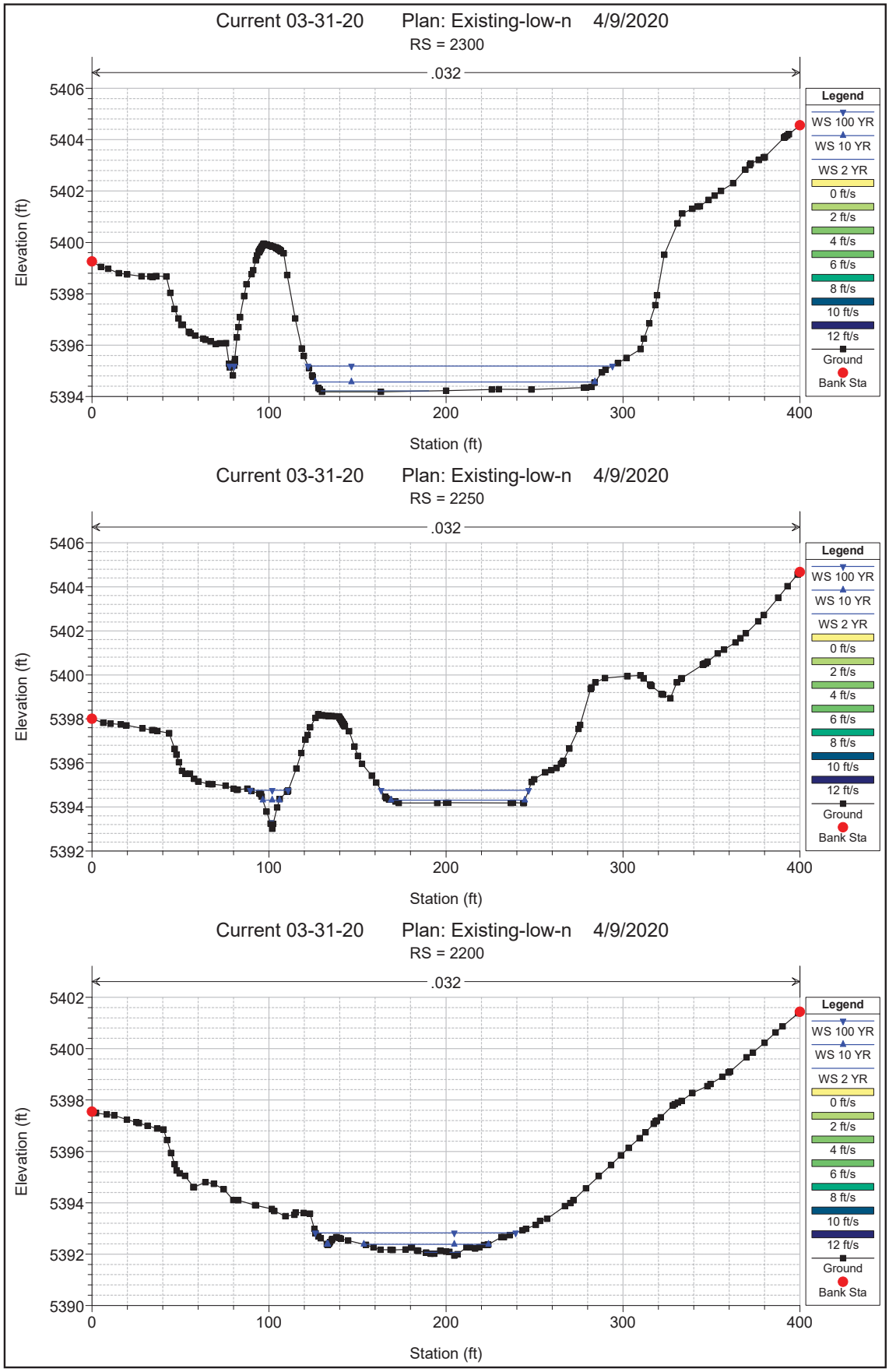

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2650
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

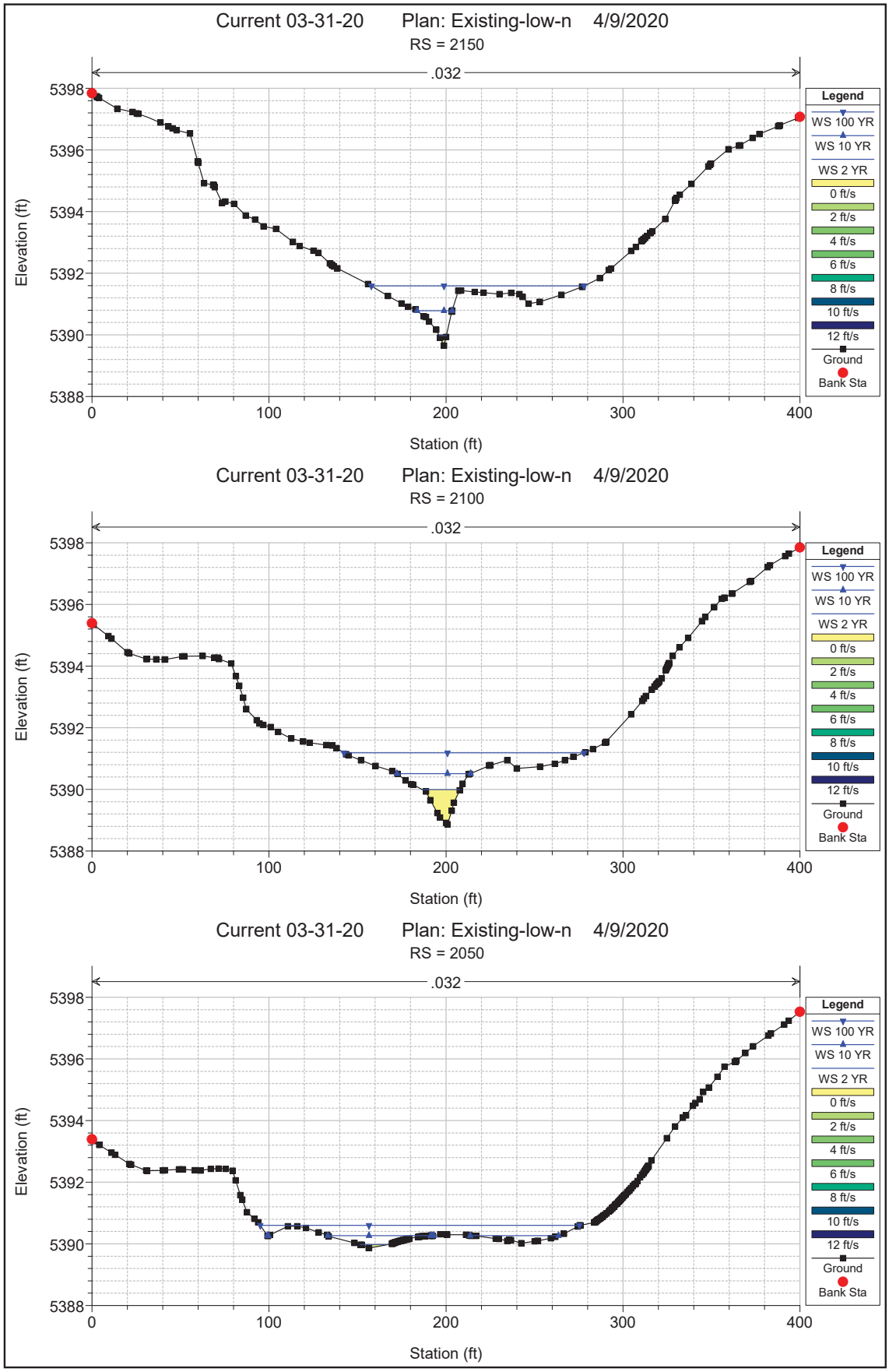

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2600
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2550
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2500
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

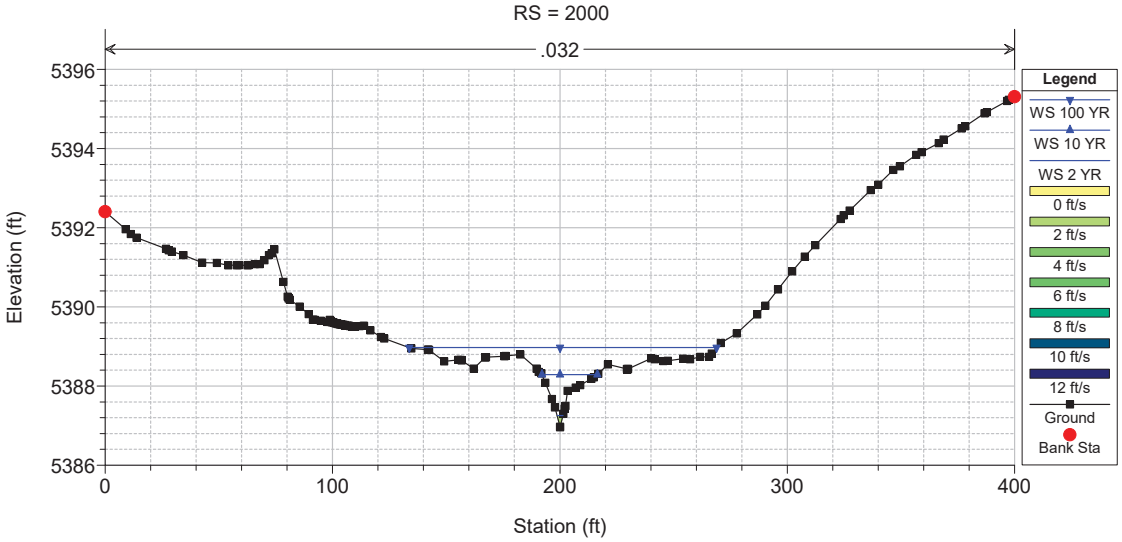

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2450
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

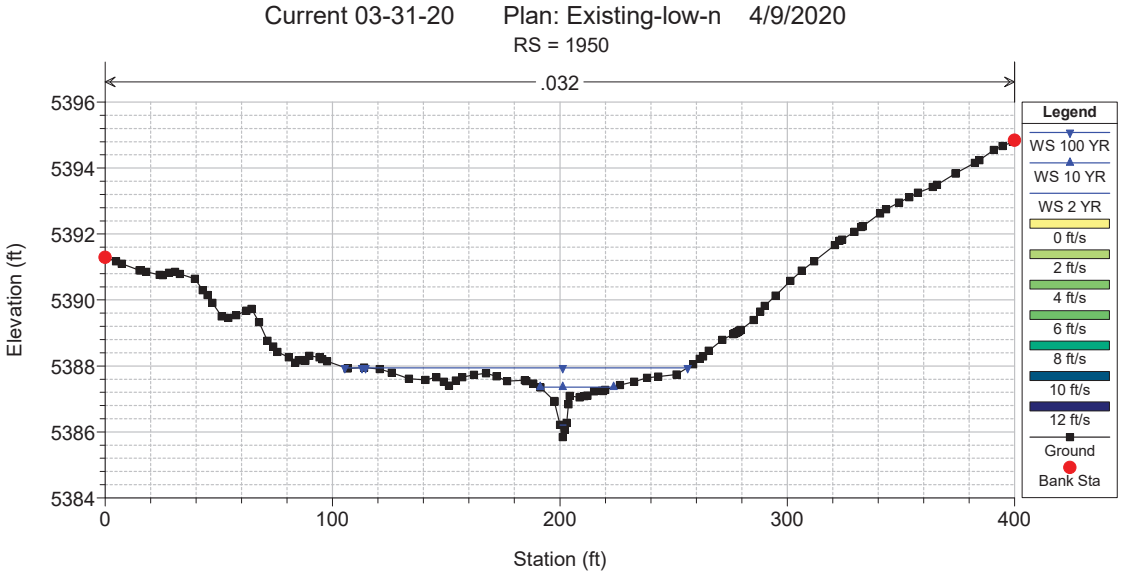

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2400
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

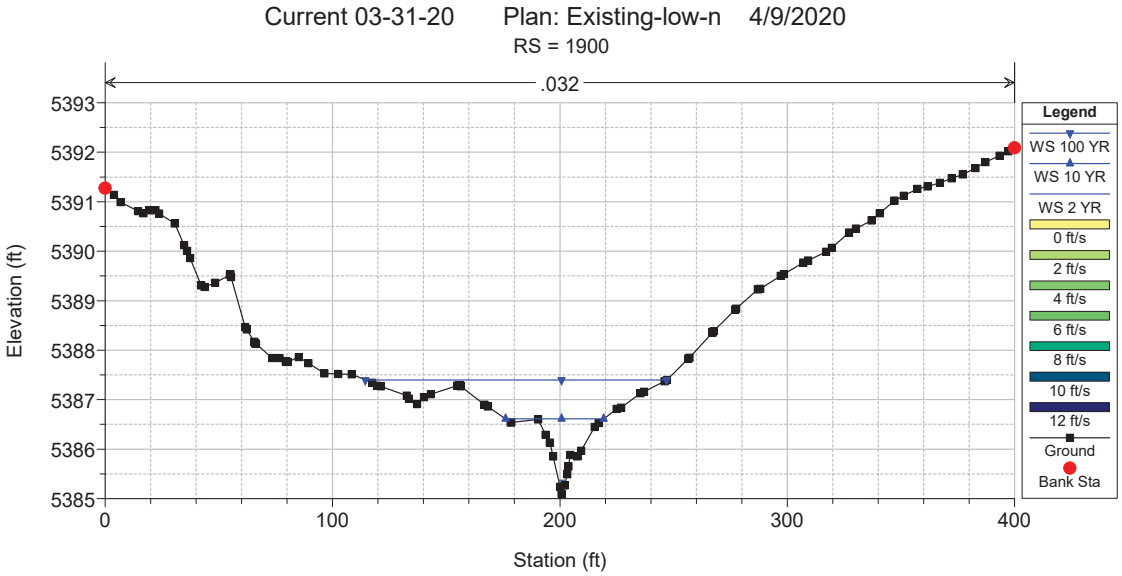

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2350
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

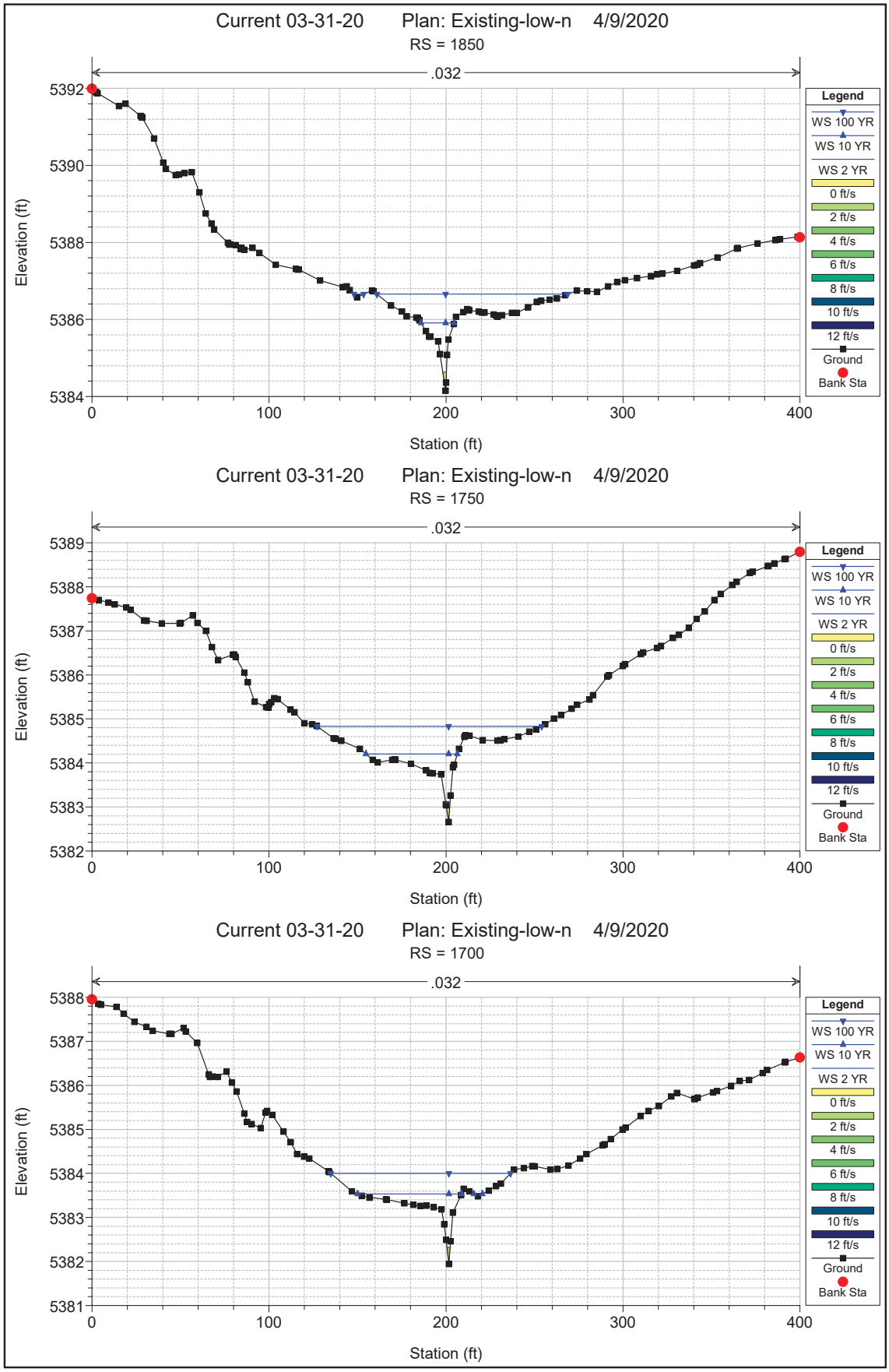

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2300
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2250
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2200
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

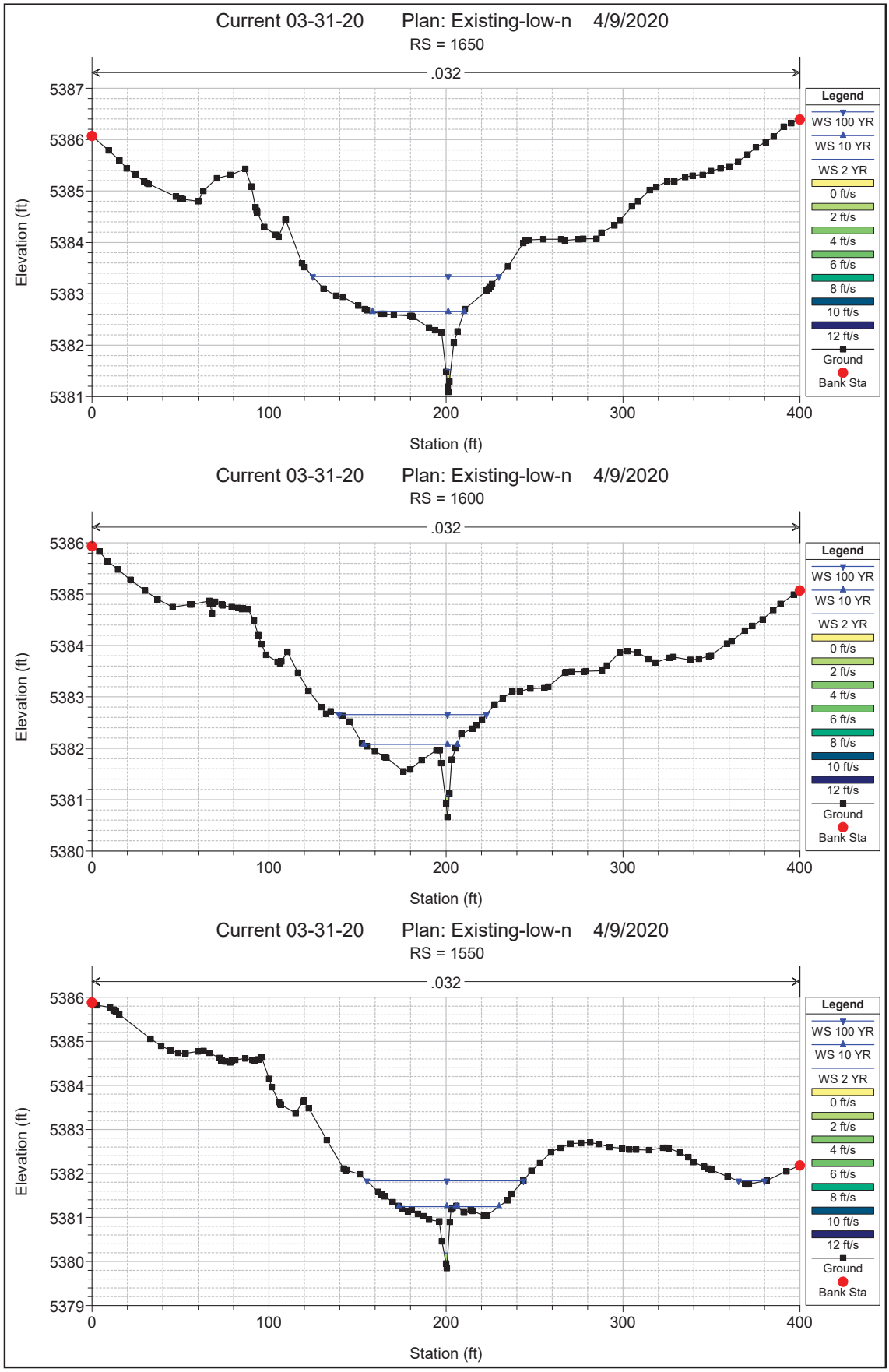

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2150
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2100
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2050
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

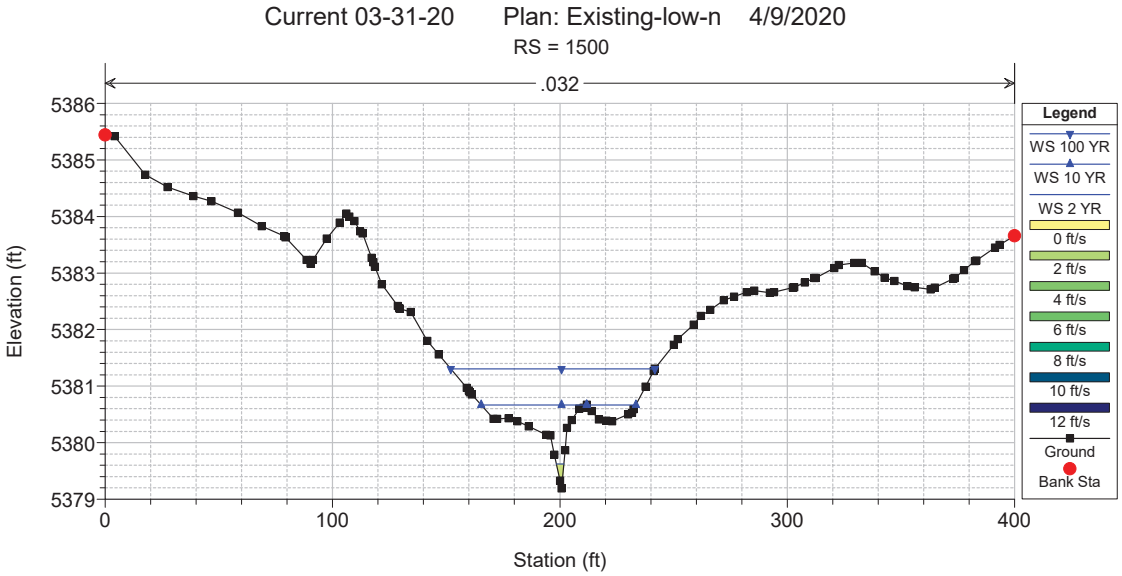

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 2000
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

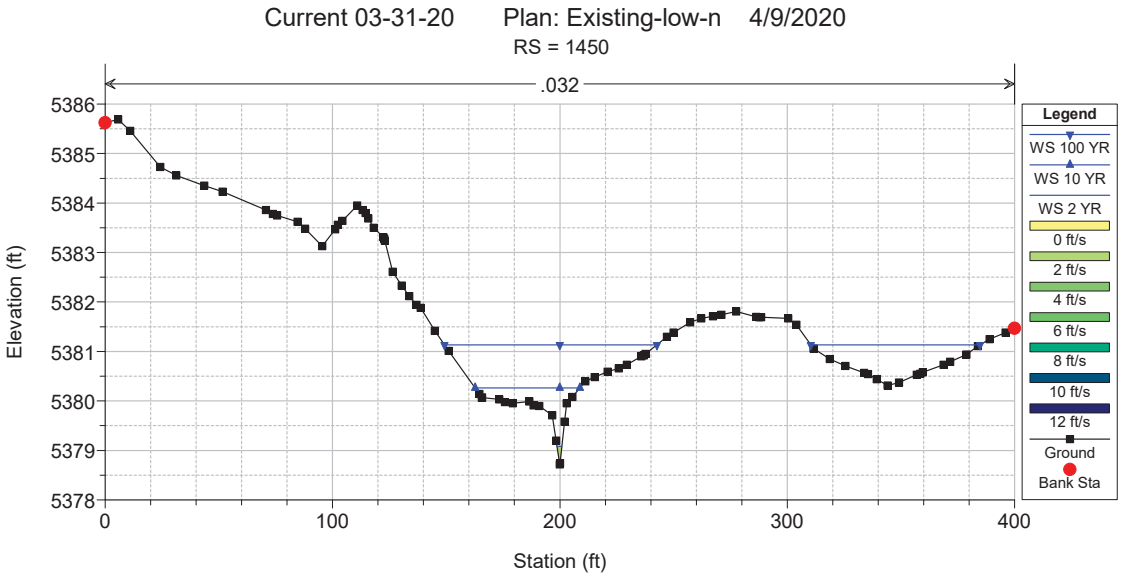

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1950
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

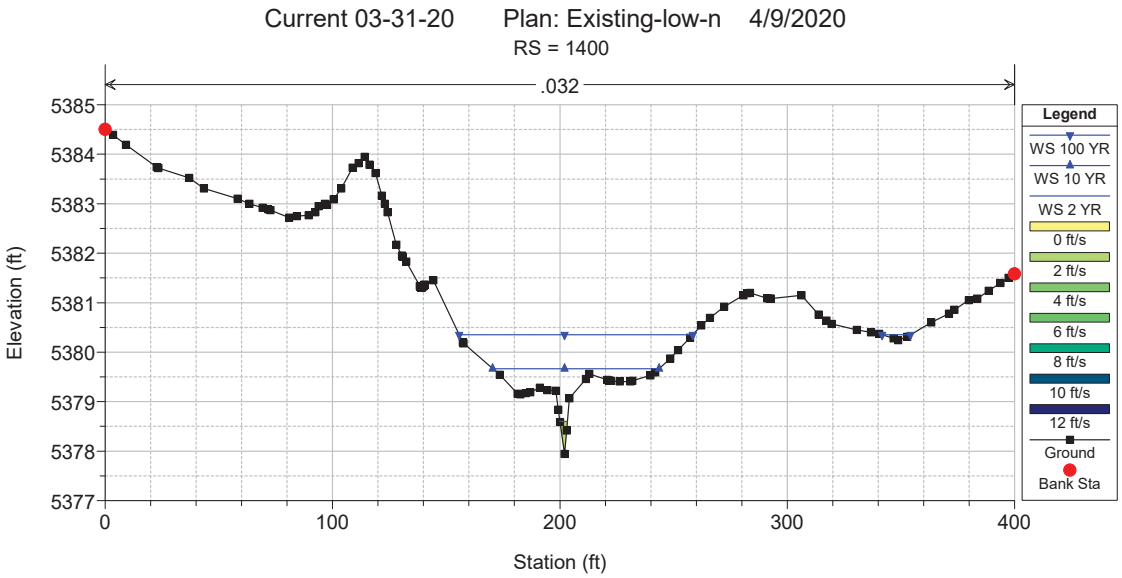

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1900
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

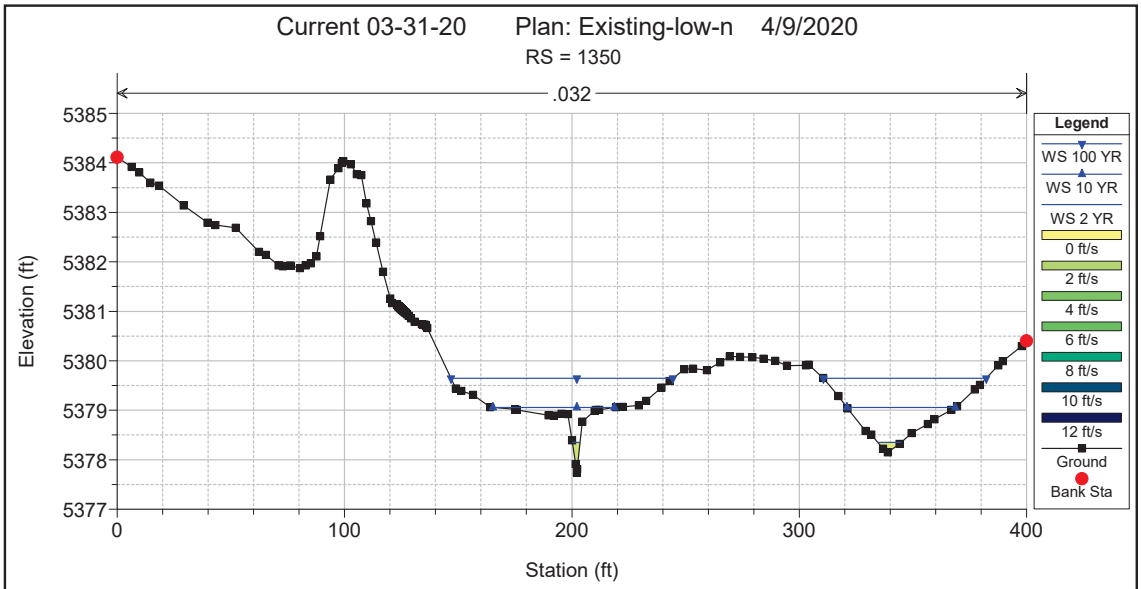

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1850
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1750
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1700
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

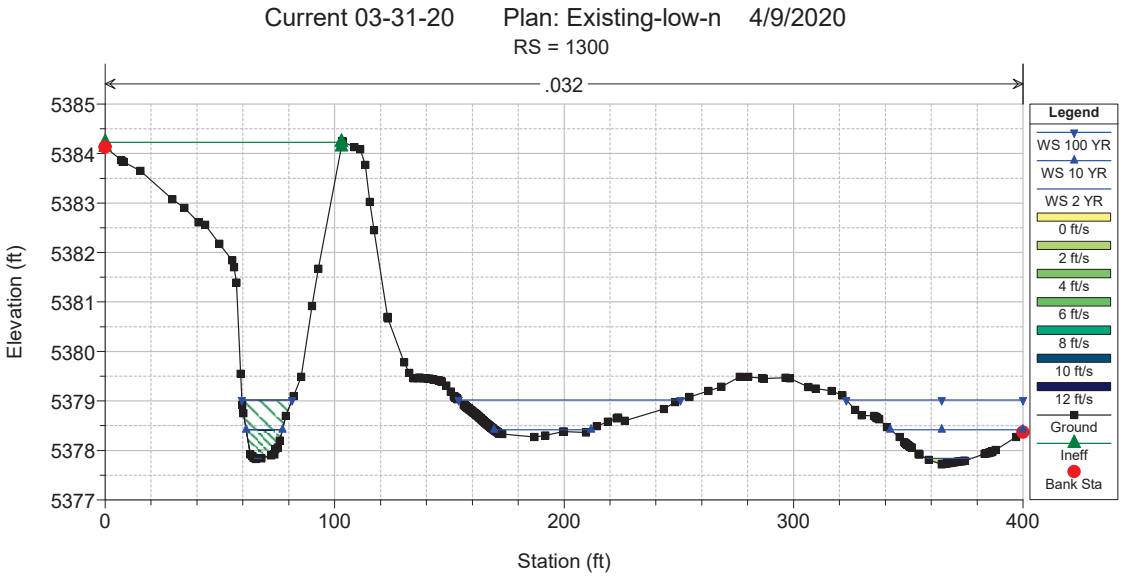

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1650
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1600
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1550
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

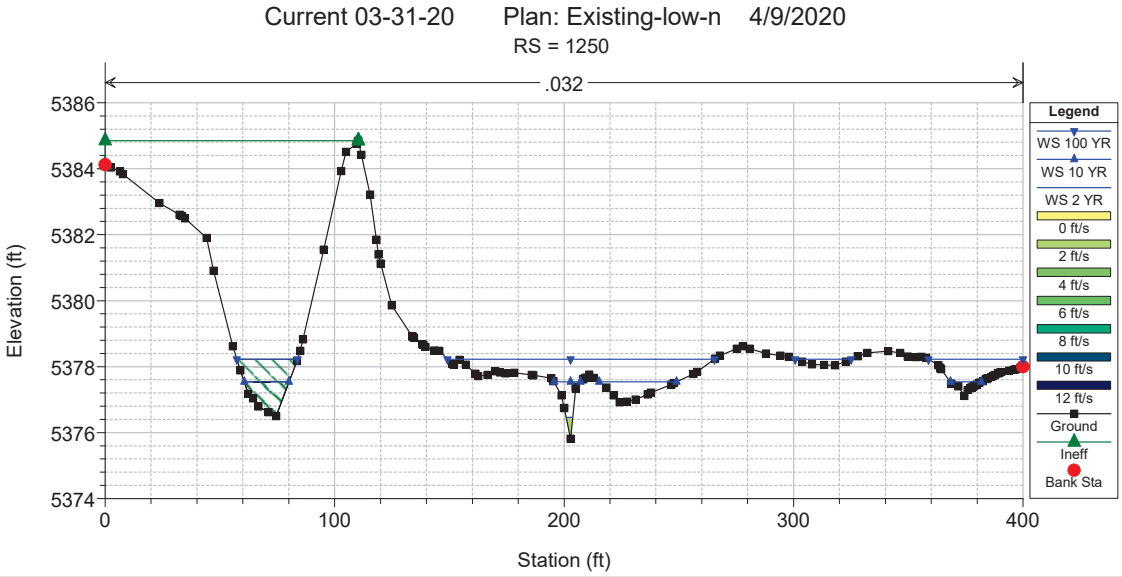

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1500
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

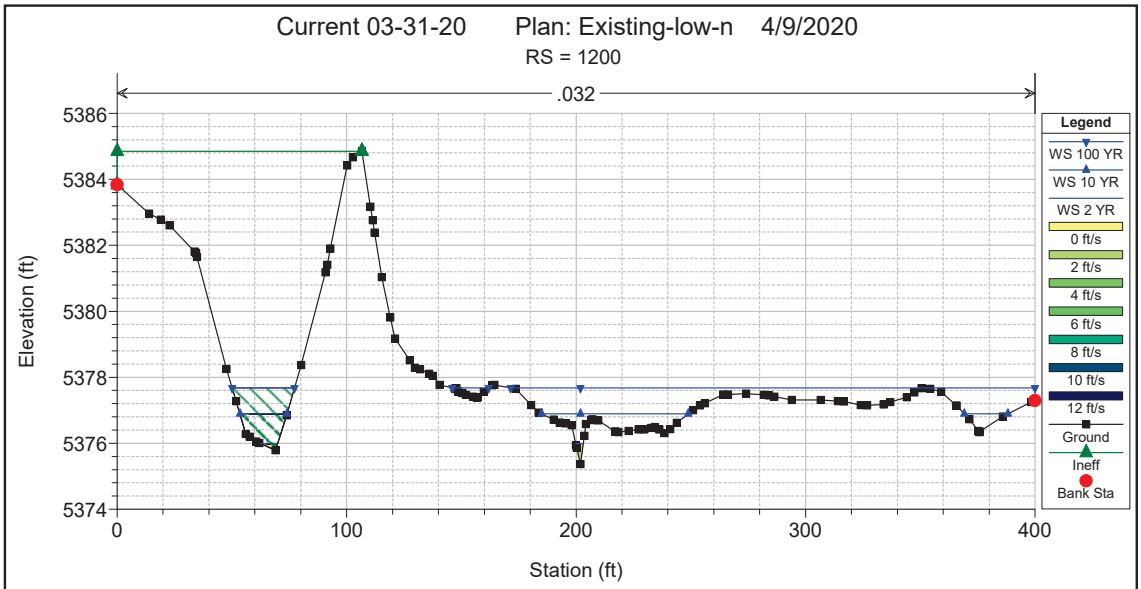

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1450
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

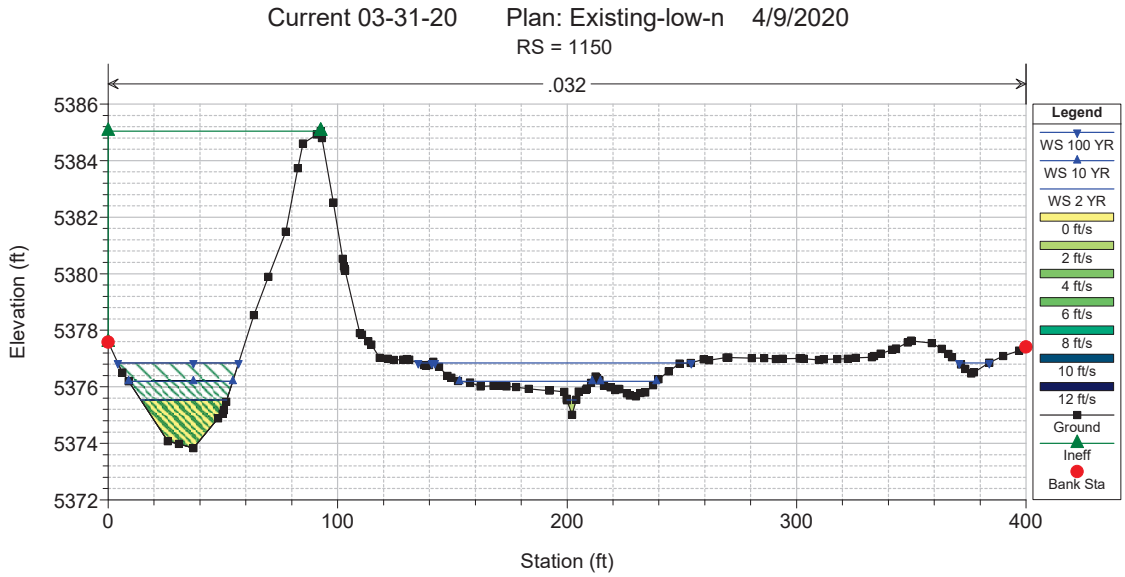

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1400
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

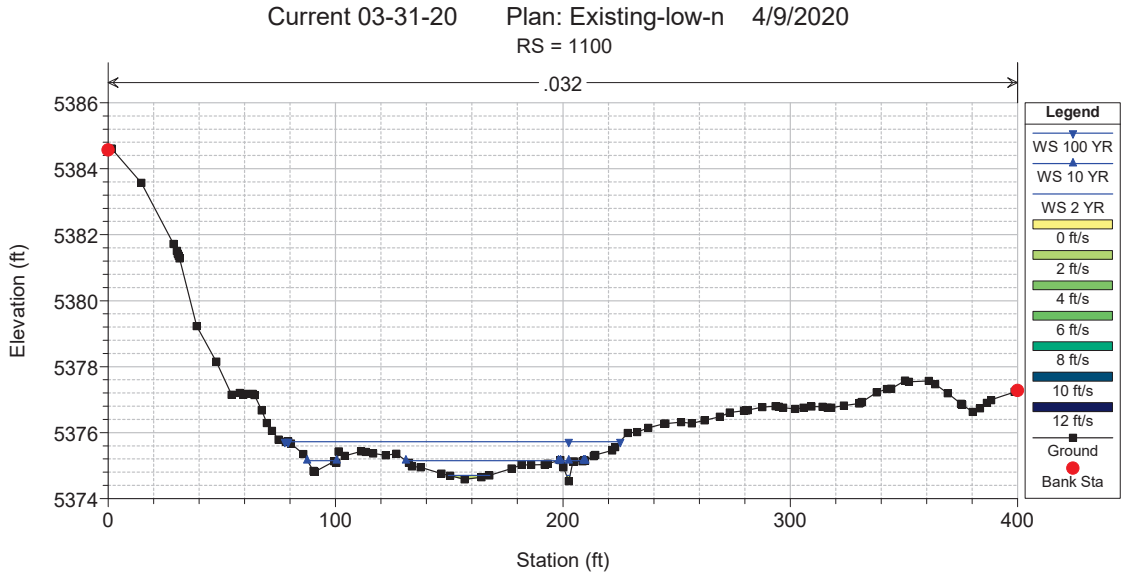

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1350
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

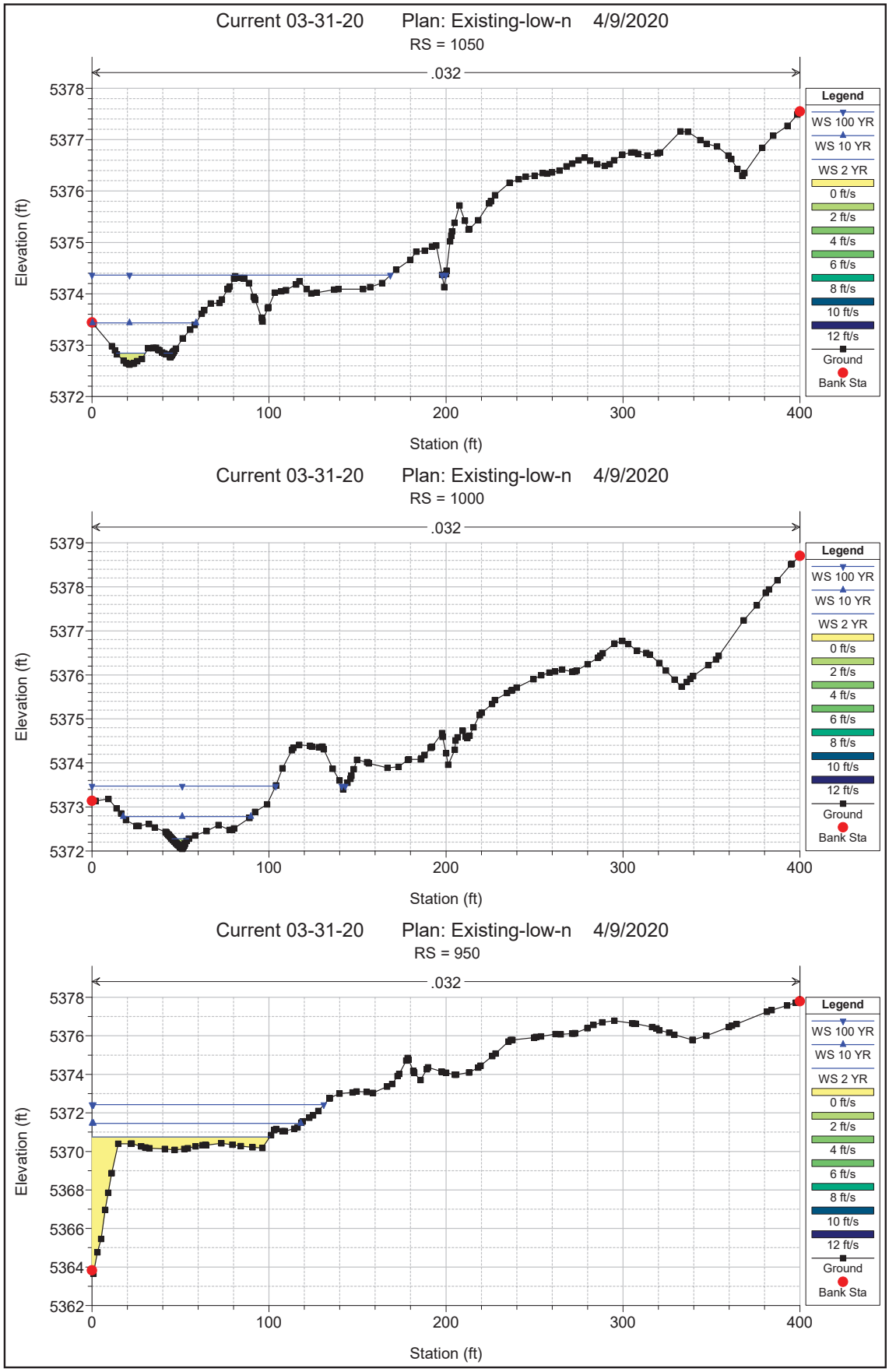

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1300
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Ineff
Bank Sta

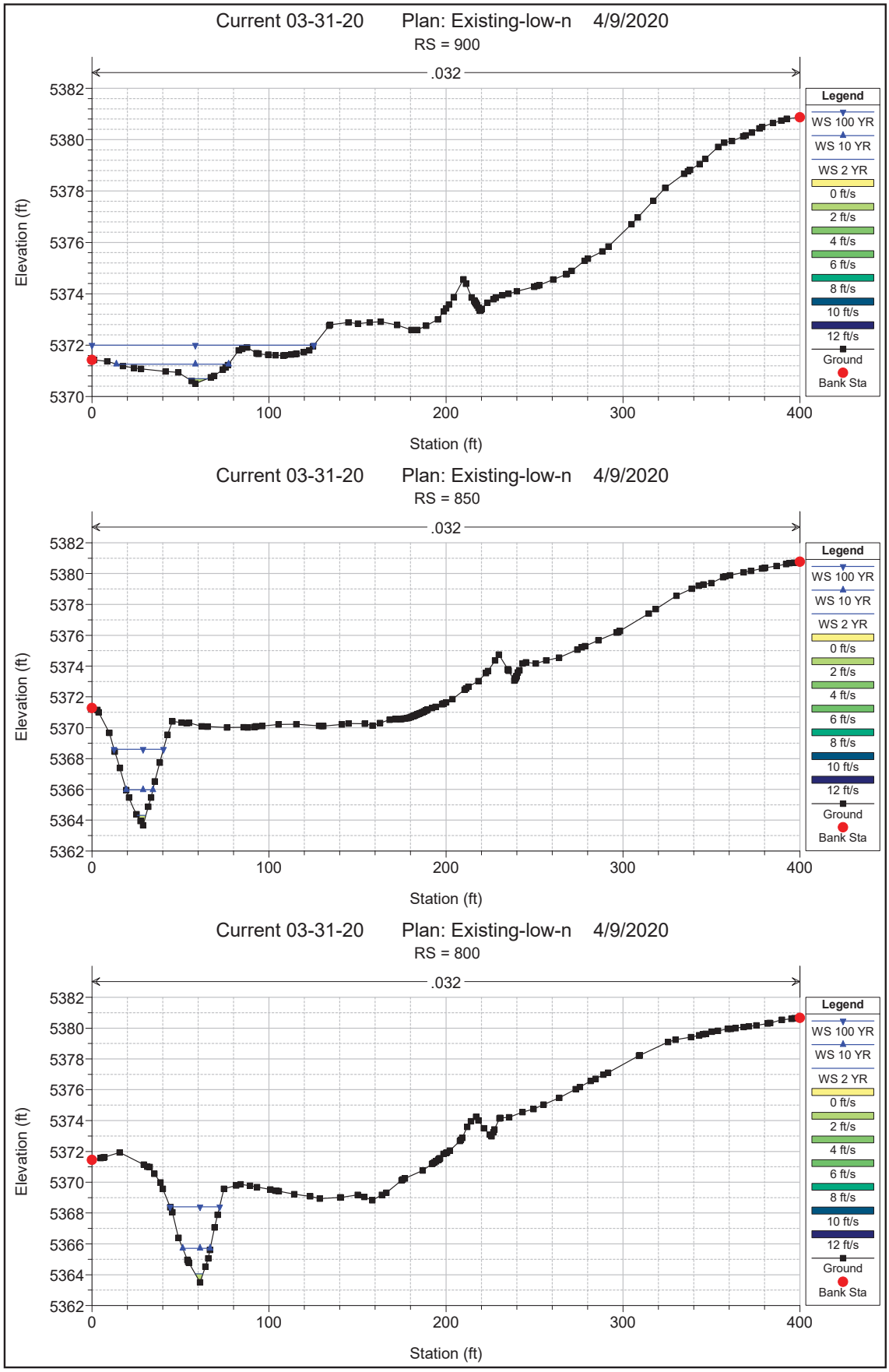

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1250
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Ineff
Bank Sta

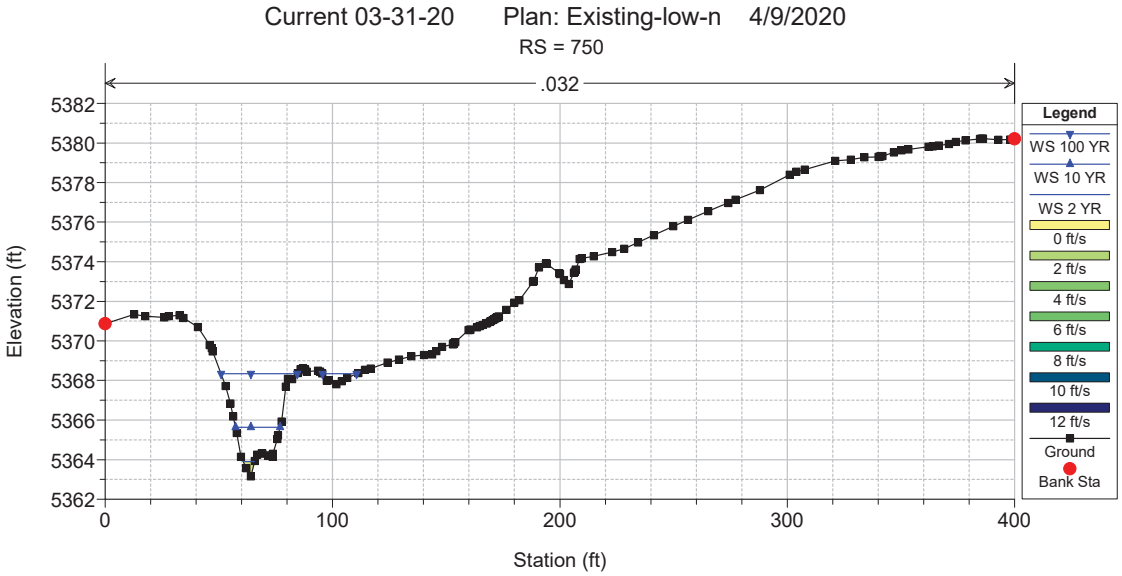

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1200
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Ineff
Bank Sta

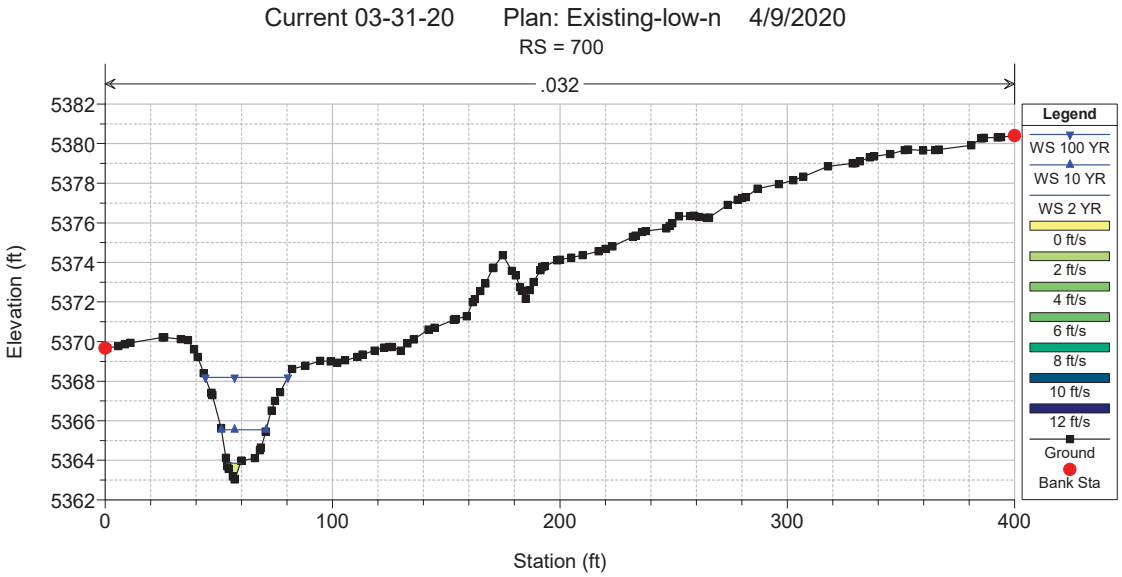

Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1150
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Ineff
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1100
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1050
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 1000
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 950
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 900
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 850
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 800
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 750
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 700
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
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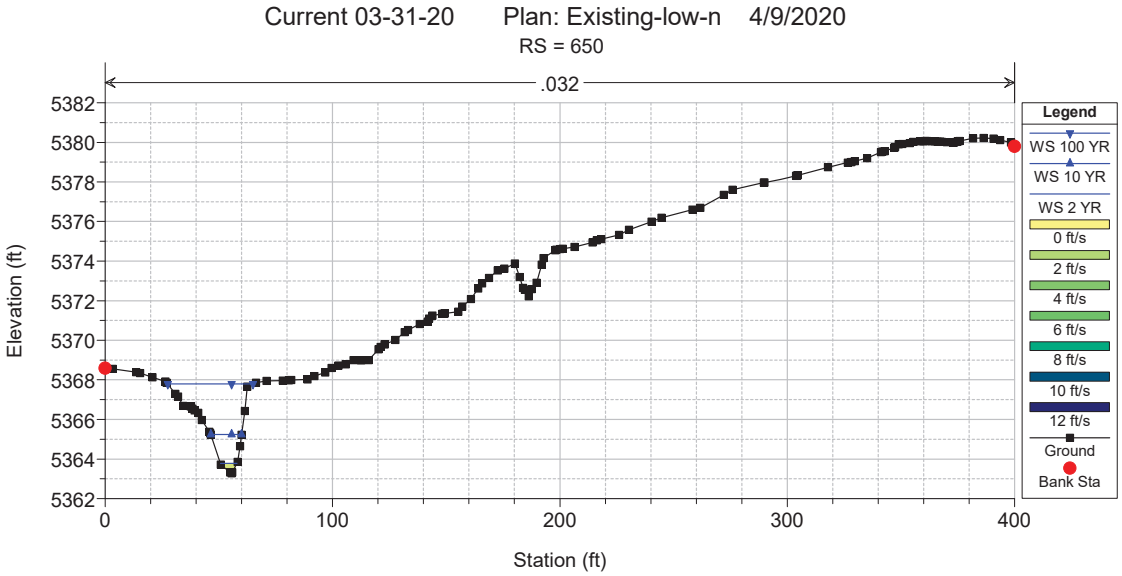
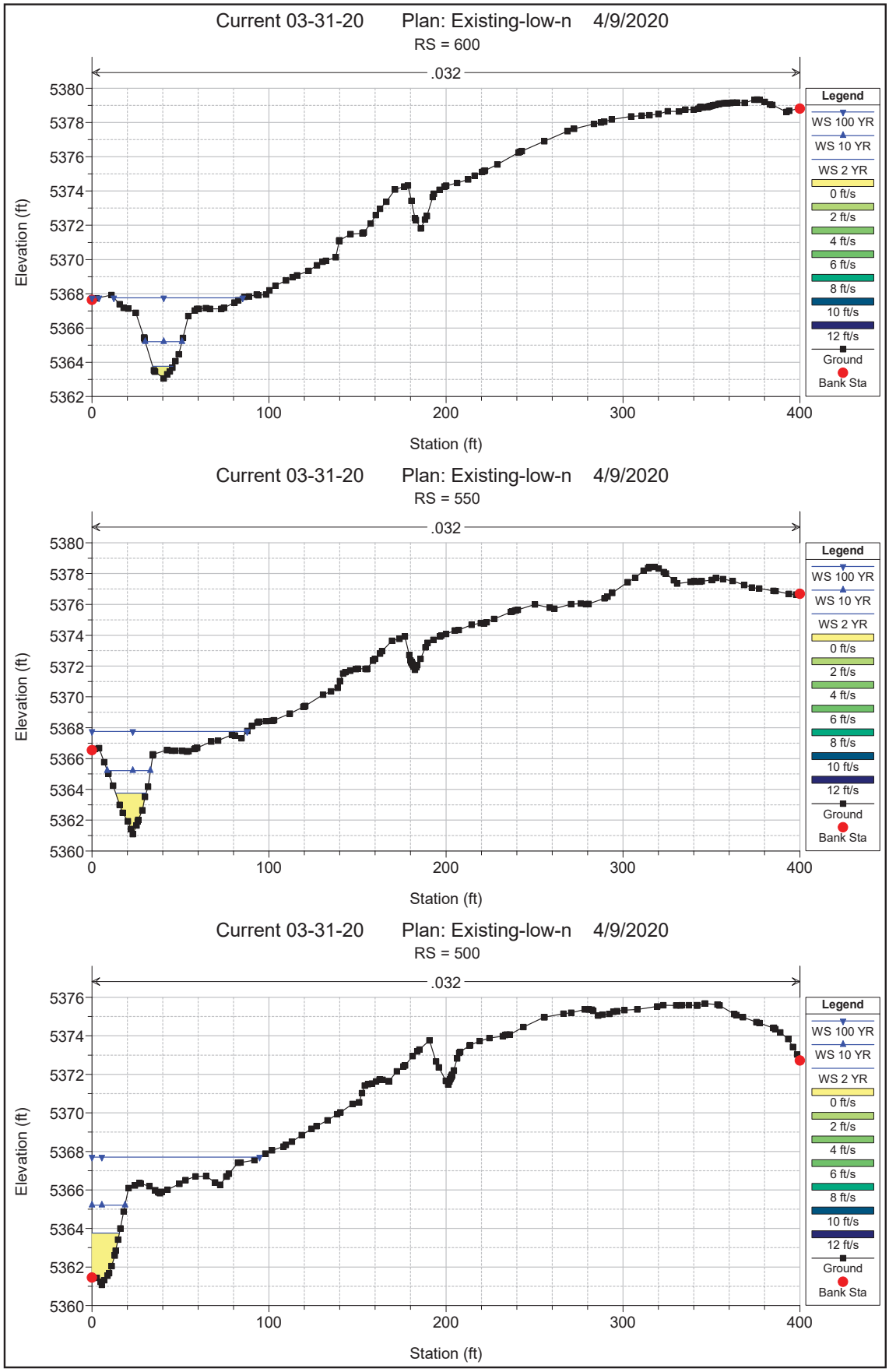
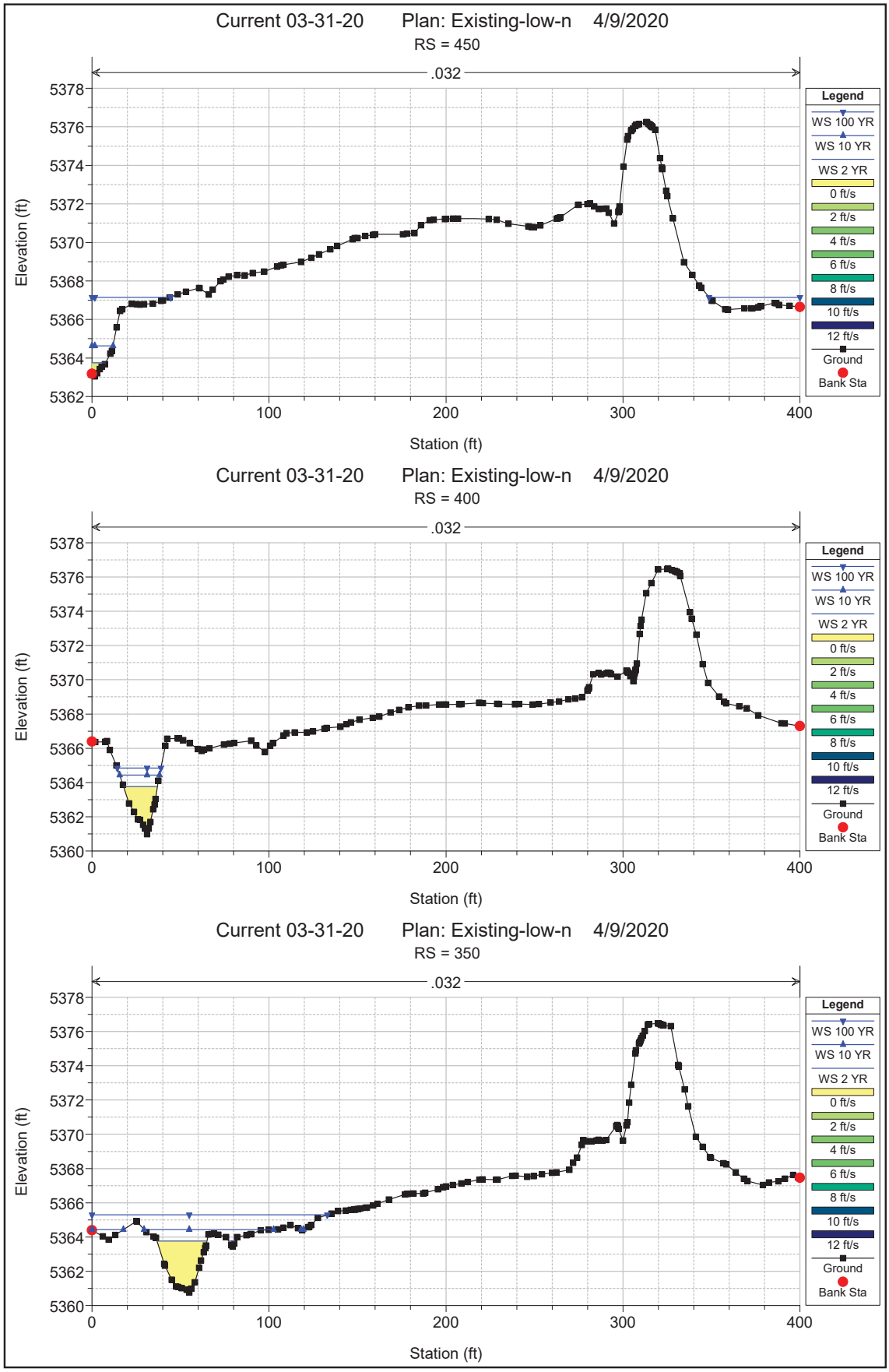
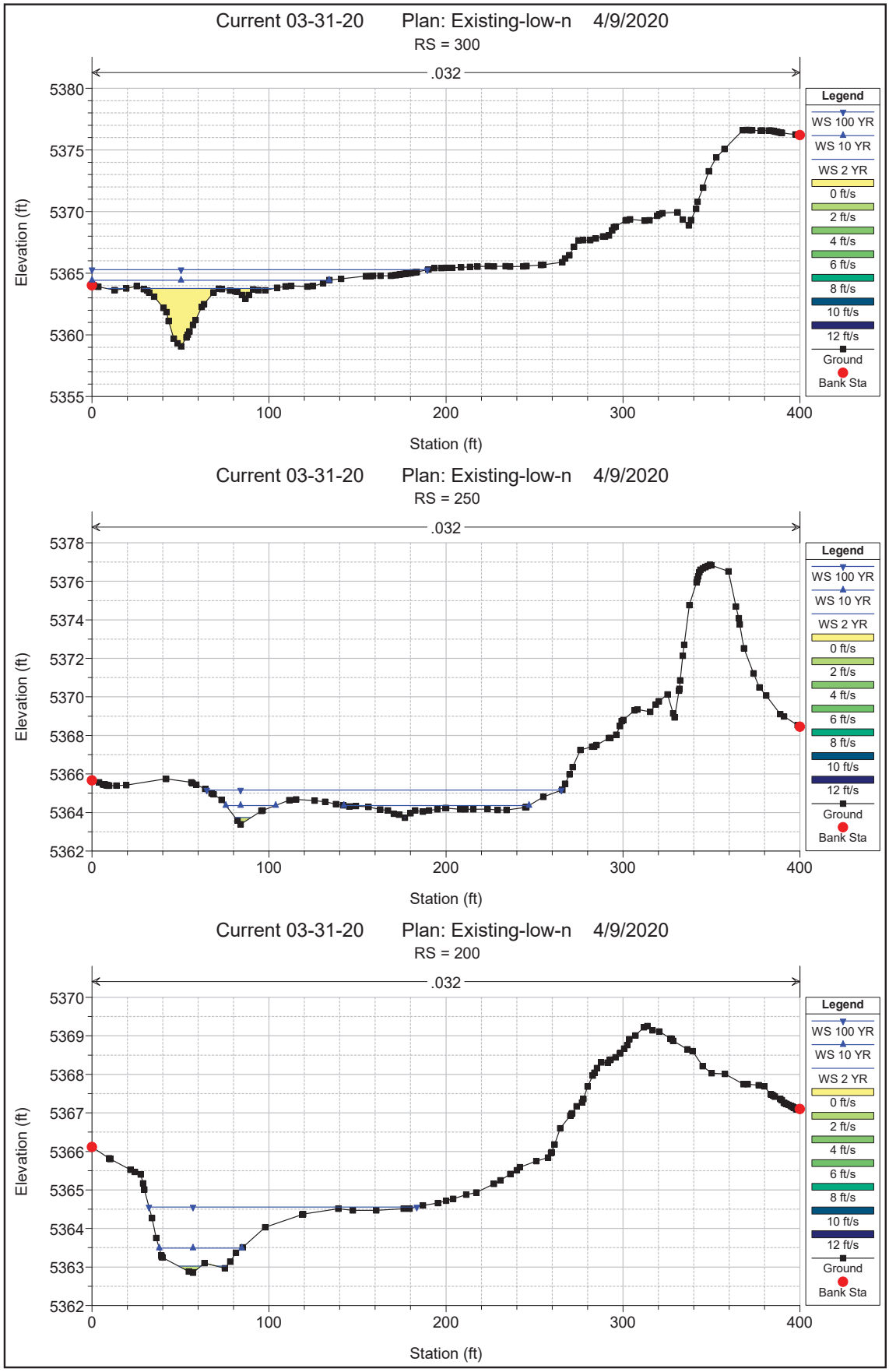
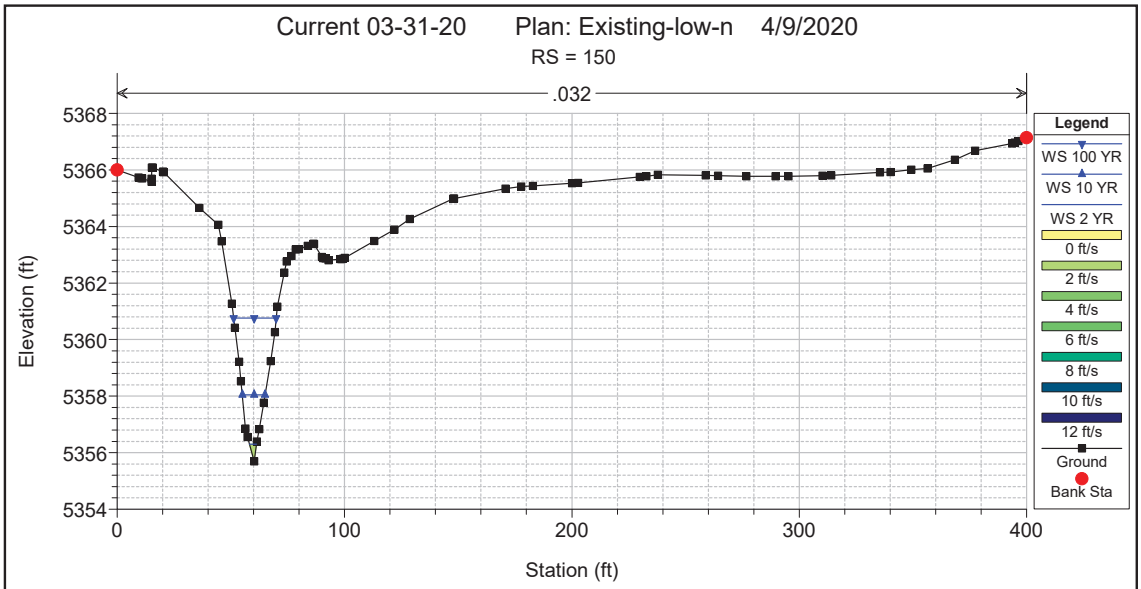
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 650
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 600
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 550
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 500
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 450
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 400
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 350
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 300
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 250
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 200
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Existing-low-n 4/9/2020
RS = 150
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Elevation (ft)
5368
5366
5364
5362
5360
5358
5356
5354
0
100
200
300
400
Station (ft)
Legend
WS 100 YR
WS 10 YR
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 2 YR

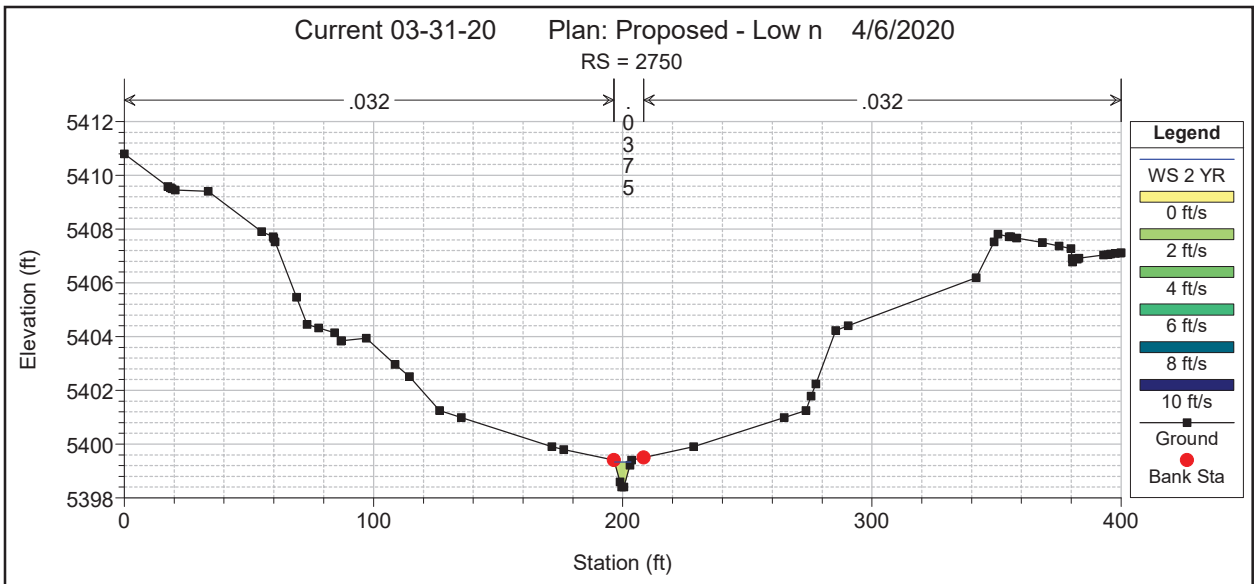
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR - Tributary I	5750	2 YR	1.82	5450.60	5451.25	5451.05	5451.27	0.003940	1.29	1.41	4.55	0.41	0.07
PR - Tributary I	5700	2 YR	1.82	5450.44	5450.87	5450.84	5450.89	0.021511	1.23	1.48	19.17	0.78	0.10
PR - Tributary I	5650	2 YR	1.82	5449.61	5449.76	5449.75	5449.77	0.022908	1.03	1.78	31.79	0.76	0.08
PR - Tributary I	5600	2 YR	1.82	5448.25	5448.31	5448.31	5448.33	0.037546	1.14	1.60	35.72	0.95	0.11
PR - Tributary I	5550	2 YR	1.82	5446.77	5446.95	5446.95	5446.99	0.033061	1.67	1.09	12.47	0.99	0.18
PR - Tributary I	5500	2 YR	1.82	5445.70	5445.91	5445.84	5445.92	0.005160	0.82	2.22	18.30	0.41	0.04
PR - Tributary I	5450	2 YR	1.82	5445.24	5445.34	5445.34	5445.38	0.036538	1.52	1.20	16.95	1.01	0.16
PR - Tributary I	5400	2 YR	1.82	5444.05	5444.24	5444.22	5444.26	0.015088	1.21	1.50	15.33	0.68	0.09
PR - Tributary I	5350	2 YR	1.82	5443.51	5443.61	5443.59	5443.62	0.010792	0.83	2.18	30.31	0.55	0.05
PR - Tributary I	5300	2 YR	1.82	5443.08	5443.18		5443.19	0.007199	0.69	2.63	35.70	0.45	0.03
PR - Tributary I	5250	2 YR	1.82	5442.33	5442.42	5442.42	5442.45	0.048281	1.28	1.42	32.13	1.07	0.13
PR - Tributary I	5200	2 YR	1.82	5441.18	5441.31	5441.26	5441.32	0.006189	0.71	2.55	29.49	0.43	0.03
PR - Tributary I	5150	2 YR	1.82	5440.49	5440.63	5440.63	5440.65	0.046322	1.26	1.45	32.56	1.05	0.13
PR - Tributary I	5100	2 YR	1.82	5438.27	5440.57	5438.37	5440.57	0.000000	0.02	120.82	86.81	0.00	0.00
PR - Tributary I	5050	2 YR	1.82	5440.42	5440.53	5440.53	5440.56	0.033483	1.45	1.26	17.95	0.96	0.15
PR - Tributary I	5000	2 YR	1.82	5438.12	5438.36	5438.40	5438.47	0.053327	2.62	0.70	5.74	1.33	0.40
PR - Tributary I	4950	2 YR	1.82	5437.50	5437.68	5437.64	5437.69	0.010366	0.89	2.05	25.21	0.55	0.05
PR - Tributary I	4900	2 YR	1.82	5436.66	5436.79	5436.79	5436.82	0.034230	1.40	1.30	19.71	0.96	0.14
PR - Tributary I	4850	2 YR	1.82	5435.75	5435.92	5435.88	5435.93	0.010773	0.93	1.95	22.97	0.56	0.06
PR - Tributary I	4800	2 YR	1.82	5435.31	5435.49		5435.50	0.007241	0.78	2.33	26.44	0.46	0.04
PR - Tributary I	4750	2 YR	1.82	5434.72	5434.81	5434.81	5434.83	0.033478	0.98	1.85	46.85	0.87	0.08
PR - Tributary I	4700	2 YR	1.82	5434.02	5434.15	5434.15	5434.17	0.047257	1.17	1.55	39.16	1.04	0.12
PR - Tributary I	4650	2 YR	1.82	5433.21	5433.30	5433.29	5433.32	0.015432	0.91	1.99	31.55	0.64	0.06
PR - Tributary I	4600	2 YR	1.82	5432.45	5432.55		5432.56	0.014384	0.88	2.07	33.13	0.62	0.06
PR - Tributary I	4550	2 YR	1.82	5431.45	5431.59	5431.59	5431.62	0.025793	1.39	1.31	16.23	0.86	0.13
PR - Tributary I	4500	2 YR	1.82	5430.22	5430.77	5430.39	5430.77	0.000163	0.30	6.03	16.56	0.09	0.00
PR - Tributary I	4450	2 YR	1.82	5430.61	5430.71	5430.71	5430.73	0.048250	1.35	1.34	27.83	1.09	0.15
PR - Tributary I	4400	2 YR	1.82	5428.99	5429.12	5429.11	5429.15	0.026394	1.35	1.35	17.89	0.86	0.12
PR - Tributary I	4350	2 YR	1.82	5427.82	5427.97		5428.00	0.020206	1.29	1.41	16.25	0.77	0.11
PR - Tributary I	4300	2 YR	1.82	5426.83	5426.98	5426.97	5427.00	0.020100	1.17	1.56	20.79	0.75	0.09
PR - Tributary I	4250	2 YR	1.82	5426.04	5426.16		5426.17	0.013916	0.97	1.88	25.46	0.63	0.06
PR - Tributary I	4200	2 YR	1.82	5425.05	5425.18	5425.17	5425.21	0.027617	1.32	1.38	19.42	0.88	0.12
PR - Tributary I	4150	2 YR	1.82	5424.36	5424.51	5424.48	5424.52	0.008178	0.62	2.92	51.26	0.46	0.03
PR - Tributary I	4100	2 YR	1.82	5423.72	5423.81	5423.81	5423.83	0.028995	1.00	1.82	40.47	0.83	0.08
PR - Tributary I	4050	2 YR	1.82	5422.79	5422.94	5422.90	5422.95	0.009509	0.83	2.18	27.57	0.52	0.05
PR - Tributary I	4000	2 YR	1.82	5422.19	5422.30		5422.31	0.017400	0.94	1.93	31.82	0.68	0.07
PR - Tributary I	3950	2 YR	1.82	5421.55	5421.70	5421.67	5421.71	0.008932	0.79	2.29	29.84	0.50	0.04
PR - Tributary I	3900	2 YR	1.82	5420.99	5421.09		5421.11	0.016928	0.97	1.88	29.19	0.67	0.07
PR - Tributary I	3850	2 YR	1.82	5420.41	5420.62	5420.56	5420.63	0.006044	0.69	2.63	31.41	0.42	0.03
PR - Tributary I	3800	2 YR	1.82	5419.89	5420.04		5420.06	0.027117	1.09	1.67	31.03	0.83	0.09
PR - Tributary I	3750	2 YR	1.82	5418.86	5419.04		5419.06	0.015090	1.14	1.59	17.70	0.67	0.08
PR - Tributary I	3700	2 YR	1.82	5417.97	5418.16	5418.14	5418.19	0.019819	1.37	1.33	13.88	0.78	0.12
PR - Tributary I	3650	2 YR	1.82	5416.98	5417.10	5417.08	5417.12	0.023344	1.20	1.52	21.91	0.80	0.10
PR - Tributary I	3600	2 YR	1.82	5415.58	5415.71	5415.70	5415.73	0.033809	1.30	1.40	23.74	0.94	0.12
PR - Tributary I	3550	2 YR	1.82	5414.55	5414.63		5414.64	0.015210	0.87	2.08	34.89	0.63	0.06
PR - Tributary I	3500	2 YR	1.82	5413.71	5413.82	5413.82	5413.83	0.017976	0.80	2.28	49.59	0.66	0.05
PR - Tributary I	3450	2 YR	1.82	5412.64	5412.78	5412.75	5412.79	0.005611	0.68	2.68	31.16	0.41	0.03
PR - Tributary I	3400	2 YR	4.22	5411.88	5411.99	5411.99	5412.03	0.029311	1.47	2.88	36.30	0.92	0.15
PR - Tributary I	3350	2 YR	4.22	5411.24	5411.43	5411.36	5411.43	0.003757	0.70	6.05	49.90	0.35	0.03
PR - Tributary I	3300	2 YR	4.22	5410.87	5411.00	5411.00	5411.03	0.026478	1.48	2.85	32.72	0.89	0.14
PR - Tributary I	3250	2 YR	4.22	5409.78	5410.41	5410.22	5410.43	0.005275	1.18	3.57	13.53	0.40	0.09
PR - Tributary I	3232.13	2 YR	4.22	5409.65	5410.08	5410.08	5410.22	0.033291	3.07	1.38	4.87	1.02	0.57
PR - Tributary I	3205.03	2 YR	4.22	5405.01	5405.06	5405.19	5406.92	6.030488	10.95	0.39	10.20	9.93	14.21
PR - Tributary I	3181.99	2 YR	4.22	5404.79	5404.96	5404.96	5405.05	0.042931	2.41	1.75	11.01	1.06	0.42
PR - Tributary I	3140.22	2 YR	4.22	5399.18	5399.63	5399.37	5399.65	0.002132	1.02	4.15	9.39	0.27	0.06
PR - Tributary I	3140		Culvert										
PR - Tributary I	2909.93	2 YR	4.22	5398.72	5399.60		5399.60	0.000237	0.50	8.37	9.76	0.10	0.01
PR - Tributary I	2850	2 YR	4.22	5398.60	5399.55		5399.57	0.002092	1.17	3.61	6.67	0.28	0.07
PR - Tributary I	2800	2 YR	4.22	5398.50	5399.44		5399.46	0.002090	1.17	3.61	6.66	0.28	0.07
PR - Tributary I	2750	2 YR	4.22	5398.40	5399.34		5399.36	0.002191	1.19	3.55	6.61	0.29	0.07
PR - Tributary I	2700	2 YR	4.22	5398.30	5399.22		5399.25	0.002340	1.22	3.46	6.53	0.30	0.07
PR - Tributary I	2650	2 YR	4.22	5398.20	5399.09	5398.72	5399.12	0.002733	1.29	3.27	6.37	0.32	0.08
PR - Tributary I	2600	2 YR	4.22	5398.10	5398.61	5398.61	5398.78	0.032219	3.24	1.30	4.08	1.01	0.62
PR - Tributary I	2550	2 YR	4.22	5396.43	5397.66	5396.64	5397.66	0.000008	0.09	47.75	89.62	0.02	0.00
PR - Tributary I	2500	2 YR	4.22	5394.51	5397.66		5397.66	0.000000	0.01	297.47	168.24	0.00	0.00
PR - Tributary I	2450	2 YR	4.22	5394.37	5397.66		5397.66	0.000000	0.01	539.38	215.46	0.00	0.00
PR - Tributary I	2400	2 YR	4.22	5394.18	5397.66		5397.66	0.000000	0.01	578.51	220.75	0.00	0.00
PR - Tributary I	2350	2 YR	4.22	5394.18	5397.66		5397.66	0.000000	0.01	652.67	245.61	0.00	0.00
PR - Tributary I	2300	2 YR	4.22	5394.18	5397.66		5397.66	0.000000	0.01	686.00	245.41	0.00	0.00
PR - Tributary I	2218.78	2 YR	4.22	5397.49	5397.62	5397.62	5397.66	0.059895	1.61	2.62	38.83	1.09	0.25
PR - Tributary I	2198.89	2 YR	4.22	5392.12	5392.34	5392.63	5394.37	1.017020	11.44	0.37	2.34	5.08	9.72
PR - Tributary I	2150	2 YR	4.22	5391.10	5391.68	5391.61	5391.78	0.017146	2.53	1.67	4.70	0.75	0.37
PR - Tributary I	2100	2 YR	4.22	5390.07	5390.61	5390.58	5390.75	0.025694	2.98	1.42	4.25	0.91	0.51
PR - Tributary I	2050	2 YR	4.22	5389.03	5389.63	5389.55	5389.73	0.016293	2.51	1.68	4.60	0.73	0.36
PR - Tributary I	2000	2 YR	4.22	5388.00	5388.53	5388.52	5388.68	0.028006	3.07	1.37	4.19	0.95	0.55
PR - Tributary I	1950	2 YR	4.22	5386.96	5387.56	5387.47	5387.66	0.015309	2.45	1.72	4.70	0.71	0.34
PR - Tributary I	1900	2 YR	4.22	5385.93	5386.45	5386.44	5386.60	0.029748	3.14	1.35	4.16	0.97	0.58
PR - Tributary I	1850	2 YR	4.22	5384.89	5385.49	5385.39	5385.58	0.014643	2.38	1.77	4.90	0.70	0.32
PR - Tributary I	1800	2 YR	4.22	5383.85	5384.37	5384.37	5384.53	0.031307	3.20	1.32	4.09	1.00	0.60
PR - Tributary I	1750	2 YR	4.22	5382.66	5383.52	5383.32	5383.58	0.007912	1.92	2.20	5.13	0.52	0.20
PR - Tributary I	1700	2 YR	4.22	5381.95	5382.67	5382.67	5382.85	0.033273	3.42	1.23	3.49	1.02	0.68
PR - Tributary I	1650	2 YR	4.22	5381.09	5381.94	5381.73	5381.99	0.006920	1.81	2.34	5.51	0.49	0.18
PR - Tributary I	1600	2 YR	4.22	5380.66	5381.48	5381.33	5381.56	0.011197	2.23	1.90	4.61	0.61	0.27
PR - Tributary I	1550	2 YR	4.22	5379.85	5380.50	5380.50	5380.66	0.031844	3.22	1.31	4.01	0.99	0.61

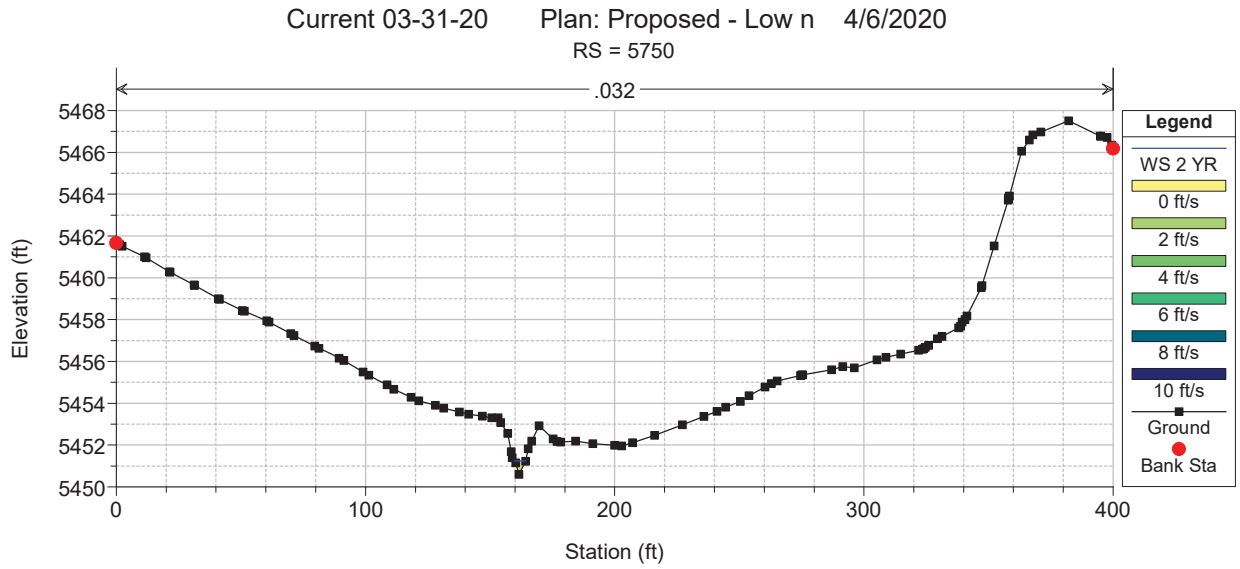
HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 2 YR (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR - Tributary I	1500	2 YR	4.22	5379.19	5380.02	5379.76	5380.05	0.004652	1.47	2.87	6.91	0.40	0.12
PR - Tributary I	1450	2 YR	4.22	5378.72	5379.40	5379.40	5379.56	0.029436	3.19	1.32	3.88	0.96	0.59
PR - Tributary I	1400	2 YR	4.22	5377.93	5379.12	5378.62	5379.14	0.002203	1.16	3.65	6.96	0.28	0.07
PR - Tributary I	1350	2 YR	10.53	5377.94	5378.76		5378.85	0.009707	2.44	4.32	8.53	0.60	0.30
PR - Tributary I	1300	2 YR	10.53	5377.44	5378.25		5378.35	0.010255	2.49	4.23	8.47	0.62	0.31
PR - Tributary I	1250	2 YR	10.53	5376.94	5377.76		5377.85	0.009843	2.45	4.30	8.53	0.61	0.30
PR - Tributary I	1200	2 YR	10.53	5376.44	5377.25		5377.35	0.010082	2.47	4.26	8.49	0.62	0.31
PR - Tributary I	1150	2 YR	10.53	5375.94	5376.76		5376.85	0.009824	2.45	4.30	8.54	0.61	0.30
PR - Tributary I	1100	2 YR	10.53	5375.44	5376.24		5376.34	0.010760	2.53	4.17	8.44	0.63	0.32
PR - Tributary I	1050	2 YR	10.53	5374.94	5375.77		5375.85	0.008615	2.32	4.55	8.90	0.57	0.27
PR - Tributary I	1000	2 YR	10.53	5374.44	5375.19		5375.31	0.013890	2.78	3.78	8.03	0.72	0.40
PR - Tributary I	950	2 YR	10.53	5373.93	5374.79		5374.85	0.006114	1.98	5.31	10.17	0.48	0.20
PR - Tributary I	900	2 YR	10.53	5373.44	5374.09	5374.08	5374.28	0.026437	3.54	2.98	7.17	0.97	0.67
PR - Tributary I	838.96	2 YR	10.53	5372.81	5373.30	5373.14	5373.37	0.009015	2.15	4.91	10.53	0.55	0.24
PR - Tributary I	838.25		Culvert										
PR - Tributary I	598.1	2 YR	10.53	5370.41	5370.95		5371.01	0.006830	1.99	5.30	10.36	0.49	0.20
PR - Tributary I	550	2 YR	10.53	5369.65	5370.37		5370.51	0.016644	2.98	3.54	7.78	0.78	0.46
PR - Tributary I	500	2 YR	10.53	5368.85	5369.59	5369.49	5369.72	0.015115	2.87	3.67	7.93	0.74	0.43
PR - Tributary I	450	2 YR	10.53	5368.05	5368.69		5368.83	0.020532	3.07	3.43	8.50	0.85	0.51
PR - Tributary I	400	2 YR	10.53	5367.25	5368.03		5368.11	0.009983	2.39	4.40	9.22	0.61	0.29
PR - Tributary I	350	2 YR	10.53	5366.46	5367.10	5367.10	5367.31	0.028813	3.65	2.88	7.04	1.01	0.72
PR - Tributary I	300	2 YR	10.53	5365.67	5364.42	5361.07	5364.42	0.000001		144.99	70.64	0.00	
PR - Tributary I	250	2 YR	10.53	5364.86	5364.41		5364.42	0.000008		82.65	84.21	0.00	
PR - Tributary I	194.84	2 YR	10.53	5363.99	5364.38	5364.21	5364.41	0.004635	1.37	7.70	20.71	0.40	0.10
PR - Tributary I	194.59		Culvert										
PR - Tributary I	113.93	2 YR	10.53	5363.86	5364.15		5364.20	0.010730	1.74	6.06	21.56	0.58	0.18
PR - Tributary I	101	2 YR	10.53	5363.73	5364.03	5363.95	5364.06	0.010004	1.40	7.50	35.61	0.54	0.13

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 2 YR

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PR - Tributary I	3140 West Ped	2 YR	5399.65	5399.63			5414.00			0.03		
PR - Tributary I	3140 West 10YR	2 YR	5399.65	5399.63	5399.49	5399.65	5414.00	4.22		0.03	1.22	0.60
PR - Tributary I	838.25 10-YR East	2 YR	5373.38	5373.30	5373.38	5373.48	5387.51	10.53		2.35	3.49	2.50
PR - Tributary I	838.25 West-Ped	2 YR	5373.38	5373.30			5387.51			2.35		
PR - Tributary I	194.59 Double	2 YR	5364.41	5364.38	5364.35	5364.41	5369.61	10.53		0.23	2.02	2.33


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2750
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5750
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Elevation (ft)
Station (ft)
Legend
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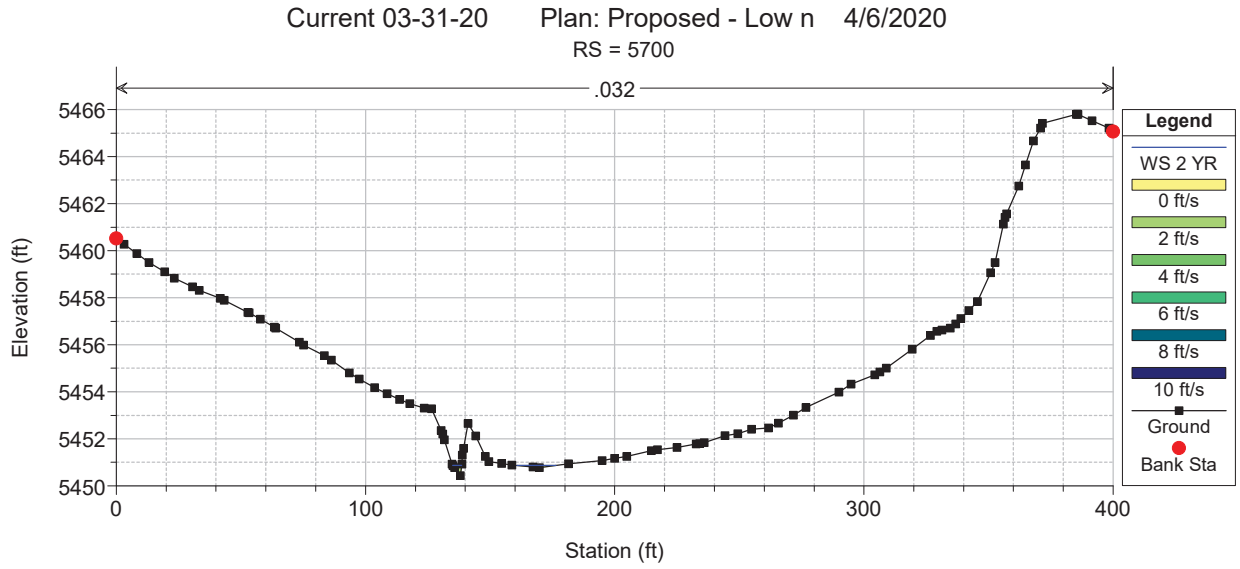
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5700
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
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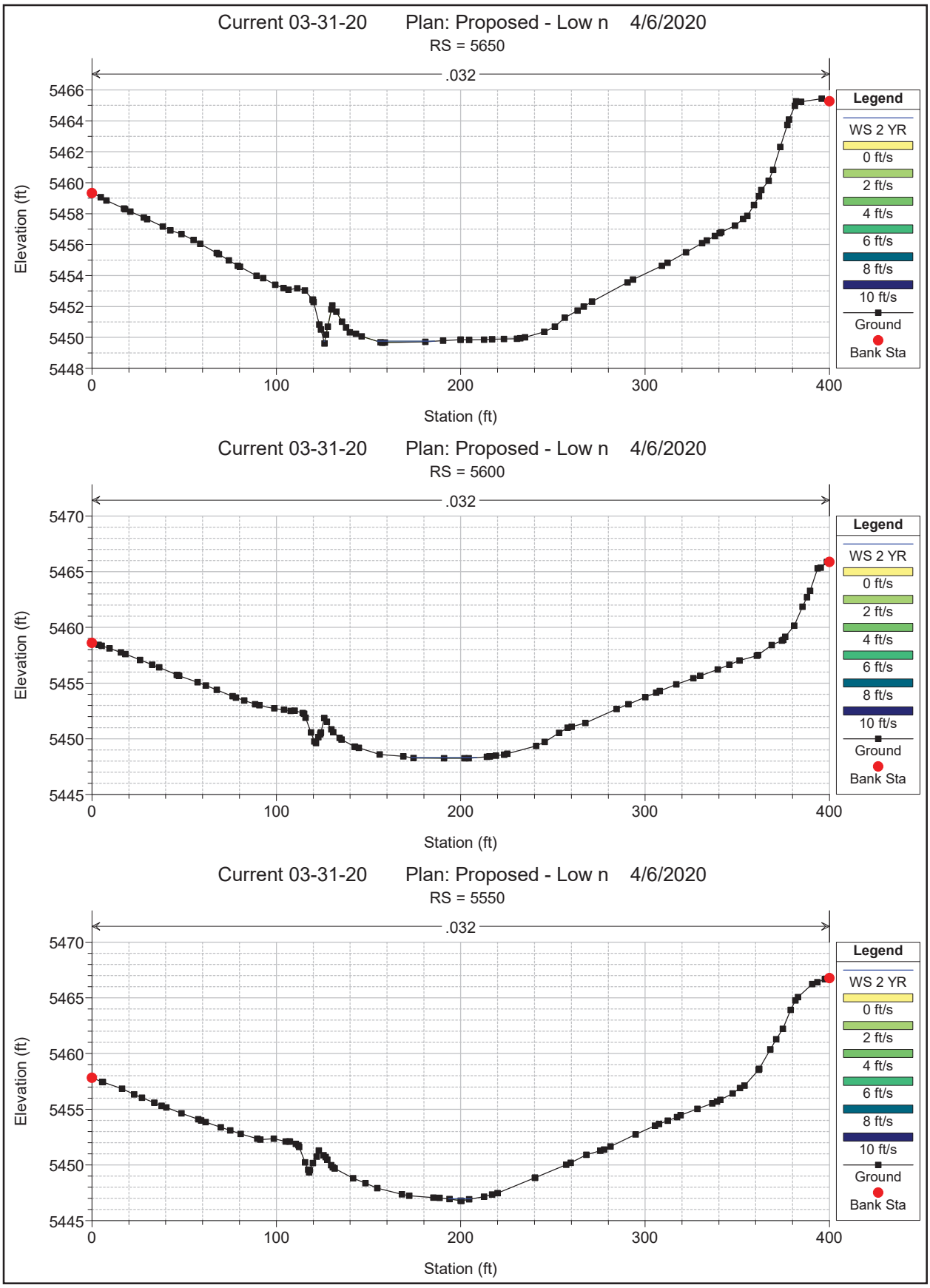
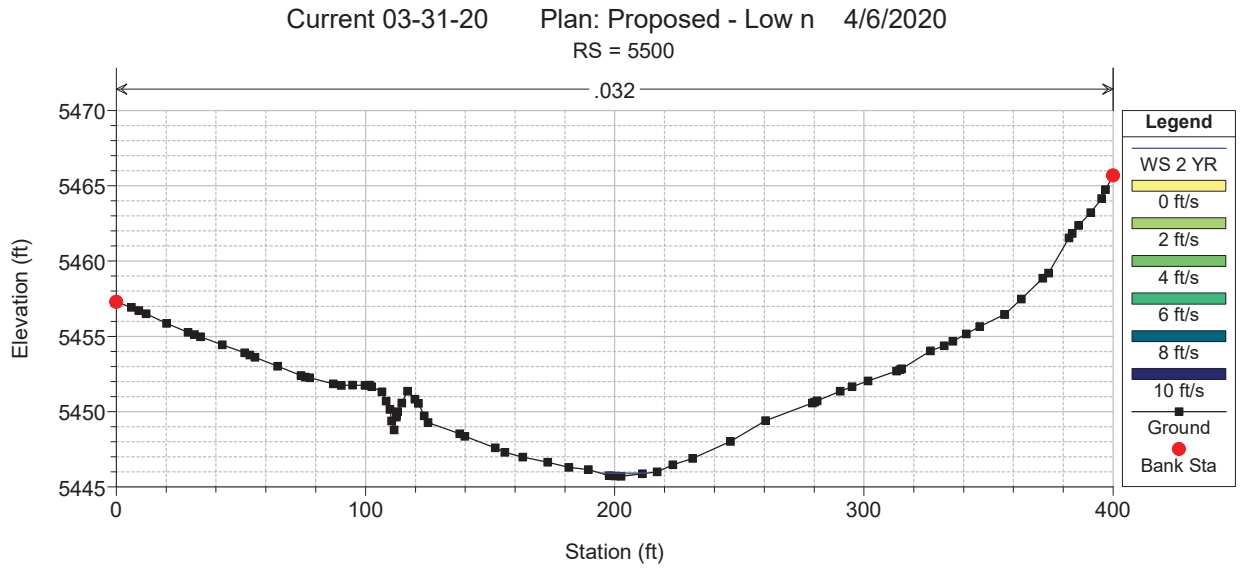
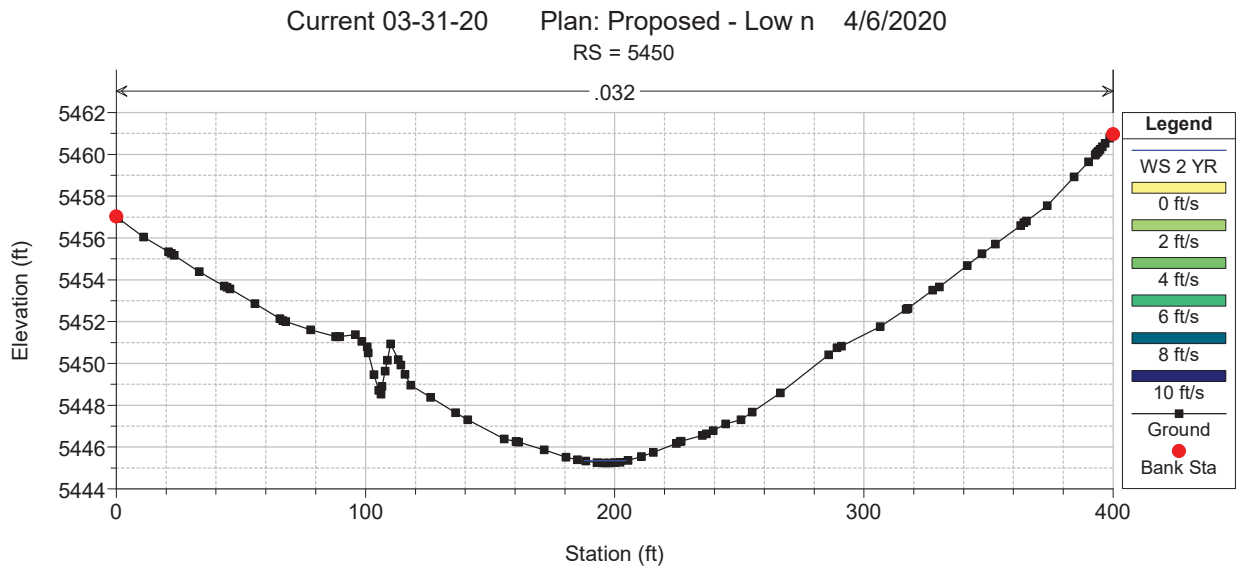
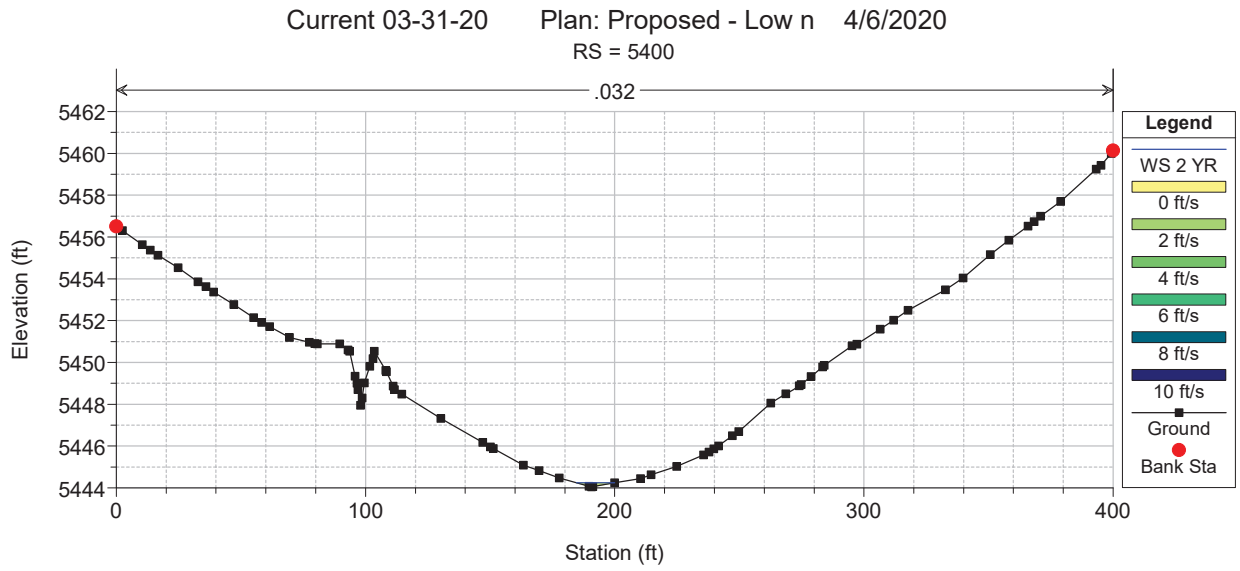
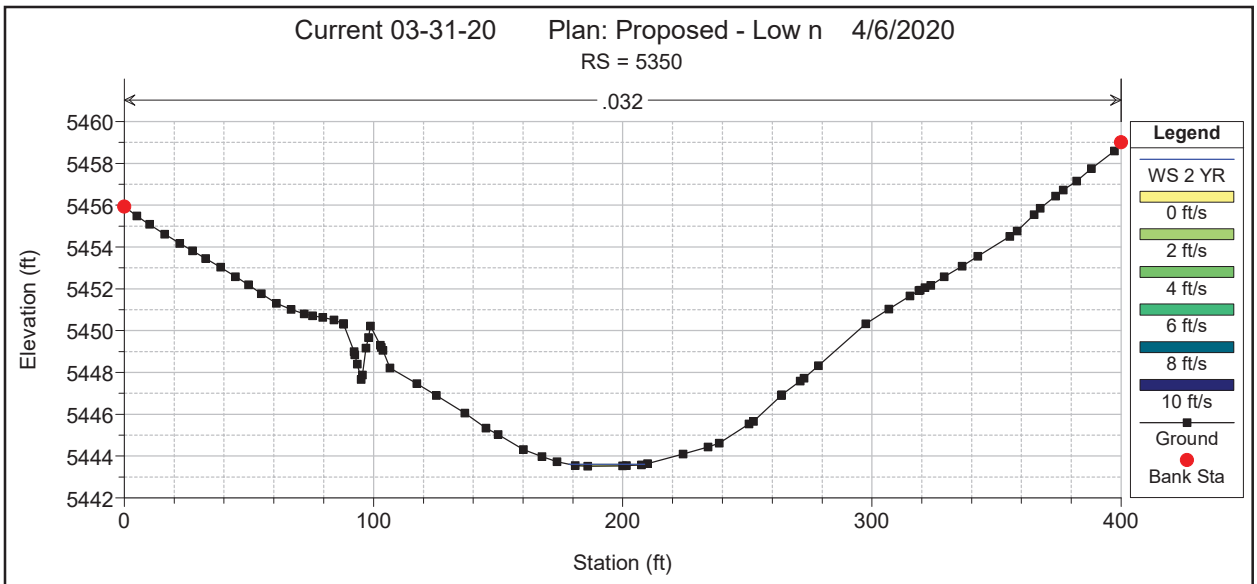
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

