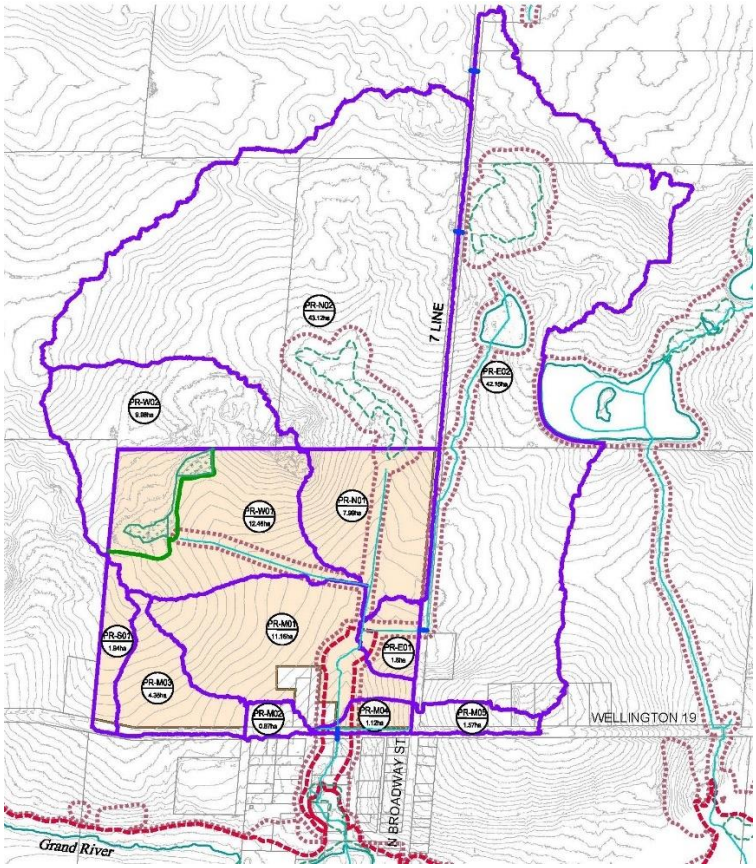
BELCAL INC

FUNCTIONAL SERVICING AND STORMWATER MANAGEMENT REPORT FOR BELCAL DEVELOPMENT

6640 SEVENTH LINE, BELWOOD, ONTARIO, LOT 12, CONCESSION 7



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6640 SEVENTH LINE, BELWOOD, ONTARIO, LOT 12, CONCESSION 7

BELCAL INC

PROJECT NO.: CA-EI-WW22011051

DATE: OCTOBER 07, 2025

WSP E&I CANADA LIMITED

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WSP.COM

QUALITY MANAGEMENT

ISSUE/REVISION	FIRST ISSUE	REVISION 1	REVISION 2	REVISION 3
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Project number	WW22011051	WW22011051	WW22011051	CA-EI-WW22011051

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1 INTRODUCTION

1.1 LOCATION AND PLAN DETAILS

The proposed residential development is located west of Seventh Line and north of Wellington Rd 19 in the community of Belwood, part of the Township of Centre Wellington (Township). The current proposal is to develop the lands into approximately 88 residential lots on private services (water and septic) through a plan of subdivision. An additional 7 lots along Seventh Line would be developed through severances.

The project would be phased\staged; details from the project planner (Stovel & Associates) are included in Appendix A. The development site is located within a catchment of a local tributary flowing through the Community of Belwood into Belwood Lake which is a controlled section of the Grand River (Shand Dam).

1.2 PURPOSE AND CONTENT OF THE REPORT

This Functional Servicing and Stormwater Management (SWM) Report has been prepared to provide details as to the proposed servicing and stormwater management works for the subject development, and specifically how these works are intended to address the governing criteria of the Township, Wellington, County, Grand River Conservation Authority (GRCA) and the Province of Ontario. This report is intended to support the review of the application by the Township and GRCA (and potentially Wellington County).

The report presents an overview of relevant references and information, a summary of existing conditions, and provides details of the assessment of the proposed development and the proposed overall servicing, grading, and stormwater management strategy for the site.

1.3 SUPPORTING REPORTS/STUDIES AND CONTENT OVERVIEW

This report has been prepared in accordance with, and in consideration of, the information and recommendations provided in the following documents:

Standards and Guidelines:

- Development Manual, Township Centre Wellington, June 2024.
- Stormwater Management Planning and Design Manual, Ministry of Environment (MOE), March 2003.

Site Specific Studies:

- Preliminary Geotechnical Characterization, Proposed Residential Subdivision, 6640 Wellington Road 19, Belwood, Ontario (Chung & Vander Doelen Engineering Limited, September 21, 2022)
- Draft Hydrogeologic Assessment BelCal Inc. Proposed Development 6640 7th Line Belwood ON (Groundwater Science Corp, March 2023)
- Environmental Impact Study (Stovel and Associates, 2023)
- Headwater Drainage Feature Assessment Fluvial Geomorphology Components & Meander Belt Analysis, Belwood Lake Tributary Township of Centre Wellington (Aqualogic May 24, 2023)

— Preliminary Onsite Sewage Servicing Assessment Proposed Residential Development 6640 Seventh Line in the Village of Belwood, Township of Centre Wellington (Crozier Consulting Engineers, October 25, 2023 and subsequent updates)

A copy of the AquaLogic report has been included in Appendix B of this report for reference.

2 EXISTING CONDITIONS

2.1 LAND USES

The proposed development site is currently under existing conditions comprised of agricultural uses with some residential properties along Wellington Road 19. There is an existing woodlot with wetland features in the northwest part of the site, and a small wetland feature at the top end on the Main watercourse (ref. EIS, Stovel and Associates).

2.2 DRAINAGE AREAS AND TOPOGRAPHY

The Belwood Lake Tributary generally drains from north to south; it has numerous sub-branches or reaches. It has a cumulative drainage area of approximately 137 ha at Wellington Road 19. Refer to Drawing SW1 for estimated overall drainage boundaries under existing conditions.

As noted in the Stream Morphology Report (AquaLogic Report May 2023 – ref. Appendix B), the reaches all appear to be man-made drainage features, constructed to facilitate field drainage. AquaLogic set up a reach nomenclature reflecting the orientation of the various branches as follows:

- North
- West
- East
- West + North
- West + North + East (Main)

There is also another minor ditch which is man-made which flows from the west along the north side of a small woodlot to reach West + North + East, through a small culvert.

2.3 SOILS AND GROUNDWATER

Groundwater Science Corp (GWS) prepared a Hydrogeologic Assessment for the subject development site (March 2023). The purpose of the Hydrogeologic study was to characterize the Site using existing information sources, complemented by site-specific field investigation in order assess the feasibility of the proposed use of on-site sewage systems and private water supply wells to service the development.

The study was conducted such that it addressed the Ontario Ministry of the Environment, Conservation and Parks Procedure D-5-4: Technical Guideline for Individual On-Site Sewage Systems: Water Quality Impact Risk Assessment (August 1996); and Procedure D-5-5: Technical Guideline for Private Wells: Water Supply Assessment (August 1996).

The Study provides overall site characterization (i.e., high water table conditions) and impact analysis (e.g. water balance) to support the site design including grading and SWM. Key findings include:

- No Well Head Protection Area (WHPA) or Intake Protection Zone (IPZ) identified at the site or in the vicinity of the proposed development.
- The ice-contact sand/gravel deposit area is part of a Significant Groundwater Recharge area, however, given the presence of till at surface or (generally) near surface, actual recharge contribution to regional groundwater flow systems (i.e. that would potentially support municipal water taking) is marginal.
- The site is identified within an area of low intrinsic groundwater vulnerability, and the site is also not within any identified Wellhead Water Quantity Zone.
- The high-water table condition measured at the site occurred in March 2022. A low water table condition at the site was observed in October/November 2022. The high-water table as defined in the GWS report should be used to plan the subdivision design.
- The sand and gravel at surface will likely result in locally enhanced infiltration, however, the sand and gravel deposit is relatively "thin" over most of the site.
- The nearby wetland areas likely contribute to the infiltration and availability of water in the shallow zone.
- The underlying till unit will limit deeper infiltration and regional/local groundwater recharge. The upper till unit is likely weathered/fractured such that some horizontal flow would occur, in both the sand/gravel unit and upper till layer. In the overall area, including the site, this shallow horizontal flow could reach the local channel system and/or any tile drains where they occur.

A Water balance analysis was completed by GWS for existing site conditions to characterize targets for stormwater management LID source controls implementation. The assessments examined average annual conditions and were developed according to standard water balance input/output methodology. Monthly actual evapotranspiration (AET) estimates were calculated for the sand/gravel and till surficial soils and site setting (hilly landscape, primarily agricultural land cover).

- The AET estimates were developed according to a Soil Moisture Retention (SMR) value of 75 mm for the sand/gravel deposit (moderately deep-rooted crops on fine sand soil), and 200 mm for the till soils (moderately deep-rooted crops on silt loam).
- Annual average precipitation is estimated to be 945.9 mm/yr. The AET on sand/gravel and till soil types is estimated to be 551.29 mm/yr and 571.29 mm/yr respectively. The difference between precipitation falling on the assessment area (direct input) and evaporation/evapotranspiration (direct initial output) is termed the water "surplus".
- The site is generally open hilly lands in which it is assumed that natural runoff could occur. Surficial sand/gravel deposits areas of the site have open sandy loam type soils and can be considered "cultivated". Therefore, an IF of 0.6 (60%) is estimated. The remainder of the surplus (40%) in this area can become runoff. Similarly, the surficial till soils (cultivated medium clay + loam) have an estimated IF value of 0.4 (40%) and runoff of 0.6 (60%). The site is approximately 38.6 ha, of which approximately 19.8 ha (51%) is estimated to have sand/gravel at surface and 18.8 ha (49%) is estimated to have till soils at surface. Under existing conditions average on-site annual recharge is therefore estimated to occur at a rate of 0.195 m/yr.
- It is expected that in order to adddress water balance requirements within the proposed development area, clean (roof and open land) runoff will be directed to LID lot level and/or conveyance control measures. In addition, end-of-pipe infiltration measures can also be considered.

2.4 ENVIRONMENTAL FEATURES

As noted, there are a few environmental features which need to be considered as part of the overall site development in terms of avoidance and protection as well as sustainability. Details on the various features and their significance and preferred management practices are in the Environmental Impact Study (EIS) which has been used in the preparation of the proposed SWM Plan to guide grading and water management activities.

Some key relevant details from the EIS include the following:

- The Environmental Impact Study (EIS) (Stovel and Associates (2023)) identified the natural heritage features located on and *adjacent* to the subject property and conducted an assessment to demonstrate that there will be no negative impacts on the natural features or on the ecological functions based on the proposed development and associated mitigation/management recommendations.
- The EIS involved field studies which included: botanical inventories, wildlife inventories, and vegetation community mapping, completed in May to August 2022.
- The subject lands are primarily disturbed and/or used for agricultural purposes, with over two decades of cultivation for common field crop production. There are no natural or semi-natural vegetation communities located within the area proposed to be developed.
- The field investigations and vegetation community mapping focused on natural heritage features located adjacent to the proposed development area. Vegetation communities adjacent to the site were described using the Ecological Land Classification ("ELC") System. Vegetation community boundaries were established on an aerial photo-mosaic base map and field checked.
- The wetland limits and driplines of the adjacent deciduous forests were flagged and surveyed (where possible). Staff from the Grand River Conservation Authority ("GRCA") confirmed the wetland limits onsite. The surveyed wetland limits and driplines of adjacent deciduous forests are shown on the Vegetation Communities map and Development Concept in the EIS.

The EIS defined a series of environmental constraints and opportunities including:

- Northwest Woodlot (FODM5)
- Wetland (SWM3-1)
- Wetland (SWT/SWD)
- Northern Onsite Plantation (WOCM1)
- Southeastern Onsite Plantation
- Onsite drainage features

The environmental constraints for the subject area are primarily associated with the woodland/wetland feature located northwest of the site. The proposed development does not encroach into any existing natural or semi-natural environmental systems. A portion of the coniferous plantation in the northern portion of the site, i.e., WOCM1, is proposed to be removed as part of the proposed development. To offset this impact, it is proposed that the northerly property limit (specifically the 7.5 m rear yard setback of the proposed residential lots in this portion of the site) be replanted with native trees and shrubs.

In summary, the ecological recommendations for the proposed development include:

- No development in existing forest/wetland community located in the northwest portion of the site.
- 30 m setback from Wetland SWM3-1.

- 15 m setback from adjacent wetland SWT/SWD in the northwest portion of the site. The wetland in this area is demarcated by an existing agricultural drain that has been excavated along the edge of the wetland.
- 15 m setback from the wetland (SWT/SWD) in the northeast portion of the site. This wetland is in a highly disturbed portion of the site and a drain has been excavated through the middle of the wetland community.
- Removal of 0.2 ha of former plantation (WOCM1) in the north-central portion of the site. To offset the loss of these trees, ecological enhancements and tree-plantings are proposed.
- Maintenance of a 7.5 m setback from the dripline of adjacent woodlands.
- Ecological enhancements adjacent to natural/semi-natural woodlands.
- Rear yard setbacks of 7.5 m in the proposed residential zoning for the subdivision. In areas next to natural heritage features, this 7.5 m rear yard setback would be planted with native trees and shrubs.
- Maintenance of existing plantations in the southern portion of the site. The proposed lot fabric has been established to use these existing plantations as part of the rear yard setback/planting zone and/or used as part of the proposed onsite open space system.
- Public awareness education, and
- Erosion and sedimentation control per Township Standards.

Specific to water management (surface and ground), the EIS acknowledges that the proposed SWM Plan will address the following impacts:

- Disruption of Surface Water Flow to the Wetland Areas. The proposed stormwater design and associated grading plan proposed for the development largely replicate the existing drainage patterns, hence impacts to the wetland areas will be mitigated from a quantity and quality perspective through the use of distributed source controls where feasible and water quality treatment train measures in accordance with Provincial requirements.
- Surface Water Storage and Conveyance The proposed stormwater management plan includes end of pipe SWM facilities to manage quantity and quality control. LID measures are generally limited as discussed in the SWM report. Rooftop downspouts should discharged to grassed areas to promote infiltration. No significant impacts are anticipated on the existing surface water storage and conveyance functions on the site.
- Ground Water Recharge and Discharge. The ground water recharge functions of the site will be preserved and maintained to the extent feasible, given limited opportunities for LID given Township direction. Rooftop areas\roof leaders should discharge to pervious\grassed areas to promote infiltration.. The discharge function is largely limited to the wetland and near wetland areas, and no impact on wetland systems or functions is anticipated with the proposed SWM plan in place.

2.5 WATERCOURSES AND HDFS

AquaLogic (2023) (refer to Appendix B) concludes that none of the reaches on the proposed development site are in historically natural alignments. That said, the man-made horizontal alignments have naturalized to a degree over time. The North Reach, the West + North Reach, and the Main (West + North + East) Branch, provide the most significant function through the development area in terms of flow conveyance and corridor linkage. The West Reach has the smallest drainage area and a nominal function with limited apparent aquatic habitat significance. The East Reach has minor functional significance in the development site, as it is bisected by Seventh Line and most of its drainage area is external to the development area which does however reinforce the need to maintain corridor linkages.

AquaLogic concludes that the West Reach can potentially be enclosed by future development with appropriate stormwater management (SWM) practices to ensure no adverse impacts at the confluence with the North Reach. It is recommended that the North Reach, West + North Reach, East Reach, and Main Branch all need to be retained as open features with appropriate setbacks to adjacent future development. Specifically, AquaLogic suggests that:

"*Given the lack of natural channel planform alignments, empirically derived meander belt limits were produced for each reach. The empirical meander belt limit approach has proven to be fair and reasonable for definition of new development limits over existing altered watercourses, for use in realignment natural channel designs, and for risk assessments of existing infrastructure. Future development options and scenarios are therefore recommended to apply meander belt limits of 16m, 19m, 16m, and 25m respectively, for the North, West + North, East, and Main Branch reaches.*"

Resulting meander belt limits are presented graphically on Drawing SW2 (attached). AquaLogic also noted that:

"It is also recommended that the existing culvert crossing on the West Reach + North Reach be removed and localized channel restoration be implemented. It is also recommended that restoration works be implemented to replace the existing dam on the Main Branch with a barrier free channel profile".

3 PROPOSED CONDITIONS

3.1 LAND USE

The current plan for the development of 6640 Seventh Line Belwood, Lot 12, Concession 7 is for 88 residential lots which will generally range in size from approximately 0.2 ha to 0.4 ha. An additional 7 residential lots will be developed through severances as noted on the available plans.

The site is proposed to be accessed from both Seventh Line and Wellington Rd 19. Other proposed features of the site include the two dedicated wet pond stormwater management (SWM) facilities, and enclosed section of the former western creek tributary (to be piped within municipal road right-of-way) and Open space for parkland, as well as protected natural areas. Localized creek overbank re-grading is proposed to reduce the floodplain hazard, as described further in subsequent sections.

Refer to Drawing SW4 and other attached drawings for an overview of the proposed land uses.

3.2 WATER AND WASTEWATER SERVICING

As noted previously, the site is proposed to be serviced by private water and wastewater (i.e. septic) services. Supporting reports have been prepared by others (Crozier) to confirm the adequacy of this proposed approach.

Water services will be provided via private individual wells for each lot. Minimum separation distances from on-site septic systems will be maintained; it is generally expected that wells will be located in front yards while septic beds will be located in the rear yards.

Sanitary services will be provided by individual septic systems on each lot. Tertiary treatment is expected to be included as required. Detailed design of individual septic systems will be completed at the subsequent detailed design stage based on the specific soil conditions and development constraints of each lot.

3.3 SITE GRADING

The site boundaries are forest and agricultural land on the south, with existing residential area on Wellington Rd 19 to the east, and a mix of residential and agricultural land that borders the Seventh Line on the north, and forest area on the west.

The western portion of the Site has the highest elevations while the eastern area between the environmental protection area and intersection of Seventh Line and Wellington Rd 19 has the lowest the lowest. The existing ground elevations for the Site range from approximately 428.4m to 456.5m. Seventh Line and Wellington Rd 19 are local municipal roads that are regular asphalt roads. Existing topographic contours (0.50 m) for the Site are shown on the Site Grading Plans (attached).

As shown on the Site Grading Plans **,** the proposed development is serviced by six internal private roads. Access to the Site is provided via one driveway entrance from Welington Rd 19 on the east and two entrances on Seventh Line on the north part of the Site. The pavement design of the internal roads follows a crowned cross-section.

The proposed road grading will be designed to match into existing roads and boundary locations, comply with Township of Wellington North Municipal Servicing Standards (March 2023), direct overland flow to approved outlets, accommodate stormwater management requirements, provide sufficient cover for proposed infrastructure.

Minimizing earthworks is also an important consideration due to the site location and preservation of the existing trees on site.

Site grading will be designed to convey positive drainage and match to existing elevations along the property boundary. The proposed grading will be designed such that existing drainage patterns on Site will mostly be maintained. Internal roadways will be designed for both vehicles and active transportation. Emergency vehicles, snow removal and garbage collection will all be considered as part of the roadway geometric design.

The proposed grading for the Site will, where possible, generally follow the existing grades to maintain drainage patterns. Minor and major storm drainage (5 year to 100-year storm event) is to be captured by catch basins and swales (including side and rear yards) which conveys flows via storm sewers and overland along roadways to the two proposed SWM Ponds and ultimately to Grand River (Belwood Lake). Maximum side slopes of the swales will be 3:1 and will have minimum depth of 150 mm. The planning of the development has accounted for the high groundwater elevations on the site, and the proposed grading will elevate select low-lying areas above the groundwater levels identified in the Hydrogeologic Assessment prepared by Groundwater Science Corp (GWS), March 2023. Major storm drainage (greater than the 100-year storm event) is provided to direct drainage away from proposed and existing structures to approved outlet points. Consideration has been given to updated hazard limits for regulated features.

Roads will be designed with a minimum longitudinal grade of 0.5% and a maximum grade of 5.0 %. Lots will be designed with a minimum longitudinal grade of 1.0 % and a maximum grade of 5.0 %. Maximum slope of all embankments will be 3:1. Where grades greater than 3:1, retaining walls will be constructed.

Maximum slope of the driveways will be 6 % and the concrete sidewalks will be placed at a 2 % grade sloped towards the road with minimum thickness of 125 mm. Where new asphalt matches existing asphalt, a minimum 0.5 m lap joint will be installed. Concrete curbs and gutters will be installed as per OPSD 600.040. Subdrains will be 150 mm polyethylene BOSS 2000 with geotextile filter wrap, class 1 with filter opening size of 100-130 μm. 50 mm diameter maximum stone size for the granular backfill on subdrains. Boulevards will have minimum 200 mm topsoil and sod. All materials will be placed in layers not exceeding 300 mm lifts. Granular courses will be compacted 100 % SPDD. All granular and asphalt materials and placement will be in accordance to OPSS 310, 314 and 1010 or otherwise specified. Granular A base will be minimum 125 mm thickness and increased to match thickness of concrete at various locations. All contraction joints will be saw cut in hardened concrete within a sufficient time of placing sidewalk. Topsoil will be stripped in all cut and fill areas and stockpiled for reuse during final lot grading operations. Site specific exceptions may be applicable at the discretion of the Township.

Geotechnical testing will be completed by the soils consultant with results provided to the Township. Subgrade will be proof rolled certified by the Geotechnical Consultant and witnessed by the Township staff prior to the placing of any granular road base material.

Refer to the Site Grading Plans for supporting details (attached).

3.4 WATERCOURSES AND HDFS

Watercourse Features:

The North, West+North, East, and West+North+East (Main) watercourses (per nomenclature of AquaLogic – see Appendix B) are recommended to remain open and as such will likely be contained within properties granted to the Municipality for operations and maintenance (Note: based on Pre-consultation Township has indicated a preference to ownership as opposed to easements; however we defer to the planner and Township as to the oucomes of these discussions).

Based on the recommendations of AquaLogic, the West watercourse can either be enclosed/piped or incorporated into the roadway drainage system. Given the Township's preference for urban roadways, the west watercourse will be piped\enclosed.

The drainage from the West + North drainage feature is proposed to remain open. The proposed dimensions for these watercourse features have been established, based on a function of hydraulics, stream morphology requirements and environmental setbacks.

Some minor overbank grading improvements have been proposed for select sections of watercourse to more efficiently convey and contain the floodplain hazard. Details are provided in subsequent sections.

Headwater Drainage Features

Open water features with a drainage area greater than 50 ha can be considered as regulated watercourses by the GRCA. Based on available mapping and drainage area calculations, this is considered limited to the Main watercourse flowing north to south to Belwood Lake.

In terms of all other open water features, these are all considered to be headwater drainage features (HDF) and their management is based on their classification per the TRCA/CVC Headwater Drainage Feature Guidelines, 2014, which is detailed in the AquaLogic Report provided in Appendix B.

GRCA Hazard Limits

The meander belt for the watercourses to be preserved (i.e. excluding the western tributary) are as defined by the estimates from AquaLogic (refer to Appendix B) and are presented on Drawing SW2. As per communication\clarification from GRCA (refer to e-mail from Jessica Conroy, September 2, 2025 in Appendix A), it is understood that in addition to the meander belt limit, an additional 6 m erosion access setback applies. This limit defines the area in which no lots, septic tanks, or development may occur. Development may still occur within the remaining setback defined by the GRCA's 15 m regulatory allowance.

Both the erosion hazard (as defined above) and floodplain hazard have been assessed to determine the governing hazard, and to ensure that all proposed lots and features are beyond the hazard limits, but as noted, may be located within the 15 m regulatory allowance. Refer to the discussion included in subsequent sub-sections of this report and associated drawings.

3.5 STORMWATER MANAGEMENT CRITERIA AND APPROACH

3.5.1 OVERVIEW AND CONSULTATION

The SWM plan needs to address specific criteria and requirements associated with the management of stormwater runoff (quantity and quality), as well as the treatment of open water features specific to watercourses and headwater drainage features (HDF). The following summarizes the respective criteria and guidance accordingly.

A Pre-consultation Meeting was held with Township staff (January 25, 2023) and the following matters were raised for consideration in the formulation of the SWM plan:

- Preferred source controls for public systems include linear systems with low maintenance needs and for private side systems infiltration galleries are preferred; enhanced/increased topsoil may be considered;
- Urban roadway standards are preferred however hybrid (urban/rural) can be considered;
- Township prefers the south SWMF location on Lots 1 and 2 rather than Lot 3;

- Discharge to County Road needs to meet its standards, including driveway upgrades;
- Preference to pipe western watercourse feature rather than incorporation into the roadside drainage system;
- Need to consider chloride infiltration in roadside works;
- Township not aware of any flooding issues downstream of the site but would be open to potential mitigation measures; and
- For maintained watercourse features Township noted a preference to ownership rather than easements

Pursuant to the Pre-consultation meeting, WSP and Scheckenberger & Associates (S&A) engaged the Township Engineer (Colin Baker) regarding the roadway drainage approach; as part of that discussion, it was confirmed that the Township would consider a roadway drainage system comprised of shallow ditches on one side of the road with a sidewalk on the other. An example cross-section is presented below in Figure 3.1.

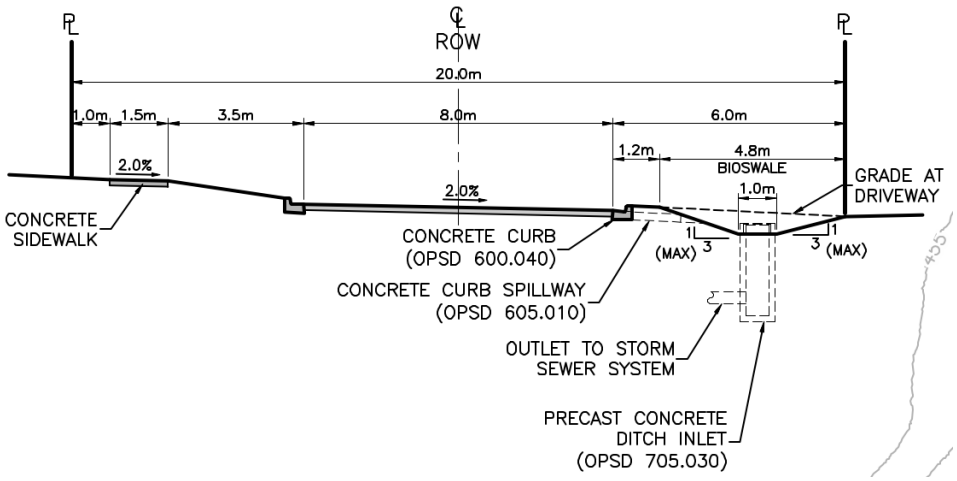


Figure 3.1: Preliminary Hybrid Road Cross-Section

Ditch depths and lengths would be limited by having gutter outlets to capture roadway runoff and a roadway storm sewer, to capture treated runoff from the enhanced swales. This approach would address provincial requirements for a treatment train while also minimizing Township maintenance.

Based on subsequent review with Centre Wellington (refer to e-mail from CW of June 11, 2024, a copy is included in Appendix A), it was ultimately determined that the Township would not support the modified roadway drainage approach. Primary concerns were noted with respect to infiltration of road salt, operations and maintenance, and lack of precedent of similar application in other areas, among other concerns.

Given that a hybrid road cross-section was not supported by Township staff, the current (revised) strategy has been developed on the basis of an urban road cross-section (i.e. curb and gutter).

3.5.2 CRITERIA

The stormwater management design criteria based on the Township of Centre Wellington, Grand River Conservation Authority Design Criteria, and the Ministry of the Environment, Conservation and Parks (MECP) Stormwater Management Guidelines include:

- Quality Control: Level 1 (Enhanced – 80% average annual removal of Total Suspended Solids (TSS))
- Erosion Control: 24-hour retention of 25 mm runoff event
- Peak Flow Control: Post- to Pre-Development Peak Flow Control for 2- through 100-year storm events

Opportunities to incorporate on-site infiltration measures (such as Low Impact Development (LID)) and groundwater recharge should be considered wherever feasible. This is reviewed further in the following sub-section.

3.5.3 LID SOURCE CONTROLS - ALTERNATIVE REVIEW

The Low Impact Development Stormwater Management Guidance Manual, (Draft), January 2022, MECP promotes the need for source controls through Low Impact Development Best Management Practices (LID BMPs). This is also consistent with the guidance in the Provincial Planning Statement (PPS) and the Township's Official Plan (OP).

The MECP recommends a three-tier hierarchal assessment and implementation process whereby Tier 1 (preferred) provides volume controls using LID BMPs at source to capture and manage the 90th percentile runoff event which for Belwood would be between 28 and 29 mm.

As noted in previous sections, the originally envisioned concept for the site involved a semi-urban\hybrid road section which would have allowed for the implementation of bioswales or infiltration galleries within one side of the roadway. With the direction to implement an urban roadway section, these types of LID features are no longer considered feasible, and potential LID measures are hence more limited.

LID measures are also considered constrained by the seasonally high depth of groundwater below surface. As such, typical LID conveyance measures for urbanized roadways (i.e. perforated exfiltration pipes) would also not be feasible in this setting. Limited roadway infiltration measures could be considered in the form of shallow infiltration galleries connected to roadway catchbasins. However, these features would be infiltrating untreated roadway stormwater, which would have higher levels of contaminants including road salt during winter periods. As such, this approach may not be acceptable to the Township based on earlier feedback.

In addition, given the lack of available Township water\wastewater servicing in this area, residences will need to be serviced by private water services (wells, in the front of the property) and wastewater services (septic tanks, in the rear of the property). As such, private-side LID measures are not considered feasible given the limited available space remaining. In addition, private side LID measures can be complicated by issues of long-term responsibility for inspection and operations and maintenance, based on WSP's experience in other areas of Ontario.

Notwithstanding, it is recommended at a minimum that all rooftop drains\roof leaders discharge to pervious (grassed) areas of the residential properties including rear yards where applicable, to promote on-site infiltration.

As discussed in the subsequent section, the proposed end of pipe SWM facilities are proposed as wet ponds due to the need to provide a sufficient level of water quality control, given the infeasibility of source controls for quality treatment. As such, infiltration through these features (i.e. dry ponds or hybrid wet\dry ponds with infiltration galleries) is also not considered feasible. The constraints of the high depth of groundwater would also be a factor.

Based on the preceding review, there appear to be limited options to support source controls and LID implementation to promote infiltration of stormwater. The currently proposed approach has therefore focused on a more typical end-of-pipe SWM design (i.e. quantity and quality control), as outlined further in the subsequent sub-sections. However, further review with the Township may be required.

3.5.4 PROPOSED SWM APPROACH

Based on the preceding, a more conventional SWM approach has been advanced to address the requirements for the proposed development. Two (2) end of pipe wet pond stormwater management facilities (SWMFs) have been proposed to provide the requisite quantity and quality control for the development. Further details are outlined in the subsequent sub-sections.

It is noted that the majority of the proposed development will occur on the west side of the existing watercourse, and the SWM facilities have been located accordingly. The SWM facility sizing has also considered future development phasing and staging.

Notwithstanding, it is noted that additional residential development has been proposed on the east side of the watercourse, including 7 lots by severance\consent (north-east corner) and an additional 8 lots along Street 'E' (south-east corner). It is currently proposed that these areas develop without quantity\quality controls, and that the overall controls for the entirety of the development be provided by the two (2) proposed wet pond SWMFs. However, depending on the preferences of the Township, some primary quality controls could potentially be provided for Street 'E' such as catchbasin inserts. Further details are presented in subsequent sections.

3.5.5 STORM SEWER SERVICING

Based on the proposed urban road cross-section, streets are proposed to be serviced with conventional storm sewers, sized using Township criteria. Storm sewers will discharge roadway drainage to the two (2) SWMFs on the west side of the development, or directly to the creek as per Street 'E'. The additional lots to be severed will not be expected to incorporate storm sewers.

Further details on storm sewer sizing and calculations are provided in the subsequent sub-section.

4 HYDROLOGIC MODELLING

4.1 EXISTING CONDITIONS

4.1.1 METHODOLOGY

Drainage Areas

As part of the model development process, points of interest corresponding to the drainage features noted in the Stream Morphology Report (AquaLogic 2023) have been identified. The publicly available LiDAR-based DTM Lake Erie DTM 2016-2018 (Package W) has been used to determine the subcatchment boundaries and the overall drainage areas.

A total of twelve (12) sub-catchments have been included in the simulation (average area of 11.5 ha +/-), including multiple subcatchments covering the proposed development site. Subcatchments have been delineated based on generally common land use and outlet locations, in order to reasonably estimate modelling results at key points of interest.

The drainage area includes lands on the north side of the 7th Line and County Road 19 intersection. A total of approximately 137 ha has been determined. In general, the drainage is from north to south towards the Belwood Lake Tributary. Drainage is facilitated by multiple man-made drainage features and a ditch.

Refer to Drawing SW1 (existing and external areas) for overall drainage areas under existing conditions. Subcatchment IDs indicate to which channel branch flows discharge, i.e:

- North Tributary
  - PR-N1 and PR-N2 (total 51.11 ha)
- Western Tributary
  - PR-W1 and PR-W2 (total 22.44 ha)
- Eastern Tributary
  - PR-E1 and PR-E2 (total 43.95 ha)
- Middle Tributary
  - PR-M1, PR-M2, PR-M3, PR-M4 and PR-M5 (total 19.07 ha)
- South Ditch (minor area which drains to CR-19 ditch and would drain westerly)
  - PR-S1 (1.94 ha)

Parameterization

A Visual OTTHYMO (VO) hydrologic model has been developed to determine pre-development (existing conditions) peak flows to nodes of interest based on the preceding subcatchments.

Drainage areas for modelled subcatchments have been calculated directly from the measured boundaries in GIS. Similarly, overland flow length and slope, which are used to determine subcatchments' time of concentration and infiltration, have been estimated from the available mapping. Flow lengths, based on the expected length of sheet flow, range from a minimum of 144 m to a maximum of 1,313 m. Overland slopes determined from the DEM have been applied, ranging from 3.2% to 9.6%.

Infiltration has been estimated using the SCS CN methodology. The SCS CN method is considered suitable for single event simulation. The land use parameters have been estimated based on the existing conditions aerial imagery corresponding to GRCA's Curve Number land use categories. The soil type has been identified from the Preliminary Geotechnical Characterization Report (Chung & Vander Doelen Engineering Limited, September 21, 2022) and Land Information Ontario. In instances with multiple land use types within a subcatchment, values have been areally weighted. The CN values range from 72 to 85 for AMC II conditions.

Initial abstraction values have been calculated based on estimated land use types and areally weighted for each subcatchment. Proposed values are included in Appendix C. The modelled time of concentration has been set at 10 minutes, in accordance with the requirements of the Township of Centre Wellington Development Manual (June 2024) for similar land use classes.

Time of concentration values have been calculated using the Airport Method and the Bransby-William's Formula. The runoff coefficient of each subcatchment has been areally weighted from estimated land use. The Airport Method has been used to calculate the time of concentration of subcatchments with runoff coefficients less than 0.4. Of the twelve (12) subcatchments modelled, only one (1) had a runoff coefficient greater than 0.4 thus requiring the use of the Bransby-William's Formula.

Detailed hydrology parameters and calculations are included in Appendix C.

Design Storms

The hydrologic model has been developed to run the 2 to 100 yr design storm events and the Regional Storm. IDF data have been taken from the Township of Centre Wellington Development Manual for the year 2010 for the development of the Chicago 6 hr, the SCS Type II 12 hr, and the SCS Type II 24 hr distributions. Rainfall intensity data for each event are included in Appendix C.

For the Regional Storm, two scenarios have been modelled to determine which yields the most conservative results:

- CN values at AMC II (normal) conditions, and the full 48-hour version of Hurricane Hazel (36-hour pre-wetting period and 12-hour primary storm) applied
- CN values converted to AMC III (saturated) conditions, and the 12-hour version of Hurricane Hazel applied

Areal reduction factors have not been applied due to the small size of the development and contributing drainage area (less than 25 km^2).

4.1.2 RESULTS

Full hydrologic simulation results are presented in Appendix C; refer to Table C18 in particular along with Figure C1 for a full summary of peak flows. For the purposes of SWM facility sizing (as discussed in Section 4.2) the key reference is the overall peak flows at the downstream outlet of the system, i.e. at Wellington Road 19. Peak flow results for this location for the three (3) design storm distributions assessed are presented in Table 4.1. These peak flows will serve as the targets for the assessment of SWM sizing as noted. The results indicate that SCS Type II 24-Hour is the most conservative and shall govern as basis for hydrologic and hydraulic modelling.

Table 4.1. Existing Conditions Hydrology – Target flows at Wellington Road 19

Design Storm Distribution	Peak Flow (m^3/s) for Specified Return Period (years)					
	2	5	10	25	50	100
Chicago 6-Hour	1.72	3.19	4.34	5.92	7.18	8.49
SCS Type II 12-Hour	3.55	5.46	7.20	9.46	11.17	12.93
SCS Type II 24-Hour	4.06	6.69	8.83	11.06	12.97	14.92

4.2 PROPOSED CONDITIONS

4.2.1 METHODOLOGY

4.2.1.1 *DRAINAGE AREAS*

For proposed conditions, there are changes in land use, land cover, as well as proposed drainage boundaries.

The proposed land coverage has been determined by the use of the current site plans provided by the development planner. Refer to the detailed site plans in Appendix A. Overall, a total of 88 residential properties\lots are proposed for the primary development, along with an additional 7 lots to be added separately through severance\consent.

The resulting drainage boundaries would also be expected to change between existing and proposed land use to reflect proposed grading and servicing. Refer to the attached site grading and drainage plans for further details. The resulting subcatchment boundaries for hydrologic modelling are presented in Drawing SW4.

Under proposed conditions, the western tributary\watercourse would be removed and flows from this area (wetland) would discharge to a storm sewer system and eventually to the northern SWM facility. The majority of the western portion of the site (west of the existing primary watercourse) would drain to two (2) separate wet pond SWMFs for the provision of quantity and quality controls. Minor areas along Wellington Road 19 would drain directly to the roadway given grading constraints.

For the eastern portion of the site, Street “E” (south-east corner at Wellington Road 19 and 7th Line) would outlet directly to the watercourse.

The design of the 7 lots at the north-east corner of the site (to be dealt with as severances\consents) is not included as part of this submission in detail, however it is generally assumed that these lots would have split grading\drainage, with the majority (rooftop and front yard) draining towards 7th Line, and the rear yard draining directly to the northern branch of the watercourse. The drainage divides for this area are therefore approximate and would be developed further as part of subsequent detailed design. Notwithstanding, for the purposes of the current SWM assessment, the impact of these properties has been considered in the overall SWM strategy to ensure that quantity control is adequate to mitigate the impact of the overall proposed development (including the 7 lots) and that downstream conditions are not adversely affected.

The ground cover estimations have been established using the Centre Wellington development manual, which specifies that for detached residential units, assume an imperviousness value of 50% and 7% for park/open space. As per previous comments from Centre Wellington and GRCA, note that the 50% value has been applied for the

majority of the development other than true open space areas (i.e. greenspace or rear yards that drain directly to the creek block)

The modelling (Visual OTTHYMO) applies the preceding as the total imperviousness; directly connected imperviousness has been estimated based on the degree of connectivity of impervious areas to the storm sewer system. SCS Curve Numbers have also considered soil types and land cover under proposed conditions.

Refer to Appendix C for detailed hydrology calculations under proposed conditions.

A summary of the resulting drainage areas and imperviousness values to key locations of interest is presented in Tables 4.2a and 4.2b.

Table 4.2a. Proposed Conditions Hydrology Summary (North, West, East)

Location	Reference ID	Subcatchment	Drainage Area (ha)	Total Imperv (%)	Directly Connected Imperv (%)
North Channel	1	PR-N2	43.12	N/A	
	2	PO-N1	4.73	N/A	
	3	PO-N2	1.67	N/A	
	N\A	**Total (North at East)**	**49.52**	**N\A**	
West	4	PR-W2	9.98	0	0
	5	PO-W1	4.31	0	0
	N\A	**Total (Wetland)**	**14.29**	**0**	**0**
	6	PO-W2-4	1.91	50	10
	7	PO-W2-1	0.85	50	5
	8	PO-W2-5	1.27	50	5
	9	PO-W2-6	0.91	50	8
	10	PO-W2-2	0.86	33	9
	11	PO-W2-3	2.15	44	26
	12	PO-W3-1	1.56	50	1
	13	PO-W3-2	1.99	50	7
	14	PO-SWM-N	0.83	30	30
	N\A	**Total (North SWMF excl wetland)**	**12.33**	**46.4**	**11.4**
	N\A	**Total (North SWMF incl wetland)**	**26.62**	**21.5**	**5.3**

Location	Reference ID	Subcatchment	Drainage Area (ha)	Total Imperv (%)	Directly Connected Imperv (%)
East	15	PR-E2	42.15	N/A	
	16	PO-E1	1.48	N/A	
	N\A	**Total (East)**	**43.63**	**N/A**	

Table 4.2a. Proposed Conditions Hydrology Summary (Mid Branch and Total)

Location	Reference ID	Subcatchment	Drainage Area (ha)	Total Imperv (%)	Directly Connected Imperv (%)
Mid Branch	17	PO-M3-3	2.17	50	9
	18	PO-M3-1	4.43	50	11
	19	PO-M3-2	3.14	50	11
	20	PO-SWM-S	0.67	56	56
	N\A	**Total (South SWMF)**	**10.41**	**50.4**	**13.5**
	21	PO-M2-3	1.29	50	20
	22	PO-M2-2	0.99	N/A	
	23	PO-M2-1	1.28	N/A	
	N\A	**Total (West outlet to CR 19)**	**13.97**	**N\A**	
	24	PO-M1-1	2.23	N/A	
	25	PO-M1-2	0.74	50	14
	26	PR-M5	1.57	N/A	
	27	PO-M4	0.36	N/A	
TOTAL AT CR 19	**N\A**	**TOTAL**	**138.64**	**N\A**	

Hydrologic modelling (Visual OTTHYMO) has been updated based on the above noted drainage areas for proposed conditions. Detailed calculations are included in Appendix C. The approach to quantity control (SWM) sizing is presented in the following sub-section.

4.2.1.2 *SWM SIZING*

The sizing of the Stormwater Management (SWM) facilities has involved a comparative analysis between pre-development and post-development conditions. The primary objective of these SWMFs is to mitigate outflows in post-development scenarios, ensuring they match the pre-development conditions for 2–100-year storms at the combined outlet at Wellington County Road 19.

To assess the difference in outflow, a unitary discharge ($m^2/s/ha$) has been calculated based on peak flow at the outlet (m^3/s) and the drainage area (ha) for both existing and proposed conditions during 2-100 year SCS Type II 24-hour design storms. The unitary discharge has been assumed to apply at any node, by using the total drainage area at the node of interest. Modelling of the SWMF has been accomplished using the Route Reservoir tool in VO.

Sizing the SWMF required determining suitable discharge and storage values for each storm event. The discharge value has been obtained by considering the unitary discharge of the storm event and the total drainage area of the SWMF. Storage values have been derived using an estimated unitary storage value and the impervious area.

The iterative process for SWMF sizing, involved an initial unitary storage estimate (m^3/impervious ha) starting with a 2-year storm event. Using this estimate, a storage value (ha-m) has been calculated based on the impervious drainage area and inputted into the model along with the 2-year storm discharge value.

The outflow at the SWMF has been compared to the outflow in pre-development conditions, which was determined by multiplying the drainage area of the SWMF with the pre-development 2-year unitary discharge. The percentage difference between the outflow in pre-development and post-development for the 2-year storm event has been assessed. Where the difference was too large (+/-), the initial unitary storage estimate was adjusted through iterations until the percentage difference was approximately 0% between existing and proposed conditions.

Once the SWMF was sized for a 2-year storm, a unitary storage estimate for a 5-year storm was made, and the same iterative process was followed. This procedure was repeated for storms of increasing intensity from 10 to 100 years. The sizing process continued until the outflow at the SWM pond location, and the outlet of the development achieved a percentage difference of approximately 0% between existing and proposed conditions for all storm events.

SCS type-II – 24 Hour storm governs based on detailed hydrologic modelling results and are included in Appendix C. Results are presented in the following sub-section.

4.2.2 RESULTS

Full hydrologic modelling results have been included in Appendix C. Key results for SWM facilities are presented in the following table.

Table 4.3a. Simulated North SWMF Performance for Proposed conditions – SCS Type II- 24 hour

Attribute	Result for Specified Return Period (years)					
	2	**5**	**10**	**25**	**50**	**100**
North SWMF Q_P in (m^3/s)	1.957	2.966	3.838	4.670	5.491	6.221
North SWMF Q_P out (m^3/s)	0.822	1.313	1.713	2.166	2.313	2.474
Peak Flow Reduction (%)	-58%	-56%	-55%	-54%	-58%	-60%
North SWMF Vol_P (m^3)	2,137	3,172	3,953	4,721	5,515	6,363

Table 4.3b. Simulated South SWMF Performance for Proposed conditions – SCS Type II- 24 hour

Attribute	Result for Specified Return Period (years)					
	2	5	10	25	50	100
South SWMF Q_P in (m^3/s)	1.108	1.670	2.391	2.833	3.204	3.576
South SWMF Q_P out (m^3/s)	0.488	0.789	1.030	1.291	1.512	1.744
Peak Flow Reduction (%)	-56%	-53%	-57%	-54%	-53%	-51%
South SWMF Vol_P (m^3)	1,432	1,944	2,379	2,777	3,098	3,405

The modelling results indicate no overflow for both ponds and the storage volume for 100-year storm is less than the permanent pool volume for both SWM facilities. Peak flow reductions range from 50 to 60% depending on the pond selected and storm event in question.

The 100-year peak storage volume for the north SWMF (6,363 m^3) is within the preliminary design active storage volume of 6,400 m^3, as shown on Drawing SW5. For the south SWMF, the 100-year storage volume of 3,405 m^3 is notably lower than the preliminary design active storage volume of 5,800 m^3. The south SWMF has been over-sized to provide flexibility for interim development phasing\staging (i.e. if only the Phase 1 area draining to the south SWMF is developed first). This will be reviewed as part of the subsequent detailed design phase however, including more explicit consideration of staging\phasing requirements.

The resulting peak flow results at the outlet of the system (i.e. at Wellington Road 19) are presented in Table 4.4 for the governing design storm distribution (SCS Type II 24-hour duration; typically governs for storage sizing given longer duration, particularly in more rural type environments).

Table 4.4: Proposed Conditions – Target flows at Wellington Road 19 – SCS Type II 24 - hour

Scenario	Peak Flow (m^3/s) for Specified Return Period (years)					
	2	5	10	25	50	100
Existing Conditions	4.17	6.84	9.01	11.27	13.20	14.92
Proposed with SWM	4.15	6.79	8.87	11.11	12.88	14.63
Difference (Absolute)	-0.02	-0.05	--0.14	-0.16	-0.32	-0.29
Difference (%)	- 0.5	- 0.8	- 1.5	- 1.4	- 2.5	- 1.9

The results indicate that peak flows are controlled for 2-year to 100-year design storm at the ultimate outlet of the overall drainage system (Wellington County Road 19), which confirms that the SWM facilities will provide the required degree of peak flow control for the proposed development.

4.2.3 QUALITY AND EROSION CONTROL

4.2.3.1 EROSION CONTROL

As described in Section 3.5.2, it is also intended that the proposed SWM facilities provide typical erosion control through SWM facility extended detention (i.e. as per the 2003 MOE SWM Planning & Design Manual). This typically involves the provision of 40 m^3/ha of extended detention volume and a 24-hour drawdown time, for the 25 mm storm event (4-hour Chicago Design storm distribution is typically employed. The proposed conditions Visual OTTHYMO (VO) model described in the previous section has been employed for this verification accordingly. Results are presented in Table 4.5

Table 4.5: Extended Detention and Erosion Control Performance of Proposed SWMFs

SWM Facility	Parameter	Result
North SWMF	Drainage Area[1] (ha)	26.62 Total (12.33 Direct)
	Required Extended Detention[1] (m^3)	1,065 (493)
	Simulated Extended Detention Volume (m^3)	718
	Drawdown Time (Hours)	7.4
South SWMF	Drainage Area (ha)	10.41
	Required Extended Detention (m^3)	416
	Simulated Extended Detention Volume (m^3)	618
	Drawdown Time (Hours)	7.6

1. Note that North SWMF includes external (undeveloped) area from wetland, both values are presented.

The results indicate that in both cases the extended detention volume can be met (for the North SWMF, as calculated using the actual development drainage area rather than the total drainage area including the wetland). However, the drawdown time does not currently meet the typically required 24-hour duration (or 12-hour in constrained applications). As such, as part of the subsequent detailed design effort, rating curve modification would be required to further optimize the low flow discharge to increase the extended detention drawdown time closer to the typically accepted values.

4.2.3.2 QUALITY CONTROL

Both of the proposed SWMFs are proposed as wet ponds in order to provide the requisite quality control for the westerly development. Reference is made to the previous discussion of criteria in Section 3.5.2 (i.e. 80% average annual TSS removal, or “Enhanced” treatment) as per the 2003 MOE SWM Planning & Design Manual. Details are provided in Table 4.6.

Table 4.6a: Water Quality Calculations for Proposed North SWMF

SWM Facility	Parameter	Result
North SWMF	Drainage Area and Imperviousness	12.33 ha at 46.4 % (Direct)
	Required Permanent Pool Rate (m^3/ha)	128.5
	Required Permanent Pool Volume (m^3)	1,584
	Provided Permanent Pool Volume (m^3)	1,600

Table 4.6b: Water Quality Calculations for Proposed South SWMF

SWM Facility	Parameter	Result
South SWMF	Drainage Area and Imperviousness	10.41 ha at 50.4 %
	Required Permanent Pool Rate (m^3/ha)	138.5
	Required Permanent Pool Volume (m^3)	1,442
	Provided Permanent Pool Volume (m^3)	2,800

The results indicate that the north SWMF provides the required permanent pool volume, as does the south SWMF. The south SWMF has a much greater permanent pool volume than actually required. This is due to two different factors. The first is to maximize the active storage volume, by ensuring a large, flat area at the permanent pool elevation (i.e. interface between water quality and active quantity control storage volumes). This can be re-evaluated as part of the subsequent detailed design phase, including consideration of interim development phasing, to ensure the south SWMF meets quantity and quality control targets under interim and ultimate development conditions.

The second reason for the sizing of the permanent pool for the south SWMF is to ensure that the south SWMF provides compensatory overall water quality treatment to account for the residential development along 7 Line, specifically Street E. Note that the total area from Street E (south-east corner at Line 7) is 2.23 ha at 50% imperviousness. As such, this area would require an additional permanent pool volume of 307 m^3 This can clearly easily be accounted for in the sizing of the south SWM facility to offset the need for quality controls for this small development area (8 residences). However, as noted previously if preferred by the Township, simplified primary treatment measures could be incorporated for Street 'E' such as catchbasin inserts (CB Shields™) to provide basic\primary treatment for the street and residences. This would in turn reduce the amount of compensatory off-site water quality treatment required.

4.2.4 SWM FACILITY DESIGN CONSIDERATIONS

The preceding sections have demonstrated that the proposed 2 SWMFs would be sufficient to meet the design criteria with respect to quantity control, erosion control, and quality control. In addition to the preceding, a number of other design criteria require further consideration. These are summarized below:

- Pond Inlets
  - Storm sewer inlets will discharge to the proposed forebays in both cases
  - Erosion protection would be proposed at the inlets (i.e. rip rap); details to be confirmed as part of detailed design phase
- Pond Outlets
  - Stage-storage-discharge rating curves have been developed for both SWMFs (refer to Appendix C)
  - Outlet control structures to be determined as part of detailed design phase to match curves and confirm required layout
- Outlet control for both SWMFs will require review to increase the extended detention time closer to the MOE standard 24 hours; the impact to the overall pond volume will also need to be considered, however extended detention volume was easily met despite the reduced drawdown time.
  - Preliminary outlet pipe layouts have been indicated on the layout drawings; erosion protection (rip-rap or riverstone) and connectivity (low flow channel) to existing watercourse to be confirmed as part of detailed design phase
  - Overflow spillways also to be incorporated (including erosion\slope protection); to be confirmed as part of detailed design
- Backflow and Tailwater
  - For the North SWMF
    - The intent would be to discharge the SWMF as far downstream along the watercourse as possible to limit tailwater impacts, as indicated on Drawing SW5.
    - Based on the preliminary design the outlet piping would be set at the proposed permanent pool elevation (432.70 m), with a discharge (outfall) grade at the watercourse of approximately 432.40 m. The peak operating elevation (i.e. 100-year storm event) in the north SWMF has been estimated as 434.50 m.
    - Based on the hydraulic modelling (refer to Section 5) for XS 334, the 100-year water level would be 432.24 m. Thus, backwater conditions are not expected to impact the SWMF performance.
  - For the South SWMF
    - The intent would be to discharge the SWMF into a dedicated storm sewer along the north side of Wellington County Road 19, sized for the 100-year discharge (refer to Drawing SW6).
    - Based on the preliminary design, the outlet piping would be set at the proposed permanent pool elevation (434.40 m).
    - Based on the hydraulic modelling (refer to Section 5) for XS 139, the 100-year water level would be 429.63 m. Thus, backwater conditions are not expected to impact SWMF performance.
- Pond Liners
  - Based on estimated groundwater levels on site, impermeable pond liners are expected to be required to isolate the SWM facility permanent pool from the surrounding groundwater
  - Requirements to be confirmed by geotechnical\hydro-geological groups based on currently proposed design
- Alternatives to be reviewed as part of detailed design (i.e. geomembrane or compacted clay) based on most efficient\cost-effective design (i.e. minimize excavation and disturbance

- Operations and Maintenance
  - Overall, both proposed SWMFs would be accessible from adjacent public roads
    - North SWMF – Queen Street extension
    - South SWMF – Wellington County Road 19 as well as proposed Street “A”
  - Dedicated maintenance access roads should be provided for both SWM facilities to permit access for future construction equipment (typically 4.0 m wide, slopes of no more than 10 to 15%)
    - Details should be confirmed as part of detailed design grading including any potential loss of storage volume due to grading requirements
  - Chain link fencing and signage should be incorporated around the SWMF perimeters to limit unauthorized access and note the potential risks to the public from unauthorized access
- Phasing and Staging
- Phase 1 limits (as per the application planner) are included in Appendix A and would include the most southerly portion of the development on the west side of the watercourse (i.e. draining to the south SWMF)
  - Based on previous sections, WSP has confirmed that the south SWMF should have sufficient capacity under interim conditions (i.e. Phase 1 only) to mitigate peak flow increases and provide the requisite quantity and quality control.
- However, it is recommended that an updated analysis be completed once the specific details of Phase 1 are confirmed to verify this conclusively.

4.2.5 STORM SEWER DESIGN

The preliminary storm sewer design details have been provided in Appendix D, including the storm sewer drainage area plan (more resolute\refined than the subcatchment boundaries applied for hydrologic modelling), and the resulting storm sewer design sheet. The storm sewer design has generally applied a Rational Method Runoff Coefficient of 0.55, consistent with the Township of Centre Wellington’s design manual and the values employed for hydrologic modelling (i.e. 50% imperviousness). The most currently specified rainfall intensity-duration-frequency (IDF) values have also been applied.

To account for the inflow from the wetland area to the former western tributary (now to be piped along Street ‘C’), a 5-year inflow of 0.80 m^3/s (as generated by the hydrologic modelling described in previous sections) has been applied.

The resulting storm sewer sizing is presented in Appendix D as noted. For the north SWMF, storm sewers will range in size from 450 mm in diameter to 825 mm in diameter at the outfall to the north SWMF. For the south SWMF, storm sewers in size from 450 mm in diameter to 1050 mm in diameter at the outfall to the south SWMF.

In addition to the preceding 450 and 525 mm diameter storm sewers have been proposed for the servicing of Street ‘E’ at the south-east corner of the development (cul-de-sac development with 8 residences).

5 HYDRAULIC MODELLING (OPEN CHANNELS)

5.1 TOPOGRAPHIC DATA

Topographic survey has been completed for the site for BelCal Inc by Van Harten; files were provided to WSP September 20, 2022. These data were combined where necessary with publicly available LiDAR-based DTM Lake Erie DTM 2016-2018 (Package W) as noted in previous sections. The vertical datum from the site-specific topographic survey (CGVD28:78) has been employed for consistency.

5.2 EXISTING CONDITIONS

1-Dimensional (1D) hydraulic modelling has been completed applying HEC-RAS version 6.3.1. Hydraulic modelling details are included in Appendix E.

5.2.1 HYDRAULIC MODEL NAMING CONVENTION

The hydraulic modelling platform, HEC-RAS developed by the US Army Corps of Engineers, allows for an input for both a "river" and a "reach" naming convention. Reaches can be a subset of segments along the primary river being modelled. The river and reach naming for the development is outlined in Table 5.1.

Table 5.1. River and Reach Naming in HEC-RAS

River	Reach
River 1	West Trib
River 2	North Trib
River 3	North East Trib
River 4	East Trib
River 6	Main Trib

The cross-section naming has been based upon the cross-section's location along the modelled reach (distance based).

5.2.2 CROSS-SECTION ALIGNMENT, CENTRELINE AND OVERBANKS

The base watercourse centreline has been based upon the ArcHydro GIS analysis of subcatchments and drainage direction within the development. The watercourses layer has been reviewed against the DEM and the aerial imagery to simplify the shape and confirm the accurate centreline location.

The overbank lines have been delineated for each watercourse feature through review of the DEM and aerial imagery to establish bank lines along both the left and right banks of the system; this has been established based

upon the bank-full width. The overbank lines have been used as part of the subsequent model building stages to assign bank stations within each of the cross-sections.

The cross-section locations and extents have been established based upon a variety of information, including the watercourse centreline, topographic information (contours), aerial imagery, building footprints, and the existing floodplain. The cross-section cutting approach has been applied looking downstream, from left to right, stopping at the high point on either end of the cross-section. The cross-section lengths have been established based upon the topographic information and the existing floodplain limits, which can provide an indication of the flood limits expected within each section of the model; these cross-section extents have been subsequently refined as needed through the model development.

The cross-sections have been cut to ensure that there are 4 bounding cross-sections for each hydraulically significant structure to be included in the modelling (2 upstream and 2 downstream), representing the contraction and expansion zones approaching each hydraulic structure. Best efforts have also been made to ensure that cross-sections bounding the structures do not cross the road deck or embankment.

5.2.3 HYDRAULIC PARAMETERS

Initial estimation of Manning's roughness coefficients has been based upon field observations and review of aerial imagery. The roughness coefficients assumed are based on Table 3-1 « Mannings 'n' Values for Channelized Flow ». The chosen Manning's n values are listed in Table 5.2.

Table 5.2. Land Cover and Assumed Roughness Category

CHANNEL COMPONENT	EXISTING CONDITION	n
Channel	Vegetated or Natural Rock	0.035
Floodplain	Brush - Light Brush and Trees	0.06
	Cultivated Areas – Mature Field Crops	0.04

5.2.4 HYDRUALIC STRUCTURES

There are two (2) hydraulic structures identified within the study area under existing conditions.

Under existing conditions, there is a farm crossing culvert on the North Trib. It is expected that this hydraulic structure would be removed under proposed conditions.

The other hydraulic structure is the culvert for the main branch at County Road 19, which will remain under proposed conditions.

The information collected for the structures under existing conditions is based on field inventory, which was used to confirm the structure geometry (i.e., type, end treatments, opening width, span, distance from obvert to top of road, etc.), as well as identify any other pertinent observations such as low flow channel geometry, vegetation and formation of overbank zones, categorizing the road deck, among others. This information has been used as the primary source for hydraulic structure coding into the HEC-RAS models, which can be supplemented by topographic survey, as-built drawings, previous modelling and aerial imagery.

Structure coding in the HEC-RAS model has been completed. The hydraulic significance of structures has been determined based upon the opening type, the structure deck and the expected impact to flow conveyance and floodplain limits.

HEC-RAS provides two (2) methods for modelling hydraulic structures, namely culvert method or bridge method. Based upon review of the completed field inventory, the structures within the study area consist of culverts. If the culvert has been noted in the field inventory as open bottom, a natural channel Manning's n value (i.e., 0.035) has been applied to the bottom 0.1 m depth of the culvert.

Ineffective flow areas have been assigned at each hydraulic structure crossing, applied to both the upstream and downstream bounding cross-sections. The approach is consistent with the HEC-RAS methodology, where a 1:1 contraction rate has been applied for placing the ineffective flow areas on both sides of the structure face. On the upstream side, the ineffective flow area elevation has been assigned based upon the low point (spill point) in the roadway deck, whereas on the downstream side the elevation has been assigned based upon the midpoint between the bridge/culvert obvert and the deck low point, as WSP has applied in other floodplain mapping modelling.

5.2.5 STEADY STATE FLOW TABLE

The steady state flow table has been developed based upon the peak flows generated as part of the hydrologic modelling which has been completed in parallel to the hydraulic modelling. The hydraulic modelling has simulated the 100-year event and Regional Storm.

The flow change locations have been established based upon a review of all available flow nodes from the hydrologic models, noting key locations throughout the drainage area (i.e. upstream of confluences, at roadways, etc.). The flow changes have been applied at the upstream extent of the reach / subcatchment, which allows for the most conservative modelling approach for the subject reach. Best efforts have been made to locate flow change locations outside of the four (4) cross-sections bounding a hydraulic structure, to ensure that a consistent flow rate is applied throughout the structure.

Table 5.3: Steady Flow Table – Existing Conditions

River	Reach	RS	100 24H SCS (m^3/s)	Regional 12H (m^3/s)
River 1	West Trib	410	2.97	2.97
River 2	North Trib	279	5.80	6.42
River 3	Northwest Trib	85	8.49	9.32
River 4	East Trib	120	4.25	5.21
River 6	Main Trib	353	13.94	15.84
River 6	Main Trib	158	14.92	17.10

5.2.6 BOUNDARY CONDITIONS

A Normal Depth boundary condition has been used in the hydraulic model for this development. To calculate the value for normal depth an average value for slope of channel has been calculated using the terrain profile of the watercourse and contour lines. Using the calculated value of slope, a normal depth has been calculated for each profile.

5.2.7 RESULTS – EXISTING CONDITIONS

The estimated floodplain limits under existing conditions are presented in Drawing SW3. Note that the existing floodplain limit for the western tributary has not been included, given that this branch\tributary is proposed to be removed under proposed conditions.

5.3 PROPOSED CONDITIONS

5.3.1 MODELLING APPROACH

For the proposed conditions, River 1 – West Trib and the farm crossing on the North West Trib have been removed from the analysis for the reasons noted previously. The cross sections have also been adjusted with the proposed street C alignment.

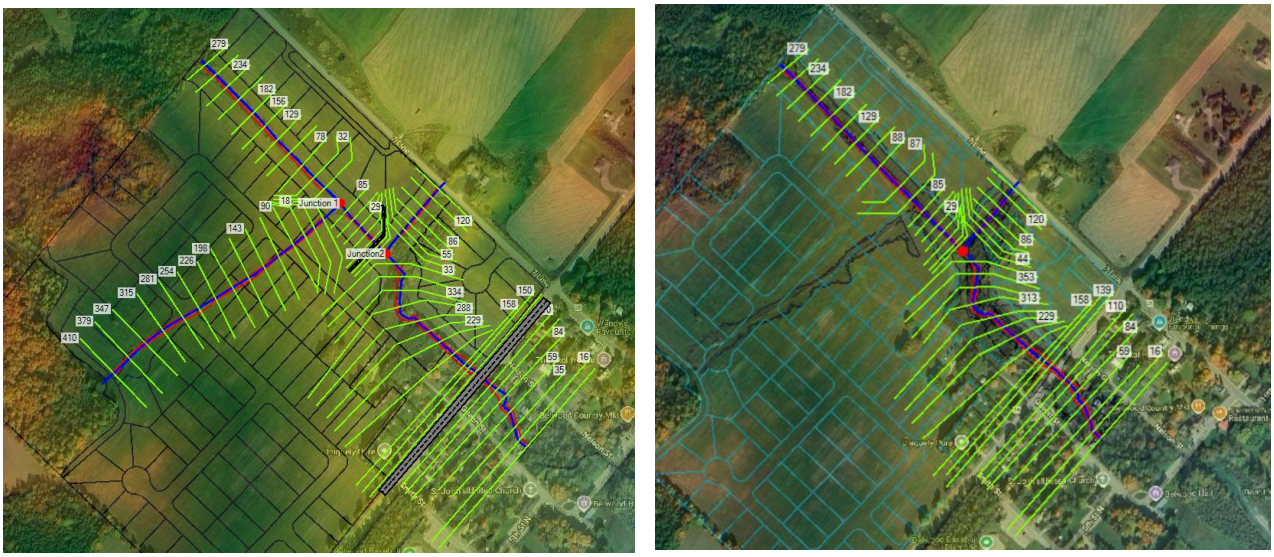


Figure 5.3: Hydraulic Model Set Up Existing (Left) vs Proposed (Right)

The RAS Mapper function in HEC-RAS has been used to plot the simulated inundation boundary for the 100 year, and 12-hour Regional Storm event, based upon the model terrain and the computed water surface elevations at each cross-section.

The updated hydrologic modelling for proposed conditions has confirmed that peak flows at the outlet (Wellington Road 19) will be controlled to less than under existing conditions. Updated steady state flows are presented in Table 5.4 accordingly. Refer to Appendix C for detailed hydrologic modelling results. Regional Storm peak flows exclude the attenuation provided by the two (2) proposed SWM Facilities, consistent with current Provincial Policy.

Table 5.4: Steady Flow Table – Proposed Conditions

River	Reach	RS	Proposed 100 24H SCS (m^3/s)	Difference from Existing (m^3/s)	Proposed Regional 12H (m^3/s)	Difference from Existing (m^3/s)
River 2	North Trib	279	5.20	-0.60	5.96	-0.46
River 3	Northwest Trib	85	7.67	-0.82	9.54	+0.22
River 4	East Trib	120	4.44	+0.19	5.25	+0.04
River 6	Main Trib (D/S East)	353	13.71	-0.23	16.45	+0.61
River 6	Main Trib (U/S CR19)	158	14.63	-0.29	17.22	+0.12

Note that for consistency the same flow change locations have been applied as under existing conditions; applicable flow nodes from the hydrologic modelling have been applied to the nearest point of comparison.

Under proposed conditions, 100-year peak flows are consistently below existing conditions flows, which is consistent with the SWMF quantity control sizing summary presented in the previous section.

For the Regional Storm Event, localized increases are indicated which is typical given that SWMF are not normally sized to accommodate or control the Regional Storm Event, given Provincial Policy (ref. MNR 2002) which does not currently credit their function under the Regulatory Event (which in this case is the Regional Storm, or Hurricane Hazel).

The minor peak flow increase at the north-west trib (former farm lane crossing) for the Regional Storm Event is likely attributable to the addition of flow from the former western trib (now north SWMF).This is actually conservative, as per Drawing SW5, the discharge is intended to be directed downstream of the east tributary confluence. However, depending on the location of the overflow spillway (to be confirmed as part of detailed design), some flow could be contributed further upstream.

Simulated peak flow increases for the main tributary (downstream of eastern and western tributaries) are indicated only for the Regional Storm Event and are considered generally minor in nature. The final simulated increase at Wellington County Road 19 is less than 1% (0.7%) which is considered negligible and within the error tolerance of the modelling.

Under proposed conditions, select riparian grading modifications have been proposed to ensure that the primary floodplain hazard is restricted to the proposed property limit or less. The approach has been to provide additional storage in the overbank areas, while leaving the primary low flow channel and associated vegetation (approximate 10 m width) untouched. Overbank areas have been included to more than half the depth of the existing low flow channel relative to the top of bank. It has also been assumed that no grading can occur on private property, such as 57 Wellington Road 19 which directly abuts the channel on the west side upstream of the existing culvert. The channel modifications have been assessed iteratively to determine the required grading and storage to ensure that the flood limits can be reduced, such that the flood hazard is generally restricted to the proposed property line or less, consistent with GRCA direction (as per Appendix B).

For further details regarding preliminary cross-section modifications, refer to the HEC-RAS modelling included with the report (Appendix E). Key modelling excerpts have also been included in Appendix E.

5.3.2 FLOODPLAIN OF EXISTING VS PROPOSED CONDITIONS

The differences in floodplain between proposed and existing conditions has been assessed through a review of the inundation limits. As would be expected with the removal of River 1 – West Trib in proposed conditions, there is no floodplain in the west region of the development.

A comparison of the existing and proposed inundation (floodplain) limits is presented in Figures 5.4 and 5.5 for the 100-year and Regional Storm Event respectively. Proposed conditions floodplain mapping is also presented in Drawing SW7 (attached). Comparison is made to the estimated existing conditions floodplain mapping as presented previously in Drawing SW3 (attached).

As evident from the updated results, the proposed flood hazard (i.e. under Regulatory Event or Regional Storm) can be managed to the proposed property lines for the creek corridor. Minor property line boundary modifications were necessary for lots 86 and 87 in particular to accommodate the expected flood hazard immediately upstream of Wellington County Road 19, as overbank grading modifications in this area are limited by the existing private property boundary to the west. As such, the property boundary of lot 87 required adjustment outward.

Further property boundary and overbank grading modifications may be considered as part of the subsequent detailed design phase to further optimize the limits of the flood hazard and developable land. However, the current assessment has demonstrated that overbank grading modifications can feasibly manage the flood hazard to allow the development to proceed as proposed.

It should also be noted that the developer and planner have proposed to implement a trail connection to 7th Line in the vicinity of the east tributary, including a future pedestrian bridge crossing of the north watercourse. This will require further consideration as part of the future detailed design phase. In general, it is noted that pedestrian bridges typically have a negligible impact on Regulatory flood levels, as they are generally open and overtopped for larger storm events. Most Conservation Authorities typically exclude pedestrian bridges from regulatory floodplain modelling and mapping in WSP's experience. However, the proposed pedestrian bridge should be assessed and this confirmed through hydraulic modelling, if necessary, as part of the future detailed design.

