WIN **22224**.00
TAYLOR BROOK BRIDGE
(**HOTEL ROAD**)
OVER **TAYLOR BROOK**

AUBURN, MAINE

HYDROLOGIC AND HYDRAULIC REPORT

March 2019

PREPARED FOR

MaineDOT
16 State House Station
Augusta, ME 04333

PREPARED BY

HNTB Corporation
340 County Road, Suite 6-C
Westbrook, ME 04092
Phone: (**207**) **774-5155**

HNTB

1.0 Introduction

Taylor Brook Bridge carries Hotel Road over Taylor Brook in Auburn, ME. The existing structure consists of twin corrugated steel culverts with individual widths of 11'-5", a rise of 7'-3", and approximate lengths of 92 feet from end to end. The culverts cross beneath the roadway at an 18-degree skew and are separated by 4-ft of borrow and gravel, providing an overall out-to-out structure width of 26'-10" measured normal to the brook. The existing culverts were installed in 1982, replacing a short single span bridge. The top of the culverts are approximately 8 to 10 feet below the top of roadway. The invert elevation at the outlet of the existing culverts is 235.5. The existing culverts have a combined hydraulic opening of approximately 128 square feet.

The proposed structure is a single span prestressed concrete NEXT beam structure founded on pile supported integral abutments. The opening is approximately 68 feet from face of abutment to face of abutment, providing bank-full width at the base of the sloping embankments. The low chord of the proposed structure is approximately elevation 246.18. The proposed structure provides approximately 578 square feet of hydraulic opening.

Figure 1 – Project Location Map

Taylor Brook Bridge is located approximately 1,000 ft downstream from Taylor Pond and 1.3 miles North of Route 11. There are no bridges directly upstream of the bridge due to the proximity of Taylor Pond. Downstream of the bridge there are several culverts and a small dam approximately 1,000 feet downstream.

Figure 2 – Aerial image of the project site

2.0 Existing Data Review

Information gathered through a review of photographs, available reports, and a site visit were used in calibrating the hydraulic models. The following information was utilized as part of the hydraulic analysis:

- On May 15, 2018, HNTB conducted a site visit at the project site to evaluate existing site conditions, validate Manning's numbers and survey water surface elevations. Site photographs are provided in **Appendix A**.

- FEMA Flood Insurance Rate Map (FIRM), provided in **Appendix B**, Androscoggin County, ME. July 8, 2013. The FEMA FIRM shows the project is located in Zone AE, indicating the base flood elevations have been determined. The base flood elevation shown on the FIRM is an elevation of 244 downstream and 246 upstream of the project bridge. The flood profile provided in the FEMA Flood Insurance Study indicated that the water surface elevation of the 100-year event was approximately 246.7 upstream of the bridge and 243.9 downstream of the bridge.

- A nearby USGS stream gage was evaluated but was not used due to the gage's distance from the site.

- Historic Flood Data: During the initial public meeting, a resident of the lake provided anecdotal information and photos regarding the June 2012 flood event. The resident lives approximately one mile from the bridge on the southwest corner of Taylor Pond. Upon further investigation, flood elevation data was not found at the project site during the aforementioned time frame.

- Taylor Pond Flood Mitigation Assessment Findings and Recommendations report by Wright-Pierce dated February 2, 2018, which can be found in **Appendix D**. Additional discussion of this report, in relation to this bridge replacement project, is provided in the following sections.

3.0 Hydrology

The hydrology report of the Taylor Brook at the location of the culvert replacement can be found in **Appendix C**. The drainage area at the location of the bridge replacement project is 14.7 square miles, as shown in **Figure 3**. Peak flows were calculated in accordance with USGS regression equations (Hodgkins, 1999 & Lombard/Hodgkins, 2015) and can be found in **Table 1**. Flow data was also available in the FEMA Flood Insurance Study (FIS) and are provided in **Appendix E**. The flows in the FIS are reasonable close to the calculated values and are provided in **Table 1**. The FEMA FIS flows are reported for the Taylor Brook at the confluence with Little Androscoggin River.

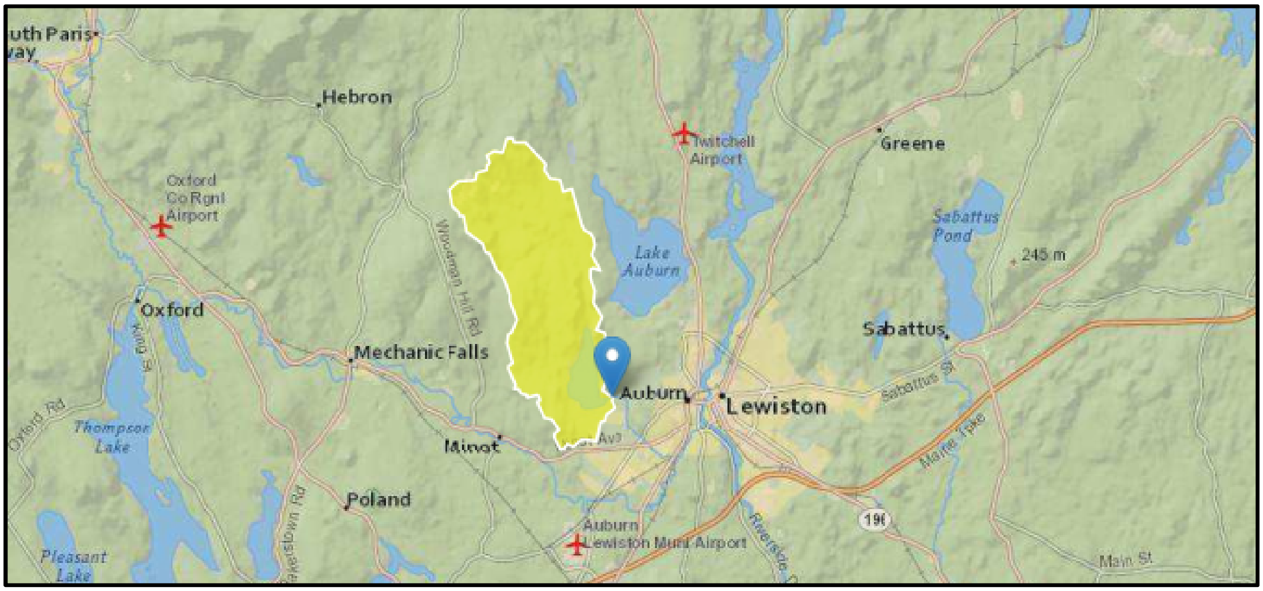

Figure 3 – Watershed above Project Site

Table 1: Flood Information
(For calculations see **Appendix C**)

Year Storm	**USGS Regression Equations at Culverts (cfs)**	FEMA FIS Flows (cfs)
Drainage Area	**14.7 sq. mi.**	14.9 sq. mi
$Q_{1.1}$	**173.3**	---
Q_5	**517.3**	----
Q_{10}	**646.8**	646
Q_{25}	**819.6**	---
Q_{50}	**953.9**	952
Q_{100}	**1,098.2**	1,096
Q_{500}	**1,449.2**	1,445

The hydraulic analyses for this project were completed using the peak flows from the USGS regression equations, shown in **bold** in Table 1.

Wright-Pierce completed a flood mitigation assessment for Taylor Pond on February 2, 2018 for the Taylor Pond Association, which can be found in **Appendix D**. This assessment found that the 100-year flood hazard elevation in Taylor Pond may be as much as two feet less than the values reported by FEMA. The difference between Wright-Pierce's values and those reported in FEMA relates to the hydrologic estimation methods used, as stated in the Taylor Pond Flood Mitigation Assessment Findings and Recommendations report by Wright-Pierce. The Wright-Pierce analyses used an unsteady analysis estimation method, rather than a steady-state analysis, to include time as a factor in determining water elevations. The assessment discusses the incorporation of time and volume in the hydrologic analysis when a large [waterbody] with substantive storage volumes and outlet structures that regulate discharge are present, as stated in the Wright-Pierce report. Since the 100-year flood elevation provided in the Wright-Pierce report is approximately two feet lower than the values provided by FEMA and those presented in **Appendix C**, the latter, more conservative, flood elevations were used to progress this project.

4.0 Hydraulic Analysis

Modeling Approach

Hydraulic calculations for the existing and proposed conditions along Taylor Brook were performed using the U.S. Army Corps of Engineers' software HEC-RAS, version 5.0.1. HEC-RAS supports one-dimensional, steady flow, water surface profile calculations. Cross-sections were cut from survey gathered for this project. See **Appendices F and G** for the full results of the HEC-RAS models.

The models were run using "subcritical" flow due to the Froude numbers at all cross-sections below 1.0. The models included approximately 526 feet of the Taylor Brook, with approximately 313 feet downstream of the structures and 213 feet upstream of the structures.

Manning's numbers were found in the FEMA FIS for Taylor Brook and validated through a site visit. The preliminary n-value for the channel was 0.035 and the n-value for the overbanks was 0.040. Ineffective flow areas were set upstream and downstream of the bridge based on contraction and expansion from the culverts in the existing model. Ineffective flow areas were not utilized in the proposed model, since the proposed structure allows for full bank width at the base of the abutment slopes.

The downstream boundary condition for the HEC-RAS model was set to known water surface elevation since the FEMA FIS provided flood profiles for Taylor Brook. The downstream water surface elevations were taken from the FEMA flood profiles for the 10-, 50-, 100-, and 500-year storm events; the other storm events were approximated. The existing conditions were analyzed in HEC-RAS to determine the validity of the known water surface elevations for the downstream boundary conditions. Using the known water surface elevations from FEMA FIS as boundary conditions, the existing conditions analysis returned water surface elevations for the 100-yr flood event of 243.7 feet downstream of the bridge and 245.6 feet upstream of the bridge. These water surface elevations were close to the water surface elevations on the FEMA Flood Insurance Rate Map (FIRM) and therefore, the boundary conditions were deemed valid for analysis.

Results

According to the Bridge Design Guide, the Q50 headwater depth to structure depth ratio (HW/D) for culverts should be less than 0.9 and the Q100 is preferred to be 1 foot below or more from the edge of pavement. The HW/D of the existing structure was determined to be 1.15 for the Q50 storm water elevation. The Q100 storm water elevation was approximately 5 feet below the edge of pavement. Since the HW/D ratio is not met, the existing culverts are not considered hydraulically adequate.

In accordance with the Highway Design Guide, the hydraulic design of culverts needs to consider various criterion, including existing and future land use in the watershed, impacts on the surrounding land, and the need to create a lower-than-existing headwater ponding in the flood-prone or sensitive areas upstream from the culvert. Flooding in June 2012 1,000 feet upstream of the structure location had significant impacts to surrounding lands and properties. Given this information, the existing structure does not meet the criteria.

The analysis found that the proposed bridge is not overtopped by any storm event. All storm events flow within the hydraulic opening of the structure. The proposed structure will reduce the upstream Q100 water elevation to 243.85 feet, providing a 1.72-foot reduction in water surface elevation.

The hydraulic opening of the proposed structure is approximately 4.5 times the amount of the existing culverts. In addition, the low chord of the proposed structure is 3.43 feet above the top of the existing culvert outlet. The proposed structure is not under pressure-flow and provides 3.56 feet of clearance between the 50-year water surface elevation and the low chord of the bridge. As a result of the proposed culvert replacement, the water surface elevations and discharge velocities for all storm events have been decreased. The Bridge Design Guide states that bridges that are not major riverine bridges shall have a depth of 2 feet minimum of freeboard over the 50-year storm event or 1 foot minimum of freeboard over the 100-year storm event. The proposed structure meets this requirement.

Table 2 provides a summary of the hydraulic analysis of the existing and proposed conditions at the Taylor Brook.

Table 2: Hydraulic Analysis Summary

Summary of Hydraulic Data – Hotel Road over Taylor Brook	Existing Culverts	Proposed Bridge	Delta
Top Chord of Culvert Outlet	242.75	-	-
Low Chord Upstream Face of Bridge	-	246.18	-
Bridge Opening Area, ft^2	128	577.76	+449.76
Headwater at Upstream Face of Bridge, Q1.1, ft.	241.05	241.01	-0.04
Headwater at Upstream Face of Bridge, Q5, ft.	242.01	241.68	-0.33
Headwater at Upstream Face of Bridge, Q10, ft.	242.51	241.99	-0.52
Headwater at Upstream Face of Bridge, Q25, ft.	243.27	242.41	-0.86
Headwater at Upstream Face of Bridge, Q50, ft.	243.83	242.62	-1.21
Headwater at Upstream Face of Bridge, Q100, ft.	245.57	243.85	-1.72
Headwater at Upstream Face of Bridge, Q500, ft.	247.31	244.27	-3.04
Discharge Velocity at Q1.1, fps	0.98	0.84	-0.14
Discharge Velocity at Q5, fps	2.59	2.21	-0.38
Discharge Velocity at Q10, fps	3.08	2.61	-0.47
Discharge Velocity at Q25, fps	3.65	3.08	-0.57
Discharge Velocity at Q50, fps	4.13	3.46	-0.67
Discharge Velocity at Q100, fps	3.93	3.23	-0.70
Discharge Velocity at Q500, fps	4.96	4.02	-0.94
Clearance at Q50, ft.	-1.08	3.56	-
Clearance at Q100, ft.	-2.82	2.33	-

The HEC-RAS models were reviewed for errors, warnings, and notes. There were several notes produced by HEC-RAS for the existing and proposed models about multiple critical depths found at several cross-sections. While no errors were produced, several warnings indicated a need for additional cross-sections. The number of cross-sections were reviewed and were deemed acceptable for this analysis. HEC-RAS outputs including cross-sections and profiles are provided for existing conditions in **Appendix F** and proposed conditions in **Appendix G**.

5.0 Scour Analysis

A scour analysis was performed based on equations from FHWA publication HEC-18 (Fifth Edition). The 100-year and 500-year events were analyzed for scour at the proposed Hotel Road crossing. The D_{50} of the streambed material was found during geotechnical testing. The D_{50} of the material was found to be 0.019 mm. This number was used to determine whether clear water or live bed scour analysis was to be performed. At Hotel Road, live bed scour is required to be calculated for contraction scour. The scour analysis indicated there was no live bed scour at the proposed project site.

In addition, local scour was calculated per HEC-18 for the abutments. Boring logs indicated that bedrock is approximately eight or nine feet below the streambed elevation. Calculations indicate scour depths of 3.96 feet and greater. Since bedrock is relatively shallow, the bridge foundations will be driven into the bedrock. The abutments are concrete integral abutments supported on H-piles driven to bedrock with rock-injector tips. Installing piles into bedrock will protect the abutments against scour. Riprap will be placed at the abutments for additional protection, which the calculations do not consider.

The total scour depths can be found in **Table 3** and the scour analysis can be found in **Appendix H**.

Table 3: Scour Depths

	100 - year storm	
	Abutment 1	Abutment 2
Aggradation/ Degradation (ft.)	0.00	0.00
Contraction/Expansion Scour (ft.)*	0.00	0.00
Local Scour (ft.)	6.43	3.96
TOTAL SCOUR (ft.)	***6.43***	***3.96***

	500-year storm	
	Abutment 1	Abutment 2
Aggradation/ Degradation (ft.)	0.00	0.00
Contraction/Expansion Scour (ft.)*	0.00	0.00
Local Scour (ft.)	7.59	4.69
TOTAL SCOUR (ft.)	***7.59***	***4.69***

**Negative outputs are reported as zero.*

Note that local scour is known to be conservative and the calculations do not account for any proposed scour protection, such as riprap.

6.0 Summary

A preliminary hydrology, hydraulic and scour evaluation was completed for the Taylor Brook Bridge Replacement. A hydrology report for the Taylor Brook was developed. Additionally, flow data from a FEMA flood insurance study (FIS) was used in the evaluation.

The existing culverts at Hotel Road over Taylor Brook in Androscoggin County is proposed to be replaced. The top chord of the existing culvert outlet is 242.75 feet. The existing structure provides approximately 128 square feet of hydraulic opening.

The proposed hydraulic opening is being increased from existing conditions to provide bank-full width of the waterway. The low chord of the proposed structure is approximately 246.18 feet to ensure the structure meets storm water elevation requirements. Replacing the existing twin culverts with a single span bridge will increase the hydraulic opening to approximately 578 square feet.

Hydraulic calculations for the existing and proposed conditions along Taylor Brook were performed using the U.S. Army Corps of Engineers' software HEC-RAS, version 5.0.1. HEC-RAS supports one-dimensional, steady flow, water surface profile calculations. Cross-sections were cut from survey data gathered for this project. The evaluation of the existing structure concluded that the Q50 and Q100 storm water elevations are 1.08 feet and 2.82 feet above the top chord of the culvert outlet, respectively. The HW/D of the existing structure is 1.15 for the Q50 storm water elevation. The Q100 storm water elevation is approximately 5 feet below the top of pavement. The results of the hydraulic analysis indicate the existing structures do not meet the requirements of the Bridge Design Guide.

The proposed structure will decrease the water surface elevations for all storm events. In addition, the increased hydraulic opening allows for approximately 3.56 and 2.33 feet of clearance between the low chord of the structure and the Q50 and Q100 water surface elevations, respectively. These values meet the clearance requirements of the Bridge Design Guide.

Although scour depths are nearly 4 ft and greater, scour is not a concern for this location since new foundations will be founded on bedrock and riprap slopes will further protect the abutments from scour.

Appendix Contents

APPENDIX A

Site Photographs

Photo 1 –Looking Downstream

Photo 2 –Looking Upstream

Photo 3 – Hotel Road – South Approach

Photo 4 – Hotel Road – North Approach

Photo 5 –Downstream Face of Culverts

Photo 6 –Upstream Face of Culverts

APPENDIX B

FEMA Flood Insurance Rate Map

NOTES TO USERS

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

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

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

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

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

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

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

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Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for multiple streams in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unrevised streams may differ from what is shown on previous maps.

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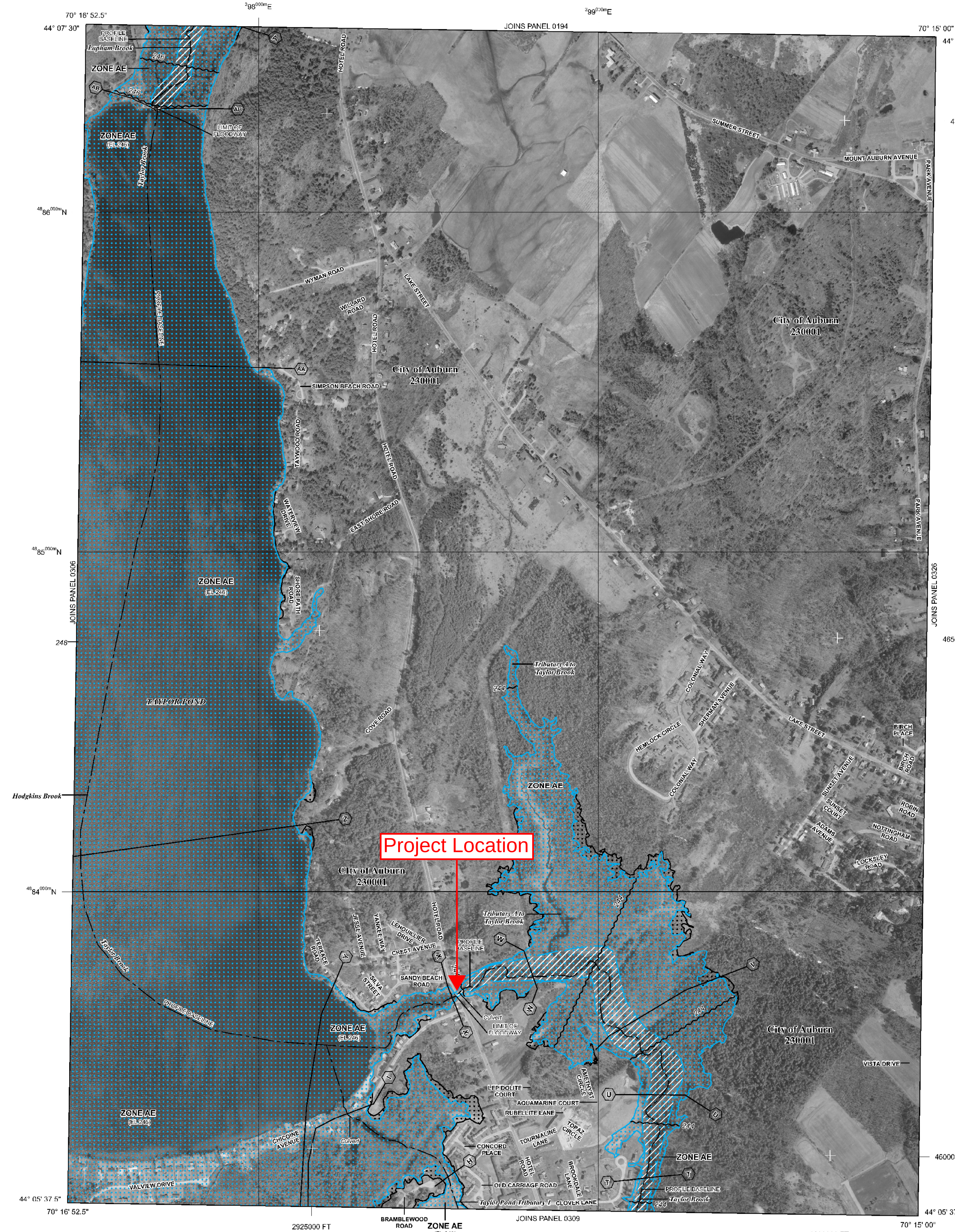
If you have **questions about this map**, how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

State of Maine Floodway Note: Under the Maine Revised Statutes Annotated (M.R.S.A.) Title 38 § 439-A, 7C where the floodway is not designated on the Flood Insurance Rate Map, the floodway is considered to be the channel of a river or other water course and the adjacent land areas to a distance of one-half the width of the floodplain, as measured from the normal high water mark to the upland limit of the floodplain, unless a technical evaluation certified by a registered professional engineer is provided demonstrating the actual floodway based upon approved FEMA modeling methods.



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

1% Annual Chance Floodplain Boundary

0.2% Annual Chance Floodplain Boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

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

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

(A)———(A)	Cross section line
(23)- - - - -(23)	Transect line
45° 02' 08", 93° 02' 12"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
3100000 FT	5000-foot ticks: Maine State Plane West Zone (FIPS Zone 1802), Transverse Mercator projection
$^{48}89^{000m}$ N	1000-meter Universal Transverse Mercator grid values, zone 19
DX5510 X	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• FT1,000	River Station

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
July 8, 2013

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

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

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

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0307E

FIRM

FLOOD INSURANCE RATE MAP

ANDROSCOGGIN COUNTY, MAINE
(ALL JURISDICTIONS)

PANEL 307 OF 470
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
AUBURN, CITY OF	230001	0307	E

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

MAP NUMBER
23001C0307E

EFFECTIVE DATE
JULY 8, 2013

Federal Emergency Management Agency

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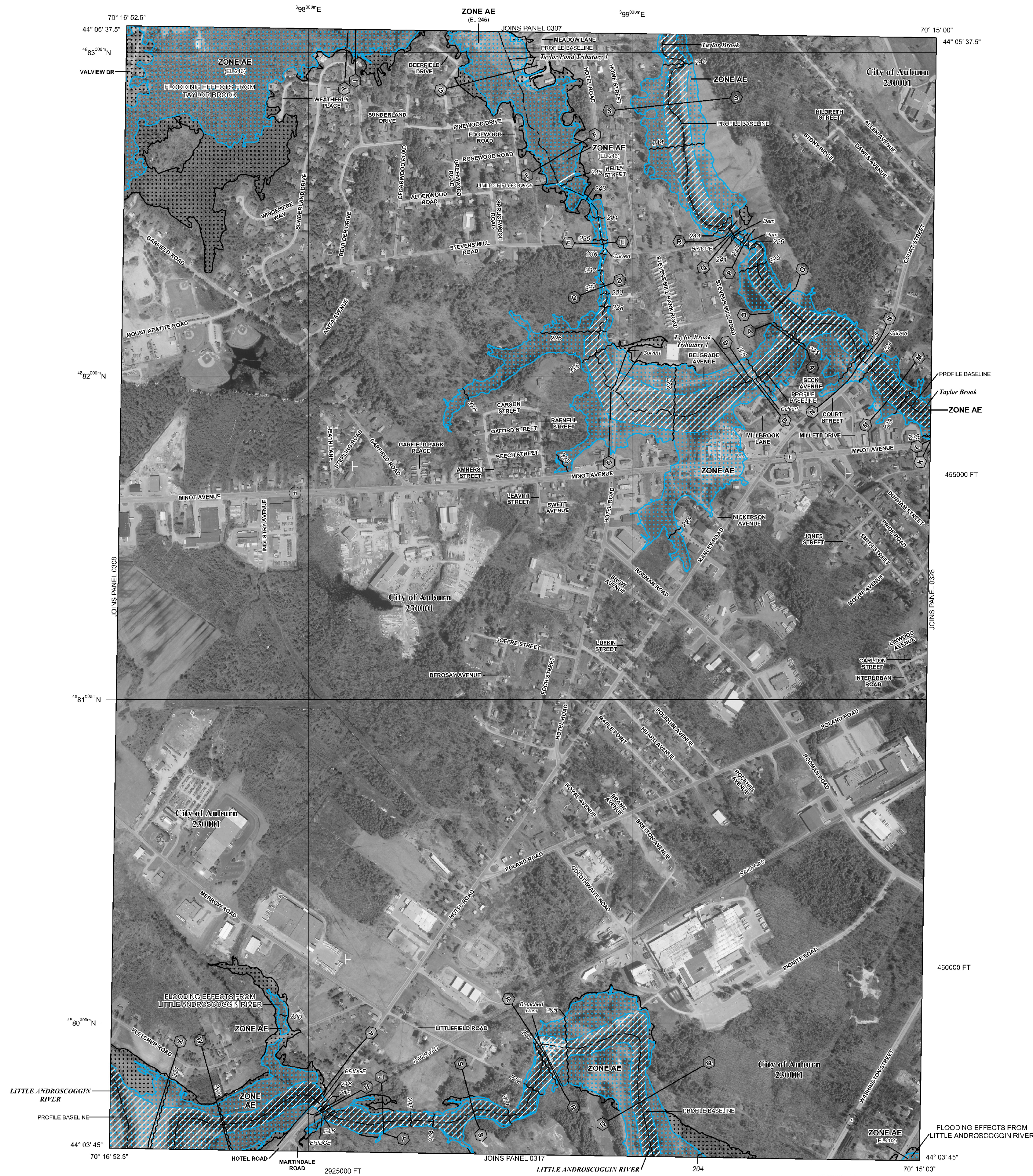
If you have **questions about this map**, how to order products, or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

State of Maine Floodway Note: Under the Maine Revised Statutes Annotated (M.R.S.A.) Title 38 § 439-A, 7C where the floodway is not designated on the Flood Insurance Rate Map, the floodway is considered to be the channel of a river or other water course and the adjacent land areas to a distance of one-half the width of the floodplain, as measured from the normal high water mark to the upland limit of the floodplain, unless a technical evaluation certified by a registered professional engineer is provided demonstrating the actual floodway based upon approved FEMA modeling methods.



LEGEND

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

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

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

FLOODWAY AREAS IN ZONE AE

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

OTHER FLOOD AREAS

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

OTHER AREAS

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

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

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

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

1% Annual Chance Floodplain Boundary

0.2% Annual Chance Floodplain Boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

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

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A —— A	Cross section line
23 - - - - - 23	Transect line
45° 02' 08", 93° 02' 12"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83) Western Hemisphere
3100000 FT	5000-foot ticks: Maine State Plane West Zone (FIPS Zone 1802), Transverse Mercator projection
$^{48}89^{000m}$ N	1000-meter Universal Transverse Mercator grid values, zone 19
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• FT1,000	River Station

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
July 8, 2013

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

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

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

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0309E

FIRM

FLOOD INSURANCE RATE MAP

ANDROSCOGGIN COUNTY, MAINE (ALL JURISDICTIONS)

PANEL 309 OF 470

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
AUBURN, CITY OF	230001	0309	E

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

MAP NUMBER 23001C0309E

EFFECTIVE DATE JULY 8, 2013

Federal Emergency Management Agency

APPENDIX C

Hydrology Report

WIN:	22224.00	**Project Name:**	Auburn Taylor Brook Bridge
Town:	Auburn	**Stream Name:**	Taylor Brook
Route No.	Hotel Road	**Bridge Name:**	Taylor Brook Bridge
Asset ID:	3225	**Analysis by:**	DFB
Lat:	44.0995 **Long:** -70.26707	**Date:**	8/9/2017

Peak Flow Calculations by USGS Regression Equations (Hodgkins, 1999 & Lombard/Hodgkins, 2015)

Enter data in blue cells only!

	km^2	mi^2	ac	
A	38.07	14.70	9408.0	Watershed Area *DRNAREA*
W	5.56	2.1	1374.5	Wetlands area (by NWI)
P_c	396008	4887878		watershed centroid (E, N; UTM 19N; meters)
County	Somerset S			*choose county from drop-down menu*
pptA	39.5			mean annual precipitation (inches; by look-up)
SG	0.00			sand & gravel aquifer as decimal fraction of watershed A

Enter data in [mi^2]

A (km^2) 38.07 **Conf Lvl** 0.67

W (%) 14.61 NWI Wetlands % *STORNWI*

Ret Pd T (yr)	Peak Flow Estimate Lower	Q_T (m^3/s)	Upper	Q_T (ft^3/s)
1.1		4.91		173.3
2		9.62		339.7
5		14.65		517.3
10		18.32		646.8
25		23.21		819.6
50		27.01		953.9
100		31.10		1098.2
500		41.04		1449.2

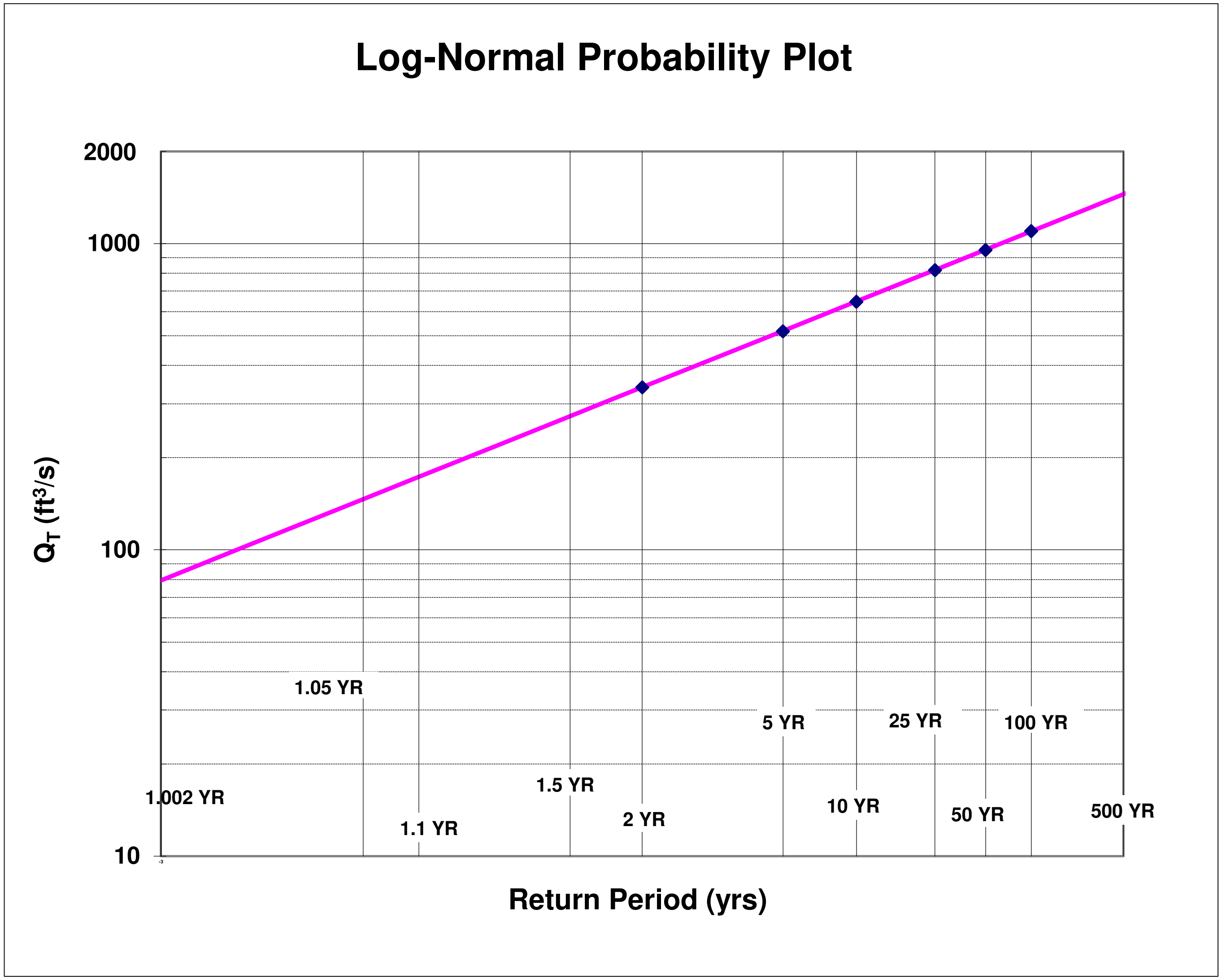
Worksheet prepared by:
Charles S. Hebson, PE
Environmental Office
Maine Dept. Transportation
Augusta, ME 04333-0016
207-557-1052
Charles.Hebson@maine.gov
ver. 2017 Jun. 09

References:

Hodgkins, G.A., 1999.
Estimating the magnitude of peak flows for streams in Maine for selected recurrence intervals
WRIR 99-4008, USGS Augusta, ME

