
**STORMWATER MANAGEMENT REPORT FOR
ENVIRONMENTAL ASSESSMENT (EA) AND
PRELIMINARY DESIGN FOR DRAINAGE
IMPROVEMENTS OF HIGHWAY 50 FROM MAYFIELD
ROAD TO HEALEY ROAD**

Draft

November 15, 2021

Prepared for:

STORMWATER MANAGEMENT REPORT FOR ENVIRONMENTAL ASSESSMENT (EA) AND PRELIMINARY DESIGN FOR DRAINAGE IMPROVEMENTS OF HIGHWAY 50 FROM MAYFIELD ROAD TO HEALEY ROAD

Draft

Region of Peel



This document is protected by copyright and was prepared by R.V. Anderson Associates Limited for the account of the Region of Peel. It shall not be copied without permission. The material in it reflects our best judgment in light of the information available to R.V. Anderson Associates Limited at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. R.V. Anderson Associates Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

RVA 194615

November 15, 2021

**Regional Road 50 / Mayfield Road / Healey Road
Storm Drainage Design Brief**

TABLE OF CONTENTS

1.0	INTRODUCTION	1
1.1	Project Description	1
1.2	Project Background	1
1.3	Purpose.....	3
2.0	EXISTING SITE CONDITIONS CHARACTERIZATION.....	5
2.1	Tributary Areas, Outlets, and Drainage Patterns	5
2.2	Condition of Receiving Watercourses	5
2.3	Watercourse and Drainage Crossings	5
2.4	Soil and Groundwater Conditions	8
2.5	Significant Natural Features	8
3.0	STORMWATER OBJECTIVES	10
3.1	Water Quantity and Flood Control	10
3.2	Water Quality, Erosion, and Sediment Control.....	10
3.3	Water Balance.....	10
4.0	MODEL BUILD PROCESS – HYDRAULIC MODELLING	12
4.1	Design Storm	12
4.2	Existing Condition Scenario.....	12
4.3	EA Recommendations / Proposed Condition Scenario	15
	4.3.1 Recommended Sidewalk on East Side of RR50 (North of RR50 and George Bolton Parkway)	16
	4.3.2 Culvert Crossing at RR50 and George Bolton Parkway	17
	4.3.3 Flooding Complaints at # 12207 RR50.....	19
	4.3.4 Proposed Culvert Upgrades.....	21
5.0	MODEL RESULTS	22
5.1	Existing Condition Scenario Results	22
5.2	EA Recommended / Proposed Condition Scenario Results.....	24
6.0	SWM AND LID FEATURES PLAN AND DESIGN	26
6.1	Evaluation and Selection of Candidate Features	26
7.0	DRAINAGE PLAN AND DESIGN	30
7.1	Minor System Design	30
7.2	Major System Design	30

7.3	Monitoring and Maintenance	30
7.3.1	Oil / Grit Separator (OGS).....	30
7.3.2	Catchbasin Capture Devices / Catchbasin Shields.....	31
7.3.3	Bioretention Facilities: Bioswales and Bioswale Box	31
7.3.4	Infiltration Trenches (Stormtech)	32
8.0	FLOW MONITORING AND RAIN GAUGE DATA ANALYSIS	33
9.0	RECOMMENDATIONS, APPROVAL AND REVIEW REQUIREMENTS	40

LIST OF FIGURES

Figure 1.1:	Study Area.....	2
Figure 4.1:	External Drainage Area That Contributes into Study Area	13
Figure 4.2:	Existing Drainage Configuration at George Bolton Parkway Intersection	15
Figure 4.3:	External Drainage Area & Proposed Storm Sewer System (North of RR50 & George Bolton intersection).....	17
Figure 4.4:	Creek Bypass Enhancements at George Bolton and RR50	18
Figure 4.5:	Proposed Maintenance at online wet pond	19
Figure 4.6:	Robinson Creek, Flood Property and Creek Bypass Channel	20
Figure 5.1:	George Bolton Parkway and RR50 Intersection Culverts	22
Figure 5.2:	Culverts on RR50 and Parr Boulevard Showing Hydraulic Restrictions Under 100 - year flows.....	24
Figure 8.1:	Measured Rainfall and Flow Data on July 6 th – 8 th	35
Figure 8.2:	Measured Rainfall and Flow Data on October 3 rd	36
Figure 8.3:	12-Hour Rainfall Data and Measured Flow Data During September 22nd, 2021.....	38

LIST OF TABLES

Table 2.1:	Existing Roadway Culverts List
Table 4.1:	Proposed Culvert Sizes and Shapes
Table 5.1:	Creek Flow Comparison (at back of # 12207 RR50)
Table 6.1:	LID Practice Analysis

APPENDICES

Appendix A	– Background Information
Appendix B	– Hydraulic Modelling Outputs
Appendix C	– OGS and Catchbasin Shield Owner’s Manual

1.0 Introduction

1.1 Project Description

R.V. Anderson Associates Limited was retained by the Region of Peel (the Region) to undertake a Schedule “B” Municipal Class Environmental Assessment (EA) and preliminary design to assess low impact development (LID) and drainage infrastructure improvements required for the roadside drainage ditches and culvert crossings on Regional Road 50 (RR50) from Mayfield Road to Healey Road. The Region has identified several driveway culverts that are failing along RR50 from Mayfield Road to Healey Road (approximately 2.5 km) within the Town of Caledon.

As part of the Class EA study, preliminary recommendations to improve pedestrian and cyclist amenities (i.e. multi-use path (MUP) along the west side of Regional Road 50 from Mayfield Road to Healey Road and a new sidewalk between #12599 Regional Road (Highway) 50 and George Bolton Parkway have also been included to support the Region’s ‘Sustainable Transportation Strategy’ (STS).

RR50 and Mayfield Road are located at the northeast corner of the City of Brampton border. RR50 / Albion - Vaughan Road is the regional border division between the Region to the west and the Regional Municipality of York (York Region) to the east. It is also the municipal border division between the City of Brampton to the west and the City of Vaughan to the east. Mayfield Road is the municipal border division between the City of Brampton and the Town of Caledon.

This Stormwater Management (SWM) report was undertaken in support of the development of the alternatives and recommendations as identified through the Class EA study and outlines the proposed storm drainage system consisting of storm sewers, infiltration facilities, ditch inlets, oil grit separators, ditches, and culvert replacements for RR50 from Mayfield Road to Healey Road.

1.2 Project Background

The subject study area is shown below in Figure 1.1 and is within the Humber River Watershed (Main Humber River primary subwatershed). It is also located within the Rainbow Creek subwatershed of the Humber River watershed. This watershed is managed by the Toronto and Region Conservation Authority (TRCA). The Rainbow Creek subwatershed is drained by two watercourses –

Rainbow Creek and Robinson Creek. A Rainbow Creek tributary parallels the study area and Robinson Creek crosses RR50 at George Bolton Parkway.

In late 1996, the driveway culverts identified by the Region were transferred from the Ministry of Transportation (MTO) in “as is” condition. The Region is in the process of improving the existing SWM / drainage along RR50 to cater to existing and future growth around the study area. Condition assessments were completed by the Region for seventeen subject culverts in 2017. Furthermore, the EA preferred alternative includes building a multi - use path (MUP) along the west side of RR50 and sidewalk on the east side of the corridor north of George Bolton, to satisfy requirements for Active Transportation (AT).

The existing subcatchments on RR50 were delineated based on the information provided by TRCA, localized survey information, and from previous studies as provided by the Region and the Town of Caledon. Current land uses in the study catchments are primarily industrial paved areas.

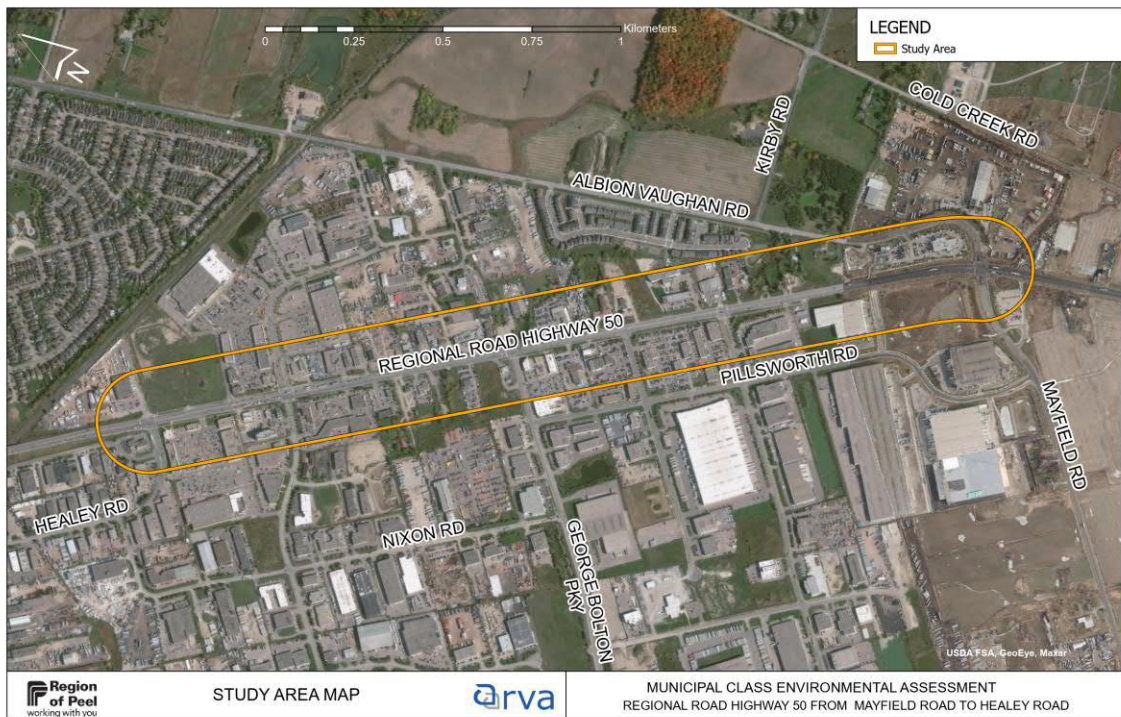


Figure 1.1: Study Area

Potential permits and approvals necessary to complete the undertaking include TRCA, Ministry of Natural Resources (MNR), Ministry of Tourism, Culture, and Sport (MTCS), surrounding regional and municipal approvals, and utility approvals or relocations.

The following reports and models were utilized as the basis for the SWM design:

- Ontario Ministry of the Environment (MECP) Stormwater Management Planning and Design Manual, 2003
- LID Implementation Process for Regional Road Right - Of - Ways, 2014
- Development Standards, Policies & Guidelines, Town of Caledon, 2009
- Fluvial Geomorphology and Hydraulic Assessments, Highway 50 – Active Transportation and Drainage Improvements, Environmental Assessment, Matrix Solutions, 2021 (Draft)
- InfoWorks Model for Regional Road 50, Region of Peel, 2020
- Public Works Stormwater Design Criteria and Procedural Manual, Region of Peel, 2019
- Stormwater Management Implementation Report, Bolton Gateway Developments Inc., Town of Caledon, Region of Peel, C.F. Crozier & Associates Inc., 2015
- Natural Heritage Report – Existing Conditions, Schedule B Class Environmental Assessment (EA) and Preliminary Design for Drainage Improvements of Regional Road 50 From Mayfield Road to Healey, Town of Caledon, Region of Peel, LGL Limited, 2020

1.3 Purpose

The purpose of this report is to provide a SWM strategy that considers best management practices, supports climate change requirements and meets existing and future regulatory requirements in support of the Class EA. The SWM strategy will support the EA study requirements by:

- identifying the recommended drainage infrastructure improvements required along Regional Road 50,
- identifying and addressing impacts related to the EA recommended MUP along the west side of RR50 and proposed sidewalk on the east side of RR50, north of George Bolton Parkway,
- incorporating concerns from stakeholders and regulatory agencies.

Under existing conditions RR50 is a fully urbanized five lane road. Sidewalk exists intermittently along the west side of the road. Between Healey Road and

Hopcroft Road there are sidewalks on both sides. In the west boulevard existing utilities including hydro poles, underground gas, bell, and watermains are present. An existing sanitary sewer runs along the west side of RR50 until George Bolton Parkway, where it crosses and runs along the east boulevard. Surrounding land use is commercial and industrial with a high percentage of impervious cover. Road drainage is primarily conveyed by storm sewers along the east side of the road, while ditches on either side of the road convey predominantly external drainage. Existing sewers discharge directly to Robinson Creek at George Bolton Parkway and Simona Drive. No quantity or quality controls are provided for the existing road drainage.

