PSOMAS

Balancing the Natural and Built Environment

February 28, 2024

City of Tucson
Attn: John Beall
201 N. Stone Avenue
Tucson, Arizona 85701

Re: RITA 10 RSSP Amendment
Comment Response

Dear John,

This letter is in response to Commissioner Makansi's request for hydraulic modeling data for the RITA 10 RSSP Amendment area. Through existing modeling, fieldwork, and the additional analysis that has been provided to the Commission, we have been able to determine that there are opportunities to consolidate flows in a way that will provide positive outcomes for both habitat and large-scale new development in Tucson, while ensuring adequate floodplain management for the overall RITA 10 area. Psomas has identified relevant regulations and researched the extent of existing floodplain studies available that have been completed for this area by Pima County Regional Flood Control District (RFCD). Floodplain extents depicted on the attached exhibit were obtained directly from those studies. Existing studies can primarily be obtained online through the RFCD website shown below. Psomas has attached the single study not currently available online, prepared by CMG for RFCD as part of work being completed for two Psomas Projects: 1) South Houghton Road for the County DOT and 2) Fairgrounds Channels for RFCD.

- RCFD Flood Studies Link: https://www.pima.gov/1505/Floodplain-Studies

Psomas has performed a review of the existing floodplain conditions and used the accepted flow rates from the various studies to perform high-level proposed conditions evaluations to support the potential flow consolidation, tying into existing and planned consolidated channels through the Fairgrounds and SELC property to provide continuity.

Once approval of the policy amendment is obtained, ASLD or future developers will be required to complete additional studies during the PCD or secondary planning stage to identify how and where the consolidated corridors will be created.

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If you have any additional questions or comments, please feel free to contact me at (520) 292-2300.

Sincerely,
PSOMAS

Regina Beem

Regina Beem, P.E.
Sr. Project Manager

Figure X
Rita I-10 PAD
Master Drainage Plan
Concept Flow Corridors

PSOMAS

DRAINAGE REPORT
FOR
FAIRGROUNDS SOUTH HOUGHTON CHANNELS PROJECT
(NORTH & CENTRAL CHANNEL)

PIMA CO. PROJECT NO. 5FGSHC

Location:
T16S, R15E, Sections 14 and 15
Pima County, Arizona

Prepared for:

PIMA COUNTY
FLOOD CONTROL

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Prepared by:

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January 3, 2023
CMG Project No. 20-017.2

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Following Page 16

LIST OF APPENDICES

SECTION 1.0 INTRODUCTION

This Drainage Report has been prepared to provide the Pima County Regional Flood Control District (District) with drainage engineering analyses for the Fairgrounds North and Central Channels located on the Pima County Fairgrounds property between Harrison Road and Houghton Road. The Fairgrounds North and Central Channels are segments of the larger channelization system being proposed for the Pima County Fairgrounds property and downstream Southeast Logistical Center (SELC) properties. This report accompanies and complements the preliminary channel plans that are being prepared by the project civil engineer, Psomas. For this study, the District has contracted CMG Drainage Engineering, Inc. (CMG) to provide project drainage design consultant services.

1.1 Project Description

The Fairgrounds Channels project is in unincorporated Pima County, Arizona. The study area is in Sections 14 and 15, Township 16 South, Range 15 East, Gila and Salt River Meridian, Pima County, Arizona. The downstream and upstream limits of the study are respectively, just downstream of Harrison Road and just downstream of Houghton Road at the Fairgrounds dragstrip alignment. This project is being coordinated with and will provide a downstream drainage discharge channel for several of the new cross drainage culverts that are part of the Pima County Department of Transportation (PCDOT) Houghton Road widening project that fronts the Fairgrounds property on the east.

The intent of the project is to create an environmentally sensitive design that improves drainage through the Fairgrounds by creating more defined channel system to convey flood flows through the northern and central parts of the Fairgrounds property and make more land available for Fairground's operations. The channel designs utilize wide flow corridors in an effort to minimize erosive velocities. At the direction of the District, bank protection and erosion control features have only been designed at locations where they would conflict with other Fairgrounds property operations. Examples of locations where erosion control measures were considered included channel bends, drop structures and road crossings where the potential for localized erosion is more pronounced. A vicinity / location map for the project is presented as Figure 1.

1.2 Proposed Improvements

The project is currently envisioned to consist of the following:

- Channel Grading

- Erosion Protection
- Channel Stabilization Measures (Drop Structures and/or Grade Control Structures)
- Landscaping and irrigation
- Pedestrian Pathway and Passive Recreation Nodes (North Channel Only)
- Access Road Drainage Crossings
- Minor Reconfiguration of Fairgrounds Infrastructure to Accommodate Channels

SECTION 2.0 FLO-2D MODELING

2.1 Expanded Existing Conditions FLO-2D Models

As part of the Pima County's South Houghton Road Widening project (South of Intereste-10, project no. 4SHRWD), The District provided the existing conditions FLO-2D models that cover both 3-hour type II & 24-hour type I, 100-year & 10-year storms (total 4 models). CMG reviewed the models and made minor modifications to them. In addition, to evaluate the Fairground Channel project's downstream drainage impacts to Wilmot Road, the modeling domain for the existing conditions FLO-2D models has been extended by CMG to Wilmot Road. The expanded FLO-2D modeling limits are shown on Figure 1. The updated and extended existing conditions FLO-2D models serve as the basis of providing the existing conditions hydrologic and hydraulic data for this project. Hydrologic cross sections were cut in the FLO-2D models to determine the quantities of flow at locations of interest. The expanded FLO-2D modeling parameters are summarized in Table 1.

Table 1: Existing Condition FLO-2D Model Parameters

FLO-2D Model Parameters	Description
FLO-2D Pro Build No.	• Build No. 21.08.23 was utilized because this version provides enhanced upstream channel to floodplain interface.
FLO-2D Study Area	• Approximately 22.9 square miles. See FLO-2D study area exhibit.
Grid Size	• 15-ft grid. The FLO-2D model has total 2,834,292 grids.
Topographic Data and Aerial Photos	• 2015 PAG bare earth LIDAR data and 2015 aerial photos.
Storm Frequencies Evaluated	• 100- and 10-year rainfall events with both 3- & 24-hr rainfall distribution.
Rainfall Data (RAIN.DAT)	• NOAA 14 (upper 90%) rainfall depths: (1) **4.32"** for 100yr/24hr; (2) **3.33"** for 100yr/3hr; (3) **2.88"** for 10yr/24hr; (4) **2.14"** for 10yr/3hr • 24-hour NRCS Type I or 3-hr NRCS Type II distribution. • No aerial reduction factors.
Inflow Hydrographs (INFLOW.DAT)	• Inflow hydrographs from the upstream Hydrologic FLO-2D models & HEC-HMS models. • Aerial reduction factors applied to upstream HEC-HMS models, based on HEC-HMS modeling areas only.
Infiltration (INFIL.DAT)	• Used SCS Curve Number method. • SCS Curve Numbers were obtained from hydrologic soils, impervious cover densities, vegetation covers. • Curve Number for paved streets is 99.

Table 1: Existing Condition FLO-2D Model Parameters	
FLO-2D Model Parameters	**Description**
Manning's Roughness Coefficient	• Manning's roughness coefficients utilize Land Use based on 2015 PAG aerial photos. • Manning's roughness coefficients follow guidance in FLO-2D Reference Manuals. • Depth variable roughness coefficient (Shallow "N") switch is OFF.
Limiting Froude Number (FPFROUDE.DAT)	• Limiting Froude No. utilized global limiting Froude No. of 0.95 (0.95 in CONT.DAT), & varying limiting Froude No. ranging from 0.95 to 1.2.
Hydraulic Structures (HYSTRUC.DAT)	• Existing culverts.
Floodplain Area and Width Reduction (ARF.DAT)	• Building was coded for runoff blockage.
Boundary Condition	• Inflow/Outflow.
Special Considerations	• N/A

The existing conditions FLO-2D flow depths and velocities are shown on Exhibits 1a/1b and 3a/3b, respectively in Appendix A.

2.2 Proposed Condition FLO-2D Models for North & Central Channels

The proposed North and Central Channels, collect runoff from the Houghton Road culverts/dragstrip (with proposed dragstrip gate openings), convey the runoff through the Fairgrounds, and then releases runoff at Harrison Road. The proposed conditions FLO-2D models, incorporating the proposed Houghton Road roadway improvements (Final PS&E Phase), Fairgrounds North & Central Channels improvements, and 90-ft (3 sets of 30-ft) gate openings within the Central Channel alignment, have been prepared to evaluate this project's drainage impacts on the Fairgrounds and downstream of the project area. Compared to the existing conditions models, the proposed conditions models have the following major modifications:

- Incorporated Houghton Road improvements (Final PS&E Phase): Raised roadway, proposed interceptor channels, and proposed culverts have been incorporated and resulting updated TOPO.DAT, HYSTRUC.DAT, MANNINGS_N.DAT, and FROUDE.DAT.
- Incorporated North Channel improvement using the proposed channel surface from Psomas. Manning's value for the channels is 0.038, with Froude Number of 1.2. The north channel has been modeled as "CHANNEL" component in the FLO-2D models. At the north

entrance to the Fairgrounds, the drainage capacities for the proposed culverts (3-10'x4' RCBC) and the roadway dip section have been obtained by using HY-8 program and have been included in the HYSTRUC.DAT. The grids along the north entrance road have been fully blocked (ARF.DAT) because the roadway dip section's drainage capacity has already been included in the HYSTRUC.DAT. At the very upstream end of the north channel, in the vicinity of the dragstrip, fully blocked grids (ARF.DAT) have been utilized on the south side of the channel to simulate proposed constructed features, such as berm. The purpose of this proposed berm is to prevent upstream runoff from entering Fairgrounds overland flow area. As a result, TOPO.DAT, MANNINGS_N.DAT, HYSTRUC.DAT, and ARF.DAT have been updated. The channel components (CHAN.DAT, CHANBANK.DAT, and XSEC.DAT) have been added.

- Incorporated Central Channel improvement using the proposed channel surface from Psomas. Manning's value for the channels is 0.038, with Froude Number of 1.2. The central channel has been modeled as "CHANNEL" component in the FLO-2D models. At the very upstream end of the central channel, the channel extends to the south to intercept upstream overland flow. As a result, TOPO.DAT, MANNINGS_N.DAT, and HYSTRUC.DAT have been updated. The channel components (CHAN.DAT, CHANBANK.DAT, and XSEC.DAT) have been added.
- Per instructions from the District, incorporated 90-ft (3 sets of 30-ft) gate opening at the Central Channel alignment along the dragstrip barriers. Preliminary gate opening evaluation has been detailed in the *Dragstrip Gate Opening Analysis Report – Fairgrounds South Houghton Channels (5FGSHC)* dated July 22, 2021. The purpose of the gate opening is to reduce the amount of runoff that breaks out to the north. Based on the flow depth data along the dragstrip, the recommended gate opening locations should be between dragstrip station 15+50 and 20+00 (see Exhibit 2a). As a result, LEVEE.DAT has been added.

The proposed conditions North & Central Channels FLO-2D model parameters are summarized in the Table 2 below:

Table 2: Proposed Conditions North & Central Channels FLO-2D Model Parameters

FLO-2D Model Parameters	Description
FLO-2D Pro Build No.	• Build No. 21.08.23 was utilized because this version provides enhanced upstream channel to floodplain interface.

Table 2: Proposed Conditions North & Central Channels FLO-2D Model Parameters	
FLO-2D Model Parameters	**Description**
FLO-2D Study Area	• Approximately 22.9 square miles. See FLO-2D study area exhibit.
Grid Size	• 15-ft grid. The FLO-2D model has total 2,834,292 grids.
Topographic Data and Aerial Photos	• 2015 PAG bare earth LIDAR data, proposed Houghton Roadway surfaces (Final Design Phase), proposed Fairground Phase 1 Channels, and 2015 aerial photos.
Storm Frequencies Evaluated	• 100- and 10-year rainfall events with both 3- & 24-hr rainfall distribution.
Updated FLO-2D files	See detail discussions above the table • (1) HYSTRUC.DAT • (2) FPFROUDE.DAT • (3) MANNINGS_N.DAT • (4) TOPO.DAT • (5) FPXSEC.DAT • (6) ARF.DAT
Added FLO-2D files	See detail discussions above the table • (1) channel components (CHAN.DAT, CHANBANK.DAT, XSEC.DAT) • (2) dragstrip barrier with 90-ft opening (LEVEE.DAT).
Deleted FLO-2D files	Deleted these files to allow the models to regenerate the files based on updated FLO-2D files. • (1) CADPTS.DAT; (2) FPLAIN.DAT; (3) NEIGHBORS.DAT
FLO-2D files with no change	No changes to all other input files (refer to Table 1).

The proposed conditions FLO-2D flow depths and velocities are shown on Exhibit 2a/2b and 4a/4b, respectively. In addition, Exhibit 5a/5b and 6a/6b show the changes (between existing and proposed conditions) of flow depths and velocities. FLO-2D exhibits are in Appendix A.

Comparing the existing and proposed conditions flow depths & velocities data, the proposed North & Central Channel have the following drainage impacts:

- The 100-year runoff are generally contained within the North & Central Channels, except in the areas in the vicinity of the channel terminus at Harrison Road. The channel velocities (average across the entire channel cross section) are up to approximately 6.3 fps within the North & Central channels. The velocities within the low flow channel segments will have higher than channel velocities. These high low flow channel velocities are erosive for earthen channels.

- With the proposed 90-ft (3 sets of 30-ft) gate opening, along the existing dragstrip barriers, south of the east entrance road within the Central Channel alignment, the 100-year break out runoff draining from Central Channel alignment to North Channel alignment is 194 cfs (Cross Section 485 on Exhibit 2a).
- As shown on Exhibit 2a, at the upstream end of the Central Channel, there is 128 cfs (Cross Section 491) breakout flow that will not be intercepted by the Central Channel. The Central Channel could extend further south between the Motorcycle Training area and the paved road/parking lot to intercept this breakout flow.
- As shown on Exhibit 2a, the 100-year runoff is contained within the Central Channel. No berms are needed near the Motorcycle Training area.
- As shown on Exhibit 5a, at the downstream of the North Channel terminus at Harrison Road, the in discharges, flow depths, and velocities generally decrease, while, at the downstream of the Central Channel terminus, those generally increase. The decreases/increases extend continuously to Wilmot Road. Along major flow corridors downstream of North & Central Channels, the 100-year discharge rates (existing, proposed, and difference) at representative Cross Sections are shown in Table 3. The downstream drainage impacts should be reviewed and approved by the District.

Table 3: FLO-2D Discharge Changes

FLO-2D Cross Section	$Q_{100\ EXT}$ (cfs)	$Q_{100\ PRP}$ (cfs)	$Q_{100\ DIFF}$ (cfs)
Downstream of North Channel Terminus at Harrison Road			
117	3268	2734	-534
445	1482	1085	-397
438	645	622	-23
Downstream of Central Channel Terminus at Harrison Road			
163	2188	2860	672
203	1934	1942	8
444	4080	4746	666
439	5019	5536	517

SECTION 3.0 HYDRAULIC EVALUATIONS

3.1 Channel Alignment, Dimensions and Hydraulic Capacity

CMG generated channel plan and profile plans and hydraulic cross sections from the digital terrain model surface files provided by Psomas for the proposed North and Central Channels. Channel alignments and geometries were determined by coordination efforts between the District, Pima County Fairgrounds staff and Psomas.

CMG performed HEC-RAS 1-dimensional steady-state hydraulic analyses on the proposed channels based on the channel geometries and longitudinal slopes provided by Psomas. Hydraulic profiles for the 100-yr and 10-yr floods were included. Design discharges taken from the project FLO-2D models, and used in the HEC-RAS hydraulic analyses were as follows:

- North Channel:
  - Upstream of channel Sta. 31+00; 100yr = 2416 cfs, 10yr = 1120 cfs
  - Downstream of channel Sta. 31+00; 100yr = 2508 cfs, 10yr = 1180 cfs
- Central Channel:
  - Upstream of channel Sta. 33+19; 100yr = 3803 cfs, 10yr = 1177 cfs
  - Downstream of channel Sta. 33+19; 100yr = 4660 cfs, 10yr = 1204 cfs

By these analyses, most channel sections were found to have sufficient hydraulic capacity for the design 100-yr discharges. In the North Channel, flow breakouts were shown to occur along the south bank in the downstream approximate 300 feet of the study reach, upstream of Harrison Road. In the Central Channel, similar flow breakouts may occur along the north bank for approximately 600 feet upstream of Harrison Road.

The HEC-RAS hydraulic cross sections are shown on Figure 2 - North Channel Plan and Profile and Figure 3 - Central Channel Plan and Profile. HEC-RAS runs for “subcritical” and “mixed flow” flow regimes were included in the analyses. Subcritical results were evaluated for channel capacity and comparison to FLO-2D results, and the mixed flow results were used in scour and erosion control computations. Flow inundation limits were determined by the FLO-2D hydraulic analyses and not by the HEC-RAS analyses, but water surface elevations have been provided for each HEC-RAS cross section in tabular form on Figures 2 and 3. Both subcritical and mixed flow hydraulic computation sheets for the HEC-RAS modeling are included in Appendix B.

3.2 Erosion and Scour Evaluation

The mixed flow regime HEC-RAS hydraulic analyses referenced in the previous section determined the following average flow velocities in the typical compound channel sections:

- North Channel:
  - 100yr – Channel: between 8 - 10 ft/s, Overbanks: between 3 - 5 ft/s
  - 10yr – Channel: between 5 - 7 ft/s, Overbanks: between 2 - 3 ft/s
- Central Channel:
  - 100yr - Channel between 8 - 10 ft/, Overbank: between 3 - 5 ft/s
  - 10yr – Channel: between 5 - 7 ft/s, Overbanks: between 2 - 3 ft/s

The 100-yr overbank (terrace) velocities are potentially erosive depending on the quality of vegetative cover that can be maintained. However, velocities concentrated in the low-flow channels are higher, as is confirmed by the FLO-2D results reported in Section 2.2 and 2.3. The low-flow channel 100-yr velocities are up to approximately 8.6 fps for "typical" compound channel sections, e.g., Sta 47+00, in the North channel, and 8.8 fps for "typical" compound channel sections, e.g., Sta 31+00, in the Central channel. In response to these results, channel segments at channel bends as well as in localized zones at channel drops or flow concentration points (such as immediately upstream and downstream of the entrance or access road crossings and just downstream of the Fairgrounds Drag Strip) have been recommended to include either shotcrete or riprap bank protection to reduce erosion potential.

For the North Channel, erosion and scour control measures from the previous 50% design submittal were generally carried forward into the final design. For the Central Channel, the following erosion/scour control measures were removed from the project for final design at the direction of the District:

- Low-flow channel bank protection along channel bends and other localized erosion-prone locations.
- Transverse grade control structures spaced along the channel based on maximum 6-foot deep cumulative general scour and long-term degradation estimates.
- Bank protection of the channel south slope along the approximate lower one-third of the channel to protect channel bank from overbank inflows from the south.

Removal of the aforementioned erosion and scour protection measures could lead to unwanted erosion and scour of the channel system during both the 100-year design flood and lesser floods.

More frequent maintenance and repair efforts should be expected to keep the unprotected segments of the channels in original design conditions.

Using the HEC-RAS hydraulic analyses results, general scour was evaluated for the typical channel sections and local scour was estimated at proposed channel drops, grade control locations, channel expansion or contraction locations, and at channel bends. The general scour computations resulted in modest depths with recommended design depths generally defaulting to a 3-foot minimum. At grade control locations the estimated local drop scour depth was compared to the general scour computed for the channel and the larger depth was used in grade control depth design. At channel bends where bank protection was being designed, bend scour was also evaluated for the channels.

CMG evaluated drop scour over the north bank of the North Channel where offsite Brekke Road flow enters the channel between Sta 26+00 and 33+00, but because the contributing flow is dispersed over a long distance, the drop scour depth did not exceed the channel general scour, which governed the toe down depths along the bank within this reach. Since the existing culverts under the dragstrip at the upstream ends of both the North and Central Channels have limited capacity compared to 100-yr discharges, the majority of flows will enter the Fairgrounds channels as dragstrip overtopping flows. CMG also evaluated drop scour at the downstream toe of the dragstrip embankment at Sta. 66+39 in the North Channel and Sta. 63+21 in the Central Channel to determine the depth of toe walls needed to protect the embankment during overtopping floods.

Erosion protection in the form of at-grade riprap aprons were designed at the outlets of the three culverts within the project limits, i.e., 1) the existing single barrel 36” diameter Spiral Rib Pipe (SRP) culvert under the dragstrip at the North Channel, 2) the existing 6-barrel 36” diameter SRP culvert under the dragstrip at the Central Channel, and 3) the proposed 3-barrel 10’x4’ Reinforced Concrete Box Culvert (RCBC) under the north entrance road crossing of the North Channel. Additional riprap protection blankets have also been provided at proposed channel drops, channel expansion or contraction areas at access road crossings, and at channel bends in the North Channel.

Riprap erosion control blankets, grade control structures, bank protection limits and toe down depths are shown on Figures 2 and 3. Scour computations sheets can be found in Appendix C. Culvert outlet protection computations are included in Appendix E.

3.2.1 Impacts to Fairgrounds Outfall Sewer Along Harrison Road Alignment

The North Channel final interim design (prior to culverts being installed) includes a lowering of the Harrison Road profile at the existing North Channel at-grade crossing just south of the Brekke Road intersection. CMG's preliminary evaluation found that the lowering of Harrison Road by approximately 1 foot, and the associated lowering of the potential scour depth, may cause the scour zone to encroach into the 2-foot clear zone above the existing pipe that Pima County RWRD standards require. Our findings are summarized below:

- There are uncertainties as to how this channelization project and future upstream and downstream development will affect flow regimes in the area. There is also an historical propensity for head cut erosion to develop in downstream watercourses within the Lee Moore Wash study area. These factors, along with the equilibrium slope and scour analyses results for this project, indicate that it would be prudent to protect against long-term channel degradation at the sewer line crossing location. General channel scour at this location is not the critical condition to consider.
- Assuming the same equilibrium slope of 0.6% that we've used throughout the project, it would only take a distance of approximately 600 ft downstream to undergo channel degradation down to the computed equilibrium slope to develop a channel depth and associated drop scour depth immediately downstream of the roadway crossing that could encroach into the 2-ft clear zone above the sewer and equal or exceed the proposed 6-ft deep ford wall depth during a 100-yr flood. We assumed this plausible channel degradation condition to estimate potential scour in the computation sheet for channel Sta. 15+03 in Appendix C. In actuality, there is not currently a profile control structure in the downstream watercourse for many thousands of feet.
- And, as you can see in Figure 2, by referencing the existing channel thalweg profile downstream of Harrison Rd, even with the channel in somewhat stable conditions over the past 10-plus years, there has been local scour develop immediately downstream of the Harrison Rd crossing to a depth of 2+ ft. With the new channel modifications per this project and upstream flow concentration/re-distribution by the Houghton Rd improvements, this depth could very well increase.
- The 6-ft cutoff wall depth at the sewer does not extend completely down below the sewer line grade, nor below potential long-term degradation scour depth, but it is being

proposed to provide protection during the interim period until permanent SELC Harrison Rd improvements (culverts) are put into place.

- The risk mitigation that extending the asphalt pavement out over the sewer line provides, exceeds its relatively low cost.
- Based on these conclusions, CMG recommends the extension of the Harrison Rd ford crossing pavement and placement of a downstream 6-ft deep ford wall a minimum of 3-ft offset west from the west edge of the 15-inch Fairgrounds trunk line sanitary sewer. This cap and ford wall should extend along Harrison Rd throughout the limits of the dip section.
- In addition, the Pima County Regional Water Reclamation Department (PCRWRD) should be included in the plan development and review process to get their concurrence that this scour mitigation approach meets their requirements.

3.3 Equilibrium Slope Estimations

In addition to channel scour computations, equilibrium slope estimations were performed for the North and Central compound channels. An equilibrium slope, S_{eq} = 0.6% was estimated for both channels using Equation 6.26 from the SMDD. It is anticipated that the upstream watersheds, which are comprised mainly of rural undeveloped lands, will undergo a moderate (10% estimated) degree of urbanization and reduction in sediment supply during the projected design life of the channel improvements.

Equation 6.26 requires estimation of bottom widths of predevelopment natural channels in the project area as well as estimated 10-year peak discharges associated with those channel widths. Given that the floodplains in the Fairgrounds property area are comprised largely of small underfit braided channels and exhibit dispersed sheet flood characteristics, even for the 10-year flood; the project FLO-2D depth mapping was used to estimate 10-year “natural channel” bottom widths.

The equilibrium slope estimations are presented in more detail on computation sheets found in Appendix D.

3.4 Grade Control Spacing for Compound Channel Sections

Based on the 0.6% equilibrium slope for the compound channels, compared to the proposed channel slopes, Grade Control Structures (GCS) were designed starting at the channel daylight transition points near the downstream terminus of the North and Central channels as beginning downstream control points. In the North Channel, new GCSs were progressively placed upstream either at locations dictated by the changes in the channel geometry, or where the difference in the equilibrium slope and proposed channel slopes created drop heights that would produce drop scour depths that, when combined with the drop heights, would approach, but not exceed 6 feet. This approach was taken to avoid potential structural design requirements for the standard vertical wall GCSs. In the Central Channel, GCSs were placed at locations identified by the District. In the immediate areas downstream of the new GCSs, existing scour depths could be increased due to additional local scour associated with eventual channel drops that develop in long-term degradation conditions. In these locations, the drop scour depth caused by the GCS was compared to the general depth of scour computed by SMDD Eq. 6.3 and the greater depth was used to determine the required grade control depth, and if applicable, adjacent bank protection toe down depths.

Additional transverse cut-off walls were included in the design at the Harrison Road ford crossings for both the North and Central Channels, the N Entrance Road crossing in the North Channel, access road crossings in the Central Channel, and at the upstream channel limits just downstream of the Drag Strip in both channels.

The design process resulted in 10 grade control structures / transverse cut-off walls for the North Compound Channel at the locations shown in Table 4 below.

Table 4: North Channel GCS Design Summary

GCS Station	Proposed Channel Slope (%)	Drop Height (ft)	Drop/Gen Scour Depth (ft)	Total Scour/GCS Depth (ft)
+-15+03	0.20	2.3	3.2/2.5	5.5/6.0
15+65	0.20	NA	NA	NA/3.0
20+00	0.75	NA	NA	NA/3.0
31+00	0.75	1.7	3.9/2.5	5.6/6.0
40+75	0.75	1.5	4.0/2.9	5.5/6.0
41+55 to 42+84	N Entrance Rd Culvert Crossing with Fully Lined Channel, Drop Inlet at approximate Sta 42+84 & Energy Dissipator at Outlet			
42+84	0.78	NA	NA	NA/4.0
47+00	0.78	0.8	2.8/2.6	3.6/4.0
54+00	0.82	1.5	4.0/2.5	5.5/6.0
61+00	0.82	1.5	4.0/2.5	5.5/6.0
66+39	0.82	8.6	3.0/0.5	3.5/4.0

The design process resulted in 8 grade control structures / transverse cut-off walls for the Central Compound Channel at the locations shown in Table 5 below.

Table 5: Central Channel GCS Design Summary

GCS Station	Proposed Channel Slope (%)	Drop Height (ft)	Drop/Gen Scour Depth (ft)	Total Scour/GCS Depth (ft)
+-14+62	0.21	NA	NA	NA/6.0
+-15+04	0.21	NA	0.0/2.5	2.5/3.0
43+53 (low-flow channel only)	0.80	4.3	6.6/3.2	10.9/11.0
43+53 Rt OB Terrace	0.80	4.3	2.2/1.9	6.5/7.0
44+36	0.80	NA	0.0/3.1	3.1/4.0
44+83	0.80	NA	0.0/2.2	2.2/3.0
56+42	0.80	2.3	3.5/2.7	5.8/6.0
56+68	0.61	NA	0.0/2.5	2.5/3.0
63+21	0.61	6.2	3.2/0.7	3.9/4.0

These equilibrium slopes and GCS spacings are only estimates. After channel construction is complete, on at least an annual basis, the height of drops that develop downstream of the GCS should be examined. If drop heights develop that are in excess of the design drop heights contained in this analysis, flatter equilibrium slopes may be developing, and installation of additional GCSs should be considered.

To provide design recommendations that can be constructed within the designated construction budget, in earthen channel segments the proposed standard 1-foot-thick GCSs have been proposed to extend laterally no further than the top of the channel terrace bank on each side of the channel.

Summaries of the grade control spacing computations are provided in Appendix D, and the proposed GCS locations are shown on Figures 2 and 3.

3.5 North Entrance Road Combination Crossing Culvert

Per the plans, a culvert with an upstream drop inlet was analyzed at the North Entrance Road combination at-grade and culvert crossing on the North Channel. At the crossing it was found that a 3–cell 10’ x 4’ RCBC would fit beneath the proposed roadway profile and pass approximately 1546 cfs flow under the roadway with an additional 870 cfs overtopping the crossing in the 100-yr design flood. The 10-yr design discharge equals 1120 cfs, so this culvert crossing design should allow the crossing to remain flood free during floods up to and exceeding the 10-yr design storm.

The culvert analysis results are summarized in Table 6 below and hydraulic computation sheets for the proposed culvert are included in Appendix E.

Table 6: Proposed Cross Drainage Culverts

Number	Channel	Roadway	Proposed Structure	Design Flow (Q_{100}) (cfs)	Outlet Velocity (ft/s)	Design HW Elev.
1	North	N Entrance	3-10'X4' RCBC	2416 cfs	12.9	3045.8

SECTION 4.0 REFERENCES

1. Natural Resources Conservation Service, Hydrologic Soils Map, Soil Survey 669 – Eastern Pima County, 1999.

2. Pima County Department of Transportation and Flood Control District, *Drainage and Channel Design Standards for Local Drainage*, June 1984.

3. Pima County Regional Flood Control District, *Floodplain and Erosion Hazard Management Ordinance No. 2010-FC5*, May 2010.

4. City of Tucson, *Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona*, July 1998

5. United States Federal Highway Administration, *Hydraulic Design Series No. 5*, Hydraulic Design of Highway Culverts, 1985.

6. United States Federal Highway Administration, *Urban Drainage Design Manual*, Hydraulic Engineering Circular No. 22, November 1996.

7. United States Federal Highway Administration, *Hydraulic Design of Energy Dissipators for Culverts and Channels*, Hydraulic Engineering Circular No. 14, July 2006.

8. Pima County Regional Flood Control District, *Lee Moore Wash Basin Management Study-Summary Report*, September 2009.

9. Pima County Regional Flood Control District, Hydrologic and Hydraulic Analysis for *Lee Moore Wash -East: Upstream of South Houghton Road*, August 2018.

10. Pima County Regional Flood Control District, *Hydrologic and Hydraulic Analysis for South Houghton Road: Camino Aureila to Interstate-10 Master Plan*, September 2016.

FIGURES

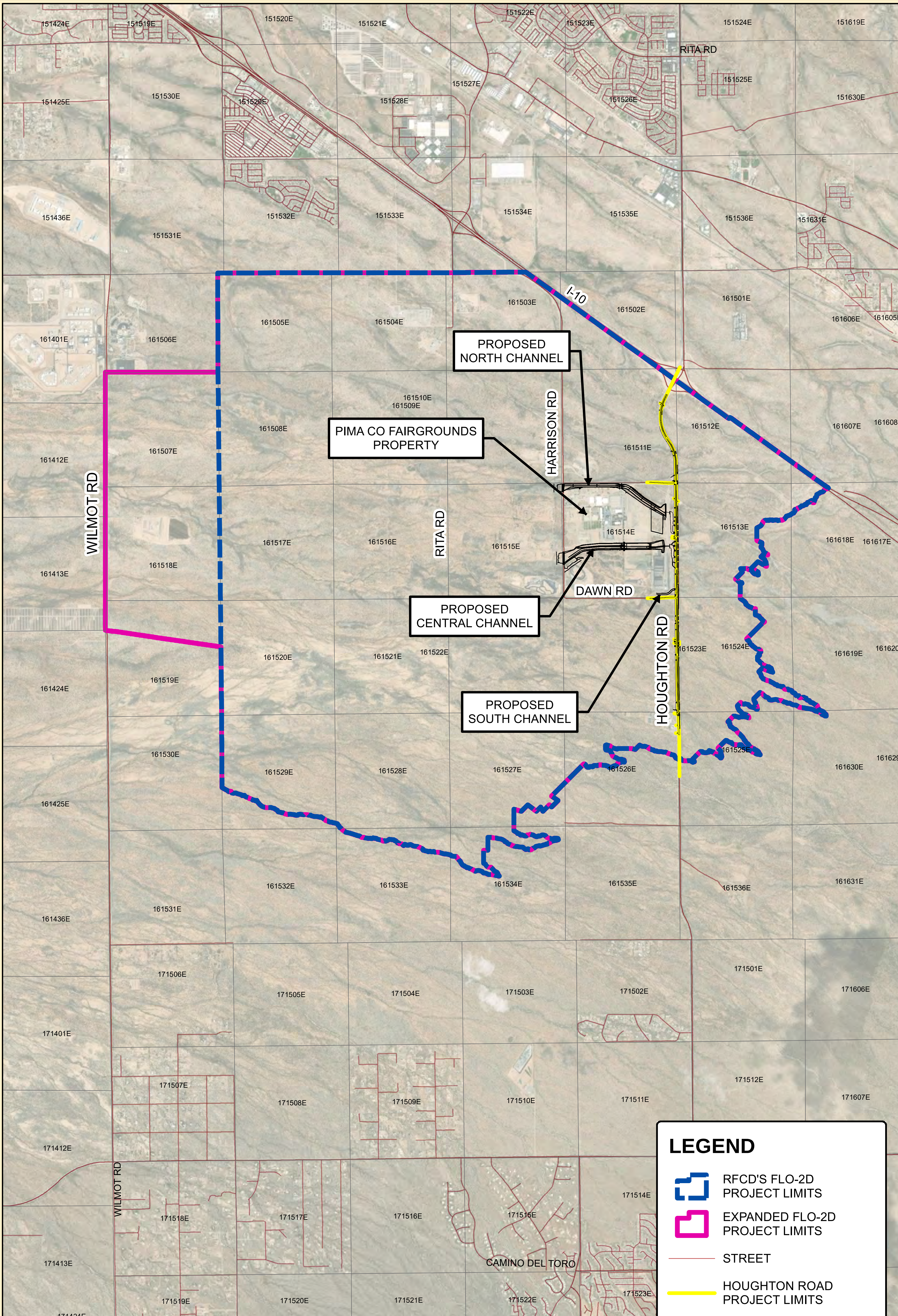

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FIGURE 1
LOCATION MAP AND EXPANDED FLO-2D LIMITS
NORTH, CENTRAL, AND SOUTH CHANNELS
PIMA COUNTY FAIRGROUND PROJECT

Project: 20-017.2

Date: 01/03/2023

1 INCH = 4,000 FEET

0 4,000 8,000 16,000 Feet

N

CMG DRAINAGE ENGINEERING, INC.

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APPENDIX A

FLO-2D EXHIBITS

Includes:

Exhibit 1a: Existing Conditions FLO-2D Flow Depth Map: 100-Year
Exhibit 1b: Existing Conditions FLO-2D Flow Depth Map: 10-Year

Exhibit 2a: Proposed Conditions FLO-2D, North & Central Channels, Flow Depth Map: 100-Year
Exhibit 2b: Proposed Conditions FLO-2D, North & Central Channels, Flow Depth Map: 10-Year

Exhibit 3a: Existing Conditions FLO-2D Velocity Map: 100-Year
Exhibit 3b: Existing Conditions FLO-2D Velocity Map: 10-Year

Exhibit 4a: Proposed Conditions FLO-2D, North & Central Channels, Velocity Map: 100-Year
Exhibit 4b: Proposed Conditions FLO-2D, North & Central Channels, Velocity Map: 10-Year

Exhibit 5a: Change in Flow Depth Map: 100-Year
Exhibit 5b: Change in Flow Depth Map: 10-Year

Exhibit 6a: Change in Flow Velocity Map: 100-Year
Exhibit 6b: Change in Flow Velocity Map: 10-Year

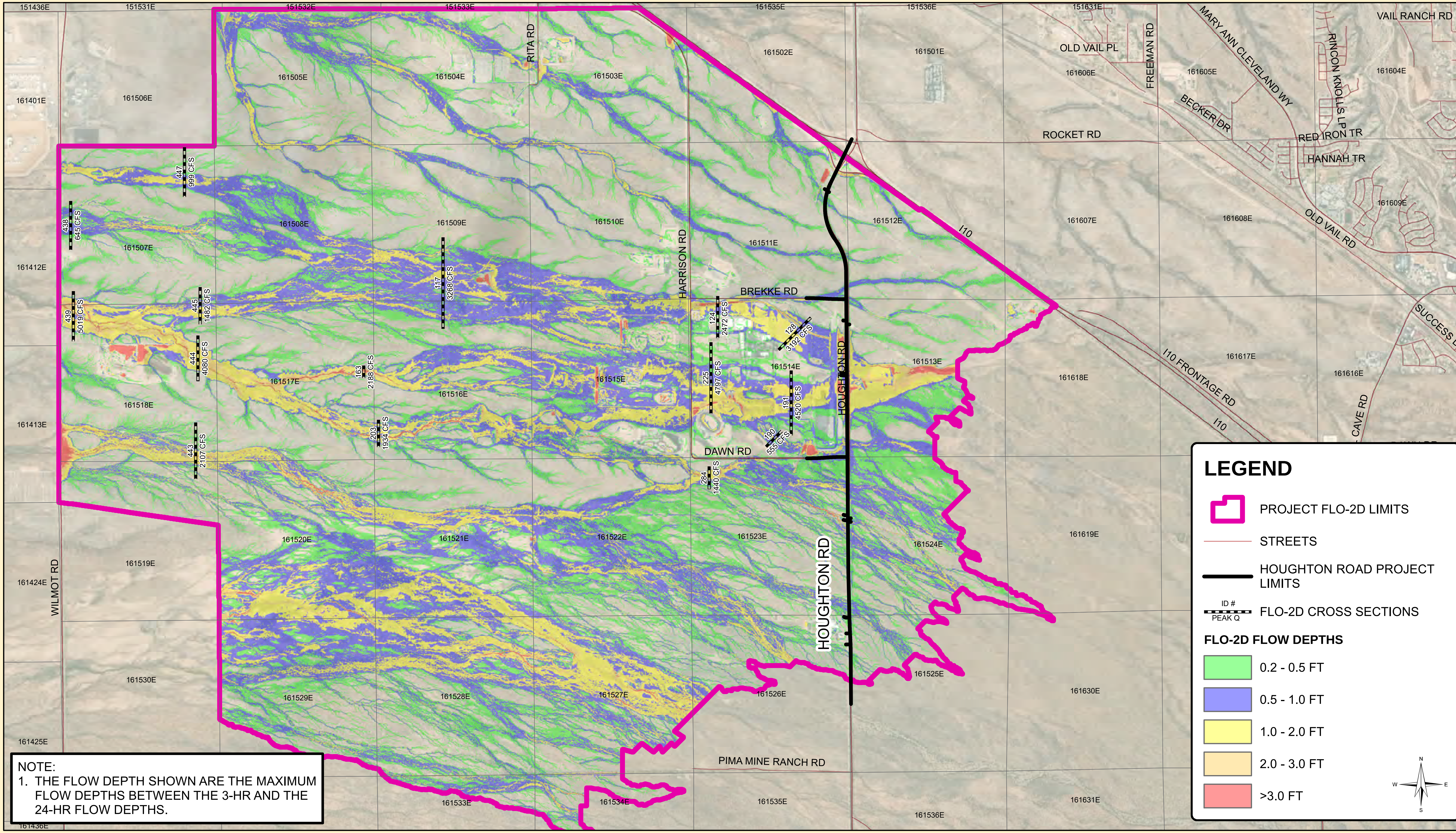

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EXHIBIT 1a

EXISTING CONDITIONS FLO-2D FLOW DEPTH MAP: 100-YEAR

PIMA COUNTY FAIRGROUND CHANNEL PROJECT

Project: 20-017.2

Date: 12/10/2021

1 INCH = 3,000 FEET

0 3,000 6,000 12,000 Feet

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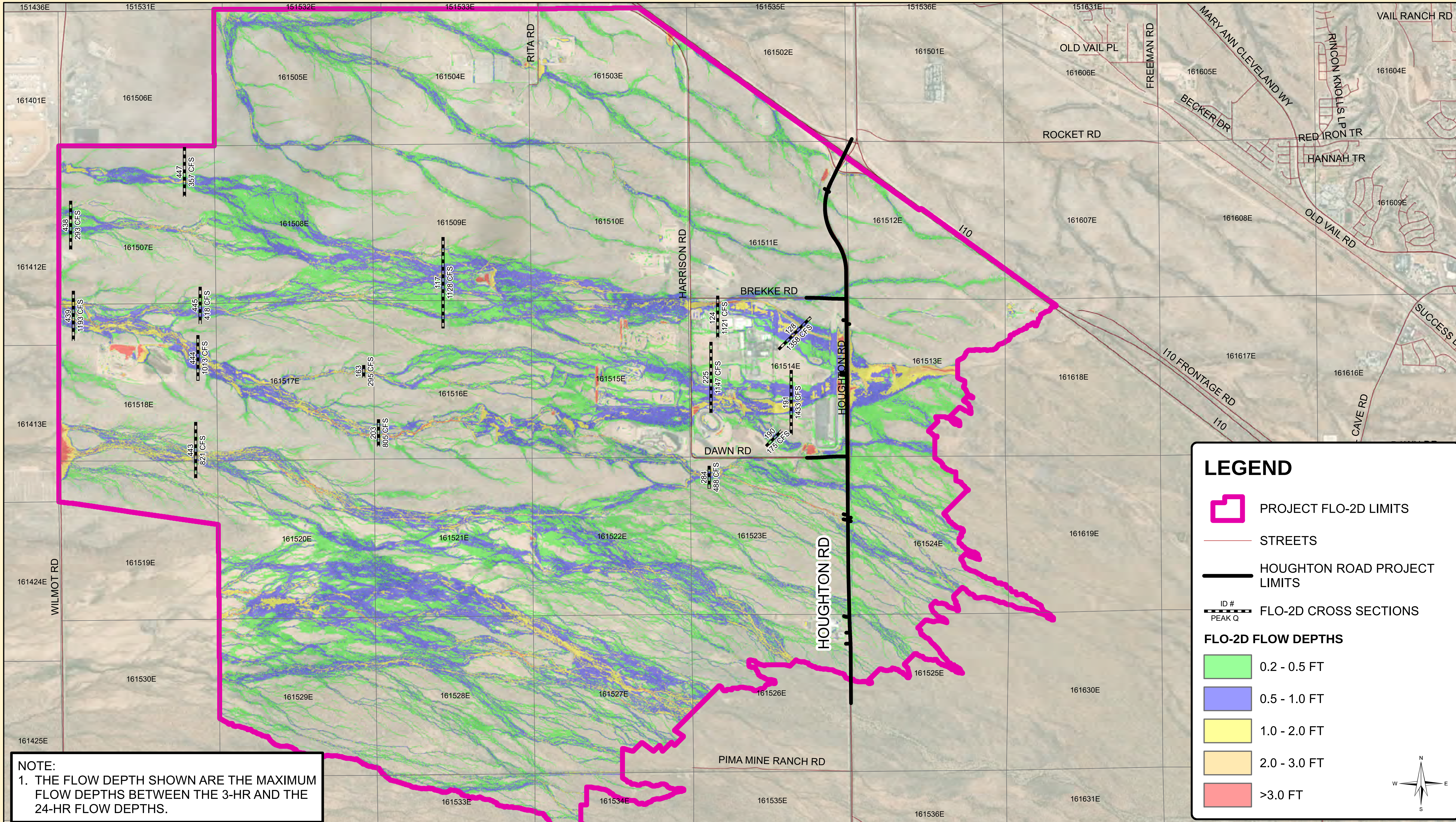

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EXHIBIT 1b

EXISTING CONDITIONS FLO-2D FLOW DEPTH MAP: 10-YEAR

PIMA COUNTY FAIRGROUND CHANNEL PROJECT

Project: 20-017.2

Date: 12/10/2021

1 INCH = 3,000 FEET

0 3,000 6,000 12,000 Feet

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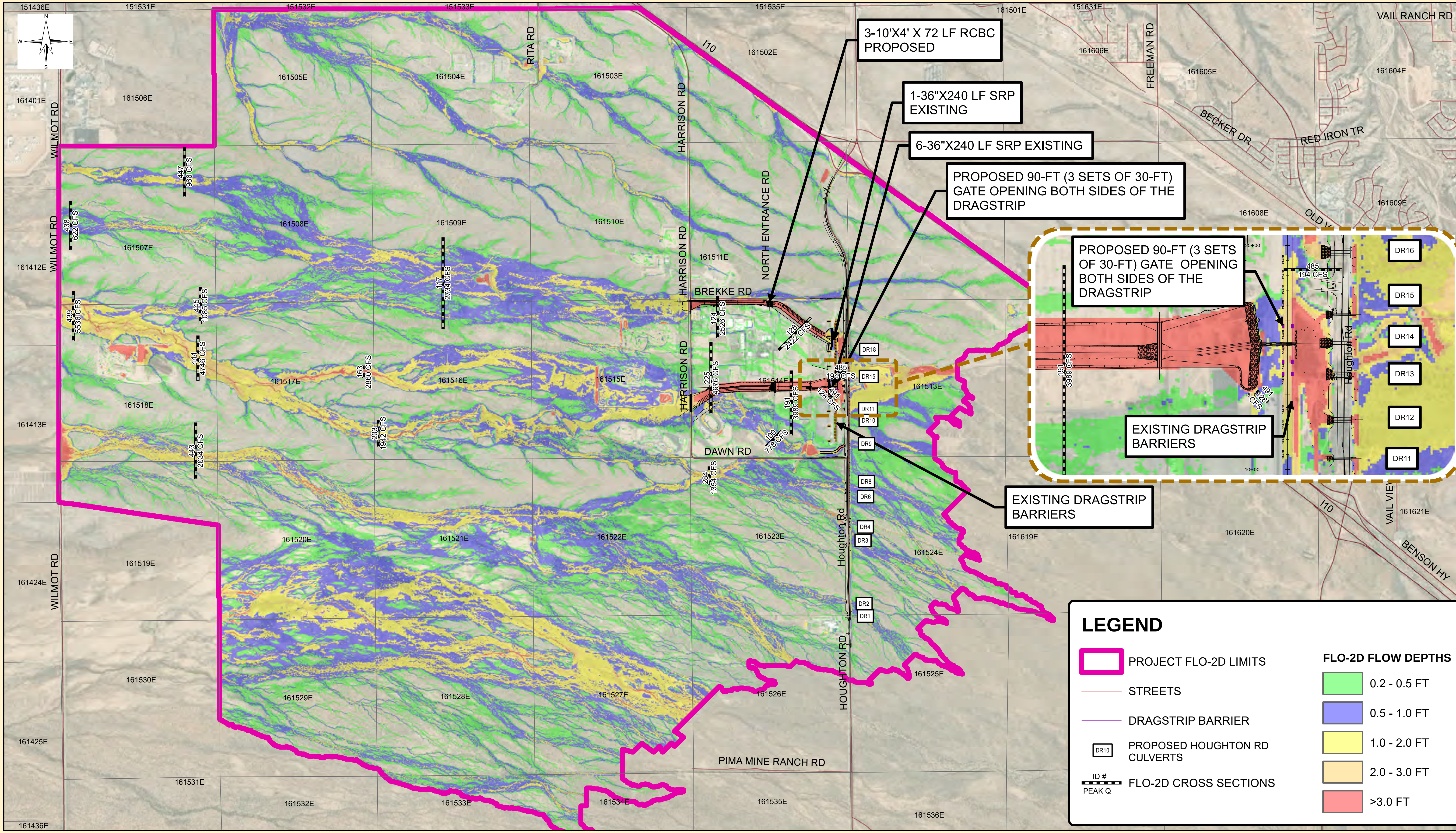

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EXHIBIT 2a
PROPOSED CONDITIONS FLO-2D, NORTH & CENTRAL CHANNELS, FLOW DEPTH MAP: 100-YEAR

PIMA COUNTY FAIRGROUND
CHANNEL PROJECT

Project: 20-017.2

Date: 08/11/2022

1 INCH = 3,000 FEET

0 3,000 6,000 12,000 Feet

CMG DRAINAGE ENGINEERING, INC.

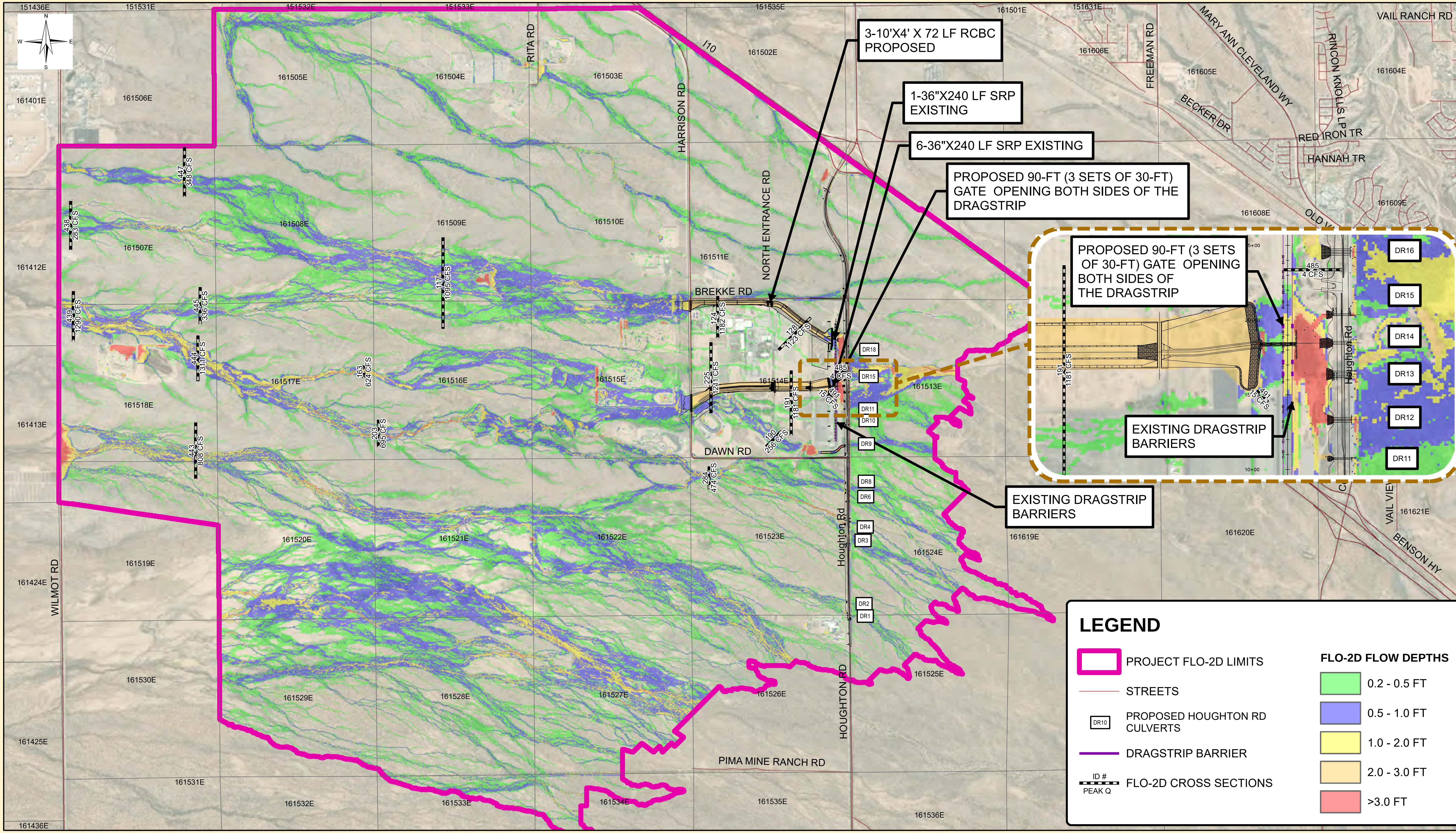

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EXHIBIT 2b

PROPOSED CONDITIONS FLO-2D, NORTH AND CENTRAL CHANNELS, FLOW DEPTH MAP: 10-YEAR

PIMA COUNTY FAIRGROUND CHANNEL PROJECT

Project: 20-017.2

Date: 08/11/2022

1 INCH = 3,000 FEET

0 3,000 6,000 12,000 Feet

CMG DRAINAGE ENGINEERING, INC.

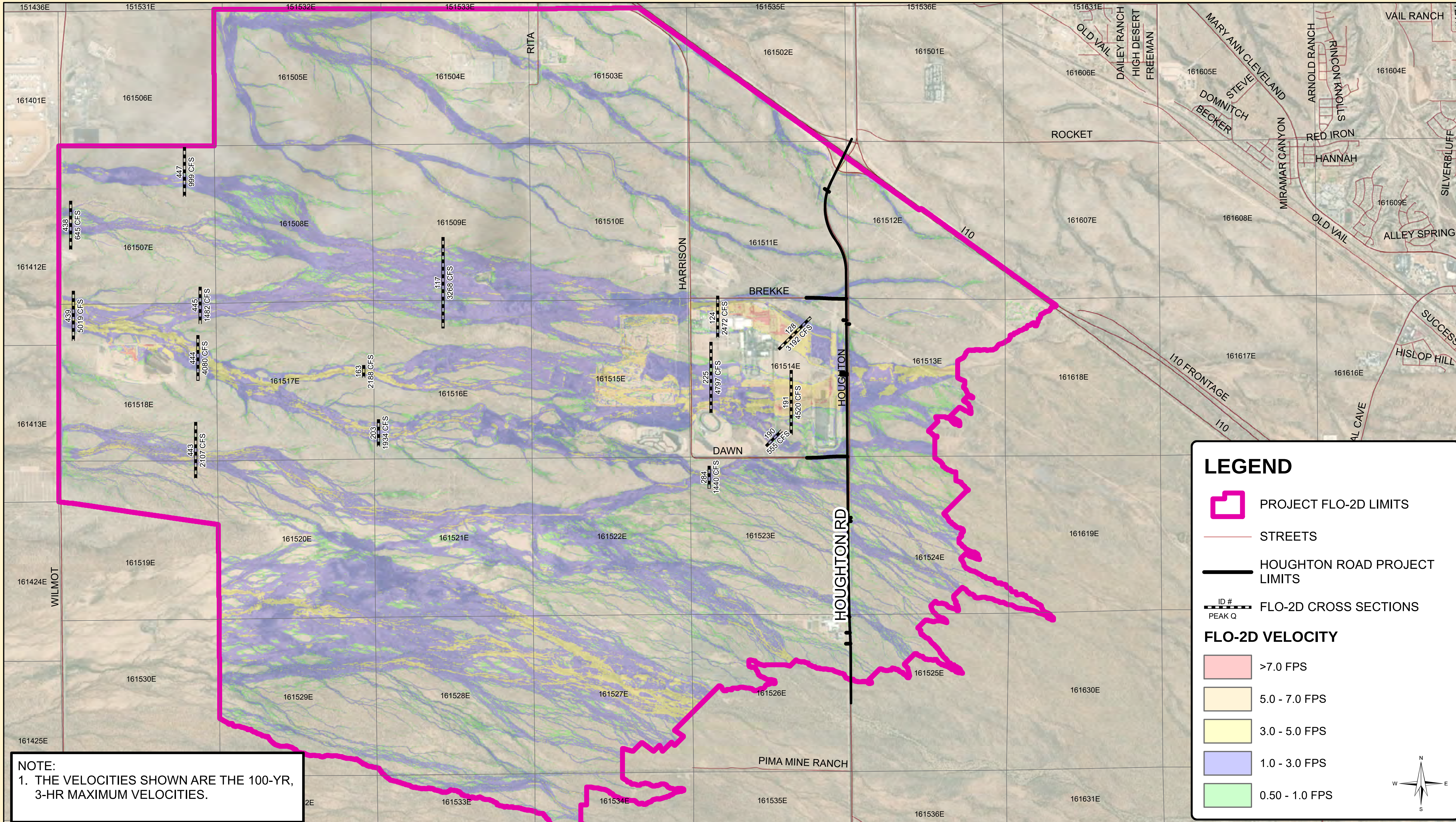

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EXHIBIT 3a
EXISTING CONDITIONS FLO-2D VELOCITY MAP: 100-YEAR

PIMA COUNTY FAIRGROUND CHANNEL PROJECT

Project: 20-017.2

Date: 12/10/2021

1 INCH = 3,000 FEET

0 3,000 6,000 12,000 Feet

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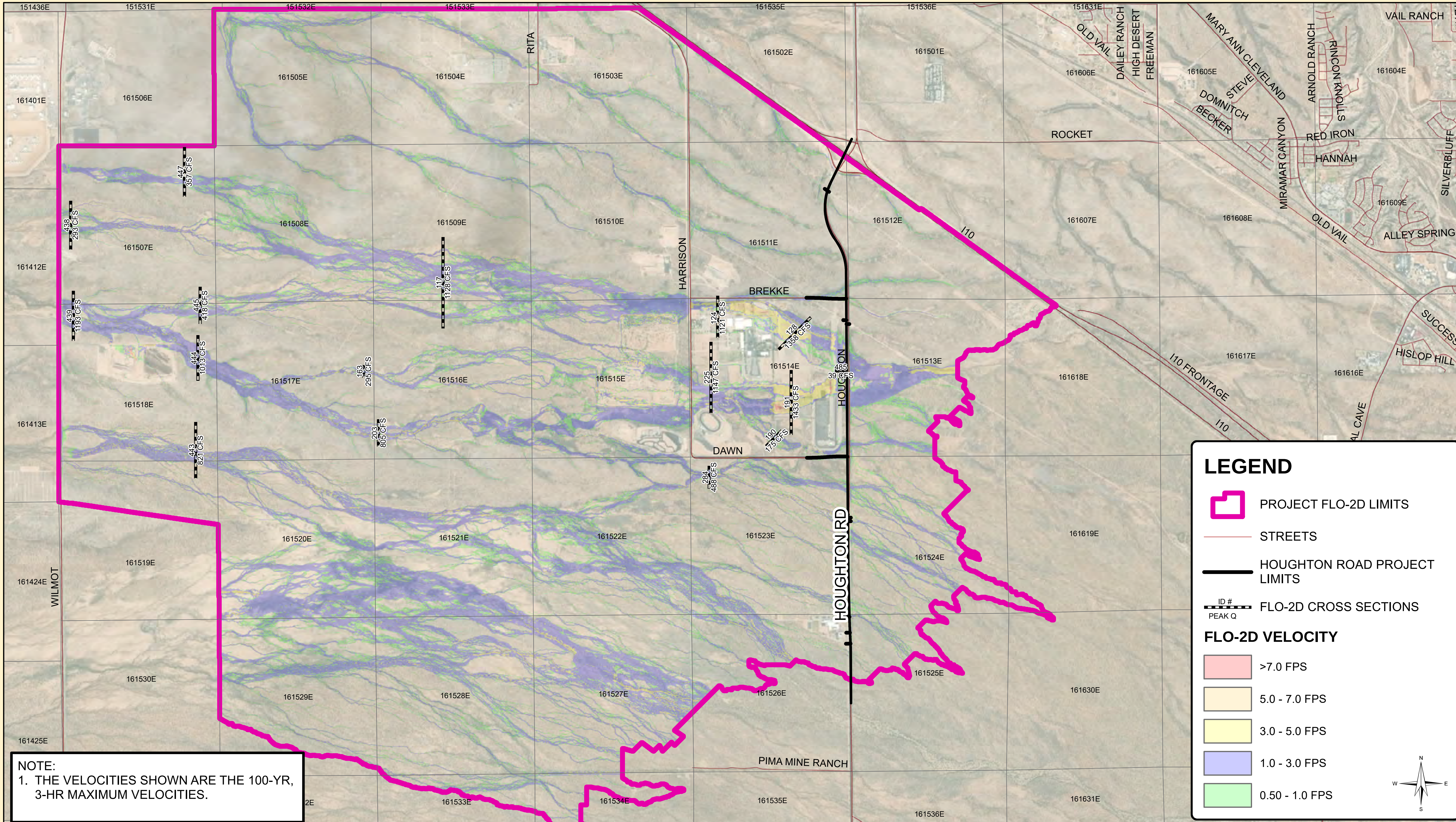

EXHIBIT 3b

EXISTING CONDITIONS FLO-2D VELOCITY MAP: 10-YEAR

PIMA COUNTY FAIRGROUND CHANNEL PROJECT

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Project: 20-017.2

Date: 12/10/2021

CMG DRAINAGE ENGINEERING, INC.

1 INCH = 3,000 FEET

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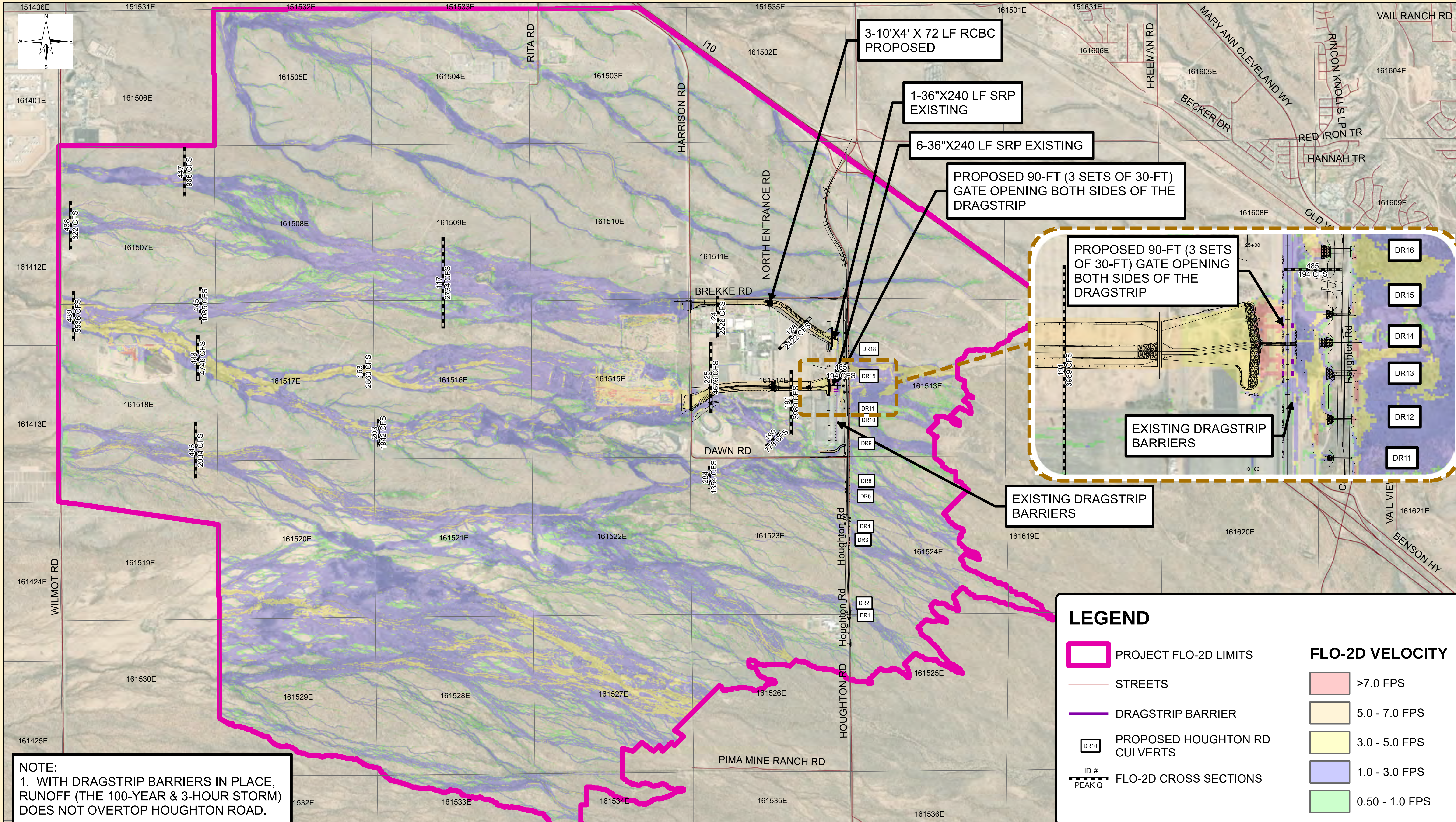

EXHIBIT 4a

PROPOSED CONDITIONS FLO-2D, NORTH AND CENTRAL CHANNELS, VELOCITY MAP: 100-YEAR

PIMA COUNTY FAIRGROUND
CHANNEL PROJECT

Project: 20-017.2

Date: 08/11/2022

1 INCH = 3,000 FEET

0 3,000 6,000 12,000 Feet

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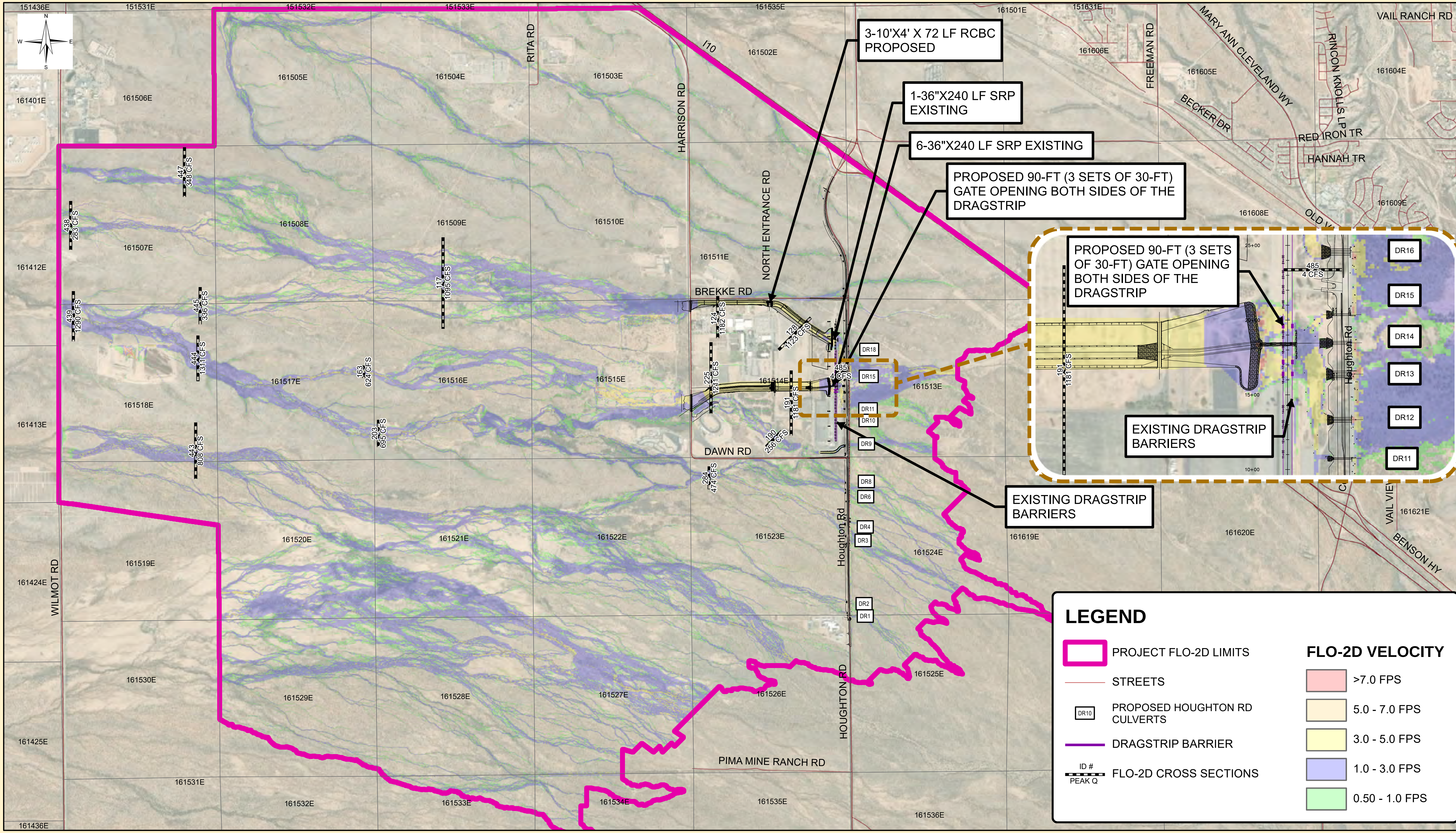

EXHIBIT 4b

PROPOSED CONDITIONS FLO-2D, NORTH AND CENTRAL CHANNELS, VELOCITY MAP: 10-YEAR

PIMA COUNTY FAIRGROUND CHANNEL PROJECT

Project: 20-017.2

Date: 08/11/2022

1 INCH = 3,000 FEET

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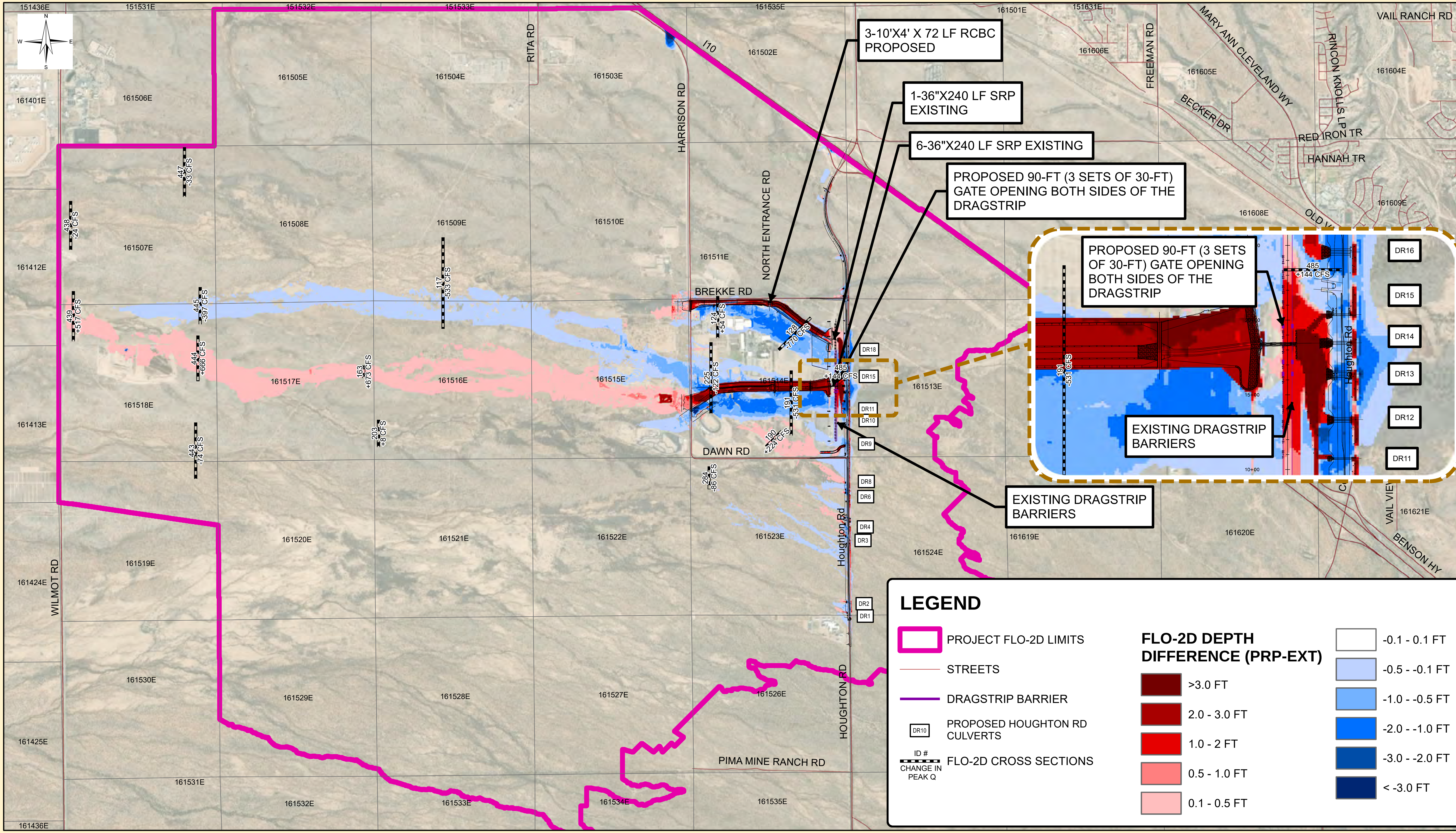

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EXHIBIT 5a
CHANGE IN FLOW DEPTH MAP: 100-YEAR

PIMA COUNTY FAIRGROUND CHANNEL PROJECT

Project: 20-017.2

Date: 08/11/2022

1 INCH = 3,000 FEET

0 3,000 6,000 12,000 Feet

CMG DRAINAGE ENGINEERING, INC.

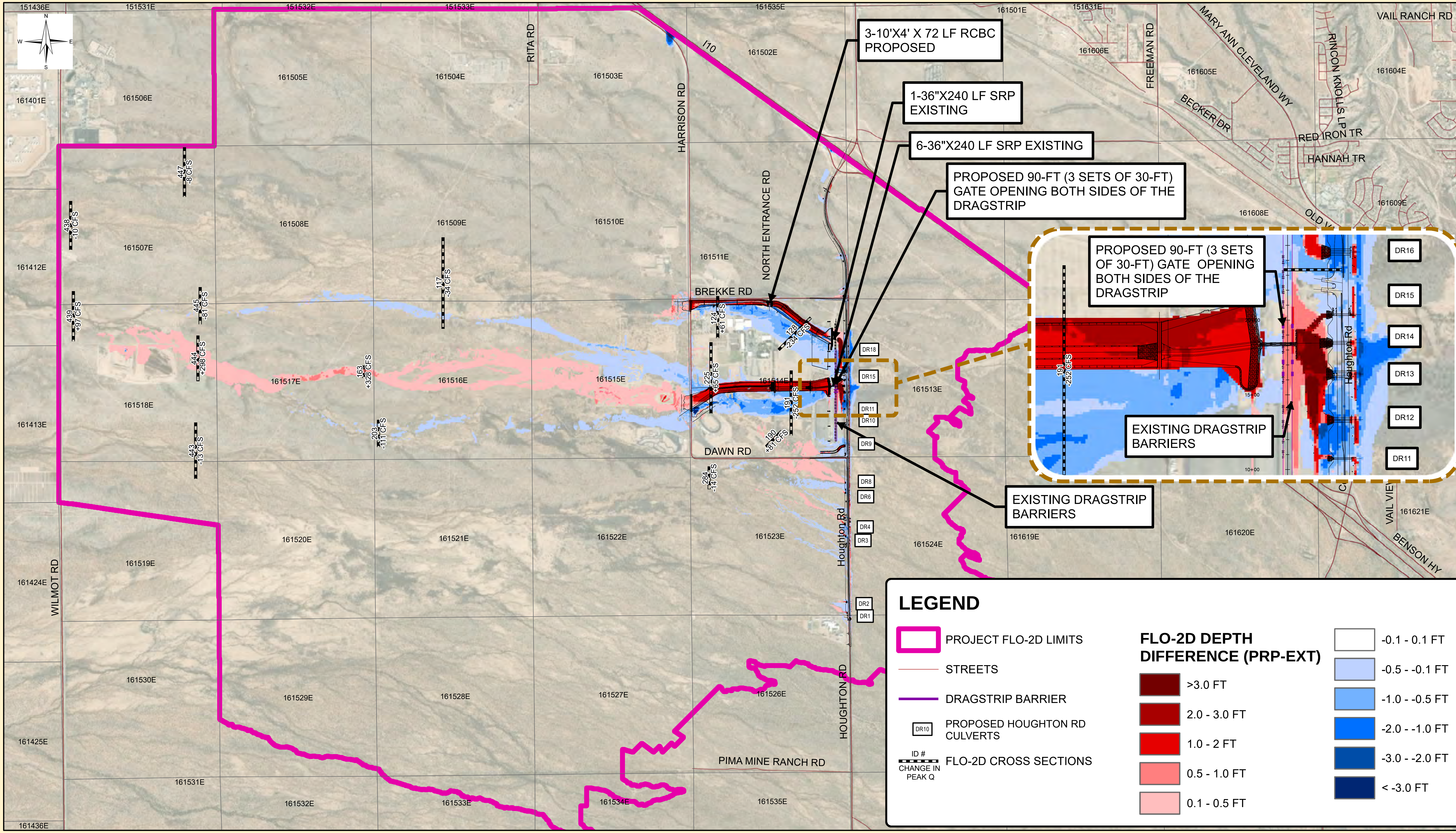

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EXHIBIT 5b
CHANGE IN FLOW DEPTH MAP: 10-YEAR

PIMA COUNTY FAIRGROUND CHANNEL PROJECT

Project: 20-017.2

Date: 08/11/2022

1 INCH = 3,000 FEET

0 3,000 6,000 12,000 Feet

CMG DRAINAGE ENGINEERING, INC.

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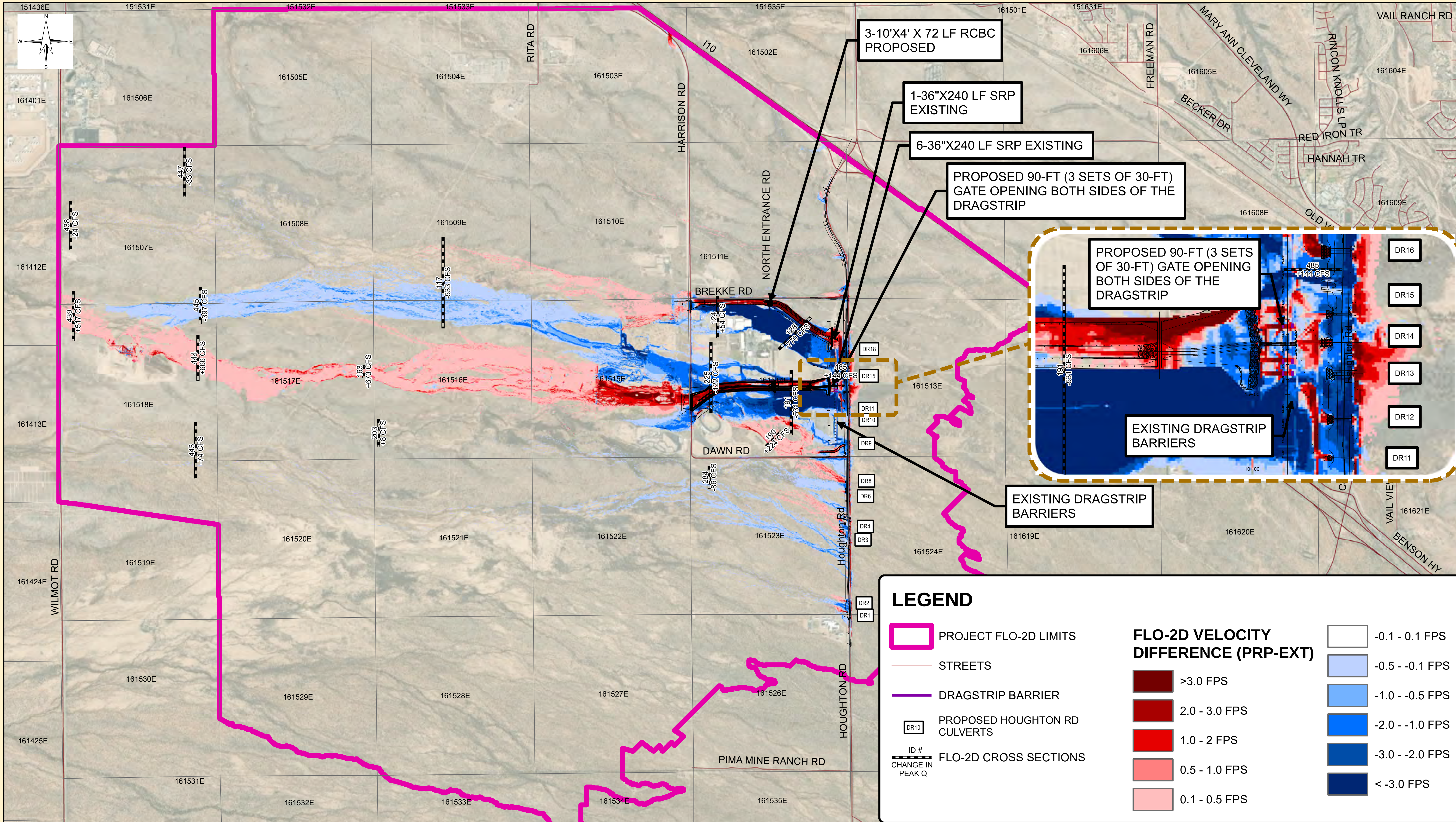

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EXHIBIT 6a
CHANGE IN FLOW VELOCITY MAP: 100-YEAR

PIMA COUNTY FAIRGROUND CHANNEL PROJECT

Project: 20-017.2

Date: 08/11/2022

1 INCH = 3,000 FEET

0 3,000 6,000 12,000 Feet

CMG DRAINAGE ENGINEERING, INC.

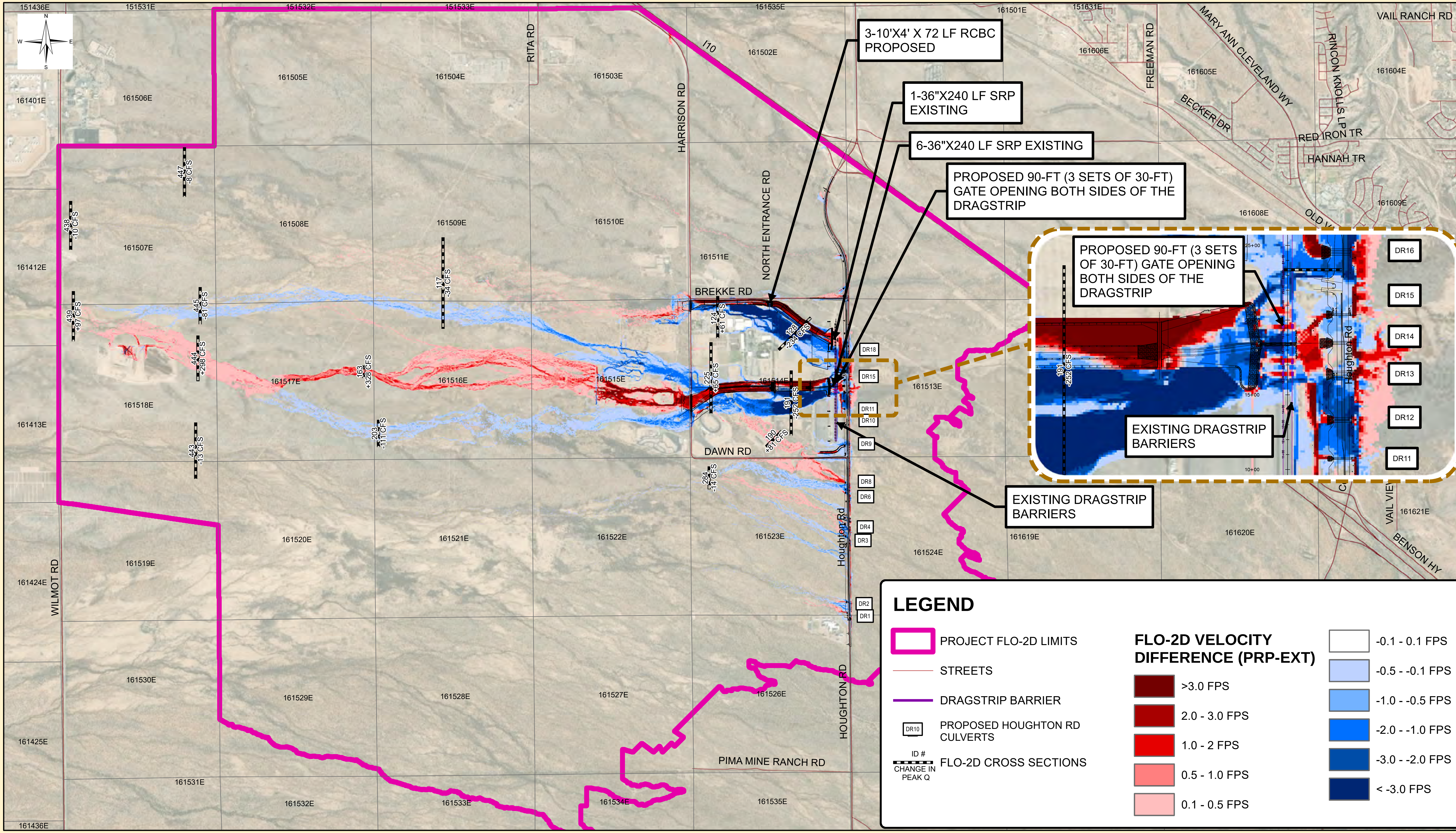

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EXHIBIT 6b
CHANGE IN FLOW VELOCITY MAP: 10-YEAR

PIMA COUNTY FAIRGROUND CHANNEL PROJECT

Project: 20-017.2

Date: 08/11/2022

1 INCH = 3,000 FEET

0 3,000 6,000 12,000 Feet

CMG DRAINAGE ENGINEERING, INC.

APPENDIX B

PROPOSED CHANNEL HYDRAULIC COMPUTATIONS

CMG DRAINAGE ENGINEERING, INC.

NORTH CHANNEL

CMG DRAINAGE ENGINEERING, INC.