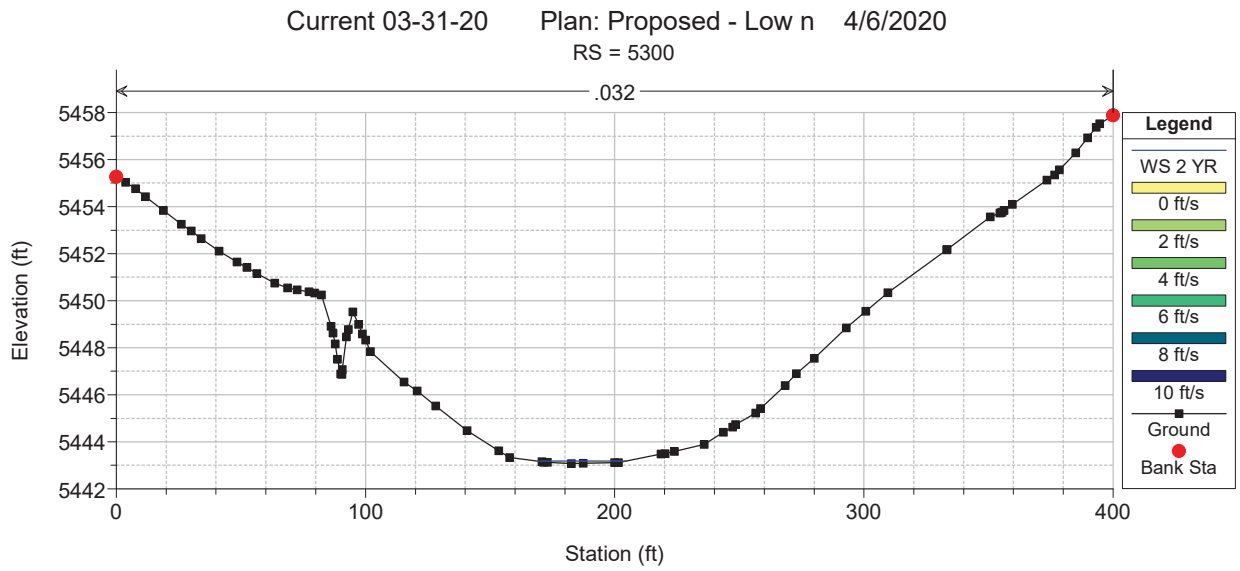

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5650
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5600
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5550
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

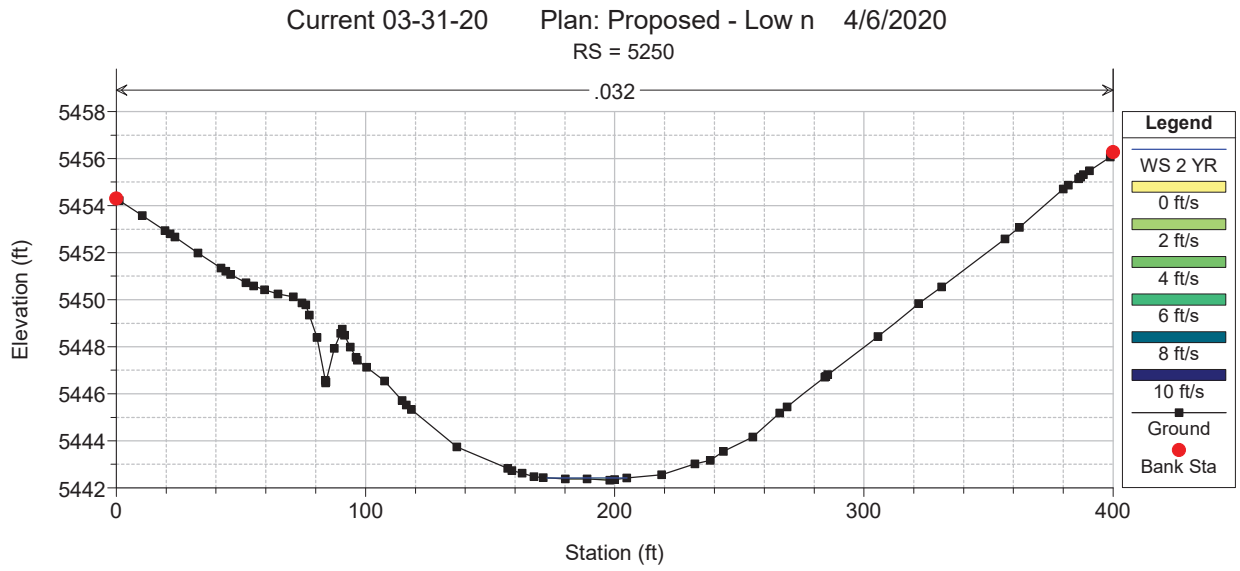

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5500
.032
Elevation (ft)
5470
5465
5460
5455
5450
5445
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

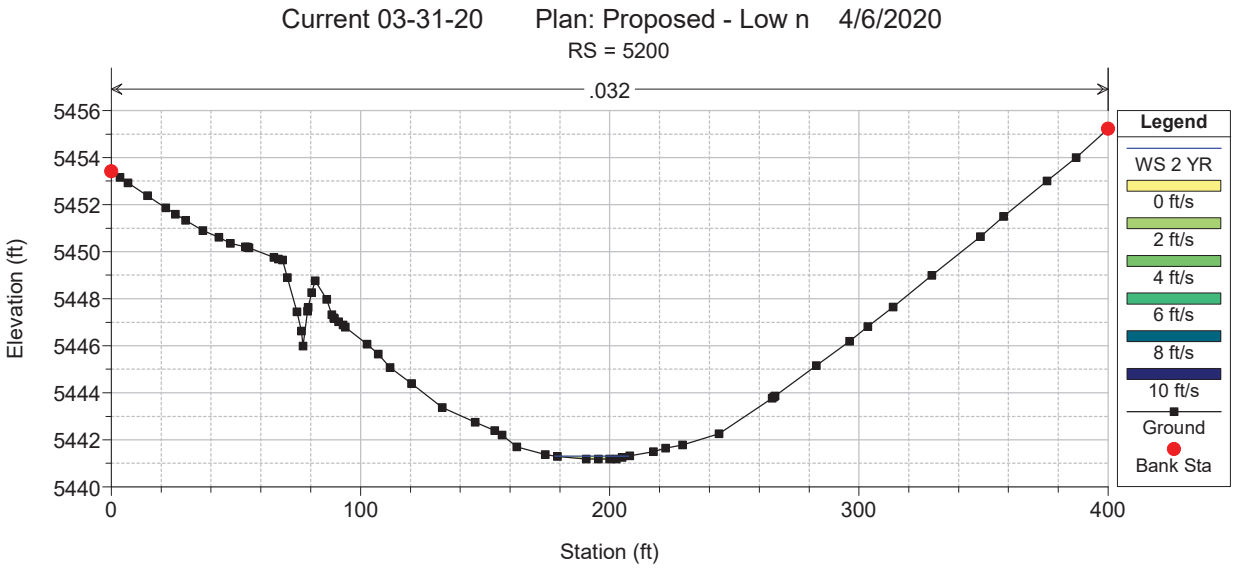

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5450
.032
Elevation (ft)
5462
5460
5458
5456
5454
5452
5450
5448
5446
5444
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

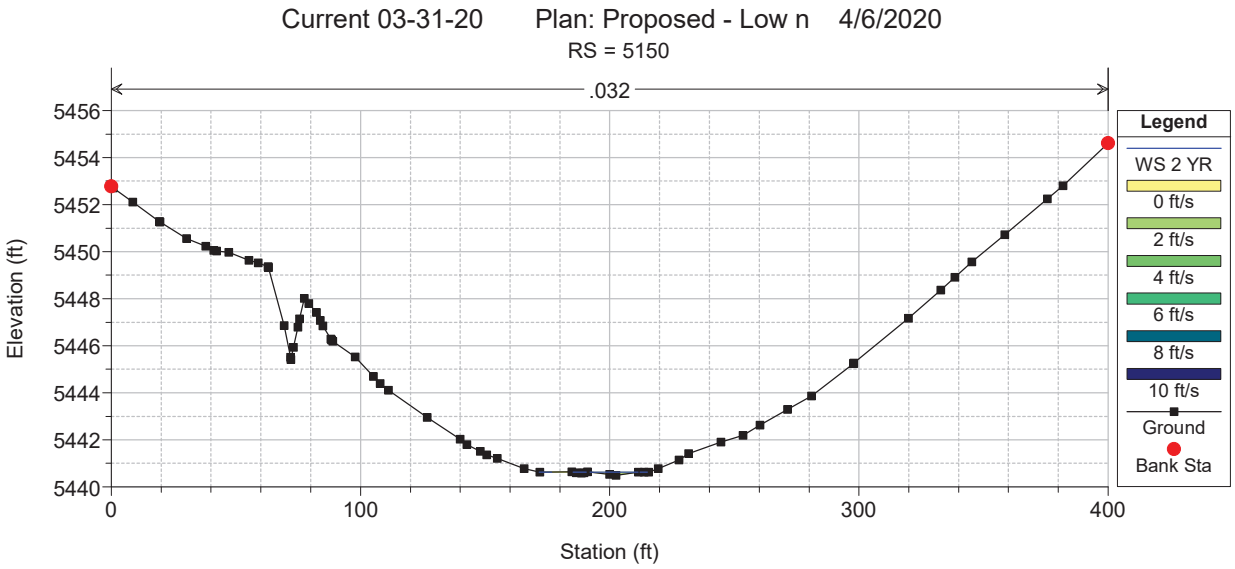

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5400
.032
Elevation (ft)
5462
5460
5458
5456
5454
5452
5450
5448
5446
5444
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

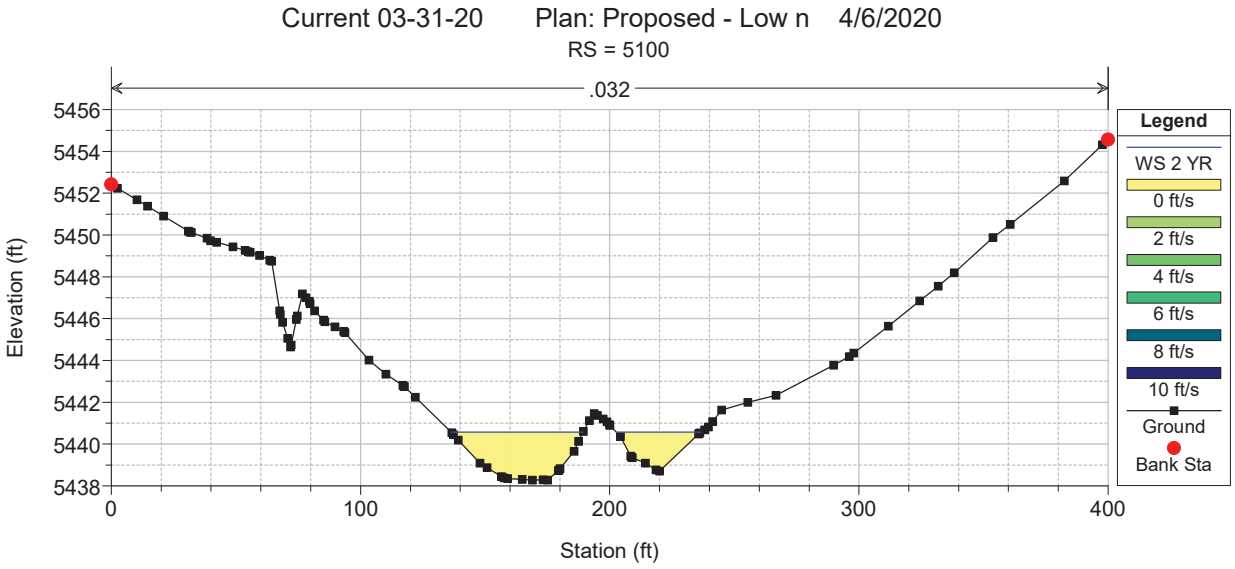

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5350
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

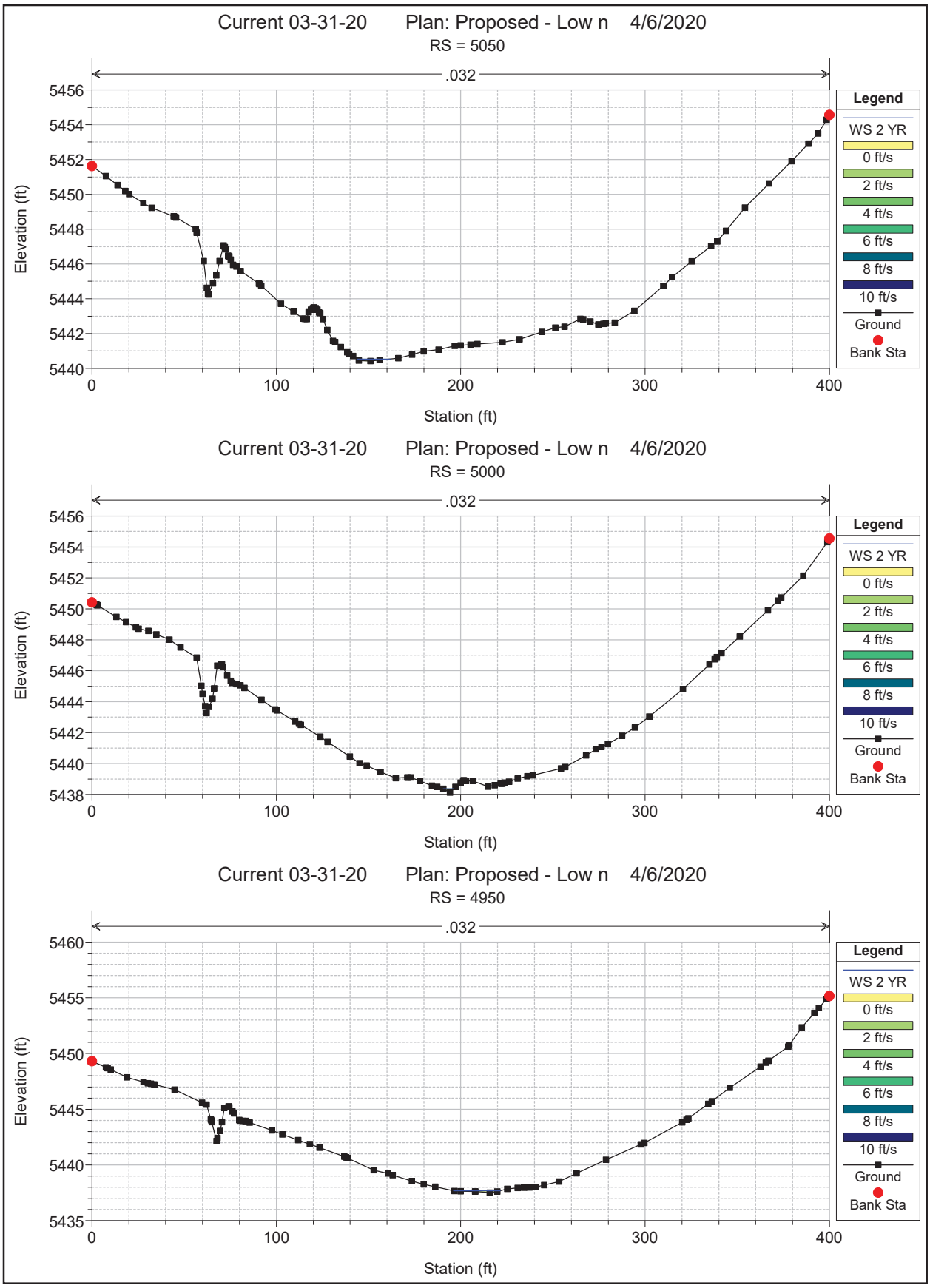

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5300
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

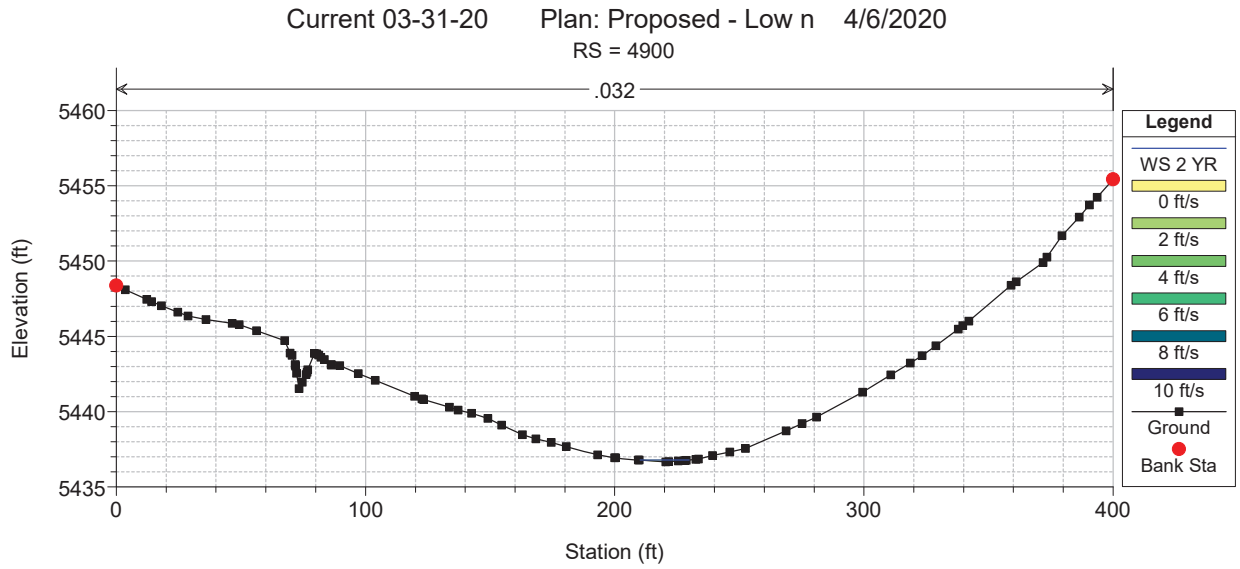

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5250
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

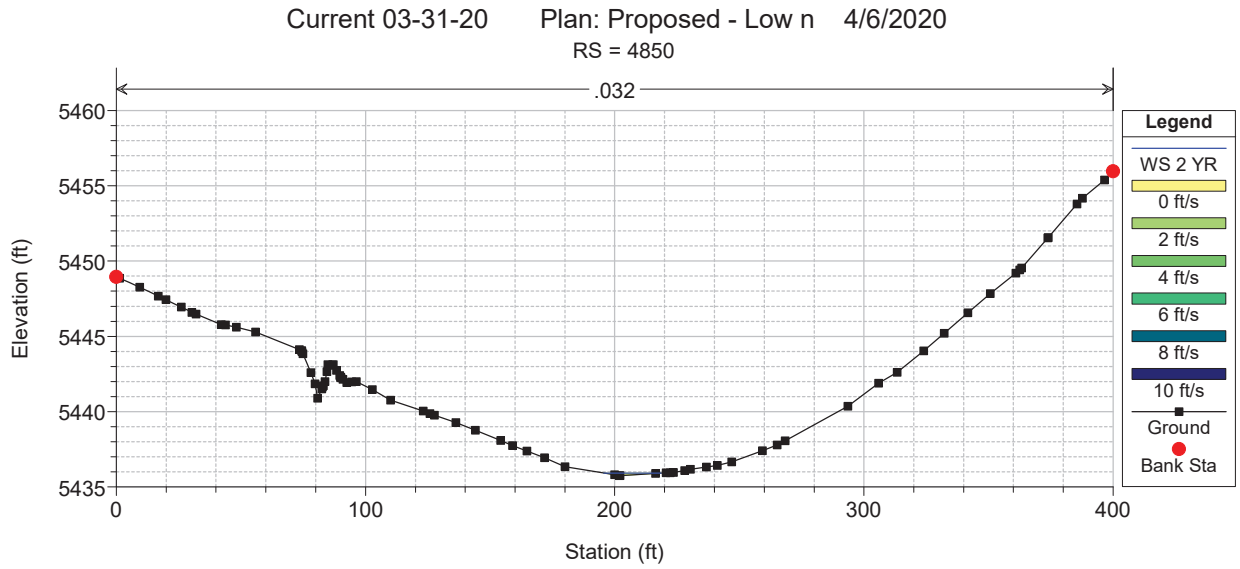

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5200
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

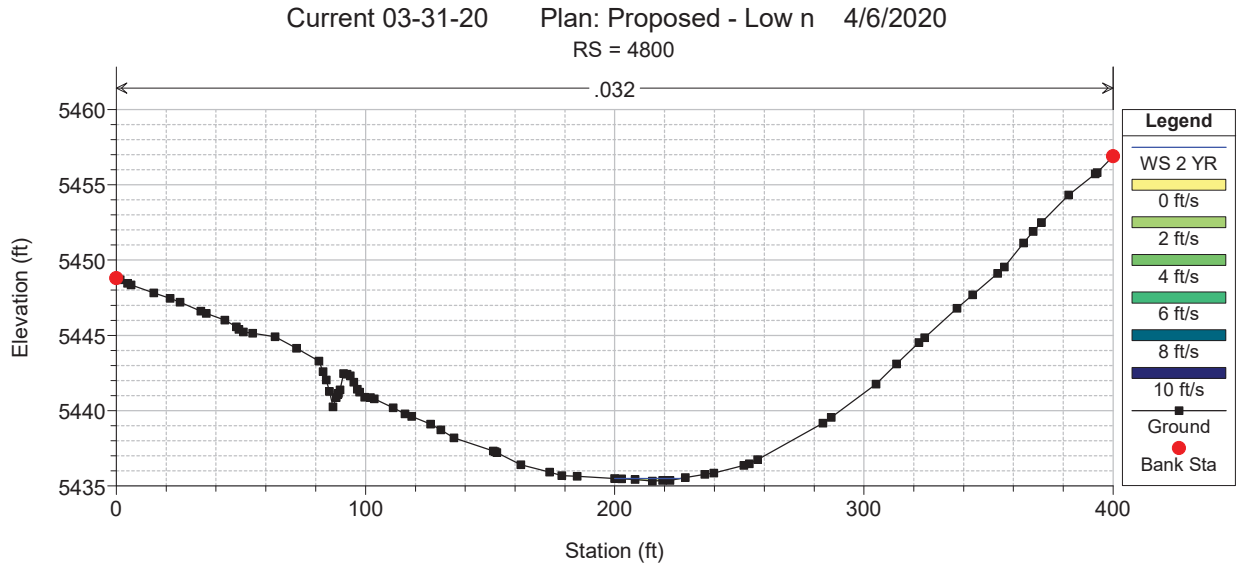

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5150
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

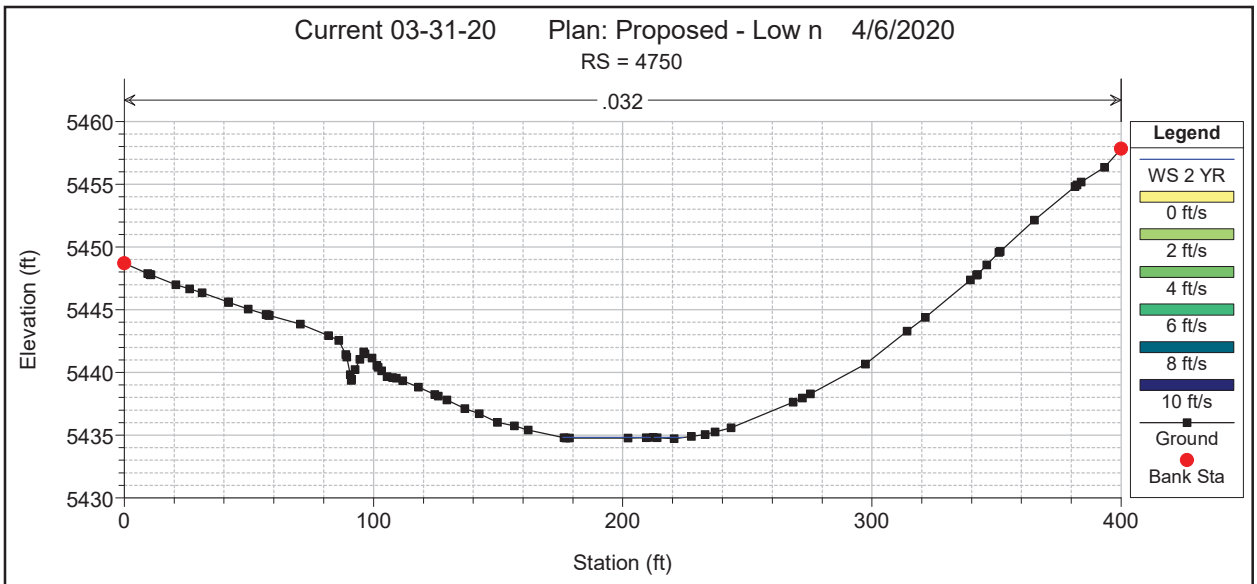

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5100
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

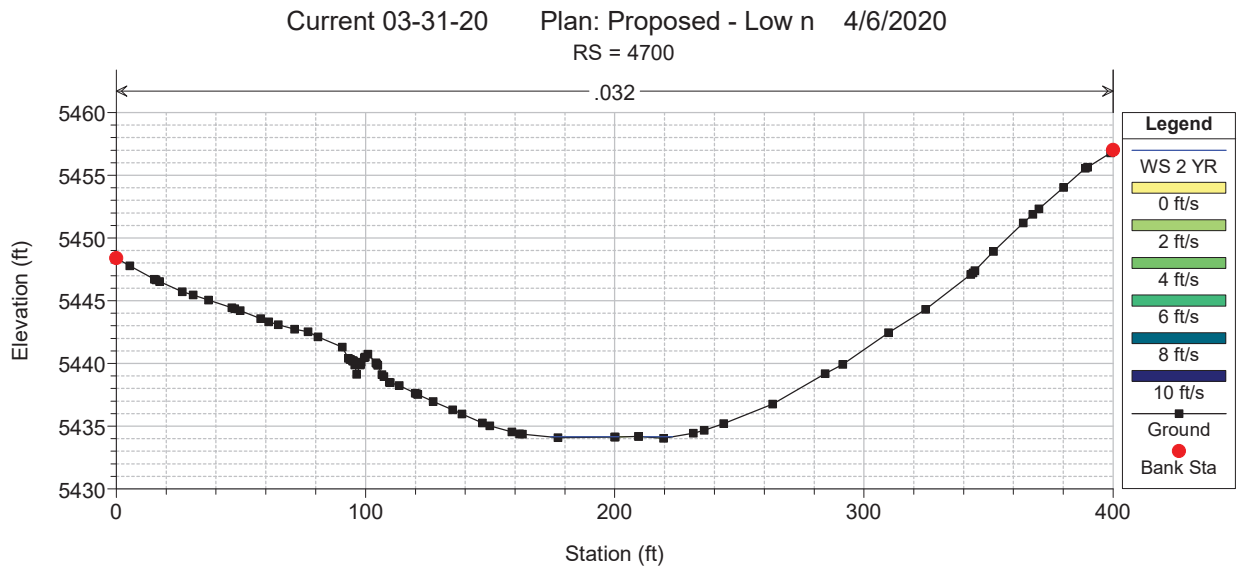

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5050
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5000
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4950
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

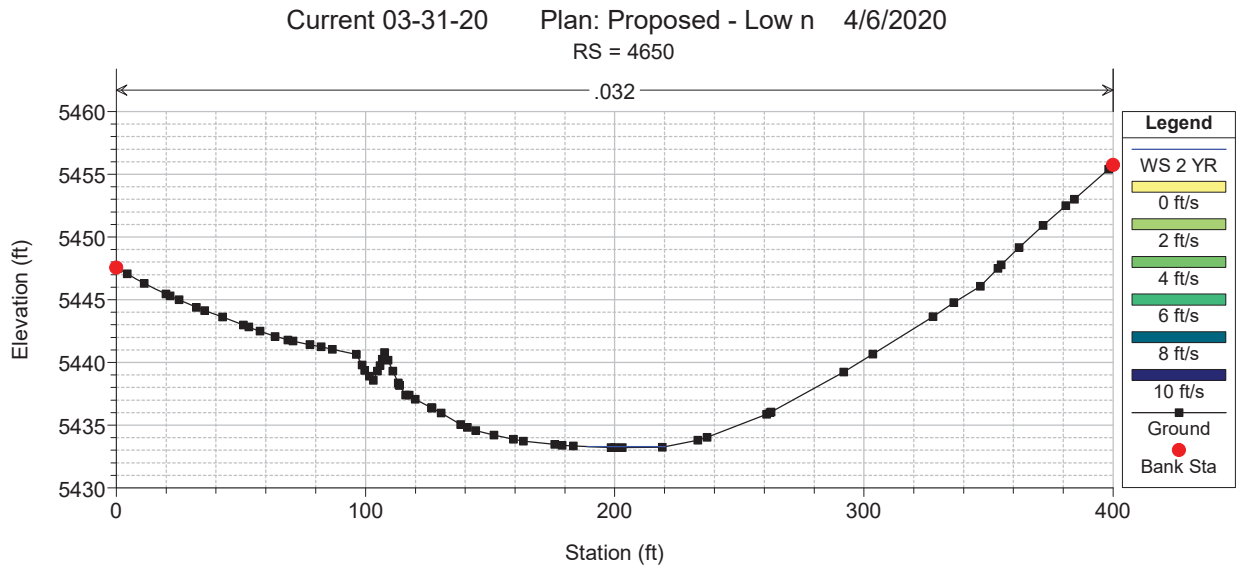

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4900
.032
Elevation (ft)
5460
5455
5450
5445
5440
5435
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

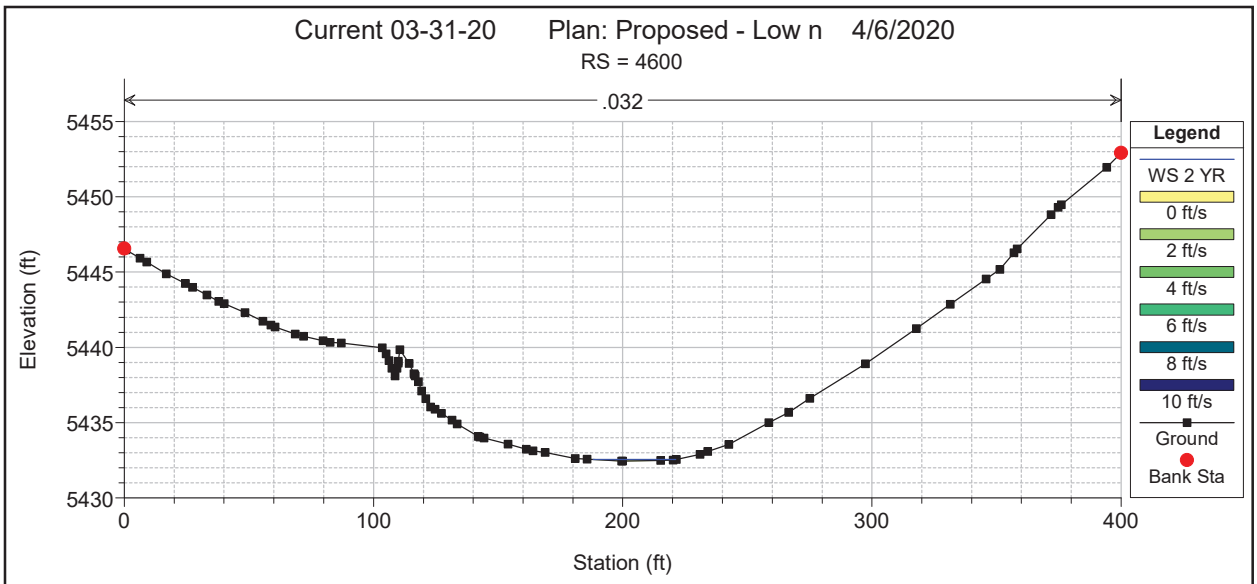

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4850
.032
Elevation (ft)
5460
5455
5450
5445
5440
5435
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

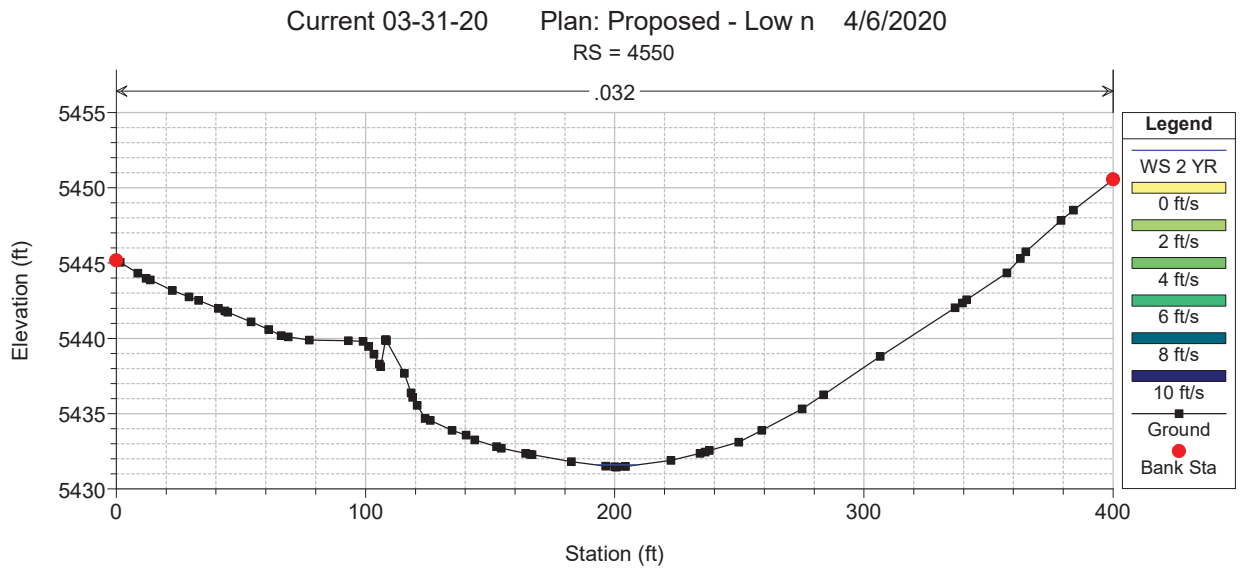

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4800
.032
Elevation (ft)
5460
5455
5450
5445
5440
5435
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

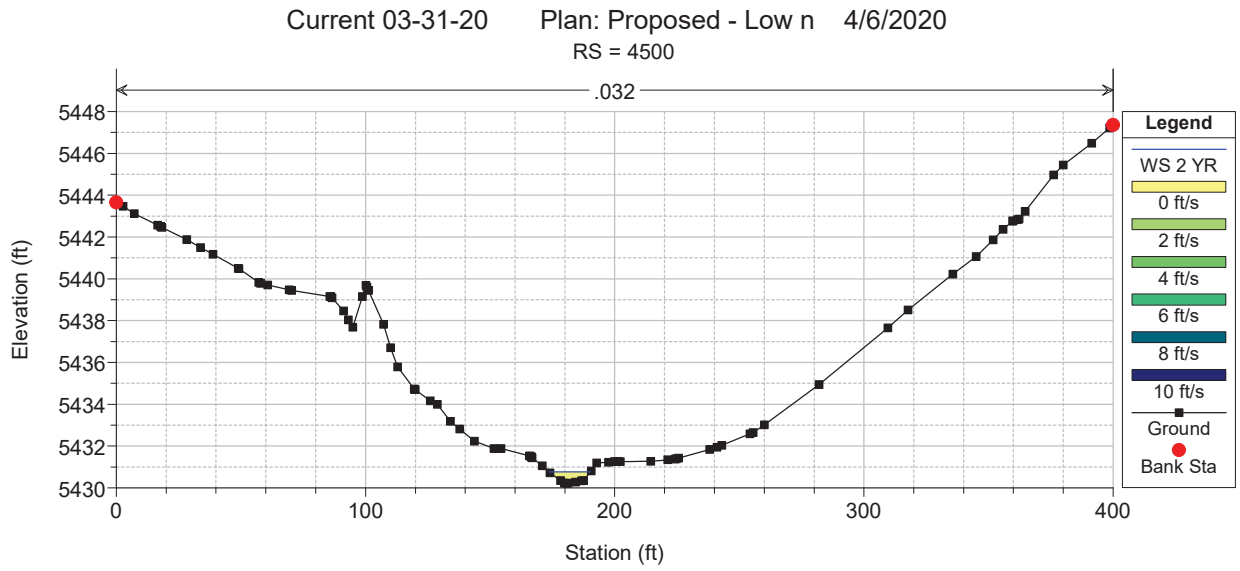

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4750
.032
Elevation (ft)
5460
5455
5450
5445
5440
5435
5430
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4700
.032
Elevation (ft)
5460
5455
5450
5445
5440
5435
5430
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4650
.032
Elevation (ft)
5460
5455
5450
5445
5440
5435
5430
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4600
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4550
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4500
.032
Elevation (ft)
Station (ft)
Legend
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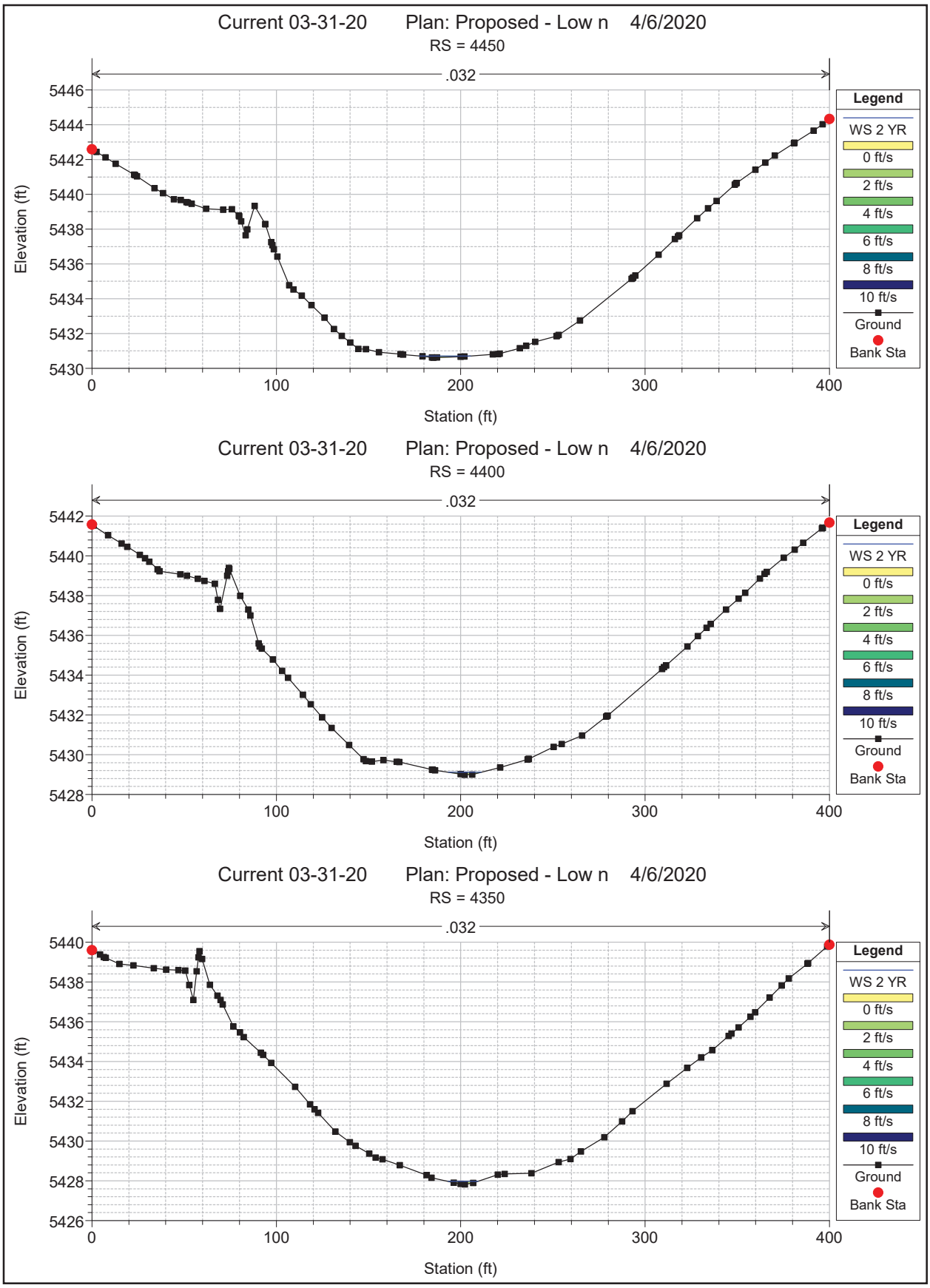
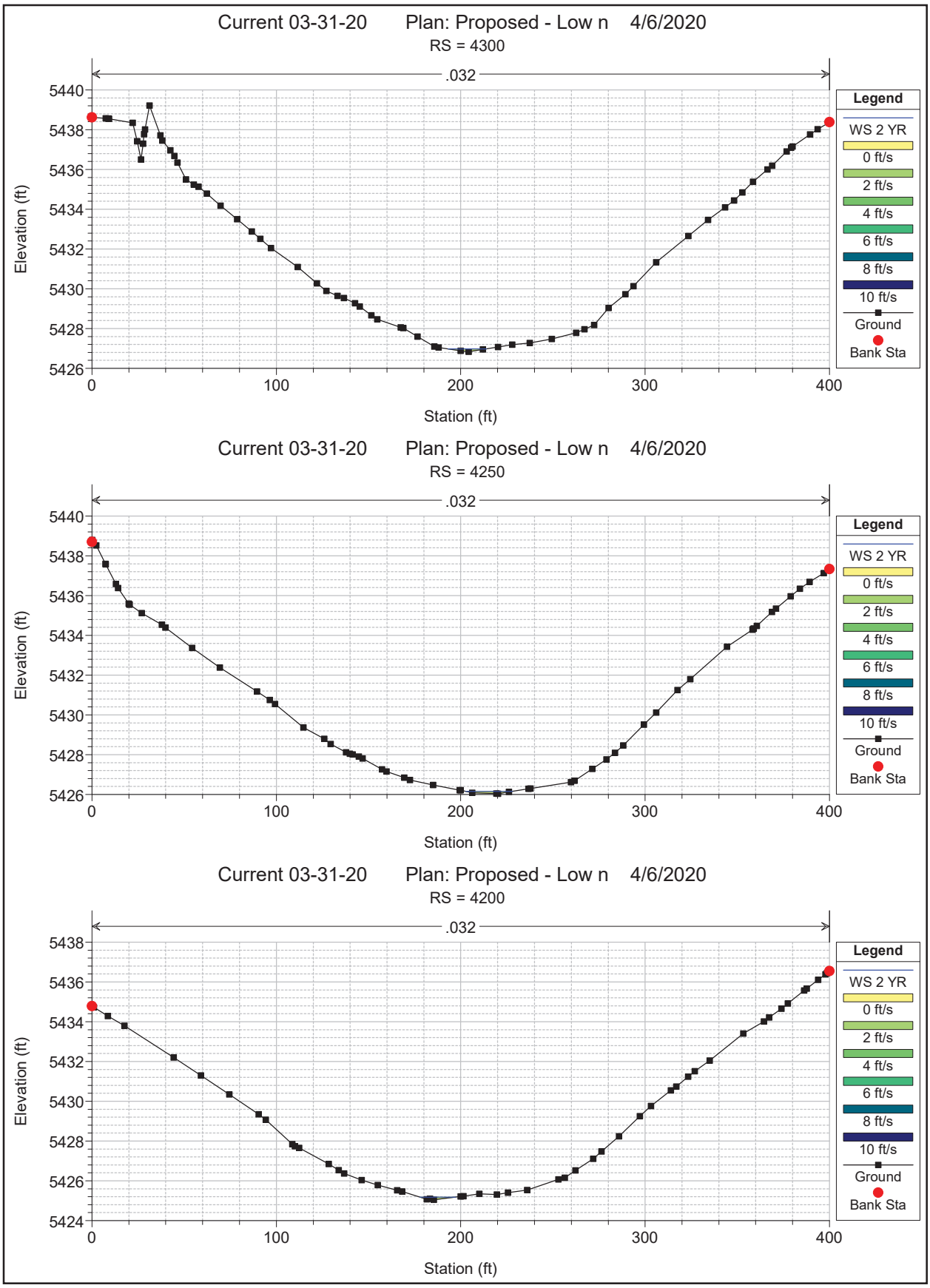
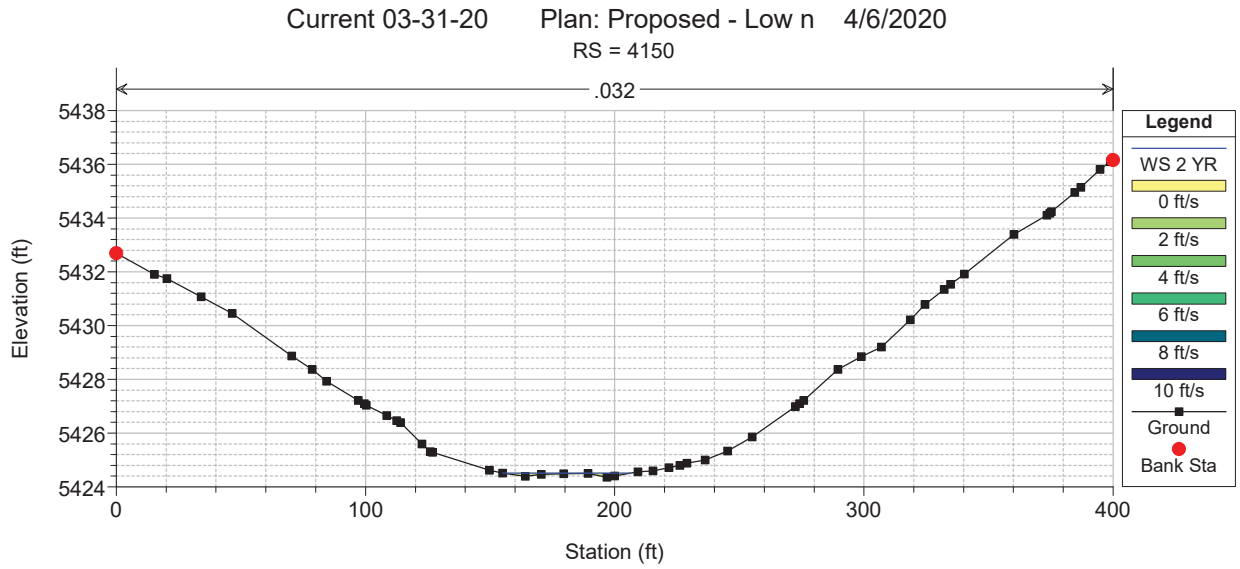
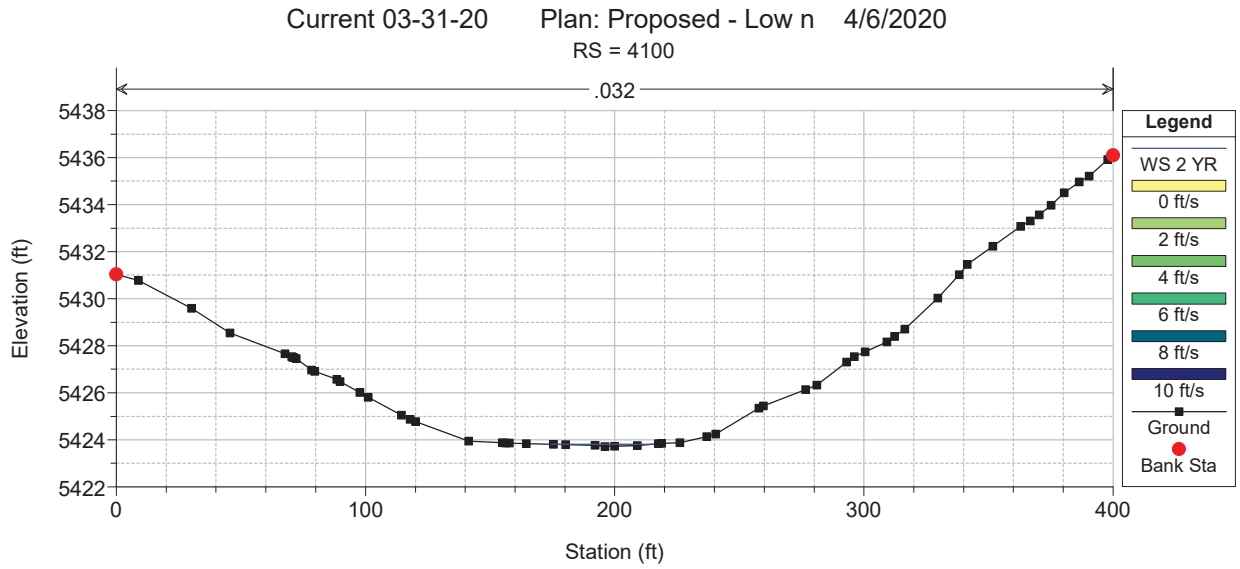
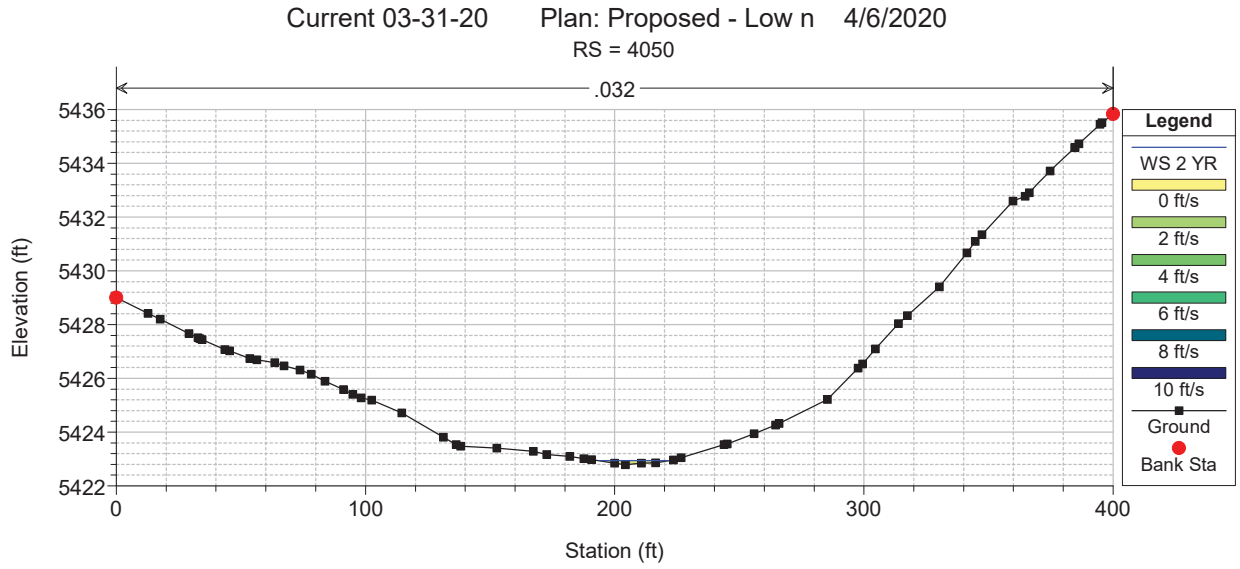
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

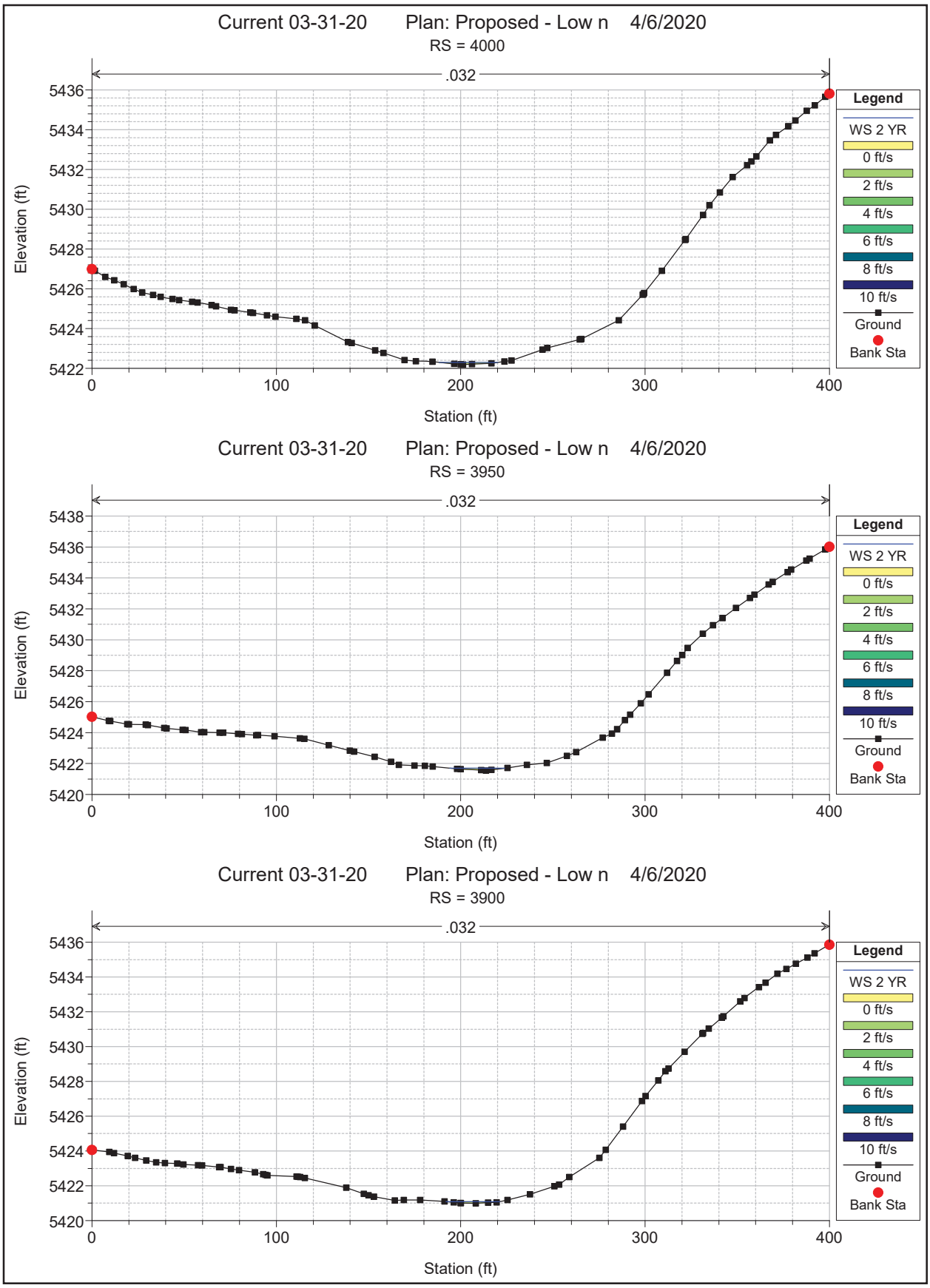

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4450
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4400
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4350
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

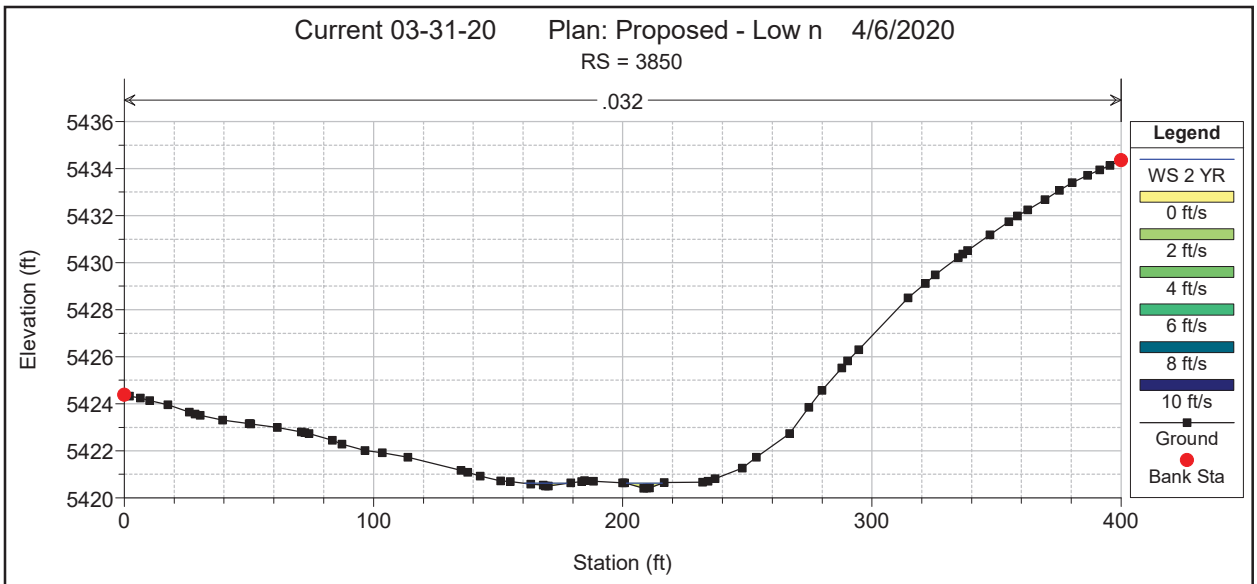

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4300
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4250
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4200
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

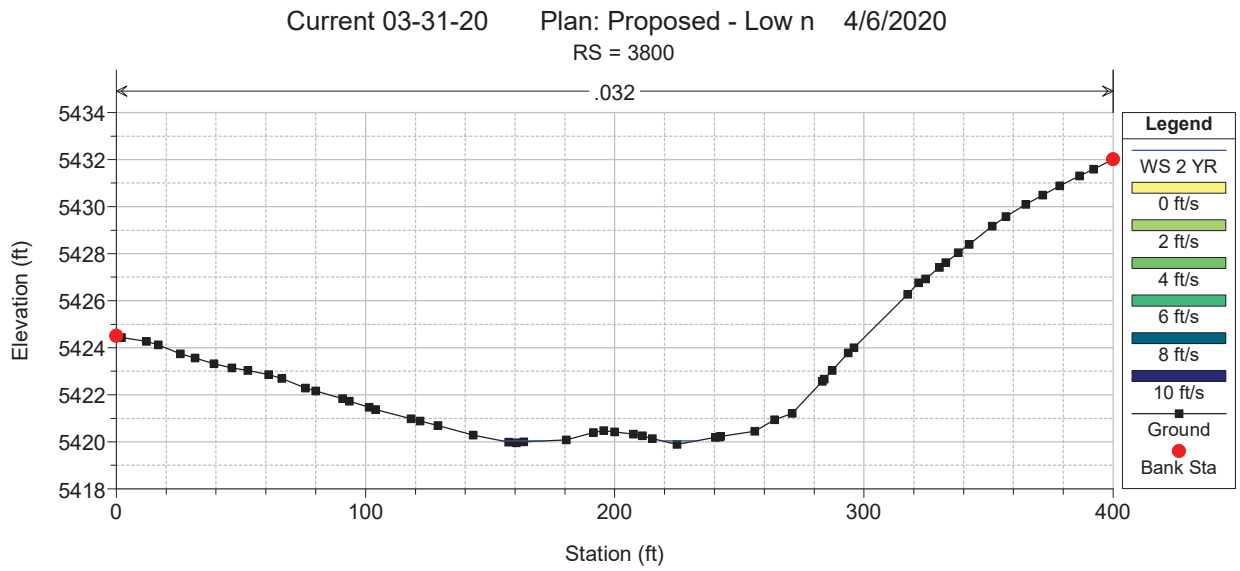

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4150
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

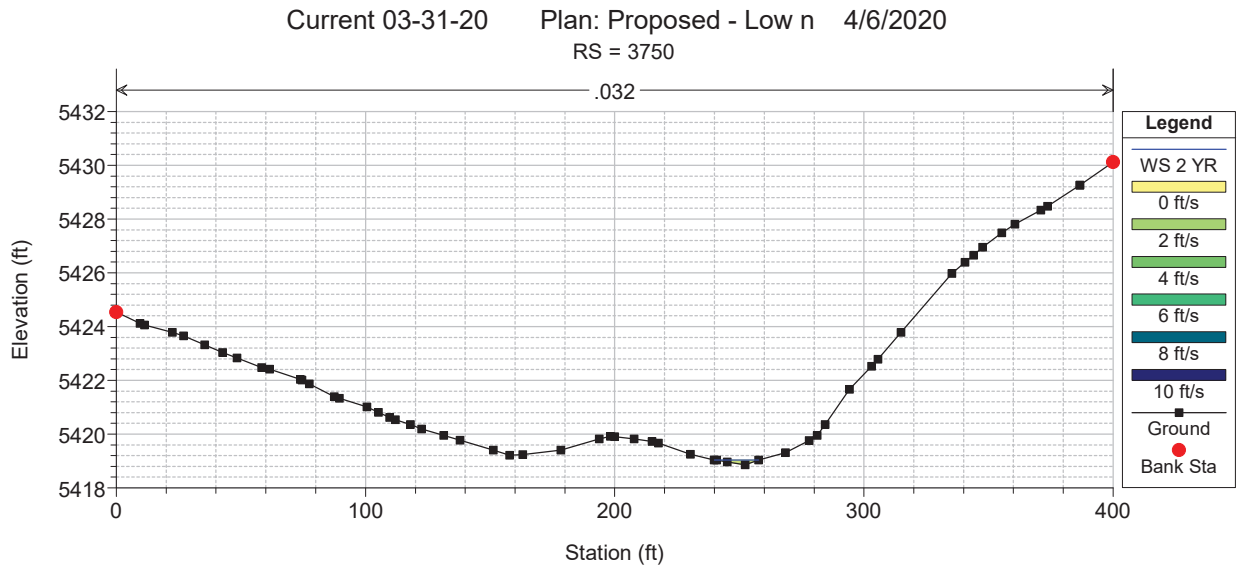

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4100
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

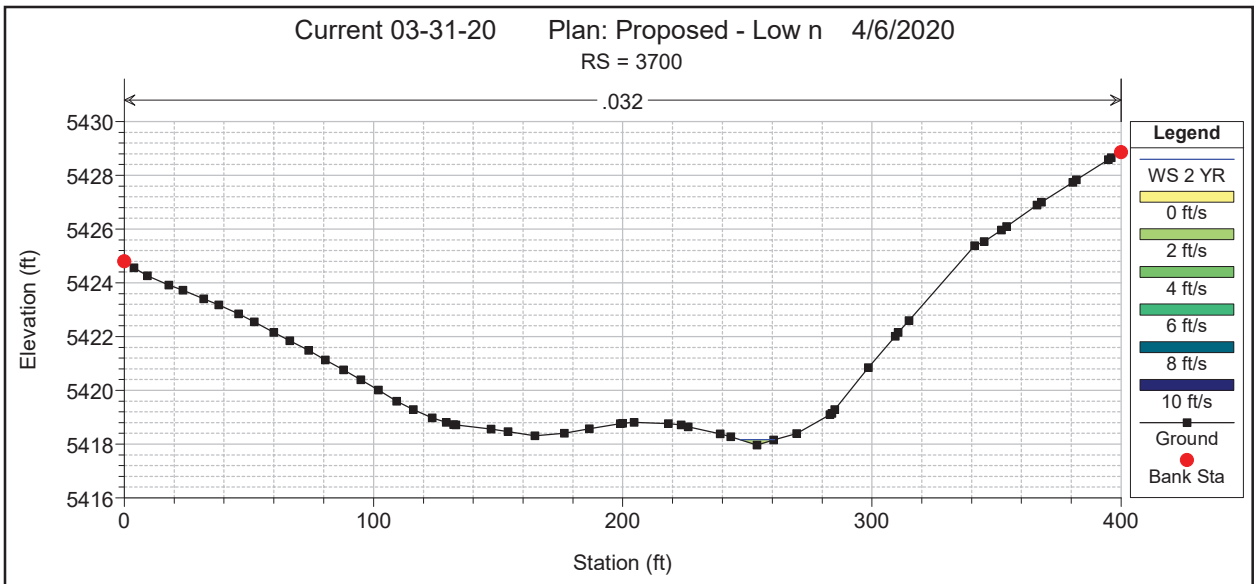

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4050
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

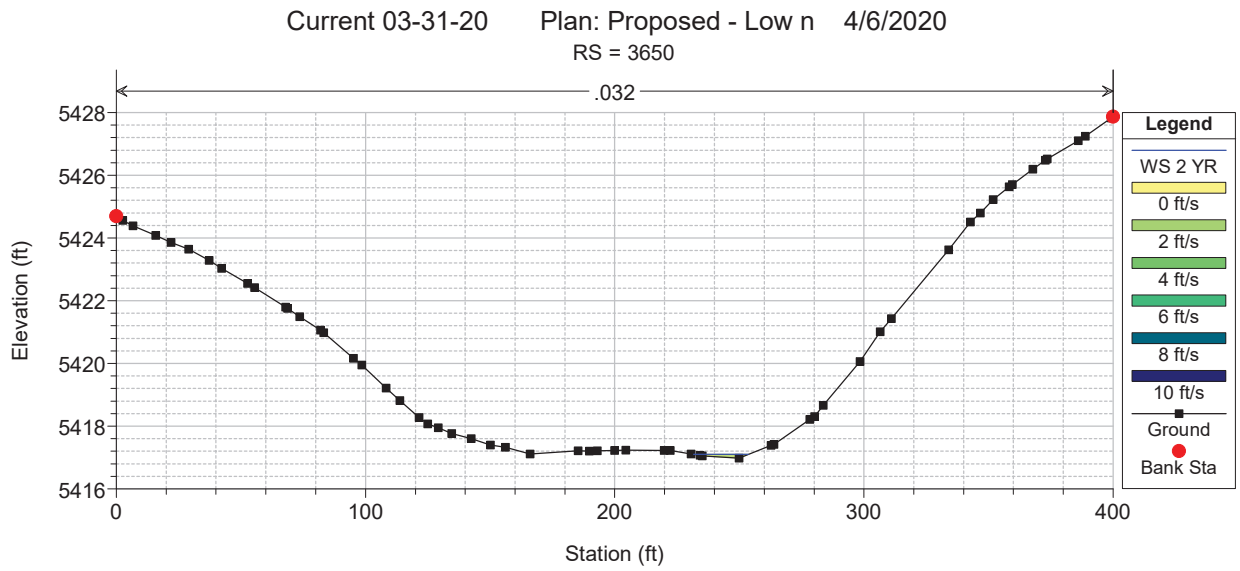

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4000
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3950
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3900
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

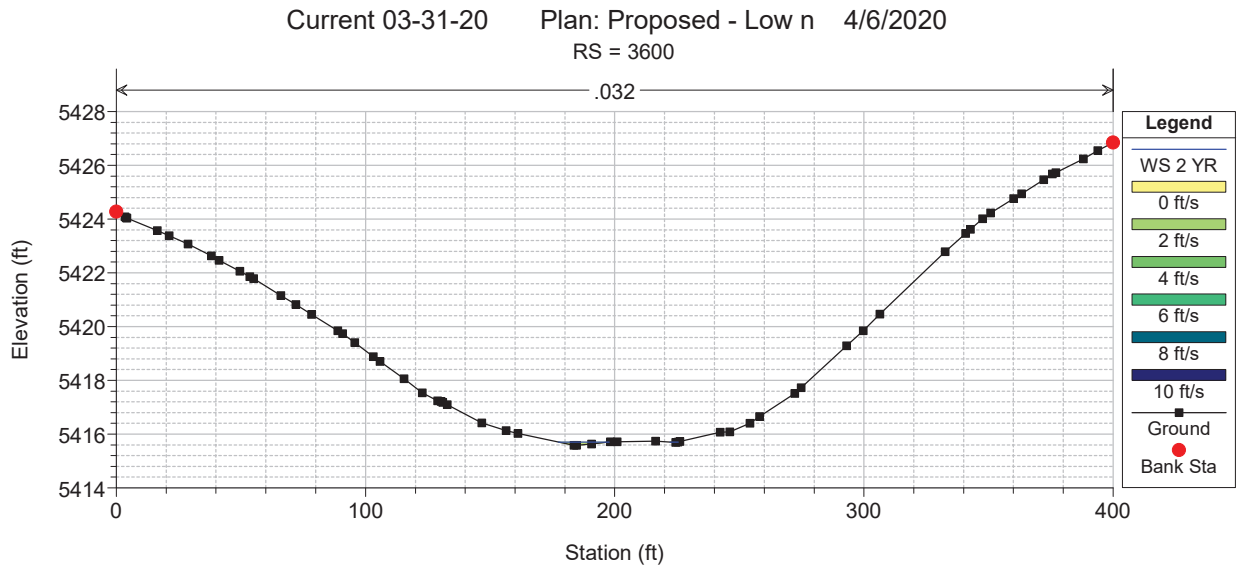

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3850
.032
Elevation (ft)
5436
5434
5432
5430
5428
5426
5424
5422
5420
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

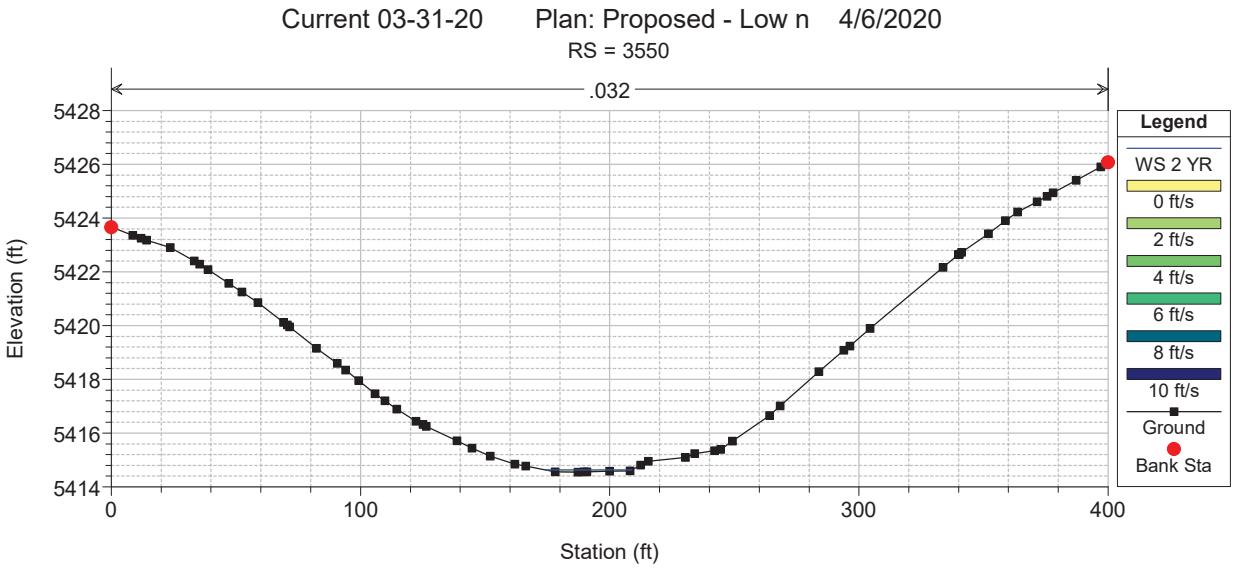

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3800
.032
Elevation (ft)
5434
5432
5430
5428
5426
5424
5422
5420
5418
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

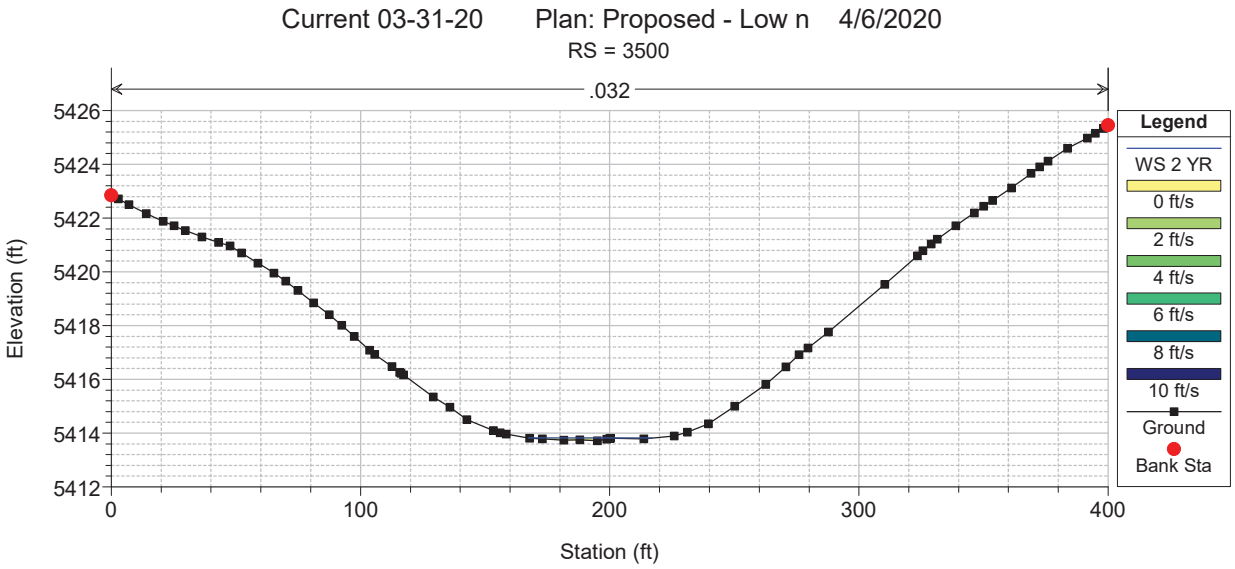

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3750
.032
Elevation (ft)
5432
5430
5428
5426
5424
5422
5420
5418
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

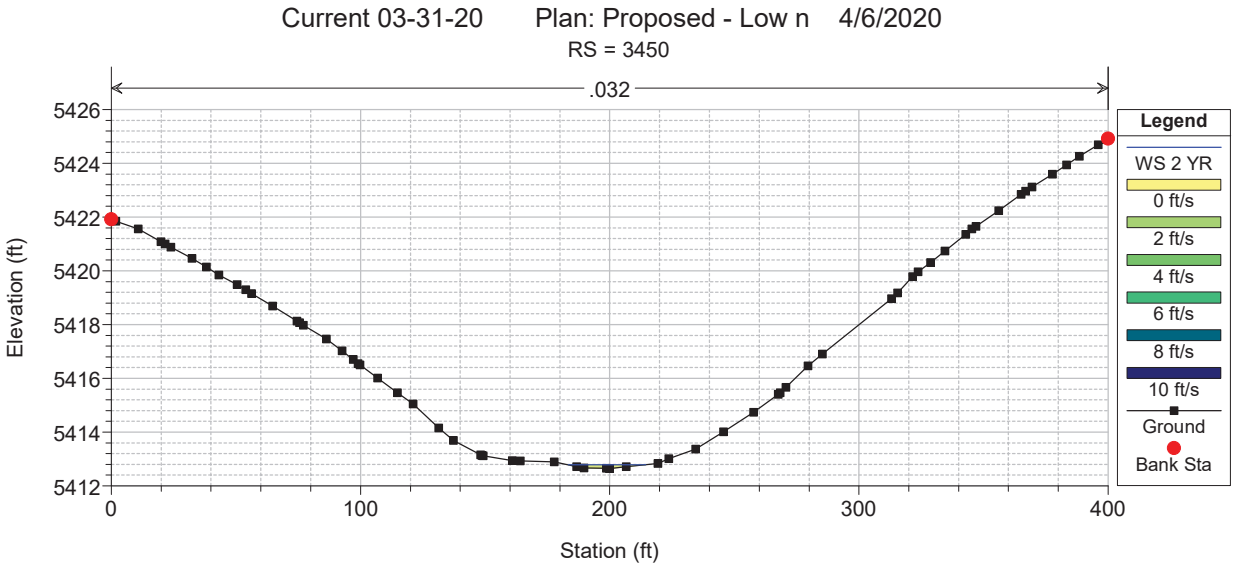

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3700
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

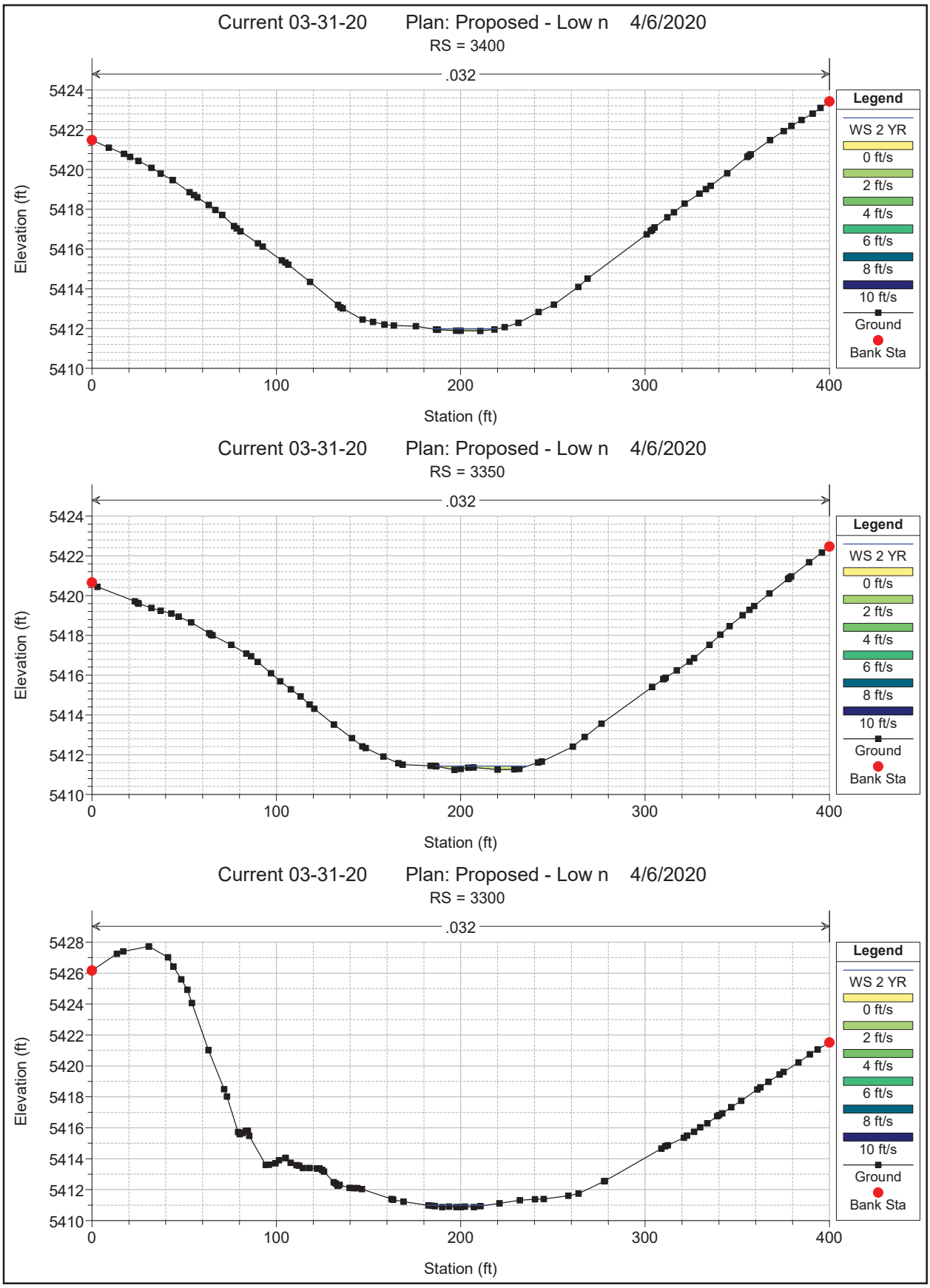

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3650
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

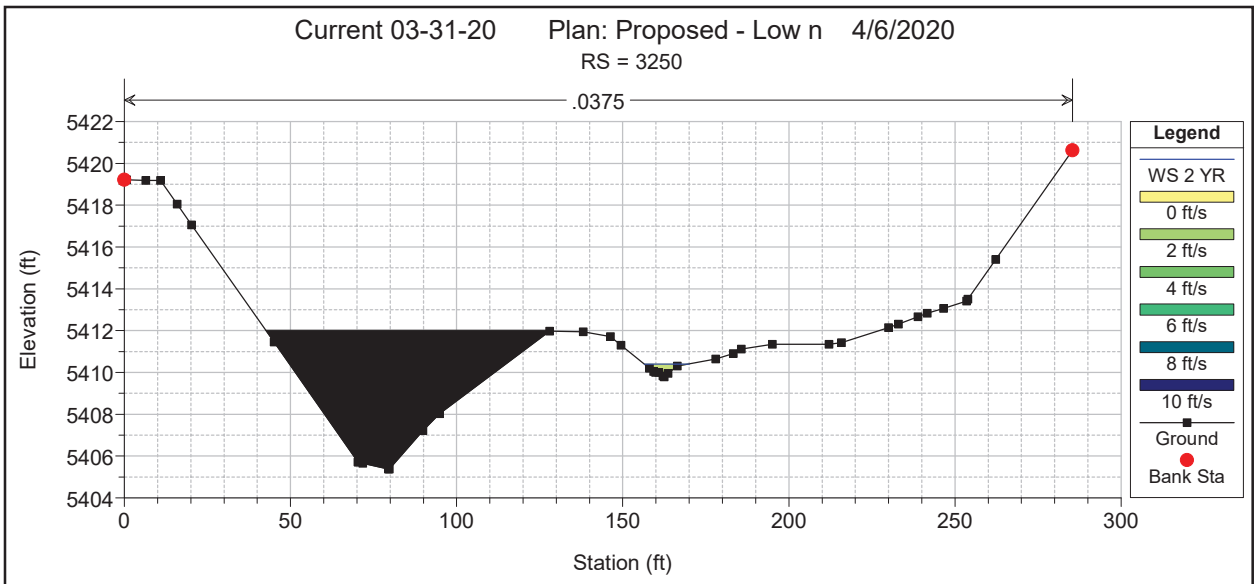

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3600
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

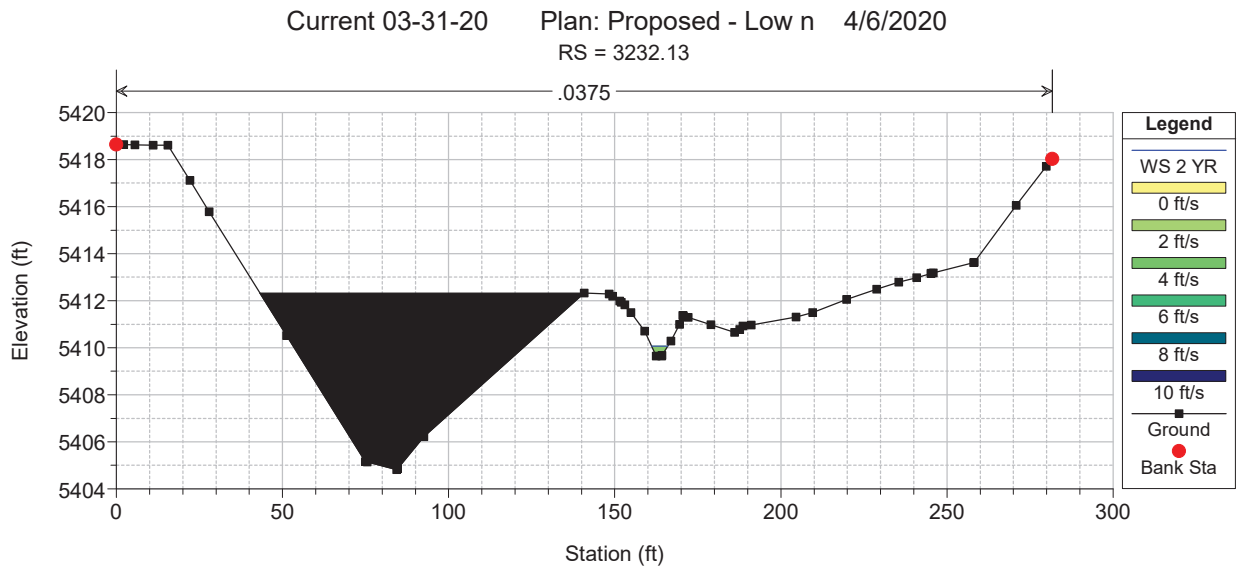

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3550
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

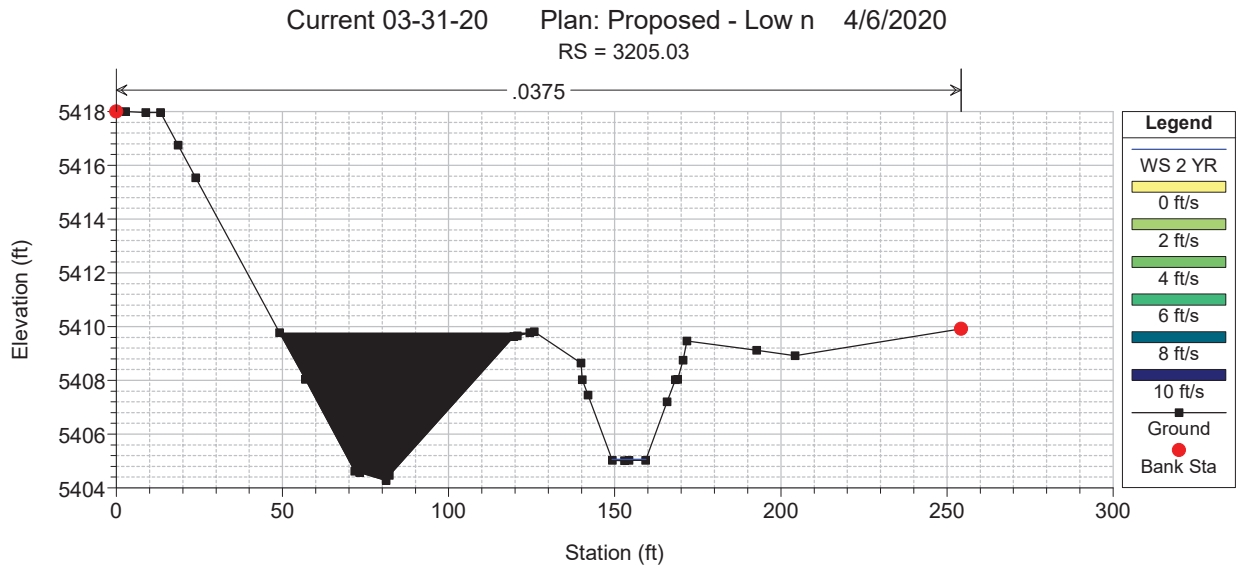

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3500
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3450
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3400
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3350
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3300
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

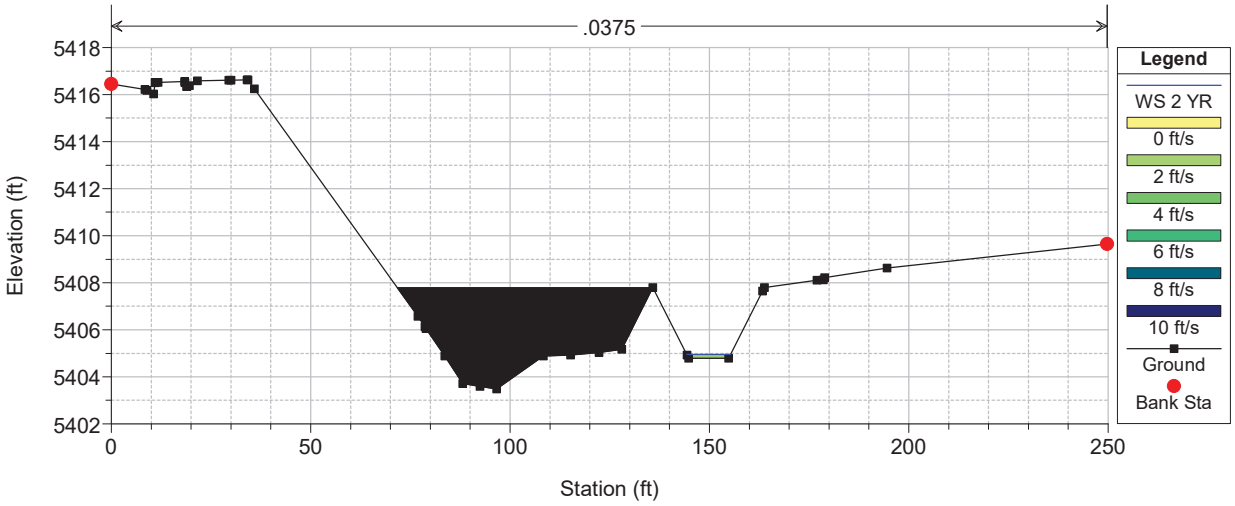

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3250
.0375
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3232.13
.0375
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3205.03
.0375
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

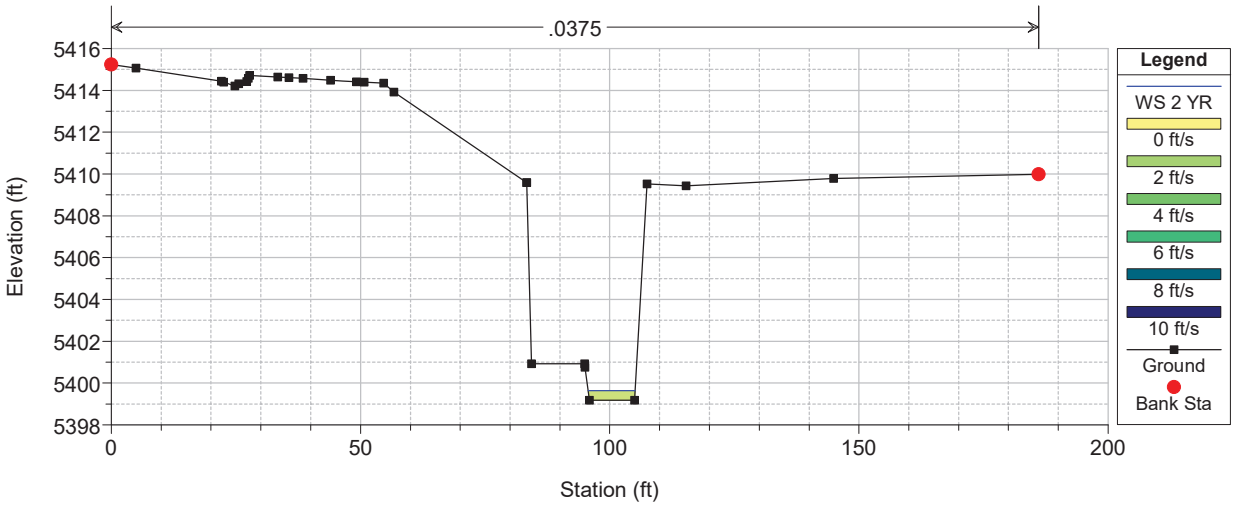
Current 03-31-20 Plan: Proposed - Low n 4/6/2020

RS = 3181.99



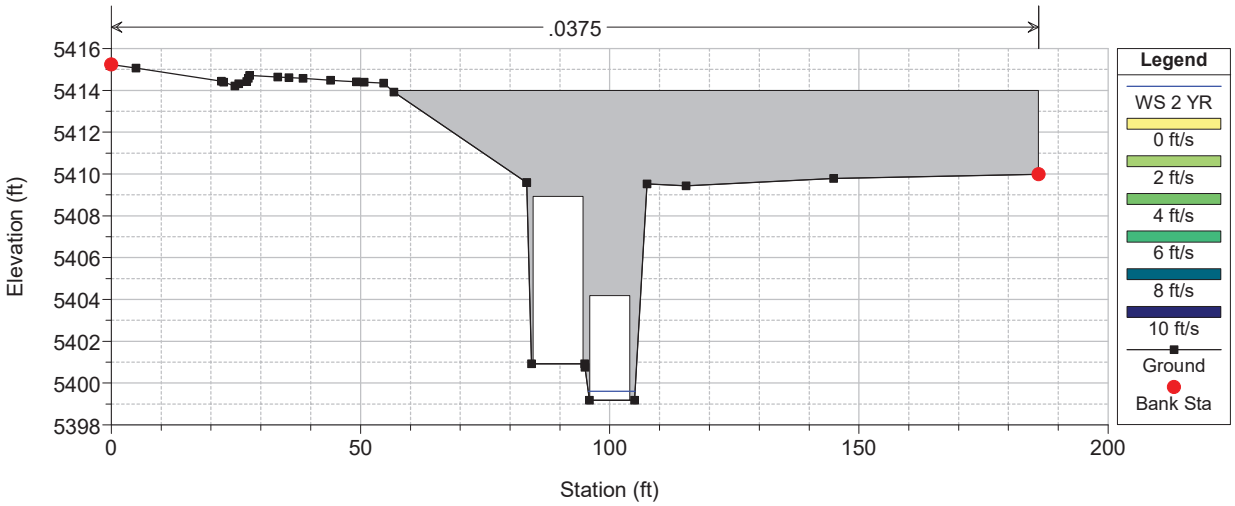
Current 03-31-20 Plan: Proposed - Low n 4/6/2020