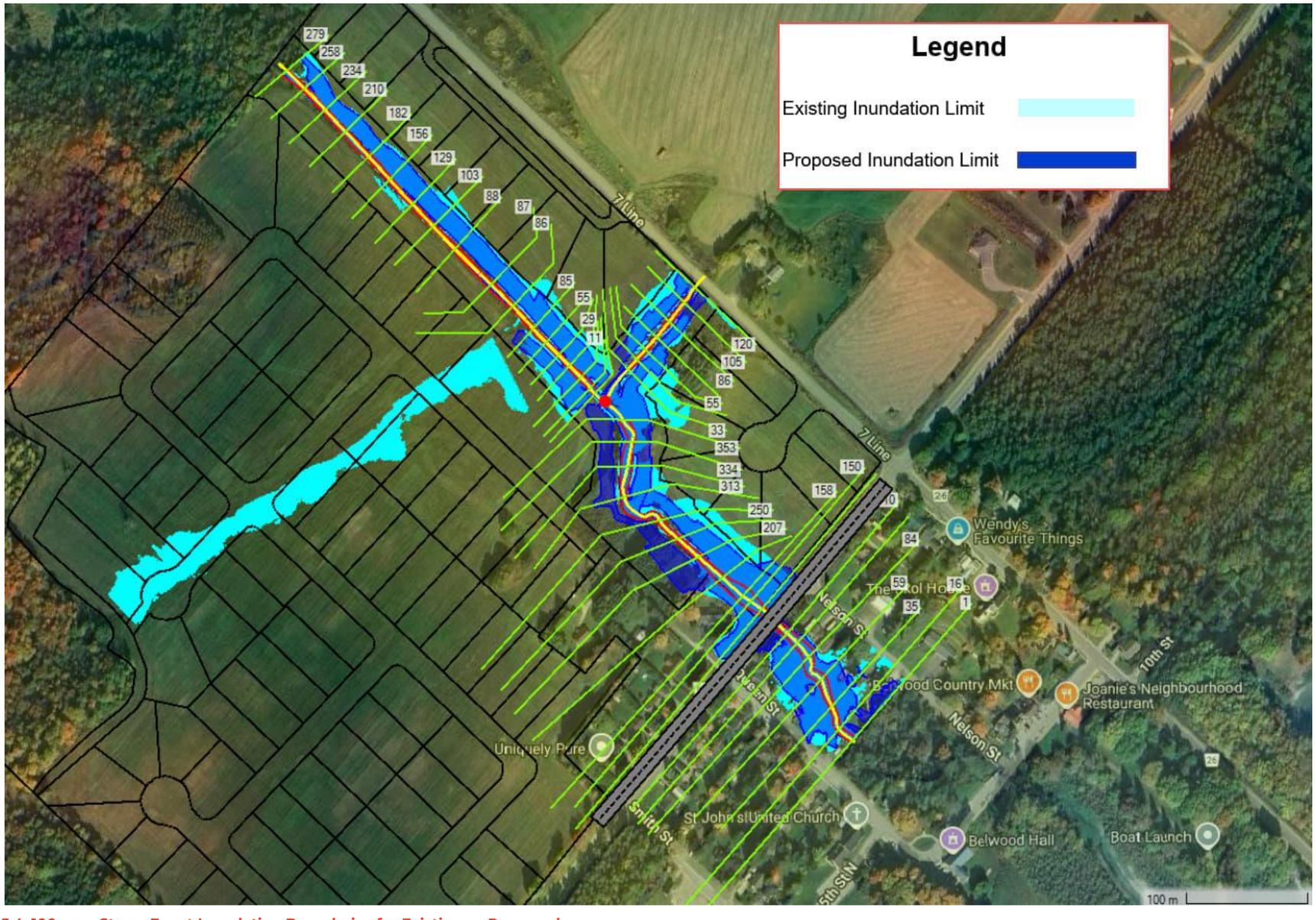


Figure 5.4: 100-year Storm Event Inundation Boundaries for Existing vs Proposed

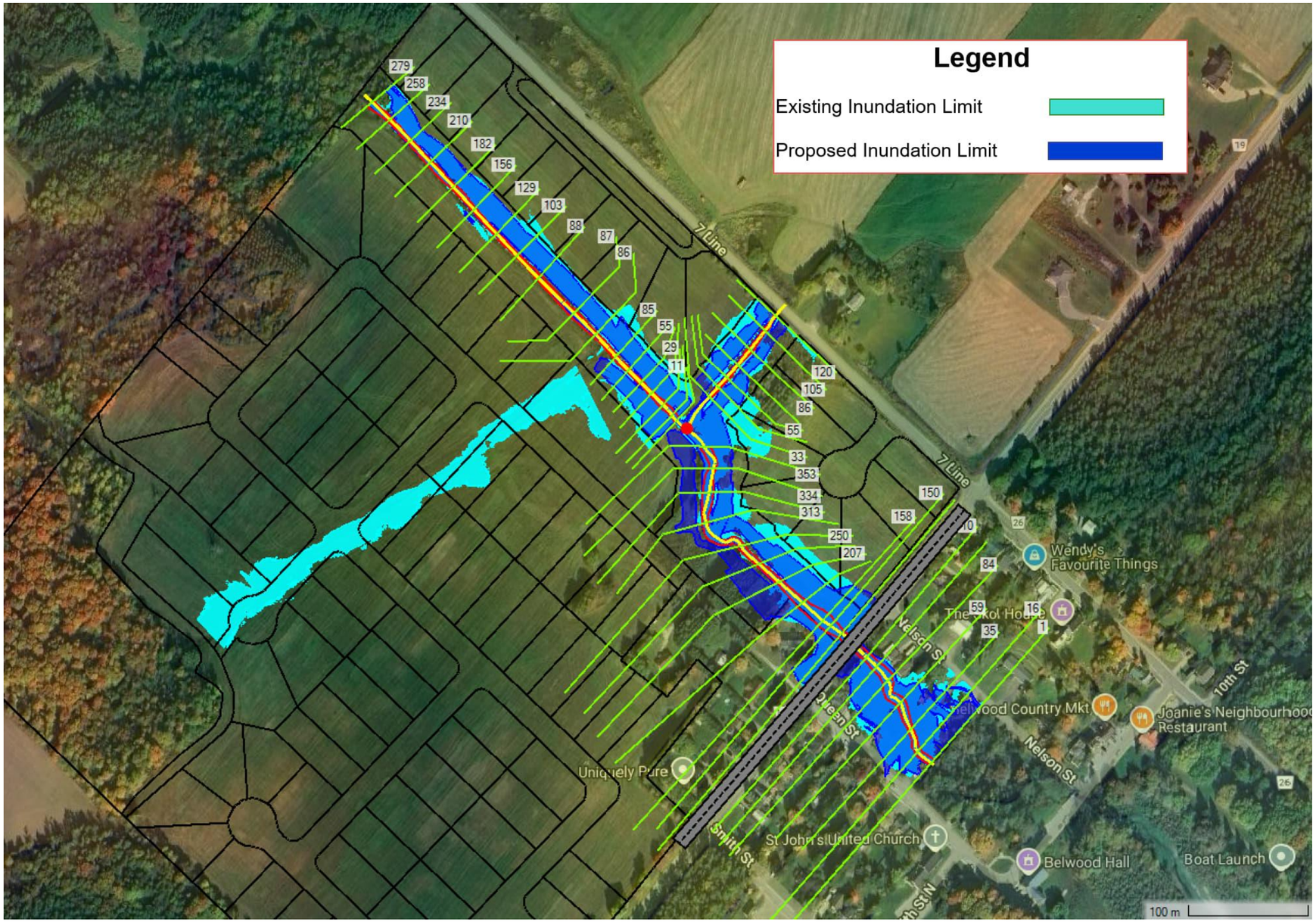


Figure 5.5: 12-hour Regional Storm Event Inundation Boundaries for Existing vs Proposed

6 SUMMARY AND CONCLUSIONS

The applicant proposes to develop 88 lots (plus 7 severances) in Belwood located northwest of Seventh Line and Wellington Rd 19. The area is currently farmland with limited structures. Future development as currently planned will alter the landscape through the introduction of roads, buildings and associated re-grading.

Each individual residential lot will be serviced by private wells (water) and septic systems (sanitary).

With respect to stormwater management, the proposed land use changes have the potential to alter the area's hydrology which can potentially impact flooding, erosion and water balance. As such, a comprehensive assessment has been completed to determine the current hydrologic conditions and use these as a target to meet the requirements of the Township, GRCA and Province in terms of stormwater management.

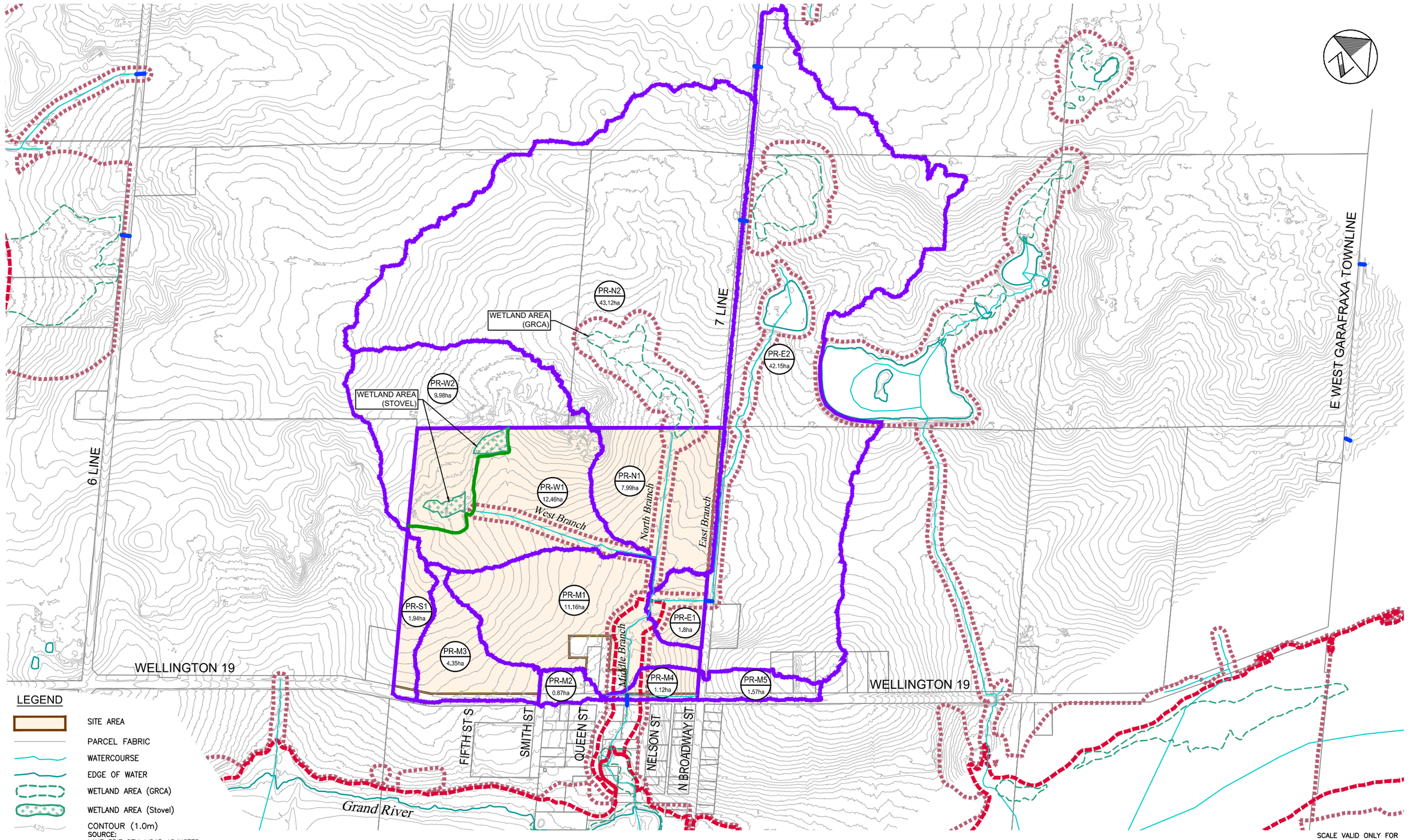
Two (2) separate end of pipe wet pond stormwater management facilities (SWMFs) have been proposed to provide the necessary, quantity, erosion, and quality control for the development. The development will have urban roadways (curb and gutter) as per Township preferences and will therefore be serviced by roadway storm sewer systems, which will collect stormwater runoff (in combination with rear-yard swales) and direct it to the two (2) proposed SWMFs.

The proposed development along Line 7 (both the 8 lots along Street 'E' and severances) would be currently proposed to be implemented without stormwater controls, given the assessment summarized previously. However, as noted, primary on-site quality controls could be implemented if preferred by the Township, such as catchbasin inserts (CB Shields™). This requires further review and confirmation.

The western tributary of the existing watercourse is proposed to be removed under proposed conditions, based on the assessment completed by AquaLogic. Flow from this area (to the existing wetland) would be collected by the proposed storm sewer system and directed to the north SWMF.

In addition to the preceding, localized grading improvements in the watercourse overbank areas have been proposed to contain/manage the flood hazard and to ensure that the overall hazard limit is contained to the proposed property boundaries for the development.

It is expected that the currently proposed development application and supporting materials (including this report) will be reviewed by Township and GRCA in conjunction with the supplied comment response matrix. If necessary, a meeting can be held to review and discuss the comments. It is expected that a re-submission will potentially be required to address and further\final comments from the preceding.



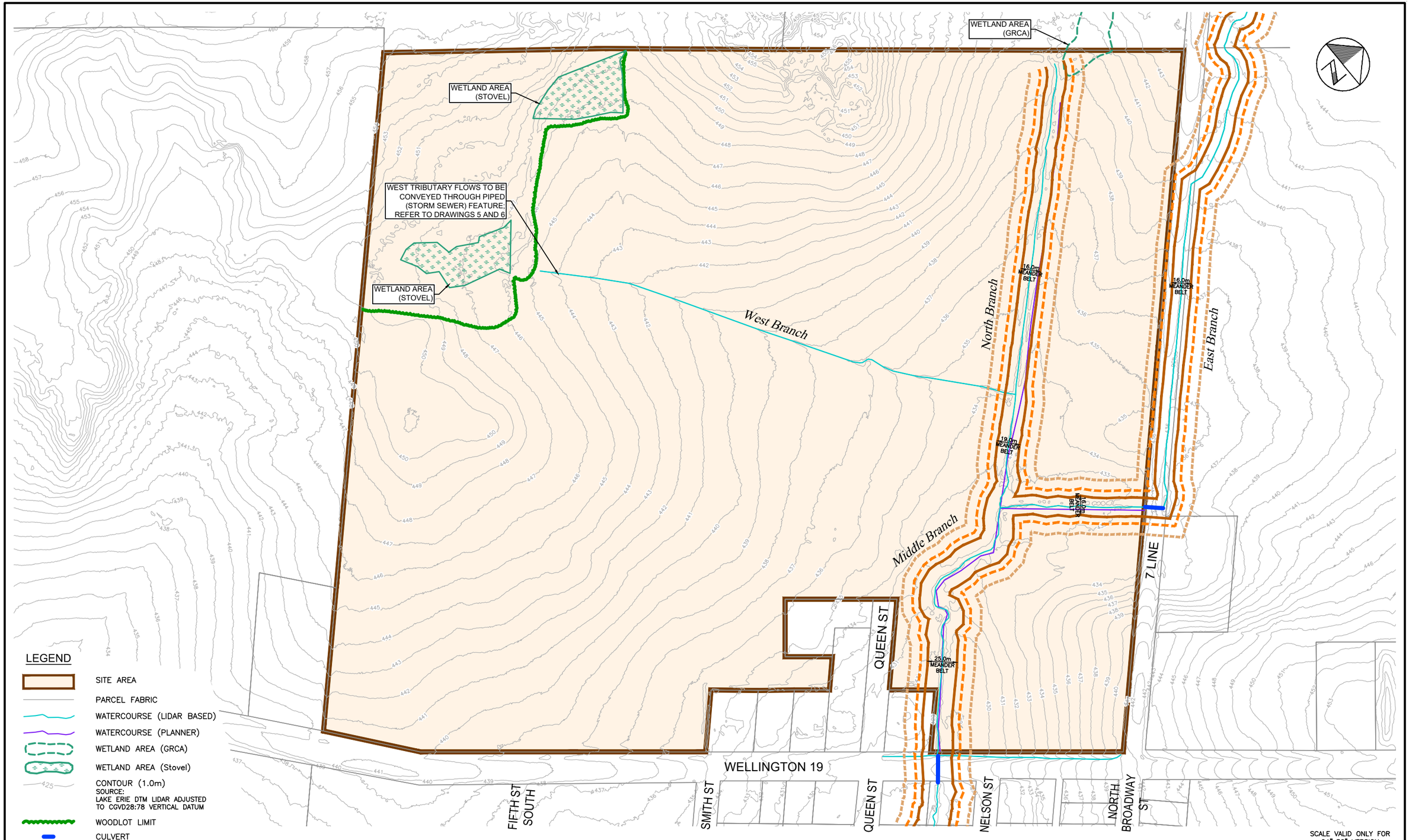
LEGEND

- SITE AREA
- PARCEL FABRIC
- WATERCOURSE
- EDGE OF WATER
- WETLAND AREA (GRCA)
- WETLAND AREA (Stovel)
- CONTOUR (1.0m) SOURCE: LAKE ERIE DTM LIDAR ADJUSTED TO CGVD28:78 VERTICAL DATUM
- WOODLOT LIMIT
- CULVERT
- GRCA REGULATION LIMIT
- GRCA REGULATORY FLOODLINE
- SUBCATCHMENT BOUNDARY
- PR-N01 / 7.99ha — SUBCATCHMENT ID# / SUBCATCHMENT AREA

NOTE:
GRCA REGULATORY LIMITS ARE SHOWN FOR INFORMATION PURPOSES ONLY. SPECIFIC REGULATORY LIMITS HAVE BEEN DETERMINED AND ARE SHOWN ON SUBSEQUENT PLANS.

SCALE VALID ONLY FOR 24"x36" VERSION

BELWOOD DEVELOPMENT BEL CAL INC.	SUBCATCHMENT BOUNDARY PLAN (EXISTING CONDITION)	wsp	Scale 1:4000 (0 40 80 160) Consultant File No. WW22011051 Drawing No. SW1



LEGEND

- SITE AREA
- PARCEL FABRIC
- WATERCOURSE (LIDAR BASED)
- WATERCOURSE (PLANNER)
- WETLAND AREA (GRCA)
- WETLAND AREA (Stovel)
- CONTOUR (1.0m) SOURCE: LAKE ERIE DTM LIDAR ADJUSTED TO CGVD28:78 VERTICAL DATUM
- WOODLOT LIMIT
- CULVERT
- MEANDER BELT (SEE PLAN FOR WIDTH)
- EROSION ACCESS ALLOWANCE (6.0m SETBACK)
- REGULATORY ALLOWANCE (15.0m SETBACK)

NOTE:
MEANDER BELTS HAVE BEEN BASED ON WATERCOURSE (LIDAR BASED) CENTRELINES.

SCALE VALID ONLY FOR 24"x36" VERSION

BELWOOD DEVELOPMENT
BEL CAL INC.

MEANDER BELT PLAN
(EXISTING CONDITION)

Scale 1:1500
0 15 30 60
Consultant File No. WW22011051
Drawing No. SW2

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Last Saved: 2025-09-26
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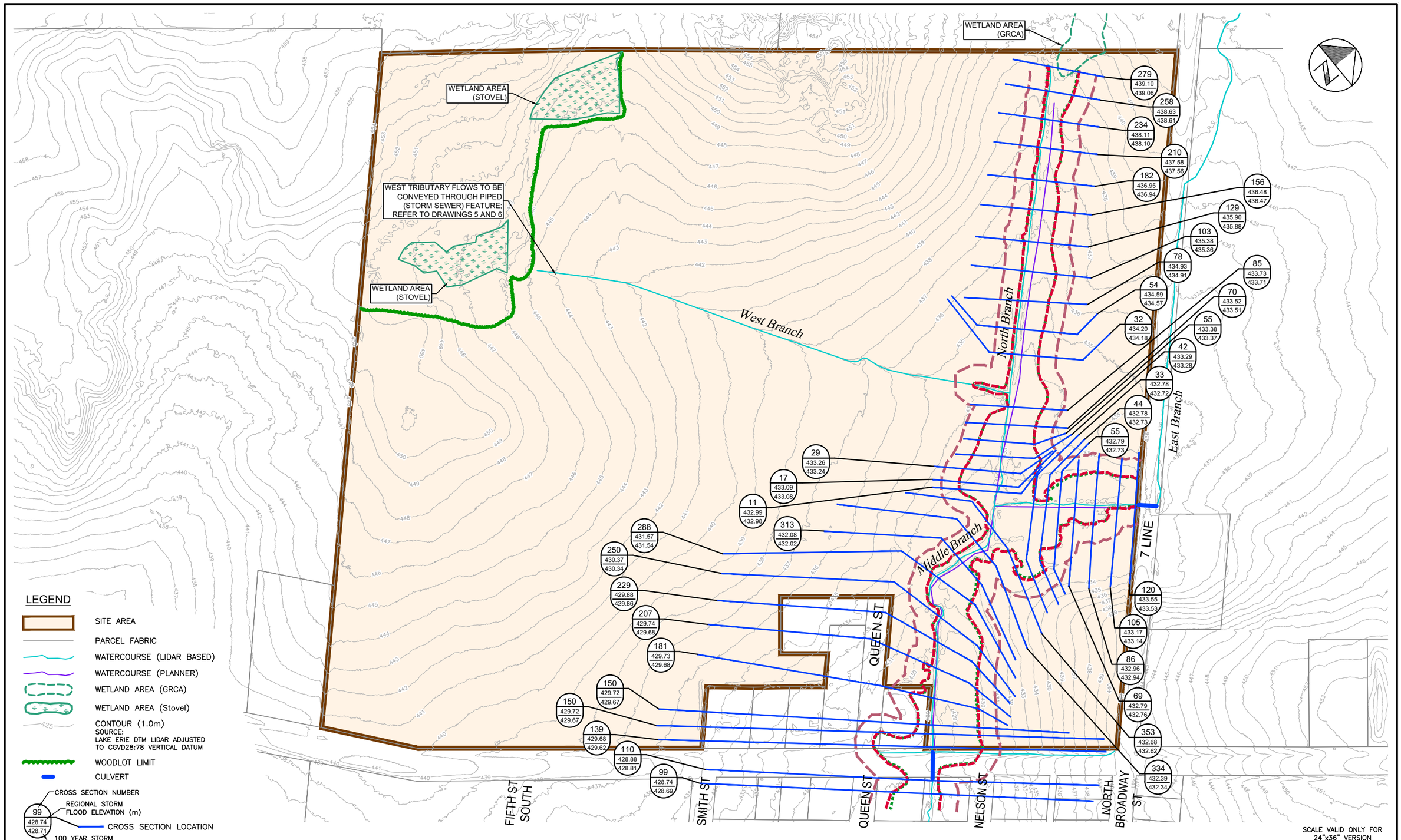

LEGEND

- SITE AREA
- PARCEL FABRIC
- WATERCOURSE (LIDAR BASED)
- WATERCOURSE (PLANNER)
- WETLAND AREA (GRCA)
- WETLAND AREA (Stovel)
- CONTOUR (1.0m) SOURCE: LAKE ERIE DTM LIDAR ADJUSTED TO CGVD28:78 VERTICAL DATUM
- WOODLOT LIMIT
- CULVERT
- CROSS SECTION NUMBER (99)
- REGIONAL STORM FLOOD ELEVATION (m) (428.74)
- CROSS SECTION LOCATION
- 100 YEAR STORM FLOOD ELEVATION (m) (428.71)
- REGIONAL STORM FLOODPLAIN
- 100 YEAR STORM FLOODPLAIN
- GRCA FLOOD HAZARD BUFFER (15.0m SETBACK)

SCALE VALID ONLY FOR 24"x36" VERSION

BELWOOD DEVELOPMENT BEL CAL INC.	FLOOD HAZARD PLAN (EXISTING CONDITION)	Scale 1:1500 (0 15 30 60) Consultant File No. WW22011051 Drawing No. SW3

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PR-W2
9.98ha

WETLAND AREA
(STOVEL)

PO-W1
4.31ha

PO-W2-1
0.85ha

PO-W2-2
0.86ha

PR-N2
43.12ha

WETLAND AREA
(GRCA)

PO-N1
4.73ha

PARCEL A
TO BE SEVERED

PARCEL B TO BE
SEVERED

PARCEL C
TO BE SEVERED

PARCEL D
TO BE SEVERED

PO-N2
1.67ha

PARCEL E
TO BE SEVERED

PARCEL F
TO BE SEVERED

PARCEL G
TO BE SEVERED

PEDESTRIAN BRIDGE CROSSING OF
CREEK TO BE DETERMINED AS PART
OF FUTURE DETAILED DESIGN

PR-E2
42.15ha

PO-E1
1.48ha

STREET 'F'

STREET 'C'

STREET 'A'

STREET 'B'

STREET 'D'

STREET 'E'

STREET 'G'

STREET 'H'

PO-W2-4
1.91ha

PO-W2-6
0.91ha

PO-W2-3
2.15ha

PO-W2-5
1.27ha

PO-M3-3
2.17ha

PO-M3-2
3.14ha

PO-M3-1
4.43ha

PO-W3-1
1.56ha

PO-W3-2
1.99ha

PO-M2-3
1.29ha

PO-M2-1
1.28ha

PO-M2-2
0.99ha

PO-M1-1
2.23ha

PO-M1-2
0.74ha

PR-M5
1.57ha

PO-M4
0.36ha

PO-SWM-1
0.83ha

PO-SWM-2
0.67ha

SWM
STORAGE
ACTIVE 6400m³
PP 1600m³

SWM
STORAGE
ACTIVE 5700m³
PP 2800m³

MAIN
CELL

FOREBAY

North Branch

East Branch

Middle Branch

QUEEN ST

7 LINE

WELLINGTON 19

FIFTH ST
SOUTH

SMITH ST

QUEEN ST

NELSON ST

NORTH
BROADWAY
ST

LEGEND

- SITE AREA
- PARCEL FABRIC
- WATERCOURSE (LIDAR BASED)
- WETLAND AREA (GRCA)
- WETLAND AREA (Stovel)
- CONTOUR (1.0m)
  SOURCE:
  LAKE ERIE DTM LIDAR ADJUSTED
  TO CGVD28:78 VERTICAL DATUM
- WOODLOT LIMIT
- CULVERT
- SUBCATCHMENT BOUNDARY
- SUBCATCHMENT ID# (e.g. PO-M2)
- SUBCATCHMENT AREA (e.g. 0.87ha)
- PROPOSED GRADE
- PROPOSED LOT GRADING SLOPE
- PROPOSED ROADWAY DIRECTION OF FLOW
- PROPOSED STORM SEWER SYSTEM

SCALE VALID ONLY FOR
24"x36" VERSION

BELWOOD DEVELOPMENT BEL CAL INC.	HYDROLOGIC MODELLING SUBCATCHMENT BOUNDARY PLAN (FUTURE CONDITION)	wsp	Scale 1:1500 (0, 15, 30, 60) Consultant File No. WW22011051 Drawing No. SW4

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Plotted: 2025-10-02
Last Saved: 2025-10-02

SWM
STORAGE
ACTIVE 6400m³
PP 1600m³

MAIN CELL
BOT 431.70
PP 432.70
T/O FACILITY 434.50

FOREBAY
BOT 431.70
PP 432.70
T/O FACILITY 434.50

18.5m–300ø PVC INLET (REVERSE SLOPED)

OUTLET CONTROL STRUCTURE

116.9m–825ø CONC STM @ 1.80%

46.9m–825ø CONC STM @ 1.50%

64.0m–450ø CONC STM @ 1.00%

23.0m–825ø CONC STM @ 1.00%

85.0m–1200ø PVC STM @ 0.20%

15.0m–1200ø PVC STM @ 1.00%

MH15

MH14

MH

STREET 'G'

7 LINE

RET. WALL

North Branch

East Branch

Middle Branch

PARCEL F
TO BE SEVERED

PARCEL G
TO BE SEVERED

PEDESTRIAN BRIDGE CROSSING OF CREEK TO BE DETERMINED AS PART OF FUTURE DETAILED DESIGN

LEGEND

- SITE AREA
- PARCEL FABRIC
- PROPOSED LOT FABRIC
- WATERCOURSE (LIDAR BASED)
- CONTOUR (1.0m) SOURCE: LAKE ERIE DTM LIDAR ADJUSTED TO CGVD28:78 VERTICAL DATUM
- PROPOSED HAZARD LIMIT (SEE DRAWING SW8)
- ×441.53 PROPOSED GRADE
- 2.4% PROPOSED LOT GRADING SLOPE
- 19.1m–450ø CONC STM @ 2.00% PROPOSED STORM SEWER
- MH5 PROPOSED MAINTENANCE HOLE
- PROPOSED CATCHBASIN

SCALE VALID ONLY FOR 24"x36" VERSION

BELWOOD DEVELOPMENT BEL CAL INC.	NORTH SWM FACILITY PLAN	wsp	Scale 1:500 (0 5 10 20) Consultant File No. WW22011051 Drawing No. SW5

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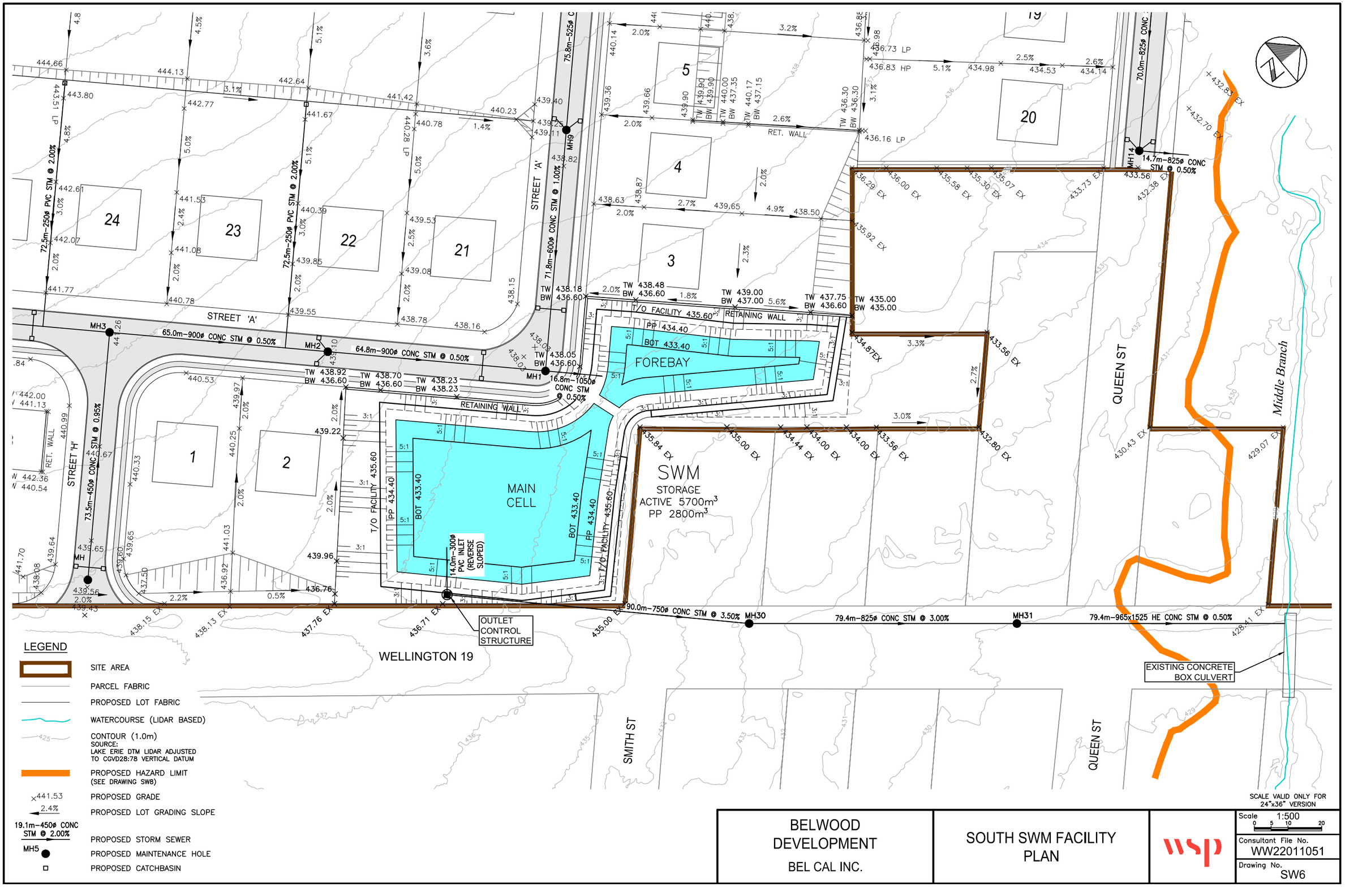

LEGEND

- SITE AREA
- PARCEL FABRIC
- PROPOSED LOT FABRIC
- WATERCOURSE (LIDAR BASED)
- CONTOUR (1.0m) SOURCE: LAKE ERIE DTM LIDAR ADJUSTED TO CGVD28:78 VERTICAL DATUM
- PROPOSED HAZARD LIMIT (SEE DRAWING SW8)
- PROPOSED GRADE
- PROPOSED LOT GRADING SLOPE
- PROPOSED STORM SEWER
- PROPOSED MAINTENANCE HOLE
- PROPOSED CATCHBASIN

SCALE VALID ONLY FOR 24"x36" VERSION

BELWOOD DEVELOPMENT BEL CAL INC.	SOUTH SWM FACILITY PLAN	wsp	Scale 1:500 (0 5 10 20) Consultant File No. WW22011051 Drawing No. SW6

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Last Saved: 2025-09-30

WETLAND AREA (GRCA)

WETLAND AREA (STOVEL)

WETLAND AREA (STOVEL)

STREET 'F'

STREET 'C'

STREET 'A'

STREET 'B'

STREET 'G'

STREET 'H'

STREET 'E'

PEDESTRIAN BRIDGE CROSSING OF CREEK TO BE DETERMINED AS PART OF FUTURE DETAILED DESIGN

SWM STORAGE ACTIVE 6400m³ PP 16000m³

SWM STORAGE ACTIVE 2800m³ PP 2800m³

MAIN CELL

FOREBAY

North Branch

Middle Branch

East Branch

7 LINE

QUEEN ST

WELLINGTON 19

FIFTH ST SOUTH

SMITH ST

NELSON ST

NORTH BROADWAY ST

279	439.07	439.01
258	438.62	438.58
234	438.1	438.07
210	437.57	437.54
182	436.94	436.92
156	436.47	436.45
129	435.89	435.87
103	435.44	435.42
88	434.93	434.91
85	433.66	433.63
87	434.26	434.25
70	433.48	433.44
86	433.89	433.86
55	433.32	433.28
42	433.21	433.17
33	432.57	432.51
44	432.61	432.56
55	432.66	432.62
29	433.1	433.06
17	433	432.96
11	432.9	432.89
313	431.76	431.73
288	431.13	431.11
250	430.08	430.07
229	429.78	429.69
207	429.76	429.69
181	429.74	429.67
158	429.74	429.67
150	429.74	429.67
139	429.68	429.61
110	428.88	428.8
99	428.74	428.69
120	433.5	433.48
105	433.26	433.24
86	432.91	432.88
69	432.73	432.71
353	432.5	432.44
334	432.27	432.23

LEGEND

- SITE AREA
- PARCEL FABRIC
- WATERCOURSE (LIDAR BASED)
- WETLAND AREA (GRCA)
- WETLAND AREA (Stovel)
- CONTOUR (1.0m) SOURCE: LAKE ERIE DTM LIDAR ADJUSTED TO CGVD28:78 VERTICAL DATUM
- WOODLOT LIMIT
- CULVERT
- CROSS SECTION NUMBER (99 / 428.74 / 428.71)
  - REGIONAL STORM FLOOD ELEVATION (m)
  - CROSS SECTION LOCATION
  - 100 YEAR STORM FLOOD ELEVATION (m)
- REGIONAL STORM FLOODPLAIN
- 100 YEAR STORM FLOODPLAIN

SCALE VALID ONLY FOR 24"x36" VERSION

BELWOOD DEVELOPMENT BEL CAL INC.	FLOOD HAZARD PLAN (FUTURE CONDITION)	wsp	Scale 1:1500 (0, 15, 30, 60) Consultant File No. WW22011051 Drawing No. SW7

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Last Saved By: wds_richard.bartolo
Plotted: 2025-10-07
Last Saved: 2025-09-26

WETLAND AREA (GRCA)

WETLAND AREA (STOVEL)

WETLAND AREA (STOVEL)

STREET 'F'

STREET 'C'

STREET 'A'

STREET 'B'

STREET 'G'

STREET 'H'

STREET 'E'

PARCEL A TO BE SEVERED

PARCEL B TO BE SEVERED

PARCEL C TO BE SEVERED

PARCEL D TO BE SEVERED

PARCEL E TO BE SEVERED

PARCEL F TO BE SEVERED

PARCEL G TO BE SEVERED

North Branch

East Branch

Middle Branch

SWM STORAGE ACTIVE 6400m³ PP 1600m³

SWM STORAGE ACTIVE 5700m³ PP 2800m³

MAIN CELL

FOREBAY

PEDESTRIAN BRIDGE CROSSING OF CREEK TO BE DETERMINED AS PART OF FUTURE DETAILED DESIGN

7 LINE

QUEEN ST

WELLINGTON 19

FIFTH ST SOUTH

SMITH ST

NELSON ST

NORTH BROADWAY ST

LEGEND

- SITE AREA
- PARCEL FABRIC
- WATERCOURSE (LIDAR BASED)
- WETLAND AREA (GRCA)
- WETLAND AREA (Stovel)
- CONTOUR (1.0m) SOURCE: LAKE ERIE DTM LIDAR ADJUSTED TO CGVD28:78 VERTICAL DATUM
- WOODLOT LIMIT
- CULVERT
- PROPOSED REGIONAL STORM FLOODPLAIN
- EROSION ACCESS ALLOWANCE
- PROPOSED HAZARD LIMIT

SCALE VALID ONLY FOR 24"x36" VERSION

BELWOOD DEVELOPMENT BEL CAL INC.	HAZARD LIMIT PLAN (FUTURE CONDITION)	wsp	Scale 1:1500 (0, 15, 30, 60) Consultant File No. WW22011051 Drawing No. SW8

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Plotted: 2025-10-02
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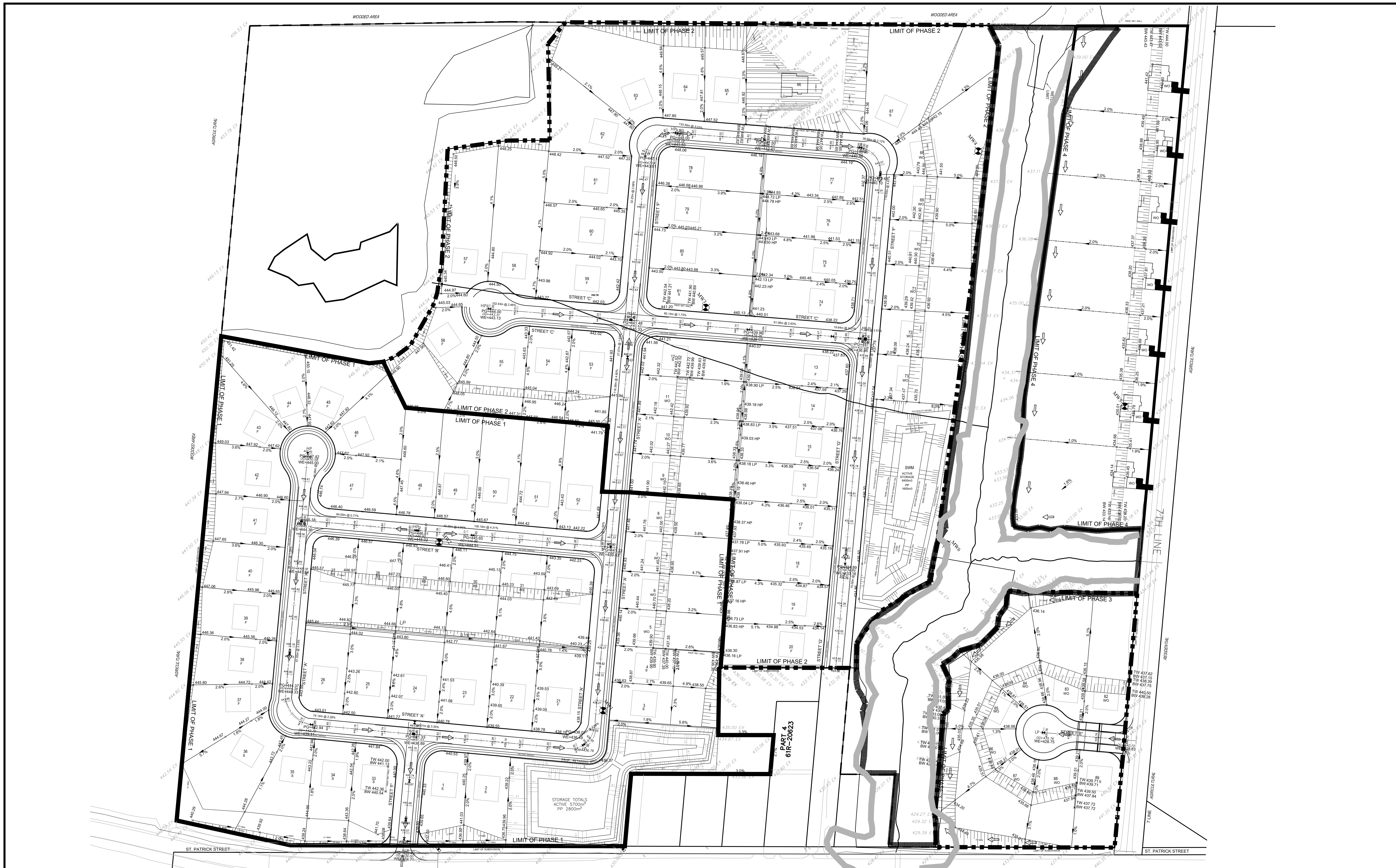
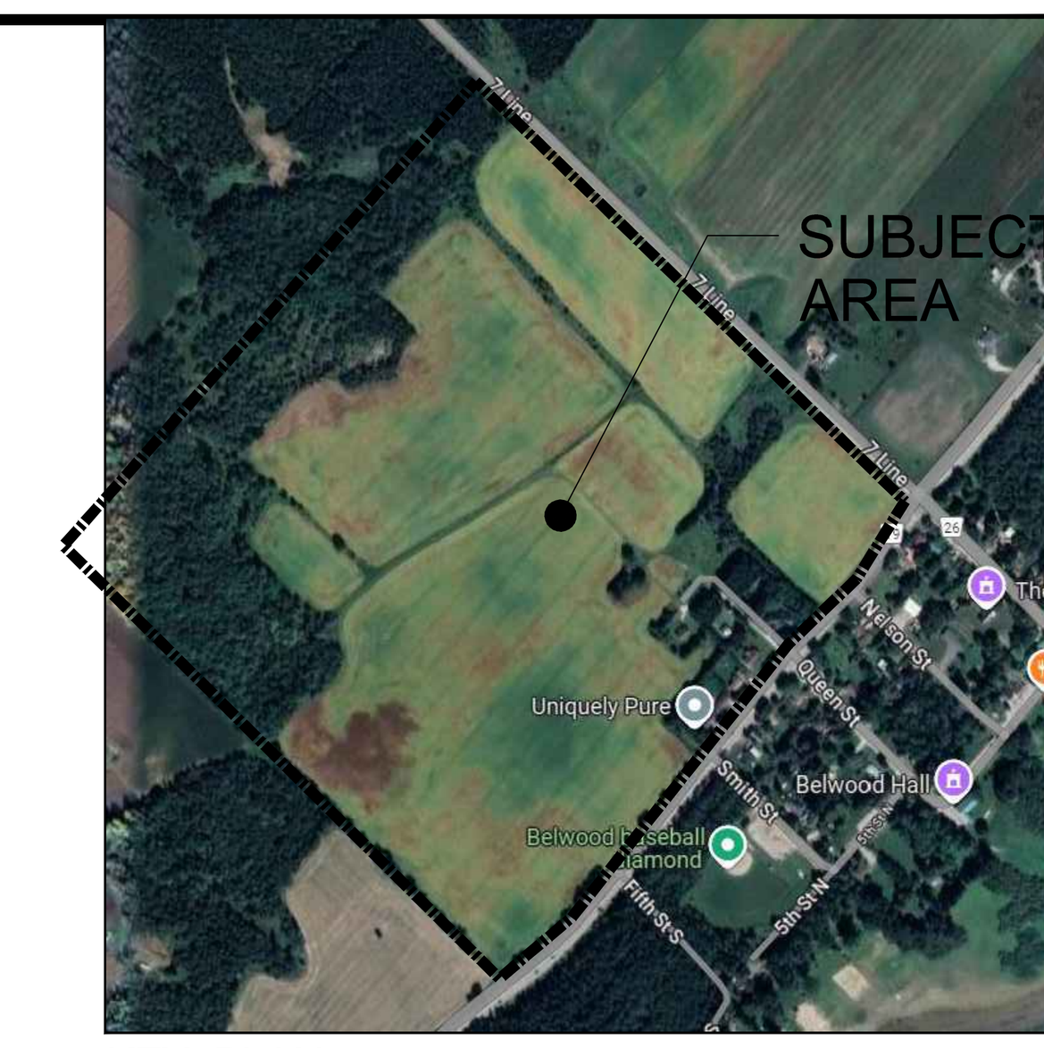
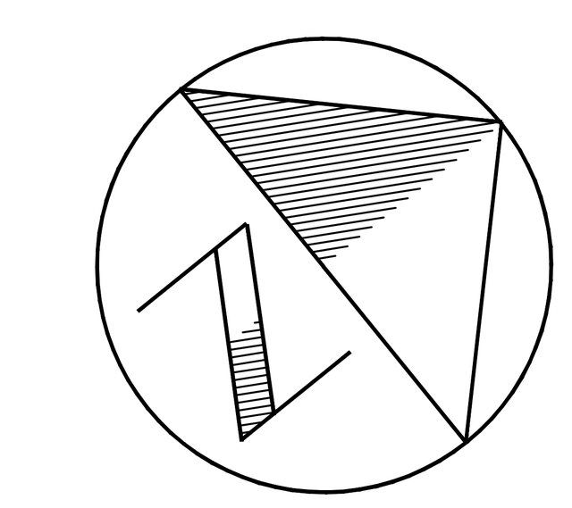




KEY PLAN



LEGEND

435.93 EX	EXISTING ELEVATION
436.14	PROP. ELEVATION
WE=429.50	WATER TABLE ELEVATION
434.00	EX. CONTOUR
2.0%	PROP. GRADE
	PROPOSED SLOPING (AS NOTED ON DWG)
	OVERLAND FLOW
WO,BS,S,F	LOT TYPES (WALK OUT, BACK SPLIT, SPLIT, FRONT DRAINING)
	PROP. STORM MANHOLE
	PROP. STORM CATCHBASIN MANHOLE
	PROP. CATCHBASIN
	PROP. DOUBLE CATCHBASIN
	PROP. VALVE AND BOX / HYDRANT
	LIMIT OF PHASE
	LIMIT OF ENVIRONMENTAL PROTECTION AREA
	HAZARD LIMIT

STAMP

CONSULTANT wsp

APPROVALS

NO.	DATE	REVISIONS

DESIGN		CHECKED	
DRAWN		CHECKED	
REFERENCES:			
FIELD NOTES:			

DATE

SCALE 1:1000 (0 5 10 20)

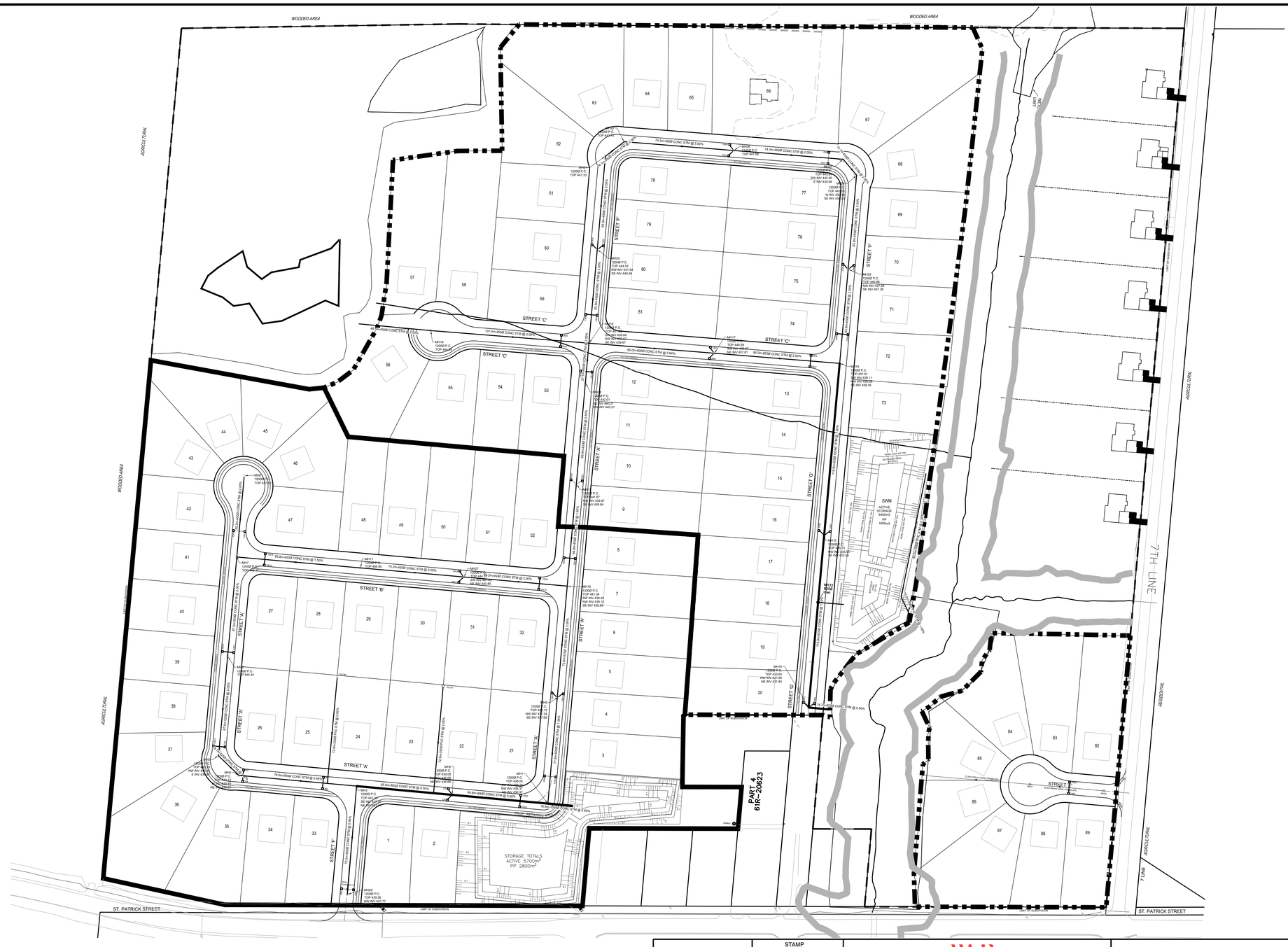
MUNICIPALITY

BELWOOD DEVELOPMENT
BEL CAL INC.

TITLE

PRELIMINARY GRADING PLAN
(PROPOSED CONDITION)

MUNICIPAL DRAWING No.	REGIONAL FILE No.
Consultant File No. WW22011051	DRAWING No. GP0



LEGEND

- PROP. STORM MANHOLE & PIPE
- PROP. STORM CATCHBASIN MANHOLE & PIPE
- CB□ PROP. CATCHBASIN
- DCB□□ PROP. DOUBLE CATCHBASIN
- ⋈ V&B VALVE AND BOX
- ⊗ V&C VALVE AND CHAMBER
- H&V HYDRANT AND VALVE
- DOUBLE SANITARY AND STORM SEWER LATERAL
- WATER SERVICE LATERAL
- LIMIT OF SUBDIVISION
- LIMIT OF ENVIRONMENTAL PROTECTION AREA
- TACTILE SURFACE INDICATOR
- HAZARD LIMIT

STAMP

CONSULTANT wsp

APPROVALS

NO.	DATE	REVISIONS

DESIGN | CHECKED | DATE
DRAWN | CHECKED | SCALE 1:1000 (0 5 10 20)
REFERENCES:
FIELD NOTES:

MUNICIPALITY

BELWOOD DEVELOPMENT
BEL CAL INC.

TITLE

PRELIMINARY SERVICING PLAN
(PROPOSED CONDITION)

MUNICIPAL DRAWING No.	REGIONAL FILE No.
Consultant File No. WW22011051	DRAWING No. SS0

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PLOTDATE: Oct 06, 2025 - 1:48pm, CAM139024

APPENDIX

A BACKGROUND INFORMATION

Senior, Matthew

From: Lee Wheildon <LWheildon@centrewellington.ca>
Sent: July 11, 2024 4:25 PM
To: Senior, Matthew; ron@scheckenberger.ca
Cc: Colin Baker
Subject: BelCal Brief

Matt/Ron,

Township Staff have completed a review of the Technical Memorandum submitted to Staff re: Brief of Hybrid Road Sections – BelCal Development (Belwood) dated June 21, 2024.

With initial discussions, Township Staff noted that Urban Roadway Standards are preferred, however hybrid (urban/rural) could be considered. Through additional comments provided by Township Staff from March 7, 2024, and a follow up meeting on March 15, 2024, WSP had discussed the preparation of a Technical Memorandum be submitted to Township Staff to provide further feedback/insight into the request for a hybrid road section for the proposed development.

Township Staff kept an open mind as it related to incorporating proposed LID measures for the BelCal Development (Belwood) specifically the request for a hybrid road cross-section including bio-swales however, with the receipt and review of the Technical Memorandum (including the potential opportunities/advantages as noted by WSP Staff), Township Staff have serious concerns that remain including but not limited to:

- introducing chlorides into the groundwater system from road, sidewalk, and driveway deicing operations;
- road icing due to proposed superelevation of all the proposed subdivision roadways (including cul de sacs) and a lack of a storm sewer system on the high side of the road;
- the memorandum discussed the elimination of driveway culverts, but from the existing design approach this does not appear to be feasible without the installation of significantly more DICB's than what the plans are currently (which would result in additional operation maintenance and costs);
- unknown depths to groundwater (throughout the site) from the bottom of the proposed bio-swales and on-site soil conditions;
- various ditches proposed through internal blocks with no outlet discussed/shown on how this will complement the hybrid cross-section;
- concerns with winter maintenance as it relates to snow removal and storage (e.g., ensuring positive drainage throughout bioswales and limiting any ice damming at multiple DICB outlet locations, etc.);
- future maintenance associated with sediment build-up and removal in roadside swales and future resident complaints/concerns regarding swale drainage, culverts, and cleanouts;
- impacts of underground utilities in the road allowance; and
- no examples of the proposed hybrid road approach being successfully implemented in municipalities where groundwater is utilized for potable drinking water (private wells) provided .

As a result of the above noted concerns, Township Staff require that the Bel Cal Subdivision (Belwood) be designed in accordance with Township's Development Standards for rural subdivisions.

Staff believe that there are opportunities to apply private side LID measures (where groundwater and soil conditions allow) however, further exploration on this will be required to ensure that adequate SWMF sizing, and design can be achieved for the proposed development.

Should it prove beneficial, Staff can provide recent example(s) of rural subdivision applications within the municipality that are in accordance with the Township's development standards. Please reach out if this would be of assistance.

Should you have any questions or concerns, please do not hesitate to contact me.

Regards,

Lee Wheildon C.E.T.,rcca | Supervisor of Development Engineering

Township of Centre Wellington | 1 MacDonald Square, Elora, ON N0B 1S0
519.846.9691 x253 CentreWellington.ca

MEMORANDUM

To: **Brett Salmon and Lee Weildon**

From: **Stovel and Associates Inc.**

Date: **June 10, 2025**

RE: **Update – BelCal Proposed Residential Subdivision - Belwood**

The BelCal study team has completed revisions to the proposed development concept. The revisions include the following:

- The proposed lot yield for the draft plan of subdivision has been reduced from 107 lots to 88 lots, with 7 proposed lots to be created on 7th Line via consent (Figure 1).
- The 7 lots on 7th Line would be 1 acre in size (see Figure 2). Our plan would be to apply to sever three of these lots from the site this fall.
- The subdivision has been engineered to provide a full urban road cross-section and to minimize the importation of fill.
- Three phases have been proposed for the subdivision, with the first phase yielding approximately 40 lots.
- The main entrance for the site has been set directly across from Fifth St. South in Belwood, as directed by the County.
- During the 1st phase of the development, the Queen St. entrance can be used as a secondary/emergency entrance as needed.
- The 1st phase of development will be serviced by a stormwater facility located in the southeast corner of the site, abutting Wellington Road 19 (see Figure 3).
- The 2nd phase of the development will be serviced by a stormwater management facility located west of the main drain/watercourse on the site. The location for this facility is essentially the same as what was initially proposed.
- As previously documented, the proposed development would be serviced by private individual services including drilled bedrock wells and septic systems with tertiary treatment.
- As we understand it, the woodlot in the northwest portion of the site will be deeded to the Township as part of the parkland dedication.
- We have identified an area east of the Queen Street extension that could be used for a community park as part of the Phase 2 development.
- The plantation in the northern portion of the site will remain in its current condition.

Let us know if you have any concerns or questions. We can set up a meeting with our team and your staff soon if you think it would be useful.

Regards,

Rob Stovel

Robert P. Stovel

Stovel and Associates Inc. 651 Orangeville Road, Fergus, ON N1M 1T9 519 766-8042

Meters
50 0 50 100

1:1250

NORTH

WOODED AREA

AGRICULTURAL

PROPOSED ARCH

PHASE 1

PHASE 2

PHASE 3

STREET 'A'

STREET 'B'

STREET 'C'

STREET 'E'

STREET 'F'

STREET 'G'

NOT PART OF DEVELOPMENT SEE FIGURE 2

ADDITIONAL LANDS OWNED BY APPLICANT

7TH LINE

SWM
ACTIVE STORAGE 6400m3
PP 1900m3

PROP. RETAINING WALL
T/G 432.00
P/F 434.40
INV 433.40

PROP. RETAINING WALL
T/G 432.00
P/F 434.40
INV 433.40
T/G 430.00
INV 429.40
T/G 429.00
INV 428.40

STORAGE TOTALS
ACTIVE 5700m³
PP 2800m³

PART 4
61R-20623

ST. PATRICK STREET

WELLINGTON RD 19

ENVIRONMENTAL PROTECTION | OPEN SPACE | SMITH STREET | RESIDENTIAL | QUEEN STREET | RESIDENTIAL | NELSON STREET | RESIDENTIAL | CEDAR ALLEY | RESIDENTIAL | NORTH BROADWAY STREET | RESIDENTIAL

KEYMAP

LOT BREAKDOWN

PHASE NO.	NO. OF LOTS	LOTS
PHASE 1	40	1 - 8, 21 - 52
PHASE 2	40	9 - 20, 53 - 80
PHASE 3	8	81 - 88

1. THIS IS NOT A PLAN OF SURVEY.
2. ALL UNITS SHOWN ARE IN METRES, UNLESS OTHERWISE NOTED.

NO.	DATE	REVISION

DO NOT SCALE DRAWINGS. ALL DIMENSIONS SHALL BE VERIFIED BY CONTRACTOR DURING THE COURSE OF WORK.

SAI
PLANNING, AGROLOGY, ENVIRONMENTAL

651 Orangeville Road
Fergus, Ontario N1M 1T9
Email: stovel.assoicates@outlook.com
Phone: (519) 766-8042

PROJECT

DRAWING
FIGURE 1
SITE PLAN

DRAWN SAI	SCALE: 1:1250
CHECKED ---	DATE: June 10, 2025
PROJECT NO. BC-1	DRAWING NO. SP-1

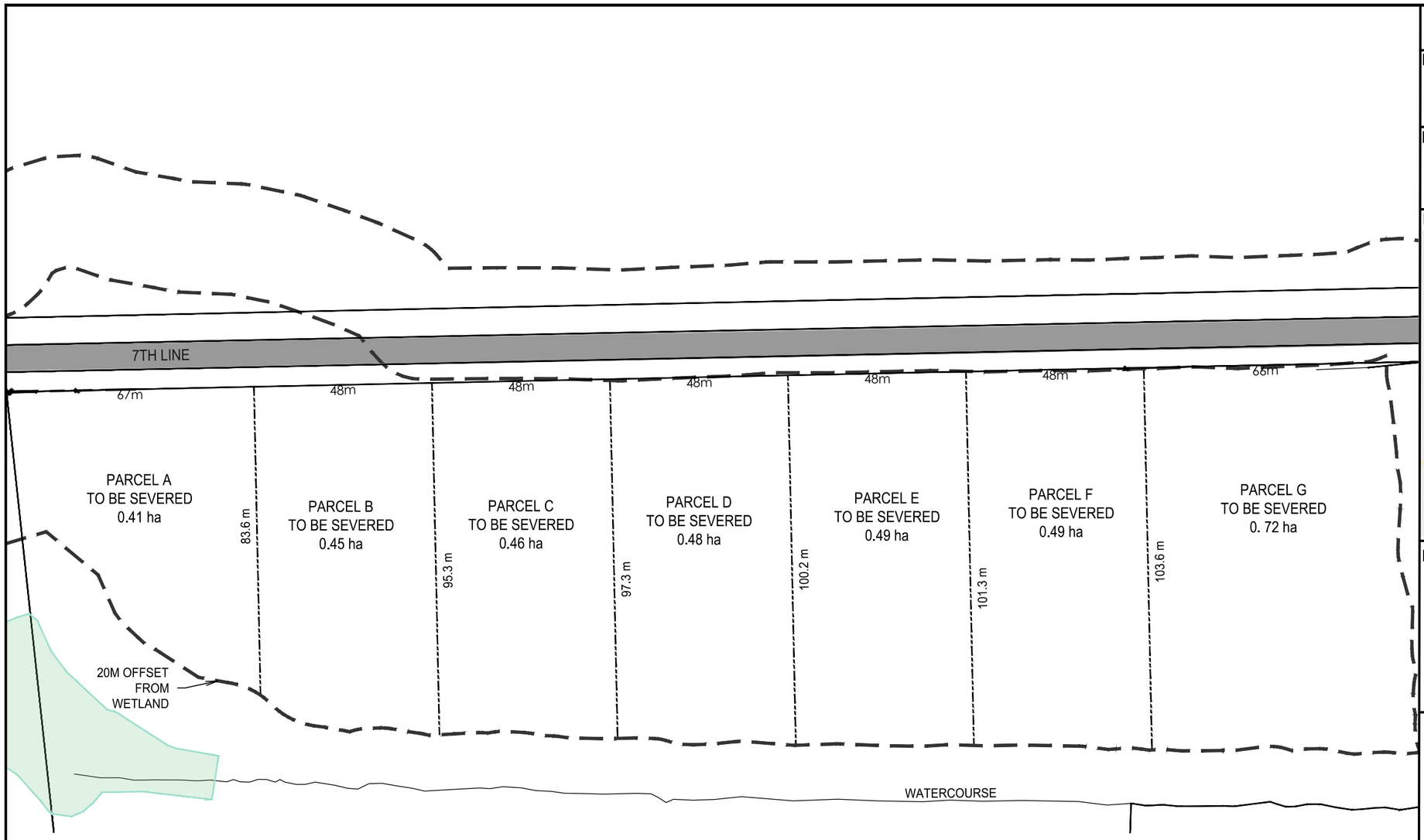


FIGURE 2 - PROPOSAL (7 LOTS)

LEGAL DESCRIPTION

6640 SEVENTH LINE BELWOOD, ONTARIO
LOT 12, CONCESSION 7

NOTES

1. THIS IS NOT A PLAN OF SURVEY.
2. ALL UNITS SHOWN ARE IN METRES, UNLESS OTHERWISE NOTED.

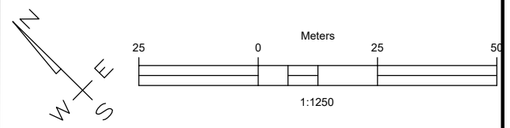
KEYMAP

LEGEND

- PROPOSED LOTS TO BE SEVERED
- WATERCOURSE (GRCA)
- WETLAND (GRCA)
- SETBACK

Land Use Table	
Parcel	*Area (ha)*
Parcel A	0.41
Parcel B	0.45
Parcel C	0.46
Parcel D	0.48
Parcel E	0.49
Parcel F	0.49
Parcel G	0.72

CLIENT: BELCAL INC.

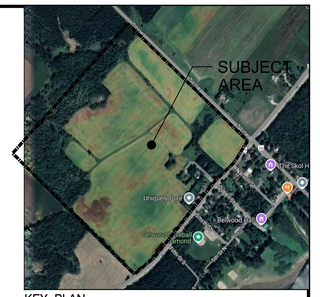


SAI
PLANNING. AGROLOGY.
ENVIRONMENTAL.

STOVEL and ASSOCIATES INC.

651 ORANGEVILLE ROAD
FERGUS, ONTARIO
N1M 1T9
P: 519-766-8042
E: stovel.associates@outlook.com

6/9/2025



KEY PLAN

LEGEND

435.93 EX	EXISTING ELEVATION
+ 436.14	PROP. ELEVATION
+ WE=429.50	WATER TABLE ELEVATION
434.00	EX. CONTOUR
2.0%	PROP. GRADE
	PROPOSED SLOPING (AS NOTED ON DWG)
	OVERLAND FLOW
WO,BS,S,F	LOT TYPES (WALK OUT, BACK SPLIT, SPLIT, FRONT DRAINING)
	PROP. STORM MANHOLE
	PROP. STORM CATCHBASIN MANHOLE
	PROP. SANITARY MANHOLE
	PROP. CATCHBASIN, DOUBLE CATCHBASIN
	PROP. VALVE AND BOX / HYDRANT
	LIMIT OF SUBDIVISION

STAMP

CONSULTANT wsp

APPROVALS

NO.	DATE	REVISIONS

DESIGN | CHECKED | DATE

DRAWN | CHECKED | SCALE 1:1000

REFERENCES:

FIELD NOTES:

MUNICIPALITY

BELWOOD DEVELOPMENT
BEL CAL INC.

TITLE

PRELIMINARY GRADING PLAN
(PROPOSED CONDITION)

MUNICIPAL DRAWING No.	REGIONAL FILE No.
Consultant File No. WW22011051	DRAWING No.

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PLOTTED: Aug 19, 2022 - 1:56pm CASA-1\3288

APPENDIX

B AQUALOGIC REPORT

Headwater Drainage Feature Assessment
Fluvial Geomorphology Components
& Meander Belt Analysis
Belwood Lake Tributary
Township of Centre Wellington

Submitted to:

WSP E & I Canada Limited
3450 Harvester Road, Suite 100
Burlington, ON L7N 3W5

DRAFT August 30, 2022, December 13, 2022 / FINAL May 24, 2023

AquaLogic Consulting • 324 St. Paul Street, Burlington, ON L7R 3J9 • (905) 637-1862 • bill.degeus@sympatico.ca

Headwater Drainage Feature Assessment
Fluvial Geomorphology Components
& Meander Belt Analysis
Belwood Lake Tributary
Township of Centre Wellington

Headwater drainage feature assessment has been done for the fluvial geomorphology characteristics of five reaches of a Belwood Lake Tributary. Assessment has been done to help establish baseline constraints to future development opportunities on adjacent lands. Four qualitative assessment protocols have been undertaken, including Rapid Geomorphic Assessment (RGA) (MOEE 2003), Rapid Habitat Assessment (RHA) (USEPA 2004), the Rapid Stream Assessment Technique (RSAT) (Galli 1996), and the Hydrology Classification component of the Evaluation, Classification, and Management of Headwater Drainage Features Guidelines (HDFG) (TRCA & CVCA 2014).

Analysis of meander belt limits has also been done with regard to future development considerations. Lacking measurable historical planform patterning in the straightened reaches, an empirical approach has been used to define the meander belt component of integrated corridor constraints.

Watershed and Watercourse Characterization

The Belwood Lake Tributary is a 2nd order feature with a cumulative drainage area of approximately 1.27 km^2 to Wellington Road 19. An appended drainage area figure shows the five reaches and respective catchment area breakdown. The study area is in the Hillsburgh Sandhills physiographic region and land use within the site boundaries is dominantly tilled agricultural with some swamp and upland forest, and some legacy plantation forest. Historically the study site has been agricultural for at least several decades as seen in the appended 1937 mapping and 1954 air photo. The reaches all appear to be man-made drainage features, constructed to facilitate field drainage. The 1937 mapping only shows the Main Branch at Wellington Road 19 and the equivalent of the current East Reach downstream from 7th Line. The 1954 air photo suggests all reaches as they currently exist were likely in place at this time step. The alignments appear generally similar as present day except for the mid-point area of the West Reach which at some interim point has been more directly straightened.

In current times, zero order drainage features (as defined in/by TRCA 2007) are also seen in a few locations within and adjacent to the study site. On-site locations are, a) at the upstream end of the West Reach where it originates from the north in a study site woodlot, and b) just below the West Reach upstream end and perpendicular between fields to the north. The two off-site but adjacent locations are, a) on the East Reach perpendicular from 7th Line at the crossing, and b) from the upstream end of the North Reach westerly into the off-site woodlot. By typical characterization and definition, the two zero order connectors to the West Branch, within the site, are too minor in terms of drainage area and function to warrant further discussion.

An appended photo inventory shows a range of overview typical conditions and detailed features across the study site reaches. Example photos from both May and August are shown for Spring and Summer comparison. Photos from May show observed baseflow and post dormant vegetation. August photos show the advanced encroachment of growing season vegetation and typically no flow in any reach, with some standing water in the Main Branch. The majority of the length of all reaches, except for the Main Branch, have riparian conditions dominated by dense groundcover with varying degrees of shrub thicket density. The Main Branch enters a mix of natural and plantation forest cover, with resultant shading limiting groundcover growth in the area above Wellington Road 19. All features have relative swale type or man-made trapezoidal geometry, with the West Reach + North Reach and Main Branch showing more definition of active channel bed and banks and some low flow meandering and profiling of riffle features with coarser gravels and cobble. The North Reach specifically originates from a wetland area just above the northerly site boundary and thus appears to provide a continuum function with high value external systems. The upstream end of the North Reach has a short segment of steeper gradient and meandering over gravels and some cobble. Further downstream, wetland vegetation emerges along the North Reach in the form of cattail stands and dogwood thickets. The East Reach is seen in air photos to originate from an off-site man-made pond and may therefore be affected by some level of flow regulation. The East Reach lacks a well-defined low flow and discharge in Spring was seen flowing opportunistically through vegetation. The West Reach has a distinct knickpoint drop near its downstream end which thus creates a vertical barrier to any aquatic habitat consideration. The Main Branch has a man-made low head dam, made of large cobble grouted with concrete, approximately 25m above Wellington Road 19, which also creates a distinct aquatic habitat barrier. Concrete culverts exist in two locations on the West Reach and the West Reach + North Reach, that facilitate existing field access. Localized erosion scars exist on the West Reach + North Reach below the culvert crossing and extensive erosion scars are seen on the Main Branch.

Rapid Assessment Protocols

Rapid assessment inspections were done at two time points, early May and mid August, to confirm differences between typical seasonal conditions of Spring and Summer. Many individual variables in respective protocols will score the same between seasons, but there are some key differences. The RGA protocol is typically best done in the Spring when vegetation is not in leaf and obscuring observations that might otherwise bias Summer only scoring to be higher. In systems that are base flow challenged, the Summer inspection is typically more accurate with regard to observations of physical habitat performance. The RHA and RSAT protocols will typically score lower in Summer, as a result. A lack of base flow yield in Summer will also result in the Spring HDFG characterization typically identifying flow conveyance functions more accurately.

Analysis using Rapid Geomorphic Assessment (RGA) was done to rate feature stability and infrastructure impact, Rapid Habitat Assessment (RHA) was done for definition of in-stream and riparian habitat, and Rapid Stream Assessment Technique (RSAT) was done to test broad indicators of stability, aquatic habitat, and water quality. A weighted score out of 100 was transposed from the results of each protocol and a combined average score was determined from

the three tests. Four qualifying ranges of optimal, good, fair, and poor are maintained in the RHA and RSAT protocols, between the original scoring and weighted scoring out of 100, while the three original ranges in RGA scoring are reflected as optimal, good-fair, and fair-poor (urban vs. natural conditions considered). The combined average score is qualified by optimal to poor ranges designed as a best fit of the individual protocol ranges. The detailed results are appended. Scoring results are summarized in Table 1.

Table 1: Rapid Assessment Results Summary

	RGA	RHA	RSAT	combined
West Reach - May	87.9	58.0	60.0	68.0
West Reach - Aug.	87.9	52.5	60.0	66.8
North Reach - May	90.4	75.0	76.0	80.5
North Reach - Aug.	90.4	64.5	72.0	75.6
West + North - May	88.9	72.0	72.0	77.6
West + North - Aug.	88.9	61.5	68.0	72.8
East Reach - May	92.9	62.5	70.0	75.1
East Reach - Aug.	92.9	58.5	60.0	70.5
W + N + E, Main Branch - May	58.6	62.0	62.0	60.9
W + N + E, Main Branch - Aug.	58.6	53.5	60.0	57.4

RGA Rapid Geomorphic Assessment
RHA Rapid Habitat Assessment
RSAT Rapid Stream Assessment Technique

Combined Assessment
Optimal 100-80 / Good 80-56 / Fair 55-30 / Poor 29-0

The RGA results confirm that four reaches are dynamically stable but the Main Branch reach is unstable. Levels of confinement and entrenchment on the Main Branch have resulted in bank erosion scars. Widening is the dominant current channel evolution process on the Main Branch. The RHA and RSAT scoring are biased higher in Spring due to observed levels of flow in all reaches. The Summer inspection confirmed however that no observable tailwater flow was occurring in any reach. Standing water was seen sporadically, with nominal flow just at the study area downstream limit at Wellington Road 19. At the next Main Branch road crossing outside the study area and close to Belwood Lake, George Street, there was no observed flow in August. Some ponded standing water was seen in Summer specifically at the 7th Line culvert crossing of the East Reach which was also the only location upstream of Wellington Road 19 seen in Spring to have fish present. No fish were seen in the Summer at this location. Some fish were seen at both time step inspections in ponded water at Wellington Road 19. The permanent year-round presence of aquatic organisms does not appear viable over most of the study area, and seasonal presence at time of ephemeral Spring flow appears to be highly constrained.

The Hydrology Classification component of the Evaluation, Classification, and Management of Headwater Drainage Features Guidelines (HDFG) (TRCA & CVCA 2014) was done to add characterization detail of the physical form and function of each reach. Inspection was specifically undertaken to identify in greater detail the differences in flow conditions and flow classification. Results are shown on the appended scoring pages and are summarized in Table 2. The results show that Spring flow classification suggested perennial flow conditions might exist on all but the West Reach. The Summer inspection confirmed however that a significant lack of base flow yield occurs over the whole study area. The seasonal drop off leaves small pockets of standing water between rainfalls in some spots. Intermittent flow from larger rain events likely occurs with interstitial flow subsequently happening on the Main Branch during Summer. The presence of various observed tile drain outlets does not appear to add low flow yield enhancement in the Summer. The qualitative results of hydrology classification suggest that the West Reach has nominal in-situ function but that all other reaches have relatively significant seasonal conveyance performance, which increases in importance moving downstream as drainage areas become confluent. All reaches, except for the West, are therefore identified for some level of protection. The East Reach could be considered for conservation, versus strict protection management, which arguably would allow for physical realignment alteration if land use planning can benefit.

Table 2: Headwater Drainage Feature Hydrology Classification

	QC	FC	FT	RM
West Reach - May	C	3	1+5+7	F
West Reach - Aug.	E	1	1+5+7	F
North Reach - May	A	5	1+5	A
North Reach - Aug.	B+C	2	1+5	A
West + North - May	A	5	1+5	A
West + North - Aug.	B+C	2	1+5	A
East Reach - May	A	5	1+5	A
East Reach - Aug.	D	2	1+5	B
W + N + E, Main Branch - May	A	5	1+5	A
W + N + E, Main Branch - Aug.	B	3	1+5	A

QC Flow Classification: A - perennial, B - intermittent, C - ephemeral,
D - dry or standing water w/recharge, E - dry or standing water w/no recharge

FC Flow Condition: 1 - no surface water, 2 - standing water,
3 - interstitial flow, 4 - <0.5l/sec, 5 - >0.5l/sec

FT Feature Type: 1 - defined bed & banks, 2 - channelized historically, 3 - multi-thread,
4 - no defined feature, 5 - tile drain, 6 - wetland, 7 - swale, 8 - roadside ditch, 9 - online pond outlet

RM Recommended Management:
A - protection, B - conservation, C - mitigation, D - recharge protection,
E - maintain/replicate terrestrial linkage, F - no management

Meander Belt Analysis

Based on the history of past drainage feature alteration, there is a lack of measurable channel meander patterns in each study reach. An empirical calculation of meander belt is realistically the best way to provide supportable recommendations. Regional regression analysis of a variety of fluvial geomorphic variables is possible. It has been demonstrated that the best statistical correlation is typically a regression plot of meander belt limits as a function of drainage area (Howett 2017).