FG Channels-N Channel Subcritical Run
2022.09.13

HEC-RAS Plan: NChnl90%v2 River: River 1 Reach: Reach 1

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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	6500	100yr 90' gate	2416.00	3061.30	3064.85		3065.08	0.002992	4.08	645.84	254.26	0.43
Reach 1	6500	10yr 90' gate	1120.00	3061.30	3063.80		3063.94	0.003156	3.19	385.95	239.02	0.41
Reach 1	6300	100yr 90' gate	2416.00	3060.12	3063.32	3063.17	3064.12	0.007846	8.27	391.12	190.00	0.84
Reach 1	6300	10yr 90' gate	1120.00	3060.12	3062.41	3062.37	3062.97	0.007908	6.54	224.13	178.78	0.80
Reach 1	6100	100yr 90' gate	2416.00	3058.48	3061.72	3061.54	3062.49	0.008332	8.11	393.34	186.71	0.82
Reach 1	6100	10yr 90' gate	1120.00	3058.48	3060.81	3060.73	3061.34	0.008302	6.39	228.14	177.59	0.77
Reach 1	5900	100yr 90' gate	2416.00	3056.84	3060.09		3060.84	0.008107	8.02	397.16	186.99	0.81
Reach 1	5900	10yr 90' gate	1120.00	3056.84	3059.17	3059.09	3059.69	0.008166	6.34	229.79	177.83	0.77
Reach 1	5700	100yr 90' gate	2416.00	3055.20	3058.43		3059.20	0.008304	8.09	393.76	186.71	0.82
Reach 1	5700	10yr 90' gate	1120.00	3055.20	3057.53	3057.45	3058.05	0.008116	6.33	230.19	177.74	0.76
Reach 1	5500	100yr 90' gate	2416.00	3053.56	3056.83		3057.56	0.007914	7.93	402.04	188.91	0.80
Reach 1	5500	10yr 90' gate	1120.00	3053.56	3055.90		3056.41	0.008185	6.33	230.50	179.63	0.77
Reach 1	5400	100yr 90' gate	2416.00	3052.74	3055.96		3056.74	0.008480	8.14	391.00	186.59	0.83
Reach 1	5400	10yr 90' gate	1120.00	3052.74	3055.07		3055.59	0.008188	6.35	229.49	177.90	0.77
Reach 1	5200	100yr 90' gate	2416.00	3051.10	3054.38		3055.11	0.007665	7.87	404.77	187.40	0.79
Reach 1	5200	10yr 90' gate	1120.00	3051.10	3053.42	3053.35	3053.94	0.008255	6.37	228.73	177.69	0.77
Reach 1	5000	100yr 90' gate	2416.00	3049.46	3052.73	3052.55	3053.51	0.008301	8.13	392.24	186.52	0.82
Reach 1	5000	10yr 90' gate	1120.00	3049.46	3051.86	3051.74	3052.36	0.007545	6.21	234.51	177.88	0.74
Reach 1	4800	100yr 90' gate	2416.00	3047.82	3051.15	3050.91	3051.88	0.007843	7.88	400.10	180.39	0.79
Reach 1	4800	10yr 90' gate	1120.00	3047.82	3050.17	3050.12	3050.72	0.008914	6.51	223.85	179.69	0.79
Reach 1	4700	100yr 90' gate	2416.00	3047.00	3049.98	3049.98	3050.94	0.010644	8.55	344.52	173.10	0.91
Reach 1	4700	10yr 90' gate	1120.00	3047.00	3049.11	3049.11	3049.75	0.010273	6.64	196.61	167.15	0.84
Reach 1	4600	100yr 90' gate	2416.00	3046.00	3049.24	3048.99	3050.02	0.006518	7.68	388.44	172.64	0.76
Reach 1	4600	10yr 90' gate	1120.00	3046.00	3048.20	3048.05	3048.75	0.006980	6.15	211.60	166.33	0.74
Reach 1	4500	100yr 90' gate	2416.00	3045.36	3048.34	3048.27	3049.26	0.008576	8.37	356.90	171.80	0.87
Reach 1	4500	10yr 90' gate	1120.00	3045.36	3047.53	3047.38	3048.06	0.006782	6.05	220.00	167.05	0.73
Reach 1	4344	100yr 90' gate	2416.00	3044.14	3047.47		3048.13	0.005433	7.16	416.61	173.96	0.70

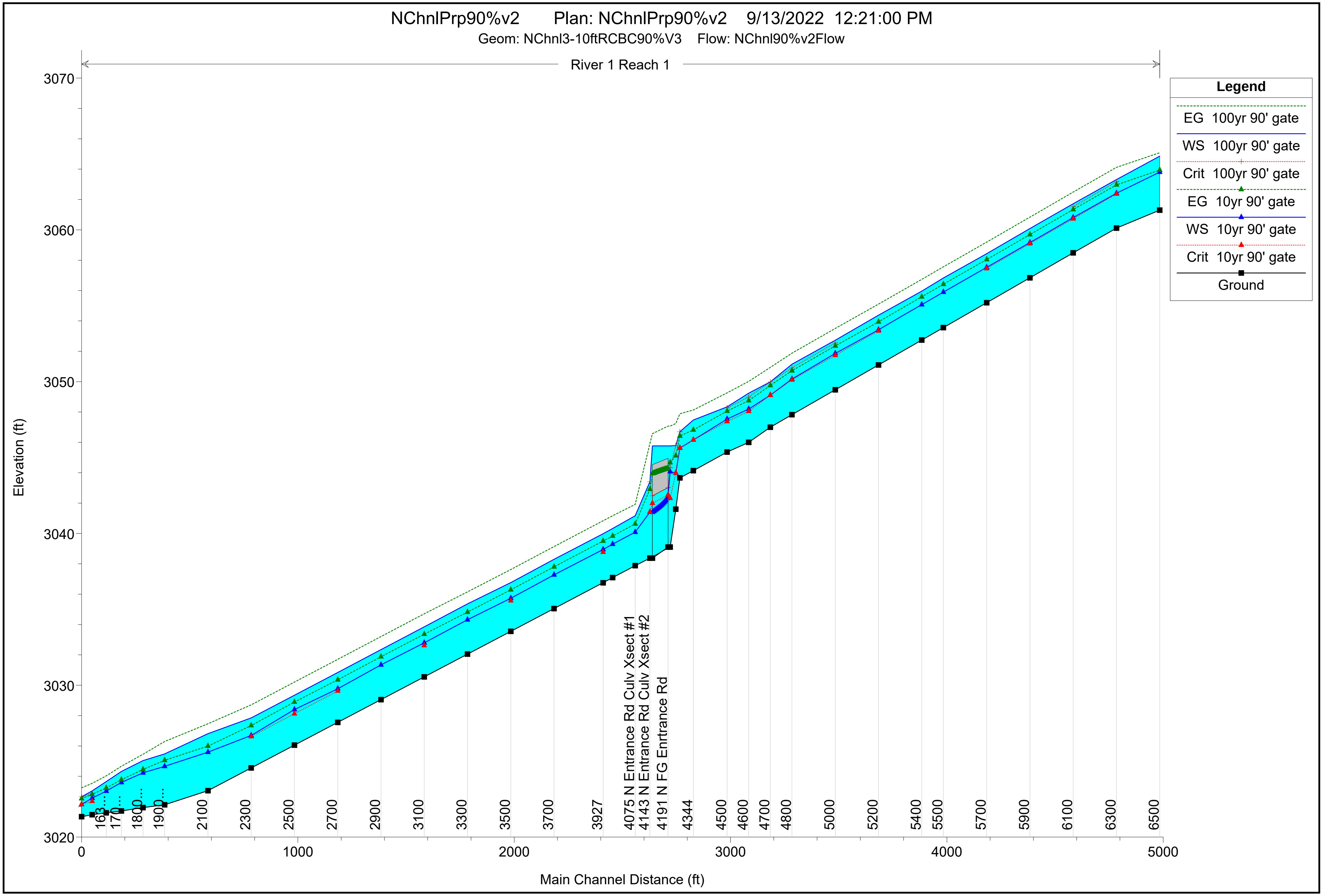
HEC-RAS Plan: NChnl90%v2 River: River 1 Reach: Reach 1 (Continued)

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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	4344	10yr 90' gate	1120.00	3044.14	3046.16	3046.16	3046.82	0.009133	6.69	193.94	166.09	0.84
Reach 1	4282	100yr 90' gate	2416.00	3043.66	3046.70	3046.70	3047.89	0.002066	9.16	362.39	172.17	0.94
Reach 1	4282	10yr 90' gate	1120.00	3043.66	3045.63	3045.63	3046.42	0.002255	7.20	181.01	165.62	0.91
Reach 1	4263	100yr 90' gate	2416.00	3041.60	3045.79	3045.79	3047.24	0.001694	9.80	305.01	165.87	0.88
Reach 1	4263	10yr 90' gate	1120.00	3041.60	3043.98	3043.98	3045.12	0.002617	8.56	130.91	58.01	1.00
Reach 1	4237	100yr 90' gate	2416.00	3039.10	3045.77	3044.34	3047.07	0.001032	9.32	343.32	164.28	0.70
Reach 1	4237	10yr 90' gate	1120.00	3039.10	3044.07	3042.32	3044.68	0.000536	6.22	180.19	42.14	0.50
Reach 1	4191		Culvert									
Reach 1	4143	100yr 90' gate	2416.00	3038.38	3043.41	3043.41	3045.93	0.017384	12.72	189.87	172.59	1.00
Reach 1	4143	10yr 90' gate	1120.00	3038.38	3041.41	3041.41	3042.91	0.020643	9.85	113.70	167.04	1.00
Reach 1	4075	100yr 90' gate	2416.00	3037.88	3041.17		3041.92	0.006837	7.62	385.76	159.91	0.76
Reach 1	4075	10yr 90' gate	1120.00	3037.88	3040.09		3040.63	0.007777	6.21	214.94	155.57	0.76
Reach 1	3971	100yr 90' gate	2416.00	3037.09	3040.32		3041.17	0.007457	7.91	361.16	149.39	0.79
Reach 1	3971	10yr 90' gate	1120.00	3037.09	3039.29		3039.83	0.007492	6.13	210.07	143.19	0.75
Reach 1	3927	100yr 90' gate	2416.00	3036.75	3039.98		3040.83	0.007551	7.95	358.82	149.36	0.80
Reach 1	3927	10yr 90' gate	1120.00	3036.75	3038.95	3038.77	3039.50	0.007654	6.17	207.57	143.15	0.76
Reach 1	3700	100yr 90' gate	2416.00	3035.05	3038.30		3039.13	0.007385	7.90	362.14	149.43	0.79
Reach 1	3700	10yr 90' gate	1120.00	3035.05	3037.27		3037.80	0.007245	6.07	212.40	143.33	0.74
Reach 1	3500	100yr 90' gate	2416.00	3033.55	3036.76		3037.62	0.007712	7.99	356.91	149.26	0.81
Reach 1	3500	10yr 90' gate	1120.00	3033.55	3035.73	3035.57	3036.29	0.007883	6.22	206.19	143.10	0.77
Reach 1	3300	100yr 90' gate	2416.00	3032.05	3035.36		3036.15	0.006857	7.69	371.43	149.86	0.76
Reach 1	3300	10yr 90' gate	1120.00	3032.05	3034.31		3034.81	0.006760	5.92	218.12	143.61	0.71
Reach 1	3100	100yr 90' gate	2508.00	3030.55	3033.85		3034.71	0.007495	8.02	369.67	149.76	0.80
Reach 1	3100	10yr 90' gate	1180.00	3030.55	3032.80	3032.63	3033.37	0.007695	6.29	216.06	143.47	0.76
Reach 1	2900	100yr 90' gate	2508.00	3029.05	3032.35		3033.21	0.007497	8.03	369.64	149.81	0.80
Reach 1	2900	10yr 90' gate	1180.00	3029.05	3031.34		3031.88	0.007106	6.13	222.41	143.78	0.73

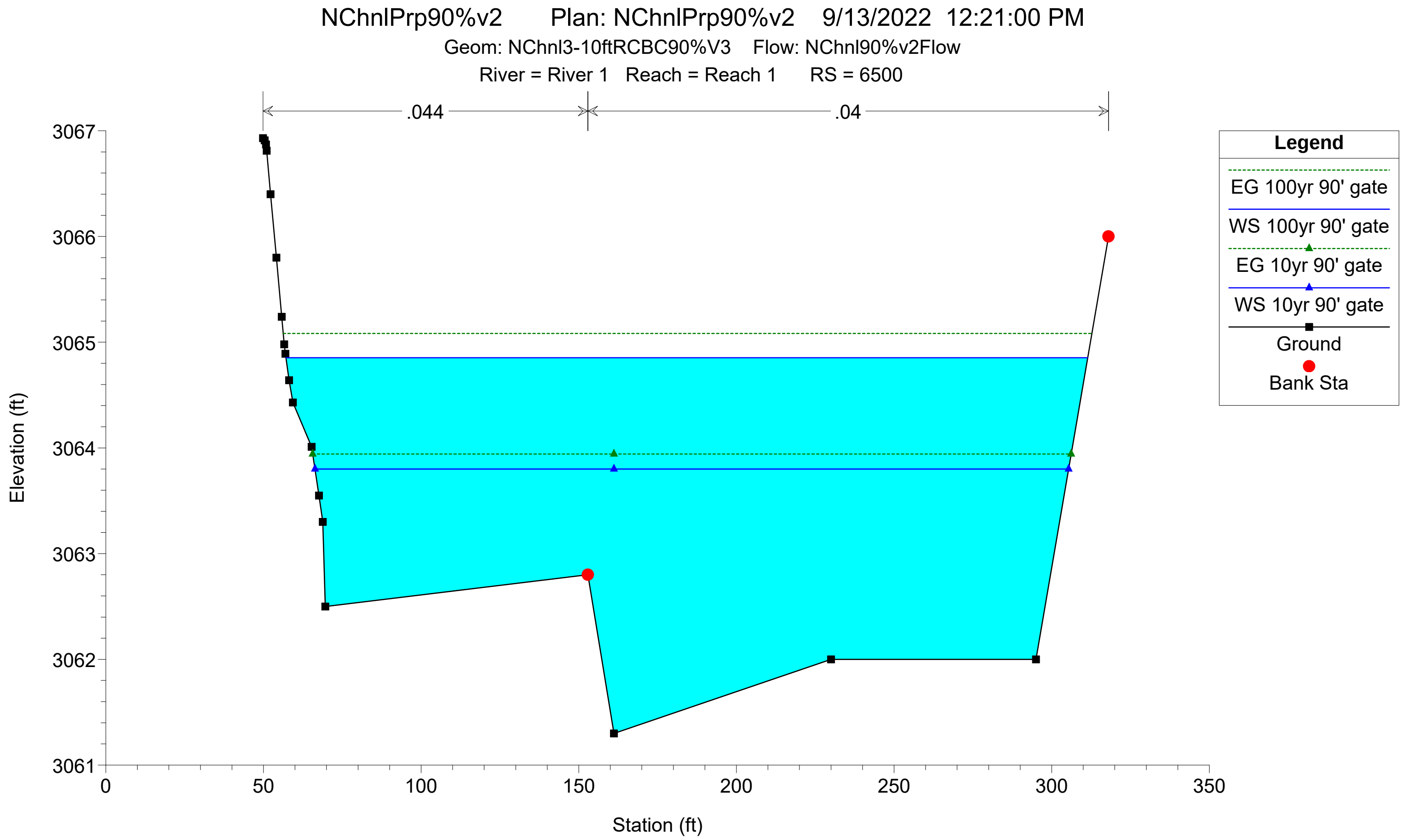
HEC-RAS Plan: NChnl90%v2 River: River 1 Reach: Reach 1 (Continued)

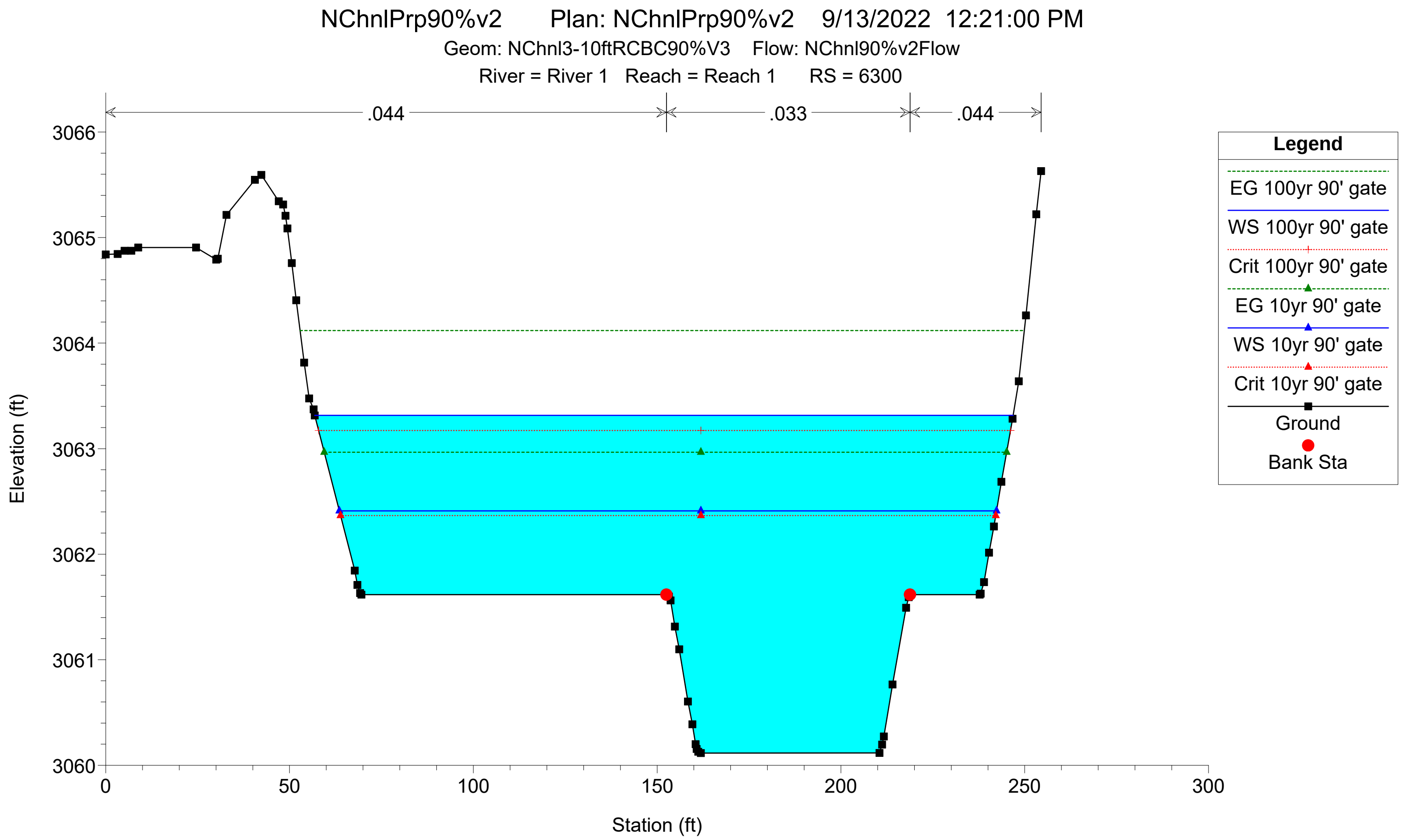
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	2700	100yr 90' gate	2508.00	3027.55	3030.84		3031.71	0.007505	8.04	369.52	149.77	0.80
Reach 1	2700	10yr 90' gate	1180.00	3027.55	3029.77	3029.63	3030.36	0.008078	6.41	212.17	143.29	0.78
Reach 1	2500	100yr 90' gate	2508.00	3026.05	3029.34		3030.20	0.007523	8.02	369.28	149.78	0.80
Reach 1	2500	10yr 90' gate	1180.00	3026.05	3028.40	3028.12	3028.90	0.006424	5.91	231.04	144.14	0.70
Reach 1	2300	100yr 90' gate	2508.00	3024.55	3027.85		3028.71	0.007437	7.99	370.76	149.77	0.79
Reach 1	2300	10yr 90' gate	1180.00	3024.55	3026.69	3026.62	3027.34	0.009382	6.71	201.11	142.85	0.83
Reach 1	2100	100yr 90' gate	2508.00	3023.05	3026.81		3027.46	0.004825	7.02	451.86	197.40	0.65
Reach 1	2100	10yr 90' gate	1180.00	3023.05	3025.60		3025.99	0.004630	5.31	259.70	145.29	0.60
Reach 1	1900	100yr 90' gate	2508.00	3022.13	3025.48		3026.30	0.006943	7.82	379.42	150.11	0.77
Reach 1	1900	10yr 90' gate	1180.00	3022.13	3024.66		3025.05	0.004709	5.34	257.93	145.11	0.61
Reach 1	1800	100yr 90' gate	2508.00	3021.94	3025.04		3025.45	0.007555	5.21	494.39	237.45	0.60
Reach 1	1800	10yr 90' gate	1180.00	3021.94	3024.23		3024.45	0.006573	3.75	314.60	195.07	0.52
Reach 1	1700	100yr 90' gate	2508.00	3021.72	3024.32		3024.66	0.007816	4.71	532.30	267.64	0.59
Reach 1	1700	10yr 90' gate	1180.00	3021.72	3023.60		3023.78	0.006606	3.41	346.18	249.35	0.51
Reach 1	1630	100yr 90' gate	2508.00	3021.59	3023.65		3024.03	0.010252	4.95	506.43	290.05	0.66
Reach 1	1630	10yr 90' gate	1180.00	3021.59	3023.03		3023.23	0.009333	3.60	327.88	282.60	0.59
Reach 1	1565	100yr 90' gate	2508.00	3021.47	3023.04	3022.87	3023.53	0.005742	5.64	444.58	316.88	0.84
Reach 1	1565	10yr 90' gate	1180.00	3021.47	3022.57	3022.36	3022.81	0.004635	3.97	296.96	305.04	0.71
Reach 1	1516	100yr 90' gate	2508.00	3021.34	3022.66	3022.66	3023.25	0.005614	6.17	406.79	348.96	1.01
Reach 1	1516	10yr 90' gate	1180.00	3021.34	3022.15	3022.15	3022.53	0.006470	4.93	239.19	318.87	1.00

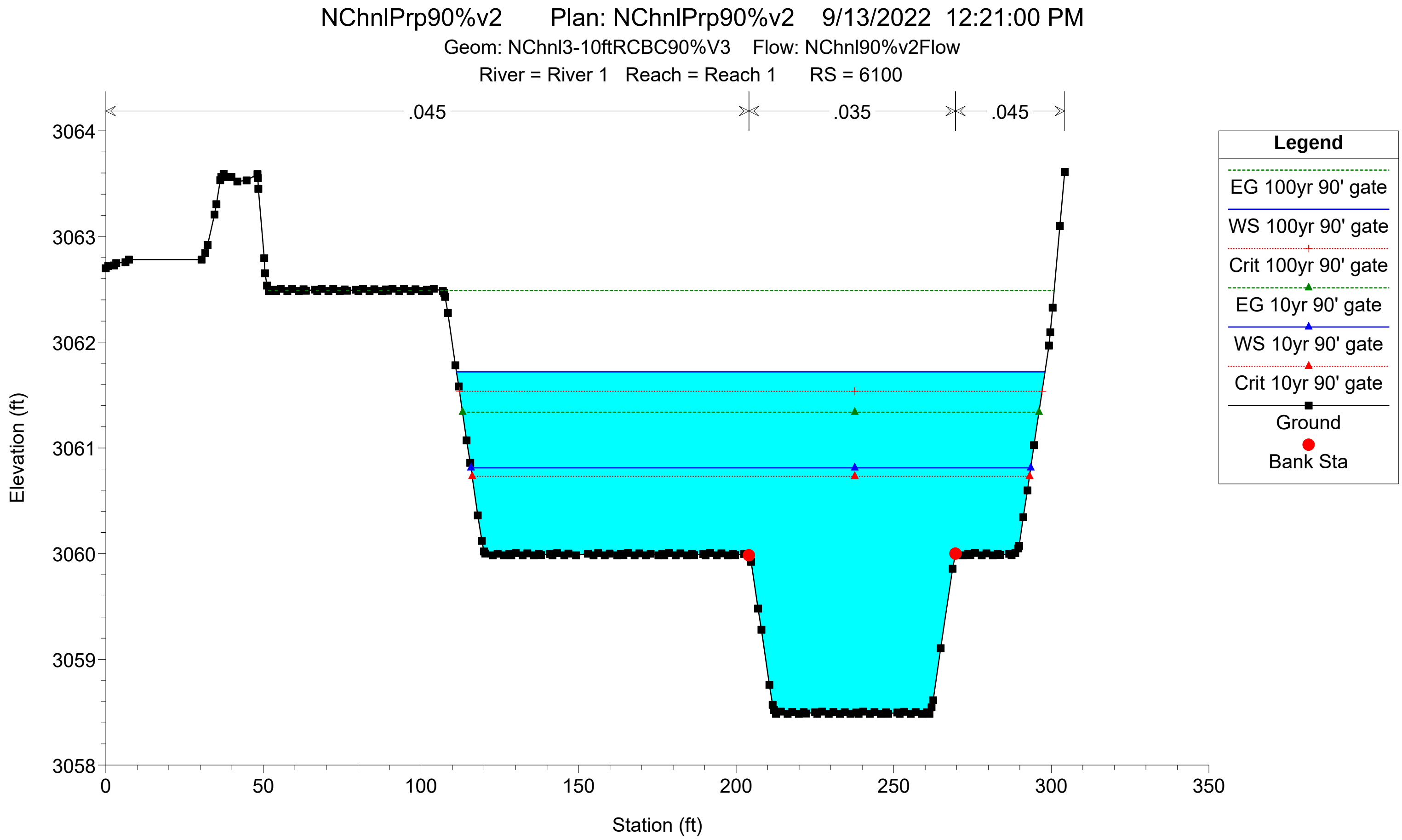
FG Channels-N Channel Subcritical Run
2022.09.13



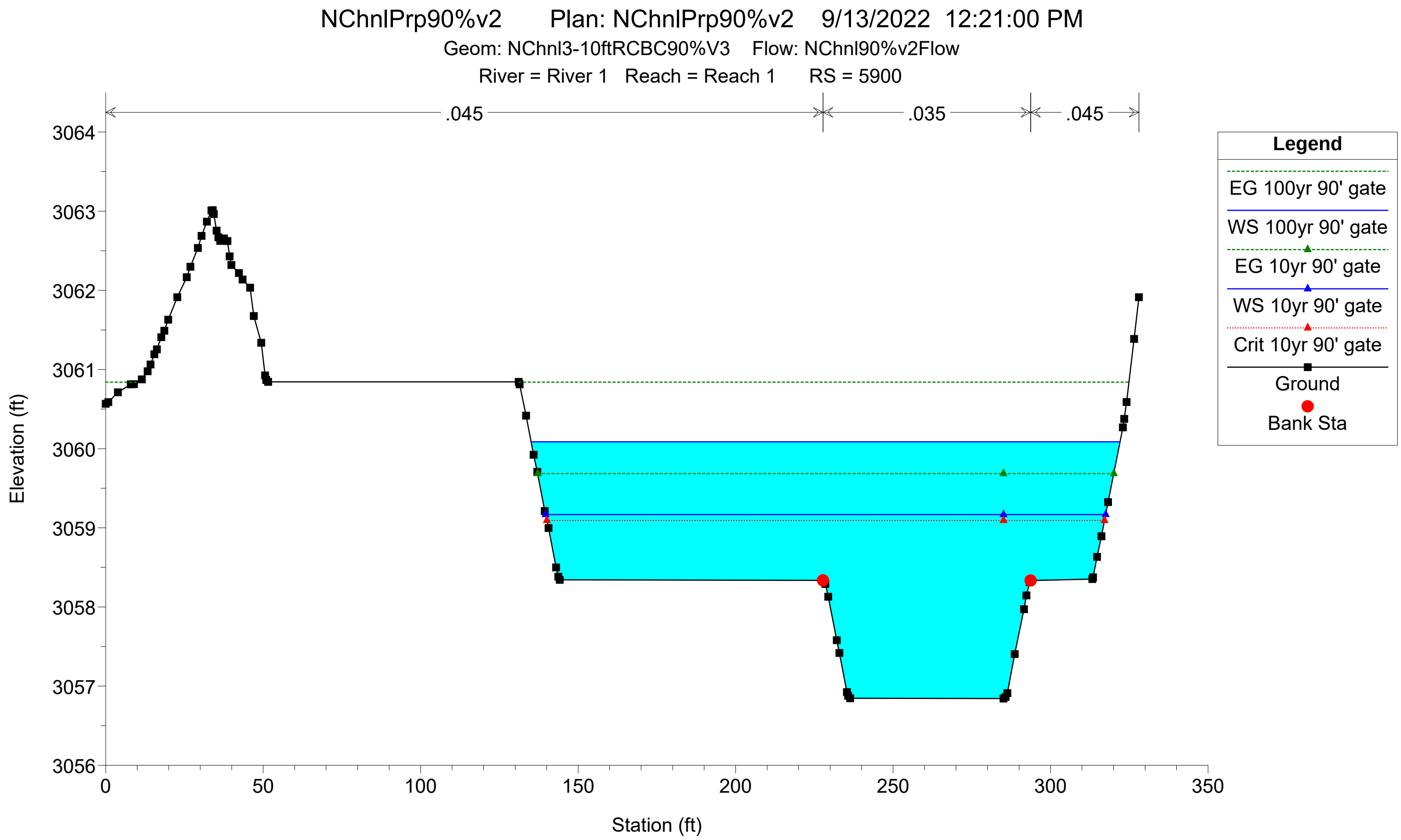
FG Channels-N Channel Subcritical Run_2022.09.13



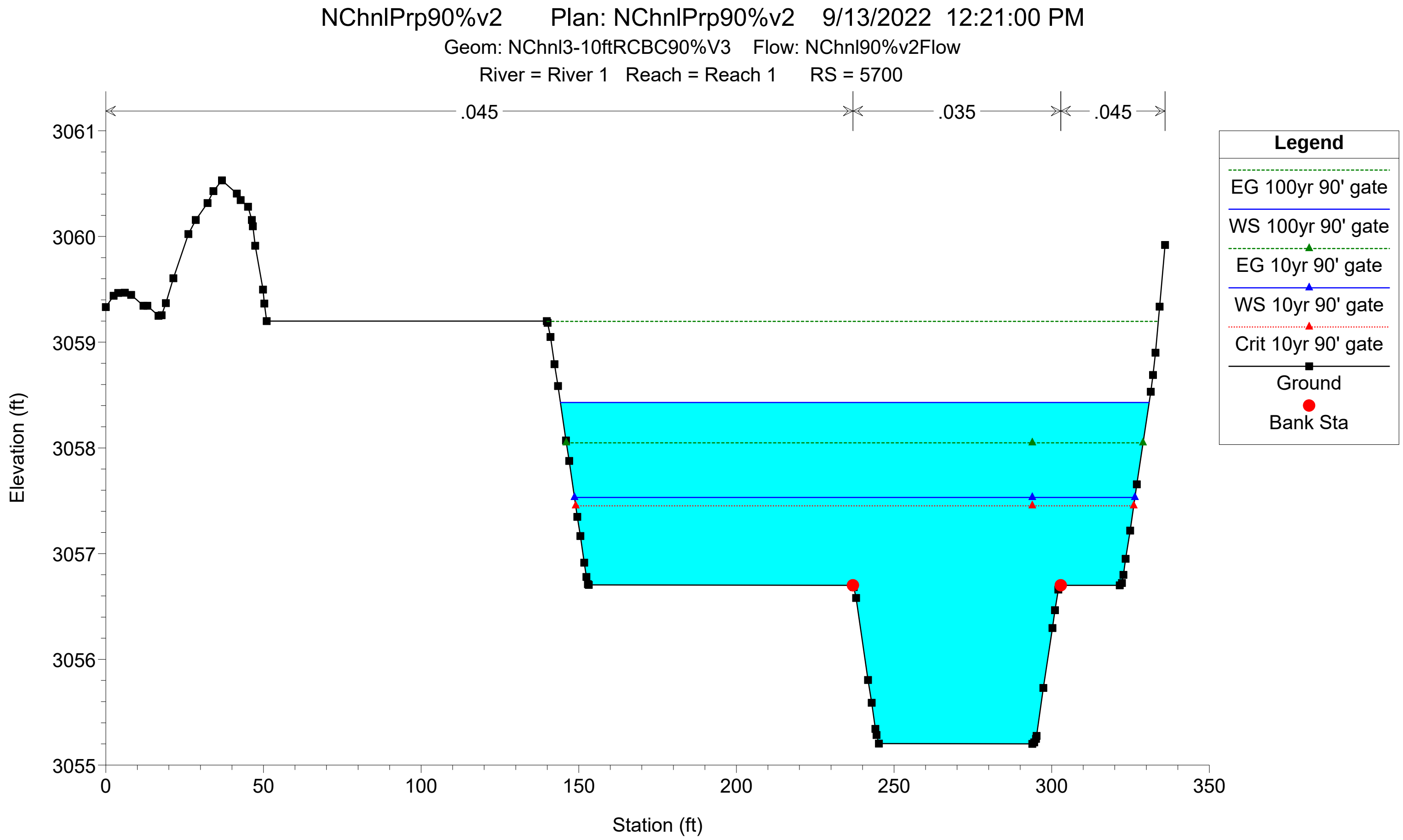




NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 6100
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta



NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 5900
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta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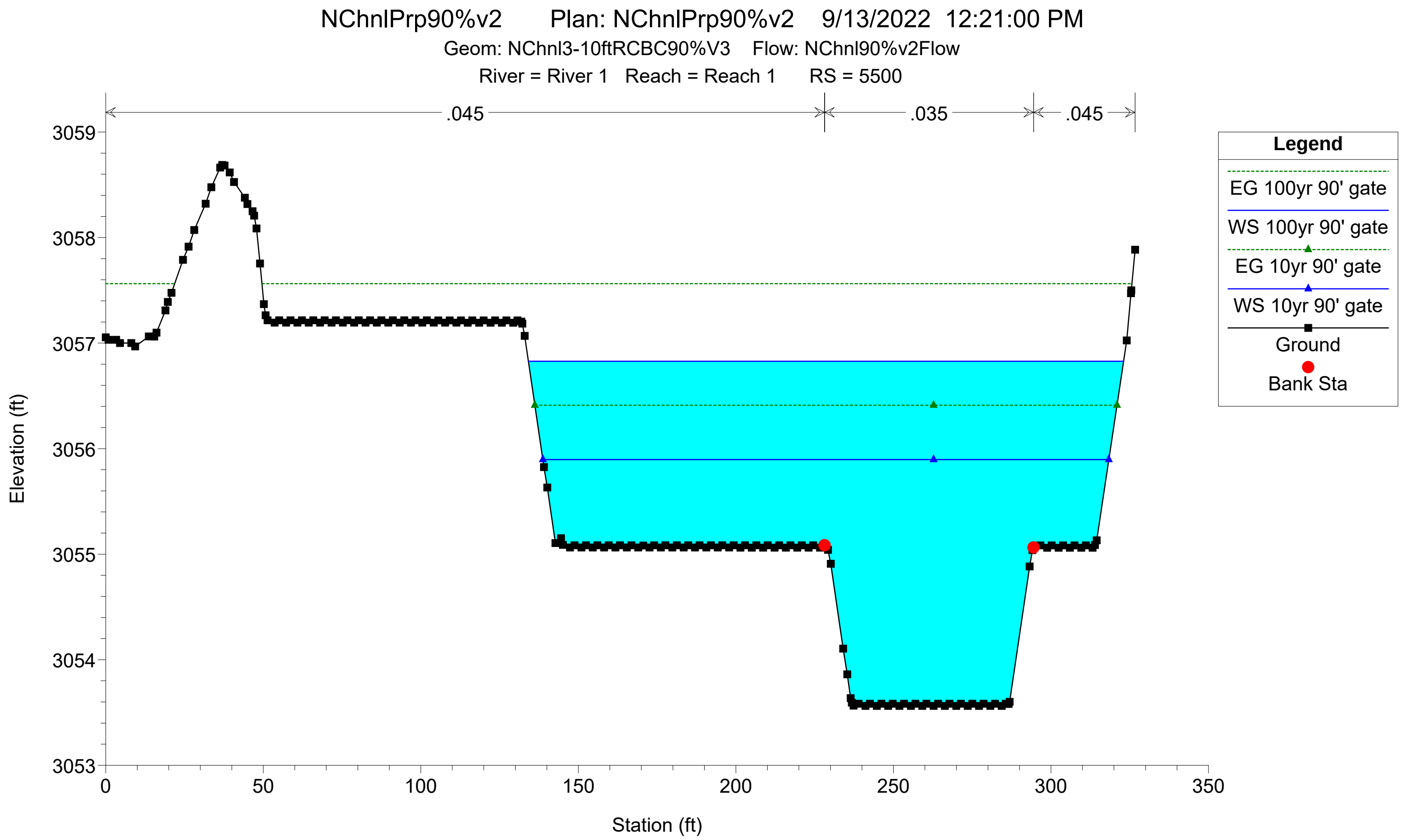
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 5700
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta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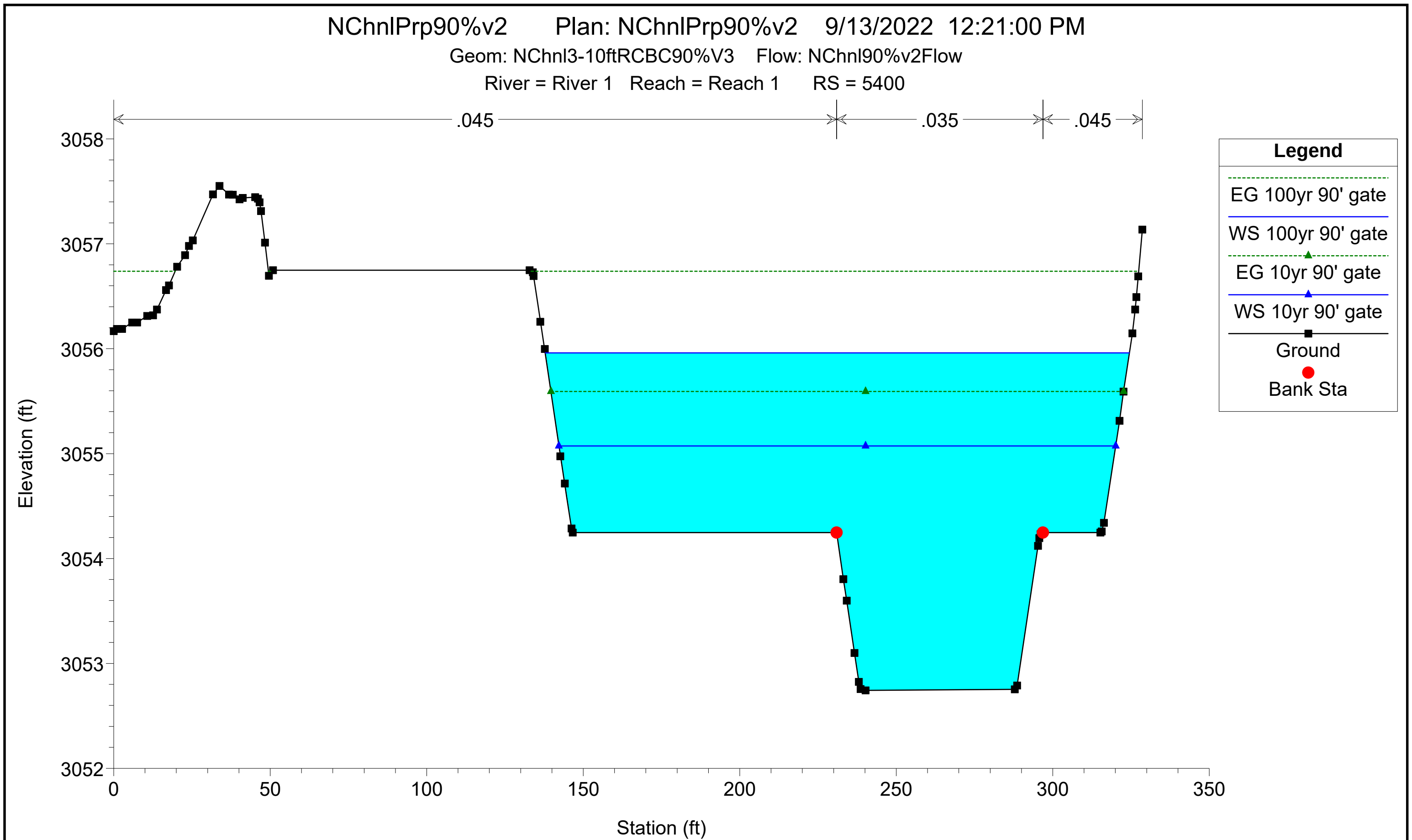
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 5500
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Ground
Bank Sta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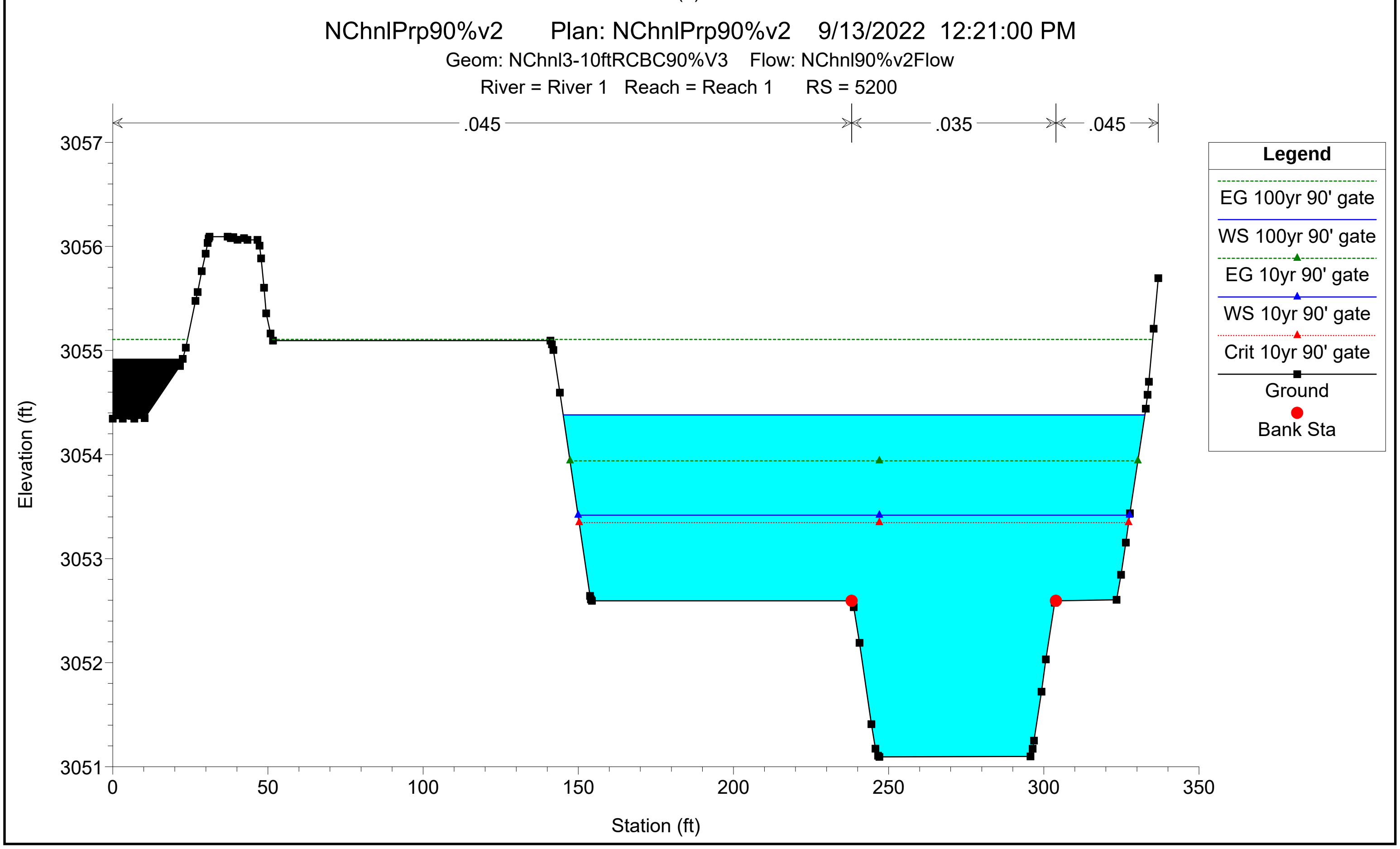
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 5400
.045
.035
.045
Elevation (ft)
3058
3057
3056
3055
3054
3053
3052
0
50
100
150
200
250
300
350
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Ground
Bank Sta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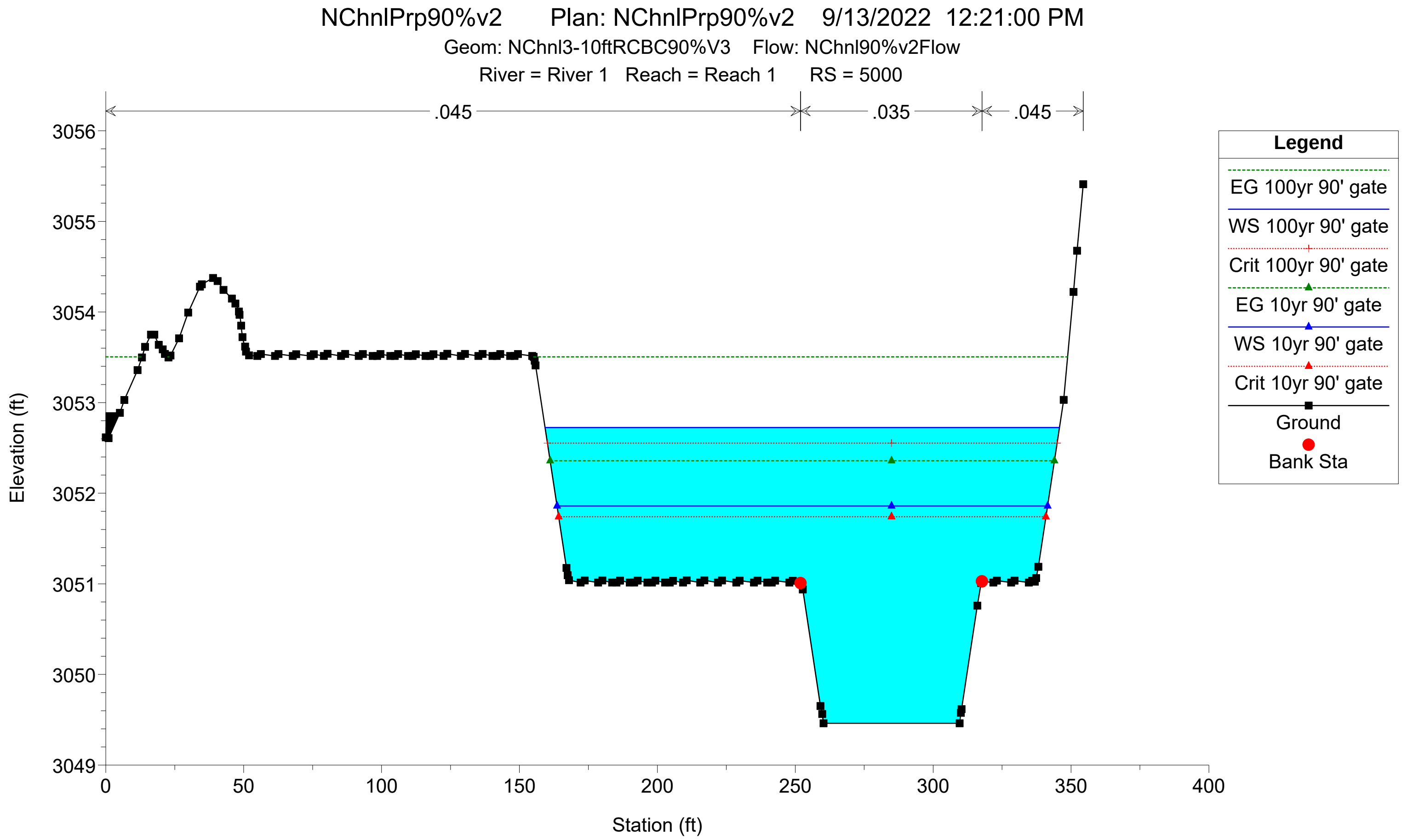
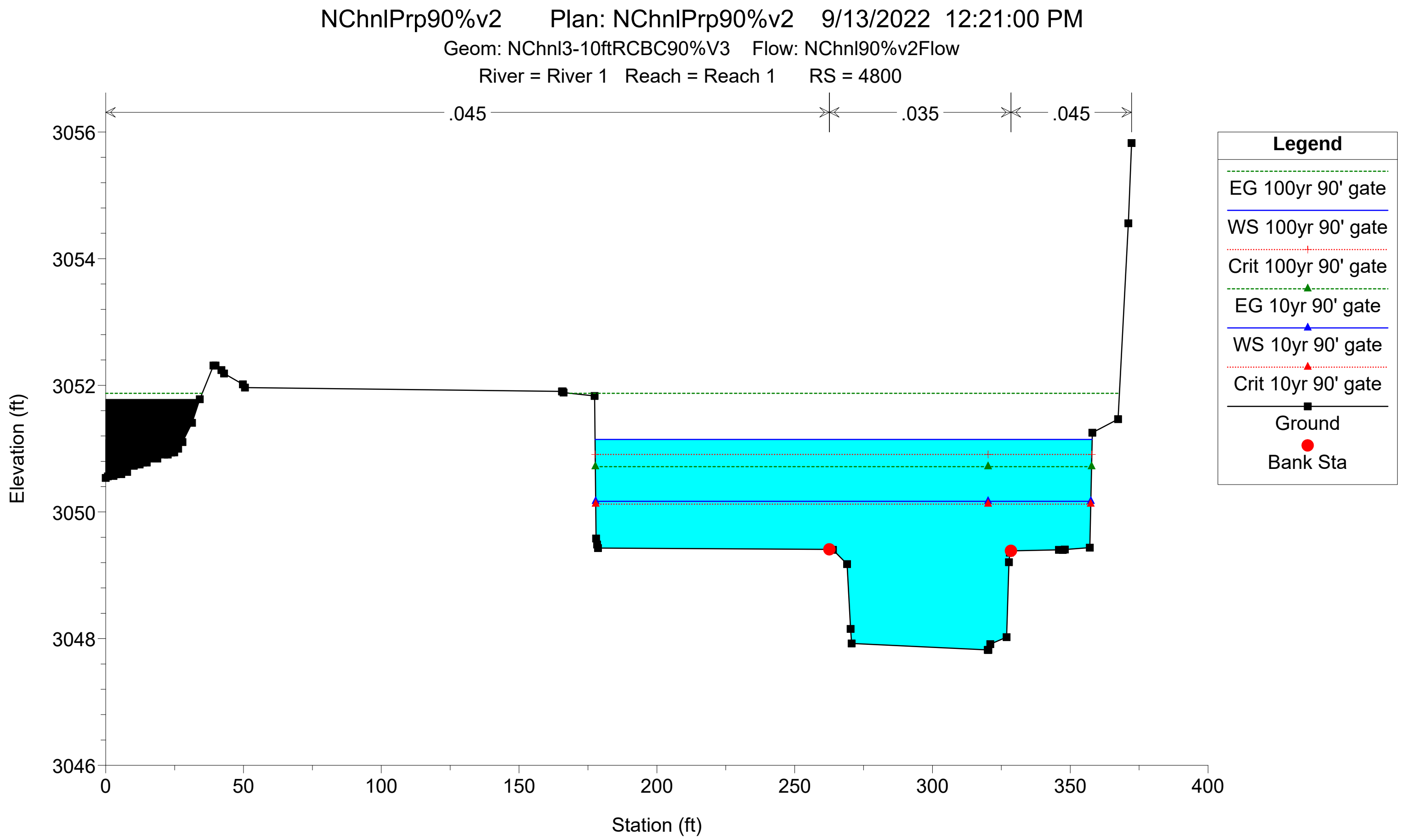
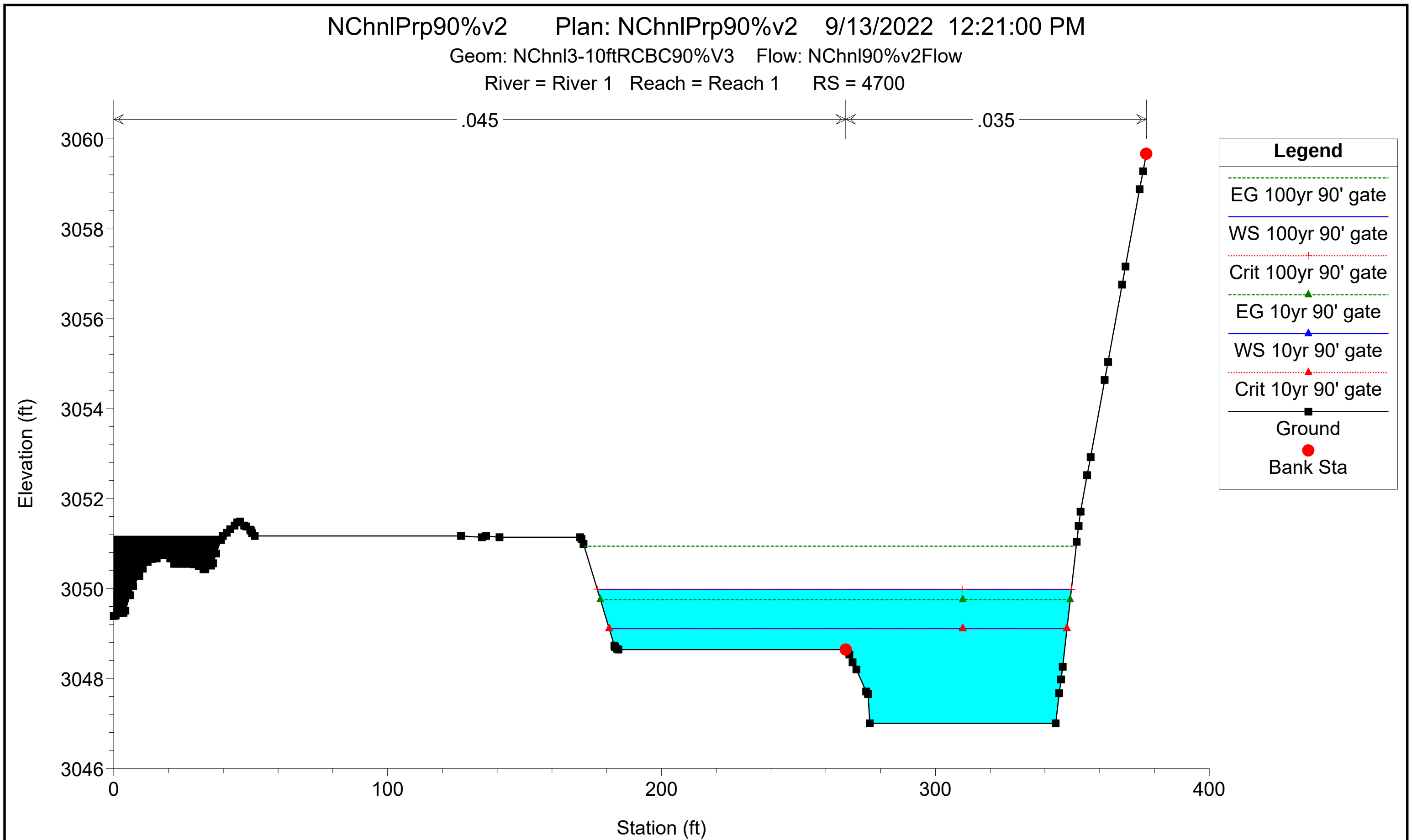
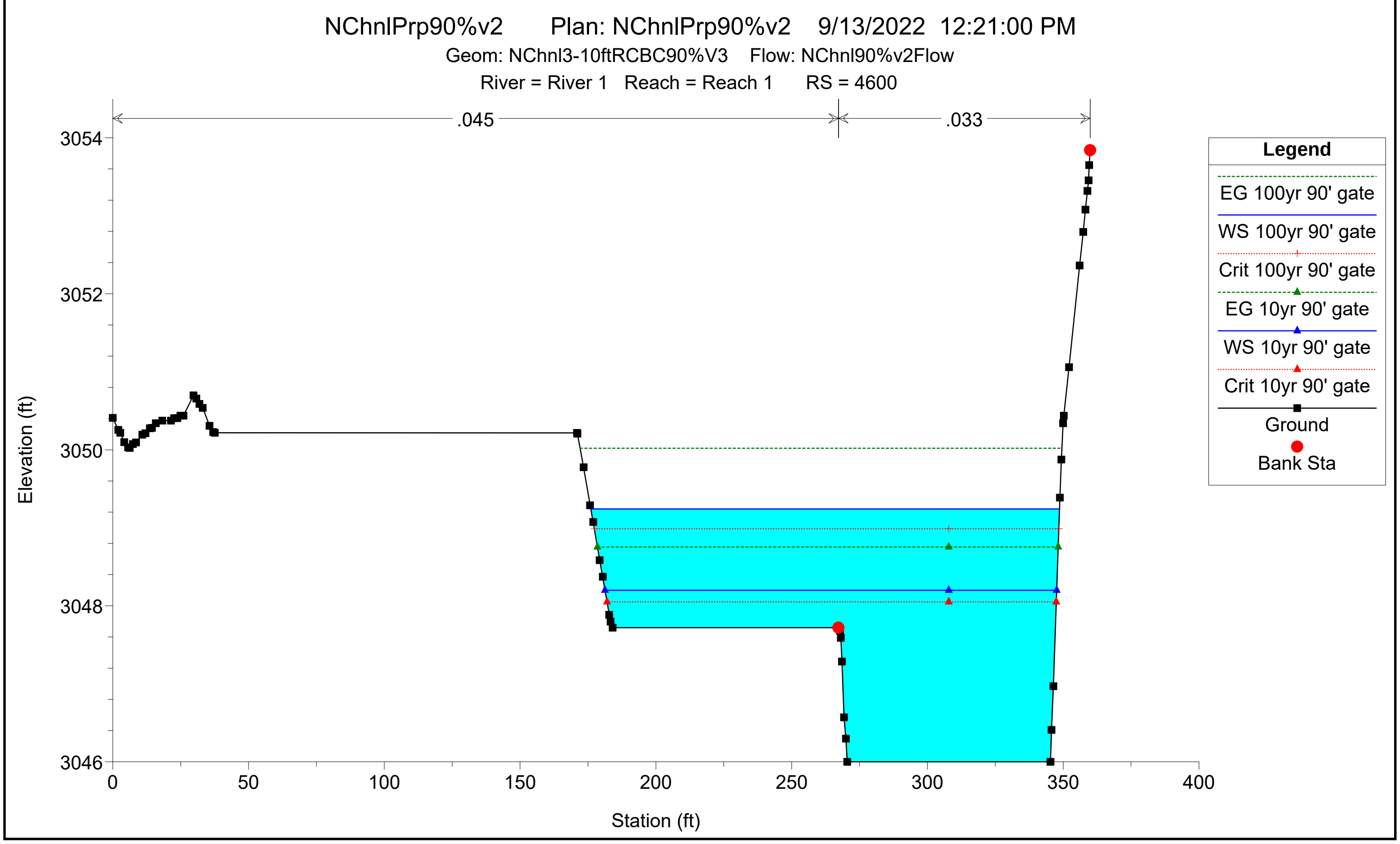
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 5200
.045
.035
.045
Elevation (ft)
3057
3056
3055
3054
3053
3052
3051
0
50
100
150
200
250
300
350
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta


NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 5000
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta

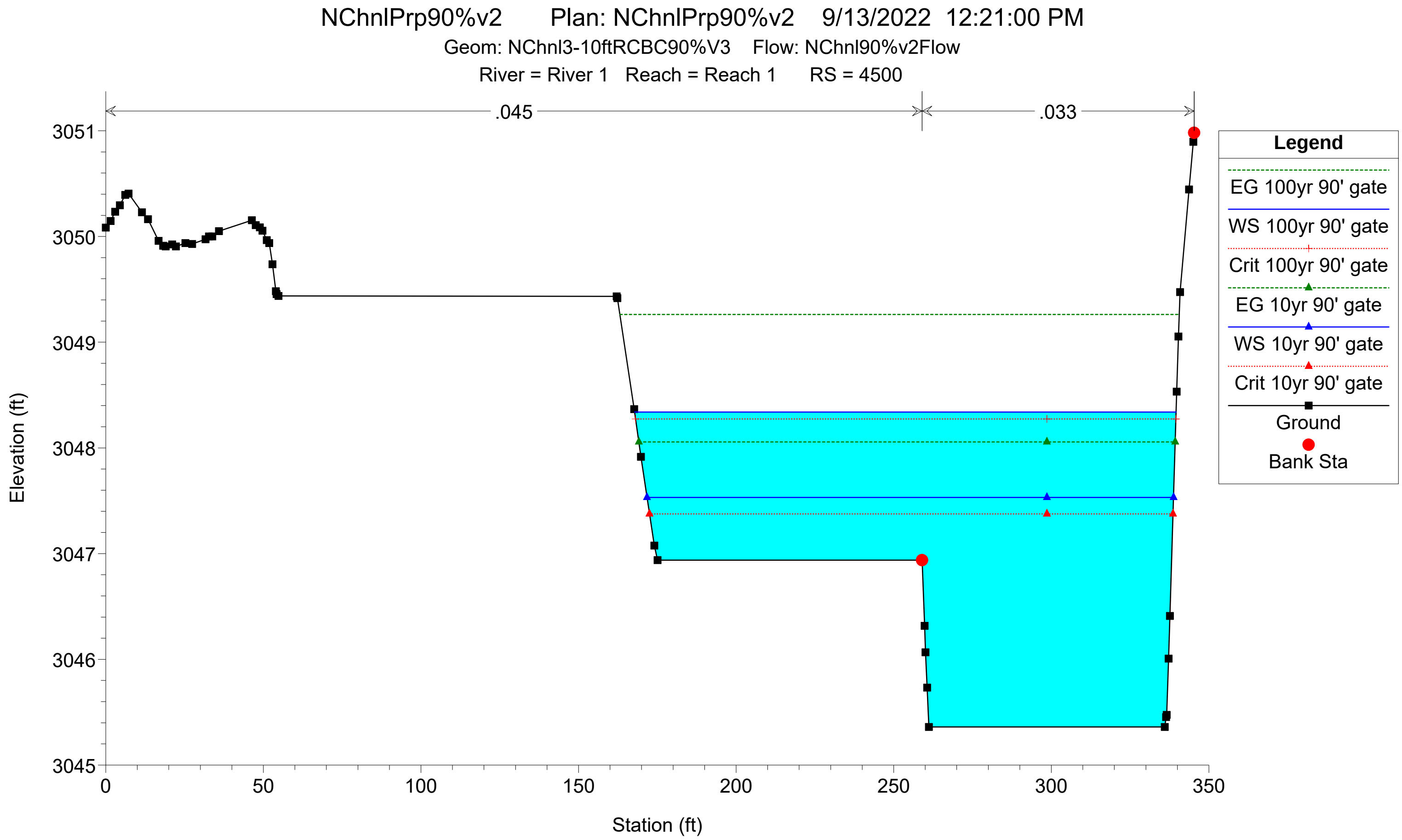

NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4800
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta



NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4700
.045
.035
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta



NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4600
.045
.033
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta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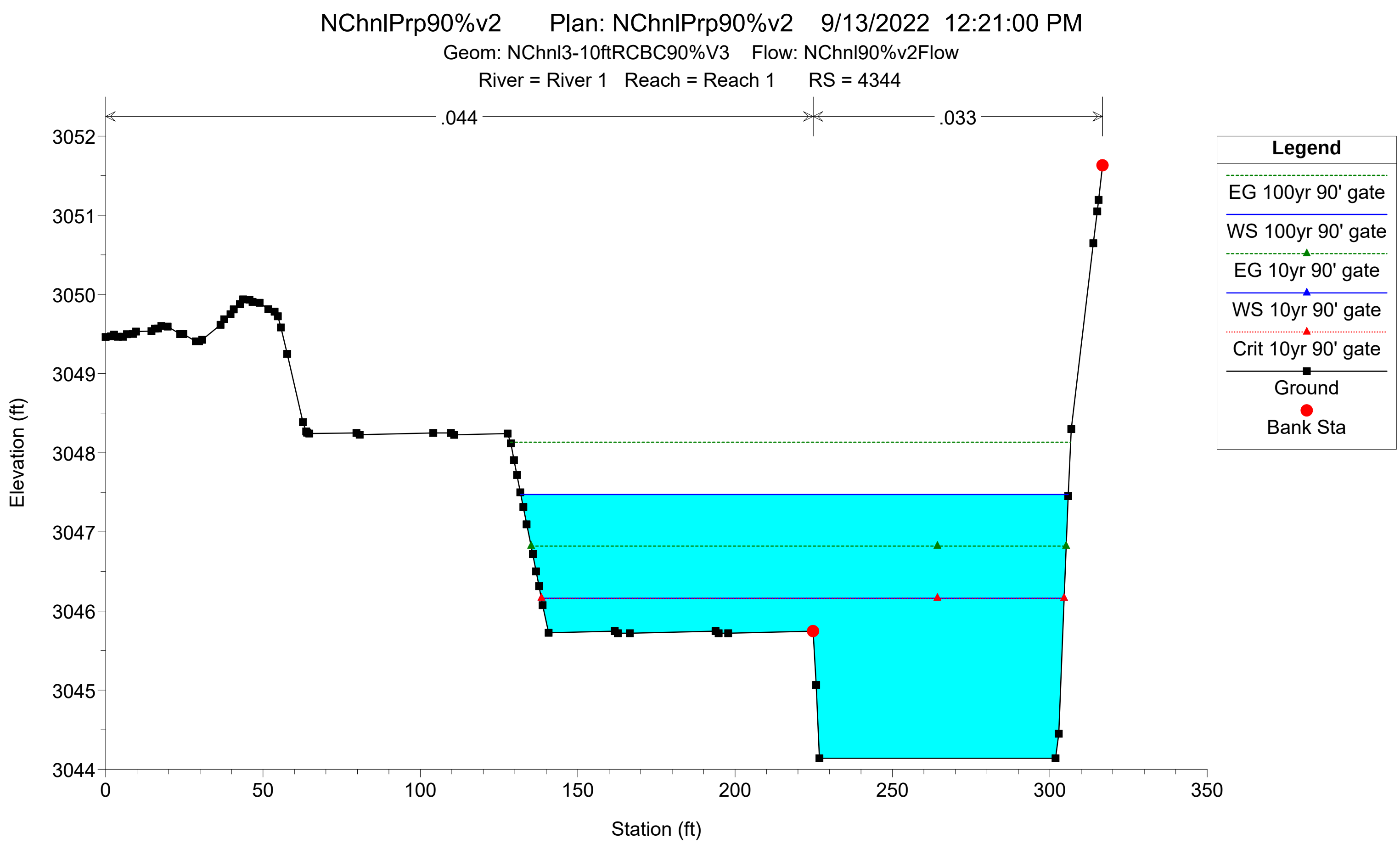
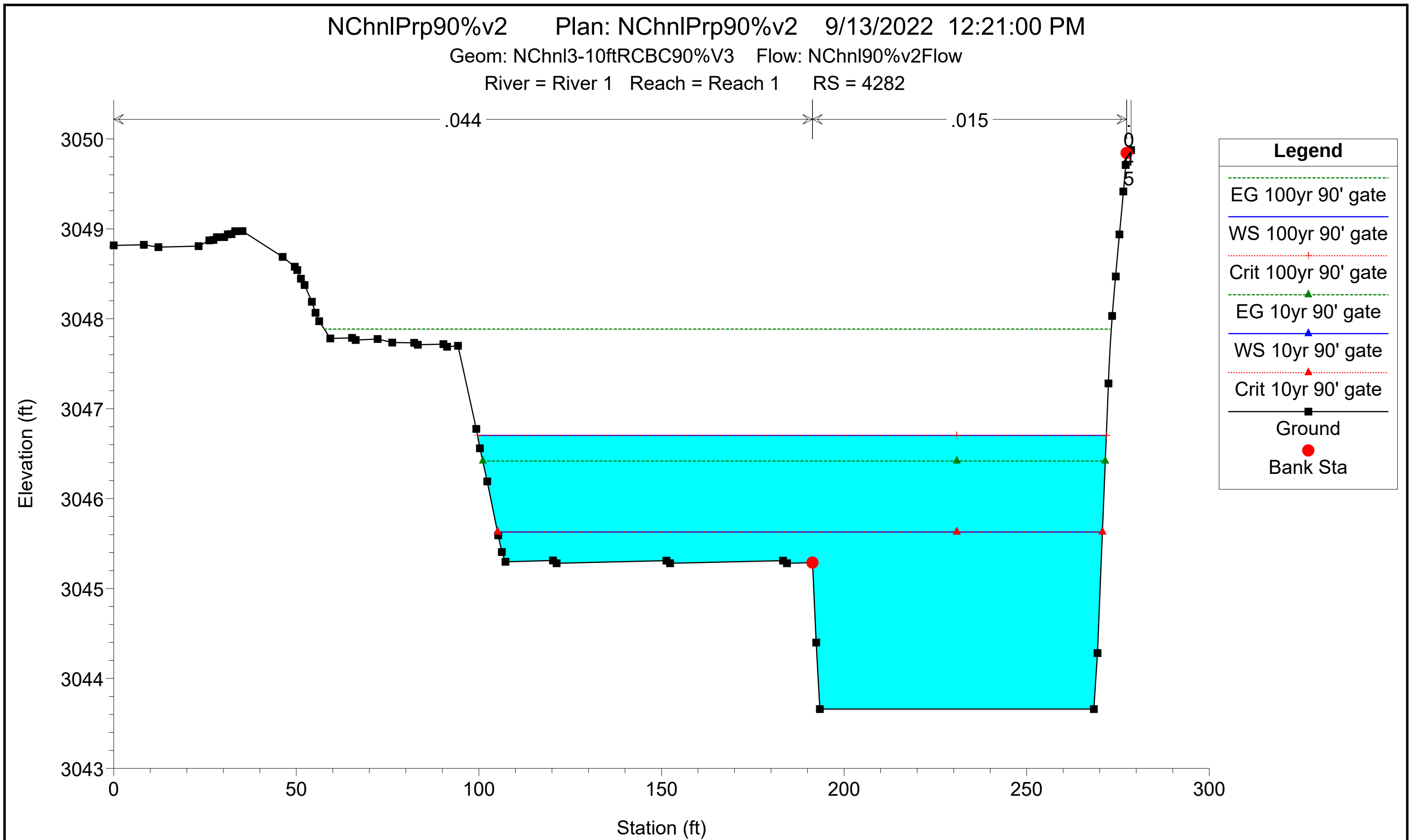
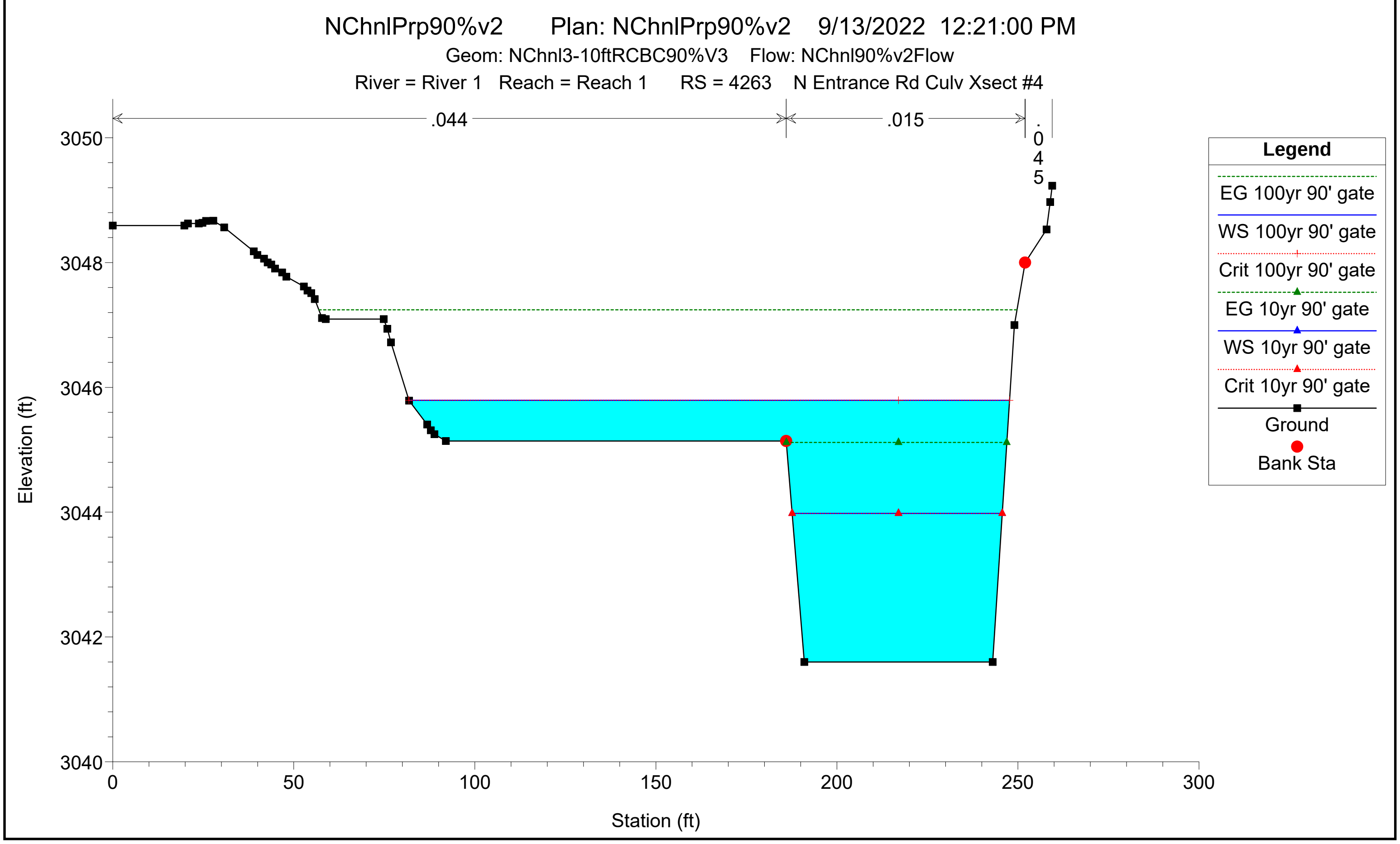
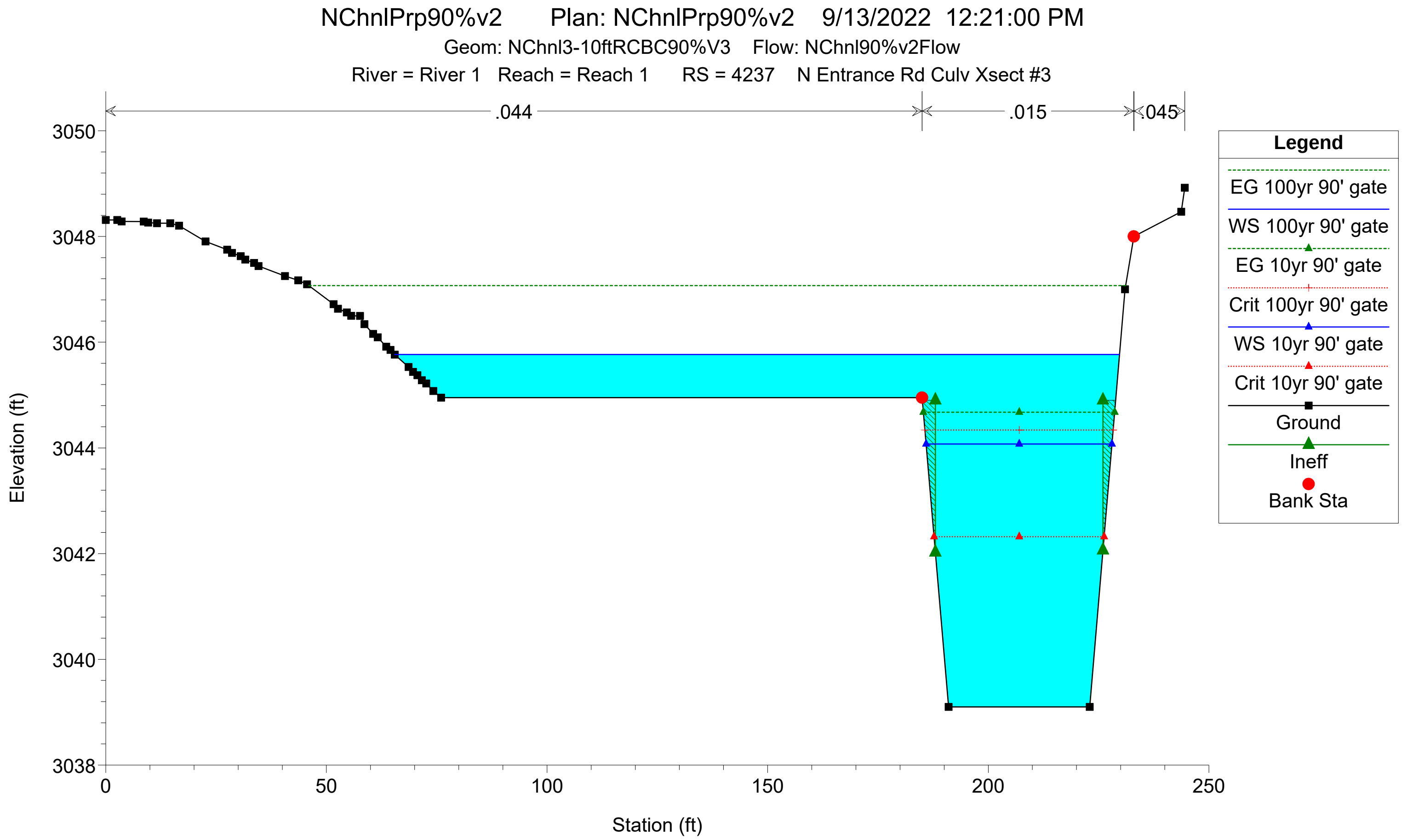
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4500
.045
.033
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta


NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4344
.044
.033
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta


NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4282
.044
.015
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta


NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4263 N Entrance Rd Culv Xsect #4
.044
.015
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta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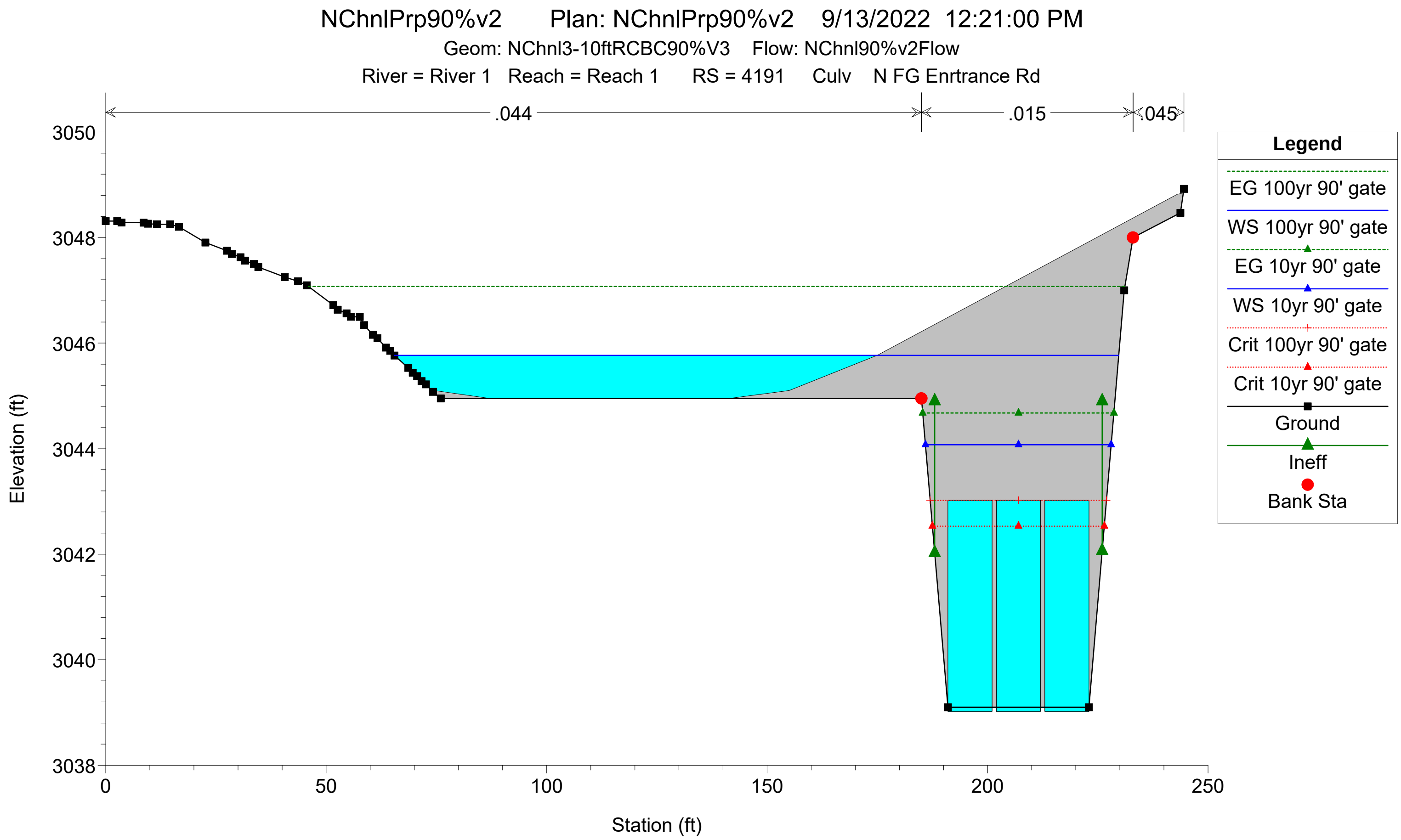
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4237 N Entrance Rd Culv Xsect #3
.044
.015
.045
Elevation (ft)
3050
3048
3046
3044
3042
3040
3038
0
50
100
150
200
250
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
Crit 100yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Ineff
Bank Sta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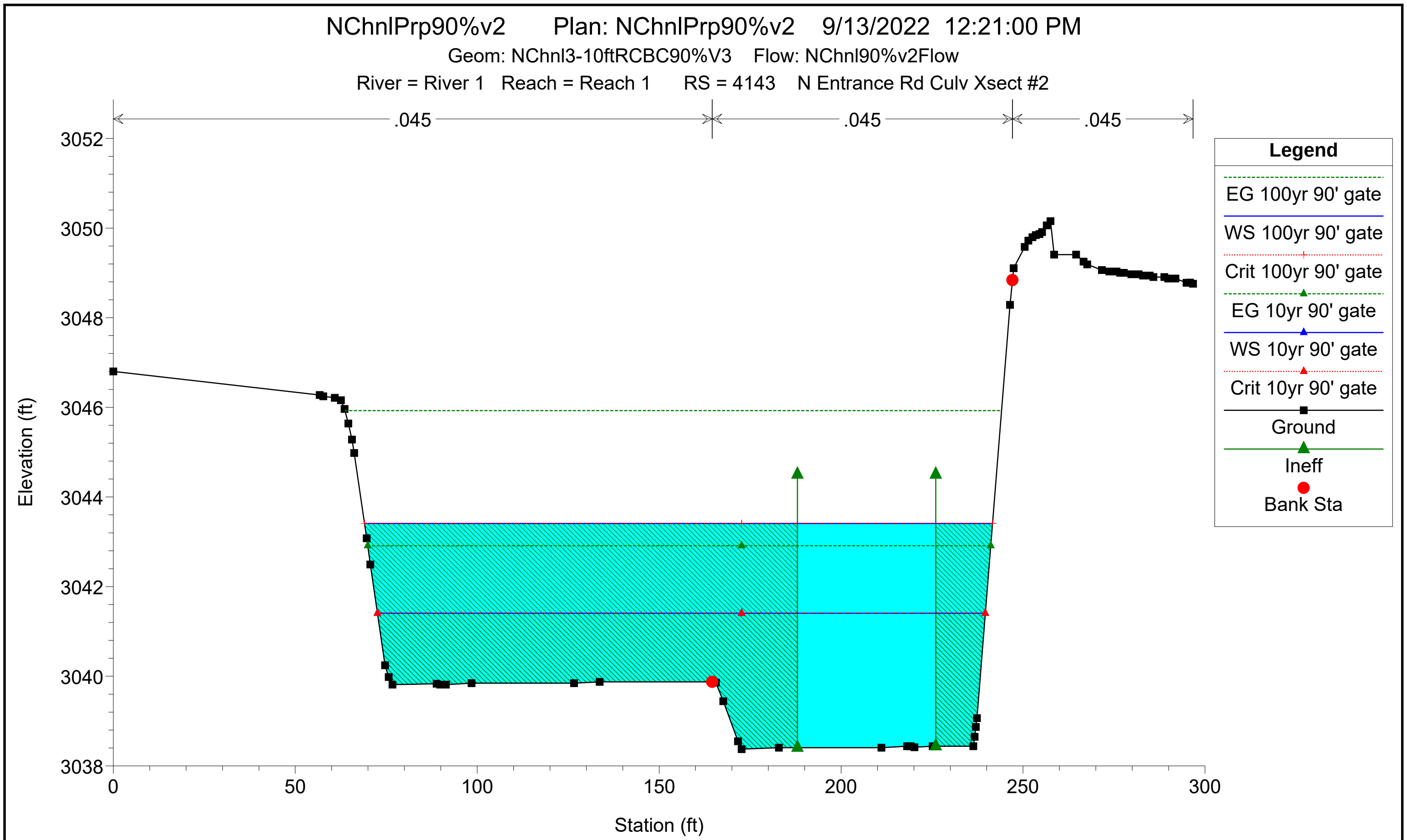
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4191 Culv N FG Enrtrance Rd
.044
.015
.045
Elevation (ft)
3050
3048
3046
3044
3042
3040
3038
0
50
100
150
200
250
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 100yr 90' gate
Crit 10yr 90' gate
Ground
Ineff
Bank Sta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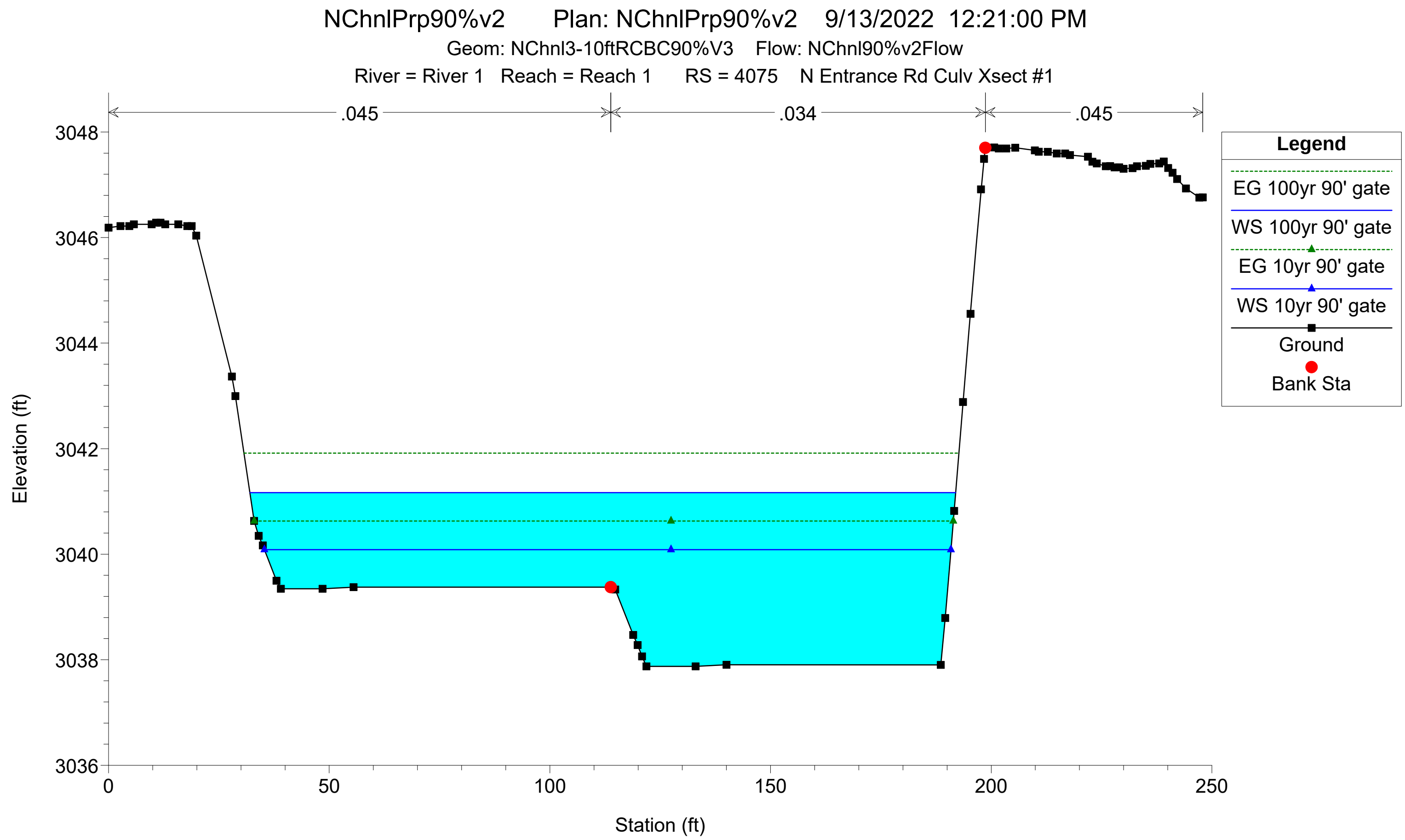
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4143 N Entrance Rd Culv Xsect #2
.045
.045
.045
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3038
3040
3042
3044
3046
3048
3050
3052
0
50
100
150
200
250
300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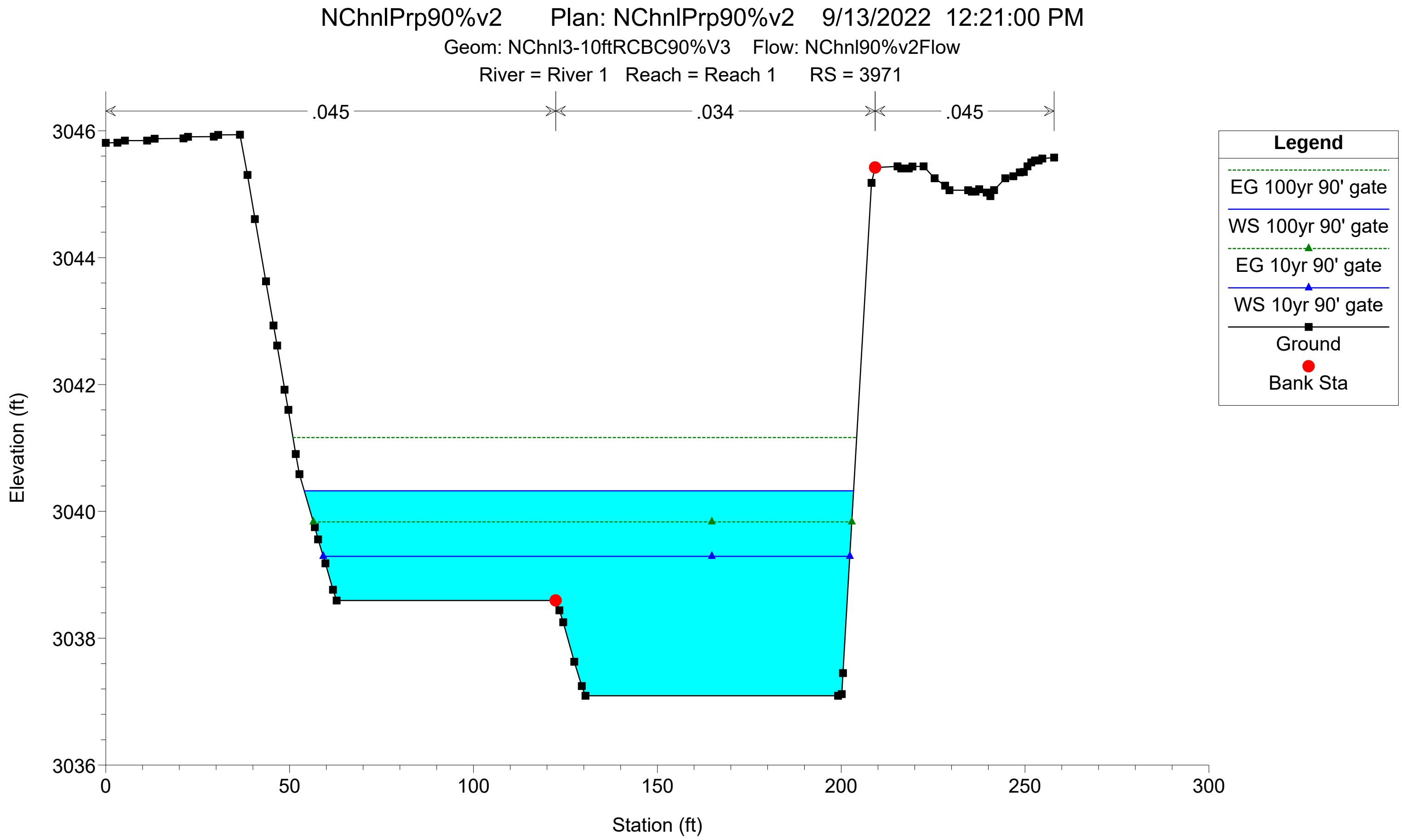
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4075 N Entrance Rd Culv Xsect #1
.045
.034
.045
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Ground
Bank Sta
Elevation (ft)
Station (ft)
3036
3038
3040
3042
3044
3046
3048
0
50
100
150
200
250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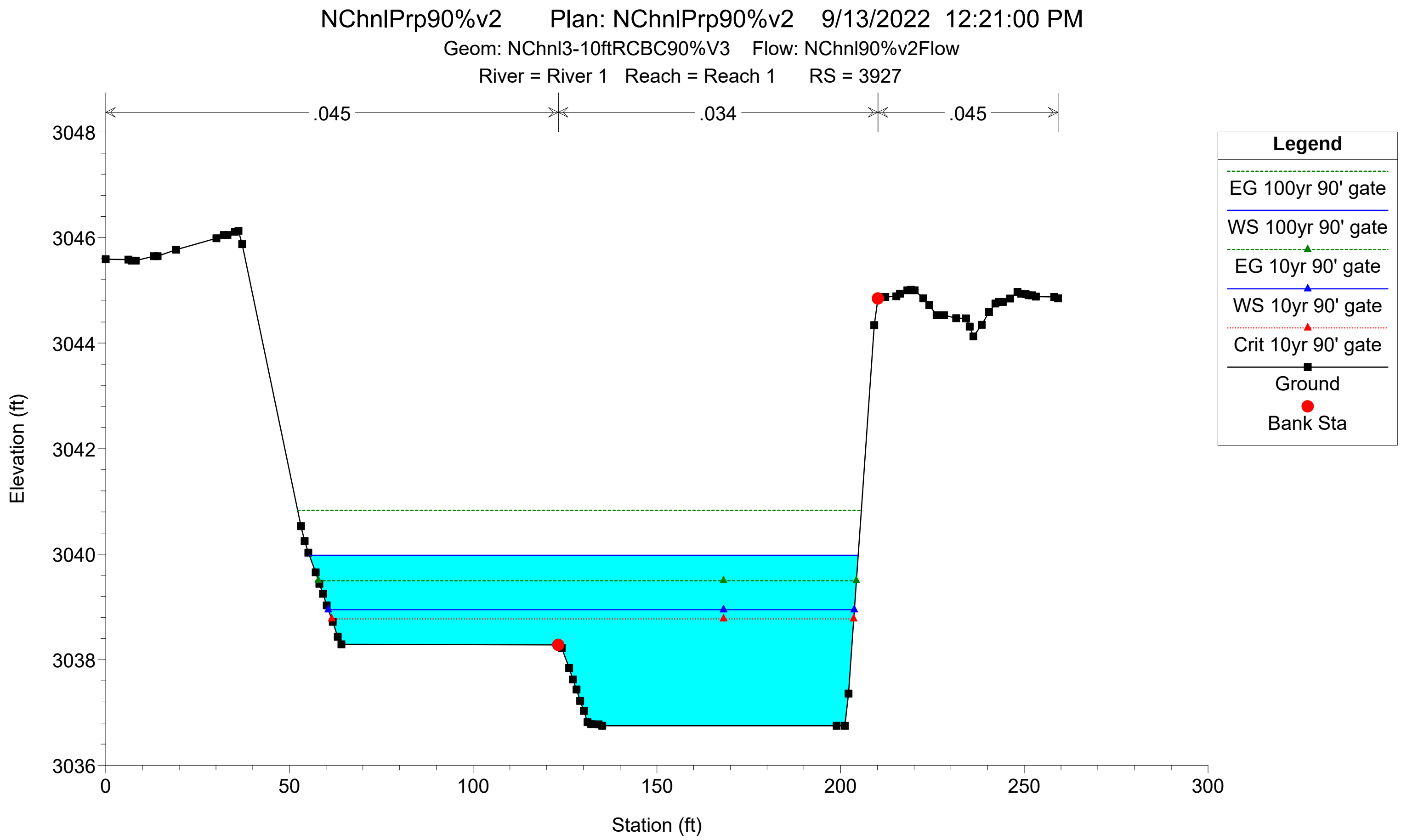
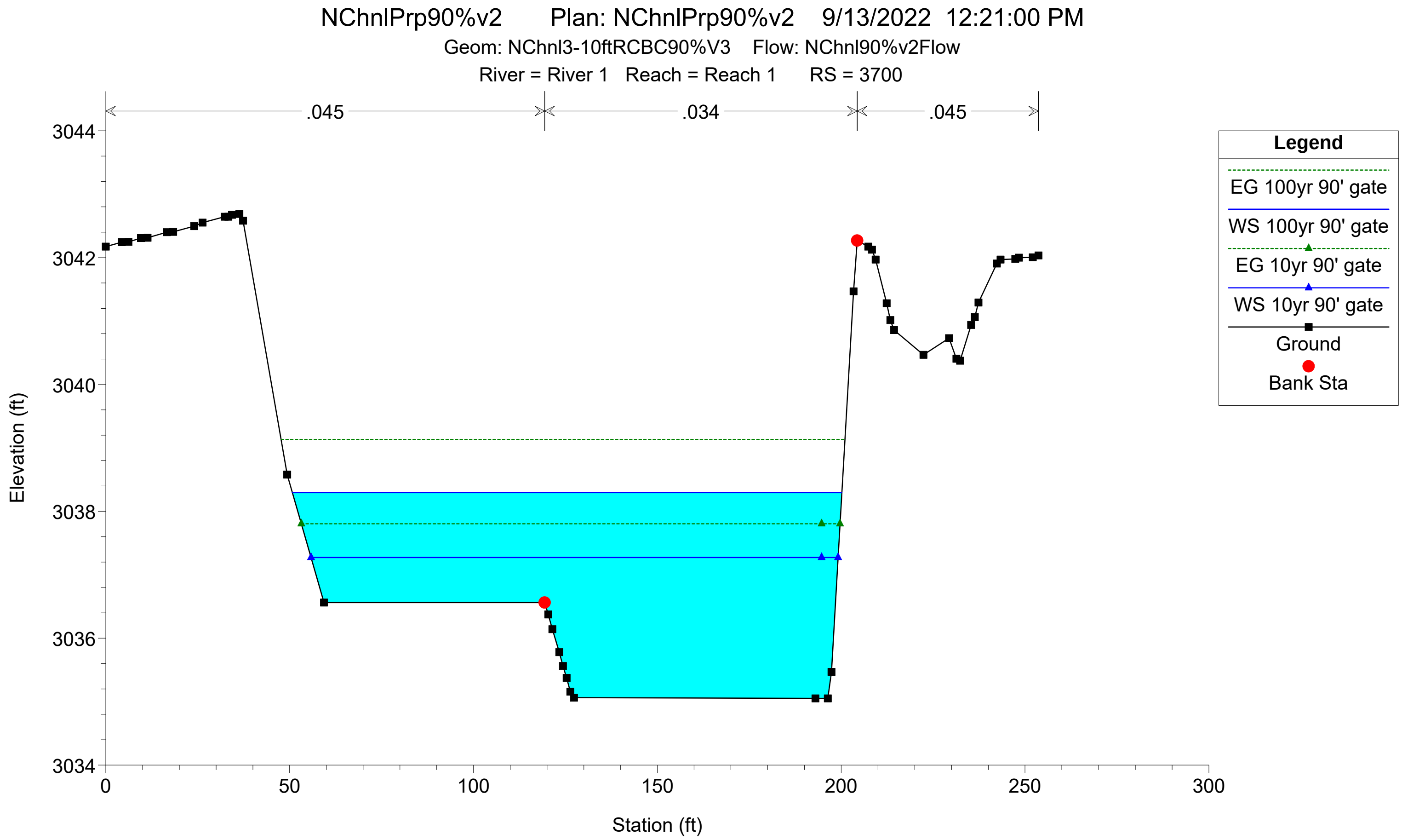
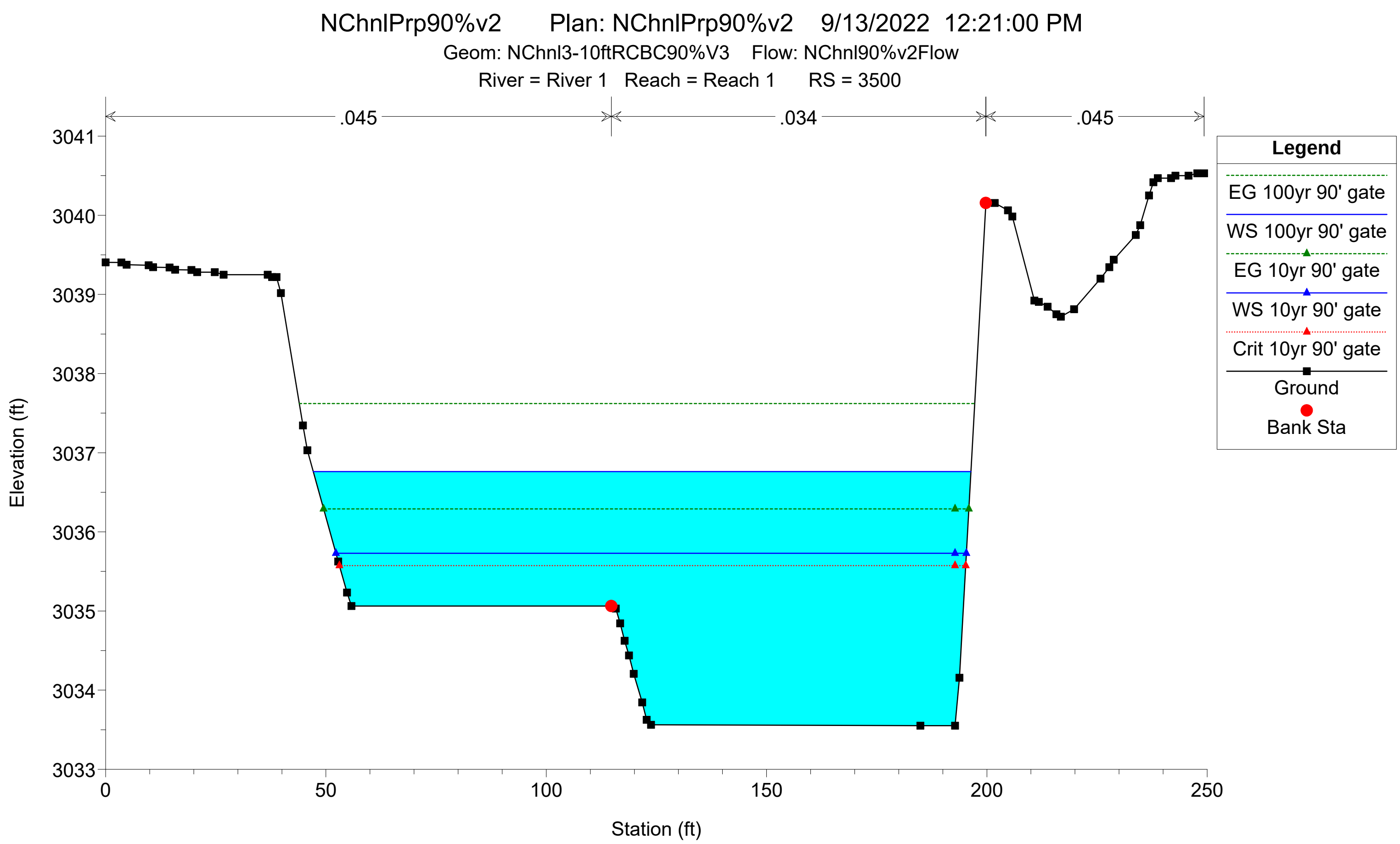
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 3971
.045
.034
.045
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Ground
Bank Sta
Elevation (ft)
3036
3038
3040
3042
3044
3046
0
50
100
150
200
250
300
Station (ft)

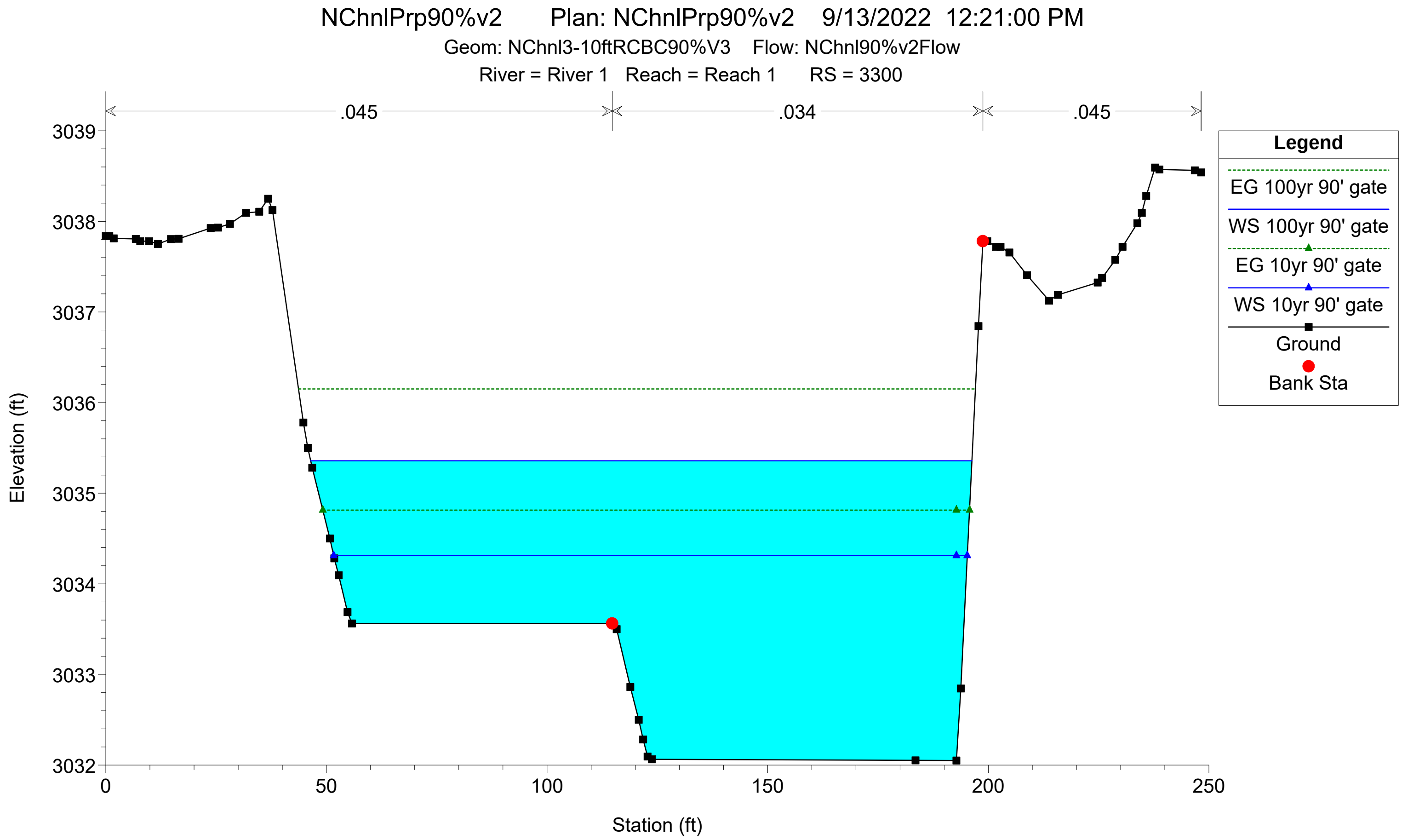

NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 3927
.045
.034
.045
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta
Elevation (ft)
3036
3038
3040
3042
3044
3046
3048
0
50
100
150
200
250
300
Station (ft)

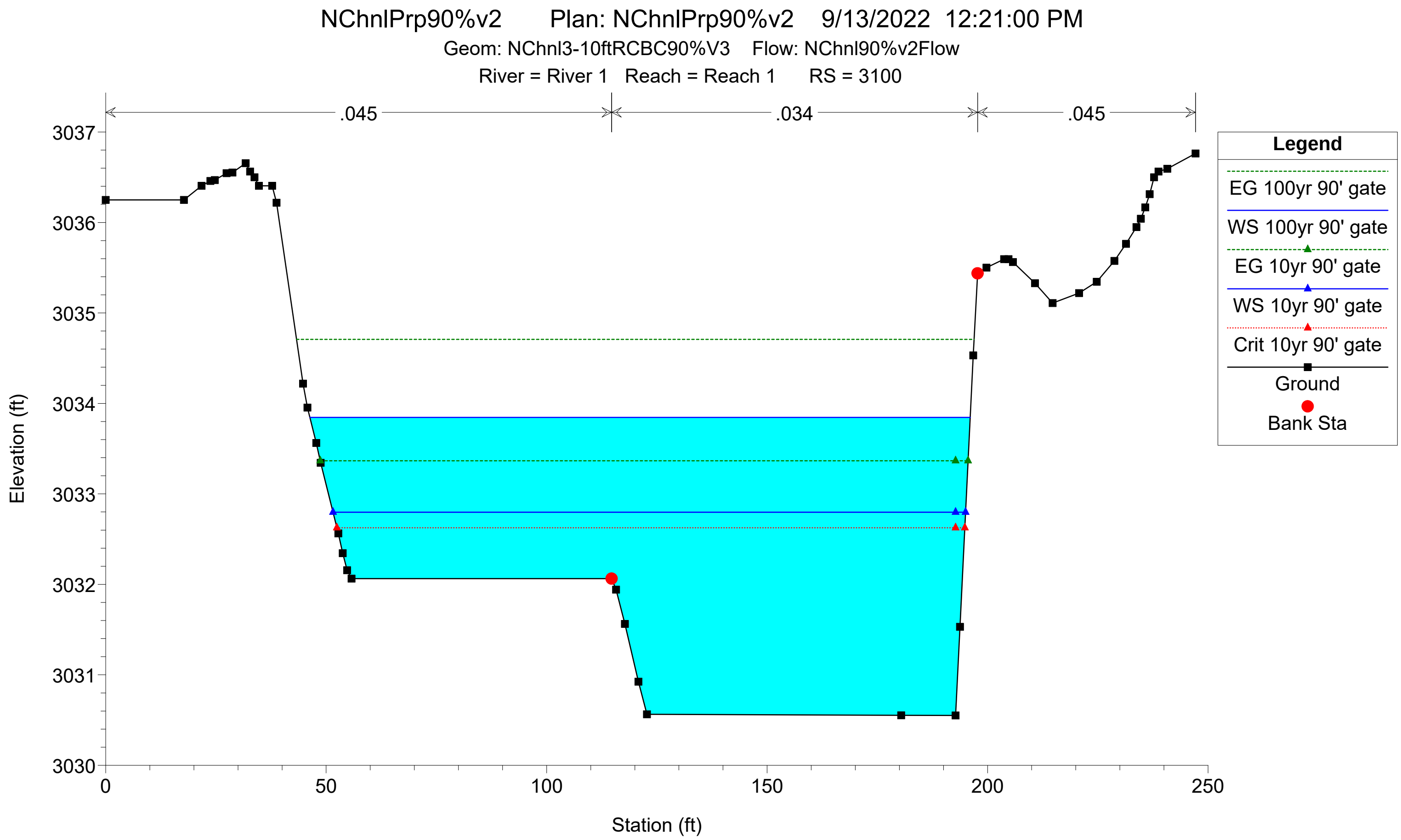


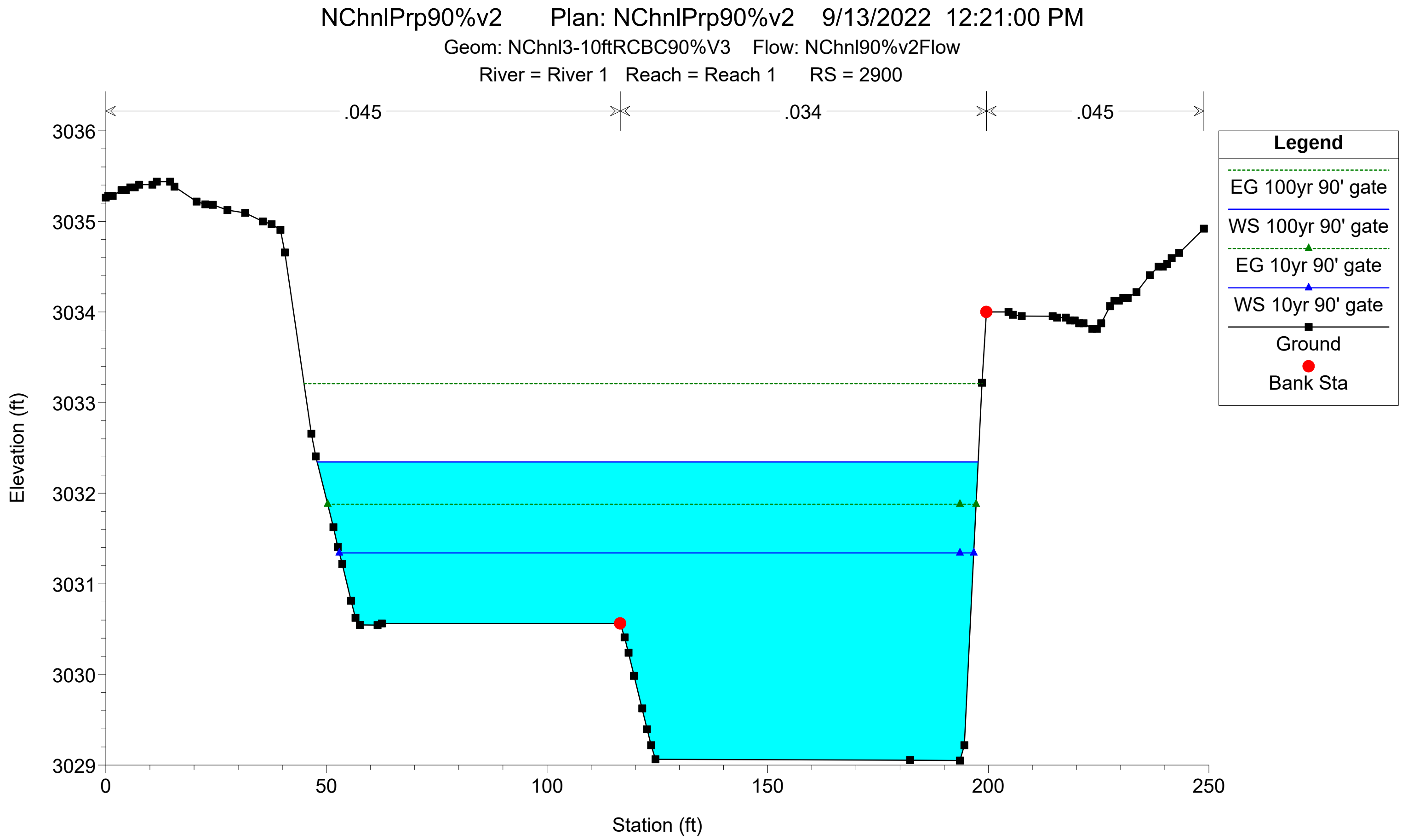
NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 3700
.045
.034
.045
Elevation (ft)
3044
3042
3040
3038
3036
3034
0
50
100
150
200
250
300
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Ground
Bank Sta

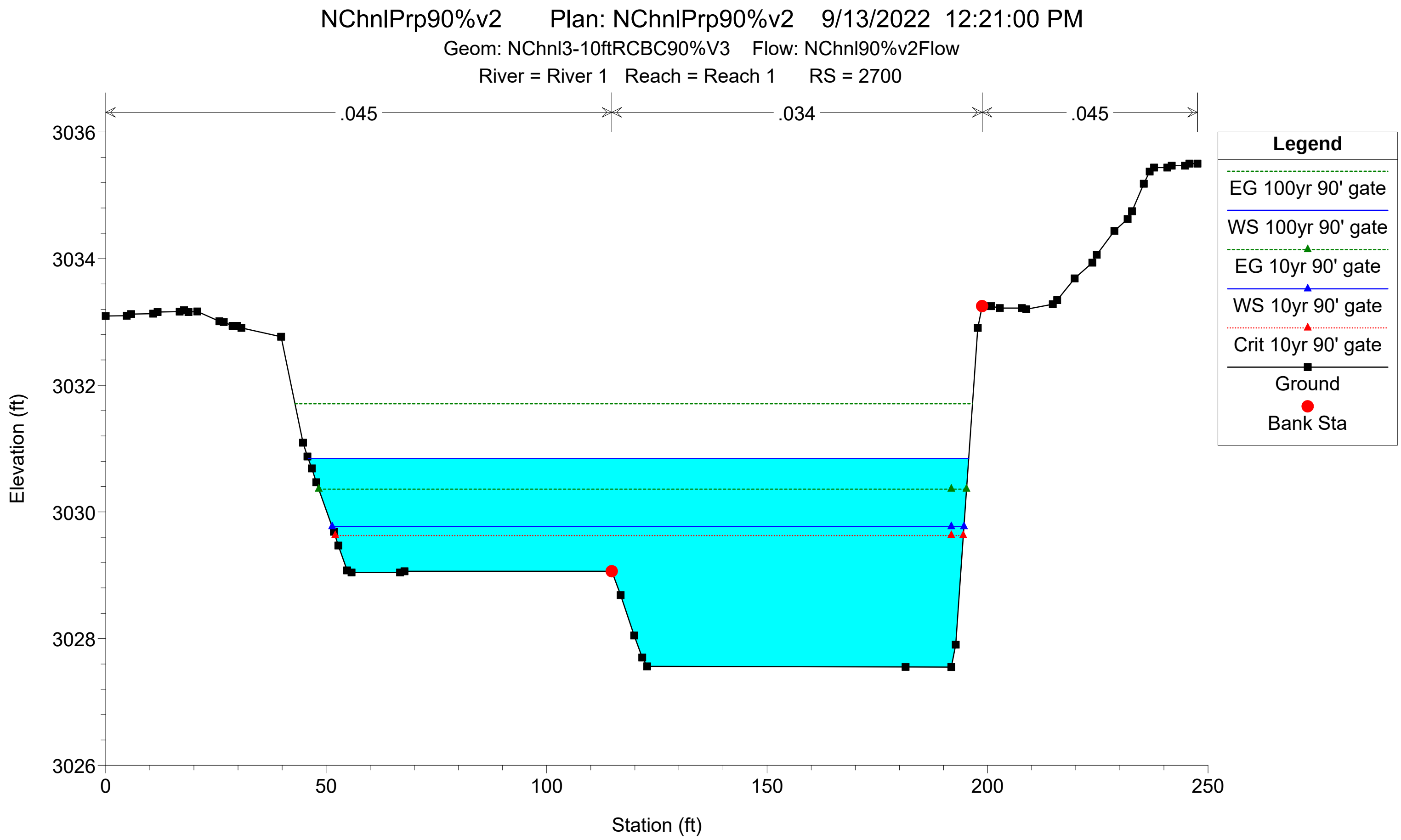


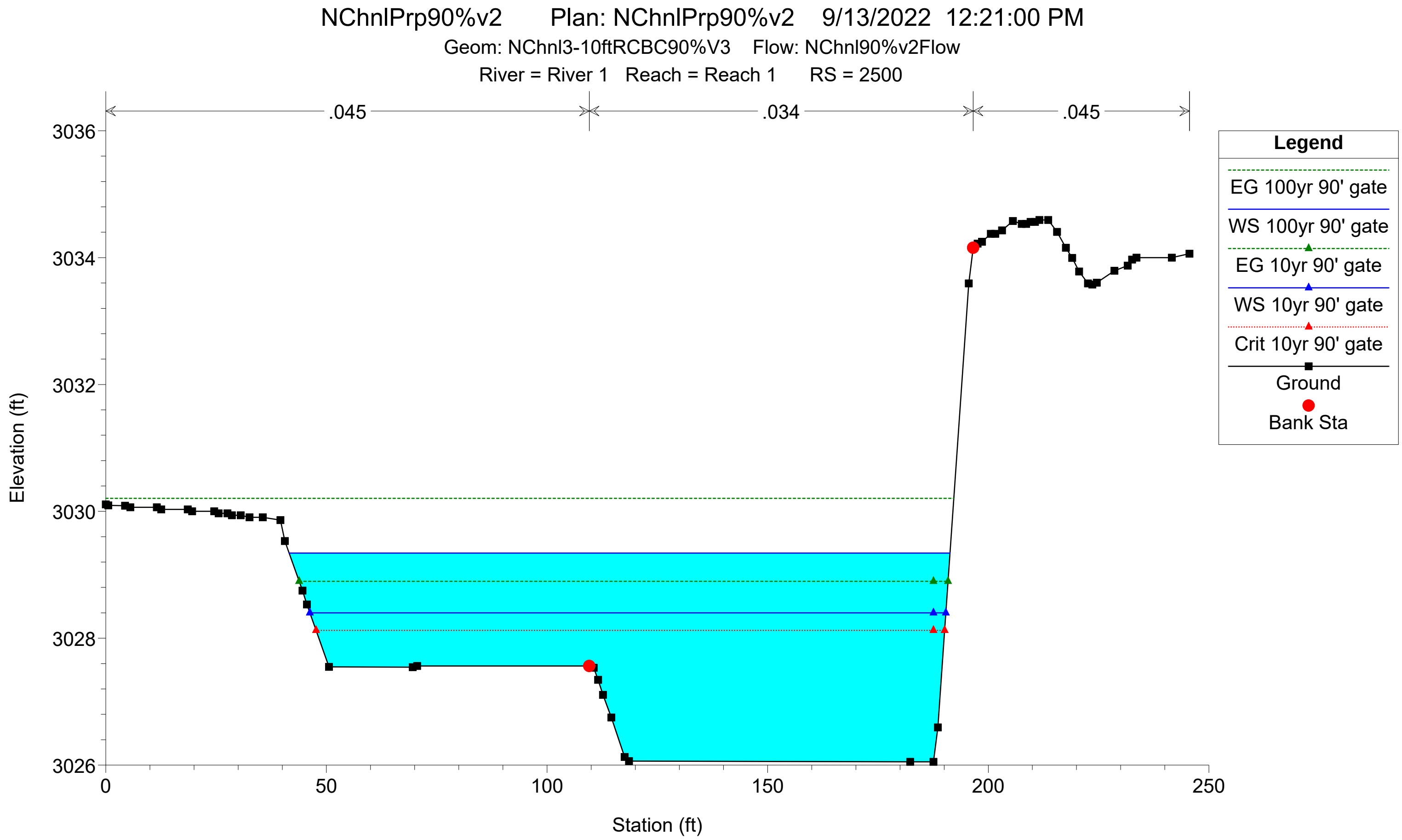
NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 3500
.045
.034
.045
Elevation (ft)
3041
3040
3039
3038
3037
3036
3035
3034
3033
0
50
100
150
200
250
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta

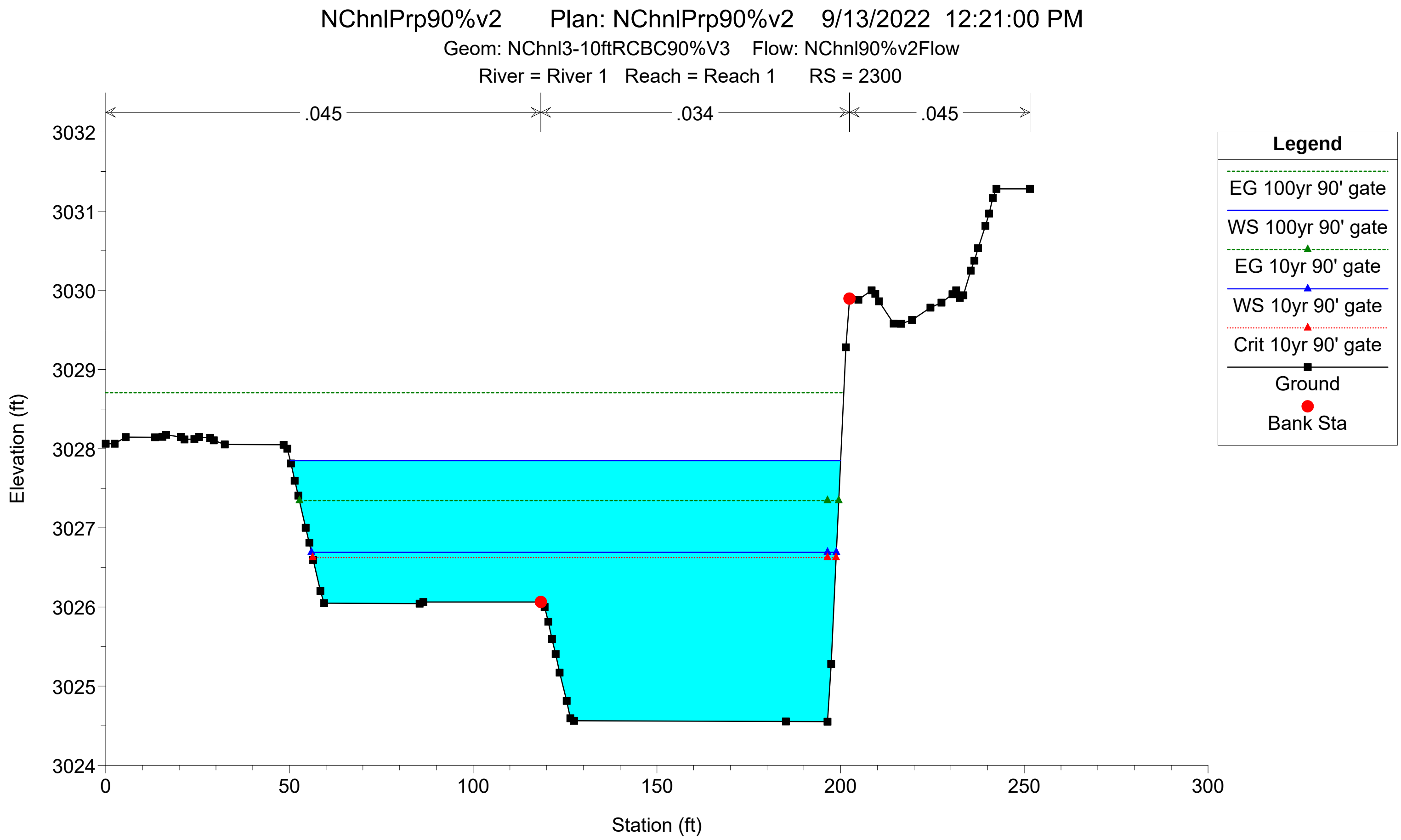

NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 3300
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Ground
Bank Sta

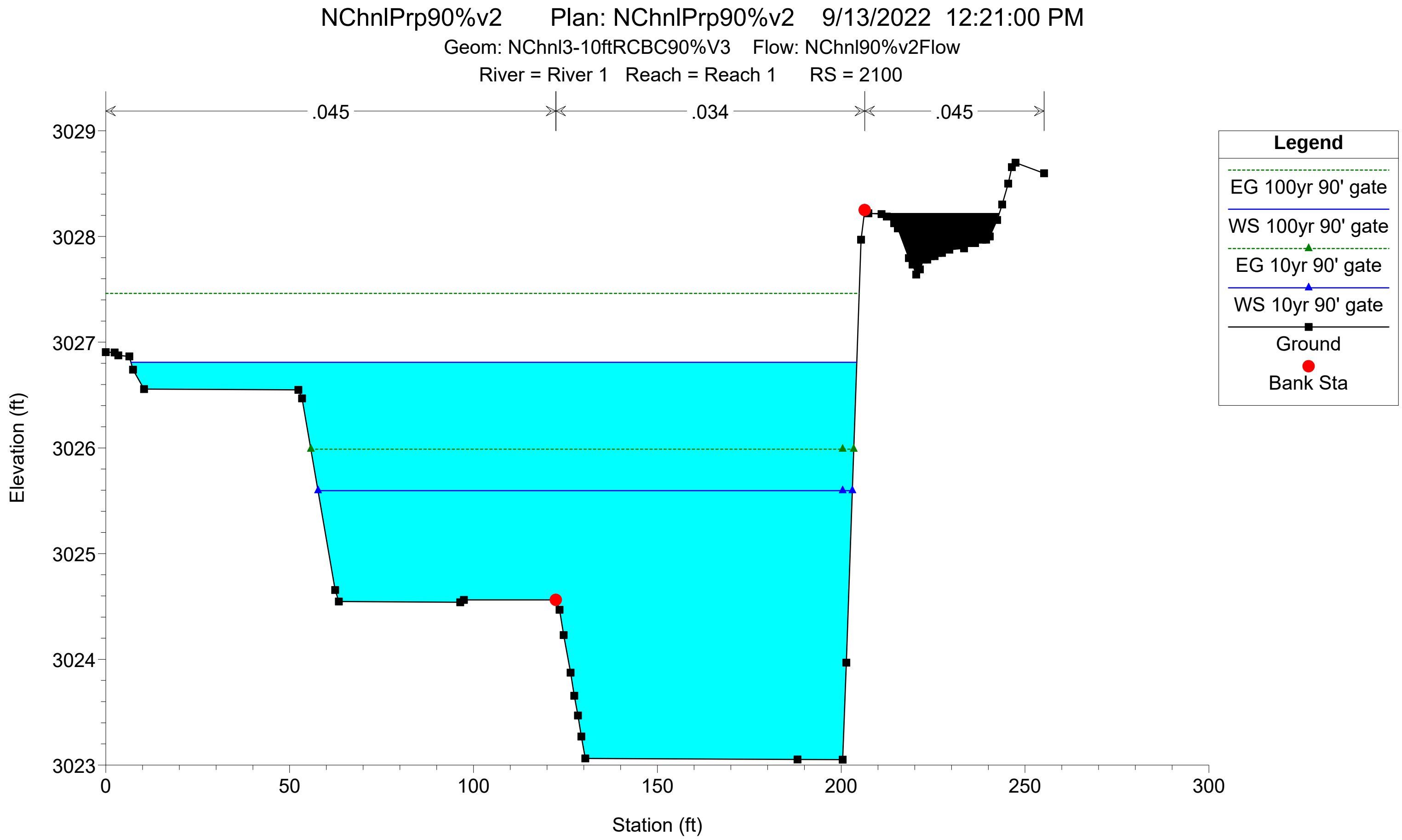

NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 3100
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta

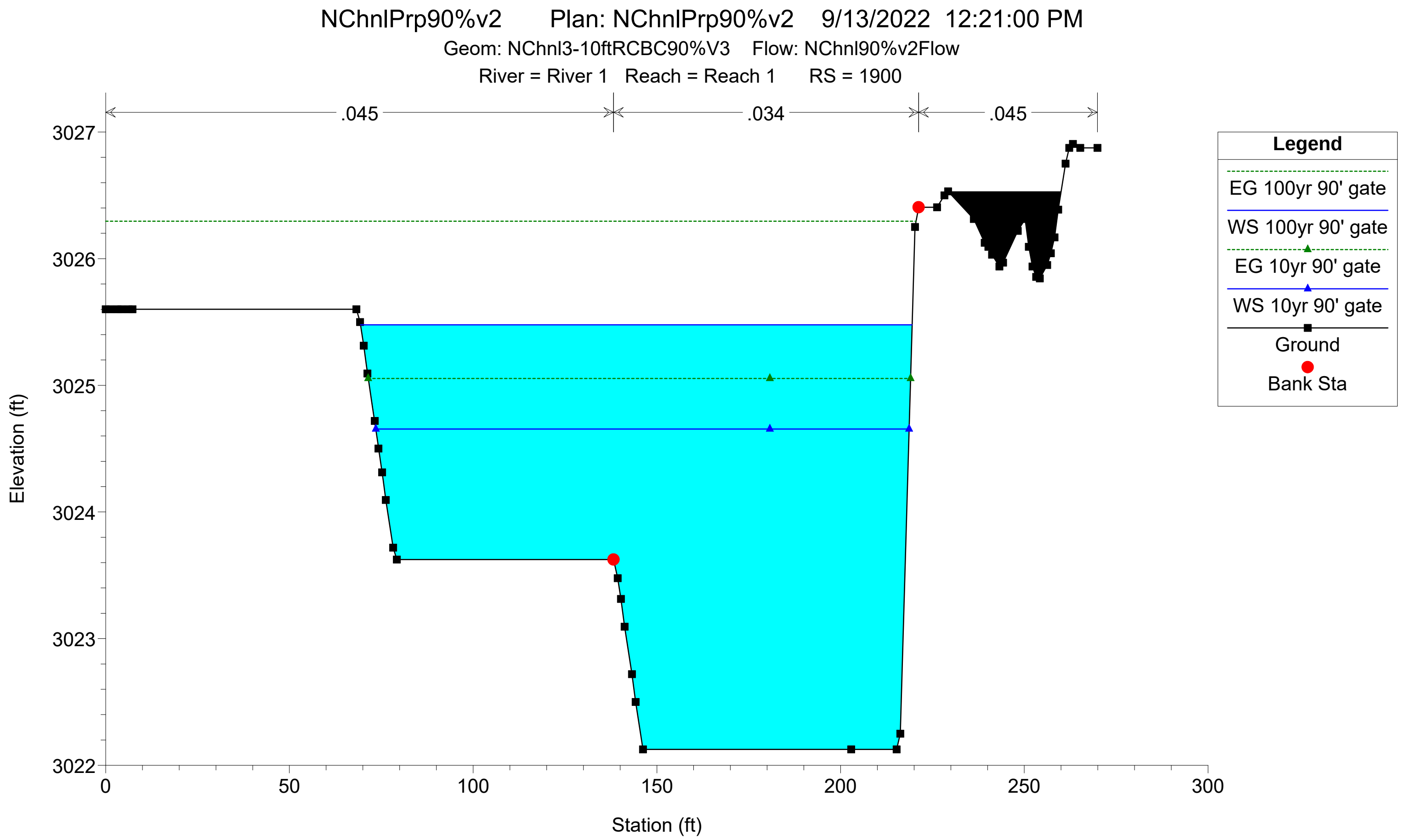

NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 2900
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Ground
Bank Sta

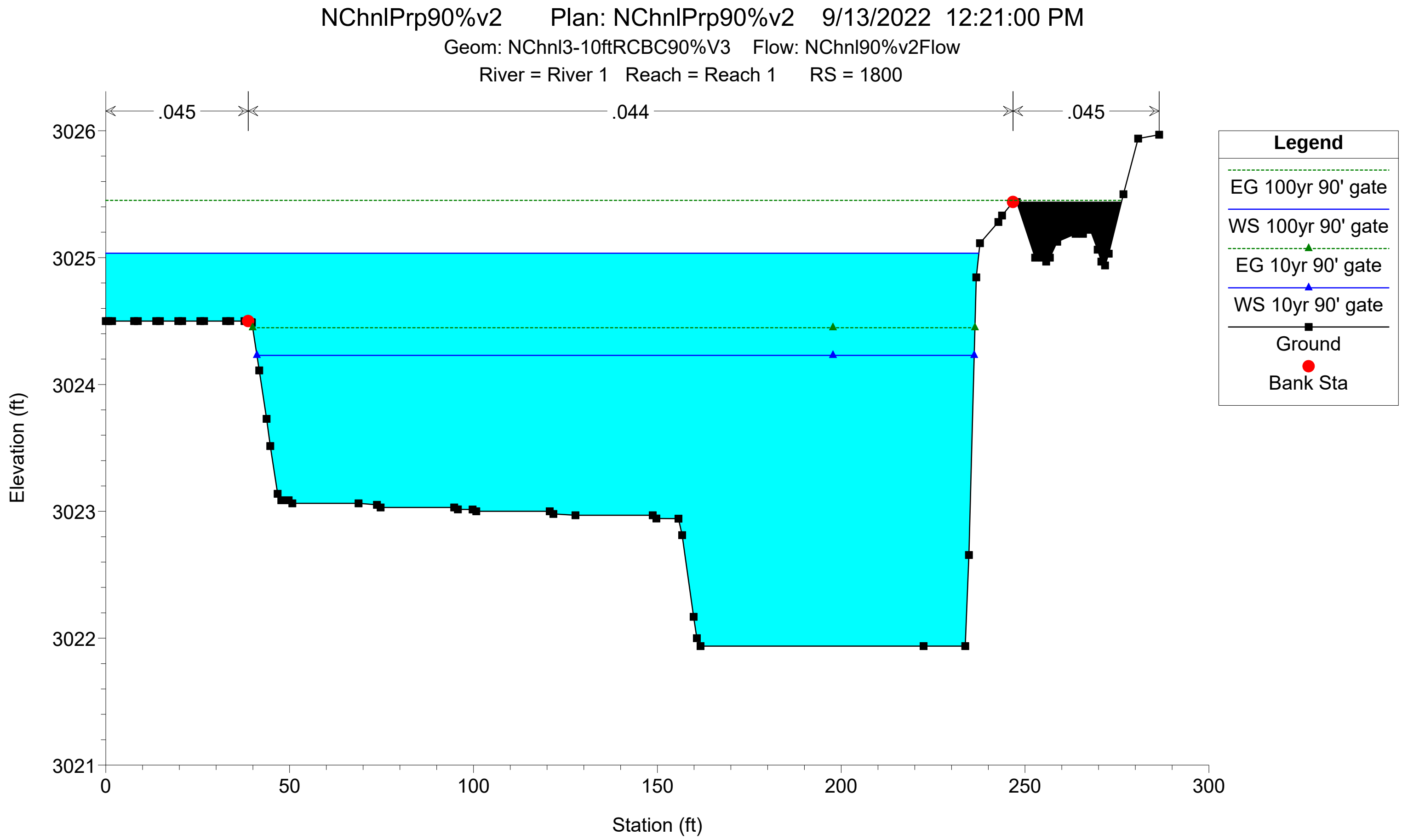

NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 2700
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta

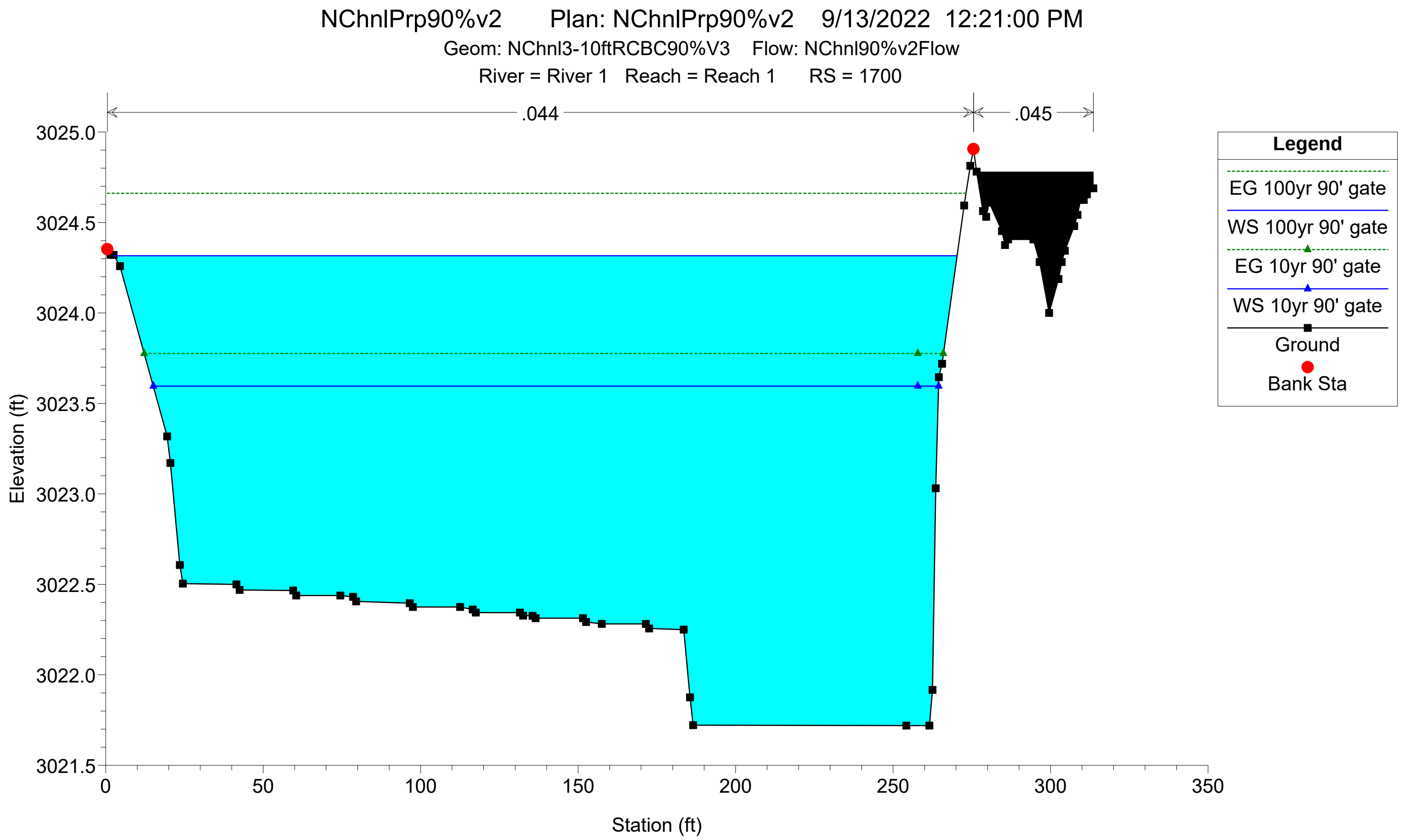

NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 2500
.045
.034
.045
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta
Elevation (ft)
Station (ft)

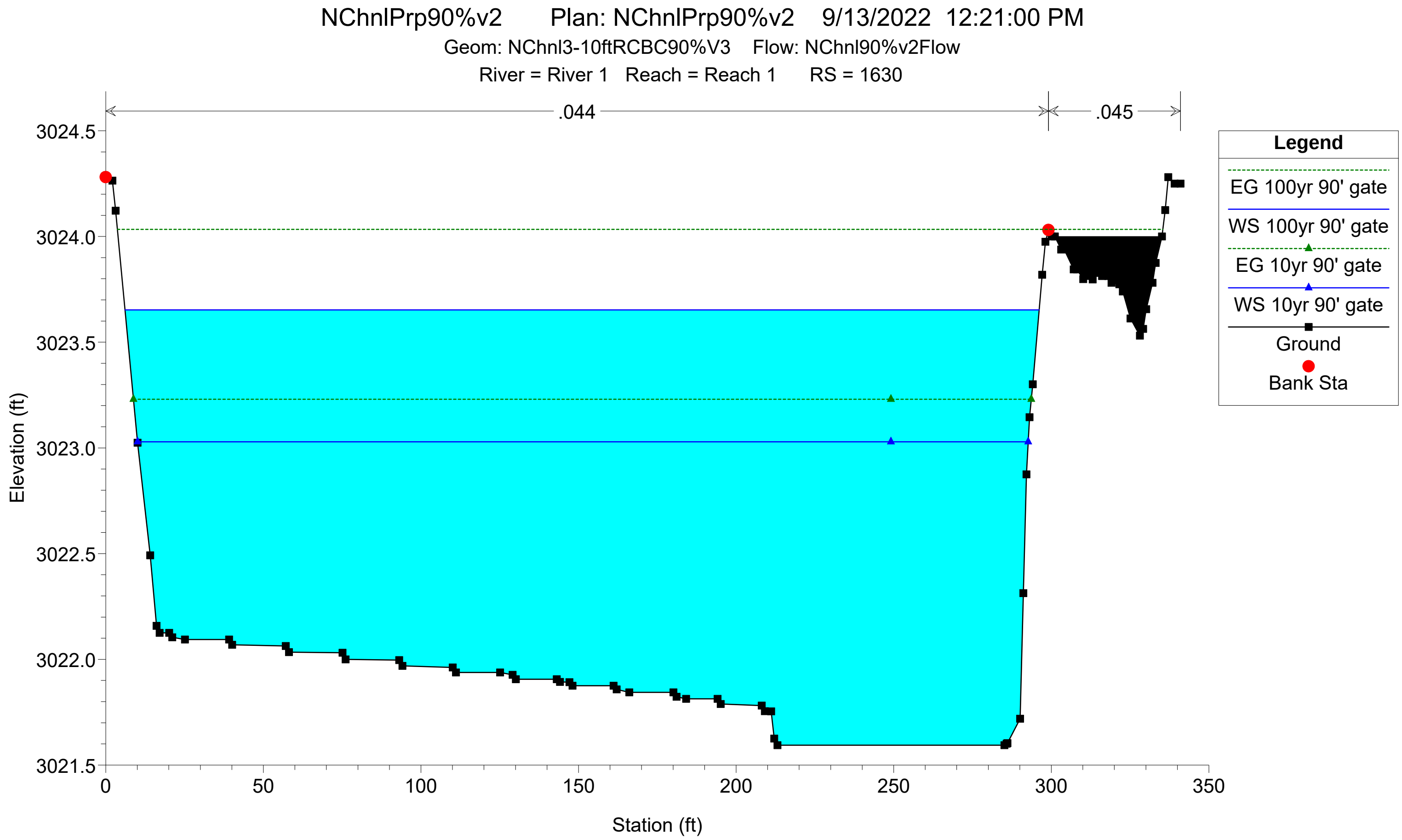

NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 2300
.045
.034
.045
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta
Elevation (ft)
Station (ft)

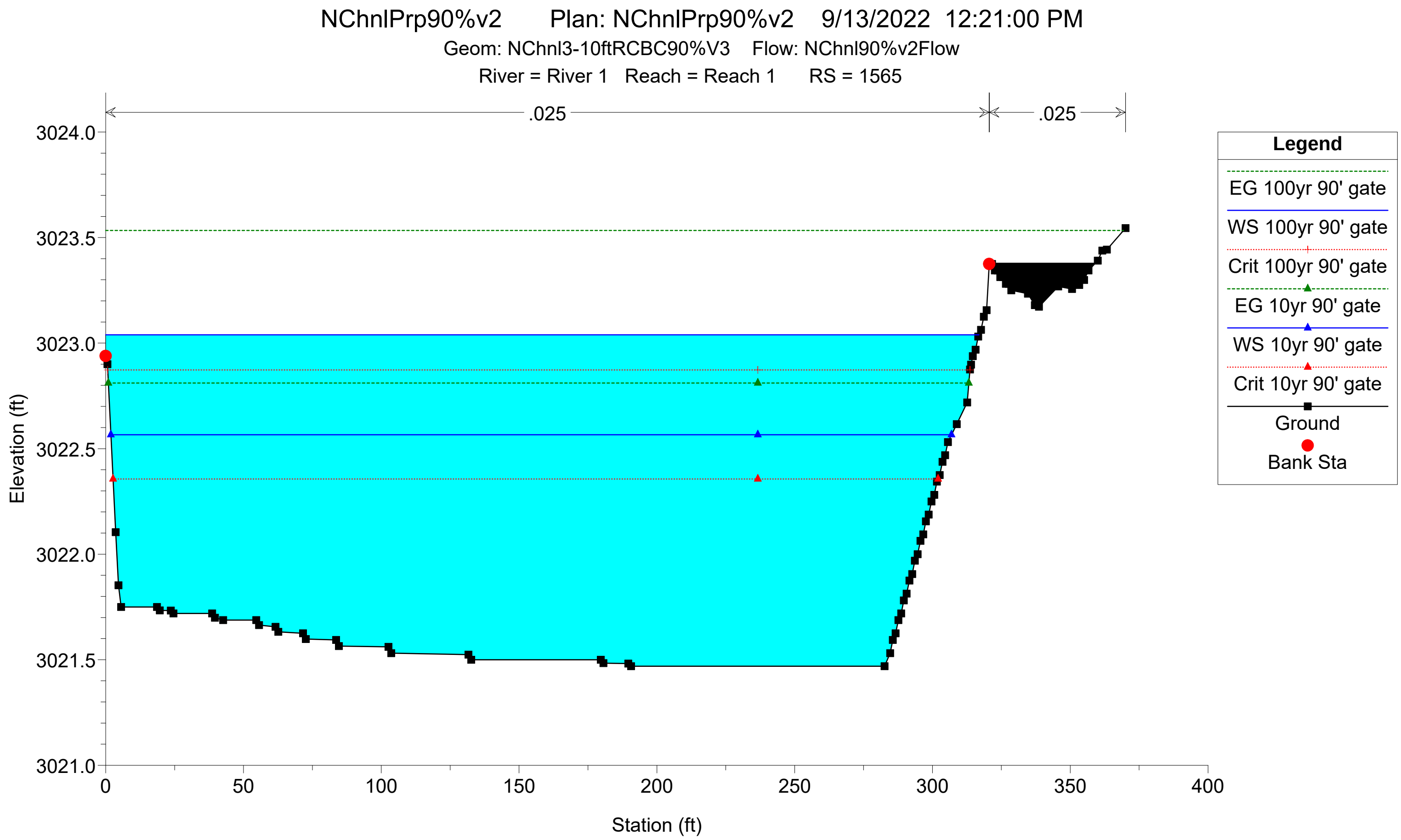

NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 2100
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Ground
Bank Sta

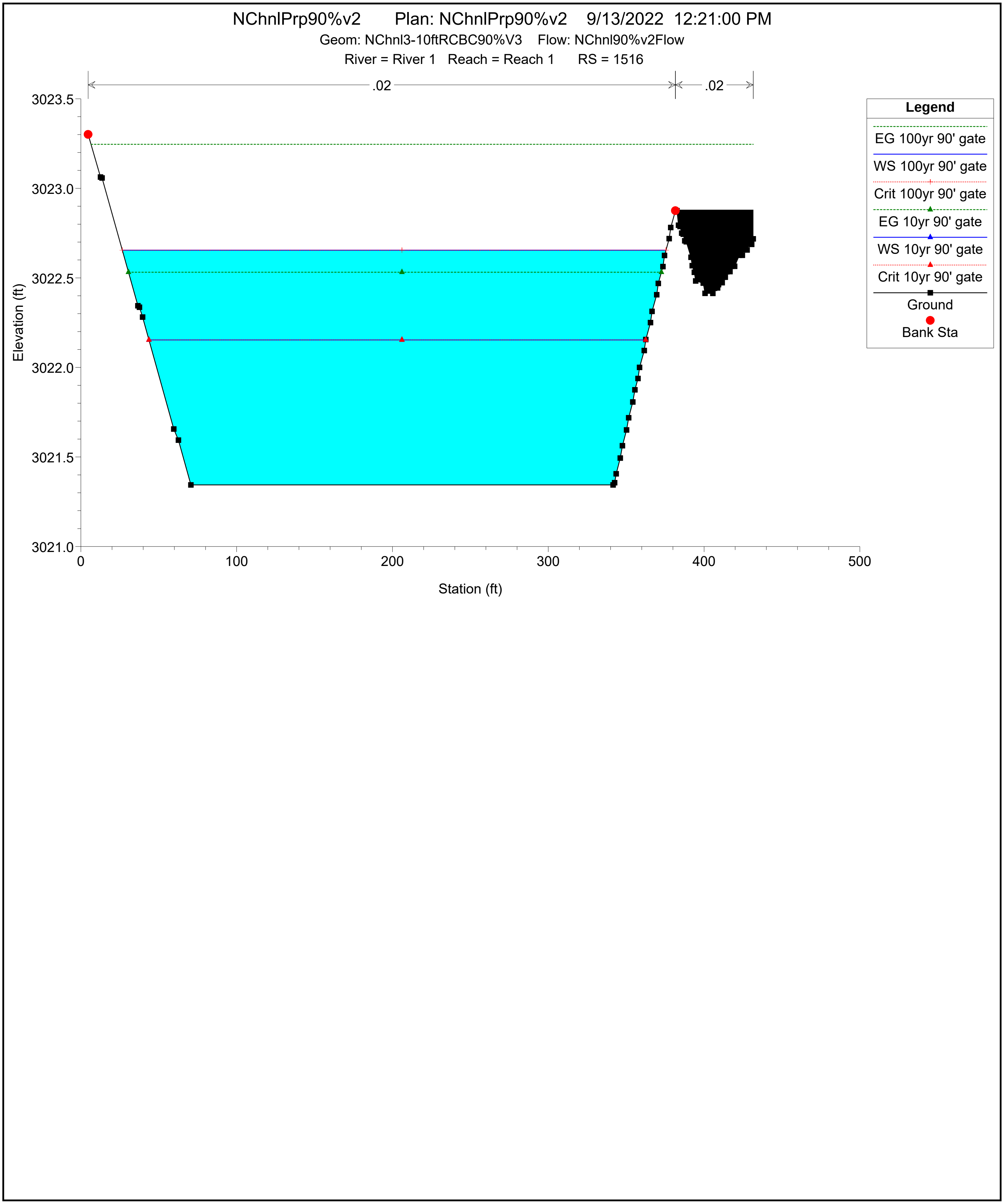

NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 1900
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Ground
Bank Sta


NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 1800
.045
.044
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Ground
Bank Sta


NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 1700
.044
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Ground
Bank Sta


NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 1630
.044
.045
Elevation (ft)
Station (ft)
3024.5
3024.0
3023.5
3023.0
3022.5
3022.0
3021.5
0
50
100
150
200
250
300
350
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Ground
Bank Sta


NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 1565
.025
.025
Elevation (ft)
Station (ft)
3024.0
3023.5
3023.0
3022.5
3022.0
3021.5
3021.0
0
50
100
150
200
250
300
350
400
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta



NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 12:21:00 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 1516
.02
.02
Elevation (ft)
3023.5
3023.0
3022.5
3022.0
3021.5
3021.0
0
100
200
300
400
500
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
Ground
Bank Sta

FG Channels-N Chnl Mixed Flow Run
2022.09.13

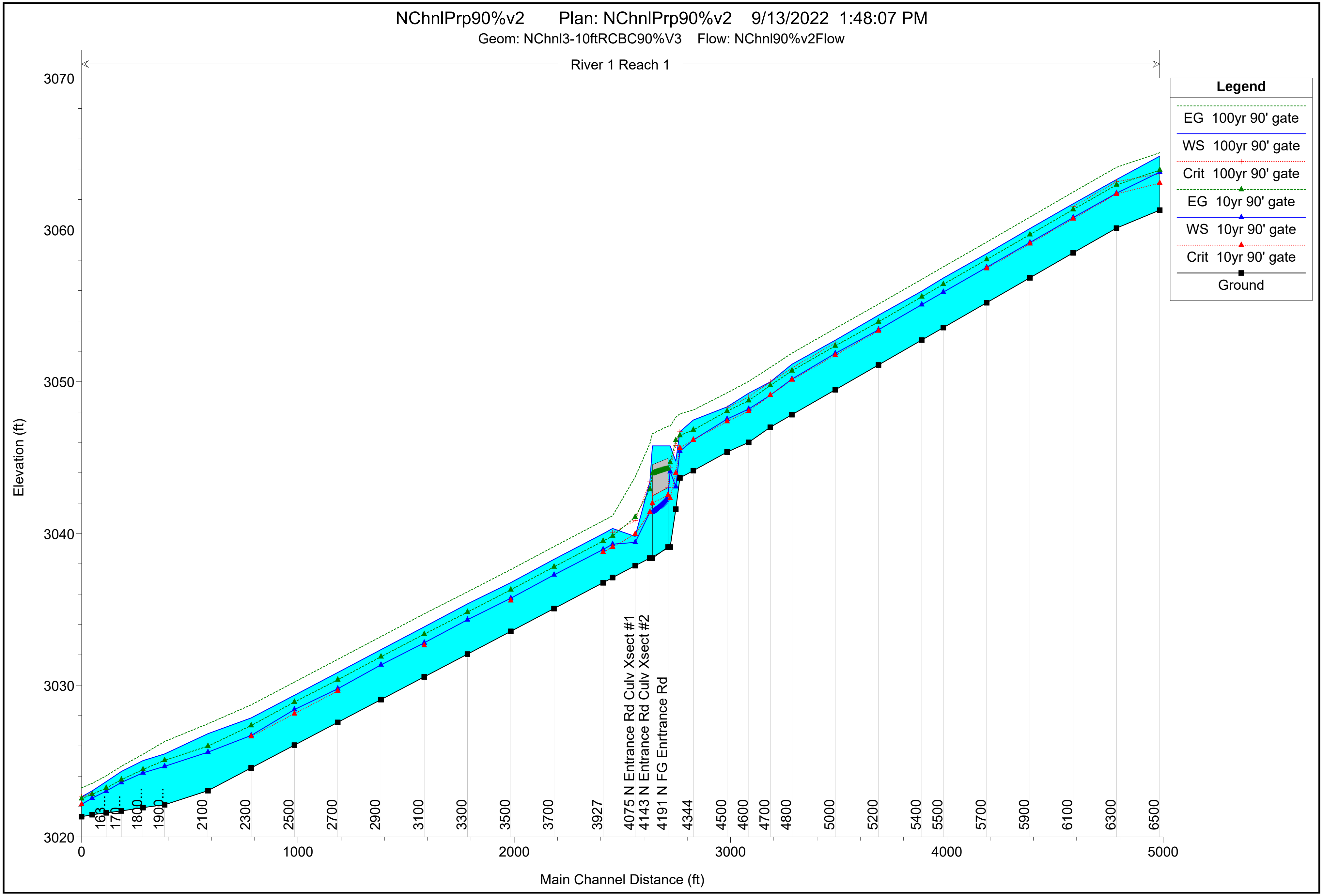
HEC-RAS Plan: NChnl90%v2 River: River 1 Reach: Reach 1

Reach	River Sta	Profile	Q Total	Q Channel	Q Left	Q Right	Max Chl Dpth	Hydr Depth C	W.S. Elev	E.G. Slope	Vel Chnl	Vel Left	Vel Right	Top W Chnl	Top W Left	Top W Right	Froude # Chl
			(cfs)	(cfs)	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft/s)	(ft/s)	(ft)	(ft)	(ft)	
Reach 1	6500	100yr 90' gate	2416.00	1846.73	569.27		3.55	2.85	3064.85	0.002992	4.08	2.94		158.51	95.75		0.43
Reach 1	6500	10yr 90' gate	1120.00	921.61	198.39		2.50	1.89	3063.80	0.003156	3.19	2.04		152.46	86.56		0.41
Reach 1	6300	100yr 90' gate	2416.00	1643.95	618.48	153.58	3.20	3.00	3063.32	0.007846	8.27	4.07	3.80	66.23	95.71	28.06	0.84
Reach 1	6300	10yr 90' gate	1120.00	906.68	172.06	41.26	2.29	2.09	3062.41	0.007908	6.54	2.52	2.42	66.23	89.01	23.54	0.80
Reach 1	6100	100yr 90' gate	2416.00	1615.58	640.11	160.31	3.23	3.04	3061.72	0.008332	8.11	4.19	3.87	65.58	92.77	28.36	0.82
Reach 1	6100	10yr 90' gate	1120.00	893.26	182.77	43.97	2.33	2.13	3060.81	0.008302	6.39	2.59	2.47	65.58	88.17	23.84	0.77
Reach 1	5900	100yr 90' gate	2416.00	1612.64	642.85	160.51	3.24	3.05	3060.09	0.008107	8.02	4.17	3.84	65.93	92.70	28.36	0.81
Reach 1	5900	10yr 90' gate	1120.00	891.45	184.39	44.16	2.32	2.13	3059.17	0.008166	6.34	2.59	2.46	65.93	88.12	23.78	0.77
Reach 1	5700	100yr 90' gate	2416.00	1617.88	640.40	157.72	3.23	3.03	3058.43	0.008304	8.09	4.19	3.86	65.93	92.80	27.98	0.82
Reach 1	5700	10yr 90' gate	1120.00	891.47	184.66	43.87	2.33	2.14	3057.53	0.008116	6.33	2.58	2.47	65.93	88.33	23.48	0.76
Reach 1	5500	100yr 90' gate	2416.00	1606.02	648.72	161.26	3.27	3.05	3056.83	0.007914	7.93	4.13	3.81	66.35	94.00	28.57	0.80
Reach 1	5500	10yr 90' gate	1120.00	890.98	184.75	44.27	2.33	2.12	3055.90	0.008185	6.33	2.58	2.46	66.35	89.39	23.89	0.77
Reach 1	5400	100yr 90' gate	2416.00	1621.16	640.26	154.58	3.22	3.02	3055.96	0.008480	8.14	4.21	3.87	65.96	93.04	27.59	0.83
Reach 1	5400	10yr 90' gate	1120.00	892.55	184.66	42.79	2.33	2.13	3055.07	0.008188	6.35	2.58	2.46	65.96	88.72	23.22	0.77
Reach 1	5200	100yr 90' gate	2416.00	1603.40	650.25	162.36	3.29	3.09	3054.38	0.007665	7.87	4.11	3.78	65.83	92.93	28.64	0.79
Reach 1	5200	10yr 90' gate	1120.00	892.95	183.21	43.83	2.32	2.13	3053.42	0.008255	6.37	2.59	2.47	65.83	88.14	23.72	0.77
Reach 1	5000	100yr 90' gate	2416.00	1636.98	623.84	155.18	3.26	3.06	3052.73	0.008301	8.13	4.15	3.83	65.79	92.66	28.07	0.82
Reach 1	5000	10yr 90' gate	1120.00	896.70	180.13	43.17	2.40	2.19	3051.86	0.007545	6.21	2.50	2.39	65.79	88.32	23.77	0.74
Reach 1	4800	100yr 90' gate	2416.00	1600.06	609.22	206.72	3.32	3.08	3051.15	0.007843	7.88	4.16	4.09	65.93	85.05	29.40	0.79
Reach 1	4800	10yr 90' gate	1120.00	902.04	161.71	56.26	2.34	2.10	3050.17	0.008914	6.51	2.56	2.56	65.93	84.82	28.94	0.79
Reach 1	4700	100yr 90' gate	2416.00	1943.55	472.45		2.98	2.76	3049.98	0.010644	8.55	4.03		82.37	90.74		0.91
Reach 1	4700	10yr 90' gate	1120.00	1039.55	80.45		2.11	1.94	3049.11	0.010273	6.64	2.01		80.75	86.39		0.84
Reach 1	4600	100yr 90' gate	2416.00	1960.55	455.45		3.24	3.14	3049.24	0.006518	7.68	3.42		81.41	91.23		0.76
Reach 1	4600	10yr 90' gate	1120.00	1052.16	67.84		2.20	2.13	3048.20	0.006980	6.15	1.67		80.37	85.97		0.74
Reach 1	4500	100yr 90' gate	2416.00	1957.16	458.84		2.98	2.90	3048.34	0.008576	8.37	3.73		80.55	91.25		0.87
Reach 1	4500	10yr 90' gate	1120.00	1023.44	96.56		2.17	2.12	3047.53	0.006782	6.05	1.90		79.74	87.31		0.73
Reach 1	4344	100yr 90' gate	2416.00	1879.95	536.05		3.33	3.24	3047.47	0.005433	7.16	3.48		81.06	92.90		0.70
Reach 1	4344	10yr 90' gate	1120.00	1053.35	66.65		2.02	1.97	3046.16	0.009133	6.69	1.82		79.75	86.34		0.84
Reach 1	4282	100yr 90' gate	2416.00	2183.80	232.20		3.04	2.96	3046.70	0.002066	9.16	1.87		80.46	91.71		0.94
Reach 1	4282	10yr 90' gate	1120.00	1114.96	5.04		1.76	1.72	3045.42	0.003397	8.20	0.48		79.18	85.11		1.10
Reach 1	4263	100yr 90' gate	2416.00	2416.00			3.16	2.95	3044.76	0.004696	13.64			59.98			1.40
Reach 1	4263	10yr 90' gate	1120.00	1120.00			1.48	1.43	3043.08	0.012692	14.02			55.74			2.06
Reach 1	4237	100yr 90' gate	2416.00	2330.14	85.86		6.67	5.59	3045.77	0.001032	9.32	0.92		44.75	119.53		0.70
Reach 1	4237	10yr 90' gate	1120.00	1120.00			4.97	4.74	3044.07	0.000536	6.22			42.14			0.50
Reach 1	4191		Culvert														
Reach 1	4143	100yr 90' gate	2416.00	2416.00			5.04	5.00	3043.41	0.017384	12.72			77.02	95.57		1.00
Reach 1	4143	10yr 90' gate	1120.00	1120.00			3.02	2.98	3041.40	0.020818	9.88			75.03	91.98		1.01

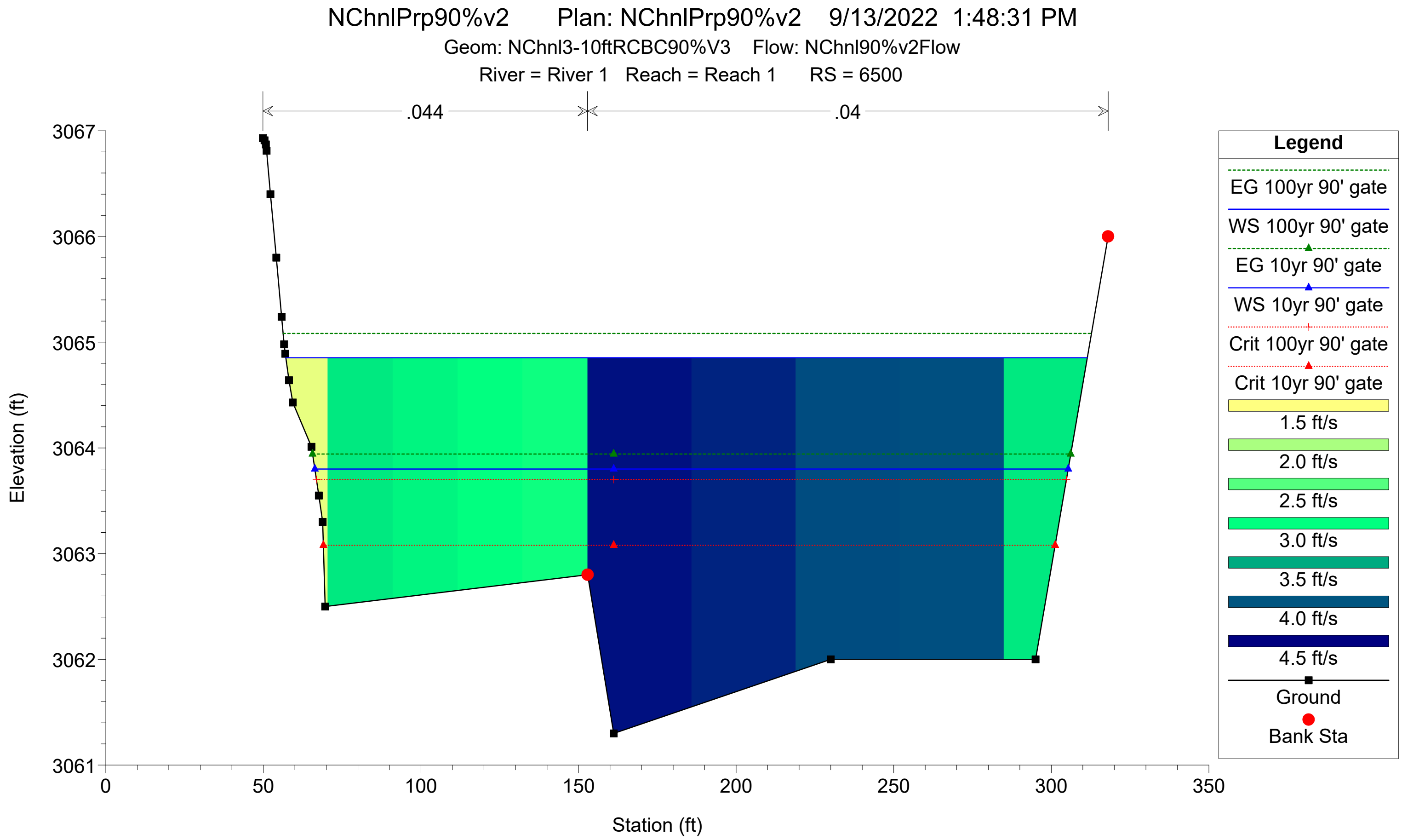
HEC-RAS Plan: NChnl90%v2 River: River 1 Reach: Reach 1 (Continued)

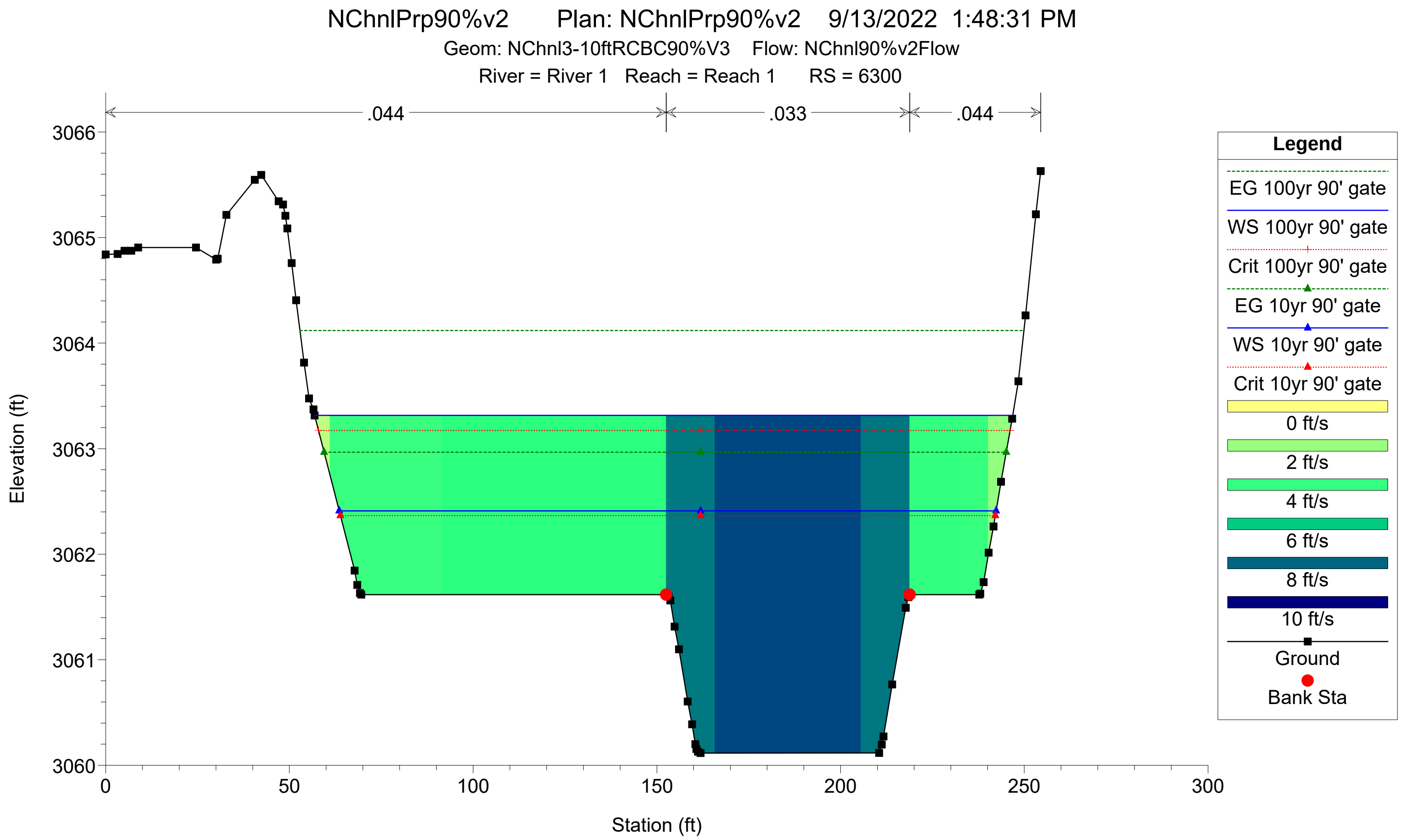
Reach	River Sta	Profile	Q Total	Q Channel	Q Left	Q Right	Max Chl Dpth	Hydr Depth C	W.S. Elev	E.G. Slope	Vel Chnl	Vel Left	Vel Right	Top W Chnl	Top W Left	Top W Right	Froude # Chl
			(cfs)	(cfs)	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft/s)	(ft/s)	(ft)	(ft)	(ft)	
Reach 1	4075	100yr 90' gate	2416.00	2258.92	157.08		1.93	1.80	3039.80	0.065311	16.38	4.78		76.77	77.18		2.15
Reach 1	4075	10yr 90' gate	1120.00	1117.82	2.18		1.53	1.41	3039.41	0.035908	10.36	0.73		76.38	75.19		1.54
Reach 1	3971	100yr 90' gate	2416.00	1980.81	435.19		3.23	3.09	3040.32	0.007457	7.91	3.93		81.00	68.39		0.79
Reach 1	3971	10yr 90' gate	1120.00	1025.60	94.40		2.20	2.09	3039.29	0.007492	6.13	2.20		79.97	63.22		0.75
Reach 1	3927	100yr 90' gate	2416.00	1996.85	419.15		3.23	3.08	3039.98	0.007551	7.95	3.90		81.63	67.74		0.80
Reach 1	3927	10yr 90' gate	1120.00	1033.66	86.34		2.20	2.08	3038.95	0.007654	6.17	2.15		80.59	62.56		0.76
Reach 1	3700	100yr 90' gate	2416.00	1979.82	436.18		3.24	3.10	3038.30	0.007385	7.90	3.91		80.83	68.60		0.79
Reach 1	3700	10yr 90' gate	1120.00	1023.81	96.19		2.22	2.11	3037.27	0.007245	6.07	2.19		79.80	63.53		0.74
Reach 1	3500	100yr 90' gate	2416.00	1991.19	424.81		3.21	3.05	3036.76	0.007712	7.99	3.95		81.60	67.66		0.81
Reach 1	3500	10yr 90' gate	1120.00	1030.99	89.01		2.18	2.06	3035.73	0.007883	6.22	2.20		80.57	62.52		0.77
Reach 1	3300	100yr 90' gate	2416.00	1974.88	441.12		3.31	3.15	3035.36	0.006857	7.69	3.85		81.52	68.35		0.76
Reach 1	3300	10yr 90' gate	1120.00	1019.46	100.54		2.26	2.14	3034.31	0.006760	5.92	2.19		80.47	63.14		0.71
Reach 1	3100	100yr 90' gate	2508.00	2050.67	457.33		3.29	3.14	3033.85	0.007495	8.02	4.01		81.31	68.45		0.80
Reach 1	3100	10yr 90' gate	1180.00	1075.95	104.05		2.25	2.13	3032.80	0.007695	6.29	2.31		80.26	63.21		0.76
Reach 1	2900	100yr 90' gate	2508.00	2048.93	459.07		3.29	3.15	3032.35	0.007497	8.03	4.01		81.12	68.69		0.80
Reach 1	2900	10yr 90' gate	1180.00	1069.06	110.94		2.29	2.18	3031.34	0.007106	6.13	2.31		80.12	63.66		0.73
Reach 1	2700	100yr 90' gate	2508.00	2046.68	461.32		3.29	3.15	3030.84	0.007505	8.04	4.02		80.94	68.83		0.80
Reach 1	2700	10yr 90' gate	1180.00	1078.44	101.56		2.22	2.11	3029.77	0.008078	6.41	2.32		79.86	63.42		0.78
Reach 1	2500	100yr 90' gate	2508.00	2052.51	455.49		3.29	3.13	3029.34	0.007523	8.02	4.02		81.75	68.03		0.80
Reach 1	2500	10yr 90' gate	1180.00	1061.06	118.95		2.35	2.22	3028.40	0.006424	5.91	2.31		80.80	63.34		0.70
Reach 1	2300	100yr 90' gate	2508.00	2048.80	459.21		3.30	3.14	3027.85	0.007437	7.99	4.01		81.57	68.20		0.79
Reach 1	2300	10yr 90' gate	1180.00	1090.22	89.78		2.14	2.02	3026.69	0.009382	6.71	2.32		80.41	62.44		0.83
Reach 1	2100	100yr 90' gate	2508.00	2061.07	446.94		3.76	3.59	3026.81	0.004825	7.02	2.82		81.84	115.56		0.65
Reach 1	2100	10yr 90' gate	1180.00	1034.63	145.37		2.54	2.42	3025.60	0.004630	5.31	2.25		80.63	64.66		0.60
Reach 1	1900	100yr 90' gate	2508.00	2037.63	470.37		3.35	3.21	3025.48	0.006943	7.82	3.95		81.23	68.88		0.77
Reach 1	1900	10yr 90' gate	1180.00	1036.23	143.77		2.53	2.41	3024.66	0.004709	5.34	2.25		80.41	64.70		0.61
Reach 1	1800	100yr 90' gate	2508.00	2469.16	38.84		3.10	2.38	3025.04	0.007555	5.21	1.87		198.71	38.74		0.60
Reach 1	1800	10yr 90' gate	1180.00	1180.00			2.29	1.61	3024.23	0.006573	3.75			195.07			0.52
Reach 1	1700	100yr 90' gate	2508.00	2508.00			2.60	1.99	3024.32	0.007816	4.71			267.64			0.59
Reach 1	1700	10yr 90' gate	1180.00	1180.00			1.88	1.39	3023.60	0.006606	3.41			249.35			0.51
Reach 1	1630	100yr 90' gate	2508.00	2508.00			2.06	1.75	3023.65	0.010252	4.95			290.05			0.66
Reach 1	1630	10yr 90' gate	1180.00	1180.00			1.43	1.16	3023.03	0.009333	3.60			282.60			0.59
Reach 1	1565	100yr 90' gate	2508.00	2508.00			1.57	1.40	3023.04	0.005742	5.64			316.88			0.84
Reach 1	1565	10yr 90' gate	1180.00	1180.00			1.10	0.97	3022.57	0.004631	3.97			305.05			0.71
Reach 1	1516	100yr 90' gate	2508.00	2508.00			1.31	1.17	3022.66	0.005614	6.17			348.96			1.01
Reach 1	1516	10yr 90' gate	1180.00	1180.00			0.81	0.75	3022.15	0.006470	4.93			318.87			1.00

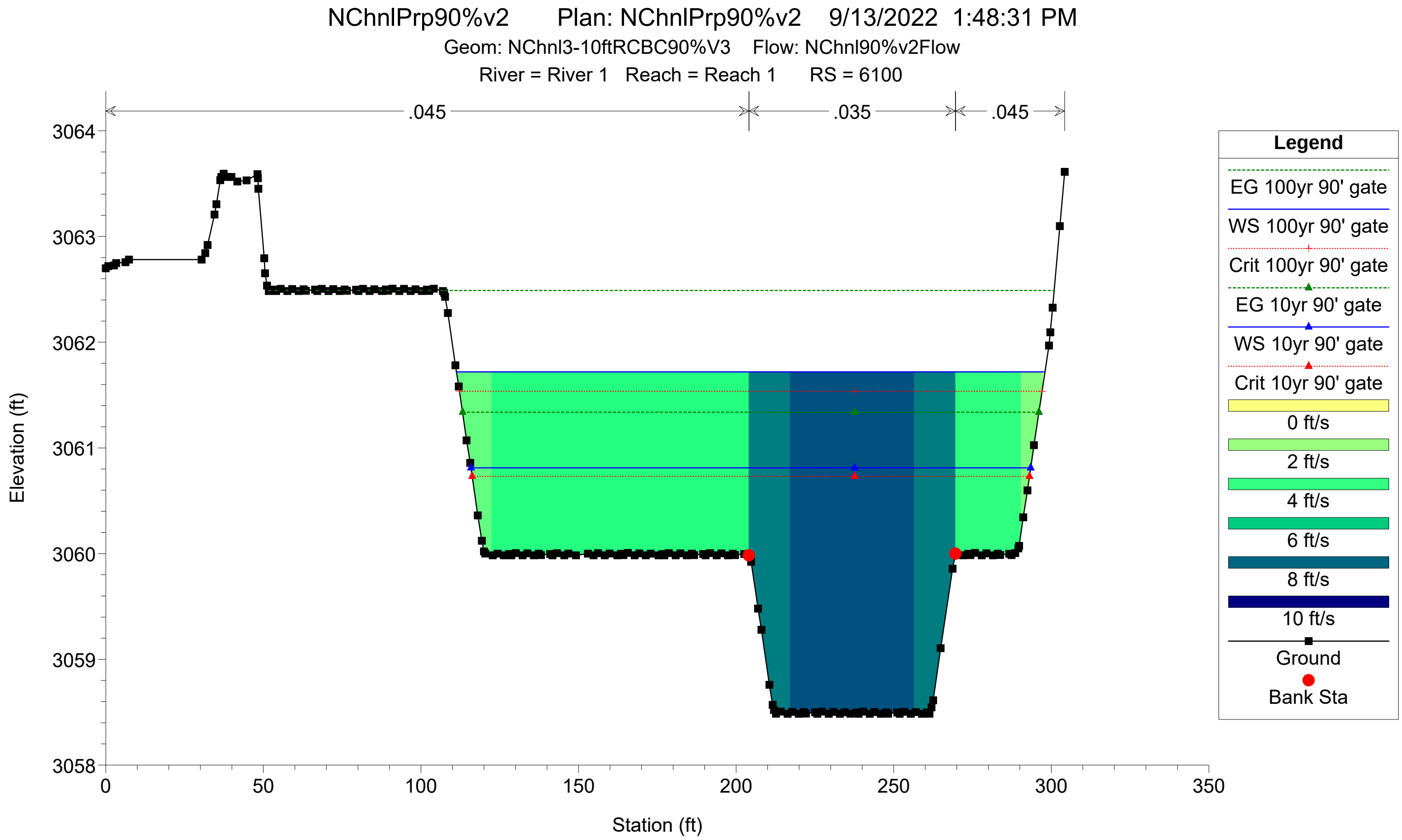
FG Channels-N Chnl Mixed Flow Run
2022.09.13



FG Channels-N Channel Mixed Flow Run_2022.09.13



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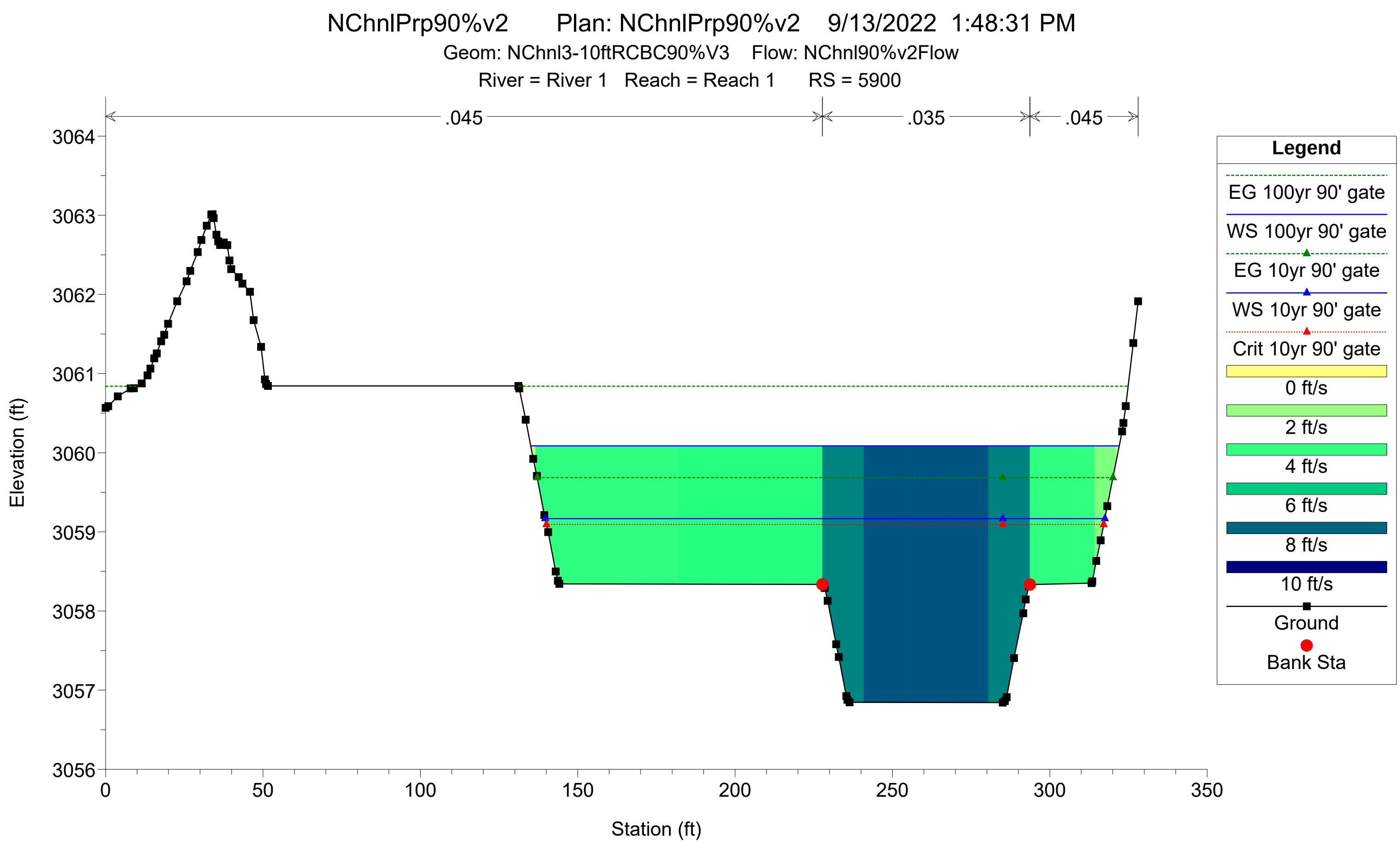
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 6100
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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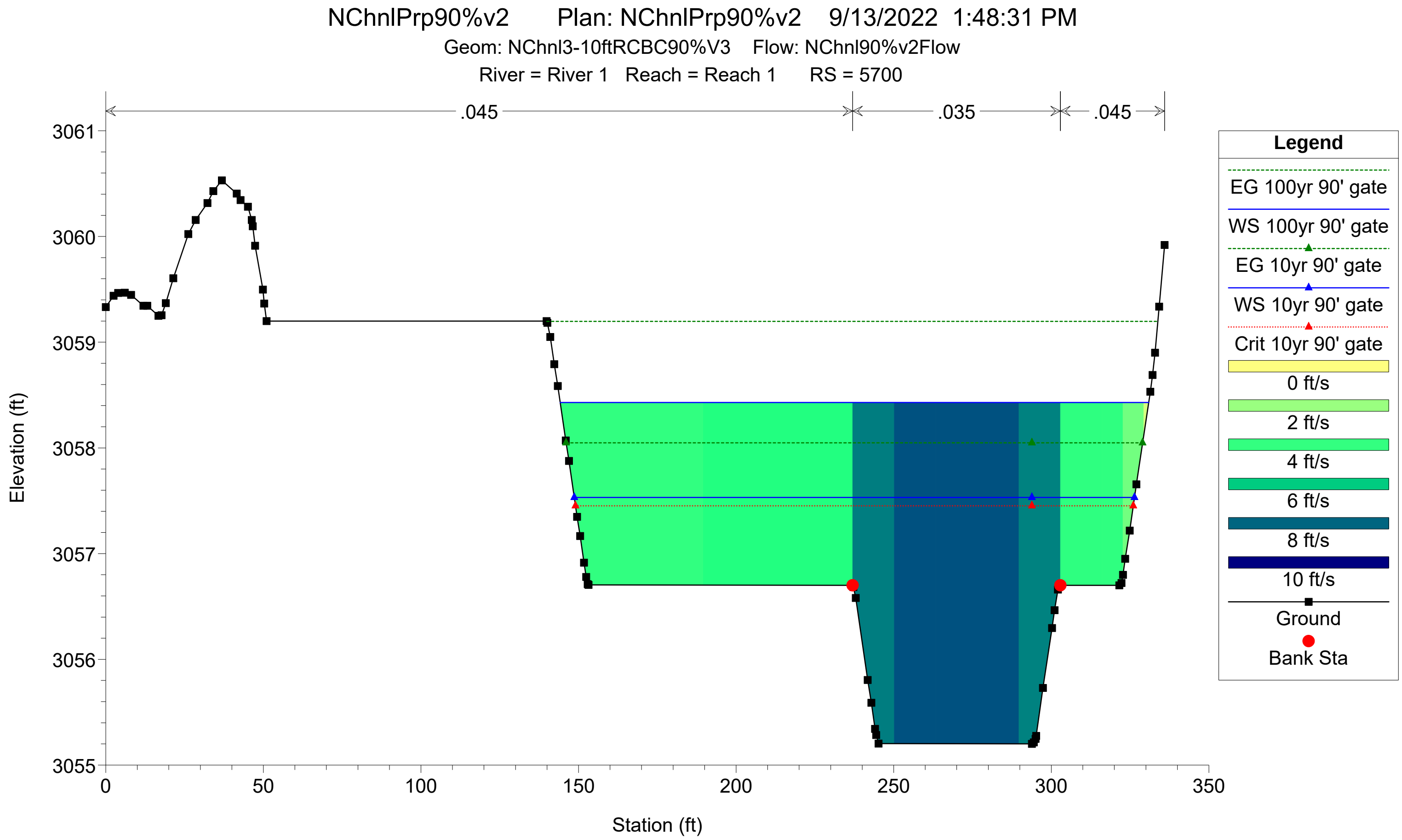
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 5900
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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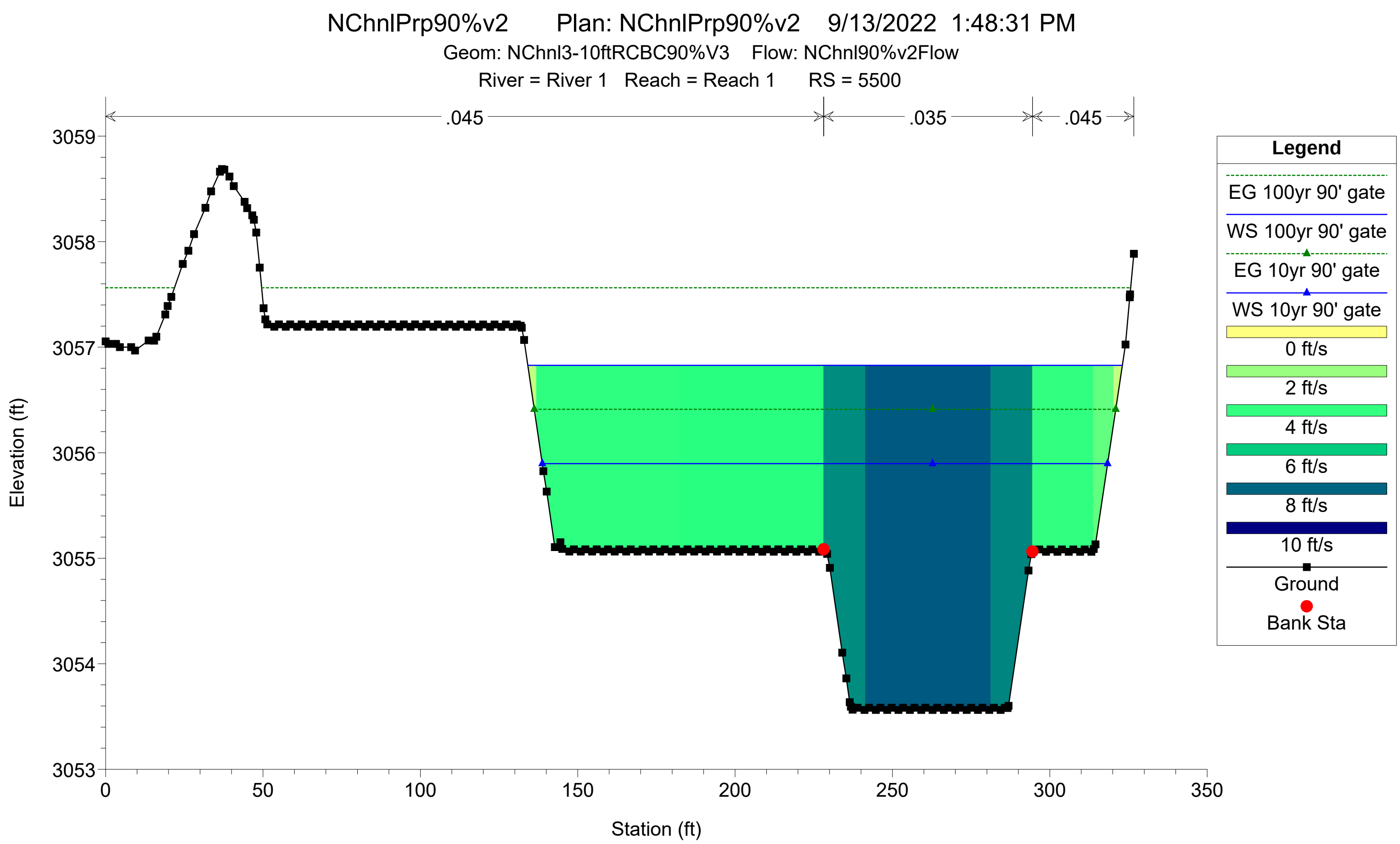
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 5700
.045
.035
.045
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)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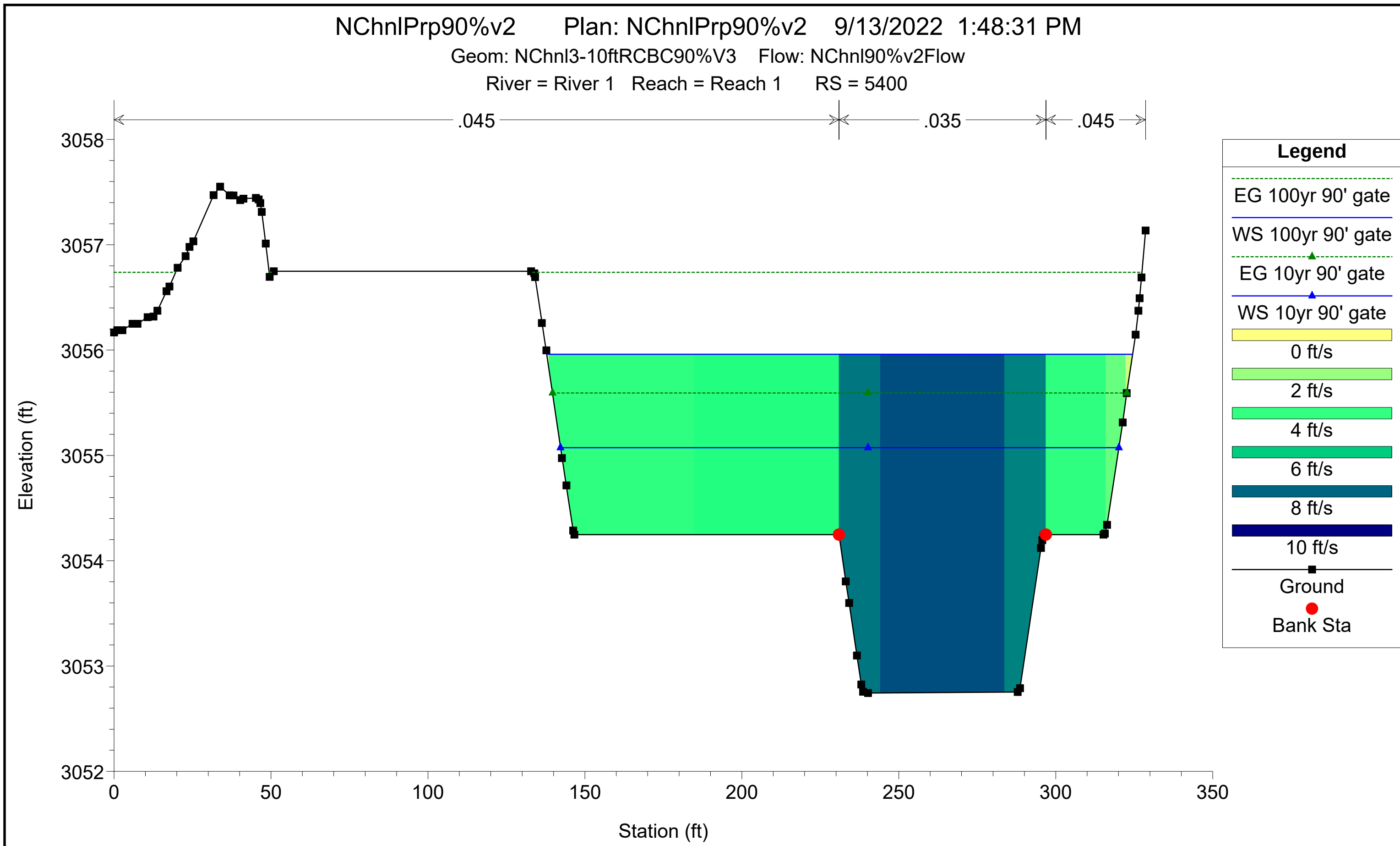
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 5500
.045
.035
.045
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)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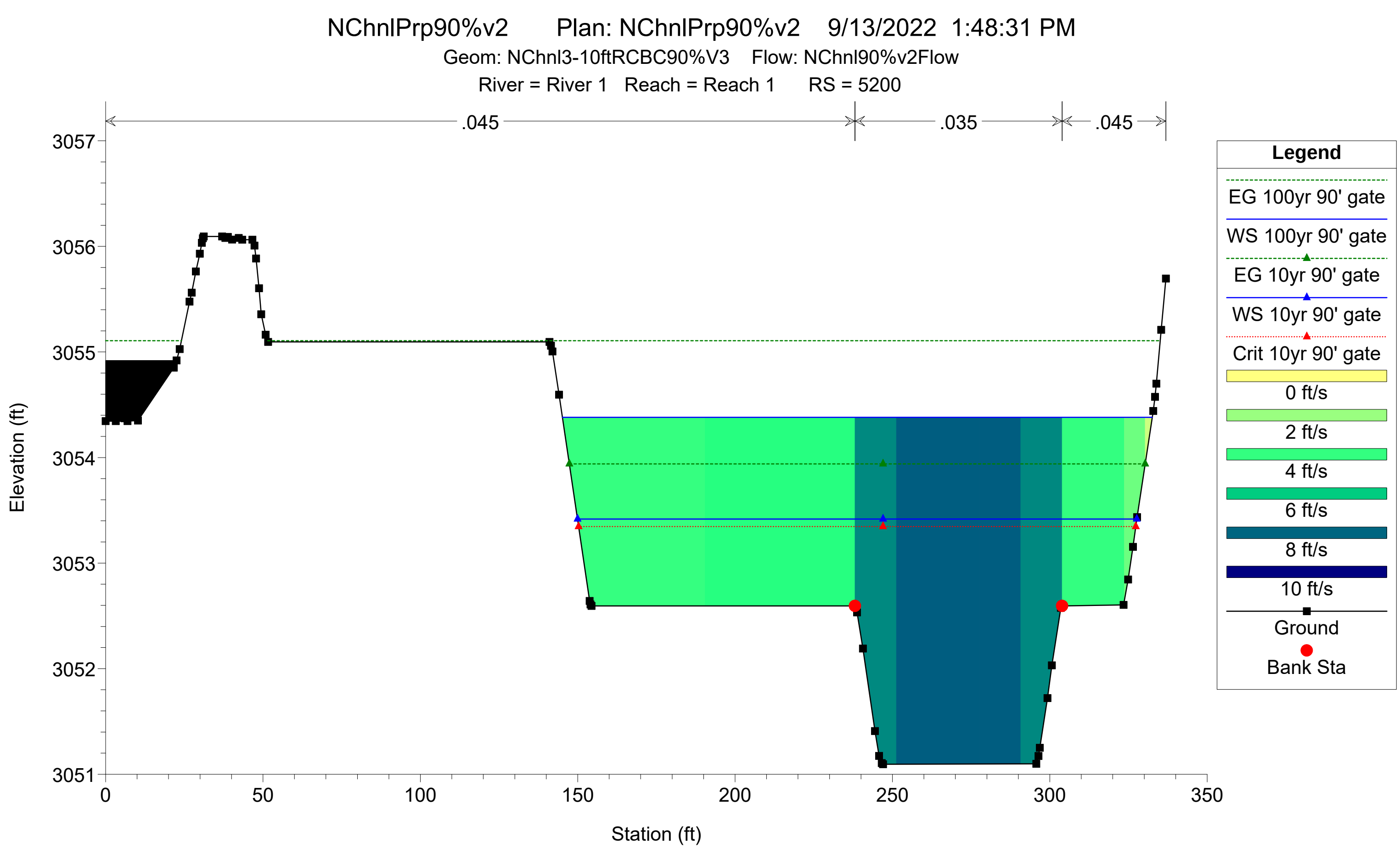
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 5400
.045
.035
.045
Elevation (ft)
3058
3057
3056
3055
3054
3053
3052
0
50
100
150
200
250
300
350
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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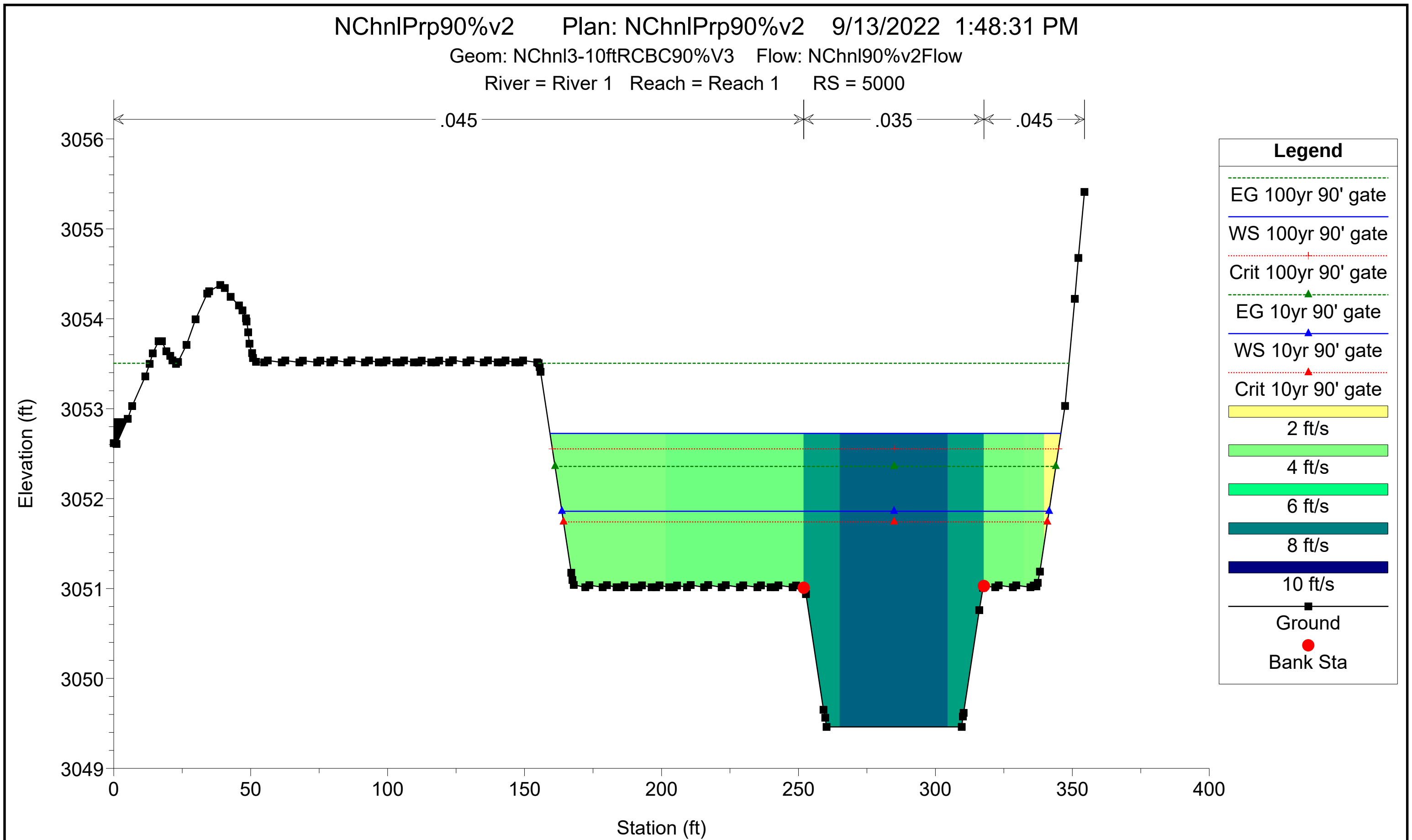
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 5200
.045
.035
.045
Elevation (ft)
3057
3056
3055
3054
3053
3052
3051
0
50
100
150
200
250
300
350
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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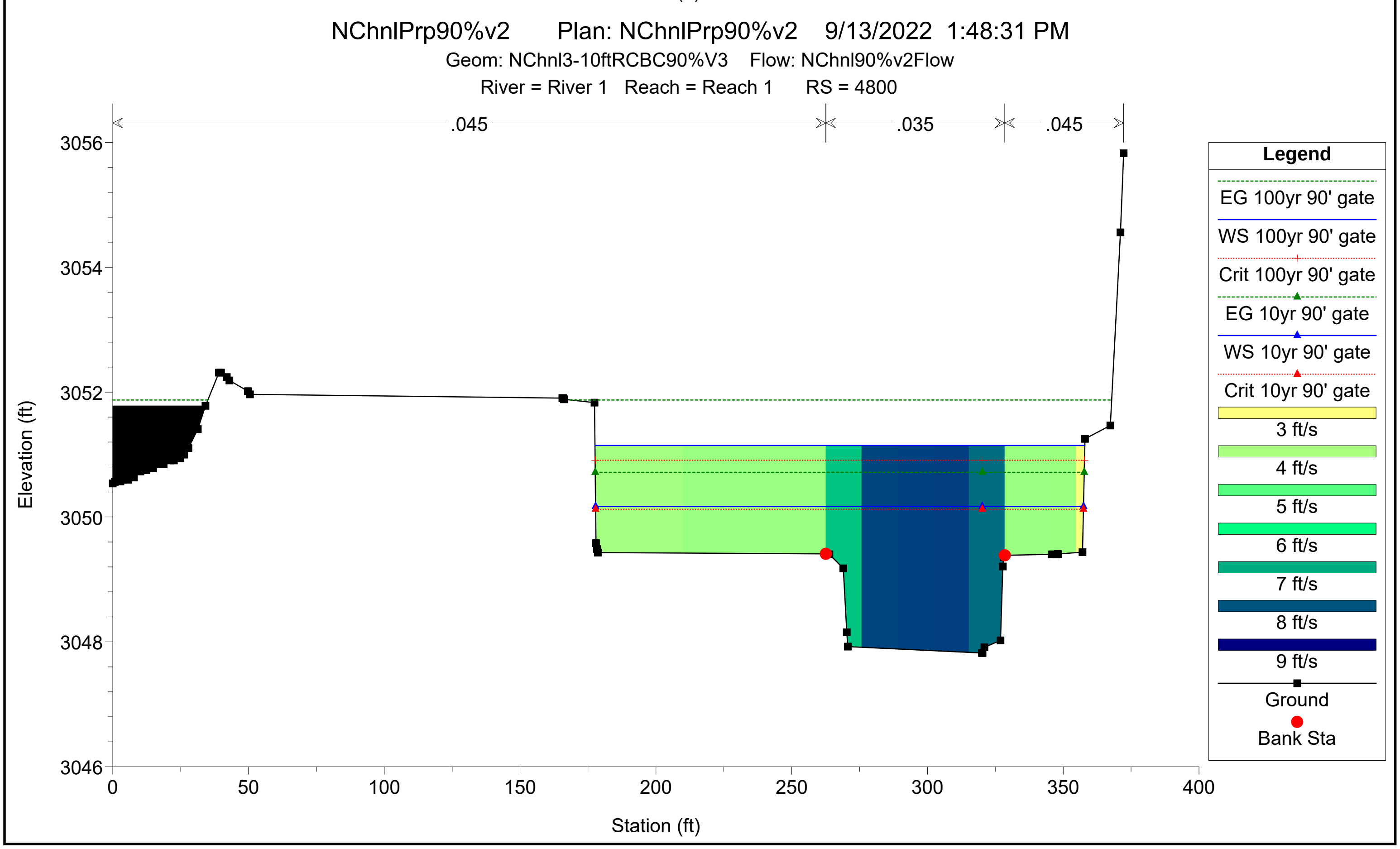
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 5000
.045
.035
.045
Elevation (ft)
3056
3055
3054
3053
3052
3051
3050
3049
0
50
100
150
200
250
300
350
400
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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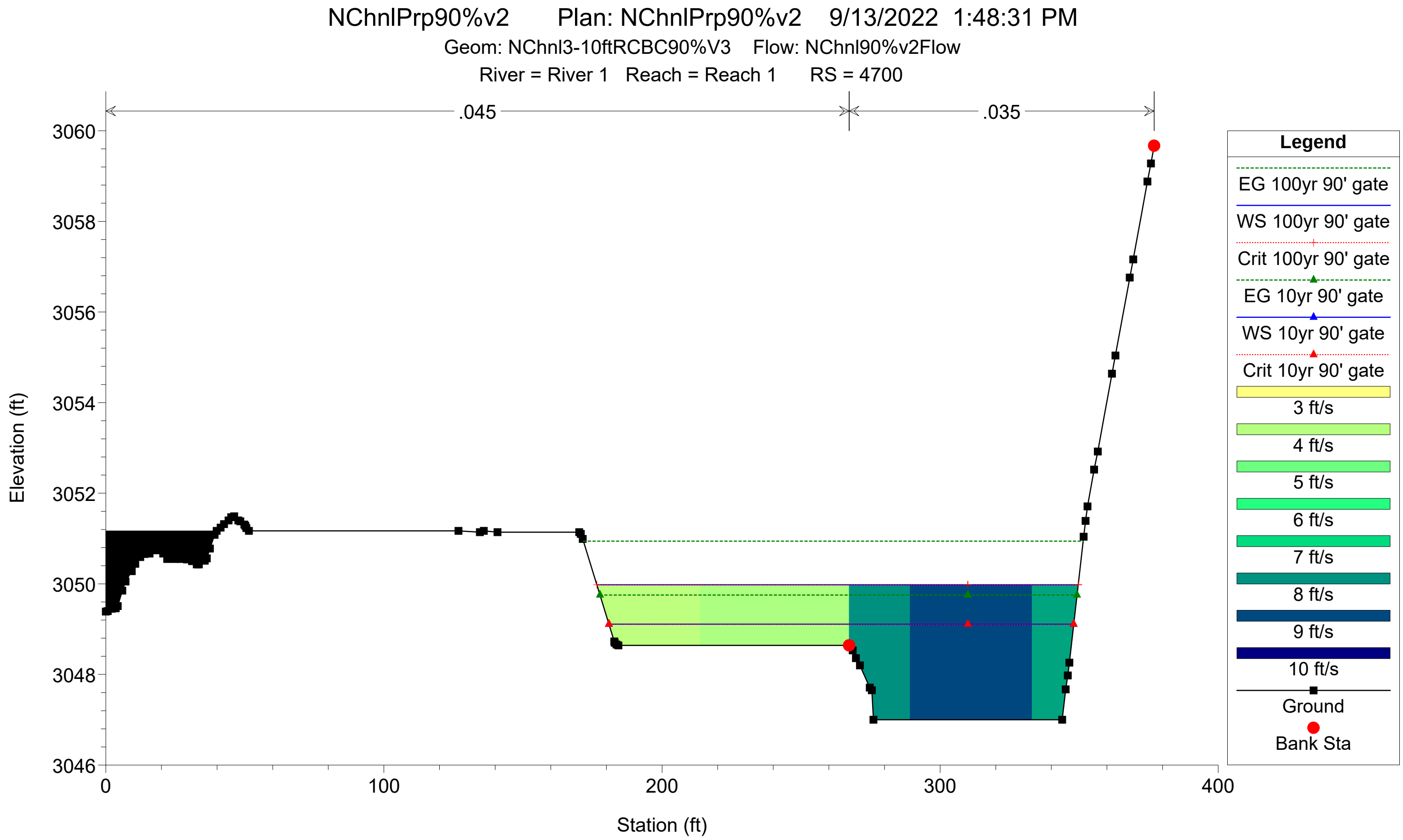
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4800
.045
.035
.045
Elevation (ft)
3056
3054
3052
3050
3048
3046
0
50
100
150
200
250
300
350
400
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta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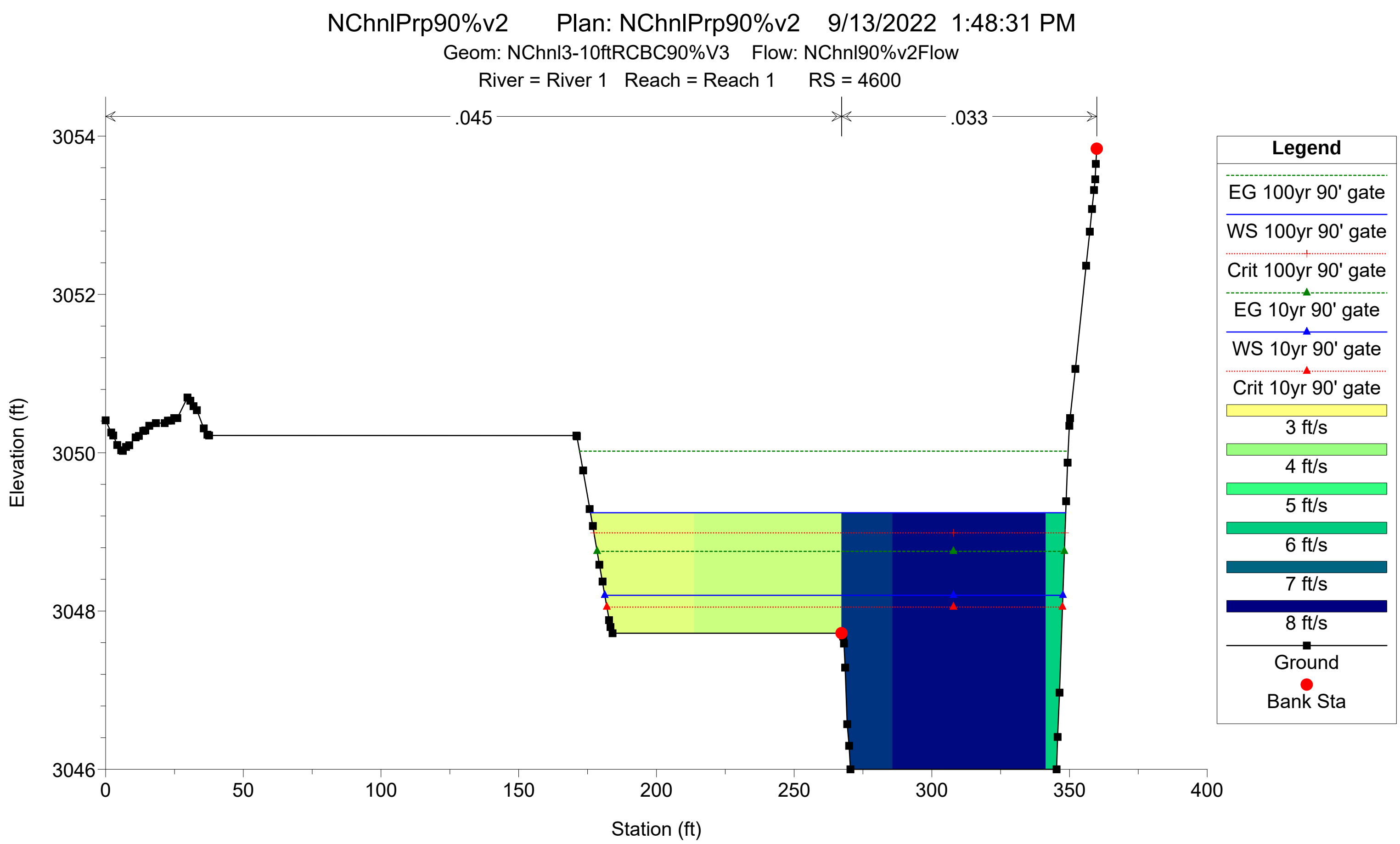
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4700
.045
.035
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
10 ft/s
Ground
Bank Sta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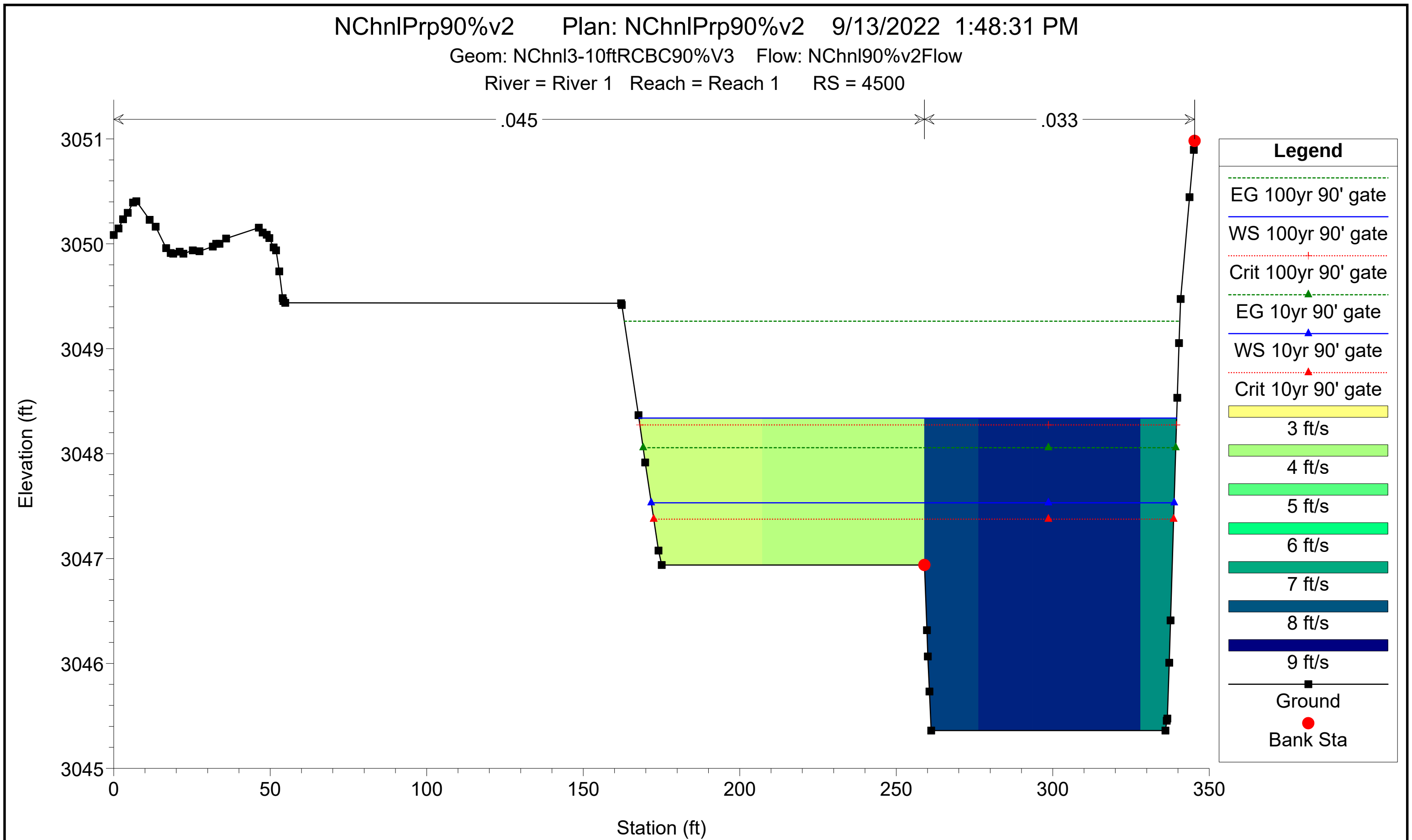
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4600
.045
.033
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
Ground
Bank Sta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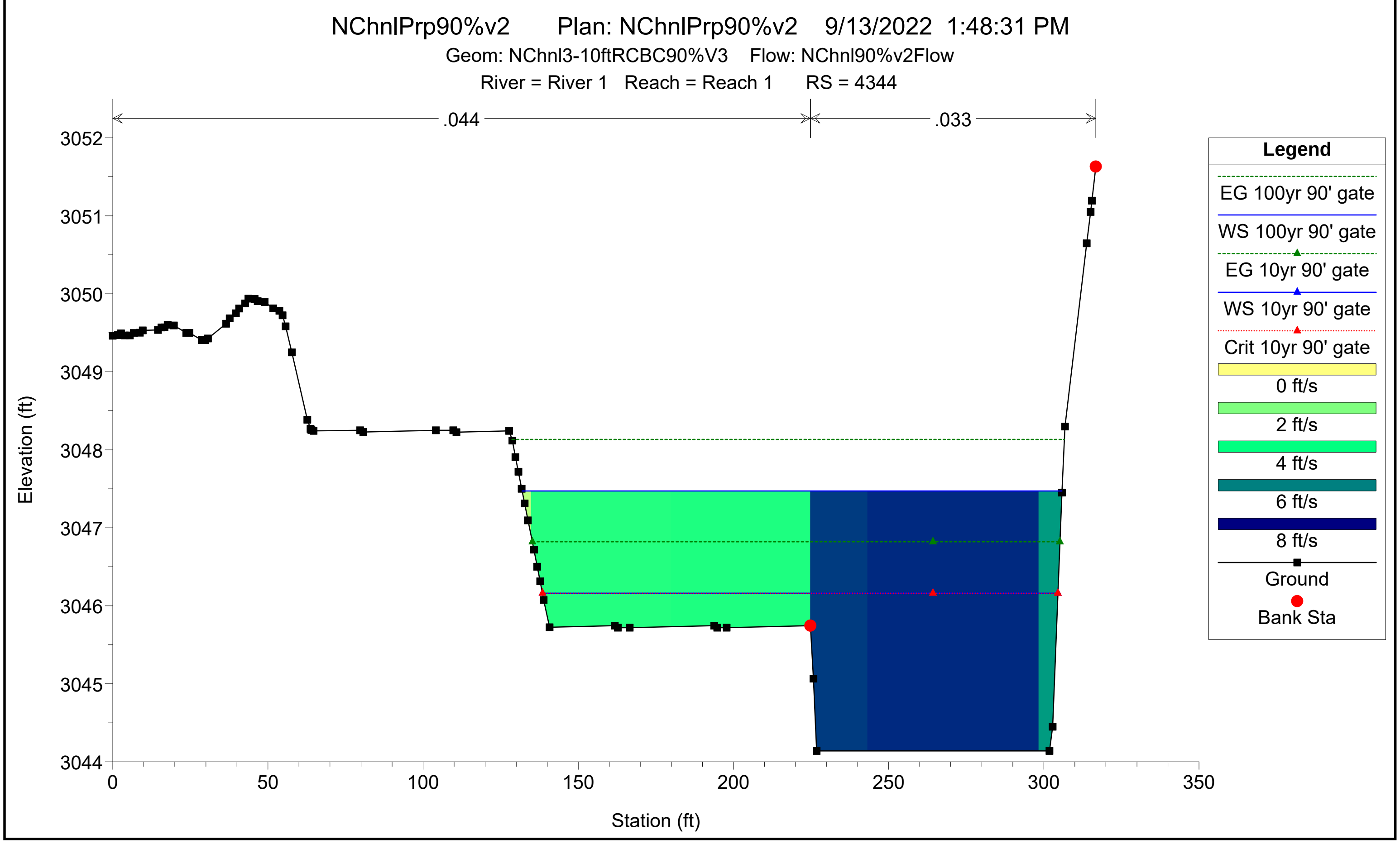
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4500
.045
.033
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta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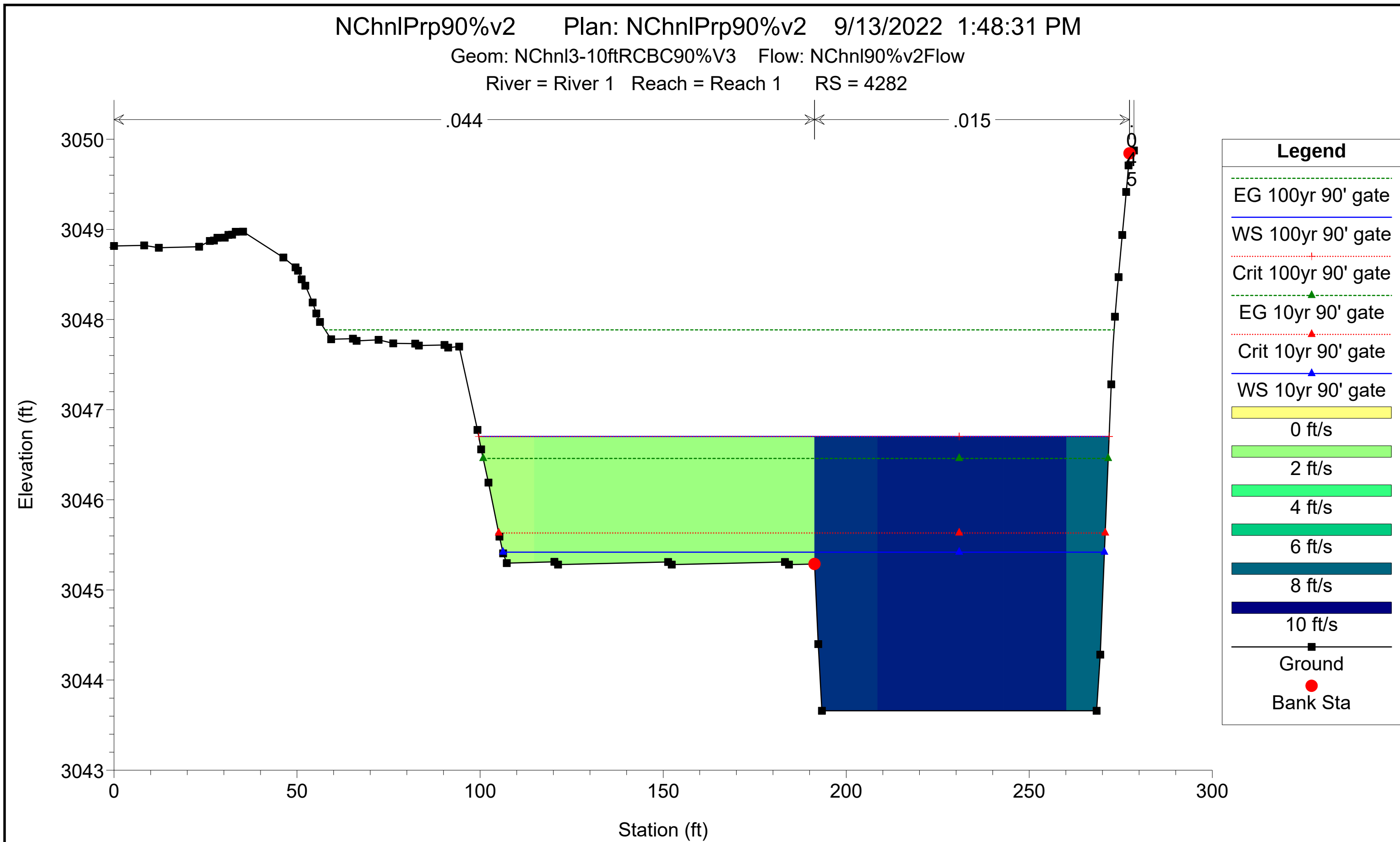
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4344
.044
.033
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta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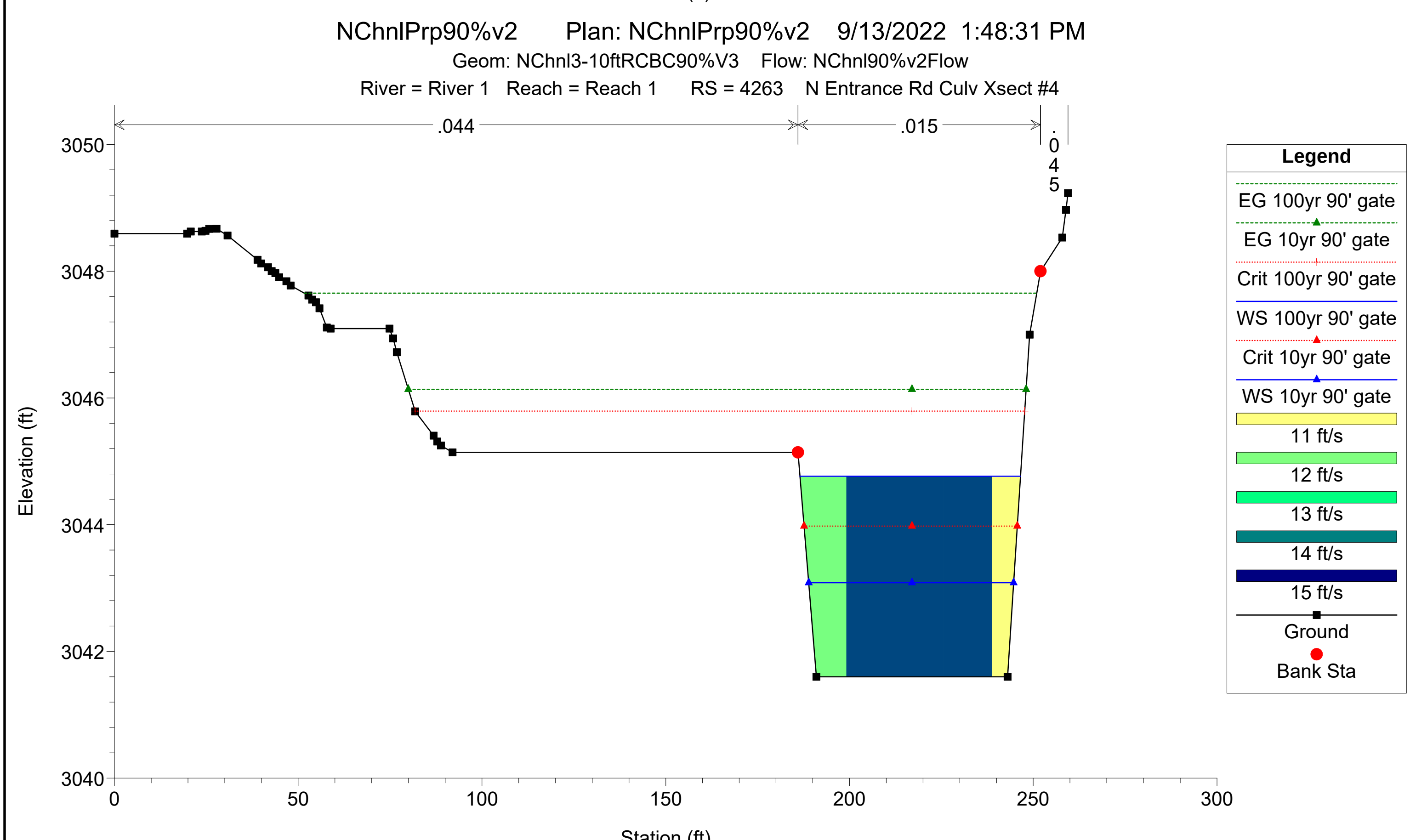
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4282
.044
.015
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
Crit 10yr 90' gate
WS 10yr 90' gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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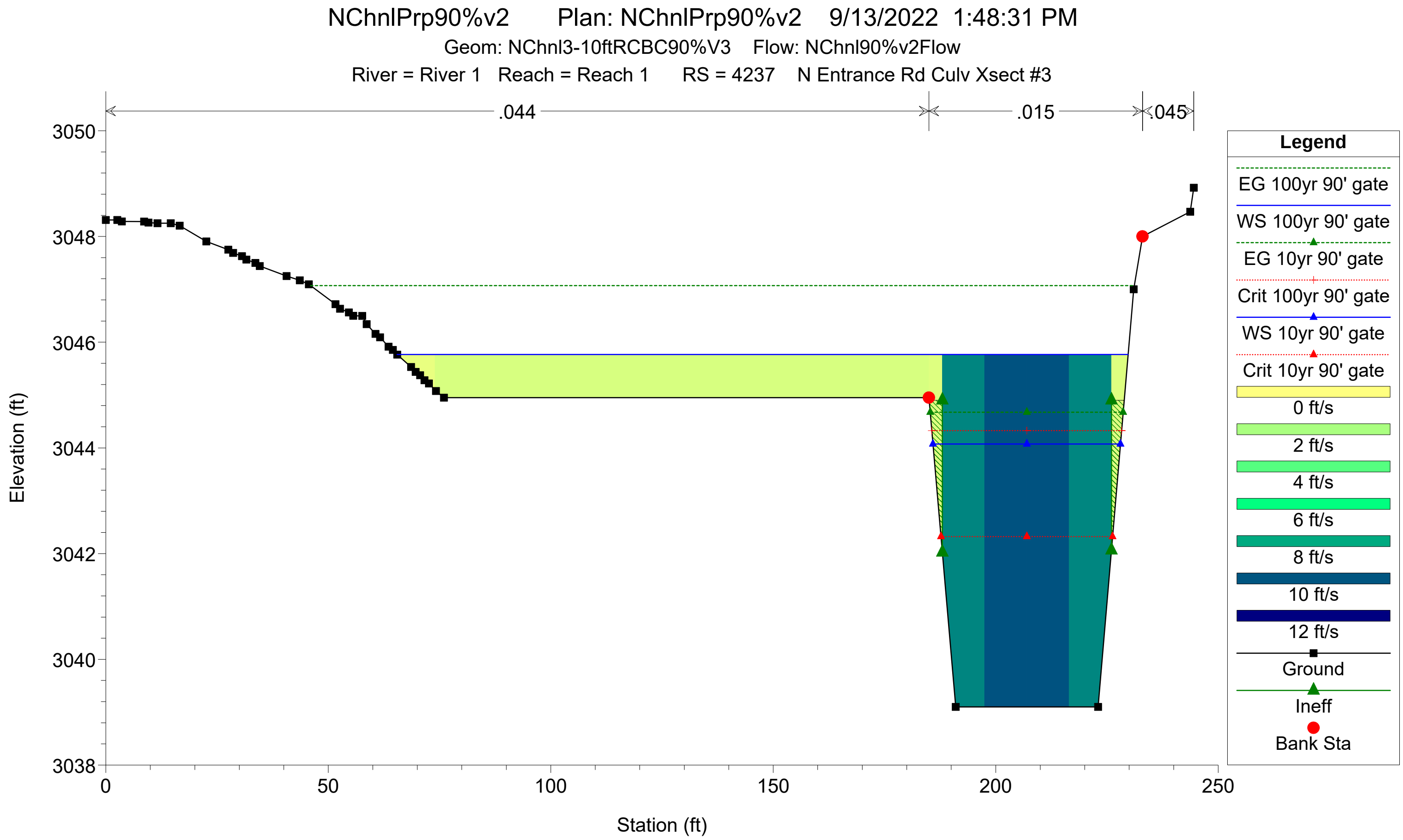
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4263 N Entrance Rd Culv Xsect #4
.044
.015
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
EG 10yr 90' gate
Crit 100yr 90' gate
WS 100yr 90' gate
Crit 10yr 90' gate
WS 10yr 90' gate
11 ft/s
12 ft/s
13 ft/s
14 ft/s
15 ft/s
Ground
Bank Sta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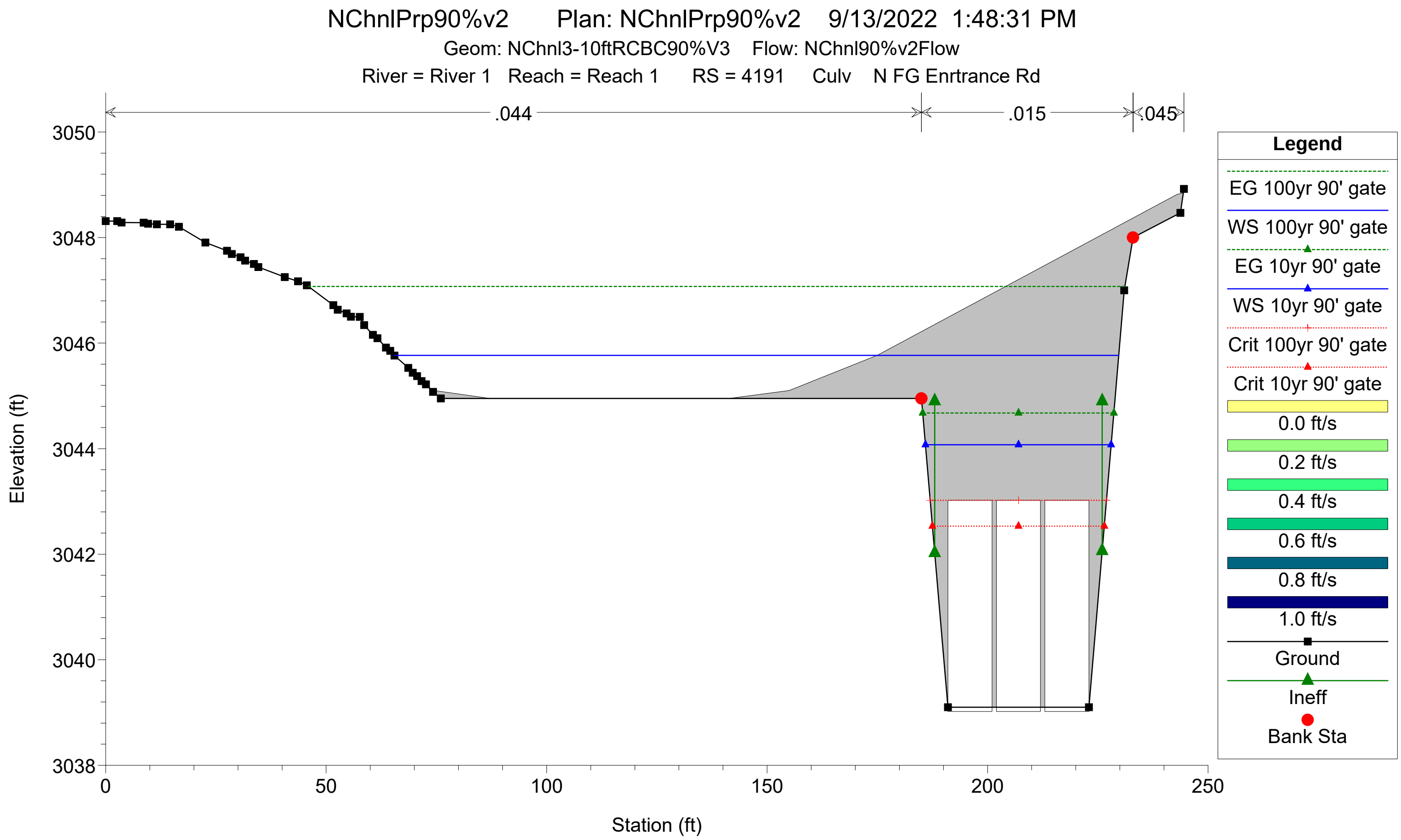
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4237 N Entrance Rd Culv Xsect #3
.044
.015
.045
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
Crit 100yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3038
3040
3042
3044
3046
3048
3050
0
50
100
150
200
250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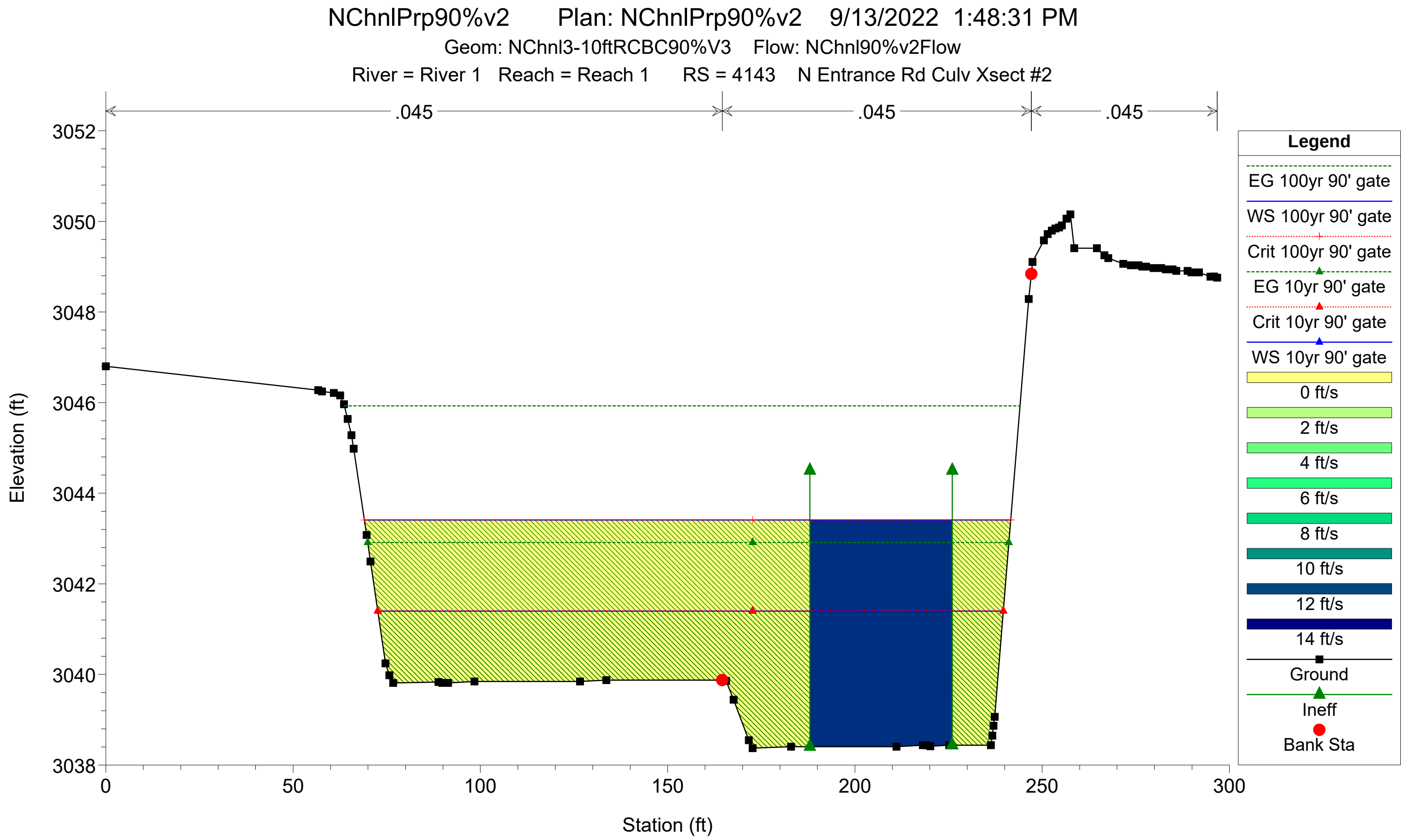
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4191 Culv N FG Enrtrance Rd
.044
.015
.045
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 100yr 90' gate
Crit 10yr 90' gate
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3038
3040
3042
3044
3046
3048
3050
0
50
100
150
200
250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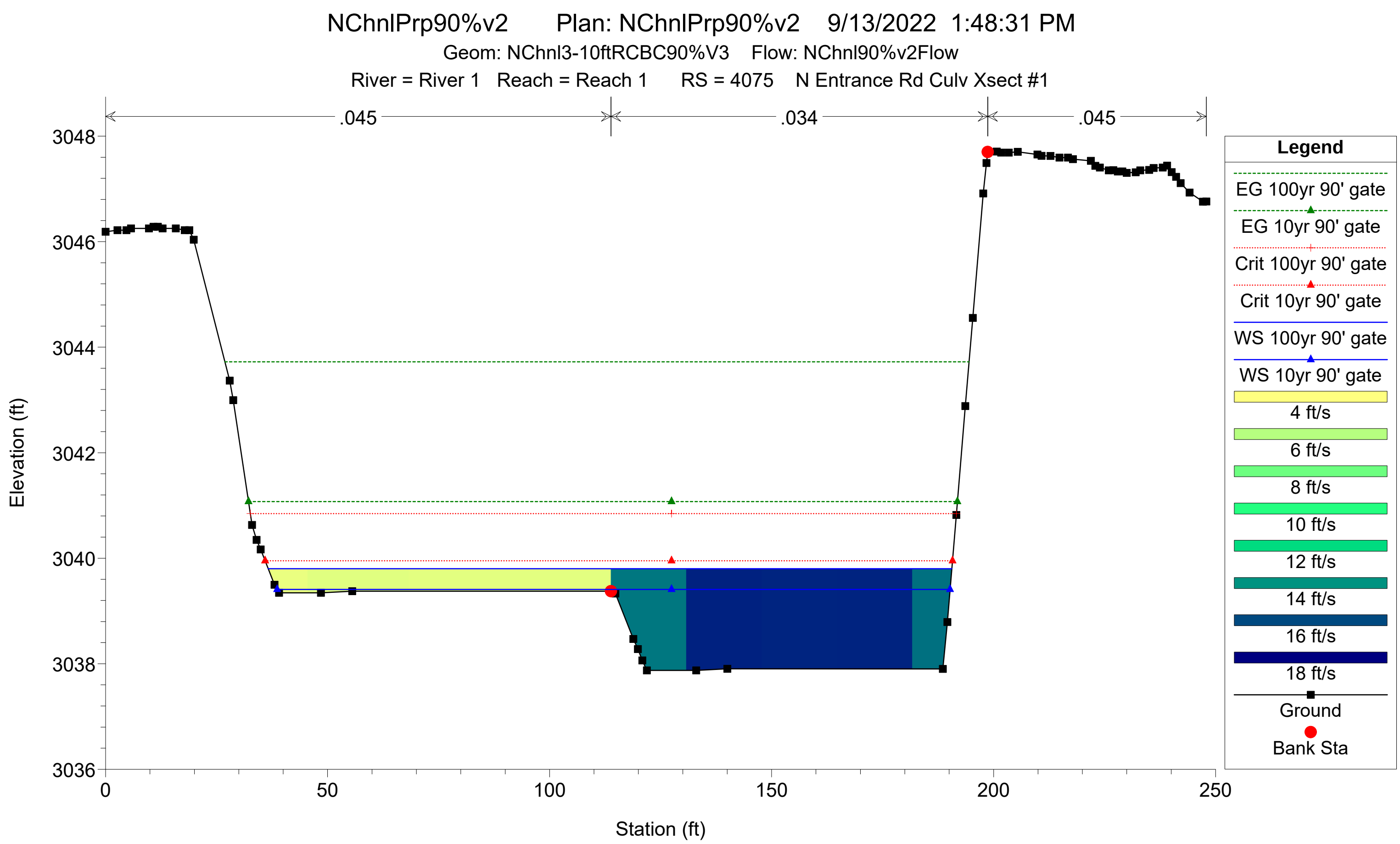
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4143 N Entrance Rd Culv Xsect #2
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
Crit 10yr 90' gate
WS 10yr 90' gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
Ground
Ineff
Bank Sta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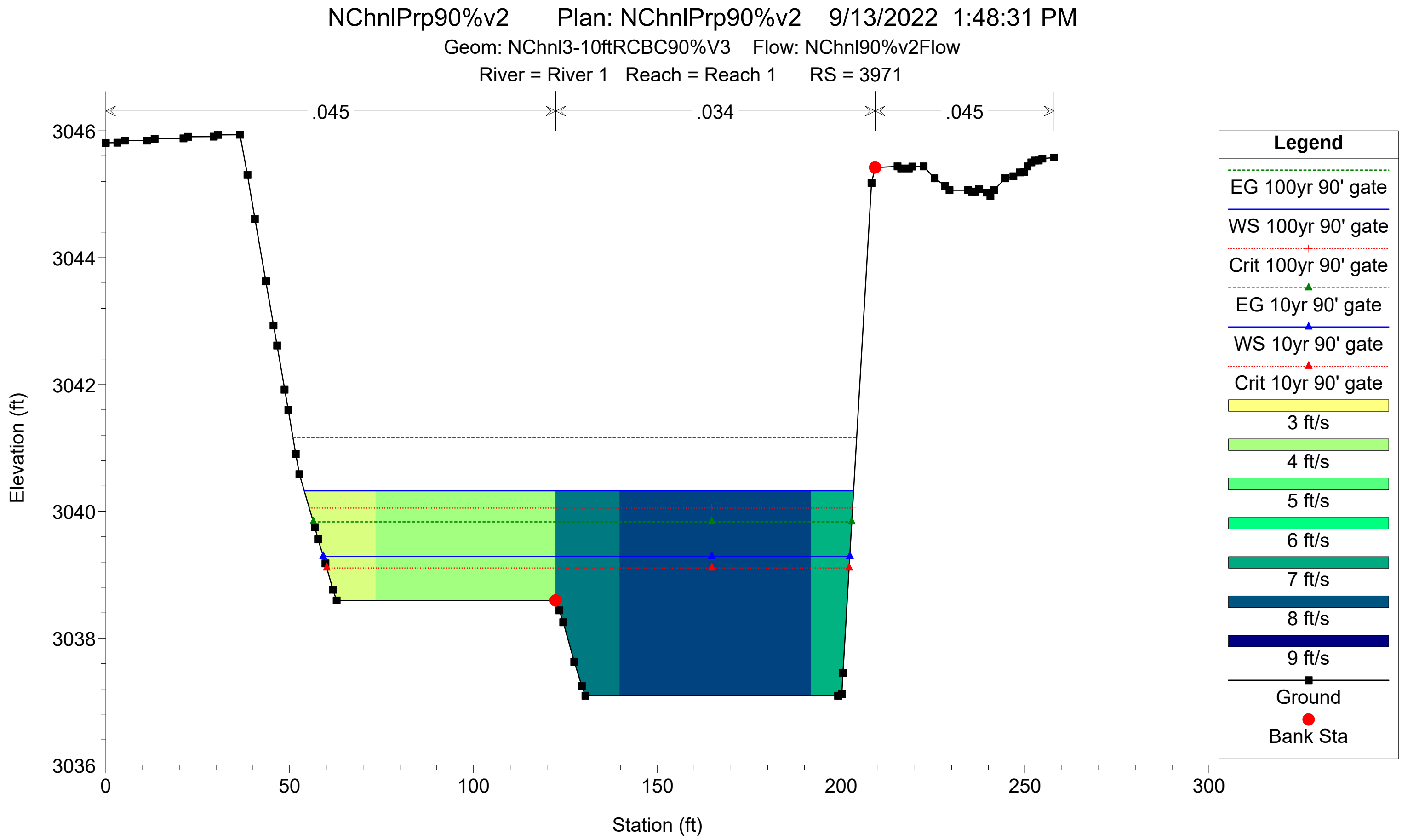
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 4075 N Entrance Rd Culv Xsect #1
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
EG 10yr 90' gate
Crit 100yr 90' gate
Crit 10yr 90' gate
WS 100yr 90' gate
WS 10yr 90' gate
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
16 ft/s
18 ft/s
Ground
Bank Sta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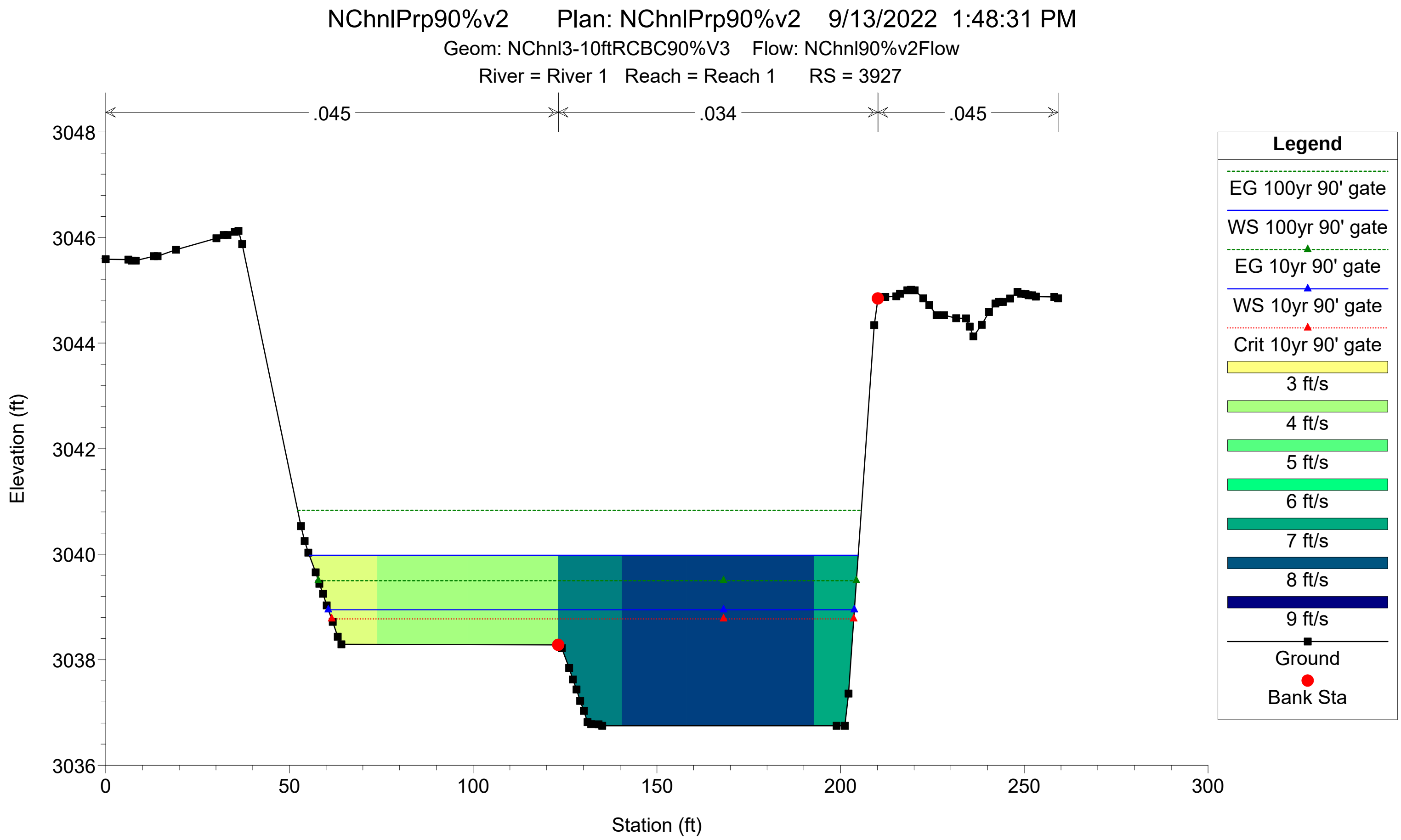
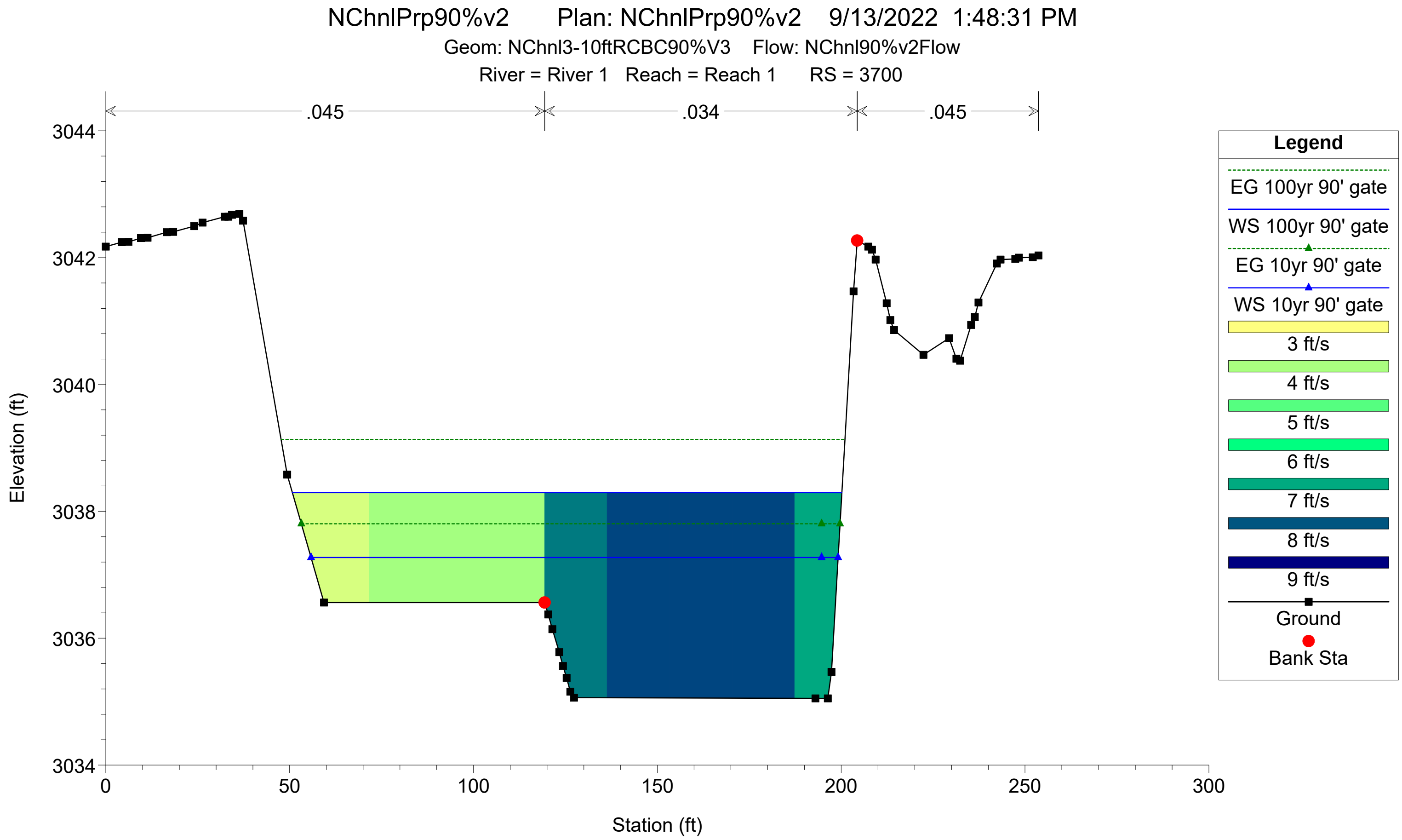
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 3971
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta


NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 1:48:31 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 3927
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta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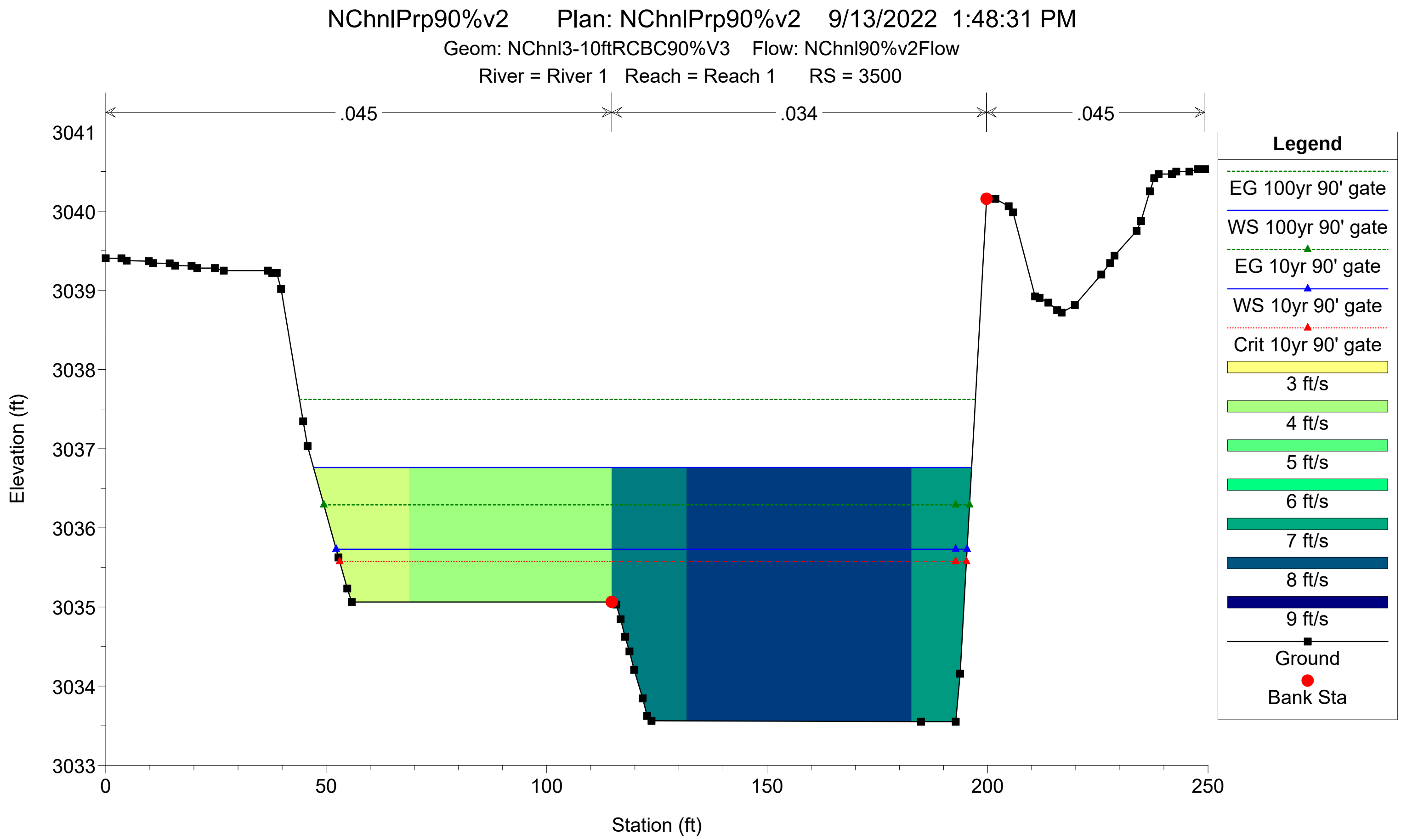
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 3700
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta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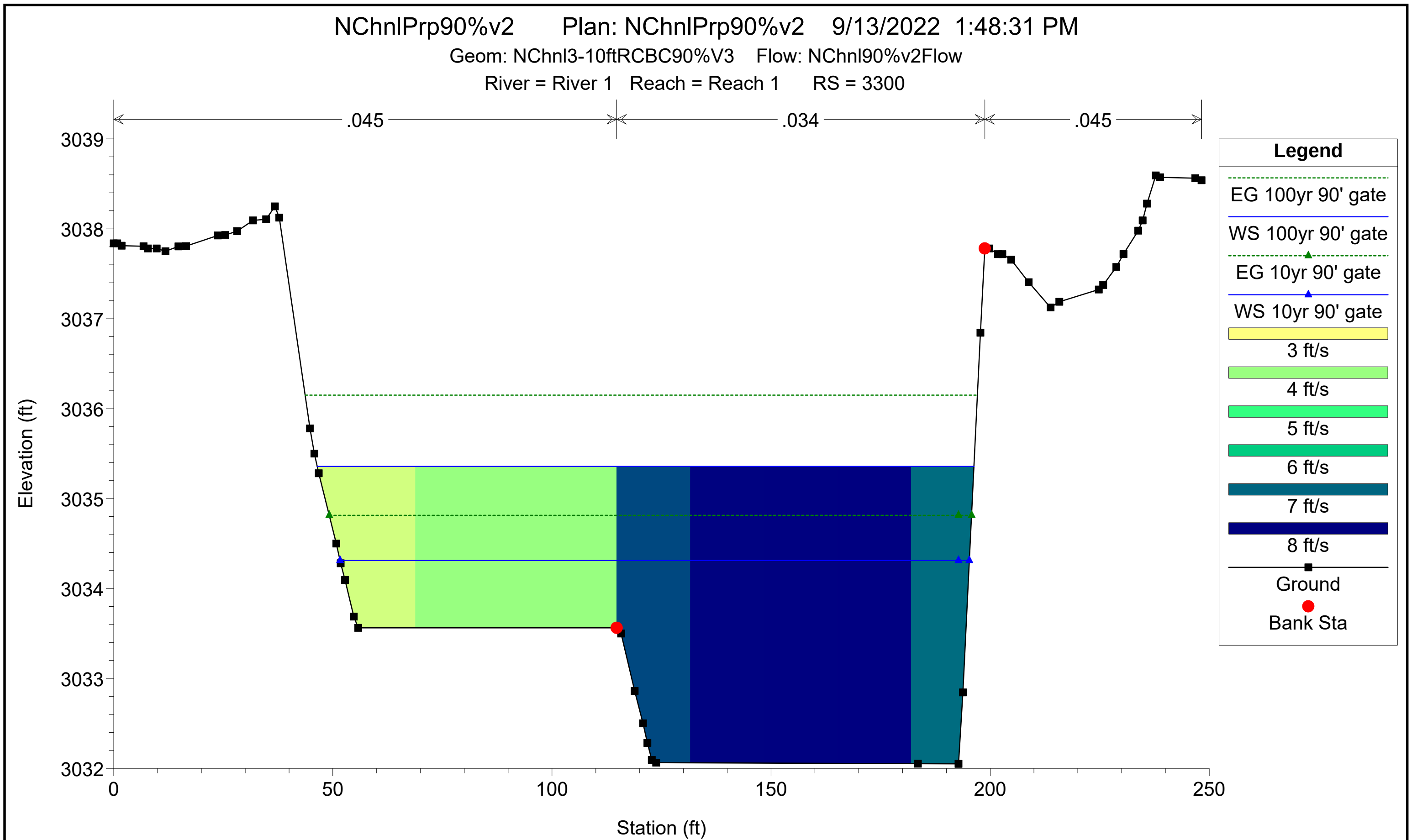
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 3500
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta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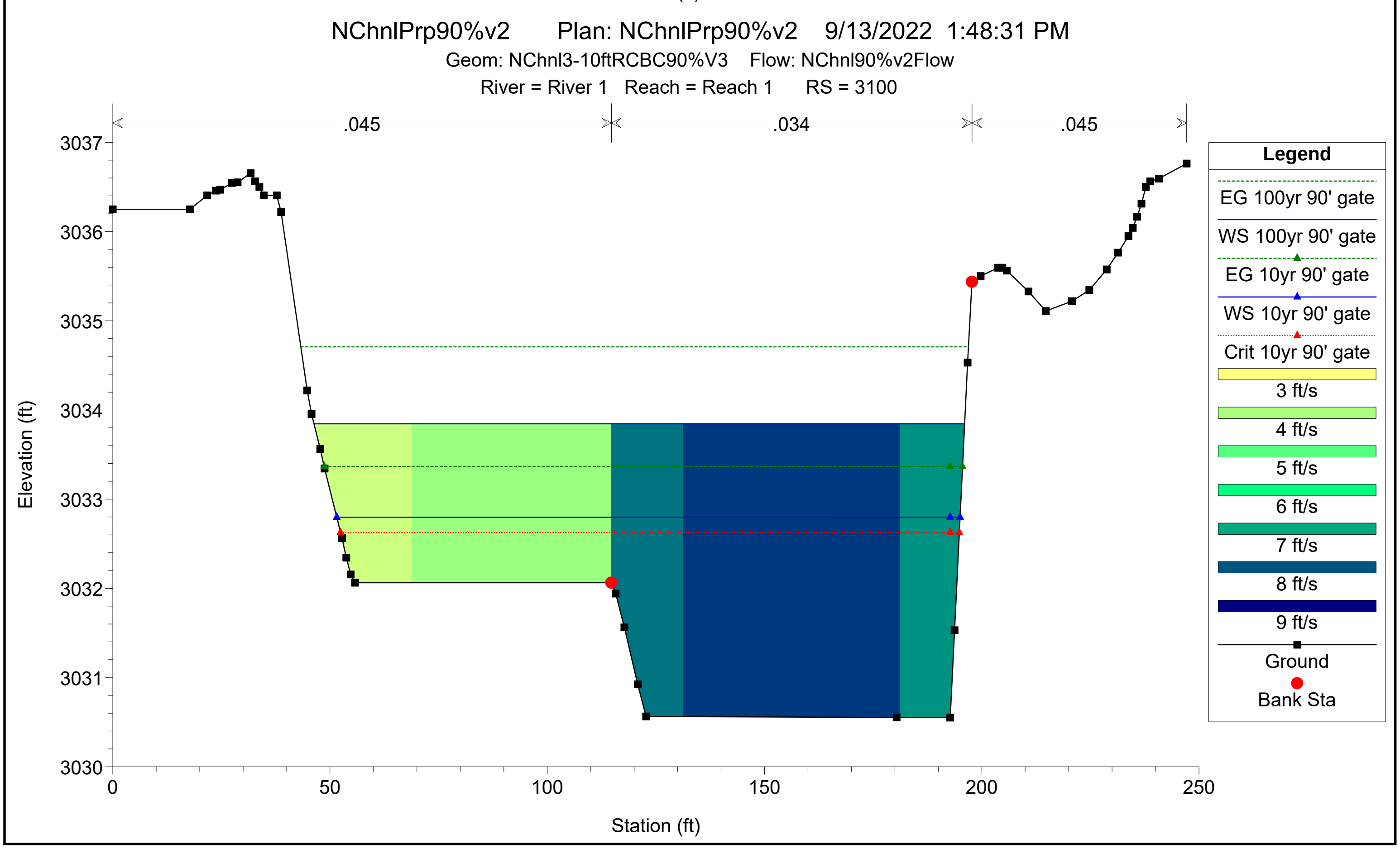
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 3300
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
Ground
Bank Sta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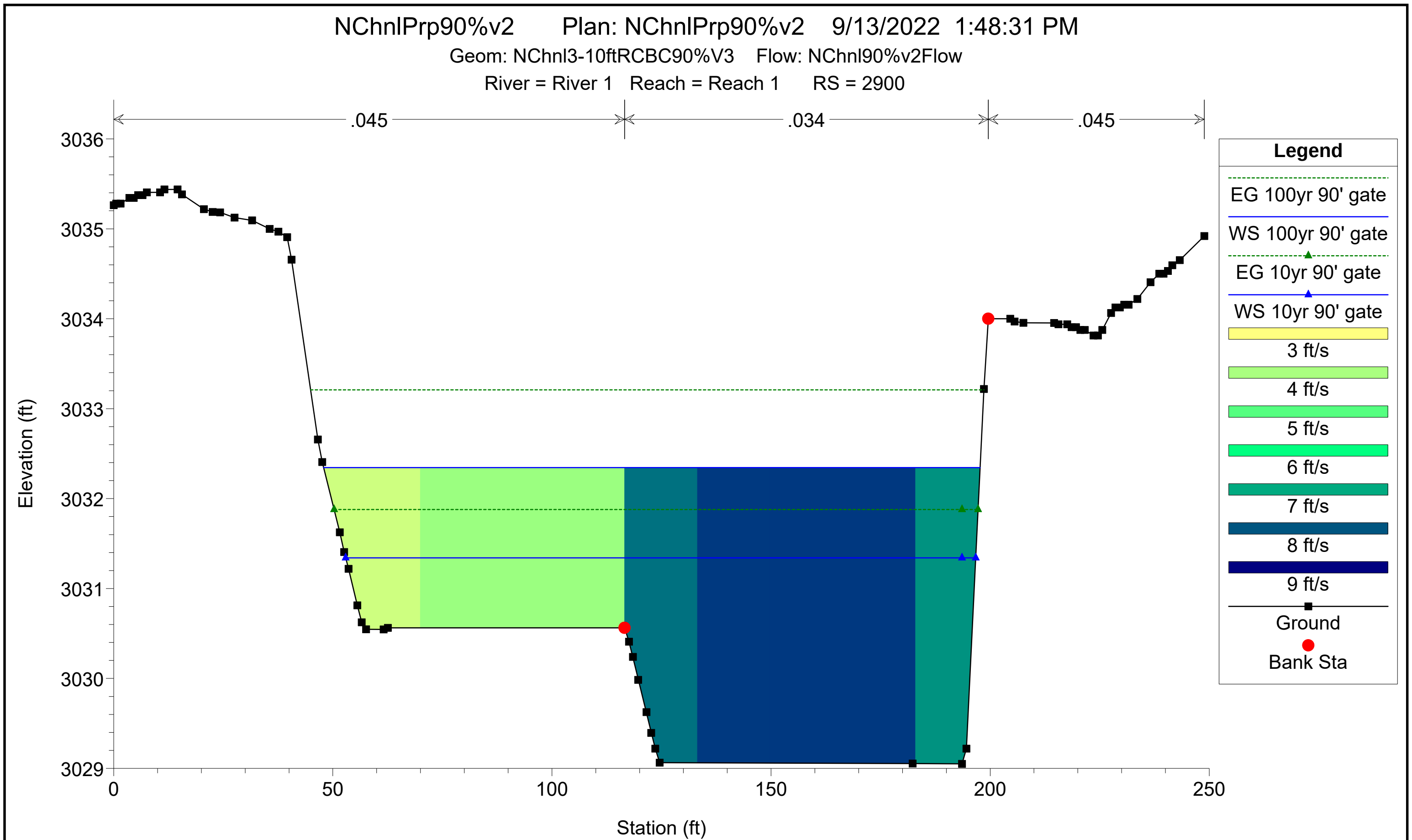
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 3100
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta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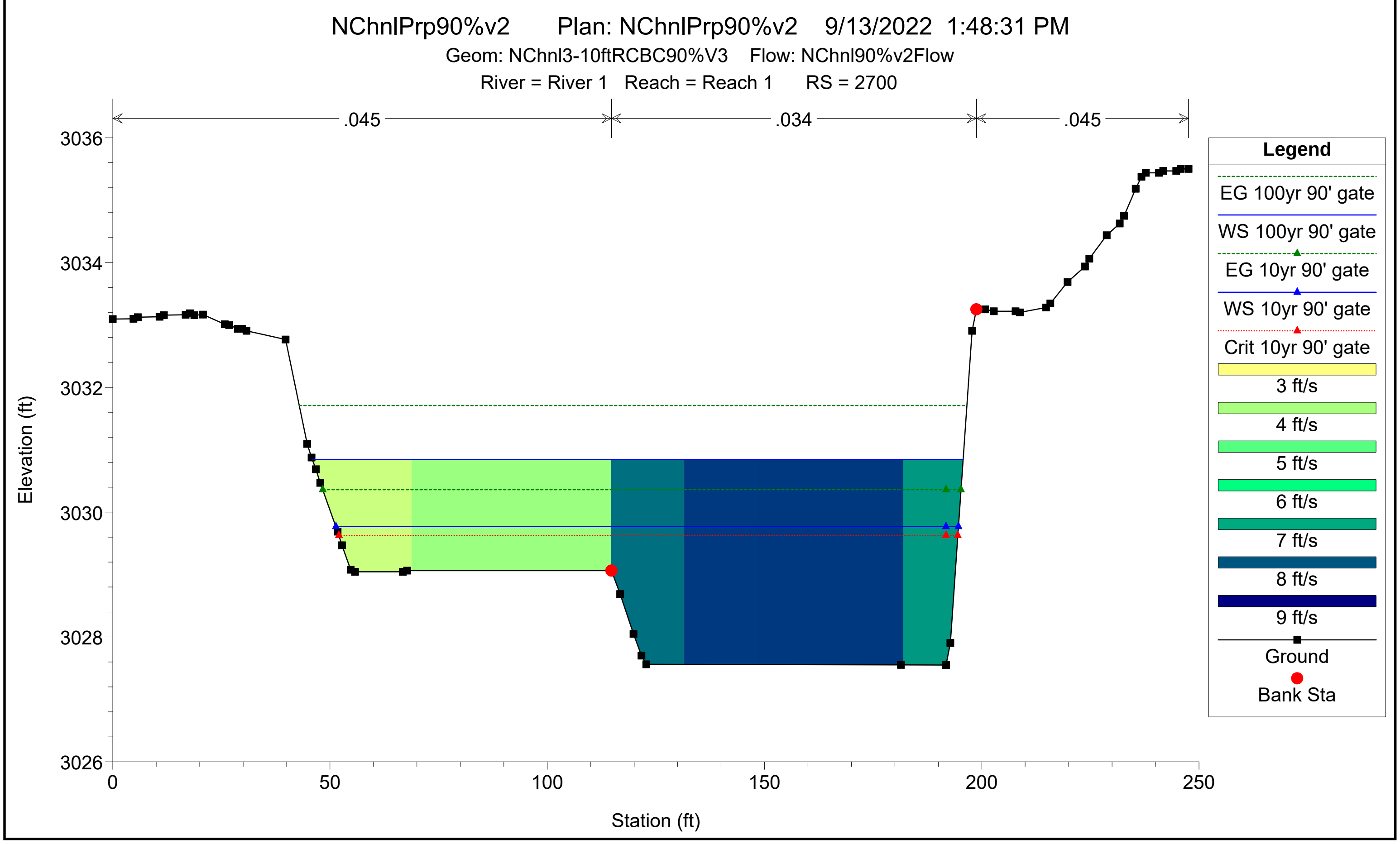
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 2900
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta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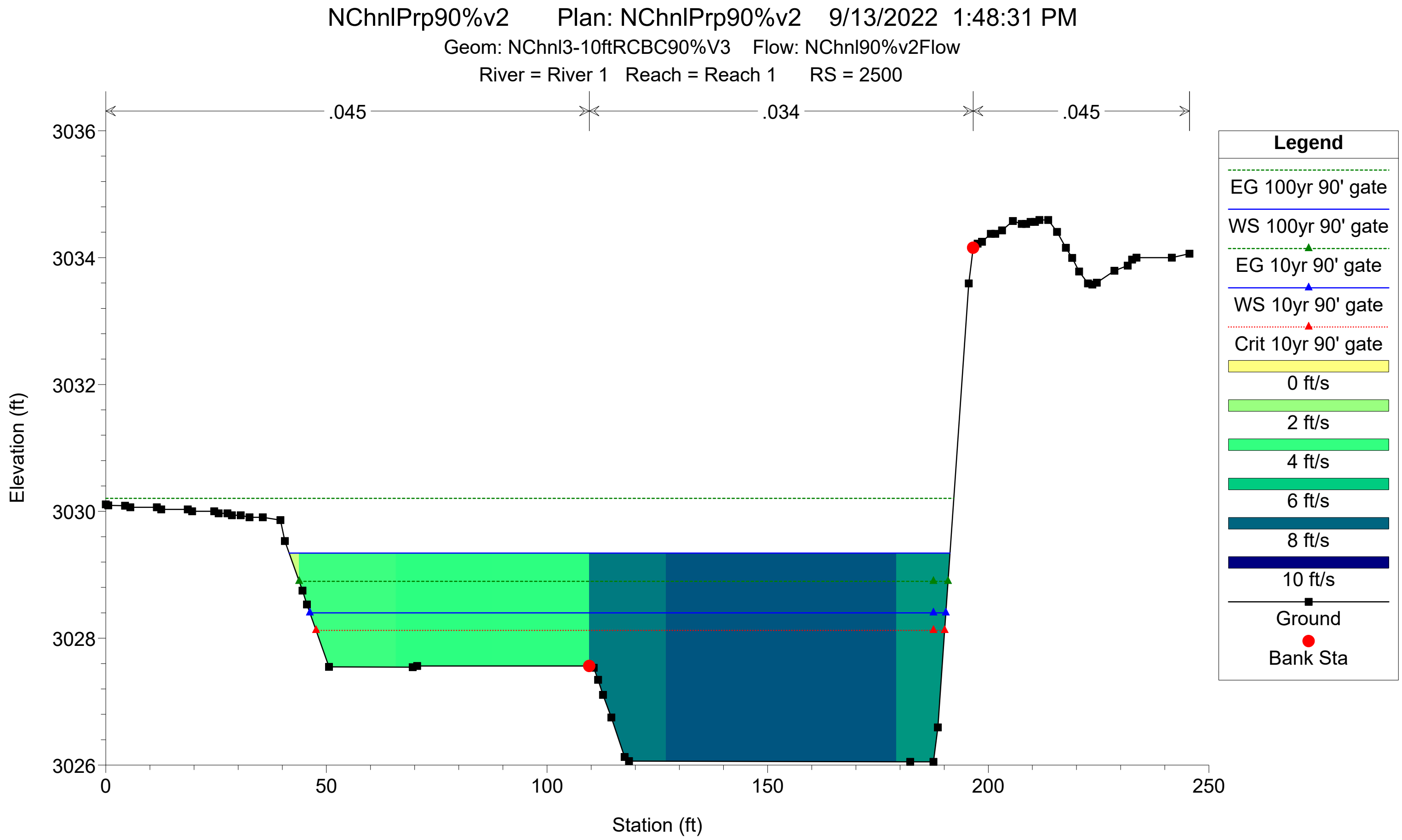
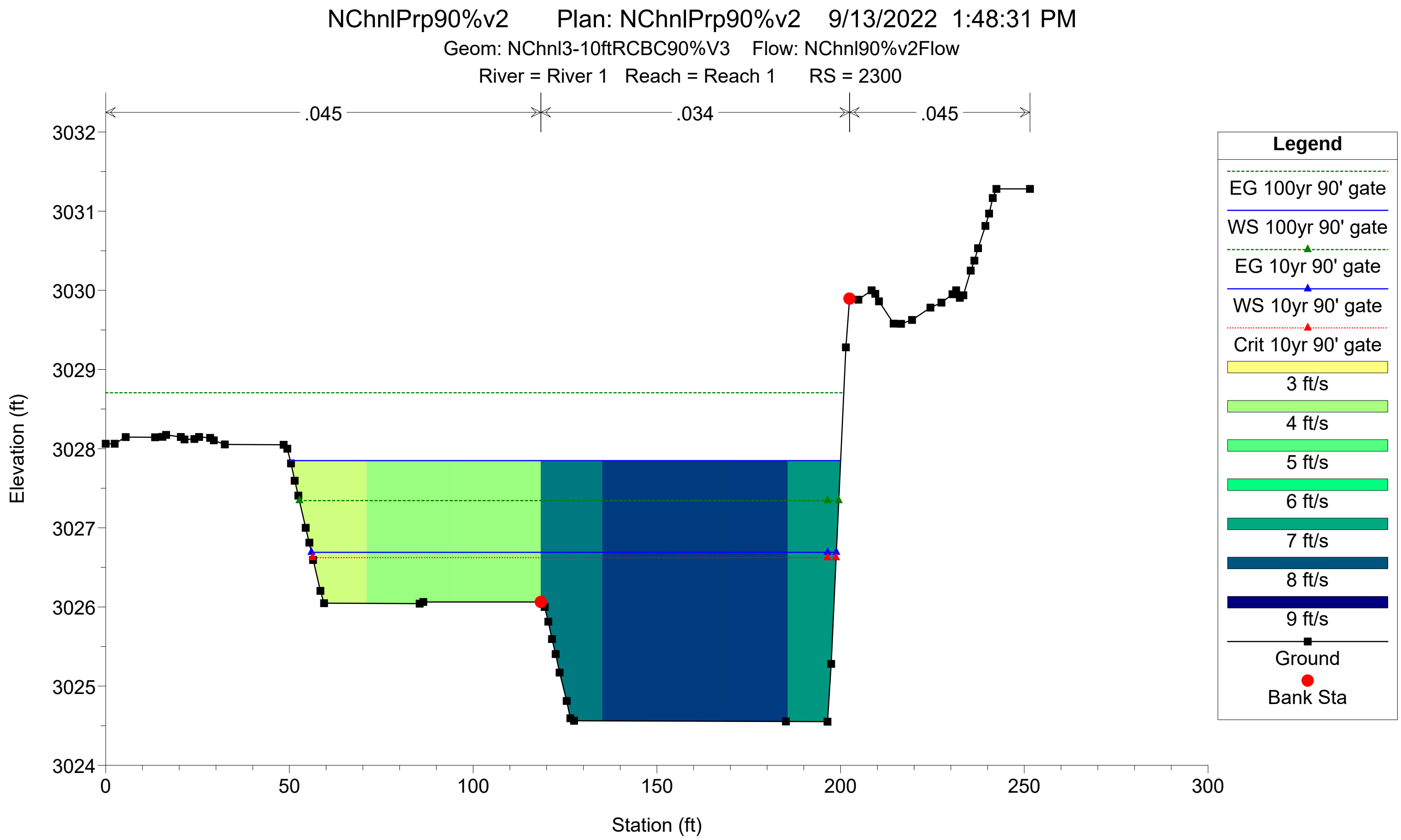
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 2700
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta


NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 1:48:31 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 2500
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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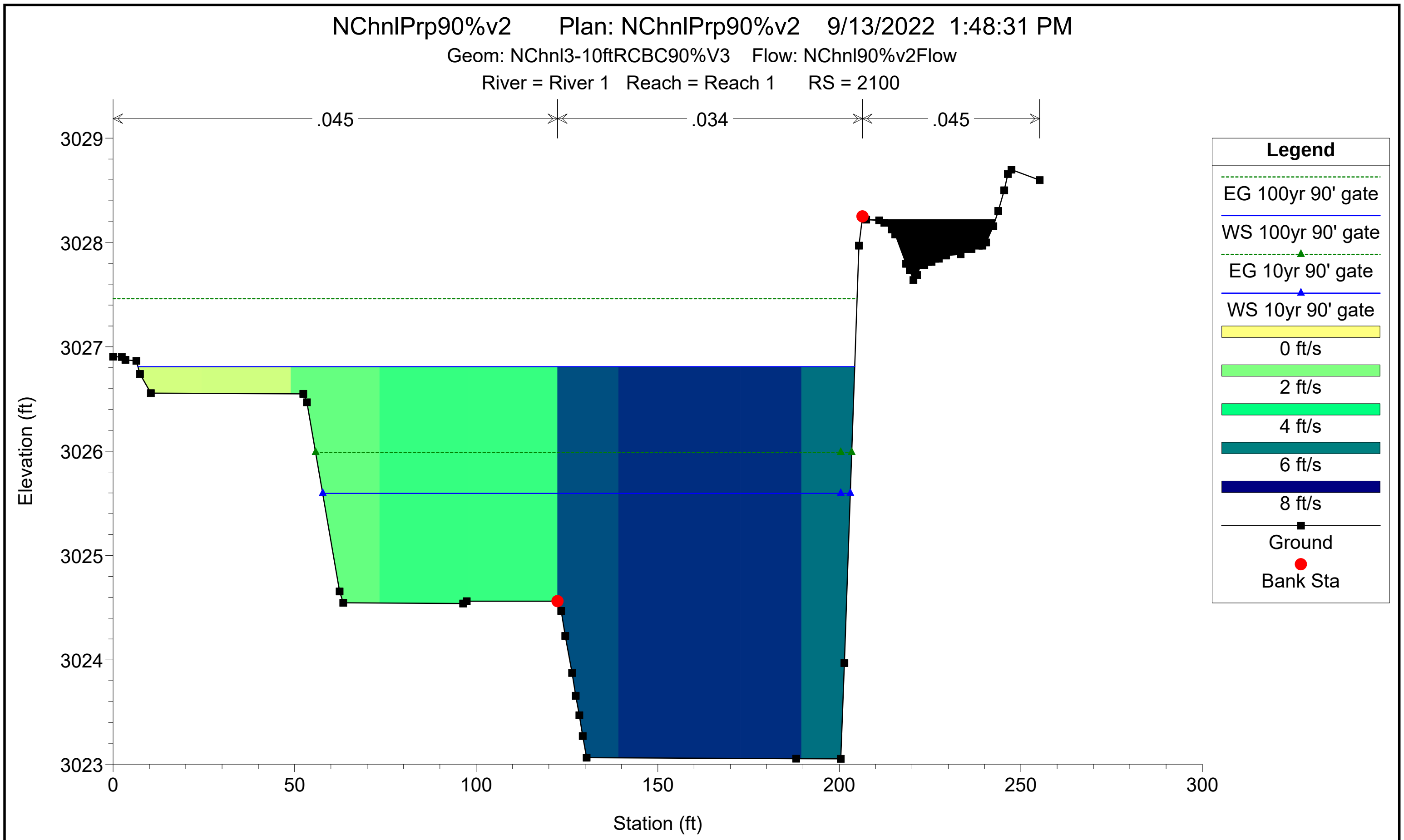
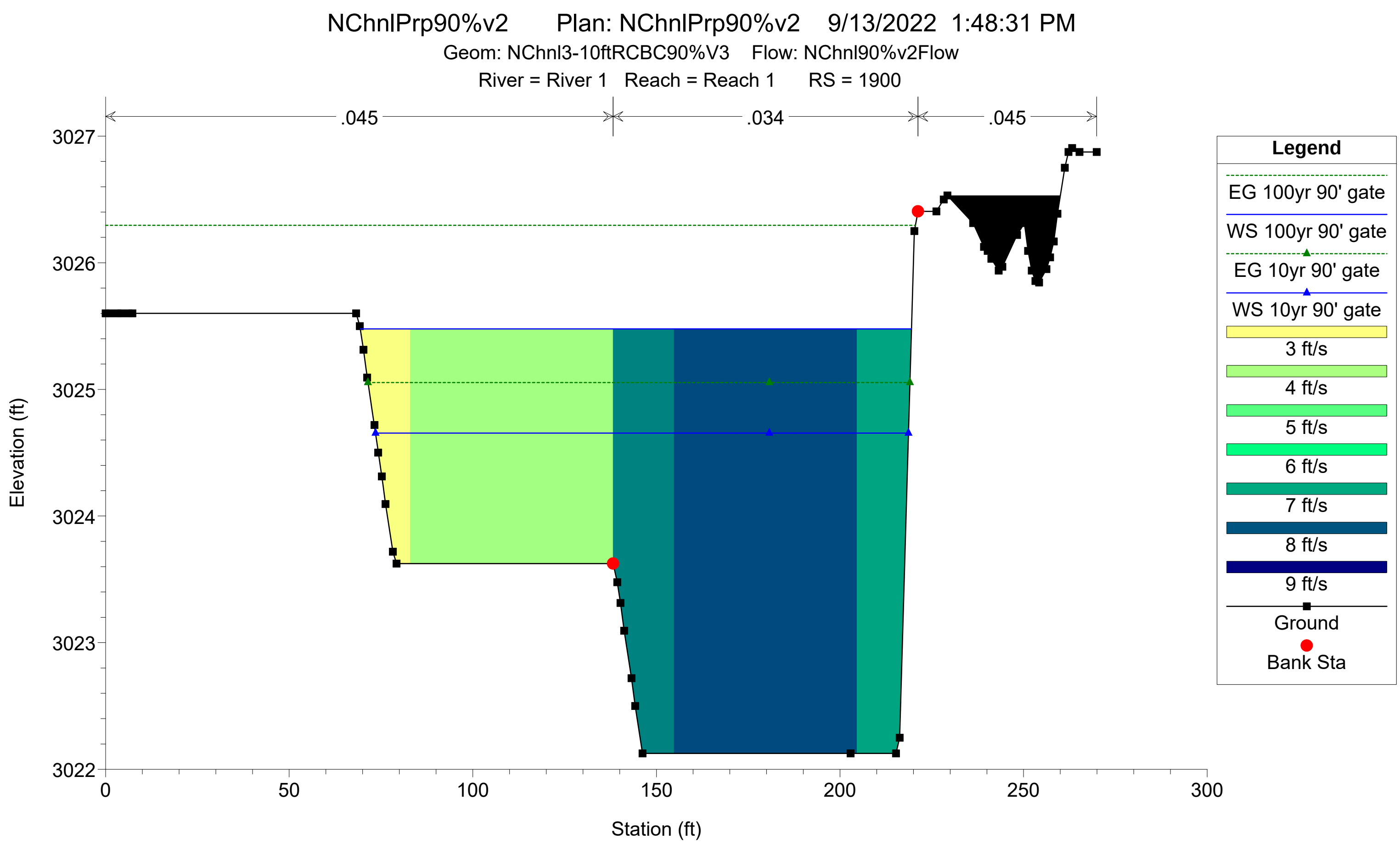
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 2300
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta


NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 1:48:31 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 2100
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta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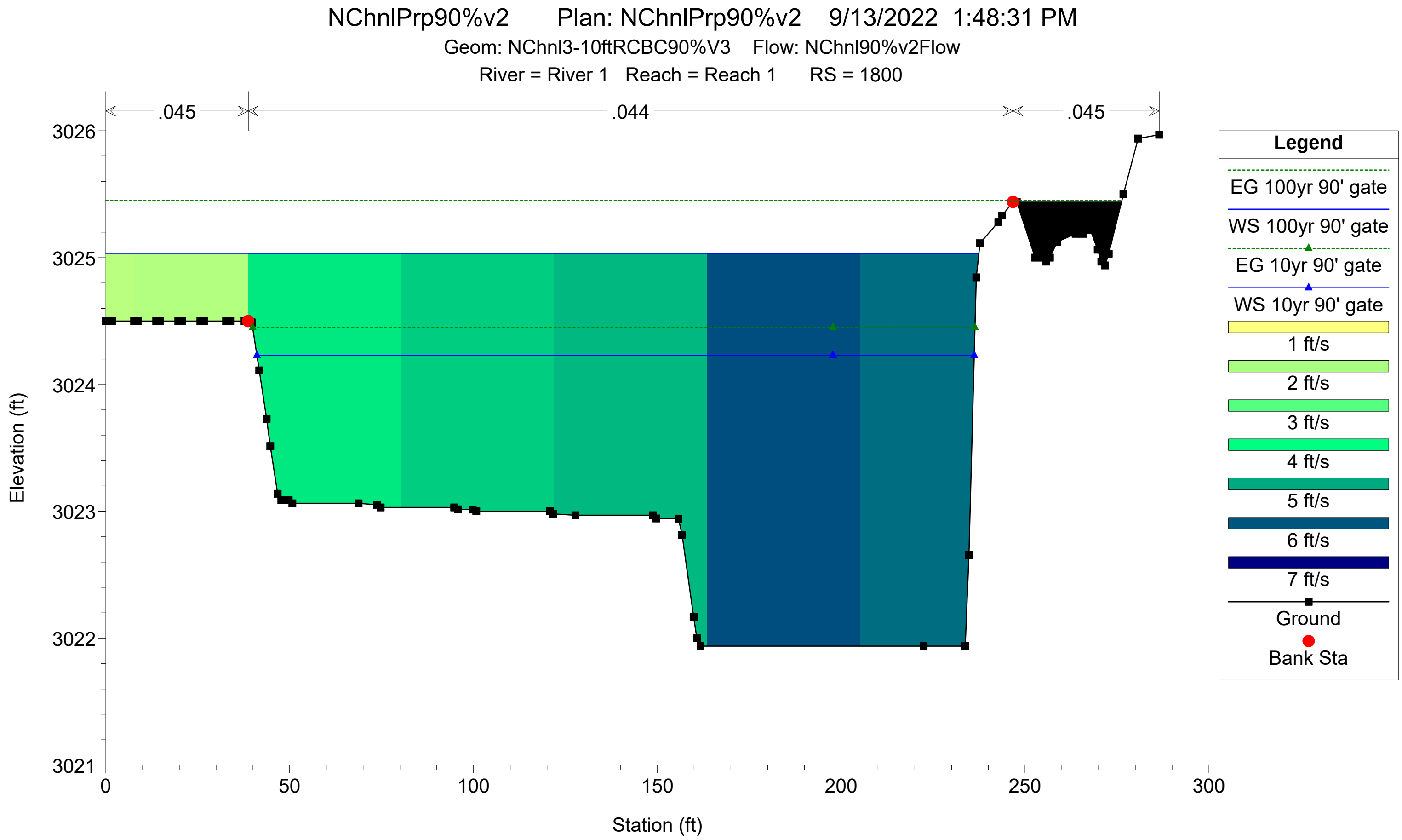
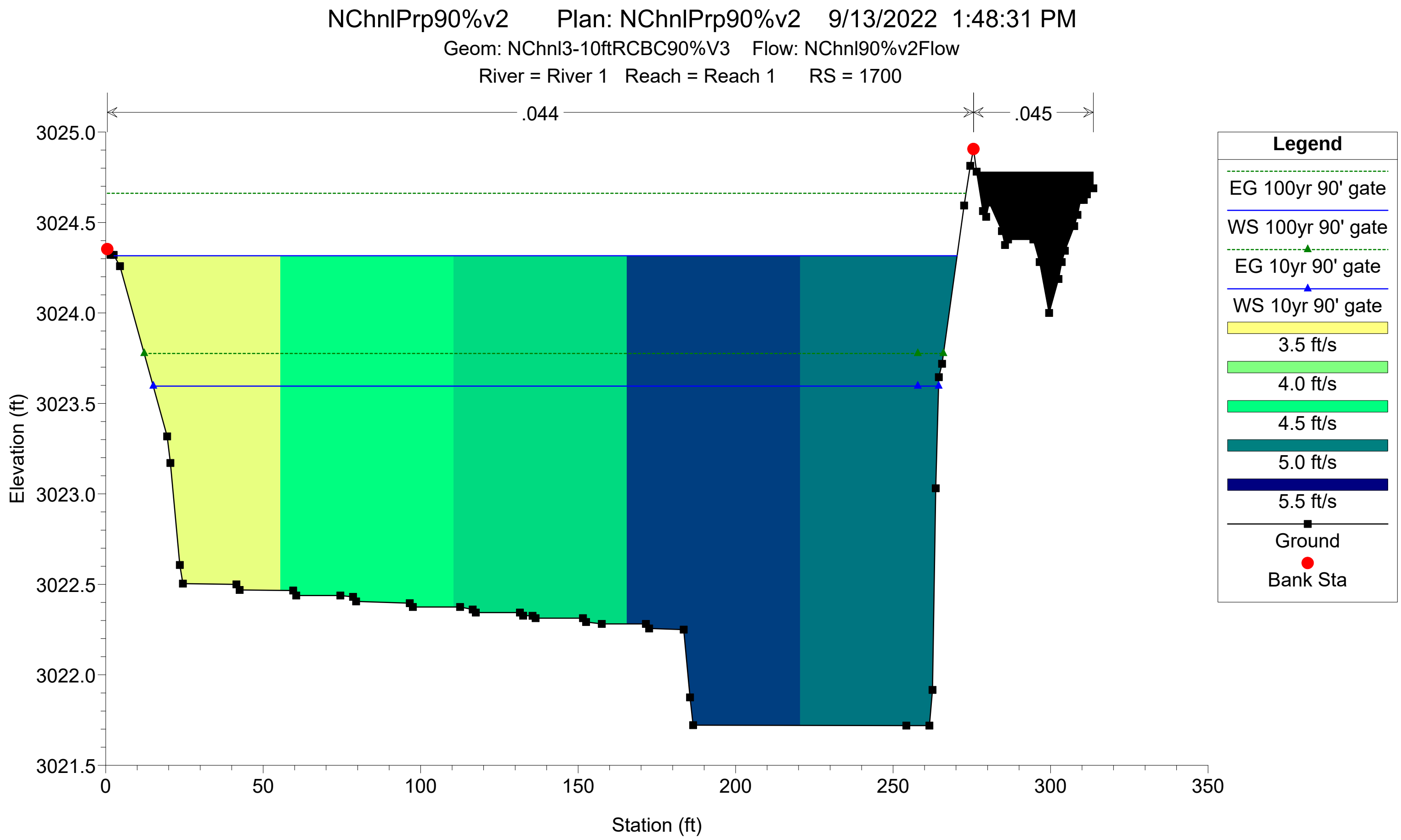
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 1900
.045
.034
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta


NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 1:48:31 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 1800
.045
.044
.045
Elevation (ft)
3026
3025
3024
3023
3022
3021
0
50
100
150
200
250
300
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta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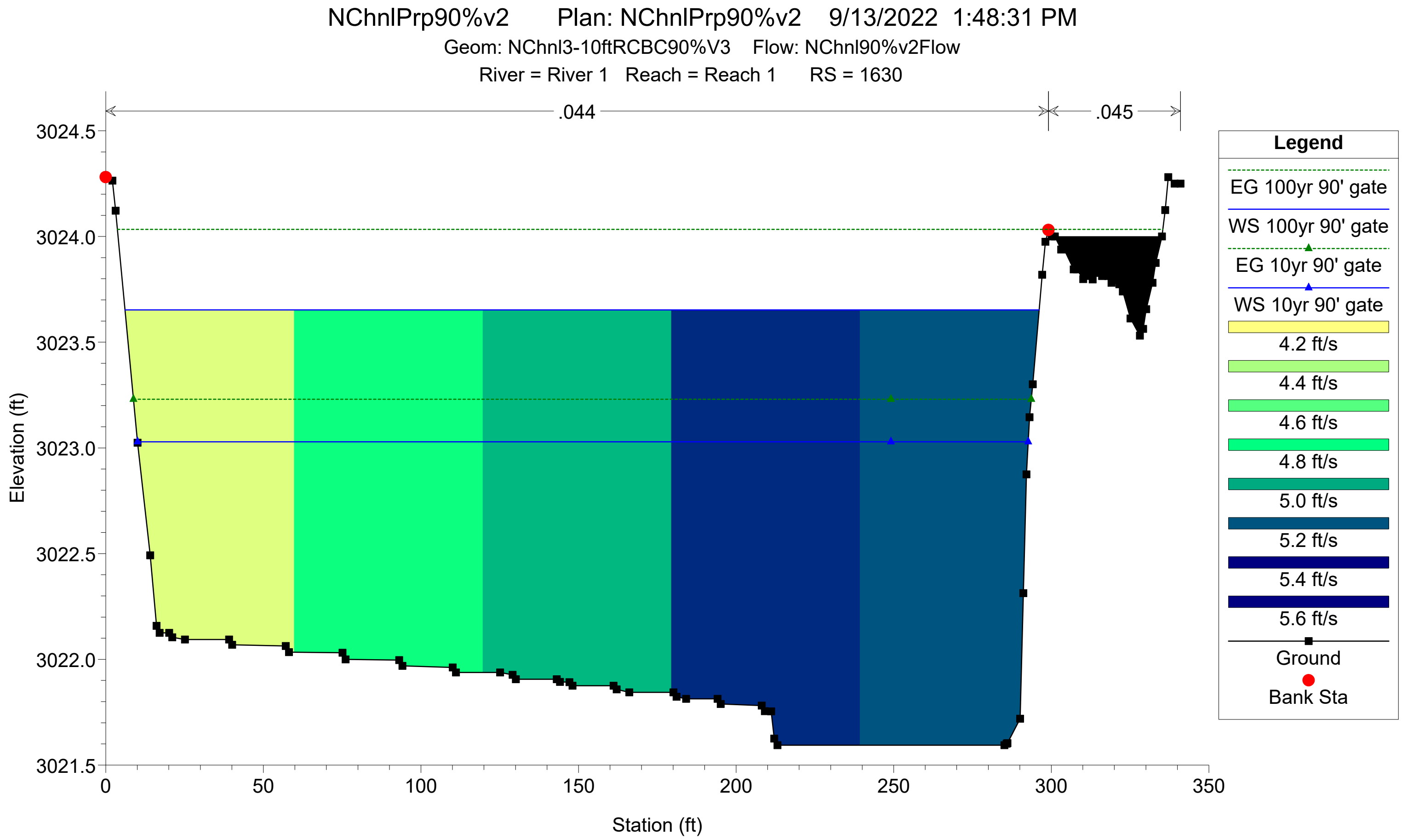
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 1700
.044
.045
Elevation (ft)
3025.0
3024.5
3024.0
3023.5
3023.0
3022.5
3022.0
3021.5
0
50
100
150
200
250
300
350
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
3.5 ft/s
4.0 ft/s
4.5 ft/s
5.0 ft/s
5.5 ft/s
Ground
Bank Sta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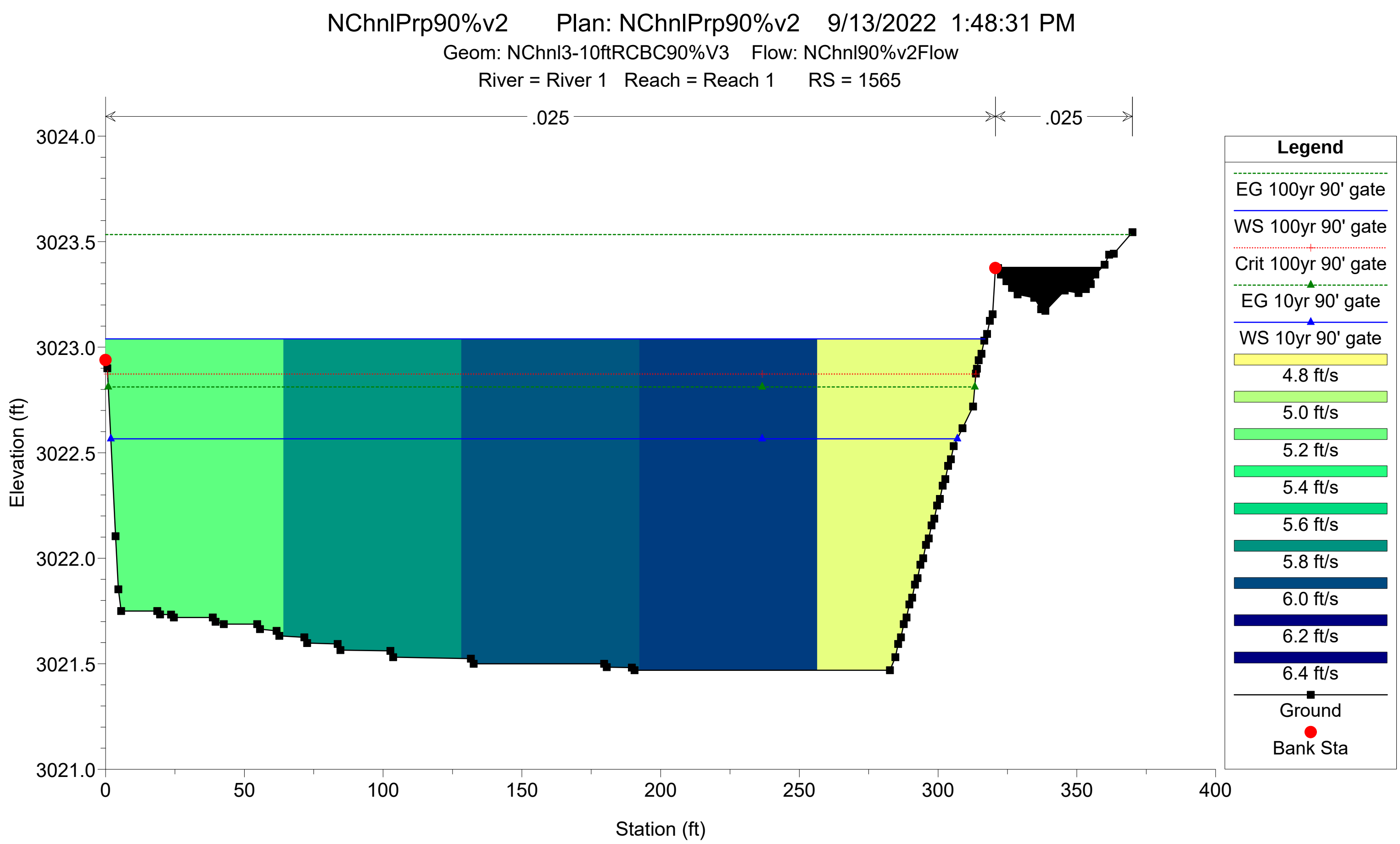
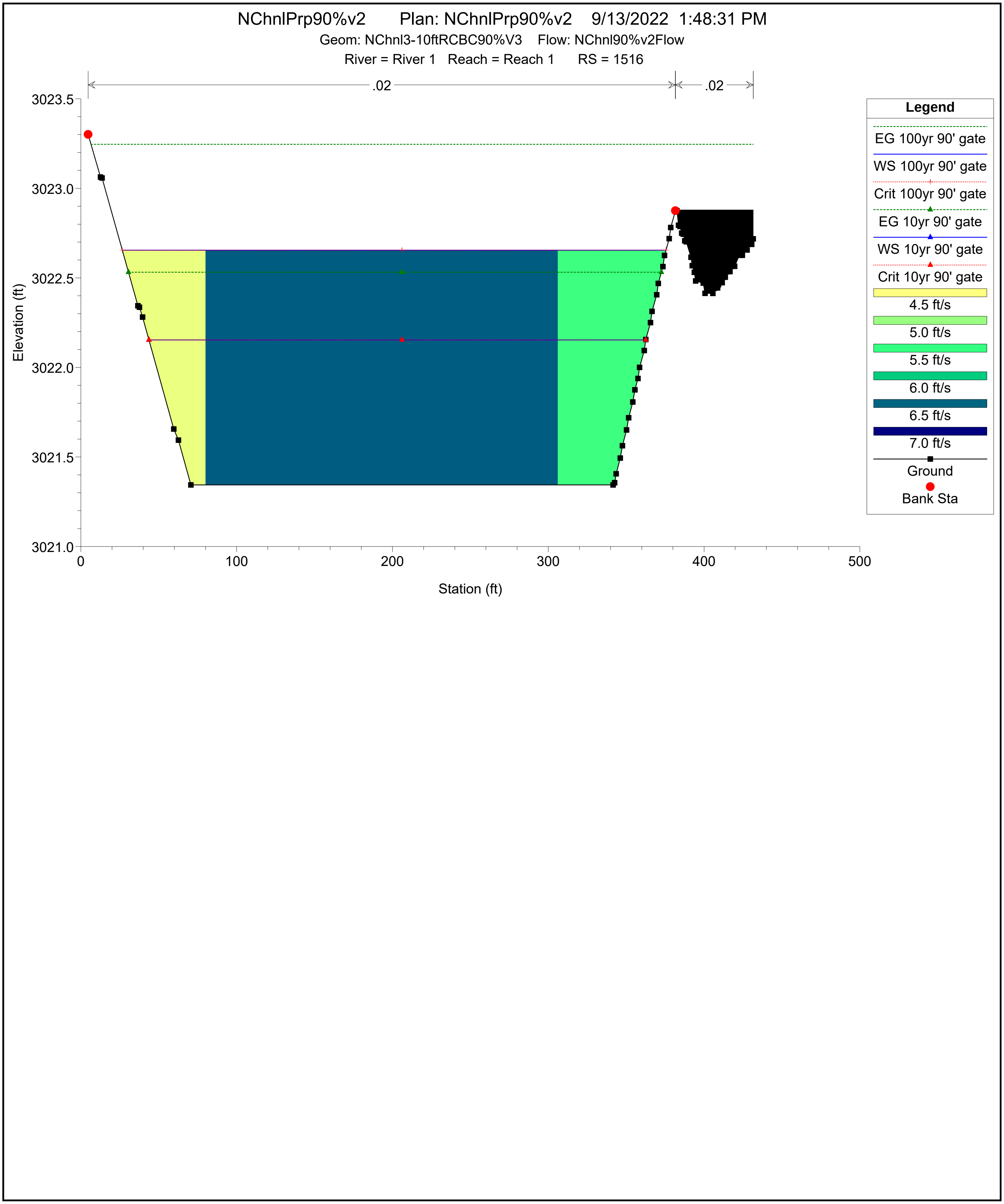
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 1630
.044
.045
Legend
EG 100yr 90' gate
WS 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
4.2 ft/s
4.4 ft/s
4.6 ft/s
4.8 ft/s
5.0 ft/s
5.2 ft/s
5.4 ft/s
5.6 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 1:48:31 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 1565
.025
.025
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
4.8 ft/s
5.0 ft/s
5.2 ft/s
5.4 ft/s
5.6 ft/s
5.8 ft/s
6.0 ft/s
6.2 ft/s
6.4 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


NChnlPrp90%v2 Plan: NChnlPrp90%v2 9/13/2022 1:48:31 PM
Geom: NChnl3-10ftRCBC90%V3 Flow: NChnl90%v2Flow
River = River 1 Reach = Reach 1 RS = 1516
.02
.02
3023.5
3023.0
3022.5
3022.0
3021.5
3021.0
Elevation (ft)
0
100
200
300
400
500
Station (ft)
Legend
EG 100yr 90' gate
WS 100yr 90' gate
Crit 100yr 90' gate
EG 10yr 90' gate
WS 10yr 90' gate
Crit 10yr 90' gate
4.5 ft/s
5.0 ft/s
5.5 ft/s
6.0 ft/s
6.5 ft/s
7.0 ft/s
Ground
Bank Sta

CENTRAL CHANNEL

CMG DRAINAGE ENGINEERING, INC.

FG Channels-C Channel Subcritical Run_2022.08.29

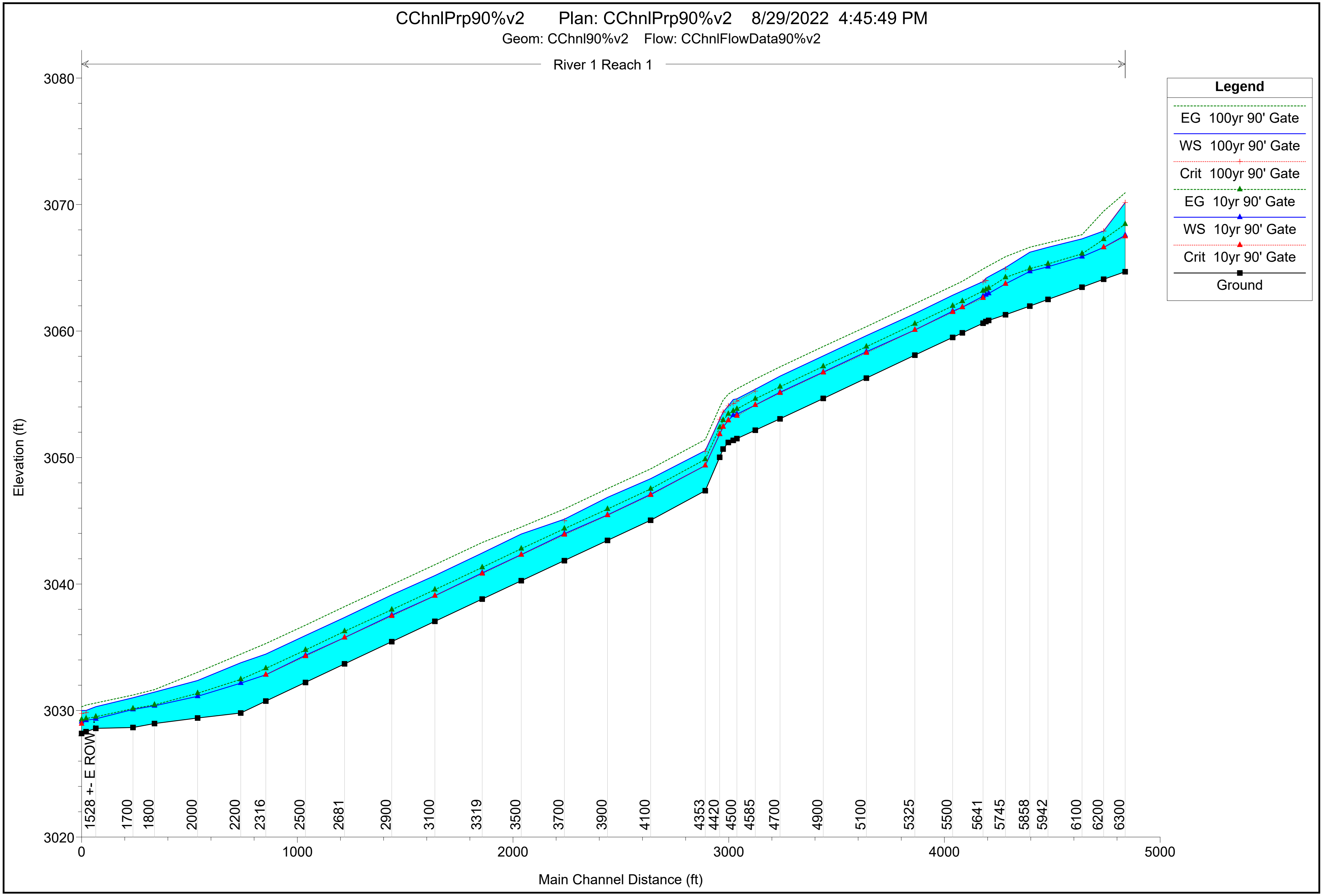
HEC-RAS Plan: CChnlPrp90%v2 River: River 1 Reach: Reach 1

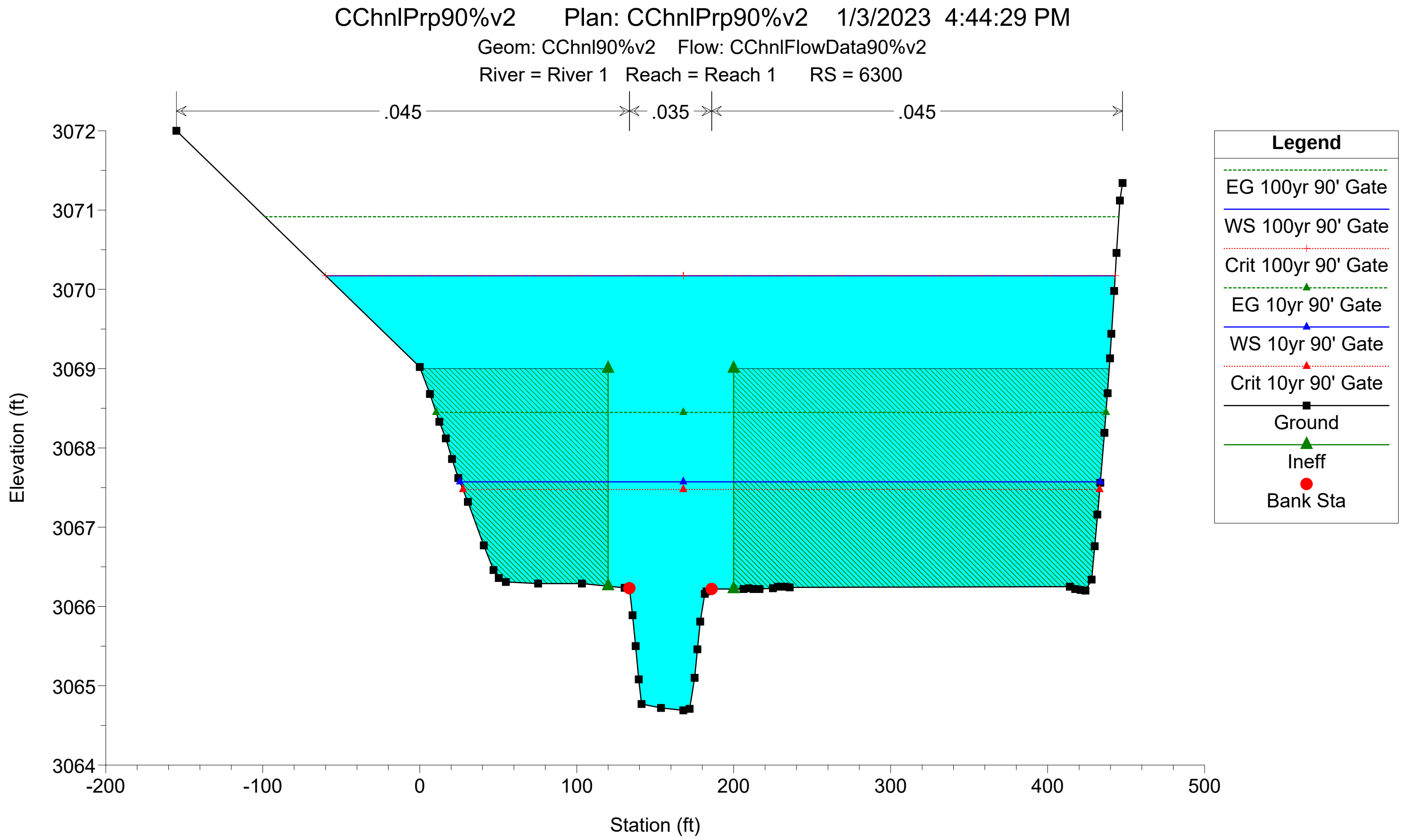
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	6300	100yr 90' Gate	3803.00	3064.69	3070.16	3070.16	3070.93	0.004894	8.73	792.51	442.96	0.68
Reach 1	6300	10yr 90' Gate	1177.00	3064.69	3067.57	3067.48	3068.45	0.010367	7.89	166.93	407.96	0.88
Reach 1	6200	100yr 90' Gate	3803.00	3064.09	3067.91	3067.91	3069.47	0.015324	11.96	416.18	560.65	1.14
Reach 1	6200	10yr 90' Gate	1177.00	3064.09	3066.61	3066.61	3067.25	0.011127	7.44	214.94	547.51	0.89
Reach 1	6100	100yr 90' Gate	3803.00	3063.47	3067.29		3067.62	0.004223	6.39	915.81	385.44	0.60
Reach 1	6100	10yr 90' Gate	1177.00	3063.47	3065.88		3066.11	0.005551	5.22	384.31	365.02	0.63
Reach 1	5942	100yr 90' Gate	3803.00	3062.50	3066.62		3066.97	0.003976	6.47	887.94	347.96	0.59
Reach 1	5942	10yr 90' Gate	1177.00	3062.50	3065.08		3065.31	0.004676	4.95	381.15	312.73	0.58
Reach 1	5858	100yr 90' Gate	3803.00	3061.97	3066.23		3066.63	0.004159	6.79	851.80	329.72	0.60
Reach 1	5858	10yr 90' Gate	1177.00	3061.97	3064.72		3064.94	0.004088	4.87	383.40	289.05	0.55
Reach 1	5745	100yr 90' Gate	3803.00	3061.29	3065.02	3064.90	3065.88	0.010184	9.69	595.18	278.94	0.92
Reach 1	5745	10yr 90' Gate	1177.00	3061.29	3063.74	3063.74	3064.23	0.009608	6.87	262.37	238.20	0.83
Reach 1	5667	100yr 90' Gate	3803.00	3060.84	3064.30		3065.15	0.008617	8.24	576.22	258.57	0.84
Reach 1	5667	10yr 90' Gate	1177.00	3060.84	3062.97		3063.39	0.008212	5.47	256.01	223.12	0.74
Reach 1	5654	100yr 90' Gate	3803.00	3060.75	3064.17	3063.99	3065.04	0.008894	8.28	569.11	257.54	0.85
Reach 1	5654	10yr 90' Gate	1177.00	3060.75	3062.86		3063.28	0.008381	5.47	254.37	223.09	0.75
Reach 1	5641	100yr 90' Gate	3803.00	3060.62	3063.91	3063.87	3064.90	0.010775	8.86	532.52	254.37	0.92
Reach 1	5641	10yr 90' Gate	1177.00	3060.62	3062.75	3062.61	3063.17	0.008270	5.47	254.95	222.87	0.74
Reach 1	5545	100yr 90' Gate	3803.00	3059.86	3063.18		3063.94	0.008158	8.20	624.47	287.45	0.82
Reach 1	5545	10yr 90' Gate	1177.00	3059.86	3061.89	3061.87	3062.35	0.008578	5.90	261.21	274.47	0.77
Reach 1	5500	100yr 90' Gate	3803.00	3059.50	3062.83		3063.57	0.007785	8.10	633.79	287.39	0.80
Reach 1	5500	10yr 90' Gate	1177.00	3059.50	3061.57	3061.49	3061.98	0.007324	5.60	277.65	274.73	0.71
Reach 1	5325	100yr 90' Gate	3803.00	3058.09	3061.38		3062.15	0.008359	8.32	618.64	286.81	0.83
Reach 1	5325	10yr 90' Gate	1177.00	3058.09	3060.08	3060.08	3060.57	0.008804	6.01	256.58	273.89	0.78
Reach 1	5100	100yr 90' Gate	3803.00	3056.28	3059.64		3060.35	0.007532	7.98	641.95	287.51	0.79
Reach 1	5100	10yr 90' Gate	1177.00	3056.28	3058.36	3058.26	3058.76	0.007088	5.52	283.34	274.68	0.70
Reach 1	4900	100yr 90' Gate	3803.00	3054.68	3058.03		3058.78	0.008170	8.16	626.42	287.59	0.82
Reach 1	4900	10yr 90' Gate	1177.00	3054.68	3056.75	3056.72	3057.20	0.008446	5.82	266.59	274.80	0.76
Reach 1	4700	100yr 90' Gate	3803.00	3053.06	3056.44		3057.17	0.007918	8.10	631.53	287.60	0.80
Reach 1	4700	10yr 90' Gate	1177.00	3053.06	3055.17	3055.10	3055.59	0.007701	5.66	274.43	274.98	0.73
Reach 1	4585	100yr 90' Gate	3803.00	3052.16	3055.40	3055.26	3056.21	0.008830	8.46	607.30	286.42	0.85
Reach 1	4585	10yr 90' Gate	1177.00	3052.16	3054.14	3054.14	3054.63	0.008886	6.00	256.11	273.85	0.78
Reach 1	4500	100yr 90' Gate	3803.00	3051.50	3054.65	3054.47	3055.44	0.009127	7.71	580.07	281.00	0.84
Reach 1	4500	10yr 90' Gate	1177.00	3051.50	3053.43	3053.29	3053.83	0.008674	5.22	253.00	251.33	0.75
Reach 1	4483	100yr 90' Gate	3803.00	3051.36	3054.59	3054.27	3055.26	0.007609	7.09	627.94	299.36	0.77
Reach 1	4483	10yr 90' Gate	1177.00	3051.36	3053.35		3053.68	0.006897	4.71	281.33	259.47	0.67
Reach 1	4460	100yr 90' Gate	3803.00	3051.19	3054.09	3054.09	3055.02	0.012485	8.29	533.92	290.61	0.96
Reach 1	4460	10yr 90' Gate	1177.00	3051.19	3052.93	3052.93	3053.44	0.012712	5.82	220.84	249.27	0.89
Reach 1	4436	100yr 90' Gate	3803.00	3050.67	3053.59	3053.59	3054.54	0.012273	8.34	529.41	283.72	0.96
Reach 1	4436	10yr 90' Gate	1177.00	3050.67	3052.43	3052.43	3052.95	0.012836	5.85	217.63	248.75	0.89
Reach 1	4420	100yr 90' Gate	3803.00	3050.02	3053.02	3053.02	3053.97	0.011784	8.43	533.96	280.87	0.94
Reach 1	4420	10yr 90' Gate	1177.00	3050.02	3051.85	3051.85	3052.37	0.011985	5.88	220.03	249.22	0.87
Reach 1	4353	100yr 90' Gate	3803.00	3047.38	3050.55	3050.48	3051.43	0.009885	8.74	582.18	285.03	0.89
Reach 1	4353	10yr 90' Gate	1177.00	3047.38	3049.37	3049.37	3049.86	0.009066	5.98	252.71	272.78	0.79

HEC-RAS Plan: CChnlPrp90%v2 River: River 1 Reach: Reach 1 (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
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	4100	100yr 90' Gate	3803.00	3045.04	3048.33		3049.10	0.008325	8.28	618.94	286.64	0.82
Reach 1	4100	10yr 90' Gate	1177.00	3045.04	3047.09	3047.03	3047.52	0.007746	5.70	271.00	274.41	0.73
Reach 1	3900	100yr 90' Gate	3803.00	3043.45	3046.85		3047.54	0.007100	7.85	653.58	288.01	0.77
Reach 1	3900	10yr 90' Gate	1177.00	3043.45	3045.47	3045.44	3045.93	0.008238	5.84	264.48	274.19	0.75
Reach 1	3700	100yr 90' Gate	3803.00	3041.85	3045.13	3045.00	3045.94	0.008952	8.47	606.25	286.72	0.85
Reach 1	3700	10yr 90' Gate	1177.00	3041.85	3043.98	3043.90	3044.38	0.007184	5.54	282.15	275.08	0.71
Reach 1	3500	100yr 90' Gate	3803.00	3040.26	3043.95		3044.50	0.005315	7.04	722.62	290.86	0.67
Reach 1	3500	10yr 90' Gate	1177.00	3040.26	3042.33	3042.31	3042.79	0.008756	5.90	262.45	274.67	0.77
Reach 1	3319	100yr 90' Gate	4660.00	3038.81	3042.45		3043.29	0.007905	8.68	721.98	290.42	0.82
Reach 1	3319	10yr 90' Gate	1204.00	3038.81	3040.89	3040.82	3041.32	0.007509	5.69	279.58	274.67	0.72
Reach 1	3100	100yr 90' Gate	4660.00	3037.05	3040.67		3041.53	0.008156	8.77	714.41	290.16	0.83
Reach 1	3100	10yr 90' Gate	1204.00	3037.05	3039.08	3039.07	3039.56	0.008553	5.96	264.59	274.18	0.77
Reach 1	2900	100yr 90' Gate	4660.00	3035.44	3039.14		3039.95	0.007533	8.53	733.98	290.85	0.80
Reach 1	2900	10yr 90' Gate	1204.00	3035.44	3037.55	3037.46	3037.97	0.007254	5.62	283.81	275.00	0.71
Reach 1	2681	100yr 90' Gate	4660.00	3033.69	3037.36		3038.21	0.008246	9.02	718.21	290.42	0.84
Reach 1	2681	10yr 90' Gate	1204.00	3033.69	3035.76	3035.76	3036.26	0.008333	6.17	268.10	274.72	0.76
Reach 1	2500	100yr 90' Gate	4660.00	3032.22	3035.93		3036.75	0.007851	8.70	728.95	291.05	0.82
Reach 1	2500	10yr 90' Gate	1204.00	3032.22	3034.37	3034.29	3034.78	0.007321	5.69	286.46	275.32	0.71
Reach 1	2316	100yr 90' Gate	4660.00	3030.75	3034.46		3035.30	0.007900	8.87	726.81	289.49	0.82
Reach 1	2316	10yr 90' Gate	1204.00	3030.75	3032.83	3032.83	3033.33	0.008491	6.17	266.56	274.04	0.77
Reach 1	2200	100yr 90' Gate	4660.00	3029.81	3033.78		3034.46	0.005948	8.05	799.94	293.91	0.72
Reach 1	2200	10yr 90' Gate	1204.00	3029.81	3032.16		3032.46	0.004603	4.95	339.49	277.20	0.58
Reach 1	2000	100yr 90' Gate	4660.00	3029.41	3032.38		3033.03	0.008897	8.17	789.35	983.97	0.84
Reach 1	2000	10yr 90' Gate	1204.00	3029.41	3031.13		3031.37	0.006561	4.83	356.75	606.98	0.66
Reach 1	1800	100yr 90' Gate	4660.00	3028.97	3031.46		3031.65	0.004615	3.82	1364.32	1269.58	0.45
Reach 1	1800	10yr 90' Gate	1204.00	3028.97	3030.38		3030.45	0.003111	2.15	600.46	1085.44	0.34
Reach 1	1700	100yr 90' Gate	4660.00	3028.66	3031.01		3031.22	0.005645	3.98	1313.78	1318.06	0.49
Reach 1	1700	10yr 90' Gate	1204.00	3028.66	3030.08		3030.15	0.003206	2.15	600.42	1096.12	0.34
Reach 1	1528	100yr 90' Gate	4660.00	3028.59	3030.30		3030.60	0.003429	4.60	1100.50	1710.67	0.66
Reach 1	1528	10yr 90' Gate	1204.00	3028.59	3029.35		3029.51	0.004913	3.32	382.73	1455.02	0.69
Reach 1	1483	100yr 90' Gate	4660.00	3028.33	3030.01	3029.83	3030.44	0.003129	5.43	921.47	1491.54	0.78
Reach 1	1483	10yr 90' Gate	1204.00	3028.33	3029.23		3029.37	0.002065	2.98	410.92	1272.70	0.58
Reach 1	1462	100yr 90' Gate	4660.00	3028.19	3030.00	3029.77	3030.29	0.008990	4.28	1083.71	1757.51	0.72
Reach 1	1462	10yr 90' Gate	1204.00	3028.19	3029.12	3028.95	3029.28	0.009005	2.81	377.31	1270.59	0.65

FG Channels-C Channel Subcritical Run_2022.08.29

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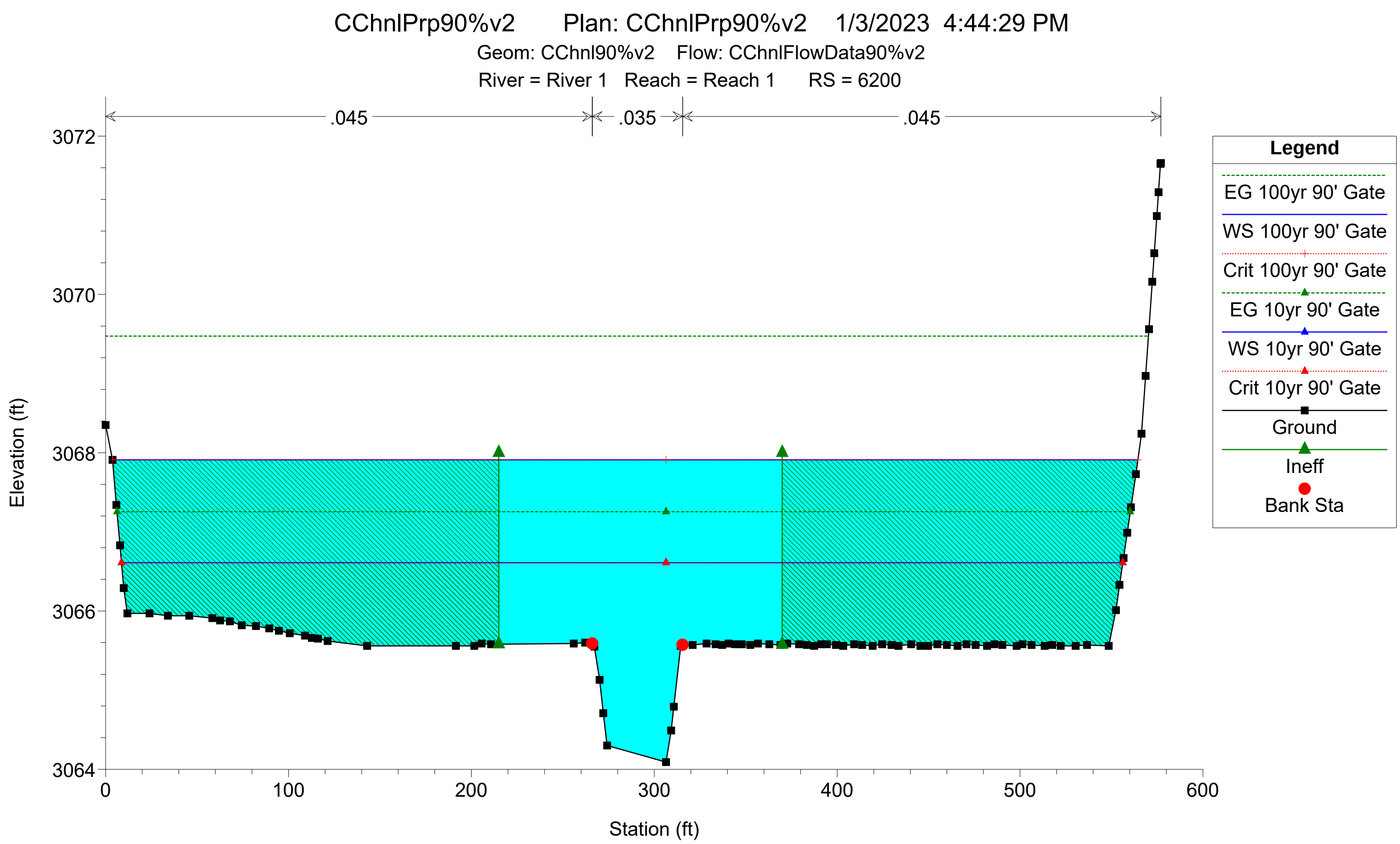
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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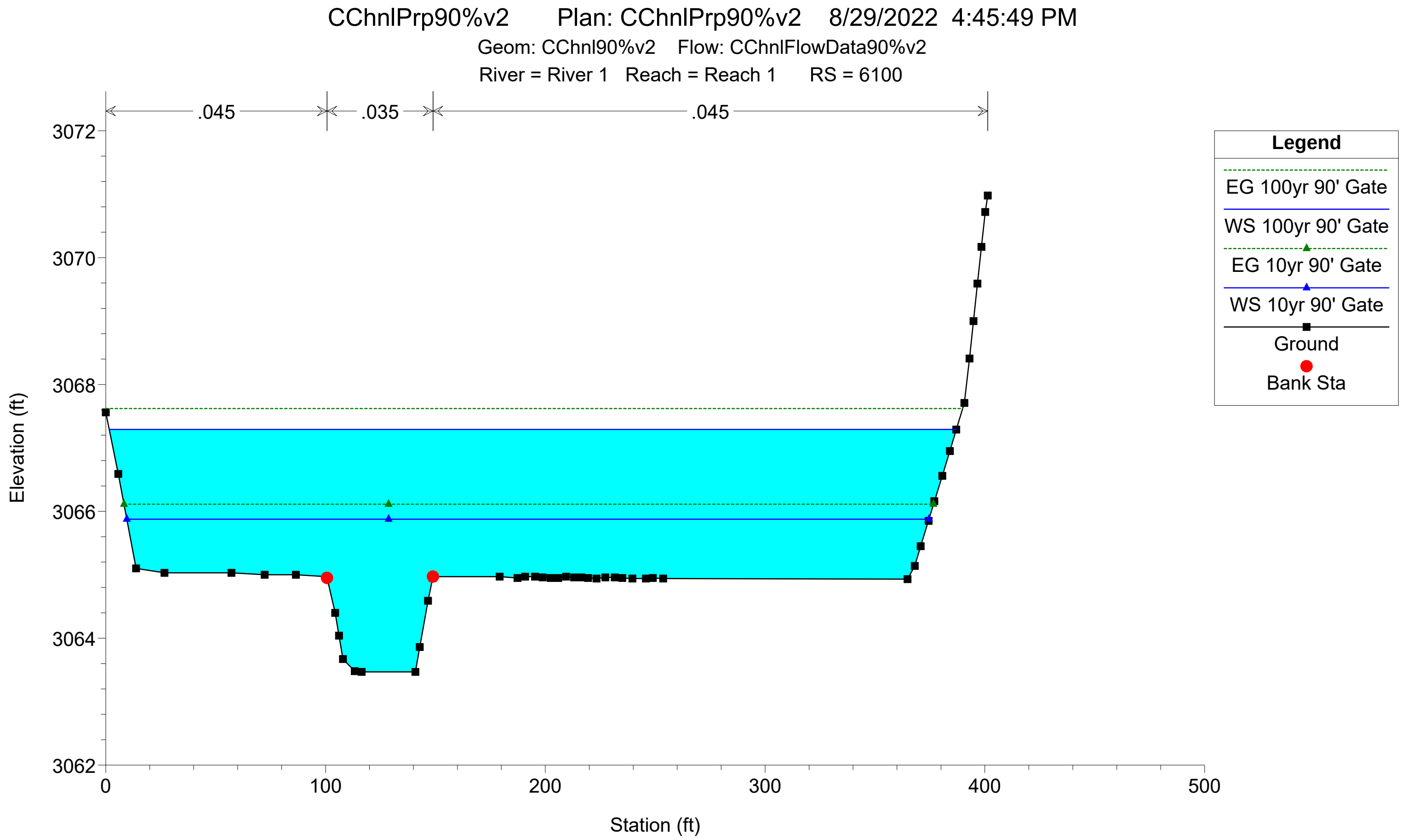
River = River 1 Reach = Reach 1 RS = 6200
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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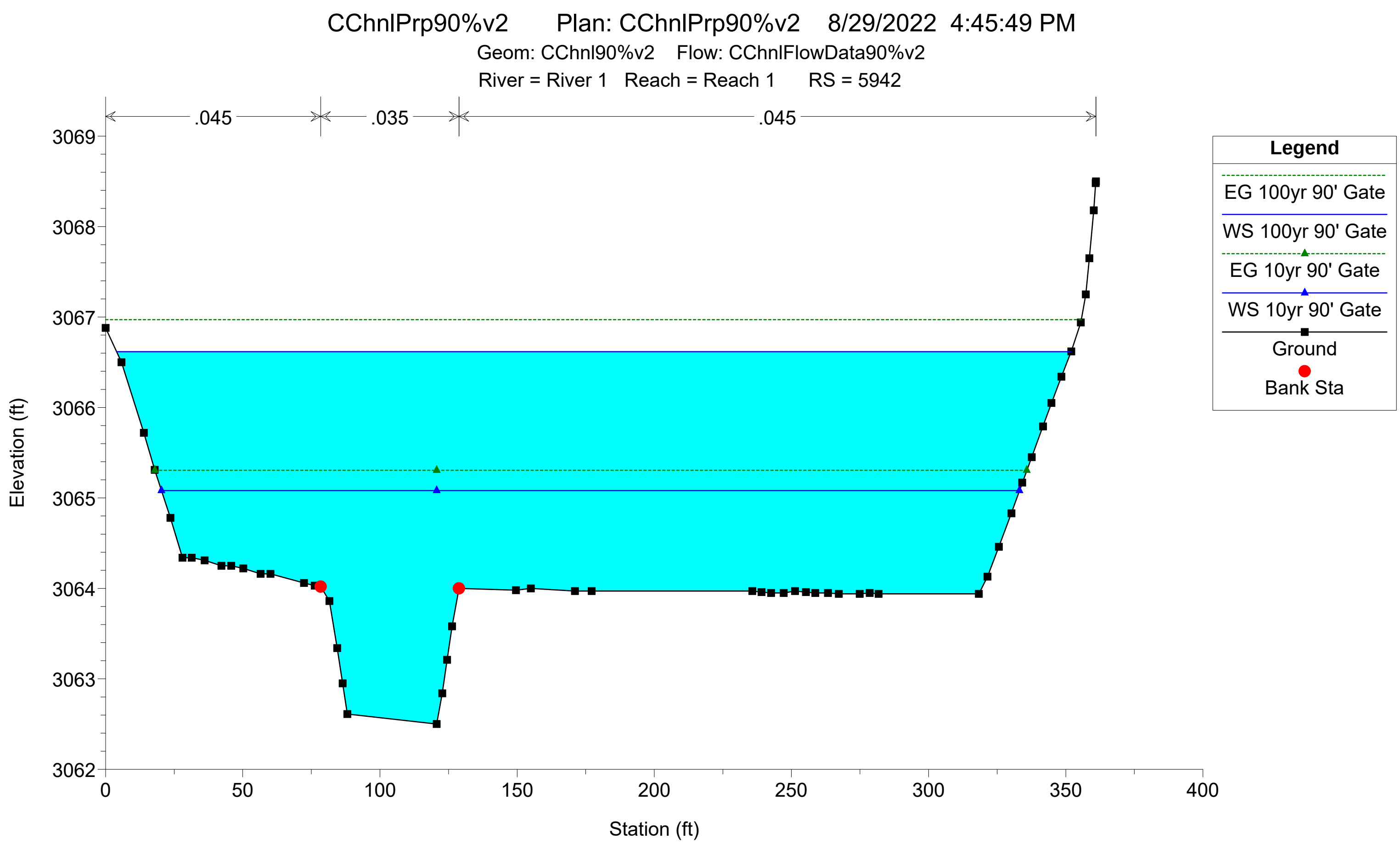
River = River 1 Reach = Reach 1 RS = 6100
.045
.035
.045
Elevation (ft)
3072
3070
3068
3066
3064
3062
0
100
200
300
400
500
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Ground
Bank Sta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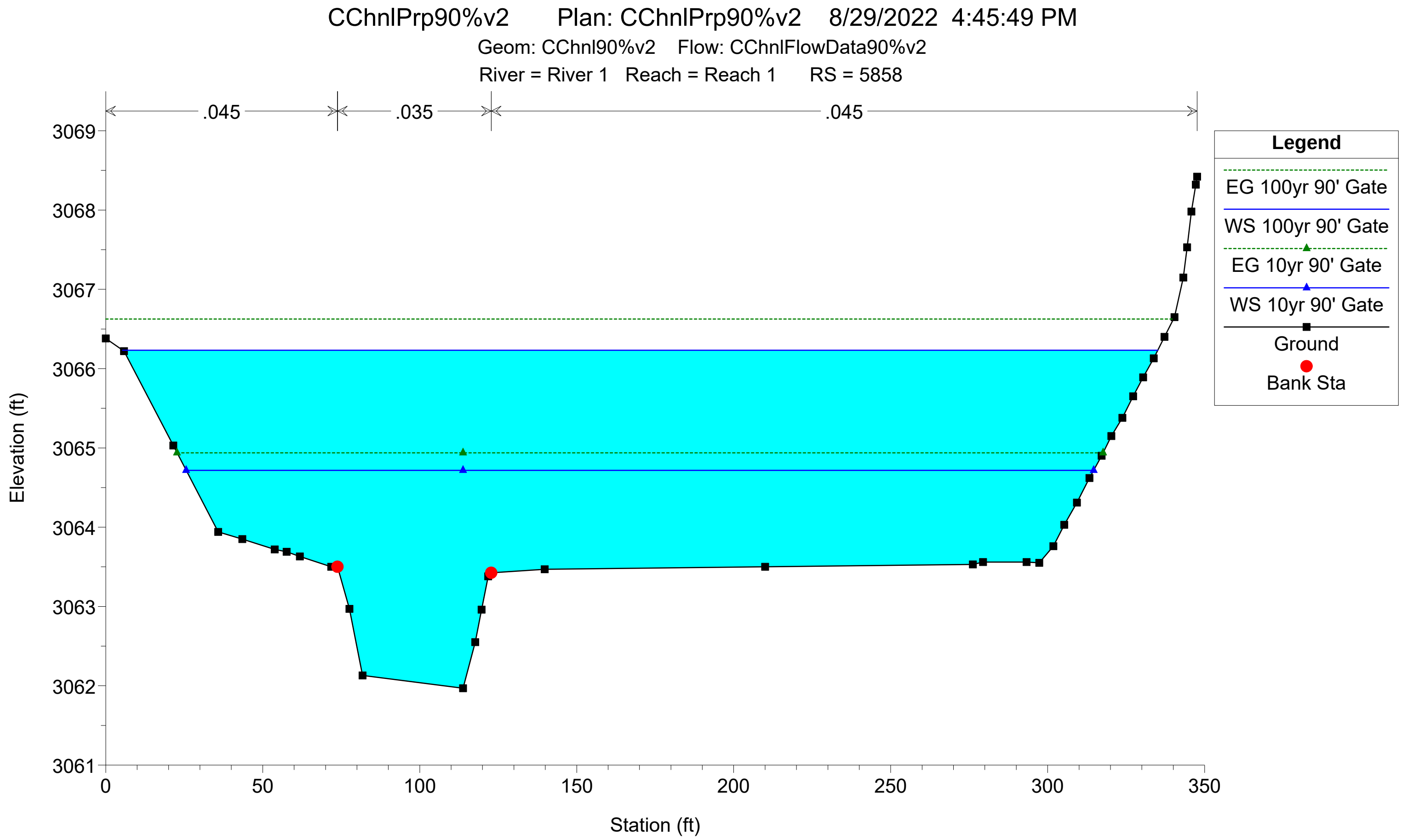
River = River 1 Reach = Reach 1 RS = 5942
.045
.035
.045
Elevation (ft)
3069
3068
3067
3066
3065
3064
3063
3062
0
50
100
150
200
250
300
350
400
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Ground
Bank Sta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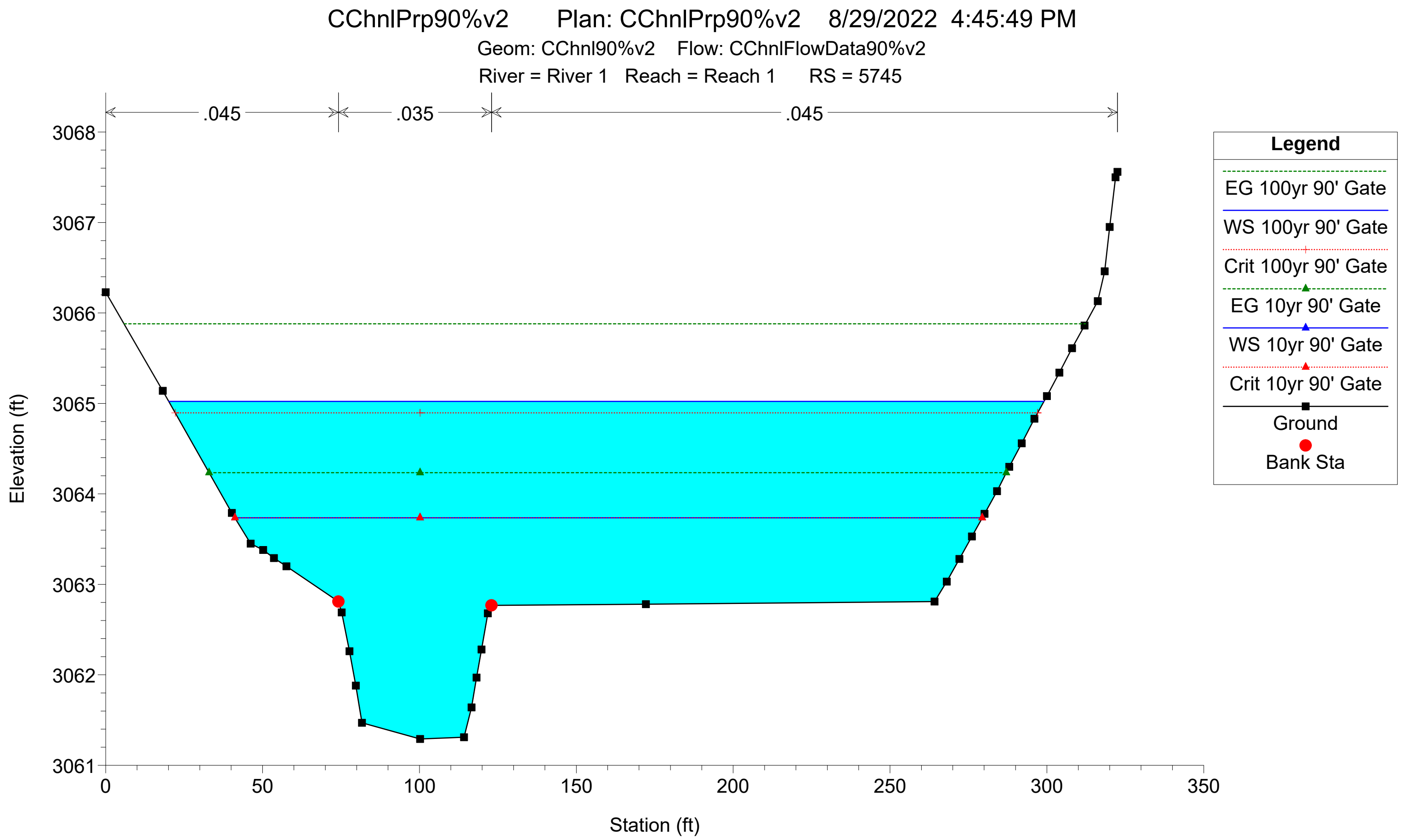
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Ground
Bank Sta
Elevation (ft)
Station (ft)
3061
3062
3063
3064
3065
3066
3067
3068
3069
0
50
100
150
200
250
300
350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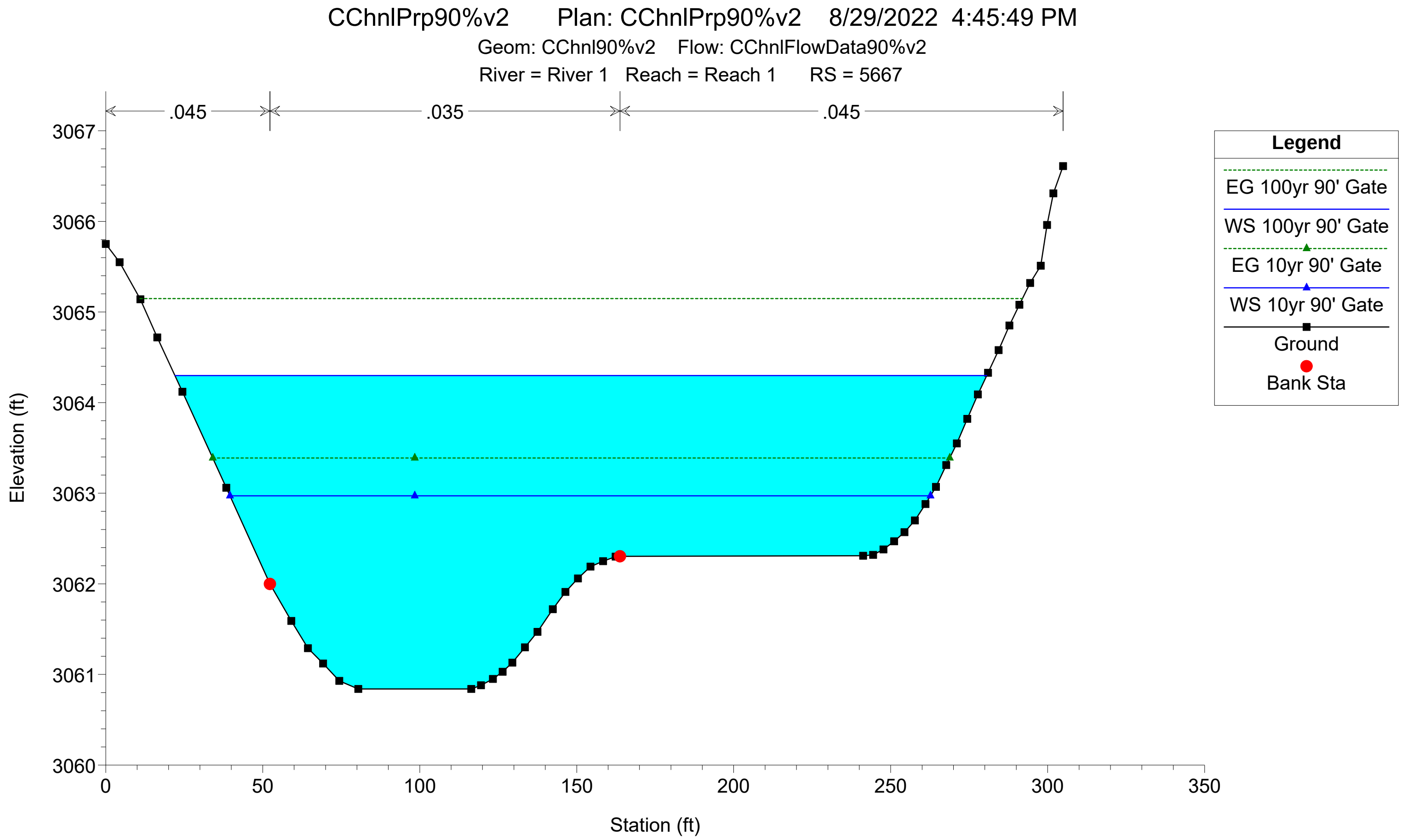
River = River 1 Reach = Reach 1 RS = 5745
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta
Elevation (ft)
Station (ft)
3061
3062
3063
3064
3065
3066
3067
3068
0
50
100
150
200
250
300
350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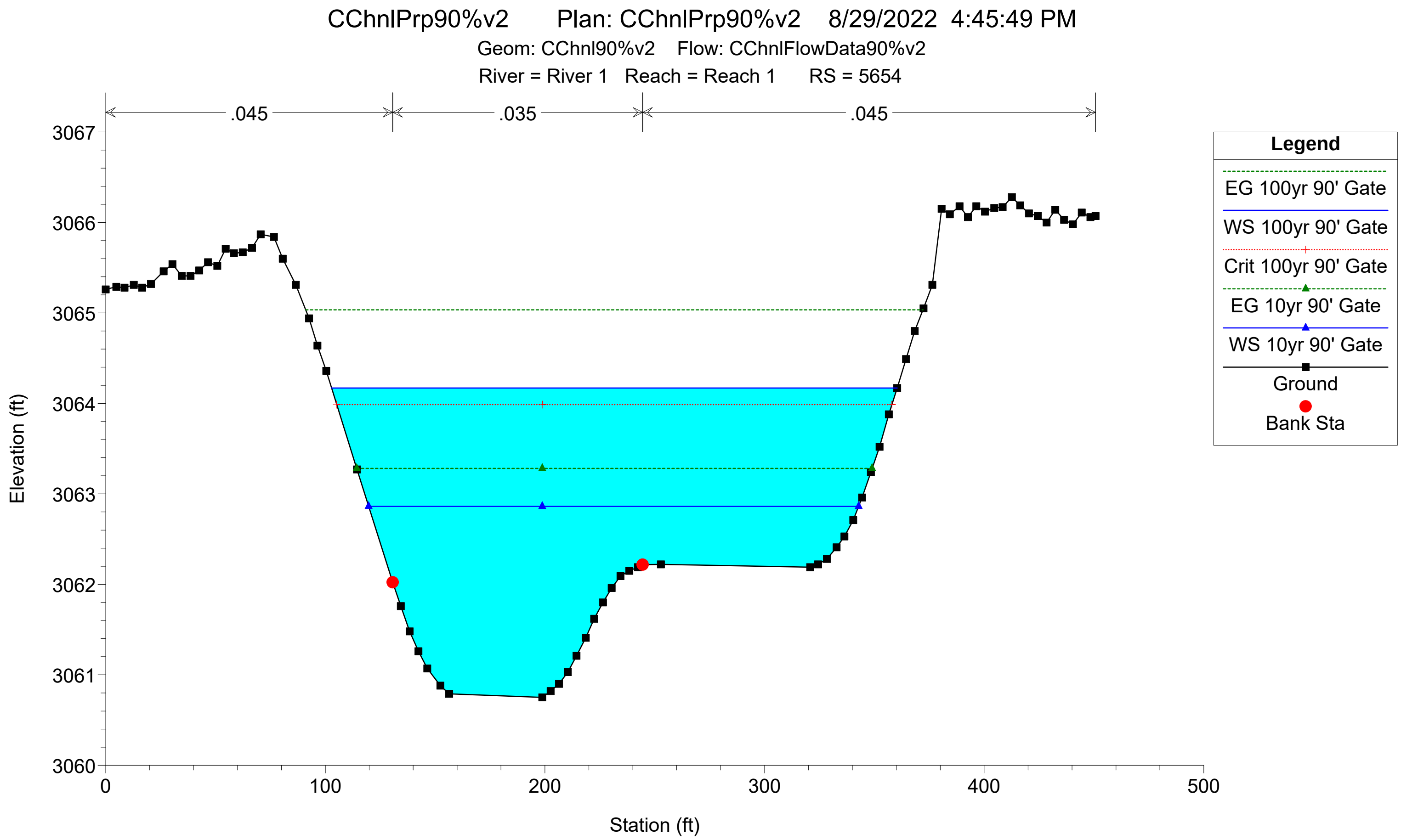
River = River 1 Reach = Reach 1 RS = 5667
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Ground
Bank Sta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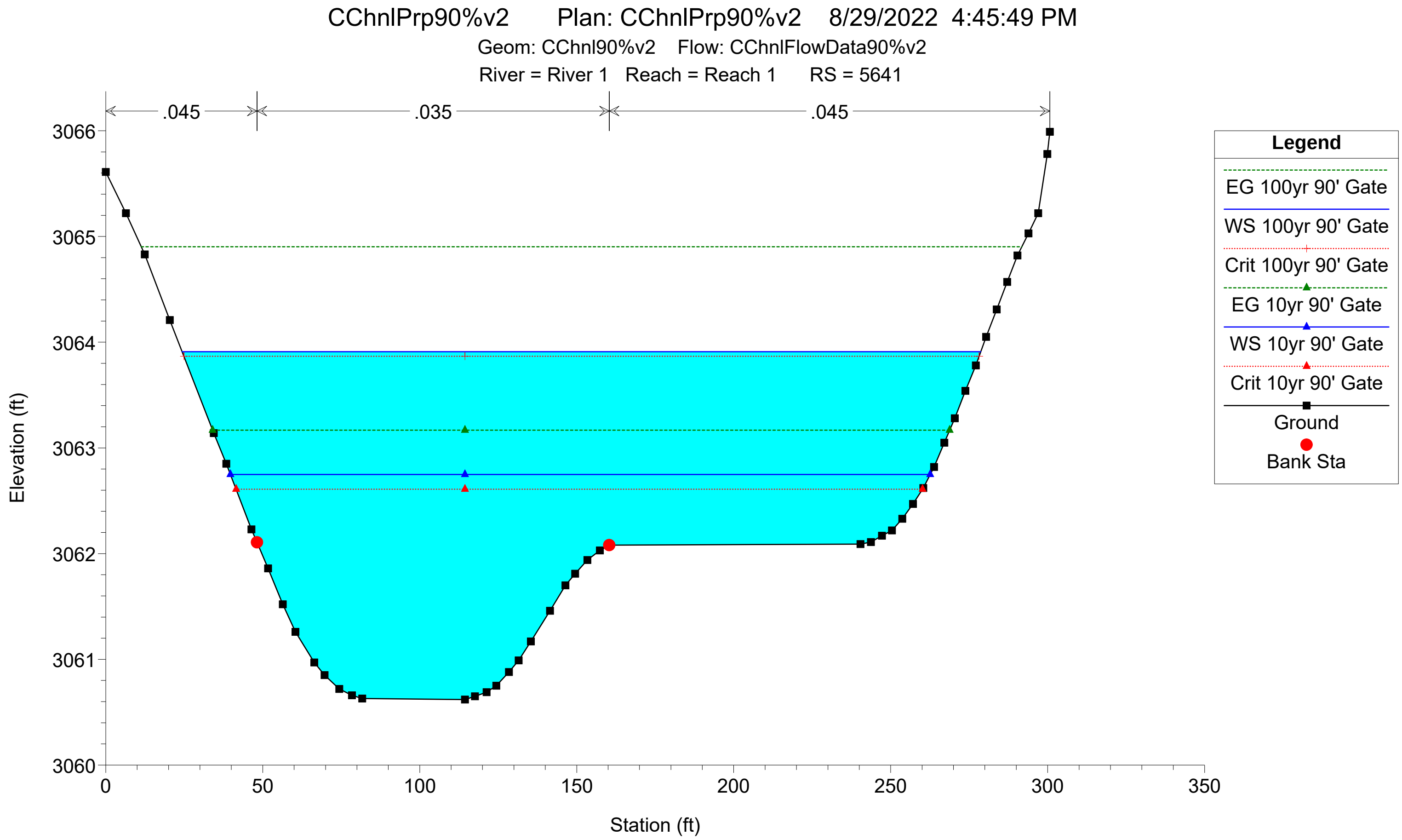
River = River 1 Reach = Reach 1 RS = 5654
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Ground
Bank Sta



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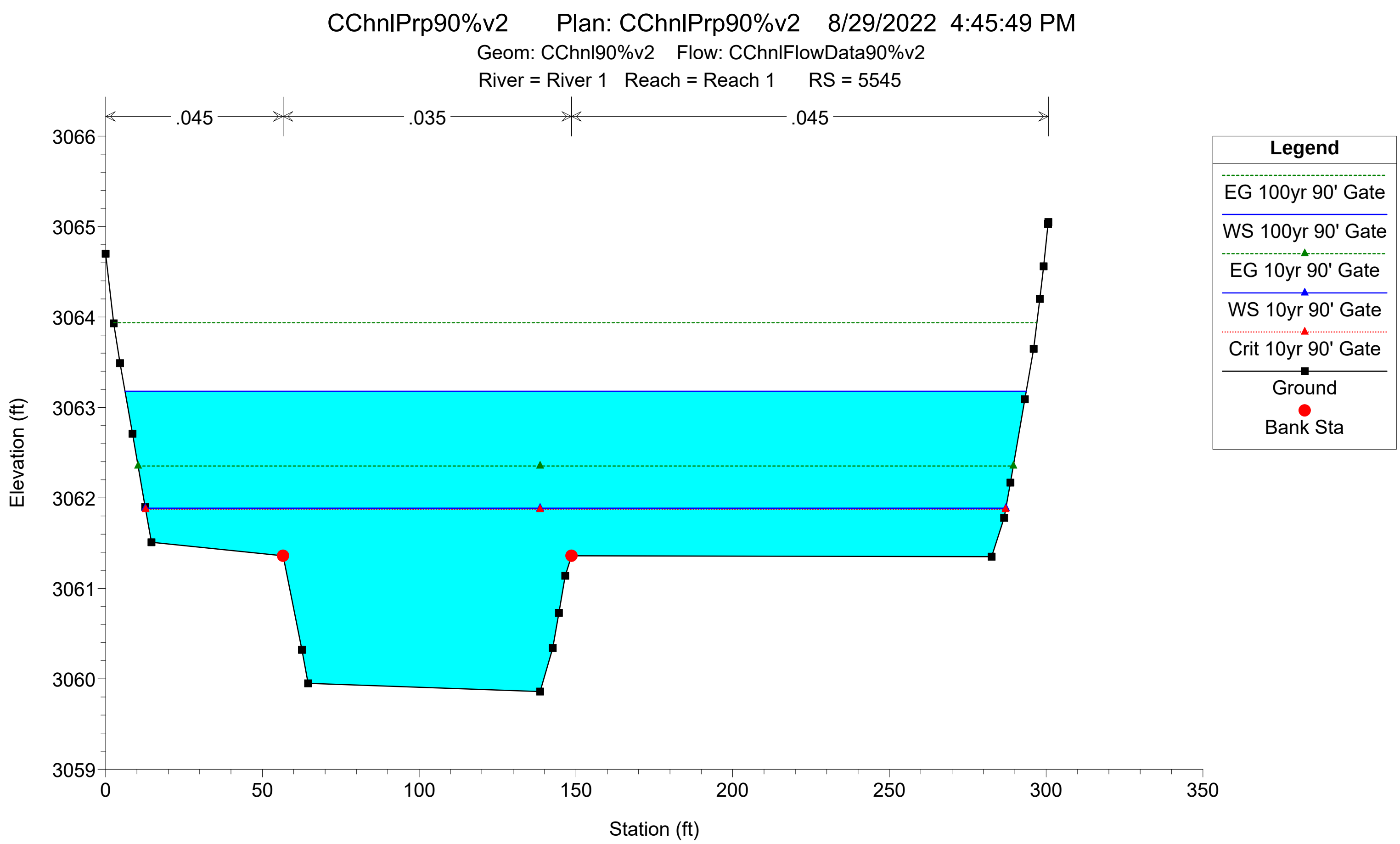
River = River 1 Reach = Reach 1 RS = 5641
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta



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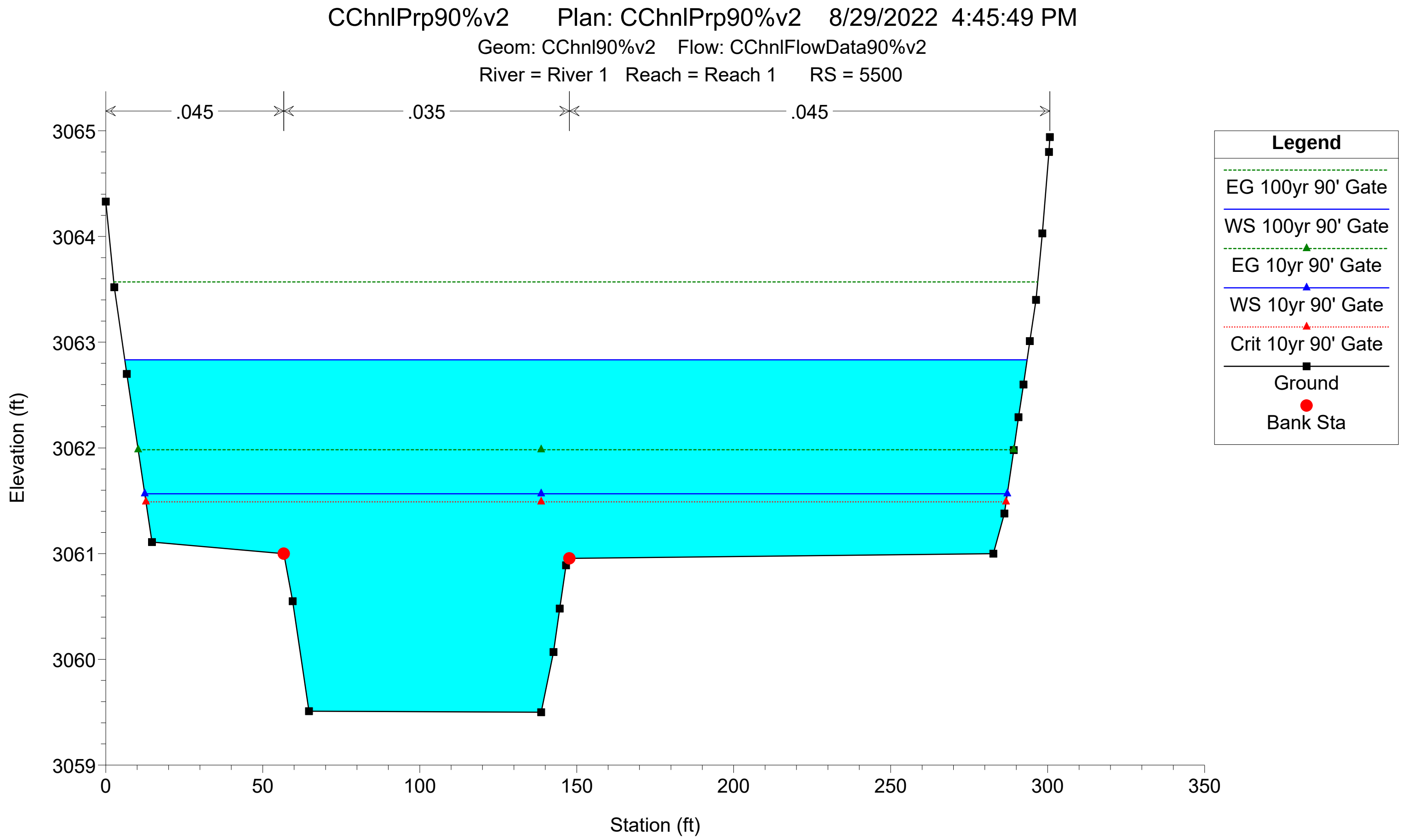
River = River 1 Reach = Reach 1 RS = 5545
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta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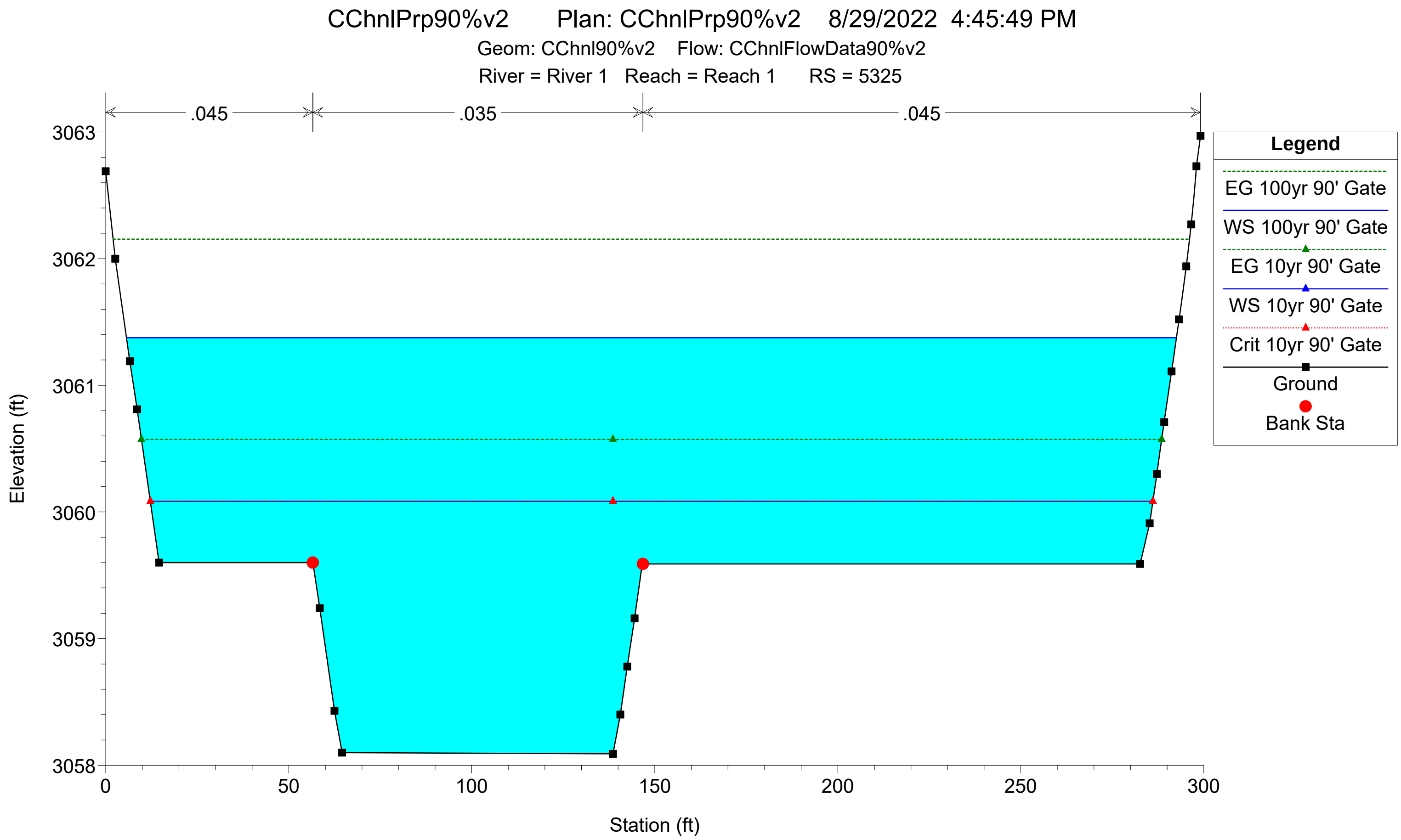
River = River 1 Reach = Reach 1 RS = 5500
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta
Elevation (ft)
Station (ft)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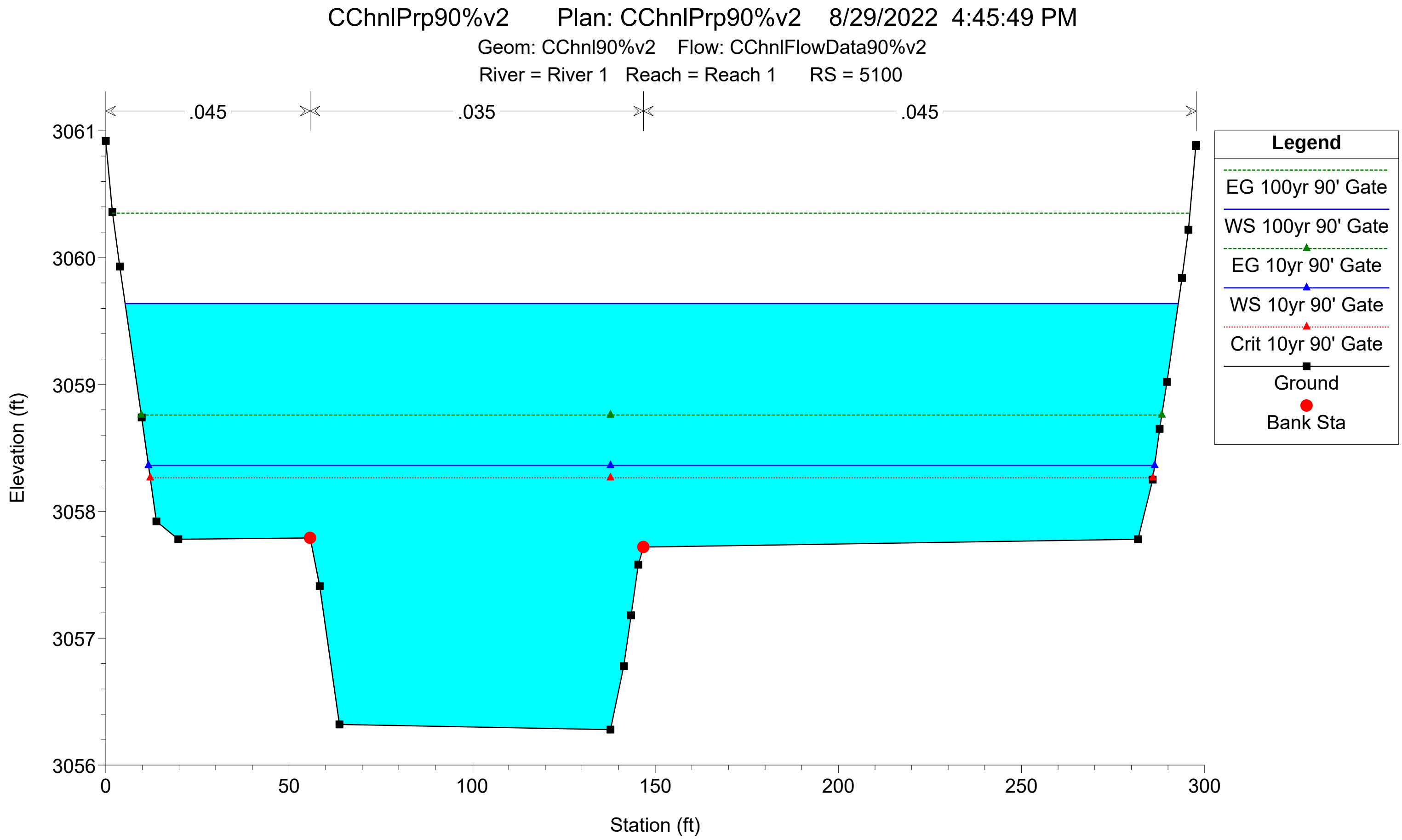
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 5325
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta
Elevation (ft)
Station (ft)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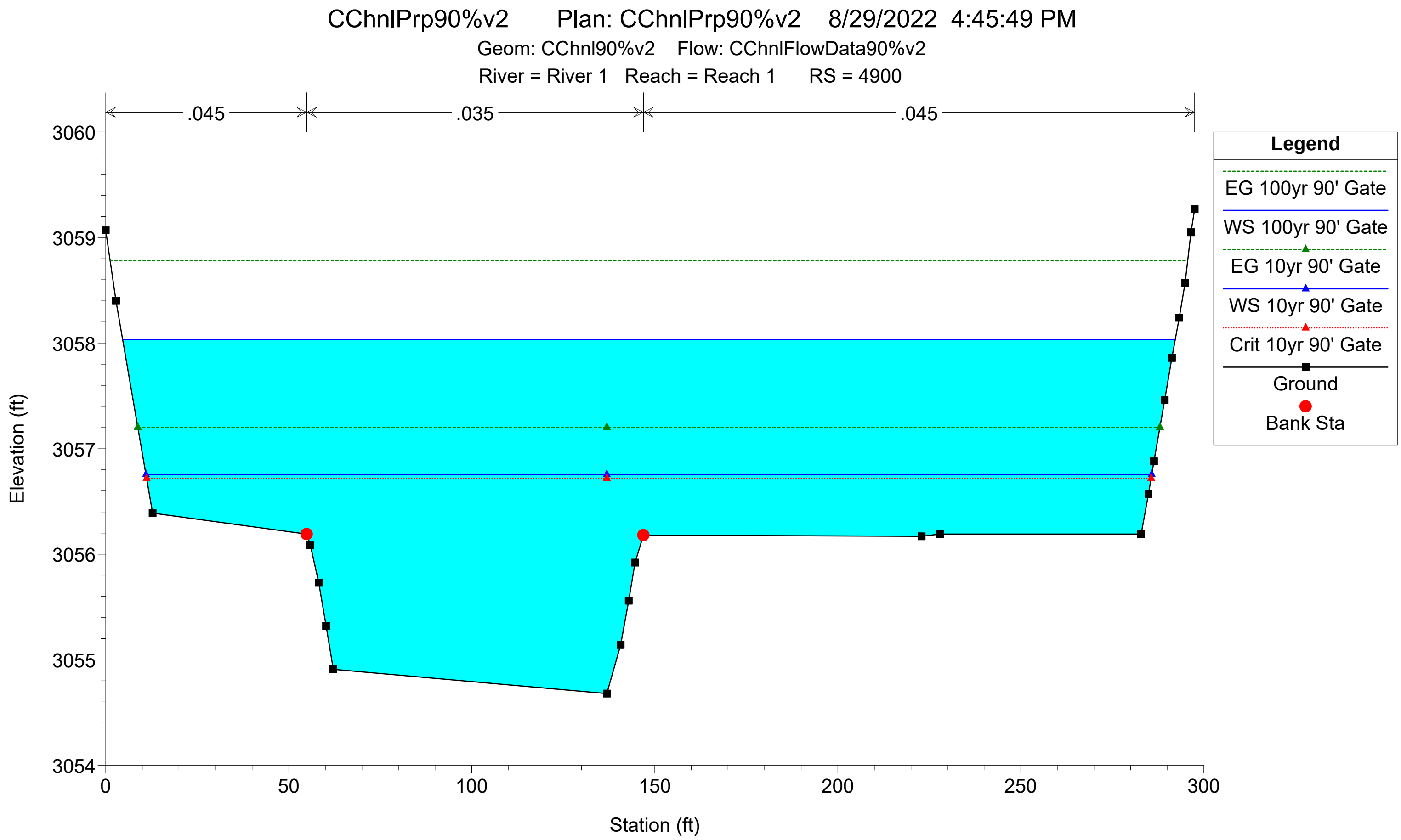
River = River 1 Reach = Reach 1 RS = 5100
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta
Elevation (ft)
3061
3060
3059
3058
3057
3056
0
50
100
150
200
250
300
Station (ft)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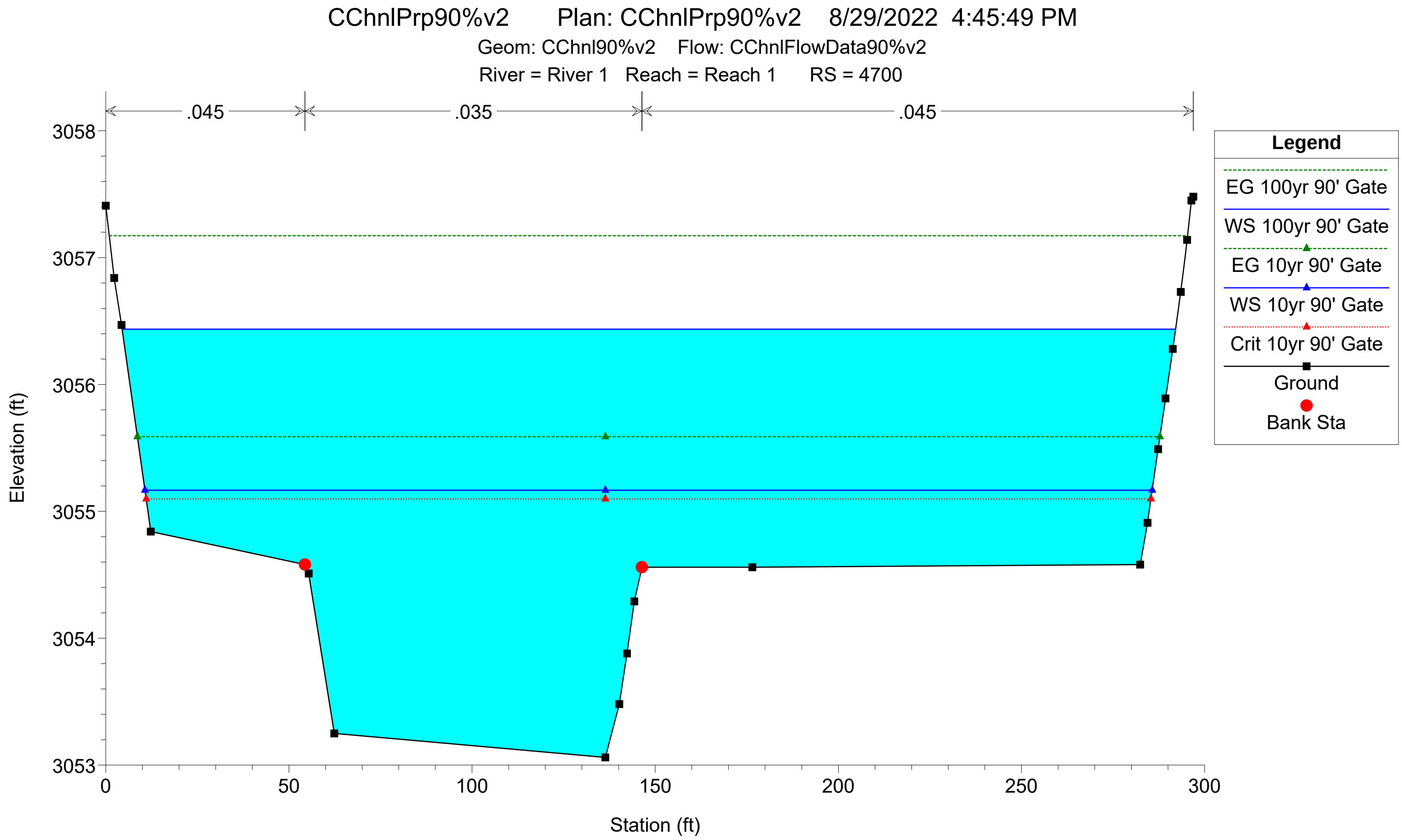
River = River 1 Reach = Reach 1 RS = 4900
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta
Elevation (ft)
3060
3059
3058
3057
3056
3055
3054
0
50
100
150
200
250
300
Station (ft)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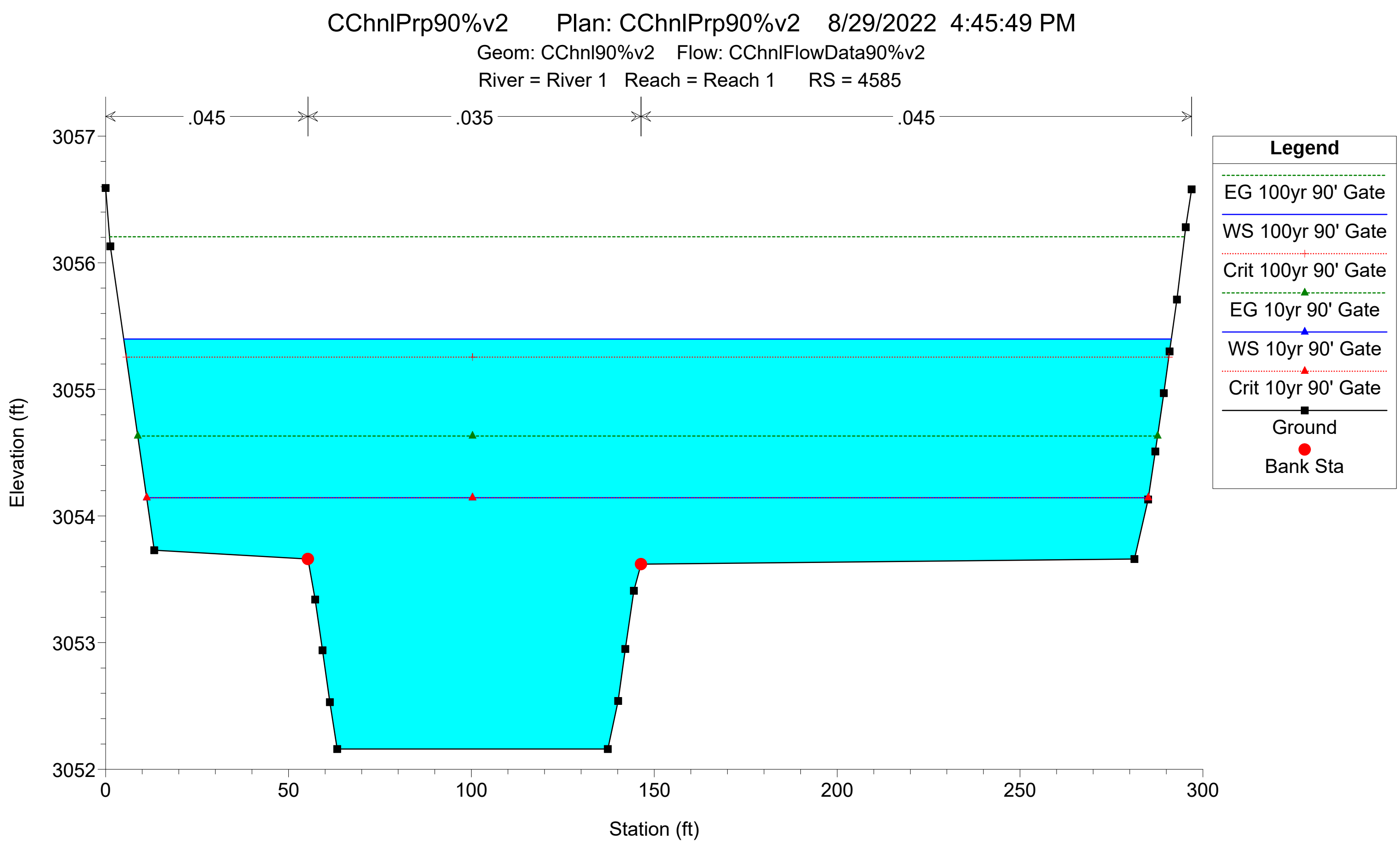
River = River 1 Reach = Reach 1 RS = 4700
.045
.035
.045
Elevation (ft)
3058
3057
3056
3055
3054
3053
0
50
100
150
200
250
300
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta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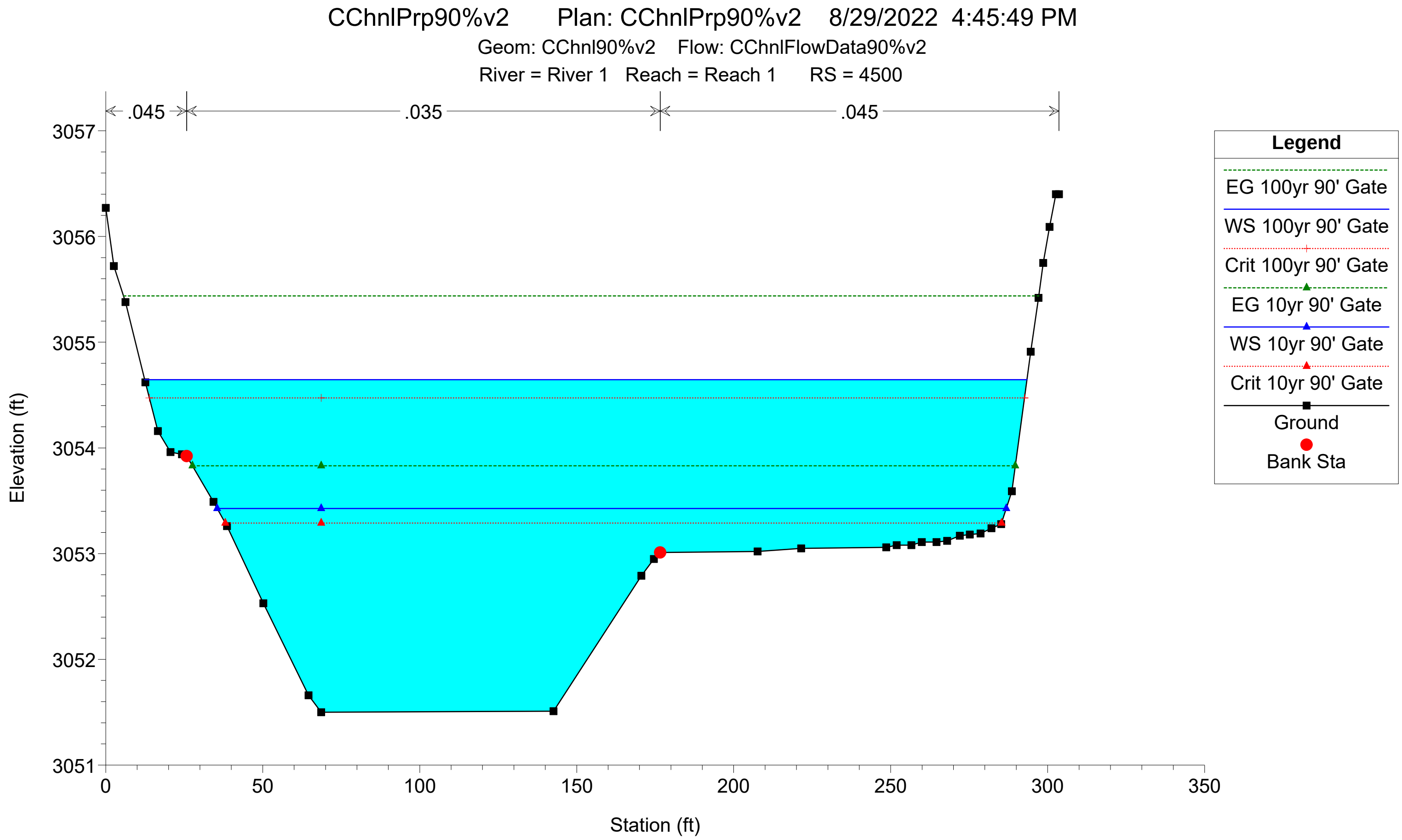
River = River 1 Reach = Reach 1 RS = 4585
.045
.035
.045
Elevation (ft)
3057
3056
3055
3054
3053
3052
0
50
100
150
200
250
300
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta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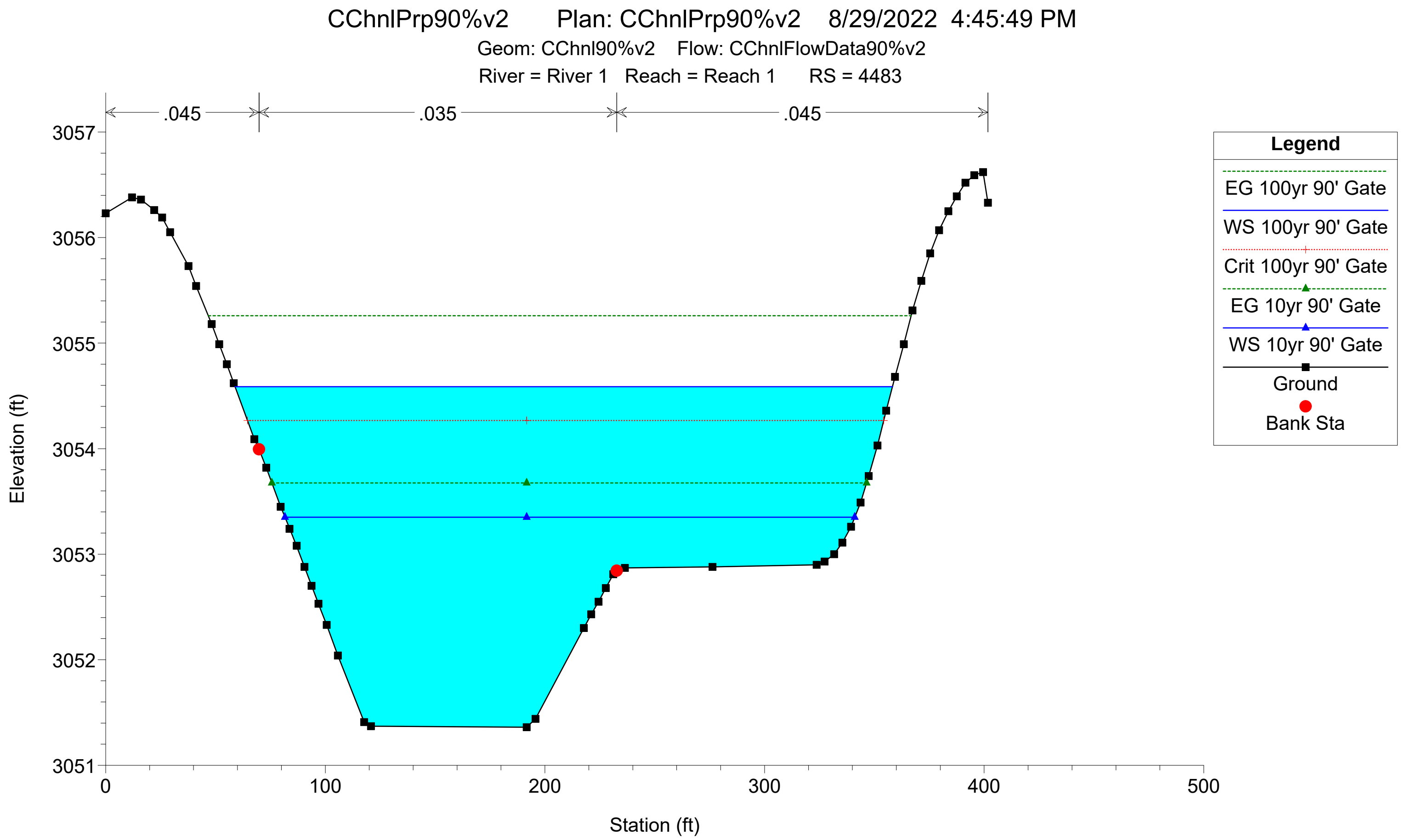
River = River 1 Reach = Reach 1 RS = 4500
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta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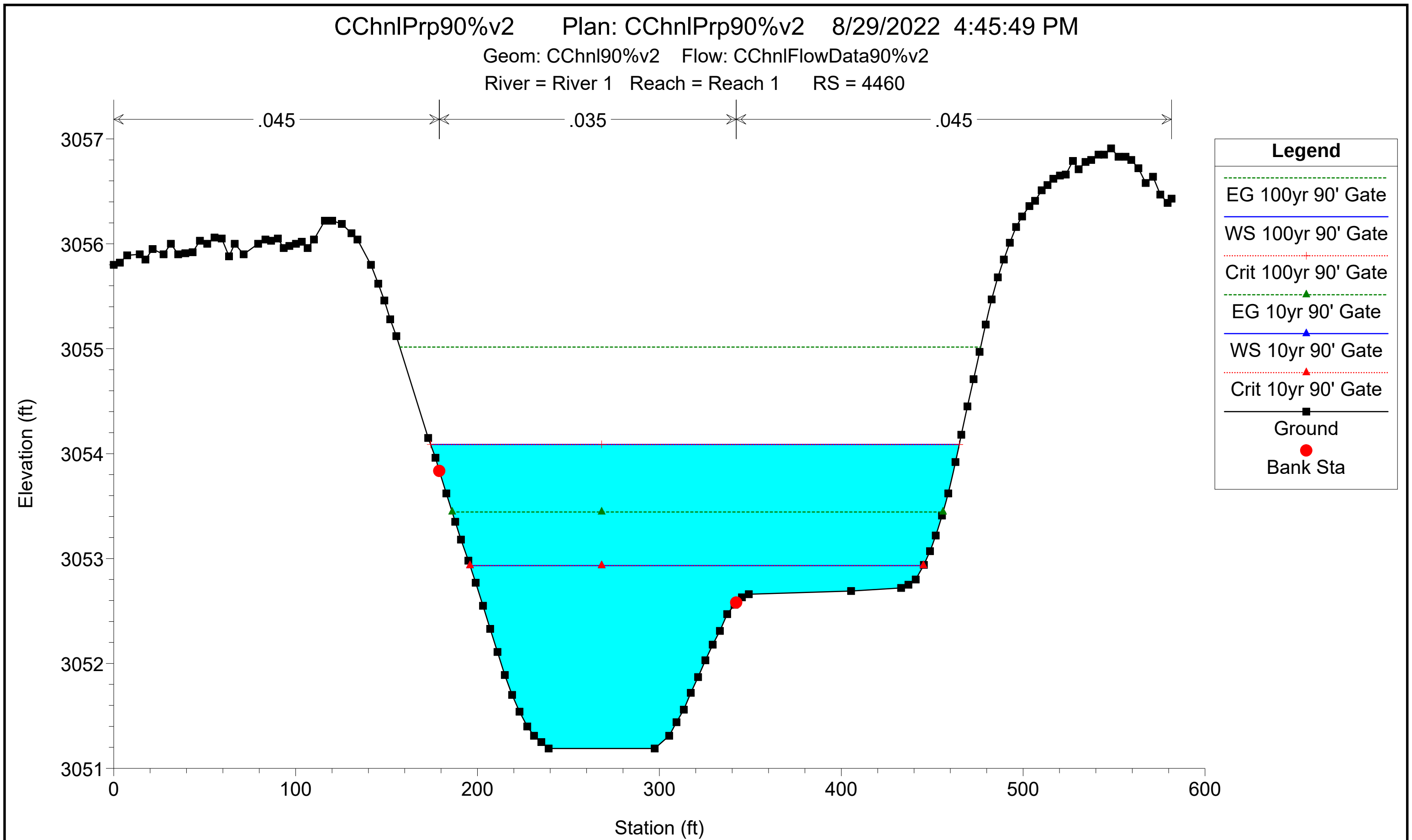
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Ground
Bank Sta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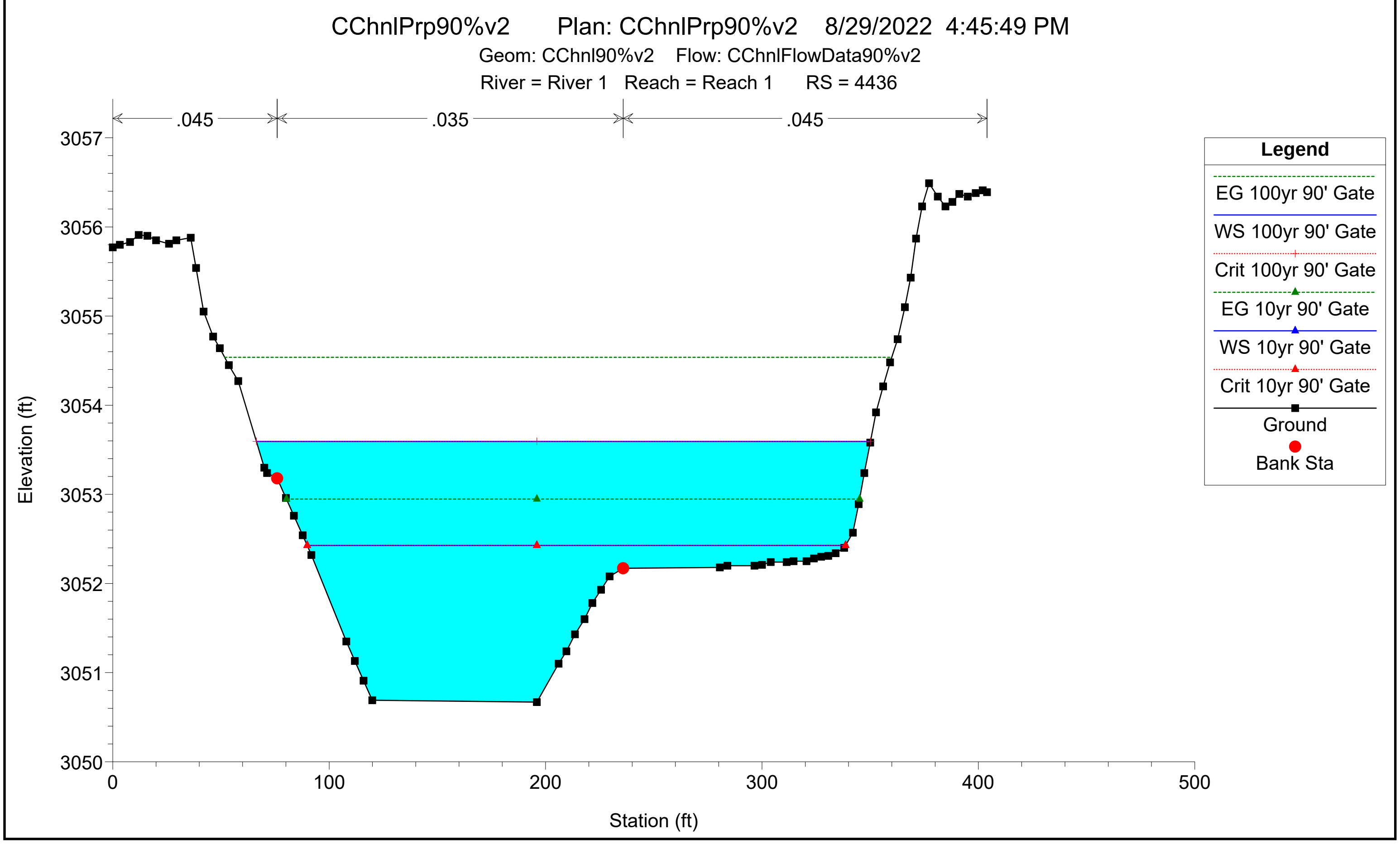
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta
Elevation (ft)
Station (ft)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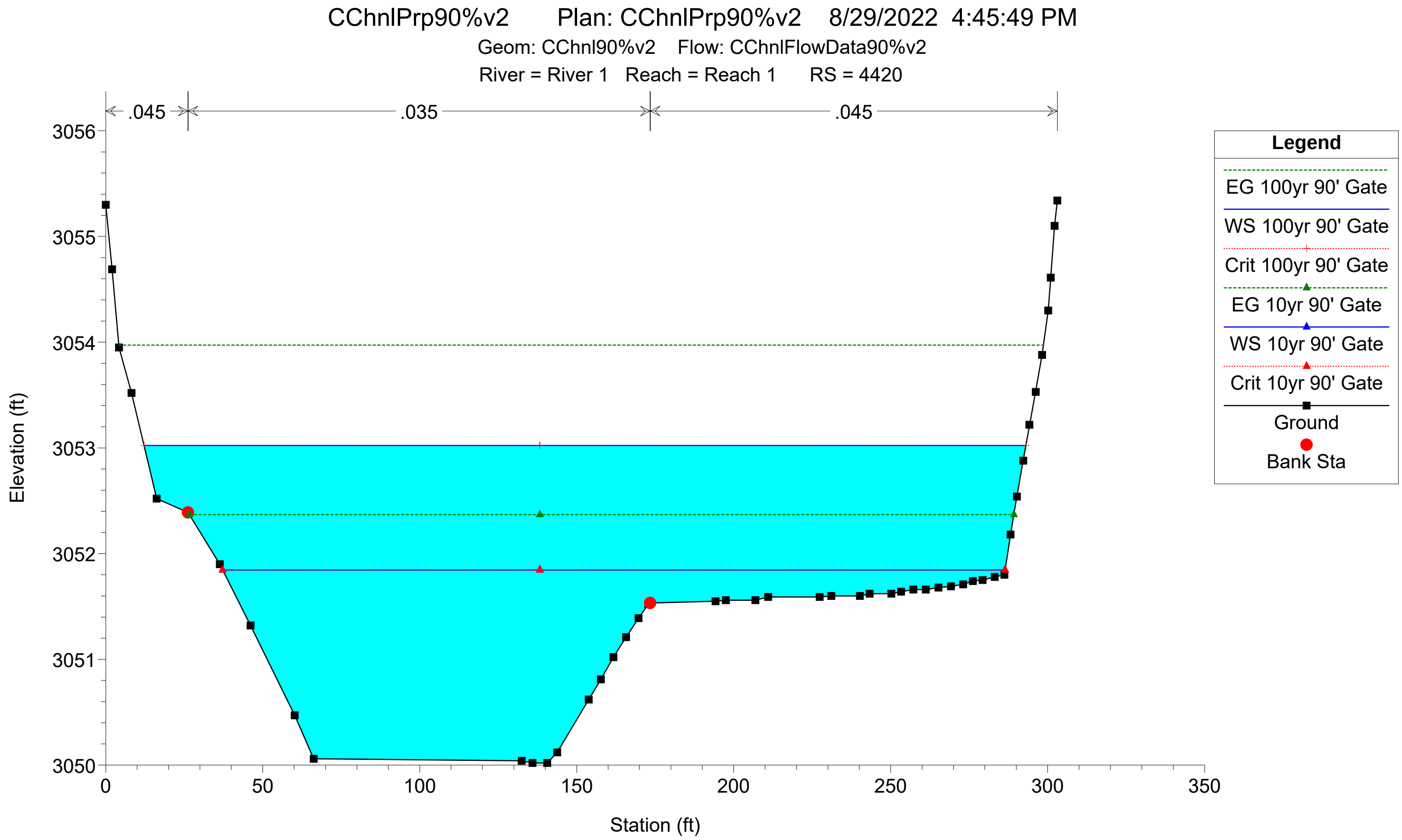
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta
Elevation (ft)
Station (ft)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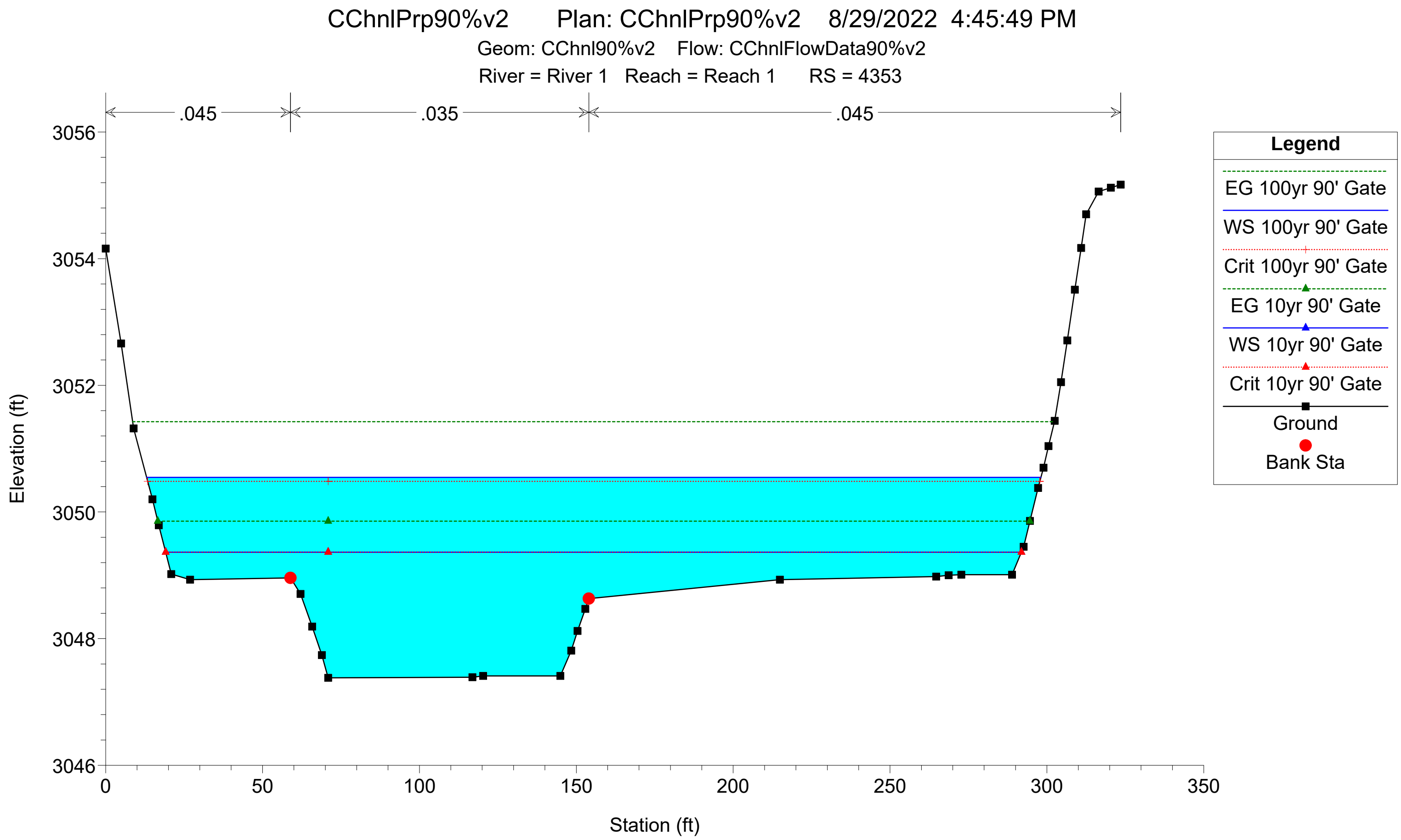
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta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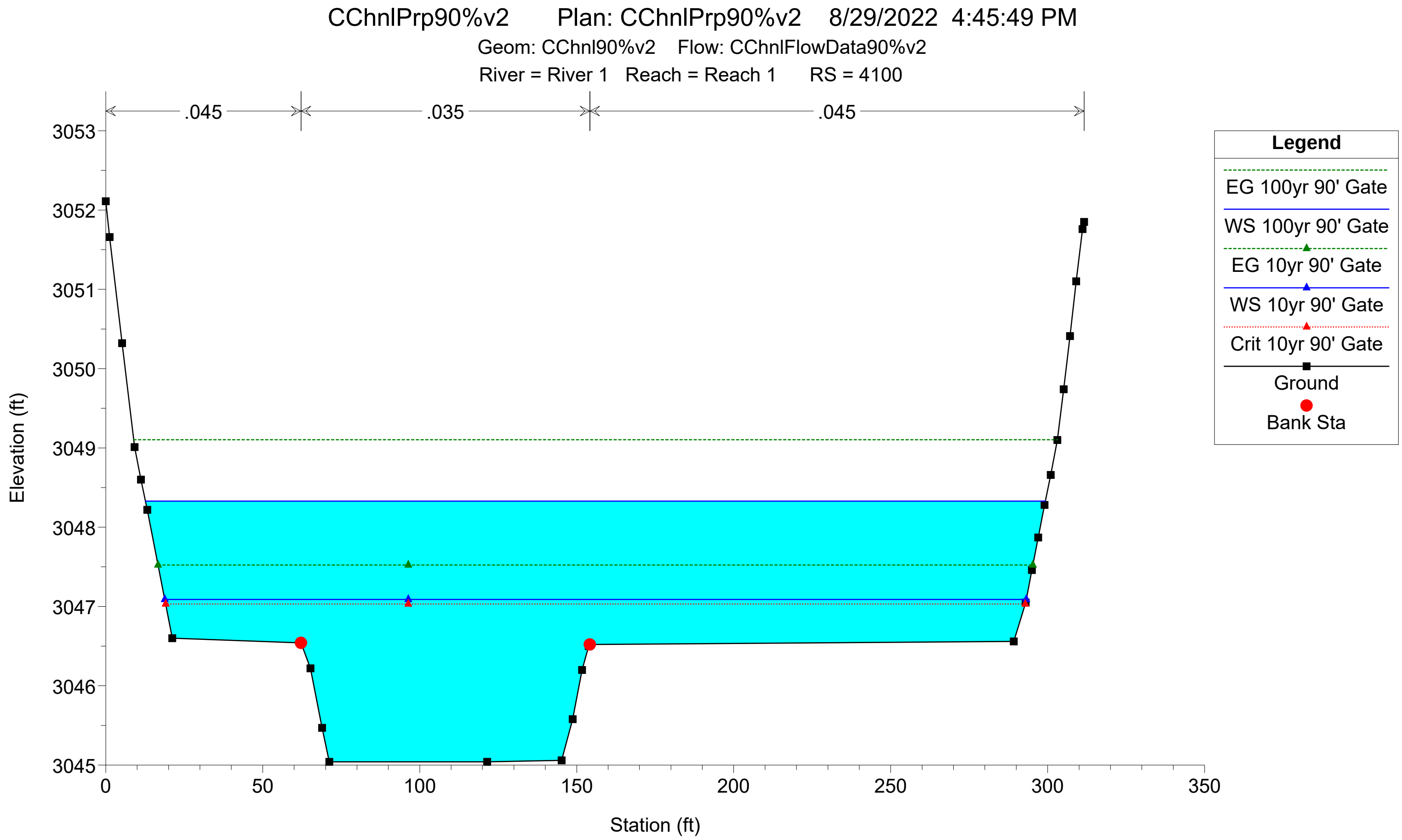
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta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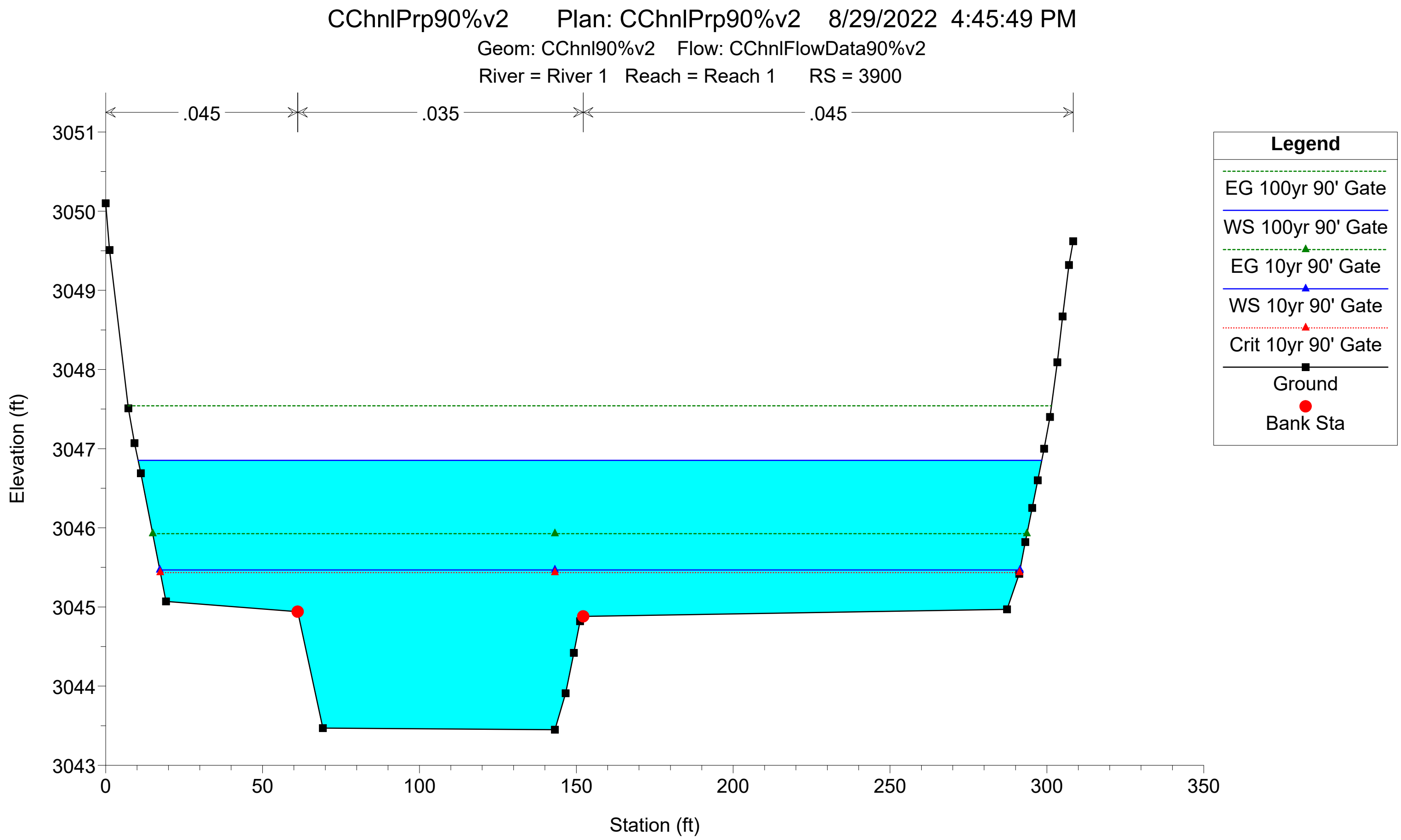
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 4100
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta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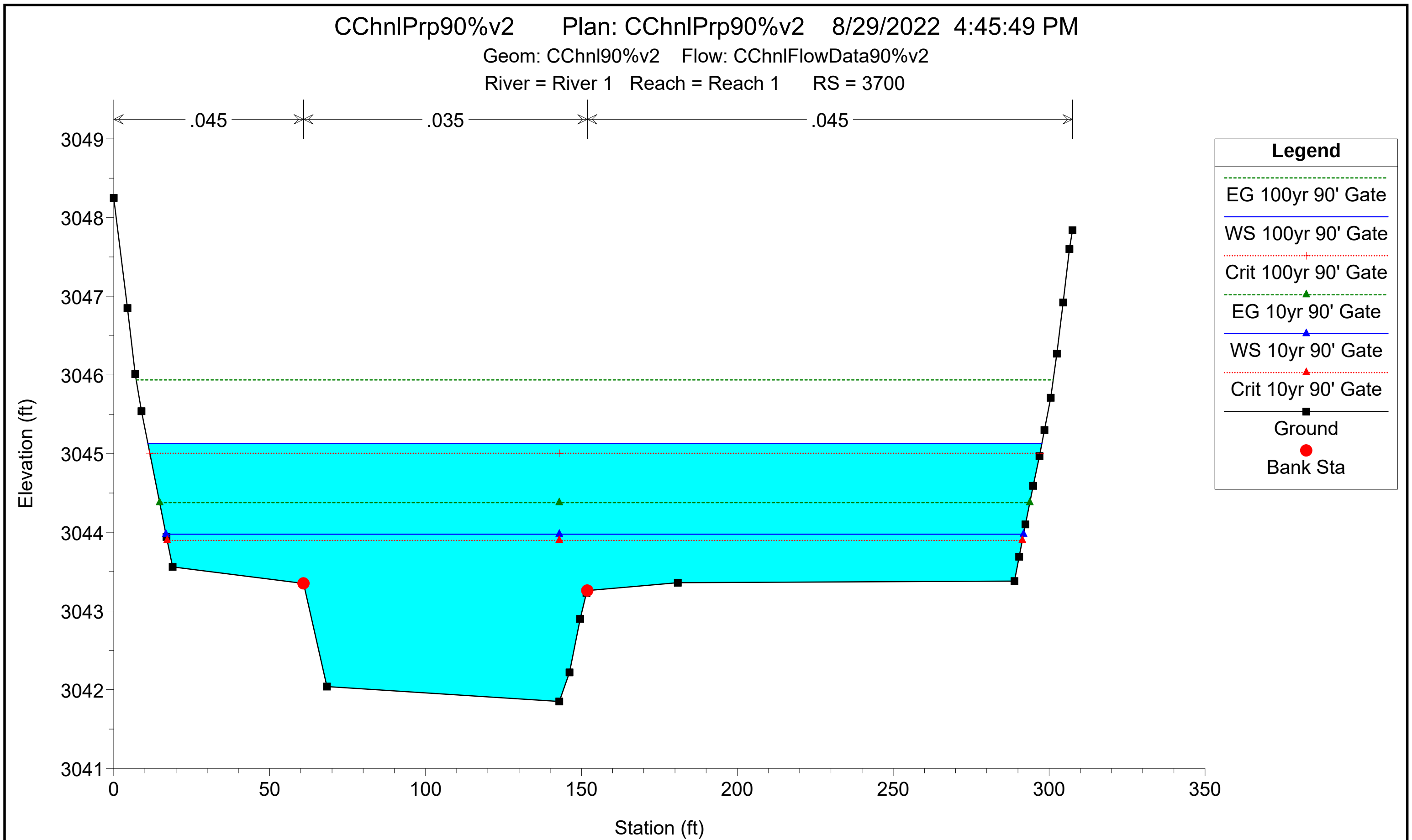
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 3900
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta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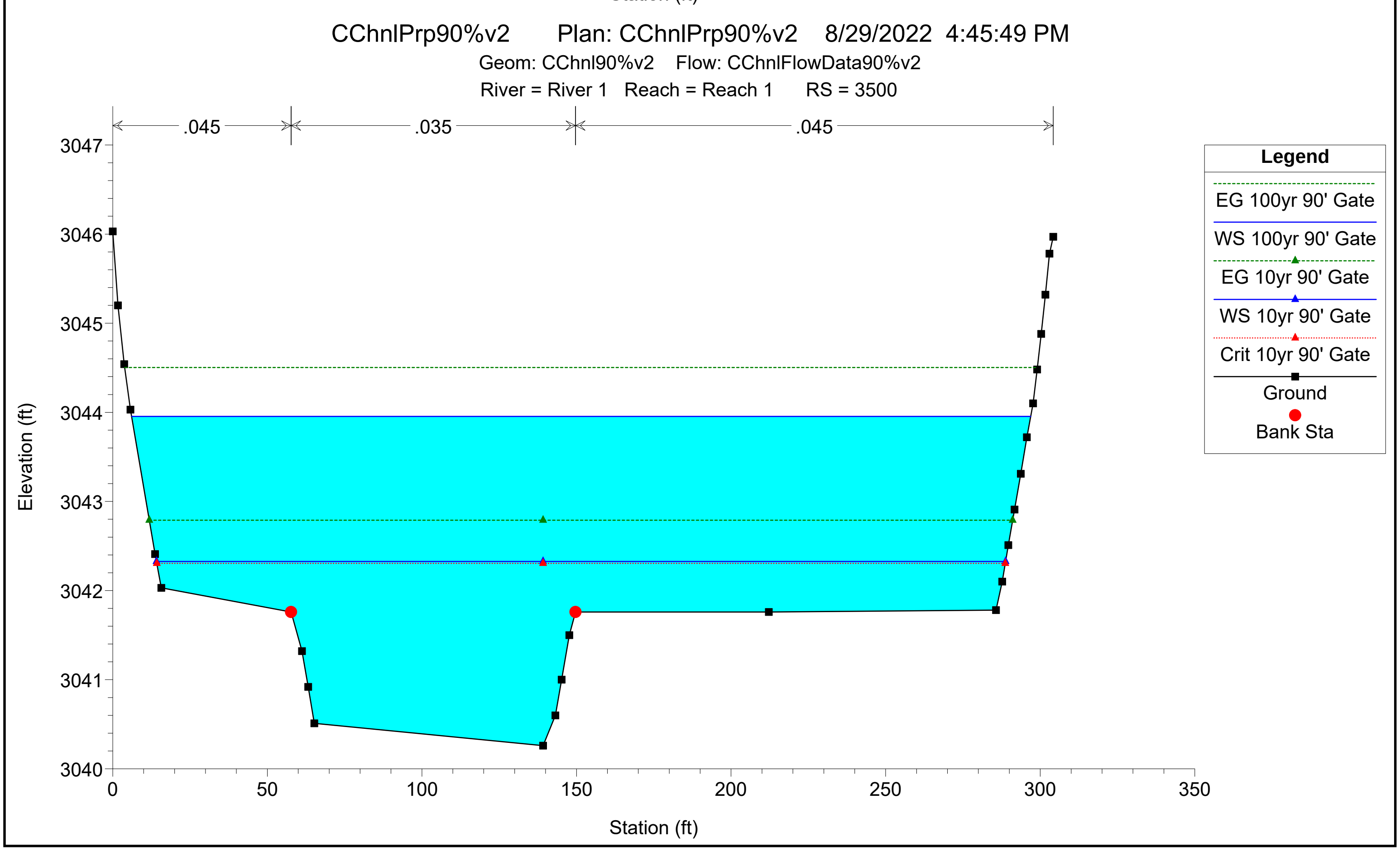
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 3700
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta
Elevation (ft)
Station (ft)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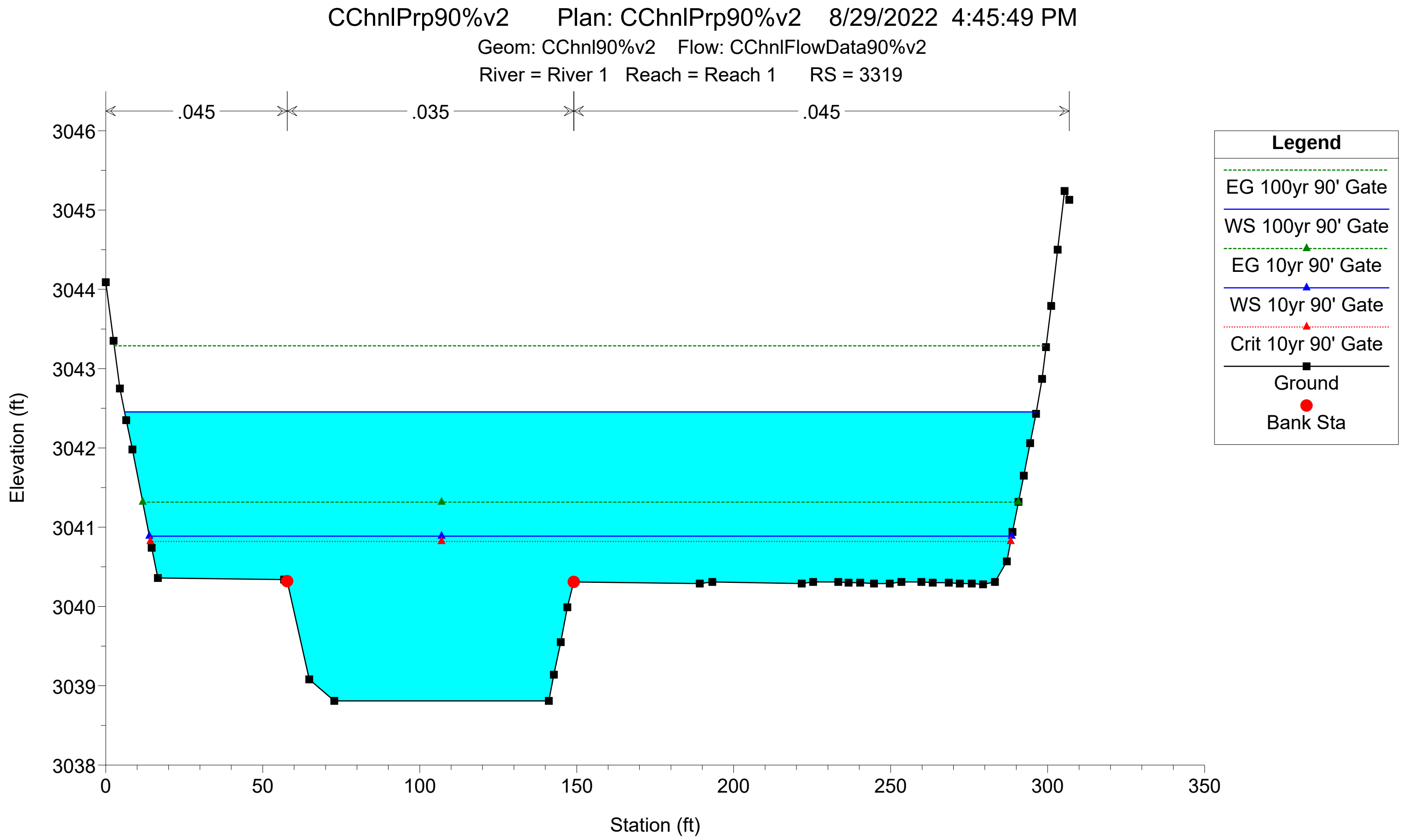
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 3500
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta
Elevation (ft)
Station (ft)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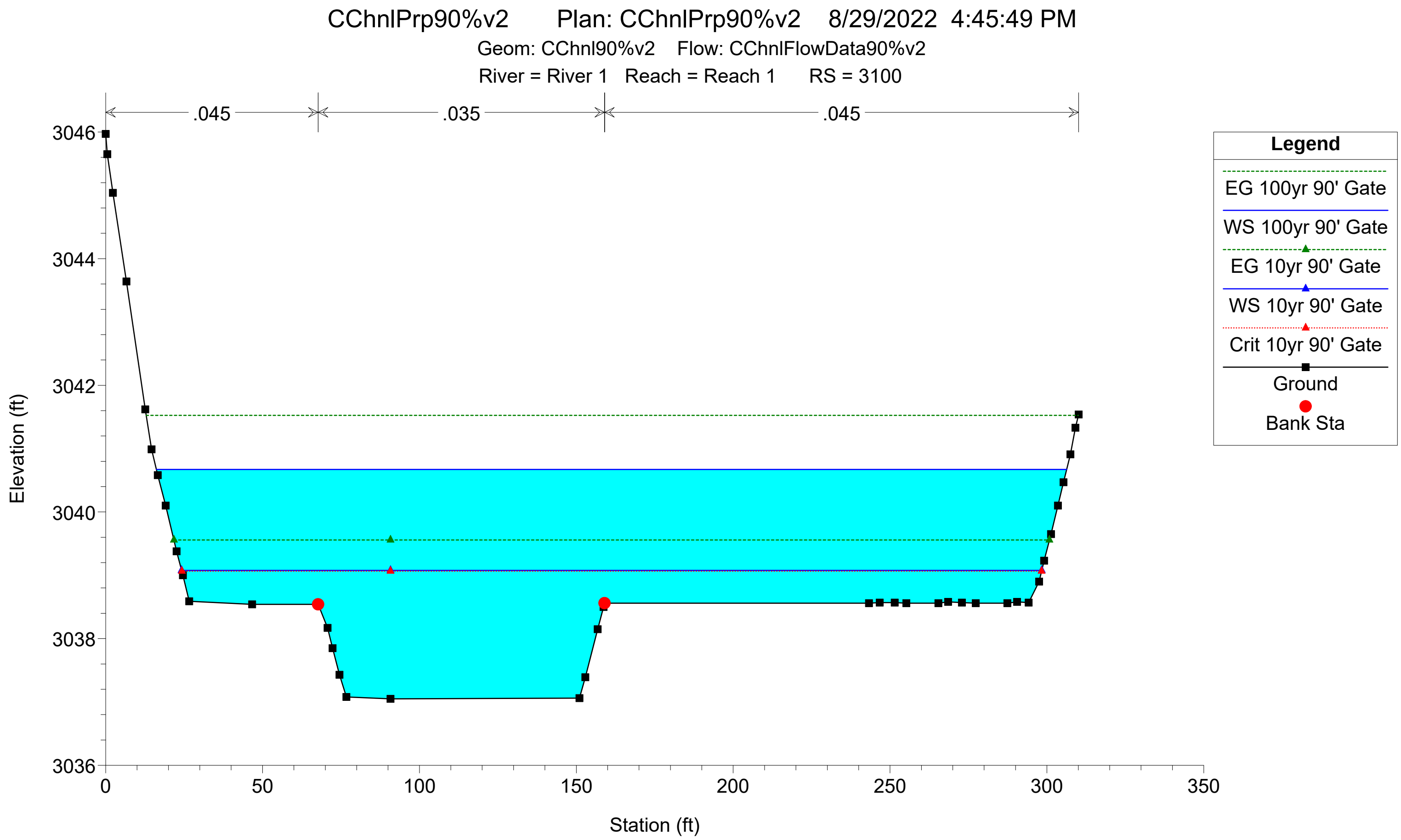
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 3319
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta
Elevation (ft)
Station (ft)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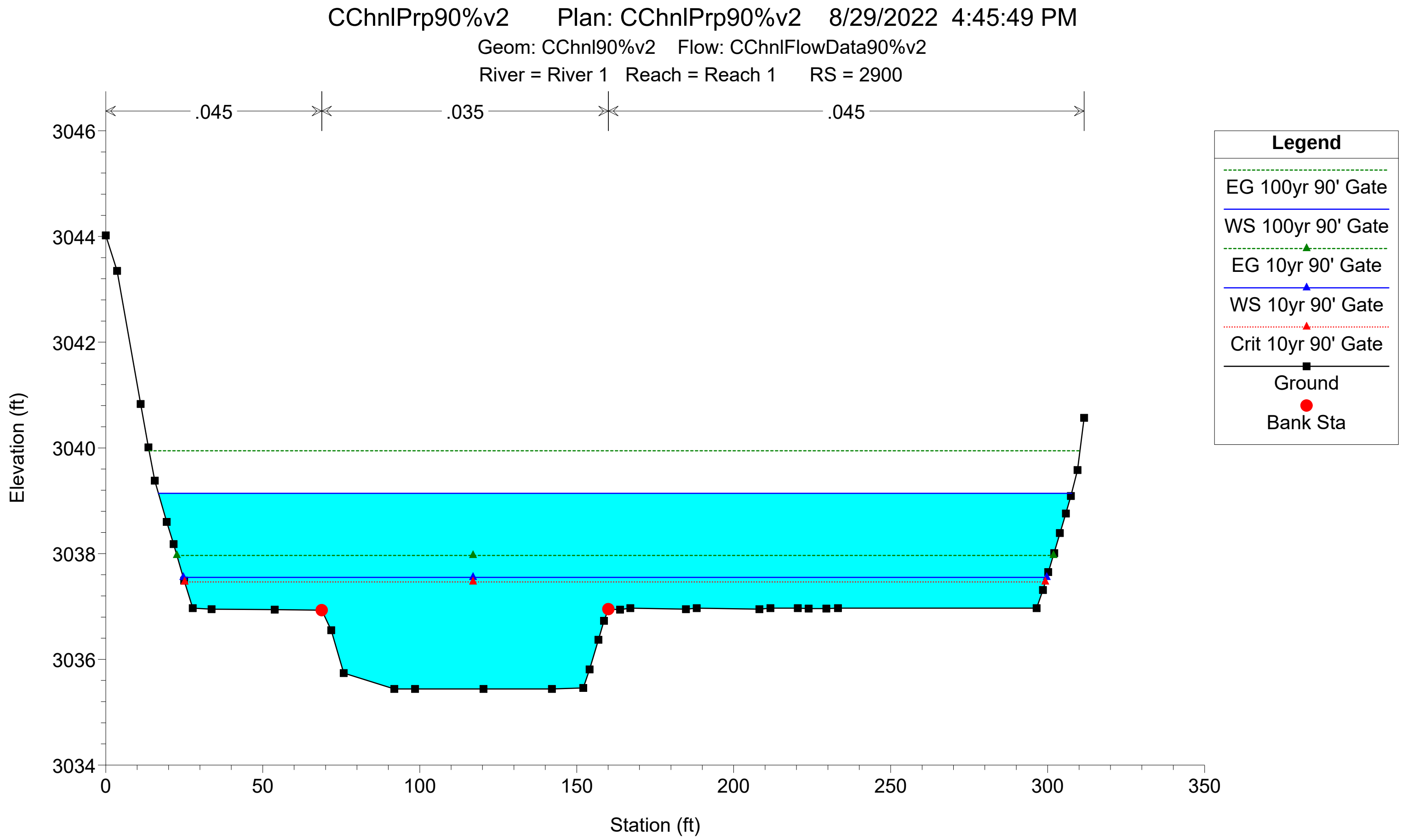
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 3100
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta
Elevation (ft)
Station (ft)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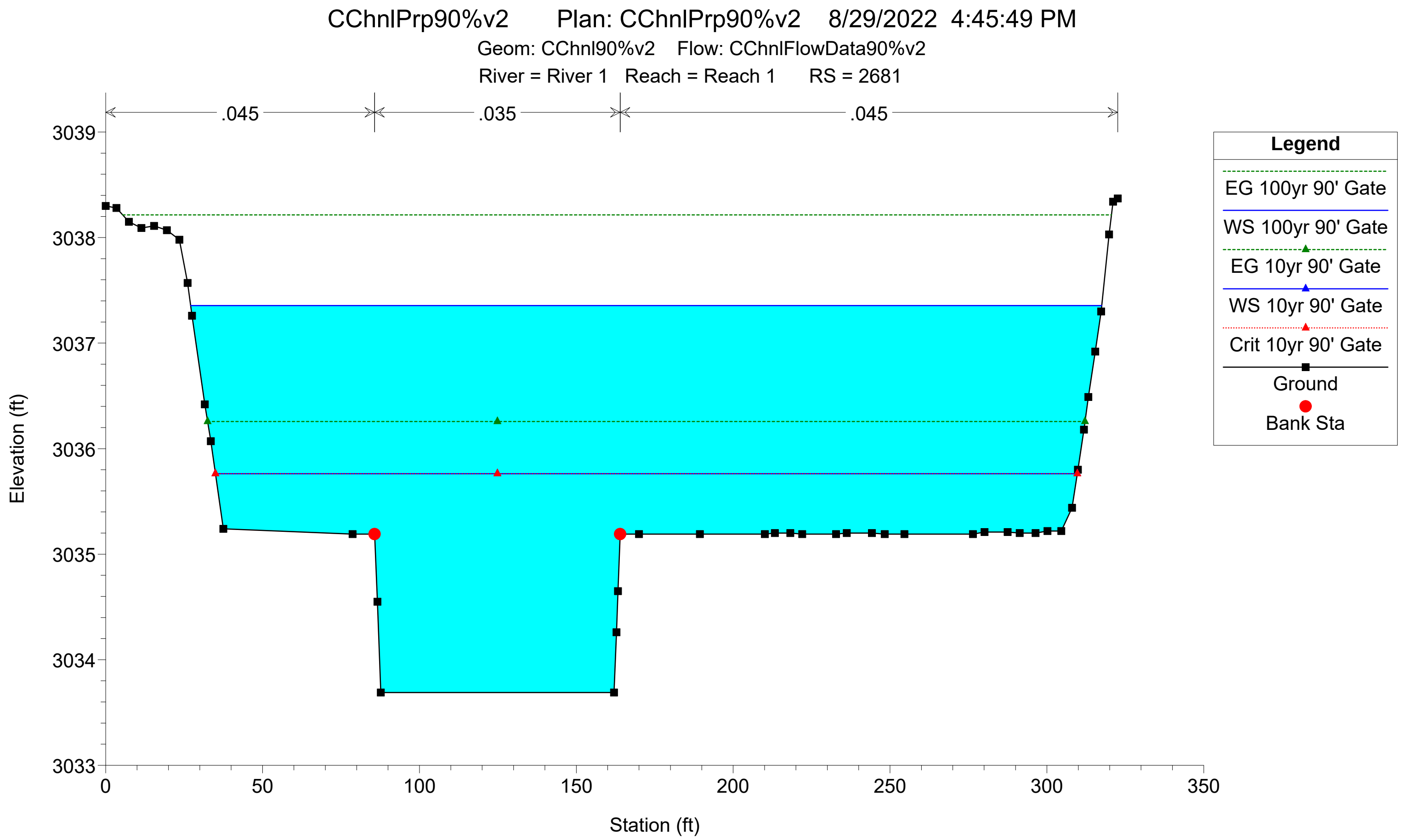
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 2900
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta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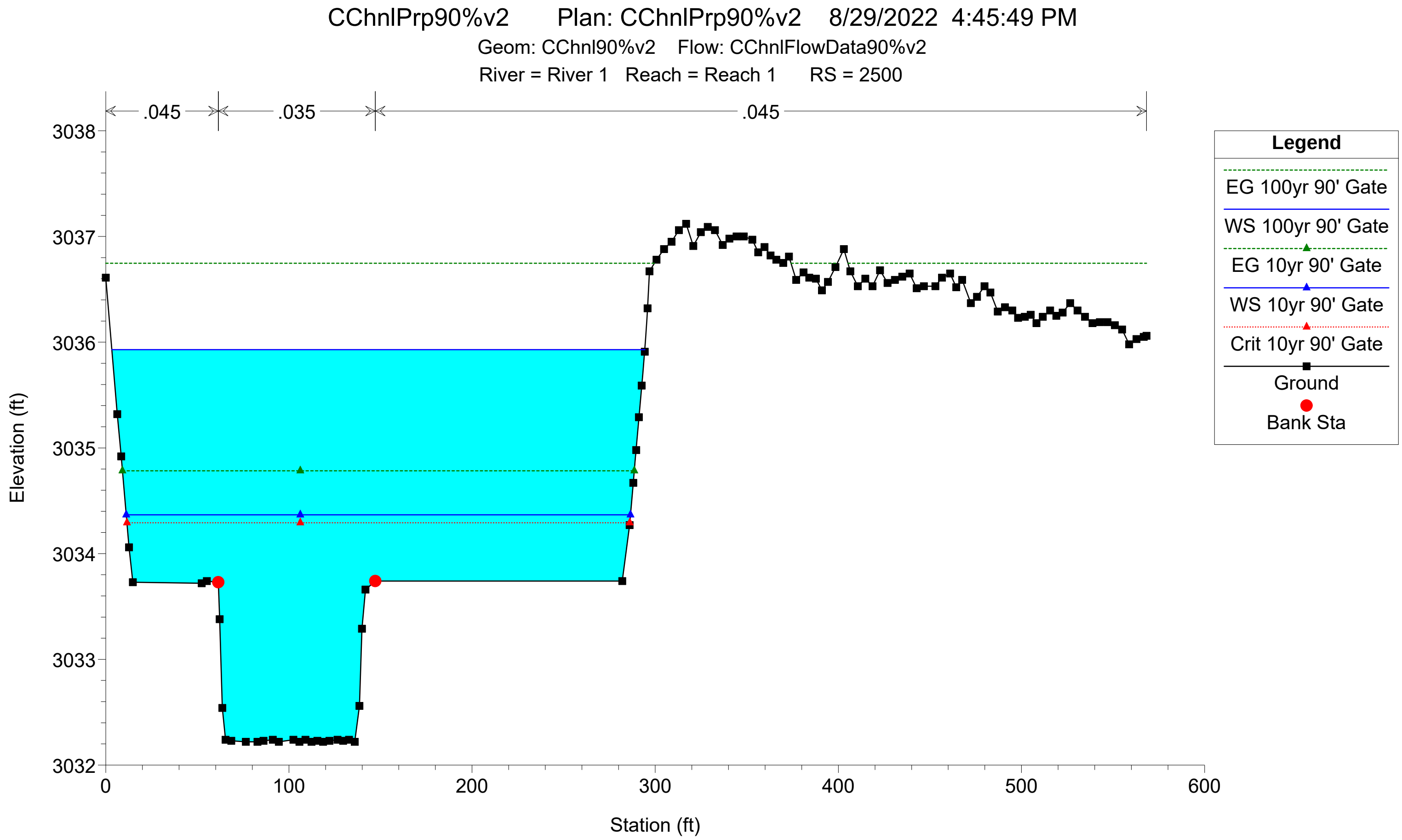
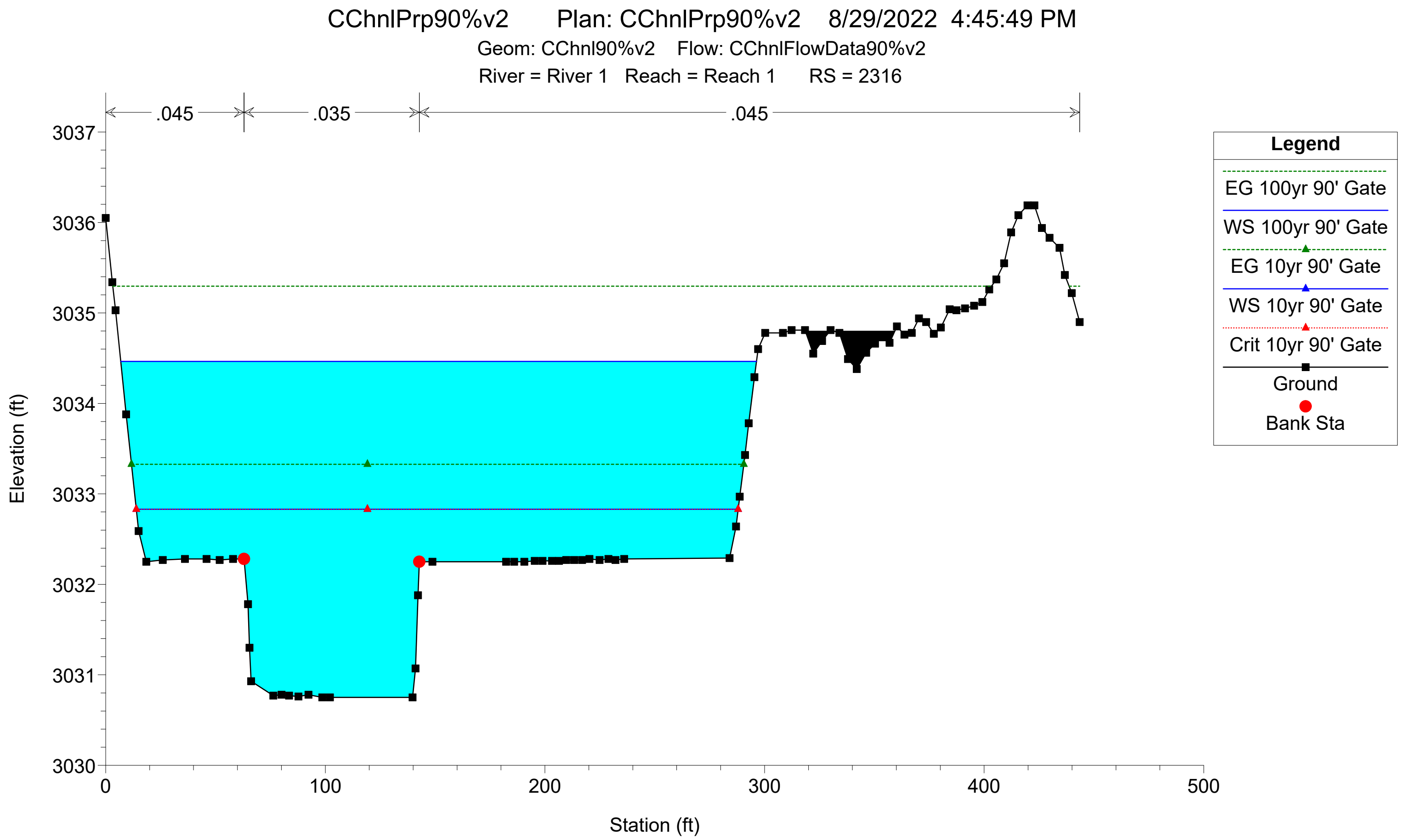
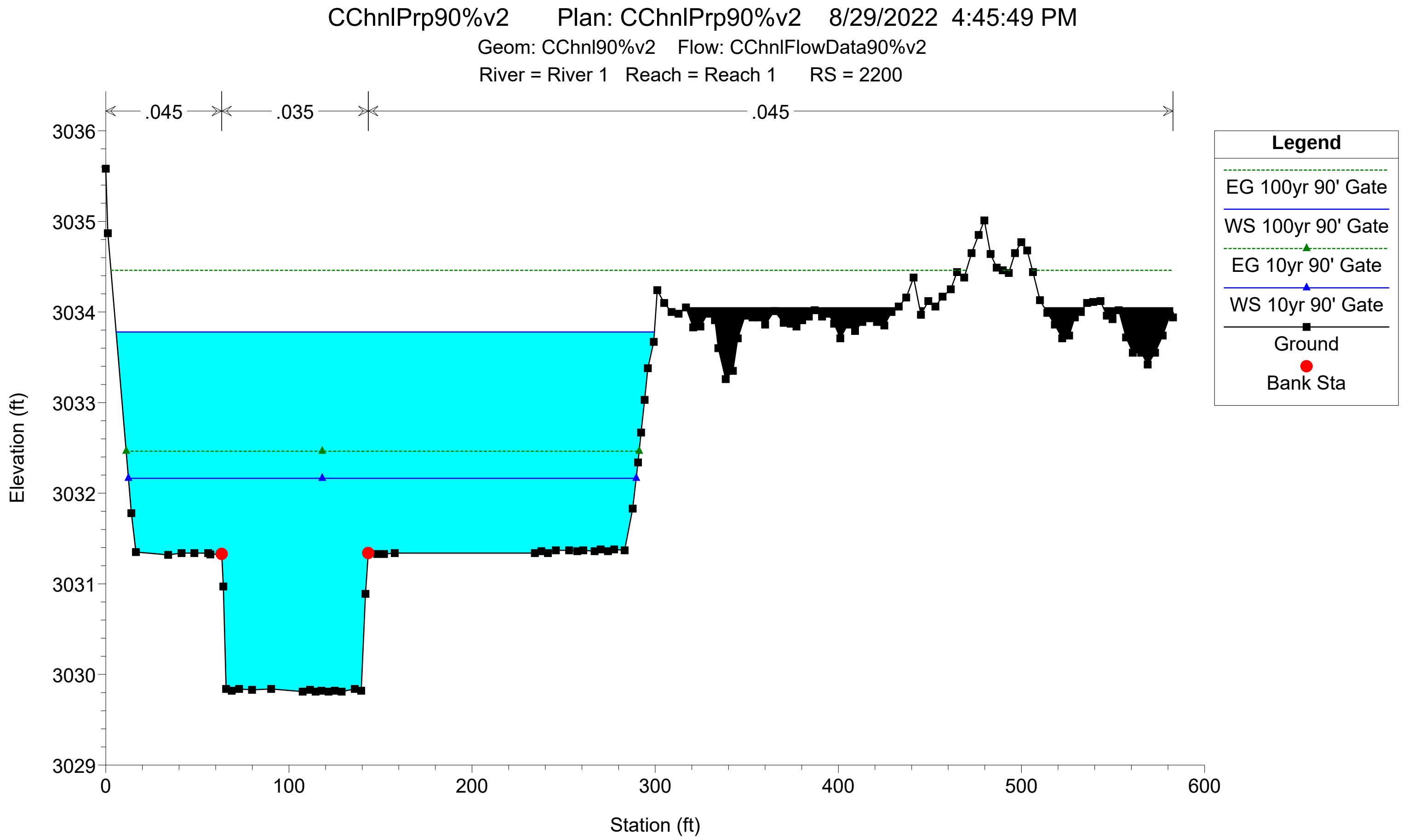
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 2681
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta


CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 4:45:49 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 2500
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta


CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 4:45:49 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 2316
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Bank Sta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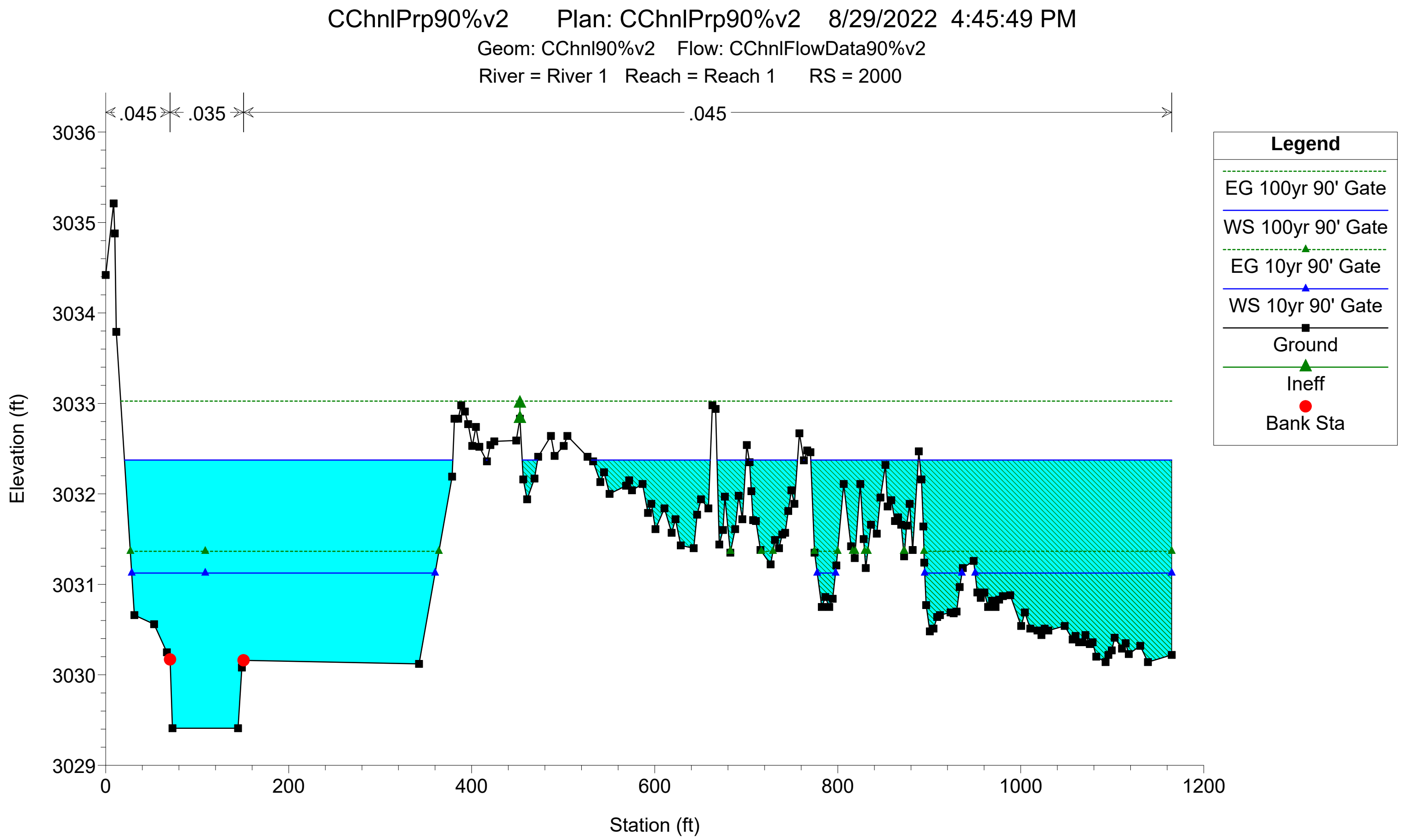
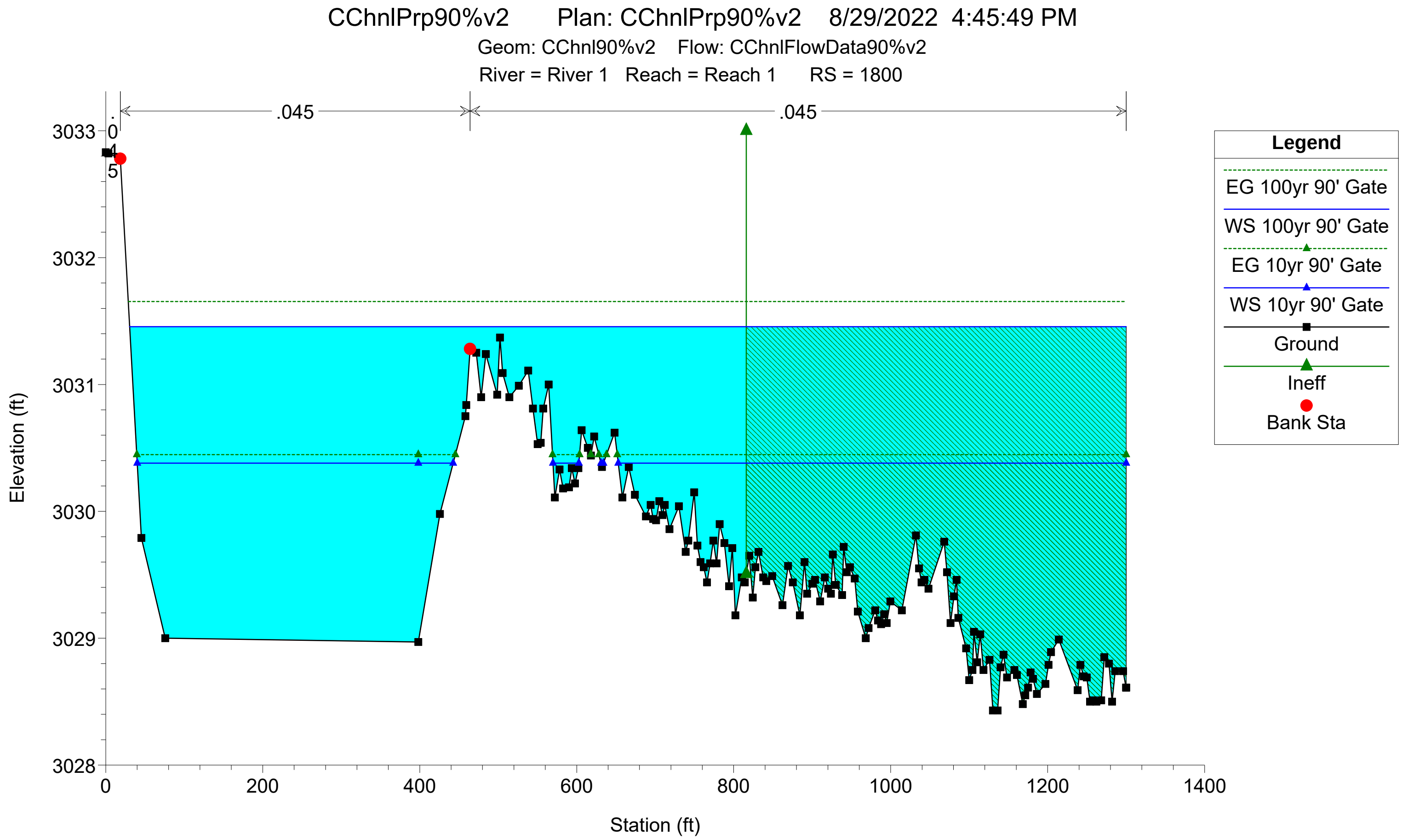
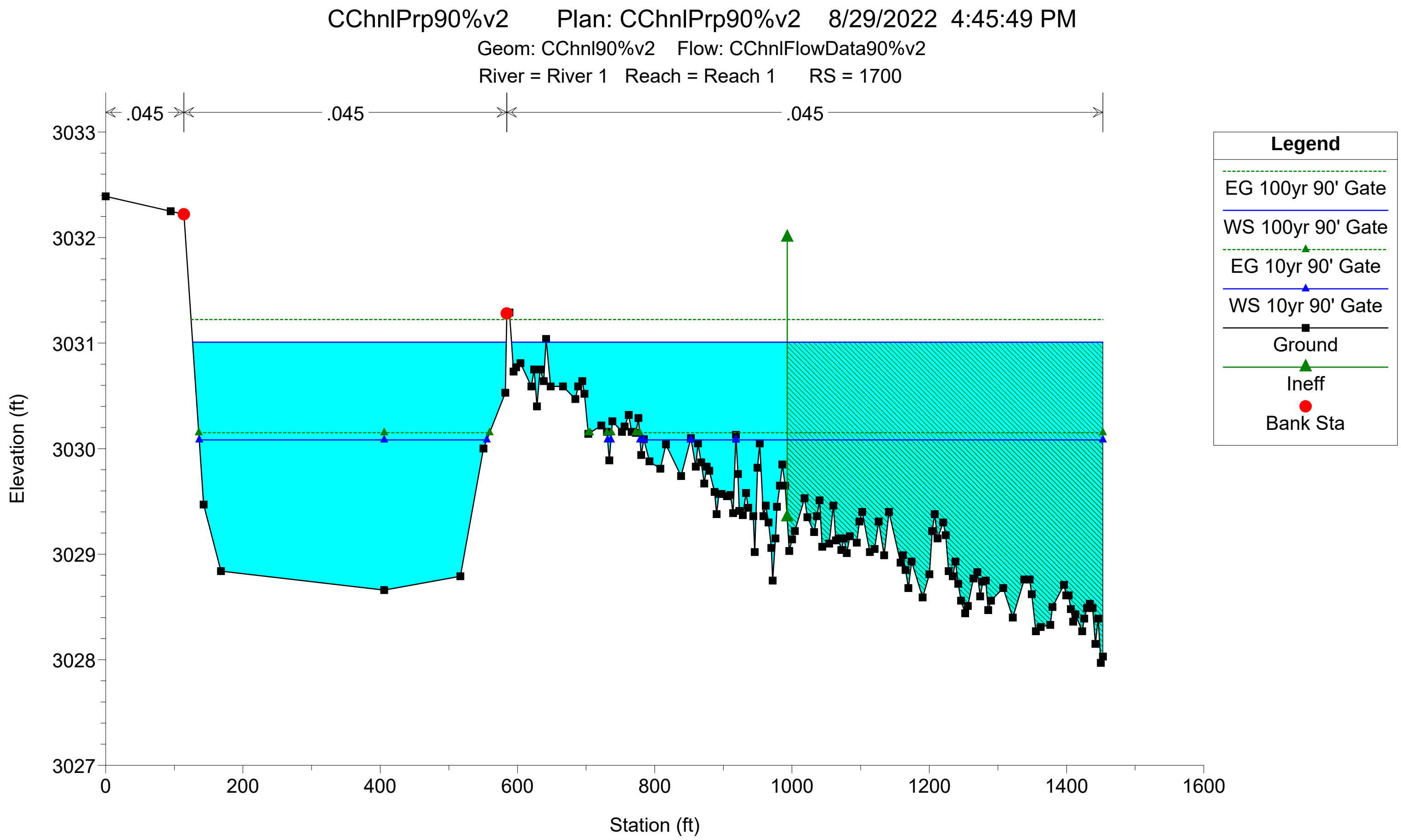
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 2200
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Ground
Bank Sta
Elevation (ft)
Station (ft)

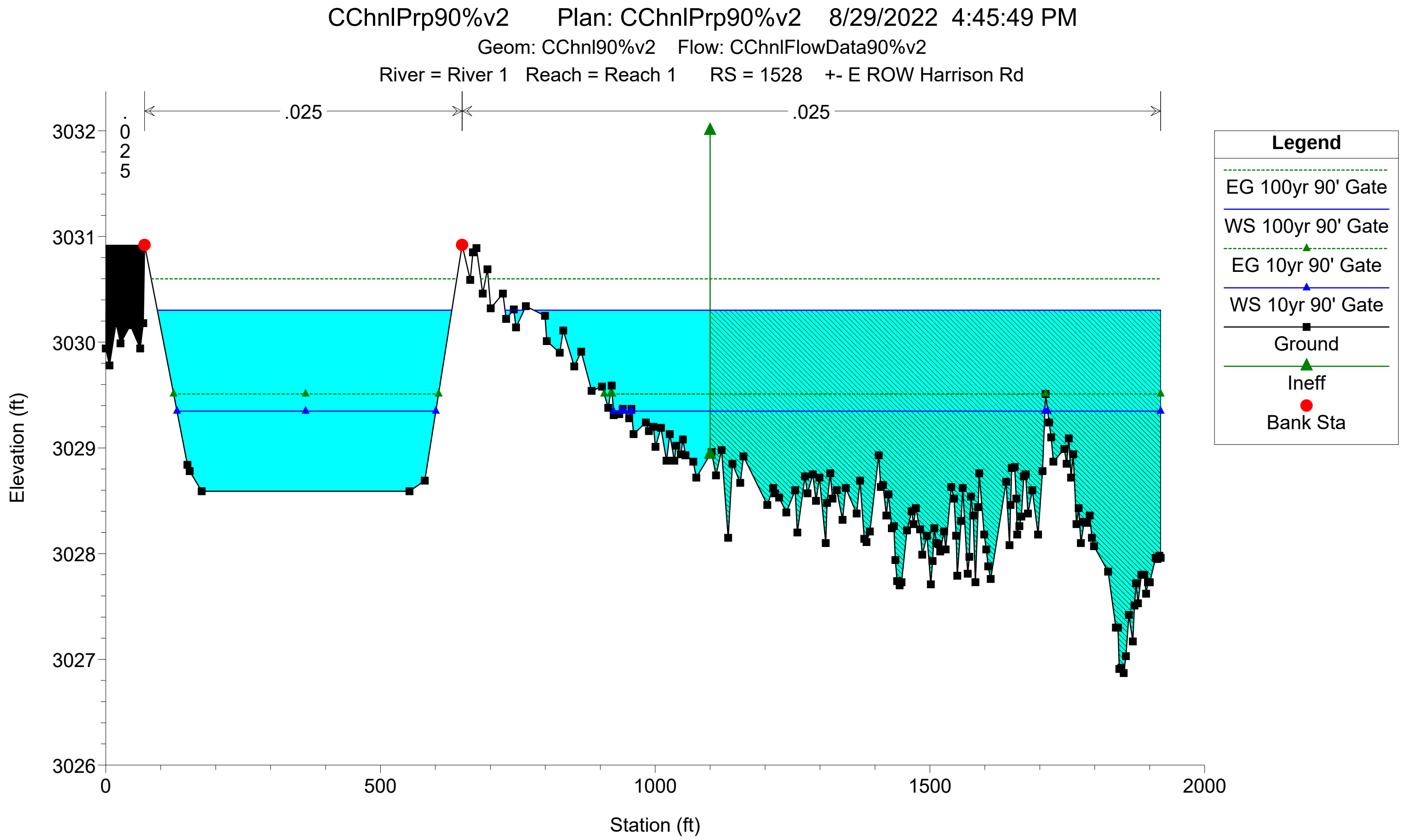

CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 4:45:49 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 2000
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

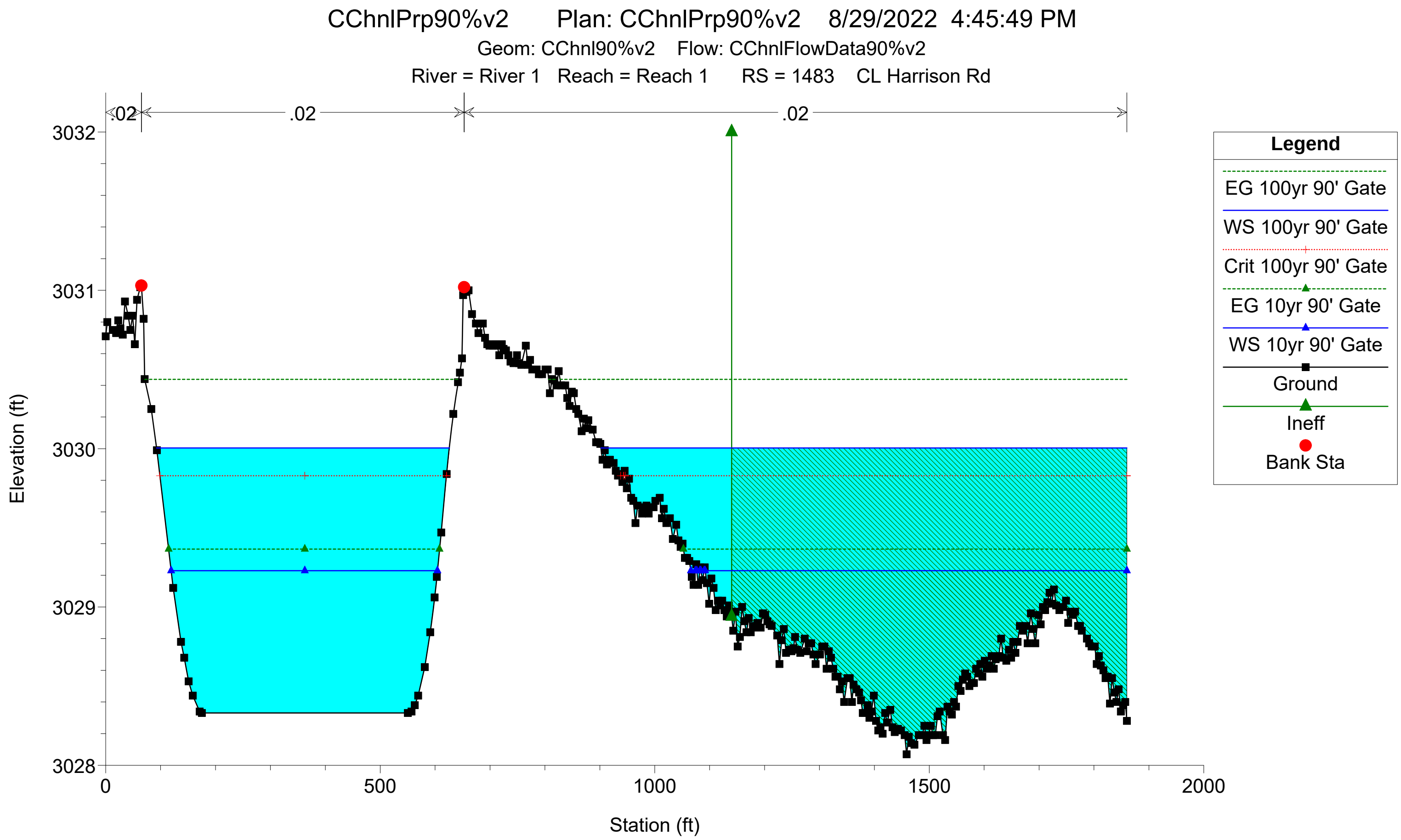


CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 4:45:49 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 1800
.045
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Ground
Ineff
Bank Sta



CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 4:45:49 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 1700
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Ground
Ineff
Bank Sta


CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 4:45:49 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 1528 +- E ROW Harrison Rd
.025
.025
.025
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Ground
Ineff
Bank Sta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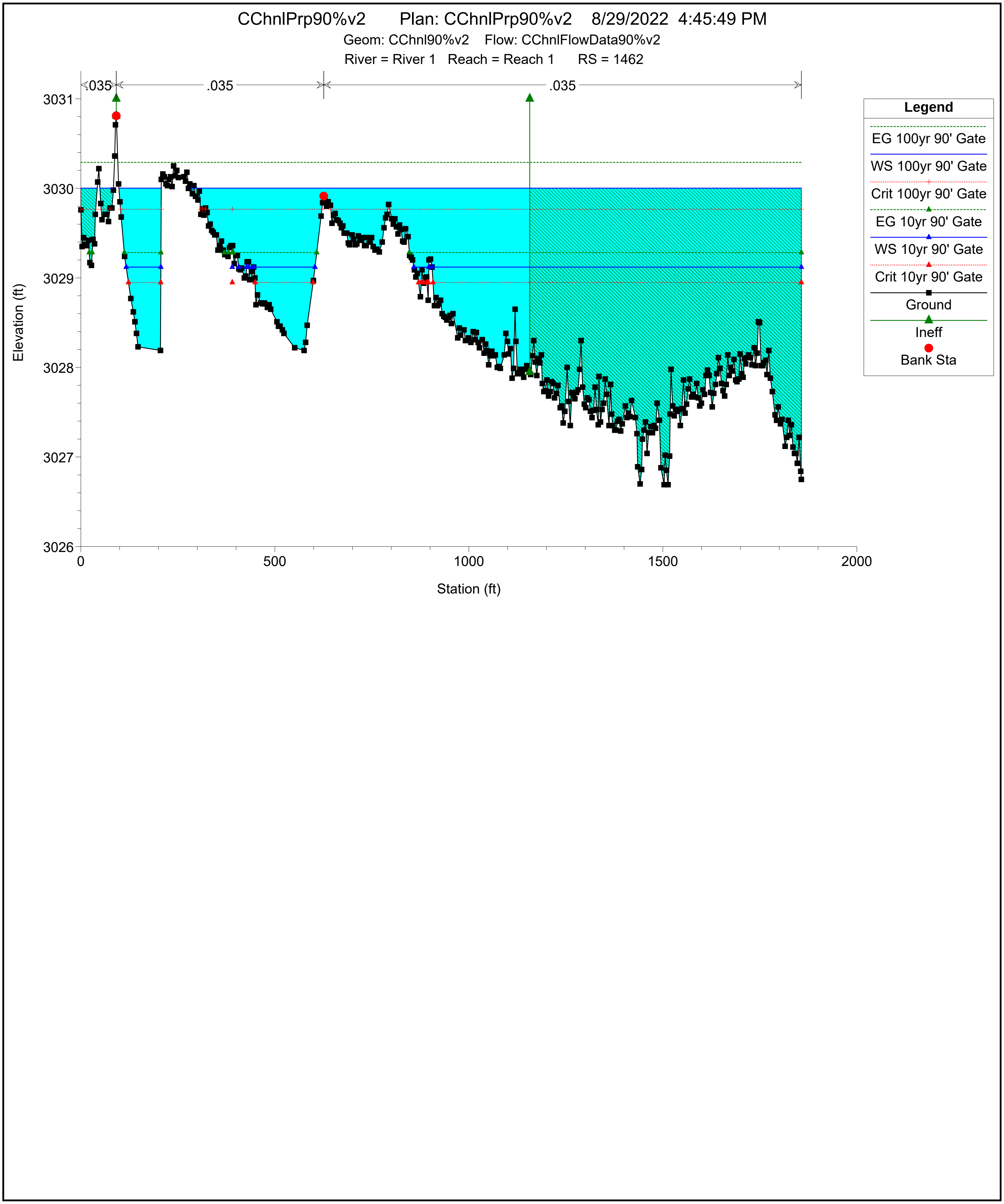
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 1483 CL Harrison Rd
.02
.02
.02
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Ground
Ineff
Bank Sta


CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 4:45:49 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 1462
.035
.035
.035
Elevation (ft)
Station (ft)
3026
3027
3028
3029
3030
3031
0
500
1000
1500
2000
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
Ground
Ineff
Bank Sta

FG Channels-C Chnl Mixed Flow Run
2023.01.01

HEC-RAS Plan: CChnlPrp90%v2 River: River 1 Reach: Reach 1

Reach	River Sta	Profile	Q Total	Q Channel	Q Left	Q Right	Max Chl Dpth	Hydr Depth C	W.S. Elev	E.G. Slope	Vel Chnl	Vel Left	Vel Right	Top W Chnl	Top W Left	Top W Right	Froude # Chl
			(cfs)	(cfs)	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft/s)	(ft/s)	(ft)	(ft)	(ft)	
Reach 1	6300	100yr 90' Gate	3803.00	2546.34	487.85	768.81	5.21	4.81	3069.91	0.007004	10.10	3.08	2.85	52.40	133.60	256.15	0.81
Reach 1	6300	10yr 90' Gate	1177.00	1025.85	73.38	77.77	2.88	2.48	3067.57	0.010367	7.89	4.06	4.11	52.40	108.01	247.55	0.88
Reach 1	6200	100yr 90' Gate	3803.00	2137.44	802.98	862.58	3.44	3.07	3067.53	0.024864	14.09	8.10	8.12	49.40	260.89	246.55	1.42
Reach 1	6200	10yr 90' Gate	1177.00	791.88	185.06	200.07	2.52	2.15	3066.61	0.011127	7.44	3.54	3.56	49.40	257.39	240.72	0.89
Reach 1	6100	100yr 90' Gate	3803.00	1093.63	745.70	1963.67	3.82	3.55	3067.29	0.004223	6.39	3.54	3.68	48.20	99.12	238.12	0.60
Reach 1	6100	10yr 90' Gate	1177.00	536.24	165.33	475.43	2.41	2.13	3065.88	0.005551	5.22	2.18	2.31	48.20	91.11	225.71	0.63
Reach 1	5942	100yr 90' Gate	3803.00	1229.36	491.84	2081.80	4.12	3.77	3066.62	0.003976	6.47	3.30	3.79	50.40	74.39	223.17	0.59
Reach 1	5942	10yr 90' Gate	1177.00	557.86	94.20	524.94	2.58	2.24	3065.08	0.004676	4.95	1.98	2.38	50.40	58.04	204.29	0.58
Reach 1	5858	100yr 90' Gate	3803.00	1306.44	425.59	2070.97	4.26	3.93	3066.23	0.004159	6.79	3.27	3.91	49.00	68.43	212.29	0.60
Reach 1	5858	10yr 90' Gate	1177.00	574.89	81.33	520.78	2.75	2.41	3064.72	0.004088	4.87	1.93	2.33	49.00	48.20	191.85	0.55
Reach 1	5745	100yr 90' Gate	3803.00	1616.73	300.46	1885.81	3.73	3.42	3065.02	0.010184	9.69	4.09	5.31	48.80	54.07	176.07	0.92
Reach 1	5745	10yr 90' Gate	1177.00	714.83	36.83	425.33	2.44	2.13	3063.74	0.009608	6.87	2.11	3.02	48.80	33.03	156.38	0.83
Reach 1	5667	100yr 90' Gate	3803.00	2777.68	116.47	908.85	3.46	3.02	3064.30	0.008617	8.24	3.35	4.45	111.50	30.29	116.79	0.84
Reach 1	5667	10yr 90' Gate	1177.00	1034.37	11.45	131.18	2.13	1.70	3062.97	0.008212	5.47	1.85	2.16	111.50	12.74	98.88	0.74
Reach 1	5654	100yr 90' Gate	3803.00	2807.98	98.08	896.94	3.42	2.98	3064.17	0.008894	8.28	3.27	4.48	113.80	27.85	115.89	0.85
Reach 1	5654	10yr 90' Gate	1177.00	1040.02	7.77	129.21	2.11	1.67	3062.86	0.008381	5.47	1.69	2.17	113.80	10.96	98.33	0.75
Reach 1	5641	100yr 90' Gate	3803.00	2832.51	69.32	901.17	3.29	2.85	3063.91	0.010775	8.86	3.20	4.72	112.20	23.88	118.29	0.92
Reach 1	5641	10yr 90' Gate	1177.00	1037.18	3.96	135.86	2.13	1.69	3062.75	0.008270	5.47	1.42	2.17	112.20	8.49	102.18	0.74
Reach 1	5545	100yr 90' Gate	3803.00	2364.15	325.73	1113.13	3.32	3.13	3063.18	0.008158	8.20	4.06	4.35	92.00	50.41	145.05	0.82
Reach 1	5545	10yr 90' Gate	1177.00	998.97	34.13	143.91	2.03	1.84	3061.89	0.008578	5.90	1.77	1.99	92.00	43.93	138.54	0.77
Reach 1	5500	100yr 90' Gate	3803.00	2348.63	329.76	1124.62	3.33	3.19	3062.83	0.007785	8.10	4.01	4.30	91.00	50.65	145.74	0.80
Reach 1	5500	10yr 90' Gate	1177.00	979.02	38.97	159.01	2.07	1.92	3061.57	0.007324	5.60	1.77	1.97	91.00	44.30	139.43	0.71
Reach 1	5325	100yr 90' Gate	3803.00	2364.53	342.36	1096.11	3.29	3.15	3061.38	0.008359	8.32	4.15	4.35	90.20	50.92	145.70	0.83
Reach 1	5325	10yr 90' Gate	1177.00	1007.04	39.20	130.76	1.99	1.86	3060.08	0.008804	6.01	1.87	1.92	90.20	44.40	139.29	0.78
Reach 1	5100	100yr 90' Gate	3803.00	2323.37	341.57	1138.06	3.36	3.20	3059.64	0.007532	7.98	4.03	4.27	91.00	50.53	145.99	0.79
Reach 1	5100	10yr 90' Gate	1177.00	964.84	45.34	166.82	2.08	1.92	3058.36	0.007088	5.52	1.87	1.98	91.00	44.15	139.53	0.70
Reach 1	4900	100yr 90' Gate	3803.00	2330.93	325.56	1146.50	3.35	3.11	3058.03	0.008170	8.16	4.06	4.40	92.00	50.28	145.31	0.82
Reach 1	4900	10yr 90' Gate	1177.00	978.09	35.47	163.44	2.07	1.83	3056.75	0.008446	5.82	1.79	2.08	92.00	43.91	138.89	0.76
Reach 1	4700	100yr 90' Gate	3803.00	2342.08	313.91	1147.01	3.38	3.14	3056.44	0.007918	8.10	3.98	4.36	92.00	49.93	145.66	0.80
Reach 1	4700	10yr 90' Gate	1177.00	975.78	32.91	168.31	2.11	1.88	3055.17	0.007701	5.66	1.69	2.04	92.00	43.70	139.28	0.73
Reach 1	4585	100yr 90' Gate	3803.00	2385.49	326.62	1090.89	3.24	3.10	3055.40	0.008830	8.46	4.16	4.42	91.10	50.34	144.98	0.85
Reach 1	4585	10yr 90' Gate	1177.00	1007.70	34.63	134.68	1.98	1.84	3054.14	0.008886	6.00	1.79	1.95	91.10	44.07	138.68	0.78
Reach 1	4500	100yr 90' Gate	3803.00	3047.74	14.31	740.95	3.15	2.62	3054.65	0.009127	7.71	2.04	4.17	150.80	13.41	116.80	0.84
Reach 1	4500	10yr 90' Gate	1177.00	1117.28		59.72	1.93	1.52	3053.43	0.008674	5.22		1.54	141.12		110.21	0.75
Reach 1	4483	100yr 90' Gate	3803.00	3057.47	4.36	741.17	3.23	2.65	3054.59	0.007609	7.09	1.31	3.84	162.90	10.92	125.54	0.77
Reach 1	4483	10yr 90' Gate	1177.00	1101.43		75.57	1.99	1.55	3053.35	0.006897	4.71		1.59	151.09		108.38	0.67
Reach 1	4460	100yr 90' Gate	3803.00	3125.23	0.50	677.27	2.90	2.31	3054.09	0.012485	8.29	0.89	4.34	163.30	4.76	122.55	0.96
Reach 1	4460	10yr 90' Gate	1177.00	1141.76		35.24	1.74	1.34	3052.93	0.012712	5.82		1.43	146.40		102.87	0.89

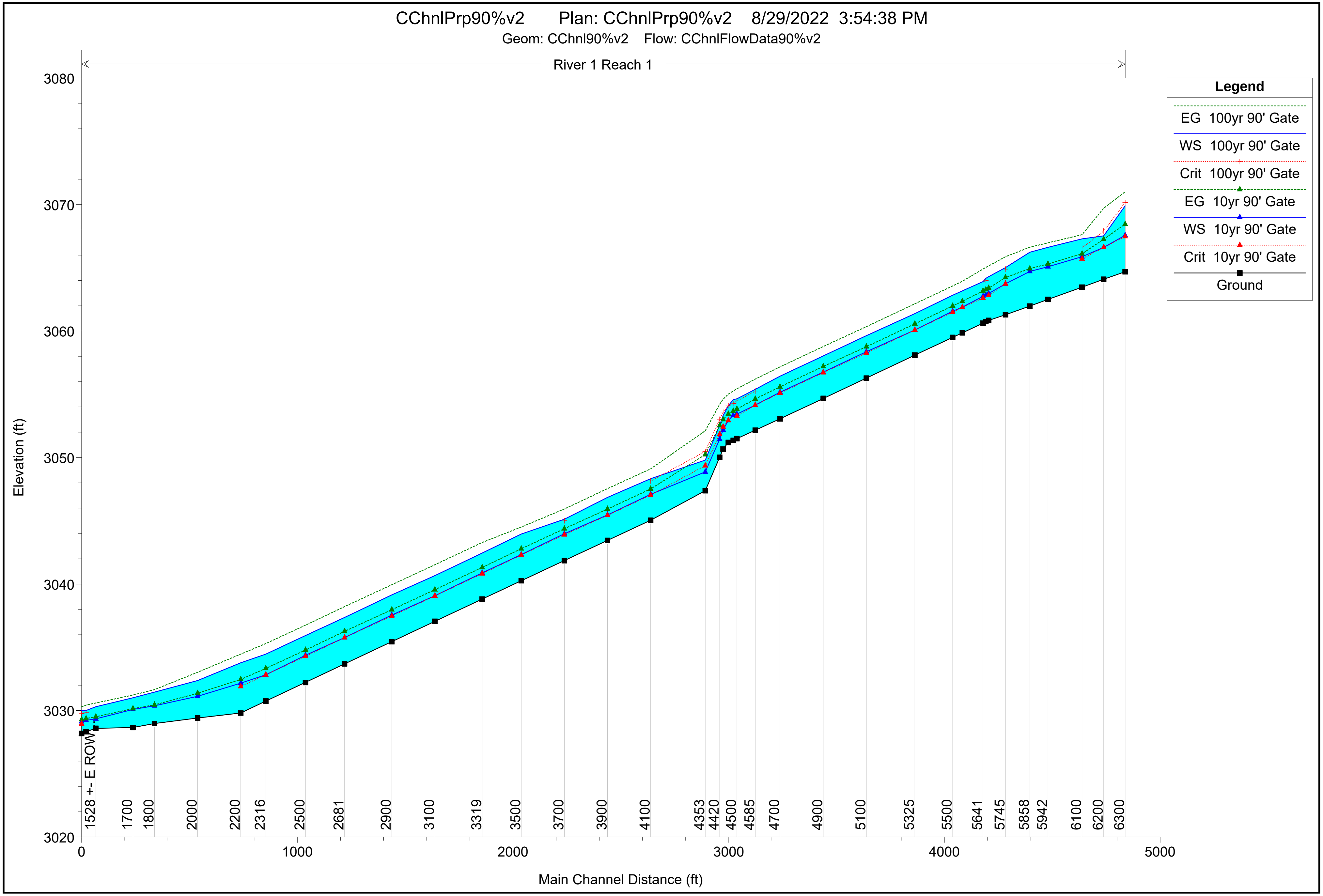
HEC-RAS Plan: CChnlPrp90%v2 River: River 1 Reach: Reach 1 (Continued)

Reach	River Sta	Profile	Q Total	Q Channel	Q Left	Q Right	Max Chl Dpth	Hydr Depth C	W.S. Elev	E.G. Slope	Vel Chnl	Vel Left	Vel Right	Top W Chnl	Top W Left	Top W Right	Froude # Chl
			(cfs)	(cfs)	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft/s)	(ft/s)	(ft)	(ft)	(ft)	
Reach 1	4436	100yr 90' Gate	3803.00	3234.63	0.61	567.76	2.66	2.09	3053.33	0.019361	9.66	0.98	4.78	159.90	6.31	112.08	1.18
Reach 1	4436	10yr 90' Gate	1177.00	1176.80		0.20	1.52	1.14	3052.19	0.024445	7.25		0.31	141.94		46.39	1.20
Reach 1	4420	100yr 90' Gate	3803.00	3251.32	1.27	550.41	2.54	2.01	3052.56	0.026260	10.97	1.18	5.08	147.20	10.33	116.93	1.36
Reach 1	4420	10yr 90' Gate	1177.00	1177.00			1.43	1.11	3051.45	0.033565	8.34			127.07			1.39
Reach 1	4353	100yr 90' Gate	3803.00	2898.14	181.42	723.44	2.42	2.24	3049.80	0.035349	13.63	5.36	5.76	95.10	42.04	140.30	1.61
Reach 1	4353	10yr 90' Gate	1177.00	1168.91		8.10	1.49	1.32	3048.87	0.034171	9.43		1.46	93.91		47.67	1.45
Reach 1	4100	100yr 90' Gate	3803.00	2383.54	327.59	1091.87	3.29	3.13	3048.33	0.008325	8.28	4.12	4.34	92.00	49.58	145.06	0.82
Reach 1	4100	10yr 90' Gate	1177.00	991.68	40.21	145.11	2.05	1.89	3047.09	0.007746	5.70	1.84	1.93	92.00	43.42	138.99	0.73
Reach 1	3900	100yr 90' Gate	3803.00	2325.54	334.99	1142.47	3.40	3.26	3046.85	0.007100	7.85	3.92	4.20	91.00	50.85	146.16	0.77
Reach 1	3900	10yr 90' Gate	1177.00	995.79	34.86	146.35	2.02	1.87	3045.47	0.008238	5.84	1.76	1.97	91.00	43.96	139.22	0.75
Reach 1	3700	100yr 90' Gate	3803.00	2363.72	317.89	1121.39	3.28	3.07	3045.13	0.008952	8.47	4.15	4.48	91.00	49.95	145.78	0.85
Reach 1	3700	10yr 90' Gate	1177.00	964.61	39.65	172.73	2.13	1.91	3043.98	0.007184	5.54	1.78	2.02	91.00	44.18	139.90	0.71
Reach 1	3500	100yr 90' Gate	3803.00	2229.14	347.68	1226.18	3.69	3.44	3043.95	0.005315	7.04	3.63	3.95	92.00	51.63	147.23	0.67
Reach 1	3500	10yr 90' Gate	1177.00	983.82	31.91	161.27	2.07	1.81	3042.33	0.008756	5.90	1.74	2.09	92.00	43.56	139.11	0.77
Reach 1	3319	100yr 90' Gate	4660.00	2767.97	436.96	1455.08	3.64	3.49	3042.45	0.007905	8.68	4.47	4.77	91.30	51.82	147.30	0.82
Reach 1	3319	10yr 90' Gate	1204.00	1001.46	42.31	160.23	2.08	1.93	3040.89	0.007509	5.69	1.85	1.99	91.30	43.92	139.44	0.72
Reach 1	3100	100yr 90' Gate	4660.00	2781.12	446.88	1431.99	3.62	3.47	3040.67	0.008156	8.77	4.56	4.78	91.30	51.55	147.31	0.83
Reach 1	3100	10yr 90' Gate	1204.00	1022.63	43.20	138.16	2.03	1.88	3039.08	0.008553	5.96	1.95	1.95	91.30	43.51	139.36	0.77
Reach 1	2900	100yr 90' Gate	4660.00	2751.16	458.63	1450.20	3.70	3.53	3039.14	0.007533	8.53	4.48	4.69	91.30	52.04	147.52	0.80
Reach 1	2900	10yr 90' Gate	1204.00	995.62	50.70	157.68	2.11	1.94	3037.55	0.007254	5.62	1.97	1.95	91.30	44.10	139.60	0.71
Reach 1	2681	100yr 90' Gate	4660.00	2562.59	534.17	1563.25	3.67	3.63	3037.36	0.008246	9.02	4.67	4.89	78.30	58.63	153.49	0.84
Reach 1	2681	10yr 90' Gate	1204.00	982.81	54.20	167.00	2.07	2.03	3035.76	0.008333	6.17	1.99	2.05	78.30	50.72	145.70	0.76
Reach 1	2500	100yr 90' Gate	4660.00	2636.57	536.03	1487.40	3.71	3.54	3035.93	0.007851	8.70	4.62	4.80	85.70	58.18	147.17	0.82
Reach 1	2500	10yr 90' Gate	1204.00	963.96	63.84	176.21	2.15	1.98	3034.37	0.007321	5.69	2.05	2.05	85.70	50.34	139.29	0.71
Reach 1	2316	100yr 90' Gate	4660.00	2570.72	521.74	1567.54	3.71	3.63	3034.46	0.007900	8.87	4.65	4.83	79.80	56.14	153.55	0.82
Reach 1	2316	10yr 90' Gate	1204.00	985.50	52.78	165.72	2.08	2.00	3032.83	0.008491	6.17	2.01	2.06	79.80	49.06	145.18	0.77
Reach 1	2200	100yr 90' Gate	4660.00	2502.60	554.98	1602.42	3.97	3.89	3033.78	0.005948	8.05	4.33	4.44	80.00	57.65	156.26	0.72
Reach 1	2200	10yr 90' Gate	1204.00	899.95	78.19	225.86	2.35	2.27	3032.16	0.004603	4.95	1.93	1.93	80.00	50.90	146.30	0.58
Reach 1	2000	100yr 90' Gate	4660.00	1915.32	358.31	2386.37	2.96	2.92	3032.38	0.008897	8.17	4.35	5.05	80.40	49.85	853.72	0.84
Reach 1	2000	10yr 90' Gate	1204.00	647.82	47.58	508.60	1.72	1.67	3031.13	0.006561	4.83	1.90	2.57	80.40	41.94	484.63	0.66
Reach 1	1800	100yr 90' Gate	4660.00	3682.37		977.63	3.03	2.22	3031.46	0.004615	3.82		2.44	433.78		835.80	0.45
Reach 1	1800	10yr 90' Gate	1204.00	1097.35		106.65	1.95	1.27	3030.38	0.003111	2.15		1.17	402.46		682.98	0.34
Reach 1	1700	100yr 90' Gate	4660.00	3689.60		970.40	3.04	2.03	3031.01	0.005645	3.98		2.51	457.11		860.95	0.49
Reach 1	1700	10yr 90' Gate	1204.00	1110.01		93.99	2.11	1.23	3030.08	0.003206	2.15		1.12	419.05		677.07	0.34
Reach 1	1528	100yr 90' Gate	4660.00	3754.36		905.64	3.43	1.52	3030.30	0.003429	4.60		3.18	536.07		1174.60	0.66
Reach 1	1528	10yr 90' Gate	1204.00	1108.82		95.18	2.48	0.71	3029.35	0.004913	3.32		1.97	471.11		983.91	0.69
Reach 1	1483	100yr 90' Gate	4660.00	4320.06		339.94	1.93	1.49	3030.01	0.003129	5.43		2.71	533.54		958.00	0.78
Reach 1	1483	10yr 90' Gate	1204.00	1193.84		10.17	1.16	0.83	3029.23	0.002065	2.98		1.04	484.84		787.86	0.58

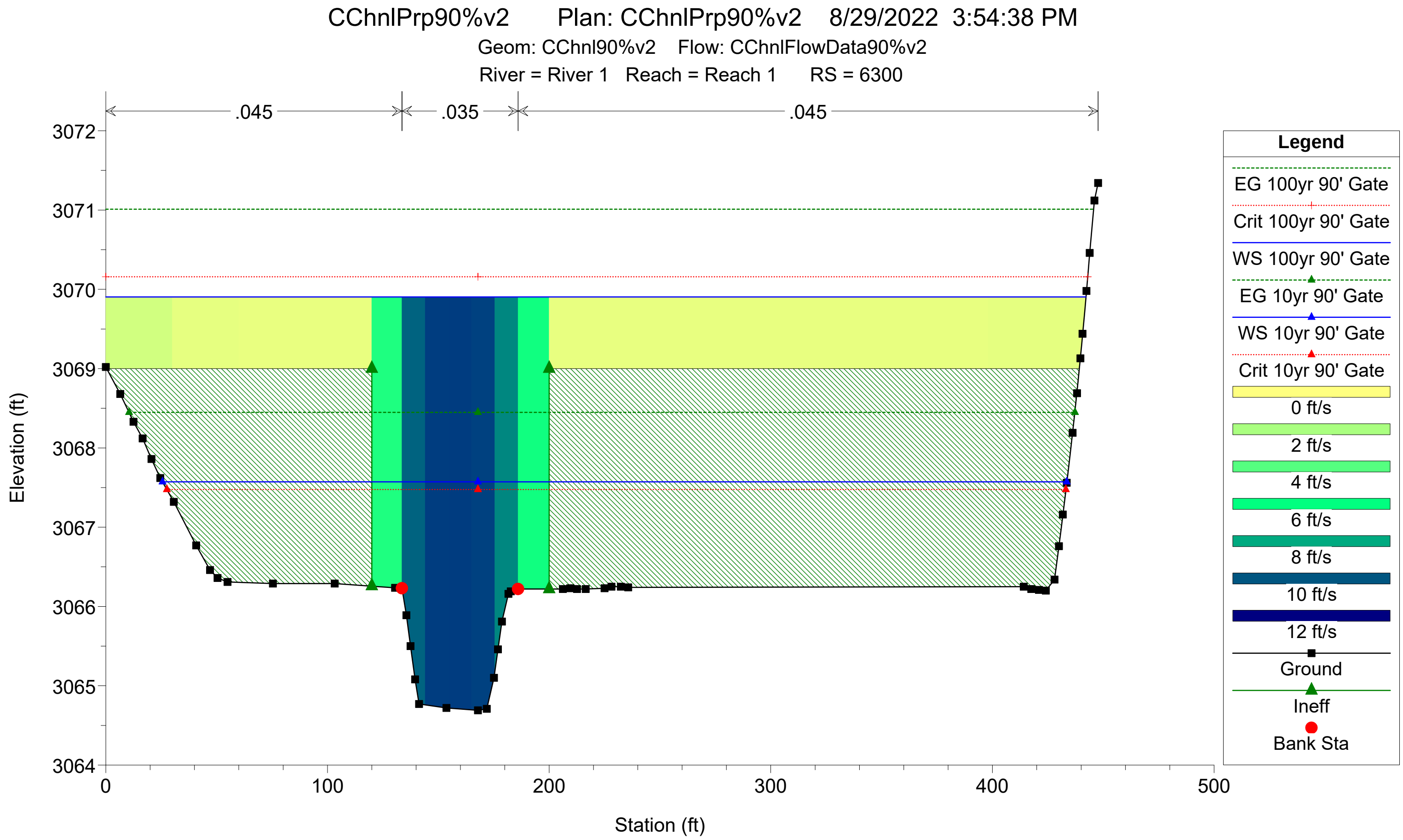
HEC-RAS Plan: CChnlPrp90%v2 River: River 1 Reach: Reach 1 (Continued)

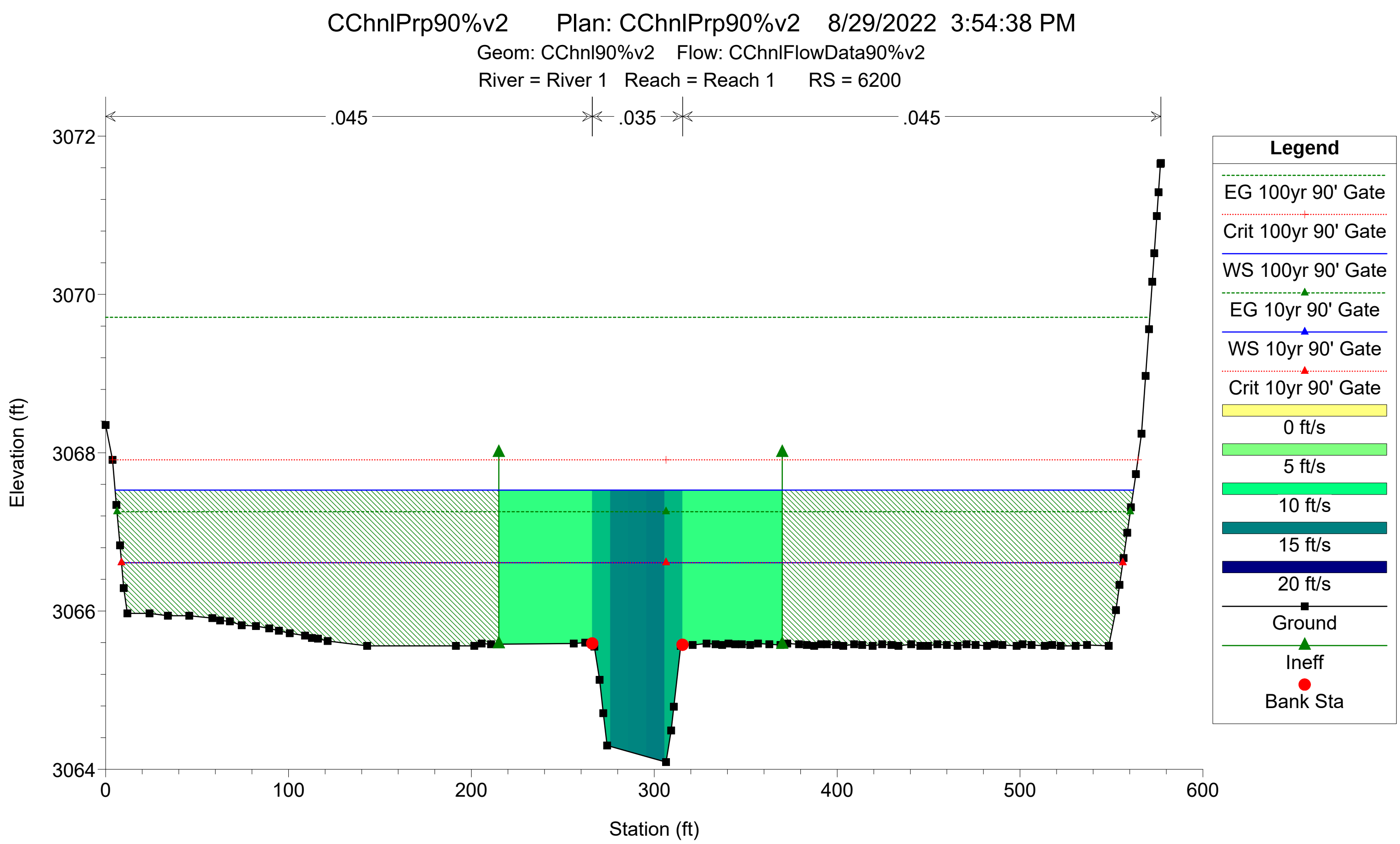
Reach	River Sta	Profile	Q Total	Q Channel	Q Left	Q Right	Max Chl Dpth	Hydr Depth C	W.S. Elev	E.G. Slope	Vel Chnl	Vel Left	Vel Right	Top W Chnl	Top W Left	Top W Right	Froude # Chl
			(cfs)	(cfs)	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(ft/s)	(ft/s)	(ft)	(ft)	(ft)	
Reach 1	1462	100yr 90' Gate	4660.00	2108.47		2551.53	3.31	1.10	3030.00	0.008990	4.28		4.32	449.60	77.13	1230.79	0.72
Reach 1	1462	10yr 90' Gate	1204.00	459.25		744.75	2.43	0.58	3029.12	0.009005	2.81		3.48	280.37		990.21	0.65

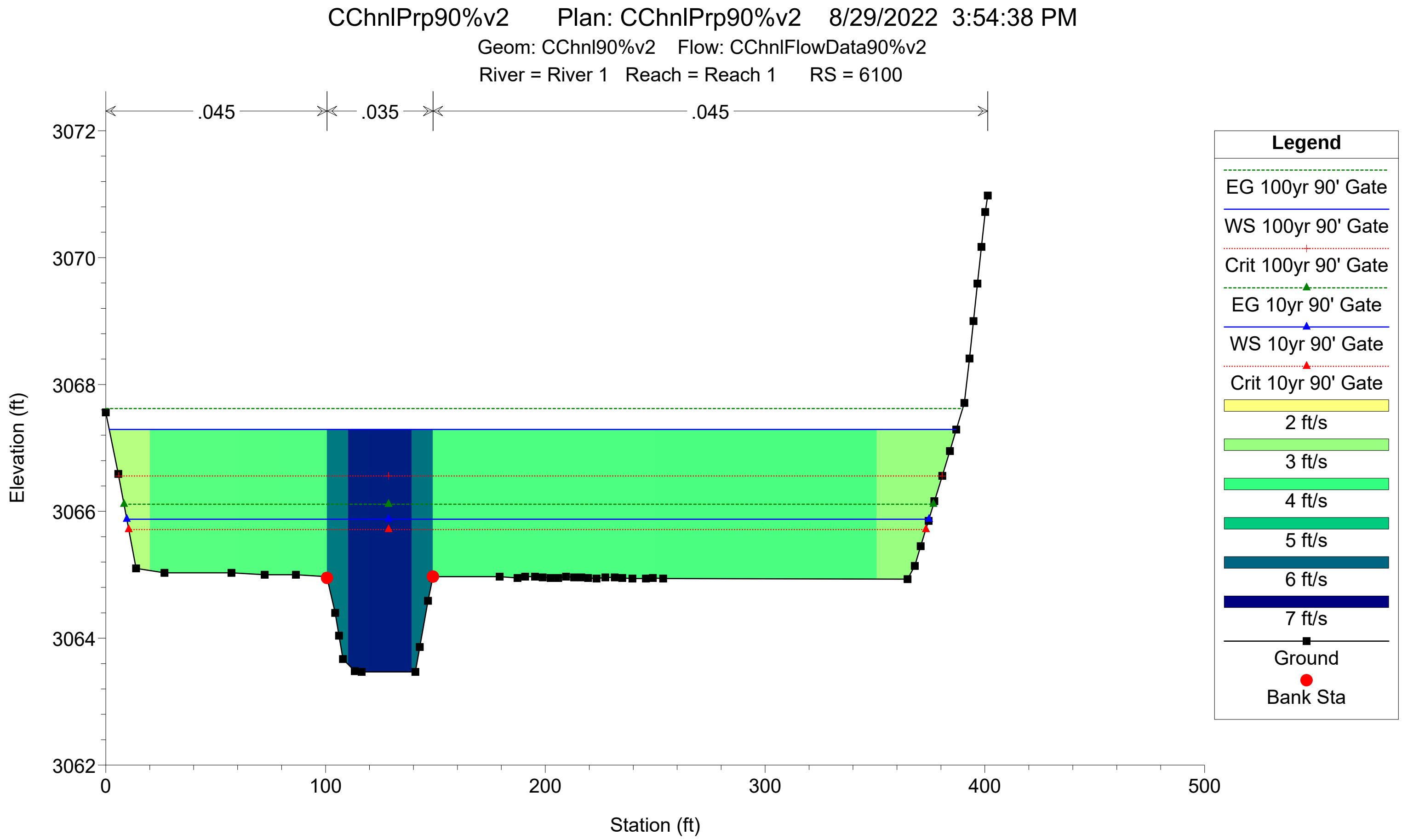
FG Channels-C Channel MixedFlow Run_2022.08.29



FG Channels-C Channel Mixed Flow Run_2022.08.29



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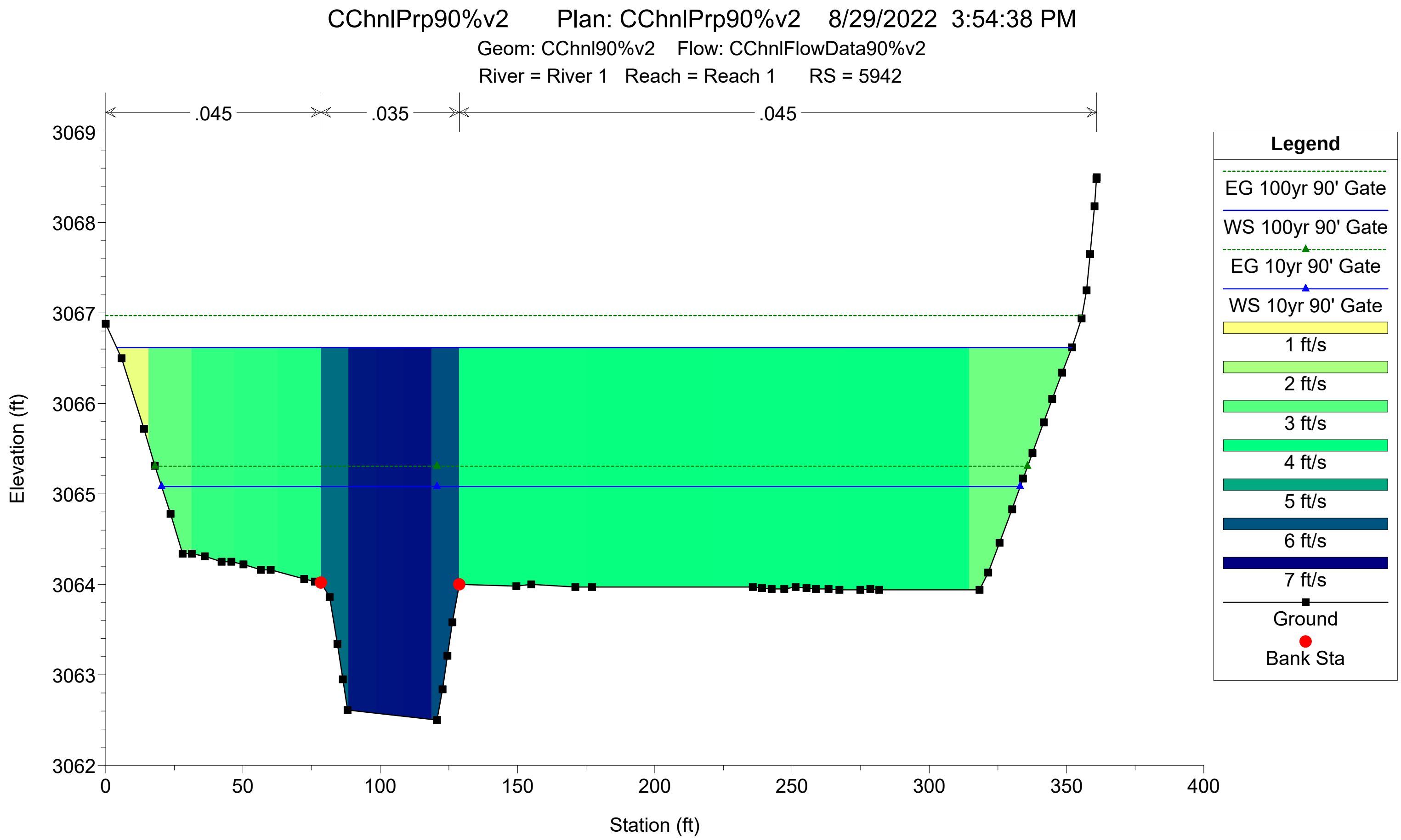
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 6100
.045
.035
.045
Elevation (ft)
Station (ft)
3062
3064
3066
3068
3070
3072
0
100
200
300
400
500
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta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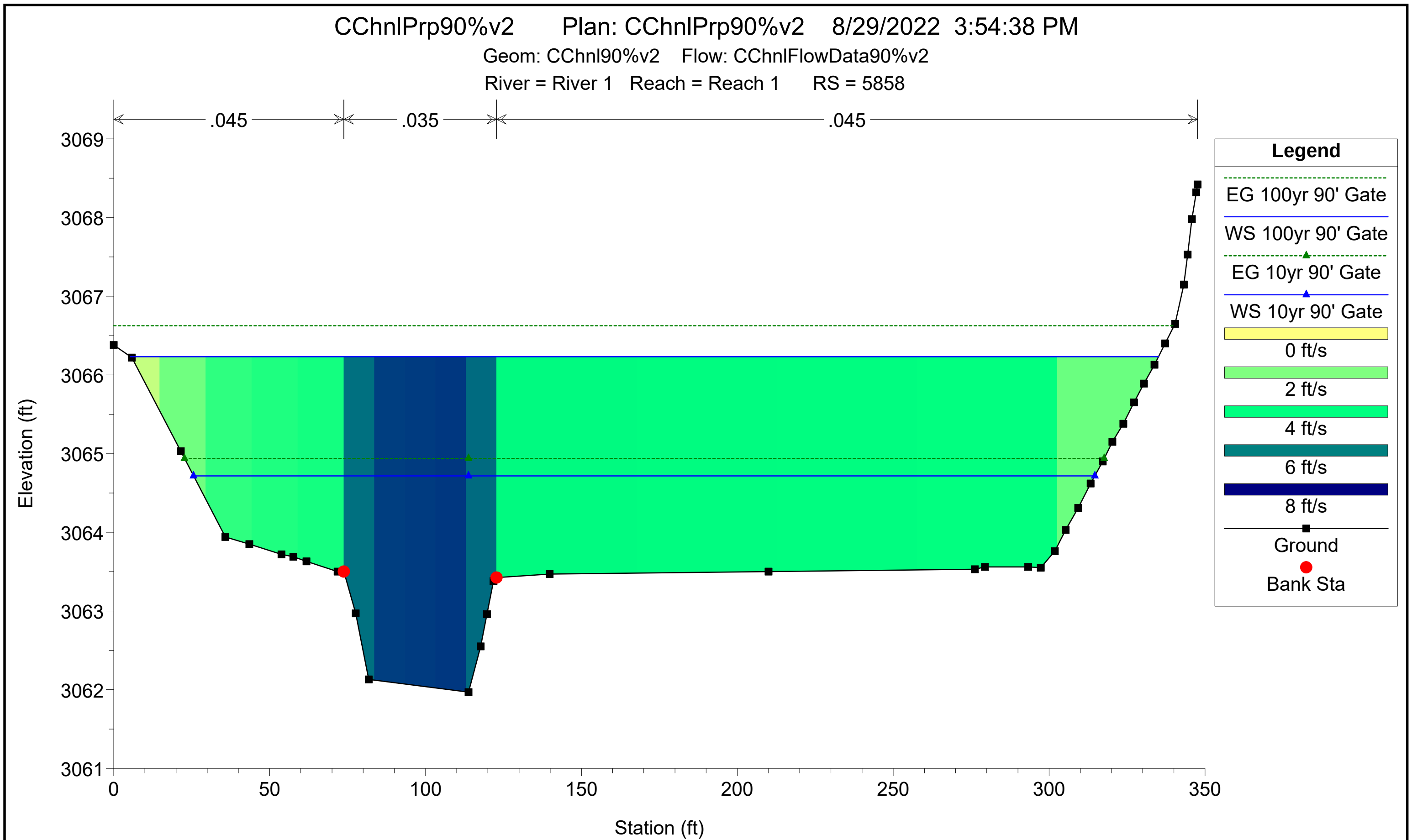
.045
.035
.045
Elevation (ft)
Station (ft)
3062
3063
3064
3065
3066
3067
3068
3069
0
50
100
150
200
250
300
350
400
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta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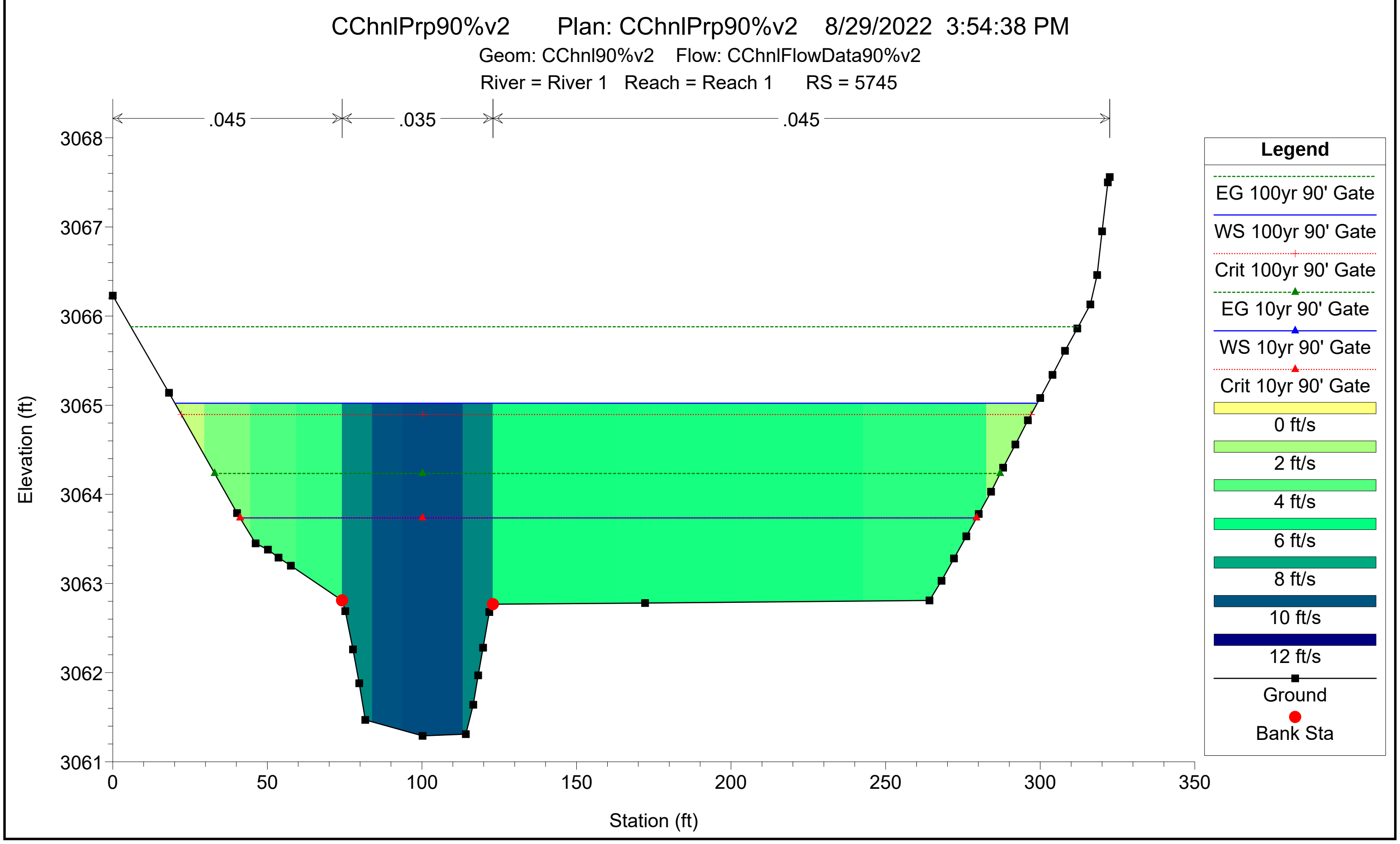
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 5858
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta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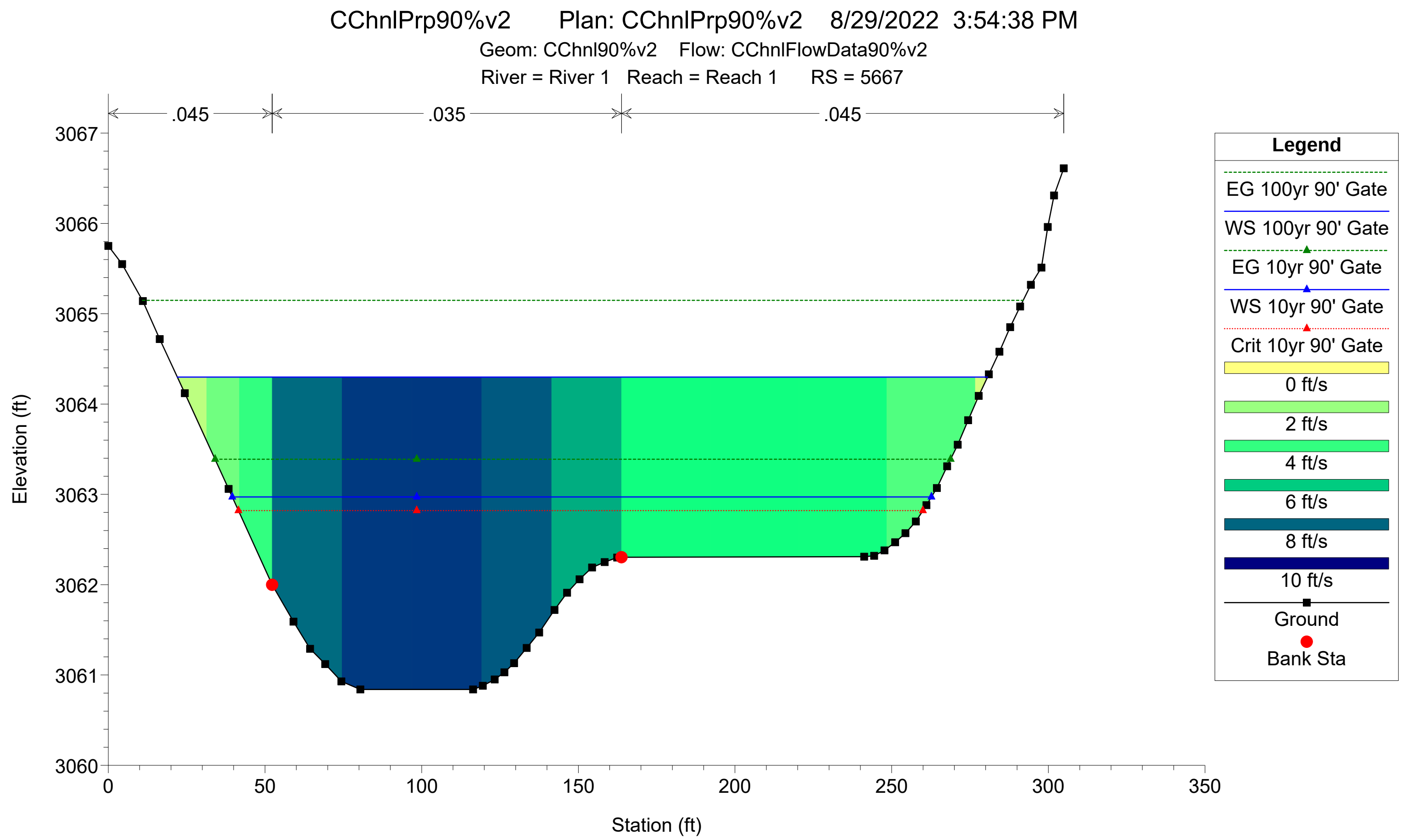
River = River 1 Reach = Reach 1 RS = 5745
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta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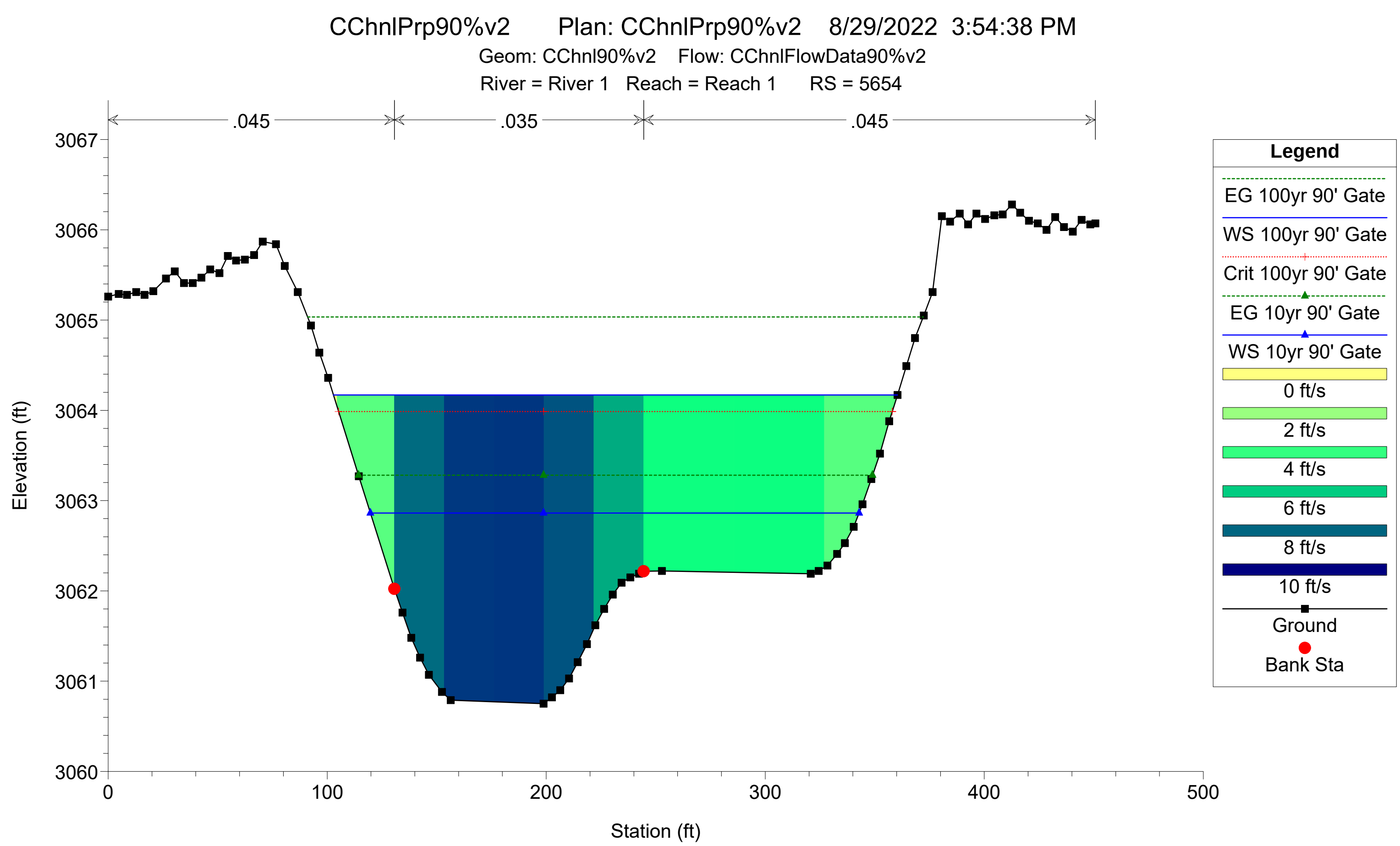
River = River 1 Reach = Reach 1 RS = 5667
.045
.035
.045
3067
3066
3065
3064
3063
3062
3061
3060
Elevation (ft)
0
50
100
150
200
250
300
350
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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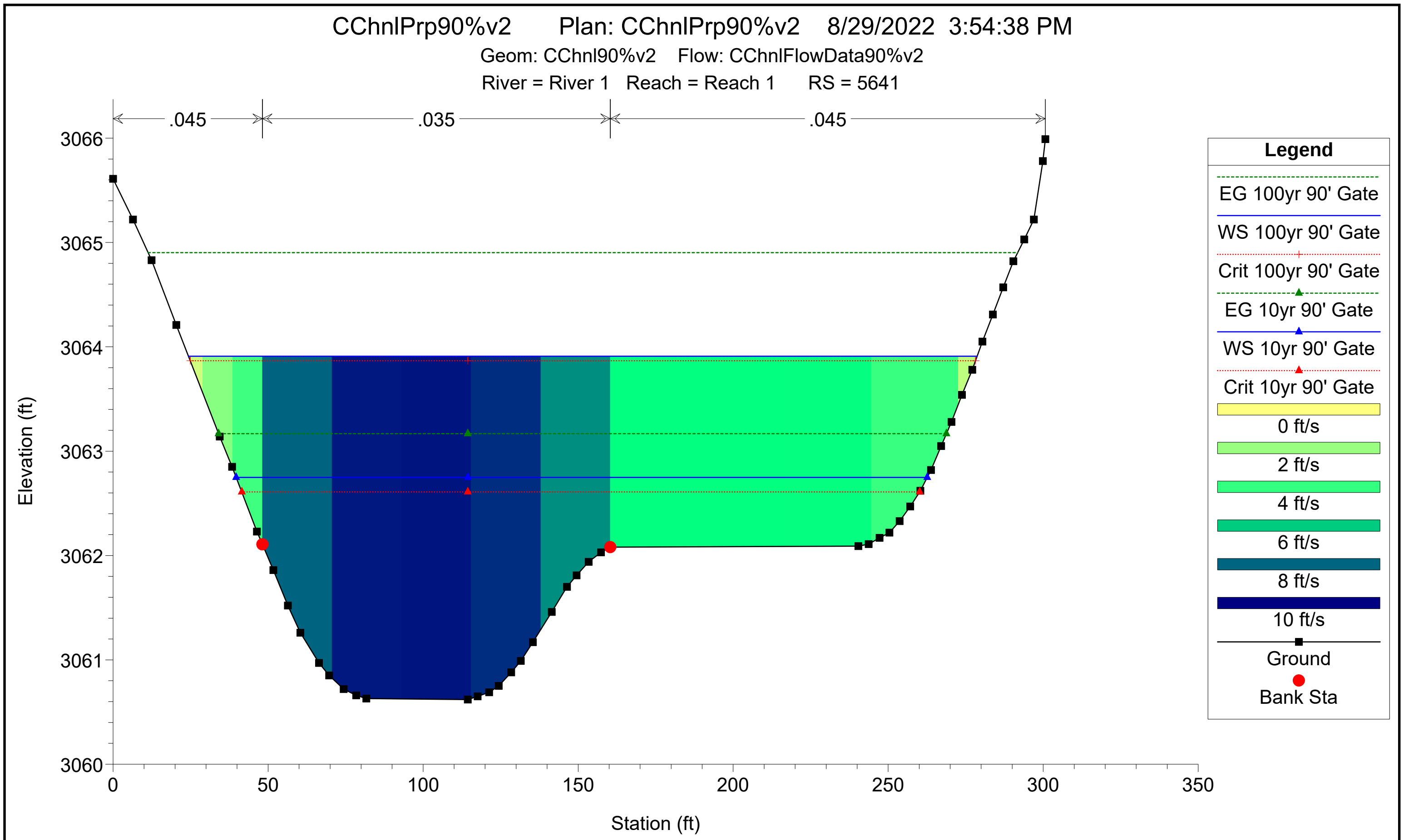
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 5654
.045
.035
.045
3067
3066
3065
3064
3063
3062
3061
3060
Elevation (ft)
0
100
200
300
400
500
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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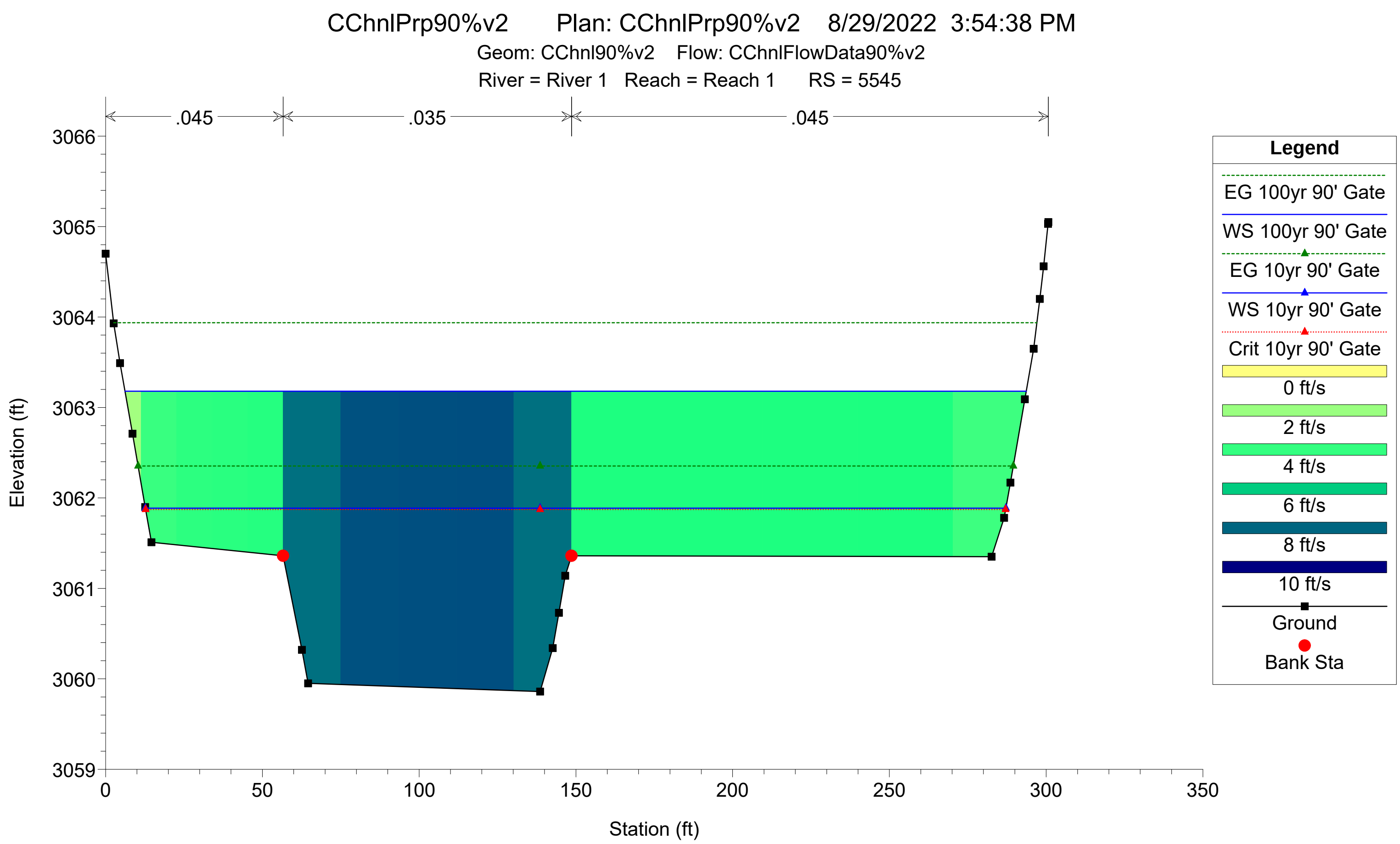
River = River 1 Reach = Reach 1 RS = 5641
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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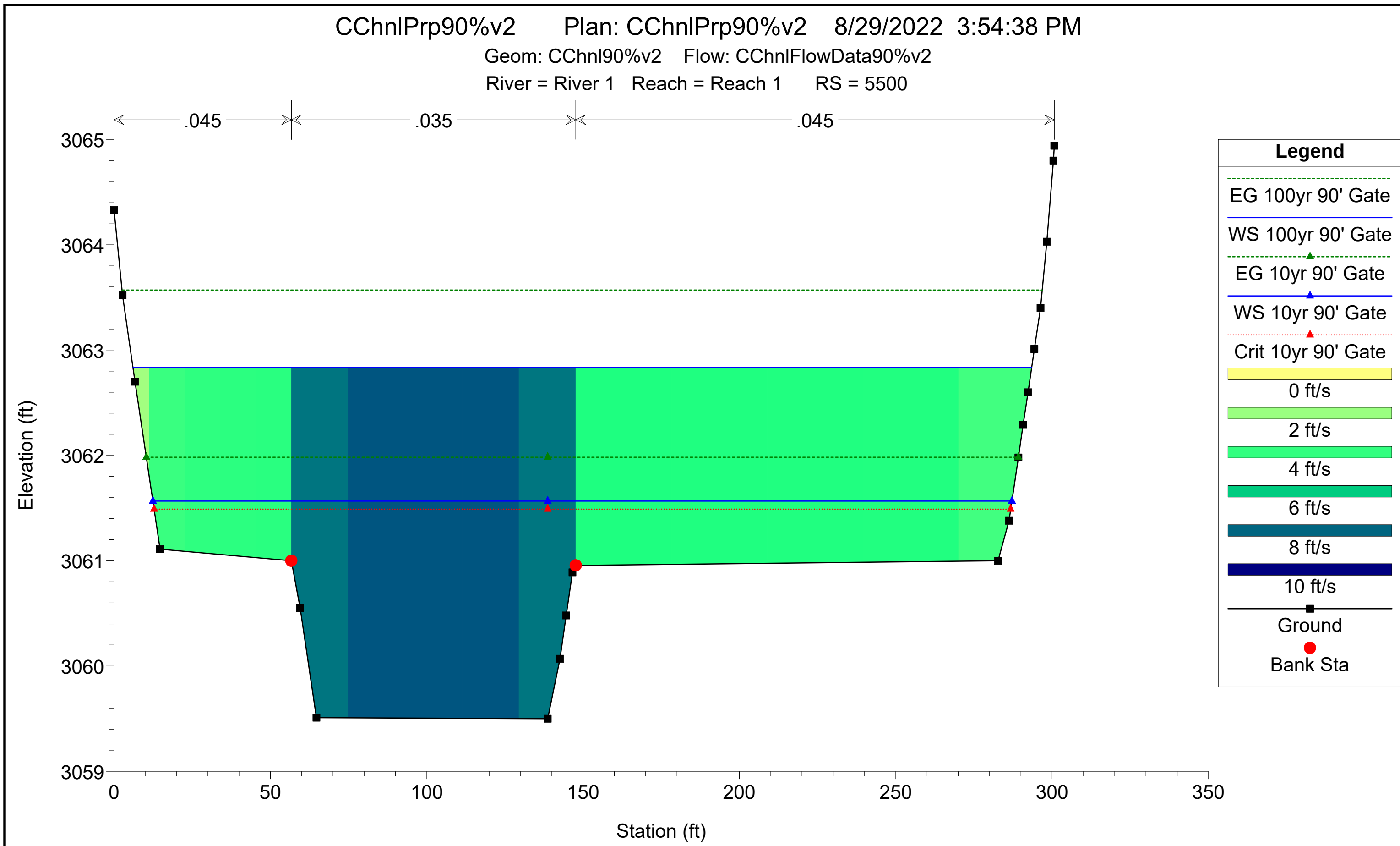
River = River 1 Reach = Reach 1 RS = 5545
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta



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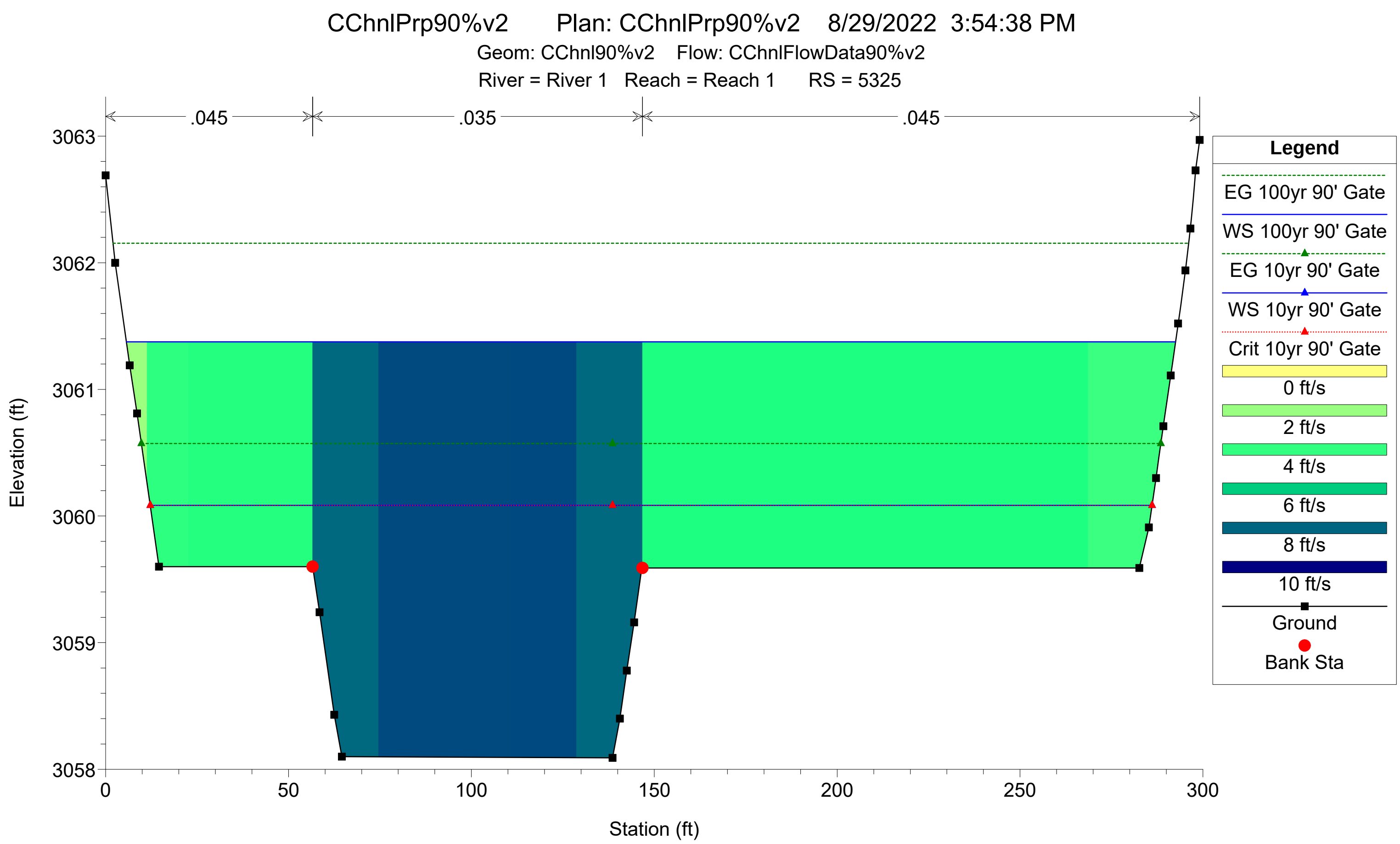
River = River 1 Reach = Reach 1 RS = 5500
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta



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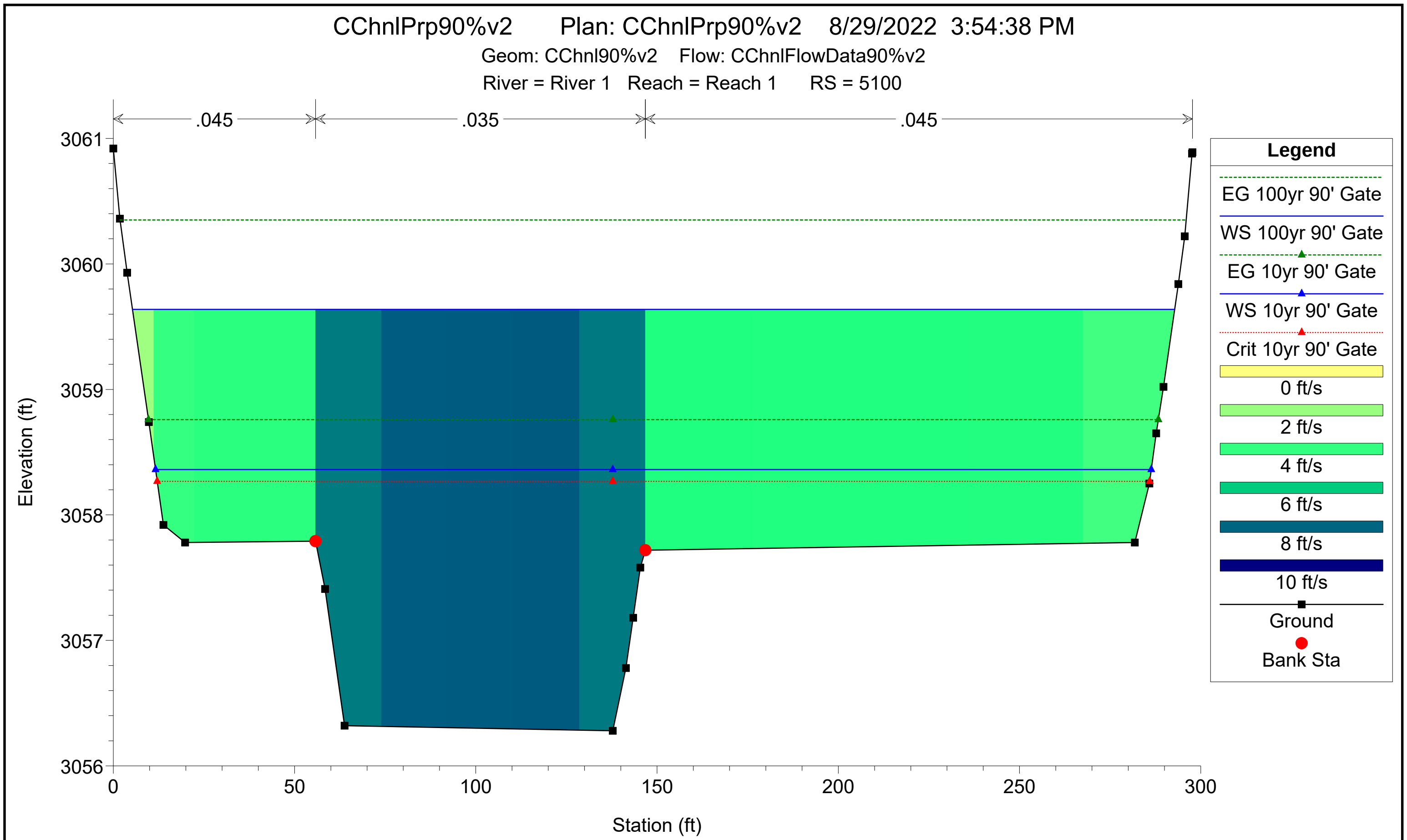
River = River 1 Reach = Reach 1 RS = 5325
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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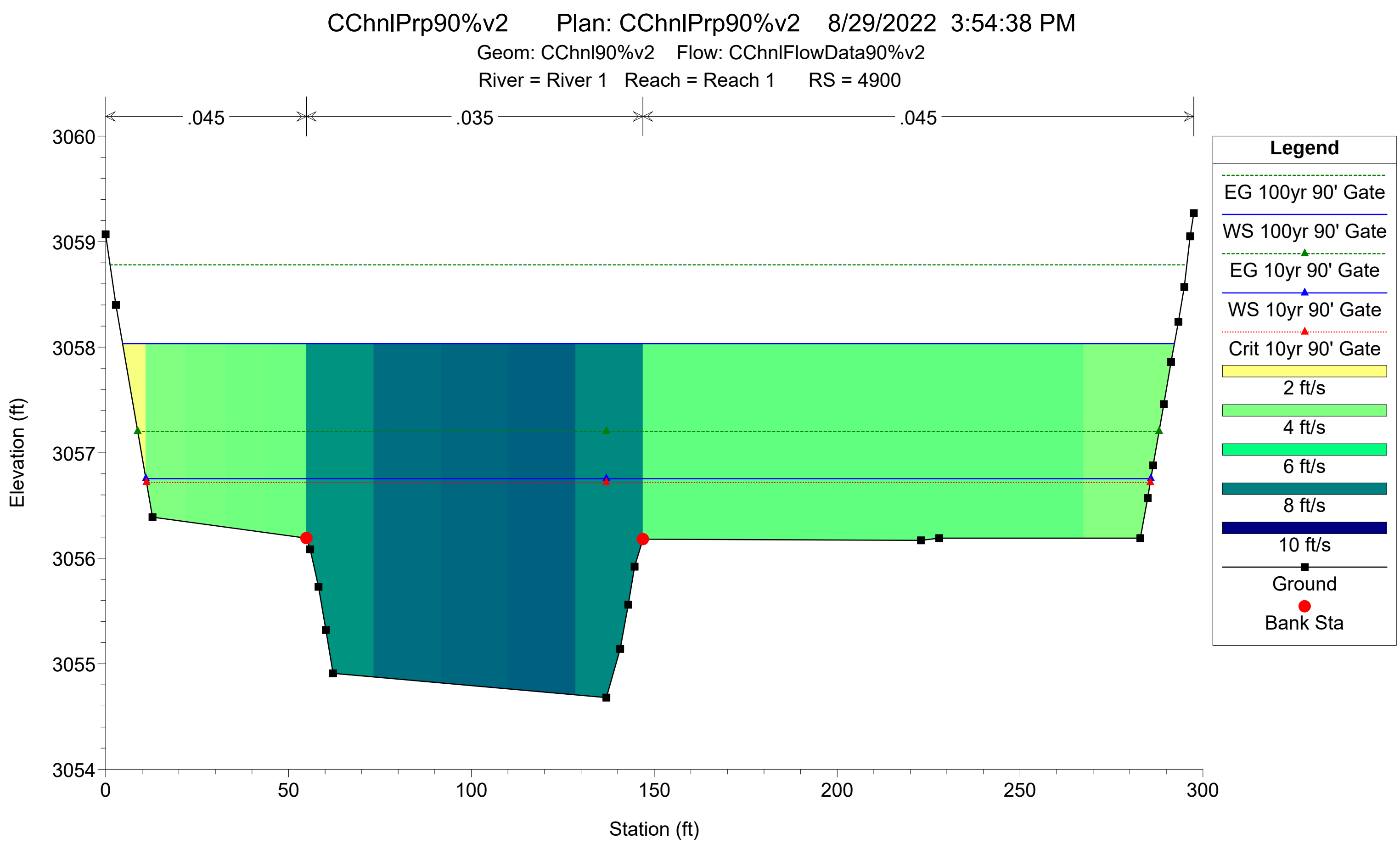
River = River 1 Reach = Reach 1 RS = 5100
.045
.035
.045
Elevation (ft)
3061
3060
3059
3058
3057
3056
0
50
100
150
200
250
300
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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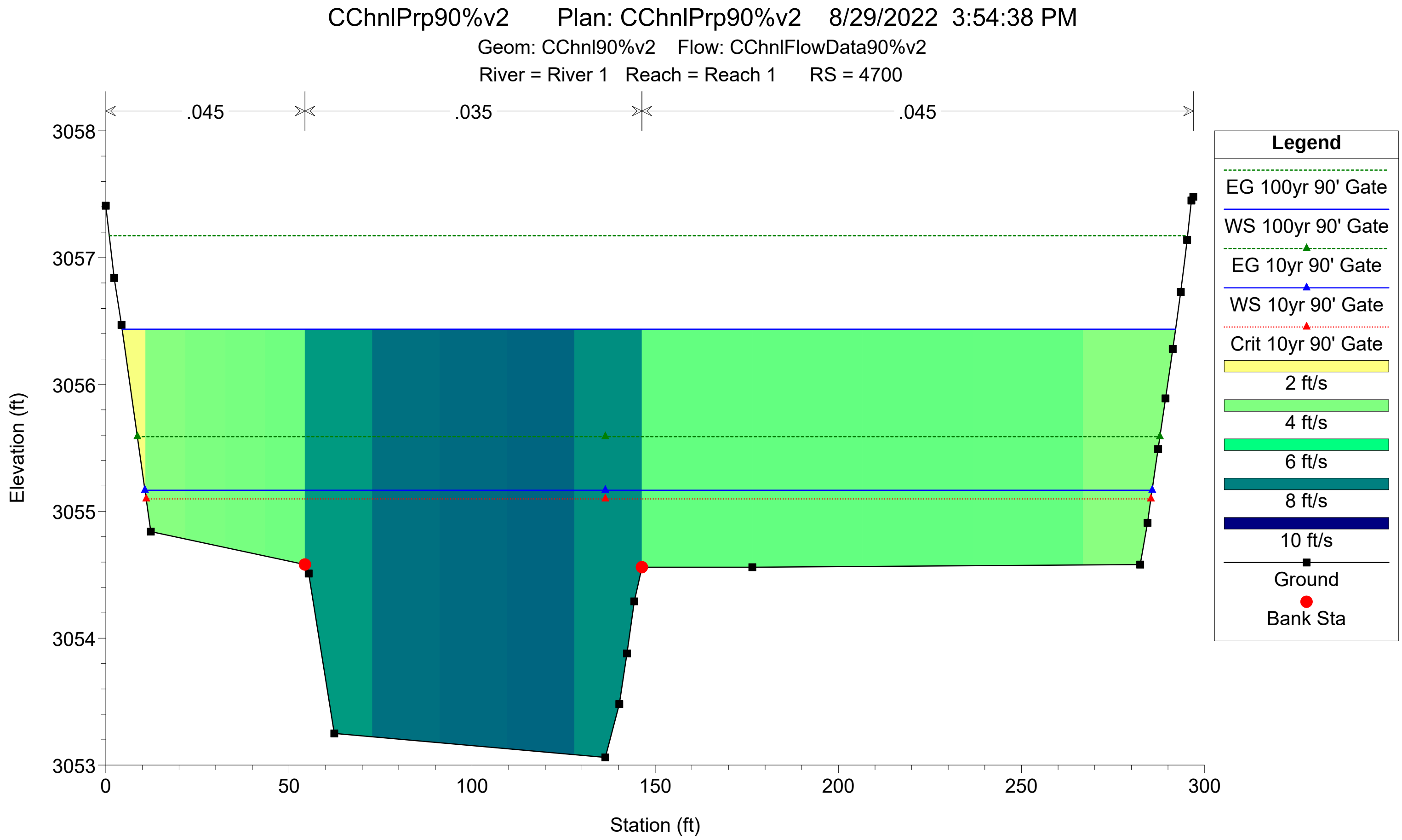
River = River 1 Reach = Reach 1 RS = 4900
.045
.035
.045
Elevation (ft)
3060
3059
3058
3057
3056
3055
3054
0
50
100
150
200
250
300
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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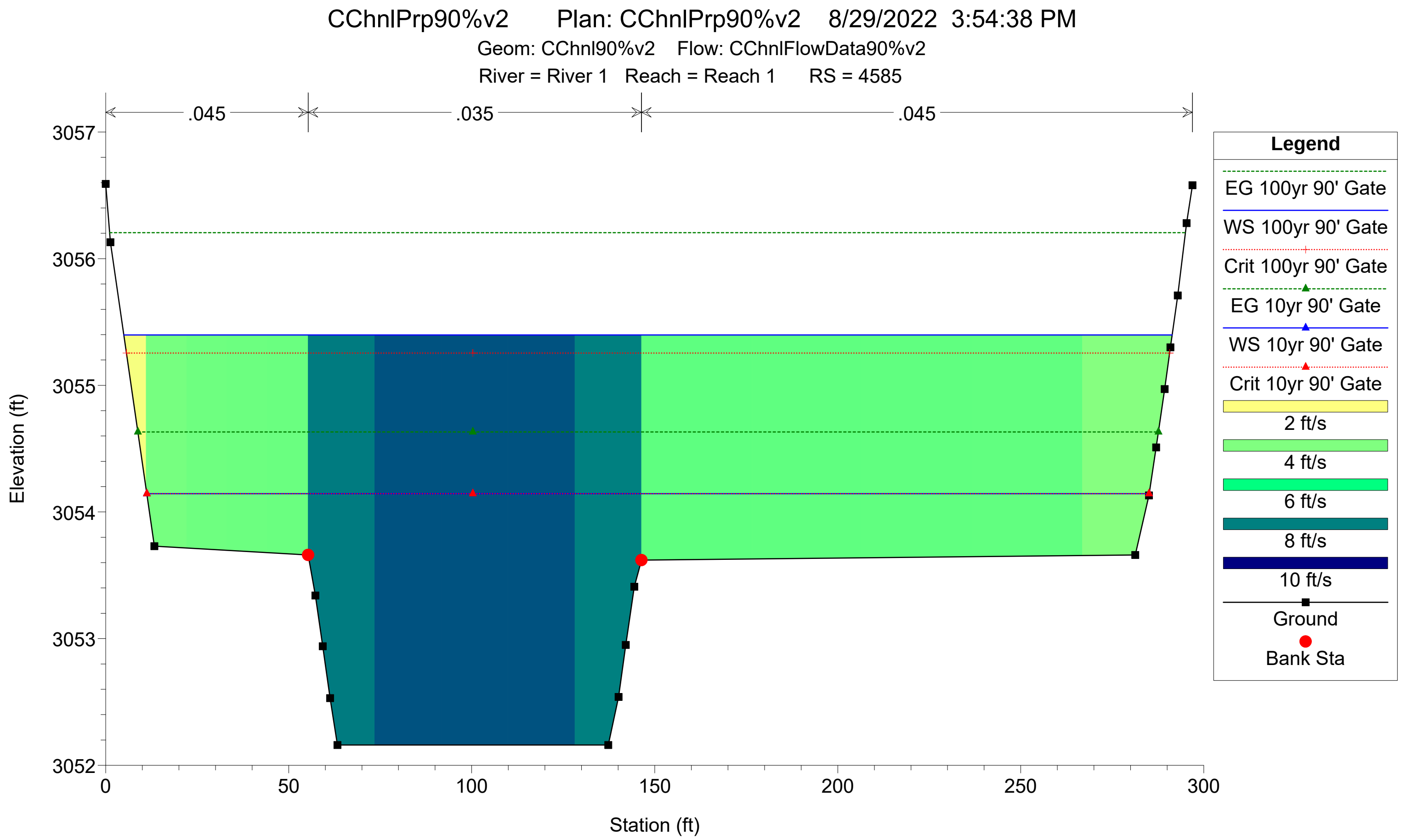
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 4700
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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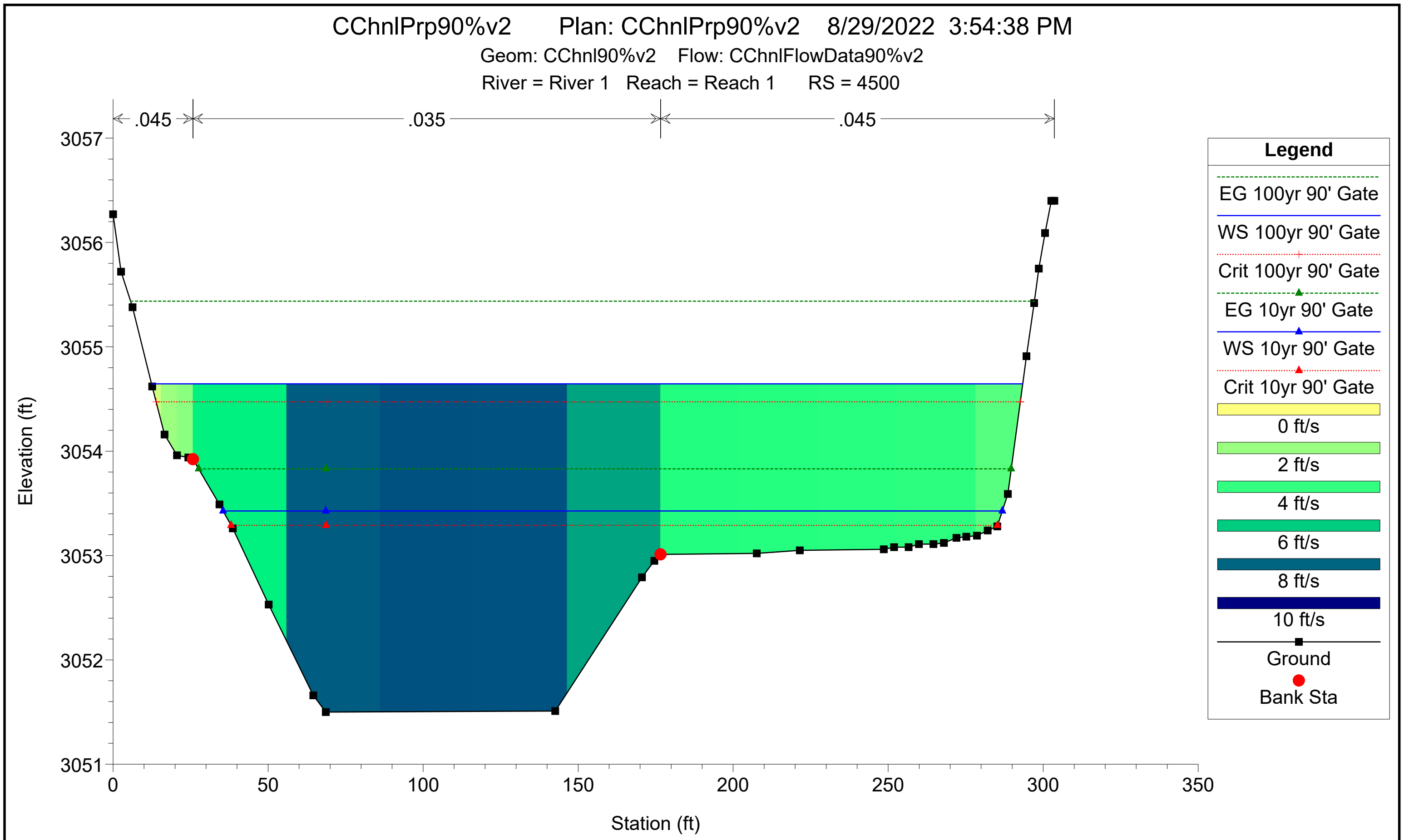
River = River 1 Reach = Reach 1 RS = 4585
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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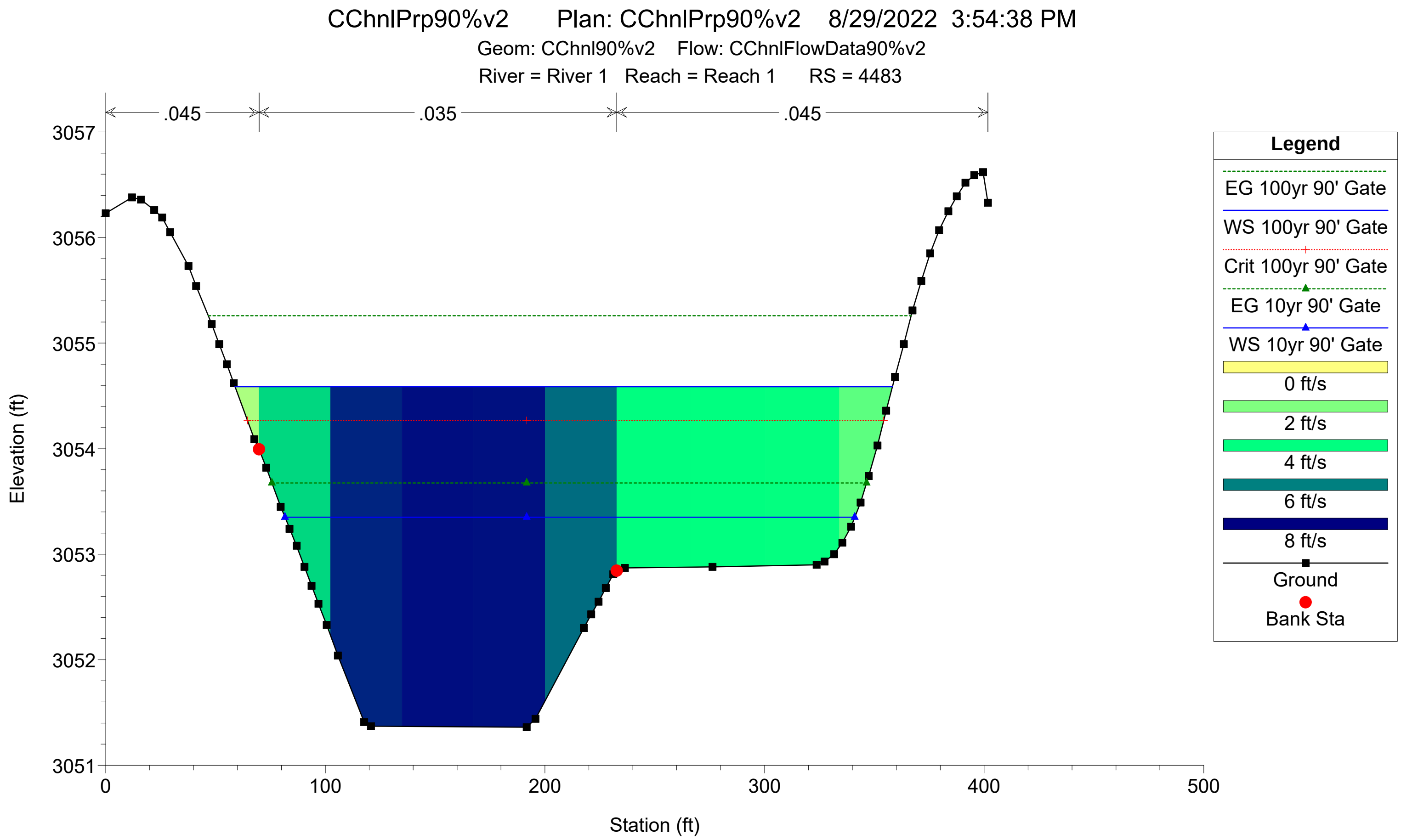
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 4500
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta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Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
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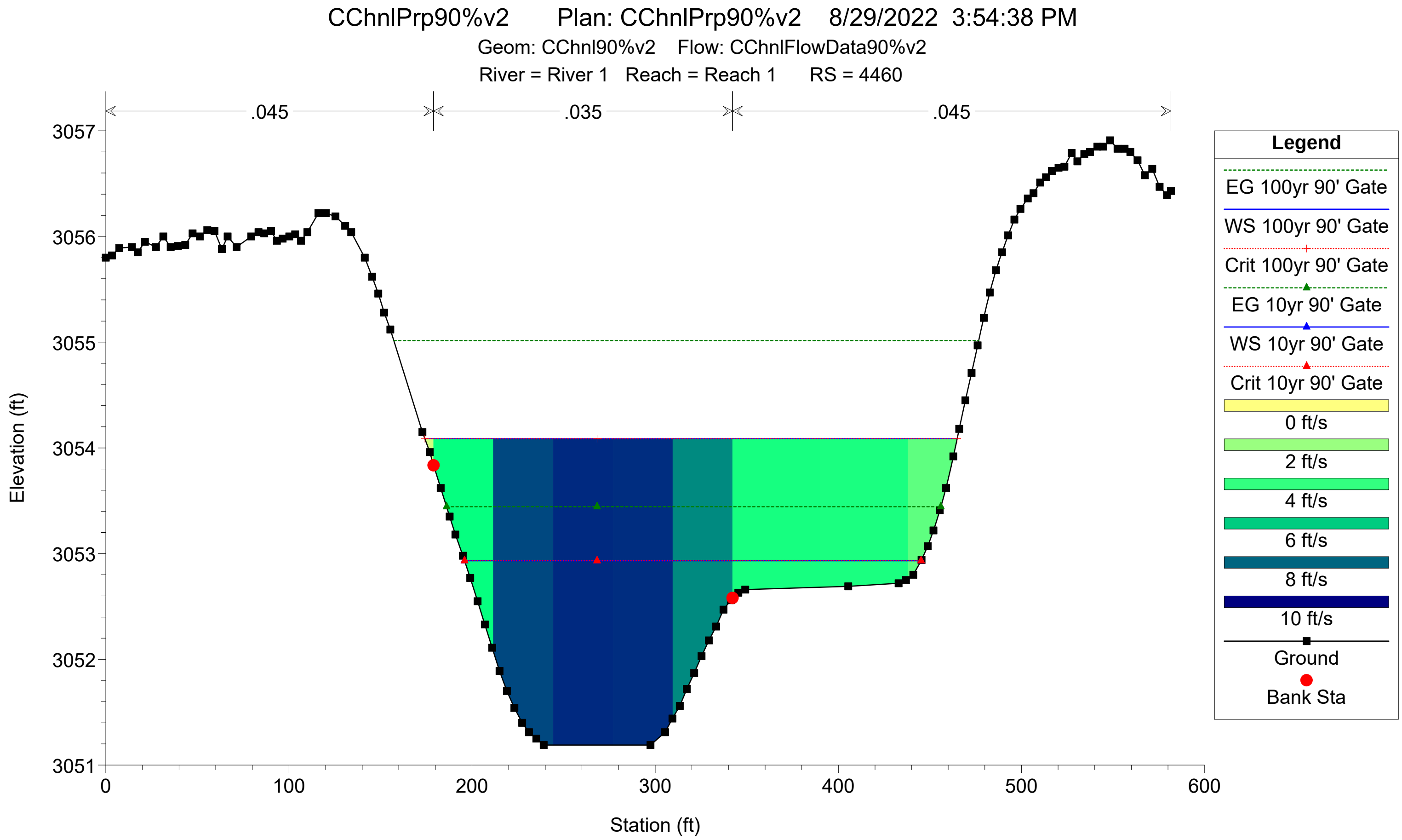
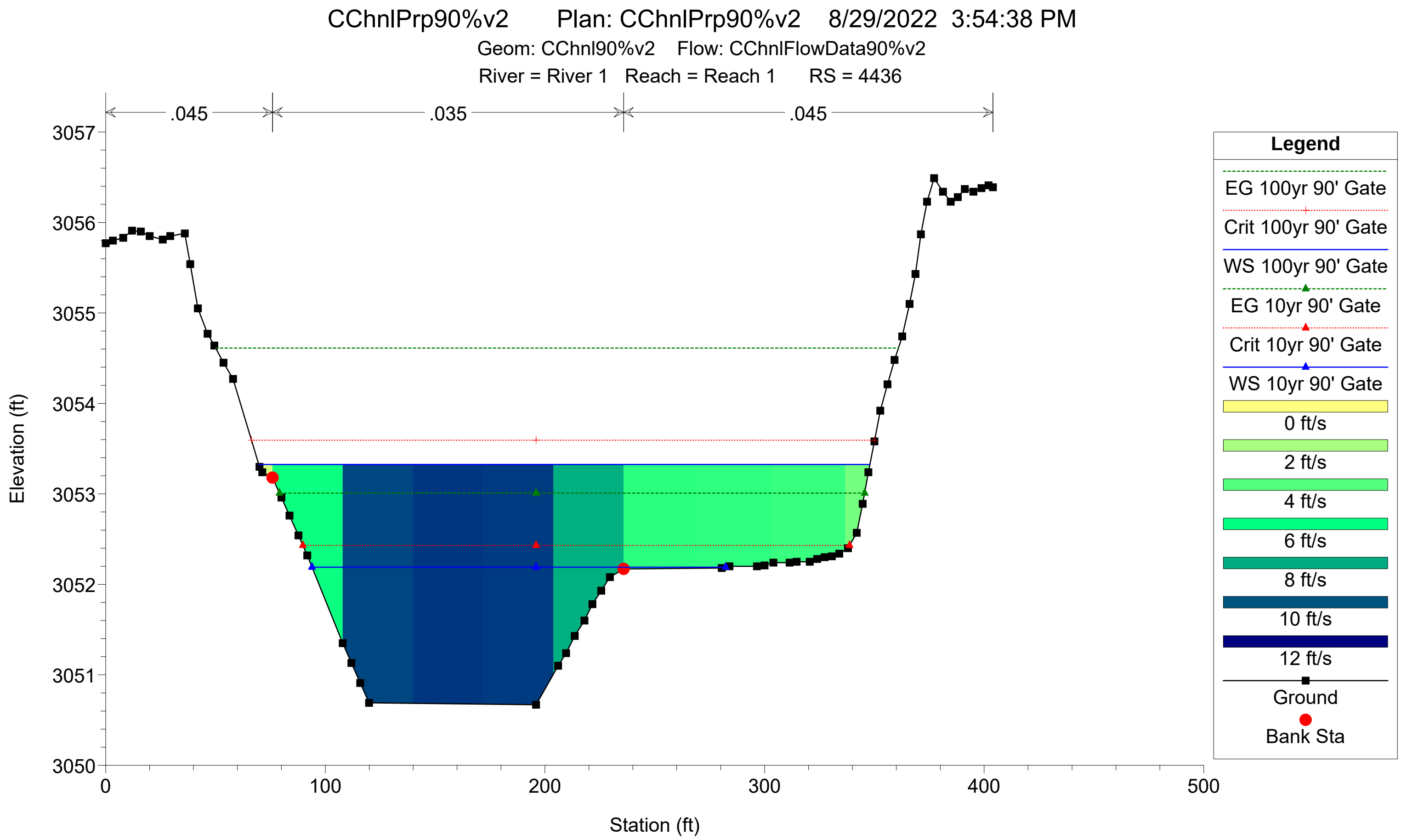
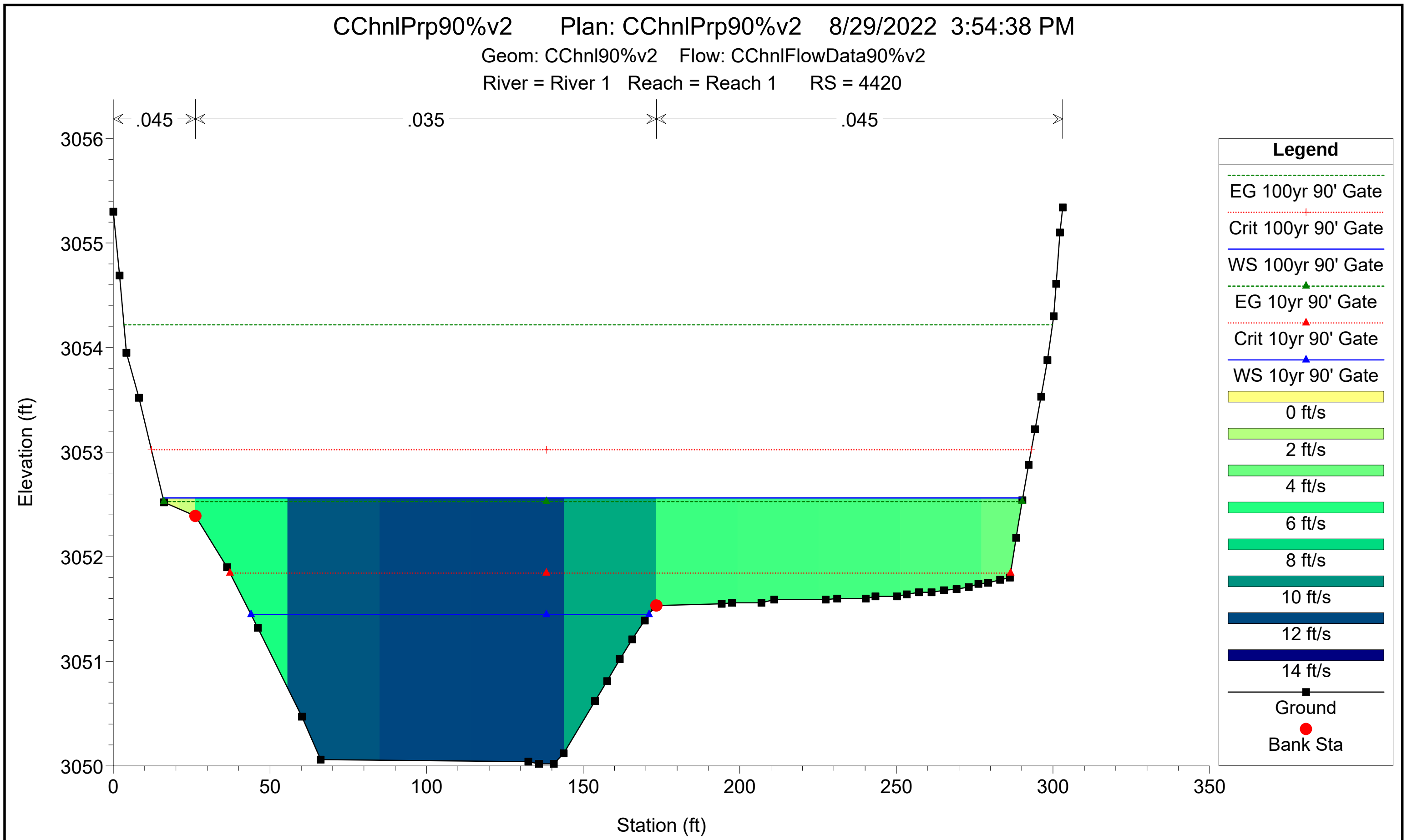
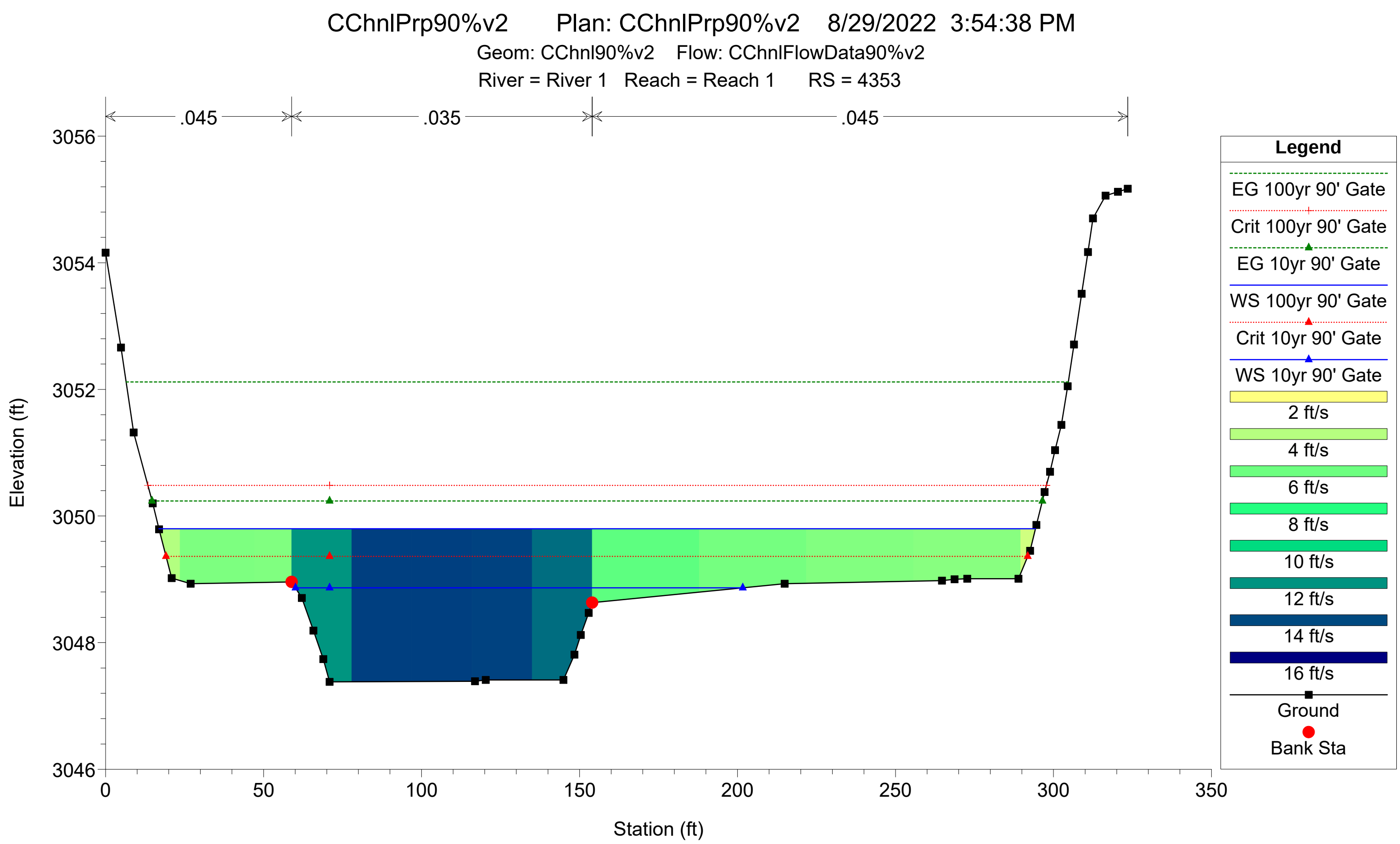
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta


CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 4460
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

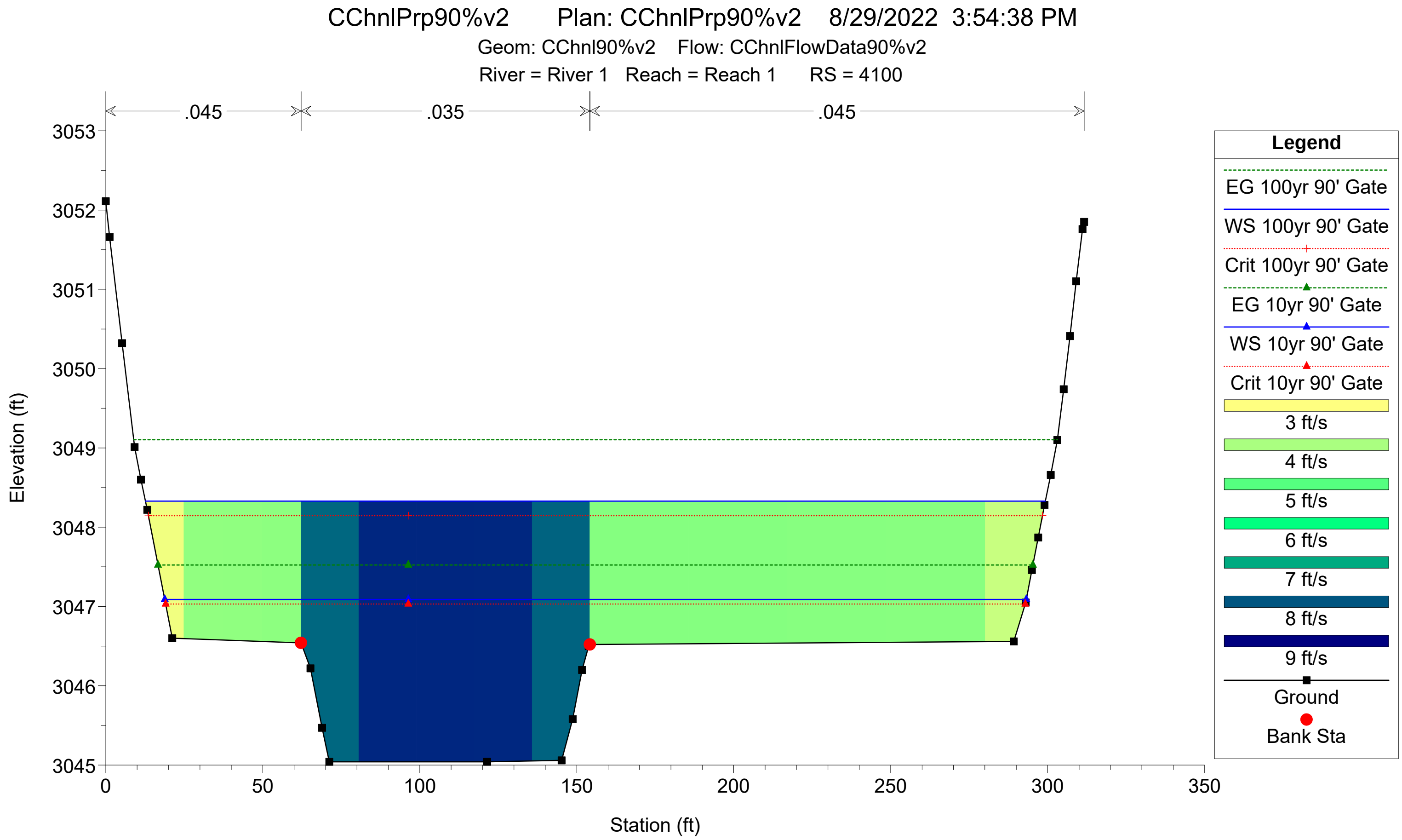

CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 4436
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
Crit 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
Crit 10yr 90' Gate
WS 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Bank Sta



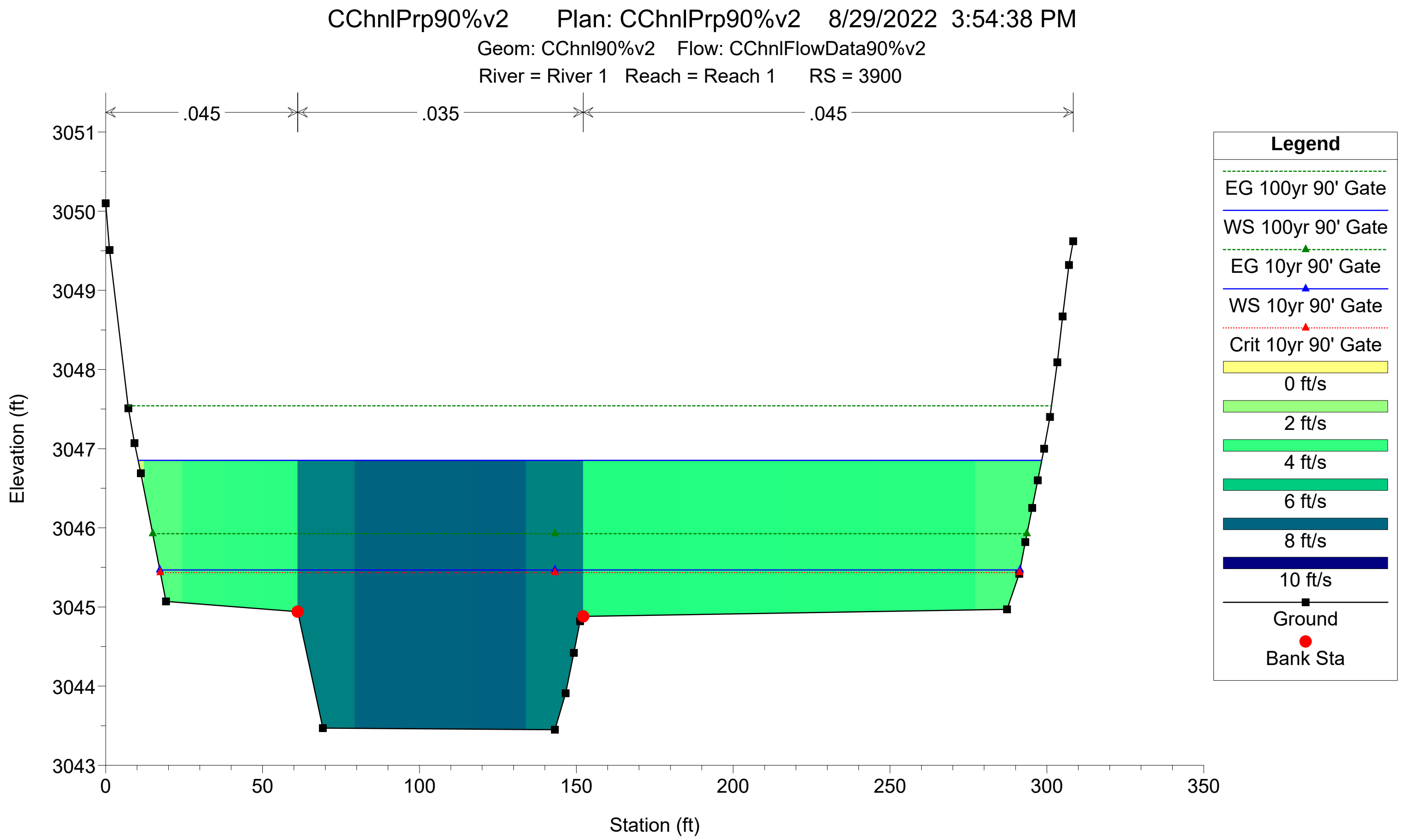
CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 4420
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
Crit 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
Crit 10yr 90' Gate
WS 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
Ground
Bank Sta



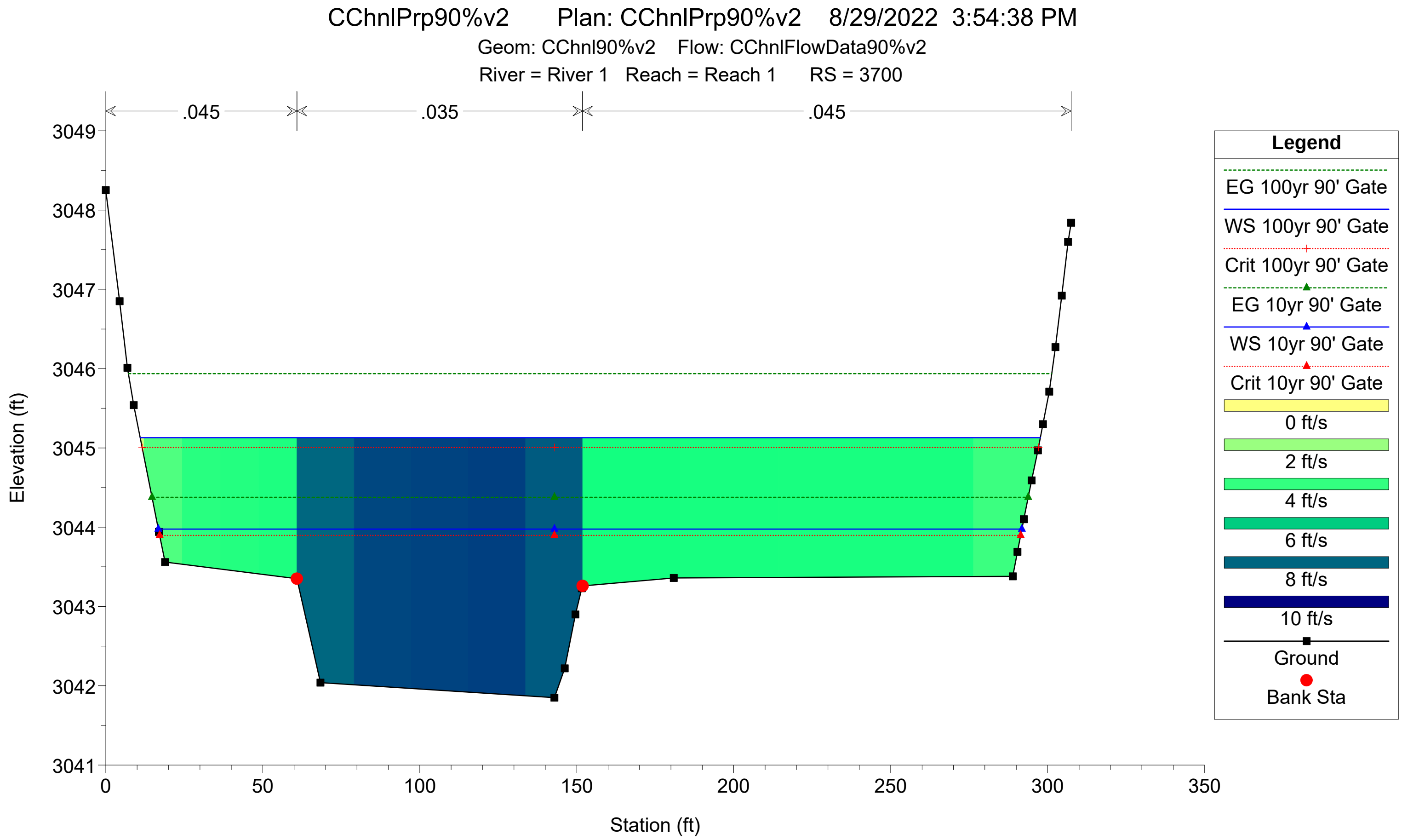
CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 4353
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 100yr 90' Gate
Crit 10yr 90' Gate
WS 10yr 90' Gate
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
16 ft/s
Ground
Bank Sta

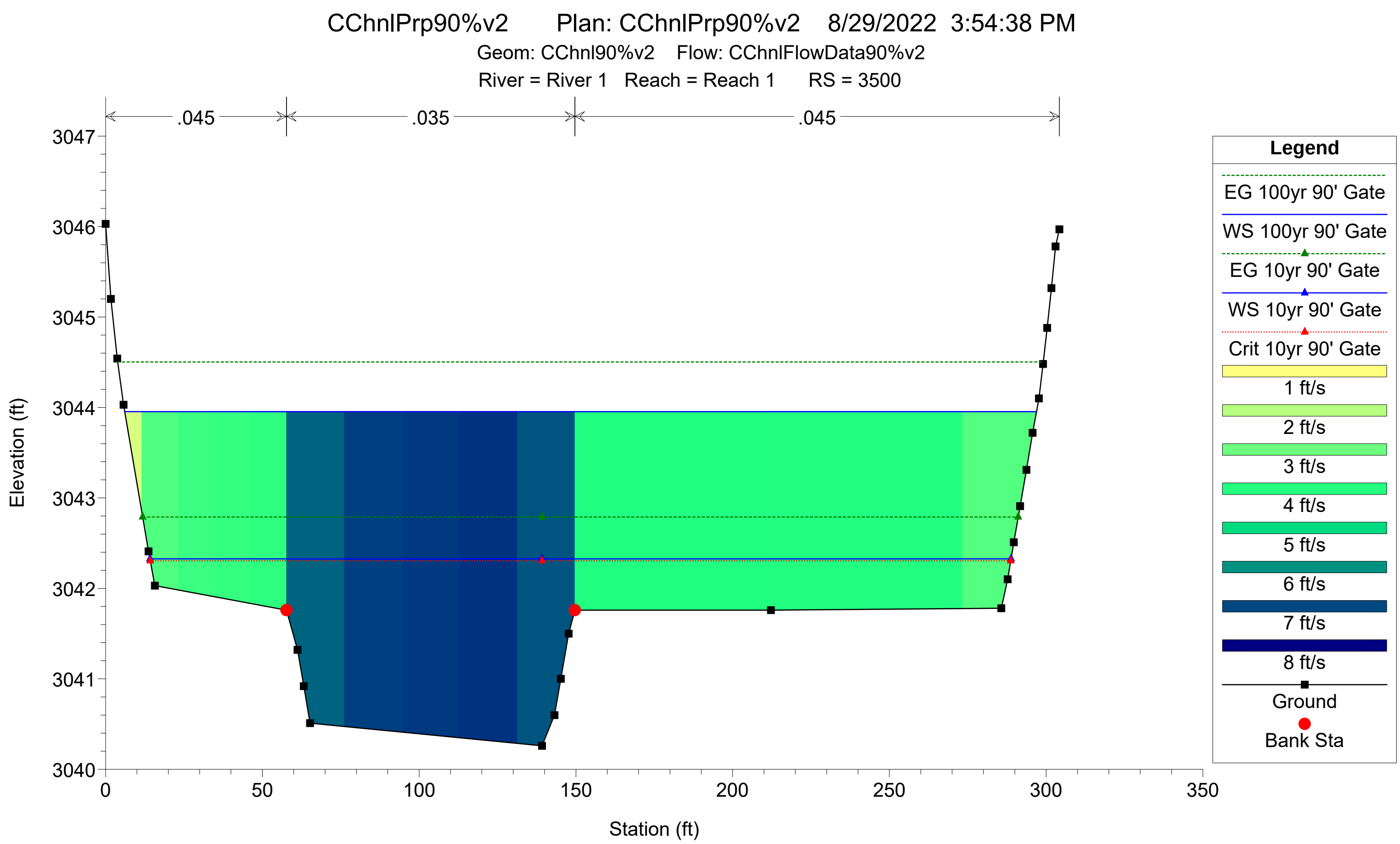


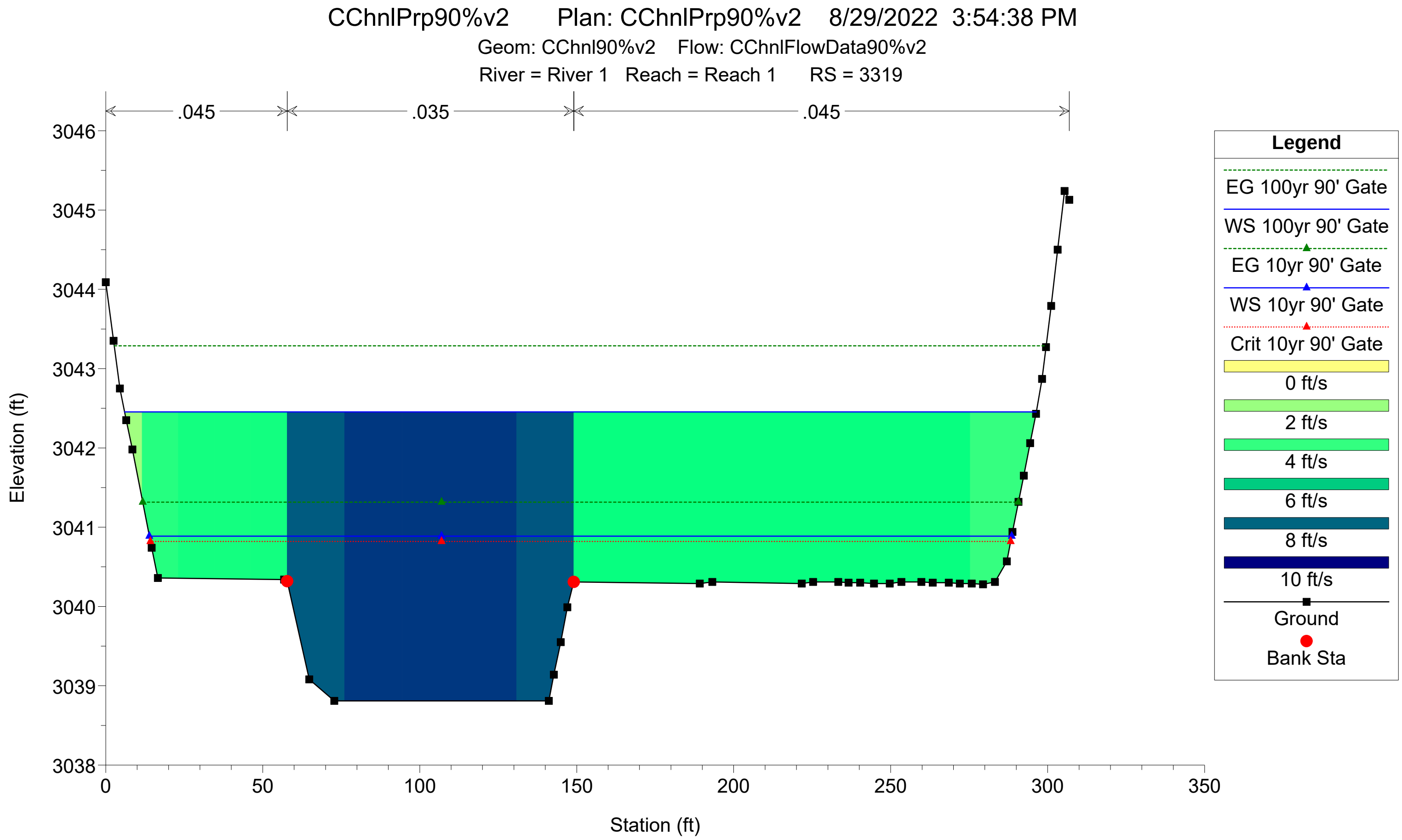
CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 4100
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)



CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 3900
.045
.035
.045
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 3700
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 3500
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
Ground
Bank Sta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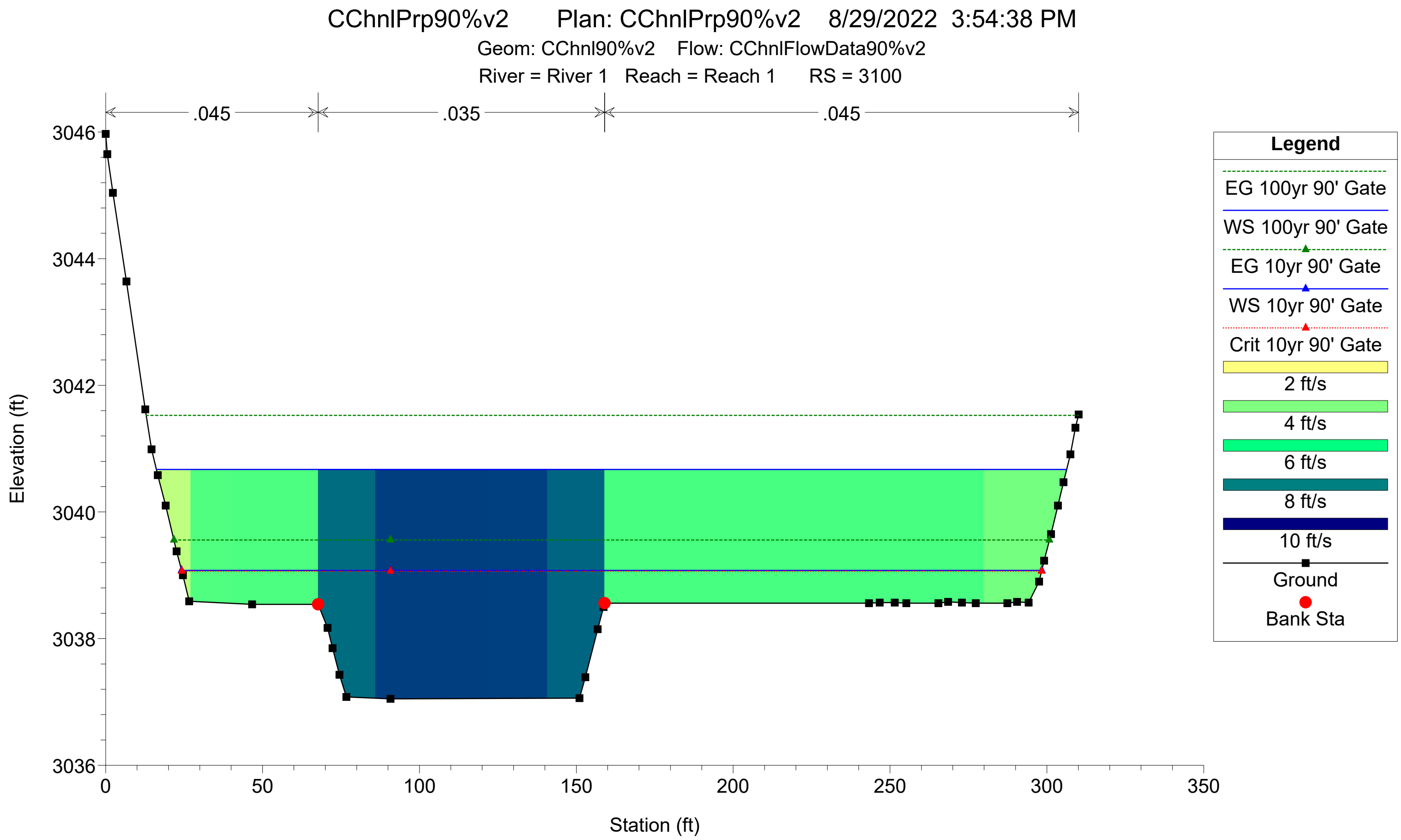
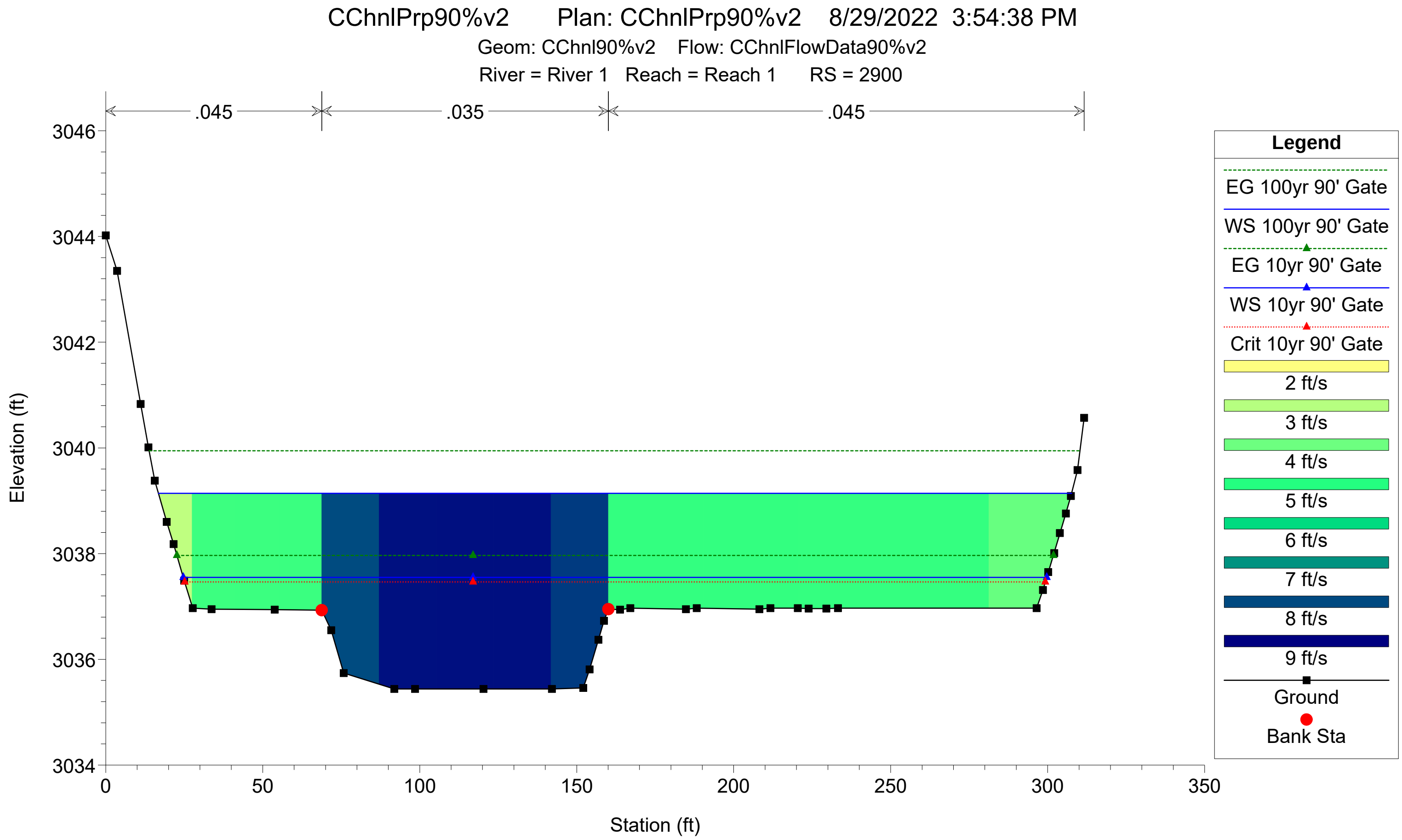
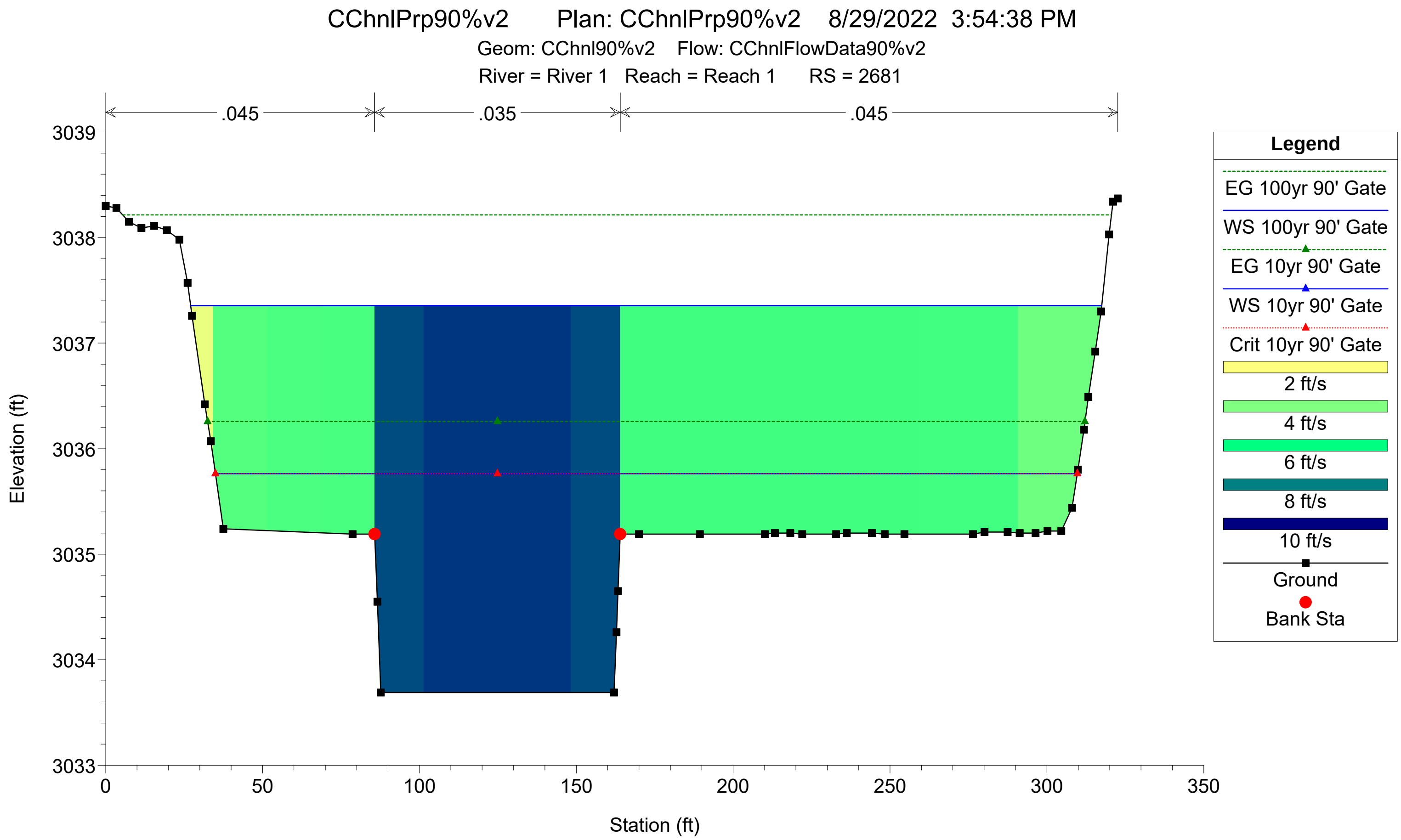
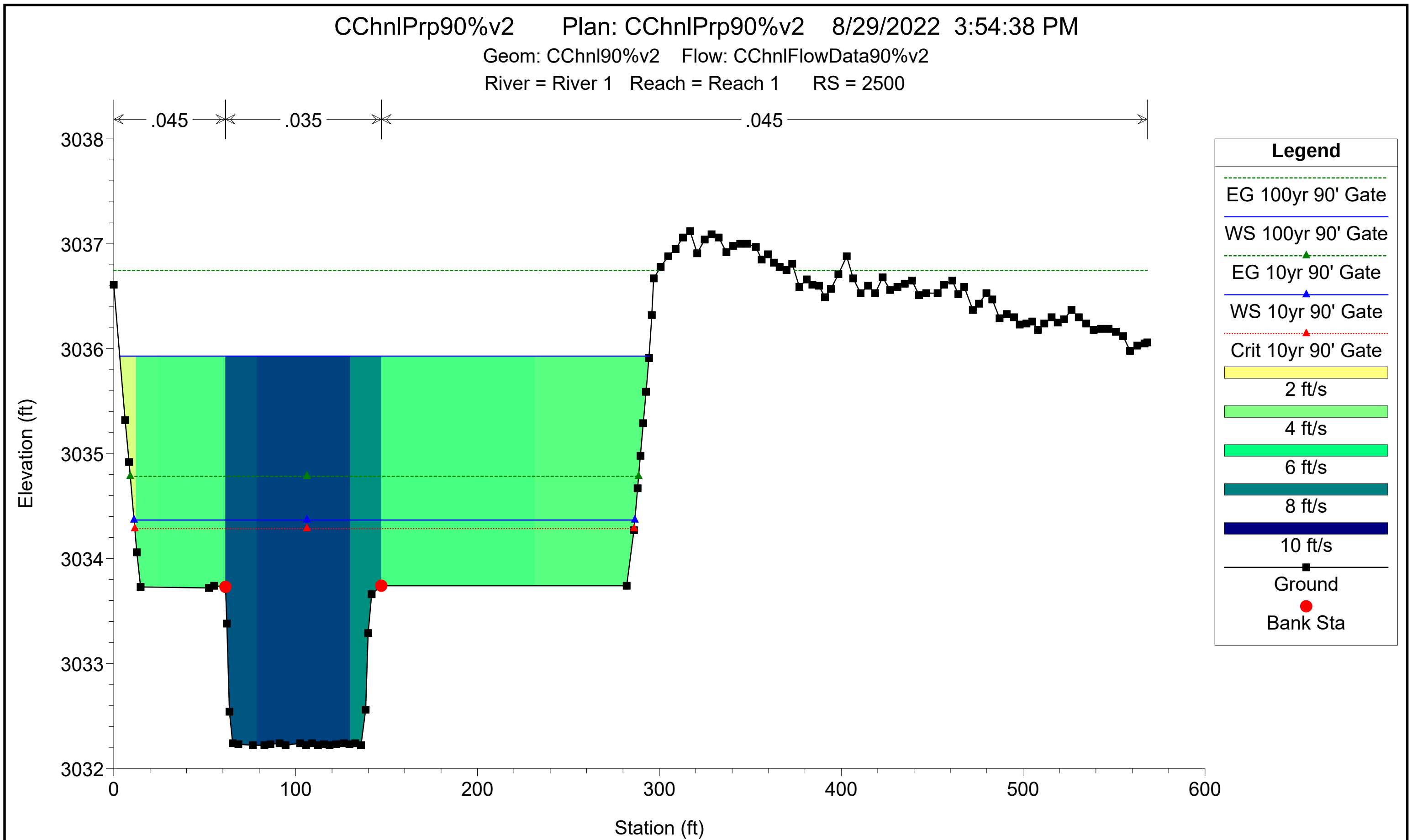
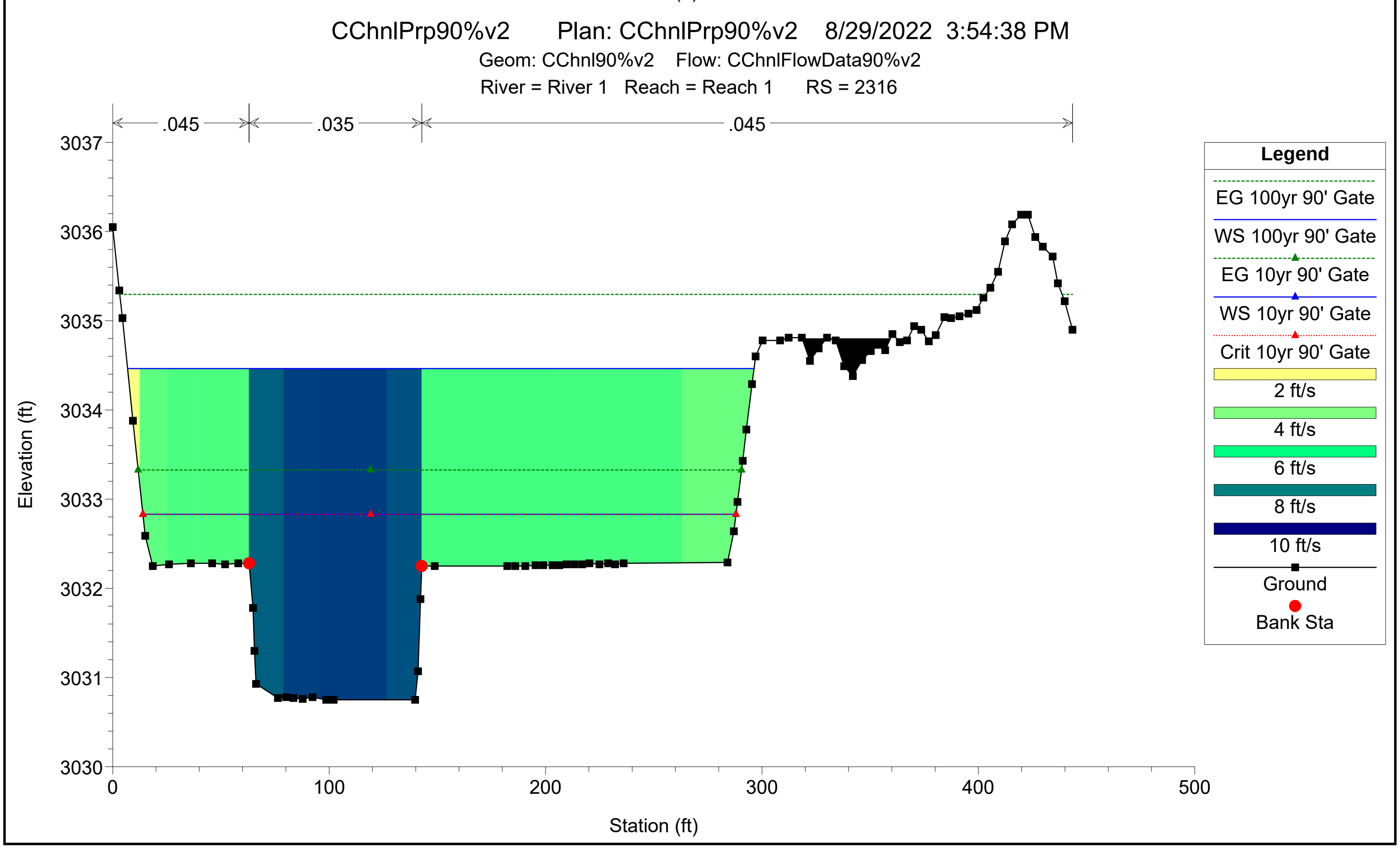
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 3319
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

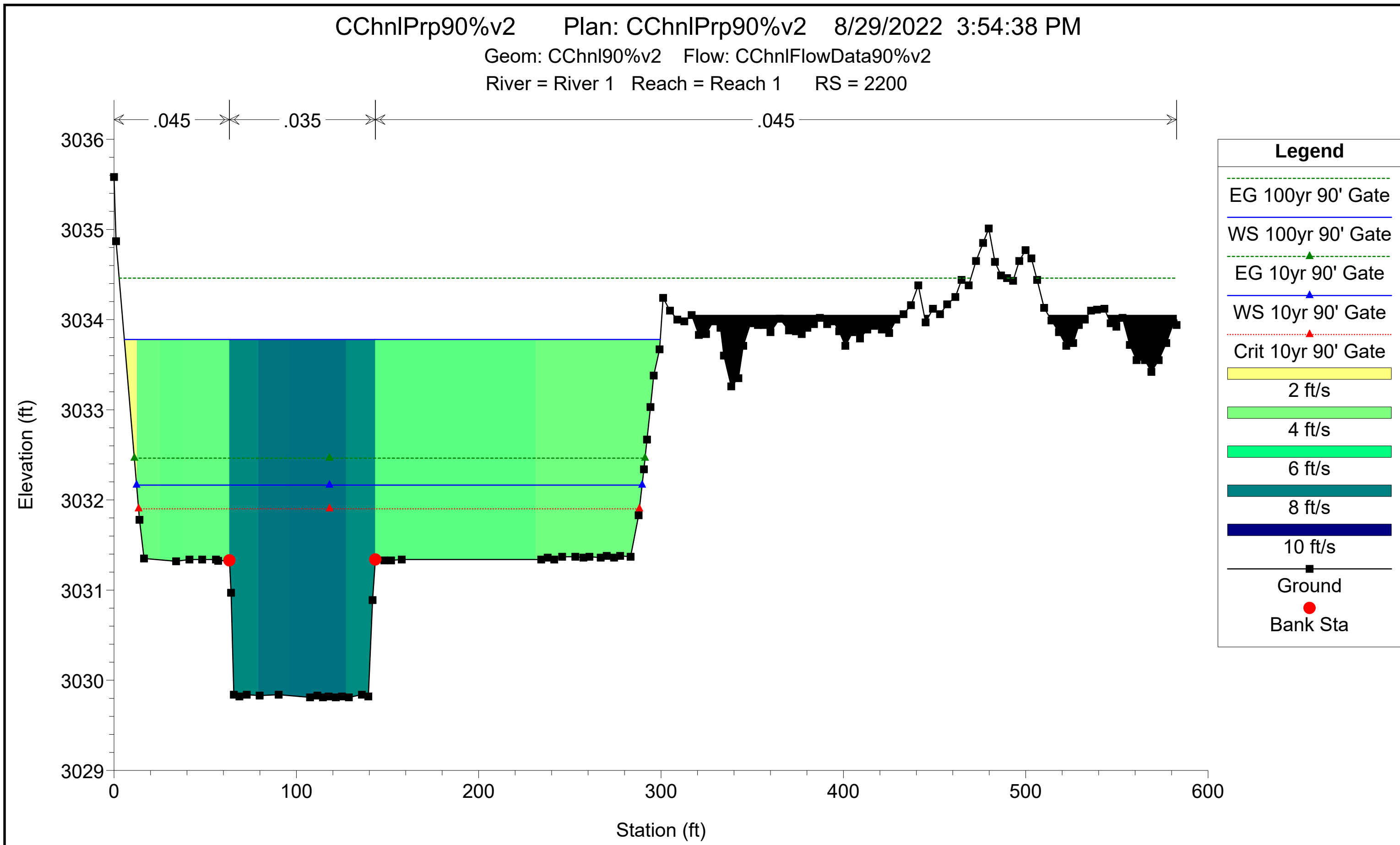

CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 3100
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

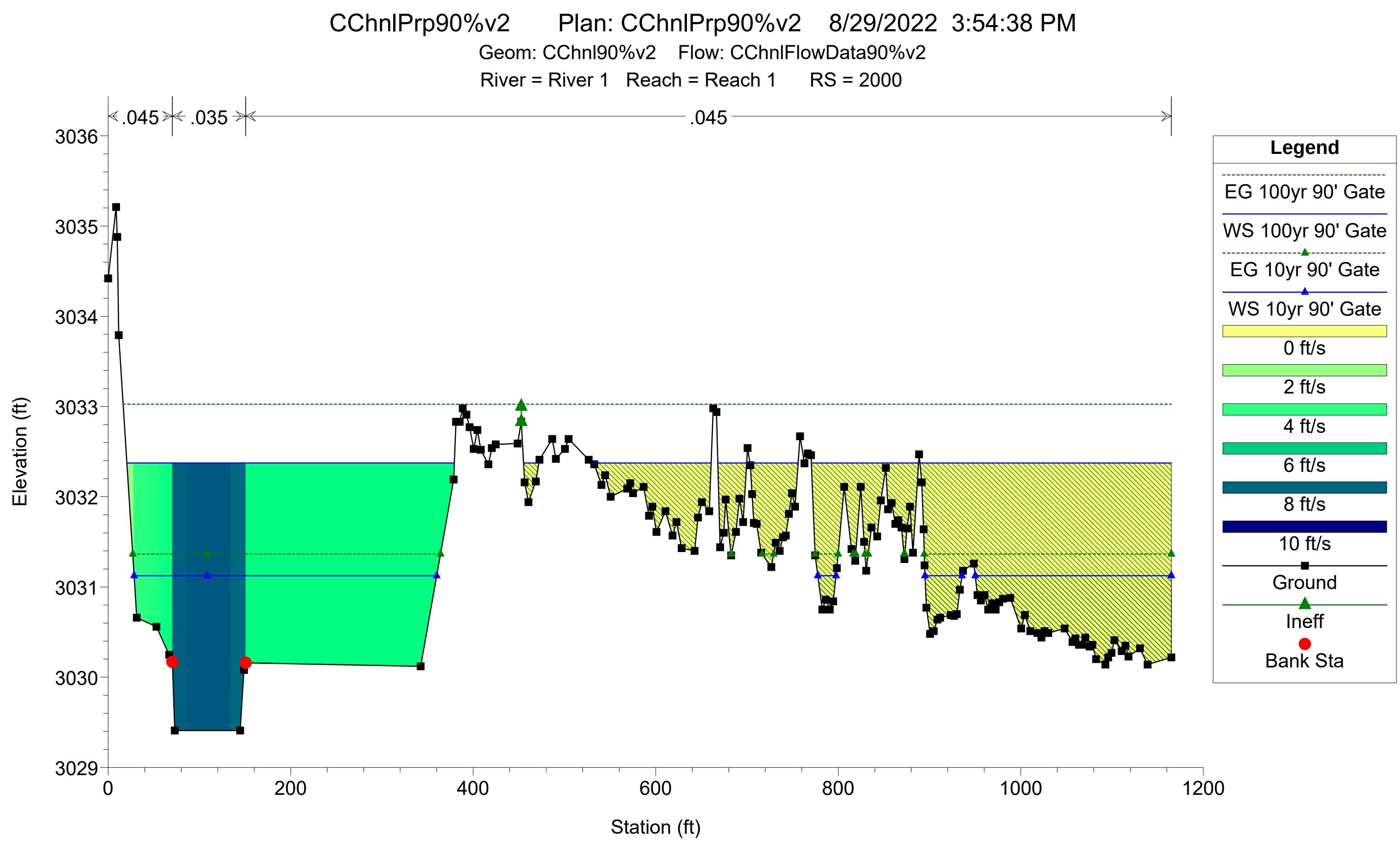

CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 2900
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta

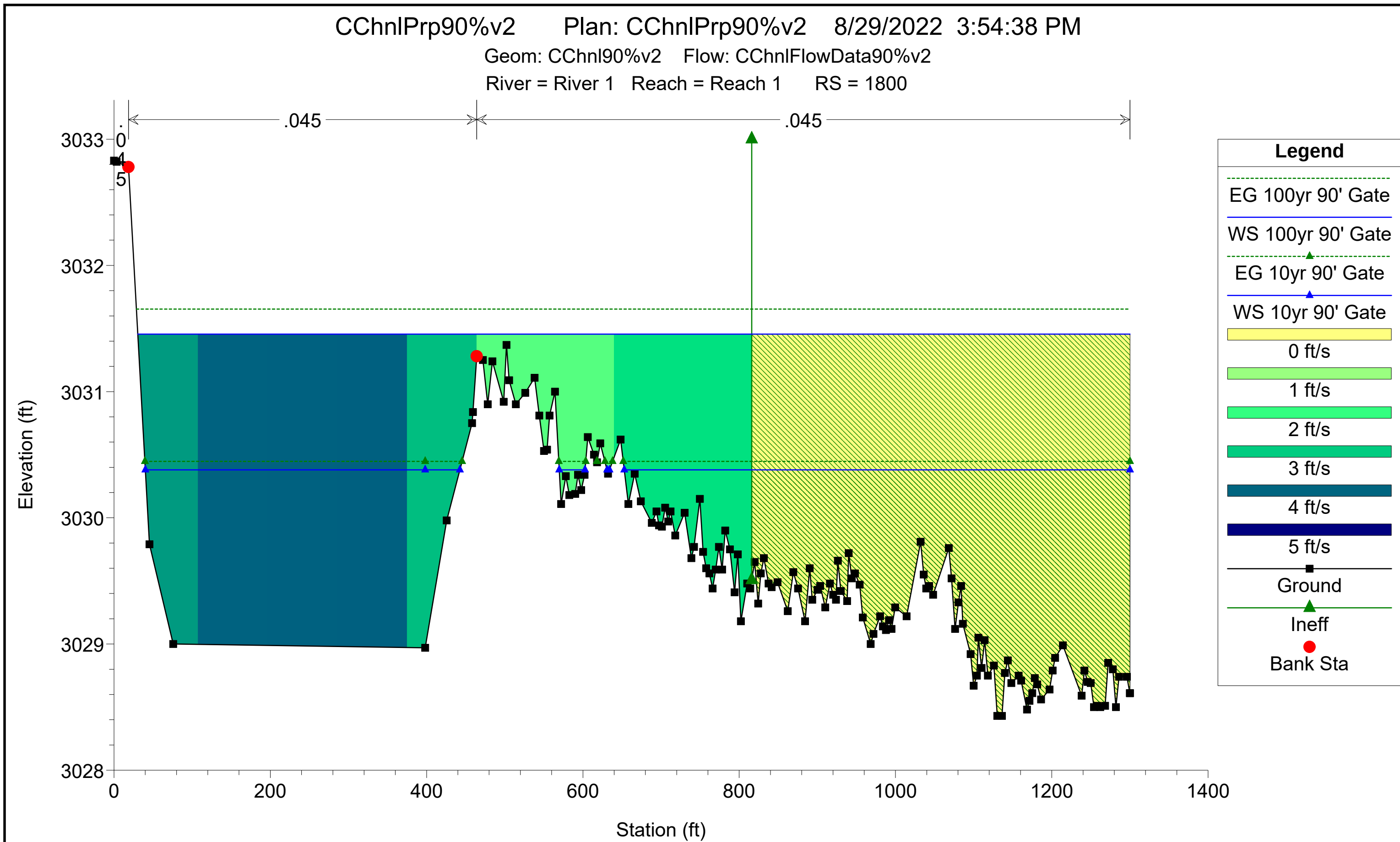

CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 2681
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

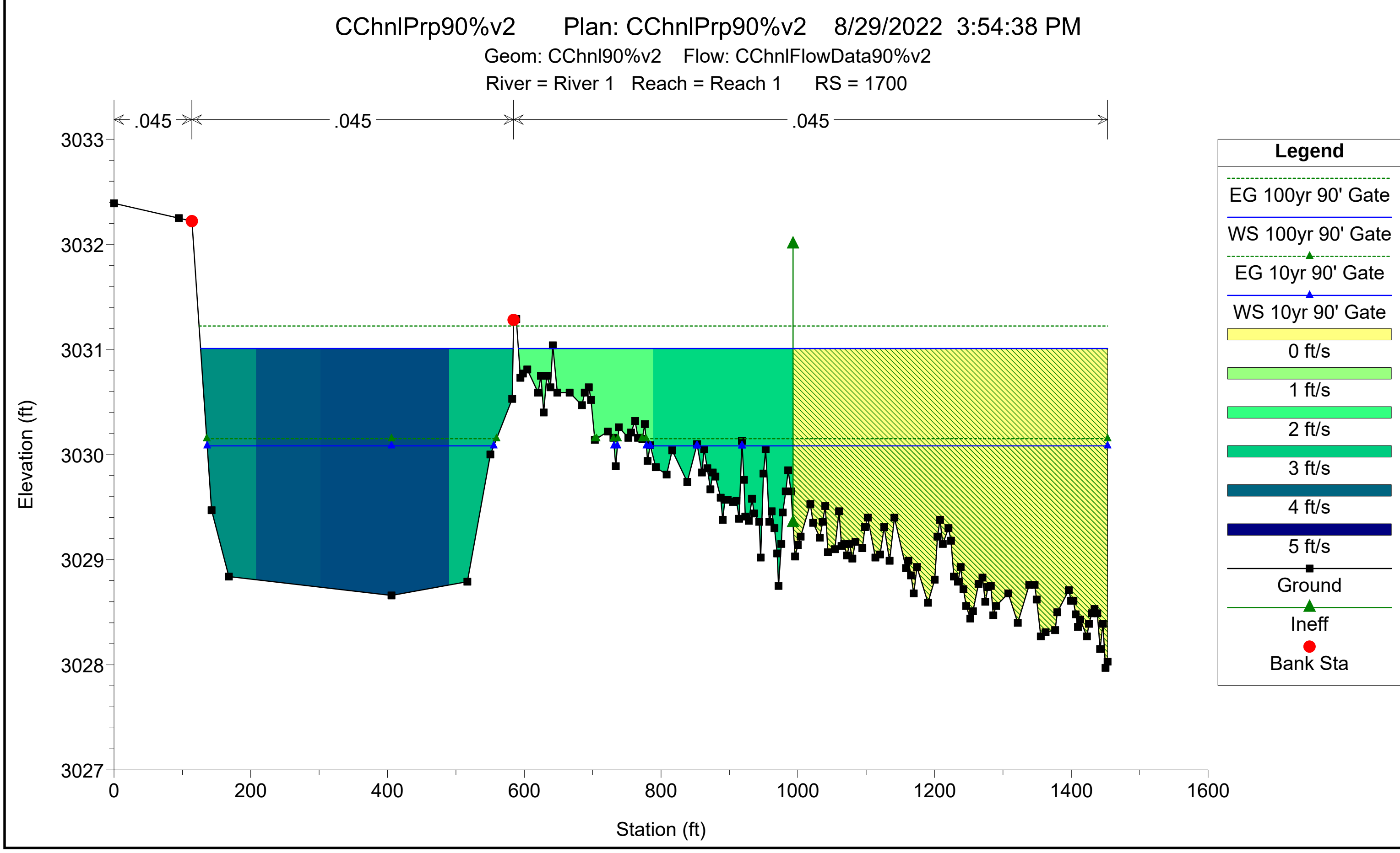

CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 2500
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

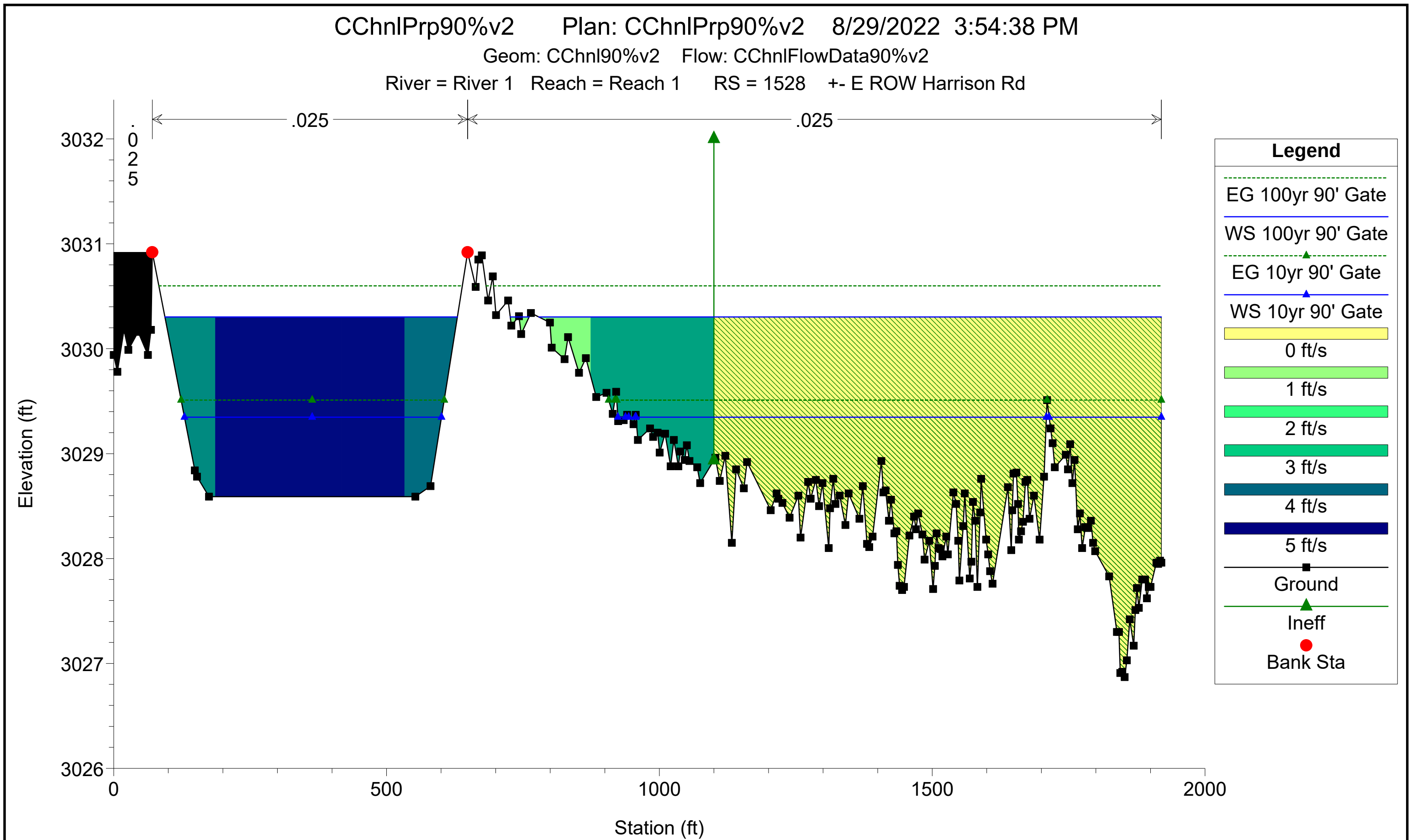

CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 2316
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

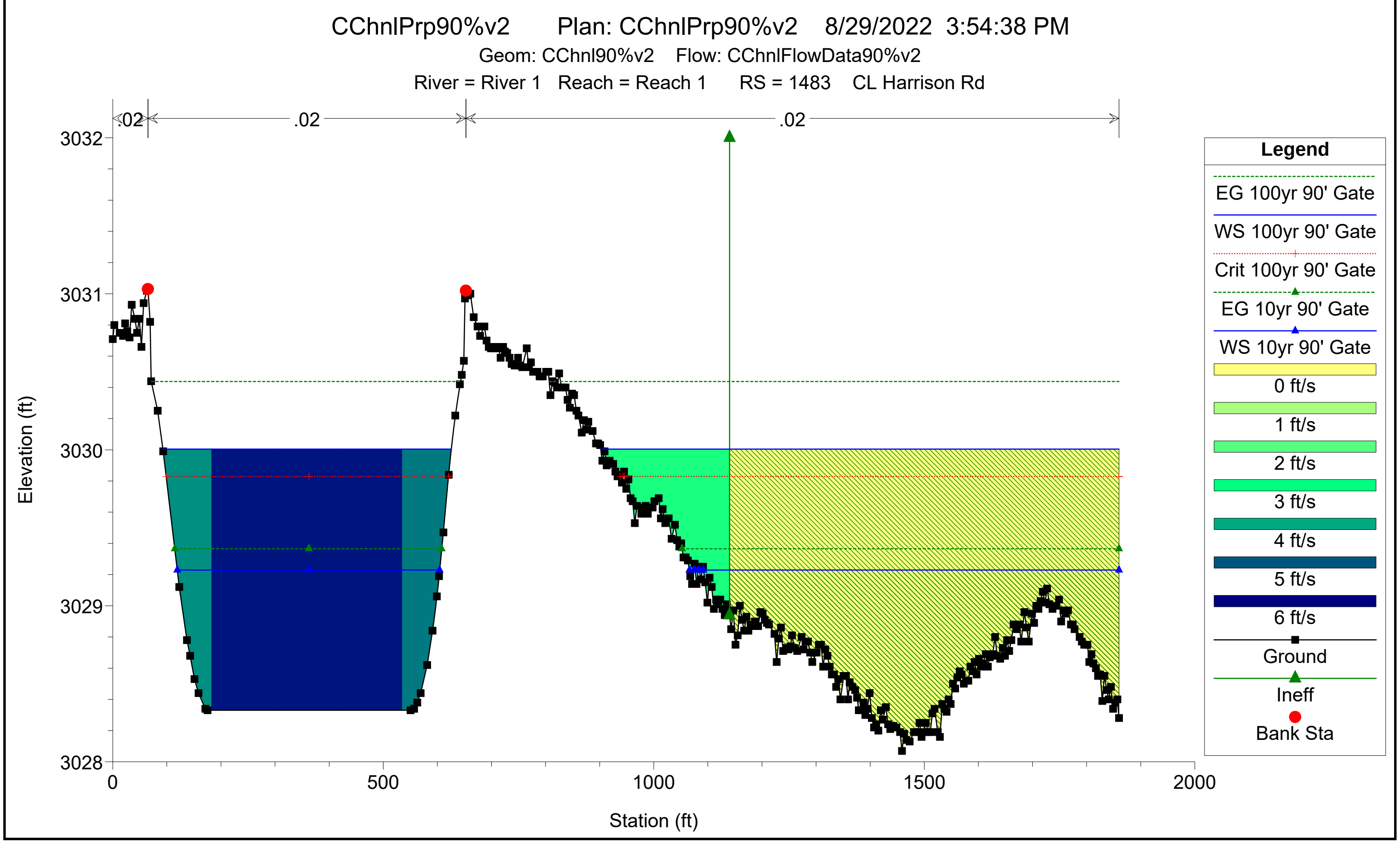

CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 2200
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

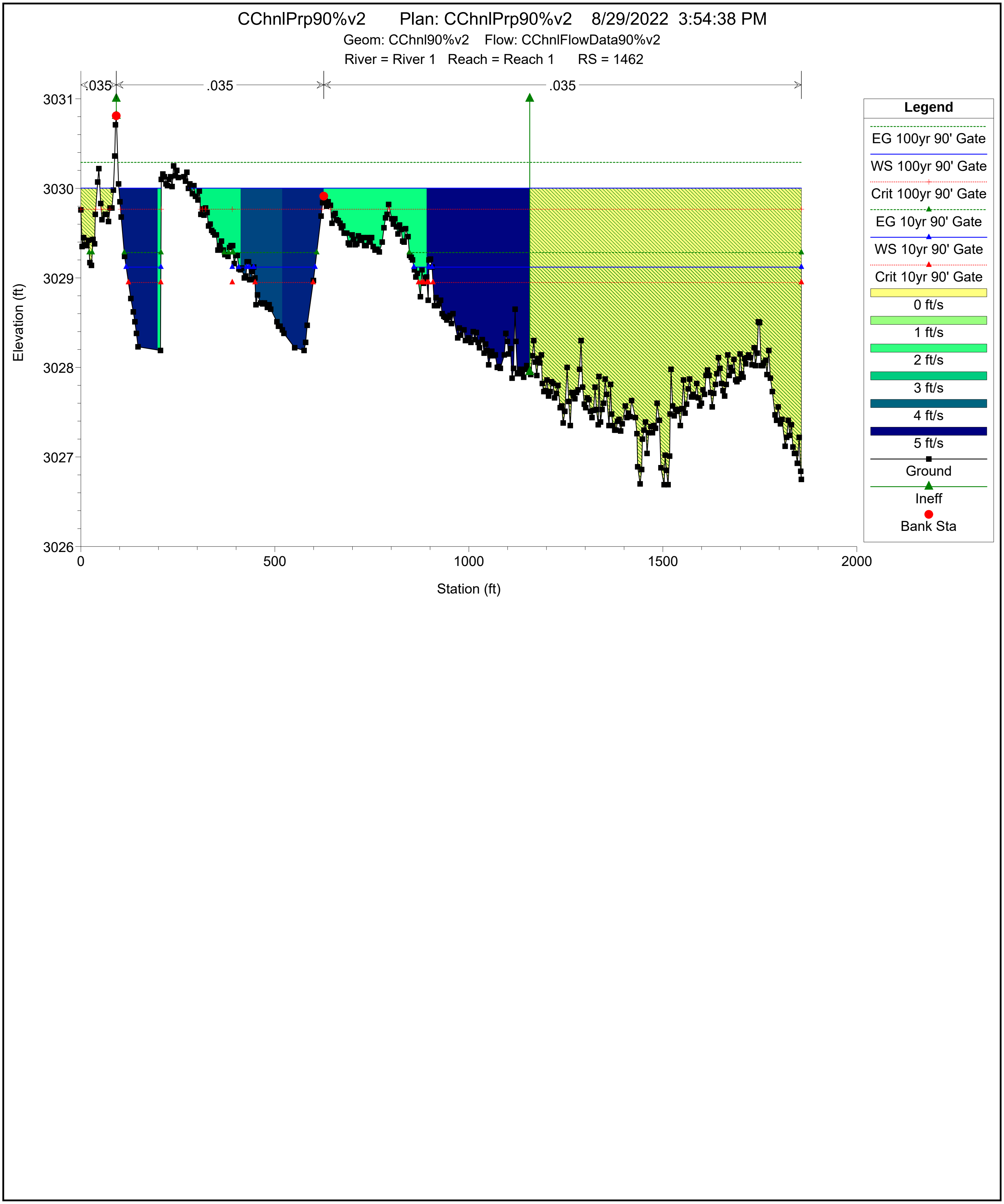

CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 2000
.045
.035
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Ineff
Bank Sta


CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 1800
.045
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
Ground
Ineff
Bank Sta


CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 1700
.045
.045
.045
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
Ground
Ineff
Bank Sta


CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 1528 +- E ROW Harrison Rd
.025
.025
.025
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
Ground
Ineff
Bank Sta


CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 1483 CL Harrison Rd
.02
.02
.02
Elevation (ft)
Station (ft)
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Ineff
Bank Sta



CChnlPrp90%v2 Plan: CChnlPrp90%v2 8/29/2022 3:54:38 PM
Geom: CChnl90%v2 Flow: CChnlFlowData90%v2
River = River 1 Reach = Reach 1 RS = 1462
.035
.035
.035
Legend
EG 100yr 90' Gate
WS 100yr 90' Gate
Crit 100yr 90' Gate
EG 10yr 90' Gate
WS 10yr 90' Gate
Crit 10yr 90' Gate
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
3031
3030
3029
3028
3027
3026
0
500
1000
1500
2000

APPENDIX C

SCOUR COMPUTATIONS

NORTH CHANNEL

CMG DRAINAGE ENGINEERING, INC.

CMG DRAINAGE ENGINEERING, INC.

3555 N. Mountain Ave. Tucson, Arizona 85719
Phone (520) 882-4244 Fax (520) 888-1421

Design Scour Depth C.O.T. EQTN 6.3

Fairgrounds Channels - North Channel Sta 15+65 to 19+00, s=0.20% (RAS Sect 18+00)

Client:	RFCD	Date	9/1/2022
Project #:	20-017.2	By:	jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	2508
Channel Bottom Width, b (ft):	194
Average Velocity, V_m (fps):	5.07
Max Depth of Flow, Y_{max} (ft):	3.10
Hydraulic Depth of Flow, Y_h (ft):	2.38
Energy Slope, S_e (ft/ft):	0.0076
Top Width, T_w (ft):	199
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour	
Bend Angle, α (deg):	0.00
Local Scour due to Pier	
Pier Width (normal to flow), b_p (ft):	
Upstream Froude, F_u:	
Pier Shape	
Pier Shape Reduction Factor	0.0
Local Scour due to Embankments	
Slope Angle of Abutment Face, θ_a (deg):	
Upstream Froude, F_u:	
Upstream Flow Depth, Y_u (ft):	0.00
Encroachment Length, a_e (ft):	
Local Scour below Channel Drops	
Drop Height, h (ft):	0.00
Downstream Depth of Flow, TW (ft):	0.00
Total drop in head, H_T (ft):	0.00

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.35
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	0.00
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	1.76
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

Design Scour Depth (ft):	**3.00**

CMG DRAINAGE ENGINEERING, INC.
3555 N. Mountain Ave. Tucson, Arizona 85719
Phone (520) 882-4244 Fax (520) 888-1421

Design Scour Depth C.O.T. EQTN 6.3
Fairgrounds Channels - North Channel Sta 19+00 to 20+00, s=0.20% (RAS Sect 19+00)

Client: RFCD
Project #: 20-017.2
Date 9/1/2022
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	2038
Channel Bottom Width, b (ft):	70
Average Velocity, V_m (fps):	7.82
Max Depth of Flow, Y_{max} (ft):	3.35
Hydraulic Depth of Flow, Y_h (ft):	3.21
Energy Slope, S_e (ft/ft):	0.0069
Top Width, T_w (ft):	81
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour	
Bend Angle, α (deg):	0.00
Local Scour due to Pier	
Pier Width (normal to flow), b_p (ft):	
Upstream Froude, F_u:	
Pier Shape	
Pier Shape Reduction Factor	0.0
Local Scour due to Embankments	
Slope Angle of Abutment Face, θ_a (deg):	
Upstream Froude, F_u:	
Upstream Flow Depth, Y_u (ft):	0.00
Encroachment Length, a_e (ft):	
Local Scour below Channel Drops	
Drop Height, h (ft):	0.00
Downstream Depth of Flow, TW (ft):	0.00
Total drop in head, H_T (ft):	0.00

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.84
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	0.00
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.39
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

Design Scour Depth (ft):	3.00

CMG DRAINAGE ENGINEERING, INC.

3555 N. Mountain Ave. Tucson, Arizona 85719
Phone (520) 882-4244 Fax (520) 888-1421

Design Scour Depth C.O.T. EQTN 6.3

Fairgrounds Channels - North Channel Sta 20+00 to 31+00, s=0.75% (RAS Sect 25+00)

Client:	RFCD	Date	9/1/2022
Project #:	20-017.2	By:	jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	2053
Channel Bottom Width, b (ft):	70
Average Velocity, V_m (fps):	8.02
Max Depth of Flow, Y_{max} (ft):	3.29
Hydraulic Depth of Flow, Y_h (ft):	3.13
Energy Slope, S_e (ft/ft):	0.0075
Top Width, T_w (ft):	82
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour	
Bend Angle, α (deg):	0.00
Local Scour due to Pier	
Pier Width (normal to flow), b_p (ft):	
Upstream Froude, F_u:	
Pier Shape	
Pier Shape Reduction Factor	0.0
Local Scour due to Embankments	
Slope Angle of Abutment Face, θ_a (deg):	
Upstream Froude, F_u:	
Upstream Flow Depth, Y_u (ft):	0.00
Encroachment Length, a_e (ft):	
Local Scour below Channel Drops	
Drop Height, h (ft):	0.00
Downstream Depth of Flow, TW (ft):	0.00
Total drop in head, H_T (ft):	0.00

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.88
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	0.00
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.45
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

Design Scour Depth (ft):	**3.00**

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Design Scour Depth C.O.T. EQTN 6.3

Fairgrounds Channels - North Channel Sta 31+00 to 41+55, s=0.75% (RAS Sect 35+00)

Client: RFCD
Project #: 20-017.2
Date 9/1/2022
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	1991
Channel Bottom Width, b (ft):	70
Average Velocity, V_m (fps):	7.99
Max Depth of Flow, Y_{max} (ft):	3.21
Hydraulic Depth of Flow, Y_h (ft):	3.05
Energy Slope, S_e (ft/ft):	0.0077
Top Width, T_w (ft):	82
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour	
Bend Angle, α (deg):	0.00
Local Scour due to Pier	
Pier Width (normal to flow), b_p (ft):	
Upstream Froude, F_u:	
Pier Shape	
Pier Shape Reduction Factor	0.0
Local Scour due to Embankments	
Slope Angle of Abutment Face, θ_a (deg):	
Upstream Froude, F_u:	
Upstream Flow Depth, Y_u (ft):	0.00
Encroachment Length, a_e (ft):	
Local Scour below Channel Drops	
Drop Height, h (ft):	0.00
Downstream Depth of Flow, TW (ft):	0.00
Total drop in head, H_T (ft):	0.00

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.87
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	0.00
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.44
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

Design Scour Depth (ft):	**3.00**

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Design Scour Depth C.O.T. EQTN 6.3

Fairgrounds Channels - North Channel Sta 4284 to 4700, s=0.78% (RAS Sect 45+00)

Client: RFCD
Project #: 20-017.2

Date 9/1/2022
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	1957
Channel Bottom Width, b (ft):	75
Average Velocity, V_m (fps):	8.37
Max Depth of Flow, Y_{max} (ft):	2.98
Hydraulic Depth of Flow, Y_h (ft):	2.90
Energy Slope, S_e (ft/ft):	0.0086
Top Width, T_w (ft):	81
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour	
Bend Angle, α (deg):	24.00
Local Scour due to Pier	
Pier Width (normal to flow), b_p (ft):	
Upstream Froude, F_u:	
Pier Shape	
Pier Shape Reduction Factor	0.0
Local Scour due to Embankments	
Slope Angle of Abutment Face, θ_a (deg):	
Upstream Froude, F_u:	
Upstream Flow Depth, Y_u (ft):	0.00
Encroachment Length, a_e (ft):	
Local Scour below Channel Drops	
Drop Height, h (ft):	0.00
Downstream Depth of Flow, TW (ft):	0.00
Total drop in head, H_T (ft):	0.00

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.06
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.96
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.43
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	0.00
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	3.19
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

Design Scour Depth (ft):	**3.19**

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Design Scour Depth C.O.T. EQTN 6.3

Fairgrounds Channels - North Channel Sta 4700 to 4800, s=0.82% (RAS Sect 47+00 Channel)

Client: RFCD
Project #: 20-017.2
Date 9/1/2022
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	1944
Channel Bottom Width, b (ft):	68
Average Velocity, V_m (fps):	8.55
Max Depth of Flow, Y_{max} (ft):	2.98
Hydraulic Depth of Flow, Y_h (ft):	2.76
Energy Slope, S_e (ft/ft):	0.0106
Top Width, T_w (ft):	82
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour	
Bend Angle, α (deg):	0.00
Local Scour due to Pier	
Pier Width (normal to flow), b_p (ft):	
Upstream Froude, F_u:	
Pier Shape	
Pier Shape Reduction Factor	0.0
Local Scour due to Embankments	
Slope Angle of Abutment Face, θ_a (deg):	
Upstream Froude, F_u:	
Upstream Flow Depth, Y_u (ft):	0.00
Encroachment Length, a_e (ft):	
Local Scour below Channel Drops	
Drop Height, h (ft):	0.00
Downstream Depth of Flow, TW (ft):	0.00
Total drop in head, H_T (ft):	0.00

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	1.00
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	0.00
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.60
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

Design Scour Depth (ft):	3.00

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Design Scour Depth C.O.T. EQTN 6.3
Fairgrounds Channels - North Channel Sta 4800 to 6300, s=0.82% (RAS Sect 55+00)

Client: RFCD
Project #: 20-017.2
Date 9/1/2022
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	1606
Channel Bottom Width, b (ft):	50
Average Velocity, V_m (fps):	7.93
Max Depth of Flow, Y_{max} (ft):	3.27
Hydraulic Depth of Flow, Y_h (ft):	3.05
Energy Slope, S_e (ft/ft):	0.0079
Top Width, T_w (ft):	66
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour	
Bend Angle, α (deg):	0.00
Local Scour due to Pier	
Pier Width (normal to flow), b_p (ft):	
Upstream Froude, F_u:	
Pier Shape	
Pier Shape Reduction Factor	0.0
Local Scour due to Embankments	
Slope Angle of Abutment Face, θ_a (deg):	
Upstream Froude, F_u:	
Upstream Flow Depth, Y_u (ft):	0.00
Encroachment Length, a_e (ft):	
Local Scour below Channel Drops	
Drop Height, h (ft):	0.00
Downstream Depth of Flow, TW (ft):	0.00
Total drop in head, H_T (ft):	0.00

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.86
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	0.00
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.42
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

Design Scour Depth (ft):	3.00

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Design Scour Depth C.O.T. EQTN 6.3

Fairgrounds Channels - North Channel Sta 6300 to 6600, s=0.82% (RAS Sect 65+00)

Client: RFCD
Project #: 20-017.2
Date: 9/1/2022
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	1847
Channel Bottom Width, b (ft):	240
Average Velocity, V_m (fps):	4.08
Max Depth of Flow, Y_{max} (ft):	3.55
Hydraulic Depth of Flow, Y_h (ft):	2.85
Energy Slope, S_e (ft/ft):	0.0030
Top Width, T_w (ft):	159
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour	
Bend Angle, α (deg):	30.00
Local Scour due to Pier	
Pier Width (normal to flow), b_p (ft):	
Upstream Froude, F_u:	
Pier Shape	
Pier Shape Reduction Factor	0.0
Local Scour due to Embankments	
Slope Angle of Abutment Face, θ_a (deg):	
Upstream Froude, F_u:	
Upstream Flow Depth, Y_u (ft):	0.00
Encroachment Length, a_e (ft):	
Local Scour below Channel Drops	
Drop Height, h (ft):	0.00
Downstream Depth of Flow, TW (ft):	0.00
Total drop in head, H_T (ft):	0.00

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.23
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.73
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	0.00
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.54
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

Design Scour Depth (ft):	**3.00**

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Design Scour Depth C.O.T. EQTN 6.3
Fairgrounds Channels - North Channel Sta 15+03 (RAS XS 15+16)

Client: Pima Co RFCD
Project #: 20-017.2
Date 12/30/2022
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	2508
Channel Bottom Width, b (ft):	265
Average Velocity, V_m (fps):	6.17
Max Depth of Flow, Y_{max} (ft):	1.31
Hydraulic Depth of Flow, Y_h (ft):	1.17
Energy Slope, S_e (ft/ft):	0.0056
Top Width, T_w (ft):	349
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour	
Bend Angle, α (deg):	0.00
Local Scour due to Pier	
Pier Width (normal to flow), b_p (ft):	
Upstream Froude, F_u:	
Pier Shape	
Pier Shape Reduction Factor	0.0
Local Scour due to Embankments	
Slope Angle of Abutment Face, θ_a (deg):	
Upstream Froude, F_u:	
Upstream Flow Depth, Y_u (ft):	0.00
Encroachment Length, a_e (ft):	
Local Scour below Channel Drops	
Drop Height, h (ft):	2.3
Downstream Depth of Flow, TW (ft):	2.6
Total drop in head, H_T (ft):	1.5

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.40
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.52
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	3.23
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.50
Long Term Agg/Deg (ft) [Eq 6.26] :	2.32

Design Scour Depth (ft):	**5.55**

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Design Scour Depth C.O.T. EQTN 6.3

Fairgrounds Channels - North Channel - Main Channel Sta 31+00, s=0.75%

Client: RFCD
Project #: 20-017.2

Date 12/30/2022
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	2051
Channel Bottom Width, b (ft):	70
Average Velocity, V_m (fps):	8.02
Max Depth of Flow, Y_{max} (ft):	3.29
Hydraulic Depth of Flow, Y_h (ft):	3.14
Energy Slope, S_e (ft/ft):	0.0075
Top Width, T_w (ft):	81
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Local Scour below Channel Drops	
Drop Height, h (ft):	1.7
Downstream Depth of Flow, TW (ft):	4.5
Total drop in head, H_T (ft):	1.3

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.88
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	3.92
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.45
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

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Design Scour Depth C.O.T. EQTN 6.3

Fairgrounds Channels - North Channel-Main Channel-Sta 40+75, s=0.75%

Client: RFCD
Project #: 20-017.2
Date 12/30/2022
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	2259
Channel Bottom Width, b (ft):	65
Average Velocity, V_m (fps):	16.40
Max Depth of Flow, Y_{max} (ft):	1.93
Hydraulic Depth of Flow, Y_h (ft):	1.80
Energy Slope, S_e (ft/ft):	0.0653
Top Width, T_w (ft):	77
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Local Scour below Channel Drops	
Drop Height, h (ft):	1.5
Downstream Depth of Flow, TW (ft):	4.8
Total drop in head, H_T (ft):	2.1

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.29
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.97
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	4.01
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.93
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

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Design Scour Depth C.O.T. EQTN 6.3
Fairgrounds Channels - North Channel Left Overbank Sta 41+43, s=0.75%

Client: RFCD
Project #: 20-017.2

Date: 12/30/2022
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	870
Channel Bottom Width, b (ft):	80
Average Velocity, V_m (fps):	13.60
Max Depth of Flow, Y_{max} (ft):	0.81
Hydraulic Depth of Flow, Y_h (ft):	0.75
Energy Slope, S_e (ft/ft):	0.0174
Top Width, T_w (ft):	84
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Local Scour below Channel Drops	
Drop Height, h (ft):	3.0
Downstream Depth of Flow, TW (ft):	2.3
Total drop in head, H_T (ft):	3.7

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.88
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.41
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	4.13
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.98
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

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Design Scour Depth C.O.T. EQTN 6.3
Fairgrounds Channels - North Channel Sta 47+00 s=0.78%

Client: RFCD
Project #: 20-017.2

Date 12/30/2022
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	1944
Channel Bottom Width, b (ft):	70
Average Velocity, V_m (fps):	8.55
Max Depth of Flow, Y_{max} (ft):	2.98
Hydraulic Depth of Flow, Y_h (ft):	2.76
Energy Slope, S_e (ft/ft):	0.0106
Top Width, T_w (ft):	82
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Local Scour below Channel Drops	
Drop Height, h (ft):	0.75
Downstream Depth of Flow, TW (ft):	3.70
Total drop in head, H_T (ft):	1.10

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	1.00
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	2.84
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.60
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

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Design Scour Depth C.O.T. EQTN 6.3
Fairgrounds Channels - North Channel Sta 54+00, s=0.82%

Client: RFCD
Project #: 20-017.2

Date 12/30/2022
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	1621
Channel Bottom Width, b (ft):	50
Average Velocity, V_m (fps):	8.14
Max Depth of Flow, Y_{max} (ft):	3.22
Hydraulic Depth of Flow, Y_h (ft):	3.02
Energy Slope, S_e (ft/ft):	0.0085
Top Width, T_w (ft):	66
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Local Scour below Channel Drops	
Drop Height, h (ft):	1.54
Downstream Depth of Flow, TW (ft):	4.60
Total drop in head, H_T (ft):	0.4

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.91
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	3.96
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.48
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

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Design Scour Depth C.O.T. EQTN 6.3
Fairgrounds Channels - North Channel Sta 61+00, s=0.82%

Client:	RFCD	Date	12/30/2022
Project #:	20-017.2	By:	jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	1616
Channel Bottom Width, b (ft):	50
Average Velocity, V_m (fps):	8.11
Max Depth of Flow, Y_{max} (ft):	3.23
Hydraulic Depth of Flow, Y_h (ft):	3.04
Energy Slope, S_e (ft/ft):	0.0083
Top Width, T_w (ft):	66
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Local Scour below Channel Drops	
Drop Height, h (ft):	1.50
Downstream Depth of Flow, TW (ft):	4.60
Total drop in head, H_T (ft):	0.4

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.90
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	3.90
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.47
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

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Design Scour Depth C.O.T. EQTN 6.3
Fairgrounds Channels - North Channel Sta 66+39, s=25.0%

Client:	RFCD	Date	12/30/2022
Project #:	20-017.2	By:	jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	2416
Channel Bottom Width, b (ft):	400
Average Velocity, V_m (fps):	9.18
Max Depth of Flow, Y_{max} (ft):	0.78
Hydraulic Depth of Flow, Y_h (ft):	0.42
Energy Slope, S_e (ft/ft):	0.2500
Top Width, T_w (ft):	635
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Local Scour below Channel Drops	
Drop Height, h (ft):	8.6
Downstream Depth of Flow, TW (ft):	2.6
Total drop in head, H_T (ft):	7.9

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.39
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	2.95
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	1.80
Long Term Agg/Deg (ft) [Eq 6.26] :	1.19

Design Scour Depth	2.95

CMG DRAINAGE ENGINEERING, INC.
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HEC-14 Straight Drop Spillways

Fairgrounds Channels - North Channel 90% Design

Client: RFCD
Project #: 20-017.2

Date 12/30/2022
By: jlc

FHWA HEC-14 CHAPTER 11: DROP STRUCTURES - STRAIGHT DROP SPILLWAYS

Q_{total} = Total design discharge in channel
W = Width of drop

Eq. 11.1 $N_d = (q^2) / g\,(h_o^3)$
N_d = Drop Number
q = Unit Discharge (cfs/ft)
g = Acceleration due to gravity, (32.2 ft/s^2)
h_o = Drop Height (ft)

Eq. 11.3a $L_1 = 4.30\,(h_o)\,(N_d^{0.27})$
11.3b $y_1 = 1.0\,(h_o)\,(N_d^{0.22})$
11.3c $y_2 = 0.54\,(h_o)\,(N_d^{0.425})$
11.3d $y_3 = 1.66\,(h_o)\,(N_d^{0.27})$

L_1 = Drop length (distance from drop wall to depth y_2) (ft)
y_1 = Pool depth under the nappe (ft)
y_2 = Depth of flow at the toe of the nappe or beginning of the hydraulic jump (ft)
y_3 = Tailwater depth sequent to y_2 (ft)

Station	Q_{total} (cfs)	W (ft)	q (cfs/ft)	h_o (ft)	N_d	L_1 (ft)	y_1 (ft)	y_2 (ft)	y_3 (ft)
15+03	2508	265	9	2.3	0.2	6.7	1.7	0.7	2.6
31+00	2051	70	29	1.7	5.4	11.5	2.5	1.9	4.5
40+75	2259	65	35	1.5	11.1	12.4	2.5	2.3	4.8
41+43 Lt	870	80	11	0.8	7	5.9	1.2	1.0	2.3
47+00	1944	70	28	0.8	57	9.6	1.8	2.3	3.7
54+00	1621	50	32	1.5	9	12.0	2.5	2.1	4.6
61+00	1616	50	32	1.5	9	11.9	2.5	2.1	4.6
66+39	2416	400	6	8.6	0.0	6.7	2.1	0.3	2.6

CENTRAL CHANNEL

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Design Scour Depth C.O.T. EQTN 6.3

Fairgrounds Channels - Central Channel Sta 15+28 to 22+00, s=0.21% (RAS Sect 20+00)

Client: RFCD
Project #: 20-017.2

Date 1/1/2023
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	4660
Channel Bottom Width, b (ft):	75
Average Velocity, V_m (fps):	8.17
Max Depth of Flow, Y_{max} (ft):	2.96
Hydraulic Depth of Flow, Y_h (ft):	2.92
Energy Slope, S_e (ft/ft):	0.0089
Top Width, T_w (ft):	80
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour	
Bend Angle, α (deg):	0.00
Local Scour due to Pier	
Pier Width (normal to flow), b_p (ft):	
Upstream Froude, F_u:	
Pier Shape	
Pier Shape Reduction Factor	0.0
Local Scour due to Embankments	
Slope Angle of Abutment Face, θ_a (deg):	
Upstream Froude, F_u:	
Upstream Flow Depth, Y_u (ft):	0.00
Encroachment Length, a_e (ft):	
Local Scour below Channel Drops	
Drop Height, h (ft):	0.00
Downstream Depth of Flow, TW (ft):	0.00
Total drop in head, H_T (ft):	0.00

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.91
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	0.00
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.49
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

Design Scour Depth (ft):	3.00

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Design Scour Depth C.O.T. EQTN 6.3

Fairgrounds Channels - Central Channel Sta 22+00 to 26+81 Rt OB, s=0.80% (RAS Sect 25+00)

Client:	RFCD	Date	1/1/2023
Project #:	20-017.2	By:	jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	1487
Channel Bottom Width, b (ft):	137
Average Velocity, V_m (fps):	4.80
Max Depth of Flow, Y_{max} (ft):	3.71
Hydraulic Depth of Flow, Y_h (ft):	3.54
Energy Slope, S_e (ft/ft):	0.0079
Top Width, T_w (ft):	147
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour	
Bend Angle, α (deg):	20.00
Local Scour due to Pier	
Pier Width (normal to flow), b_p (ft):	
Upstream Froude, F_u:	
Pier Shape	
Pier Shape Reduction Factor	0.0
Local Scour due to Embankments	
Slope Angle of Abutment Face, θ_a (deg):	
Upstream Froude, F_u:	
Upstream Flow Depth, Y_u (ft):	0.00
Encroachment Length, a_e (ft):	
Local Scour below Channel Drops	
Drop Height, h (ft):	0.00
Downstream Depth of Flow, TW (ft):	0.00
Total drop in head, H_T (ft):	0.00

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.32
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.13
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	0.00
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	1.88
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

Design Scour Depth (ft):	**2.00**

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Design Scour Depth C.O.T. EQTN 6.3
Fairgrounds Channels - Central Channel Sta 44+36, s=0.80%

Client: RFCD
Project #: 20-017.2
Date 1/1/2023
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	3235
Channel Bottom Width, b (ft):	75
Average Velocity, V_m (fps):	9.66
Max Depth of Flow, Y_{max} (ft):	2.66
Hydraulic Depth of Flow, Y_h (ft):	2.06
Energy Slope, S_e (ft/ft):	0.0194
Top Width, T_w (ft):	160
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour	
Bend Angle, α (deg):	0.00
Local Scour due to Pier	
Pier Width (normal to flow), b_p (ft):	
Upstream Froude, F_u:	
Pier Shape	
Pier Shape Reduction Factor	0.0
Local Scour due to Embankments	
Slope Angle of Abutment Face, θ_a (deg):	
Upstream Froude, F_u:	
Upstream Flow Depth, Y_u (ft):	0.00
Encroachment Length, a_e (ft):	
Local Scour below Channel Drops	
Drop Height, h (ft):	0.00
Downstream Depth of Flow, TW (ft):	0.00
Total drop in head, H_T (ft):	0.00

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.07
Anti-dune Trough Depth, Z_a (ft) [6.5] :	1.28
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	0.00
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	3.06
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

Design Scour Depth (ft):	3.06

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Design Scour Depth C.O.T. EQTN 6.3

Fairgrounds Channels - Central Channel Sta 44+83, s=0.80%

Client:	RFCD	Date	1/1/2023
Project #:	20-017.2	By:	jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	3057
Channel Bottom Width, b (ft):	75
Average Velocity, V_m (fps):	7.10
Max Depth of Flow, Y_{max} (ft):	3.23
Hydraulic Depth of Flow, Y_h (ft):	2.65
Energy Slope, S_e (ft/ft):	0.0076
Top Width, T_w (ft):	163
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour	
Bend Angle, α (deg):	0.00
Local Scour due to Pier	
Pier Width (normal to flow), b_p (ft):	
Upstream Froude, F_u:	
Pier Shape	
Pier Shape Reduction Factor	0.0
Local Scour due to Embankments	
Slope Angle of Abutment Face, θ_a (deg):	
Upstream Froude, F_u:	
Upstream Flow Depth, Y_u (ft):	0.00
Encroachment Length, a_e (ft):	
Local Scour below Channel Drops	
Drop Height, h (ft):	0.00
Downstream Depth of Flow, TW (ft):	0.00
Total drop in head, H_T (ft):	0.00

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.69
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	0.00
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.20
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

Design Scour Depth (ft):	3.00

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Design Scour Depth C.O.T. EQTN 6.3
Fairgrounds Channels - Central Channel Sta 56+68, s=0.61%

Client: RFCD
Project #: 20-017.2
Date 1/1/2023
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	2778
Channel Bottom Width, b (ft):	50
Average Velocity, V_m (fps):	8.24
Max Depth of Flow, Y_{max} (ft):	3.46
Hydraulic Depth of Flow, Y_h (ft):	3.02
Energy Slope, S_e (ft/ft):	0.0086
Top Width, T_w (ft):	112
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour	
Bend Angle, α (deg):	0.00
Local Scour due to Pier	
Pier Width (normal to flow), b_p (ft):	
Upstream Froude, F_u:	
Pier Shape	
Pier Shape Reduction Factor	0.0
Local Scour due to Embankments	
Slope Angle of Abutment Face, θ_a (deg):	
Upstream Froude, F_u:	
Upstream Flow Depth, Y_u (ft):	0.00
Encroachment Length, a_e (ft):	
Local Scour below Channel Drops	
Drop Height, h (ft):	0.00
Downstream Depth of Flow, TW (ft):	0.00
Total drop in head, H_T (ft):	0.00

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.93
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	0.00
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.51
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

Design Scour Depth (ft):	**3.00**

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Design Scour Depth C.O.T. EQTN 6.3

Fairgrounds Channels - Central Channel Rt Overbank Sta 43+45, s=0.80%

Client: RFCD
Project #: 20-017.2

Date 1/1/2023
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	723
Channel Bottom Width, b (ft):	136
Average Velocity, V_m (fps):	5.76
Max Depth of Flow, Y_{max} (ft):	0.90
Hydraulic Depth of Flow, Y_h (ft):	0.88
Energy Slope, S_e (ft/ft):	0.0353
Top Width, T_w (ft):	140
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Local Scour below Channel Drops	
Drop Height, h (ft):	4.30
Downstream Depth of Flow, TW (ft):	2.10
Total drop in head, H_T (ft):	3.50

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.45
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	2.21
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	1.89
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

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Design Scour Depth C.O.T. EQTN 6.3

Fairgrounds Channels - Central Channel Sta 43+53 Low Flow Chnl, s=0.80%

Client: RFCD
Project #: 20-017.2

Date 1/1/2023
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	2898
Channel Bottom Width, b (ft):	75
Average Velocity, V_m (fps):	13.63
Max Depth of Flow, Y_{max} (ft):	2.42
Hydraulic Depth of Flow, Y_h (ft):	2.24
Energy Slope, S_e (ft/ft):	0.0353
Top Width, T_w (ft):	95
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Local Scour below Channel Drops	
Drop Height, h (ft):	4.30
Downstream Depth of Flow, TW (ft):	6.20
Total drop in head, H_T (ft):	1.90

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.23
Anti-dune Trough Depth, Z_a (ft) [6.5] :	1.21
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	6.58
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	3.17
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

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Design Scour Depth C.O.T. EQTN 6.3
Fairgrounds Channels - Central Channel Sta 56+42, s=0.80%

Client: RFCD
Project #: 20-017.2
Date 1/1/2023
By: jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	2833
Channel Bottom Width, b (ft):	188
Average Velocity, V_m (fps):	8.86
Max Depth of Flow, Y_{max} (ft):	3.29
Hydraulic Depth of Flow, Y_h (ft):	2.85
Energy Slope, S_e (ft/ft):	0.0108
Top Width, T_w (ft):	112
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	1.00
Local Scour below Channel Drops	
Drop Height, h (ft):	2.30
Downstream Depth of Flow, TW (ft):	3.30
Total drop in head, H_T (ft):	0.30

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.01
Anti-dune Trough Depth, Z_a (ft) [6.5] :	1.08
Low Flow Thalweg Depth, Z_{lft} (ft):	1.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	3.52
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	2.72
Long Term Agg/Deg (ft) [Eq 6.26] :	0.00

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Phone (520) 882-4244 Fax (520) 888-1421

Design Scour Depth C.O.T. EQTN 6.3

Fairgrounds Channels - Central Channel Sta 63+21, s=25.0%

Client:	RFCD	Date	1/1/2023
Project #:	20-017.2	By:	jlc

INPUTS	
General Scour	
Factor of Safety:	1.3
Discharge, Q (cfs):	3016
Channel Bottom Width, b (ft):	400
Average Velocity, V_m (fps):	10.28
Max Depth of Flow, Y_{max} (ft):	1.07
Hydraulic Depth of Flow, Y_h (ft):	0.49
Energy Slope, S_e (ft/ft):	0.2500
Top Width, T_w (ft):	598
Long Term Factor of Safety (not reqd):	1.0
Low-Flow Thalweg	
Thalweg Depth Required?:	Yes
Thalweg Depth, Z_{lft} (ft):	0.00
Local Scour below Channel Drops	
Drop Height, h (ft):	6.2
Downstream Depth of Flow, TW (ft):	2.7
Total drop in head, H_T (ft):	6.0

Results	
General Scour	
General Scour, Z_{gs} (ft) [Eq. 6.4] :	0.00
Anti-dune Trough Depth, Z_a (ft) [6.5] :	0.53
Low Flow Thalweg Depth, Z_{lft} (ft):	0.00
Bend Scour, Z_{bs} (ft) [Eq. 6.6] :	0.00
local scour:	
Pier Scour Depth, Z_{lsp} (ft) [Eq 6.9] :	0.00
Encroachment Scour Depth, Z_{lse} (ft) [Eq 6.12] :	0.00
Vertical Drop Scour Depth, Z_{lss} (ft) [Eq. 6.14] :	3.18
Calculated Scour Depth, Z_t (ft) [Eq 6.3] :	0.69
Long Term Agg/Deg (ft) [Eq 6.26] :	1.19

Design Scour Depth	3.87

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HEC-14 Straight Drop Spillways

Fairgrounds Channels - Central Channel 90% Design

Client: RFCD
Project #: 20-017.2

Date 1/1/2023
By: jlc

FHWA HEC-14 CHAPTER 11: DROP STRUCTURES - STRAIGHT DROP SPILLWAYS

Q_{total} = Total design discharge in channel
W = Width of drop

Eq. 11.1 $N_d = (q^2) / g\ (h_o^3)$
N_d = Drop Number
q = Unit Discharge (cfs/ft)
g = Acceleration due to gravity, (32.2 ft/s^2)
h_o = Drop Height (ft)

Eq. 11.3a $L_1 = 4.30\ (h_o)\ (N_d^{0.27})$
11.3b $y_1 = 1.0\ (h_o)\ (N_d^{0.22})$
11.3c $y_2 = 0.54\ (h_o)\ (N_d^{0.425})$
11.3d $y_3 = 1.66\ (h_o)\ (N_d^{0.27})$

L_1 = Drop length (distance from drop wall to depth y_2) (ft)
y_1 = Pool depth under the nappe (ft)
y_2 = Depth of flow at the toe of the nappe or beginning of the hydraulic jump (ft)
y_3 = Tailwater depth sequent to y_2 (ft)

Station	Q_{total} (cfs)	W (ft)	q (cfs/ft)	h_o (ft)	N_d	L_1 (ft)	y_1 (ft)	y_2 (ft)	y_3 (ft)
43+45	2898	75	39	4.3	1	16.0	3.8	1.8	6.2
43+45 Rt OB	723	136	5	4.3	0	5.5	1.6	0.3	2.1
56+42	2833	188	15	2.3	1	8.5	2.0	1.0	3.3
63+21	3016	400	8	6.2	0	7.1	2.1	0.4	2.7

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Scour Hole Geometry at Culvert Outlets - C.O.T. EQTN 6.17

Fairgrounds Channels - Central Channel Sta 43+53 at Bottom of Chnl Drop

Client: RFCD **Date** 1/1/2023
Project #: 20-017.2 **By:** jlc

$$DSG = \alpha\left(\frac{Q_r}{\sqrt{g}\,D^{5/2}}\right)^{\beta}(0.09)^{\theta}$$

$$DSG = Z_{lsc}/D,\ W_{sc}/D,\ L_{sc}/D,\ V_{sc}/D$$

DSG = dimensionless scour geometry
Z_{lsc} = depth of scour hole below culvert (ft)
W_{sc} = width of scour hole below culvert (ft)
L_{sc} = length of scour hole below culvert (ft)
V_{sc} = volume of scour hole below culvert (ft)
α, β, and θ = empirically derived coefficients (Table 6.2)
D = culvert diameter (ft)

for non-circular or partially full culverts, D = y_e
$y_e = (A/2)^{0.5}$
A = cross-sectional area of flow (ft^2)

Q_r = representative discharge (cfs)

$$Q_r = \frac{Q_{100}}{2}\left(1+\frac{T_r-10}{T_r}\right)$$

T_r = hydrograph rise time (min)

Box Culvert

Soil Type	Q_{100} (cfs)	T_r (min)	Total Span (ft)	Outlet Depth (ft)	y_e (ft)	Q_r (cfs)
Uniform Sand (0.2)	2898	90	90	6.2	16.7	2737

Geometry	α	β	θ	DSG		
Depth	2.79	0.375	0.1	1.59	Z_{lsc}:	27
Width	6.44	0.92	0.15	2.03	W_{sc}:	34
Length	11.75	0.71	0.125	4.72	L_{sc}:	79
Volume	80.71	2	0.375	5.85	V_{sc}:	98

APPENDIX D

EQUILIBRIUM SLOPE & GRADE CONTROL SPACING COMPUTATIONS

5FGSHC Fairgrounds North Channel

January 2, 2023

Equilibrium Slope & Grade Control Spacing Evaluation

1. North Channel Equilibrium Slope Estimation (for Typical Channel Section per Psomas preliminary channel plans) – Use COT Eq. 6.26 for lesser urbanized watersheds, since Fairgrounds contributing watersheds are mostly rural undeveloped lands that are not expected to develop to a highly urbanized state within the design life of the facilities.

   Eq. 6.26: $S_{eq} = [(n_u/n_n)^2 (Q_{u,10}/Q_{n,10})^{-1.1} (b_u/b_n)^{0.4} (1 - R_s)^{0.7}]S_n$

   Where:

   S_{eq} = equilibrium slope after development (ft/ft)

   n_u = Manning's roughness coefficient for proposed channel = 0.038

   n_n = Manning's roughness coefficient for natural channel = 0.045

   $Q_{u,10}$ = Q_{10} urban channel = 1173 cfs (from FLO-2D)

   $Q_{n,10}$ = Q_{10} in natural channel = 1360 cfs (from FLO-2D)

   b_u = bottom width of proposed channel = 220 ft

   b_n = bottom width of natural channel = 400 ft

   R_s = sediment supply reduction factor for upstream watershed ~ 10% or 0.10

   S_n = avg. Ph1 & Ph2 natural channel slope ~ 0.009 ft/ft

   $S_{eq} = [(0.038/0.045)^2 (1173/1360)^{-1.1} (220/400)^{0.4} (1 - 0.10)^{0.7}]\ 0.009 =$ **0.006 ft/ft or 0.6%**

2. Grade Control Spacing Evaluation - (based on 100-yr design storm)

   Per guidance in the City of Tucson Standards Manual, grade control structure (GCS) drop heights were targeted to create maximum 6-ft of total scour within the low-flow channel at each GCS to avoid potential structural design requirements.

   Preliminary Estimated Scour & GCS Depth Summary -

   The assumed downstream control is provided at Harrison Rd for Phase 1. The first two GCSs are shown at approximate Sta. 15+03 at the downstream ford wall for the Harrison Rd at-grade crossing and at Sta. 15+65 at the upstream Harrison Rd ford wall location. The next GCS was placed at the upstream end of the channel daylight transition segment at Sta 20+00, then GCS placement progressed upstream based on equilibrium slope versus proposed channel slope; and drop height parameters. Proposed GCS locations and depths are summarized in the table below.

GCS Sta	Proposed Channel Slope (%)	Drop Height (ft)	Drop/Gen Scour Depth (ft)	Total Scour/GCS Depth (ft)
+-15+03	0.20	2.3	3.2/2.5	5.5/6.0
15+65	0.20	NA	NA	NA/3.0
20+00	0.75	NA	NA	NA/3.0
31+00	0.75	1.7	3.9/2.5	5.6/6.0
40+75	0.75	1.5	4.0/2.9	5.5/6.0

GCS Sta	Proposed Channel Slope (%)	Drop Height (ft)	Drop/Gen Scour Depth (ft)	Total Scour/GCS Depth (ft)
41+55 to 42+84	N Entrance Rd Culvert Crossing with Fully Lined Channel, Drop Inlet at approximate Sta 42+84 & Energy Dissipator at Outlet			
42+84	0.78	NA	NA	NA/4.0
47+00	0.78	0.8	2.8/2.6	3.6/4.0
54+00	0.82	1.5	4.0/2.5	5.5/6.0
61+00	0.82	1.5	4.0/2.5	5.5/6.0
66+39	0.82	8.6	3.0/0.5	3.5/4.0

5FGSHC Fairgrounds Central Channel

January 1, 2023

Equilibrium Slope & Grade Control Spacing Evaluation

1. Central Channel Equilibrium Slope Estimation (for Typical Channel Section per Psomas preliminary channel plans) – Use COT Eq. 6.26 for lesser urbanized watersheds, since Fairgrounds contributing watersheds are mostly rural undeveloped lands that are not expected to develop to a highly urbanized state within the design life of the facilities.

   Eq. 6.26: $\mathbf{S_{eq} = [(n_u/n_n)^2 (Q_{u,10}/Q_{n,10})^{-1.1} (b_u/b_n)^{0.4} (1 - R_s)^{0.7}]S_n}$

   Where:

   - $\mathbf{S_{eq}}$ = equilibrium slope after development (ft/ft)
   - $\mathbf{n_u}$ = Manning's roughness coefficient for proposed channel = 0.038
   - $\mathbf{n_n}$ = Manning's roughness coefficient for natural channel = 0.045
   - $\mathbf{Q_{u,10}}$ = Q_{10} urban channel = 1215 cfs (from FLO-2D)
   - $\mathbf{Q_{n,10}}$ = Q_{10} in natural channel = 1516 cfs (from FLO-2D)
   - $\mathbf{b_u}$ = bottom width of proposed channel = 310 ft
   - $\mathbf{b_n}$ = bottom width of natural channel = 490 ft
   - $\mathbf{R_s}$ = sediment supply reduction factor for upstream watershed ~ 10% or 0.10
   - $\mathbf{S_n}$ = avg. Ph1 & Ph2 natural channel slope ~ 0.009 ft/ft

   $\mathbf{S_{eq}}$ = $[(0.038/0.045)^2 (1215/1516)^{-1.1} (310/490)^{0.4} (1 - 0.10)^{0.7}]$ 0.009 = **0.006 ft/ft or <u>0.6%</u>**

2. Grade Control Spacing Evaluation – (based on 100-yr design storm)

   Per direction from the Regional Flood Control District (RFCD), grade control structures were only evaluated at 1) Harrison Rd, 2) at the two access road crossings and 3) at the upstream end of the channel.

   Preliminary Estimated Scour & GCS Depth Summary -

   The assumed downstream control for this evaluation is provided at approximate channel Sta. 15+04 at the upstream ford wall for the Harrison Rd at-grade crossing. The next GCS is shown at approximate Sta. 43+53 at the toe of a channel drop immediately downstream of the South Access Rd at-grade crossing. ADOT ford walls have been included in the design on either side of the South Access Rd crossing at approximate Sta. 44+36 and Sta. 44+83, and then again on either side of the Secondary Access Rd at-grade crossing at approximate Sta. 56+42 and Sta. 56+68. Finally, a GCS was placed at the upstream end of the channel at the toe of the dragstrip embankment. Proposed GCS locations and depths are summarized in the table below.

GCS Sta	Proposed Channel Slope (%)	Drop Height (ft)	Drop/Gen Scour Depth (ft)	Total Scour/GCS Depth (ft)
+-14+62 Harrison Rd DS Ford Wall	0.21	NA	NA	NA/6.0
+-15+04 Harrison Rd US Ford Wall	0.21	NA	0.0/2.5	2.5/3.0
43+53 (low-flow channel only)	0.80	4.3	6.6/3.2	10.9/11.0
43+53 Rt OB Terrace	0.80	4.3	2.2/1.9	6.5/7.0

GCS Sta	Proposed Channel Slope (%)	Drop Height (ft)	Drop/Gen Scour Depth (ft)	Total Scour/GCS Depth (ft)
44+36 S Access Rd DS Ford Wall	0.80	NA	0.0/3.1	3.1/4.0
44+83 S Access Rd US Ford Wall	0.80	NA	0.0/2.2	2.2/3.0
56+42 Secondary Access Rd DS Ford Wall	0.80	2.3	3.5/2.7	5.8/6.0
56+68 Secondary Access Rd US Ford Wall	0.61	NA	0.0/2.5	2.5/3.0
63+21	0.61	6.2	3.2/0.7	3.9/4.0

APPENDIX E

CULVERT HYDRAULIC COMPUTATIONS

CMG DRAINAGE ENGINEERING, INC.

5FGSHC Existing Culverts – 1-1-2023
HY-8 Culvert Analysis Report

Crossing Discharge Data

Design Flow: 1896.00 cfs

Maximum Flow: 2336.00 cfs

Table 1 - Summary of Culvert Flows at Crossing: Dragstrip North Culvert Q100=2336 6-17-21

Headwater Elevation (ft)	Total Discharge (cfs)	1-36-inch SRP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
3067.20	0.00	0.00	0.00	1
3072.93	233.60	61.87	170.84	12
3073.14	467.20	63.47	401.37	7
3073.28	700.80	64.59	635.23	6
3073.40	934.40	65.49	867.89	5
3073.50	1168.00	66.27	1100.10	4
3073.59	1401.60	66.95	1334.13	4
3073.68	1635.20	67.56	1565.57	3
3073.77	1896.00	68.21	1826.83	3
3073.83	2102.40	68.69	2033.46	3
3073.90	2336.00	69.20	2264.56	2
3072.50	58.33	58.33	0.00	Overtopping

Culvert Data: 1-36-inch SRP

Table 2 - Culvert Summary Table: 1-36-inch SRP

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 cfs	0.00 cfs	3067.20	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
233.60 cfs	61.87 cfs	3072.93	5.73	5.116	7-M2c	3.00	2.53	2.53	0.70	9.71	3.27
467.20 cfs	63.47 cfs	3073.14	5.94	5.467	7-M2c	3.00	2.56	2.56	1.06	9.88	4.27
700.80 cfs	64.59 cfs	3073.28	6.08	5.709	7-M2c	3.00	2.58	2.58	1.35	9.99	4.99
934.40 cfs	65.49 cfs	3073.40	6.20	5.866	7-M2c	3.00	2.59	2.59	1.60	10.09	5.57
1168.00 cfs	66.27 cfs	3073.50	6.30	6.007	7-M2c	3.00	2.60	2.60	1.83	10.17	6.06
1401.60 cfs	66.95 cfs	3073.59	6.39	6.132	7-M2c	3.00	2.61	2.61	2.04	10.24	6.48
1635.20 cfs	67.56 cfs	3073.68	6.48	6.246	7-M2c	3.00	2.62	2.62	2.23	10.31	6.87
1896.00 cfs	68.21 cfs	3073.77	6.57	6.364	7-M2c	3.00	2.63	2.63	2.44	10.38	7.25
2102.40 cfs	68.69 cfs	3073.83	6.63	6.461	7-M2c	3.00	2.64	2.64	2.59	10.43	7.53
2336.00 cfs	69.20 cfs	3073.90	6.70	6.555	7-M2c	3.00	2.65	2.65	2.76	10.48	7.83

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 3067.20 ft,

Outlet Elevation (invert): 3064.99 ft

Culvert Length: 240.01 ft,

Culvert Slope: 0.0092

Site Data - 1-36-inch SRP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 3067.20 ft

Outlet Station: 240.00 ft

Outlet Elevation: 3064.99 ft

Number of Barrels: 1

Culvert Data Summary - 1-36-inch SRP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope (Ke=0.7)

Inlet Depression: None

Tailwater Data for Crossing: Dragstrip North Culvert Q100=2336 6-17-21

Table 3 - Downstream Channel Rating Curve (Crossing: Dragstrip North Culvert Q100=2336 6-17-21)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	3064.00	0.00	0.00	0.00	0.00
233.60	3064.70	0.70	3.27	0.36	0.69
467.20	3065.06	1.06	4.27	0.54	0.74
700.80	3065.35	1.35	4.99	0.69	0.77
934.40	3065.60	1.60	5.57	0.82	0.79
1168.00	3065.83	1.83	6.06	0.94	0.81
1401.60	3066.04	2.04	6.48	1.04	0.82
1635.20	3066.23	2.23	6.87	1.14	0.84
1896.00	3066.44	2.44	7.25	1.25	0.85
2102.40	3066.59	2.59	7.53	1.33	0.85
2336.00	3066.76	2.76	7.83	1.41	0.86

Tailwater Channel Data - Dragstrip North Culvert Q100=2336 6-17-21

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 100.00 ft

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0082

Channel Manning's n: 0.0320

Channel Invert Elevation: 3064.00 ft

Roadway Data for Crossing: Dragstrip North Culvert Q100=2336 6-17-21

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section

Coord No.	Station (ft)	Elevation (ft)
0	2755.00	3074.60
1	2950.00	3073.90
2	3040.00	3073.20
3	3190.00	3072.90
4	3305.00	3072.50
5	3400.00	3072.60
6	3500.00	3072.60
7	3600.00	3072.90
8	3813.00	3073.50
9	3963.00	3074.50

Coefficient of Discharge: 2.7000

Roadway Top Width: 150.00 ft

Crossing Discharge Data

Design Flow: 2998.00 cfs

Maximum Flow: 3926.00 cfs

Table 4 - Summary of Culvert Flows at Crossing: Dragstrip South Culvert Q100=3926 6-17-21

Headwater Elevation (ft)	Total Discharge (cfs)	6-36-inch SRP Discharge (cfs)	Roadway Discharge (cfs)	Iterations
3070.39	0.00	0.00	0.00	1
3075.10	392.60	318.95	73.59	9
3076.01	785.20	365.68	418.99	4
3076.32	1177.80	378.62	797.82	7
3076.56	1570.40	366.08	1202.79	7
3076.73	1963.00	353.70	1606.35	5
3076.87	2355.60	341.52	2010.55	4
3077.00	2748.20	329.91	2416.87	4
3077.07	2998.00	322.64	2672.10	3
3077.21	3533.40	307.69	3223.68	3
3077.31	3926.00	297.11	3628.60	3
3074.00	251.24	251.24	0.00	Overtopping

Culvert Data: 6-36-inch SRP

Table 5 - Culvert Summary Table: 6-36-inch SRP

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 cfs	0.00 cfs	3070.39	0.00	0.000	0-NF	0.00	0.00	0.00	0.00	0.00	0.00
392.60 cfs	318.95 cfs	3075.10	4.71	4.400	7-M2c	2.46	2.37	2.37	1.85	8.88	4.79
785.20 cfs	365.68 cfs	3076.01	5.62	5.235	7-M2c	3.00	2.52	2.52	2.71	9.62	5.95
1177.80 cfs	378.62 cfs	3076.32	5.89	5.935	4-FFf	3.00	2.55	3.00	3.38	8.93	6.72
1570.40 cfs	366.08 cfs	3076.56	5.63	6.166	4-FFf	3.00	2.52	3.00	3.93	8.63	7.31
1963.00 cfs	353.70 cfs	3076.73	5.37	6.342	4-FFf	3.00	2.48	3.00	4.41	8.34	7.79
2355.60 cfs	341.52 cfs	3076.87	5.13	6.484	4-FFf	3.00	2.44	3.00	4.85	8.05	8.20
2748.20 cfs	329.91 cfs	3077.00	4.91	6.609	4-FFf	2.57	2.41	3.00	5.24	7.78	8.56
2998.00 cfs	322.64 cfs	3077.07	4.77	6.681	4-FFf	2.49	2.38	3.00	5.48	7.61	8.77
3533.40 cfs	307.69 cfs	3077.21	4.50	6.825	4-FFf	2.37	2.33	3.00	5.95	7.25	9.18
3926.00 cfs	297.11 cfs	3077.31	4.32	6.923	4-FFf	2.29	2.29	3.00	6.27	7.01	9.45

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

Inlet Elevation (invert): 3070.39 ft,

Outlet Elevation (invert): 3068.37 ft

Culvert Length: 240.01 ft,

Culvert Slope: 0.0084

Site Data - 6-36-inch SRP

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 3070.39 ft

Outlet Station: 240.00 ft

Outlet Elevation: 3068.37 ft

Number of Barrels: 6

Culvert Data Summary - 6-36-inch SRP

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0150

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope (Ke=0.7)

Inlet Depression: None

Tailwater Data for Crossing: Dragstrip South Culvert Q100=3926 6-17-21

Table 6 - Downstream Channel Rating Curve (Crossing: Dragstrip South Culvert Q100=3926 6-17-21)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
0.00	3068.00	0.00	0.00	0.00	0.00
392.60	3069.85	1.85	4.79	0.70	0.68
785.20	3070.71	2.71	5.95	1.03	0.72
1177.80	3071.38	3.38	6.72	1.29	0.74
1570.40	3071.93	3.93	7.31	1.50	0.76
1963.00	3072.41	4.41	7.79	1.68	0.77
2355.60	3072.85	4.85	8.20	1.85	0.78
2748.20	3073.24	5.24	8.56	2.00	0.79
2998.00	3073.48	5.48	8.77	2.09	0.79
3533.40	3073.95	5.95	9.18	2.26	0.80
3926.00	3074.27	6.27	9.45	2.39	0.81

Tailwater Channel Data - Dragstrip South Culvert Q100=3926 6-17-21

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 35.00 ft

Side Slope (H:V): 5.00 (_:1)

Channel Slope: 0.0061

Channel Manning's n: 0.0320

Channel Invert Elevation: 3068.00 ft

Roadway Data for Crossing: Dragstrip South Culvert Q100=3926 6-17-21

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section

Coord No.	Station (ft)	Elevation (ft)
0	0.00	3078.10
1	177.00	3078.10
2	323.00	3077.00
3	483.00	3076.30
4	555.00	3076.10
5	636.00	3075.90
6	709.00	3075.60
7	738.00	3075.60
8	813.00	3075.90
9	844.00	3076.70
10	972.00	3076.50
11	1030.00	3076.70
12	1030.10	3074.00
13	1240.00	3078.00
14	1336.00	3079.00

Roadway Surface: Paved

Roadway Top Width: 1.00 ft

FG Channels-N Channel Subcritical Run_2022.09.13

HEC-RAS Plan: NChnl90%v2 River: River 1 Reach: Reach 1

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)
Reach 1	4191 Culvert #1	100yr 90' gate	3047.07	3045.77	3047.01	3047.07	3044.96	1545.87	870.13	2.36	12.88	12.88
Reach 1	4191 Culvert #1	10yr 90' gate	3044.68	3044.07	3044.68	3044.64	3044.96	1120.00		2.67	10.63	12.79

FG Channels-N Channel Subcritical Run_2022.09.13

HEC-RAS Plan: NChnl90%v2 River: River 1 Reach: Reach 1

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Vel Head	Frctn Loss	C & E Loss	Q Left	Q Channel	Q Right	Top Width
			(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft)
Reach 1	4263	100yr 90' gate	3047.24	3045.79	1.45	0.03	0.04	66.18	2349.82		165.87
Reach 1	4263	10yr 90' gate	3045.12	3043.98	1.14	0.03	0.16		1120.00		58.01
Reach 1	4237	100yr 90' gate	3047.07	3045.77	1.30			85.86	2330.14		164.28
Reach 1	4237	10yr 90' gate	3044.68	3044.07	0.60				1120.00		42.14
Reach 1	4191		Culvert								
Reach 1	4143	100yr 90' gate	3045.93	3043.41	2.52	0.70	0.88		2416.00		172.59
Reach 1	4143	10yr 90' gate	3042.91	3041.41	1.51	0.81	0.48		1120.00		167.04
Reach 1	4075	100yr 90' gate	3041.92	3041.17	0.75	0.74	0.01	559.35	1856.65		159.91
Reach 1	4075	10yr 90' gate	3040.63	3040.09	0.54	0.79	0.00	126.58	993.42		155.57

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Hec-14 Riprap Apron for Culverts

Fairgrounds Channels - North & Central Channel

Client:	**RFCD**	**Date:**	**1/1/2023**
Project #:	**20-017.2**	**By:**	**jlc**

For Circular Culverts -

U.S. Department of Transportation
Federal Highway Administration
Hydraulic Engineering Circular No. 14
Equation 10.4 Riprap Apron for Culverts
Length and Depth factors from table 10.1

$$D_{50} = 0.2D\left(\frac{Q}{\sqrt{g}D^{2.5}}\right)^{4/3}\left(\frac{D}{TW}\right)$$

D_{50} = riprap size (ft)
Q = design discharge (cfs)
D = culvert diameter (ft)
TW = tailwater depth (ft) ($0.4D < TW < D$)
$L_A = X_L * D$
L_A = Apron Length (ft); X_L = Length Coefficient
$D_A = X_D * D_{50}$
D_A = Apron Depth (ft); X_D = Depth Coefficient

*Q is discharge rate per pipe

Sta. / Culvert No.	Q* (cfs)	D (ft)	TW (ft)	D_{50} (ft)	X_L	X_D	L_A (ft)	D_A (ft)	Recommended Design: D_{50} (ft)	Recommended Design: L (ft)	Recommended Design: T (ft)
NChnl Dragstrip Exist 1-36" SRP	69	3	2.8	0.5	4	3.3	12	1.7	**0.75**	**10**	**1.5**
CChnl Dragstrip Exist 6-36" SRP	50	3	6.3	0.5	4	3.3	12	1.7	**0.75**	**30**	**1.5**

For Rectangular Culverts - Eq. MD-19, & attached Figure MD-22 & Table MD-7 from Urban Drainage and Flood Control District in Denver, CO (UD&FCD, 2008) were used for riprap outlet apron design

Eq. MD-19: $D_{50} = 0.014D\,(Q/BD^{1.5})(D/TW)$

Q* = design discharge per barrel, B = culvert barrel span (ft), D = culvert rise (ft), TW = tailwater depth (ft)

Sta. / Culvert No.	Q* (cfs)	B (ft)	D (ft)	TW (ft)	TW/D	$Q/BD^{0.5}$	Riprap Type	L (min. 3D) (ft)	Recommended Design: D_{50} (ft)	Recommended Design: L (ft)	Recommended Design: T (ft)
NChnl 41+91 / N Ent Rd	515	10	4	5.0	1.25	25.75	M	12	**1.0**	**75**	**2.0**

APPENDIX F

ELECTRONIC MODEL FILES, SUPPORTING DATA & REPORT PDF

CMG DRAINAGE ENGINEERING, INC.