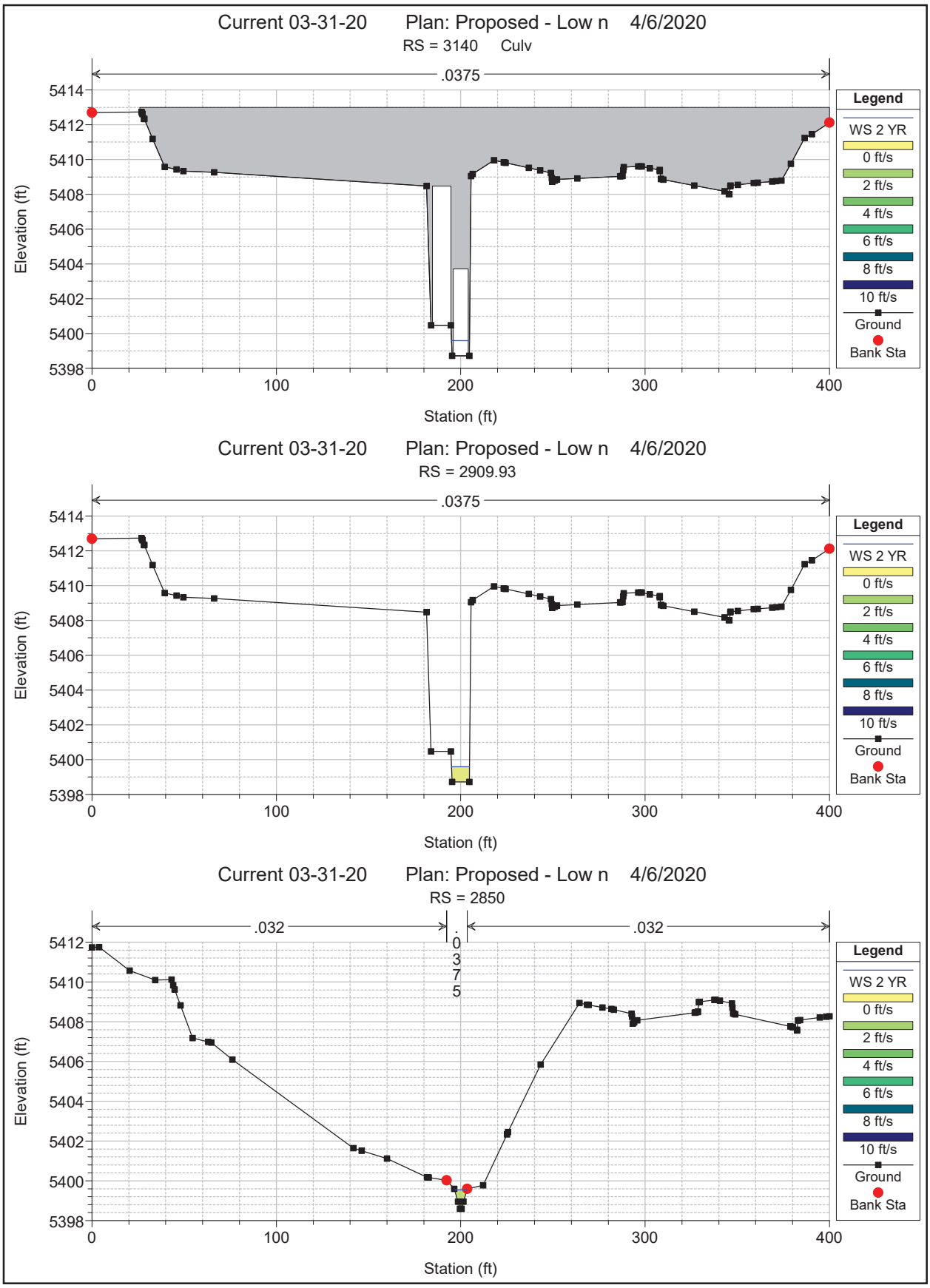
RS = 3140.22

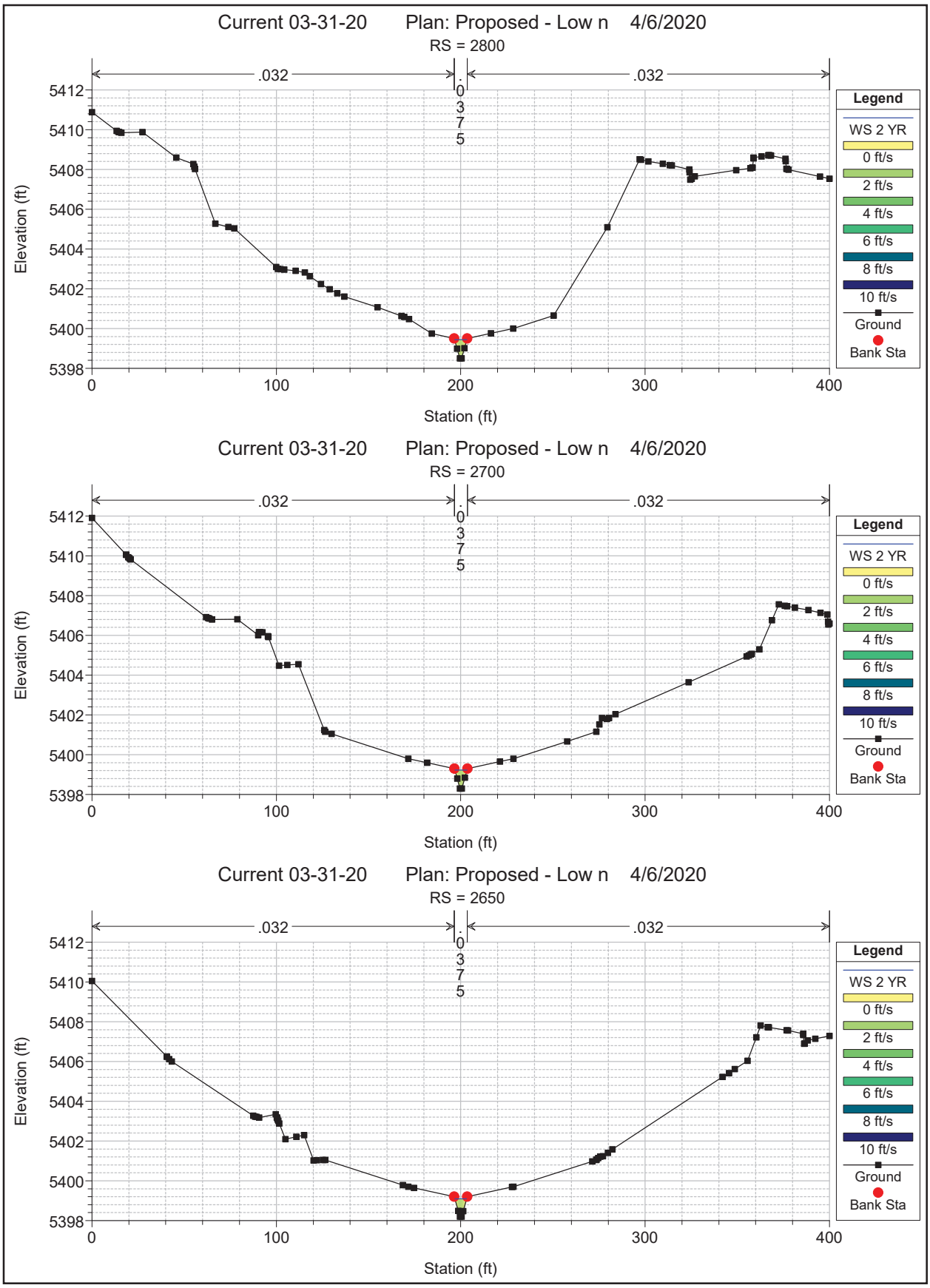


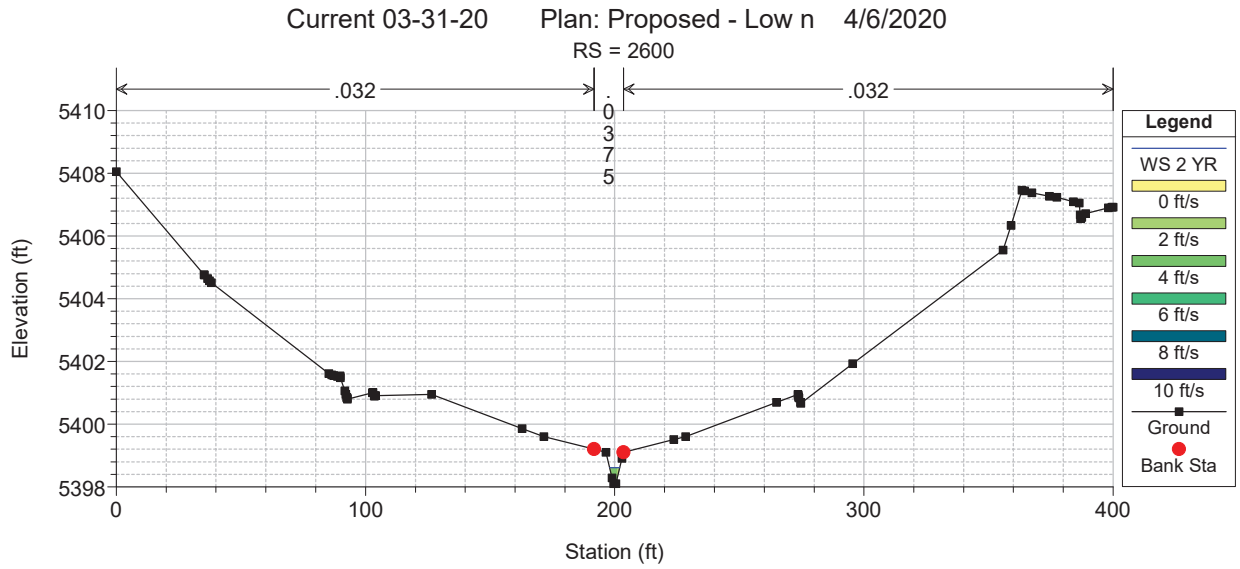
Current 03-31-20 Plan: Proposed - Low n 4/6/2020

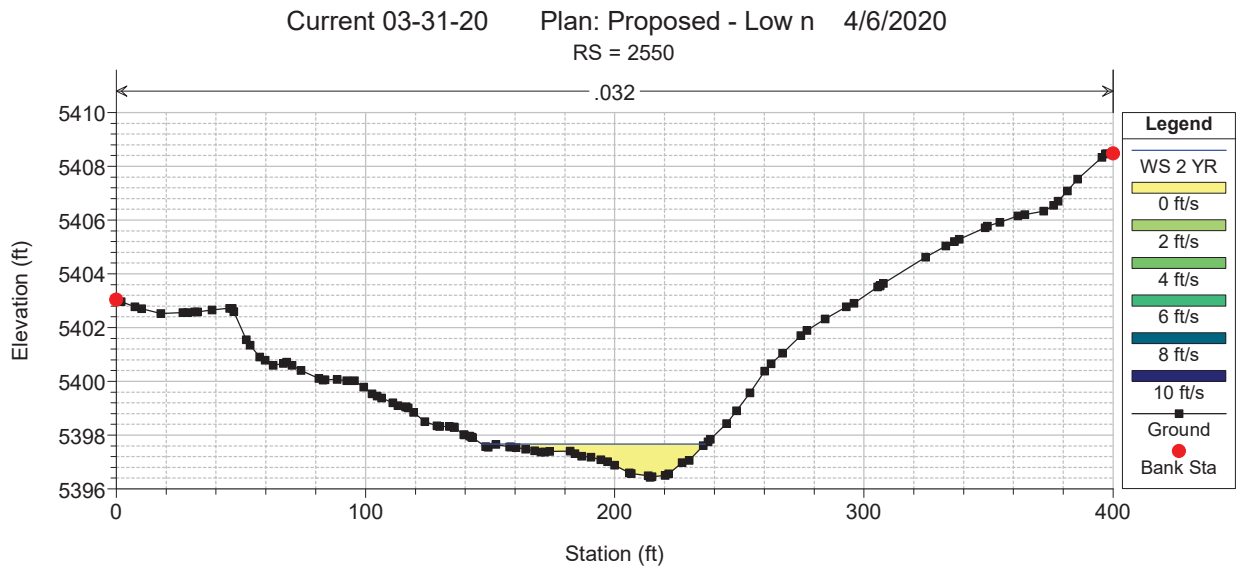
RS = 3140 Culv

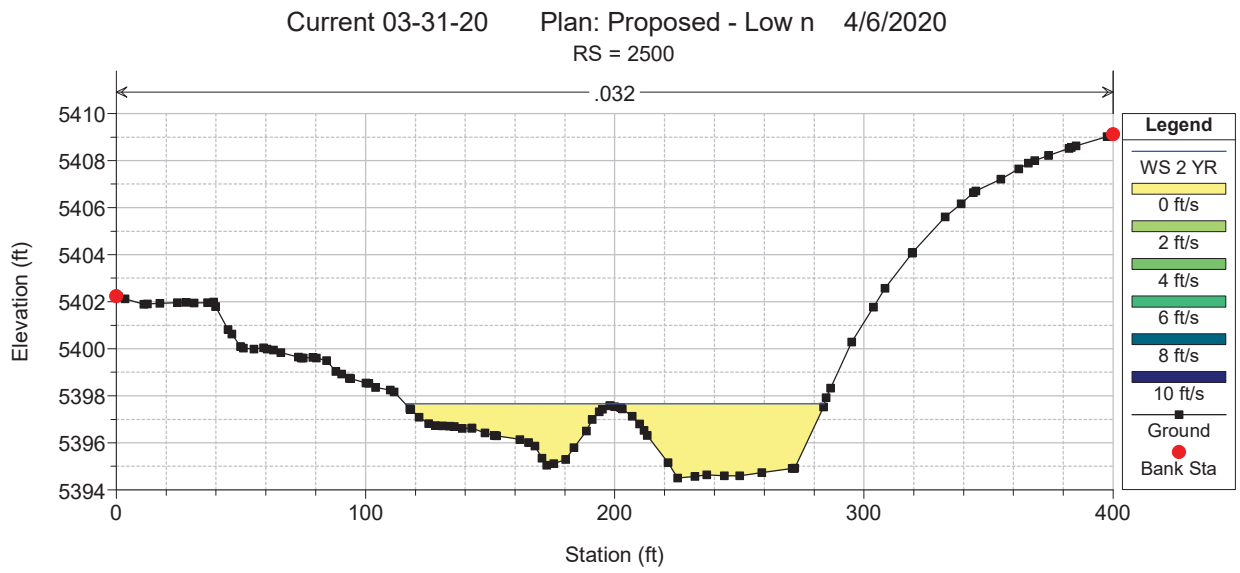


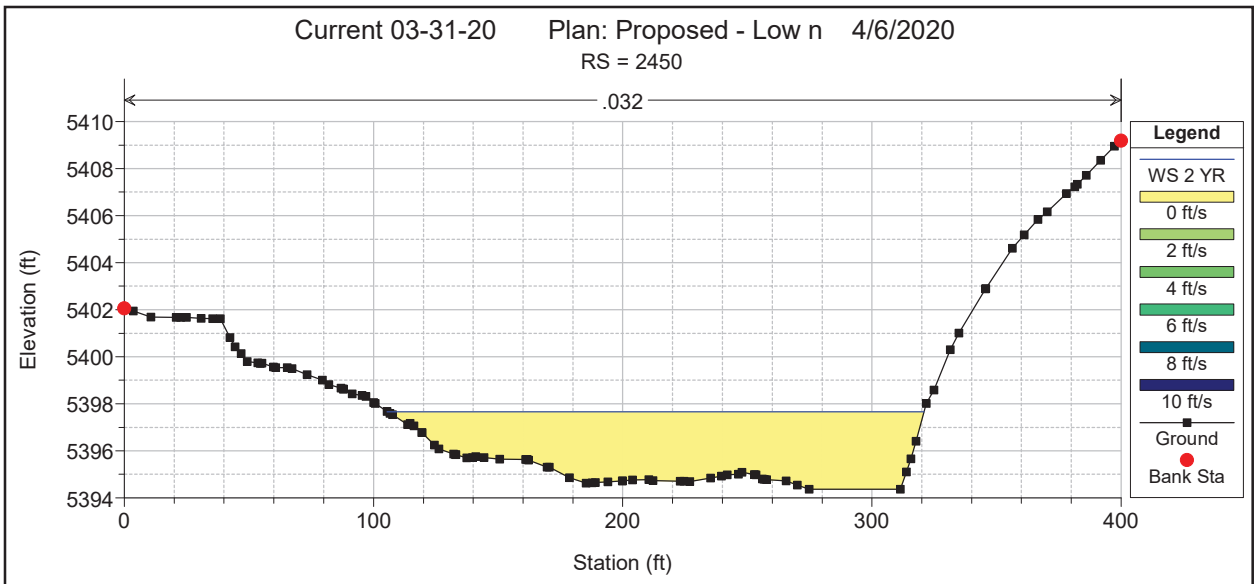

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3140 Culv
.0375
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2909.93
.0375
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2850
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

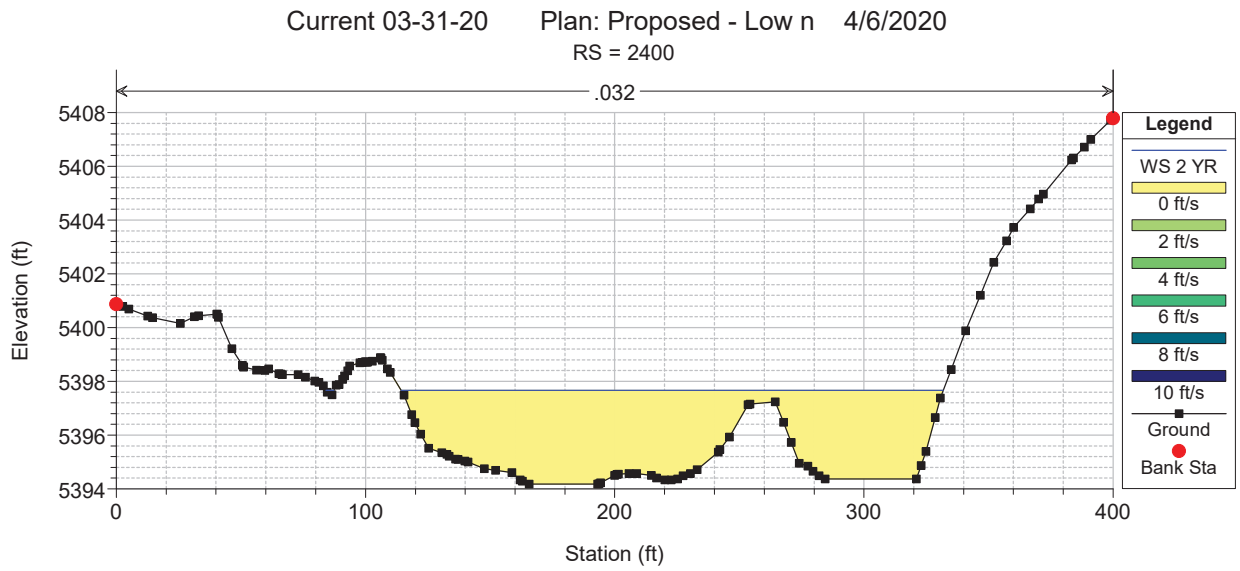

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2800
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2700
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2650
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

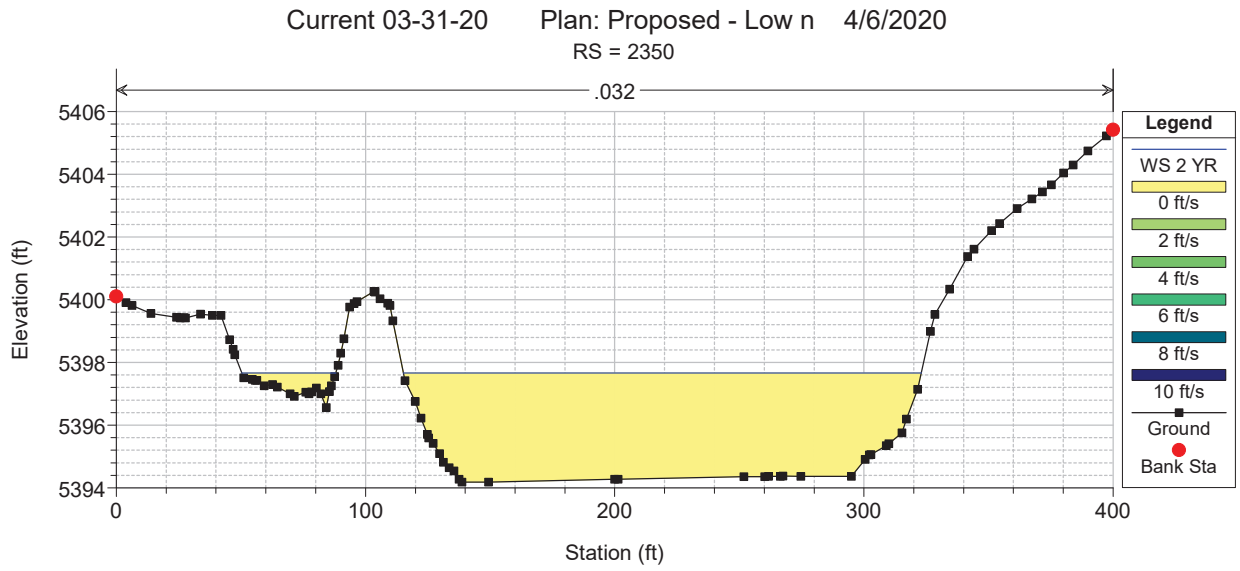

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2600
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

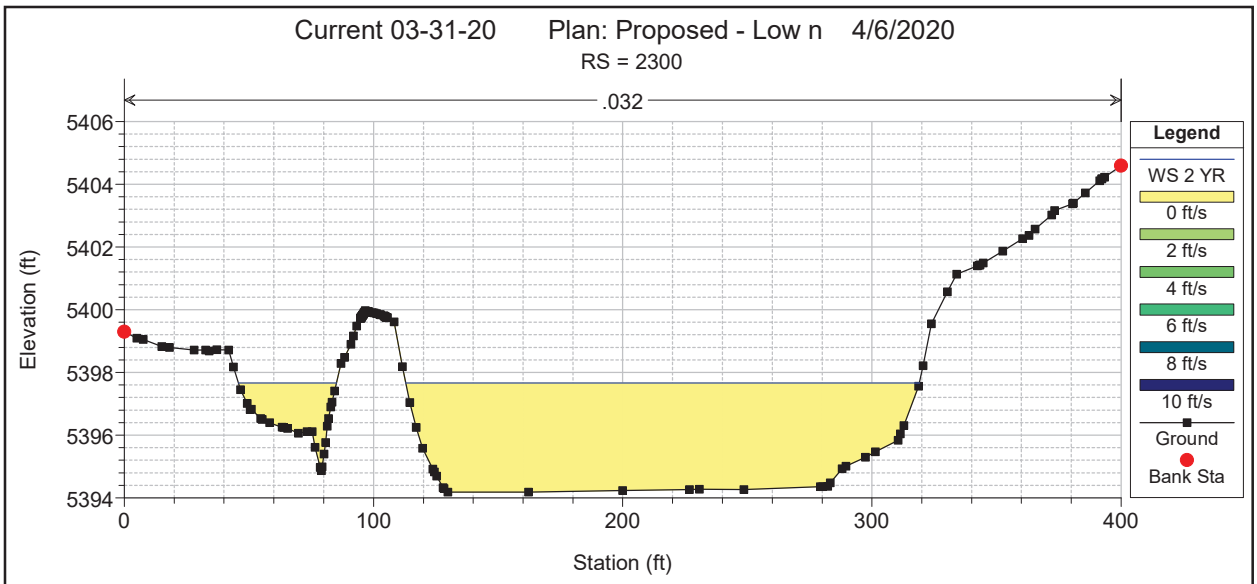

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2550
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

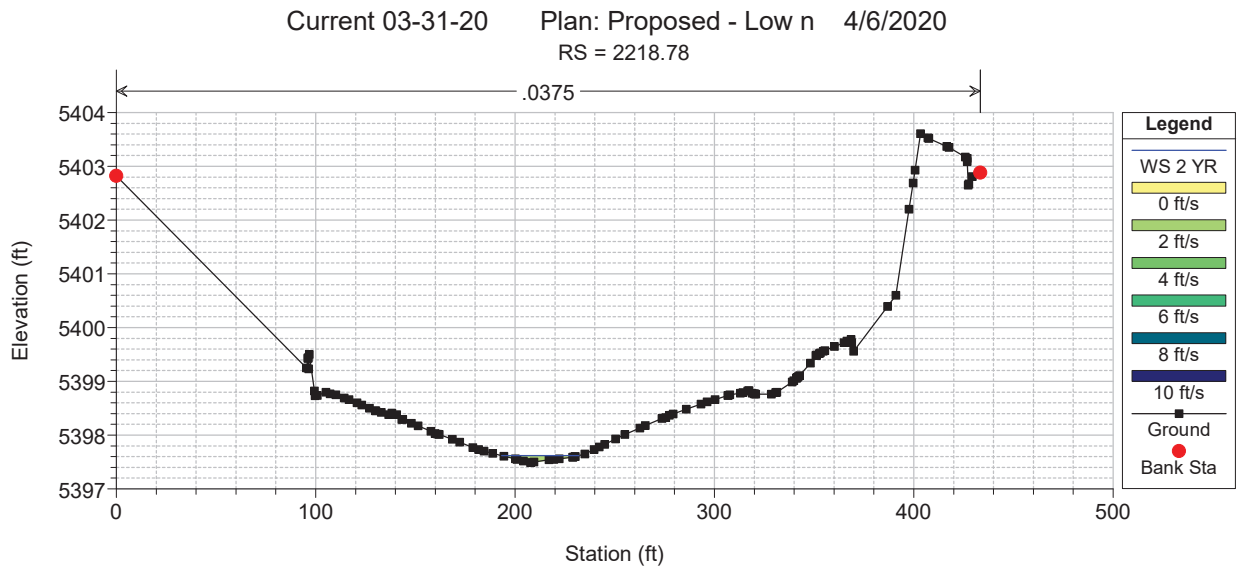

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2500
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

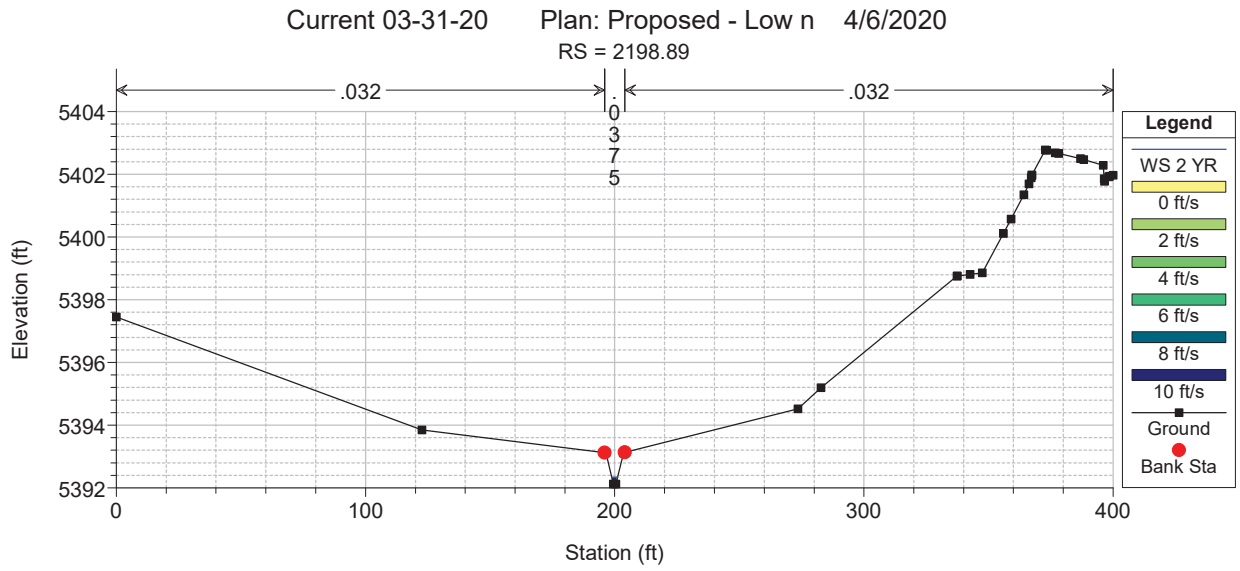

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2450
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

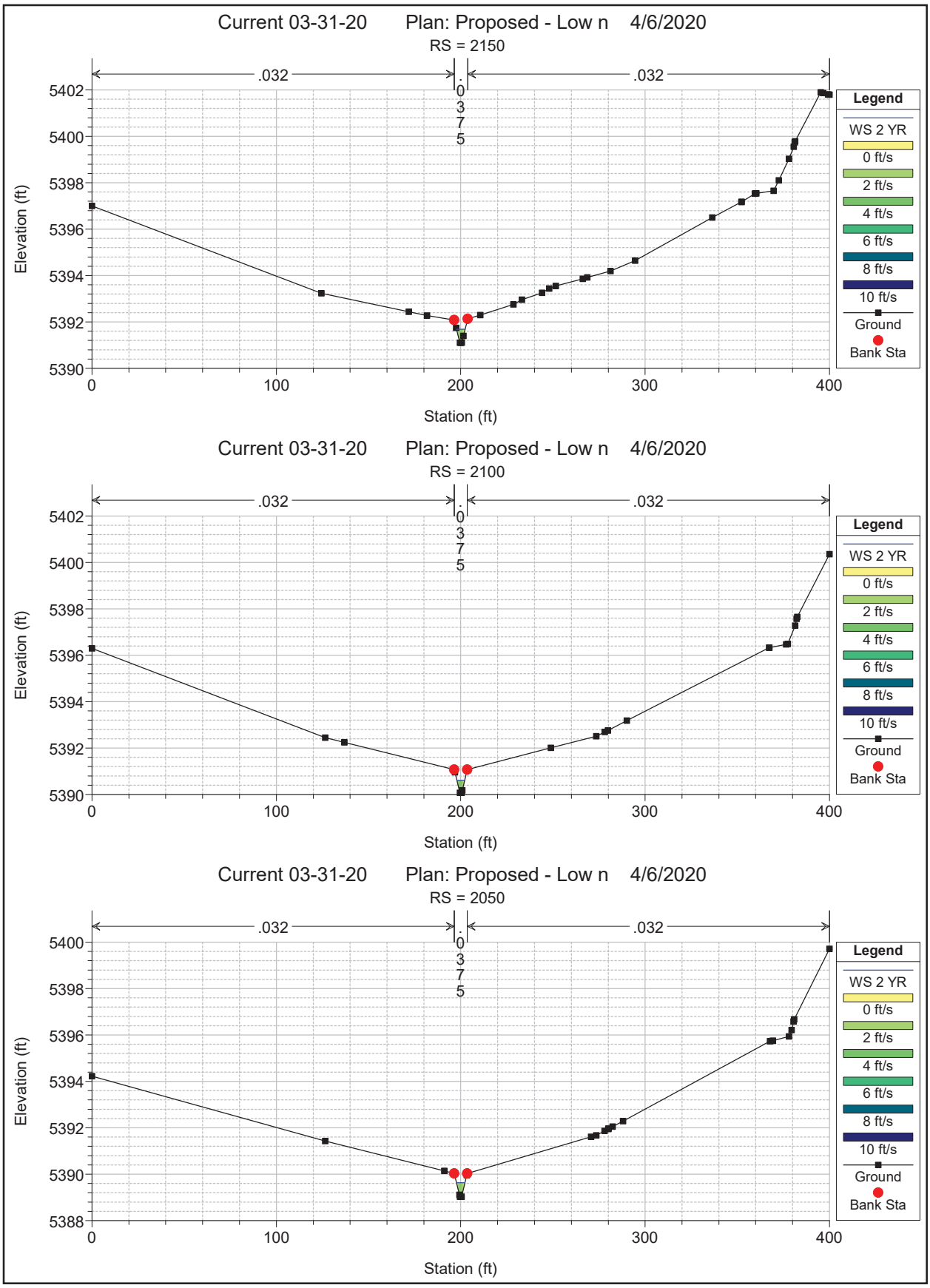

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2400
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

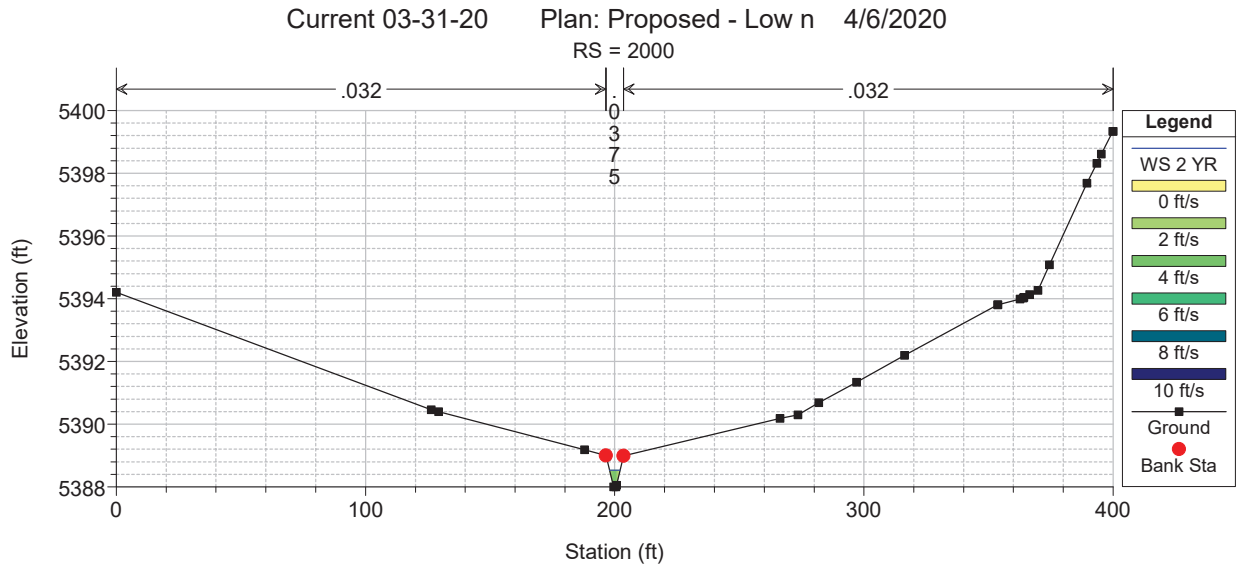

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2350
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

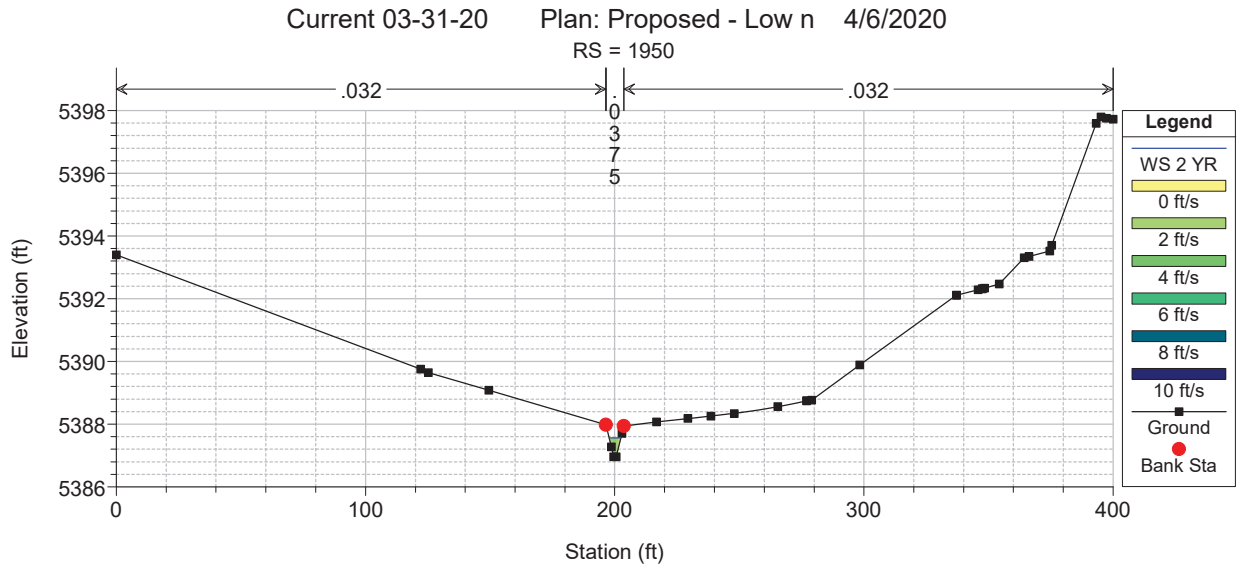

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2300
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

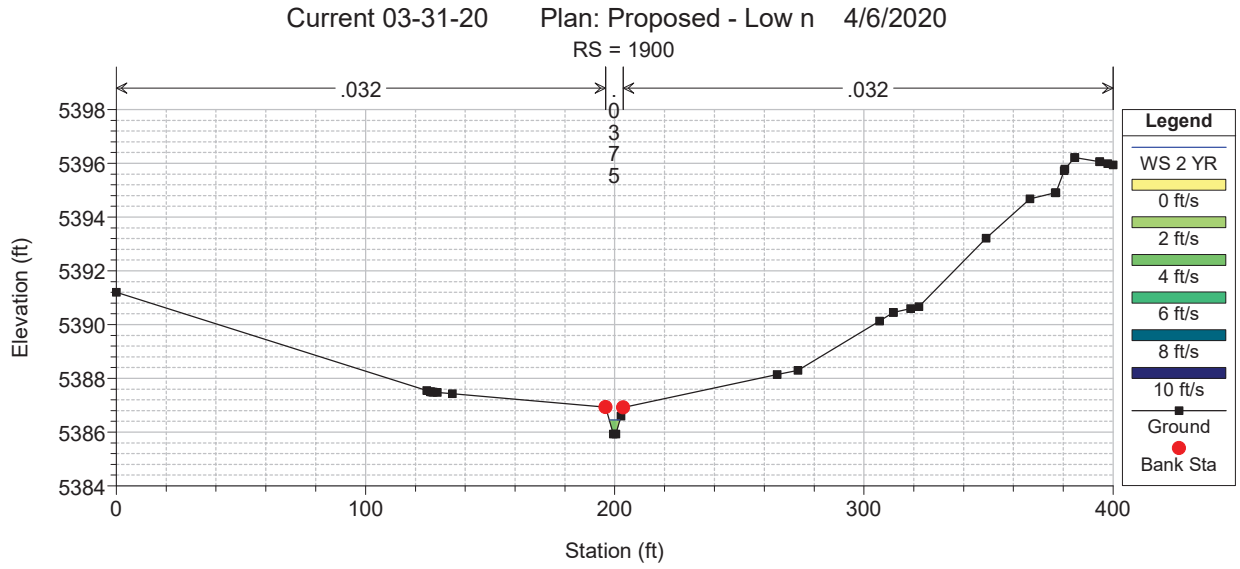

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2218.78
.0375
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

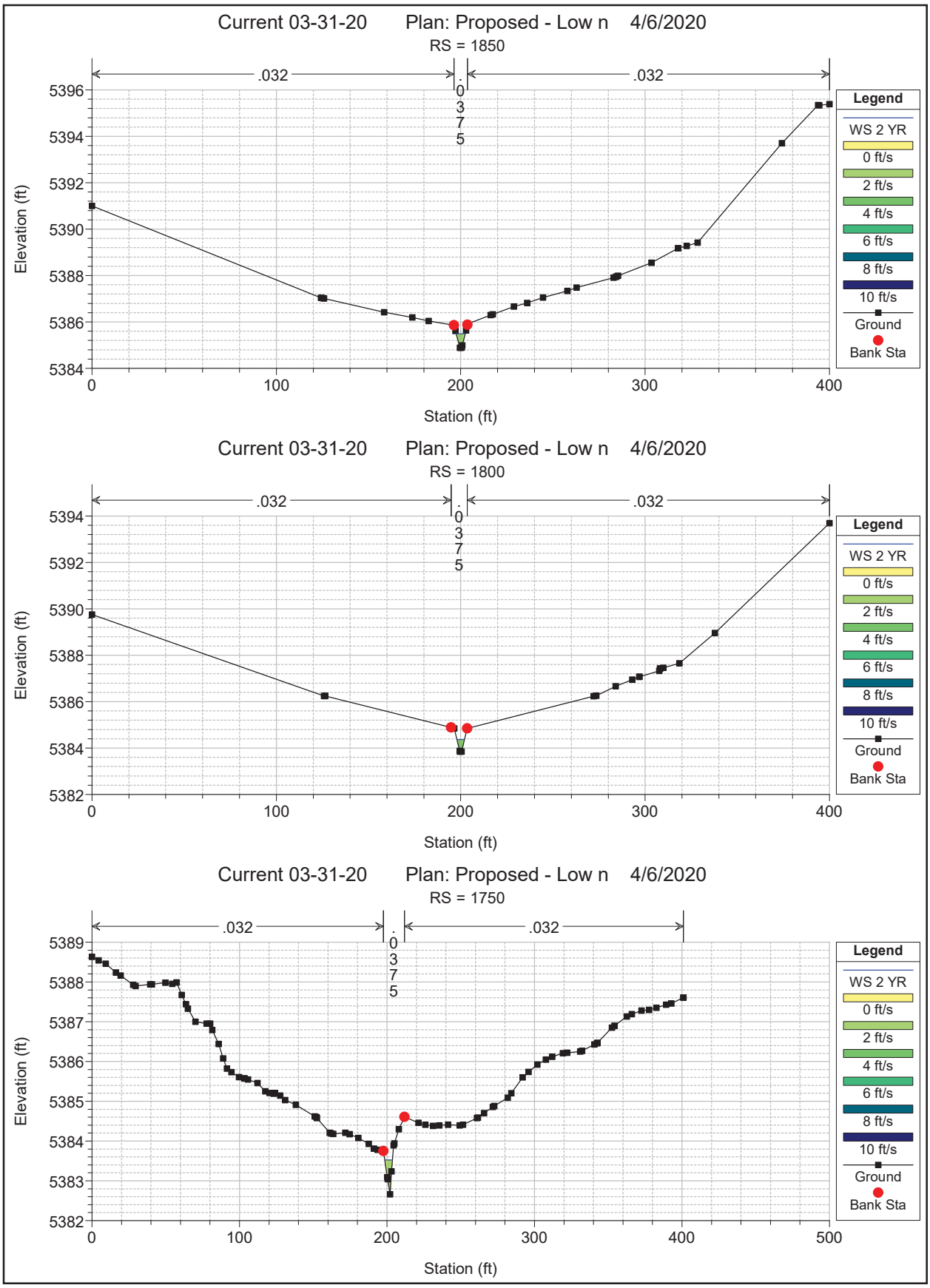

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2198.89
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

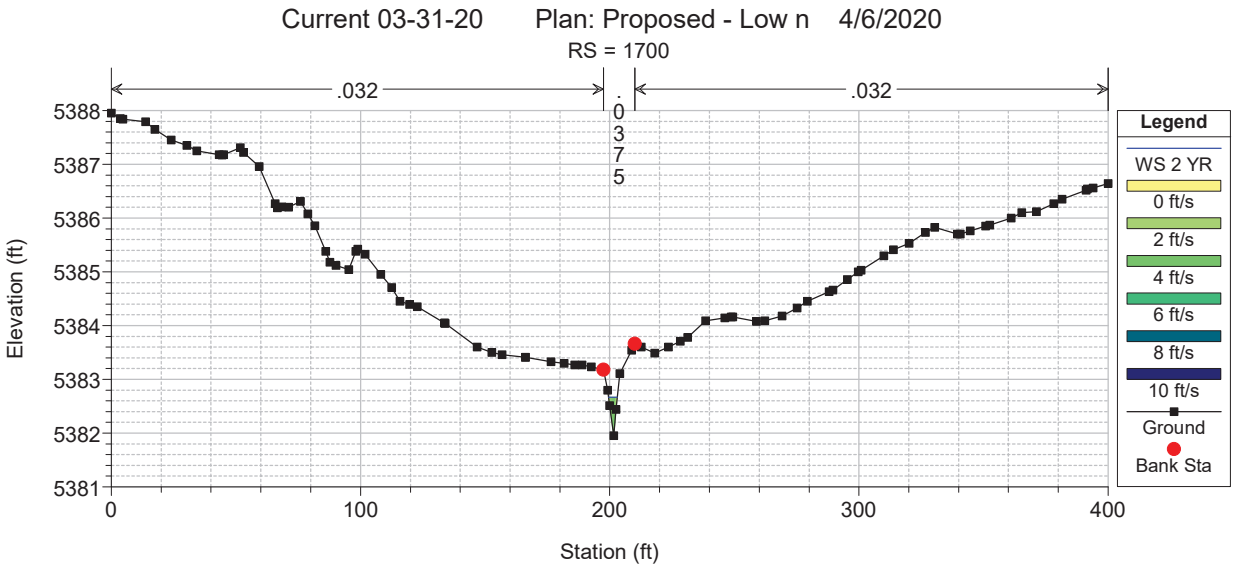

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2150
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2100
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2050
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

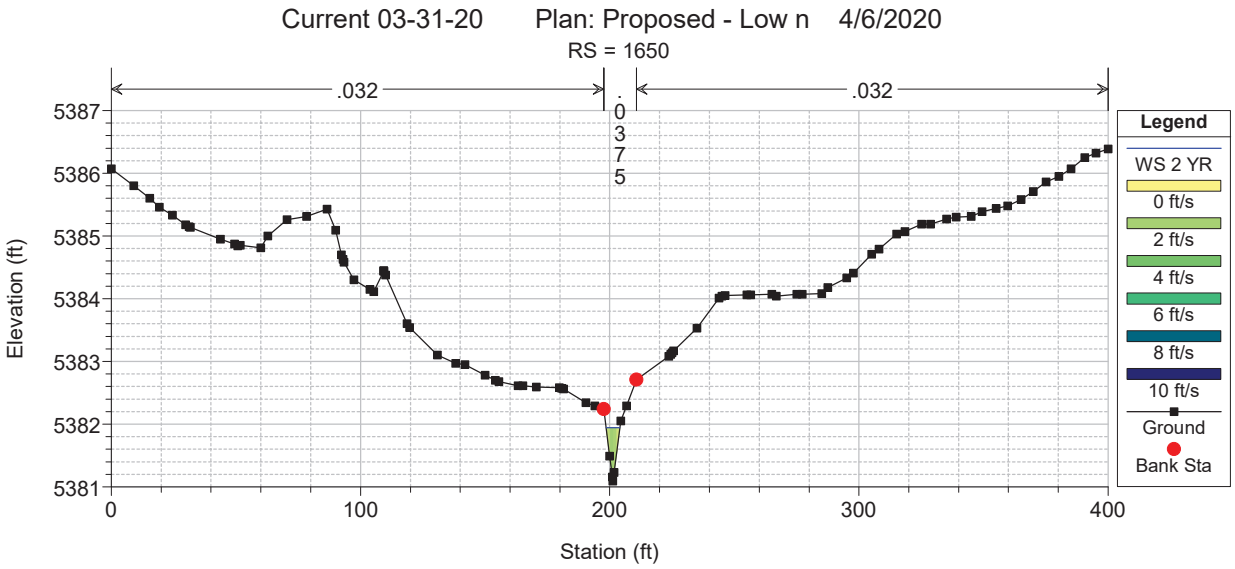

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2000
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

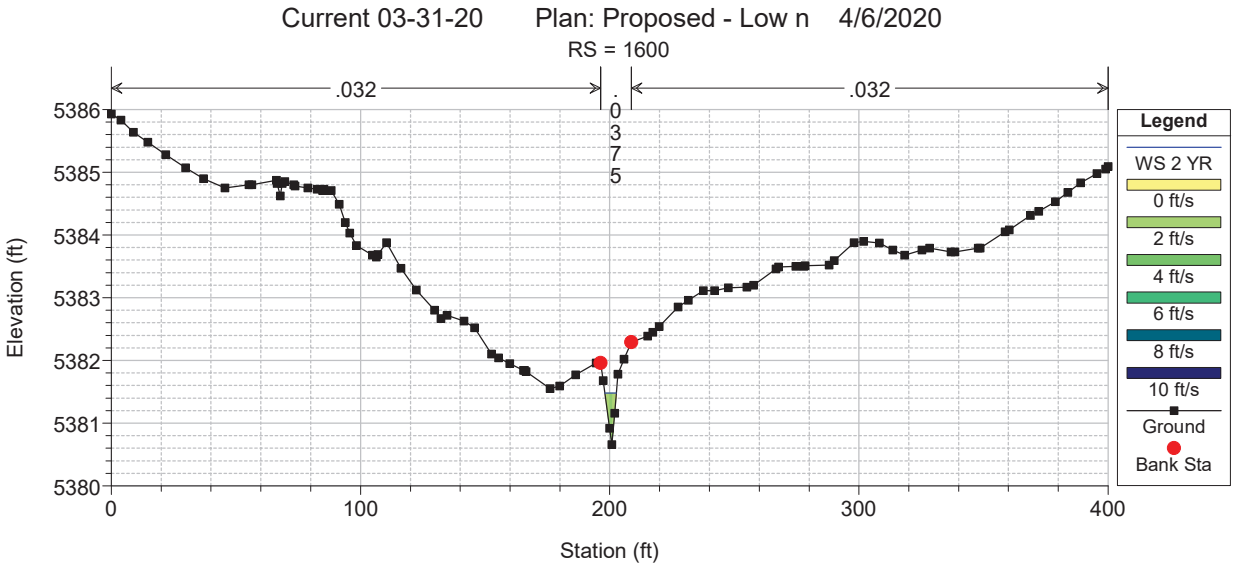

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1950
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

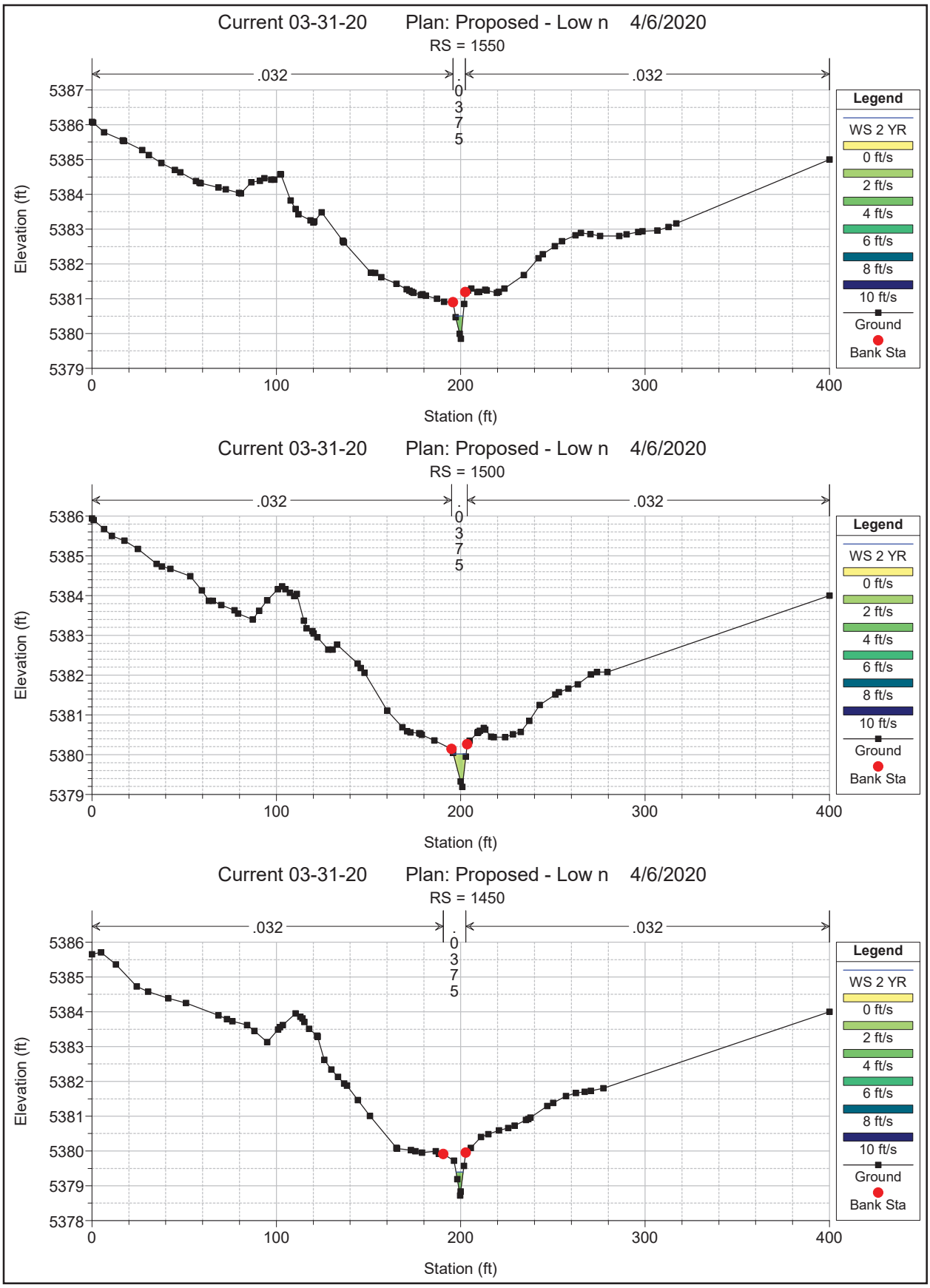

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1900
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

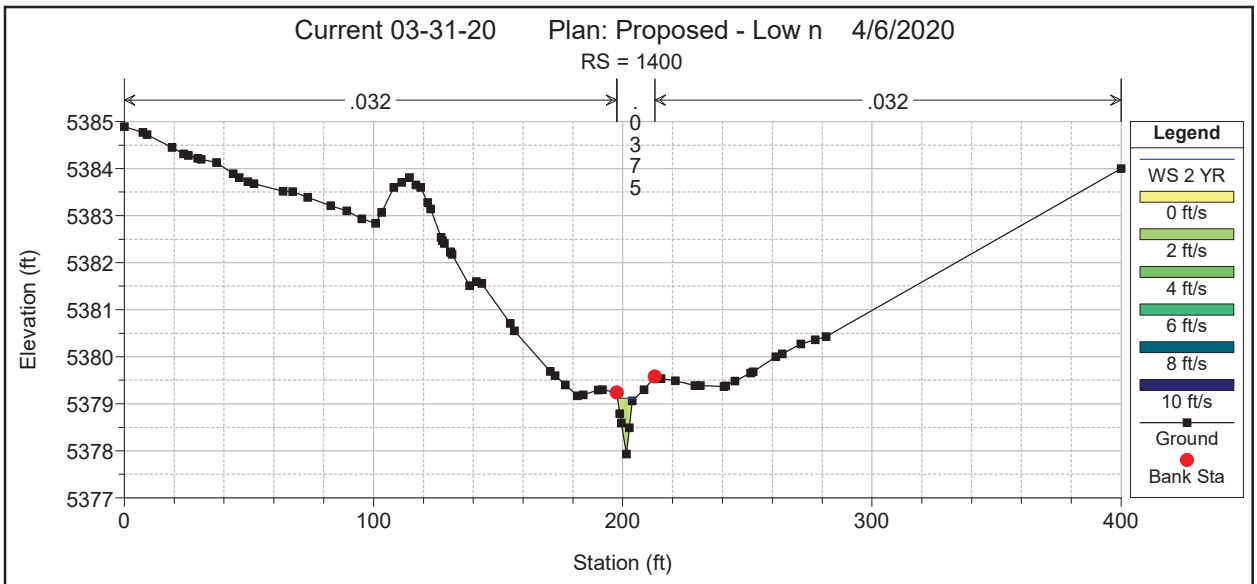

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1850
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1800
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1750
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

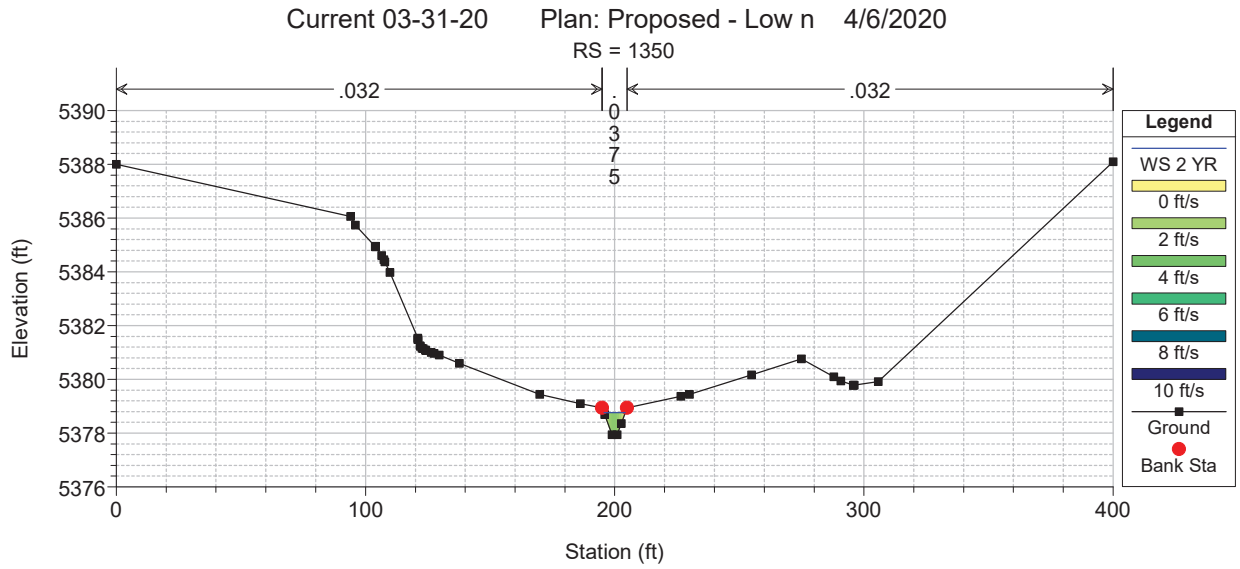

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1700
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

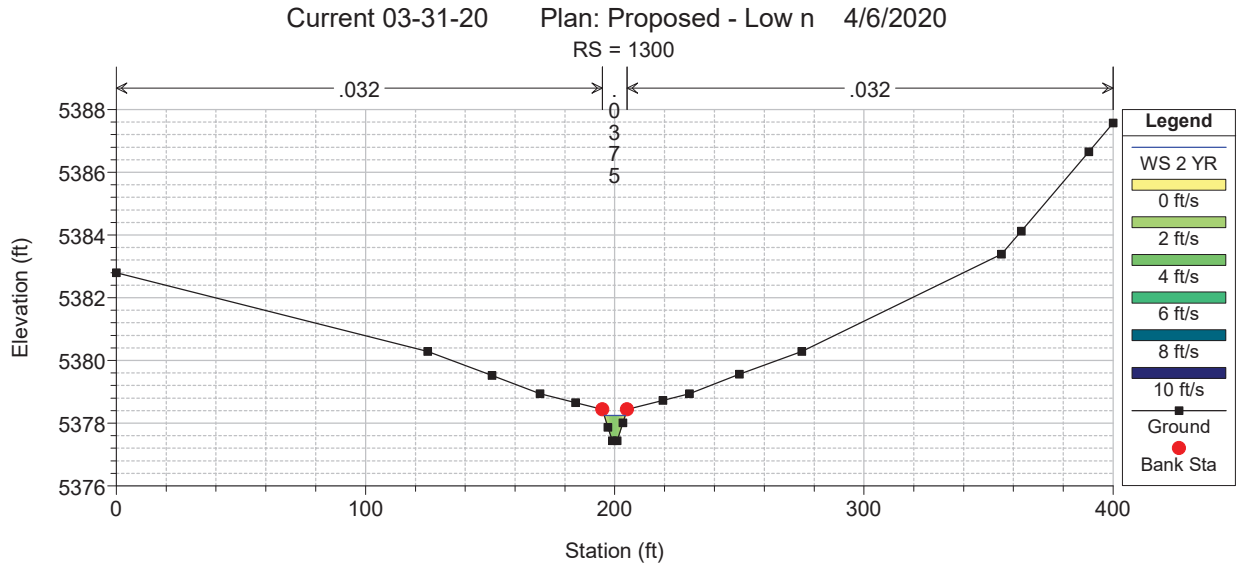

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1650
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

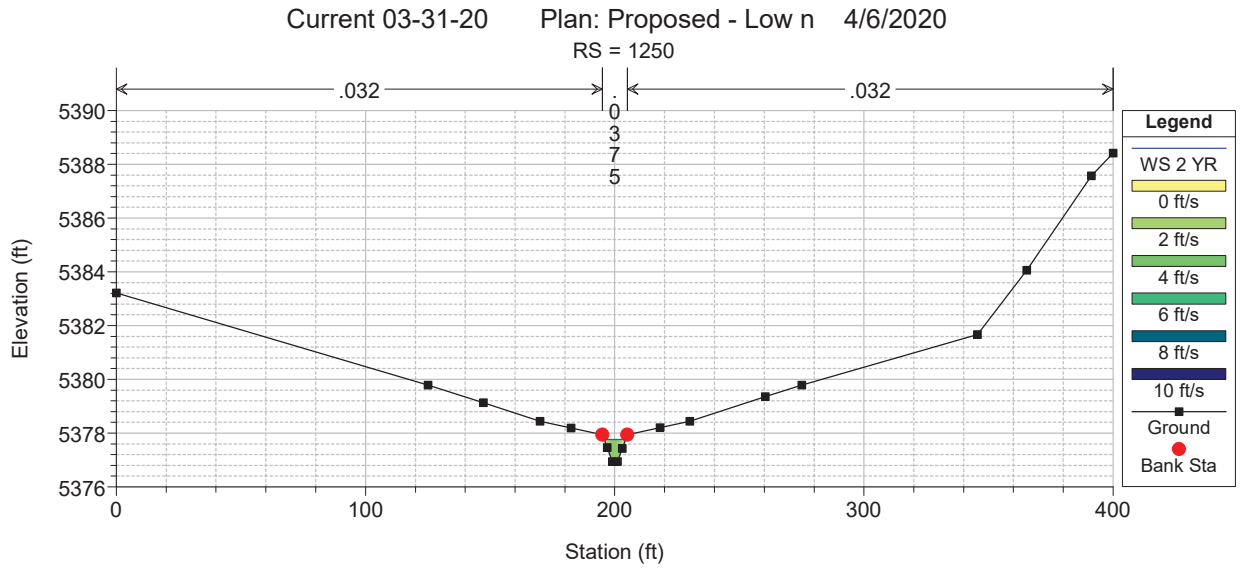

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1600
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

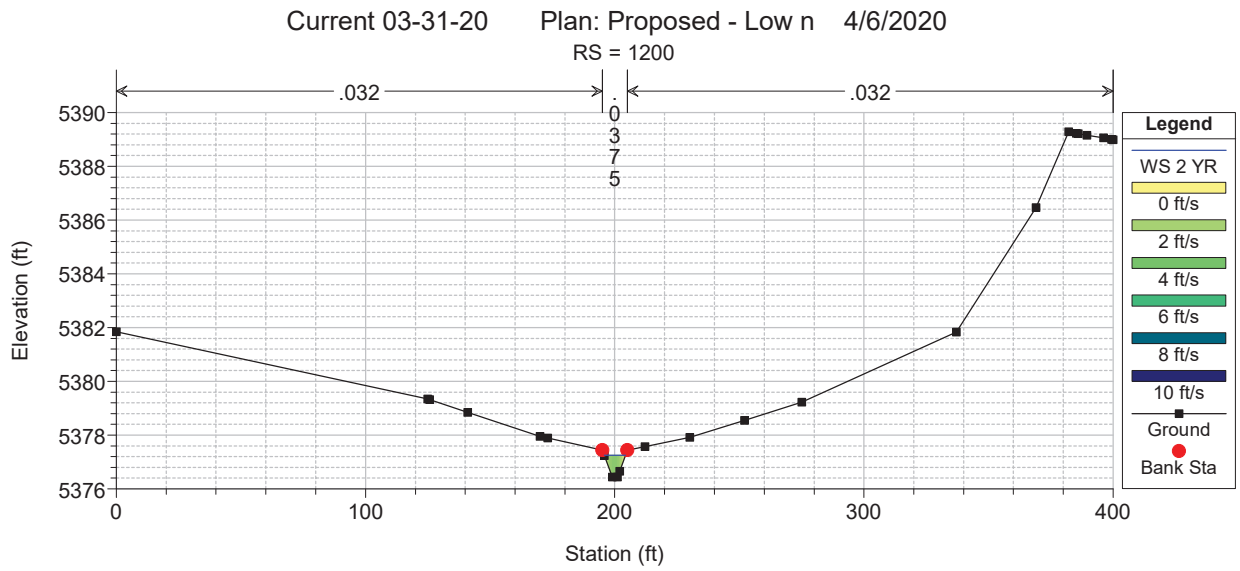

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1550
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1500
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1450
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

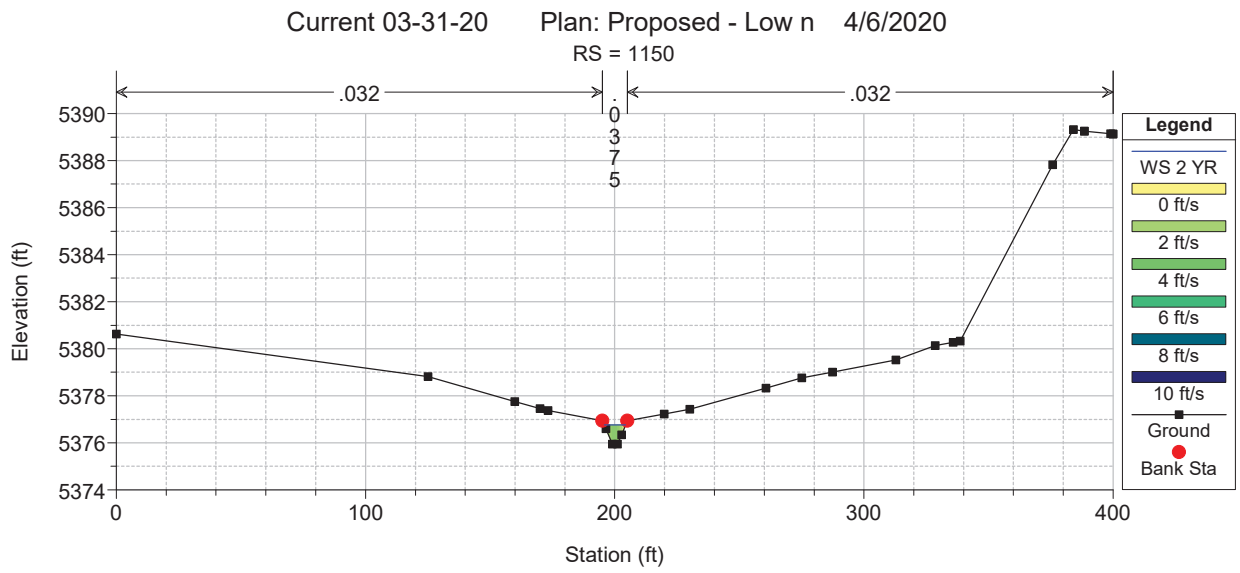

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1400
.032
.0375
.032
Elevation (ft)
5385
5384
5383
5382
5381
5380
5379
5378
5377
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

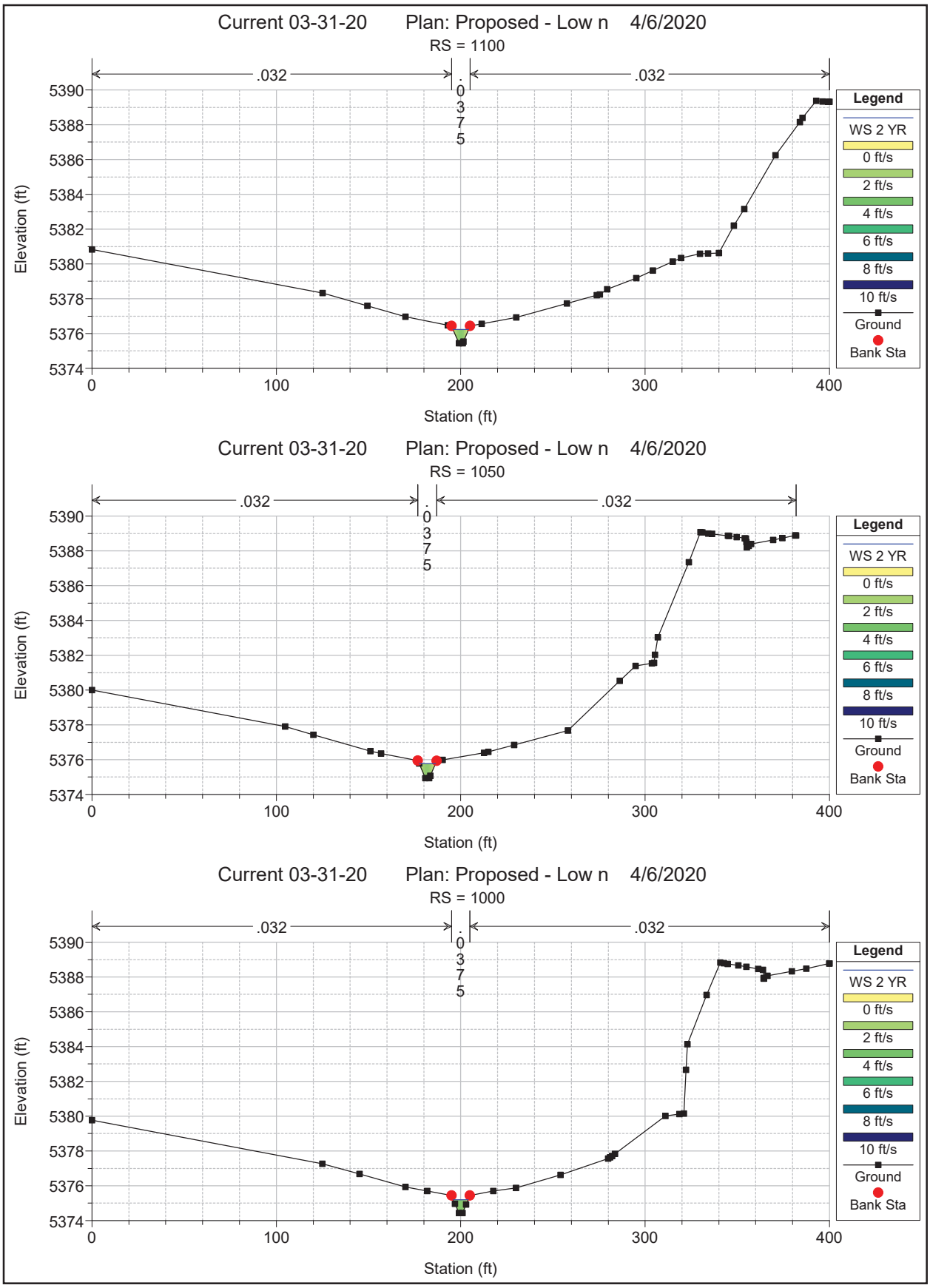

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1350
.032
.0375
.032
Elevation (ft)
5390
5388
5386
5384
5382
5380
5378
5376
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

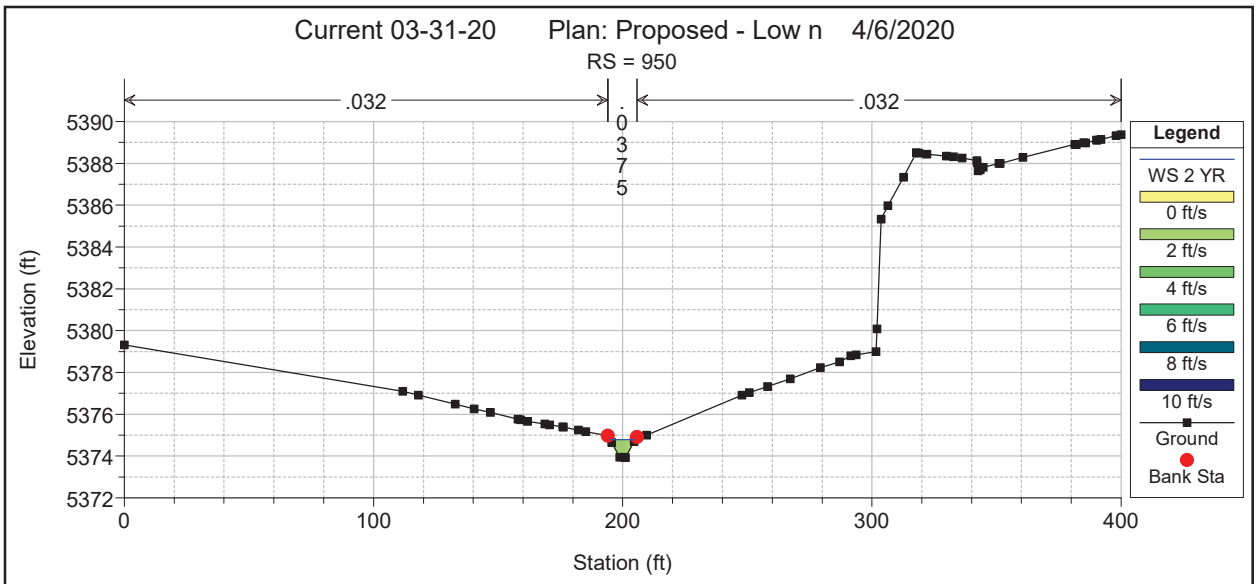

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1300
.032
.0375
.032
Elevation (ft)
5388
5386
5384
5382
5380
5378
5376
0
100
200
300
400
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

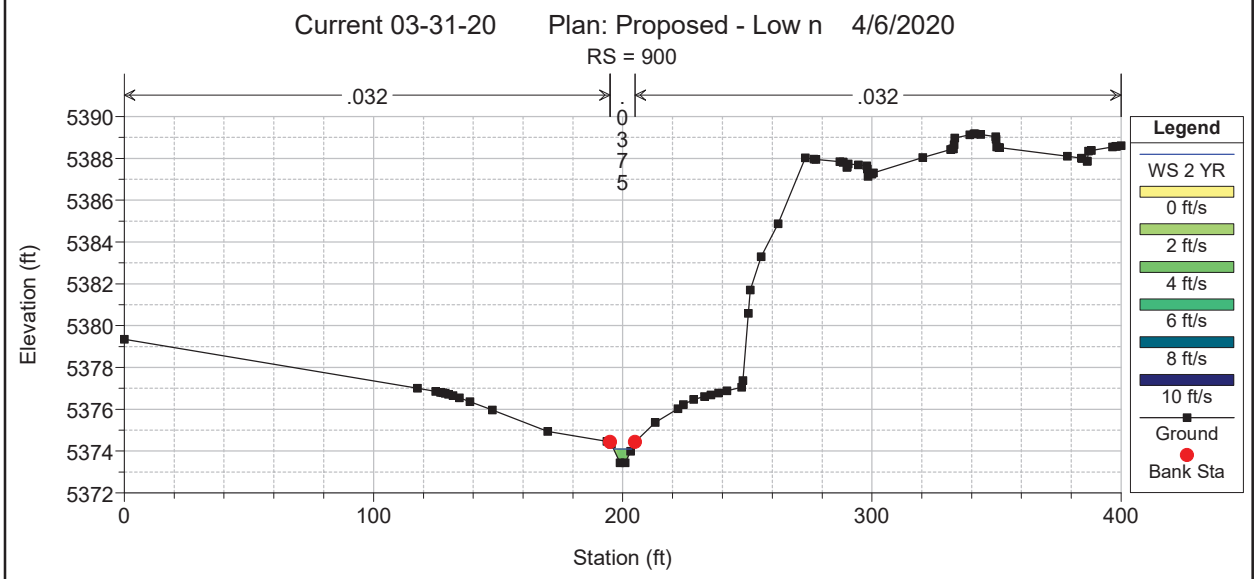

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1250
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

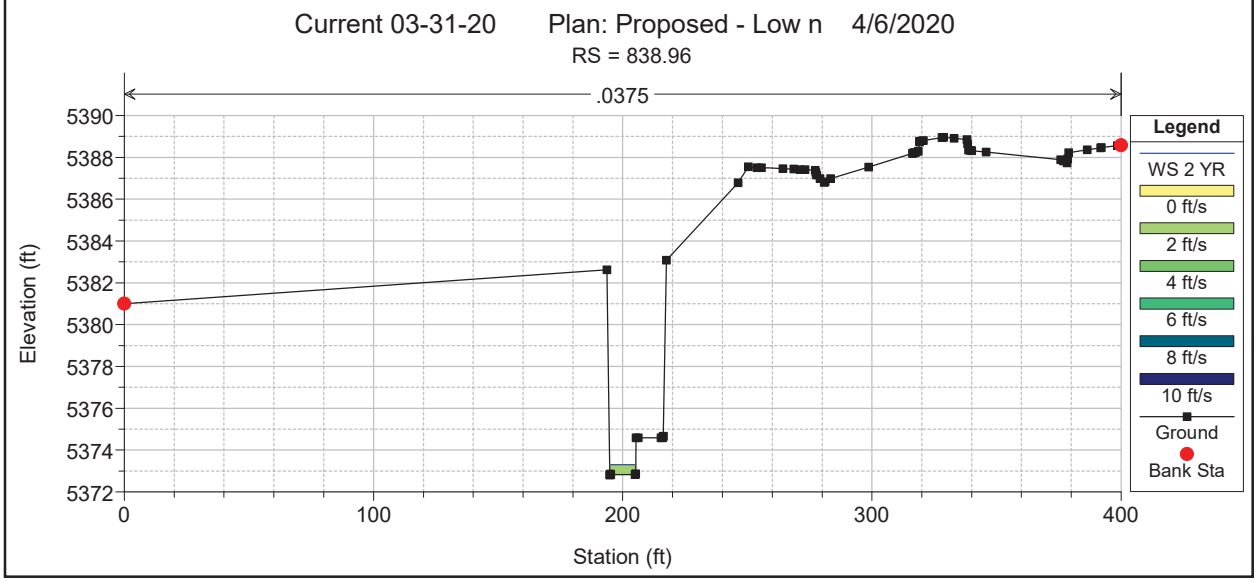

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1200
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

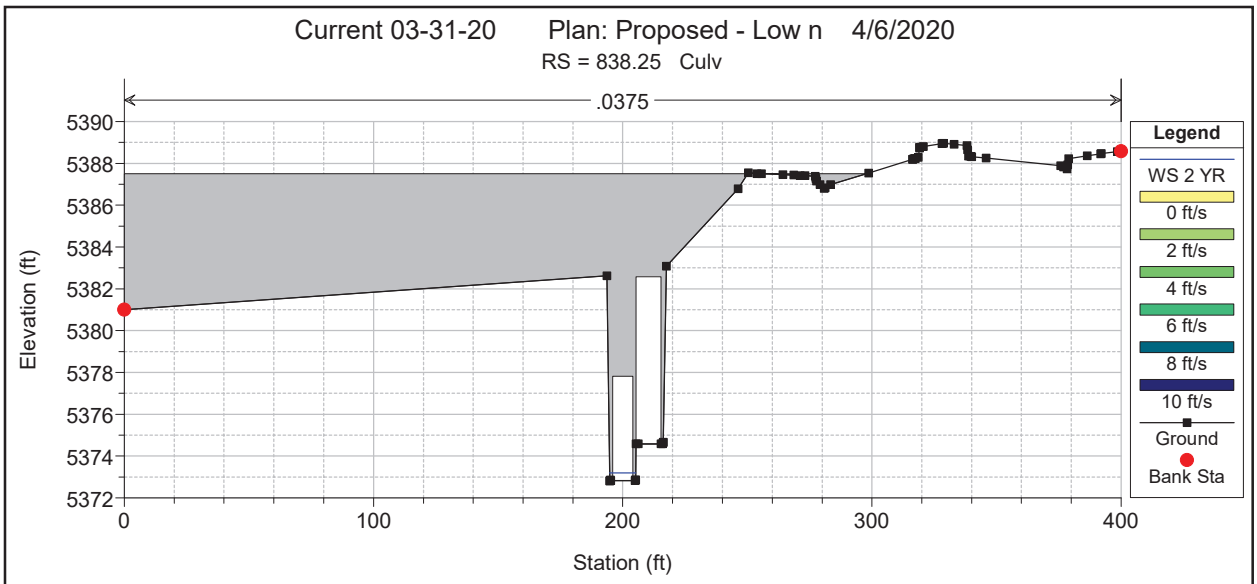

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1150
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

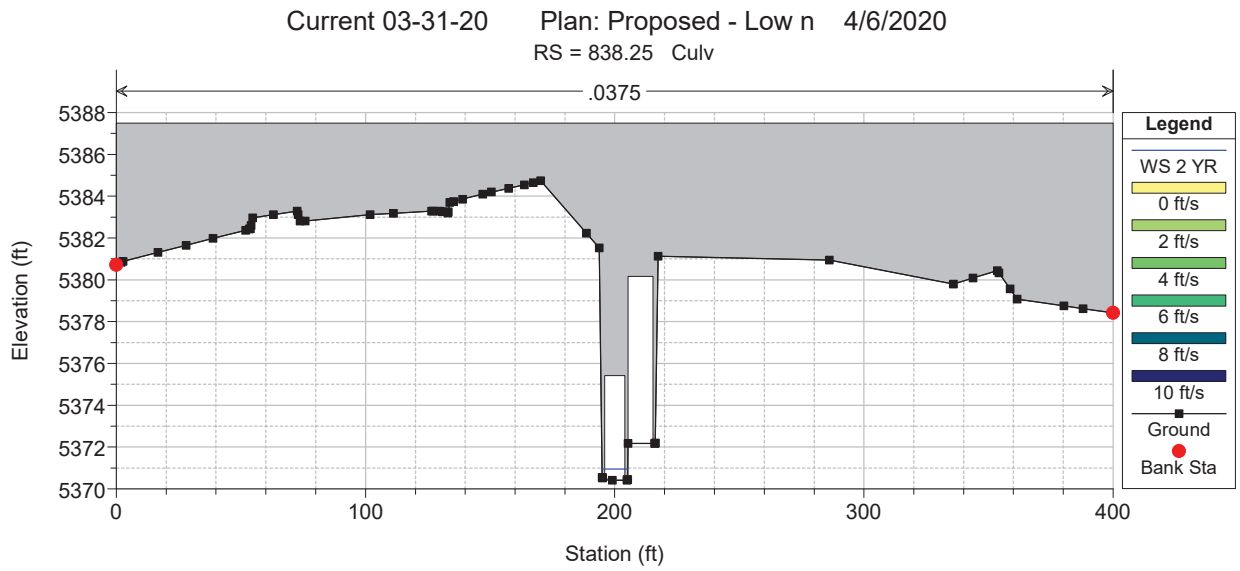

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1100
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1050
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1000
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

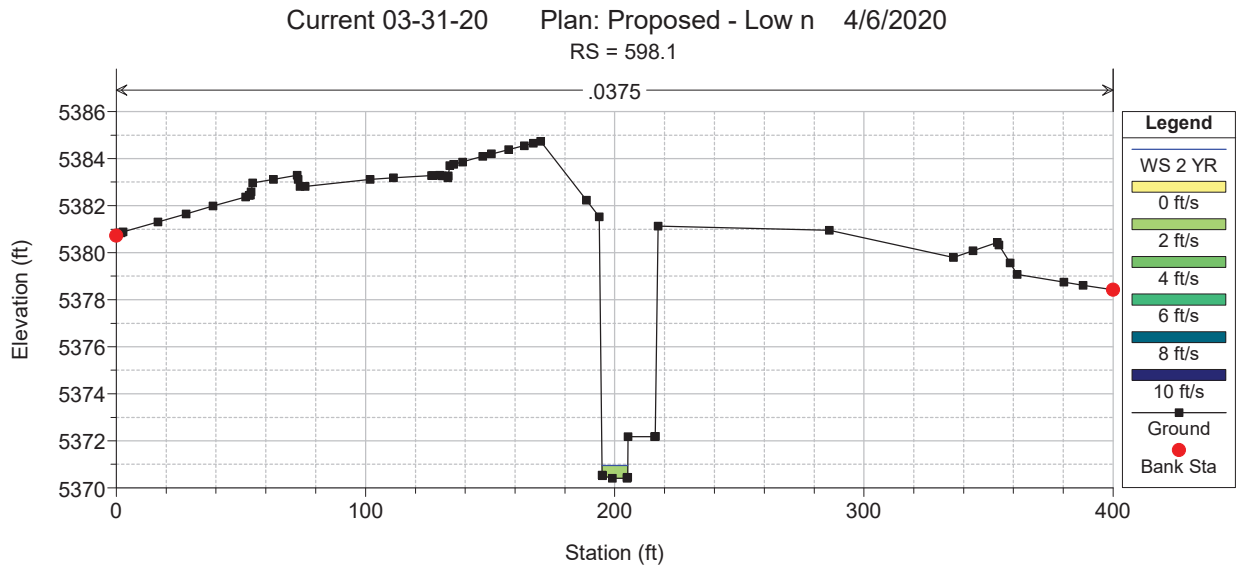

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 950
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

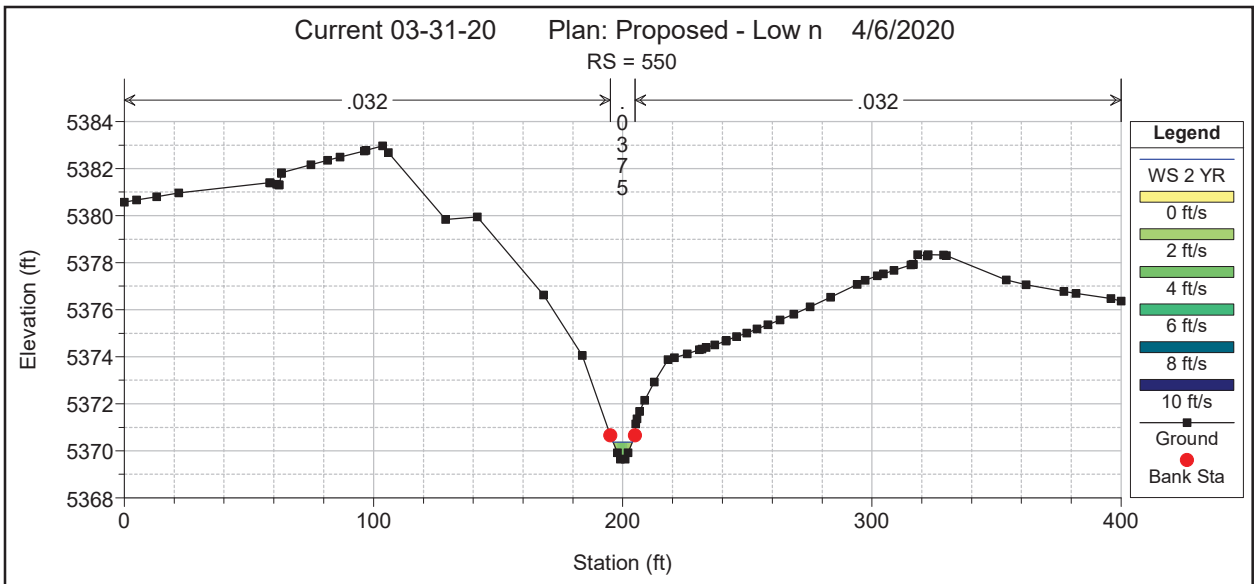

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 900
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

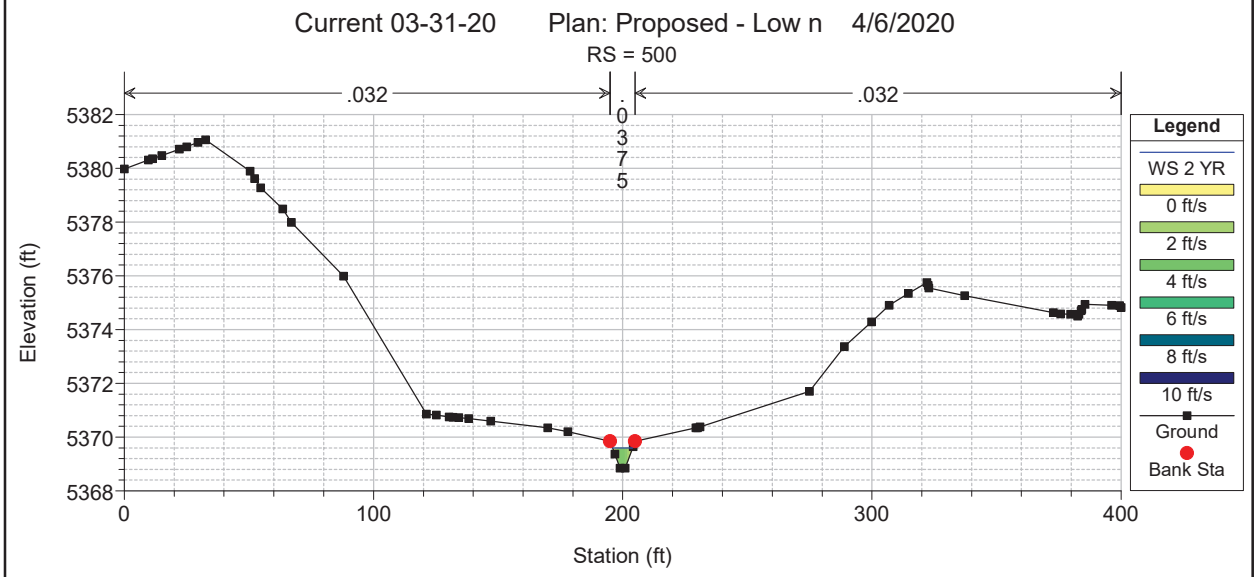

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 838.96
.0375
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

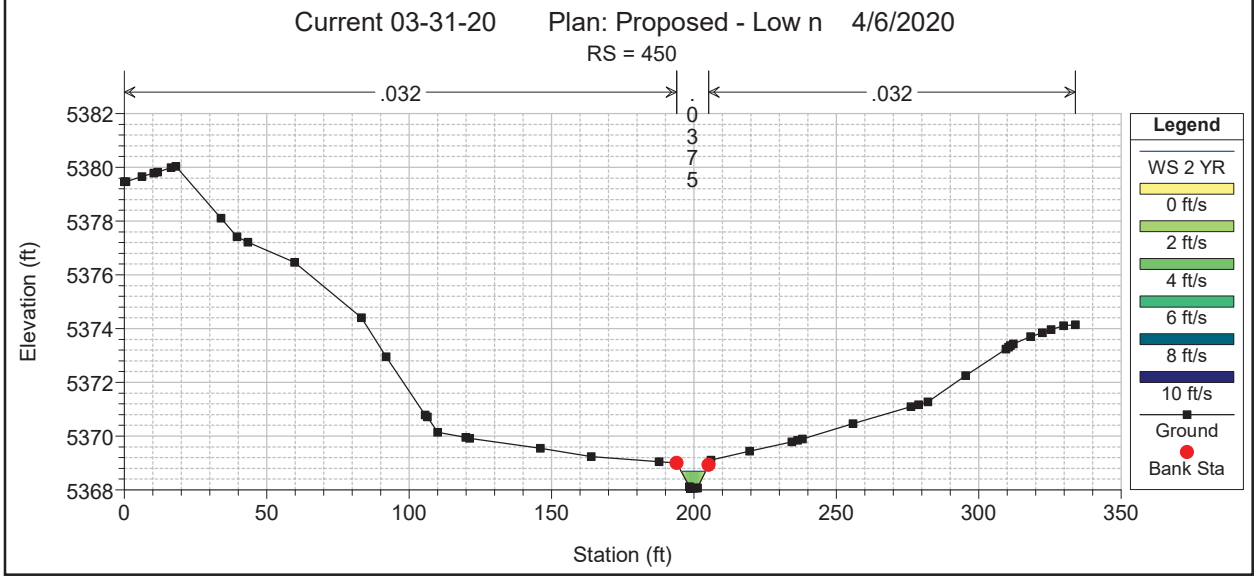

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 838.25 Culv
.0375
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

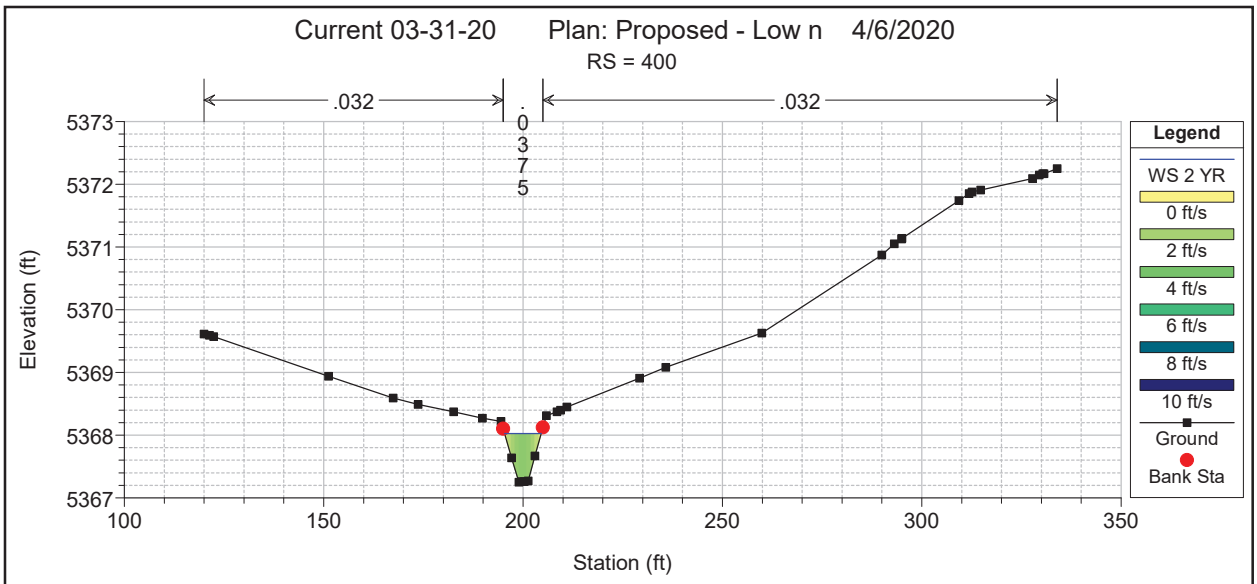

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 838.25 Culv
.0375
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

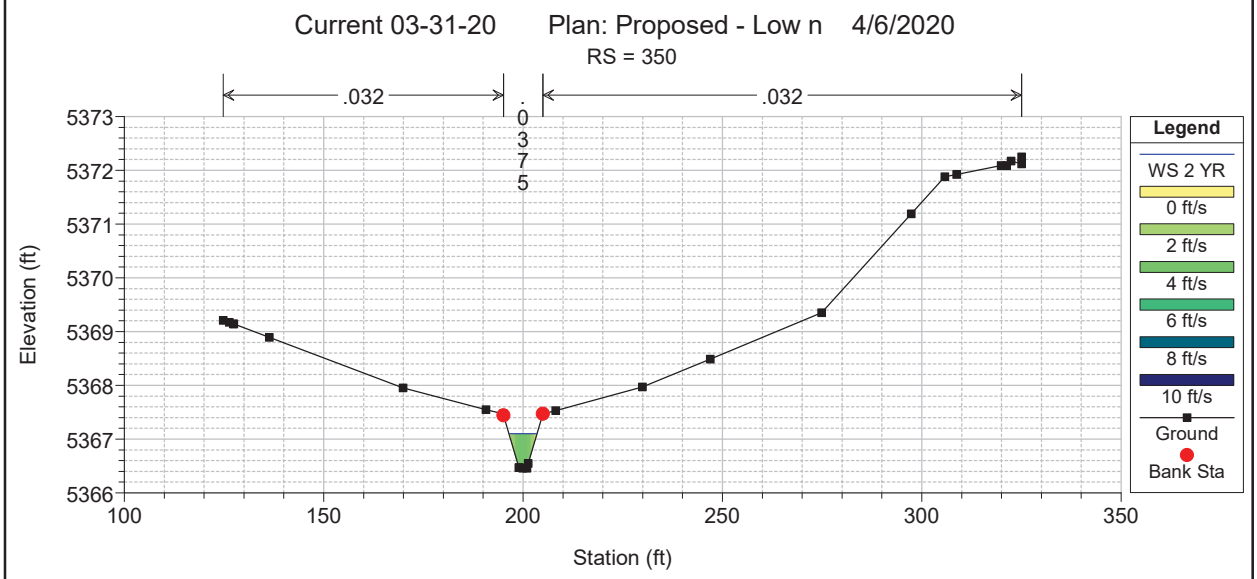

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 598.1
.0375
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

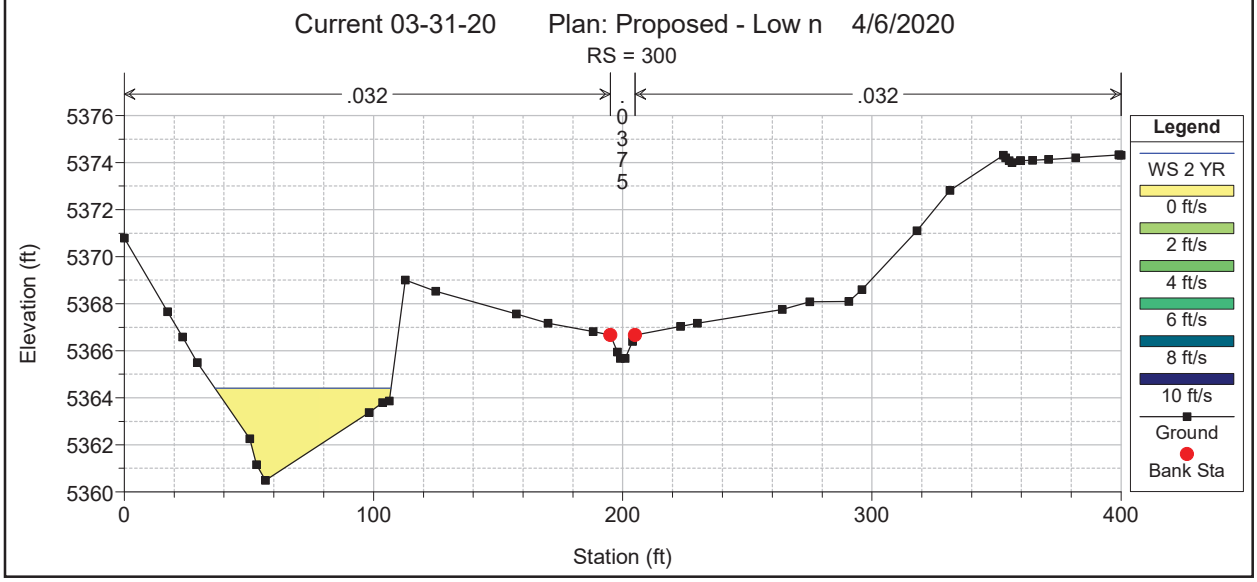

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 550
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

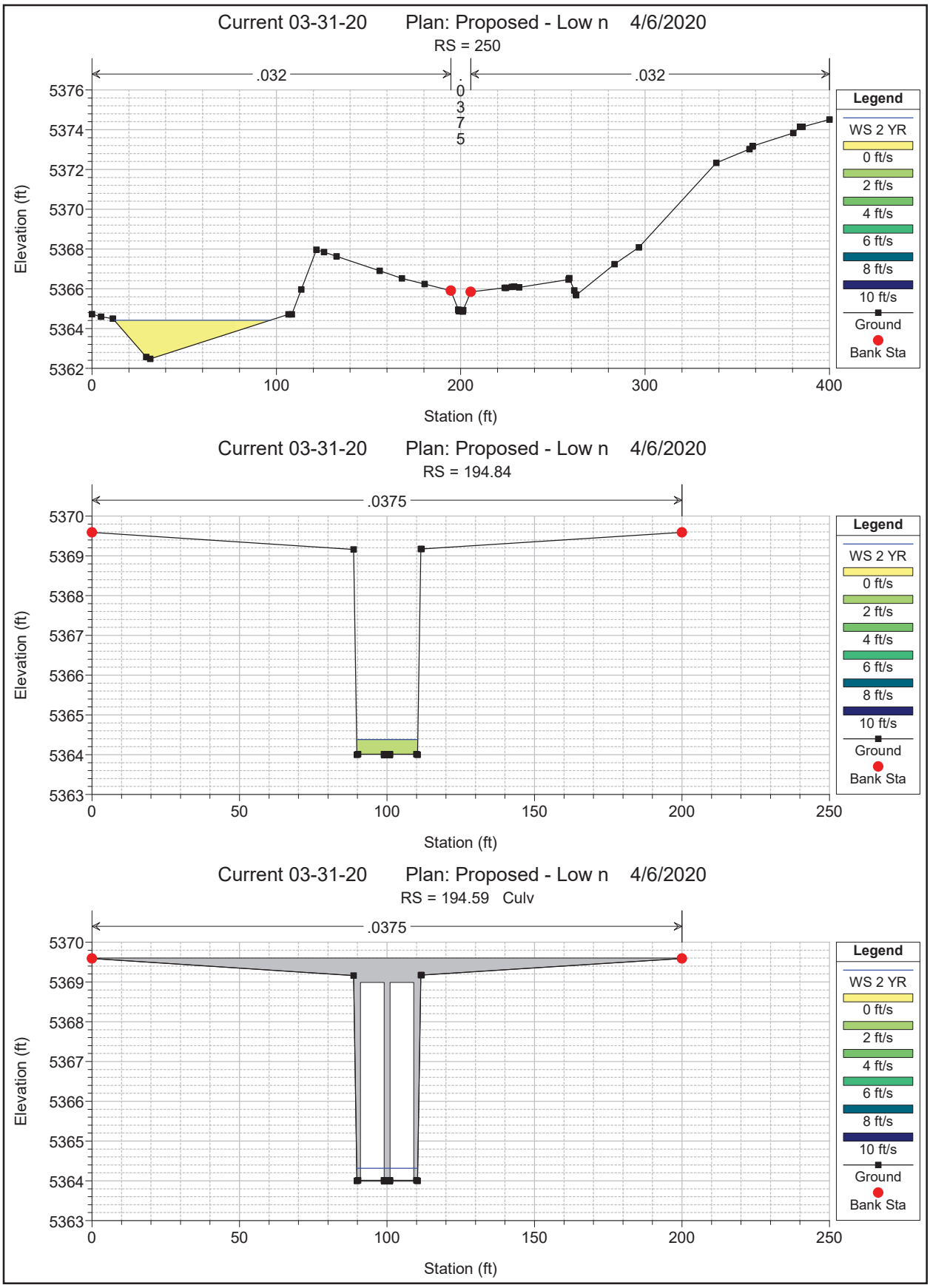

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 500
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 450
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 400
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

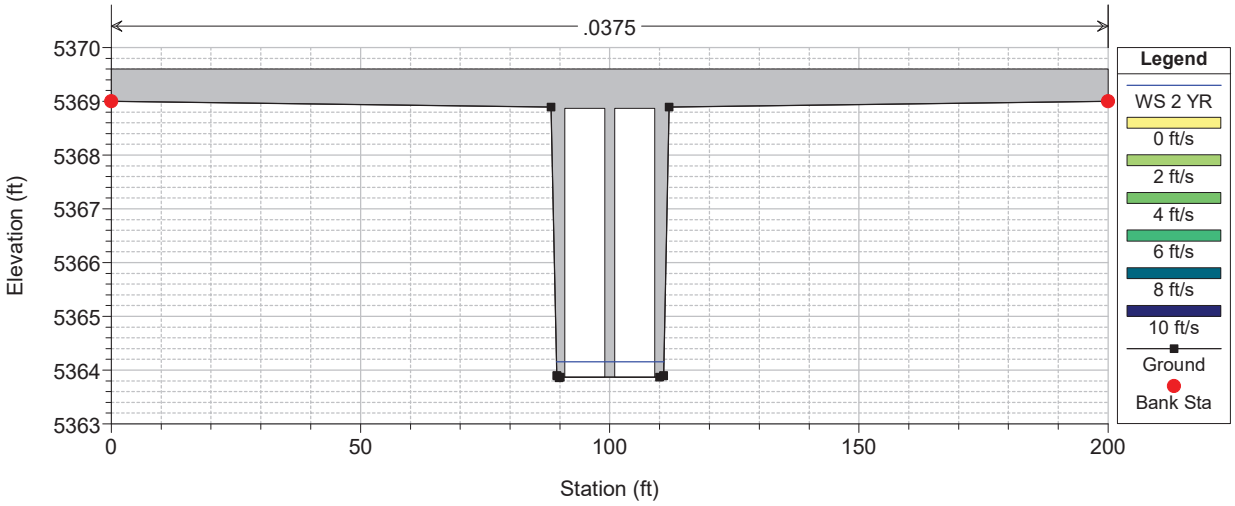

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 350
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 300
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 250
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 194.84
.0375
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 194.59 Culv
.0375
Elevation (ft)
Station (ft)
Legend
WS 2 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