Robinson Creek crosses RR50 at George Bolton Parkway and flows east behind several industrial lots, before flowing west back towards RR50, and flowing alongside the road in existing ditches for approximately 200 m. The existing culverts along this section of RR50 show signs of deterioration and present a potential flood risk for surrounding properties. These culverts will need to be replaced due to safety concerns and to improve drainage flows.

As part of the EA study recommendations, a MUP is proposed along the west side of RR50, which will widen and replace the existing sidewalk where it exists. The proposed MUP is not expected to increase peak flows, as the overall increase in impervious area is negligible compared to the existing roadway, surrounding commercial lots and industrial lots. Due to the proposed alignment of the MUP some existing ditches along the west side of RR50 will be replaced by storm sewers with ditch inlet catchbasins.

The EA study has also recommended a sidewalk on the east side of RR50. The sidewalk ties in with the existing sidewalk at the front of property #12599 and runs south to the intersection of George Bolton Parkway and RR50. This recommendation was undertaken to address public concerns and pedestrian safety considerations.

2.0 Existing Site Conditions Characterization

2.1 Tributary Areas, Outlets, and Drainage Patterns

Catchment boundaries for the entire project area were put together through information received from the Region, Town of Caledon, and existing hydraulic assessment models. For the RR50 right-of-way, these areas were confirmed through localized road survey.

2.2 Condition of Receiving Watercourses

Existing watercourses receiving drainage from RR50, Healey Road, Mayfield Road and external areas within the project limits are located within the Humber River watershed, as well as the Rainbow Creek and Robinson Creek subwatersheds. These existing watercourses flow primarily across scattered woody riparian cover.

Rainbow Creek and Robinson Creek are intermittent watercourses regarded as warmwater habitat by the TRCA. However, the TRCA has indicated that all watercourses within the study area currently have a Redside Dace timing window (July 1st - September 15th).

2.3 Watercourse and Drainage Crossings

The existing storm drainage system of RR50 consists of roadside ditches and culverts as shown on drawings enclosed in Appendix B. As previously mentioned, the Region determined that a total of seventeen culverts require improvements. RVA inspected all culverts within the corridor and identified an additional twenty - three deficient culverts. RVA suggests that in total, thirty culverts may require improvements. The existing information for the roadway culverts is summarized in Table 2.1.

Table 2.1: Existing Roadway Culverts List

Crossing Number	Culvert ID	Material and Shape	Existing Diameter / Dimensions	Length (m)	U / S Invert (m)	U / S Edge of Travelled Lane	D / S Invert (m)
RR - WD - 3.1	1	Circular CSP	750 mm	65.5	244.853	247.288	244.720
RR - WD - 6.1	2	Circular CSP	750 mm	92.6	244.310	245.882	244.000
RR - WD - 8.1	3	Circular CSP	900 mm	47.2	243.032	245.500	242.887
RR - WD - 10.1	4	Circular CSP	750 mm	51.8	242.399	243.730	241.796
RR - WD - 12.1	5	Circular CSP	900 mm	111.9	241.668	243.114	240.816
RR - WD - 14.1	6	Circular CSP	900 mm	10.9	240.733	242.240	240.500
RR - WD - 16.1	7	Circular CSP	900 mm	34.9	240.500	242.049	240.350
RR - WD - 18.1	8	Circular CSP	600 mm	22.1	240.150	241.594	240.024
RR - WD - 20.1	9	Circular CSP	900 mm	19.8	239.801	241.213	239.610
RR - WD - 22.1	10	Circular CSP	900 mm	43.1	239.305	241.000	238.672
RR - WD - 24.1	11	Circular CSP	750 mm	26.1	237.763	240.000	237.685
RR - WD - 26.1	12	Circular CSP	900 mm	17.2	236.790	239.000	236.340
2223.44 - 2.1	13	PVC	600 mm	15.1	236.763	238.500	236.668
2223.44 - 3.1	-	Concrete	900 mm	36.6	236.008	238.599	235.825
RR - WD - 28.1	14	Circular CSP	600 mm	23.2	236.823	237.600	236.730
RR - WD - 30.1	15	Circular CSP	500 mm	17.9	236.566	237.600	236.505
RR - WD - 46.1	16	Circular CSP	450 mm	25.6	228.659	231.000	228.328

2223.08 - 2.1	17	Concrete Box	4500 mm x 1700 mm	19.8	226.290	230.850	226.130
2223.11 - 2.1	18	Concrete Box	4500 mm x 1450 mm	19.0	226.700	229.750	226.520
RR - ED - 41.1	19	Circular CSP	525 mm	38.1	229.054	230.641	228.708
RR - ED - 38.1	20	Circular CSP	525 mm	23.8	229.745	230.898	229.376
2223.19 - 2.1	21	Metal Arch	2270 mm x 1600 mm	17.2	229.300	233.050	229.260
2223.22 - 2.1	22	Metal Arch	2060 mm x 1450 mm	24.1	230.150	233.400	230.060
2223.25 - 2.1	24	Metal Arch	2260 mm x 1660 mm	23.5	230.408	234.000	230.200
2223.29 - 2.1	25	Metal Arch	2900 mm x 1900 mm	16.7	231.178	234.850	231.142
RR - ED - 33.1	26	Circular CSP	600 mm	30.1	233.560	235.000	233.200
RR - ED - 31.1	27	Circular CSP	600 mm	9.1	234.112	236.000	233.966
RR - ED - 29.1	28	Circular CSP	525 mm	18.8	234.744	237.000	234.381
RR - ED - 26A.1	29	Circular CSP	450 mm	35.2	235.650	238.000	235.190
2223.44 - 4.1	30	Concrete Box	1800 mm x 1200 mm	34.2	235.825	238.500	235.654

2.4 Soil and Groundwater Conditions

Below the existing road surface, the general subsurface soils within the project area consist of fill material (sand and gravel, sand, gravelly sand, silty sand, sandy silt, silt, clayey silt, and silty clay). The fill layer extends to depths ranging from 0.6 m to 3.3 m below the ground surface.

Groundwater levels in the monitoring wells were measured by Thurber Engineering Ltd. between May 26, 2020 and August 24, 2020. The range of water level elevations in the monitoring wells were from 223.65 m to 243.67 m. The groundwater levels indicated that shallow groundwater flows follow local topography from northwest to southeast towards the tributary of Humber River. Hydraulic conductivity values were obtained through a series of slug tests carried out at some of the boreholes within the study area. The estimated hydraulic conductivity values range from 1.10×10^{-8} m / s to 9.80×10^{-10} m / s.

Guelph Permeameter testing was also carried out at nine locations along the grass boulevards on the west side of RR50. An infiltration rate was estimated by measuring the change in water level in the Guelph Permeameter reservoir once a steady state was reached. The infiltration rate was estimated to be in the range from 43 mm / hr to 101 mm / hr.

The subsurface information is described in detail within the hydrogeological report titled 'Preliminary Design for Drainage Improvements Regional Road Highway 50 from Mayfield Road to Healey Road' prepared by Thurber Engineering Ltd. dated October 2020.

2.5 Significant Natural Features

A Natural Heritage Report on existing conditions has been prepared by LGL Limited dated December 2020. The report indicated that the Land Information Ontario (LIO) and the Humber River Fisheries Management Plan has identified Robinson Creek as 'Small Riverine Warmwater' fish habitat. Brook Stickleback (*Culea inconstans*) and Creek Chuck (*Semotilus atromaculatus*) have been identified south of the study area. These two fish are a tolerant warmwater species.

The study area consists of naturalized vegetation communities of Dry - Moist Old Field Meadow (CUM1 - 1) and Mineral Shallow Marsh (MAS2 - 1 and MAS). These communities consist of high proportion of non - native and tolerant plant species. These plant species are well adopted to survive in areas that are

regularly disturbed and subjected to high light conditions. During LGL's botanical investigation no plant species that are regulated under the Ontario Endangered Species Act (ESA) or the Canada Species at Risk Act were encountered.

The report also indicated that the wildlife species identified within the study area are tolerant of anthropogenic features and disturbance. During LGL's investigation, ten birds were recorded that are protected under the Migratory Birds Convention Act (MBCA) and a single bird species is protected under the Fish and Wildlife Conservation Act (FWCA). In total there were eighteen wildlife species recorded within the study area. However, none of the wildlife species are regulated under the Ontario Endangered Species Act, 2007 (ESA) or the federal Species at Risk Act (SARA). Furthermore, LGL reviewed the National Heritage Information Center database (MNR 2020) for rare species records but the study area contains no element occurrences for wildlife species at risk.

LGL limited is currently working on the second phase of the Natural Heritage Report which will indicate if the proposed condition impacts the natural heritage within the study area.

3.0 Stormwater Objectives

3.1 Water Quantity and Flood Control

The objective of the SWM report for drainage infrastructure improvements on RR50 from Mayfield Road to Healey Road is to assess the EA recommended solutions that will address the following:

- Ensure no increased risk of flooding to downstream properties and / or infrastructure.
- Design any proposed sewer to convey 10 - year return period storm runoff.
- Where applicable, promote infiltration within the road right - of - way.

It is important to note that best management practices (BMP) were utilized to match the precondition of RR50 in the postcondition. Since no road widening is proposed along RR50 from Mayfield Road to Healey Road, there is a negligible increase in the percent of impervious surface present in the postcondition as compared to the precondition. As such, no water quantity or flood controls are proposed within the study area. However, wherever there is a risk of flooding due to undersized culverts this report proposes an upsized to existing infrastructure as part of the EA process.

3.2 Water Quality, Erosion, and Sediment Control

The objective for water quality and erosion and sediment control for this project is to provide best efforts to treat stormwater runoff from RR50. A combination of different Low Impact Development (LID) techniques to provide a basic level treatment (50 % Total Suspended Solids (TSS) removal) are proposed. To improve water quality in the postcondition Oil Grit Separators (OGS), bioretention facilities, infiltration trenches and catchbasin shields were included in the study recommendations. It is to note that no lane widening has been identified in the EA recommended alternative. As a result there is a negligible increase in the amount of impervious surface. Since the increase in imperviousness is negligible in the postcondition, the TSS loading is approximately the same as precondition. However, the improvements recommended through the EA are expected to improve stormwater quality in the postcondition, compared to precondition.

3.3 Water Balance

Water balance was not considered to be an objective for this project. Since no road widening is proposed along RR50 from Mayfield Road to Healey Road,

there is a negligible increase in the percent of impervious surface in the postcondition as compared to the precondition.

4.0 Model Build Process – Hydraulic Modelling

An InfoWorks model was created to model the creek, ditches, culverts, and sewers to assess the existing drainage conditions of RR50. The creek, ditch and culvert information were obtained from the TRCA's HEC - RAS model updated by Matrix Solutions Inc. The HEC - RAS model also included design flows for the creek. In addition, an InfoWorks model was also obtained from the Region. This InfoWorks model consisted of partial road subcatchment data as well as design storm and sewer information.

The InfoWorks model that was created by RVA combined the information obtained from the updated HEC - RAS and the existing InfoWorks models. Two scenarios were created in the RVA InfoWorks model for assessment: (1) the existing / precondition, and (2) the EA recommended condition. The following sections describe in detail how the RVA InfoWorks model was developed.

4.1 Design Storm

The design storm used in this project was obtained through the Region's InfoWorks Model. The design storm was developed using the Chicago Distribution storm for a duration of four hours using a five -minute time step. All sewers and roadside culverts were designed to convey the 10 - year design storm event. A 100 - year storm event was also modelled and run to understand the effect of flooding, if any, within the RR50 right - of - way.

4.2 Existing Condition Scenario

The existing condition was built in InfoWorks using two main sources: HEC - RAS and InfoWorks models, from the TRCA and the Region, respectively. The profile data of the creek was imported into InfoWorks by using the cross - section data from HEC - RAS. The inverts of the channels were assigned based on the cross - section inverts of the HEC - RAS model. In general, the creek has several culverts that allow conveyance. The information for these culverts was also imported as per the HEC - RAS model.

The Region's InfoWorks model did not include open profile roadside ditches. Instead, the existing roadside ditches were modelled in a simplified manner as 1000 mm diameter circular pipes running along RR50. To be able to accurately capture the drainage capacity RVA used topographic survey data to model all the roadside ditches with their respective open profiles.