Lombard, P.J. & G.A. Hodgkins, 2015.
Peak flow regression equations for small, ungaged streams in Maine - Comparing map-based to field-based variables
SIR 2015-4059, USGS, Augusta, ME

$Q_T = b \times A^a \times 10^{-wW}$


Log-Normal Probability Plot
2000
1000
100
10
Q_T (ft³/s)
1.05 YR
5 YR
25 YR
100 YR
1.002 YR
1.5 YR
10 YR
500 YR
1.1 YR
2 YR
50 YR
Return Period (yrs)

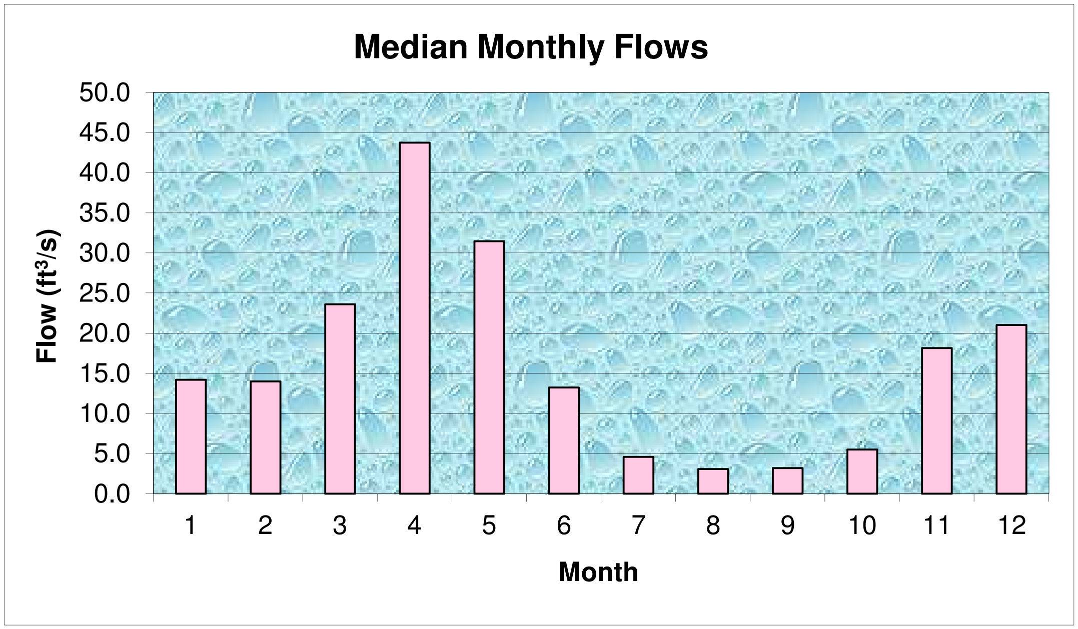
WIN:	22224.00		**Project Name:**	Auburn Taylor Brook Bridge
Town:	Auburn		**Stream Name:**	Taylor Brook
Route No.	Hotel Road		**Bridge Name:**	Taylor Brook Bridge
Asset ID:	3225		**Analysis by:**	DFB
Lat:	44.09949	**Long:** -70.26707	**Date:**	8/9/2017

DO NOT ENTER ANY DATA ON THIS PAGE; EVERYTHING IS CALCULATED

MAINE MONTHLY MEDIAN FLOWS and HYDRAULIC GEOMETRY BY USGS REGRESSION EQUATIONS (2004, 2013)

	Value	Variable	Explanation
	14.70	*A*	Area (mi^2)
396008.3	4887878	P_c	Watershed centroid (E,N; UTM; Zone 19; meters)
	63.29	*DIST*	Distance from Coastal reference line (mi)
	39.5	*pptA*	Mean Annual Precipitation (inches)
	0.00	*SG*	Sand & Gravel Aquifer (decimal fraction of watershed area)

Month	Q_{median} (ft3/s)	(m^3/s)
Jan	**14.22**	0.4030
Feb	**14.02**	0.3973
Mar	**23.61**	0.6692
Apr	**43.75**	1.2399
May	**31.46**	0.8915
Jun	**13.24**	0.3751
Jul	**4.61**	0.1306
Aug	**3.08**	0.0874
Sep	**3.19**	0.0904
Oct	**5.51**	0.1560
Nov	**18.16**	0.5146
Dec	**21.01**	0.5954



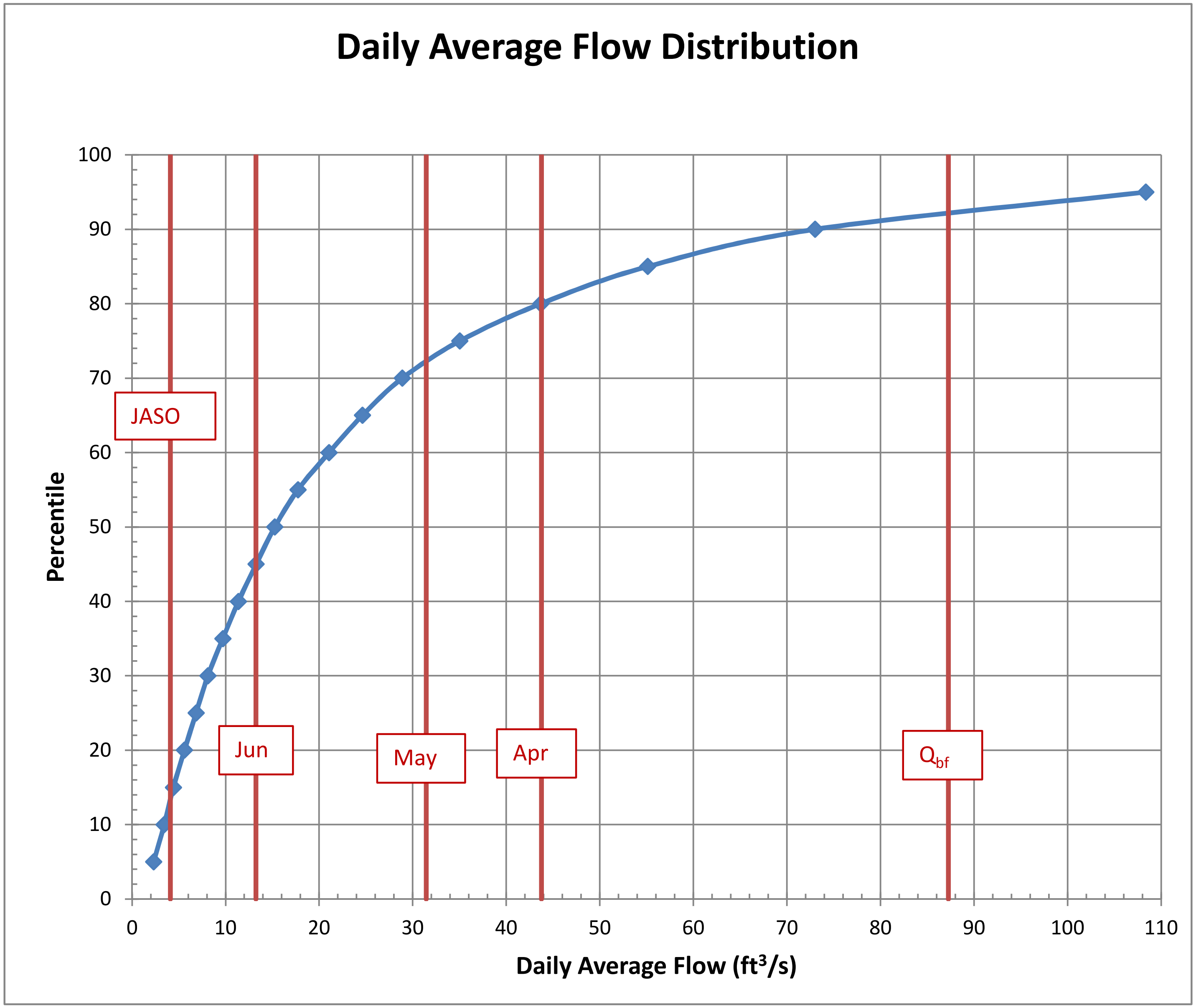
Q_{bf}	**87.3**	
ann avg	**27.9**	
ann med	**13.0**	
$Q_{1.002}$	**79.5**	
$Q_{1.01}$	**104.9**	
$Q_{1.05}$	**146.4**	
Q_{bf}	**199.1**	assume v = 4ft/s

W_{bf}	**33.6**	estimated bankfull width (ft)
d_{bf}	**1.5**	estimated bankfull depth (ft)
A_{bf}	**45.9**	estimated bankfull flow area (ft^2)

References

Dudley, R.W., 2013. FY2013 Progress Report - Phase 1 …, USFWS QRP Project

Dudley, R.W., 2004. Estimating Monthly Streamflows … , SIR 2004-5026



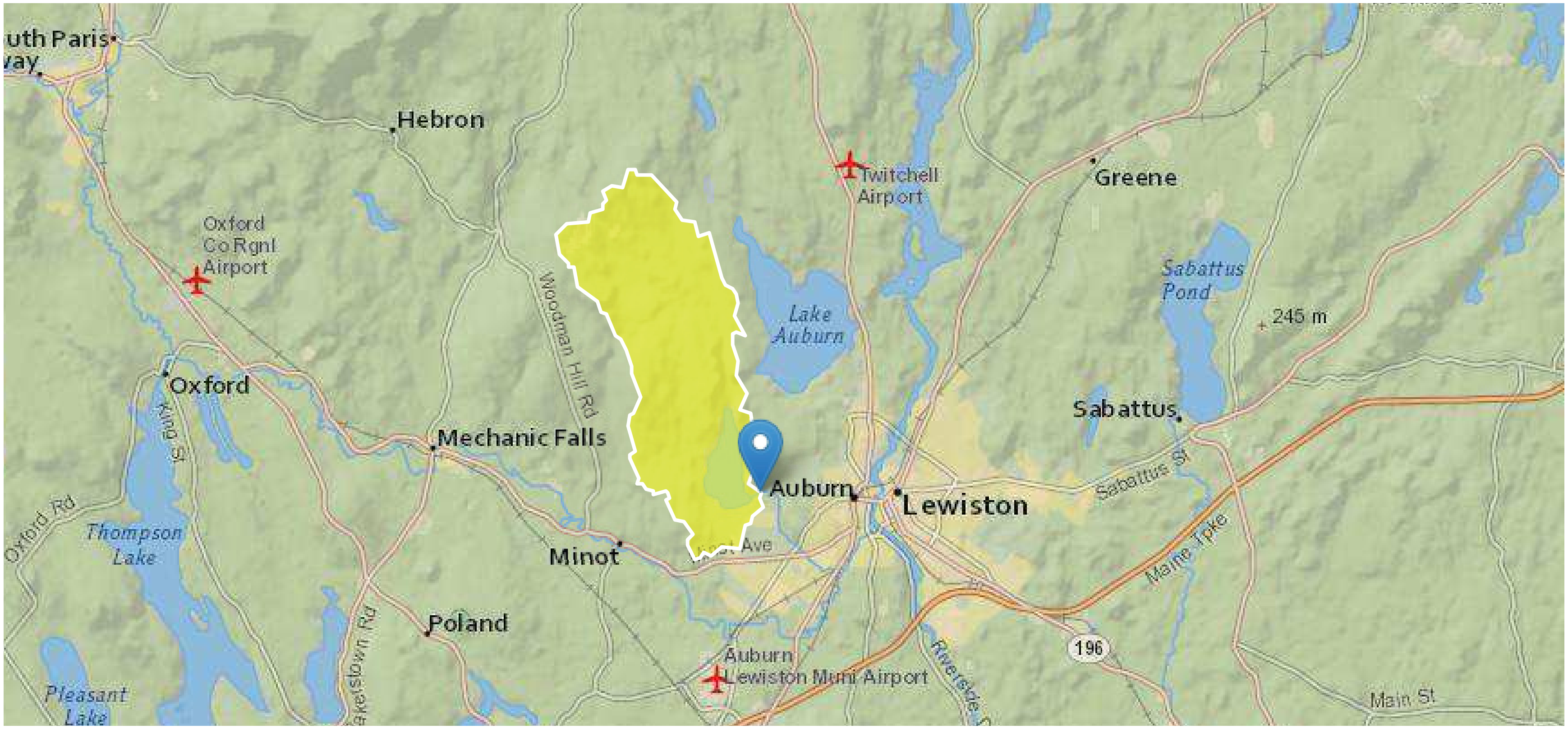
Daily Avg Flow Dist

A_{ws} = (mi^2)		14.7
	Q (ft^3/s)	
Pctl	**Median**	**84^{th} pctl**
5	2.31	3.72
10	3.44	5.17
15	4.42	6.45
20	5.59	7.83
25	6.84	9.17
30	8.10	10.45
35	9.70	11.94
40	11.38	13.73
45	13.26	15.53
50	15.27	18.33
55	17.73	21.33
60	21.06	25.04
65	24.64	29.18
70	28.90	34.04
75	35.03	40.93
80	43.69	48.87
85	55.13	62.63
90	73.03	84.10
95	108.38	130.78

Q_{bf}	87.3
$Q_{1.002}$	79.5
$Q_{1.1}$	173.3
Q_2	339.7

Auburn 22224 Br3225 Taylor Br

Region ID: ME
Workspace ID: ME20170810085458043000
Clicked Point (Latitude, Longitude): 44.09953, -70.26695
Time: 2017-08-10 08:56:10 -0400



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	14.7	square miles
STORNWI	Percentage of storage (combined water bodies and wetlands) from the Nationa Wetlands Inventory	14.61	percent

Parameter Code	Parameter Description	Value	Unit
SANDGRAVAF	Fraction of land surface underlain by sand and gravel aquifers	0	dimensionless
ELEV	Mean Basin Elevation	404.9	feet
BSLDEM10M	Mean basin slope computed from 10 m DEM	7.92	percent
COASTDIST	Shortest distance from the coastline to the basin centroid	64.2	miles
ELEVMAX	Maximum basin elevation	844.8	feet
LC06WATER	Percent of open water, class 11, from NLCD 2006	6.99	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	7.27	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	1.16	percent
PRECIP	Mean Annual Precipitation	46.5	inches
SANDGRAVAP	Percentage of land surface underlain by sand and gravel aquifers	0	percent
STATSGOA	Percentage of area of Hydrologic Soil Type A from STATSGO	5.28	percent

Bankfull Statistics Parameters [Central and Coastal Bankfull 2004 5042]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	14.7	square miles	2.92	298

Bankfull Statistics Flow Report [Central and Coastal Bankfull 2004 5042]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEe
Bankfull Streamflow	87.3	ft^3/s	54.1
Bankfull Width	31	ft	33
Bankfull Depth	1.48	ft	26.2
Bankfull Area	45.9	ft^2	57.4

Bankfull Statistics Citations

Dudley, R.W.,2004, Hydraulic-Geometry Relations for Rivers in Coastal and Central Maine: U.S. Geological Survey Scientific Investigations Report 2004-5042, 30 p (http://pubs.usgs.gov/sir/2004/5042/pdf/sir2004-5042.pdf)

Peak-Flow Statistics Parameters [Statewide Peak Flow Full GT 12sqmi WRI 99 4008]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	14.7	square miles	0.93	1653
STORNWI	Percentage of Storage from NWI	14.61	percent	0.7	26.7

Peak-Flow Statistics Flow Report [Statewide Peak Flow Full GT 12sqmi WRI 99 4008]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	PIl	PIu	SE	SEp	Equiv. Yrs.
2 Year Peak Flood	340	ft^3/s	189	611	35.1	35.1	1.8
5 Year Peak Flood	517	ft^3/s	285	940	36.1	36.1	2.5
10 Year Peak Flood	647	ft^3/s	350	1190	36.8	36.8	3.2
25 Year Peak Flood	820	ft^3/s	433	1550	38.6	38.6	4.1
50 Year Peak Flood	954	ft^3/s	493	1850	39.9	39.9	4.8
100 Year Peak Flood	1100	ft^3/s	555	2170	41.2	41.2	5.4
500 Year Peak Flood	1450	ft^3/s	691	3040	44.9	44.9	6.4

Peak-Flow Statistics Citations

Hodgkins, G. A.,1999, Estimating the Magnitude of Peak Flows for Streams in Maine for Selected Recurrence Intervals: U.S. Geological Survey Water-Resources Investigations Report 99-4008, 45 p. (http://me.water.usgs.gov/99-4008.pdf)

Low-Flow Statistics Parameters [Statewide LowFlow SIR 2004 5026]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	14.7	square miles	9.79	1418
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0	dimensionless	0	0.455

Low-Flow Statistics Flow Report [Statewide LowFlow SIR 2004 5026]

PII: Prediction Interval-Lower, Plu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SE	SEp	Equiv. Yrs.
7 Day 10 Year Low Flow	0.538	ft^3/s	44.3	44.3	2.9

Low-Flow Statistics Citations

Dudley, R.W.,2004, Estimating Monthly, Annual, and Low 7-Day, 10-Year Streamflows for Ungaged Rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2004-5026, 22 p. (http://water.usgs.gov/pubs/sir/2004/5026/pdf/sir2004-5026.pdf)

Flow-Duration Statistics Parameters [Statewide Annual SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	14.7	square miles	14.9	1419
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0	dimensionless	0	0.212
ELEV	Mean Basin Elevation	404.9	feet	239	2120

Flow-Duration Statistics Disclaimers [Statewide Annual SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Flow-Duration Statistics Flow Report [Statewide Annual SIR 2015 5151]

Statistic	Value	Unit
1 Percent Duration	0.0858	ft^3/s
5 Percent Duration	0.423	ft^3/s
10 Percent Duration	1.03	ft^3/s
25 Percent Duration	4.24	ft^3/s
50 Percent Duration	13.2	ft^3/s
75 Percent Duration	34	ft^3/s

Statistic	Value	Unit
90 Percent Duration	75.9	ft^3/s
95 Percent Duration	119	ft^3/s
99 Percent Duration	274	ft^3/s

Flow-Duration Statistics Citations

Dudley, R.W.,2015, Regression equations for monthly and annual mean and selected percentile streamflows for ungaged rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2015–5151, 35 p. (http://dx.doi.org/10.3133/sir20155151)

Annual Flow Statistics Parameters [Statewide Annual SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	14.7	square miles	14.9	1419
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0	dimensionless	0	0.212
ELEV	Mean Basin Elevation	404.9	feet	239	2120

Annual Flow Statistics Disclaimers [Statewide Annual SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Annual Flow Statistics Flow Report [Statewide Annual SIR 2015 5151]

Statistic	Value	Unit
Mean Annual Flow	30.9	ft^3/s

Annual Flow Statistics Citations

Dudley, R.W.,2015, Regression equations for monthly and annual mean and selected percentile streamflows for ungaged rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2015–5151, 35 p. (http://dx.doi.org/10.3133/sir20155151)

APPENDIX D

Taylor Pond Flood Mitigation Assessment

WRIGHT-PIERCE
Engineering a Better Environment™

11 Bowdoin Mill Island, Suite 140
Topsham, ME 04086
Phone: 207.725.8721 | Fax: 207.729.8414
www.wright-pierce.com

February 2, 2018
W-P Project No. 13843A

Mr. Dana Little, President
Taylor Pond Association
585 Garfield Road
Auburn, ME 04210

Subject: Taylor Pond Flood Mitigation Assessment
Findings and Recommendations

Dear Mr. Little:

For the past year, Wright-Pierce has been working with the Taylor Pond Association to assess options for flood mitigation at Taylor Pond. These options have focused on some combination of improvements to infrastructure along Taylor Brook, as this infrastructure limits discharge and flow capacity during large storm events. The following sections of this letter outline the findings of our assessment.

WP Modeled Flood Elevations versus Flood Elevations published by FEMA

A primary finding our assessment was the difference between the flood elevations modeled by Wright-Pierce versus the flood elevations published by the Federal Emergency Management Agency (FEMA) in their Flood Insurance Study (FIS) for Androscoggin County (FIS# 23001CV001). The most recent FEMA FIS (dated July 8, 2013) indicates that the 100-year flood hazard elevation in Taylor Pond is 245.5 (NAVD88). Wright-Pierce modeling estimates the 100-year flood hazard elevation to be as much as two feet less than FEMA (approximately 243.6 feet NAVD88).

The principle difference between the Wright-Pierce modeling and the FEMA modeling relates to hydrologic estimation methods. The FEMA FIS states that the methods for determining flow rates (hydrologic conditions) in Taylor brook were determined by a regression technique developed by the USGS. While regression techniques can be quite accurate in undeveloped and unregulated drainage basins, there are some limitations. In particular, regression analysis predicts a single peak flow rate, which can be useful in steady-state modeling efforts. However, to estimate water surface elevations in large waterbodies with substantive storage volumes and outlet structures that regulate discharge, it is important to incorporate modeling methods that incorporate time and volume. The regression methodology does not effectively account for the flow regulation at the outlet of Taylor Pond, nor the storage volume of Taylor Pond.

Wright-Pierce utilized the United States Department of Agriculture (USDA) Soil Conservation Services (SCS) TR-20 methodology to develop flow hydrographs for Taylor Pond and associated tributary streams to Taylor Brook. The flow hydrographs were then routed through an unsteady (time based) HEC-RAS hydraulic model that accurately incorporated the specific stage-storage-discharge relationships of Taylor Pond and the infrastructure along Taylor Brook. This methodology more accurately reflects the relationship of the detention capacity of Taylor Pond and the associated flood elevation that results from a 100-year event.

It appears that the FEMA analysis is substantively overestimating the flood hazard elevation in Taylor Pond. Utilizing more a more detailed and volume based hydrologic modeling approach, we anticipate that the FEMA flood hazard mapping could be revised below its currently published elevation. While this reduction in flood elevations would be mainly a "paper" improvement (would not make an actual change to the flood levels in Taylor Pond), it may provide substantive financial relief to residents around the pond via reducing flood insurance requirements.

If the Taylor Pond Association is interested in revising the FEMA Flood Hazard mapping, it will be necessary to file an application for a LOMR (Letter of Map Revision) with FEMA. The LOMR process will take time as substantive technical information will accompany the application for review by FEMA. The modeling prepared by Wright-Peirce for this exercise would also require further refinement and additional detail prior to being acceptable for submission to FEMA for review. We would be happy to discuss this process with further with the Taylor Pond Association, however it was outside of the scope of this study.

Taylor Brook Infrastructure and Stream Summary

Discharge from Taylor Pond forms Taylor Brook, which flows through twin culverts under Hotel Road prior to crossing under a bridge structure and over a dam (Upper Kendall Dam). One of the focal points of this study was to quantify actual flood elevation improvements in Taylor Pond by improvement and/or modification to the infrastructure along Taylor Brook.

Wright-Pierce focused data collection, stream assessment, and hydraulic modeling efforts on the segment of Taylor Stream from the outlet of Taylor Pond to the point just downstream of the Upper Kendall Dam. The data review included the collection of available plans for the associated infrastructure, limited topographic survey in the area of infrastructure (particularly in the area of hotel road), and a paddling survey of the brook segment. Wright-Pierce also constructed an unsteady HEC-RAS computer model of the Taylor Pond and Brook system to calculate hydraulic characteristics in the system and determine the associated effects of modifying the infrastructure.

Hotel Road Crossing and the Upstream Reach of Taylor Brook

The segment of Taylor Brook between Hotel Road and the Pond contains dense woody vegetation and a rather non-descript braided channel. Much of the substrate in this reach area is a sandy gravel, which appears to be general aggradation of sediment transported from the adjacent beach areas and sandy shoreline near the outlet of the Pond. Anecdotal accounts of beach nourishment practices indicate that excessive artificial sand and gravel sediment loads have been supplied to the Pond for many decades since the early 1900s. While these sands loadings have improved the beach conditions for recreational purposes, substantive amounts of sand and gravel have been transported into the mouth of Taylor Brook at the outlet of the Pond.

As shown on a plan from 1935 on file with the Maine DOT, a small bridge existed at the crossing of Hotel Road and Taylor Brook in the early 1900s. The plan depicted the existence of a "Fish Screen" just upstream of the bridge location prior to 1935. While not specifically defined as a "dam", the existing conditions survey identified that a water surface elevation step of over two feet (>2') existed at the crossing. The combined effect of the "fish screen" and bridge created a damming effect at hotel road.

In 1935, the Maine DOT replaced the prior bridge with an new sixteen foot (16') span concrete structure. This bridge existed until 1978, until it was replaced with the set of twin corrugated metal arch culverts that exist today. Each of these structures creates a hydraulic "constriction" of the Taylor Brook channel, which limits its hydraulic capacity.

It is likely that prior to the construction of infrastructure along Taylor Brook, the reach upstream of Hotel Road had similar channel form, floodplain, and vegetative qualities as the segment downstream of Hotel Road. However, these two reaches are substantively different at this time. The difference is obvious and evident by standing on Hotel Road and comparing the general visual observation of these reaches from upstream to downstream.

It appears that the damming effects of historic structures on the Brook combined with the excessive sediment loading from upstream recreational beach nourishment, has severely altered the segment of Taylor Brook upstream of Hotel Road. The sedimentation appears to have effectively raised the elevation of the channel bed and adjacent flood plain (filled with sand and gravel sediments). The higher channel and flood plain elevations, combined with altered soils has promoted the growth of dense woody vegetation with an aggressive root structure throughout the upper reach.

Taylor Brook below the Hotel Road Crossing

Downstream of Hotel Road the Taylor Brook channel is notably different. The channel bed material is generally a fine silty-clay. The channel is well defined and meanders through a wide floodplain covered in emergent marsh grass. This downstream reach is reflective of the a more natural condition of Taylor Brook prior to the influences of infrastructure that have altered the upper reach.

The presence of beaver and their associated dams are evident throughout Taylor Brook between the Upper Kendall Dam and the Hotel Road Crossing. Based upon a review of prior studies and historic aerial photographs, it is evident that the beaver dam structures regularly breach and reform in different locations throughout the system. The relatively wide floodplain, flat channel gradient, fine/erodible bed materials and presence of Beaver Dams combine to cause a reasonable level of channel movement and migration over time. The aerial photo depicts several historic channel alignments and thalweag locations, indicating that the channel can fully utilize the flood plain as it meanders and may shift substantively during high flow events.

The Taylor Brook Channel form is substantively impacted by the Upper Kendall Dam for approximately 3,200 feet upstream from the dam. In this area, the channel is impounded during normal flow conditions. Channel velocities are reduced and water depths are increased. These effects are more pronounced with closer proximity to the dam location.

Just upstream from the Upper Kendal Dam is a bridge structure. This bridge structure carries a single lane road/driveway over Taylor Brook. The road/driveway appears to only serve a single residential property.

Taylor Brook Infrastructure Improvement Analysis

Wright-Pierce constructed a hydrologic and hydraulic model to evaluate the performance of Taylor Brook (and the corresponding effect to water surface elevations in Taylor Pond) during a variety of infrastructure improvement scenarios.

Hotel Road Crossing

As described above, the constriction created by the Hotel Road crossing and its impact to the upstream channel area is notable. Alleviation of this constriction by increasing the span and capacity of the Hotel Road crossing structure can aid Taylor Brook in reforming to a more natural (pre-impact) channel morphology. The U.S. Army Corps of Engineers' Programmatic General Permit for the State of Maine includes standards for the crossing of streams and brooks. A primary criterion of these standards is that a road crossing structure provides a span of 1.2 times (120%) of the stream's bank-full width. By providing a structure with a 1.2 bank-full width, the stream can maintain a more natural geomorphologic function.

There are limited locations to reference the appropriate bank-full width of Taylor Brook for the Hotel Road Crossing. As noted, the channel above the crossing is already severely altered. Downstream of the crossing, several tributary streams converge with Taylor Brook approximately 900 feet downstream. Beaver dam activity has also impounded the channel and there is some channel braiding within the remaining representative areas. During our in-stream survey in the Spring of 2017, Wright-Pierce measured the bank width of the stream to be in the range of 22 to 27 feet. For the purposes of design, we suggest the use of a bank-full width of 24 feet. Based upon this bank-full width, the structure at Hotel Road should be improved to a span of at least 29 feet.

Upper Kendal Dam and Bridge Crossing

The Upper Kendal Dam and Bridge Crossing are located in close proximity to each other. During normal monthly flow conditions, these two structure do not have a direct impact on Taylor Pond. However during high flow events (i.e. 100-year storm) both of these structure have a substantive impact on the flood level in Taylor Pond.

The Upper Kendal Dam sits on natural bedrock and has a simple overflow style spillway crest that spans the entire Taylor Book Channel. The bridge is located approximately 30 feet upstream and has a span of approximately 13.5 feet. Each structure has its own individual impacts to Taylor Brook, however their combined impact is more substantial.

Improvement Scenarios

To quantify the associated impact to Taylor Pond, our hydraulic modeling evaluated a variety of infrastructure improvement scenario combinations. Specifically, the following list of scenarios was evaluated:

SCENARIO EX – No improvements to infrastructure. This represents the existing conditions.

SCENARIO 1 – Improvement to Hotel Road Crossing: 20' wide Arch Culvert, Crown Elevation:241.5'
No Improvement to Steven's Mill Bridge Crossing
No Improvement to Upper Kendal Dam

SCENARIO 2 – Improvement to Hotel Road Crossing: 20' wide Arch Culvert, Crown Elevation:241.5'
Improvement to Steven's Mill Bridge Crossing: 23' wide Bridge, Deck Elevation Retained.
No Improvement to Upper Kendal Dam

SCENARIO 3 – Improvement to Hotel Road Crossing: 20' wide Arch Culvert, Crown Elevation:241.5'
Improvement to Steven's Mill Bridge Crossing: 23' wide Bridge, Deck Elevation Retained.
Removal of Upper Kendal Dam

SCENARIO 4 – Improvement to Hotel Road Crossing: 20' wide Arch Culvert, Crown Elevation:241.5'
No Improvement to Steven's Mill Crossing
Removal of Upper Kendal Dam

SCENARIO 5 – Improvement to Hotel Road Crossing: 29' wide Bridge, Crown Elevation: 246'
No Improvement to Steven's Mill Bridge Crossing
No Improvement to Upper Kendal Dam

SCENARIO 6 – Improvement to Hotel Road Crossing: 29' wide Bridge, Crown Elevation: 246'
Improvement to Steven's Mill Crossing: 35' wide Bridge, Bridge Deck Elevation Retained.
No Improvement to Upper Kendal Dam

SCENARIO 7 – Improvement to Hotel Road Crossing: 29' wide Bridge, Crown Elevation: 246'
Improvement to Steven's Mill Crossing: 35' wide Bridge, Bridge Deck Elevation Retained.
Removal of Upper Kendal Dam

SCENARIO 8 – Improvement to Hotel Road Crossing: 29' wide Bridge, Crown Elevation: 246'
No Improvement to Steven's Mill Crossing
Removal of Upper Kendal Dam

SCENARIO 9 – No Improvement to Hotel Road Crossing
Improvement to Steven's Mill Crossing: 23' wide Bridge, Deck Elevation Retained.
No Improvement to Upper Kendal Dam

SCENARIO 10 – No Improvement to Hotel Road Crossing
Improvement to Steven's Mill Crossing: 35' wide Bridge, Bridge Deck Elevation Retained.
No Improvement to Upper Kendal Dam

Based upon these scenarios, we determined the following performance (shown in Table 1). It is important to note that the reported existing condition differs from the FEMA published information. As discussed in prior sections, this is due to a difference in hydrologic modeling techniques and pond routing methods.

**Table 1 – Taylor Brook Hydraulic Performance Summary (100-year event)
No Channel Adjustment/Response**

Scenario	Taylor Pond Outlet		Upstream of Hotel Road		Downstream of Hotel Road	
	Elevation (Feet)	Shear Stress (Ft-lbs)	Elevation (Feet)	Shear Stress (Ft-lbs)	Elevation (Feet)	Shear Stress (Ft-lbs)
EX	243.57	0.12	243.43	0.13	242.31	0.05
#1	243.30	0.15	243.11	0.16	242.32	0.05
#2	243.26	0.19	243.02	0.20	242.01	0.08
#3	243.17	0.27	242.78	0.32	241.17	0.20
#4	243.19	0.23	242.88	0.26	241.61	0.12
#5	243.23	0.19	242.99	0.20	242.62	0.05
#6	243.17	0.27	242.80	0.31	242.16	0.09
#7	243.09	0.36	242.53	0.47	241.32	0.22
#8	243.13	0.29	242.71	0.34	241.99	0.11
#9	243.32	0.15	243.13	0.15	241.93	0.06
#10	243.32	0.15	243.13	0.16	241.87	0.07

Note: Elevations are in reference to NGVD88 and reflect the modeled maximum water surface of the brook at the noted location. Shear stress is the average shear stress in the channel at the noted location.

As shown in Table 1, there is only approximately six inches (6”) of flood reduction associated with the most aggressive improvement scenario (Scenario #7). Considering these water surface elevations on their own, one would conclude that there is little benefit to improvements to any of the infrastructure along Taylor Brook. However, considering the overall modeling results more closely (particularly the associated shear stress at each location), it becomes apparent that some level of channel geometry adjustment and response would also occur during large storm events.

As noted in prior sections of this report, the channel bed material in Taylor Brook is a uniform sand in the reach upstream of Hotel Road. Downstream of Hotel Road the channel bed material is a finer silt/clay. To determine the potential for channel response and adjustment, a representative sample of the channel bed material (sandy material upstream of hotel road) was collected and analyzed.

The laboratory analysis of the material identified it as a relatively uniform sand. The test indicated that 99% of the material had a particle size smaller than 12.5 millimeters (1/2”) and about 10% of the material was less than 0.15 millimeters (No. 100 sieve). The average size of the sand particles is approximately 1.0 to 1.5 millimeters in size.