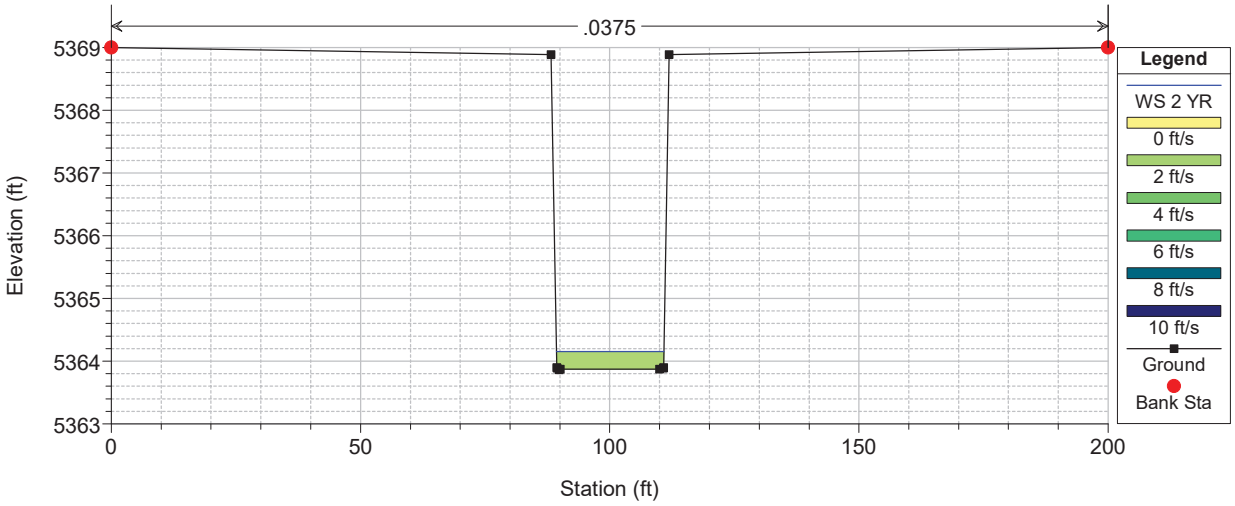
Current 03-31-20 Plan: Proposed - Low n 4/6/2020

RS = 194.59 Culv



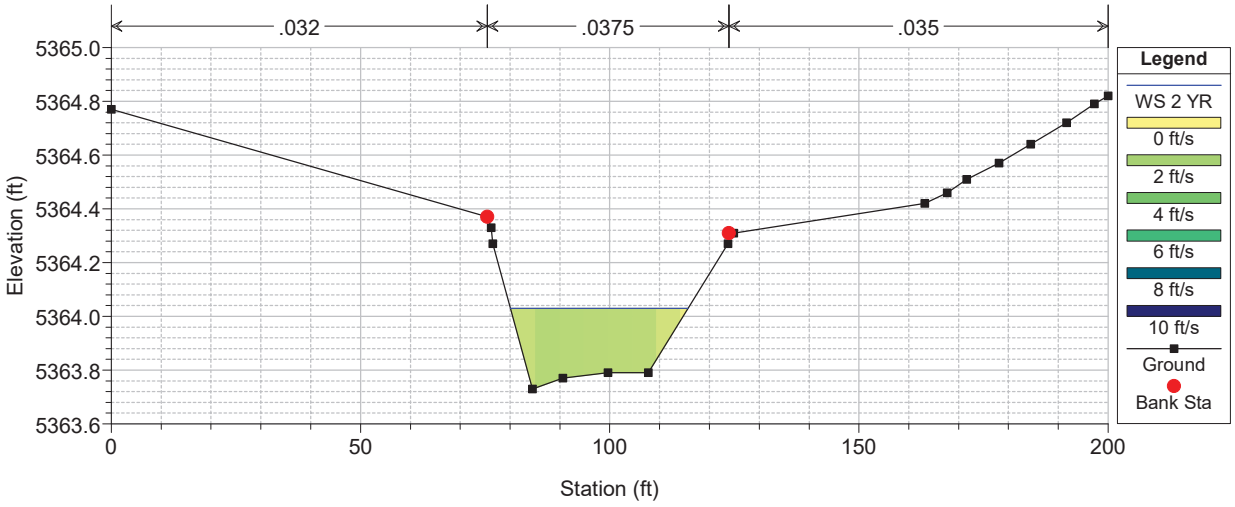
Current 03-31-20 Plan: Proposed - Low n 4/6/2020

RS = 113.93



Current 03-31-20 Plan: Proposed - Low n 4/6/2020

RS = 101



HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 10 YR

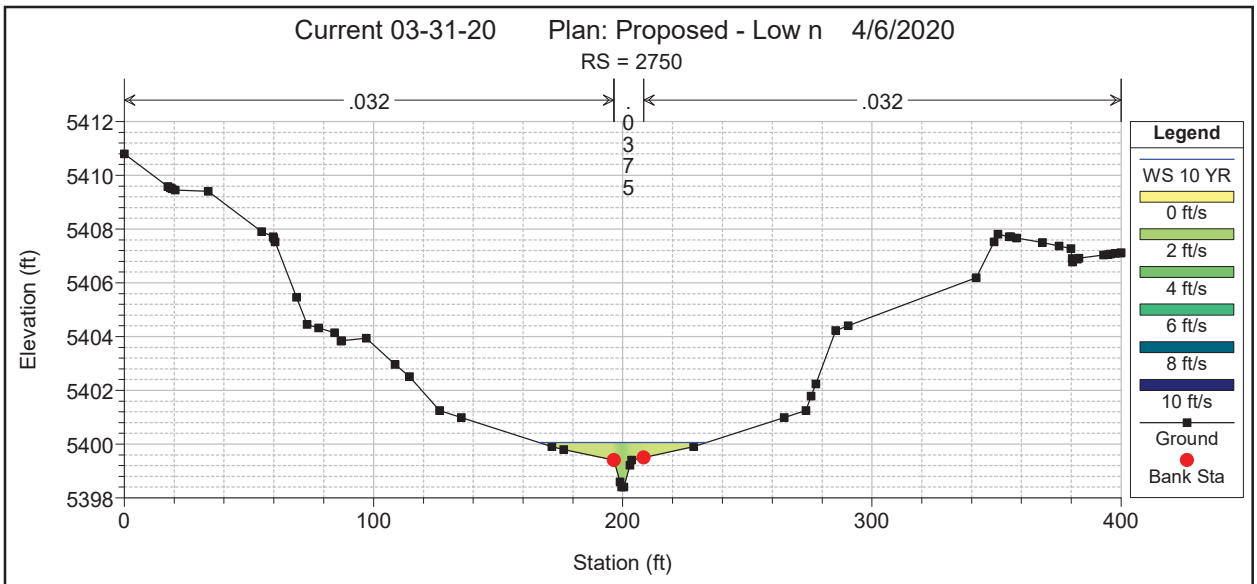
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR - Tributary I	5750	10 YR	18.04	5450.60	5451.76	5451.70	5452.02	0.014576	4.04	4.46	6.82	0.88	0.56
PR - Tributary I	5700	10 YR	18.04	5450.44	5451.08	5451.05	5451.14	0.018483	2.00	9.01	50.14	0.83	0.21
PR - Tributary I	5650	10 YR	18.04	5449.61	5449.90	5449.90	5449.96	0.030730	1.97	9.17	76.97	1.01	0.23
PR - Tributary I	5600	10 YR	18.04	5448.25	5448.42	5448.46	5448.56	0.063014	2.98	6.06	47.01	1.46	0.51
PR - Tributary I	5550	10 YR	18.04	5446.77	5447.20	5447.20	5447.29	0.025433	2.45	7.35	38.51	0.99	0.30
PR - Tributary I	5500	10 YR	18.04	5445.70	5446.21	5446.09	5446.26	0.007591	1.80	10.01	33.68	0.58	0.14
PR - Tributary I	5450	10 YR	18.04	5445.24	5445.58	5445.57	5445.67	0.019686	2.41	7.47	33.13	0.90	0.28
PR - Tributary I	5400	10 YR	18.04	5444.05	5444.47	5444.47	5444.57	0.024412	2.59	6.96	32.64	0.99	0.33
PR - Tributary I	5350	10 YR	18.04	5443.51	5443.85	5443.77	5443.89	0.007631	1.60	11.30	45.76	0.57	0.12
PR - Tributary I	5300	10 YR	18.04	5443.08	5443.35		5443.40	0.012986	1.74	10.37	55.02	0.71	0.15
PR - Tributary I	5250	10 YR	18.04	5442.33	5442.60		5442.65	0.017459	1.89	9.56	56.07	0.81	0.19
PR - Tributary I	5200	10 YR	18.04	5441.18	5441.44	5441.44	5441.53	0.029765	2.47	7.29	42.47	1.05	0.32
PR - Tributary I	5150	10 YR	18.04	5440.49	5440.85	5440.77	5440.88	0.007010	1.42	12.67	57.20	0.53	0.10
PR - Tributary I	5100	10 YR	18.04	5438.27	5440.87		5440.87	0.000004	0.12	148.62	96.59	0.02	0.00
PR - Tributary I	5050	10 YR	18.04	5440.42	5440.75	5440.75	5440.86	0.025389	2.67	6.76	31.16	1.01	0.34
PR - Tributary I	5000	10 YR	18.04	5438.12	5438.66	5438.74	5438.89	0.067518	3.89	4.64	25.26	1.60	0.77
PR - Tributary I	4950	10 YR	18.04	5437.50	5437.90	5437.85	5437.97	0.012775	1.99	9.06	38.74	0.73	0.19
PR - Tributary I	4900	10 YR	18.04	5436.66	5436.98	5436.98	5437.08	0.026183	2.48	7.27	38.31	1.00	0.31
PR - Tributary I	4850	10 YR	18.04	5435.75	5436.19	5436.08	5436.23	0.006599	1.52	11.87	46.41	0.53	0.11
PR - Tributary I	4800	10 YR	18.04	5435.31	5435.68	5435.64	5435.73	0.016645	1.90	9.51	53.40	0.79	0.19
PR - Tributary I	4750	10 YR	18.04	5434.72	5434.98	5434.94	5435.02	0.011869	1.65	10.95	58.94	0.67	0.14
PR - Tributary I	4700	10 YR	18.04	5434.02	5434.31	5434.27	5434.36	0.015096	1.73	10.44	62.62	0.75	0.16
PR - Tributary I	4650	10 YR	18.04	5433.21	5433.47	5433.45	5433.53	0.017735	1.99	9.04	49.36	0.82	0.20
PR - Tributary I	4600	10 YR	18.04	5432.45	5432.74		5432.79	0.012536	1.80	10.01	49.05	0.70	0.16
PR - Tributary I	4550	10 YR	18.04	5431.45	5431.81	5431.81	5431.91	0.025298	2.52	7.17	36.08	0.99	0.31
PR - Tributary I	4500	10 YR	18.04	5430.22	5431.14	5430.72	5431.17	0.001725	1.36	13.29	22.38	0.31	0.06
PR - Tributary I	4450	10 YR	18.04	5430.61	5430.86	5430.86	5430.93	0.029133	2.14	8.43	60.16	1.01	0.25
PR - Tributary I	4400	10 YR	18.04	5428.99	5429.34	5429.32	5429.42	0.020227	2.25	8.02	40.35	0.89	0.25
PR - Tributary I	4350	10 YR	18.04	5427.82	5428.20	5428.20	5428.30	0.025106	2.60	6.94	33.05	1.00	0.33
PR - Tributary I	4300	10 YR	18.04	5426.83	5427.19	5427.16	5427.26	0.016866	2.06	8.76	43.92	0.81	0.21
PR - Tributary I	4250	10 YR	18.04	5426.04	5426.35		5426.41	0.016630	1.96	9.21	49.27	0.80	0.19
PR - Tributary I	4200	10 YR	18.04	5425.05	5425.39	5425.38	5425.46	0.022471	2.06	8.76	54.38	0.91	0.23
PR - Tributary I	4150	10 YR	18.04	5424.36	5424.66		5424.70	0.010952	1.50	12.06	70.55	0.64	0.12
PR - Tributary I	4100	10 YR	18.04	5423.72	5423.95	5423.93	5423.99	0.018753	1.61	11.20	87.79	0.80	0.15
PR - Tributary I	4050	10 YR	18.04	5422.79	5423.13	5423.09	5423.18	0.014143	1.82	9.91	52.31	0.74	0.17
PR - Tributary I	4000	10 YR	18.04	5422.19	5422.48		5422.52	0.012249	1.62	11.12	62.63	0.68	0.14
PR - Tributary I	3950	10 YR	18.04	5421.55	5421.90	5421.84	5421.94	0.011255	1.53	11.78	68.00	0.65	0.12
PR - Tributary I	3900	10 YR	18.04	5420.99	5421.27		5421.31	0.014587	1.64	11.01	69.72	0.73	0.14
PR - Tributary I	3850	10 YR	18.04	5420.41	5420.80	5420.73	5420.82	0.006906	1.19	15.18	88.85	0.51	0.07
PR - Tributary I	3800	10 YR	18.04	5419.89	5420.19	5420.17	5420.25	0.022314	1.92	9.41	64.78	0.89	0.20
PR - Tributary I	3750	10 YR	18.04	5418.86	5419.30	5419.26	5419.35	0.014371	1.81	9.97	53.73	0.74	0.17
PR - Tributary I	3700	10 YR	18.04	5417.97	5418.43	5418.41	5418.49	0.020687	1.99	9.06	55.60	0.87	0.21
PR - Tributary I	3650	10 YR	18.04	5416.98	5417.26	5417.26	5417.31	0.026902	1.71	10.56	99.49	0.92	0.18
PR - Tributary I	3600	10 YR	18.04	5415.58	5415.84	5415.84	5415.91	0.029097	2.12	8.50	61.27	1.00	0.25
PR - Tributary I	3550	10 YR	18.04	5414.55	5414.83	5414.77	5414.88	0.011293	1.74	10.38	49.69	0.67	0.15
PR - Tributary I	3500	10 YR	18.04	5413.71	5413.93	5413.93	5413.99	0.030584	2.09	8.65	66.41	1.02	0.25
PR - Tributary I	3450	10 YR	18.04	5412.64	5413.01	5412.92	5413.04	0.006179	1.28	14.08	67.75	0.50	0.08
PR - Tributary I	3400	10 YR	37.95	5411.88	5412.22	5412.22	5412.32	0.025166	2.57	14.75	71.48	1.00	0.32
PR - Tributary I	3350	10 YR	37.95	5411.24	5411.67	5411.56	5411.71	0.006296	1.62	23.46	80.66	0.53	0.11
PR - Tributary I	3300	10 YR	37.95	5410.87	5411.41		5411.45	0.004563	1.44	26.34	84.56	0.46	0.09
PR - Tributary I	3250	10 YR	37.95	5409.78	5411.26		5411.29	0.002154	1.39	27.40	41.77	0.30	0.09
PR - Tributary I	3232.13	10 YR	37.95	5409.65	5410.96	5410.96	5411.18	0.027574	3.76	10.08	22.95	1.00	0.74
PR - Tributary I	3205.03	10 YR	37.95	5405.01	5405.26	5405.73	5408.64	1.022259	14.76	2.57	11.42	5.48	14.27
PR - Tributary I	3181.99	10 YR	37.95	5404.79	5405.47	5405.50	5405.80	0.028282	4.61	8.24	14.11	1.06	1.01
PR - Tributary I	3140.22	10 YR	37.95	5399.18	5399.49	5399.98	5402.35	0.615744	13.58	2.80	9.27	4.36	11.09
PR - Tributary I	3140		Culvert										
PR - Tributary I	2909.93	10 YR	37.95	5398.72	5399.51	5399.51	5399.91	0.026466	5.02	7.56	9.72	1.00	1.14
PR - Tributary I	2850	10 YR	37.95	5398.60	5400.27		5400.35	0.004100	2.41	18.22	35.05	0.43	0.24
PR - Tributary I	2800	10 YR	37.95	5398.50	5400.15		5400.19	0.002159	2.04	26.82	56.07	0.33	0.16
PR - Tributary I	2750	10 YR	37.95	5398.40	5400.05		5400.09	0.002054	1.73	29.57	67.25	0.31	0.12
PR - Tributary I	2700	10 YR	37.95	5398.30	5399.94		5399.98	0.002089	2.00	28.77	66.64	0.32	0.15
PR - Tributary I	2650	10 YR	37.95	5398.20	5399.84	5399.60	5399.88	0.002169	2.03	28.34	66.09	0.33	0.16
PR - Tributary I	2600	10 YR	37.95	5398.10	5399.47	5399.47	5399.64	0.014420	3.63	13.20	43.35	0.77	0.60
PR - Tributary I	2550	10 YR	37.95	5396.43	5397.95	5397.02	5397.95	0.000175	0.51	74.09	97.31	0.10	0.01
PR - Tributary I	2500	10 YR	37.95	5394.51	5397.95		5397.95	0.000002	0.11	345.74	171.53	0.01	0.00
PR - Tributary I	2450	10 YR	37.95	5394.37	5397.95		5397.95	0.000000	0.06	601.27	220.14	0.01	0.00
PR - Tributary I	2400	10 YR	37.95	5394.18	5397.95		5397.95	0.000000	0.06	642.26	228.94	0.01	0.00
PR - Tributary I	2350	10 YR	37.95	5394.18	5397.95		5397.95	0.000000	0.05	723.03	249.56	0.01	0.00
PR - Tributary I	2300	10 YR	37.95	5394.18	5397.95		5397.95	0.000000	0.05	756.23	248.84	0.01	0.00
PR - Tributary I	2218.78	10 YR	37.95	5397.49	5397.83	5397.83	5397.94	0.034877	2.60	14.62	70.40	1.00	0.45
PR - Tributary I	2198.89	10 YR	37.95	5392.12	5392.91	5393.48	5396.01	0.372962	14.12	2.69	5.77	3.65	10.38
PR - Tributary I	2150	10 YR	37.95	5391.10	5392.38	5392.47	5392.67	0.019254	4.79	10.75	38.33	0.92	0.98
PR - Tributary I	2100	10 YR	37.95	5390.07	5391.36	5391.46	5391.68	0.020368	4.98	10.28	35.90	0.94	1.05
PR - Tributary I	2050	10 YR	37.95	5389.03	5390.33	5390.42	5390.65	0.020708	5.02	10.09	34.31	0.95	1.07
PR - Tributary I	2000	10 YR	37.95	5388.00	5389.28	5389.40	5389.61	0.021262	5.05	10.14	35.94	0.96	1.08
PR - Tributary I	1950	10 YR	37.95	5386.96	5388.21	5388.31	5388.52	0.022011	5.01	10.80	46.08	0.97	1.08
PR - Tributary I	1900	10 YR	37.95	5385.93	5387.19	5387.28	5387.46	0.020039	4.81	11.70	52.16	0.93	0.99
PR - Tributary I	1850	10 YR	37.95	5384.89	5386.15	5386.24	5386.46	0.020199	4.89	10.31	35.58	0.94	1.02
PR - Tributary I	1800	10 YR	37.95	5383.85	5385.16	5385.24	5385.43	0.020635	4.63	10.66	37.11	0.94	0.94
PR - Tributary I	1750	10 YR	37.95	5382.66	5384.13	5384.15	5384.38	0.021180	4.43	10.51	29.26	0.93	0.89
PR - Tributary I	1700	10 YR	37.95	5381.95	5383.53	5383.53	5383.65	0.013633	3.31	15.54	61.91	0.73	0.52
PR - Tributary I	1650	10 YR	37.95	5381.09	5382.67	5382.55	5382.80	0.011326	3.28	15.09	53.13	0.69	0.48
PR - Tributary I	1600	10 YR	37.95	5380.66	5382.01	5382.00	5382.13	0.015841	3.34	14.48	48.77	0.78	0.54
PR - Tributary I	1550	10 YR	37.95	5379.85	5381.32	5381.32	5381.47	0.011004	3.72	14.96	55.74	0.69	0.58

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 10 YR (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR - Tributary I	1500	10 YR	37.95	5379.19	5380.68	5380.62	5380.76	0.005271	2.78	20.46	65.59	0.49	0.31
PR - Tributary I	1450	10 YR	37.95	5378.72	5380.19	5380.19	5380.34	0.014230	3.49	13.65	43.67	0.76	0.56
PR - Tributary I	1400	10 YR	37.95	5377.93	5379.73	5379.50	5379.76	0.002071	1.44	32.83	83.58	0.30	0.09
PR - Tributary I	1350	10 YR	51.57	5377.94	5379.34	5379.33	5379.52	0.009838	3.87	18.13	50.19	0.68	0.60
PR - Tributary I	1300	10 YR	51.57	5377.44	5378.84	5378.83	5379.02	0.010060	3.90	17.94	49.86	0.69	0.61
PR - Tributary I	1250	10 YR	51.57	5376.94	5378.34	5378.34	5378.53	0.009727	3.85	18.22	50.44	0.68	0.59
PR - Tributary I	1200	10 YR	51.57	5376.44	5377.83	5377.83	5378.02	0.010170	3.92	17.85	49.87	0.69	0.62
PR - Tributary I	1150	10 YR	51.57	5375.94	5377.35	5377.33	5377.53	0.009529	3.82	18.39	50.89	0.67	0.58
PR - Tributary I	1100	10 YR	51.57	5375.44	5376.83	5376.82	5377.02	0.010502	3.97	17.47	48.46	0.70	0.63
PR - Tributary I	1050	10 YR	51.57	5374.94	5376.33	5376.32	5376.52	0.009691	3.83	18.28	51.36	0.68	0.59
PR - Tributary I	1000	10 YR	51.57	5374.44	5375.84	5375.84	5376.03	0.009797	3.87	18.32	52.97	0.68	0.60
PR - Tributary I	950	10 YR	51.57	5373.93	5375.40	5375.26	5375.54	0.006798	3.34	19.42	41.47	0.57	0.44
PR - Tributary I	900	10 YR	51.57	5373.44	5374.85	5374.85	5375.10	0.011807	4.27	15.00	34.14	0.75	0.73
PR - Tributary I	838.96	10 YR	51.57	5372.81	5374.57	5373.74	5374.69	0.003416	2.79	18.47	10.76	0.38	0.28
PR - Tributary I	838.25		Culvert										
PR - Tributary I	598.1	10 YR	51.57	5370.41	5371.81		5372.02	0.007177	3.60	14.34	10.50	0.54	0.50
PR - Tributary I	550	10 YR	51.57	5369.65	5371.00	5371.00	5371.45	0.020617	5.40	9.70	11.30	0.98	1.19
PR - Tributary I	500	10 YR	51.57	5368.85	5370.16	5370.25	5370.47	0.016947	4.77	13.82	40.44	0.88	0.94
PR - Tributary I	450	10 YR	51.57	5368.05	5369.25	5369.35	5369.56	0.019193	4.80	13.69	48.08	0.93	0.98
PR - Tributary I	400	10 YR	51.57	5367.25	5368.57	5368.60	5368.80	0.011890	4.21	16.28	46.85	0.75	0.71
PR - Tributary I	350	10 YR	51.57	5366.46	5367.77	5367.86	5368.08	0.017032	4.79	13.84	41.19	0.88	0.95
PR - Tributary I	300	10 YR	51.57	5365.67	5365.19	5361.60	5365.19	0.000008		201.72	76.60	0.00	
PR - Tributary I	250	10 YR	51.57	5364.86	5365.18		5365.19	0.000028	0.08	163.38	115.13	0.03	0.00
PR - Tributary I	194.84	10 YR	51.57	5363.99	5365.09	5364.58	5365.17	0.003399	2.29	22.50	21.03	0.39	0.21
PR - Tributary I	194.59		Culvert										
PR - Tributary I	113.93	10 YR	51.57	5363.86	5364.44	5364.43	5364.71	0.025947	4.23	12.18	21.69	1.00	0.88
PR - Tributary I	101	10 YR	51.57	5363.73	5364.36	5364.23	5364.45	0.010018	2.34	22.49	68.06	0.61	0.28

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 10 YR

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PR - Tributary I	3140 West Ped	10 YR					5414.00					
PR - Tributary I	3140 West 10YR	10 YR					5414.00					
PR - Tributary I	838.25 10-YR East	10 YR	5374.70	5374.57	5374.48	5374.70	5387.51	50.51		2.76	5.88	8.47
PR - Tributary I	838.25 West-Ped	10 YR	5374.70	5374.57	5374.64	5374.69	5387.51	1.06		2.76	1.51	1.82
PR - Tributary I	194.59 Double	10 YR	5365.18	5365.09	5365.05	5365.18	5369.61	51.57		0.65	3.79	4.70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RS = 2750
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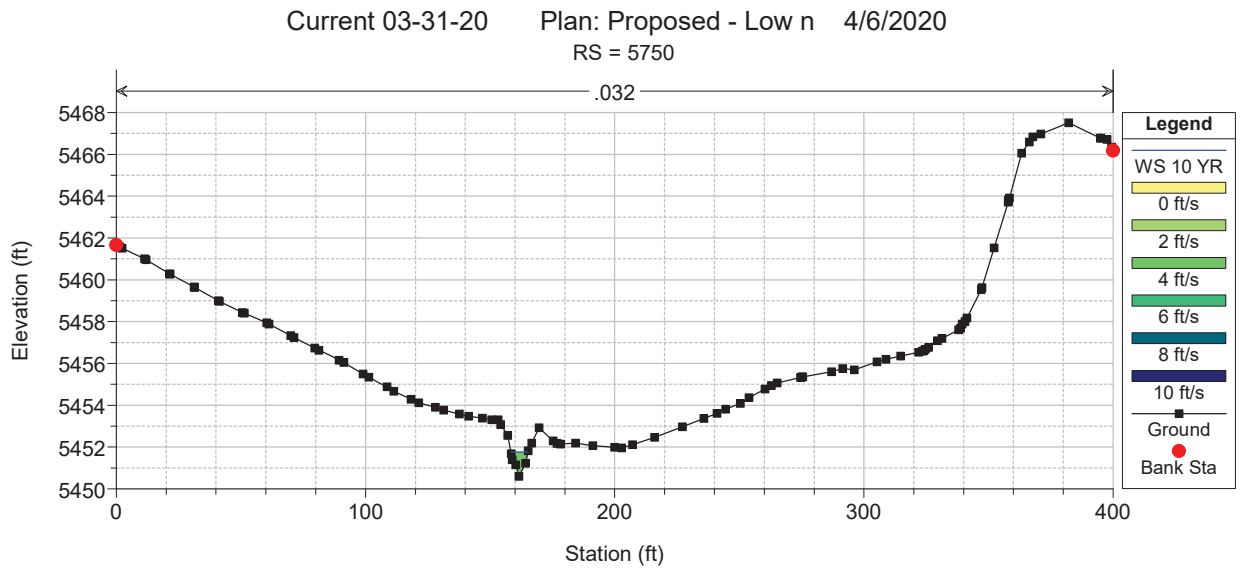
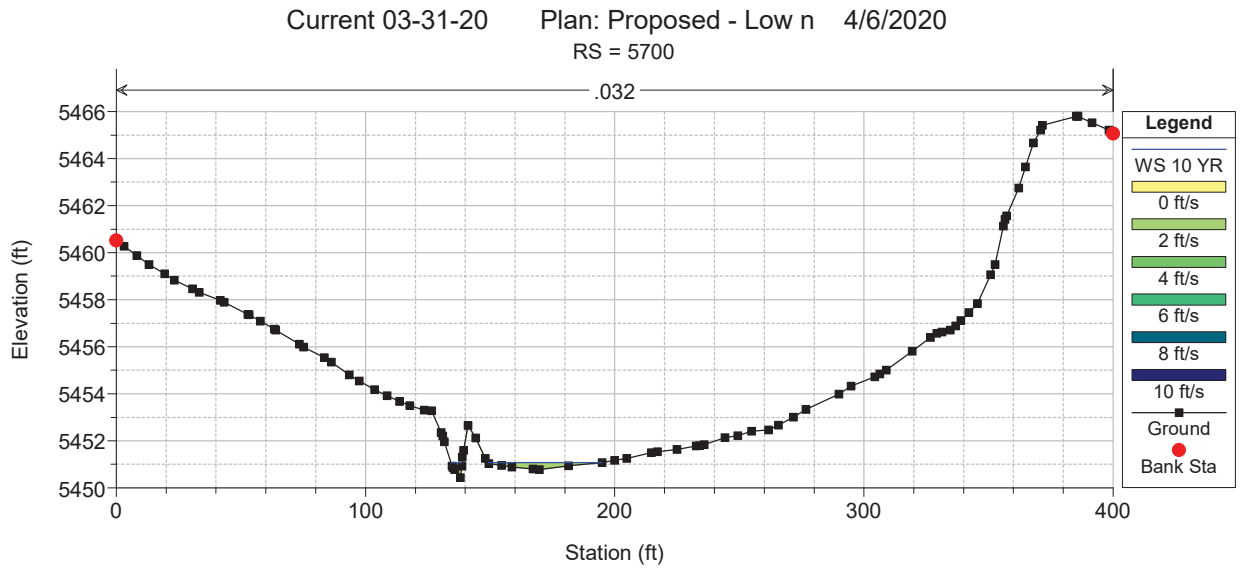
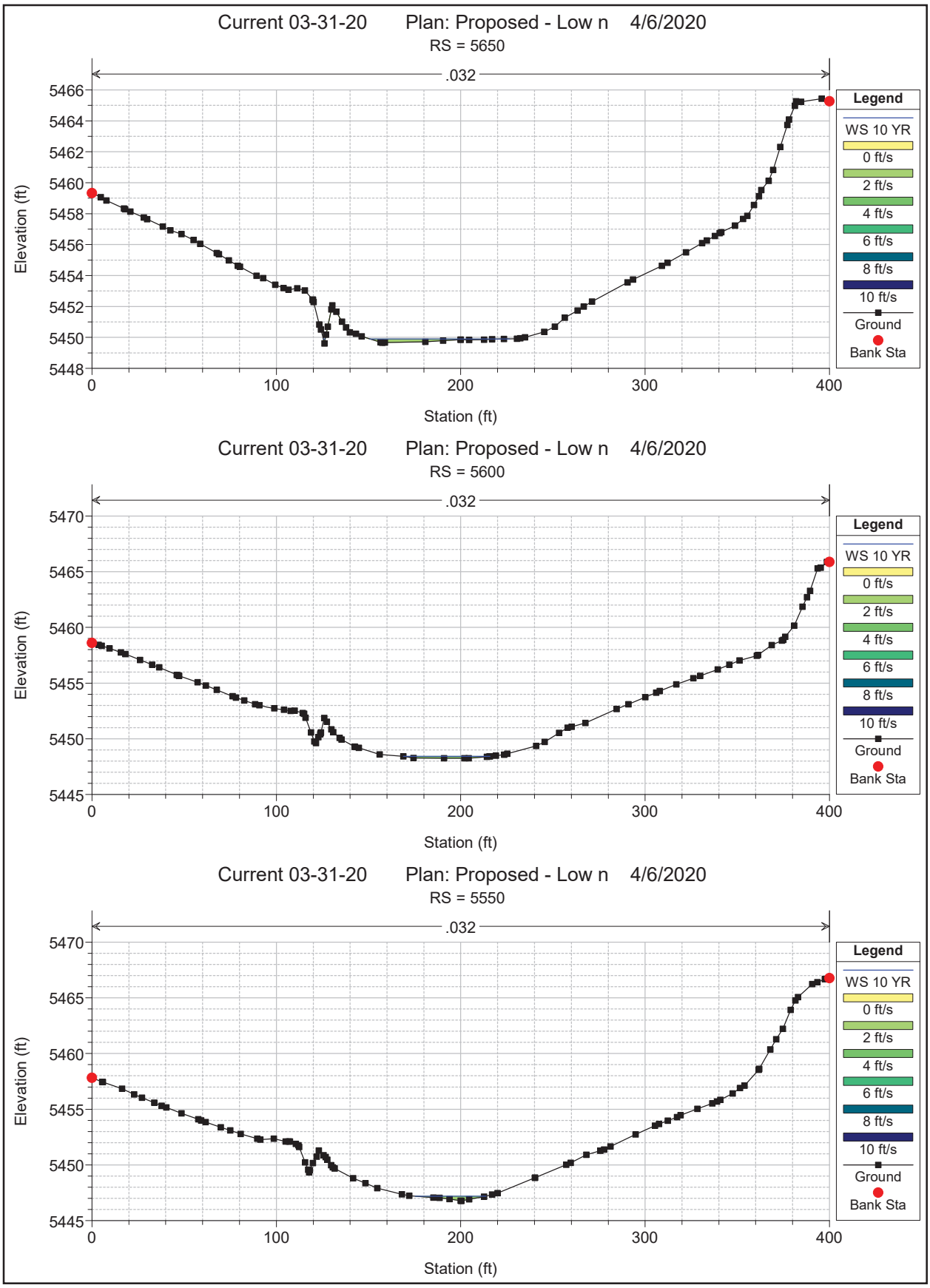
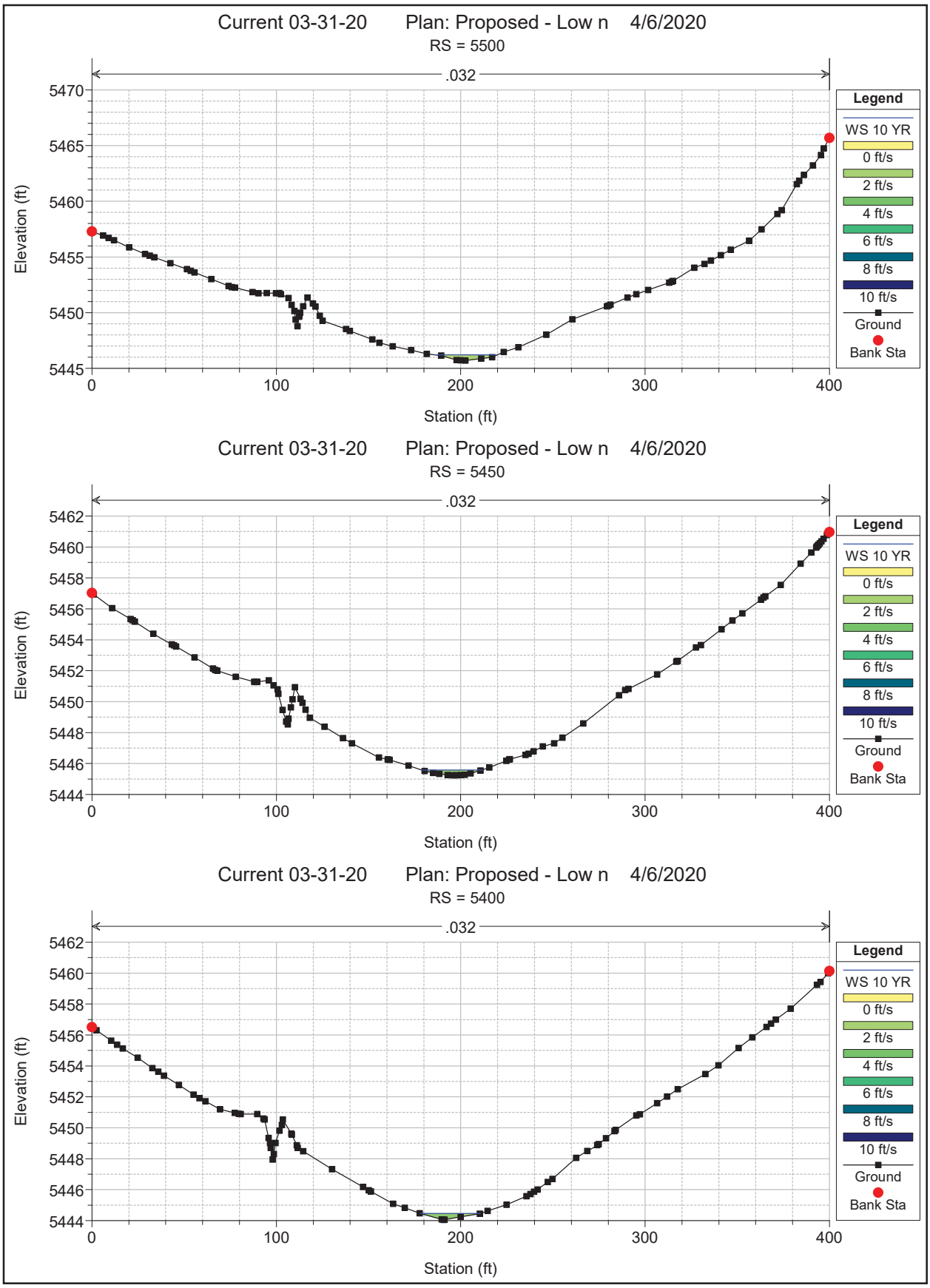
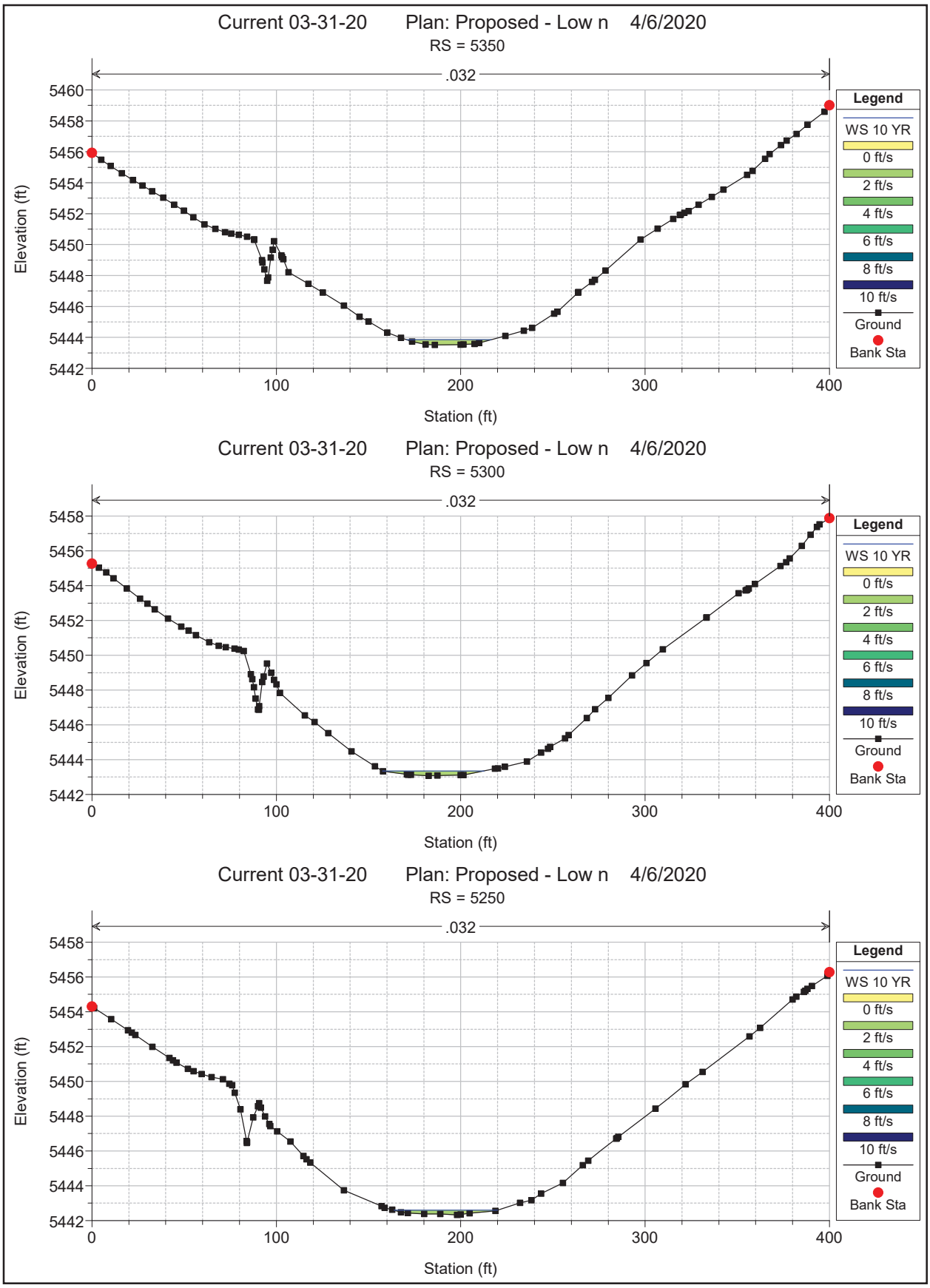
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

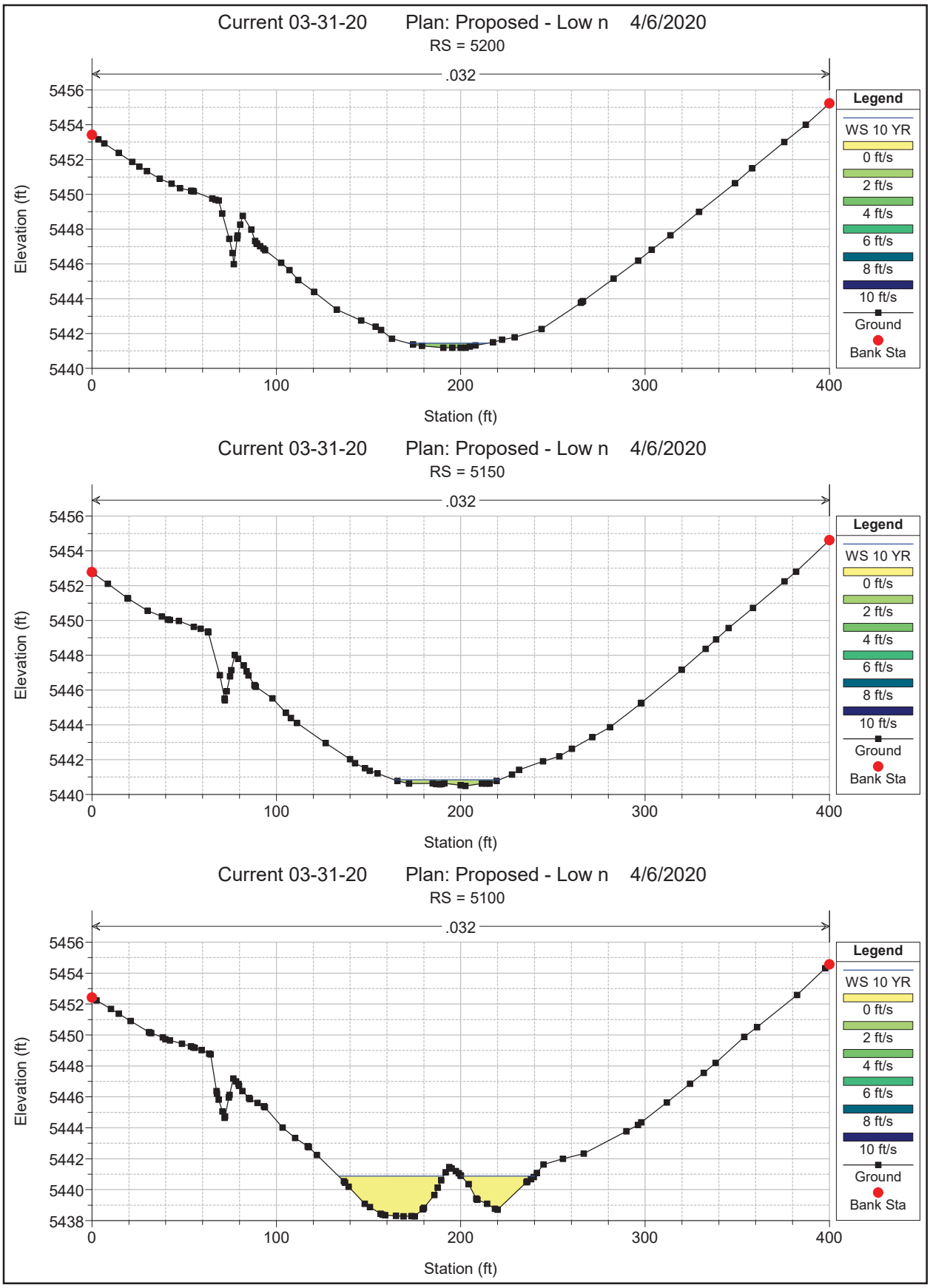

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5750
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

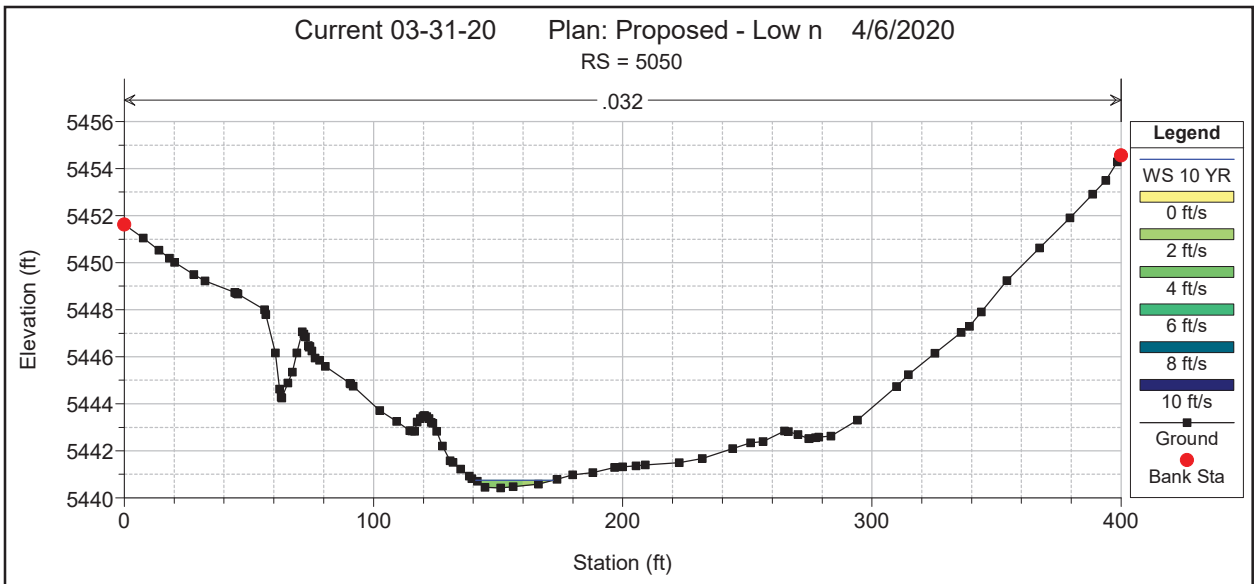

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5700
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

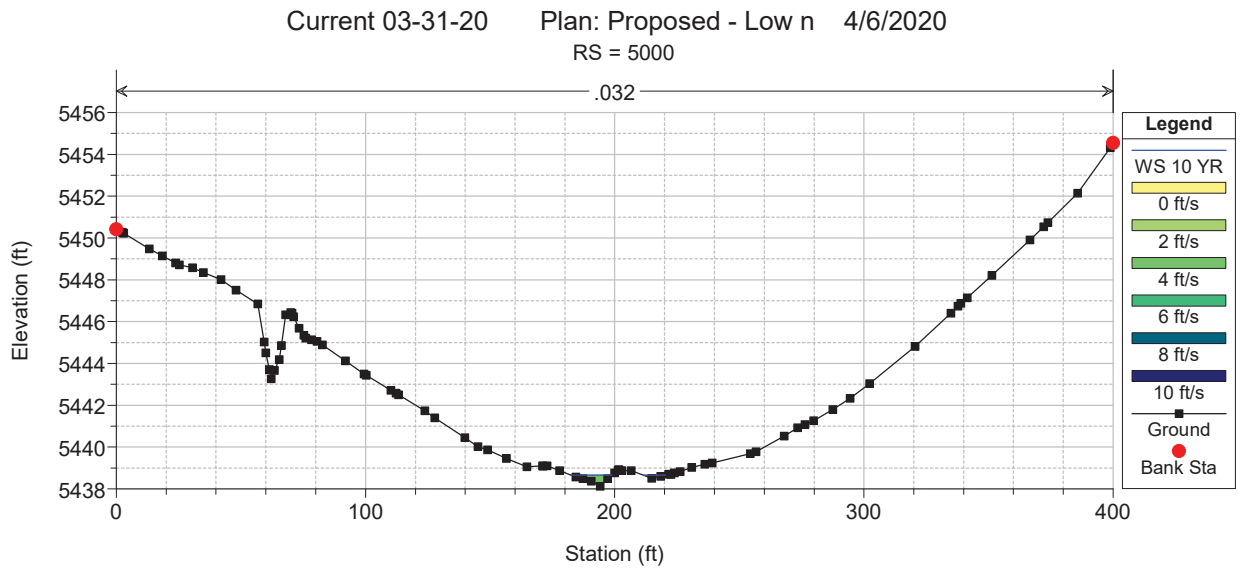

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5650
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5600
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5550
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

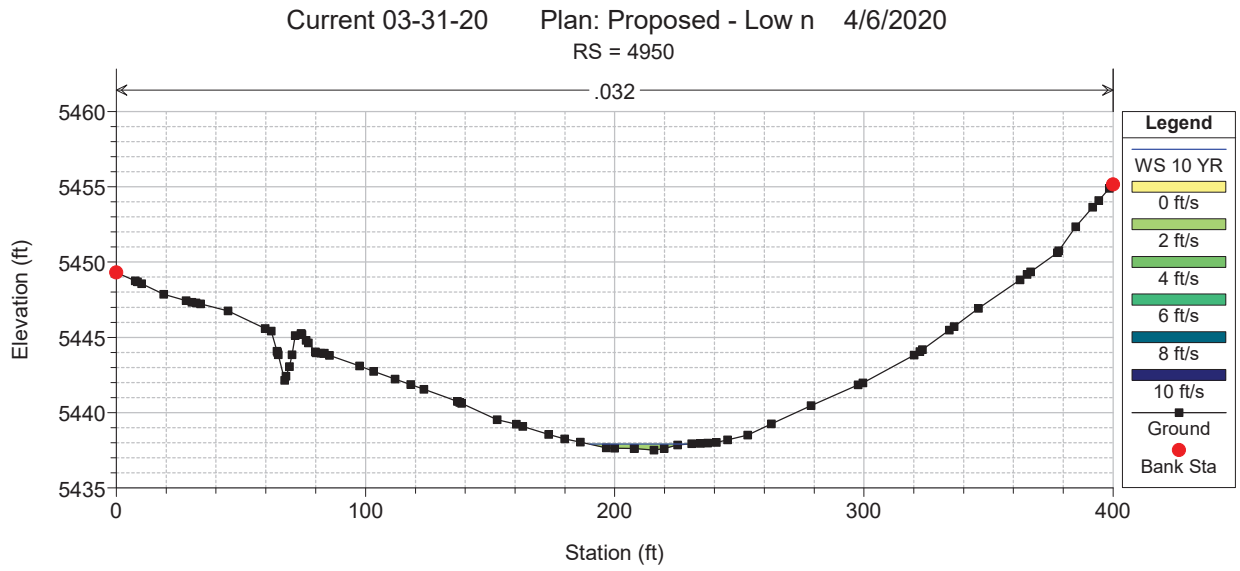

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5500
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5450
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5400
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

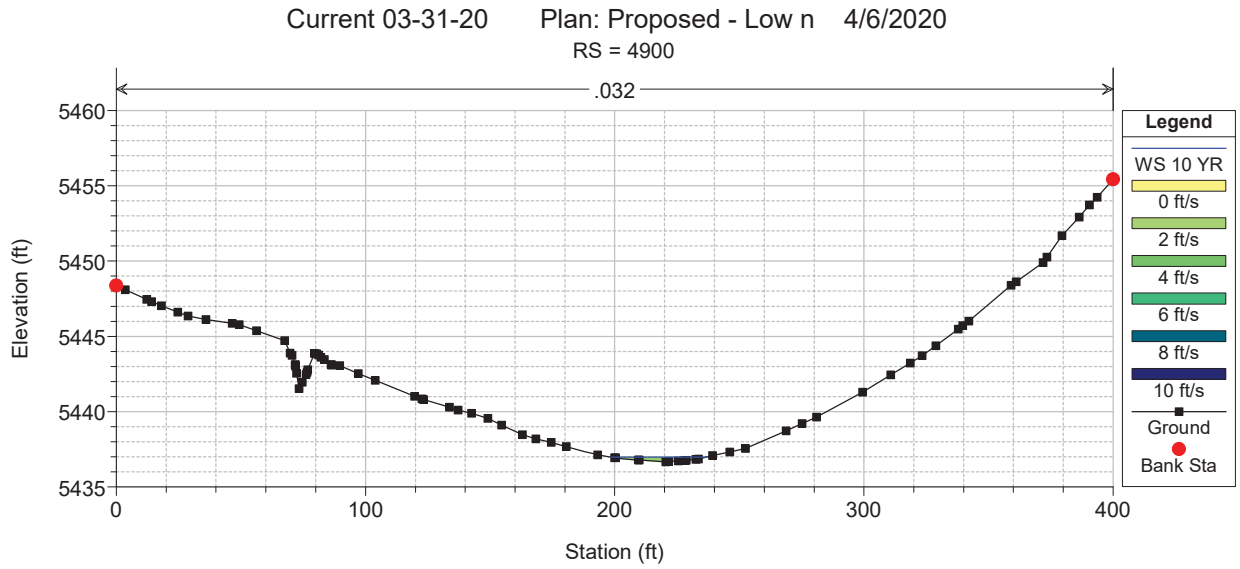

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5350
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5300
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5250
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

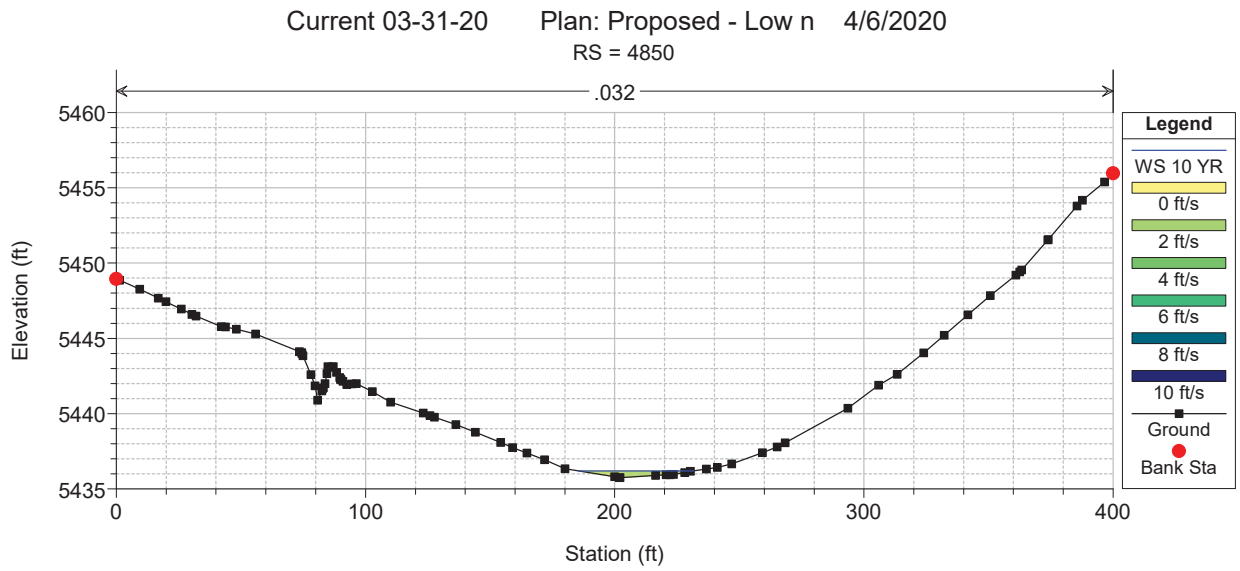

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5200
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5150
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5100
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

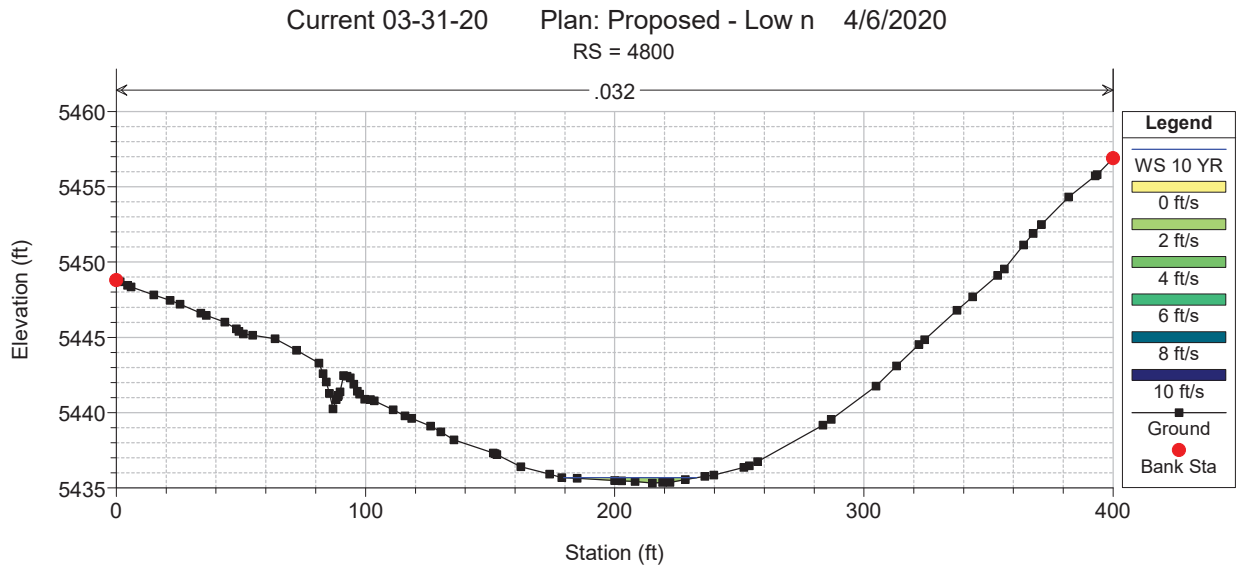

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5050
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

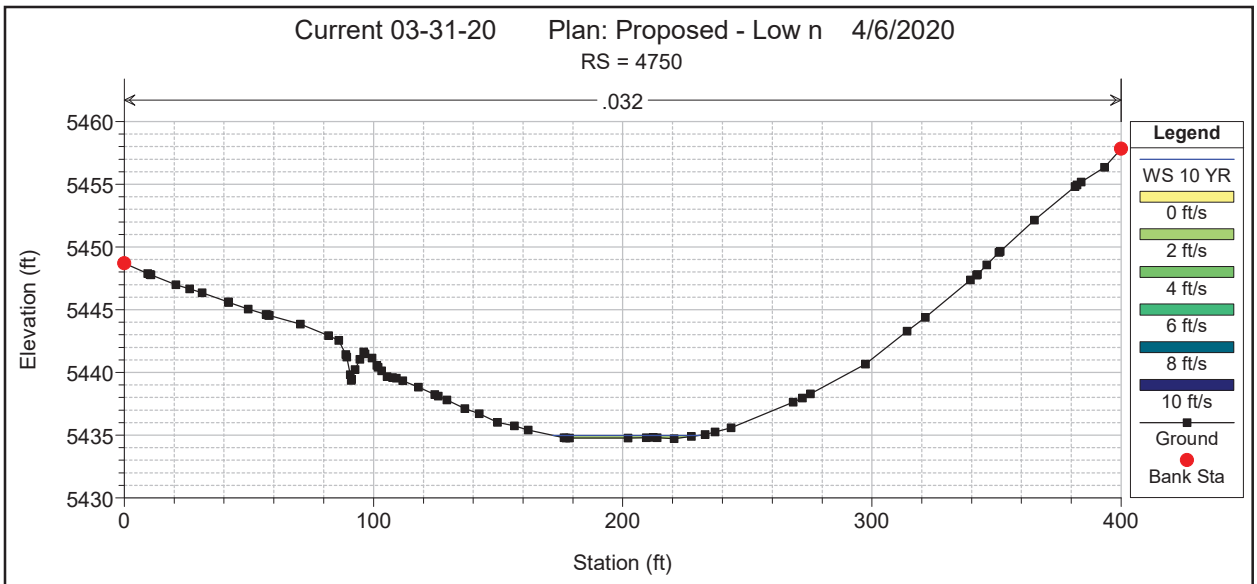

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5000
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

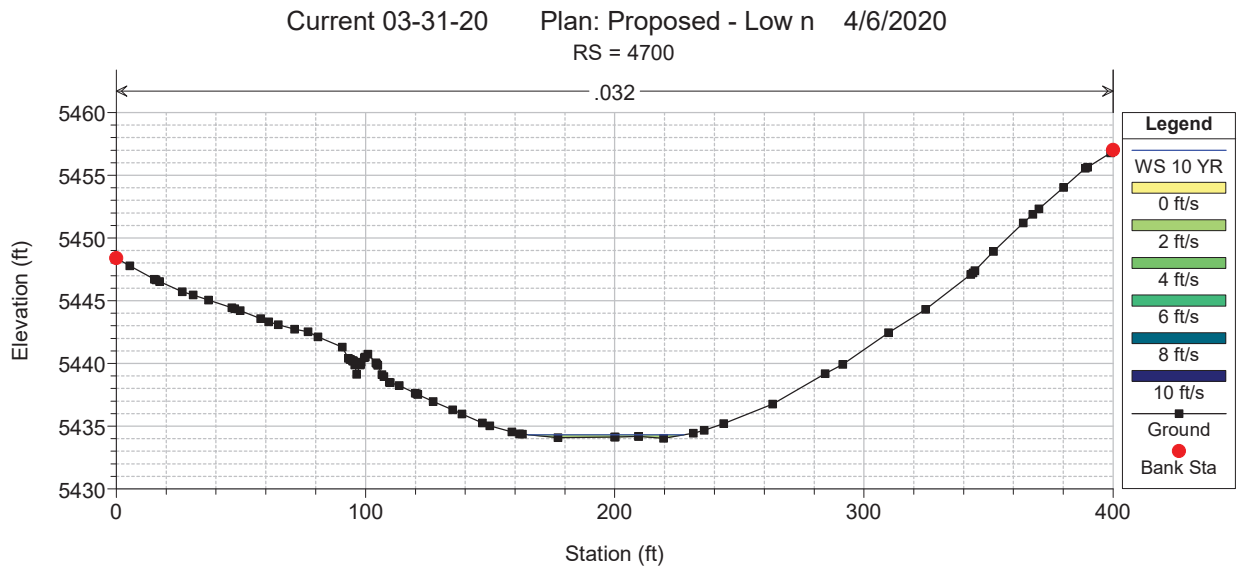

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4950
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

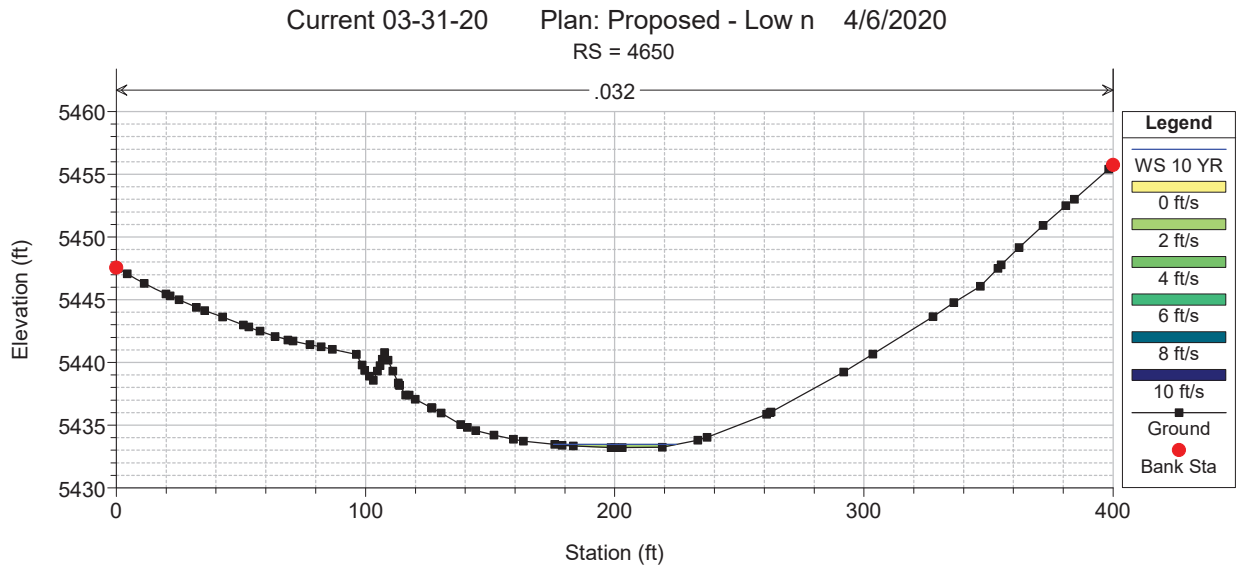

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4900
.032
Elevation (ft)
5460
5455
5450
5445
5440
5435
0
100
200
300
400
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

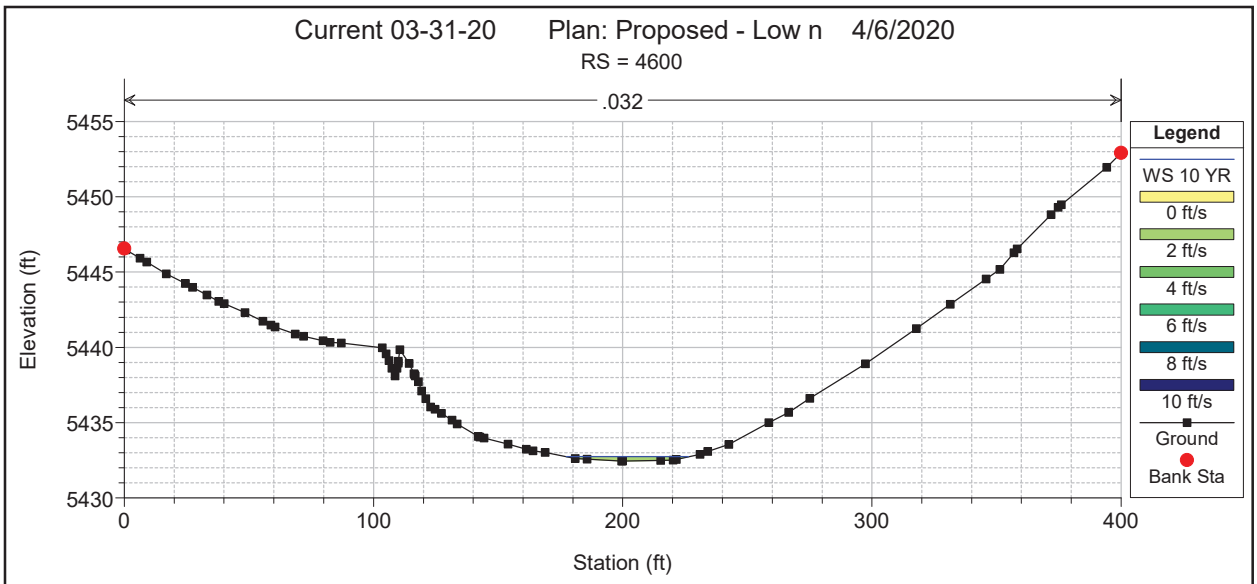

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4850
.032
Elevation (ft)
5460
5455
5450
5445
5440
5435
0
100
200
300
400
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

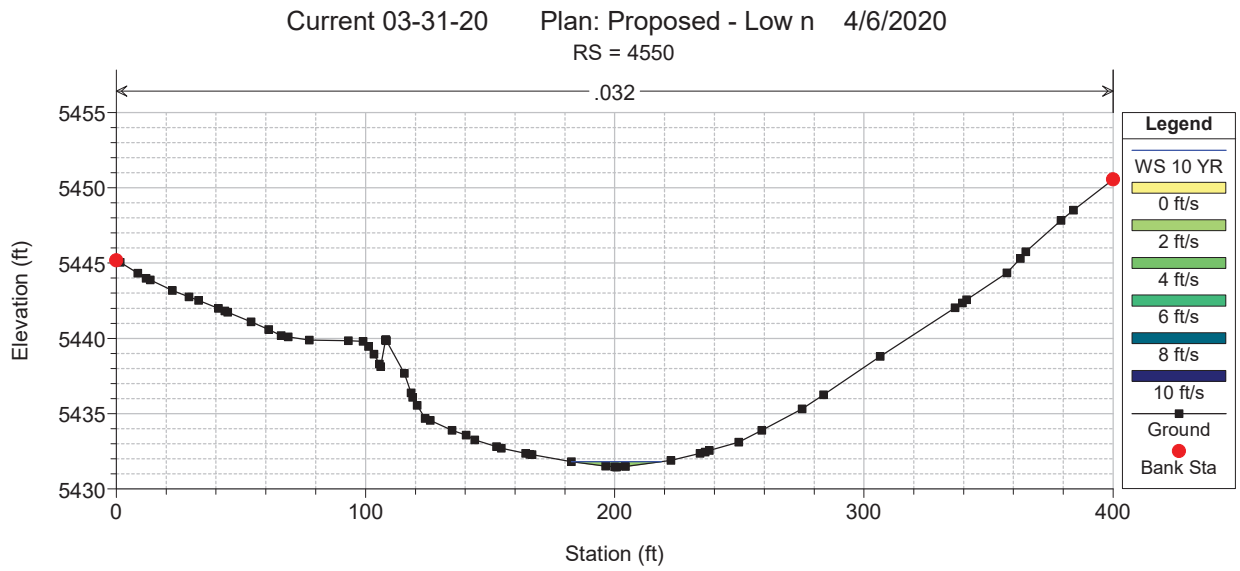

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4800
.032
Elevation (ft)
5460
5455
5450
5445
5440
5435
0
100
200
300
400
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

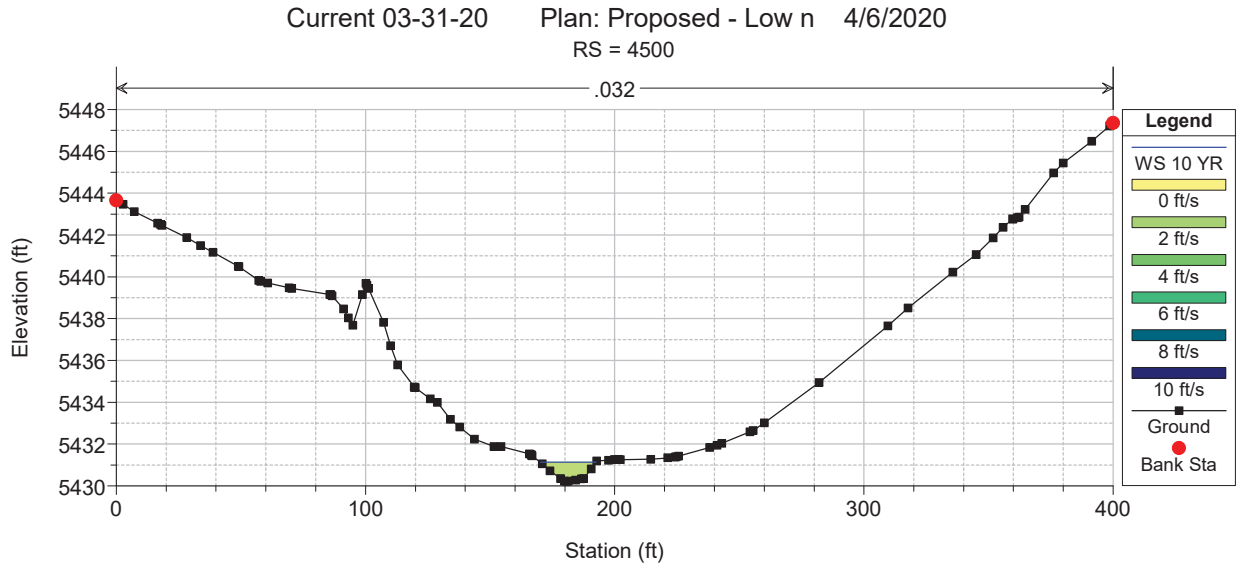

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4750
.032
Elevation (ft)
5460
5455
5450
5445
5440
5435
5430
0
100
200
300
400
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

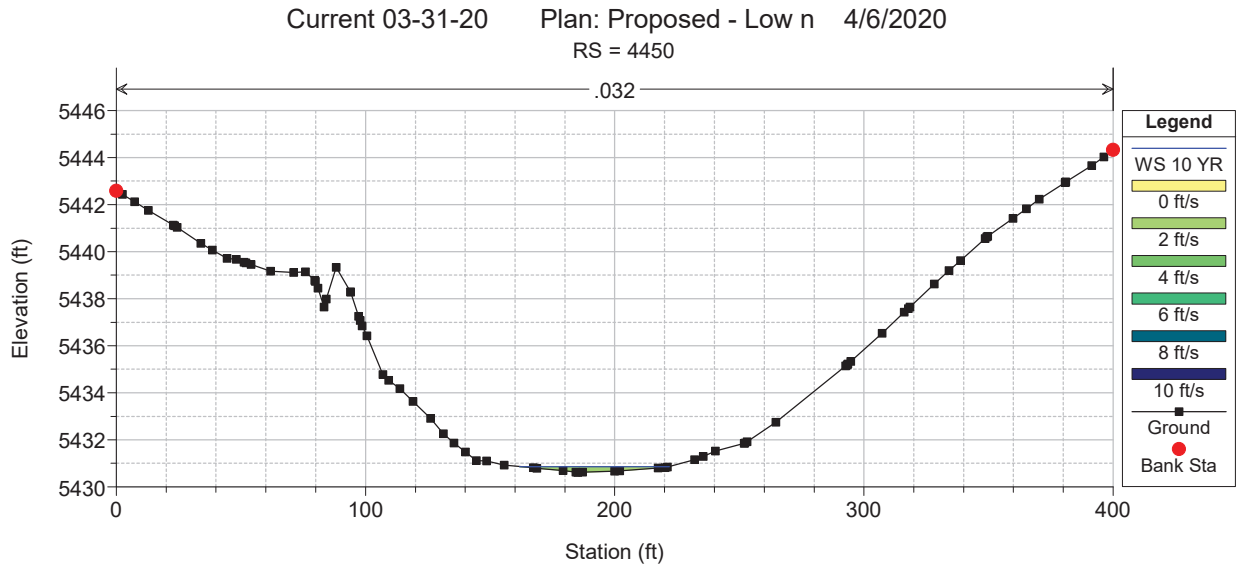

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4700
.032
Elevation (ft)
5460
5455
5450
5445
5440
5435
5430
0
100
200
300
400
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

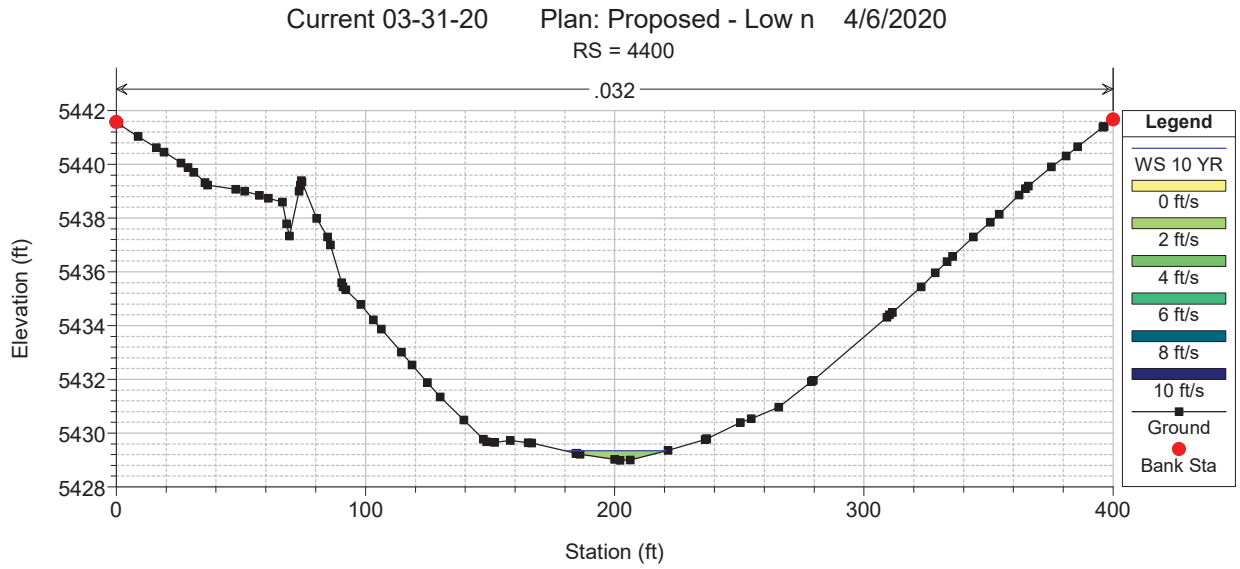

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4650
.032
Elevation (ft)
5460
5455
5450
5445
5440
5435
5430
0
100
200
300
400
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

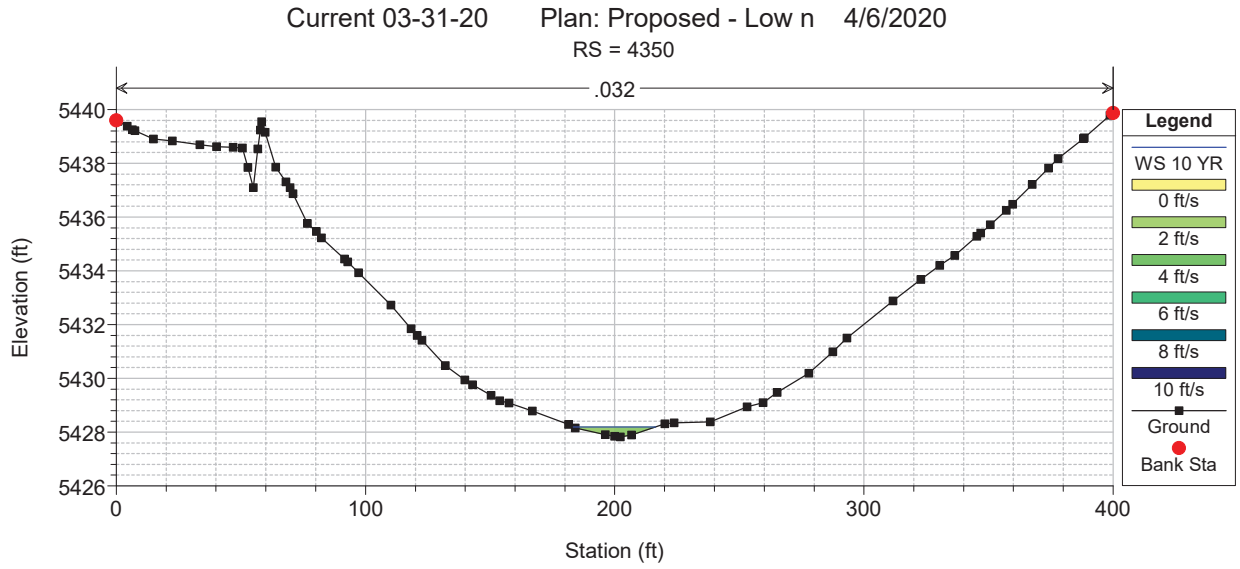

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4600
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

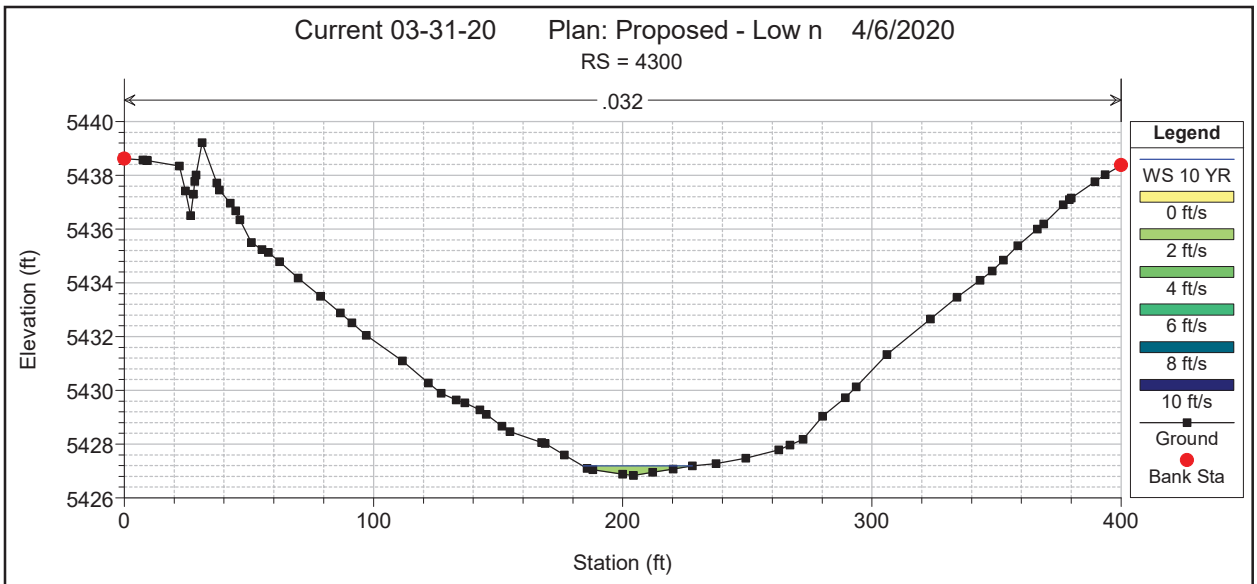

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4550
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

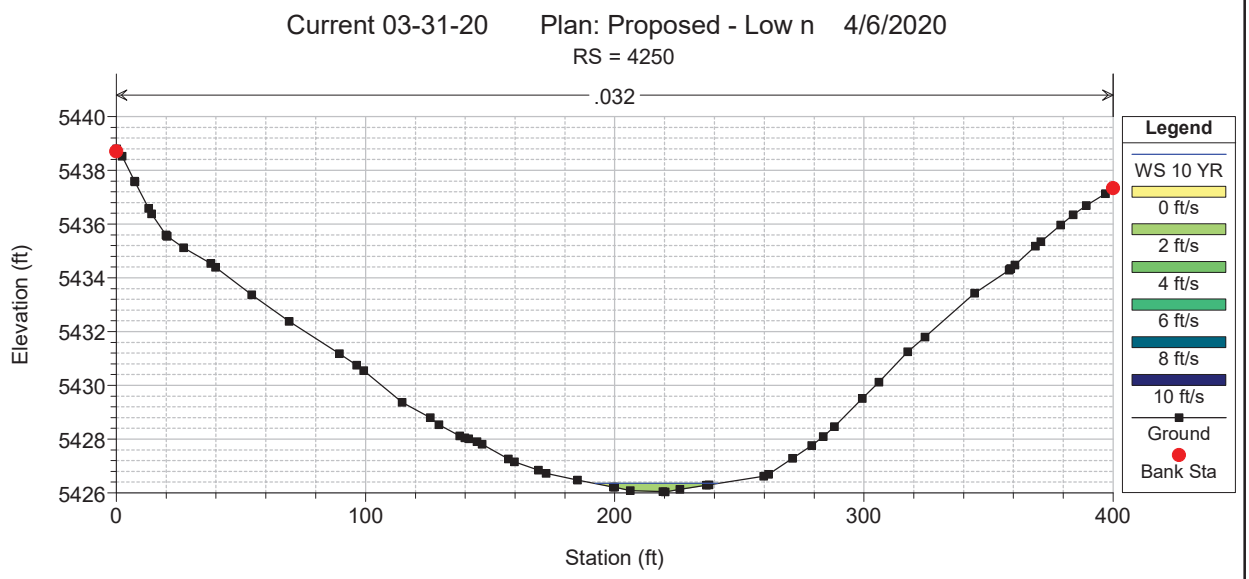

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4500
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

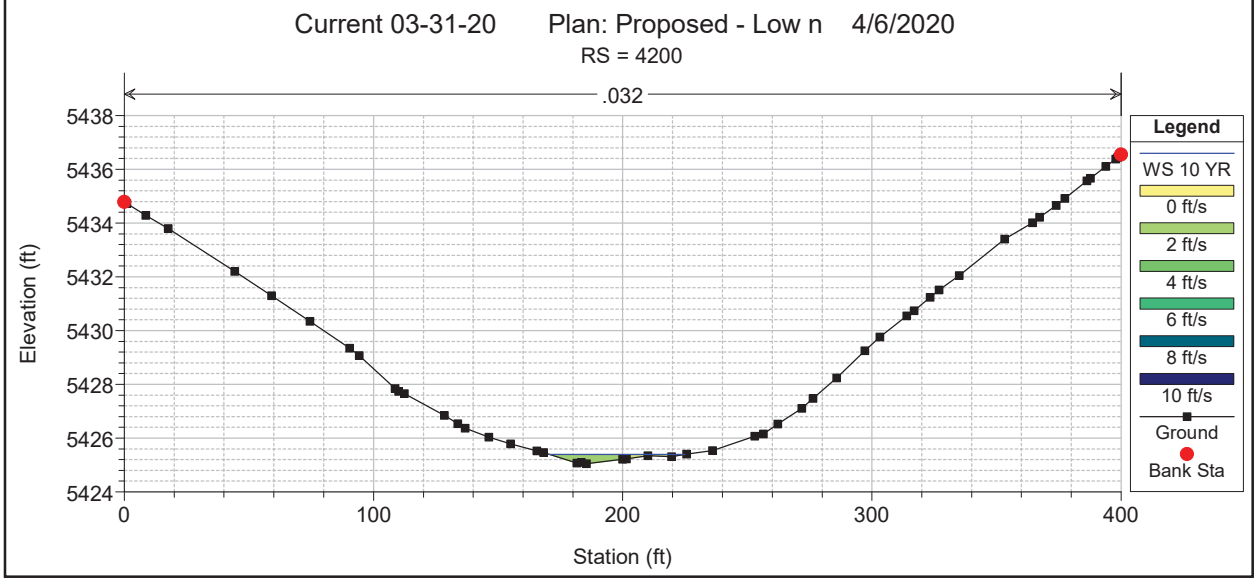

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4450
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

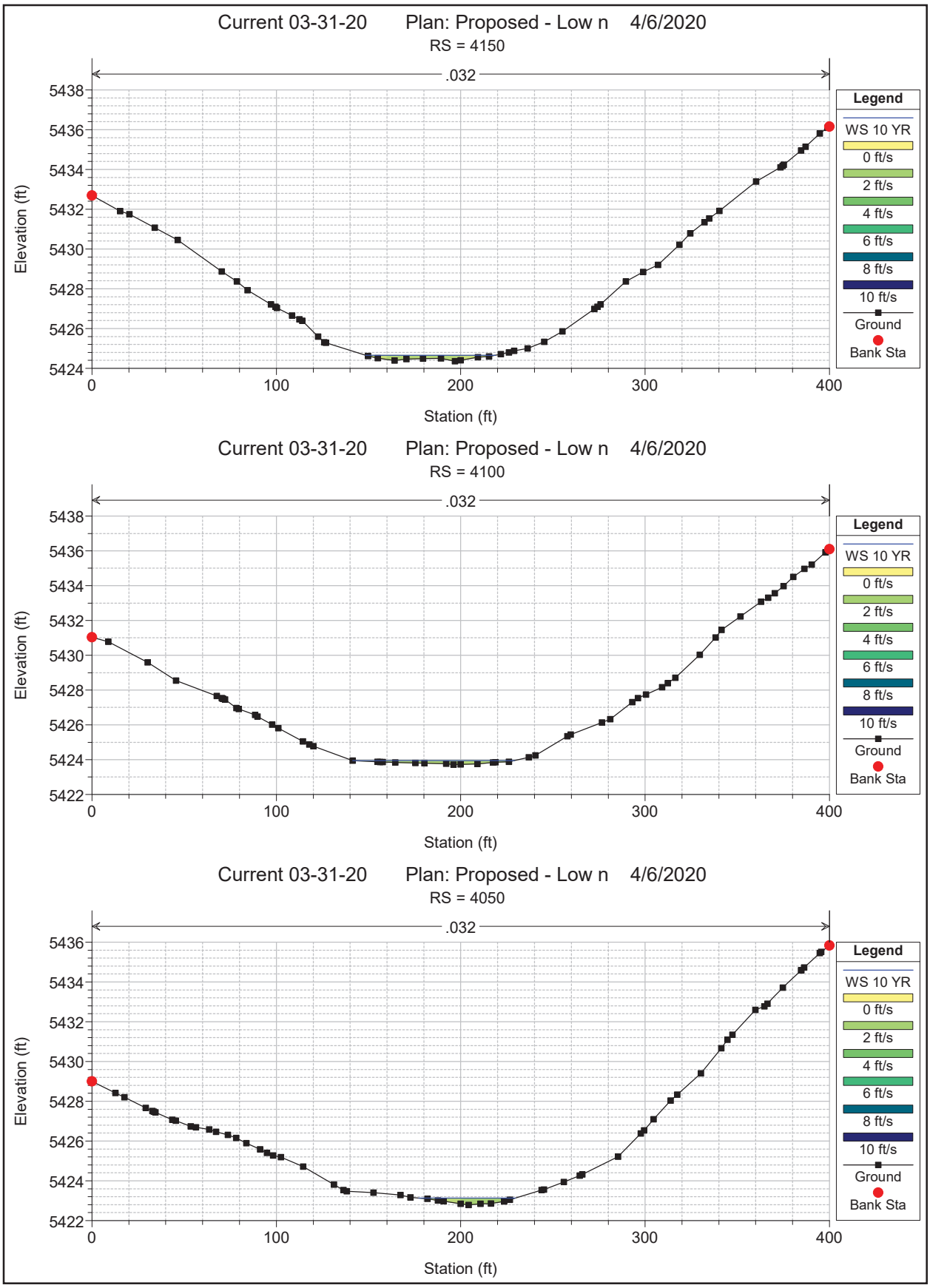

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4400
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

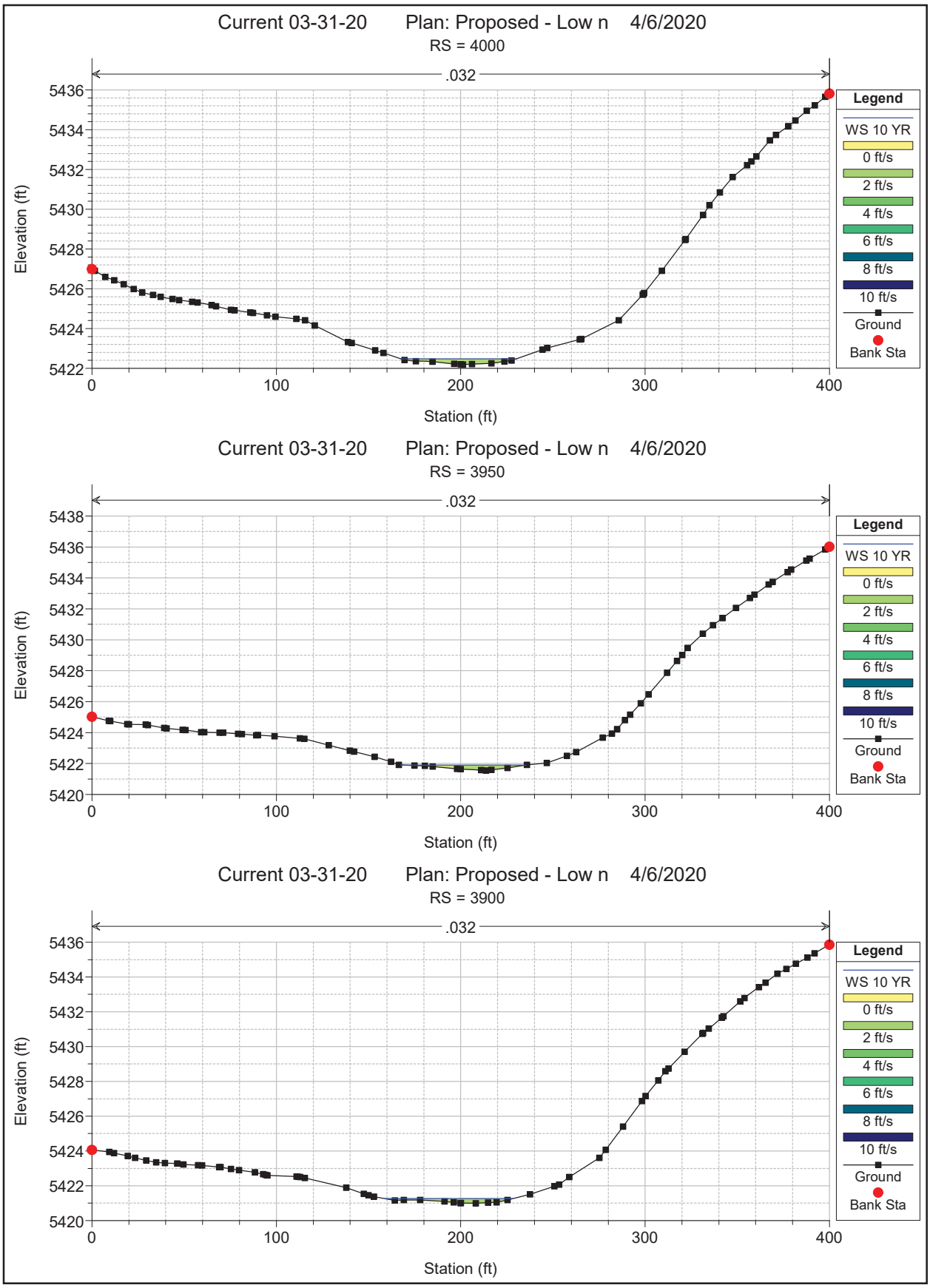

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4350
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

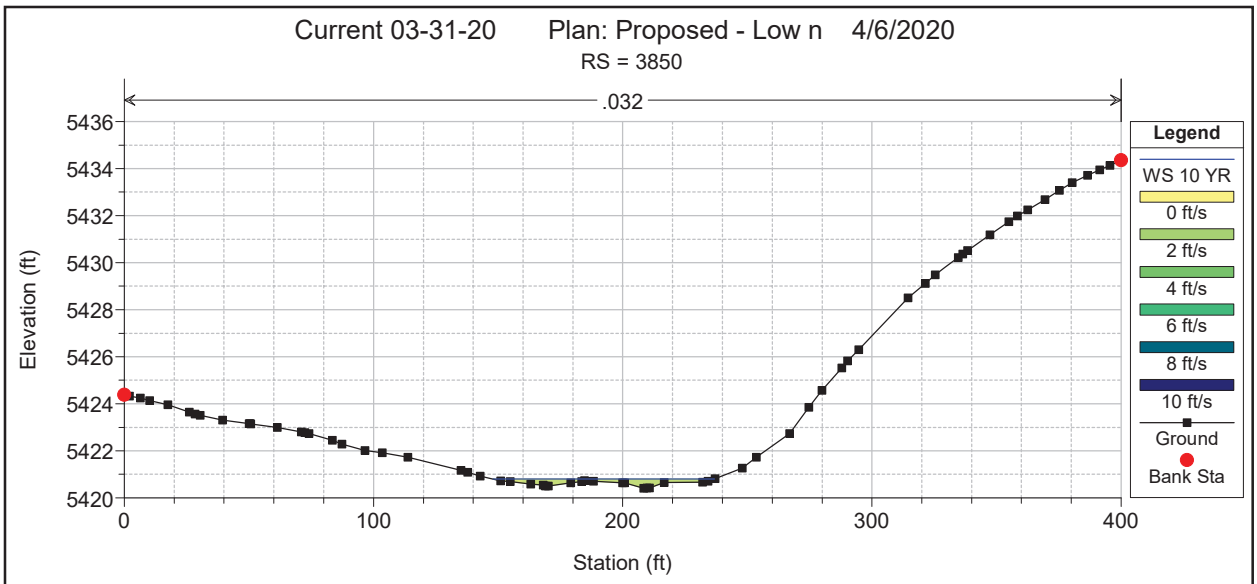

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4300
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

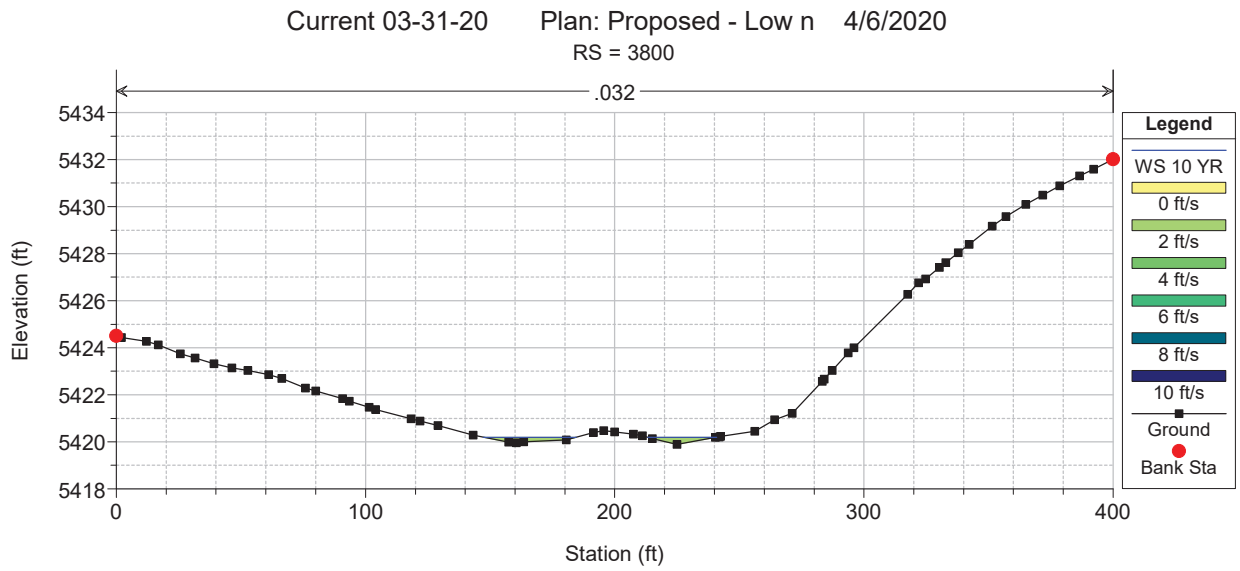

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4250
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

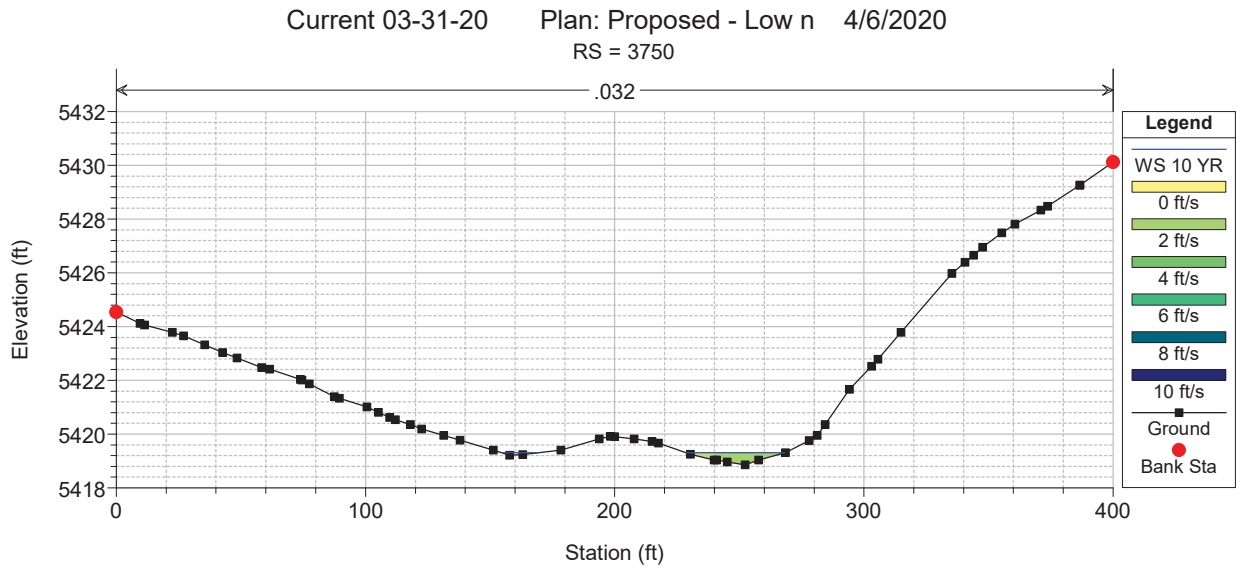

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4200
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

