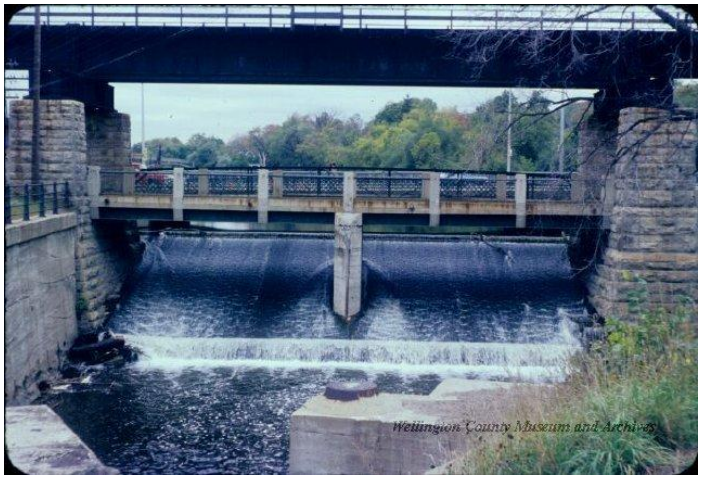
APPENDIX 6

HYDRAULIC ANALYSIS TECHNICAL MEMORANDUM



Macdonell and Allan's Structures Class Environmental Assessment Hydraulic Analysis

Technical Memorandum

August 12, 2025

Prepared for:

CITY OF Guelph

arva

CAN-DAS BEST MANAGED COMPANIES Platinum member

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August 12, 2025 RVA 215632.02

City of Guelph
1 Carden Street
Guelph, ON N1H 3A1

Attention: Steven Di Pietro

Dear Steven:

Re: Macdonell and Allan's Structures Schedule C Municipal Class Environmental Assessment - Existing Conditions Hydraulic Analysis Technical Memorandum

Please find attached the Hydraulic Analysis Existing Conditions Technical Memorandum for the above-noted project for your review and comments. Please feel free to reach out for any questions or comments.

Yours very truly,

R.V. ANDERSON ASSOCIATES LIMITED

Stewart Dickson, P.Eng.
Vice President, Municipal

Encls.

R:\2021\215632 - Guelph Downtown Infrastructure\07 EA, Planning, Studies\05 Macdonnel and Allan Class EA\03ExistingConditions-HydraulicAnalysis

Macdonell and Allan's Structures Class Environmental Assessment

Hydraulic Analysis

Technical Memorandum

Draft

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1.0 INTRODUCTION

R.V. Anderson Associates Limited (RVA) has been retained by the City of Guelph (City) to complete a Schedule B Class Environmental Assessment (Class EA) for the Macdonell Bridge, Allan's Dam Bridge, and Allan's Dam Sluiceway Structures crossing the Speed River. As a component of the hydraulic analysis, a review of the existing hydraulic conditions of each structure within the study was undertaken. The purpose of this Technical Memorandum is to document the preliminary existing hydraulic conditions of the three structures which will be used to identify potential impacts associated with the implementation of the Phase 2 Class EA alternatives. This memo will also identify data gaps and additional hydraulic assessments to support future design phases for the preferred alternatives.

2.0 STUDY AREA

The Macdonell and Allan's structures are located within the City of Guelph downtown area in southwest Ontario. As shown in Figure 1, the study area is bounded by the Guelph Junction Railway (GJR) tracks to the south, Arthur/Elizabeth Streets to the East, Woolwich/Wellington Streets to the west. The subject structures are located on the Speed River within the Grand River Watershed.

Macdonell Street is an urban arterial road (as defined by the City), with a daily traffic volume of 17,000 AADT and the bridge has a span greater than 6 meters. Based on the requirements of the Ministry of Transportation (MTO) Drainage Design Manual, this bridge would be required to convey a 100 year storm with a 0.5 meter freeboard.

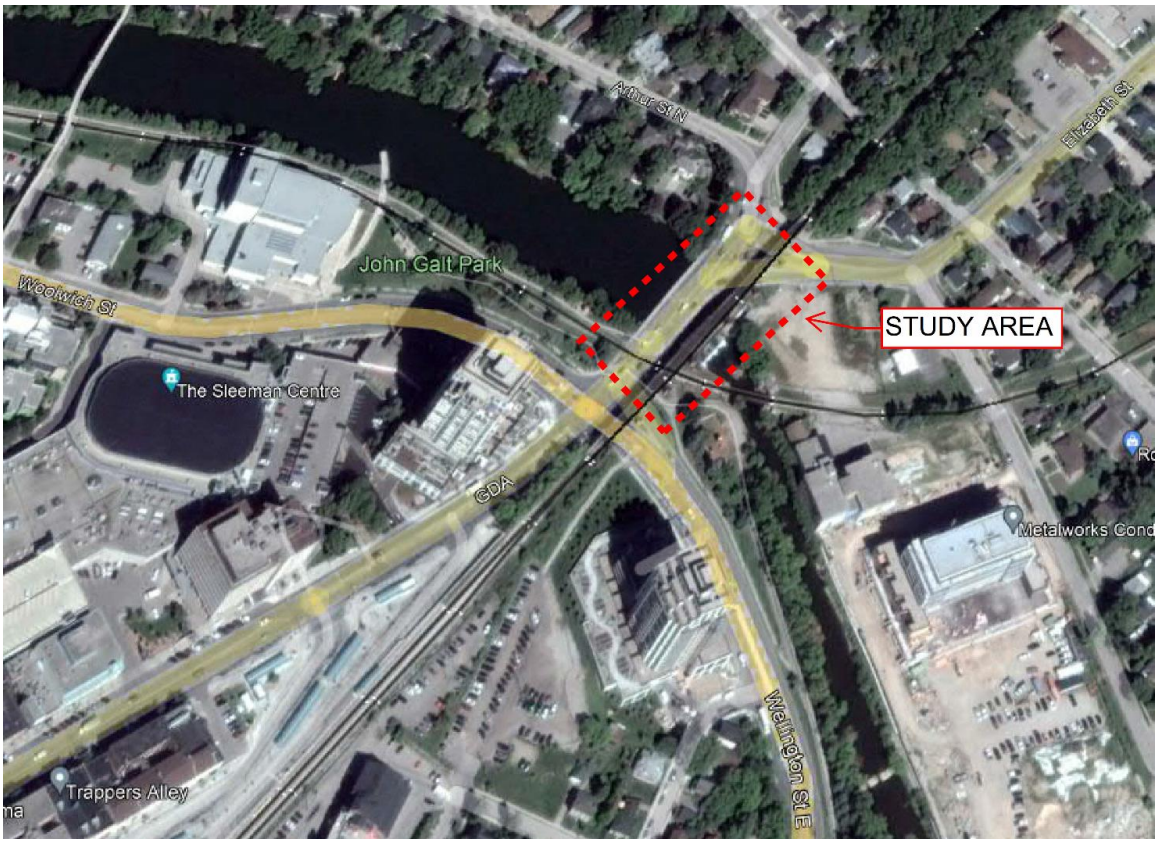


Figure 1 - Study Area

3.0 DATA COLLECTION

To date RVA has received the following data and hydraulic models relevant to the study:

- Pedestrian Bridge over the Speed River: Ward to Downtown, Fluvial Geomorphic Assessment, Ecosystem Recovery Inc., April 2017
- City of Guelph, Speed River Reach HEC RAS model, provided by Grand River Conservation Authority
- OSIM Inspection Form for Allan's Dam Sluiceway, 2018, Allan's Dam Bridge, 2017 and Allan's Dam Sluiceway, 2018
- Bridge Check Canada detailed Condition Survey Reports for all structures, 2021
- Sluiceway Operations summary provided by City of Guelph Public Works Staff via email on February 17, 2022.

- Flows representing those regulated by the Guelph Dam were provided by GRCA via e-mail on March 29, 2022.