Based upon the analysis of this sample, Wright-Pierce performed calculations relating to the potential for mobilization of this sand during various conditions. Our calculations indicate that the smaller (finer) particles of sand will begin to mobilize when shear stress in the channel reaches approximately 0.04 foot-pounds (ft-lbs). Once a shear stress of 0.16 foot-pounds develops in the channel, all particles in this sandy material will mobilize. As such, the sandy material that forms the Taylor Brook Channel around the outlet of the Pond will begin to mobilize during storm events that create shear stress in the channel of 0.04 ft-lbs. It should be expected that the channel will begin to meaningfully reform once shear stress reaches 0.16 ft-lbs.

As shown in Table 1, shear stress in the Taylor Brook study area does not exceed 0.12 ft-lbs in the existing conditions. This result is to be expected, as the geometry of the Taylor Brook Channel has developed around this existing hydraulic condition. However, improvements to infrastructure along Taylor Brook will increase shear stress on the channel, which will trigger changes to the existing channel geometry. As identified in Table 1, a shear stress of as much as 0.36 ft-lbs could develop in the most aggressive improvement scenario (Scenario #7).

Considering the potential for the channel bed to mobilize upon improvement of infrastructure, it is important to consider the associated affects of restoring the natural channel form to Taylor Brook. In addition to collecting the aforementioned sample of bed material, several explorations were performed via excavation and probes in the channel (with hand tools). Throughout the most confined channel sections (constricted horizontally and vertically) there is multiple feet sandy bed material. Hand probes were advanced at least four feet without reaching refusal. Generally, a fine grey silt/clay material was found underlying the sand bed. The underlying silt/clay was similar to the composition of the bed material downstream of Hotel Road. Overall, it appears that mobilization of the sand bed material would be generally unrestricted within the extent of the flood plain.

The precise channel adjustments that would occur during large storm events are dynamic and complicated to predict. It is also likely that the channel would take time to respond and the mobilization of materials would occur gradually over a series of high flow events. However, it is reasonable to expect that the channel form and grade associated with Taylor Brook downstream of Hotel Road, would continue through Hotel Road and up to Taylor Pond. Utilizing the Taylor Brook Channel downstream of Hotel Road as a proxy for the restored condition of the upstream reach, the HEC-RAS model was revisited for several key scenarios to consider hydraulic performance of Taylor Brook that would include channel response and restoration of channel form. The associated results are shown below in Table 2.

Table 2 – Taylor Brook Hydraulic Performance Summary (100-year event)
Includes Channel Adjustment/Response

Scenario	Taylor Pond Outlet Water Surface Elevation (Feet)
EX	243.6
#1	243.3
#5	243.2
#6 or #8	242.4
#7	241.8

As shown in Table 2, there are minimal impacts to the water level in Taylor Pond by improvement only to the Hotel Road structure. However, a combination of improvements to the Hotel Road crossing and one of the other structures (either the Upper Kendal Dam or the Bridge) will result in approximately one foot of reduction to the flood level in Taylor Pond during the 100-year event. If the most aggressive infrastructure improvement strategy is employed (under scenario #7), it may be possible to reduce flood levels (100-year event) in Taylor pond by as much as 1.5 feet or more.

Reccomendations and Considerations

Based upon this analysis, we have the following basic recommendations:

- Improve the Hotel Road crossing structure to at least a 29 foot span with a crown at or above elevation 244.0 feet (NGVD88)
- Coordinate with the Owner of the Upper Kendall Dam and Bridge to improve/modify at least one of those structures
- Coordinate with the City of Auburn and FEMA to revise the FEMA mapping for the 100-year flood levels.

There are several additional points to consider if these recommendations are acted upon. This includes, the associated effect of channel restoration to the normal water levels in Taylor Pond. During our in-stream survey in the Spring of 2017, the water level in Taylor Brook was controlled principally by a beaver dam located approximately 1,200 feet downstream of Hotel Road. Based upon our review of prior studies, it seems that other beaver dams and/or temporary "berms" have controlled water levels over-time. The restoration of the Taylor Brook Channel will result in the potential for increased mobility of these structures and, perhaps impact (lower) normal water surfaces in Taylor Pond. This could be mitigated for by the construction of a new grade control structure at the pond outlet (such as a "nature-like" stone weir structure).

It is also likely that the woody vegetative growth that has encroached the Taylor Pond channel upstream of Hotel road will inhibit channel restoration. The root structure of those woody species is much more aggressive than the root structure of the marsh grasses and floodplain vegetation located in downstream reaches. As such, further consideration may be warranted to proactively cutting vegetation and/or dredging of portions of the channel upstream of Hotel Road to accelerate the channel restoration. This would only be recommended if it was happening after or in conjunction with the recommended improvements.

We appreciate this opportunity to work with the Taylor Pond Association. Please feel free to contact me with any additional questions or if you need further information.

Sincerely,
WRIGHT-PIERCE

Joseph M. McLean, PE
Senior Project Manager

STATE OF MAINE
JOSEPH M.
McLEAN
No. 11182
LICENSED
PROFESSIONAL ENGINEER

APPENDIX E

FEMA Flood Insurance Study

Table 5 – Summary of Discharges (Continued)

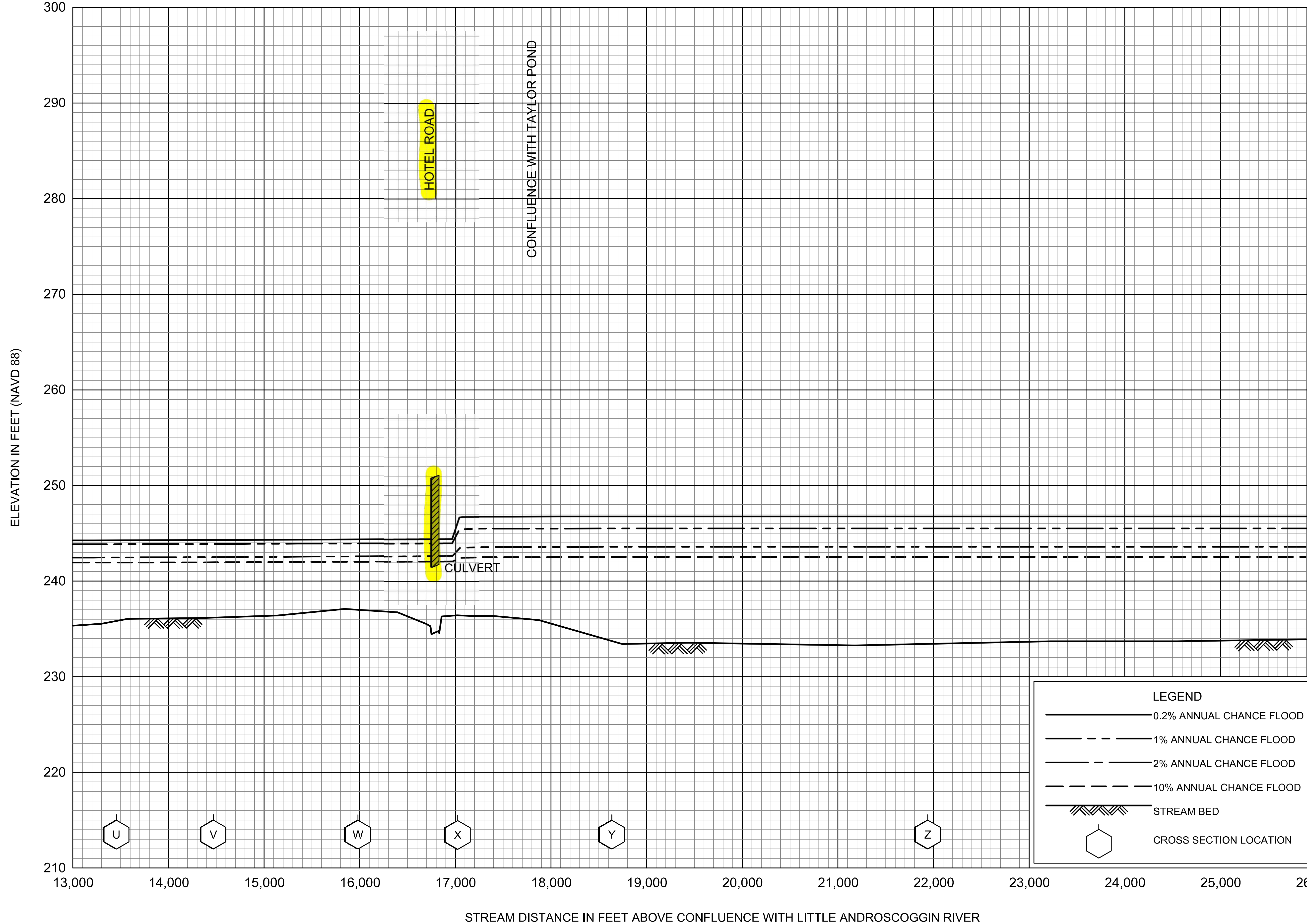
FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10%-ANNUAL-CHANCE	2%-ANNUAL-CHANCE	1%-ANNUAL-CHANCE	0.2%-ANNUAL-CHANCE
TAYLOR BROOK					
Approximately 220 upstream of confluence with Little Androscoggin River	19.2	893	1,318	1,517	2,003
Approximately 500 feet downstream of Minot Avenue	18.3	839	1,238	1,425	1,880
Approximately 1,300 feet upstream of Court Street	16.7	741	1,093	1,257	1,658
Approximately 0.80 mile upstream of Court Street	16.5	732	1,079	1,242	1,638
Approximately 0.2 mile downstream of Hotel Road	14.9	646	952	1,096	1,445
Approximately 170 feet upstream of confluence with Taylor Pond Tributary 1	14.6	649	958	1,104	1,457
Approximately 95 feet upstream of confluence with Hodgkins Brook	9.3	493	740	857	1,145
Approximately 2,475 feet upstream of confluence with Hodgkins Brook	8.7	528	801	930	1,251
TAYLOR BROOK TRIBUTARY 1					
At the confluence with Taylor Brook	1.4	209	319	373	474
Approximately 600 feet downstream of Hotel Road	1.1	174	269	315	401
Approximately 70 feet downstream of Stevens Mill Road	0.3	67	88	97	140
THE BASIN					
Approximately 1.10 miles downstream of Lake Shore Drive	9.6	527	793	919	1,230
At North Auburn Road	7.8	476	723	840	1,131

Table 7 – Manning's "n" Values (Continued)

Stream	Channel	Overbank
Hart Brook	0.045-0.060	0.040-0.120
Hooper Brook	0.040-0.065	0.078-0.095
Hooper Brook Tributary 1	0.065-0.067	0.078-0.095
House Brook	0.045	0.045-0.150
Jepson Brook	0.013-0.050	0.032-0.120
Lake Auburn	0.032-0.040	0.032-0.120
Lapham Brook	0.035-0.045	0.035-0.090
Little Androscoggin River	0.050	0.035-0.110
Lively Brook	*	*
Lower Range Pond	0.032	0.032-0.090
Martin Stream	*	*
Maxwell Brook	0.060-0.075	0.080-0.085
Meadow Brook	0.045	0.035-0.150
Moody Brook	0.035-0.045	0.050-0.080
Newell Brook	0.050	0.032-0.130
Nezinscot River	0.040-0.052	0.060-0.080
No Name Brook	0.040-0.045	0.030-0.150
No Name Brook Tributary A	0.045-0.050	0.040-0.120
Potash Brook	0.032-0.055	0.032-0.150
Range Brook	0.032-0.060	0.035-0.090
Redwater Brook	0.032-0.055	0.032-0.150
Sabattus River	0.015-0.062	0.017-0.092
Salmon Brook	0.040	0.040-0.150
Soper Mill Brook	0.045	0.040-0.090
Stetson Brook	0.065	0.035-0.150
Taylor Brook	0.035-0.070	0.030-0.120
Taylor Brook Tributary 1	0.050	0.100
The Basin	0.032	0.032-0.120
Tributary A to Little Androscoggin River	0.045	0.032-0.090
Tributary A to Soper Mill Brook	0.045	0.032-0.150
Waterhouse Brook	0.060	0.040-0.090
Winter Brook	0.035-0.060	0.060-0.105
Worthley Brook	0.055	0.035-0.150
Worthley Pond	0.032-0.055	0.055-0.120

*Data not available

All qualifying benchmarks within a given jurisdiction that are catalogued by the National Geodetic Survey (NGS) and entered into the National Spatial Reference System (NSRS) as First or Second Order Vertical and have a vertical stability classification of A, B or C are shown and labeled on the FIRM with their 6-character NSRS Permanent Identifier.



FLOOD PROFILES

TAYLOR BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY

ANDROSCOGGIN COUNTY, ME

(ALL JURISDICTIONS)

APPENDIX F

Existing HEC-RAS Analysis

HEC-RAS Plan: MaineDOT River: Taylor Brook Reach: Reach

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach	525.7824	Q1.1	173.30	234.97	241.07		241.07	0.000009	0.33	539.30	132.91	0.03
Reach	525.7824	Q5	517.30	234.97	242.09		242.10	0.000037	0.78	677.02	137.10	0.06
Reach	525.7824	Q10	646.80	234.97	242.61		242.62	0.000042	0.88	749.19	139.24	0.06
Reach	525.7824	Q25	819.60	234.97	243.40		243.41	0.000044	0.98	860.33	142.47	0.07
Reach	525.7824	Q50	953.90	234.97	243.97		243.99	0.000045	1.05	943.10	146.18	0.07
Reach	525.7824	Q100	1098.20	234.97	245.69		245.70	0.000028	0.96	1222.60	180.19	0.06
Reach	525.7824	Q500	1449.20	234.97	247.46		247.48	0.000025	1.03	1580.78	225.60	0.06
Reach	485.7806	Q1.1	173.30	233.69	241.07		241.07	0.000005	0.26	664.56	139.35	0.02
Reach	485.7806	Q5	517.30	233.69	242.09		242.09	0.000021	0.65	809.74	145.10	0.05
Reach	485.7806	Q10	646.80	233.69	242.61		242.62	0.000025	0.75	886.34	148.04	0.05
Reach	485.7806	Q25	819.60	233.69	243.40		243.41	0.000028	0.84	1004.90	152.24	0.05
Reach	485.7806	Q50	953.90	233.69	243.97		243.99	0.000029	0.90	1093.15	155.03	0.06
Reach	485.7806	Q100	1098.20	233.69	245.69		245.70	0.000019	0.84	1384.44	187.28	0.05
Reach	485.7806	Q500	1449.20	233.69	247.46		247.47	0.000018	0.92	1749.78	224.68	0.05
Reach	435.5161	Q1.1	173.30	234.96	241.07		241.07	0.000012	0.36	490.70	132.46	0.03
Reach	435.5161	Q5	517.30	234.96	242.08		242.09	0.000048	0.84	627.93	137.93	0.07
Reach	435.5161	Q10	646.80	234.96	242.60		242.62	0.000053	0.94	700.69	141.10	0.07
Reach	435.5161	Q25	819.60	234.96	243.39		243.41	0.000053	1.04	813.84	145.89	0.07
Reach	435.5161	Q50	953.90	234.96	243.97		243.98	0.000053	1.10	898.67	151.29	0.07
Reach	435.5161	Q100	1098.20	234.96	245.68		245.70	0.000032	0.99	1209.74	202.49	0.06
Reach	435.5161	Q500	1449.20	234.96	247.46		247.47	0.000027	1.03	1600.53	237.90	0.06
Reach	399.7550	Q1.1	173.30	235.03	241.06		241.07	0.000037	0.54	333.99	121.39	0.05
Reach	399.7550	Q5	517.30	235.03	242.07		242.09	0.000122	1.18	460.56	130.37	0.10
Reach	399.7550	Q10	646.80	235.03	242.59		242.61	0.000125	1.30	529.55	135.01	0.11
Reach	399.7550	Q25	819.60	235.03	243.38		243.40	0.000114	1.38	637.67	139.16	0.10
Reach	399.7550	Q50	953.90	235.03	243.95		243.98	0.000108	1.43	718.77	143.87	0.10
Reach	399.7550	Q100	1098.20	235.03	245.67		245.69	0.000057	1.24	979.92	159.38	0.08
Reach	399.7550	Q500	1449.20	235.03	247.45		247.47	0.000047	1.29	1286.25	198.81	0.07
Reach	363.2124	Q1.1	173.30	234.30	241.06		241.07	0.000032	0.58	302.24	87.12	0.05
Reach	363.2124	Q5	517.30	234.30	242.05		242.08	0.000129	1.37	392.52	94.59	0.11
Reach	363.2124	Q10	646.80	234.30	242.57		242.61	0.000142	1.53	442.61	99.53	0.12
Reach	363.2124	Q25	819.60	234.30	243.36		243.40	0.000141	1.67	523.81	107.50	0.12
Reach	363.2124	Q50	953.90	234.30	243.93		243.97	0.000139	1.76	587.36	115.02	0.12
Reach	363.2124	Q100	1098.20	234.30	245.66		245.69	0.000078	1.54	803.54	131.15	0.09

HEC-RAS Plan: MaineDOT River: Taylor Brook Reach: Reach (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach	363.2124	Q500	1449.20	234.30	247.43		247.47	0.000066	1.60	1045.48	141.54	0.09
Reach	346.2246	Q1.1	173.30	234.28	241.05	235.92	241.06	0.000047	0.83	209.30	57.25	0.06
Reach	346.2246	Q5	517.30	234.28	242.01	237.27	242.08	0.000234	2.09	251.02	65.71	0.15
Reach	346.2246	Q10	646.80	234.28	242.51	237.62	242.60	0.000280	2.41	272.90	70.30	0.16
Reach	346.2246	Q25	819.60	234.28	243.27	238.05	243.39	0.000309	2.72	306.39	79.82	0.18
Reach	346.2246	Q50	953.90	234.28	243.83	238.35	243.96	0.000327	2.94	330.74	86.75	0.18
Reach	346.2246	Q100	1098.20	234.28	245.57	238.65	245.68	0.000221	2.75	406.72	99.78	0.16
Reach	346.2246	Q500	1449.20	234.28	247.31	239.27	247.45	0.000218	3.06	483.23	110.91	0.16
Reach	312.9504		Culvert									
Reach	242.1242	Q1.1	173.30	234.28	241.00	236.10	241.02	0.000064	0.98	182.35	57.28	0.08
Reach	242.1242	Q5	517.30	234.28	241.59	237.49	241.69	0.000394	2.59	205.28	71.27	0.19
Reach	242.1242	Q10	646.80	234.28	241.88	237.88	242.02	0.000519	3.08	216.48	75.55	0.22
Reach	242.1242	Q25	819.60	234.28	242.26	238.37	242.46	0.000674	3.65	231.20	81.13	0.25
Reach	242.1242	Q50	953.90	234.28	242.44	238.70	242.70	0.000828	4.13	238.27	84.42	0.28
Reach	242.1242	Q100	1098.20	234.28	243.72	239.04	243.95	0.000592	3.93	288.05	106.21	0.25
Reach	242.1242	Q500	1449.20	234.28	244.07	239.77	244.44	0.000889	4.96	301.47	111.84	0.31
Reach	224.3764	Q1.1	173.30	234.37	241.00		241.01	0.000087	0.89	195.92	67.13	0.08
Reach	224.3764	Q5	517.30	234.37	241.60		241.67	0.000446	2.25	246.79	101.19	0.19
Reach	224.3764	Q10	646.80	234.37	241.89		241.99	0.000534	2.57	277.41	106.06	0.22
Reach	224.3764	Q25	819.60	234.37	242.29		242.41	0.000611	2.91	320.45	112.54	0.23
Reach	224.3764	Q50	953.90	234.37	242.48		242.63	0.000705	3.21	342.70	115.76	0.25
Reach	224.3764	Q100	1098.20	234.37	243.78		243.88	0.000355	2.66	507.08	136.36	0.19
Reach	224.3764	Q500	1449.20	234.37	244.17		244.31	0.000478	3.21	561.36	141.94	0.22
Reach	179.7377	Q1.1	173.30	234.05	241.00		241.01	0.000060	0.77	247.56	105.34	0.07
Reach	179.7377	Q5	517.30	234.05	241.60		241.65	0.000299	1.90	315.74	122.83	0.16
Reach	179.7377	Q10	646.80	234.05	241.89		241.96	0.000356	2.17	353.42	130.67	0.18
Reach	179.7377	Q25	819.60	234.05	242.29		242.37	0.000406	2.45	407.28	141.12	0.19
Reach	179.7377	Q50	953.90	234.05	242.49		242.59	0.000467	2.69	435.57	146.31	0.21
Reach	179.7377	Q100	1098.20	234.05	243.79		243.85	0.000235	2.22	648.40	181.14	0.15
Reach	179.7377	Q500	1449.20	234.05	244.18		244.27	0.000315	2.67	721.96	191.80	0.18
Reach	140.6379	Q1.1	173.30	233.92	241.00		241.01	0.000031	0.67	378.84	149.83	0.05
Reach	140.6379	Q5	517.30	233.92	241.61		241.63	0.000154	1.62	473.55	162.95	0.12

HEC-RAS Plan: MaineDOT River: Taylor Brook Reach: Reach (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach	140.6379	Q10	646.80	233.92	241.91		241.94	0.000186	1.84	523.60	169.47	0.13
Reach	140.6379	Q25	819.60	233.92	242.31		242.35	0.000219	2.08	593.99	181.87	0.14
Reach	140.6379	Q50	953.90	233.92	242.51		242.56	0.000254	2.28	631.05	186.84	0.16
Reach	140.6379	Q100	1098.20	233.92	243.80		243.84	0.000141	1.91	899.32	229.29	0.12
Reach	140.6379	Q500	1449.20	233.92	244.20		244.25	0.000191	2.30	993.97	242.94	0.14
Reach	100.2462	Q1.1	173.30	234.00	241.00		241.00	0.000019	0.50	449.99	149.91	0.04
Reach	100.2462	Q5	517.30	234.00	241.61		241.63	0.000101	1.24	546.82	169.44	0.10
Reach	100.2462	Q10	646.80	234.00	241.91		241.93	0.000123	1.42	599.30	179.14	0.11
Reach	100.2462	Q25	819.60	234.00	242.31		242.34	0.000146	1.62	673.61	192.03	0.12
Reach	100.2462	Q50	953.90	234.00	242.51		242.55	0.000171	1.79	712.85	198.50	0.13
Reach	100.2462	Q100	1098.20	234.00	243.80		243.83	0.000096	1.54	997.91	243.57	0.10
Reach	100.2462	Q500	1449.20	234.00	244.20		244.24	0.000132	1.86	1098.44	258.05	0.12
Reach	47.9043	Q1.1	173.30	233.51	241.00		241.00	0.000027	0.58	411.54	165.39	0.05
Reach	47.9043	Q5	517.30	233.51	241.60		241.62	0.000135	1.41	516.60	185.77	0.11
Reach	47.9043	Q10	646.80	233.51	241.90		241.92	0.000162	1.60	573.82	196.21	0.12
Reach	47.9043	Q25	819.60	233.51	242.30		242.33	0.000186	1.80	654.99	210.13	0.13
Reach	47.9043	Q50	953.90	233.51	242.50		242.54	0.000214	1.97	697.62	217.09	0.14
Reach	47.9043	Q100	1098.20	233.51	243.80		243.82	0.000111	1.62	1009.59	262.44	0.11
Reach	47.9043	Q500	1449.20	233.51	244.20		244.23	0.000149	1.95	1117.21	276.36	0.12
Reach	11.2148	Q1.1	173.30	233.91	241.00	236.41	241.00	0.000019	0.40	474.37	186.10	0.04
Reach	11.2148	Q5	517.30	233.91	241.60	237.53	241.61	0.000090	0.99	592.57	207.89	0.09
Reach	11.2148	Q10	646.80	233.91	241.90	237.80	241.92	0.000106	1.12	656.56	218.78	0.10
Reach	11.2148	Q25	819.60	233.91	242.30	238.11	242.32	0.000120	1.27	746.98	233.30	0.11
Reach	11.2148	Q50	953.90	233.91	242.50	238.32	242.53	0.000138	1.40	794.37	240.56	0.11
Reach	11.2148	Q100	1098.20	233.91	243.80	238.52	243.82	0.000071	1.18	1137.78	287.76	0.08
Reach	11.2148	Q500	1449.20	233.91	244.20	238.98	244.23	0.000095	1.43	1255.79	302.29	0.10

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Division:

Username:

Date:12/16/2018

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE PLANS

WIN
022224.00

BRIDGE NO. 3225

	BY	DATE
PROJ. MANAGER	D Eaton	
DESIGN-DETAILED	N. Willey	06/29/18
CHECKED-REVIEWED	A. Stephens	06/29/18
DESIGN2-DETAILED2		
DESIGN3-DETAILED3		
REVISIONS 1		
REVISIONS 2		
REVISIONS 3		
REVISIONS 4		
FIELD CHANGES		

SIGNATURE

P.E. NUMBER

DATE

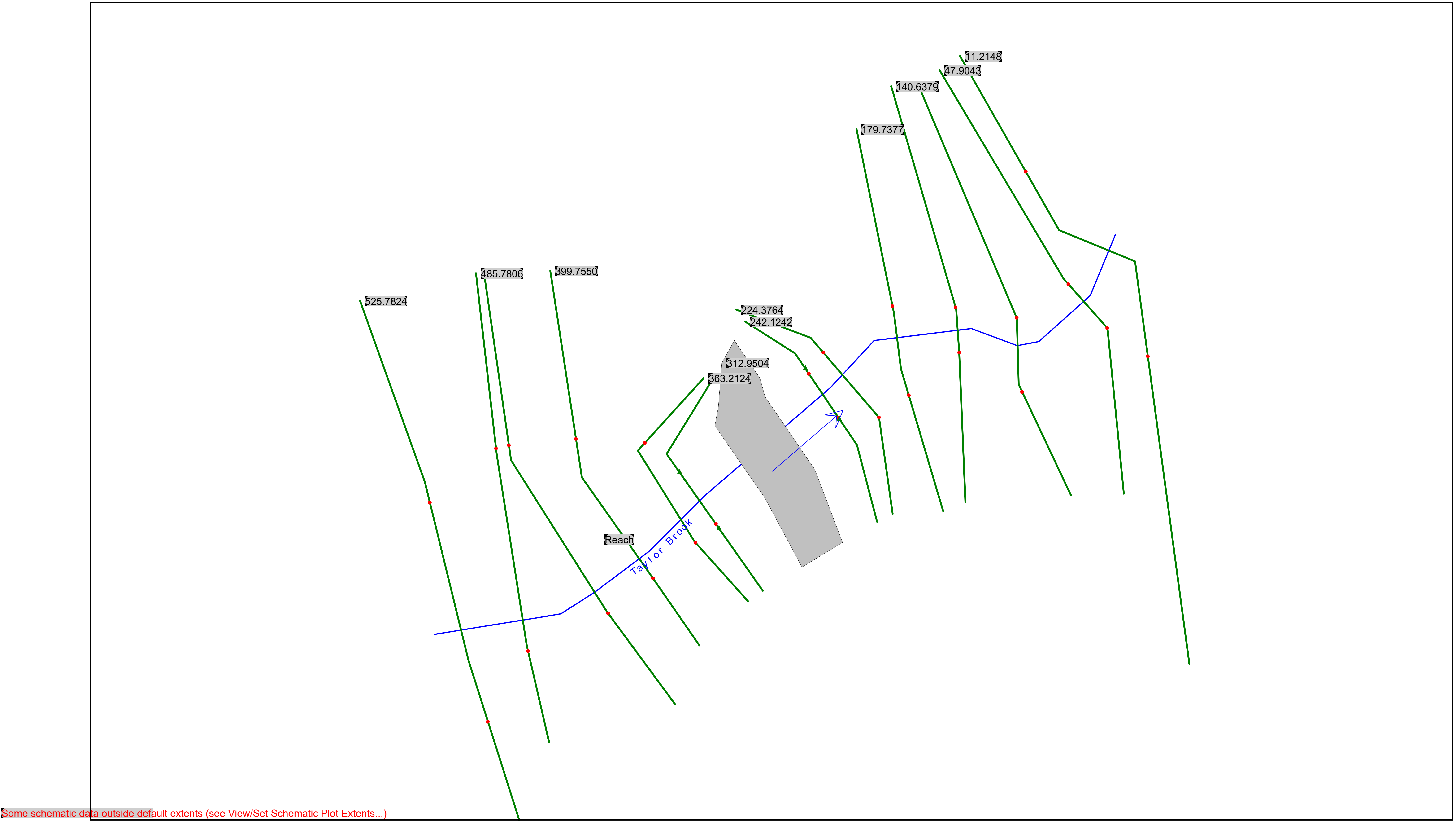
TAYLOR BROOK BRIDGE
TAYLOR BROOK
AUBURN ANDROSCOGGIN COUNTY

HEC-RAS GENERAL PLAN

SHEET NUMBER

1

OF 1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Taylor Brook
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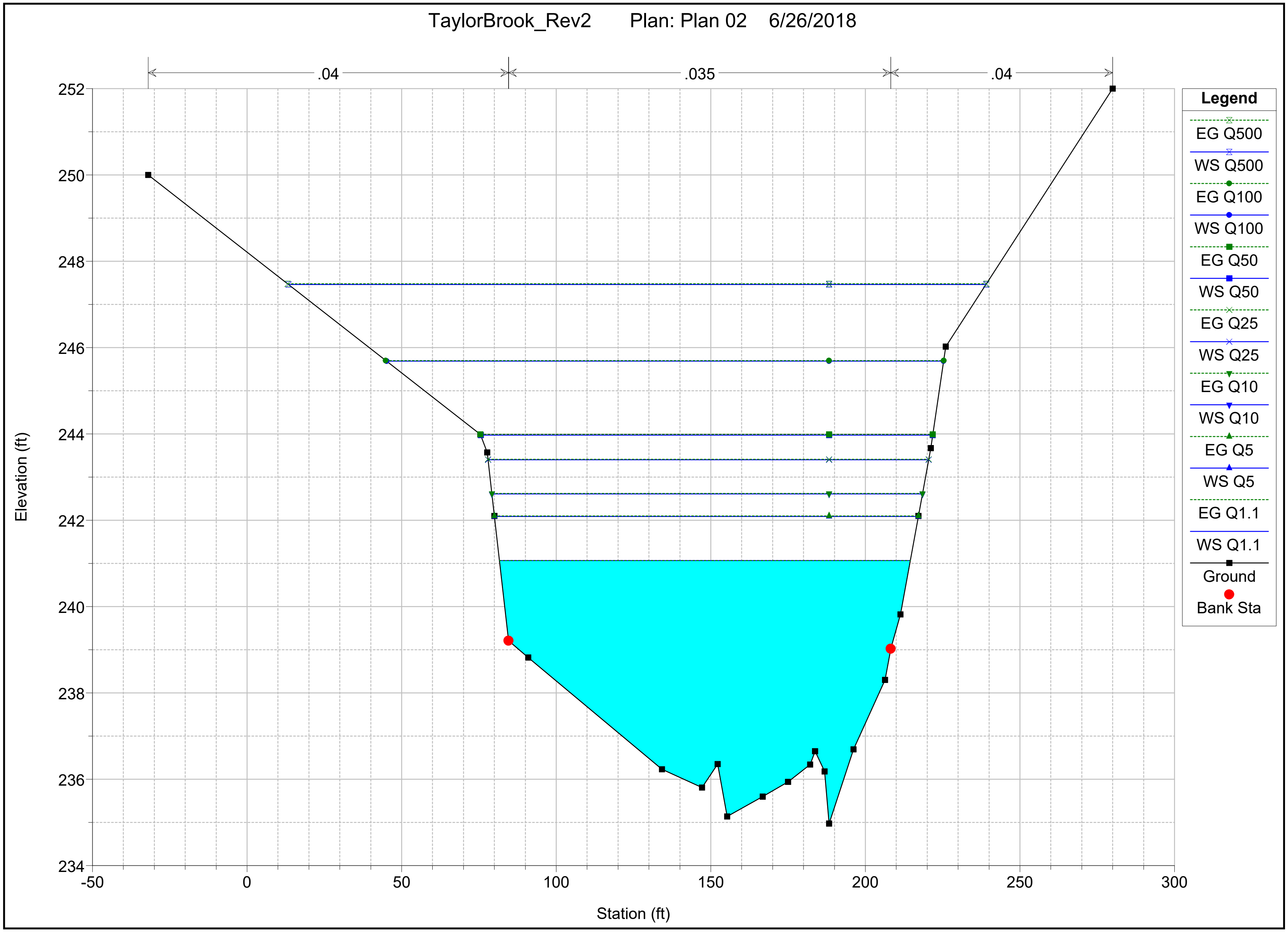