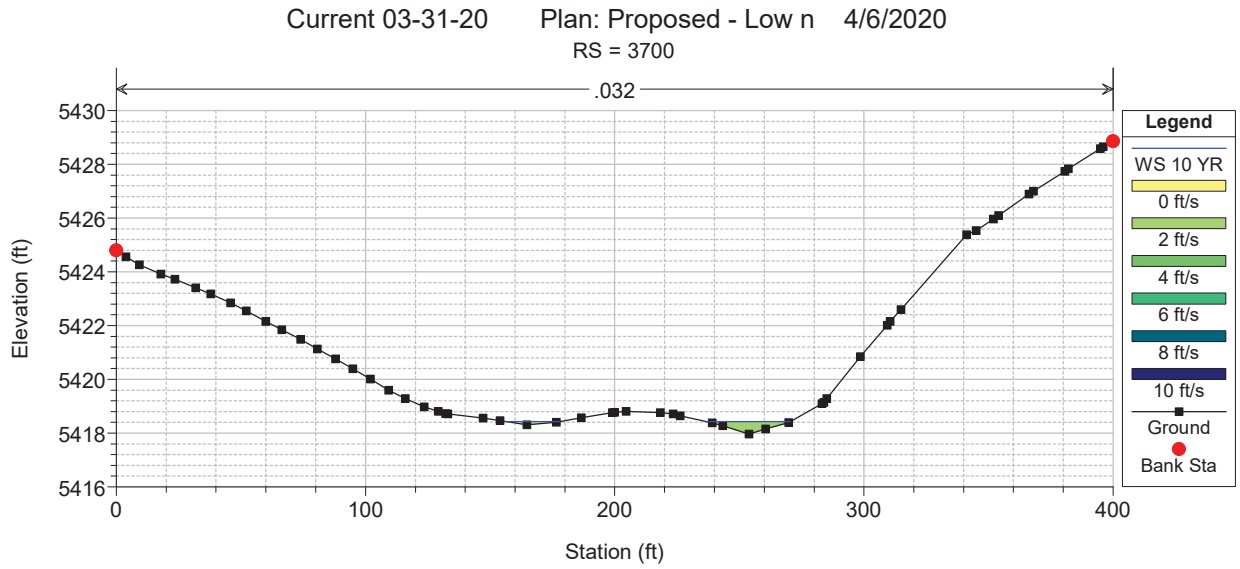

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4150
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4100
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4050
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

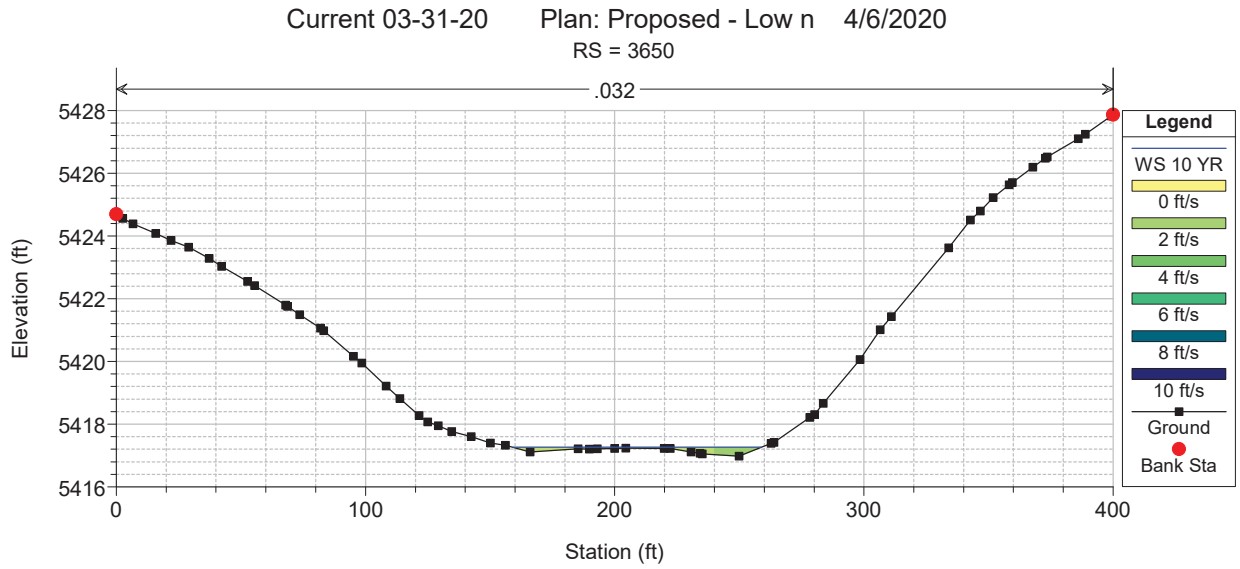

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4000
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3950
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3900
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

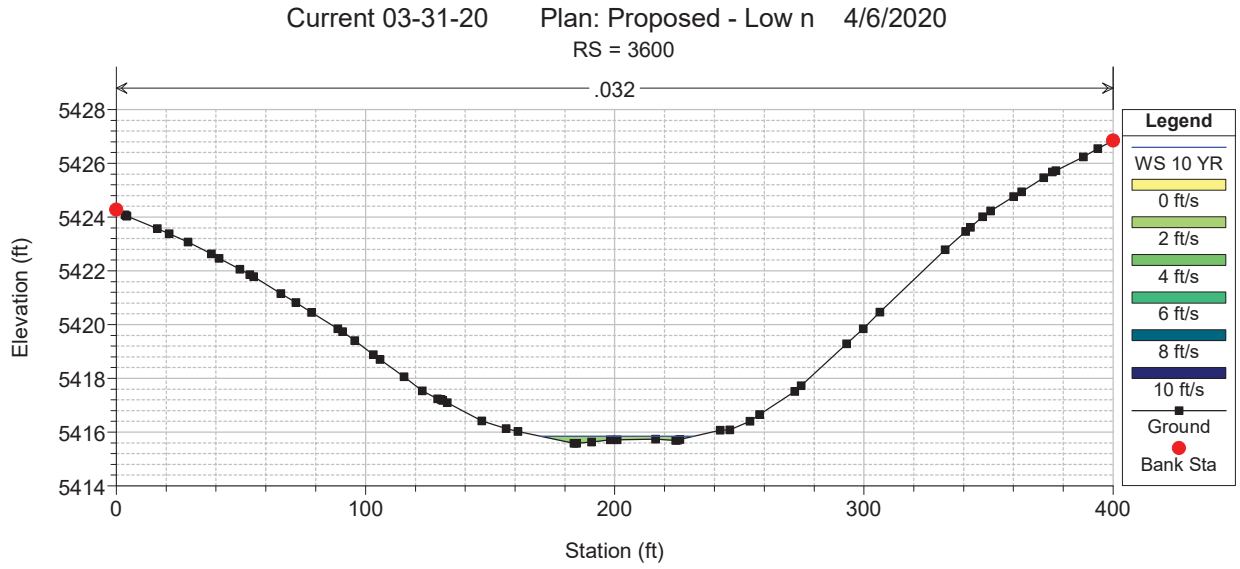

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3850
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

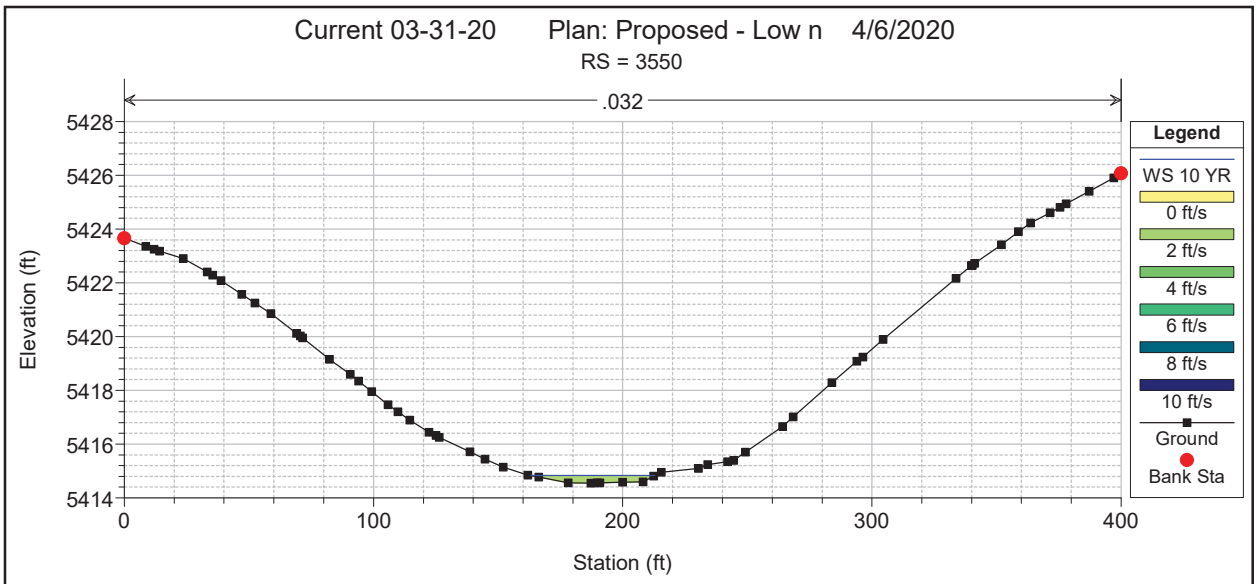

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3800
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

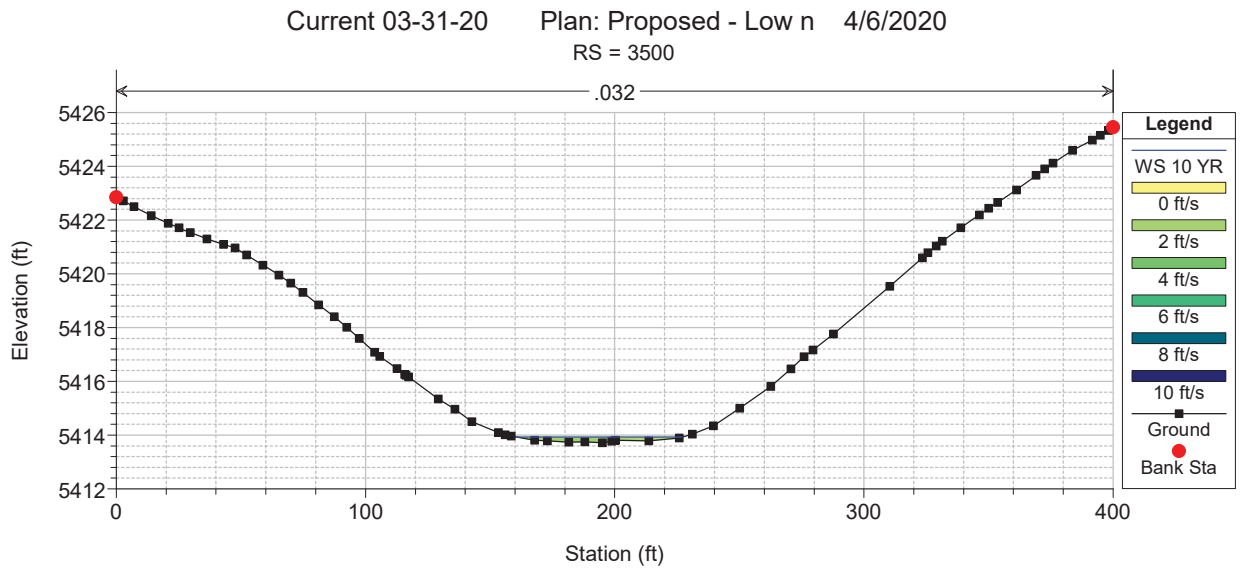

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3750
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

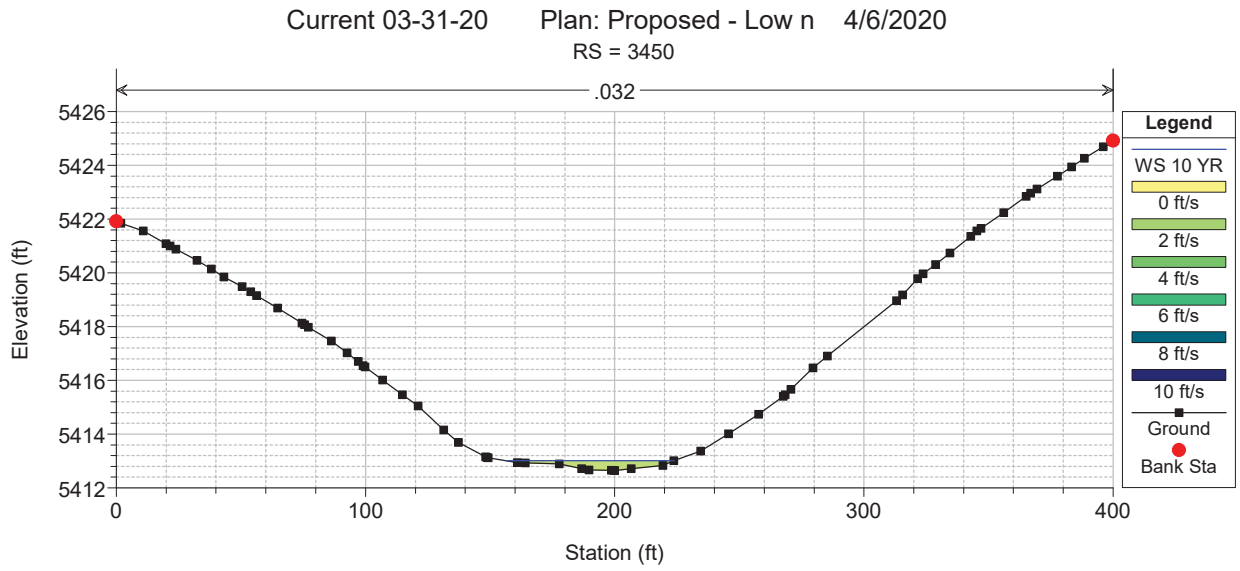

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3700
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

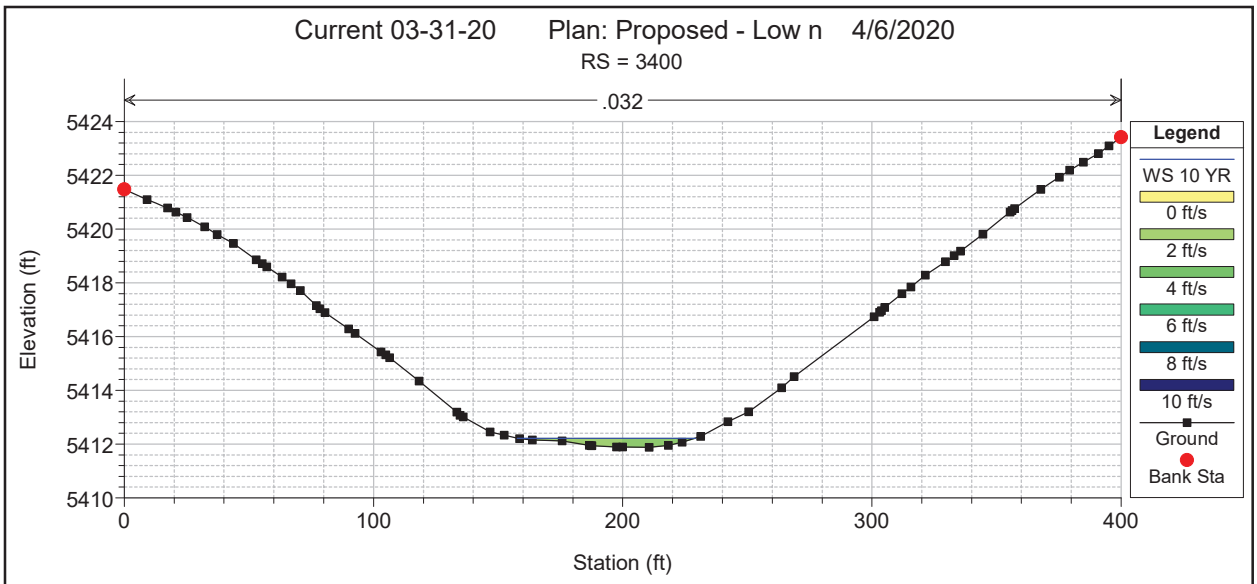

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3650
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

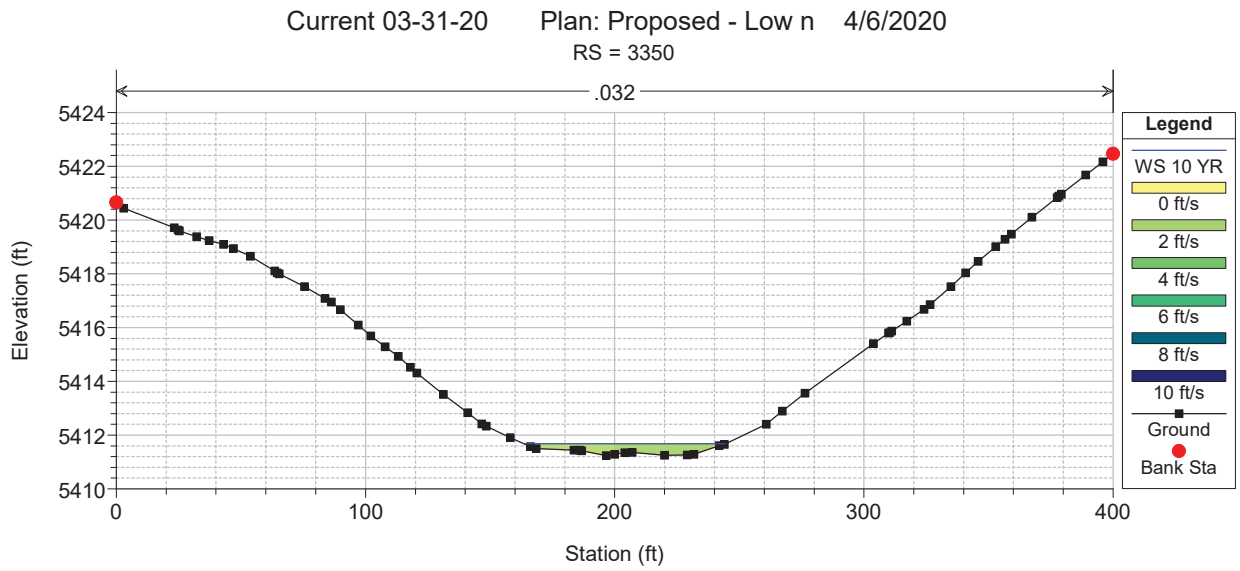

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3600
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

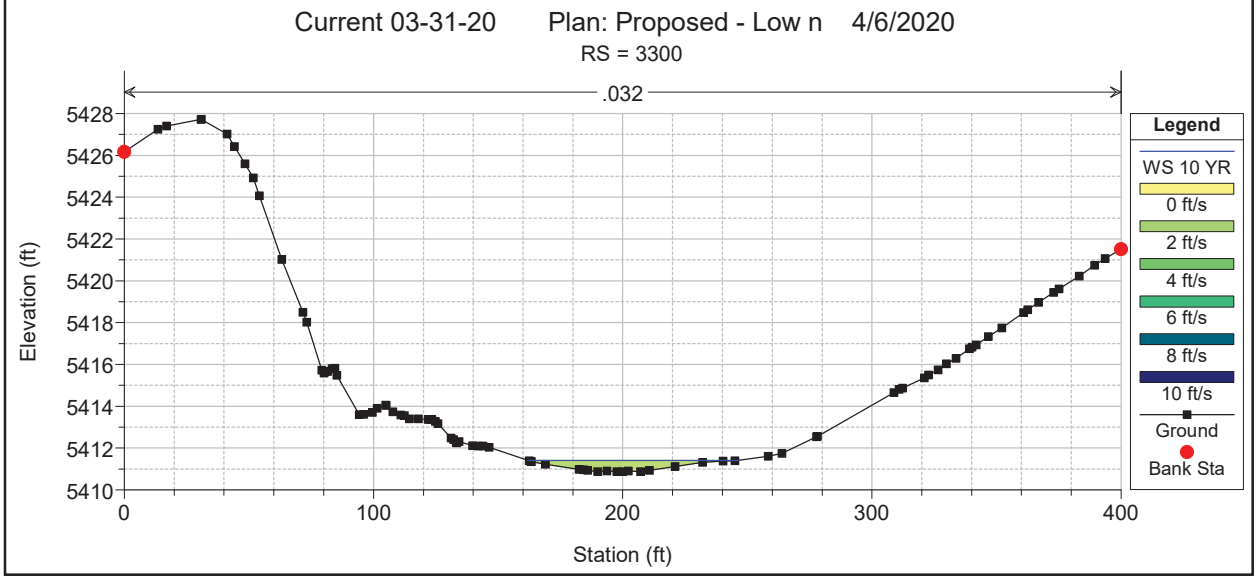

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3550
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

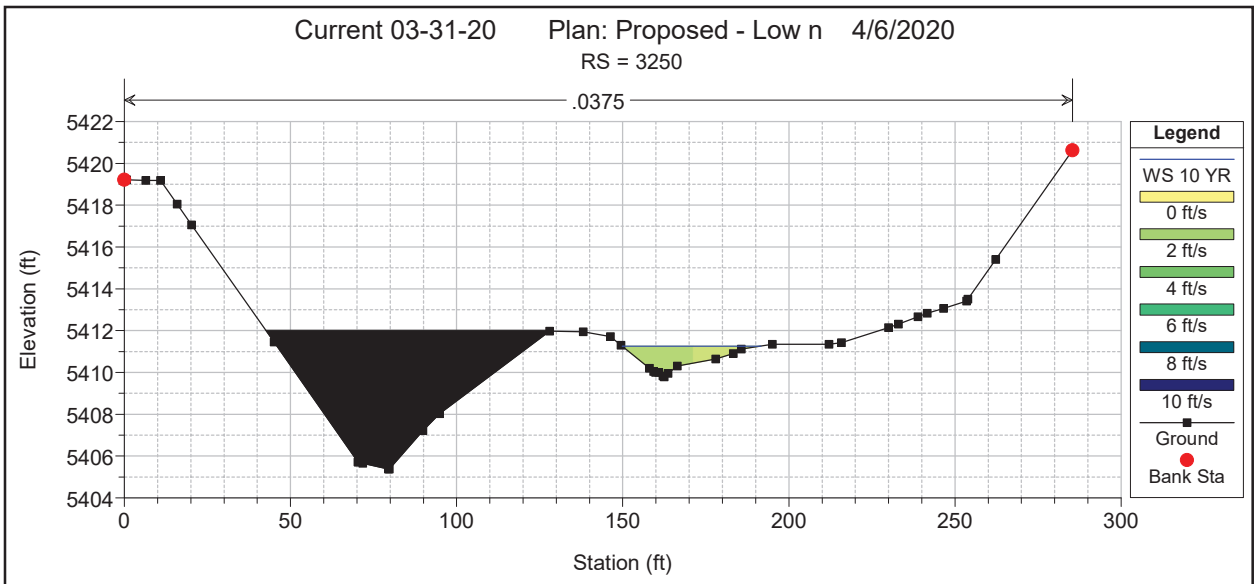

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3500
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

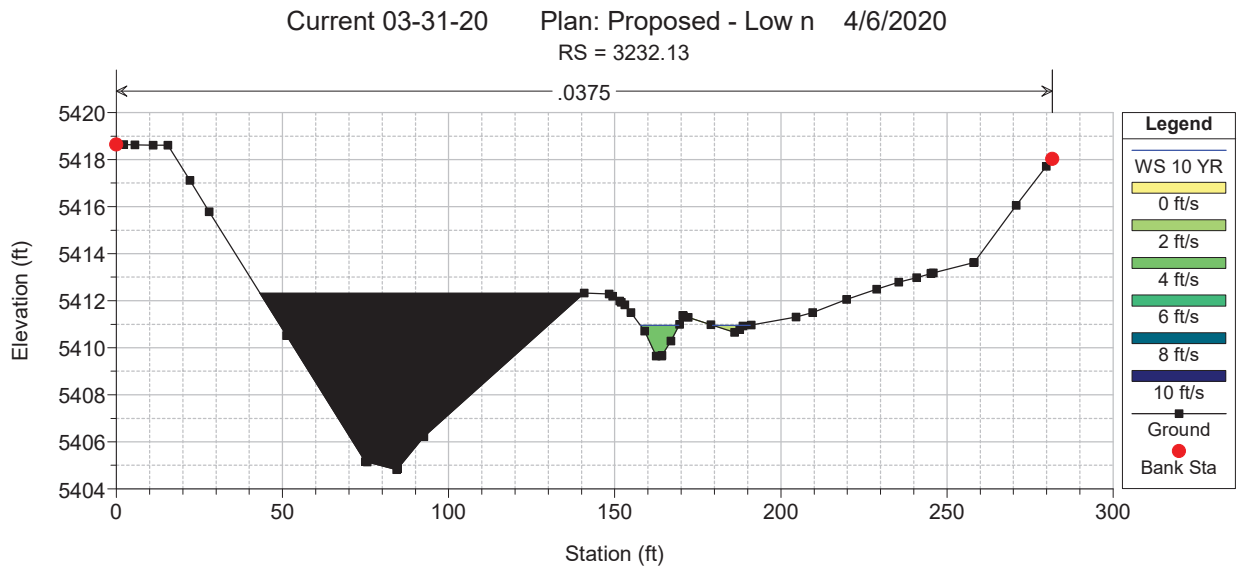

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3450
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

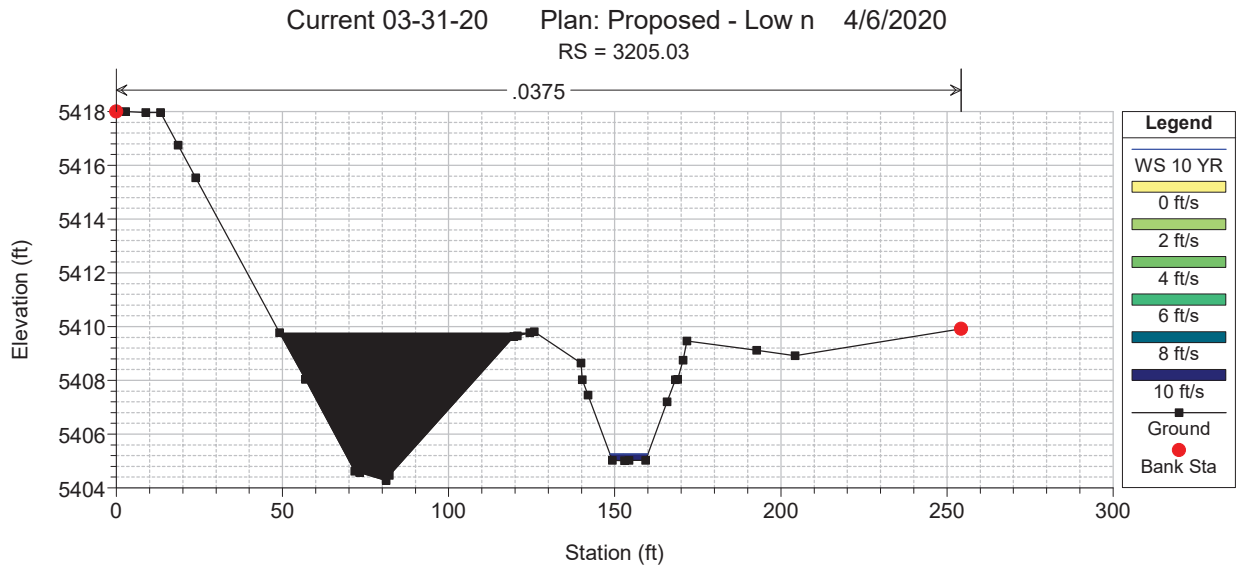

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3400
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3350
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3300
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

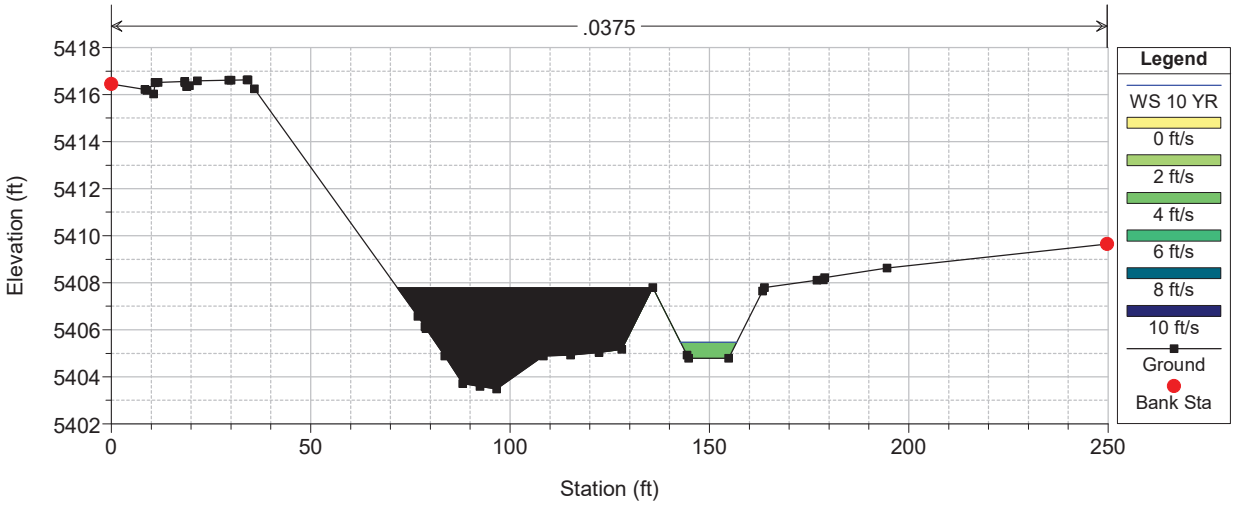

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3250
.0375
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3232.13
.0375
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3205.03
.0375
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

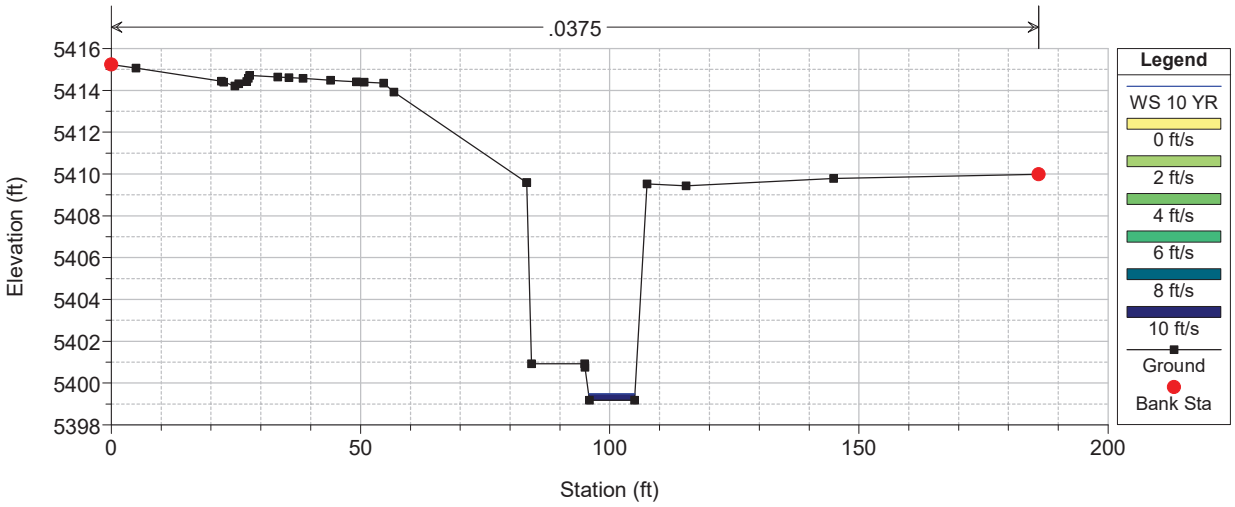
Current 03-31-20 Plan: Proposed - Low n 4/6/2020

RS = 3181.99



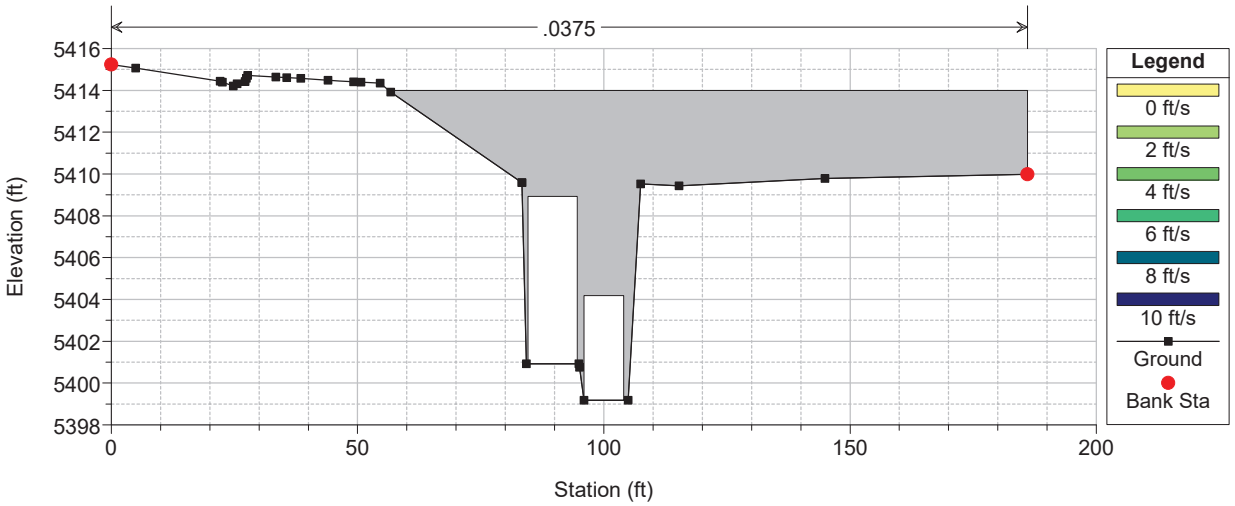
Current 03-31-20 Plan: Proposed - Low n 4/6/2020

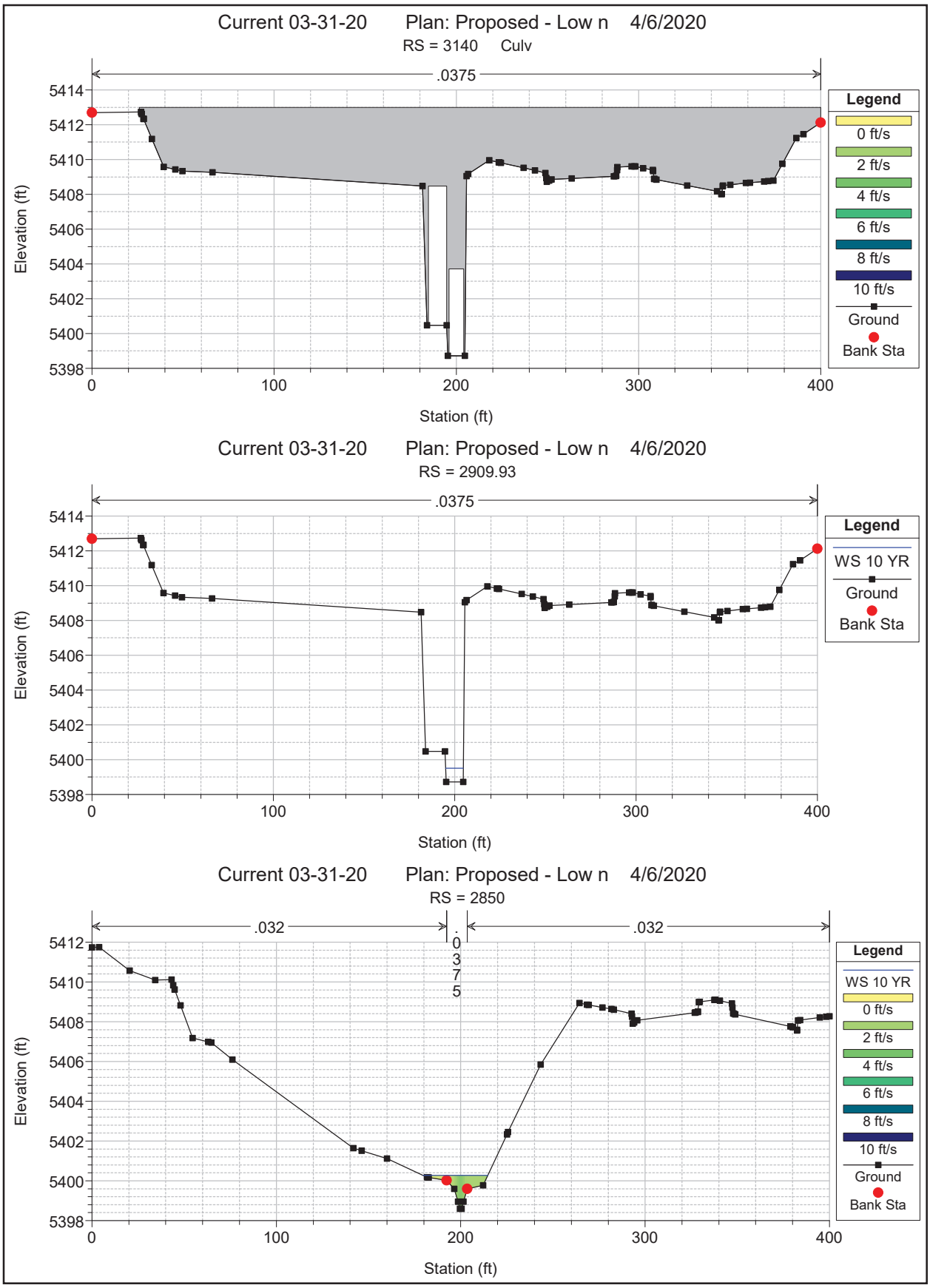
RS = 3140.22

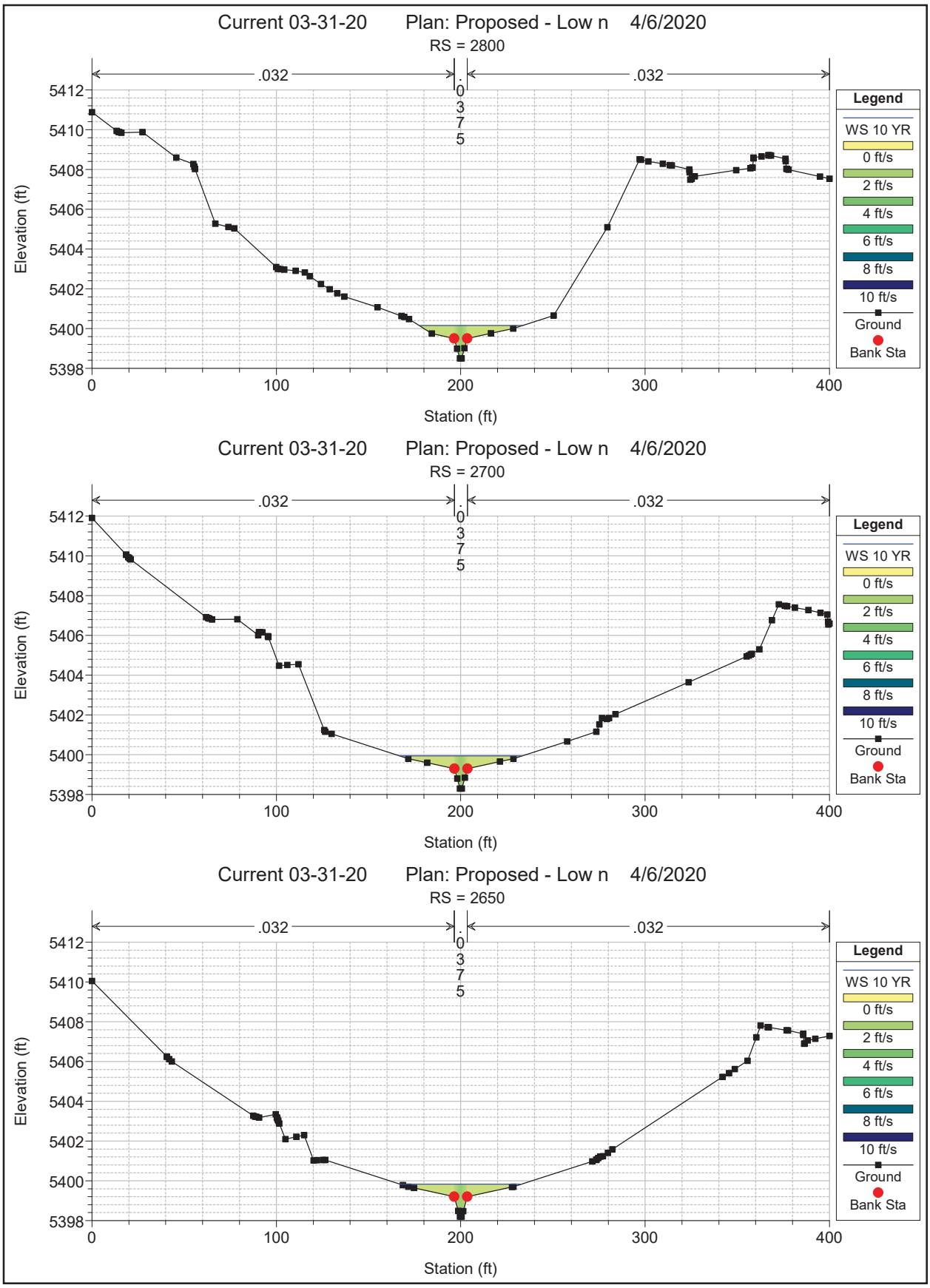


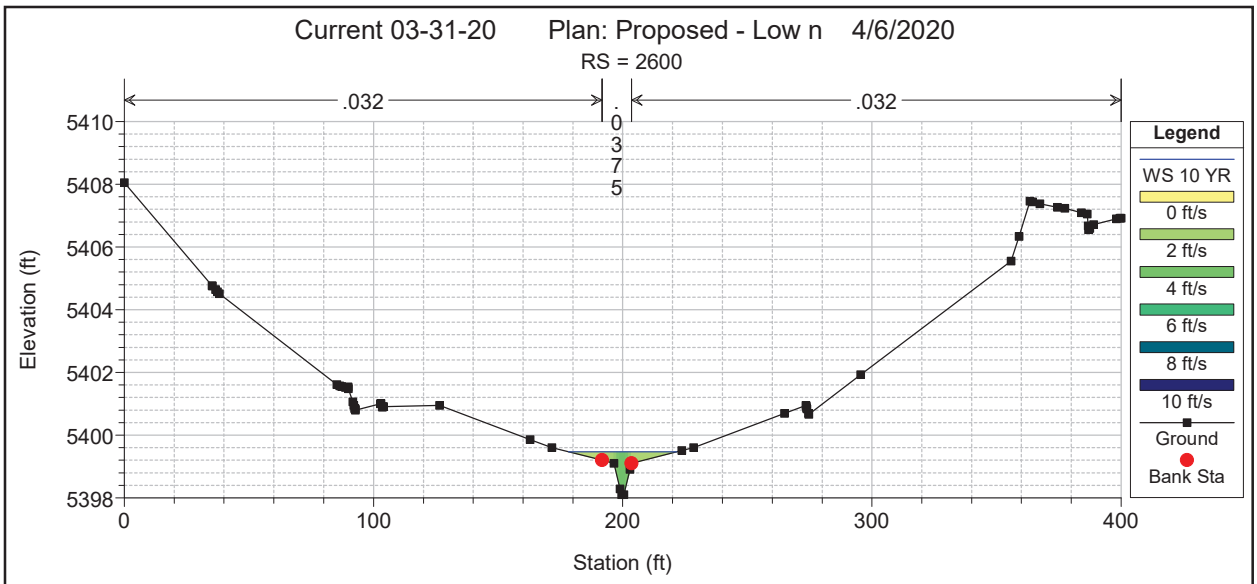
Current 03-31-20 Plan: Proposed - Low n 4/6/2020

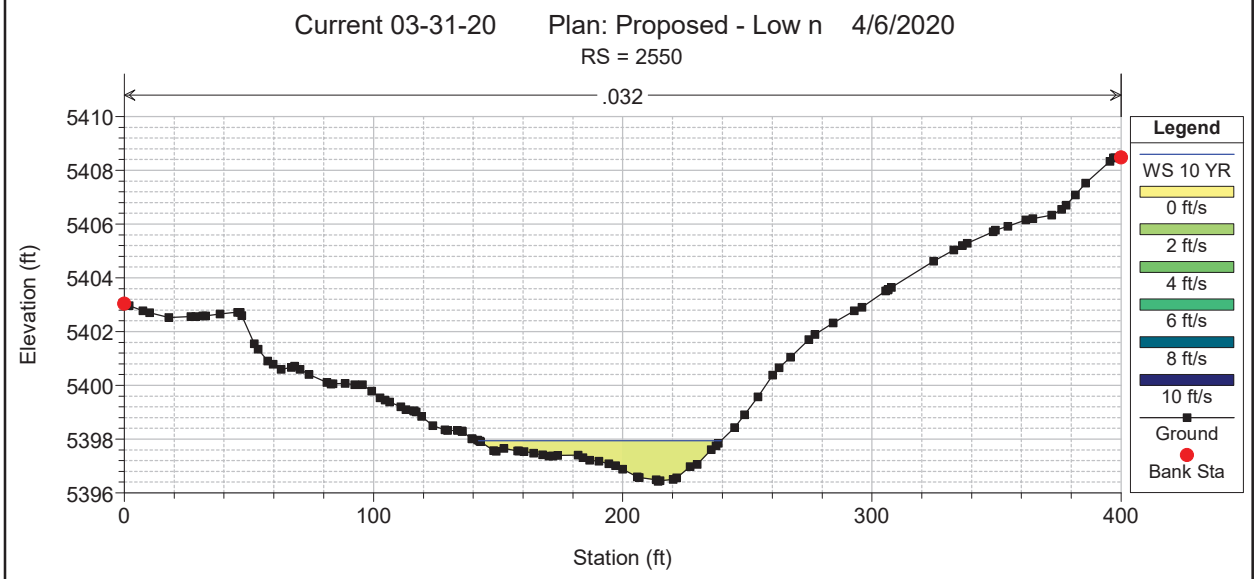
RS = 3140 Culv

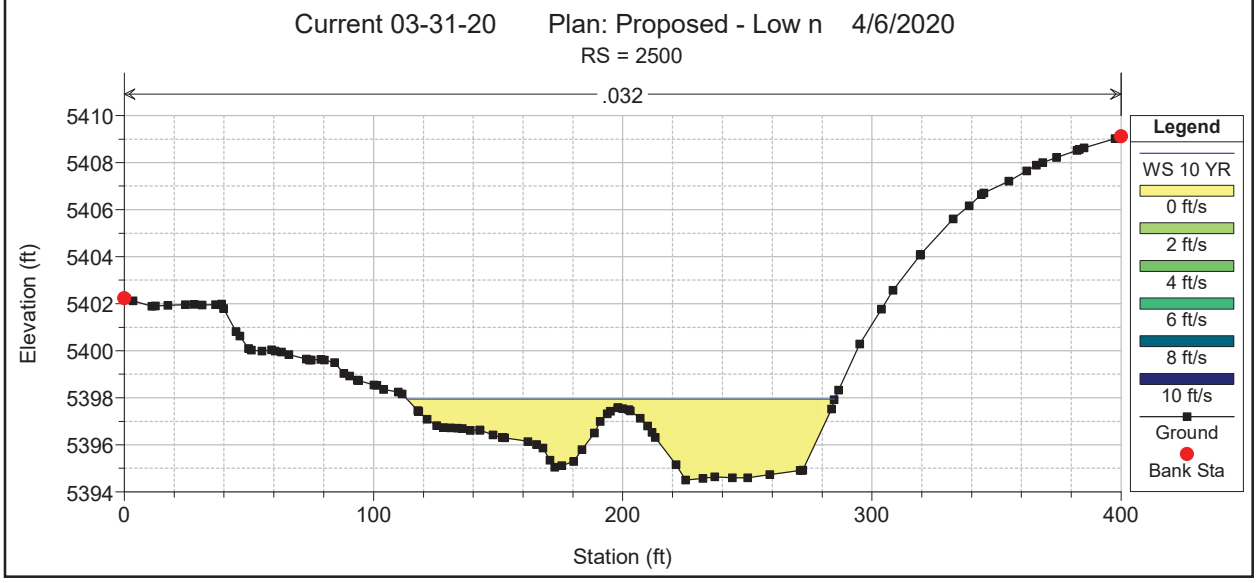


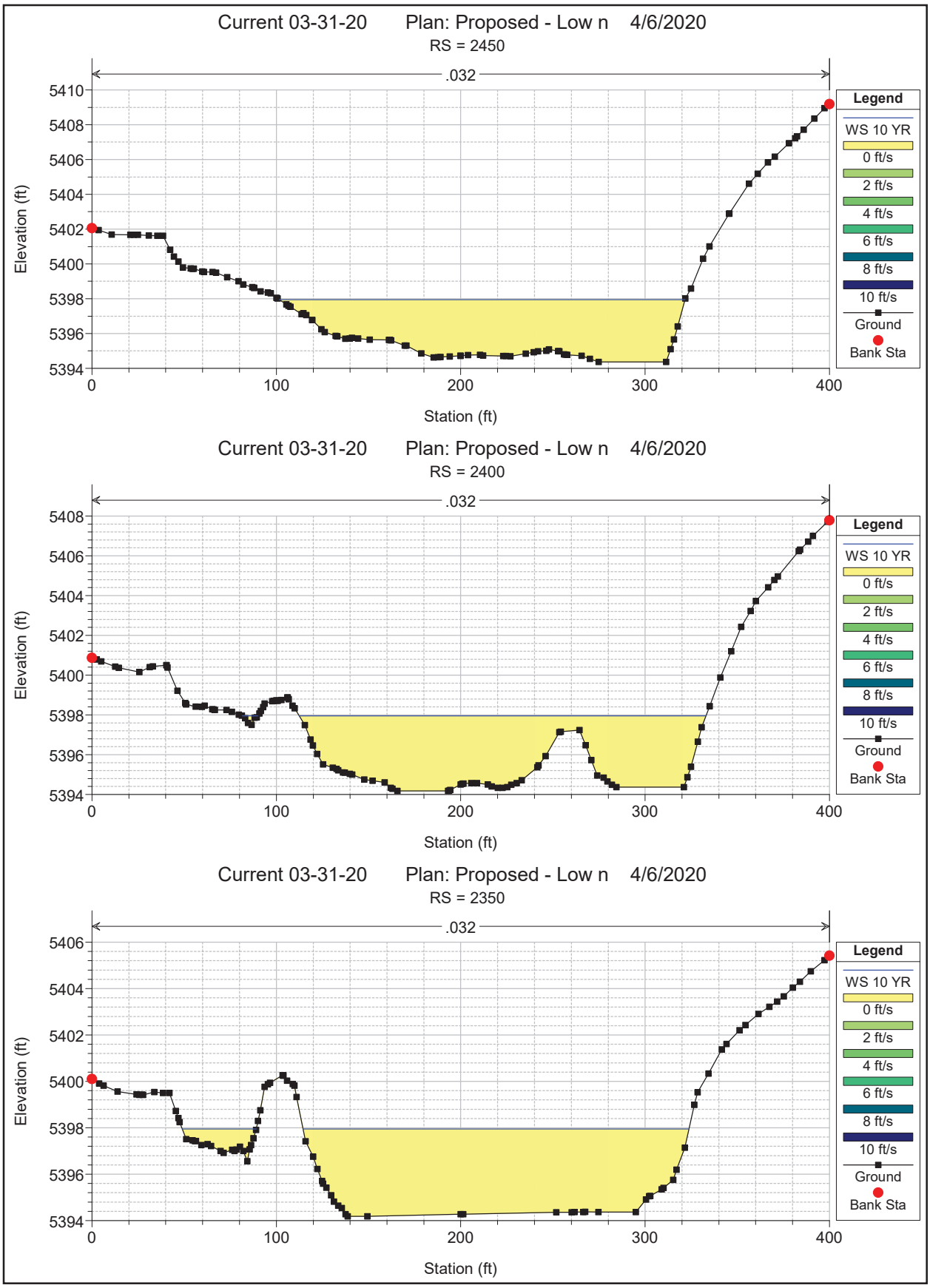

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3140 Culv
.0375
Elevation (ft)
Station (ft)
Legend
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2909.93
.0375
Elevation (ft)
Station (ft)
Legend
WS 10 YR
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2850
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

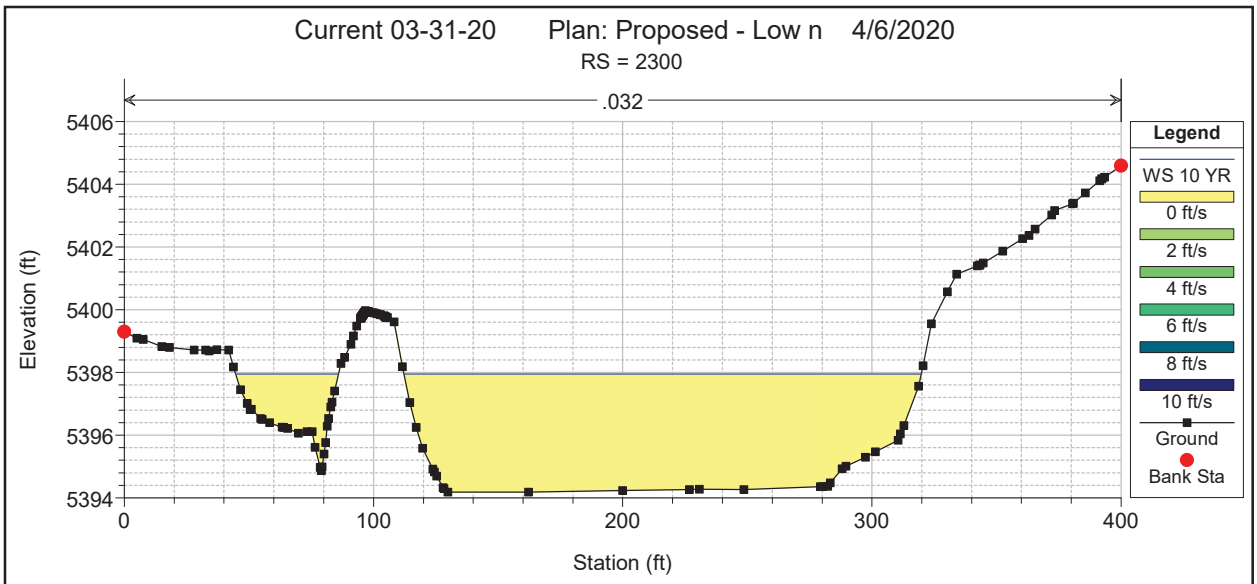

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2800
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2700
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2650
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

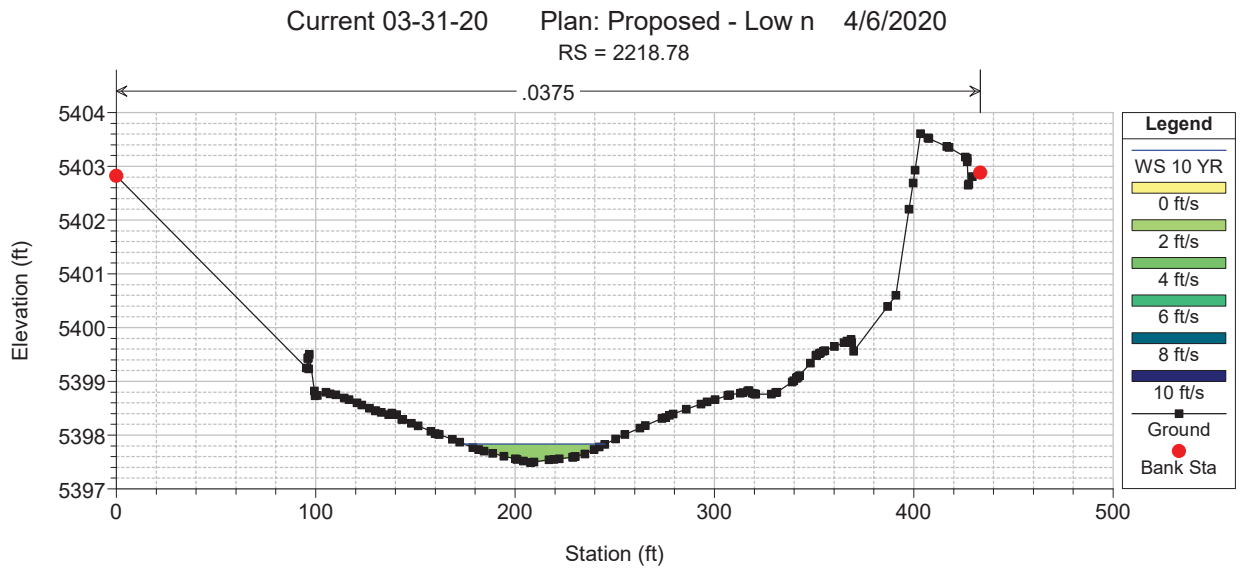

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2600
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

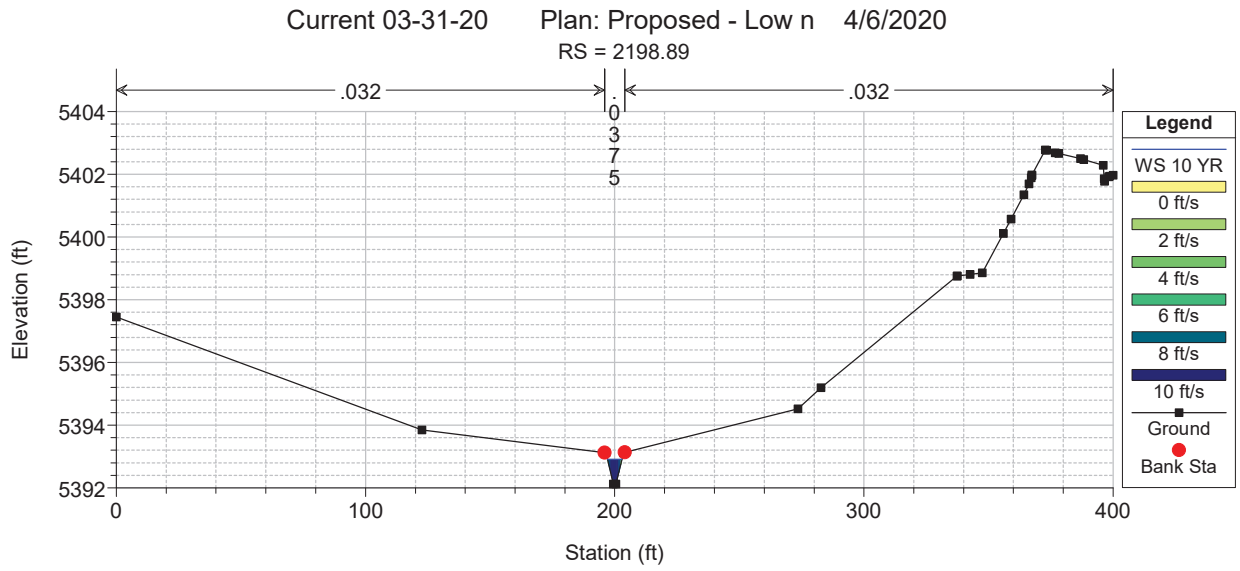

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2550
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

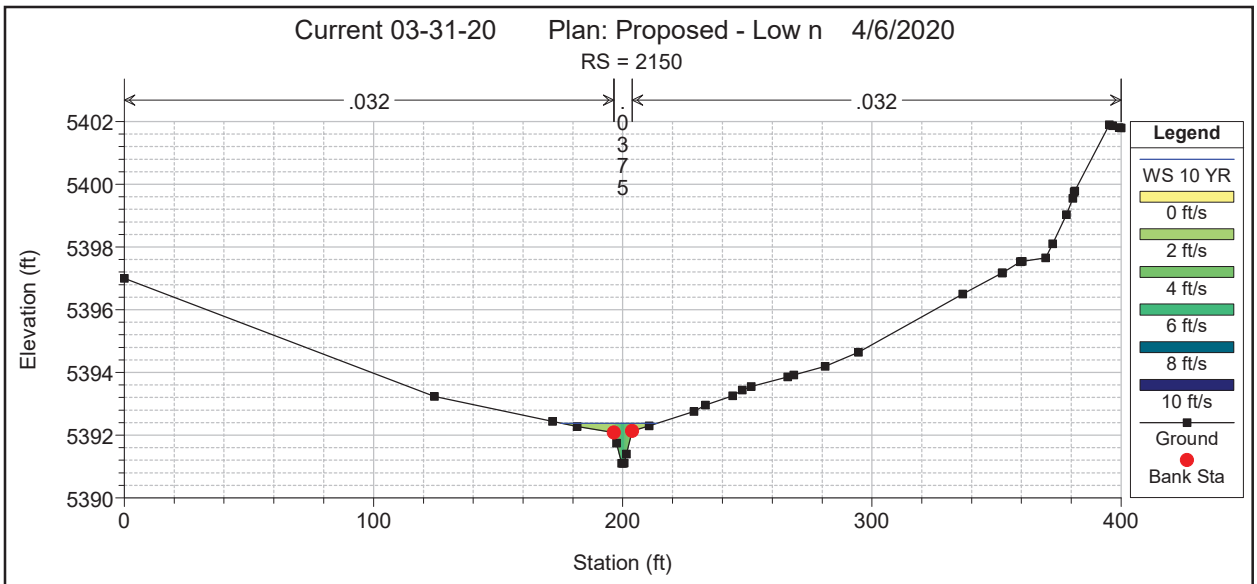

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2500
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

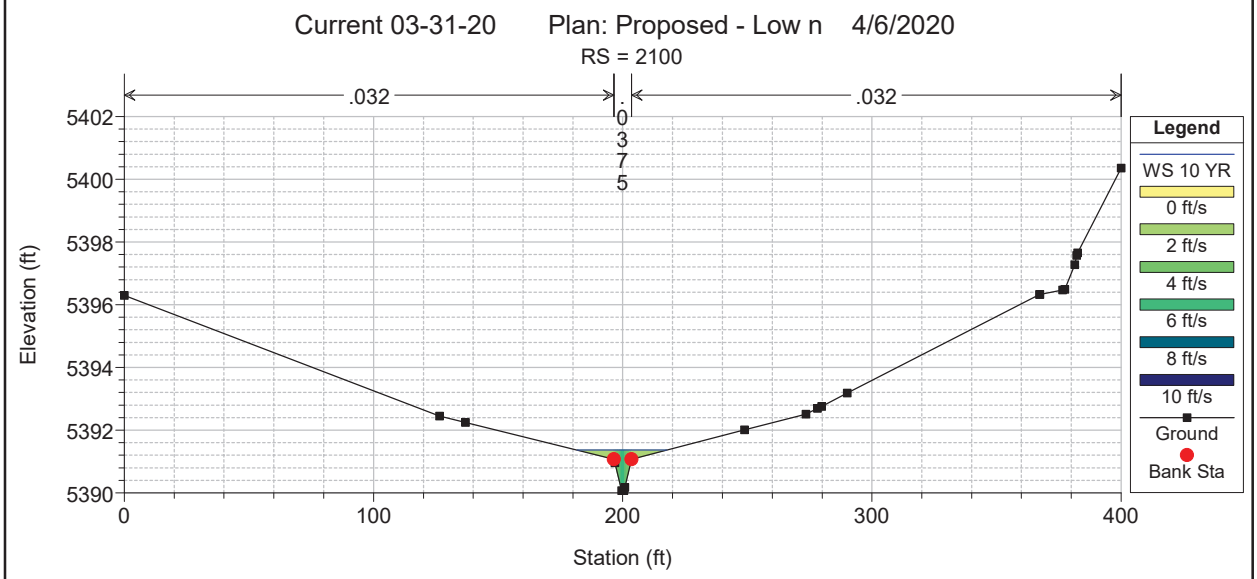

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2450
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2400
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2350
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

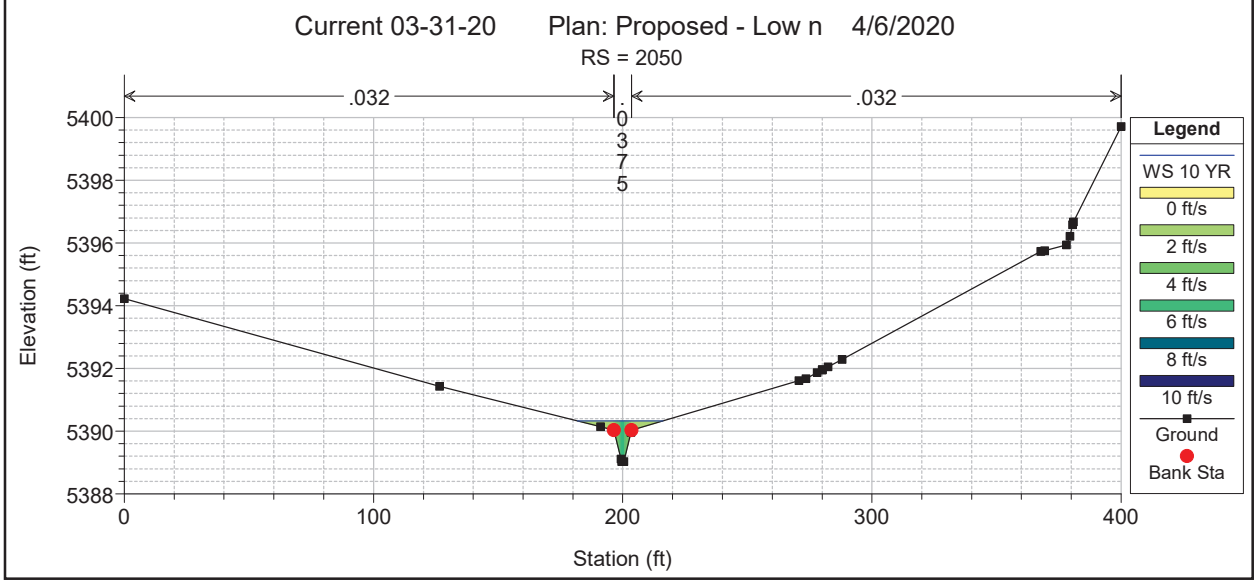

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2300
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

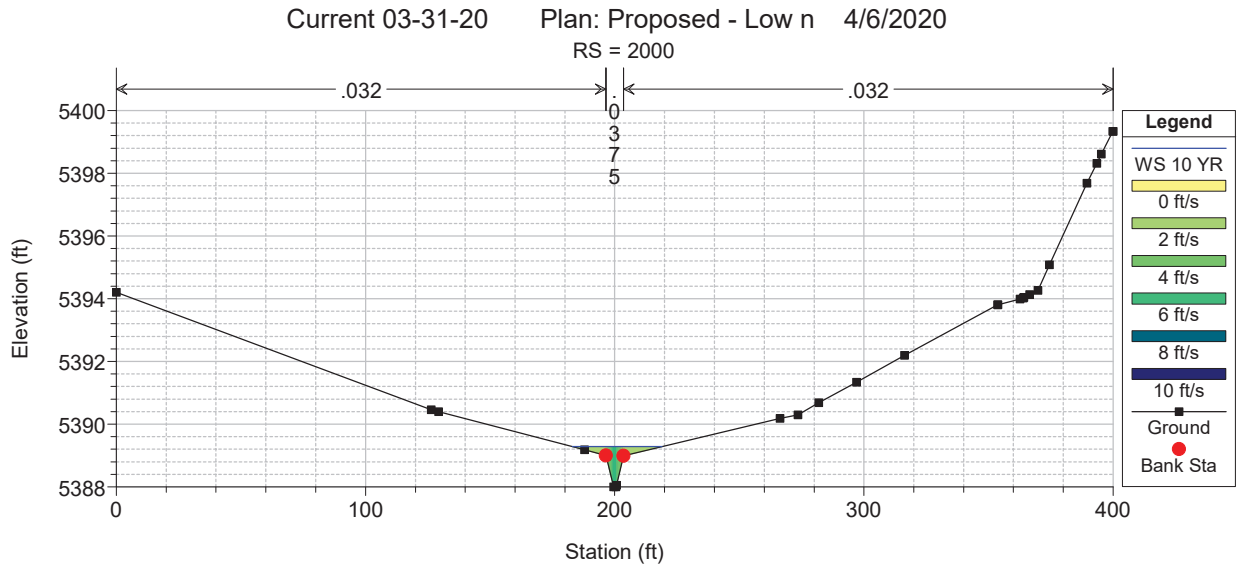

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2218.78
.0375
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

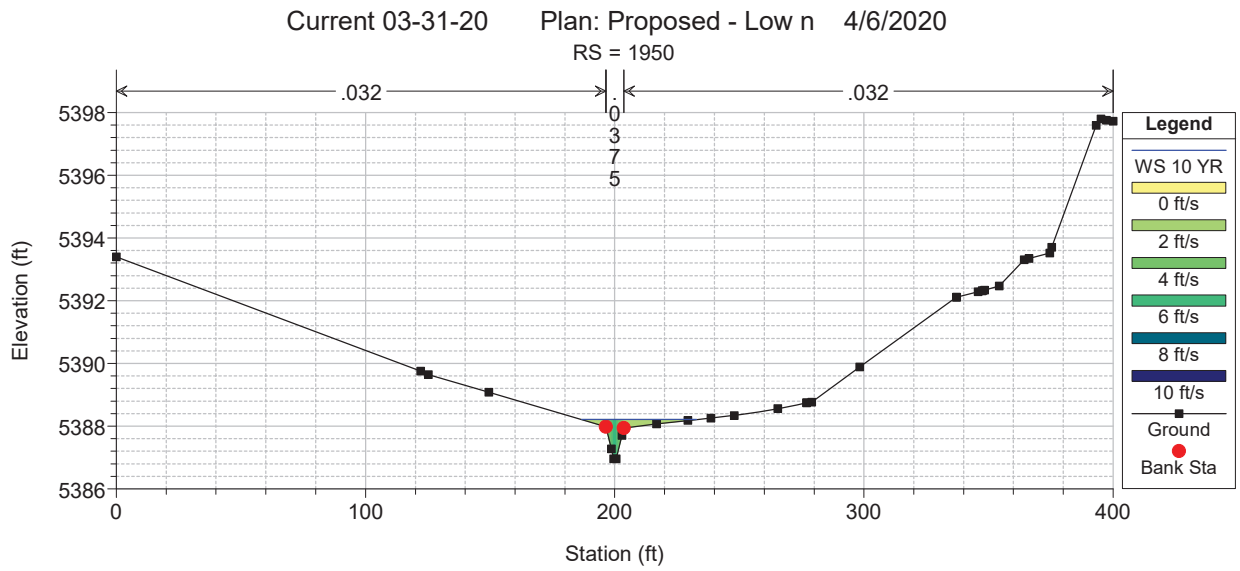

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2198.89
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

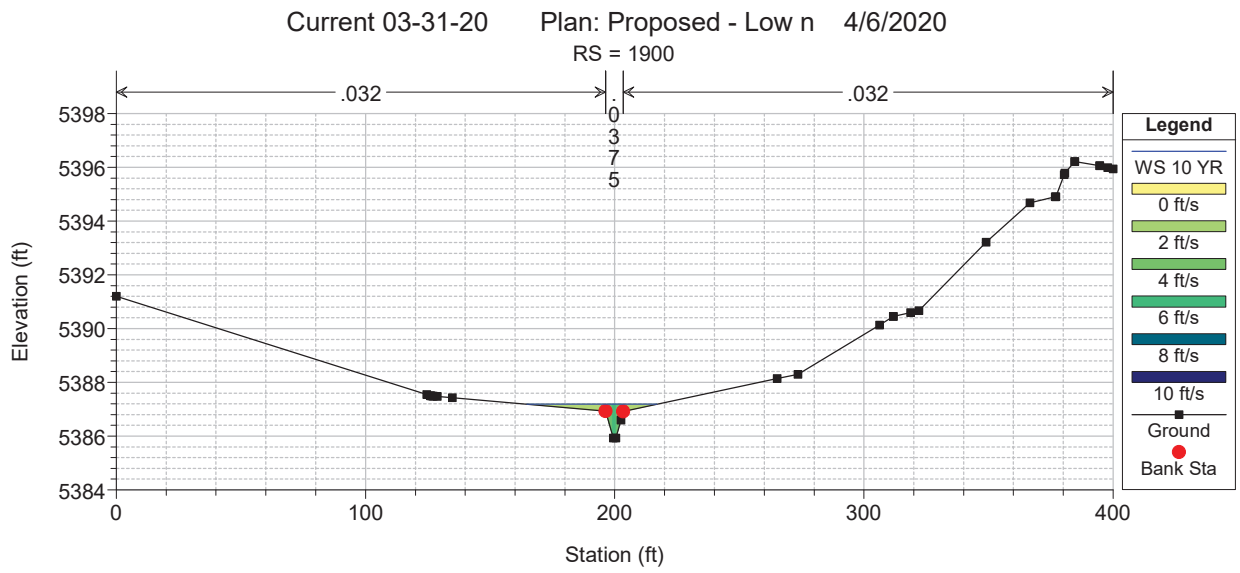

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2150
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

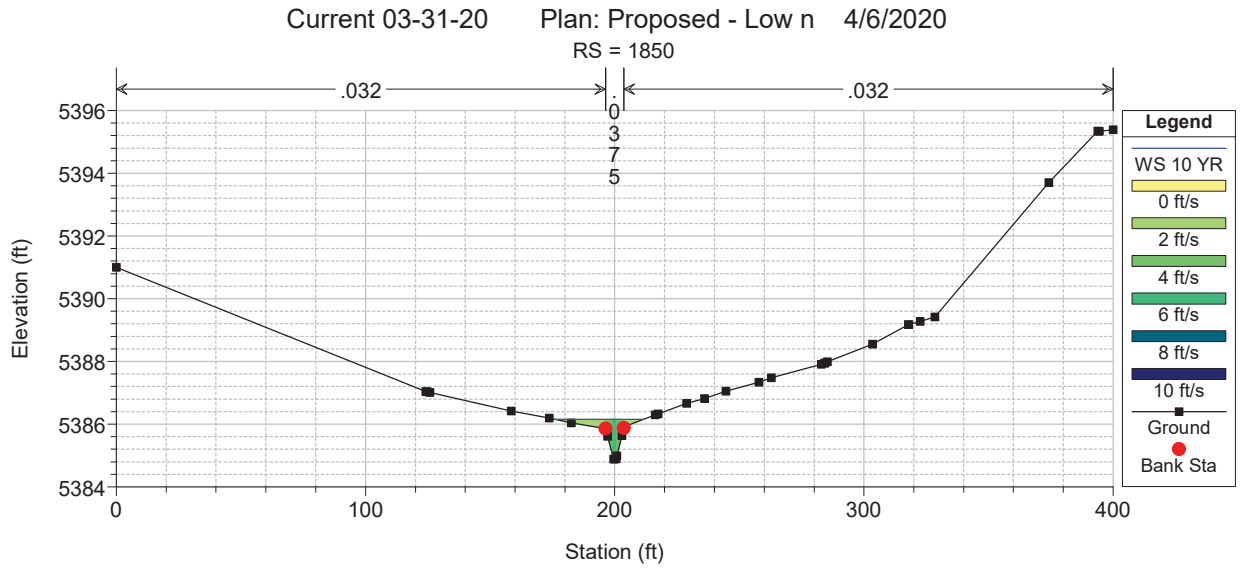

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2100
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

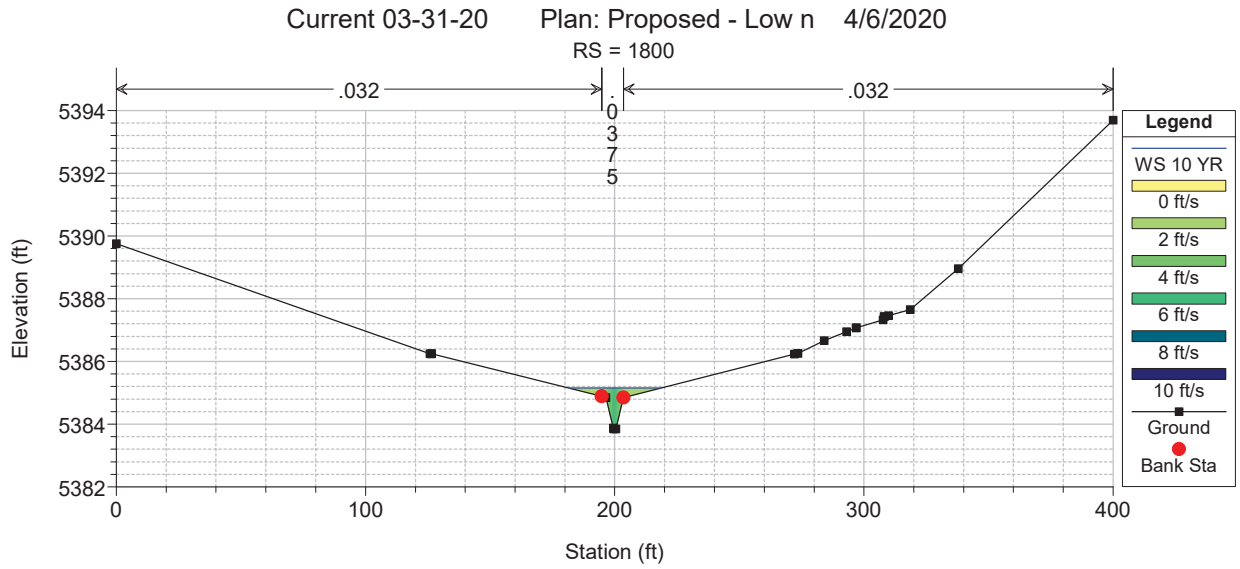

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2050
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

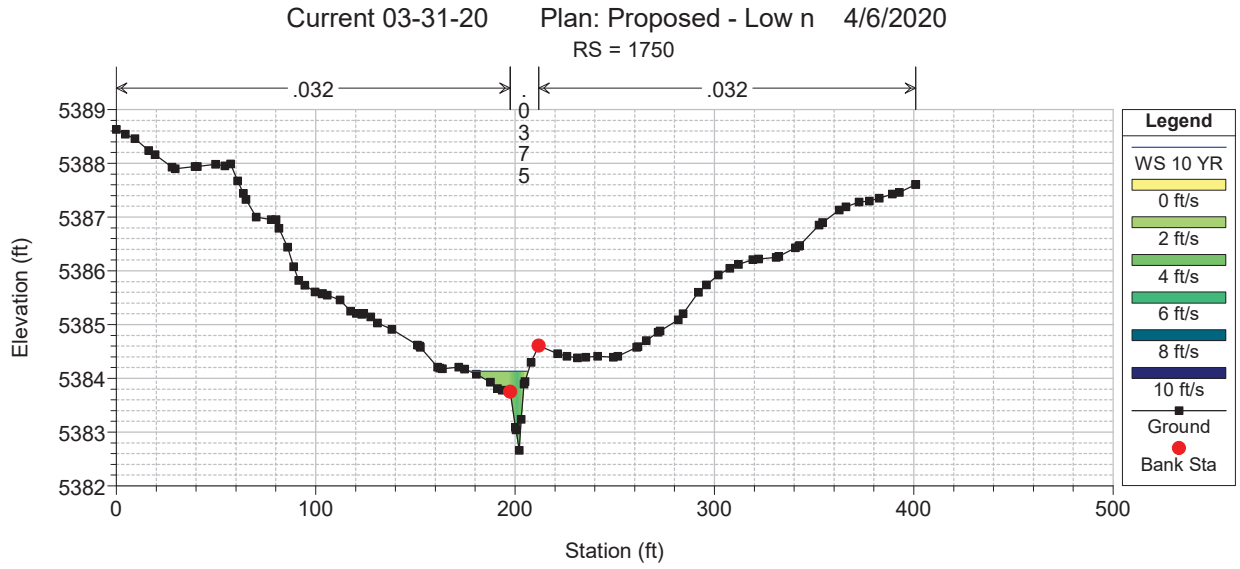

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2000
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

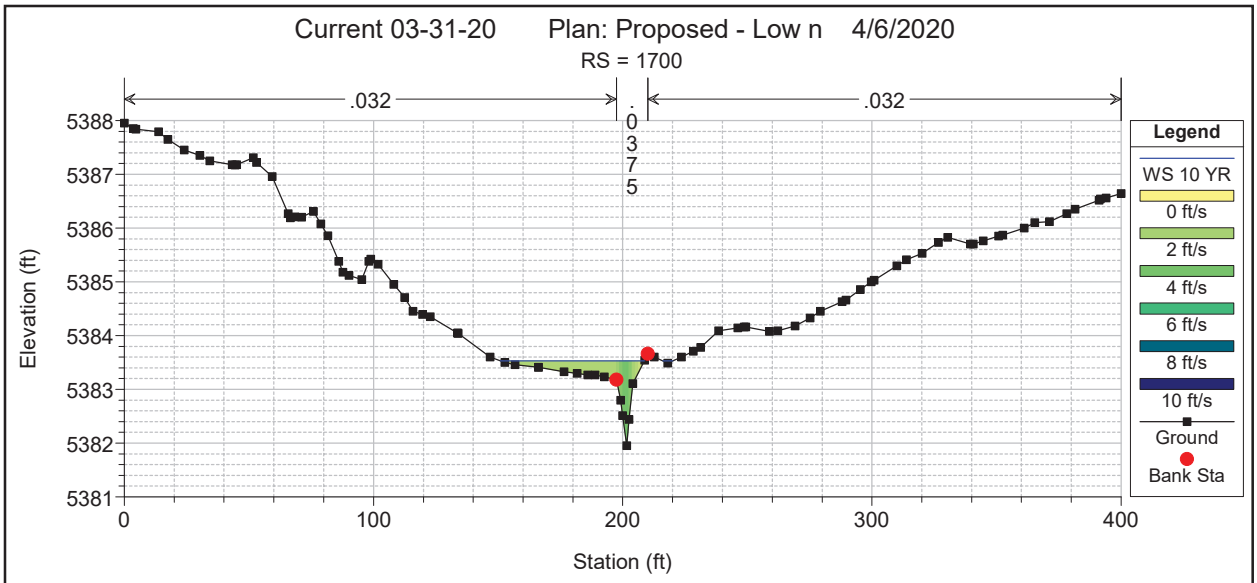

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1950
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

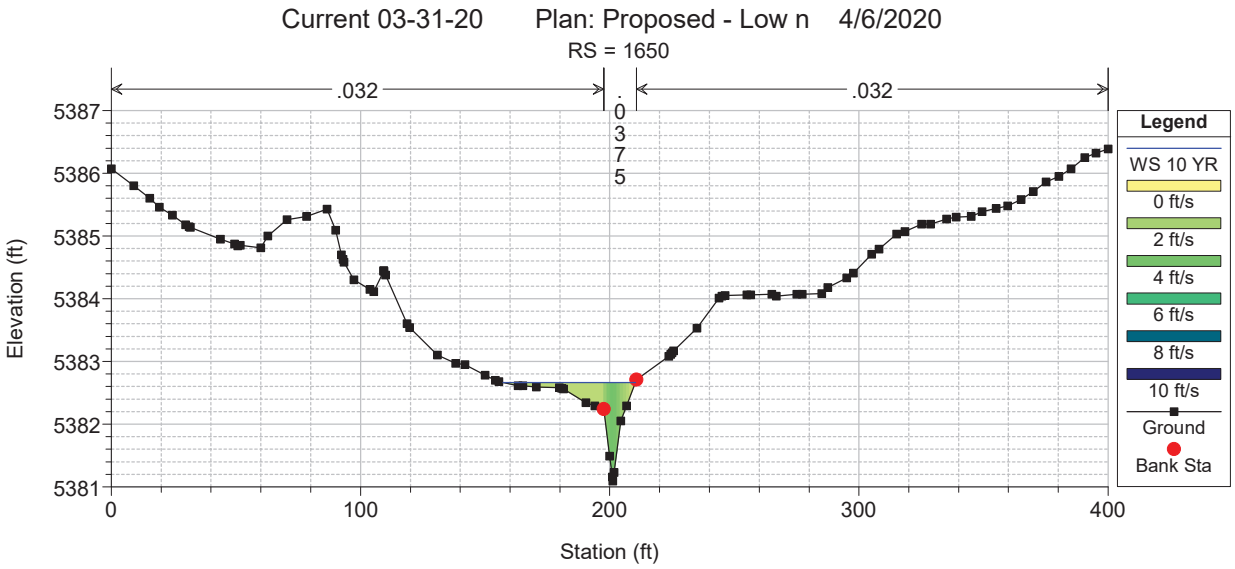

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1900
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

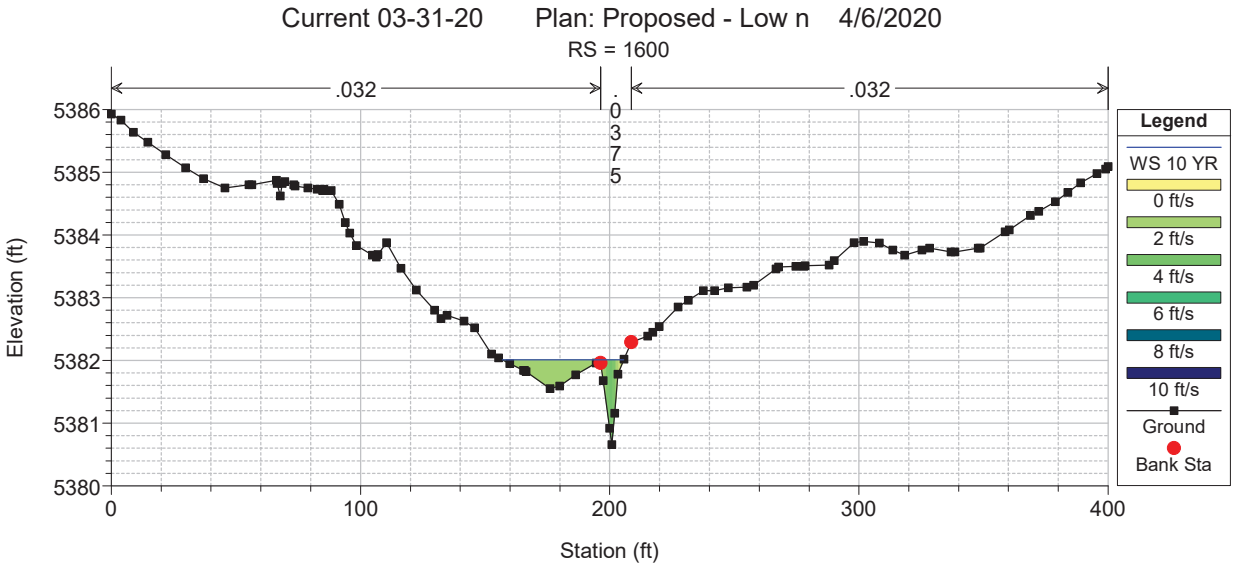

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1850
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

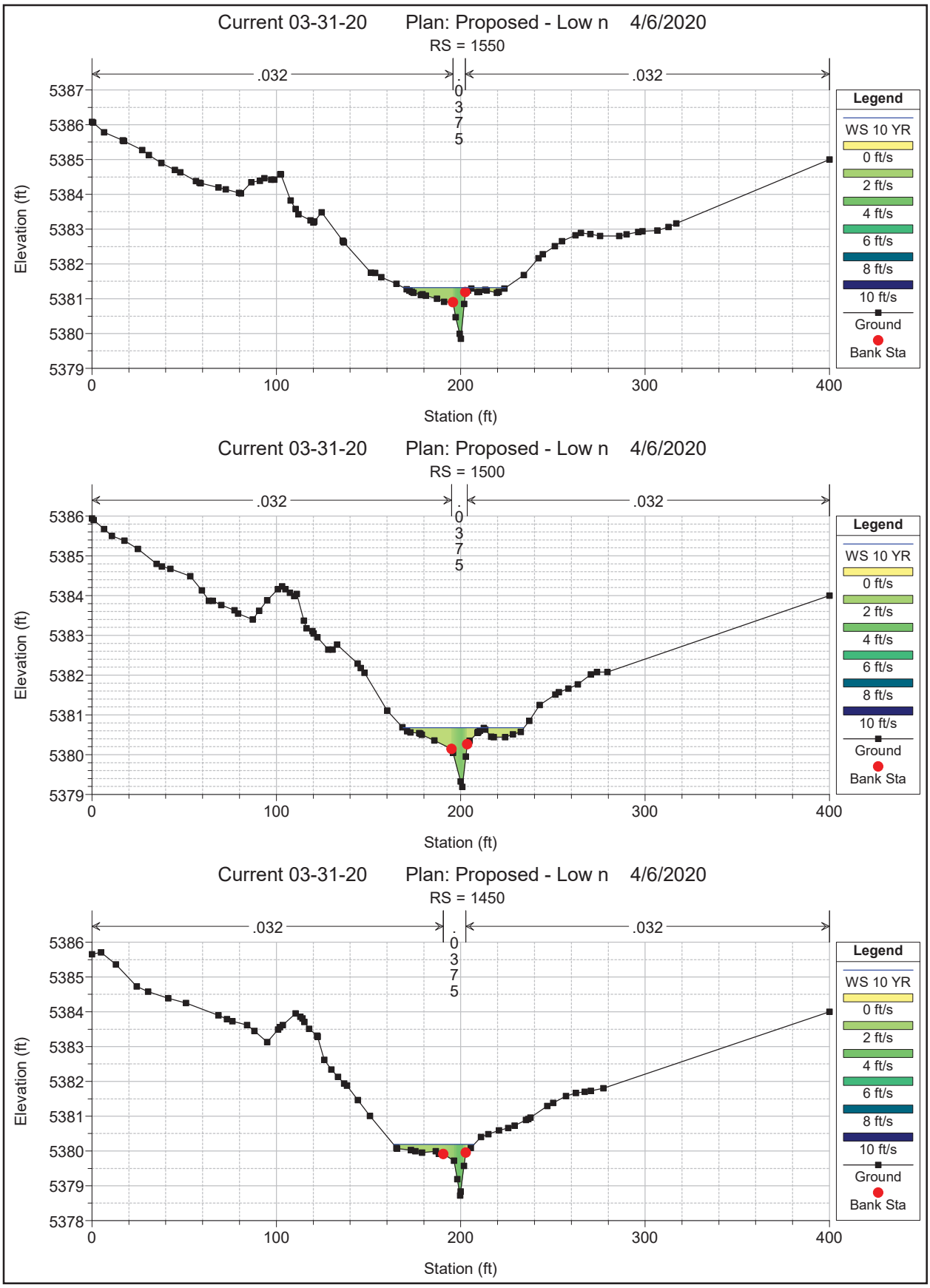

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1800
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

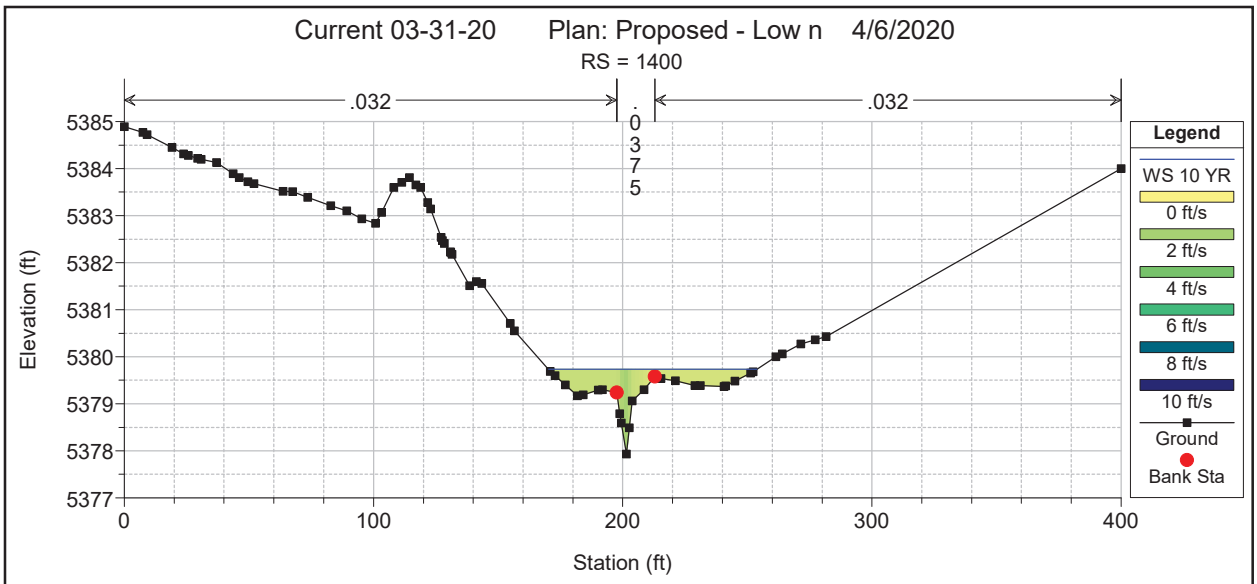

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1750
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

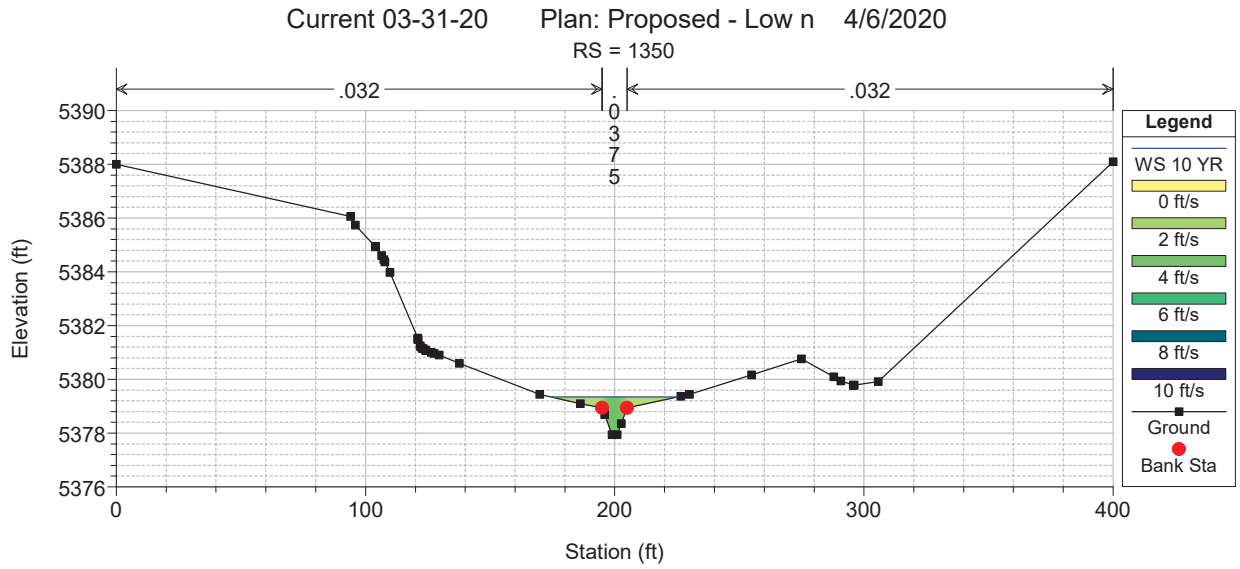

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1700
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

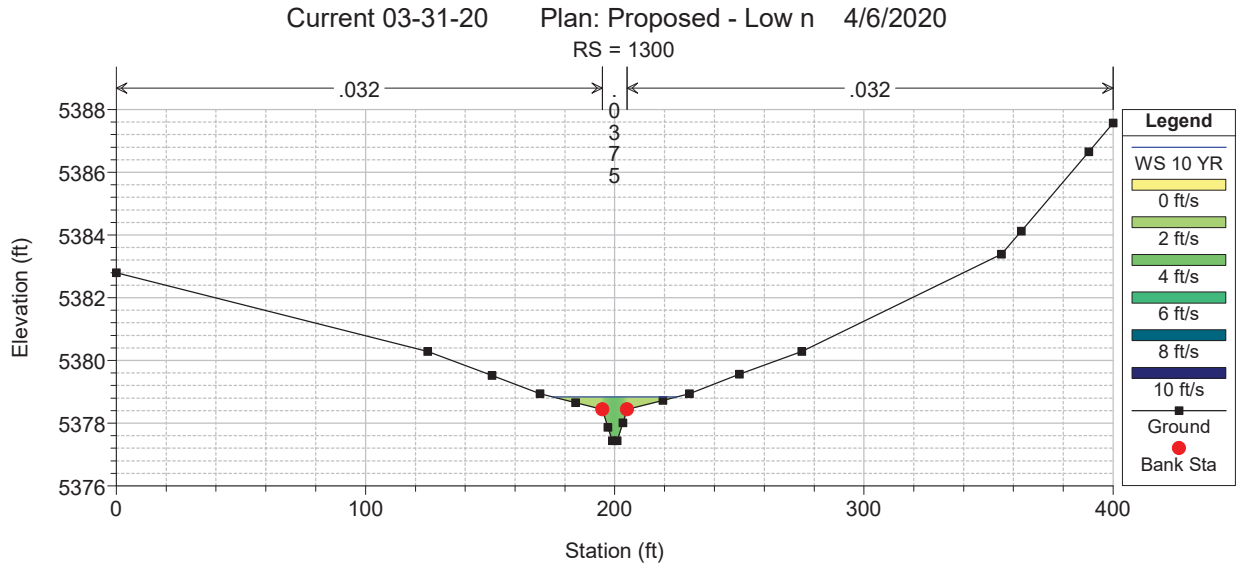

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1650
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

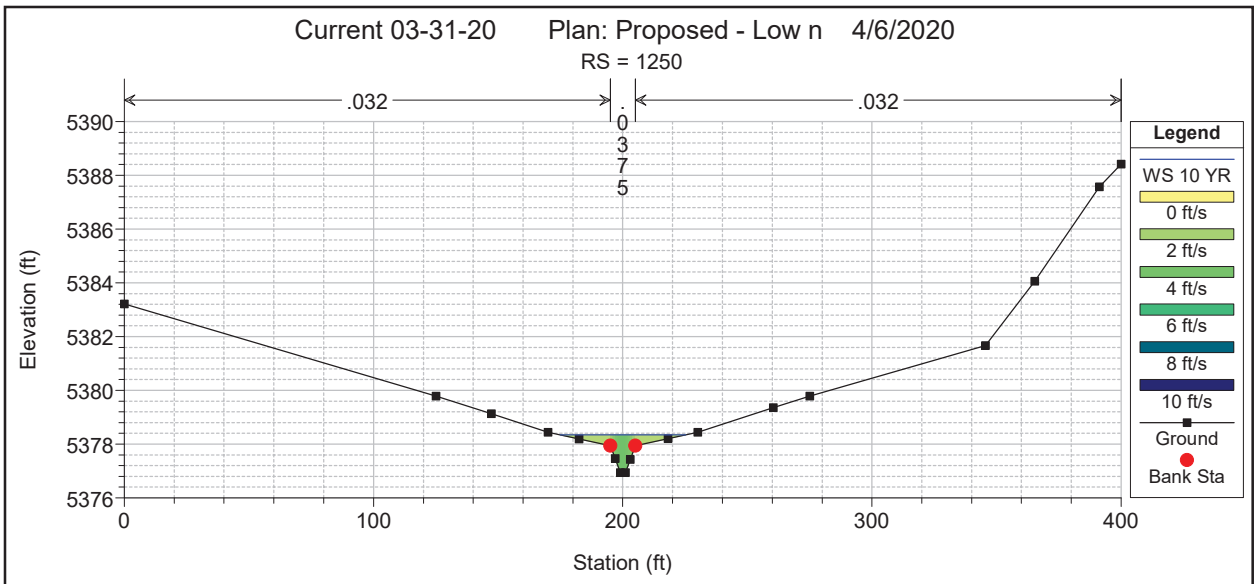

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1600
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

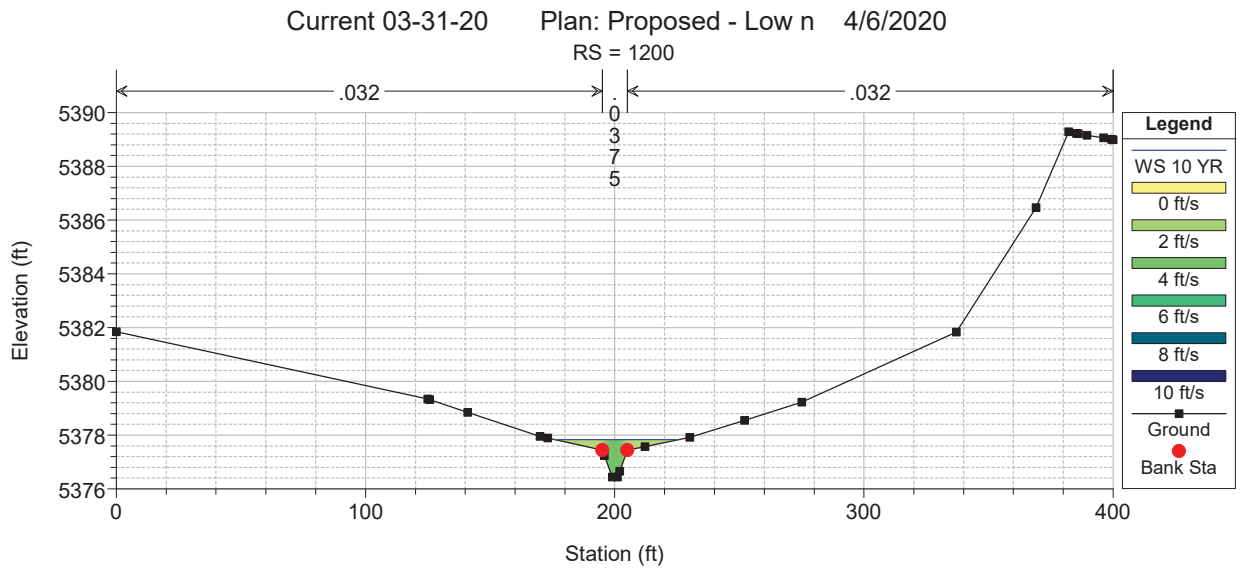

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1550
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1500
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1450
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