Plotting results are appended showing the full Ontario data record produced by AquaLogic over 20 years of past studies, with three more focussed sample plots that are specific to headwater features defined by 1st to 3rd stream order. The downstream drainage area of each Belwood Lake tributary reach was used in the power regression calculation from the comparative plots. The downstream drainage area node represents a conservative approach to represent the upstream reach length, because incremental drainage area decreases moving upstream.

Provincial guidelines for meander belt characterization do not require additional factors of safety or contingency allowances for features deemed to be unconfined by valley walls (OMNR 2002). Interpretation of confinement and unconfined conditions can vary depending on specific case circumstances. Some consideration of added buffers is in practice used and discussed in other guidelines (TRC 2004) relative to unconfined scenarios. For the current study, it is deemed that the reaches are all unconfined and fall across topography that lacks classic valley wall demarcation. Nonetheless, a factor of safety (FS) equal to 1.2, or 20% contingency, is deemed appropriate to be conservative, but also to not be biased unreasonably high. Based on the data cloud ranges shown in the regression plots, an FS=1.2 falls lower than upper data point outliers. The FS adjustment calculation is shown on the plotting summary. In turn, a ceiling function ($\mathrm{ceil}(x)$) whole number integer adjustment is made to each result to simplify the recommendations. All reaches are summarized, but the West Reach calculation is for context only due to the proposed potential enclosure. Meander belt limits of 16m, 19m, 16m, and 25m respectively, for the North, West + North, East, and Main Branches are recommended.

Plotting empirical meander belt limits on straightened watercourses is a simple exercise of splitting the width over the active channel centreline. The straightened channel is effectively coincident to the meander belt axis.

Conclusions and Recommendations

Headwater drainage feature assessment has been done for the fluvial geomorphology characteristics of five reaches of a Belwood Lake Tributary. Assessment has been done to help establish baseline constraints to future development opportunities on adjacent lands. None of the reaches are in historically natural alignments. The man-made planforms have nonetheless naturalized over time and currently supply flow conveyance functions in the Spring and intermittently at other times of the year. The North Reach, the West Reach + North Reach, and the Main Branch, provide the most significant cumulative function through the study site in terms

of flow conveyance and physical feature corridor linkage. The West Reach has the smallest drainage area and nominal function with limited apparent aquatic habitat significance. The East Reach has minor functional significance but most of its drainage area is external to the study site which thus influences the need to maintain corridor linkages.

It is recommended that the West Reach can be enclosed by future development with stormwater management practices implemented to maintain no adverse change at the confluence with the North Reach. It is recommended that the North Reach, West Reach + North Reach, East Reach, and Main Branch all need to be retained features with appropriate setbacks to adjacent future development. Stormwater targets and controls should also be established on a retained reach-by-reach basis to maintain or improve thresholds for channel stability. The East Reach could be retained through realignment that replicates or improves conditions; however, this may not be geometrically necessary or advantageous to development layout. It is also recommended that the existing culvert crossing on the West Reach + North Reach be removed and localized channel restoration be implemented. It is also recommended that restoration works be implemented to replace the existing dam on the Main Branch with a barrier free channel profile.

Given the lack of natural channel planform alignments, empirically derived meander belt limits were produced for each reach. The empirical meander belt limit approach has proven to be fair and reasonable for definition of new development limits over existing altered watercourses, for use in realignment natural channel designs, and for risk assessments of existing infrastructure. Future development options and scenarios are therefore recommended to apply meander belt limits of 16m, 19m, 16m, and 25m respectively, for the North, West + North, East, and Main Branch reaches.

Prepared by,

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AquaLogic Consulting

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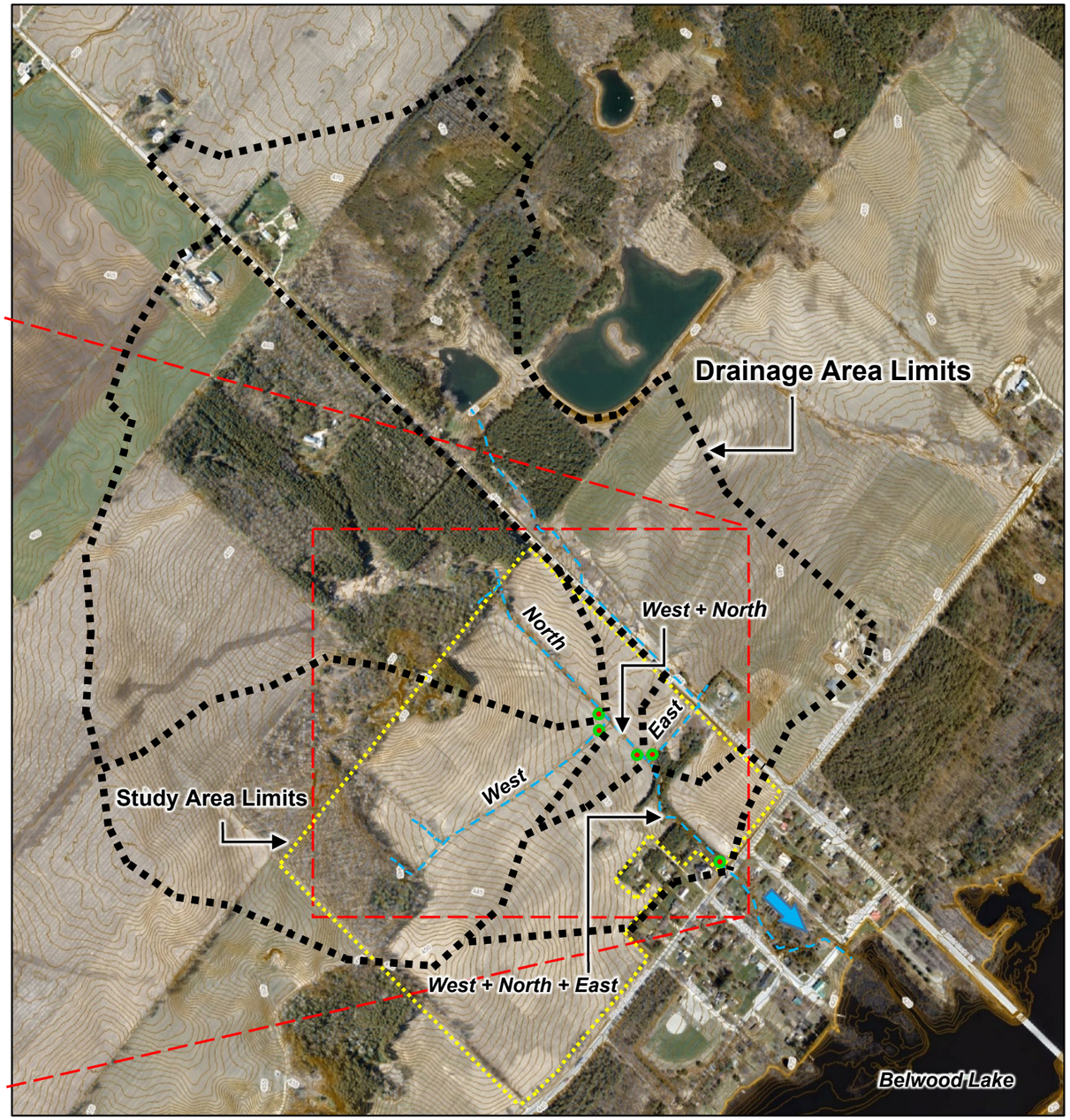
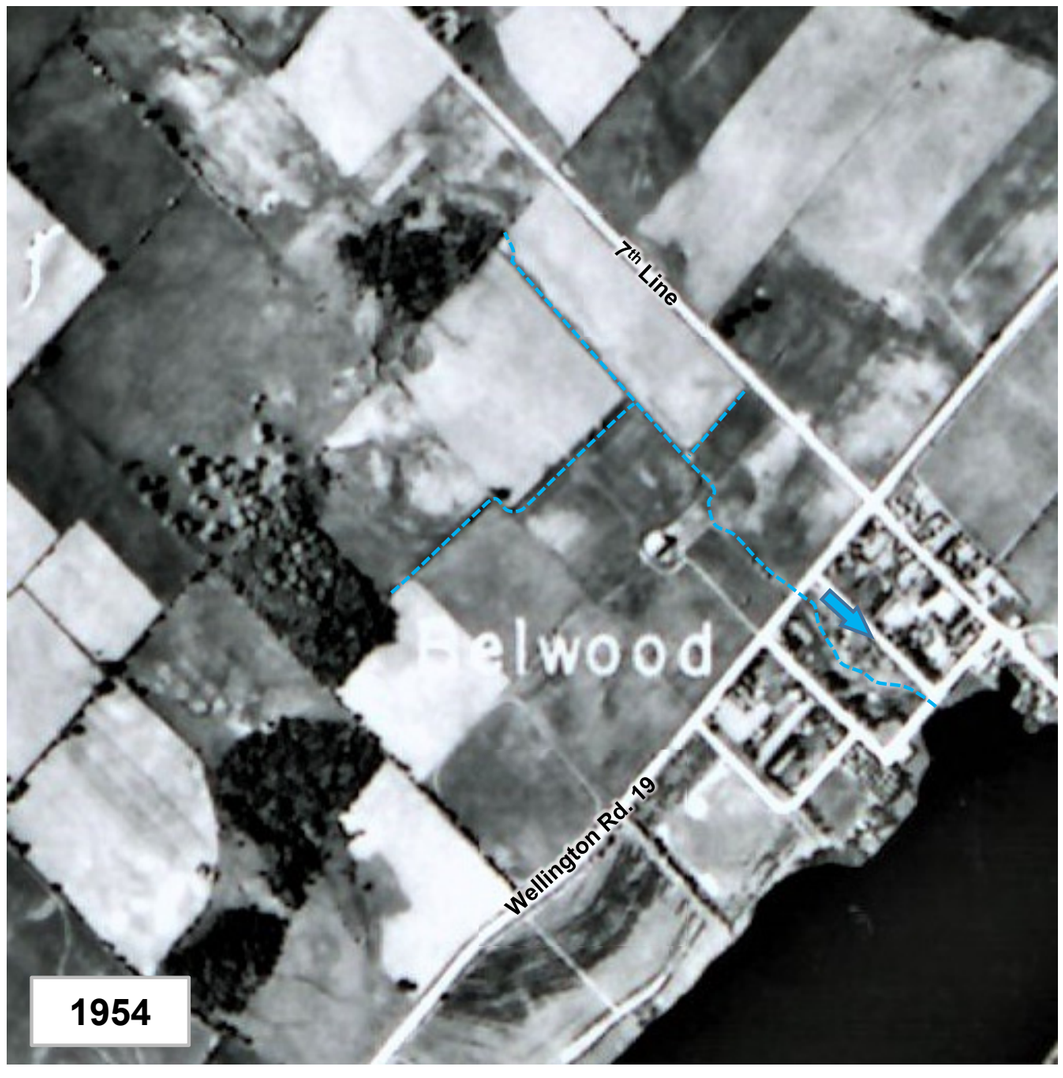
Drainage Areas
Belwood Lake Tributary

West Reach	0.27 km^2
North Reach	0.44 km^2
West Reach + North Reach	0.74 km^2
East Reach	0.44 km^2
West + North + East = Main Branch	1.27 km^2
Total at Belwood Lake	1.44 km^2

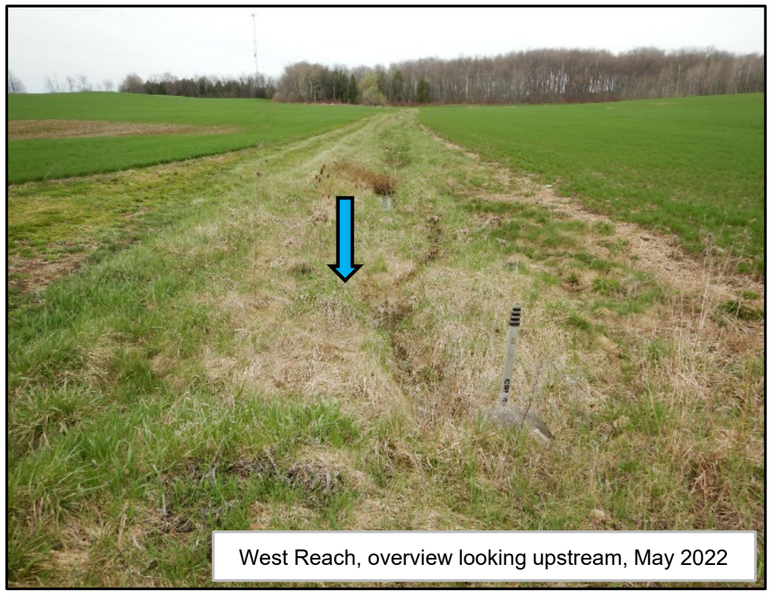


Historic Conditions
Belwood Lake Tributary

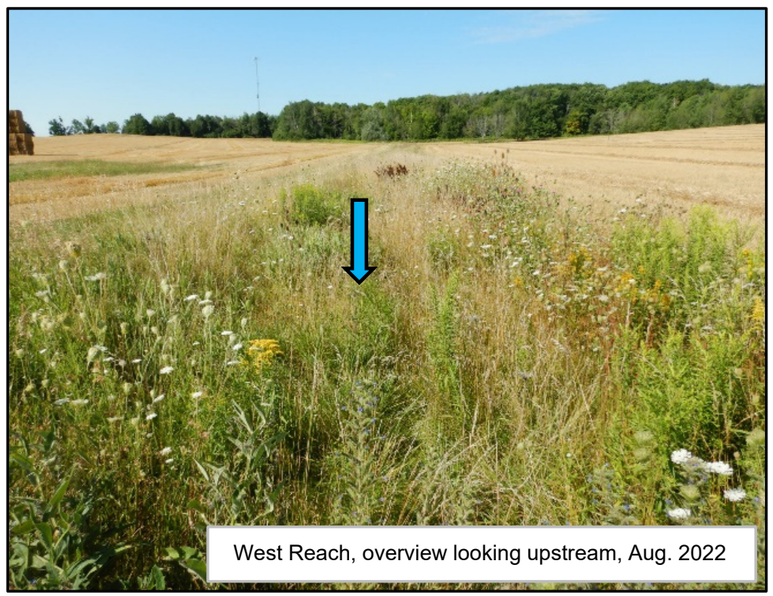
N▲ not to scale



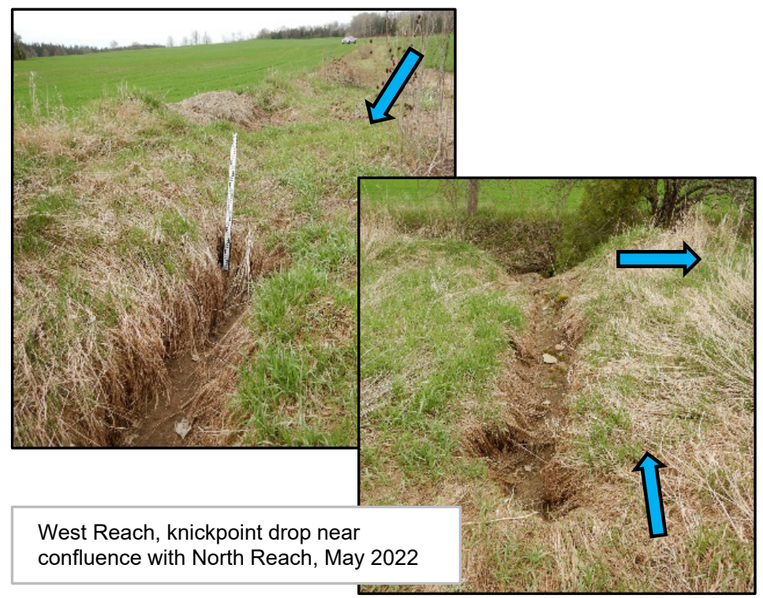
Belwood Lake Tributary, Photo Inventory



West Reach, overview looking upstream, May 2022

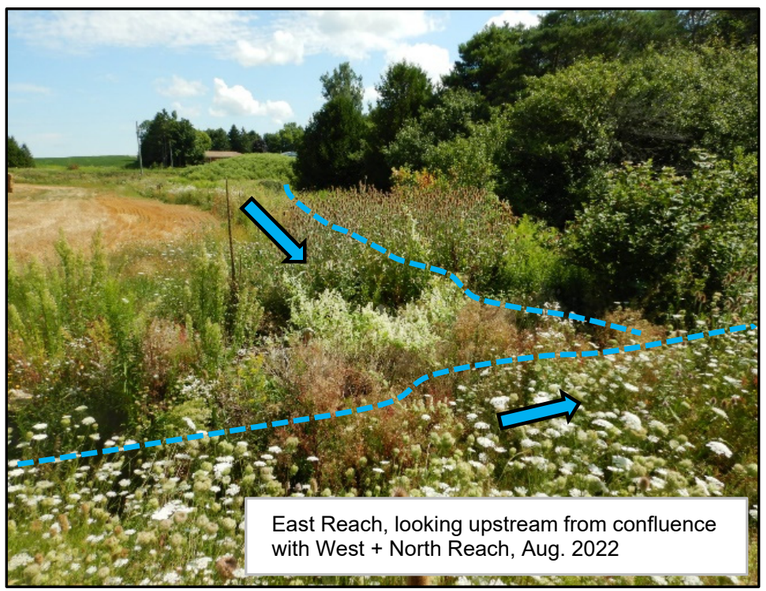


West Reach, overview looking upstream, Aug. 2022



West Reach, knickpoint drop near confluence with North Reach, May 2022

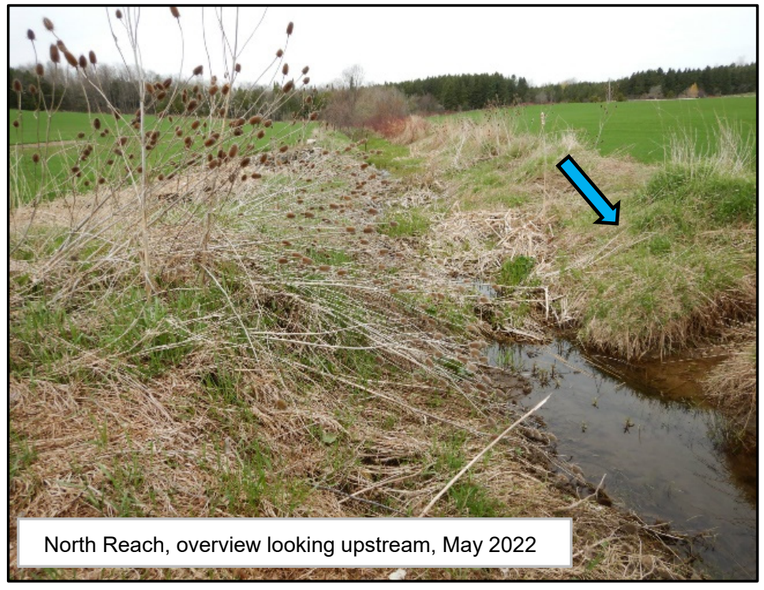
East Reach, looking downstream from near 7th Line, May 2022



East Reach, looking upstream from confluence with West + North Reach, Aug. 2022

East Reach, 7th Line, May 2022

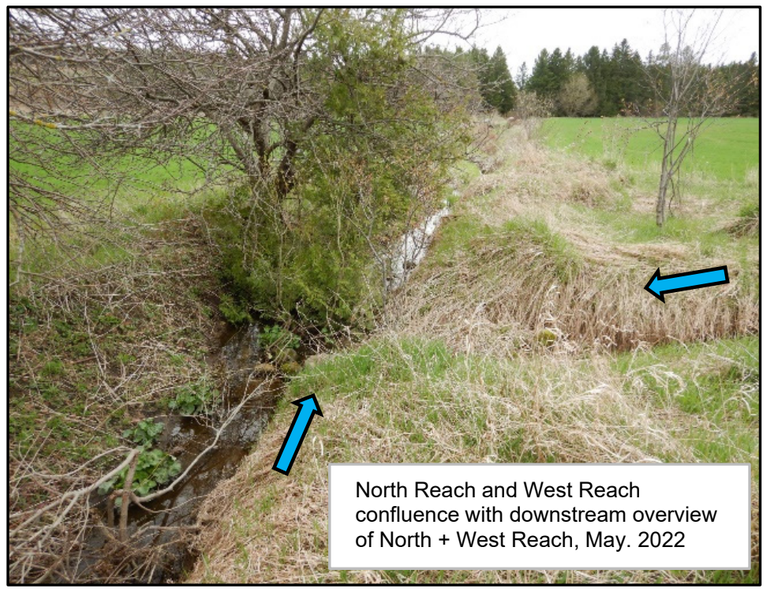
Belwood Lake Tributary, Photo Inventory



North Reach, overview looking upstream, May 2022

North Reach, overview looking upstream, Aug. 2022

North Reach, overview looking downstream, May 2022



North Reach and West Reach confluence with downstream overview of North + West Reach, May. 2022

North + West Reach, overview looking upstream, May 2022

North + West Reach, culvert crossing and local erosion scar, May 2022

Belwood Lake Tributary, Photo Inventory

East Reach and North + West Reach confluence, Main Branch downstream, May. 2022

Main Branch confined bank erosion scar, May. 2022

Main Branch entrenched bank erosion scars and undercuts, May. 2022

Main Branch, looking upstream from Wellington Rd. 19, May and Aug. 2022

Main Branch, dam upstream of Wellington Rd. 19, May and Aug. 2022. with and without flow over top

Main Branch, standing water above and below dam, Aug. 2022

SPRING Assessment Results

GEO-RAP v.2.0 Rapid Assessment Protocol Model

Project: **Headwater Drainage Feature Assessment**
Belwood Lake Tributary, West Reach
SPRING Inspection

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	
	Siltation in pools	
	Medial bars	
	Accretion on point bars	
	Poor longitudinal sorting of bed materials	1
	Deposition in the overbank zone	
	n/7 =	0.14
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	1
	Head cutting due to knick point migration	1
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	
	n/10 =	0.20

Widening	Fallen/leaning trees/fence posts etc.	
	Occurrence of Large Organic Debris	
	Exposed tree roots	
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.00
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	1
	Bar forms poorly formed/reworked/removed	
	n/7 =	0.14
	STABILITY INDEX (SI) = (A + D + W + P) / 4 =	**0.12**
	SI < 0.2	In Regime
	0.2 < SI < 0.4	Transitional
	SI > 0.4	In Adjustment
	100 - (100*SI) =	**87.9**

2) Rapid Habitat Assessment (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	15	20--16	15-11	10-6	5-0
Embeddedness	15	20--16	15-11	10-6	5-0
Velocity / Depth Regime	6	20--16	15-11	10-6	5-0
Sediment Deposition	15	20--16	15-11	10-6	5-0
Channel Flow Status	5	20--16	15-11	10-6	5-0
Channel Alteration	5	20--16	15-11	10-6	5-0
Frequency of Riffles	15	20--16	15-11	10-6	5-0
Bank Stability u/s L	9	10-8	7-6	5-3	2-0
u/s R	9	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	5	10-8	7-6	5-3	2-0
u/s R	5	10-8	7-6	5-3	2-0
/200	116				
/100	**58.0**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	9	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	6	8-7	6-5	4-3	2-0
Physical Instream Habitat	5	8-7	6-5	4-3	2-0
Water Quality	6	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	4	7-6	5-4	3-2	1-0
Biological Indicators	0	8-7	6-5	4-3	2-0
/50	30				
/100	**60.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

1) - 3) Combined Assessment

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =	**68.6**	100-80	80-56	55-30	29-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =		100-80	80-56	55-30	29-0

4) TRCA & CVCA Headwater Drainage Features Guideline (HDFG)

DA (ha)	QC	FC	FT	RM
28.5	**C**	**3**	**1+5+7**	**F**

QC — Flow Classification: A - perennial, B - intermittent, C - ephemeral, D - dry or standing water w/recharge, E - dry or standing water w/no recharge

FC — Flow Condition: 1 - no surface water, 2 - standing water, 3 - interstitial flow, 4 - <0.5l/sec, 5 - >0.5l/sec

FT — Feature Type: 1 - defined bed & banks, 2 - channelized historically, 3 - multi-thread, 4 - no defined feature, 5 - tile drain, 6 - wetland, 7 - swale, 8 - roadside ditch, 9 - online pond outlet

RM — Recommended Management: A - protection, B - conservation, C - mitigation, D - recharge protection, E - maintain/replicate terrestrial linkage, F - no management

References

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3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

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GEO-RAP v.2.0 Rapid Assessment Protocol Model

Project: **Headwater Drainage Feature Assessment**
Belwood Lake Tributary, North Reach
SPRING Inspection

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	
	Siltation in pools	
	Medial bars	
	Accretion on point bars	1
	Poor longitudinal sorting of bed materials	
	Deposition in the overbank zone	
	n/7 =	0.14
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	1
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	
	n/10 =	0.10

Widening	Fallen/leaning trees/fence posts etc.	
	Occurrence of Large Organic Debris	
	Exposed tree roots	
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.00
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	1
	Bar forms poorly formed/reworked/removed	
	n/7 =	0.14
	STABILITY INDEX (SI) = (A + D + W + P) / 4 =	**0.10**
	SI < 0.2	In Regime
	0.2 < SI < 0.4	Transitional
	SI > 0.4	In Adjustment
	100 - (100*SI) =	**90.4**

2) Rapid Habitat Assessment (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	17	20--16	15-11	10-6	5-0
Embeddedness	17	20--16	15-11	10-6	5-0
Velocity / Depth Regime	12	20--16	15-11	10-6	5-0
Sediment Deposition	15	20--16	15-11	10-6	5-0
Channel Flow Status	15	20--16	15-11	10-6	5-0
Channel Alteration	11	20--16	15-11	10-6	5-0
Frequency of Riffles	15	20--16	15-11	10-6	5-0
Bank Stability u/s L	9	10-8	7-6	5-3	2-0
u/s R	9	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	8	10-8	7-6	5-3	2-0
u/s R	8	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
/200	150				
/100	**75.0**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	9	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	7	8-7	6-5	4-3	2-0
Physical Instream Habitat	7	8-7	6-5	4-3	2-0
Water Quality	6	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	6	7-6	5-4	3-2	1-0
Biological Indicators	3	8-7	6-5	4-3	2-0
/50	38				
/100	**76.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

1) - 3) Combined Assessment

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =	**80.5**	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

4) TRCA & CVCA Headwater Drainage Features Guideline (HDFG)

DA (ha)	QC	FC	FT	RM
44	**A**	**5**	**1 + 5**	**A**

QC — Flow Classification: A - perennial, B - intermittent, C - ephemeral, D - dry or standing water w/recharge, E - dry or standing water w/no recharge

FC — Flow Condition: 1 - no surface water, 2 - standing water, 3 - interstitial flow, 4 - <0.5l/sec, 5 - >0.5l/sec

FT — Feature Type: 1 - defined bed & banks, 2 - channelized historically, 3 - multi-thread, 4 - no defined feature, 5 - tile drain, 6 - wetland, 7 - swale, 8 - roadside ditch, 9 - online pond outlet

RM — Recommended Management: A - protection, B - conservation, C - mitigation, D - recharge protection, E - maintain/replicate terrestrial linkage, F - no management

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GEO-RAP v.2.0 Rapid Assessment Protocol Model

Project: **Headwater Drainage Feature Assessment**
Belwood Lake Tributary. West Reach + North Reach
SPRING Inspection

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	
	Siltation in pools	
	Medial bars	
	Accretion on point bars	1
	Poor longitudinal sorting of bed materials	
	Deposition in the overbank zone	
	n/7 =	0.14
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	1
	Cut face on bar forms	1
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	
	n/10 =	0.20

Widening	Fallen/leaning trees/fence posts etc.	
	Occurrence of Large Organic Debris	
	Exposed tree roots	
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	1
	Exposed building foundation	
	n/10 =	0.10
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	
	Bar forms poorly formed/reworked/removed	
	n/7 =	0.00

STABILITY INDEX (SI) = (A + D + W + P) / 4 = **0.11**

SI < 0.2	In Regime
0.2 < SI < 0.4	Transitional
SI > 0.4	In Adjustment
100 - (100*SI) =	**88.9**

2) Rapid Habitat Assessment (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	17	20--16	15-11	10-6	5-0
Embeddedness	17	20--16	15-11	10-6	5-0
Velocity / Depth Regime	12	20--16	15-11	10-6	5-0
Sediment Deposition	15	20--16	15-11	10-6	5-0
Channel Flow Status	15	20--16	15-11	10-6	5-0
Channel Alteration	9	20--16	15-11	10-6	5-0
Frequency of Riffles	15	20--16	15-11	10-6	5-0
Bank Stability u/s L	9	10-8	7-6	5-3	2-0
u/s R	9	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
/200	144				
/100	**72.0**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	9	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	7	8-7	6-5	4-3	2-0
Physical Instream Habitat	7	8-7	6-5	4-3	2-0
Water Quality	6	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	4	7-6	5-4	3-2	1-0
Biological Indicators	3	8-7	6-5	4-3	2-0
/50	36				
/100	**72.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

1) - 3) Combined Assessment

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =	**77.6**				
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =					
		100-80	80-56	55-30	29-0

4) TRCA & CVCA Headwater Drainage Features Guideline (HDFG)

DA (ha)	QC	FC	FT	RM
46.1	**A**	**5**	**1 + 5**	**A**

QC — Flow Classification: A - perennial, B - intermittent, C - ephemeral, D - dry or standing water w/recharge, E - dry or standing water w/no recharge

FC — Flow Condition: 1 - no surface water, 2 - standing water, 3 - interstitial flow, 4 - <0.5l/sec, 5 - >0.5l/sec

FT — Feature Type: 1 - defined bed & banks, 2 - channelized historically, 3 - multi-thread, 4 - no defined feature, 5 - tile drain, 6 - wetland, 7 - swale, 8 - roadside ditch, 9 - online pond outlet

RM — Recommended Management: A - protection, B - conservation, C - mitigation, D - recharge protection, E - maintain/replicate terrestrial linkage, F - no management

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.

2) United States Environmental Protection Association. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.

3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

4) Toronto and Region Conservation Authority and Credit Valley Conservation Authority. 2014. Evaluation, Classification and Management of Headwater Drainage Features Guideline. TRCA Approval July 2013 (Finalized January 2014).

GEO-RAP v.2.0 Rapid Assessment Protocol Model

Project: **Headwater Drainage Feature Assessment**
Belwood Lake Tributary, East Reach
SPRING Inspection

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	
	Siltation in pools	
	Medial bars	
	Accretion on point bars	1
	Poor longitudinal sorting of bed materials	
	Deposition in the overbank zone	
	n/7 =	0.14
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	
	n/10 =	0.00

Widening	Fallen/leaning trees/fence posts etc.	
	Occurrence of Large Organic Debris	
	Exposed tree roots	
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.00
Planimetric Form	Formation of chute(s)	1
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	
	Bar forms poorly formed/reworked/removed	
	n/7 =	0.14
	STABILITY INDEX (SI) = (A + D + W + P) / 4 =	**0.07**
	SI < 0.2	In Regime
	0.2 < SI < 0.4	Transitional
	SI > 0.4	In Adjustment
	100 - (100*SI) =	**92.9**

2) Rapid Habitat Assessment (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	12	20--16	15-11	10-6	5-0
Embeddedness	15	20--16	15-11	10-6	5-0
Velocity / Depth Regime	6	20--16	15-11	10-6	5-0
Sediment Deposition	16	20--16	15-11	10-6	5-0
Channel Flow Status	6	20--16	15-11	10-6	5-0
Channel Alteration	5	20--16	15-11	10-6	5-0
Frequency of Riffles	15	20--16	15-11	10-6	5-0
Bank Stability u/s L	9	10-8	7-6	5-3	2-0
u/s R	9	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	8	10-8	7-6	5-3	2-0
u/s R	8	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	8	10-8	7-6	5-3	2-0
u/s R	8	10-8	7-6	5-3	2-0
/200	125				
/100	**62.5**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	9	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	6	8-7	6-5	4-3	2-0
Physical Instream Habitat	4	8-7	6-5	4-3	2-0
Water Quality	6	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	4	7-6	5-4	3-2	1-0
Biological Indicators	6	8-7	6-5	4-3	2-0
/50	35				
/100	**70.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

1) - 3) Combined Assessment

Riffle Run Channel Type

(RGA + RHA + RSAT) / 3 =	**75.1**	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

4) TRCA & CVCA Headwater Drainage Features Guideline (HDFG)

DA (ha)	QC	FC	FT	RM
47.5	**A**	**5**	**1 + 5**	**A**

QC — Flow Classification: A - perennial, B - intermittent, C - ephemeral, D - dry or standing water w/recharge, E - dry or standing water w/no recharge

FC — Flow Condition: 1 - no surface water, 2 - standing water, 3 - interstitial flow, 4 - <0.5l/sec, 5 - >0.5l/sec

FT — Feature Type: 1 - defined bed & banks, 2 - channelized historically, 3 - multi-thread, 4 - no defined feature, 5 - tile drain, 6 - wetland, 7 - swale, 8 - roadside ditch, 9 - online pond outlet

RM — Recommended Management: A - protection, B - conservation, C - mitigation, D - recharge protection, E - maintain/replicate terrestrial linkage, F - no management

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.

2) United States Environmental Protection Association. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.

3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

4) Toronto and Region Conservation Authority and Credit Valley Conservation Authority. 2014. Evaluation, Classification and Management of Headwater Drainage Features Guideline. TRCA Approval July 2013 (Finalized January 2014).

GEO-RAP v.2.0 Rapid Assessment Protocol Model

Project: **Headwater Drainage Feature Assessment**
Belwood Lake Tributary, West + North + East = Main Branch
SPRING Inspection

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	
	Siltation in pools	1
	Medial bars	1
	Accretion on point bars	1
	Poor longitudinal sorting of bed materials	1
	Deposition in the overbank zone	
	n/7 =	0.57
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	1
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	1
	n/10 =	0.20

Widening	Fallen/leaning trees/fence posts etc.	1
	Occurrence of Large Organic Debris	1
	Exposed tree roots	1
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	1
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	1
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	1
	Exposed building foundation	
	n/10 =	0.60
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	1
	Bar forms poorly formed/reworked/removed	1
	n/7 =	0.29
	STABILITY INDEX (SI) = (A + D + W + P) / 4 =	**0.41**
	SI < 0.2	In Regime
	0.2 < SI < 0.4	Transitional
	SI > 0.4	In Adjustment
	100 - (100*SI) =	**58.6**

2) Rapid Habitat Assessment (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	15	20--16	15-11	10-6	5-0
Embeddedness	10	20--16	15-11	10-6	5-0
Velocity / Depth Regime	12	20--16	15-11	10-6	5-0
Sediment Deposition	10	20--16	15-11	10-6	5-0
Channel Flow Status	15	20--16	15-11	10-6	5-0
Channel Alteration	9	20--16	15-11	10-6	5-0
Frequency of Riffles	15	20--16	15-11	10-6	5-0
Bank Stability u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
/200	124				
/100	**62.0**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	6	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	4	8-7	6-5	4-3	2-0
Physical Instream Habitat	6	8-7	6-5	4-3	2-0
Water Quality	6	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	6	7-6	5-4	3-2	1-0
Biological Indicators	3	8-7	6-5	4-3	2-0
/50	31				
/100	**62.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

1) - 3) Combined Assessment

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =	**60.9**	100-80	80-56	55-30	29-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =		100-80	80-56	55-30	29-0

4) TRCA & CVCA Headwater Drainage Features Guideline (HDFG)

DA (ha)	QC	FC	FT	RM
129.2	**A**	**5**	**1 + 5**	**A**

QC — Flow Classification: A - perennial, B - intermittent, C - ephemeral, D - dry or standing water w/recharge, E - dry or standing water w/no recharge

FC — Flow Condition: 1 - no surface water, 2 - standing water, 3 - interstitial flow, 4 - <0.5l/sec, 5 - >0.5l/sec

FT — Feature Type: 1 - defined bed & banks, 2 - channelized historically, 3 - multi-thread, 4 - no defined feature, 5 - tile drain, 6 - wetland, 7 - swale, 8 - roadside ditch, 9 - online pond outlet

RM — Recommended Management: A - protection, B - conservation, C - mitigation, D - recharge protection, E - maintain/replicate terrestrial linkage, F - no management

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.

2) United States Environmental Protection Association. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.

3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

4) Toronto and Region Conservation Authority and Credit Valley Conservation Authority. 2014. Evaluation, Classification and Management of Headwater Drainage Features Guideline. TRCA Approval July 2013 (Finalized January 2014).

SUMMER Assessment Results

GEO-RAP v.2.0 Rapid Assessment Protocol Model

Project: **Headwater Drainage Feature Assessment**
Belwood Lake Tributary, West Reach
SUMMER Inspection

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	
	Siltation in pools	
	Medial bars	
	Accretion on point bars	
	Poor longitudinal sorting of bed materials	1
	Deposition in the overbank zone	
	n/7 =	0.14
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	1
	Head cutting due to knick point migration	1
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	
	n/10 =	0.20

Widening	Fallen/leaning trees/fence posts etc.	
	Occurrence of Large Organic Debris	
	Exposed tree roots	
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.00
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	1
	Bar forms poorly formed/reworked/removed	
	n/7 =	0.14
	STABILITY INDEX (SI) = (A + D + W + P) / 4 =	**0.12**
	SI < 0.2	In Regime
	0.2 < SI < 0.4	Transitional
	SI > 0.4	In Adjustment
	100 - (100*SI) =	**87.9**

2) Rapid Habitat Assessment (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	15	20--16	15-11	10-6	5-0
Embeddedness	15	20--16	15-11	10-6	5-0
Velocity / Depth Regime	0	20--16	15-11	10-6	5-0
Sediment Deposition	15	20--16	15-11	10-6	5-0
Channel Flow Status	0	20--16	15-11	10-6	5-0
Channel Alteration	5	20--16	15-11	10-6	5-0
Frequency of Riffles	15	20--16	15-11	10-6	5-0
Bank Stability u/s L	9	10-8	7-6	5-3	2-0
u/s R	9	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	5	10-8	7-6	5-3	2-0
u/s R	5	10-8	7-6	5-3	2-0
/200	105				
/100	**52.5**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	9	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	6	8-7	6-5	4-3	2-0
Physical Instream Habitat	5	8-7	6-5	4-3	2-0
Water Quality	6	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	4	7-6	5-4	3-2	1-0
Biological Indicators	0	8-7	6-5	4-3	2-0
/50	30				
/100	**60.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

1) - 3) Combined Assessment

Riffle Run Channel Type

(RGA + RHA + RSAT) / 3 =	**66.8**	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

4) TRCA & CVCA Headwater Drainage Features Guideline (HDFG)

DA (ha)	QC	FC	FT	RM
28.5	**E**	**1**	**1+5+7**	**F**

QC — Flow Classification: A - perennial, B - intermittent, C - ephemeral, D - dry or standing water w/recharge, E - dry or standing water w/no recharge

FC — Flow Condition: 1 - no surface water, 2 - standing water, 3 - interstitial flow, 4 - <0.5l/sec, 5 - >0.5l/sec

FT — Feature Type: 1 - defined bed & banks, 2 - channelized historically, 3 - multi-thread, 4 - no defined feature, 5 - tile drain, 6 - wetland, 7 - swale, 8 - roadside ditch, 9 - online pond outlet

RM — Recommended Management: A - protection, B - conservation, C - mitigation, D - recharge protection, E - maintain/replicate terrestrial linkage, F - no management

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.

2) United States Environmental Protection Association. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.

3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

4) Toronto and Region Conservation Authority and Credit Valley Conservation Authority. 2014. Evaluation, Classification and Management of Headwater Drainage Features Guideline. TRCA Approval July 2013 (Finalized January 2014).

GEO-RAP v.2.0 Rapid Assessment Protocol Model

Project: Headwater Drainage Feature Assessment
Belwood Lake Tributary, North Reach
SUMMER Inspection

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	
	Siltation in pools	
	Medial bars	
	Accretion on point bars	1
	Poor longitudinal sorting of bed materials	
	Deposition in the overbank zone	
	n/7 =	0.14
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	1
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	
	n/10 =	0.10

Widening	Fallen/leaning trees/fence posts etc.	
	Occurrence of Large Organic Debris	
	Exposed tree roots	
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.00
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	1
	Bar forms poorly formed/reworked/removed	
	n/7 =	0.14
	STABILITY INDEX (SI) = (A + D + W + P) / 4 =	**0.10**
	SI < 0.2	In Regime
	0.2 < SI < 0.4	Transitional
	SI > 0.4	In Adjustment
	100 - (100*SI) =	**90.4**

2) Rapid Habitat Assessment (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	17	20--16	15-11	10-6	5-0
Embeddedness	17	20--16	15-11	10-6	5-0
Velocity / Depth Regime	3	20--16	15-11	10-6	5-0
Sediment Deposition	15	20--16	15-11	10-6	5-0
Channel Flow Status	3	20--16	15-11	10-6	5-0
Channel Alteration	11	20--16	15-11	10-6	5-0
Frequency of Riffles	15	20--16	15-11	10-6	5-0
Bank Stability u/s L	9	10-8	7-6	5-3	2-0
u/s R	9	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	8	10-8	7-6	5-3	2-0
u/s R	8	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
/200	129				
/100	**64.5**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	9	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	7	8-7	6-5	4-3	2-0
Physical Instream Habitat	7	8-7	6-5	4-3	2-0
Water Quality	6	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	6	7-6	5-4	3-2	1-0
Biological Indicators	1	8-7	6-5	4-3	2-0
/50	36				
/100	**72.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

1) - 3) Combined Assessment

Riffle Run Channel Type

(RGA + RHA + RSAT) / 3 =	**75.6**	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

4) TRCA & CVCA Headwater Drainage Features Guideline (HDFG)

DA (ha)	QC	FC	FT	RM
44	**B + C**	**2**	**1 + 5**	**A**

QC — Flow Classification: A - perennial, B - intermittent, C - ephemeral, D - dry or standing water w/recharge, E - dry or standing water w/no recharge

FC — Flow Condition: 1 - no surface water, 2 - standing water, 3 - interstitial flow, 4 - <0.5l/sec, 5 - >0.5l/sec

FT — Feature Type: 1 - defined bed & banks, 2 - channelized historically, 3 - multi-thread, 4 - no defined feature, 5 - tile drain, 6 - wetland, 7 - swale, 8 - roadside ditch, 9 - online pond outlet

RM — Recommended Management:
A - protection, B - conservation, C - mitigation, D - recharge protection, E - maintain/replicate terrestrial linkage, F - no management

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.

2) United States Environmental Protection Association. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.

3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

4) Toronto and Region Conservation Authority and Credit Valley Conservation Authority. 2014. Evaluation, Classification and Management of Headwater Drainage Features Guideline. TRCA Approval July 2013 (Finalized January 2014).

GEO-RAP v.2.0 Rapid Assessment Protocol Model

Project: **Headwater Drainage Feature Assessment**
Belwood Lake Tributary, West Reach + North Reach
SUMMER Inspection

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	
	Siltation in pools	
	Medial bars	
	Accretion on point bars	1
	Poor longitudinal sorting of bed materials	
	Deposition in the overbank zone	
	n/7 =	0.14
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	1
	Cut face on bar forms	1
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	
	n/10 =	0.20

Widening	Fallen/leaning trees/fence posts etc.	
	Occurrence of Large Organic Debris	
	Exposed tree roots	
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	1
	Exposed building foundation	
	n/10 =	0.10
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	
	Bar forms poorly formed/reworked/removed	
	n/7 =	0.00

STABILITY INDEX (SI) = (A + D + W + P) / 4 = **0.11**

SI < 0.2	In Regime
0.2 < SI < 0.4	Transitional
SI > 0.4	In Adjustment
100 - (100*SI) =	**88.9**

2) Rapid Habitat Assessment (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	17	20--16	15-11	10-6	5-0
Embeddedness	17	20--16	15-11	10-6	5-0
Velocity / Depth Regime	3	20--16	15-11	10-6	5-0
Sediment Deposition	15	20--16	15-11	10-6	5-0
Channel Flow Status	3	20--16	15-11	10-6	5-0
Channel Alteration	9	20--16	15-11	10-6	5-0
Frequency of Riffles	15	20--16	15-11	10-6	5-0
Bank Stability u/s L	9	10-8	7-6	5-3	2-0
u/s R	9	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
/200	123				
/100	**61.5**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	9	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	7	8-7	6-5	4-3	2-0
Physical Instream Habitat	7	8-7	6-5	4-3	2-0
Water Quality	6	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	4	7-6	5-4	3-2	1-0
Biological Indicators	1	8-7	6-5	4-3	2-0
/50	34				
/100	**68.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

1) - 3) Combined Assessment

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =	**72.8**	100-80	80-56	55-30	29-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =		100-80	80-56	55-30	29-0

4) TRCA & CVCA Headwater Drainage Features Guideline (HDFG)

DA (ha)	QC	FC	FT	RM
46.1	**B + C**	**2**	**1 + 5**	**A**

QC — Flow Classification: A - perennial, B - intermittent, C - ephemeral, D - dry or standing water w/recharge, E - dry or standing water w/no recharge

FC — Flow Condition: 1 - no surface water, 2 - standing water, 3 - interstitial flow, 4 - <0.5l/sec, 5 - >0.5l/sec

FT — Feature Type: 1 - defined bed & banks, 2 - channelized historically, 3 - multi-thread, 4 - no defined feature, 5 - tile drain, 6 - wetland, 7 - swale, 8 - roadside ditch, 9 - online pond outlet

RM — Recommended Management: A - protection, B - conservation, C - mitigation, D - recharge protection, E - maintain/replicate terrestrial linkage, F - no management

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.

2) United States Environmental Protection Association. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.

3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

4) Toronto and Region Conservation Authority and Credit Valley Conservation Authority. 2014. Evaluation, Classification and Management of Headwater Drainage Features Guideline. TRCA Approval July 2013 (Finalized January 2014).

GEO-RAP v.2.0 Rapid Assessment Protocol Model

Project: **Headwater Drainage Feature Assessment**
Belwood Lake Tributary, East Reach
SUMMER Inspection

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	
	Siltation in pools	
	Medial bars	
	Accretion on point bars	1
	Poor longitudinal sorting of bed materials	
	Deposition in the overbank zone	
	n/7 =	0.14
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	
	n/10 =	0.00

Widening	Fallen/leaning trees/fence posts etc.	
	Occurrence of Large Organic Debris	
	Exposed tree roots	
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	
	Exposed building foundation	
	n/10 =	0.00
Planimetric Form	Formation of chute(s)	1
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	
	Bar forms poorly formed/reworked/removed	
	n/7 =	0.14
	STABILITY INDEX (SI) = (A + D + W + P) / 4 =	**0.07**
	SI < 0.2	In Regime
	0.2 < SI < 0.4	Transitional
	SI > 0.4	In Adjustment
	100 - (100*SI) =	**92.9**

2) Rapid Habitat Assessment (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	12	20--16	15-11	10-6	5-0
Embeddedness	15	20--16	15-11	10-6	5-0
Velocity / Depth Regime	2	20--16	15-11	10-6	5-0
Sediment Deposition	16	20--16	15-11	10-6	5-0
Channel Flow Status	2	20--16	15-11	10-6	5-0
Channel Alteration	5	20--16	15-11	10-6	5-0
Frequency of Riffles	15	20--16	15-11	10-6	5-0
Bank Stability u/s L	9	10-8	7-6	5-3	2-0
u/s R	9	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	8	10-8	7-6	5-3	2-0
u/s R	8	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	8	10-8	7-6	5-3	2-0
u/s R	8	10-8	7-6	5-3	2-0
/200	117				
/100	**58.5**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	9	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	6	8-7	6-5	4-3	2-0
Physical Instream Habitat	4	8-7	6-5	4-3	2-0
Water Quality	6	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	4	7-6	5-4	3-2	1-0
Biological Indicators	1	8-7	6-5	4-3	2-0
/50	30				
/100	**60.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

1) - 3) Combined Assessment

Riffle Run Channel Type

(RGA + RHA + RSAT) / 3 =	**70.5**	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

4) TRCA & CVCA Headwater Drainage Features Guideline (HDFG)

DA (ha)	QC	FC	FT	RM
47.5	**D**	**2**	**1 + 5**	**B**

QC — Flow Classification: A - perennial, B - intermittent, C - ephemeral, D - dry or standing water w/recharge, E - dry or standing water w/no recharge

FC — Flow Condition: 1 - no surface water, 2 - standing water, 3 - interstitial flow, 4 - <0.5l/sec, 5 - >0.5l/sec

FT — Feature Type: 1 - defined bed & banks, 2 - channelized historically, 3 - multi-thread, 4 - no defined feature, 5 - tile drain, 6 - wetland, 7 - swale, 8 - roadside ditch, 9 - online pond outlet

RM — Recommended Management: A - protection, B - conservation, C - mitigation, D - recharge protection, E - maintain/replicate terrestrial linkage, F - no management

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.

2) United States Environmental Protection Association. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.

3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

4) Toronto and Region Conservation Authority and Credit Valley Conservation Authority. 2014. Evaluation, Classification and Management of Headwater Drainage Features Guideline. TRCA Approval July 2013 (Finalized January 2014).

GEO-RAP v.2.0 Rapid Assessment Protocol Model

Project: **Headwater Drainage Feature Assessment**
Belwood Lake Tributary, West + North + East = Main Branch
SUMMER Inspection

1) Rapid Geomorphic Assessment (RGA)

Aggradation	Lobate bar	
	Coarse material in riffles embedded	
	Siltation in pools	1
	Medial bars	1
	Accretion on point bars	1
	Poor longitudinal sorting of bed materials	1
	Deposition in the overbank zone	
	n/7 =	0.57
Degradation	Exposed bridge footing(s)	
	Exposed sanitary/storm sewer/pipeline etc.	
	Elevated stormsewer outfall(s)	
	Undermined gabion baskets/concrete aprons etc.	
	Scour pools d/s of culverts/stormsewer outlets	
	Cut face on bar forms	1
	Head cutting due to knick point migration	
	Terrace cut through older bar material	
	Suspended armour layer visible in bank	
	Channel worn into undisturbed overburden/bedrock	1
	n/10 =	0.20

Widening	Fallen/leaning trees/fence posts etc.	1
	Occurrence of Large Organic Debris	1
	Exposed tree roots	1
	Basal scour on inside meander bends	
	Basal scour on both sides of channel through riffle	1
	Gabion baskets/concrete walls etc. out flanked	
	Length of basal scour >50% through subject reach	1
	Exposed length of previously buried pipe/cable etc.	
	Fracture lines along top of bank	1
	Exposed building foundation	
	n/10 =	0.60
Planimetric Form	Formation of chute(s)	
	Single thread channel to multiple channel	
	Evolution of pool-riffle form to low bed relief form	
	Cut-off channel(s)	
	Formation of island(s)	
	Thalweg alignment out of phase meander form	1
	Bar forms poorly formed/reworked/removed	1
	n/7 =	0.29
	STABILITY INDEX (SI) = (A + D + W + P) / 4 =	**0.41**
	SI < 0.2	In Regime
	0.2 < SI < 0.4	Transitional
	SI > 0.4	In Adjustment
	100 - (100*SI) =	**58.6**

2) Rapid Habitat Assessment (RHA)

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover	15	20--16	15-11	10-6	5-0
Embeddedness	10	20--16	15-11	10-6	5-0
Velocity / Depth Regime	5	20--16	15-11	10-6	5-0
Sediment Deposition	10	20--16	15-11	10-6	5-0
Channel Flow Status	5	20--16	15-11	10-6	5-0
Channel Alteration	9	20--16	15-11	10-6	5-0
Frequency of Riffles	15	20--16	15-11	10-6	5-0
Bank Stability u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
Vegetative Protection u/s L	6	10-8	7-6	5-3	2-0
u/s R	6	10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L	7	10-8	7-6	5-3	2-0
u/s R	7	10-8	7-6	5-3	2-0
/200	107				
/100	**53.5**	Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
Epifaunal Substrate / Available Cover		20--16	15-11	10-6	5-0
Pool Substrate Characterization		20--16	15-11	10-6	5-0
Pool Variability		20--16	15-11	10-6	5-0
Sediment Deposition		20--16	15-11	10-6	5-0
Channel Flow Status		20--16	15-11	10-6	5-0
Channel Alteration		20--16	15-11	10-6	5-0
Channel Sinuosity		20--16	15-11	10-6	5-0
Bank Stability u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Vegetative Protection u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
Riparian Vegetation Zone Width u/s L		10-8	7-6	5-3	2-0
u/s R		10-8	7-6	5-3	2-0
/200					
/100		Optimal	Good	Fair	Poor
		100-78	77-53	52-28	27-0

3) Rapid Stream Assessment Technique (RSAT)

		Optimal	Good	Fair	Poor
Channel Stability	6	11-9	8-6	5-3	2-0
Channel Scouring/Deposition	4	8-7	6-5	4-3	2-0
Physical Instream Habitat	6	8-7	6-5	4-3	2-0
Water Quality	6	8-7	6-5	4-3	2-0
Riparian Habitat Conditions	6	7-6	5-4	3-2	1-0
Biological Indicators	2	8-7	6-5	4-3	2-0
/50	30				
/100	**60.0**	Optimal	Good	Fair	Poor
		100-83	82-59	58-31	30-0

1) - 3) Combined Assessment

Riffle Run Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =	**57.4**	Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

Glide Pool Channel Type

		Optimal	Good	Fair	Poor
(RGA + RHA + RSAT) / 3 =		Optimal	Good	Fair	Poor
		100-80	80-56	55-30	29-0

4) TRCA & CVCA Headwater Drainage Features Guideline (HDFG)

DA (ha)	QC	FC	FT	RM
129.2	**B**	**3**	**1 + 5**	**A**

QC — Flow Classification: A - perennial, B - intermittent, C - ephemeral, D - dry or standing water w/recharge, E - dry or standing water w/no recharge

FC — Flow Condition: 1 - no surface water, 2 - standing water, 3 - interstitial flow, 4 - <0.5l/sec, 5 - >0.5l/sec

FT — Feature Type: 1 - defined bed & banks, 2 - channelized historically, 3 - multi-thread, 4 - no defined feature, 5 - tile drain, 6 - wetland, 7 - swale, 8 - roadside ditch, 9 - online pond outlet

RM — Recommended Management: A - protection, B - conservation, C - mitigation, D - recharge protection, E - maintain/replicate terrestrial linkage, F - no management

References

1) Ontario Ministry of Environment and Energy. 2003. Stormwater Management Planning and Design Manual. Appendix C.

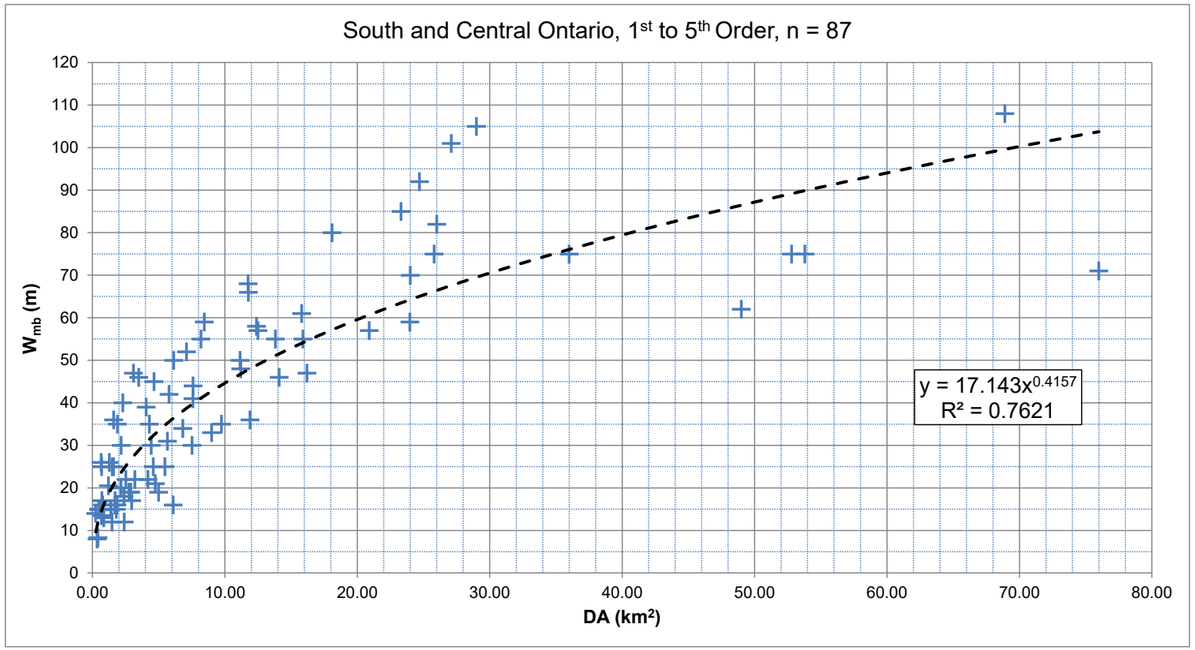
2) United States Environmental Protection Association. 2004. Wadeable Stream Assessment: Field Operations Manual. EPA841-B-04-004. U.S. Environmental Protection Agency, Office of Water and Office of Research and Development, Washington, DC.

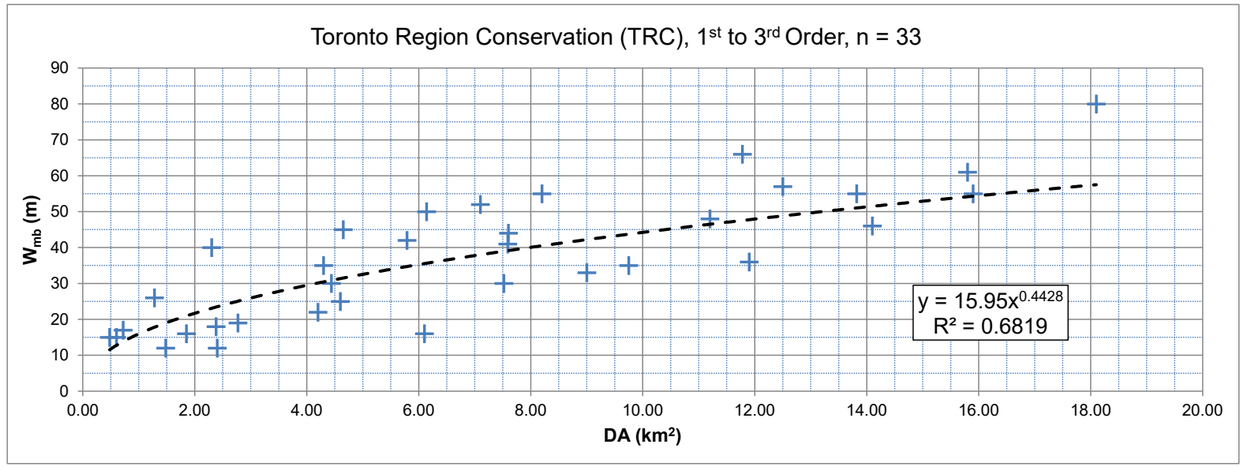
3) Galli, J., 1996. Rapid stream assessment technique, field methods. Metropolitan Washington Council of Governments.

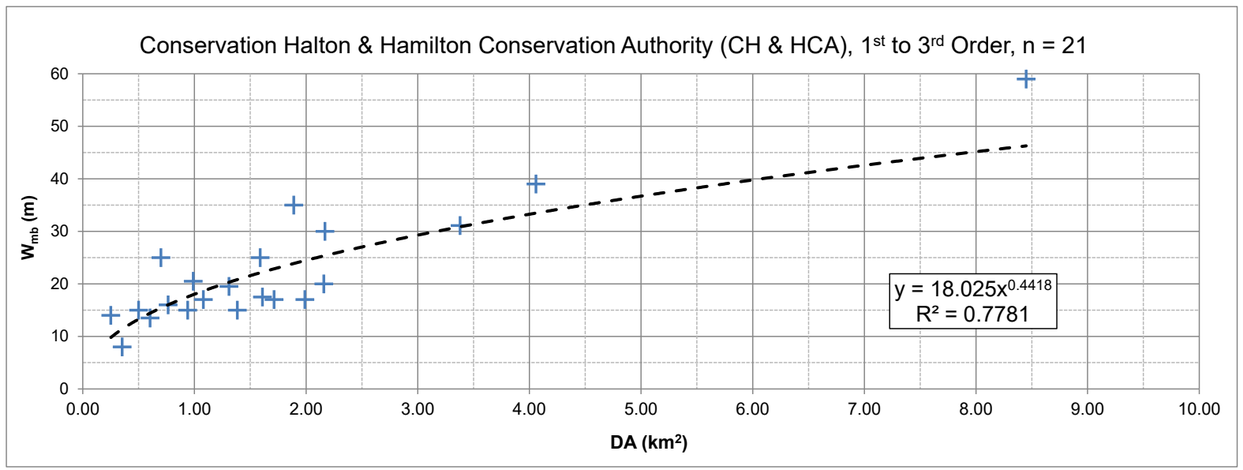
4) Toronto and Region Conservation Authority and Credit Valley Conservation Authority. 2014. Evaluation, Classification and Management of Headwater Drainage Features Guideline. TRCA Approval July 2013 (Finalized January 2014).

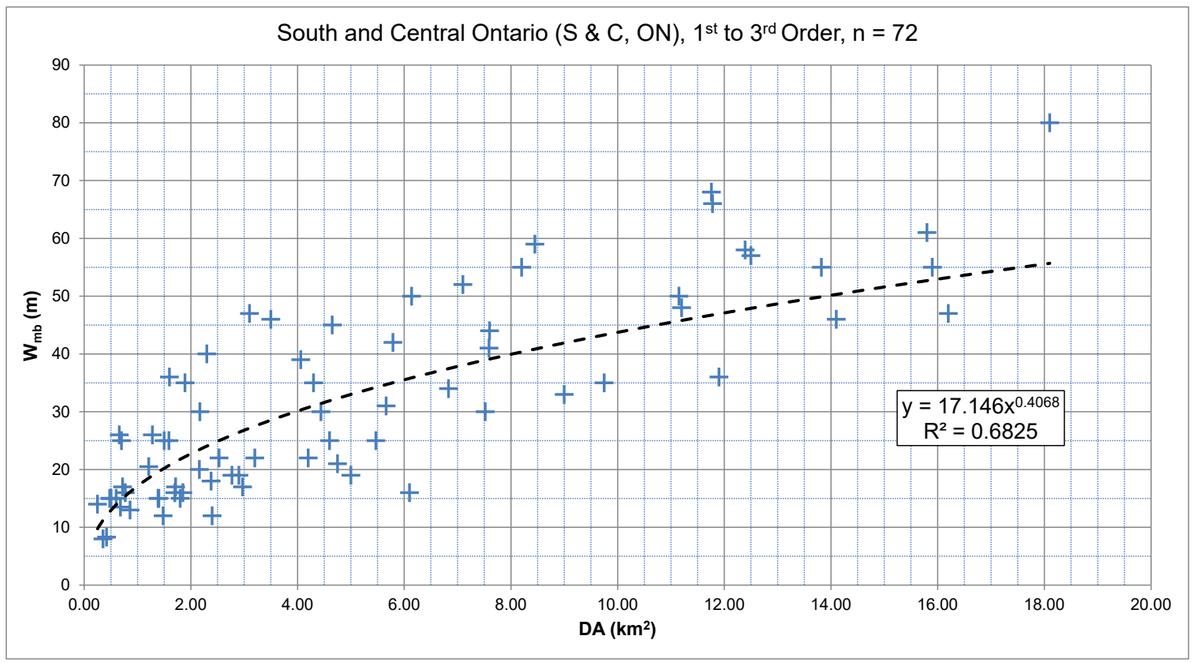
Belwood Lake Tributary Reaches, Meander Belt Analysis

Regional Regression Curves for Meander Belt Width









Solve for *(using 1st to 3rd Order Regime Equation):*	DA (km^2)	W_{mb} (m) S & C ON	W_{mb} (m) TRC	W_{mb} (m) CH & HCA	max *1.2 FS (m)	$\text{ceil}(x)$ (m)
West Reach	0.27	10.07	8.93	10.11	12.13	**13**
North Reach	0.44	12.28	11.09	12.54	15.05	**16**
West Reach + North Reach	0.74	15.17	13.96	15.78	18.94	**19**
East Reach	0.44	12.28	11.09	12.54	15.05	**16**
West Reach + North Reach + East Reach = Main Branch	1.27	18.90	17.73	20.03	24.04	**25**

APPENDIX

C HYDDROLOGIC MODELLING

Appendix C - Hydrology

Table C1 Summary of Existing Conditions Parameters

SUBCATCHMENTS	TYPE	AREA (ha)	SCS CURVE		OUTLET	DT (min)	CATCHMENT LENGTH (m)	SLOPE (%)	RUNOFF C	EQUATION	TP (hours)
			CN	IA (mm)							
PR-W01	NasHyd	12.46	73	7.9	2	10	580	5.8	0.20	Airport	0.4
PR-W02		9.98	79	8.6	1		369	6	0.20	Airport	0.3
PR-N01		7.99	78	7.1	4		365	3.6	0.20	Airport	0.4
PR-N02		43.12	79	8.4	3		779	4.8	0.21	Airport	0.5
PR-E01		1.8	72	8.0	6		159	3.3	0.20	Airport	0.3
PR-E02		42.15	79	8.2	5		1313	6.6	0.23	Airport	0.6
PR-M01		11.16	84	6.8	9		452	4.4	0.24	Airport	0.4
PR-M02		0.87	79	4.4	13		144	4.6	0.55	Bransby-Williams	0.1
PR-M03		4.35	85	7.0	12		382	4.5	0.20	Airport	0.4
PR-M04		1.12	84	7.3	15		217	9.6	0.20	Airport	0.2
PR-M05		1.57	83	6.1	14		273	5.8	0.33	Airport	0.3
PR-S01		1.94	85	7.0	-		357	3.2	0.20	Airport	0.3

Table C2 Summary of Proposed Conditions Parameters

SUBCATCHMENTS	TYPE	AREA (HA)	SCS CURVE		IMPERVIOUSNESS		PERVIOUS AREA		IMPERVIOUS AREA	
			CN	IA (mm)	TIMP (%)	XIMP (%)	FLOW LENGTH	SLOPE (%)	FLOW LENGTH	SLOPE (%)
PO-W2-1	StandHyd	0.85	85	3	0.50	0.05	81	2.28	75	4.15
PO-W2-2		0.86	85	3	0.33	0.09	60	2.5	76	3.0
PO-W2-3		2.15	85	3	0.44	0.26	20	3.0	120	2.9
PO-W2-4		1.91	85	3	0.50	0.10	100	2.76	113	3.63
PO-W2-5		1.27	85	3	0.50	0.05	40	3.45	92	2.5
PO-W2-6		0.91	85	3	0.50	0.08	40	3	78	2.5
PO-W3-1		1.56	90	3	0.50	0.01	55	3.6	102	1.67
PO-W3-2		1.99	90	3	0.50	0.07	55	3.6	115	1.67
PO-M3-1		4.43	90	3	0.50	0.11	71	2.7	157	2.11
PO-M3-2		3.14	90	3	0.50	0.11	71	2.7	157	2.11
PO-M3-3		2.17	90	3	0.50	0.09	50	3.06	120	1.02
PO-M1-2		0.74	90	3	0.50	0.14	20	1.9	70	5.0
PO-M2-3		1.29	90	3	0.50	0.20	105	2.0	93	2.65
PO-SWM-N	SWM-POND	0.83	50	2	0.3	0.3	40	2	67	2.63
PO-SWM-S		0.67	50	2	0.56	0.56	40	2	74	2.0
PO-W1	NasHyd	4.31	58.8	10.6	N/A					
PO-N1		4.73	73	7.33	N/A					
PR-W2		9.98	79	8.6	N/A					
PR-N2		43.12	79	8.4	N/A					
PR-E2		42.15	79	8.2	N/A					
PO-M1-1		2.23	80.6	6.9	N/A					

SUBCATCHMENTS	TYPE	AREA (HA)	SCS CURVE		IMPERVIOUSNESS		PERVIOUS AREA		IMPERVIOUS AREA	
			CN	IA (mm)	TIMP (%)	XIMP (%)	FLOW LENGTH	SLOPE (%)	FLOW LENGTH	SLOPE (%)
PO-M2-1	NasHyd	1.28	79	4.4	N/A					
PO-M2-2		0.99	79	4.4	N/A					
PO-N02		1.67	78	8.0	N/A					
PO-E1		1.48	65	9.4	N/A					
PO-M04		0.36	84	7.3	N/A					
PR-M05		1.57	83	6.1	N/A					

Table C3 Typical (Conservation Halton) Curve Numbers

LAND USE	NOTES	A	B	C	D
Agriculture		67	78	85	89
Buildings		98	98	98	98
Bedrock		98	98	98	98
Cemetery /Golf course		49	69	79	84
Commercial and business area	85% imp	89	92	94	95
Dirt		72	82	87	89
Extraction		98	98	98	98
Field / Meadow / Pasture		49	69	79	84
Forest / Plantation		36	60	73	79
Grass / Highway Median		49	69	79	84
Hedge Row / Orchard		45	66	77	83
Industrial	72% imp	81	88	91	93
Institutional	50% imp	71	80	88	90
Open Water		98	98	98	98
Residential High Density		89	92	94	95
Residential Medium / Low Density	65% imp	77	85	90	92
Residential Trailer Park		71	80	88	90
Residential Rural		51	69	79	98
SWM Pond		50	50	50	84
Transportation	roads, railway, parking	98	98	98	98
Wetland / Marsh		50	50	50	50

Table C4 **Existing Conditions Curve Numbers**

CATCHMENT	MODEL LAND USE	SOIL TYPE	CN VALUE	AREA (m2)	TOTAL AREA (m2)	AREA PERCENTAGE	WEIGHTED AMC2 CN VALUE
PR-S1	Agricultural	C	85				
PR-N2	Agricultural	C	85	209179.5	431191.417	49%	79
	Forest		73	211192.3		49%	
	Residential		79	10819.62		3%	
PR-W2	Agricultural	C	85	47366.32	99789.387	47%	79
	Forest		73	52423.06		53%	
PR-W1	Agricultural	B	78	86977.84	124553.189	70%	73
	Forest		60	37575.35		30%	
PR-E1	Agricultural	B	78	12318.52	18031.522	68%	72
	Forest		60	5713.006		32%	
PR-M5	Agricultural	C	85	10065.01	15741.963	64%	83
	Residential		79	5676.953		36%	
PR-M4	Agricultural	C	85	10237.24	11224.021	91%	84
	Forest		73	986.779		9%	
PR-M2	Residential	C	79				
PR-M3	Agricultural	C	85				
PR-M1	Agricultural	C	85	93235.22	111567.604	84%	84
	Forest		73	4174.833		4%	
	Residential		79	14157.55		13%	
PR-E2	Agricultural	C	85	179730.9	421526.209	43%	79
	Forest		73	205240.2		49%	
	Residential		79	36555.17		9%	
PR-N1	Agricultural	B	78	78964.3	80344.083	98%	78

Table C5 Proposed Conditions Curve Numbers

CATCHMENT	MODEL LAND USE	SOIL TYPE	CN VALUE	AREA (m2)	TOTAL AREA	AREA PERCENTAGE	WEIGHTED CN VALUE
PO-W01	Forest	B	60	3792	4310	88%	58.8
	Wetlands		50	517		12%	
PO-W2-1	Residential Medium / Low Density	B	85	8520	8520	100%	85
PO-W2-2	Residential Medium / Low Density	B	85	8600	8600	100%	85
PO-W2-3	Residential Medium / Low Density	B	85	21500	21500	100%	85
PO-W2-4	Residential Medium / Low Density	B	85	19100	19100	100%	85
PO-W2-5	Residential Medium / Low Density	B	85	12700	12700	100%	85
PO-W2-6	Residential Medium / Low Density	B	85	9100	9100	100%	85
PO-W3-1	Residential Medium / Low Density	C	90	15600	15600	100%	90
PO-W3-2	Residential Medium / Low Density	C	90	19900	19900	100%	90
PO-SWM-N	SWM Pond	C	50	830	8300	100%	50
PO-M3-1	Residential Medium / Low Density	C	90	44300	44300	100%	90
PO-M3-2	Residential Medium / Low Density	C	90	31400	31400	100%	90
PO-M3-3	Residential Medium / Low Density	C	90	21700	21700	100%	90
PO-SWM-S	SWM Pond	C	50	670	6700	100%	50
PO-M2-3	Residential Medium / Low Density	C	90	1290	1290	100%	90
PO-M2-2	Along CR-19/ Residential Rural	C	79	1280	1280	100%	79
PO-M2-1	Along CR-19/ Residential Rural	C	79	990	990	100%	79
PO-N01	Agriculture	B	78	16258	47300	34%	73
	Residential Medium / Low Density	B	85	13365		28%	
	Forest	B	60	17677		37%	
PO-N02	Agriculture	B	78	16700	16700	100%	78
PO-E1	Agriculture	B	78	4275	14800	29%	65
	Forest	B	60	10525		71%	
PO-M1-2	Residential Medium / Low Density	C	90	7400	7400	100%	90
PO-M1-1	Residential Medium / Low Density	C	90	9993	22300	45%	80.6
	Forest	C	73	12307		55%	