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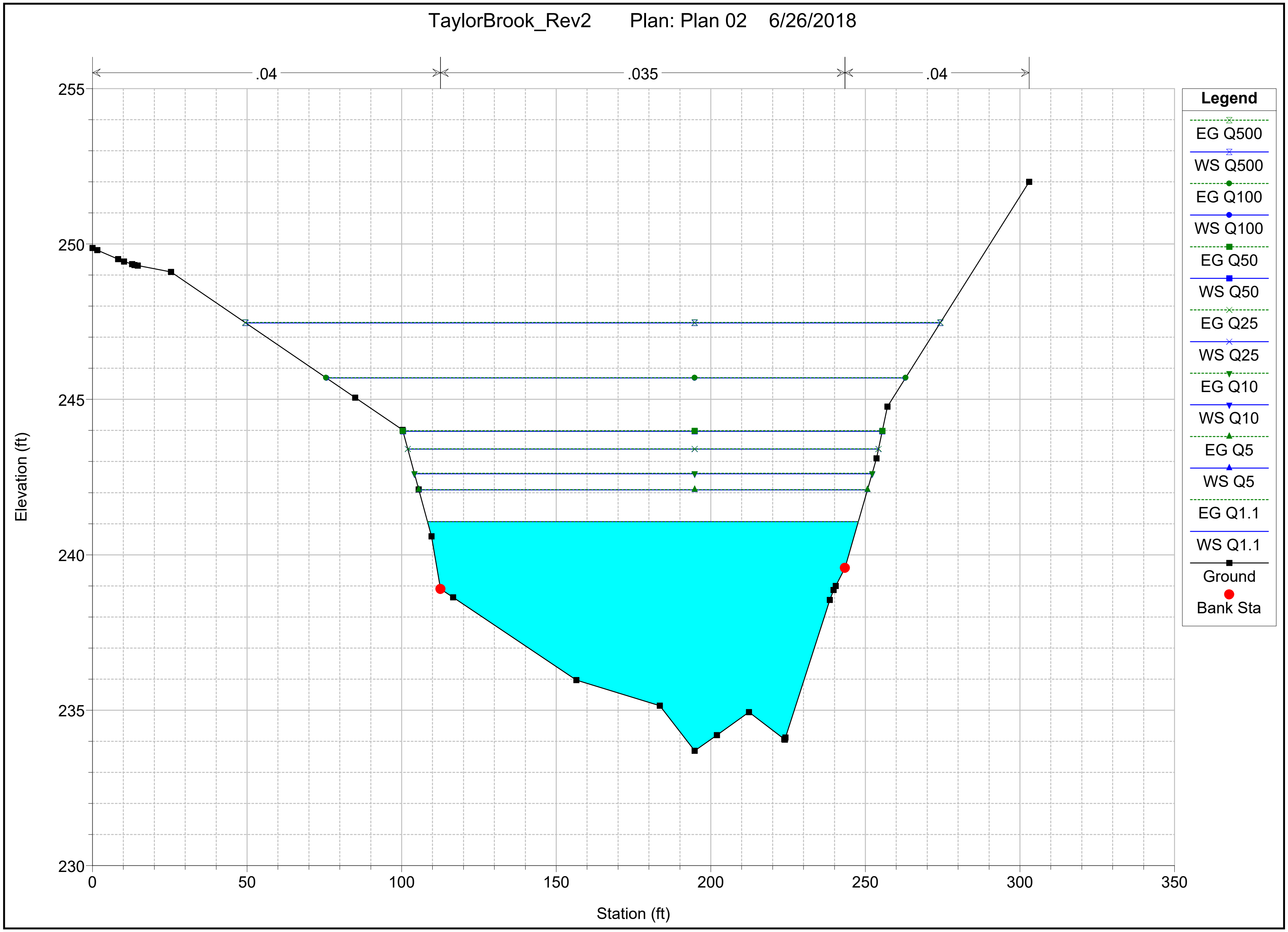
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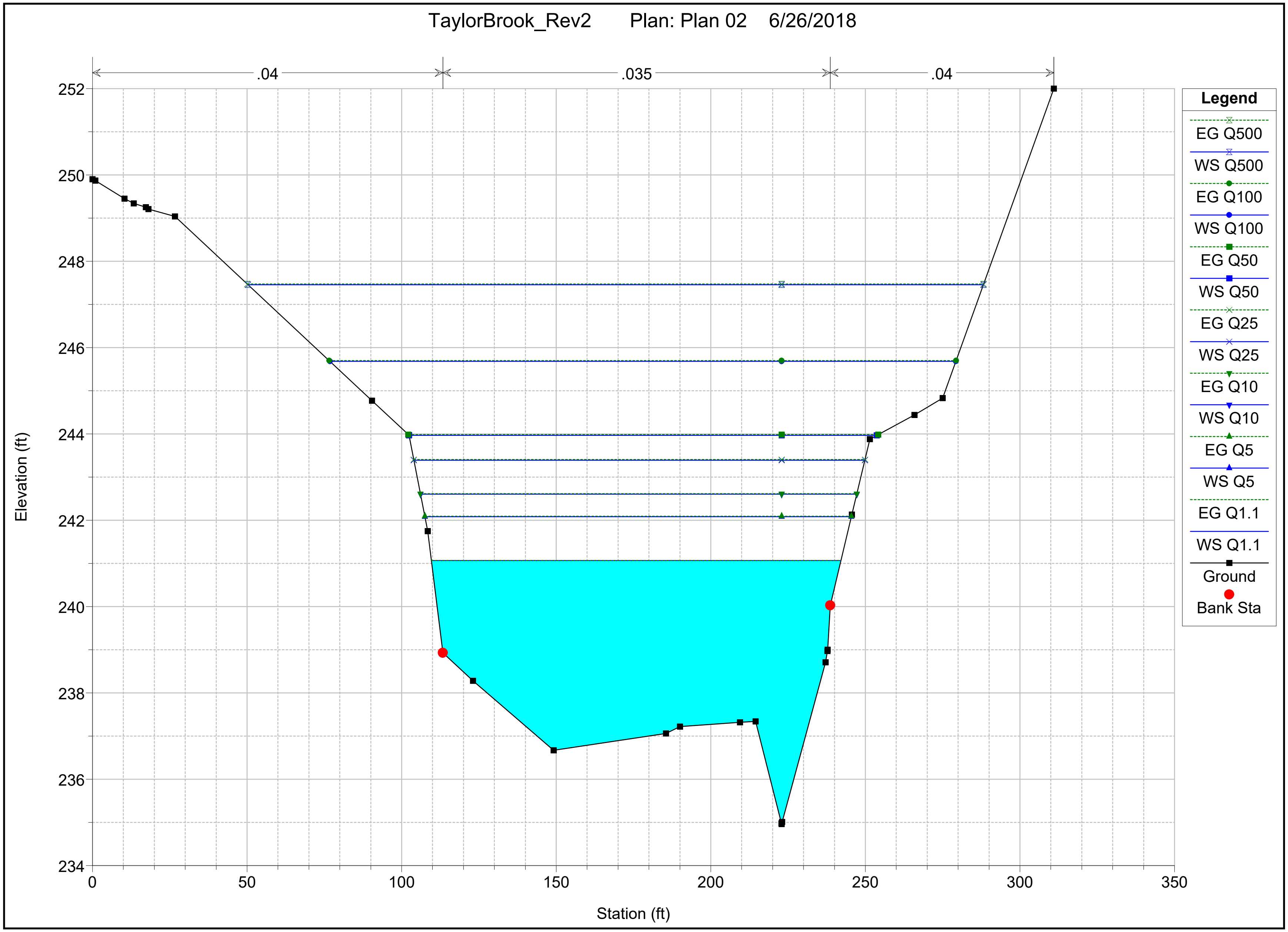
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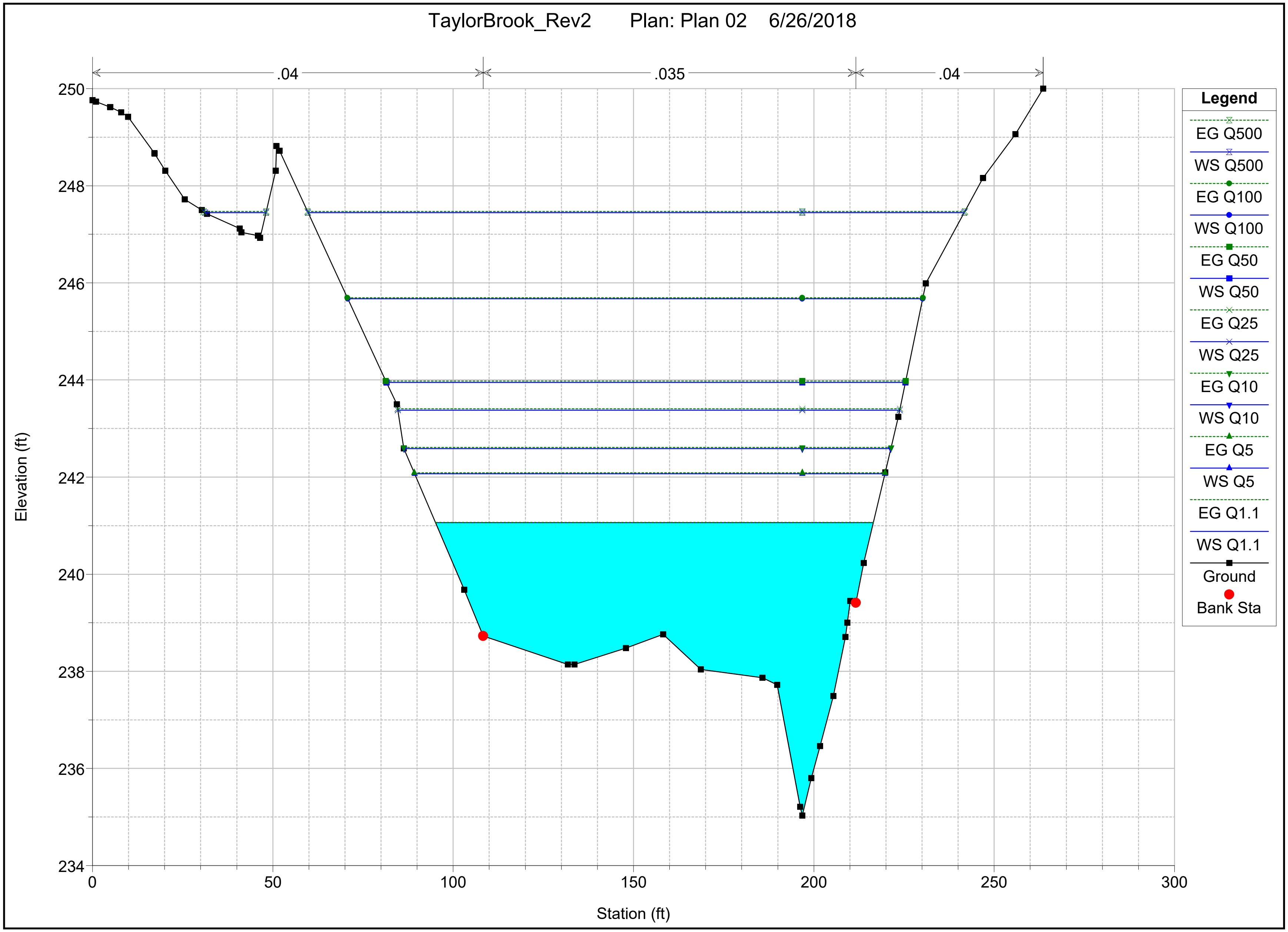
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Ground
Bank Sta
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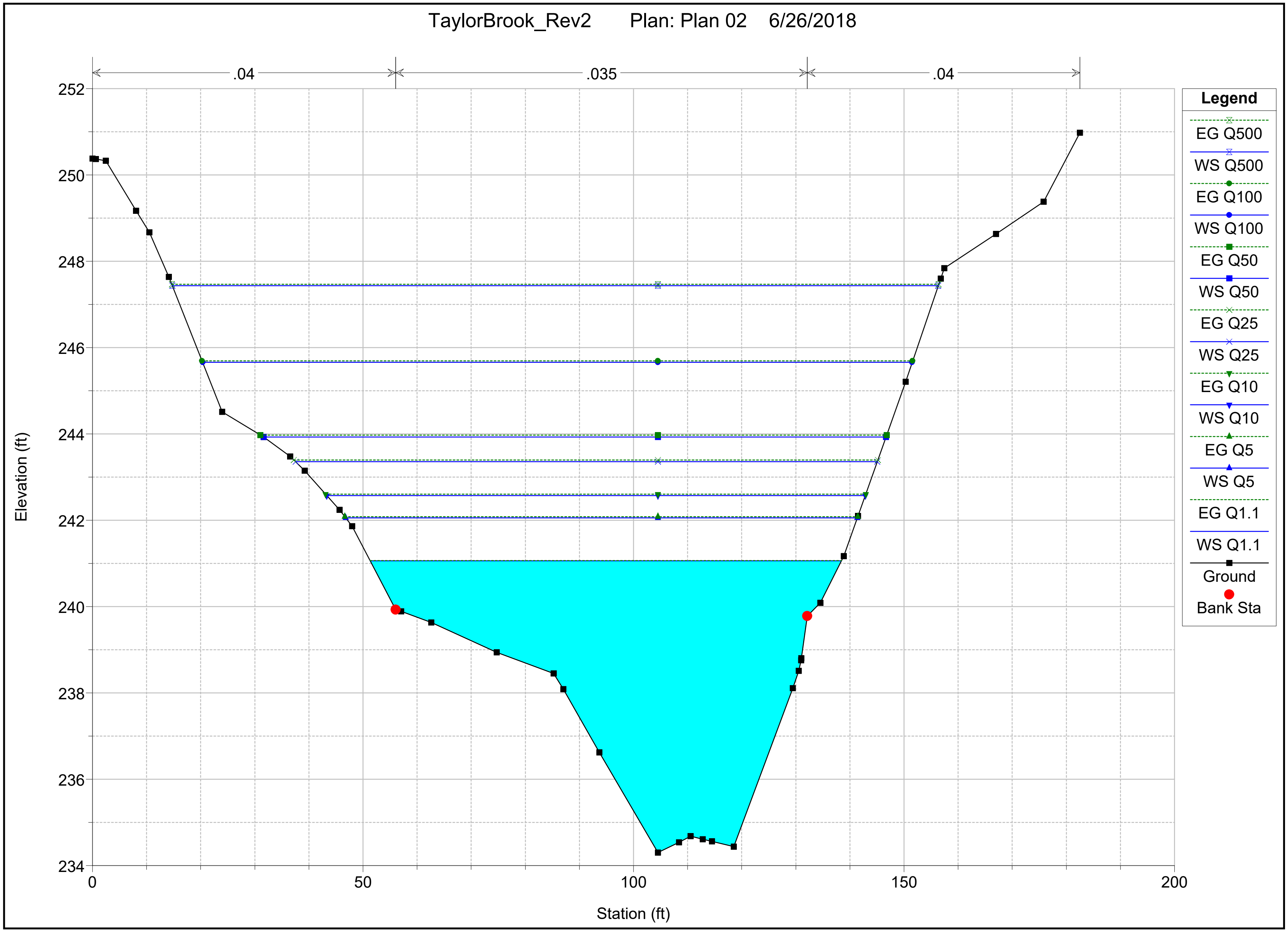

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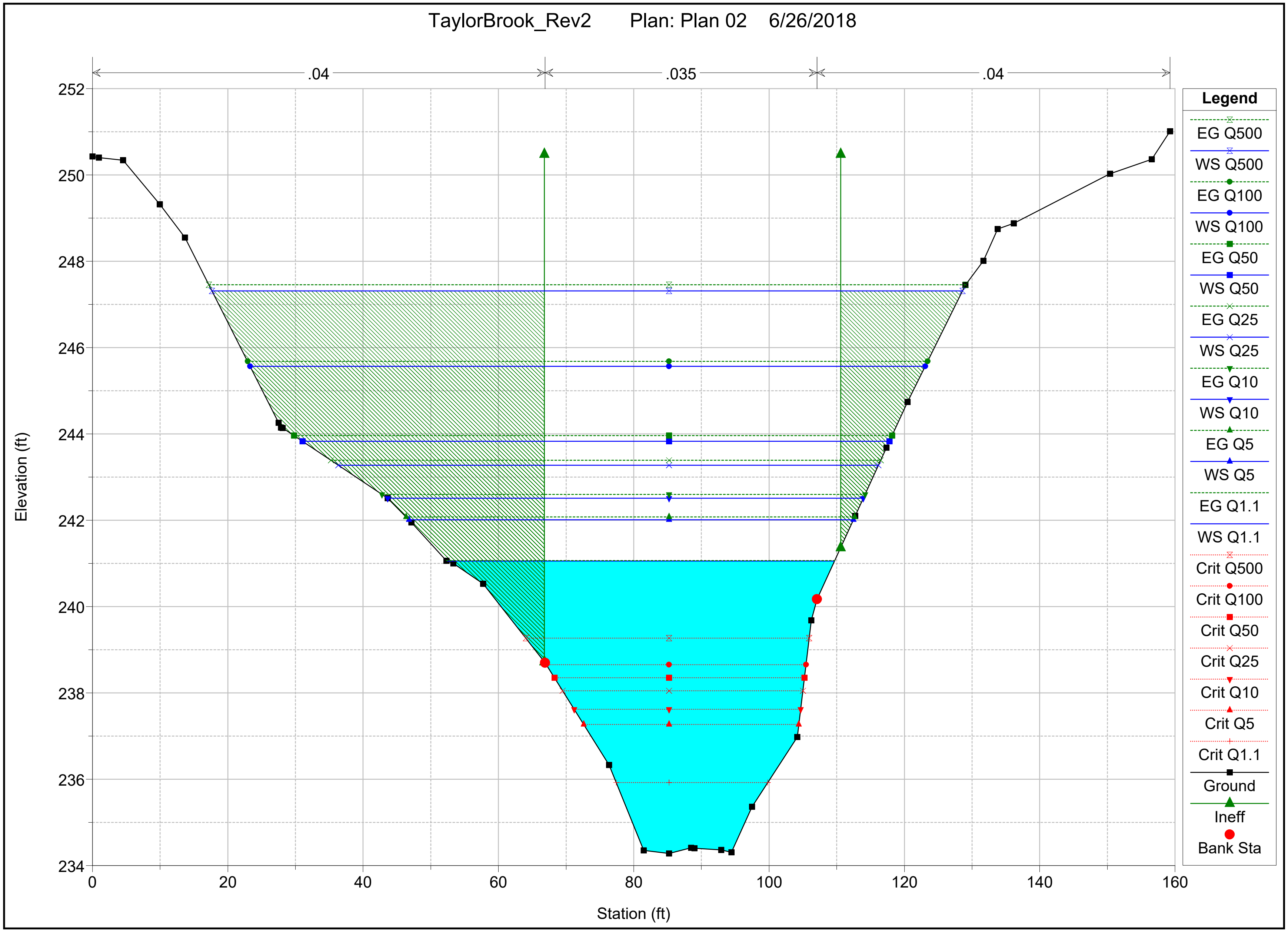
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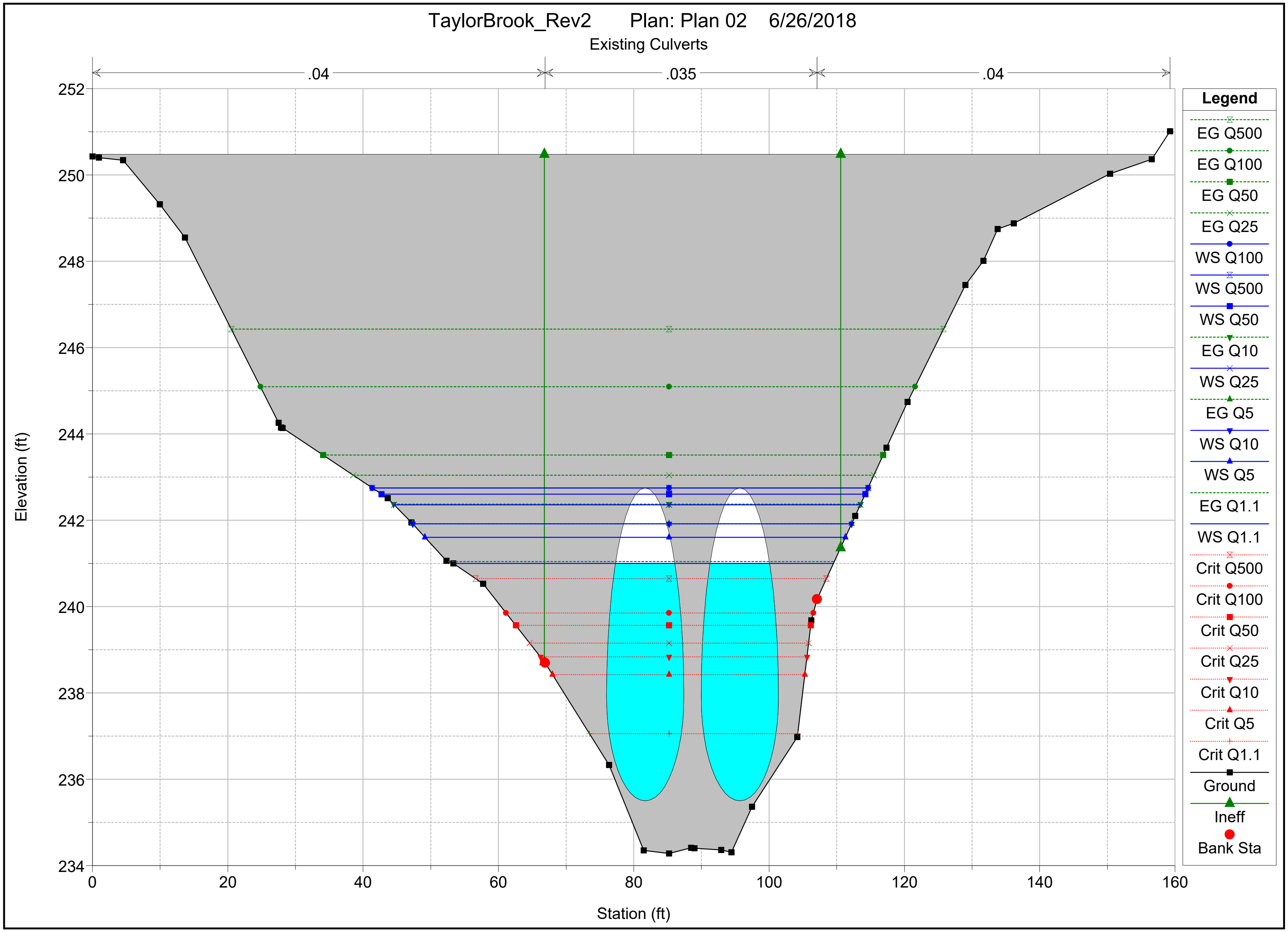
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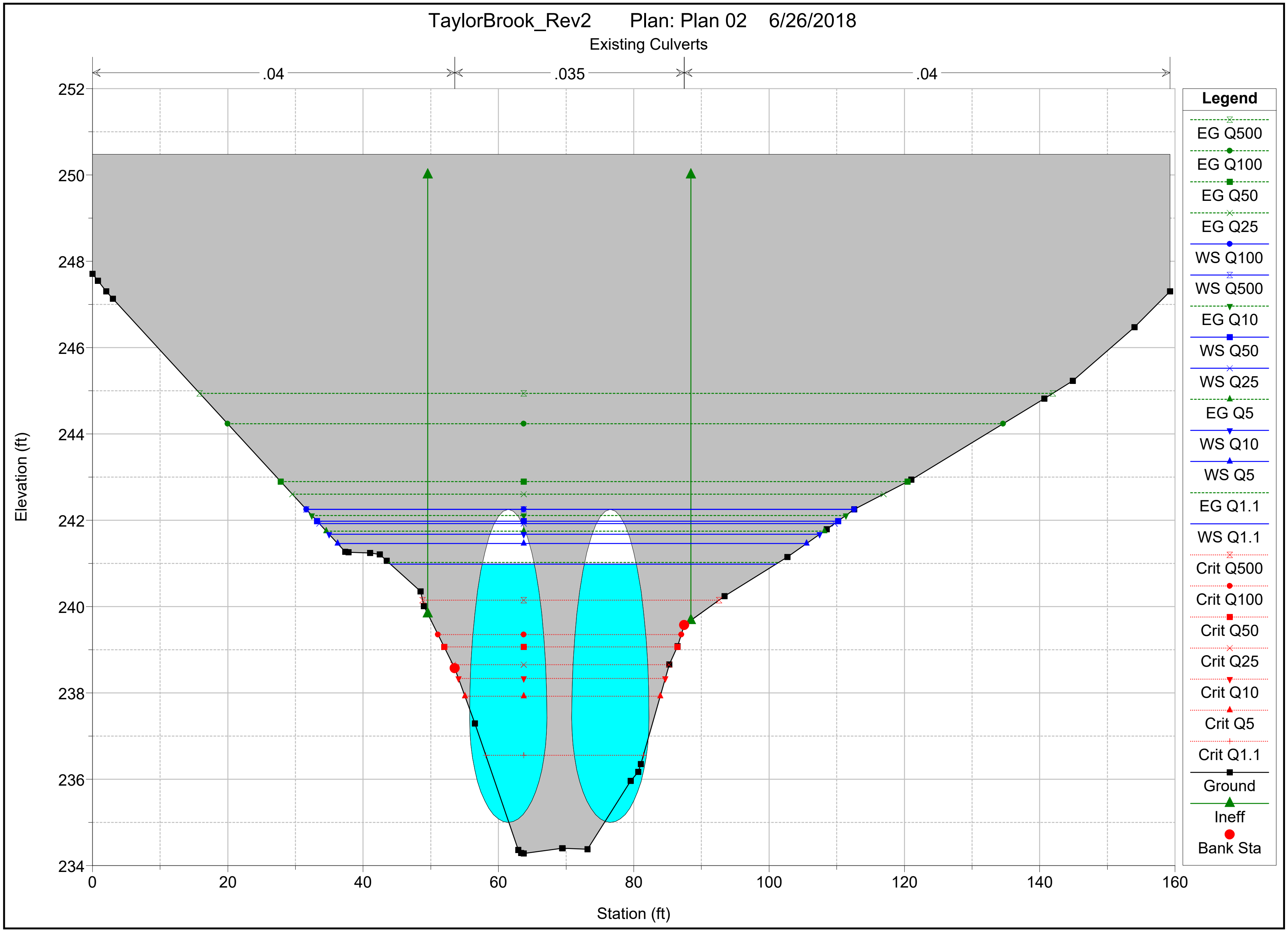
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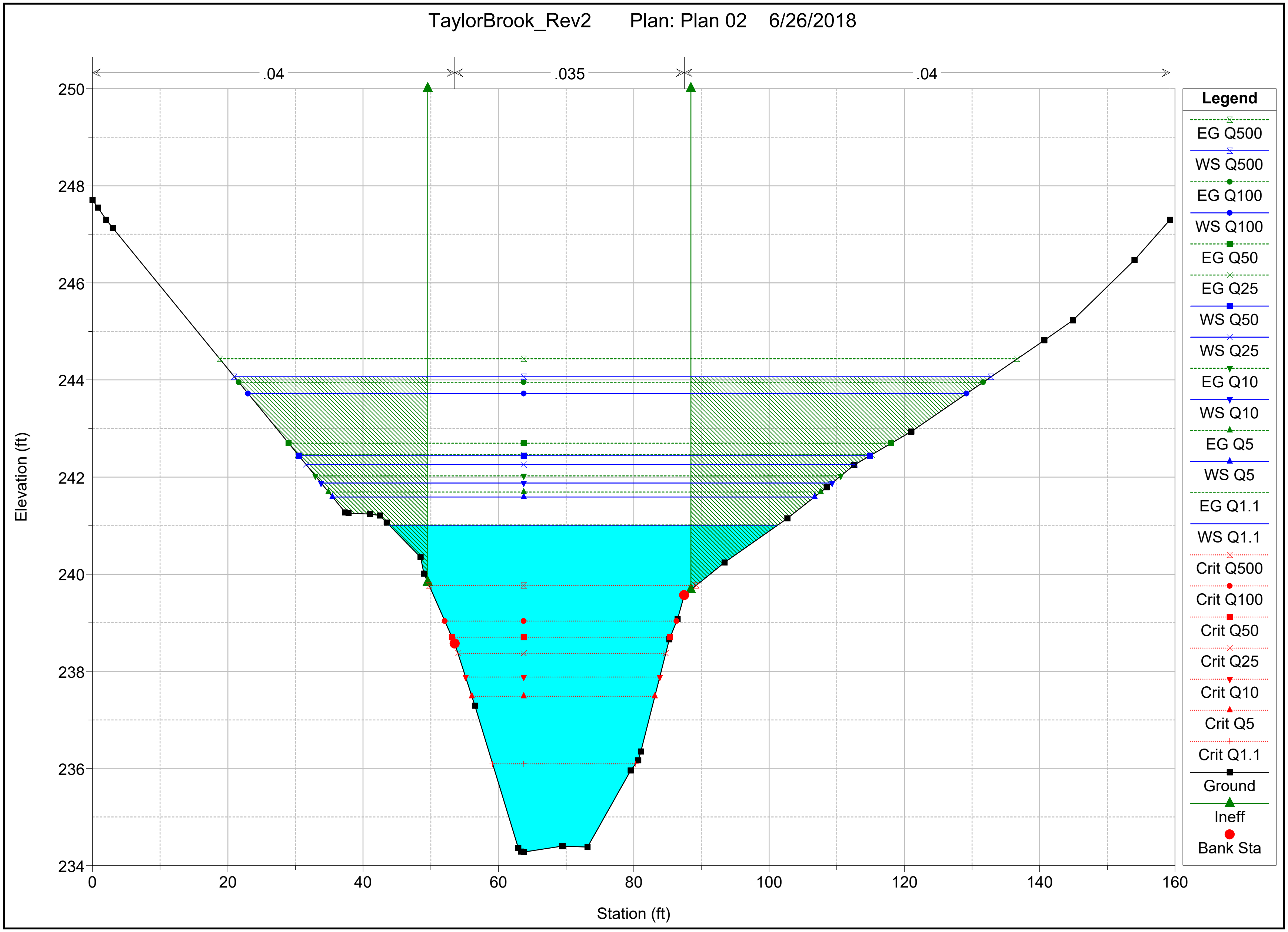
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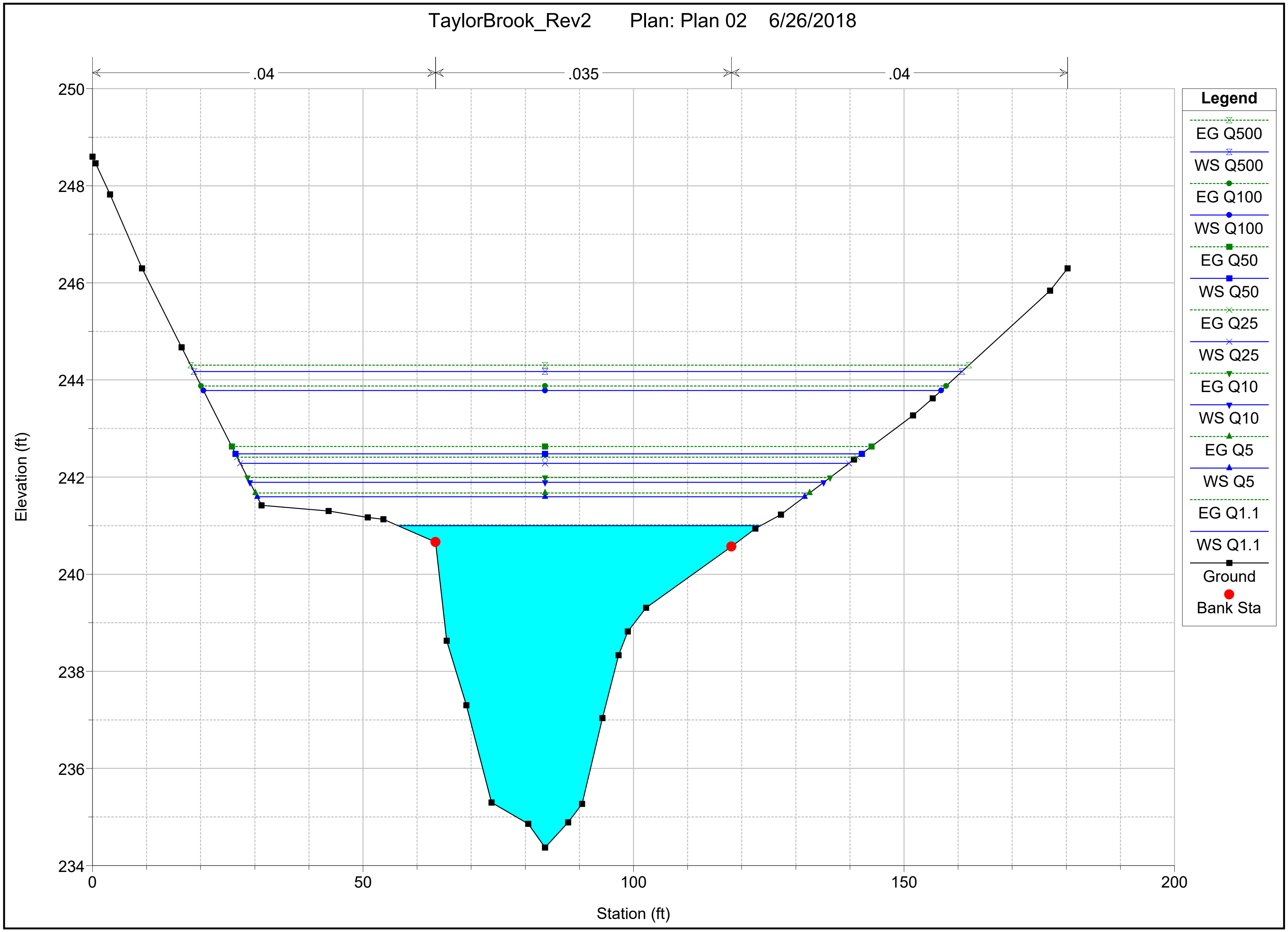
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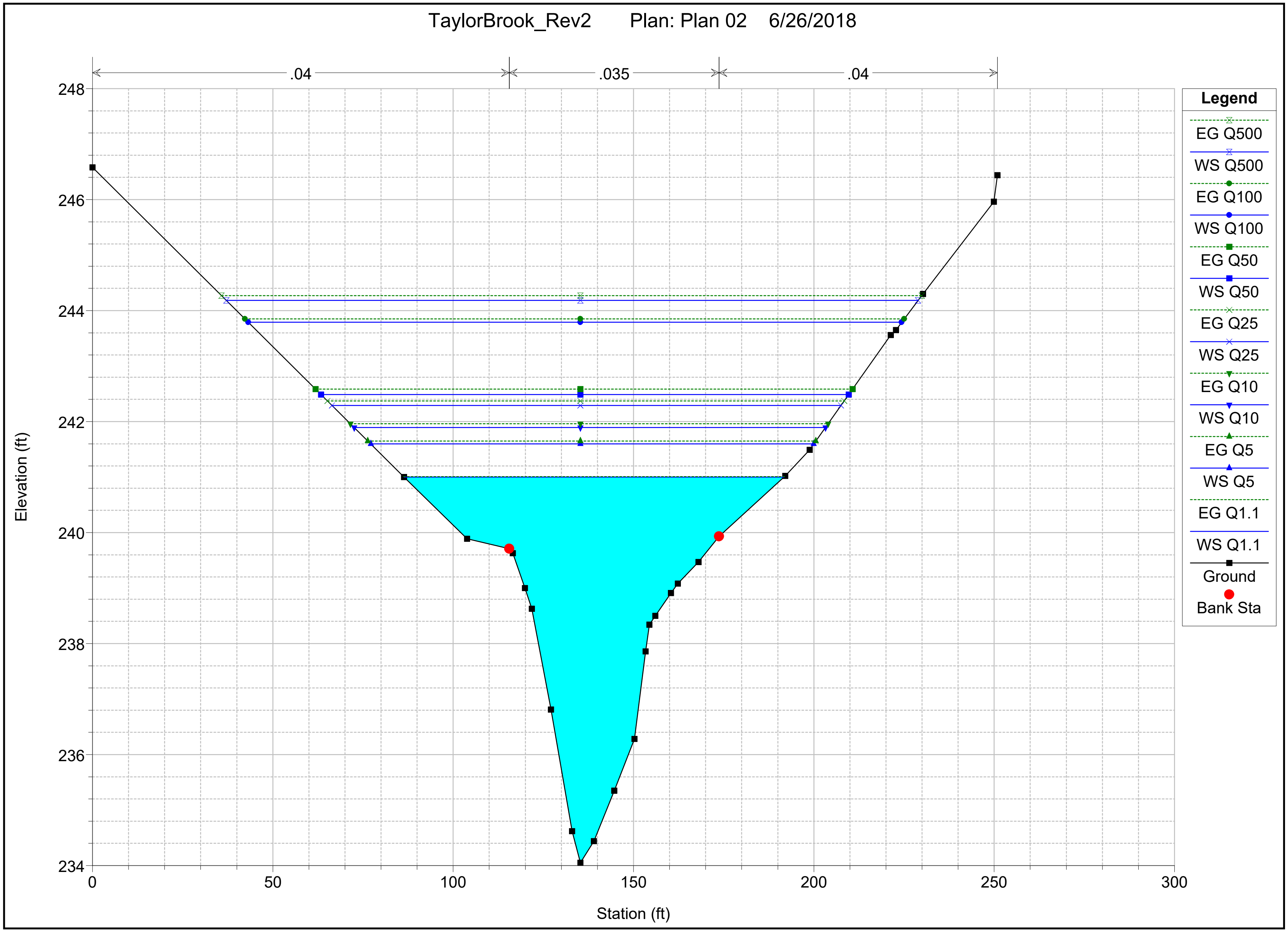
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EG Q5
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Ground
Bank Sta
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Station (ft)
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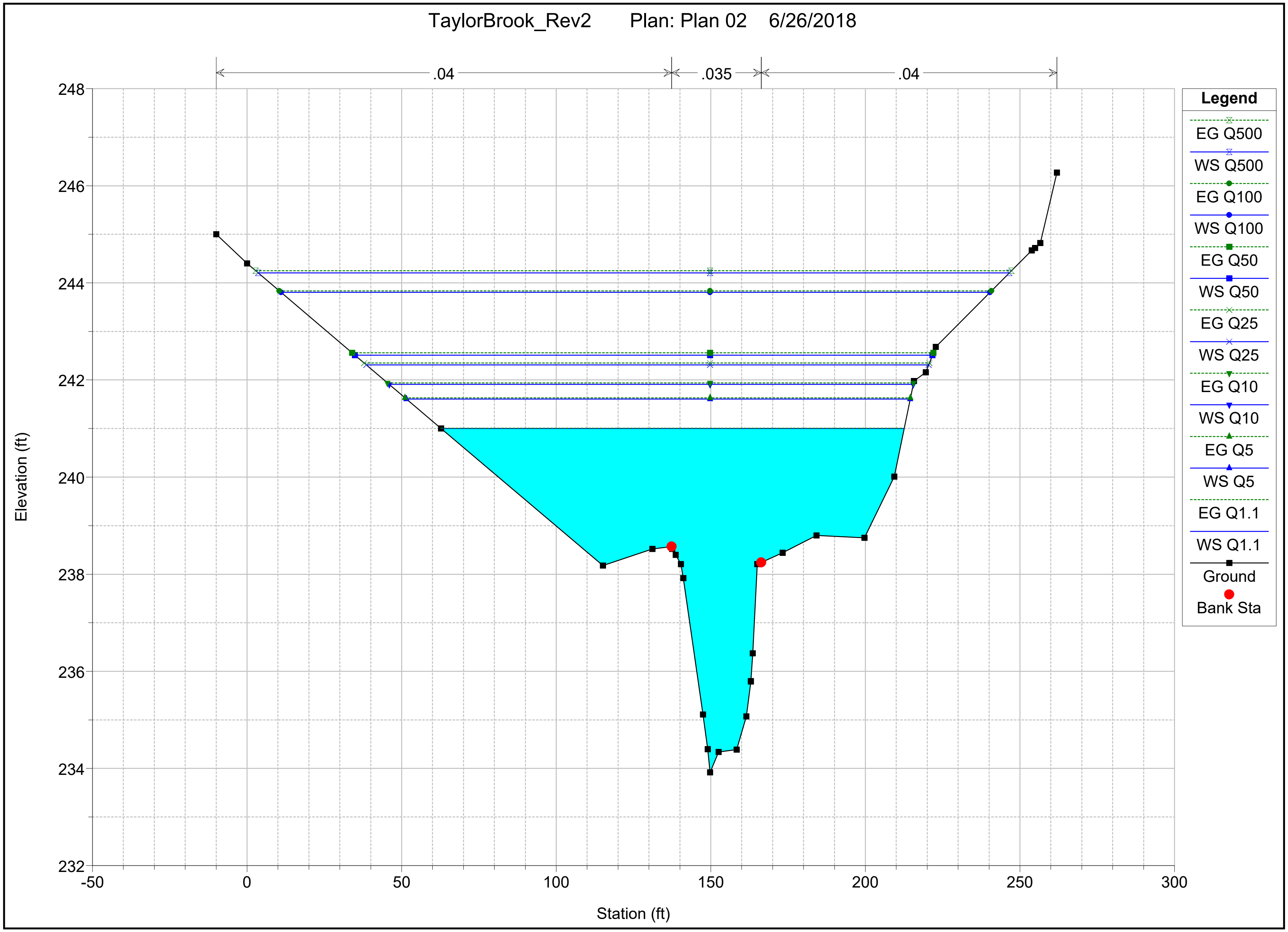
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Station (ft)
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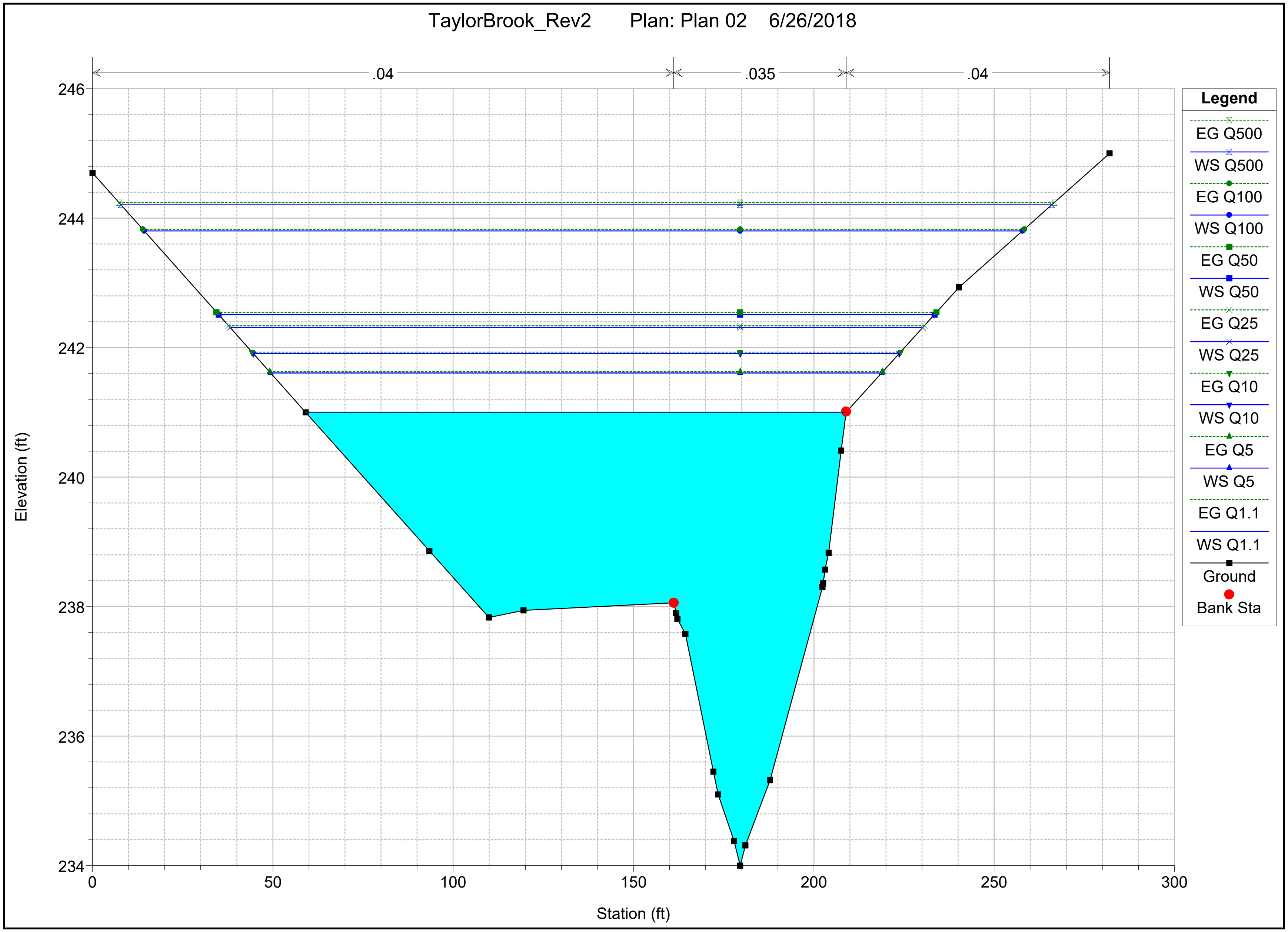
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Station (ft)
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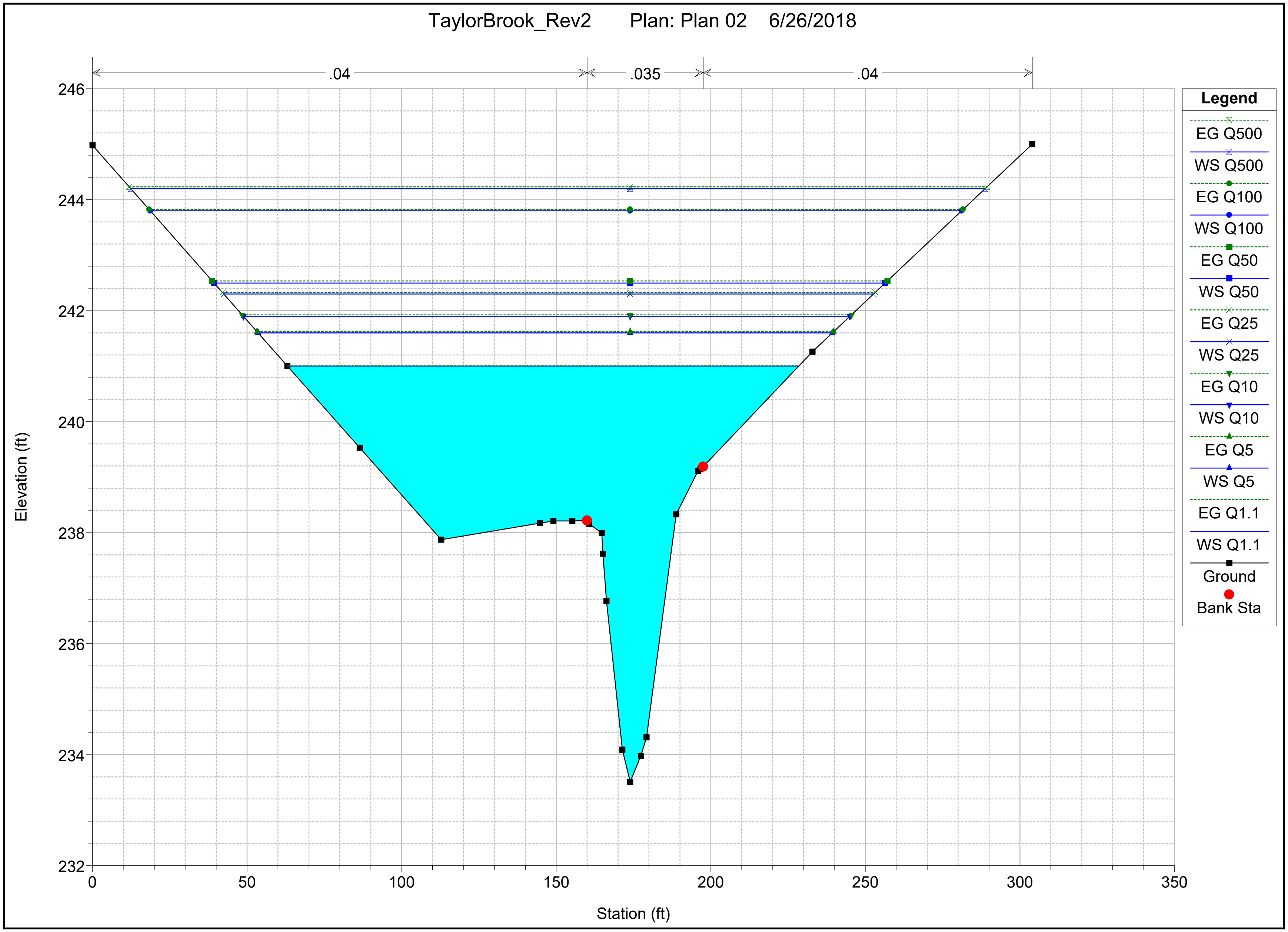
Ground
Bank Sta