To the north of Healey Road there is a railway track that crosses RR50. The ditches along the railway track west of RR50 and the external drainage area draining to those ditches, were added to the Region's InfoWorks model since they contribute runoff and flows into the study area. Flows from these additional drainage areas contribute to the west side road ditch and enter the Robinson Creek culvert at George Bolton Parkway.

RVA performed an onsite investigation to determine the approximate external drainage areas that drain to these ditches and included them in the InfoWorks model. Since limited information about the outside drainage areas was available, runoff surface area parameters, such as imperviousness and runoff factors, were estimated. Flows from these areas were limited to a maximum runoff value into the west side ditch based on available rail crossing culvert capacity (750 mm diameter culvert, $pfc = 1.08 \text{ m}^3 / \text{s}$, restricted 1 - year flows to approximately 500 l / s peak flow). This estimate was made based on the assumption that the rail line should not flood for a 10 - year design storm. Figure 4.1 below shows the extent of the described external drainage area.



Figure 4.1: External Drainage Area That Contributes into Study Area

A large culvert crossing exists at the intersection of George Bolton Road and RR50. Figure 4.2 below shows the drainage / culvert alignment. The flows from Robinson Creek enter a 600 mm diameter PVC storm sewer and merge after 15 m with a 900 mm diameter CSP pipe, that conveys additional flow from the west side of RR50 ditch drainage towards an 1800 mm x 1200 mm rectangular box culvert that crosses beneath RR50. The box culvert outlets into an online pond on the east side of RR50 and continues its flow path further as Robinson Creek.

A site investigation was also carried out to understand the online pond's drainage condition. The site investigation revealed that the inlet of the wet pond has a significant amount of silt and debris accumulated which causes a tail water condition and permanent submergence within the 1800 mm x 1200 mm rectangular box culvert. The outlet of the pond was also observed to be approximately 0.5 m higher than the inlet of the wet pond which leads to the silt and debris built up and standing water in the culvert.

RVA has added into the hydraulic model a storage node on the southwest corner (west of Esso Gas station) of George Bolton Parkway and RR50. This floodplain storage was added based on the observations made on the site to represent available floodplain storage flood volume that would be activated during the 100-year storm scenario. This storage would fill up and slowly raise the water elevation before reaching a level where RR50 would be overtopped. Figure 4.2 below shows the described 1800 mm x 1200 mm rectangular box culvert alignment. The road overtopping is predicted in the existing scenario model due to the applied steady peak flows from Robinson Creek. Such an overtopping scenario has not been reported from historic observations and this would depend greatly on the duration of an experienced extreme storm event and the upstream associated catchment wetting and runoff parameters.

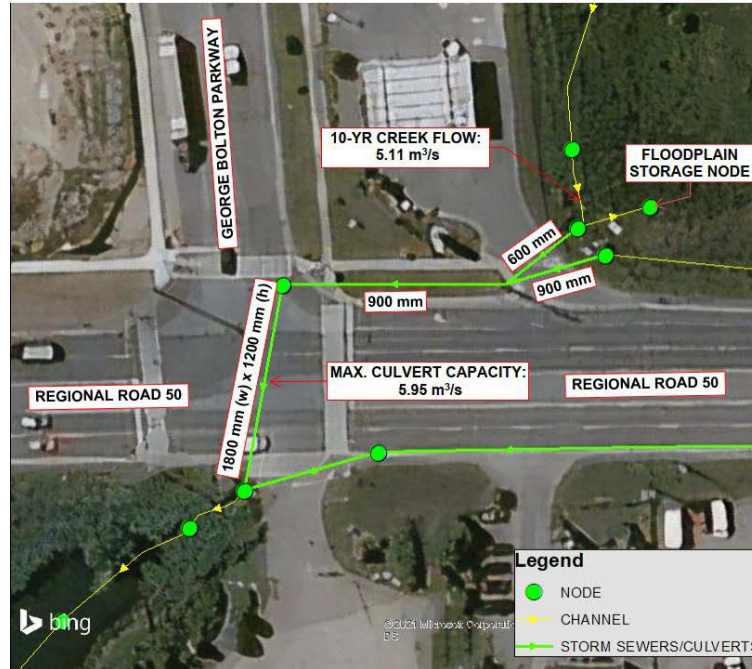


Figure 4.2: Existing Drainage Configuration at George Bolton Parkway Intersection

4.3 EA Recommendations / Proposed Condition Scenario

The preferred solution to address active transportation (AT) enhancements as identified through the EA study includes the implementation of a MUP along the west side of the corridor and a sidewalk along the east side of RR50 north of George Bolton Parkway. In support of the recommended AT amenities, the preferred drainage infrastructure improvements include infiltration trenches and bioretention facilities on the west side of RR50 and culvert upsizing where hydraulic restrictions exist along the east side the corridor.

Bioretention facilities include bioswales and bioswale boxes. All three of these LID techniques were placed in locations, based on their implementation feasibility and hydrogeologic soil conditions. These features were modelled with infiltration rates that matched the test results taken from the locations considered. Bioswales are proposed in strategic locations where a bioswale box was not feasible to be implemented due to spatial constraints.

Bioswales are proposed on the west side ditch section RR - WD - 27.1 to RR - WD - 28.1 and RR - WD - 29.1 to RR - WD - 30.1. Within the bioswales, check dams are recommended to create a cascading system for runoff to flow along. This effect will decrease the runoff velocity and utilize the storage volume of the bioswale to promote settling. The cascading system of check dams will ensure

adequate infiltration within the proposed bioswales. A bioswale box is proposed south of the Simona Drive and RR50 intersection. This bioswale box is modelled with a depth of 1 m and a 201.60 m² surface area. An OGS is also proposed at the west side of RR50, north of and the Mayfield Road intersection.

4.3.1 Recommended Sidewalk on East Side of RR50 (North of RR50 and George Bolton Parkway)

As part EA process, an approximately 400 m long sidewalk on the east side of RR50 is recommended. The sidewalk starts at the front of the property #12559 RR50 and ends at the intersection of RR50 and George Bolton Parkway. There are currently roadside ditches in place of the proposed sidewalk alignment. These ditches convey external drainage area flow into the Robinson Creek. Due to the sidewalk construction, the roadside ditches are proposed to be filled and a storm sewer system is proposed to convey the 10-year storm flow without surcharge and the 100-year storm flow without flooding.

North of RR50 and George Bolton Parkway intersection there are multiple catch basins that capture 10-year road drainage flow from RR50 and convey these into the existing 825 mm diameter storm sewer system. The existing storm sewer system conveys the road drainage flows into the Robinson Creek, outletting at RR50 and George Bolton Parkway intersection into the online pond. It is important to note that the existing 825 mm diameter storm sewer system does currently not convey any external drainage area other than the road drainage.

As such, a parallel storm sewer system is recommended, ranging from 450 mm to 825 mm diameter to connect to the existing 825 mm diameter storm sewer system. From the connection point of the new storm sewer with the existing 825 mm diameter storm sewer, approximately 181 m of 825 mm diameter pipes need to be upgraded to 1050 mm to 1200 mm diameter to be able to convey the added flows without surcharge during a 10-year storm event into the pond. This pipe upgrade ensures that only one outfall into the pond will remain. All road catchbasins currently connected to the existing storm maintenance holes will be kept as per current drainage arrangement.

The extent of the external drainage area and the proposed and the existing storm sewer system are shown in Figure 4.3.

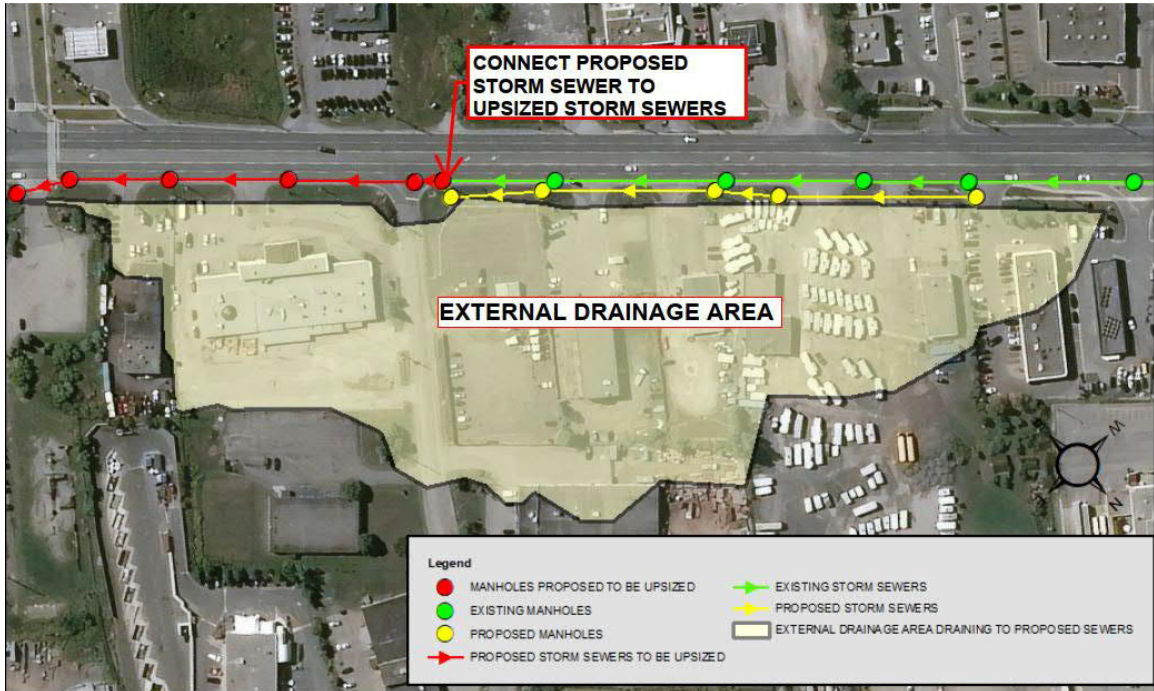


Figure 4.3: External Drainage Area & Proposed Storm Sewer System (North of RR50 & George Bolton intersection)

4.3.2 Culvert Crossing at RR50 and George Bolton Parkway

Due to anticipated high peak flows in Robinson Creek, the existing 600 mm / 900 mm diameter inlet pipes are insufficient to convey the proposed flows and require upsizing. The existing box culvert crossing (1800 mm x 1200 mm) has an available full pipe capacity of approximately 5.95 m³/s and is in itself capable to convey the 10-year design storm flow without flooding or overtopping the road. However due to the upstream pipe capacity limitations, the current model scenario shows road overtopping.

Based on the available HEC - RAS flows, the road crossing is proposed to be enhanced with a consistent 1800 mm x 1200 mm box culvert crossing along the existing pipe alignment. Figure 4.3 shows the proposed culverts at the George Bolton Parkway and RR50 intersection.