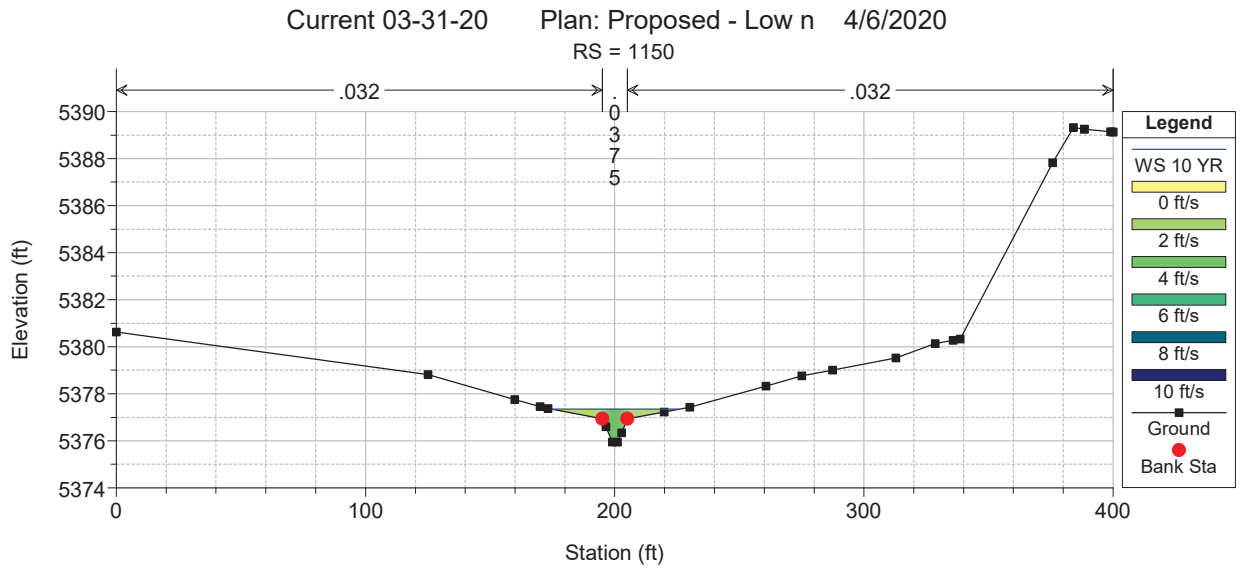

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1400
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

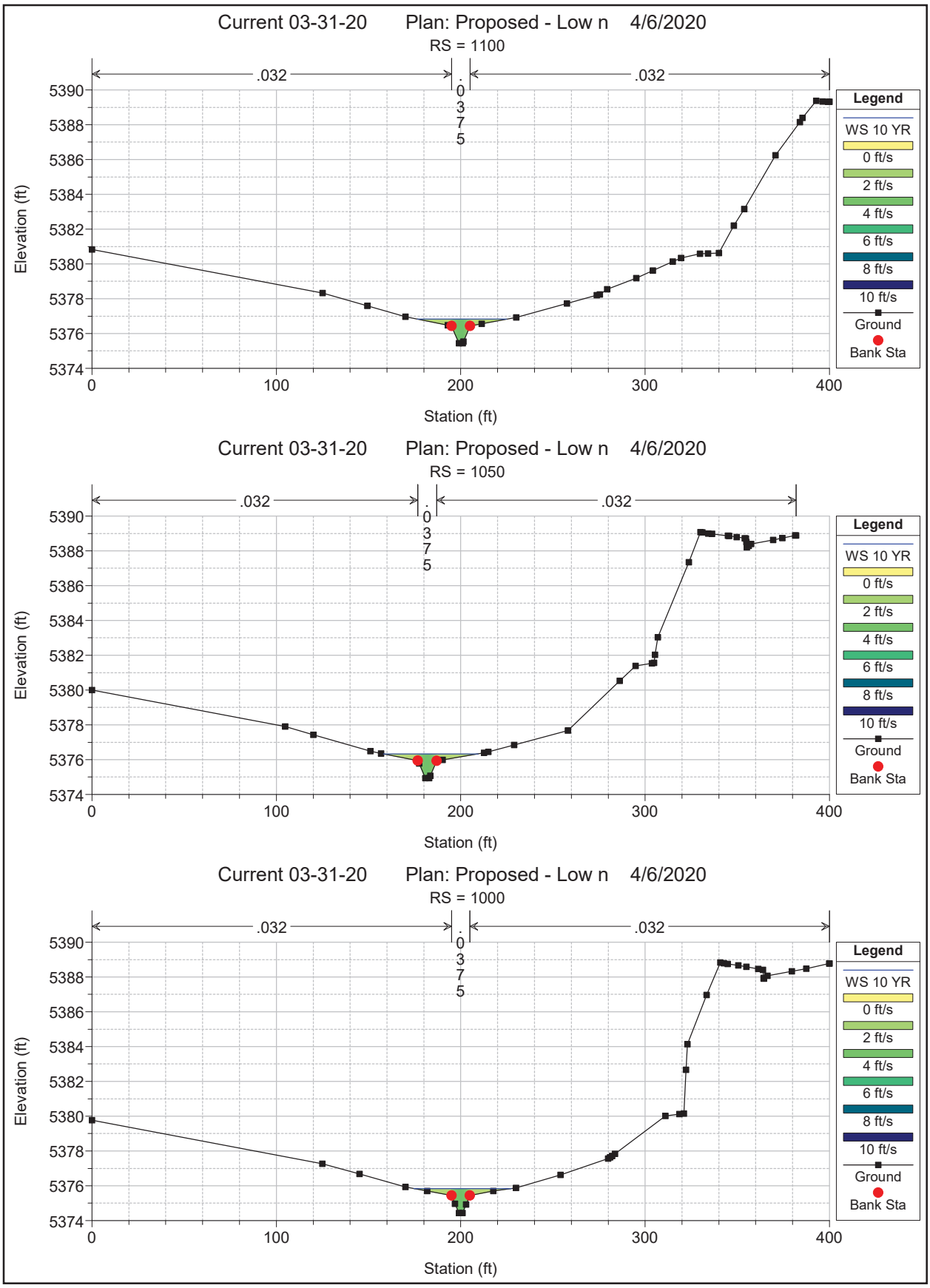

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1350
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

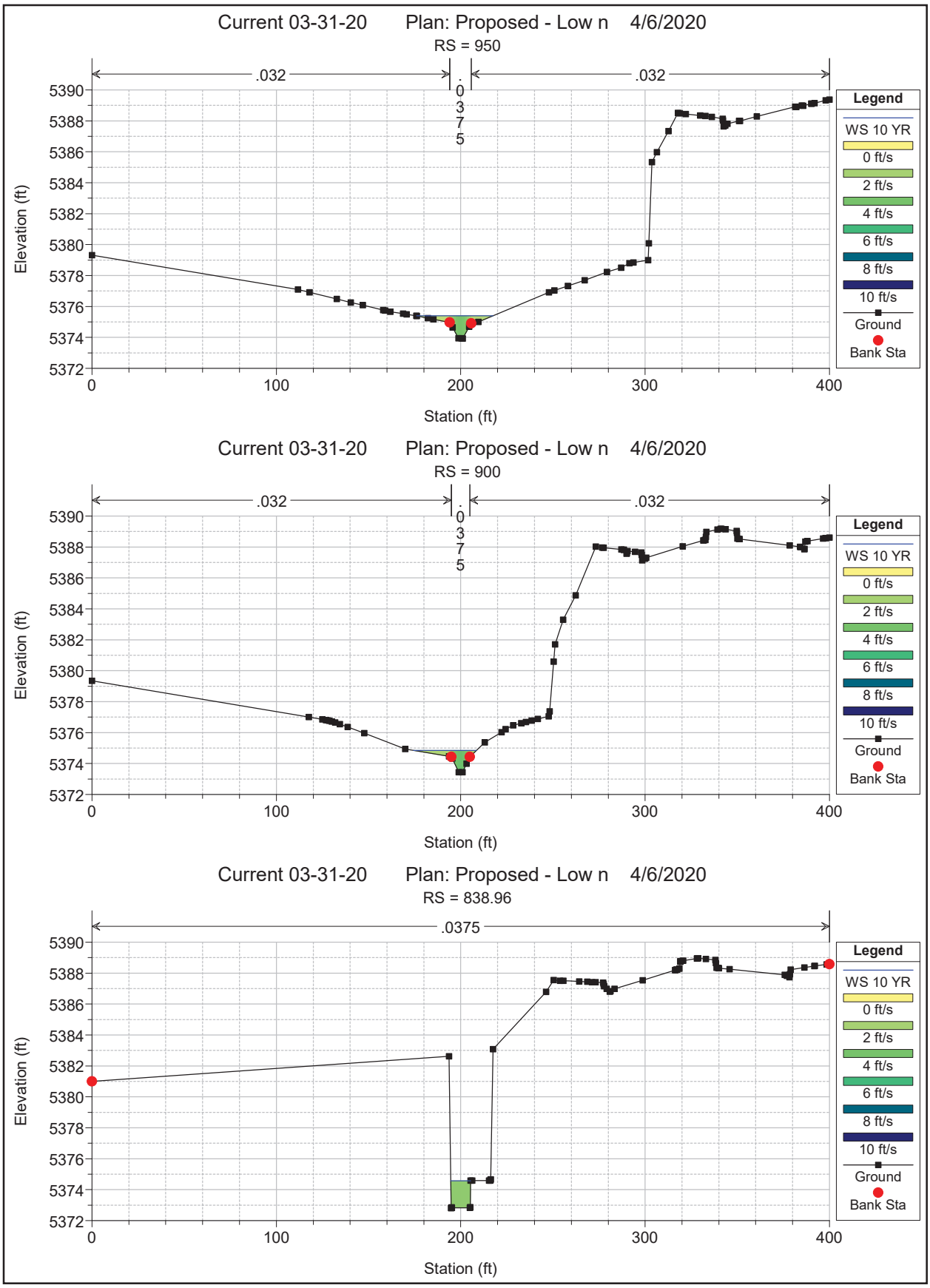

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1300
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

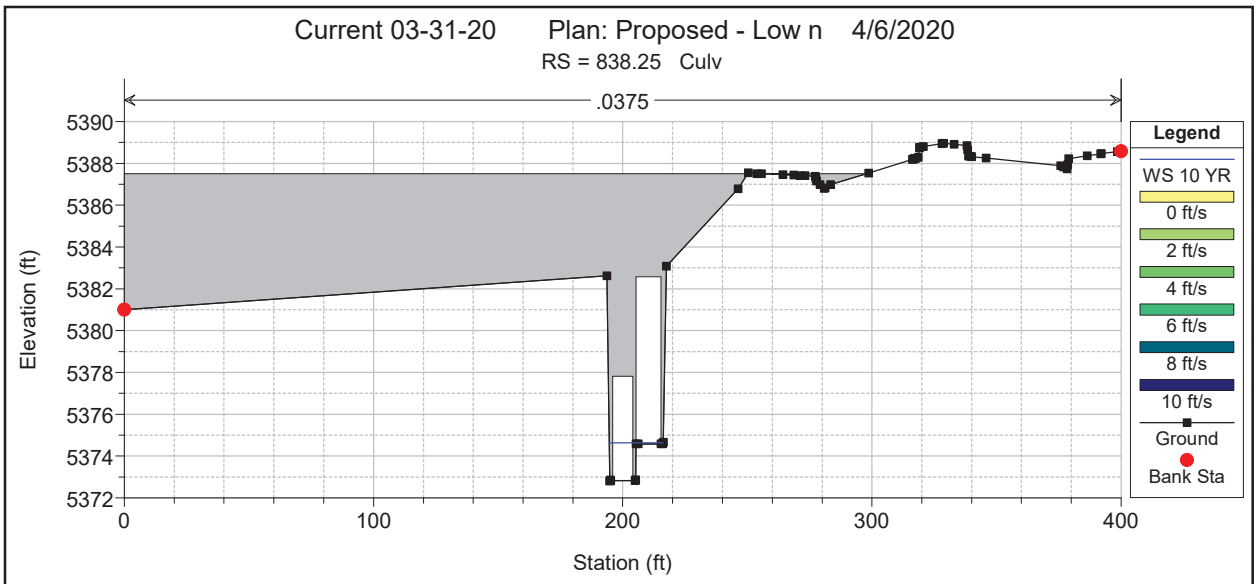

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1250
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

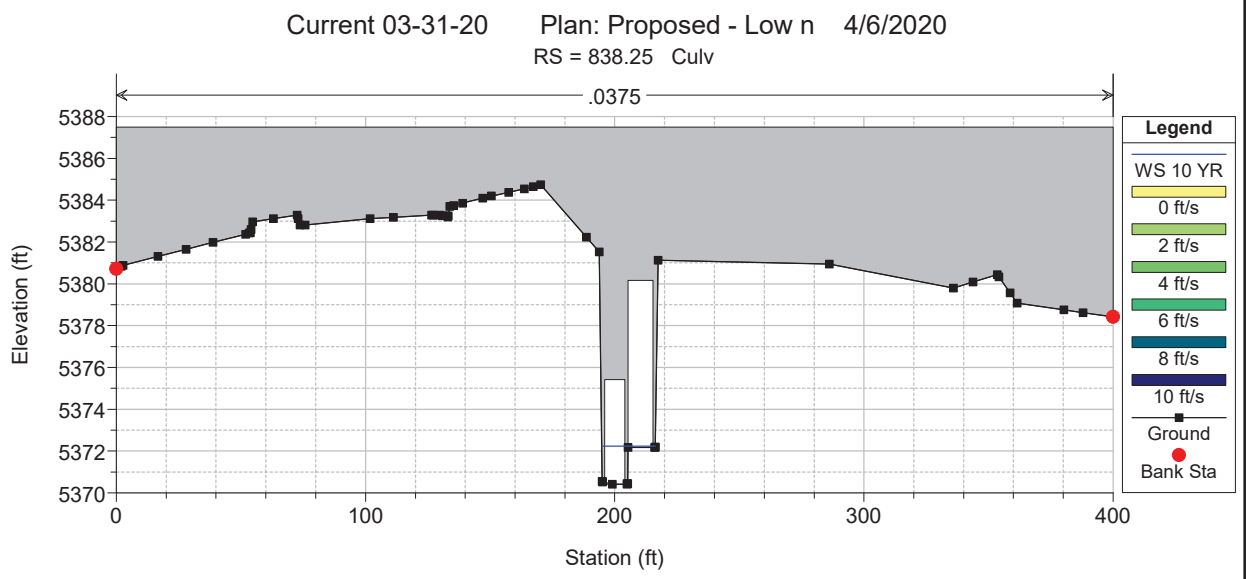

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1200
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

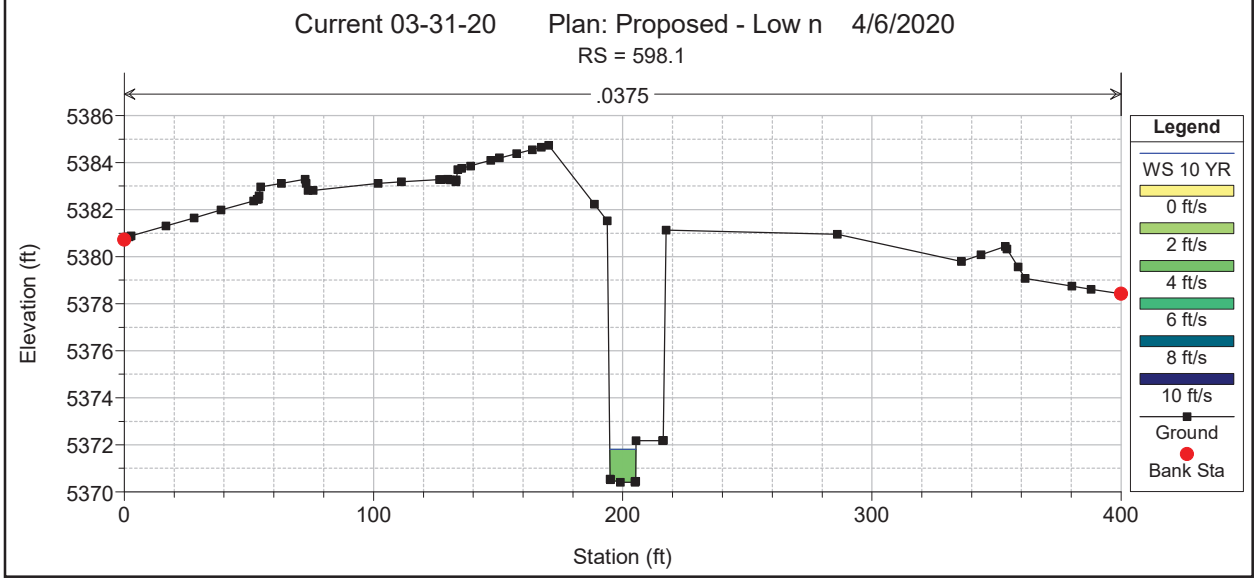

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1150
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

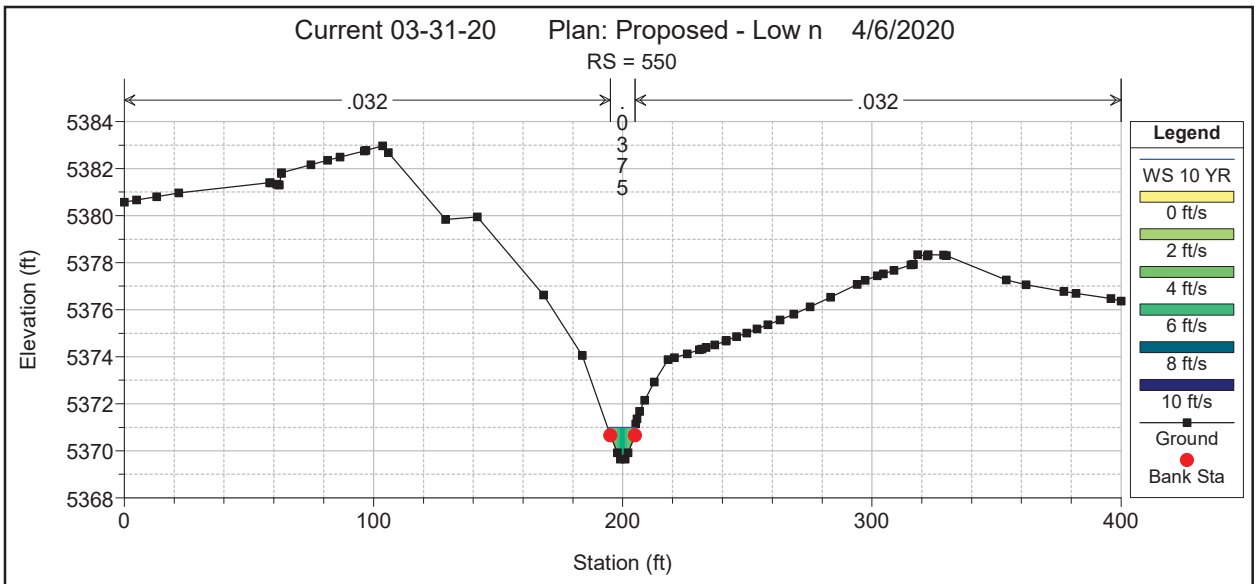

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1100
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1050
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1000
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

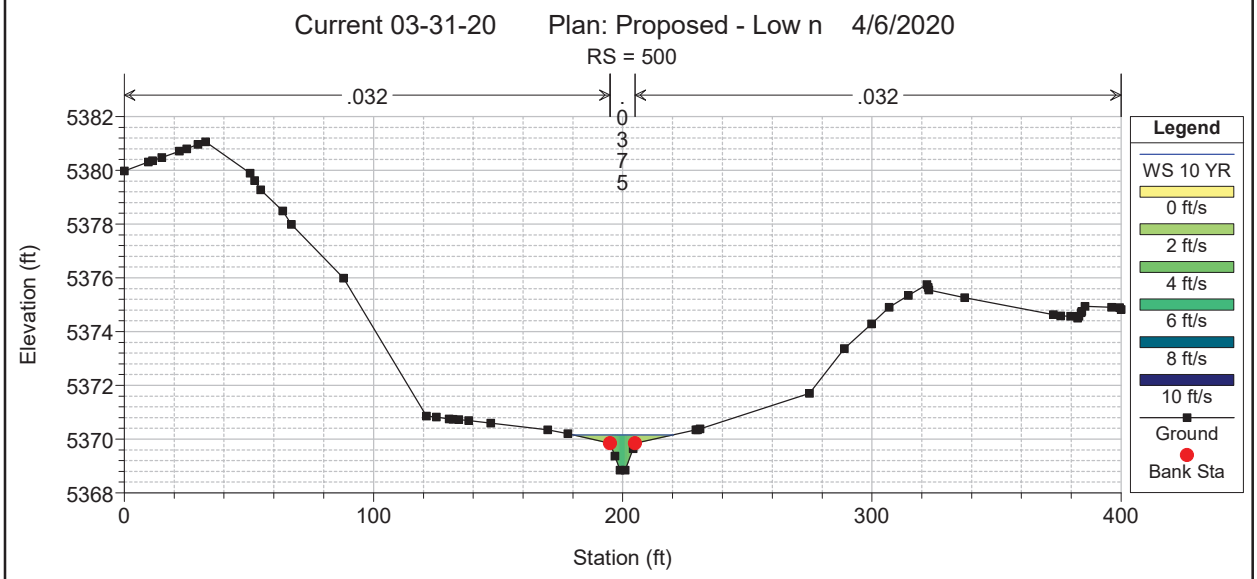

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 950
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 900
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 838.96
.0375
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

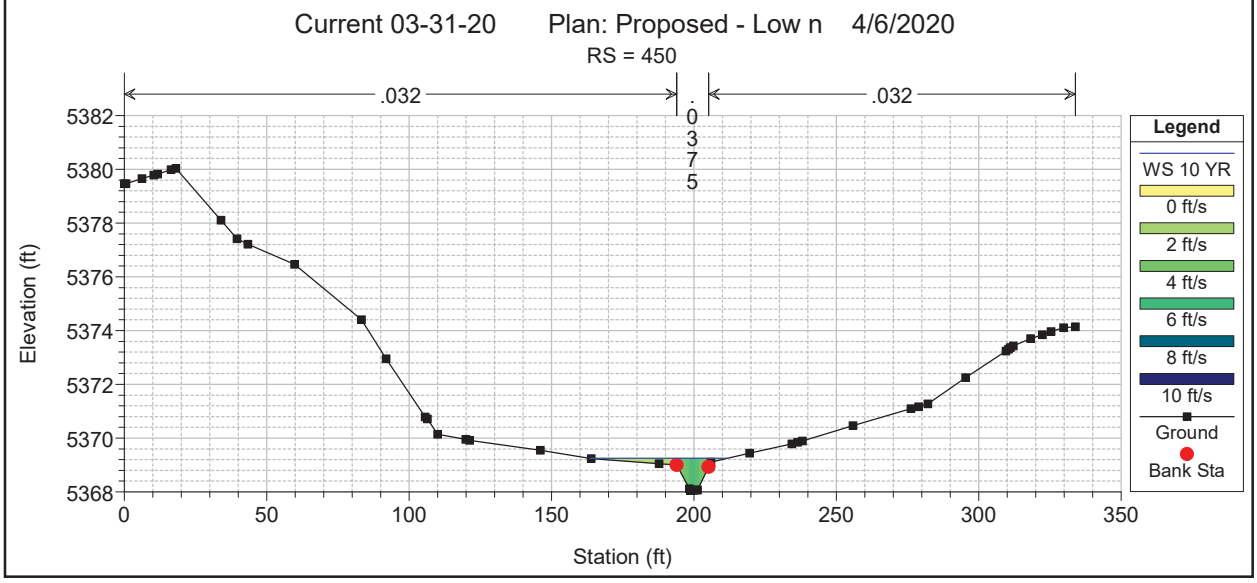

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 838.25 Culv
.0375
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

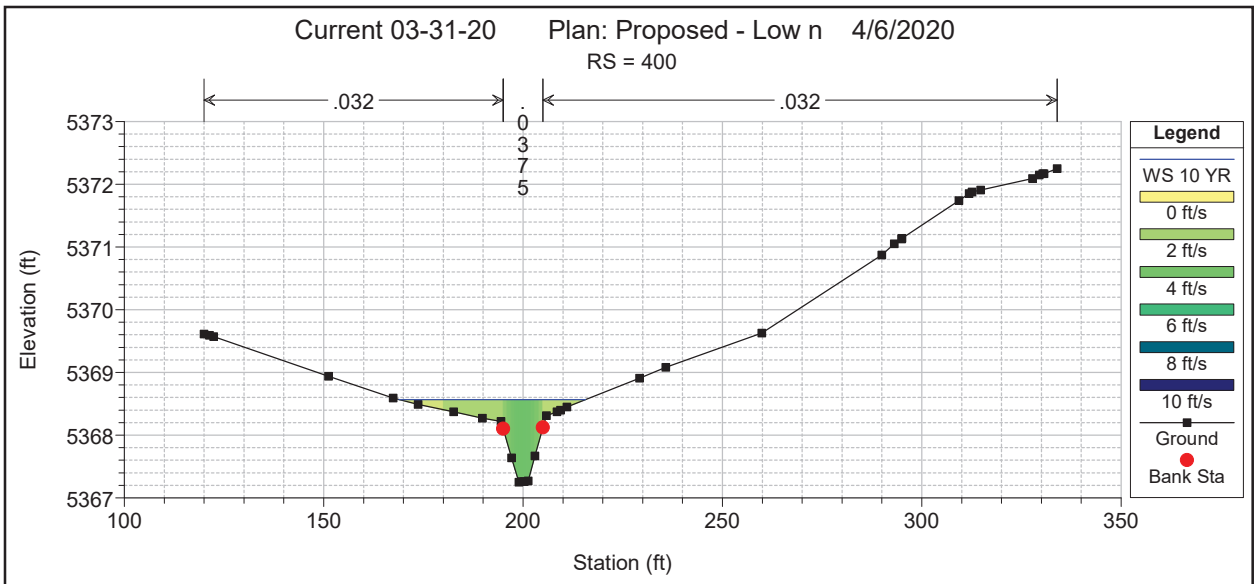

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 838.25 Culv
.0375
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

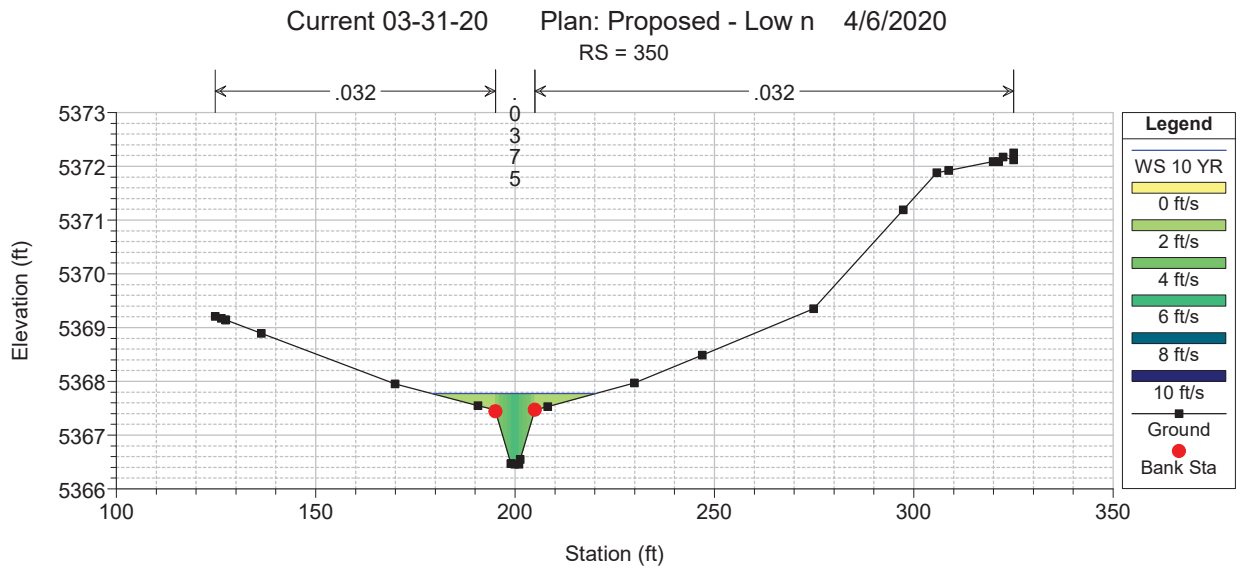

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 598.1
.0375
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

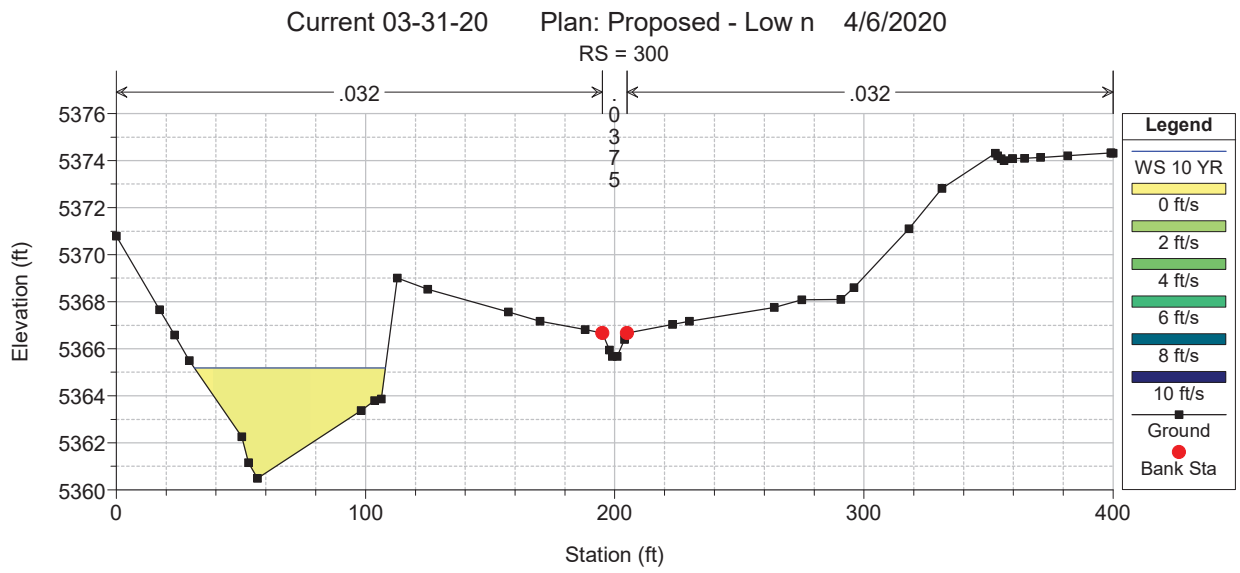

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 550
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

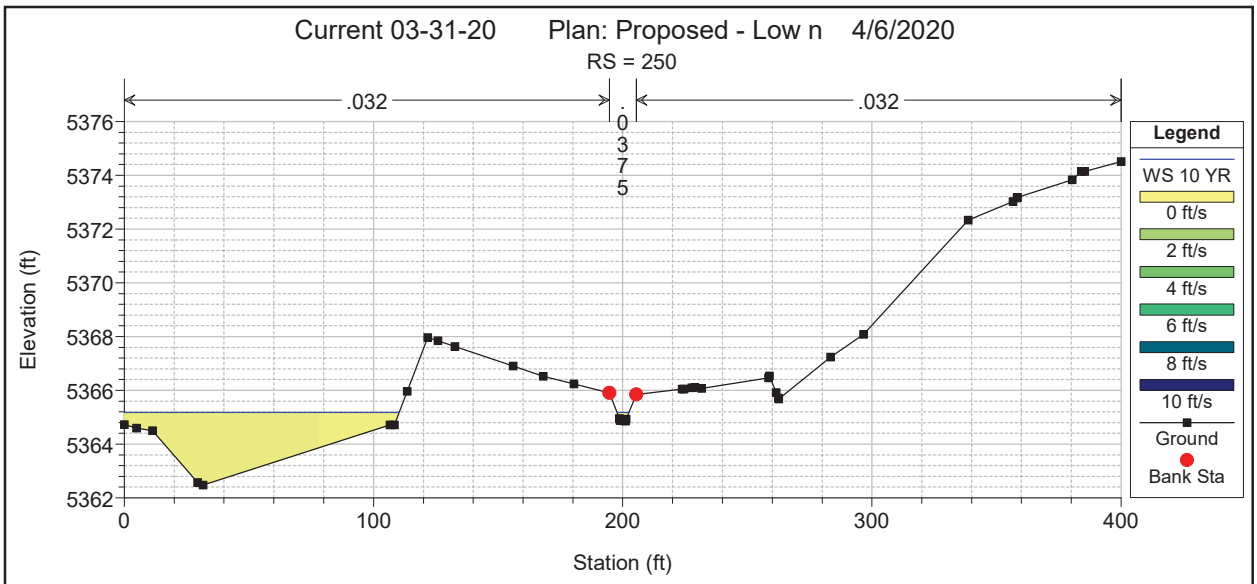

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 500
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

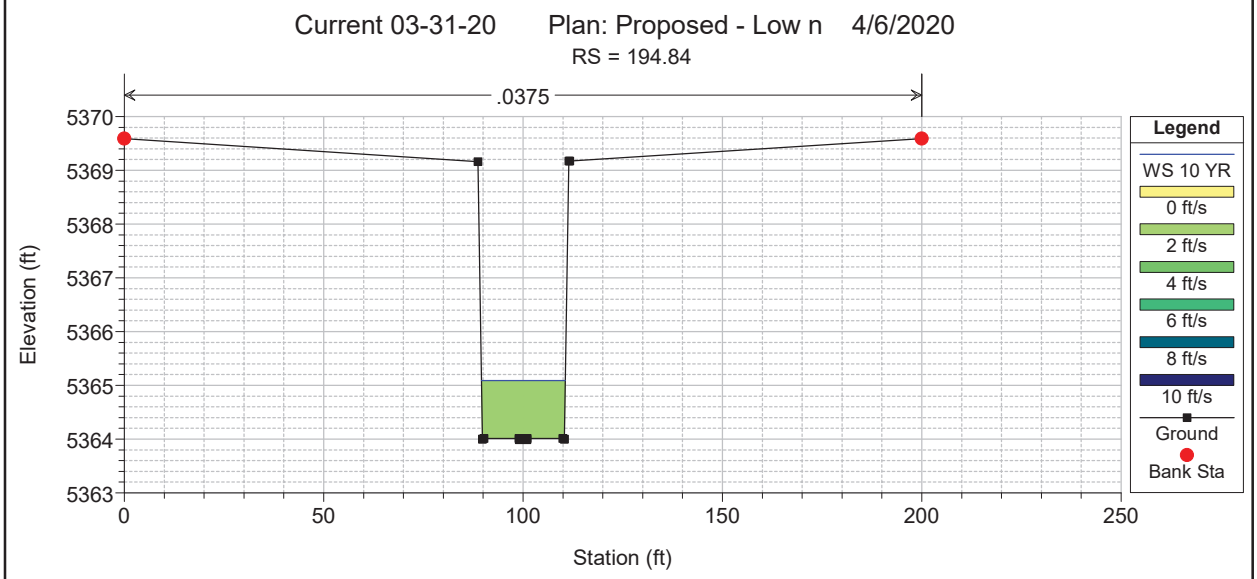

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 450
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

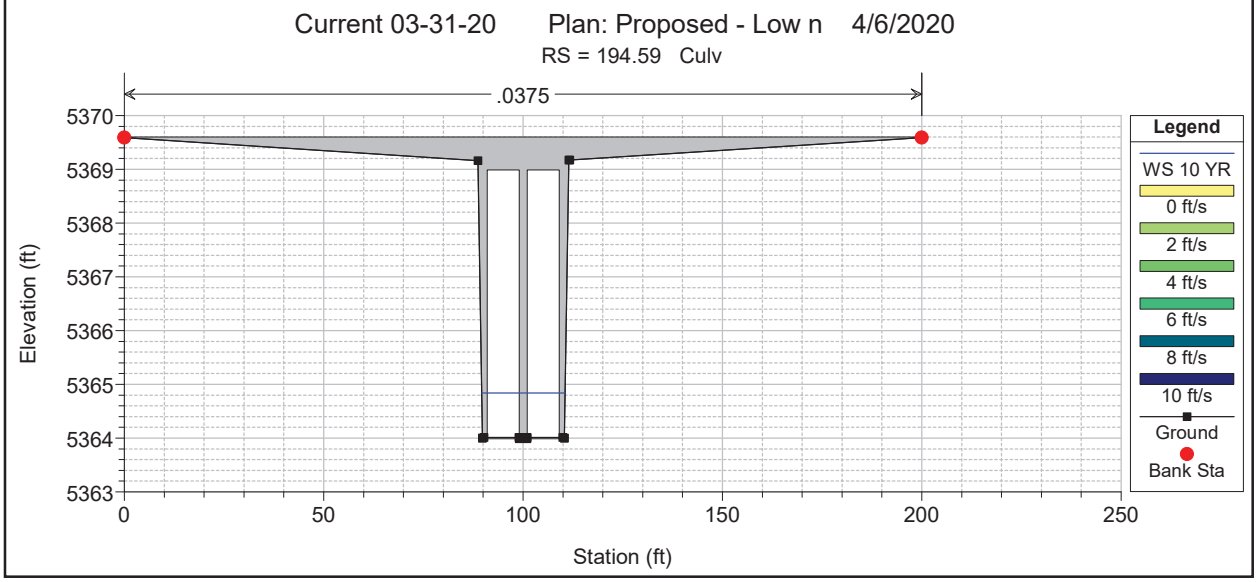

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 400
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

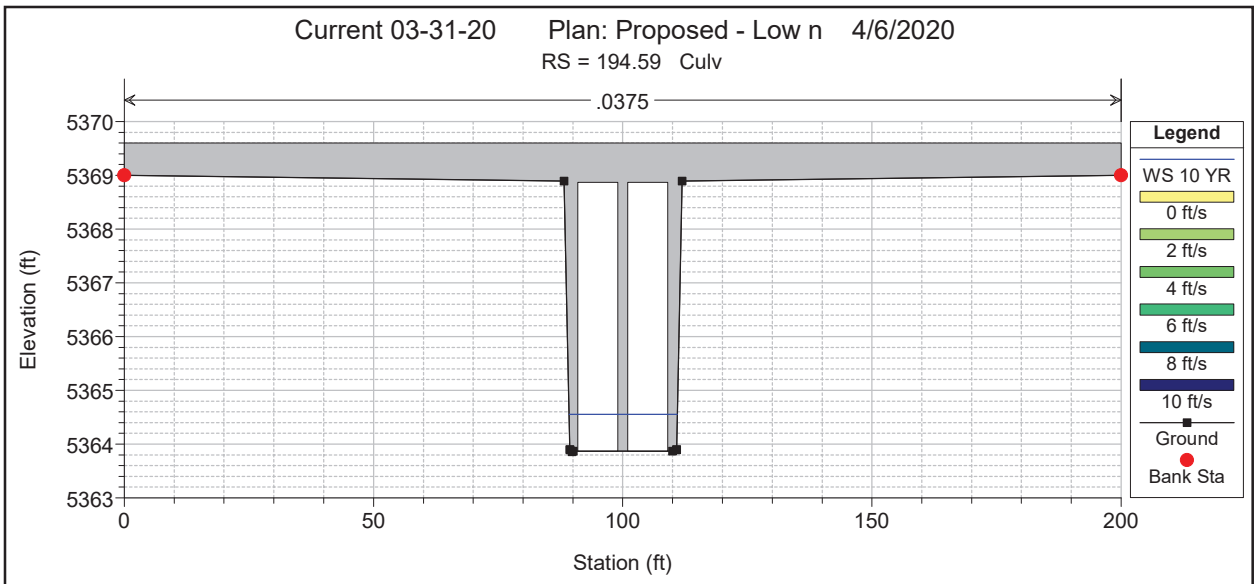

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 350
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

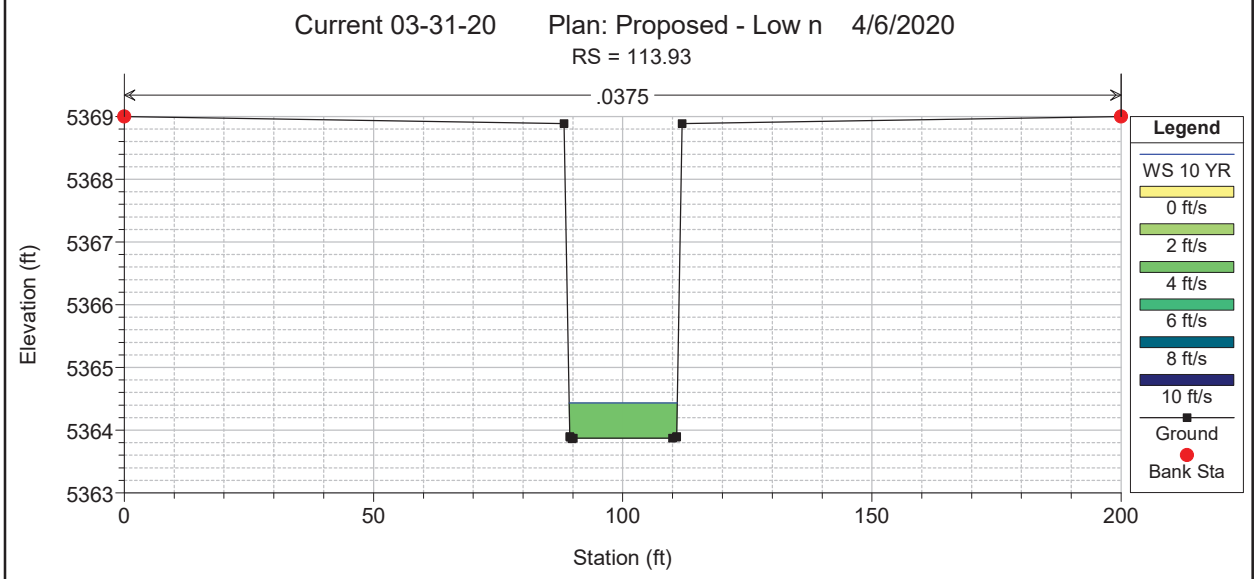

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 300
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

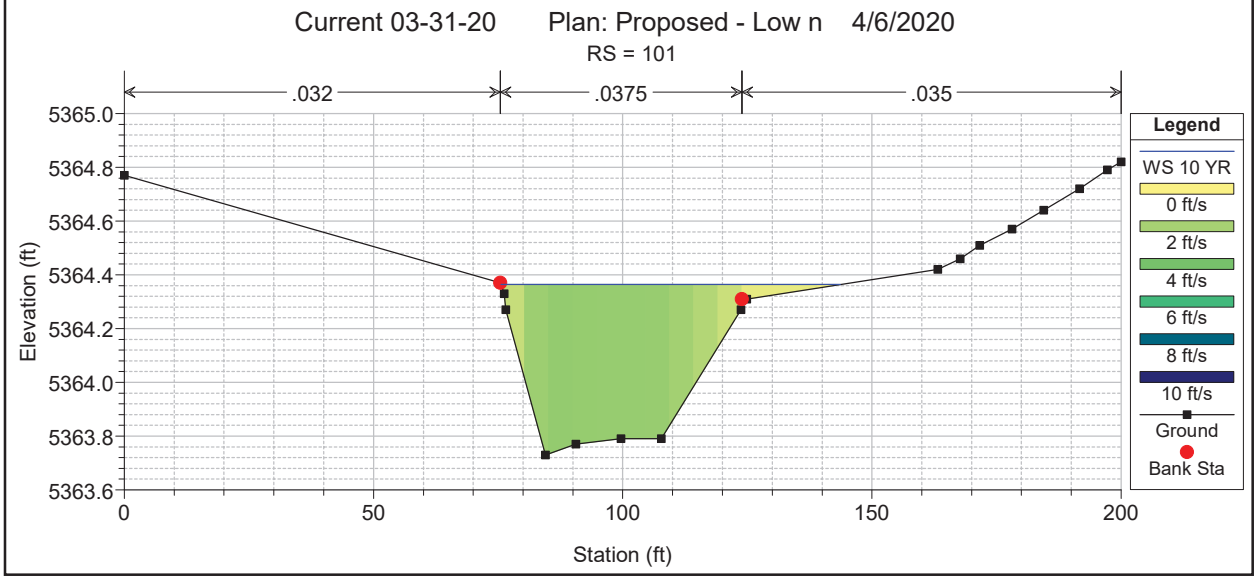

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 250
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 194.84
.0375
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 194.59 Culv
.0375
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 194.59 Culv
.0375
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 113.93
.0375
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 101
.032
.0375
.035
Elevation (ft)
Station (ft)
Legend
WS 10 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 100 YR

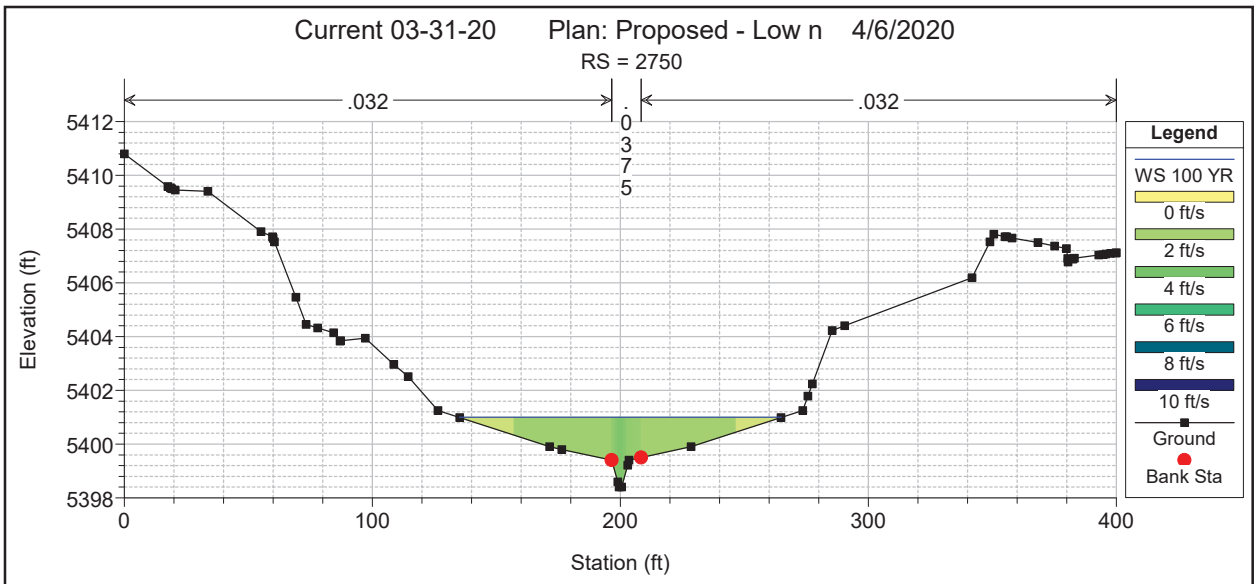
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR - Tributary I	5750	100 YR	93.17	5450.60	5452.46	5452.46	5452.70	0.020550	3.90	23.88	52.43	1.02	0.58
PR - Tributary I	5700	100 YR	93.17	5450.44	5451.35	5451.37	5451.57	0.024835	3.77	24.75	66.46	1.09	0.57
PR - Tributary I	5650	100 YR	93.17	5449.61	5450.12	5450.13	5450.29	0.025845	3.31	28.11	94.70	1.07	0.48
PR - Tributary I	5600	100 YR	93.17	5448.25	5448.72	5448.75	5448.94	0.028136	3.78	24.64	72.87	1.15	0.59
PR - Tributary I	5550	100 YR	93.17	5446.77	5447.53	5447.55	5447.77	0.022917	3.92	23.78	57.11	1.07	0.60
PR - Tributary I	5500	100 YR	93.17	5445.70	5446.69	5446.52	5446.82	0.008252	2.91	32.03	55.87	0.68	0.30
PR - Tributary I	5450	100 YR	93.17	5445.24	5445.97	5445.97	5446.21	0.020095	3.93	23.73	51.48	1.02	0.58
PR - Tributary I	5400	100 YR	93.17	5444.05	5444.84	5444.87	5445.11	0.024130	4.18	22.31	50.59	1.11	0.66
PR - Tributary I	5350	100 YR	93.17	5443.51	5444.22	5444.11	5444.35	0.010106	2.90	32.15	65.70	0.73	0.31
PR - Tributary I	5300	100 YR	93.17	5443.08	5443.70		5443.82	0.011338	2.83	32.89	75.80	0.76	0.31
PR - Tributary I	5250	100 YR	93.17	5442.33	5442.86	5442.86	5443.05	0.021427	3.52	26.49	71.18	1.02	0.50
PR - Tributary I	5200	100 YR	93.17	5441.18	5441.77	5441.78	5441.98	0.021643	3.61	25.78	66.97	1.03	0.52
PR - Tributary I	5150	100 YR	93.17	5440.49	5441.39	5441.06	5441.44	0.003058	1.86	50.02	80.91	0.42	0.12
PR - Tributary I	5100	100 YR	93.17	5438.27	5441.41		5441.42	0.000044	0.45	205.46	113.47	0.06	0.00
PR - Tributary I	5050	100 YR	93.17	5440.42	5441.17	5441.17	5441.39	0.019584	3.76	24.79	56.31	1.00	0.54
PR - Tributary I	5000	100 YR	93.17	5438.12	5438.93	5439.13	5439.52	0.090923	6.14	15.17	52.15	2.01	1.65
PR - Tributary I	4950	100 YR	93.17	5437.50	5438.26	5438.21	5438.42	0.015074	3.24	28.78	67.26	0.87	0.40
PR - Tributary I	4900	100 YR	93.17	5436.66	5437.34	5437.34	5437.56	0.020063	3.72	25.03	58.74	1.01	0.53
PR - Tributary I	4850	100 YR	93.17	5435.75	5436.59	5436.44	5436.70	0.007803	2.63	35.40	68.83	0.65	0.25
PR - Tributary I	4800	100 YR	93.17	5435.31	5435.98	5435.95	5436.15	0.016599	3.28	28.42	70.03	0.91	0.42
PR - Tributary I	4750	100 YR	93.17	5434.72	5435.29		5435.43	0.012195	2.94	31.74	73.28	0.79	0.33
PR - Tributary I	4700	100 YR	93.17	5434.02	5434.59	5434.55	5434.74	0.015276	3.09	30.19	76.52	0.87	0.38
PR - Tributary I	4650	100 YR	93.17	5433.21	5433.80	5433.76	5433.96	0.015934	3.21	28.99	71.40	0.89	0.40
PR - Tributary I	4600	100 YR	93.17	5432.45	5433.07		5433.23	0.013516	3.13	29.79	67.56	0.83	0.37
PR - Tributary I	4550	100 YR	93.17	5431.45	5432.18	5432.18	5432.40	0.020692	3.74	24.93	59.56	1.02	0.54
PR - Tributary I	4500	100 YR	93.17	5430.22	5431.68	5431.44	5431.76	0.004851	2.24	41.68	72.39	0.52	0.17
PR - Tributary I	4450	100 YR	93.17	5430.61	5431.13	5431.13	5431.30	0.022048	3.27	28.50	87.31	1.01	0.45
PR - Tributary I	4400	100 YR	93.17	5428.99	5429.60	5429.69	5429.90	0.036196	4.34	21.48	62.40	1.30	0.78
PR - Tributary I	4350	100 YR	93.17	5427.82	5428.56	5428.56	5428.76	0.021614	3.55	26.23	69.87	1.02	0.51
PR - Tributary I	4300	100 YR	93.17	5426.83	5427.54	5427.49	5427.69	0.014909	3.10	30.02	74.13	0.86	0.38
PR - Tributary I	4250	100 YR	93.17	5426.04	5426.64	5426.64	5426.81	0.021131	3.29	28.31	83.16	0.99	0.45
PR - Tributary I	4200	100 YR	93.17	5425.05	5425.69	5425.67	5425.84	0.017584	3.13	29.76	82.07	0.92	0.40
PR - Tributary I	4150	100 YR	93.17	5424.36	5424.92		5425.04	0.014575	2.83	32.92	91.73	0.83	0.33
PR - Tributary I	4100	100 YR	93.17	5423.72	5424.19	5424.15	5424.31	0.014798	2.71	34.40	103.57	0.83	0.31
PR - Tributary I	4050	100 YR	93.17	5422.79	5423.46	5423.41	5423.58	0.014657	2.74	34.01	99.94	0.83	0.31
PR - Tributary I	4000	100 YR	93.17	5422.19	5422.78		5422.91	0.012474	2.83	32.93	81.68	0.79	0.31
PR - Tributary I	3950	100 YR	93.17	5421.55	5422.19	5422.11	5422.30	0.011551	2.66	35.08	90.35	0.75	0.28
PR - Tributary I	3900	100 YR	93.17	5420.99	5421.55		5421.67	0.013639	2.78	33.52	91.36	0.81	0.31
PR - Tributary I	3850	100 YR	93.17	5420.41	5421.08		5421.16	0.007332	2.18	42.78	105.49	0.60	0.19
PR - Tributary I	3800	100 YR	93.17	5419.89	5420.45	5420.44	5420.58	0.020857	2.87	32.42	115.53	0.96	0.37
PR - Tributary I	3750	100 YR	93.17	5418.86	5419.62	5419.55	5419.73	0.014014	2.72	34.24	98.31	0.81	0.30
PR - Tributary I	3700	100 YR	93.17	5417.97	5418.69	5418.69	5418.83	0.023793	3.04	30.67	111.00	1.02	0.41
PR - Tributary I	3650	100 YR	93.17	5416.98	5417.45	5417.46	5417.59	0.025991	3.07	30.40	116.02	1.06	0.43
PR - Tributary I	3600	100 YR	93.17	5415.58	5416.10	5416.11	5416.28	0.026529	3.44	27.11	88.53	1.09	0.51
PR - Tributary I	3550	100 YR	93.17	5414.55	5415.14	5415.11	5415.29	0.016469	3.11	29.92	79.22	0.89	0.39
PR - Tributary I	3500	100 YR	93.17	5413.71	5414.18	5414.18	5414.35	0.021510	3.29	28.31	84.25	1.00	0.45
PR - Tributary I	3450	100 YR	93.17	5412.64	5413.50	5413.20	5413.54	0.002781	1.69	55.02	95.64	0.39	0.10
PR - Tributary I	3400	100 YR	270.80	5411.88	5412.75	5412.75	5413.05	0.017661	4.45	60.87	99.42	1.00	0.67
PR - Tributary I	3350	100 YR	270.80	5411.24	5412.53	5412.09	5412.63	0.003121	2.48	109.40	117.32	0.45	0.18
PR - Tributary I	3300	100 YR	270.80	5410.87	5412.46		5412.51	0.001416	1.79	150.96	145.05	0.31	0.09
PR - Tributary I	3250	100 YR	270.80	5409.78	5412.36		5412.41	0.003131	1.85	146.66	192.70	0.37	0.15
PR - Tributary I	3232.13	100 YR	270.80	5409.65	5411.84	5411.84	5412.26	0.022243	5.18	52.25	63.07	1.00	1.14
PR - Tributary I	3205.03	100 YR	270.80	5405.01	5406.22	5407.26	5410.49	0.192654	16.56	16.35	17.20	3.00	11.18
PR - Tributary I	3181.99	100 YR	270.80	5404.79	5406.68	5407.03	5407.98	0.035965	9.16	29.55	21.33	1.37	3.02
PR - Tributary I	3140.22	100 YR	270.80	5399.18	5400.95	5401.84	5404.66	0.225512	15.45	17.53	21.12	2.99	10.48
PR - Tributary I	3140		Culvert										
PR - Tributary I	2909.93	100 YR	270.80	5398.72	5401.40	5401.40	5402.25	0.021582	7.39	36.64	21.28	0.99	1.93
PR - Tributary I	2850	100 YR	270.80	5398.60	5401.19		5401.52	0.008243	5.36	62.47	61.92	0.69	0.94
PR - Tributary I	2800	100 YR	270.80	5398.50	5401.11		5401.22	0.003036	3.56	102.75	99.75	0.43	0.39
PR - Tributary I	2750	100 YR	270.80	5398.40	5401.00		5401.08	0.002427	2.95	122.33	129.82	0.38	0.28
PR - Tributary I	2700	100 YR	270.80	5398.30	5400.86		5400.95	0.002662	3.28	117.90	127.76	0.40	0.34
PR - Tributary I	2650	100 YR	270.80	5398.20	5400.70		5400.80	0.003161	3.51	110.54	123.91	0.43	0.39
PR - Tributary I	2600	100 YR	270.80	5398.10	5400.18	5400.18	5400.49	0.013674	5.69	64.02	95.58	0.85	1.16
PR - Tributary I	2550	100 YR	270.80	5396.43	5398.59	5397.79	5398.65	0.001293	1.86	145.60	123.71	0.30	0.09
PR - Tributary I	2500	100 YR	270.80	5394.51	5398.62		5398.63	0.000048	0.58	466.52	190.23	0.07	0.01
PR - Tributary I	2450	100 YR	270.80	5394.37	5398.62		5398.63	0.000013	0.36	754.83	237.14	0.04	0.00
PR - Tributary I	2400	100 YR	270.80	5394.18	5398.62		5398.62	0.000012	0.33	810.54	272.91	0.03	0.00
PR - Tributary I	2350	100 YR	270.80	5394.18	5398.62		5398.62	0.000008	0.30	894.05	257.92	0.03	0.00
PR - Tributary I	2300	100 YR	270.80	5394.18	5398.62		5398.62	0.000007	0.29	926.68	257.94	0.03	0.00
PR - Tributary I	2218.78	100 YR	270.80	5397.49	5398.34	5398.34	5398.60	0.026245	4.04	67.07	134.46	1.01	0.82
PR - Tributary I	2198.89	100 YR	270.80	5392.12	5393.56	5394.04	5397.05	0.260638	18.86	22.27	74.48	3.44	14.64
PR - Tributary I	2150	100 YR	270.80	5391.10	5393.01	5393.14	5393.49	0.022842	7.57	54.53	97.76	1.10	2.03
PR - Tributary I	2100	100 YR	270.80	5390.07	5392.07	5392.15	5392.46	0.017795	6.94	60.73	106.16	0.98	1.67
PR - Tributary I	2050	100 YR	270.80	5389.03	5391.01	5391.14	5391.47	0.021289	7.52	55.64	98.02	1.06	1.97
PR - Tributary I	2000	100 YR	270.80	5388.00	5389.95	5390.07	5390.39	0.021451	7.46	56.69	103.32	1.07	1.95
PR - Tributary I	1950	100 YR	270.80	5386.96	5388.75	5388.87	5389.21	0.026504	7.69	55.32	113.83	1.16	2.15
PR - Tributary I	1900	100 YR	270.80	5385.93	5387.74	5387.79	5388.07	0.018724	6.53	64.51	126.81	0.98	1.55
PR - Tributary I	1850	100 YR	270.80	5384.89	5386.91	5386.95	5387.24	0.014741	6.41	64.77	108.09	0.89	1.41
PR - Tributary I	1800	100 YR	270.80	5383.85	5385.78	5385.93	5386.28	0.025203	7.62	53.18	99.40	1.14	2.10
PR - Tributary I	1750	100 YR	270.80	5382.66	5384.88	5384.83	5385.10	0.012132	4.56	75.28	132.94	0.77	0.81
PR - Tributary I	1700	100 YR	270.80	5381.95	5384.06	5384.06	5384.38	0.017357	5.37	62.12	104.43	0.91	1.13
PR - Tributary I	1650	100 YR	270.80	5381.09	5383.41	5383.27	5383.62	0.008373	4.51	77.76	108.79	0.67	0.72
PR - Tributary I	1600	100 YR	270.80	5380.66	5382.69	5382.69	5383.04	0.015995	5.14	58.64	87.51	0.87	1.04
PR - Tributary I	1550	100 YR	270.80	5379.85	5381.95	5381.95	5382.27	0.014263	6.01	62.17	90.73	0.86	1.27

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 100 YR (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear Chan
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)
PR - Tributary I	1500	100 YR	270.80	5379.19	5381.54	5381.21	5381.69	0.004646	3.97	89.93	97.51	0.52	0.52
PR - Tributary I	1450	100 YR	270.80	5378.72	5380.93	5380.93	5381.29	0.013872	5.70	59.93	84.95	0.85	1.17
PR - Tributary I	1400	100 YR	270.80	5377.93	5380.76	5380.04	5380.82	0.001482	2.19	147.01	138.53	0.29	0.16
PR - Tributary I	1350	100 YR	439.06	5377.94	5380.34		5380.62	0.008484	5.71	113.23	143.59	0.71	1.04
PR - Tributary I	1300	100 YR	439.06	5377.44	5379.82	5379.74	5380.15	0.010029	6.16	101.84	118.19	0.77	1.21
PR - Tributary I	1250	100 YR	439.06	5376.94	5379.32		5379.65	0.009950	6.13	102.14	118.32	0.77	1.20
PR - Tributary I	1200	100 YR	439.06	5376.44	5378.80	5378.73	5379.14	0.010447	6.24	100.48	117.91	0.79	1.25
PR - Tributary I	1150	100 YR	439.06	5375.94	5378.54		5378.74	0.005281	4.79	130.15	133.67	0.57	0.71
PR - Tributary I	1100	100 YR	439.06	5375.44	5378.47		5378.56	0.001822	3.17	193.35	160.31	0.34	0.29
PR - Tributary I	1050	100 YR	439.06	5374.94	5378.45		5378.49	0.000643	2.11	281.73	188.51	0.21	0.12
PR - Tributary I	1000	100 YR	439.06	5374.44	5378.44		5378.47	0.000289	1.56	384.36	225.09	0.14	0.06
PR - Tributary I	950	100 YR	439.06	5373.93	5378.44		5378.45	0.000213	1.46	432.90	240.57	0.13	0.05
PR - Tributary I	900	100 YR	439.06	5373.44	5378.42		5378.44	0.000200	1.52	411.72	202.49	0.13	0.06
PR - Tributary I	838.96	100 YR	439.06	5372.81	5378.05	5376.05	5378.38	0.003128	4.60	95.38	22.63	0.40	0.58
PR - Tributary I	838.25		Culvert										
PR - Tributary I	598.1	100 YR	439.06	5370.41	5374.28		5375.01	0.010462	6.88	63.79	22.00	0.71	1.45
PR - Tributary I	550	100 YR	439.06	5369.65	5373.49	5373.49	5374.50	0.010089	8.93	59.49	30.40	0.85	2.12
PR - Tributary I	500	100 YR	439.06	5368.85	5370.59	5371.10	5373.13	0.118015	16.26	41.21	89.92	2.48	9.62
PR - Tributary I	450	100 YR	439.06	5368.05	5370.05	5370.18	5370.55	0.019494	7.60	85.27	128.42	1.05	1.96
PR - Tributary I	400	100 YR	439.06	5367.25	5369.51	5369.51	5369.88	0.011971	6.62	99.11	129.43	0.84	1.41
PR - Tributary I	350	100 YR	439.06	5366.46	5368.70	5368.76	5369.17	0.015870	7.36	86.01	110.38	0.96	1.78
PR - Tributary I	300	100 YR	439.06	5365.67	5368.93	5363.17	5368.94	0.000024	0.39	795.79	286.82	0.04	0.00
PR - Tributary I	250	100 YR	439.06	5364.86	5368.93		5368.94	0.000017	0.38	1024.82	305.03	0.03	0.00
PR - Tributary I	194.84	100 YR	439.06	5363.99	5368.60	5366.40	5368.90	0.002547	4.44	98.99	22.59	0.37	0.53
PR - Tributary I	194.59		Culvert										
PR - Tributary I	113.93	100 YR	439.06	5363.86	5366.19	5366.19	5367.35	0.019399	8.61	50.98	22.48	1.01	2.36
PR - Tributary I	101	100 YR	439.06	5363.73	5364.55	5364.96	5366.68	0.176991	12.37	42.35	134.84	2.73	7.07

HEC-RAS Plan: PR-Low-n River: Tributary - I Reach: PR - Tributary I Profile: 100 YR

Reach	River Sta	Profile	E.G. US.	W.S. US.	E.G. IC	E.G. OC	Min El Weir Flow	Q Culv Group	Q Weir	Delta WS	Culv Vel US	Culv Vel DS
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(ft)	(ft/s)	(ft/s)
PR - Tributary I	3140 West Ped	100 YR					5414.00					
PR - Tributary I	3140 West 10YR	100 YR					5414.00					
PR - Tributary I	838.25 10-YR East	100 YR	5378.38	5378.05	5377.94	5378.39	5387.51	257.37		3.77	10.12	14.05
PR - Tributary I	838.25 West-Ped	100 YR	5378.38	5378.05	5377.96	5378.37	5387.51	181.69		3.77	8.36	12.18
PR - Tributary I	194.59 Double	100 YR	5368.90	5368.60	5368.60	5368.90	5369.61	439.06		2.41	8.25	9.59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RS = 2750
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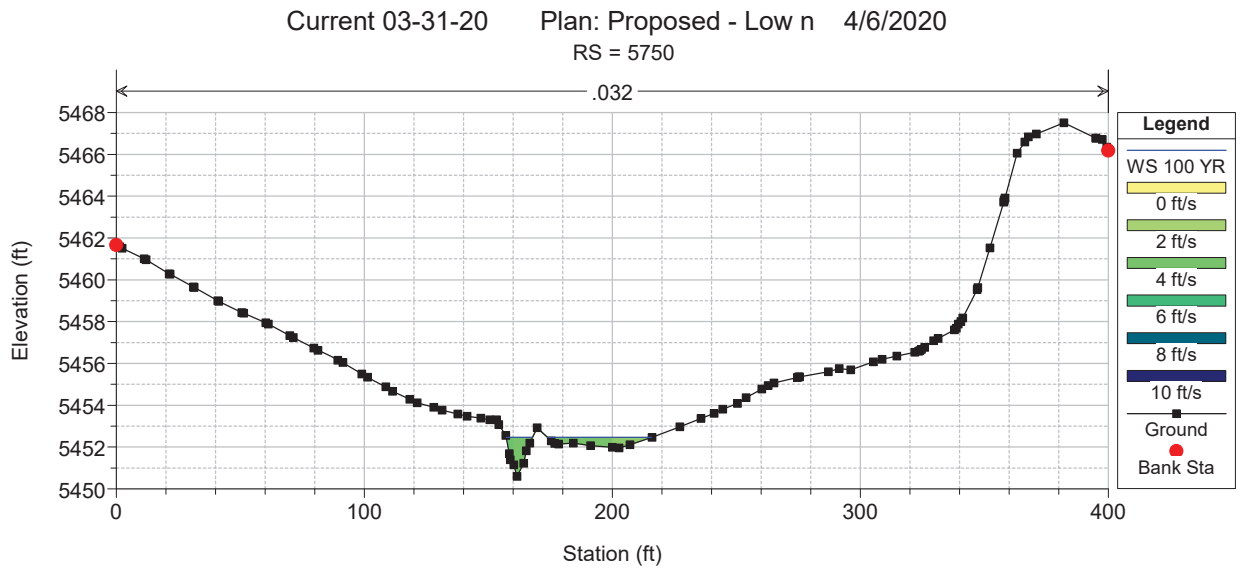
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5750
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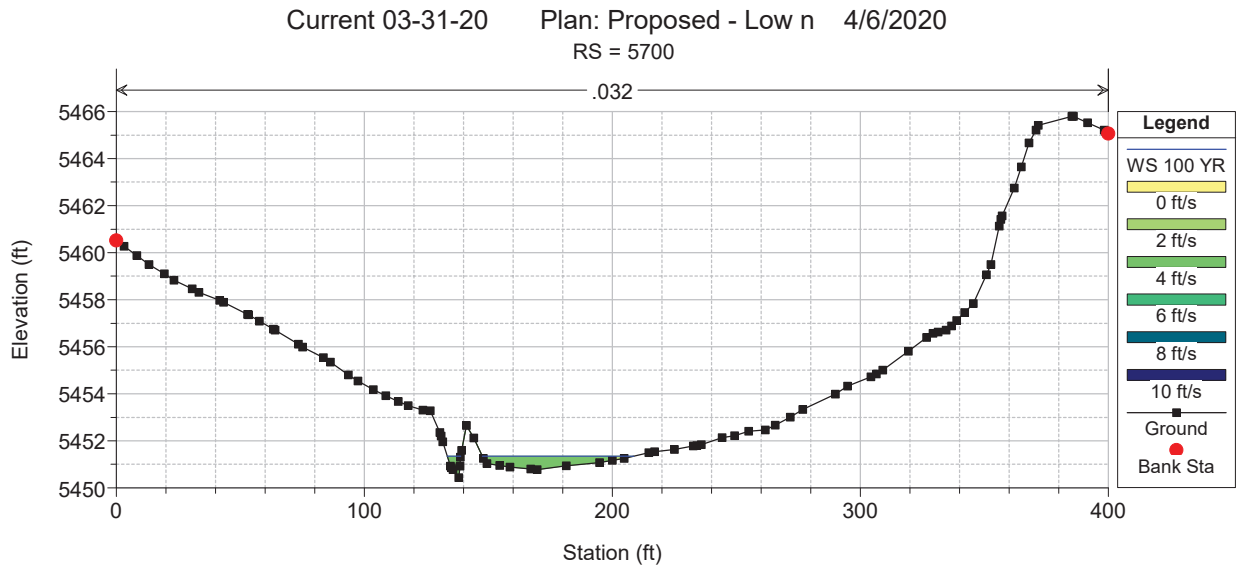
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5700
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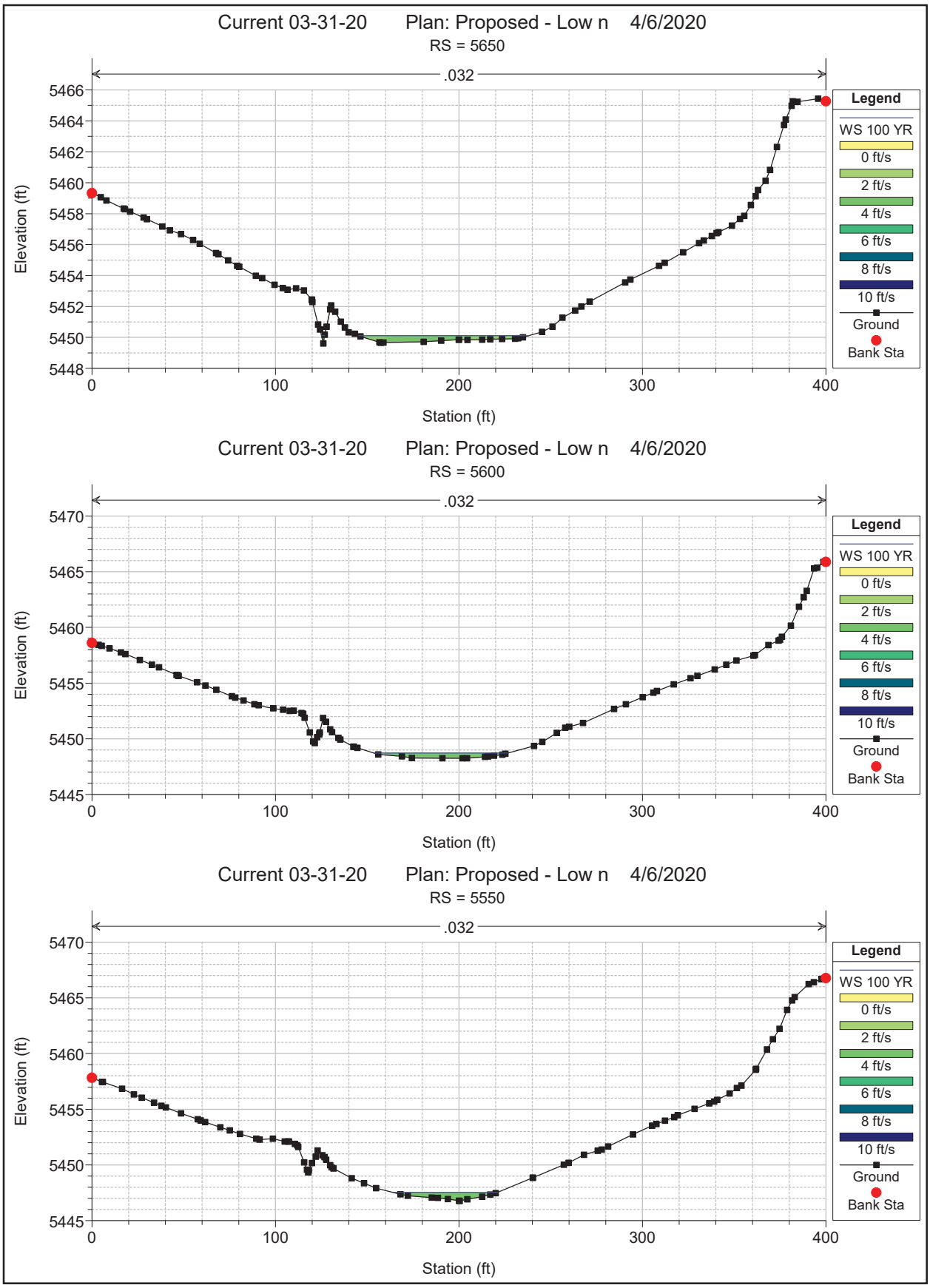
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5650
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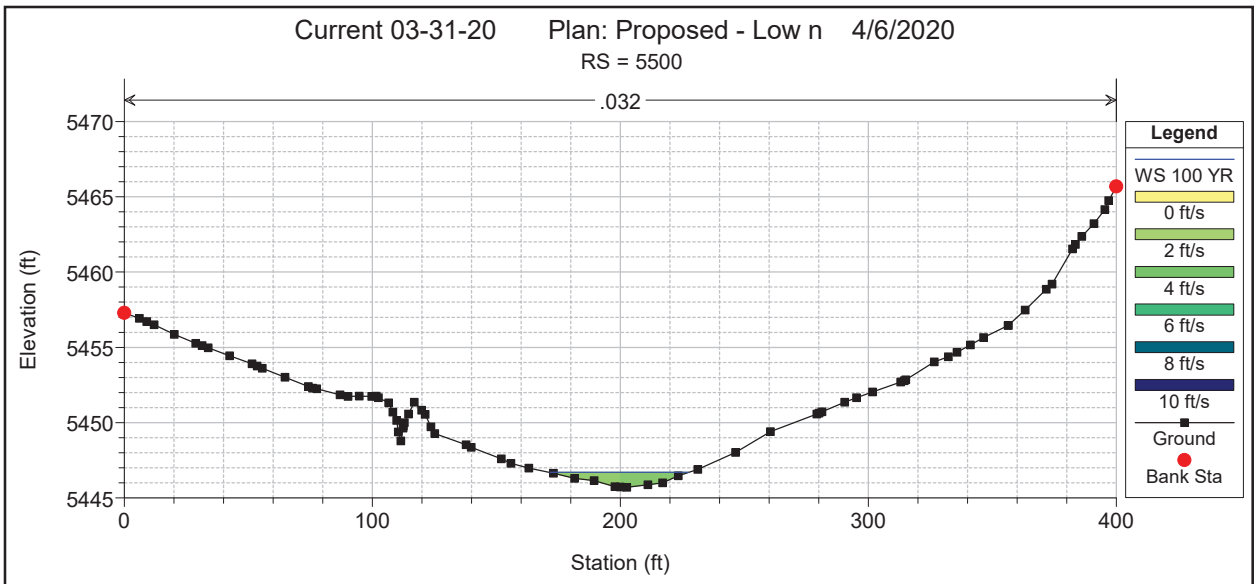
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5600
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5550
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
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Elevation (ft)
Station (ft)
Legend
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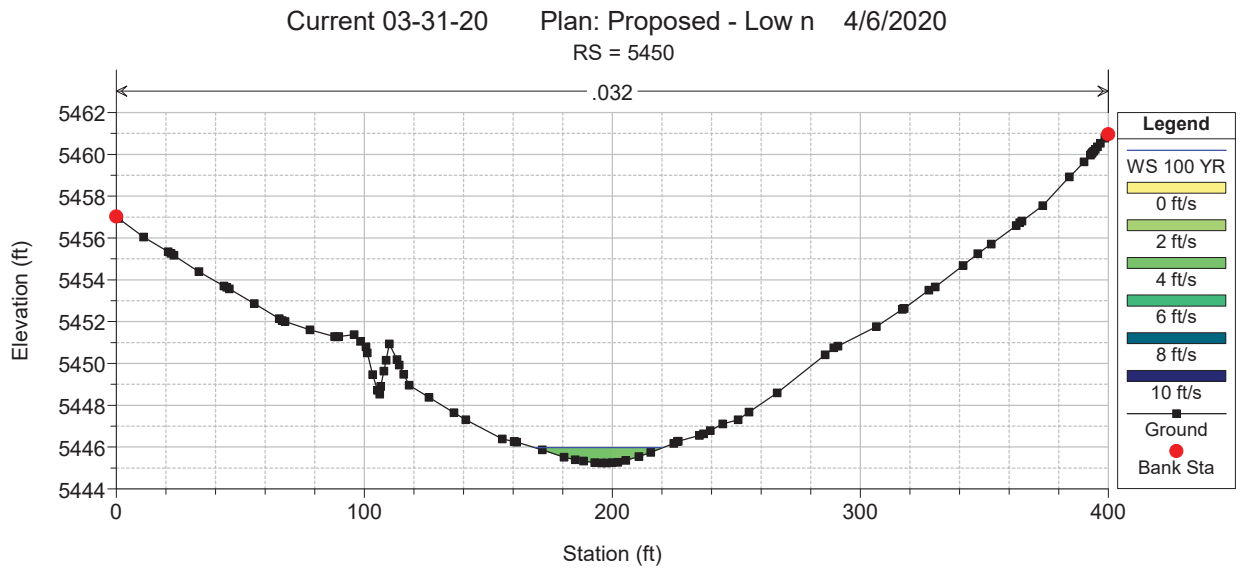
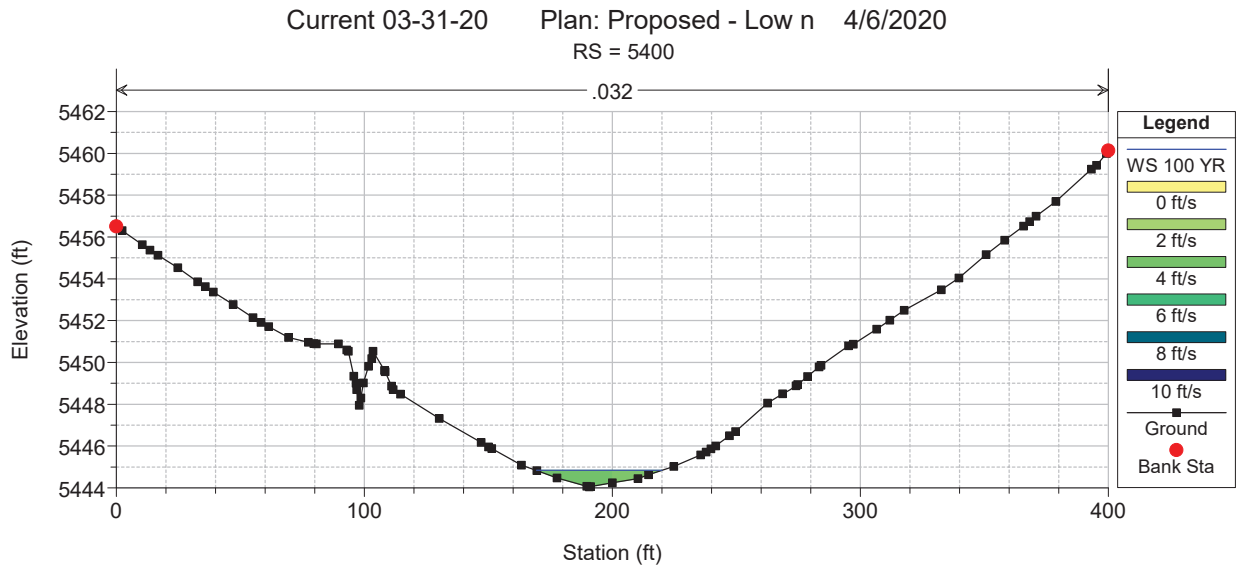
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5450
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
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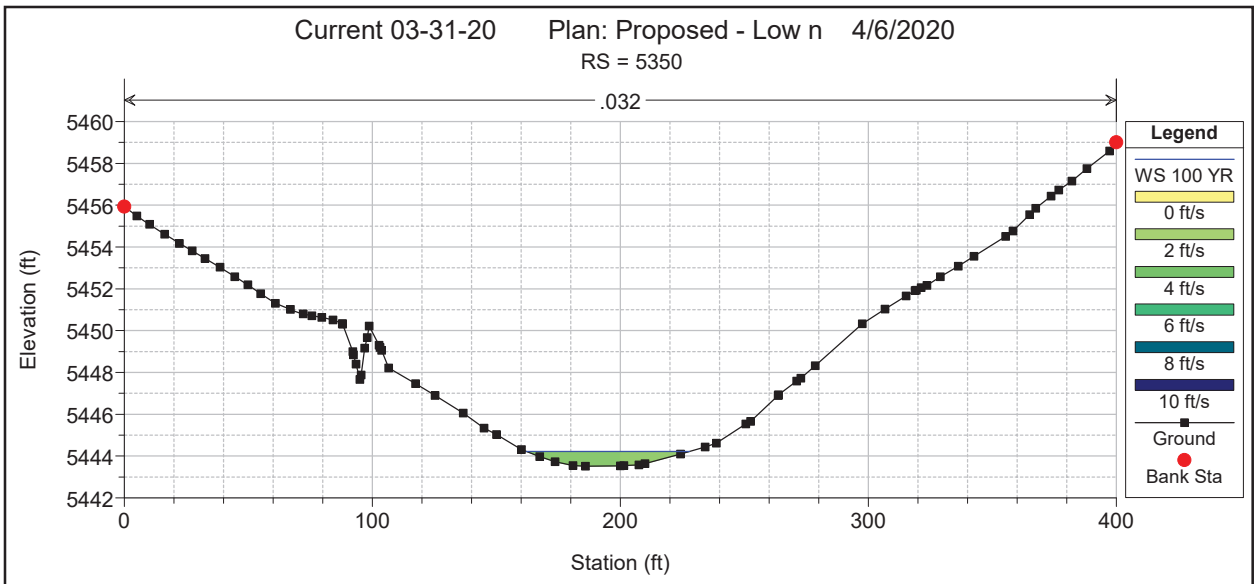
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
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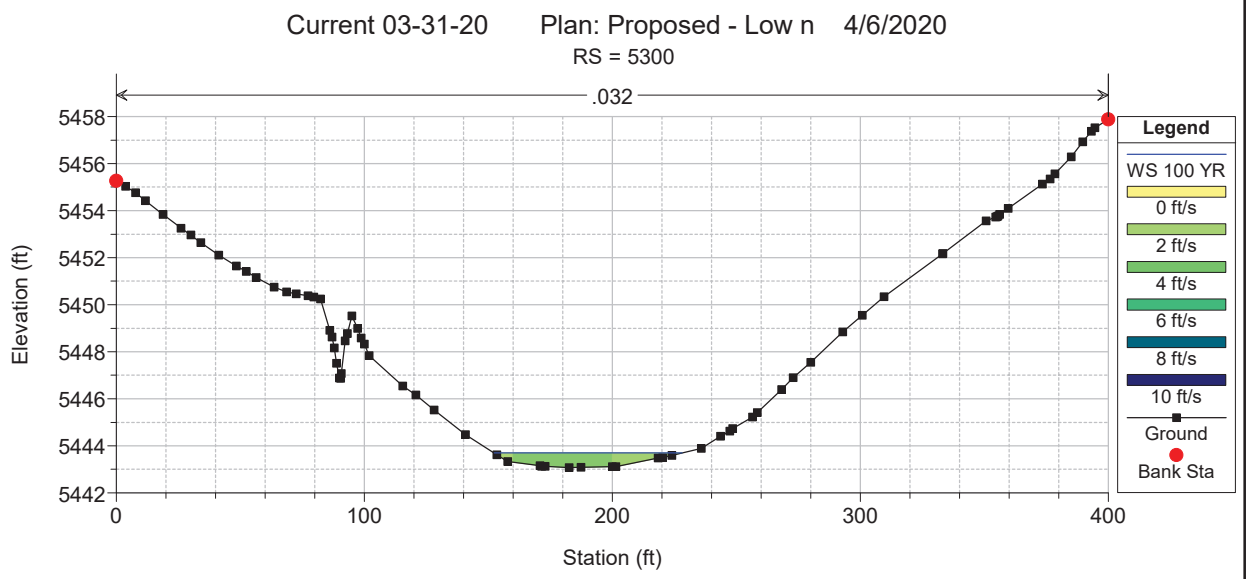
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5300
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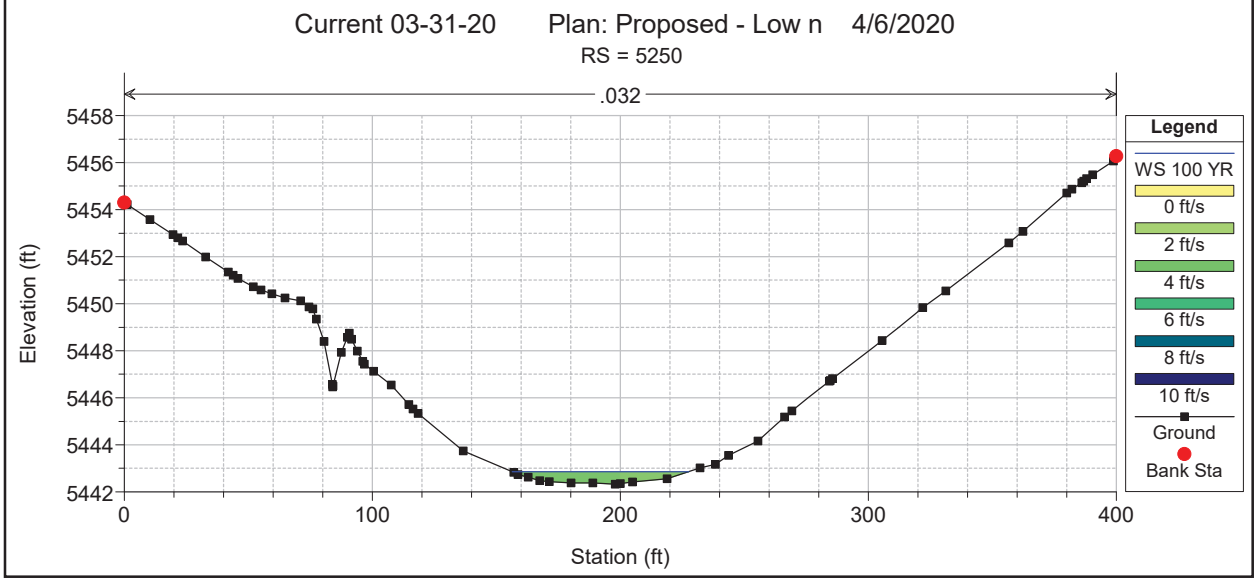
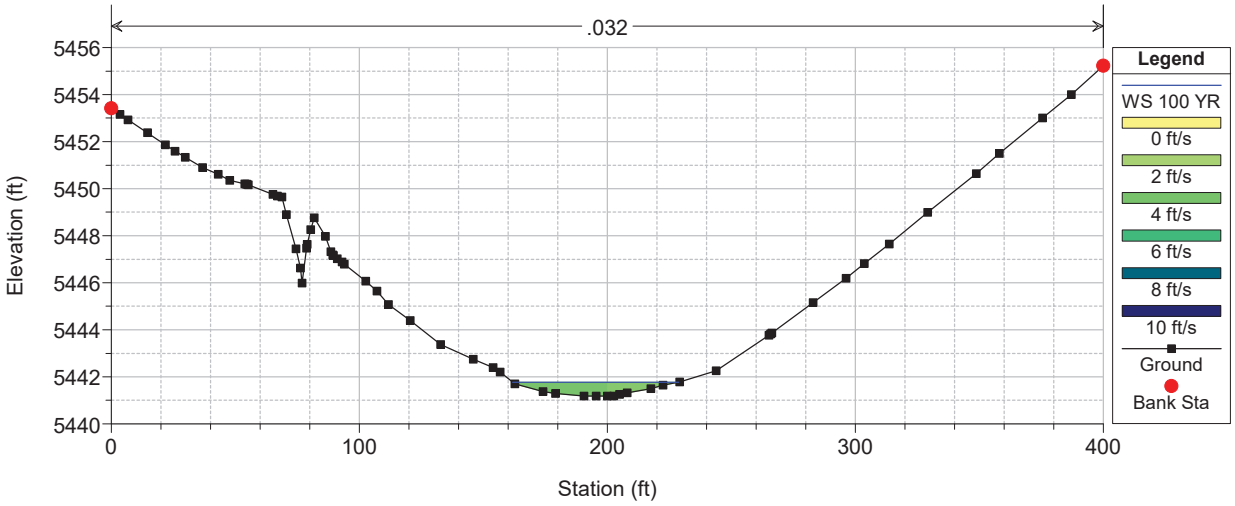
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5250
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

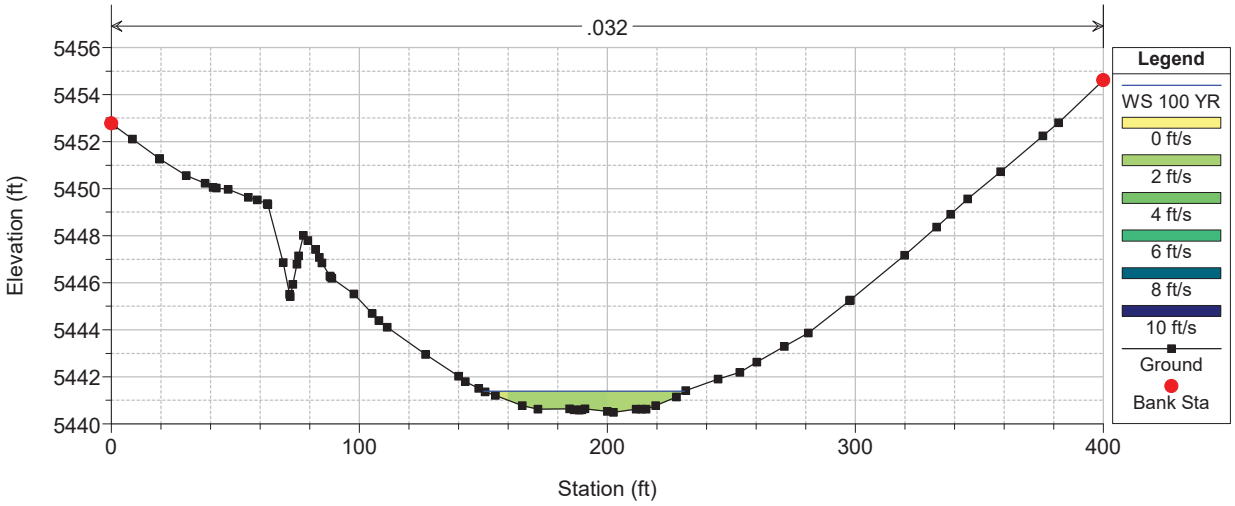
Current 03-31-20 Plan: Proposed - Low n 4/6/2020

RS = 5200



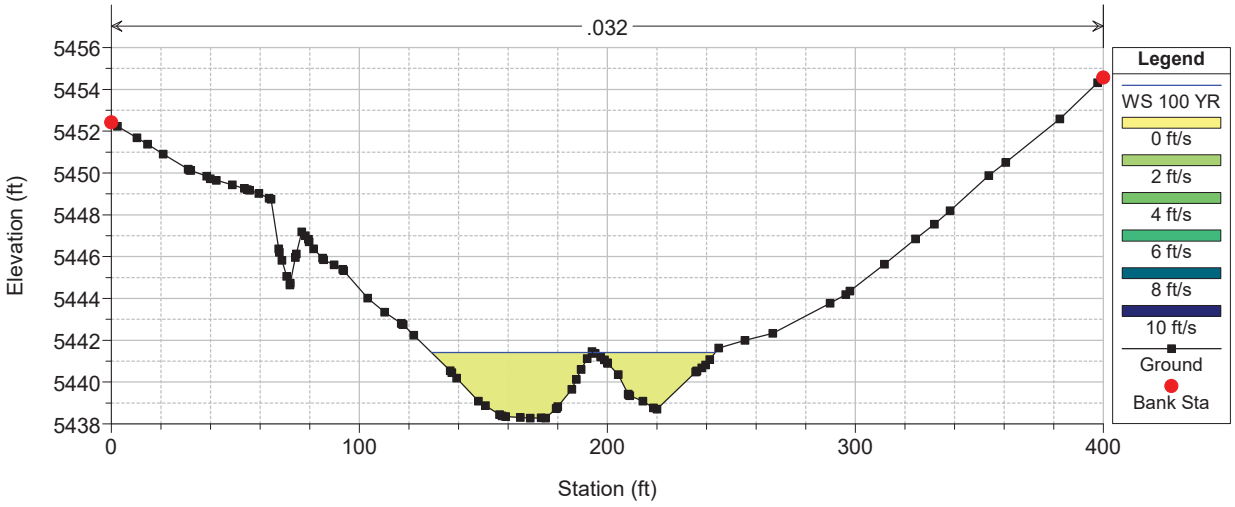
Current 03-31-20 Plan: Proposed - Low n 4/6/2020

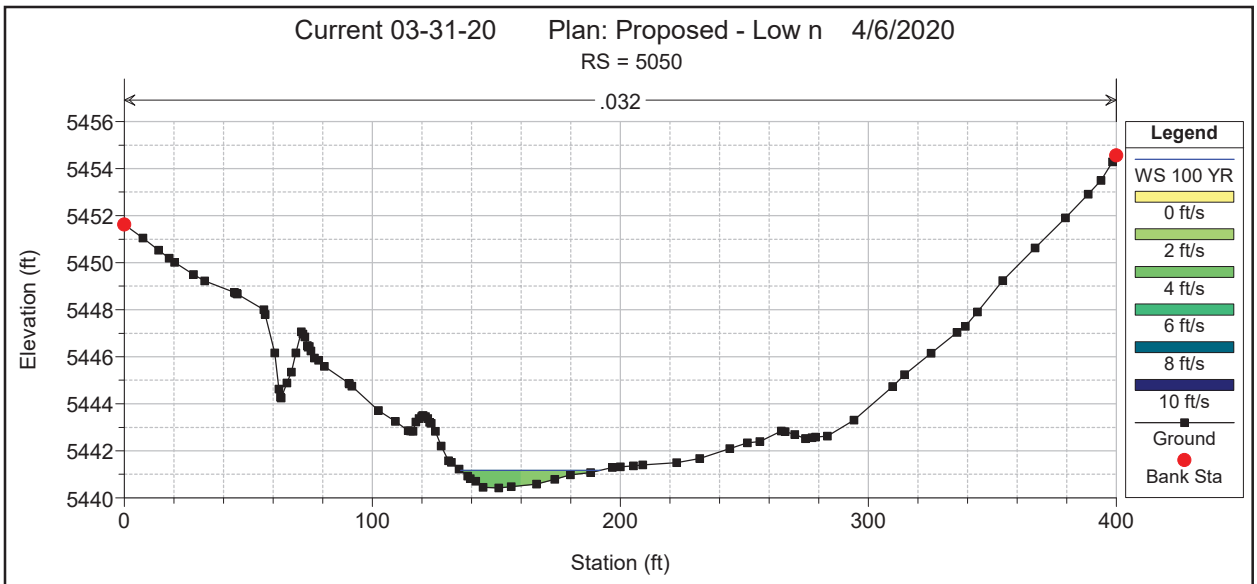
RS = 5150

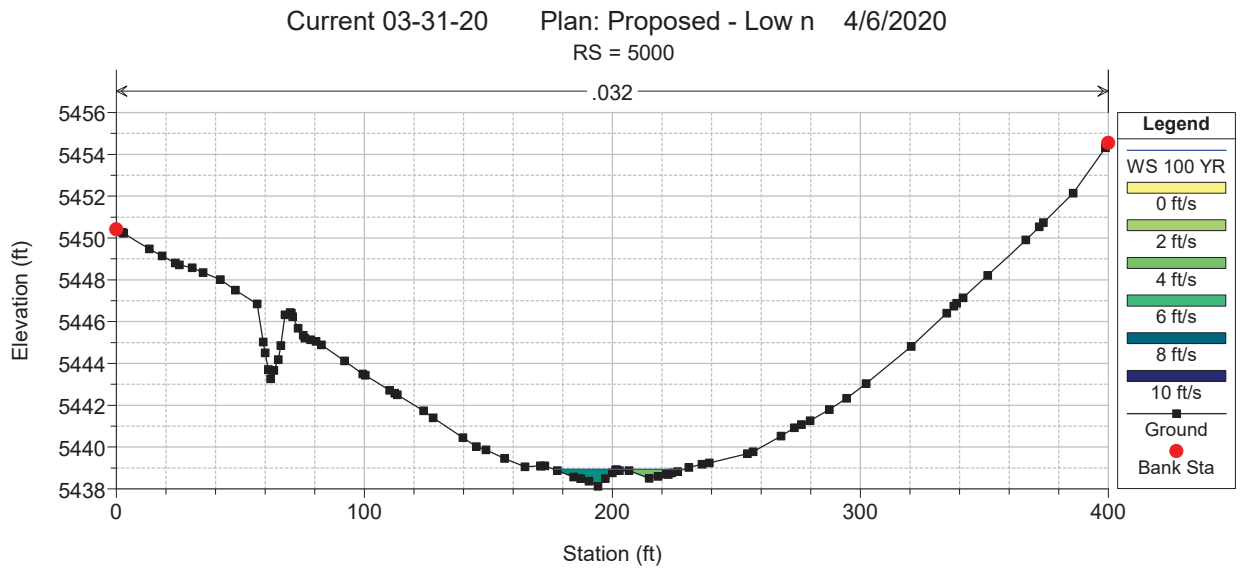


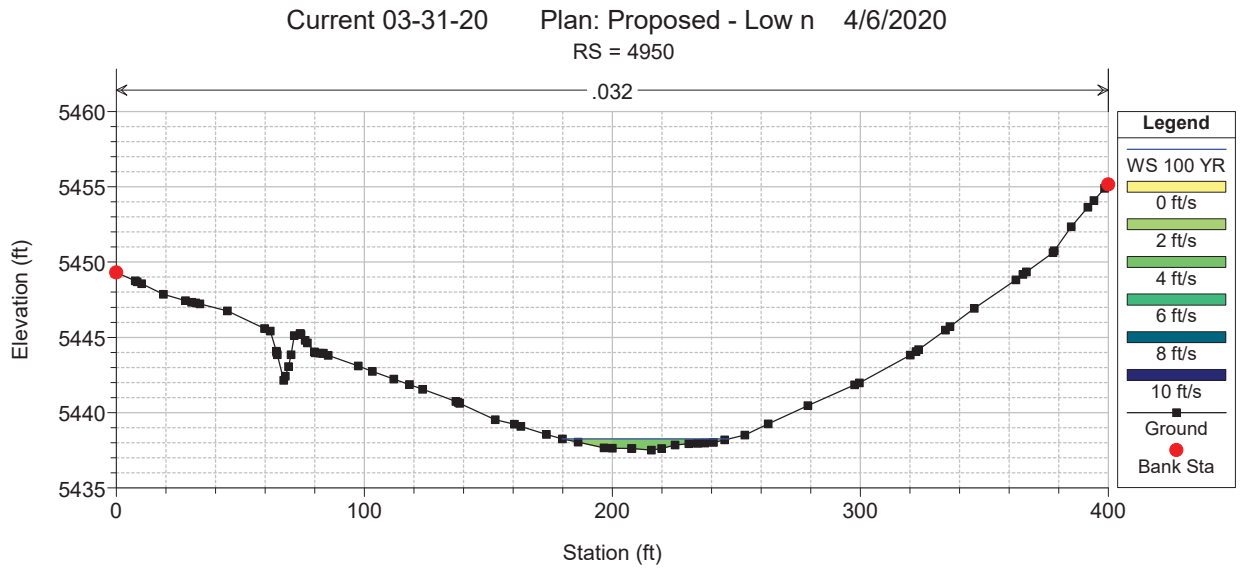
Current 03-31-20 Plan: Proposed - Low n 4/6/2020