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.035
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Elevation (ft)
Station (ft)
246
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Legend
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WS Q500
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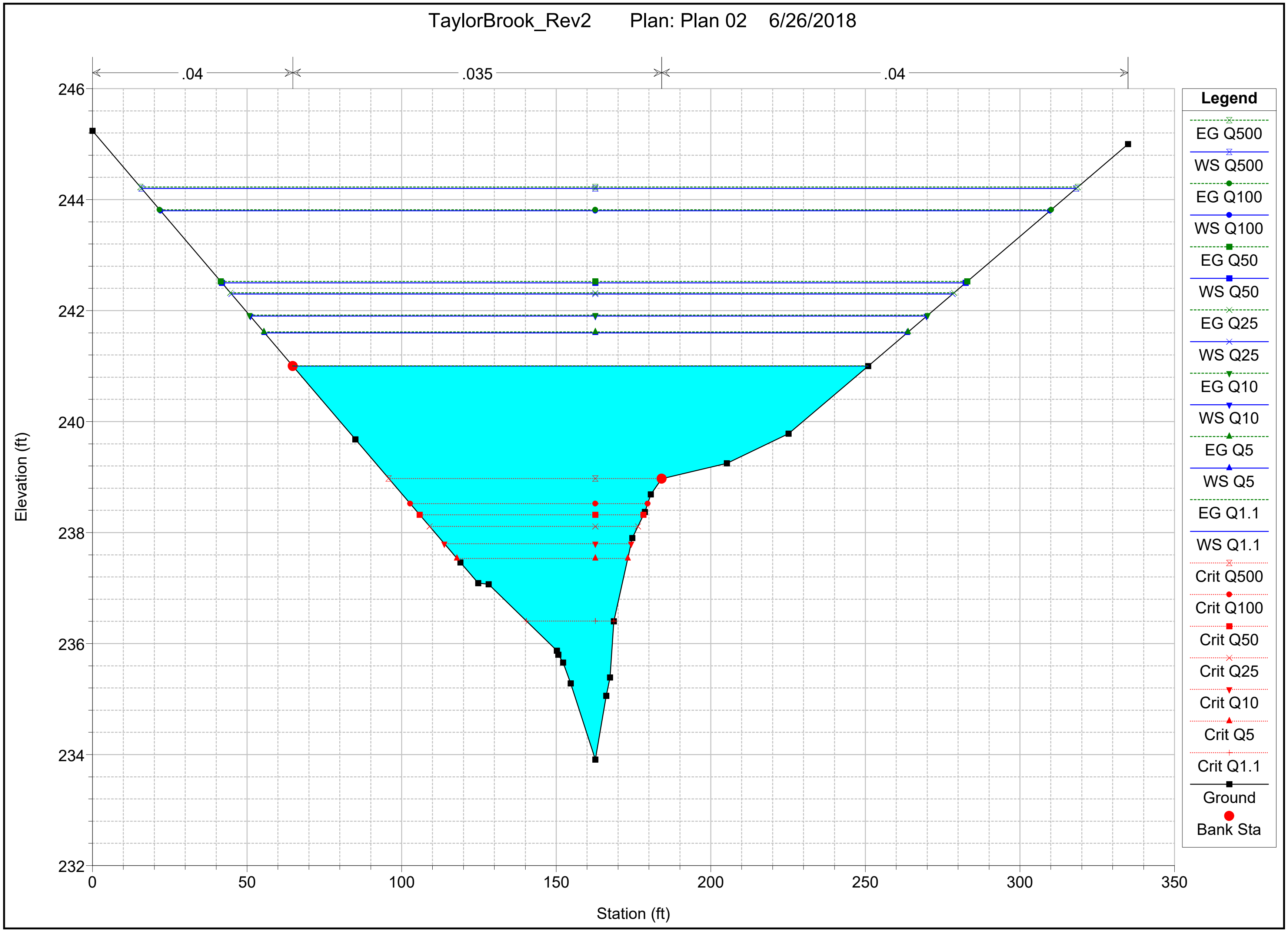
Ground
Bank Sta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.035
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Elevation (ft)
Station (ft)
246
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232
0
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Legend
EG Q500
WS Q500
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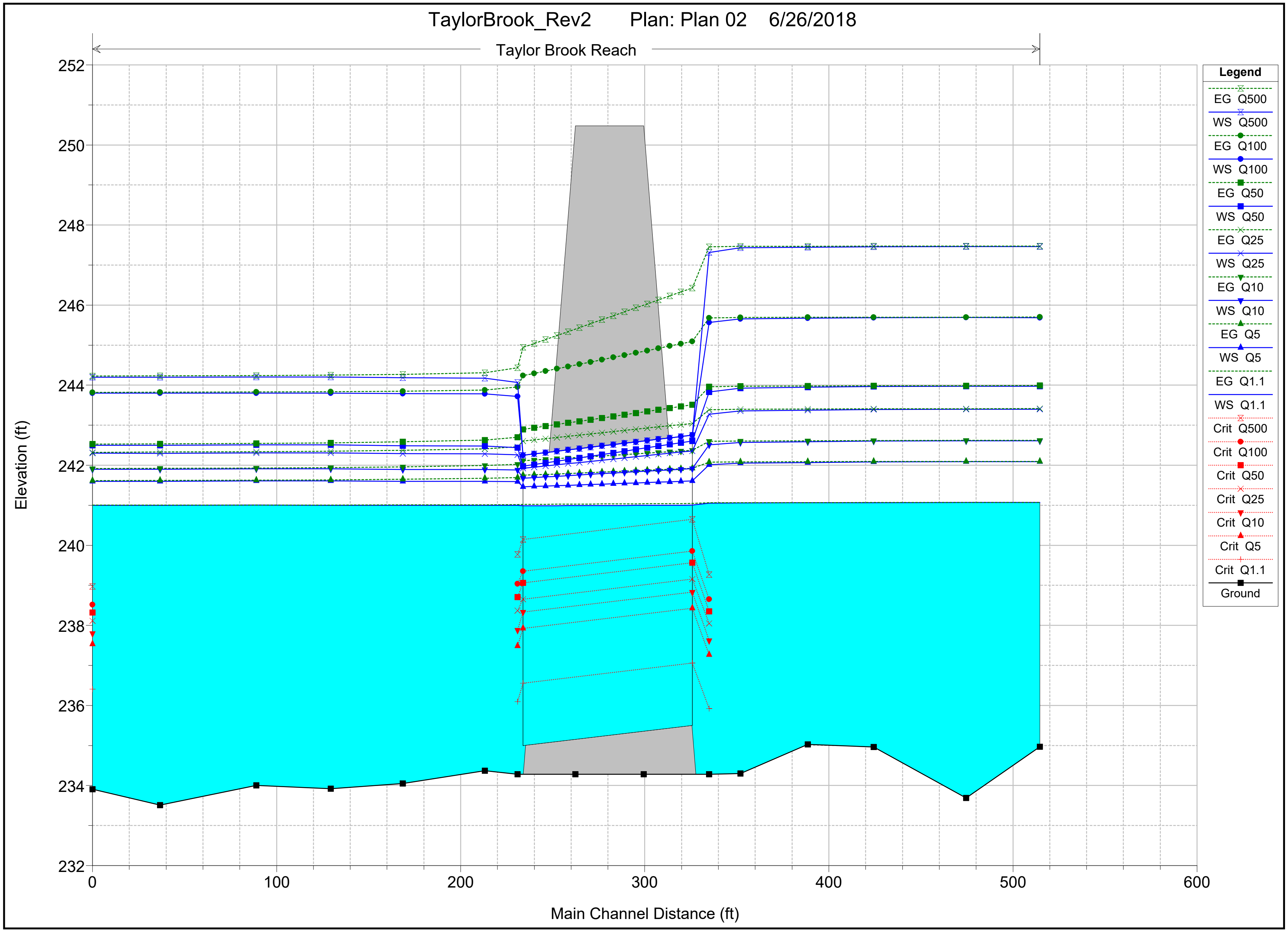
Bank Sta


TaylorBrook_Rev2 Plan: Plan 02 6/26/2018
Taylor Brook Reach
Elevation (ft)
Main Channel Distance (ft)
252
250
248
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244
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240
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234
232
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200
300
400
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600
Legend
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EG Q5
WS Q5
EG Q1.1
WS Q1.1
Crit Q500
Crit Q100
Crit Q50
Crit Q25
Crit Q10
Crit Q5
Crit Q1.1
Ground

APPENDIX G

Proposed HEC-RAS Analysis

Plan: MaineDOT   Taylor Brook   Reach RS: 312.9504BR U   Profile: Q100

E.G. Elev (ft)	243.95	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.11	Wt. n-Val.	0.040	0.035	0.040
W.S. Elev (ft)	243.84	Reach Len. (ft)	36.57	36.57	36.57
Crit W.S. (ft)	238.38	Flow Area (sq ft)	5.96	407.09	7.07
E.G. Slope (ft/ft)	0.000310	Area (sq ft)	5.96	407.09	7.07
Q Total (cfs)	1098.20	Flow (cfs)	3.66	1089.24	5.30
Top Width (ft)	68.64	Top Width (ft)	6.26	57.34	5.05
Vel Total (ft/s)	2.61	Avg. Vel. (ft/s)	0.61	2.68	0.75
Max Chl Dpth (ft)	8.84	Hydr. Depth (ft)	0.95	7.10	1.40
Conv. Total (cfs)	62368.1	Conv. (cfs)	207.9	61859.2	301.0
Length Wtd. (ft)	36.57	Wetted Per. (ft)	6.54	60.12	5.77
Min Ch El (ft)	235.00	Shear (lb/sq ft)	0.02	0.13	0.02
Alpha	1.04	Stream Power (lb/ft s)	0.01	0.35	0.02
Frctn Loss (ft)	0.01	Cum Volume (acre-ft)	1.62	2.37	1.16
C & E Loss (ft)	0.01	Cum SA (acres)	0.49	0.34	0.53

Errors Warnings and Notes

Note:	Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

Plan: MaineDOT   Taylor Brook   Reach RS: 312.9504BR U   Profile: Q500

E.G. Elev (ft)	244.43	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.17	Wt. n-Val.	0.040	0.035	0.040
W.S. Elev (ft)	244.26	Reach Len. (ft)	36.57	36.57	36.57
Crit W.S. (ft)	238.98	Flow Area (sq ft)	8.81	430.83	9.31
E.G. Slope (ft/ft)	0.000444	Area (sq ft)	8.81	430.83	9.31
Q Total (cfs)	1449.20	Flow (cfs)	7.45	1432.50	9.25
Top Width (ft)	70.42	Top Width (ft)	7.49	57.34	5.58
Vel Total (ft/s)	3.23	Avg. Vel. (ft/s)	0.85	3.32	0.99
Max Chl Dpth (ft)	9.26	Hydr. Depth (ft)	1.18	7.51	1.67
Conv. Total (cfs)	68780.3	Conv. (cfs)	353.8	67987.6	439.0
Length Wtd. (ft)	36.57	Wetted Per. (ft)	7.84	60.12	6.50
Min Ch El (ft)	235.00	Shear (lb/sq ft)	0.03	0.20	0.04
Alpha	1.05	Stream Power (lb/ft s)	0.03	0.66	0.04
Frctn Loss (ft)	0.02	Cum Volume (acre-ft)	1.82	2.51	1.39
C & E Loss (ft)	0.02	Cum SA (acres)	0.52	0.34	0.58

Errors Warnings and Notes

Note:	Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

Plan: MaineDOT Taylor Brook Reach RS: 312.9504BR D Profile: Q100

E.G. Elev (ft)	243.93	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.15	Wt. n-Val.	0.040	0.035	0.040
W.S. Elev (ft)	243.77	Reach Len. (ft)	21.84	21.84	21.84
Crit W.S. (ft)	238.68	Flow Area (sq ft)	6.64	325.76	39.02
E.G. Slope (ft/ft)	0.000425	Area (sq ft)	6.64	325.76	39.02
Q Total (cfs)	1098.20	Flow (cfs)	5.73	1047.97	44.50
Top Width (ft)	68.97	Top Width (ft)	4.84	43.36	20.77
Vel Total (ft/s)	2.96	Avg. Vel. (ft/s)	0.86	3.22	1.14
Max Chl Dpth (ft)	8.77	Hydr. Depth (ft)	1.37	7.51	1.88
Conv. Total (cfs)	53261.5	Conv. (cfs)	277.8	50825.5	2158.2
Length Wtd. (ft)	21.84	Wetted Per. (ft)	5.57	46.24	21.47
Min Ch El (ft)	235.00	Shear (lb/sq ft)	0.03	0.19	0.05
Alpha	1.14	Stream Power (lb/ft s)	0.03	0.60	0.06
Frctn Loss (ft)	0.01	Cum Volume (acre-ft)	1.62	2.06	1.14
C & E Loss (ft)	0.00	Cum SA (acres)	0.49	0.30	0.52

Errors Warnings and Notes

Note:	Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

Plan: MaineDOT Taylor Brook Reach RS: 312.9504BR D Profile: Q500

E.G. Elev (ft)	244.39	Element	Left OB	Channel	Right OB
Vel Head (ft)	0.24	Wt. n-Val.	0.040	0.035	0.040
W.S. Elev (ft)	244.15	Reach Len. (ft)	21.84	21.84	21.84
Crit W.S. (ft)	239.35	Flow Area (sq ft)	8.65	342.19	46.89
E.G. Slope (ft/ft)	0.000615	Area (sq ft)	8.65	342.19	46.89
Q Total (cfs)	1449.20	Flow (cfs)	9.32	1368.02	71.86
Top Width (ft)	70.16	Top Width (ft)	6.03	43.36	20.77
Vel Total (ft/s)	3.64	Avg. Vel. (ft/s)	1.08	4.00	1.53
Max Chl Dpth (ft)	9.15	Hydr. Depth (ft)	1.43	7.89	2.26
Conv. Total (cfs)	58444.0	Conv. (cfs)	376.0	55170.1	2897.8
Length Wtd. (ft)	21.84	Wetted Per. (ft)	6.83	46.24	21.85
Min Ch El (ft)	235.00	Shear (lb/sq ft)	0.05	0.28	0.08
Alpha	1.15	Stream Power (lb/ft s)	0.05	1.14	0.13
Frctn Loss (ft)	0.01	Cum Volume (acre-ft)	1.82	2.18	1.36
C & E Loss (ft)	0.00	Cum SA (acres)	0.51	0.30	0.57

Errors Warnings and Notes

Note:	Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

Plan: MaineDOT Taylor Brook Reach RS: 312.9504 Profile: Q100

E.G. US. (ft)	243.96	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	243.85	E.G. Elev (ft)	243.95	243.93
Q Total (cfs)	1098.20	W.S. Elev (ft)	243.84	243.77
Q Bridge (cfs)	1098.20	Crit W.S. (ft)	238.38	238.68
Q Weir (cfs)		Max Chl Dpth (ft)	8.84	8.77
Weir Sta Lft (ft)		Vel Total (ft/s)	2.61	2.96
Weir Sta Rgt (ft)		Flow Area (sq ft)	420.12	371.42
Weir Submerg		Froude # Chl	0.18	0.19
Weir Max Depth (ft)		Specif Force (cu ft)	1678.66	1449.11
Min El Weir Flow (ft)	250.53	Hydr Depth (ft)	6.12	5.39
Min El Prs (ft)	246.99	W.P. Total (ft)	72.43	73.28
Delta EG (ft)	0.04	Conv. Total (cfs)	62368.1	53261.5
Delta WS (ft)	0.09	Top Width (ft)	68.64	68.97
BR Open Area (sq ft)	577.76	Frctn Loss (ft)	0.01	0.01
BR Open Vel (ft/s)	2.96	C & E Loss (ft)	0.01	0.00
BR Sluice Coef		Shear Total (lb/sq ft)	0.11	0.13
BR Sel Method	Energy only	Power Total (lb/ft s)	0.29	0.40

Errors Warnings and Notes

Note:	Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
Note:	Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

Plan: MaineDOT Taylor Brook Reach RS: 312.9504 Profile: Q500

E.G. US. (ft)	244.44	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	244.27	E.G. Elev (ft)	244.43	244.39
Q Total (cfs)	1449.20	W.S. Elev (ft)	244.26	244.15
Q Bridge (cfs)	1449.20	Crit W.S. (ft)	238.98	239.35
Q Weir (cfs)		Max Chl Dpth (ft)	9.26	9.15
Weir Sta Lft (ft)		Vel Total (ft/s)	3.23	3.64
Weir Sta Rgt (ft)		Flow Area (sq ft)	448.95	397.73
Weir Submerg		Froude # Chl	0.19	0.23
Weir Max Depth (ft)		Specif Force (cu ft)	1916.28	1662.06
Min El Weir Flow (ft)	250.53	Hydr Depth (ft)	6.38	5.67
Min El Prs (ft)	246.99	W.P. Total (ft)	74.47	74.92
Delta EG (ft)	0.06	Conv. Total (cfs)	68780.3	58444.0
Delta WS (ft)	0.13	Top Width (ft)	70.42	70.16
BR Open Area (sq ft)	577.76	Frctn Loss (ft)	0.02	0.01
BR Open Vel (ft/s)	3.64	C & E Loss (ft)	0.02	0.00

Plan: MaineDOT   Taylor Brook   Reach RS: 312.9504   Profile: Q500 (Continued)

BR Sluice Coef		Shear Total (lb/sq ft)	0.17	0.20
BR Sel Method	Energy only	Power Total (lb/ft s)	0.54	0.74

Errors Warnings and Notes

Note:	Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
Note:	Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

HEC-RAS Plan: MaineDOT   River: Taylor Brook   Reach: Reach

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach	525.7824	Q1.1	173.30	234.97	241.03		241.03	0.000009	0.33	533.91	132.74	0.03
Reach	525.7824	Q5	517.30	234.97	241.75		241.76	0.000046	0.83	631.32	135.72	0.07
Reach	525.7824	Q10	646.80	234.97	242.09		242.11	0.000058	0.97	678.05	137.13	0.07
Reach	525.7824	Q25	819.60	234.97	242.54		242.56	0.000070	1.13	739.86	138.96	0.08
Reach	525.7824	Q50	953.90	234.97	242.79		242.82	0.000082	1.26	774.52	139.98	0.09
Reach	525.7824	Q100	1098.20	234.97	243.99		244.01	0.000059	1.20	945.26	146.29	0.08
Reach	525.7824	Q500	1449.20	234.97	244.47		244.51	0.000082	1.48	1018.39	155.92	0.09
Reach	485.7806	Q1.1	173.30	233.69	241.03		241.03	0.000005	0.27	658.91	139.12	0.02
Reach	485.7806	Q5	517.30	233.69	241.75		241.76	0.000026	0.69	761.47	143.21	0.05
Reach	485.7806	Q10	646.80	233.69	242.10		242.11	0.000033	0.81	810.91	145.14	0.06
Reach	485.7806	Q25	819.60	233.69	242.54		242.56	0.000042	0.95	876.53	147.66	0.07
Reach	485.7806	Q50	953.90	233.69	242.79		242.81	0.000050	1.07	913.47	149.06	0.07
Reach	485.7806	Q100	1098.20	233.69	243.99		244.01	0.000038	1.04	1095.52	155.10	0.06
Reach	485.7806	Q500	1449.20	233.69	244.47		244.50	0.000054	1.29	1172.58	162.93	0.08
Reach	435.5161	Q1.1	173.30	234.96	241.03		241.03	0.000012	0.36	485.33	132.26	0.03
Reach	435.5161	Q5	517.30	234.96	241.75		241.76	0.000061	0.90	581.90	135.91	0.07
Reach	435.5161	Q10	646.80	234.96	242.09		242.10	0.000074	1.05	628.55	137.96	0.08
Reach	435.5161	Q25	819.60	234.96	242.53		242.55	0.000089	1.21	690.64	140.67	0.09
Reach	435.5161	Q50	953.90	234.96	242.78		242.81	0.000103	1.35	725.51	142.16	0.10
Reach	435.5161	Q100	1098.20	234.96	243.98		244.00	0.000070	1.26	900.56	151.75	0.09
Reach	435.5161	Q500	1449.20	234.96	244.46		244.50	0.000097	1.56	978.09	171.23	0.10
Reach	399.7550	Q1.1	173.30	235.03	241.02		241.03	0.000038	0.54	329.05	121.02	0.06
Reach	399.7550	Q5	517.30	235.03	241.73		241.75	0.000165	1.30	416.74	127.33	0.12
Reach	399.7550	Q10	646.80	235.03	242.06		242.10	0.000191	1.48	460.13	130.34	0.13
Reach	399.7550	Q25	819.60	235.03	242.51		242.55	0.000213	1.67	518.52	134.28	0.14
Reach	399.7550	Q50	953.90	235.03	242.75		242.80	0.000240	1.84	551.28	135.87	0.15
Reach	399.7550	Q100	1098.20	235.03	243.96		244.00	0.000142	1.65	719.87	143.94	0.12
Reach	399.7550	Q500	1449.20	235.03	244.43		244.49	0.000189	2.00	788.88	148.19	0.14
Reach	363.2124	Q1.1	173.30	234.30	241.02		241.02	0.000033	0.59	298.70	86.78	0.05
Reach	363.2124	Q5	517.30	234.30	241.71		241.75	0.000166	1.48	360.67	91.81	0.12
Reach	363.2124	Q10	646.80	234.30	242.04		242.09	0.000204	1.71	391.49	94.49	0.14
Reach	363.2124	Q25	819.60	234.30	242.48		242.54	0.000243	1.98	433.37	98.61	0.15
Reach	363.2124	Q50	953.90	234.30	242.71		242.79	0.000282	2.20	456.87	100.93	0.16
Reach	363.2124	Q100	1098.20	234.30	243.93		243.99	0.000184	2.03	587.40	115.03	0.14

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach	363.2124	Q500	1449.20	234.30	244.39		244.48	0.000253	2.48	641.74	122.37	0.16
Reach	346.2246	Q1.1	173.30	234.28	241.01		241.02	0.000046	0.82	221.24	56.44	0.06
Reach	346.2246	Q5	517.30	234.28	241.67		241.74	0.000265	2.14	260.57	62.72	0.16
Reach	346.2246	Q10	646.80	234.28	241.99		242.08	0.000340	2.51	280.76	65.49	0.18
Reach	346.2246	Q25	819.60	234.28	242.40		242.53	0.000427	2.94	308.55	69.28	0.20
Reach	346.2246	Q50	953.90	234.28	242.61		242.77	0.000512	3.29	323.69	71.60	0.22
Reach	346.2246	Q100	1098.20	234.28	243.85		243.98	0.000355	3.06	421.39	86.95	0.19
Reach	346.2246	Q500	1449.20	234.28	244.26		244.46	0.000502	3.77	458.69	91.57	0.23
Reach	332.5634	Q1.1	173.30	235.00	241.01	236.05	241.02	0.000040	0.70	245.98	54.80	0.06
Reach	332.5634	Q5	517.30	235.00	241.68	237.11	241.73	0.000231	1.83	283.21	57.77	0.14
Reach	332.5634	Q10	646.80	235.00	241.99	237.44	242.06	0.000299	2.15	301.73	59.23	0.17
Reach	332.5634	Q25	819.60	235.00	242.41	237.83	242.51	0.000372	2.52	326.70	61.33	0.19
Reach	332.5634	Q50	953.90	235.00	242.62	238.11	242.75	0.000444	2.82	340.12	62.43	0.21
Reach	332.5634	Q100	1098.20	235.00	243.85	238.38	243.96	0.000309	2.67	420.60	68.68	0.18
Reach	332.5634	Q500	1449.20	235.00	244.27	238.98	244.44	0.000442	3.32	449.68	70.67	0.21
Reach	312.9504		Bridge									
Reach	252.5632	Q1.1	173.30	235.00	241.01	236.15	241.02	0.000053	0.84	207.58	46.94	0.07
Reach	252.5632	Q5	517.30	235.00	241.62	237.31	241.70	0.000315	2.21	238.27	52.50	0.17
Reach	252.5632	Q10	646.80	235.00	241.92	237.65	242.03	0.000409	2.61	254.27	55.18	0.19
Reach	252.5632	Q25	819.60	235.00	242.31	238.08	242.46	0.000521	3.08	276.45	58.69	0.22
Reach	252.5632	Q50	953.90	235.00	242.50	238.38	242.69	0.000631	3.46	287.94	60.43	0.24
Reach	252.5632	Q100	1098.20	235.00	243.76	238.68	243.92	0.000429	3.23	371.21	71.77	0.21
Reach	252.5632	Q500	1449.20	235.00	244.14	239.35	244.38	0.000623	4.02	398.64	75.59	0.25
Reach	242.1242	Q1.1	173.30	234.28	241.00		241.02	0.000063	0.97	193.02	57.29	0.08
Reach	242.1242	Q5	517.30	234.28	241.60		241.69	0.000374	2.53	231.53	71.33	0.19
Reach	242.1242	Q10	646.80	234.28	241.89		242.01	0.000478	2.96	252.99	75.67	0.21
Reach	242.1242	Q25	819.60	234.28	242.27		242.44	0.000593	3.43	283.42	81.43	0.24
Reach	242.1242	Q50	953.90	234.28	242.46		242.67	0.000711	3.83	299.20	84.86	0.26
Reach	242.1242	Q100	1098.20	234.28	243.76		243.91	0.000430	3.36	423.97	106.88	0.21
Reach	242.1242	Q500	1449.20	234.28	244.14		244.36	0.000604	4.11	465.58	113.06	0.25
Reach	224.3764	Q1.1	173.30	234.37	241.00		241.01	0.000087	0.89	195.92	67.13	0.08
Reach	224.3764	Q5	517.30	234.37	241.60		241.67	0.000446	2.25	246.79	101.19	0.19

HEC-RAS Plan: MaineDOT River: Taylor Brook Reach: Reach (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach	224.3764	Q10	646.80	234.37	241.89		241.99	0.000534	2.57	277.41	106.06	0.22
Reach	224.3764	Q25	819.60	234.37	242.29		242.41	0.000611	2.91	320.45	112.54	0.23
Reach	224.3764	Q50	953.90	234.37	242.48		242.63	0.000705	3.21	342.70	115.76	0.25
Reach	224.3764	Q100	1098.20	234.37	243.78		243.88	0.000355	2.66	507.08	136.36	0.19
Reach	224.3764	Q500	1449.20	234.37	244.17		244.31	0.000478	3.21	561.36	141.94	0.22
Reach	179.7377	Q1.1	173.30	234.05	241.00		241.01	0.000060	0.77	247.56	105.34	0.07
Reach	179.7377	Q5	517.30	234.05	241.60		241.65	0.000299	1.90	315.74	122.83	0.16
Reach	179.7377	Q10	646.80	234.05	241.89		241.96	0.000356	2.17	353.42	130.67	0.18
Reach	179.7377	Q25	819.60	234.05	242.29		242.37	0.000406	2.45	407.28	141.12	0.19
Reach	179.7377	Q50	953.90	234.05	242.49		242.59	0.000467	2.69	435.58	146.31	0.21
Reach	179.7377	Q100	1098.20	234.05	243.79		243.85	0.000235	2.22	648.40	181.14	0.15
Reach	179.7377	Q500	1449.20	234.05	244.18		244.27	0.000315	2.67	721.96	191.80	0.18
Reach	140.6379	Q1.1	173.30	233.92	241.00		241.01	0.000031	0.67	378.84	149.83	0.05
Reach	140.6379	Q5	517.30	233.92	241.61		241.63	0.000154	1.62	473.55	162.95	0.12
Reach	140.6379	Q10	646.80	233.92	241.91		241.94	0.000186	1.84	523.60	169.47	0.13
Reach	140.6379	Q25	819.60	233.92	242.31		242.35	0.000219	2.08	593.99	181.87	0.14
Reach	140.6379	Q50	953.90	233.92	242.51		242.56	0.000254	2.28	631.05	186.84	0.16
Reach	140.6379	Q100	1098.20	233.92	243.80		243.84	0.000141	1.91	899.32	229.29	0.12
Reach	140.6379	Q500	1449.20	233.92	244.20		244.25	0.000191	2.30	993.97	242.94	0.14
Reach	100.2462	Q1.1	173.30	234.00	241.00		241.00	0.000019	0.50	449.99	149.91	0.04
Reach	100.2462	Q5	517.30	234.00	241.61		241.63	0.000101	1.24	546.82	169.44	0.10
Reach	100.2462	Q10	646.80	234.00	241.91		241.93	0.000123	1.42	599.30	179.14	0.11
Reach	100.2462	Q25	819.60	234.00	242.31		242.34	0.000146	1.62	673.61	192.03	0.12
Reach	100.2462	Q50	953.90	234.00	242.51		242.55	0.000171	1.79	712.85	198.51	0.13
Reach	100.2462	Q100	1098.20	234.00	243.80		243.83	0.000096	1.54	997.92	243.57	0.10
Reach	100.2462	Q500	1449.20	234.00	244.20		244.24	0.000132	1.86	1098.44	258.05	0.12
Reach	47.9043	Q1.1	173.30	233.51	241.00		241.00	0.000027	0.58	411.54	165.39	0.05
Reach	47.9043	Q5	517.30	233.51	241.60		241.62	0.000135	1.41	516.60	185.77	0.11
Reach	47.9043	Q10	646.80	233.51	241.90		241.92	0.000162	1.60	573.82	196.21	0.12
Reach	47.9043	Q25	819.60	233.51	242.30		242.33	0.000186	1.80	654.99	210.13	0.13
Reach	47.9043	Q50	953.90	233.51	242.50		242.54	0.000214	1.97	697.62	217.09	0.14
Reach	47.9043	Q100	1098.20	233.51	243.80		243.82	0.000111	1.62	1009.59	262.44	0.11
Reach	47.9043	Q500	1449.20	233.51	244.20		244.23	0.000149	1.95	1117.22	276.36	0.12

HEC-RAS Plan: MaineDOT   River: Taylor Brook   Reach: Reach (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach	11.2148	Q1.1	173.30	233.91	241.00	236.41	241.00	0.000019	0.40	474.37	186.10	0.04
Reach	11.2148	Q5	517.30	233.91	241.60	237.53	241.61	0.000090	0.99	592.57	207.89	0.09
Reach	11.2148	Q10	646.80	233.91	241.90	237.80	241.92	0.000106	1.12	656.56	218.78	0.10
Reach	11.2148	Q25	819.60	233.91	242.30	238.11	242.32	0.000120	1.27	746.98	233.30	0.11
Reach	11.2148	Q50	953.90	233.91	242.50	238.32	242.53	0.000138	1.40	794.37	240.56	0.11
Reach	11.2148	Q100	1098.20	233.91	243.80	238.53	243.82	0.000071	1.18	1137.78	287.76	0.08
Reach	11.2148	Q500	1449.20	233.91	244.20	238.97	244.23	0.000095	1.43	1255.79	302.29	0.10

Date:12/16/2018

Username:

Division:

Filename: 00X_HEC-RAS Plan.dgn

STATE OF MAINE
DEPARTMENT OF TRANSPORTATION

BRIDGE PLANS

WIN
022224.00

BRIDGE NO. 3225

		BY	DATE
PROJ. MANAGER	D. Eaton		
DESIGN-DETAILED	N. Willey	N. Willey	06/29/18
CHECKED-REVIEWED	A. Stephens	J. Olund	06/29/18
DESIGN2-DETAILED2			
DESIGN3-DETAILED3			
REVISIONS 1			
REVISIONS 2			
REVISIONS 3			
REVISIONS 4			
FIELD CHANGES			

SIGNATURE

P.E. NUMBER

DATE

TAYLOR BROOK BRIDGE
TAYLOR BROOK
AUBURN ANDROSCOGGIN COUNTY

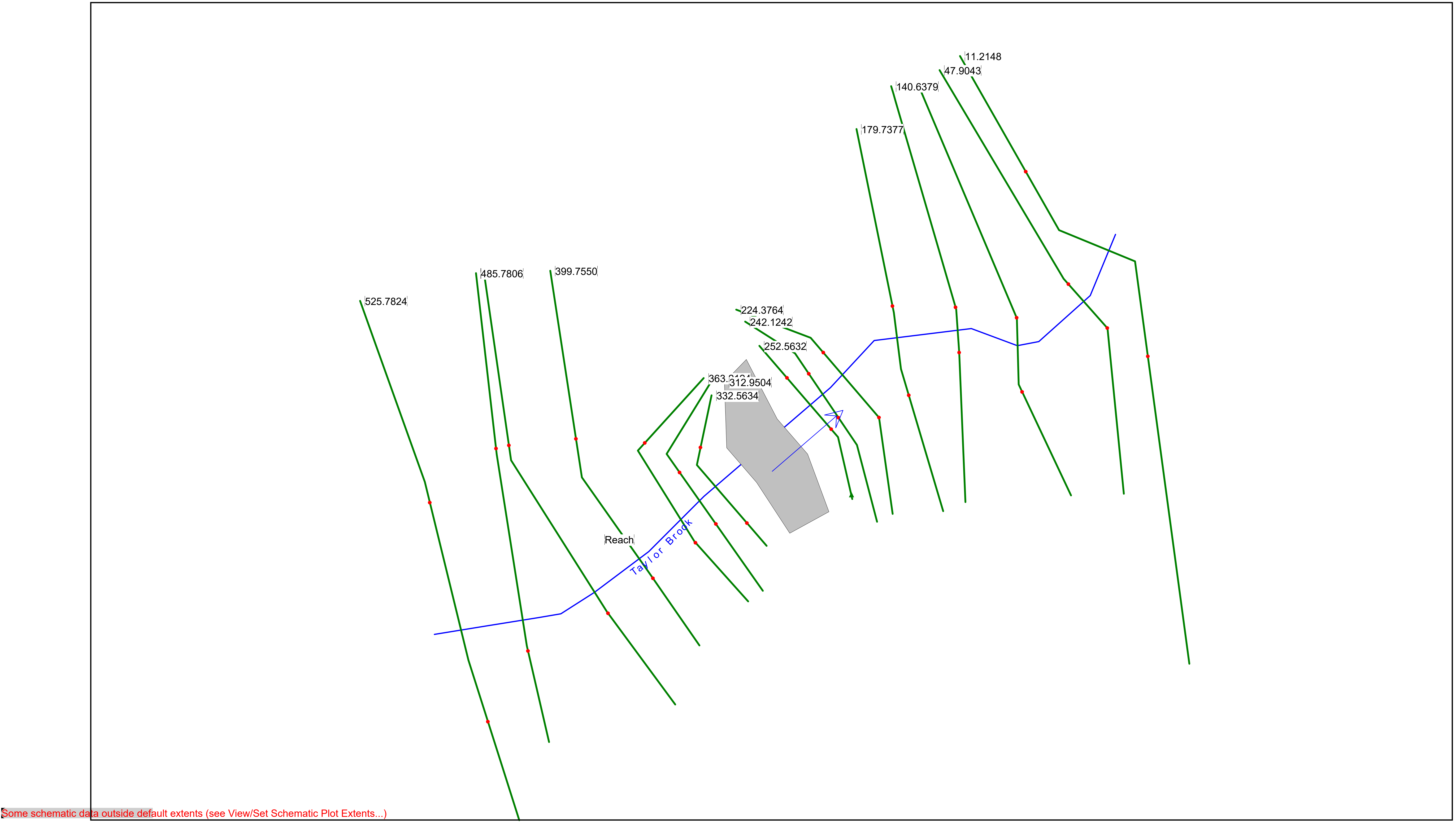
HEC-RAS GENERAL PLAN

SHEET NUMBER

1

OF 1

HNTB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485.7806
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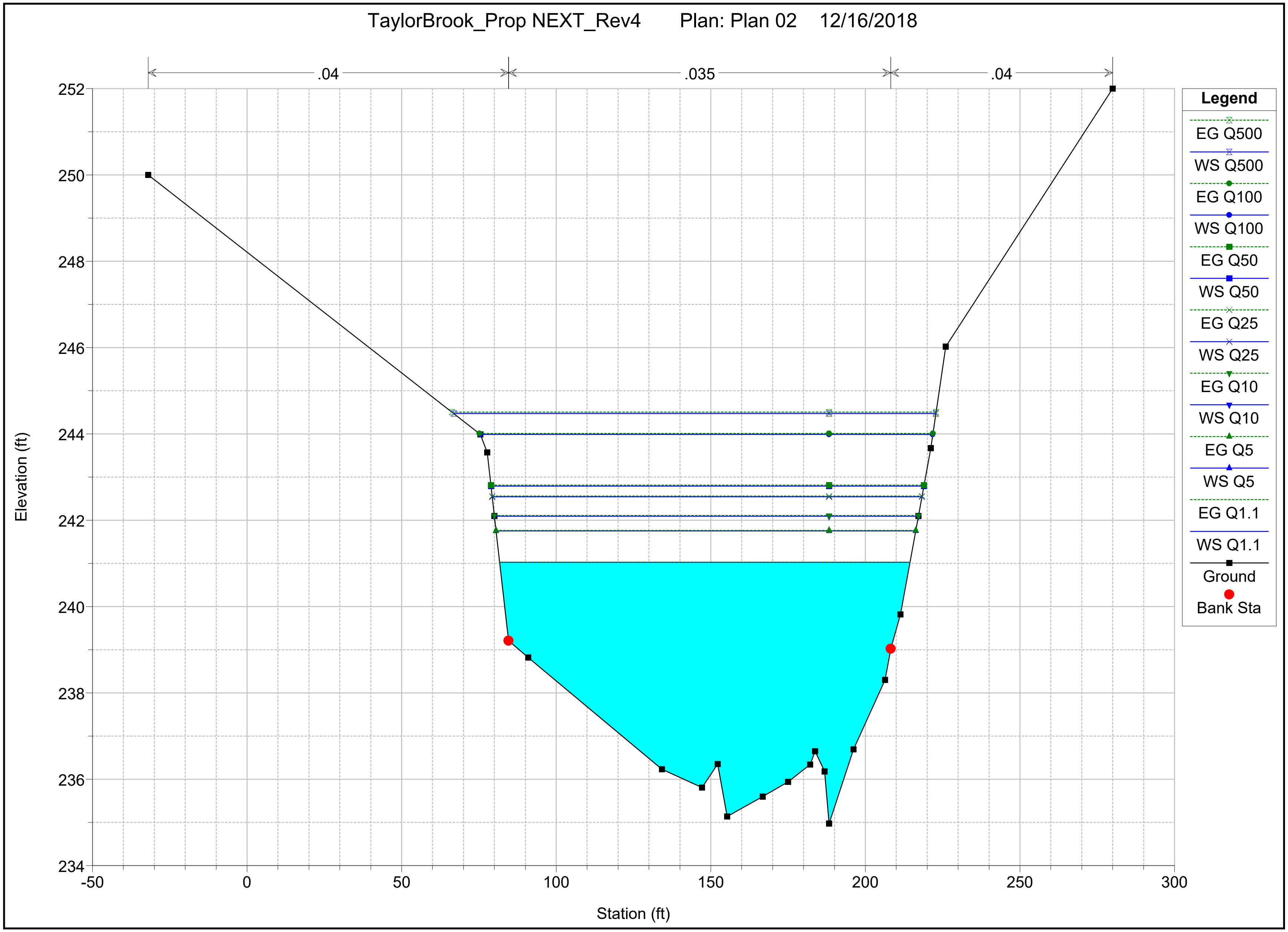
312.9504
332.5634
Reach
Taylor Brook
Some schematic data outside default extents (see View/Set Schematic Plot Extents...)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.04
.035
.04
Elevation (ft)
Station (ft)
252
250
248
246
244
242
240
238
236
234
-50
0
50
100
150
200
250
300
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
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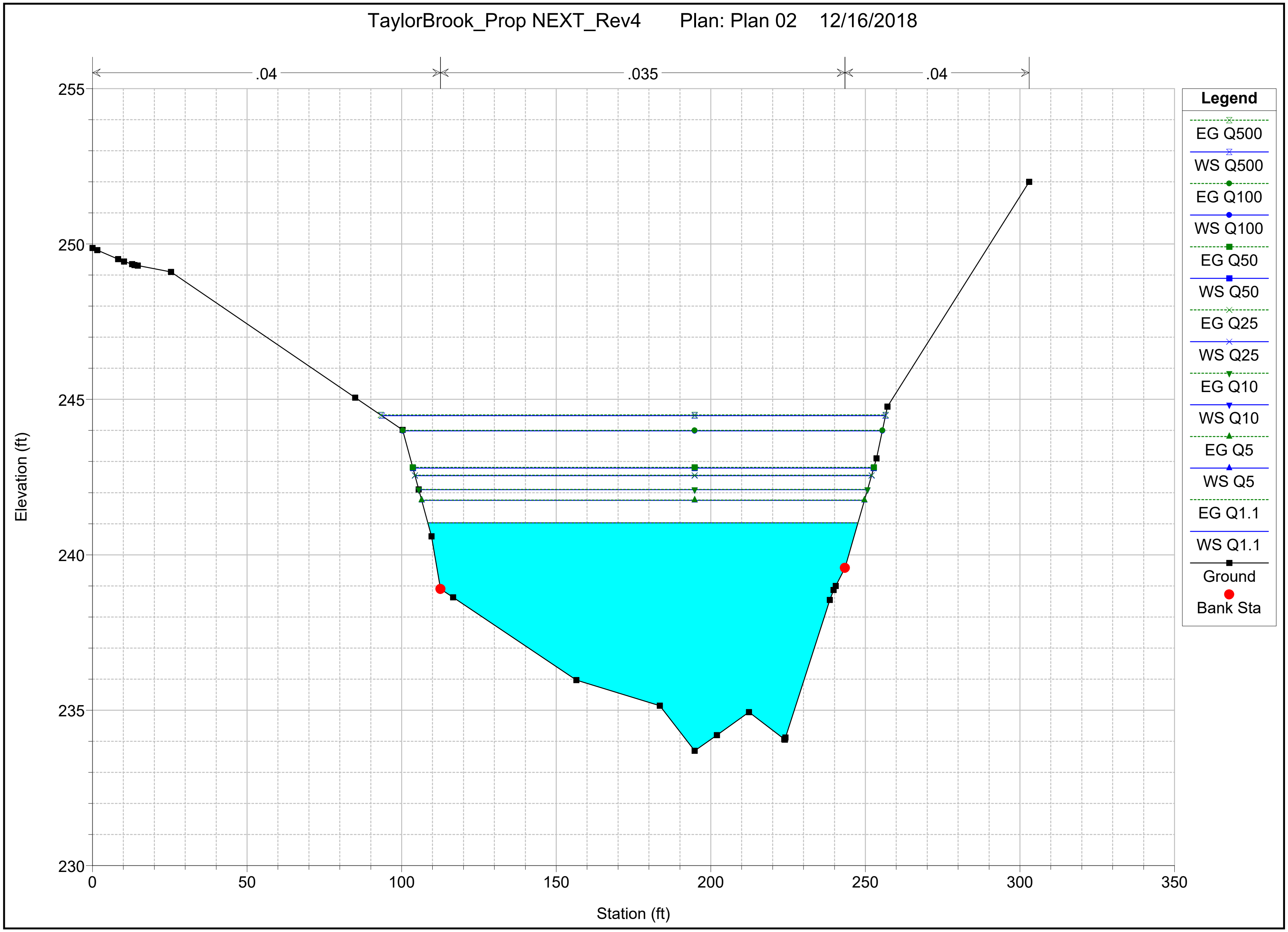
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Ground
Bank Sta



TaylorBrook_Prop NEXT_Rev4 Plan: Plan 02 12/16/2018
.04
.035
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Legend
EG Q500
WS Q500
EG Q100
WS Q100
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WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Ground
Bank Sta
Elevation (ft)
Station (ft)
255
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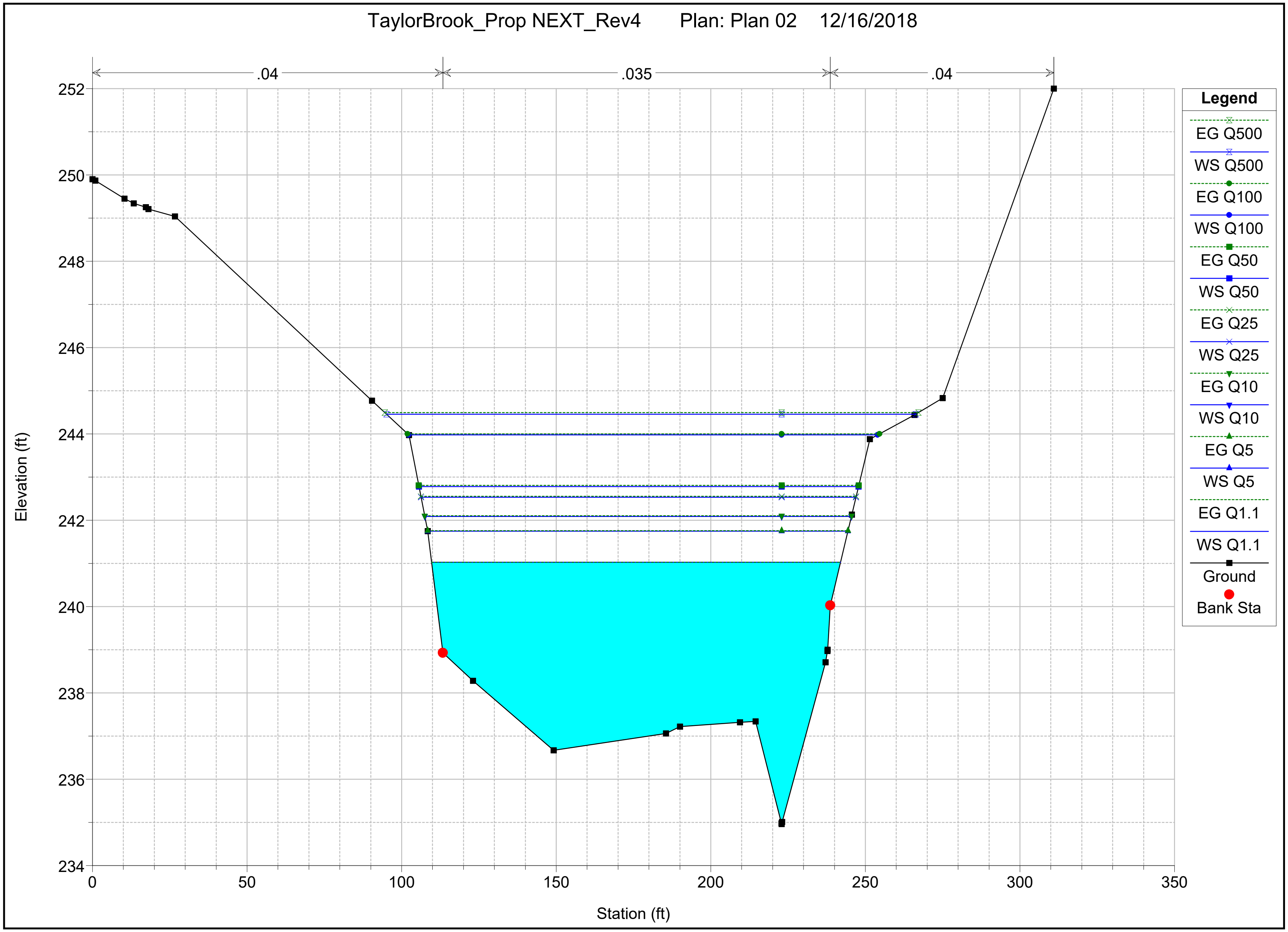
240
235
230
0
50
100
150
200
250
300
350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.035
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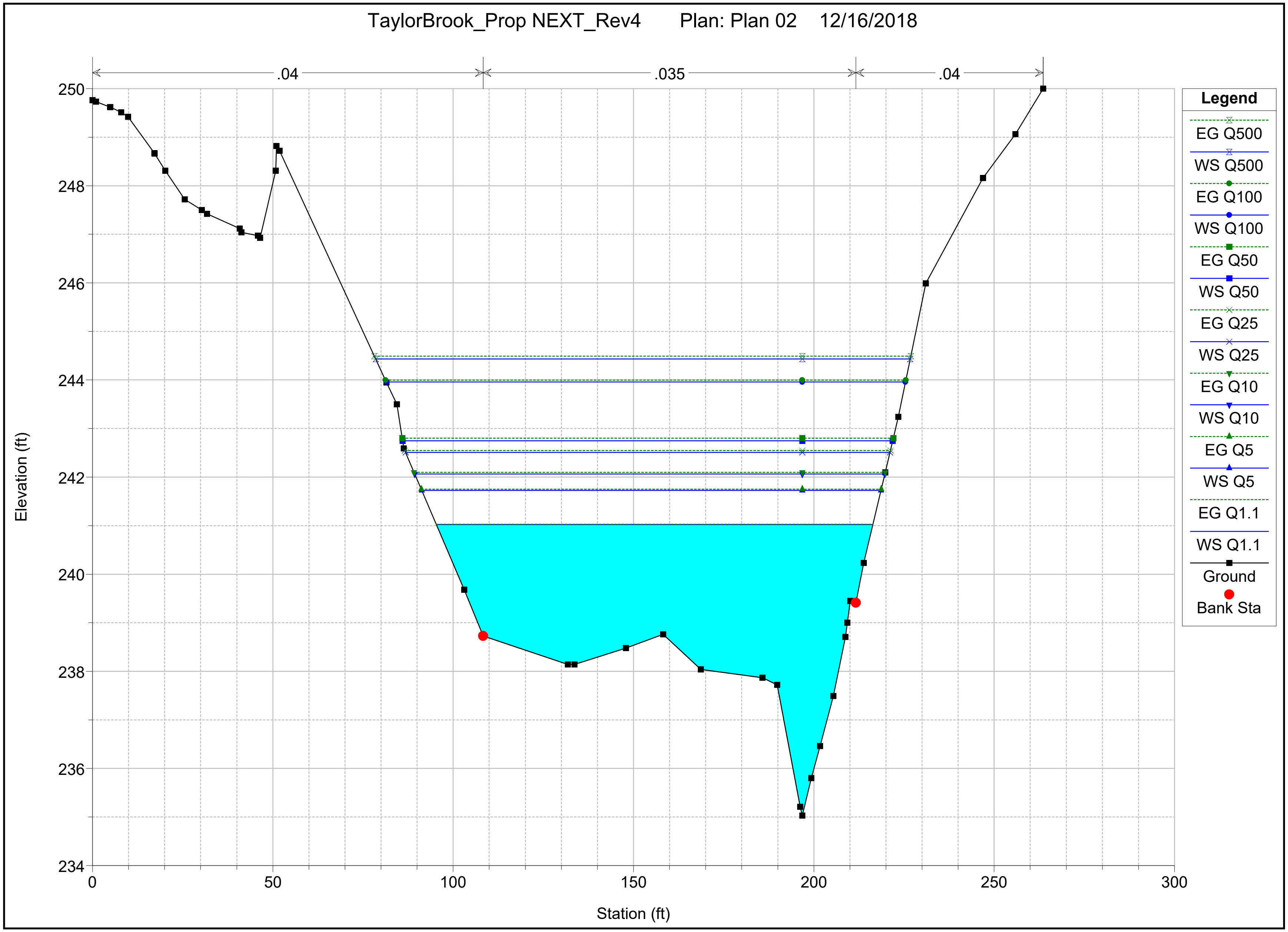
Elevation (ft)
Station (ft)
252
250
248
246
244
242
240
238
236
234
0
50
100
150
200
250
300
350
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Ground
Bank Sta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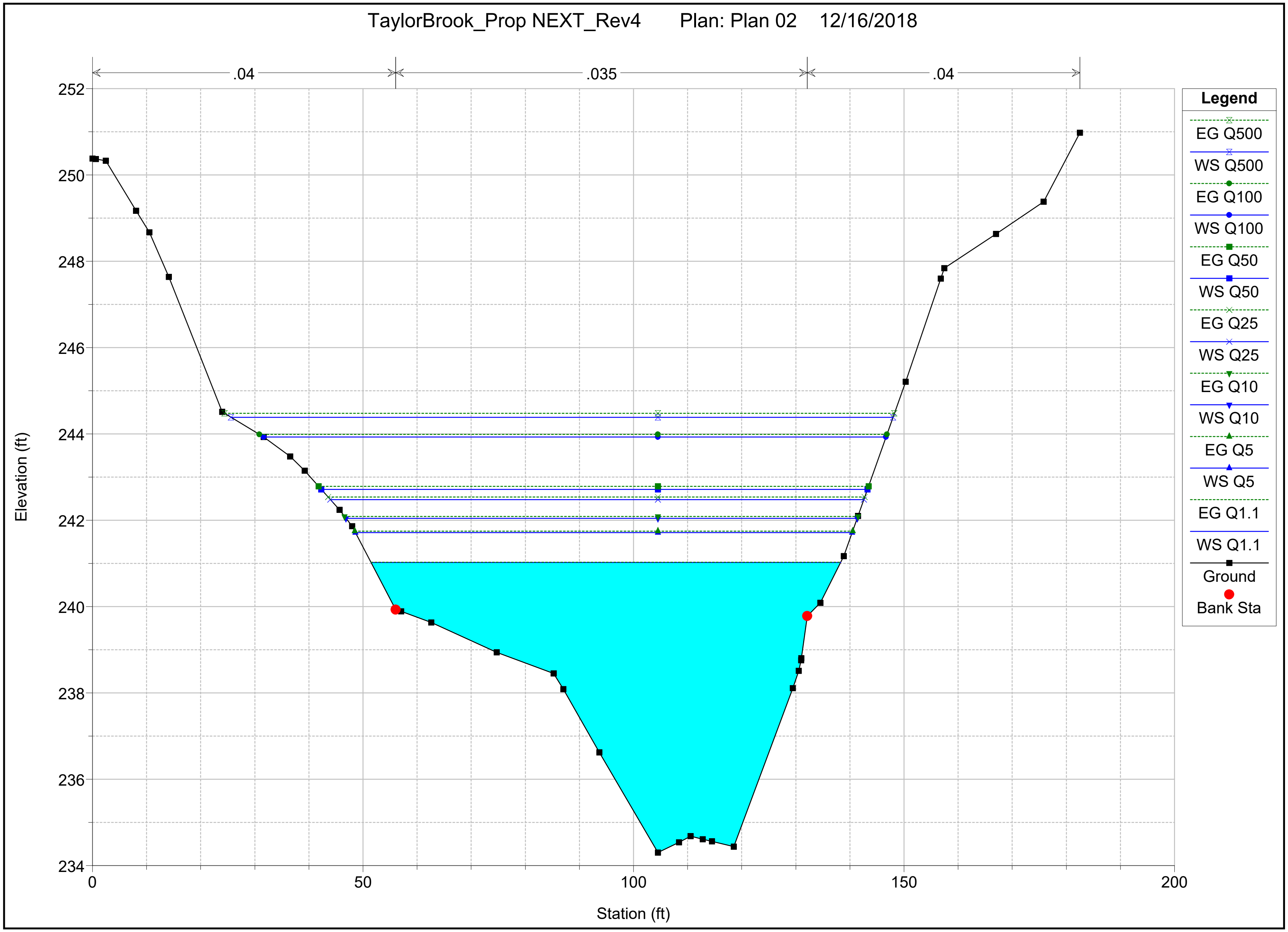
.04
.035
.04
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Ground
Bank Sta
Elevation (ft)
Station (ft)
234
236
238
240
242
244
246
248
250
0
50
100
150
200
250
300



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.04
.035
.04
Legend
EG Q500
WS Q500
EG Q100
WS Q100
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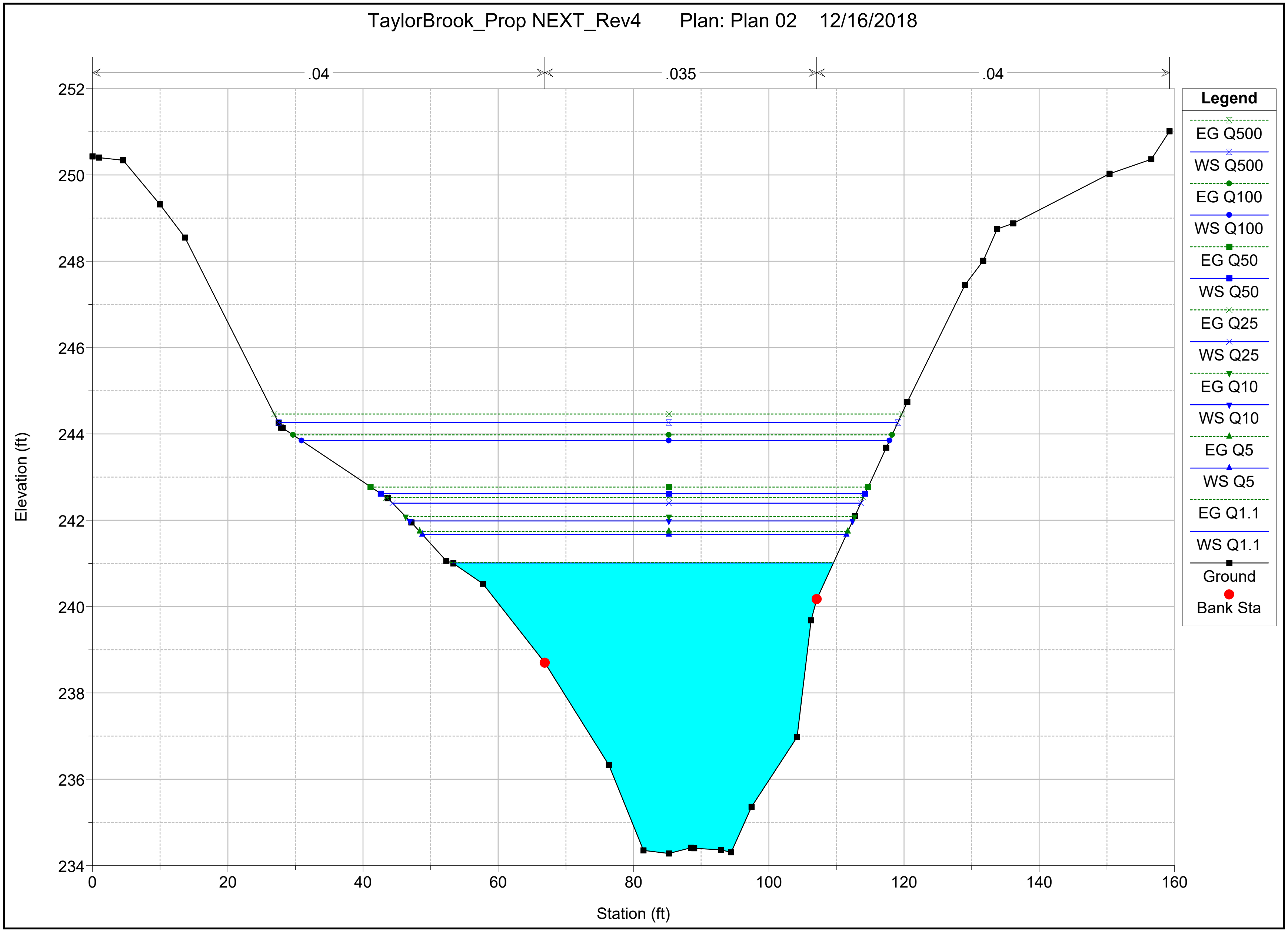
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Ground
Bank Sta
Elevation (ft)
252
250
248
246
244
242
240
238
236
234
0
50
100
150
200
Station (ft)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.035
.04
Elevation (ft)
Station (ft)
252
250
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246
244
242
240
238
236
234
0
20
40
60
80
100
120
140
160
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
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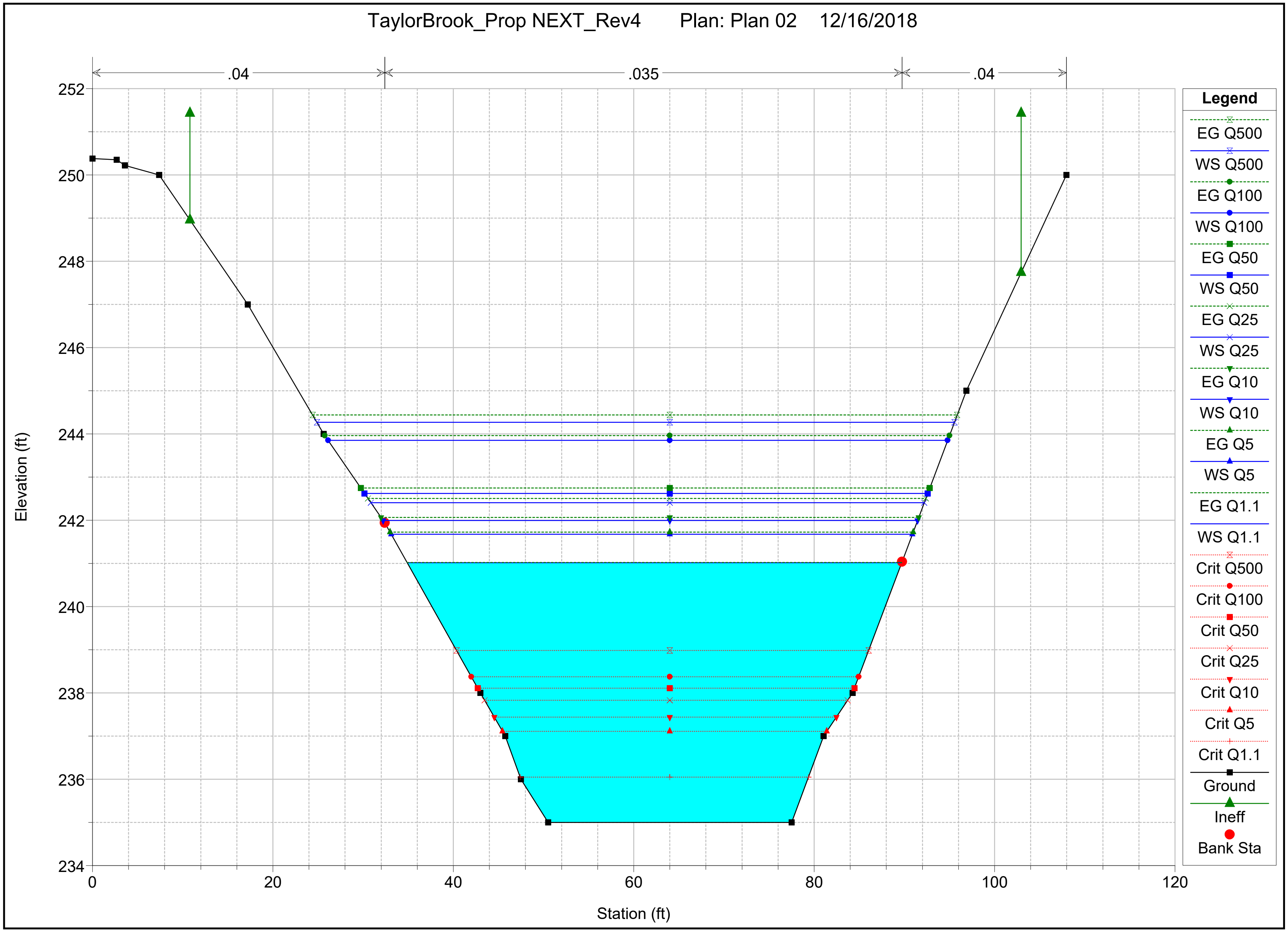
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Ground
Bank Sta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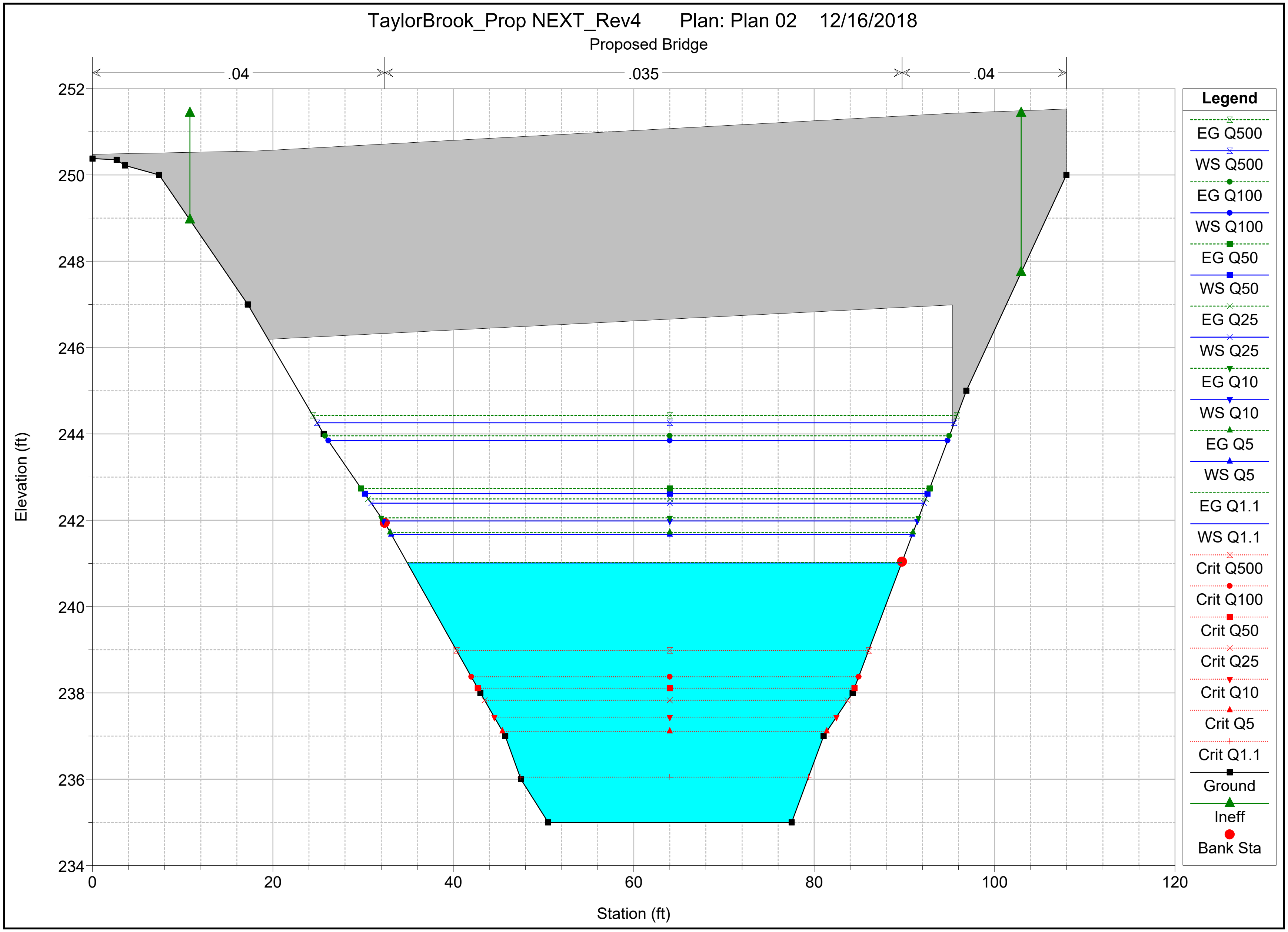
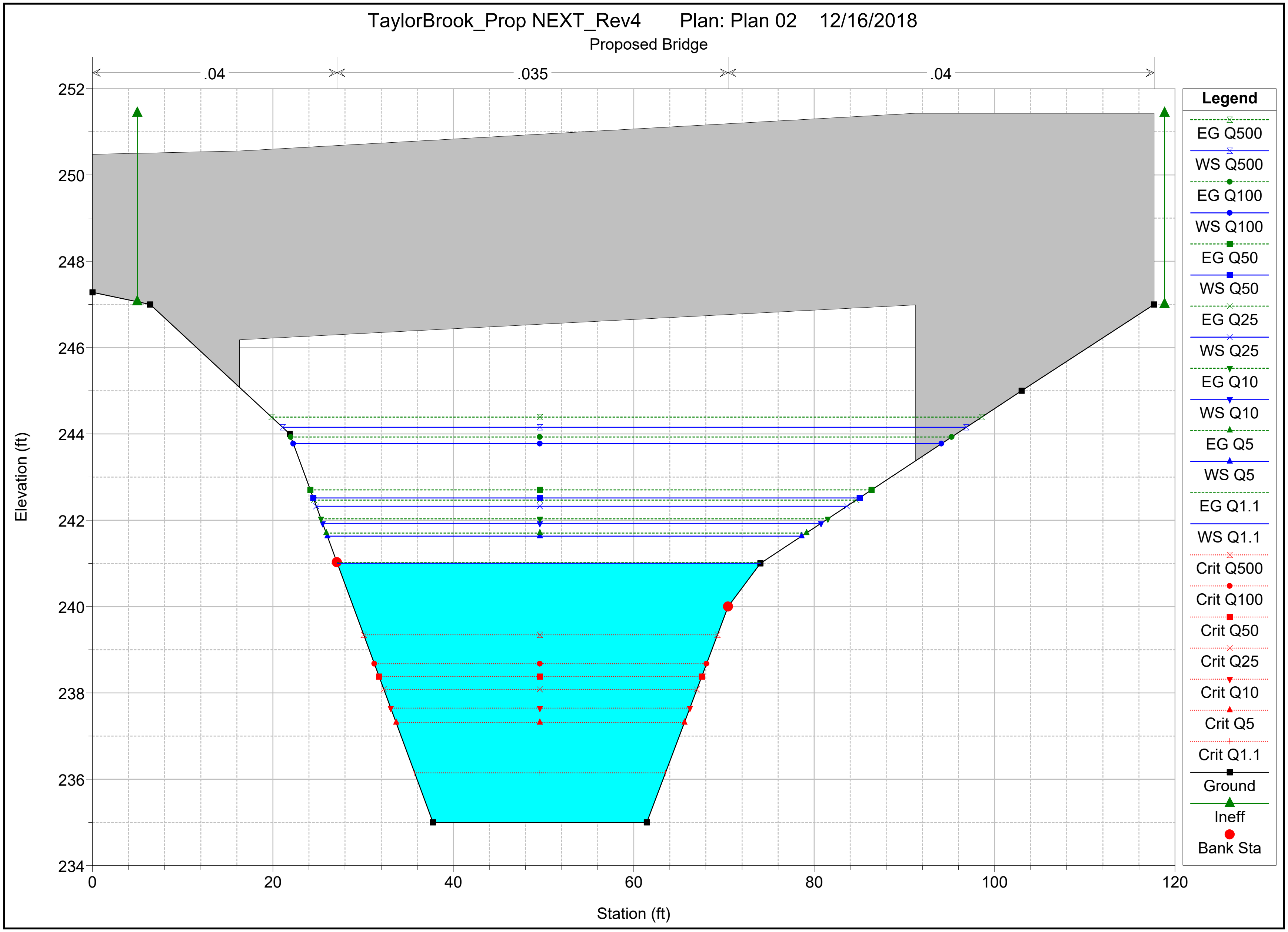
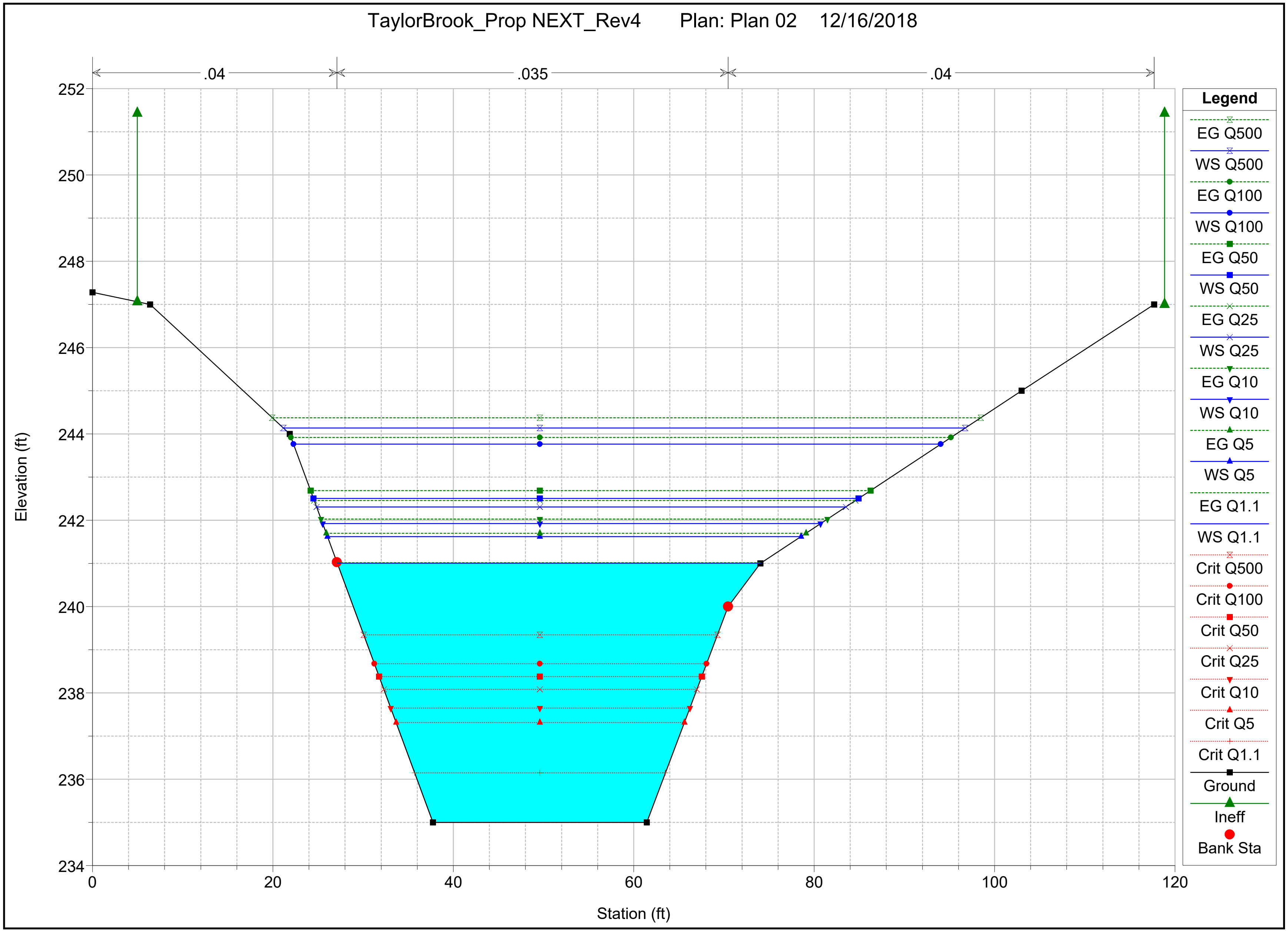
.035
.04
Elevation (ft)
Station (ft)
252
250
248
246
244
242
240
238
236
234
0
20
40
60
80
100
120
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Crit Q500
Crit Q100
Crit Q50
Crit Q25
Crit Q10
Crit Q5
Crit Q1.1
Ground
Ineff
Bank Sta



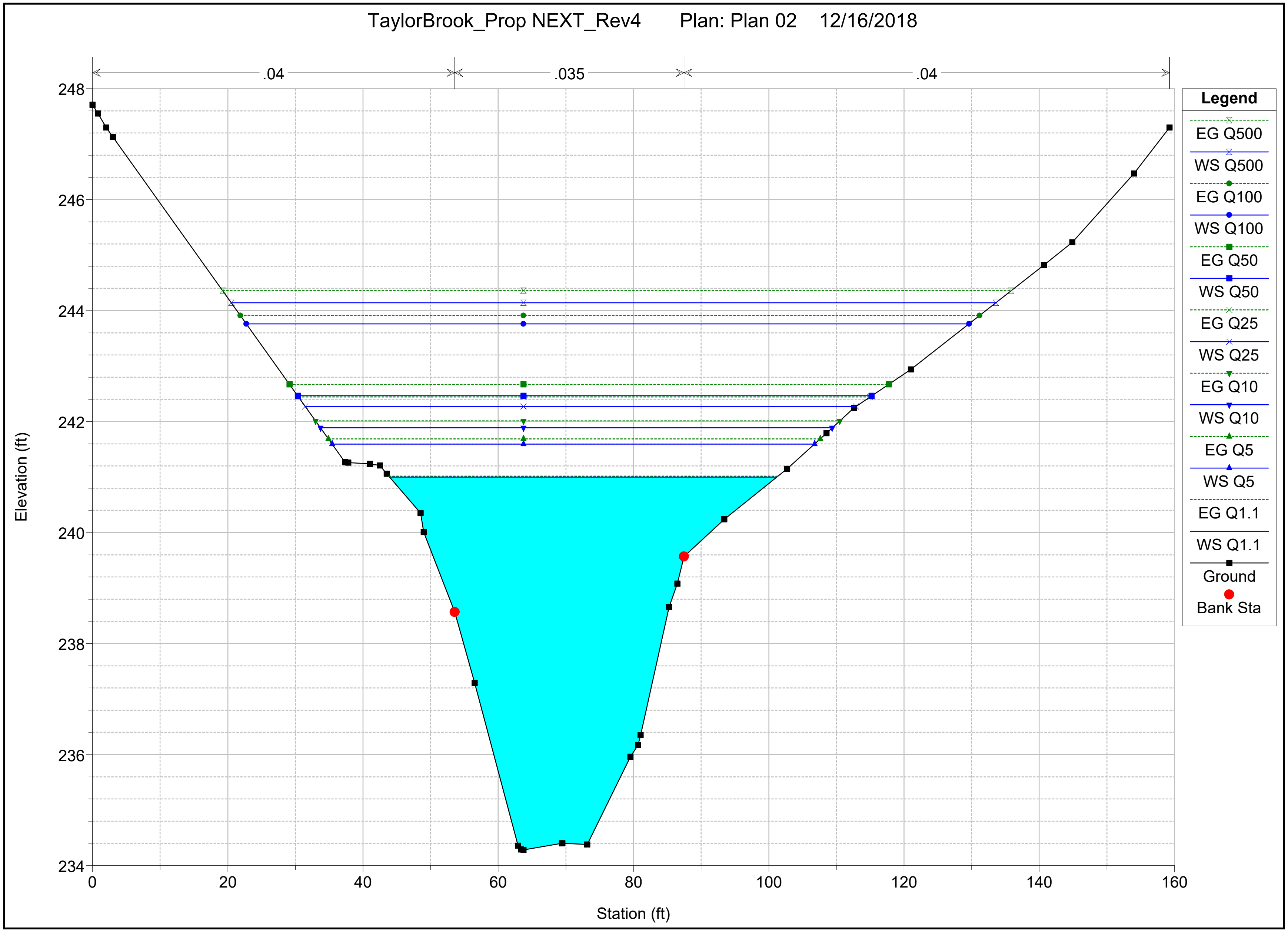
TaylorBrook_Prop NEXT_Rev4 Plan: Plan 02 12/16/2018
Proposed Bridge
.04
.035
.04
Elevation (ft)
Station (ft)
252
250
248
246
244
242
240
238
236
234
0
20
40
60
80
100
120
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Crit Q500
Crit Q100
Crit Q50
Crit Q25
Crit Q10
Crit Q5
Crit Q1.1
Ground
Ineff
Bank Sta



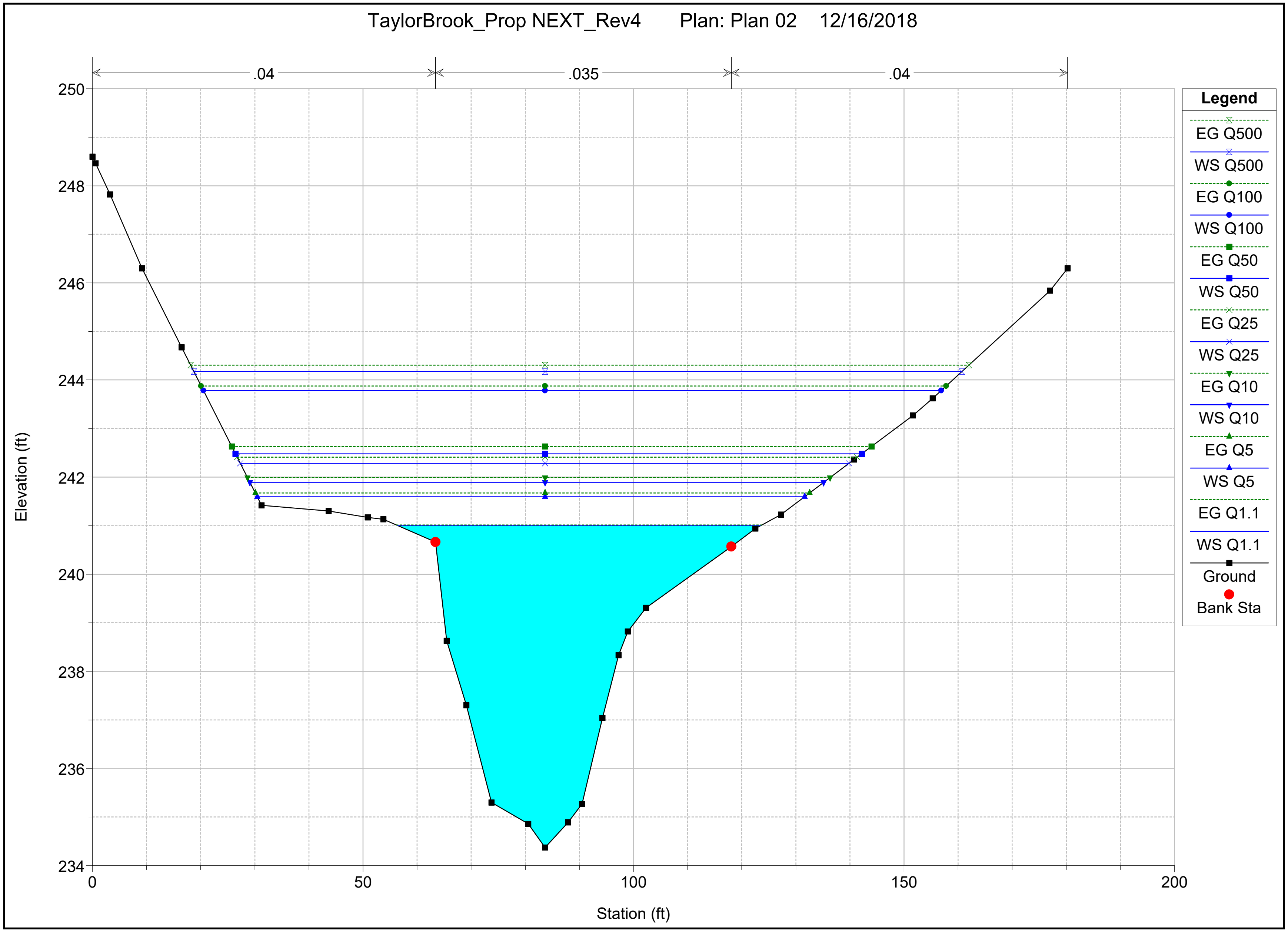
TaylorBrook_Prop NEXT_Rev4 Plan: Plan 02 12/16/2018
Proposed Bridge
.04
.035
.04
Elevation (ft)
Station (ft)
252
250
248
246
244
242
240
238
236
234
0
20
40
60
80
100
120
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Crit Q500
Crit Q100
Crit Q50
Crit Q25
Crit Q10
Crit Q5
Crit Q1.1
Ground
Ineff
Bank Sta

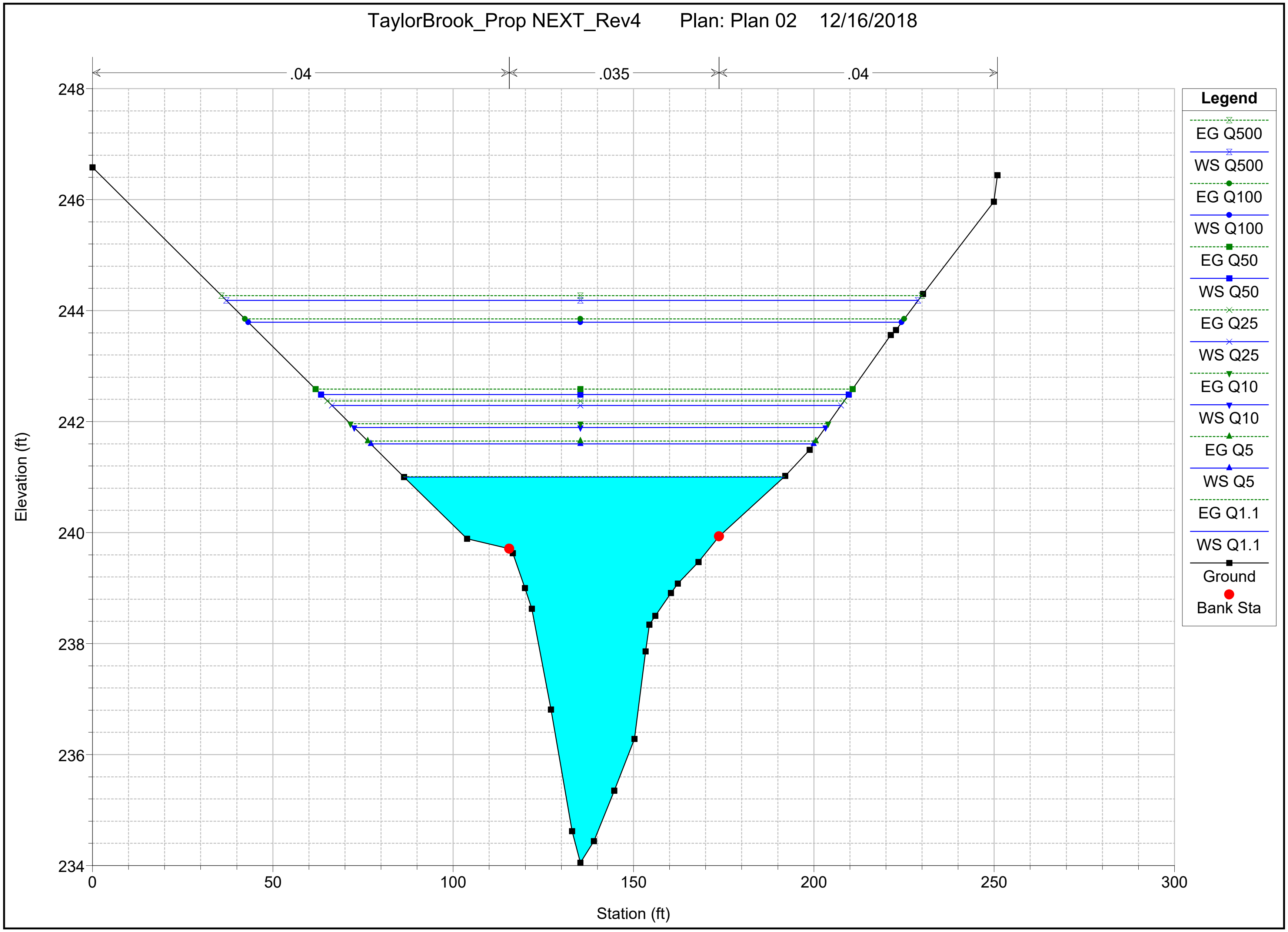


TaylorBrook_Prop NEXT_Rev4 Plan: Plan 02 12/16/2018
.04
.035
.04
Elevation (ft)
Station (ft)
252
250
248
246
244
242
240
238
236
234
0
20
40
60
80
100
120
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Crit Q500
Crit Q100
Crit Q50
Crit Q25
Crit Q10
Crit Q5
Crit Q1.1
Ground
Ineff
Bank Sta

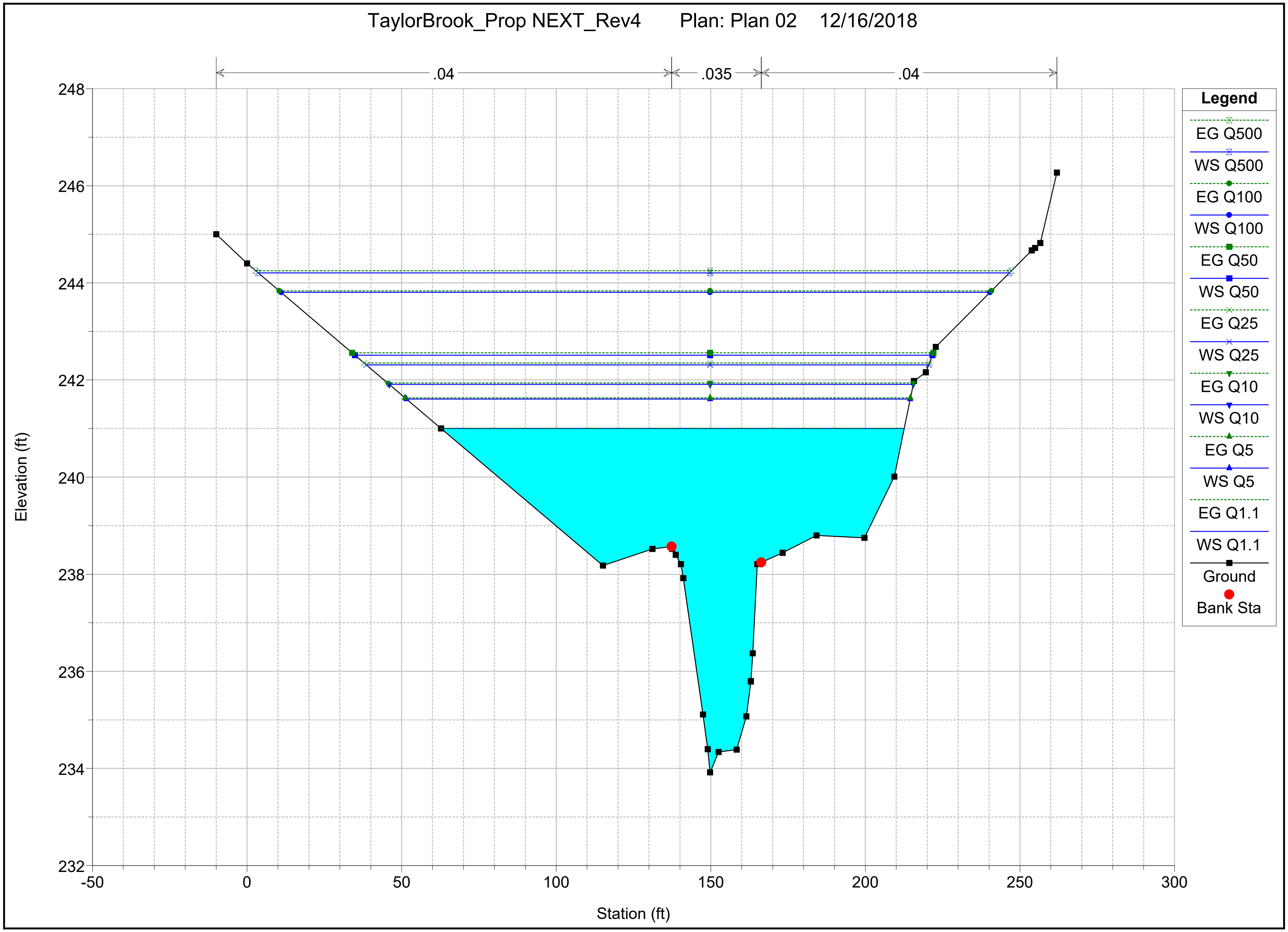


TaylorBrook_Prop NEXT_Rev4 Plan: Plan 02 12/16/2018
.04
.035
.04
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Ground
Bank Sta
Elevation (ft)
Station (ft)
248
246
244
242
240
238
236
234
0
20
40
60
80
100
120
140
160

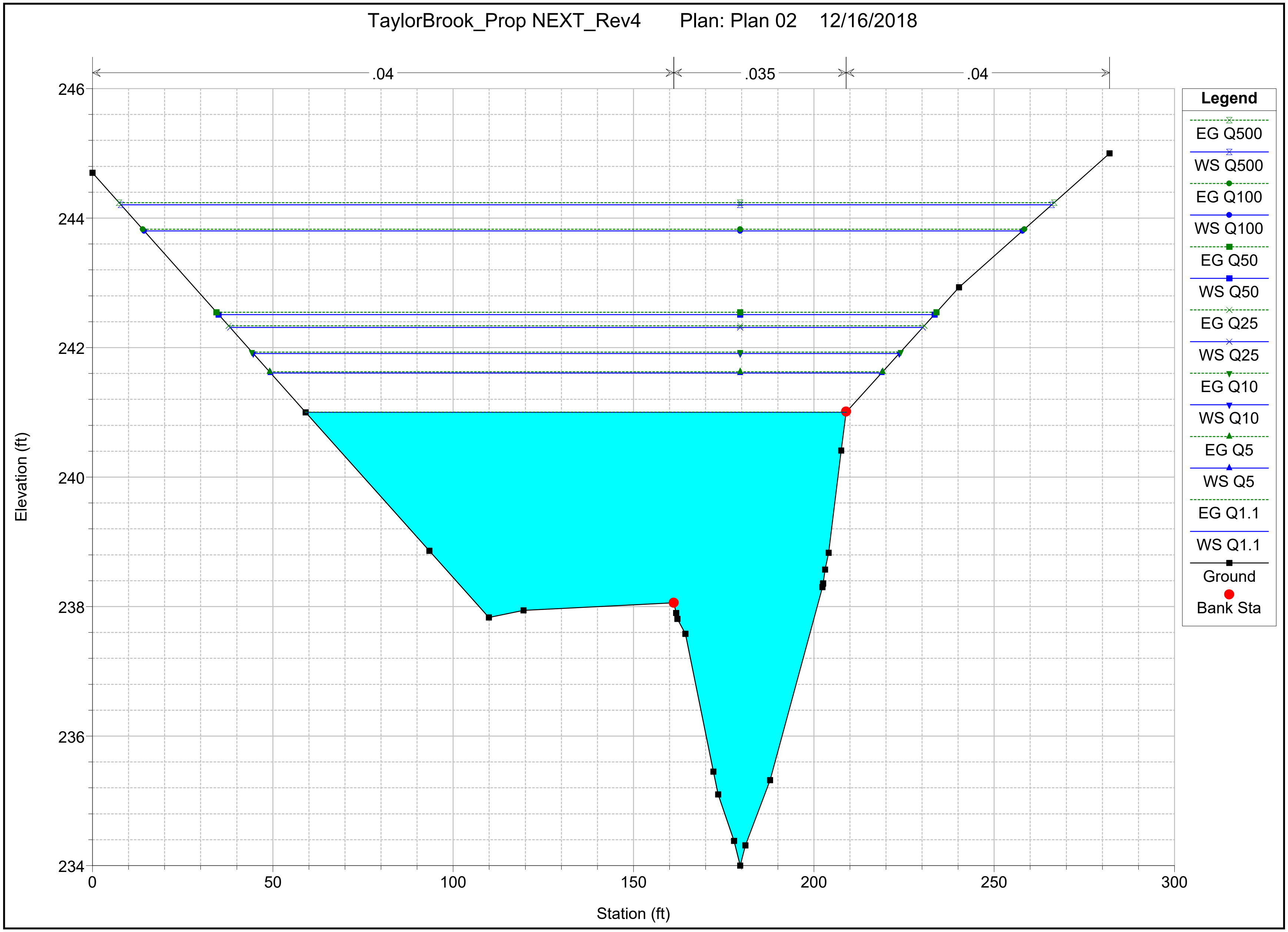

TaylorBrook_Prop NEXT_Rev4 Plan: Plan 02 12/16/2018
.04
.035
.04
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Ground
Bank Sta
Elevation (ft)
Station (ft)
250
248
246
244
242
240
238
236
234
0
50
100
150
200



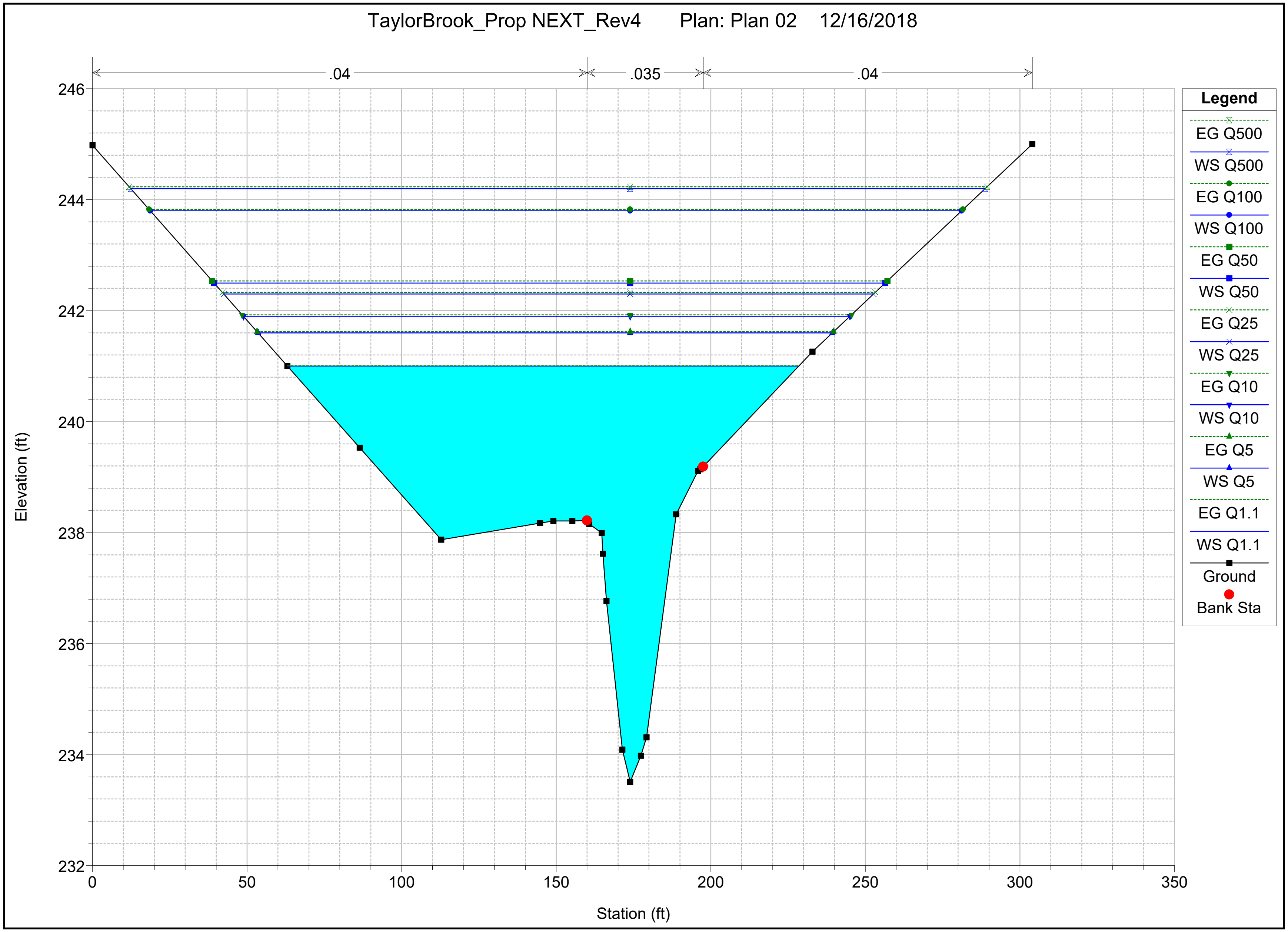
TaylorBrook_Prop NEXT_Rev4 Plan: Plan 02 12/16/2018
.04
.035
.04
Elevation (ft)
Station (ft)
248
246
244
242
240
238
236
234
0
50
100
150
200
250
300
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Ground
Bank Sta



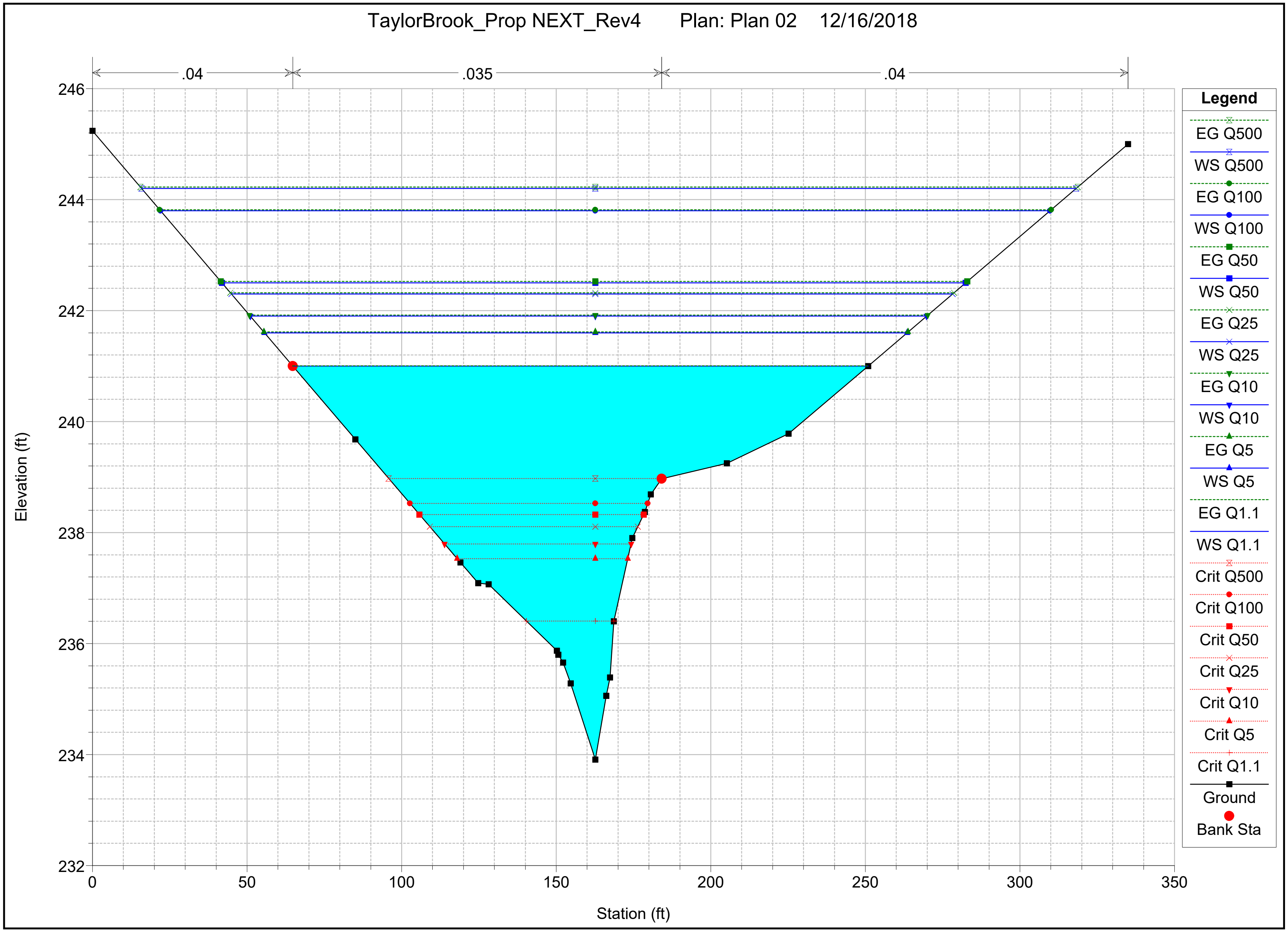
TaylorBrook_Prop NEXT_Rev4 Plan: Plan 02 12/16/2018
.04
.035
.04
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Ground
Bank Sta
Elevation (ft)
248
246
244
242
240
238
236
234
232
-50
0
50
100
150
200
250
300
Station (ft)

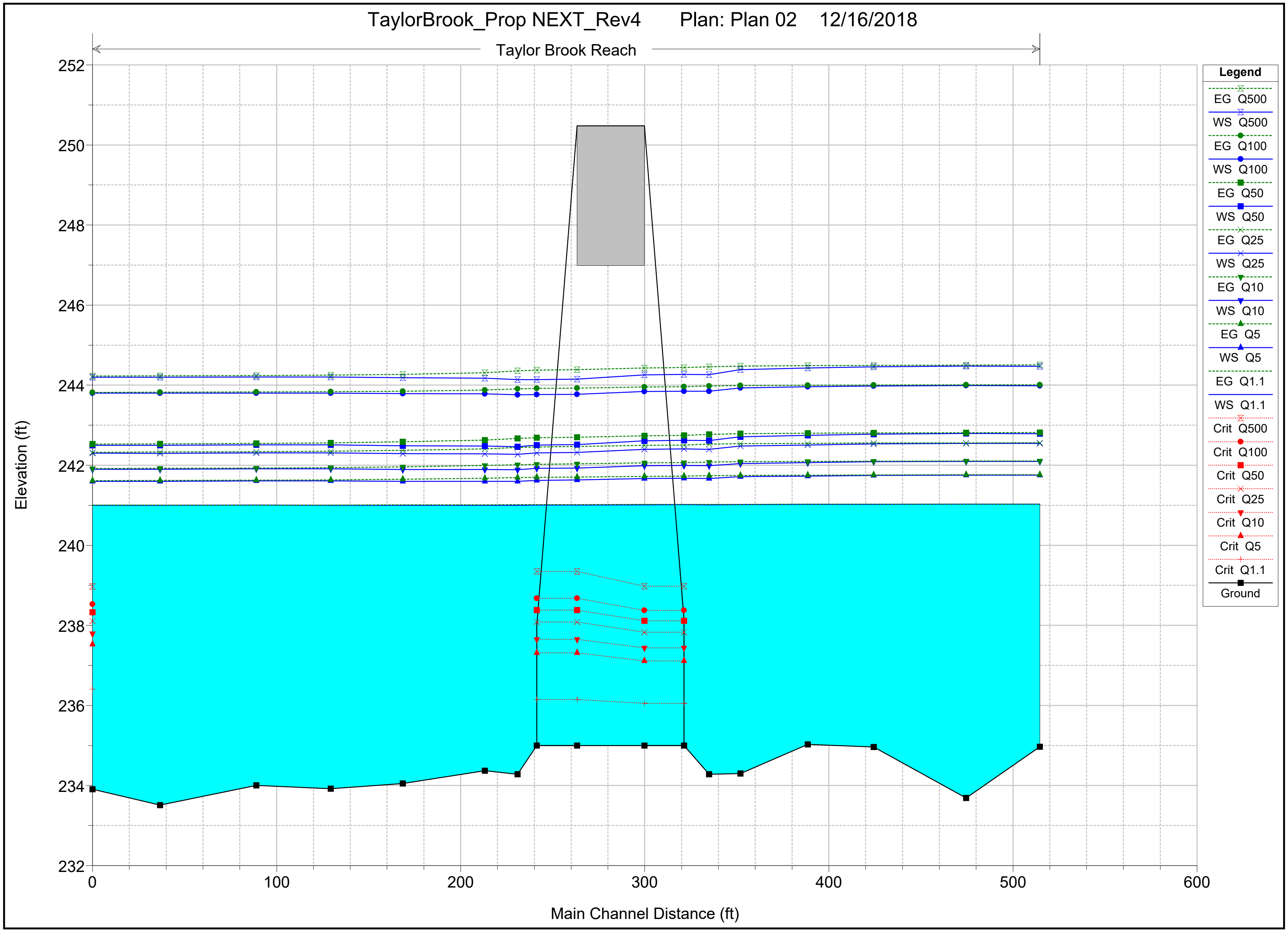


TaylorBrook_Prop NEXT_Rev4 Plan: Plan 02 12/16/2018
.04
.035
.04
Elevation (ft)
Station (ft)
246
244
242
240
238
236
234
0
50
100
150
200
250
300
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Ground
Bank Sta



TaylorBrook_Prop NEXT_Rev4 Plan: Plan 02 12/16/2018
.04
.035
.04
Elevation (ft)
Station (ft)
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Ground
Bank Sta

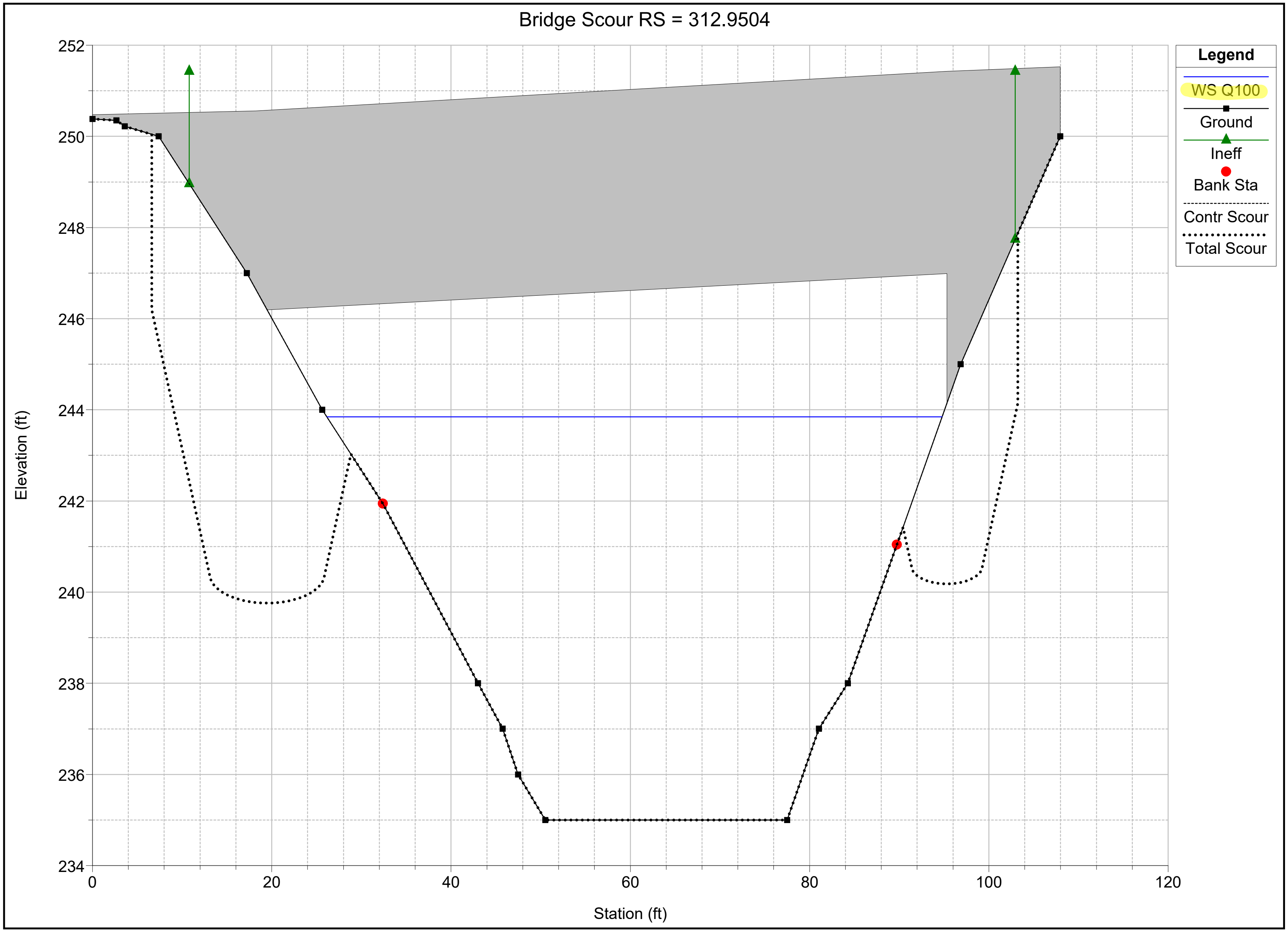

TaylorBrook_Prop NEXT_Rev4 Plan: Plan 02 12/16/2018
.04
.035
.04
246
244
242
240
238
236
234
232
Elevation (ft)
0
50
100
150
200
250
300
350
Station (ft)
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Crit Q500
Crit Q100
Crit Q50
Crit Q25
Crit Q10
Crit Q5
Crit Q1.1
Ground
Bank Sta



TaylorBrook_Prop NEXT_Rev4 Plan: Plan 02 12/16/2018
Taylor Brook Reach
Legend
EG Q500
WS Q500
EG Q100
WS Q100
EG Q50
WS Q50
EG Q25
WS Q25
EG Q10
WS Q10
EG Q5
WS Q5
EG Q1.1
WS Q1.1
Crit Q500
Crit Q100
Crit Q50
Crit Q25
Crit Q10
Crit Q5
Crit Q1.1
Ground
Elevation (ft)
Main Channel Distance (ft)
252
250
248
246
244
242
240
238
236
234
232
0
100
200
300
400
500
600

APPENDIX H

Scour Analysis



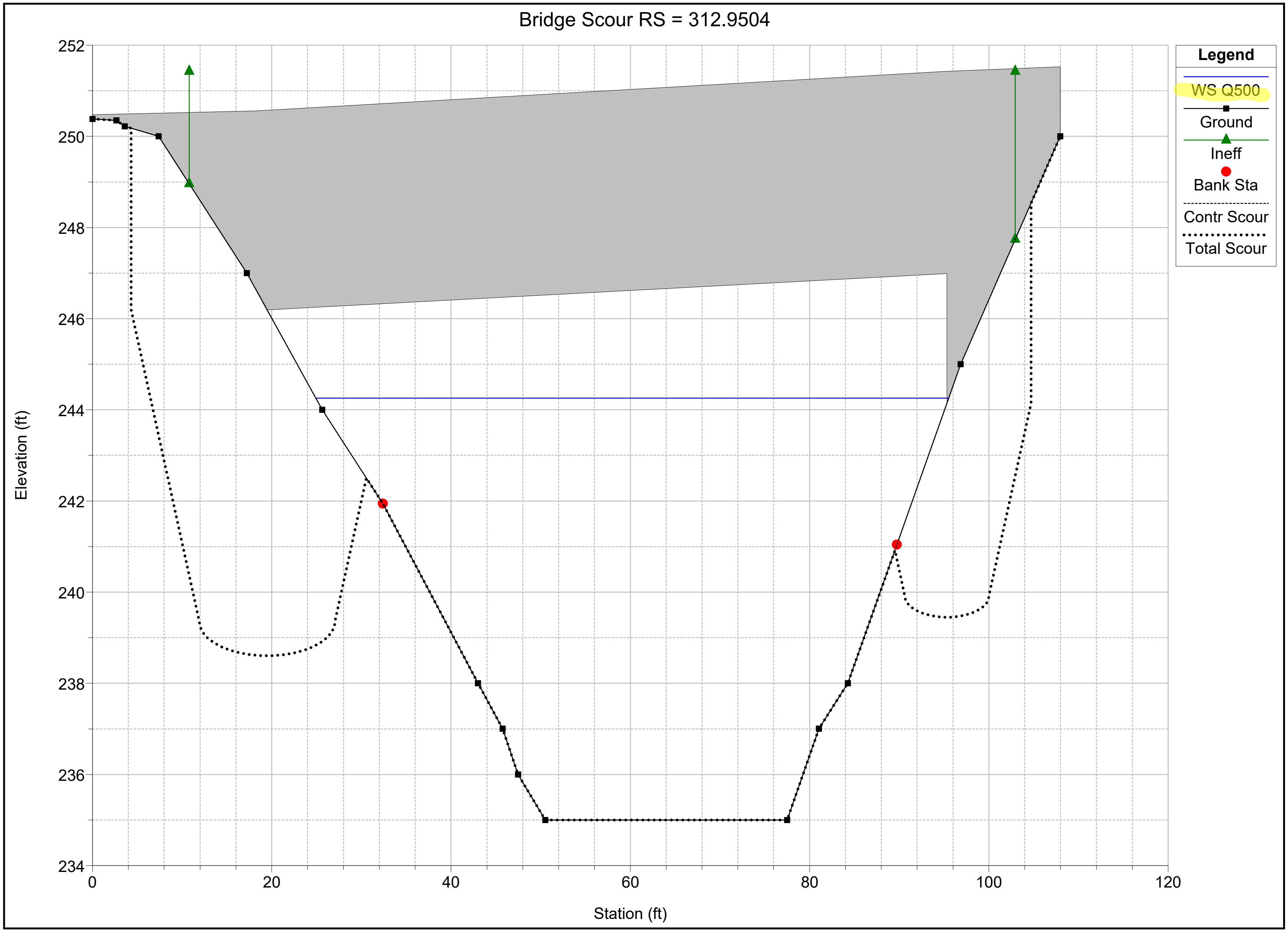
Bridge Scour RS = 312.9504
Elevation (ft)
Station (ft)
252
250
248
246
244
242
240
238
236
234
0
20
40
60
80
100
120
Legend
WS Q100
Ground
Ineff
Bank Sta
Contr Scour
Total Scour

Contraction Scour

		Left	Channel	Right
Input Data				
	Average Depth (ft):	2.26	7.96	1.84
	Approach Velocity (ft/s):	1.20	3.06	1.01
	Br Average Depth (ft):	0.95	7.10	1.40
	BR Opening Flow (cfs):	3.66	1089.24	5.30
	BR Top WD (ft):	6.26	57.34	5.05
	Grain Size D50 (mm):	0.19	0.19	0.19
	Approach Flow (cfs):	97.48	980.75	19.97
	Approach Top WD (ft):	35.99	40.21	10.75
	K1 Coefficient:	0.690	0.690	0.690
Results				
	Scour Depth Ys (ft):	0.00	0.00	0.00
	Critical Velocity (ft/s):			
	Equation:	Live	Live	Live

Abutment Scour

		Left	Right
Input Data			
	Station at Toe (ft):	19.48	95.32
	Toe Sta at appr (ft):	53.97	112.68
	Abutment Length (ft):	35.99	10.75
	Depth at Toe (ft):	-2.34	-0.29
	K1 Shape Coef:	0.82 - Vert. with wing walls	
	Degree of Skew (degrees):	90.00	90.00
	K2 Skew Coef:	1.00	1.00
	Projected Length L' (ft):	35.99	10.75
	Avg Depth Obstructed Ya (ft):	2.26	1.84
	Flow Obstructed Qe (cfs):	97.48	19.97
	Area Obstructed Ae (sq ft):	81.43	19.75
Results			
	Scour Depth Ys (ft):	6.43	3.96
	Qe/Ae = Ve:	1.20	1.01
	Froude #:	0.14	0.13
	Equation:	Froehlich	Froehlich



Bridge Scour RS = 312.9504
Legend
WS Q500
Ground
Ineff
Bank Sta
Contr Scour
Total Scour
Elevation (ft)
Station (ft)
252
250
248
246
244
242
240
238
236
234
0
20
40
60
80
100
120

Contraction Scour

		Left	Channel	Right
Input Data				
	Average Depth (ft):	2.47	8.38	2.04
	Approach Velocity (ft/s):	1.51	3.77	1.29
	Br Average Depth (ft):	1.18	7.51	1.67
	BR Opening Flow (cfs):	7.45	1432.50	9.25
	BR Top WD (ft):	7.49	57.34	5.58
	Grain Size D50 (mm):	0.19	0.19	0.19
	Approach Flow (cfs):	146.83	1270.73	31.64
	Approach Top WD (ft):	39.38	40.21	11.98
	K1 Coefficient:	0.690	0.690	0.690
Results				
	Scour Depth Ys (ft):	0.00	0.00	0.00
	Critical Velocity (ft/s):			
	Equation:	Live	Live	Live

Abutment Scour

		Left	Right
Input Data			
	Station at Toe (ft):	19.48	95.32
	Toe Sta at appr (ft):	53.97	112.68
	Abutment Length (ft):	39.38	11.98
	Depth at Toe (ft):	-1.92	0.13
	K1 Shape Coef:	0.82 - Vert. with wing walls	
	Degree of Skew (degrees):	90.00	90.00
	K2 Skew Coef:	1.00	1.00
	Projected Length L' (ft):	39.38	11.98
	Avg Depth Obstructed Ya (ft):	2.47	2.04
	Flow Obstructed Qe (cfs):	146.83	31.64
	Area Obstructed Ae (sq ft):	97.24	24.48
Results			
	Scour Depth Ys (ft):	7.59	4.69
	Qe/Ae = Ve:	1.51	1.29
	Froude #:	0.17	0.16
	Equation:	Froehlich	Froehlich

TABLE 1
Grain Size Distributions
D_{50} and % Fines

Taylor Brook Bridge
Auburn, Maine
WIN 22224.00

Soil Unit	Representative Zone	Boring	Sample	Depth (feet)	Elev. (feet)	% Fines (<No. 200)	D_{50} (mm)	Classification of D_{50} particle size	Representative D_{50} (mm)
Alluvium	Streambed	BB-ATB-101	3D	15-17	236.4-234.4	35.7	0.11	Fine Sand	0.19
		BB-ATB-103	3D	15-17	235.2-233.2	4.3	0.26		
Glaciomarine Clay	Below Streambed	BB-ATB-103	4D	20-22	230.2-228.2	98.6	0.002	Clay	0.002

Prepared by /date: ABV 5/24/18
Checked by /date LK 5/2018
Backcheck /date