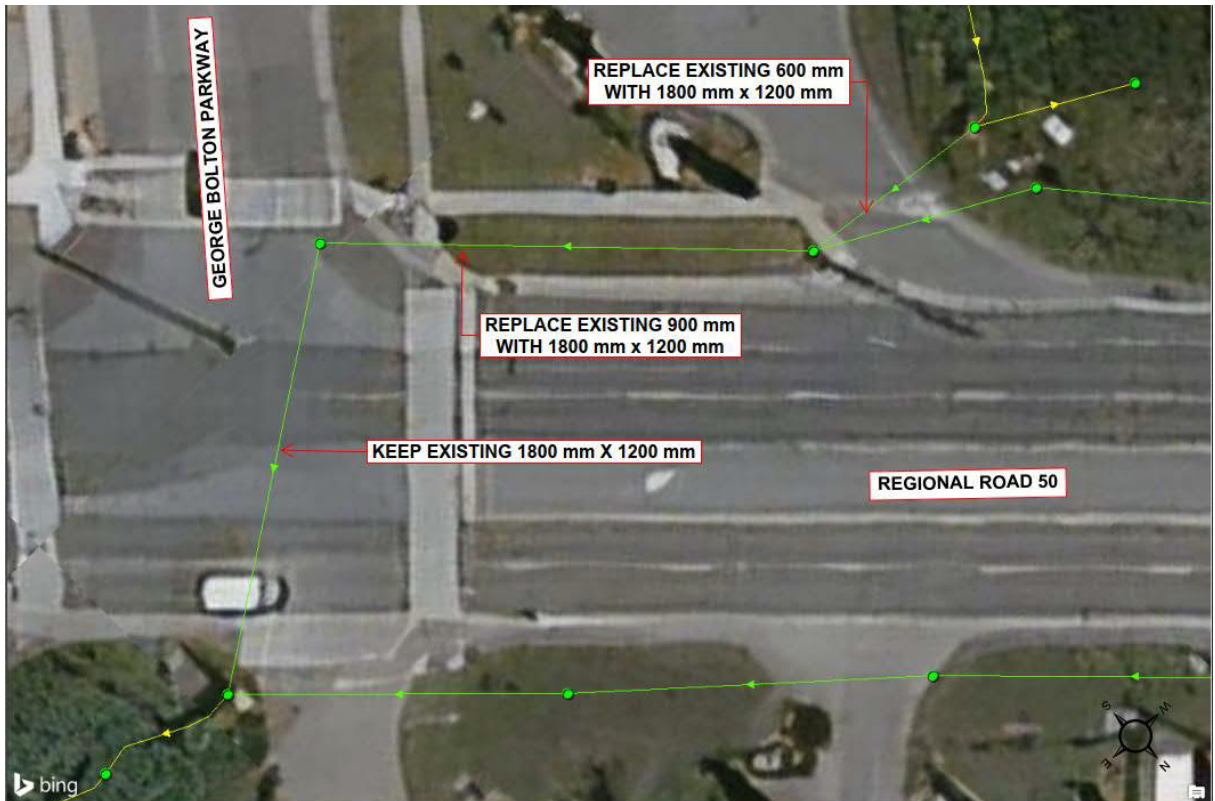


Figure 4.4: Creek Bypass Enhancements at George Bolton and RR50

RVA carried out a site investigation to understand the hydraulic situation and condition of the online pond into which the existing 1800 mm x 1200 mm box culvert outlets. It is proposed to remove the debris and silt built up at the inlet of the online pond. To avoid future built up at the inlet again, it is also proposed to lower the outlet of the online pond by approximately 0.5 m. Figure 4.5 shows the online wet pond and proposed maintenance required to mitigate tailwater condition at the existing 1800 mm x 1200 mm box culvert.

In order to validate the provided flows, RVA has analyzed flow monitoring and rain gauge data at the inlet of the online pond. The results and discussion of this analysis is provided in Section 8.0. It is also important to note that the Region is currently undertaking the preliminary condition assessments of these culverts at this intersection.

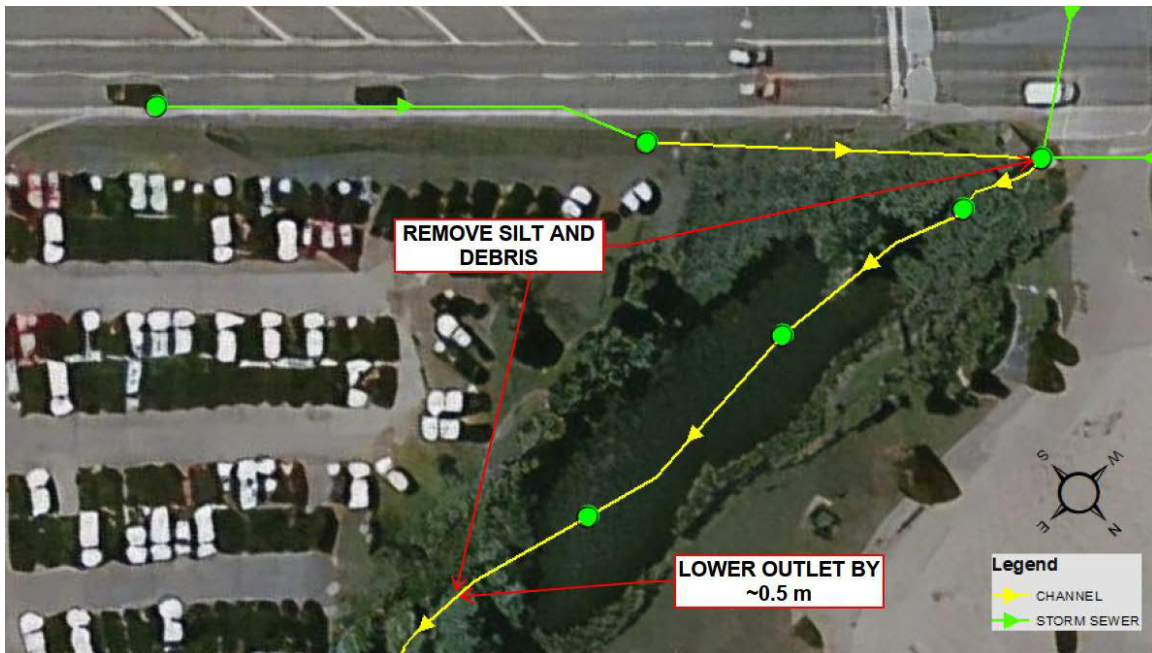


Figure 4.5: Proposed Maintenance at online wet pond

4.3.3 Flooding Complaints at # 12207 RR50

During the study’s public consultation period, a flooding complaint was received pertaining to property # 12207 RR50. The problem was described as backyard property flooding due to high water levels in Robinson Creek. Robinson Creek turns away from the roadside and flows around the backyard of this property before realigning back to the east side of RR50. In relation to the flooding report, the property owner mentioned a former roadside ditch to the front of his property had provided flood relief and a creek bypass, but this was replaced by the Region with a 525 mm diameter sewer to fill the ditch.

In addition, directly opposite this flooding issue, a recent residential development was created with a Storm Water Management (SWM) pond with a controlled discharge point directly into the creek.

RVA undertook site investigation works to better understand the flooding mechanism and reviewed the SWM report and drawings of the pond to understand the discharge flow rate from the pond to the creek. The SWM pond is proposed to discharge at $0.18 \text{ m}^3 / \text{s}$ and $0.34 \text{ m}^3 / \text{s}$ for 10 - year and 100 - year, respectively. Compared to the HEC - RAS flows in the creek of $5.57 \text{ m}^3 / \text{s}$ and $8.62 \text{ m}^3 / \text{s}$ for 10 - year and 100 - year, respectively, the proposed SWM pond discharge rates are negligible. Excerpts from the SWM report have been attached in Appendix A. As such, it can be understood that the flooding at #

12207 RR50 is not due to the discharge rate from the SWM pond. Figure 4.6 illustrates Robinson Creek, the flood property, and the creek bypass channel.

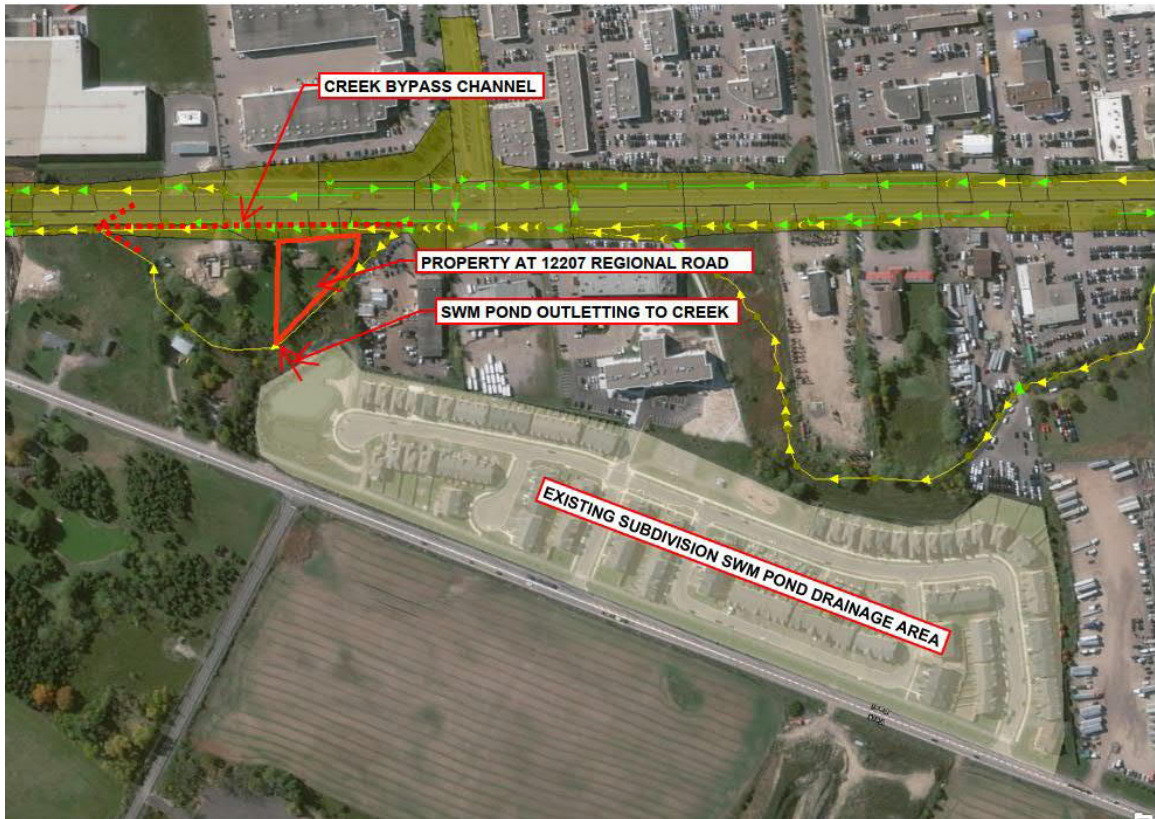


Figure 4.6: Robinson Creek, Flood Property and Creek Bypass Channel

RVA has designed increased capacity for flooding relief of this property. The bypass level between the creek and the relief pipe was adjusted as well as the relief pipe being upsized from 525 mm diameter to 900 mm diameter.

4.3.4 Proposed Culvert Upgrades

The following culverts are proposed to be upgraded:

Table 4.1: Proposed Culvert Sizes and Shapes

Crossing Number	Existing Material and Shape	Existing Diameter / Dimensions	Proposed Material and Shape	Proposed Diameter / Dimensions
2223.44 - 2.1	Circular PVC	600 mm	Concrete Box	1800 mm x 1200 mm
2223.44 - 3.1	Circular CSP	900 mm	Concrete Box	1800 mm x 1200 mm
2223.25 - 2.1	Metal Arch	2260 mm x 1660 mm	Concrete Box	3000 mm x 1500 mm
2223.22 - 2.1	Metal Arch	2060 mm x 1450 mm	Concrete Box	3000 mm x 1500 mm
2223.19 - 2.1	Metal Arch	2270 mm x 1600 mm	Concrete Box	3000 mm x 1500 mm
RR - ED - 38.1	CSP	525 mm	Concrete	900 mm
RR - ED - 39.1	CSP	525 mm	Concrete	900 mm
RR - ED - 40.1	CSP	525 mm	Concrete	900 mm
RR - ED - 41.1	CSP	525 mm	Concrete	900 mm

5.0 Model Results

5.1 Existing Condition Scenario Results

The existing condition scenario was tested for a 10 - year storm and a 100 - year storm event to analyze the effects of a design storm and a major storm on the culverts along RR50.

The results indicate that under a 10 - year storm the culverts under George Bolton Parkway and RR50 flood. The existing culverts on this intersection are 600 mm diameter PVC pipe, which is connected to a 900 mm diameter CSP culvert. The 900 mm diameter pipe connects to an 1800 mm x 1200 mm concrete box culvert that crosses RR50 and outlets into the online pond. Robinson Creek flows through this pipe/culvert arrangement. Based on the created InfoWorks model, for 10-year storm and 100-year storm events under existing conditions, there is road ponding of 230 mm and 311 mm respectively predicted for the RR50 and George Bolton Parkway intersection. Figure 5.1 represents the culverts under the George Bolton Parkway and RR50 intersection. Based on TRCA's HEC - RAS model, the 10 - year flow at the intersection is 5.10 m³ / s and the InfoWorks model predicts hydraulic restrictions due to the small culverts (600 mm and 900mm) under the intersection.



Figure 5.1: George Bolton Parkway and RR50 Intersection Culverts

For a location further south near Parr Boulevard, a flooding complaint was received during the public consultation meeting. The complaint is related to

property # 12207 RR50. Hydraulic details were added and analyzed in the existing model.