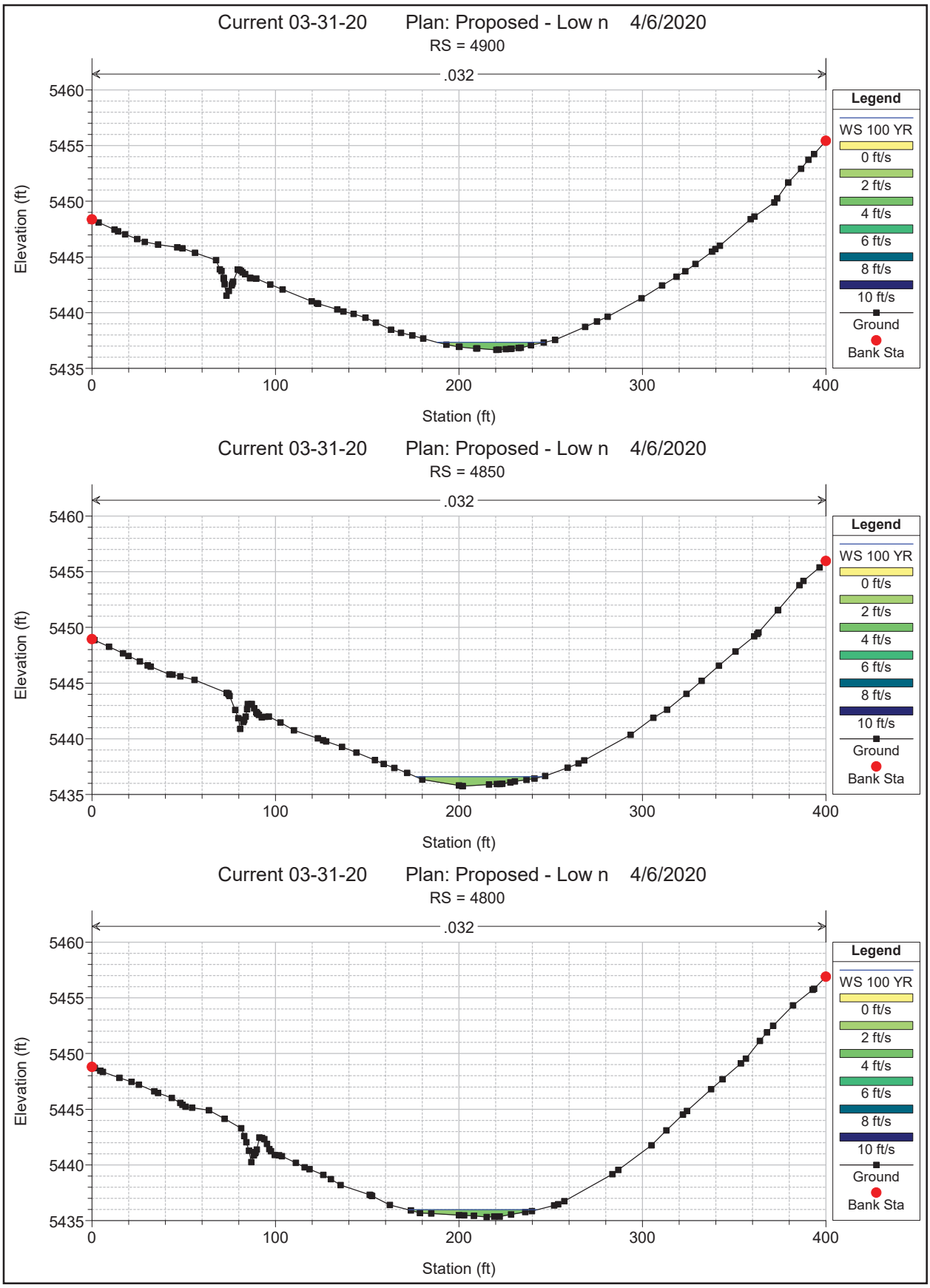
RS = 5100

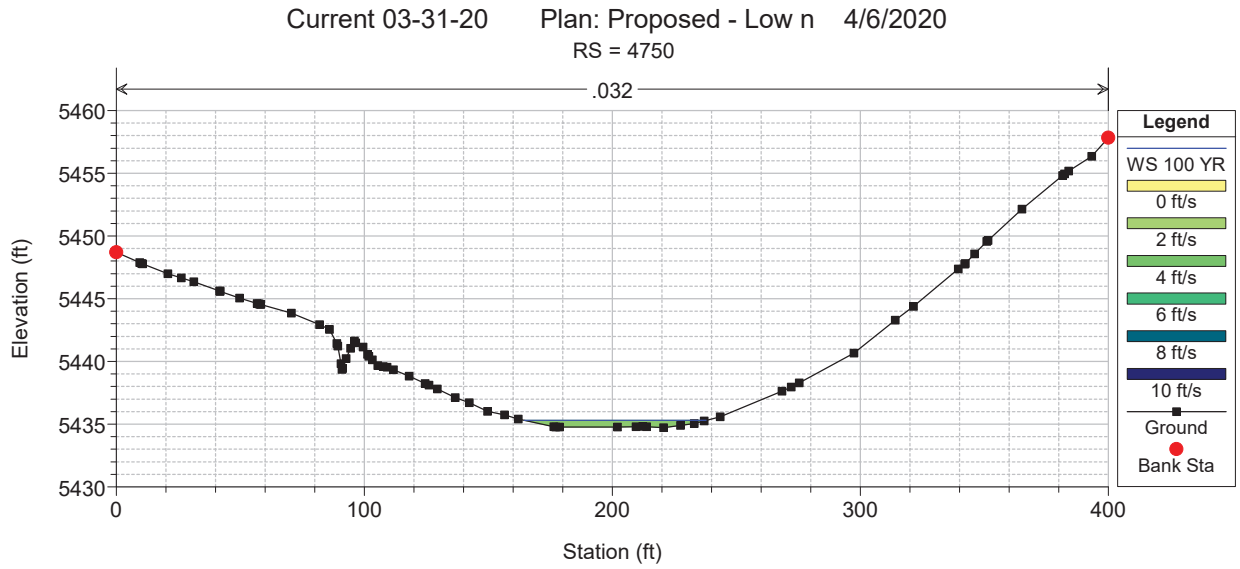


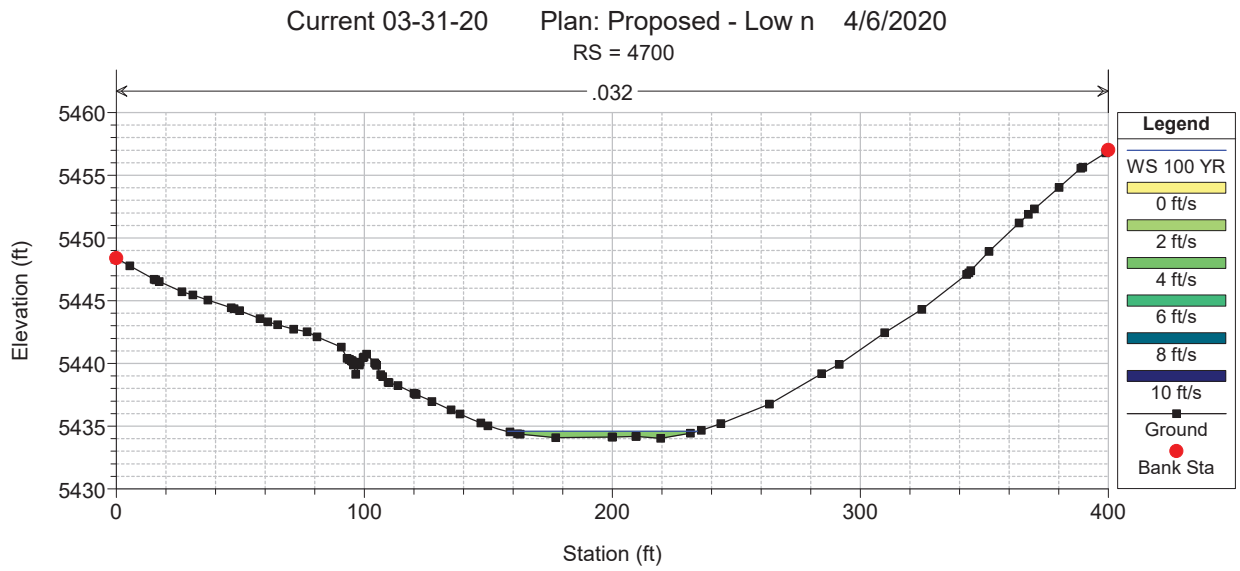

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5050
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

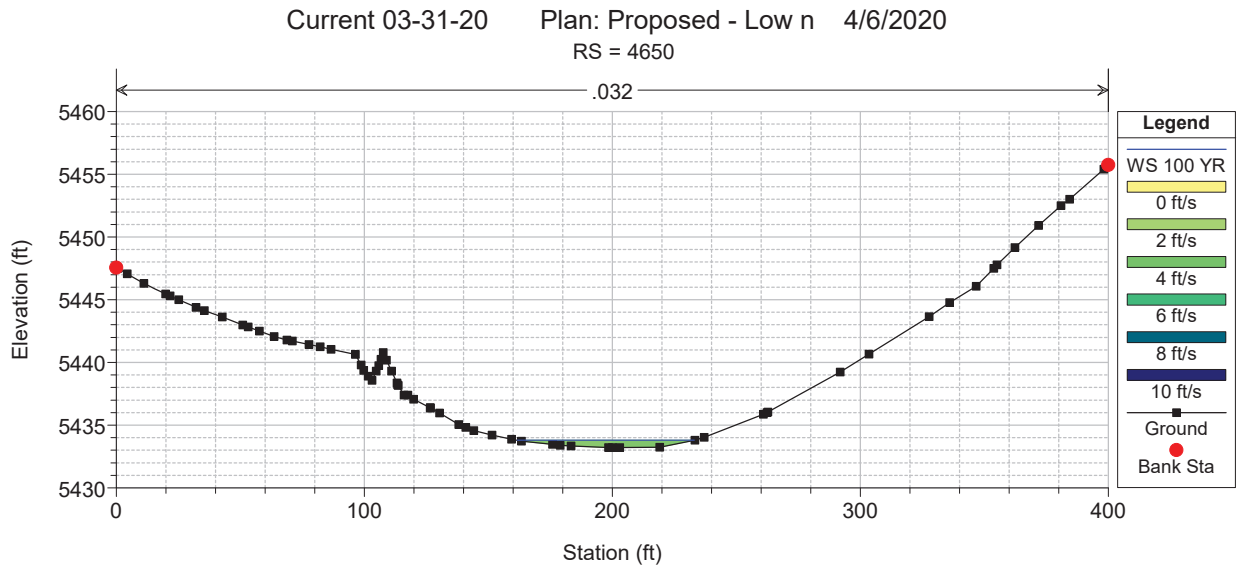

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 5000
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

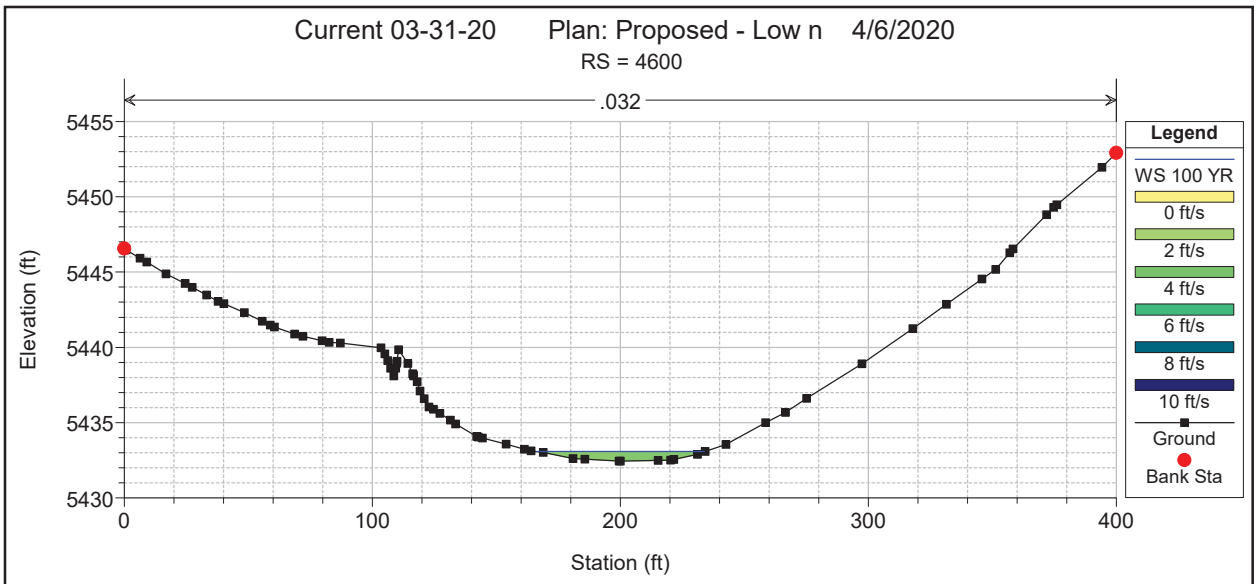

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4950
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

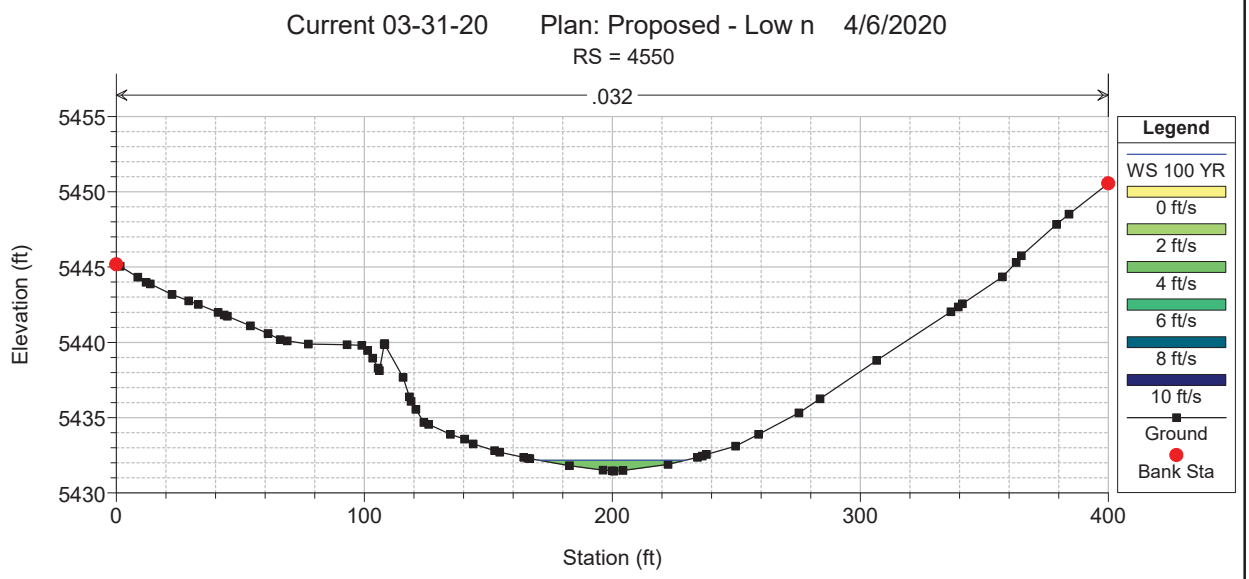

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4900
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4850
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4800
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

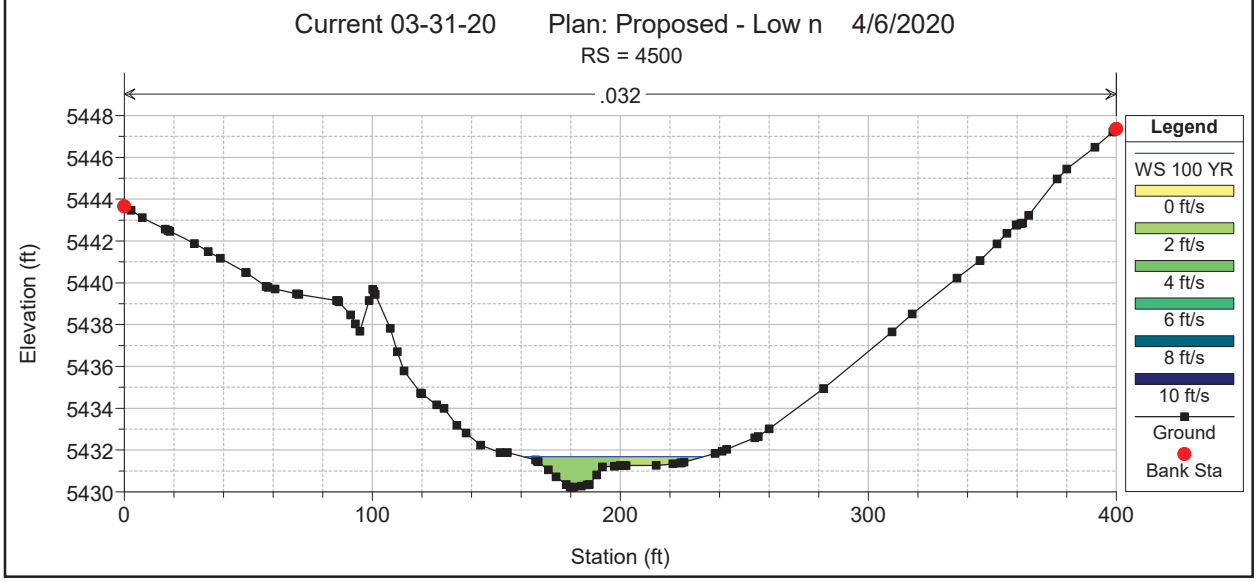

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4750
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

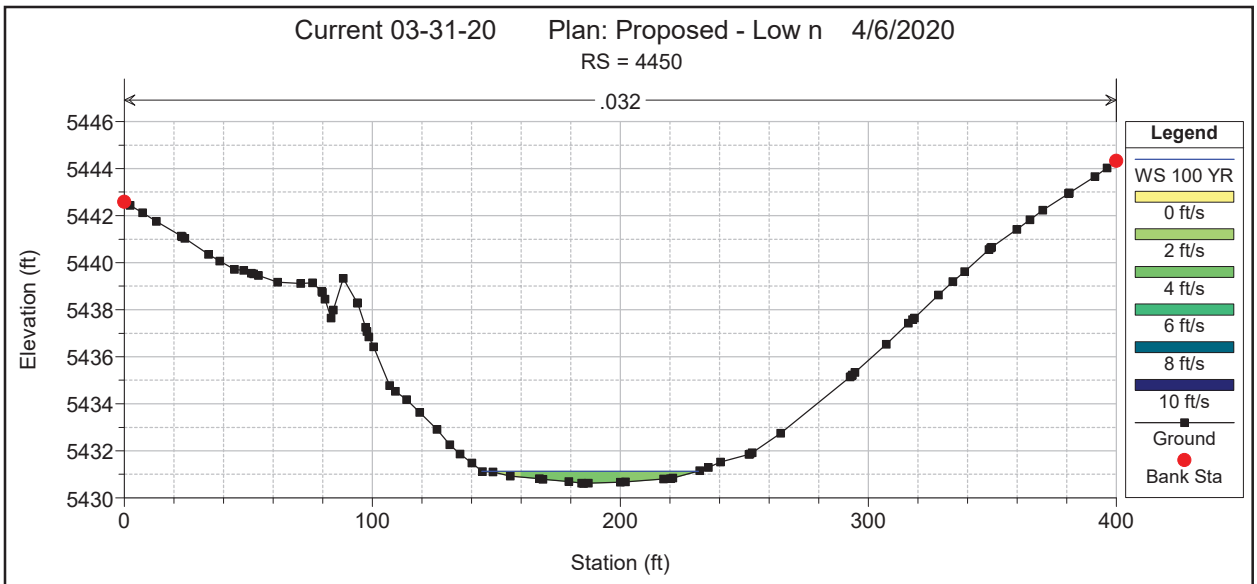

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4700
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

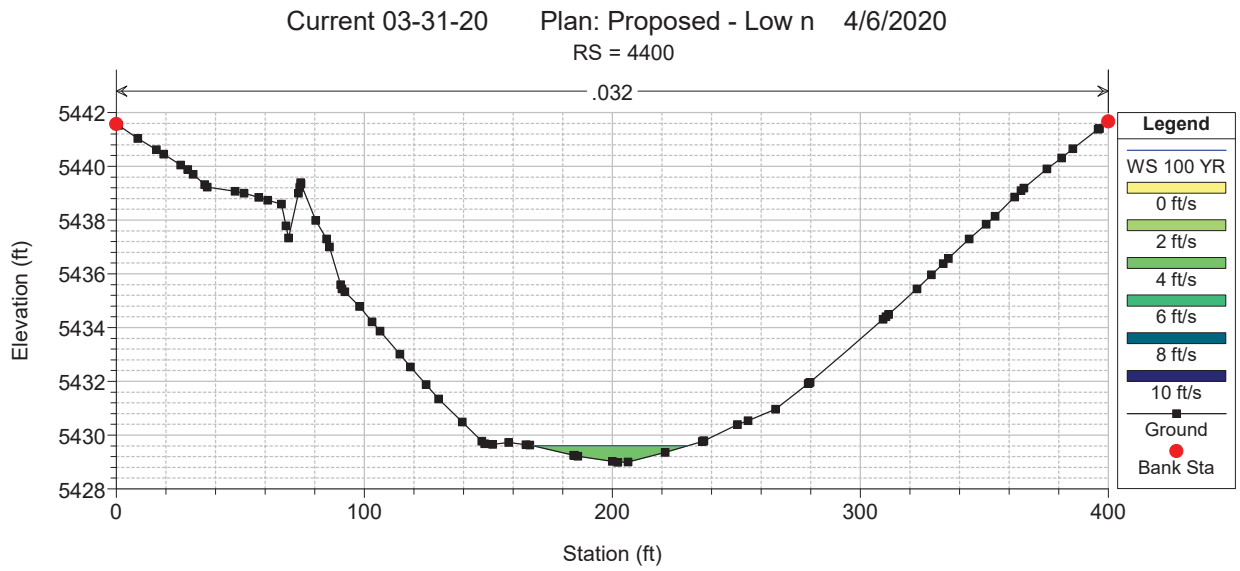

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4650
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

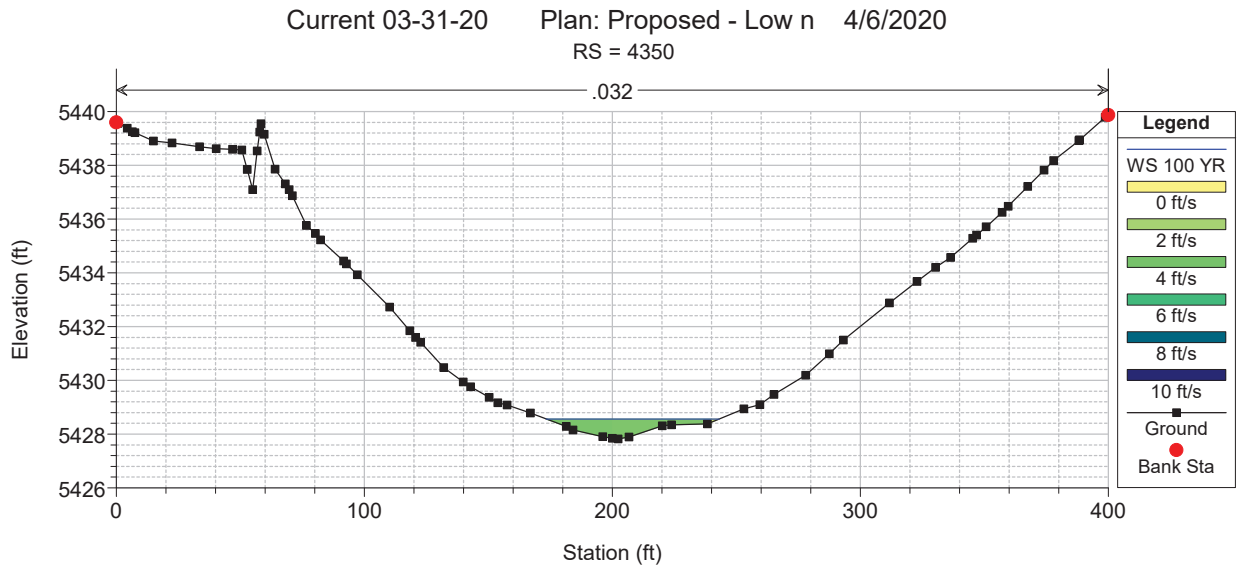

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4600
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

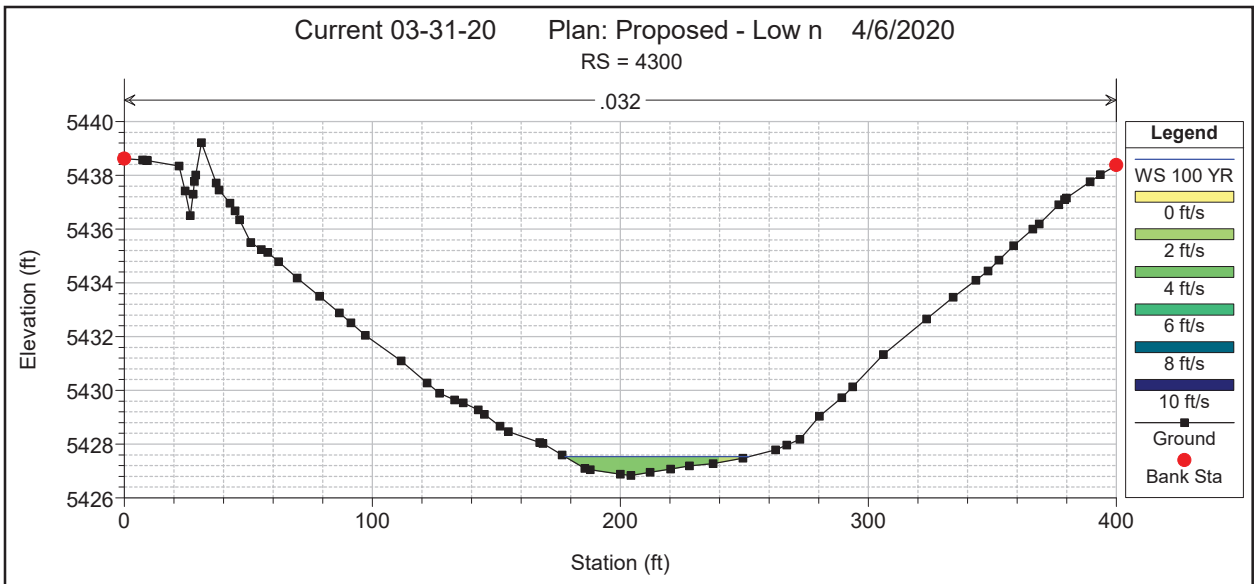

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4550
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

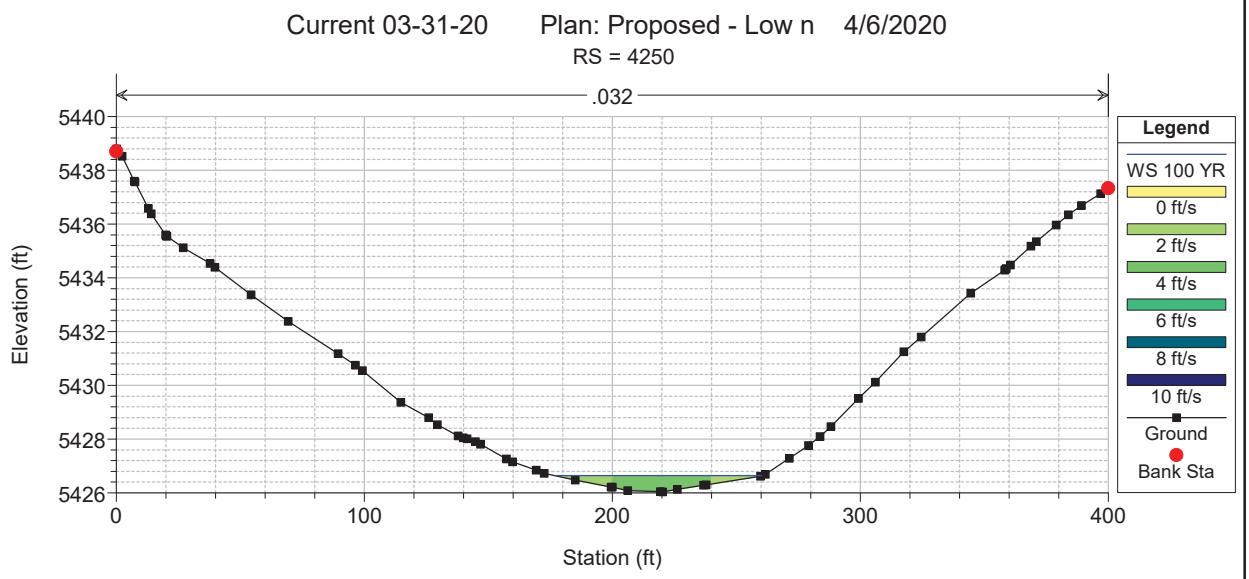

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4500
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

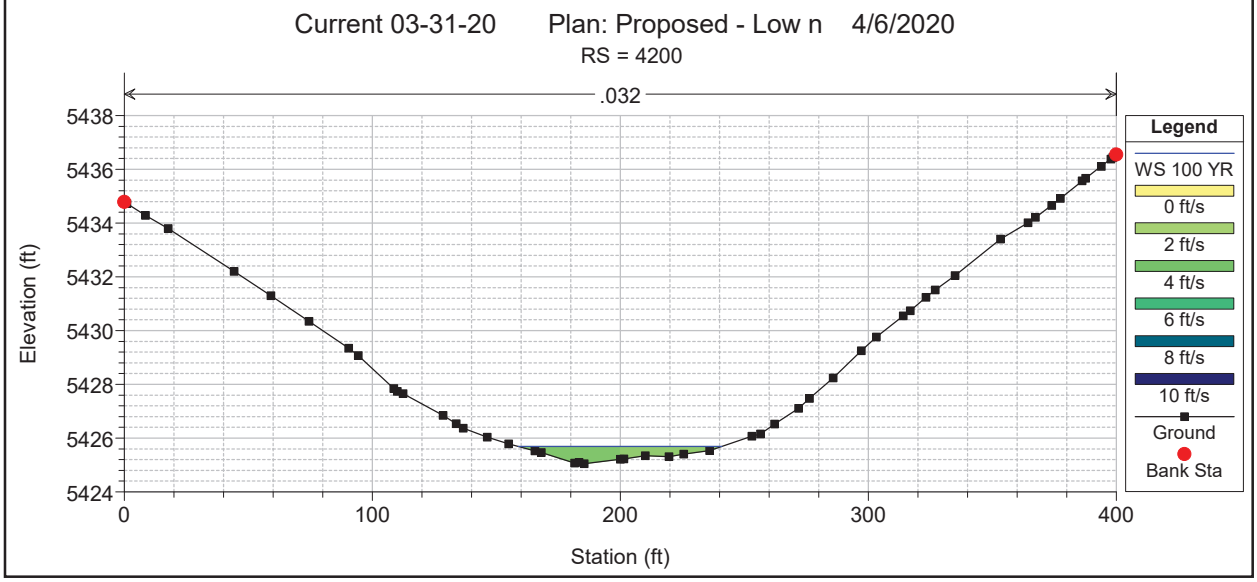

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4450
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

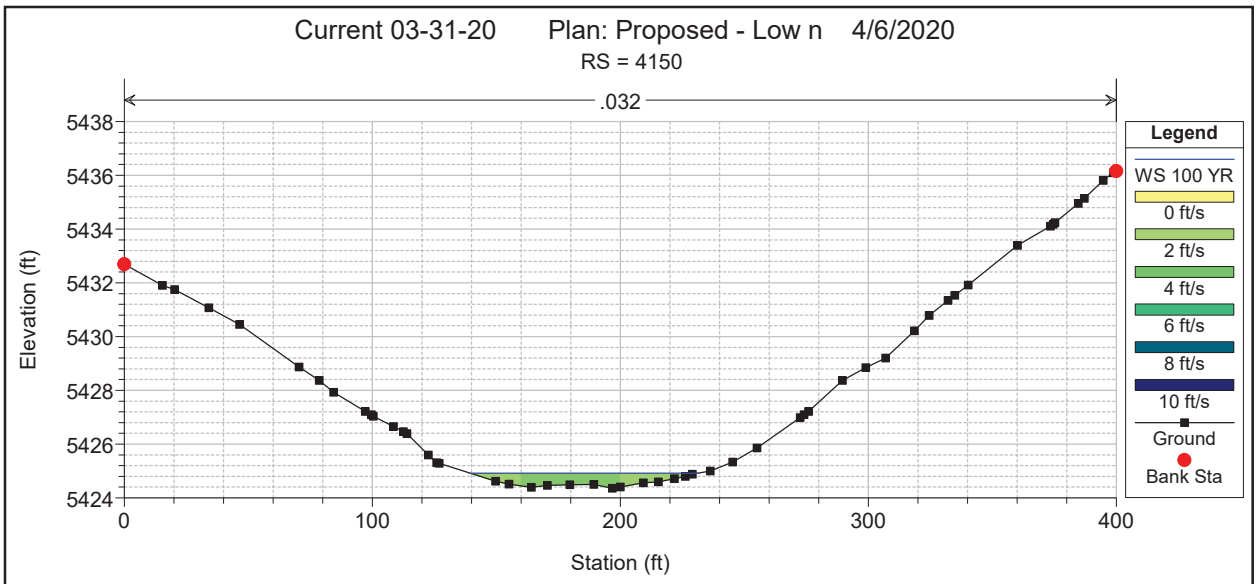

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4400
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

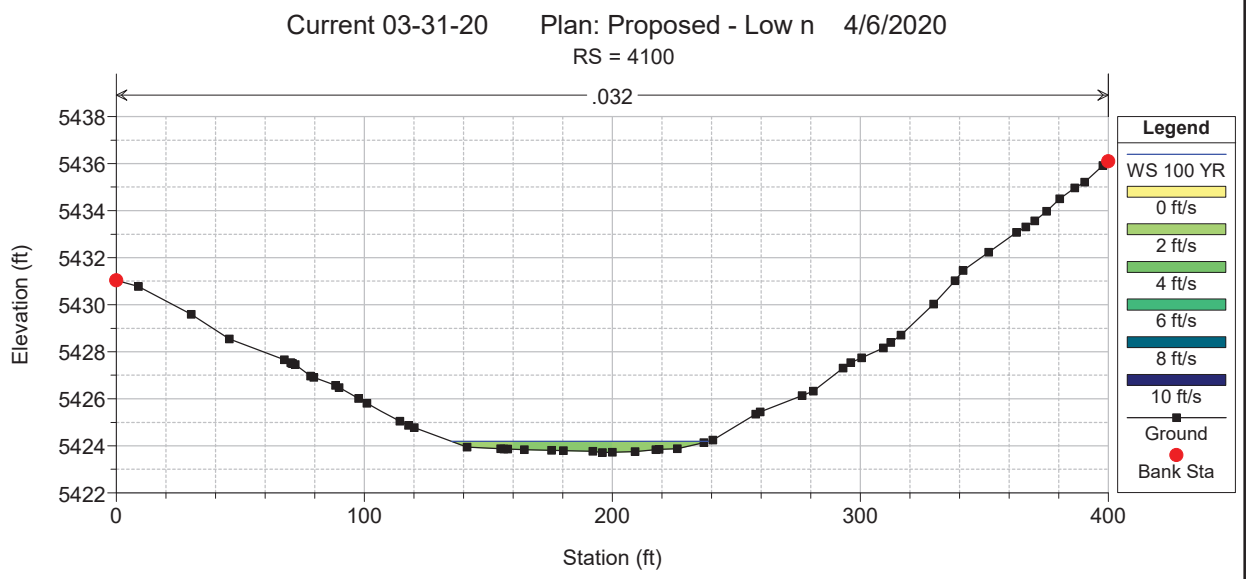

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4350
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

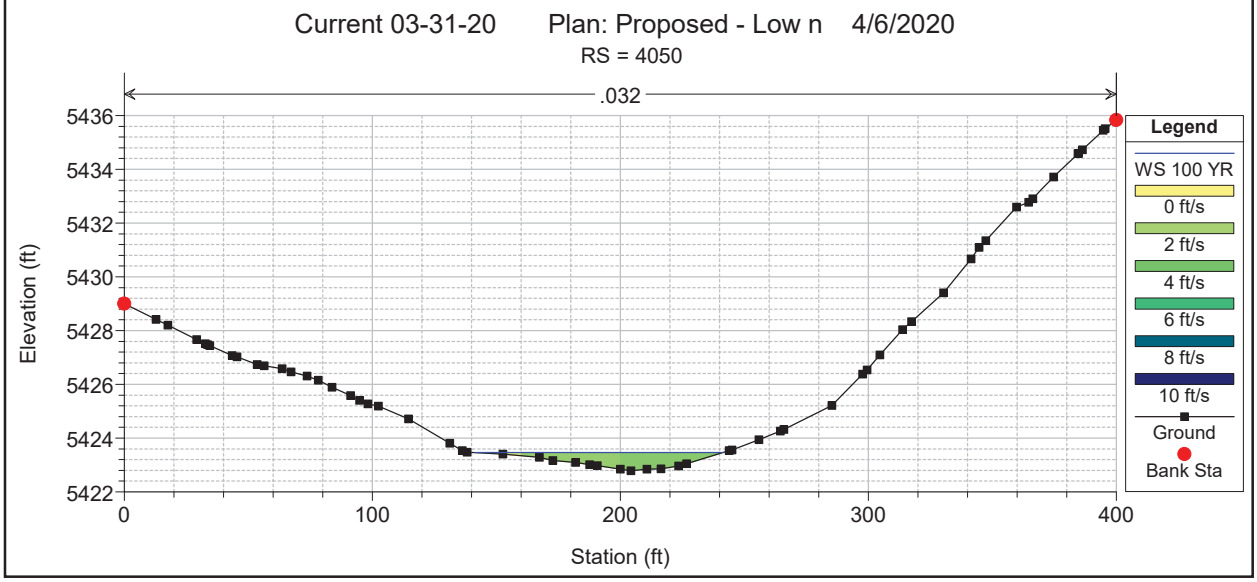

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4300
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

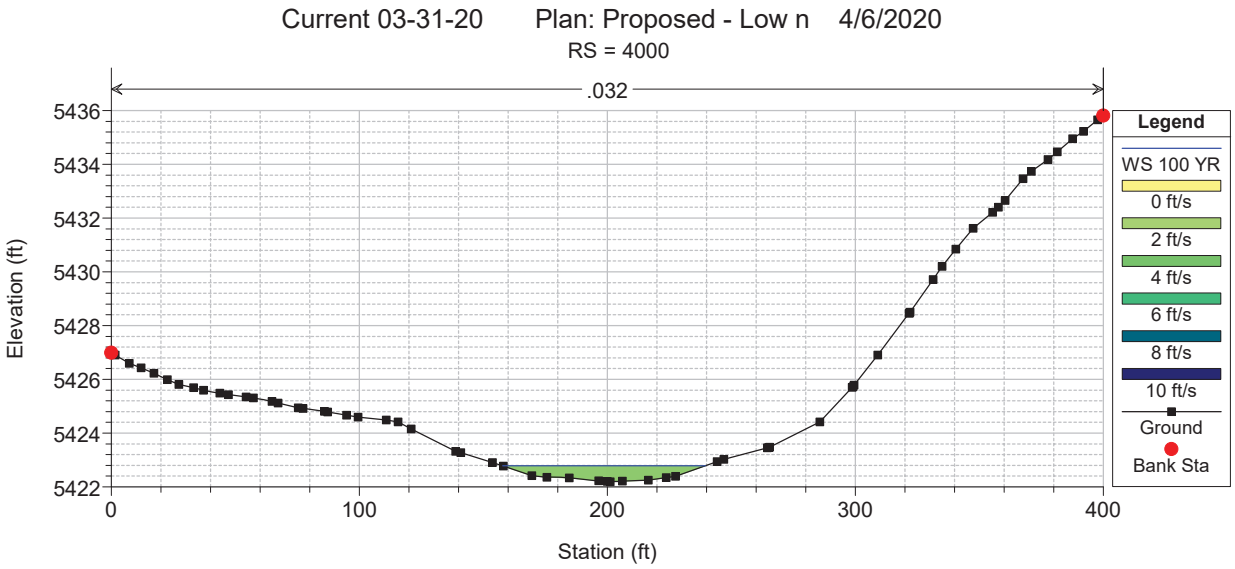

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4250
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

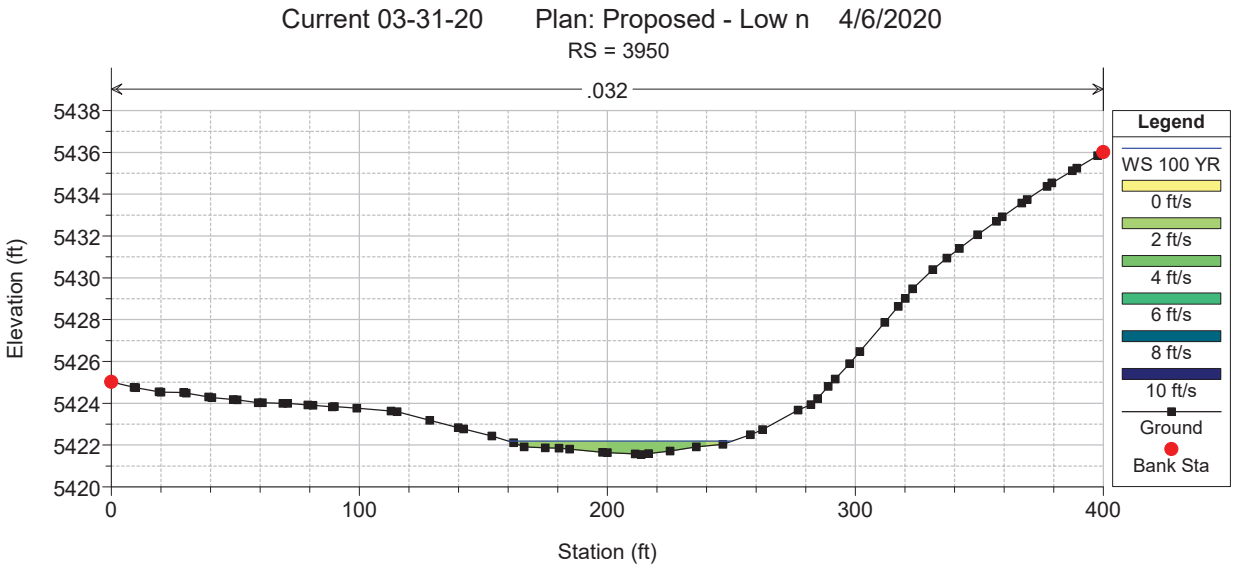

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4200
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

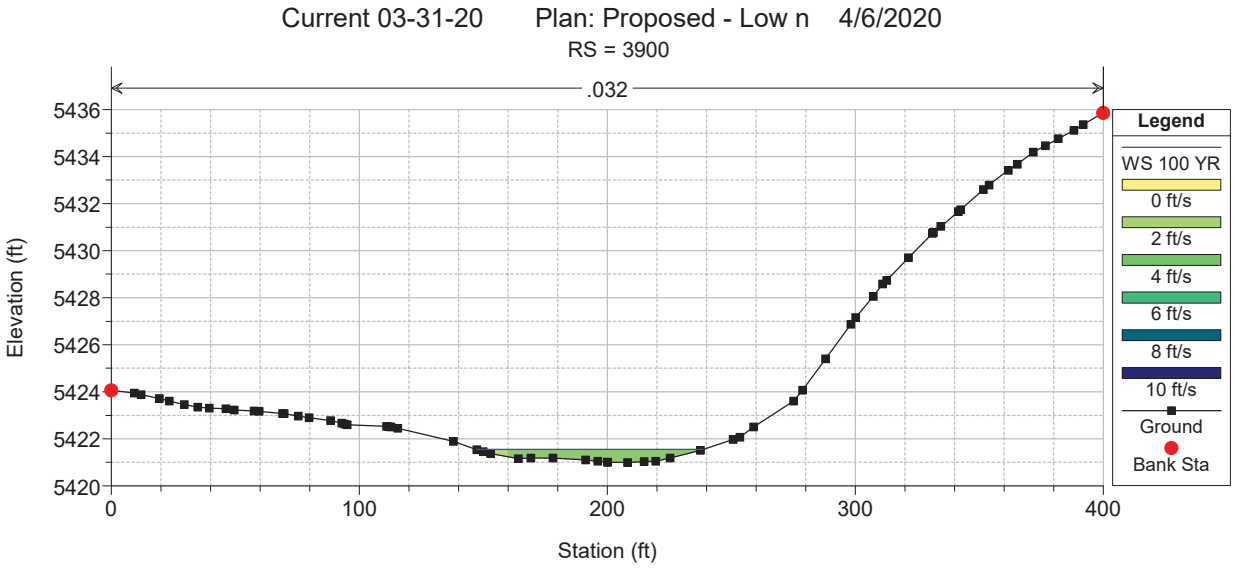

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4150
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

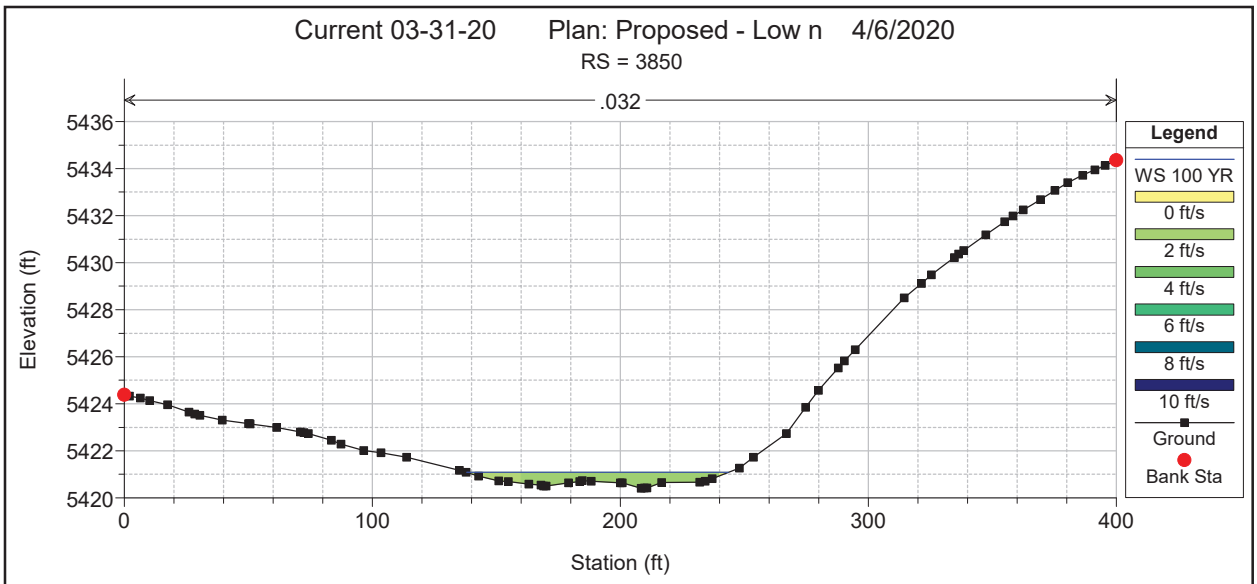

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4100
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

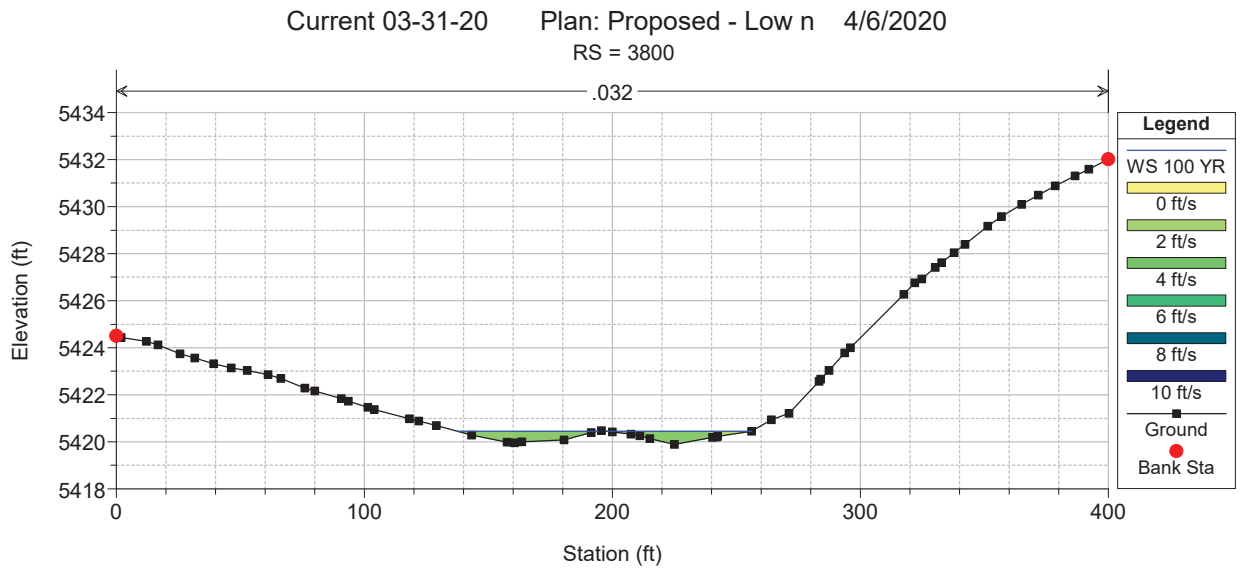

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4050
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

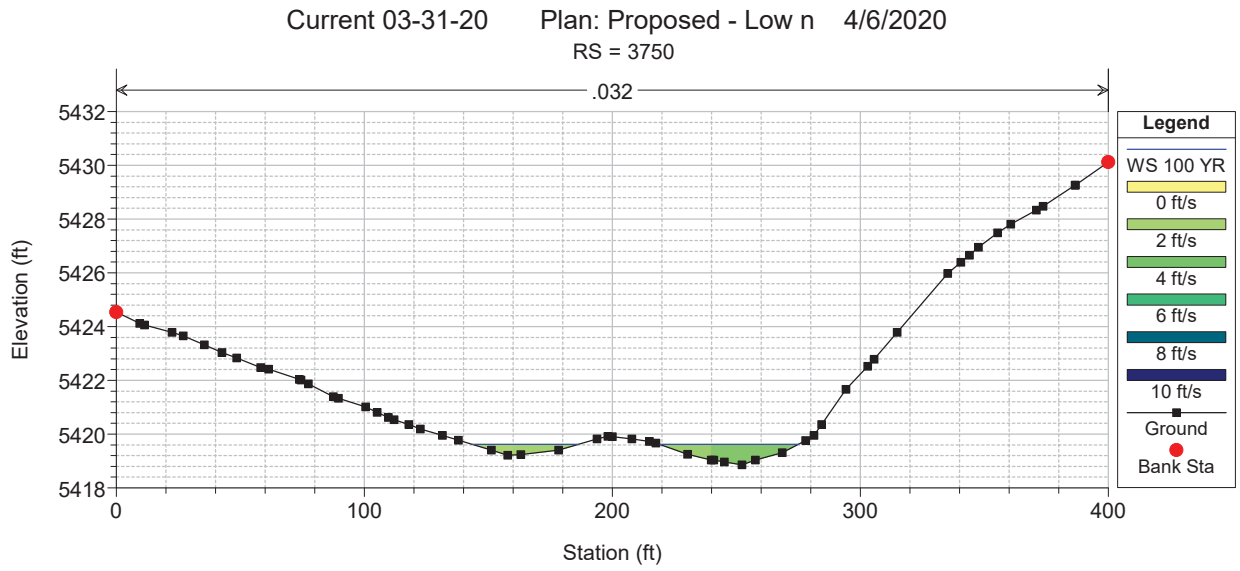

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 4000
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

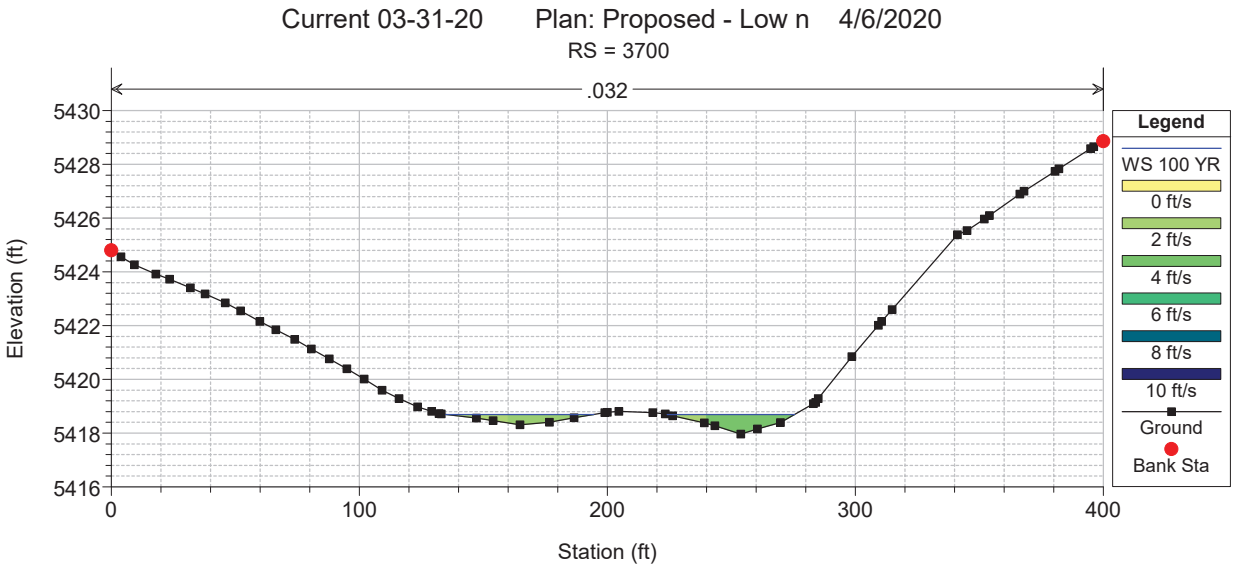

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3950
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

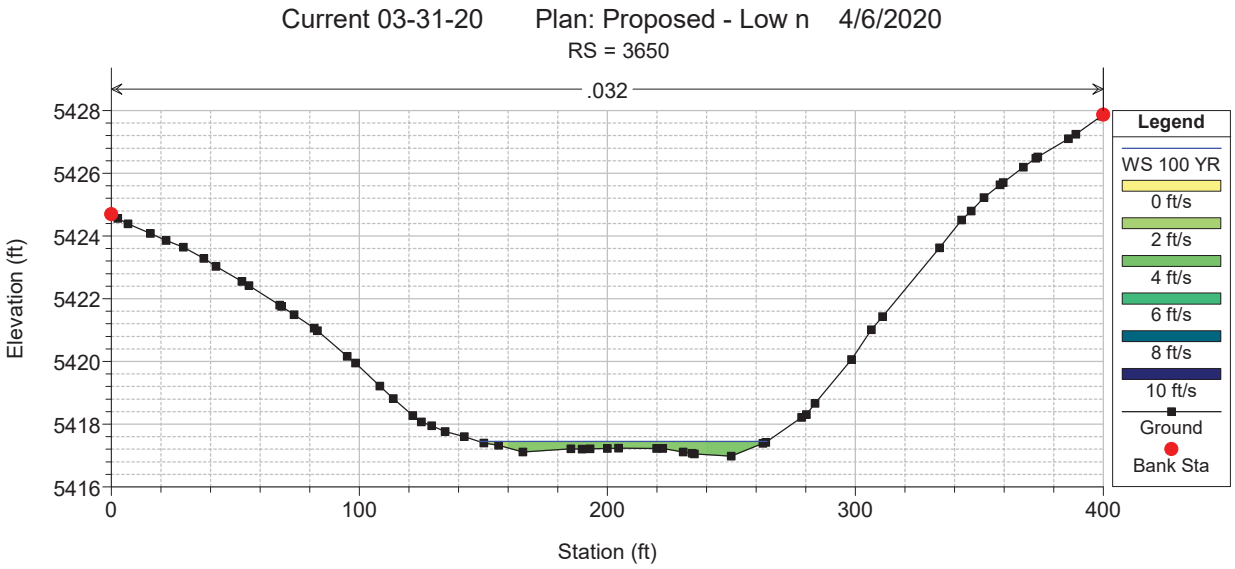

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3900
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

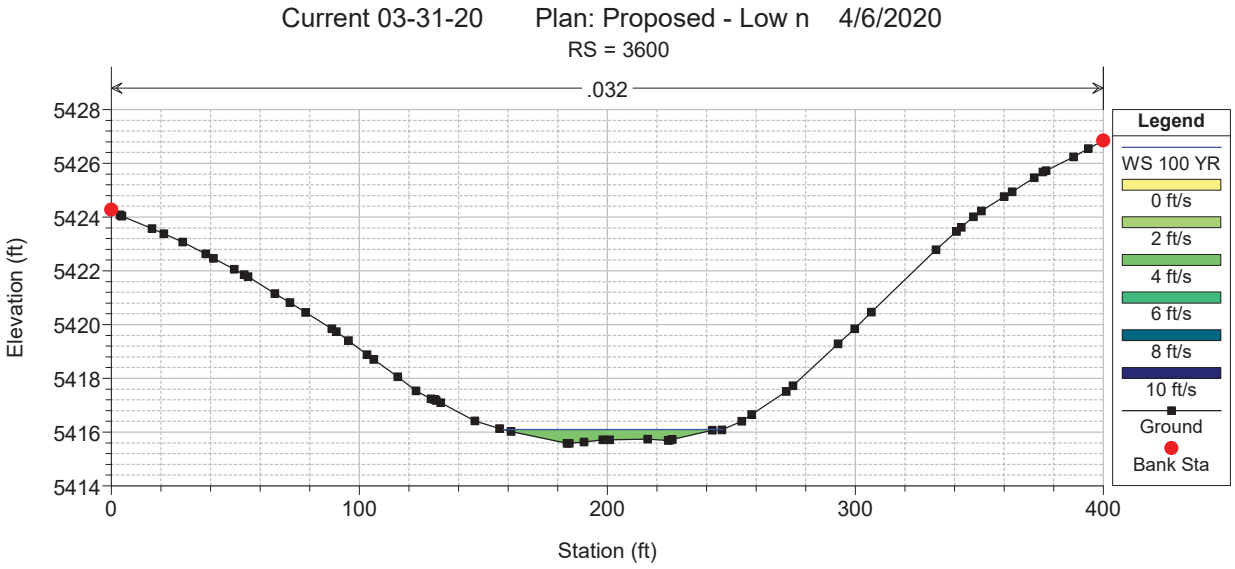

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3850
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

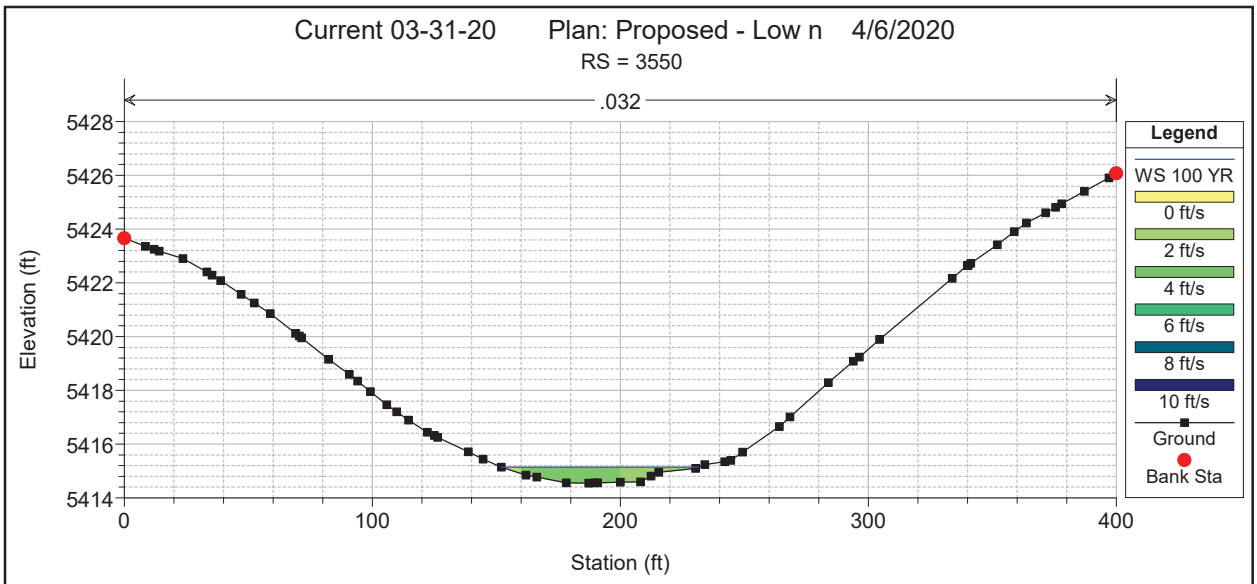

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3800
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

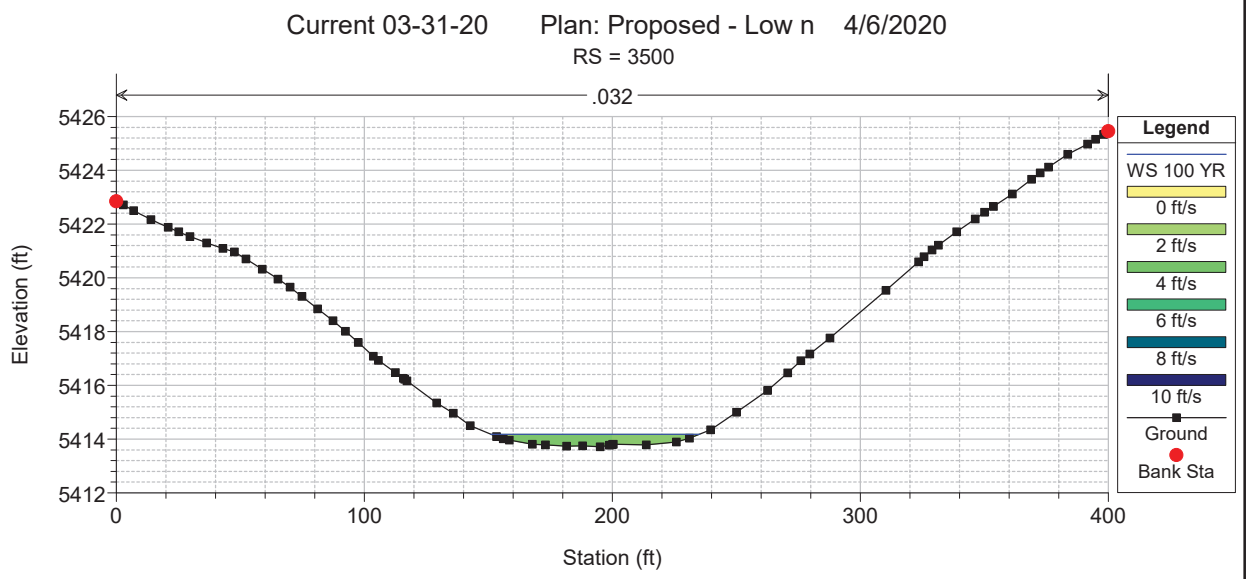

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3750
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

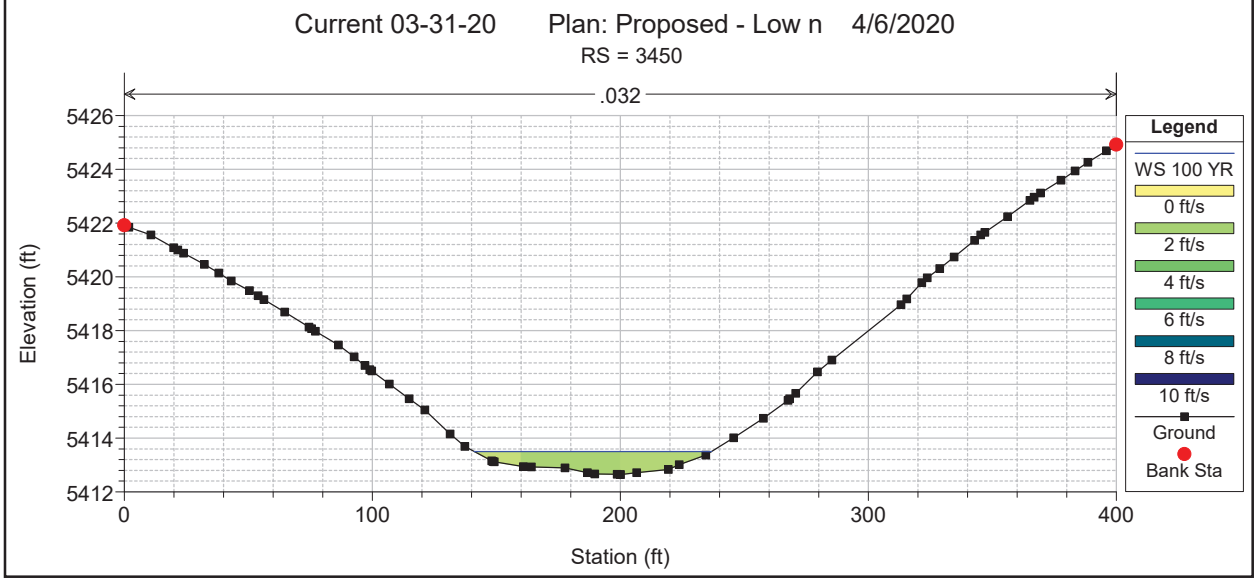

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3700
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

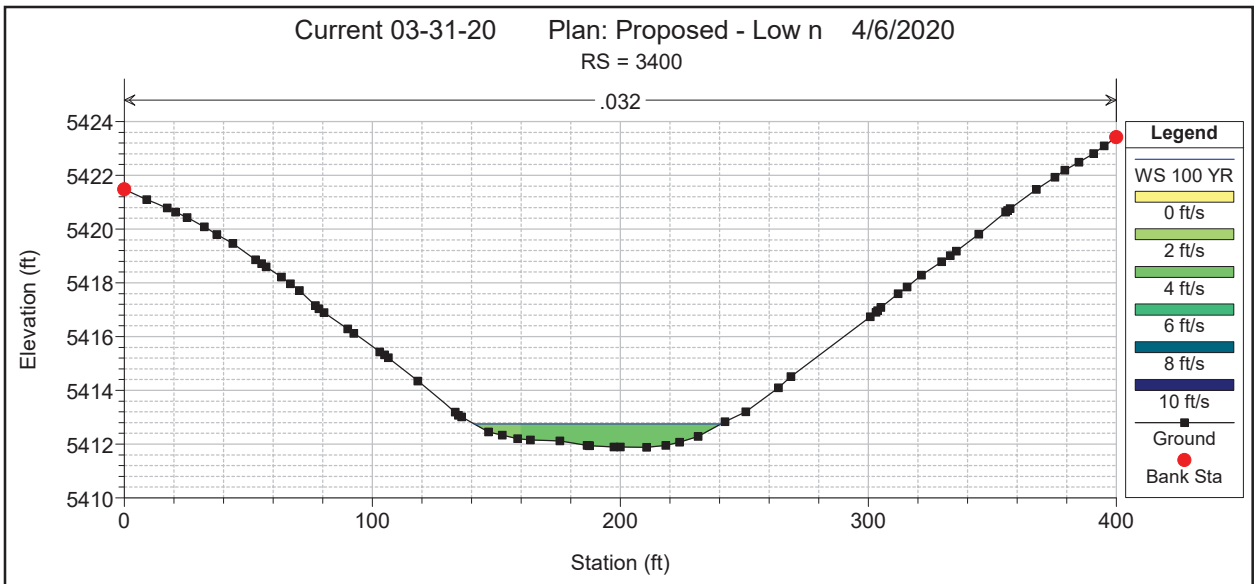

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3650
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

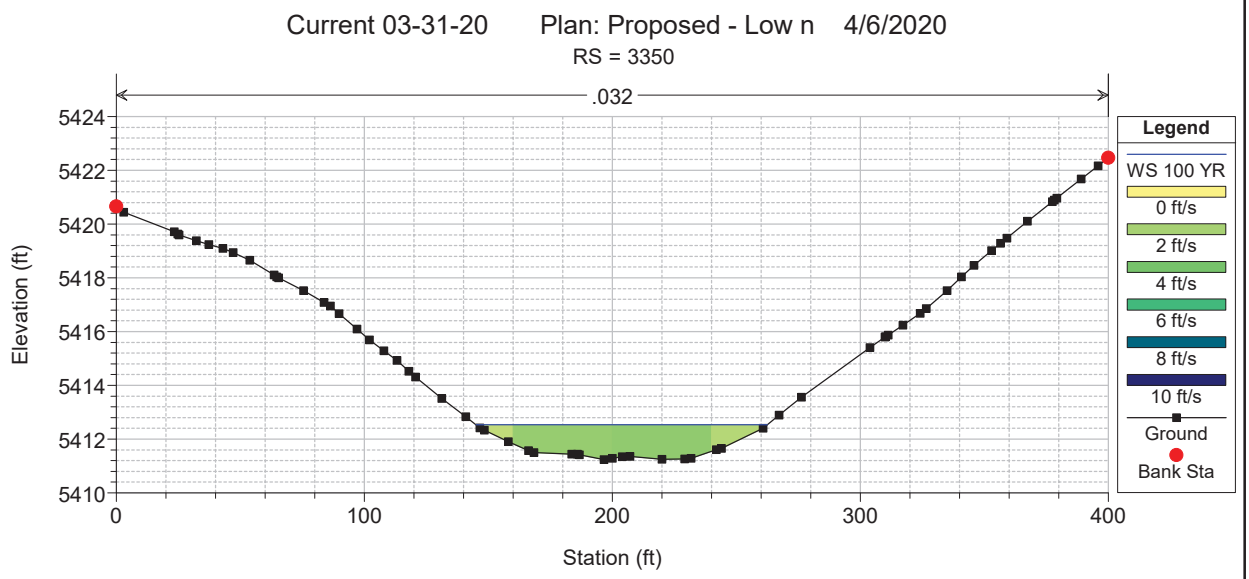

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3600
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

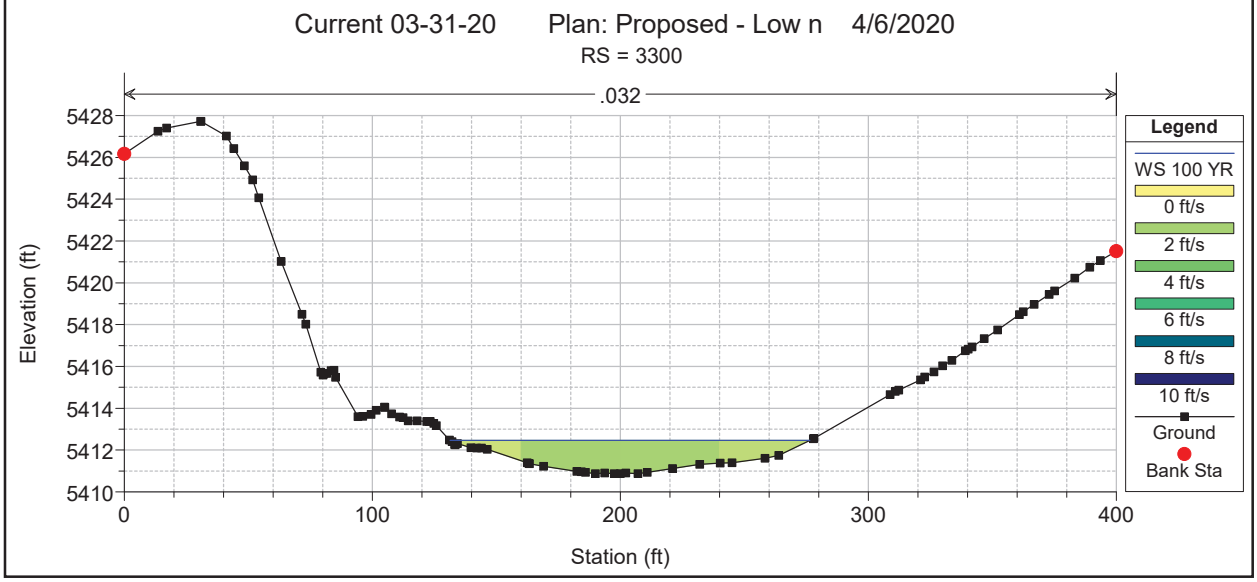

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3550
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

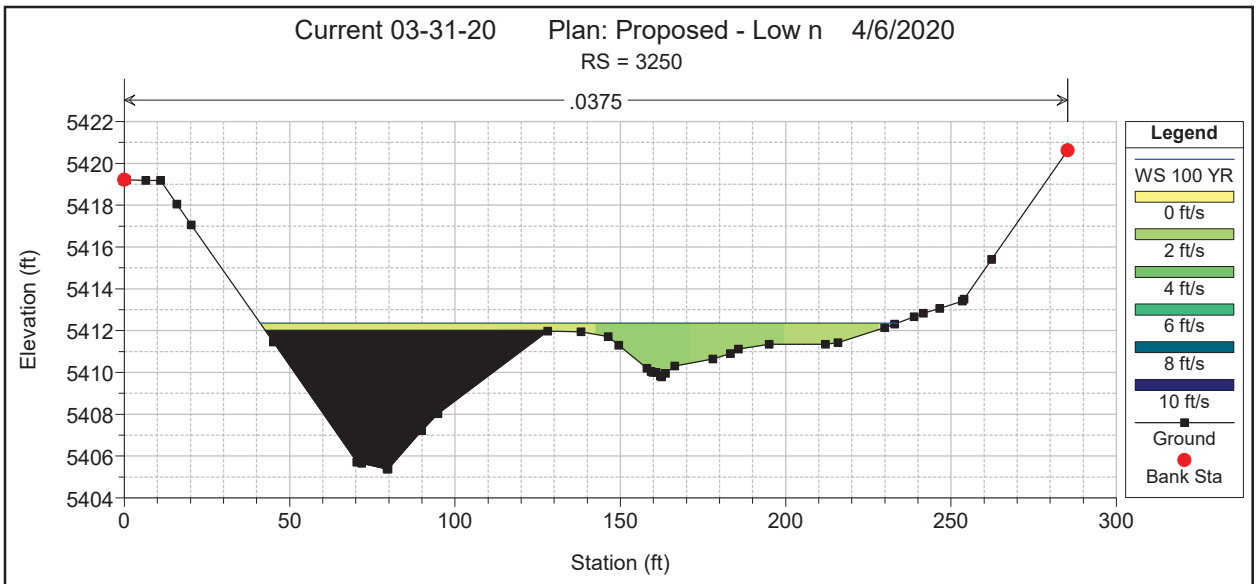

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3500
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

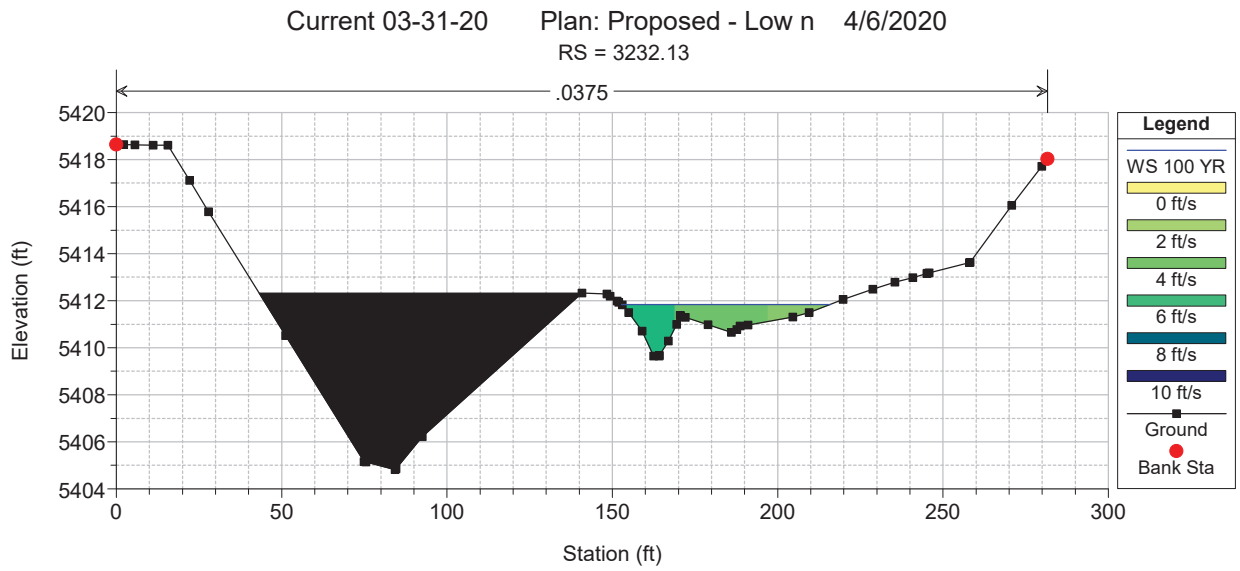

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3450
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

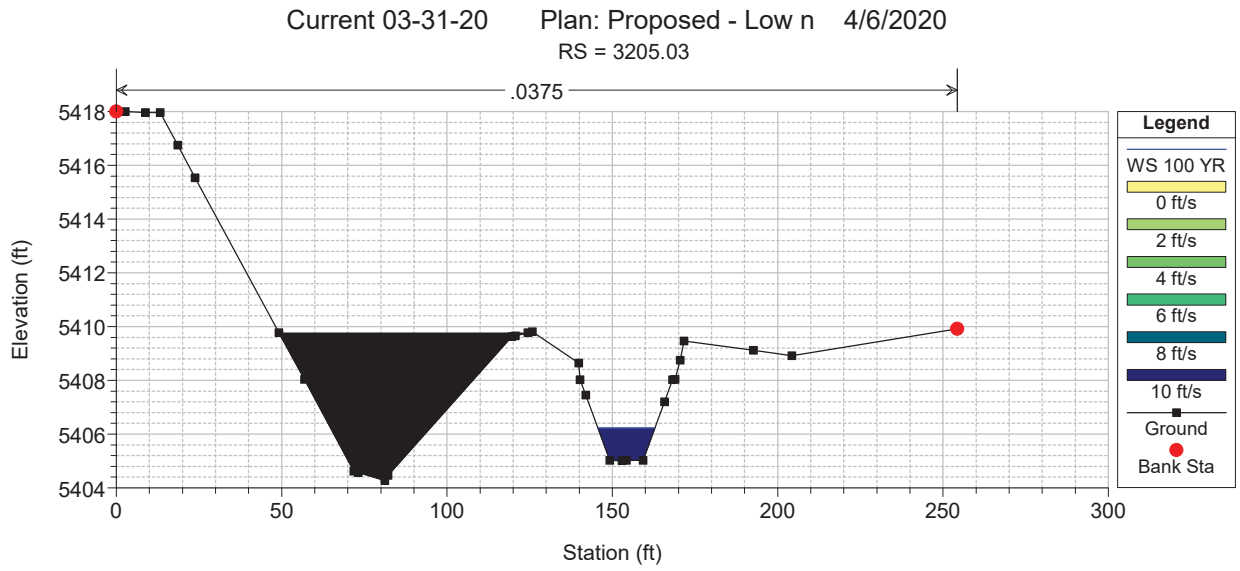

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3400
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

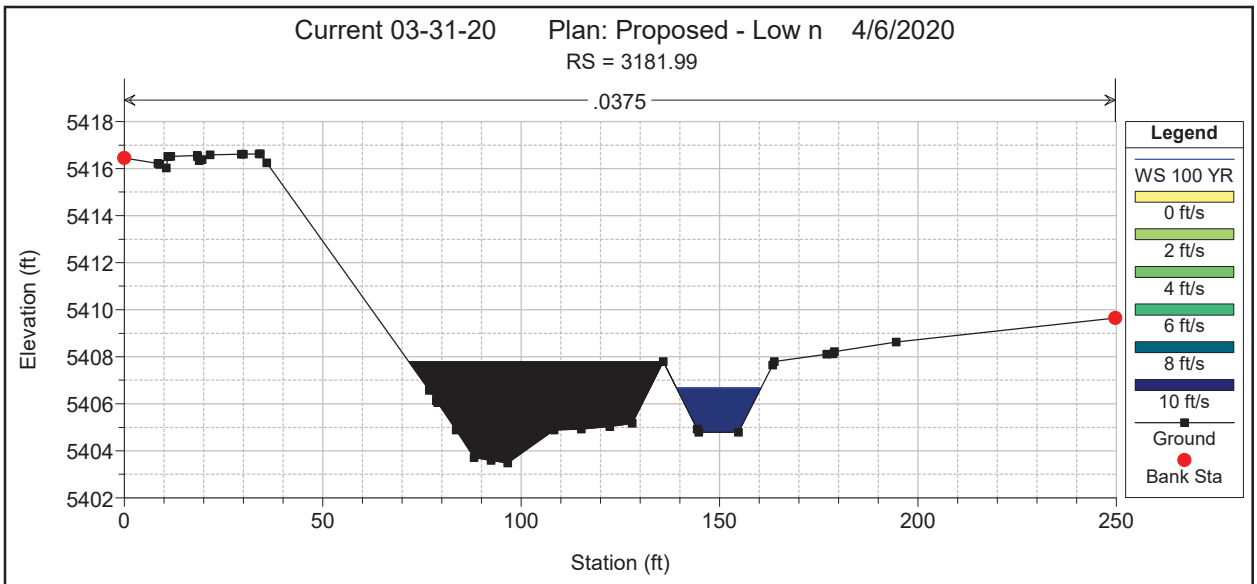

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3350
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

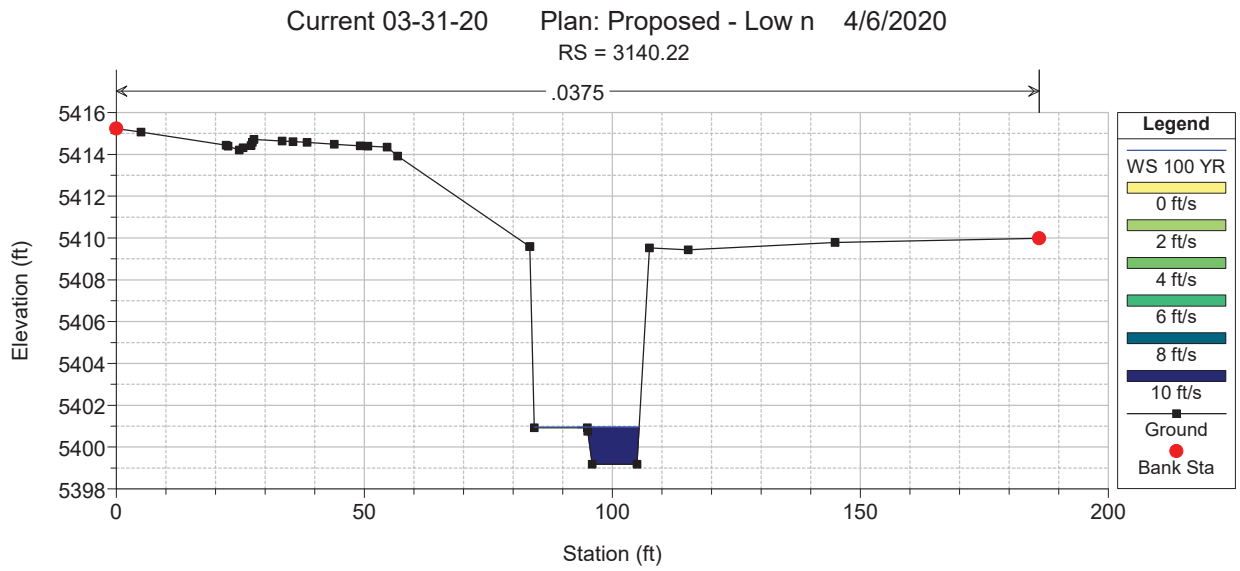

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3300
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

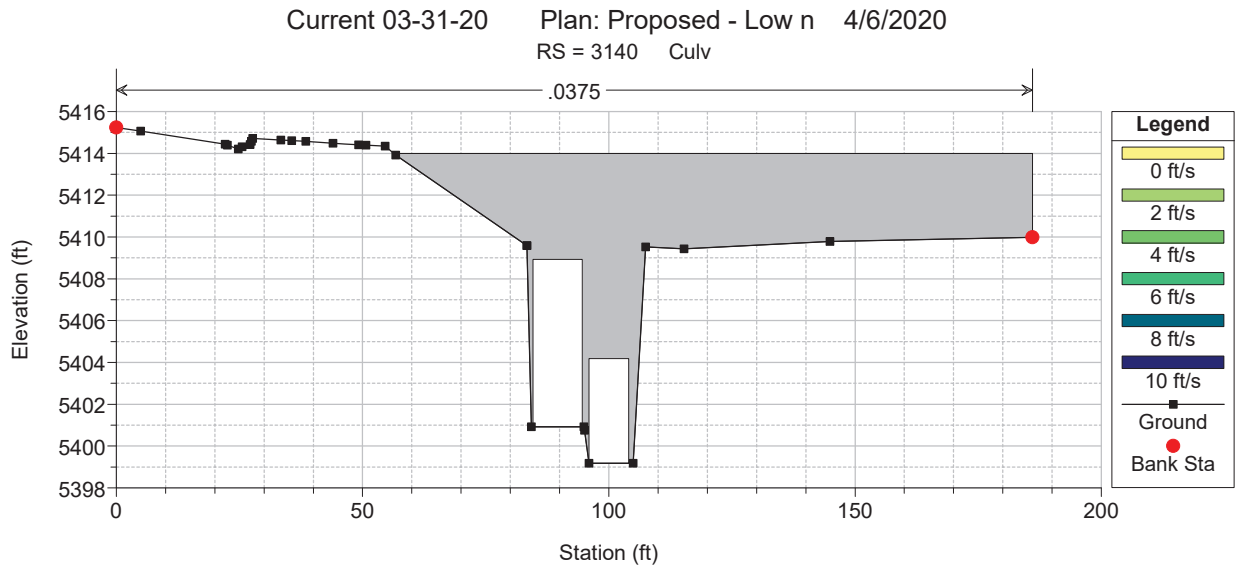

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3250
.0375
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

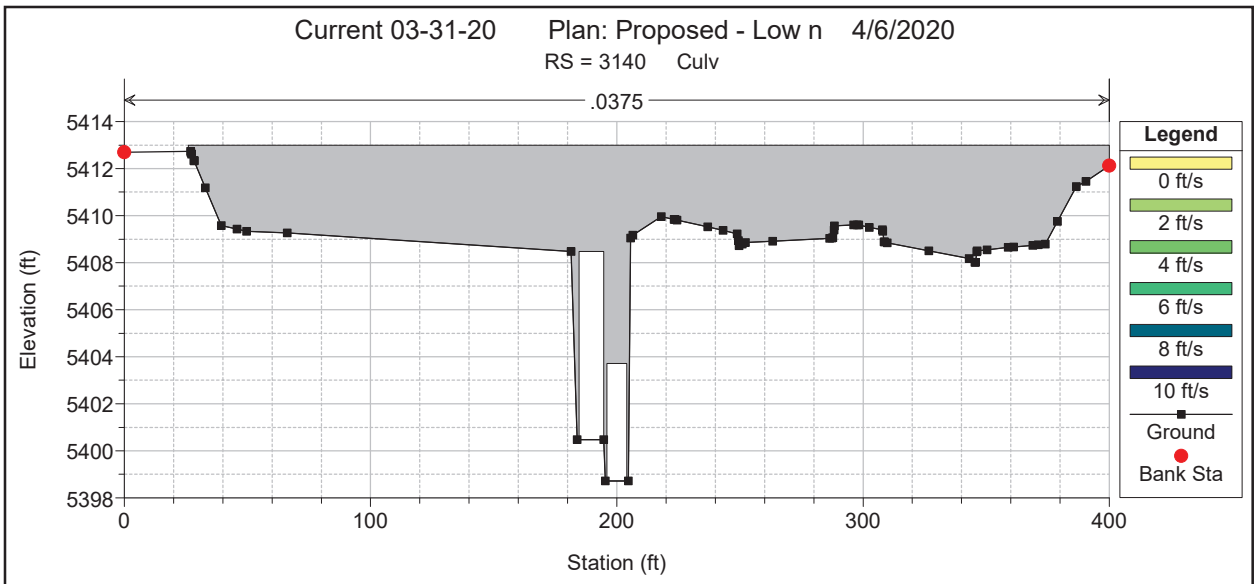

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3232.13
.0375
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

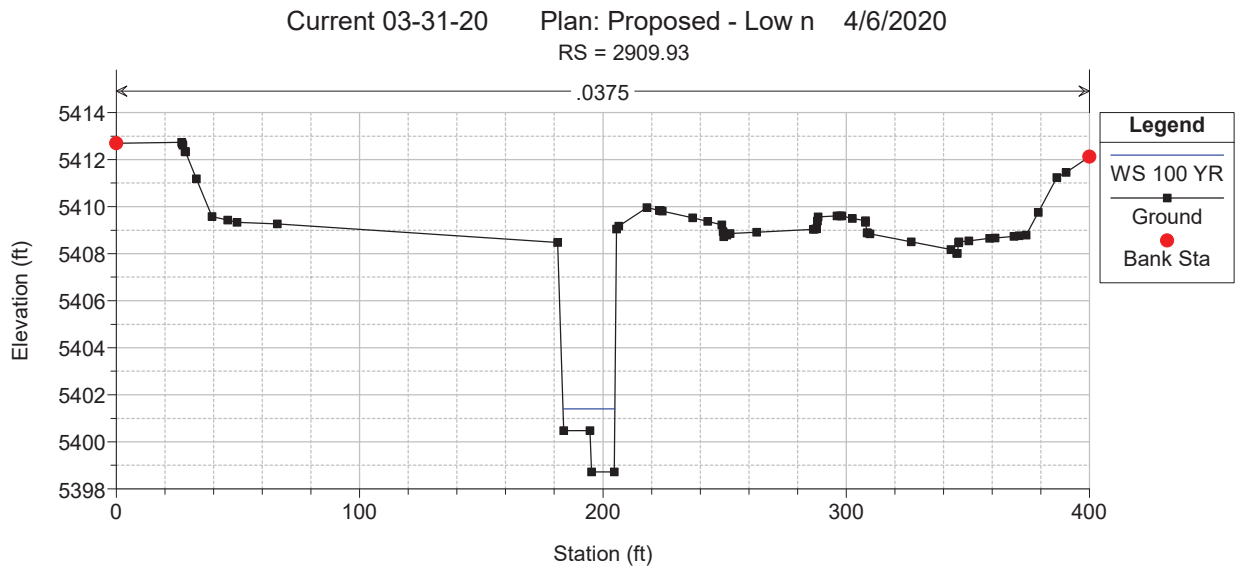

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3205.03
.0375
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

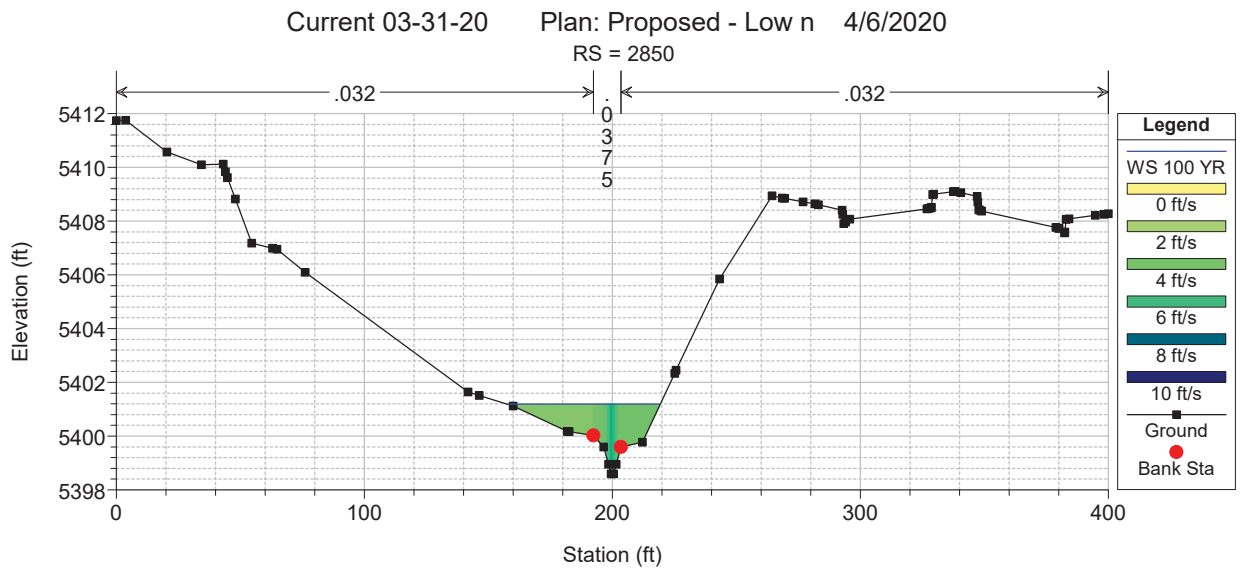

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3181.99
.0375
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

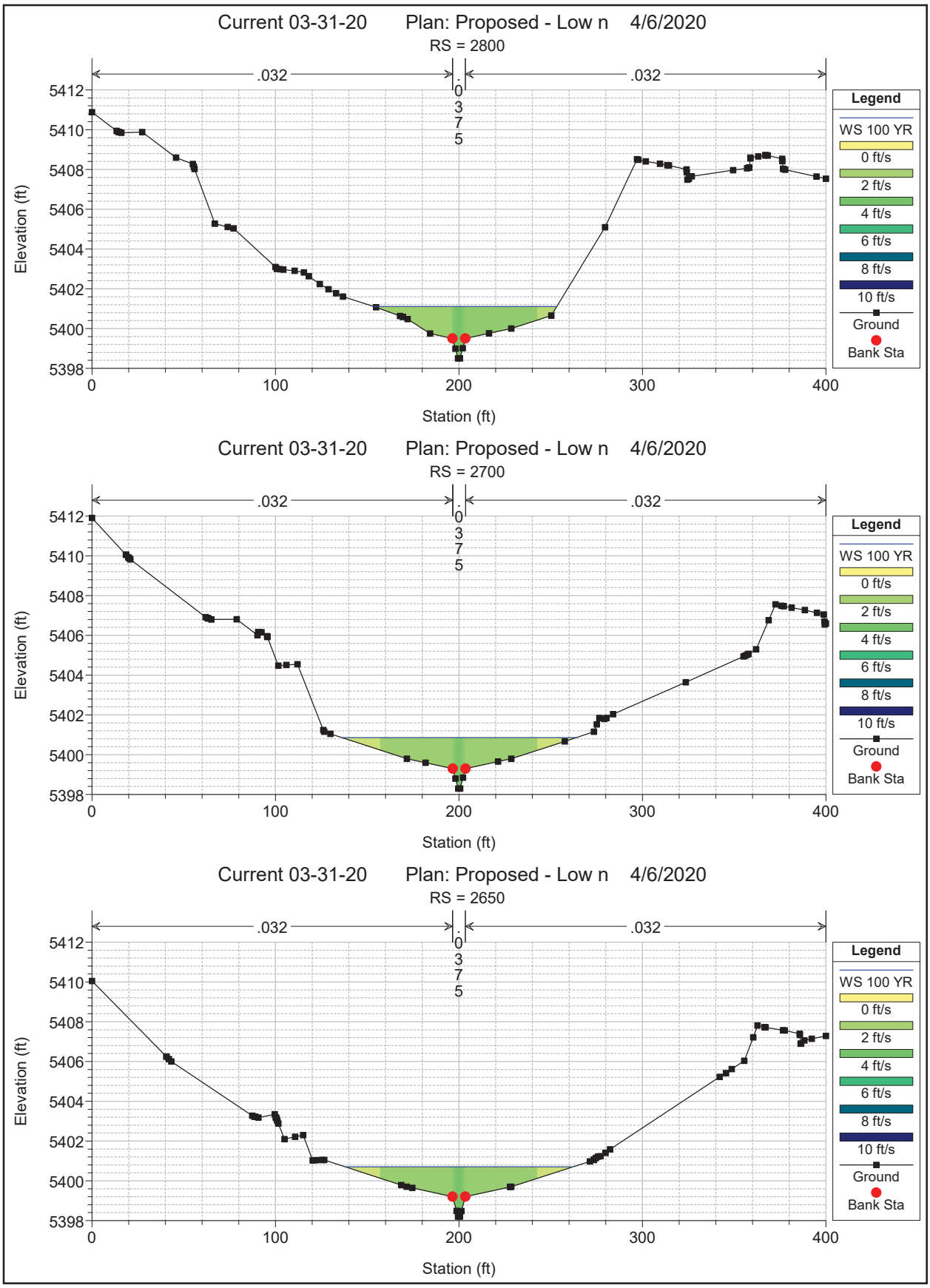

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3140.22
.0375
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

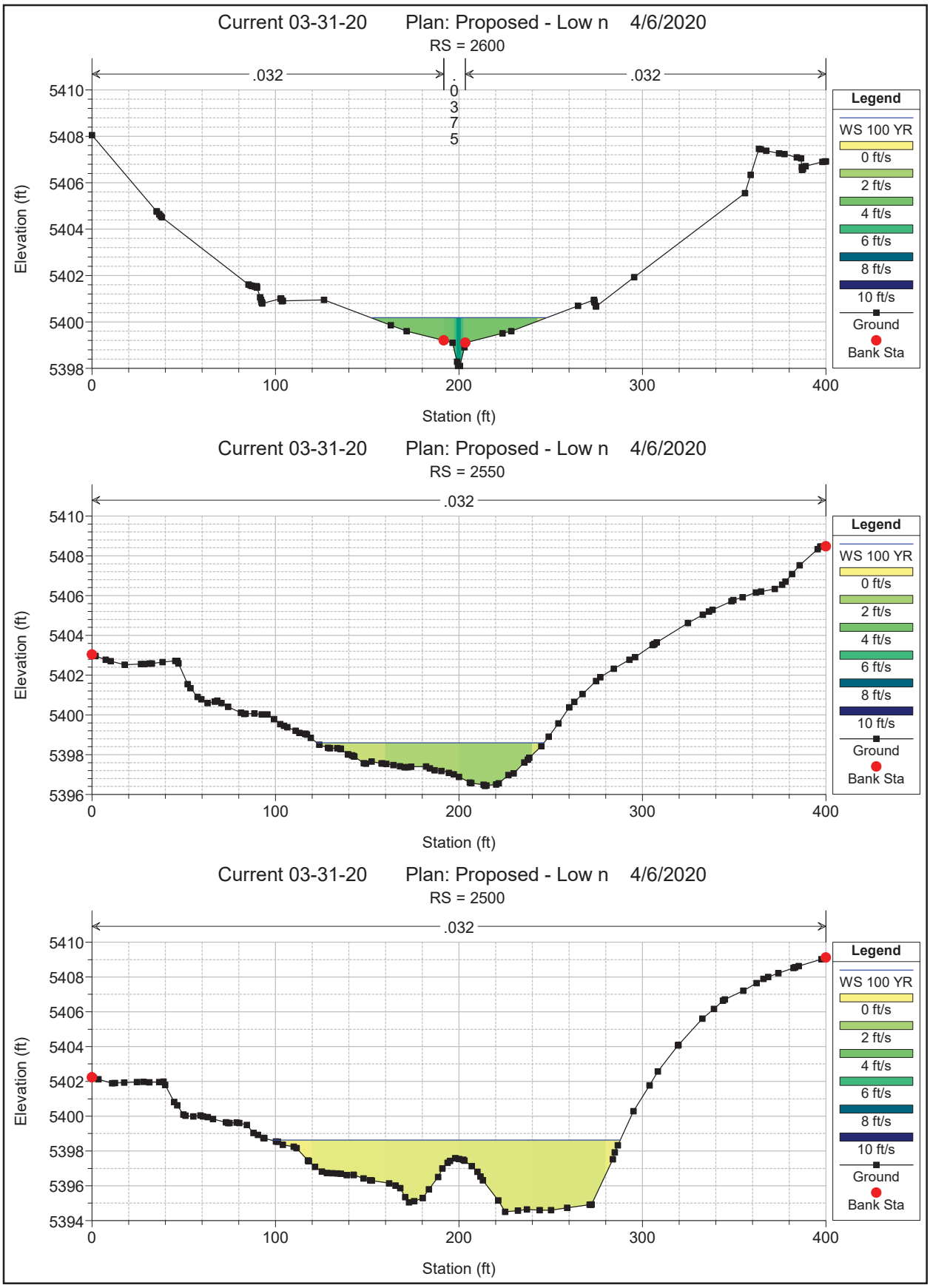

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3140 Culv
.0375
Elevation (ft)
Station (ft)
Legend
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