In addition to the above noted information, RVA completed an onsite inspection on June 16, 2021, and documented the conditions and dimensions outlined in the pictures and sketch below:

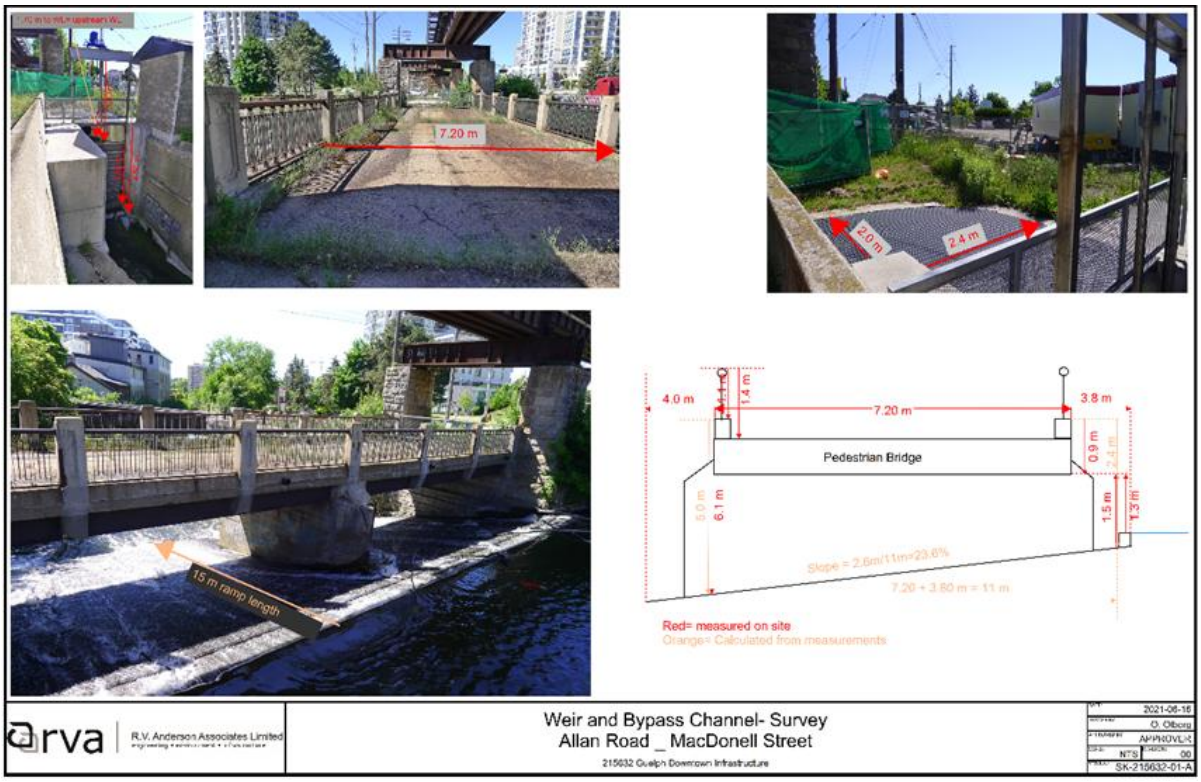


Figure 2 – Allan's Dam Bridge and Sluiceway Field Measurements

4.0 EXISTING HYDRAULIC CONDITIONS

Utilizing the existing HEC-RAS model provided to RVA by the GRCA (data received March 2022), the following key notes representing the existing Macdonell Bridge and Allan's Dam / Sluiceway hydraulic conditions:

- Figure 3 through Figure 5 are the HEC-RAS model Cross-sections and Profile view output which demonstrate that the Macdonell Bridge can only convey flows generated by 2-year and 5-year storm events, and flows greater than 5-year storm event including Regional flow will overtop the bridge.
- Allan's Dam Bridge can convey flows up to 100-year storm event, but the Regional flood will overtop the crossing.
- The spillway / dam is not modeled as a separate control structure. Instead, both dam and spillway are modeled per the station-elevation geometry (simple ground cross-section type).
- The weir gate, installed in the sluiceway in 2012 is operated by City of Guelph operations staff. The gate is generally opened in late November and closed in early April, is not opened prior to major storms, and is also opened occasionally to remove built up debris. It is noted that the City has received requests from the River Run Centre to keep the gate closed.
- There are discrepancies between the structural reports, our field measurements, and the model regarding structures sizes and cross-sections, e.g., Macdonell Bridge is a two-span bridge with 18.6m and 24.4m openings, and the total span length is 43m vs. 35m span size with equal openings in the model. Allan's Dam Bridge span is 24.7m vs. 23.8m in the model.
- The spillway slope is not consistent throughout the chute section, our field measurements show a slope of 23.6%, but it's modeled as a 52.5% slope chute. The downstream cross-section of the spillway is at the same level as the chute, while it needs to be lower and should not include the pier geometry.

In Figure 3, the line types denoted in the legend represent the water surface elevation for various return period events for unregulated flows as well as for Regional storm flows, which are labelled as "Reg."

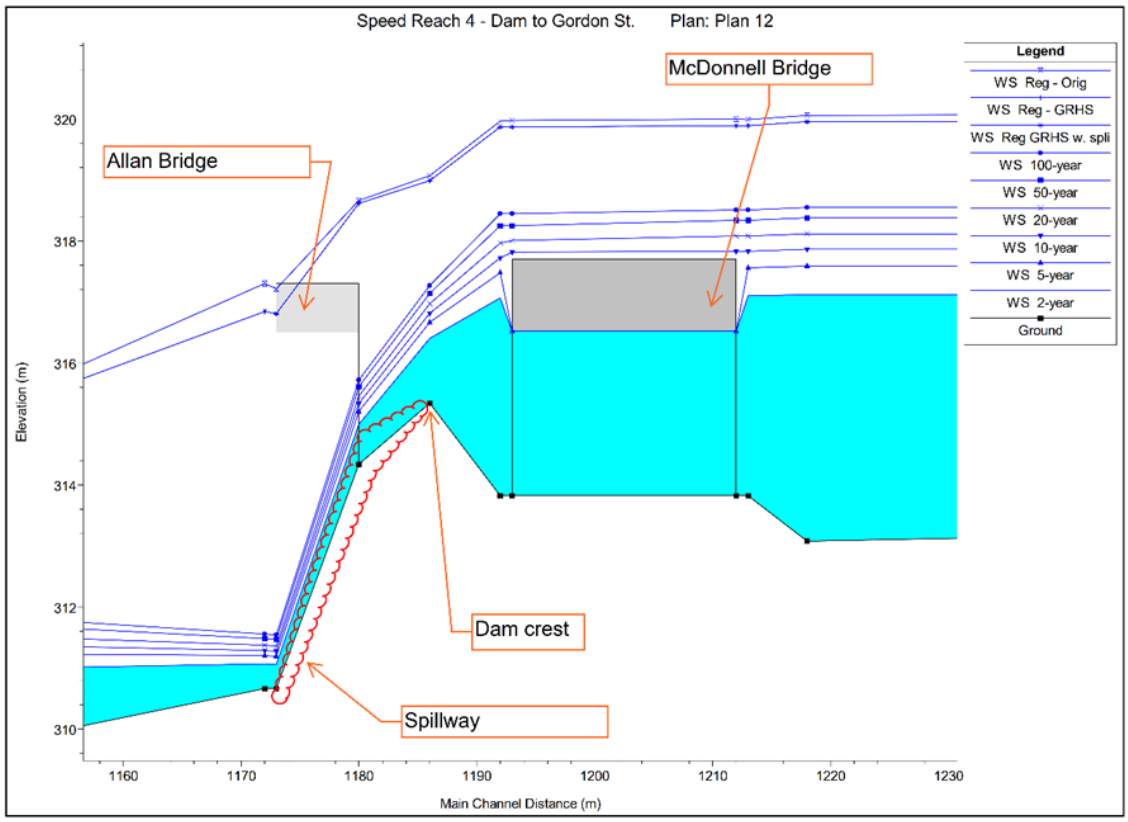


Figure 3 - Macdonell, Allan's Dam Bridge, and Spillway HEC-RAS Profile View

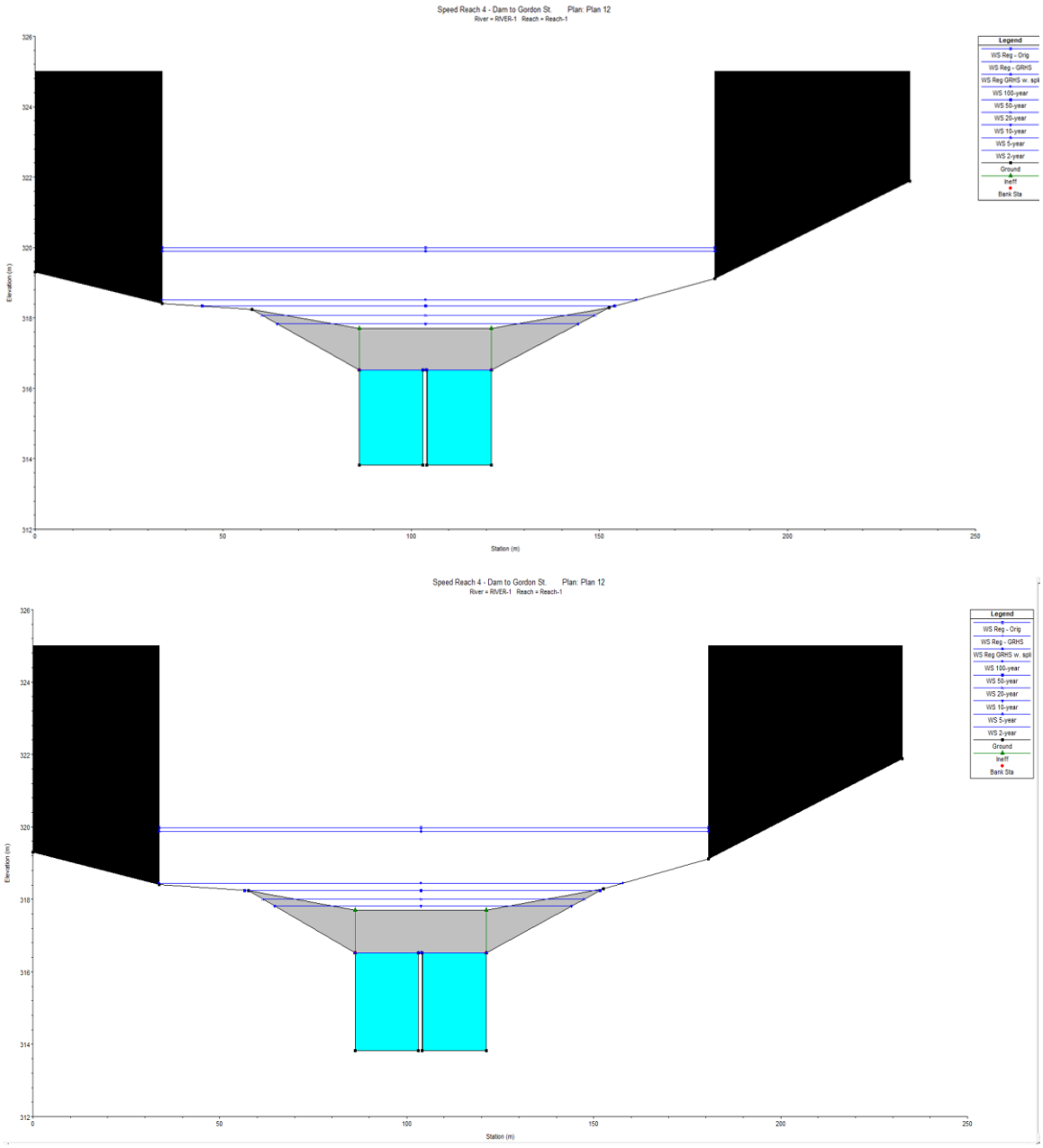


Figure 4 - Macdonell Bridge U/S and D/S Cross-sections

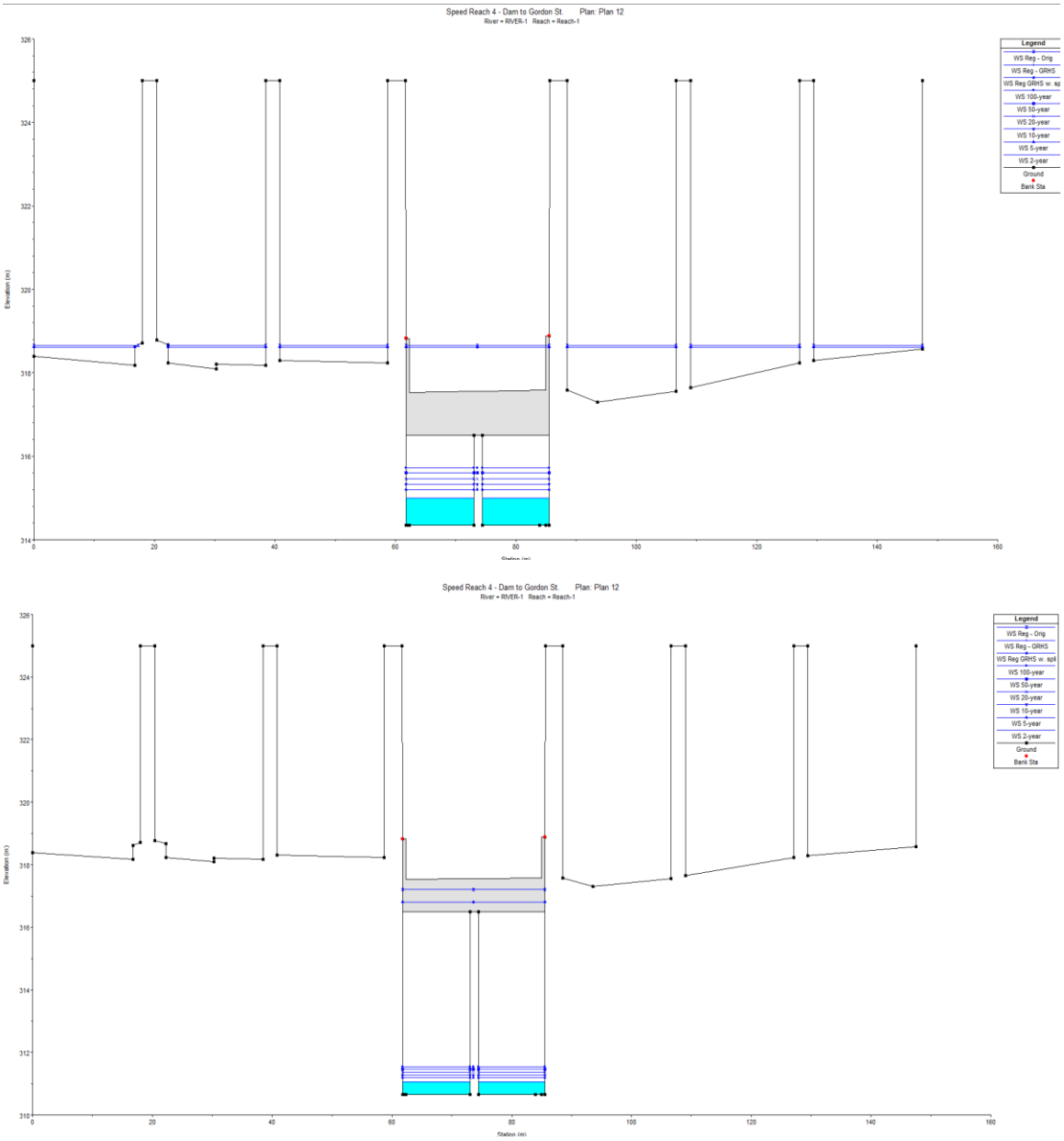


Figure 5 – Allan's Dam Bridge U/S and D/S cross-sections

5.0 MODIFICATIONS TO THE HYDRAULIC MODEL

As mentioned in the previous section, the existing HEC-RAS model geometry needs to be refined to better evaluate the hydraulic conditions of the current and proposed alternative options. The following basic modifications were made to the model and the revised results are illustrated on Figure 6 (refer to Attachment A for updated section views).

- Macdonell Bridge total U/S and D/S span length has been modified to 43m and 30m, respectively.
- Cross-section 24271 (Allan's Dam crest), bottom elevation was reduced by 1 m, and an inline weir structure was added to the model to represent the control structure at the previous crest elevation. The width of the weir was assumed to be 0.3m.
- The downstream reach length for Cross-section 24271 has been reduced to 3.8m as per the field measurements.
- Cross-section 24258 (Allan's Bridge D/S), bottom elevation was raised by 2 m to reflect the spillway slope of 23.6%.
- Cross-section 24257 (end of spillway), bottom elevation was refined to reflect the spillway slope of 23.6%. The pier section has been removed from the cross-section.
- Cross-section 24256 has been added to the model to represent the geometry of the plunge pool at the toe of the spillway.
- The regulated flows provided by GRCA were input into the model. It should be noted that only one value was provided for the entire river, while the current HEC-RAS model has up to 4 locations where flows change longitudinally through the length of the river. The water level surfaces for regulated flows are denoted as "WS Reg" in the Figure 6 legend. Water level surfaces for unregulated flows are denoted as "WS Dereg."

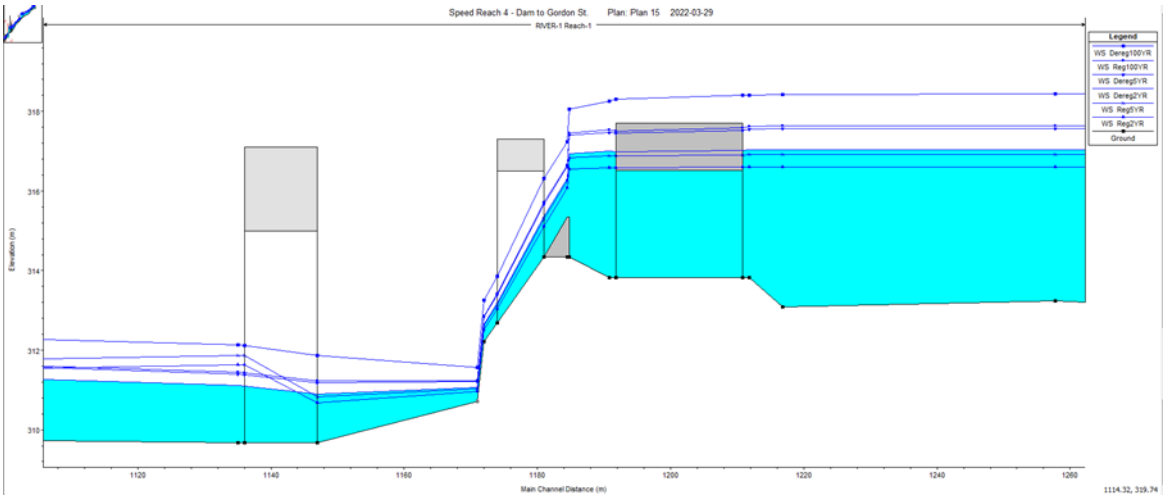


Figure 6 - Macdonell, Allan's Dam Bridge, and Spillway HEC-RAS Revised Profile View

6.0 CONCLUSIONS AND NEXT STEPS

The findings of the Hydraulic Analysis for the Existing Conditions Scenario as outlined in this memo were used to evaluate the relative hydraulic impacts associated with implementing each of the Alternative Solutions (Phase 2 EA). From the Class EA assessment of alternatives, the following combination of Alternative Solutions is recommended to be implemented:

- Replace the entire Macdonell Bridge with a wider bridge to accommodate active transportation facilities,
- Remove the Allan's Bridge, and
- Rehabilitate the Allan's Dam Spillway & Sluiceway.

As shown on the revised hydraulic profile in Figure 6, the model is still indicating that the Macdonell Bridge is overtopping during deregulated flows for storms above the five-year return period. For regulated conditions, flows from the 2 to 100 years return period leave no freeboard to the deck of the bridge, but do not overtop it. Based on this model, the Macdonell Bridge does not meet the MTO Drainage Design Manual hydraulic requirements of conveying the 100-year storm with a 0.5-meter freeboard. However, based on discussions with the GRCA and City staff, there is no recent evidence of the Macdonell Bridge coming close to overtopping. This suggests that additional updates to the GRCA model will be required to support the bridge replacement in future design phases.

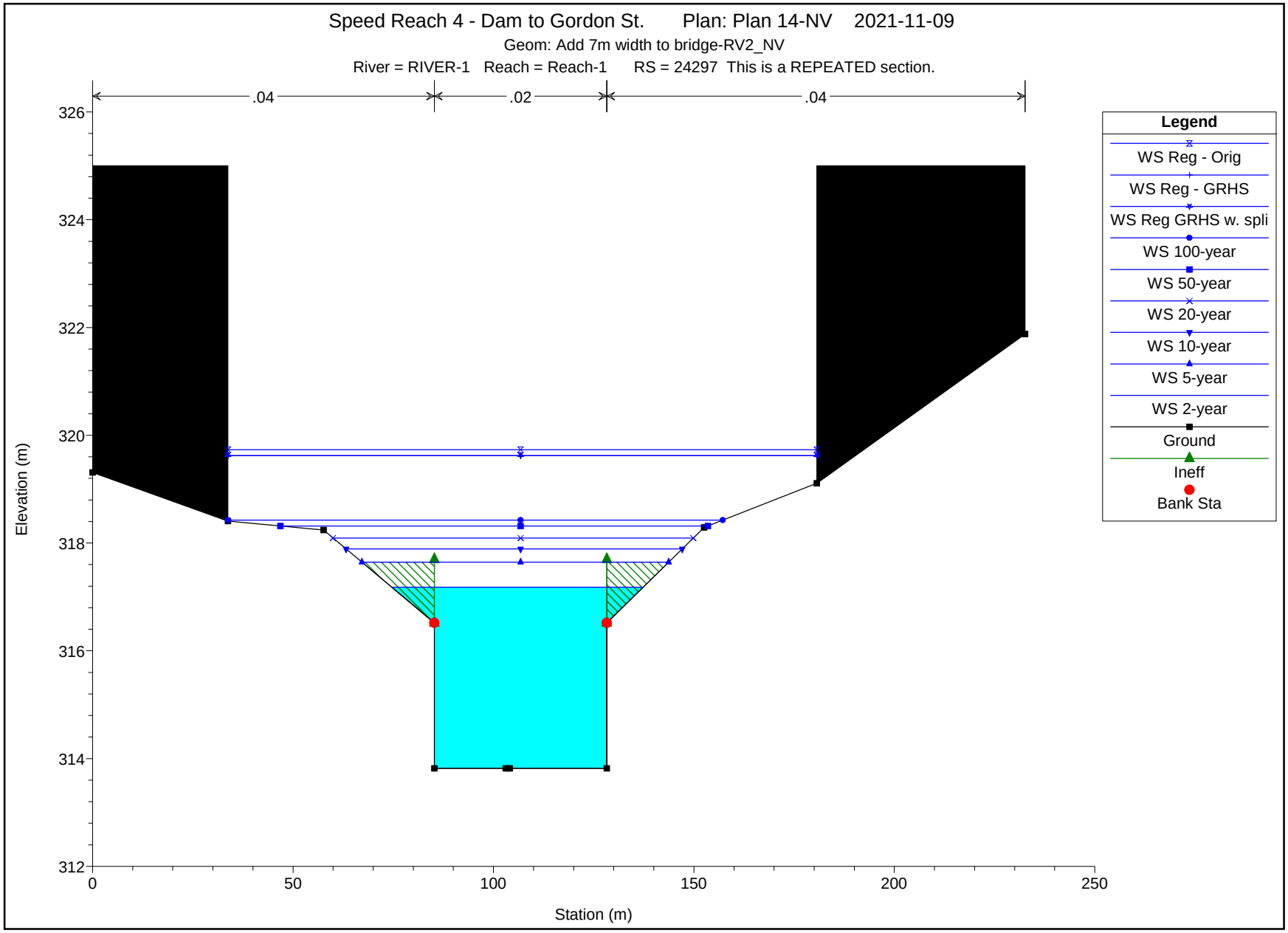
The Allan's Bridge does not appear to function as a hydraulic control (per Figure 6). As such, there are no anticipated hydraulic impacts associated with the removal of the Allan's Bridge based on the updated study model. Furthermore, as the Allan's Dam Sluiceway / Spillway is not currently modelled as a separate control structure within GRCA's HEC-RAS Model, the hydraulic function of the dam on the Speed River cannot be quantified at this time. However, as the preferred solution is to maintain the dam/spillway, there are no quantifiable hydraulic impacts relative to existing conditions. Furthermore, as the dam structure has a large influence on the elevation of the Speed River, upstream and downstream, it is reasonable to assume that removal of the structure would result in significant impacts to the water level elevation of the Speed River upstream and likely come with significant public scrutiny.

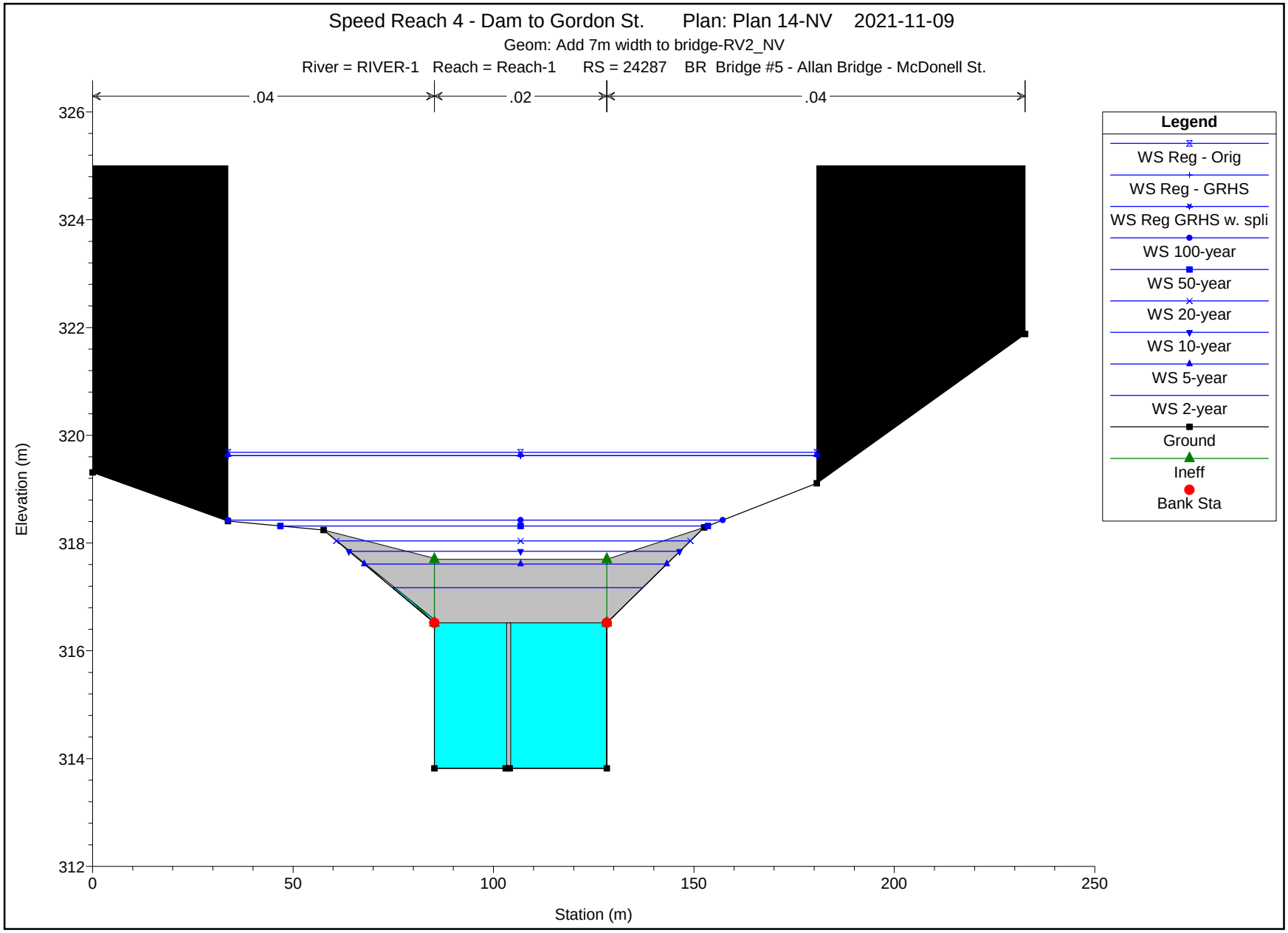
Through ongoing discussions with the GRCA, they have indicated that a more thorough modelling exercise is underway to update the HEC-RAS model for this stretch of the Speed River, however, an updated model was not made available during the preparation of this study. While the existing model has been used to compare the relative impacts of alternative solutions, the precise hydraulic impacts and/or improvements should be determined in future design phases using the updated GRCA hydraulic model. This includes:

- Potential hydraulic impacts associated with the dam/spillway removal; and
- Potential hydraulic risks and design requirements for the proposed Macdonell Bridge structure replacement.

Attachment A

Revised HEC-RAS Section Output


Speed Reach 4 - Dam to Gordon St. Plan: Plan 14-NV 2021-11-09
Geom: Add 7m width to bridge-RV2_NV
River = RIVER-1 Reach = Reach-1 RS = 24297 This is a REPEATED section.
.04
.02
.04
326
324
322
320
318
316
314
312
Elevation (m)
0
50
100
150
200
250
Station (m)
Legend
WS Reg - Orig
WS Reg - GRHS
WS Reg GRHS w. spli
WS 100-year
WS 50-year
WS 20-year
WS 10-year
WS 5-year
WS 2-year
Ground
Ineff
Bank Sta


Speed Reach 4 - Dam to Gordon St. Plan: Plan 14-NV 2021-11-09
Geom: Add 7m width to bridge-RV2_NV
River = RIVER-1 Reach = Reach-1 RS = 24287 BR Bridge #5 - Allan Bridge - McDonell St.
.04
.02
.04
Elevation (m)
326
324
322
320
318
316
314
312
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50
100
150
200
250
Station (m)
Legend
WS Reg - Orig
WS Reg - GRHS
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WS 100-year
WS 50-year
WS 20-year
WS 10-year
WS 5-year
WS 2-year
Ground
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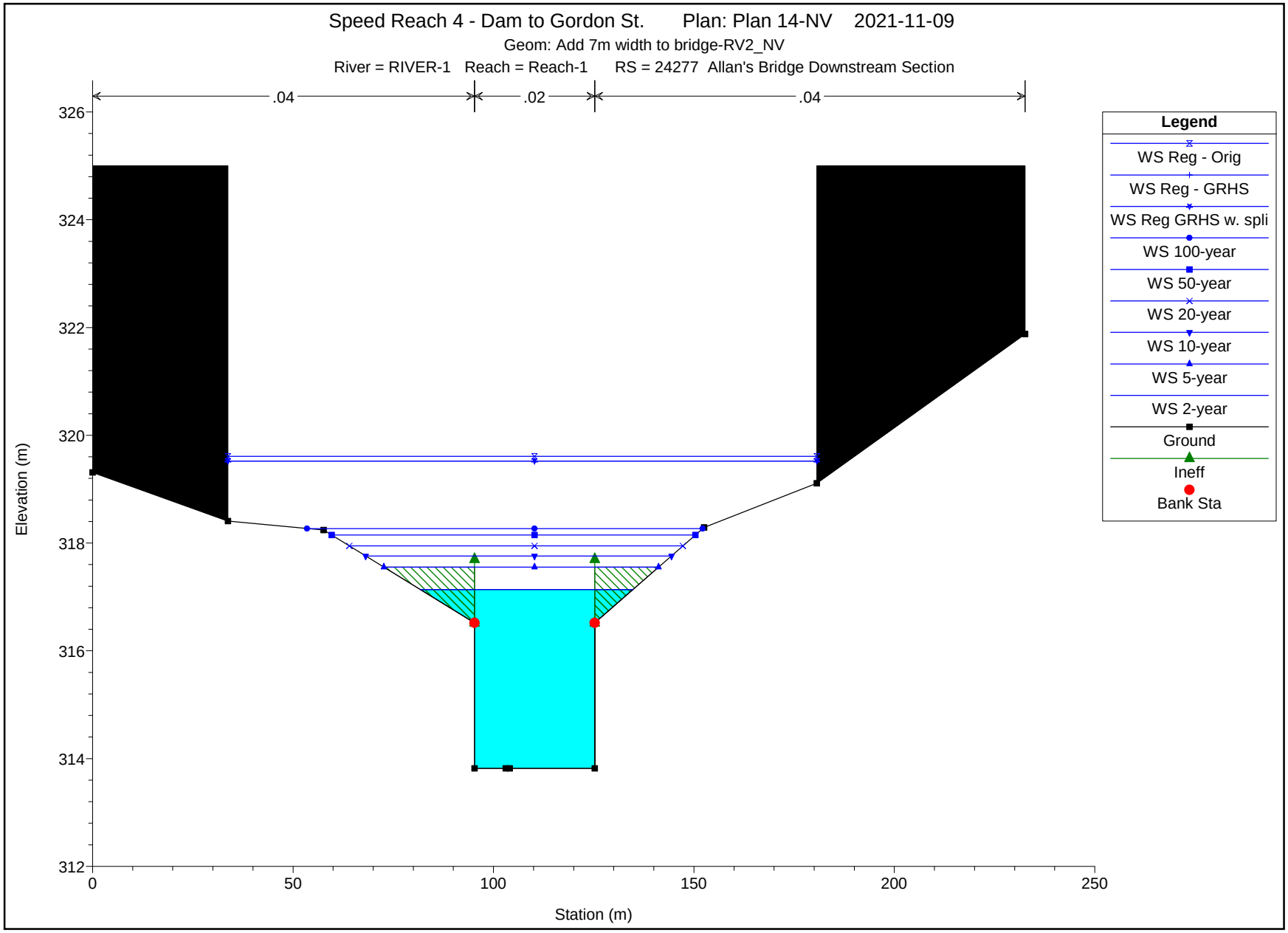
Speed Reach 4 - Dam to Gordon St. Plan: Plan 14-NV 2021-11-09
Geom: Add 7m width to bridge-RV2_NV
River = RIVER-1 Reach = Reach-1 RS = 24277 Allan's Bridge Downstream Section
.04
.02
.04
326
324
322
320
318
316
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312
Elevation (m)
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150
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Station (m)
Legend
WS Reg - Orig
WS Reg - GRHS
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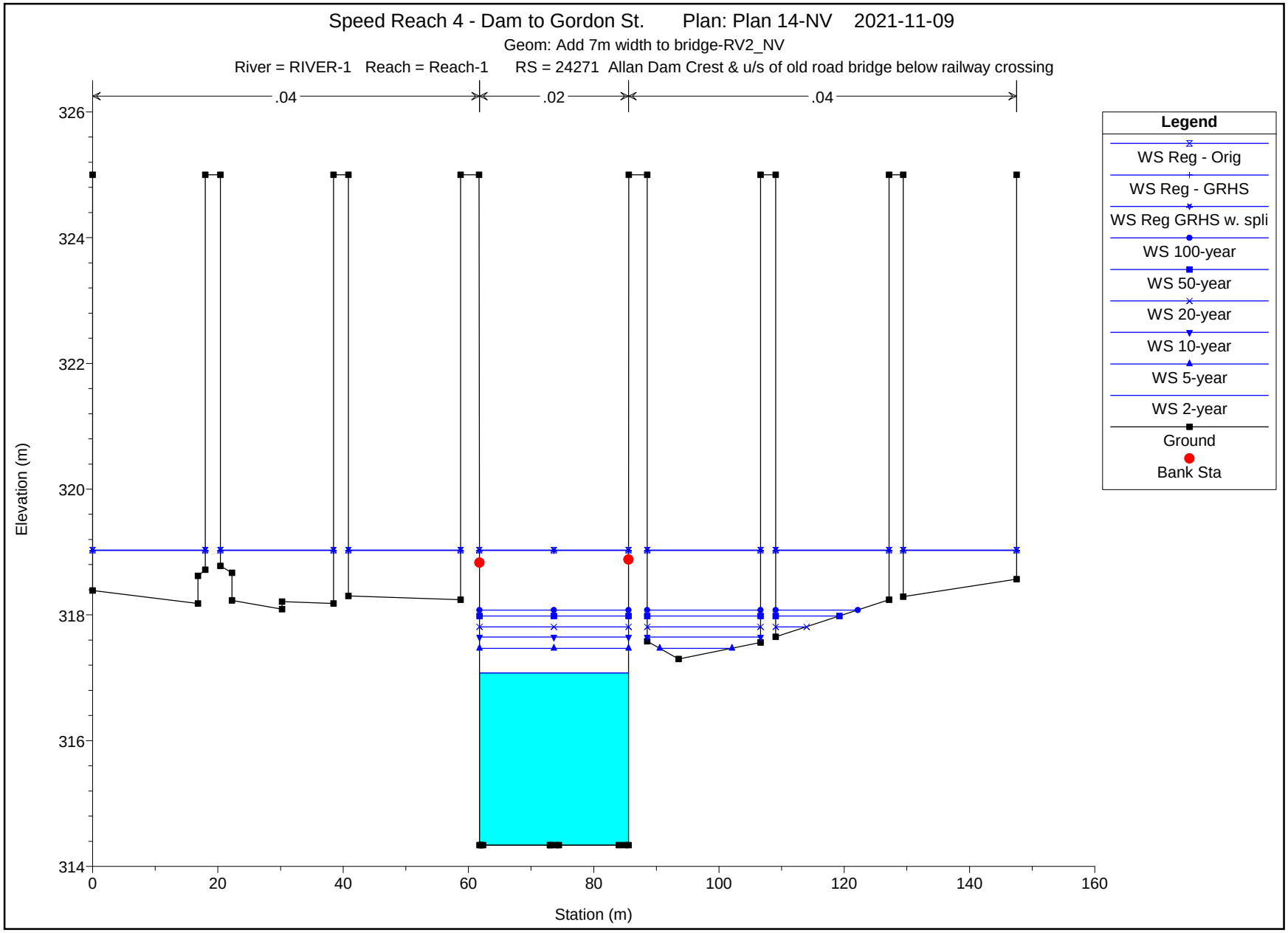
Speed Reach 4 - Dam to Gordon St. Plan: Plan 14-NV 2021-11-09
Geom: Add 7m width to bridge-RV2_NV
River = RIVER-1 Reach = Reach-1 RS = 24271 Allan Dam Crest & u/s of old road bridge below railway crossing
.04
.02
.04
Legend
WS Reg - Orig
WS Reg - GRHS
WS Reg GRHS w. spli
WS 100-year
WS 50-year
WS 20-year
WS 10-year
WS 5-year
WS 2-year
Ground
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314
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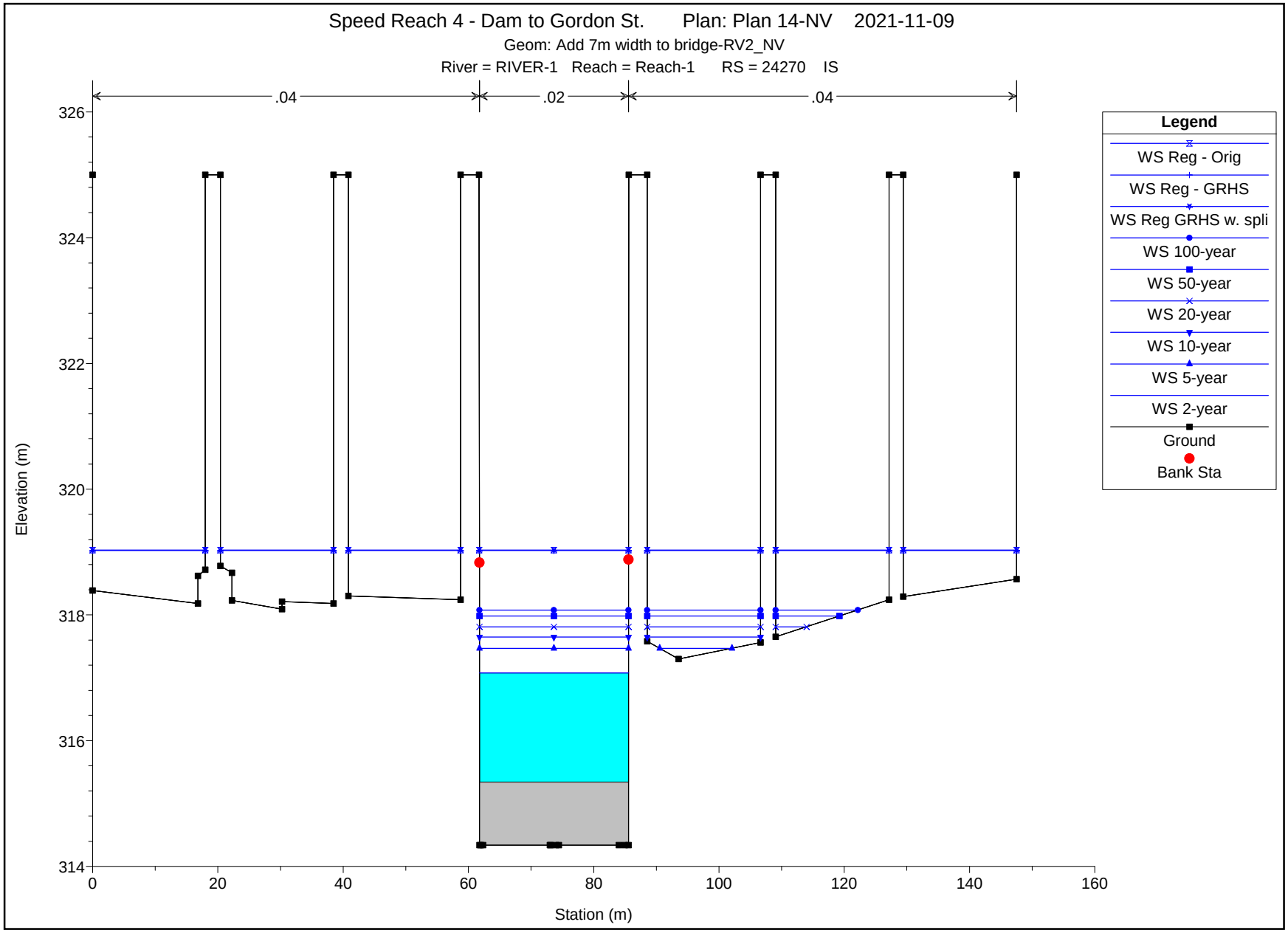
80
100
120
140
160
Station (m)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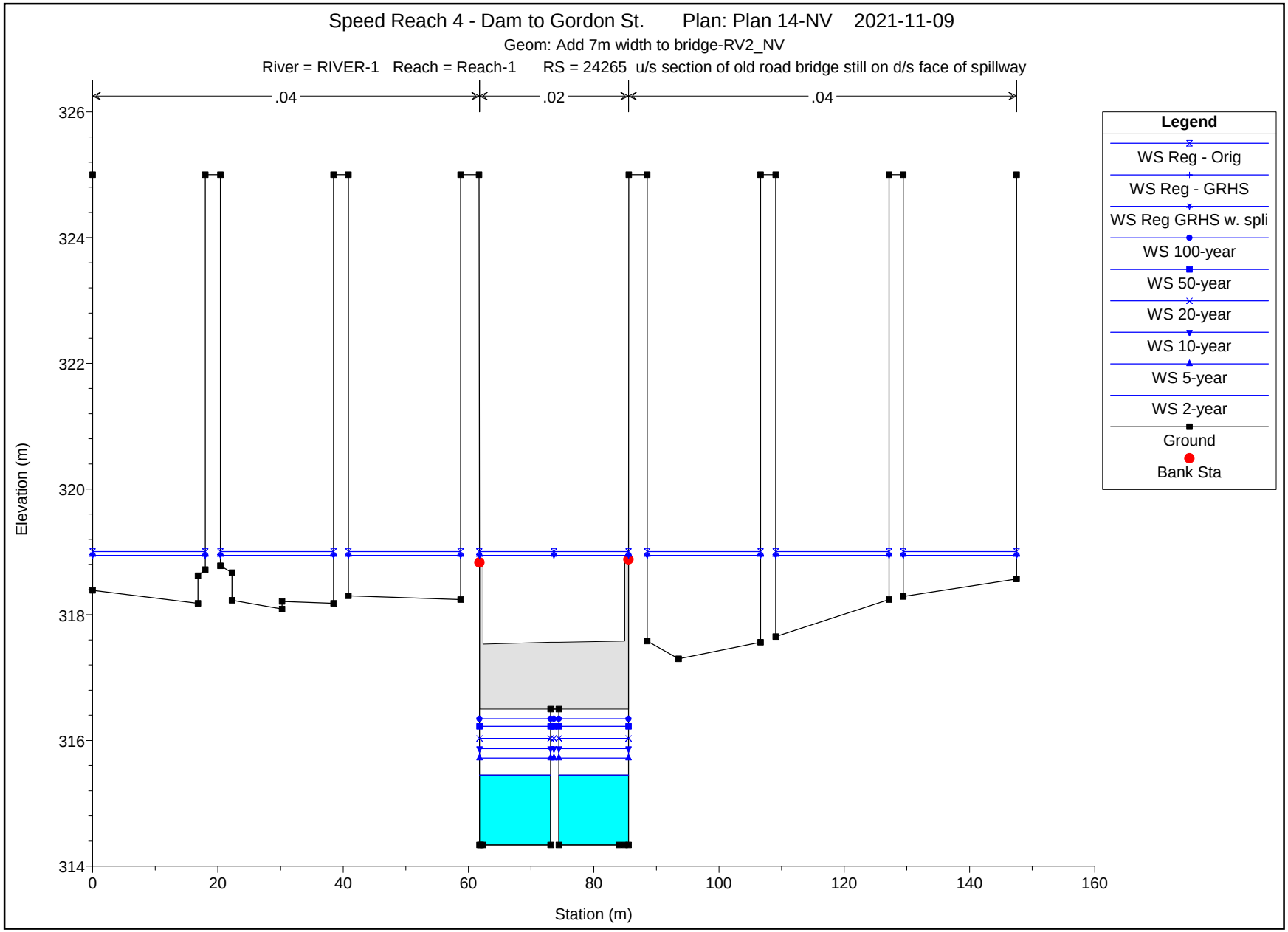
Geom: Add 7m width to bridge-RV2_NV
River = RIVER-1 Reach = Reach-1 RS = 24270 IS
.04
.02
.04
Elevation (m)
326
324
322
320
318
316
314
0
20
40
60
80
100
120
140
160
Station (m)
Legend
WS Reg - Orig
WS Reg - GRHS
WS Reg GRHS w. spli
WS 100-year
WS 50-year
WS 20-year
WS 10-year
WS 5-year
WS 2-year
Ground
Bank Sta


Speed Reach 4 - Dam to Gordon St. Plan: Plan 14-NV 2021-11-09
Geom: Add 7m width to bridge-RV2_NV
River = RIVER-1 Reach = Reach-1 RS = 24265 u/s section of old road bridge still on d/s face of spillway
.04
.02
.04
Legend
WS Reg - Orig
WS Reg - GRHS
WS Reg GRHS w. spli
WS 100-year
WS 50-year
WS 20-year
WS 10-year
WS 5-year
WS 2-year
Ground
Bank Sta
Elevation (m)
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314
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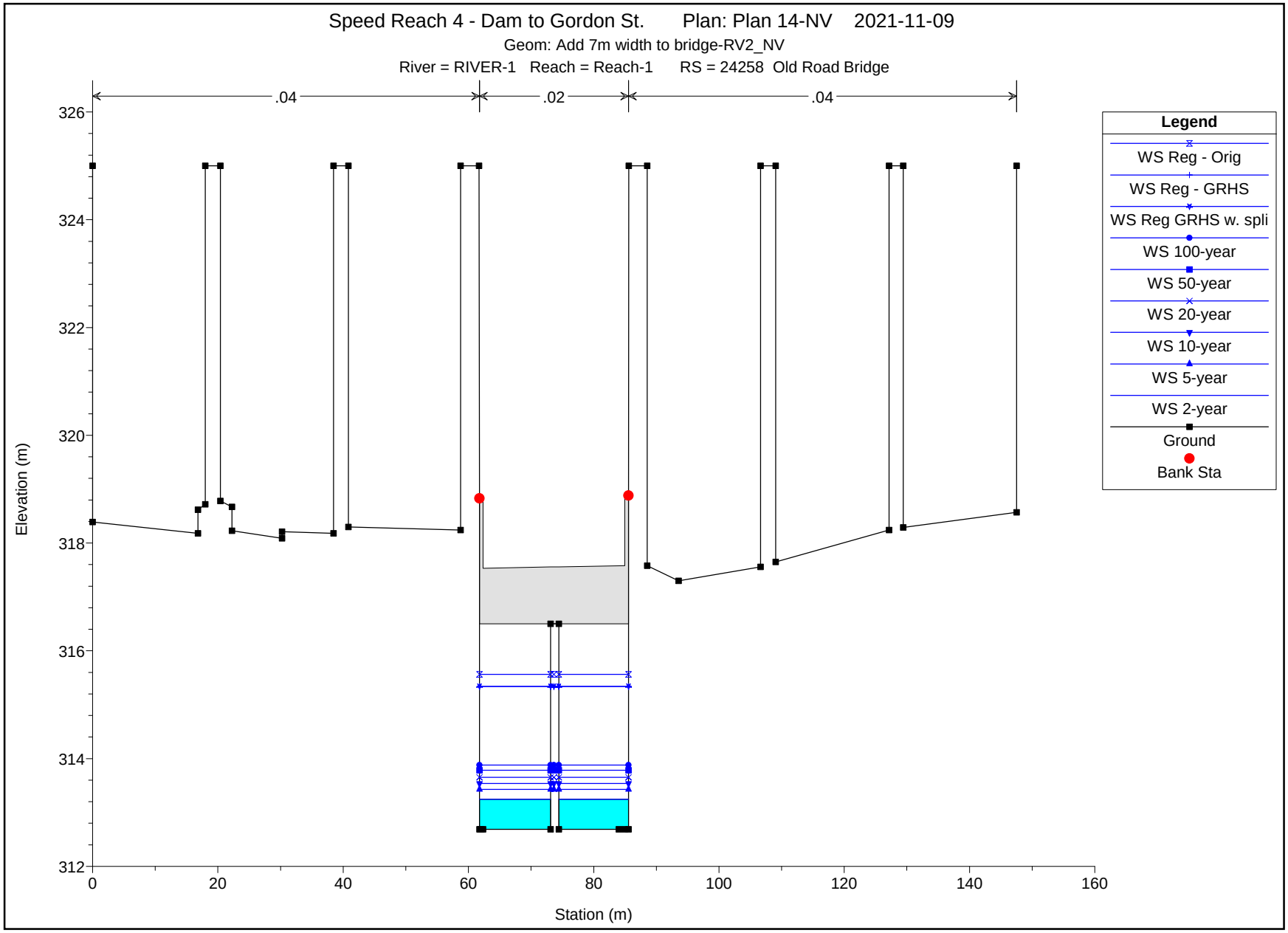
Station (m)


Speed Reach 4 - Dam to Gordon St. Plan: Plan 14-NV 2021-11-09
Geom: Add 7m width to bridge-RV2_NV
River = RIVER-1 Reach = Reach-1 RS = 24258 Old Road Bridge
.04
.02
.04
Elevation (m)
326
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160
Station (m)
Legend
WS Reg - Orig
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WS 50-year
WS 20-year
WS 10-year
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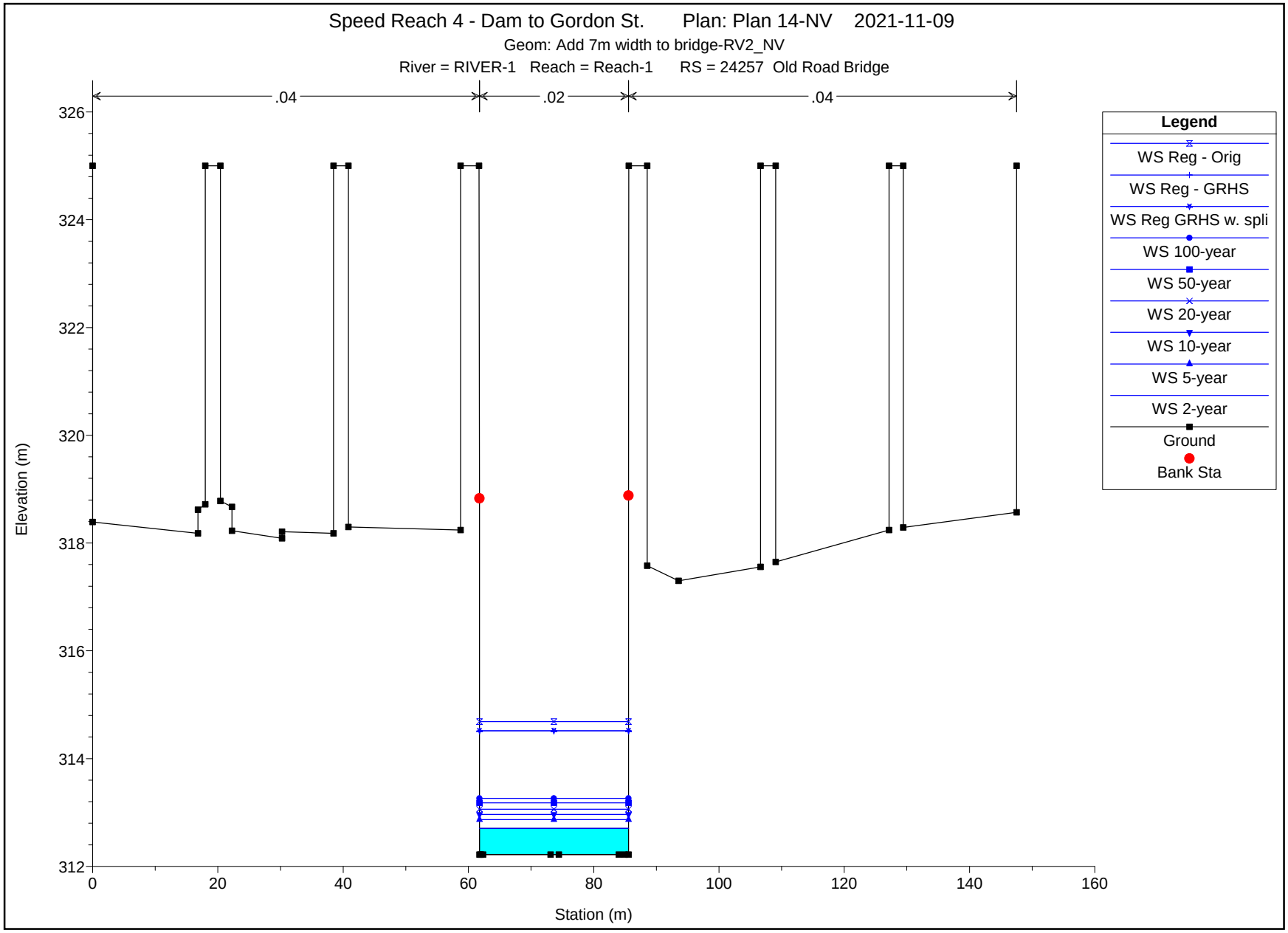
WS 2-year
Ground
Bank Sta


Speed Reach 4 - Dam to Gordon St. Plan: Plan 14-NV 2021-11-09
Geom: Add 7m width to bridge-RV2_NV
River = RIVER-1 Reach = Reach-1 RS = 24257 Old Road Bridge
.04
.02
.04
Elevation (m)
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Station (m)
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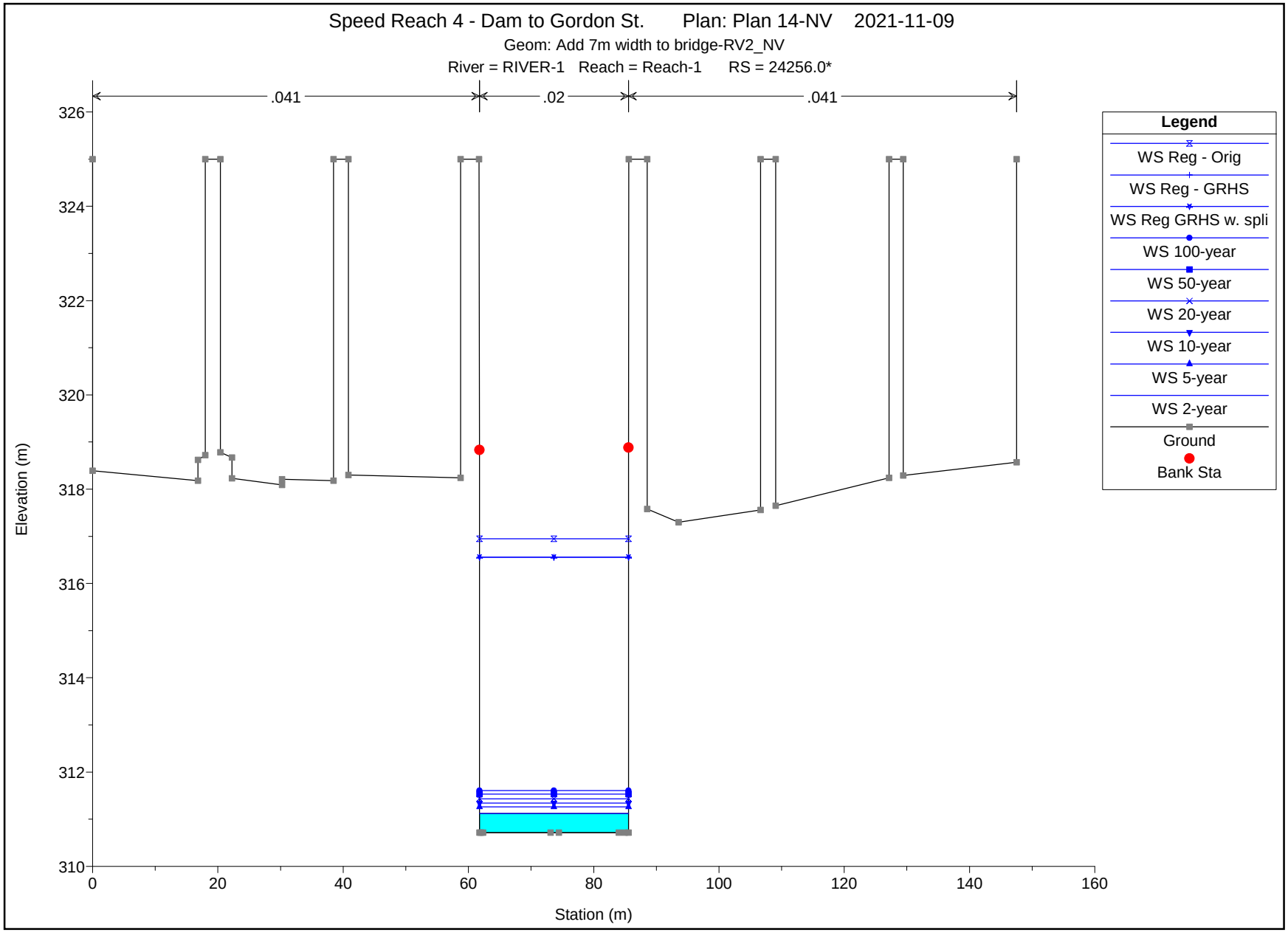
WS 50-year
WS 20-year
WS 10-year
WS 5-year
WS 2-year
Ground
Bank Sta


Speed Reach 4 - Dam to Gordon St. Plan: Plan 14-NV 2021-11-09
Geom: Add 7m width to bridge-RV2_NV
River = RIVER-1 Reach = Reach-1 RS = 24256.0*
.041
.02
.041
Elevation (m)
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Station (m)
Legend
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WS 10-year
WS 5-year
WS 2-year
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