The hydraulic situation around this property can be explained as follows. Robinson Creek departs from the RR50 road alignment and runs around the property. Between the property and RR50, a former roadside ditch, that acted as flow relief to bypass high flows in Robinson Creek was filled and replaced with a 525 mm diameter sewer of lesser conveyance capacity. Compared with the former drainage situation, the water level in the creek rises due to decreased relief capacity from the replaced ditch sections with 525 mm diameter storm sewers. The water level in the adjacent creek section ranges from 230.25 m to 229 m for the 10-year storm flows and 230.5 m to 229 m for the 100-year storm flows. Since the property elevation is within 230 m to 231 m, RVA can confirm that a flood risk currently exists at property # 12207 RR50. This flood risk might have been increased due to the filling of the ditch and replacement with a 525 mm diameter sewer which provides less flow capacity and flow relief than the previously existing ditch sections. In addition, the existing 525 mm storm sewers surcharge during a 10 - year storm event.

For a section of Robinson Creek that is located upstream of the above described flood complaint property, the following hydraulic capacity restrictions exist. Under a 100 - year storm, there are three culverts that run along RR50 that show hydraulic restrictions to convey the 100 - year storm flows. The three culverts are located near the Parr Boulevard and RR50 intersection and their crossing ID numbers are 2223.22 - 2.1, 2223.25 - 2.1 and 2223.19 - 2.1. These culverts are made of corrugated metal arch culverts with sizes 2060 mm x 1450 mm, 2260 mm x 1660 mm and 2270 mm x 1600 mm. Figure 5.2 highlights the three culverts that show hydraulic restrictions in the existing condition.

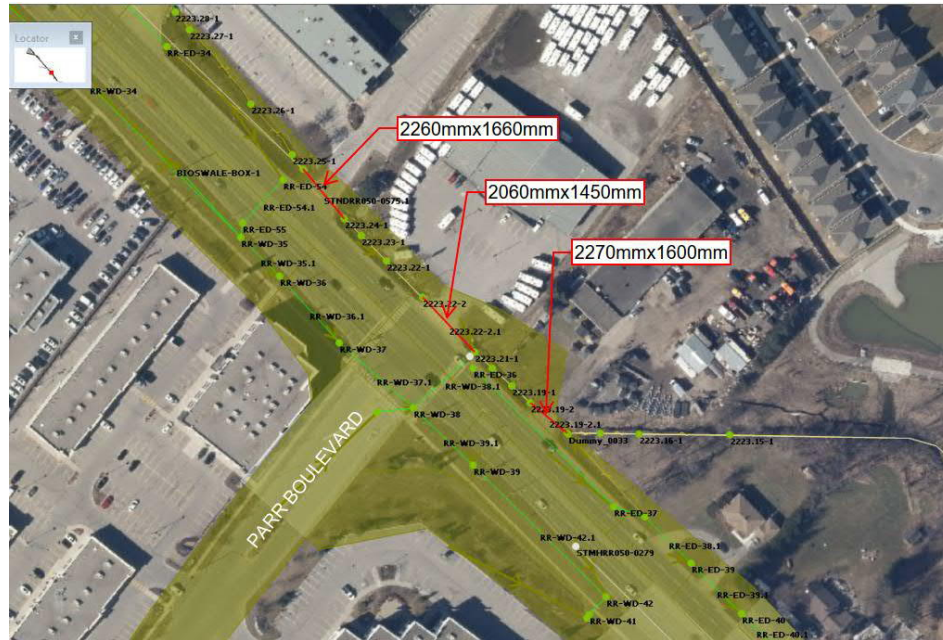


Figure 5.2: Culverts on RR50 and Parr Boulevard Showing Hydraulic Restrictions Under 100 - year flows

The InfoWorks model output results are presented in Appendix B.

5.2 EA Recommended / Proposed Condition Scenario Results

The EA recommended condition scenario was set up to analyze the proposed drainage infrastructure improvements within the RR50 corridor. LID design elements were also proposed and were integrated into the model to promote sustainable drainage features.

The proposed condition model performs well under the established 10 - year design storm scenario and does not show any culvert capacity restrictions along the study area section for Robinson Creek and Rainbow Creek. The roadside drainage features that consist of ditches, pipes, swales, and infiltration trenches / chambers are all performing as expected and within their capacity limits. Under the 10 - year design storm, all the proposed culverts under the George Bolton Parkway and RR50 intersection convey the 10 - year flows without ponding or overtopping the intersection. Under the 100-year design storm the InfoWorks model predicts a ponding depth of 123 mm at the intersection. This represents a ponding depth reduction of approximately 100 mm from the existing condition. Since the predicted flow depth over the road depends on the width of the spill path and is difficult to properly quantify with a one-dimensional model, the result is an approximate value that is based on best available topographic data. Since

no historic overtopping at the road was observed for the existing conditions and the proposed pipe upgrades show a significant improvement in drainage conditions, the likelihood of actual road overtopping to occur is very limited. Further considerations are made with regards to peak flows in Robinson Creek under section 8 of this report. Several meetings were held with the TRCA on the peak flow prediction of Robinson Creek and the current presented peak flows represent already a reduction, compared with original supplied hydrologic data. Further flow measurements during observed rainfall events in 2021 were undertaken to relate measured flows and try to upscale and compare them to the current predicted peak flows, since it is observed that the predicted peak flows might be excessive and overpredict current conditions.

The 525 mm CSP sewers at the front of property # 12207 RR50 are upsized to 900 mm concrete sewers in the proposed condition. The model predicts that since the sewer capacity has been increased, the flows in the creek decreases in the post condition compared to the precondition. The proposed 900 mm concrete sewers also do not surcharge during a 100 - year storm event. The table below summarizes the pre and post flows of the creek at the back of # 12207 RR50.

Table 5.1: Creek Flow Comparison (at back of # 12207 RR50)

Cross - Section Number	Existing (10 - Year) (m ³ /s)	Proposed (10 - Year) (m ³ /s)	Existing (100 - year) (m ³ /s)	Proposed (100 - year) (m ³ /s)
2223.16 - 1.1	5.57	4.72	8.63	7.68
2223.15 - 1.1	5.57	4.72	8.63	7.68
2223.14 - 1.1	5.57	4.72	8.63	7.68

The three culverts near Parr Boulevard and RR50 also show no hydraulic restriction or flooding during a 100 - year storm event. It is important to note that these proposed concrete box culverts of size 3000 mm x 1500 mm operate at 60-90% capacity during the 100 - year storm event.

The InfoWorks model output results for the proposed condition scenario are presented in Appendix B.

6.0 SWM and LID Features Plan and Design

6.1 Evaluation and Selection of Candidate Features

In support of the evaluation process that was undertaken as part of the Class EA study, the Region’s *LID Implementation Process for Regional Road Right - of - Ways* was utilized in developing the most applicable Low Impact Development (LID) technique(s) for this project. Based on a thorough review of available information and evaluation against all relevant criteria during the EA process, it was determined that a combination of underground storage elements combined with infiltration elements and Oil and Grit Separator (OGS) units were feasible options for this site.

Table 6.1 below indicates the opportunities and constraints for each of the applicable LID techniques relevant to Regional Roads within the Region.

Table 6.1: LID Practice Analysis

Project Type	LID Practice	Constraint / Opportunity
Regional Road Works (Urban)	Stormwater Management (SWM) Pond	<p>Constraint</p> <ul style="list-style-type: none"> - Space is not available within the road right - of - way. - The adjacent properties within the project area are either farmlands or developed sites. - To meet the Region’s SWM initiative, multiple SWM ponds will be required at each existing culvert. - Buying a large amount of property to build SWM ponds is not an economical solution.
	Bioretention Facilities – Bioswales and Bioswale Box	<p>Opportunity</p> <ul style="list-style-type: none"> - Can be designed with overflow capacity and can provide surface conveyance for flows. - Water retention can be designed above the capacity for the filtration element to account for emergency overflows. - Higher costs for soil remediation and maintenance.

Project Type	LID Practice	Constraint / Opportunity
Regional Road Works (Urban)	Bioswales and Bioswale Box	<p>Constraint</p> <ul style="list-style-type: none"> - Permeable surfaces can be provided along the MUP. - Runoff water from boulevard is relatively clean and from a small area. - If provided along the MUP, periodic cleaning is required to maintain drainage properties. - No costs associated with property requirements. - Higher maintenance costs to maintain permeability. - Will not meet the drainage requirements due to capacity restrictions.
	Permeable Pavement	<p>Opportunity</p> <ul style="list-style-type: none"> - OGS units can be used due to their smaller footprint and treatment design flexibility for treatment area size. - OGS units need to be designed as part of a multi component approach to achieve water quality treatment targets.
	Oil / Grit Separator Units (OGS)	<p>Constraint</p> <ul style="list-style-type: none"> - Shallow outlet points will not allow water to drain completely. Larger pipes will require the proposed road profile to be raised. - Does not provide the quality controls that the Region and other agencies are looking for.

Project Type	LID Practice	Constraint / Opportunity
Regional Road Works (Urban)	Infiltration Trenches	<p>Opportunity</p> <ul style="list-style-type: none"> - Underground storage / infiltration arches such as those manufactured by Terrafix, Stormtech or Cultec can be used to detain and infiltrate stormwater. - Can be used underneath pavement. - Clean out manholes provide the opportunity to clean out sediment without removal or any pavement.
	Enhanced Roadside Ditches	<p>Constraint</p> <ul style="list-style-type: none"> - Not compatible with adjacent land use. - Enhanced swale would require significant adjacent property. - Not practical within the RR50 corridor due to constant water flows and large storm flows. - Significant property required to widen ditches for enhanced swales.
	Catchbasin Capture Devices / (Catchbasin Shields)	<p>Opportunity</p> <ul style="list-style-type: none"> - Does not impact existing flow capture and conveyance. - Provides some treatment benefits by removing larger TSS particles at catchbasin locations. - Compatible with adjacent land use. - No cost associated with property requirement. - Standard maintenance costs anticipated.

As indicated above, the selected feasible LID techniques that are recommended for incorporation in the SWM Design for RR50 from Healey Road to Mayfield Rd are:

- Oil / Grit Separator Units (OGS)
- Bioretention Facilities
- Infiltration Trenches
- Catchbasin Capture Devices / Catchbasin Shields

7.0 Drainage Plan and Design

7.1 Minor System Design

The minor drainage system consists of storm sewers, roadside ditches, and driveway culverts. The systems were designed to convey the 10 - year storm event for the RR50 subcatchments and external contributing drainage areas.

7.2 Major System Design

The major drainage system consists of the minor drainage system and the overland flow routes which convey excess runoff above the minor drainage system's capacity. The major drainage system was designed to convey the peak runoff flow from the 100 - year storm events.

7.3 Monitoring and Maintenance

To allow the stormwater maintenance facilities to function properly, the following monitoring and maintenance program is recommended by the MECP and TRCA guidelines.

The storm drainage systems should be maintained at regular intervals by inspecting and cleaning the sumps of catchbasins and maintenance holes as well as the OGS structures. In addition, infiltration trenches should be flushed out and any collected sediment should be removed via vacuum truck. The following sections describe the operations and maintenance requirement for each type of LID systems proposed within the study area.

7.3.1 Oil / Grit Separator (OGS)

With regards to monitoring and maintenance Imbrium System's OGS manual was reviewed. However, in the detailed design stage any OGS that is approved and equivalent to Imbrium System's OGS can be used. The manual by Imbrium System suggests that the inspection of the EFO® filter units should be carried out over the first year on a regular basis to inspect and assess sediment accumulation. Inspection in subsequent years should be based on the inspection schedule established based on the results on the first year. It is also important to note that the inspections should be performed immediately after oil, fuel or other chemical spills that take place within the area and drain to the OGS.

Task of inspection includes the removal of manhole covers, inspection of sediment buildup using a sediment probe with bulb valve or sludge judge, and an

oil dipstick for oil inspection. The remaining tasks are primarily visual. Inspection and assessment of the unit performance can be logged using the sample maintenance logs provided in the EF Owner's manual. A copy of the owner's manual is attached in Appendix C.

7.3.2 Catchbasin Capture Devices / Catchbasin Shields

A Catchbasin Shield Operation manual was reviewed as part of this report. Inspecting a Catchbasin Shield should be done by opening the grate and then attaching a lifting rope to the top of the centered leg of the Catchbasin Shield insert. A Sludge Judge should be used to measure the sediment depth in four to six locations of the sump. The unit is recommended to be cleaned if the sediment depth is 300 mm – 600 mm. A copy of the owner's manual is attached in Appendix C.

7.3.3 Bioretention Facilities: Bioswales and Bioswale Box

Based on the 'Low Impact Development Stormwater Management Planning and Design Guide: Version 1.0,' developed by the Credit Valley Conservation (CVC) and TRCA, the proposed bioswales and bioswale box need to be maintained to ensure that the infiltration and water quality benefits are preserved. At the bioretention facility locations, routine roadside ditch maintenance practices to be avoided are scraping and regrading. In addition, vehicles should not be parked or driven on the bioswales and bioswale boxes. If routine mowing takes place, then it should be carried out using the lightest possible mowing equipment to prevent soil compaction.

After every major storm event (> 25 mm) and quarterly for the first two years the vegetation density needs to be inspected to ensure at least 80 % coverage exists, to observe if vegetation has been damaged due to foot or vehicular traffic, as well as, for channelization and accumulation of debris, waste, or sediment. After two years inspections are required twice annually.

At least twice annually during the first two years the proposed bioswales and bioswale box need to be regularly watered while vegetation is becoming established. The bioswales need to be mowed to ensure the height is between 75 mm to 150 mm.

Annually the proposed bioswales and bioswale box need to be inspected for dead vegetation, invasive growth, dethatching, thatching, and aerating. Dead vegetation needs to be replaced. Also, any erosion must be repaired. If the

sediment within the bioretention facilities exceeds 25 mm depth, then it must be removed when dry.

7.3.4 Infiltration Trenches (Stormtech)

Maintenance hole inspections should be carried out to observe if trash, debris, or pipe blockages have occurred. More thorough inspection should be conducted if vacuuming and removal of sediment or nondraining water are required. During the first two years of operation, inspections should be made after every significant storm event (> 25 mm) to ensure proper functioning. On an average about four inspections are required every year for the first two years.

After the first two years, the infiltration trenches should be inspected on a regular basis, typically twice per year, and maintained as required. The maintenance frequency should be based on site specific characteristics and driven by the amount of runoff and pollutant loading encountered by the system. Typically, maintenance intervals for the proposed infiltration trenches would be 5 years.

8.0 Flow Monitoring and Rain Gauge Data Analysis

Meetings were held with TRCA and Peel Region to discuss the perceived overprediction of the peak flows in Robinson Creek that are based on the TRCA's HEC-Ras model. The reason for this observation was, that flows at the road intersection of George Bolton Parkway and RR50 were predicted to overtop the road even in 5-year and 10-year storm events and the creek peak flows did exceed the available culvert conveyance capacity. No such observations were made in the past and no flood complaints exists for this road section or the creek.

TRCA agreed to reduce the duration of the design storm to lessen the peak design flows for the creek. In addition, it was agreed between Peel Region and RVA to conduct further flow monitoring to gain a better understanding of the creek flow response to rainfall events and based on the results, to hopefully be able to extrapolate flow data to give an indication for the TRCA predicted extreme storm peak flows and either confirm these or find out if these flows are still conservative.

For this purpose, Advanced Monitoring Group (AMG) Environmental installed a flow monitor and rain gauge at the RR50 and George Bolton Parkway intersection. The flow monitor and the rain gauge were installed at the outlet of the existing 1800 mm x 1200 mm rectangular box culvert on April 20, 2021. RVA has obtained and analyzed flow monitoring and rain gauge data between April 20, 2021 and July 31, 2021. The monitored data was measured under a 5-minute timestep.

The monitored data analysis revealed that there were four (4) significant rainfall events that happened during the monitored period. For the purpose of this analysis, any flow recorded below 200 L/s was considered to be insignificant. The four (4) significant rainfall events occurred twice in July and once in September and October. The peak flow ranged from 200 L/s to 652 L/s. The most significant peak flow was observed in the month of July. The below graph, Figure 8.1, shows the recorded flow data and rainfall data between the period July 6, 2021 20:50 to July 8, 2021 16:00 (2 rain events).

During the aforementioned period in July, two independent rainfall events occurred. The first rainfall event produced a volume of 10.16 mm with a peak intensity of 30.48 mm/hr. As there was no previous rainfall event, the flow

monitor recorded approximately 150 L/s from the drainage area. However, the second rainfall of 21.34 mm of volume and a peak intensity of 45.72 mm/hr produced approximately 652 L/s of peak flow. The high peak flow of 652 L/s is caused due to the already wet drainage area due to previous rainfall approximately 5 hours before. This indicates, that catchment wetting and storm duration have a significant impact on the peak flow outcome.

In October 2021, there was also a significant rainfall that was captured by the rain gauge. Figure 8.2 illustrates the measured rainfall and the flow response from the drainage area. The graph shows that there was a 23.37 mm rainfall that occurred with an intensity of 36.58 mm/hr. The duration of the rain event was approximately 4 hours. The peak flow that was recorded during this event was approximately 460 L/s.

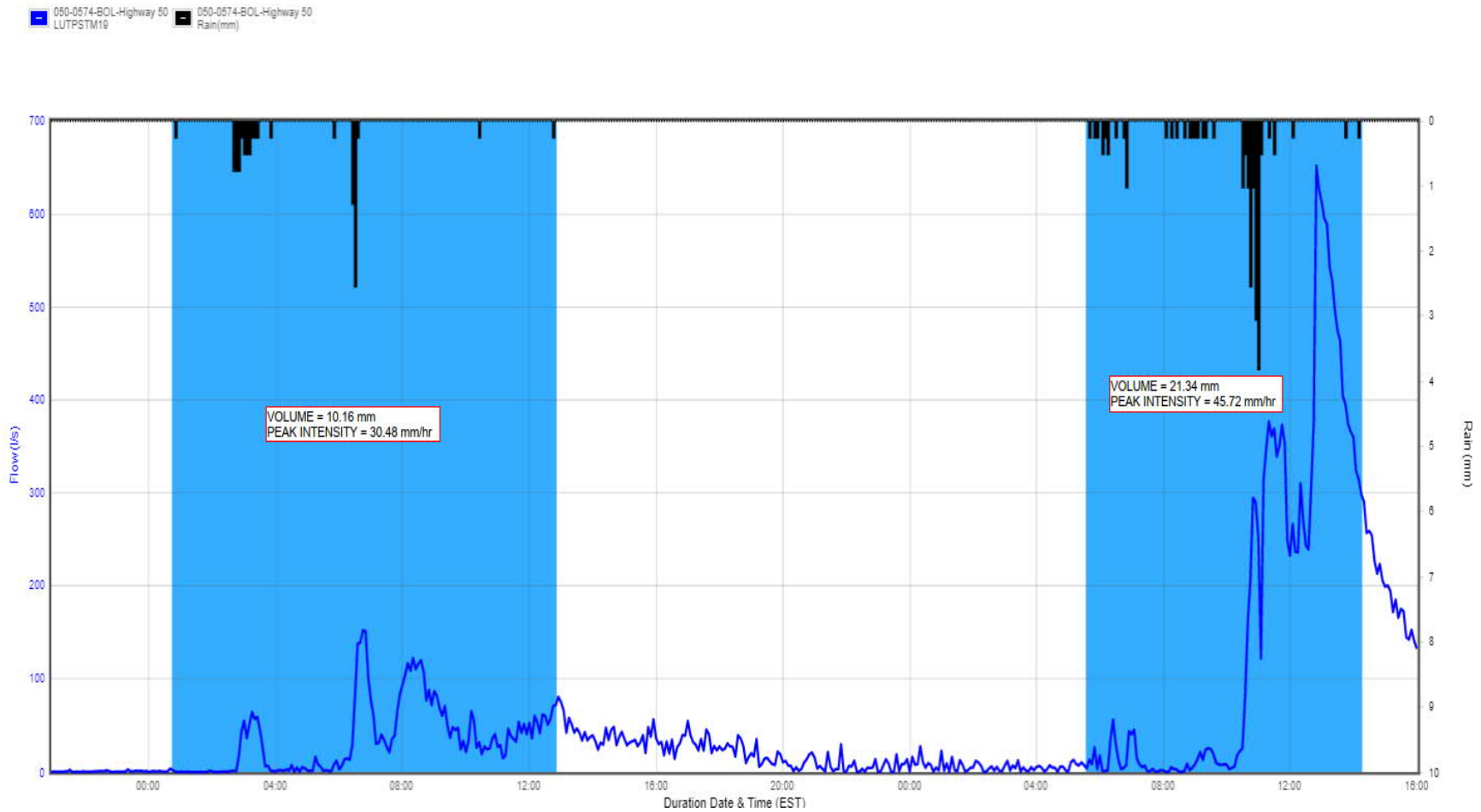


Figure 8.1: Measured Rainfall and Flow Data on July 6th – 8th

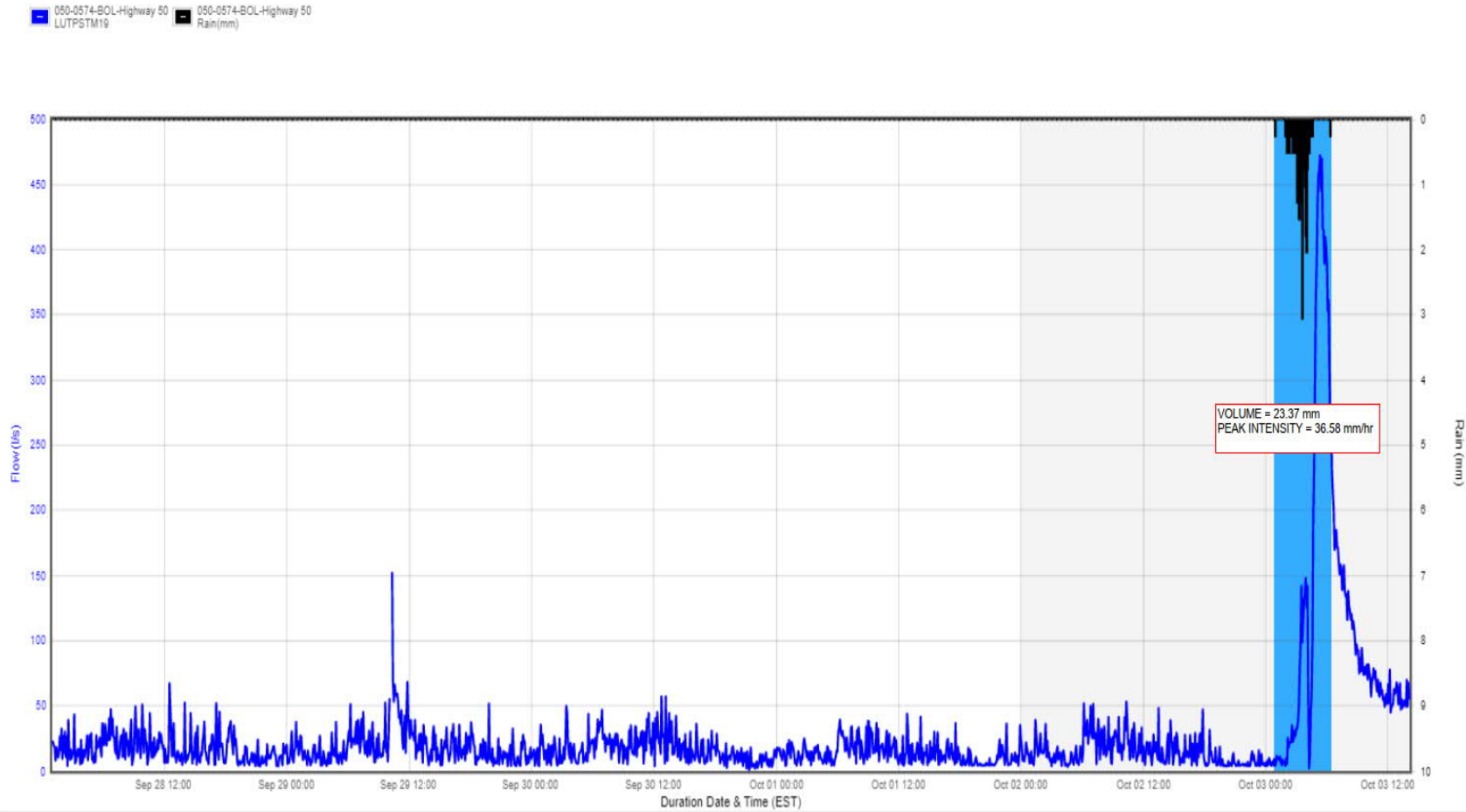


Figure 8.2: Measured Rainfall and Flow Data on October 3rd

The TRCA has revised the HEC-RAS flows, since RVA's previous SWM brief for this project, by changing the design storms from 6-Hour AES to 12-Hour AES. Email correspondence with TRCA is attached in Appendix A. The 12-Hour AES storm was analyzed to calculate the total volume for a 2-year storm. The calculation shows that under a 2-year 12-Hour AES storm, the total depth of rainfall would be approximately 42 mm. To compare the TRCA's provided 2-year flow of 3.11 m³/s and the measured flow, RVA compared the closest rainfall event that occurred for approximately 12 hours with approximately volume of 42 mm. Between September 22nd, 2021 10:25 AM and September 22, 2021 22:45 PM, a total volume of 41.66 mm rainfall was recorded with a peak intensity of 42.67 mm/hr. The graph **below, Figure 8.3, shows the** accumulated rainfall (total depth) and observed flow under an approximately 12-hour storm duration.

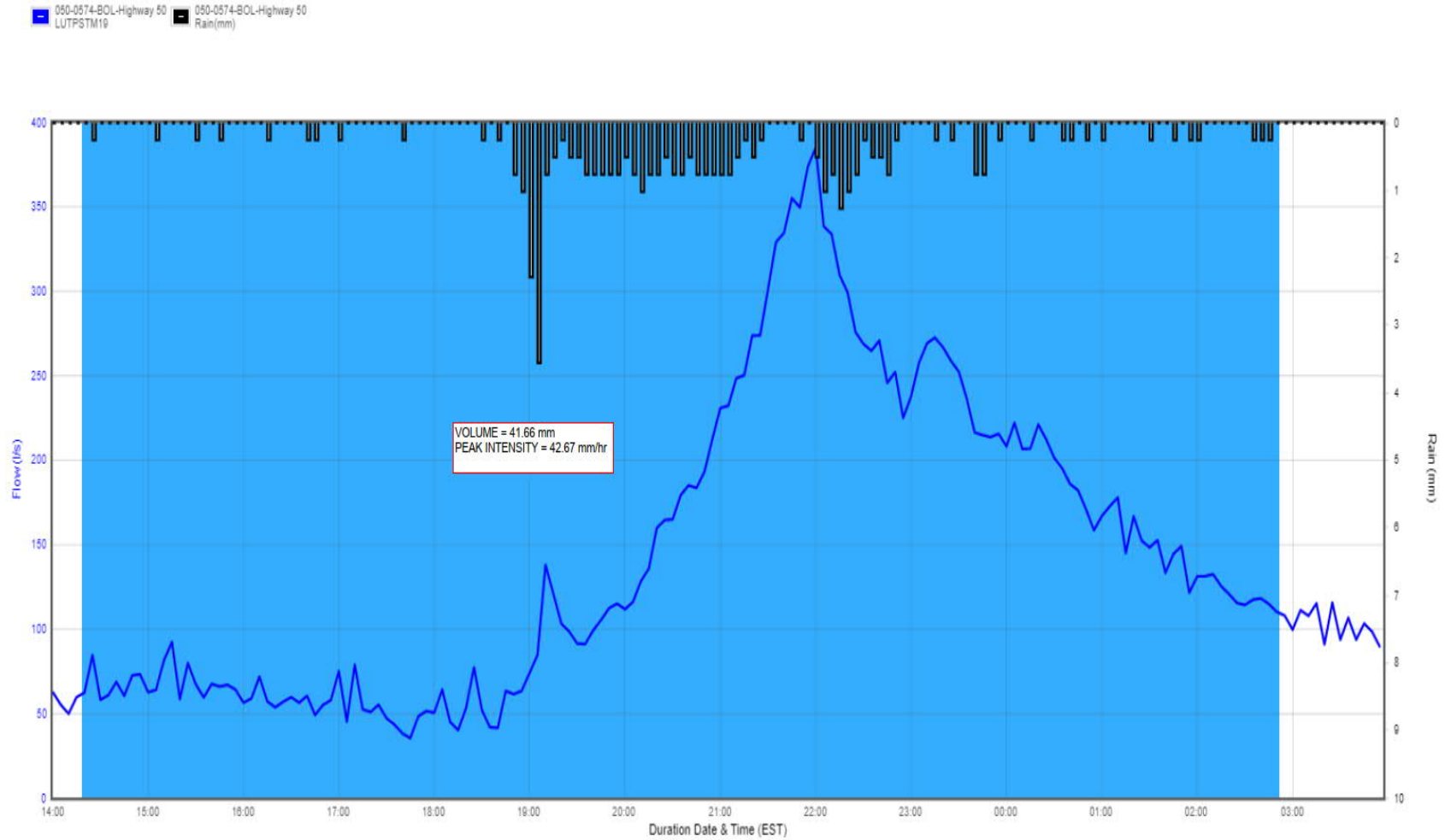


Figure 8.3: 12-Hour Rainfall Data and Measured Flow Data During September 22nd, 2021

The graph above shows that an approximately 42 mm depth of rainfall over a 12-hour period results into an approximately ~375 L/s of recorded flow. Since, the accumulated rainfall is approximately same as the 2-year 12-hour AES storm total rainfall depth, it can be inferred that the flows provided by TRCA are overestimated. This could be due to the overestimation of the drainage areas and controlled site plan areas which may not have been included in the hydrologic model used to estimate the provided flows to RVA.

9.0 Recommendations, Approval and Review Requirements

The proposed SWM measures outlined in this report have been developed in support of the recommendations developed through the Class EA planning and design process. The recommended infrastructure upgrades outlined in this document are expected to perform without flooding with the current TRCA's provided flows. Although it should be noted that based on the flow monitoring and rain gauge data analysis, RVA finds the flows provided by TRCA to be overestimated. However, the proposed culvert upgrades on RR50 and George Bolton Parkway are sized adequately to perform under a 10-year without overtopping and during 100-year with an approximately 123 mm ponding with the TRCA provided flows.

The Stormwater Management (SWM) Report is subject to review and approval from the following regulatory agencies:

- The Region of Peel
- Toronto and Region Conservation Authority (TRCA)
- Town of Caledon
- Ministry of Environment, Conservation and Parks (MECP)
- Public interest groups and stakeholders

The implementation of the recommended storm drainage systems described within this report has been developed in support of the EA recommendations and will control the site's runoff in accordance with the Region and TRCA.

Report Prepared By:

R.V. Anderson Associates Limited

Sadman Soumik, M.A.Sc., EIT
Engineer-in-Training, Hydraulic Modeler

Oliver Olberg
Manager of Hydraulic Modelling

Appendix A

Background Information

**STORMWATER MANAGEMENT
IMPLEMENTATION REPORT**

BOLTON GATEWAY DEVELOPMENTS INC.

**TOWN OF CALEDON
REGION OF PEEL**

PREPARED BY:

**C.F. CROZIER & ASSOCIATES INC.
2800 HIGH POINT DRIVE, SUITE 100
MILTON, ON L9T 6P4**

**SEPTEMBER 2014
REVISED MARCH 2015**

CFCA FILE NO. 649-3357

The material in this report reflects best judgment in light of the information available at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions made based on it, are the responsibilities of such third parties. C.F. Crozier & Associates Inc. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.



Table 4: Proposed Controlled Peak Flow Rates

Return Period (Years)	Maximum Allowable Release Rate (Per Table 1) (m ³ /s)	PROPOSED SWM FACILITY		
		Proposed Discharge (m ³ /s)	Active Storage Required (m ³)	Active Storage Provided* (m ³)
2	0.16	0.06	1660	5770
5	0.21	0.13	2200	
10	0.24	0.18	2570	
25	0.29	0.25	3050	
50	0.34	0.30	3420	
100	0.38	0.34	3790	
Regional	-	1.23	4720	

*Note: Active storage is measured from the permanent pool volume, elevation 229.1m, to the top of berm, elevation 230.60m

With the use of the proposed SWM facility, post development peak flows will respect the target flow rates for Robinson Creek for storms up to and including the 100 year event.

3.4 Stormwater Quality Control Requirements

As previously noted, the site drains to Robinson Creek and therefore is required to meet Enhanced level of protection (80% TSS removal) as defined by the MOE SWMPD Manual.

A wet pond has been selected as the preferred end of pipe treatment facility for the proposed development. Based on the MOE Stormwater Management Planning and Design Manual (2003), the following volumes are required for the contributing 8.1 ha site development area (65% composite imperviousness):

- Permanent Pool: 1404 m³
- Extended Detention: 1098 m³

A composite imperviousness of 65% imperviousness is based on the conservative value of 68% imperviousness for catchment 201, and an imperviousness of 20% for catchment 202. It is to be noted that the contributing area from the Pannia lands have been excluded from the water quality calculations given that it is not the responsibility of the proponent to provide water quality control for external lands. Refer to **Appendix D** for sizing calculations and **Section 4.1** for the provided storage volumes in the SWM facility.

Sadman Soumik

From: Jairo Morelli <Jairo.Morelli@trca.ca>
Sent: February 24, 2021 12:33 PM
To: Andrew McGregor; emma.benko@trca.ca
Cc: Banuri, Syeda; Oliver Olberg; Peter Cho; Matthew de Wit; Sadman Soumik; Dilnesaw Chekol
Subject: FW: Hwy 50 Drainage Improvements Class EA

[CAUTION EXTERNAL EMAIL] Make Sure that it is legitimate **before** Replying or Clicking on any links

Hi Andrew

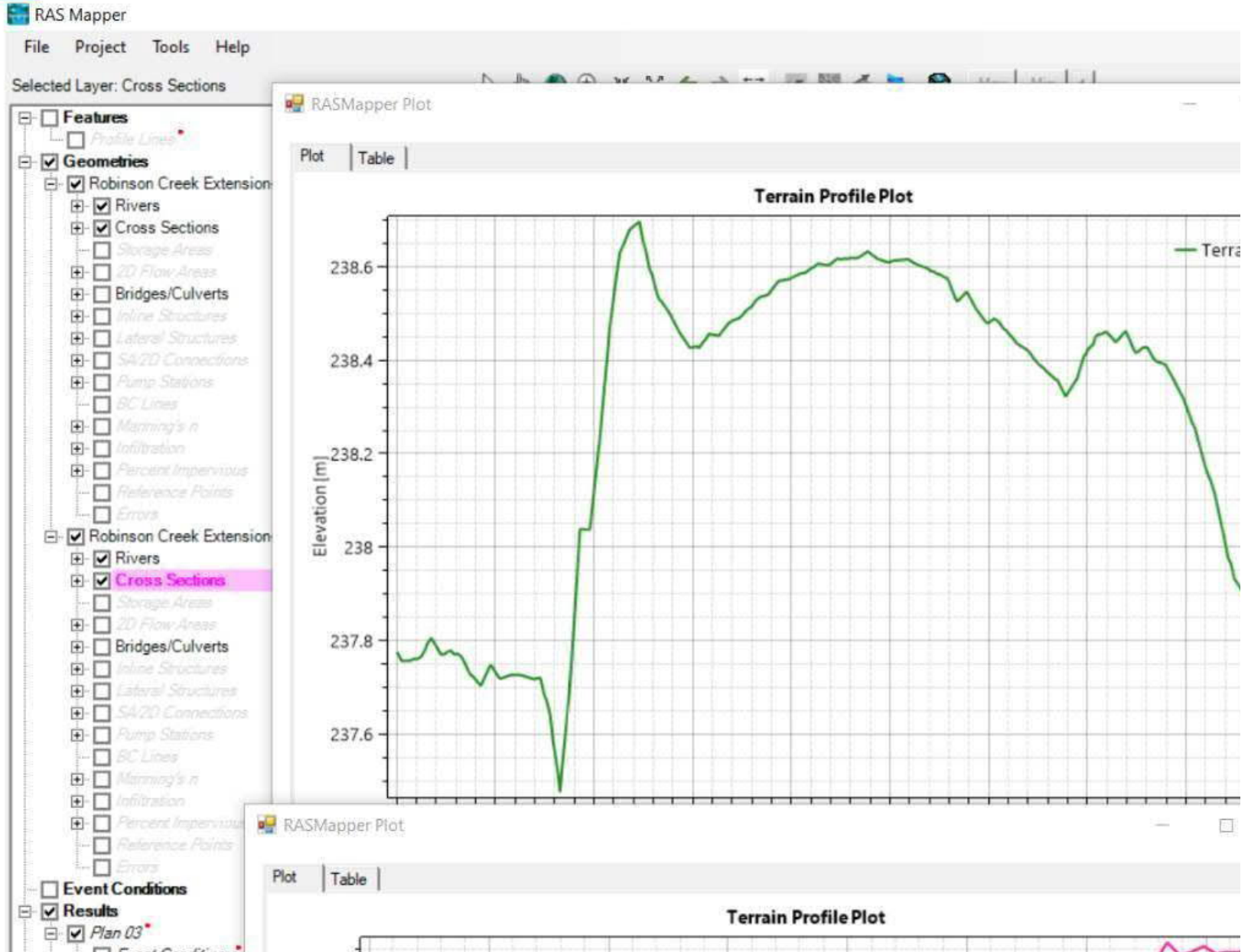
Staff had the opportunity to review the HEC RAS model and peak flows associated with the above-noted project. It appears that the flows resulting from the Humber River hydrology update are correct and consistent with those used in the hydraulic model.