Table C6 Typical (Conservation Halton) Initial Abstraction Values

LAND USE	IA (MM)
Impervious	2
Open Space / Green Space / Lawns	5
Crop / Cultivated	7
Pasture / Meadow	8
Woods / Woodlot / Forest	10
Wetlands	15

Table C7 Existing Conditions Initial Abstraction Values

CATCHMENT	LAND USE	LAND USE AREA (M2)	TOTAL AREA (M2)	LAND USE PERCENT	IA (MM)	AVERAGED IA (MM)
S01	Agricultural	7				
N02	Agricultural	209179.532	431191.417	49%	7	8.4
	Forest	211192.264		49%	10	
	Residential	10819.621		3%	4.4	
W02	Agricultural	47366.324	99789.387	47%	7	8.6
	Forest	52423.063		53%	10	
W01	Agricultural	86977.842	124553.189	70%	7	7.9
	Forest	37575.347		30%	10	
E01	Agricultural	12318.516	18031.522	68%	7	8.0
	Forest	5713.006		32%	10	
M05	Agricultural	10065.01	15741.963	64%	7	6.1
	Residential	5676.953		36%	4.4	
M04	Agricultural	10237.242	11224.021	91%	7	7.3
	Forest	986.779		9%	10	
M02	Residential	4.4				
M03	Agricultural	7				
M01	Agricultural	93235.218	111567.604	84%	7	6.8
	Forest	4174.833		4%	10	
	Residential	14157.553		13%	4.4	
E02	Agricultural	179730.888	421526.209	43%	7	8.2
	Forest	205240.155		49%	10	
	Residential	36555.166		9%	4.4	
N01	Agricultural	78964.297	80344.083	98%	7	7.1
	Forest	1379.786		2%	10	

Table C8 Proposed Conditions Initial Abstraction Values

CATCHMENT	MODEL LAND USE	AREA (m2)	TOTAL AREA (m2)	AREA PERCENTAGE	IA (mm)	AVERAGED IA (mm)
PO-W01	Forest	3792	4310	88%	10	10.6
	Wetlands	517		12%	15	
PO-W2-1	Residential Medium / Low Density	8520	8520	100%	3	3.0
PO-W2-2	Residential Medium / Low Density	8600	8600	100%	3	3.0
PO-W2-3	Residential Medium / Low Density	21500	21500	100%	3	3.0
PO-W2-4	Residential Medium / Low Density	19100	19100	100%	3	3.0
PO-W2-5	Residential Medium / Low Density	12700	12700	100%	3	3.0
PO-W2-6	Residential Medium / Low Density	9100	9100	100%	3	3.0
PO-W3-1	Residential Medium / Low Density	15600	15600	100%	3	3.0
PO-W3-2	Residential Medium / Low Density	19900	19900	100%	3	3.0
PO-SWM-N	SWM Pond	8300	8300	100%	2	2.0
PO-M3-1	Residential Medium / Low Density	44300	44300	100%	3	3.0
PO-M3-2	Residential Medium / Low Density	31400	31400	100%	3	3.0
PO-M3-3	Residential Medium / Low Density	21700	21700	100%	3	3.0
PO-SWM-S	SWM Pond	6700	6700	100%	2	2.0
PO-M2-3	Residential Medium / Low Density	12900	12900	100%	3	3.0
PO-M2-2	Along CR-19	1280	1280	100%	4.4	4.4
PO-M2-1	Along CR-19	990	990	100%	4.4	4.4
PO-N01	Agriculture	16258	47300	34%	8	7.3
	Residential Medium / Low Density	13365		28%	3	
	Forest	17677		37%	10	
PO-N02	Agriculture	16700	16700	100%	8	8.0
PO-E1	Agriculture	4275	14800	29%	8	9.4
	Forest	10525		71%	10	
PO-M1-2	Residential Medium / Low Density	7400	7400	100%	3	3.0
PO-M1-1	Residential Medium / Low Density	9993	22300	45%	3	6.9
	Forest	12307		55%	10	

Table C9 **Centre Wellington Development Manual Runoff Coefficients and Percentage Impervious**

LAND USE		RUNOFF COEFFICIENT	PERCENTAGE IMPERVIOUS
- Minimum storm drainage runoff coefficients with 10 minute Time of Concentration:			
Parks	>4 hectares	0.2	0%
	<4 hectares	0.25	7%
Single Family Residential	>18 m frontage (59 ft.)	0.55	50%
	12-18m frontage (39 – 59 ft.)	0.6	60%
	<12m frontage (39 ft.)	0.65	65%
- Minimum storm drainage runoff coefficients with 5 minute Time of Concentration			
Semi - Detached		0.7	70%
Maisonettes, Townhouses, etc.		0.75	80%
Apartments		0.75	80%
Schools		0.75	80%
Churches		0.75	80%
Industrial		0.9	100%
Commercial, Highway Commercial		0.9	100%
Heavily Developed Areas		0.9	100%

Table C10 Existing Conditions Runoff Coefficients

CATCHMENT	MODEL LAND USE	RUNOFF COEFFICIENT	AREA (M2)	TOTAL AREA (M2)	AREA PERCENTAGE	WEIGHTED RUNOFF COEFFICIENT
S01	Agricultural	0.2				
N02	Agricultural	0.2	209179.532	431191.417	49%	0.21
	Forest	0.2	211192.264		49%	
	Residential	0.55	10819.621		3%	
W02	Agricultural	0.2	47366.324	99789.387	47%	0.20
	Forest	0.2	52423.063		53%	
W01	Agricultural	0.2	86977.842	124553.189	70%	0.20
	Forest	0.2	37575.347		30%	
E01	Agricultural	0.2	12318.516	18031.522	68%	0.20
	Forest	0.2	5713.006		32%	
M05	Agricultural	0.2	10065.01	15741.963	64%	0.33
	Residential	0.55	5676.953		36%	
M04	Agricultural	0.2	10237.242	11224.021	91%	0.20
	Forest	0.2	986.779		9%	
M02	Residential	0.55				
M03	Agricultural	0.2				
M01	Agricultural	0.2	93235.218	111567.604	84%	0.24
	Forest	0.2	4174.833		4%	
	Residential	0.55	14157.553		13%	
E02	Agricultural	0.2	179730.888	421526.209	43%	0.23
	Forest	0.2	205240.155		49%	
	Residential	0.55	36555.166		9%	
N01	Agricultural	0.2	78964.297	80344.083	98%	0.20
	Forest	0.2	1379.786		2%	

Table C11 Proposed Conditions Imperviousness

CATCHMENT	AREA (HA)	RESIDENTIAL AREA	OPEN AREA	TIMP
PO-W02-1	0.852	0.852		50%
PO-W02-2	0.86	0.520	0.340	33%
PO-W02-3	2.15	1.835	0.315	44%
PO-W02-4	1.91	1.91		50%
PO-W02-5	1.27	1.27		50%
PO-W02-6	0.91	0.91		50%
PO-W03-1	1.56	1.56		50%
PO-W03-2	1.99	1.99		50%
PO-M03-1	3.72	3.72		50%
PO-M03-2	3.72	3.72		50%
PO-M03-3	2.17	2.17		50%
PO-M2-3	2.49	2.49		50%
PO-M1-2	0.74	0.74		50%

Meteorological Data

Table C12 Centre Wellington Development Manual IDF Data

RETURN PERIOD	2-YR	5-YR	10-YR	25-YR	50-YR	100-YR
A	23.3	30.7	35.6	41.8	46.4	51
B	-0.699	-0.699	-0.699	-0.699	-0.699	-0.699

Table C13 Chicago 6 hr Distribution

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
0	2.033	2.679	3.106	3.647	4.048	4.45
5	2.092	2.757	3.197	3.754	4.167	4.58
10	2.157	2.841	3.295	3.869	4.295	4.72
15	2.226	2.932	3.4	3.993	4.432	4.871
20	2.3	3.031	3.514	4.126	4.581	5.035
25	2.381	3.137	3.638	4.272	4.742	5.212
30	2.47	3.254	3.773	4.43	4.918	5.405
35	2.566	3.381	3.921	4.604	5.111	5.617
40	2.673	3.522	4.084	4.795	5.323	5.85
45	2.791	3.677	4.264	5.007	5.558	6.109
50	2.922	3.85	4.465	5.243	5.819	6.396
55	3.07	4.045	4.69	5.507	6.113	6.719
60	3.237	4.265	4.946	5.807	6.446	7.085
65	3.428	4.517	5.238	6.15	6.827	7.504
70	3.649	4.808	5.576	6.547	7.267	7.988
75	3.909	5.15	5.972	7.012	7.784	8.556
80	4.218	5.558	6.445	7.568	8.4	9.233
85	4.595	6.054	7.021	8.243	9.15	10.058
90	5.066	6.674	7.74	9.088	10.088	11.088
95	5.674	7.476	8.669	10.179	11.299	12.419
100	6.498	8.561	9.928	11.657	12.939	14.222
105	7.691	10.134	11.751	13.798	15.316	16.834
110	9.617	12.671	14.694	17.253	19.151	21.05
115	13.434	17.7	20.525	24.1	26.752	29.404
120	26.346	34.713	40.254	47.264	52.466	57.667

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
125	132.344	174.376	202.208	237.424	263.552	289.68
130	25.316	33.356	38.68	45.416	50.414	55.412
135	16.626	21.906	25.403	29.827	33.109	36.392
140	12.854	16.937	19.64	23.06	25.598	28.136
145	10.663	14.049	16.292	19.129	21.234	23.339
150	9.204	12.128	14.063	16.513	18.33	20.147
155	8.153	10.742	12.456	14.626	16.235	17.845
160	7.353	9.688	11.234	13.19	14.642	16.094
165	6.72	8.854	10.268	12.056	13.382	14.709
170	6.205	8.176	9.481	11.133	12.358	13.583
175	5.777	7.612	8.827	10.364	11.505	12.646
180	5.415	7.134	8.273	9.714	10.783	11.852
185	5.103	6.723	7.796	9.154	10.161	11.169
190	4.831	6.365	7.381	8.667	9.621	10.575
195	4.592	6.051	7.016	8.238	9.145	10.052
200	4.38	5.771	6.692	7.858	8.723	9.587
205	4.19	5.521	6.403	7.518	8.345	9.172
210	4.02	5.296	6.141	7.211	8.005	8.798
215	3.865	5.092	5.905	6.933	7.696	8.459
220	3.723	4.906	5.689	6.68	7.415	8.15
225	3.594	4.736	5.492	6.448	7.158	7.867
230	3.475	4.579	5.31	6.235	6.921	7.607
235	3.366	4.435	5.142	6.038	6.702	7.367
240	3.264	4.301	4.987	5.856	6.5	7.144
245	3.17	4.176	4.843	5.686	6.312	6.938
250	3.081	4.06	4.708	5.528	6.136	6.745
255	2.999	3.951	4.582	5.38	5.972	6.564
260	2.922	3.85	4.464	5.242	5.818	6.395
265	2.849	3.754	4.353	5.111	5.674	6.236
270	2.781	3.664	4.249	4.989	5.538	6.087
275	2.716	3.579	4.15	4.873	5.409	5.946
280	2.655	3.499	4.057	4.764	5.288	5.812

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
285	2.598	3.423	3.969	4.66	5.173	5.686
290	2.543	3.351	3.885	4.562	5.064	5.566
295	2.491	3.282	3.806	4.469	4.96	5.452
300	2.441	3.217	3.73	4.38	4.862	5.344
305	2.394	3.154	3.658	4.295	4.768	5.24
310	2.349	3.095	3.589	4.214	4.678	5.142
315	2.306	3.038	3.523	4.137	4.592	5.047
320	2.265	2.984	3.46	4.063	4.51	4.957
325	2.225	2.932	3.4	3.992	4.432	4.871
330	2.188	2.882	3.342	3.924	4.356	4.788
335	2.151	2.835	3.287	3.859	4.284	4.709
340	2.116	2.789	3.234	3.797	4.215	4.633
345	2.083	2.744	3.182	3.737	4.148	4.559
350	2.051	2.702	3.133	3.679	4.084	4.489
355	2.02	2.661	3.086	3.623	4.022	4.421

Table C14 SCS 12 hr Distribution

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
0	1.05888	1.39463	1.62706	1.91115	2.11776	2.32438
6	1.07058	1.41004	1.64504	1.93227	2.14117	2.35006
12	1.08228	1.42545	1.66302	1.95339	2.16457	2.37574
18	1.09398	1.44086	1.681	1.97451	2.18797	2.40143
24	1.10568	1.45627	1.69898	1.99562	2.21137	2.42711
30	1.11738	1.47168	1.71696	2.01674	2.23477	2.45279
36	1.12908	1.48709	1.73493	2.03786	2.25817	2.47848
42	1.14078	1.5025	1.75291	2.05898	2.28157	2.50416
48	1.15249	1.51791	1.77089	2.0801	2.30497	2.52985
54	1.16419	1.53332	1.78887	2.10121	2.32837	2.55553
60	1.17589	1.54873	1.80685	2.12233	2.35177	2.58121
66	1.18759	1.56414	1.82483	2.14345	2.37517	2.6069
72	1.19929	1.57955	1.84281	2.16457	2.39857	2.63258
78	1.21099	1.59496	1.86078	2.18568	2.42197	2.65826
84	1.22269	1.61037	1.87876	2.2068	2.44537	2.68395
90	1.23439	1.62578	1.89674	2.22792	2.46878	2.70963
96	1.24609	1.64119	1.91472	2.24904	2.49218	2.73532
102	1.25779	1.6566	1.9327	2.27015	2.51558	2.761
108	1.26949	1.67201	1.95068	2.29127	2.53898	2.78668
114	1.28119	1.68742	1.96866	2.31239	2.56238	2.81237
120	1.33969	1.73365	2.02259	2.37574	2.63258	2.88942
126	1.32214	1.8107	2.11249	2.48133	2.74958	3.01784
132	1.31044	1.88775	2.20238	2.58692	2.86659	3.14625
138	1.29289	1.9648	2.29227	2.69251	2.98359	3.27467
144	1.28119	2.04185	2.38216	2.7981	3.10059	3.40309
150	1.26364	2.11891	2.47206	2.90369	3.2176	3.53151
156	1.25194	2.19596	2.56195	3.00927	3.3346	3.65993
162	1.23439	2.27301	2.65184	3.11486	3.45161	3.78835
168	1.22269	2.35006	2.74174	3.22045	3.56861	3.91677
174	1.20514	2.42711	2.83163	3.32604	3.68561	4.04518
180	1.19344	2.46564	2.87658	3.37883	3.74411	4.10939

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
186	1.17589	2.46564	2.87658	3.37883	3.74411	4.10939
192	1.16419	2.46564	2.87658	3.37883	3.74411	4.10939
198	1.14663	2.46564	2.87658	3.37883	3.74411	4.10939
204	1.13493	2.46564	2.87658	3.37883	3.74411	4.10939
210	1.11738	2.52728	2.94849	3.46331	3.83772	4.21213
216	1.10568	2.65056	3.09232	3.63225	4.02492	4.4176
222	1.08813	2.77384	3.23615	3.80119	4.21213	4.62307
228	1.07643	2.89712	3.37998	3.97013	4.39933	4.82854
234	1.05888	3.0204	3.5238	4.13907	4.58654	5.03401
240	1.31629	3.17451	3.70359	4.35025	4.82055	5.29084
246	1.37479	3.35943	3.91933	4.60366	5.10136	5.59905
252	1.43329	3.54435	4.13508	4.85707	5.38216	5.90725
258	1.4918	3.72927	4.35082	5.11049	5.66297	6.21546
264	1.5503	3.9142	4.56656	5.3639	5.94378	6.52366
270	1.6088	4.16076	4.85422	5.70178	6.31819	6.9346
276	1.6673	4.46897	5.21379	6.12414	6.78621	7.44828
282	1.7258	4.77717	5.57337	6.54649	7.25422	7.96195
288	1.7843	5.08537	5.93294	6.96885	7.72224	8.47562
294	1.84281	5.39358	6.29251	7.3912	8.19025	8.9893
300	1.87206	5.91753	6.90378	8.1092	8.98587	9.86254
306	1.87206	6.65722	7.76675	9.12285	10.10911	11.09536
312	1.87206	7.39691	8.62973	10.1365	11.23234	12.32818
318	1.87206	8.1366	9.4927	11.15015	12.35558	13.561
324	1.87206	8.87629	10.35567	12.1638	13.47881	14.79382
330	1.91886	18.36899	21.43049	25.17232	27.89365	30.61498
336	2.01246	36.6147	42.71715	50.1757	55.6001	61.02449
342	2.10606	58.89018	68.70521	80.70136	89.42583	98.1503
348	2.19967	105.614	123.2163	144.7303	160.3768	176.0233
354	2.29327	73.30644	85.52419	100.457	111.3172	122.1774
360	2.41027	14.60889	17.04371	20.0196	22.18388	24.34816
366	2.55068	12.85213	14.99415	17.61218	19.5162	21.42021
372	2.69108	11.09536	12.94459	15.20476	16.84851	18.49227

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
378	2.83149	9.3386	10.89503	12.79734	14.18083	15.56433
384	2.97189	7.58183	8.84547	10.38992	11.51315	12.63639
390	3.1591	6.50312	7.58697	8.91168	9.8751	10.83853
396	3.3931	6.10245	7.11952	8.36262	9.26668	10.17075
402	3.62711	5.70178	6.65208	7.81356	8.65826	9.50297
408	3.86112	5.30112	6.18464	7.26449	8.04985	8.8352
414	4.09512	4.90045	5.71719	6.71543	7.44143	8.16742
420	4.49294	4.59225	5.35762	6.29308	6.97341	7.65375
426	5.05455	4.3765	5.10592	5.99743	6.6458	7.29417
432	5.61617	4.16076	4.85422	5.70178	6.31819	6.9346
438	6.17779	3.94502	4.60252	5.40614	5.99058	6.57503
444	6.73941	3.72927	4.35082	5.11049	5.66297	6.21546
450	13.94683	3.54435	4.13508	4.85707	5.38216	5.90725
456	27.80005	3.39025	3.95529	4.6459	5.14816	5.65042
462	44.71291	3.23615	3.77551	4.43472	4.91415	5.39358
468	80.18839	3.08205	3.59572	4.22354	4.68014	5.13674
474	55.6586	2.92794	3.41593	4.01237	4.44614	4.8799
480	11.09194	2.82778	3.29907	3.8751	4.29403	4.71296
486	9.7581	2.76614	3.22716	3.79063	4.20043	4.61023
492	8.42426	2.7199	3.17322	3.72728	4.13023	4.53317
498	7.09042	2.65826	3.10131	3.64281	4.03662	4.43044
504	5.75658	2.61203	3.04737	3.57945	3.96642	4.35339
510	4.93755	2.55039	2.97546	3.49498	3.87282	4.25065
516	4.63334	2.50416	2.92152	3.43163	3.80262	4.1736
522	4.32913	2.44252	2.84961	3.34716	3.70901	4.07087
528	4.02492	2.39629	2.79567	3.2838	3.63881	3.99382
534	3.72071	2.33465	2.72376	3.19933	3.54521	3.89108
540	3.48671	2.28842	2.66982	3.13598	3.47501	3.81403
546	3.3229	2.22678	2.59791	3.05151	3.3814	3.7113
552	3.1591	2.18055	2.54397	2.98816	3.3112	3.63424
558	2.99529	2.11891	2.47206	2.90369	3.2176	3.53151
564	2.83149	2.07268	2.41812	2.84033	3.1474	3.45446

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
570	2.69108	2.01103	2.34621	2.75586	3.05379	3.35172
576	2.57408	1.9648	2.29227	2.69251	2.98359	3.27467
582	2.45707	1.90316	2.22036	2.60804	2.88999	3.17194
588	2.34007	1.85693	2.16642	2.54468	2.81979	3.09489
594	2.22307	1.79529	2.09451	2.46021	2.72618	2.99215
600	2.14702	1.76447	2.05855	2.41798	2.67938	2.94078
606	2.10021	1.74136	2.03158	2.3863	2.64428	2.90226
612	2.06511	1.72595	2.0136	2.36518	2.62088	2.87658
618	2.01831	1.70283	1.98663	2.33351	2.58578	2.83805
624	1.98321	1.68742	1.96866	2.31239	2.56238	2.81237
630	1.93641	1.6643	1.94169	2.28071	2.52728	2.77384
636	1.90131	1.64889	1.92371	2.2596	2.50388	2.74816
642	1.85451	1.62578	1.89674	2.22792	2.46878	2.70963
648	1.81941	1.61037	1.87876	2.2068	2.44537	2.68395
654	1.7726	1.58725	1.8518	2.17512	2.41027	2.64542
660	1.7375	1.57184	1.83382	2.15401	2.38687	2.61974
666	1.6907	1.54873	1.80685	2.12233	2.35177	2.58121
672	1.6556	1.53332	1.78887	2.10121	2.32837	2.55553
678	1.6088	1.5102	1.7619	2.06954	2.29327	2.517
684	1.5737	1.49479	1.74392	2.04842	2.26987	2.49132
690	1.5269	1.47168	1.71696	2.01674	2.23477	2.45279
696	1.4918	1.45627	1.69898	1.99562	2.21137	2.42711
702	1.44499	1.43315	1.67201	1.96395	2.17627	2.38859
708	1.40989	1.41774	1.65403	1.94283	2.15287	2.3629
714	1.36309	1.39463	1.62706	1.91115	2.11776	2.32438

Table C15 SCS 24 hr Distribution

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
0	0.606	0.79992	0.94536	1.0908	1.212	1.3332
6	0.606	0.79992	0.94536	1.0908	1.212	1.3332
12	0.618	0.81576	0.96408	1.1124	1.236	1.3596
18	0.618	0.81576	0.96408	1.1124	1.236	1.3596
24	0.63	0.8316	0.9828	1.134	1.26	1.386
30	0.63	0.8316	0.9828	1.134	1.26	1.386
36	0.642	0.84744	1.00152	1.1556	1.284	1.4124
42	0.642	0.84744	1.00152	1.1556	1.284	1.4124
48	0.654	0.86328	1.02024	1.1772	1.308	1.4388
54	0.654	0.86328	1.02024	1.1772	1.308	1.4388
60	0.666	0.87912	1.03896	1.1988	1.332	1.4652
66	0.666	0.87912	1.03896	1.1988	1.332	1.4652
72	0.678	0.89496	1.05768	1.2204	1.356	1.4916
78	0.678	0.89496	1.05768	1.2204	1.356	1.4916
84	0.69	0.9108	1.0764	1.242	1.38	1.518
90	0.69	0.9108	1.0764	1.242	1.38	1.518
96	0.702	0.92664	1.09512	1.2636	1.404	1.5444
102	0.702	0.92664	1.09512	1.2636	1.404	1.5444
108	0.714	0.94248	1.11384	1.2852	1.428	1.5708
114	0.714	0.94248	1.11384	1.2852	1.428	1.5708
120	0.726	0.95832	1.13256	1.3068	1.452	1.5972
126	0.726	0.95832	1.13256	1.3068	1.452	1.5972
132	0.738	0.97416	1.15128	1.3284	1.476	1.6236
138	0.738	0.97416	1.15128	1.3284	1.476	1.6236
144	0.75	0.99	1.17	1.35	1.5	1.65
150	0.75	0.99	1.17	1.35	1.5	1.65
156	0.762	1.00584	1.18872	1.3716	1.524	1.6764
162	0.762	1.00584	1.18872	1.3716	1.524	1.6764
168	0.774	1.02168	1.20744	1.3932	1.548	1.7028
174	0.774	1.02168	1.20744	1.3932	1.548	1.7028
180	0.786	1.03752	1.22616	1.4148	1.572	1.7292

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
186	0.786	1.03752	1.22616	1.4148	1.572	1.7292
192	0.798	1.05336	1.24488	1.4364	1.596	1.7556
198	0.798	1.05336	1.24488	1.4364	1.596	1.7556
204	0.81	1.0692	1.2636	1.458	1.62	1.782
210	0.81	1.0692	1.2636	1.458	1.62	1.782
216	0.822	1.08504	1.28232	1.4796	1.644	1.8084
222	0.822	1.08504	1.28232	1.4796	1.644	1.8084
228	0.834	1.10088	1.30104	1.5012	1.668	1.8348
234	0.834	1.10088	1.30104	1.5012	1.668	1.8348
240	0.846	1.11672	1.31976	1.5228	1.692	1.8612
246	0.858	1.13256	1.33848	1.5444	1.716	1.8876
252	0.87	1.1484	1.3572	1.566	1.74	1.914
258	0.882	1.16424	1.37592	1.5876	1.764	1.9404
264	0.894	1.18008	1.39464	1.6092	1.788	1.9668
270	0.906	1.19592	1.41336	1.6308	1.812	1.9932
276	0.918	1.21176	1.43208	1.6524	1.836	2.0196
282	0.93	1.2276	1.4508	1.674	1.86	2.046
288	0.942	1.24344	1.46952	1.6956	1.884	2.0724
294	0.954	1.25928	1.48824	1.7172	1.908	2.0988
300	0.966	1.27512	1.50696	1.7388	1.932	2.1252
306	0.978	1.29096	1.52568	1.7604	1.956	2.1516
312	0.99	1.3068	1.5444	1.782	1.98	2.178
318	1.002	1.32264	1.56312	1.8036	2.004	2.2044
324	1.014	1.33848	1.58184	1.8252	2.028	2.2308
330	1.026	1.35432	1.60056	1.8468	2.052	2.2572
336	1.038	1.37016	1.61928	1.8684	2.076	2.2836
342	1.05	1.386	1.638	1.89	2.1	2.31
348	1.062	1.40184	1.65672	1.9116	2.124	2.3364
354	1.074	1.41768	1.67544	1.9332	2.148	2.3628
360	1.086	1.43352	1.69416	1.9548	2.172	2.3892
366	1.098	1.44936	1.71288	1.9764	2.196	2.4156
372	1.11	1.4652	1.7316	1.998	2.22	2.442

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
378	1.122	1.48104	1.75032	2.0196	2.244	2.4684
384	1.134	1.49688	1.76904	2.0412	2.268	2.4948
390	1.146	1.51272	1.78776	2.0628	2.292	2.5212
396	1.158	1.52856	1.80648	2.0844	2.316	2.5476
402	1.17	1.5444	1.8252	2.106	2.34	2.574
408	1.182	1.56024	1.84392	2.1276	2.364	2.6004
414	1.194	1.57608	1.86264	2.1492	2.388	2.6268
420	1.206	1.59192	1.88136	2.1708	2.412	2.6532
426	1.218	1.60776	1.90008	2.1924	2.436	2.6796
432	1.23	1.6236	1.9188	2.214	2.46	2.706
438	1.242	1.63944	1.93752	2.2356	2.484	2.7324
444	1.254	1.65528	1.95624	2.2572	2.508	2.7588
450	1.266	1.67112	1.97496	2.2788	2.532	2.7852
456	1.278	1.68696	1.99368	2.3004	2.556	2.8116
462	1.29	1.7028	2.0124	2.322	2.58	2.838
468	1.302	1.71864	2.03112	2.3436	2.604	2.8644
474	1.314	1.73448	2.04984	2.3652	2.628	2.8908
480	1.35	1.782	2.106	2.43	2.7	2.97
486	1.41	1.8612	2.1996	2.538	2.82	3.102
492	1.47	1.9404	2.2932	2.646	2.94	3.234
498	1.53	2.0196	2.3868	2.754	3.06	3.366
504	1.59	2.0988	2.4804	2.862	3.18	3.498
510	1.65	2.178	2.574	2.97	3.3	3.63
516	1.71	2.2572	2.6676	3.078	3.42	3.762
522	1.77	2.3364	2.7612	3.186	3.54	3.894
528	1.83	2.4156	2.8548	3.294	3.66	4.026
534	1.89	2.4948	2.9484	3.402	3.78	4.158
540	1.92	2.5344	2.9952	3.456	3.84	4.224
546	1.92	2.5344	2.9952	3.456	3.84	4.224
552	1.92	2.5344	2.9952	3.456	3.84	4.224
558	1.92	2.5344	2.9952	3.456	3.84	4.224
564	1.92	2.5344	2.9952	3.456	3.84	4.224

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
570	1.968	2.59776	3.07008	3.5424	3.936	4.3296
576	2.064	2.72448	3.21984	3.7152	4.128	4.5408
582	2.16	2.8512	3.3696	3.888	4.32	4.752
588	2.256	2.97792	3.51936	4.0608	4.512	4.9632
594	2.352	3.10464	3.66912	4.2336	4.704	5.1744
600	2.472	3.26304	3.85632	4.4496	4.944	5.4384
606	2.616	3.45312	4.08096	4.7088	5.232	5.7552
612	2.76	3.6432	4.3056	4.968	5.52	6.072
618	2.904	3.83328	4.53024	5.2272	5.808	6.3888
624	3.048	4.02336	4.75488	5.4864	6.096	6.7056
630	3.24	4.2768	5.0544	5.832	6.48	7.128
636	3.48	4.5936	5.4288	6.264	6.96	7.656
642	3.72	4.9104	5.8032	6.696	7.44	8.184
648	3.96	5.2272	6.1776	7.128	7.92	8.712
654	4.2	5.544	6.552	7.56	8.4	9.24
660	4.608	6.08256	7.18848	8.2944	9.216	10.1376
666	5.184	6.84288	8.08704	9.3312	10.368	11.4048
672	5.76	7.6032	8.9856	10.368	11.52	12.672
678	6.336	8.36352	9.88416	11.4048	12.672	13.9392
684	6.912	9.12384	10.78272	12.4416	13.824	15.2064
690	14.304	18.88128	22.31424	25.7472	28.608	31.4688
696	28.512	37.63584	44.47872	51.3216	57.024	62.7264
702	45.858	60.53256	71.53848	82.5444	91.716	100.8876
708	82.242	108.5594	128.2975	148.0356	164.484	180.9324
714	57.084	75.35088	89.05104	102.7512	114.168	125.5848
720	11.376	15.01632	17.74656	20.4768	22.752	25.0272
726	10.008	13.21056	15.61248	18.0144	20.016	22.0176
732	8.64	11.4048	13.4784	15.552	17.28	19.008
738	7.272	9.59904	11.34432	13.0896	14.544	15.9984
744	5.904	7.79328	9.21024	10.6272	11.808	12.9888
750	5.064	6.68448	7.89984	9.1152	10.128	11.1408
756	4.752	6.27264	7.41312	8.5536	9.504	10.4544

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
762	4.44	5.8608	6.9264	7.992	8.88	9.768
768	4.128	5.44896	6.43968	7.4304	8.256	9.0816
774	3.816	5.03712	5.95296	6.8688	7.632	8.3952
780	3.576	4.72032	5.57856	6.4368	7.152	7.8672
786	3.408	4.49856	5.31648	6.1344	6.816	7.4976
792	3.24	4.2768	5.0544	5.832	6.48	7.128
798	3.072	4.05504	4.79232	5.5296	6.144	6.7584
804	2.904	3.83328	4.53024	5.2272	5.808	6.3888
810	2.76	3.6432	4.3056	4.968	5.52	6.072
816	2.64	3.4848	4.1184	4.752	5.28	5.808
822	2.52	3.3264	3.9312	4.536	5.04	5.544
828	2.4	3.168	3.744	4.32	4.8	5.28
834	2.28	3.0096	3.5568	4.104	4.56	5.016
840	2.202	2.90664	3.43512	3.9636	4.404	4.8444
846	2.154	2.84328	3.36024	3.8772	4.308	4.7388
852	2.118	2.79576	3.30408	3.8124	4.236	4.6596
858	2.07	2.7324	3.2292	3.726	4.14	4.554
864	2.034	2.68488	3.17304	3.6612	4.068	4.4748
870	1.986	2.62152	3.09816	3.5748	3.972	4.3692
876	1.95	2.574	3.042	3.51	3.9	4.29
882	1.902	2.51064	2.96712	3.4236	3.804	4.1844
888	1.866	2.46312	2.91096	3.3588	3.732	4.1052
894	1.818	2.39976	2.83608	3.2724	3.636	3.9996
900	1.782	2.35224	2.77992	3.2076	3.564	3.9204
906	1.734	2.28888	2.70504	3.1212	3.468	3.8148
912	1.698	2.24136	2.64888	3.0564	3.396	3.7356
918	1.65	2.178	2.574	2.97	3.3	3.63
924	1.614	2.13048	2.51784	2.9052	3.228	3.5508
930	1.566	2.06712	2.44296	2.8188	3.132	3.4452
936	1.53	2.0196	2.3868	2.754	3.06	3.366
942	1.482	1.95624	2.31192	2.6676	2.964	3.2604
948	1.446	1.90872	2.25576	2.6028	2.892	3.1812

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
954	1.398	1.84536	2.18088	2.5164	2.796	3.0756
960	1.374	1.81368	2.14344	2.4732	2.748	3.0228
966	1.356	1.78992	2.11536	2.4408	2.712	2.9832
972	1.344	1.77408	2.09664	2.4192	2.688	2.9568
978	1.326	1.75032	2.06856	2.3868	2.652	2.9172
984	1.314	1.73448	2.04984	2.3652	2.628	2.8908
990	1.296	1.71072	2.02176	2.3328	2.592	2.8512
996	1.284	1.69488	2.00304	2.3112	2.568	2.8248
1002	1.266	1.67112	1.97496	2.2788	2.532	2.7852
1008	1.254	1.65528	1.95624	2.2572	2.508	2.7588
1014	1.236	1.63152	1.92816	2.2248	2.472	2.7192
1020	1.224	1.61568	1.90944	2.2032	2.448	2.6928
1026	1.206	1.59192	1.88136	2.1708	2.412	2.6532
1032	1.194	1.57608	1.86264	2.1492	2.388	2.6268
1038	1.176	1.55232	1.83456	2.1168	2.352	2.5872
1044	1.164	1.53648	1.81584	2.0952	2.328	2.5608
1050	1.146	1.51272	1.78776	2.0628	2.292	2.5212
1056	1.134	1.49688	1.76904	2.0412	2.268	2.4948
1062	1.116	1.47312	1.74096	2.0088	2.232	2.4552
1068	1.104	1.45728	1.72224	1.9872	2.208	2.4288
1074	1.086	1.43352	1.69416	1.9548	2.172	2.3892
1080	1.074	1.41768	1.67544	1.9332	2.148	2.3628
1086	1.056	1.39392	1.64736	1.9008	2.112	2.3232
1092	1.044	1.37808	1.62864	1.8792	2.088	2.2968
1098	1.026	1.35432	1.60056	1.8468	2.052	2.2572
1104	1.014	1.33848	1.58184	1.8252	2.028	2.2308
1110	0.996	1.31472	1.55376	1.7928	1.992	2.1912
1116	0.984	1.29888	1.53504	1.7712	1.968	2.1648
1122	0.966	1.27512	1.50696	1.7388	1.932	2.1252
1128	0.954	1.25928	1.48824	1.7172	1.908	2.0988
1134	0.936	1.23552	1.46016	1.6848	1.872	2.0592
1140	0.924	1.21968	1.44144	1.6632	1.848	2.0328

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
1146	0.906	1.19592	1.41336	1.6308	1.812	1.9932
1152	0.894	1.18008	1.39464	1.6092	1.788	1.9668
1158	0.876	1.15632	1.36656	1.5768	1.752	1.9272
1164	0.864	1.14048	1.34784	1.5552	1.728	1.9008
1170	0.846	1.11672	1.31976	1.5228	1.692	1.8612
1176	0.834	1.10088	1.30104	1.5012	1.668	1.8348
1182	0.816	1.07712	1.27296	1.4688	1.632	1.7952
1188	0.804	1.06128	1.25424	1.4472	1.608	1.7688
1194	0.786	1.03752	1.22616	1.4148	1.572	1.7292
1200	0.78	1.0296	1.2168	1.404	1.56	1.716
1206	0.774	1.02168	1.20744	1.3932	1.548	1.7028
1212	0.774	1.02168	1.20744	1.3932	1.548	1.7028
1218	0.768	1.01376	1.19808	1.3824	1.536	1.6896
1224	0.768	1.01376	1.19808	1.3824	1.536	1.6896
1230	0.762	1.00584	1.18872	1.3716	1.524	1.6764
1236	0.762	1.00584	1.18872	1.3716	1.524	1.6764
1242	0.756	0.99792	1.17936	1.3608	1.512	1.6632
1248	0.756	0.99792	1.17936	1.3608	1.512	1.6632
1254	0.75	0.99	1.17	1.35	1.5	1.65
1260	0.75	0.99	1.17	1.35	1.5	1.65
1266	0.744	0.98208	1.16064	1.3392	1.488	1.6368
1272	0.744	0.98208	1.16064	1.3392	1.488	1.6368
1278	0.738	0.97416	1.15128	1.3284	1.476	1.6236
1284	0.738	0.97416	1.15128	1.3284	1.476	1.6236
1290	0.732	0.96624	1.14192	1.3176	1.464	1.6104
1296	0.732	0.96624	1.14192	1.3176	1.464	1.6104
1302	0.726	0.95832	1.13256	1.3068	1.452	1.5972
1308	0.726	0.95832	1.13256	1.3068	1.452	1.5972
1314	0.72	0.9504	1.1232	1.296	1.44	1.584
1320	0.72	0.9504	1.1232	1.296	1.44	1.584
1326	0.714	0.94248	1.11384	1.2852	1.428	1.5708
1332	0.714	0.94248	1.11384	1.2852	1.428	1.5708

TIME (MIN)	STORM EVENT RAINFALL INTENSITY (MM/HR)					
	2YR	5YR	10YR	25YR	50YR	100YR
1338	0.708	0.93456	1.10448	1.2744	1.416	1.5576
1344	0.708	0.93456	1.10448	1.2744	1.416	1.5576
1350	0.702	0.92664	1.09512	1.2636	1.404	1.5444
1356	0.702	0.92664	1.09512	1.2636	1.404	1.5444
1362	0.696	0.91872	1.08576	1.2528	1.392	1.5312
1368	0.696	0.91872	1.08576	1.2528	1.392	1.5312
1374	0.69	0.9108	1.0764	1.242	1.38	1.518
1380	0.69	0.9108	1.0764	1.242	1.38	1.518
1386	0.684	0.90288	1.06704	1.2312	1.368	1.5048
1392	0.684	0.90288	1.06704	1.2312	1.368	1.5048
1398	0.678	0.89496	1.05768	1.2204	1.356	1.4916
1404	0.678	0.89496	1.05768	1.2204	1.356	1.4916
1410	0.672	0.88704	1.04832	1.2096	1.344	1.4784
1416	0.672	0.88704	1.04832	1.2096	1.344	1.4784
1422	0.666	0.87912	1.03896	1.1988	1.332	1.4652
1428	0.666	0.87912	1.03896	1.1988	1.332	1.4652
1434	0.66	0.8712	1.0296	1.188	1.32	1.452

Table C16 Regional 12 hr Storm Event

TIME (MIN)	RAINFALL INTENSITY (MM/HR)
0	0
10	6.35
20	6.35
30	6.35
40	6.35
50	6.35
60	6.35
70	4.32
80	4.32
90	4.32
100	4.32
110	4.32
120	4.32
130	6.35
140	6.35
150	6.35
160	6.35
170	6.35
180	6.35
190	12.7
200	12.7
210	12.7
220	12.7
230	12.7
240	12.7
250	16.76
260	16.76
270	16.76
280	16.76
290	16.76
300	16.76
310	13.97

TIME (MIN)	RAINFALL INTENSITY (MM/HR)
320	13.97
330	13.97
340	13.97
350	13.97
360	13.97
370	23.11
380	23.11
390	23.11
400	23.11
410	23.11
420	23.11
430	12.7
440	12.7
450	12.7
460	12.7
470	12.7
480	12.7
490	12.7
500	12.7
510	12.7
520	12.7
530	12.7
540	12.7
550	52.83
560	52.83
570	52.83
580	52.83
590	52.83
600	52.83
610	37.85
620	37.85
630	37.85
640	37.85

TIME (MIN)	RAINFALL INTENSITY (MM/HR)
650	37.85
660	37.85
670	12.7
680	12.7
690	12.7
700	12.7
710	12.7
720	12.7

Table C17 Regional 48 hr Storm Event

TIME (MIN)	RAINFALL INTENSITY (MM/HR)
0	0
60	2
120	2
180	2
240	2
300	2
360	2
420	2
480	2
540	2
600	2
660	2
720	2
780	2
840	2
900	2
960	2
1020	2
1080	2
1140	2
1200	2
1260	2

TIME (MIN)	RAINFALL INTENSITY (MM/HR)
1320	2
1380	2
1440	2
1500	2
1560	2
1620	2
1680	2
1740	2
1800	2
1860	2
1920	2
1980	2
2040	2
2100	2
2160	3
2220	6
2280	4
2340	6
2400	13
2460	17
2520	13
2580	23
2640	13
2700	13
2760	53
2820	38
2880	13

Hydrology Results

Table C18 Existing Conditions Peak Flows

POINT OF INTEREST		PEAK FLOW (m3/s)																	
		CHICAGO 6HR						SCS TYPE2 12 HOUR						SCS TYPE2 24 HOUR					
NYHD	NAME	2	5	10	25	50	100	2	5	10	25	50	100	2	5	10	25	50	100
Nodes																			
60	7	0.295	0.572	0.788	1.090	1.331	1.584	0.672	1.049	1.396	1.850	2.196	2.554	0.773	1.295	1.725	2.178	2.568	2.969
55	8	0.637	1.209	1.649	2.259	2.744	3.250	1.364	2.110	2.788	3.670	4.338	5.024	1.564	2.589	3.423	4.295	5.041	5.803
9	9	0.484	0.909	1.234	1.685	2.042	2.414	0.999	1.543	2.037	2.678	3.164	3.663	1.144	1.891	2.498	3.132	3.684	4.248
10	10	0.920	1.739	2.368	3.240	3.932	4.671	1.970	3.052	4.034	5.309	6.277	7.272	2.252	3.731	4.943	6.235	7.348	8.486
11	11	1.370	2.602	3.553	4.873	5.922	7.020	2.940	4.555	6.031	7.950	9.409	10.908	3.374	5.604	7.423	9.327	10.962	12.631
57	18	0.101	0.179	0.237	0.316	0.377	0.440	0.196	0.292	0.375	0.481	0.559	0.639	0.219	0.345	0.444	0.545	0.631	0.720
58	19	1.721	3.191	4.336	5.920	7.176	8.487	3.547	5.461	7.203	9.461	11.171	12.928	4.059	6.692	8.829	11.060	12.972	14.920
Subcatchments																			
5	PR-E01	0.023	0.044	0.060	0.083	0.102	0.123	0.052	0.082	0.110	0.147	0.175	0.205	0.060	0.102	0.137	0.174	0.206	0.240
61	PR-E02	0.470	0.879	1.193	1.630	1.975	2.336	0.968	1.494	1.972	2.593	3.063	3.545	1.108	1.832	2.420	3.033	3.559	4.095
12	PR-M01	0.224	0.402	0.536	0.716	0.857	1.003	0.442	0.661	0.853	1.098	1.280	1.466	0.498	0.788	1.018	1.253	1.452	1.653
53	PR-M02	0.032	0.055	0.073	0.098	0.118	0.138	0.055	0.082	0.105	0.134	0.155	0.178	0.060	0.094	0.121	0.149	0.172	0.196
14	PR-M03	0.091	0.163	0.216	0.289	0.345	0.403	0.179	0.267	0.343	0.440	0.513	0.586	0.201	0.317	0.408	0.501	0.579	0.658
54	PR-M04	0.033	0.059	0.079	0.106	0.127	0.148	0.071	0.107	0.138	0.177	0.206	0.236	0.080	0.126	0.163	0.200	0.231	0.263
63	PR-M05	0.038	0.066	0.088	0.118	0.141	0.166	0.075	0.112	0.143	0.183	0.213	0.244	0.083	0.131	0.168	0.207	0.239	0.272
4	PR-N01	0.118	0.217	0.295	0.403	0.489	0.579	0.243	0.374	0.493	0.648	0.766	0.888	0.278	0.458	0.606	0.760	0.893	1.029
62	PR-N02	0.527	0.994	1.360	1.869	2.273	2.696	1.123	1.740	2.305	3.038	3.594	4.165	1.291	2.145	2.840	3.565	4.188	4.822
20	PR-S01	0.048	0.085	0.114	0.153	0.184	0.215	0.098	0.146	0.187	0.238	0.276	0.314	0.109	0.170	0.218	0.267	0.308	0.349
2	PR-W01	0.139	0.264	0.365	0.509	0.626	0.749	0.302	0.474	0.637	0.853	1.020	1.193	0.350	0.596	0.802	1.022	1.214	1.412
56	PR-W02	0.161	0.309	0.423	0.581	0.714	0.853	0.370	0.575	0.759	0.997	1.177	1.361	0.423	0.699	0.922	1.155	1.355	1.557

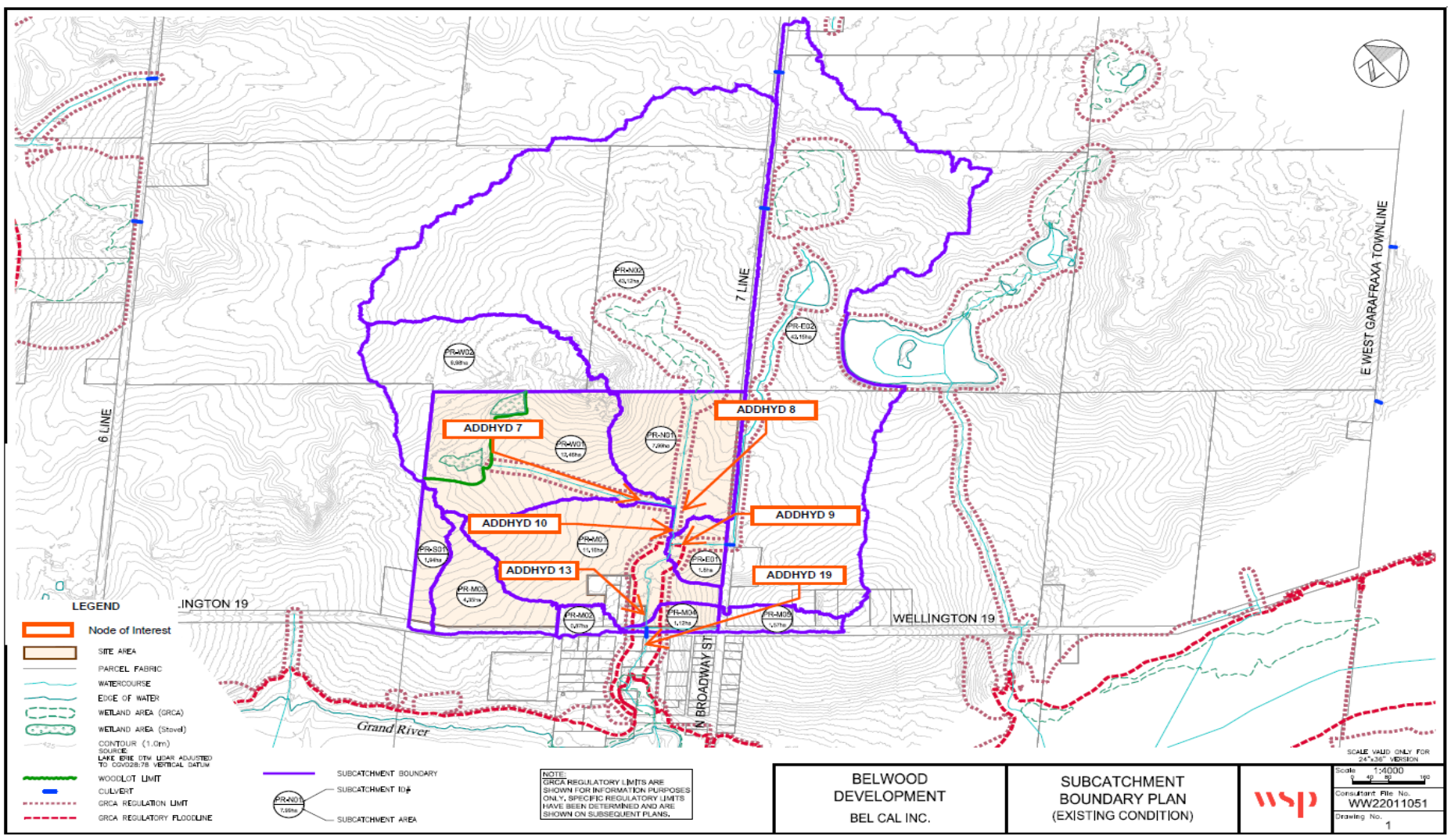


Figure C1 Nodes of Interest Existing Conditions

TABLE C19 PROPOSED CONTROLLED CONDITIONS PEAK FLOWS

POINT OF INTEREST		PEAK FLOW (M3/S)																	
		CHICAGO 6HR						SCS TYPE2 12 HOUR						SCS TYPE2 24 HOUR					
NYHD	NAME	2	5	10	25	50	100	2	5	10	25	50	100	2	5	10	25	50	100
Nodes																			
101	10	1.023	1.809	2.424	3.271	3.944	4.64	1.956	2.994	4.776	5.164	6.073	6.832	2.217	3.628	4.776	6.003	6.827	7.672
105	13	1.547	2.768	3.729	5.056	6.111	7.207	3.02	4.632	6.115	8.019	9.45	10.746	3.44	5.653	7.454	9.365	10.776	12.22
104	AddHyd - 55	0.419	0.636	0.899	1.191	1.402	1.62	0.604	0.938	1.442	1.792	1.941	2.237	0.644	1.042	1.442	1.792	2.11	2.433
90	19	1.985	3.444	4.598	6.158	7.38	8.664	3.677	5.632	8.867	9.59	11.314	14.632	4.145	6.785	8.867	11.112	12.875	14.632

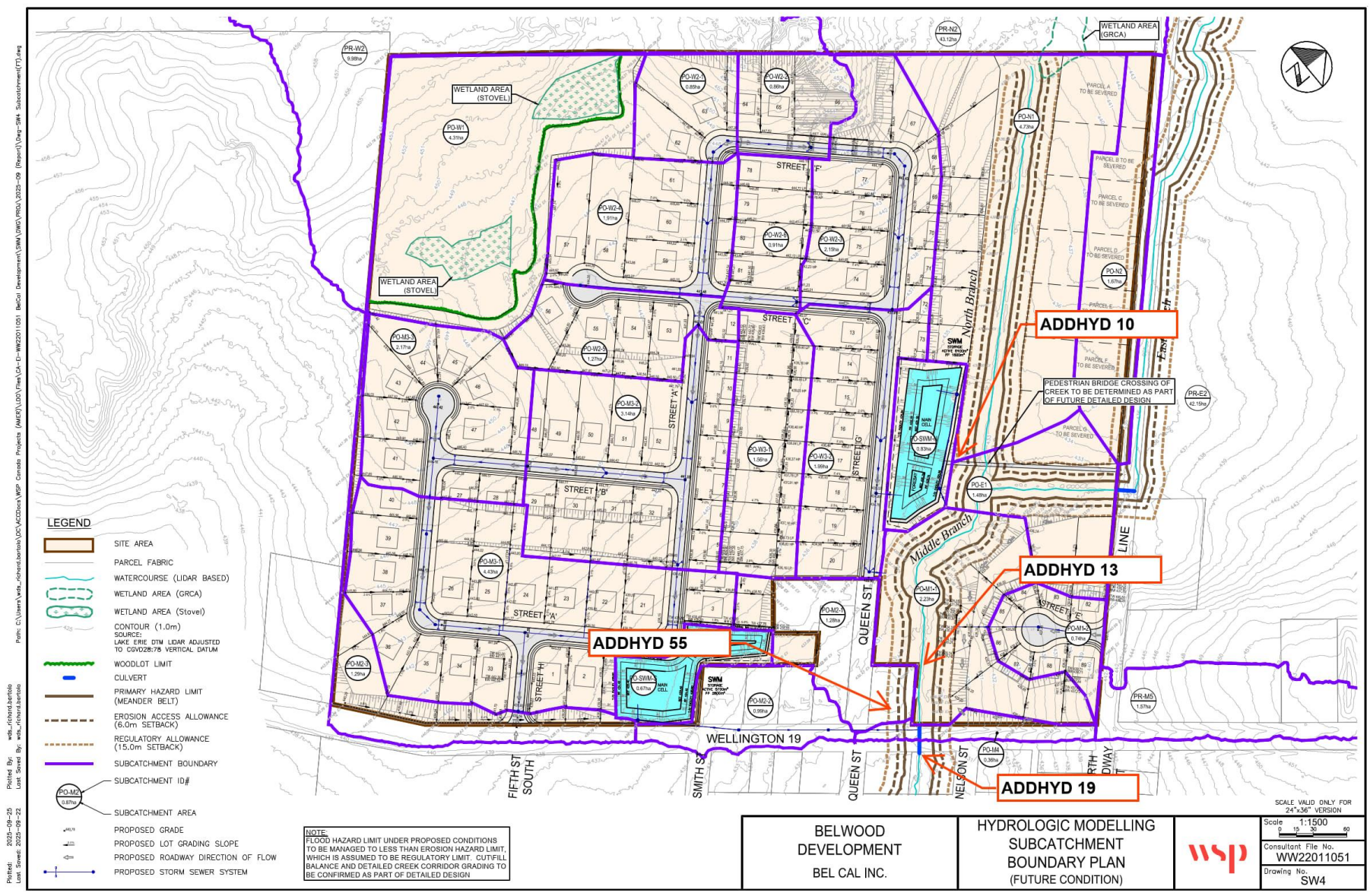
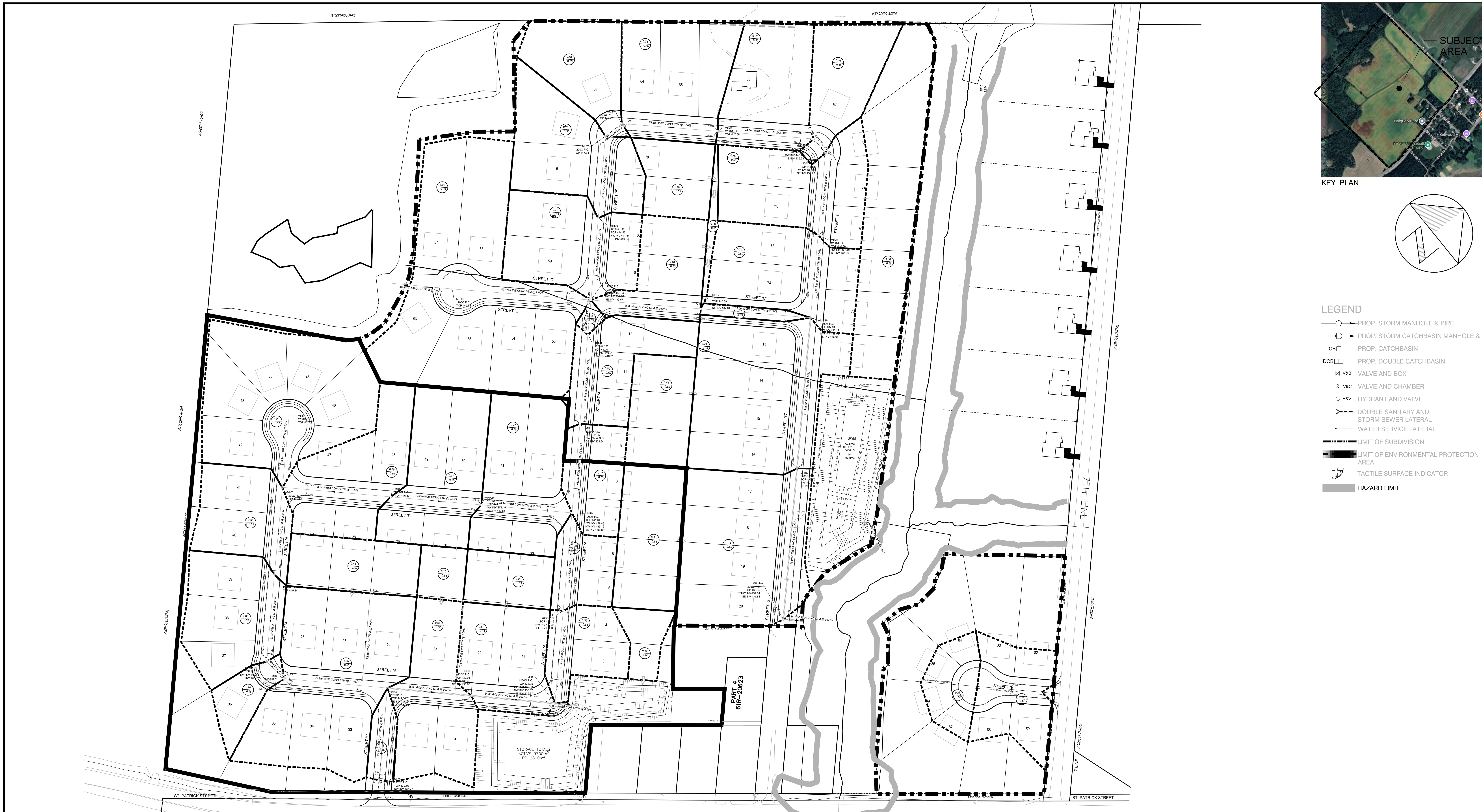


Figure C2 Nodes of Interest Proposed Conditions

APPENDIX

D STORM SEWER DESIGN



STAMP	
CONSULTANT	wsp
APPROVALS	
NO. DATE	REVISIONS
DESIGN	CHECKED
DRAWN	CHECKED
DATE	
SCALE	1:1000 (0 5 10 20)
REFERENCES:	
FIELD NOTES:	
MUNICIPALITY	
	BELWOOD DEVELOPMENT BEL CAL INC.
TITLE	PRELIMINARY STORM DRAINAGE PLAN (PROPOSED CONDITION)
MUNICIPAL DRAWING No.	REGIONAL FILE No.
Consultant File No. WW22011051	DRAWING No.

DEVELOPMENT: BELWOOD DEVELOPMENT, BELCAL INC.

CONSULTANT: WSP CANADA INC.

DATE: 2025-10-02

	5 Year Parameters	100 Year Parameters
A=	32.79	52.97
B=	-0.686	-0.691

Minimum Initial Time of Concentration = 10.00

STORM DESIGN SHEET

Runoff Coefficients:	
Apartments	0.75
ROW Townhouses	0.70
Semi-detached	0.60
Single Family	0.45

KCAi Conversion Factor	0.002800
Manning Coefficient	0.013
Area (ha)	
Rainfall Intensity	= A*(t)^B

DESIGNED BY: AM

REVIEWED BY: CW

LOCATION			DRAINAGE AREA				RUNOFF							PIPE SELECTION						
STREET	FROM	TO	AREA (ha)	RUN OFF COEF.	CA	CUMUL CA	INT. 5YR (i) (mm/hr)	FLOW 5YR (Q) (cms)	INT. 100YR (i) (mm/hr)	FLOW 100YR (Q) (cms)	INLET TIME (min)	SECTION TIME (min)	ACCUM TIME (min)	LENGTH (m)	SLOPE (%)	VELOCITY (m/s)	PIPE DIA. (mm)	CAPACITY (cms)	CAPACITY CHECK (AGAINST 5 YEAR?)	CAPACITY CHECK (AGAINST 100 YEAR?)
NORTH TO EAST																				
	MH22	MH26	0.69	0.55	0.38	0.38	112.09	0.119	182.70	0.194	10.00	0.48	10.48	74.3	2.00	2.562	450	0.42	28.3%	46.2%
	MH26	MH25	0.54	0.55	0.30	0.30	108.52	0.090	176.83	0.147	10.48	0.48	10.97	74.3	2.00	2.562	450	0.42	21.5%	35.0%
	MH25	MH24	0.48	0.55	0.26	0.56	105.21	0.165	171.41	0.269	10.97	0.09	11.06	14.1	2.00	2.562	450	0.42	39.3%	64.0%
	MH24	MH23	1.27	0.55	0.70	1.26	104.61	0.369	170.43	0.601	11.06	0.38	11.43	63.9	2.00	2.839	525	0.63	58.1%	94.7%
	MH23	MH16	0.79	0.55	0.43	1.69	102.25	0.485	166.55	0.790	11.43	0.38	11.81	63.9	2.00	2.839	525	0.63	76.4%	124.5%
	MH22	MH21	0.48	0.55	0.26	0.26	112.09	0.083	182.70	0.135	10.00	0.10	10.10	16.1	2.00	2.562	450	0.42	19.7%	32.1%
	MH21	MH20	0.73	0.55	0.40	0.67	111.29	0.207	181.39	0.338	10.10	0.41	10.52	63.3	2.00	2.562	450	0.42	49.3%	80.4%
	MH20	MH18	0.70	0.55	0.39	1.05	108.28	0.318	176.45	0.519	10.52	0.37	10.89	63.5	2.00	2.839	525	0.63	50.2%	81.8%
	MH19	MH18	1.97	0.55	1.08	1.08	112.09	0.340	182.70	0.554	10.00	0.63	10.63	107.4	2.00	2.839	525	0.63	53.6%	87.4%
	MH28	MH18	0.19	0.55	0.10	0.10	112.09	0.033	182.70	0.053	10.00	0.18	10.18	27.1	2.00	2.562	450	0.42	7.8%	12.7%
	MH18	MH17	0.46	0.55	0.25	2.49	112.09	0.782	182.70	1.275	10.00	0.46	10.46	85.0	2.00	3.104	600	0.91	86.3%	140.7%
	MH17	MH16	0.07	0.55	0.04	2.53	108.71	0.770	177.15	1.255	10.46	0.46	10.91	85.0	2.00	3.104	600	0.91	85.0%	138.5%
	MH16	MH15	1.64	0.55	0.90	5.13	105.57	1.515	172.00	2.469	10.91	0.54	11.45	116.9	1.80	3.641	825	2.01	75.4%	122.9%
	MH15	MH14	1.57	0.55	0.86	5.99	102.16	1.713	166.40	2.791	11.45	0.59	12.03	116.9	1.50	3.324	825	1.83	93.4%	152.2%
	MH14	NORTH POND	0.00	0.55	0.00	5.99	98.72	1.656		0.000	12.03	0.59	12.62	116.9	1.50	3.324	825	1.83	90.3%	0.0%
EAST TO SOUTH																				
	MH28	MH12	0.34	0.55	0.19	0.19	112.09	0.059	182.70	0.096	10.00	0.90	10.90	68.9	0.50	1.281	450	0.21	27.9%	45.5%
	MH12	MH10	0.43	0.55	0.24	0.42	105.68	0.125	172.18	0.204	10.90	0.63	11.53	68.9	1.00	1.812	450	0.30	42.1%	68.6%
	MH11	MH27	0.77	0.55	0.42	0.42	112.09	0.133	182.70	0.217	10.00	0.46	10.46	70.20	2.00	2.562	450	0.42	31.6%	51.5%
	MH27	MH10	0.77	0.55	0.42	0.85	108.71	0.258	177.15	0.420	10.46	0.46	10.91	70.20	2.00	2.562	450	0.42	61.3%	99.9%
	MH10	MH9	0.27	0.55	0.15	1.42	112.09	0.445	182.70	0.726	10.00	0.44	10.44	75.8	2.00	2.839	525	0.63	70.2%	114.4%
	MH9	MH1	0.34	0.55	0.19	1.61	108.79	0.489	177.28	0.797	10.44	0.55	10.99	71.8	1.00	2.195	600	0.64	76.4%	124.5%
WEST TO SOUTH																				
	MH8	MH7	1.32	0.55	0.73	0.73	112.09	0.228	182.70	0.371	10.00	0.36	10.36	55.2	2.00	2.562	450	0.42	54.2%	88.3%
	MH11	MH7	0.69	0.55	0.38	0.38	112.09	0.119	182.70	0.194	10.00	0.63	10.63	83.8	1.50	2.219	450	0.36	32.7%	53.3%
	MH7	MH6	0.44	0.55	0.24	1.35	112.09	0.423	182.70	0.689	10.00	0.40	10.40	67.5	2.00	2.839	525	0.63	66.7%	108.6%
	MH6	MH5	0.64	0.55	0.35	1.70	109.14	0.519	177.86	0.846	10.40	0.40	10.79	67.5	2.00	2.839	525	0.63	81.9%	133.4%
	MH5	MH4	0.25	0.55	0.14	1.84	106.37	0.547	173.32	0.891	10.79	0.11	10.90	19.1	2.00	2.839	525	0.63	86.2%	140.5%
	MH4	MH3	1.54	0.55	0.85	2.68	105.62	0.794	172.09	1.293	10.90	0.43	11.33	79.9	2.00	3.104	600	0.91	87.6%	142.8%
	MH29	MH3	0.12	0.55	0.07	0.07	112.09	0.021	182.70	0.034	10.00	0.64	10.64	70.0	1.00	1.812	450	0.30	7.0%	11.4%
	MH3	MH2	0.75	0.55	0.41	3.16	112.09	0.993	182.70	1.618	10.00	0.53	10.53	65.0	0.50	2.034	900	1.34	74.3%	121.1%
	MH2	MH1	0.55	0.55	0.30	3.47	108.17	1.049	176.26	1.710	10.53	0.53	11.06	64.8	0.50	2.034	900	1.34	78.6%	128.1%
	MH1	SOUTH POND	0.00	0.55	0.00	5.07	104.58	1.485		0.000	11.06	0.48	11.54	64.8	0.50	2.254	1050	2.01	73.7%	0.0%
	MH30	MH31	0.46	0.55	0.25	0.25	112.09	0.079	182.70	0.129	10.00	0.84	10.84	64.8	0.50	1.281	450	0.21	37.8%	61.5%
	MH31	DISCHARGE	0.26	0.55	0.14	0.40	106.03	0.118	172.76	0.192	10.84	0.76	11.60	64.8	0.50	1.420	525	0.32	37.1%	60.4%

APPENDIX

E HEC-RAS HYDRAULICS

Hydraulic Results

Table E1 Existing Conditions – 100 Year Storm Event Flood Elevations Associated with Cross Sections

RIVER	REACH	RIVER STATION	Q TOTAL (m3/s)	MIN CH EL (m)	W.S. ELEV (m)	CRIT W.S. (m)
River 6	Main Trib	353	13.94	431.5	432.62	
River 6	Main Trib	334	13.94	431.26	432.34	432.34
River 6	Main Trib	313	13.94	431.08	432.02	432.02
River 6	Main Trib	288	13.94	430.55	431.54	431.54
River 6	Main Trib	250	13.94	429.24	430.34	430.34
River 6	Main Trib	229	13.94	429.03	429.86	429.86
River 6	Main Trib	207	13.94	428.65	429.68	
River 6	Main Trib	181	13.94	428.3	429.68	
River 6	Main Trib	158	14.92	427.93	429.67	
River 6	Main Trib	150	14.92	427.91	429.67	
River 6	Main Trib	139	14.92	427.80	429.62	428.70
River 6	Main Trib					
River 6	Main Trib	110	14.92	427.84	428.81	428.81
River 6	Main Trib	99	14.92	427.75	428.69	428.69
River 6	Main Trib	84	14.92	427.65	428.58	
River 6	Main Trib	59	14.92	427.21	428.4	428.31
River 6	Main Trib	35	14.92	426.93	428.38	
River 6	Main Trib	16	14.92	426.57	428.12	428.12
River 6	Main Trib	1	14.92	426.45	427.82	427.82
River 4	East Trib	120	4.25	433.18	433.53	433.53
River 4	East Trib	105	4.25	432.86	433.14	433.14
River 4	East Trib	86	4.25	432.62	432.94	
River 4	East Trib	69	4.25	432.28	432.76	432.76
River 4	East Trib	55	4.25	432.24	432.73	
River 4	East Trib	44	4.25	432.1	432.73	
River 4	East Trib	33	4.25	431.97	432.72	
River 3	North West Trib	85	8.49	432.99	433.71	
River 3	NorthWest Trib	70	8.49	432.8	433.51	433.5
River 3	North West Trib	55	8.49	432.5	433.37	433.35
River 3	North West Trib	42	8.49	432.43	433.28	
River 3	North West Trib	29	8.49	432.26	433.24	433.14
River 3	North West Trib					
River 3	North West Trib	17	8.49	432.06	433.08	433.08
River 3	North West Trib	11	8.49	431.89	432.98	432.98
River 2	North Trib	279	5.8	438.29	439.06	439.06
River 2	North Trib	258	5.8	437.87	438.61	438.61
River 2	North Trib	234	5.8	437.33	438.1	438.1

RIVER	REACH	RIVER STATION	Q TOTAL (m3/s)	MIN CH EL (m)	W.S. ELEV (m)	CRIT W.S. (m)
River 2	North Trib	210	5.8	436.97	437.56	437.56
River 2	North Trib	182	5.8	436.17	436.94	436.94
River 2	North Trib	156	5.8	435.86	436.47	436.47
River 2	North Trib	129	5.8	435.49	435.88	435.88
River 2	North Trib	103	5.8	435.1	435.36	435.33
River 2	North Trib	78	5.8	434.7	434.91	434.89
River 2	North Trib	54	5.80	434.05	434.57	434.51
River 2	North Trib	32	5.80	433.74	434.18	434.18
River 1	West Trib	410	2.97	443.95	444.35	444.35
River 1	West Trib	379	2.97	443	443.32	443.32
River 1	West Trib	347	2.97	442.09	442.49	442.49
River 1	West Trib	315	2.97	441.28	441.67	441.67
River 1	West Trib	281	2.97	440.13	440.54	440.54
River 1	West Trib	254	2.97	439.58	439.94	439.94
River 1	West Trib	226	2.97	438.89	439.45	439.45
River 1	West Trib	198	2.97	438.05	438.58	438.58
River 1	West Trib	171	2.97	437.5	437.88	437.88
River 1	West Trib	143	2.97	436.89	437.38	437.38
River 1	West Trib	117	2.97	436	436.61	436.61
River 1	West Trib	90	2.97	435.05	435.61	435.61
River 1	West Trib	54	2.97	434.5	434.97	434.97
River 1	West Trib	34	2.97	434.23	434.58	434.58
River 1	West Trib	18	2.97	433.97	434.15	

Table E2 Existing Conditions – 12 Hr Regional Storm Event Flood Elevations Associated with Cross Sections

RIVER	REACH	RIVER STATION	Q TOTAL (m3/s)	MIN CH EL (m)	W.S. ELEV (m)	CRIT W.S. (m)
River 6	Main Trib	353	15.84	431.5	432.68	
River 6	Main Trib	334	15.84	431.26	432.39	432.39
River 6	Main Trib	313	15.84	431.08	432.08	432.08
River 6	Main Trib	288	15.84	430.55	431.57	431.57
River 6	Main Trib	250	15.84	429.24	430.37	430.37
River 6	Main Trib	229	15.84	429.03	429.88	429.88
River 6	Main Trib	207	15.84	428.65	429.74	
River 6	Main Trib	181	15.84	428.3	429.73	
River 6	Main Trib	158	17.1	427.93	429.72	
River 6	Main Trib	150	17.1	427.91	429.72	
River 6	Main Trib	139	17.1	427.8	429.68	428.77
River 6	Main Trib	138 Culvert				
River 6	Main Trib	110	17.1	427.84	428.88	428.88
River 6	Main Trib	99	17.1	427.75	428.74	428.74
River 6	Main Trib	84	17.1	427.65	428.63	
River 6	Main Trib	59	17.1	427.21	428.45	428.38
River 6	Main Trib	35	17.1	426.93	428.44	
River 6	Main Trib	16	17.1	426.57	428.26	428.26
River 6	Main Trib	1	17.1	426.45	427.87	427.87
River 4	East Trib	120	5.21	433.18	433.55	433.55
River 4	East Trib	105	5.21	432.86	433.17	433.17
River 4	East Trib	86	5.21	432.62	432.96	
River 4	East Trib	69	5.21	432.28	432.79	432.78
River 4	East Trib	55	5.21	432.24	432.79	
River 4	East Trib	44	5.21	432.1	432.78	
River 4	East Trib	33	5.21	431.97	432.78	
River 3	North West Trib	85	9.32	432.99	433.73	
River 3	North West Trib	70	9.32	432.8	433.52	433.52
River 3	North West Trib	55	9.32	432.5	433.38	433.35
River 3	North West Trib	42	9.32	432.43	433.29	
River 3	North West Trib	29	9.32	432.26	433.26	433.15
River 3	North West Trib	22 North + West Cul				
River 3	North West Trib	17	9.32	432.06	433.09	433.09
River 3	North West Trib	11	9.32	431.89	432.99	432.99
River 2	North Trib	279	6.42	438.29	439.1	439.1
River 2	North Trib	258	6.42	437.87	438.63	438.63
River 2	North Trib	234	6.42	437.33	438.11	438.11
River 2	North Trib	210	6.42	436.97	437.58	437.58
River 2	North Trib	182	6.42	436.17	436.95	436.95
River 2	North Trib	156	6.42	435.86	436.48	436.48

RIVER	REACH	RIVER STATION	Q TOTAL (m3/s)	MIN CH EL (m)	W.S. ELEV (m)	CRIT W.S. (m)
River 2	North Trib	129	6.42	435.49	435.9	435.9
River 2	North Trib	103	6.42	435.1	435.38	435.35
River 2	North Trib	78	6.42	434.7	434.93	434.9
River 2	North Trib	54	6.42	434.05	434.59	434.53
River 2	North Trib	32	6.42	433.74	434.20	434.20
River 1	West Trib	410	2.97	443.95	444.35	444.35
River 1	West Trib	379	2.97	443	443.32	443.32
River 1	West Trib	347	2.97	442.09	442.49	442.49
River 1	West Trib	315	2.97	441.28	441.67	441.67
River 1	West Trib	281	2.97	440.13	440.54	440.54
River 1	West Trib	254	2.97	439.58	439.94	439.94
River 1	West Trib	226	2.97	438.89	439.45	439.45
River 1	West Trib	198	2.97	438.05	438.58	438.58
River 1	West Trib	171	2.97	437.5	437.88	437.88
River 1	West Trib	143	2.97	436.89	437.38	437.38
River 1	West Trib	117	2.97	436	436.61	436.61
River 1	West Trib	90	2.97	435.05	435.61	435.61
River 1	West Trib	54	2.97	434.5	434.97	434.97
River 1	West Trib	34	2.97	434.23	434.58	434.58
River 1	West Trib	18	2.97	433.97	434.16	

Table E3 Proposed Conditions - 100 Year Storm Event

RIVER	REACH	RIVER STATION	Q TOTAL (m3/s)	MIN CH EL (m)	W.S. ELEV (m)	CRIT W.S. (m)
River 6	Main Trib	353	13.71	431.5	432.44	
River 6	Main Trib	334	13.71	431.26	432.23	432.23
River 6	Main Trib	313	13.71	431.08	431.73	431.73
River 6	Main Trib	288	13.71	430.55	431.11	431.11
River 6	Main Trib	250	13.71	429.24	430.07	430.02
River 6	Main Trib	229	13.71	429.03	429.69	429.69
River 6	Main Trib	207	13.71	428.65	429.69	
River 6	Main Trib	181	13.71	428.3	429.67	
River 6	Main Trib	158	14.63	427.93	429.67	
River 6	Main Trib	150	14.63	427.91	429.67	
River 6	Main Trib	139	14.63	427.8	429.61	428.69
River 6	Main Trib	138 Culvert				
River 6	Main Trib	110	14.63	427.84	428.8	428.8
River 6	Main Trib	99	14.63	427.75	428.69	428.69
River 6	Main Trib	84	14.63	427.65	428.57	428.53
River 6	Main Trib	59	14.63	427.21	428.4	428.3
River 6	Main Trib	35	14.63	426.93	428.38	
River 6	Main Trib	16	14.63	426.57	428.08	428.08
River 6	Main Trib	1	14.63	426.45	427.81	427.81
River 4	East Trib	120	4.44	433.18	433.48	
River 4	East Trib	105	4.44	432.86	433.24	433.21
River 4	East Trib	86	4.44	432.62	432.88	432.88
River 4	East Trib	69	4.44	432.28	432.71	
River 4	East Trib	55	4.44	432.24	432.62	
River 4	East Trib	44	4.44	432.1	432.56	
River 4	East Trib	33	4.25	431.97	432.51	
River 2	North Trib	279	5.2	438.29	439.01	439.01
River 2	North Trib	258	5.2	437.87	438.58	438.58
River 2	North Trib	234	5.2	437.33	438.07	438.07

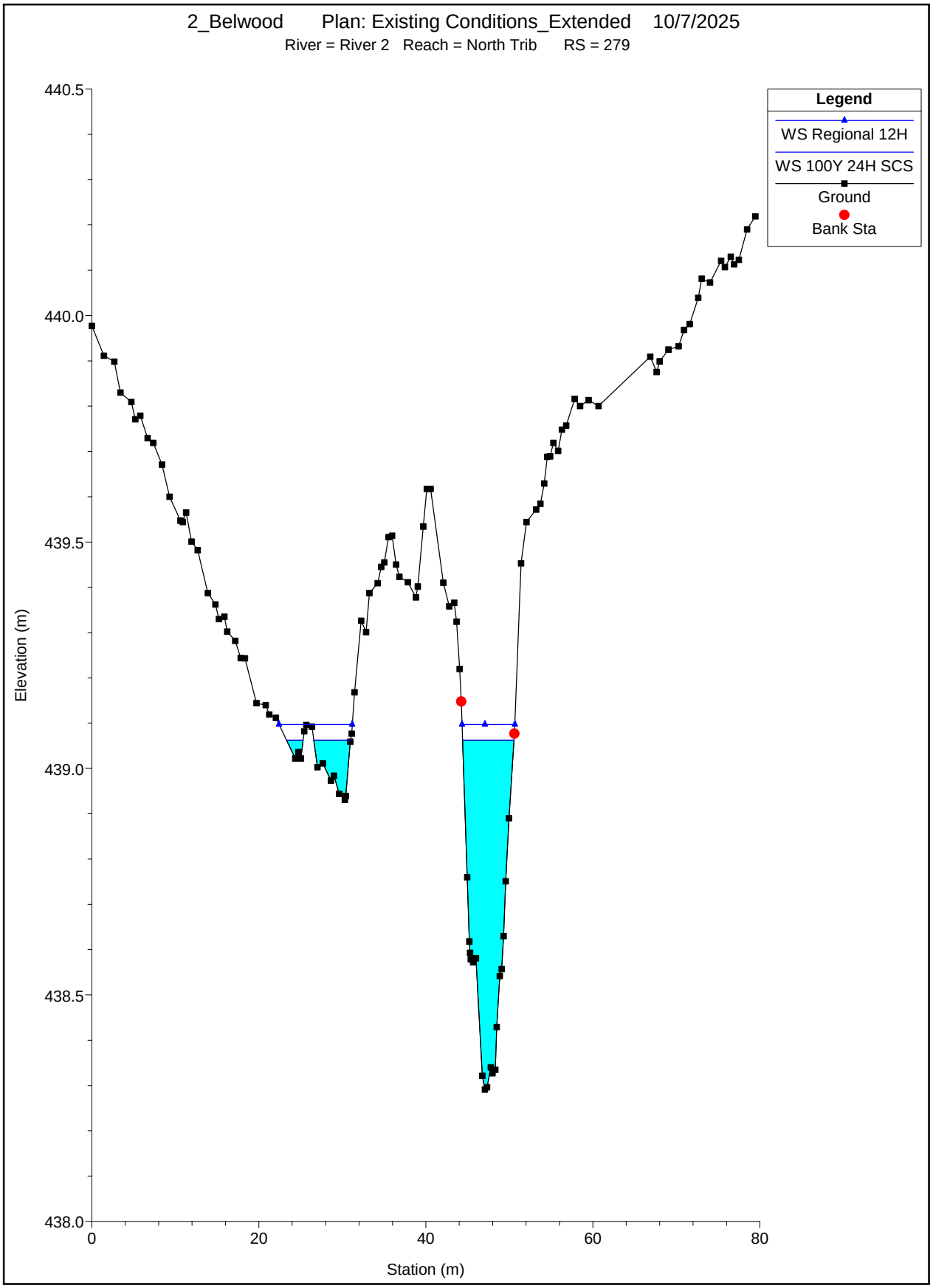
RIVER	REACH	RIVER STATION	Q TOTAL (m3/s)	MIN CH EL (m)	W.S. ELEV (m)	CRIT W.S. (m)
River 2	North Trib	210	5.2	436.97	437.54	437.54
River 2	North Trib	182	5.2	436.17	436.92	436.92
River 2	North Trib	156	5.2	435.86	436.45	436.45
River 2	North Trib	129	5.2	435.49	435.87	435.86
River 2	North Trib	103	5.2	435.1	435.42	435.38
River 2	North Trib	88	5.2	434.7	434.91	434.91
River 2	North Trib	87	5.2	433.79	434.25	
River 2	North Trib	86	5.2	433.39	433.86	
River 2	North Trib	85	7.67	432.99	433.63	
River 2	North Trib	70	7.67	432.8	433.44	
River 2	North Trib	55	7.67	432.5	433.28	
River 2	North Trib	42	7.67	432.43	433.17	
River 2	North Trib	29	7.67	432.26	433.06	433.02
River 2	North Trib	17	7.67	432.06	432.96	432.96
River 2	North Trib	11	7.67	431.89	432.89	432.89

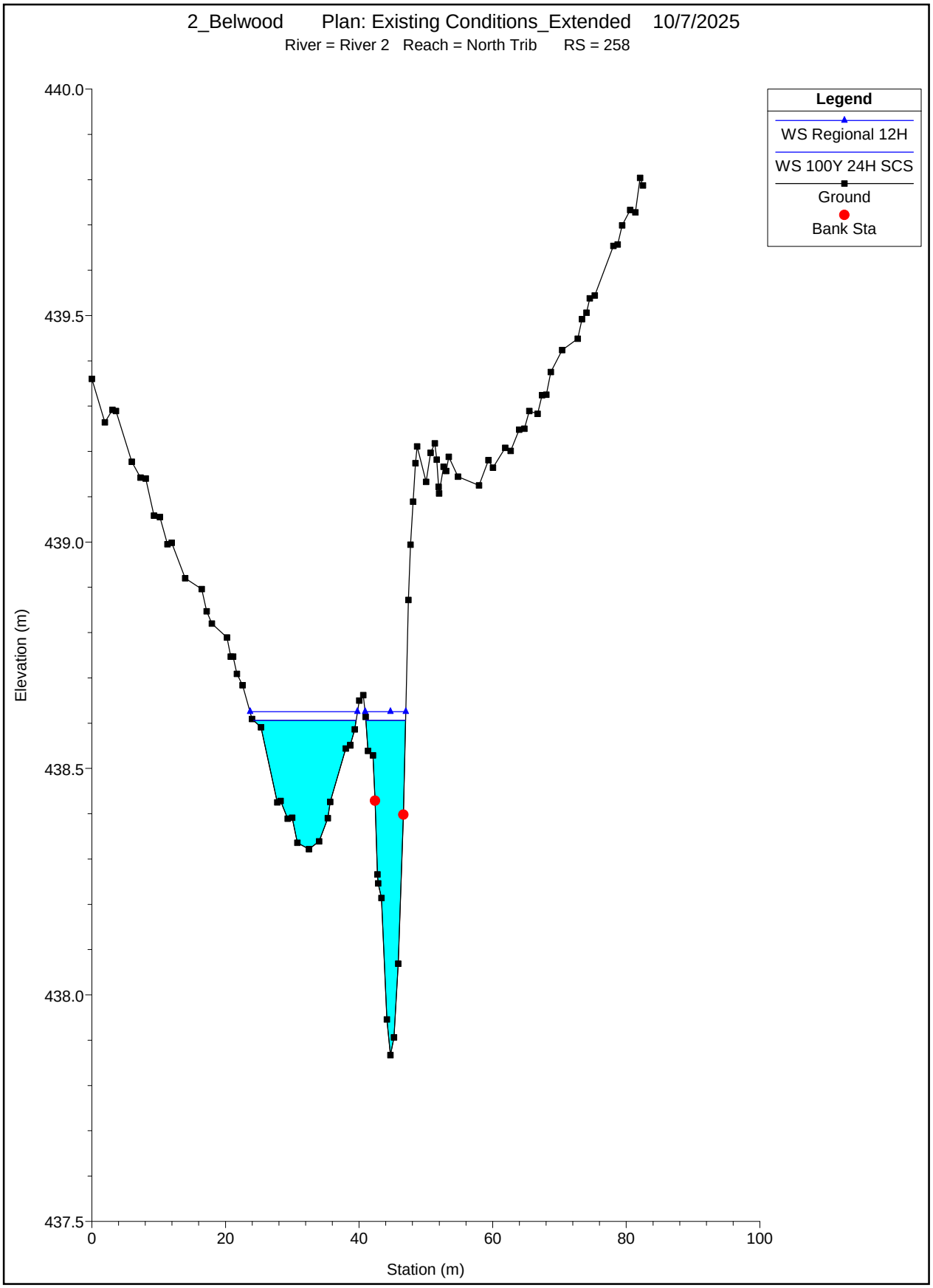
Table E4 Proposed Conditions – 12 Hr Regional Storm Event (Without SWMF)

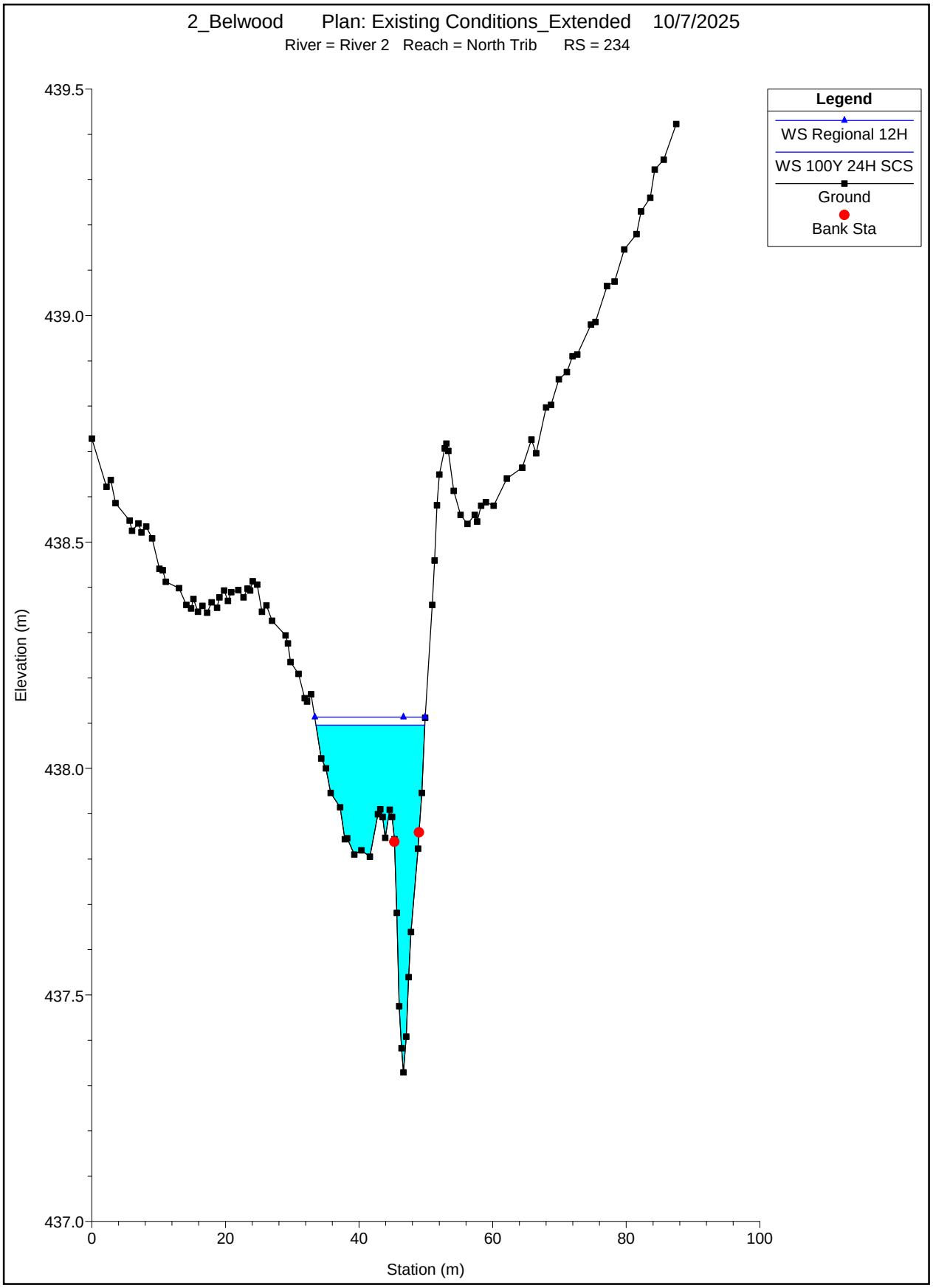
RIVER	REACH	RIVER STATION	Q TOTAL (m3/s)	MIN CH EL (m)	W.S. ELEV (m)	CRIT W.S. (m)
River 6	Main Trib	353	16.45	431.5	432.5	
River 6	Main Trib	334	16.45	431.26	432.27	432.27
River 6	Main Trib	313	16.45	431.08	431.76	431.76
River 6	Main Trib	288	16.45	430.55	431.13	431.13
River 6	Main Trib	250	16.45	429.24	430.08	430.06
River 6	Main Trib	229	16.45	429.03	429.78	
River 6	Main Trib	207	16.45	428.65	429.76	
River 6	Main Trib	181	16.45	428.3	429.74	
River 6	Main Trib	158	17.22	427.93	429.74	
River 6	Main Trib	150	17.22	427.91	429.74	
River 6	Main Trib	139	17.22	427.8	429.68	428.77
River 6	Main Trib	138 Culvert				
River 6	Main Trib	110	17.22	427.84	428.88	428.88
River 6	Main Trib	99	17.22	427.75	428.74	428.74
River 6	Main Trib	84	17.22	427.65	428.63	
River 6	Main Trib	59	17.22	427.21	428.45	428.38
River 6	Main Trib	35	17.22	426.93	428.44	
River 6	Main Trib	16	17.22	426.57	428.26	428.26
River 6	Main Trib	1	17.22	426.45	427.87	427.87
River 4	East Trib	120	5.25	433.18	433.5	
River 4	East Trib	105	5.25	432.86	433.26	433.24
River 4	East Trib	86	5.25	432.62	432.91	432.89
River 4	East Trib	69	5.25	432.28	432.73	
River 4	East Trib	55	5.25	432.24	432.66	
River 4	East Trib	44	5.25	432.1	432.61	
River 4	East Trib	33	5.25	431.97	432.57	
River 2	North Trib	279	5.96	438.29	439.07	439.07
River 2	North Trib	258	5.96	437.87	438.62	438.62
River 2	North Trib	234	5.96	437.33	438.1	438.1

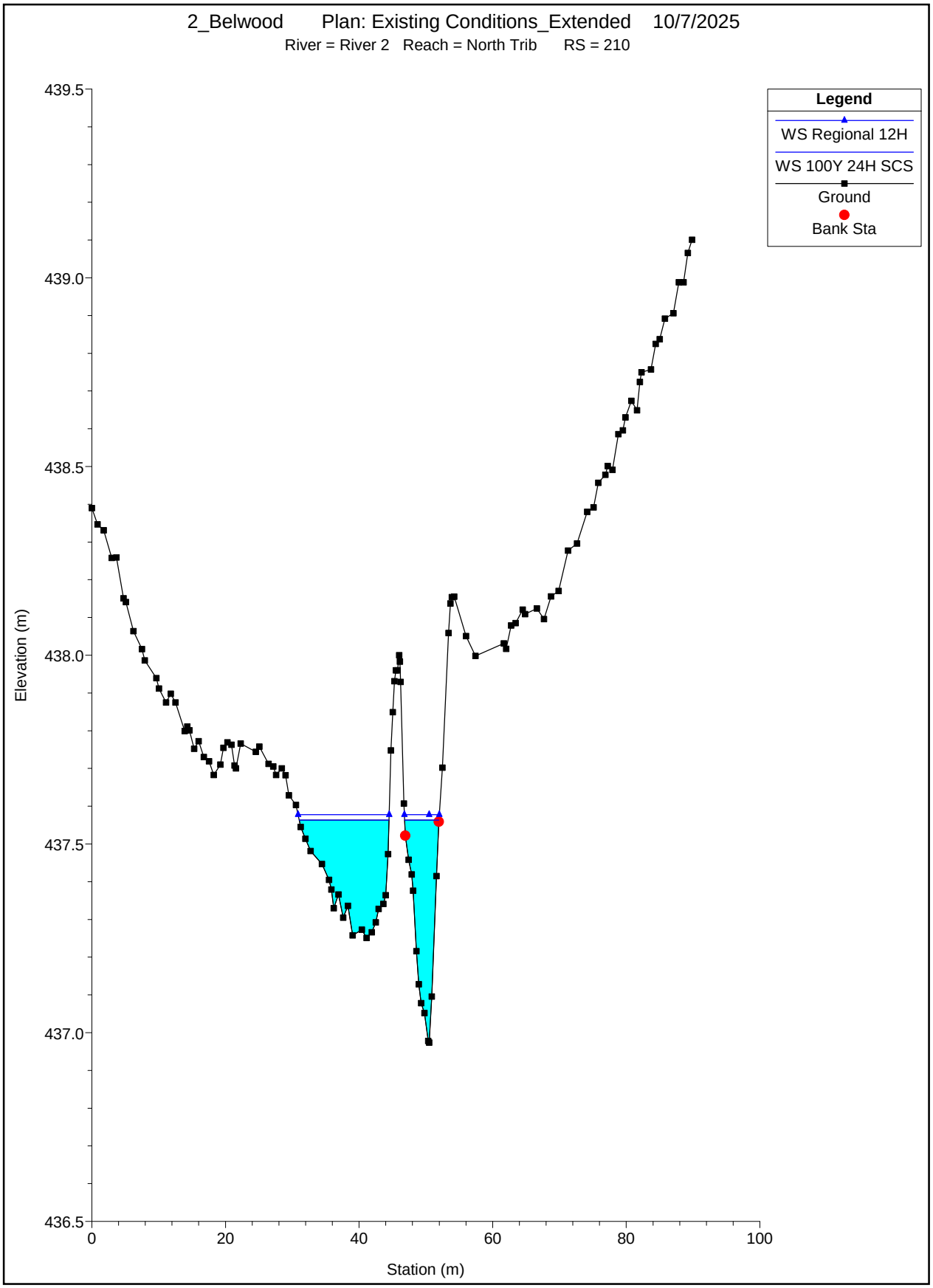
RIVER	REACH	RIVER STATION	Q TOTAL (m3/s)	MIN CH EL (m)	W.S. ELEV (m)	CRIT W.S. (m)
River 2	North Trib	210	5.96	436.97	437.57	437.57
River 2	North Trib	182	5.96	436.17	436.94	436.94
River 2	North Trib	156	5.96	435.86	436.47	436.47
River 2	North Trib	129	5.96	435.49	435.89	435.88
River 2	North Trib	103	5.96	435.1	435.44	
River 2	North Trib	88	5.96	434.7	434.93	434.93
River 2	North Trib	87	5.96	433.79	434.26	434.24
River 2	North Trib	86	5.96	433.39	433.89	
River 2	North Trib	85	9.54	432.99	433.66	
River 2	North Trib	70	9.54	432.8	433.48	
River 2	North Trib	55	9.54	432.5	433.32	
River 2	North Trib	42	9.54	432.43	433.21	
River 2	North Trib	29	9.54	432.26	433.1	
River 2	North Trib	17	9.54	432.06	433	433
River 2	North Trib	11	9.54	431.89	432.90	432.90

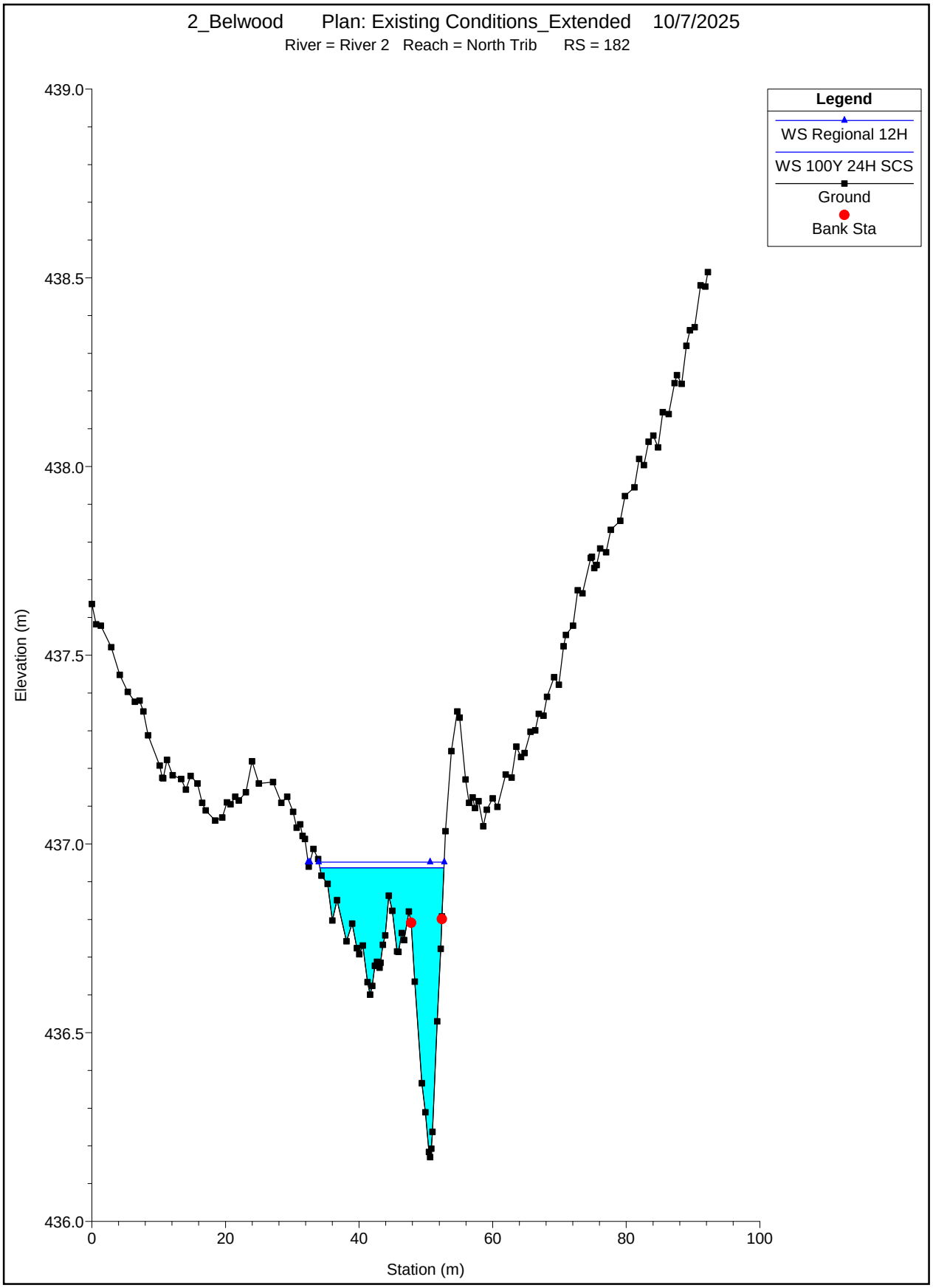
Existing Conditions - Cross Sections

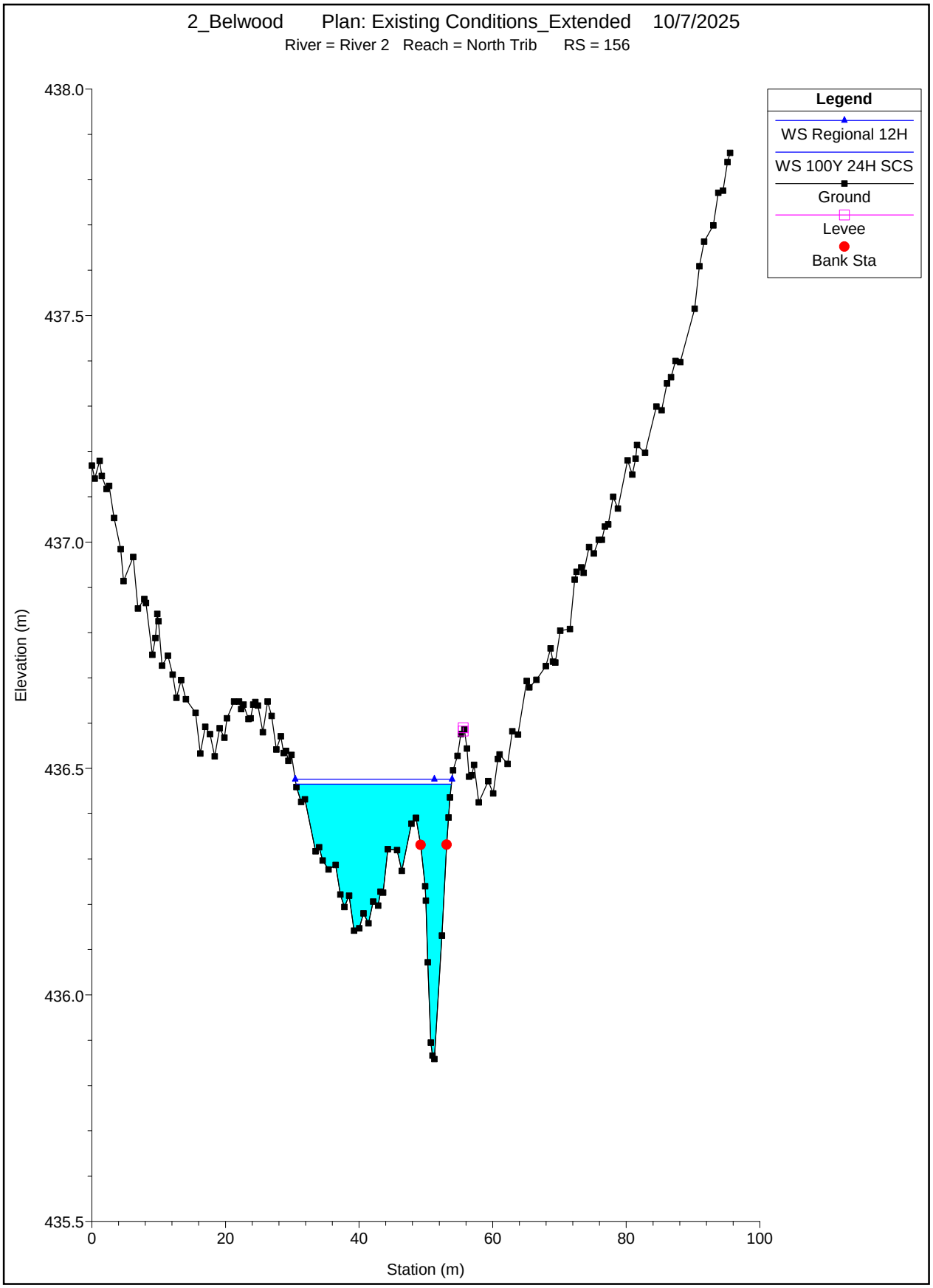

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 2 Reach = North Trib RS = 279
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
440.5
440.0
439.5
439.0
438.5
438.0
0
20
40
60
80

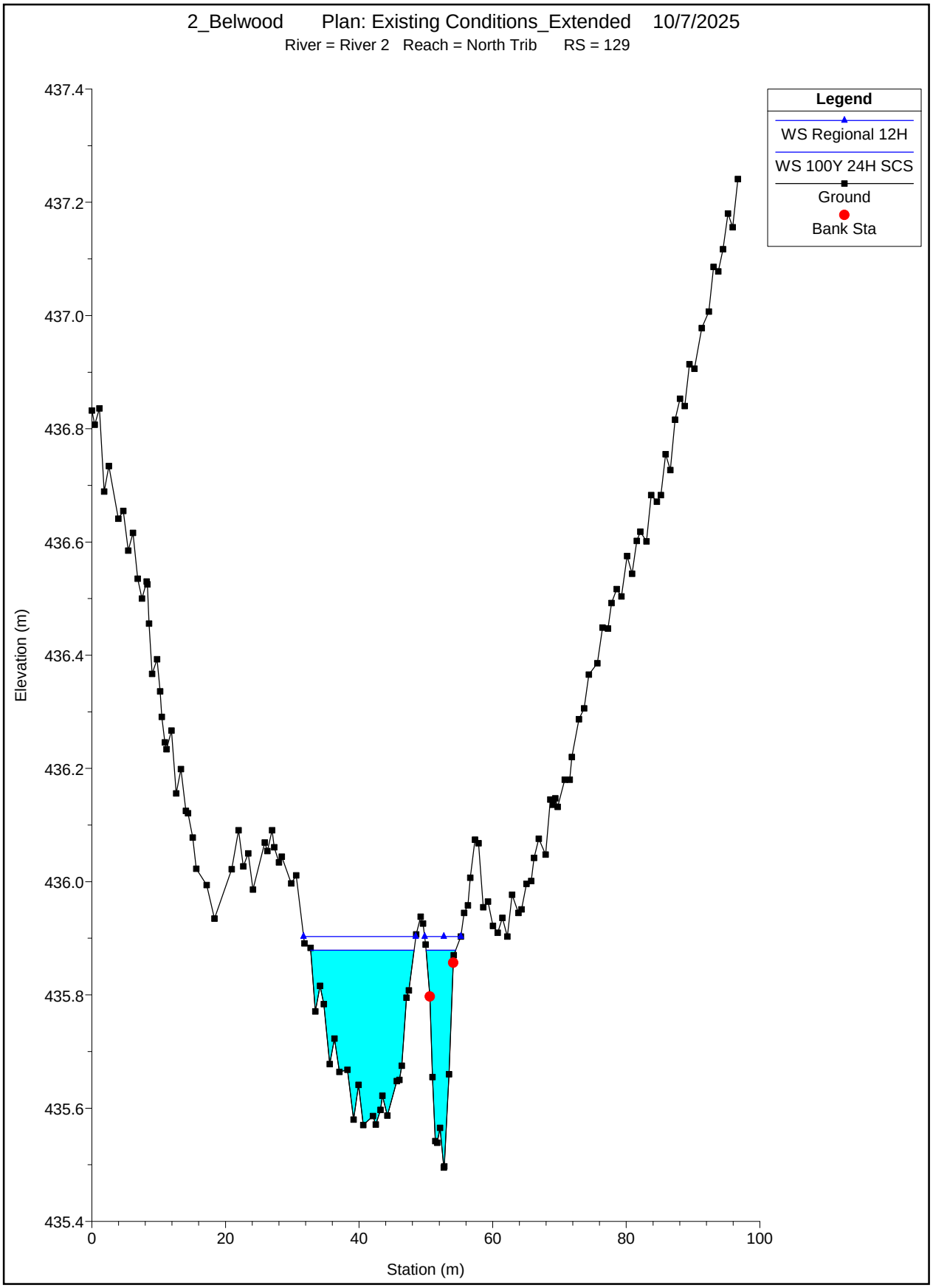

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 2 Reach = North Trib RS = 258
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
440.0
439.5
439.0
438.5
438.0
437.5
0
20
40
60
80
100

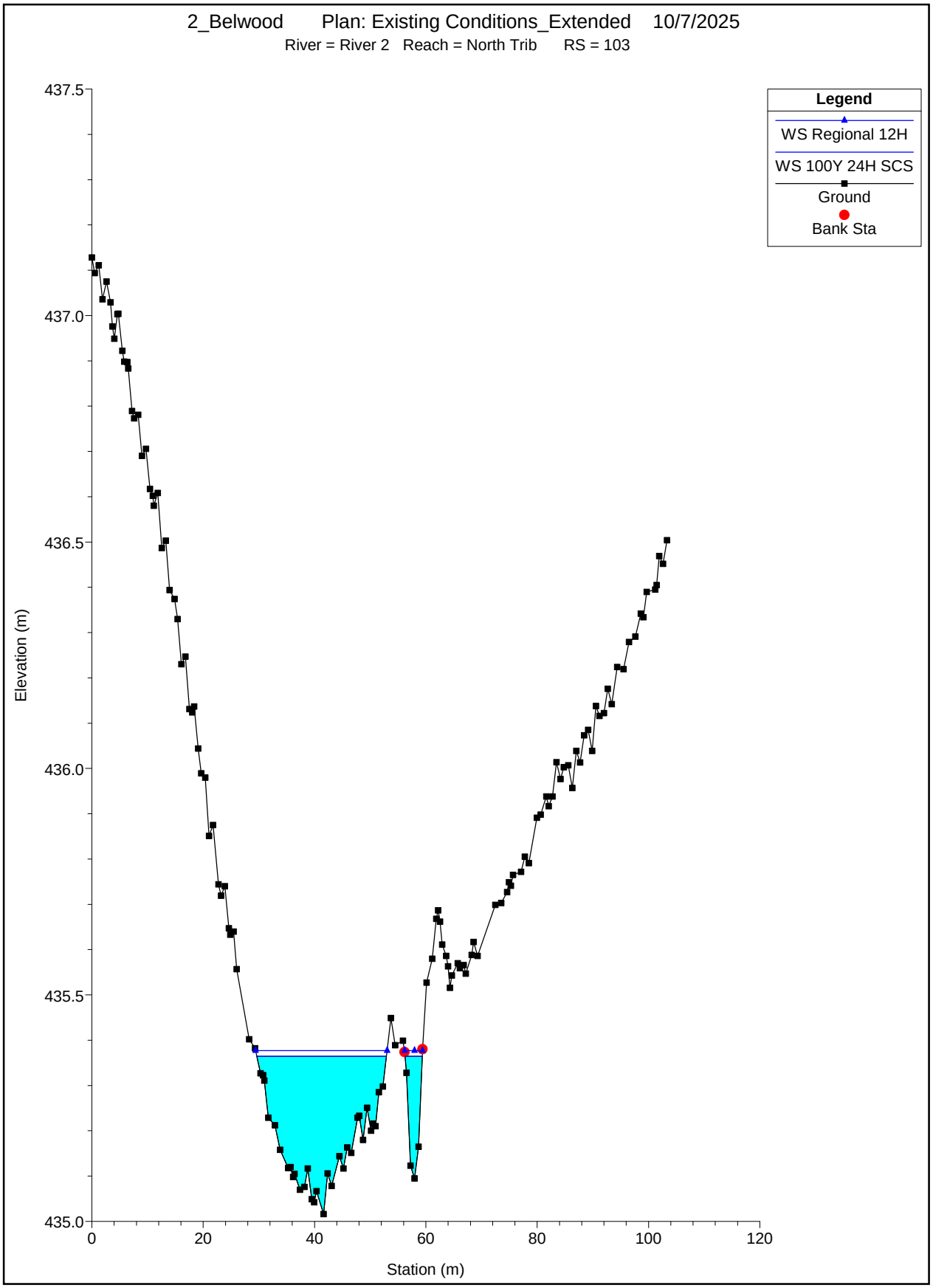

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 2 Reach = North Trib RS = 234
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
439.5
439.0
438.5
438.0
437.5
437.0
Elevation (m)
0
20
40
60
80
100
Station (m)

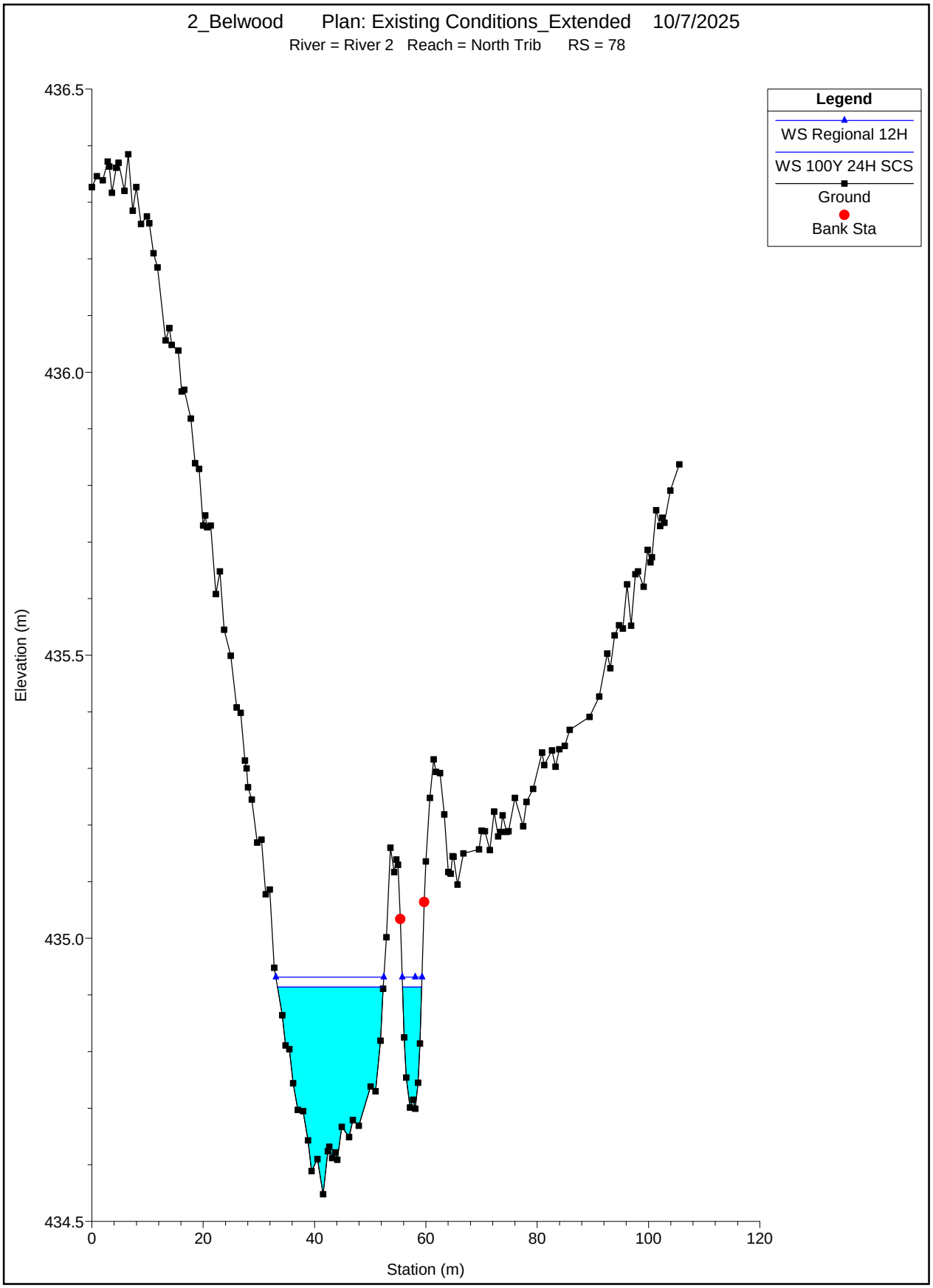

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 2 Reach = North Trib RS = 210
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
439.5
439.0
438.5
438.0
437.5
437.0
436.5
0
20
40
60
80
100
Station (m)

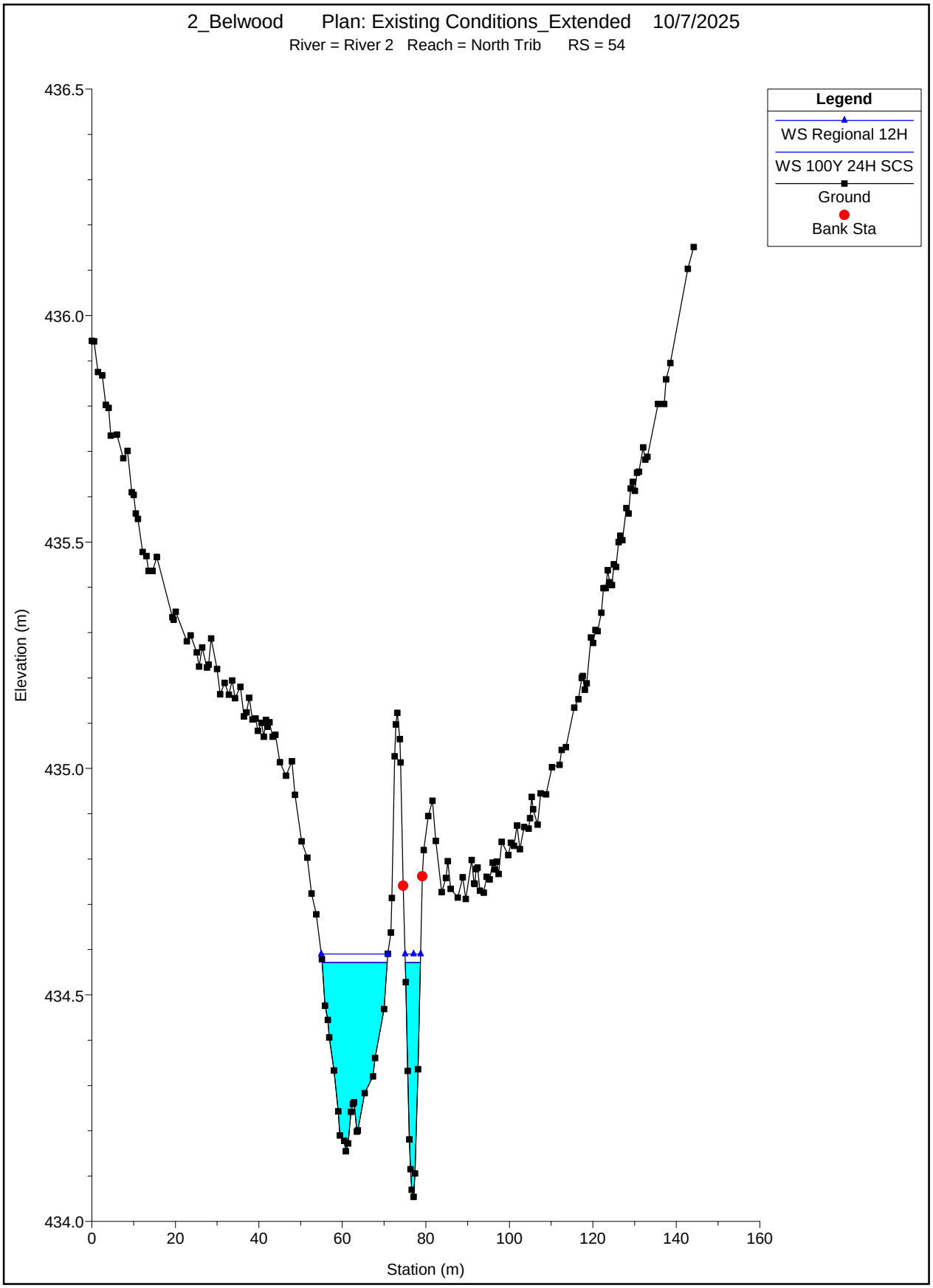

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 2 Reach = North Trib RS = 182
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
439.0
438.5
438.0
437.5
437.0
436.5
436.0
0
20
40
60
80
100

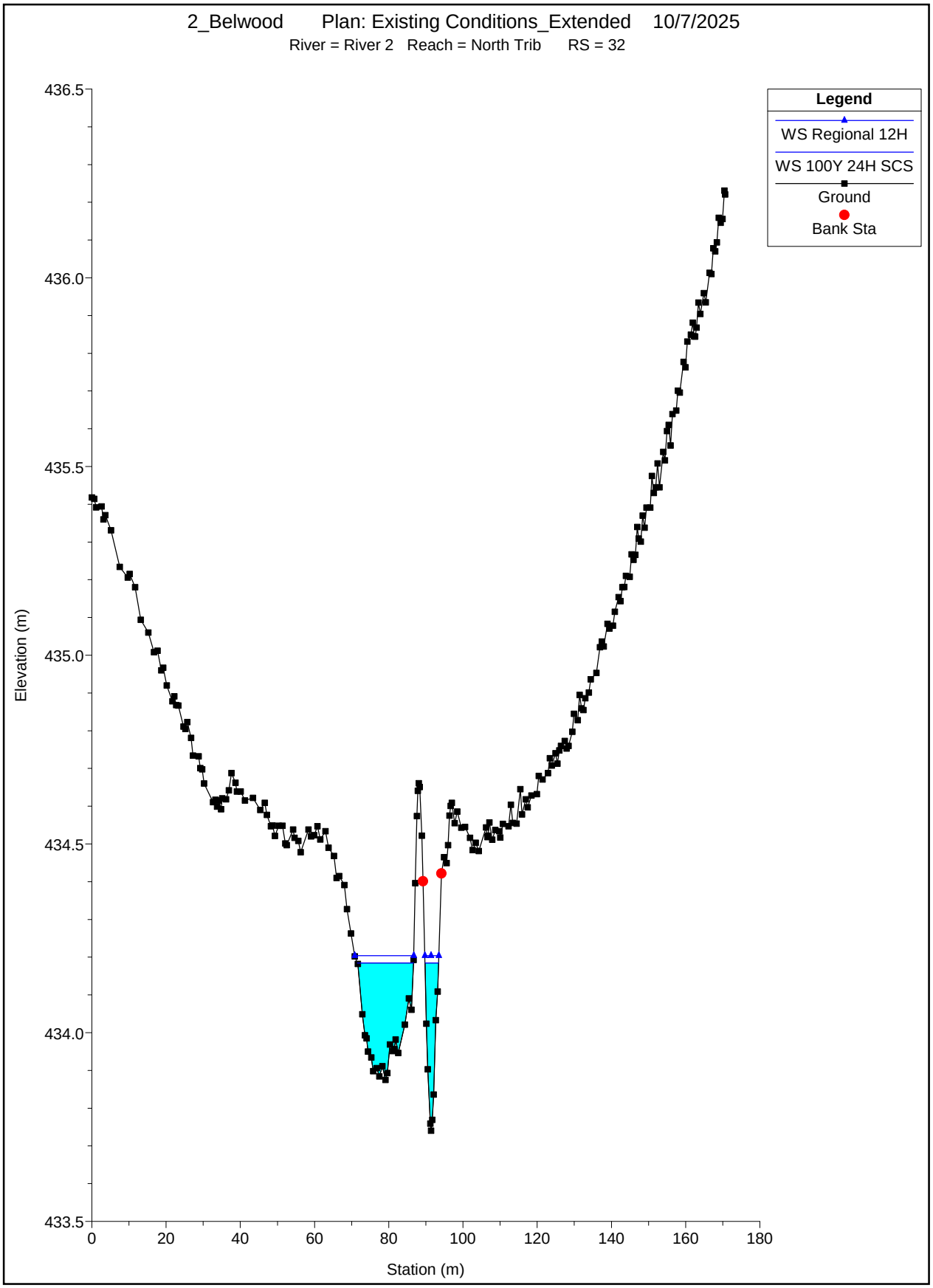

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 2 Reach = North Trib RS = 156
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Levee
Bank Sta
438.0
437.5
437.0
436.5
436.0
435.5
Elevation (m)
0
20
40
60
80
100
Station (m)

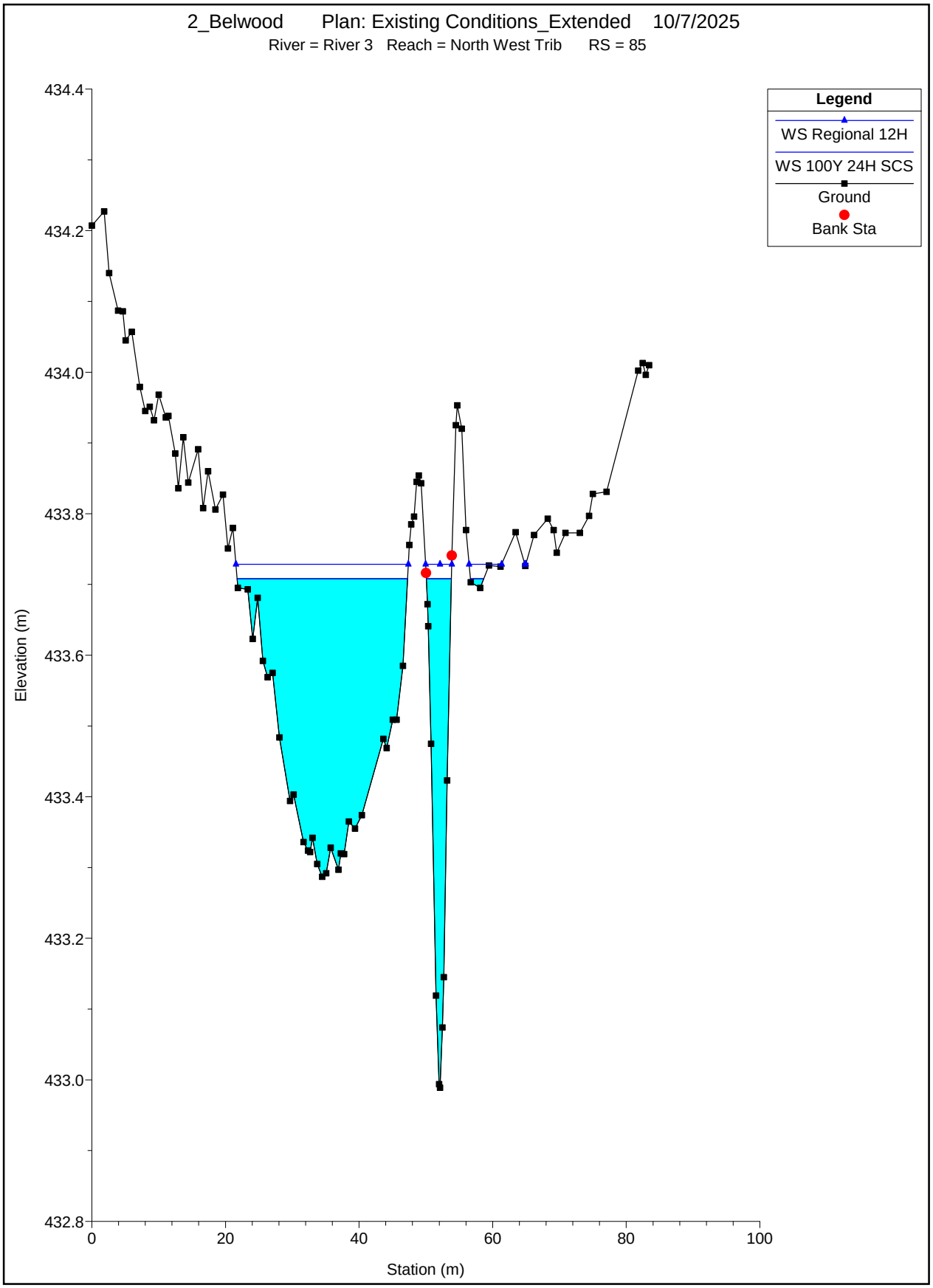

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 2 Reach = North Trib RS = 129
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
437.4
437.2
437.0
436.8
436.6
436.4
436.2
436.0
435.8
435.6
435.4
0
20
40
60
80
100

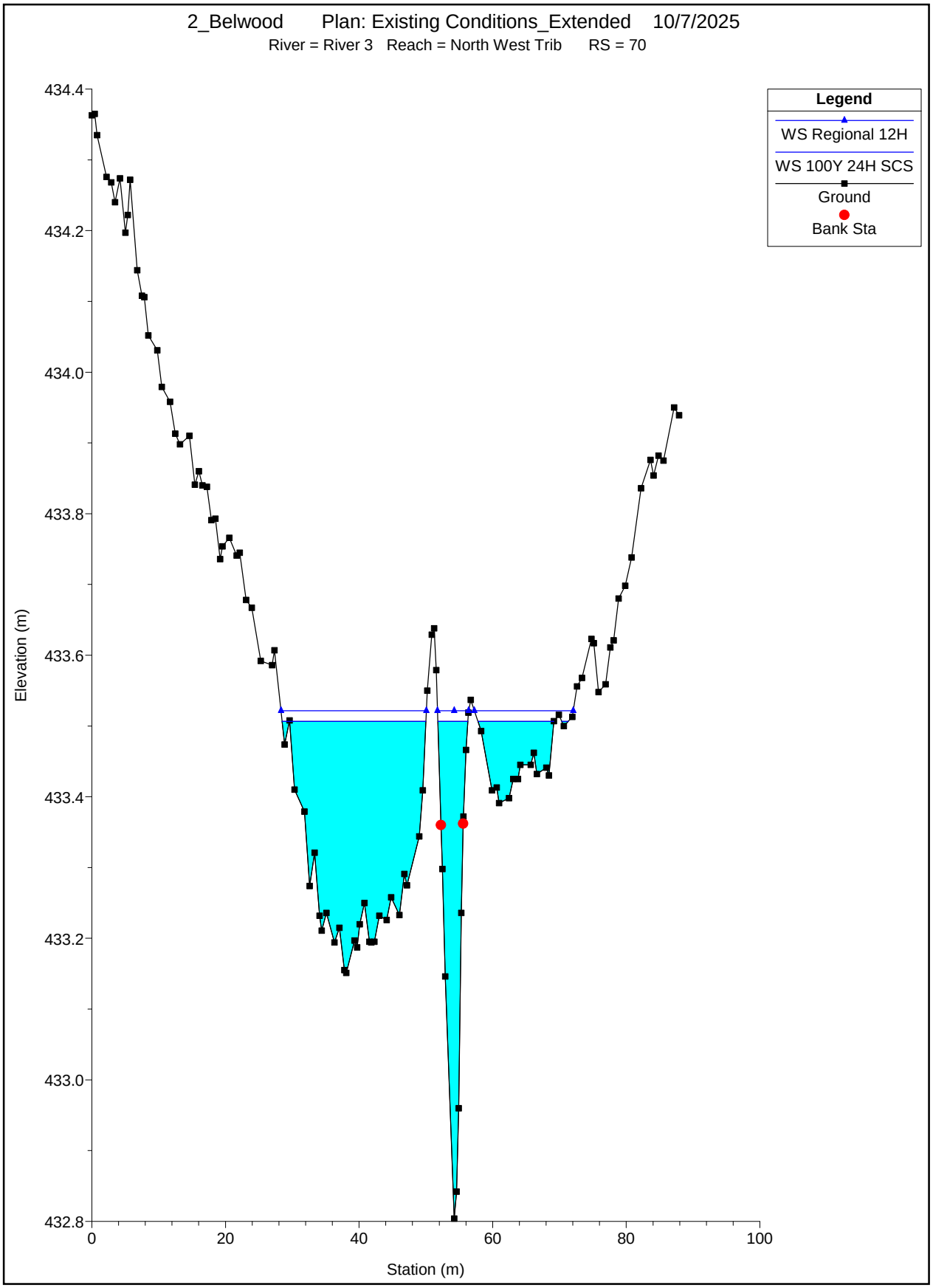

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 2 Reach = North Trib RS = 103
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
437.5
437.0
436.5
436.0
435.5
435.0
0
20
40
60
80
100
120

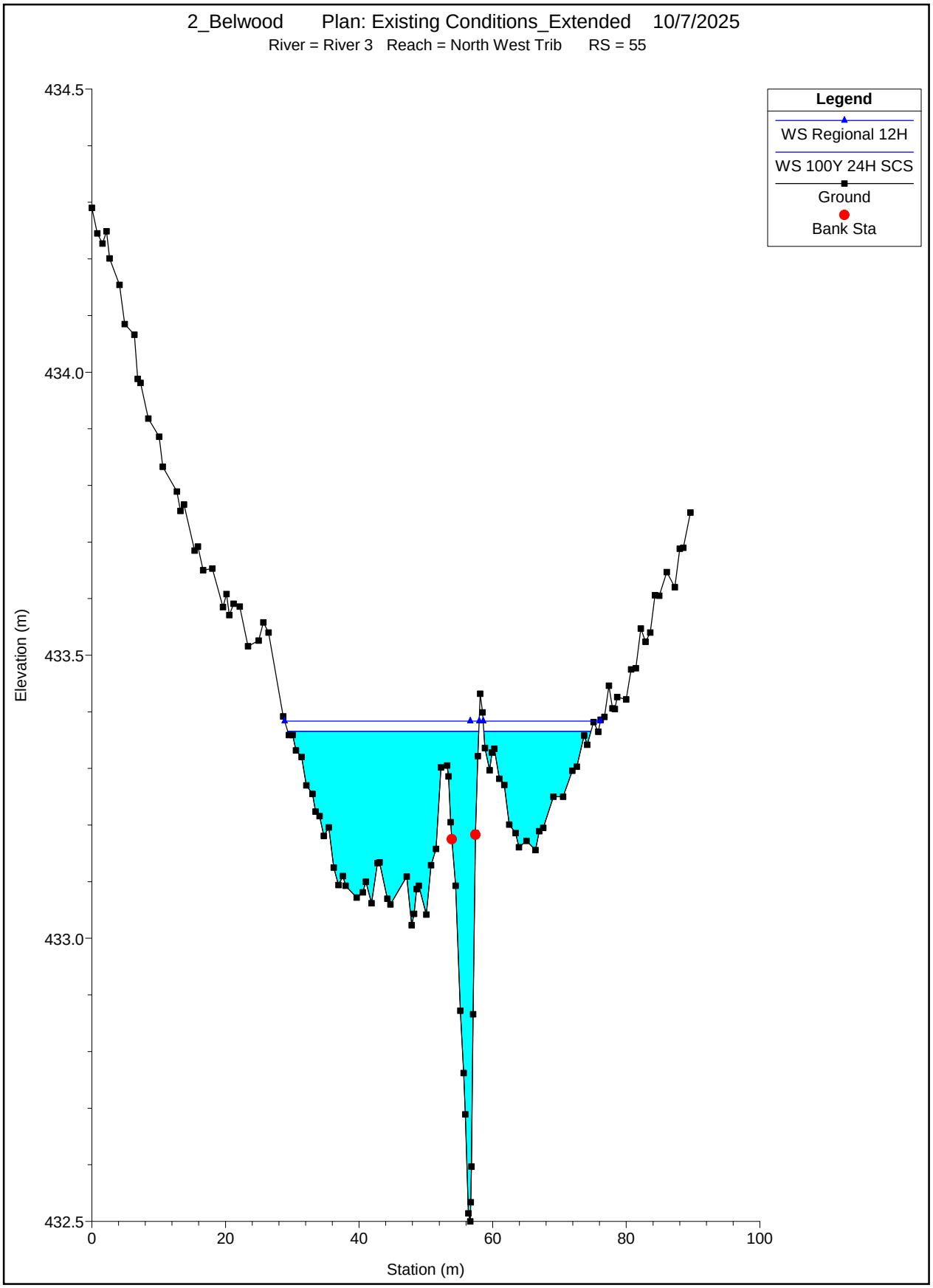

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 2 Reach = North Trib RS = 78
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
436.5
436.0
435.5
435.0
434.5
0
20
40
60
80
100
120
Station (m)

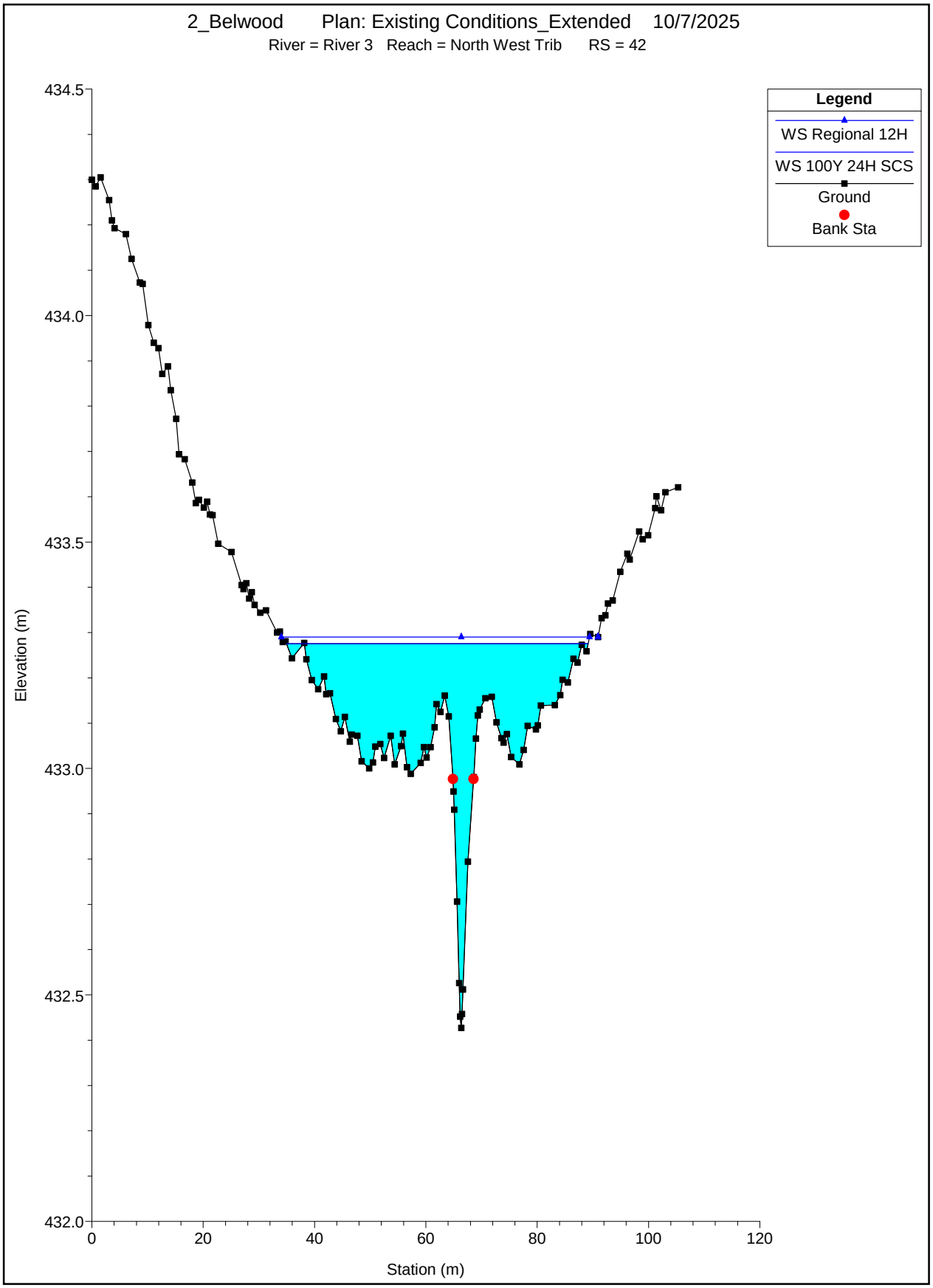

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 2 Reach = North Trib RS = 54
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
436.5
436.0
435.5
435.0
434.5
434.0
0
20
40
60
80
100
120
140
160
Station (m)

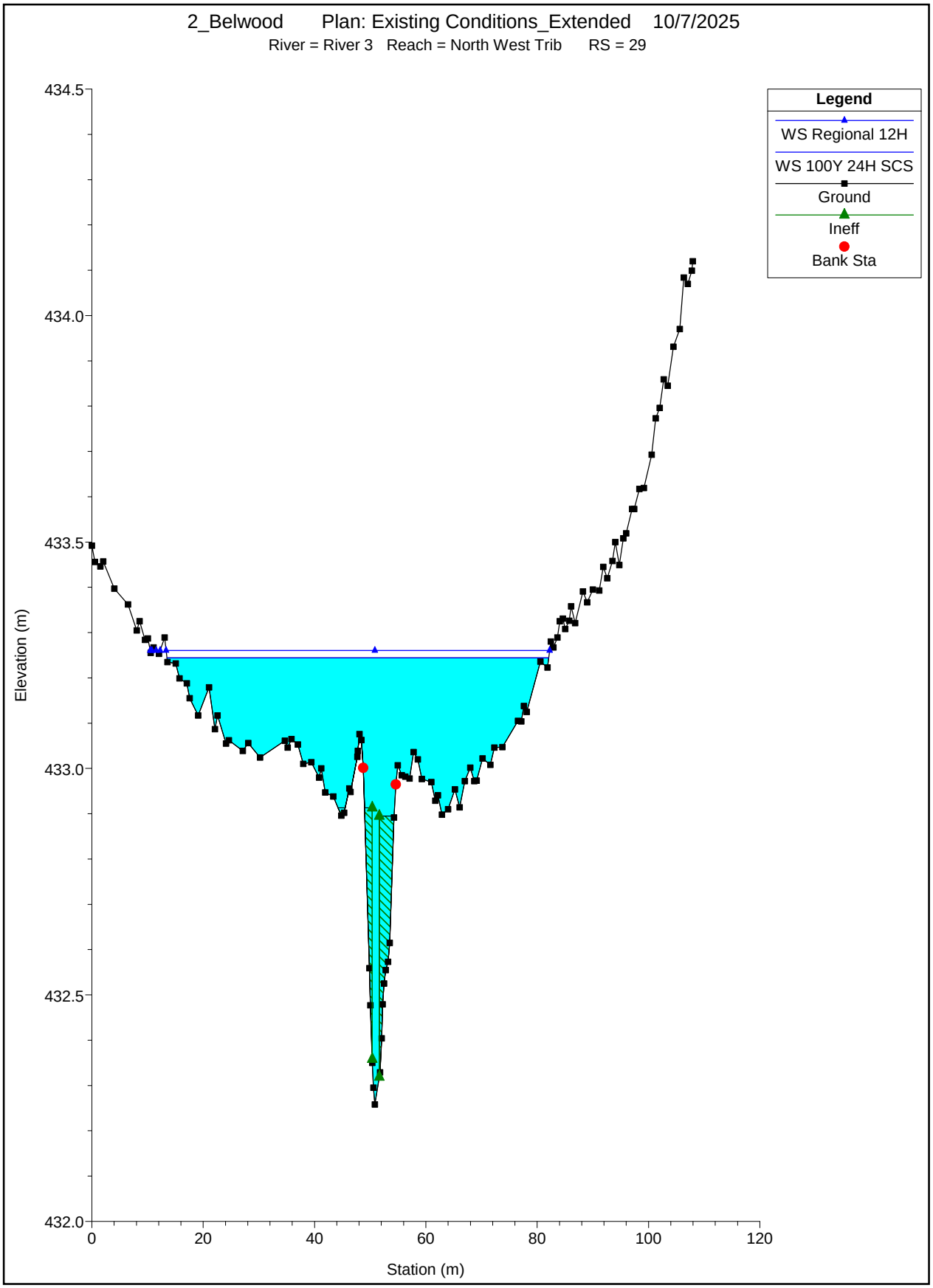

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 2 Reach = North Trib RS = 32
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
436.5
436.0
435.5
435.0
434.5
434.0
433.5
0
20
40
60
80
100
120
140
160
180
Station (m)

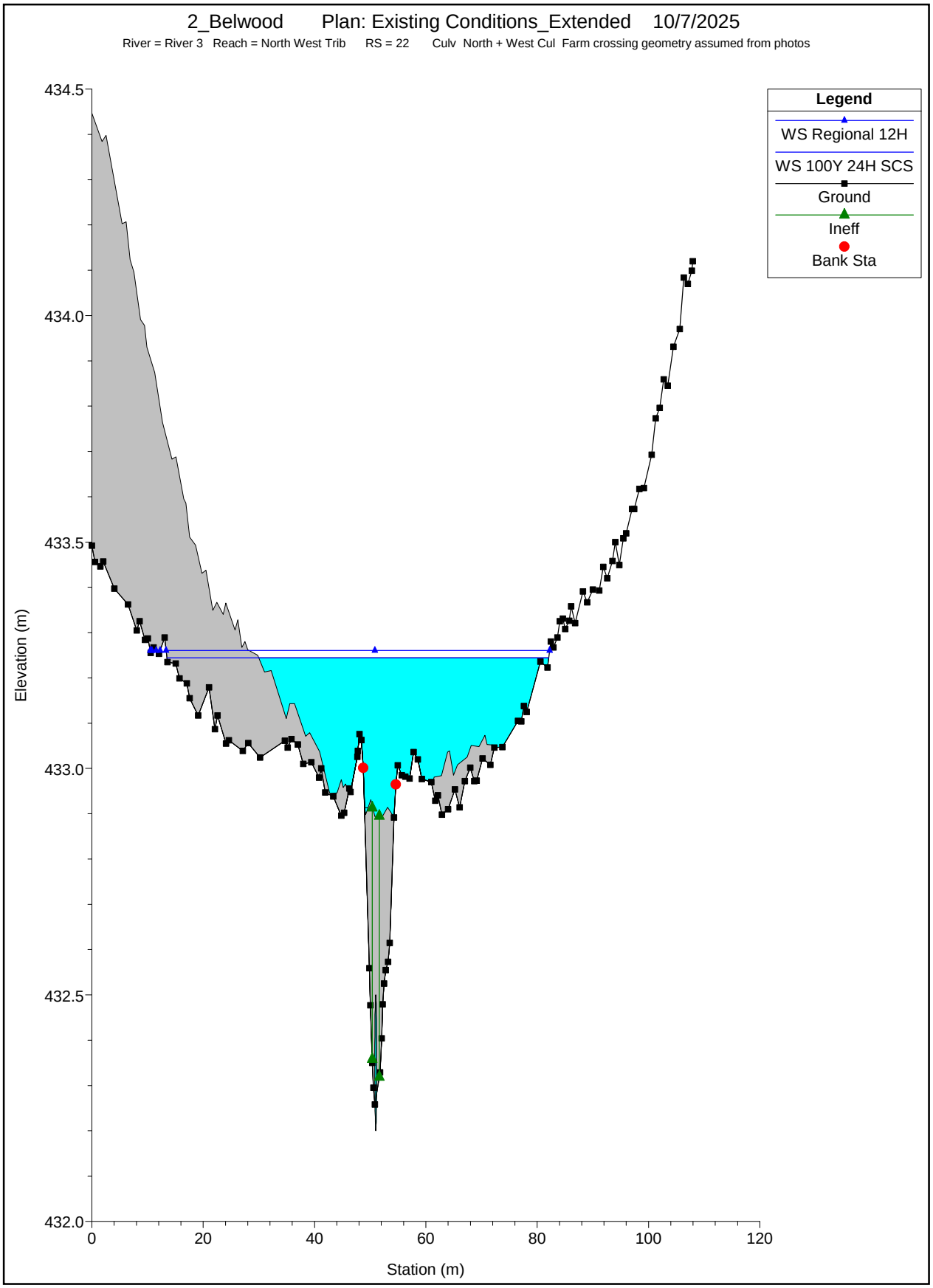

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 3 Reach = North West Trib RS = 85
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
434.4
434.2
434.0
433.8
433.6
433.4
433.2
433.0
432.8
0
20
40
60
80
100

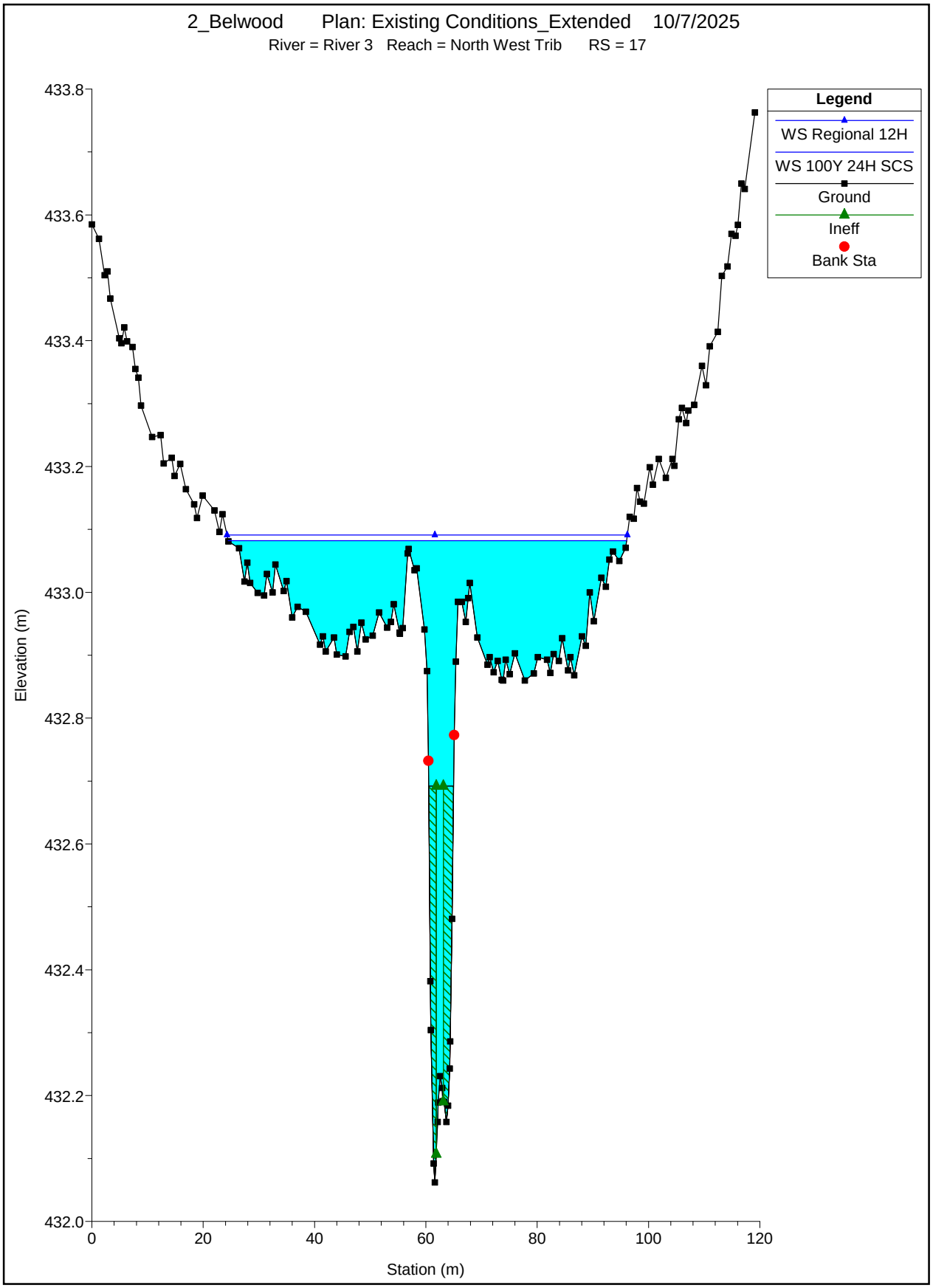

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 3 Reach = North West Trib RS = 70
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
434.4
434.2
434.0
433.8
433.6
433.4
433.2
433.0
432.8
0
20
40
60
80
100

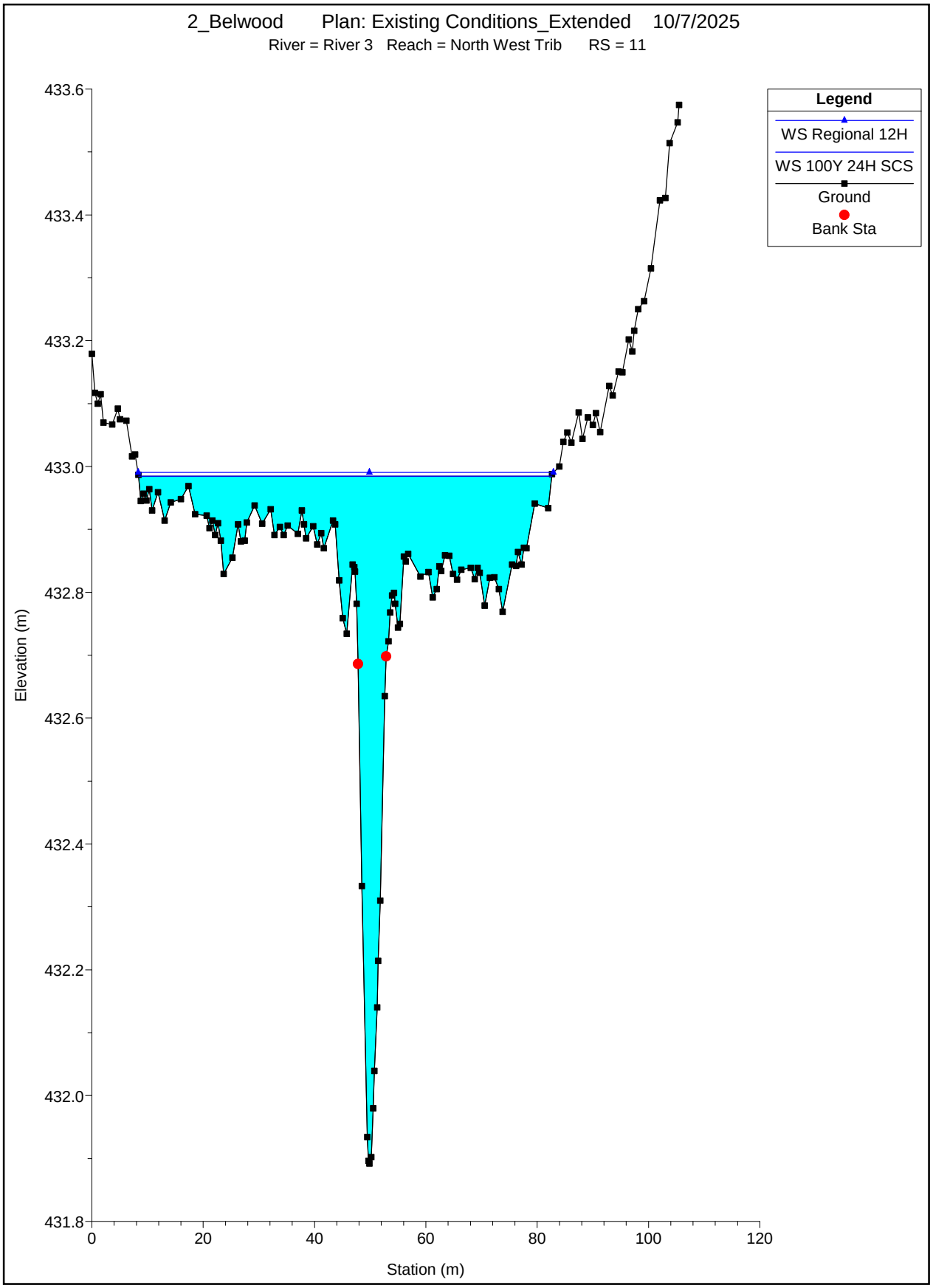

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 3 Reach = North West Trib RS = 55
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
434.5
434.0
433.5
433.0
432.5
0
20
40
60
80
100
Station (m)

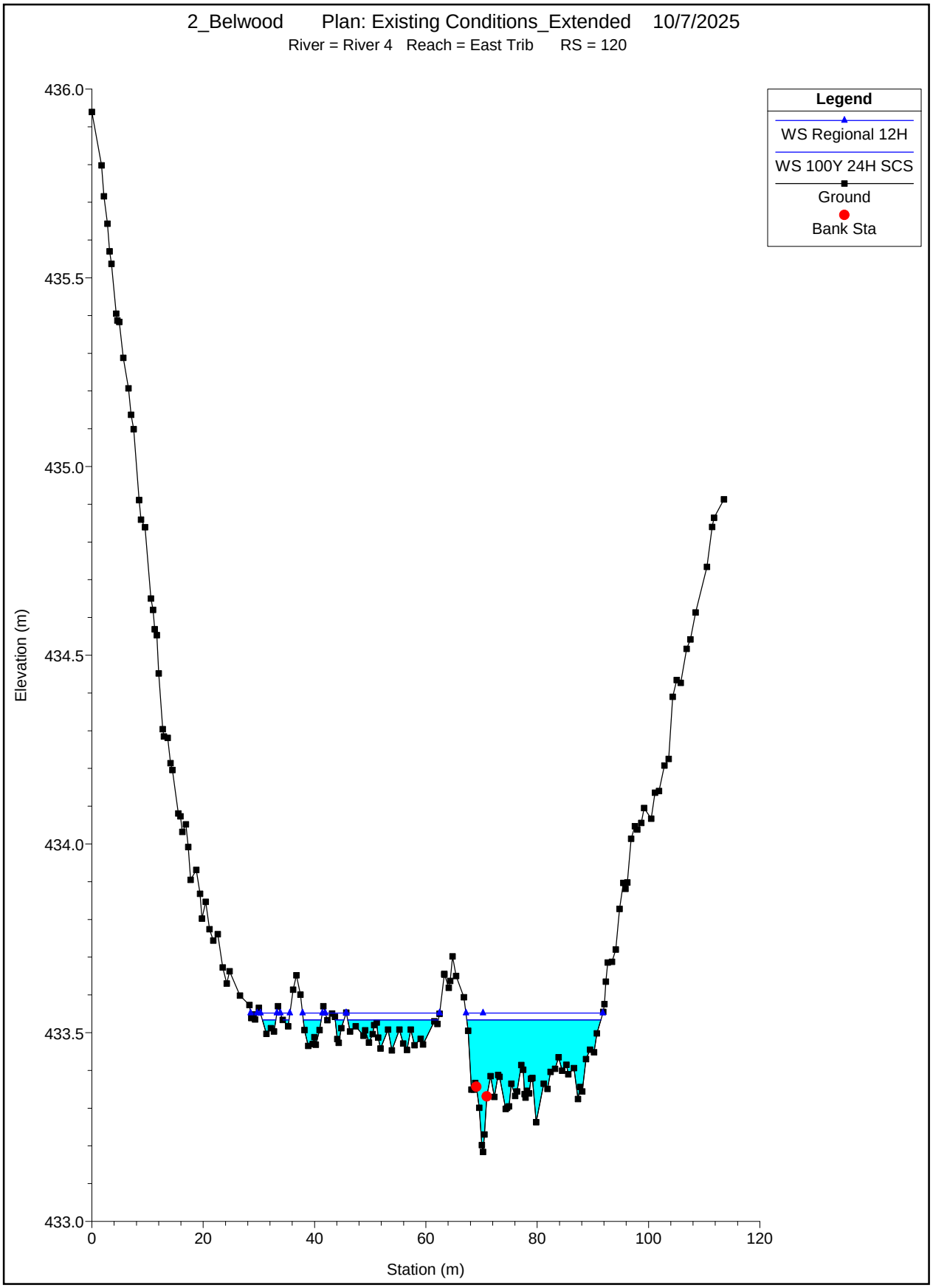

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 3 Reach = North West Trib RS = 42
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
434.5
434.0
433.5
433.0
432.5
432.0
0
20
40
60
80
100
120

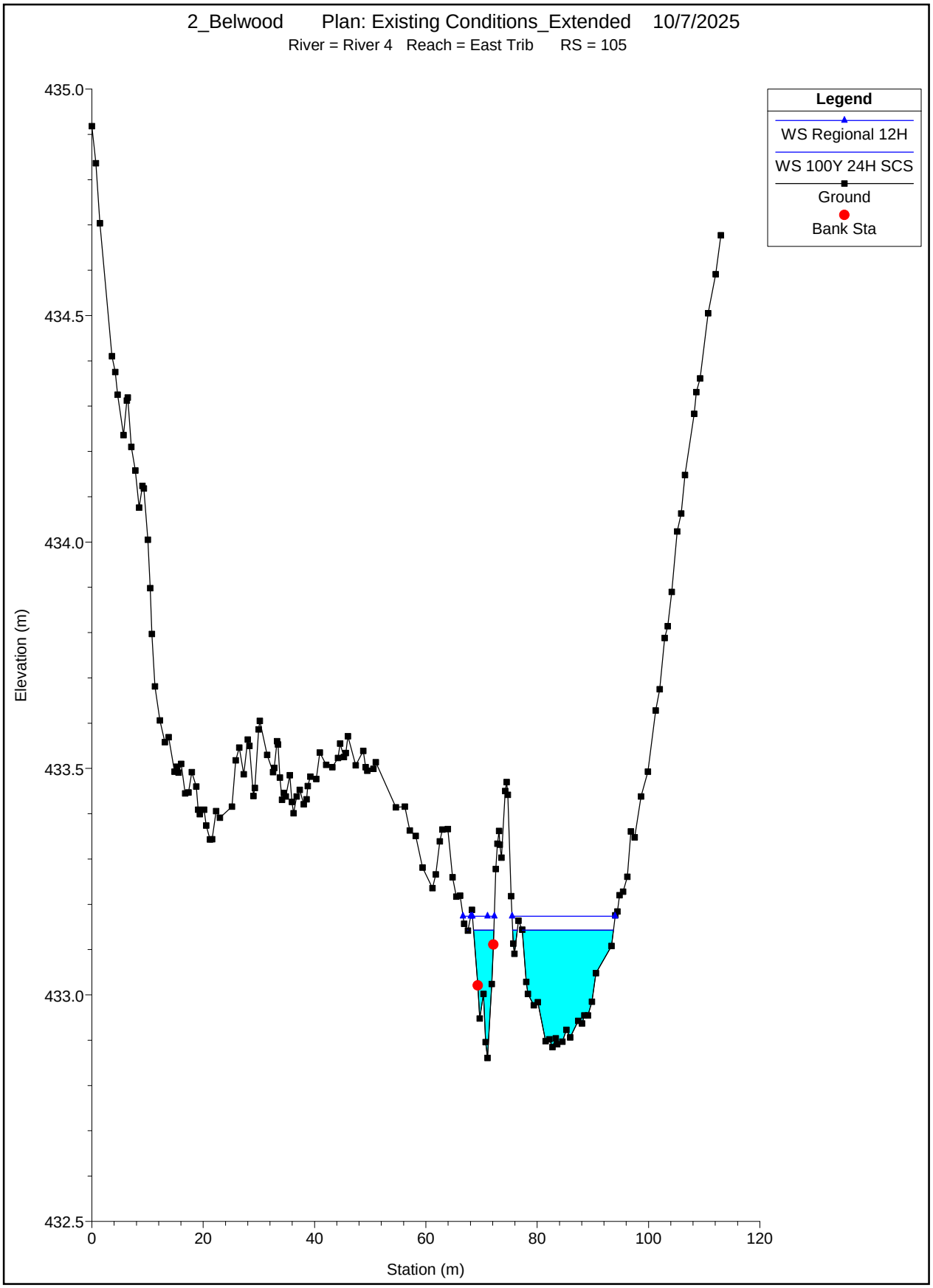

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 3 Reach = North West Trib RS = 29
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
434.5
434.0
433.5
433.0
432.5
432.0
0
20
40
60
80
100
120

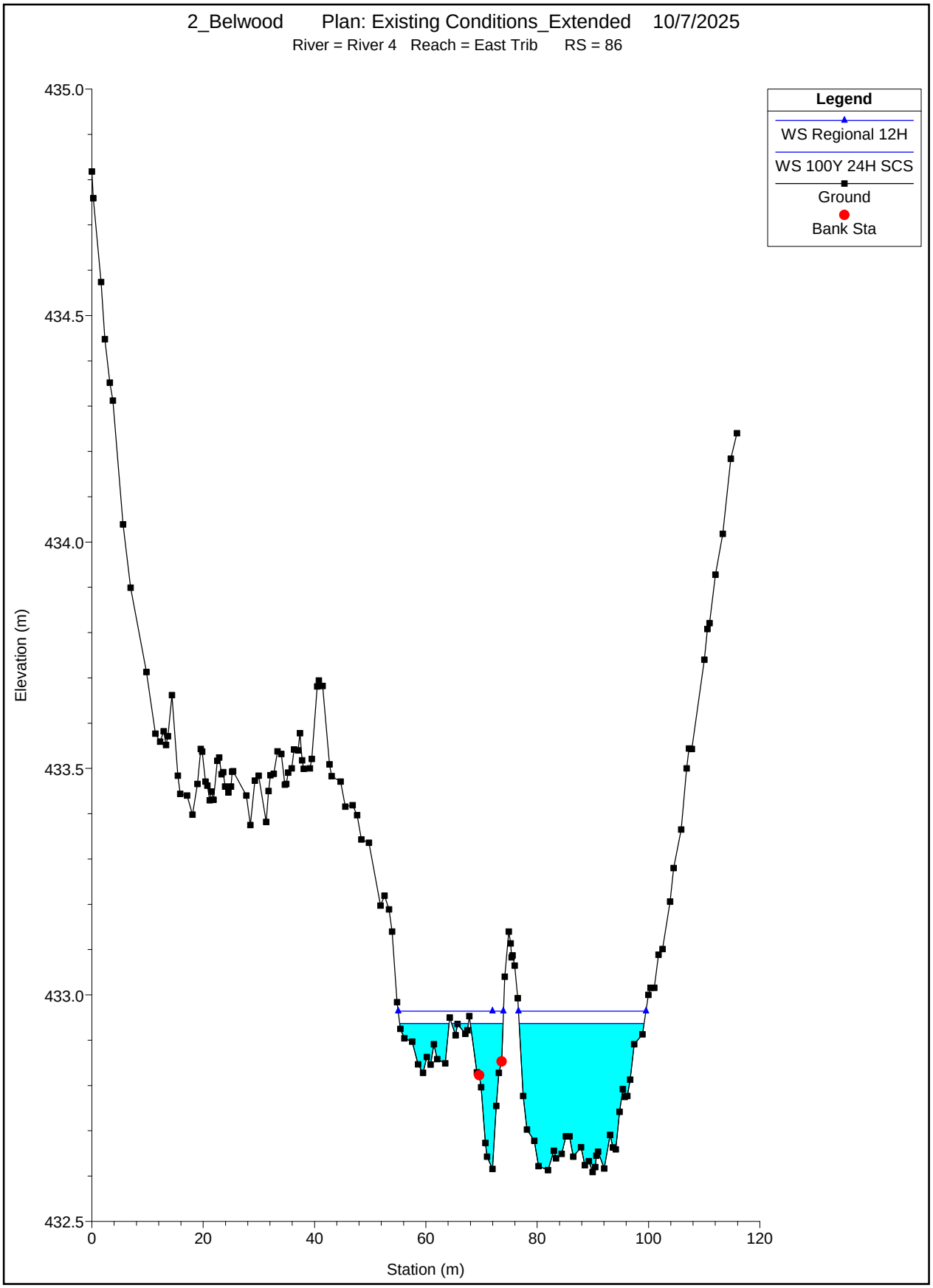

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 3 Reach = North West Trib RS = 22 Culv North + West Cul Farm crossing geometry assumed from photos
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
434.5
434.0
433.5
433.0
432.5
432.0
0
20
40
60
80
100
120

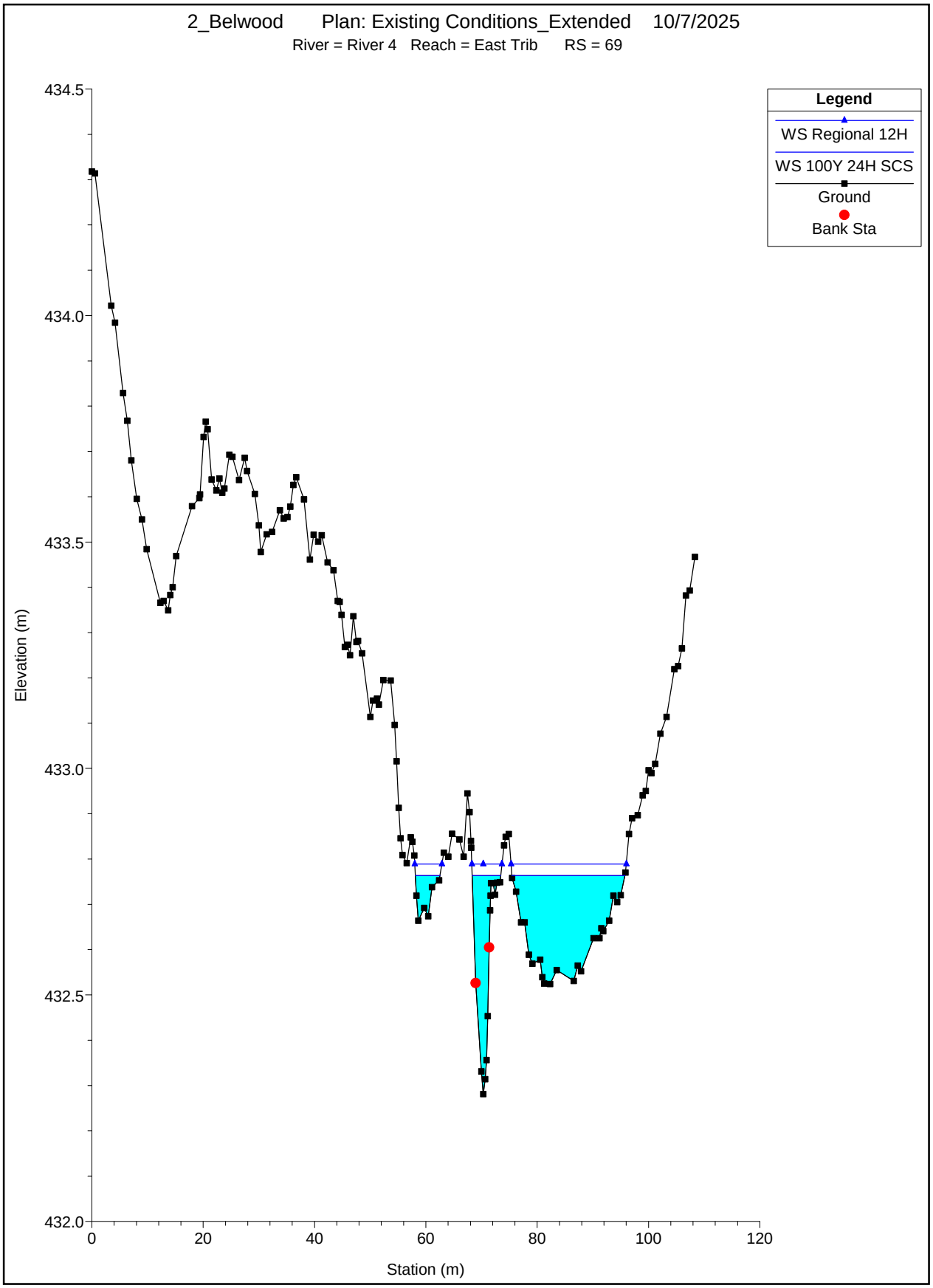

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 3 Reach = North West Trib RS = 17
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
433.8
433.6
433.4
433.2
433.0
432.8
432.6
432.4
432.2
432.0
0
20
40
60
80
100
120

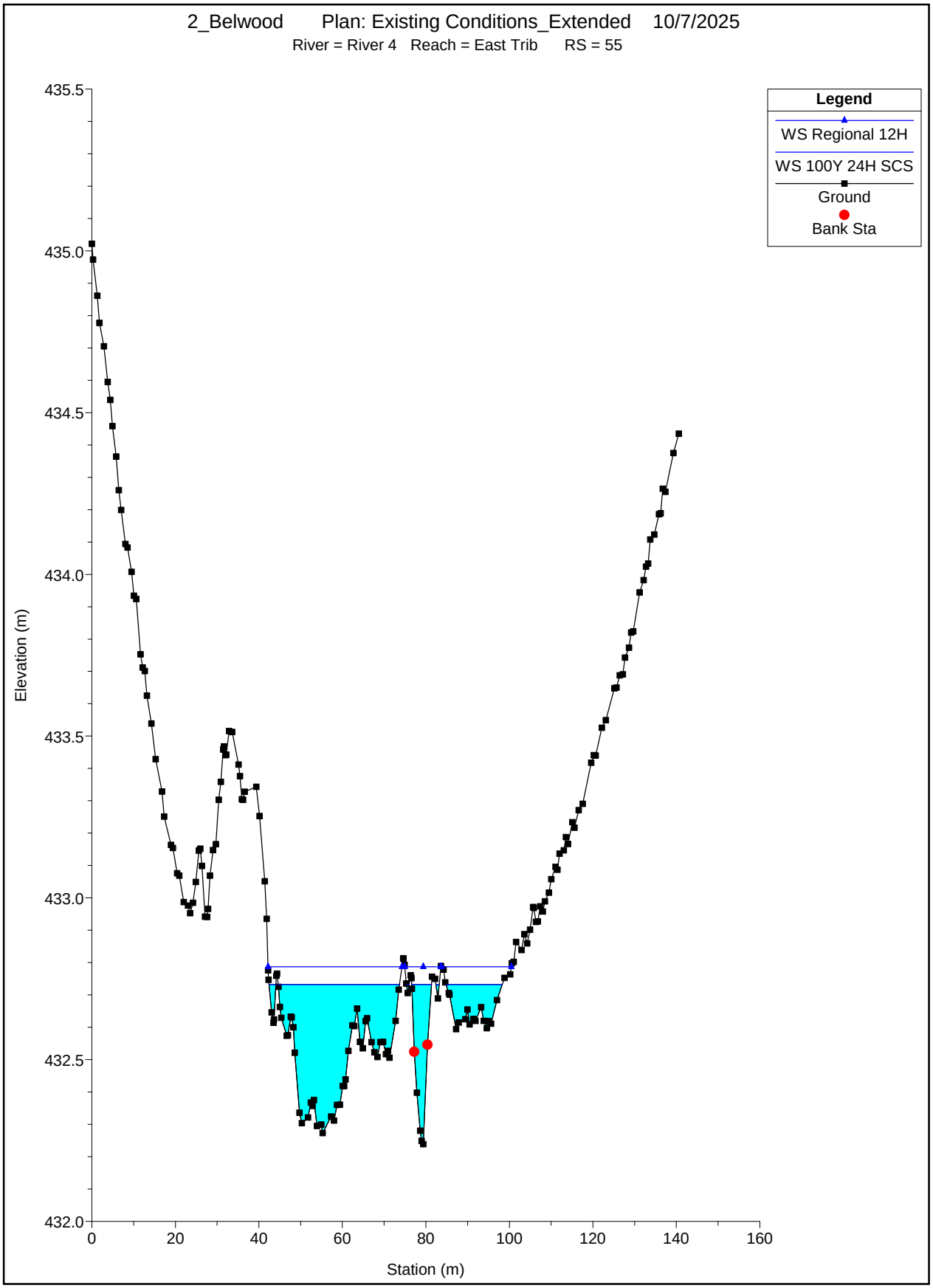

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 3 Reach = North West Trib RS = 11
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
433.6
433.4
433.2
433.0
432.8
432.6
432.4
432.2
432.0
431.8
0
20
40
60
80
100
120

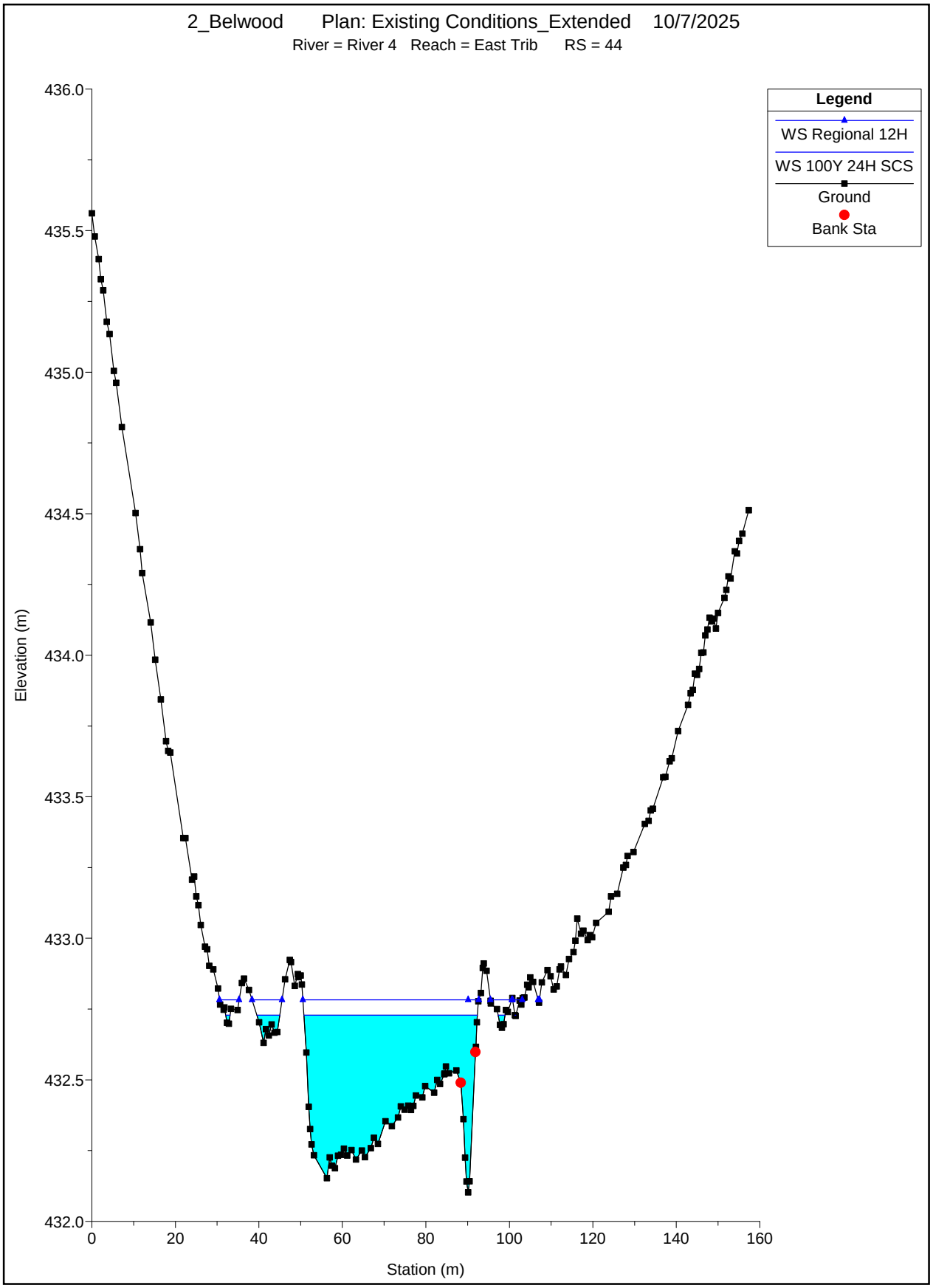

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 4 Reach = East Trib RS = 120
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
436.0
435.5
435.0
434.5
434.0
433.5
433.0
0
20
40
60
80
100
120
Station (m)

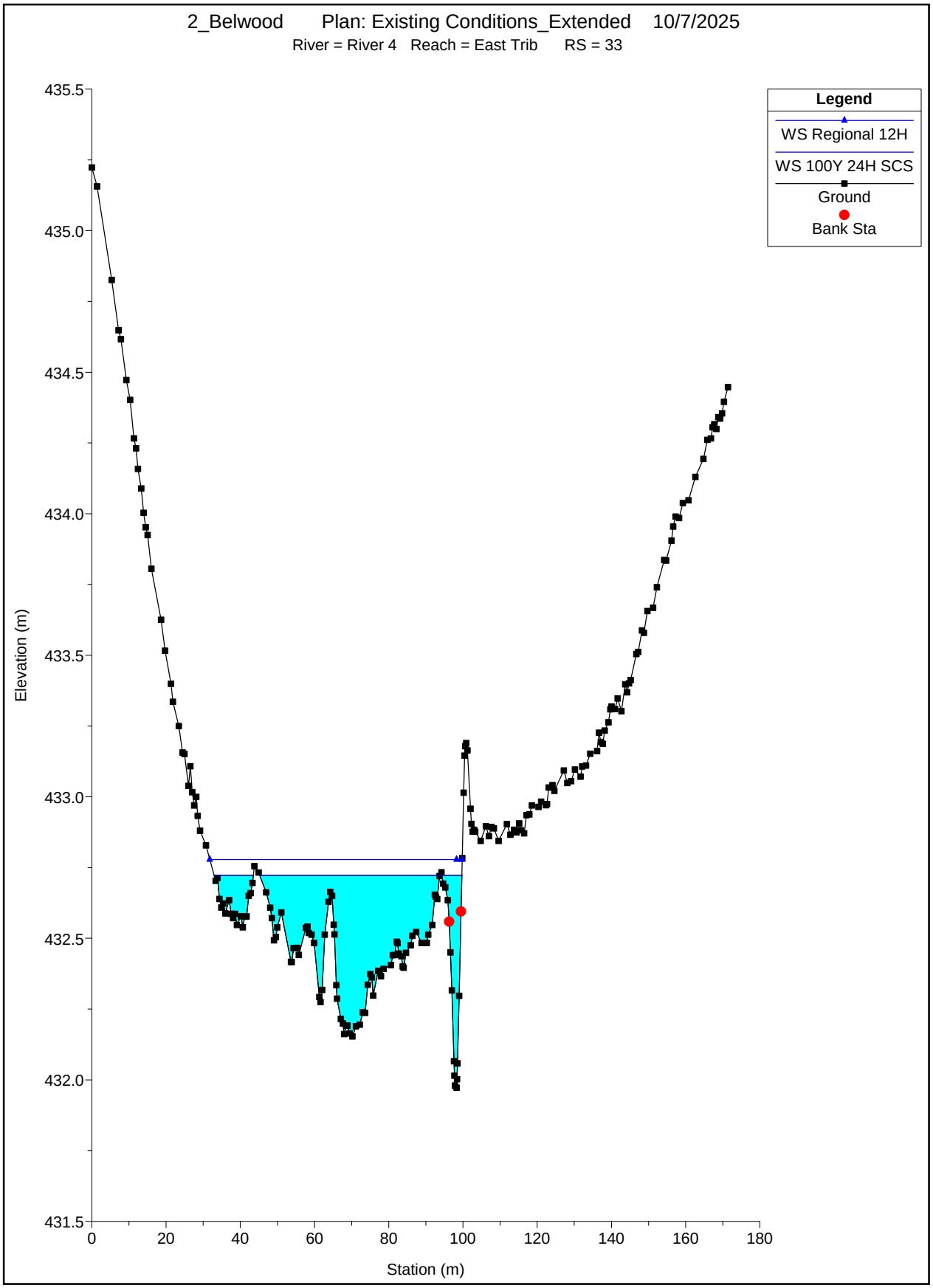

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 4 Reach = East Trib RS = 105
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
435.0
434.5
434.0
433.5
433.0
432.5
0
20
40
60
80
100
120

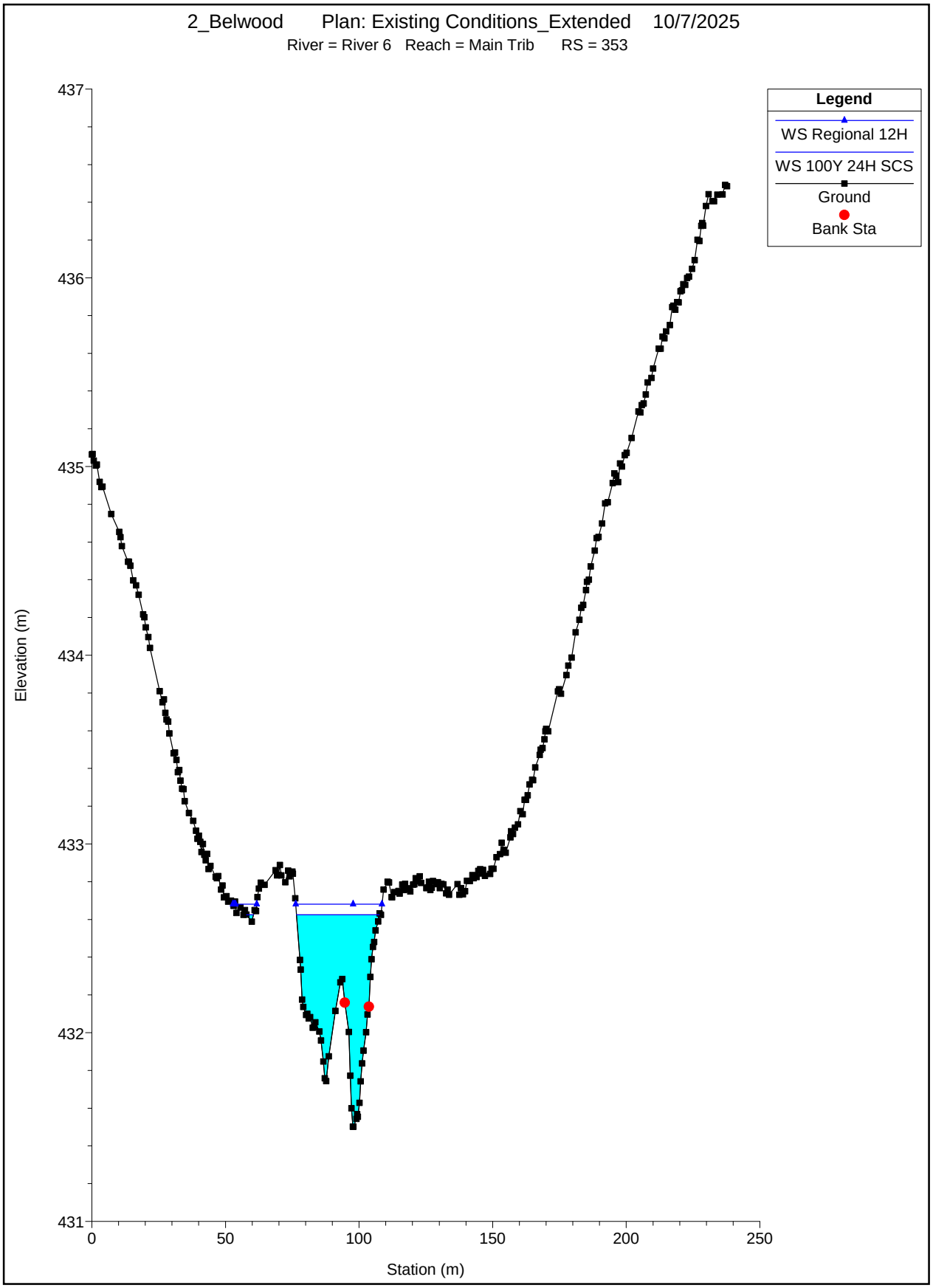

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 4 Reach = East Trib RS = 86
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
435.0
434.5
434.0
433.5
433.0
432.5
0
20
40
60
80
100
120

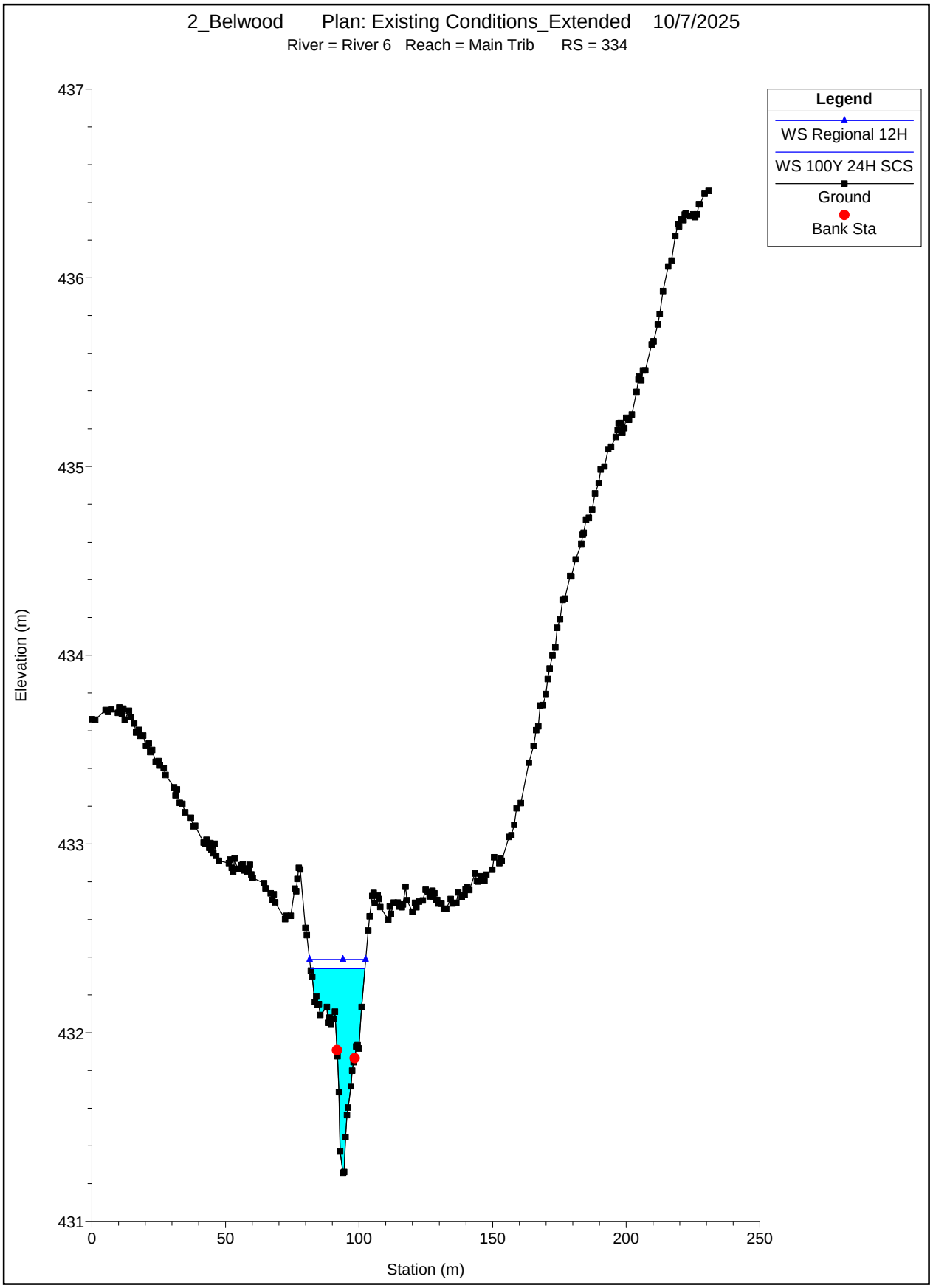

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 4 Reach = East Trib RS = 69
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
434.5
434.0
433.5
433.0
432.5
432.0
0
20
40
60
80
100
120

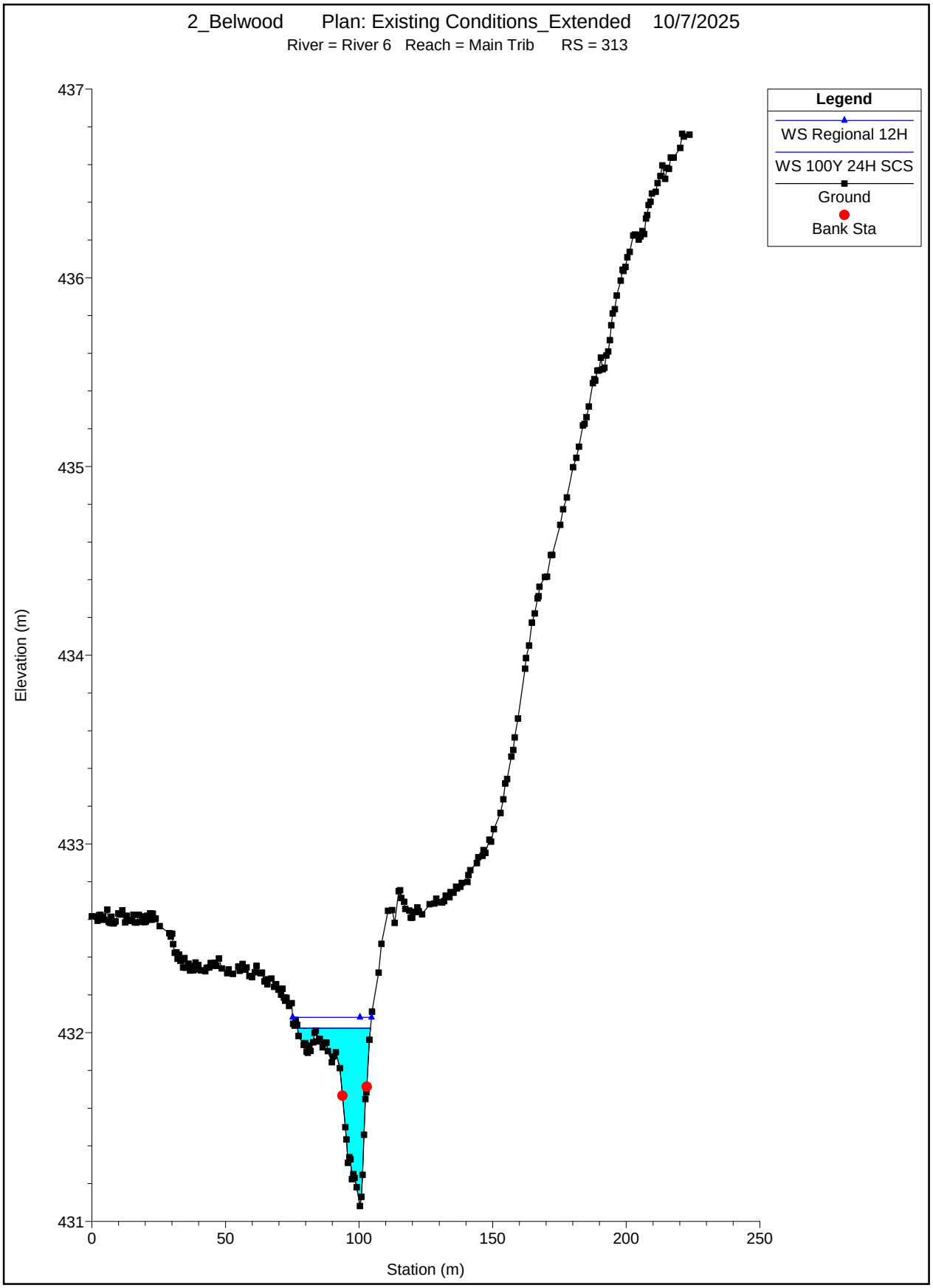

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 4 Reach = East Trib RS = 55
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
435.5
435.0
434.5
434.0
433.5
433.0
432.5
432.0
0
20
40
60
80
100
120
140
160

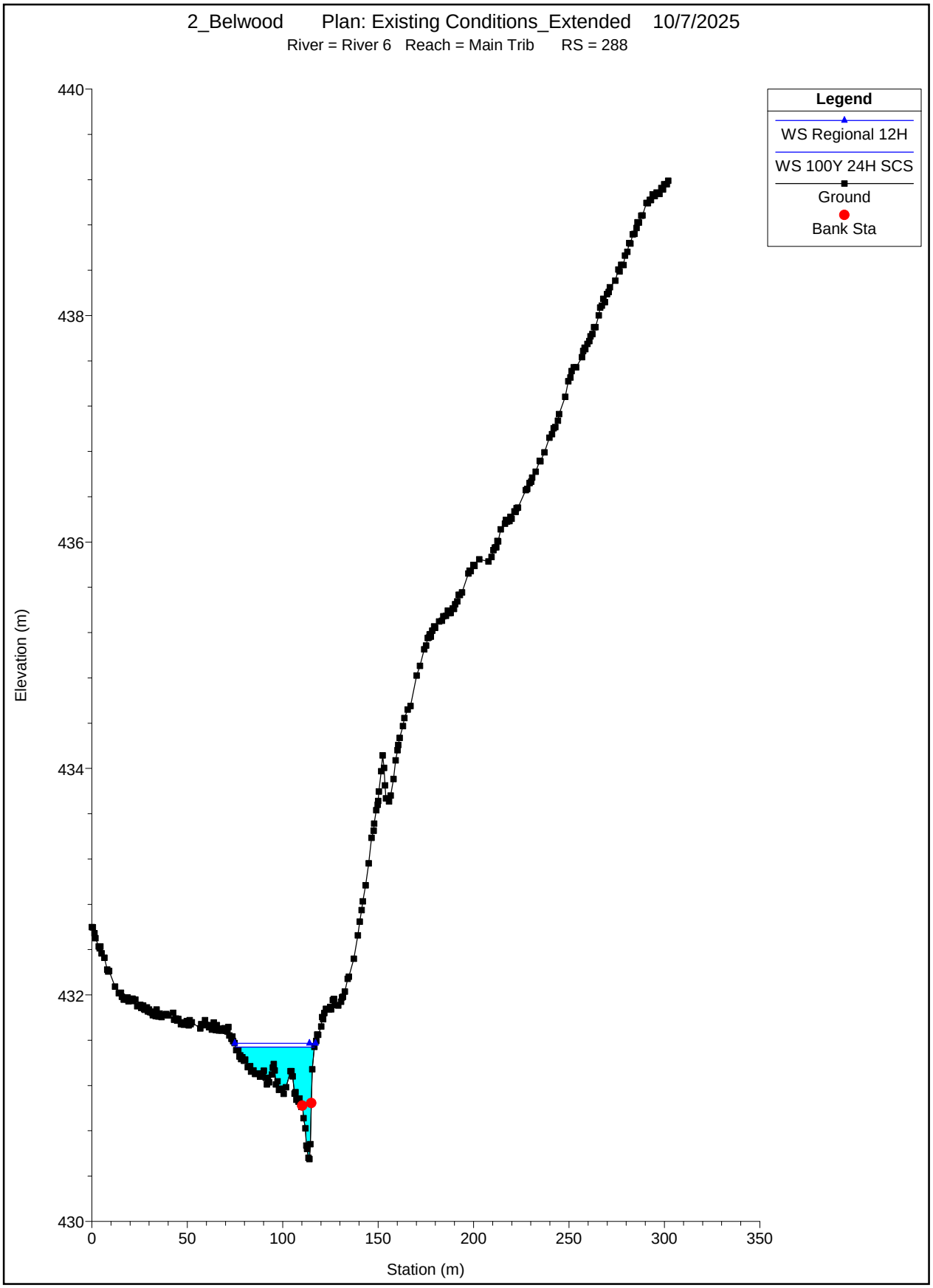

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 4 Reach = East Trib RS = 44
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
436.0
435.5
435.0
434.5
434.0
433.5
433.0
432.5
432.0
0
20
40
60
80
100
120
140
160

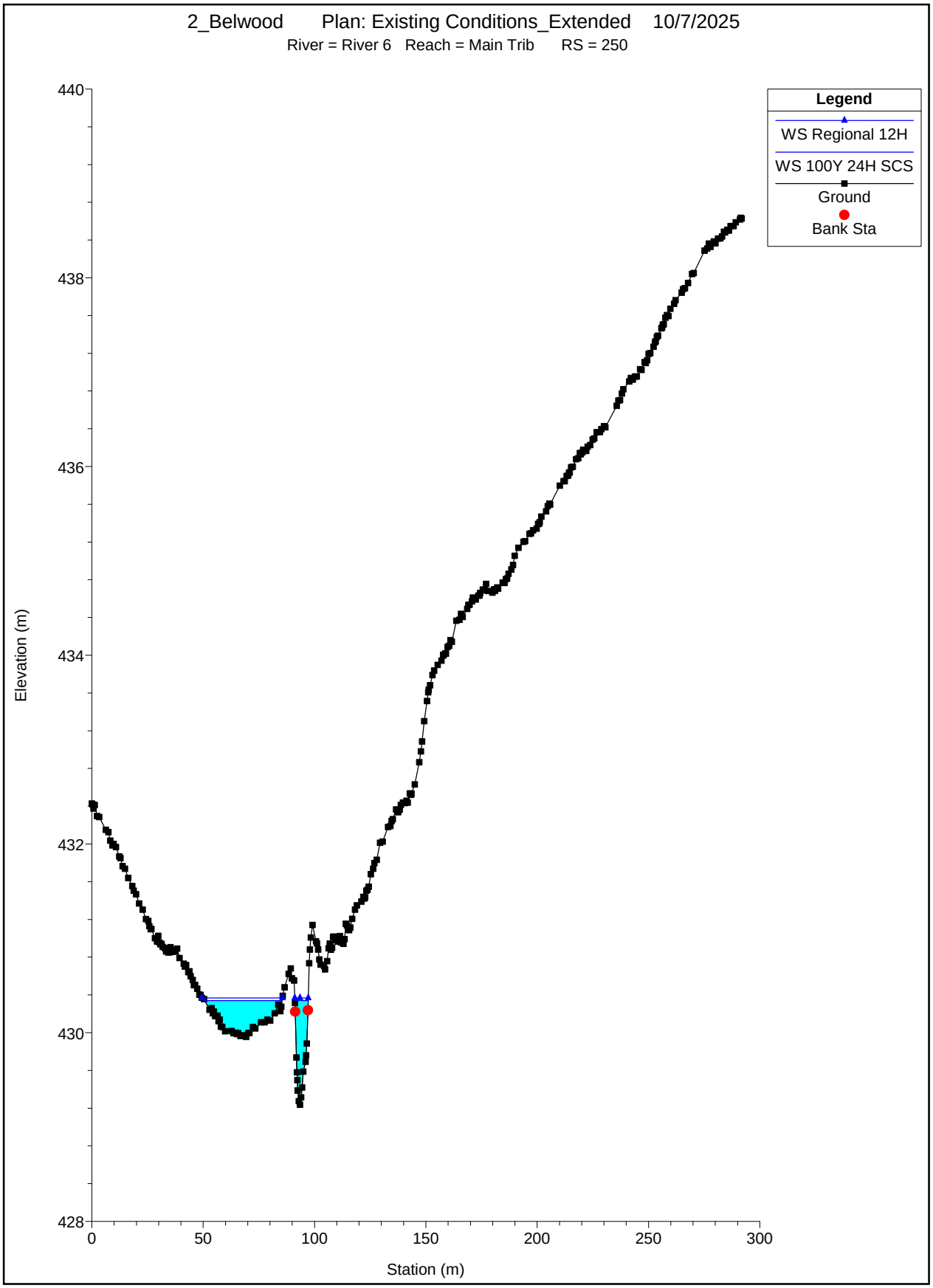

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 4 Reach = East Trib RS = 33
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
435.5
435.0
434.5
434.0
433.5
433.0
432.5
432.0
431.5
0
20
40
60
80
100
120
140
160
180

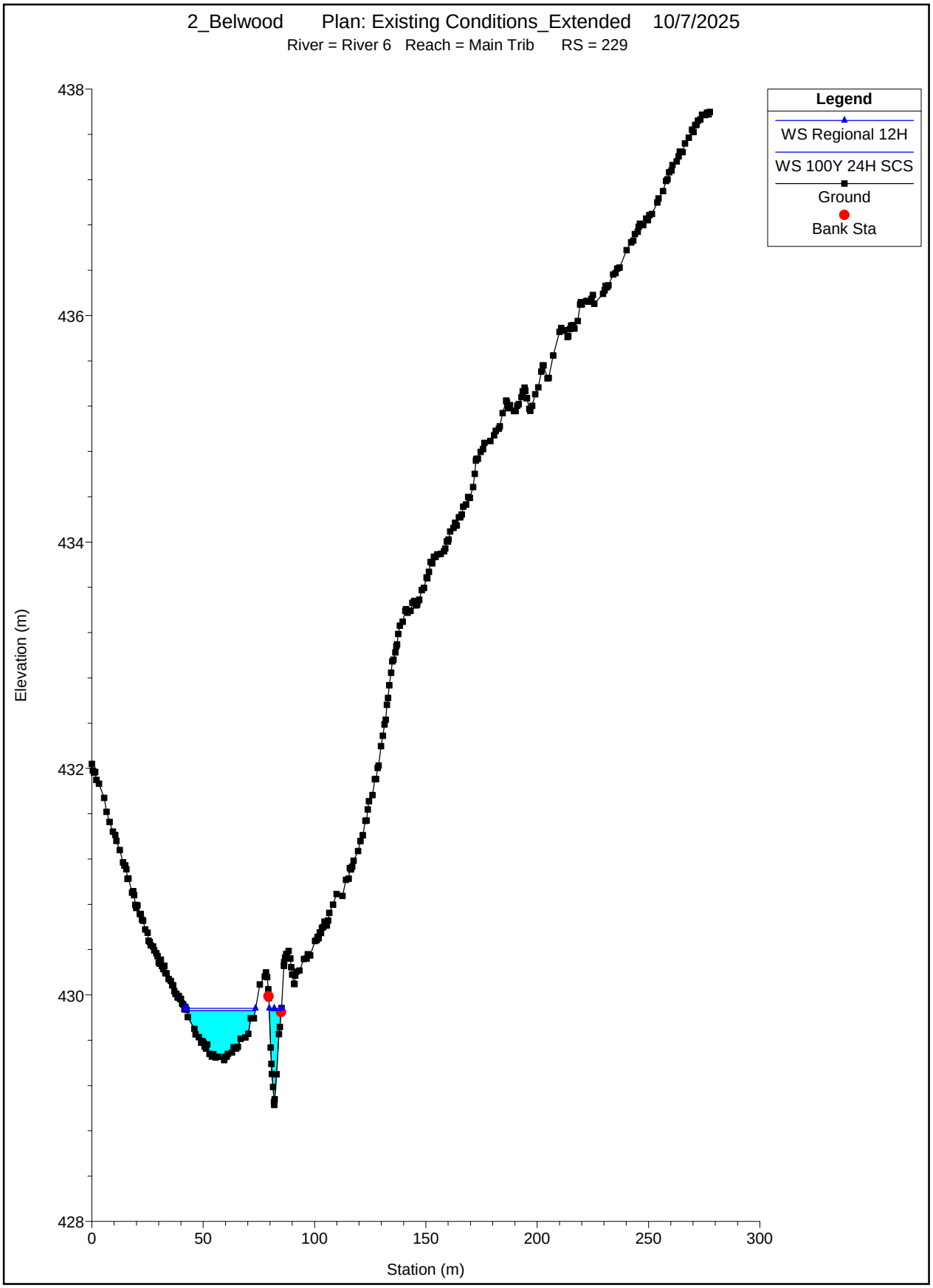

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 6 Reach = Main Trib RS = 353
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
437
436
435
434
433
432
431
0
50
100
150
200
250

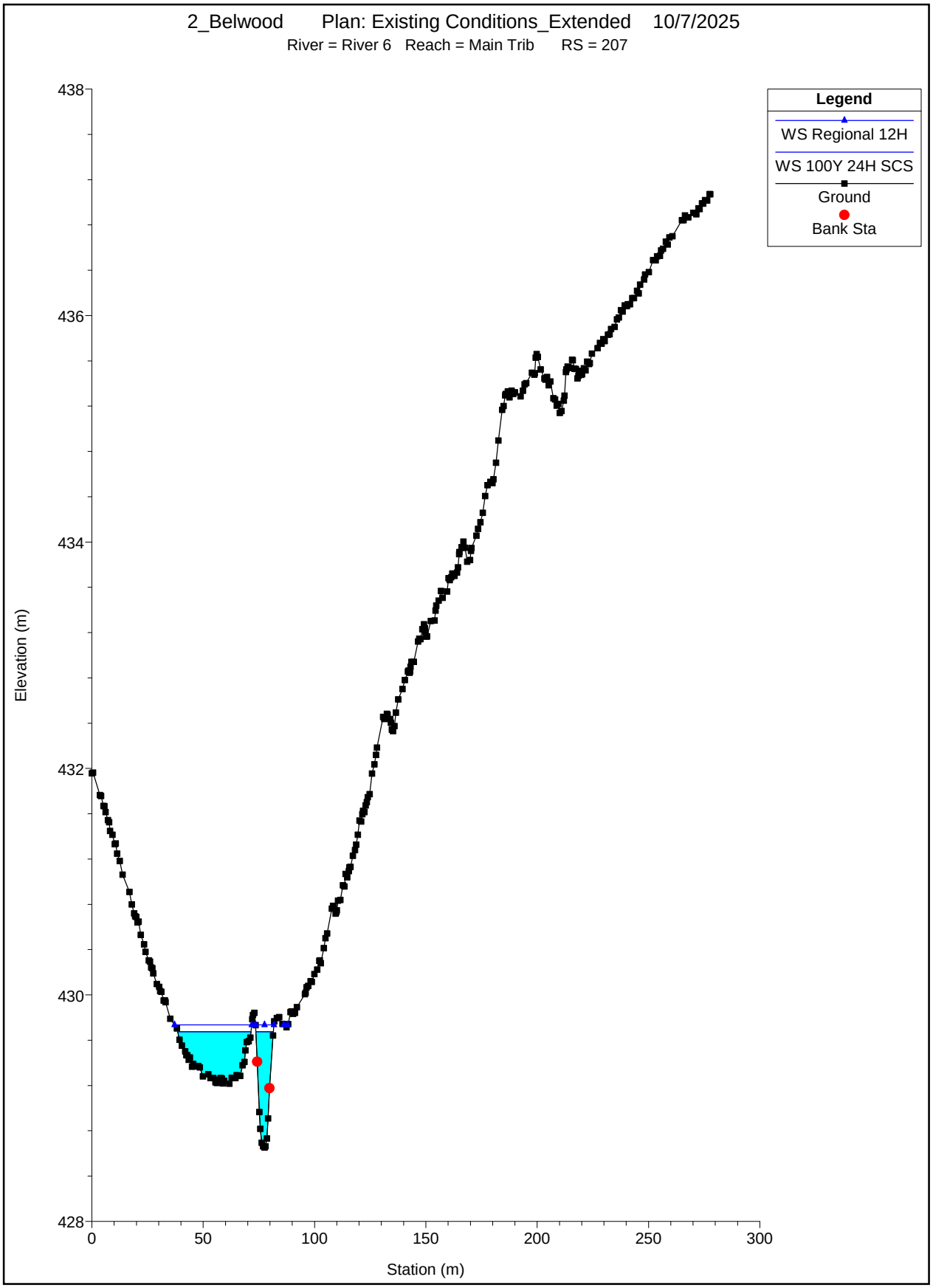

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 6 Reach = Main Trib RS = 334
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
437
436
435
434
433
432
431
0
50
100
150
200
250

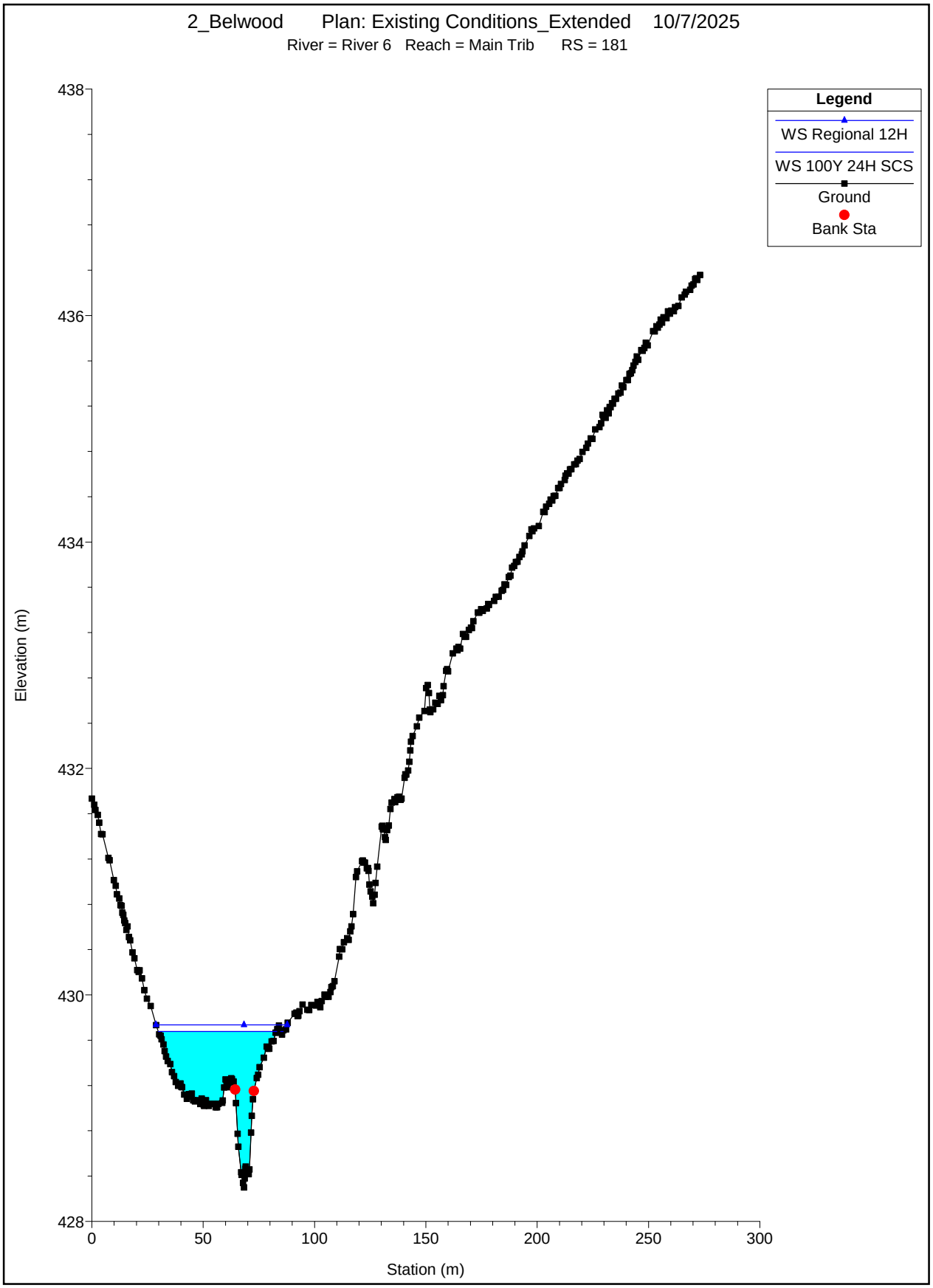

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 6 Reach = Main Trib RS = 313
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
437
436
435
434
433
432
431
0
50
100
150
200
250

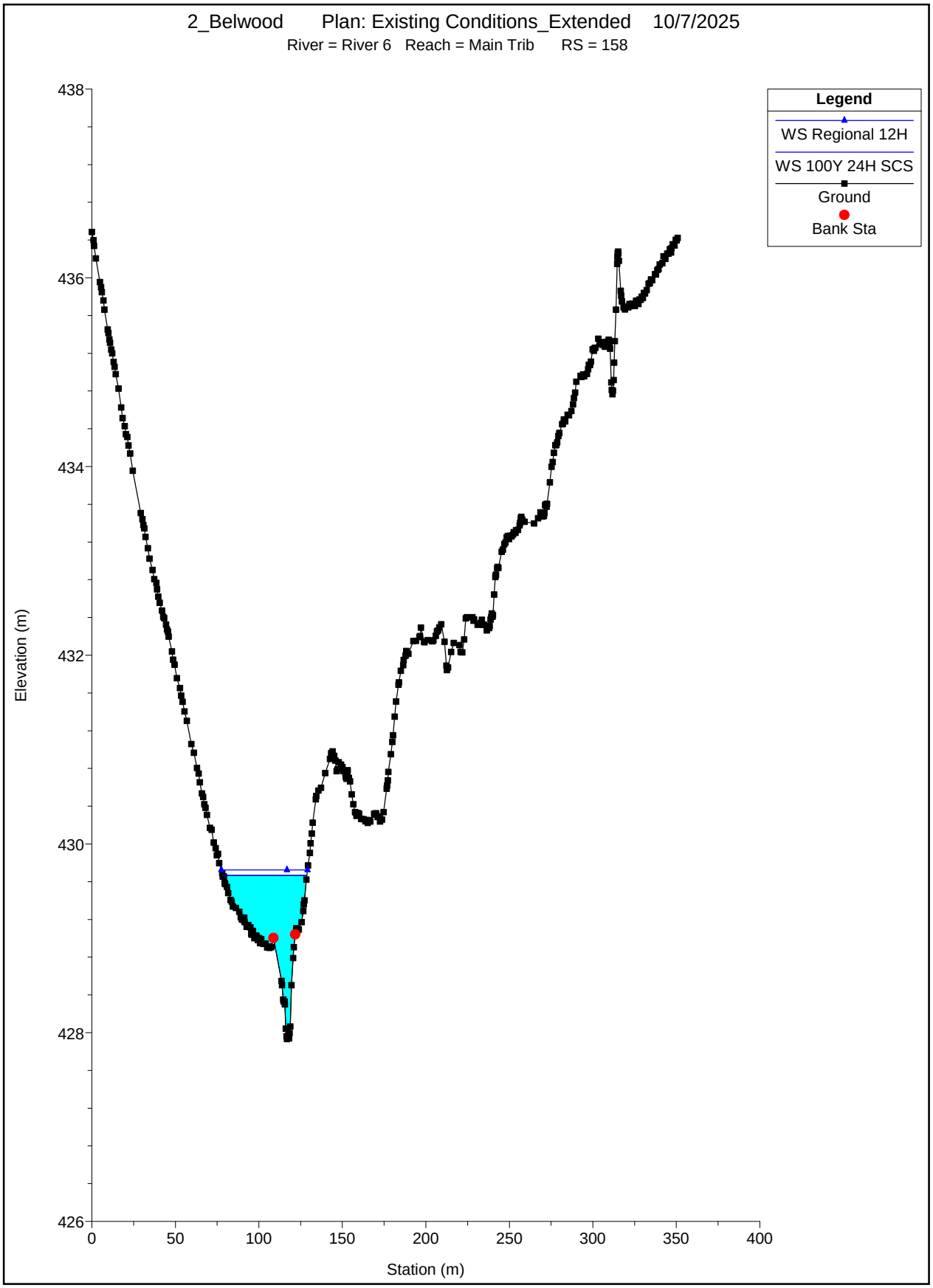

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 6 Reach = Main Trib RS = 288
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
440
438
436
434
432
430
0
50
100
150
200
250
300
350

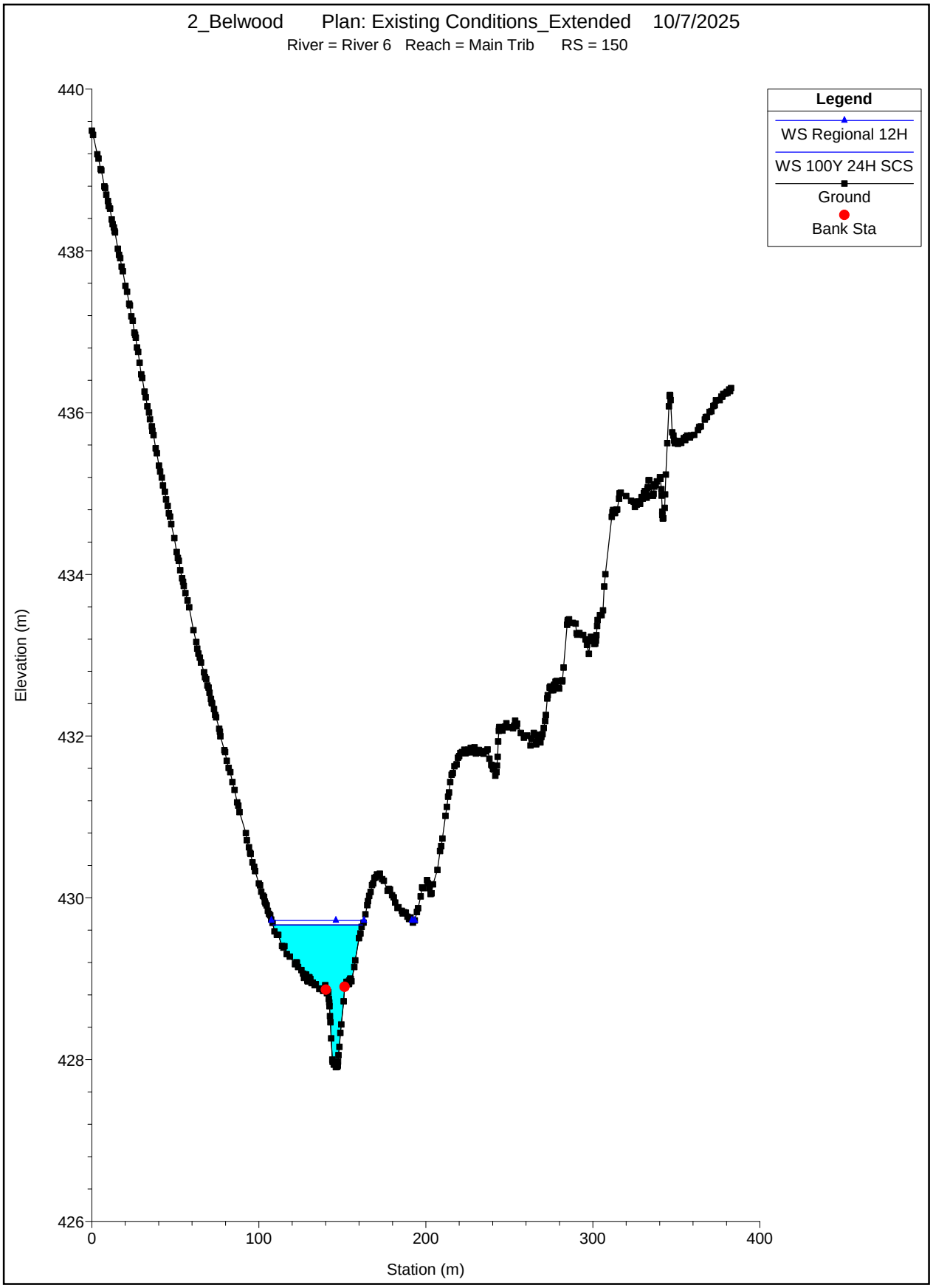

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 6 Reach = Main Trib RS = 250
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
440
438
436
434
432
430
428
0
50
100
150
200
250
300

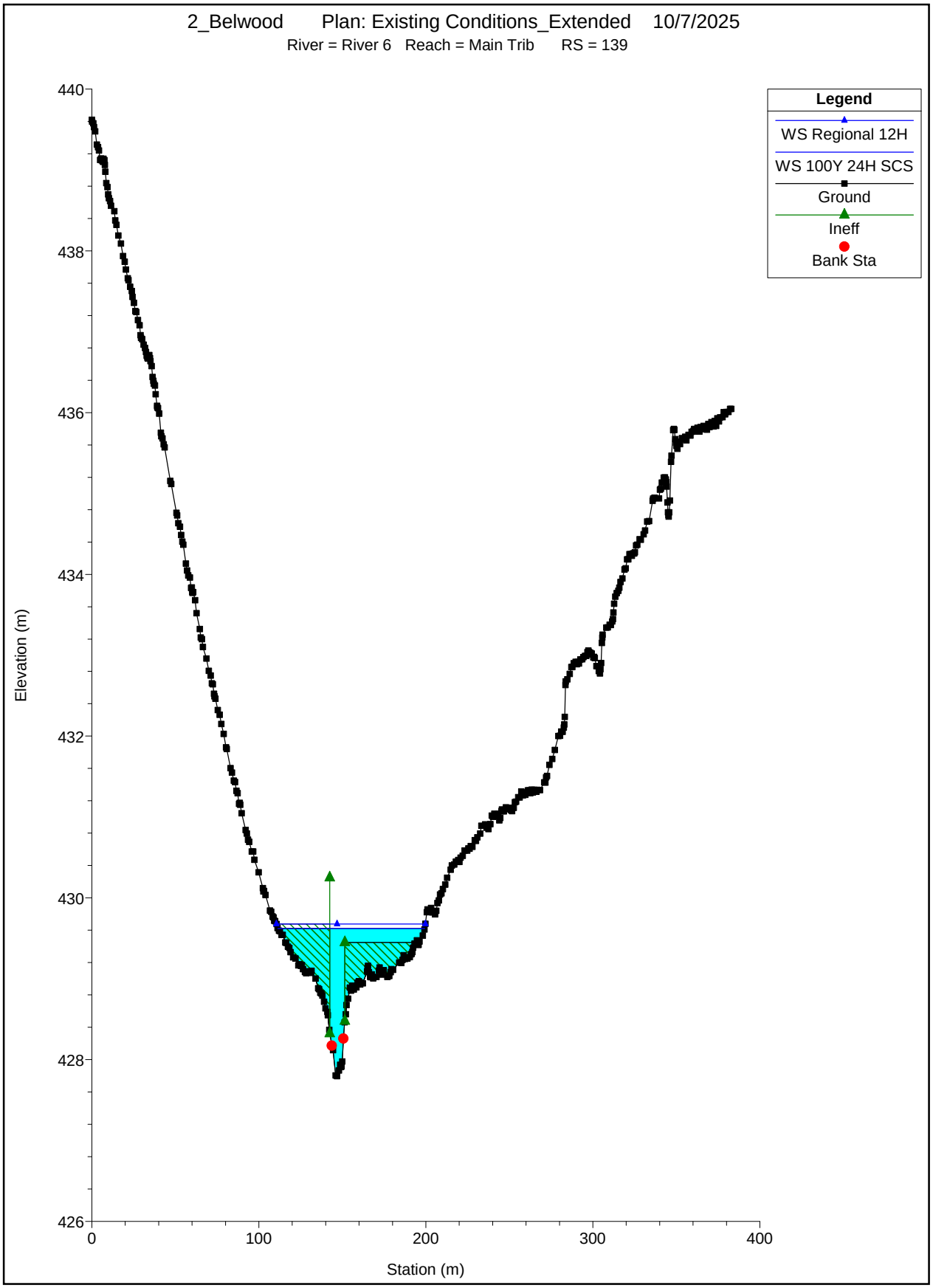

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 6 Reach = Main Trib RS = 229
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
438
436
434
432
430
428
0
50
100
150
200
250
300


2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 6 Reach = Main Trib RS = 207
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
438
436
434
432
430
428
0
50
100
150
200
250
300

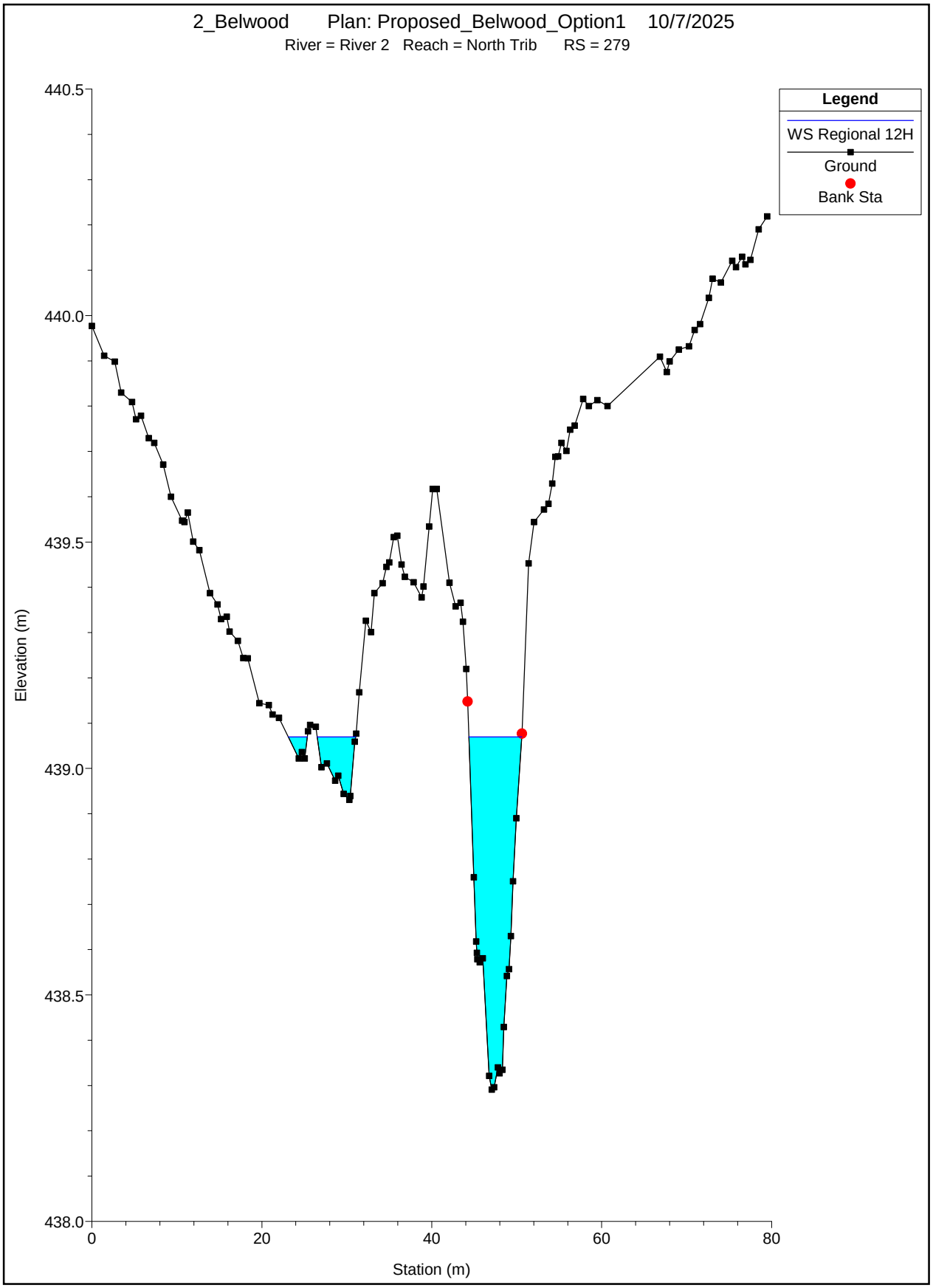

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 6 Reach = Main Trib RS = 181
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
438
436
434
432
430
428
0
50
100
150
200
250
300

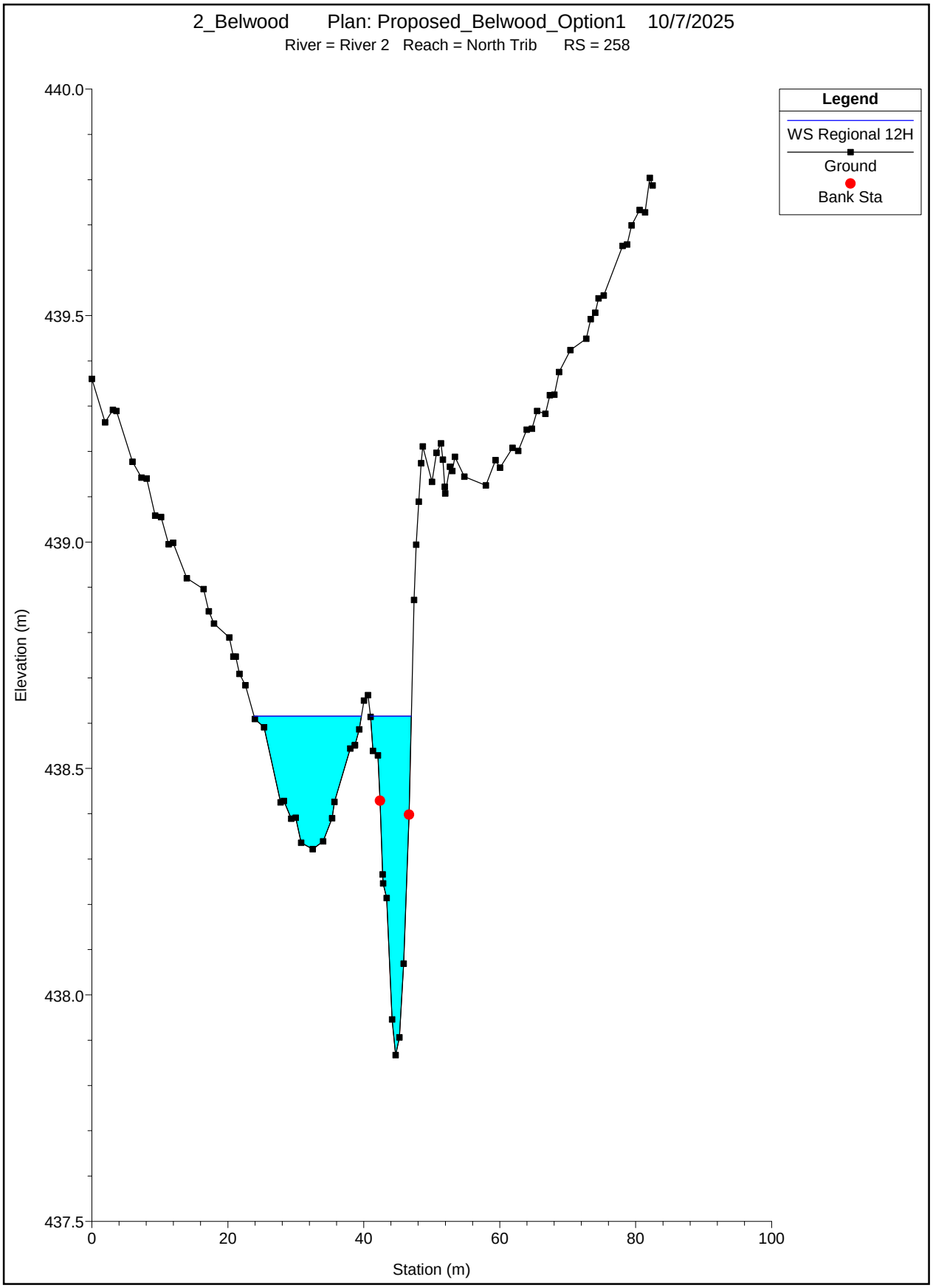

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 6 Reach = Main Trib RS = 158
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
438
436
434
432
430
428
426
0
50
100
150
200
250
300
350
400

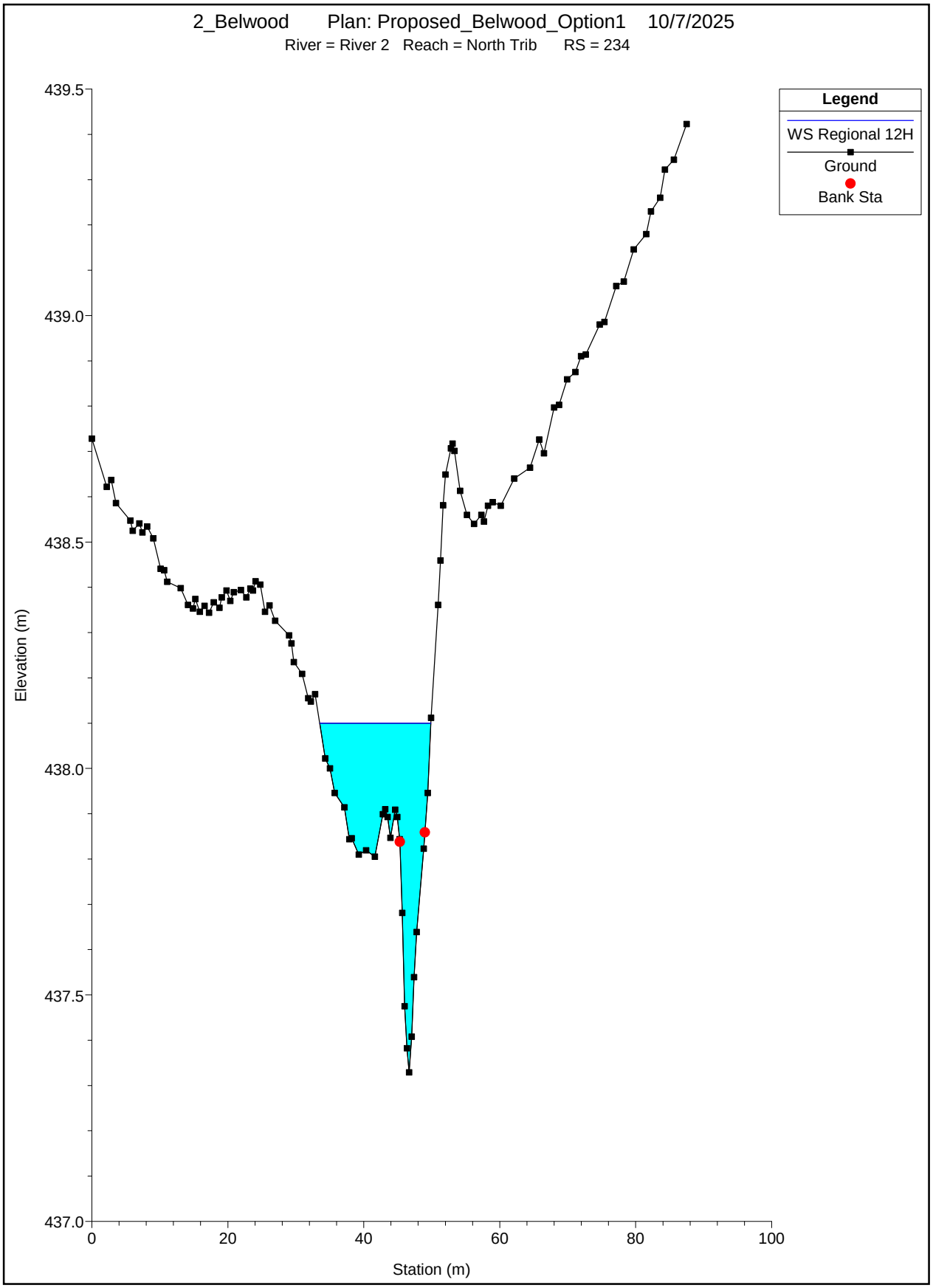

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 6 Reach = Main Trib RS = 150
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Bank Sta
Elevation (m)
Station (m)
440
438
436
434
432
430
428
426
0
100
200
300
400

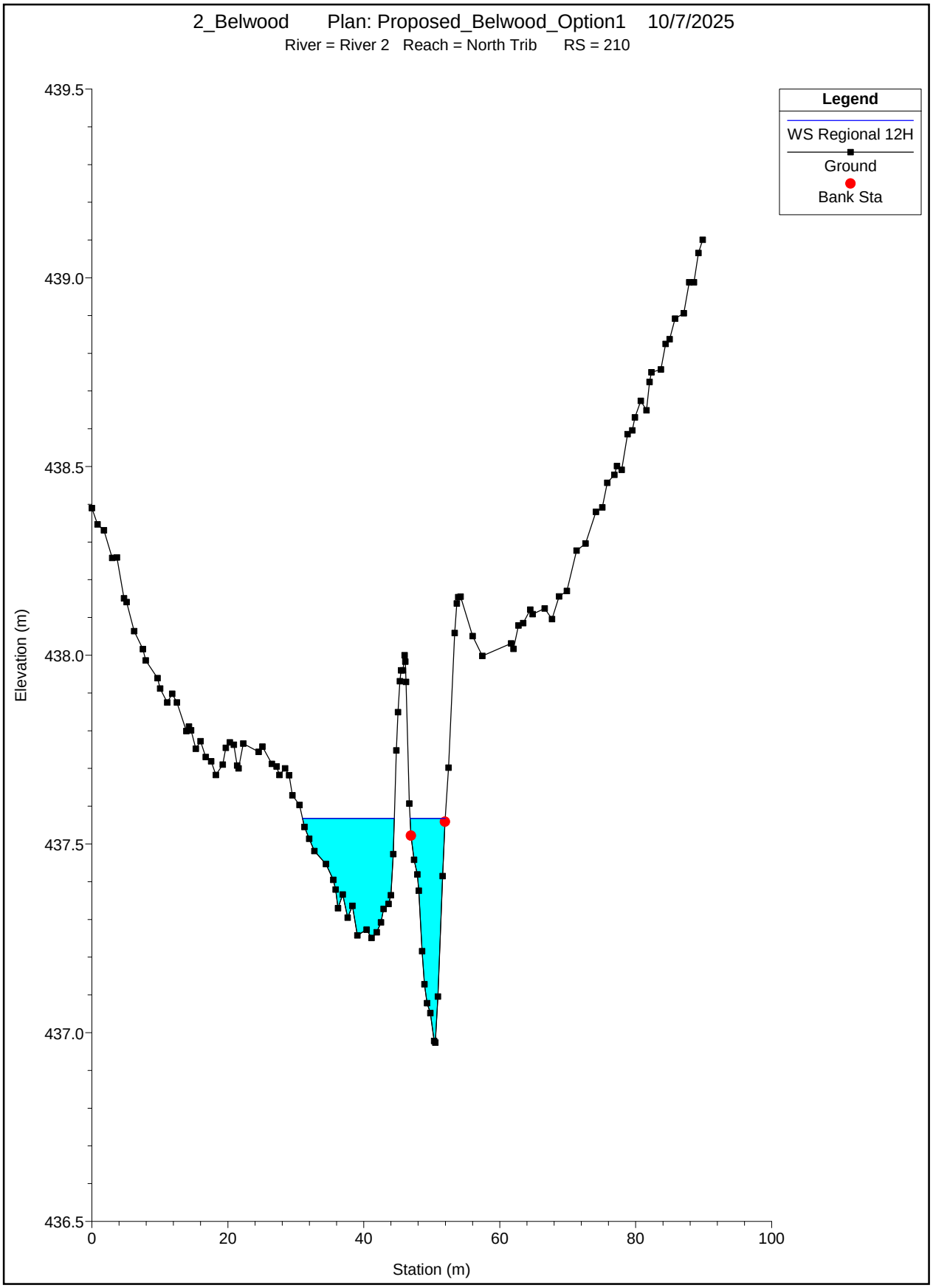

2_Belwood Plan: Existing Conditions_Extended 10/7/2025
River = River 6 Reach = Main Trib RS = 139
Legend
WS Regional 12H
WS 100Y 24H SCS
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
440
438
436
434
432
430
428
426
0
100
200
300
400

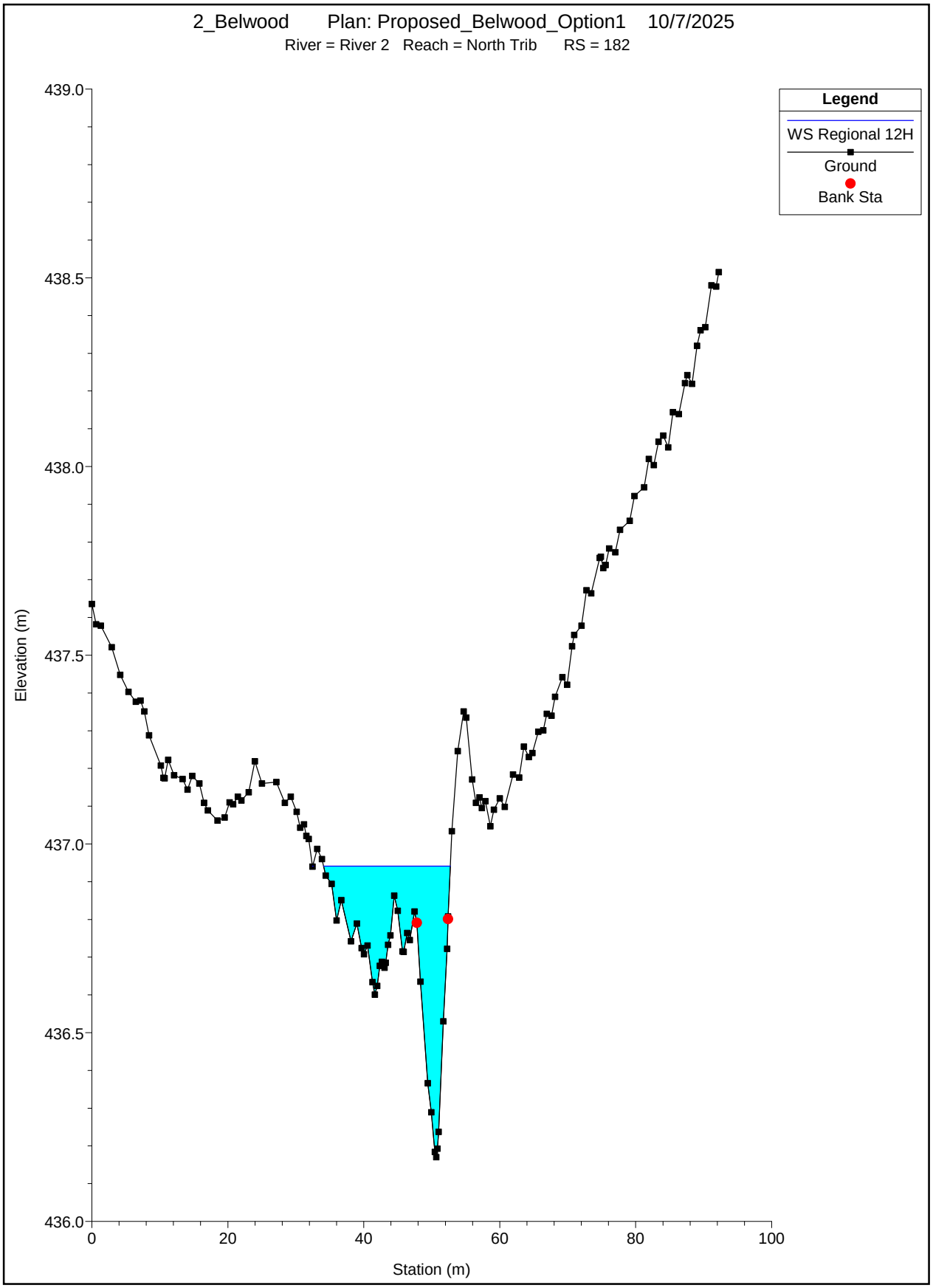
Proposed Conditions - Cross Sections

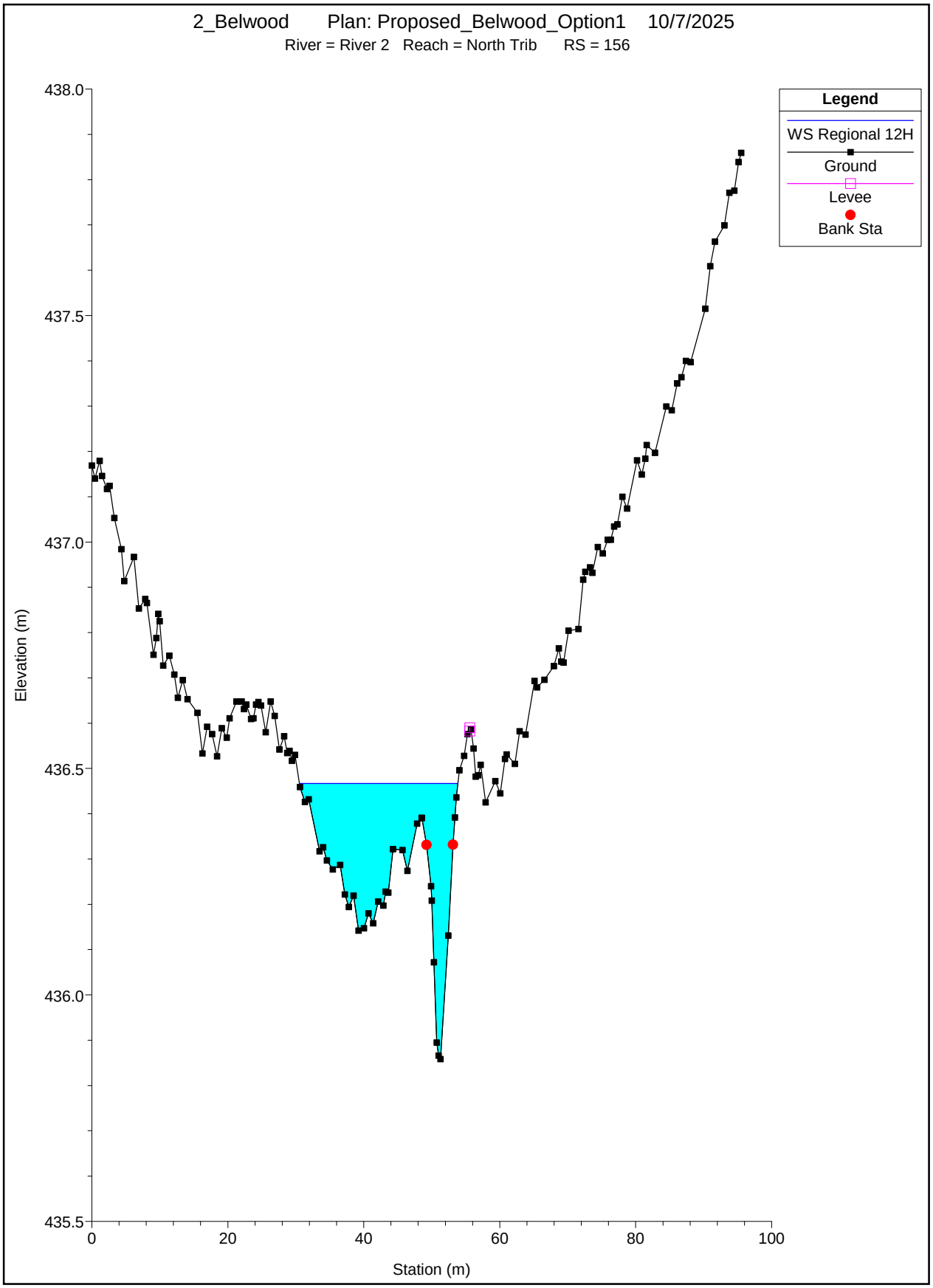

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 279
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
440.5
440.0
439.5
439.0
438.5
438.0
0
20
40
60
80

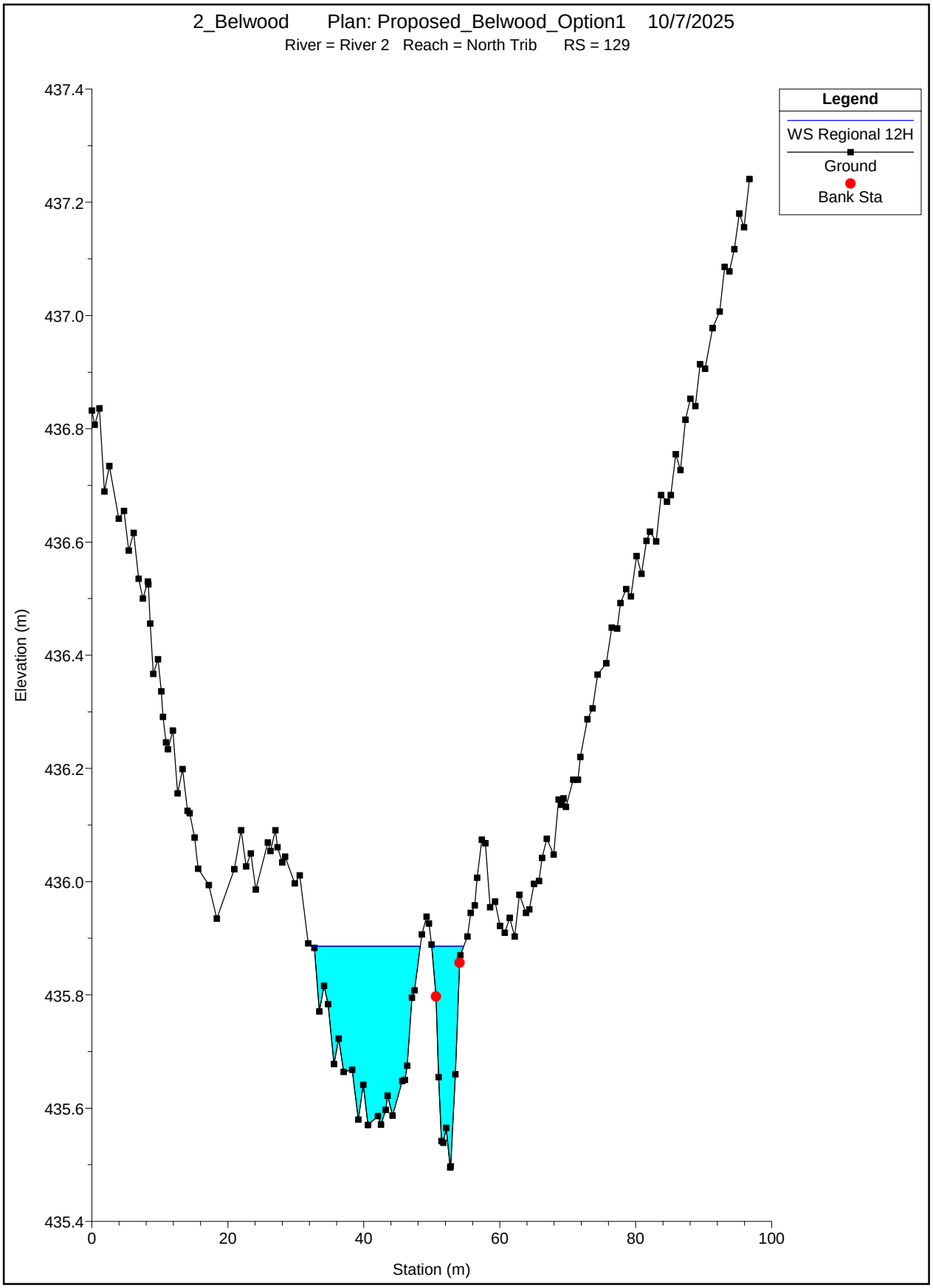

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 258
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
440.0
439.5
439.0
438.5
438.0
437.5
0
20
40
60
80
100

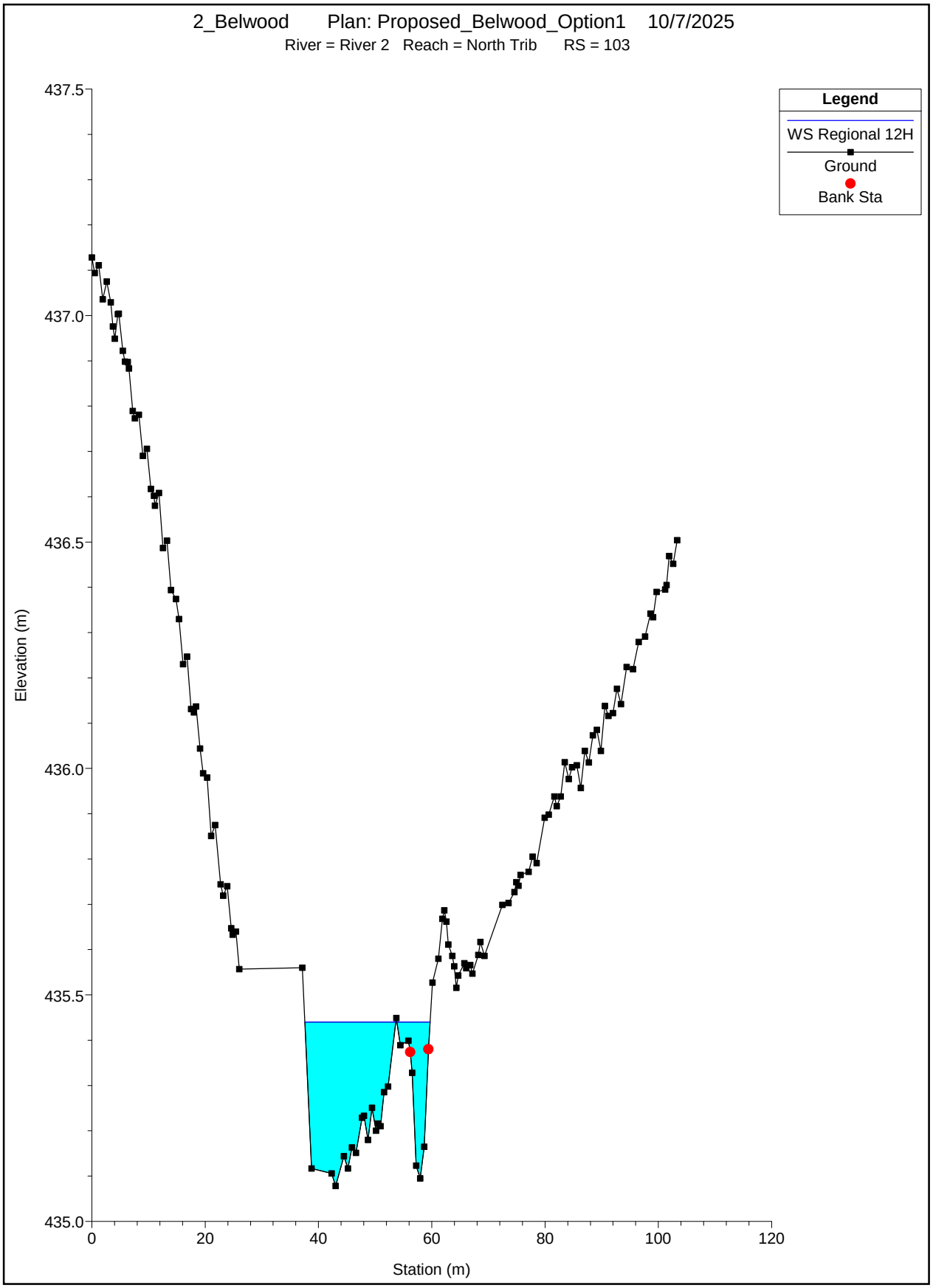

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 234
Legend
WS Regional 12H
Ground
Bank Sta
439.5
439.0
438.5
438.0
437.5
437.0
Elevation (m)
0
20
40
60
80
100
Station (m)

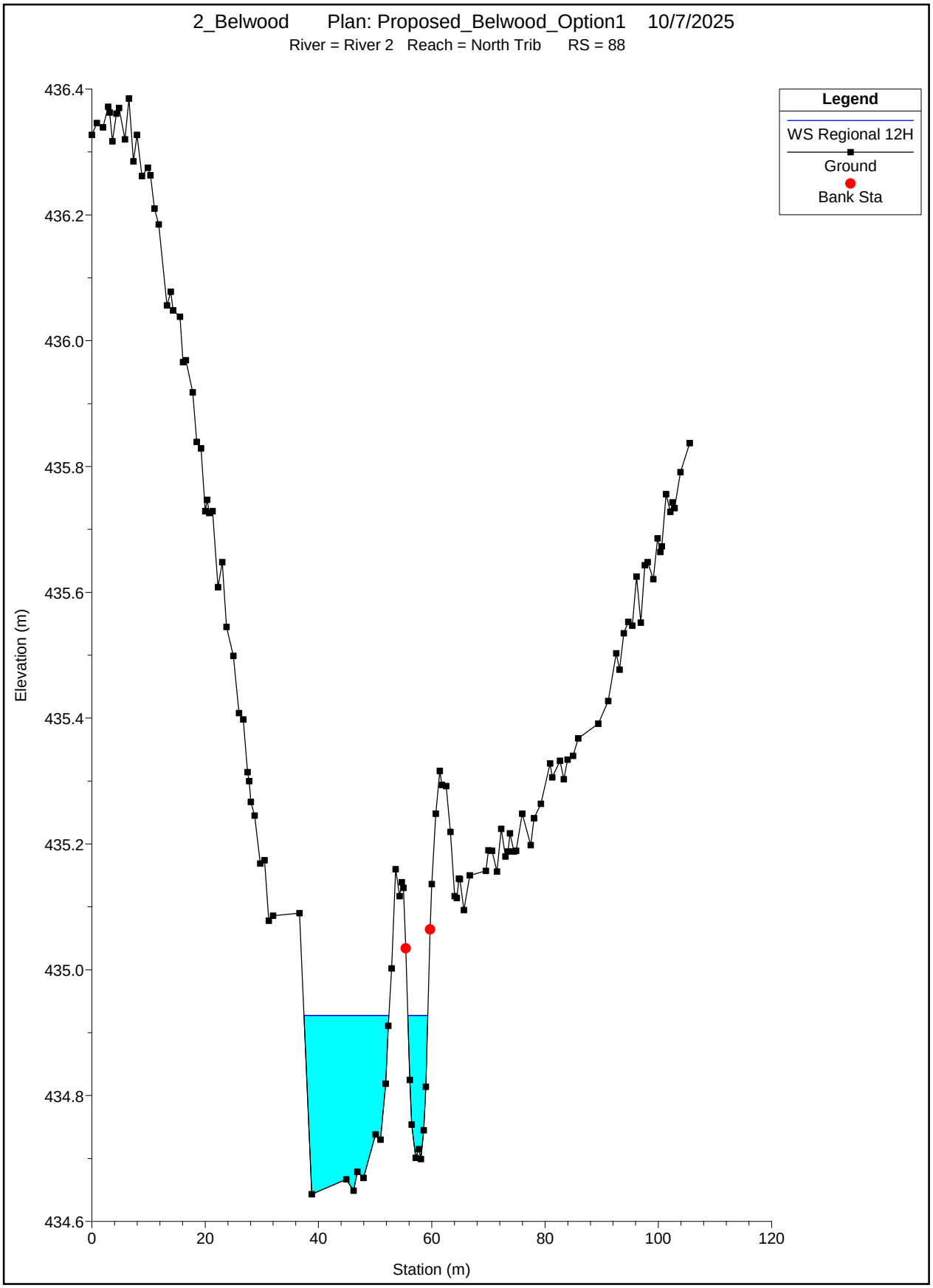

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 210
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
439.5
439.0
438.5
438.0
437.5
437.0
436.5
0
20
40
60
80
100

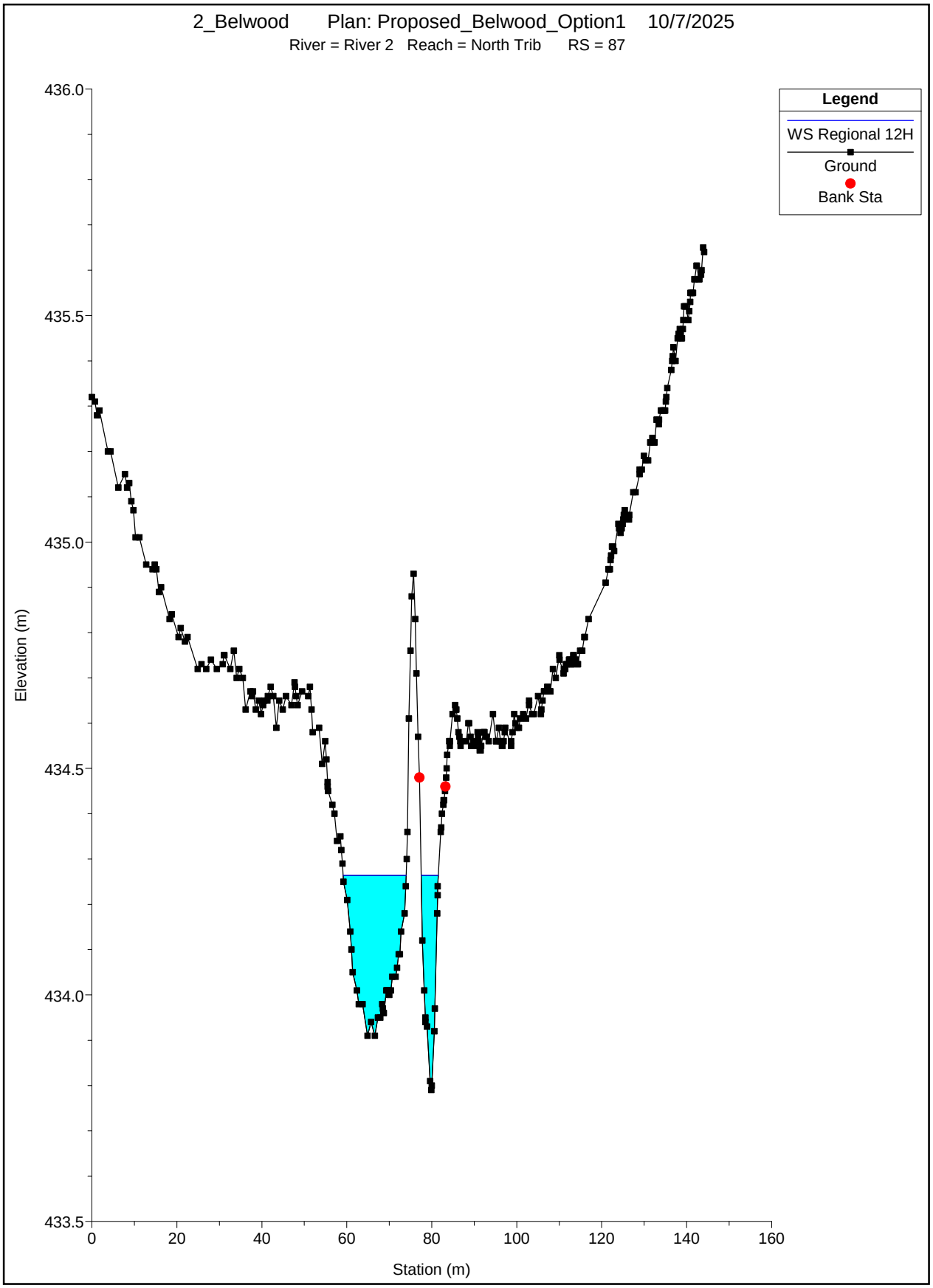

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 182
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
439.0
438.5
438.0
437.5
437.0
436.5
436.0
0
20
40
60
80
100
Station (m)

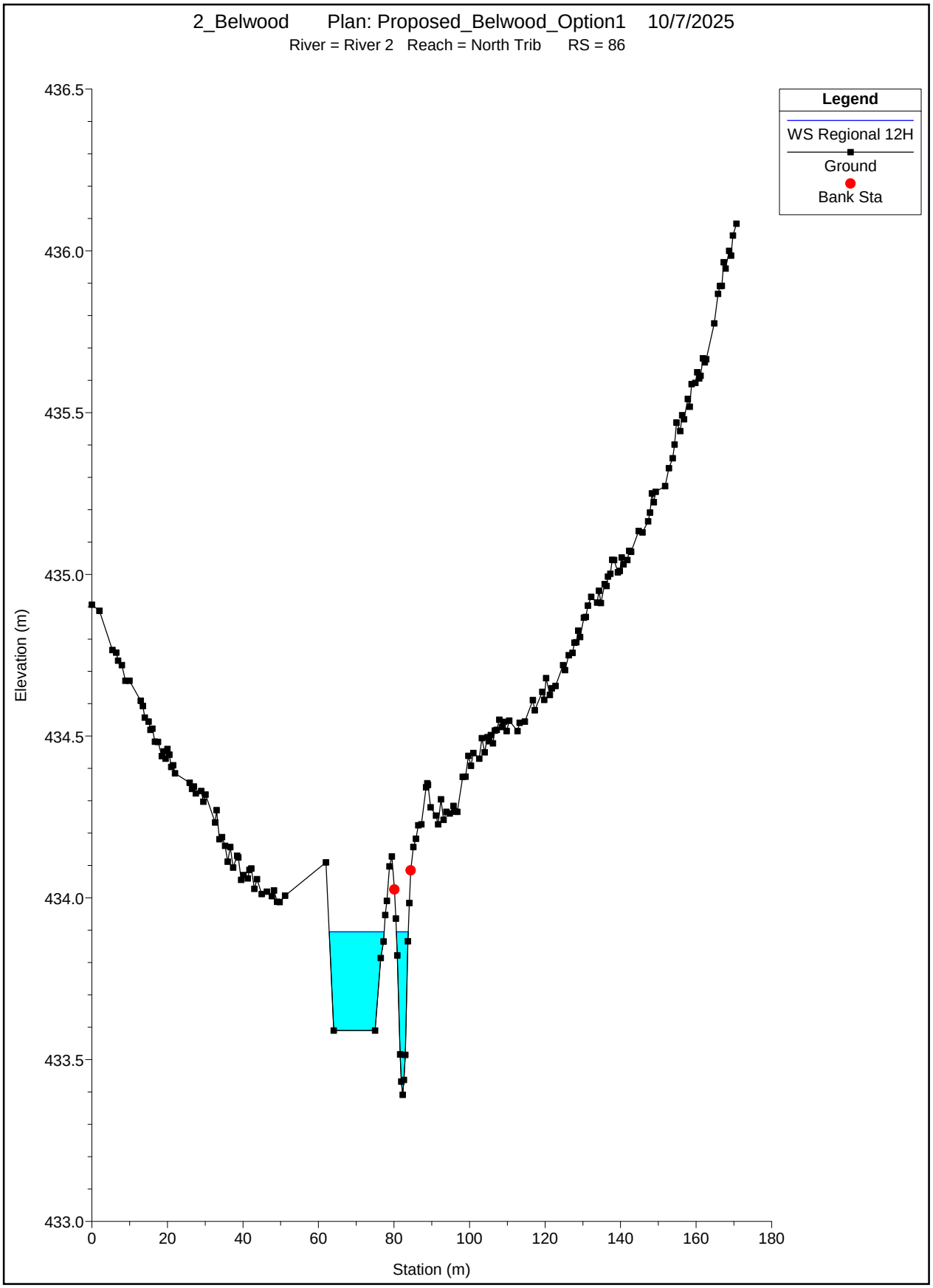

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 156
Legend
WS Regional 12H
Ground
Levee
Bank Sta
438.0
437.5
437.0
436.5
436.0
435.5
Elevation (m)
0
20
40
60
80
100
Station (m)

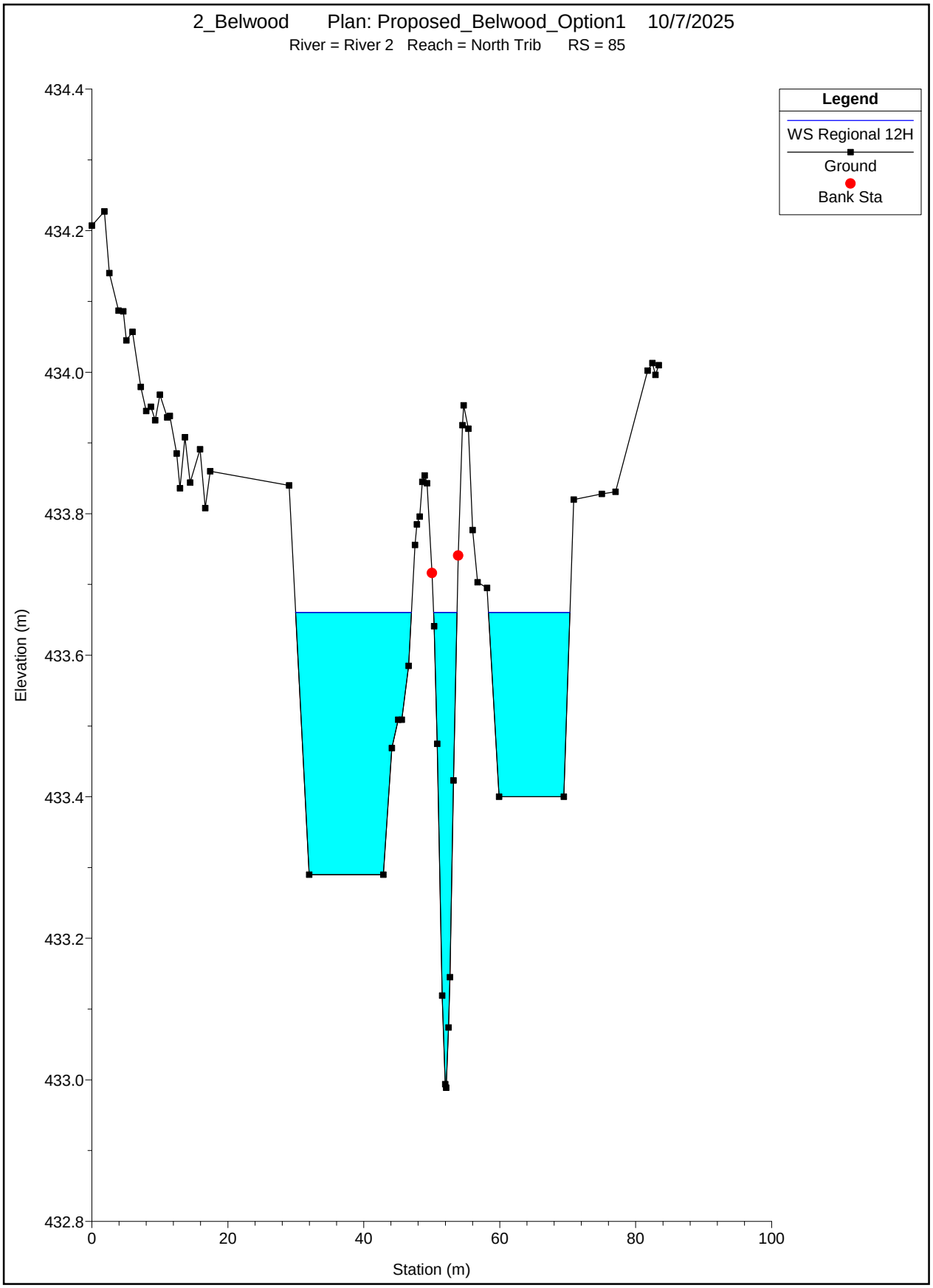

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 129
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
437.4
437.2
437.0
436.8
436.6
436.4
436.2
436.0
435.8
435.6
435.4
0
20
40
60
80
100

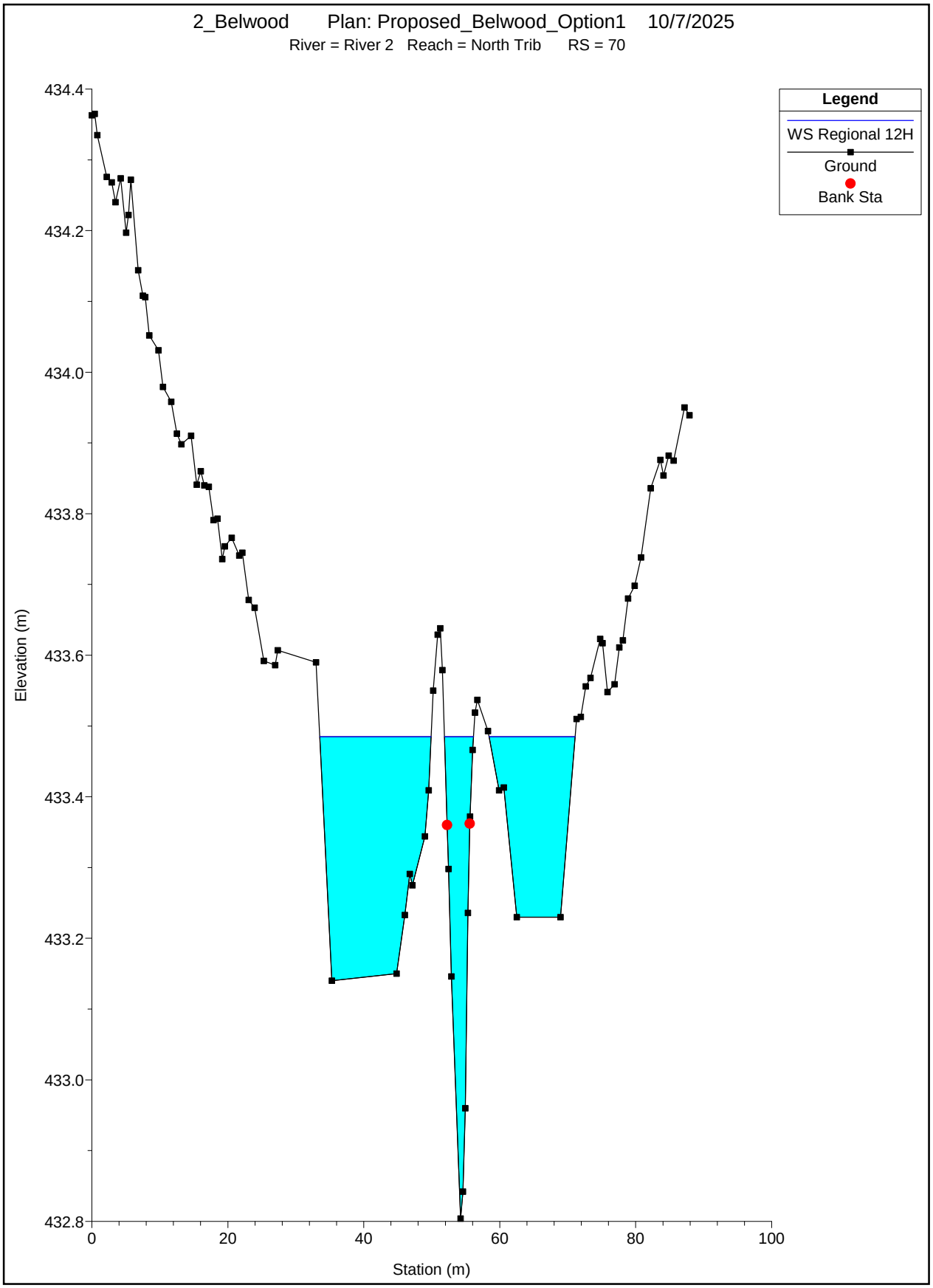

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 103
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
437.5
437.0
436.5
436.0
435.5
435.0
0
20
40
60
80
100
120

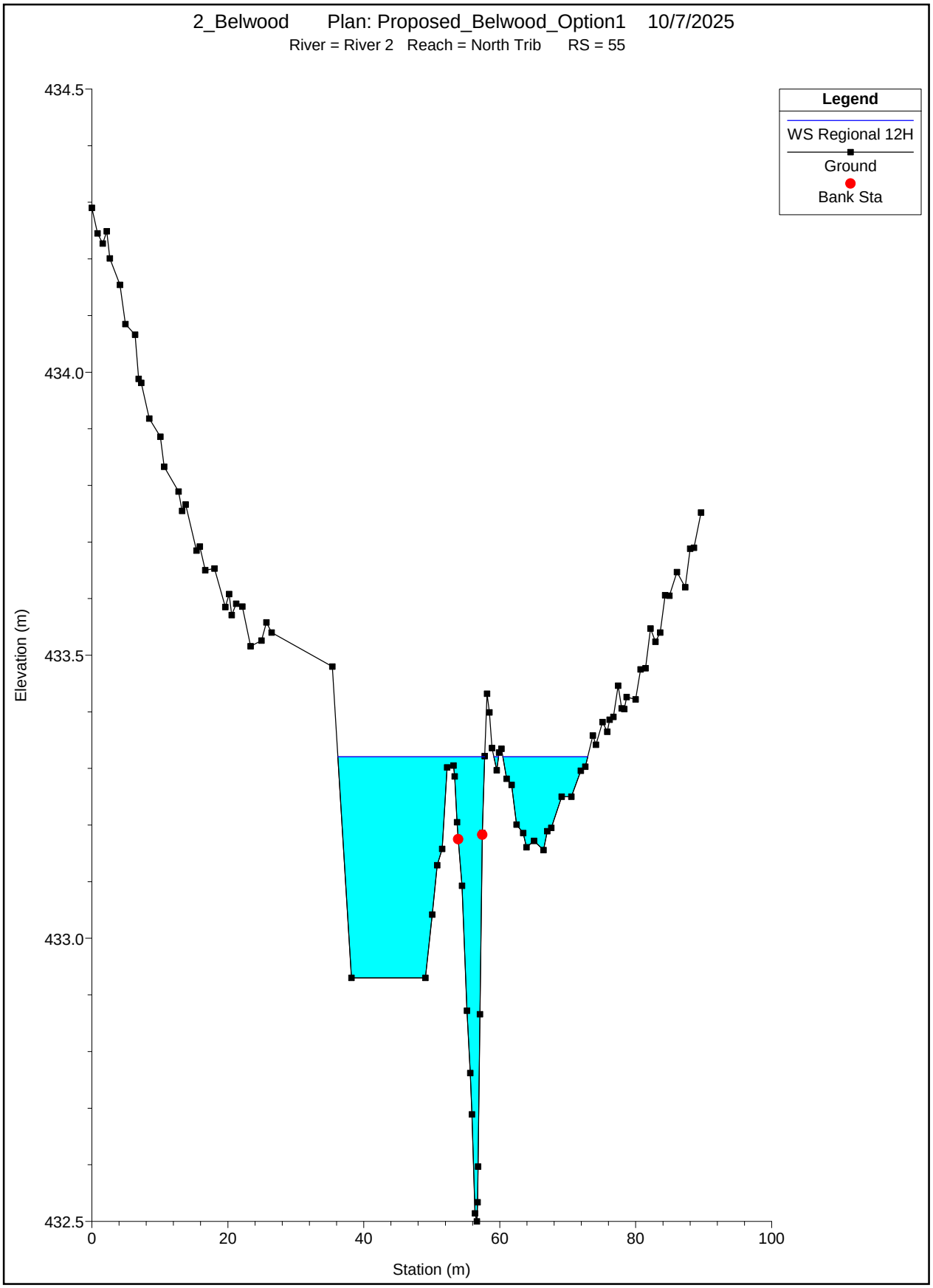

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 88
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
436.4
436.2
436.0
435.8
435.6
435.4
435.2
435.0
434.8
434.6
0
20
40
60
80
100
120

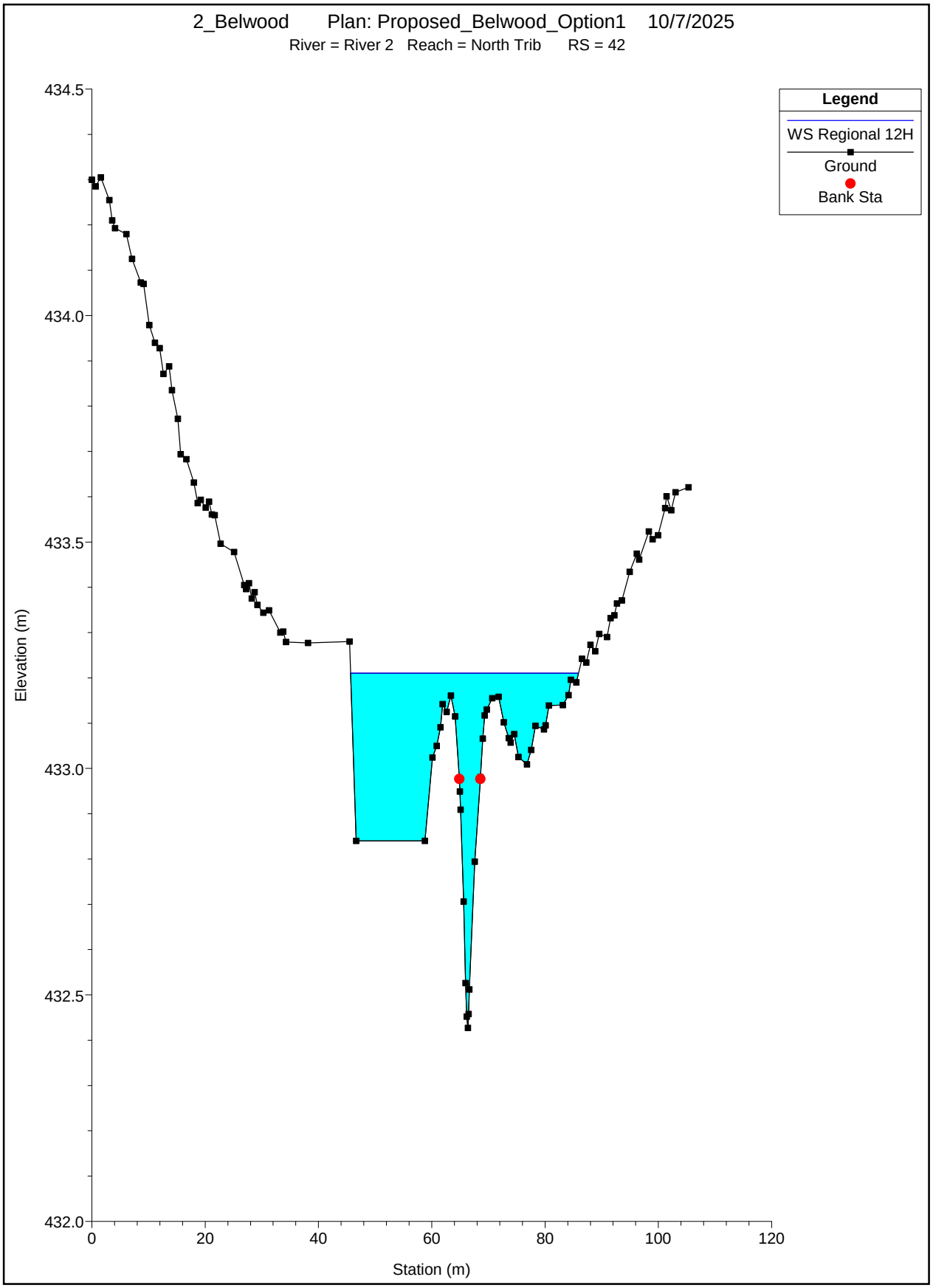

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 87
Legend
WS Regional 12H
Ground
Bank Sta
436.0
435.5
435.0
434.5
434.0
433.5
Elevation (m)
0
20
40
60
80
100
120
140
160
Station (m)

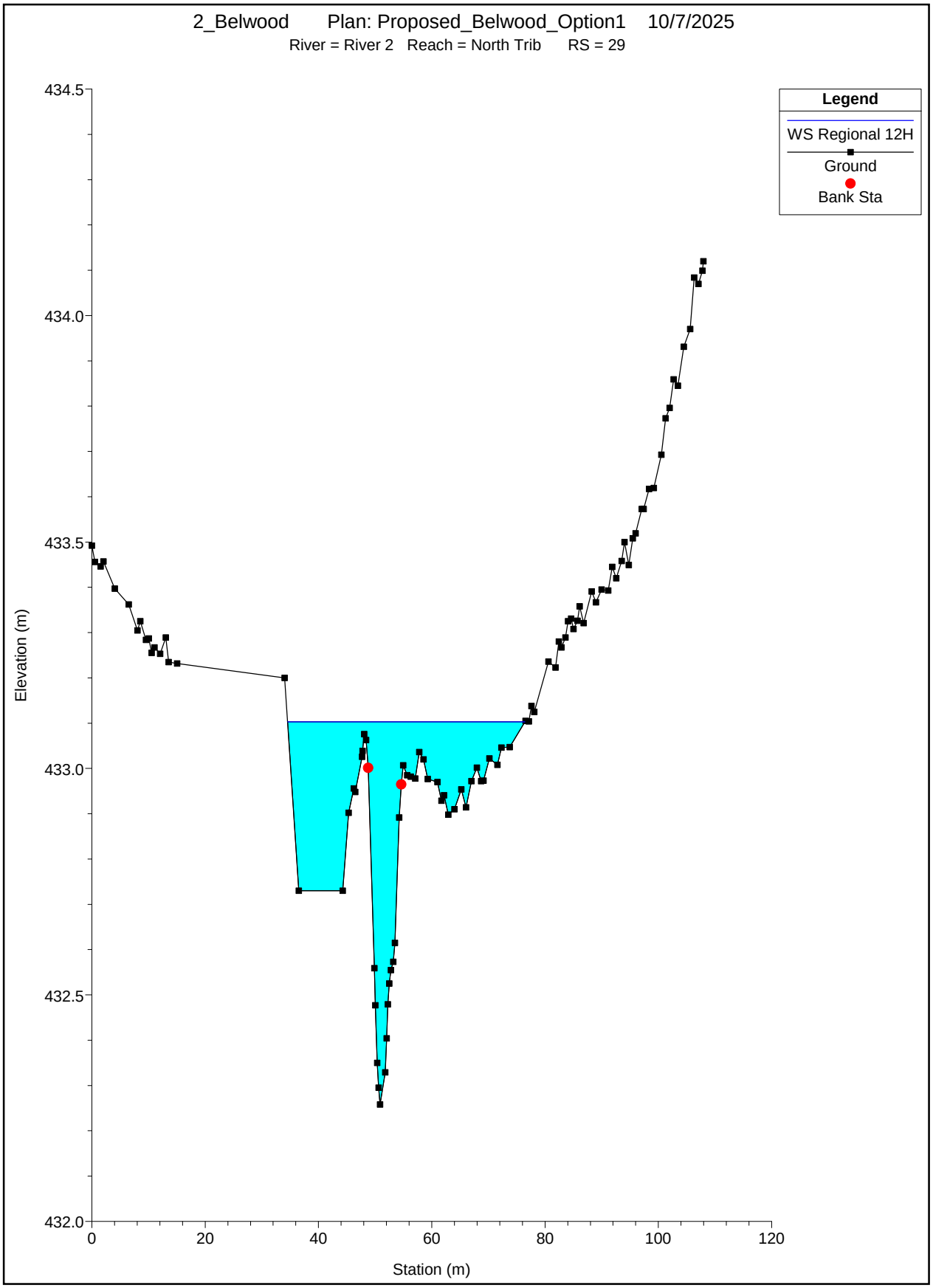

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 86
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
436.5
436.0
435.5
435.0
434.5
434.0
433.5
433.0
0
20
40
60
80
100
120
140
160
180

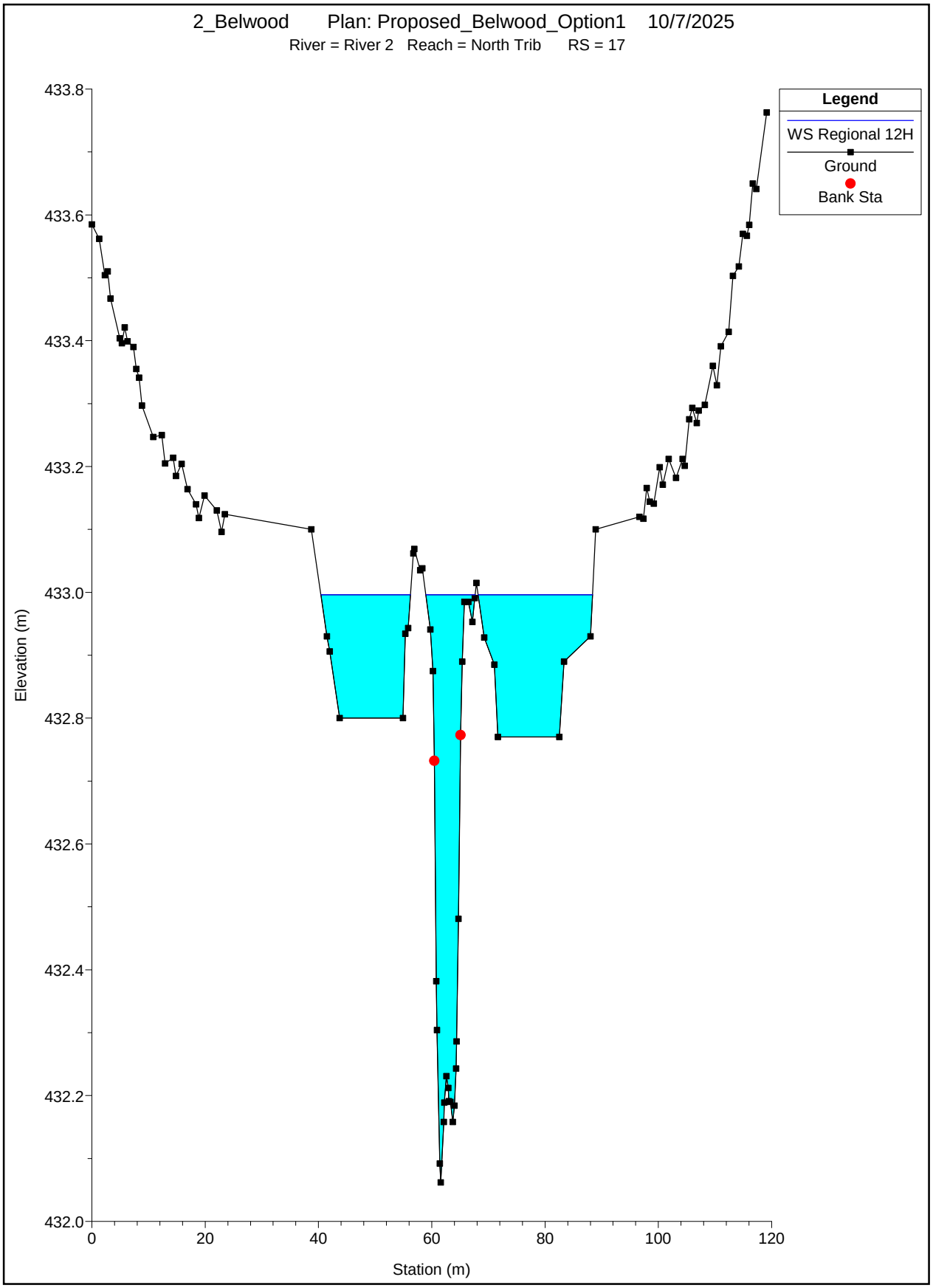

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 85
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
434.4
434.2
434.0
433.8
433.6
433.4
433.2
433.0
432.8
0
20
40
60
80
100

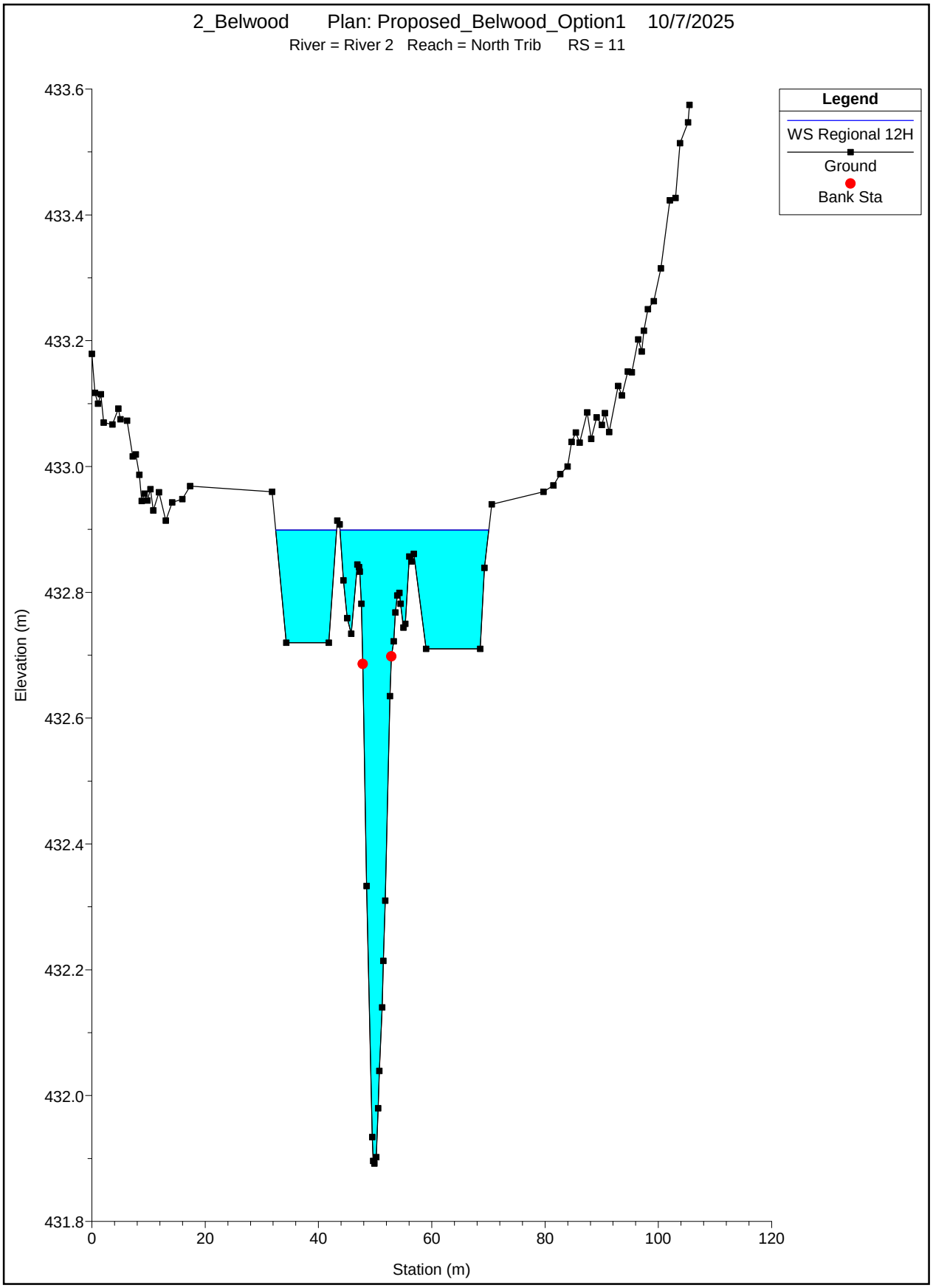

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 70
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
434.4
434.2
434.0
433.8
433.6
433.4
433.2
433.0
432.8
0
20
40
60
80
100

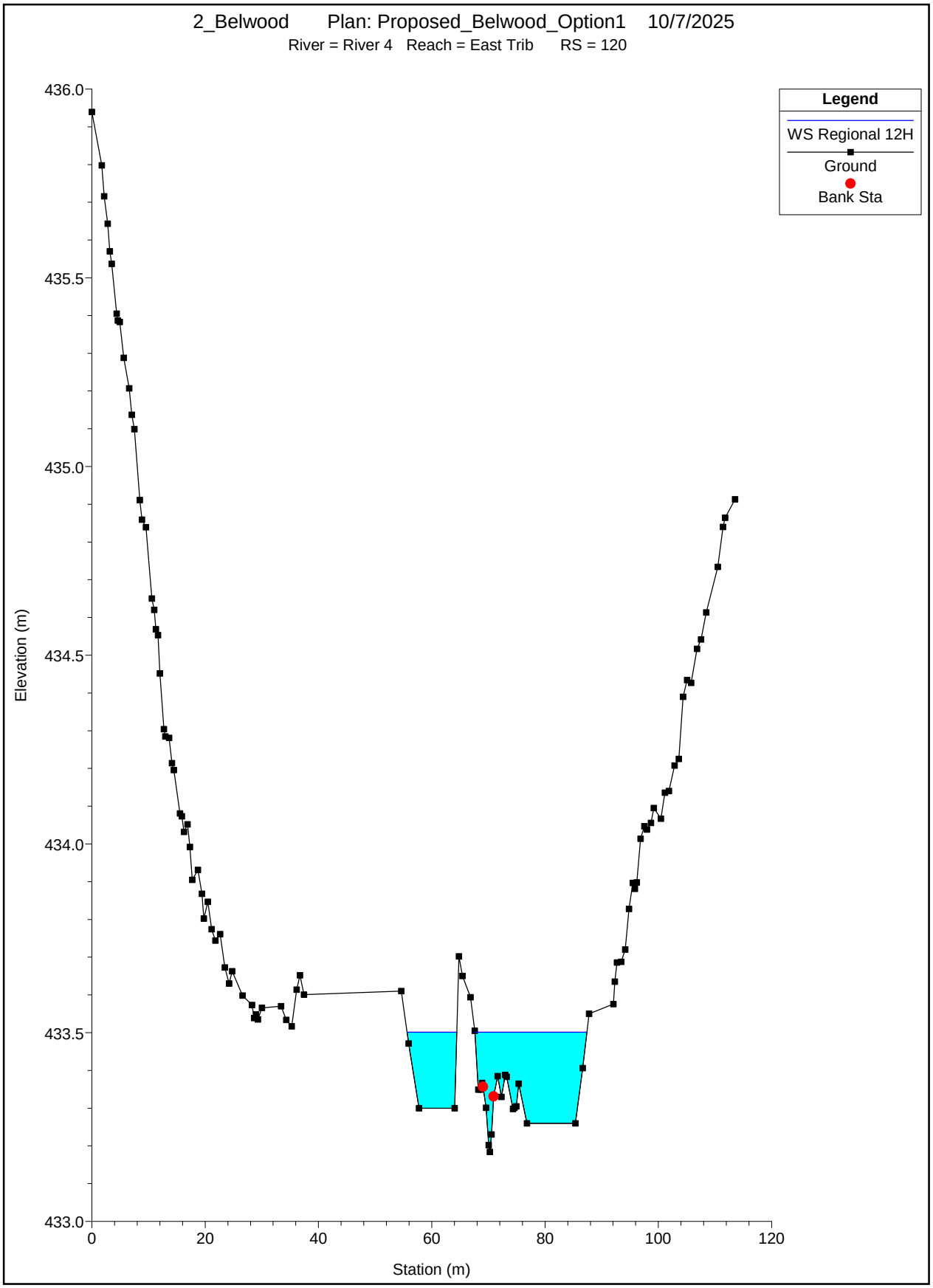

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 55
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
434.5
434.0
433.5
433.0
432.5
0
20
40
60
80
100
Station (m)

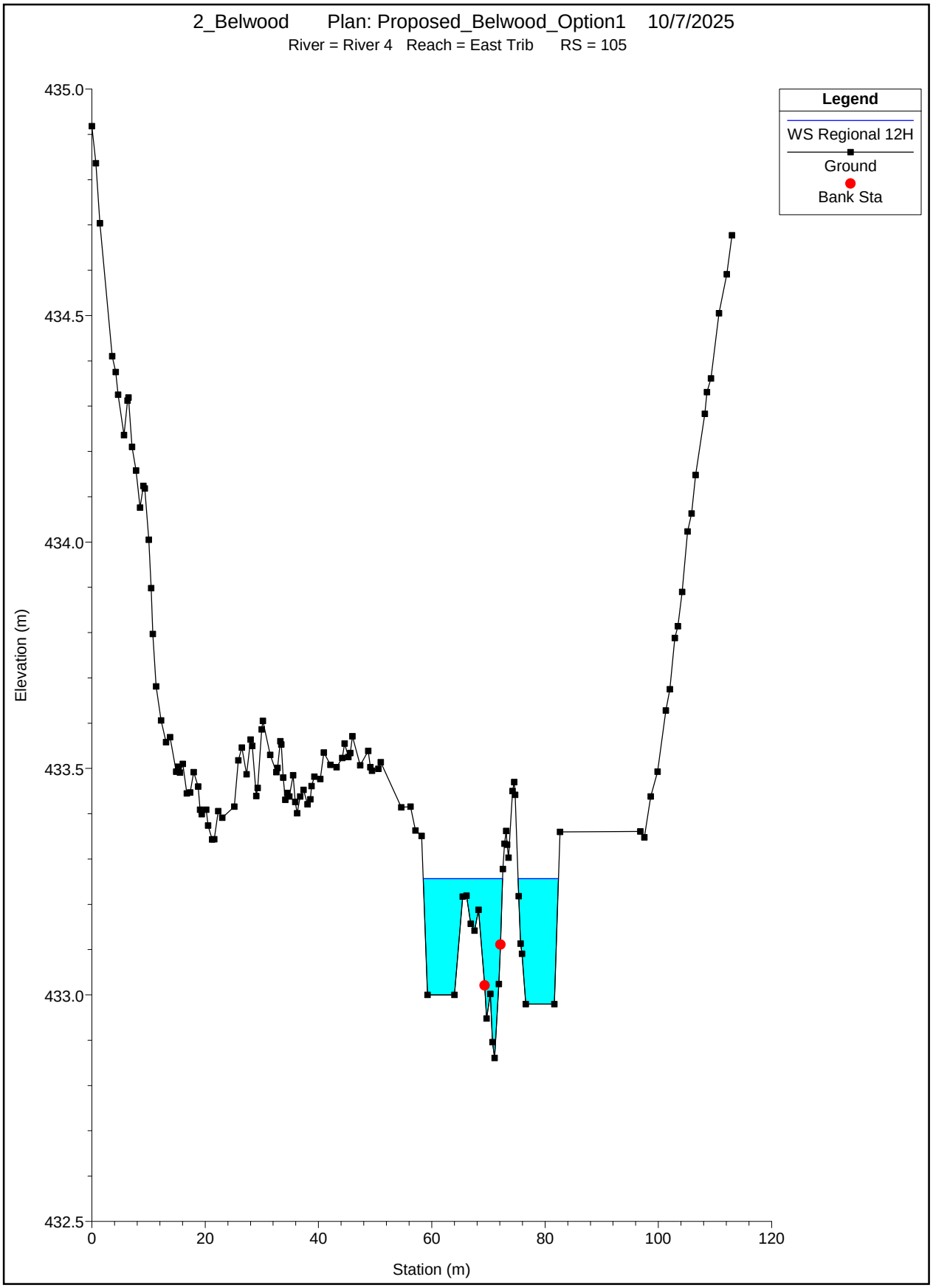

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 42
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
434.5
434.0
433.5
433.0
432.5
432.0
0
20
40
60
80
100
120

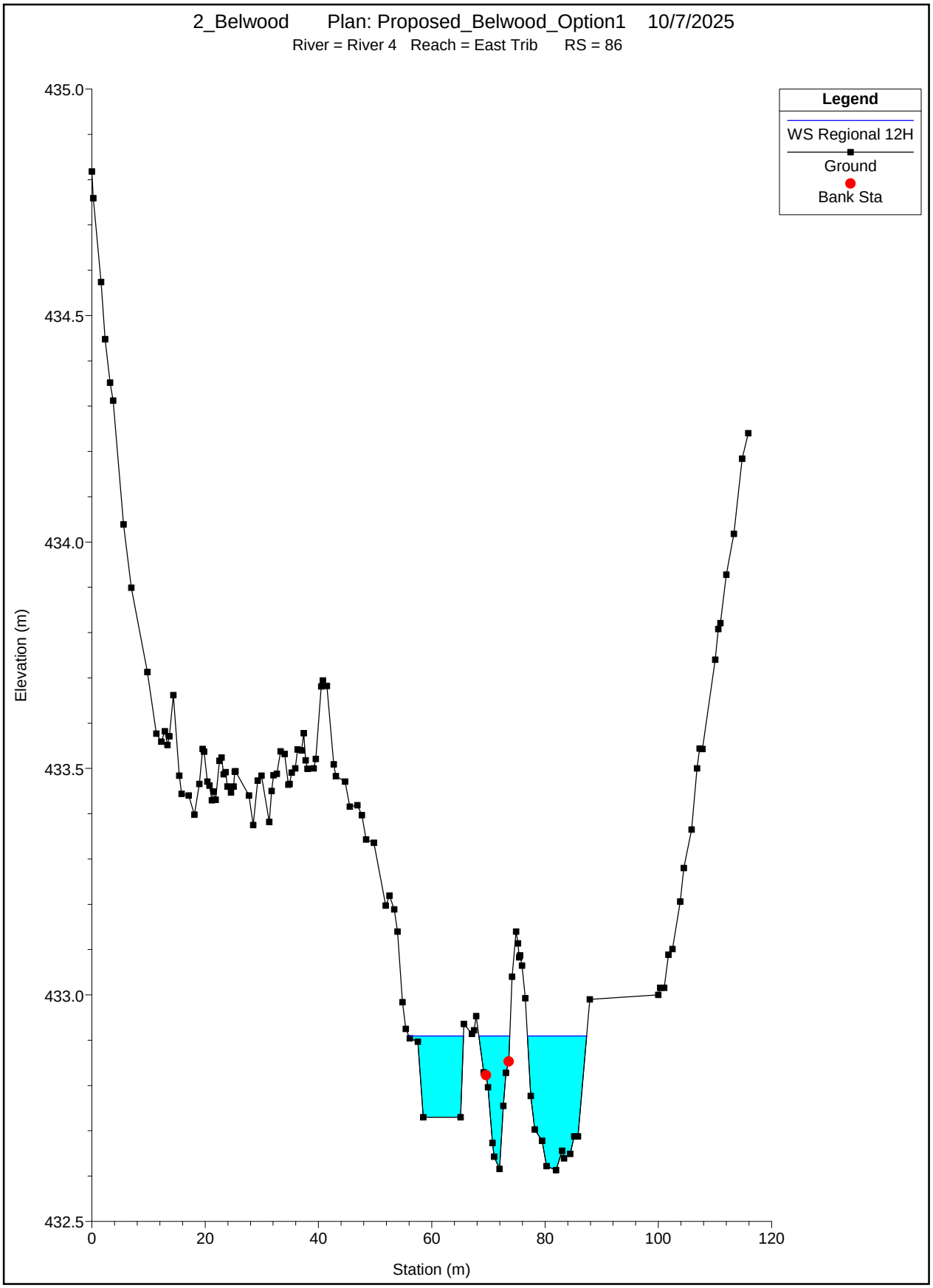

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 29
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
434.5
434.0
433.5
433.0
432.5
432.0
0
20
40
60
80
100
120

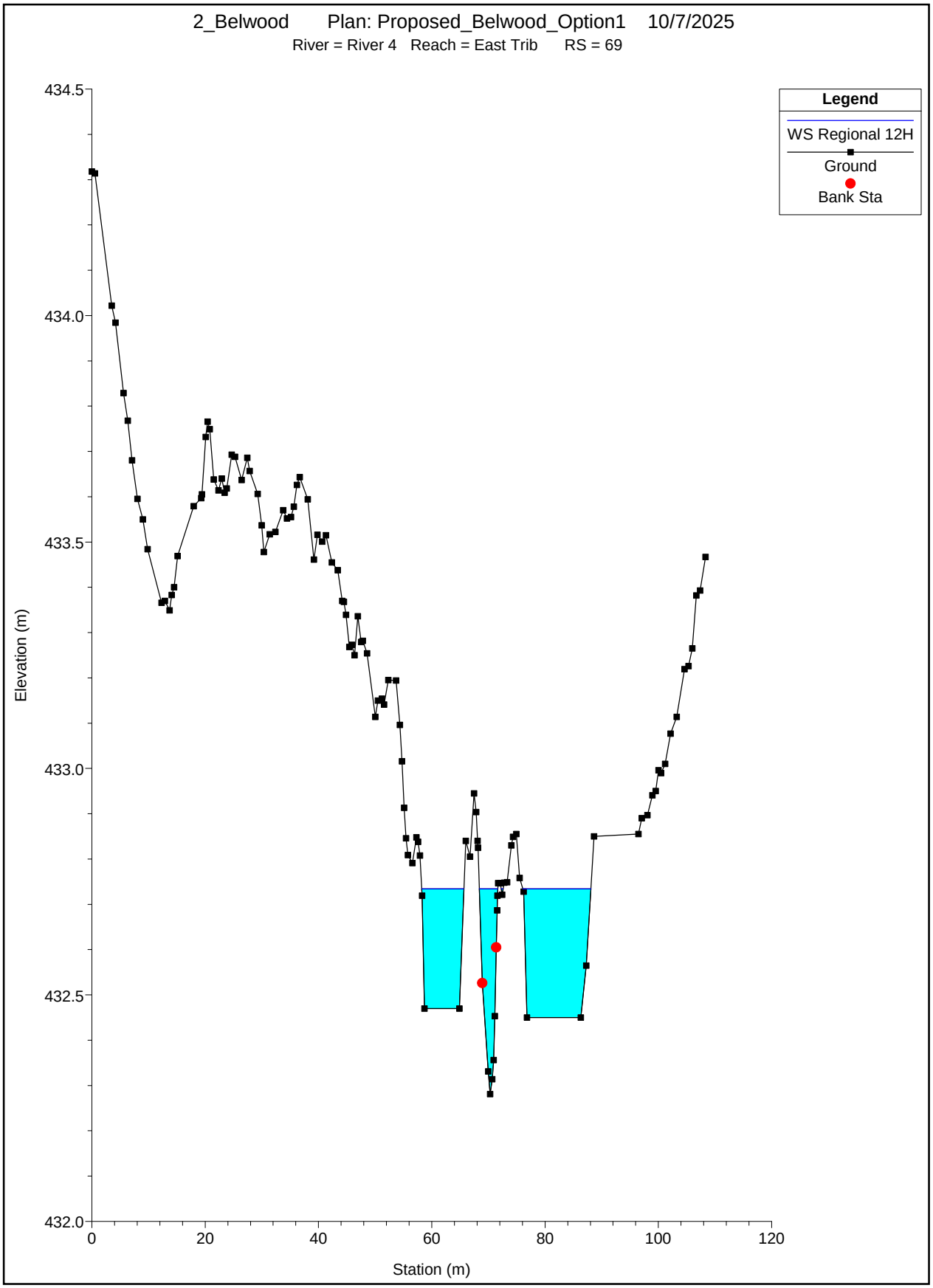

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 17
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
433.8
433.6
433.4
433.2
433.0
432.8
432.6
432.4
432.2
432.0
0
20
40
60
80
100
120

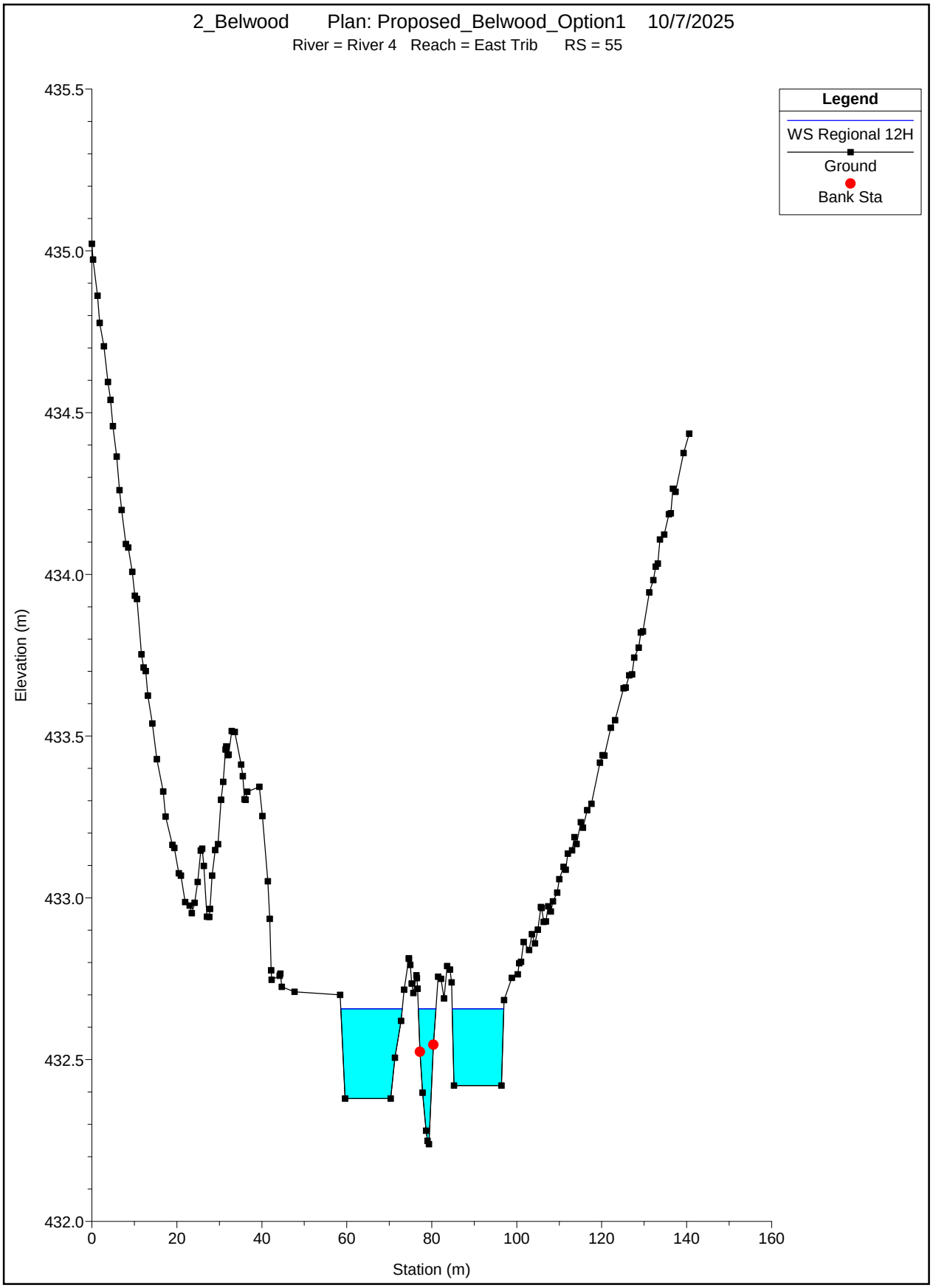

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 2 Reach = North Trib RS = 11
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
433.6
433.4
433.2
433.0
432.8
432.6
432.4
432.2
432.0
431.8
0
20
40
60
80
100
120

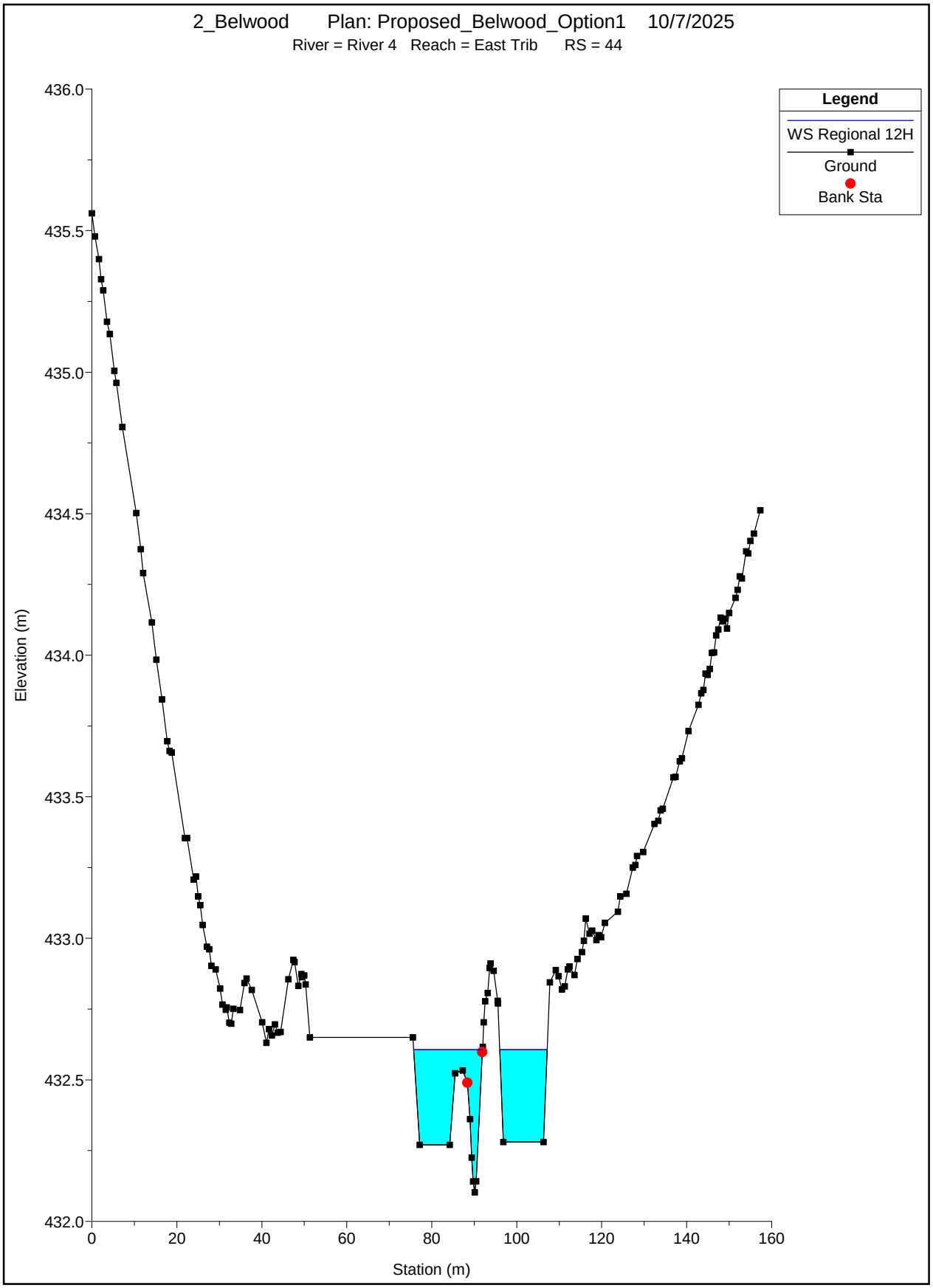

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 4 Reach = East Trib RS = 120
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
436.0
435.5
435.0
434.5
434.0
433.5
433.0
0
20
40
60
80
100
120
Station (m)

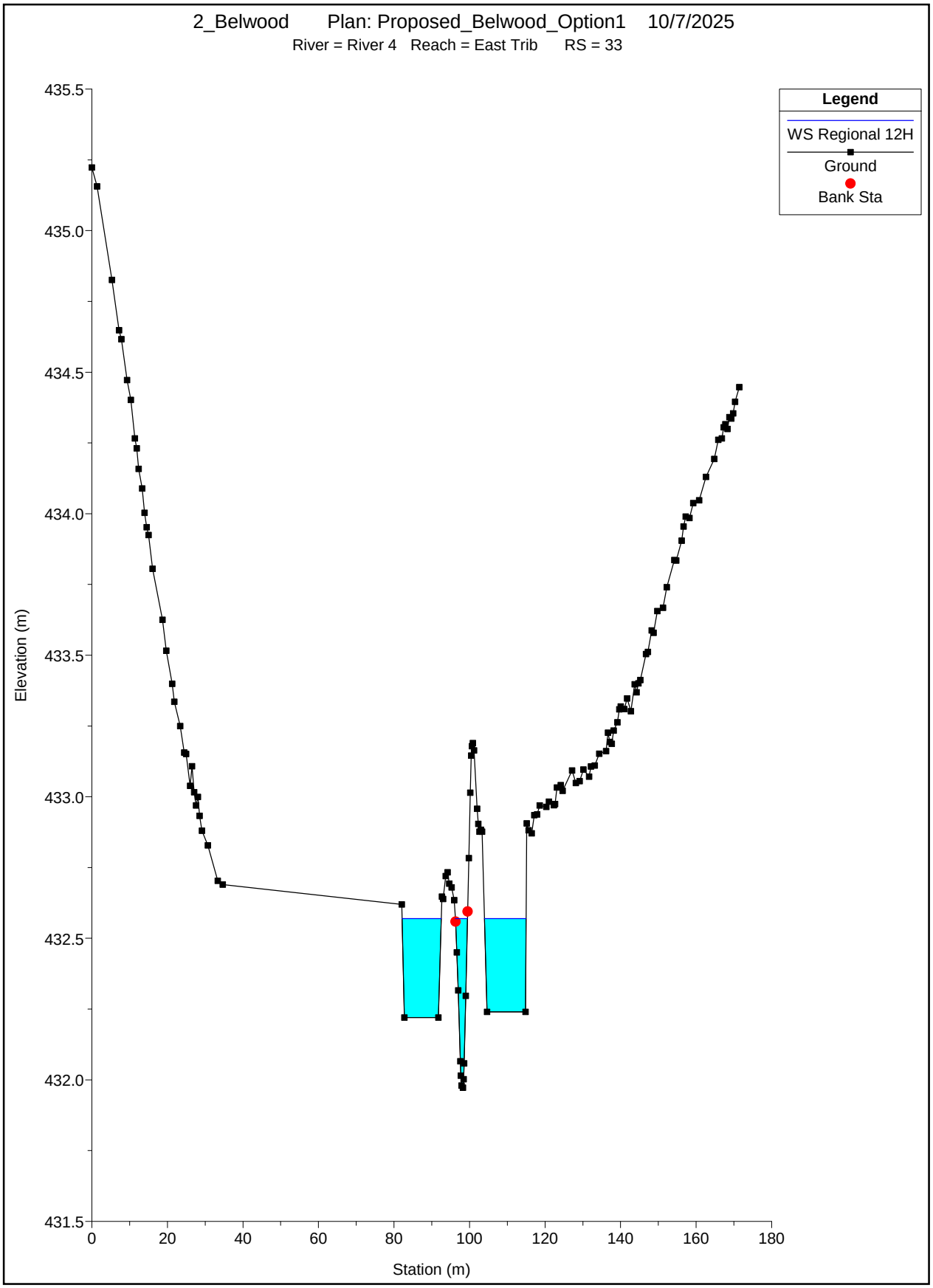

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 4 Reach = East Trib RS = 105
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
435.0
434.5
434.0
433.5
433.0
432.5
0
20
40
60
80
100
120

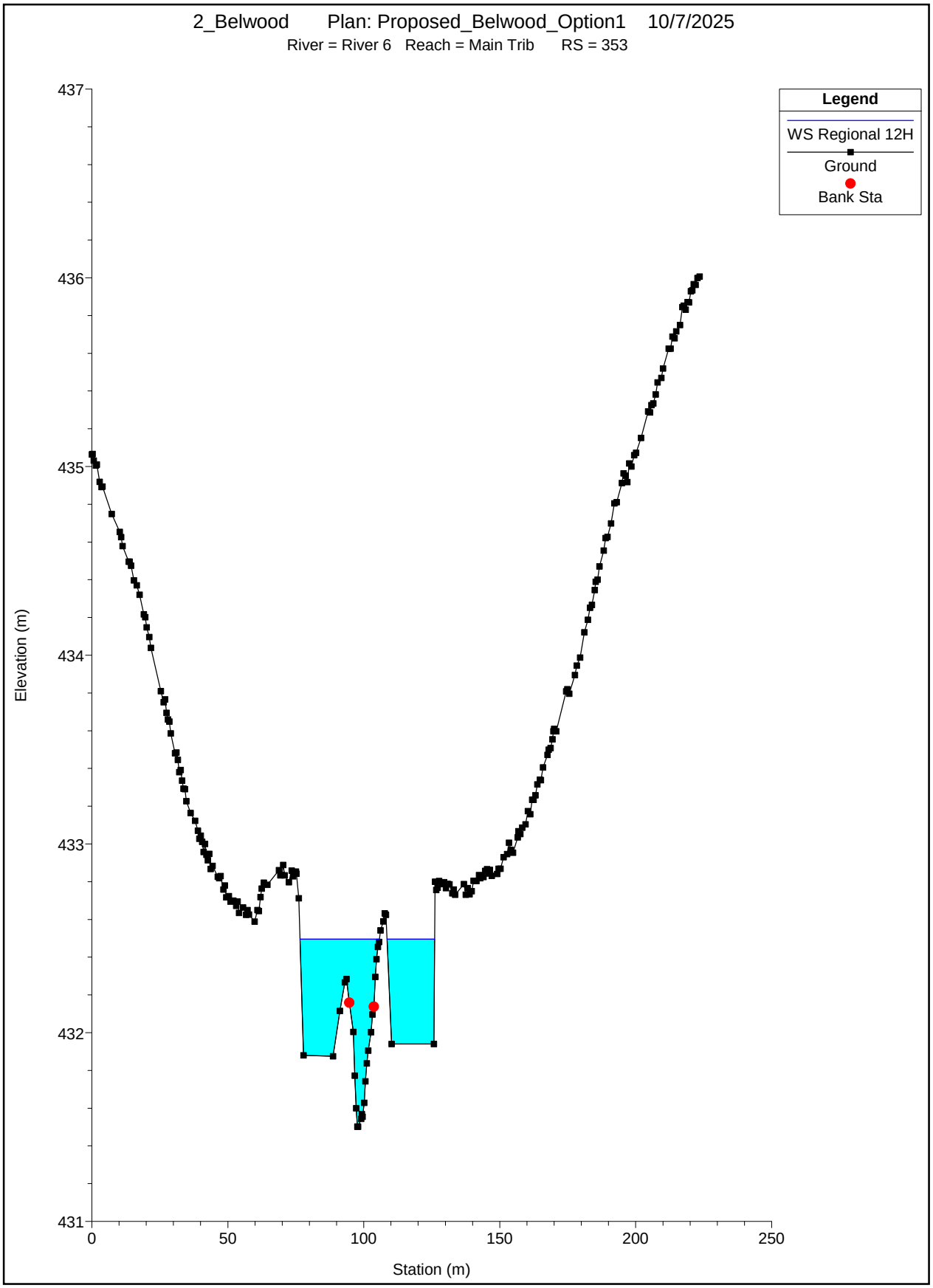

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 4 Reach = East Trib RS = 86
Legend
WS Regional 12H
Ground
Bank Sta
435.0
434.5
434.0
433.5
433.0
432.5
Elevation (m)
0
20
40
60
80
100
120
Station (m)

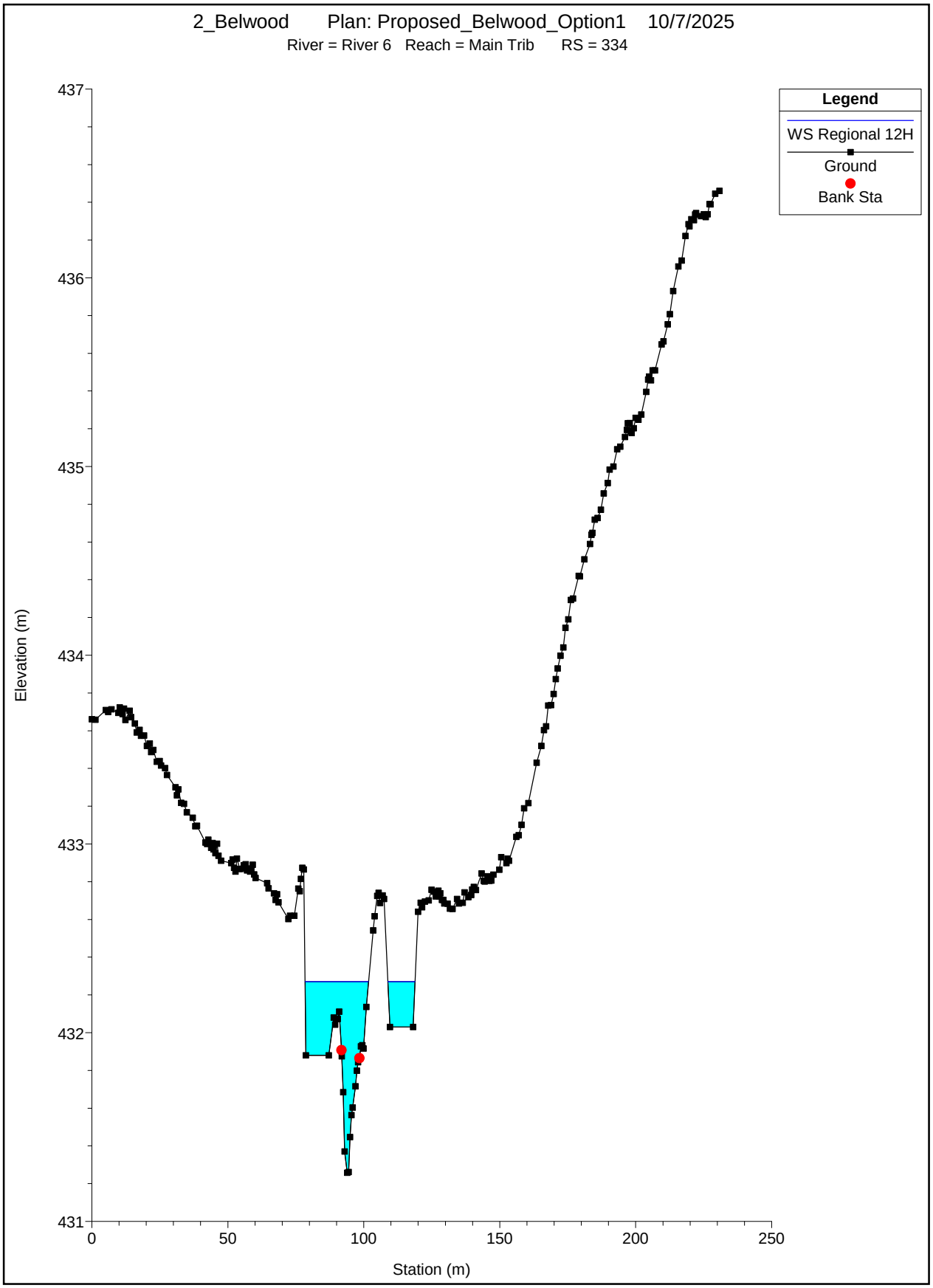

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 4 Reach = East Trib RS = 69
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
434.5
434.0
433.5
433.0
432.5
432.0
0
20
40
60
80
100
120

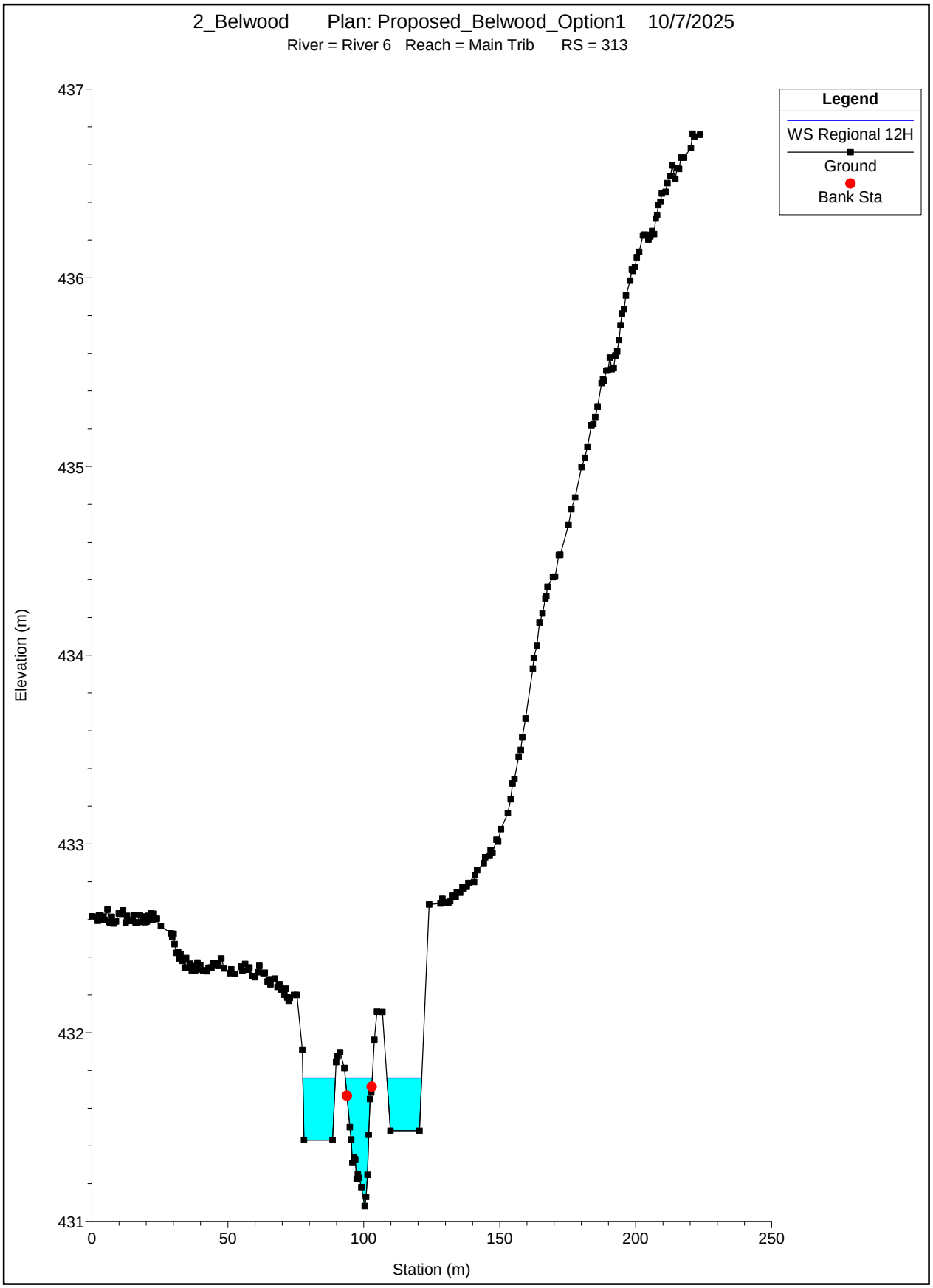

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 4 Reach = East Trib RS = 55
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
435.5
435.0
434.5
434.0
433.5
433.0
432.5
432.0
0
20
40
60
80
100
120
140
160

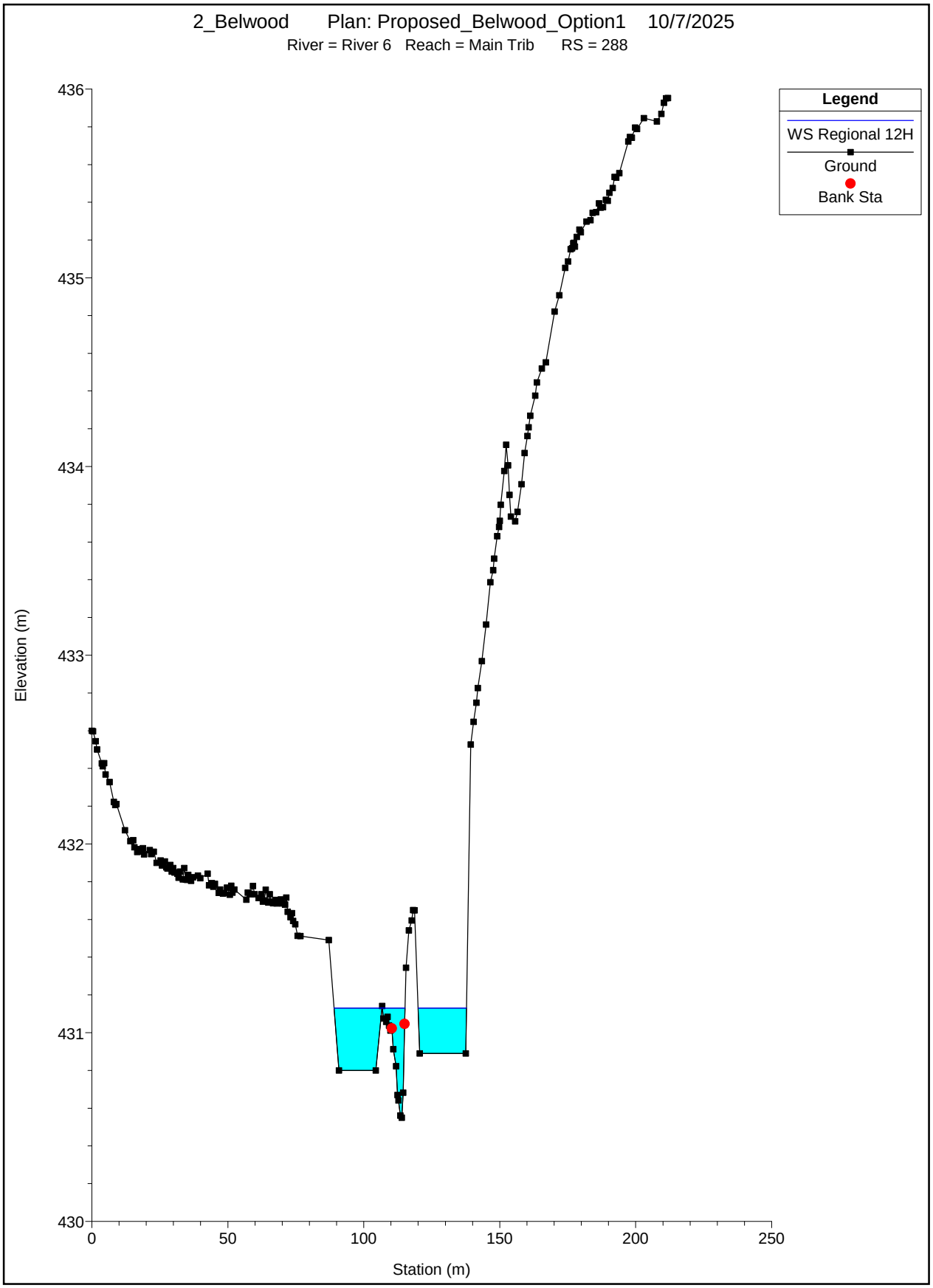

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 4 Reach = East Trib RS = 44
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
436.0
435.5
435.0
434.5
434.0
433.5
433.0
432.5
432.0
0
20
40
60
80
100
120
140
160

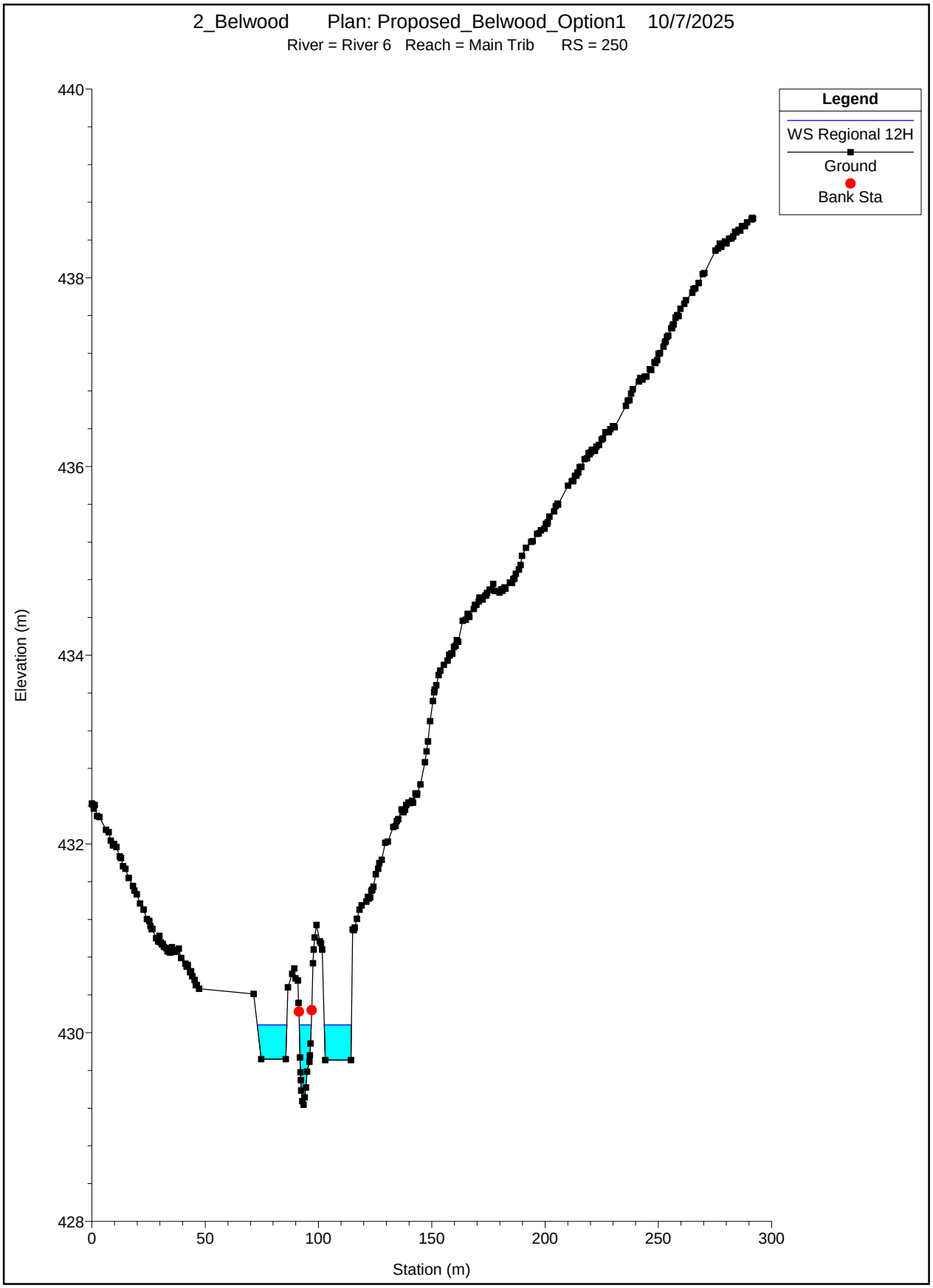

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 4 Reach = East Trib RS = 33
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
435.5
435.0
434.5
434.0
433.5
433.0
432.5
432.0
431.5
0
20
40
60
80
100
120
140
160
180

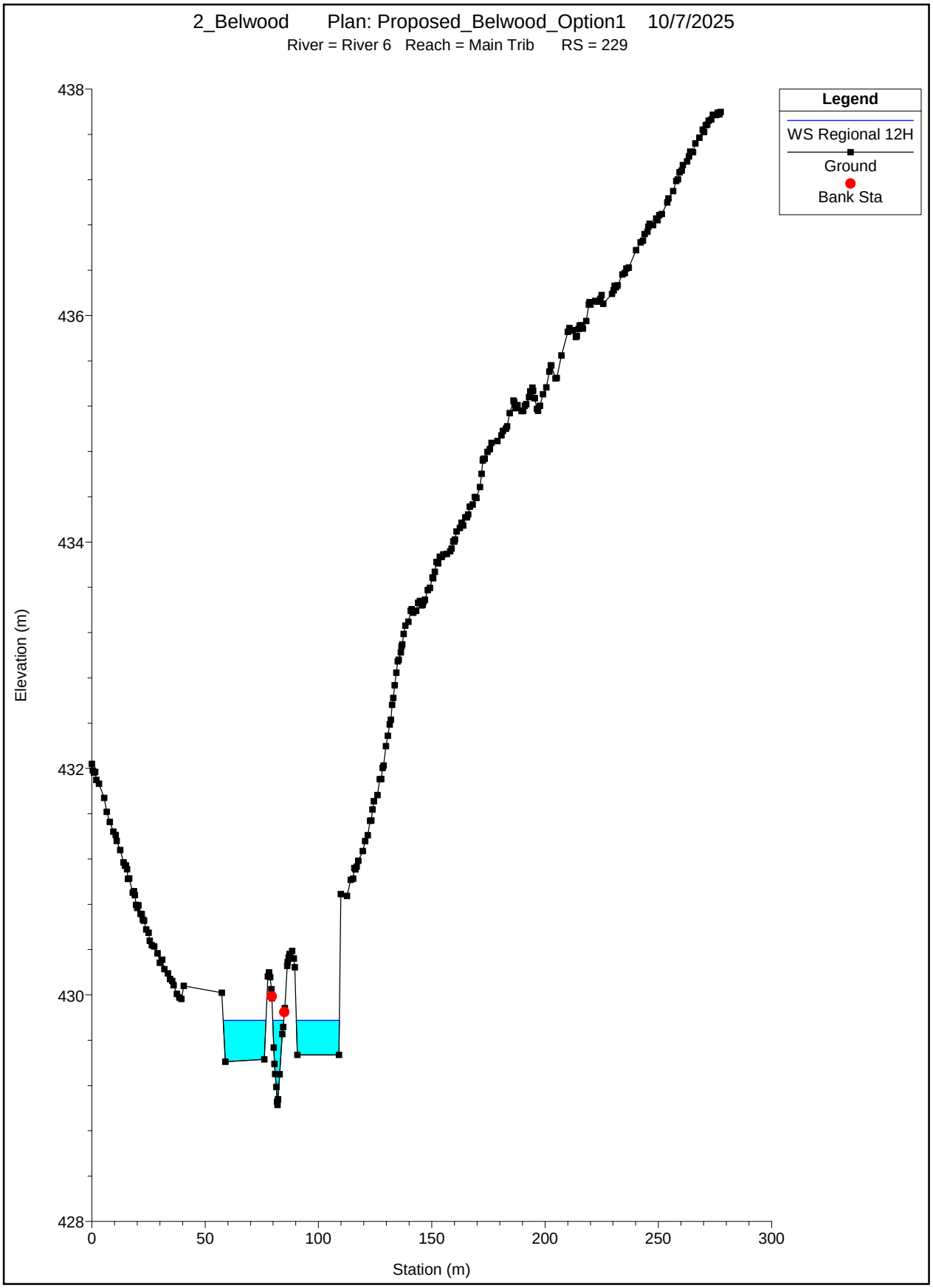

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 6 Reach = Main Trib RS = 353
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
437
436
435
434
433
432
431
0
50
100
150
200
250

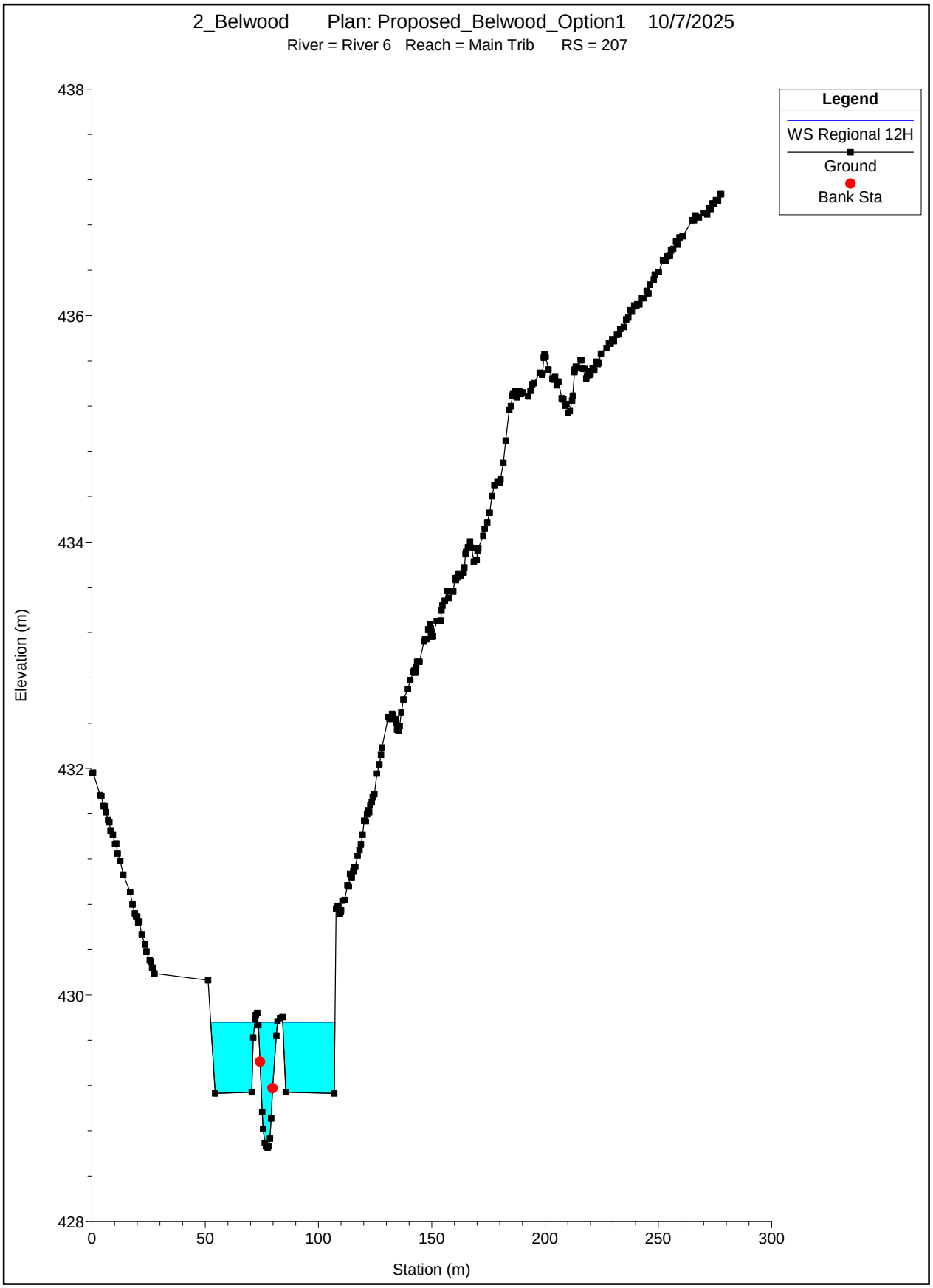

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 6 Reach = Main Trib RS = 334
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
437
436
435
434
433
432
431
0
50
100
150
200
250

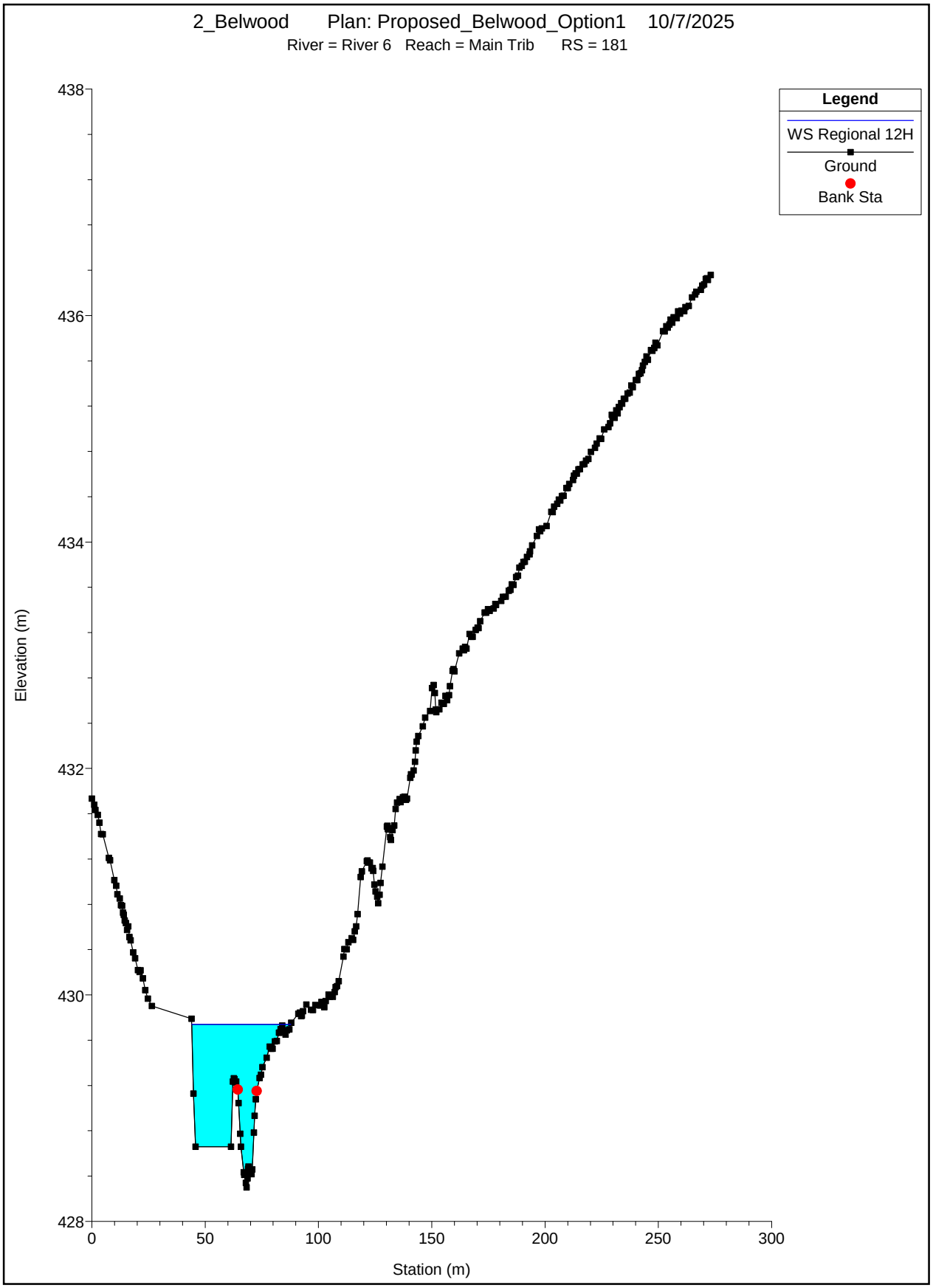

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 6 Reach = Main Trib RS = 313
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
437
436
435
434
433
432
431
0
50
100
150
200
250

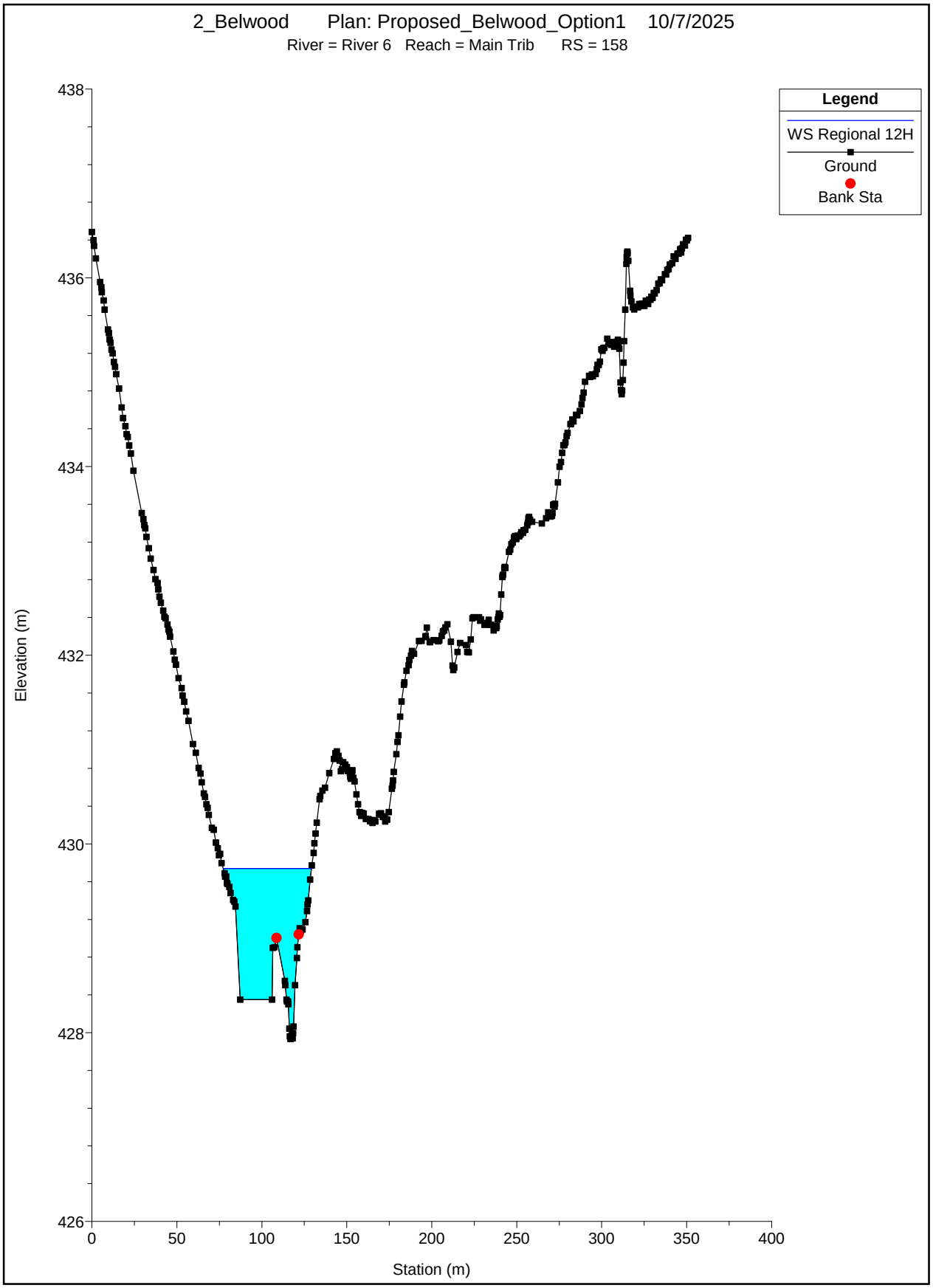

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 6 Reach = Main Trib RS = 288
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
436
435
434
433
432
431
430
0
50
100
150
200
250

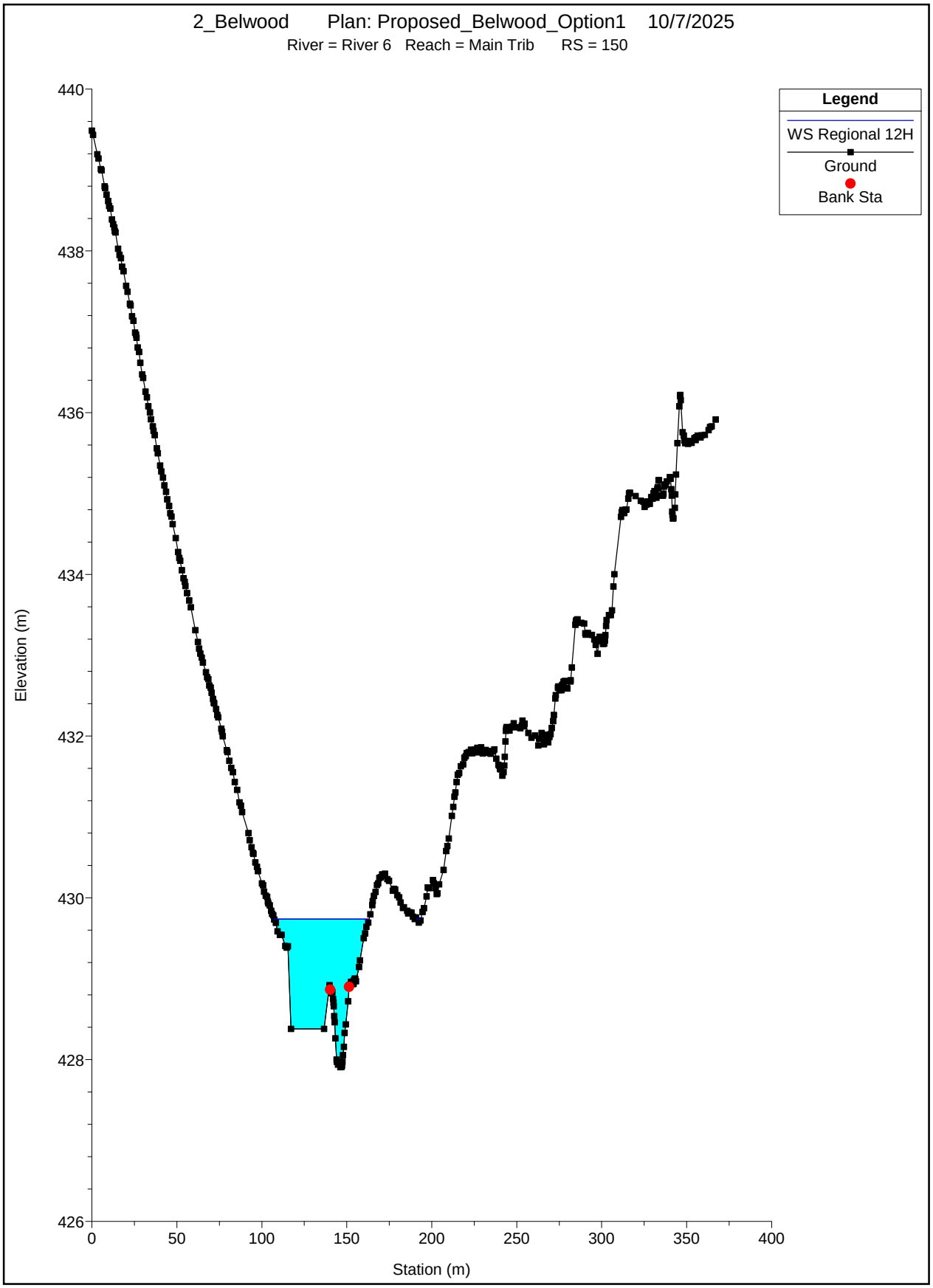

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 6 Reach = Main Trib RS = 250
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
440
438
436
434
432
430
428
0
50
100
150
200
250
300

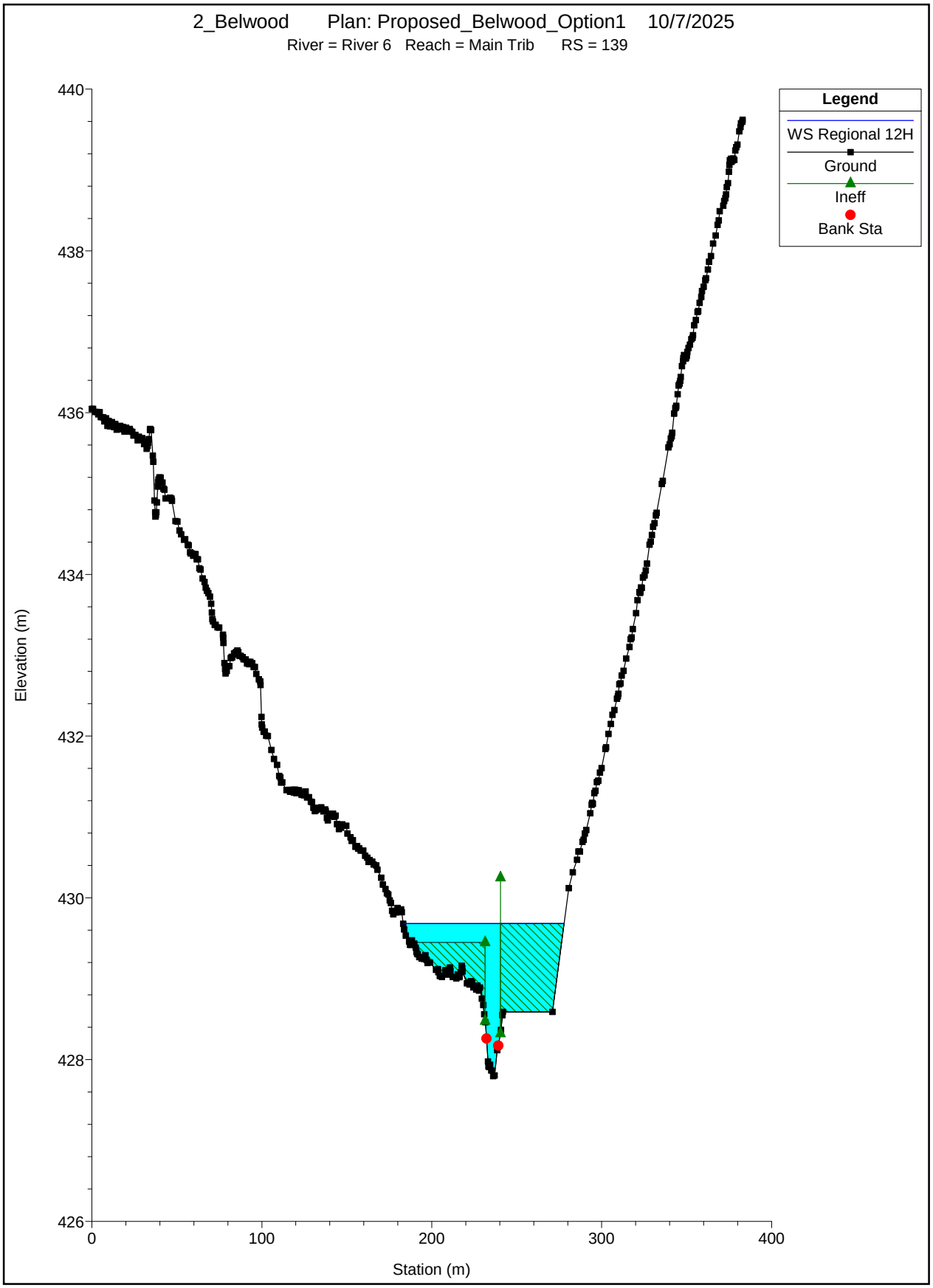

2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 6 Reach = Main Trib RS = 229
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
438
436
434
432
430
428
0
50
100
150
200
250
300


2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 6 Reach = Main Trib RS = 207
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
438
436
434
432
430
428
0
50
100
150
200
250
300


2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 6 Reach = Main Trib RS = 181
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
438
436
434
432
430
428
0
50
100
150
200
250
300


2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 6 Reach = Main Trib RS = 158
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
438
436
434
432
430
428
426
0
50
100
150
200
250
300
350
400


2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 6 Reach = Main Trib RS = 150
Legend
WS Regional 12H
Ground
Bank Sta
Elevation (m)
Station (m)
440
438
436
434
432
430
428
426
0
50
100
150
200
250
300
350
400


2_Belwood Plan: Proposed_Belwood_Option1 10/7/2025
River = River 6 Reach = Main Trib RS = 139
Legend
WS Regional 12H
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
440
438
436
434
432
430
428
426
0
100
200
300
400