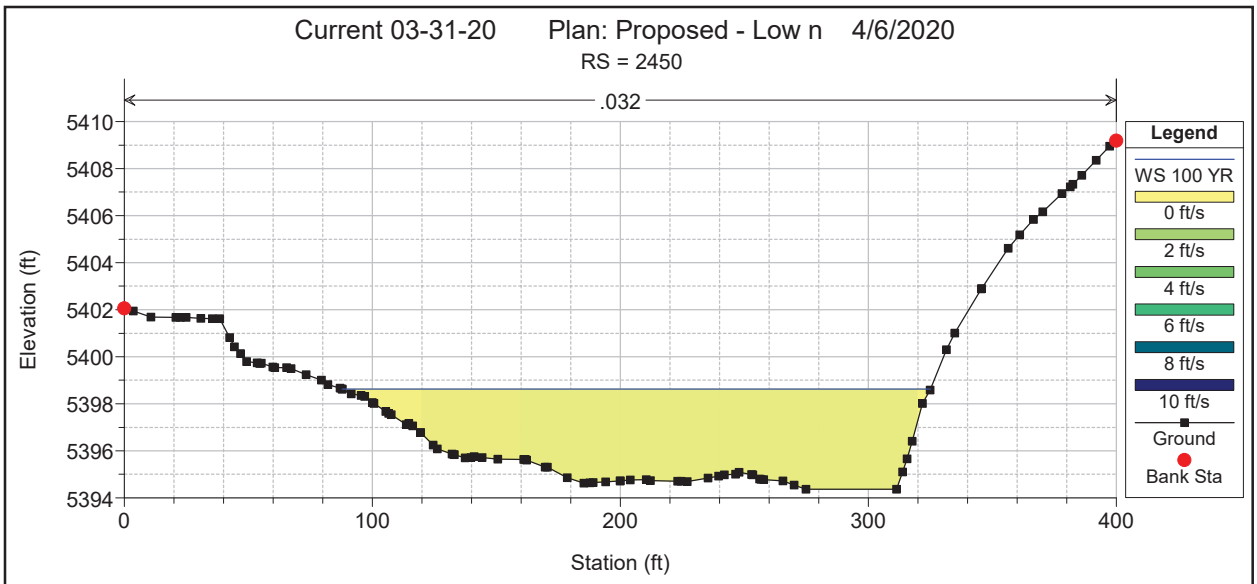

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 3140 Culv
.0375
Elevation (ft)
Station (ft)
Legend
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

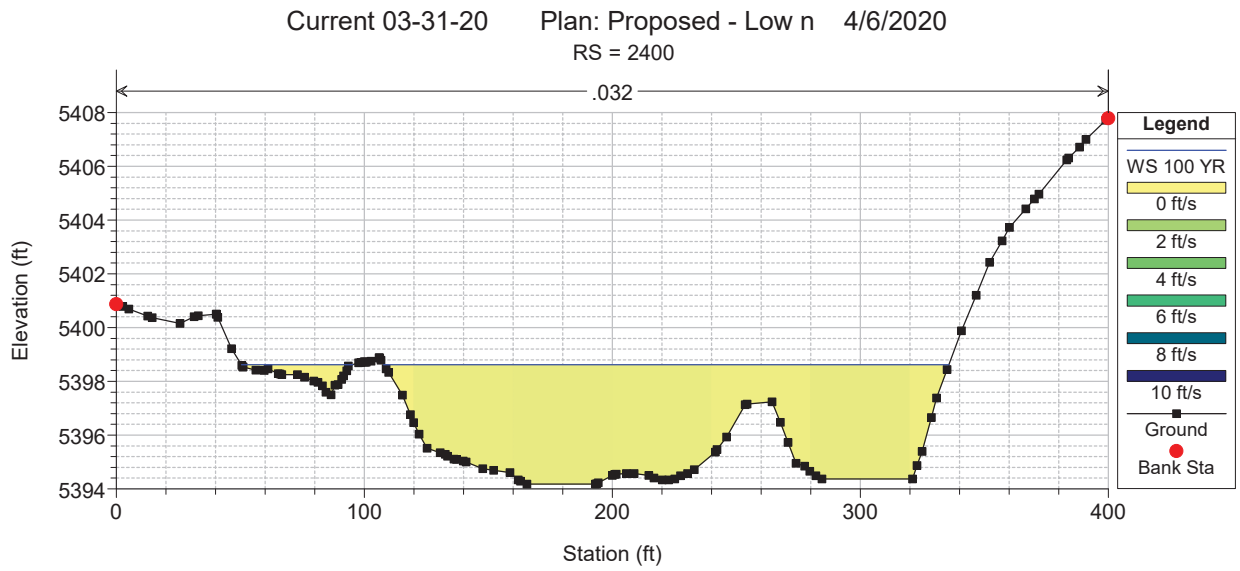

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2909.93
.0375
Elevation (ft)
Station (ft)
Legend
WS 100 YR
Ground
Bank Sta

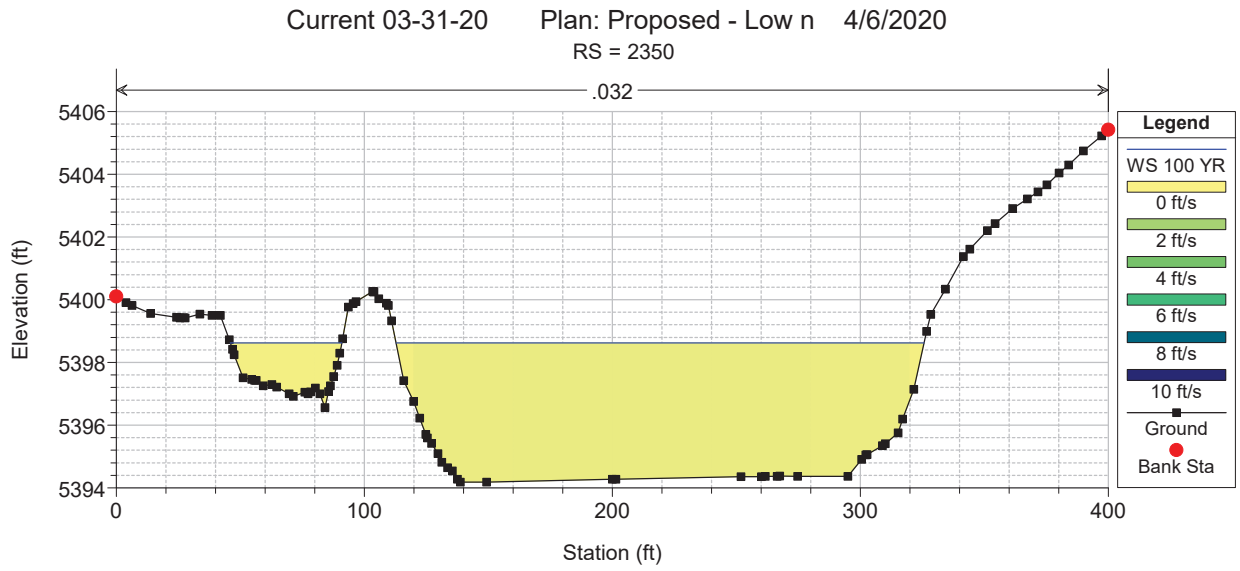

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2850
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

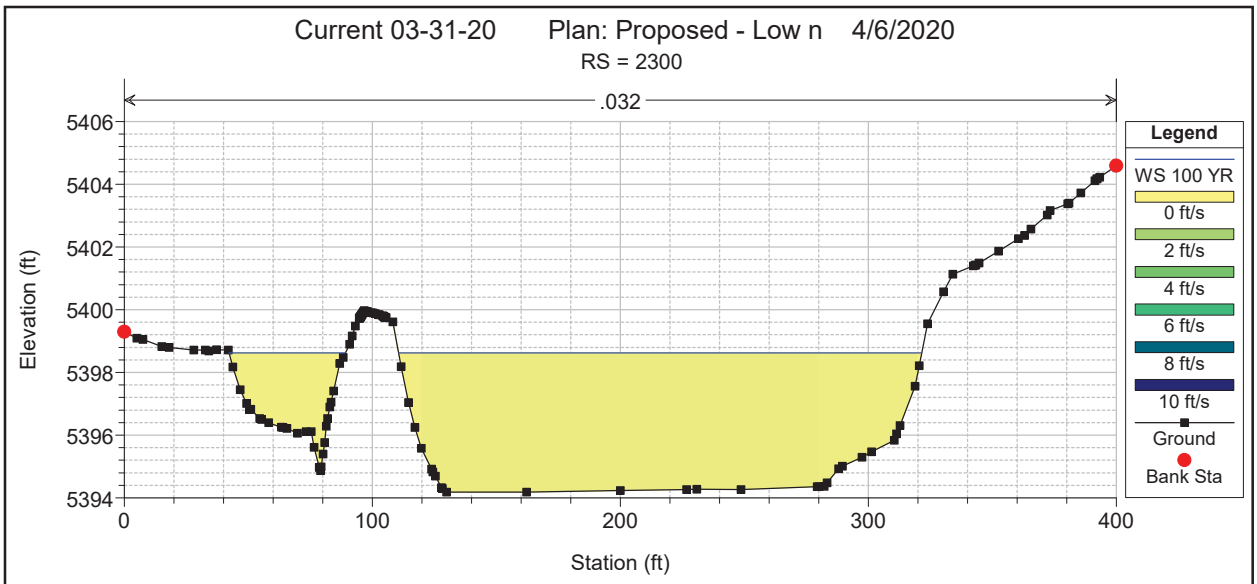

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2800
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2700
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2650
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

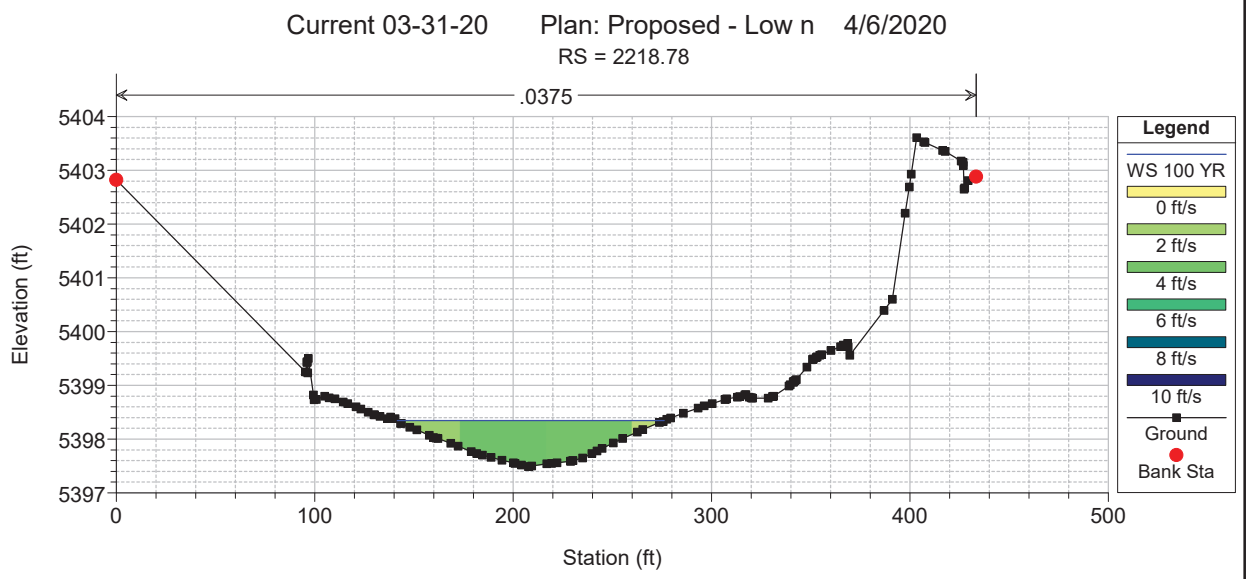

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2600
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2550
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2500
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

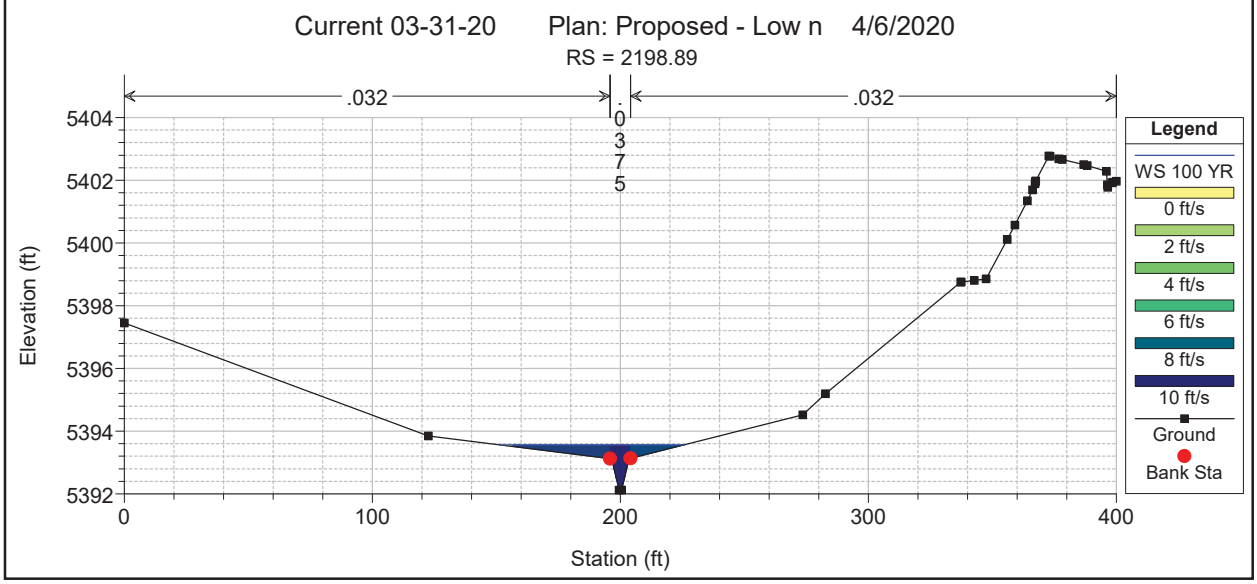

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2450
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

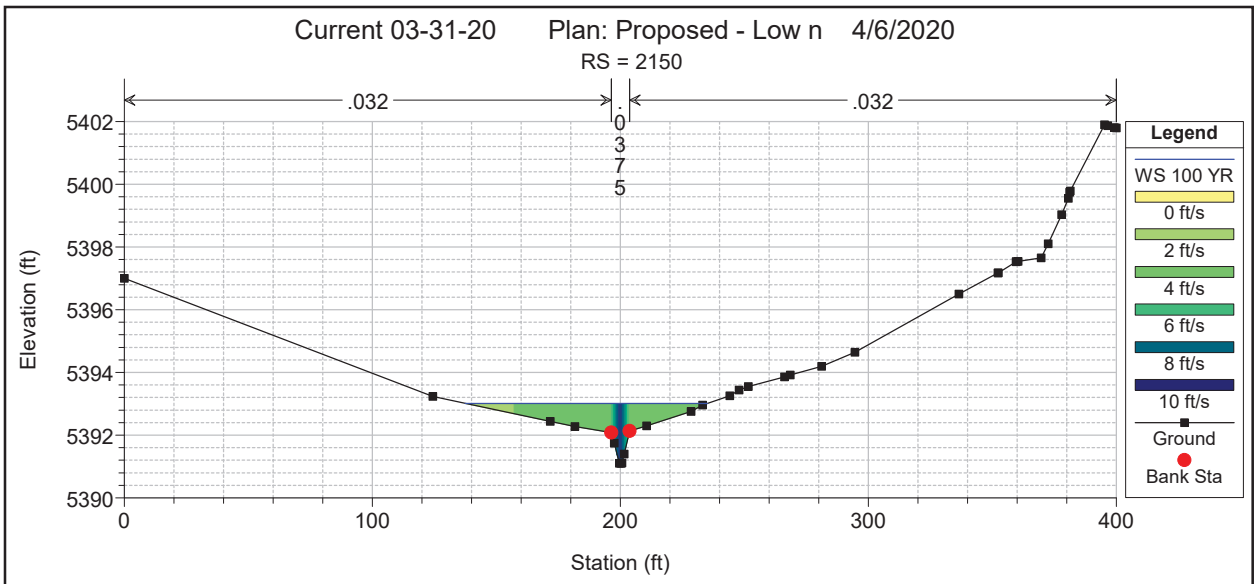

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2400
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

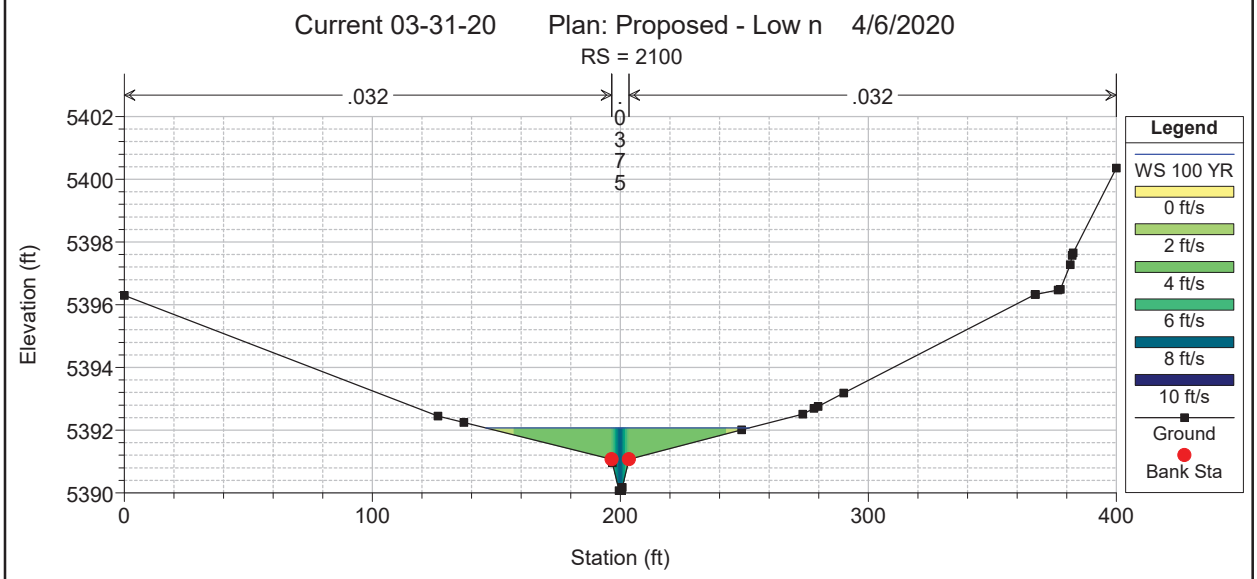

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2350
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

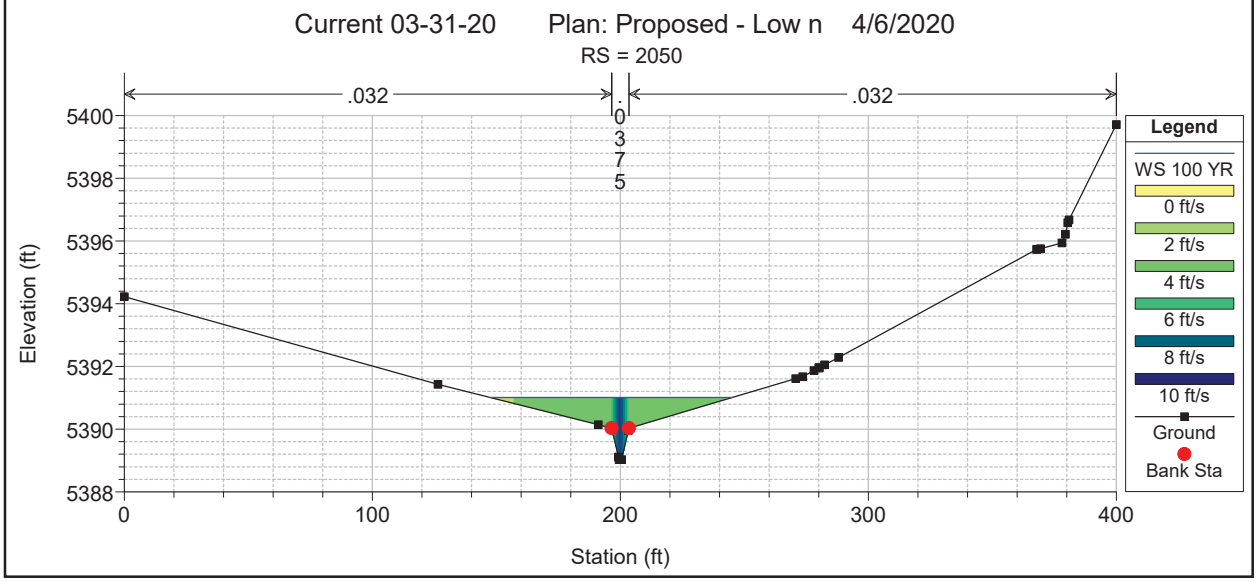

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2300
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

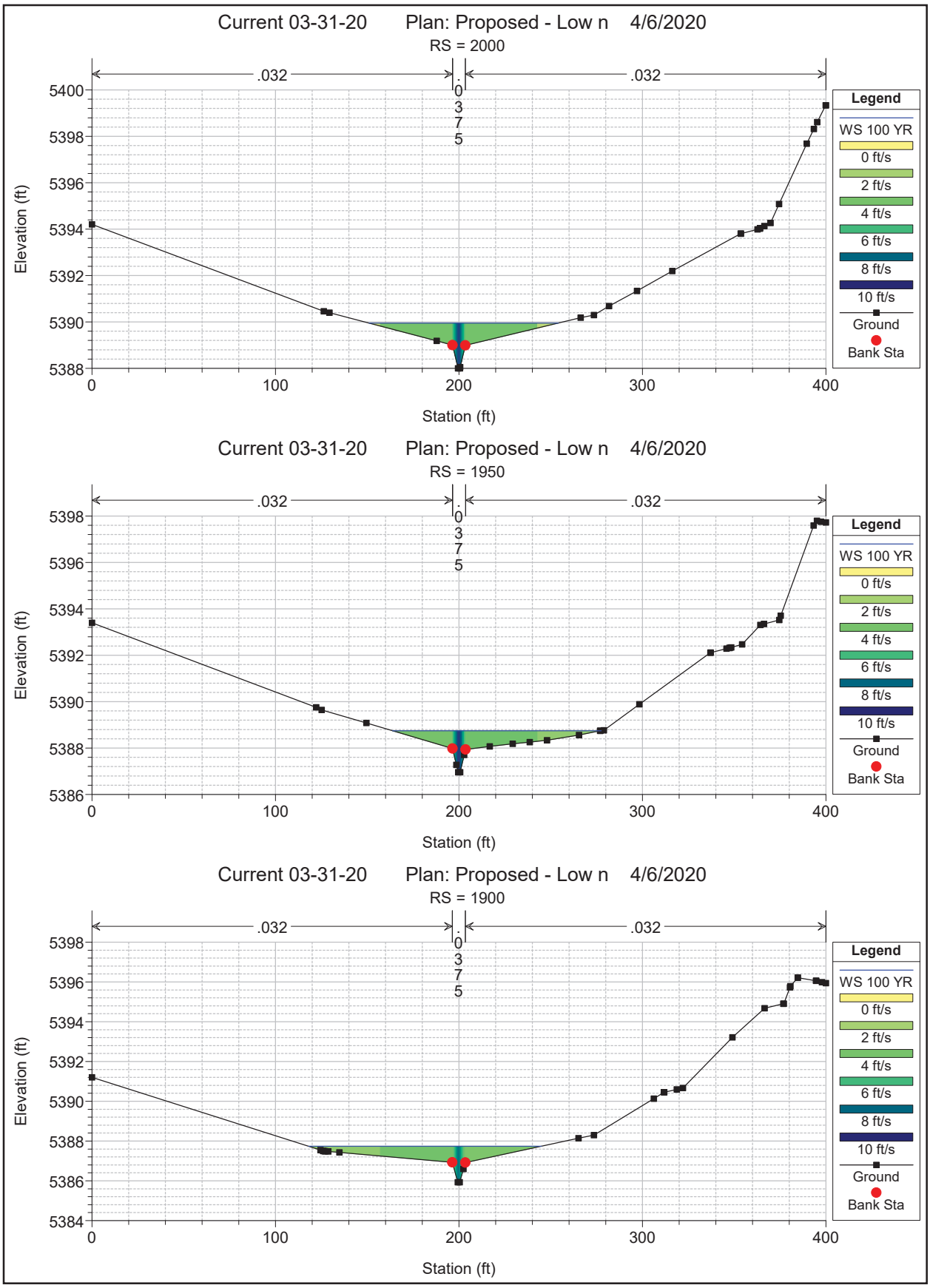

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2218.78
.0375
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

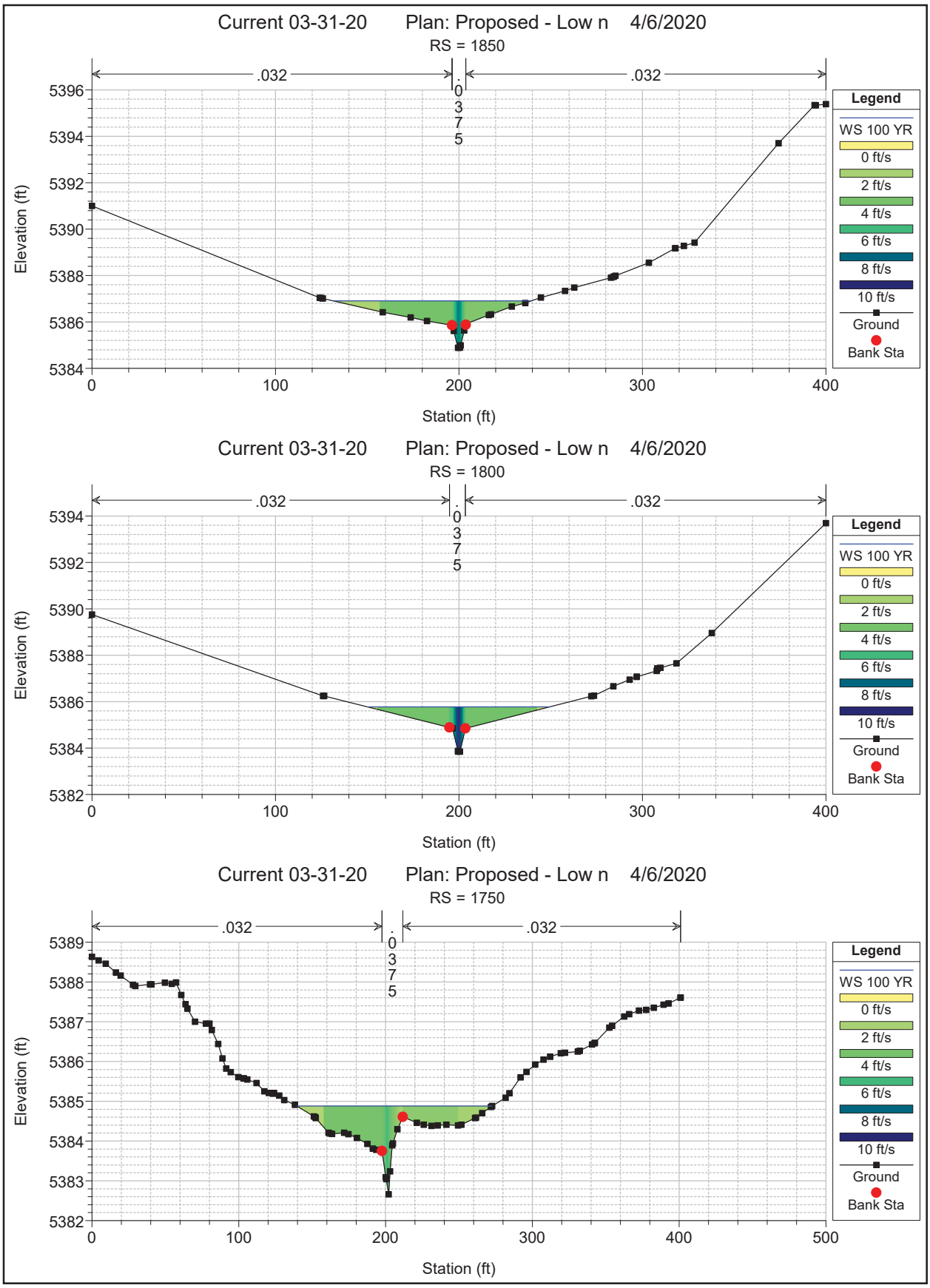

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2198.89
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

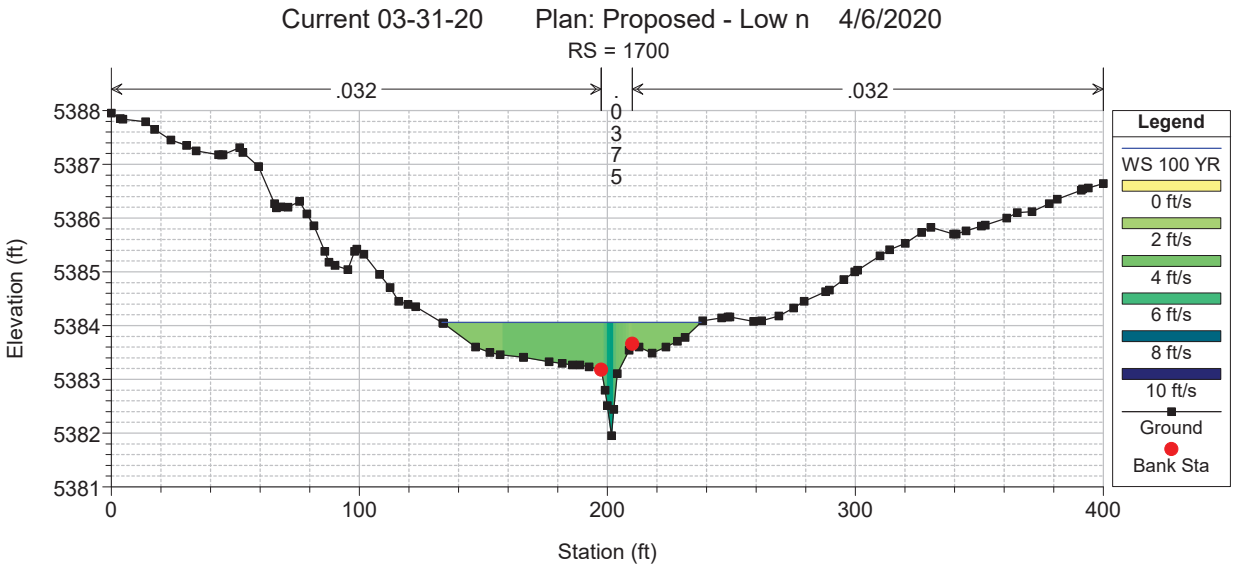

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2150
.032
.037
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

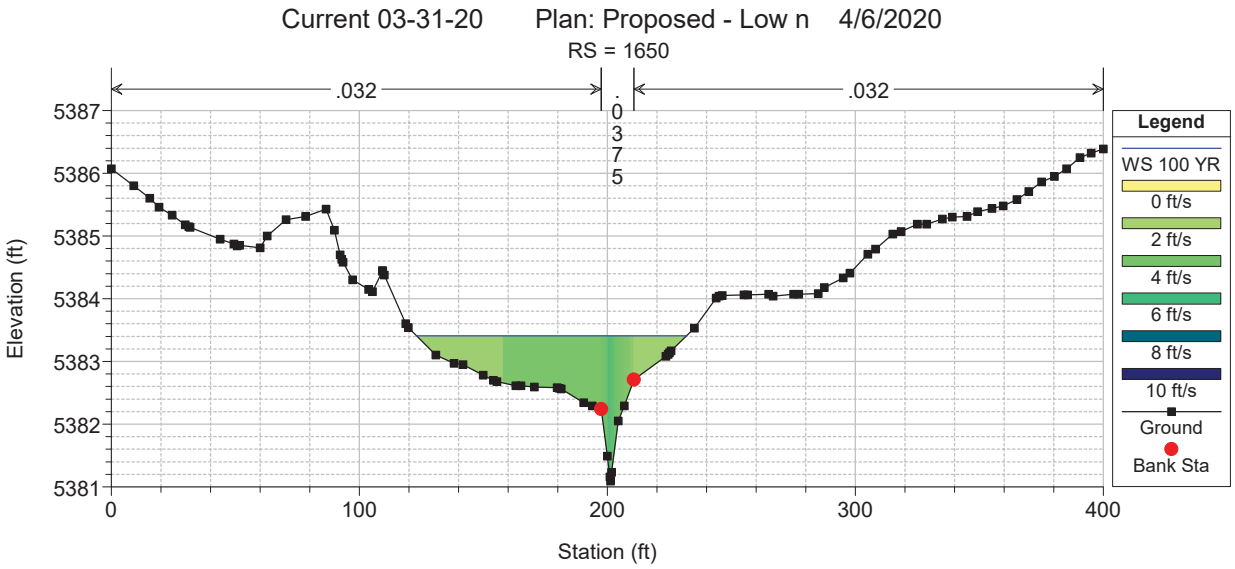

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2100
.032
.037
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

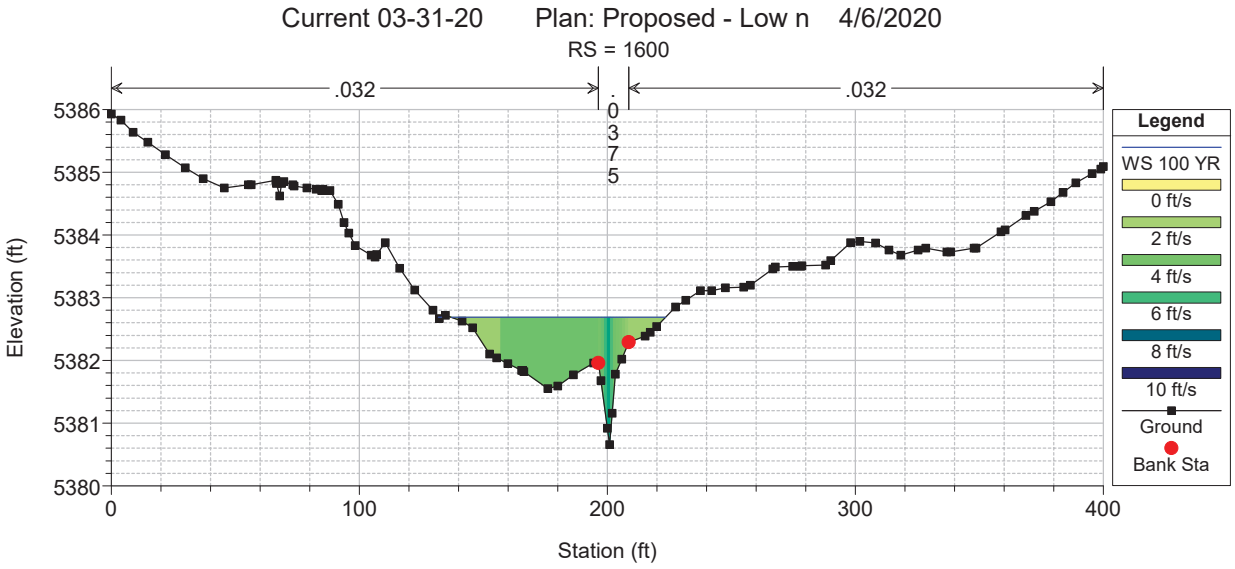

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2050
.032
.037
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

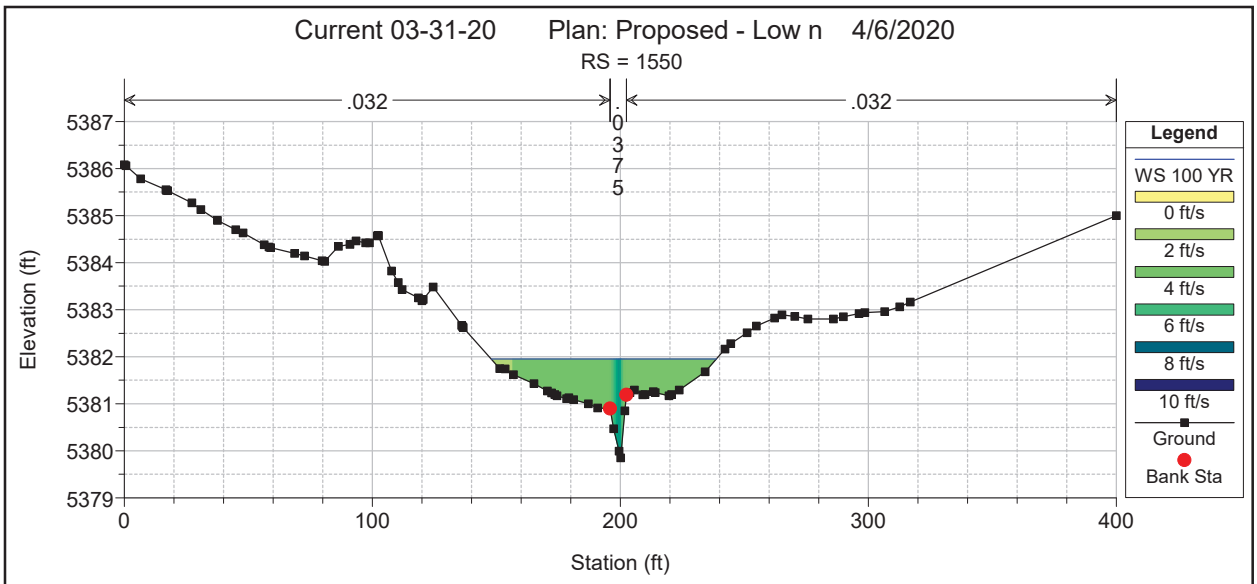

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 2000
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1950
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1900
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

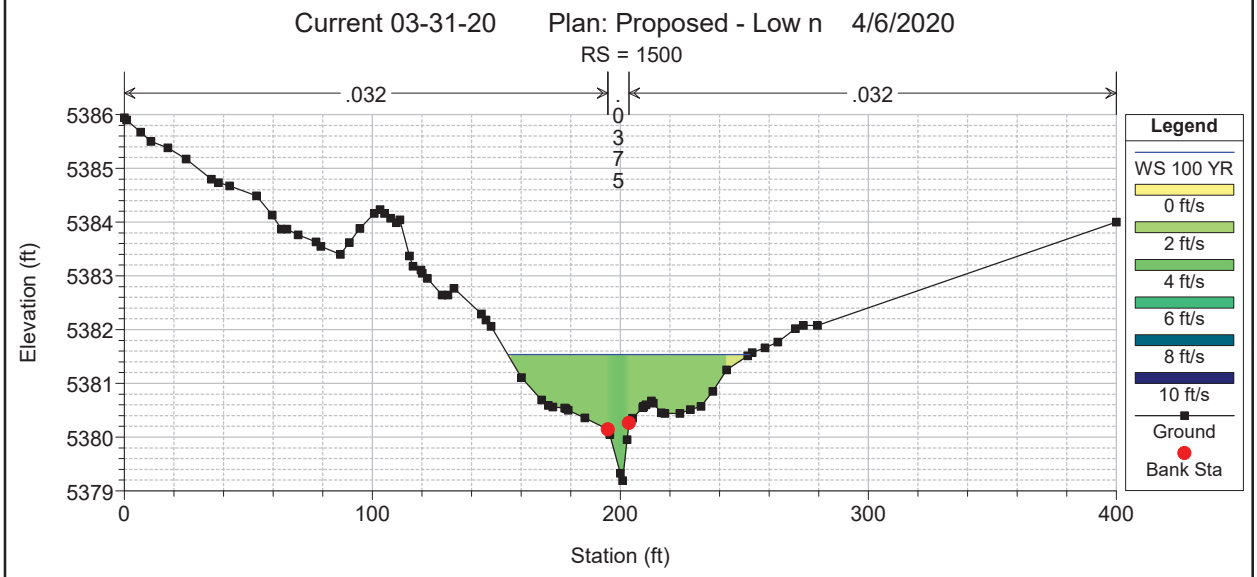

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1850
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1800
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1750
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

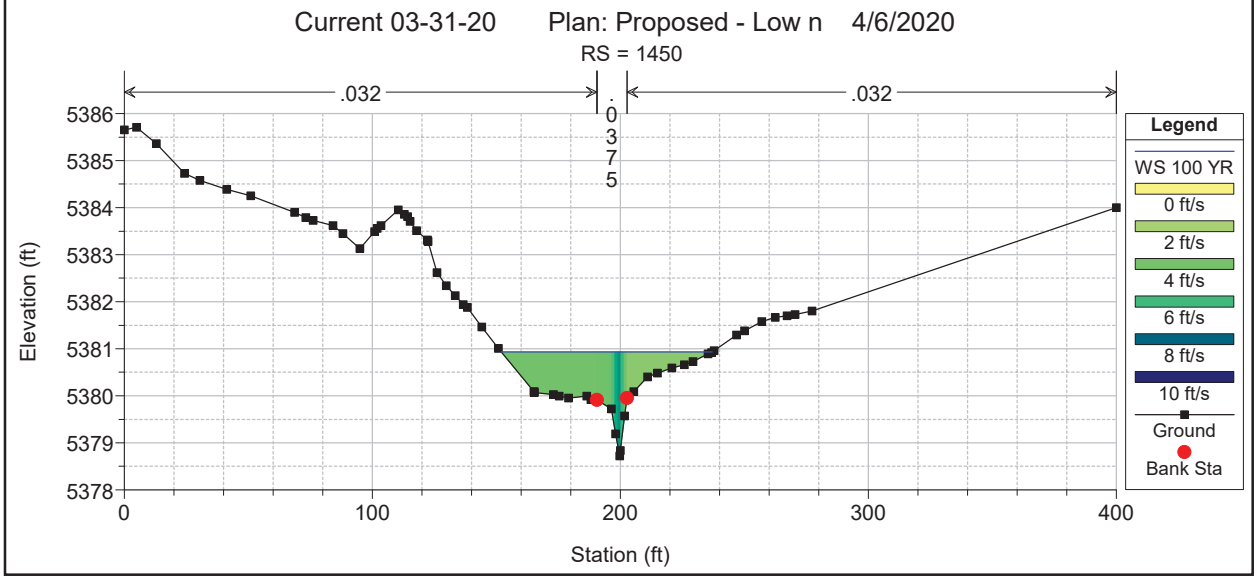

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1700
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

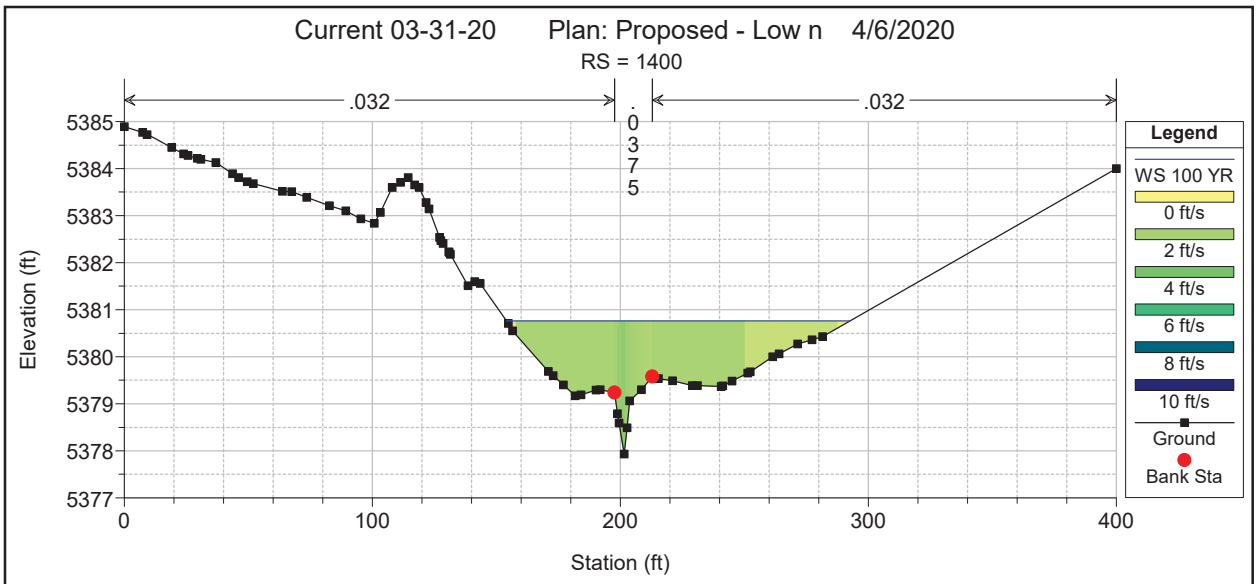

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1650
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

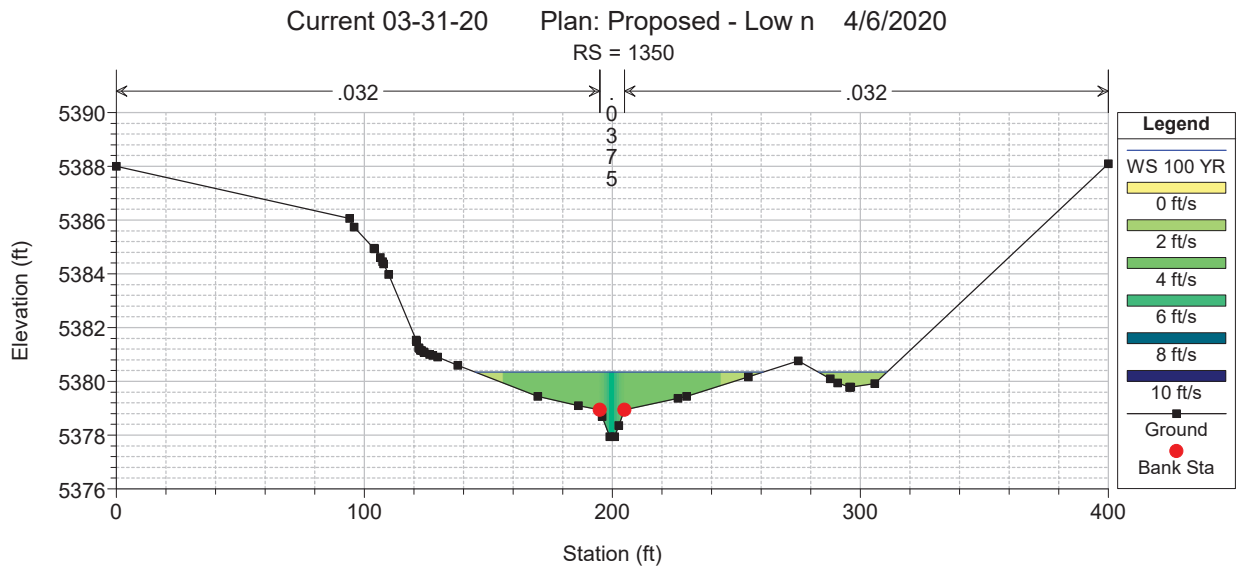

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1600
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

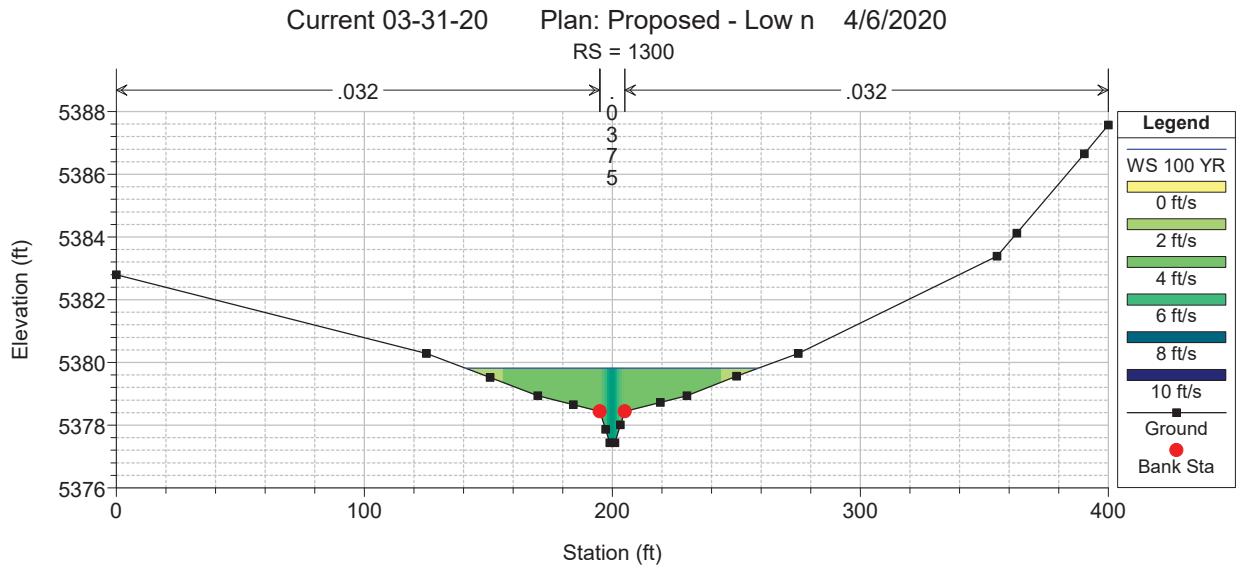

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1550
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

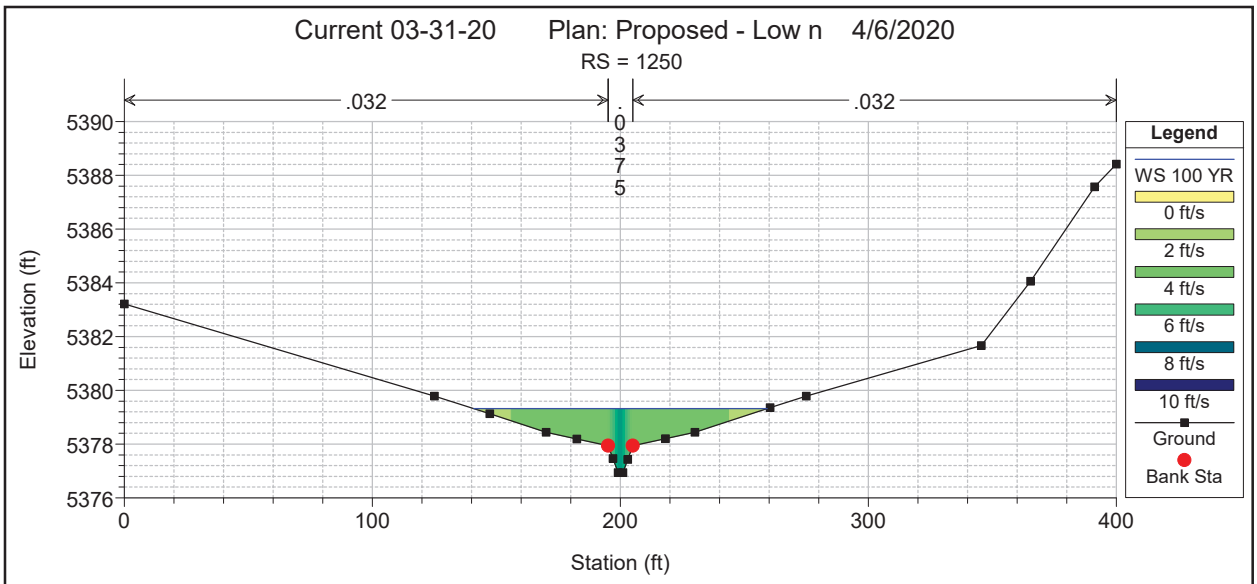

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1500
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

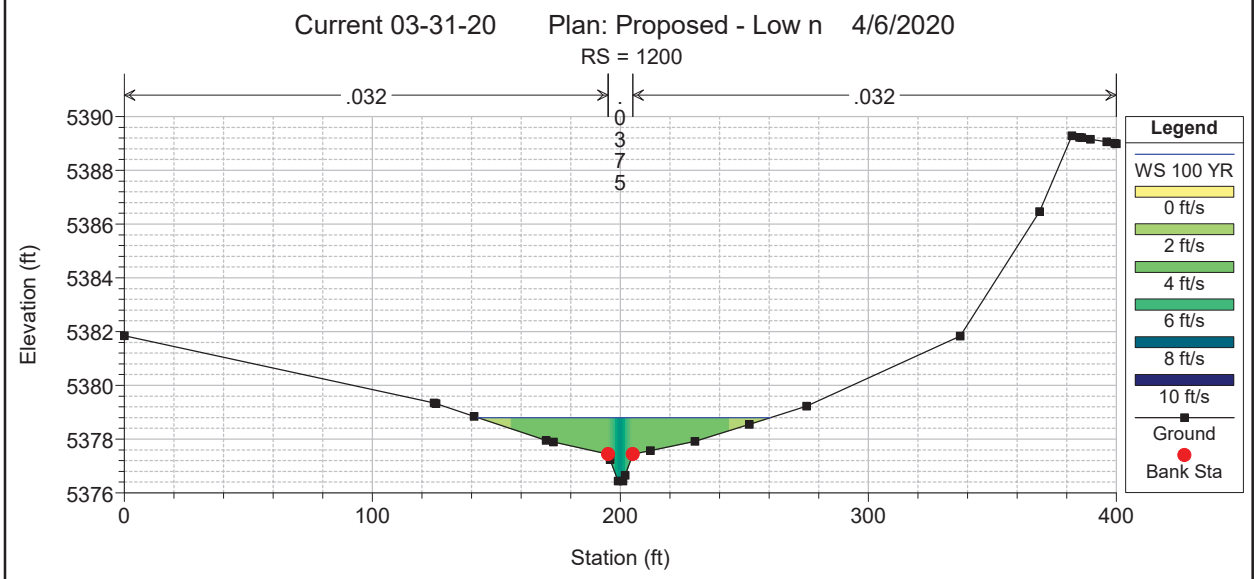

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1450
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

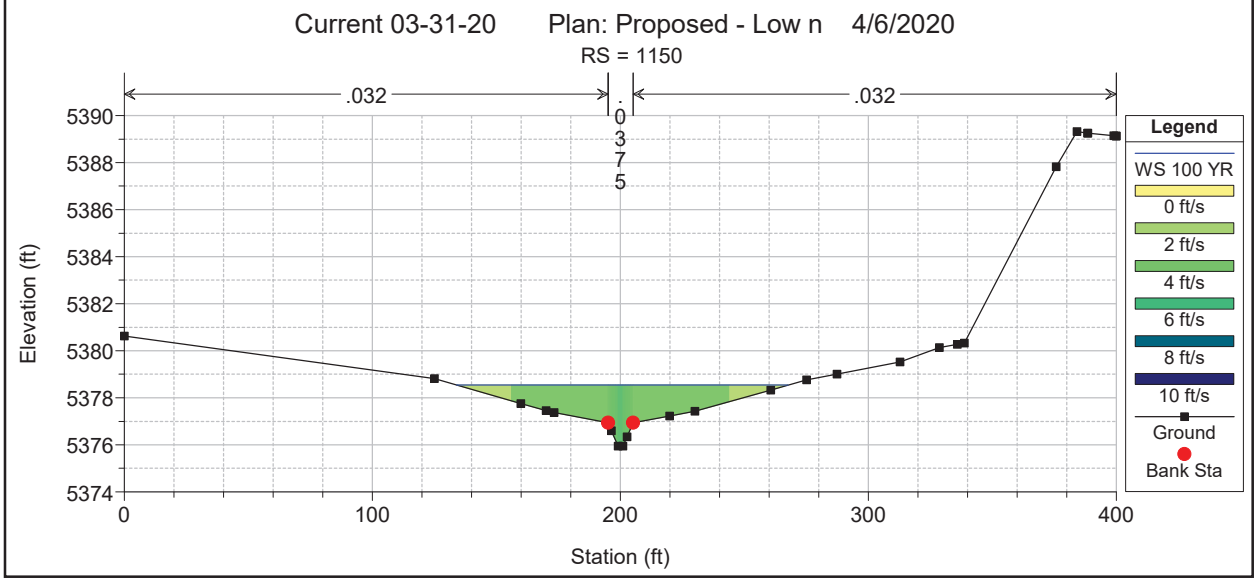

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1400
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

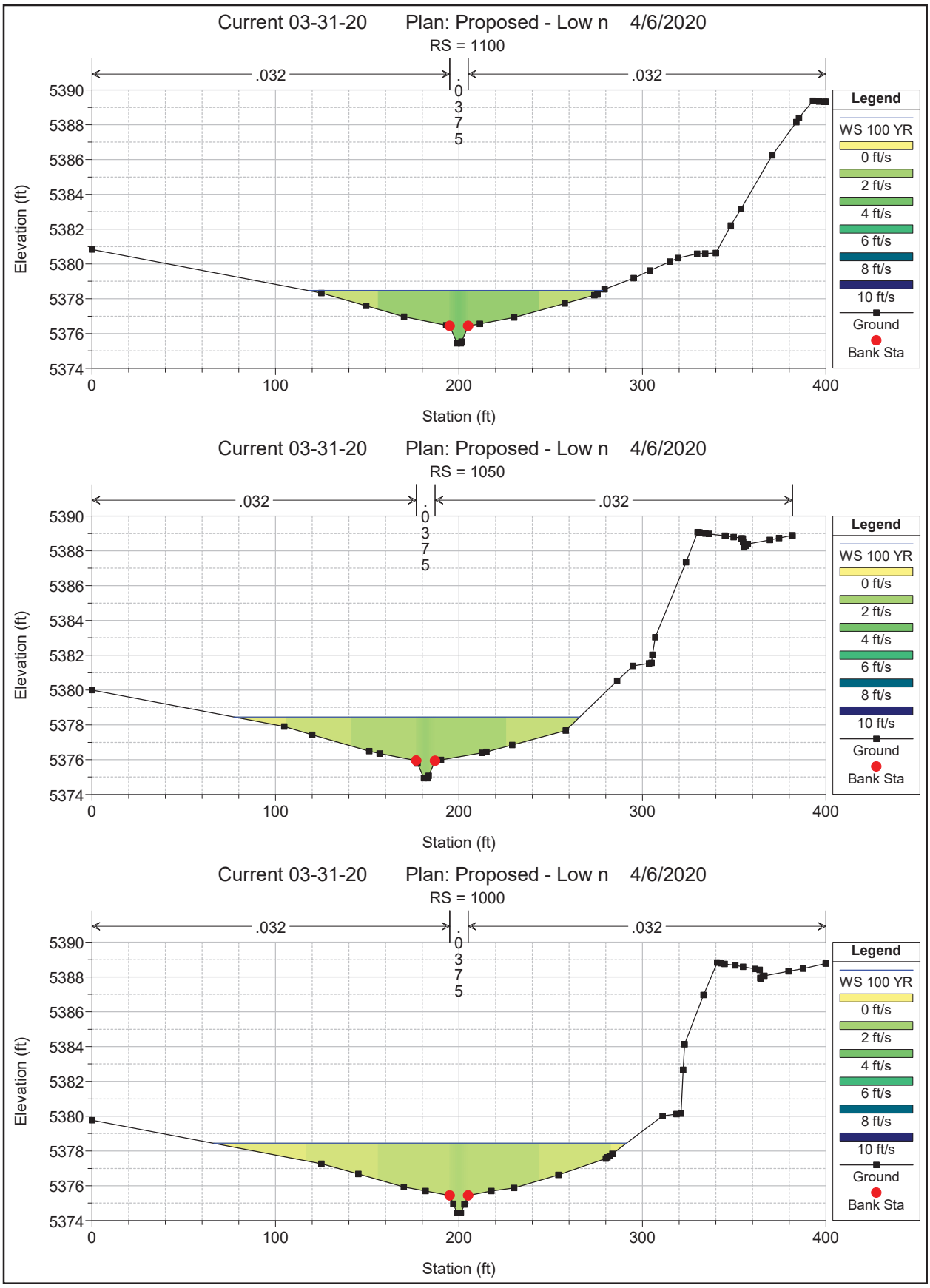

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1350
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

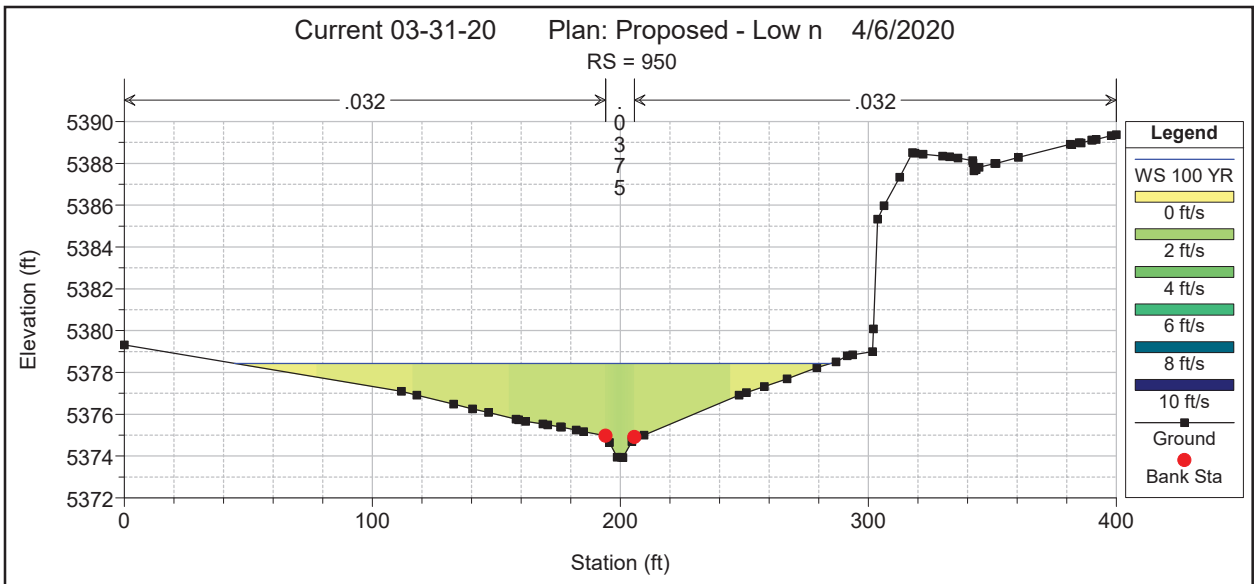

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1300
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

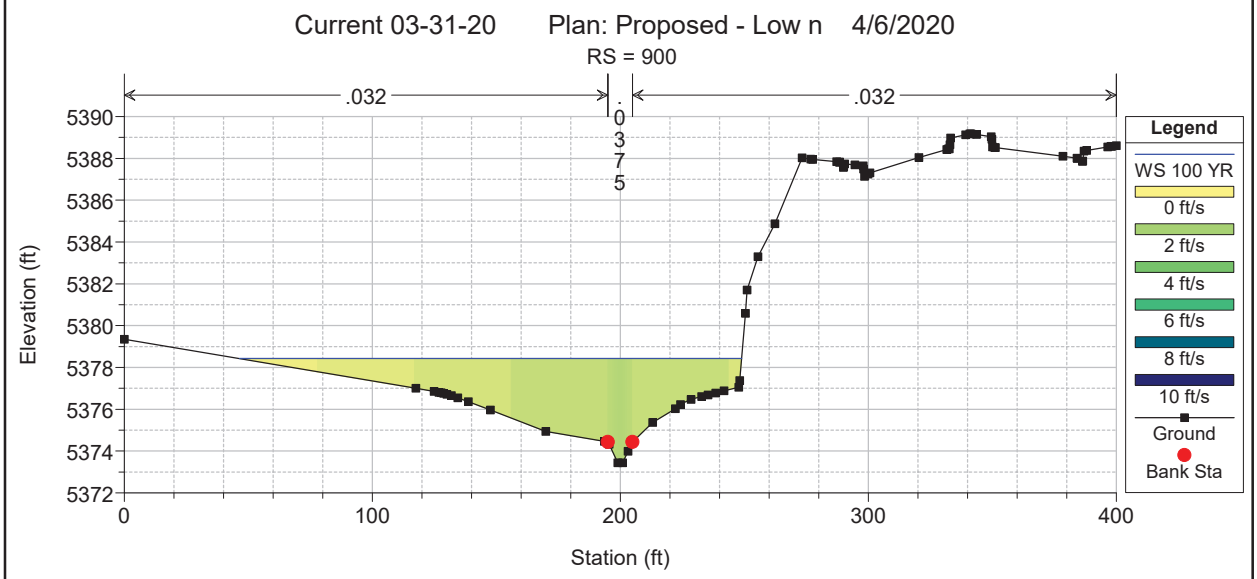

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1250
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

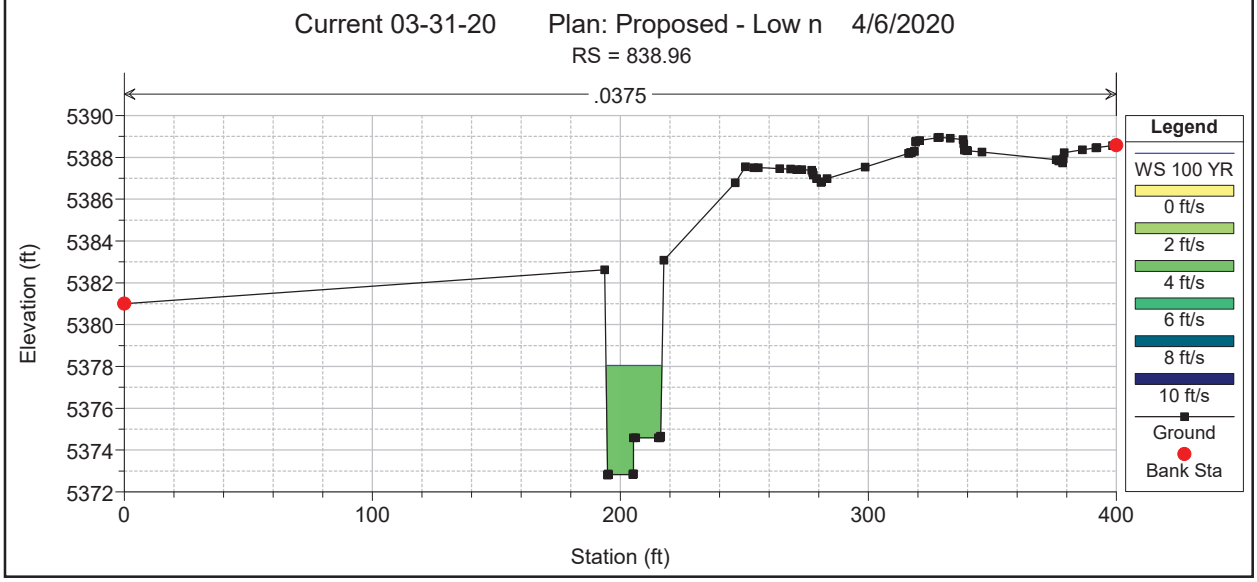

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1200
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

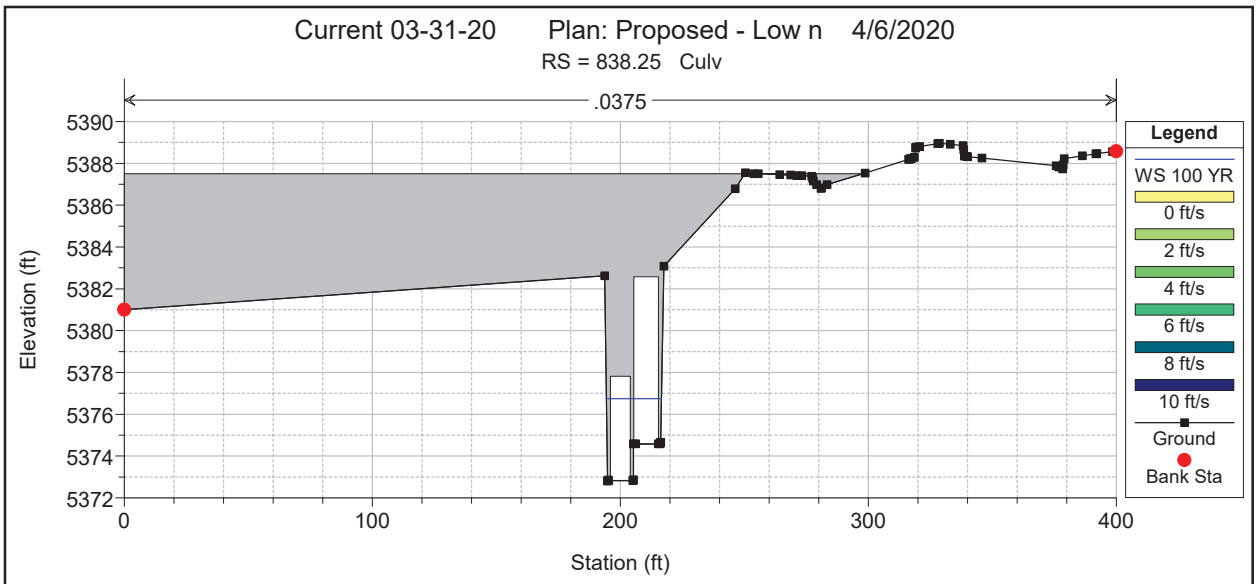

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1150
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

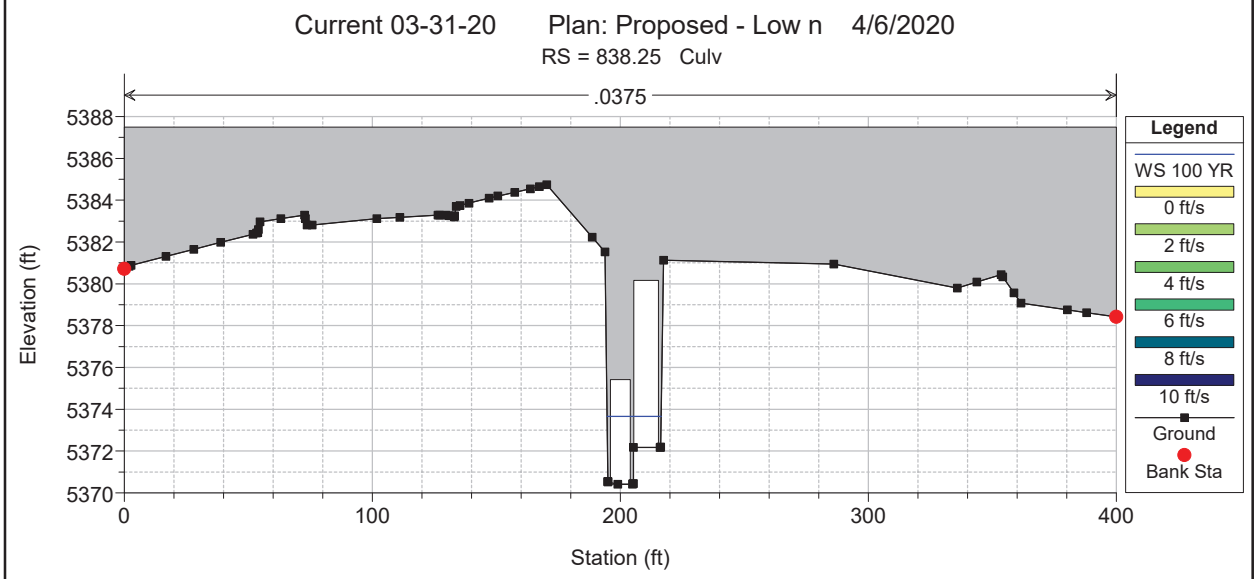

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1100
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1050
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 1000
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

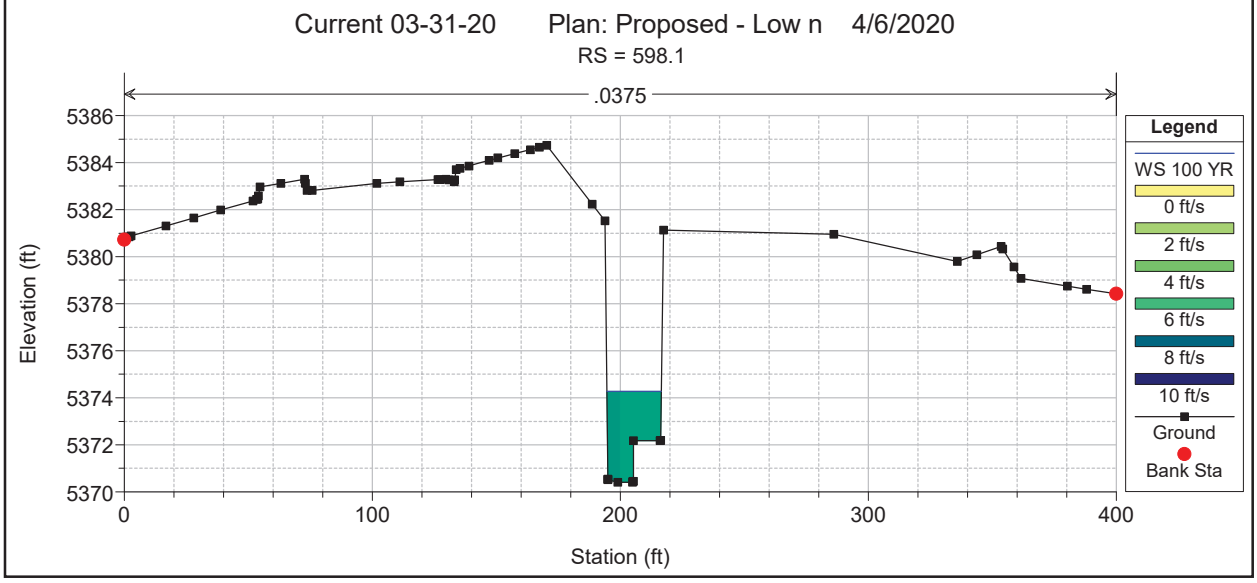

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 950
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

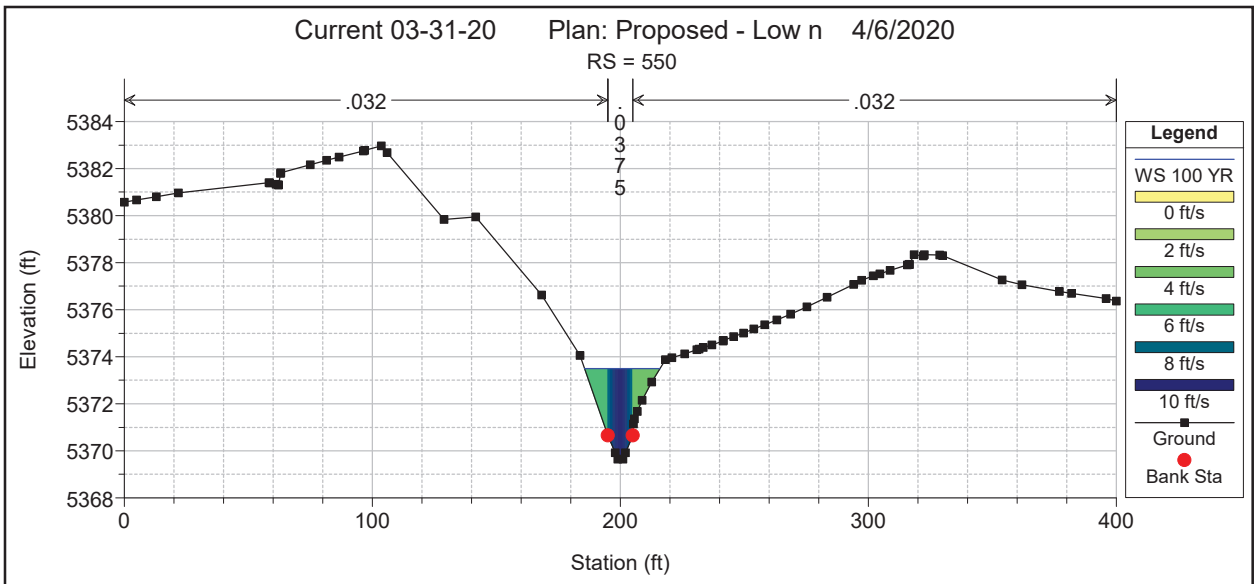

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 900
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

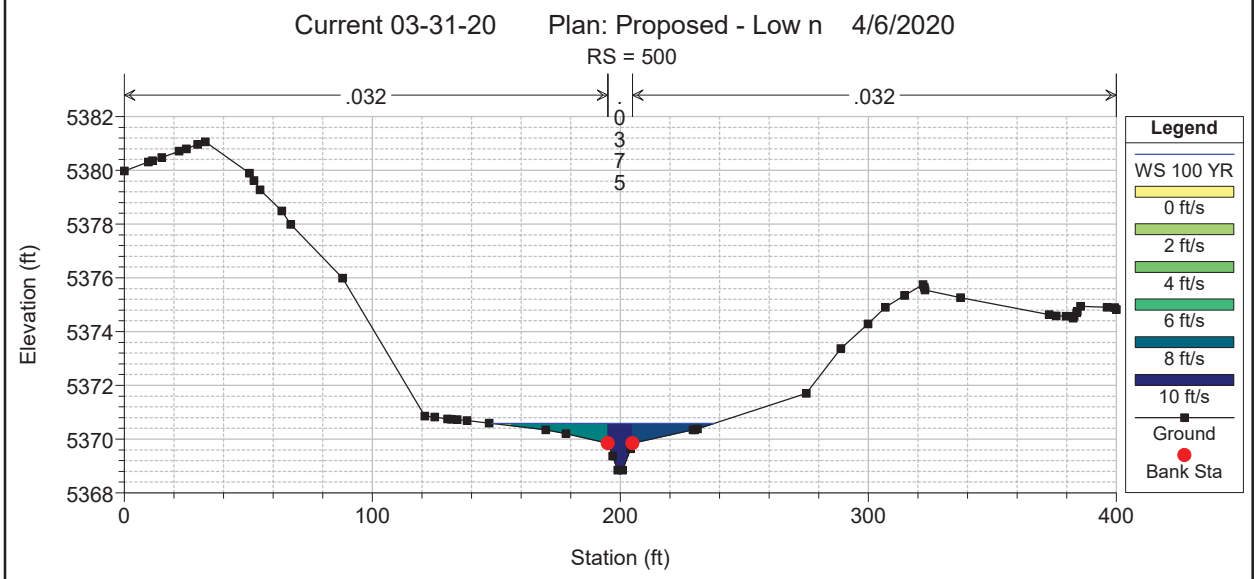

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 838.96
.0375
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

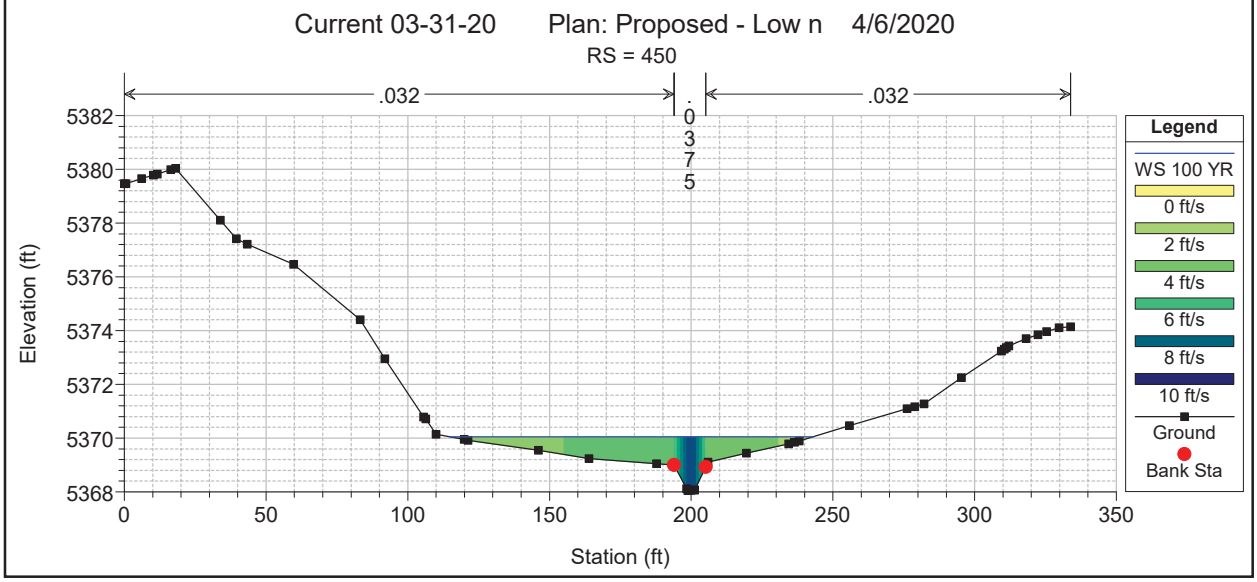

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 838.25 Culv
.0375
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

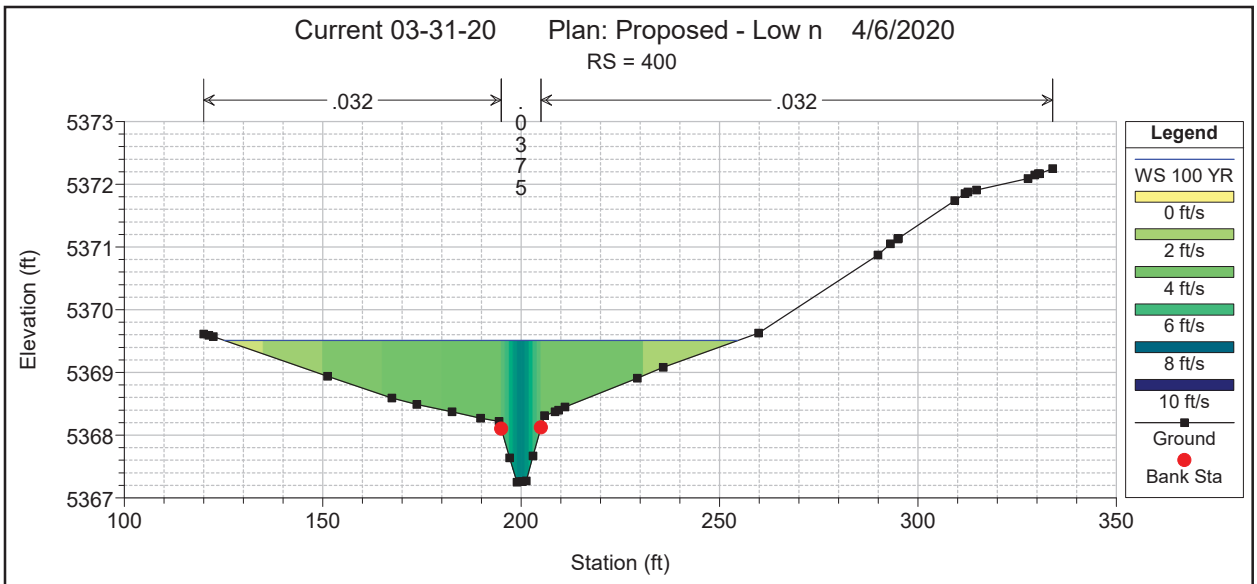

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 838.25 Culv
.0375
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

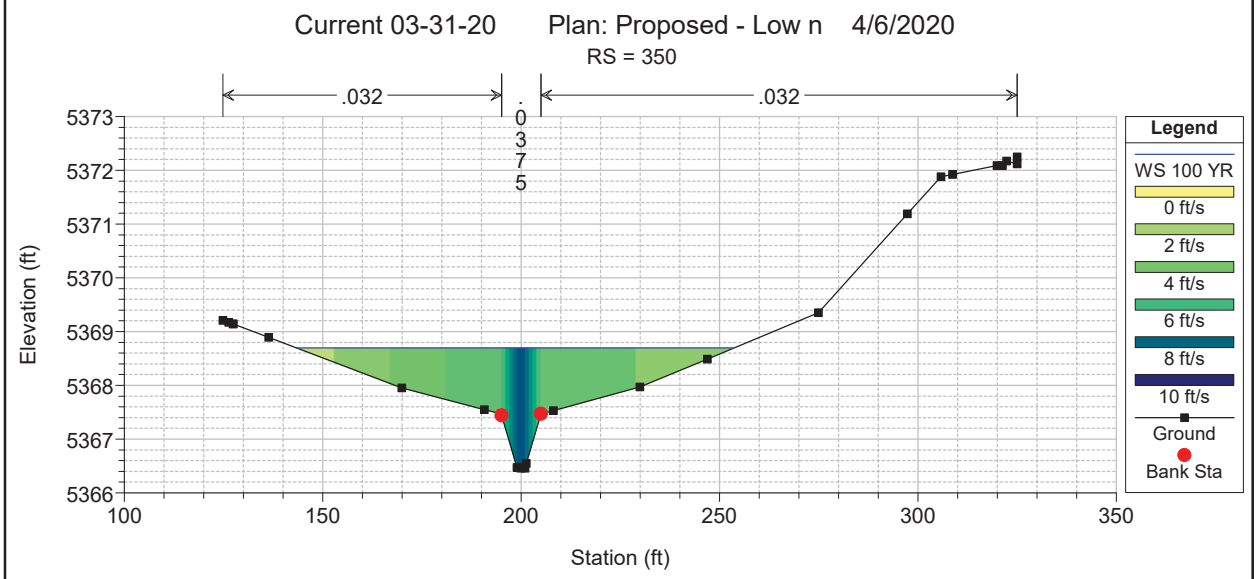

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 598.1
.0375
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

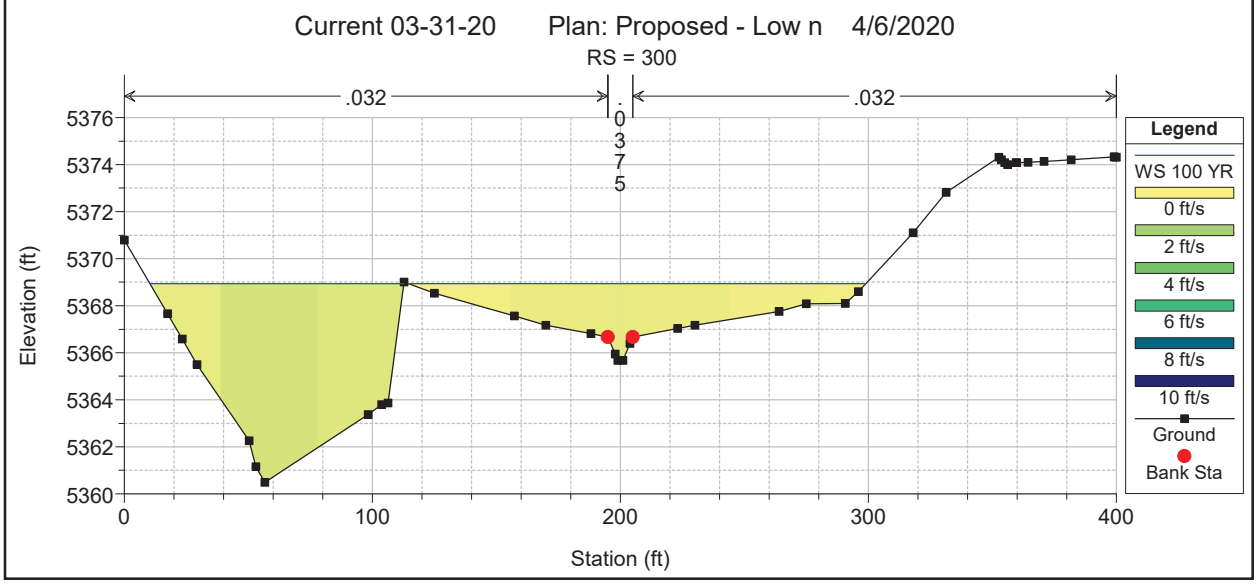

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 550
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 500
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 450
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

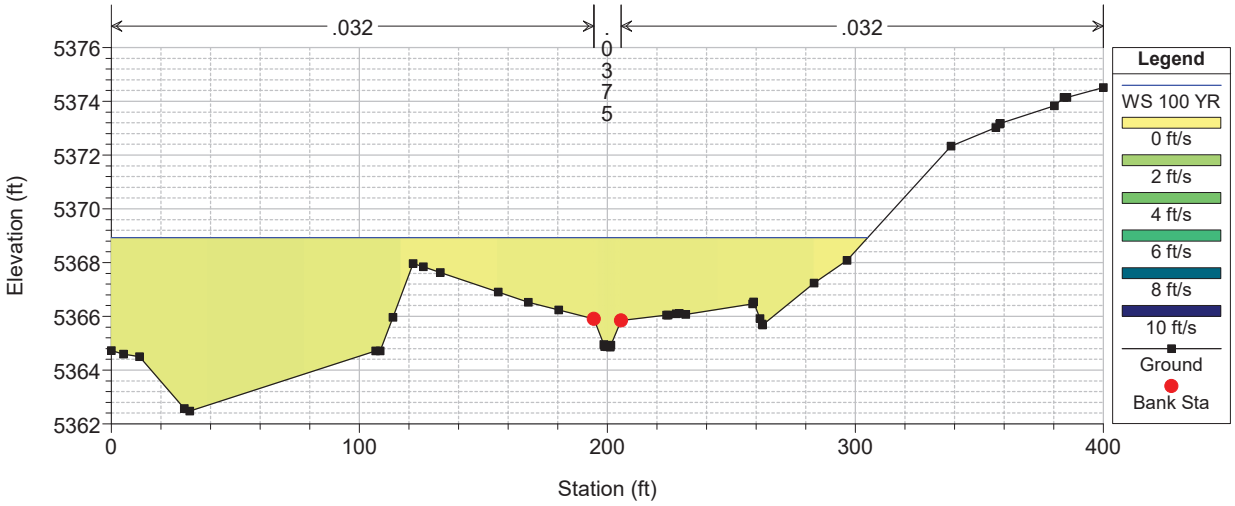

Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 400
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 350
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 300
.032
.0375
.032
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

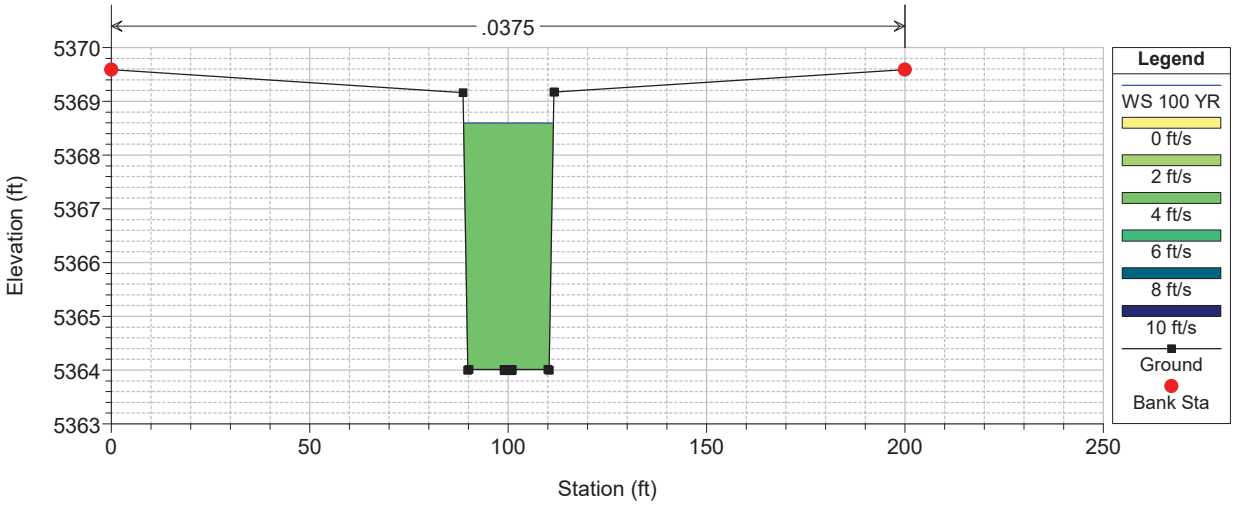
Current 03-31-20 Plan: Proposed - Low n 4/6/2020

RS = 250



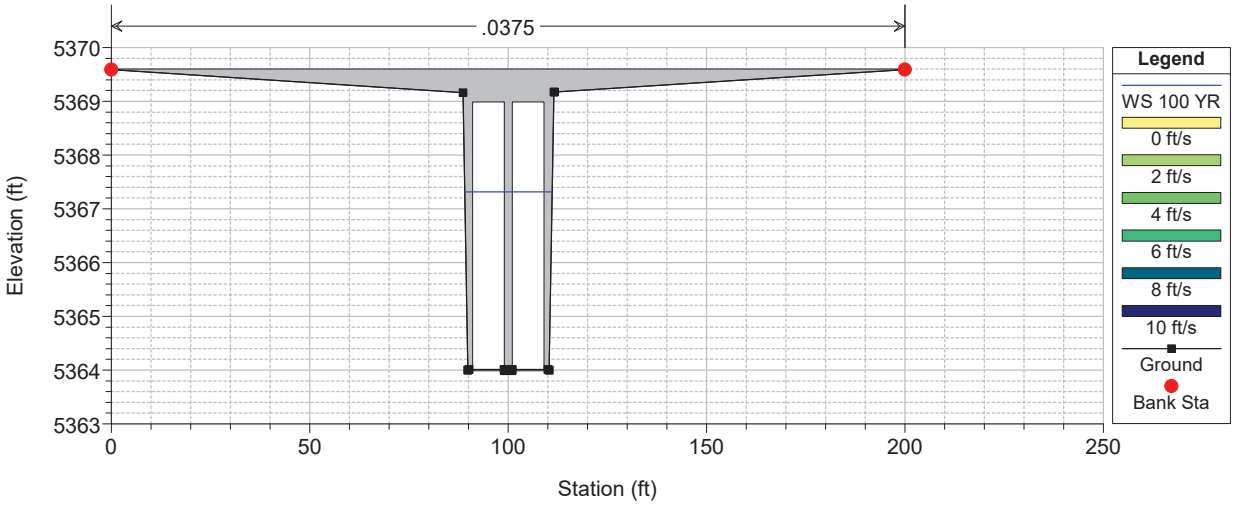
Current 03-31-20 Plan: Proposed - Low n 4/6/2020

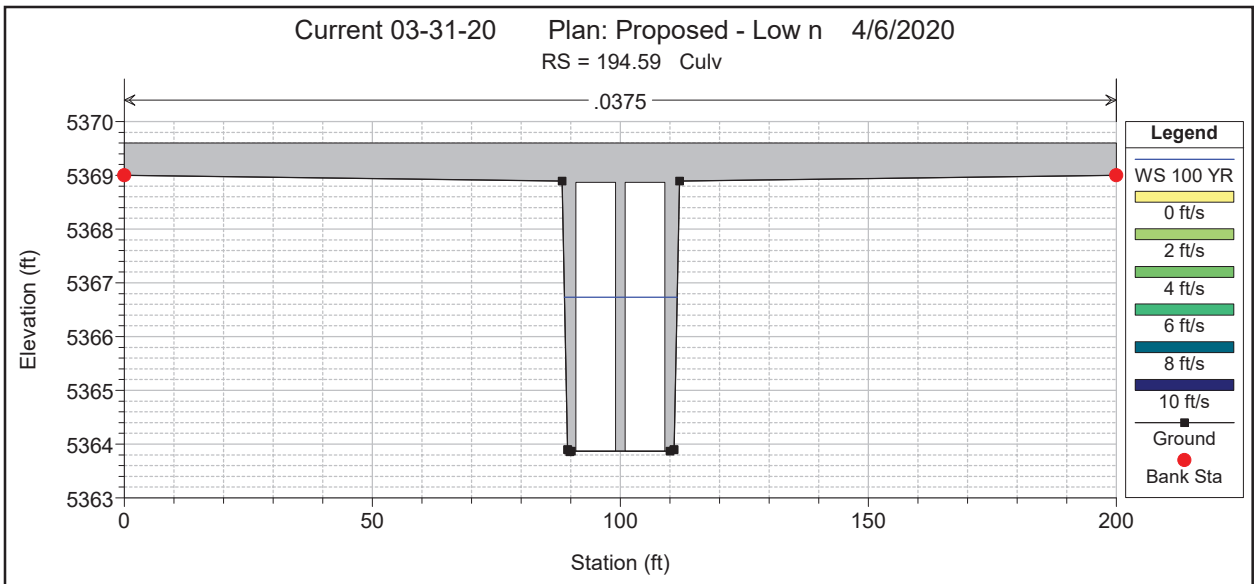
RS = 194.84

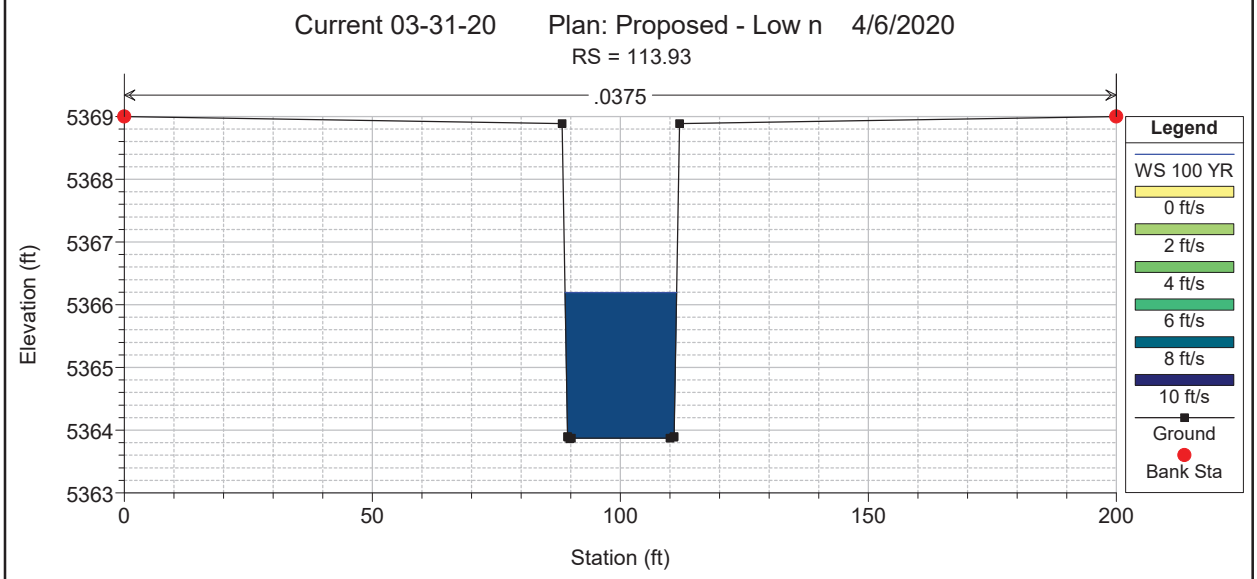


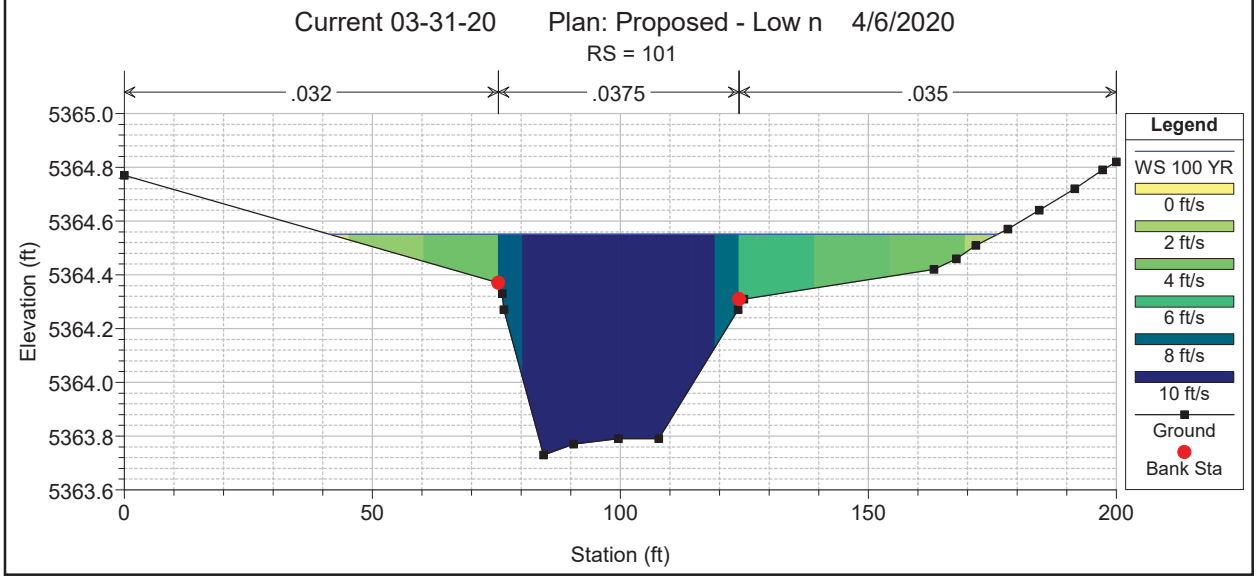
Current 03-31-20 Plan: Proposed - Low n 4/6/2020

RS = 194.59 Culv




Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 194.59 Culv
.0375
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 113.93
.0375
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


Current 03-31-20 Plan: Proposed - Low n 4/6/2020
RS = 101
.032
.0375
.035
Elevation (ft)
Station (ft)
Legend
WS 100 YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta