Drainage Study Report

North Houston Highway Improvement Project

Segment 3E: I-45 Downtown Connectors

CSJ: 0500-03-598

Houston, Texas

Prepared for:

Texas Department of Transportation

STATE OF TEXAS
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Executive Summary

Dannenbaum Engineering Corporation (Dannenbaum) was contracted by the Texas Department of Transportation (TxDOT) to prepare a drainage study for the proposed highway and drainage improvements along Interstate Highway 45 (I-45) near downtown Houston, Texas. The proposed improvements are a part of the Segment 3 (Downtown Loop) of the North Houston Highway Improvement Project (NHHIP). The current study documents the drainage analysis and preliminary drainage design for Segment 3E of the NHHIP. The study presents the following: (i) analysis of the existing storm sewer drainage systems, (ii) proposed storm sewer design, (iii) drainage impacts due to the proposed roadway and drainage improvements, (iv) detention mitigation recommendations, (v) preliminary storm sewer quantities, and (vi) hydraulic impact analysis of the proposed bridges over Buffalo Bayou, HCFCD Unit W100-00-00.

Segment 3E is approximately 6,000 feet in length. The project limits are located within the Buffalo Bayou Watershed. Buffalo Bayou, HCFCD Unit W100-00-00, is the only stream that crosses the project limits, and serves as outfall for the entire Segment 3E. The Segment 3E improvements include removing the section of the existing I-45 west of downtown and replacing it with Downtown Connectors. The proposed I-45 will wrap around the east side of downtown following the I-10 and I-69 corridors. The Downtown Connectors will begin from the proposed I-10/I-45 corridor and end at Jefferson Street. The Downtown Connectors will have typical main lane, frontage road, and entrance and exit ramp configurations.

The existing I-45 right-of-way in Segment 3E is drained by nine (9) existing storm sewer systems that range in size from 18” RCPs to 42” RCPs. The storm sewer systems were originally constructed between the 1930s and 1970s, with some upgrades over the years. Some of the storm sewer systems within the project right-of-way are interconnected with City of Houston storm sewer systems that cross the right-of-way. The storm sewer systems collect runoff generally through curb inlets such as City of Houston Type B and Type BB inlets, and TxDOT Type C inlets; and a few pavement grated inlets such as TxDOT Type AZR. The bridges generally drain through open slots in the concrete railings, and the flow is then collected by the storm sewers. Analysis of the existing storm sewer systems showed that the existing systems generally do not have adequate 10-year design capacity to drain the main lanes. In addition, many of the storm sewer systems are more than 40 years old.

New storm sewer systems are proposed to drain the right-of-way and provide adequate design capacity. The proposed storm sewer systems range in size from 24” RCPs to 5’x3 RCBs. The existing City of Houston storm sewer systems that cross the right-of-way will be kept in place. However, the design concept presented in this study either disconnects the right-of-way drainage areas from the existing City of Houston storm sewer systems or reduces flows from the right-of-way to the existing City of Houston storm sewers. This is achieved by proposing new storm sewer systems to drain the right-of-way directly to Buffalo Bayou. Since the proposed storm sewers will convey runoff from the main lanes, they were designed to convey the 10-year design flows at full pipe capacity.

A drainage impact analysis was also performed for the project to analyze the impacts of the following: (i) increase in impervious area due to new pavement, (ii) increase in conveyance due to the proposed storm

sewer improvements, and (iii) impacts due to fill in the floodplain due to construction of the new roadways. The total proposed right-of-way area is 58.42 acres. The existing pavement area is 38.43 acres, and the proposed pavement area is 32.46 acres. The replacement of the existing I-45 with proposed Downtown Connectors will not increase the pavement impervious area within the right-of-way. However, the existing storm sewer systems are inadequate to convey the design flows, which require upsizing in the proposed conditions. The increase in efficiency of the proposed storm sewer systems results in peak flow impacts to Buffalo Bayou.

A preliminary analysis was performed for the project based on the Design Schematic to determine the net fill in the floodplain due to the proposed improvements. The net fill in the floodplain was calculated based on the corrected effective condition 100-year flood elevation in Buffalo Bayou in the vicinity of the project, which is approximately 40.02 feet. The net fill in the floodplain due to the proposed roadway improvements amounts to 11.0 acre-feet.

The current study proposes mitigation of peak flow impacts and net floodplain fill compensation within two (2) interconnected detention basins just south of Allen Parkway. The proposed detention basins will receive flows from a major proposed storm sewer system south of Buffalo Bayou and will provide mitigation for the entire project. The detention basins are referred to as Basin 1 and Basin 2. The basins will be interconnected with a 5'x3' RCB. The outflow to Buffalo Bayou will be from Basin 1 only. The Basins will have a top elevation of 35.00 feet. Basin 1 will have a bottom elevation of 15.00 feet and will provide a total volume of 11.7 acre-feet. Basin 2 will have a bottom elevation of 24.00 feet and will provide a total volume of 7.5 acre-feet. Both the basins together will provide a total volume of 19.1 acre-feet. The outflow restrictor from Basin 1 will be comprised of a 36" RCP. The total volume utilized for peak flow impact mitigation is approximately 4.5 acre-feet. The additional volume available in the basins is 14.6 acre-feet, which is adequate to compensate for the net fill in the floodplain, which is 11.0 acre-feet.

There are eight (8) bridges within the I-45 right-of-way that cross Buffalo Bayou in existing conditions. The eight (8) existing bridges will be replaced with eight (8) proposed bridges, which will have different alignments from existing bridges. A preliminary hydraulic impact analysis was performed based on an unsteady HEC-RAS model of Buffalo Bayou. The unsteady HEC-RAS model was developed by Lockwood Andrews and Newman (LAN) by converting the steady state FEMA effective model and calibrating with gage data. The existing Segment 3E bridges were updated in the model by Dannenbaum based on survey data to create a Corrected Effective Model. A Proposed Model was developed by replacing the existing bridges in the unsteady model with the proposed bridges. The results of the bridge hydraulic analysis show that the proposed bridges do not cause any adverse impacts to the 100-year or 10-year water surface elevations along Buffalo Bayou upstream of the project right-of-way. A minor impact of 0.01 to 0.03 feet was observed downstream of the project for both 10-year and 100-year storm events. This is due to the improved efficiency of the proposed bridges, which have longer spans.

LAN's drainage report for Segment 3D (LAN Report) proposes a scenario (Scenario 4), which includes regional detention mitigation for roadway and bridge improvements in NHHIP Segment 3. This scenario

does not include North Canal or South Canal Projects or any other channel improvement measures. The regional detention will eliminate the downstream water surface elevation impacts from Segment 3E bridges for the 10-year and 100-year storm events. The Scenario 4 results in drops in proposed condition water surface elevations of up to 0.05 feet compared to the corrected effective condition, downstream of Segment 3E bridges.

The proposed bridges analyzed in this study are preliminary in nature. The schematic does not provide any deck or column details. The hydraulic model will have to be updated during the final design phase to reevaluate the hydraulic impacts of the proposed bridges based on final design. The current study also does not consider the effects of the North Canal or South Canal Projects along Buffalo Bayou, which are proposed to be constructed in the future. Scenarios 1 to 3 in the LAN Report evaluate the flood benefits and hydraulic impacts of the North Canal and South Canal Projects.

Based on the drainage improvement recommendations in this study, the proposed roadway improvements along Segment 3E will not cause any adverse hydraulic impacts to Buffalo Bayou, HCFCD Unit W100-00-00, for storm events up to and including the 1% (100-year) storm event.

1.0 Introduction

Dannenbaum Engineering Corporation (Dannenbaum) was contracted by the Texas Department of Transportation (TxDOT) to prepare a drainage study for the proposed highway and drainage improvements along Interstate Highway 45 (I-45) near downtown Houston, Texas. The proposed improvements are a part of the Segment 3 (Downtown Loop) of the North Houston Highway Improvement Project (NHHIP). The current study focuses on Segment 3E of the project, which includes converting the existing I-45 through downtown into Downtown Connectors. This report documents the technical findings of the drainage study. The drainage study presents the following: (i) analysis of the existing storm sewer drainage systems, (ii) proposed storm sewer design, (iii) drainage impacts due to the proposed roadway and drainage improvements, (iv) detention mitigation recommendations, (v) preliminary storm sewer quantities, and (vi) hydraulic impact analysis of the proposed bridges over Buffalo Bayou, HCFCD Unit W100-00-00.

1.1 Project Location and Description

Segment 3E of the NHHIP is located along I-45 in downtown Houston, Texas. The NHHIP Segment 3E project limits generally extend from south of Interstate Highway 10 (I-10), near the Union Pacific Rail Road (UPRR) crossing, to Brazos Street, a length of approximately 6,000 feet. The project limits are shown on **Exhibit 1**. The project limits are located within the Buffalo Bayou Watershed. Buffalo Bayou, HCFCD Unit W100-00-00, is the only stream that crosses the project limits, and serves as outfall for the entire Segment 3E. The channel crosses the I-45 corridor approximately midway along the project length.

The Segment 3E improvements include removing the section of the existing I-45 west of downtown and replacing it with Downtown Connectors. The proposed I-45 will wrap around the east side of downtown following the I-10 and I-69 corridors. The Downtown Connectors will begin from the proposed I-10/I-45 corridor and end at Jefferson Street. The Downtown Connectors will have a typical main lane, frontage road, and entrance and exit ramp configuration.

1.2 2016 Preliminary Drainage Study

TxDOT conducted a preliminary drainage study for all three (3) segments of the NHHIP in 2016. The study, which was performed by AECOM, evaluated preliminary drainage solutions for several alignment and roadway configuration alternatives for all the three segments. This study is referred to as the 2016 Preliminary Drainage Study. A summary of the study is presented below:

1. Segment 3 begins along the existing I-45 near Wrightwood Street (south of Little White Oak Bayou crossing) and ends along US 59 at Spur 527.
2. The study evaluated three (3) alternatives for the roadway alignment/configuration in Segment 3. Preliminary drainage evaluation was performed for these alternatives.
3. Main lane profile adjustments were recommended to meet the 100-year level of service. Frontage road profiles were not evaluated.
4. Preliminary drainage impact analysis was performed based on right-of-way drainage areas, and the detention volume was estimated based on increase in impervious area only. Impacts from

increase in hydraulic conveyance due to storm sewer improvements was not evaluated. It was determined that Segment 3E does not add any additional impervious area. Therefore, no mitigation was determined to be necessary for this segment. The current study will perform a detailed evaluation of impacts to account for impervious area increase as well as hydraulic conveyance improvements.

5. Preliminary hydraulic impact analysis was performed for existing and proposed bridge crossings over Buffalo Bayou in Segment 3E. The analysis assumed that the proposed bridges are similar to existing bridges and will not result in hydraulic impacts. The hydraulic analysis was performed based on a steady state FEMA Effective HEC-RAS model. The current study will utilize an unsteady HEC-RAS model to perform a detailed hydraulic impact analysis. The existing bridges will be updated based on topographic survey and the proposed bridges will be evaluated based on the latest design schematic.

6. The study assumed that the proposed roadway configuration in Segment 3E is generally similar to the existing roadway configuration, resulting in no net fill in the 100-year floodplain. The current study will evaluate this assumption in detail, identify any floodplain fill areas, and provide compensatory storage.

7. The study also performed preliminary evaluation of two (2) bypass channels to link Buffalo and Little White Oak Bayous in the downtown area to lower the flood elevations in the project area. These bypass channels are identified as the North Canal and the South Canal. More details on these bypass channels is provided in section 1.3 of this report.

Since the completion of the 2016 Preliminary Drainage Study, TxDOT has chosen an alternative from the study for Segment 3 for a more detailed drainage evaluation before final design and construction. The current study presents more detailed drainage evaluation of Segment 3E, a portion of Segment 3. Segments 3A, 3B, 3C, and 3D are being studied by other engineering consultants.

1.3 Proposed Buffalo Bayou Improvements

Harris County Flood Control District (HCFCD) has developed a concept of channel improvements along Buffalo Bayou, identified as the North Canal Bypass Channel Project (North Canal Project), to reduce flooding to downtown areas and to provide flood reduction benefits to upstream areas along Buffalo Bayou and White Oak Bayou. The concept includes a bypass channel connecting White Oak Bayou to Buffalo Bayou from upstream of their existing confluence to downstream of the confluence. This will allow high flows from White Oak Bayou and Buffalo Bayou to continue downstream efficiently as opposed to along the meandering channels. As part of the NHHIP Segment 3 project, TxDOT is proposing a second bypass channel along Buffalo Bayou (South Canal Project) to further lower the flood levels along the bayou in order to reduce flooding conditions in the depressed sections and to provide sufficient freeboard at the elevated sections of the proposed highway. The South Canal Project provides a high flow bypass along Buffalo Bayou between Elysian Street and Jensen Drive.

The 2016 Preliminary Drainage Study presented preliminary evaluation of the North Canal and the South Canal Projects. Currently, Lockwood Andrews & Newman (LAN) is assisting TxDOT with a detailed

hydraulic analysis of these proposed channel improvements in their study of I-45 Segment 3D. The LAN study utilizes an unsteady HEC-RAS model of Buffalo Bayou and White Oak Bayou in the downtown area. The unsteady model was converted from the steady state FEMA effective HEC-RAS model and calibrated with gage data. As per the unsteady model, the 100-year flood elevations along Buffalo Bayou are generally 3.0 feet higher than what are presented in the FEMA Effective Flood Insurance Study (FIS). The model also shows that the proposed North Canal Project and the South Canal Project together will lower the 100-year flood elevations along Buffalo Bayou by generally 3.0 feet upstream of I-69, which are close to the FEMA effective base flood elevations.

Since the North Canal and the South Canal Projects are still in the planning phase, the flood benefits of these improvements were not considered in this study. The storm sewer design, bridge freeboard evaluation, and floodplain fill calculations in this study are based on the existing condition flood elevations as per the unsteady HEC-RAS hydraulic model.

1.4 Tropical Storm Harvey

Hurricane Harvey, a Category IV hurricane, made landfall south of Houston in Rockport, Texas on August 25, 2017. The hurricane turned into a massive tropical storm on August 26, 2017 when it moved inland, dumping over 40 inches of rainfall in some parts of Houston. The storm event was classified as a greater than 500-year event. As per the gage along Buffalo Bayou just west of the I-45 corridor, near Shepherd Street, the flood stage in the bayou surpassed 100-year levels. The I-45 corridor was severely impacted by the overbank flooding from Buffalo Bayou. Segments of the 1-45 main lanes near Dallas Street underpass were submerged several feet below the flood waters. The I-45 corridor, which is classified as an evacuation route remained closed for a few days until the flood waters receded. The 2017 Tropical Storm Harvey was preceded by the 2016 Tax Day, and the 2015 Memorial Day flood events. The two preceding flood events also resulted in significant flooding along the I-45 corridor, however, Tropical Storm Harvey caused the most flooding.

These recent significant storm events have caused significant economic damage to TxDOT and to the public. The citizens, law makers, and the engineering community are looking for a new framework for revitalizing Houston's infrastructure to a higher level of service. TxDOT is sensitive to the needs of the community, and through the proposed North Houston Highway Improvement Project, TxDOT is leading the way in renewing infrastructure that is resilient and operational during extreme storm events and provides a significantly higher level of service. The North Houston Highway Improvement Project is a significant first step towards defining and establishing the new framework.

1.5 Project Datum

All elevations presented in this study are referenced to the North American Vertical Datum (NAVD) of 1988, 2001 Adjustment unless otherwise stated. This datum is referred to as the Project Datum. The Design Schematic is referenced to NAVD 1988 (no adjustment). The conversion from NAVD 1988 to NAVD 1988, 2001 Adjustment was determined to be -0.06 feet for Segment 3E in the 2016 Preliminary Drainage Study.

1.6 Flood Hazard Areas

The project limits are located within FEMA Effective Flood Insurance Rate Maps (FIRMs) with Panel Numbers 48201C0690N and 48201C0670M, effective January 6, 2017 and June 9, 2014, respectively. The FEMA Effective FIRM with project limits are shown on **Exhibit 2**. Portions of the existing main lane and frontage road bridge abutments and columns are located within the Zone AE, represented by the 100-year floodplain of Buffalo Bayou. Buffalo Bayou is a FEMA studied stream in the vicinity of the project with established flood elevations. The effective 100-year flood elevation across Segment 3E is approximately 37.00 feet.

1.7 Reference Manuals

The following manuals were referred to in this study:

1. TxDOT Hydraulic Design Manual: Hydraulic Design Manual, dated July 2016, Texas Department of Transportation.
2. HCFCD Guidance Manual: Hydrology and Hydraulics Guidance Manual, dated December 2009, HCFCD.

1.8 Data Collection

Data collection was performed for this study to gather all the relevant data to assist with the hydrologic and hydraulic analysis. The following data was acquired for this study:

- Design Schematic
- Low Flight DEM
- Drainage Study Reports
- Record Drawings
- Topographic Survey
- Field Reconnaissance
- Hydrologic and Hydraulic Models
- LiDAR DEM
- Aerial Photography

1.8.1 Design Schematic

Design Schematic for Segment 3 prepared by HNTB was provided by TxDOT. The information in the Design Schematic is summarized below. The Design Schematic is included in **Appendix A**.

1. The elevations in the Design Schematic are referenced to the NAVD 1988. The conversion from NAVD 1988 to NAVD 1988, 2001 Adjustment for Segment 3E is -0.06 feet as recommended in the 2016 Preliminary Drainage Study.
2. The plan view shows the location of the main lanes, entrance and exit ramps, frontage roads.

3. The plan view also shows the extents of bridges, retaining walls, and at grade segments of the main lanes and ramps only. The frontage roads are generally shown as at-grade. However, the extents of the frontage road bridges across Buffalo Bayou are not shown.
4. The plan view of the bridge sections show the preliminary location of bents; however, the pier diameter and configuration are not shown.
5. The vertical profiles are shown for the main lanes only. The vertical profiles of the ramps and the frontage roads are not shown.

1.8.2 Low Flight DTM

A low flight DTM for Segment 3 was provided by TxDOT and is referred to as TxDOT DTM in this study. The DTM is referenced to the NAD 83 State Plane Coordinate System, Texas South Central Zone. Vertical elevations are referenced to the NAVD 1988 (no adjustment). The TxDOT DTM covers the Segment 3E right-of-way and up to 450 feet on either of the right-of-way.

1.8.3 Drainage Study Reports

A preliminary drainage study report prepared by AECOM, dated 2016 and entitled *"North Houston Highway Improvement Project – Preliminary Drainage Report"* was acquired for this study. The study, which was performed by AECOM, evaluated preliminary drainage solutions for several alignment alternatives for all the three (3) segments of the NHHIP.

1.8.4 Record Drawings

Several record drawings were obtained for the project from TxDOT and the City of Houston. The record drawings were used to confirm the storm sewer system configuration and sizes against the topographic survey. The important record drawings along I-45 are listed below. All the record drawings are provided in a USB drive included with this report.

1. Final Plans of Houston Urban Expressways, Fourth Street System from Louisiana Street to Dowling Street, TxDOT, dated 1946.
2. Final Plans of Proposed State Highway Improvement, North Expressway from Louisiana Street to West Dallas Avenue, TxDOT, dated 1953.
3. Final Plans of Proposed Highway Improvement, North Freeway Buffalo Interchange, TxDOT, dated 1955.
4. Final Plans of Proposed State Highway Improvement, North Expressway Houston Avenue Connection, TxDOT, dated 1953.
5. Final Plans of Proposed State Highway Improvement, First Stage Construction of Substructure only for a Portion of Interstate Highway 45 Elevated Freeway in Vicinity of Capitol Avenue Bridge, TxDOT, dated 1958.

6. Final Plans of Proposed State Highway Improvement, Construction of a Portion of Superstructure and Substructure for Interstate Highway 45 Elevated Freeway in Vicinity of Capitol Avenue Bridge, TxDOT, dated 1958.
7. Final Plans of Proposed State Highway Improvement, North Freeway from Andrews Street to Vicinity of Capitol Avenue, TxDOT, dated 1960.
8. Final Plans of Proposed State Highway Improvement, North Freeway from Vicinity of Capitol Avenue to Vicinity of T & No. RR Bridge, TxDOT, 1960.
9. Plans of Proposed State Highway Improvement, IH 45 from Allen Parkway to Jefferson Street, TxDOT, dated 2015.
10. Several City of Houston record drawings for storm sewer improvements in the vicinity of the project limits.

1.8.5 Topographic Survey

Topographic survey was performed for Segment 3E by Kuo & Associates, Inc and is referred to as Project Survey. The Project Survey included the following items:

1. Survey of existing outfalls locations, pipe sizes, and flow lines.
2. Survey of existing storm sewer systems, inlets, and manholes within the TxDOT right-of-way and along a 200-foot wide strip on either side of the right-of-way.
3. Survey of existing bridges including decks, bents, columns, and abutments within extents of the effective 500-year floodplain.

1.8.6 Field Reconnaissance

Multiple field investigations of the project site were conducted by Dannenbaum staff to verify the existing drainage and highway conditions. The following data was collected during the field investigations:

1. Outfall locations into Buffalo Bayou from the project site were identified.
2. Storm sewer systems and inlets along the I-45 corridor, along the main lanes, frontage roads, and City of Houston streets (to which I-45 corridor contributes flow) were identified.
3. Storm sewer and inlet systems within developments adjacent to and inside ROW such as Aquarium, courthouse parking lots, etc. were also identified.
4. Bridge drainage features (scuppers, open slots, etc.) were identified.
5. General existing roadway and bridge configuration was documented.

The information gathered was utilized in developing existing condition storm sewer system models and evaluating existing condition hydraulics. A detailed field investigation report with photographs is included in **Appendix B**.

1.8.7 Hydrologic and Hydraulic Models

The following hydrologic and hydraulic models were acquired for the current study:

1. FEMA Effective Models: The FEMA effective hydrologic (HEC-HMS) and hydraulic (HEC-RAS) models for Buffalo Bayou were acquired for the study from the Harris County Flood Control District's Map and Model Management (M3) system. The models provide flows and water surface elevations along Buffalo Bayou for the 10% (10-year), 2% (50-year), 1% (100-year), and 0.2% (500-year) storm events in the vicinity of the project area.
2. LAN's Corrected Effective HEC-RAS Model: LAN has developed an unsteady HEC-RAS model of Buffalo Bayou and White Oak Bayou in the downtown area for the NHHIP Segment 3D study. The unsteady HEC-RAS model was converted from the steady state FEMA effective HEC-RAS model and calibrated with gage data. The existing bridges over Buffalo Bayou along I-45 and US-59 were updated in the model based on survey data.

1.8.8 Other Data

The other data gathered for the project include the following:

1. LiDAR DEM: The 2008 LiDAR DEM obtained from Houston-Galveston Area Council (H-GAC) was used in this study for the development of drainage areas using ArcHydro and for surface elevations beyond the survey limits.
2. Aerial Photography: The 2016 H-GAC aerial photographs were used in this study.

1.9 Coordination with TxDOT and Other Segment Engineers

Coordination with TxDOT and other segment Engineers was extensive throughout the course of the drainage study. The coordination included the following items:

1. Drainage Criteria Determination: TxDOT and all the segment Engineers discussed suitable criteria for the project. In the aftermath of Hurricane Harvey, a new framework for hydraulic design criteria, which provided a higher level of service, was deemed necessary. A technical provisions document was prepared and is included in **Appendix C**.
2. Data Collection Coordination: TxDOT provided the segment Engineers with the 2016 Preliminary Drainage Study, as-built plans, low flight DTM, and Design Schematic.
3. Progress Updates: Regular updates were provided to TxDOT regarding the progress of the drainage study.
4. Technical Information Sharing: Segment Engineers coordinated with each other to share technical information such as hydraulic models, drainage area divides between segments, drainage calculations, etc. Sharing of technical information ensured consistency in analysis between segments.

5. Hydraulic Impact & Floodplain Fill Mitigation: Segment Engineers coordinated among themselves to discuss the detention and floodplain fill compensation volume requirements of each segment. Options were evaluated to maximize available volume along each segment.

2.0 Existing and Proposed Roadway

The NHHIP Segment 3 will reroute the proposed I-45 in the downtown area around the east side of downtown following the I-10/I-69 corridor. When approaching downtown along I-45 from the north, the proposed I-45 will be routed east along the I-10 corridor and then south along the 1-69 corridor. The proposed I-45 will tie back to the existing I-45 south of downtown. The existing I-45 in Segment 3E will be demolished and replaced with Downtown Connectors.

2.1 Existing Roadway

The existing I-45 in Segment 3E is comprised of a complex network of main lanes, frontage roads, and entrance and exit ramps. The existing roadway configuration is summarized in **Table 1**. North of Buffalo Bayou, the existing highway is comprised of main lanes and entrance and exit ramps only, which are elevated on bridges. The ramps include the I-45 Southbound Main Lane (SBML) exit ramps to Dallas Street and McKinney Street, and the I-45 Northbound Main Lane (NBML) entrance ramps from Houston Avenue and Walker Street. There are no frontage roads in this section. The Houston Aquarium and its parking and parking lots for the Herbert W. Gee municipal courthouse are located underneath the main lane bridges in this section. These features are expected to remain operational after the completion of the NHHIP Segment 3E. Several City of Houston Streets cross underneath the main lanes in this section including Franklin Street, Preston Street, Prairie Street, Memorial Drive, Capitol Street, and Rusk Street.

South of Buffalo Bayou, the highway is comprised of main lanes, ramps, and frontage roads. In this section, the main lanes are elevated on embankments for a short section between Allen Parkway and Dallas Street. The main lanes cross underneath Dallas Street as an underpass. The main lanes then cross Jefferson Street and St. Joseph Parkway over elevated bridges near the south project limits. St. Joseph Parkway traverses the main lanes below grade in this area, and then runs parallel to the main lanes. It crosses over Dallas Street via bridges and eventually merges with I-45 NBML entrance ramp from Allen Parkway. Heiner Street and Pease Street run parallel to the main lanes within the I-45 right-of-way and serve as frontage roads. The ramps in this section include I-45 SBML entrance ramp from Allen Parkway, I-45 NBML entrance ramp from Allen Parkway, and I-45 NBML exit ramps to Allen Parkway and Houston Avenue. The City of Houston streets that cross the I-45 corridor south of Buffalo Bayou include Allen Parkway, Dallas Street, Jefferson Street, St. Joseph Parkway, and Brazos Street.

The main lanes and ramps cross Buffalo Bayou with existing concrete bridges. The bridges crossing Buffalo Bayou within the I-45 right-of-way, from upstream to downstream include: (i) I-45 SBML Exit Ramp Bridge to Dallas Street (Pierce Elevated), (ii) I-45 SBML Bridge, (iii) I-45 SBML Exit Ramp Bridge to Allen Parkway, (iv) I-45 SBML Bridge, (v) I-45 NBML Exit Ramp Bridge to Houston Avenue, (vi) I-45 NBML Entrance Ramp Bridge from Allen Parkway/Pease Street, (vii) I-45 SBML Exit Ramp Bridge to McKinney Street , and (viii) I-45 NBML Entrance Ramp Bridge from Walker Street.

2.2 Proposed Roadway Improvements

The proposed roadway configuration is shown on **Exhibit 7** and is summarized in **Table 1**. The Design Schematic is included in **Appendix A**. The proposed NHHIP improvements will reroute I-45 around the east side of downtown following the I-10 and I-69 corridors. The existing I-45 in Segment 3E will be demolished and replaced with Downtown Connectors. The Downtown Connectors will begin from the proposed I-45/I-10 corridor and end at Jefferson Street. The Downtown Connectors will be comprised of main lanes, entrance and exit ramps, and frontage roads. The existing City of Houston cross streets will remain as in existing conditions.

North of Buffalo Bayou, the proposed roadway configuration will be comprised of main lanes and entrance and exit ramps only. The main lanes and ramps will be elevated on bridges and the City of Houston streets will cross underneath as in existing conditions. The Houston Aquarium and the parking lots will continue to operate underneath the main lane bridges. The existing I-45 NBML exit ramp to Houston Avenue will be removed and new frontage roads will be constructed providing connection to Houston Avenue from Heiner Street and Pease Street. The ramps include the SBML exit ramps to Allen Parkway and the McKinney Street, and NBML entrance ramps from Houston Avenue and Walker Street. There are no frontage roads in this section.

South of Buffalo Bayou, the proposed main lanes will continue to be elevated on bridges until near Robin Street. South of Robin Street, the main lanes will be located on retaining walls until they tie into Pease Street and Jefferson Street at grade. Heiner Street, Pease Street, and Allen Parkway will be replaced within the project right-of-way with new pavement, but with a different configuration than in existing conditions. The ramps in this section include the SBML entrance ramp from Allen Parkway and the SBML Exit Ramp to Bagby Street.

The existing bridges over Buffalo Bayou will be replaced with proposed bridges. The following bridges will cross Buffalo Bayou in proposed conditions from upstream to downstream: (i) SBML Exit Ramp Bridge to Allen Parkway (ii) Southbound Frontage Road (SBFR) Bridge connecting Houston Avenue with Heiner Street, (iii) Northbound Frontage Road (NBFR) Bridge connecting Pease Street with Houston Avenue, (iv) SBML Bridge, (v) NBML Bridge, (vi) NBML Entrance Ramp Bridge from Allen Parkway, (vii) SBML Exit Ramp Bridge to McKinney Street, and (viii) NBML Entrance Ramp Bridge from Walker Street.

Table 1. Existing and Proposed Roadway Configuration

Station	Section	Roadway Confguration	
		Existing	**Proposed**
232+00 - 262+00	North of Buffalo Bayou	I-45 Main lanes I-45 SBML Exit Ramp to Dallas St. I-45 SBML Exit Ramp to McKinney St. I-45 SBML Exit Ramp to Allen Pkwy. I-45 NBML Entramce Ramp from Walker St.	Main Lanes SBML Exit Ramp to Allen Pkwy. SBML Exit Ramp to McKinney St. NBML Entrance Ramp from Walker St.
225+00 - 232+00	Over Buffalo Bayou	I-45 SBML Exit Ramp Bridge to Dallas St. I-45 SBML Bridge I-45 SBML Exit Ramp Bridge to Allen Pkwy. I-45 NBML Bridge I-45 NBML Exit Ramp Bridge to Houston Ave. I-45 NBML Entrance Ramp from Allen Pkwy. I-45 SBML Exit Ramp Bridge to McKinney St. I-45 NBML Entrance Ramp Bridge from Walker St.	SBML Exit Ramp Bridge to Allen Pkwy. SBFR Bridge connecting Houston Ave. with Heiner St. NBFR Bridge connecting Pease St. with Houston Ave. SBML Bridge NBML Bridge NBML Entrance Ramp Bridge from Allen Pkwy. SBML Exit Ramp Bridge to McKinney St. NBML Entrance Ramp Bridge from Walker St.
200+00 - 225+00	South of Buffalo Bayou	I-45 Main Lanes SBFR (Heiner St.) NBFR (Pease St.) I-45 SBML Entrance Ramp from Allen Pkwy. I-45 SBML Exit Ramp to Dallas St. I-45 NBML Entrance Ramp from Allen Pkway I-45 NBML Exit Ramp to Allen Pkwy. I-45 NBML Exit Ramp to Houston Ave. St. Joseph Pkwy. parallel to I-45 Main Lanes	SBML connection to Jefferson St. NBML connection to Pease St. SBFR (Heiner St.) NBFR (Pease St.) I-45 SBML Entrance Ramp from Allen Pkwy. I-45 SBML Exit Ramp to Bagby St. I-45 NBML Entrance Ramp from Allen Pkwy.

3.0 Hydrologic and Hydraulic Methodology

This section describes the design criteria and hydrologic and hydraulic analysis methodology used in this study. The drainage areas, flows, and hydraulic analysis for existing and proposed conditions are presented in the following sections.

3.1 Drainage Area Delineation

The drainage areas contributing to the existing I-45 corridor were delineated based on record drawings, Project Survey, TxDOT DTM, ArcHydro with the use of LiDAR DEM, contour data, and aerial photographs. The drainage areas were confirmed based on field visits. The overall storm sewer system drainage areas were delineated and then divided into subareas for calculating flows at nodes along the storm sewer system. The subareas within the project right-of-way are less than 200 acres.

3.2 Drainage Design Hydrology

Hydrologic methods were determined based on drainage area size. **Table 2** shows the methodology selection based on the drainage area size.

Table 2. Flow Calculation Methodology

Drainage Area Size (ac)	Methodology
<= 200 acres	Rational Method
> 200 acres	HCFCD Clark Unit Hydrograph Method

3.2.1 Rational Method

The Rational Method approach used in this study follows the TxDOT HDM. The methodology uses drainage area, rainfall intensity and runoff coefficient to calculate peak flows as follows:

$Q = CIA$

Where:

Q = computed peak flow (cfs),

C = weighted runoff coefficient,

I = average rainfall intensity (in/hr), and

A = drainage area (ac)

Runoff coefficient, C, is based on land use. Runoff coefficients for various land uses was derived from the TxDOT HDM. Within the project right-of-way, a C value of 0.35 was used for grass areas and 0.90 for pavement areas. For each drainage area, different land use types were delineated and a C value was assigned. A composite area-weighted C value was then calculated for each drainage area. The rainfall intensity is calculated based on time of concentration (tc) as follows:

$I = b/(tc + d)^e$

Where:

I = average rainfall intensity (in/hr),

tc = time of concentration (min), and

b, d, e = coefficients specific for each storm frequency and county.

The b, d, e coefficients are derived from the Rainfall Intensity-Duration-Frequency data from the Atlas of the Depth-Duration Frequency of Precipitation Annual Maxima for Texas. The coefficients for Harris County are presented in **Table 3**.

Table 3. Rainfall Intensity-Duration-Frequency Coefficients for Harris County

Coefficient	50% (2-yr)	10% (10-yr)	2% (50-yr)	1% (100-yr)
b	57.73	86.47	116.88	136.33
d	9.48	11.27	12.95	14.08
e	0.7939	0.7829	0.7727	0.772

Time of concentration, Tc, was calculated based on travel velocities along the flow path. The following table lists the velocity for each flow type.

Table 4. Travel Time – Flow Velocity Summary

Flow Component	Velocity
Unpaved Sheet Flow	0.5 ft/s
Paved Sheet Flow	1.5 ft/s
Roadside Ditch Flow	2.0 ft/s
Storm Sewer Flow	3.0 ft/s
Channel Flow	3.0 ft/s

In the existing conditions, runoff typically sheet flows over paved areas to the storm sewer inlet. The flow is then carried along the storm sewer to the outfall channel. Similar drainage conditions will be maintained in proposed conditions.

3.2.2 Flow Hydrograph Method for Rational Method Peak Flow

The storm sewer hydraulic analysis was performed using the dynamic hydraulic modeling software XP SWMM 2017. The dynamic model requires flow hydrographs from drainage areas. For peak flows calculated with Rational Method, flow hydrographs were developed based on the Clark Unit Hydrograph Method using USACE's HEC-HMS software. The Clark Unit Hydrograph Method uses time of concentration, tc, and storage coefficient, R, to develop hydrographs. The time of concentration, tc, calculated for Rational Method was used in the HEC-HMS model and the storage coefficient, R, was calibrated by matching the hydrograph peak with the Rational Method peak flow for each storm event.

3.2.3 HCFCD Clark Unit Hydrograph Method

This methodology was applied for large areas, greater than 200 acres. The methodology utilizes the Green and Ampt Loss Method to calculate the runoff losses and the Clark Unit Hydrograph Method to calculate hydrographs and peak flows. The methodology is documented in detail in the HCFCD Guidance Manual. Green and Ampt Loss Method parameters are provided by the HCFCD. The HCFCD Guidance Manual provides procedures to calculate time of concentration and storage coefficient. The procedures are based on watershed parameters such as channel length, channel slope, watershed slope, channel capacity, watershed development, etc. Please refer to the HCFCD Guidance Manual for more details on the methodology. There is only one drainage area in this study that is larger than 200 acres to which this methodology is applicable.

3.3 Design Criteria

The design solutions presented in this study are based on the drainage criteria developed for the current study. The drainage design criteria is summarized in **Table 5**, and the document is included in **Appendix C**. The design criteria was developed for the entire Segment 3. Criteria for depressed sections and pump stations are not applicable to Segment 3E.

3.4 Storm Sewer Design & Hydraulic Analysis Methodology

Storm design and hydraulic analysis was performed using the dynamic hydraulic model XP SWMM 2017. Since the storm sewers systems draining the project are a network of TxDOT and City of Houston storm sewer systems, the analysis was performed for the 2-year, 10-year, and 100-year storm events. The model development includes building a storm sewer network based on design plans and Project Survey, incorporating flow hydrographs from drainage areas, and assigning variable tailwater condition (time vs. stage) at the outfall channel. The flow hydrograph calculation methodology is described above. The variable tail water data was obtained from the corrected effective condition unsteady HEC-RAS model for Buffalo Bayou. For any given storm sewer system outfall, the time vs. water surface elevation in Buffalo Bayou was extracted from the nearest downstream HEC-RAS cross section. Buffalo Bayou is the only outfall for all the storm sewer systems within the project area.

Due to a complex roadway network and underpasses in existing conditions, there is no clear overland flow path for storm water flows, which are surcharged from the storm sewer systems during extreme events. The storm water flows generally tend to pond in low lying areas during extreme events. This scenario was modeled by including surface storage elements at suitable storm sewer nodes in the model. The surface storage element was entered in the model as elevation vs. surface area data, which was derived from a combination of TxDOT DTM and 2008 LiDAR DEM.

Table 5. Drainage Design Criteria

Design Element	Mainlanes	Ramp	Direct Connect.	Frontage Road	Arterial / Cross Street	Application Notes
Note: AHW = Allowable High Water, EOP = Edge of Pavement, FB = Freeboard, HGL = Hydraulic Grade Line, HOU = TxDOT Houston District Design Practice, WSE = Water Surface Elevation.						
Minimum Roadway Elevation	100-yr	25-yr	100-yr	10-yr	10-yr*	Crossing or adjacent waterway WSE, **plus 1' FB at low EOP**. Does not apply to storm drain or roadside ditch HGL. *No FB required.
Bridge Waterway Crossing	100-yr plus 2.5' FB	100-yr plus 1.5' FB	100-yr plus 2.5' FB	100-yr plus 1.5' FB	Match Exist.	Applies to WSE at new location bridges. **For existing FR bridges**, use min 10-yr with Low chord > WSEL.
Cross Drain Culverts	100-yr	25-yr	100-yr	10-yr	Match Exist.	Set maximum AHW at 1' below low EOP. Check for 100-year.
Storm Drain Inlets and Pavement Drainage	10-yr	10-yr	10-yr	2-yr	Match Exist. or better	Applies to ponded widths in gutter and inlet capacity.
Storm Drain Conduits	10-yr	10-yr	10-yr	2-yr	Match Exist. or better	Size conduit for non-pressure full flow; i.e. Design Q<= Full Flow Capacity Q. See HGL requirements below.
Storm Drain HGL	100-yr < EOP	25-yr < EOP	100-yr < EOP	10-yr: max 1-lane ponding	10-yr: max 1-lane ponding	Starting HGL at outfall: 25-yr if it works. Otherwise, base the starting HGL on hydrograph timing or top of pipe. Determine and report maximum frequency flood contained in ROW.
Depressed Roadway Storm Drain, Inlets and Pavement Drainage	100-yr	100-yr	100-yr	100-yr	100-yr	Depressed roadway occurs if water has nowhere to drain overland when curb height is exceeded. Size conduit for non-pressure full flow. Check for 100-yr HGL < EOP.
Storm Water Pumping Stations	100-yr	100-yr	100-yr	100-yr	100-yr	Design pump capacity >/= 100-yr Q + 25%. Check for 100-year < EOP.
Detention Ponds	100-year + 3' FB. Provide Detention Summary with Area Serviced, Detention Storage Volume Required, Detention Storage Volume Provided, Maximum Design WSE, Maximum Outflow Rate Allowed, Maximum Outflow Rate Provided, and Restrictor Size.					Sample plans available from TxDOT upon request.
Outfall Ditches	Design for No Impact to 100-yr WSE. Use HCFCD Standard Details for Outfalls and other construction within HCFCD channels and ponds.					
Separation Ditches	10-yr	10-yr	10-yr	N/A	N/A	Separation Ditches are those in medians between adjacent roadways. AHW = 1' below EOP.
Roadside Ditches***	N/A	N/A	N/A	2-yr*	2-yr**	*If required outside curb line. **Or match existing capacity. *** Roadside ditches are those between the roadway and ROW

3.5 Bridge Hydraulic Analysis Methodology

There are several bridges over Buffalo Bayou within the project right-of-way, which will be demolished and replaced with new bridges in proposed conditions. The bridge hydraulic analysis was performed based on an unsteady HEC-RAS model of Buffalo Bayou. The unsteady HEC-RAS model was developed by LAN by converting from the FEMA effective steady HEC-RAS model and calibrating with gage data. The existing bridges over Buffalo Bayou along I-45 and US-59 were updated in the model based on survey data. Cross sections adjacent to the bridges were also updated. This model is referred to as the Corrected Effective Model. In the Proposed Model, the existing bridges were removed and replaced with proposed condition bridges based on Design Schematic. Since the alignment of the proposed bridges is different from the existing bridges, the cross sections within the project right-of-way were updated in the proposed conditions as well. The existing and proposed condition water surface elevations were compared to ensure there are no hydraulic impacts.

3.6 Floodplain Cut and Fill Calculation Methodology

Preliminary calculations for cut and fill in the floodplain were performed based on the Design Schematic, the Corrected Effective Model 100-year water surface elevations, and the topographic survey. Areas of potential floodplain fill were identified and fill volume calculations were performed using ArcGIS volume calculator, which uses a TIN file for existing ground and the water surface elevation up to which the fill is to be calculated.

4.0 Existing Drainage System Analysis

The existing I-45 right-of-way in Segment 3E is drained primarily by storm sewer systems. The storm sewer systems were originally constructed between 1930s and 1970s, with some upgrades over the years. There are nine (9) existing storm drainage systems along the project limits that drain the project right-of-way. These systems are identified as Systems A through System I. Some of the storm sewer systems within the project right-of-way are interconnected with City of Houston storm sewer systems that cross the right-of-way. All of these systems outfall into Buffalo Bayou. The overall drainage area map is shown in **Exhibit 3** and **t**he land use map is shown in **Exhibit 4**. The system drainage areas are shown in **Exhibit 5**. In **Exhibit 5**, and other exhibits, the storm sewer systems that drain the I-45 right-of-way are identified as "Project Storm Sewer", whereas the storm sewers that do not drain the I-45 right-of-way are identified as "Other Storm Sewer". The land use within the project right-of-way is typical of an urban highway corridor. The offsite areas are generally comprised of high density residential (single and multi-family), commercial, parks, and downtown business areas.

The storm sewer systems are described in detail below. The drainage subareas within each system, detailed storm sewer configuration, and hydraulic analysis nodes are shown in **Exhibit 6**. The storm sewer systems collect runoff generally through curb inlets such as City of Houston Type B and Type BB inlets, and TxDOT Type C inlets; and a few pavement grated inlets such as TxDOT Type AZR. The bridges generally drain through open slots in the concrete railings, and the flow is then collected by the storm sewers. Drainage areas, land use, and peak flows are summarized in **Table 6**. The detailed rational method parameters, peak flows, and hydraulic analysis results are presented in **Appendix D**.

The storm sewer segments within the project right-of-way were evaluated based on the 10-year design flow criteria. The conveyance capacity of the storm sewer was compared with the 10-year flow. If a storm sewer segment has a flow capacity less than the 10-year flow, then it was determined to be inadequate. For offsite areas, the storm sewer capacity was compared with 2-year design flows since these conform to the City of Houston criteria. The current study does not recommend any storm sewer improvements outside the project right-of-way. The evaluation of the offsite storm sewer system capacity is for documentation purposes only.

System A: System A drains the northern portion of the project area between Preston Street and the UPRR. The storm sewer system is a City of Houston system that runs along Franklin Street and drains approximately 25.74 acres. The storm sewer system begins west of the I-45 right-of-way and drains east across I-45 and outfalls into Buffalo Bayou. The storm sewer crosses I-45 underneath the elevated main lanes and collects runoff from the I-45 right-of-way. The drainage area contributing from the right-of-way is approximately 5.05 acres. The system ranges in size from an 18" RCP at the upstream end to a 36" CMP at the outfall into Buffalo Bayou, and is a 24" RCP within the project right-of-way.

System B: System B is located north of Buffalo Bayou and drains the I-45 right-of-way and the Houston Aquarium. The trunk line generally runs parallel to the I-45 main lanes, within the right-of-way, and ranges in size from an 18" RCP to a 24" RCP. The storm sewer system was likely constructed by the Houston Aquarium. The total contributing drainage area to the system is approximately 5.71 acres.

System C: System C is comprised of areas within the right-of-way which drain directly to Buffalo Bayou. These areas include bridges above the bayou and areas adjacent to the channel bank. The bridges drain via open slots along the concrete railings, whereas the areas adjacent to the channel banks sheet flow to the channel. The total area within System C is approximately 15.45 acres.

System D: System D is a City of Houston storm sewer system that runs along Houston Avenue and drains a small portion of the I-45 right-of-way. The total drainage area contributing to the system is approximately 13.90 acres. The system ranges in size from an 18" RCP to a 30" RCP at the outfall into Buffalo Bayou.

System E: System E is a City of Houston system that drains the Walker Street connection to Allen Parkway. The system is located inside the I-45 right-of-way and drains a portion of the right-of-way and offsite areas to Buffalo Bayou. The pipe sizes range from an 18" RCP to 24" RCP and drain a total area of 7.17 acres.

System F: System F drains a portion of the I-45 main lanes south of Buffalo Bayou. The system drains from south to north and ranges in size from an 18" RCP near the south project limit to a 42" RCP at the outfall into Buffalo Bayou. The drainage area of System F is approximately 9.77 acres, and all of it is contained within the I-45 right-of-way. Near Andrews Street, System F crosses underneath System G and is not connected to System G storm sewer (**Exhibit 6e**). This is further explained in description of System G below. System F also crosses underneath System I near Allen Parkway. Systems F and I are also not interconnected.

System G: System G is a City of Houston system that drains a portion of the I-45 right-of-way south of Buffalo Bayou. In addition, the system drains a significantly large offsite area. The storm sewer system ranges in size from an 18" RCP to 120" RCP and drains approximately 772.34 acres. The main trunk of the system runs along Crosby Street before discharging into Buffalo Bayou. A lateral from the main trunk runs along Andrews Street across I-45 right-of-way and collects runoff from a portion of Heiner Street and Pease Street, which are located within the right-of-way and currently serve as frontage roads along I-45. This storm sewer is 48" RCP across the right-of-way and it crosses above System F storm sewer. System F and System G are not interconnected. The drainage area contributing to system G from the I-45 right-of-way is approximately 4.73 acres.

System H: System H drains a portion of Heiner Street and I-45 main lanes south of Buffalo Bayou. The original storm sewer main trunk was constructed by the City of Houston, whereas some lateral connections were added by TxDOT. The storm sewer system discharges into Buffalo Bayou underneath Sabine Street. The system ranges in size from an 18" RCP to a 36" CMP. The drainage area contributing to System E is approximately 6.90 acres.

System I: System I is a City of Houston system that drains Allen Parkway inside the I-45 right-of-way and adjacent to the right-of-way. The system I drainage area is 14.61 acres and the system ranges in size from an 18" RCP to a 36" RCP at the outfall into Buffalo Bayou.

Summary of Existing Storm Sewer Hydraulic Analysis: The hydraulic analysis of the existing storm sewer systems show that most of the storm sewer systems do not fully meet the design criteria for pipe capacity. In addition, many of the storm sewer systems are more than 40 years old. The storm sewer system segments within the I-45 right-of-way drain the main lanes, but do not have adequate capacity to convey the 10-year design event flows at least for a part of the system. However, the 10-year hydraulic grade line (HGL) along the storm sewer systems is generally below the natural ground since the storm sewer systems are deep. The 100-year HGL along the storm sewer systems is below the main lane edge of pavement elevation. Due to a complex roadway network and underpasses in existing conditions, there are no clear overland flow paths to the outfall channel, the flows generally pond overland. The outflows to Buffalo Bayou are mostly through outfall pipes. Therefore, the difference between 10-year and 100-year outflows is not significant.

The 100-year backwater elevations from Buffalo Bayou inundate main lanes where they pass under Dallas Street (System F). The flows in the bayou peak more than 24 hours after the peak flows from the storm sewer systems have passed. The hydraulic grade line elevations along the storm sewer systems at key locations along the project are presented in **Table 9**, where they are also compared with proposed condition hydraulic grade line elevations.

Table 6. Existing Conditions Peak Flows Summary

System ID	Drainage Area (ac)	ROW Drain. (ac)	Size Range (in/ft)	Imper-vious (%)	C-value	Peak Flow (cfs)	
						10-year	100-year
Systems North of Buffalo Bayou							
A	25.74	5.05	18" RCP - 36" RCP	83.6%	0.79	80.1	82.5
B	5.71	4.51	18" RCP - 24" RCP	84.3%	0.78	11.0	18.7
D	13.90	2.35	18" RCP - 30" RCP	80.7%	0.77	55.0	51.3
Systems Over Buffalo Bayou							
C	15.45	14.63	Overland Flow	74.7%	0.77	84.2	126.4
Systems South of Buffalo Bayou							
E	7.17	2.08	18" RCP - 24" RCP	24.1%	0.39	15.8	24.1
F	9.77	9.77	18" RCP - 42" RCP	79.3%	0.78	60.9	77.9
G	772.34	4.73	18" RCP - 120" RCP	76.5%	0.71	923.5	1345.5
H	6.90	4.22	18" RCP - 36" RCP	60.8%	0.67	35.1	51.4
I	14.61	11.08	18" RCP - 36" CMP	57.9%	0.68	62.8	87.4
Total	**871.59**	**58.42**		76.0%	0.71		

Notes:

1. The peak flows are from the SWMM hydraulic model at the outfall into Buffalo Bayou.
2. Since there are no clear overland flow paths to the outfall channel, the flows generally pond overland. The outflows to Buffalo Bayou are mostly through outfall pipes. Therefore, the difference between 10-year and 100-year outflows is not significant.
3. System D 10-year outflows are slightly higher than 100-year outflows because the 100-year tailwater in Buffalo Bayou is significantly higher than the 10-year tailwater. Therefore, there is more resistance for outflow during the 100-year storm event. Another reason is Houston Avenue underpass under Memorial Drive. The overland storage/ponding in this underpass is greater during the 100-year than during the 10-year, thereby reducing the outflow.
4. The SWMM models were run at 5 seconds, whereas the graphical output was recorded at 60 seconds. The peak outflow values presented in the table are from the graphical output and not the tabular output. This was done in order to read the peak outflows from the storm sewer systems rather than backflow from Buffalo Bayou. Negligible differences may be observed between the graphical and tabular outputs.

5.0 Proposed Drainage System Improvements

The proposed Segment 3E improvements will demolish the existing I-45 roadway in Segment 3E and construct new Downtown Connectors. As part of these improvements, new storm sewer systems are proposed to drain the right-of-way and provide adequate design capacity. The existing City of Houston storm sewer systems that cross the right-of-way will be kept in place. However, the design concept presented in this study either disconnects the right-of-way drainage areas from the existing City of Houston storm sewer systems or reduces flows from the right-of-way to the existing City of Houston storm sewers. This is achieved by proposing new storm sewer systems to drain the right-of-way directly to Buffalo Bayou. The proposed storm sewer systems are described in detail in **Table 7**. The system flows are summarized in **Table 8**. The proposed storm sewer systems and drainage areas are shown in **Exhibit 7**, and the drainage subareas within each system, detailed storm sewer configuration, and hydraulic analysis nodes are shown in **Exhibit 8**. The detailed rational method parameters, peak flows, and hydraulic analysis results are presented in **Appendix D**.

Since the proposed storm sewers will convey runoff from the main lanes, they were designed to convey the 10-year design flows at full pipe capacity. The hydraulic grade line elevations along the proposed storm sewers at key points along the project are compared with existing condition hydraulic grade line elevations in **Table 9**.

System A: The right-of-way area from the existing System A will be redirected to proposed System B. The offsite areas will continue to drain as in existing conditions. The existing System A and the proposed System B will not be interconnected. The System B (Alternative 1) storm sewer will cross underneath the existing System A. The area diverted to proposed System B is 5.74 acres, which reduces the drainage area of this system to 20.00 acres.

System B: The proposed System B will replace the existing System B and extend it further north to include drainage areas from existing System A. Two alternatives were analyzed for System B:

1. **Alternative 1 (Recommended):** Alternative 1 will separate the right-of-way drainage from the existing System A (City of Houston system) and provide adequate drainage for the right-of-way. In existing conditions it was determined that there was no proper drainage for the right-of-way in System A due to lack of storm sewer lateral connections and inlets. The proposed System B storm sewer will pass underneath the existing System A, but the systems will not be interconnected. The proposed Alternative 1 will range in size from a 24" RCP to a 5'x3' RCB and will drain approximately 11.45 acres. This is the recommended alternative for System B since it causes minimal impacts to Buffalo Bayou while maintaining the design capacity along the project.
2. **Alternative 2:** Alternative 2 is similar in concept to Alternative 1, except that the proposed System B will be interconnected with existing System A. Some of the flows from the project right-of-way will continue to drain to existing System A, however, they will be less than existing conditions. This system ranges in size from a 24" RCP to a 5'x4' RCB. The impacts to Buffalo Bayou, are higher for this alternative since offsite flows from the existing City of Houston system upstream are connected to the new storm sewer allowing more flow to discharge into the bayou.

System C: The right-of-way areas adjacent to the channel banks and the proposed bridges over Buffalo Bayou will continue to drain directly to Buffalo Bayou as in existing conditions.

System D: The System D will be upgraded within the right-of-way to provide adequate capacity to meet the design criteria within the right-of-way. The existing storm sewer system upstream of the right-of-way will not be modified. The proposed System D improvements will include upgrading the outfall into Buffalo Bayou to a 5'x3' RCB. The drainage area contributing to proposed System D is same as in existing conditions.

System E: System E will be replaced with a larger system to adequately convey the design storm event. The system will maintain the same alignment as in existing conditions. The proposed System E will range in size from a 24" RCP to a 36" RCP, and will drain the same drainage area as in existing conditions.

System F: The proposed System F will drain majority of the project right-of-way south of Buffalo Bayou. The storm sewer system will drain into a detention basin just south of Allen Parkway and will ultimately discharge into Buffalo Bayou. There are two alternatives presented proposed for System F:

1. **Alternative 1 (Recommended):** The Alternative 1 will drain a total of 33.26 acres and will range in size from a 24" RCP to a 42" RCP. This system will runoff from main lanes as well as the NBFR (Pease Street) and a portion of SBFR (Heiner Street) south of Buffalo Bayou. The frontage road drainage will be diverted from the existing System G to proposed System F, however, the proposed System F will not be interconnected with existing System G as in existing conditions. Alternative 1 is the recommended alternative since it does not include drainage areas outside the right-of-way, thereby minimizing the storm sewer size. The impacts to Buffalo Bayou are also lower for Alternative 1.
2. **Alternative 2:** Alternative 2 is similar to Alternative 1 except that it recommends including the offsite area from existing System G east of the right-of-way (along Andrews Street) into the proposed System F. This adds approximately 45.40 acres of additional area to System F, making the total system drainage area 78.66 acres. This increases flows to the system, thereby increasing the storm sewer sizes. The system ranges in size from 24" RCP to 9'x6' RCB.

The current study proposes two interconnected detention basins that will collect flow from the proposed System A (Alternative 1) and mitigate the drainage impacts for the entire watershed. The impact analysis, mitigation and the detention basin details are presented in section 6 of this document.

System G: The right-of-way drainage areas currently draining to existing System G will be diverted to proposed System F (Alternative 1) in proposed conditions. Therefore in proposed conditions, System G will only receive flows from offsite areas. The System G will still cross the right-of-way as in existing conditions, but no flow from the right-of-way will drain to it. The drainage area of this system is reduced to 766.23 acres.

System H: No improvements are recommended to System H since it outfalls outside the project right-of-way. Some of the subareas within the right-of-way will be diverted to System F or System I. Only 1.04 acres will drain through the existing system.

System I: The System I will be replaced with a new storm sewer system. Some of the areas from the existing System I will be diverted to the proposed System A, while some of the areas from the existing System H will be included in proposed System I. The net area draining through the proposed System I is less than in existing conditions. The proposed System H ranges in size from a 24" RCP to a 30" RCP and will drain approximately 3.09 acres.

Table 7. Proposed Storm Sewer Improvements Summary

System ID	Existing System	Proposed System	Notes
A	18" RCP - 36" RCP	No Improvements	ROW area diverted to proposed System B and disconnected from existing System A.
B (Alternative 1)	18" RCP - 24" RCP	24" - 5'x3' RCB	ROW area diverted from existing System A.
C	Overland Flow	Overland Flow	Sheet flow to channel from adjacent areas and flow from bridges directly over Buffalo Bayou.
D	18" RCP - 30" RCP	18" RCP - 5'x3' RCB	The 18" RCP is upstream and outside the ROW. It is not being replaced.
E	18" RCP - 24" RCP	24" RCP - 36" RCP	System upsized to meet design criteria. Existing alignment is maintained.
F (Alternative 1)	18" RCP - 42" RCP	24" - 42" RCP	Outfalls into Detention Basins. Outflow is restricted to mitigate impacts of entire project.
G	18" RCP - 120" RCP	No Improvements	ROW area diverted to System F and disconnected from System G.
H	18" RCP - 36" RCP	No Improvements	Drainage area partially diverted to System F and System I.
I	18" RCP - 36" CMP	24" RCP - 30" RCP	Drainage area diverted to System F. Less area draining to Outfall I in proposed conditions.

Table 8. Proposed (Unmitigated) Conditions Peak Flows Summary

System ID	Drainage Area (ac)	ROW Drain. (ac)	Size Range (in/ft)	Imper-vious (%)	C-value	Peak Flow (cfs) 10-year	Peak Flow (cfs) 100-year
Systems North of Buffalo Bayou							
A	20.00	--	18" RCP - 36" RCP No Improvements	80.8%	0.77	73.5	80.4
B	11.45	9.56	24" RCP - 5'x3' RCB	89.4%	0.82	68.4	101.7
D	13.90	2.35	18" RCP - 5'x3' RCB	80.8%	0.77	54.4	62.9
Systems Over Buffalo Bayou							
C	15.45	14.63	Overland Flow	72.5%	0.76	83.0	124.5
Systems South of Buffalo Bayou							
E	7.17	2.08	24" RCP	14.2%	0.33	14.5	21.8
F	33.26	27.90	24" RCP - 42" RCP	55.0%	0.65	162.4	237.9
G	766.23	--	18" RCP - 120" RCP No Improvements	76.4%	0.71	917.5	1341.9
H	1.04	--	36" RCP No improvements	30.5%	0.46	3.9	5.5
I	3.09	1.90	24" RCP - 30" RCP	45.5%	0.59	11.6	17.1
Total	**871.59**	**58.42**		75.2%	0.71		

Notes:

1. The peak flows are from the SWMM hydraulic model at the outfall into Buffalo Bayou.
2. Since there are no clear overland flow paths to the outfall channel, the flows generally pond overland. The outflows to Buffalo Bayou are mostly through outfall pipes. Therefore, the difference between 10-year and 100-year outflows is not significant.
3. The unmitigated flows for System F were determined by adding all the inflow hydrographs into the proposed basins (described in Section 6). This represents the total unmitigated flows.
4. The SWMM models were run at 5 seconds, whereas the graphical output was recorded at 60 seconds. The peak outflow values presented in the table are from the graphical output and not the tabular output. This was done in order to read the peak outflows from the storm sewer systems rather than backflow from Buffalo Bayou. Negligible differences may be observed between the graphical and tabular outputs.

Table 9. Hydraulic Analysis Summary – Existing and Proposed Conditions

General Location	Roadway Station	10-year WSE (ft)			100-year WSE (ft)			NG/ Gutter El. (ft)
		Exis	Prop	Pr-Ex	Exis	Prop	Pr-Ex	
Franklin Street	255+00	37.95	24.45	-13.51	38.59	25.15	-13.44	38.09
Preston Street	253+50	36.34	24.45	-11.90	37.45	25.15	-12.30	38.01
Houston Aquarium	250+00	35.27	24.05	-11.22	36.02	24.67	-11.35	38.45
Memorial Drive	246+00	31.80	10.34	-21.46	32.01	18.41	-13.60	36.21
Houston Avenue	234+00	17.06	14.16	-2.90	22.67	21.37	-1.30	24.75
Walker Street	236+00	17.22	14.98	-2.24	19.07	18.14	-0.93	20.74
Sam Houston Park	230+00	21.87	18.73	-3.13	21.98	18.87	-3.11	25.50
Allen Parkway	224+00	27.01	25.23	-1.78	27.43	26.36	-1.07	36.00
ML Underpass at Dallas St. (Filled to Natural Ground in Proposed Conditions)	215+50	26.72	23.62	-3.09	29.02	27.56	-1.45	33.00
Andrews Street	208+50	29.28	24.31	-4.98	31.09	28.97	-2.12	46.70
St. Josephs Parkway Underpass at Cleveland St. (Filled to Natural Ground in Proposed Conditions)	203+50	29.64	25.86	-3.79	31.41	29.91	-1.51	30.02

Notes:

1. WSE from the nearest SWMM node was used at street locations and may not represent the exact location.
2. The existing 10-year and 100-year HGLs are generally below the natural ground elevation due to deep storm sewers, but the storm sewer systems do not meet the 10-year storm event design capacity criteria. The proposed 10-year and 100-year HGLs are lower than existing due to larger more efficient proposed storm sewers and also due to reconfiguration of storm sewers and redirection of drainage areas to different outfalls in proposed conditions.

5.1 Quantities and Cost Estimation

Storm sewer and detention basin quantities and costs are presented in **Table 10**. A contingency of 20% was applied to the cost along with engineering and construction management fees. The focus of the current study is trunk line design, therefore, the storm sewer quantities for the trunk line were estimated based on the hydraulic model for the recommended alternative. The current study does not include inlet and lead level analysis. The quantities for the pipe leads from inlets to the trunk line were estimated based on the assumption that there will be at least a 100-foot lead pipe connecting every manhole to the nearest inlet on either side of the manhole. The lead pipes were assumed to be 24" RCPs. The quantities were estimated for the recommended alternatives for System B and System F. The estimate of storm sewer quantities presented in this report is preliminary in nature and is subject to change based on final roadway and drainage design. **Please note that the cost is preliminary and includes only storm sewer and detention items.**

Table 10. Summary of Storm Sewer and Detention Quantities and Preliminary Cost Estimate

A.	COST SUMMARY					
TOTAL BASE COST						$3,842,782
CONTINGENCY (20% OF BASE UNIT PRICE)						$768,556
TOTAL BASE COST + CONTINGENCY						$4,611,338
ENGINEERING FEE (20% OF BASE+CONTINGENCY)						$922,268
CONSTRUCTION MANAGEMENT (5% OF BASE+CONTINGENCY)						$230,567
TOTAL COST						$5,764,173
B.	BASE UNIT PRICE TABLE:					
Item No.	Item Description	Unit Measure	Unit Quantity	Unit Price		Total in Figures
1	MOBILIZATION	LS	1	$250,000.00		$250,000.00
2	Traffic Control	LS	1	$100,000.00		$100,000.00
STORM SEWER						
3	REMOV STR (PIPE)	LF	11,803	$16.00	$188,843.15	
4	REMOV STR (INLET)	EA	80	$470.00	$37,600.00	
5	REMOV STR (MANHOLE)	EA	40	$500.00	$20,000.00	
6	MANH (COMPL)(PRM)(48IN)	EA	40	$3,300.00	$132,000.00	
7	INLET (COMPL)(CURB)(TY C)	EA	56	$4,200.00	$235,200.00	
8	SET (TY II) (54 IN) (RCP) (6: 1) (C)	EA	6	$6,900.00	$41,400.00	
9	INLET BRIDGE DECK DRAIN	EA	28	$5,000.00	$140,000.00	
10	MANH (COMPL)(TY A)	EA	24	$3,200.00	$76,800.00	
11	PIPE (PVC) (SCH 40) 8"	LF	700	$42.00	$29,400.00	
12	24-inch RCP	LF	4,353	$64.00	$278,568.94	
13	30-inch RCP	LF	2,187	$77.00	$168,388.38	
14	36-inch RCP	LF	3,642	$110.00	$400,630.25	
15	42-inch RCP	LF	987	$125.00	$123,368.23	
18	5x3 RCB	LF	634	$400.00	$253,662.41	
20	EXCAVATION (DITCH)	CY	3537	$12.00	$42,446.22	
21	TRENCH EXCAVATION PROTECTION	LF	11,803	$3.00	$35,408.09	
22	DEWATERING	LF	1,500	$25.00	$37,500.00	
23	SWPPP	LF	11,803	$4.00	$47,210.79	
24	HEADWALL/WINGWALL	EA	5	$10,000.00	$50,000.00	
25	TEMPORARY DRAINAGE				$100,000.00	
	SubTotal of Storm Sewer					$2,438,426.47
DETENTION						
26	PREPARING ROW	AC	3.71	$3,700.00	$13,727.00	
27	EXCAVATION	CY	43,366	$10.00	$433,664.00	
28	BACKSLOPE DRAINAGE SWALE	LF	2,565	$5.00	$12,825.00	
29	BACKSLOPE DRAINAGE INTERCEPTOR STRUCTURE	EA	13	$4,500.00	$57,712.50	
30	INLET/OUTLET STRUCTURE	EA	1	$25,000.00	$25,000.00	
31	HYDRO MULCH SEEDING ON DETENTION BASIN	AC	5.2	$2,200.00	$11,426.80	
	SubTotal of Detention					$554,355.30
32	UTILITY CONFLICTS	LS	1	$500,000.00		$500,000.00
TOTAL BASE COST						$3,842,781.77

6.0 Drainage Impact Analysis and Mitigation

A drainage impact analysis was also performed for the project to analyze the impacts of the following: (i) Increase in impervious area due to new pavement, (ii) increase in conveyance due to the proposed storm sewer improvements, and (iii) impacts due to fill in the floodplain due to construction of the new roadways. The total proposed right-of-way area is 58.42 acres. The existing pavement area is 38.43 acres, and the proposed pavement area is 32.46 acres. The replacement of the existing I-45 with proposed Downtown Connectors will not increase the pavement impervious area within the right-of-way. However, the existing storm sewer systems are inadequate to convey the design flows, which require upsizing in the proposed conditions. The hydraulic efficiency of the proposed storm sewer systems will cause adverse flow impacts to Buffalo Bayou as shown in **Table 11**. Redirection of the right-of-way drainage areas to drain directly to the bayou will also cause adverse peak flow impacts.

Table 11. Peak Flow Impacts to Buffalo Bayou

System ID	Drainage Area (ac)		Proposed Peak Flow (cfs)		Existing Peak Flow (cfs)		Peak Flow Impact (cfs)	
	Existing	Proposed	10-year	100-year	10-year	100-year	10-year	100-year
Systems North of Buffalo Bayou								
A	25.74	20.00	73.5	80.4	80.1	82.5	-6.6	-2.1
B	5.71	11.45	68.4	101.7	11.0	18.7	57.4	82.9
D	13.90	13.90	54.4	62.9	55.0	51.3	-0.6	11.7
Systems Over Buffalo Bayou								
C	15.45	15.45	83.0	124.5	84.2	126.4	-1.3	-1.9
Systems South of Buffalo Bayou								
E	7.17	7.17	14.5	21.8	15.8	24.1	-1.3	-2.3
F	9.77	33.26	162.4	237.9	60.9	77.9	101.5	160.0
G	772.34	766.23	917.5	1341.9	923.5	1345.5	-5.9	-3.6
H	6.90	1.04	3.9	5.5	35.1	51.4	-31.2	-45.9
I	14.61	3.09	11.6	17.1	62.8	87.4	-51.2	-70.2
Total	**871.59**	**871.59**	**1389.1**	**1993.7**	**1328.4**	**1865.1**	**60.7**	**128.6**

Notes:

1. The SWMM models were run at 5 seconds, whereas the graphical output was recorded at 60 seconds. The peak outflow values presented in the table are from the graphical output and not the tabular output. This was done in order to read the peak outflows from the storm sewer systems rather than backflow from Buffalo Bayou. Negligible differences may be observed between the graphical and tabular outputs.

6.1 Minimum Required Detention Volume

The current study proposes mitigation of peak flow impacts within two (2) interconnected detention basins just south of Allen Parkway. The basins are shown in **Exhibit 9**. The basins will receive flows from the proposed System A and mitigate the impacts for the entire project. Based on this concept, the allowable outflow from the proposed basins was calculated and is summarized in **Table 12**. The minimum required detention volume for mitigation of peak flow impacts was determined using the linear detention estimation method as shown in **Figure 1**. The minimum required detention volume for peak flow impact mitigation is 3.7 acre-feet. This volume is the minimum required volume, whereas the final volume will depend upon flow routing, system inefficiencies, and backwater effects from Buffalo Bayou.

Table 12. Detention Basin Allowable Outflow and Minimum Required Detention Volume

Flow Component	10-year	100-year
Proposed Basin Inflow from System F, cfs	162.4	237.9
Proposed Unmitigated Outflows from Other Systems, cfs **(1)**	1226.7	1755.8
Total Existing Outflow from All Systems, cfs **(2)**	1328.4	1865.1
Allowable Outflow from System F/Basins, cfs **(2) - (1)**	101.7	109.3
Minimum Required Detention Volume - Linear Estimate, ac-ft	3.7	

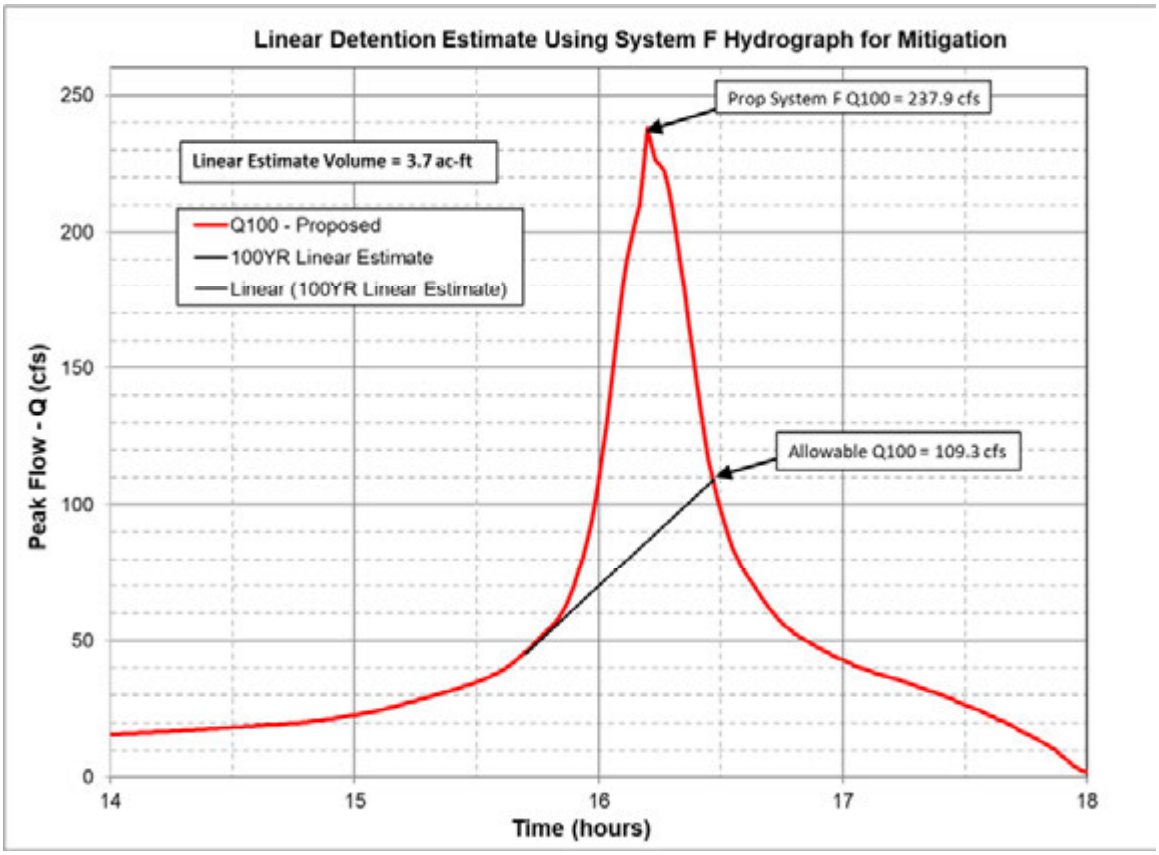


Figure 1. Minimum Required Detention Volume Estimate

6.2 Floodplain Fill Calculations

A preliminary analysis was performed for the project based on the Design Schematic to determine the net fill in the floodplain due to the proposed improvements. The net fill in the floodplain was calculated based on the Corrected effective condition 100-year flood elevation in Buffalo Bayou in the vicinity of the project, which is approximately 40.02 feet. The proposed fill in the floodplain is due to the following: (i) filling of the two (2) existing underpasses along the highway (I-45 at Dallas Street and St. Joseph Parkway at south project limit) to natural ground elevation, (ii) proposed frontage roads over Buffalo Bayou, and (iii) proposed retaining walls for ramps. The Design Schematic does not provide bridge abutments for frontage road bridges. The current study assumes that the proposed frontage bridge abutments will encroach up to the FEMA effective floodway. It was also assumed that the abutments and the approach roads in the floodplain fringe will be supported on retaining walls. The total fill in the floodplain due to the proposed improvements was calculated to be 21.0 acre-feet.

Based on the natural ground elevation in the area, the top of the proposed basin is approximately 35.00 feet. The existing condition in this area is comprised of main lanes raised on embankments to an elevation of approximately 53.00 feet. These embankments will be removed in the proposed conditions to construct the new main lanes and the detention basins. These modifications will add approximately 10.0 acre-feet of storage to the existing floodplain.

The net fill in the floodplain is the difference between the total fill in the floodplain minus the total cut in the floodplain, which amounts to 11.0 acre-feet. This volume will be provided within the proposed detention basins along with the volume for peak flow impact mitigation. The floodplain cut and fill volume components are summarized in **Table 13**.

Table 13. Floodplain Cut and Fill Summary

Component	Volume
	(ac-ft)
Fill in 100-year Floodplain	21.0
Cut in 100-year Floodplain	10.0
Net Fill in 100-year Floodplain	11.0

6.3 Detention Routing Analysis and Detention Basin Configuration

The proposed detention basins will be located just south of Allen Parkway as shown on **Exhibit 9**. The results of the detention routing analysis are summarized in **Table 14**. The proposed detention basins will receive flows from proposed System F and will provide peak flow impact mitigation for the entire project. The east detention basin is referred to as Basin 1 and the west detention basin is referred to as Basin 2. The proposed System F main trunk will discharge into Basin 1, whereas some of the areas adjacent to Basin 2 will discharge directly into Basin 2. The outflow to Buffalo Bayou will be from Basin 1 only. The basins will be interconnected with a 5'x3' RCB. The Basins will have a top elevation of 35.00 feet. The natural ground near the southern boundary of the basins will be excavated to achieve the basin top. Therefore, the proposed basin tops will be located below the 100-year water surface elevation along

Buffalo Bayou. Basin 1 will have a bottom elevation of 15.00 feet and will provide a total volume of 11.7 acre-feet. Basin 2 will have a bottom elevation of 24.00 feet and will provide a total volume of 7.5 acre-feet. Both the basins together will provide a total volume of 19.1 acre-feet. The outflow restrictor from Basin 1 will be comprised of a 36" RCP restrictor.

The 100-year allowable outflow into Buffalo Bayou is 109.3 cfs, and the 100-year discharge from the basins into Buffalo Bayou is 108.8 cfs, which is less than allowable. The 100-year water surface elevation in Basin 1 is 26.34 feet, whereas that in Basin 2 is 26.36 feet. The basins have the required minimum 3-foot freeboard above the 100-year water surface elevation. The total volume utilized for peak flow impact mitigation is approximately 4.5 acre-feet. The additional volume available in the basins is 14.6 acre-feet, which is adequate to compensate for the net fill in the floodplain, which is 11.0 acre-feet.

The 100-year water surface elevations in the basins represent the elevations based on the storm sewer hydraulics. The peak 100-year water surface elevation in Buffalo Bayou is at 40.02 feet and occurs several hours later inundating the basins.

Table 14. Detention Pond Routing Summary

Detention Basin Details	Unit	Basin 1		Basin 2	
Detention Basin Drainage Area	(ac)	33.26			
Detention Basin Surface Area (Including 20' Maintenance Berms)	(ac)	1.64		2.07	
Basin Flowline Elevation	(ft)	15.00		24.00	
Pond Top Elevation	(ft)	35.00		35.00	
Volume Summary					
Total Proposed Basin Volume	(ac-ft)	11.7		7.5	
Drainage Impact Mitigation Volume (100-year)	(ac-ft)	3.9		0.6	
Floodplain Fill Compensation Volume	(ac-ft)	11.0			
		10-year		100-year	
Detention Routing Details	**Unit**	**Basin 1**	**Basin 2**	**Basin 1**	**Basin 2**
Total Basin Inflow	(cfs)	162.4		237.9	
Total Allowable Outflow	(cfs)	101.7		109.3	
Proposed Basin Outflow	(cfs)	89.1		108.8	
Water Surface Elevation	(ft)	23.31	25.23	26.34	26.36
Detention Volume (below WSE)	(ac-ft)	2.3	0.3	3.9	0.6
Connection Between Basins					
Size of Connection Between Basins	(ft)	5'x3' RCB			
Basin Restrictor					
Restrictor Size	(in)	36" RCP			
Restrictor Length	(ft)	486			

Notes:

1. The 10-year WSE in Basin 1 is lower than the flowline of Basin 2, which explains the difference in 10-year WSE between Basin 1 and Basin 2.
2. The 100-year water surface elevations in the basins represent the elevations based on the storm sewer hydraulics. The peak 100-year water surface elevation in Buffalo Bayou is at 40.02 feet and occurs several hours later inundating the basins.
3. The SWMM models were run at 5 seconds, whereas the graphical output was recorded at 60 seconds. The peak outflow values presented in the table are from the graphical output and not the tabular output. This was done in order to read the peak outflows from the storm sewer systems rather than backflow from Buffalo Bayou. Negligible differences may be observed between the graphical and tabular outputs.

Based on the recommendations presented above, the proposed roadway, storm sewer, and the detention basin improvements along Segment 3E will not cause adverse impacts to Buffalo Bayou for storm events up to and including the 1% (100-year) storm event. The proposed improvements will also not cause adverse impacts to water surface elevations along the roadway.

7.0 Bridge Hydraulic Analysis

There are eight (8) bridges within the I-45 right-of-way that cross Buffalo Bayou in existing conditions. The bridges are identified as follows: (i) I-45 SBML Exit Ramp Bridge to Dallas Street (Pierce Elevated), (ii) I-45 SBML Bridge, (iii) I-45 SBML Exit Ramp Bridge to Allen Parkway, (iv) I-45 SBML Bridge, (v) I-45 NBML Exit Ramp Bridge to Houston Avenue, (vi) I-45 NBML Entrance Ramp Bridge from Allen Parkway/Pease Street, (vii) I-45 SBML Exit Ramp Bridge to McKinney Street , and (viii) I-45 NBML Entrance Ramp Bridge from Walker Street. All the existing bridges have concrete decks supported with steel beams over concrete bents and circular concrete columns. The columns range from 30 inches to 42 inches in diameter.

7.1 FEMA Effective Model

The FEMA effective hydraulic model for Buffalo Bayou is a steady state HEC-RAS model. The I-45 right-of-way is located between HEC-RAS stations 116078.2 and 114492.0. The base (100-year) flood elevation across the right-of-way is approximately 37.00 feet. The effective model includes only four (4) of the eight (8) existing bridges in the I-45 right-of-way. The bridges included in the model are the following: I-45 SBML Bridge, I-45 SBML Exit Ramp Bridge to Allen Parkway, I-45 NBML Exit Ramp Bridge to Houston Avenue, and I-45 NBML Entrance Ramp Bridge. The effective model also does not model many of the bridge columns that are located within the floodplain. The bridge stations/locations are also not accurate. The FEMA effective water surface elevations across the I-45 right-of-way are presented in **Table 15**. Detailed HEC-RAS outputs and cross sections are included in **Appendix E**.

7.2 Corrected Effective Model

As part of the overall Segment 3 drainage study, LAN is assisting TxDOT with a detailed hydraulic analysis of Buffalo Bayou. The steady FEMA effective HEC-RAS model was converted to an unsteady HEC-RAS model. The unsteady model extends approximately 6 miles upstream of the I-45 right-of-way. White Oak Bayou and Little White Oak Bayou, which are tributaries of Buffalo Bayou, were also included in the unsteady model. The hydraulic analysis for Segment 3E, however, focuses on the hydraulic impacts along Buffalo Bayou only. LAN also made other updates to the model based on the latest survey to represent the latest existing conditions. Dannenbaum acquired the unsteady model from LAN and updated the existing Segment 3E bridges with the latest topographic survey. The bridges missing in the effective model were added, and all the columns in the floodplain were represented. Cross sections were added and modified within the I-45 right-of-way to model all the bridges. The columns underneath the elevated main lanes north of the bayou are spread over several cross sections. These columns were modeled as blocked obstructions in the nearest cross sections. The updated unsteady model serves as the Corrected Effective Model. The corrected effective water surface elevations are compared with FEMA effective water surface elevations in **Table 15**. The corrected effective water surface elevations are generally more than 3.00 feet higher than the FEMA effective water surface elevations. This is due to the more accurate unsteady model, which accounts for hydrograph timing in the channel along Buffalo Bayou combined with hydrograph timing of inflows from White Oak Bayou. Detailed HEC-RAS outputs and cross sections are included in **Appendix E**.

7.3 Proposed Model

The Proposed Model was developed by updating the Corrected Effective Model with proposed bridges. The approach used to model the main lane, ramp, and frontage road bridges is presented below. All the proposed bridges were assumed to have deck thickness and column configuration similar to existing bridges. A deck thickness of 5.0 feet was assumed to be supported by 36" diameter circular columns.

1. Main lane bridges: The Design Schematic provides the vertical profile of the main lanes, and abutment and bent locations (spans) of the main lanes bridges. The Design Schematic does not provide the diameter of the bridge columns. The main lane bridges are elevated several feet above the 100-year water surface elevation and meet the minimum freeboard requirement of 2.50 feet. The main lane profile and spans were updated in the model as per the Design Schematic.
2. Ramp Bridges: The Design Schematic provides the abutment locations of the ramp bridges, but it does not provide the bent locations (spans) and vertical profiles. A minimum required freeboard of 1.50 feet above the 100-year water surface elevations was assumed and a preliminary profile was set within the model. The bent locations/spans were assumed to be similar to main lane bridges.
3. Frontage Road Bridges: The Design Schematic does not provide the abutment locations or vertical profile of the frontage road bridges. A minimum required freeboard of 1.50 feet above the 100-year water surface elevations was assumed and a preliminary profile was set within the model. The abutments were assumed to be located at the floodway boundary. The bent locations/spans were assumed to be similar to main lane bridges.

Since the alignments of the proposed bridges is different from the existing bridges, cross sections within the right-of-way were added/modified in proposed conditions. Also, similar to corrected effective conditions, blocked obstructions were used to model the columns that are spread out over several cross sections north of Buffalo Bayou. The corrected effective and proposed condition water surface elevations are compared in **Table 15**. Detailed HEC-RAS outputs and cross sections are included in **Appendix E**.

The current study evaluates the hydraulic impacts of the proposed bridge replacements in Segment 3E only in order to separate the hydraulic impacts of Segment 3E from the hydraulic impacts of bridge replacements in other segments. The bridge hydraulic impact analysis also does not include any detention mitigation measures provided by other segments. In addition, the effects of the North Canal and South Canal Projects was also not considered. The effect of all the proposed bridge replacements in all the segments and the proposed channel improvements are being analyzed by LAN. The proposed Segment 3E bridges were provided to LAN to include in their overall proposed conditions model.

Table 15. Bridge Hydraulic Analysis – FEMA Effective, Corrected Effective, Proposed Conditions

Location	River Station			10-yr Flow (cfs)			10-YR Water Surface Elevation (ft)					100-yr Flow (cfs)			100-YR Water Surface Elevation (ft)				
	FEMA Effective	Corrected Effective	Proposed	FEMA Eff.	Corr. Effective	Prop-osed	FEMA Eff.	Corr. Effective	Prop-osed	Diff. CE-Eff	Diff. Pr-CE	FEMA Eff.	Corr. Effective	Prop-osed	FEMA Eff.	Corr. Effective	Prop-osed	Diff. CE-Eff	Diff. Pr-CE
Downstream of ROW	113644.0	113644.0	113644	8535	9124	9070	28.30	29.89	29.77	1.59	-0.12	17393	18912	19007	36.52	39.66	39.68	3.14	0.02
	114043.4	114043.4	114043.4	8535	9131	9100	28.33	29.93	29.81	1.60	-0.12	17393	18913	19020	36.58	39.71	39.74	3.13	0.03
	114070.4	114070.4	114070.4	Capitol Street Bridge															
	114097.4	114097.4	114097.4	8535	9148	9139	29.34	30.97	30.76	1.63	-0.21	17393	18929	19058	36.65	39.77	39.79	3.12	0.02
	114141.9	114141.9	114141.9	8535	9132	9109	29.34	30.96	30.75	1.62	-0.21	17393	18923	19041	36.63	39.76	39.78	3.13	0.02
	114168.9	114168.9	114168.9	Rusk Street Bridge															
	114195.9	114195.9	114195.9	8535	9190	9186	29.36	31.02	30.79	1.66	-0.23	17393	19013	19100	36.74	39.86	39.86	3.12	0.00
	114492	114492	114492	8535	9203	9197	29.37	31.04	30.82	1.67	-0.22	17393	19025	19105	36.75	39.91	39.91	3.16	0.00
Segment 3E ROW			114804.3	--	--	9171	--	--	30.81	--	--	--	--	19079	--	--	39.90	--	--
			114830	Proposed Downtown Connector NBML Entrance Ramp from Walker Street															
		114838.5		--	9174	--	--	31.04	--	--	--	--	18991	--	--	39.90	--	--	--
			114842.1	--	--	9173	--	--	30.82	--	--	--	--	19084	--	--	39.90	--	--
	114864.5	114864.5		FEMA Effective/Existing I-45 NBML Entrance Ramp from Walker Street															
		114885.0		--	9276	--	--	31.21	--	--	--	--	19036	--	--	39.97	--	--	--
		114890.5		--	9280	--	--	31.21	--	--	--	--	19039	--	--	39.97	--	--	--
			114907.3	--	--	9178	--	--	30.83	--	--	--	--	19079	--	--	39.91	--	--
		115000.0	115000.0	Existing I-45 SBML Exit Ramp to McKinney Street (Not modeled in FEMA Effective)/Proposed Downtown Connector SBML Exit Ramp to McKinne															
		115001.1	115001.2	--	9280	9170	--	31.21	30.82	--	-0.39	--	19043	19082	--	39.99	39.91	--	-0.08
		115104.1	115104.1	--	9325	9182	--	31.23	30.84	--	-0.39	--	19053	19078	--	40.02	39.94	--	-0.08
	115123.0			8535	--	--	30.04	--	--	--	--	17393	--	--	36.82	--	--	--	--
	115168.5	115168.5		FEMA Effective/Existing I-45 NBML Exit Ramp to Houston Avenue															
	115214.0			8535	--	--	30.06	--	--	--	--	17393	--	--	36.88	--	--	--	--
		115284.6	115284.6	--	9341	9174	--	31.24	30.84	--	-0.40	--	19064	19076	--	40.08	39.94	--	-0.14
		115365.4	115365.4	--	9337	9177	--	31.25	30.84	--	-0.41	--	19057	19070	--	40.07	39.94	--	-0.13
		115400.0		Existing I-45 NBML (Not modeled in FEMA Effective)															
			115423	--	--	9174	--	--	30.84	--	--	--	--	19064	--	--	39.94	--	--
		115438.9		--	9332	--	--	31.24	--	--	--	--	19059	--	--	40.08	--	--	--
			115490	Proposed Downtown Connector NBML															
			115509.1	--	--	9170	--	--	30.84	--	--	--	--	19067	--	--	39.96	--	--
			115514.4	--	--	9169	--	--	30.84	--	--	--	--	19066	--	--	39.96	--	--
	115533.5			8535	--	--	30.08	--	--	--	--	17393	--	--	36.93	--	--	--	--
		115545.8		--	9327	--	--	31.25	--	--	--	--	19049	--	--	40.09	--	--	--
	115553.5	115553.5	115553.5	FEMA Effective/Existing I-45 SBML Exit Ramp to Allen Parkway/Proposed Downtown Connector SBML															
	115573.5			8535	--	--	30.10	--	--	--	--	17393	--	--	36.95	--	--	--	--
			115587.7	--	--	9158	--	--	30.83	--	--	--	--	19067	--	--	39.95	--	--
		115594.6		--	9327	--	--	31.25	--	--	--	--	19053	--	--	40.09	--	--	--
	115615.5			8535	--	--	30.09	--	--	--	--	17393	--	--	36.94	--	--	--	--
		115621.1	115621.1	--	9326	9159	--	31.24	30.84	--	-0.40	--	19053	19058	--	40.09	39.94	--	-0.15
	115635.5	115635.5	115635.5	FEMA Effective/Existing I-45 SBML/Proposed SBFR Frontage Roads -Houston Avenue to Heiner Street Connection															
	115655.5			8535	--	--	30.09	--	--	--	--	17393	--	--	36.95	--	--	--	--
			115662.6	--	--	9148	--	--	30.83	--	--	--	--	19051	--	--	39.94	--	--
		115672.3		--	9309	--	--	31.23	--	--	--	--	19035	--	--	40.07	--	--	--
			115674.0	--	--	9147	--	--	30.83	--	--	--	--	19049	--	--	39.94	--	--
			115700.0	Proposed SBFR Frontage Roads -Houston Avenue to Heiner Street Connection															
		115729.9		--	9311	--	--	31.23	--	--	--	--	19031	--	--	40.07	--	--	--
			115740.6	--	--	9150	--	--	30.84	--	--	--	--	19061	--	--	39.97	--	--
		115800.0		Existing I-45 Exit Ramp to Dallas Street (Pearce Elevated) (Not modeled in FEMA Effective)															
		115804.5	115804.5	--	9311	9144	--	31.24	30.83	--	-0.41	--	19038	19056	--	40.08	39.97	--	-0.11
Upstream of ROW	116076.2	116076.2	116076.2	8535	9317	9158	30.11	31.26	30.86	1.15	-0.40	17393	19033	19058	36.98	40.12	40.01	3.14	-0.11
	116121.9	116121.9	116121.9	Sabine Street															
	116167.6	116167.6	116167.6	8535	9331	9193	30.28	31.45	31.05	1.17	-0.40	17393	19060	19091	37.09	40.24	40.14	3.15	-0.10
	116395.7	116395.7	116395.7	8535	9355	9252	30.31	31.48	31.08	1.17	-0.40	17393	19065	19097	37.19	40.30	40.19	3.11	-0.11
	117204.3	117204.3	117204.3	8535	9326	9223	30.34	31.49	31.10	1.15	-0.40	17393	19019	19050	37.24	40.32	40.22	3.08	-0.10

Note: For the corrected effective and proposed conditions, the flows represent flows at the time of maximum water surface elevation.

7.4 Bridge Hydraulic Impacts Analysis and Mitigation

The results of the bridge hydraulic analysis show that the proposed bridges do not cause any adverse impacts to the 100-year or 10-year water surface elevations along Buffalo Bayou upstream of the project right-of-way. A minor impact of 0.01 to 0.03 feet was observed downstream of the project for both 10-year and 100-year storm events. In the case of 10-year, the impacts are observed a few miles downstream (not shown in Table 15). This is due to the efficiency of the proposed bridges, which have longer spans.

The proposed bridges analyzed in this study are preliminary in nature. The schematic does not provide any deck or column details. The hydraulic model will have to be updated during the final design phase to reevaluate the hydraulic impacts of the proposed bridges based on final design. It also has to be considered that the current study does not consider the benefits of detention mitigation measures along Buffalo Bayou implemented by other segments. In addition, the effects of the North Canal or South Canal Projects along Buffalo Bayou are also not considered.

Bridge Hydraulic Impact Mitigation: LAN's drainage report for Segment 3D (LAN Report) proposes a scenario (Scenario 4), which includes regional detention mitigation for roadway and bridge improvements in NHHIP Segment 3. This scenario does not include North Canal or South Canal Projects or any other channel improvement measures. The regional detention will eliminate the downstream water surface elevation impacts from Segment 3E bridges for the 10-year and 100-year storm events. The Scenario 4 results in drops in proposed condition water surface elevations of up to 0.05 feet compared to the corrected effective condition, downstream of the Segment 3E bridges.

The LAN Report also recommends Scenarios 1, 2, and 3, which include a combination of North Canal and South Canal Projects and other channel improvements. All the scenarios result in flood benefits upstream of I-69 and adverse hydraulic impacts downstream. LAN report recommends potential solutions to mitigate these impacts, which include regional detention (in addition to regional detention in Scenario 4) and/or safe controlled increase in water surface elevations. All the potential mitigation solutions will require state and local participation as per the LAN Report.

8.0 Conclusions

Segment 3E is approximately 6,000 feet in long. The project limits are located within the Buffalo Bayou Watershed. Buffalo Bayou, HCFCD Unit W100-00-00, is the only stream that crosses the project limits, and serves as outfall for the entire Segment 3E. The Segment 3E improvements include removing the section of the existing I-45 west of downtown and replacing it with Downtown Connectors. The Downtown Connectors will have a typical main lane, frontage road, and entrance and exit ramp configuration.

The existing I-45 right-of-way in Segment 3E is drained primarily by nine (9) existing storm sewer systems. The storm sewer systems were originally constructed between 1930s and 1970s, with some upgrades over the years. The existing systems range in size from 18" RCPs to 42" RCPs. Analysis of the existing storm sewer systems showed that the existing systems generally do not have adequate 10-year design capacity to drain the main lanes. In addition, many of the storm sewer systems are more than 40 years old. New storm sewer systems are proposed to drain the right-of-way and provide adequate design capacity. The existing City of Houston storm sewer systems that cross the right-of-way will be kept in place. The proposed storm sewer systems range in size from 24" RCPs to 5'x3' RCBs. Since the proposed storm sewers will convey runoff from the main lanes, they were designed to convey the 10-year design flows at full pipe capacity.

The replacement of the existing I-45 with proposed Downtown Connectors will not increase the pavement impervious area within the right-of-way. However, the proposed storm sewer systems provide additional capacity increasing flows into Buffalo Bayou and causing pea flow impacts. The detention volume provided to mitigate peak flow impacts is 4.5 acre-feet. Also, a net fill in the floodplain of 11.0 acre-feet was determined for the roadway improvements. The current study proposes volumes for peak flow impact mitigation and net floodplain fill compensation within two (2) interconnected detention basins just south of Allen Parkway. The proposed detention basins will receive flows from a proposed storm sewer system south of Buffalo Bayou and will provide mitigation for the entire project. The detention basins will also provide compensatory storage for the net fill in the floodplain.

There are eight (8) bridges within the I-45 right-of-way that cross Buffalo Bayou in existing conditions. The existing eight (8) bridges will be replaced with proposed bridges, which will have different alignments from existing bridges. A hydraulic impact analysis was performed based on an unsteady HEC-RAS model of Buffalo Bayou. The results of the bridge hydraulic analysis show that the proposed bridges do not cause any adverse impacts to the 100-year or 10-year water surface elevations along Buffalo Bayou upstream of the project right-of-way. A minor impact of 0.01 to 0.03 feet was observed downstream of the project for both 10-year and 100-year storm events. This is due to the efficiency of the proposed bridges, which have longer spans.

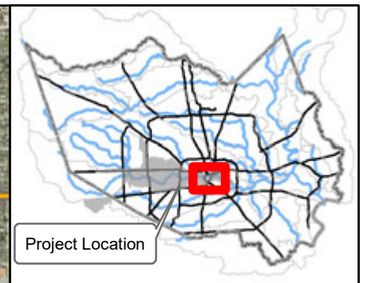
LAN's drainage report for Segment 3D (LAN Report) proposes a scenario (Scenario 4), which includes regional detention mitigation for roadway and bridge improvements in NHHIP Segment 3. This scenario does not include North Canal or South Canal Projects or any other channel improvement measures. The regional detention will eliminate the downstream water surface elevation impacts from Segment 3E

bridges for the 10-year and 100-year storm events. The Scenario 4 results in drops in proposed condition water surface elevations of up to 0.05 feet compared to the corrected effective condition, downstream of Segment 3E bridges.

The proposed bridges analyzed in this study are preliminary in nature. The schematic does not provide any deck or column details. The hydraulic model will have to be updated during the final design phase to reevaluate the hydraulic impacts of the proposed bridges based on final design. The current study also does not consider the effects of the North Canal or South Canal Projects along Buffalo Bayou, which are proposed to be constructed in the future.

Based on the drainage improvement recommendations in this study, the proposed roadway improvements along Segment 3E will not cause any adverse hydraulic impacts to Buffalo Bayou, HCFCD Unit W100-00-00, for storm events up to and including the 1% (100-year) storm event.

EXHIBITS



0 1,200 2,400
Feet

1 inch = 2,400 feet

N

Legend

- Drainage Channel
- Railroad
- Segment 3E
- Segment 3A
- Segment 3B
- Segment 3C
- Segment 3D
- HCFCD Watersheds

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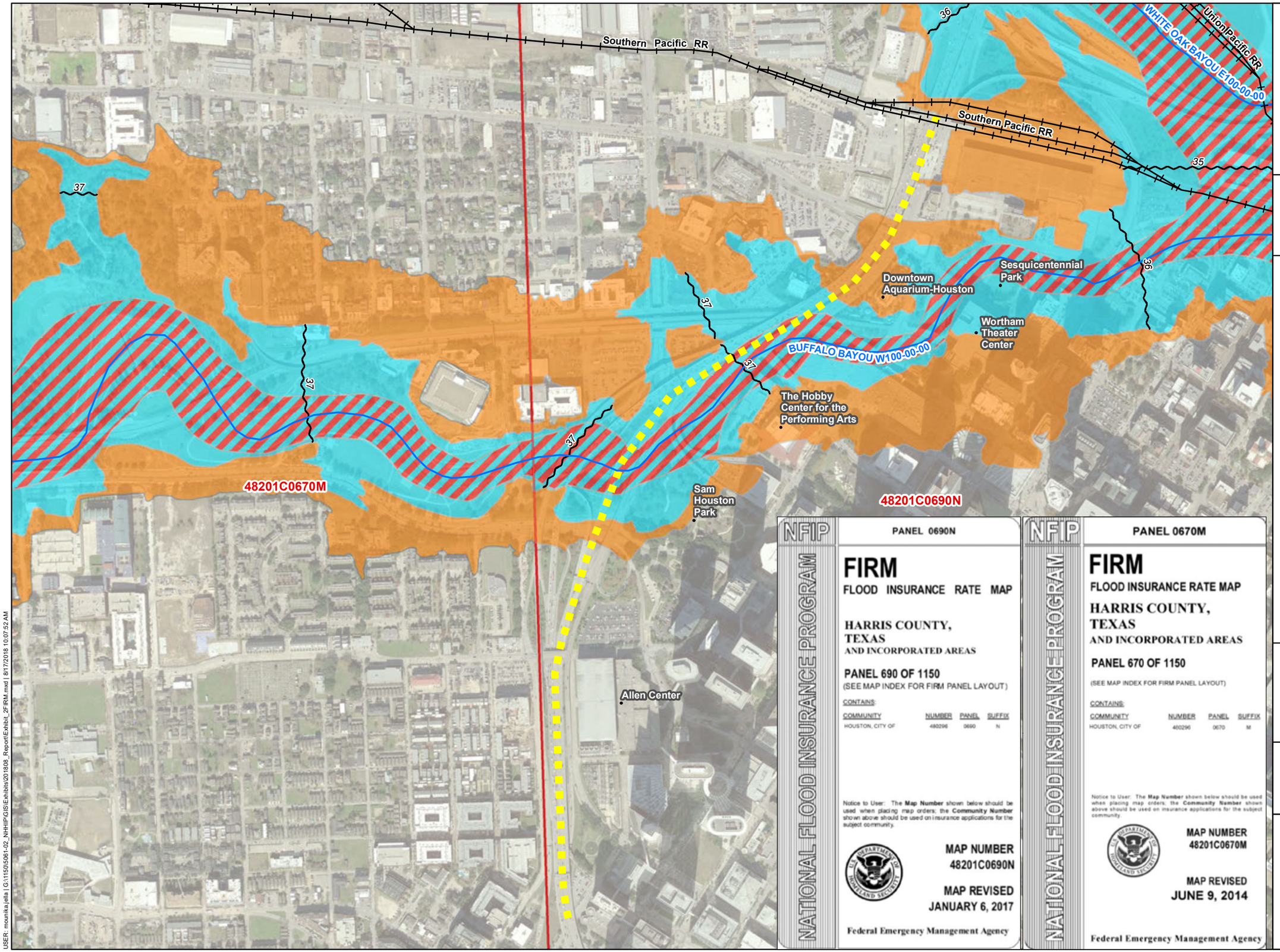
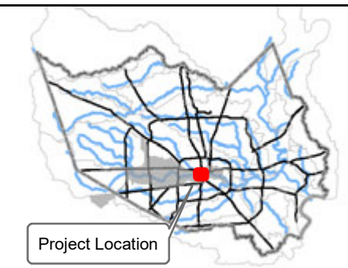
Drainage Study Report
NHHIP Segment 3E

EXHIBIT 1
Vicinity Map
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018





0 300 600
Feet

1 inch = 600 feet

N

Legend

- Railroad
- Drainage Channel
- Project Limits
- Base Flood Elevation
- Firm Panel

FEMA NFHL TEXAS FLOOD HAZARD AREAS

- AE
- AE, Floodway
- X, 0.2 Pct Annual Chance Flood Hazard
- X, Area Of Minimal Flood Hazard

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0690N

FIRM

FLOOD INSURANCE RATE MAP

HARRIS COUNTY, TEXAS
AND INCORPORATED AREAS

PANEL 690 OF 1150
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
HOUSTON, CITY OF	480296	0690	N

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

MAP NUMBER
48201C0690N

MAP REVISED
JANUARY 6, 2017

Federal Emergency Management Agency

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0670M

FIRM

FLOOD INSURANCE RATE MAP

HARRIS COUNTY, TEXAS
AND INCORPORATED AREAS

PANEL 670 OF 1150

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
HOUSTON, CITY OF	480296	0670	M

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

MAP NUMBER
48201C0670M

MAP REVISED
JUNE 9, 2014

Federal Emergency Management Agency

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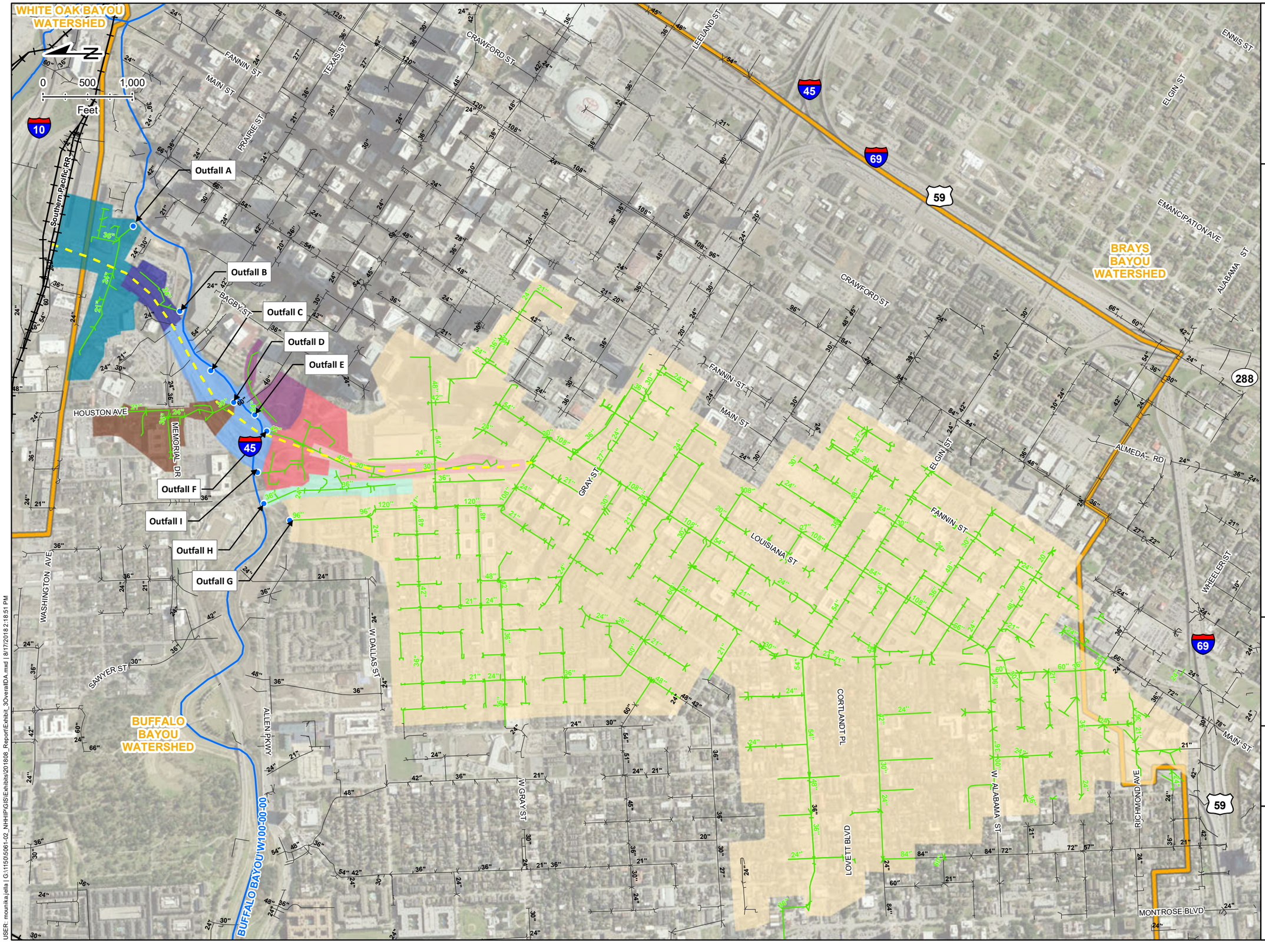
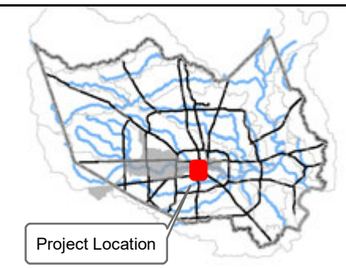
Drainage Study Report
NHHIP Segment 3E

EXHIBIT 2
FEMA Effective FIRM
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018





Legend

- Outfalls
- Drainage Channel
- Railroad
- Project Limits

Existing Storm Sewer

- Other Systems
- Project Systems
- HCFCD Watersheds

Existing Drainage Areas

- System A (25.74 acres)
- System B (5.71 acres)
- System C (15.45 acres)
- System D (13.90 acres)
- System E (7.17 acres)
- System F (9.77 acres)
- System G (772.34 acres)
- System H (6.90 acres)
- System I (14.61 acres)

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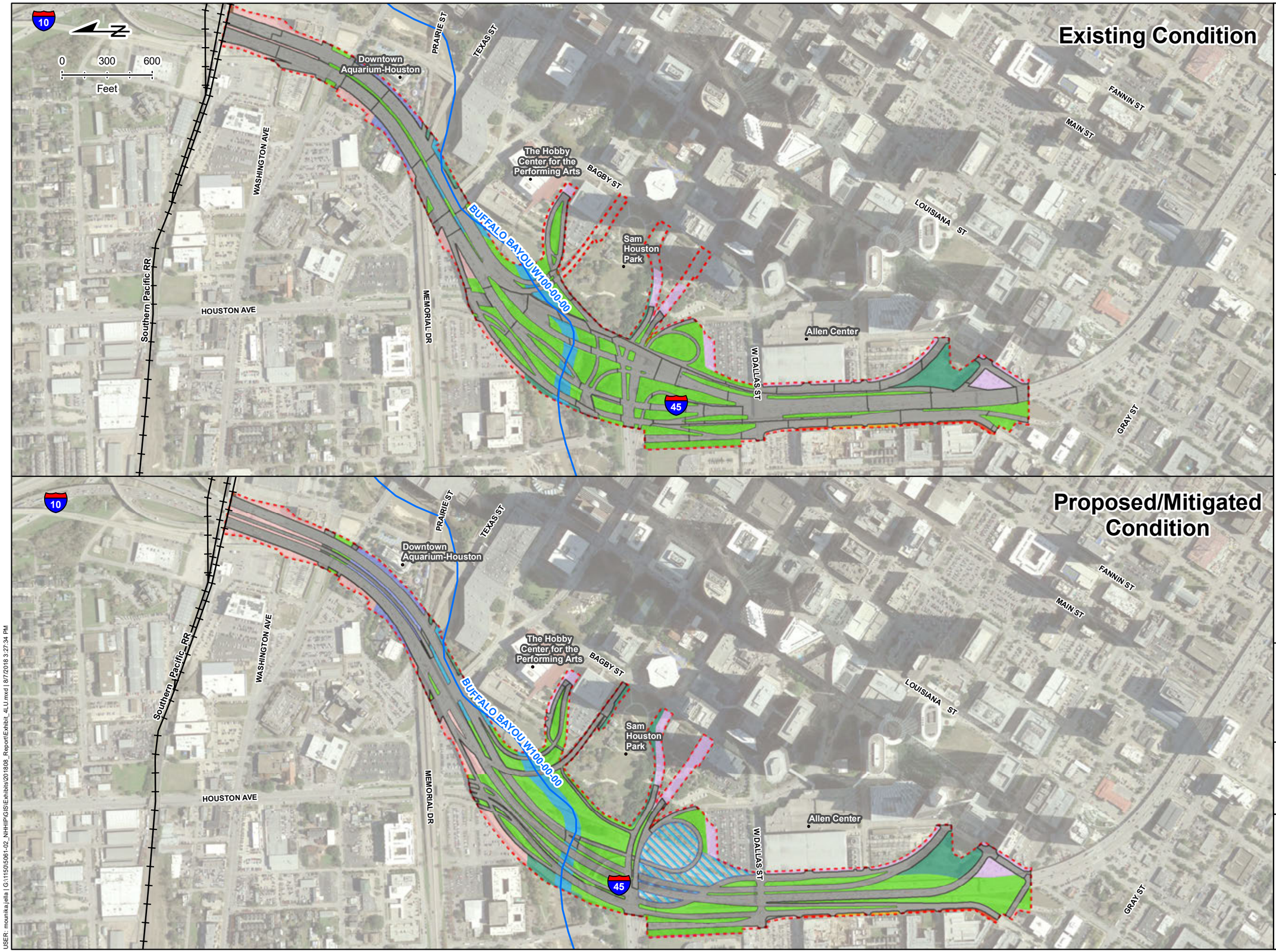
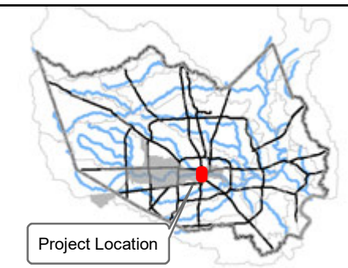
Drainage Study Report NHHIP Segment 3E

EXHIBIT 3
Overall Drainage Area Map
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018





Legend

- Railroad
- Drainage Channel
- ROW

Landuse

- Apartments
- Commercial/Industrial
- Commercial/Industrial Light
- Detention Basin
- Downtown Areas
- Multi-units
- Open Area
- Park/Cemetery
- Pavement
- Railroad
- School/Library/Public Buildings
- Single Family
- Water

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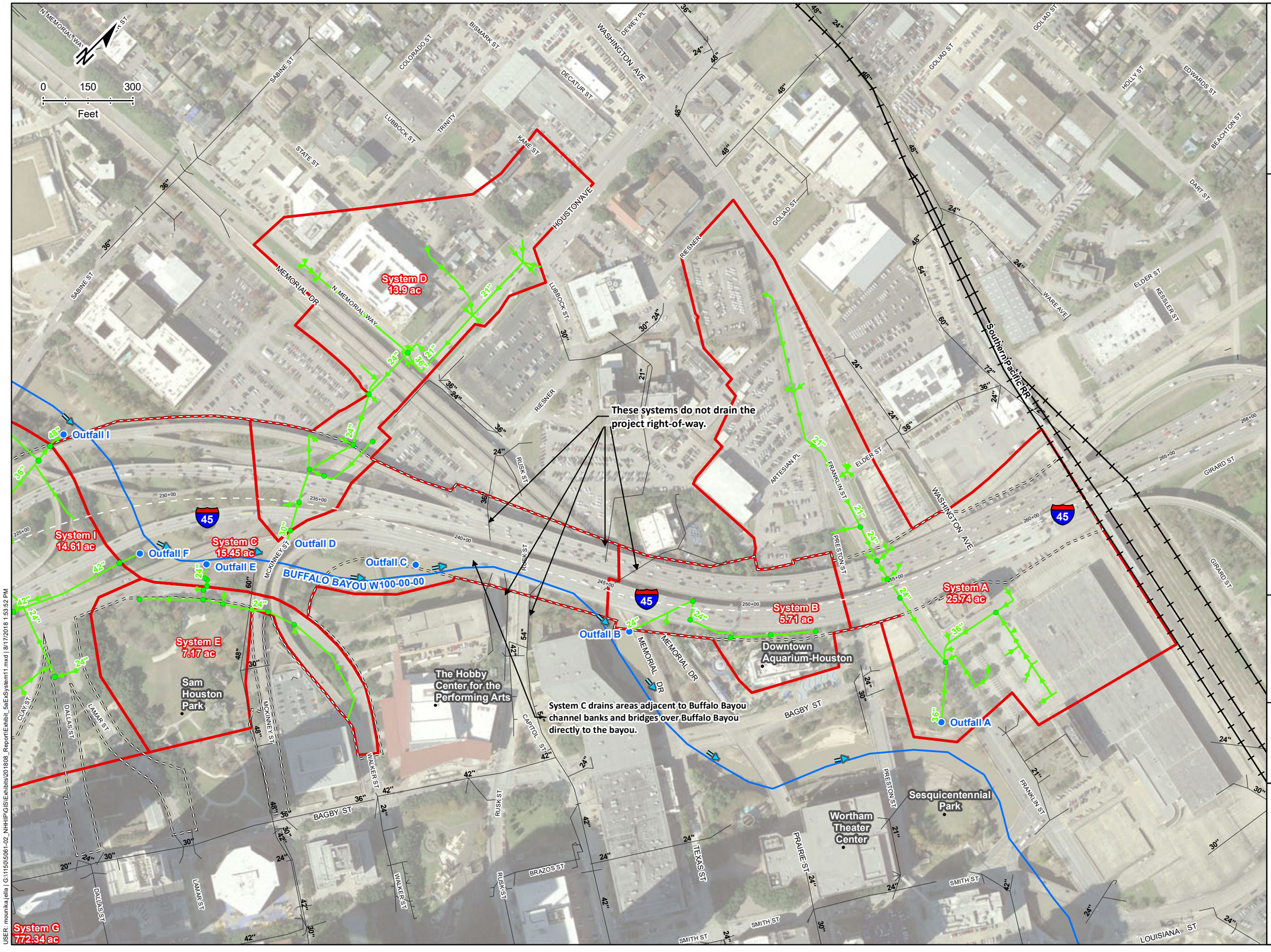
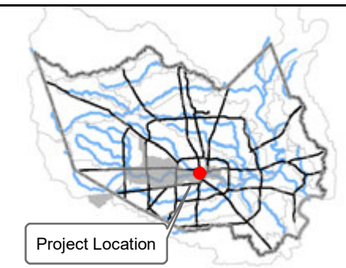
EXHIBIT 4
Right-of-way Landuse Map
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018





Legend

- Outfalls
- Existing Analysis Nodes
- Railroad
- Drainage Channel
- Channel Flow Direction

Existing Storm Sewer

- Other Storm Sewer
- Project Storm Sewer
- Existing Drainage Areas
- Right-of-Way

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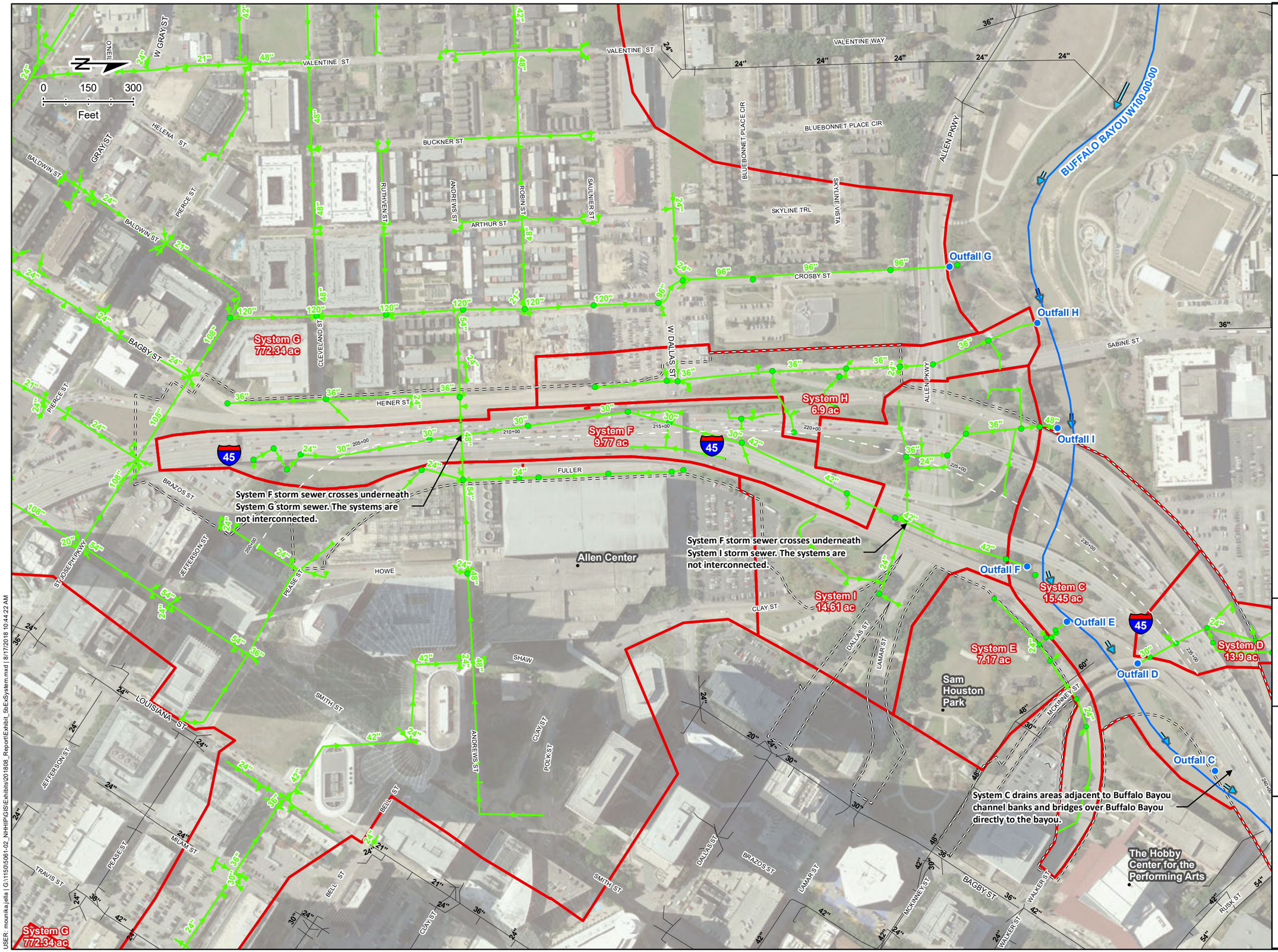
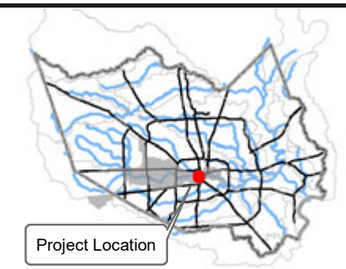
Drainage Study Report NHHIP Segment 3E

EXHIBIT 5a
Existing Drainage Systems Map
North of Buffalo Bayou
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018





Legend

- Outfalls
- Existing Analysis Nodes
- Channel Flow Direction
- Railroad
- Drainage Channel

Existing Storm Sewer

- Other Storm Sewer
- Project Storm Sewer
- Right-of-Way
- Existing Drainage Areas

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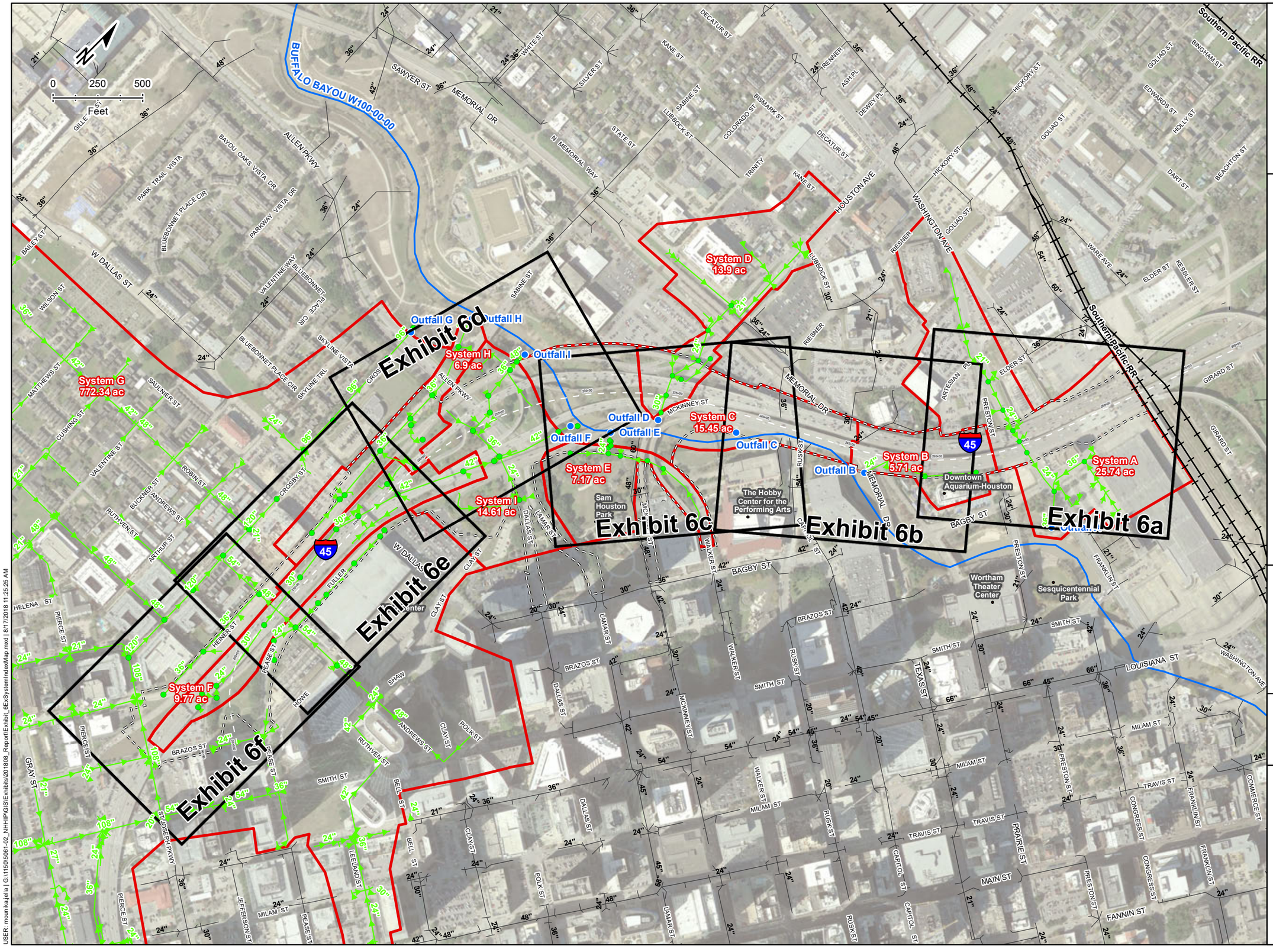
NHHIP Segment 3E

EXHIBIT 5b
Existing Drainage Systems Map
South of Buffalo Bayou
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018



USER: mounika.jella | G:\1150\50061-02_NHHIP\GIS\Exhibits\20180808_Report\Exhibit_6\ExSystemIndexMap.mxd | 8/17/2018 11:25:25 AM

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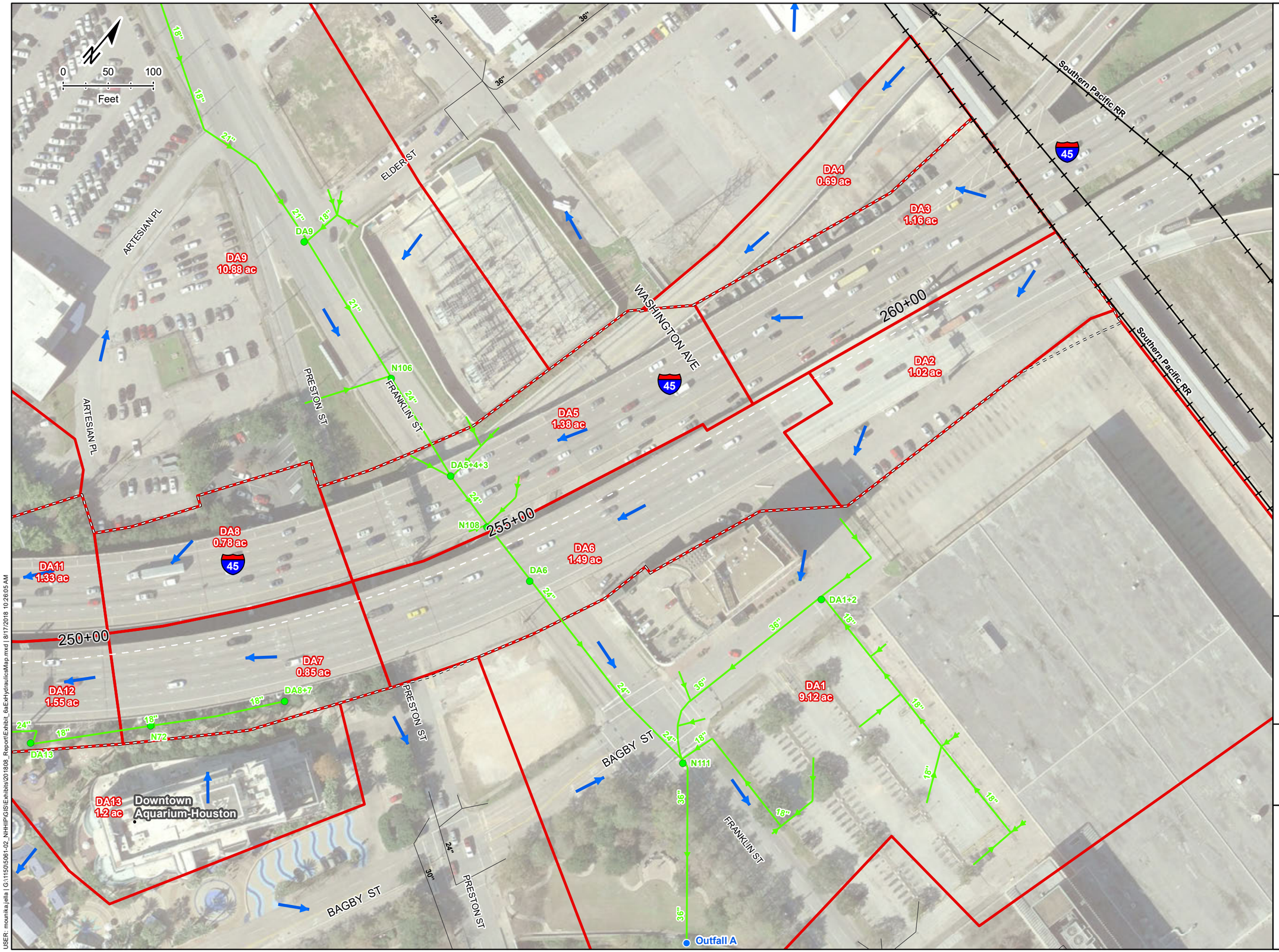
NHHIP Segment 3E

EXHIBIT 6
Existing System Hydraulics Map
Index Sheet
North of Buffalo Bayou
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018



Legend

- Outfalls
- Existing Analysis Nodes
- Railroad
- Drainage Channel
- Existing Overland Flow Path

Existing Storm Sewer

- Other Storm Sewer
- Project Storm Sewer
- Right-of-Way
- Existing Drainage Subareas

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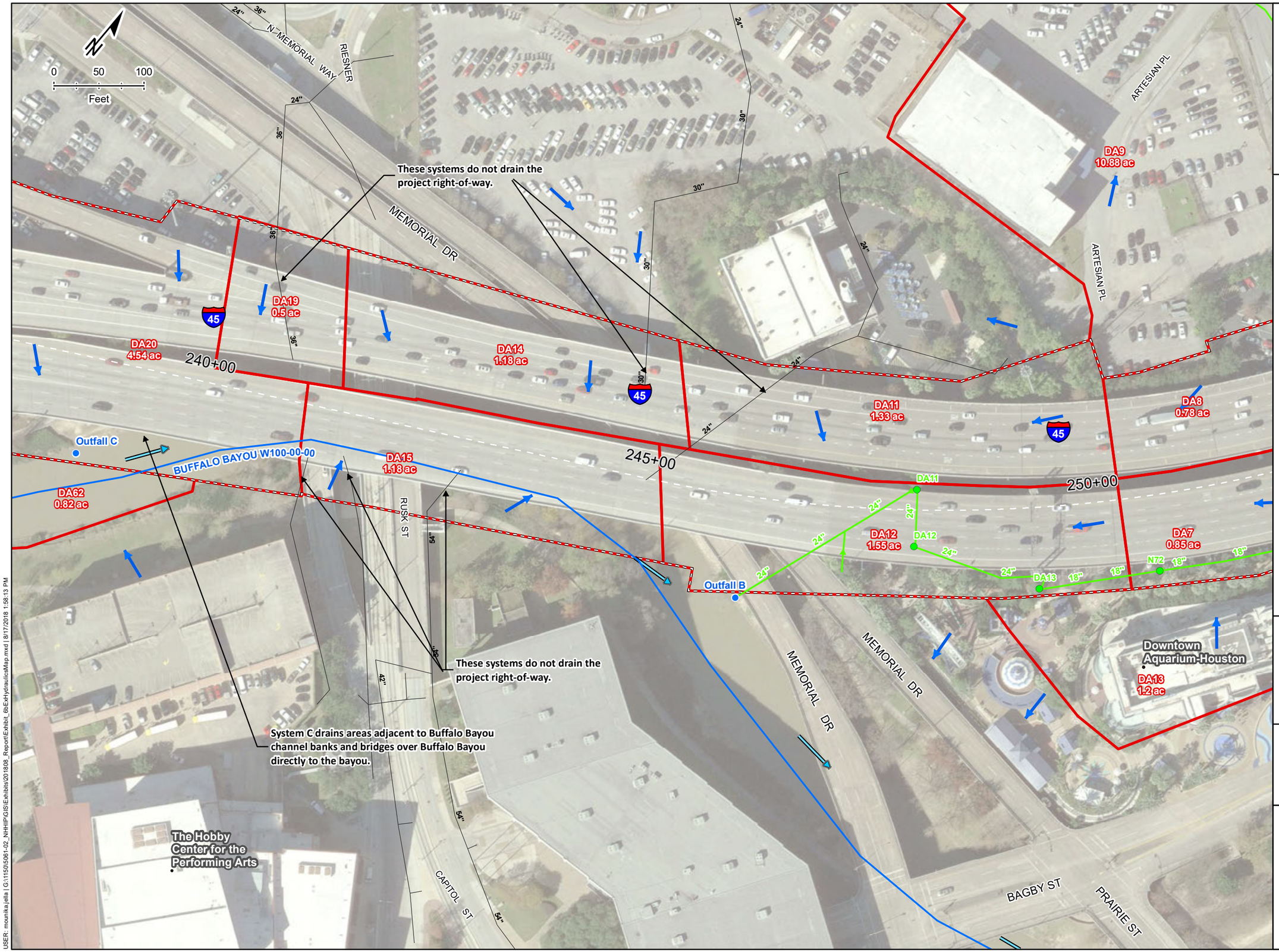
NHHIP Segment 3E

EXHIBIT 6a
Existing System Hydraulics Map
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018



Legend

- Outfalls
- Existing Analysis Nodes
- Railroad
- Drainage Channel
- Channel Flow Direction
- Existing Overland Flow Path

Existing Storm Sewer

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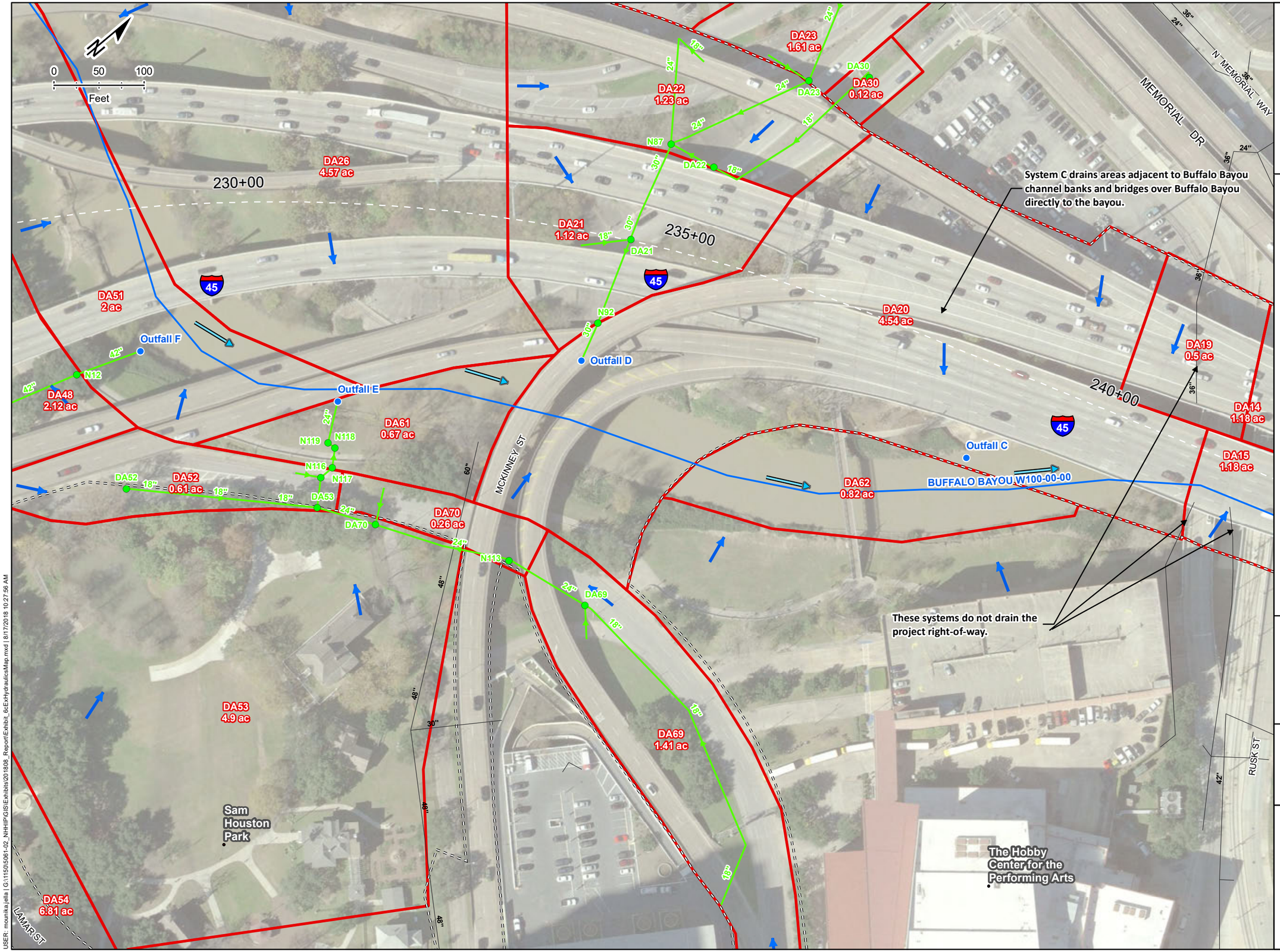
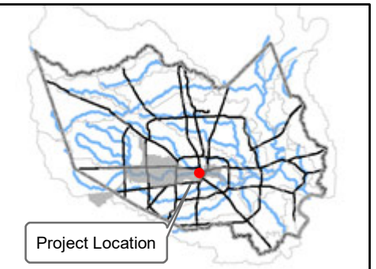
NHHIP Segment 3E

EXHIBIT 6b
Existing System Hydraulics Map
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018





Legend

- Outfalls
- Existing Analysis Nodes
- Railroad
- Drainage Channel
- Existing Overland Flow Path
- Channel Flow Direction

Existing Storm Sewer

- Other Storm Sewer
- Project Storm Sewer
- Right-of-Way
- Existing Drainage Subareas

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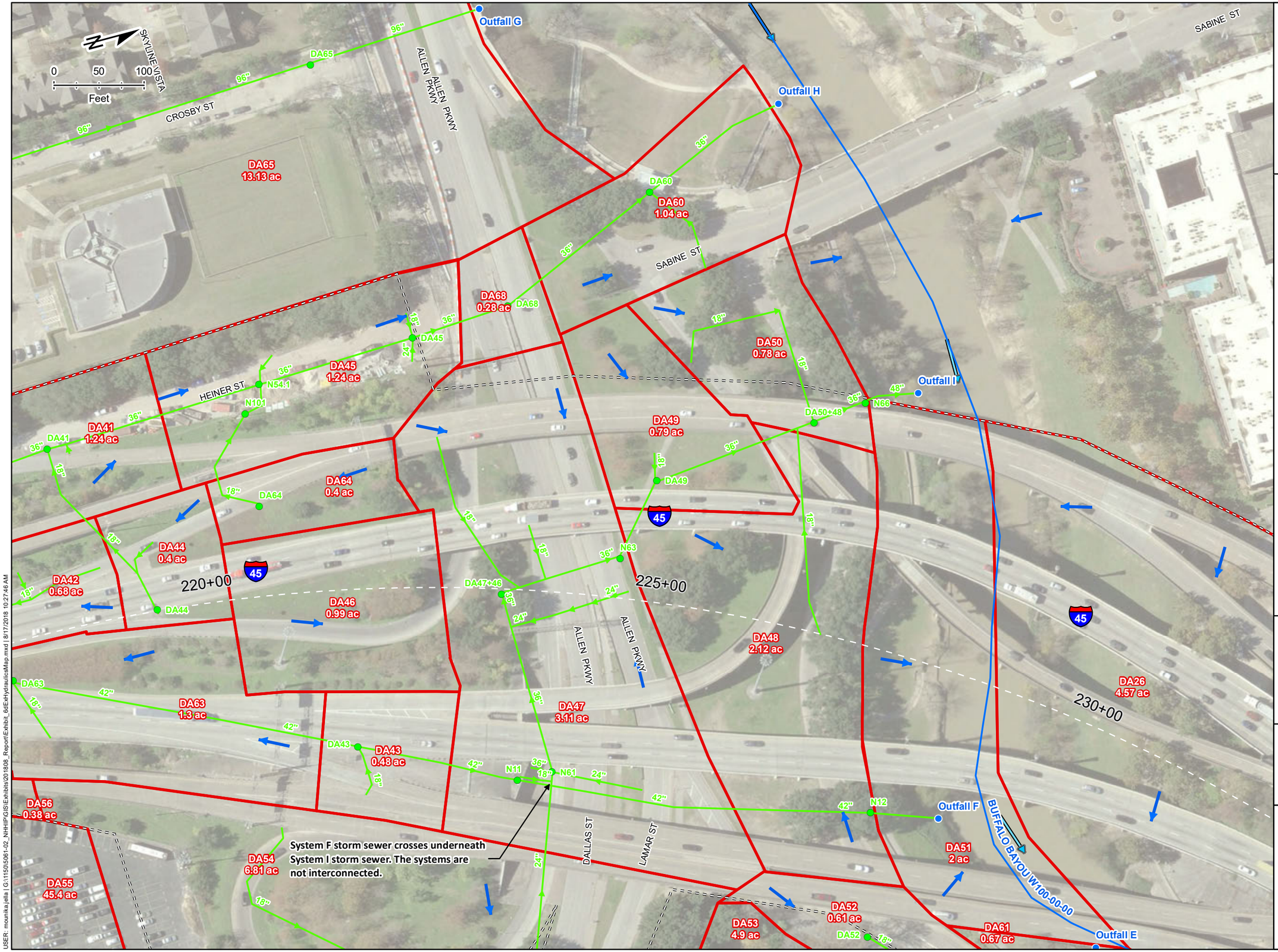
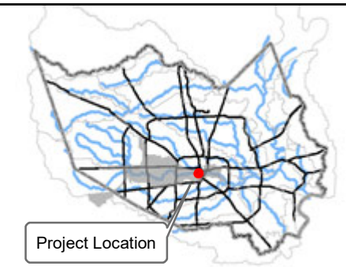
Drainage Study Report
NHHIP Segment 3E

EXHIBIT 6c
Existing System Hydraulics Map
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018





Legend

- Outfalls
- Existing Analysis Nodes
- Railroad
- Drainage Channel
- Channel Flow Direction
- Existing Overland Flow Path

Existing Storm Sewer

- Other Storm Sewer
- Project Storm Sewer
- Right-of-Way
- Existing Drainage Subareas

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EXHIBIT 6d
Existing System Hydraulics Map
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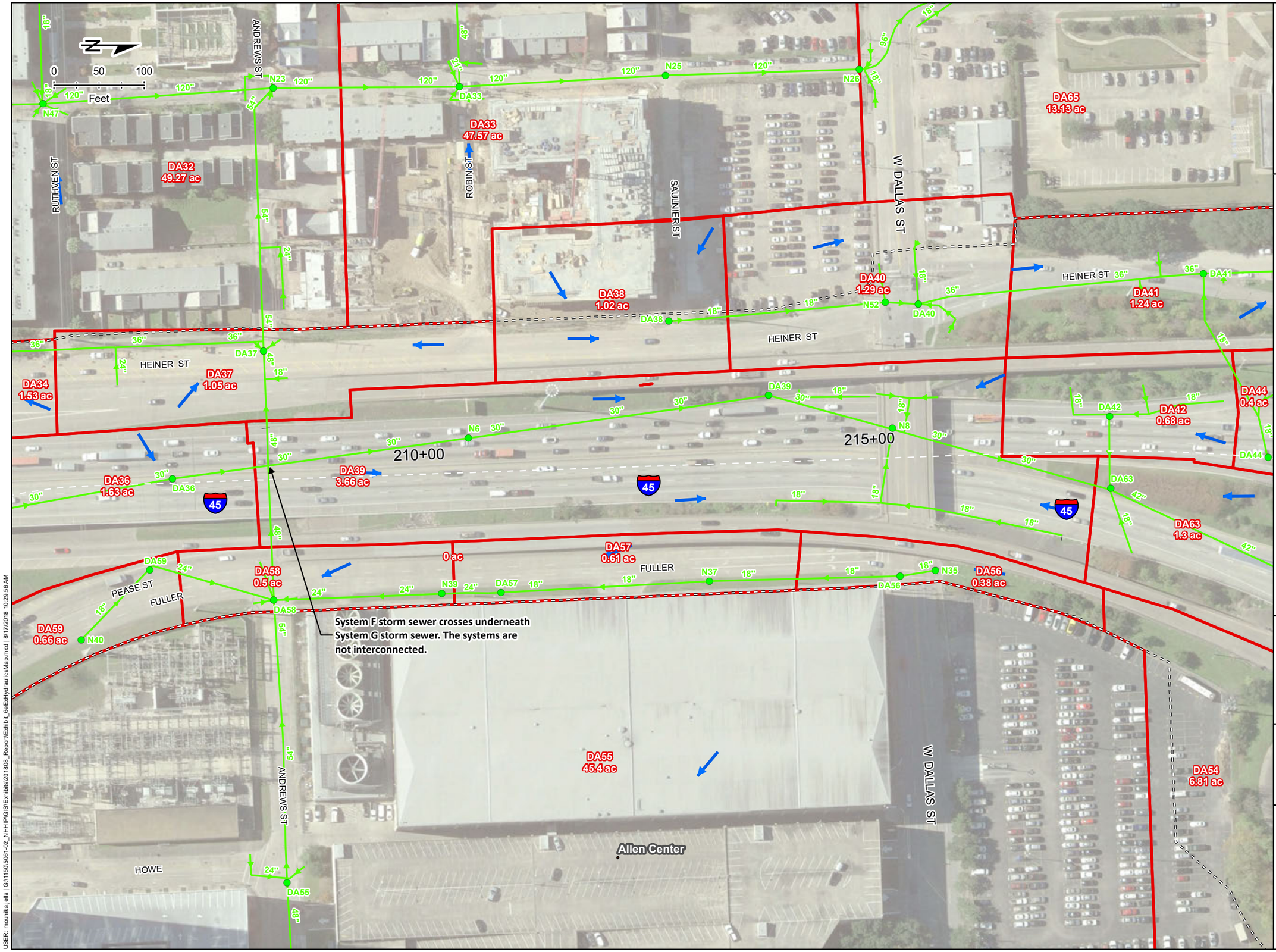
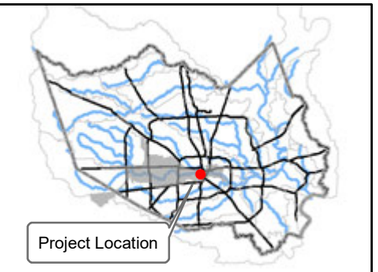
Project No. 5061-02
August, 2018





Legend

- Outfalls
- Existing Analysis Nodes
- Drainage Channel
- Railroad
- Existing Overland Flow Path

Existing Storm Sewer

- Other Storm Sewer
- Project Storm Sewer
- Right-of-Way
- Existing Drainage Subareas

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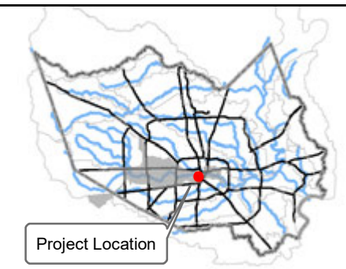
Drainage Study Report
NHHIP Segment 3E

EXHIBIT 6e
Existing System Hydraulics Map
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018



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NHHIP Segment 3E

EXHIBIT 6f
Existing System Hydraulics Map
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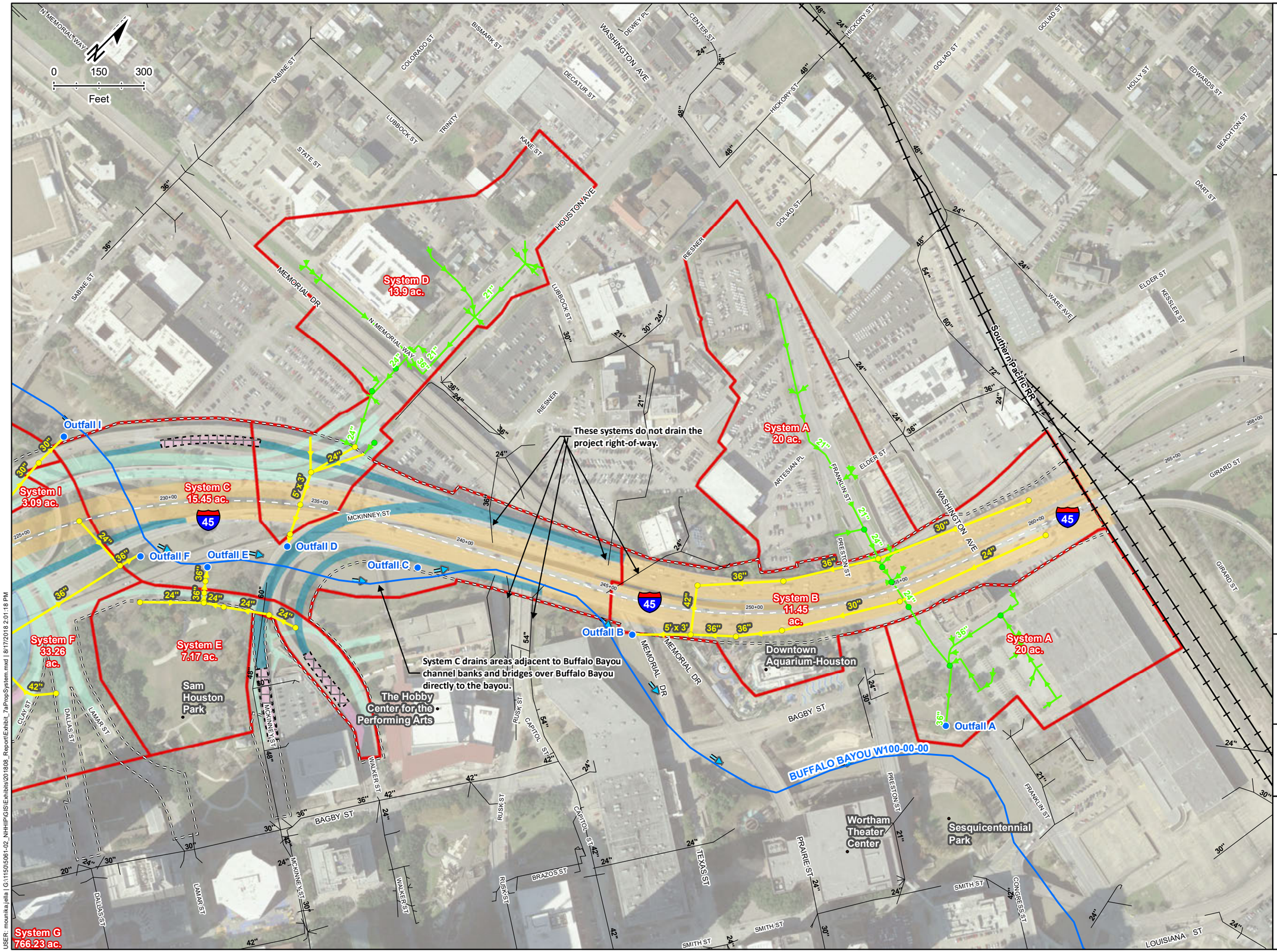
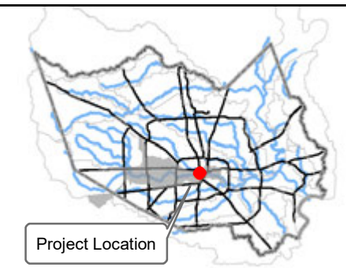
Project No. 5061-02
August, 2018





Legend

- Outfalls
- Proposed Analysis Nodes
- Existing Analysis Nodes
- Railroad
- Channel Flow Direction
- Drainage Channel
- Proposed Storm Sewer

Existing Storm Sewer

- Other Storm Sewer
- Project Storm Sewer
- Proposed Drainage Areas
- Proposed Retaining Wall
- Right-of-Way
- Proposed Detention Basin

Proposed Roadway

- Ramp
- Main Lanes
- Frontage Roads
- Ramp-Bridge
- Main Lane-Bridge

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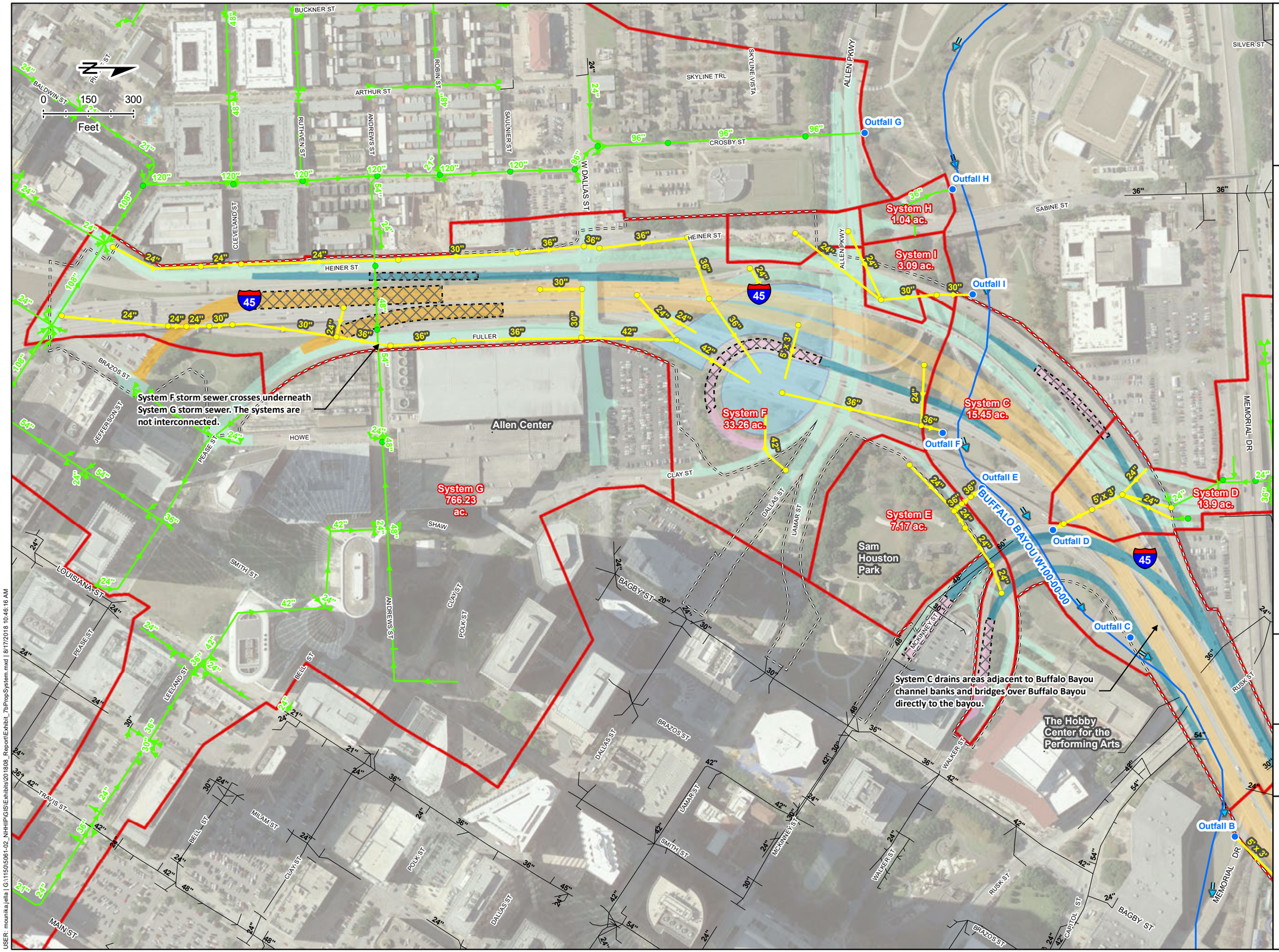
Drainage Study Report
NHHIP Segment 3E

EXHIBIT 7a
Proposed Drainage Systems Map
North of Buffalo Bayou
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018



Legend

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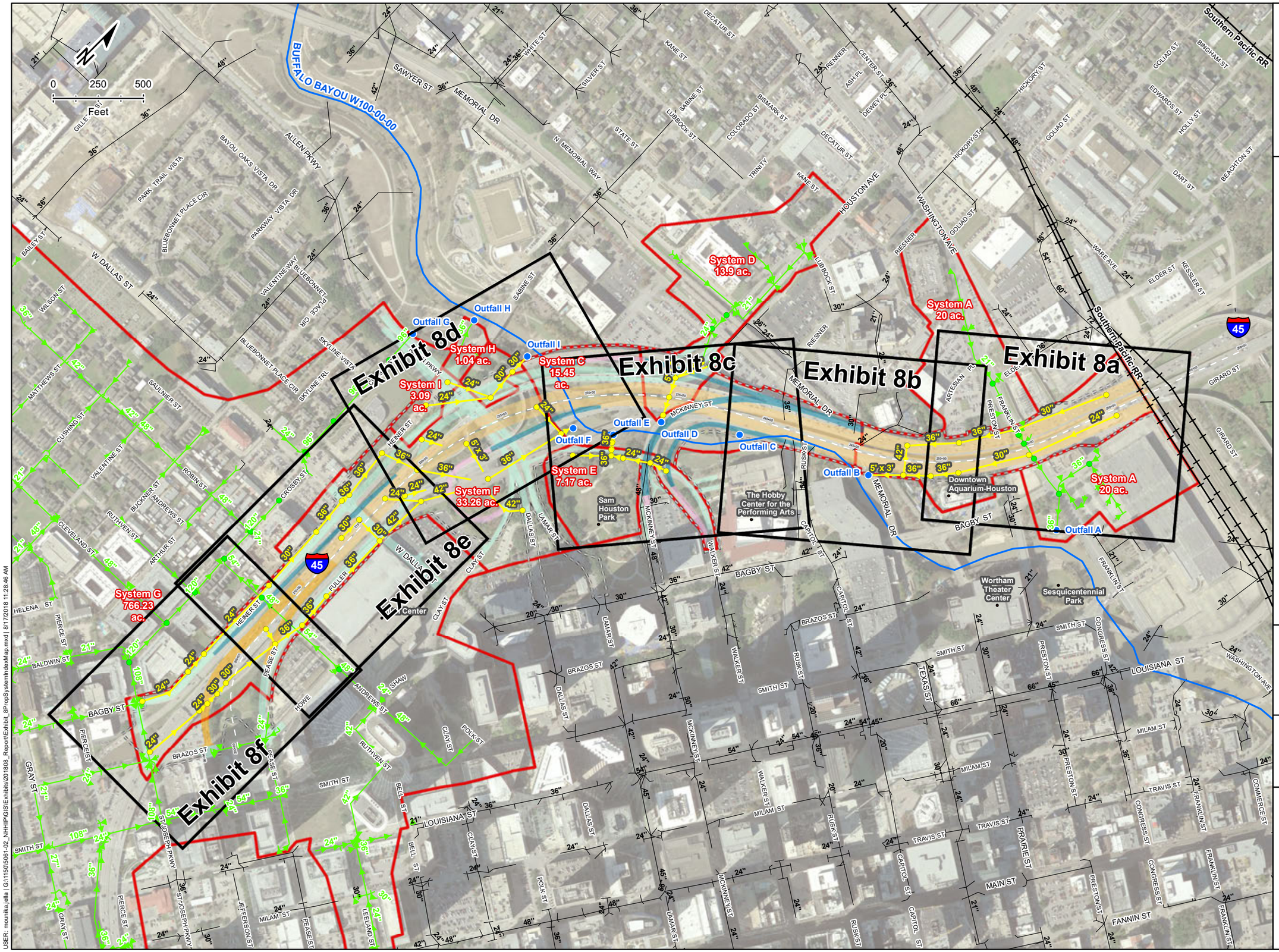
Drainage Study Report
NHHIP Segment 3E

EXHIBIT 7b
Proposed Drainage Systems Map
South of Buffalo Bayou
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018



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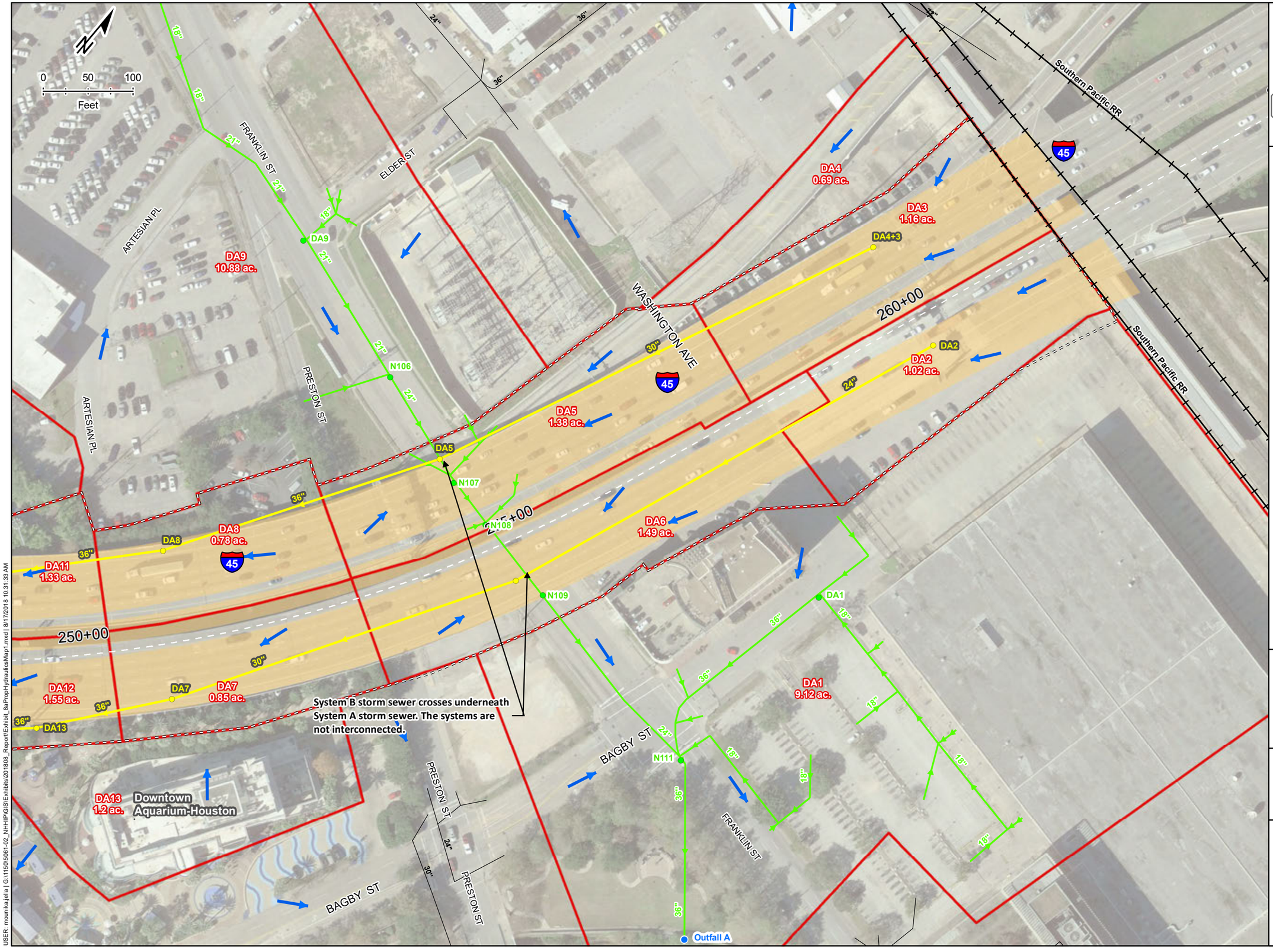
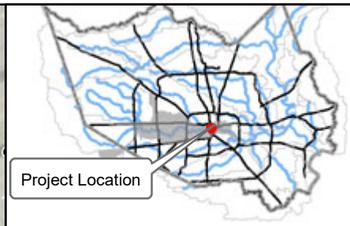
Drainage Study Report
NHHIP Segment 3E

EXHIBIT 8
Proposed System Hydraulics Map
Index Sheet
North of Buffalo Bayou
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018





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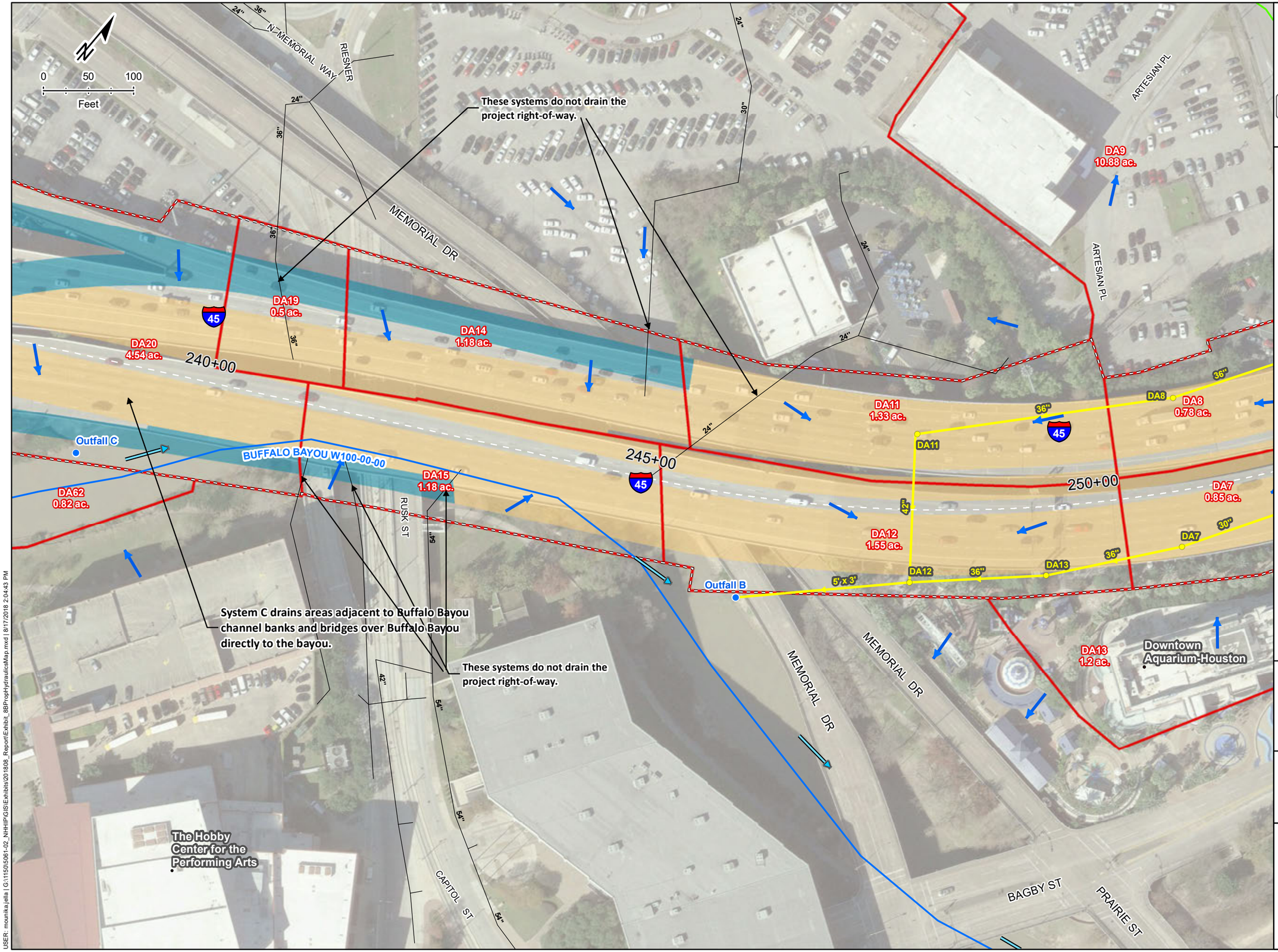
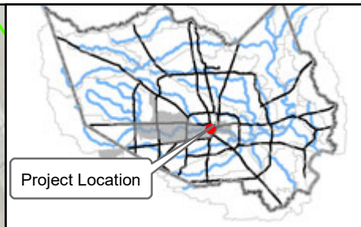
NHHIP Segment 3E

EXHIBIT 8a
Proposed System Hydraulics Map
CSJ No: 0500-03-598
Project No. 5061-02
August, 2018





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Drainage Study Report
NHHIP Segment 3E

EXHIBIT 8b
Proposed System Hydraulics Map
CSJ No: 0500-03-598
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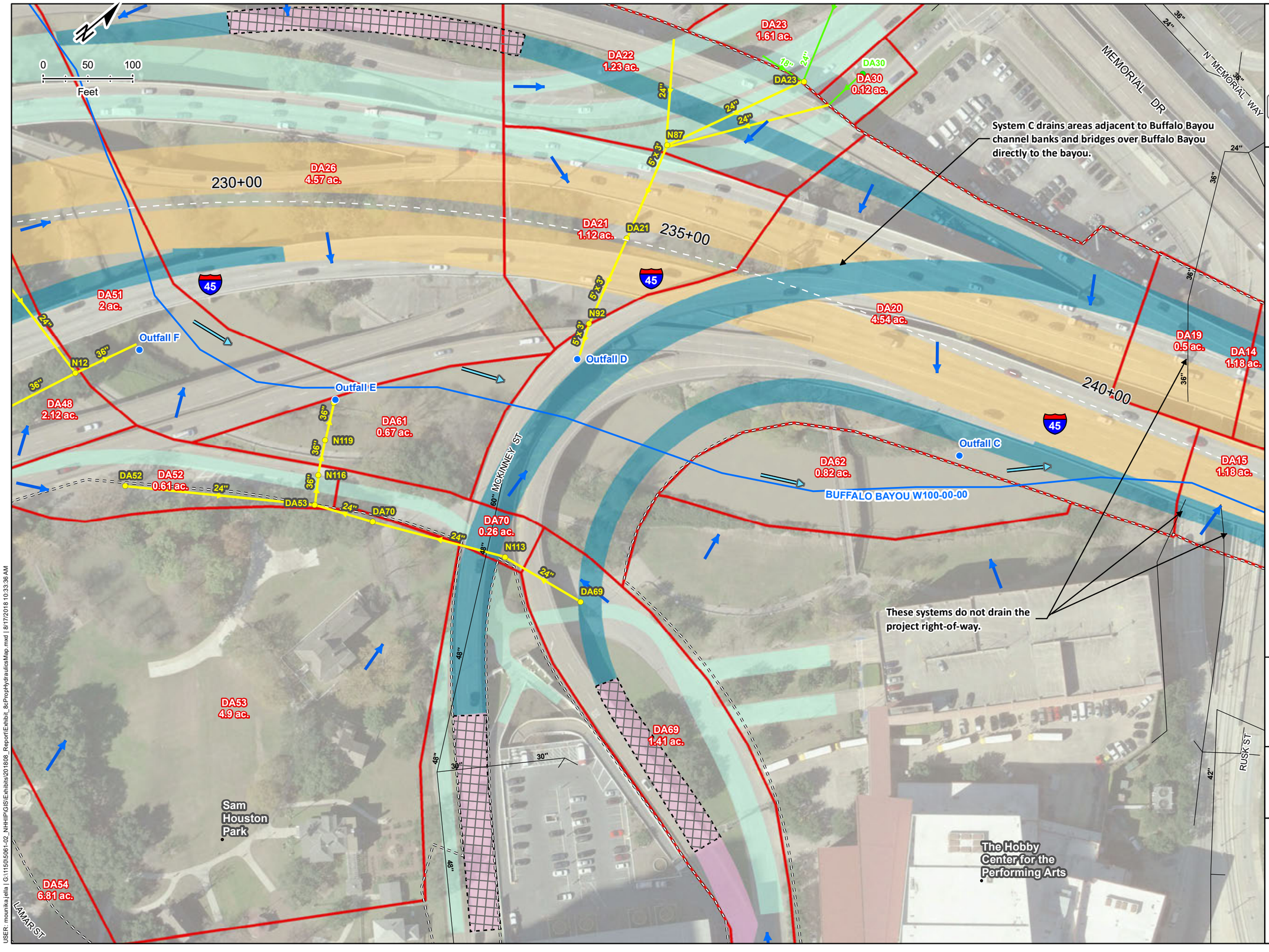
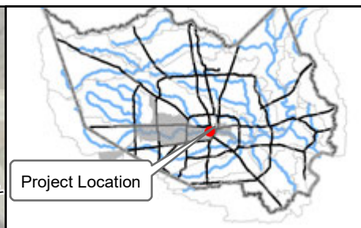
August, 2018





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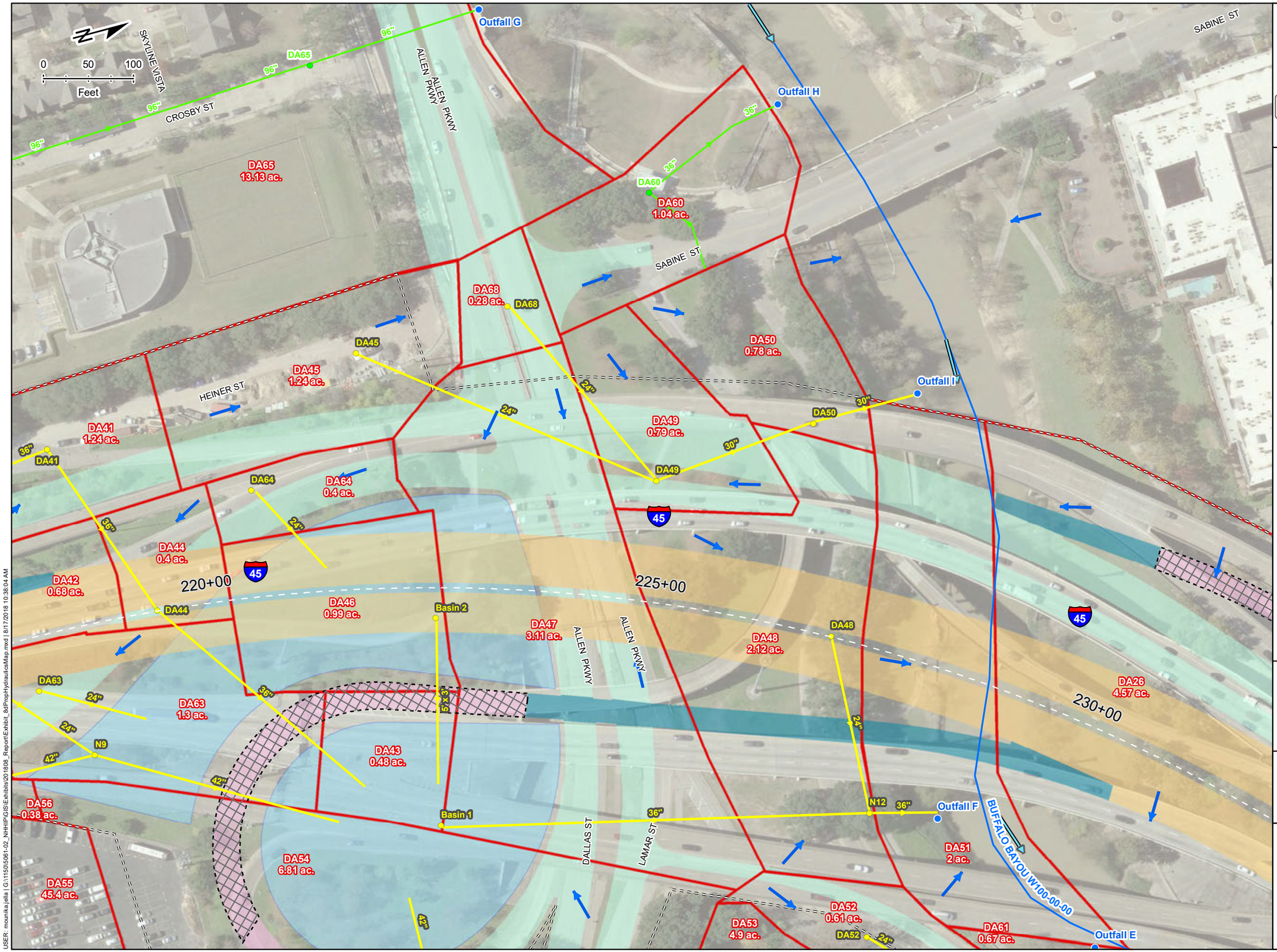
Drainage Study Report
NHHIP Segment 3E

EXHIBIT 8c
Proposed System Hydraulics Map
CSJ No: 0500-03-598
Project No. 5061-02
August, 2018



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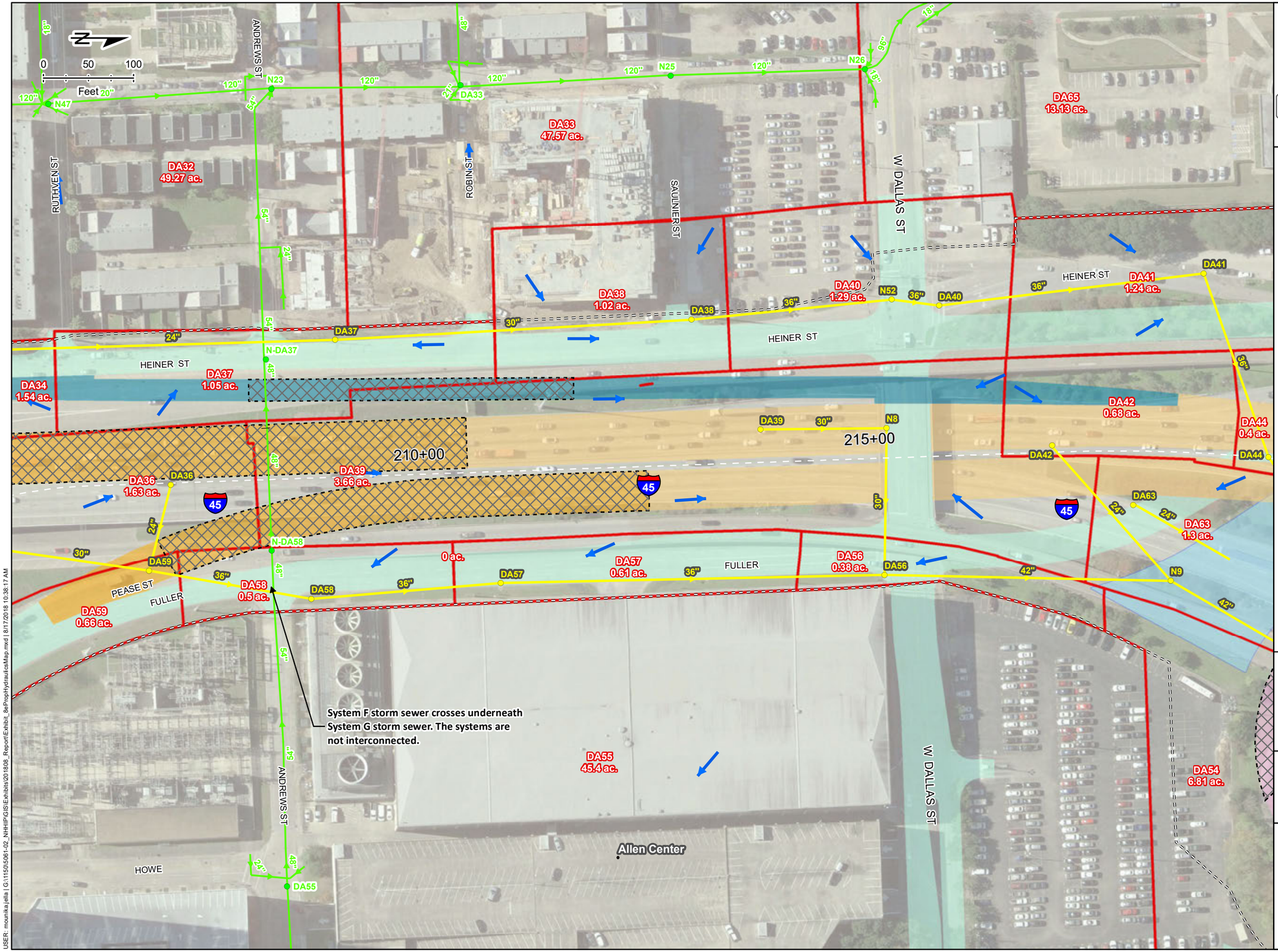
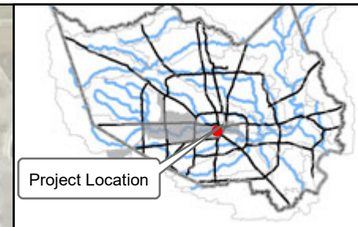
NHHIP Segment 3E
EXHIBIT 8d
Proposed System Hydraulics Map
CSJ No: 0500-03-598
Project No. 5061-02
August, 2018





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- Main Lane-Bridge
- Proposed Detention Basin

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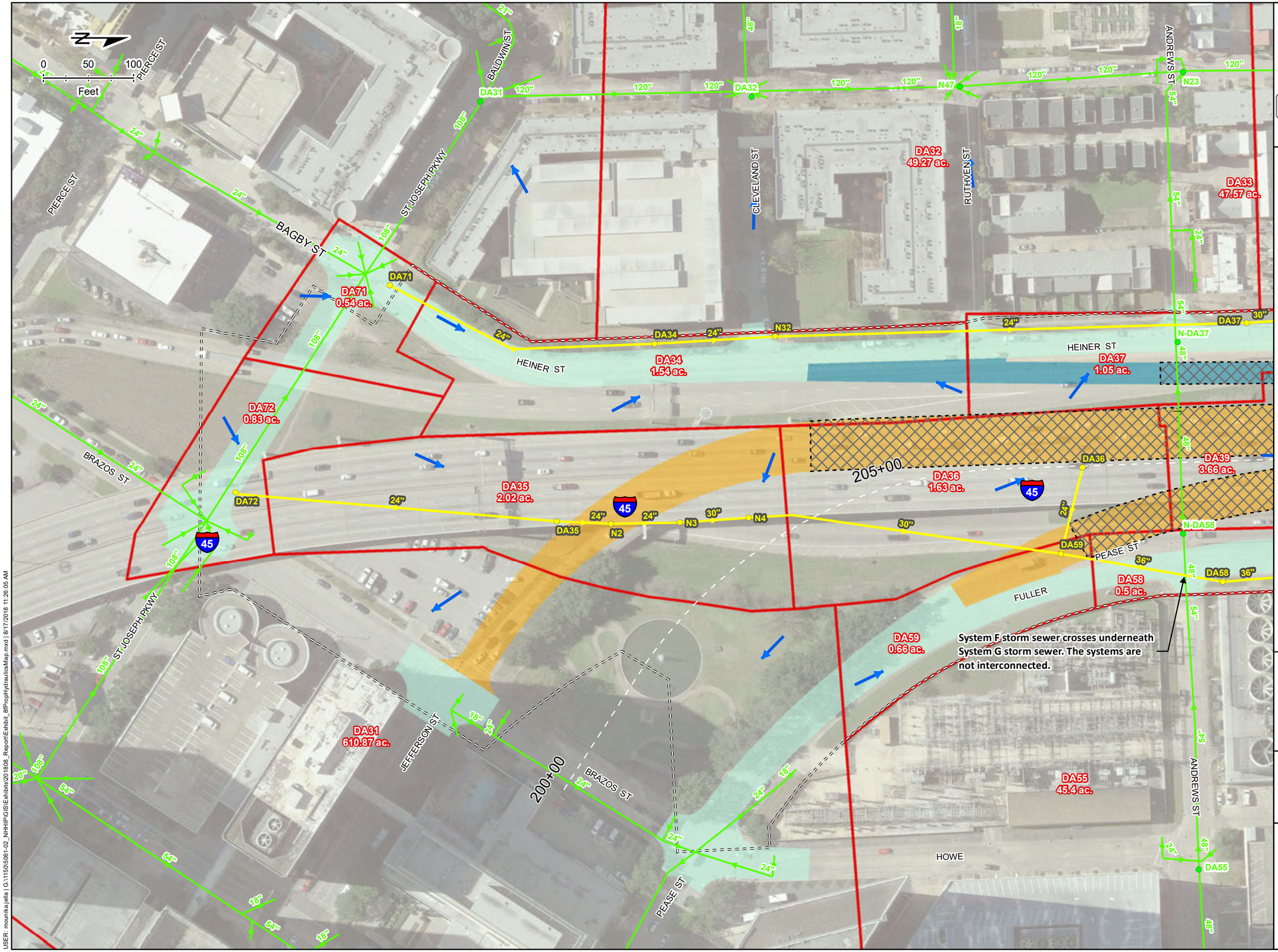
NHHIP Segment 3E
EXHIBIT 8e
Proposed System Hydraulics Map
CSJ No: 0500-03-598
Project No. 5061-02
August, 2018



Legend

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- Existing Analysis Nodes
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Proposed Roadway

- Ramp
- Main Lanes
- Frontage Roads
- Ramp-Bridge
- Main Lane-Bridge
- Proposed Detention Basin

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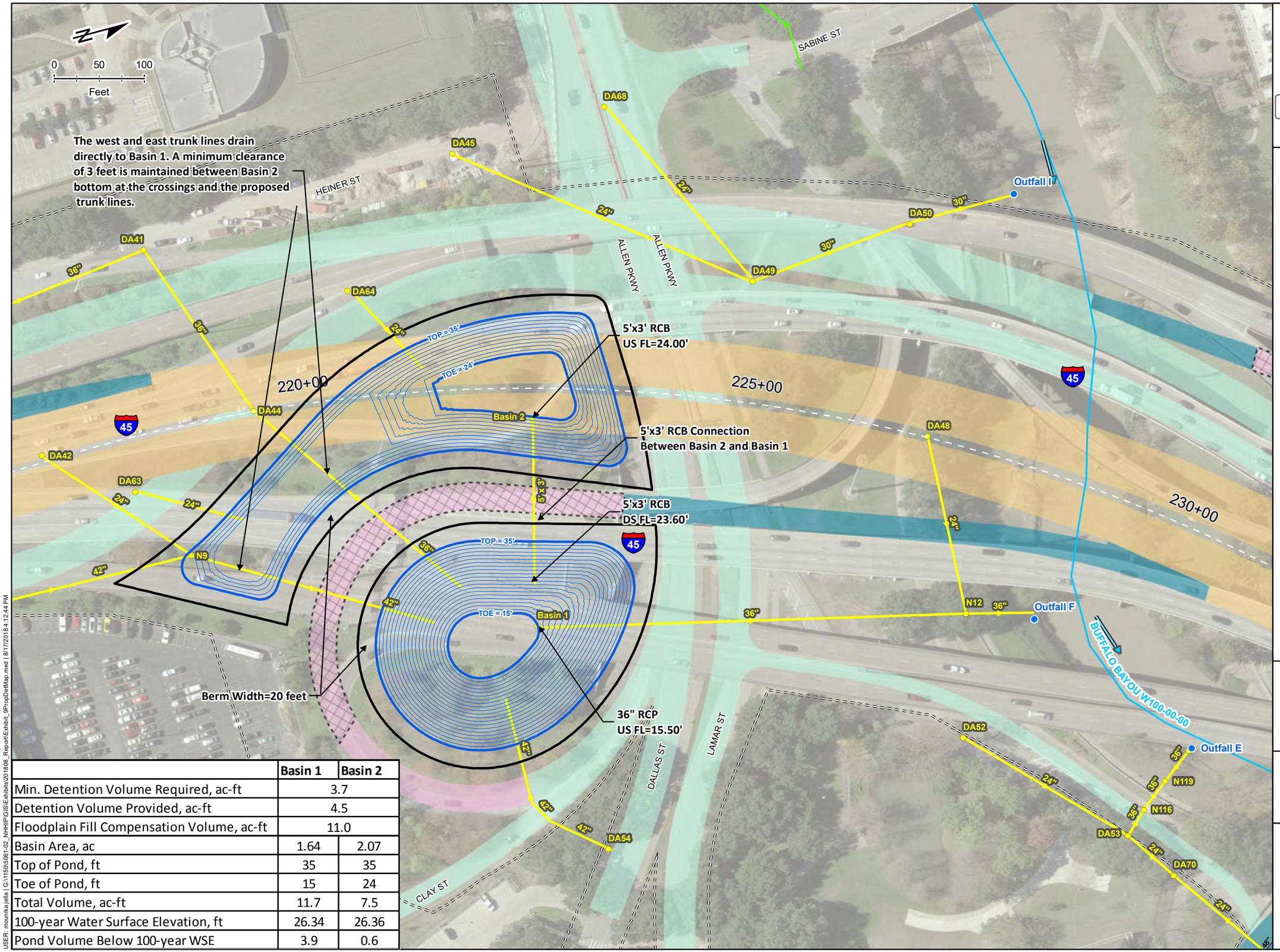
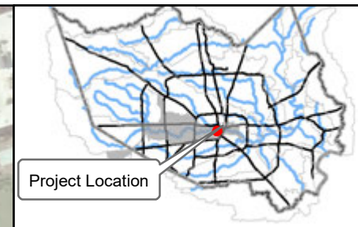
Drainage Study Report
NHHIP Segment 3E

EXHIBIT 8f
Proposed System Hydraulics Map
CSJ No: 0500-03-598
Project No. 5061-02
August, 2018



	Basin 1	Basin 2
Min. Detention Volume Required, ac-ft	3.7	
Detention Volume Provided, ac-ft	4.5	
Floodplain Fill Compensation Volume, ac-ft	11.0	
Basin Area, ac	1.64	2.07
Top of Pond, ft	35	35
Toe of Pond, ft	15	24
Total Volume, ac-ft	11.7	7.5
100-year Water Surface Elevation, ft	26.34	26.36
Pond Volume Below 100-year WSE	3.9	0.6



Legend

- Outfalls
- Proposed Analysis Nodes
- Existing Analysis Nodes
- Railroad
- Channel Flow Direction
- Proposed Storm Sewer

Existing Storm Sewer

- Other Storm Sewer
- Project Storm Sewer
- Drainage Channel

Proposed Detention Pond

- Pond Contours
- TOP
- TOE
- BERM
- Right-of-Way
- Proposed Retaining Wall

Proposed Roadway

- Ramp
- Main Lanes
- Frontage Roads
- Ramp-Bridge
- Main Lane-Bridge

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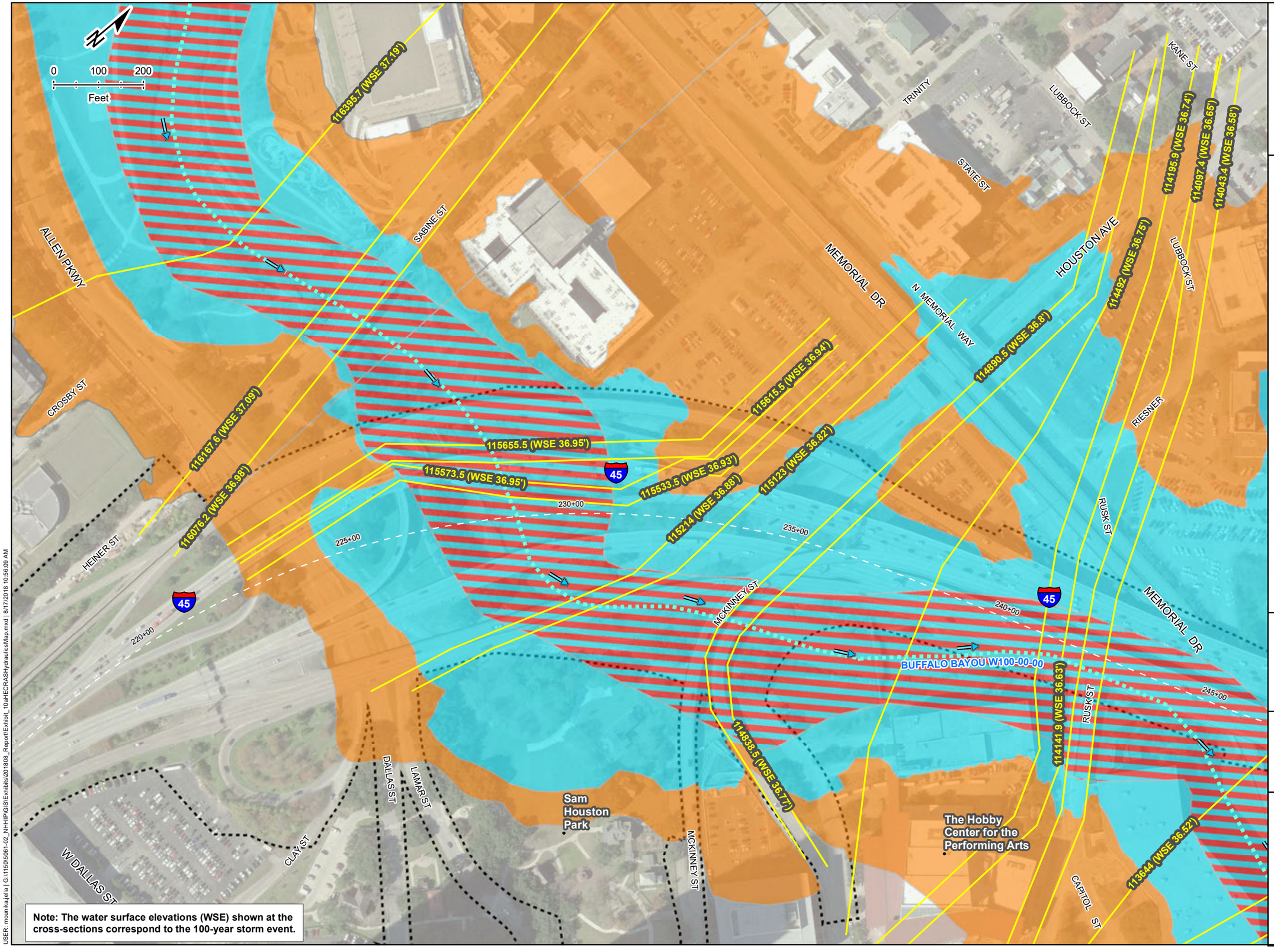
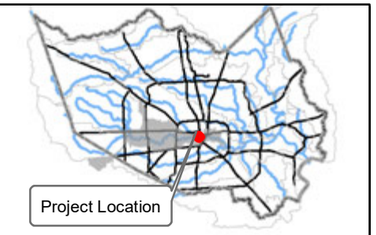
Drainage Study Report
NHHIP Segment 3E

EXHIBIT 9
Proposed Detention Basin Layout
CSJ No: 0500-03-598
Project No. 5061-02
August, 2018





Legend

- Drainage Channel
- Channel Flow Direction
- Railroad
- Effective Cross-sections

FEMA NFHL TEXAS FLOOD HAZARD AREAS

- AE
- AE, Floodway
- X, 0.2 Pct Annual Chance Flood Hazard
- X, Area Of Minimal Flood Hazard
- Right-of-Way

Note: The water surface elevations (WSE) shown at the cross-sections correspond to the 100-year storm event.

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Drainage Study Report NHHIP Segment 3E

EXHIBIT 10a
FEMA Effective Conditions
Bridge Hydraulics Map
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018

N

0 100 200
Feet

ALLEN PKWY
CROSBY ST
HEINER ST
SABINE ST
TRINITY
STATE ST
LUBBOCK ST
KANE ST
MEMORIAL DR
N MEMORIAL WAY
HOUSTON AVE
RIESNER
RUSK ST
MCKINNEY ST
DALLAS ST
LAMAR ST
CLAY ST
W DALLAS ST
CAPITOL ST

116395.7 (WSE 40.3')
116167.6 (WSE 40.24')
116076.2 (WSE 40.12')
115729.9 (WSE 40.07')
115804.5 (WSE 40.08')
115672.3 (WSE 40.07')
115545.8 (WSE 40.08')
115438.9 (WSE 40.08')
115284.6 (WSE 40.06')
115104.1 (WSE 40.02')
115621.1 (WSE 40.09')
115365.4 (WSE 40.07')
115594.6 (WSE 40.09')
115001.1 (WSE 39.99')
114885 (WSE 39.97')
114838.5 (WSE 39.9')
114492 (WSE 39.91')
114195.9 (WSE 39.86')
114141.9 (WSE 39.76')
114043.4 (WSE 39.74')
114390.5 (WSE 39.97')
114097.4 (WSE 39.77')
113644 (WSE 39.66')

45
230+00
235+00
240+00
245+00
225+00
220+00

BUFFALO BAYOU W100-00-00

Sam Houston Park

The Hobby Center for the Performing Arts

Note: The water surface elevations (WSE) shown at the cross-sections correspond to the 100-year storm event.

Project Location

Legend

- Drainage Channel
- Channel Flow Direction
- Railroad
- Effective Cross-sections
- Corrected Existing Cross-sections

FEMA NFHL TEXAS FLOOD HAZARD AREAS

- AE
- AE, Floodway
- X, 0.2 Pct Annual Chance Flood Hazard
- X, Area Of Minimal Flood Hazard
- Right-of-Way

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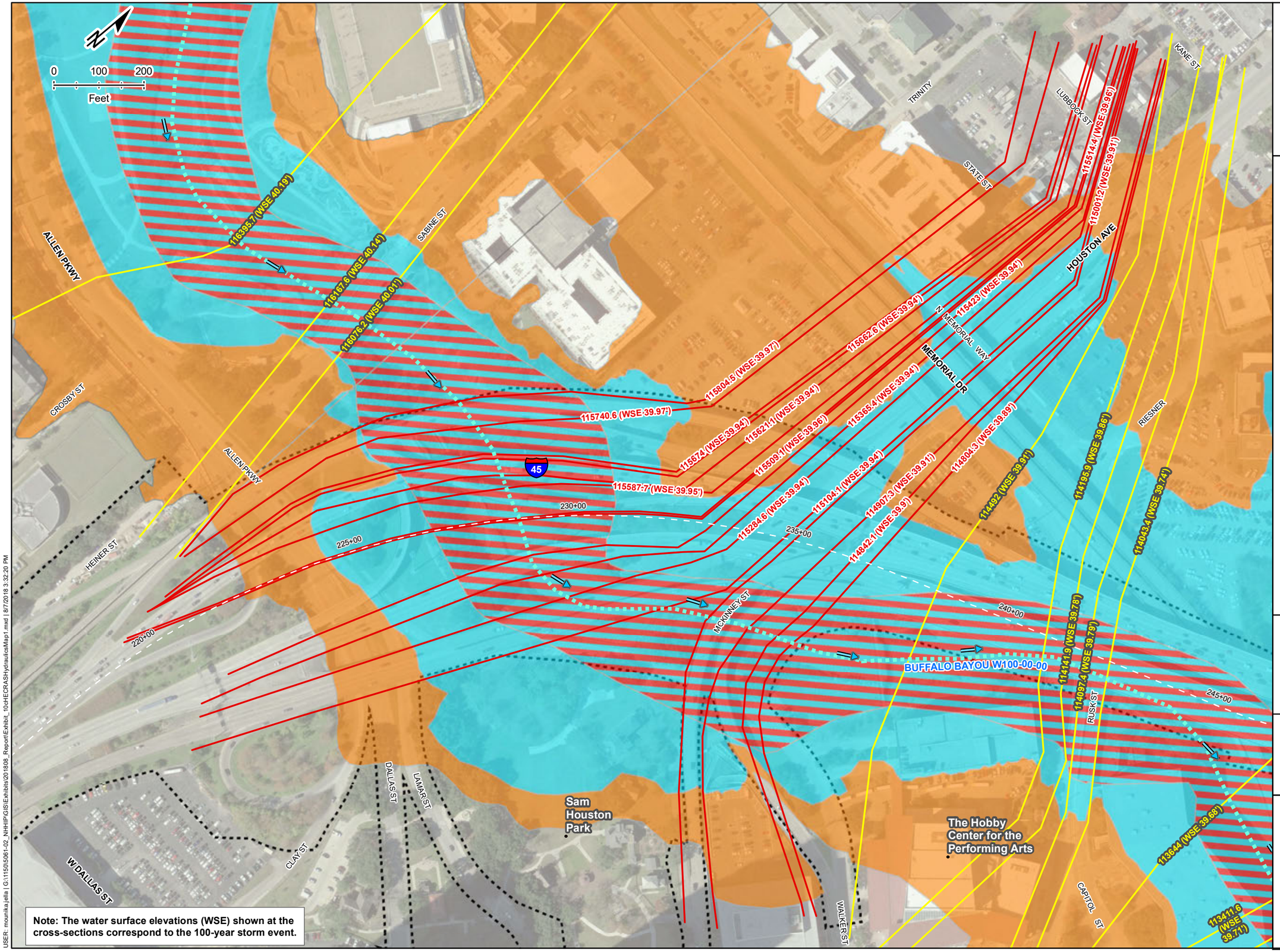
Drainage Study Report
NHHIP Segment 3E

EXHIBIT 10b
Corrected Effective Conditions
Bridge Hydraulics Map
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018



Note: The water surface elevations (WSE) shown at the cross-sections correspond to the 100-year storm event.

Legend

- Drainage Channel
- Channel Flow Direction
- Railroad
- Effective Cross-sections
- Proposed Cross-sections

FEMA NFHL TEXAS FLOOD HAZARD AREAS

Flood Zone / Zone Subtype

- AE
- AE, Floodway
- X, 0.2 Pct Annual Chance Flood Hazard
- X, Area Of Minimal Flood Hazard
- Right-of-Way

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Drainage Study Report NHHIP Segment 3E

EXHIBIT 10c
Proposed Conditions
Bridge Hydraulics Map
CSJ No: 0500-03-598

Project No. 5061-02
August, 2018

APPENDIX A

DESIGN SCHEMATIC

PRINTED AT 50% SCALE

PUBLIC HEARING LAYOUT

NHHIP DOWNTOWN CONN. SEGMENT 3

COUNTY: HARRIS
LIMITS FROM: BLODGETT ST
LIMITS TO: GRAY ST
DATE: 28-APR-2017
APPROVED:

CONSTRUCTION CSJ:0027-13-200, 0027-13-201, 0027-13-221, 0500-03-598, 0500-03-599, 0500-03-601, 0500-08-001

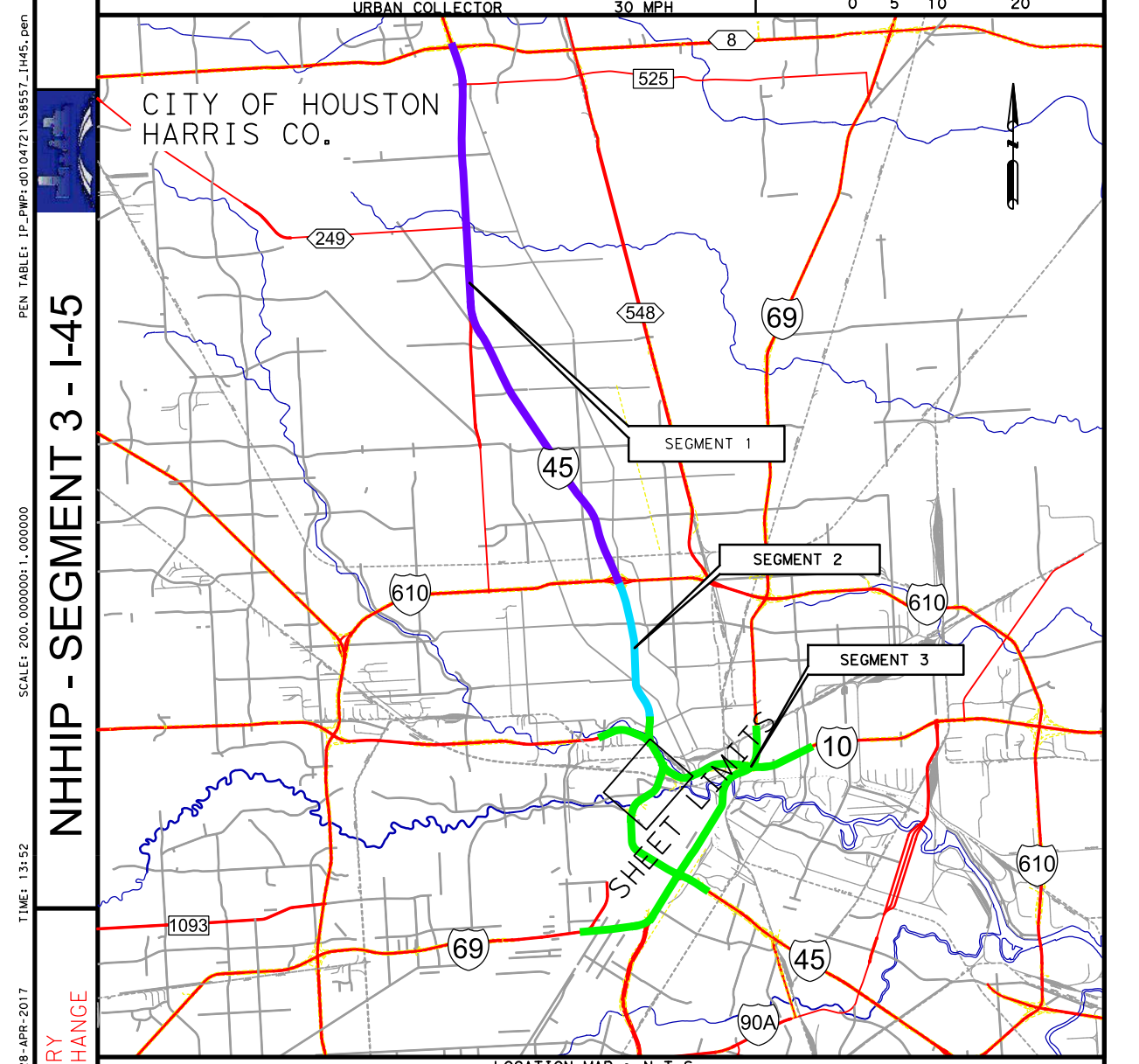
PRELIMINARY CSJ: 0912-00-146, 0912-00-147, 0912-00-479

HOUSTON DISTRICT PROJECT DEVELOPMENT

ROADWAY	FUNCTIONAL CLASSIFICATION	DESIGN SPEED
MAINLANES	URBAN FREEWAY	50 MPH
DIRECT CONNECTORS	DIRECT CONNECTORS	40 MPH
RAMPS	RAMPS	40 MPH
COLLECTOR-DISTRIBUTORS	COLLECTOR-DISTRIBUTORS	40 MPH
FRONTAGE ROADS	URBAN COLLECTOR	40 MPH
SIDE STREETS	URBAN MINOR ARTERIAL/	30 MPH
	URBAN COLLECTOR	30 MPH

HORZ SCALE: 1"=200'
0 50 100 200

VERT SCALE: 1"=20'
0 5 10 20



LOCATION MAP : N.T.S.
SURVEY DATA: TEXAS SOUTH CENTRAL ZONE #4204 (HARRIS COUNTY)
ADJUSTED TO SURFACE USING COMBINED SCALE FACTOR 1.00013

PLAN LEGEND

SYMBOLOGY	ROADWAY	BRIDGE	STYLE	LINE WT	COLOR CODE	
CENTERLINE				2	BLACK	0
I-45 MAINLANES				2	BLACK	0
I-69/US 59 MAINLANES				2	BLACK	0
I-10 MAINLANES				2	BLACK	0
SH 288 MAINLANES				2	BLACK	0
I-610 MAINLANES				2	BLACK	0
I-10 MAX LANES				2	PINK	10
MAX LANES				2	PINK	28
FRONTAGE ROADS				2	GREEN	2
LOCAL STREETS				2	BLUE	1
RAMPS				2	RED	3
DIRECT CONNECTOR				2	MAGENTA	5
POTENTIAL GREENSPACE				7		
EXISTING RDWY TO BE REMOVED				1		
SURPLUS ROW				1		
EMBANKMENT				3	RED	3
PROPOSED CONTROL OF ACCESS				0	RED	3
PROPOSED DEIS ROW				6	BLACK	0
PROPOSED FEIS ROW				6	BLUE	126
EXISTING ROW				1	BLACK	0
ACCESS ROAD				1	BLUE	1
METRO RAIL RED (MAIN STREET LINE)				1	RED	3
METRO RAIL(EAST END LINE)				1	GREEN	156
METRO RAIL(SOUTHEAST LINE)				1	PURPLE	203
RAILROAD				1	BLACK	0
LIMITS OF FLOODWAY				1	BLUE	171
PLANIMETRIC				2	GREEN	2
TRAFFIC COUNT YEAR (2040) DHV			0000	0	BLACK	0
AM MAX LANE TRAFFIC COUNT YEAR (2040) DHV			0000 AM	0	BLACK	0
PM MAX LANE TRAFFIC COUNT YEAR (2040) DHV			0000 PM	0	BLACK	0
EXISTING LANE DIRECTIONAL INDICATOR:						
MAIN LANES				0	BLACK	0
FRONTAGE ROADS/TURNAROUNDS				0	BLUE	168
PROPOSED LANE DIRECTIONAL INDICATOR:						
MAIN LANES				2	BLACK	0
FRONTAGE ROADS/TURNAROUNDS				2	BLUE	168
RAMPS				2	RED	3
DIRECT CONNECTOR				2	RED	139
MAX LANES				2	MAGENTA	5
DEPRESSED				3	RED	3
FUTURE				1	BLUE	1
RETAINING WALL				6	RED	3
STRIPING				0	ORANGE	6
OVERHEAD MAX LANES				2	GREY	7
TEMPORARY CONNECTIONS				2	YELLOW	37
RDWY UNDER CONSTRUCTION				2	LT GREEN	196
RECOMMENDED NOISE ABATEMENT WALL				2	PURPLE	203

PRELIMINARY SUBJECT TO CHANGE

DATE: 28-APR-2017

HNTB Corporation
2950 N Loop W, Suite 900
Houston, TX 77092
TBPE Firm Registration No. 420

FILE LOCATION: IP_PWP:d0157186\I45_PP09.dgn

PREPARED BY: joherrera

ROADWAY: I-45 NORTH
COUNTY: HARRIS
LIMITS FROM: BELTWAY 8
LIMITS TO: I-69

9 / 9

PRELIMINARY

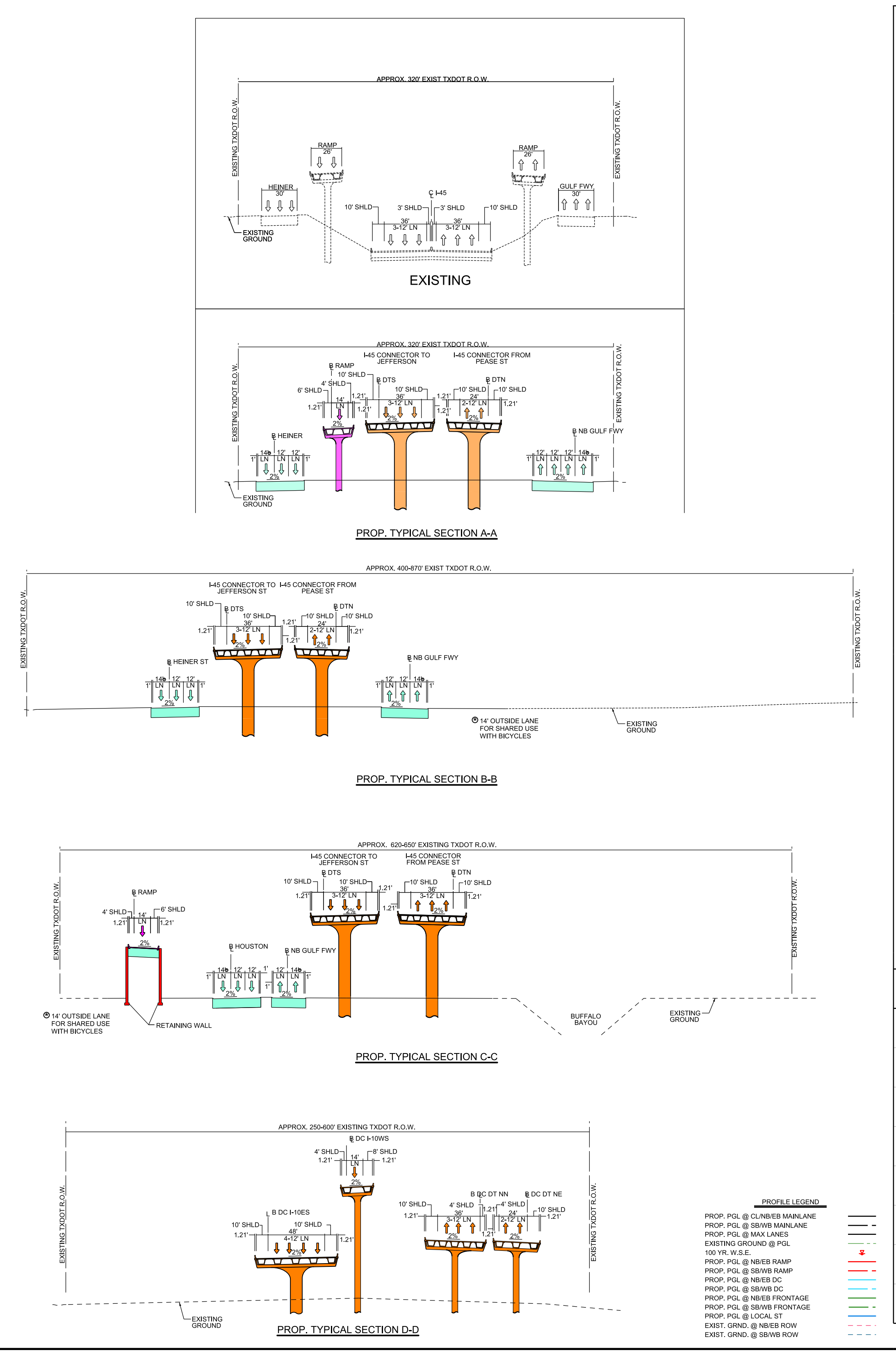
SUBMITTED FOR REVIEW
Engineer: DARRIN J. WILLER
P.E. Serial No.: 82119
Date: 28-APR-2017
Signature:

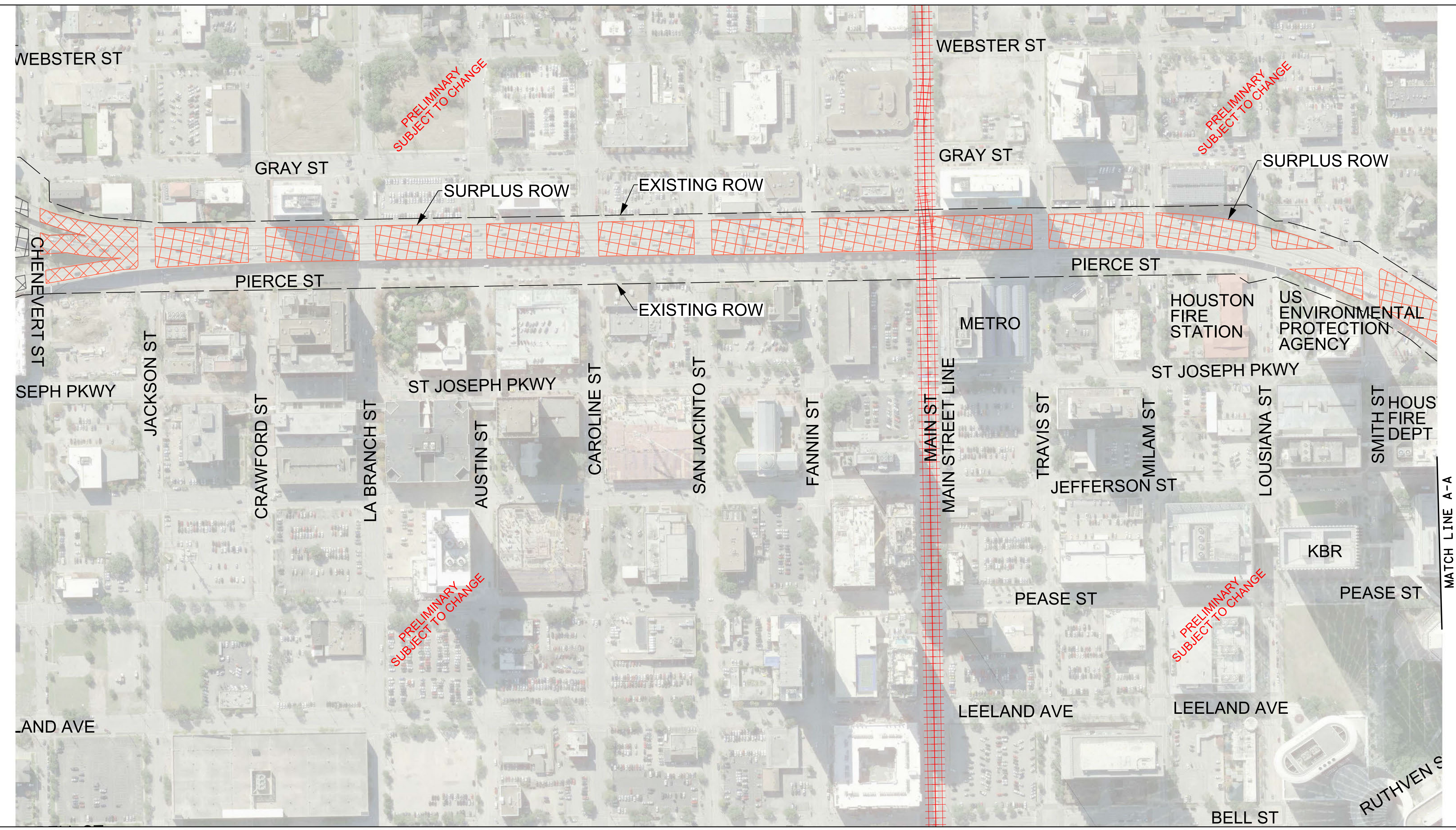
NOT FOR CONSTRUCTION, BIDDING OR PERMITTING

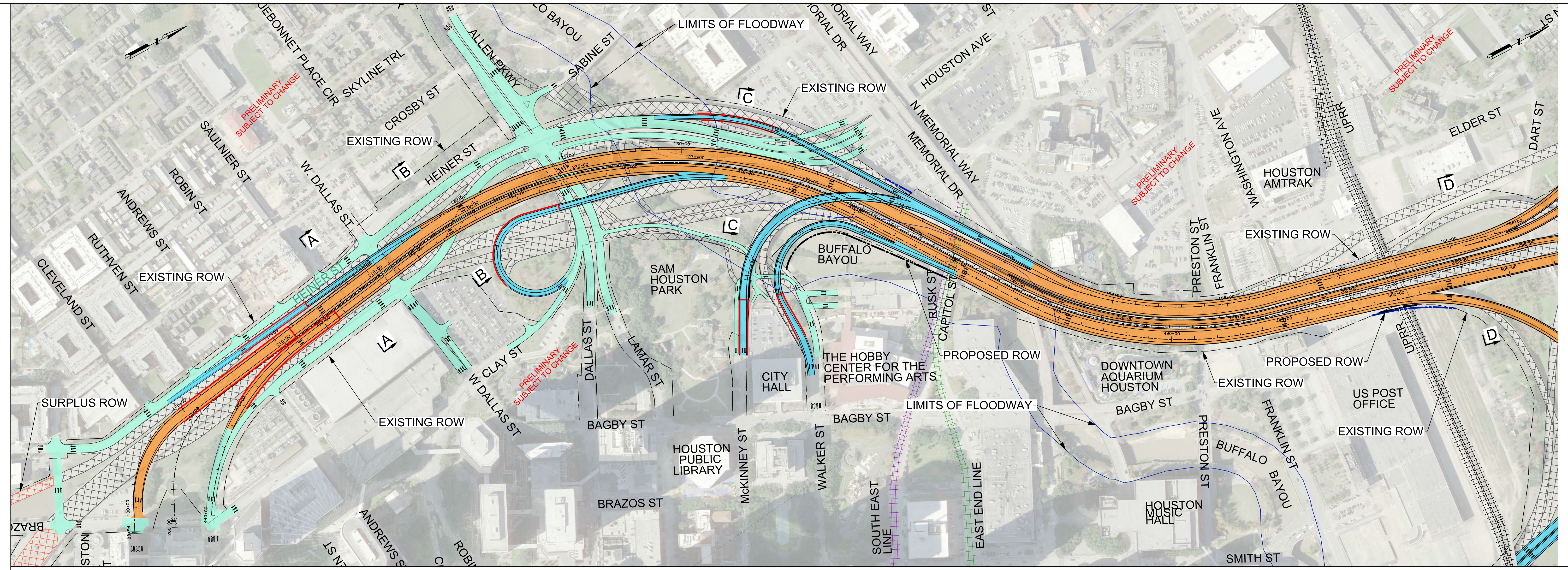
TxDOT (DISTRICT-"APPROVED BY") LETTER DATED

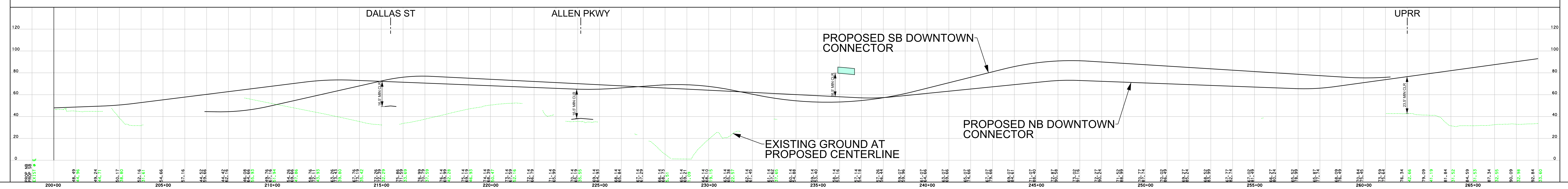
FHWA REPRESENTATIVES ("APPROVED BY") LETTER DATED

SHEET 9 OF 9









APPENDIX B

SUMMARY OF FIELD VISITS

N

0 200 400 Feet

AREA 1

AREA 2

AREA 3

AREA 4

AREA 5

Outfall A

Outfall B

Outfall C

Outfall D

Outfall E

Outfall F

Outfall G

Outfall H

Outfall I

BUFFALO BAYOU

WASHINGTON AVE

HOUSTON AVE

ALLEN PKWY

W DALLAS ST

MEMORIAL DR

N MEMORIAL WAY

PRAIRIE ST

TEXAS ST

LAMAR ST

WALKER ST

MCKINNEY ST

CAPITOL ST

DECATUR ST

BISMARK ST

KANE ST

LUBBOCK ST

STATE ST

SKYLINE VISTA

BLUEBONNET PLACE CIR

SAULNIER ST

ROBIN ST

ANDREWS ST

RUTHVEN ST

CLEVELAND ST

PEASE ST

JEFFERSON ST

CLAY ST

DALLAS ST

BELL ST

LEELAND ST

PRESTON ST

FRANKLIN ST

GIRARD ST

DART ST

KESSLER ST

ELDER ST

HICKORY ST

GOLIAD ST

RENNER

ASH PL

DEWEY PL

RIESNER

ARTESIAN PL

SABINE ST

COLORADO ST

TRINITY

SILVER ST

HEINER ST

FULLER

HOWE

SHAW

SMITH ST

MILAM ST

POLK ST

MAIN ST

FANNIN ST

TRAVIS ST

BAGBY ST

RUSK ST

HELENA ST

PIERCE ST

BALDWIN ST

BRAZOS ST

BUCKNER ST

ARTHUR ST

SKYLINE TRL

45

10

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TX 77098 (713) 526-4579

Project No. 5061-02
IH-45 Drainage Study

Appendix B1
Field Visit Map

1 inch = 400 feet | June, 2018

Document Path: G:\1150\5061-02_NHHIP\GIS\Exhibits\Report\AppendixA1.mxd

Legend

- Outfalls

Existing Storm Sewer

- Other Storm Sewer
- Project Storm Sewer

Appendix B.2 - Summary of Field Visits
NHHIP Segment 3E (I-45 Downtown Connectors)
CSJ: 0500-03-598

File Visit Summary

No. of Field Visits: 2

Dates: 02/06/2018
03/07/2018

Summary: Two filed visits were performed to the Segment 3E to gather the following data:

1. Outfall locations into Buffalo Bayou.
2. Storm sewer systems and inlets along the corridor. Storm sewer systems along the frontage roads and city streets (to which I-45 contributes flow) were identified. The inlets on the main lanes were visually identified by driving. It was not considered safe to photograph the inlets on the main lanes.
3. Storm sewer and inlet systems within developments adjacent to and inside ROW such as Aquarium, courthouse parking lots, etc.
4. Bridge drainage features (scuppers, open slots, etc.).
5. General existing roadway and bridge configuration.

The information gathered was utilized in developing existing condition storm sewer system models and evaluating existing condition hydraulics. The information was also provided to the surveyor to assist in acquisition of accurate survey data.

Date: February 6, 2018	Crosby Street outfall from the south.
Area 1	

Date: February 6, 2018	Crosby Street outfall from the south.
Area 1	

Date: February 6, 2018	Outfall along Sabine Street from the north.
Area 1	

Date: February 6, 2018	Outfall A. The storm sewer that runs along the majority of I-45 south of Buffalo Bayou.
Area 1	

Date: February 6, 2018	Outfall A. The storm sewer that runs along the majority of I-45 south of Buffalo Bayou.
Area 1	

Date: February 6, 2018 **Area 1**	Outfall A. The storm sewer that runs along the majority of I-45 south of Buffalo Bayou.

Date: February 6, 2018 **Area 1**	Inlet near Sabine Street. Inlets along Allen Parkway in the general area underneath I-45.

Date: February 6, 2018	Inlet near Sabine Street. Inlets along Allen Parkway in the general area underneath I-45.
Area 1	

Date: February 6, 2018	Inlets along Allen Parkway in the general area underneath I-45.
Area 1	

Date: February 6, 2018	Inlets along Allen Parkway in the general area underneath I-45.
Area 1	

Date: February 6, 2018	Inlets along Allen Parkway in the general area underneath I-45.
Area 1	

Date: February 6, 2018	Inlets along Allen Parkway in the general area underneath I-45.
Area 1	

Date: February 6, 2018	Inlets along Allen Parkway in the general area underneath I-45.
Area 1	

Date: February 6, 2018	Inlets along Allen Parkway in the general area underneath I-45.
Area 1	

Date: February 6, 2018	Inlets along Allen Parkway in the general area underneath I-45.
Area 1	

Date: February 6, 2018	Inlets along Allen Parkway in the general area underneath I-45.
Area 1	

Date: February 6, 2018	Inlets along Allen Parkway in the general area underneath I-45.
Area 1	

Date: February 6, 2018	Manholes for Allen Parkway/Walker system from the east (downtown).
Area 2	

Date: February 6, 2018	Manhole for Allen Parkway/Walker system from the east (downtown).
Area 2	

Date: February 6, 2018	McKinney Street outfall from the east (downtown).
Area 2	

Date: February 6, 2018	McKinney exit and Walker entrance ramps.
Area 2	

Date: February 6, 2018	Outfall from west, underneath McKinney exit ramp.
Area 2	

Date: February 6, 2018	Outfall from west, underneath McKinney exit ramp.
Area 2	

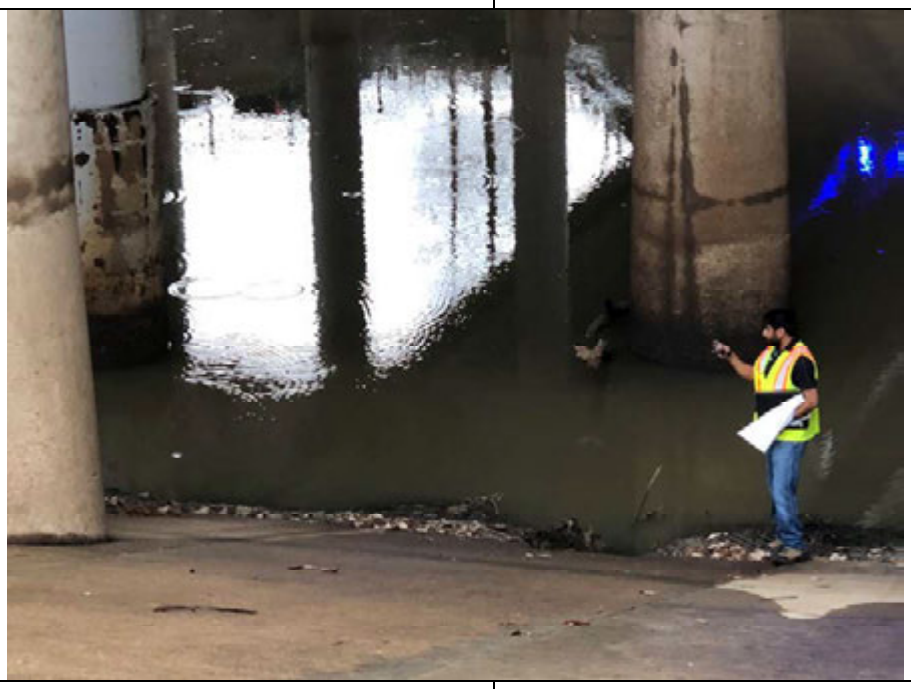
Date: February 6, 2018	Outfall from west, underneath McKinney exit ramp.
Area 2	

Date: February 6, 2018	Private development outfall from the east (downtown), south of pedestrian bridge.
Area 2	

Date: February 6, 2018	Outfall just south of Rusk underneath west abutment.
Area 3	

Date: February 6, 2018	Outfall underneath Rusk Street, west abutment.
Area 3	

Date: February 6, 2018	Outfalls underneath Rusk Street west abutment.
Area 3	



Date: February 6, 2018	Outfall underneath Capitol Street east abutment.
Area 3	

Date: February 6, 2018	Outfall underneath Capitol Street east abutment.
Area 3	

Date: February 6, 2018	Between Capitol and Rusk Streets. Manhole for the one of the outfalls under Capitol/Rusk Street.
Area 3	

Date: February 6, 2018	Adjacent to Capitol Street underneath I-45. Adjacent to the Capitol Street outfall from the east.
Area 3	

Date: February 6, 2018	Capitol Street outfall from the east.
Area 3	

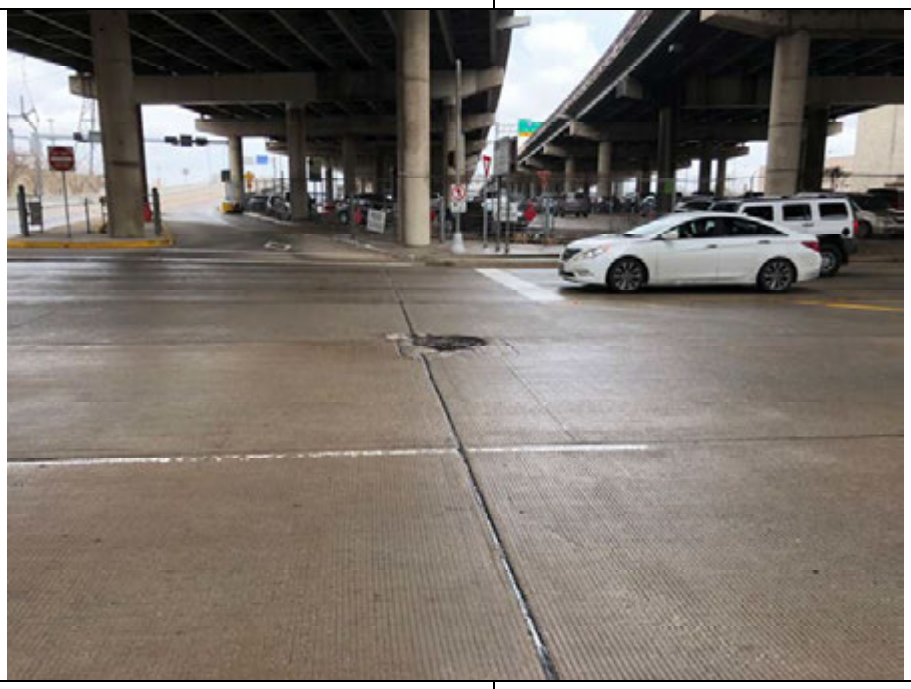
Date: February 6, 2018	Outfall from the Aquarium storm sewer.
Area 3	

Date: February 6, 2018	Preston Street outfall. Local drainage.
Area 4	

Date: February 6, 2018	Outfall from the Franklin Street storm sewer.
Area 4	

Date: February 6, 2018	Franklin Street looking west towards I-45.
Area 4	

Date: February 6, 2018	Franklin Street, underneath I-45, looking northeast.
Area 4	



Date: February 6, 2018	Franklin Street, underneath I-45, looking north.
Area 4	

Date: February 6, 2018	Franklin Street, underneath I-45, looking west.
Area 4	

Due to heavy traffic and lack of adequate parking, it was not possible to photograph drainage features in Area 5. However, a field visit was performed by driving through this area and identifying storm sewer systems and inlets along Heiner Street, I-45 main lanes, Crosby Street, Andrews Street, and Fuller Street. The underpasses along main lanes and feeder roads were also identified.

Date: February 6, 2018	Field visit information for Area 5.
Area 5	

APPENDIX C

DRAINGE DESIGN CRITERIA/

TECHNICAL PROVISIONS

TEXAS DEPARTMENT OF TRANSPORTATION

TECHNICAL PROVISIONS

NHHIP I-45 SEGMENT 3

DRAINAGE

FEBRUARY 14, 2018

AHW	Allowable High Water	HOU	District Design Practice
HCFCD	Policy Criteria & Procedure Manual (HCFCD)	RCB	Reinforced Concrete Box
HDM	Hydraulic Design Manual (TxDOT)	RCP	Reinforced Concrete Pipe
HGL	Hydraulic Grade Line	WSEL	Water Surface Elevation
EOP	Edge of Pavement	FB	Freedboard

Table 12-1: Drainage Design Frequencies

(Any deviation requires TxDOT approval)

Design Element	Mainlanes	Ramp	Direct Connect.	Frontage Road	Arterial / Cross Street	Application Notes
Minimum Roadway Elevation	100-yr	25-yr	100-yr	10-yr	10-yr*	Crossing or adjacent waterway WSEL, **plus 1' FB at low EOP**. Does not apply to storm drain or roadside ditch HGL. *No FB required.
Bridge Waterway Crossing	100-yr plus 2.5' FB	100-yr plus 1.5' FB	100-yr plus 2.5' FB	100-yr plus 1.5' FB	Match Exist.	Applies to WSEL at new location bridges. **For existing FR bridges**, use min 10-yr w/ Low chord > WSEL
Cross Drain Culverts	100-yr	25-yr	100-yr	10-yr	Match Exist.	Set maximum AHW at 1' below low EOP. Check for 100-year.
Storm Drain Inlets and Pavement Drainage	10-yr	10-yr	10-yr	2-yr	Match Exist. or better	Applies to ponded widths in gutter and inlet capacity.
Storm Drain Conduits	10-yr	10-yr	10-yr	2-yr	Match Exist. or better	Size conduit for non-pressure full flow; i.e. Design Q<= Full Flow Capacity Q. See HGL requirements below.
Storm Drain HGL	100-yr < EOP	25-yr < EOP	100-yr < EOP	10-yr: max 1-lane ponding	10-yr: max 1-lane ponding	Starting HGL at outfall: 25-yr if it works. Otherwise, base the starting HGL on hydrograph timing or top of pipe. Determine and report maximum frequency flood contained in ROW.
Depressed Roadway Storm Drain, Inlets and Pavement Drainage	100-yr	100-yr	100-yr	100-yr	100-yr	Depressed roadway occurs if water has nowhere to drain overland when curb height is exceeded. Size conduit for non-pressure full flow. Check for 100-yr HGL < EOP.
Storm Water Pumping Stations	100-yr	100-yr	100-yr	100-yr	100-yr	Design pump capacity >/= 100-yr Q + 25%. Check for 100-year < EOP.
Detention Ponds	100-year + 3' FB. Provide Detention Summary with Area Serviced, Detention Storage Volume Required, Detention Storage Volume Provided, Maximum Design WSEL, Maximum Outflow Rate Allowed, Maximum Outflow Rate Provided, and Restrictor Size.					Sample plans available from TxDOT upon request.

Design Element	Mainlanes	Ramp	Direct Connect.	Frontage Road	Arterial / Cross Street	Application Notes
Outfall Ditches	Design for No Impact to 100-yr WSEL. Use HCFCD Standard Details for Outfalls and other construction within HCFCD channels and ponds.					
Separation Ditches	10-yr	10-yr	10-yr	N/A	N/A	Separation Ditches are those in medians between adjacent roadways. AHW = 1' below EOP.
Roadside Ditches***	N/A	N/A	N/A	2-yr*	2-yr**	*If required outside curb line. **Or match existing capacity. *** Roadside ditches are those between the roadway and ROW

APPENDIX D

DRAINAGE SYSTEM HYDROLOGY AND HYDRAULIC ANALYSIS

EXISTING AND PROPOSED CONDITIONS

Table D.1: Rational Method Calculations - Existing Conditions

NHHIP Segment 3E (I-45 Downtown Connectors), CSJ: 0500-03-598

Harris County, Texas

Description: Rational Method Calculations
Project Name: NHHIP Drainage Study-Segment 3E
Location: Houston, Texas
Drainage Condition: Existing Conditions
Date: 6/6/2018

Sub-Basin Name	Area Total (acre)	Overland Sheet Flow Length (ft)	Paved Sheet Flow / Gutter Flow Length (ft)	Storm Sewer Length (ft)	Channel Length (ft)	Calculated Time of Conc (min)	Time of Conc (min)	Open Area	Park/ Cemetery	School/ Library	Single Family Residential	Multi Residential Units	Apartments	Light Commercial	Heavy Commercial/ Industrial	Downtown Areas	Railroad	ROW Grass	Pavement	Channel	% Imperv-ious Cover	Runoff Coeff-icient, C	Peak Flow (cfs)				Peak Flow (cfs)			
Runoff Coefficient								**0.30**	**0.20**	**0.65**	**0.50**	**0.60**	**0.70**	**0.65**	**0.80**	**0.90**	**0.35**	**0.35**	**0.90**	**1.00**										
% Impervious Cover								**0%**	**0%**	**72%**	**60%**	**70%**	**75%**	**72%**	**85%**	**85%**	**40%**	**0%**	**100%**	**100%**			**2yr**	**10yr**	**50yr**	**100yr**	**2yr**	**10yr**	**50yr**	**100yr**
Travel Velocity		**0.5 ft/s**	**1.5 ft/s**	**3 ft/s**	**3 ft/s**																									
System A																														
DA1	9.12	0	380	553	0	7.3	10.0	0.00	0.87	0.00	0.00	0.00	0.00	0.00	6.74	0.00	0.27	0.30	0.89	0.05	74%	0.73	5.5	7.9	10.4	11.7	36.2	52.2	68.7	77.4
DA2	1.02	0	440	0	0	4.9	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.00	0.02	0.00	0.63	0.00	94%	0.85	5.5	7.9	10.4	11.7	4.8	6.9	9.1	10.2
DA3	1.16	0	457	0	0	5.1	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	0.00	0.80	0.00	95%	0.87	5.5	7.9	10.4	11.7	5.5	7.9	10.4	11.8
DA4	0.69	0	0	0	0	0.0	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.01	0.00	0.37	0.00	93%	0.85	5.5	7.9	10.4	11.7	3.2	4.6	6.1	6.8
DA5	1.38	0	118	280	0	2.9	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.05	1.20	0.00	95%	0.87	5.5	7.9	10.4	11.7	6.6	9.5	12.5	14.1
DA6	1.49	0	420	79	0	5.1	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.12	1.14	0.00	90%	0.84	5.5	7.9	10.4	11.7	6.8	9.9	13.0	14.6
DA9	10.88	0	333	958	0	9.0	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.60	0.00	0.00	0.20	2.08	0.00	86%	0.81	5.5	7.9	10.4	11.7	48.2	69.6	91.6	103.2
Total	**25.74**							**0.00**	**0.87**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**16.73**	**0.00**	**0.30**	**0.67**	**7.12**	**0.05**	**84%**	**0.79**								
System B																														
DA7	0.85	0	170	184	0	2.9	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.11	0.59	0.00	82%	0.79	5.5	7.9	10.4	11.7	3.7	5.3	6.9	7.8
DA8	0.78	0	326	0	0	3.6	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00	0.00	0.51	0.00	95%	0.87	5.5	7.9	10.4	11.7	3.7	5.3	7.0	7.9
DA11	1.33	0	240	0	0	2.7	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.07	0.00	0.00	0.03	0.93	0.00	91%	0.83	5.5	7.9	10.4	11.7	6.0	8.7	11.4	12.8
DA12	1.55	100	0	434	0	5.8	10.0	0.00	0.03	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.16	1.10	0.06	84%	0.80	5.5	7.9	10.4	11.7	6.8	9.8	12.9	14.5
DA13	1.20	320	0	0	0	10.7	10.7	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00	72%	0.65	5.3	7.7	10.2	11.5	4.2	6.0	7.9	9.0
Total	**5.71**							**0.00**	**0.03**	**0.00**	**0.00**	**0.00**	**0.00**	**1.84**	**0.34**	**0.00**	**0.00**	**0.30**	**3.14**	**0.06**	**84%**	**0.78**								
System C																														
DA14	1.18	0	0	0	358	2.0	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.07	1.03	0.02	93%	0.86	5.5	7.9	10.4	11.7	5.6	8.1	10.6	11.9
DA15	1.18	0	0	0	449	2.5	10.0	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.88	0.14	87%	0.83	5.5	7.9	10.4	11.7	5.3	7.7	10.1	11.4
DA19	0.50	226	0	0	0	7.5	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.01	0.41	0.02	96%	0.88	5.5	7.9	10.4	11.7	2.4	3.5	4.6	5.2
DA20	4.54	434	0	0	260	15.9	15.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.82	2.94	0.47	81%	0.80	4.4	6.5	8.7	9.9	16.2	23.8	31.8	36.0
DA26	4.57	492	0	0	73	16.8	16.8	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	1.49	2.41	0.33	63%	0.70	4.3	6.4	8.5	9.7	13.8	20.3	27.1	30.8
DA51	2.00	225	0	0	434	9.9	10.0	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.81	0.53	67%	0.74	5.5	7.9	10.4	11.7	8.1	11.7	15.4	17.3
DA61	0.67	331	0	0	0	11.0	11.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.37	0.09	0.21	45%	0.63	5.2	7.6	10.0	11.3	2.2	3.2	4.2	4.8
DA62	0.82	0	0	0	417	2.3	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.74	90%	0.93	5.5	7.9	10.4	11.7	4.2	6.0	8.0	9.0
Total	**15.45**							**0.00**	**0.30**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.62**	**0.00**	**0.00**	**3.51**	**8.57**	**2.45**	**75%**	**0.77**								
System D																														
DA17	9.83	173	173	711	0	11.6	11.6	0.00	0.00	0.00	0.00	0.00	2.84	0.00	5.34	0.00	0.00	0.37	1.28	0.00	81%	0.77	5.1	7.4	9.8	11.1	38.7	56.2	74.2	83.8
DA21	1.12	169	0	213	0	6.8	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.78	0.00	70%	0.73	5.5	7.9	10.4	11.7	4.5	6.5	8.5	9.6
DA22	1.23	0	44	224	0	1.7	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.00	0.31	0.80	0.00	73%	0.75	5.5	7.9	10.4	11.7	5.1	7.3	9.6	10.8
DA23	1.61	0	264	313	0	4.7	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.11	1.43	0.00	92%	0.86	5.5	7.9	10.4	11.7	7.5	10.9	14.3	16.1
DA30	0.12	0	16	86	0	0.7	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.00	80%	0.79	5.5	7.9	10.4	11.7	0.5	0.7	0.9	1.1
Total	**13.90**							**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2.84**	**0.00**	**5.52**	**0.00**	**0.00**	**1.15**	**4.38**	**0.00**	**81%**	**0.77**								
System E																														
DA52	0.61	0	177	261	0	3.4	10.0	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.49	0.00	82%	0.78	5.5	7.9	10.4	11.7	2.6	3.7	4.9	5.5
DA53	4.90	600	0	0	0	20.0	20.0	0.00	4.69	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.07	0.00	1%	0.21	3.9	5.8	7.9	8.9	4.1	6.1	8.2	9.4
DA69	1.41	0	219	401	0	4.7	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.00	0.43	0.80	0.00	67%	0.73	5.5	7.9	10.4	11.7	5.6	8.1	10.7	12.1
DA70	0.26	0	51	204	0	1.7	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.21	0.00	82%	0.80	5.5	7.9	10.4	11.7	1.1	1.6	2.2	2.4
Total	**7.17**							**0.00**	**4.76**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.18**	**0.00**	**0.65**	**1.58**	**0.00**	**24%**	**0.39**								
System F																														
DA35	2.02	0	316	354	0	5.5	10.0	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.03	1.61	0.00	83%	0.78	5.5	7.9	10.4	11.7	8.6	12.5	16.4	18.5
DA36	1.63	47	47	387	0	4.2	10.0	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	1.28	0.00	78%	0.76	5.5	7.9	10.4	11.7	6.8	9.8	12.9	14.5
DA39	3.66	0	586	432	0	8.9	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	3.05	0.00	83%	0.81	5.5	7.9	10.4	11.7	16.2	23.3	30.7	34.6
DA42	0.68	0	296	0	0	3.3	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.51	0.00	74%	0.76	5.5	7.9	10.4	11.7	2.8	4.1	5.4	6.0
DA43	0.48	0	198	0	0	2.2	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.00	100%	0.90	5.5	7.9	10.4	11.7	2.3	3.4	4.4	5.0

Table D.1: Rational Method Calculations - Existing Conditions

NHHIP Segment 3E (I-45 Downtown Connectors), CSJ: 0500-03-598

Harris County, Texas

Description: Rational Method Calculations
Project Name: NHHIP Drainage Study-Segment 3E
Location: Houston, Texas
Drainage Condition: Existing Conditions
Date: 6/6/2018

Sub-Basin Name	Area Total (acre)	Overland Sheet Flow Length (ft)	Paved Sheet Flow / Gutter Flow Length (ft)	Storm Sewer Length (ft)	Channel Length (ft)	Calculated Time of Conc (min)	Time of Conc (min)	Open Area	Park/ Cemetery	School/ Library	Single Family Residential	Multi Residential Units	Apartments	Light Commercial	Heavy Commercial/ Industrial	Downtown Areas	Railroad	ROW Grass	Pavement	Channel	% Imperv-ious Cover	Runoff Coeff-icient, C	Peak Flow (cfs)				Peak Flow (cfs)			
Runoff Coefficient								**0.30**	**0.20**	**0.65**	**0.50**	**0.60**	**0.70**	**0.65**	**0.80**	**0.90**	**0.35**	**0.35**	**0.90**	**1.00**										
% Impervious Cover								**0%**	**0%**	**72%**	**60%**	**70%**	**75%**	**72%**	**85%**	**85%**	**40%**	**0%**	**100%**	**100%**			**2yr**	**10yr**	**50yr**	**100yr**	**2yr**	**10yr**	**50yr**	**100yr**
Travel Velocity		**0.5 ft/s**	**1.5 ft/s**	**3 ft/s**	**3 ft/s**																									
DA63	1.30	0	385	0	0	4.3	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.77	0.00	60%	0.68	5.5	7.9	10.4	11.7	4.8	6.9	9.1	10.3
Total	**9.77**							**0.00**	**0.52**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.06**	**0.00**	**1.49**	**7.69**	**0.00**	**79%**	**0.78**								
System G																														
DA31	612.24	**Calculated using HCFCD Clark UH Method**					22.0	6.53	2.81	1.74	6.34	184.92	97.70	0.00	269.63	14.22	0.00	1.12	27.23	0.00	78%	0.72	**Calculated using HCFCD Clark UH Method**							
DA32	49.27	125	146	3209	0	23.6	23.6	1.52	0.46	3.81	10.10	9.19	19.04	0.00	5.15	0.00	0.00	0.00	0.00	0.00	69%	0.63	3.6	5.4	7.2	8.3	111.3	166.3	224.8	256.8
DA33	47.57	112	117	3202	0	22.8	22.8	0.75	2.69	0.00	31.19	8.22	0.90	0.00	3.82	0.00	0.00	0.00	0.00	0.00	60%	0.53	3.7	5.5	7.4	8.4	91.4	136.3	184.0	210.1
DA34	1.53	0	48	610	0	3.9	10.0	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.19	1.15	0.00	84%	0.81	5.5	7.9	10.4	11.7	6.8	9.8	12.8	14.5
DA37	1.05	0	86	219	0	2.2	10.0	0.00	0.00	0.00	0.00	0.18	0.01	0.00	0.00	0.00	0.00	0.07	0.80	0.00	88%	0.81	5.5	7.9	10.4	11.7	4.7	6.7	8.8	10.0
DA55	45.40	156	106	2865	0	22.3	22.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.83	0.00	0.01	0.56	0.00	85%	0.90	3.7	5.5	7.5	8.5	151.4	225.7	304.5	347.5
DA56	0.38	212	0	154	0	7.9	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.10	0.23	0.00	71%	0.75	5.5	7.9	10.4	11.7	1.6	2.2	3.0	3.3
DA57	0.61	0	140	280	0	3.1	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.00	0.47	0.00	97%	0.90	5.5	7.9	10.4	11.7	3.0	4.3	5.7	6.4
DA58	0.50	0	200	85	0	2.7	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.40	0.00	97%	0.90	5.5	7.9	10.4	11.7	2.5	3.6	4.7	5.3
DA59	0.66	0	191	145	0	2.9	10.0	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.00	0.43	0.00	85%	0.82	5.5	7.9	10.4	11.7	2.9	4.2	5.6	6.3
DA65	13.13	0	226	1176	0	9.0	10.0	0.24	0.07	3.76	0.00	6.38	0.00	0.00	1.15	0.00	0.00	0.12	1.41	0.00	73%	0.65	5.5	7.9	10.4	11.7	46.9	67.8	89.2	100.4
Total	**772.34**							**9.05**	**6.11**	**9.31**	**47.63**	**208.88**	**117.84**	**0.00**	**279.74**	**59.47**	**0.00**	**1.61**	**32.68**	**0.00**	**77%**	**0.71**								
System H																														
DA38	1.02	0	232	65	0	2.9	10.0	0.00	0.00	0.00	0.00	0.00	0.55	0.00	0.15	0.00	0.00	0.00	0.32	0.00	84%	0.78	5.5	7.9	10.4	11.7	4.3	6.2	8.2	9.2
DA40	1.29	0	202	184	0	3.3	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.08	0.60	0.00	87%	0.82	5.5	7.9	10.4	11.7	5.8	8.4	11.0	12.4
DA41	1.24	163	0	208	0	6.6	10.0	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.48	0.00	40%	0.57	5.5	7.9	10.4	11.7	3.9	5.6	7.3	8.2
DA44	0.40	82	0	106	0	3.3	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.27	0.00	68%	0.72	5.5	7.9	10.4	11.7	1.6	2.3	3.0	3.4
DA45	1.24	141	0	271	0	6.2	10.0	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.61	0.00	51%	0.63	5.5	7.9	10.4	11.7	4.3	6.2	8.1	9.1
DA60	1.04	145	0	175	0	5.8	10.0	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.41	0.00	39%	0.51	5.5	7.9	10.4	11.7	2.9	4.1	5.5	6.1
DA64	0.40	0	197	61	0	2.5	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.16	0.00	41%	0.58	5.5	7.9	10.4	11.7	1.3	1.8	2.4	2.7
DA68	0.28	0	83	57	0	1.2	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.24	0.00	88%	0.84	5.5	7.9	10.4	11.7	1.3	1.8	2.4	2.7
Total	**6.90**							**0.00**	**0.41**	**0.07**	**0.00**	**0.00**	**0.55**	**0.00**	**0.76**	**0.00**	**0.00**	**2.02**	**3.09**	**0.00**	**61%**	**0.67**								
System I																														
DA46	0.99	278	0	0	0	9.3	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.62	0.38	0.00	38%	0.56	5.5	7.9	10.4	11.7	3.0	4.4	5.7	6.5
DA47	3.11	0	155	461	0	4.3	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.82	2.30	0.00	74%	0.76	5.5	7.9	10.4	11.7	12.9	18.6	24.4	27.5
DA48	2.12	112	231	229	0	7.6	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.12	1.00	0.00	47%	0.61	5.5	7.9	10.4	11.7	7.1	10.2	13.4	15.1
DA49	0.79	174	0	160	0	6.7	10.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.26	0.00	33%	0.53	5.5	7.9	10.4	11.7	2.3	3.3	4.3	4.9
DA50	0.78	96	0	325	0	5.0	10.0	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.58	0.00	74%	0.72	5.5	7.9	10.4	11.7	3.1	4.5	5.9	6.6
DA54	6.81	282	0	570	0	12.6	12.6	0.00	0.72	0.00	0.00	0.00	0.00	0.00	0.00	3.06	0.00	1.71	1.35	0.00	58%	0.69	5.0	7.2	9.6	10.8	23.3	34.0	45.0	50.9
Total	**14.61**							**0.00**	**0.88**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**3.06**	**0.00**	**4.82**	**5.86**	**0.00**	**58%**	**0.68**								

Table D.2: Rational Method Calculations - Proposed Conditions

NHHIP Segment 3E (I-45 Downtown Connectors), CSJ: 0500-03-598

Harris County, Texas

Description: Rational Method Calculations
Project Name: NHHIP Drainage Study-Segment 3E
Location: Houston, Texas
Drainage Condition: Proposed Conditions
Date: 6/6/2018

Sub-Basin Name	Area Total [acre]	Overland Sheet Flow Length (ft)	Paved Sheet Flow / Gutter Flow Length (ft)	Storm Sewer Length (ft)	Channel Length (ft)	Calculated Time of Conc (min)	Time of Concentration [min]	Open Area	Park/ Cemetery	School/ Library	Single Family Residential	Multi Residential Units	Apartments	Light Commercial	Heavy Commercial/ Industrial	Downtown Areas	Railroad	ROW Grass	Pavement	Channel	Detention	% Impervious Cover	Runoff Coeff-icient, C	Peak Flow (cfs)				Peak Flow (cfs)			
Runoff Coefficient								**0.30**	**0.20**	**0.65**	**0.50**	**0.60**	**0.70**	**0.65**	**0.80**	**0.90**	**0.35**	**0.35**	**0.90**	**1.00**	**1.00**										
% Impervious Cover								**0%**	**0%**	**72%**	**60%**	**70%**	**75%**	**72%**	**85%**	**85%**	**40%**	**0%**	**100%**	**100%**	**100%**			**2yr**	**10yr**	**50yr**	**100yr**	**2yr**	**10yr**	**50yr**	**100yr**
Travel Velocity																															
System A																															
DA1	9.12	0.0	379.9	552.6	0.0	7.3	10.00	0.00	0.87	0.00	0.00	0.00	0.00	0.00	6.74	0.00	0.27	0.30	0.89	0.05	0.00	74%	0.73	5.5	7.9	10.4	11.7	36.2	52.2	68.7	77.4
DA9	10.88	0.0	333.1	958.0	0.0	9.0	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.60	0.00	0.00	0.20	2.08	0.00	0.00	86%	0.81	5.5	7.9	10.4	11.7	48.2	69.6	91.6	103.2
Total	**20.00**							**0.00**	**0.87**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**15.34**	**0.00**	**0.27**	**0.50**	**2.97**	**0.05**	**0.00**	**81%**	**0.77**								
System B																															
DA2	1.02	0.0	440.0	0.0	0.0	4.9	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.46	0.00	0.00	0.00	0.56	0.00	0.00	93%	0.85	5.5	7.9	10.4	11.7	4.8	6.9	9.1	10.2
DA3	1.16	0.0	457.1	0.0	0.0	5.1	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.82	0.00	0.00	95%	0.87	5.5	7.9	10.4	11.7	5.5	8.0	10.5	11.8
DA4	0.69	0.0	0.0	0.0	0.0	0.0	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.00	0.01	0.00	0.00	0.00	0.00	84%	0.79	5.5	7.9	10.4	11.7	3.0	4.3	5.6	6.4
DA5	1.38	0.0	118.4	279.6	0.0	2.9	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.07	1.00	0.00	0.00	92%	0.85	5.5	7.9	10.4	11.7	6.4	9.3	12.2	13.8
DA6	1.49	0.0	419.7	78.7	0.0	5.1	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.13	1.04	0.00	0.00	88%	0.83	5.5	7.9	10.4	11.7	6.7	9.7	12.8	14.4
DA7	0.85	0.0	170.1	184.5	0.0	2.9	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.00	0.00	0.55	0.00	0.00	90%	0.81	5.5	7.9	10.4	11.7	3.8	5.5	7.2	8.1
DA8	0.78	0.0	326.5	0.0	0.0	3.6	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.22	0.00	0.00	0.00	0.49	0.00	0.00	93%	0.85	5.5	7.9	10.4	11.7	3.6	5.2	6.9	7.7
DA11	1.33	0.0	239.9	0.0	0.0	2.7	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.07	0.00	0.00	0.00	0.93	0.00	0.00	92%	0.83	5.5	7.9	10.4	11.7	6.1	8.7	11.5	13.0
DA12	1.55	100.4	0.0	434.4	0.0	5.8	10.00	0.00	0.02	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	1.15	0.05	0.00	93%	0.84	5.5	7.9	10.4	11.7	7.1	10.3	13.5	15.2
DA13	1.20	319.9	0.0	0.0	0.0	10.7	10.66	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	72%	0.65	5.3	7.7	10.2	11.5	4.2	6.0	7.9	9.0
Total	**11.45**							**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.00**	**2.23**	**2.38**	**0.00**	**0.02**	**0.20**	**6.55**	**0.05**	**0.00**	**89%**	**0.82**								
System C																															
DA14	1.18	0.0	0.0	0.0	357.7	2.0	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.07	1.07	0.00	0.00	94%	0.86	5.5	7.9	10.4	11.7	5.6	8.1	10.6	12.0
DA15	1.18	0.0	0.0	0.0	449.4	2.5	10.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.94	0.15	0.00	93%	0.86	5.5	7.9	10.4	11.7	5.5	8.0	10.5	11.9
DA19	0.50	226.0	0.0	0.0	0.0	7.5	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.41	0.00	0.00	97%	0.88	5.5	7.9	10.4	11.7	2.4	3.5	4.6	5.2
DA20	4.54	433.7	0.0	0.0	259.8	15.9	15.90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.00	0.00	1.06	2.49	0.50	0.00	75%	0.77	4.4	6.5	8.7	9.9	15.5	22.8	30.5	34.6
DA26	4.57	491.7	0.0	0.0	73.1	16.8	16.80	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.35	0.00	0.00	1.28	2.09	0.46	0.00	62%	0.69	4.3	6.4	8.5	9.7	13.6	20.0	26.7	30.4
DA51	2.00	225.2	0.0	0.0	434.5	9.9	10.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.71	0.69	0.57	0.00	63%	0.72	5.5	7.9	10.4	11.7	7.9	11.4	15.0	16.9
DA61	0.67	331.4	0.0	0.0	0.0	11.0	11.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.27	0.00	41%	0.61	5.2	7.6	10.0	11.3	2.2	3.1	4.1	4.7
DA62	0.82	0.0	0.0	0.0	417.0	2.3	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.74	0.00	90%	0.93	5.5	7.9	10.4	11.7	4.2	6.0	8.0	9.0
Total	**15.45**							**0.00**	**0.50**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.97**	**0.00**	**0.00**	**3.60**	**7.69**	**2.70**	**0.00**	**73%**	**0.76**								
System D																															
DA17	9.83	173.1	173.5	710.5	0.0	11.6	11.64	0.00	0.00	0.00	0.00	0.00	2.84	0.00	5.34	0.00	0.00	0.37	1.28	0.00	0.00	81%	0.77	5.1	7.4	9.8	11.1	38.7	56.2	74.2	83.8
DA21	1.12	168.9	0.0	213.4	0.0	6.8	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.35	0.76	0.00	0.00	68%	0.73	5.5	7.9	10.4	11.7	4.4	6.4	8.4	9.5
DA22	1.23	0.0	43.6	224.1	0.0	1.7	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00	0.00	0.26	0.74	0.00	0.00	76%	0.77	5.5	7.9	10.4	11.7	5.1	7.4	9.8	11.0
DA23	1.61	0.0	263.6	313.1	0.0	4.7	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.11	1.44	0.00	0.00	92%	0.86	5.5	7.9	10.4	11.7	7.5	10.9	14.3	16.1
DA30	0.12	0.0	16.2	86.5	0.0	0.7	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.09	0.00	0.00	79%	0.79	5.5	7.9	10.4	11.7	0.5	0.7	0.9	1.1
Total	**13.90**							**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**2.84**	**0.00**	**5.63**	**0.00**	**0.00**	**1.12**	**4.31**	**0.00**	**0.00**	**81%**	**0.77**								
System E																															
DA52	0.61	0.0	177.1	260.7	0.0	3.4	10.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.14	0.00	0.00	22%	0.42	5.5	7.9	10.4	11.7	1.4	2.0	2.7	3.0
DA53	4.90	600.1	0.0	0.0	0.0	20.0	20.00	0.00	4.70	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.01	0.00	0.00	0%	0.21	3.9	5.8	7.9	8.9	4.0	5.9	7.9	9.1
DA69	1.41	0.0	218.5	401.1	0.0	4.7	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.20	0.00	0.61	0.60	0.00	0.00	55%	0.66	5.5	7.9	10.4	11.7	5.1	7.4	9.7	10.9
DA70	0.26	0.0	51.1	203.8	0.0	1.7	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.11	0.00	0.00	42%	0.58	5.5	7.9	10.4	11.7	0.8	1.2	1.6	1.8
Total	**7.17**							**0.00**	**4.90**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.20**	**0.00**	**1.22**	**0.85**	**0.00**	**0.00**	**14%**	**0.33**								
System F																															
DA34	1.54	0.0	48.2	610.4	0.0	3.9	10.00	0.00	0.00	0.00	0.00	0.00	0.19	0.00	0.00	0.00	0.00	0.72	0.63	0.00	0.00	50%	0.62	5.5	7.9	10.4	11.7	5.2	7.5	9.9	11.1
DA35	2.02	0.0	315.6	353.7	0.0	5.5	10.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.00	1.27	0.34	0.00	0.00	20%	0.44	5.5	7.9	10.4	11.7	4.8	7.0	9.2	10.3
DA36	1.63	47.3	46.7	386.8	0.0	4.2	10.00	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	0.62	0.00	0.00	38%	0.54	5.5	7.9	10.4	11.7	4.8	7.0	9.2	10.3
DA37	1.05	0.0	86.2	219.1	0.0	2.2	10.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.31	0.58	0.00	0.00	66%	0.69	5.5	7.9	10.4	11.7	4.0	5.7	7.5	8.5

Table D.2: Rational Method Calculations - Proposed Conditions

NHHIP Segment 3E (I-45 Downtown Connectors), CSJ: 0500-03-598

Harris County, Texas

Description: Rational Method Calculations
Project Name: NHHIP Drainage Study-Segment 3E
Location: Houston, Texas
Drainage Condition: Proposed Conditions
Date: 6/6/2018

Sub-Basin Name	Area Total [acre]	Overland Sheet Flow Length (ft)	Paved Sheet Flow / Gutter Flow Length (ft)	Storm Sewer Length (ft)	Channel Length (ft)	Calculated Time of Conc (min)	Time of Concentration [min]	Open Area	Park/ Cemetery	School/ Library	Single Family Residential	Multi Residential Units	Apartments	Light Commercial	Heavy Commercial/ Industrial	Downtown Areas	Railroad	ROW Grass	Pavement	Channel	Detention	% Impervious Cover	Runoff Coeff-icient, C	Peak Flow (cfs)				Peak Flow (cfs)			
Runoff Coefficient								**0.30**	**0.20**	**0.65**	**0.50**	**0.60**	**0.70**	**0.65**	**0.80**	**0.90**	**0.35**	**0.35**	**0.90**	**1.00**	**1.00**										
% Impervious Cover								**0%**	**0%**	**72%**	**60%**	**70%**	**75%**	**72%**	**85%**	**85%**	**40%**	**0%**	**100%**	**100%**	**100%**			**2yr**	**10yr**	**50yr**	**100yr**	**2yr**	**10yr**	**50yr**	**100yr**
Travel Velocity																															
DA38	1.02	0.0	232.3	65.4	0.0	2.9	10.00	0.00	0.00	0.00	0.00	0.00	0.54	0.00	0.14	0.00	0.00	0.08	0.25	0.00	0.00	76%	0.73	5.5	7.9	10.4	11.7	4.1	5.9	7.7	8.7
DA39	3.66	0.0	586.4	432.0	0.0	8.9	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07	2.59	0.00	0.00	71%	0.74	5.5	7.9	10.4	11.7	14.8	21.4	28.1	31.7
DA40	1.29	0.0	202.1	183.9	0.0	3.3	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00	0.00	0.07	0.61	0.00	0.00	87%	0.82	5.5	7.9	10.4	11.7	5.8	8.4	11.0	12.4
DA41	1.24	163.1	0.0	207.6	0.0	6.6	10.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.61	0.60	0.00	0.00	50%	0.62	5.5	7.9	10.4	11.7	4.2	6.1	8.0	9.0
DA42	0.68	0.0	296.2	0.0	0.0	3.3	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.40	0.00	0.00	59%	0.68	5.5	7.9	10.4	11.7	2.5	3.6	4.8	5.4
DA43	0.48	0.0	198.1	0.0	0.0	2.2	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.40	0.07	0.00	0.00	16%	0.44	5.5	7.9	10.4	11.7	1.1	1.6	2.2	2.4
DA44	0.40	82.5	0.0	105.7	0.0	3.3	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.22	0.00	0.00	54%	0.65	5.5	7.9	10.4	11.7	1.4	2.0	2.7	3.0
DA46	0.99	277.9	0.0	0.0	0.0	9.3	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	0.57	0.00	0.00	57%	0.67	5.5	7.9	10.4	11.7	3.6	5.2	6.9	7.7
DA47	3.11	0.0	155.3	461.4	0.0	4.3	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.27	1.85	0.00	0.00	59%	0.68	5.5	7.9	10.4	11.7	11.5	16.6	21.9	24.6
DA48	2.12	111.7	231.0	229.3	0.0	7.6	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.21	0.91	0.00	0.00	43%	0.59	5.5	7.9	10.4	11.7	6.8	9.8	12.9	14.5
DA54	6.81	281.8	0.0	570.1	0.0	12.6	12.56	0.00	0.71	0.00	0.00	0.00	0.00	0.00	0.00	2.99	0.00	1.99	1.12	0.00	0.00	54%	0.67	5.0	7.2	9.6	10.8	22.5	32.8	43.5	49.2
DA56	0.38	212.1	0.0	154.3	0.0	7.9	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.14	0.20	0.00	0.00	62%	0.70	5.5	7.9	10.4	11.7	1.4	2.1	2.7	3.1
DA57	0.61	0.0	139.8	280.3	0.0	3.1	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.00	0.06	0.41	0.00	0.00	87%	0.85	5.5	7.9	10.4	11.7	2.8	4.1	5.3	6.0
DA58	0.50	0.0	199.7	85.4	0.0	2.7	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.10	0.30	0.00	0.00	76%	0.79	5.5	7.9	10.4	11.7	2.2	3.1	4.1	4.6
DA59	0.66	0.0	191.0	145.2	0.0	2.9	10.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.01	0.43	0.00	0.00	85%	0.82	5.5	7.9	10.4	11.7	2.9	4.2	5.6	6.3
DA63	1.30	0.0	384.7	0.0	0.0	4.3	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.87	0.43	0.00	0.00	33%	0.53	5.5	7.9	10.4	11.7	3.8	5.5	7.2	8.1
DA64	0.40	0.0	196.8	60.9	0.0	2.5	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.22	0.18	0.00	0.00	45%	0.60	5.5	7.9	10.4	11.7	1.3	1.9	2.5	2.8
DA71	0.54	262.8	0.0	0.0	0.0	8.8	10.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.09	0.00	0.00	0.19	0.24	0.00	0.00	62%	0.68	5.5	7.9	10.4	11.7	2.0	2.9	3.9	4.3
DA72	0.83	217.0	0.0	0.0	0.0	7.2	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.45	0.33	0.00	0.00	44%	0.59	5.5	7.9	10.4	11.7	2.7	3.9	5.1	5.7
Total	**33.26**							**0.00**	**1.31**	**0.03**	**0.00**	**0.16**	**0.77**	**0.00**	**0.87**	**3.49**	**0.00**	**12.73**	**13.89**	**0.00**	**0.00**	**55%**	**0.65**								
System G																															
DA31	610.87	**Calculated using HCFCD Clark UH Method**						6.53	2.85	1.74	6.34	184.92	97.64	0.00	272.79	14.12	0.00	0.71	23.22	0.00	0.00	78%	0.72	**Calculated using HCFCD Clark UH Method**							
DA32	49.27	125.1	145.7	3208.8	0.0	23.6	23.62	1.52	0.46	3.81	10.10	9.19	19.03	0.00	5.15	0.00	0.00	0.00	0.01	0.00	0.00	69%	0.63	3.6	5.4	7.2	8.3	111.4	166.3	224.8	256.8
DA33	47.57	111.8	117.0	3202.1	0.0	22.8	22.82	0.75	2.69	0.00	31.19	8.21	0.90	0.00	3.82	0.00	0.00	0.00	0.01	0.00	0.00	60%	0.53	3.7	5.5	7.4	8.4	91.4	136.3	184.0	210.1
DA55	45.40	156.0	105.9	2864.8	0.0	22.3	22.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.76	0.00	0.01	0.63	0.00	0.00	85%	0.90	3.7	5.5	7.5	8.5	151.4	225.7	304.5	347.5
DA65	13.13	0.0	226.2	1176.3	0.0	9.0	10.00	0.24	0.07	3.76	0.00	6.38	0.00	0.00	1.15	0.00	0.00	0.33	1.20	0.00	0.00	71%	0.65	5.5	7.9	10.4	11.7	46.3	66.9	88.0	99.1
Total	**766.23**							**9.05**	**6.07**	**9.31**	**47.63**	**208.70**	**117.58**	**0.00**	**282.90**	**58.88**	**0.00**	**1.04**	**25.08**	**0.00**	**0.00**	**76%**	**0.71**								
System H																															
DA60	1.04	145.3	0.0	175.2	0.0	5.8	10.00	0.00	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.32	0.00	0.00	30%	0.46	5.5	7.9	10.4	11.7	2.6	3.7	4.9	5.6
Total	**1.04**							**0.00**	**0.41**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.31**	**0.32**	**0.00**	**0.00**	**30%**	**0.46**								
System I																															
DA45	1.24	141.0	0.0	271.4	0.0	6.2	10.00	0.00	0.00	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.53	0.68	0.00	0.00	57%	0.66	5.5	7.9	10.4	11.7	4.5	6.5	8.5	9.6
DA49	0.79	173.9	0.0	160.1	0.0	6.7	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.41	0.00	0.00	52%	0.63	5.5	7.9	10.4	11.7	2.7	3.9	5.2	5.8
DA50	0.78	96.0	0.0	325.2	0.0	5.0	10.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.02	0.00	0.00	2%	0.33	5.5	7.9	10.4	11.7	1.4	2.0	2.7	3.0
DA68	0.28	0.0	82.7	56.6	0.0	1.2	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.00	100%	0.90	5.5	7.9	10.4	11.7	1.4	2.0	2.6	2.9
Total	**3.09**							**0.00**	**0.17**	**0.04**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**1.50**	**1.38**	**0.00**	**0.00**	**46%**	**0.59**								

Table D.3: HCFCD Clark Unit Hydrograph Method - Tc & R Calculations - Existing Conditions

NHHIP Segment 3E (I-45 Downtown Connectors), CSJ: 0500-03-598

Harris County, Texas

Description: HCFCD Clark Unit Hydrograph Method - Tc & R Calculations

Project Name: NHHIP Drainage Study-Segment 3E

Location: Houston, Texas

Drainage Condition: Existing Conditions

Date: 6/6/2018

L Length of longest watercourse (miles)

L_{CA} Watershed length to centroid (miles)

S Channel slope (feet/mile)

S_O Watershed slope (feet/mile)

DLU Percent land urbanization (%)

IMP Percent impervious (%)

DCI Percent channel improvement (%)

DCC Percent channel conveyance (%)

DET On-site detention (%)

DPP Percent ponding (%)

DA ID	L	L_{ca}	S	S_o	DLU	DCC	DCI	DPP	DET	D	DLU_{min}	DLU_{det}	T_C	T_C+R	R
	mi	mi	(ft/mi)	(ft/mi)	(%)	(%)	(%)	(%)	(%)	(---)	(%)	(%)	(hr)	(hr)	(hr)
DA31	2.025	1.345	10.56	11	100	30	100	0	0	2.46	95.4	100	0.3671	5.053503	4.6864

	Existing Conditions			
DA ID	DA	Q - 2yr	Q - 10yr	Q - 100yr
	(ac)	(cfs)	(cfs)	(cfs)
DA56	612.24	254.7	420.8	721.1

Table D.4: HCFCD Clark Unit Hydrograph Method - Tc & R Calculations - Proposed Conditions

NHHIP Segment 3E (I-45 Downtown Connectors), CSJ: 0500-03-598

Harris County, Texas

Description: HCFCD Clark Unit Hydrograph Method - Tc & R Calculations

Project Name: NHHIP Drainage Study-Segment 3E

Location: Houston, Texas

Drainage Condition: Proposed Conditions

Date: 6/6/2018

L Length of longest watercourse (miles)

L_{CA} Watershed length to centroid (miles)

S Channel slope (feet/mile)

S_O Watershed slope (feet/mile)

DLU Percent land urbanization (%)

IMP Percent impervious (%)

DCI Percent channel improvement (%)

DCC Percent channel conveyance (%)

DET On-site detention (%)

DPP Percent ponding (%)

DA ID	L	L_{ca}	S	S_o	DLU	DCC	DCI	DPP	DET	D	DLU_{min}	DLU_{det}	T_C	T_C+R	R
	mi	mi	(ft/mi)	(ft/mi)	(%)	(%)	(%)	(%)	(%)	(---)	(%)	(%)	(hr)	(hr)	(hr)
DA31	2.025	1.345	10.56	11	100	30	100	0	0	2.46	95.4	100	0.3671	5.053503	4.6864

	Proposed Conditions			
DA ID	DA	Q - 2yr	Q - 10yr	Q - 100yr
	(ac)	(cfs)	(cfs)	(cfs)
DA56	610.87	254.1	419.9	719.5

Table D.5: Existing Conditions XP SWMM Hydraulic Analysis Results

NHHIP Segment 3E (I-45 Downtown Connectors), CSJ: 0500-03-598
Harris County, Texas

Description: Existing Conditions XP SWMM Hydraulic Analysis Results
Project Name: NHHIP Drainage Study-Segment 3E
Location: Houston, Texas
Drainage Condition: Existing Conditions
Date: 6/6/2018

			Storm Sewer Configuration							WSE (ft)			WSE - Ground/Curb El. (ft)			Flow (cfs)				
Location	US Node ID/ DA ID	DS Node ID/ DA ID	Shape	Material	Dia/Ht (in/ft)	Span (ft)	Length (ft)	No.	Ground/ Gutter El. (ft)	100-year	10-year	2-year	100-year	10-year	2-year	Design Capacity	100-year	10-year	2-year	Diff. 10yr (cfs)
	Systems North of Buffalo Bayou																			
	SYSTEM A - FRANKLIN STREET																			
Franklin Street	DA9	N106	Circular	RCP	21	0	178	1	39.88	40.66	40.18	39.72	0.78	0.30	-0.16	10	25	25	24	-14
	N106	DA5+4+3	Circular	RCP	24	0	140	1	38.69	39.53	38.97	38.37	0.84	0.28	-0.32	13	25	25	24	-11
ROW	DA5+4+3	N108	Circular	RCP	24	0	62	1	38.06	39.11	38.52	37.87	1.05	0.46	-0.19	13	34	34	32	-21
	N108	DA6	Circular	RCP	24	0	73	1	38.09	38.59	37.95	37.21	0.50	-0.14	-0.88	13	34	34	32	-21
	DA6	N111	Circular	RCP	24	0	267	1	38.27	37.98	37.31	36.45	-0.29	-0.96	-1.82	13	41	39	35	-27
Franklin Street	DA1+2	N111	Circular	RCP	36	0	325	1	41.00	37.13	36.42	33.28	-3.87	-4.58	-7.72	28	57	55	40	-12
	N111	**OutA**	Circular	CMP	36	0	201	1	38.91	35.12	34.54	32.41	-3.79	-4.37	-6.50	28	83	80	71	-42
	SYSTEM B - ROW/HOUSTON AQUARIUM																			
ROW/ Aquarium	DA8+7	N72	Circular	RCP	18	0	150	1	38.01	37.45	36.34	35.09	-0.56	-1.67	-2.92	7	11	10	7	-3
	N72	DA13	Circular	RCP	18	0	135	1	38.45	36.02	35.27	34.50	-2.43	-3.18	-3.95	7	11	10	7	-3
	DA13	DA12	Circular	RCP	24	0	166	1	36.48	34.73	34.34	34.03	-1.75	-2.14	-2.46	13	20	16	11	-3
	DA12	DA11	Circular	RCP	24	0	66	1	35.69	33.34	32.90	32.59	-2.35	-2.79	-3.10	13	15	8	5	4
	DA11	**OutB**	Circular	RCP	24	0	265	1	36.21	32.01	31.80	31.67	-4.20	-4.41	-4.54	13	19	11	6	2
	SYSTEM D - HOUSTON AVENUE																			
Houston Avenue	DA17	N89	Circular	RCP	24	0	172	1	35.09	31.93	30.49	29.55	-3.16	-4.60	-5.54	13	33	23	20	-7
	N89	DA23	Circular	RCP	24	0	178	1	37.51	28.37	27.89	27.83	-9.14	-9.62	-9.69	13	33	23	20	-7
ROW	DA23	N87	Circular	RCP	24	0	171	1	24.75	22.67	17.06	13.01	-2.08	-7.69	-11.74	13	31	30	24	-18
	N87	DA21	Circular	RCP	30	0	116	1	20.00	20.29	14.48	11.59	0.29	-5.52	-8.41	20	43	49	37	-29
	DA21	N92	Circular	RCP	30	0	102	1	20.00	19.28	13.08	10.89	-0.72	-6.92	-9.11	20	51	55	41	-36
	N92	**OutD**	Circular	RCP	30	0	43	1	18.19	18.48	11.64	9.70	0.29	-6.56	-8.49	20	51	55	41	-36
	DA30	DA22	Circular	RCP	18	0	195	1	33.30	24.53	24.50	24.46	-8.77	-8.81	-8.84	7	1	1	0	6
	DA22	N87	Circular	RCP	18	0	50	1	22.35	20.73	19.47	19.22	-1.62	-2.88	-3.13	7	12	8	6	-1
	Systems South of Buffalo Bayou																			
	SYSTEM E - ALLEN PARKWAY TO WALKER STREET CONNECTION																			
ROW/ Walker Street	DA69	N113	Circular	RCP	24	0	99	1	23.29	19.29	18.82	18.70	-4.00	-4.47	-4.59	13	12	8	6	4
	N113	DA70	Circular	RCP	24	0	153	1	20.74	19.07	17.22	17.09	-1.67	-3.52	-3.65	13	12	8	6	4
	DA70	DA53	Circular	RCP	24	0	68	1	20.83	18.76	14.75	14.51	-2.07	-6.08	-6.32	13	14	10	7	3
	DA53	N116	Circular	RCP	24	0	34	1	21.42	18.60	11.57	11.06	-2.82	-9.85	-10.36	13	24	16	11	-3
	N116	N117	Circular	RCP	24	0	17	1	21.43	18.31	11.36	10.32	-3.12	-10.07	-11.11	13	24	16	11	-3
	N117	N118	Circular	RCP	24	0	22	1	22.00	18.19	11.32	9.27	-3.81	-10.68	-12.73	13	24	16	11	-3
	N118	N119	Circular	RCP	24	0	9	1	16.71	18.04	11.26	9.28	1.33	-5.45	-7.44	13	24	16	11	-3
	N119	**OutE**	Circular	RCP	24	0	43	1	15.50	17.98	11.23	9.26	2.48	-4.27	-6.24	13	24	16	11	-3
	DA52	DA53	Circular	RCP	18	0	213	1	25.50	21.98	21.87	21.77	-3.52	-3.64	-3.73	7	5	3	2	4
	SYSTEM F - I-45 MAIN LANES																			

Table D.5: Existing Conditions XP SWMM Hydraulic Analysis Results

NHHIP Segment 3E (I-45 Downtown Connectors), CSJ: 0500-03-598
Harris County, Texas

Description: Existing Conditions XP SWMM Hydraulic Analysis Results
Project Name: NHHIP Drainage Study-Segment 3E
Location: Houston, Texas
Drainage Condition: Existing Conditions
Date: 6/6/2018

			Storm Sewer Configuration							WSE (ft)			WSE - Ground/Curb El. (ft)			Flow (cfs)				
Location	US Node ID/ DA ID	DS Node ID/ DA ID	Shape	Material	Dia/Ht (in/ft)	Span (ft)	Length (ft)	No.	Ground/ Gutter El. (ft)	100-year	10-year	2-year	100-year	10-year	2-year	Design Capacity	100-year	10-year	2-year	Diff. 10yr (cfs)
ROW/ I-45 Main Lanes South of Buffalo Bayou	DA35	N2	Circular	RCP	18	0	76	1	31.76	33.96	30.86	28.84	2.20	-0.90	-2.92	7	19	12	9	-5
	N2	N3	Circular	RCP	24	0	84	1	29.89	32.02	30.01	27.33	2.13	0.12	-2.56	13	19	12	9	0
	N3	N4	Circular	RCP	24	0	67	1	29.70	31.67	29.81	26.89	1.97	0.11	-2.82	13	19	12	9	0
	N4	DA36	Circular	RCP	30	0	435	1	30.02	31.41	29.64	26.36	1.39	-0.38	-3.67	20	23	12	8	7
	DA36	N6	Circular	RCP	30	0	336	1	46.70	31.09	29.28	26.10	-15.61	-17.42	-20.60	20	30	26	15	-7
	N6	DA39	Circular	RCP	30	0	332	1	46.90	30.26	28.12	25.77	-16.64	-18.78	-21.13	20	30	26	15	-7
	DA39	N8	Circular	RCP	42	0	142	1	34.50	29.42	26.96	25.35	-5.08	-7.54	-9.16	38	58	49	30	-10
	N8	DA63	Circular	RCP	42	0	250	1	33.00	29.02	26.72	25.19	-3.98	-6.28	-7.81	38	58	48	29	-10
	DA63	DA43	Circular	RCP	42	0	418	1	39.50	28.30	26.28	24.91	-11.20	-13.22	-14.59	38	74	59	37	-20
	DA43	N11	Circular	RCP	42	0	221	1	55.30	26.34	25.12	24.18	-28.96	-30.18	-31.12	38	79	61	38	-23
	N11	N12	Circular	RCP	42	0	307	1	34.00	25.28	24.49	23.72	-8.72	-9.51	-10.29	38	79	61	38	-22
	N12	OutF	Circular	RCP	42	0	42	1	29.70	19.96	12.72	10.54	-9.74	-16.99	-19.16	38	79	61	38	-22
	DA42	DA63	Circular	RCP	18	0	83	1	39.12	31.98	31.85	31.75	-7.14	-7.27	-7.37	7	6	4	3	3
	SYSTEM G - CROSBY STREET & PORTIONS OF ROW																			
Andrew St	DA55	DA58	Circular	RCP	48	0	275	1	46.61	45.25	44.19	40.39	-1.37	-2.42	-6.22	50	195	196	151	-101
ROW/Fuller Street/ NBFR	DA56	N37	Circular	RCP	18	0	206	1	48.52	44.71	44.56	44.45	-3.81	-3.96	-4.07	7	3	2	2	5
	N37	DA57	Circular	RCP	18	0	228	1	47.44	43.98	43.85	43.76	-3.47	-3.59	-3.69	7	3	2	2	5
	DA57	N39	Circular	RCP	24	0	40	1	46.30	42.56	42.37	42.22	-3.74	-3.93	-4.08	13	10	7	4	6
	N39	DA58	Circular	RCP	24	0	218	1	46.26	42.48	42.13	42.00	-3.78	-4.13	-4.26	13	10	7	4	6
	DA59	DA58	Circular	RCP	24	0	143	1	44.19	42.44	39.90	39.21	-1.75	-4.29	-4.98	13	6	5	3	7
	DA58	DA37	Circular	RCP	48	0	276	1	45.50	42.42	39.90	37.81	-3.08	-5.60	-7.69	50	212	201	157	-151
ROW/ Heiner Street/ SBFR	DA34	N32	Circular	RCP	36	0	31	1	45.74	39.41	38.71	38.54	-6.33	-7.03	-7.20	28	15	10	7	19
	N32	DA37	Circular	RCP	36	0	442	1	45.84	39.41	38.18	38.02	-6.43	-7.67	-7.82	28	14	9	7	19
	DA37	N23	Circular	RCP	54	0	300	1	45.45	39.38	34.39	32.76	-6.07	-11.06	-12.70	64	238	212	164	-148
Crosby Street	N23	DA33	Circular	RCP	120	0	234	1	46.54	37.50	23.06	21.32	-9.04	-23.48	-25.23	314	1095	764	486	-172
	N25	N26	Circular	RCP	120	0	220	1	46.00	35.44	21.64	20.04	-10.56	-24.36	-25.96	314	1301	898	578	-264
	N26	N27	Circular	RCP	120	0	117	1	46.00	34.30	20.76	19.22	-11.71	-25.24	-26.78	314	1301	898	578	-264
	N27	N28	Circular	RCP	96	0	249	1	46.00	33.68	20.19	18.61	-12.32	-25.81	-27.39	201	1301	898	578	-377
	DA33	N25	Circular	RCP	120	0	229	1	46.00	36.63	22.44	20.77	-9.37	-23.56	-25.23	314	1301	898	577	-263
	N28	DA65	Circular	RCP	96	0	285	1	42.63	29.45	17.67	16.09	-13.18	-24.96	-26.54	201	1301	898	579	-378
	DA65	OutG	Circular	RCP	96	0	346	1	42.63	24.61	14.80	13.14	-18.03	-27.83	-29.49	201	1346	923	601	-400
	DA31	DA32	Circular	RCP	120	0	289	1	46.08	39.12	23.65	21.98	-6.96	-22.43	-24.10	314	721	421	255	59
	DA32	N47	Circular	RCP	120	0	230	1	46.00	38.71	23.44	21.68	-7.29	-22.56	-24.32	314	925	572	349	-35
	N47	N23	Circular	RCP	120	0	229	1	46.00	38.10	23.28	21.47	-7.90	-22.72	-24.53	314	925	582	351	-37

Table D.5: Existing Conditions XP SWMM Hydraulic Analysis Results

NHHIP Segment 3E (I-45 Downtown Connectors), CSJ: 0500-03-598
Harris County, Texas

Description: Existing Conditions XP SWMM Hydraulic Analysis Results
Project Name: NHHIP Drainage Study-Segment 3E
Location: Houston, Texas
Drainage Condition: Existing Conditions
Date: 6/6/2018

			Storm Sewer Configuration							WSE (ft)			WSE - Ground/Curb El. (ft)			Flow (cfs)				
Location	US Node ID/ DA ID	DS Node ID/ DA ID	Shape	Material	Dia/Ht (in/ft)	Span (ft)	Length (ft)	No.	Ground/ Gutter El. (ft)	100-year	10-year	2-year	100-year	10-year	2-year	Design Capacity	100-year	10-year	2-year	Diff. 10yr (cfs)
	SYSTEM H - HIENER STREET																			
ROW/ Heiner Street	DA38	N52	Circular	RCP	18	0	217	1	45.94	44.72	43.48	42.96	-1.22	-2.46	-2.98	7	8	6	4	1
	N52	DA40	Circular	RCP	18	0	37	1	46.36	42.40	42.34	42.29	-3.96	-4.02	-4.07	7	8	6	4	1
	DA40	DA41	Circular	RCP	36	0	319	1	46.52	33.89	33.64	33.45	-12.63	-12.89	-13.07	28	21	14	10	14
	DA41	N54.1	Circular	RCP	36	0	247	1	45.00	32.23	31.91	31.67	-12.77	-13.10	-13.33	28	32	22	15	6
	N54.1	DA45	Circular	RCP	36	0	176	1	43.47	30.76	30.41	30.18	-12.71	-13.06	-13.30	28	35	23	16	5
	DA45	DA68	Circular	RCP	36	0	112	1	42.38	29.54	29.24	29.02	-12.84	-13.14	-13.36	28	44	30	21	-1
	DA68	DA60	Circular	RCP	36	0	201	1	42.02	27.69	27.41	27.28	-14.33	-14.61	-14.74	28	46	31	22	-3
	DA60	**OutH**	Circular	CMP	36	0	175	1	43.02	20.91	13.79	13.25	-22.11	-29.23	-29.77	28	52	35	25	-7
	DA44	DA41	Circular	RCP	18	0	224	1	49.07	42.08	42.00	41.93	-6.99	-7.07	-7.14	7	3	2	2	5
	DA64	N101	Circular	RCP	18	0	138	1	51.38	47.27	47.21	47.16	-4.11	-4.17	-4.22	7	3	2	1	5
	N101	N54.1	Circular	RCP	15	0	44	1	44.05	41.13	41.07	41.03	-2.92	-2.98	-3.03	5	3	2	1	3
	SYSTEM I - ALLEN PARKWAY & PORTIONS OF ROW																			
ROW/ Allen Parkway	DA54	N61	Circular	RCP	24	0	270	1	40.00	36.95	36.56	36.30	-3.05	-3.44	-3.71	13	41	28	19	-16
	N61	DA47+46	Circular	RCP	36	0	205	1	33.94	28.67	28.30	28.00	-5.27	-5.64	-5.94	28	41	28	19	0
	DA47+46	N63	Circular	RCP	36	0	136	1	36.00	27.43	27.01	26.64	-8.57	-9.00	-9.36	28	62	46	31	-17
	N63	DA49	Circular	RCP	36	0	92	1	35.00	26.13	25.71	25.34	-8.87	-9.29	-9.66	28	62	46	31	-17
	DA49	DA50+48	Circular	RCP	36	0	188	1	35.00	24.44	24.16	23.94	-10.56	-10.84	-11.06	28	67	49	33	-21
	DA50+48	N66	Circular	RCP	36	0	77	1	34.00	19.97	14.18	13.75	-14.04	-19.82	-20.25	28	87	63	43	-35
	N66	**OutI**	Circular	RCP	48	0	45	1	14.00	19.93	12.76	10.60	5.93	-1.24	-3.40	50	87	63	43	-13

Notes: Within the ROW the design capacity is compared with 10-year flow. Outside the ROW, for City systems, the design capacity is compared with 2-year flow.

Table D.6: Proposed (Mitigated) Conditions XP SWMM Hydraulic Analysis Results

NHHIP Segment 3E (I-45 Downtown Connectors), CSJ: 0500-03-598
Harris County, Texas

Description: Proposed (Mitigated) Conditions XP SWMM Hydraulic Analysis Results
Project Name: NHHIP Drainage Study-Segment 3E
Location: Houston, Texas
Drainage Condition: Proposed Conditions
Date: 6/6/2018

			Storm Sewer Configuration							WSE (ft)			WSE - Ground El. (ft)			Flow (cfs)				
Location	US Node ID/ DA ID	DS Node ID/ DA ID	Shape	Material	Dia/Ht (in/ft)	Span (ft)	Length (ft)	No.	Ground/ Rd. El. (ft)	100-year	10-year	2-year	100-year	10-year	2-year	Design Capacity	100-year	10-year	2-year	Diff. 10yr (cfs)
	Systems North of Buffalo Bayou																			
	SYSTEM A - FRANKLIN STREET																			
Franklin Street	DA9	N106	Circular	RCP	21	0	178	1	39.88	40.49	39.96	39.43	0.61	0.08	-0.45	10	27	26	25	-16
	N106	N107	Circular	RCP	24	0	140	1	38.69	38.10	37.05	35.74	-0.59	-1.64	-2.95	13	27	26	25	-13
	N107	N108	Circular	RCP	24	0	62	1	38.00	37.20	36.00	34.32	-0.80	-2.00	-3.68	13	27	26	25	-13
	N108	N109	Circular	RCP	24	0	73	1	38.09	36.80	35.54	33.70	-1.29	-2.55	-4.39	13	27	26	25	-13
	N109	N111	Circular	RCP	24	0	267	1	38.00	36.33	35.00	32.97	-1.67	-3.01	-5.03	13	27	26	25	-13
	N111	OutA	Circular	CMP	36	0	201	1	38.91	34.63	33.02	30.32	-4.28	-5.89	-8.59	28	80	73	60	-32
	DA1	N111	Circular	RCP	36	0	325	1	41.00	36.87	34.71	32.37	-4.13	-6.30	-8.63	28	61	52	36	-8
	SYSTEM B - ROW/HOUSTON AQUARIUM																			
ROW/ Aquarium	DA2	DA6	Circular	RCP	24	0	481	1	42.00	26.35	25.77	25.51	-15.65	-16.23	-16.49	9	9	7	5	3
	DA6	DA7	Circular	RCP	30	0	384	1	38.27	25.73	25.06	24.71	-12.54	-13.21	-13.57	17	23	16	11	2
	DA7	DA13	Circular	RCP	36	0	197	1	38.01	24.70	24.14	23.78	-13.31	-13.87	-14.23	28	31	21	14	8
	DA13	DA12	Circular	RCP	36	0	139	1	36.48	24.34	23.85	23.51	-12.14	-12.63	-12.97	27	39	26	19	1
	DA4+3	DA5	Circular	RCP	30	0	462	1	42.00	25.81	25.17	24.90	-16.19	-16.83	-17.11	17	18	12	8	5
	DA5	DA8	Circular	RCP	36	0	312	1	38.06	25.15	24.45	24.25	-12.91	-13.61	-13.81	28	30	20	14	7
	DA8	DA11	Circular	RCP	36	0	377	1	41.00	24.67	24.05	23.68	-16.33	-16.95	-17.32	26	37	25	17	2
	DA11	DA12	Circular	RCP	42	0	216	1	29.00	18.41	10.34	8.39	-10.59	-18.66	-20.61	47	49	33	23	14
	DA12	OutB	Rectangular	RCB	3	5	202	1	31.00	18.05	10.34	8.39	-12.95	-20.66	-22.61	80	102	68	48	11
	SYSTEM D - HOUSTON AVENUE																			
Houston Avenue	DA17	N89	Circular	RCP	24	0	172.4	1	35.09	31.95	30.49	29.55	-3.14	-4.60	-5.54	13	32	23	20	-7
	N89	DA23	Circular	RCP	24	0	177.8	1	37.51	28.25	27.89	27.83	-9.26	-9.62	-9.69	13	32	23	20	-7
ROW	DA23	N87	Circular	RCP	24	0	171	1	24.75	21.37	14.16	12.92	-3.38	-10.59	-11.83	19	33	30	23	-11
	N87	DA21	Rectangular	RCB	3	5	115.5	1	20	18.82	11.88	9.93	-1.18	-8.12	-10.07	68	54	49	37	19
	DA21	N92	Rectangular	RCB	3	5	102	1	20	18.78	11.85	9.91	-1.22	-8.15	-10.09	69	63	55	42	14
	N92	OutD	Rectangular	RCB	3	5	42.65	1	18.19	18.74	11.83	9.90	0.55	-6.36	-8.29	69	63	55	42	14
	DA30	DA22	Circular	RCP	18	0	195.2	1	33.3	24.53	24.50	24.46	-8.77	-8.81	-8.84	20	1	1	0	19
	DA22	N87	Circular	RCP	18	0	50	1	22.35	19.91	19.49	19.23	-2.44	-2.86	-3.12	6	12	8	6	-3
	Systems South of Buffalo Bayou																			
	SYSTEM E - ALLEN PARKWAY TO WALKER STREET CONNECTION																			
ROW/ alker Street	DA69	N113	Circular	RCP	24	0	99	1	23.29	18.45	15.16	14.92	-4.84	-8.13	-8.37	10	11	7	5	3
	N113	DA70	Circular	RCP	24	0	153	1	20.74	18.14	14.98	14.74	-2.60	-5.76	-6.00	10	11	7	5	3
	DA70	DA53	Circular	RCP	24	0	68	1	20.83	17.93	14.67	14.46	-2.90	-6.16	-6.37	10	13	9	6	2
	DA53	N116	Circular	RCP	36	0	34	1	21.42	17.82	11.15	9.30	-3.61	-10.27	-12.12	30	22	15	10	15
	N116	N117	Circular	RCP	36	0	17	1	21.43	17.78	11.14	9.26	-3.65	-10.29	-12.17	30	22	15	10	15
	N117	N118	Circular	RCP	36	0	22	1	22.00	17.76	11.13	9.25	-4.24	-10.87	-12.76	30	22	15	10	15

Table D.6: Proposed (Mitigated) Conditions XP SWMM Hydraulic Analysis Results

NHHIP Segment 3E (I-45 Downtown Connectors), CSJ: 0500-03-598
Harris County, Texas

Description: Proposed (Mitigated) Conditions XP SWMM Hydraulic Analysis Results
Project Name: NHHIP Drainage Study-Segment 3E
Location: Houston, Texas
Drainage Condition: Proposed Conditions
Date: 6/6/2018

			Storm Sewer Configuration							WSE (ft)			WSE - Ground El. (ft)			Flow (cfs)				
Location	US Node ID/ DA ID	DS Node ID/ DA ID	Shape	Material	Dia/Ht (in/ft)	Span (ft)	Length (ft)	No.	Ground/ Rd. El. (ft)	100-year	10-year	2-year	100-year	10-year	2-year	Design Capacity	100-year	10-year	2-year	Diff. 10yr (cfs)
W	N118	N119	Circular	RCP	36	0	9	1	16.71	17.74	11.13	9.22	1.03	-5.58	-7.49	29	22	15	10	15
	N119	OutE	Circular	RCP	36	0	43	1	15.50	17.74	11.12	9.22	2.24	-4.38	-6.29	32	22	15	10	18
	DA52	DA53	Circular	RCP	24	0	213	1	25.50	18.87	18.73	18.63	-6.63	-6.77	-6.87	10	3	2	1	8
	SYSTEM F - I-45 MAIN LANES & FRONTAGE ROADS																			
ROW/ Main Trunk along NBFR to Basin 1	DA72	DA35	Circular	RCP	24	0	368	1	46.00	30.64	26.48	26.20	-15.36	-19.53	-19.80	9	6	4	3	6
	DA35	N2	Circular	RCP	24	0	76	1	46.00	30.58	26.33	26.00	-15.42	-19.67	-20.00	11	16	10	7	1
	N2	N3	Circular	RCP	24	0	84	1	46.00	30.35	26.18	25.85	-15.65	-19.83	-20.15	10	16	10	7	0
	N3	N4	Circular	RCP	24	0	67	1	45.50	30.10	26.00	25.68	-15.40	-19.50	-19.82	11	16	10	7	1
	N4	DA59	Circular	RCP	24	0	400	1	45.50	29.91	25.86	25.55	-15.59	-19.65	-19.95	11	16	10	7	1
	DA59	DA58	Circular	RCP	36	0	135	1	44.19	28.77	24.21	23.66	-15.42	-19.98	-20.53	28	27	20	14	8
	DA58	DA57	Circular	RCP	36	0	224	1	45.50	28.59	24.09	23.52	-16.91	-21.41	-21.98	28	29	22	15	7
	DA57	DA56	Circular	RCP	36	0	457	1	46.30	28.25	23.89	23.26	-18.06	-22.41	-23.04	28	32	24	17	4
	DA56	N9	Circular	RCP	42	0	348	1	48.52	27.40	23.61	22.65	-21.12	-24.91	-25.87	49	55	44	30	5
	N9	Pond-East	Circular	RCP	42	0	272	1	45.50	26.82	23.46	21.96	-18.68	-22.04	-23.54	49	60	46	32	3
	Pond-East	N12	Circular	RCP	36	0	428	1	34.00	26.34	23.31	21.18	-7.66	-10.69	-12.83	16	97	81	64	-65
	N12	OutF	Circular	RCP	36	0	42	1	29.70	20.39	12.95	10.57	-9.31	-16.75	-19.13	16	109	89	69	-73
Connections to Main Trunk from East	DA48	N12	Circular	RCP	24	0	200	1	21.00	20.39	16.37	16.12	-0.61	-4.63	-4.88	10	13	10	7	1
	DA54	Pond-East	Circular	RCP	42	0	270	1	40.00	30.95	30.31	29.87	-9.05	-9.70	-10.13	42	58	39	27	3
	DA43	Pond-East	Circular	RCP	24	0	80	1	55.30	28.11	27.93	27.80	-27.19	-27.37	-27.50	11	6	4	3	7
	DA42	N9	Circular	RCP	24	0	174	1	45.50	26.80	23.47	21.96	-18.71	-22.04	-23.54	11	5	4	2	7
	N8	DA56	Circular	RCP	30	0	99	1	46.00	27.56	23.62	22.73	-18.44	-22.38	-23.28	21	32	21	15	0
	DA39	N8	Circular	RCP	30	0	10	1	46.00	27.58	23.63	22.73	-18.42	-22.37	-23.27	21	32	21	15	0
	DA36	DA59	Circular	RCP	24	0	137	1	46.70	28.97	24.31	23.71	-17.73	-22.39	-22.99	11	10	7	5	4
ROW/ Lateral along SBFR to Basin 1	DA71	DA34	Circular	RCP	24	0	324	1	46.08	31.62	24.79	24.43	-14.46	-21.29	-21.65	10	5	3	2	7
	DA34	N32	Circular	RCP	24	0	31	1	45.74	31.54	24.72	24.31	-14.21	-21.02	-21.43	11	15	10	7	1
	N32	DA37	Circular	RCP	24	0	442	1	45.84	31.43	24.67	24.26	-14.41	-21.18	-21.58	11	15	10	7	1
	DA37	DA38	Circular	RCP	30	0	475	1	45.45	29.87	24.14	23.56	-15.58	-21.32	-21.89	17	23	15	11	2
	DA38	N52	Circular	RCP	36	0	217	1	45.94	28.78	23.87	22.44	-17.17	-22.07	-23.50	28	30	20	14	8
	N52	DA40	Circular	RCP	36	0	37	1	46.36	28.45	23.80	22.05	-17.91	-22.56	-24.31	28	30	19	14	9
	DA40	DA41	Circular	RCP	36	0	319	1	46.52	28.39	23.79	21.97	-18.13	-22.73	-24.55	28	40	26	19	2
	DA41	DA44	Circular	RCP	36	0	224	1	45.00	27.65	23.64	21.54	-17.35	-21.36	-23.46	31	49	30	23	0
	DA44	Pond-East	Circular	RCP	36	0	300	1	49.07	26.95	23.50	21.27	-22.12	-25.58	-27.80	31	52	30	25	0
ROW/ Connections to Basins 1 and Basin 2	DA64	Pond-West	Circular	RCP	24	0	115	1	51.38	30.88	30.75	30.66	-20.50	-20.64	-20.72	9	3	2	1	8
	DA63	Pond-West	Circular	RCP	24	0	125	1	45.50	32.94	32.58	32.31	-12.56	-12.92	-13.19	11	15	10	6	1
	DA47+46	Pond-West	Circular	RCP	36	0	136	1	36.00	30.67	30.17	29.82	-5.33	-5.83	-6.19	28	41	27	19	0
	Pond-West	Pond-East	Rectangular	RCB	3	5	200	1	43.00	26.36	25.23	24.96	-16.64	-17.78	-18.04	80	47	32	22	48

Table D.6: Proposed (Mitigated) Conditions XP SWMM Hydraulic Analysis Results

NHHIP Segment 3E (I-45 Downtown Connectors), CSJ: 0500-03-598
Harris County, Texas

Description: Proposed (Mitigated) Conditions XP SWMM Hydraulic Analysis Results
Project Name: NHHIP Drainage Study-Segment 3E
Location: Houston, Texas
Drainage Condition: Proposed Conditions
Date: 6/6/2018

			Storm Sewer Configuration							WSE (ft)			WSE - Ground El. (ft)			Flow (cfs)				
Location	US Node ID/ DA ID	DS Node ID/ DA ID	Shape	Material	Dia/Ht (in/ft)	Span (ft)	Length (ft)	No.	Ground/ Rd. El. (ft)	100-year	10-year	2-year	100-year	10-year	2-year	Design Capacity	100-year	10-year	2-year	Diff. 10yr (cfs)
	SYSTEM G - CROSBY STREET (NO ROW DRAINAGE)																			
Andrew St	DA55	N-DA58	Circular	RCP	48	0	275	1	46.61	45.20	44.12	40.15	-1.41	-2.49	-6.46	50	204	199	151	-149
	N-DA58	N-DA37	Circular	RCP	48	0	276	1	45.50	42.19	39.71	37.57	-3.31	-5.79	-7.93	50	204	199	151	-149
	N-DA37	N23	Circular	RCP	54	0	300	1	45.45	39.14	33.78	32.47	-6.31	-11.67	-12.98	64	211	199	152	-135
Crosby Street	N23	DA33	Circular	RCP	120	0	234	1	46.54	37.37	23.02	21.27	-9.17	-23.52	-25.27	314	1090	757	478	-164
	DA33	N25	Circular	RCP	120	0	229	1	46.00	36.51	22.40	20.74	-9.49	-23.60	-25.27	314	1296	891	570	-256
	N25	N26	Circular	RCP	120	0	220	1	46.00	35.33	21.60	20.01	-10.67	-24.40	-25.99	314	1296	891	570	-256
	N26	N27	Circular	RCP	120	0	117	1	46.00	34.19	20.73	19.18	-11.81	-25.27	-26.82	314	1296	891	570	-256
	N27	N28	Circular	RCP	96	0	249	1	46.00	33.59	20.15	18.58	-12.41	-25.85	-27.42	201	1296	891	571	-370
	N28	DA65	Circular	RCP	96	0	285	1	42.63	29.38	17.64	16.06	-13.25	-24.99	-26.57	201	1296	891	571	-370
	DA65	**OutG**	Circular	RCP	96	0	346	1	42.63	24.57	14.77	13.11	-18.07	-27.86	-29.52	201	1342	918	592	-391
	DA31	DA32	Circular	RCP	120	0	289	1	46.08	39.00	23.63	21.97	-7.08	-22.45	-24.11	314	721	421	255	59
	DA32	N47	Circular	RCP	120	0	230	1	46.00	38.58	23.42	21.66	-7.42	-22.59	-24.34	314	925	575	349	-35
	N47	N23	Circular	RCP	120	0	229	1	46.00	37.97	23.25	21.44	-8.03	-22.76	-24.56	314	925	586	351	-37
	SYSTEM H - HIENER STREET																			
Heiner Street	DA60	**OutH**	Circular	CMP	36	0	175	1	43.02	19.89	12.84	12.29	-23.13	-30.18	-30.73	28	6	4	3	26
	SYSTEM I - ALLEN PARKWAY & PORTIONS OF ROW																			
ROW/ Allen Parkway	DA45	DA49	Circular	RCP	24	0	361	1	42.38	19.93	19.28	19.36	-22.45	-23.10	-23.02	10	10	6	4	3
	DA68	DA49	Circular	RCP	24	0	254	1	42.02	19.92	19.21	19.10	-22.10	-22.81	-22.92	9	3	2	1	8
	DA49	DA50	Circular	RCP	30	0	185	1	35.00	19.92	18.75	18.51	-15.08	-16.25	-16.49	17	18	12	8	5
	DA50	**OutI**	Circular	RCP	30	0	121	1	34.00	19.92	12.75	10.59	-14.08	-21.25	-23.41	17	18	12	8	5

Notes: Within the ROW the design capacity is compared with 10-year flow. Outside the ROW, for City systems, the design capacity is compared with 2-year flow.

Table D.7: Detention Basins Elevation-Storage

NHHIP Segment 3E (I-45 Downtown Connectors), CSJ: 0500-03-598

Harris County, Texas

Description: Detention Basins Elevation-Storage

Project Name: NHHIP Drainage Study-Segment 3E

Location: Houston, Texas

Drainage Condition: Proposed Conditions

Date: 6/6/2018

	Basin 1				Basin 2				
Elevation	Area (SF)	Area (ac-ft)	Cumulative Volume (Cu.Ft.)	Cumulative Volume (ac-ft)	Area (SF)	Area (ac-ft)	Incremental Volume (Cu.Ft.)	Cumulative Volume (ac-ft)	Total Volume (ac-ft)
15.00	5,653	0.13	5,075	0.0	--	--	--	--	0.0
16.00	6,874	0.16	6,264	0.1	--	--	--	--	0.1
17.00	8,250	0.19	7,562	0.3	--	--	--	--	0.3
18.00	9,782	0.22	9,016	0.5	--	--	--	--	0.5
19.00	11,469	0.26	10,625	0.8	--	--	--	--	0.8
20.00	13,312	0.31	12,391	1.1	--	--	--	--	1.1
21.00	15,129	0.35	14,221	1.4	--	--	--	--	1.4
22.00	17,082	0.39	16,105	1.7	--	--	--	--	1.7
23.00	19,170	0.44	18,126	2.2	--	--	--	--	2.2
24.00	21,394	0.49	20,282	2.6	8,714	0.20	7,872	0.0	2.6
25.00	23,754	0.55	22,574	3.1	10,615	0.24	9,664	0.2	3.4
26.00	26,130	0.60	24,942	3.7	13,409	0.31	12,012	0.5	4.2
27.00	28,619	0.66	27,374	4.3	15,723	0.36	14,566	0.8	5.2
28.00	31,222	0.72	29,920	5.0	18,281	0.42	17,002	1.2	6.3
29.00	33,938	0.78	32,580	5.8	21,082	0.48	19,682	1.7	7.5
30.00	36,767	0.84	35,352	6.6	24,127	0.55	22,605	2.2	8.8
31.00	39,650	0.91	38,209	7.5	39,273	0.90	31,700	2.9	10.4
32.00	42,633	0.98	41,142	8.4	44,116	1.01	41,694	3.9	12.3
33.00	45,716	1.05	44,175	9.4	49,152	1.13	46,634	4.9	14.4
34.00	48,899	1.12	47,307	10.5	54,381	1.25	51,767	6.1	16.7
35.00	52,193	1.20	50,546	11.7	60,089	1.38	57,235	7.5	19.1

APPENDIX E

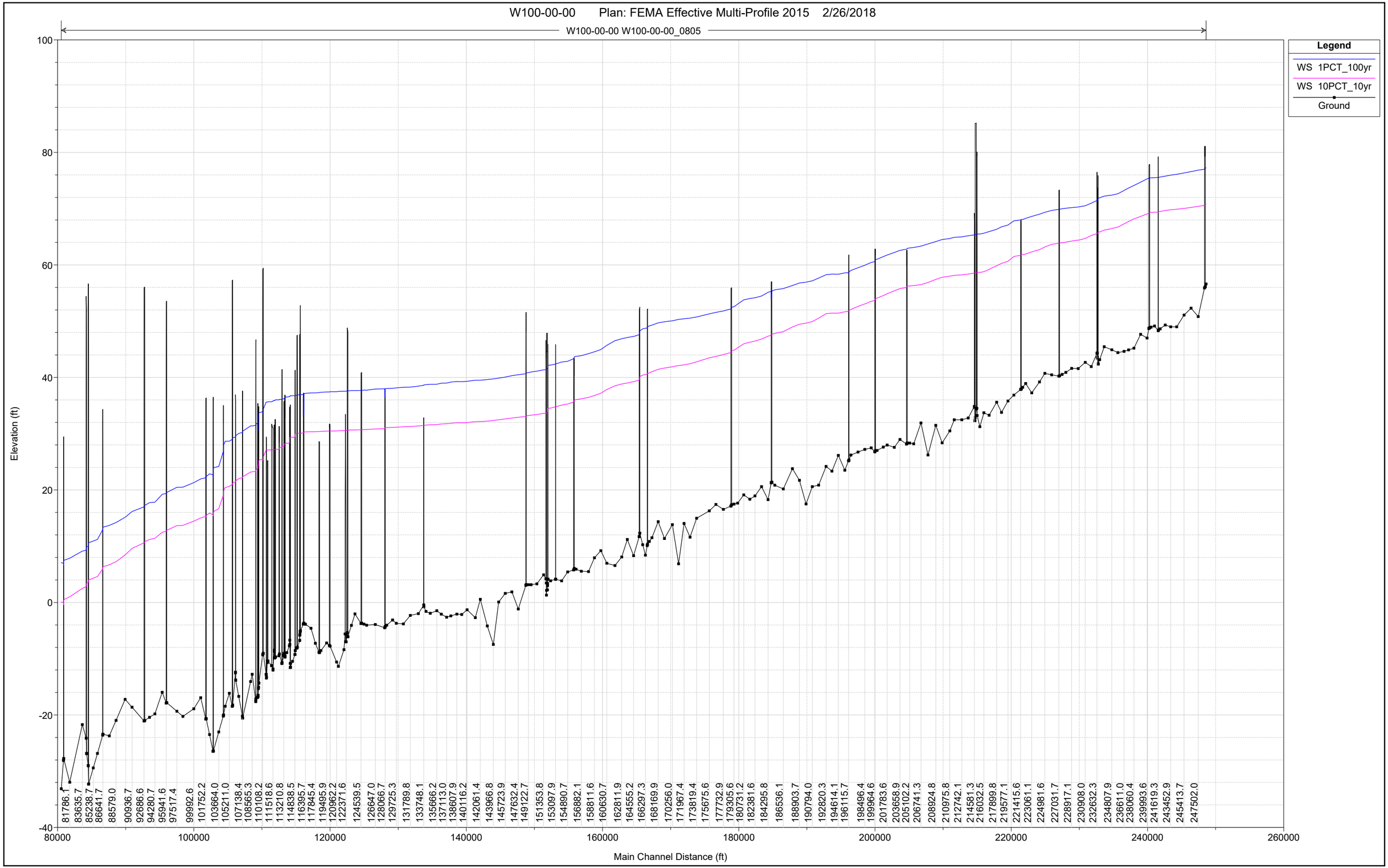
BRIDGE HYDRAULIC ANALYSIS

FEMA EFFECTIVE, CORRECTED EXISTING, & PROPOSED CONDITIONS

APPENDIX E.1

FEMA EFFECTIVE CONDITIONS

W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018



HEC-RAS Plan: Eff+LOMR MP River: W100-00-00 Reach: W100-00-00_0805

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)	
W100-00-00_0805	80538.0	10PCT_10yr	39606.00	-33.12	0.08	-20.19	0.32	0.000150	3.95	10017.38	472.21	0.15
W100-00-00_0805	80538.0	1PCT_100yr	61636.00	-33.12	7.09	-17.03	7.41	0.000150	4.58	13471.92	521.38	0.16
W100-00-00_0805	80863.1	10PCT_10yr	39606.00	-28.10	-0.06	-12.78	0.64	0.000648	6.74	5872.50	362.82	0.30
W100-00-00_0805	80863.1	1PCT_100yr	61636.00	-28.10	6.93	-9.31	7.73	0.000506	7.20	8580.03	407.83	0.27
W100-00-00_0805	80883.1		Bridge									
W100-00-00_0805	80903.1	10PCT_10yr	39606.00	-27.77	0.49	-12.46	1.17	0.000625	6.65	5952.35	365.17	0.29
W100-00-00_0805	80903.1	1PCT_100yr	61636.00	-27.77	7.48	-8.98	8.27	0.000490	7.12	8669.41	408.89	0.27
W100-00-00_0805	81786.1	10PCT_10yr	39496.00	-31.97	1.01		1.87	0.000763	7.47	5290.19	322.17	0.32
W100-00-00_0805	81786.1	1PCT_100yr	61411.00	-31.97	7.86		8.87	0.000634	8.05	7626.12	358.33	0.31
W100-00-00_0805	83635.7	10PCT_10yr	39496.00	-21.72	2.49		3.47	0.000938	7.92	4989.87	326.20	0.36
W100-00-00_0805	83635.7	1PCT_100yr	61411.00	-21.72	9.13		10.22	0.000822	8.40	7312.44	394.24	0.34
W100-00-00_0805	84192.0	10PCT_10yr	39246.00	-24.10	2.82	-6.85	4.30	0.001168	9.74	4029.79	222.16	0.40
W100-00-00_0805	84192.0	1PCT_100yr	60900.00	-24.10	9.26	-2.79	11.15	0.001124	11.02	5524.21	242.01	0.41
W100-00-00_0805	84222.3		Bridge									
W100-00-00_0805	84252.6	10PCT_10yr	39246.00	-26.90	3.45	-9.65	4.49	0.000697	8.16	4809.45	232.73	0.32
W100-00-00_0805	84252.6	1PCT_100yr	60900.00	-26.90	9.93	-5.58	11.35	0.000709	9.55	6555.94	446.67	0.33
W100-00-00_0805	84501.1	10PCT_10yr	39246.00	-28.97	3.54	-9.92	4.76	0.000785	8.85	4433.39	203.63	0.33
W100-00-00_0805	84501.1	1PCT_100yr	60900.00	-28.97	9.98	-5.52	11.68	0.000876	10.48	5921.80	305.36	0.36
W100-00-00_0805	84531.4		Bridge									
W100-00-00_0805	84561.7	10PCT_10yr	39246.00	-32.27	4.02	-13.22	4.90	0.000492	7.51	5223.51	214.37	0.27
W100-00-00_0805	84561.7	1PCT_100yr	60900.00	-32.27	10.61	-8.82	11.86	0.000546	9.03	7360.35	422.96	0.29
W100-00-00_0805	85238.7	10PCT_10yr	39246.00	-29.43	4.30		5.39	0.000671	8.38	4685.64	215.50	0.31
W100-00-00_0805	85238.7	1PCT_100yr	60900.00	-29.43	10.91		12.42	0.000733	9.88	6627.46	352.18	0.33
W100-00-00_0805	85855.2	10PCT_10yr	39246.00	-26.84	4.60		5.94	0.000907	9.31	4215.69	200.56	0.36
W100-00-00_0805	85855.2	1PCT_100yr	60900.00	-26.84	11.20		13.04	0.000970	10.87	5603.90	227.28	0.38
W100-00-00_0805	86623.2	10PCT_10yr	39246.00	-23.61	5.98	-10.28	6.59	0.000368	6.25	6282.23	285.16	0.23
W100-00-00_0805	86623.2	1PCT_100yr	60900.00	-23.61	12.94	-6.63	13.78	0.000373	7.35	8341.46	310.43	0.24
W100-00-00_0805	86641.7		Bridge									
W100-00-00_0805	86660.2	10PCT_10yr	39246.00	-23.42	6.35	-10.09	6.94	0.000359	6.20	6332.78	286.26	0.23
W100-00-00_0805	86660.2	1PCT_100yr	60900.00	-23.42	13.37	-6.45	14.19	0.000364	7.29	8415.64	311.39	0.24
W100-00-00_0805	87591.9	10PCT_10yr	39246.00	-23.72	6.69		7.46	0.000586	7.04	5572.95	298.66	0.29
W100-00-00_0805	87591.9	1PCT_100yr	60900.00	-23.72	13.70		14.66	0.000521	7.89	7715.40	311.49	0.28
W100-00-00_0805	88579.0	10PCT_10yr	39246.00	-20.97	7.24		8.22	0.000883	7.94	4942.52	306.26	0.35
W100-00-00_0805	88579.0	1PCT_100yr	60900.00	-20.97	14.21		15.31	0.000726	8.42	7231.45	353.15	0.33
W100-00-00_0805	89918.4	10PCT_10yr	39246.00	-17.23	8.44		9.46	0.000950	8.12	4831.68	305.25	0.36
W100-00-00_0805	89918.4	1PCT_100yr	60900.00	-17.23	15.14		16.30	0.000728	8.69	7699.60	632.00	0.33
W100-00-00_0805	90936.7	10PCT_10yr	39136.00	-18.64	9.61		10.30	0.000667	6.68	5861.09	382.22	0.30
W100-00-00_0805	90936.7	1PCT_100yr	60674.00	-18.64	16.16		16.96	0.000516	7.17	8483.65	417.54	0.28
W100-00-00_0805	92686.6	10PCT_10yr	39136.00	-21.08	10.59	-5.32	11.33	0.000498	6.88	5684.58	277.09	0.27
W100-00-00_0805	92686.6	1PCT_100yr	60674.00	-21.08	16.99	-1.47	17.99	0.000547	8.00	7585.07	316.53	0.29
W100-00-00_0805	92741.1		Bridge									
W100-00-00_0805	92795.6	10PCT_10yr	39136.00	-20.98	10.82	-5.22	11.54	0.000490	6.84	5719.69	277.87	0.27
W100-00-00_0805	92795.6	1PCT_100yr	60674.00	-20.98	17.25	-1.37	18.23	0.000537	7.95	7633.68	317.76	0.29
W100-00-00_0805	93495.6	10PCT_10yr	39073.00	-20.43	11.18		11.90	0.000530	6.80	5748.82	300.94	0.27
W100-00-00_0805	93495.6	1PCT_100yr	60545.00	-20.43	17.73		18.63	0.000554	7.62	7947.61	363.93	0.29
W100-00-00_0805	94280.7	10PCT_10yr	39073.00	-19.82	11.41		12.47	0.000664	8.26	4733.11	202.43	0.30
W100-00-00_0805	94280.7	1PCT_100yr	60545.00	-19.82	17.83		19.33	0.000792	9.86	6315.75	281.58	0.34
W100-00-00_0805	95362.9	10PCT_10yr	38910.00	-15.97	12.47		13.07	0.000419	6.26	6212.28	312.98	0.25
W100-00-00_0805	95362.9	1PCT_100yr	60210.00	-15.97	19.22		20.01	0.000415	7.14	8433.53	344.52	0.25
W100-00-00_0805	95941.6	10PCT_10yr	38910.00	-17.87	12.67	-3.32	13.38	0.000452	6.73	5794.64	276.46	0.25
W100-00-00_0805	95941.6	1PCT_100yr	60210.00	-17.87	19.37	1.23	20.35	0.000441	7.94	7778.76	310.89	0.26
W100-00-00_0805	95985.1		Bridge									
W100-00-00_0805	96028.6	10PCT_10yr	38910.00	-17.81	12.83	-3.27	13.52	0.000446	6.70	5820.56	277.04	0.25

HEC-RAS Plan: Eff+LOMR MP River: W100-00-00 Reach: W100-00-00_0805 (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)	
W100-00-00_0805	96028.6	1PCT_100yr	60210.00	-17.81	19.54	1.29	20.51	0.000436	7.91	7811.73	311.22	0.26
W100-00-00_0805	97517.4	10PCT_10yr	38910.00	-19.35	13.65		14.07	0.000233	5.24	7438.01	311.01	0.19
W100-00-00_0805	97517.4	1PCT_100yr	60210.00	-19.35	20.47		21.09	0.000244	6.32	9590.15	319.89	0.20
W100-00-00_0805	98399.4	10PCT_10yr	38910.00	-20.26	13.71		14.46	0.000482	6.95	5601.45	250.78	0.26
W100-00-00_0805	98399.4	1PCT_100yr	60210.00	-20.26	20.49		21.52	0.000525	8.14	7392.67	277.53	0.28
W100-00-00_0805	99992.6	10PCT_10yr	38910.00	-18.90	14.45		15.25	0.000492	7.16	5432.91	238.49	0.26
W100-00-00_0805	99992.6	1PCT_100yr	60210.00	-18.90	21.30		22.39	0.000548	8.39	7175.23	266.19	0.28
W100-00-00_0805	101007.3	10PCT_10yr	38563.00	-16.93	15.02		15.72	0.000435	6.76	5704.29	255.99	0.25
W100-00-00_0805	101007.3	1PCT_100yr	59499.00	-16.93	21.95		22.91	0.000457	7.87	7561.24	277.43	0.27
W100-00-00_0805	101752.2	10PCT_10yr	38563.00	-20.69	15.28	-0.82	16.16	0.000513	7.53	5120.88	217.53	0.27
W100-00-00_0805	101752.2	1PCT_100yr	59499.00	-20.69	22.17	3.44	23.42	0.000520	8.98	6907.57	295.29	0.29
W100-00-00_0805	101790.1		Bridge									
W100-00-00_0805	101828.0	10PCT_10yr	38563.00	-20.70	15.46	-0.84	16.33	0.000500	7.47	5162.33	219.15	0.27
W100-00-00_0805	101828.0	1PCT_100yr	59499.00	-20.70	22.39	3.43	23.61	0.000507	8.91	6974.31	298.10	0.28
W100-00-00_0805	102309.0	10PCT_10yr	38563.00	-23.48	15.90		16.58	0.000329	6.59	5855.47	216.46	0.22
W100-00-00_0805	102309.0	1PCT_100yr	59499.00	-23.48	22.86		23.88	0.000367	8.10	7375.88	223.15	0.24
W100-00-00_0805	102819.7	10PCT_10yr	38563.00	-26.43	15.60	0.56	17.44	0.001030	11.73	4705.83	335.22	0.36
W100-00-00_0805	102819.7	1PCT_100yr	59499.00	-26.43	22.70	10.26	24.62	0.000942	12.76	7231.86	375.06	0.35
W100-00-00_0805	102847.5		Bridge									
W100-00-00_0805	102875.3	10PCT_10yr	38563.00	-26.39	16.13	0.64	17.86	0.000958	11.43	4872.08	338.74	0.35
W100-00-00_0805	102875.3	1PCT_100yr	59499.00	-26.39	23.95	10.33	25.64	0.000814	12.10	7689.73	382.33	0.33
W100-00-00_0805	103664.0	10PCT_10yr	38563.00	-23.03	16.67		19.11	0.001444	13.24	4063.85	258.58	0.42
W100-00-00_0805	103664.0	1PCT_100yr	59499.00	-23.03	24.18		26.97	0.001364	14.86	6734.96	682.64	0.42
W100-00-00_0805	104329.2	10PCT_10yr	38563.00	-20.20	19.04	3.48	20.11	0.000586	8.70	6136.94	433.81	0.30
W100-00-00_0805	104329.2	1PCT_100yr	59499.00	-20.20	26.81	9.28	27.98	0.000496	9.48	9725.06	487.51	0.28
W100-00-00_0805	104350.0		Bridge									
W100-00-00_0805	104370.8	10PCT_10yr	38563.00	-19.99	19.82	3.69	20.83	0.000538	8.45	6385.48	436.21	0.28
W100-00-00_0805	104370.8	1PCT_100yr	59499.00	-19.99	27.94	9.49	29.01	0.000446	9.14	10174.24	491.06	0.27
W100-00-00_0805	104608.2	10PCT_10yr	38563.00	-18.46	20.45		21.07	0.000598	6.36	6061.14	386.62	0.28
W100-00-00_0805	104608.2	1PCT_100yr	59499.00	-18.46	28.65		29.26	0.000389	6.24	9555.38	483.81	0.24
W100-00-00_0805	105211.0	10PCT_10yr	38563.00	-16.14	20.62	2.27	21.46	0.000483	7.39	5219.46	217.57	0.27
W100-00-00_0805	105211.0	1PCT_100yr	59499.00	-16.14	28.66	6.95	29.67	0.000627	8.05	7387.17	333.97	0.30
W100-00-00_0805	105629.4	10PCT_10yr	38563.00	-18.43	20.97	1.89	21.69	0.000436	6.82	5659.64	253.14	0.25
W100-00-00_0805	105629.4	1PCT_100yr	59499.00	-18.43	28.98	6.47	29.90	0.000397	7.71	8021.50	339.05	0.25
W100-00-00_0805	105667.4		Bridge									
W100-00-00_0805	105705.4	10PCT_10yr	38563.00	-18.22	21.27	2.10	21.99	0.000430	6.79	5681.98	254.18	0.25
W100-00-00_0805	105705.4	1PCT_100yr	59499.00	-18.22	29.30	6.68	30.21	0.000393	7.68	8056.56	340.49	0.25
W100-00-00_0805	106110.8	10PCT_10yr	38563.00	-12.53	21.41	4.90	22.25	0.000584	7.37	5503.77	248.42	0.26
W100-00-00_0805	106110.8	1PCT_100yr	59499.00	-12.53	29.38	9.38	30.51	0.000582	8.55	7621.45	283.73	0.27
W100-00-00_0805	106131.1		Bridge									
W100-00-00_0805	106151.4	10PCT_10yr	38563.00	-13.85	21.63	3.57	22.37	0.000485	6.93	5891.72	254.97	0.24
W100-00-00_0805	106151.4	1PCT_100yr	59499.00	-13.85	29.64	8.06	30.65	0.000501	8.13	8074.02	291.29	0.25
W100-00-00_0805	106594.0	10PCT_10yr	38563.00	-16.70	22.00	0.70	22.60	0.000342	6.19	6406.05	247.44	0.20
W100-00-00_0805	106594.0	1PCT_100yr	59499.00	-16.70	30.05	5.21	30.90	0.000378	7.41	8520.94	278.19	0.22
W100-00-00_0805	107138.4	10PCT_10yr	38563.00	-20.19	22.17	1.67	22.96	0.000721	7.14	5633.65	321.93	0.25
W100-00-00_0805	107138.4	1PCT_100yr	59499.00	-20.19	30.23	6.30	31.25	0.000663	8.21	8758.77	396.31	0.25
W100-00-00_0805	107158.9		Bridge									
W100-00-00_0805	107179.4	10PCT_10yr	38563.00	-20.52	22.34	1.34	23.10	0.000675	6.99	5799.78	336.50	0.24
W100-00-00_0805	107179.4	1PCT_100yr	59499.00	-20.52	30.45	5.97	31.43	0.000626	8.06	8975.73	396.54	0.24
W100-00-00_0805	108334.0	10PCT_10yr	38441.00	-14.06	23.18		23.72	0.000356	5.88	6571.48	271.75	0.20
W100-00-00_0805	108334.0	1PCT_100yr	59250.00	-14.06	31.37		32.04	0.000340	6.65	12214.67	840.92	0.21
W100-00-00_0805	108565.3	10PCT_10yr	38441.00	-12.77	23.22	4.32	23.83	0.000429	6.28	6124.70	248.13	0.22
W100-00-00_0805	108565.3	1PCT_100yr	59250.00	-12.77	31.38	8.20	32.16	0.000401	7.14	9691.62	547.04	0.22

HEC-RAS Plan: Eff+LOMR MP River: W100-00-00 Reach: W100-00-00_0805 (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)	
W100-00-00_0805	109087.2	10PCT_10yr	38441.00	-17.55	23.30	5.10	24.30	0.000667	8.20	5222.16	343.04	0.27
W100-00-00_0805	109087.2	1PCT_100yr	59250.00	-17.55	31.49	10.53	32.54	0.000555	8.80	8038.05	506.95	0.25
W100-00-00_0805	109103.1		Bridge									
W100-00-00_0805	109119.0	10PCT_10yr	38441.00	-17.14	23.54	5.51	24.56	0.000683	8.26	5170.75	340.72	0.27
W100-00-00_0805	109119.0	1PCT_100yr	59250.00	-17.14	31.74	10.82	32.81	0.000565	8.85	7980.17	503.19	0.25
W100-00-00_0805	109350.2	10PCT_10yr	38441.00	-16.89	23.89	3.87	24.73	0.000471	7.63	6493.36	320.67	0.24
W100-00-00_0805	109350.2	1PCT_100yr	59250.00	-16.89	31.84	8.83	32.96	0.000487	8.98	9088.02	332.29	0.25
W100-00-00_0805	109395.2		Bridge									
W100-00-00_0805	109440.2	10PCT_10yr	38441.00	-16.48	24.23	4.28	25.08	0.000475	7.65	6470.25	320.56	0.24
W100-00-00_0805	109440.2	1PCT_100yr	59250.00	-16.48	32.57	9.24	33.66	0.000472	8.90	9193.60	332.75	0.25
W100-00-00_0805	109485.7	10PCT_10yr	38441.00	-15.31	24.45	3.87	25.14	0.000413	6.89	6942.18	334.93	0.22
W100-00-00_0805	109485.7	1PCT_100yr	59250.00	-15.31	32.86	9.38	33.75	0.000395	7.95	9893.74	366.78	0.23
W100-00-00_0805	109518.7		Bridge									
W100-00-00_0805	109551.7	10PCT_10yr	38441.00	-14.28	25.28	4.90	25.98	0.000423	6.95	6873.12	334.15	0.22
W100-00-00_0805	109551.7	1PCT_100yr	59250.00	-14.28	33.70	10.41	34.59	0.000403	7.99	9822.87	366.04	0.23
W100-00-00_0805	110108.2	10PCT_10yr	38441.00	-9.31	25.47	10.90	26.37	0.000681	8.19	6686.43	433.87	0.28
W100-00-00_0805	110108.2	1PCT_100yr	59250.00	-9.31	33.91	14.50	34.91	0.000554	8.91	10931.97	562.57	0.27
W100-00-00_0805	110154.2		Bridge									
W100-00-00_0805	110200.2	10PCT_10yr	38441.00	-9.11	25.88	11.10	26.76	0.000661	8.11	6778.16	438.88	0.28
W100-00-00_0805	110200.2	1PCT_100yr	59250.00	-9.11	34.36	14.70	35.34	0.000539	8.83	11069.32	566.54	0.26
W100-00-00_0805	110614.7	10PCT_10yr	8535.00	-12.75	27.07	-1.41	27.12	0.000034	1.86	6814.65	639.94	0.06
W100-00-00_0805	110614.7	1PCT_100yr	17393.00	-12.75	35.61	2.99	35.70	0.000048	2.62	15020.52	1322.07	0.08
W100-00-00_0805	110643.7		Bridge									
W100-00-00_0805	110672.7	10PCT_10yr	8535.00	-13.25	27.07	-1.88	27.12	0.000032	1.82	7113.65	659.24	0.06
W100-00-00_0805	110672.7	1PCT_100yr	17393.00	-13.25	35.63	2.49	35.71	0.000045	2.56	15711.19	1341.87	0.07
W100-00-00_0805	110799.0	10PCT_10yr	8535.00	-10.72	27.08	-1.29	27.12	0.000023	1.73	6898.96	342.72	0.05
W100-00-00_0805	110799.0	1PCT_100yr	17393.00	-10.72	35.63	2.08	35.72	0.000037	2.58	14547.72	1393.60	0.07
W100-00-00_0805	110837.8		Bridge									
W100-00-00_0805	110876.6	10PCT_10yr	8535.00	-10.43	27.09	-1.00	27.14	0.000023	1.75	6812.73	330.75	0.05
W100-00-00_0805	110876.6	1PCT_100yr	17393.00	-10.43	35.66	2.40	35.75	0.000038	2.61	14183.81	1377.27	0.07
W100-00-00_0805	111410.5	10PCT_10yr	8535.00	-11.23	27.11	1.35	27.16	0.000037	1.89	5295.53	228.19	0.06
W100-00-00_0805	111410.5	1PCT_100yr	17393.00	-11.23	35.67	5.41	35.79	0.000060	2.89	8018.81	517.83	0.09
W100-00-00_0805	111518.6		Bridge									
W100-00-00_0805	111626.7	10PCT_10yr	8535.00	-11.83	27.15	0.75	27.20	0.000034	1.84	5441.79	229.26	0.06
W100-00-00_0805	111626.7	1PCT_100yr	17393.00	-11.83	35.84	4.87	35.96	0.000056	2.83	8435.26	575.86	0.08
W100-00-00_0805	111783.7	10PCT_10yr	8535.00	-8.67	27.17	2.30	27.21	0.000028	1.67	5246.43	222.30	0.06
W100-00-00_0805	111783.7	1PCT_100yr	17393.00	-8.67	35.87	5.88	35.97	0.000044	2.55	7553.10	430.28	0.08
W100-00-00_0805	111818.6		Bridge									
W100-00-00_0805	111853.5	10PCT_10yr	8535.00	-9.86	27.19	1.11	27.23	0.000024	1.60	5517.84	225.96	0.05
W100-00-00_0805	111853.5	1PCT_100yr	17393.00	-9.86	35.93	4.69	36.02	0.000039	2.46	8123.00	478.25	0.07
W100-00-00_0805	111903.3	10PCT_10yr	8535.00	-9.84	27.20	1.40	27.24	0.000027	1.65	5856.92	285.15	0.05
W100-00-00_0805	111903.3	1PCT_100yr	17393.00	-9.84	35.93	4.58	36.02	0.000042	2.49	8842.57	483.45	0.07
W100-00-00_0805	111953.3		Bridge									
W100-00-00_0805	112003.3	10PCT_10yr	8535.00	-9.69	27.22	1.55	27.26	0.000027	1.66	5821.47	284.63	0.06
W100-00-00_0805	112003.3	1PCT_100yr	17393.00	-9.69	36.01	4.73	36.10	0.000042	2.49	8808.28	481.23	0.07
W100-00-00_0805	112493.5	10PCT_10yr	8535.00	-9.47	27.23	1.67	27.30	0.000049	2.11	4858.21	239.41	0.07
W100-00-00_0805	112493.5	1PCT_100yr	17393.00	-9.47	36.02	7.19	36.15	0.000074	3.11	9426.89	953.14	0.09
W100-00-00_0805	112534.5		Bridge									
W100-00-00_0805	112575.5	10PCT_10yr	8535.00	-9.20	27.57	1.94	27.63	0.000049	2.10	4872.19	239.52	0.07
W100-00-00_0805	112575.5	1PCT_100yr	17393.00	-9.20	36.09	7.47	36.23	0.000076	3.13	9240.28	939.82	0.09
W100-00-00_0805	112915.8	10PCT_10yr	8535.00	-10.82	27.57	0.34	27.65	0.000066	2.33	4104.86	199.71	0.08

HEC-RAS Plan: Eff+LOMR MP River: W100-00-00 Reach: W100-00-00_0805 (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)	
W100-00-00_0805	112915.8	1PCT_100yr	17393.00	-10.82	36.10	5.84	36.28	0.000100	3.49	5901.61	269.62	0.10
W100-00-00_0805	112944.9		Bridge									
W100-00-00_0805	112974.0	10PCT_10yr	8535.00	-10.69	27.72	0.47	27.80	0.000065	2.33	4109.26	199.75	0.08
W100-00-00_0805	112974.0	1PCT_100yr	17393.00	-10.69	36.17	5.97	36.35	0.000101	3.49	5885.40	266.84	0.10
W100-00-00_0805	113210.8	10PCT_10yr	8535.00	-9.46	27.73	2.05	27.82	0.000056	2.35	4297.42	237.75	0.08
W100-00-00_0805	113210.8	1PCT_100yr	17393.00	-9.46	36.19	6.57	36.37	0.000087	3.52	7048.92	586.30	0.10
W100-00-00_0805	113238.6		Bridge									
W100-00-00_0805	113266.4	10PCT_10yr	8535.00	-9.11	28.13	2.40	28.22	0.000055	2.35	4309.61	237.94	0.08
W100-00-00_0805	113266.4	1PCT_100yr	17393.00	-9.11	36.26	6.93	36.45	0.000089	3.55	6902.73	494.85	0.11
W100-00-00_0805	113337.0	10PCT_10yr	8535.00	-9.65	28.18	-0.04	28.22	0.000025	1.75	5282.50	370.34	0.05
W100-00-00_0805	113337.0	1PCT_100yr	17393.00	-9.65	36.35	3.61	36.47	0.000046	2.78	6795.38	560.53	0.08
W100-00-00_0805	113374.3		Bridge									
W100-00-00_0805	113411.6	10PCT_10yr	8535.00	-9.61	28.29	-0.03	28.34	0.000025	1.75	5296.55	370.54	0.05
W100-00-00_0805	113411.6	1PCT_100yr	17393.00	-9.61	36.50	3.65	36.61	0.000046	2.77	6814.36	564.05	0.08
W100-00-00_0805	113644.0	10PCT_10yr	8535.00	-8.91	28.30		28.36	0.000047	1.91	5135.49	360.94	0.07
W100-00-00_0805	113644.0	1PCT_100yr	17393.00	-8.91	36.52		36.62	0.000062	2.70	9509.47	628.71	0.09
W100-00-00_0805	114043.4	10PCT_10yr	8535.00	-7.72	28.33	2.53	28.37	0.000028	1.65	6202.03	377.76	0.06
W100-00-00_0805	114043.4	1PCT_100yr	17393.00	-7.72	36.58	6.24	36.65	0.000039	2.34	10320.96	1004.36	0.07
W100-00-00_0805	114070.4		Bridge									
W100-00-00_0805	114097.4	10PCT_10yr	8535.00	-7.46	29.34	2.79	29.38	0.000025	1.59	6485.95	379.45	0.05
W100-00-00_0805	114097.4	1PCT_100yr	17393.00	-7.46	36.65	6.54	36.72	0.000040	2.36	10135.08	970.30	0.07
W100-00-00_0805	114141.9	10PCT_10yr	8535.00	-10.83	29.34	1.43	29.39	0.000030	1.76	5630.93	317.66	0.06
W100-00-00_0805	114141.9	1PCT_100yr	17393.00	-10.83	36.63	5.80	36.74	0.000051	2.69	8331.81	599.62	0.08
W100-00-00_0805	114168.9		Bridge									
W100-00-00_0805	114195.9	10PCT_10yr	8535.00	-11.52	29.36	0.75	29.40	0.000027	1.71	5848.52	322.08	0.06
W100-00-00_0805	114195.9	1PCT_100yr	17393.00	-11.52	36.74	5.12	36.84	0.000046	2.62	8902.01	799.37	0.08
W100-00-00_0805	114492.0	10PCT_10yr	8535.00	-10.48	29.37		29.41	0.000030	1.76	6387.13	348.16	0.06
W100-00-00_0805	114492.0	1PCT_100yr	17393.00	-10.48	36.75		36.86	0.000053	2.75	9910.79	930.01	0.08
W100-00-00_0805	114838.5	10PCT_10yr	8535.00	-9.27	29.38	0.51	29.42	0.000025	1.74	6857.29	417.82	0.06
W100-00-00_0805	114838.5	1PCT_100yr	17393.00	-9.27	36.77	4.09	36.87	0.000047	2.73	12435.23	1369.14	0.08
W100-00-00_0805	114864.5		Bridge									
W100-00-00_0805	114890.5	10PCT_10yr	8535.00	-8.56	30.03	1.22	30.08	0.000025	1.74	6835.61	417.13	0.06
W100-00-00_0805	114890.5	1PCT_100yr	17393.00	-8.56	36.80	4.82	36.91	0.000050	2.80	11609.26	1282.55	0.08
W100-00-00_0805	115123.0	10PCT_10yr	8535.00	-8.12	30.04	0.48	30.08	0.000020	1.63	6551.66	327.87	0.05
W100-00-00_0805	115123.0	1PCT_100yr	17393.00	-8.12	36.82	3.74	36.92	0.000042	2.66	9364.22	629.01	0.07
W100-00-00_0805	115168.5		Bridge									
W100-00-00_0805	115214.0	10PCT_10yr	8535.00	-7.96	30.06	0.64	30.10	0.000020	1.63	6511.16	327.05	0.05
W100-00-00_0805	115214.0	1PCT_100yr	17393.00	-7.96	36.88	3.92	36.98	0.000042	2.67	9302.41	614.40	0.07
W100-00-00_0805	115533.5	10PCT_10yr	8535.00	-6.77	30.08	1.65	30.11	0.000021	1.64	7919.02	496.82	0.05
W100-00-00_0805	115533.5	1PCT_100yr	17393.00	-6.77	36.93	5.38	37.00	0.000037	2.49	11391.72	662.23	0.07
W100-00-00_0805	115553.5		Bridge									
W100-00-00_0805	115573.5	10PCT_10yr	8535.00	-5.72	30.10	2.69	30.14	0.000024	1.73	7408.74	493.83	0.05
W100-00-00_0805	115573.5	1PCT_100yr	17393.00	-5.72	36.95	6.43	37.02	0.000042	2.59	10859.79	513.73	0.07
W100-00-00_0805	115615.5	10PCT_10yr	8535.00	-5.27	30.09	3.77	30.15	0.000032	2.03	6210.45	545.28	0.06
W100-00-00_0805	115615.5	1PCT_100yr	17393.00	-5.27	36.94	7.37	37.05	0.000052	2.96	10425.64	749.09	0.08
W100-00-00_0805	115635.5		Bridge									
W100-00-00_0805	115655.5	10PCT_10yr	8535.00	-5.03	30.09	4.01	30.15	0.000033	2.06	6080.34	537.44	0.07
W100-00-00_0805	115655.5	1PCT_100yr	17393.00	-5.03	36.95	7.63	37.06	0.000053	2.99	10258.27	732.21	0.09
W100-00-00_0805	116076.2	10PCT_10yr	8535.00	-3.86	30.11	3.62	30.16	0.000037	1.92	5869.21	270.16	0.06
W100-00-00_0805	116076.2	1PCT_100yr	17393.00	-3.86	36.98	7.04	37.11	0.000074	3.09	7641.13	291.20	0.09
W100-00-00_0805	116121.9		Bridge									

HEC-RAS Plan: Eff+LOMR MP River: W100-00-00 Reach: W100-00-00_0805 (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)	
W100-00-00_0805	116167.6	10PCT_10yr	8535.00	-3.68	30.28	3.79	30.34	0.000037	1.92	5867.94	270.14	0.06
W100-00-00_0805	116167.6	1PCT_100yr	17393.00	-3.68	37.09	7.22	37.22	0.000074	3.10	7622.41	290.98	0.09
W100-00-00_0805	116395.7	10PCT_10yr	8535.00	-3.88	30.31		30.34	0.000023	1.53	9643.77	499.34	0.05
W100-00-00_0805	116395.7	1PCT_100yr	17393.00	-3.88	37.19		37.25	0.000043	2.38	13223.27	544.01	0.07
W100-00-00_0805	117204.3	10PCT_10yr	8535.00	-4.60	30.34		30.37	0.000026	1.54	10736.64	646.18	0.05
W100-00-00_0805	117204.3	1PCT_100yr	17393.00	-4.60	37.24		37.28	0.000041	2.21	15739.72	1090.33	0.06
W100-00-00_0805	117845.4	10PCT_10yr	8535.00	-7.26	30.36		30.39	0.000027	1.63	8960.73	567.47	0.05
W100-00-00_0805	117845.4	1PCT_100yr	17393.00	-7.26	37.26		37.31	0.000043	2.34	13771.46	833.65	0.07
W100-00-00_0805	118370.1	10PCT_10yr	8535.00	-8.87	30.38	1.21	30.42	0.000028	1.77	8175.45	789.22	0.05
W100-00-00_0805	118370.1	1PCT_100yr	17393.00	-8.87	37.28	5.28	37.35	0.000046	2.56	14343.97	1126.73	0.07
W100-00-00_0805	118418.1		Bridge									
W100-00-00_0805	118466.1	10PCT_10yr	8535.00	-8.89	30.41	1.23	30.45	0.000028	1.77	8212.90	790.06	0.05
W100-00-00_0805	118466.1	1PCT_100yr	17393.00	-8.89	37.32	5.29	37.40	0.000046	2.55	14414.68	1131.69	0.07
W100-00-00_0805	118667.7	10PCT_10yr	8535.00	-8.56	30.42		30.45	0.000022	1.56	10537.45	698.83	0.05
W100-00-00_0805	118667.7	1PCT_100yr	17393.00	-8.56	37.36		37.41	0.000036	2.24	16174.21	924.91	0.06
W100-00-00_0805	119495.9	10PCT_10yr	8535.00	-7.21	30.45		30.46	0.000009	0.97	20418.16	1227.62	0.03
W100-00-00_0805	119495.9	1PCT_100yr	17393.00	-7.21	37.41		37.43	0.000014	1.36	29414.89	1337.48	0.04
W100-00-00_0805	119900.0	10PCT_10yr	8535.00	-7.64	30.46	3.24	30.47	0.000015	1.15	13332.20	892.31	0.04
W100-00-00_0805	119900.0	1PCT_100yr	17393.00	-7.64	37.42	7.82	37.44	0.000024	1.67	20220.54	1034.98	0.05
W100-00-00_0805	119952.6		Bridge									
W100-00-00_0805	120005.2	10PCT_10yr	8535.00	-7.78	30.48	3.10	30.49	0.000015	1.14	13474.07	903.43	0.04
W100-00-00_0805	120005.2	1PCT_100yr	17393.00	-7.78	37.46	7.73	37.48	0.000023	1.65	20408.16	1036.70	0.05
W100-00-00_0805	120962.2	10PCT_10yr	8535.00	-10.59	30.48		30.54	0.000056	2.19	6265.17	652.27	0.07
W100-00-00_0805	120962.2	1PCT_100yr	17393.00	-10.59	37.46		37.55	0.000076	2.94	11115.64	728.41	0.08
W100-00-00_0805	121229.5	10PCT_10yr	8535.00	-11.37	30.51		30.56	0.000043	1.93	8246.94	832.58	0.06
W100-00-00_0805	121229.5	1PCT_100yr	17393.00	-11.37	37.52		37.57	0.000052	2.45	14318.65	903.82	0.07
W100-00-00_0805	122036.7	10PCT_10yr	8535.00	-8.40	30.55		30.59	0.000023	1.89	7478.56	744.00	0.06
W100-00-00_0805	122036.7	1PCT_100yr	17393.00	-8.40	37.55		37.62	0.000033	2.57	13206.07	889.80	0.07
W100-00-00_0805	122210.0	10PCT_10yr	8535.00	-5.60	30.54	4.24	30.59	0.000025	1.96	6203.88	716.61	0.06
W100-00-00_0805	122210.0	1PCT_100yr	17393.00	-5.60	37.55	8.38	37.63	0.000036	2.70	12768.20	806.83	0.08
W100-00-00_0805	122265		Bridge									
W100-00-00_0805	122371.6	10PCT_10yr	8535.00	-7.00	30.56	3.71	30.62	0.000030	2.16	5860.88	829.08	0.07
W100-00-00_0805	122371.6	1PCT_100yr	17393.00	-7.00	37.56	8.66	37.64	0.000040	2.84	14343.34	1035.21	0.08
W100-00-00_0805	122517.1	10PCT_10yr	8535.00	-5.38	30.59	4.35	30.63	0.000019	1.58	7818.31	587.43	0.05
W100-00-00_0805	122517.1	1PCT_100yr	17393.00	-5.38	37.57	8.82	37.64	0.000031	2.33	13514.47	983.40	0.07
W100-00-00_0805	122572.1		Mult Open									
W100-00-00_0805	122627.1	10PCT_10yr	8535.00	-6.08	30.63	3.65	30.66	0.000027	1.40	8271.39	635.91	0.05
W100-00-00_0805	122627.1	1PCT_100yr	17393.00	-6.08	37.62	8.10	37.66	0.000038	1.96	14334.63	1059.28	0.06
W100-00-00_0805	123138.8	10PCT_10yr	8535.00	-4.08	30.66		30.67	0.000016	1.11	14764.85	949.70	0.04
W100-00-00_0805	123138.8	1PCT_100yr	17393.00	-4.08	37.66		37.68	0.000024	1.59	22580.21	1452.81	0.05
W100-00-00_0805	123658.2	10PCT_10yr	8535.00	-2.04	30.66		30.69	0.000036	1.72	11133.36	1158.72	0.06
W100-00-00_0805	123658.2	1PCT_100yr	17393.00	-2.04	37.67		37.70	0.000039	2.10	22383.04	2049.26	0.06
W100-00-00_0805	124539.5	10PCT_10yr	8588.00	-3.74	30.68	7.91	30.74	0.000057	2.26	5544.08	485.27	0.07
W100-00-00_0805	124539.5	1PCT_100yr	17411.00	-3.74	37.67	12.90	37.78	0.000091	3.29	7848.15	560.92	0.10
W100-00-00_0805	124591.8		Bridge									
W100-00-00_0805	124644.1	10PCT_10yr	8588.00	-3.69	30.71	7.96	30.76	0.000057	2.27	5535.40	484.99	0.07
W100-00-00_0805	124644.1	1PCT_100yr	17411.00	-3.69	37.69	12.95	37.80	0.000091	3.29	7837.34	560.53	0.10
W100-00-00_0805	124983.5	10PCT_10yr	8588.00	-3.86	30.72	7.82	30.77	0.000053	2.19	5758.03	982.59	0.07
W100-00-00_0805	124983.5	1PCT_100yr	17411.00	-3.86	37.74	13.16	37.83	0.000082	3.13	8799.57	1281.43	0.09
W100-00-00_0805	125376.9	10PCT_10yr	8588.00	-4.05	30.73		30.80	0.000055	2.27	5544.00	329.88	0.07
W100-00-00_0805	125376.9	1PCT_100yr	17411.00	-4.05	37.73		37.89	0.000098	3.49	8105.97	511.19	0.10
W100-00-00_0805	126647.0	10PCT_10yr	8588.00	-3.93	30.84		30.86	0.000030	1.62	11144.21	744.77	0.05
W100-00-00_0805	126647.0	1PCT_100yr	17411.00	-3.93	37.94		37.98	0.000045	2.31	17544.35	995.73	0.07

HEC-RAS Plan: Eff+LOMR MP River: W100-00-00 Reach: W100-00-00_0805 (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)	
W100-00-00_0805	128028.8	10PCT_10yr	8588.00	-4.51	30.87	5.57	30.92	0.000041	1.87	6717.69	385.54	0.06
W100-00-00_0805	128028.8	1PCT_100yr	17411.00	-4.51	37.98	9.83	38.09	0.000070	2.85	9206.73	641.31	0.09
W100-00-00_0805	128066.7		Bridge									
W100-00-00_0805	128104.6	10PCT_10yr	8588.00	-4.29	31.10	5.78	31.14	0.000041	1.87	6718.92	385.58	0.06
W100-00-00_0805	128104.6	1PCT_100yr	17411.00	-4.29	38.00	10.05	38.10	0.000072	2.88	9133.53	604.07	0.09
W100-00-00_0805	128326.9	10PCT_10yr	8717.00	-4.05	31.10	6.08	31.14	0.000042	1.88	8440.24	811.98	0.06
W100-00-00_0805	128326.9	1PCT_100yr	17455.00	-4.05	38.02	10.30	38.12	0.000069	2.80	12529.54	1203.08	0.08
W100-00-00_0805	129163.2	10PCT_10yr	8717.00	-3.13	31.12		31.18	0.000061	2.13	5901.55	478.75	0.07
W100-00-00_0805	129163.2	1PCT_100yr	17455.00	-3.13	38.06		38.19	0.000093	3.10	9823.43	665.83	0.10
W100-00-00_0805	129725.3	10PCT_10yr	8717.00	-3.71	31.15		31.22	0.000070	2.37	7799.08	684.38	0.08
W100-00-00_0805	129725.3	1PCT_100yr	17455.00	-3.71	38.14		38.25	0.000096	3.23	13223.99	896.46	0.10
W100-00-00_0805	130765.5	10PCT_10yr	8717.00	-3.81	31.23		31.27	0.000038	1.76	8185.63	487.39	0.06
W100-00-00_0805	130765.5	1PCT_100yr	17455.00	-3.81	38.24		38.32	0.000062	2.62	11808.68	558.26	0.08
W100-00-00_0805	131789.8	10PCT_10yr	8717.00	-2.31	31.26	7.47	31.35	0.000095	2.57	5522.41	482.52	0.09
W100-00-00_0805	131789.8	1PCT_100yr	17455.00	-2.31	38.27	12.07	38.43	0.000134	3.59	9133.30	616.95	0.11
W100-00-00_0805	132963.8	10PCT_10yr	8717.00	-1.98	31.37	8.65	31.46	0.000099	2.46	4871.11	451.38	0.09
W100-00-00_0805	132963.8	1PCT_100yr	17455.00	-1.98	38.44	13.46	38.60	0.000146	3.43	8557.16	559.50	0.11
W100-00-00_0805	133748.1	10PCT_10yr	8717.00	-0.46	31.46	9.14	31.53	0.000077	2.49	7848.69	788.31	0.08
W100-00-00_0805	133748.1	1PCT_100yr	17455.00	-0.46	38.60	13.52	38.71	0.000097	3.27	14065.09	904.98	0.10
W100-00-00_0805	133760.1		Bridge									
W100-00-00_0805	133772.1	10PCT_10yr	8717.00	-0.79	31.46	8.82	31.54	0.000072	2.43	8117.43	801.61	0.08
W100-00-00_0805	133772.1	1PCT_100yr	17455.00	-0.79	38.66	13.20	38.77	0.000092	3.21	14422.24	909.88	0.10
W100-00-00_0805	134090.6	10PCT_10yr	8717.00	-1.59	31.53		31.57	0.000049	1.89	9717.28	714.94	0.07
W100-00-00_0805	134090.6	1PCT_100yr	17455.00	-1.59	38.72		38.79	0.000069	2.64	15309.26	828.02	0.08
W100-00-00_0805	134706.7	10PCT_10yr	8717.00	-1.93	31.58		31.60	0.000037	1.54	12314.14	857.38	0.06
W100-00-00_0805	134706.7	1PCT_100yr	17455.00	-1.93	38.78		38.82	0.000049	2.13	19368.56	1100.57	0.07
W100-00-00_0805	135666.2	10PCT_10yr	8717.00	-1.47	31.60		31.67	0.000079	2.20	6582.73	544.22	0.08
W100-00-00_0805	135666.2	1PCT_100yr	17455.00	-1.47	38.79		38.90	0.000100	2.99	11074.01	693.99	0.10
W100-00-00_0805	136331.2	10PCT_10yr	8717.00	-2.09	31.72	9.33	31.74	0.000166	1.41	8922.87	633.09	0.05
W100-00-00_0805	136331.2	1PCT_100yr	17455.00	-2.09	38.97	13.21	39.00	0.000207	1.76	13805.64	713.72	0.06
W100-00-00_0805	137113.0	10PCT_10yr	8717.00	-2.62	31.77	9.43	31.86	0.000088	2.56	5905.02	439.74	0.09
W100-00-00_0805	137113.0	1PCT_100yr	17455.00	-2.62	39.00	13.93	39.18	0.000137	3.75	9045.94	1116.69	0.11
W100-00-00_0805	137732.0	10PCT_10yr	8717.00	-2.40	31.86	9.65	31.91	0.000063	2.15	9156.42	866.01	0.07
W100-00-00_0805	137732.0	1PCT_100yr	17455.00	-2.40	39.18	14.15	39.25	0.000077	2.81	15481.55	1158.31	0.09
W100-00-00_0805	138607.9	10PCT_10yr	8717.00	-2.08	31.93	10.30	31.94	0.000021	1.12	15821.93	1066.79	0.04
W100-00-00_0805	138607.9	1PCT_100yr	17455.00	-2.08	39.27	14.49	39.29	0.000026	1.46	23772.52	1319.21	0.05
W100-00-00_0805	139320.0	10PCT_10yr	8840.00	-2.14	31.92	9.42	31.98	0.000086	2.06	6237.11	583.39	0.08
W100-00-00_0805	139320.0	1PCT_100yr	17497.00	-2.14	39.24	13.65	39.34	0.000114	2.75	11722.78	920.29	0.09
W100-00-00_0805	140116.2	10PCT_10yr	8840.00	-1.31	31.97	9.75	32.07	0.000116	2.54	5387.01	589.56	0.09
W100-00-00_0805	140116.2	1PCT_100yr	17497.00	-1.31	39.30	14.60	39.45	0.000143	3.36	10364.04	803.38	0.11
W100-00-00_0805	141320.1	10PCT_10yr	8840.00	-2.70	32.12	9.02	32.15	0.000046	1.58	10195.42	741.52	0.06
W100-00-00_0805	141320.1	1PCT_100yr	17497.00	-2.70	39.51	13.23	39.55	0.000055	2.03	16132.10	866.64	0.07
W100-00-00_0805	142061.4	10PCT_10yr	8840.00	0.55	32.14		32.21	0.000082	2.29	5578.20	450.54	0.09
W100-00-00_0805	142061.4	1PCT_100yr	17497.00	0.55	39.50		39.63	0.000106	3.15	9167.67	517.62	0.10
W100-00-00_0805	143078.2	10PCT_10yr	8840.00	-4.19	32.23		32.32	0.000138	2.57	5342.34	510.36	0.10
W100-00-00_0805	143078.2	1PCT_100yr	17497.00	-4.19	39.61		39.77	0.000158	3.43	9739.69	677.65	0.12
W100-00-00_0805	143966.8	10PCT_10yr	8840.00	-7.47	32.34	11.17	32.47	0.000189	3.04	4129.35	437.54	0.12
W100-00-00_0805	143966.8	1PCT_100yr	17497.00	-7.47	39.74	17.08	39.93	0.000208	3.86	8364.51	1050.25	0.13
W100-00-00_0805	144753.5	10PCT_10yr	8840.00	0.07	32.47	11.06	32.59	0.000140	2.82	3889.90	297.04	0.11
W100-00-00_0805	144753.5	1PCT_100yr	17497.00	0.07	39.88	15.80	40.08	0.000198	3.82	6564.38	417.73	0.13
W100-00-00_0805	145723.9	10PCT_10yr	8840.00	1.61	32.60		32.74	0.000164	3.24	4532.91	380.63	0.12
W100-00-00_0805	145723.9	1PCT_100yr	17497.00	1.61	40.06		40.28	0.000200	4.30	7591.48	441.61	0.14
W100-00-00_0805	146698.0	10PCT_10yr	8840.00	1.88	32.79	10.63	32.88	0.000116	2.50	4878.03	325.52	0.10
W100-00-00_0805	146698.0	1PCT_100yr	17497.00	1.88	40.32	14.87	40.46	0.000157	3.30	7661.58	662.59	0.12

HEC-RAS Plan: Eff+LOMR MP River: W100-00-00 Reach: W100-00-00_0805 (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)	
W100-00-00_0805	147632.4	10PCT_10yr	8840.00	-1.17	32.91	10.72	32.98	0.000097	2.16	4864.31	397.61	0.09
W100-00-00_0805	147632.4	1PCT_100yr	17497.00	-1.17	40.47	15.07	40.59	0.000114	2.79	8145.93	490.15	0.10
W100-00-00_0805	148741.4	10PCT_10yr	8840.00	3.04	33.07	13.46	33.15	0.000265	2.34	4819.05	1007.78	0.09
W100-00-00_0805	148741.4	1PCT_100yr	17497.00	3.04	40.66	17.81	40.79	0.000330	3.19	7320.79	1799.21	0.10
W100-00-00_0805	148768.4		Bridge									
W100-00-00_0805	148795.4	10PCT_10yr	8840.00	3.15	33.17	13.57	33.25	0.000266	2.34	4816.90	1007.28	0.09
W100-00-00_0805	148795.4	1PCT_100yr	17497.00	3.15	40.78	17.92	40.91	0.000329	3.19	7326.19	1799.37	0.10
W100-00-00_0805	149122.7	10PCT_10yr	8798.00	3.15	33.22		33.30	0.000132	2.32	4436.93	267.96	0.08
W100-00-00_0805	149122.7	1PCT_100yr	17412.00	3.15	40.84		41.00	0.000191	3.34	6798.07	358.30	0.10
W100-00-00_0805	149526.4	10PCT_10yr	8798.00	3.15	33.29	14.02	33.35	0.000149	2.16	5937.49	465.20	0.08
W100-00-00_0805	149526.4	1PCT_100yr	17412.00	3.15	40.98	18.03	41.07	0.000159	2.77	9829.70	546.62	0.09
W100-00-00_0805	150358.8	10PCT_10yr	8798.00	3.31	33.41		33.49	0.000189	2.42	4205.05	372.21	0.10
W100-00-00_0805	150358.8	1PCT_100yr	17412.00	3.31	41.10		41.24	0.000212	3.18	7244.97	412.97	0.11
W100-00-00_0805	151353.8	10PCT_10yr	8692.00	4.90	33.61	15.51	33.64	0.000119	1.71	7914.54	869.22	0.07
W100-00-00_0805	151353.8	1PCT_100yr	17200.00	4.90	41.35	20.12	41.39	0.000106	2.07	13201.21	1157.29	0.07
W100-00-00_0805	151685.6	10PCT_10yr	8591.00	4.19	33.63	13.54	33.70	0.000125	2.15	4502.85	302.92	0.08
W100-00-00_0805	151685.6	1PCT_100yr	16998.00	4.19	41.34	16.51	41.49	0.000177	3.11	6616.77	607.27	0.10
W100-00-00_0805	151711.1		Bridge									
W100-00-00_0805	151736.6	10PCT_10yr	8591.00	3.46	33.66	12.81	33.72	0.000111	2.07	4702.99	308.40	0.08
W100-00-00_0805	151736.6	1PCT_100yr	16998.00	3.46	41.38	15.77	41.51	0.000162	3.03	6846.39	647.88	0.10
W100-00-00_0805	151767.3	10PCT_10yr	8591.00	1.30	33.72	10.06	33.74	0.000029	1.10	8316.23	617.87	0.04
W100-00-00_0805	151767.3	1PCT_100yr	16998.00	1.30	41.51	12.42	41.55	0.000043	1.62	11526.05	1314.62	0.05
W100-00-00_0805	151846.3		Bridge									
W100-00-00_0805	151925.3	10PCT_10yr	8591.00	2.99	34.50	11.74	34.52	0.000033	1.15	7956.68	609.15	0.04
W100-00-00_0805	151925.3	1PCT_100yr	16998.00	2.99	42.13	14.11	42.17	0.000049	1.68	11076.40	1273.76	0.05
W100-00-00_0805	151930.4	10PCT_10yr	8591.00	3.37	34.50	13.55	34.53	0.000065	1.41	6864.64	478.49	0.06
W100-00-00_0805	151930.4	1PCT_100yr	16998.00	3.37	42.12	17.36	42.18	0.000081	1.94	10255.63	1155.26	0.07
W100-00-00_0805	151963.3		Bridge									
W100-00-00_0805	151996.2	10PCT_10yr	8591.00	4.14	34.53	14.32	34.56	0.000075	1.47	6537.60	473.21	0.06
W100-00-00_0805	151996.2	1PCT_100yr	16998.00	4.14	42.16	18.12	42.22	0.000089	2.00	9926.72	1126.28	0.07
W100-00-00_0805	152376.3	10PCT_10yr	8591.00	3.84	34.54	15.80	34.63	0.000250	2.68	4600.67	985.55	0.10
W100-00-00_0805	152376.3	1PCT_100yr	16998.00	3.84	42.19	22.15	42.26	0.000174	2.76	10107.11	1363.03	0.09
W100-00-00_0805	153097.9	10PCT_10yr	8591.00	4.13	34.78	14.45	34.86	0.000435	2.37	3983.78	687.07	0.09
W100-00-00_0805	153097.9	1PCT_100yr	16998.00	4.13	42.36	19.17	42.49	0.000539	3.09	6651.23	961.78	0.11
W100-00-00_0805	153108.9		Bridge									
W100-00-00_0805	153119.9	10PCT_10yr	8591.00	4.13	34.79	14.45	34.87	0.000434	2.37	3988.21	687.48	0.09
W100-00-00_0805	153119.9	1PCT_100yr	16998.00	4.13	42.39	19.16	42.53	0.000536	3.08	6665.17	964.22	0.11
W100-00-00_0805	153992.6	10PCT_10yr	8591.00	3.83	35.07	16.21	35.15	0.000246	2.50	4850.19	849.72	0.11
W100-00-00_0805	153992.6	1PCT_100yr	16998.00	3.83	42.72	21.38	42.82	0.000218	2.79	10264.15	1335.30	0.10
W100-00-00_0805	154890.7	10PCT_10yr	8591.00	5.42	35.27	15.80	35.41	0.000303	2.97	3301.43	472.62	0.12
W100-00-00_0805	154890.7	1PCT_100yr	16998.00	5.42	42.87	20.31	43.09	0.000361	3.90	5770.38	899.35	0.13
W100-00-00_0805	155748.6	10PCT_10yr	8437.00	5.79	35.64	16.04	35.69	0.000312	1.89	4454.13	292.39	0.09
W100-00-00_0805	155748.6	1PCT_100yr	16690.00	5.79	43.32	20.64	43.42	0.000323	2.45	6956.65	424.29	0.09
W100-00-00_0805	155805.1		Bridge									
W100-00-00_0805	155861.6	10PCT_10yr	8437.00	6.03	35.98	16.28	36.04	0.000306	1.88	4484.61	293.02	0.08
W100-00-00_0805	155861.6	1PCT_100yr	16690.00	6.03	43.66	20.88	43.75	0.000319	2.44	6995.29	427.43	0.09
W100-00-00_0805	156116.3	10PCT_10yr	8390.00	5.91	36.06		36.11	0.000256	1.81	4634.14	282.71	0.08
W100-00-00_0805	156116.3	1PCT_100yr	16564.00	5.91	43.74		43.83	0.000284	2.39	7413.21	455.28	0.09
W100-00-00_0805	156882.1	10PCT_10yr	8390.00	5.55	36.19		36.31	0.000216	2.78	3506.34	231.51	0.10
W100-00-00_0805	156882.1	1PCT_100yr	16564.00	5.55	43.87		44.08	0.000281	3.86	5943.15	469.75	0.12
W100-00-00_0805	157933.4	10PCT_10yr	8390.00	5.48	36.45	17.64	36.59	0.000323	3.21	3998.67	401.48	0.12
W100-00-00_0805	157933.4	1PCT_100yr	16564.00	5.48	44.22	22.35	44.39	0.000315	3.88	7441.11	485.38	0.13
W100-00-00_0805	158811.6	10PCT_10yr	8390.00	7.94	36.79		36.85	0.000265	2.06	4975.39	442.68	0.08

HEC-RAS Plan: Eff+LOMR MP River: W100-00-00 Reach: W100-00-00_0805 (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)	
W100-00-00_0805	158811.6	1PCT_100yr	16564.00	7.94	44.56		44.64	0.000266	2.56	9223.20	695.79	0.08
W100-00-00_0805	159757.4	10PCT_10yr	8276.00	9.20	37.19		37.29	0.001027	2.58	3203.99	181.36	0.11
W100-00-00_0805	159757.4	1PCT_100yr	16245.00	9.20	44.95		45.12	0.001156	3.38	5473.48	348.28	0.12
W100-00-00_0805	160630.7	10PCT_10yr	8276.00	6.96	37.84		37.97	0.000591	3.00	3104.68	255.61	0.12
W100-00-00_0805	160630.7	1PCT_100yr	16245.00	6.96	45.71		45.89	0.000681	3.62	5382.10	415.57	0.13
W100-00-00_0805	161822.3	10PCT_10yr	8276.00	6.55	38.50		38.61	0.000493	2.87	3710.21	272.90	0.11
W100-00-00_0805	161822.3	1PCT_100yr	16245.00	6.55	46.52		46.66	0.000608	3.43	6064.72	315.82	0.12
W100-00-00_0805	162811.9	10PCT_10yr	8276.00	8.08	38.83		38.91	0.000199	2.54	4621.19	290.32	0.10
W100-00-00_0805	162811.9	1PCT_100yr	16245.00	8.08	46.87		47.01	0.000231	3.38	7149.21	341.57	0.11
W100-00-00_0805	163635.5	10PCT_10yr	8093.00	11.20	39.01		39.09	0.000245	2.67	5417.21	552.18	0.11
W100-00-00_0805	163635.5	1PCT_100yr	15757.00	11.20	47.10		47.18	0.000183	2.90	10117.00	611.40	0.10
W100-00-00_0805	164555.2	10PCT_10yr	8093.00	8.31	39.25		39.37	0.000425	2.89	3192.94	208.09	0.12
W100-00-00_0805	164555.2	1PCT_100yr	15757.00	8.31	47.28		47.45	0.000559	3.62	4968.71	239.16	0.13
W100-00-00_0805	165380.1	10PCT_10yr	7961.00	11.69	39.51	20.91	39.67	0.000299	3.41	3148.98	211.51	0.12
W100-00-00_0805	165380.1	1PCT_100yr	15440.00	11.69	47.61	24.80	47.86	0.000362	4.51	5089.74	291.84	0.14
W100-00-00_0805	165428.1		Bridge									
W100-00-00_0805	165476.1	10PCT_10yr	7961.00	12.30	40.16	21.52	40.32	0.000297	3.40	3157.13	211.78	0.12
W100-00-00_0805	165476.1	1PCT_100yr	15440.00	12.30	48.27	25.41	48.52	0.000360	4.50	5105.27	294.19	0.14
W100-00-00_0805	165903.2	10PCT_10yr	7261.00	10.27	40.42		40.48	0.000318	2.22	4561.02	355.14	0.08
W100-00-00_0805	165903.2	1PCT_100yr	13835.00	10.27	48.63		48.72	0.000308	2.70	8281.34	597.96	0.09
W100-00-00_0805	166297.3	10PCT_10yr	7261.00	8.40	40.53		40.60	0.000268	2.16	4263.90	264.62	0.08
W100-00-00_0805	166297.3	1PCT_100yr	13835.00	8.40	48.74		48.84	0.000303	2.79	6816.96	359.11	0.09
W100-00-00_0805	166558.2	10PCT_10yr	7041.00	10.11	40.58	23.10	40.70	0.000327	3.43	4167.25	307.43	0.12
W100-00-00_0805	166558.2	1PCT_100yr	13331.00	10.11	48.79	27.90	48.97	0.000374	4.42	8097.03	892.61	0.13
W100-00-00_0805	166585.6		Bridge									
W100-00-00_0805	166613.0	10PCT_10yr	7041.00	10.36	40.69	23.35	40.81	0.000335	3.46	4124.28	306.09	0.12
W100-00-00_0805	166613.0	1PCT_100yr	13331.00	10.36	48.97	28.15	49.15	0.000379	4.44	8040.31	880.48	0.13
W100-00-00_0805	166879.7	10PCT_10yr	6989.00	10.84	40.79		40.91	0.000365	3.42	4494.21	511.77	0.12
W100-00-00_0805	166879.7	1PCT_100yr	13209.00	10.84	49.17		49.26	0.000246	3.40	9093.80	649.87	0.10
W100-00-00_0805	167249.9	10PCT_10yr	6989.00	11.50	41.01	21.90	41.09	0.000534	2.21	3168.11	204.12	0.10
W100-00-00_0805	167249.9	1PCT_100yr	13209.00	11.50	49.29	25.77	49.40	0.000532	2.63	5587.92	636.82	0.10
W100-00-00_0805	168169.9	10PCT_10yr	6979.00	14.35	41.43		41.48	0.000356	1.92	4591.26	352.53	0.08
W100-00-00_0805	168169.9	1PCT_100yr	13185.00	14.35	49.69		49.75	0.000297	2.07	7910.50	457.72	0.07
W100-00-00_0805	169087.1	10PCT_10yr	6979.00	11.36	41.67		41.69	0.000182	1.35	8583.96	675.52	0.05
W100-00-00_0805	169087.1	1PCT_100yr	13185.00	11.36	49.89		49.92	0.000150	1.53	14898.92	869.90	0.05
W100-00-00_0805	170256.0	10PCT_10yr	6958.00	13.83	41.90		41.97	0.000315	2.30	3562.21	251.37	0.09
W100-00-00_0805	170256.0	1PCT_100yr	13131.00	13.83	50.07		50.18	0.000298	2.79	6317.61	450.68	0.10
W100-00-00_0805	171168.9	10PCT_10yr	6958.00	6.86	42.12		42.15	0.000127	1.57	7079.39	502.87	0.06
W100-00-00_0805	171168.9	1PCT_100yr	13131.00	6.86	50.31		50.35	0.000139	1.93	11558.35	658.92	0.06
W100-00-00_0805	171967.4	10PCT_10yr	6958.00	14.04	42.23		42.25	0.000198	1.65	7650.68	678.84	0.07
W100-00-00_0805	171967.4	1PCT_100yr	13131.00	14.04	50.42		50.45	0.000150	1.70	13404.51	728.21	0.06
W100-00-00_0805	172846.5	10PCT_10yr	6958.00	11.61	42.43		42.47	0.000461	1.68	6047.96	642.20	0.07
W100-00-00_0805	172846.5	1PCT_100yr	13131.00	11.61	50.54		50.57	0.000261	1.66	11408.93	684.04	0.06
W100-00-00_0805	173819.4	10PCT_10yr	6958.00	14.97	42.79		42.81	0.000410	1.32	6569.23	604.16	0.07
W100-00-00_0805	173819.4	1PCT_100yr	13131.00	14.97	50.75		50.77	0.000272	1.36	12394.50	883.72	0.06
W100-00-00_0805	175675.6	10PCT_10yr	6958.00	16.27	43.48	24.71	43.54	0.000370	1.94	3592.06	242.85	0.09
W100-00-00_0805	175675.6	1PCT_100yr	13131.00	16.27	51.30	28.52	51.38	0.000381	2.21	5823.31	323.14	0.09
W100-00-00_0805	176644.1	10PCT_10yr	6893.00	17.41	43.74	27.23	43.80	0.000211	2.23	5354.10	570.79	0.10
W100-00-00_0805	176644.1	1PCT_100yr	12967.00	17.41	51.56	30.61	51.62	0.000167	2.33	10416.38	829.65	0.08
W100-00-00_0805	177732.9	10PCT_10yr	6893.00	16.54	44.04		44.10	0.000415	2.09	3685.08	273.70	0.09
W100-00-00_0805	177732.9	1PCT_100yr	12967.00	16.54	51.81		51.89	0.000442	2.42	6143.44	376.39	0.09
W100-00-00_0805	178843.1	10PCT_10yr	6660.00	17.13	44.43	29.06	44.57	0.000358	3.37	3097.95	301.10	0.13
W100-00-00_0805	178843.1	1PCT_100yr	12457.00	17.13	52.17	32.76	52.34	0.000313	3.89	5715.17	872.58	0.13
W100-00-00_0805	178899.3		Bridge									

HEC-RAS Plan: Eff+LOMR MP River: W100-00-00 Reach: W100-00-00_0805 (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)	
W100-00-00_0805	178955.5	10PCT_10yr	6660.00	17.37	44.73	29.30	44.87	0.000354	3.36	3115.93	302.51	0.13
W100-00-00_0805	178955.5	1PCT_100yr	12457.00	17.37	52.47	33.00	52.64	0.000310	3.88	5734.66	883.38	0.13
W100-00-00_0805	179305.6	10PCT_10yr	6625.00	17.48	44.85		45.01	0.000380	3.48	2622.08	221.70	0.13
W100-00-00_0805	179305.6	1PCT_100yr	12379.00	17.48	52.56		52.78	0.000369	4.23	4676.10	313.90	0.14
W100-00-00_0805	179838.1	10PCT_10yr	6625.00	17.65	45.26		45.33	0.000991	2.06	3223.66	239.86	0.10
W100-00-00_0805	179838.1	1PCT_100yr	12379.00	17.65	53.04		53.12	0.001198	2.31	5363.08	331.57	0.10
W100-00-00_0805	180731.2	10PCT_10yr	6625.00	19.12	45.98		46.03	0.000641	1.91	3521.07	297.21	0.09
W100-00-00_0805	180731.2	1PCT_100yr	12379.00	19.12	53.78		53.86	0.000610	2.19	6129.13	387.45	0.09
W100-00-00_0805	181623.0	10PCT_10yr	6625.00	18.35	46.26		46.29	0.000181	1.57	8478.24	900.22	0.07
W100-00-00_0805	181623.0	1PCT_100yr	12379.00	18.35	54.03		54.05	0.000125	1.66	15895.65	1013.86	0.06
W100-00-00_0805	182381.6	10PCT_10yr	6625.00	18.93	46.46		46.53	0.000616	2.12	3501.57	286.41	0.10
W100-00-00_0805	182381.6	1PCT_100yr	12379.00	18.93	54.16		54.23	0.000578	2.38	5957.33	365.13	0.09
W100-00-00_0805	183335.1	10PCT_10yr	6500.00	20.58	46.82	30.65	46.98	0.000358	3.44	2497.40	170.44	0.13
W100-00-00_0805	183335.1	1PCT_100yr	12103.00	20.58	54.47	34.66	54.72	0.000403	4.47	4065.03	556.13	0.15
W100-00-00_0805	184295.8	10PCT_10yr	6500.00	18.27	47.34		47.43	0.000631	2.60	3239.60	261.97	0.11
W100-00-00_0805	184295.8	1PCT_100yr	12103.00	18.27	55.13		55.22	0.000709	2.84	5575.23	480.70	0.10
W100-00-00_0805	184752.4	10PCT_10yr	6500.00	21.24	47.50	31.11	47.61	0.000249	2.89	3100.81	231.32	0.11
W100-00-00_0805	184752.4	1PCT_100yr	12103.00	21.24	55.28	34.64	55.42	0.000245	3.51	5066.98	502.22	0.11
W100-00-00_0805	184807.6		Bridge									
W100-00-00_0805	184862.8	10PCT_10yr	6500.00	21.37	47.64	31.24	47.74	0.000249	2.88	3102.59	231.36	0.11
W100-00-00_0805	184862.8	1PCT_100yr	12103.00	21.37	55.34	34.77	55.49	0.000247	3.52	5048.32	494.48	0.11
W100-00-00_0805	185293.8	10PCT_10yr	6388.00	20.84	47.83		47.86	0.000186	1.72	5809.46	423.47	0.07
W100-00-00_0805	185293.8	1PCT_100yr	11852.00	20.84	55.56		55.60	0.000174	2.06	9330.79	490.55	0.07
W100-00-00_0805	186536.1	10PCT_10yr	6388.00	20.17	48.14		48.23	0.000625	2.47	3475.40	484.37	0.12
W100-00-00_0805	186536.1	1PCT_100yr	11852.00	20.17	55.80		55.87	0.000349	2.49	8021.77	651.13	0.10
W100-00-00_0805	187878.1	10PCT_10yr	6388.00	23.78	48.98		49.07	0.000689	2.74	2846.81	202.13	0.11
W100-00-00_0805	187878.1	1PCT_100yr	11852.00	23.78	56.34		56.48	0.000667	3.38	4583.77	288.85	0.12
W100-00-00_0805	188903.7	10PCT_10yr	6388.00	21.71	49.44		49.49	0.000272	2.02	5098.67	570.85	0.08
W100-00-00_0805	188903.7	1PCT_100yr	11852.00	21.71	56.78		56.83	0.000208	2.19	9685.12	718.87	0.08
W100-00-00_0805	189869.8	10PCT_10yr	6303.00	17.50	49.65		49.74	0.000226	2.60	3998.50	431.05	0.10
W100-00-00_0805	189869.8	1PCT_100yr	11699.00	17.50	56.94		57.04	0.000203	3.00	7838.44	603.97	0.10
W100-00-00_0805	190794.0	10PCT_10yr	6303.00	20.58	49.93		50.01	0.000439	2.59	3703.97	339.57	0.11
W100-00-00_0805	190794.0	1PCT_100yr	11699.00	20.58	57.17		57.28	0.000392	3.04	6484.08	463.23	0.10
W100-00-00_0805	191722.7	10PCT_10yr	6303.00	20.85	50.53		50.60	0.000990	2.01	3275.10	418.54	0.10
W100-00-00_0805	191722.7	1PCT_100yr	11699.00	20.85	57.66		57.73	0.000647	2.15	6793.88	637.09	0.09
W100-00-00_0805	192820.3	10PCT_10yr	6303.00	24.17	51.34		51.41	0.000582	2.12	3336.61	278.76	0.09
W100-00-00_0805	192820.3	1PCT_100yr	11699.00	24.17	58.25		58.34	0.000516	2.52	6166.55	576.16	0.09
W100-00-00_0805	193675.6	10PCT_10yr	6140.00	23.35	51.43		51.43	0.000009	0.57	14428.52	933.63	0.02
W100-00-00_0805	193675.6	1PCT_100yr	11407.00	23.35	58.36		58.37	0.000010	0.69	21092.31	992.25	0.02
W100-00-00_0805	194614.1	10PCT_10yr	6140.00	26.15	51.42		51.47	0.000300	2.16	5326.04	475.14	0.09
W100-00-00_0805	194614.1	1PCT_100yr	11407.00	26.15	58.34		58.41	0.000291	2.61	8940.64	590.87	0.09
W100-00-00_0805	195567.4	10PCT_10yr	6140.00	23.51	51.67		51.69	0.000204	1.29	7624.32	657.17	0.05
W100-00-00_0805	195567.4	1PCT_100yr	11407.00	23.51	58.59		58.61	0.000182	1.50	12529.22	799.59	0.05
W100-00-00_0805	196115.7	10PCT_10yr	6059.00	25.16	51.75	36.15	51.91	0.000420	3.37	2569.28	392.92	0.14
W100-00-00_0805	196115.7	1PCT_100yr	11262.00	25.16	58.62	39.89	58.87	0.000450	4.29	4265.24	672.33	0.15
W100-00-00_0805	196149.0		Bridge									
W100-00-00_0805	196182.3	10PCT_10yr	6059.00	25.30	51.88	36.29	52.04	0.000422	3.38	2565.16	392.65	0.14
W100-00-00_0805	196182.3	1PCT_100yr	11262.00	25.30	58.76	40.03	59.00	0.000450	4.29	4263.97	672.07	0.15
W100-00-00_0805	196463.1	10PCT_10yr	5977.00	26.19	52.08		52.20	0.000804	2.78	2207.79	243.27	0.13
W100-00-00_0805	196463.1	1PCT_100yr	11113.00	26.19	59.02		59.17	0.000617	3.19	4688.99	432.20	0.12
W100-00-00_0805	197506.8	10PCT_10yr	5977.00	26.73	52.63		52.72	0.000342	2.58	3445.35	371.43	0.10
W100-00-00_0805	197506.8	1PCT_100yr	11113.00	26.73	59.49		59.60	0.000318	3.06	6478.43	542.51	0.11
W100-00-00_0805	198496.4	10PCT_10yr	5977.00	27.21	53.06		53.13	0.000523	2.13	2806.65	213.29	0.10
W100-00-00_0805	198496.4	1PCT_100yr	11113.00	27.21	59.94		60.04	0.000660	2.52	4456.81	314.92	0.10

HEC-RAS Plan: Eff+LOMR MP River: W100-00-00 Reach: W100-00-00_0805 (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)	
W100-00-00_0805	199440.6	10PCT_10yr	5977.00	27.48	53.52		53.57	0.000425	1.98	4105.41	450.14	0.09
W100-00-00_0805	199440.6	1PCT_100yr	11113.00	27.48	60.44		60.50	0.000351	2.17	7833.22	844.01	0.08
W100-00-00_0805	199964.6	10PCT_10yr	5833.00	26.77	53.70	36.19	53.77	0.000309	2.12	2756.40	199.18	0.10
W100-00-00_0805	199964.6	1PCT_100yr	10859.00	26.77	60.59	39.29	60.70	0.000317	2.56	4240.09	235.52	0.10
W100-00-00_0805	200020.5		Bridge									
W100-00-00_0805	200076.4	10PCT_10yr	5833.00	27.02	54.03	36.43	54.10	0.000305	2.10	2771.64	199.59	0.10
W100-00-00_0805	200076.4	1PCT_100yr	10859.00	27.02	60.94	39.53	61.04	0.000312	2.55	4261.48	236.01	0.10
W100-00-00_0805	200299.3	10PCT_10yr	5620.00	27.02	54.10		54.17	0.000356	2.19	2643.52	214.15	0.09
W100-00-00_0805	200299.3	1PCT_100yr	10489.00	27.02	61.01		61.12	0.000425	2.75	4794.69	494.21	0.10
W100-00-00_0805	201212.1	10PCT_10yr	5620.00	27.61	54.54	36.36	54.59	0.000593	1.74	3229.91	368.54	0.09
W100-00-00_0805	201212.1	1PCT_100yr	10489.00	27.61	61.48	39.34	61.53	0.000468	1.92	5509.49	568.39	0.09
W100-00-00_0805	201783.6	10PCT_10yr	5620.00	27.98	54.87		54.93	0.000595	1.98	2854.85	278.44	0.10
W100-00-00_0805	201783.6	1PCT_100yr	10489.00	27.98	61.76		61.83	0.000544	2.17	6187.83	610.80	0.09
W100-00-00_0805	202834.1	10PCT_10yr	5497.00	27.57	55.39		55.44	0.000392	1.79	3288.18	306.75	0.08
W100-00-00_0805	202834.1	1PCT_100yr	10276.00	27.57	62.20		62.26	0.000332	2.14	5579.52	372.36	0.08
W100-00-00_0805	203658.9	10PCT_10yr	5497.00	28.97	55.79		55.83	0.000575	1.44	3824.75	305.77	0.07
W100-00-00_0805	203658.9	1PCT_100yr	10276.00	28.97	62.58		62.63	0.000610	1.68	6138.57	378.24	0.07
W100-00-00_0805	204620.0	10PCT_10yr	5288.00	28.15	55.98	36.81	56.06	0.000110	2.38	3271.51	257.26	0.09
W100-00-00_0805	204620.0	1PCT_100yr	9914.00	28.15	62.79	40.24	62.90	0.000130	3.08	5446.74	456.09	0.10
W100-00-00_0805	204673.8		Bridge									
W100-00-00_0805	204727.6	10PCT_10yr	5288.00	28.33	56.20	36.99	56.28	0.000109	2.37	3283.18	258.30	0.09
W100-00-00_0805	204727.6	1PCT_100yr	9914.00	28.33	62.95	40.42	63.06	0.000130	3.08	5440.81	448.78	0.10
W100-00-00_0805	205102.2	10PCT_10yr	5288.00	28.33	56.26		56.32	0.000094	2.21	3938.47	305.47	0.08
W100-00-00_0805	205102.2	1PCT_100yr	9914.00	28.33	63.02		63.12	0.000111	2.85	6360.97	613.23	0.09
W100-00-00_0805	205679.6	10PCT_10yr	5288.00	28.19	56.32		56.38	0.000101	2.24	4280.92	397.67	0.08
W100-00-00_0805	205679.6	1PCT_100yr	9914.00	28.19	63.10		63.19	0.000112	2.83	7696.89	801.85	0.09
W100-00-00_0805	206741.3	10PCT_10yr	5230.00	31.91	56.50		56.56	0.000321	1.89	3218.17	308.30	0.08
W100-00-00_0805	206741.3	1PCT_100yr	9809.00	31.91	63.34		63.40	0.000430	2.19	6013.86	733.75	0.08
W100-00-00_0805	207774.7	10PCT_10yr	5230.00	26.21	56.88		56.92	0.000406	1.88	4166.28	510.68	0.08
W100-00-00_0805	207774.7	1PCT_100yr	9809.00	26.21	63.72		63.75	0.000311	1.72	8674.44	931.31	0.07
W100-00-00_0805	208924.8	10PCT_10yr	5230.00	31.48	57.42		57.48	0.000618	2.03	2612.08	226.11	0.10
W100-00-00_0805	208924.8	1PCT_100yr	9809.00	31.48	64.15		64.24	0.000599	2.36	4957.87	687.32	0.10
W100-00-00_0805	209864.1	10PCT_10yr	5230.00	28.37	57.80		57.84	0.000262	1.90	4329.07	404.37	0.08
W100-00-00_0805	209864.1	1PCT_100yr	9809.00	28.37	64.52		64.57	0.000235	2.23	7583.13	716.87	0.08
W100-00-00_0805	210975.8	10PCT_10yr	5116.00	30.49	58.00		58.10	0.000197	2.71	2739.59	188.22	0.11
W100-00-00_0805	210975.8	1PCT_100yr	9600.00	30.49	64.68		64.87	0.000255	3.67	4562.29	564.72	0.13
W100-00-00_0805	211631.3	10PCT_10yr	5116.00	32.47	58.15		58.18	0.000080	1.94	7009.95	670.40	0.07
W100-00-00_0805	211631.3	1PCT_100yr	9600.00	32.47	64.92		64.96	0.000079	2.31	11881.20	898.90	0.08
W100-00-00_0805	212742.1	10PCT_10yr	5040.00	32.47	58.22		58.28	0.000093	2.07	3932.30	294.32	0.08
W100-00-00_0805	212742.1	1PCT_100yr	9467.00	32.47	64.98		65.08	0.000116	2.79	6037.81	334.24	0.09
W100-00-00_0805	213687.7	10PCT_10yr	5040.00	32.80	58.38		58.44	0.000401	2.24	3002.09	237.32	0.09
W100-00-00_0805	213687.7	1PCT_100yr	9467.00	32.80	65.18		65.27	0.000458	2.69	4666.06	257.70	0.10
W100-00-00_0805	214581.3	10PCT_10yr	4942.00	34.85	58.53	41.53	58.62	0.000108	2.57	2200.99	183.46	0.10
W100-00-00_0805	214581.3	1PCT_100yr	9299.00	34.85	65.34	44.73	65.46	0.000107	3.11	3577.11	492.78	0.11
W100-00-00_0805	214625.3		Bridge									
W100-00-00_0805	214669.3	10PCT_10yr	4942.00	32.30	58.58	40.85	58.64	0.000067	2.07	2532.91	185.96	0.08
W100-00-00_0805	214669.3	1PCT_100yr	9299.00	32.30	65.39	43.90	65.49	0.000073	2.66	3945.63	465.95	0.09
W100-00-00_0805	214717.4	10PCT_10yr	4922.00	32.88	58.59	41.31	58.65	0.000062	1.99	2692.33	213.61	0.08
W100-00-00_0805	214717.4	1PCT_100yr	9264.00	32.88	65.41	44.30	65.49	0.000064	2.49	4326.93	325.97	0.09
W100-00-00_0805	214806.4		Bridge									
W100-00-00_0805	214895.5	10PCT_10yr	4922.00	34.39	58.64	40.62	58.67	0.000033	1.45	3795.26	660.10	0.06
W100-00-00_0805	214895.5	1PCT_100yr	9264.00	34.39	65.47	42.96	65.52	0.000037	1.90	5825.93	805.26	0.07
W100-00-00_0805	214953.1	10PCT_10yr	4922.00	34.51	58.64	41.78	58.68	0.000046	1.75	3333.03	687.50	0.07

HEC-RAS Plan: Eff+LOMR MP River: W100-00-00 Reach: W100-00-00_0805 (Continued)

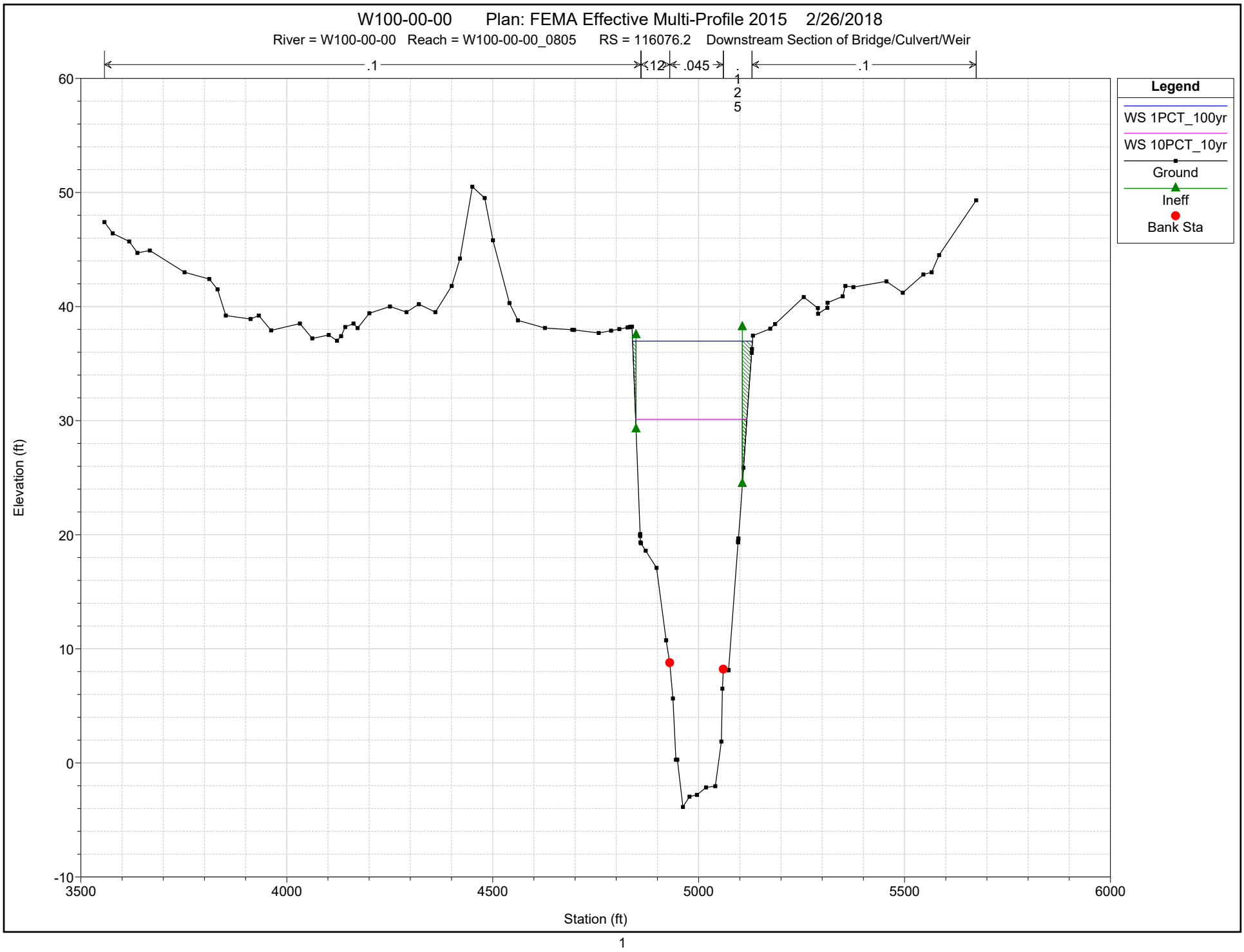
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
W100-00-00_0805	214953.1	1PCT_100yr	9264.00	34.51	65.47	44.65	65.53	0.000043	2.08	5326.61	844.69	0.07
W100-00-00_0805	214987.8		Bridge									
W100-00-00_0805	215022.5	10PCT_10yr	4922.00	33.23	58.67	40.71	58.69	0.000030	1.33	4059.80	756.76	0.06
W100-00-00_0805	215022.5	1PCT_100yr	9264.00	33.23	65.49	43.35	65.53	0.000031	1.69	6255.65	1219.19	0.06
W100-00-00_0805	215429.6	10PCT_10yr	4835.00	31.24	58.66		58.73	0.000084	2.31	4795.97	606.99	0.09
W100-00-00_0805	215429.6	1PCT_100yr	9096.00	31.24	65.48		65.57	0.000080	2.74	9119.65	685.99	0.09
W100-00-00_0805	216032.5	10PCT_10yr	4835.00	33.72	58.82	42.94	58.84	0.000885	1.31	4189.21	412.75	0.07
W100-00-00_0805	216032.5	1PCT_100yr	9096.00	33.72	65.64	46.47	65.66	0.000644	1.37	7230.86	481.96	0.06
W100-00-00_0805	216802.9	10PCT_10yr	4835.00	33.28	59.21	42.49	59.22	0.000280	0.94	7834.27	851.32	0.04
W100-00-00_0805	216802.9	1PCT_100yr	9096.00	33.28	65.92	46.03	65.93	0.000187	0.87	13782.45	916.85	0.03
W100-00-00_0805	217899.8	10PCT_10yr	4835.00	35.59	59.83	44.30	59.92	0.002365	2.34	2063.09	177.02	0.12
W100-00-00_0805	217899.8	1PCT_100yr	9096.00	35.59	66.33	47.81	66.45	0.002192	2.72	3595.11	519.77	0.12
W100-00-00_0805	218625.5	10PCT_10yr	4748.00	33.78	60.27		60.29	0.000208	1.25	6638.49	745.80	0.06
W100-00-00_0805	218625.5	1PCT_100yr	8930.00	33.78	66.76		66.78	0.000184	1.30	11955.65	979.07	0.05
W100-00-00_0805	219577.1	10PCT_10yr	4748.00	35.81	60.65		60.73	0.001406	2.34	3009.34	315.15	0.12
W100-00-00_0805	219577.1	1PCT_100yr	8930.00	35.81	67.09		67.19	0.001497	2.69	6491.55	753.93	0.12
W100-00-00_0805	220426.4	10PCT_10yr	4748.00	36.86	61.50		61.56	0.000717	1.95	2833.54	423.34	0.10
W100-00-00_0805	220426.4	1PCT_100yr	8930.00	36.86	67.83		67.87	0.000486	1.89	6294.77	808.94	0.08
W100-00-00_0805	221415.6	10PCT_10yr	4616.00	37.86	61.70	44.17	61.76	0.000090	1.99	3078.94	249.42	0.08
W100-00-00_0805	221415.6	1PCT_100yr	8675.00	37.86	68.00	46.98	68.08	0.000108	2.61	4823.74	1921.58	0.09
W100-00-00_0805	221469.5		Bridge									
W100-00-00_0805	221523.4	10PCT_10yr	4616.00	37.95	61.80	44.27	61.86	0.000090	1.99	3081.74	249.52	0.08
W100-00-00_0805	221523.4	1PCT_100yr	8675.00	37.95	68.08	47.07	68.15	0.000094	2.43	8504.87	1920.02	0.08
W100-00-00_0805	221721.3	10PCT_10yr	4580.00	38.24	61.81		61.88	0.000111	2.19	2363.15	180.51	0.09
W100-00-00_0805	221721.3	1PCT_100yr	8606.00	38.24	68.08		68.21	0.000143	2.98	3788.43	358.01	0.10
W100-00-00_0805	222172.8	10PCT_10yr	4580.00	38.92	61.94	48.18	61.99	0.000777	1.94	2575.72	602.38	0.10
W100-00-00_0805	222172.8	1PCT_100yr	8606.00	38.92	68.27	53.15	68.33	0.000603	1.99	4457.90	1449.34	0.09
W100-00-00_0805	223061.1	10PCT_10yr	4580.00	37.26	62.32	46.43	62.37	0.000268	1.95	2346.84	437.05	0.10
W100-00-00_0805	223061.1	1PCT_100yr	8606.00	37.26	68.62	50.72	68.70	0.000286	2.31	3937.61	956.45	0.10
W100-00-00_0805	224198.0	10PCT_10yr	4484.00	39.20	62.71		62.76	0.000476	1.88	2733.89	345.47	0.09
W100-00-00_0805	224198.0	1PCT_100yr	8422.00	39.20	69.02		69.07	0.000365	1.98	5464.62	478.97	0.08
W100-00-00_0805	224981.6	10PCT_10yr	4484.00	40.72	63.18		63.24	0.000784	2.07	2914.92	391.73	0.10
W100-00-00_0805	224981.6	1PCT_100yr	8422.00	40.72	69.35		69.39	0.000444	1.99	6965.93	1011.49	0.08
W100-00-00_0805	225979.2	10PCT_10yr	4297.00	40.46	63.65		63.69	0.000285	1.64	3085.35	306.91	0.08
W100-00-00_0805	225979.2	1PCT_100yr	8117.00	40.46	69.69		69.73	0.000280	1.91	5164.28	510.00	0.08
W100-00-00_0805	227031.7	10PCT_10yr	4139.00	40.22	63.86	48.39	63.89	0.000134	1.37	3261.98	383.46	0.06
W100-00-00_0805	227031.7	1PCT_100yr	7870.00	40.22	69.89	50.59	69.93	0.000133	1.70	6657.46	1252.77	0.07
W100-00-00_0805	227088.2		Bridge									
W100-00-00_0805	227144.7	10PCT_10yr	4139.00	40.30	63.89	48.47	63.92	0.000136	1.37	3241.16	380.47	0.06
W100-00-00_0805	227144.7	1PCT_100yr	7870.00	40.30	69.91	50.64	69.95	0.000134	1.71	6616.58	1209.65	0.07
W100-00-00_0805	227524.1	10PCT_10yr	4040.00	40.54	63.94	48.59	63.97	0.000151	1.51	2688.38	257.02	0.07
W100-00-00_0805	227524.1	1PCT_100yr	7745.00	40.54	69.96	50.84	70.01	0.000167	1.85	6817.40	1828.41	0.07
W100-00-00_0805	228060.7	10PCT_10yr	4040.00	40.89	64.06		64.08	0.000282	1.54	4502.49	876.54	0.07
W100-00-00_0805	228060.7	1PCT_100yr	7745.00	40.89	70.08		70.09	0.000131	1.34	12684.72	2238.97	0.05
W100-00-00_0805	228917.1	10PCT_10yr	4040.00	41.61	64.24		64.27	0.000171	1.52	4125.86	591.70	0.08
W100-00-00_0805	228917.1	1PCT_100yr	7745.00	41.61	70.19		70.22	0.000136	1.62	8379.89	980.20	0.07
W100-00-00_0805	229882.5	10PCT_10yr	3878.00	41.58	64.40		64.45	0.000190	1.78	2530.23	419.03	0.09
W100-00-00_0805	229882.5	1PCT_100yr	7549.00	41.58	70.30		70.34	0.000127	1.77	7698.55	1763.02	0.07
W100-00-00_0805	230908.0	10PCT_10yr	3878.00	42.68	64.70		64.74	0.000459	1.68	2824.67	351.86	0.09
W100-00-00_0805	230908.0	1PCT_100yr	7549.00	42.68	70.51		70.55	0.000383	1.75	6905.53	1062.23	0.08
W100-00-00_0805	231798.0	10PCT_10yr	3708.00	41.92	65.24		65.31	0.000942	2.16	1713.56	176.21	0.12
W100-00-00_0805	231798.0	1PCT_100yr	7344.00	41.92	70.98		71.08	0.001000	2.59	2917.19	344.08	0.13
W100-00-00_0805	232632.3	10PCT_10yr	3634.00	44.30	65.56	51.89	65.63	0.000205	2.14	1696.54	141.42	0.11
W100-00-00_0805	232632.3	1PCT_100yr	7254.00	44.30	71.45	54.82	71.57	0.000385	2.75	2635.75	177.32	0.13

HEC-RAS Plan: Eff+LOMR MP River: W100-00-00 Reach: W100-00-00_0805 (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)	
W100-00-00_0805	232645.3		Bridge									
W100-00-00_0805	232657.7	10PCT_10yr	3634.00	44.33	65.57	51.91	65.64	0.000205	2.15	1693.21	141.12	0.11
W100-00-00_0805	232657.7	1PCT_100yr	7254.00	44.33	71.48	54.84	71.60	0.000384	2.76	2632.92	176.86	0.13
W100-00-00_0805	232669.7		Bridge									
W100-00-00_0805	232681.7	10PCT_10yr	3634.00	43.64	65.60	51.22	65.66	0.000188	2.02	1796.01	145.48	0.10
W100-00-00_0805	232681.7	1PCT_100yr	7254.00	43.64	71.54	54.16	71.65	0.000348	2.62	2767.24	181.27	0.12
W100-00-00_0805	232732.9		Bridge									
W100-00-00_0805	232790.8	10PCT_10yr	3634.00	42.38	65.74	50.46	65.81	0.000357	2.02	1796.89	267.95	0.10
W100-00-00_0805	232790.8	1PCT_100yr	7254.00	42.38	71.79	53.58	71.90	0.000482	2.62	2765.98	520.24	0.12
W100-00-00_0805	232794.9	10PCT_10yr	3634.00	42.38	65.76	50.49	65.82	0.000437	1.97	1845.56	275.23	0.10
W100-00-00_0805	232794.9	1PCT_100yr	7254.00	42.38	71.80	53.69	71.90	0.000541	2.55	2843.54	525.18	0.11
W100-00-00_0805	232805.9		Bridge									
W100-00-00_0805	232816.9	10PCT_10yr	3634.00	42.42	65.79	50.53	65.85	0.000438	1.97	1844.17	275.06	0.10
W100-00-00_0805	232816.9	1PCT_100yr	7254.00	42.42	71.83	53.73	71.93	0.000542	2.55	2841.51	524.39	0.11
W100-00-00_0805	233029.3	10PCT_10yr	3539.00	43.15	65.88		65.95	0.000463	2.08	1701.27	149.46	0.11
W100-00-00_0805	233029.3	1PCT_100yr	7139.00	43.15	71.94		72.05	0.000579	2.68	2687.73	256.49	0.12
W100-00-00_0805	233698.4	10PCT_10yr	3539.00	45.45	66.18	51.63	66.22	0.000357	1.67	2122.16	636.37	0.09
W100-00-00_0805	233698.4	1PCT_100yr	7139.00	45.45	72.23	54.60	72.25	0.000164	1.37	8280.27	869.96	0.06
W100-00-00_0805	234807.9	10PCT_10yr	3539.00	44.91	66.46		66.50	0.000185	1.64	2794.65	365.40	0.09
W100-00-00_0805	234807.9	1PCT_100yr	7139.00	44.91	72.41		72.45	0.000182	1.88	5115.70	430.92	0.08
W100-00-00_0805	235706.9	10PCT_10yr	3361.00	44.41	66.73		66.79	0.000605	2.00	1678.13	162.38	0.11
W100-00-00_0805	235706.9	1PCT_100yr	6923.00	44.41	72.65		72.74	0.000647	2.49	3144.52	597.55	0.11
W100-00-00_0805	236611.0	10PCT_10yr	3361.00	44.63	67.29		67.35	0.000625	1.89	1778.56	159.03	0.10
W100-00-00_0805	236611.0	1PCT_100yr	6923.00	44.63	73.24		73.32	0.000622	2.30	3612.56	695.96	0.10
W100-00-00_0805	237276.3	10PCT_10yr	3152.00	44.89	67.73		67.78	0.000670	1.74	1807.08	159.83	0.09
W100-00-00_0805	237276.3	1PCT_100yr	6670.00	44.89	73.67		73.73	0.000611	2.05	3821.64	597.08	0.09
W100-00-00_0805	238060.4	10PCT_10yr	3152.00	45.20	68.17		68.22	0.000478	1.79	1762.40	157.80	0.09
W100-00-00_0805	238060.4	1PCT_100yr	6670.00	45.20	74.12		74.20	0.000607	2.29	3340.87	637.23	0.11
W100-00-00_0805	239036.8	10PCT_10yr	3152.00	47.67	68.62		68.67	0.000456	1.75	1800.34	153.54	0.09
W100-00-00_0805	239036.8	1PCT_100yr	6670.00	47.67	74.71		74.79	0.000609	2.32	3203.55	765.73	0.10
W100-00-00_0805	239993.6	10PCT_10yr	3152.00	47.00	69.07		69.12	0.000506	1.71	1846.95	160.16	0.09
W100-00-00_0805	239993.6	1PCT_100yr	6670.00	47.00	75.30		75.36	0.000565	1.97	4833.93	1666.67	0.09
W100-00-00_0805	240254.3	10PCT_10yr	1665.00	48.68	69.19	52.81	69.20	0.000100	0.80	2084.56	198.34	0.04
W100-00-00_0805	240254.3	1PCT_100yr	3758.00	48.68	75.43	55.40	75.45	0.000146	1.09	3685.53	827.81	0.05
W100-00-00_0805	240315.3		Bridge									
W100-00-00_0805	240376.3	10PCT_10yr	1665.00	48.86	69.32	52.99	69.33	0.000101	0.80	2075.41	198.06	0.04
W100-00-00_0805	240376.3	1PCT_100yr	3758.00	48.86	75.46	55.57	75.48	0.000150	1.10	3597.31	751.68	0.05
W100-00-00_0805	240579.0	10PCT_10yr	1665.00	48.94	69.33		69.34	0.000070	0.81	2062.26	197.65	0.04
W100-00-00_0805	240579.0	1PCT_100yr	3758.00	48.94	75.48		75.50	0.000103	1.08	3707.10	871.39	0.05
W100-00-00_0805	241079.0	10PCT_10yr	1665.00	49.13	69.36		69.36	0.000042	0.63	2646.87	209.56	0.03
W100-00-00_0805	241079.0	1PCT_100yr	3758.00	49.13	75.52		75.53	0.000064	0.90	5429.32	938.35	0.04
W100-00-00_0805	241619.3	10PCT_10yr	1698.00	48.33	69.38	53.91	69.40	0.000138	1.09	1562.09	139.91	0.06
W100-00-00_0805	241619.3	1PCT_100yr	3772.00	48.33	75.55	57.30	75.59	0.000161	1.48	3440.79	1201.56	0.06
W100-00-00_0805	241632.7		Bridge									
W100-00-00_0805	241646.1	10PCT_10yr	1698.00	48.40	69.46	53.98	69.48	0.000137	1.09	1563.40	139.96	0.06
W100-00-00_0805	241646.1	1PCT_100yr	3772.00	48.40	75.56	57.39	75.59	0.000164	1.49	3363.37	1169.31	0.06
W100-00-00_0805	241917.5	10PCT_10yr	1698.00	48.64	69.51	54.22	69.53	0.000187	1.13	1507.10	151.09	0.06
W100-00-00_0805	241917.5	1PCT_100yr	3772.00	48.64	75.62	57.61	75.64	0.000180	1.33	3445.33	1106.74	0.06
W100-00-00_0805	242655.3	10PCT_10yr	1698.00	49.31	69.67		69.69	0.000277	1.31	1291.26	127.06	0.07
W100-00-00_0805	242655.3	1PCT_100yr	3772.00	49.31	75.79		75.83	0.000351	1.66	2825.05	684.09	0.08
W100-00-00_0805	243452.9	10PCT_10yr	1698.00	49.00	69.81		69.83	0.000096	1.08	1572.66	165.07	0.06
W100-00-00_0805	243452.9	1PCT_100yr	3772.00	49.00	75.96		75.99	0.000139	1.39	3480.43	579.05	0.06

HEC-RAS Plan: Eff+LOMR MP River: W100-00-00 Reach: W100-00-00_0805 (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)	
W100-00-00_0805	244345.5	10PCT_10yr	1724.00	49.00	69.89		69.92	0.000105	1.23	1401.04	136.05	0.07
W100-00-00_0805	244345.5	1PCT_100yr	3784.00	49.00	76.11		76.14	0.000207	1.58	2404.98	192.13	0.08
W100-00-00_0805	245413.7	10PCT_10yr	1724.00	51.09	70.05		70.08	0.000219	1.38	1248.77	122.75	0.08
W100-00-00_0805	245413.7	1PCT_100yr	3784.00	51.09	76.35		76.39	0.000261	1.78	2127.59	156.67	0.09
W100-00-00_0805	246449.8	10PCT_10yr	1752.00	52.30	70.22		70.26	0.000154	1.47	1192.67	122.76	0.08
W100-00-00_0805	246449.8	1PCT_100yr	3797.00	52.30	76.59		76.64	0.000219	1.81	2118.18	229.60	0.09
W100-00-00_0805	247502.0	10PCT_10yr	1752.00	50.81	70.41		70.44	0.000218	1.44	1213.36	118.63	0.08
W100-00-00_0805	247502.0	1PCT_100yr	3797.00	50.81	76.84		76.90	0.000297	1.81	2093.87	155.69	0.09
W100-00-00_0805	248414.4	10PCT_10yr	1765.00	55.90	70.58	60.84	70.63	0.000161	1.92	918.79	106.71	0.12
W100-00-00_0805	248414.4	1PCT_100yr	3803.00	55.90	77.01	63.31	77.08	0.000136	2.20	1736.42	155.65	0.11
W100-00-00_0805	248481.1		Bridge									
W100-00-00_0805	248547.8	10PCT_10yr	1765.00	56.16	70.82	61.10	70.88	0.000161	1.92	917.54	106.64	0.12
W100-00-00_0805	248547.8	1PCT_100yr	3803.00	56.16	77.25	63.56	77.32	0.000136	2.20	1733.36	155.59	0.11
W100-00-00_0805	248647.7	10PCT_10yr	1765.00	56.61	70.83		70.90	0.000046	2.03	871.17	103.96	0.12
W100-00-00_0805	248647.7	1PCT_100yr	3803.00	56.61	77.26		77.34	0.000038	2.28	1666.18	146.47	0.12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.1
.12
.045
.1
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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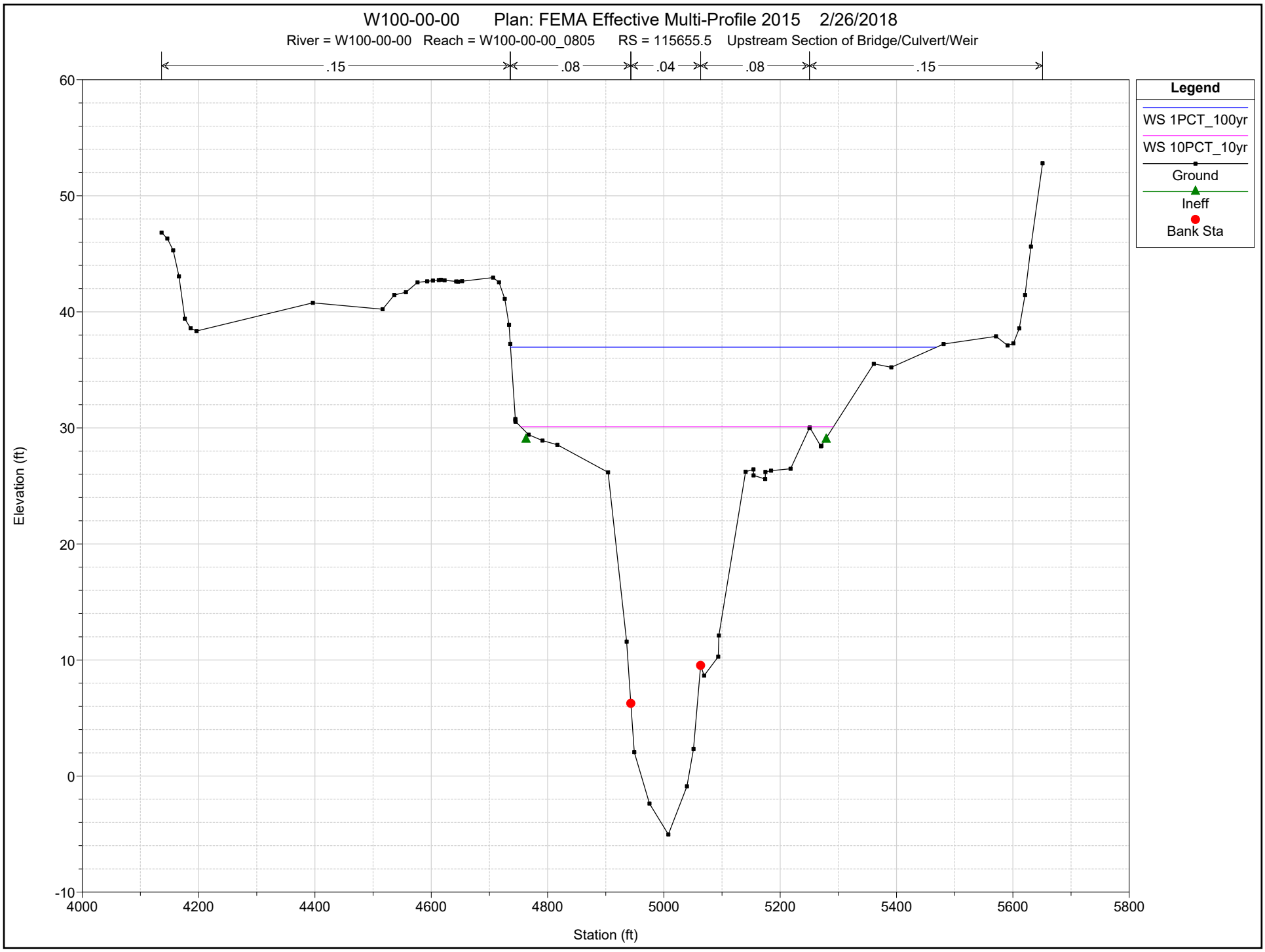
50
40
30
20
10
0
-10
3500
4000
4500
5000
5500
6000


W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
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.15
.08
.04
.08
.15
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
4000
4200
4400
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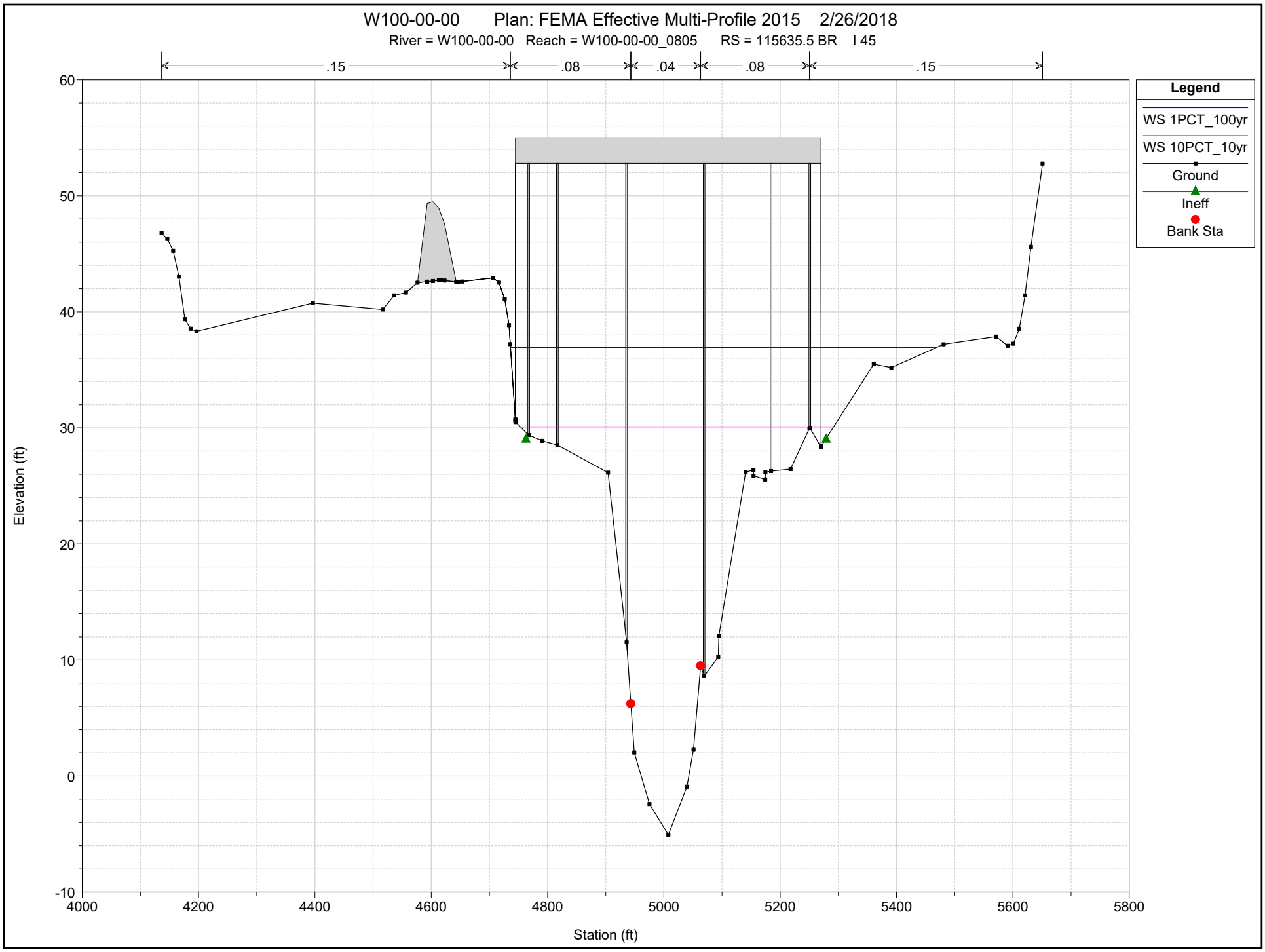
5000
5200
5400
5600
5800
Station (ft)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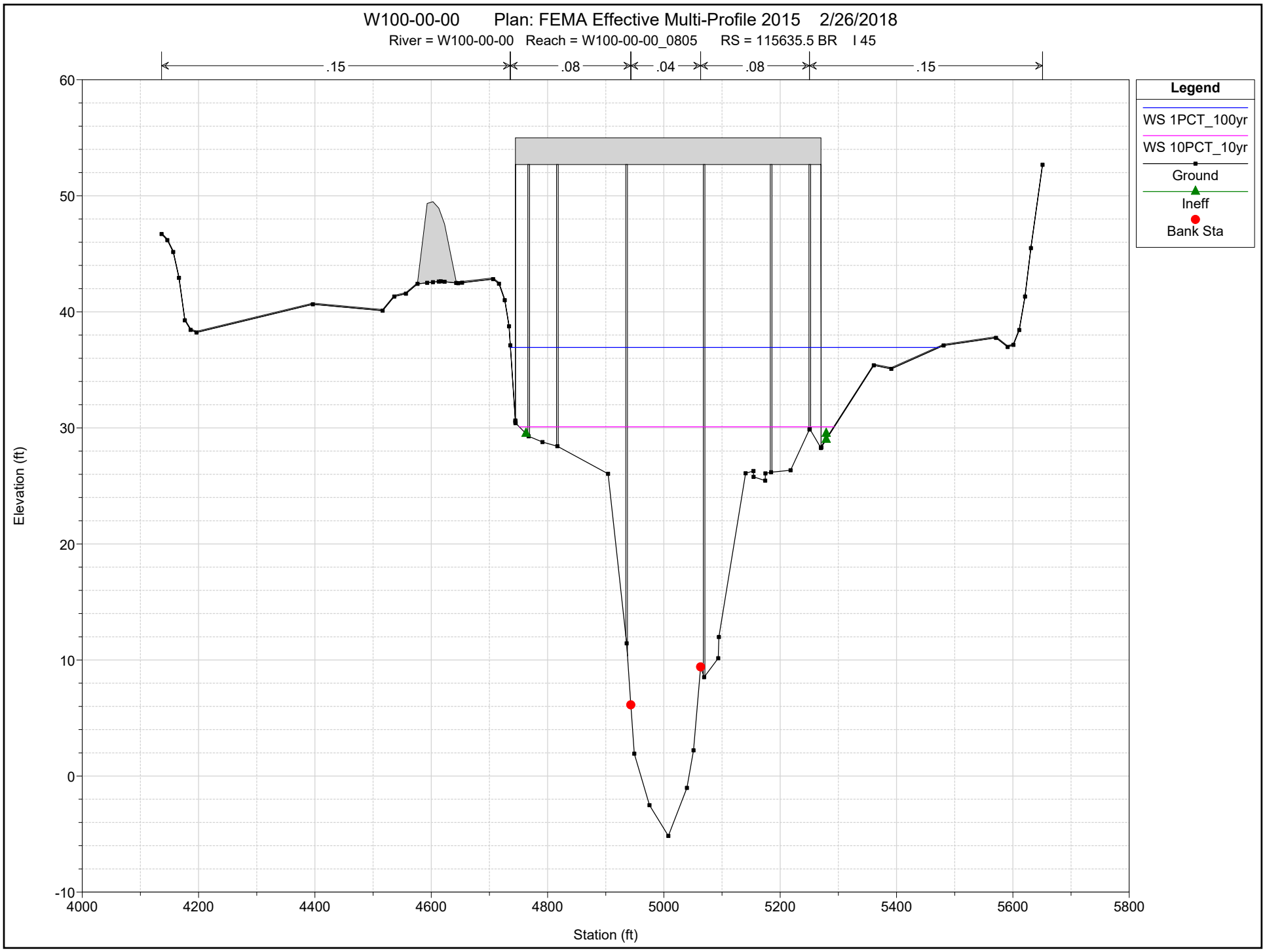
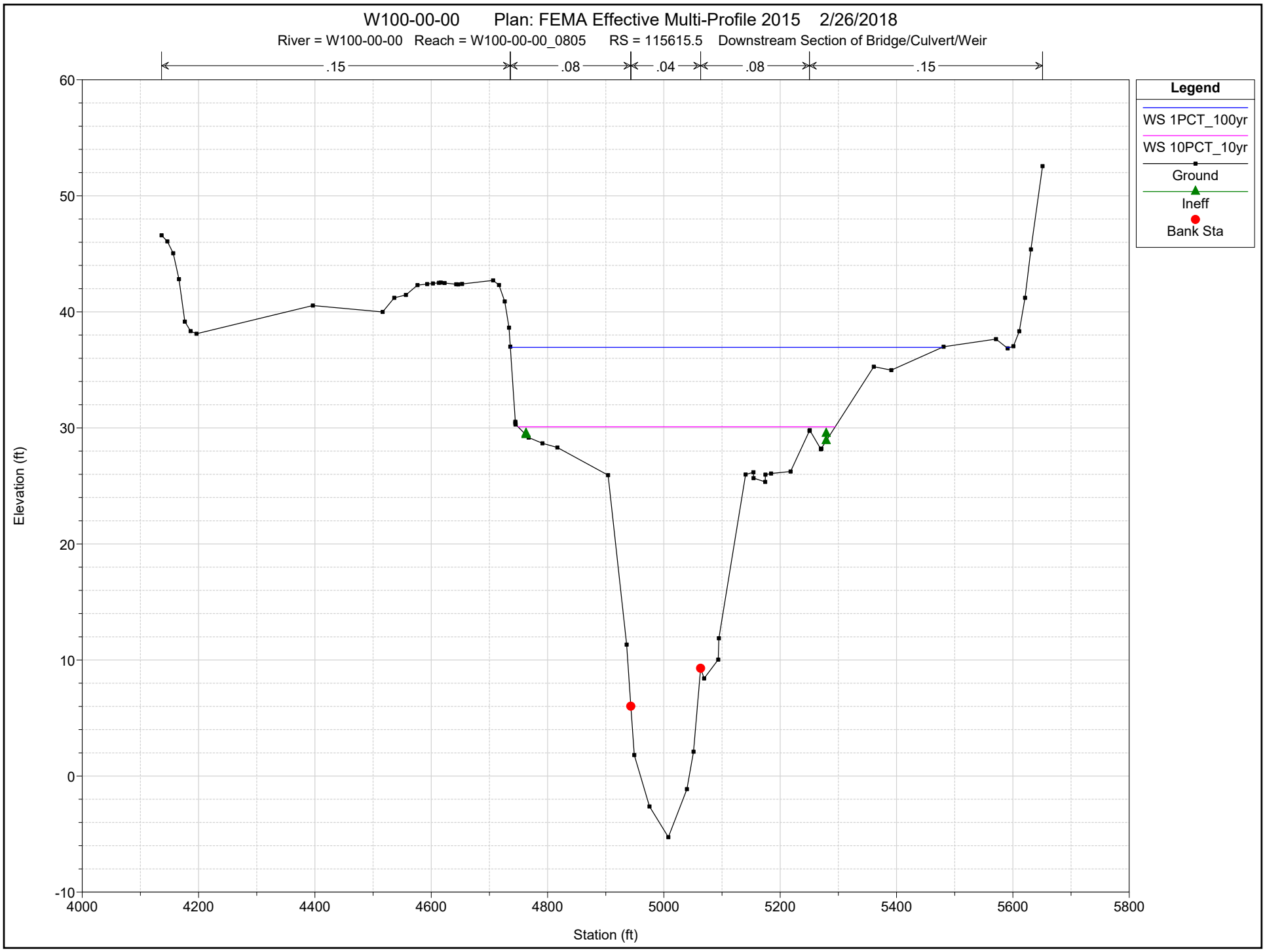
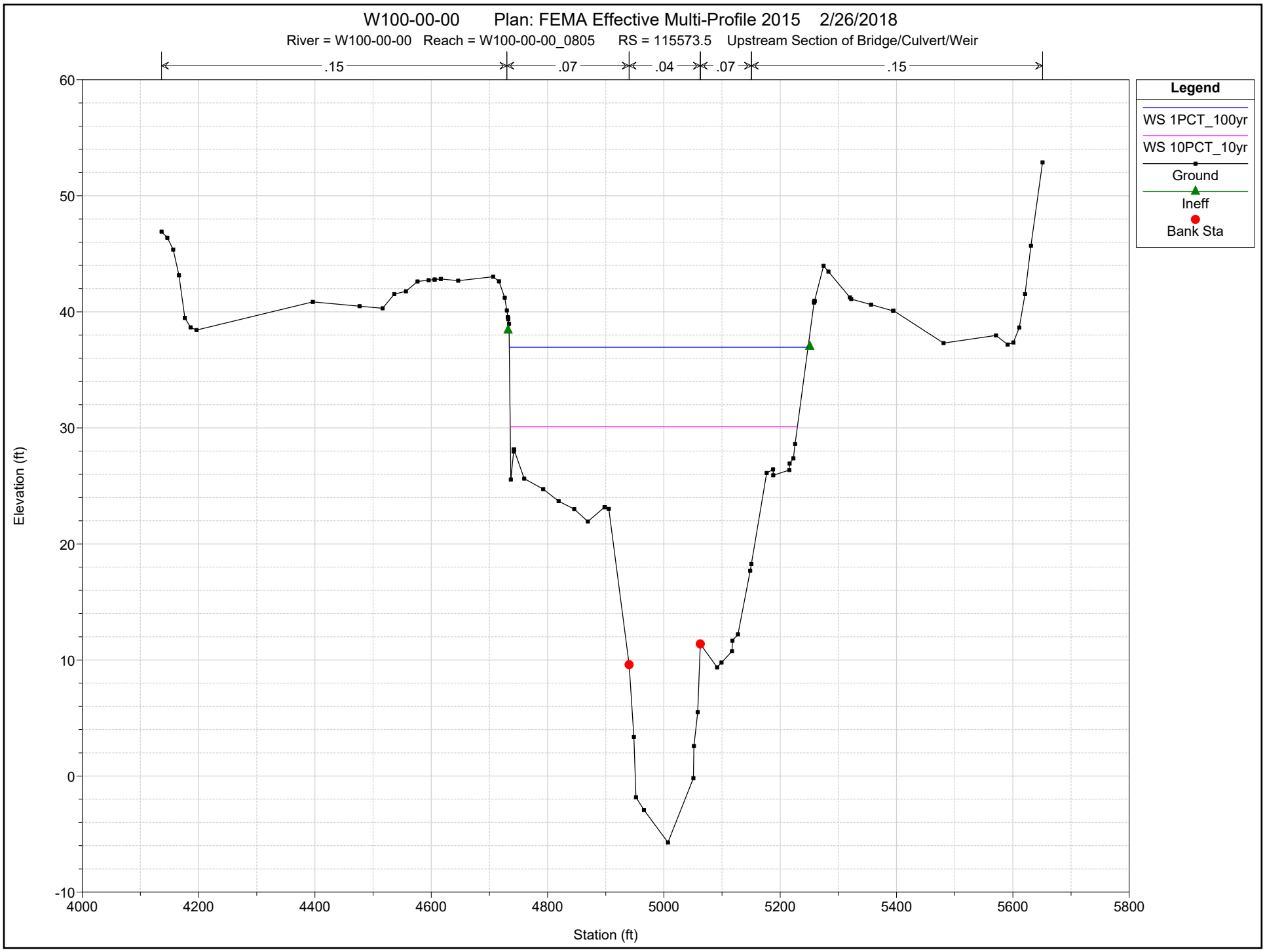
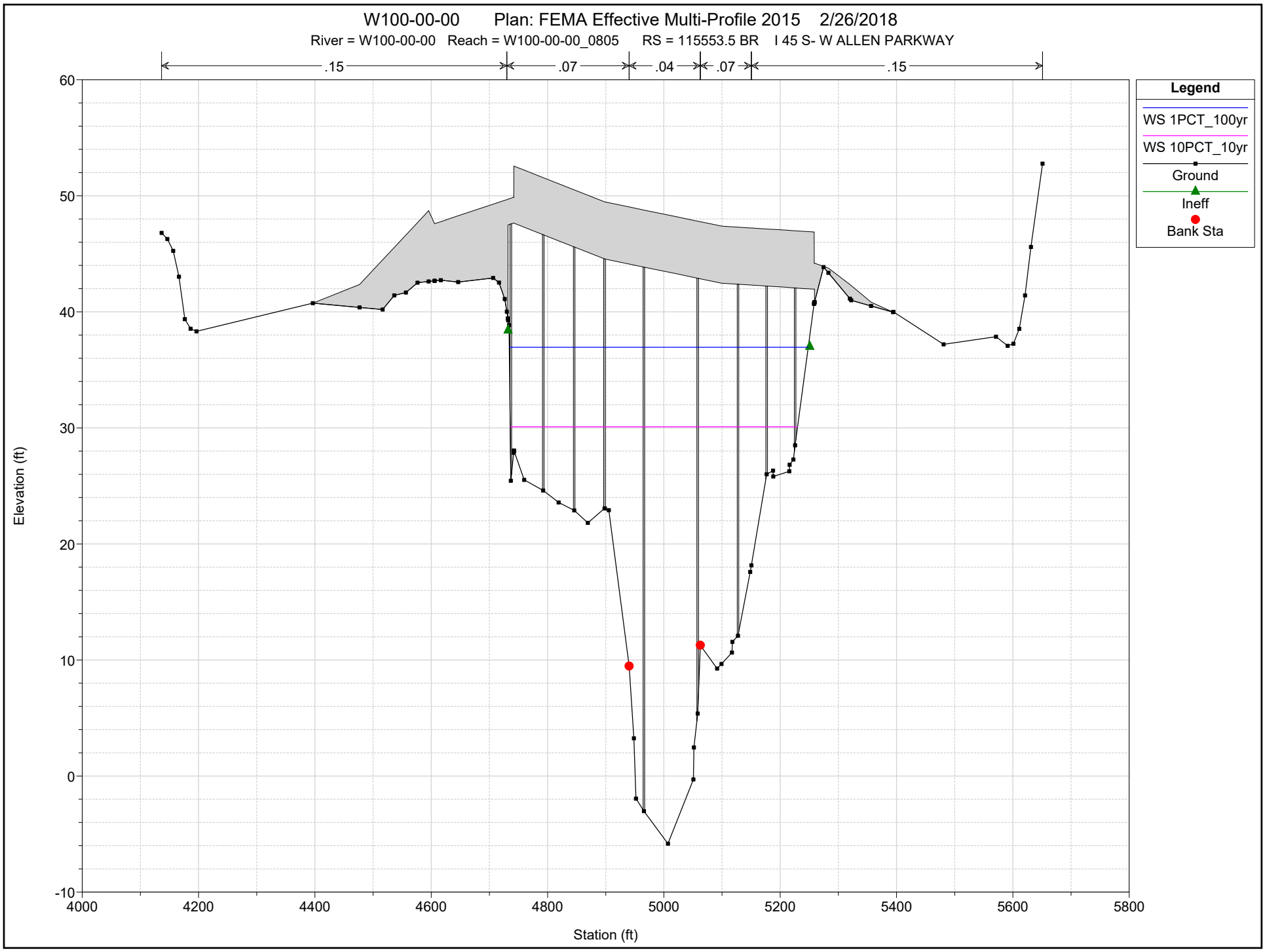
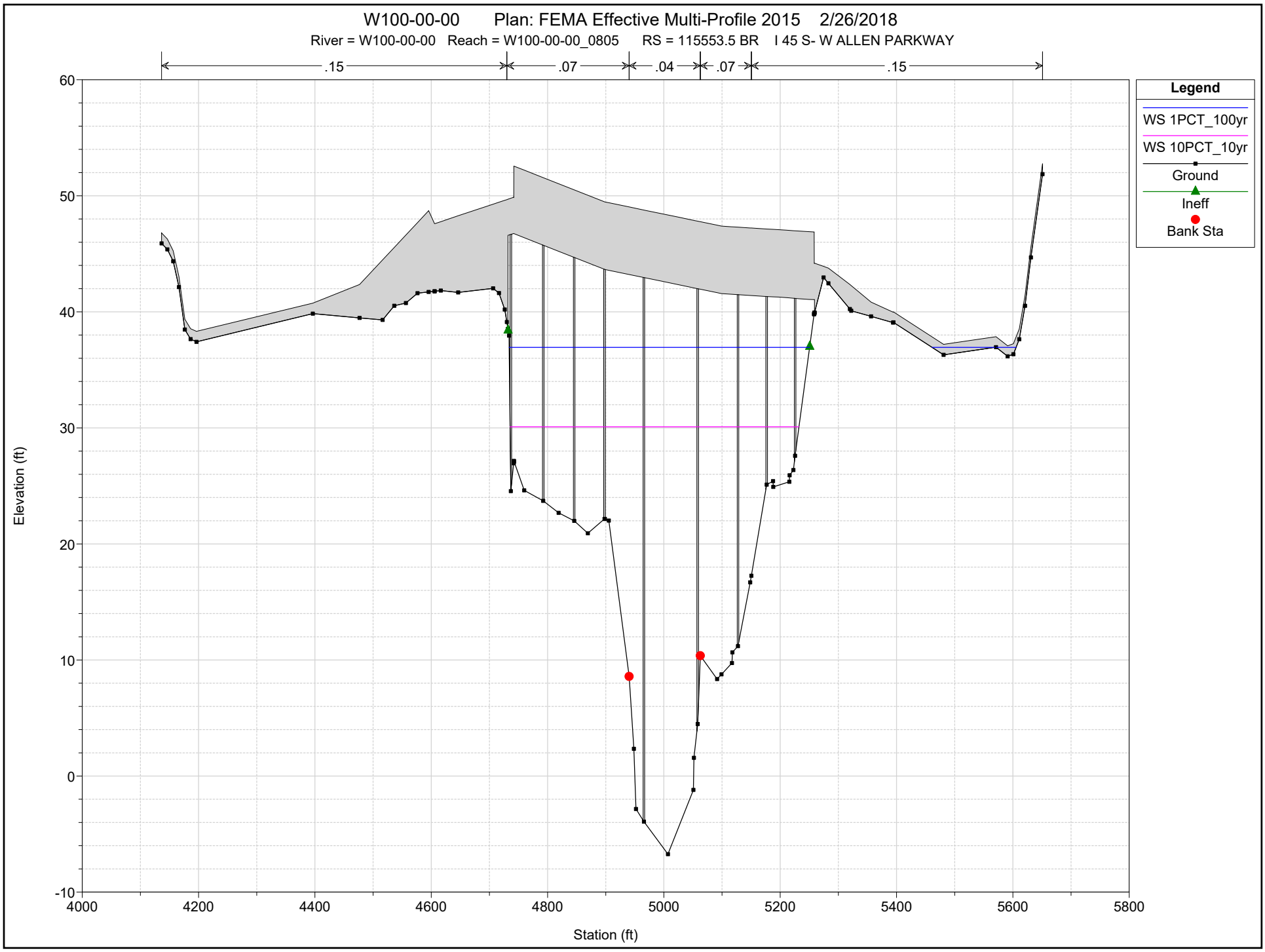
.15
.08
.04
.08
.15
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
4000
4200
4400
4600
4800
5000
5200
5400
5600
5800
Station (ft)

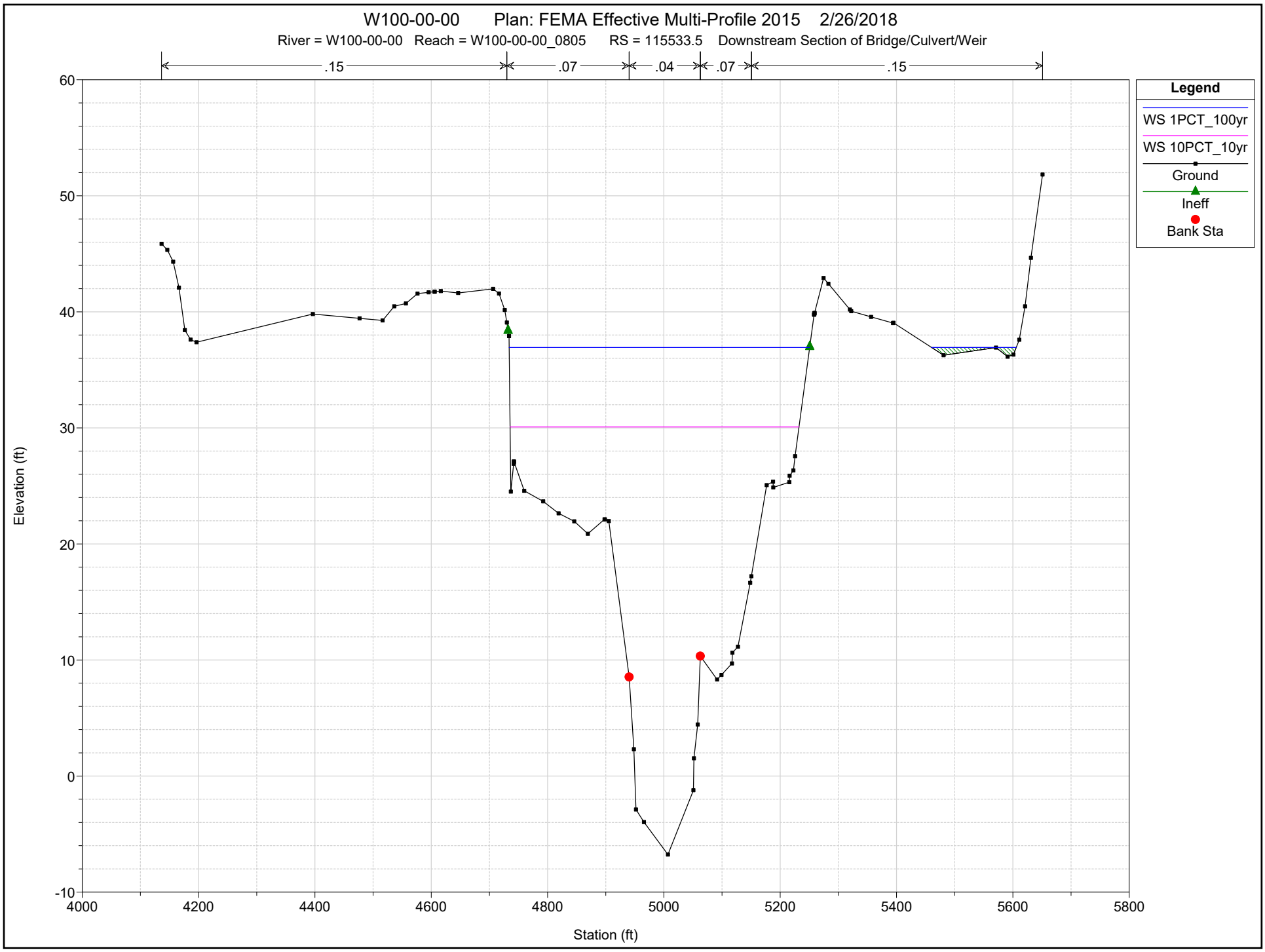

W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 115635.5 BR I 45
.15
.08
.04
.08
.15
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
4000
4200
4400
4600
4800
5000
5200
5400
5600
5800
Station (ft)

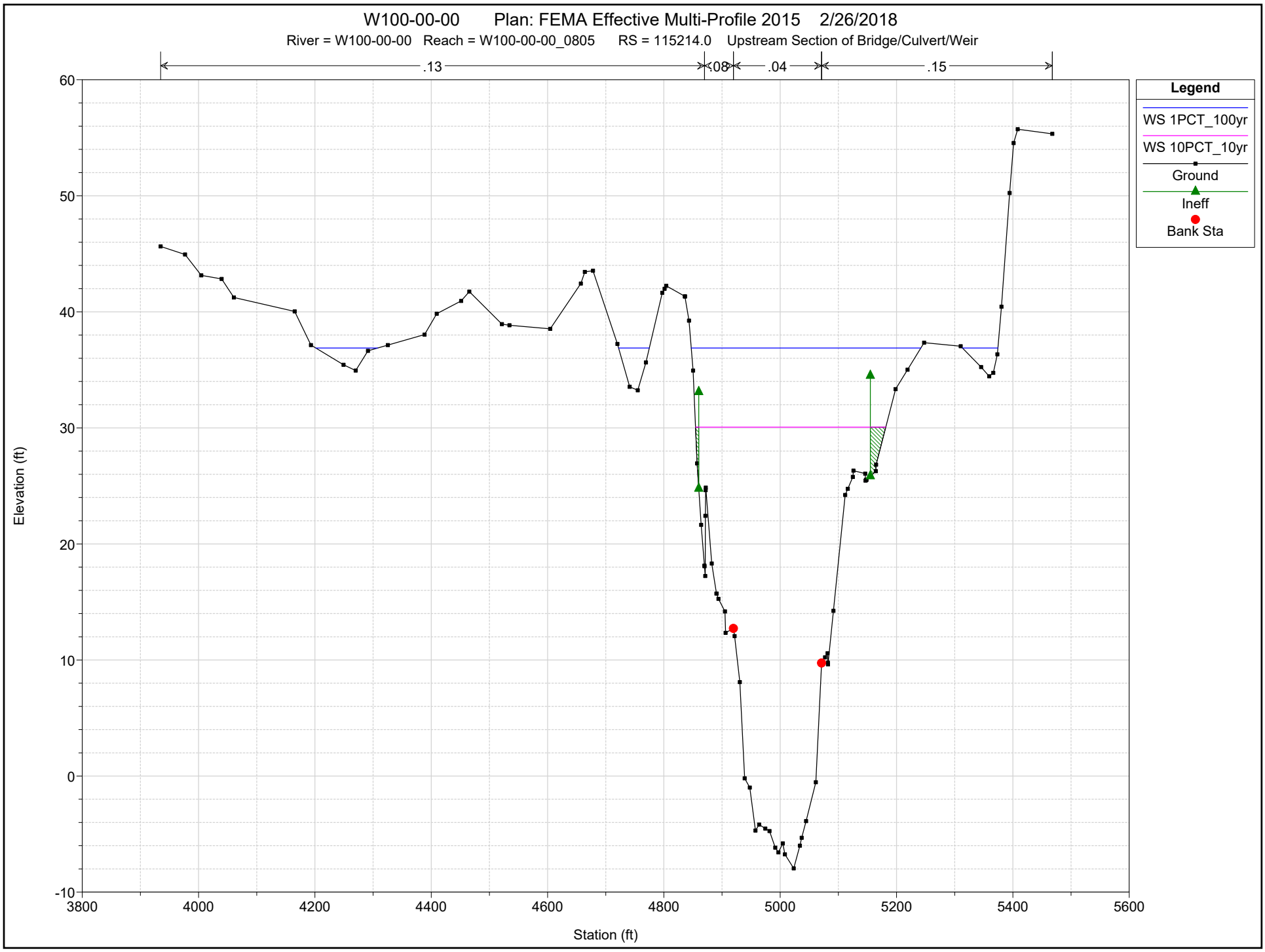

W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 115615.5 Downstream Section of Bridge/Culvert/Weir
.15
.08
.04
.08
.15
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
4000
4200
4400
4600
4800
5000
5200
5400
5600
5800
Station (ft)

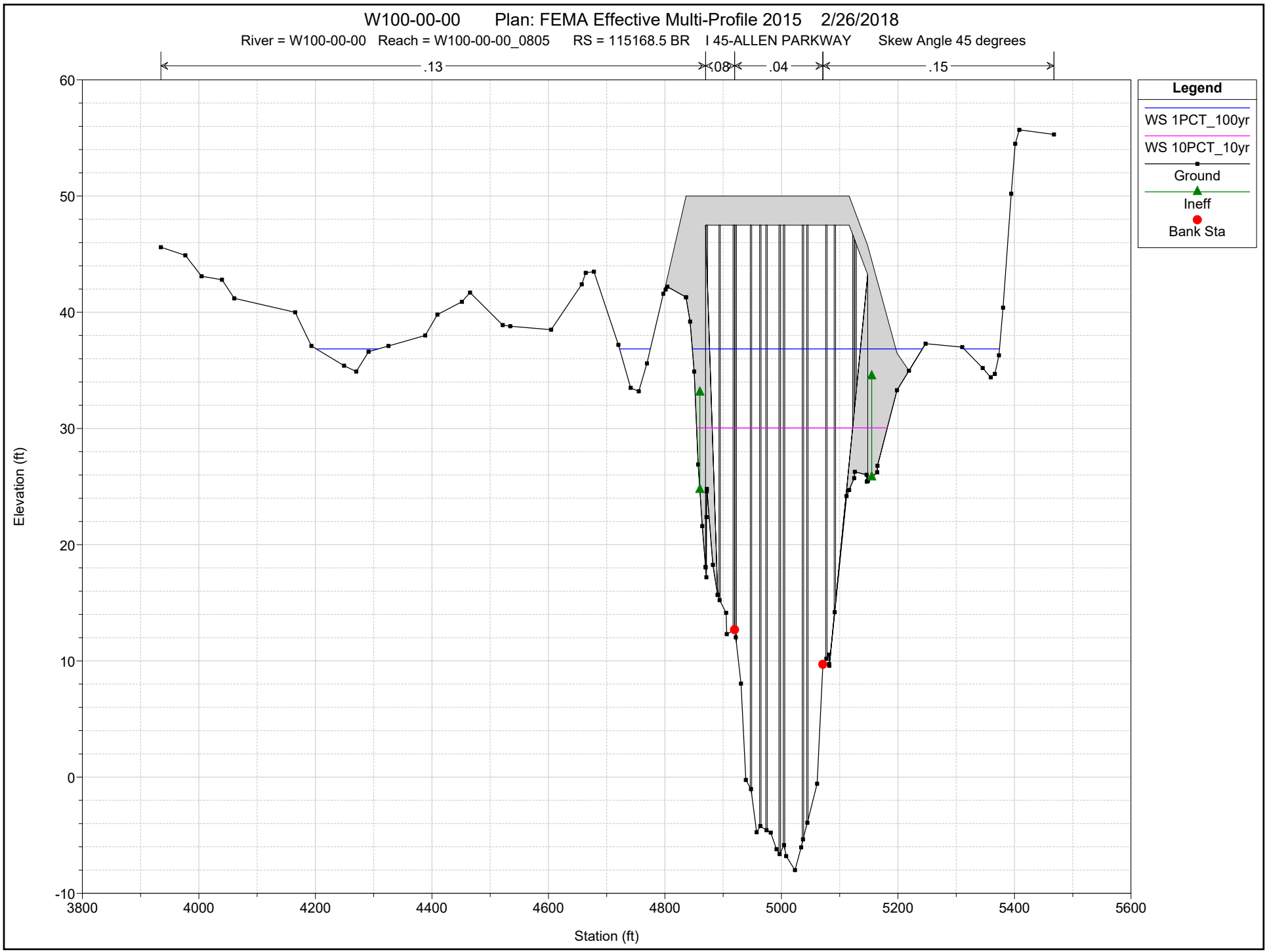

W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 115573.5 Upstream Section of Bridge/Culvert/Weir
.15
.07
.04
.07
.15
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
4000
4200
4400
4600
4800
5000
5200
5400
5600
5800
Station (ft)

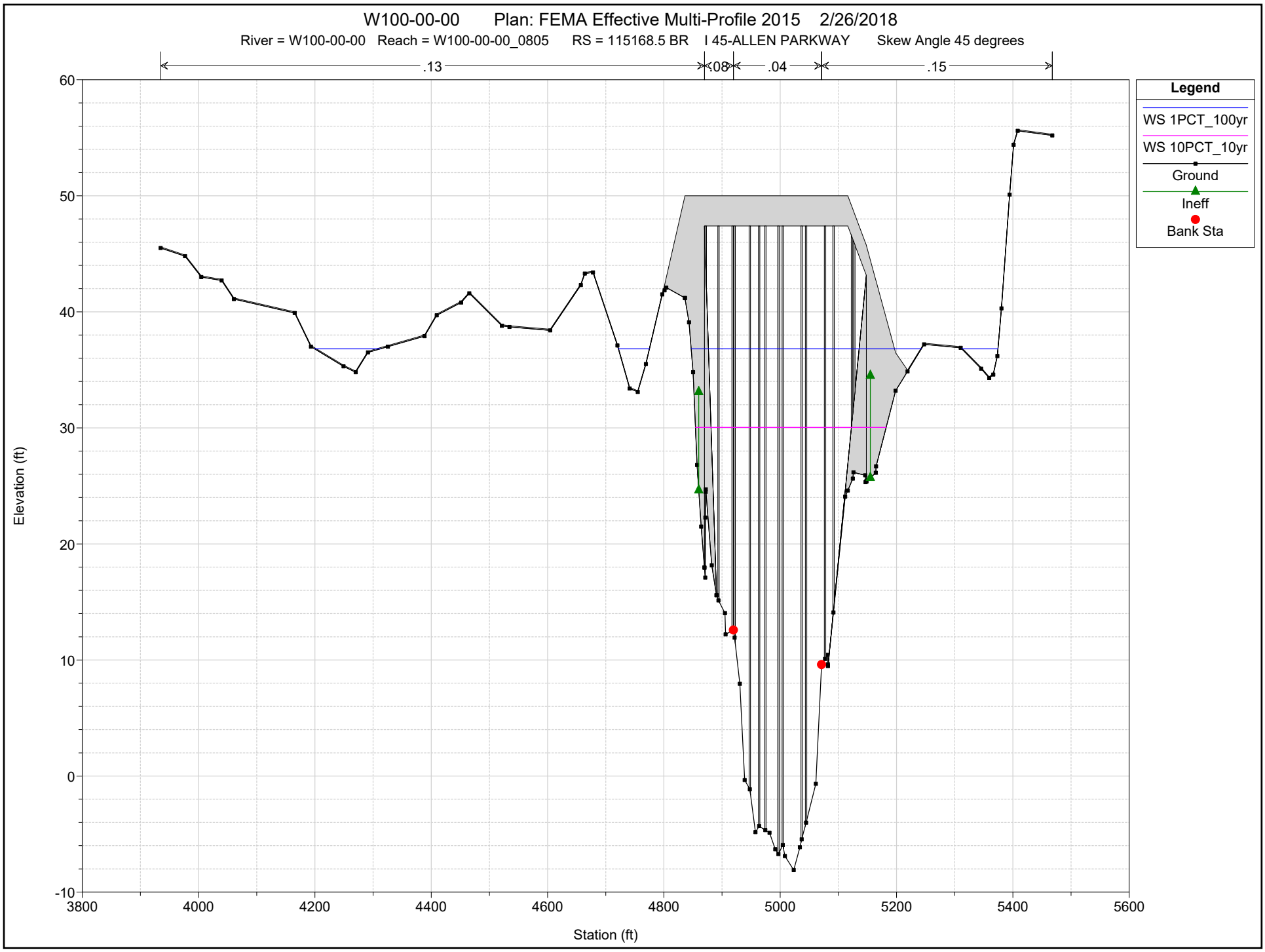

W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 115553.5 BR I 45 S- W ALLEN PARKWAY
.15
.07
.04
.07
.15
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
4000
4200
4400
4600
4800
5000
5200
5400
5600
5800
Station (ft)

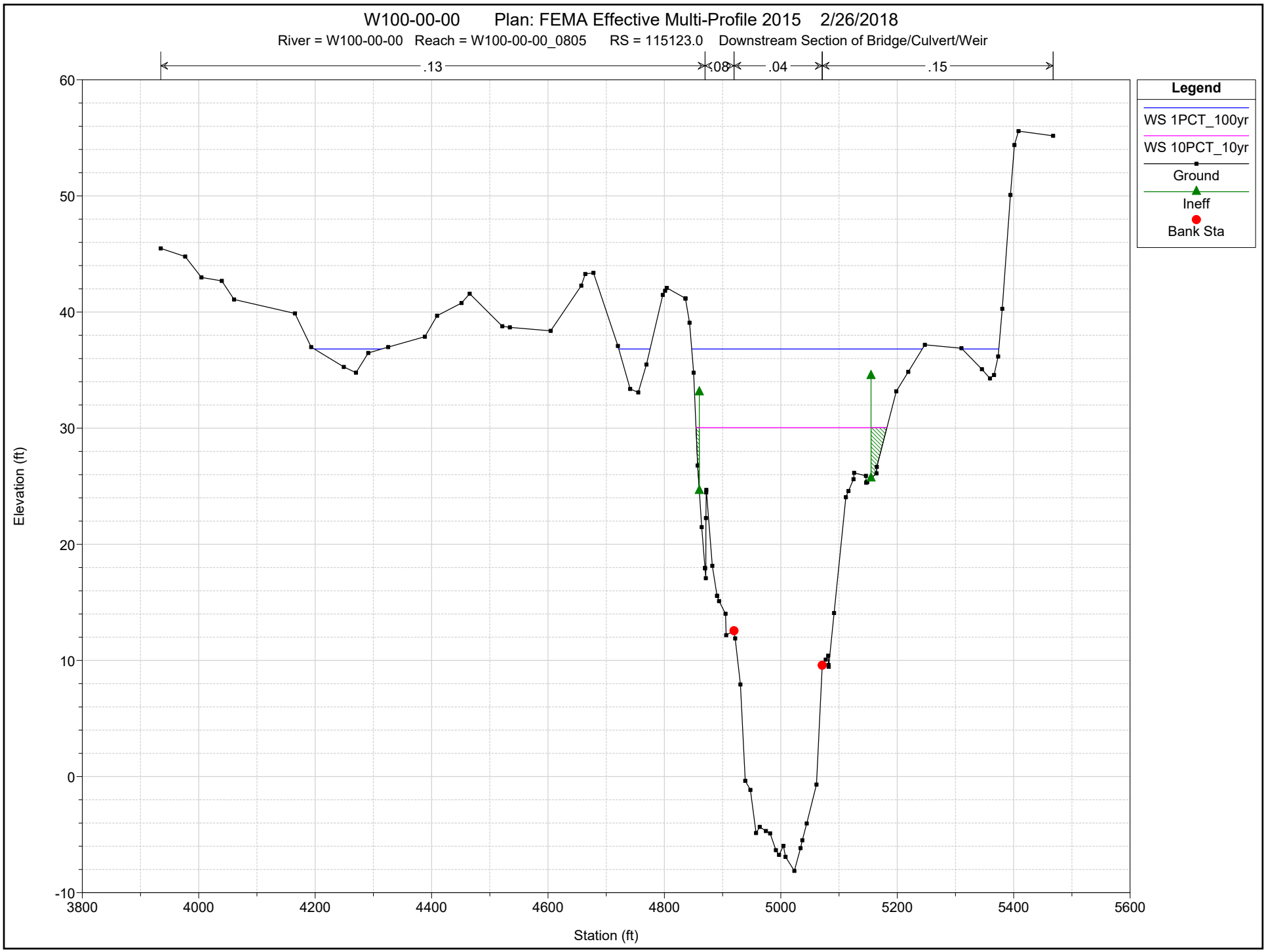

W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 115553.5 BR I 45 S- W ALLEN PARKWAY
.15
.07
.04
.07
.15
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
4000
4200
4400
4600
4800
5000
5200
5400
5600
5800
Station (ft)

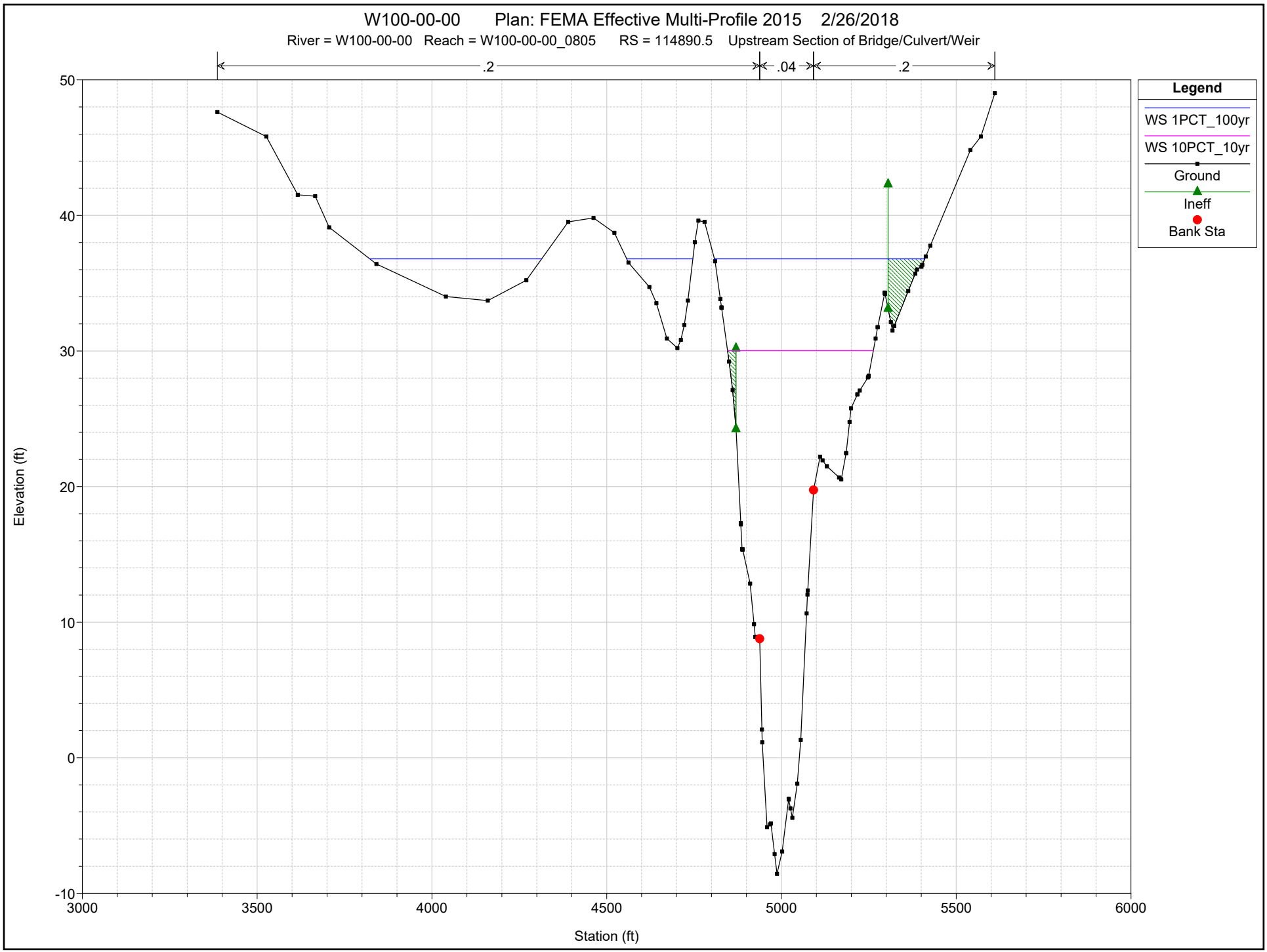

W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 115533.5 Downstream Section of Bridge/Culvert/Weir
.15
.07
.04
.07
.15
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
4000
4200
4400
4600
4800
5000
5200
5400
5600
5800
Station (ft)

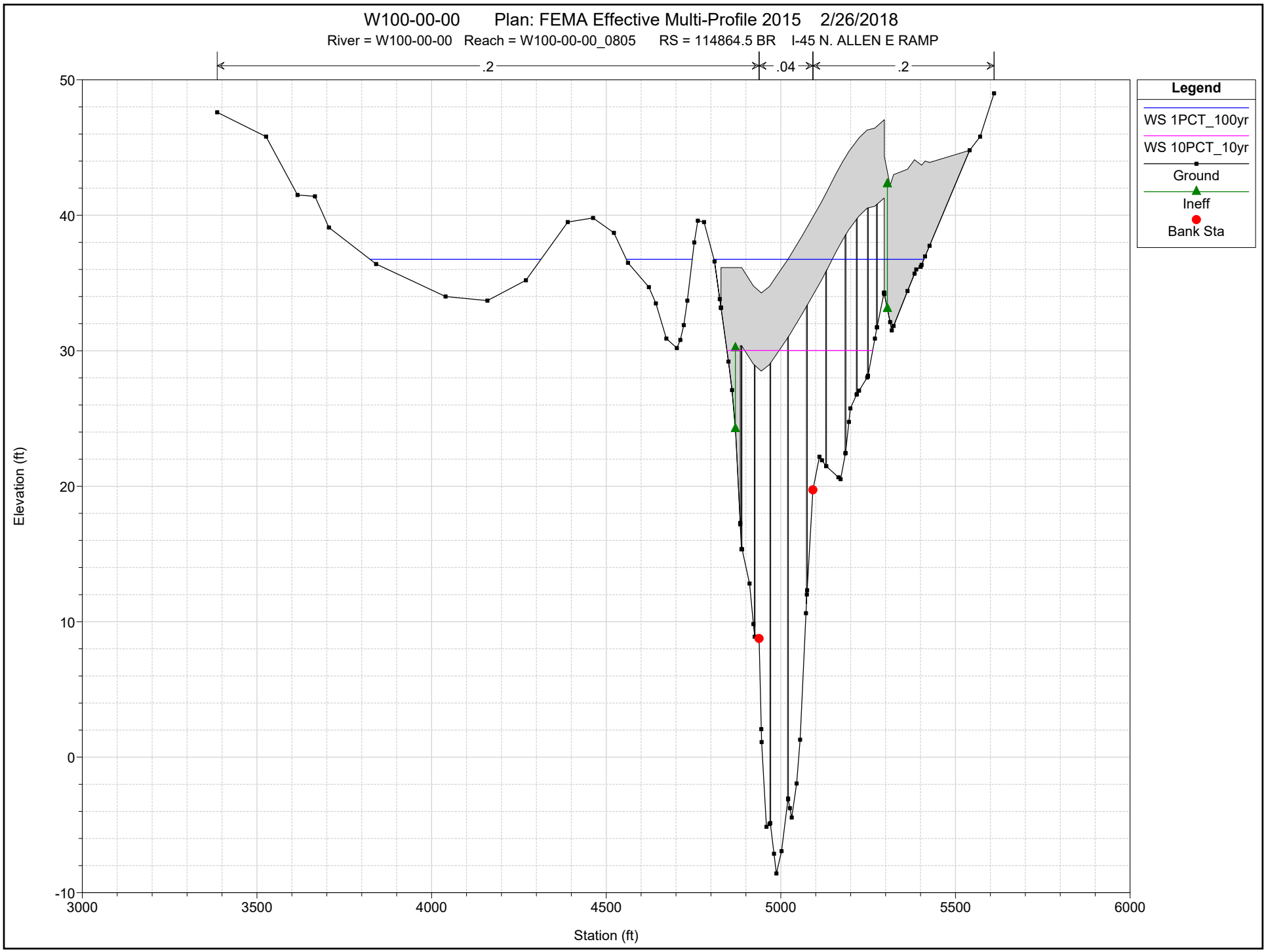

W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 115214.0 Upstream Section of Bridge/Culvert/Weir
.13
.08
.04
.15
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
3800
4000
4200
4400
4600
4800
5000
5200
5400
5600
Station (ft)

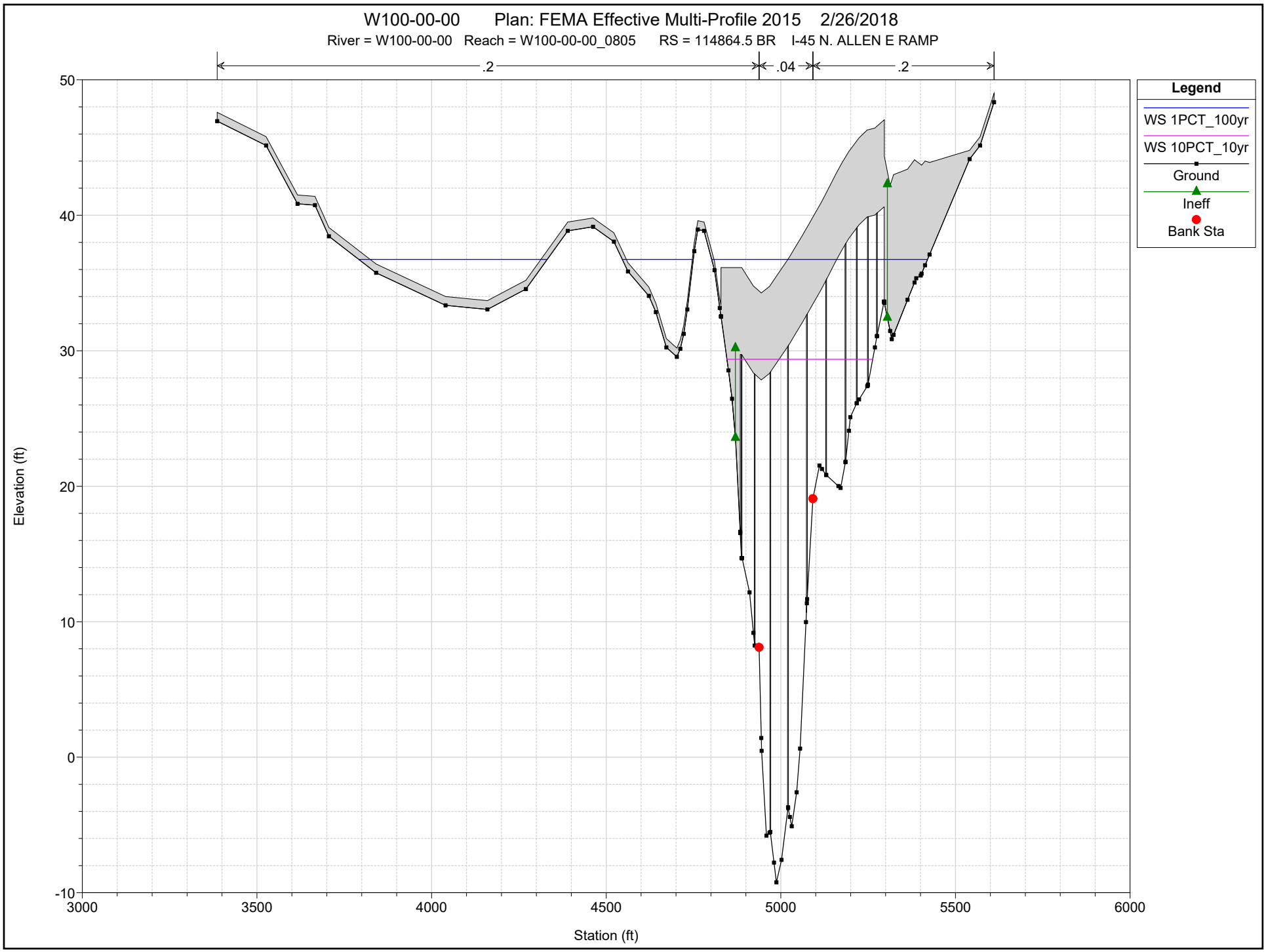

W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 115168.5 BR I 45-ALLEN PARKWAY Skew Angle 45 degrees
.13
.08
.04
.15
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
3800
4000
4200
4400
4600
4800
5000
5200
5400
5600
Station (ft)

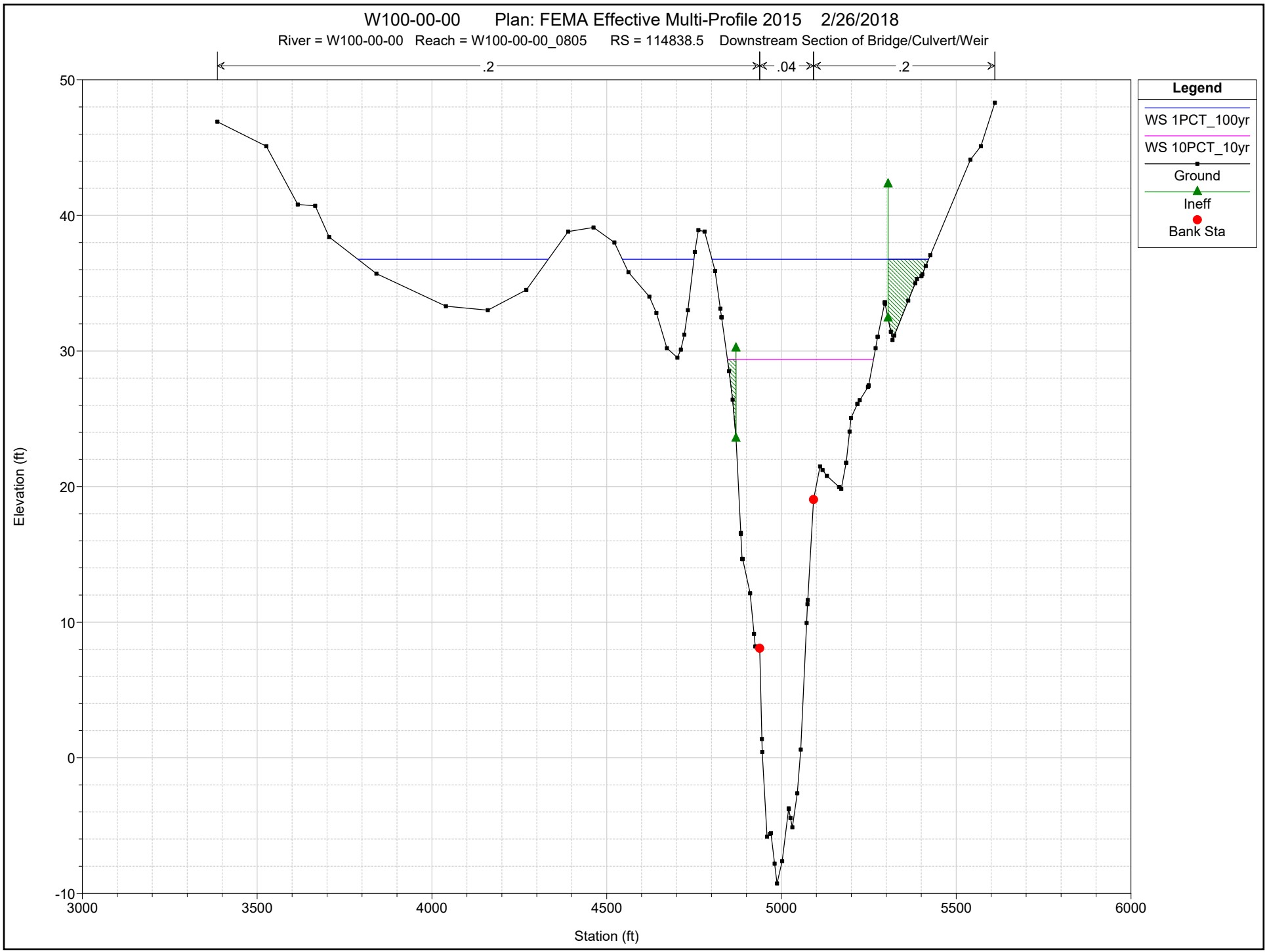

W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 115168.5 BR I 45-ALLEN PARKWAY Skew Angle 45 degrees
.13
.08
.04
.15
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
3800
4000
4200
4400
4600
4800
5000
5200
5400
5600
Station (ft)

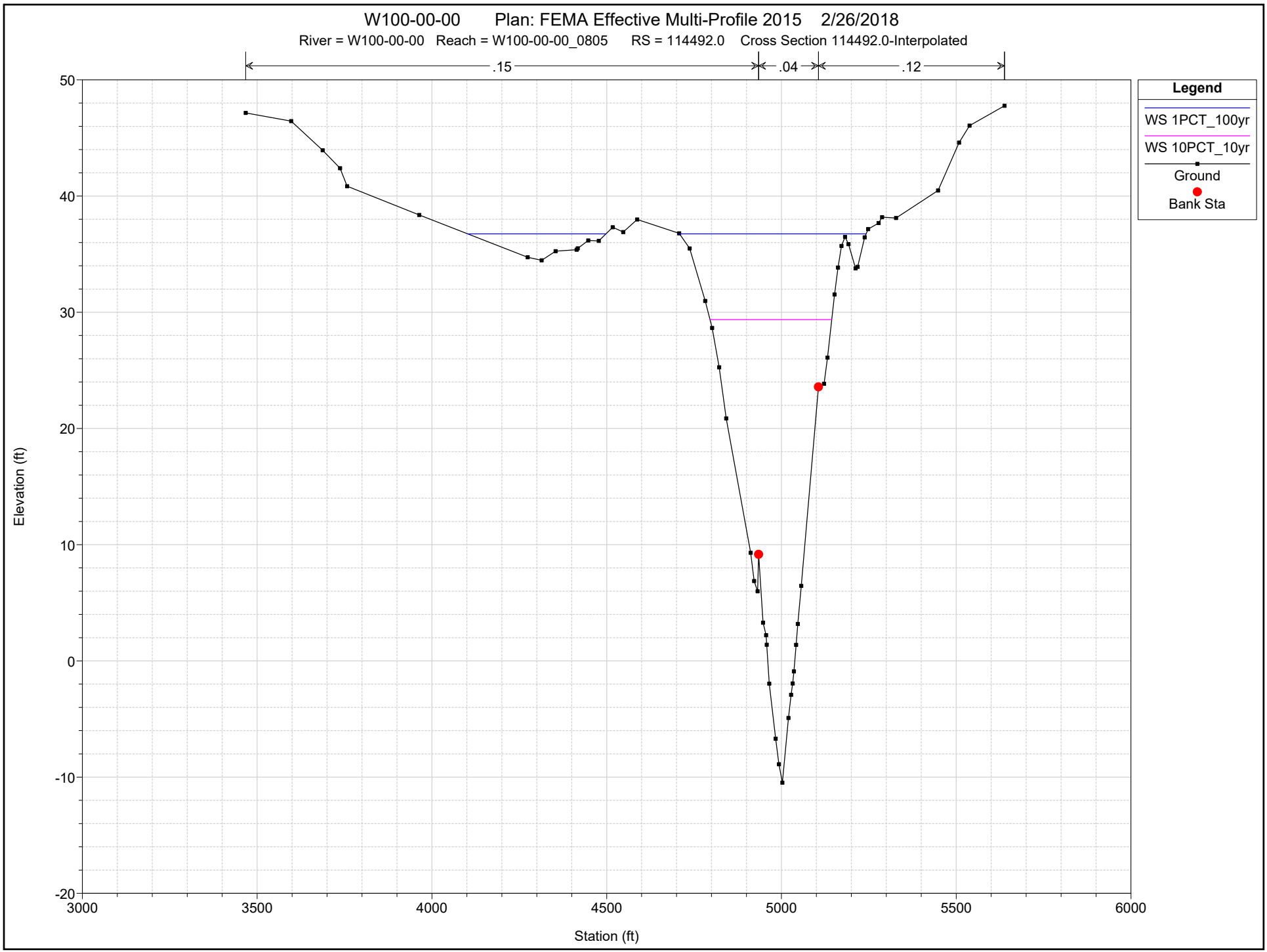

W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 115123.0 Downstream Section of Bridge/Culvert/Weir
.13
.08
.04
.15
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
3800
4000
4200
4400
4600
4800
5000
5200
5400
5600
Station (ft)


W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 114890.5 Upstream Section of Bridge/Culvert/Weir
.2
.04
.2
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
3000
3500
4000
4500
5000
5500
6000
Station (ft)


W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 114864.5 BR I-45 N. ALLEN E RAMP
.2
.04
.2
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
3000
3500
4000
4500
5000
5500
6000
Station (ft)


W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 114864.5 BR I-45 N. ALLEN E RAMP
.2
.04
.2
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
3000
3500
4000
4500
5000
5500
6000
Station (ft)


W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 114838.5 Downstream Section of Bridge/Culvert/Weir
.2
.04
.2
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
3000
3500
4000
4500
5000
5500
6000
Station (ft)


W100-00-00 Plan: FEMA Effective Multi-Profile 2015 2/26/2018
River = W100-00-00 Reach = W100-00-00_0805 RS = 114492.0 Cross Section 114492.0-Interpolated
.15
.04
.12
Legend
WS 1PCT_100yr
WS 10PCT_10yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
50
40
30
20
10
0
-10
-20
3000
3500
4000
4500
5000
5500
6000

APPENDIX E.2

CORRECTED EFFECTIVE CONDITIONS

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018

W100-00-00 Downstream

W100-00-00 W100_upstrm

Legend

WS Max WS - CE100yr_Seg3E

WS Max WS - CE10yr_Seg3E

Ground

Elevation (ft)

80
60
40
20
0
-20
-40

80863.1 81786.1 83635.7 84222.3 85238.7 85855.2 86623.2 87591.9 88579.0 89918.4 90936.7 92686.6 93495.6 94280.7 95362.9 95941.6 97517.4 98399.4 99992.6 101007.3 101752.2 102819.7 103664.0 104242 104948 105629.4 106594.0 107158.9 108334.0 109087.2 109924.2 110614.7 111410.5 111953.3 112534.5 113210.8 114043.4 114838.5 115545.8 116121.9 117204.3 117845.4 118418.1 119495.9 120962.2 122036.7 122572.1 123658.2 124539.5 125376.9 126647.0 128028.8 129163.2 130765.5 131789.8 132963.8 133748.1 134706.7 135666.2 136331.2 137113.0 137732.0 138607.9 139320.0 140116.2 141320.1 142061.4 143078.2 143966.8 144753.5 145723.9 146698.0 147632.4 148741.4

80000 90000 100000 110000 120000 130000 140000 150000

Main Channel Distance (ft)

HEC-RAS Profile: Max WS

Reach	River Sta	Profile	Plan	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)	
W100_upstrm	148800.4	Max WS	CE100yr_Seg3E	17171.39	3.15	42.91		43.01	0.000242	2.86	8039.24	1820.81	0.09
W100_upstrm	148800.4	Max WS	CE10yr_Seg3E	8254.13	3.15	33.82		33.88	0.000207	2.11	5024.36	1152.53	0.08
W100_upstrm	148795.4	Max WS	CE100yr_Seg3E	17171.37	3.15	42.91	17.82	43.01	0.000242	2.86	8038.83	1820.80	0.09
W100_upstrm	148795.4	Max WS	CE10yr_Seg3E	8254.13	3.15	33.82	13.28	33.88	0.000207	2.11	5024.03	1152.39	0.08
W100_upstrm	148768.4			Bridge									
W100_upstrm	148741.4	Max WS	CE100yr_Seg3E	17166.81	3.04	42.79		42.90	0.000242	2.86	8036.52	1820.73	0.09
W100_upstrm	148741.4	Max WS	CE10yr_Seg3E	8251.90	3.04	33.72		33.78	0.000206	2.10	5028.40	1154.25	0.08
W100_upstrm	147632.4	Max WS	CE100yr_Seg3E	17145.57	-1.17	42.63		42.71	0.000080	2.47	9181.45	548.01	0.09
W100_upstrm	147632.4	Max WS	CE10yr_Seg3E	8243.43	-1.17	33.57		33.62	0.000075	1.93	5129.69	402.67	0.08
W100_upstrm	146698.0	Max WS	CE100yr_Seg3E	17203.06	1.88	42.52		42.63	0.000114	2.93	8649.43	801.46	0.10
W100_upstrm	146698.0	Max WS	CE10yr_Seg3E	8281.97	1.88	33.48		33.55	0.000091	2.25	5105.87	330.36	0.09
W100_upstrm	145723.9	Max WS	CE100yr_Seg3E	17257.40	1.61	42.38		42.54	0.000144	3.83	8649.80	473.43	0.12
W100_upstrm	145723.9	Max WS	CE10yr_Seg3E	8316.97	1.61	33.36		33.47	0.000127	2.91	4823.73	386.89	0.10
W100_upstrm	144753.5	Max WS	CE100yr_Seg3E	17317.88	0.07	42.24		42.39	0.000147	3.38	7655.37	562.32	0.11
W100_upstrm	144753.5	Max WS	CE10yr_Seg3E	8361.59	0.07	33.25		33.34	0.000112	2.56	4126.21	310.78	0.10
W100_upstrm	143966.8	Max WS	CE100yr_Seg3E	17358.88	-7.47	42.15		42.29	0.000141	3.36	10852.62	1301.47	0.11
W100_upstrm	143966.8	Max WS	CE10yr_Seg3E	8390.17	-7.47	33.15		33.25	0.000147	2.74	4446.41	465.47	0.11
W100_upstrm	143078.2	Max WS	CE100yr_Seg3E	17418.28	-4.19	42.04		42.17	0.000115	3.10	11584.50	944.19	0.10
W100_upstrm	143078.2	Max WS	CE10yr_Seg3E	8430.85	-4.19	33.05		33.13	0.000107	2.33	5773.68	536.85	0.09
W100_upstrm	142061.4	Max WS	CE100yr_Seg3E	17493.83	0.55	41.96		42.07	0.000078	2.85	10458.92	532.52	0.09
W100_upstrm	142061.4	Max WS	CE10yr_Seg3E	8481.32	0.55	32.98		33.04	0.000066	2.10	5959.32	458.67	0.08
W100_upstrm	141320.1	Max WS	CE100yr_Seg3E	17552.56	-2.70	41.96		41.99	0.000039	1.82	18318.33	975.89	0.06
W100_upstrm	141320.1	Max WS	CE10yr_Seg3E	8519.96	-2.70	32.96		32.99	0.000037	1.44	10818.89	749.06	0.06
W100_upstrm	140116.2	Max WS	CE100yr_Seg3E	17617.46	-1.31	41.85		41.96	0.000103	3.00	12353.54	883.45	0.09
W100_upstrm	140116.2	Max WS	CE10yr_Seg3E	8558.93	-1.31	32.86		32.94	0.000094	2.33	5920.05	610.77	0.08
W100_upstrm	139320.0	Max WS	CE100yr_Seg3E	17664.17	-2.14	41.80		41.88	0.000083	2.44	14108.92	944.07	0.08
W100_upstrm	139320.0	Max WS	CE10yr_Seg3E	8587.30	-2.14	32.82		32.87	0.000070	1.90	6775.77	613.81	0.07
W100_upstrm	138607.9	Max WS	CE100yr_Seg3E	17711.54	-2.08	41.80		41.82	0.000019	1.32	26666.23	1417.13	0.04
W100_upstrm	138607.9	Max WS	CE10yr_Seg3E	8618.64	-2.08	32.82		32.83	0.000017	1.04	16755.24	1119.24	0.04
W100_upstrm	137732.0	Max WS	CE100yr_Seg3E	17743.50	-2.40	41.76		41.82	0.000057	2.55	18145.21	1348.43	0.08
W100_upstrm	137732.0	Max WS	CE10yr_Seg3E	8638.39	-2.40	32.78		32.83	0.000052	2.00	9912.01	898.77	0.07
W100_upstrm	137113.0	Max WS	CE100yr_Seg3E	17794.45	-2.62	41.68		41.81	0.000093	3.27	14429.16	1341.22	0.10
W100_upstrm	137113.0	Max WS	CE10yr_Seg3E	8667.26	-2.62	32.72		32.80	0.000076	2.43	6273.46	465.39	0.08
W100_upstrm	136331.2	Max WS	CE100yr_Seg3E	17857.38	-2.09	41.64		41.66	0.000149	1.58	15771.83	768.74	0.05
W100_upstrm	136331.2	Max WS	CE10yr_Seg3E	8706.70	-2.09	32.67		32.69	0.000143	1.30	9526.82	642.74	0.05
W100_upstrm	135666.2	Max WS	CE100yr_Seg3E	17893.06	-1.47	41.54		41.63	0.000073	2.71	13088.45	789.97	0.08
W100_upstrm	135666.2	Max WS	CE10yr_Seg3E	8721.44	-1.47	32.59		32.64	0.000067	2.08	7127.33	563.71	0.08
W100_upstrm	134706.7	Max WS	CE100yr_Seg3E	17953.21	-1.93	41.53		41.56	0.000036	1.92	22475.54	1161.51	0.06
W100_upstrm	134706.7	Max WS	CE10yr_Seg3E	8760.42	-1.93	32.57		32.59	0.000031	1.46	13172.71	876.08	0.05
W100_upstrm	134090.6	Max WS	CE100yr_Seg3E	17982.75	-1.59	41.49		41.55	0.000051	2.40	17640.23	852.58	0.07
W100_upstrm	134090.6	Max WS	CE10yr_Seg3E	8776.01	-1.59	32.54		32.58	0.000042	1.80	10450.22	731.86	0.06
W100_upstrm	133772.1	Max WS	CE100yr_Seg3E	18000.55	-0.79	41.47	13.45	41.55	0.000067	2.87	17038.54	952.43	0.08
W100_upstrm	133772.1	Max WS	CE10yr_Seg3E	8783.91	-0.79	32.51	8.86	32.58	0.000062	2.32	8989.05	862.18	0.08
W100_upstrm	133760.1			Bridge									
W100_upstrm	133748.1	Max WS	CE100yr_Seg3E	18000.48	-0.46	41.42		41.51	0.000070	2.93	16678.35	946.34	0.08
W100_upstrm	133748.1	Max WS	CE10yr_Seg3E	8783.47	-0.46	32.49		32.56	0.000065	2.35	8687.63	832.59	0.08
W100_upstrm	132963.8	Max WS	CE100yr_Seg3E	18062.85	-1.98	41.32		41.45	0.000107	3.13	10247.22	701.85	0.10
W100_upstrm	132963.8	Max WS	CE10yr_Seg3E	8814.46	-1.98	32.42		32.50	0.000086	2.35	5380.41	499.92	0.09
W100_upstrm	131789.8	Max WS	CE100yr_Seg3E	18144.58	-2.31	41.21		41.34	0.000100	3.28	10835.24	740.77	0.10
W100_upstrm	131789.8	Max WS	CE10yr_Seg3E	8853.13	-2.31	32.33		32.41	0.000082	2.46	6043.68	491.38	0.08
W100_upstrm	130765.5	Max WS	CE100yr_Seg3E	18223.35	-3.81	41.17		41.24	0.000050	2.48	13548.28	671.33	0.07
W100_upstrm	130765.5	Max WS	CE10yr_Seg3E	8899.96	-3.81	32.29		32.33	0.000034	1.71	8706.61	495.28	0.06
W100_upstrm	129725.3	Max WS	CE100yr_Seg3E	18292.30	-3.71	41.11		41.20	0.000071	2.94	16417.40	1196.26	0.08
W100_upstrm	129725.3	Max WS	CE10yr_Seg3E	8935.25	-3.71	32.24		32.30	0.000061	2.27	8561.49	716.84	0.08
W100_upstrm	129163.2	Max WS	CE100yr_Seg3E	18350.98	-3.13	41.05		41.15	0.000071	2.87	12129.92	859.95	0.09

HEC-RAS Profile: Max WS (Continued)

Reach	River Sta	Profile	Plan	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)	
W100_upstrm	129163.2	Max WS	CE10yr_Seg3E	8966.38	-3.13	32.19		32.26	0.000055	2.08	6430.44	504.60	0.07
W100_upstrm	128326.9	Max WS	CE100yr_Seg3E	18416.90	-4.05	41.01		41.08	0.000049	2.49	20269.41	1352.38	0.07
W100_upstrm	128326.9	Max WS	CE10yr_Seg3E	9004.55	-4.05	32.17		32.21	0.000038	1.84	9027.80	843.48	0.06
W100_upstrm	128109.6	Max WS	CE100yr_Seg3E	18416.65	-4.29	41.00		41.04	0.000206	1.68	12475.24	1144.21	0.06
W100_upstrm	128109.6	Max WS	CE10yr_Seg3E	9005.22	-4.29	32.16		32.19	0.000085	1.27	7092.63	396.52	0.05
W100_upstrm	128104.6	Max WS	CE100yr_Seg3E	18416.65	-4.29	41.00	10.47	41.04	0.000206	1.68	12474.06	1144.17	0.06
W100_upstrm	128104.6	Max WS	CE10yr_Seg3E	9005.92	-4.29	32.16	6.03	32.19	0.000085	1.27	7092.48	396.51	0.05
W100_upstrm	128066.7			Bridge									
W100_upstrm	128028.8	Max WS	CE100yr_Seg3E	18416.10	-4.51	40.94		40.98	0.000166	1.67	12663.09	1150.71	0.06
W100_upstrm	128028.8	Max WS	CE10yr_Seg3E	9003.81	-4.51	31.95		31.97	0.000057	1.27	7092.93	396.52	0.05
W100_upstrm	126647.0	Max WS	CE100yr_Seg3E	18413.13	-3.93	40.83		40.85	0.000022	0.95	20495.10	1033.44	0.03
W100_upstrm	126647.0	Max WS	CE10yr_Seg3E	8991.24	-3.93	31.91		31.92	0.000019	0.75	11990.63	835.04	0.03
W100_upstrm	125376.9	Max WS	CE100yr_Seg3E	18500.08	-4.05	40.67		40.73	0.000177	1.95	10157.66	858.84	0.08
W100_upstrm	125376.9	Max WS	CE10yr_Seg3E	9026.32	-4.05	31.79		31.83	0.000124	1.53	5897.96	339.88	0.06
W100_upstrm	124983.5	Max WS	CE100yr_Seg3E	18527.80	-3.86	40.66		40.68	0.000021	1.40	21056.86	1405.43	0.05
W100_upstrm	124983.5	Max WS	CE10yr_Seg3E	9037.19	-3.86	31.76		31.80	0.000031	1.47	6148.19	1027.71	0.06
W100_upstrm	124644.1	Max WS	CE100yr_Seg3E	18548.32	-3.69	40.61	13.69	40.68	0.000048	2.09	8863.48	655.05	0.07
W100_upstrm	124644.1	Max WS	CE10yr_Seg3E	9050.15	-3.69	31.75	8.31	31.78	0.000038	1.54	5864.66	495.68	0.06
W100_upstrm	124591.8			Bridge									
W100_upstrm	124539.5	Max WS	CE100yr_Seg3E	18547.21	-3.74	40.59		40.65	0.000048	2.09	8871.93	656.73	0.07
W100_upstrm	124539.5	Max WS	CE10yr_Seg3E	9046.27	-3.74	31.74		31.77	0.000037	1.54	5877.29	496.09	0.06
W100_upstrm	123658.2	Max WS	CE100yr_Seg3E	18613.60	-2.04	40.60		40.61	0.000016	0.86	29080.29	2441.84	0.03
W100_upstrm	123658.2	Max WS	CE10yr_Seg3E	9099.38	-2.04	31.73		31.74	0.000018	0.79	12559.90	1452.46	0.04
W100_upstrm	123138.8	Max WS	CE100yr_Seg3E	18649.72	-4.08	40.59		40.60	0.000013	0.80	27271.74	1779.92	0.03
W100_upstrm	123138.8	Max WS	CE10yr_Seg3E	9125.80	-4.08	31.73		31.74	0.000010	0.59	15838.80	1051.83	0.02
W100_upstrm	122627.1	Max WS	CE100yr_Seg3E	18691.90	-6.08	40.57		40.62	0.000021	1.55	17866.11	1330.50	0.05
W100_upstrm	122627.1	Max WS	CE10yr_Seg3E	9147.94	-6.08	31.71		31.75	0.000019	1.27	9010.53	730.95	0.05
W100_upstrm	122572.1			Mult Open									
W100_upstrm	122517.1	Max WS	CE100yr_Seg3E	18691.37	-5.38	40.57		40.60	0.000036	1.44	16834.29	1255.81	0.05
W100_upstrm	122517.1	Max WS	CE10yr_Seg3E	9150.69	-5.38	31.71		31.73	0.000032	1.28	8517.38	676.63	0.05
W100_upstrm	122371.6	Max WS	CE100yr_Seg3E	18699.61	-7.00	40.57	9.25	40.59	0.000038	1.40	17636.27	1141.60	0.05
W100_upstrm	122371.6	Max WS	CE10yr_Seg3E	9146.50	-7.00	31.69	4.16	31.72	0.000058	1.47	6202.78	873.70	0.06
W100_upstrm	122265			Bridge									
W100_upstrm	122210.0	Max WS	CE100yr_Seg3E	18694.69	-5.60	40.53		40.56	0.000032	1.57	15209.79	835.50	0.05
W100_upstrm	122210.0	Max WS	CE10yr_Seg3E	9138.15	-5.60	31.66		31.69	0.000036	1.40	6540.17	749.06	0.05
W100_upstrm	122036.7	Max WS	CE100yr_Seg3E	18708.27	-8.40	40.52		40.55	0.000030	1.46	16000.32	1005.20	0.05
W100_upstrm	122036.7	Max WS	CE10yr_Seg3E	9149.42	-8.40	31.66		31.68	0.000037	1.25	8318.64	766.19	0.05
W100_upstrm	121229.5	Max WS	CE100yr_Seg3E	18763.44	-11.37	40.50		40.53	0.000026	1.39	17288.43	1135.06	0.05
W100_upstrm	121229.5	Max WS	CE10yr_Seg3E	9183.26	-11.37	31.63		31.65	0.000026	1.16	9187.73	843.56	0.05
W100_upstrm	120962.2	Max WS	CE100yr_Seg3E	18782.26	-10.59	40.48		40.52	0.000040	1.79	13779.63	1144.41	0.06
W100_upstrm	120962.2	Max WS	CE10yr_Seg3E	9188.16	-10.59	31.61		31.65	0.000036	1.44	7017.99	672.16	0.06
W100_upstrm	120005.2	Max WS	CE100yr_Seg3E	18841.98	-7.78	40.47	8.35	40.48	0.000028	0.80	23584.78	1093.69	0.03
W100_upstrm	120005.2	Max WS	CE10yr_Seg3E	9229.80	-7.78	31.60	3.60	31.61	0.000028	0.64	14528.57	967.54	0.03
W100_upstrm	119952.6			Bridge									
W100_upstrm	119900.0	Max WS	CE100yr_Seg3E	18836.71	-7.64	40.41		40.42	0.000019	0.81	23366.03	1069.26	0.03
W100_upstrm	119900.0	Max WS	CE10yr_Seg3E	9221.33	-7.64	31.59		31.60	0.000017	0.64	14378.55	957.68	0.03
W100_upstrm	119495.9	Max WS	CE100yr_Seg3E	18865.90	-7.21	40.41		40.41	0.000010	0.58	33479.07	1380.99	0.02
W100_upstrm	119495.9	Max WS	CE10yr_Seg3E	9244.50	-7.21	31.59		31.59	0.000007	0.43	21834.22	1255.97	0.02
W100_upstrm	118667.7	Max WS	CE100yr_Seg3E	18934.22	-8.56	40.38		40.40	0.000029	1.06	19296.36	1304.75	0.04
W100_upstrm	118667.7	Max WS	CE10yr_Seg3E	9285.38	-8.56	31.57		31.58	0.000025	0.83	11366.74	757.36	0.03
W100_upstrm	118466.1	Max WS	CE100yr_Seg3E	18938.93	-8.89	40.37	5.88	40.40	0.000022	1.40	18163.41	1343.78	0.05
W100_upstrm	118466.1	Max WS	CE10yr_Seg3E	9282.35	-8.89	31.55	1.64	31.57	0.000018	1.13	9129.02	809.03	0.04
W100_upstrm	118418.1			Bridge									

HEC-RAS Profile: Max WS (Continued)

Reach	River Sta	Profile	Plan	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)	
W100_upstrm	118370.1	Max WS	CE100yr_Seg3E	18937.41	-8.87	40.35		40.38	0.000023	1.40	18109.19	1339.04	0.05
W100_upstrm	118370.1	Max WS	CE10yr_Seg3E	9267.05	-8.87	31.51		31.53	0.000019	1.13	9079.63	808.13	0.04
W100_upstrm	117845.4	Max WS	CE100yr_Seg3E	18972.65	-7.26	40.33		40.36	0.000035	1.33	16564.06	1171.01	0.05
W100_upstrm	117845.4	Max WS	CE10yr_Seg3E	9289.18	-7.26	31.50		31.52	0.000027	0.99	9618.02	587.59	0.04
W100_upstrm	117204.3	Max WS	CE100yr_Seg3E	19018.60	-4.60	40.32		40.34	0.000020	1.07	19603.14	1336.83	0.04
W100_upstrm	117204.3	Max WS	CE10yr_Seg3E	9325.96	-4.60	31.49		31.50	0.000017	0.81	11483.91	654.46	0.03
W100_upstrm	116395.7	Max WS	CE100yr_Seg3E	19065.06	-3.88	40.30		40.32	0.000025	1.25	15542.52	1093.72	0.05
W100_upstrm	116395.7	Max WS	CE10yr_Seg3E	9354.68	-3.88	31.48		31.49	0.000016	0.91	10227.69	505.48	0.04
W100_upstrm	116167.6	Max WS	CE100yr_Seg3E	19060.02	-3.68	40.24	7.84	40.31	0.000102	2.15	10140.65	1230.29	0.07
W100_upstrm	116167.6	Max WS	CE10yr_Seg3E	9330.68	-3.68	31.45	4.15	31.48	0.000060	1.51	6167.71	273.70	0.05
W100_upstrm	116121.9			Bridge									
W100_upstrm	116076.2	Max WS	CE100yr_Seg3E	19033.19	-3.86	40.12		40.19	0.000117	2.12	10209.56	1241.72	0.07
W100_upstrm	116076.2	Max WS	CE10yr_Seg3E	9316.69	-3.86	31.26		31.30	0.000058	1.51	6167.11	273.69	0.05
W100_upstrm	115804.5	Max WS	CE100yr_Seg3E	19037.85	-4.60	40.08	8.07	40.18	0.000046	2.92	12939.20	1522.20	0.08
W100_upstrm	115804.5	Max WS	CE10yr_Seg3E	9311.36	-4.60	31.24	4.15	31.29	0.000030	2.00	6330.09	310.45	0.06
W100_upstrm	115800			Bridge									
W100_upstrm	115729.9	Max WS	CE100yr_Seg3E	19031.24	-4.81	40.07		40.16	0.000042	2.70	12889.63	1520.15	0.08
W100_upstrm	115729.9	Max WS	CE10yr_Seg3E	9311.36	-4.81	31.23		31.29	0.000030	1.90	6178.77	357.50	0.06
W100_upstrm	115672.3	Max WS	CE100yr_Seg3E	19034.67	-5.10	40.07	8.61	40.16	0.000046	2.82	13789.65	1565.24	0.08
W100_upstrm	115672.3	Max WS	CE10yr_Seg3E	9308.53	-5.10	31.23	4.29	31.29	0.000033	2.03	6582.71	422.86	0.06
W100_upstrm	115635.5			Bridge									
W100_upstrm	115621.1	Max WS	CE100yr_Seg3E	19052.71	-5.57	40.09		40.15	0.000028	2.26	18183.75	1942.41	0.06
W100_upstrm	115621.1	Max WS	CE10yr_Seg3E	9325.96	-5.57	31.24		31.28	0.000022	1.70	8131.63	688.29	0.05
W100_upstrm	115594.6	Max WS	CE100yr_Seg3E	19052.54	-6.04	40.09	6.36	40.14	0.000022	2.01	19189.70	1953.11	0.06
W100_upstrm	115594.6	Max WS	CE10yr_Seg3E	9327.36	-6.04	31.25	2.78	31.28	0.000017	1.48	9063.48	708.03	0.05
W100_upstrm	115553.5			Bridge									
W100_upstrm	115545.8	Max WS	CE100yr_Seg3E	19048.87	-6.85	40.09		40.13	0.000023	2.09	20116.05	1993.46	0.06
W100_upstrm	115545.8	Max WS	CE10yr_Seg3E	9327.36	-6.85	31.25		31.27	0.000018	1.54	9711.21	721.95	0.05
W100_upstrm	115438.9	Max WS	CE100yr_Seg3E	19058.80	-7.24	40.08	7.35	40.13	0.000025	2.11	18100.43	1887.39	0.06
W100_upstrm	115438.9	Max WS	CE10yr_Seg3E	9332.15	-7.24	31.24	3.06	31.27	0.000018	1.51	8922.12	531.46	0.05
W100_upstrm	115400			Bridge									
W100_upstrm	115365.4	Max WS	CE100yr_Seg3E	19056.89	-7.52	40.07		40.12	0.000020	1.92	19708.14	2019.68	0.05
W100_upstrm	115365.4	Max WS	CE10yr_Seg3E	9336.93	-7.52	31.25		31.27	0.000014	1.34	9387.85	591.30	0.04
W100_upstrm	115284.6	Max WS	CE100yr_Seg3E	19064.38	-7.89	40.08	5.94	40.12	0.000021	1.98	25684.47	1572.05	0.05
W100_upstrm	115284.6	Max WS	CE10yr_Seg3E	9340.52	-7.89	31.24	2.29	31.27	0.000017	1.50	13356.69	1188.74	0.05
W100_upstrm	115168.5			Bridge									
W100_upstrm	115104.1	Max WS	CE100yr_Seg3E	19052.75	-8.31	40.02		40.07	0.000018	1.84	21421.22	1621.76	0.05
W100_upstrm	115104.1	Max WS	CE10yr_Seg3E	9324.50	-8.31	31.23		31.25	0.000011	1.24	11095.24	768.01	0.04
W100_upstrm	115001.1	Max WS	CE100yr_Seg3E	19043.14	-8.48	39.99	6.11	40.10	0.000042	2.81	18529.09	1766.79	0.08
W100_upstrm	115001.1	Max WS	CE10yr_Seg3E	9279.66	-8.48	31.21	2.20	31.26	0.000026	1.90	8224.71	662.04	0.06
W100_upstrm	115000			Bridge									
W100_upstrm	114890.5	Max WS	CE100yr_Seg3E	19039.16	-8.56	39.97		40.08	0.000043	2.75	16394.01	1770.24	0.08
W100_upstrm	114890.5	Max WS	CE10yr_Seg3E	9279.66	-8.56	31.21		31.26	0.000026	1.82	7425.44	478.72	0.06
W100_upstrm	114885	Max WS	CE100yr_Seg3E	19035.59	-8.56	39.97	5.39	40.08	0.000043	2.75	16504.46	1770.23	0.08
W100_upstrm	114885	Max WS	CE10yr_Seg3E	9276.44	-8.56	31.21	1.58	31.26	0.000026	1.82	7425.37	478.72	0.06
W100_upstrm	114864.5			Bridge									
W100_upstrm	114838.5	Max WS	CE100yr_Seg3E	18991.08	-9.27	39.90		40.00	0.000039	2.64	17342.92	1753.32	0.07
W100_upstrm	114838.5	Max WS	CE10yr_Seg3E	9174.27	-9.27	31.04		31.09	0.000024	1.76	7691.31	502.21	0.05
W100_upstrm	114492.0	Max WS	CE100yr_Seg3E	19025.23	-10.48	39.91		39.96	0.000039	1.79	13579.65	1548.75	0.07
W100_upstrm	114492.0	Max WS	CE10yr_Seg3E	9203.18	-10.48	31.04		31.07	0.000026	1.36	6752.85	340.82	0.05
W100_upstrm	114195.9	Max WS	CE100yr_Seg3E	19013.44	-11.52	39.86	5.66	39.93	0.000211	2.09	11354.87	1251.81	0.08
W100_upstrm	114195.9	Max WS	CE10yr_Seg3E	9189.69	-11.52	31.02	1.16	31.06	0.000085	1.60	5743.43	313.89	0.06
W100_upstrm	114168.9			Bridge									

HEC-RAS Profile: Max WS (Continued)

Reach	River Sta	Profile	Plan	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)	
W100_upstrm	114141.9	Max WS	CE100yr_Seg3E	18922.50	-10.83	39.76		39.83	0.000233	2.17	10420.36	1148.56	0.08
W100_upstrm	114141.9	Max WS	CE10yr_Seg3E	9131.60	-10.83	30.96		31.01	0.000090	1.65	5536.60	304.26	0.07
W100_upstrm	114097.4	Max WS	CE100yr_Seg3E	18929.48	-7.46	39.77	7.05	39.82	0.000095	1.87	13150.59	1473.02	0.07
W100_upstrm	114097.4	Max WS	CE10yr_Seg3E	9147.60	-7.46	30.97	3.08	31.00	0.000050	1.40	6528.34	358.64	0.06
W100_upstrm	114070.4			Bridge									
W100_upstrm	114043.4	Max WS	CE100yr_Seg3E	18913.44	-7.72	39.71		39.76	0.000088	1.82	13614.06	1570.58	0.06
W100_upstrm	114043.4	Max WS	CE10yr_Seg3E	9130.62	-7.72	29.93		29.96	0.000053	1.43	6364.20	360.35	0.06
W100_upstrm	113644.0	Max WS	CE100yr_Seg3E	18911.80	-8.91	39.66		39.76	0.000045	2.63	11548.51	899.19	0.08
W100_upstrm	113644.0	Max WS	CE10yr_Seg3E	9123.52	-8.91	29.89		29.94	0.000037	1.89	5740.36	442.45	0.07
W100_upstrm	113411.6	Max WS	CE100yr_Seg3E	18950.63	-9.61	39.68	4.19	39.71	0.000138	1.34	14339.74	942.62	0.05
W100_upstrm	113411.6	Max WS	CE10yr_Seg3E	9140.47	-9.61	29.89	0.27	29.93	0.000035	1.63	5591.74	374.80	0.05
W100_upstrm	113374.3			Bridge									
W100_upstrm	113337.0	Max WS	CE100yr_Seg3E	18770.56	-9.65	39.51		39.54	0.000138	1.34	14220.68	944.42	0.05
W100_upstrm	113337.0	Max WS	CE10yr_Seg3E	9114.96	-9.65	29.77		29.81	0.000035	1.63	5576.68	374.59	0.05
W100_upstrm	113266.4	Max WS	CE100yr_Seg3E	18696.68	-9.11	39.44	7.49	39.55	0.000175	2.72	9192.68	831.33	0.09
W100_upstrm	113266.4	Max WS	CE10yr_Seg3E	9095.80	-9.11	29.74	2.76	29.80	0.000142	2.04	4696.17	243.89	0.08
W100_upstrm	113238.6			Bridge									
W100_upstrm	113210.8	Max WS	CE100yr_Seg3E	18543.51	-9.46	39.32		39.42	0.000171	2.67	9383.75	855.43	0.08
W100_upstrm	113210.8	Max WS	CE10yr_Seg3E	9088.15	-9.46	29.32		29.39	0.000147	2.05	4680.09	243.64	0.08
W100_upstrm	112974.0	Max WS	CE100yr_Seg3E	18493.18	-10.69	39.26	6.54	39.38	0.000157	2.81	7611.43	815.78	0.09
W100_upstrm	112974.0	Max WS	CE10yr_Seg3E	9092.17	-10.69	29.29	0.87	29.36	0.000097	2.05	4425.12	203.06	0.08
W100_upstrm	112944.9			Bridge									
W100_upstrm	112915.8	Max WS	CE100yr_Seg3E	18352.29	-10.82	39.21		39.33	0.000154	2.78	7679.27	819.35	0.09
W100_upstrm	112915.8	Max WS	CE10yr_Seg3E	9092.17	-10.82	29.14		29.20	0.000097	2.06	4420.57	203.01	0.08
W100_upstrm	112575.5	Max WS	CE100yr_Seg3E	18371.26	-9.20	39.20	7.91	39.26	0.000154	2.11	12835.68	1405.78	0.07
W100_upstrm	112575.5	Max WS	CE10yr_Seg3E	9105.02	-9.20	29.12	3.06	29.17	0.000117	1.75	5205.05	242.22	0.06
W100_upstrm	112534.5			Bridge									
W100_upstrm	112493.5	Max WS	CE100yr_Seg3E	18294.20	-9.47	39.15		39.21	0.000148	2.07	13155.40	1446.26	0.06
W100_upstrm	112493.5	Max WS	CE10yr_Seg3E	9066.82	-9.47	28.98		29.02	0.000115	1.73	5232.15	242.44	0.06
W100_upstrm	112003.3	Max WS	CE100yr_Seg3E	18264.97	-9.69	39.09	5.00	39.14	0.000110	1.89	11066.48	975.67	0.06
W100_upstrm	112003.3	Max WS	CE10yr_Seg3E	9071.60	-9.69	28.94	1.83	28.97	0.000073	1.44	6296.99	291.51	0.05
W100_upstrm	111953.3			Bridge									
W100_upstrm	111903.3	Max WS	CE100yr_Seg3E	18120.92	-9.84	38.97		39.03	0.000108	1.88	11098.92	980.31	0.06
W100_upstrm	111903.3	Max WS	CE10yr_Seg3E	9024.69	-9.84	28.89		28.92	0.000072	1.43	6324.74	291.91	0.05
W100_upstrm	111853.5	Max WS	CE100yr_Seg3E	18097.86	-9.86	38.95	4.93	39.02	0.000120	2.11	10287.83	955.57	0.06
W100_upstrm	111853.5	Max WS	CE10yr_Seg3E	9022.39	-9.86	28.88	1.35	28.92	0.000075	1.53	5900.59	231.07	0.05
W100_upstrm	111818.6			Bridge									
W100_upstrm	111783.7	Max WS	CE100yr_Seg3E	18036.74	-8.67	38.88		38.96	0.000137	2.21	9222.17	748.28	0.07
W100_upstrm	111783.7	Max WS	CE10yr_Seg3E	8998.56	-8.67	28.86		28.90	0.000084	1.60	5625.77	227.40	0.06
W100_upstrm	111626.7	Max WS	CE100yr_Seg3E	18037.46	-11.83	38.87	5.14	38.93	0.000130	2.08	10676.18	849.62	0.06
W100_upstrm	111626.7	Max WS	CE10yr_Seg3E	8993.89	-11.83	28.85	1.03	28.88	0.000090	1.54	5833.05	232.11	0.05
W100_upstrm	111518.6			Bridge									
W100_upstrm	111410.5	Max WS	CE100yr_Seg3E	17748.74	-11.23	38.67		38.74	0.000098	2.12	10017.90	799.98	0.07
W100_upstrm	111410.5	Max WS	CE10yr_Seg3E	8906.88	-11.23	28.76		28.80	0.000062	1.57	5674.58	230.96	0.06
W100_upstrm	110876.6	Max WS	CE100yr_Seg3E	17775.83	-10.43	38.66	2.53	38.69	0.000056	1.47	18680.11	1612.52	0.05
W100_upstrm	110876.6	Max WS	CE10yr_Seg3E	8918.06	-10.43	28.74	-0.80	28.77	0.000061	1.21	7453.71	450.01	0.05
W100_upstrm	110837.8			Bridge									
W100_upstrm	110799.0	Max WS	CE100yr_Seg3E	17758.06	-10.72	38.65		38.67	0.000144	1.40	19131.54	1616.47	0.04
W100_upstrm	110799.0	Max WS	CE10yr_Seg3E	8878.04	-10.72	28.68		28.71	0.000169	1.19	7549.38	465.57	0.04
W100_upstrm	110672.7	Max WS	CE100yr_Seg3E	17747.53	-13.25	38.63	2.63	38.66	0.000112	1.66	19934.54	1447.58	0.05
W100_upstrm	110672.7	Max WS	CE10yr_Seg3E	8855.90	-13.25	28.66	-1.68	28.69	0.000136	1.44	8062.66	729.36	0.05
W100_upstrm	110643.7			Bridge									

HEC-RAS Profile: Max WS (Continued)

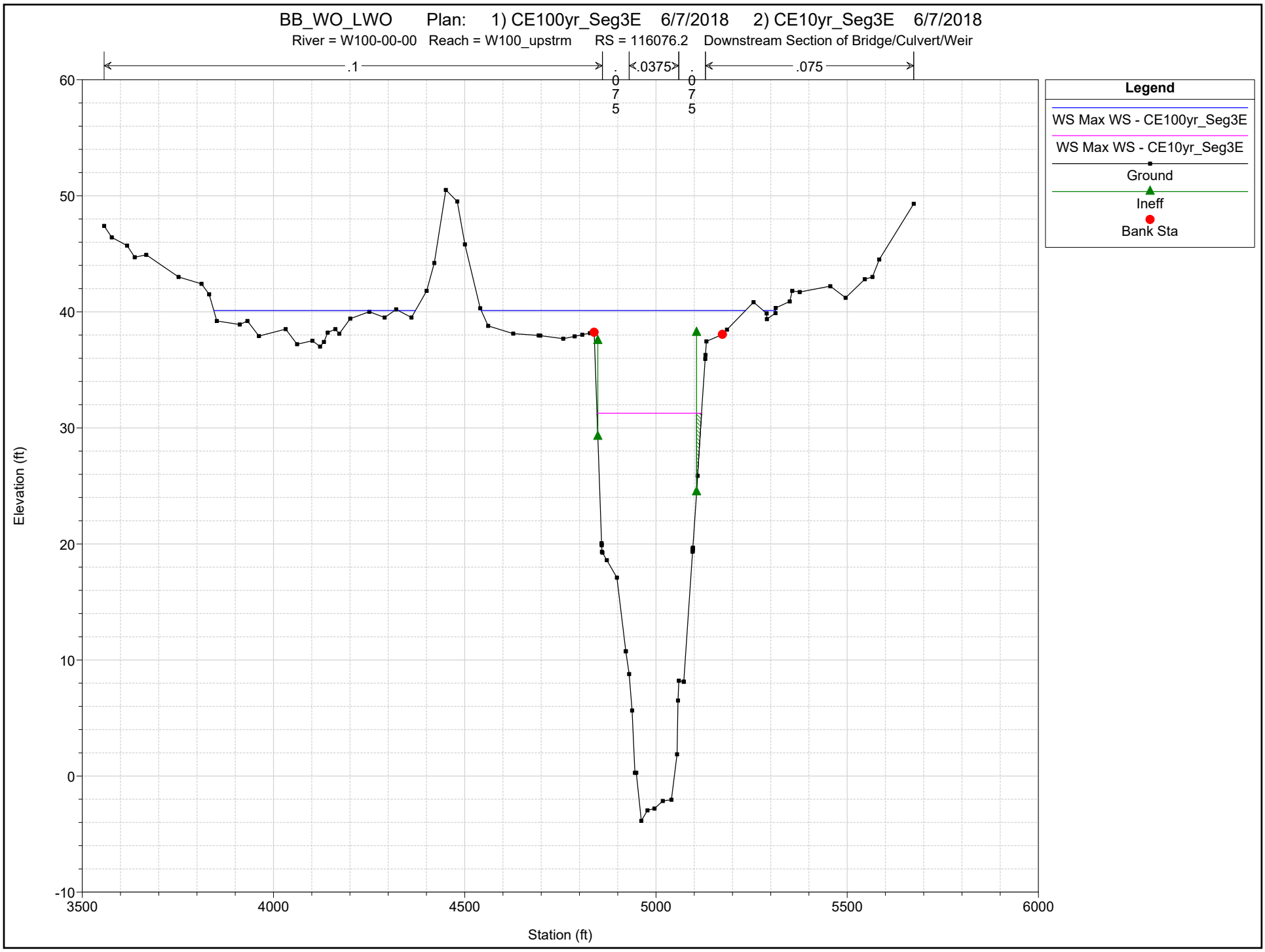
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
W100_upstrm	110614.7	Max WS	CE100yr_Seg3E	17724.21	-12.75	38.59		38.63	0.000124	1.70	19164.05	1434.15	0.05
W100_upstrm	110614.7	Max WS	CE10yr_Seg3E	8831.30	-12.75	28.64		28.67	0.000154	1.48	7747.06	709.27	0.06
W100_upstrm	110200.2	Max WS	CE100yr_Seg3E	17723.66	-9.11	38.56	5.05	38.59	0.000038	1.52	13995.27	778.95	0.05
W100_upstrm	110200.2	Max WS	CE10yr_Seg3E	8824.97	-9.11	28.61	1.26	28.63	0.000028	1.16	8042.76	486.11	0.04
W100_upstrm	110154.2			Bridge									
W100_upstrm	110108.2	Max WS	CE100yr_Seg3E	17703.29	-9.31	38.54		38.58	0.000037	1.51	14140.19	782.54	0.05
W100_upstrm	110108.2	Max WS	CE10yr_Seg3E	8805.55	-9.31	28.40		28.42	0.000028	1.15	8040.65	486.05	0.04
W100_upstrm	110103.2	Max WS	CE100yr_Seg3E	17711.36	-9.31	38.54		38.58	0.000037	1.51	14140.04	782.53	0.05
W100_upstrm	110103.2	Max WS	CE10yr_Seg3E	8801.23	-9.31	28.40		28.42	0.000028	1.15	8040.58	486.05	0.04
Downstream	109924.2	Max WS	CE100yr_Seg3E	57118.23	-13.02	38.54		38.99	0.000563	5.45	12945.11	2507.10	0.16
Downstream	109924.2	Max WS	CE10yr_Seg3E	33162.01	-13.02	28.40		28.72	0.000579	4.56	7458.98	378.47	0.16
Downstream	109551.7	Max WS	CE100yr_Seg3E	57117.76	-14.28	38.41	9.94	38.77	0.000536	4.86	14859.21	2218.68	0.15
Downstream	109551.7	Max WS	CE10yr_Seg3E	33160.63	-14.28	28.24	3.46	28.52	0.000528	4.21	7880.97	345.38	0.16
Downstream	109518.7			Bridge									
Downstream	109485.7	Max WS	CE100yr_Seg3E	57114.77	-15.31	38.22		38.55	0.000477	4.68	16732.26	2244.75	0.15
Downstream	109485.7	Max WS	CE10yr_Seg3E	33159.33	-15.31	27.36		27.63	0.000519	4.18	7932.24	345.94	0.15
Downstream	109440.2	Max WS	CE100yr_Seg3E	57111.94	-16.48	38.12	8.86	38.53	0.000819	5.13	12011.69	2404.26	0.16
Downstream	109440.2	Max WS	CE10yr_Seg3E	33159.07	-16.48	27.29	2.87	27.60	0.000939	4.45	7458.80	325.04	0.16
Downstream	109395.2			Bridge									
Downstream	109350.2	Max WS	CE100yr_Seg3E	57094.14	-16.89	37.31		37.73	0.000856	5.21	11666.87	2391.89	0.16
Downstream	109350.2	Max WS	CE10yr_Seg3E	33158.30	-16.89	26.96		27.26	0.000930	4.43	7484.07	325.15	0.16
Downstream	109119.0	Max WS	CE100yr_Seg3E	57089.72	-17.14	37.00	10.44	37.35	0.002424	4.83	13655.29	2318.19	0.18
Downstream	109119.0	Max WS	CE10yr_Seg3E	33155.56	-17.14	26.54	3.52	27.00	0.001406	5.40	6135.00	410.38	0.23
Downstream	109103.1			Bridge									
Downstream	109087.2	Max WS	CE100yr_Seg3E	57087.16	-17.55	36.72		37.06	0.002372	4.79	13810.39	2358.88	0.18
Downstream	109087.2	Max WS	CE10yr_Seg3E	33154.16	-17.55	26.37		26.81	0.001371	5.33	6215.96	417.28	0.22
Downstream	108565.3	Max WS	CE100yr_Seg3E	57073.99	-12.77	35.76		36.22	0.000988	5.55	14257.79	1955.32	0.17
Downstream	108565.3	Max WS	CE10yr_Seg3E	33150.49	-12.77	25.84		26.20	0.000954	4.84	6942.59	415.04	0.18
Downstream	108334.0	Max WS	CE100yr_Seg3E	57071.36	-14.06	35.54		35.87	0.001010	4.88	16954.23	1720.01	0.16
Downstream	108334.0	Max WS	CE10yr_Seg3E	33149.66	-14.06	25.61		25.93	0.001321	4.51	7838.09	710.39	0.17
Downstream	107179.4	Max WS	CE100yr_Seg3E	57067.15	-20.52	34.42	5.49	34.94	0.000934	6.02	10587.78	768.42	0.19
Downstream	107179.4	Max WS	CE10yr_Seg3E	33143.45	-20.52	24.21	-0.16	24.66	0.000979	5.43	6510.60	392.93	0.20
Downstream	107158.9			Bridge									
Downstream	107138.4	Max WS	CE100yr_Seg3E	57065.58	-20.19	34.22		34.76	0.000982	6.14	10370.85	542.06	0.19
Downstream	107138.4	Max WS	CE10yr_Seg3E	33143.03	-20.19	24.06		24.53	0.001041	5.57	6321.47	392.07	0.21
Downstream	106594.0	Max WS	CE100yr_Seg3E	57064.06	-16.70	33.52		34.07	0.001526	5.96	9656.39	658.59	0.19
Downstream	106594.0	Max WS	CE10yr_Seg3E	33141.52	-16.70	23.66		24.03	0.000763	4.86	6822.35	253.79	0.17
Downstream	106151.4	Max WS	CE100yr_Seg3E	57059.70	-13.85	32.59	7.70	33.22	0.002301	6.37	8954.82	305.46	0.21
Downstream	106151.4	Max WS	CE10yr_Seg3E	33139.29	-13.85	23.08	2.31	23.52	0.001569	5.29	6265.63	261.13	0.19
Downstream	106131.1			Bridge									
Downstream	106110.8	Max WS	CE100yr_Seg3E	57059.23	-12.53	32.23		32.94	0.002588	6.75	8447.35	297.38	0.22
Downstream	106110.8	Max WS	CE10yr_Seg3E	33138.30	-12.53	22.80		23.29	0.001797	5.66	5852.10	254.31	0.21
Downstream	105705.4	Max WS	CE100yr_Seg3E	57056.93	-18.22	31.66	6.21	32.29	0.000575	6.40	8922.22	483.47	0.23
Downstream	105705.4	Max WS	CE10yr_Seg3E	33136.63	-18.22	22.34	0.83	22.82	0.000562	5.56	5959.71	266.75	0.21
Downstream	105667.4			Bridge									
Downstream	105629.4	Max WS	CE100yr_Seg3E	57056.93	-18.43	31.32		31.97	0.000583	6.44	8869.96	452.72	0.23
Downstream	105629.4	Max WS	CE10yr_Seg3E	33135.81	-18.43	22.02		22.51	0.000570	5.59	5931.54	265.50	0.21
Downstream	105476	Max WS	CE100yr_Seg3E	57056.60	-18.70	31.30		31.78	0.001593	5.60	10220.87	459.12	0.20
Downstream	105476	Max WS	CE10yr_Seg3E	33135.20	-18.70	21.91		22.32	0.001689	5.11	6482.06	368.17	0.21
Downstream	104962	Max WS	CE100yr_Seg3E	57055.60	-18.70	30.98	7.05	31.16	0.000767	3.38	16928.87	904.15	0.13
Downstream	104962	Max WS	CE10yr_Seg3E	33134.02	-18.70	21.48	1.82	21.64	0.000889	3.18	10415.58	618.66	0.14
Downstream	104948			Bridge									

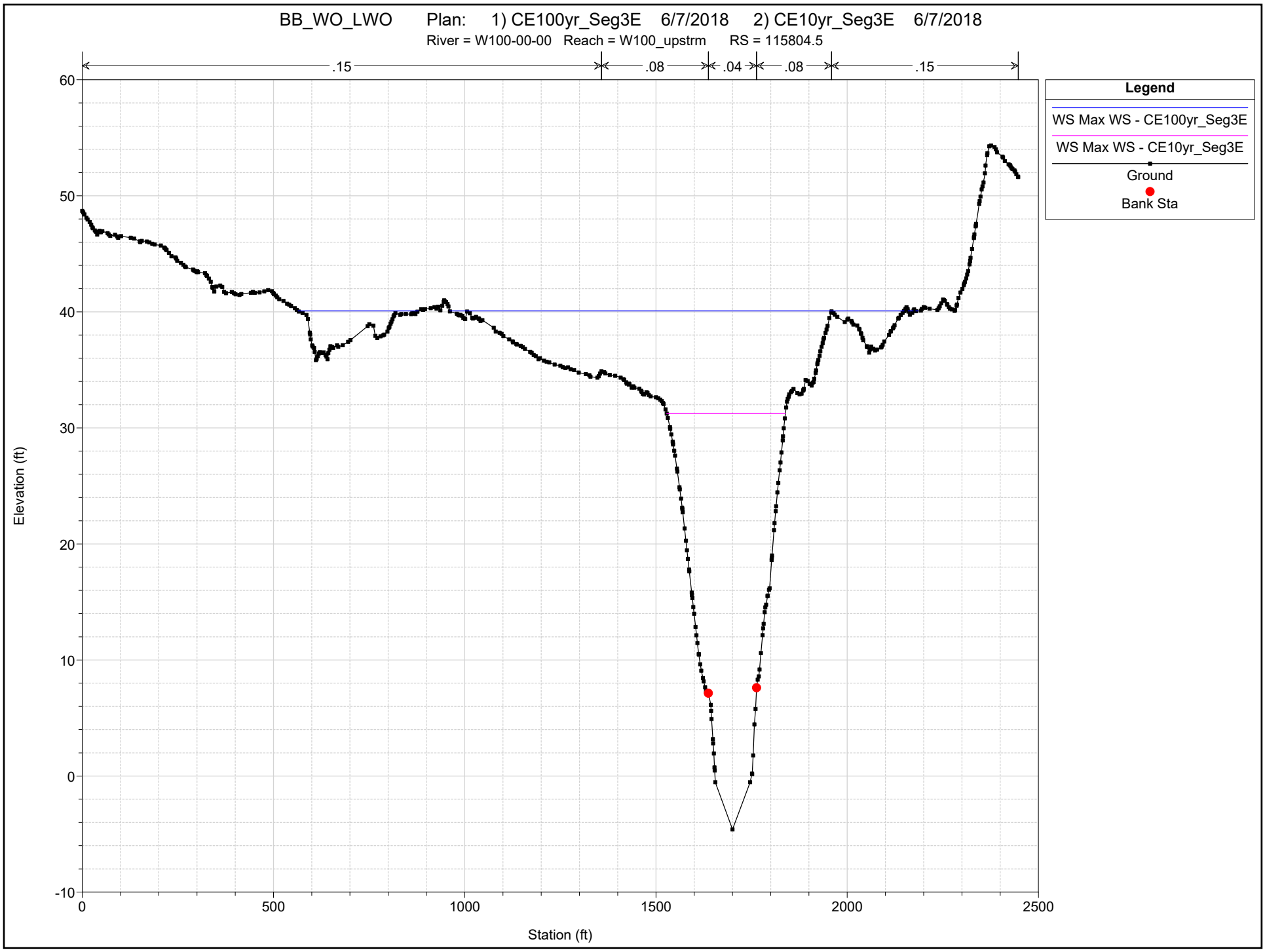
HEC-RAS Profile: Max WS (Continued)

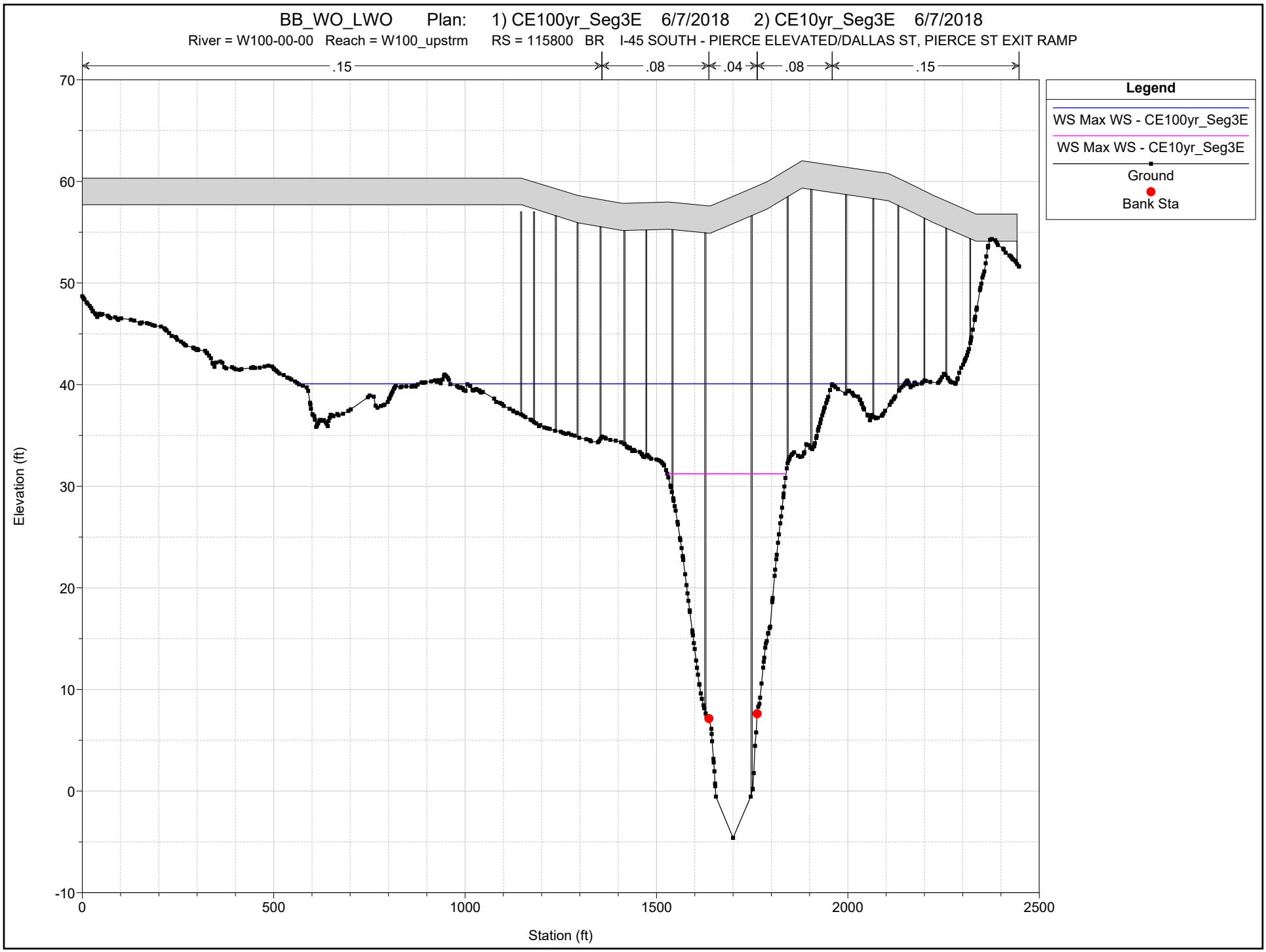
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Downstream	104900.1	Max WS	CE100yr_Seg3E	57055.20	-19.15	30.89		31.04	0.000193	3.18	17958.50	931.24	0.13
Downstream	104900.1	Max WS	CE10yr_Seg3E	33133.66	-19.15	21.35		21.51	0.000234	3.19	10389.26	650.11	0.14
Downstream	104900	Max WS	CE100yr_Seg3E	57055.08	-19.15	30.89	7.06	31.04	0.000193	3.18	17958.48	931.24	0.13
Downstream	104900	Max WS	CE10yr_Seg3E	33133.47	-19.15	21.35	1.67	21.51	0.000234	3.19	10389.24	650.11	0.14
Downstream	104566			Bridge									
Downstream	104464.1	Max WS	CE100yr_Seg3E	57053.85	-19.86	30.50		30.75	0.001674	3.95	14436.53	764.86	0.16
Downstream	104464.1	Max WS	CE10yr_Seg3E	33132.00	-19.86	20.88		21.16	0.001742	4.23	7834.92	514.24	0.19
Downstream	104464	Max WS	CE100yr_Seg3E	57053.72	-19.86	30.50	6.30	30.75	0.001674	3.95	14436.40	764.85	0.16
Downstream	104464	Max WS	CE10yr_Seg3E	33132.20	-19.86	20.88	1.39	21.16	0.001742	4.23	7834.83	514.23	0.19
Downstream	104383			Bridge									
Downstream	104301.1	Max WS	CE100yr_Seg3E	57052.57	-20.42	30.22		30.52	0.000280	4.41	13049.63	817.38	0.18
Downstream	104301.1	Max WS	CE10yr_Seg3E	33131.44	-20.42	20.66		20.97	0.000310	4.45	7441.26	476.54	0.20
Downstream	104301	Max WS	CE100yr_Seg3E	57052.57	-20.42	30.22	6.03	30.52	0.000280	4.41	13049.61	817.38	0.18
Downstream	104301	Max WS	CE10yr_Seg3E	33131.25	-20.42	20.66	1.45	20.97	0.000310	4.45	7441.25	476.54	0.20
Downstream	104271			Bridge									
Downstream	104242.1	Max WS	CE100yr_Seg3E	57051.54	-20.62	29.85		30.24	0.002973	5.04	11328.72	601.14	0.20
Downstream	104242.1	Max WS	CE10yr_Seg3E	33130.28	-20.62	20.43		20.79	0.001257	4.78	6924.65	384.40	0.20
Downstream	104242	Max WS	CE100yr_Seg3E	57051.67	-20.62	29.85	7.22	30.24	0.002973	5.04	11328.56	601.12	0.20
Downstream	104242	Max WS	CE10yr_Seg3E	33130.28	-20.62	20.43	1.46	20.79	0.001257	4.78	6924.62	384.40	0.20
Downstream	104204			Bridge									
Downstream	104133	Max WS	CE100yr_Seg3E	57047.37	-21.02	28.99		29.58	0.000654	6.19	10695.75	1136.15	0.28
Downstream	104133	Max WS	CE10yr_Seg3E	33126.42	-21.02	19.51		20.19	0.000754	6.60	5015.52	282.45	0.28
Downstream	103664.0	Max WS	CE100yr_Seg3E	57045.92	-23.03	28.44		29.18	0.001478	7.13	10188.59	927.67	0.26
Downstream	103664.0	Max WS	CE10yr_Seg3E	33122.55	-23.03	18.68		19.49	0.002228	7.21	4592.61	267.10	0.31
Downstream	102875.3	Max WS	CE100yr_Seg3E	57043.64	-26.39	27.42	9.79	28.03	0.001403	6.30	9056.55	406.02	0.24
Downstream	102875.3	Max WS	CE10yr_Seg3E	33117.21	-26.39	17.26	-1.41	17.88	0.001857	6.30	5260.02	345.59	0.28
Downstream	102847.5			Bridge									
Downstream	102819.7	Max WS	CE100yr_Seg3E	57042.66	-26.43	27.01		27.65	0.001459	6.40	8907.60	403.48	0.24
Downstream	102819.7	Max WS	CE10yr_Seg3E	33115.63	-26.43	16.90		17.54	0.001963	6.43	5148.95	343.65	0.29
Downstream	102309.0	Max WS	CE100yr_Seg3E	57096.65	-23.48	26.35		27.10	0.000657	6.99	8168.12	232.21	0.21
Downstream	102309.0	Max WS	CE10yr_Seg3E	33153.02	-23.48	16.47		16.95	0.000373	5.55	5977.52	216.71	0.19
Downstream	101828.0	Max WS	CE100yr_Seg3E	57145.89	-20.70	25.83	3.03	26.60	0.001422	7.08	8104.84	374.42	0.25
Downstream	101828.0	Max WS	CE10yr_Seg3E	33186.15	-20.70	16.10	-2.04	16.71	0.000626	6.25	5306.05	231.90	0.23
Downstream	101790.1			Bridge									
Downstream	101752.2	Max WS	CE100yr_Seg3E	57144.73	-20.69	25.51		26.31	0.001479	7.18	7982.76	369.92	0.26
Downstream	101752.2	Max WS	CE10yr_Seg3E	33185.93	-20.69	15.93		16.55	0.000603	6.30	5265.64	228.39	0.23
Downstream	101007.3	Max WS	CE100yr_Seg3E	57224.43	-16.93	24.88		25.60	0.000409	6.82	8384.76	285.29	0.22
Downstream	101007.3	Max WS	CE10yr_Seg3E	33241.26	-16.93	15.68		16.18	0.000389	5.66	5875.56	258.78	0.21
Downstream	99992.6	Max WS	CE100yr_Seg3E	57330.05	-18.90	24.27		25.07	0.000624	7.18	7980.82	275.47	0.24
Downstream	99992.6	Max WS	CE10yr_Seg3E	33314.81	-18.90	15.21		15.76	0.000431	5.93	5615.63	242.07	0.22
Downstream	98399.4	Max WS	CE100yr_Seg3E	57503.30	-20.26	23.45		24.20	0.000463	6.99	8230.95	289.20	0.23
Downstream	98399.4	Max WS	CE10yr_Seg3E	33435.82	-20.26	14.57		15.08	0.000417	5.75	5818.56	254.17	0.21
Downstream	97517.4	Max WS	CE100yr_Seg3E	57594.61	-19.35	23.38		23.85	0.000330	5.47	10527.99	323.69	0.17
Downstream	97517.4	Max WS	CE10yr_Seg3E	33499.59	-19.35	14.49		14.78	0.000240	4.35	7700.84	312.10	0.15
Downstream	96028.6	Max WS	CE100yr_Seg3E	57744.15	-17.81	22.36	0.93	23.04	0.000752	6.64	8700.78	319.82	0.22
Downstream	96028.6	Max WS	CE10yr_Seg3E	33604.71	-17.81	13.75	-4.32	14.23	0.000509	5.53	6079.61	282.80	0.21
Downstream	95985.1			Bridge									
Downstream	95941.6	Max WS	CE100yr_Seg3E	57744.04	-17.87	22.20		22.88	0.000758	6.66	8667.79	319.50	0.23
Downstream	95941.6	Max WS	CE10yr_Seg3E	33604.71	-17.87	13.61		14.09	0.000512	5.55	6055.76	282.27	0.21
Downstream	95362.9	Max WS	CE100yr_Seg3E	57805.91	-15.97	21.97		22.56	0.000367	6.15	9399.31	357.13	0.21
Downstream	95362.9	Max WS	CE10yr_Seg3E	33648.29	-15.97	13.42		13.83	0.000357	5.17	6513.04	317.66	0.20
Downstream	94280.7	Max WS	CE100yr_Seg3E	57928.00	-19.82	20.47		21.51	0.001578	8.17	7086.54	300.68	0.30
Downstream	94280.7	Max WS	CE10yr_Seg3E	33735.67	-19.82	12.52		13.24	0.000845	6.79	4966.53	226.13	0.26

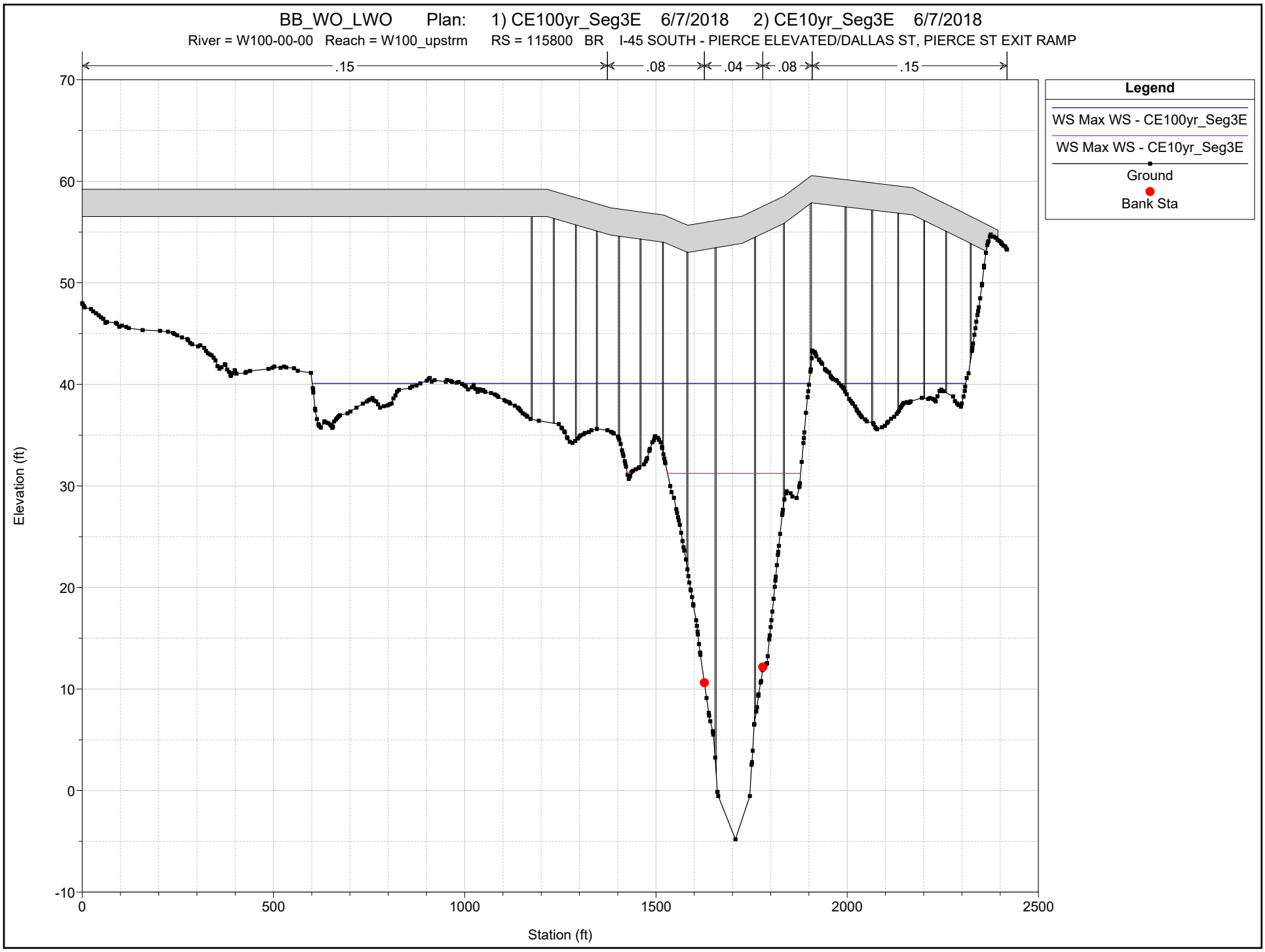
HEC-RAS Profile: Max WS (Continued)

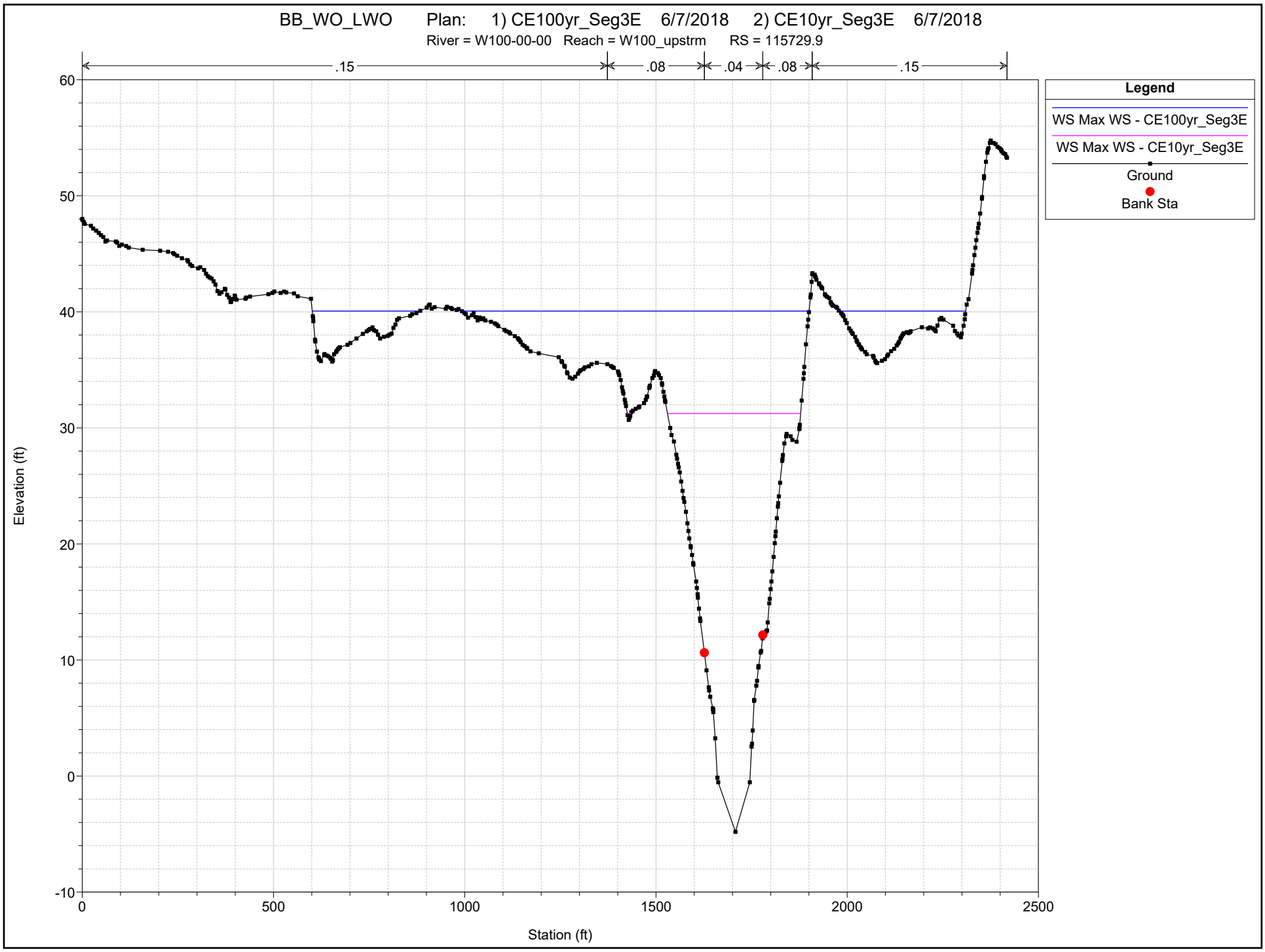
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Downstream	93495.6	Max WS	CE100yr_Seg3E	58002.38	-20.43	19.85		20.53	0.000908	6.63	8743.37	389.13	0.25
Downstream	93495.6	Max WS	CE10yr_Seg3E	33788.36	-20.43	12.23		12.72	0.000582	5.56	6072.05	315.82	0.22
Downstream	92795.6	Max WS	CE100yr_Seg3E	58084.43	-20.98	19.27	-1.79	20.03	0.000502	7.00	8294.01	334.11	0.25
Downstream	92795.6	Max WS	CE10yr_Seg3E	33846.57	-20.98	11.87	-6.25	12.37	0.000417	5.63	6016.80	284.38	0.22
Downstream	92741.1			Bridge									
Downstream	92686.6	Max WS	CE100yr_Seg3E	58084.22	-21.08	19.03		19.80	0.000510	7.04	8245.32	332.94	0.25
Downstream	92686.6	Max WS	CE10yr_Seg3E	33846.52	-21.08	11.67		12.17	0.000422	5.65	5988.51	283.77	0.22
Downstream	90936.7	Max WS	CE100yr_Seg3E	58269.85	-18.64	17.70		18.33	0.001160	6.38	9136.54	431.02	0.24
Downstream	90936.7	Max WS	CE10yr_Seg3E	33978.18	-18.64	10.42		10.89	0.001032	5.50	6175.33	387.41	0.24
Downstream	89918.4	Max WS	CE100yr_Seg3E	58378.23	-17.23	16.41		17.33	0.000854	7.78	8560.75	713.62	0.29
Downstream	89918.4	Max WS	CE10yr_Seg3E	34055.52	-17.23	9.25		9.95	0.000828	6.70	5080.63	308.25	0.29
Downstream	88579.0	Max WS	CE100yr_Seg3E	58519.42	-20.97	15.09		16.02	0.001082	7.75	7547.18	362.60	0.30
Downstream	88579.0	Max WS	CE10yr_Seg3E	34155.18	-20.97	8.24		8.90	0.000735	6.50	5250.94	312.81	0.28
Downstream	87591.9	Max WS	CE100yr_Seg3E	58630.57	-23.72	14.30		15.16	0.000666	7.43	7903.37	312.37	0.26
Downstream	87591.9	Max WS	CE10yr_Seg3E	34233.74	-23.72	7.74		8.27	0.000533	5.81	5889.60	300.89	0.23
Downstream	86660.2	Max WS	CE100yr_Seg3E	58719.50	-23.42	13.84	-6.76	14.57	0.000580	6.86	8564.65	313.32	0.23
Downstream	86660.2	Max WS	CE10yr_Seg3E	34296.52	-23.42	7.45	-11.02	7.86	0.000338	5.16	6648.81	289.23	0.19
Downstream	86641.7			Bridge									
Downstream	86623.2	Max WS	CE100yr_Seg3E	58719.50	-23.61	13.41		14.15	0.000587	6.92	8489.44	312.35	0.23
Downstream	86623.2	Max WS	CE10yr_Seg3E	34296.55	-23.61	7.13		7.55	0.000343	5.19	6613.61	288.90	0.19
Downstream	85855.2	Max WS	CE100yr_Seg3E	58800.99	-26.84	11.93		13.54	0.001091	10.18	5778.17	251.27	0.37
Downstream	85855.2	Max WS	CE10yr_Seg3E	34354.30	-26.84	6.27		7.16	0.000727	7.54	4555.77	205.34	0.28
Downstream	85238.7	Max WS	CE100yr_Seg3E	58863.88	-29.43	11.51		12.84	0.001175	9.31	6839.91	357.84	0.31
Downstream	85238.7	Max WS	CE10yr_Seg3E	34398.82	-29.43	6.01		6.74	0.000627	6.82	5088.59	255.90	0.25
Downstream	84561.7	Max WS	CE100yr_Seg3E	58950.85	-32.27	11.10	-9.10	12.20	0.000629	8.45	7570.97	435.80	0.29
Downstream	84561.7	Max WS	CE10yr_Seg3E	34460.49	-32.27	5.80	-14.25	6.38	0.000404	6.14	5661.31	287.30	0.21
Downstream	84531.4			Bridge									
Downstream	84501.1	Max WS	CE100yr_Seg3E	58950.77	-28.97	9.97		11.57	0.001072	10.15	5921.14	305.31	0.35
Downstream	84501.1	Max WS	CE10yr_Seg3E	34460.38	-28.97	5.27		6.07	0.000634	7.20	4788.95	208.53	0.26
Downstream	84252.6	Max WS	CE100yr_Seg3E	58977.12	-26.90	10.01	-5.90	11.32	0.000860	9.19	6591.56	456.61	0.32
Downstream	84252.6	Max WS	CE10yr_Seg3E	34479.18	-26.90	5.25	-10.62	5.92	0.000550	6.59	5233.21	238.28	0.25
Downstream	84222.3			Bridge									
Downstream	84192.0	Max WS	CE100yr_Seg3E	58976.86	-24.10	8.79		10.63	0.001462	10.90	5409.63	240.55	0.41
Downstream	84192.0	Max WS	CE10yr_Seg3E	34478.95	-24.10	4.62		5.56	0.000890	7.78	4433.18	227.69	0.31
Downstream	83635.7	Max WS	CE100yr_Seg3E	59035.87	-21.72	8.88		9.92	0.001029	8.18	7215.81	392.06	0.34
Downstream	83635.7	Max WS	CE10yr_Seg3E	34520.95	-21.72	4.55		5.13	0.000631	6.09	5666.96	332.26	0.26
Downstream	81786.1	Max WS	CE100yr_Seg3E	59225.88	-31.97	7.20		8.20	0.000823	8.04	7391.01	355.24	0.31
Downstream	81786.1	Max WS	CE10yr_Seg3E	34656.02	-31.97	3.59		4.08	0.000492	5.65	6138.52	337.08	0.23
Downstream	80903.1	Max WS	CE100yr_Seg3E	59316.80	-27.77	6.73	-9.31	7.51	0.000739	7.09	8363.94	405.27	0.28
Downstream	80903.1	Max WS	CE10yr_Seg3E	34720.48	-27.77	3.31	-13.30	3.69	0.000389	4.95	7016.21	384.40	0.20
Downstream	80883.1			Bridge									
Downstream	80863.1	Max WS	CE100yr_Seg3E	59316.78	-28.10	6.13		6.93	0.000879	7.18	8256.04	403.98	0.28
Downstream	80863.1	Max WS	CE10yr_Seg3E	34720.48	-28.10	2.91		3.29	0.000451	4.97	6987.05	384.02	0.21
Downstream	80538.0	Max WS	CE100yr_Seg3E	59316.78	-33.12	6.41	-17.33	6.73	0.000236	4.52	13125.75	505.42	0.16
Downstream	80538.0	Max WS	CE10yr_Seg3E	34720.48	-33.12	3.04	-21.00	3.18	0.000110	3.03	11448.36	490.78	0.11

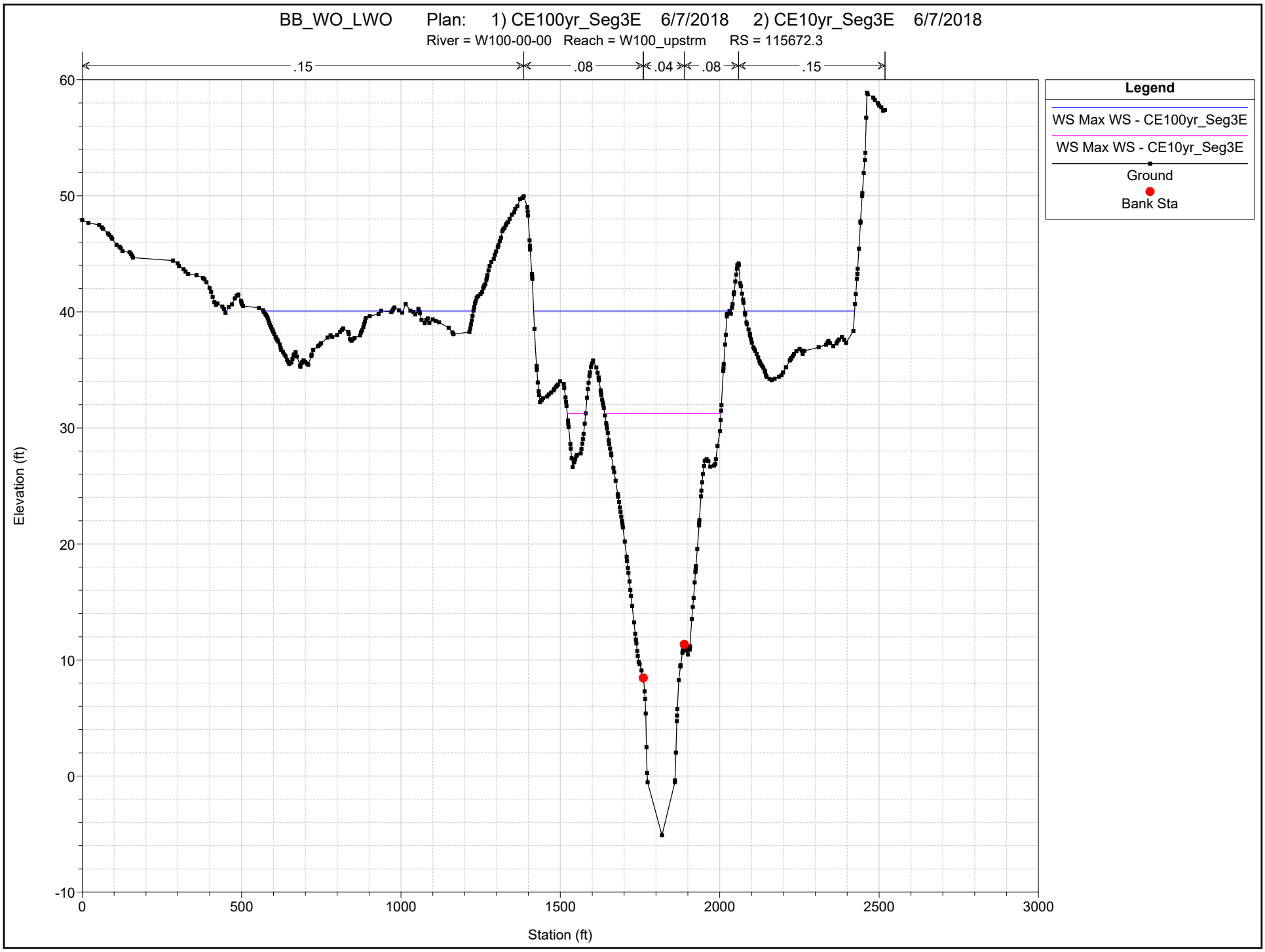

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 116076.2 Downstream Section of Bridge/Culvert/Weir
.1
.075
.0375
.075
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
60
50
40
30
20
10
0
-10
3500
4000
4500
5000
5500
6000

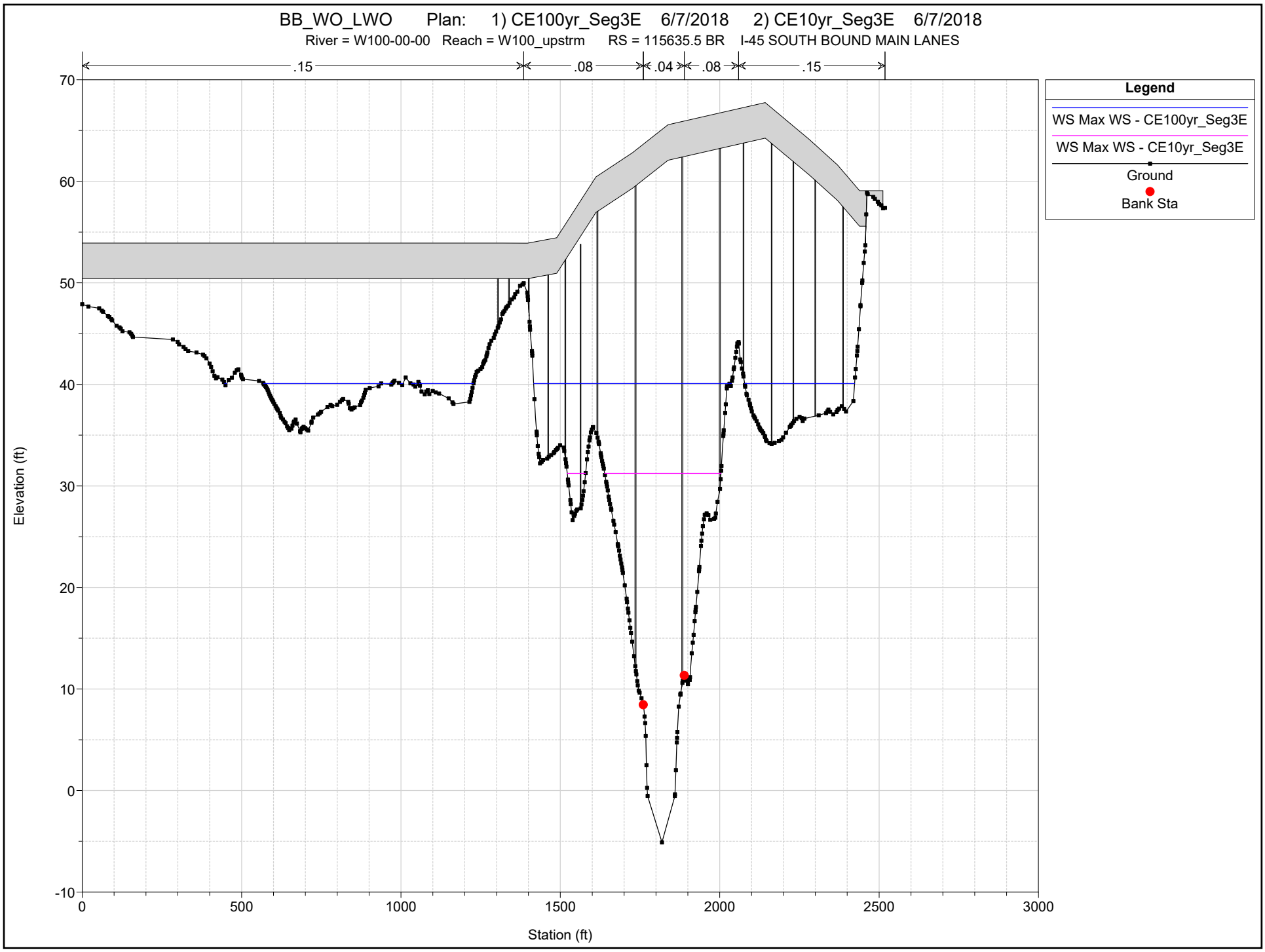

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115804.5
.15
.08
.04
.08
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
Station (ft)

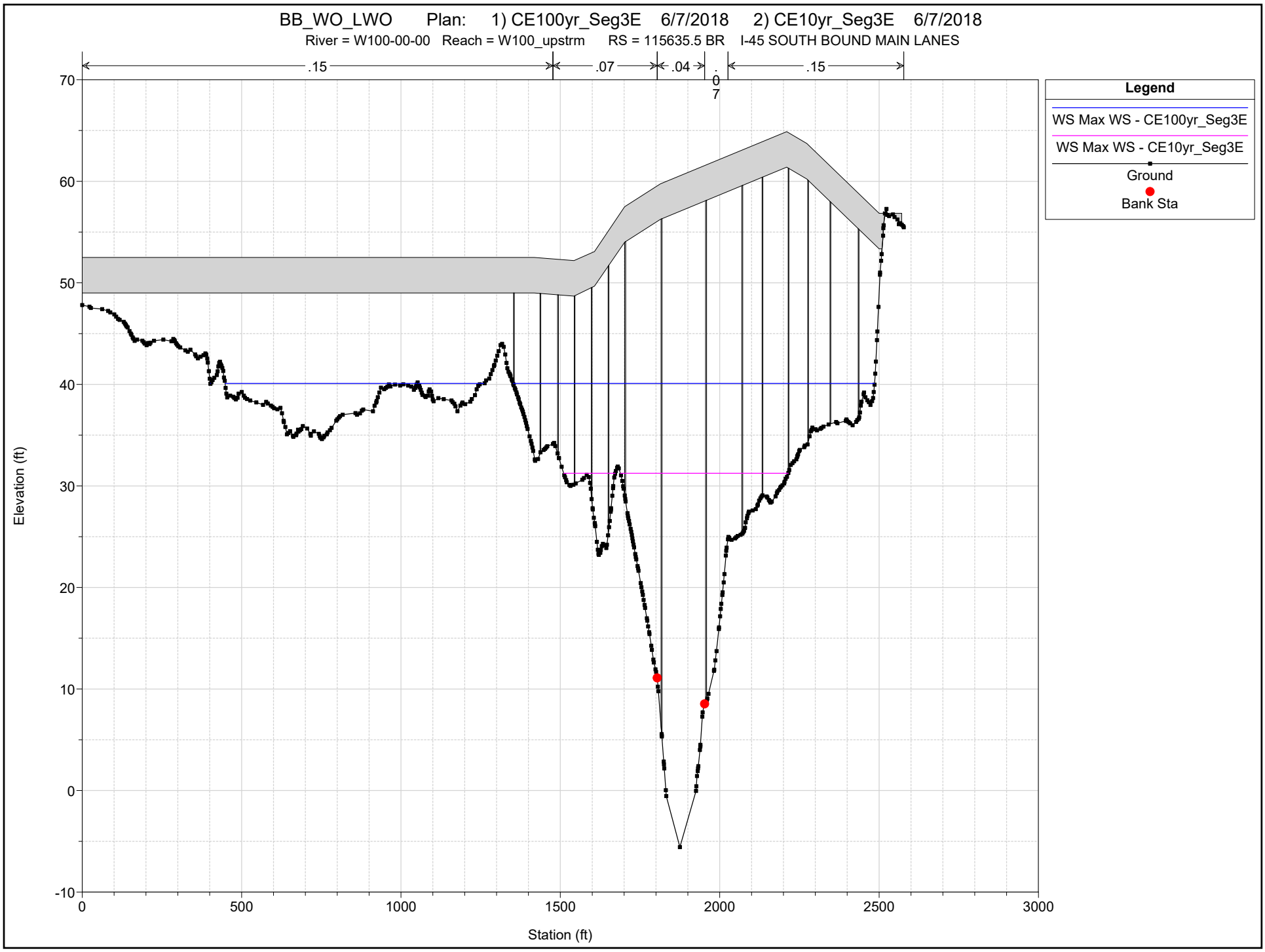

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115800 BR I-45 SOUTH - PIERCE ELEVATED/DALLAS ST, PIERCE ST EXIT RAMP
.15
.08
.04
.08
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
70
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
Station (ft)

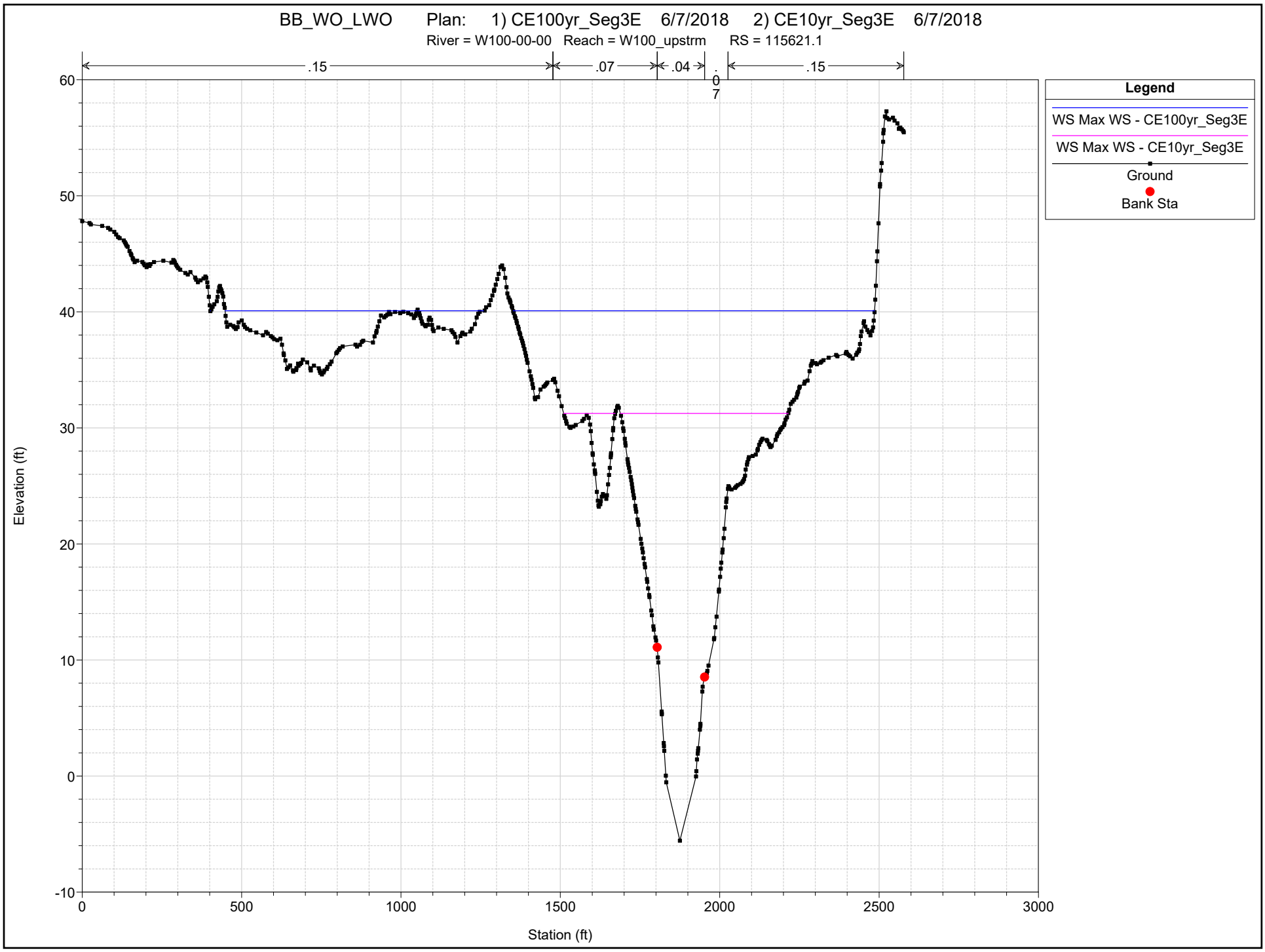

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115800 BR I-45 SOUTH - PIERCE ELEVATED/DALLAS ST, PIERCE ST EXIT RAMP
.15
.08
.04
.08
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
70
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
Station (ft)

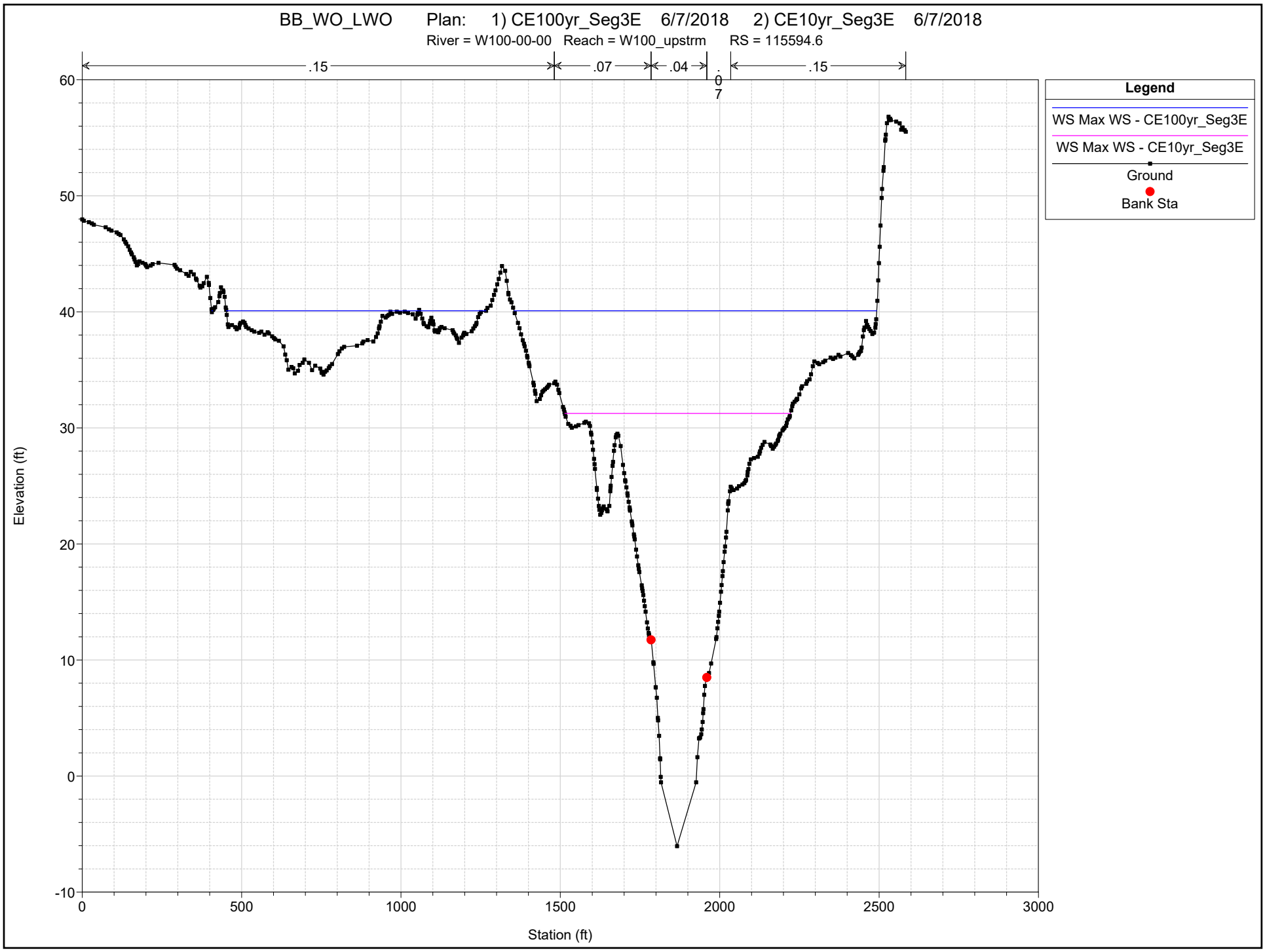

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115729.9
.15
.08
.04
.08
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
Station (ft)

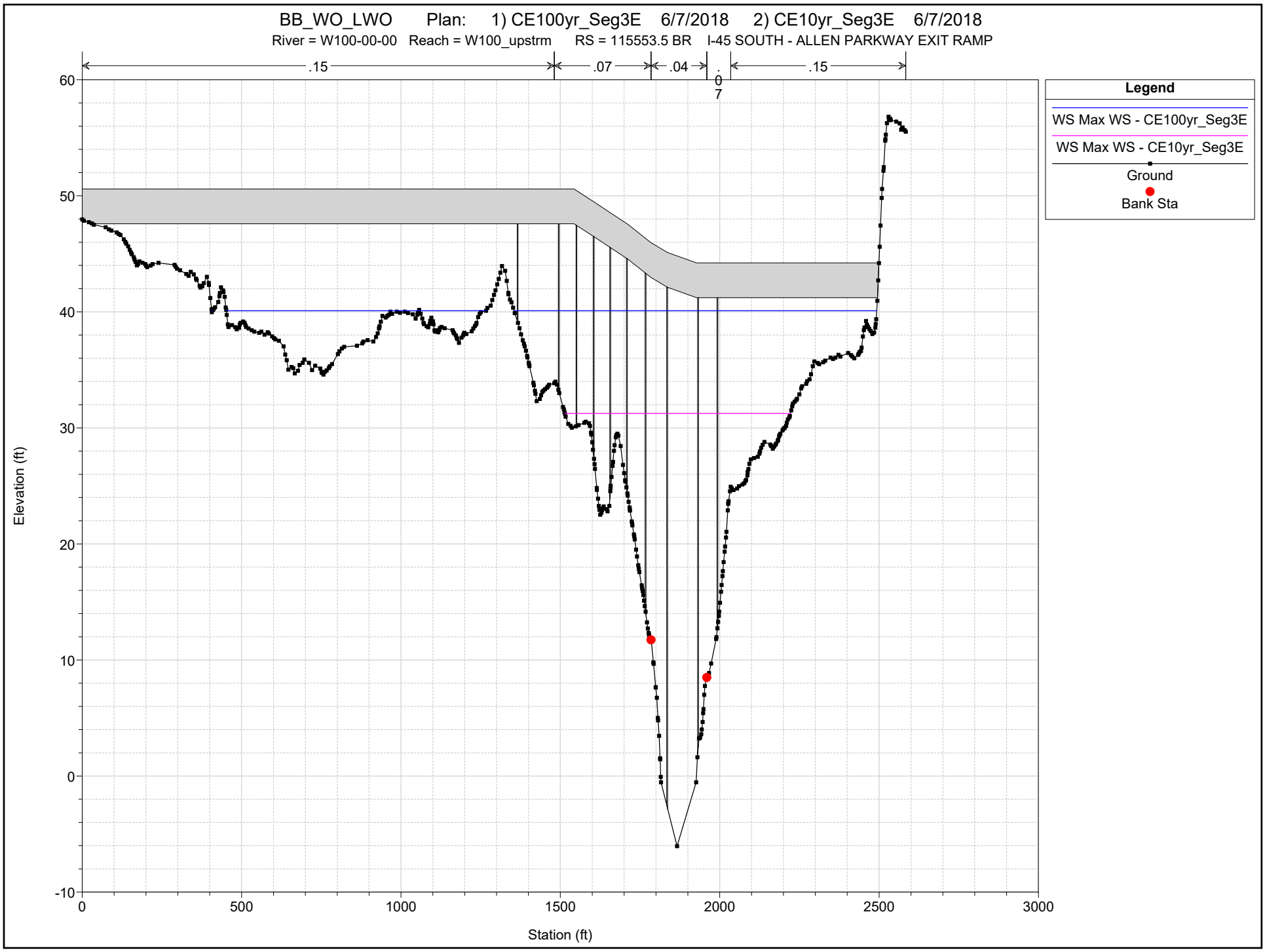

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115672.3
.15
.08
.04
.08
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000
Station (ft)

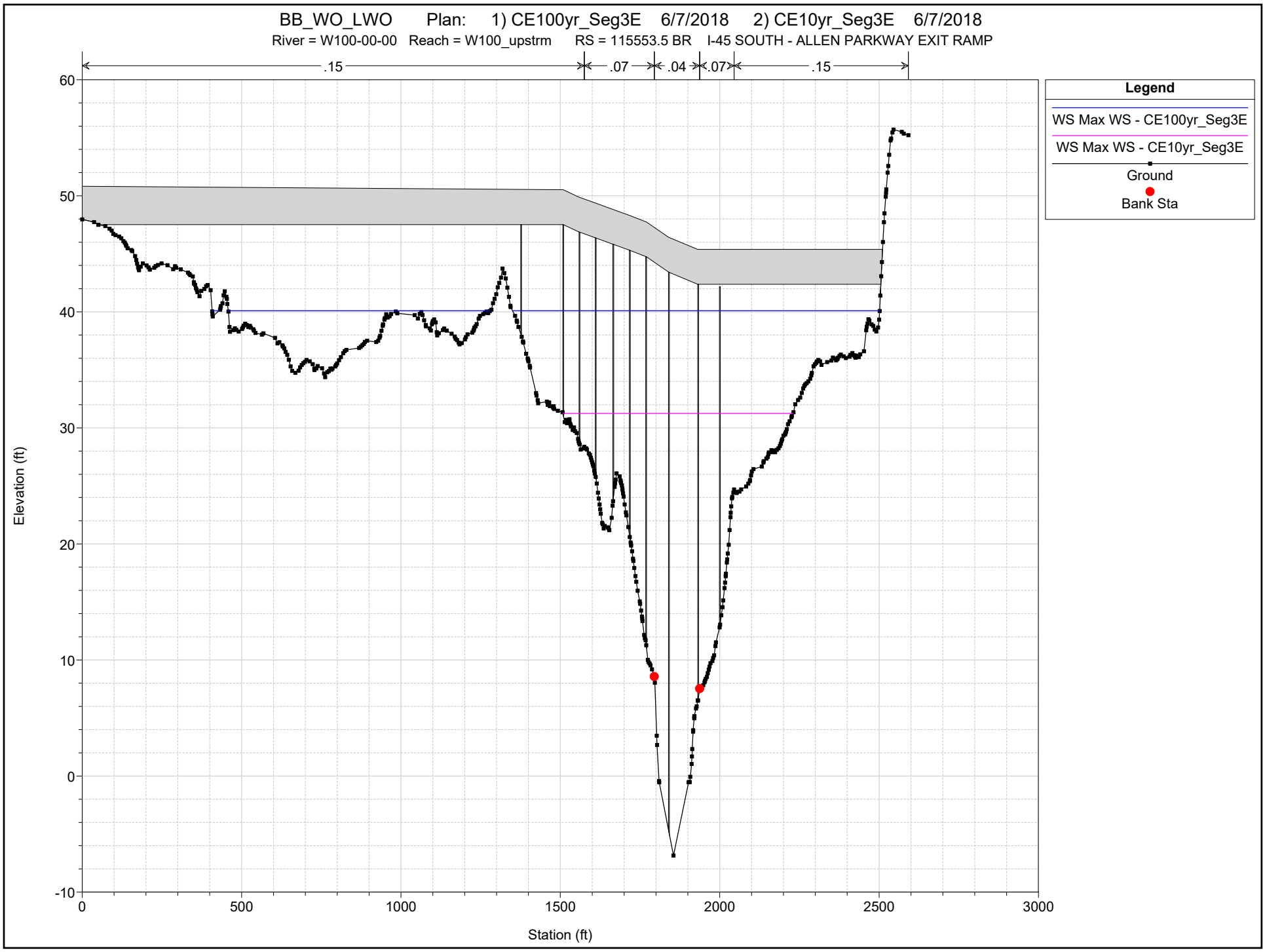

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115635.5 BR I-45 SOUTH BOUND MAIN LANES
.15
.08
.04
.08
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
70
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000
Station (ft)

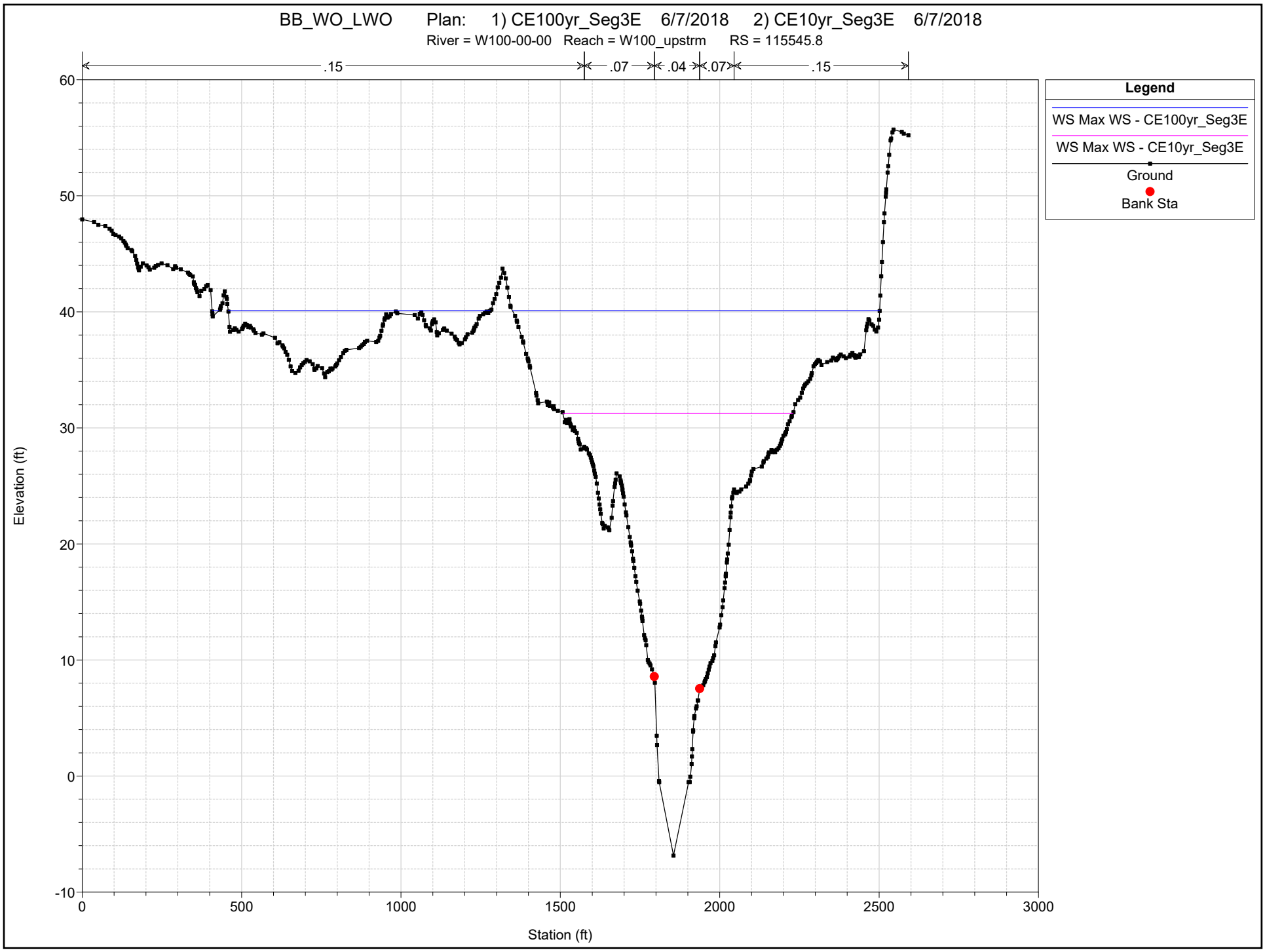

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115635.5 BR I-45 SOUTH BOUND MAIN LANES
.15
.07
.04
.07
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
70
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000
Station (ft)

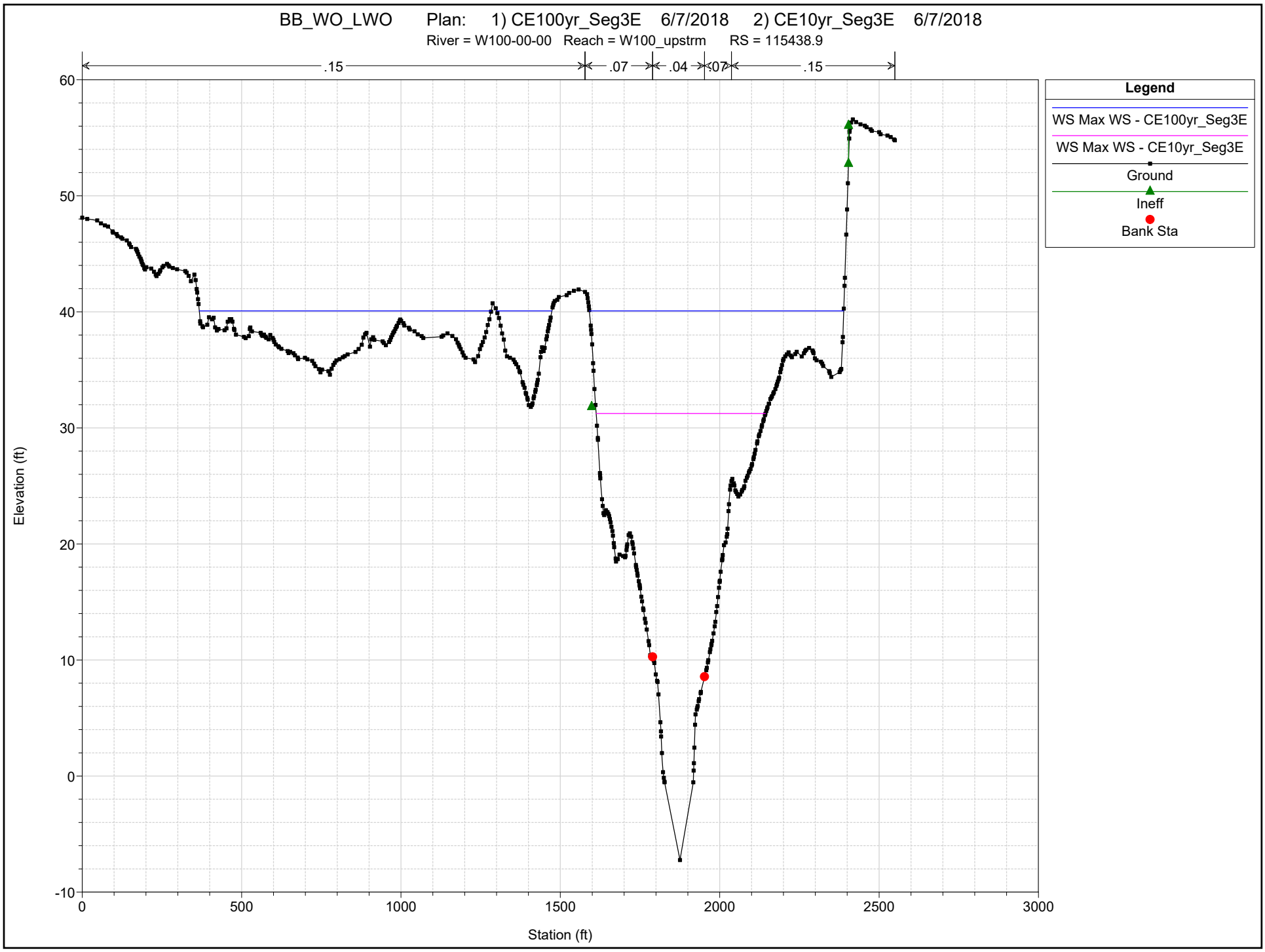

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115621.1
.15
.07
.04
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
Station (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000

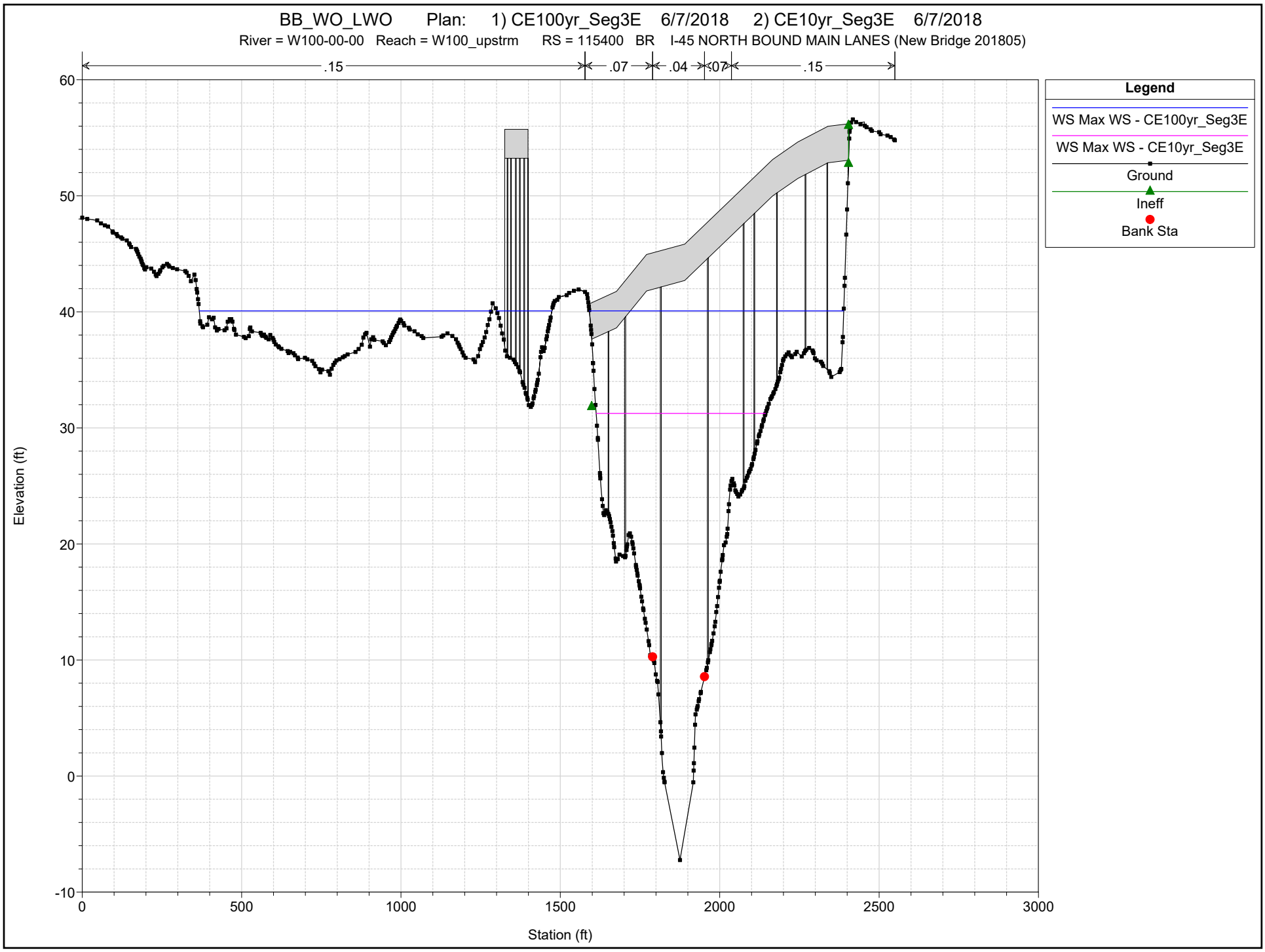

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115594.6
.15
.07
.04
.07
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
Station (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000

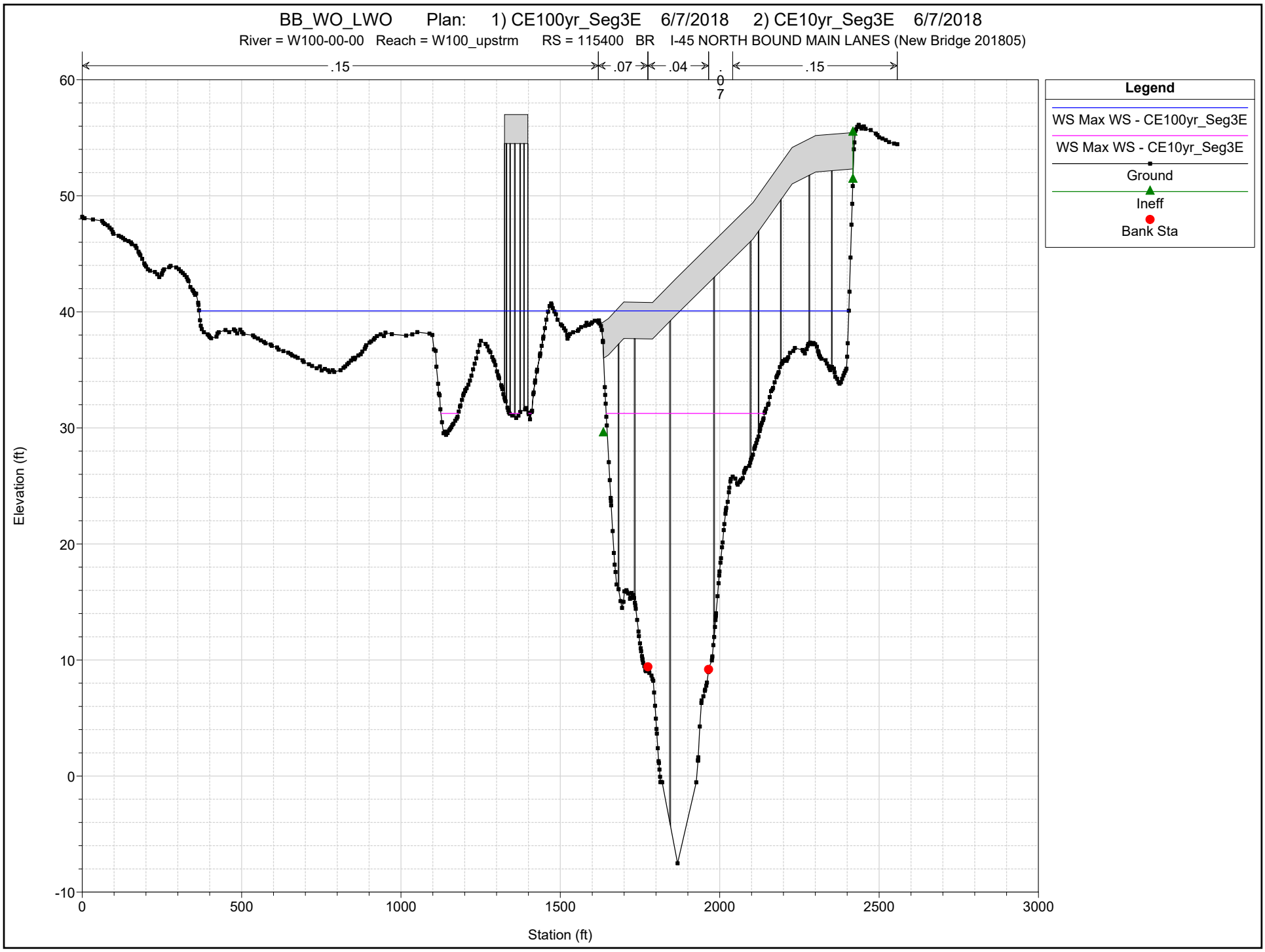

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115553.5 BR I-45 SOUTH - ALLEN PARKWAY EXIT RAMP
.15
.07
.04
.07
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
Station (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000

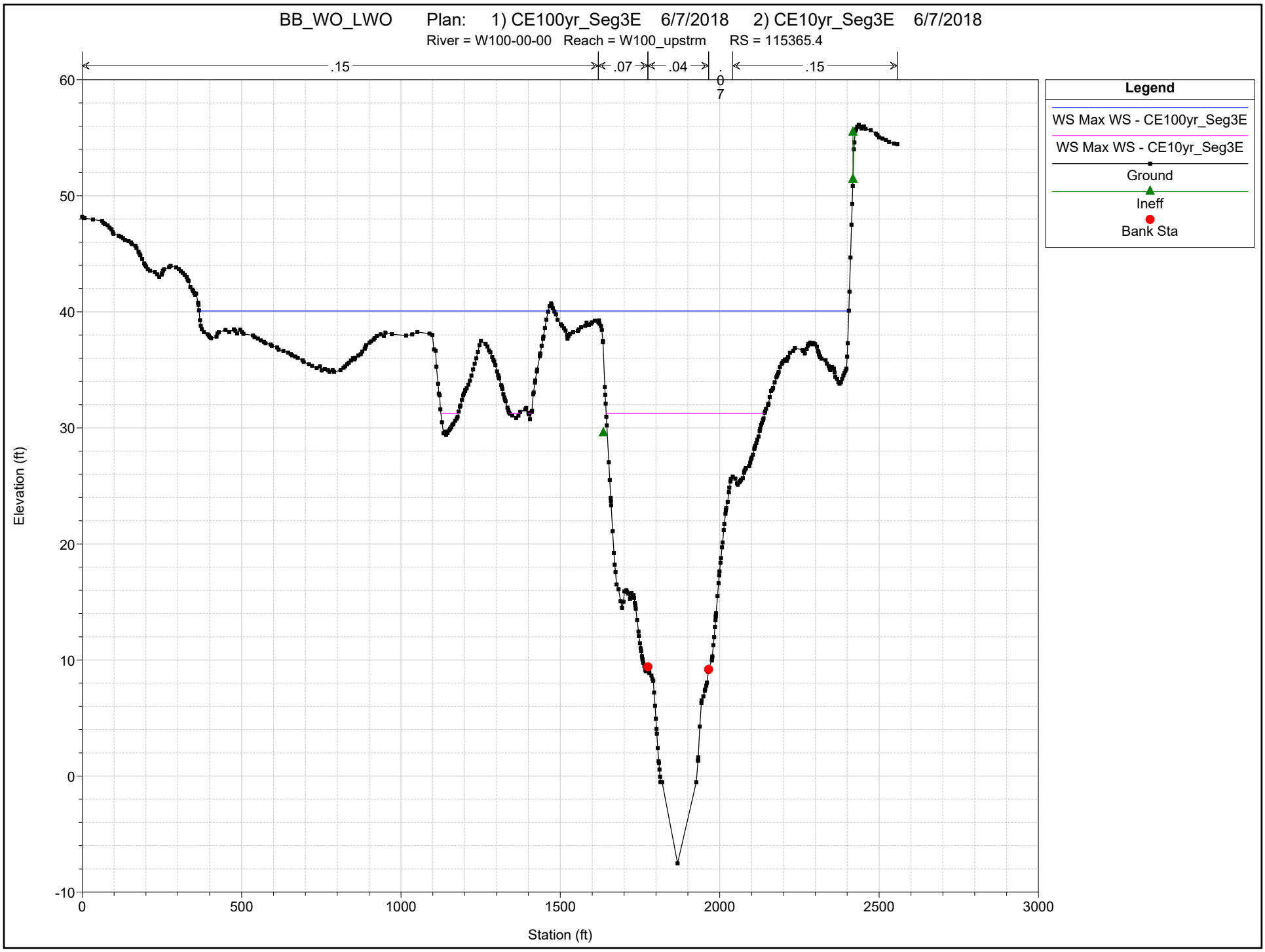

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115553.5 BR I-45 SOUTH - ALLEN PARKWAY EXIT RAMP
.15
.07
.04
.07
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000
Station (ft)

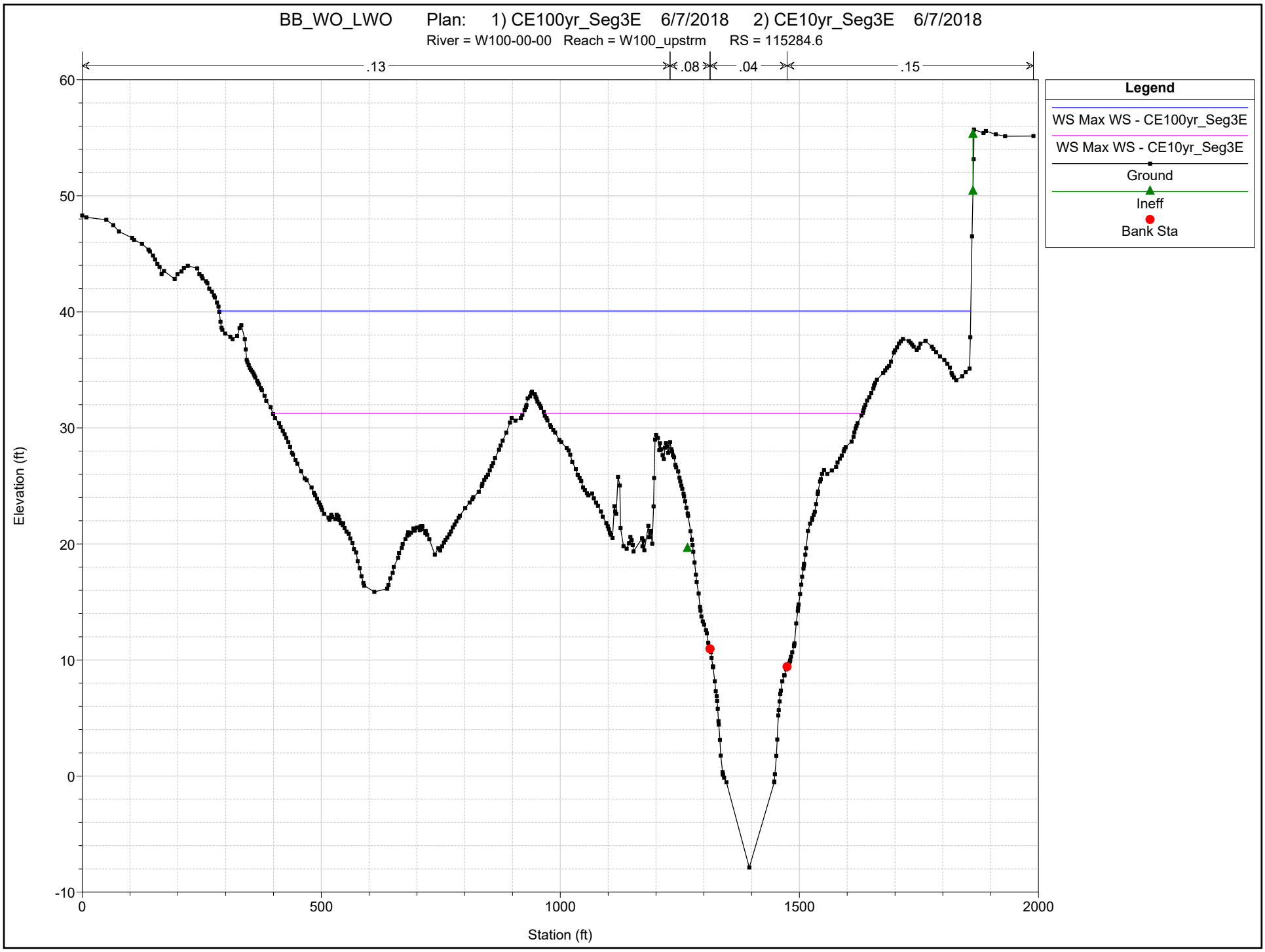

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115545.8
.15
.07
.04
.07
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000
Station (ft)

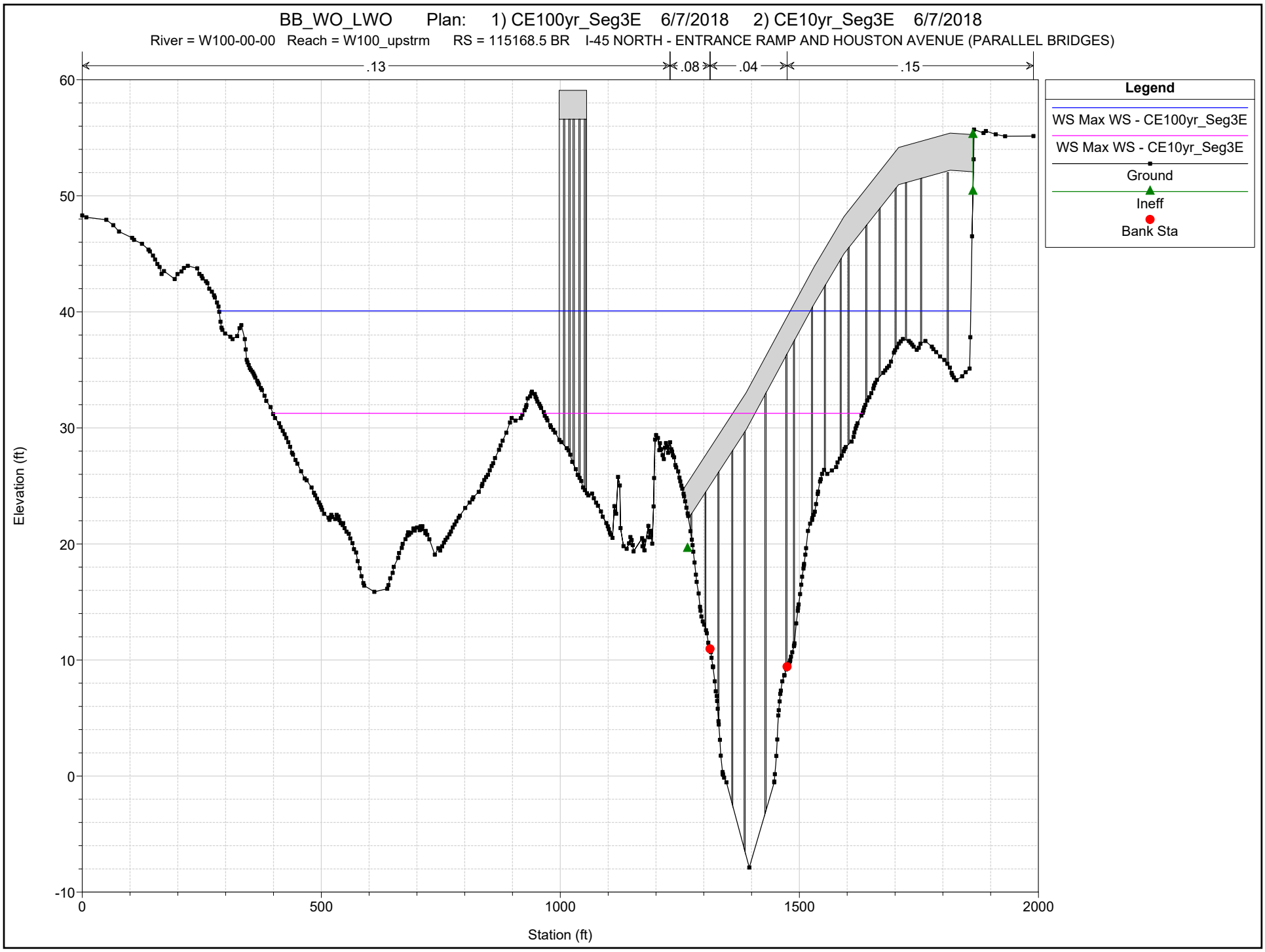

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115438.9
.15
.07
.04
.07
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000
Station (ft)

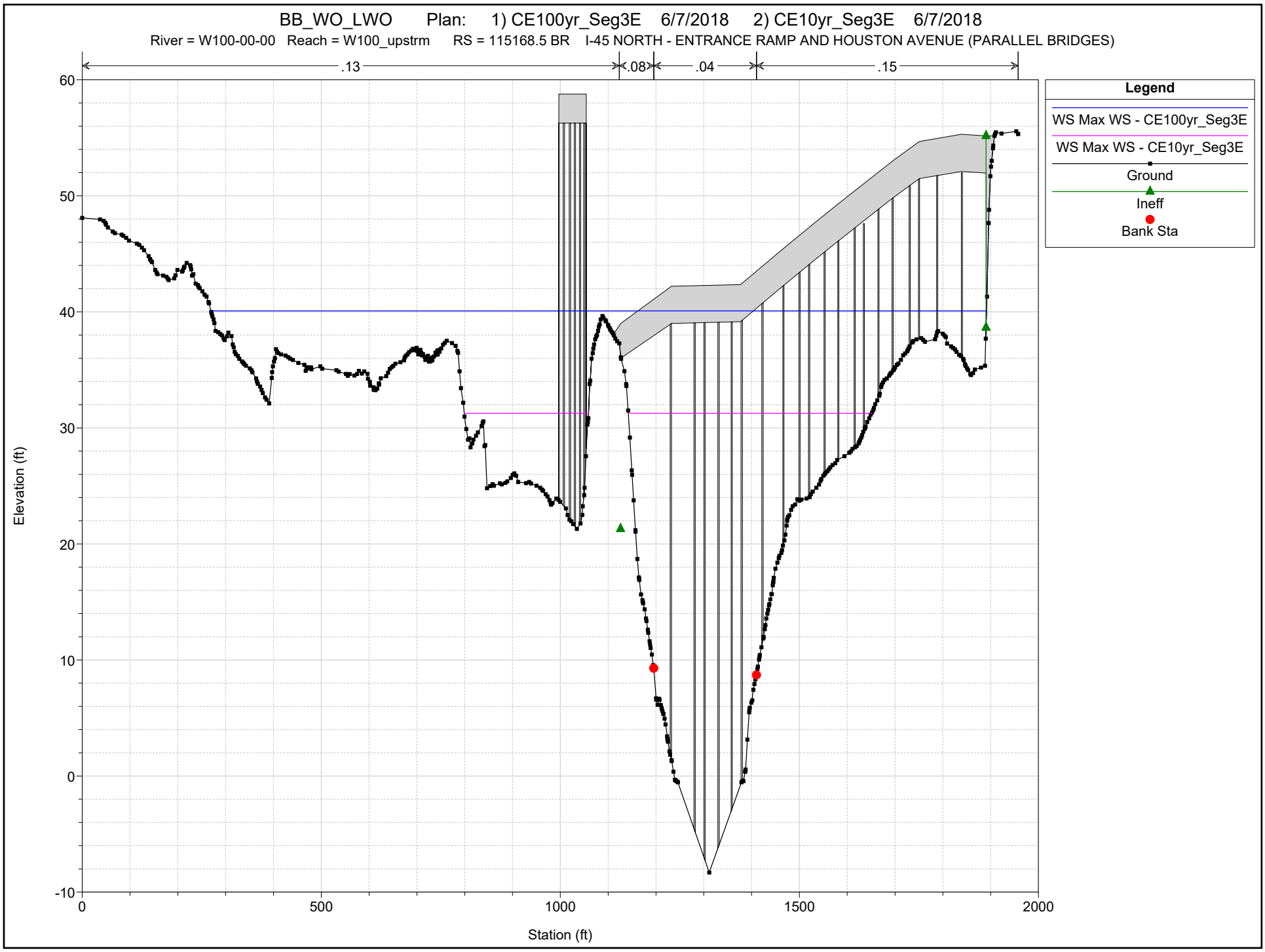

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115400 BR I-45 NORTH BOUND MAIN LANES (New Bridge 201805)
.15
.07
.04
.07
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000
Station (ft)

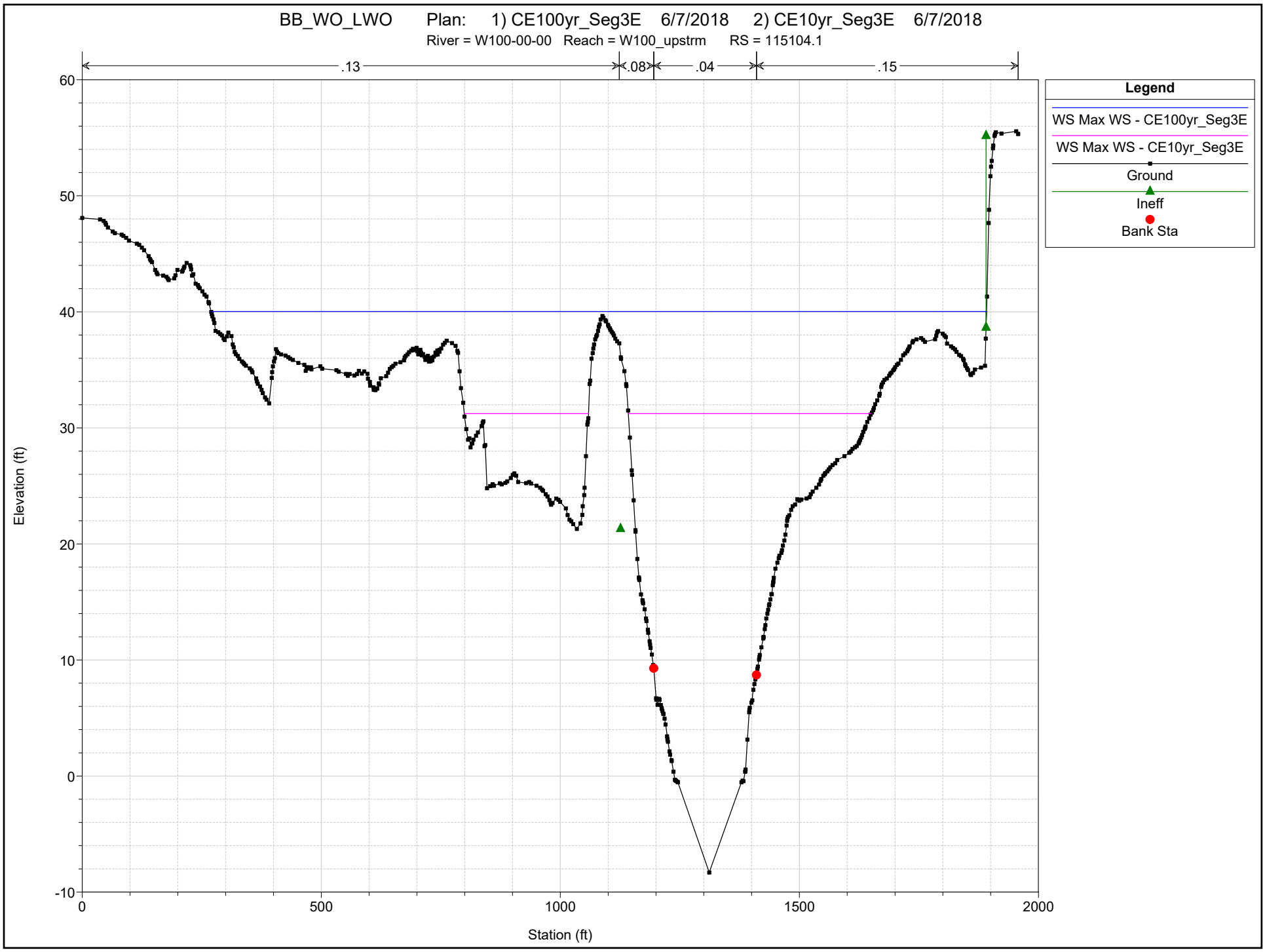

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115400 BR I-45 NORTH BOUND MAIN LANES (New Bridge 201805)
.15
.07
.04
.07
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000

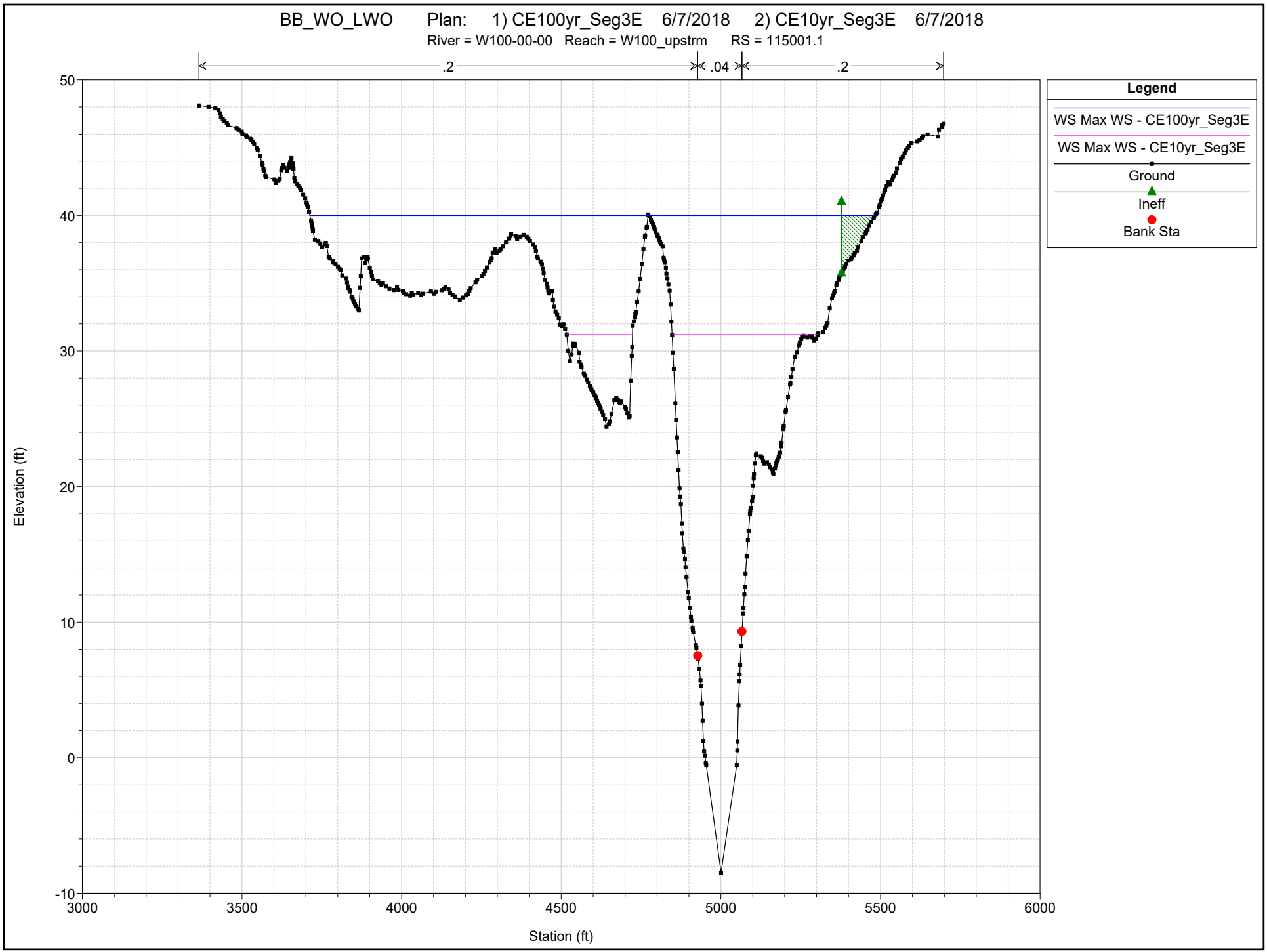

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115365.4
.15
.07
.04
.07
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000

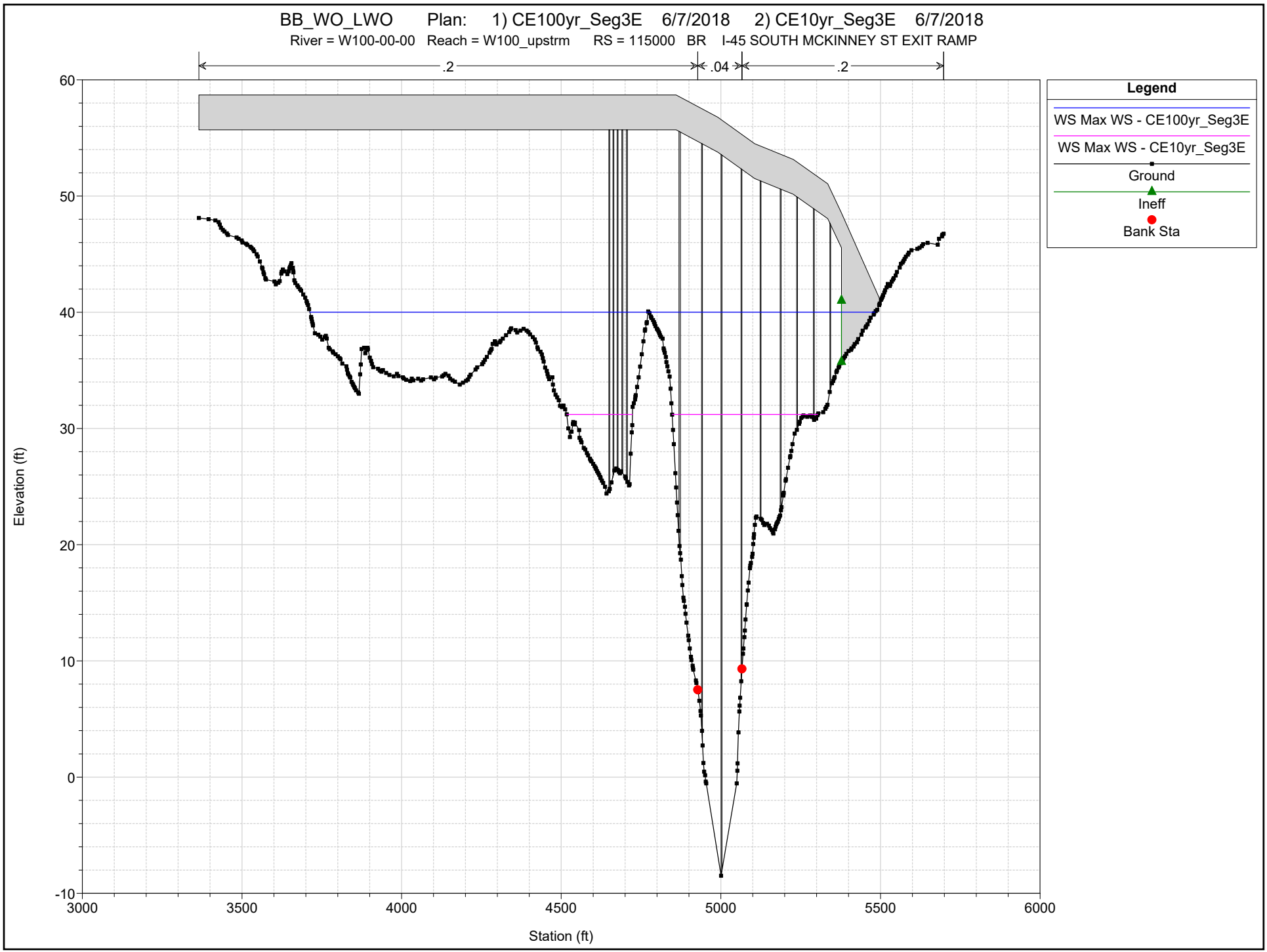

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115284.6
.13
.08
.04
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
Station (ft)

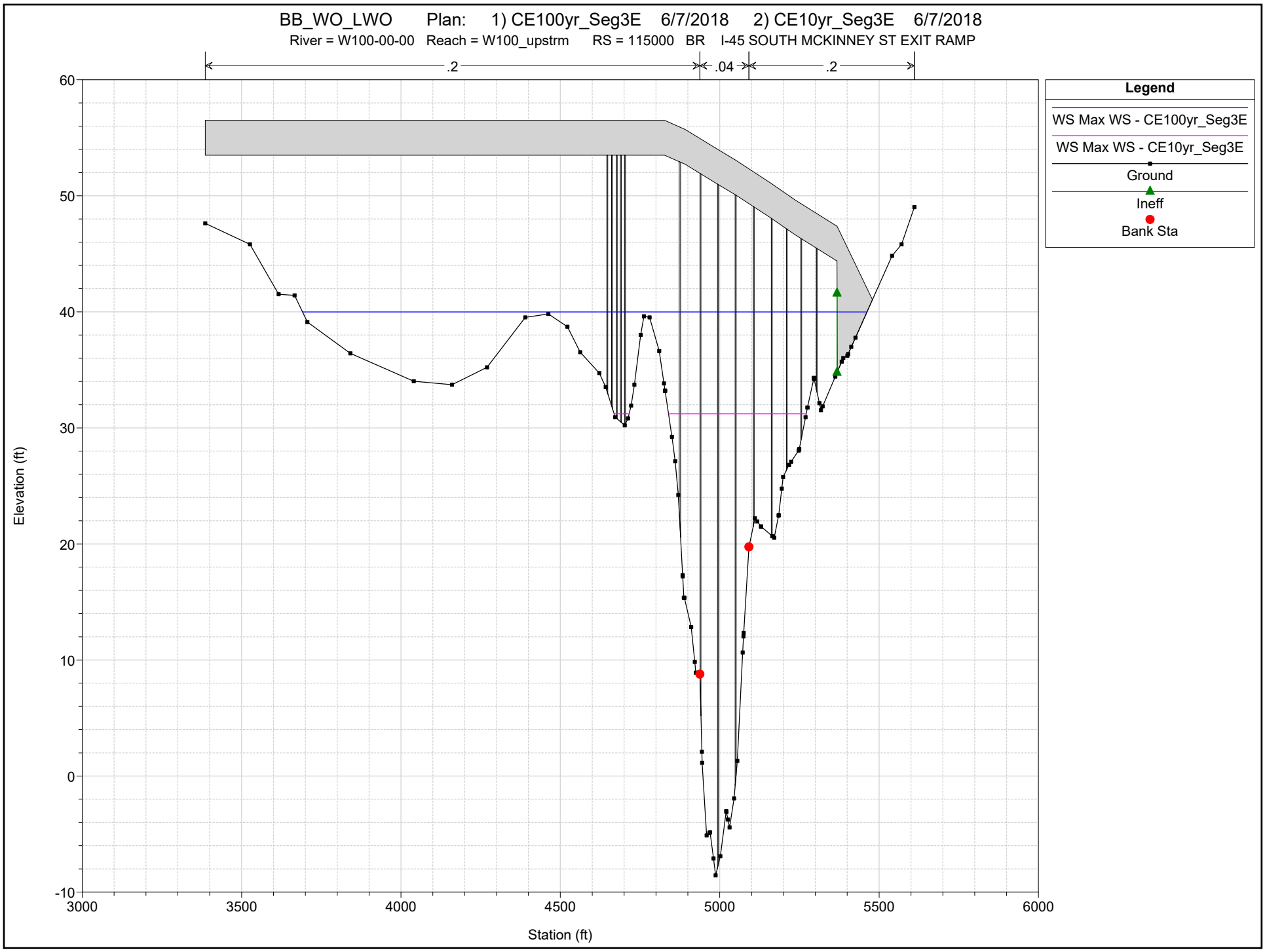

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115168.5 BR I-45 NORTH - ENTRANCE RAMP AND HOUSTON AVENUE (PARALLEL BRIDGES)
.13
.08
.04
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
Station (ft)

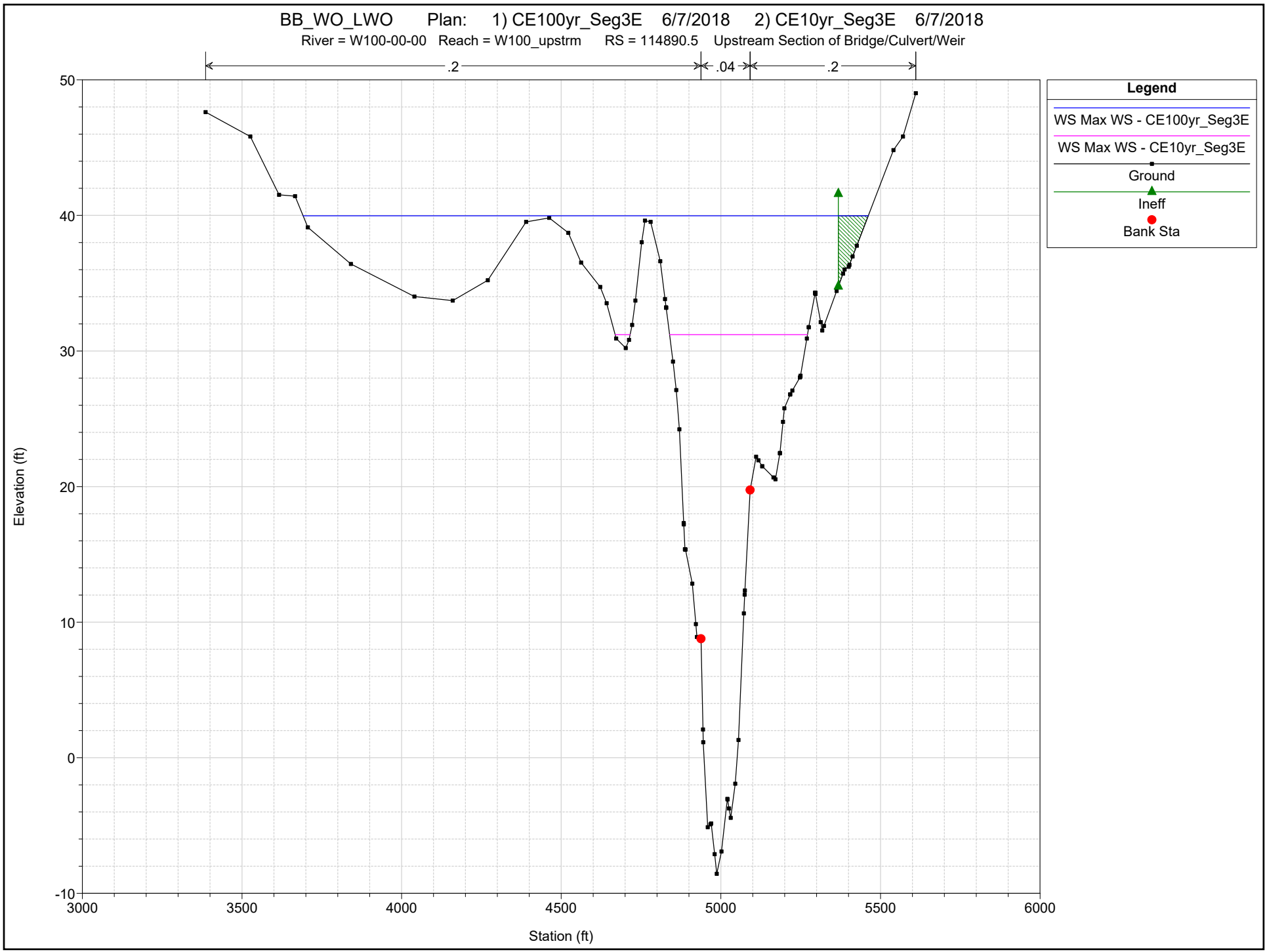

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115168.5 BR I-45 NORTH - ENTRANCE RAMP AND HOUSTON AVENUE (PARALLEL BRIDGES)
.13
.08
.04
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
Station (ft)

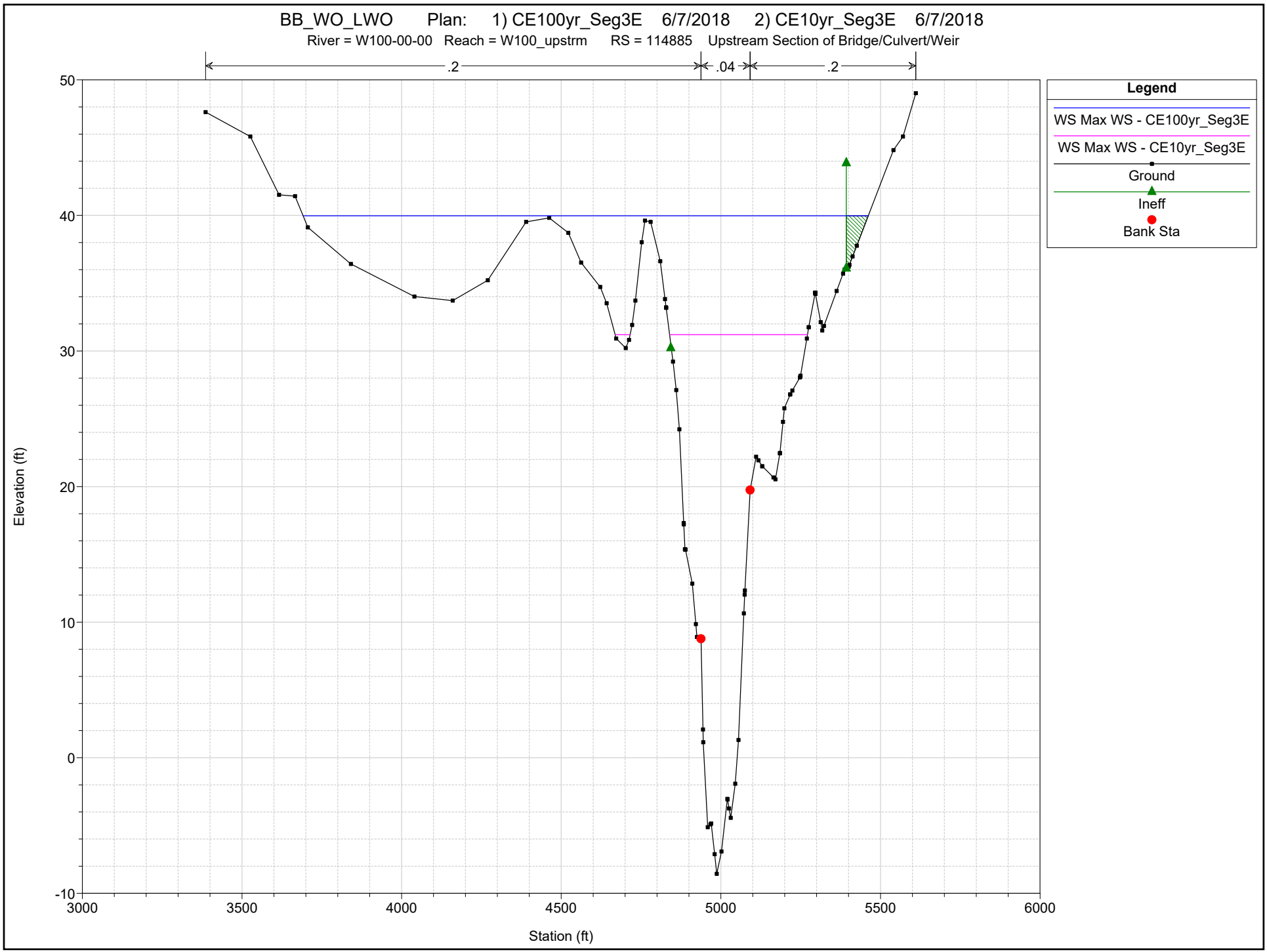

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115104.1
.13
.08
.04
.15
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
Station (ft)

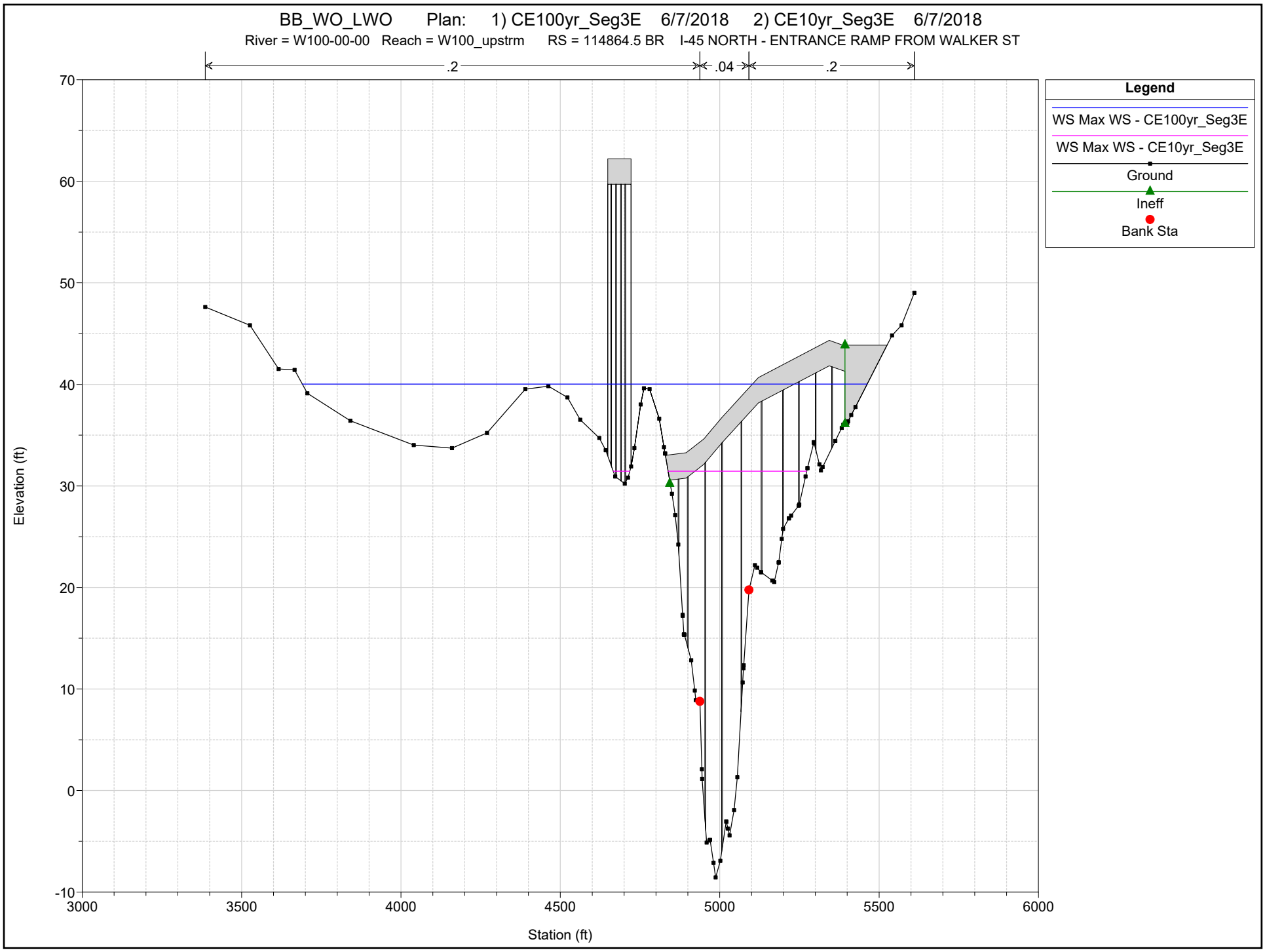

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115001.1
.2
.04
.2
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
3000
3500
4000
4500
5000
5500
6000
Station (ft)

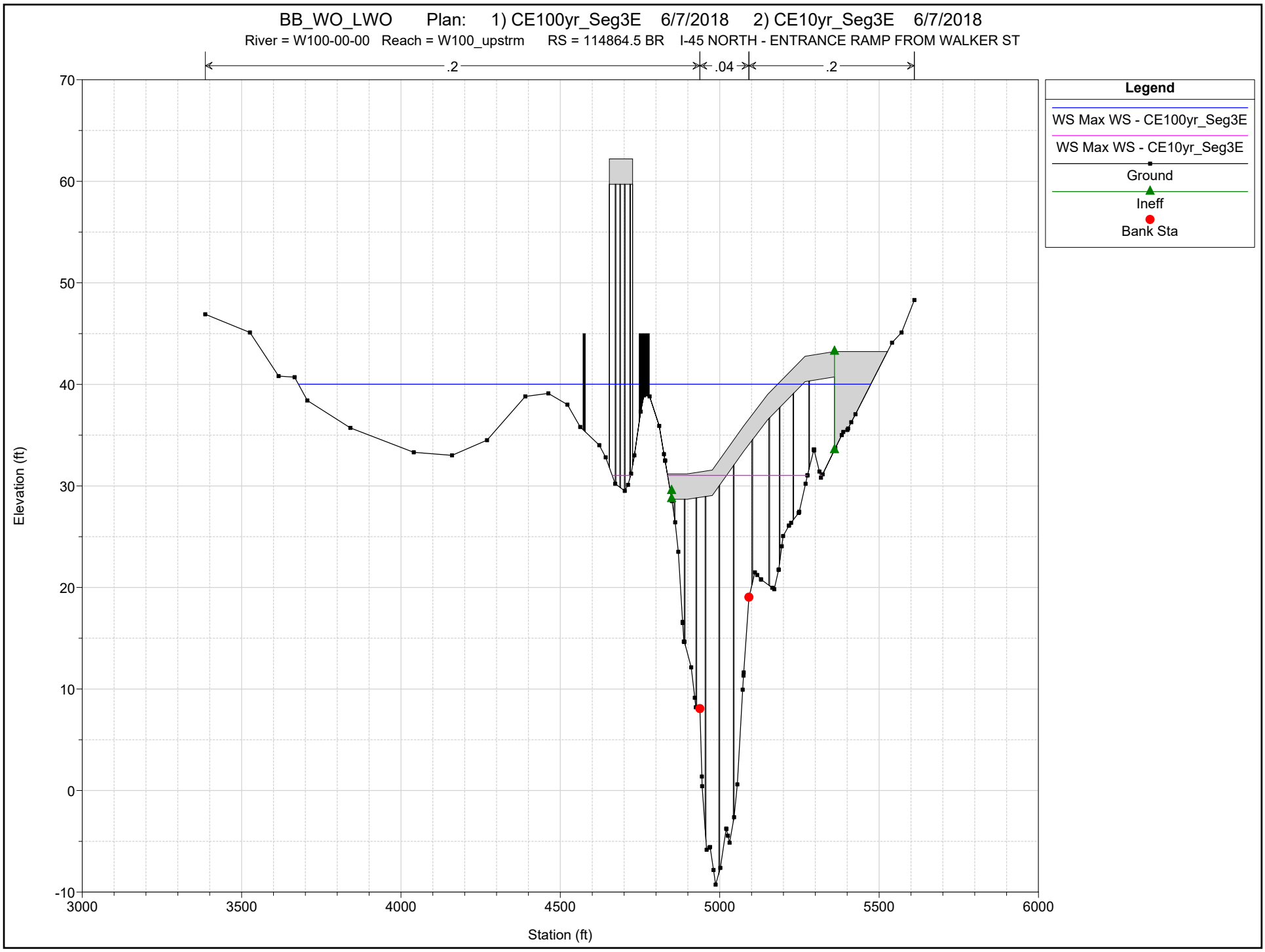

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115000 BR I-45 SOUTH MCKINNEY ST EXIT RAMP
.2
.04
.2
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
3000
3500
4000
4500
5000
5500
6000
Station (ft)

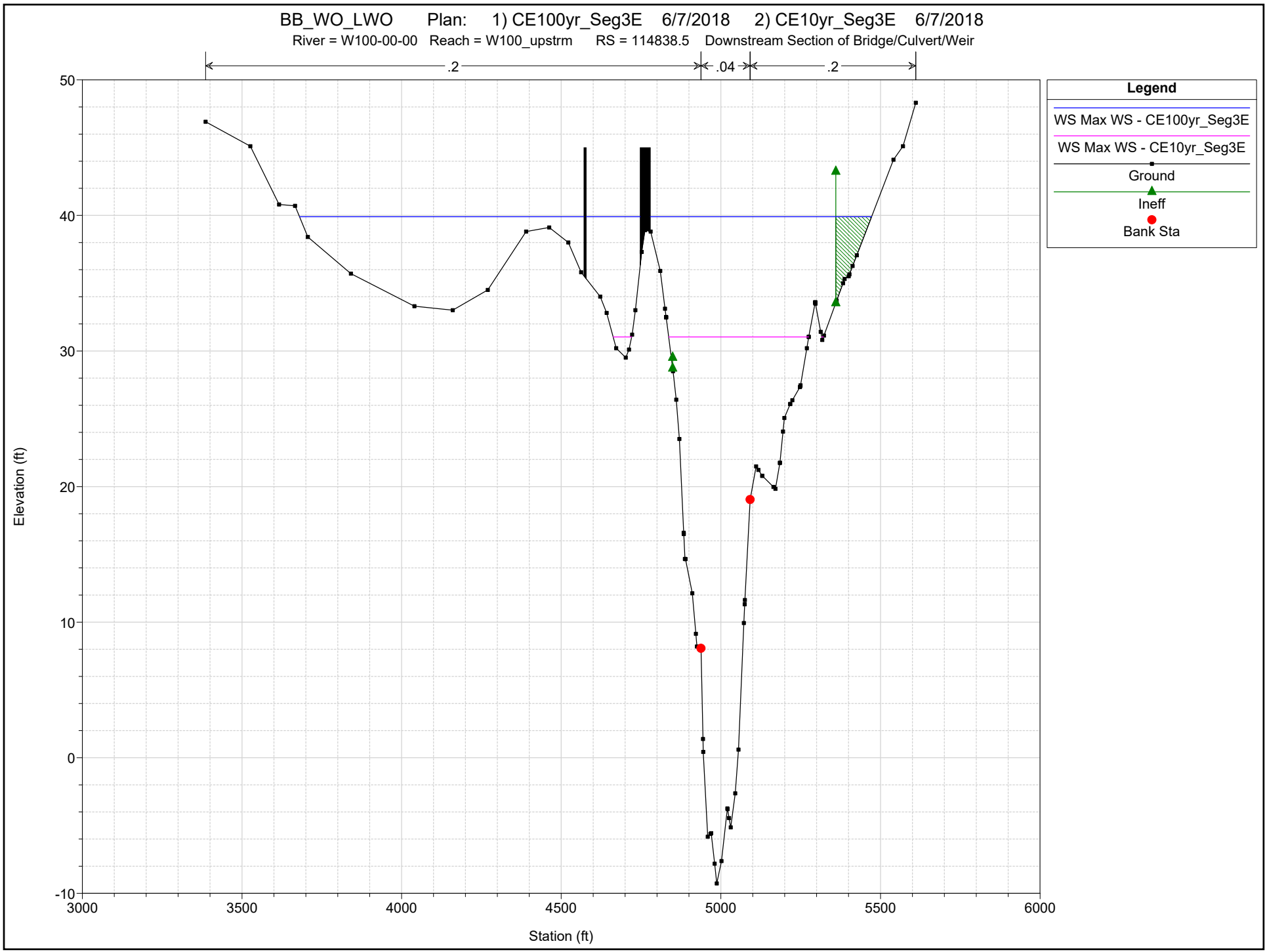

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 115000 BR I-45 SOUTH MCKINNEY ST EXIT RAMP
.2
.04
.2
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
3000
3500
4000
4500
5000
5500
6000
Station (ft)

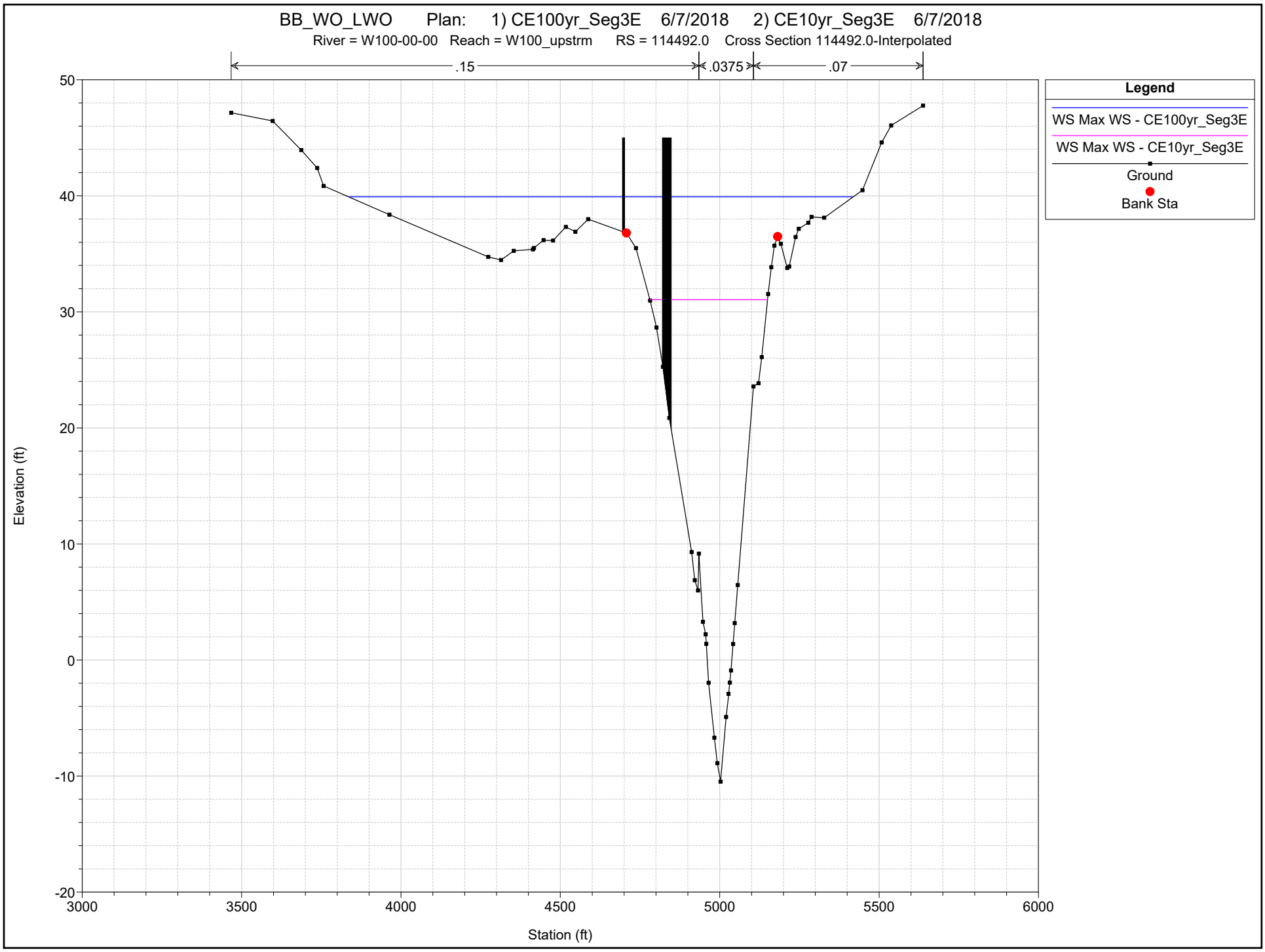

BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 114890.5 Upstream Section of Bridge/Culvert/Weir
.2
.04
.2
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
3000
3500
4000
4500
5000
5500
6000
Station (ft)


BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 114885 Upstream Section of Bridge/Culvert/Weir
.2
.04
.2
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
3000
3500
4000
4500
5000
5500
6000
Station (ft)


BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 114864.5 BR I-45 NORTH - ENTRANCE RAMP FROM WALKER ST
.2
.04
.2
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
70
60
50
40
30
20
10
0
-10
3000
3500
4000
4500
5000
5500
6000
Station (ft)


BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 114864.5 BR I-45 NORTH - ENTRANCE RAMP FROM WALKER ST
.2
.04
.2
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
70
60
50
40
30
20
10
0
-10
3000
3500
4000
4500
5000
5500
6000
Station (ft)


BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 114838.5 Downstream Section of Bridge/Culvert/Weir
.2
.04
.2
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
3000
3500
4000
4500
5000
5500
6000
Station (ft)


BB_WO_LWO Plan: 1) CE100yr_Seg3E 6/7/2018 2) CE10yr_Seg3E 6/7/2018
River = W100-00-00 Reach = W100_upstrm RS = 114492.0 Cross Section 114492.0-Interpolated
.15
.0375
.07
Legend
WS Max WS - CE100yr_Seg3E
WS Max WS - CE10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
-20
3000
3500
4000
4500
5000
5500
6000
Station (ft)

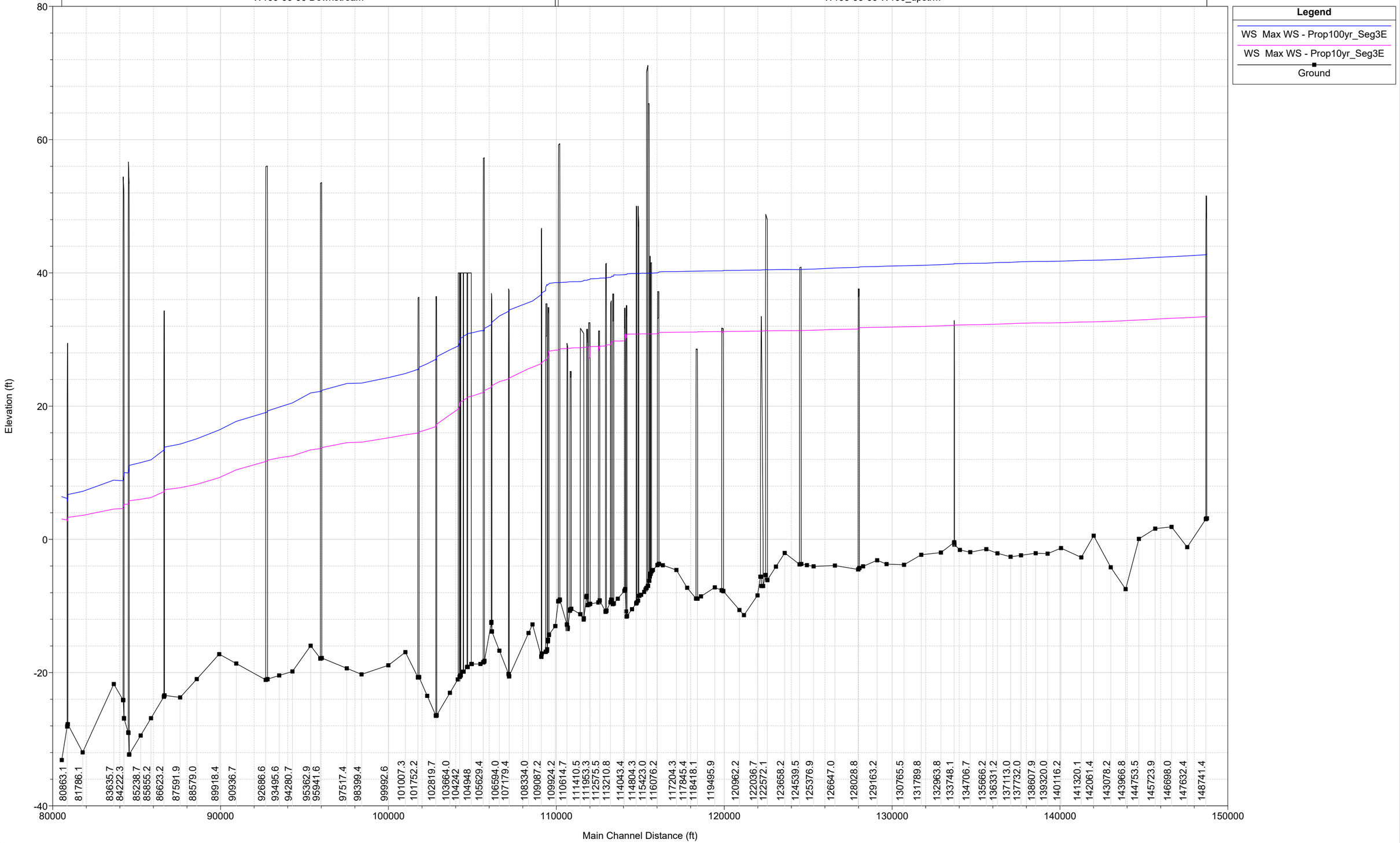
APPENDIX E.3

PROPOSED CONDITIONS

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018

W100-00-00 Downstream

W100-00-00 W100_upstrm



HEC-RAS Profile: Max WS

Reach	River Sta	Profile	Plan	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)	
W100_upstrm	148800.4	Max WS	Prop100yr_Seg3E	17187.89	3.15	42.84		42.94	0.000244	2.88	8015.53	1820.10	0.09
W100_upstrm	148800.4	Max WS	Prop10yr_Seg3E	8238.31	3.15	33.53		33.60	0.000217	2.14	4931.88	1066.57	0.08
W100_upstrm	148795.4	Max WS	Prop100yr_Seg3E	17188.38	3.15	42.84	17.83	42.94	0.000244	2.88	8015.12	1820.09	0.09
W100_upstrm	148795.4	Max WS	Prop10yr_Seg3E	8238.50	3.15	33.53	13.27	33.59	0.000217	2.14	4931.53	1066.26	0.08
W100_upstrm	148768.4			Bridge									
W100_upstrm	148741.4	Max WS	Prop100yr_Seg3E	17180.46	3.04	42.72		42.83	0.000244	2.88	8012.65	1820.01	0.09
W100_upstrm	148741.4	Max WS	Prop10yr_Seg3E	8236.45	3.04	33.43		33.50	0.000216	2.14	4935.54	1069.81	0.08
W100_upstrm	147632.4	Max WS	Prop100yr_Seg3E	17167.38	-1.17	42.55		42.64	0.000081	2.48	9145.21	545.98	0.09
W100_upstrm	147632.4	Max WS	Prop10yr_Seg3E	8226.38	-1.17	33.27		33.33	0.000079	1.96	5010.62	400.41	0.08
W100_upstrm	146698.0	Max WS	Prop100yr_Seg3E	17224.46	1.88	42.45		42.56	0.000115	2.95	8612.64	797.37	0.10
W100_upstrm	146698.0	Max WS	Prop10yr_Seg3E	8269.54	1.88	33.18		33.26	0.000095	2.28	5006.97	328.27	0.09
W100_upstrm	145723.9	Max WS	Prop100yr_Seg3E	17281.05	1.61	42.30		42.47	0.000145	3.84	8613.59	472.38	0.12
W100_upstrm	145723.9	Max WS	Prop10yr_Seg3E	8311.40	1.61	33.05		33.17	0.000134	2.97	4705.28	384.56	0.11
W100_upstrm	144753.5	Max WS	Prop100yr_Seg3E	17345.74	0.07	42.16		42.31	0.000149	3.40	7612.95	554.10	0.12
W100_upstrm	144753.5	Max WS	Prop10yr_Seg3E	8357.45	0.07	32.93		33.03	0.000117	2.60	4030.03	305.26	0.10
W100_upstrm	143966.8	Max WS	Prop100yr_Seg3E	17386.26	-7.47	42.08		42.21	0.000143	3.38	10761.09	1295.30	0.11
W100_upstrm	143966.8	Max WS	Prop10yr_Seg3E	8386.41	-7.47	32.83		32.94	0.000156	2.79	4319.60	454.46	0.11
W100_upstrm	143078.2	Max WS	Prop100yr_Seg3E	17448.35	-4.19	41.96		42.09	0.000116	3.12	11508.95	919.33	0.10
W100_upstrm	143078.2	Max WS	Prop10yr_Seg3E	8426.61	-4.19	32.73		32.81	0.000114	2.38	5601.50	526.43	0.10
W100_upstrm	142061.4	Max WS	Prop100yr_Seg3E	17521.77	0.55	41.88		41.98	0.000079	2.86	10415.13	532.02	0.09
W100_upstrm	142061.4	Max WS	Prop10yr_Seg3E	8474.82	0.55	32.65		32.71	0.000069	2.13	5809.17	455.49	0.08
W100_upstrm	141320.1	Max WS	Prop100yr_Seg3E	17582.11	-2.70	41.87		41.91	0.000040	1.83	18242.46	971.20	0.06
W100_upstrm	141320.1	Max WS	Prop10yr_Seg3E	8512.45	-2.70	32.63		32.66	0.000039	1.47	10572.38	746.09	0.06
W100_upstrm	140116.2	Max WS	Prop100yr_Seg3E	17646.08	-1.31	41.77		41.88	0.000104	3.01	12286.53	880.87	0.09
W100_upstrm	140116.2	Max WS	Prop10yr_Seg3E	8554.58	-1.31	32.53		32.61	0.000099	2.38	5716.47	603.14	0.08
W100_upstrm	139320.0	Max WS	Prop100yr_Seg3E	17694.52	-2.14	41.72		41.79	0.000084	2.45	14028.99	942.90	0.08
W100_upstrm	139320.0	Max WS	Prop10yr_Seg3E	8583.09	-2.14	32.48		32.53	0.000074	1.94	6570.34	602.39	0.07
W100_upstrm	138607.9	Max WS	Prop100yr_Seg3E	17740.00	-2.08	41.72		41.73	0.000019	1.33	26567.28	1413.28	0.04
W100_upstrm	138607.9	Max WS	Prop10yr_Seg3E	8614.34	-2.08	32.48		32.49	0.000018	1.06	16397.74	1105.49	0.04
W100_upstrm	137732.0	Max WS	Prop100yr_Seg3E	17772.22	-2.40	41.68		41.74	0.000058	2.56	18052.31	1328.84	0.08
W100_upstrm	137732.0	Max WS	Prop10yr_Seg3E	8632.22	-2.40	32.44		32.49	0.000055	2.04	9632.15	886.70	0.07
W100_upstrm	137113.0	Max WS	Prop100yr_Seg3E	17823.71	-2.62	41.59		41.72	0.000095	3.29	14308.80	1339.27	0.10
W100_upstrm	137113.0	Max WS	Prop10yr_Seg3E	8660.23	-2.62	32.37		32.46	0.000080	2.47	6138.44	455.84	0.08
W100_upstrm	136331.2	Max WS	Prop100yr_Seg3E	17886.85	-2.09	41.55		41.58	0.000151	1.59	15704.46	766.47	0.05
W100_upstrm	136331.2	Max WS	Prop10yr_Seg3E	8696.47	-2.09	32.32		32.34	0.000150	1.34	9304.60	639.21	0.05
W100_upstrm	135666.2	Max WS	Prop100yr_Seg3E	17923.09	-1.47	41.45		41.54	0.000074	2.72	13018.05	789.00	0.09
W100_upstrm	135666.2	Max WS	Prop10yr_Seg3E	8708.84	-1.47	32.23		32.29	0.000071	2.12	6930.57	556.75	0.08
W100_upstrm	134706.7	Max WS	Prop100yr_Seg3E	17983.89	-1.93	41.44		41.47	0.000036	1.93	22371.67	1159.83	0.06
W100_upstrm	134706.7	Max WS	Prop10yr_Seg3E	8747.37	-1.93	32.21		32.24	0.000033	1.49	12864.83	869.42	0.05
W100_upstrm	134090.6	Max WS	Prop100yr_Seg3E	18013.52	-1.59	41.40		41.46	0.000052	2.42	17563.59	851.78	0.07
W100_upstrm	134090.6	Max WS	Prop10yr_Seg3E	8761.15	-1.59	32.19		32.23	0.000045	1.83	10192.09	725.95	0.06
W100_upstrm	133772.1	Max WS	Prop100yr_Seg3E	18031.42	-0.79	41.38	13.45	41.46	0.000068	2.89	16952.59	950.98	0.08
W100_upstrm	133772.1	Max WS	Prop10yr_Seg3E	8769.08	-0.79	32.16	8.85	32.23	0.000065	2.34	8684.42	831.39	0.08
W100_upstrm	133760.1			Bridge									
W100_upstrm	133748.1	Max WS	Prop100yr_Seg3E	18031.45	-0.46	41.33		41.42	0.000071	2.94	16592.26	944.88	0.09
W100_upstrm	133748.1	Max WS	Prop10yr_Seg3E	8762.47	-0.46	32.13		32.20	0.000069	2.40	8385.50	814.66	0.08
W100_upstrm	132963.8	Max WS	Prop100yr_Seg3E	18094.16	-1.98	41.23		41.36	0.000108	3.15	10189.77	698.89	0.10
W100_upstrm	132963.8	Max WS	Prop10yr_Seg3E	8791.18	-1.98	32.05		32.13	0.000091	2.39	5196.40	491.44	0.09
W100_upstrm	131789.8	Max WS	Prop100yr_Seg3E	18176.43	-2.31	41.12		41.25	0.000101	3.30	10778.85	737.36	0.10
W100_upstrm	131789.8	Max WS	Prop10yr_Seg3E	8826.75	-2.31	31.95		32.03	0.000087	2.50	5859.01	488.26	0.09
W100_upstrm	130765.5	Max WS	Prop100yr_Seg3E	18255.49	-3.81	41.07		41.15	0.000050	2.49	13485.02	664.13	0.07
W100_upstrm	130765.5	Max WS	Prop10yr_Seg3E	8870.77	-3.81	31.91		31.95	0.000036	1.73	8519.49	492.53	0.06
W100_upstrm	129725.3	Max WS	Prop100yr_Seg3E	18324.12	-3.71	41.01		41.10	0.000072	2.96	16303.21	1186.95	0.09
W100_upstrm	129725.3	Max WS	Prop10yr_Seg3E	8902.50	-3.71	31.85		31.92	0.000064	2.32	8288.97	707.66	0.08
W100_upstrm	129163.2	Max WS	Prop100yr_Seg3E	18383.05	-3.13	40.95		41.06	0.000072	2.88	12047.06	853.25	0.09
W100_upstrm	129163.2	Max WS	Prop10yr_Seg3E	8930.01	-3.13	31.81		31.87	0.000058	2.11	6238.31	495.36	0.07
W100_upstrm	128326.9	Max WS	Prop100yr_Seg3E	18449.67	-4.05	40.92		40.99	0.000049	2.51	20137.85	1351.10	0.07
W100_upstrm	128326.9	Max WS	Prop10yr_Seg3E	8966.14	-4.05	31.78		31.83	0.000040	1.87	8814.39	832.04	0.06

HEC-RAS Profile: Max WS (Continued)

Reach	River Sta	Profile	Plan	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)	
W100_upstrm	128109.6	Max WS	Prop100yr_Seg3E	18450.06	-4.29	40.90		40.94	0.000210	1.69	12364.21	1140.36	0.06
W100_upstrm	128109.6	Max WS	Prop10yr_Seg3E	8963.77	-4.29	31.78		31.80	0.000090	1.29	6957.52	392.56	0.05
W100_upstrm	128104.6	Max WS	Prop100yr_Seg3E	18449.84	-4.29	40.90	10.48	40.94	0.000210	1.69	12363.04	1140.32	0.06
W100_upstrm	128104.6	Max WS	Prop10yr_Seg3E	8964.57	-4.29	31.78	6.01	31.80	0.000090	1.29	6957.36	392.56	0.05
W100_upstrm	128066.7			Bridge									
W100_upstrm	128028.8	Max WS	Prop100yr_Seg3E	18449.42	-4.51	40.84		40.89	0.000169	1.68	12551.85	1146.87	0.06
W100_upstrm	128028.8	Max WS	Prop10yr_Seg3E	8959.80	-4.51	31.56		31.58	0.000061	1.29	6957.65	392.57	0.05
W100_upstrm	126647.0	Max WS	Prop100yr_Seg3E	18444.60	-3.93	40.74		40.75	0.000022	0.95	20393.04	1032.54	0.03
W100_upstrm	126647.0	Max WS	Prop10yr_Seg3E	8945.72	-3.93	31.52		31.53	0.000020	0.77	11671.56	803.67	0.03
W100_upstrm	125376.9	Max WS	Prop100yr_Seg3E	18531.26	-4.05	40.57		40.63	0.000180	1.96	10070.21	853.27	0.08
W100_upstrm	125376.9	Max WS	Prop10yr_Seg3E	8966.32	-4.05	31.40		31.43	0.000130	1.56	5764.40	336.48	0.07
W100_upstrm	124983.5	Max WS	Prop100yr_Seg3E	18559.47	-3.86	40.56		40.58	0.000022	1.41	20912.91	1403.10	0.05
W100_upstrm	124983.5	Max WS	Prop10yr_Seg3E	8973.92	-3.86	31.37		31.40	0.000032	1.50	5997.26	1010.48	0.07
W100_upstrm	124644.1	Max WS	Prop100yr_Seg3E	18579.21	-3.69	40.51	13.70	40.58	0.000049	2.10	8826.64	648.77	0.07
W100_upstrm	124644.1	Max WS	Prop10yr_Seg3E	8983.97	-3.69	31.35	8.27	31.39	0.000040	1.57	5738.41	491.60	0.06
W100_upstrm	124591.8			Bridge									
W100_upstrm	124539.5	Max WS	Prop100yr_Seg3E	18579.21	-3.74	40.48		40.55	0.000049	2.10	8835.44	650.83	0.07
W100_upstrm	124539.5	Max WS	Prop10yr_Seg3E	8982.96	-3.74	31.34		31.38	0.000039	1.56	5750.87	492.00	0.06
W100_upstrm	123658.2	Max WS	Prop100yr_Seg3E	18644.76	-2.04	40.50		40.51	0.000016	0.87	28831.57	2436.75	0.03
W100_upstrm	123658.2	Max WS	Prop10yr_Seg3E	9033.61	-2.04	31.34		31.35	0.000019	0.81	11990.02	1389.31	0.04
W100_upstrm	123138.8	Max WS	Prop100yr_Seg3E	18683.59	-4.08	40.49		40.50	0.000013	0.81	27091.10	1760.63	0.03
W100_upstrm	123138.8	Max WS	Prop10yr_Seg3E	9060.35	-4.08	31.33		31.34	0.000011	0.60	15422.00	1012.06	0.02
W100_upstrm	122627.1	Max WS	Prop100yr_Seg3E	18722.32	-6.08	40.46		40.52	0.000021	1.56	17730.15	1322.68	0.05
W100_upstrm	122627.1	Max WS	Prop10yr_Seg3E	9077.08	-6.08	31.31		31.35	0.000020	1.29	8726.48	700.29	0.05
W100_upstrm	122572.1			Mult Open									
W100_upstrm	122517.1	Max WS	Prop100yr_Seg3E	18722.92	-5.38	40.47		40.49	0.000037	1.45	16706.16	1245.45	0.05
W100_upstrm	122517.1	Max WS	Prop10yr_Seg3E	9078.26	-5.38	31.31		31.33	0.000034	1.29	8256.27	631.38	0.05
W100_upstrm	122371.6	Max WS	Prop100yr_Seg3E	18732.25	-7.00	40.46	9.26	40.49	0.000038	1.41	17519.36	1139.28	0.05
W100_upstrm	122371.6	Max WS	Prop10yr_Seg3E	9075.22	-7.00	31.29	4.11	31.33	0.000061	1.49	6082.00	858.23	0.06
W100_upstrm	122265			Bridge									
W100_upstrm	122210.0	Max WS	Prop100yr_Seg3E	18724.95	-5.60	40.42		40.46	0.000033	1.58	15123.93	834.27	0.05
W100_upstrm	122210.0	Max WS	Prop10yr_Seg3E	9064.56	-5.60	31.26		31.29	0.000038	1.41	6419.83	740.88	0.05
W100_upstrm	122036.7	Max WS	Prop100yr_Seg3E	18737.52	-8.40	40.42		40.45	0.000031	1.47	15896.99	1002.62	0.05
W100_upstrm	122036.7	Max WS	Prop10yr_Seg3E	9073.78	-8.40	31.26		31.28	0.000040	1.28	8014.23	758.22	0.05
W100_upstrm	121229.5	Max WS	Prop100yr_Seg3E	18796.86	-11.37	40.40		40.43	0.000026	1.40	17172.70	1105.19	0.05
W100_upstrm	121229.5	Max WS	Prop10yr_Seg3E	9100.23	-11.37	31.23		31.25	0.000027	1.19	8850.08	839.64	0.05
W100_upstrm	120962.2	Max WS	Prop100yr_Seg3E	18816.98	-10.59	40.37		40.42	0.000041	1.80	13661.70	1130.97	0.06
W100_upstrm	120962.2	Max WS	Prop10yr_Seg3E	9103.96	-10.59	31.21		31.25	0.000038	1.47	6749.16	665.13	0.06
W100_upstrm	120005.2	Max WS	Prop100yr_Seg3E	18877.03	-7.78	40.37	8.37	40.38	0.000029	0.80	23471.90	1081.15	0.03
W100_upstrm	120005.2	Max WS	Prop10yr_Seg3E	9145.28	-7.78	31.20	3.54	31.21	0.000029	0.65	14143.98	941.68	0.03
W100_upstrm	119952.6			Bridge									
W100_upstrm	119900.0	Max WS	Prop100yr_Seg3E	18868.96	-7.64	40.31		40.32	0.000019	0.81	23253.91	1066.02	0.03
W100_upstrm	119900.0	Max WS	Prop10yr_Seg3E	9132.89	-7.64	31.19		31.19	0.000018	0.65	13999.21	931.68	0.03
W100_upstrm	119495.9	Max WS	Prop100yr_Seg3E	18899.67	-7.21	40.30		40.31	0.000010	0.58	33334.09	1378.98	0.02
W100_upstrm	119495.9	Max WS	Prop10yr_Seg3E	9157.32	-7.21	31.19		31.19	0.000008	0.43	21331.10	1249.20	0.02
W100_upstrm	118667.7	Max WS	Prop100yr_Seg3E	18961.59	-8.56	40.28		40.29	0.000029	1.07	19159.36	1292.75	0.04
W100_upstrm	118667.7	Max WS	Prop10yr_Seg3E	9192.35	-8.56	31.16		31.17	0.000026	0.84	11067.52	729.56	0.04
W100_upstrm	118466.1	Max WS	Prop100yr_Seg3E	18975.27	-8.89	40.27	5.89	40.29	0.000023	1.41	18022.00	1331.37	0.05
W100_upstrm	118466.1	Max WS	Prop10yr_Seg3E	9186.11	-8.89	31.15	1.59	31.17	0.000019	1.14	8803.88	803.08	0.05
W100_upstrm	118418.1			Bridge									
W100_upstrm	118370.1	Max WS	Prop100yr_Seg3E	18970.68	-8.87	40.24		40.27	0.000024	1.41	17968.09	1326.61	0.05
W100_upstrm	118370.1	Max WS	Prop10yr_Seg3E	9166.72	-8.87	31.11		31.13	0.000020	1.14	8758.88	802.18	0.05
W100_upstrm	117845.4	Max WS	Prop100yr_Seg3E	19002.79	-7.26	40.23		40.25	0.000035	1.34	16445.69	1066.24	0.05
W100_upstrm	117845.4	Max WS	Prop10yr_Seg3E	9186.24	-7.26	31.11		31.12	0.000029	1.01	9385.42	579.20	0.04
W100_upstrm	117204.3	Max WS	Prop100yr_Seg3E	19049.66	-4.60	40.22		40.23	0.000021	1.08	19461.26	1333.28	0.04
W100_upstrm	117204.3	Max WS	Prop10yr_Seg3E	9223.30	-4.60	31.09		31.11	0.000018	0.82	11223.10	651.59	0.03
W100_upstrm	116395.7	Max WS	Prop100yr_Seg3E	19097.20	-3.88	40.19		40.22	0.000026	1.26	15428.76	1041.83	0.05

HEC-RAS Profile: Max WS (Continued)

Reach	River Sta	Profile	Plan	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)	
W100_upstrm	116395.7	Max WS	Prop10yr_Seg3E	9251.59	-3.88	31.08		31.09	0.000016	0.92	10025.89	503.36	0.04
W100_upstrm	116167.6	Max WS	Prop100yr_Seg3E	19090.90	-3.68	40.14	7.85	40.21	0.000103	2.16	10009.55	1199.31	0.07
W100_upstrm	116167.6	Max WS	Prop10yr_Seg3E	9192.77	-3.68	31.05	4.09	31.08	0.000061	1.52	6064.35	272.47	0.06
W100_upstrm	116121.9			Bridge									
W100_upstrm	116076.2	Max WS	Prop100yr_Seg3E	19057.90	-3.86	40.01		40.08	0.000119	2.13	10073.30	1218.74	0.07
W100_upstrm	116076.2	Max WS	Prop10yr_Seg3E	9158.40	-3.86	30.86		30.90	0.000059	1.51	6063.27	272.46	0.05
W100_upstrm	115804.5	Max WS	Prop100yr_Seg3E	19055.66	-4.60	39.97		40.07	0.000047	2.94	12771.37	1485.22	0.08
W100_upstrm	115804.5	Max WS	Prop10yr_Seg3E	9143.64	-4.60	30.83		30.89	0.000030	1.99	6205.99	305.69	0.06
W100_upstrm	115740.6	Max WS	Prop100yr_Seg3E	19061.47	-4.78	39.97	8.33	40.06	0.000042	2.73	12248.58	1552.79	0.08
W100_upstrm	115740.6	Max WS	Prop10yr_Seg3E	9149.63	-4.78	30.84	4.24	30.89	0.000028	1.87	6276.09	343.29	0.06
W100_upstrm	115700			Bridge									
W100_upstrm	115674.0	Max WS	Prop100yr_Seg3E	19048.74	-5.10	39.94		40.03	0.000044	2.75	12427.46	1692.02	0.08
W100_upstrm	115674.0	Max WS	Prop10yr_Seg3E	9147.48	-5.10	30.83		30.88	0.000030	1.92	6622.45	429.50	0.06
W100_upstrm	115662.6	Max WS	Prop100yr_Seg3E	19050.53	-5.20	39.94	8.33	40.03	0.000042	2.66	12145.53	1765.14	0.08
W100_upstrm	115662.6	Max WS	Prop10yr_Seg3E	9148.13	-5.20	30.83	3.97	30.88	0.000029	1.85	6749.76	443.87	0.06
W100_upstrm	115635.5			Bridge									
W100_upstrm	115621.1	Max WS	Prop100yr_Seg3E	19058.38	-5.57	39.94		40.02	0.000034	2.50	12702.25	1812.88	0.07
W100_upstrm	115621.1	Max WS	Prop10yr_Seg3E	9158.86	-5.57	30.84		30.87	0.000023	1.71	7451.90	566.57	0.05
W100_upstrm	115587.7	Max WS	Prop100yr_Seg3E	19067.42	-6.22	39.95	8.18	40.01	0.000033	2.45	16911.37	2075.36	0.07
W100_upstrm	115587.7	Max WS	Prop10yr_Seg3E	9158.49	-6.22	30.83	3.76	30.88	0.000026	1.83	7900.34	625.48	0.06
W100_upstrm	115553.5			Bridge									
W100_upstrm	115514.4	Max WS	Prop100yr_Seg3E	19066.44	-6.96	39.96		40.01	0.000024	2.10	18677.69	2240.83	0.06
W100_upstrm	115514.4	Max WS	Prop10yr_Seg3E	9169.24	-6.96	30.84		30.87	0.000018	1.53	8835.20	613.12	0.05
W100_upstrm	115509.1	Max WS	Prop100yr_Seg3E	19066.85	-6.99	39.96	7.23	40.01	0.000024	2.12	18713.17	2270.73	0.06
W100_upstrm	115509.1	Max WS	Prop10yr_Seg3E	9169.56	-6.99	30.84	3.33	30.87	0.000019	1.55	8875.87	604.05	0.05
W100_upstrm	115490			Bridge									
W100_upstrm	115423.0	Max WS	Prop100yr_Seg3E	19063.94	-7.30	39.94		39.99	0.000023	2.02	17841.40	2089.85	0.06
W100_upstrm	115423.0	Max WS	Prop10yr_Seg3E	9173.89	-7.30	30.84		30.87	0.000016	1.41	9059.54	516.57	0.05
W100_upstrm	115365.4	Max WS	Prop100yr_Seg3E	19069.98	-7.52	39.94		39.99	0.000021	1.94	19201.06	2271.98	0.05
W100_upstrm	115365.4	Max WS	Prop10yr_Seg3E	9177.13	-7.52	30.84		30.87	0.000014	1.34	9159.10	543.55	0.04
W100_upstrm	115284.6	Max WS	Prop100yr_Seg3E	19075.54	-7.89	39.94		39.99	0.000022	2.00	25265.06	1778.15	0.06
W100_upstrm	115284.6	Max WS	Prop10yr_Seg3E	9173.70	-7.89	30.84		30.87	0.000017	1.50	12881.44	1169.39	0.05
W100_upstrm	115104.1	Max WS	Prop100yr_Seg3E	19077.98	-8.31	39.94		39.98	0.000018	1.85	21150.09	1832.77	0.05
W100_upstrm	115104.1	Max WS	Prop10yr_Seg3E	9181.78	-8.31	30.84		30.86	0.000011	1.24	10797.93	761.92	0.04
W100_upstrm	115001.2	Max WS	Prop100yr_Seg3E	19081.97	-8.48	39.91	6.11	40.01	0.000040	2.75	18354.97	1760.99	0.08
W100_upstrm	115001.2	Max WS	Prop10yr_Seg3E	9169.63	-8.48	30.82	2.14	30.87	0.000026	1.85	7976.66	610.31	0.06
W100_upstrm	115000			Bridge									
W100_upstrm	114907.3	Max WS	Prop100yr_Seg3E	19078.88	-9.19	39.91		40.00	0.000036	2.51	16194.96	1728.11	0.07
W100_upstrm	114907.3	Max WS	Prop10yr_Seg3E	9178.45	-9.19	30.82		30.87	0.000022	1.66	7498.12	510.25	0.05
W100_upstrm	114842.1	Max WS	Prop100yr_Seg3E	19083.72	-9.48	39.90	5.78	40.00	0.000041	2.65	16114.91	1676.70	0.07
W100_upstrm	114842.1	Max WS	Prop10yr_Seg3E	9173.48	-9.48	30.82	1.84	30.87	0.000026	1.77	7477.40	543.65	0.06
W100_upstrm	114830			Bridge									
W100_upstrm	114804.3	Max WS	Prop100yr_Seg3E	19078.56	-9.61	39.89		39.99	0.000042	2.67	15828.21	1610.57	0.08
W100_upstrm	114804.3	Max WS	Prop10yr_Seg3E	9171.28	-9.61	30.81		30.86	0.000028	1.80	7702.59	547.70	0.06
W100_upstrm	114492.0	Max WS	Prop100yr_Seg3E	19105.24	-10.48	39.91		39.96	0.000039	1.80	13574.97	1548.35	0.07
W100_upstrm	114492.0	Max WS	Prop10yr_Seg3E	9197.25	-10.48	30.82		30.85	0.000026	1.38	6676.36	337.97	0.05
W100_upstrm	114195.9	Max WS	Prop100yr_Seg3E	19099.80	-11.52	39.86	5.70	39.92	0.000213	2.10	11350.49	1251.17	0.08
W100_upstrm	114195.9	Max WS	Prop10yr_Seg3E	9185.94	-11.52	30.79	1.16	30.83	0.000087	1.62	5677.99	310.96	0.06
W100_upstrm	114168.9			Bridge									
W100_upstrm	114141.9	Max WS	Prop100yr_Seg3E	19040.92	-10.83	39.78		39.85	0.000235	2.18	10441.54	1150.29	0.08
W100_upstrm	114141.9	Max WS	Prop10yr_Seg3E	9108.72	-10.83	30.75		30.80	0.000092	1.66	5476.31	302.05	0.07
W100_upstrm	114097.4	Max WS	Prop100yr_Seg3E	19058.06	-7.46	39.79	7.10	39.84	0.000096	1.88	13177.93	1479.10	0.07
W100_upstrm	114097.4	Max WS	Prop10yr_Seg3E	9138.87	-7.46	30.76	3.06	30.79	0.000051	1.42	6453.30	358.16	0.06
W100_upstrm	114070.4			Bridge									
W100_upstrm	114043.4	Max WS	Prop100yr_Seg3E	19019.95	-7.72	39.74		39.79	0.000092	1.85	13523.34	1573.07	0.07
W100_upstrm	114043.4	Max WS	Prop10yr_Seg3E	9100.07	-7.72	29.81		29.84	0.000056	1.46	6228.97	356.59	0.06

HEC-RAS Profile: Max WS (Continued)

Reach	River Sta	Profile	Plan	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)	
W100_upstrm	113644.0	Max WS	Prop100yr_Seg3E	19006.65	-8.91	39.68		39.78	0.000045	2.64	11569.59	902.54	0.08
W100_upstrm	113644.0	Max WS	Prop10yr_Seg3E	9070.18	-8.91	29.77		29.82	0.000037	1.89	5689.38	433.51	0.07
W100_upstrm	113411.6	Max WS	Prop100yr_Seg3E	19046.74	-9.61	39.71	4.23	39.74	0.000139	1.35	14362.05	944.43	0.05
W100_upstrm	113411.6	Max WS	Prop10yr_Seg3E	9087.39	-9.61	29.77	0.24	29.81	0.000035	1.63	5570.21	374.49	0.05
W100_upstrm	113374.3			Bridge									
W100_upstrm	113337.0	Max WS	Prop100yr_Seg3E	18873.10	-9.65	39.53		39.56	0.000139	1.35	14242.22	945.76	0.05
W100_upstrm	113337.0	Max WS	Prop10yr_Seg3E	9029.50	-9.65	29.65		29.69	0.000034	1.63	5555.17	374.28	0.05
W100_upstrm	113266.4	Max WS	Prop100yr_Seg3E	18805.90	-9.11	39.46	7.53	39.57	0.000177	2.73	9211.12	832.46	0.09
W100_upstrm	113266.4	Max WS	Prop10yr_Seg3E	9022.72	-9.11	29.62	2.73	29.69	0.000142	2.04	4667.82	243.46	0.08
W100_upstrm	113238.6			Bridge									
W100_upstrm	113210.8	Max WS	Prop100yr_Seg3E	18688.01	-9.46	39.34		39.44	0.000173	2.69	9401.33	858.27	0.09
W100_upstrm	113210.8	Max WS	Prop10yr_Seg3E	9014.10	-9.46	29.21		29.27	0.000146	2.04	4651.71	243.21	0.08
W100_upstrm	112974.0	Max WS	Prop100yr_Seg3E	18640.81	-10.69	39.28	6.61	39.40	0.000160	2.83	7627.54	816.63	0.09
W100_upstrm	112974.0	Max WS	Prop10yr_Seg3E	9020.77	-10.69	29.17	0.83	29.24	0.000097	2.05	4401.48	202.81	0.08
W100_upstrm	112944.9			Bridge									
W100_upstrm	112915.8	Max WS	Prop100yr_Seg3E	18475.18	-10.82	39.23		39.35	0.000156	2.79	7693.97	820.12	0.09
W100_upstrm	112915.8	Max WS	Prop10yr_Seg3E	9016.78	-10.82	29.02		29.09	0.000097	2.05	4396.94	202.77	0.08
W100_upstrm	112575.5	Max WS	Prop100yr_Seg3E	18493.88	-9.20	39.22	7.96	39.28	0.000155	2.12	12860.82	1409.08	0.07
W100_upstrm	112575.5	Max WS	Prop10yr_Seg3E	9030.46	-9.20	29.00	3.01	29.05	0.000117	1.74	5180.05	242.01	0.06
W100_upstrm	112534.5			Bridge									
W100_upstrm	112493.5	Max WS	Prop100yr_Seg3E	18411.82	-9.47	39.17		39.23	0.000149	2.09	13178.56	1449.22	0.06
W100_upstrm	112493.5	Max WS	Prop10yr_Seg3E	8973.59	-9.47	28.96		29.01	0.000113	1.72	5229.65	242.41	0.06
W100_upstrm	112003.3	Max WS	Prop100yr_Seg3E	18382.44	-9.69	39.10	5.04	39.16	0.000111	1.90	11081.42	977.81	0.06
W100_upstrm	112003.3	Max WS	Prop10yr_Seg3E	8961.11	-9.69	28.93	1.78	28.96	0.000071	1.42	6293.92	291.46	0.05
W100_upstrm	111953.3			Bridge									
W100_upstrm	111903.3	Max WS	Prop100yr_Seg3E	18261.50	-9.84	38.99		39.04	0.000109	1.89	11112.80	982.28	0.06
W100_upstrm	111903.3	Max WS	Prop10yr_Seg3E	8892.53	-9.84	28.88		28.91	0.000070	1.41	6322.05	291.87	0.05
W100_upstrm	111853.5	Max WS	Prop100yr_Seg3E	18254.69	-9.86	38.97	4.98	39.04	0.000122	2.12	10301.13	957.51	0.06
W100_upstrm	111853.5	Max WS	Prop10yr_Seg3E	8883.42	-9.86	28.87	1.29	28.91	0.000073	1.51	5898.45	231.04	0.05
W100_upstrm	111818.6			Bridge									
W100_upstrm	111783.7	Max WS	Prop100yr_Seg3E	18155.51	-8.67	38.90		38.97	0.000139	2.22	9231.94	750.03	0.07
W100_upstrm	111783.7	Max WS	Prop10yr_Seg3E	8831.69	-8.67	28.85		28.89	0.000081	1.57	5623.84	227.37	0.06
W100_upstrm	111626.7	Max WS	Prop100yr_Seg3E	18155.98	-11.83	38.88	5.29	38.95	0.000131	2.09	10687.13	850.48	0.06
W100_upstrm	111626.7	Max WS	Prop10yr_Seg3E	8823.02	-11.83	28.84	0.94	28.87	0.000087	1.51	5831.15	232.09	0.05
W100_upstrm	111518.6			Bridge									
W100_upstrm	111410.5	Max WS	Prop100yr_Seg3E	17901.76	-11.23	38.68		38.75	0.000099	2.14	10026.11	800.57	0.07
W100_upstrm	111410.5	Max WS	Prop10yr_Seg3E	8661.07	-11.23	28.76		28.79	0.000058	1.53	5673.63	230.95	0.05
W100_upstrm	110876.6	Max WS	Prop100yr_Seg3E	17930.67	-10.43	38.67	2.58	38.70	0.000056	1.48	18696.34	1612.66	0.05
W100_upstrm	110876.6	Max WS	Prop10yr_Seg3E	8651.17	-10.43	28.74	-0.93	28.76	0.000058	1.17	7452.38	449.79	0.04
W100_upstrm	110837.8			Bridge									
W100_upstrm	110799.0	Max WS	Prop100yr_Seg3E	17906.82	-10.72	38.66		38.68	0.000146	1.41	19147.51	1616.61	0.04
W100_upstrm	110799.0	Max WS	Prop10yr_Seg3E	8598.42	-10.72	28.68		28.70	0.000158	1.15	7548.85	465.48	0.04
W100_upstrm	110672.7	Max WS	Prop100yr_Seg3E	17894.14	-13.25	38.64	2.69	38.67	0.000113	1.68	19948.42	1447.83	0.05
W100_upstrm	110672.7	Max WS	Prop10yr_Seg3E	8557.78	-13.25	28.66	-1.86	28.69	0.000127	1.39	8062.85	729.37	0.05
W100_upstrm	110643.7			Bridge									
W100_upstrm	110614.7	Max WS	Prop100yr_Seg3E	17874.27	-12.75	38.60		38.64	0.000126	1.71	19177.42	1434.38	0.05
W100_upstrm	110614.7	Max WS	Prop10yr_Seg3E	8531.92	-12.75	28.64		28.67	0.000143	1.43	7748.04	709.35	0.05
W100_upstrm	110200.2	Max WS	Prop100yr_Seg3E	17857.47	-9.11	38.57	5.09	38.60	0.000038	1.53	14002.08	779.17	0.05
W100_upstrm	110200.2	Max WS	Prop10yr_Seg3E	8484.83	-9.11	28.61	1.08	28.63	0.000026	1.11	8044.51	486.17	0.04
W100_upstrm	110154.2			Bridge									
W100_upstrm	110108.2	Max WS	Prop100yr_Seg3E	17843.00	-9.31	38.55		38.59	0.000037	1.52	14146.88	782.66	0.05
W100_upstrm	110108.2	Max WS	Prop10yr_Seg3E	8463.54	-9.31	28.41		28.42	0.000026	1.11	8042.80	486.11	0.04
W100_upstrm	110103.2	Max WS	Prop100yr_Seg3E	17834.42	-9.31	38.55		38.59	0.000037	1.52	14146.73	782.66	0.05
W100_upstrm	110103.2	Max WS	Prop10yr_Seg3E	8466.44	-9.31	28.41		28.42	0.000026	1.11	8042.73	486.11	0.04
Downstream	109924.2	Max WS	Prop100yr_Seg3E	57159.41	-13.02	38.55		39.00	0.000564	5.45	12954.84	2508.47	0.16

HEC-RAS Profile: Max WS (Continued)

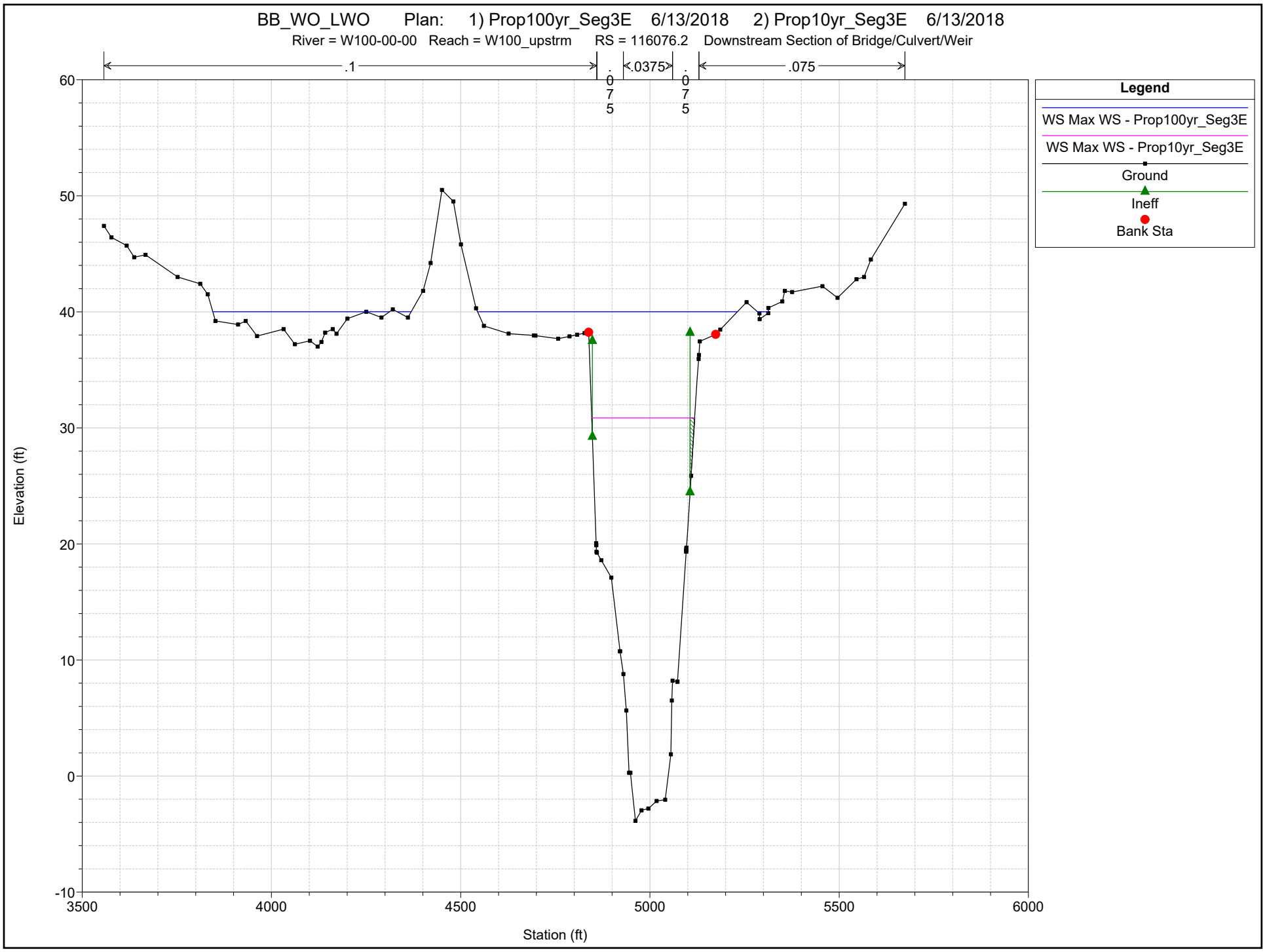
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Downstream	109924.2	Max WS	Prop10yr_Seg3E	33148.11	-13.02	28.41		28.73	0.000579	4.56	7460.65	378.51	0.16
Downstream	109551.7	Max WS	Prop100yr_Seg3E	57155.80	-14.28	38.42	9.95	38.78	0.000536	4.86	14878.36	2218.95	0.15
Downstream	109551.7	Max WS	Prop10yr_Seg3E	33147.68	-14.28	28.25	3.46	28.52	0.000528	4.21	7882.57	345.40	0.16
Downstream	109518.7			Bridge									
Downstream	109485.7	Max WS	Prop100yr_Seg3E	57153.08	-15.31	38.23		38.56	0.000477	4.68	16750.31	2245.00	0.15
Downstream	109485.7	Max WS	Prop10yr_Seg3E	33147.32	-15.31	27.36		27.64	0.000519	4.18	7933.90	345.96	0.15
Downstream	109440.2	Max WS	Prop100yr_Seg3E	57150.39	-16.48	38.13	8.86	38.54	0.000819	5.14	12018.47	2405.08	0.16
Downstream	109440.2	Max WS	Prop10yr_Seg3E	33147.16	-16.48	27.30	2.86	27.60	0.000938	4.44	7460.39	325.05	0.16
Downstream	109395.2			Bridge									
Downstream	109350.2	Max WS	Prop100yr_Seg3E	57131.98	-16.89	37.32		37.74	0.000856	5.21	11677.79	2392.17	0.16
Downstream	109350.2	Max WS	Prop10yr_Seg3E	33146.29	-16.89	26.96		27.27	0.000928	4.43	7485.73	325.16	0.16
Downstream	109119.0	Max WS	Prop100yr_Seg3E	57126.21	-17.14	37.01	10.44	37.36	0.002422	4.82	13671.34	2322.43	0.18
Downstream	109119.0	Max WS	Prop10yr_Seg3E	33145.00	-17.14	26.55	3.52	27.00	0.001404	5.40	6136.97	410.55	0.23
Downstream	109103.1			Bridge									
Downstream	109087.2	Max WS	Prop100yr_Seg3E	57124.77	-17.55	36.73		37.08	0.002370	4.79	13825.64	2362.85	0.18
Downstream	109087.2	Max WS	Prop10yr_Seg3E	33143.76	-17.55	26.37		26.81	0.001369	5.33	6218.01	417.45	0.22
Downstream	108565.3	Max WS	Prop100yr_Seg3E	57111.38	-12.77	35.77		36.23	0.000987	5.55	14283.36	1960.67	0.17
Downstream	108565.3	Max WS	Prop10yr_Seg3E	33141.99	-12.77	25.84		26.21	0.000953	4.84	6945.30	415.31	0.18
Downstream	108334.0	Max WS	Prop100yr_Seg3E	57109.71	-14.06	35.55		35.89	0.001010	4.88	16976.62	1729.96	0.16
Downstream	108334.0	Max WS	Prop10yr_Seg3E	33141.60	-14.06	25.62		25.93	0.001319	4.50	7842.95	710.47	0.17
Downstream	107179.4	Max WS	Prop100yr_Seg3E	57105.44	-20.52	34.43	5.50	34.95	0.000934	6.02	10593.19	775.07	0.19
Downstream	107179.4	Max WS	Prop10yr_Seg3E	33138.20	-20.52	24.22	-0.16	24.67	0.000978	5.43	6514.11	392.94	0.20
Downstream	107158.9			Bridge									
Downstream	107138.4	Max WS	Prop100yr_Seg3E	57104.23	-20.19	34.23		34.78	0.000982	6.14	10376.22	544.34	0.19
Downstream	107138.4	Max WS	Prop10yr_Seg3E	33137.78	-20.19	24.06		24.54	0.001040	5.56	6325.04	392.12	0.21
Downstream	106594.0	Max WS	Prop100yr_Seg3E	57101.95	-16.70	33.53		34.08	0.001526	5.96	9661.63	660.44	0.19
Downstream	106594.0	Max WS	Prop10yr_Seg3E	33137.36	-16.70	23.67		24.04	0.000763	4.86	6824.75	253.83	0.17
Downstream	106151.4	Max WS	Prop100yr_Seg3E	57098.85	-13.85	32.60	7.71	33.23	0.002302	6.37	8958.57	305.52	0.21
Downstream	106151.4	Max WS	Prop10yr_Seg3E	33136.46	-13.85	23.09	2.31	23.53	0.001567	5.29	6268.25	261.17	0.19
Downstream	106131.1			Bridge									
Downstream	106110.8	Max WS	Prop100yr_Seg3E	57097.01	-12.53	32.24		32.95	0.002590	6.76	8450.97	297.44	0.22
Downstream	106110.8	Max WS	Prop10yr_Seg3E	33135.95	-12.53	22.81		23.30	0.001795	5.66	5854.74	254.35	0.21
Downstream	105705.4	Max WS	Prop100yr_Seg3E	57095.26	-18.22	31.67	6.21	32.31	0.000575	6.41	8927.44	484.79	0.23
Downstream	105705.4	Max WS	Prop10yr_Seg3E	33134.99	-18.22	22.35	0.83	22.83	0.000561	5.56	5962.63	266.87	0.21
Downstream	105667.4			Bridge									
Downstream	105629.4	Max WS	Prop100yr_Seg3E	57094.96	-18.43	31.33		31.98	0.000583	6.44	8874.85	455.69	0.23
Downstream	105629.4	Max WS	Prop10yr_Seg3E	33134.73	-18.43	22.03		22.52	0.000569	5.58	5934.48	265.63	0.21
Downstream	105476	Max WS	Prop100yr_Seg3E	57094.62	-18.70	31.31		31.80	0.001594	5.60	10226.38	459.42	0.20
Downstream	105476	Max WS	Prop10yr_Seg3E	33134.71	-18.70	21.92		22.33	0.001687	5.11	6486.27	368.24	0.21
Downstream	104962	Max WS	Prop100yr_Seg3E	57094.05	-18.70	30.99	7.14	31.17	0.000767	3.38	16939.67	905.62	0.13
Downstream	104962	Max WS	Prop10yr_Seg3E	33133.98	-18.70	21.50	1.82	21.65	0.000887	3.18	10423.18	618.81	0.14
Downstream	104948			Bridge									
Downstream	104900.1	Max WS	Prop100yr_Seg3E	57093.54	-19.15	30.90		31.06	0.000193	3.18	17969.68	931.58	0.13
Downstream	104900.1	Max WS	Prop10yr_Seg3E	33133.88	-19.15	21.36		21.52	0.000234	3.19	10397.41	650.49	0.14
Downstream	104900	Max WS	Prop100yr_Seg3E	57093.54	-19.15	30.90	7.08	31.06	0.000193	3.18	17969.66	931.58	0.13
Downstream	104900	Max WS	Prop10yr_Seg3E	33133.98	-19.15	21.36	1.67	21.52	0.000234	3.19	10397.38	650.49	0.14
Downstream	104566			Bridge									
Downstream	104464.1	Max WS	Prop100yr_Seg3E	57092.20	-19.86	30.52		30.76	0.001672	3.95	14445.74	765.35	0.16
Downstream	104464.1	Max WS	Prop10yr_Seg3E	33133.24	-19.86	20.89		21.17	0.001743	4.23	7841.79	515.04	0.19
Downstream	104464	Max WS	Prop100yr_Seg3E	57092.20	-19.86	30.52	6.31	30.76	0.001672	3.95	14445.61	765.34	0.16
Downstream	104464	Max WS	Prop10yr_Seg3E	33133.36	-19.86	20.89	1.39	21.17	0.001743	4.23	7841.70	515.03	0.19
Downstream	104383			Bridge									
Downstream	104301.1	Max WS	Prop100yr_Seg3E	57090.80	-20.42	30.23		30.53	0.000280	4.41	13059.46	817.80	0.18
Downstream	104301.1	Max WS	Prop10yr_Seg3E	33132.68	-20.42	20.67		20.98	0.000310	4.45	7447.80	476.75	0.20
Downstream	104301	Max WS	Prop100yr_Seg3E	57090.80	-20.42	30.23	6.03	30.53	0.000280	4.41	13059.44	817.80	0.18
Downstream	104301	Max WS	Prop10yr_Seg3E	33132.68	-20.42	20.67	1.45	20.98	0.000310	4.45	7447.78	476.75	0.20

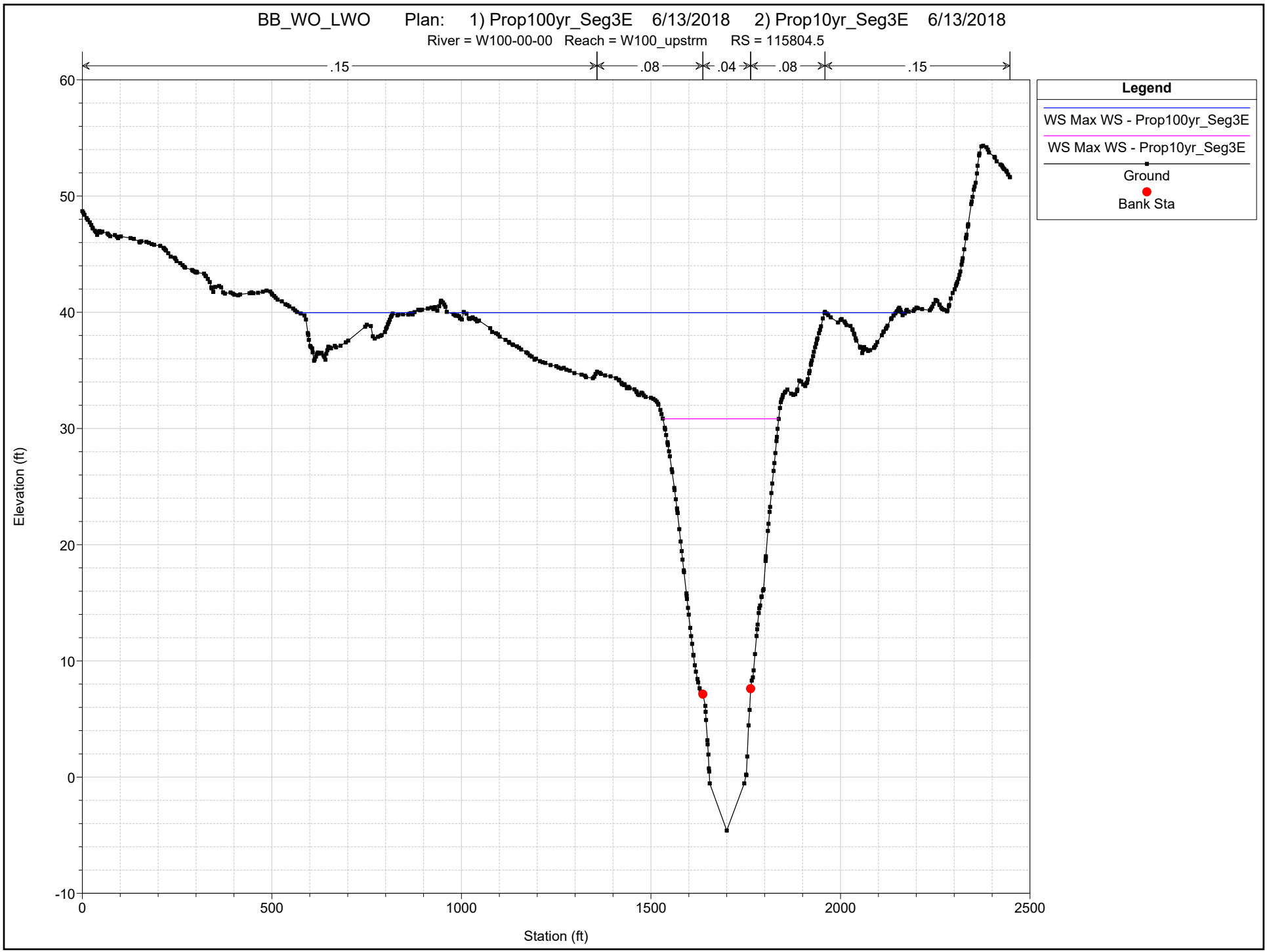
HEC-RAS Profile: Max WS (Continued)

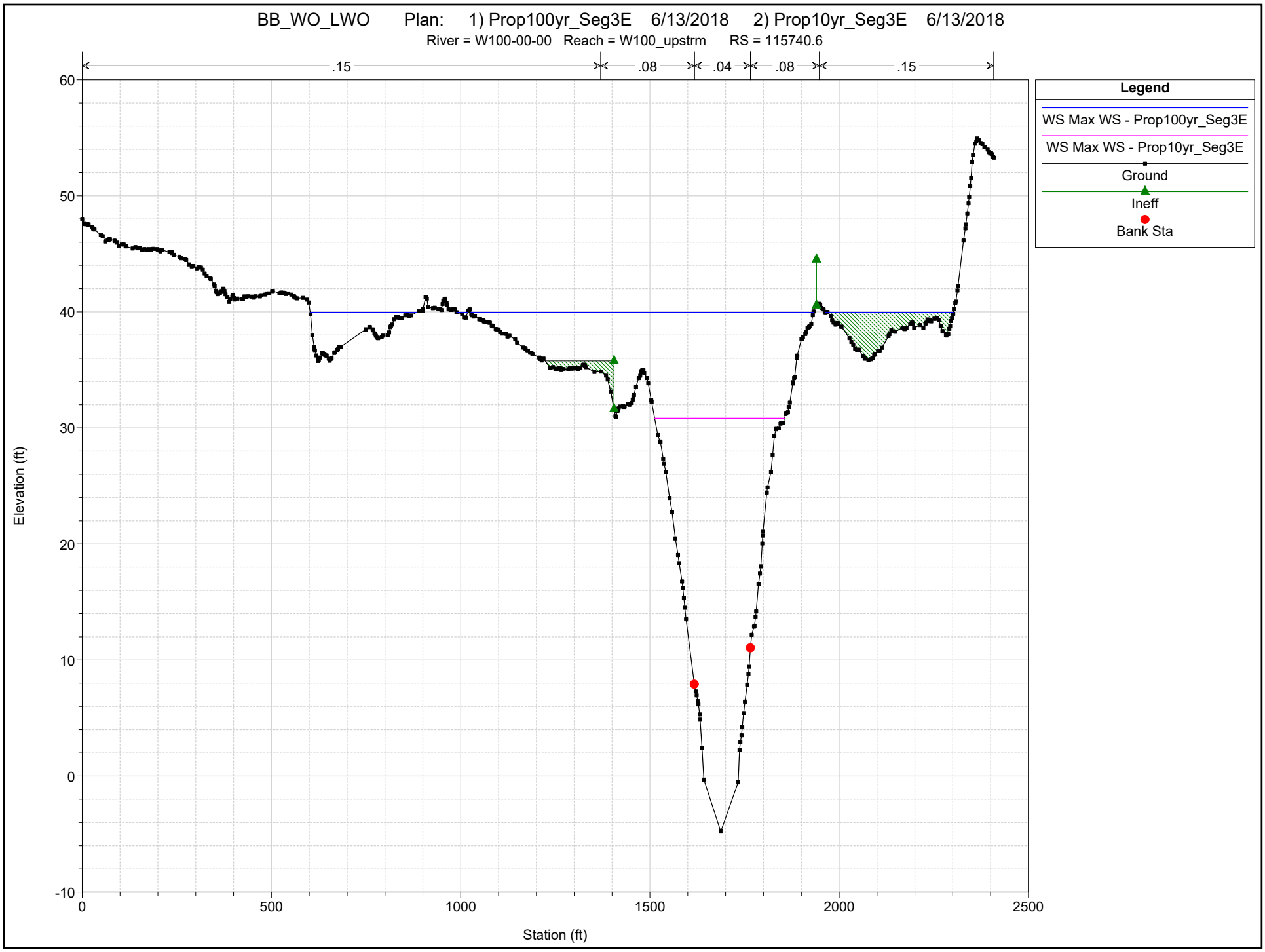
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Downstream	104271			Bridge									
Downstream	104242.1	Max WS	Prop100yr_Seg3E	57089.63	-20.62	29.86		30.26	0.002978	5.04	11335.88	601.64	0.20
Downstream	104242.1	Max WS	Prop10yr_Seg3E	33132.45	-20.62	20.45		20.80	0.001255	4.78	6929.99	384.53	0.20
Downstream	104242	Max WS	Prop100yr_Seg3E	57089.48	-20.62	29.86	7.23	30.25	0.002978	5.04	11335.71	601.63	0.20
Downstream	104242	Max WS	Prop10yr_Seg3E	33132.32	-20.62	20.45	1.46	20.80	0.001255	4.78	6929.96	384.53	0.20
Downstream	104204			Bridge									
Downstream	104133	Max WS	Prop100yr_Seg3E	57086.01	-21.02	29.00		29.59	0.000654	6.19	10709.59	1137.81	0.28
Downstream	104133	Max WS	Prop10yr_Seg3E	33130.54	-21.02	19.53		20.20	0.000753	6.60	5019.83	282.58	0.28
Downstream	103664.0	Max WS	Prop100yr_Seg3E	57084.12	-23.03	28.45		29.19	0.001477	7.13	10200.23	930.08	0.26
Downstream	103664.0	Max WS	Prop10yr_Seg3E	33128.88	-23.03	18.70		19.51	0.002222	7.21	4597.12	267.17	0.31
Downstream	102875.3	Max WS	Prop100yr_Seg3E	57082.15	-26.39	27.43	9.80	28.05	0.001403	6.30	9061.63	406.10	0.24
Downstream	102875.3	Max WS	Prop10yr_Seg3E	33126.06	-26.39	17.29	-1.42	17.90	0.001851	6.29	5267.43	345.72	0.28
Downstream	102847.5			Bridge									
Downstream	102819.7	Max WS	Prop100yr_Seg3E	57081.52	-26.43	27.02		27.66	0.001459	6.40	8912.62	403.57	0.24
Downstream	102819.7	Max WS	Prop10yr_Seg3E	33125.66	-26.43	16.92		17.57	0.001957	6.42	5156.62	343.78	0.29
Downstream	102309.0	Max WS	Prop100yr_Seg3E	57134.86	-23.48	26.36		27.12	0.000658	6.99	8170.89	232.25	0.21
Downstream	102309.0	Max WS	Prop10yr_Seg3E	33164.13	-23.48	16.49		16.97	0.000373	5.54	5982.50	216.72	0.19
Downstream	101828.0	Max WS	Prop100yr_Seg3E	57183.96	-20.70	25.84	3.02	26.62	0.001422	7.08	8109.38	374.84	0.25
Downstream	101828.0	Max WS	Prop10yr_Seg3E	33199.44	-20.70	16.12	-2.04	16.73	0.000630	6.25	5311.34	232.36	0.23
Downstream	101790.1			Bridge									
Downstream	101752.2	Max WS	Prop100yr_Seg3E	57182.97	-20.69	25.52		26.32	0.001479	7.18	7987.25	369.98	0.26
Downstream	101752.2	Max WS	Prop10yr_Seg3E	33199.08	-20.69	15.96		16.57	0.000607	6.30	5270.87	228.85	0.23
Downstream	101007.3	Max WS	Prop100yr_Seg3E	57261.91	-16.93	24.89		25.61	0.000409	6.83	8388.21	285.32	0.22
Downstream	101007.3	Max WS	Prop10yr_Seg3E	33256.09	-16.93	15.70		16.20	0.000388	5.65	5881.14	258.87	0.21
Downstream	99992.6	Max WS	Prop100yr_Seg3E	57367.41	-18.90	24.28		25.09	0.000624	7.19	7984.10	275.51	0.24
Downstream	99992.6	Max WS	Prop10yr_Seg3E	33331.91	-18.90	15.23		15.78	0.000431	5.93	5620.96	242.25	0.22
Downstream	98399.4	Max WS	Prop100yr_Seg3E	57539.95	-20.26	23.46		24.22	0.000463	6.99	8234.33	289.24	0.23
Downstream	98399.4	Max WS	Prop10yr_Seg3E	33456.30	-20.26	14.59		15.10	0.000416	5.74	5824.32	254.26	0.21
Downstream	97517.4	Max WS	Prop100yr_Seg3E	57630.88	-19.35	23.40		23.86	0.000330	5.47	10531.78	323.70	0.17
Downstream	97517.4	Max WS	Prop10yr_Seg3E	33521.23	-19.35	14.51		14.81	0.000240	4.35	7707.96	312.13	0.15
Downstream	96028.6	Max WS	Prop100yr_Seg3E	57779.92	-17.81	22.37	0.93	23.05	0.000752	6.64	8704.45	319.85	0.22
Downstream	96028.6	Max WS	Prop10yr_Seg3E	33628.85	-17.81	13.78	-4.32	14.25	0.000509	5.53	6086.11	282.94	0.21
Downstream	95985.1			Bridge									
Downstream	95941.6	Max WS	Prop100yr_Seg3E	57779.46	-17.87	22.21		22.90	0.000758	6.66	8671.46	319.54	0.23
Downstream	95941.6	Max WS	Prop10yr_Seg3E	33628.79	-17.87	13.63		14.11	0.000512	5.55	6062.27	282.42	0.21
Downstream	95362.9	Max WS	Prop100yr_Seg3E	57841.54	-15.97	21.98		22.57	0.000367	6.15	9403.41	357.19	0.21
Downstream	95362.9	Max WS	Prop10yr_Seg3E	33673.32	-15.97	13.44		13.86	0.000357	5.16	6520.40	317.77	0.20
Downstream	94280.7	Max WS	Prop100yr_Seg3E	57963.29	-19.82	20.48		21.52	0.001579	8.18	7089.86	300.75	0.30
Downstream	94280.7	Max WS	Prop10yr_Seg3E	33762.65	-19.82	12.54		13.26	0.000846	6.79	4970.44	226.24	0.26
Downstream	93495.6	Max WS	Prop100yr_Seg3E	58037.22	-20.43	19.86		20.54	0.000909	6.63	8747.50	389.26	0.25
Downstream	93495.6	Max WS	Prop10yr_Seg3E	33816.50	-20.43	12.25		12.73	0.000582	5.57	6076.11	316.08	0.22
Downstream	92795.6	Max WS	Prop100yr_Seg3E	58118.71	-20.98	19.28	-1.78	20.04	0.000502	7.00	8297.45	334.20	0.25
Downstream	92795.6	Max WS	Prop10yr_Seg3E	33875.98	-20.98	11.89	-6.24	12.38	0.000417	5.63	6020.40	284.46	0.22
Downstream	92741.1			Bridge									
Downstream	92686.6	Max WS	Prop100yr_Seg3E	58118.50	-21.08	19.04		19.81	0.000510	7.05	8248.74	333.02	0.25
Downstream	92686.6	Max WS	Prop10yr_Seg3E	33875.98	-21.08	11.69		12.18	0.000423	5.65	5992.09	283.85	0.22
Downstream	90936.7	Max WS	Prop100yr_Seg3E	58303.29	-18.64	17.71		18.34	0.001160	6.38	9140.90	431.13	0.24
Downstream	90936.7	Max WS	Prop10yr_Seg3E	34010.55	-18.64	10.44		10.91	0.001032	5.50	6180.23	387.48	0.24
Downstream	89918.4	Max WS	Prop100yr_Seg3E	58411.56	-17.23	16.42		17.34	0.000853	7.78	8568.11	713.70	0.29
Downstream	89918.4	Max WS	Prop10yr_Seg3E	34089.49	-17.23	9.26		9.96	0.000828	6.70	5084.45	308.29	0.29
Downstream	88579.0	Max WS	Prop100yr_Seg3E	58551.98	-20.97	15.10		16.03	0.001083	7.75	7550.67	362.71	0.30
Downstream	88579.0	Max WS	Prop10yr_Seg3E	34191.28	-20.97	8.25		8.91	0.000735	6.51	5254.75	312.89	0.28
Downstream	87591.9	Max WS	Prop100yr_Seg3E	58662.73	-23.72	14.31		15.16	0.000666	7.43	7906.18	312.38	0.26
Downstream	87591.9	Max WS	Prop10yr_Seg3E	34271.60	-23.72	7.75		8.28	0.000533	5.82	5893.17	300.91	0.23
Downstream	86660.2	Max WS	Prop100yr_Seg3E	58751.35	-23.42	13.85	-6.76	14.58	0.000580	6.86	8567.43	313.36	0.23
Downstream	86660.2	Max WS	Prop10yr_Seg3E	34335.84	-23.42	7.46	-11.01	7.87	0.000339	5.16	6652.14	289.27	0.19

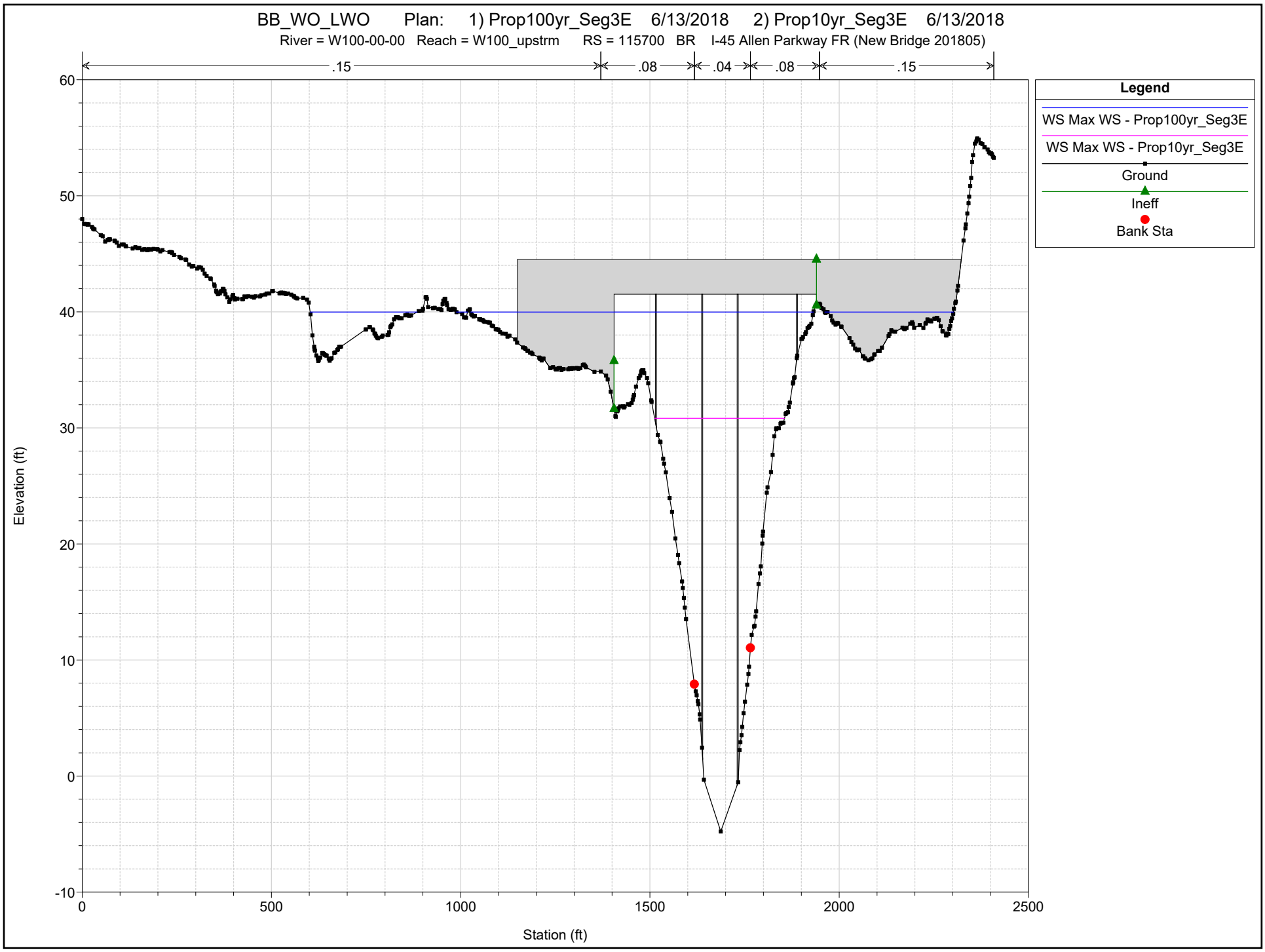
HEC-RAS Profile: Max WS (Continued)

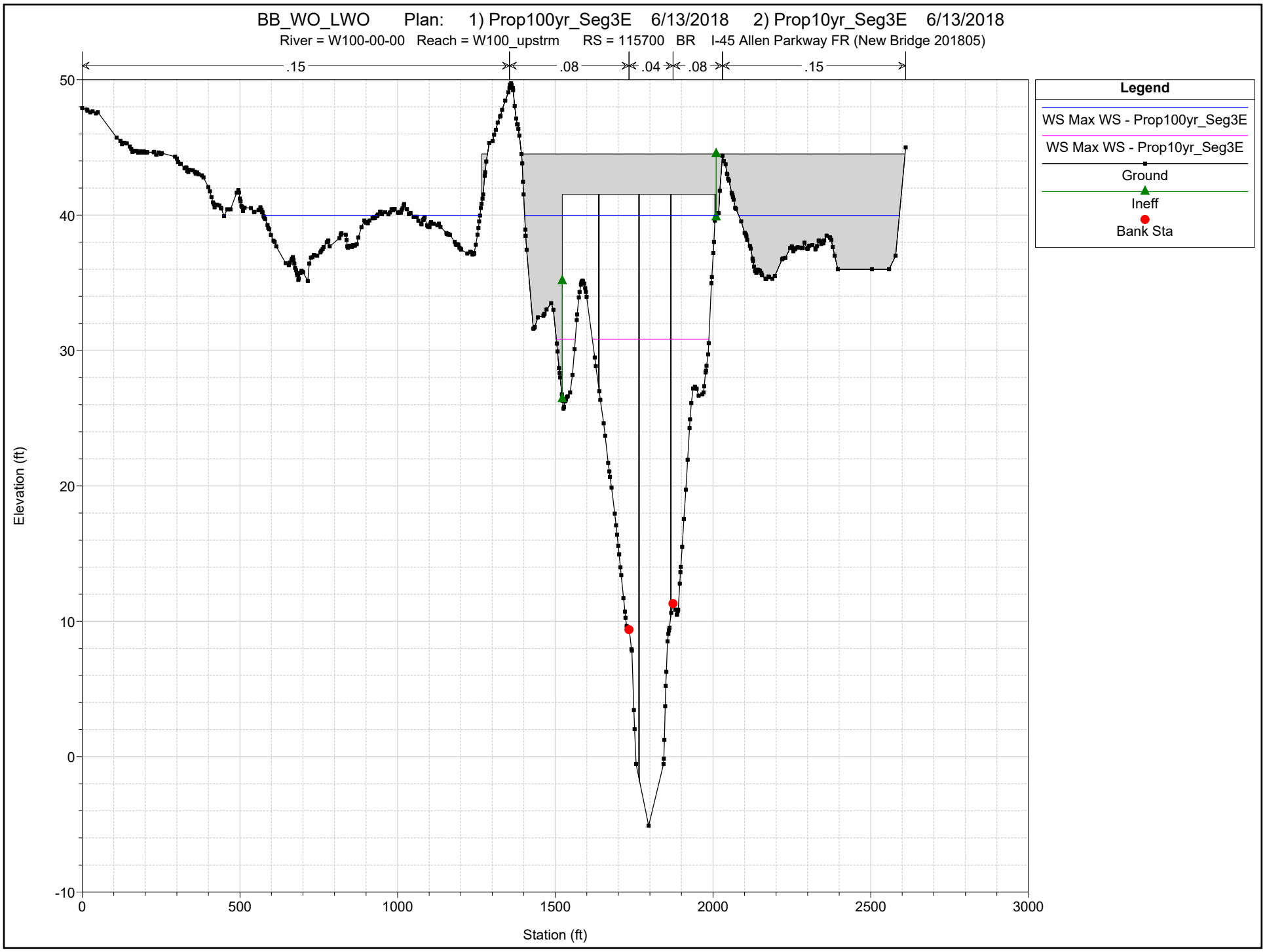
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Downstream	86641.7			Bridge									
Downstream	86623.2	Max WS	Prop100yr_Seg3E	58751.24	-23.61	13.42		14.16	0.000587	6.92	8492.18	312.39	0.23
Downstream	86623.2	Max WS	Prop10yr_Seg3E	34335.84	-23.61	7.15		7.56	0.000343	5.19	6616.89	288.94	0.19
Downstream	85855.2	Max WS	Prop100yr_Seg3E	58832.52	-26.84	11.94		13.55	0.001091	10.18	5780.28	251.55	0.37
Downstream	85855.2	Max WS	Prop10yr_Seg3E	34394.78	-26.84	6.28		7.17	0.000728	7.55	4557.85	205.36	0.28
Downstream	85238.7	Max WS	Prop100yr_Seg3E	58895.10	-29.43	11.52		12.85	0.001175	9.31	6842.87	357.88	0.31
Downstream	85238.7	Max WS	Prop10yr_Seg3E	34440.36	-29.43	6.02		6.75	0.000628	6.82	5091.07	256.12	0.25
Downstream	84561.7	Max WS	Prop100yr_Seg3E	58981.75	-32.27	11.11	-9.09	12.21	0.000629	8.46	7574.53	436.01	0.29
Downstream	84561.7	Max WS	Prop10yr_Seg3E	34503.49	-32.27	5.81	-14.24	6.39	0.000405	6.15	5663.95	287.49	0.21
Downstream	84531.4			Bridge									
Downstream	84501.1	Max WS	Prop100yr_Seg3E	58981.59	-28.97	9.98		11.58	0.001073	10.15	5923.47	305.48	0.35
Downstream	84501.1	Max WS	Prop10yr_Seg3E	34503.30	-28.97	5.28		6.08	0.000635	7.20	4790.67	208.56	0.26
Downstream	84252.6	Max WS	Prop100yr_Seg3E	59007.86	-26.90	10.02	-5.89	11.33	0.000860	9.19	6595.11	457.58	0.32
Downstream	84252.6	Max WS	Prop10yr_Seg3E	34522.50	-26.90	5.26	-10.61	5.93	0.000551	6.59	5235.17	238.30	0.25
Downstream	84222.3			Bridge									
Downstream	84192.0	Max WS	Prop100yr_Seg3E	59007.61	-24.10	8.80		10.64	0.001462	10.90	5411.43	240.57	0.41
Downstream	84192.0	Max WS	Prop10yr_Seg3E	34522.18	-24.10	4.62		5.56	0.000892	7.78	4434.77	227.71	0.31
Downstream	83635.7	Max WS	Prop100yr_Seg3E	59066.29	-21.72	8.89		9.93	0.001029	8.18	7218.96	392.13	0.34
Downstream	83635.7	Max WS	Prop10yr_Seg3E	34565.21	-21.72	4.56		5.13	0.000632	6.10	5669.30	332.29	0.26
Downstream	81786.1	Max WS	Prop100yr_Seg3E	59255.57	-31.97	7.21		8.21	0.000823	8.04	7393.97	355.28	0.31
Downstream	81786.1	Max WS	Prop10yr_Seg3E	34703.43	-31.97	3.59		4.09	0.000493	5.65	6140.30	337.13	0.23
Downstream	80903.1	Max WS	Prop100yr_Seg3E	59346.11	-27.77	6.74	-9.31	7.52	0.000739	7.09	8367.41	405.31	0.28
Downstream	80903.1	Max WS	Prop10yr_Seg3E	34769.39	-27.77	3.32	-13.28	3.70	0.000389	4.95	7018.00	384.42	0.20
Downstream	80883.1			Bridge									
Downstream	80863.1	Max WS	Prop100yr_Seg3E	59346.09	-28.10	6.14		6.94	0.000878	7.19	8259.50	404.02	0.28
Downstream	80863.1	Max WS	Prop10yr_Seg3E	34769.39	-28.10	2.91		3.30	0.000452	4.98	6988.67	384.04	0.21
Downstream	80538.0	Max WS	Prop100yr_Seg3E	59346.09	-33.12	6.42	-17.33	6.74	0.000236	4.52	13130.07	505.46	0.16
Downstream	80538.0	Max WS	Prop10yr_Seg3E	34769.39	-33.12	3.05	-20.99	3.19	0.000110	3.04	11450.59	490.80	0.11

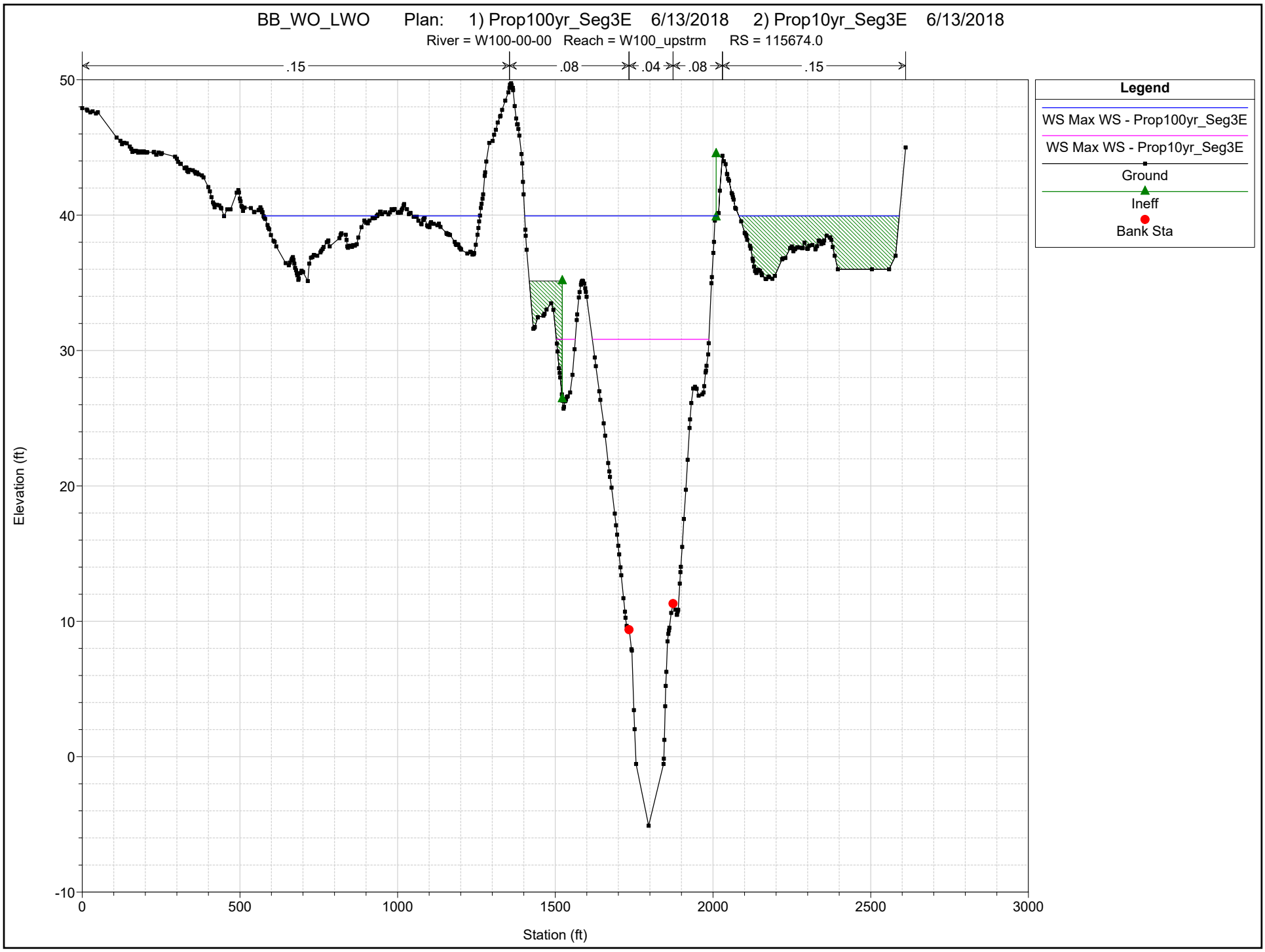

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 116076.2 Downstream Section of Bridge/Culvert/Weir
.1
.075
.0375
.075
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
60
50
40
30
20
10
0
-10
3500
4000
4500
5000
5500
6000

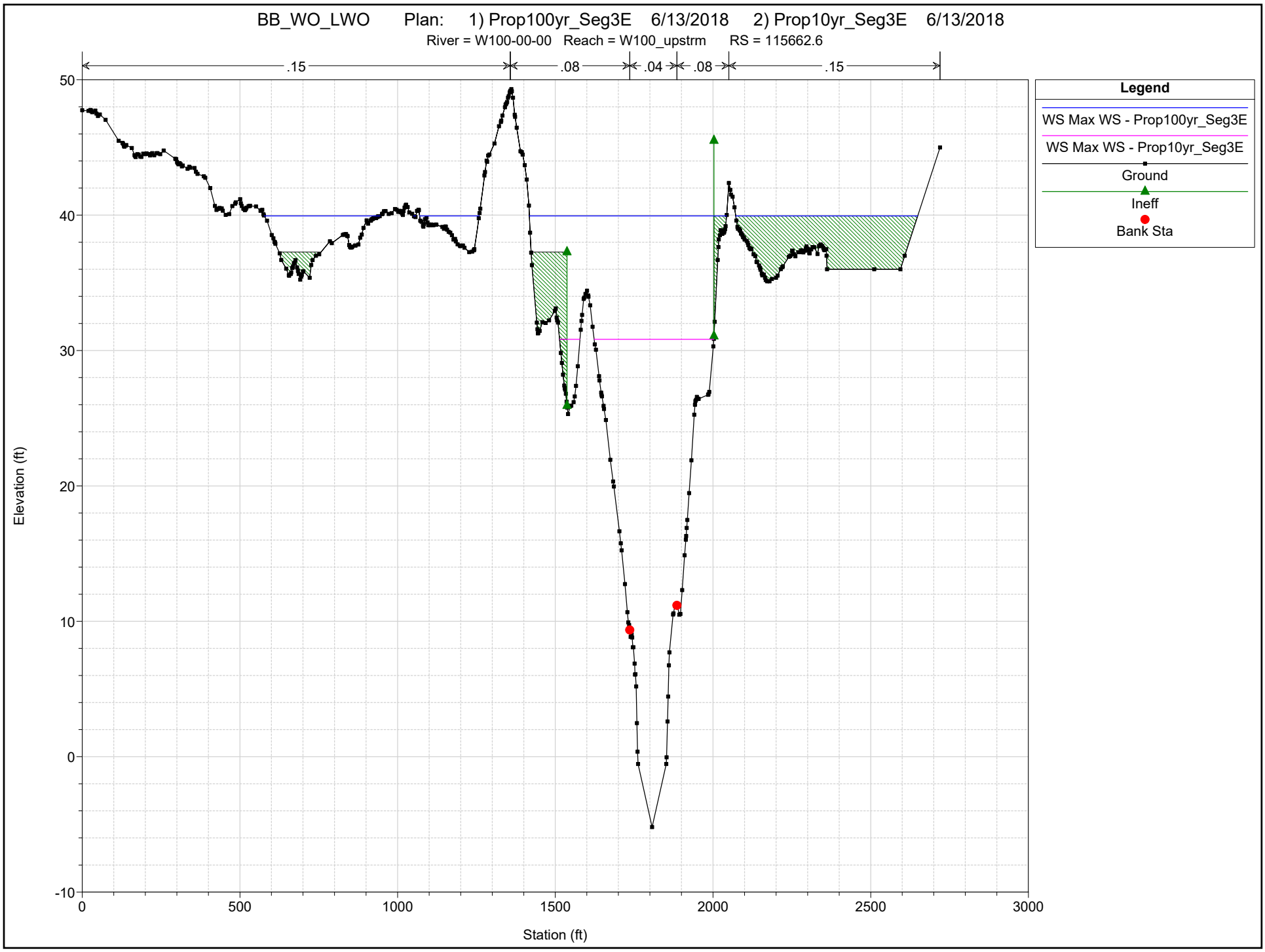

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115804.5
.15
.08
.04
.08
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
Station (ft)

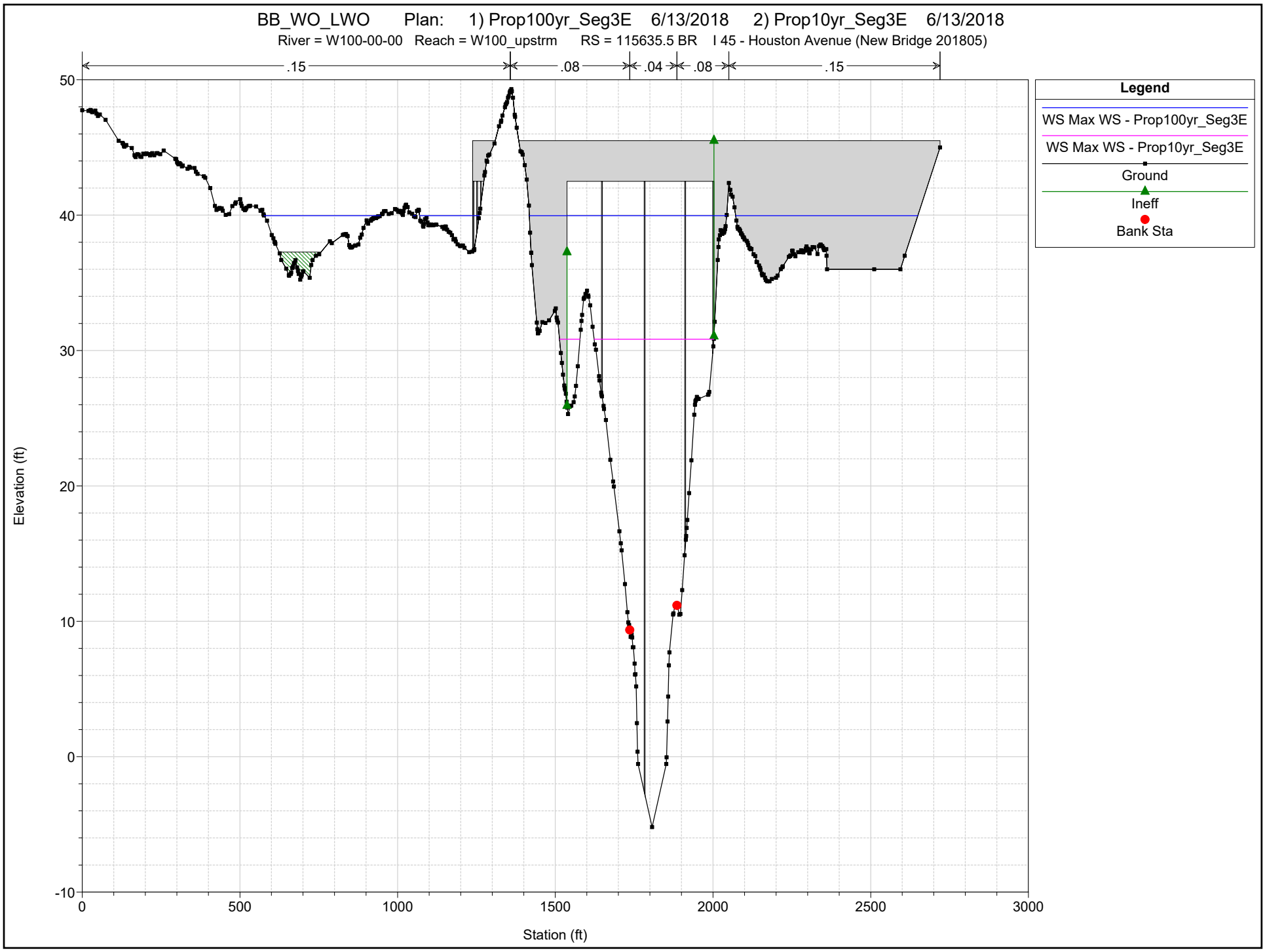

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115740.6
.15
.08
.04
.08
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500

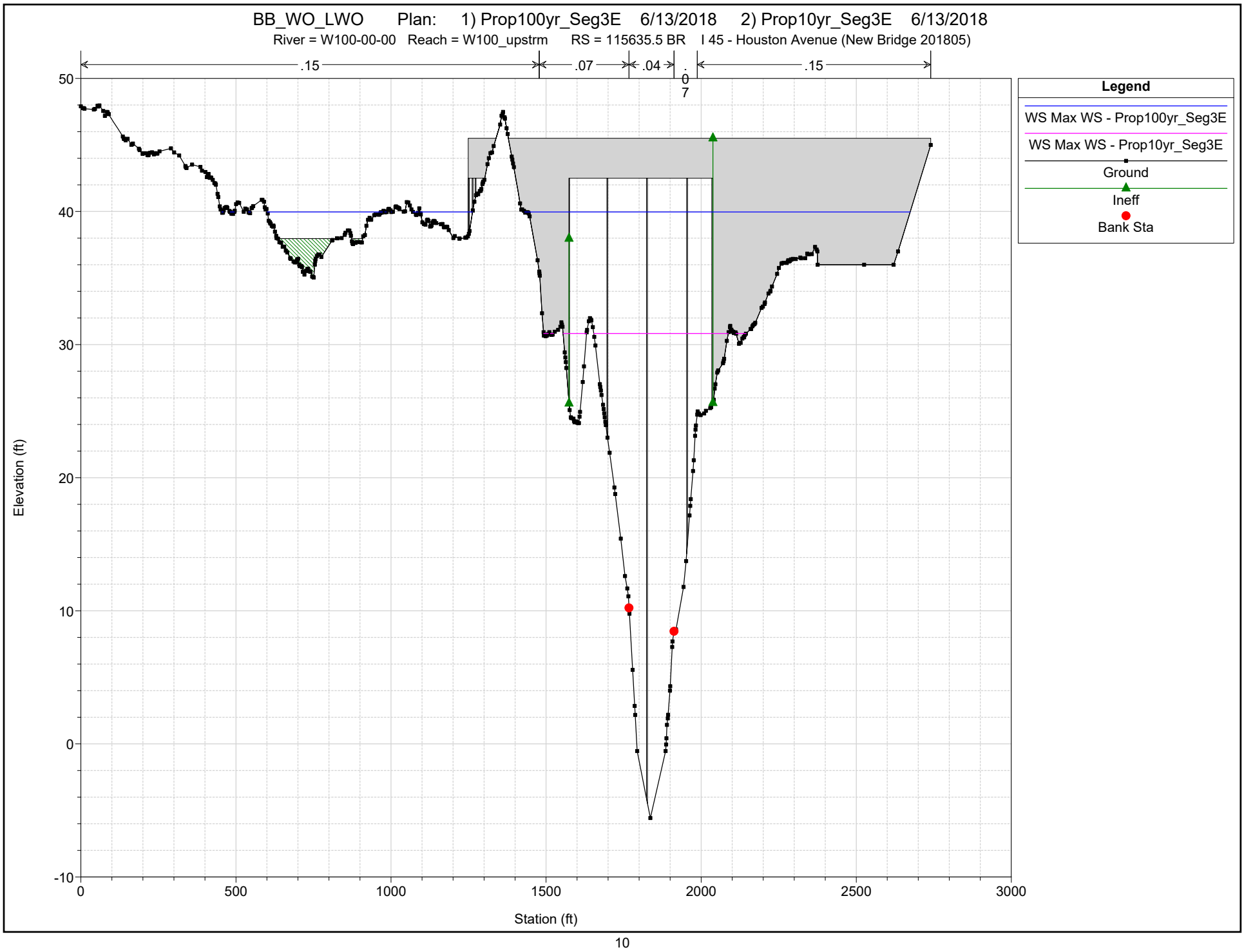

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115700 BR I-45 Allen Parkway FR (New Bridge 201805)
.15
.08
.04
.08
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
Station (ft)

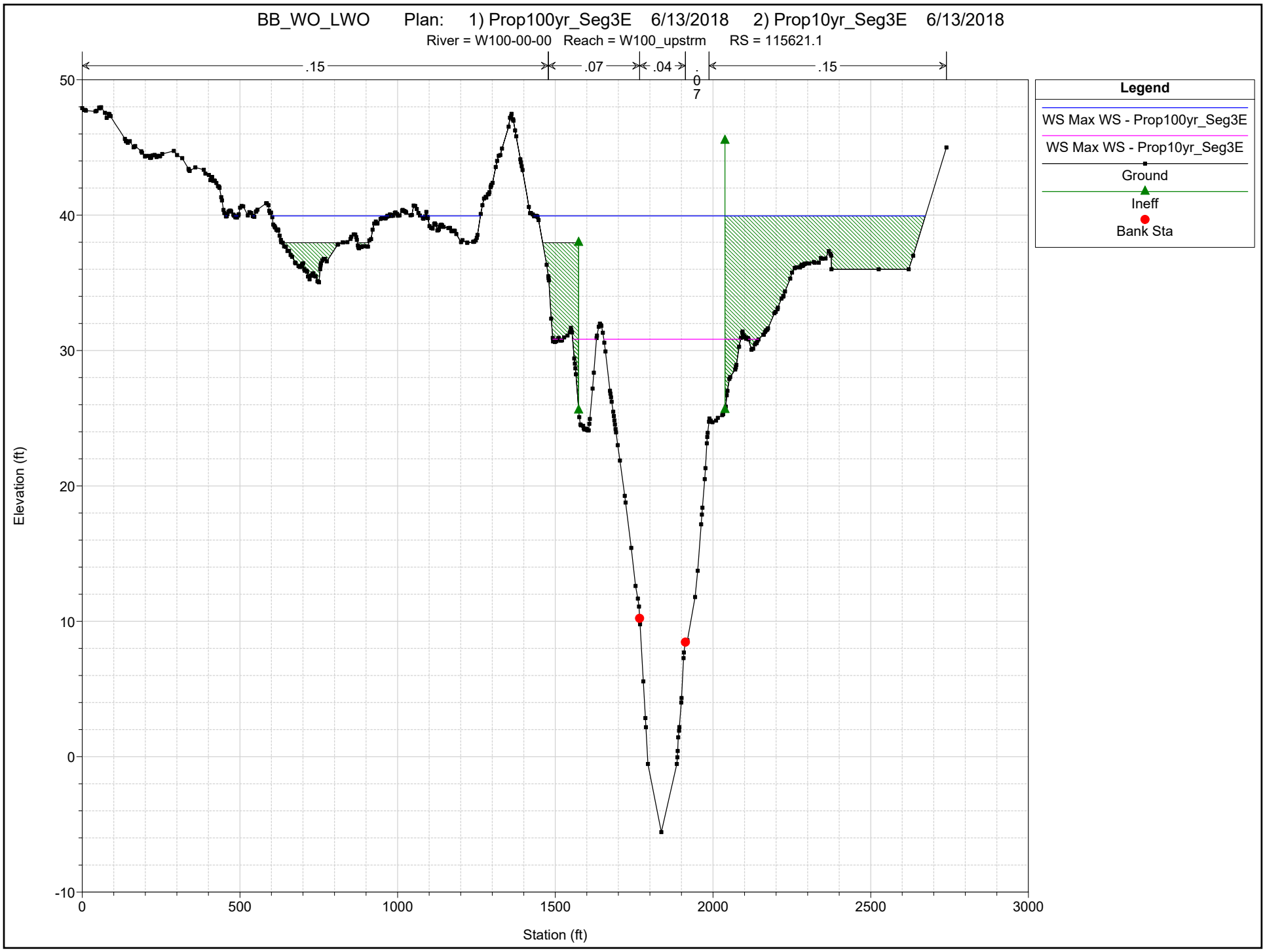

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115700 BR I-45 Allen Parkway FR (New Bridge 201805)
.15
.08
.04
.08
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000
Station (ft)

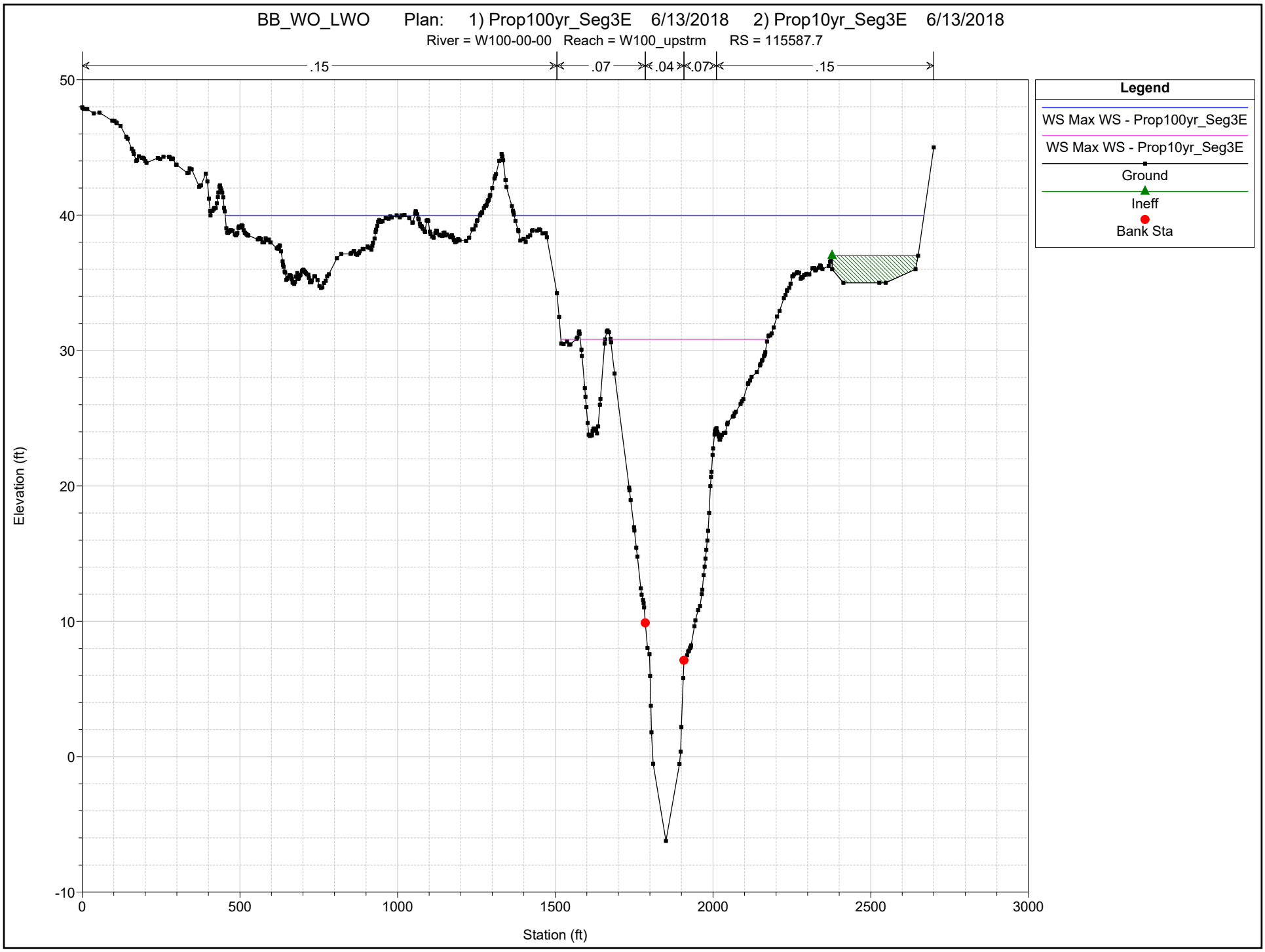

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115674.0
.15
.08
.04
.08
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000
Station (ft)

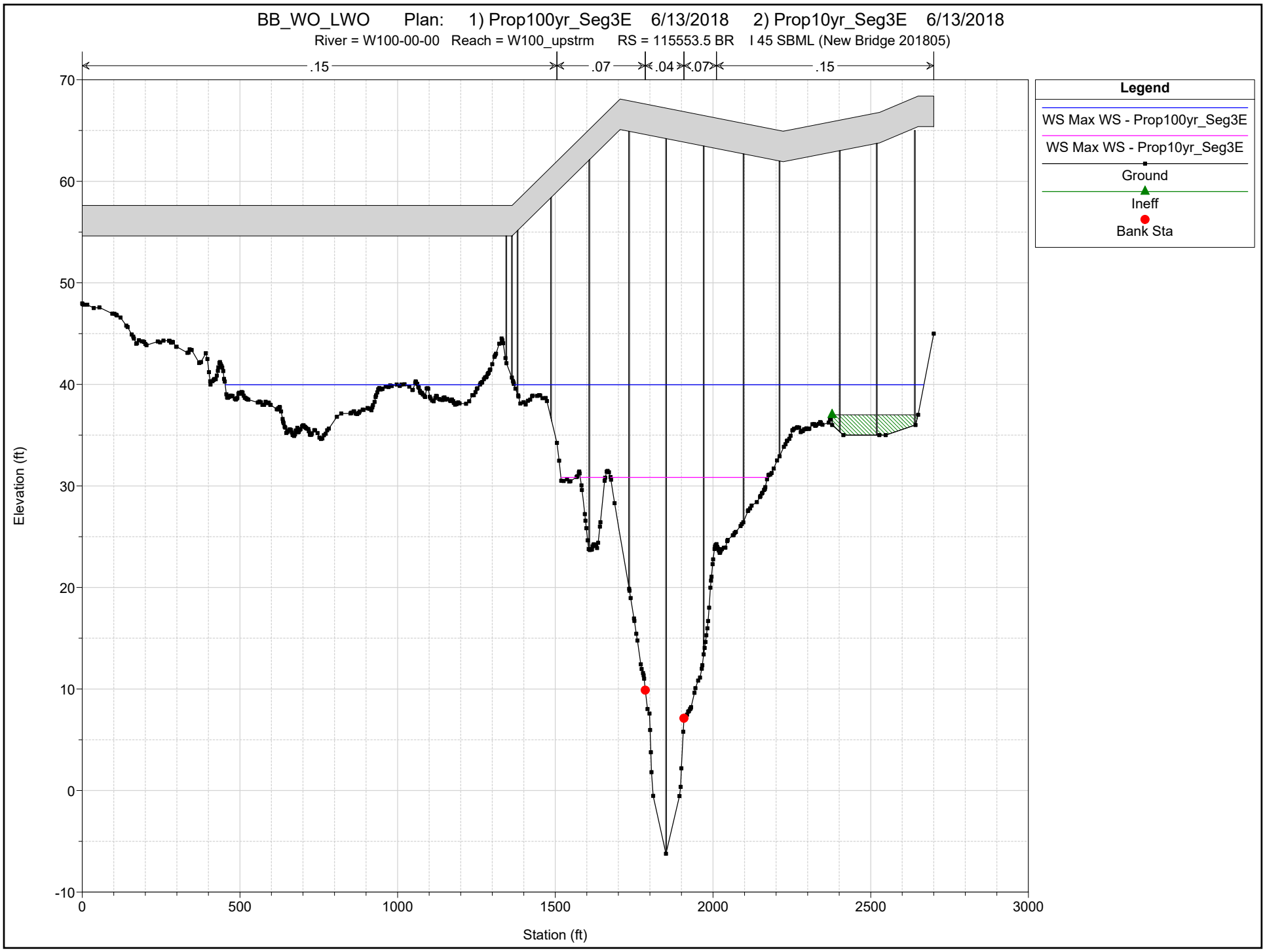

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115662.6
.15
.08
.04
.08
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000

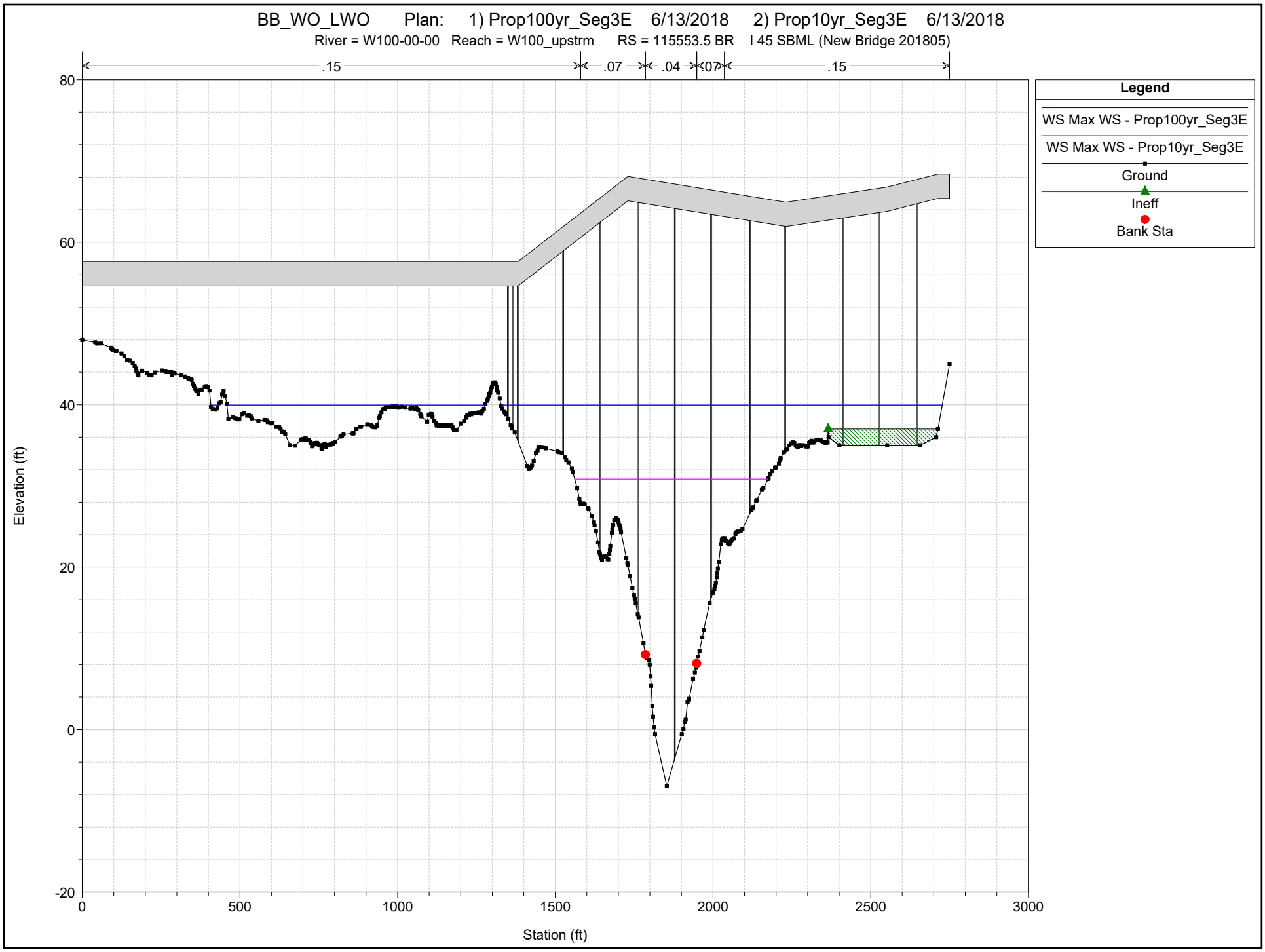

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115635.5 BR I 45 - Houston Avenue (New Bridge 201805)
.15
.08
.04
.08
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000
Station (ft)

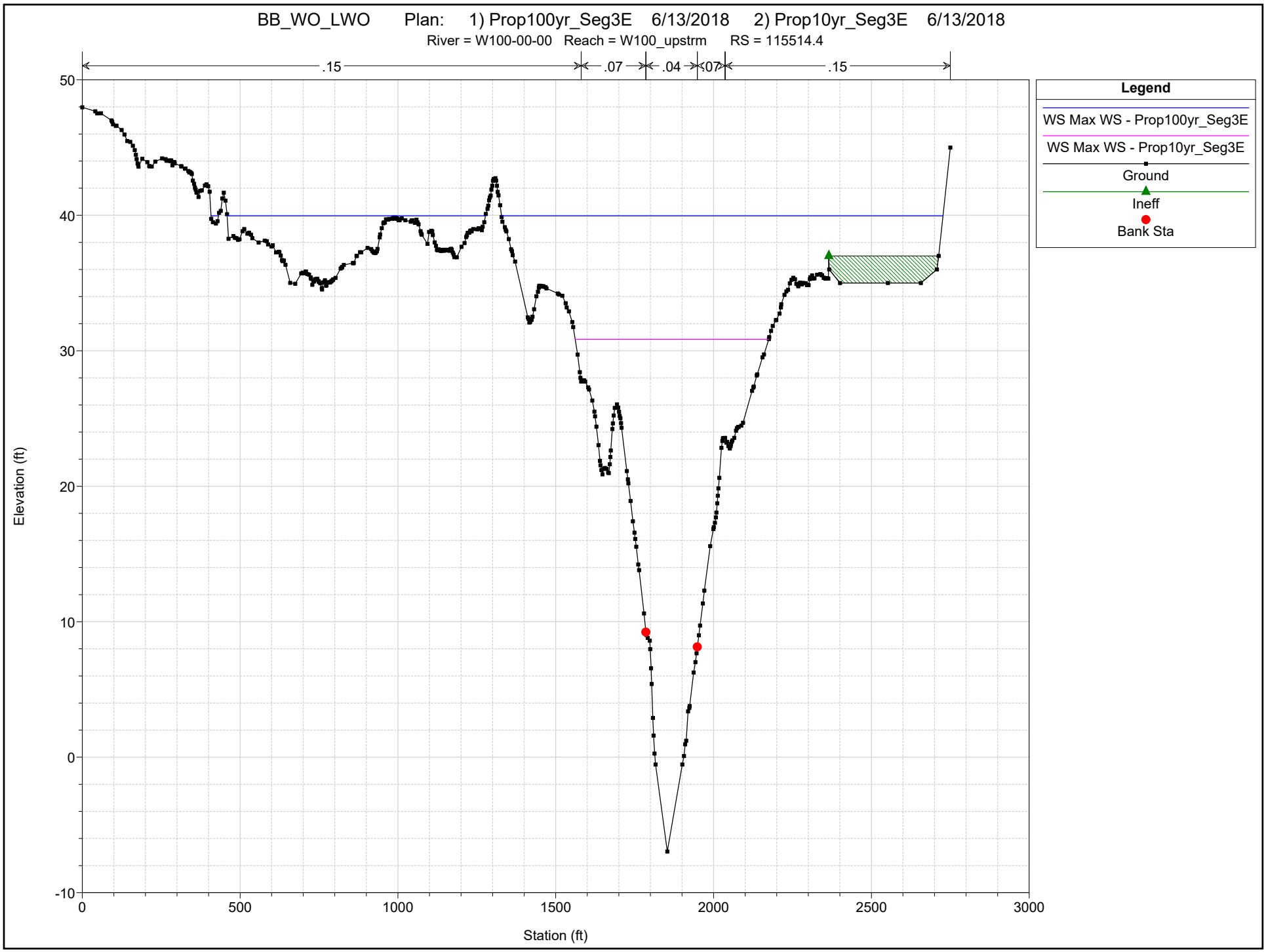

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115635.5 BR I 45 - Houston Avenue (New Bridge 201805)
.15
.07
.04
.07
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000

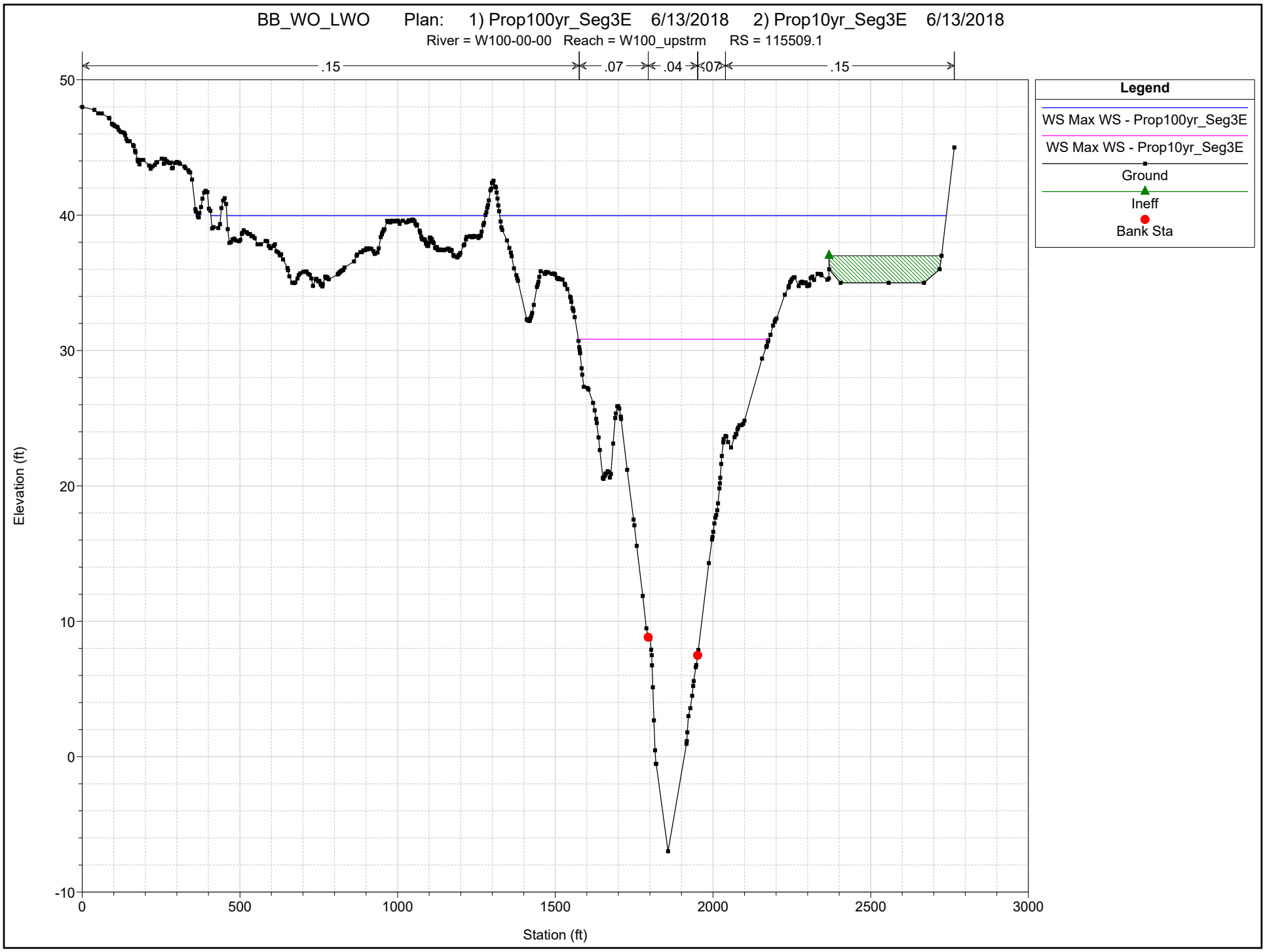

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115621.1
.15
.07
.04
.0
7
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000
Station (ft)

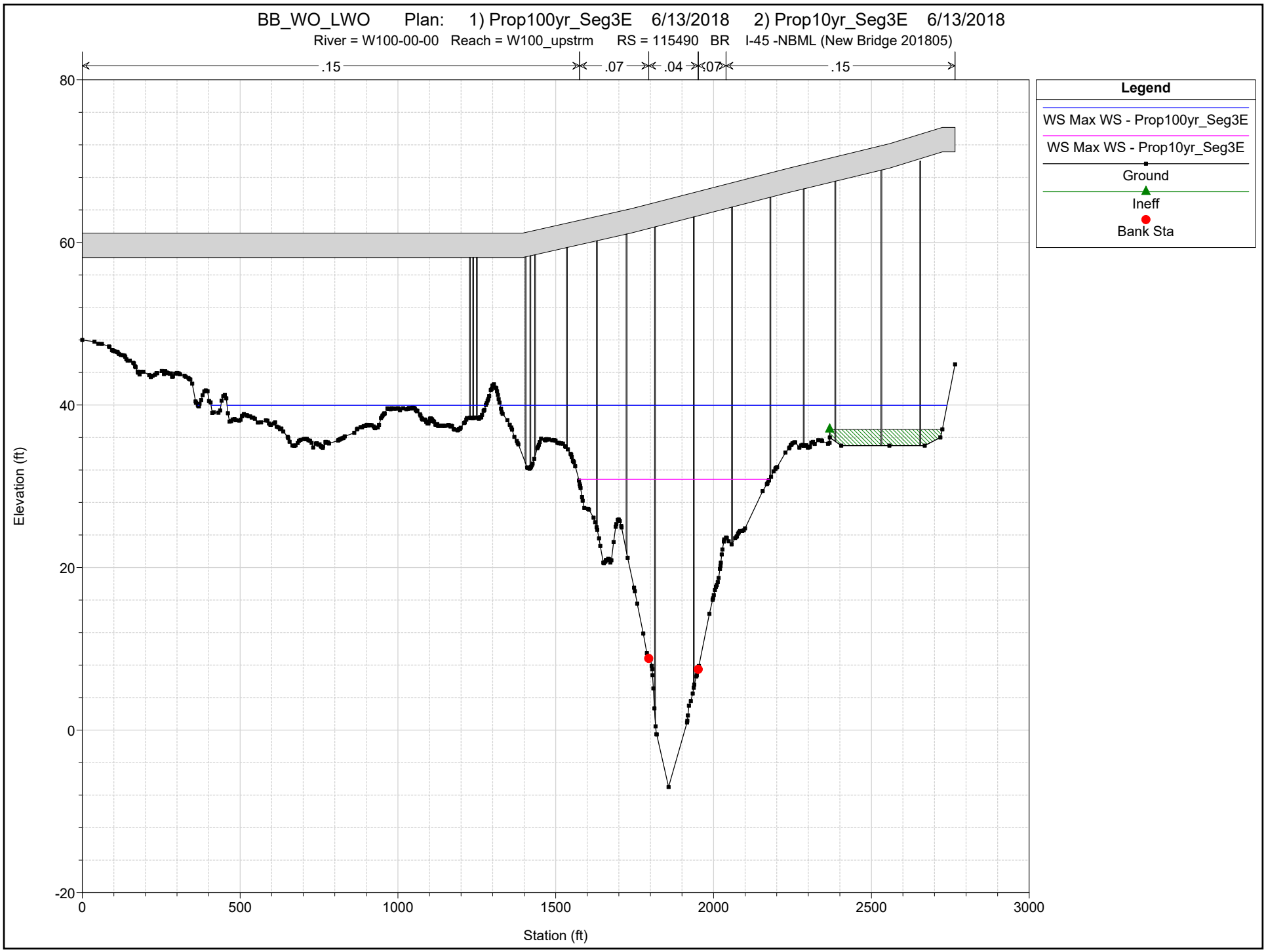

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115587.7
.15
.07
.04
.07
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000

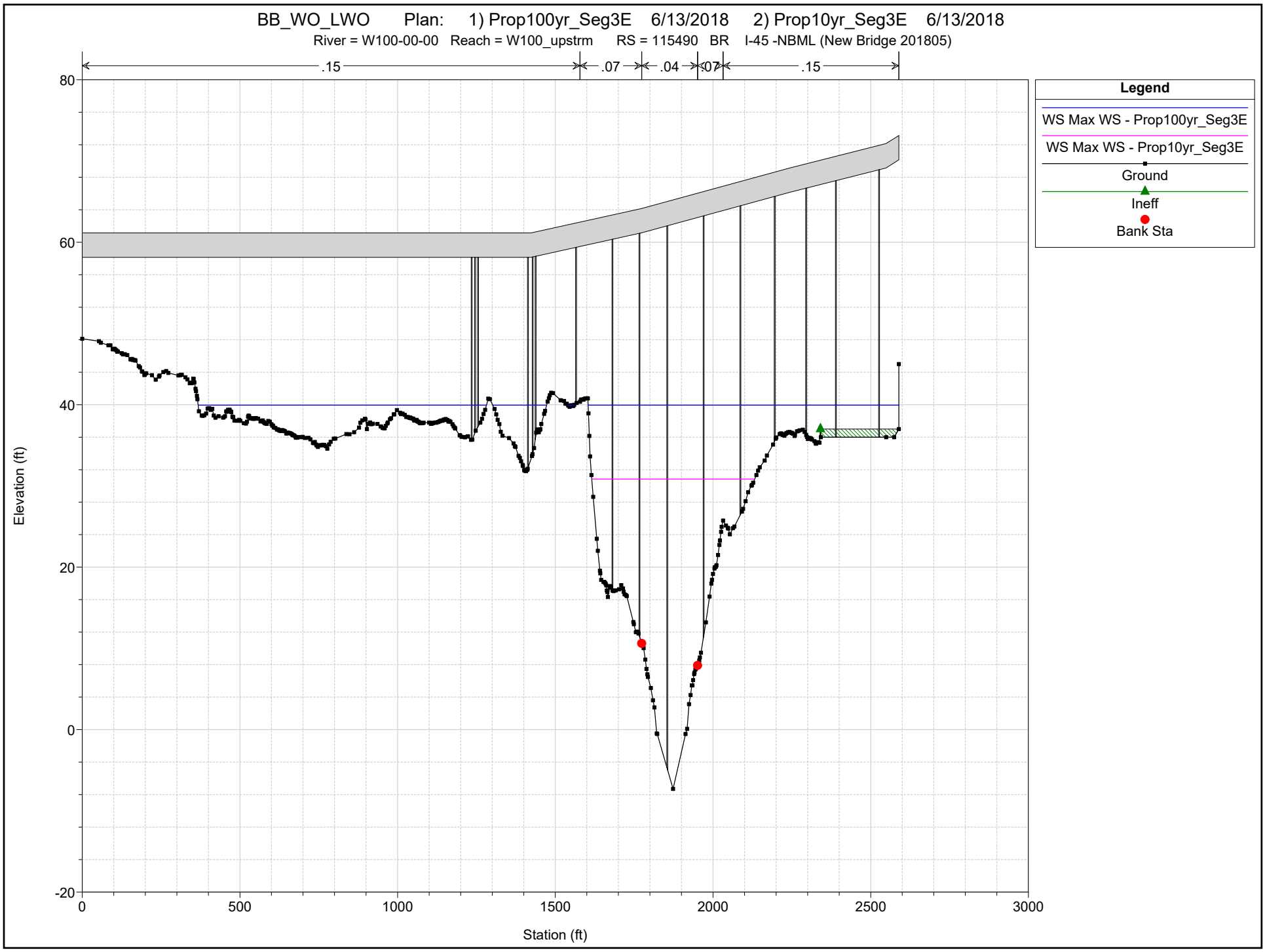

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115553.5 BR I 45 SBML (New Bridge 201805)
.15
.07
.04
.07
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
70
60
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000
Station (ft)

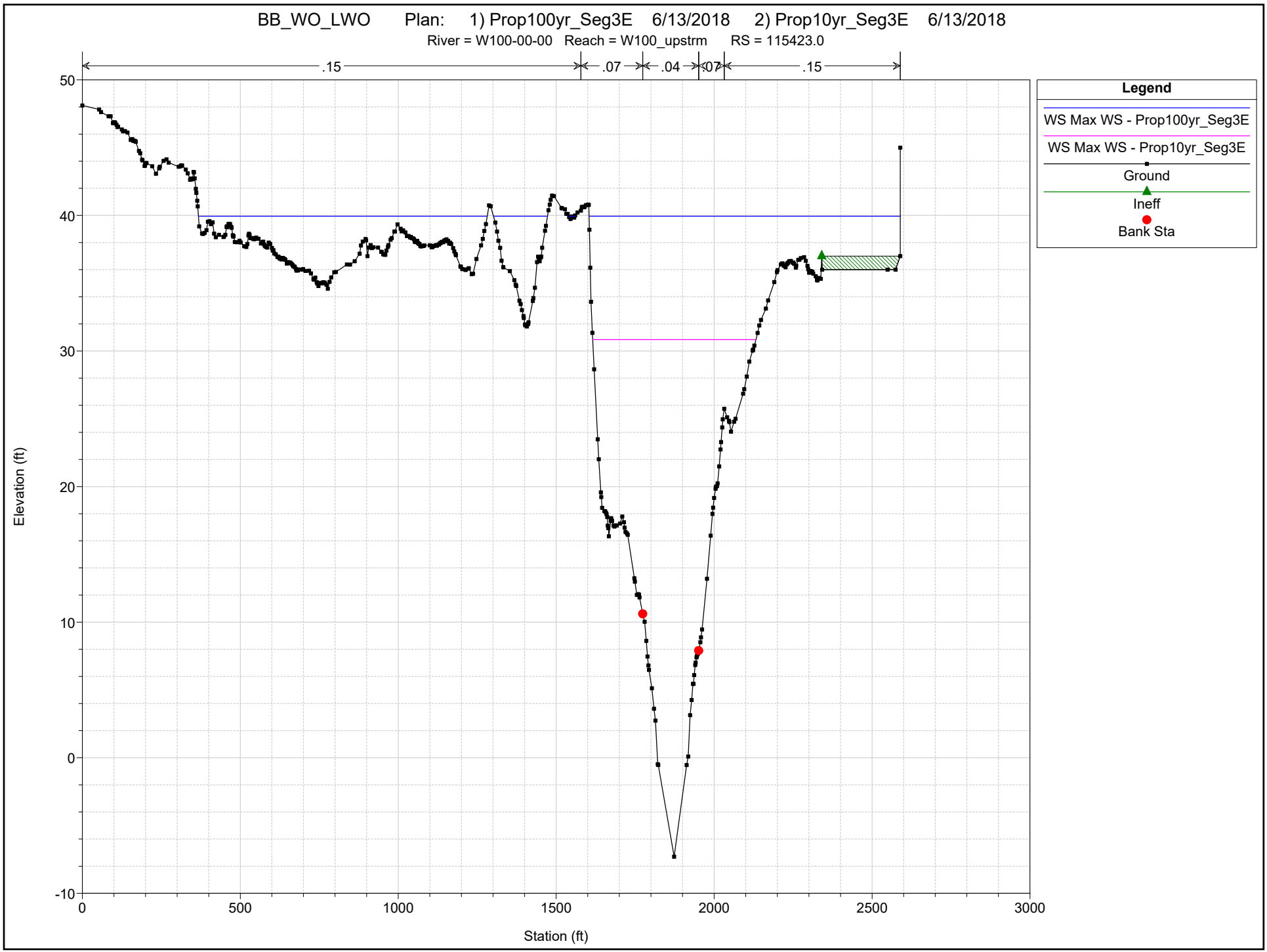

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115553.5 BR I 45 SBML (New Bridge 201805)
.15
.07
.04
.07
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
80
60
40
20
0
-20
0
500
1000
1500
2000
2500
3000
Station (ft)

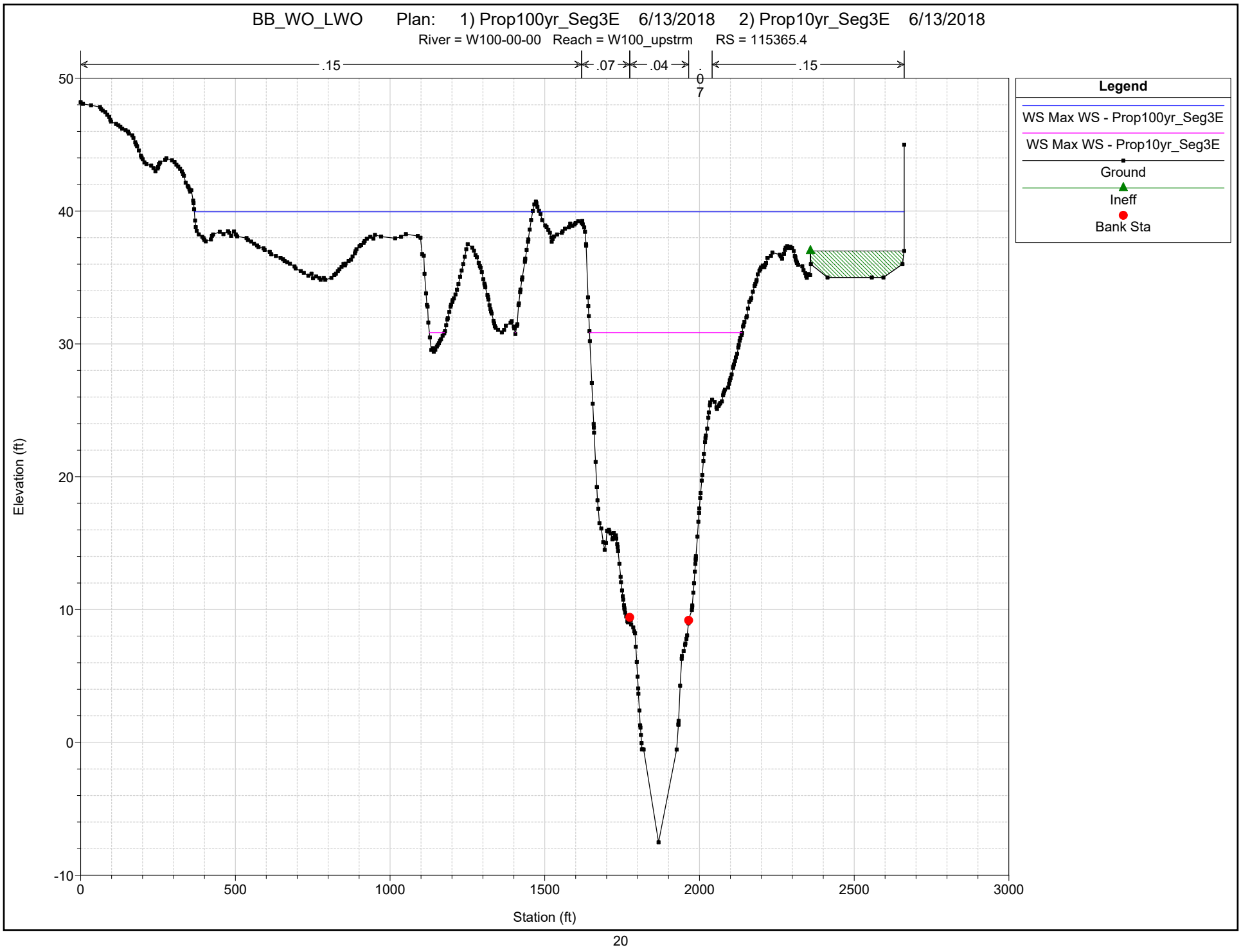

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115514.4
.15
.07
.04
.07
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000

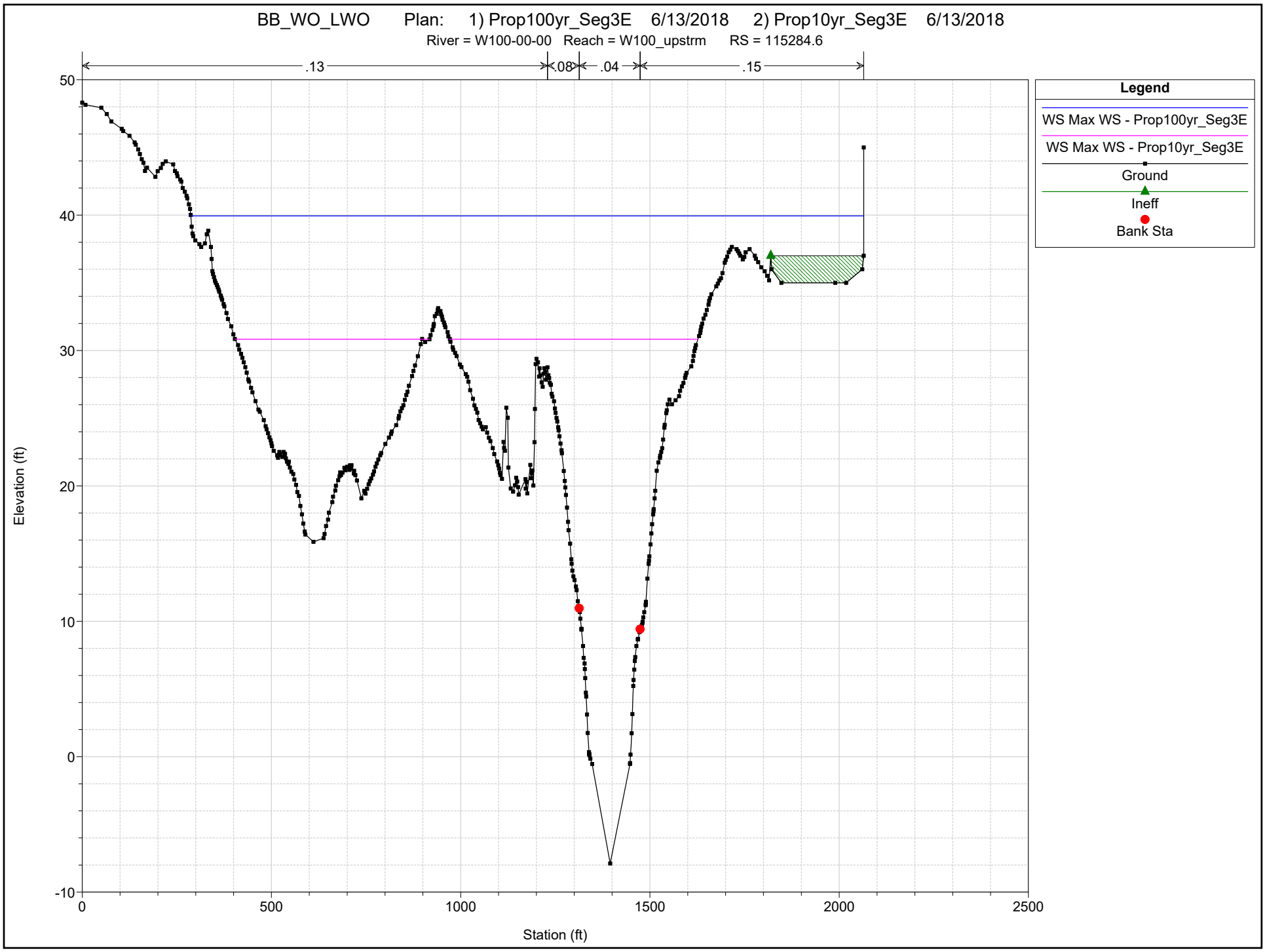

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115509.1
.15
.07
.04
.07
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000

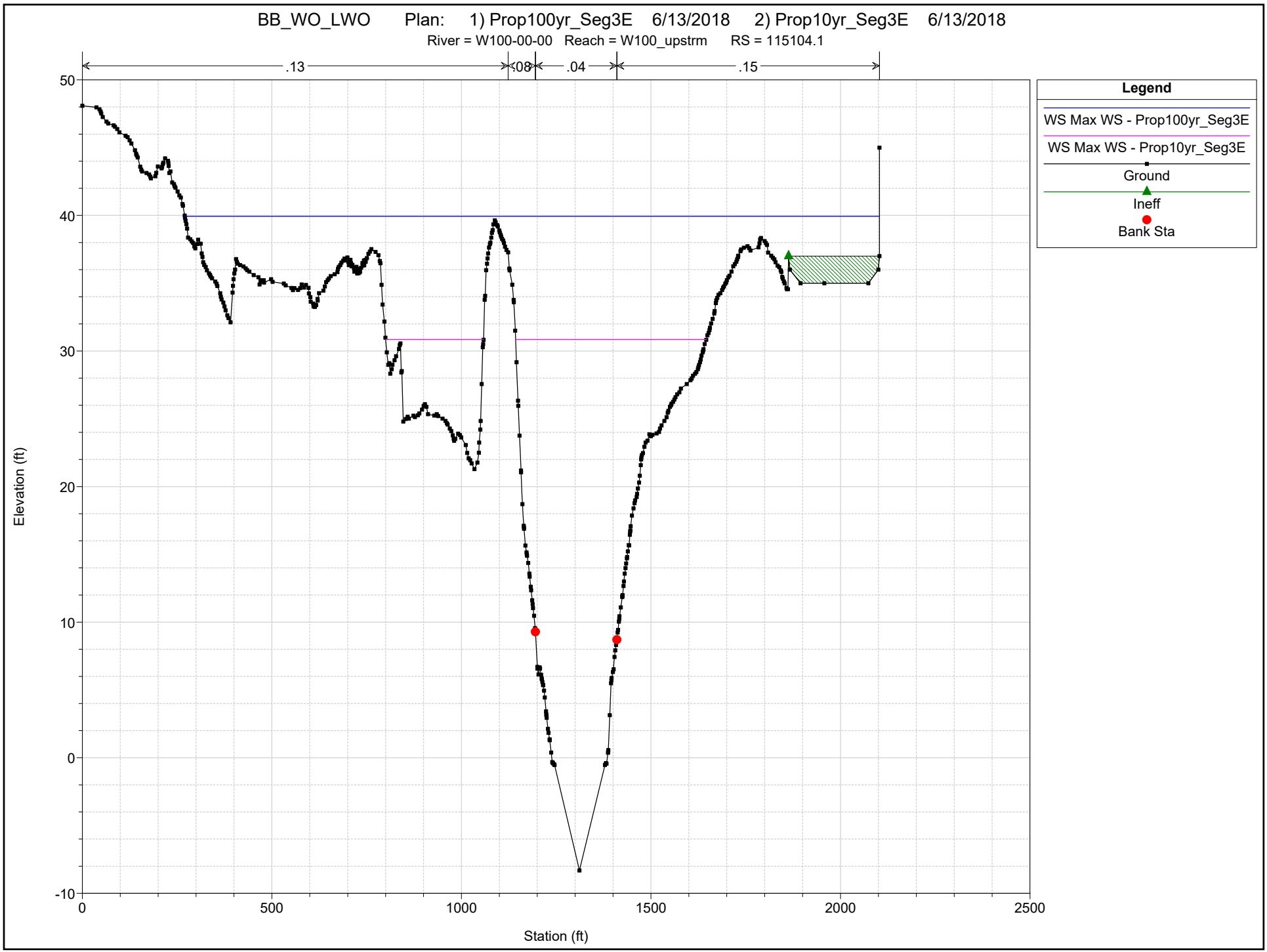

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115490 BR I-45 -NBML (New Bridge 201805)
.15
.07
.04
.07
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
80
60
40
20
0
-20
0
500
1000
1500
2000
2500
3000
Station (ft)

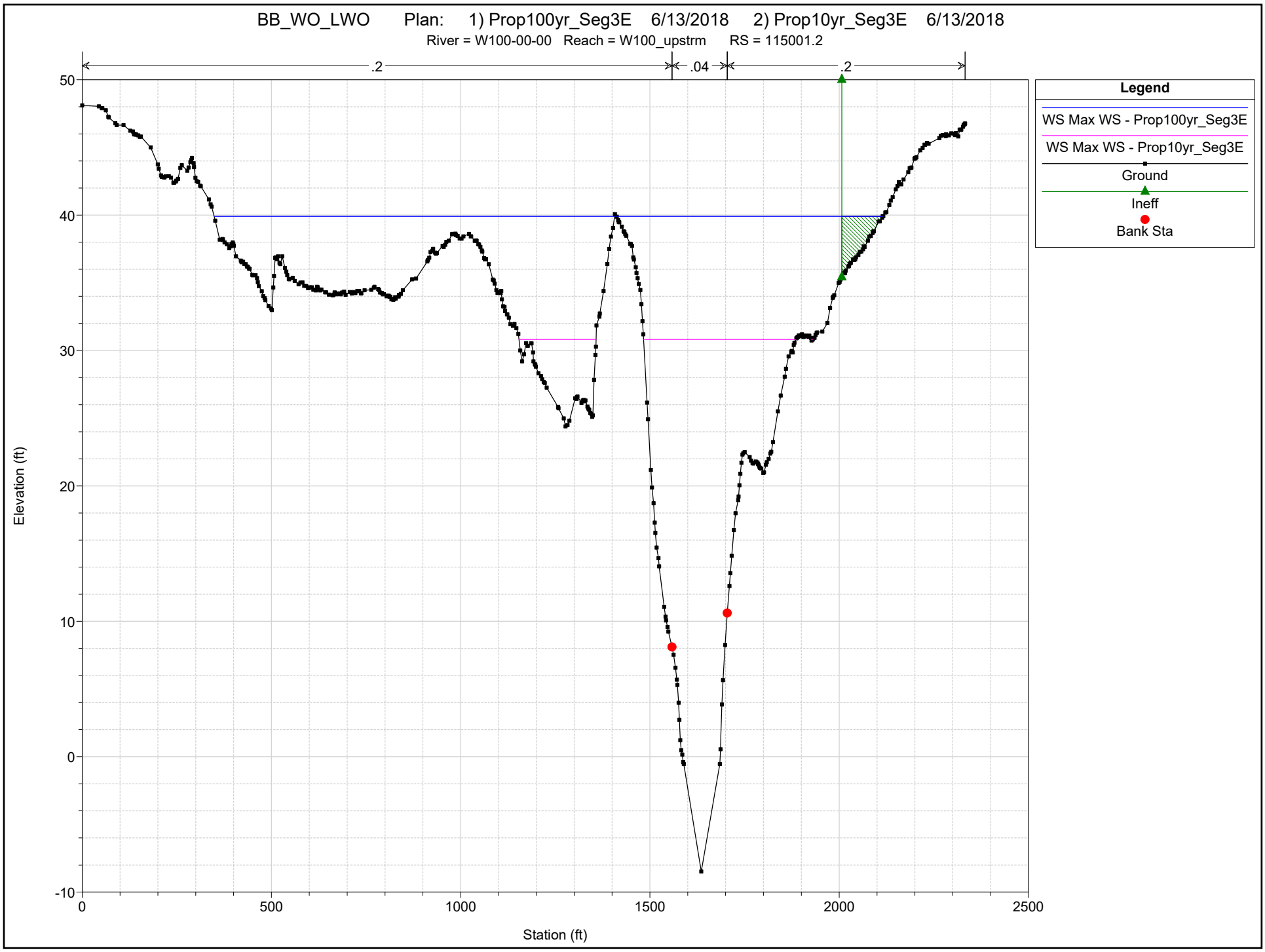

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115490 BR I-45 -NBML (New Bridge 201805)
.15
.07
.04
.07
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
80
60
40
20
0
-20
0
500
1000
1500
2000
2500
3000
Station (ft)

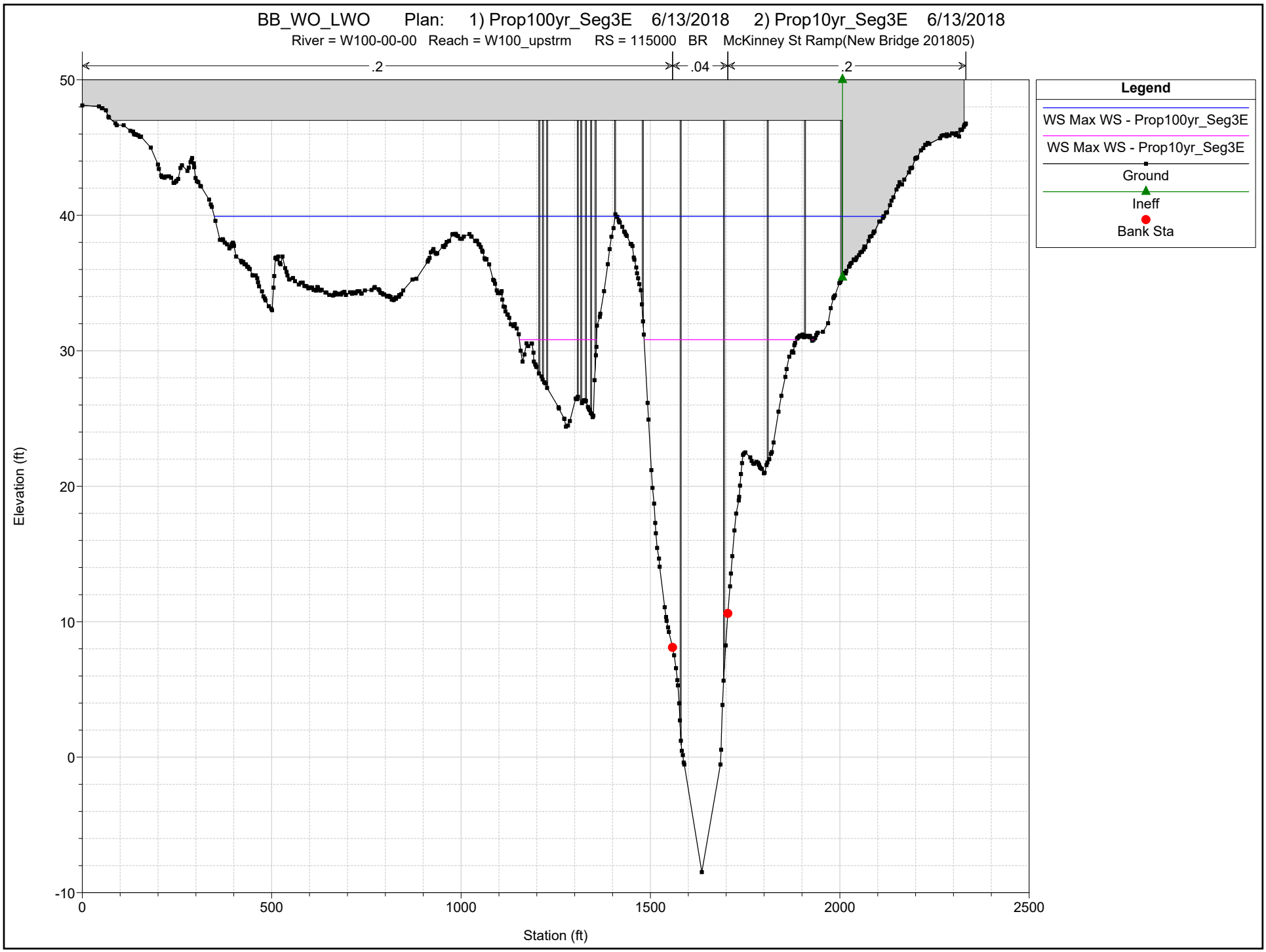

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115423.0
.15
.07
.04
.07
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000

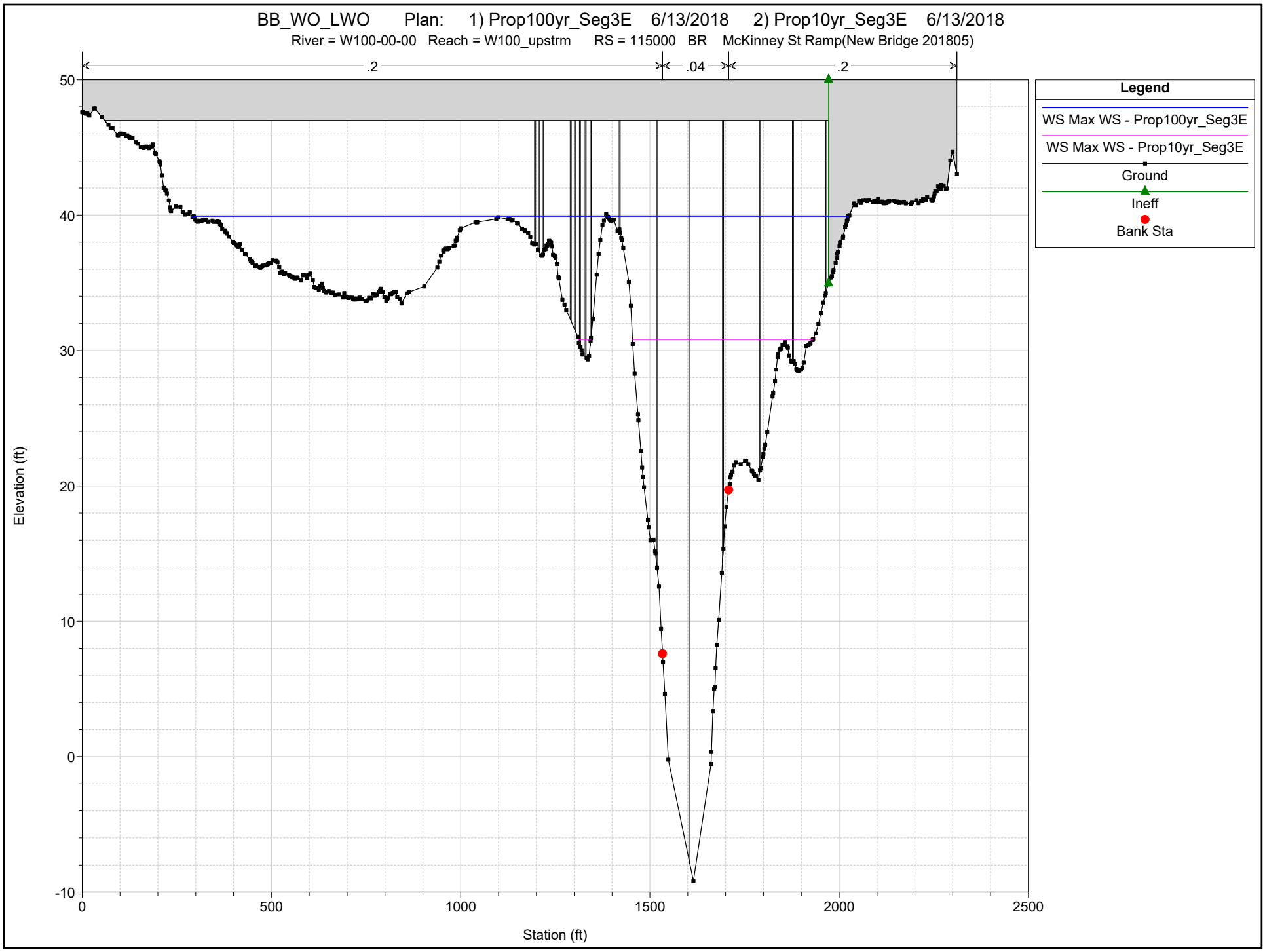

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115365.4
.15
.07
.04
.
0
7
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
3000
Station (ft)

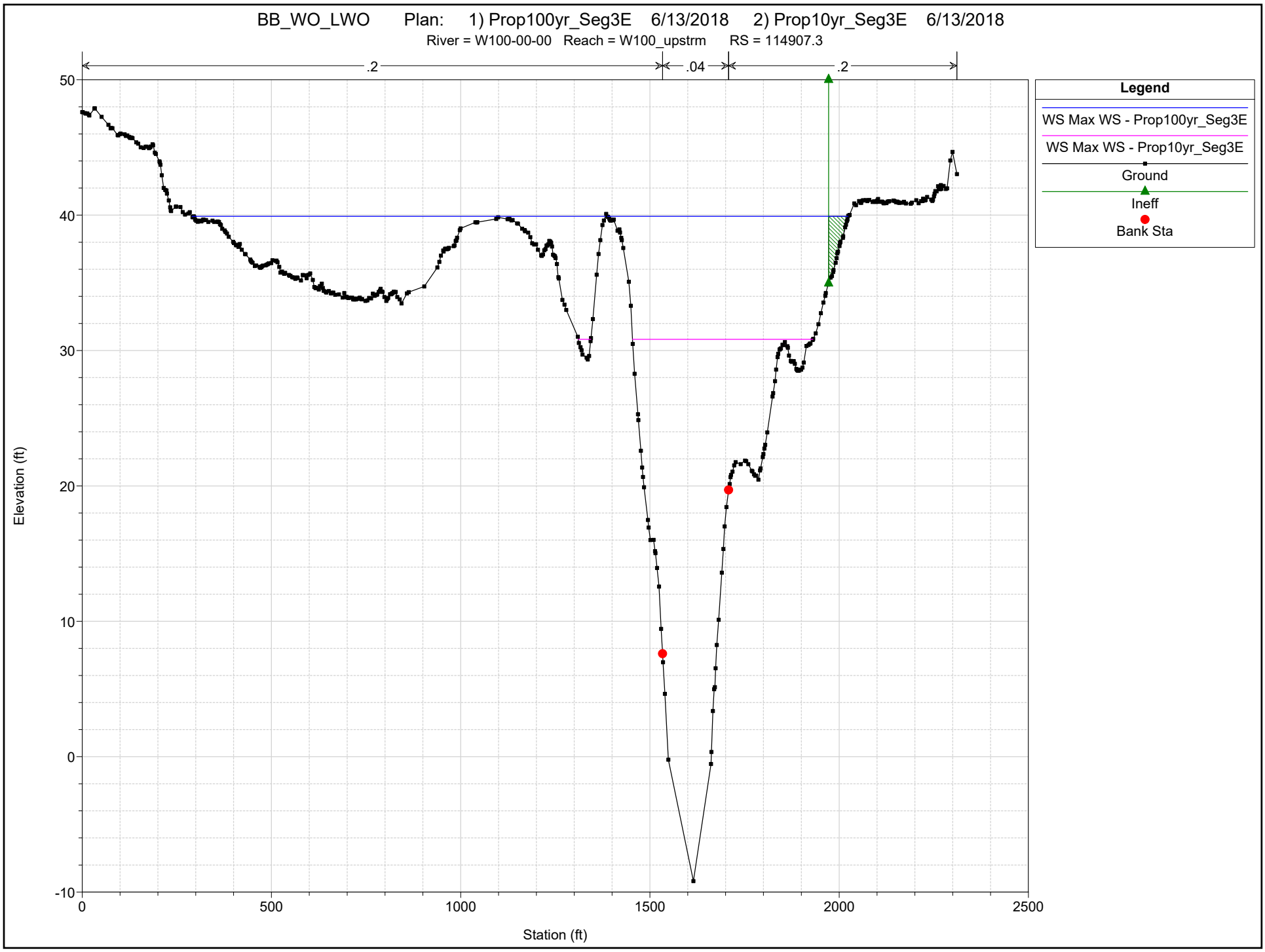

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115284.6
.13
.08
.04
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500

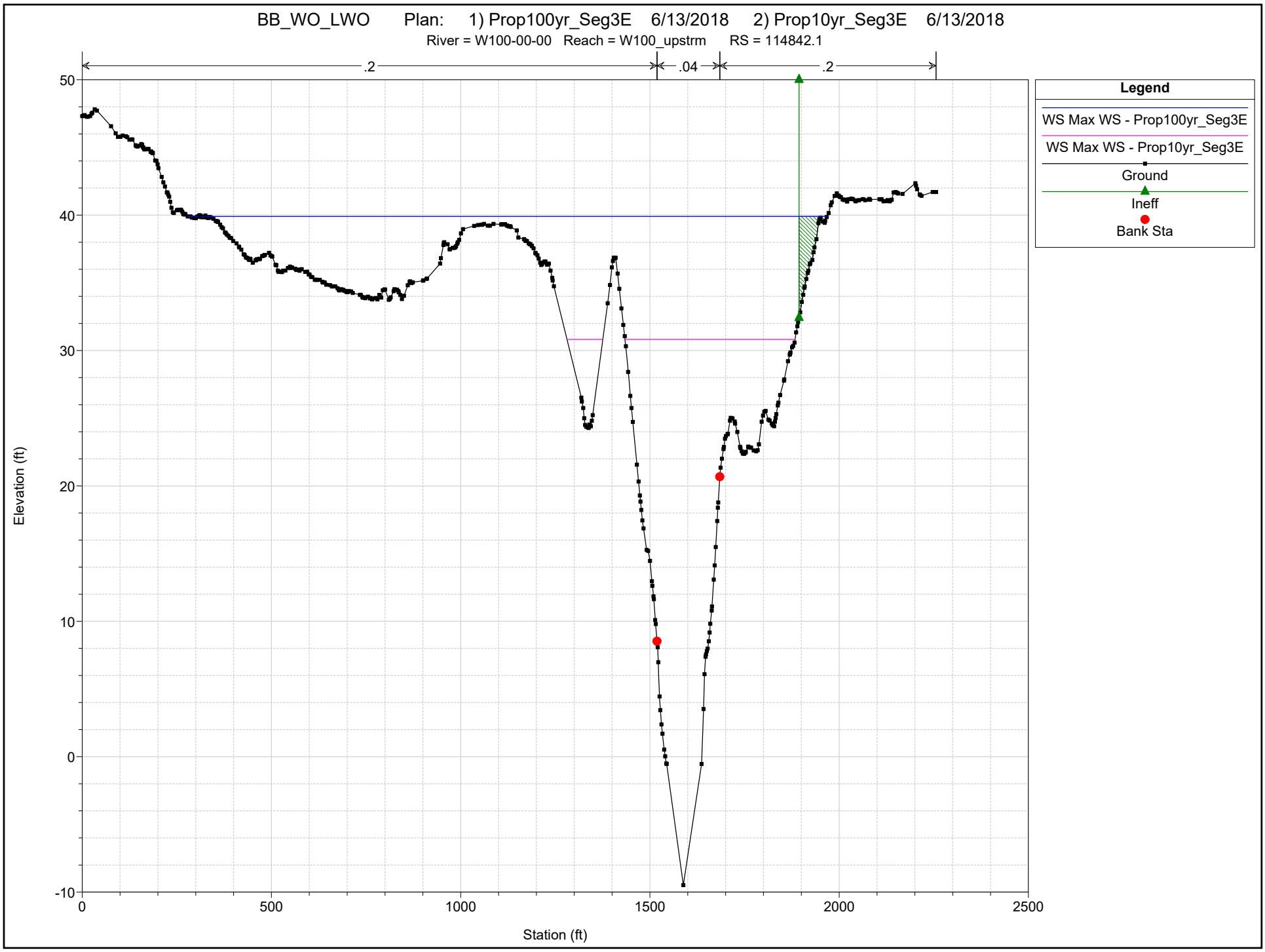

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115104.1
.13
.08
.04
.15
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500

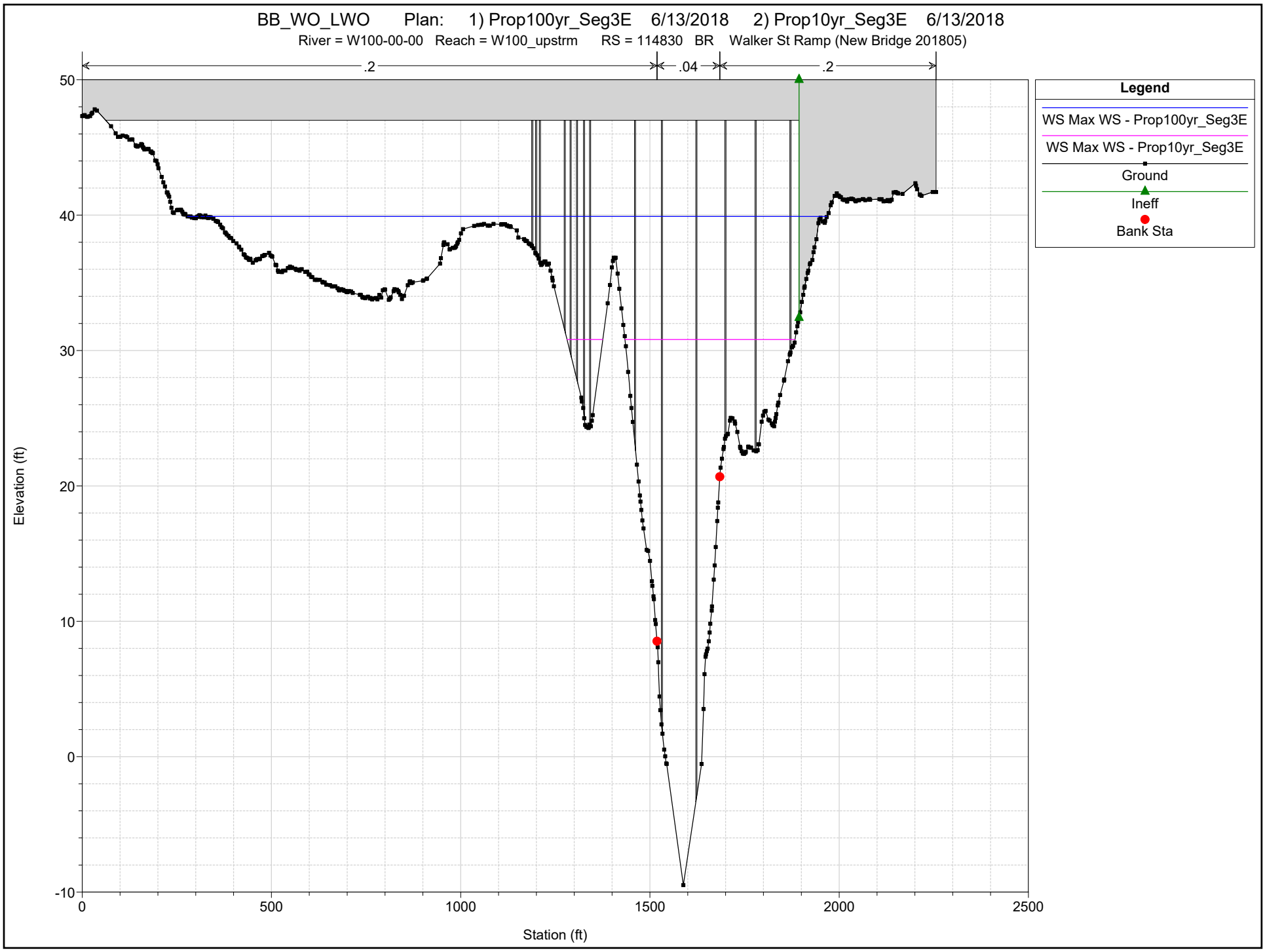

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115001.2
.2
.04
.2
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500

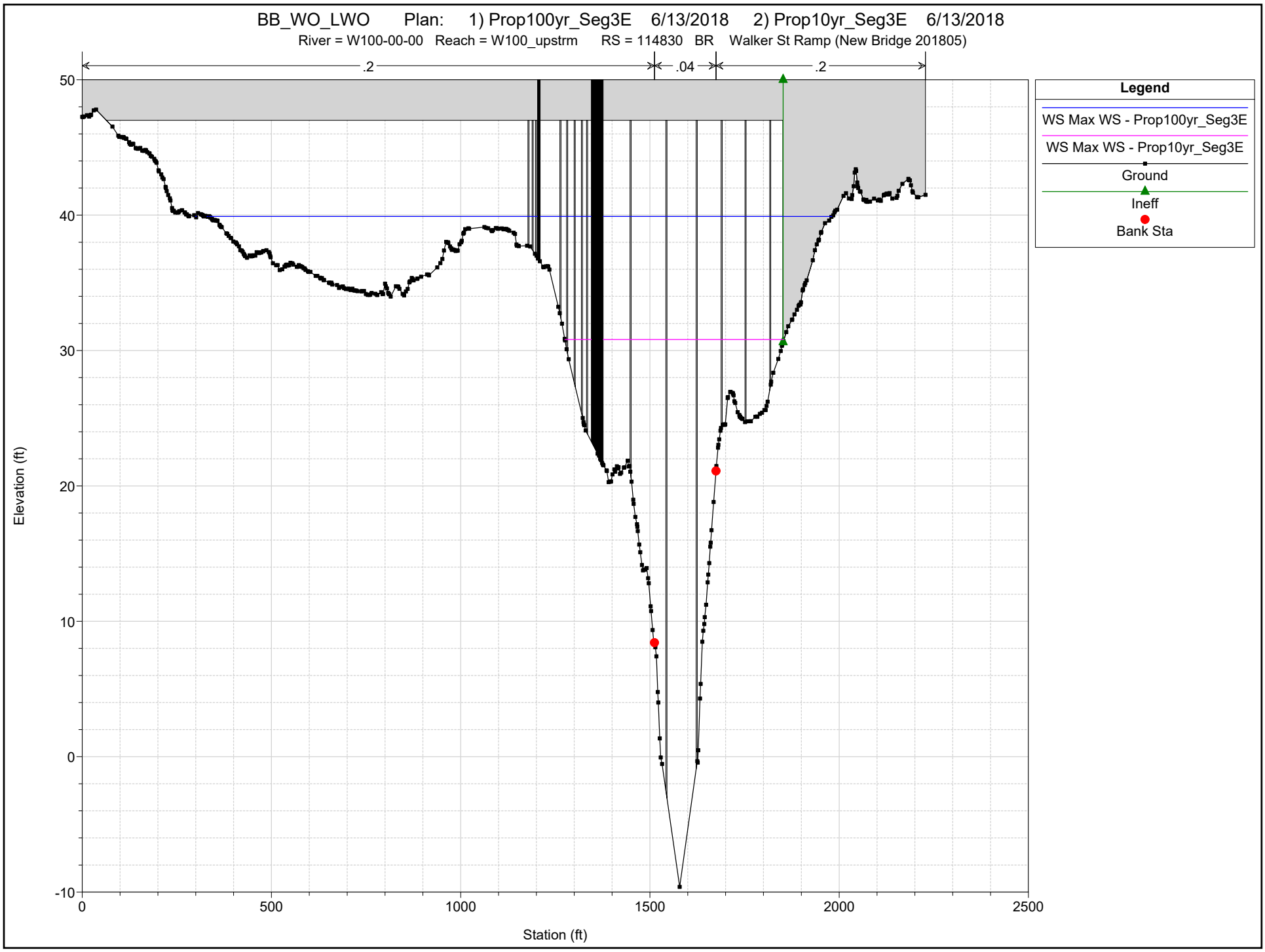

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115000 BR McKinney St Ramp(New Bridge 201805)
.2
.04
.2
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
Station (ft)

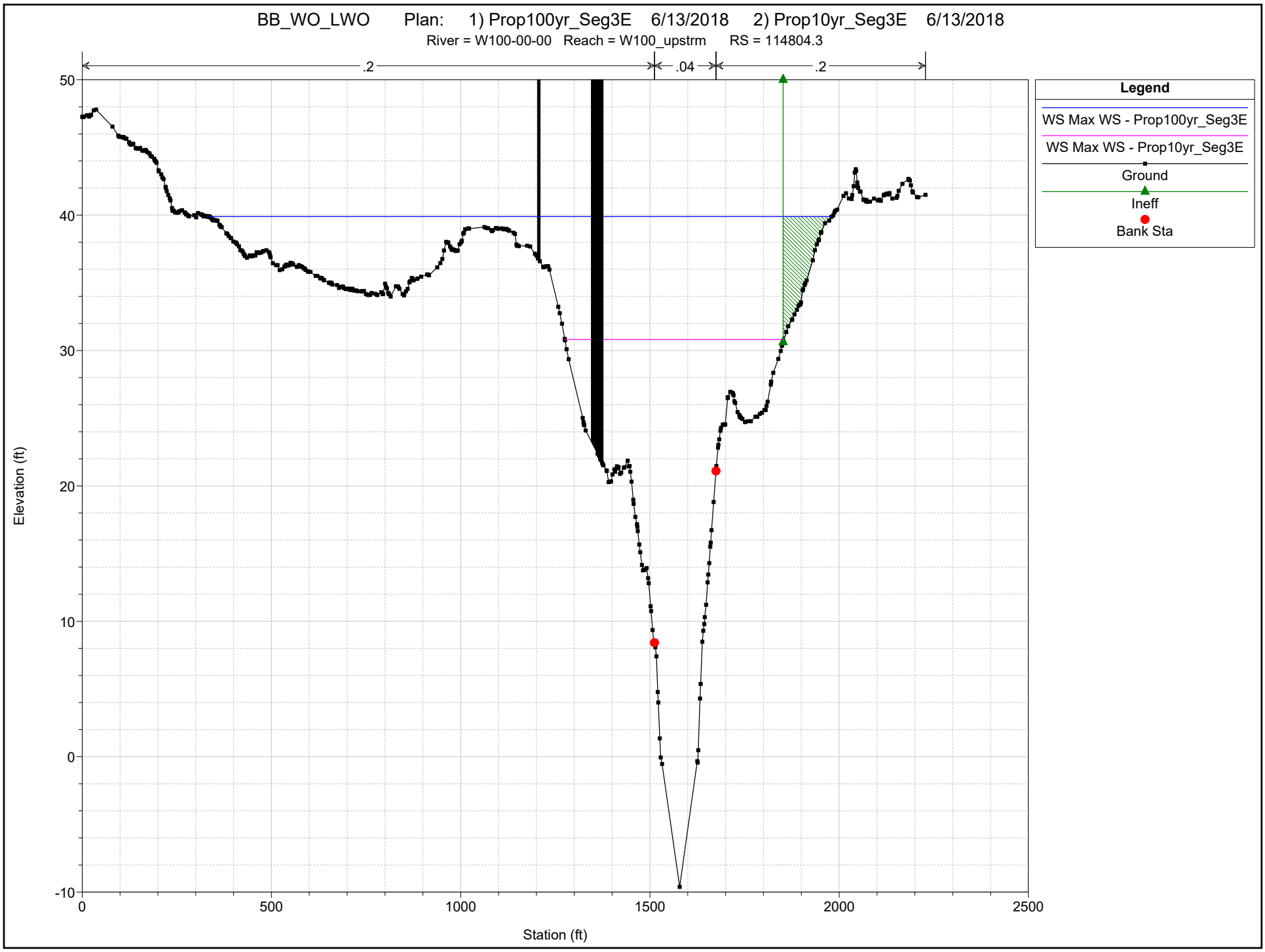

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 115000 BR McKinney St Ramp(New Bridge 201805)
.2
.04
.2
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
Station (ft)

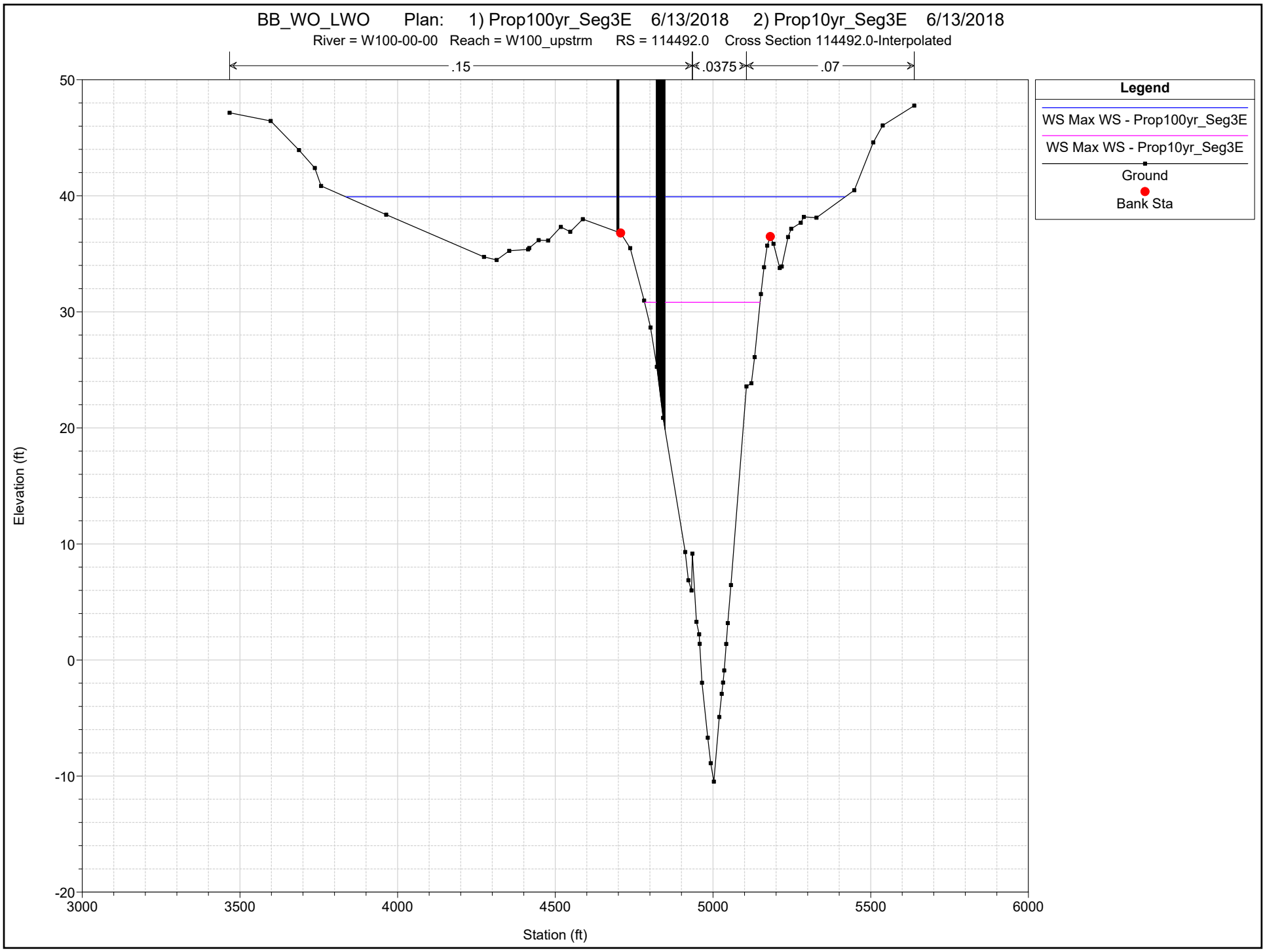

BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 114907.3
.2
.04
.2
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500


BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 114842.1
.2
.04
.2
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
Station (ft)


BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 114830 BR Walker St Ramp (New Bridge 201805)
.2
.04
.2
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
Station (ft)


BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 114830 BR Walker St Ramp (New Bridge 201805)
.2
.04
.2
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500
Station (ft)


BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 114804.3
.2
.04
.2
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
50
40
30
20
10
0
-10
0
500
1000
1500
2000
2500


BB_WO_LWO Plan: 1) Prop100yr_Seg3E 6/13/2018 2) Prop10yr_Seg3E 6/13/2018
River = W100-00-00 Reach = W100_upstrm RS = 114492.0 Cross Section 114492.0-Interpolated
.15
.0375
.07
Legend
WS Max WS - Prop100yr_Seg3E
WS Max WS - Prop10yr_Seg3E
Ground
Bank Sta
Elevation (ft)
50
40
30
20
10
0
-10
-20
3000
3500
4000
4500
5000
5500
6000
Station (ft)