We run a series of scenarios to simulate the conveyance of flow through the complex crossing at Geroge Bolton and Highway #50 and the analysis demonstrated that the rating curve used in the model is acceptable. The fact that flooding has not been frequently recorded within the intersection may be among others due to:

- The model is run in a steady-state assuming an unlimited supply of water to represent worst-case scenarios.
- The average ground elevations along the curb (parallel to the west side ditch =238.70m), appear to be a bit higher than the one assumed for the centreline of the road (238.50m). Please refer to the cross-sections shown below, which illustrate ground elevations across the intersection, cut from left to right looking north.

See all photos

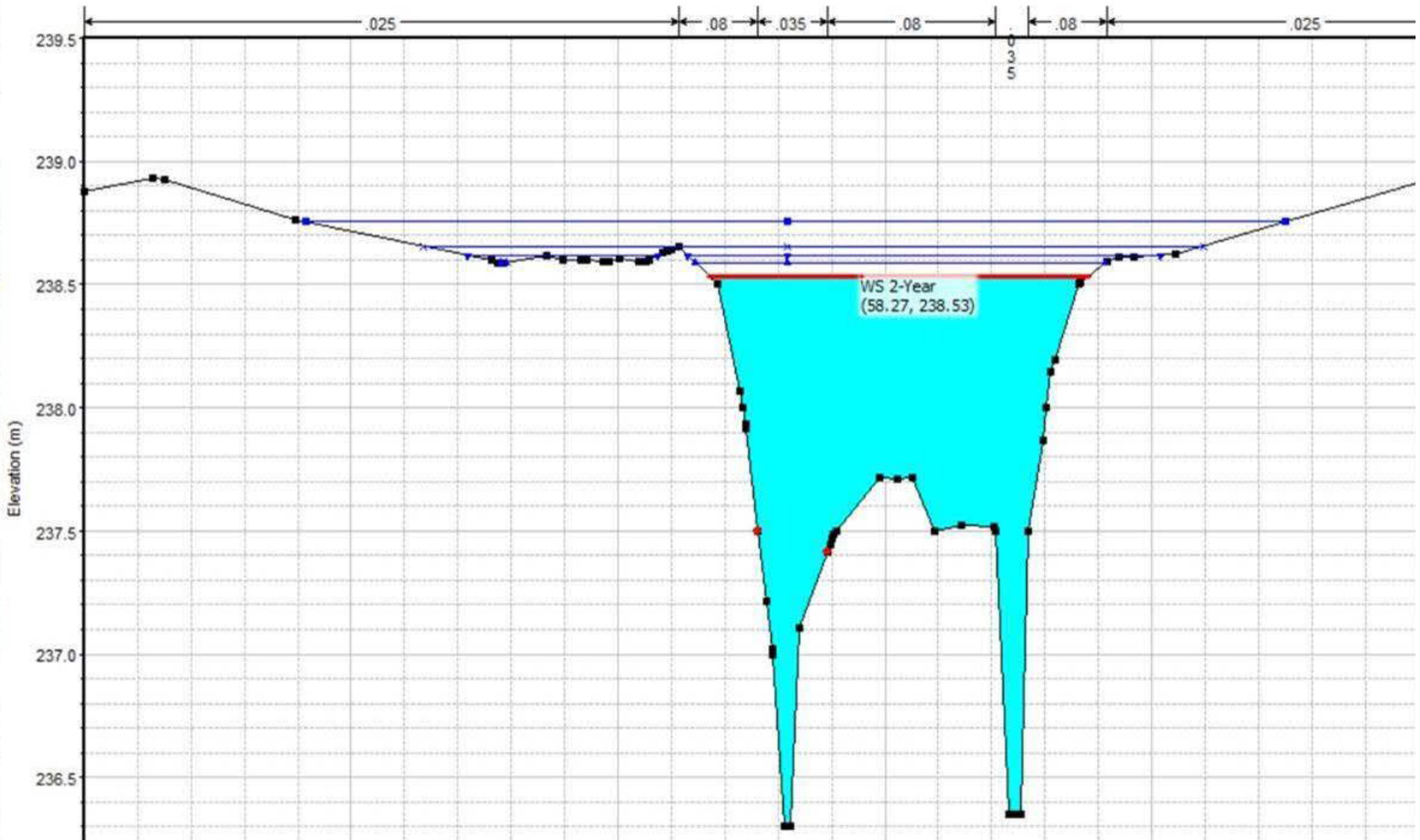
+ Add to



River: CEG_DESIGN 94.71, 237.38

Reach: REACH1 River Sta.: 2223.44

Robinson Creek Extension Project Plan: Plan 03 2/22/2021



TRCA staff run delineation using high-resolution LiDAR topography and the results show that generally, the drainage areas included in the hydrology model are more or less similar with this delineation except for some minor changes.

TRCA has no concerns, in case your team would like to take a closer look at the hydrology and/or hydraulic model. If that is the case, please let us know if your findings suggest further revisions to the models.

Due to staff and resource constraints, TRCA has a list of criteria to determine installations of stream gauges across its jurisdiction. The idea of installing a new stream gauge at the project site was discussed with the department that is responsible for the installation of stream gauges and the team indicated the site, does not satisfy the majority of the criteria. However, if the Region has an interest in installing and running it, the TRCA would be willing to provide advice.

Please contact me should you have any questions or concerns.

Regards

Jairo Morelli

Andrew McGregor <AMcGregor@rvanderson.com>; Emma Benko <emma.benko@trca.ca>

From: Andrew McGregor <AMcGregor@rvanderson.com>

Sent: Thursday, February 4, 2021 12:45 PM

To: Jairo Morelli <Jairo.Morelli@trca.ca>; Emma Benko <emma.benko@trca.ca>

Cc: Banuri, Syeda <syeda.banuri@peelregion.ca>; Oliver Olberg <OOlberg@rvanderson.com>; Peter Cho <pcho@rvanderson.com>; Matthew de Wit <MdeWit@rvanderson.com>; Sadman Soumik <ssoumik@rvanderson.com>

Subject: RE: Hwy 50 Drainage Improvements Class EA ~ Meeting Availability

Thanks Jairo,

The SWM report is attached. Let us know if you need anything else.

Kind regards,

RVA IS GROWING!

Our NEW *Halton* and *Halifax*
offices are now open.



Andrew McGregor, MCIP, RPP

Senior Planner, EA & Approvals

P: (905) 685-5049 ext. 4211

C: (905) 964-4056

R.V. Anderson Associates Limited

43 Church Street, Suite 104, St. Catharines, ON L2R 7E1

rvanderson.com



From: Jairo Morelli <Jairo.Morelli@trca.ca>

Sent: February 4, 2021 11:01 AM

To: Andrew McGregor <AMcGregor@rvanderson.com>; emma.benko@trca.ca

Cc: Banuri, Syeda <syeda.banuri@peelregion.ca>; Oliver Olberg <OOlberg@rvanderson.com>; Peter Cho <pcho@rvanderson.com>; Matthew de Wit <MdeWit@rvanderson.com>; Sadman Soumik <ssoumik@rvanderson.com>

Subject: RE: Hwy 50 Drainage Improvements Class EA ~ Meeting Availability

[CAUTION EXTERNAL EMAIL] Make Sure that it is legitimate **before** Replying or Clicking on any links

Hi Andrew

We will review the HEC RAS model and associated peak flows at the George Bolton Parkway/Hwy 50 intersection. You mentioned that you received the SWM report associated with the development site, discussed with regards to Figure 3. Would you mind providing us with that report?

I will bring the Region's proposal in regards to the monitoring of the Robinson creek into the discussion with my team next Tuesday. We aim to provide you with our suggestions/findings by the end of next week.

Regards

Jairo.

From: Andrew McGregor <AMcGregor@rvanderson.com>

Sent: Wednesday, February 3, 2021 5:21 PM

To: Jairo Morelli <Jairo.Morelli@trca.ca>; Emma Benko <emma.benko@trca.ca>

Cc: Banuri, Syeda <syeda.banuri@peelregion.ca>; Oliver Olberg <OOlberg@rvanderson.com>; Peter Cho <pcho@rvanderson.com>; Matthew de Wit

<MdeWit@rvanderson.com>; Sadman Soumik <ssoumik@rvanderson.com>

Subject: RE: Hwy 50 Drainage Improvements Class EA ~ Meeting Availability

Jairo and Emma,

Thanks for taking the time to meet earlier. Kindly review the attached notes from our meeting and note any errors or omissions. We would appreciate your follow up on the action items noted (eg. review of HEC-Ras model flows) at your earliest convenience. Any questions, please don't hesitate to ask.

Kind regards,



RVA IS GROWING!

Our NEW *Halton* and *Halifax*
offices are now open.



Andrew McGregor, MCIP, RPP

Senior Planner, EA & Approvals

P: (905) 685-5049 ext. 4211

C: (905) 964-4056

R.V. Anderson Associates Limited

43 Church Street, Suite 104, St. Catharines, ON L2R 7E1

rvanderson.com



From: Jairo Morelli <Jairo.Morelli@trca.ca>

Sent: January 29, 2021 11:39 AM

To: Andrew McGregor <AMcGregor@rvanderson.com>

Cc: Banuri, Syeda <syeda.banuri@peelregion.ca>; Oliver Olberg <OOlberg@rvanderson.com>; Peter Cho <pcho@rvanderson.com>; Matthew de Wit <MdeWit@rvanderson.com>; Sadman Soumik <ssoumik@rvanderson.com>; emma.benko@trca.ca

Subject: RE: Hwy 50 Drainage Improvements Class EA ~ Meeting Availability

[CAUTION EXTERNAL EMAIL] Make Sure that it is legitimate **before** Replying or Clicking on any links

Hi Andrew

Emma from our team will provide you with potential dates

In order to facilitate our meeting/discussion I would like to provide you with the following information:

Figure 1

We welcome the refinement or addition of drainage areas that were not part of the existing hydraulic model and may impact your study area. If feasible please provide us with the estimated flows and supporting calculations/assumptions before our meeting.

Figure 2

I will take a further look at this project next week. However, as far as I remember the description that you mentioned for the arrangement of the 900 and 600mm culverts that join to a large box under RR50 is correct.

We do not have any evidence of flooding on this intersection (Peel Region may know). However, we cannot predict it would not be flooded in the future. Due to the complex “hydraulics” of the three culverts that join at the George Bolton Parkway/RR50 intersection, the hydraulic update concluded that using a rating curve at the crossing will better simulate the existing conditions. You may refer to the COLE Hydraulic Report dated March 24, 2015, for further details.

The flows that were used in the HEC RAS model were derived from the hydrology study update we had at the time the HEC RAS was completed. We encourage your team to use these flows. However, if you would like to reassess them feel free to do so and provide us with the supporting calculations/modeling, hydrological parameters and relevant documentation.

We suggest the consultant investigate further opportunities to upgrade this crossing and reduce the existing flooding conditions as much as possible.

Figure 3

TRCA supports any measure that alleviates or enhance the existing flooding condition throughout the study area based on available BMP. Please go ahead and provide us with the rationale that supports your findings. We will take a look at TRCA database and provide you with details (if any) on the controlled flows from the mentioned new development.

Please contact me should you have further questions or concerns

Regards

Jairo Morelli

From: Andrew McGregor <AMcGregor@rvanderson.com>

Sent: Thursday, January 28, 2021 12:24 PM

To: Jairo Morelli <Jairo.Morelli@trca.ca>

Cc: Banuri, Syeda <syeda.banuri@peelregion.ca>; Oliver Olberg <OOlberg@rvanderson.com>; Peter Cho <pcho@rvanderson.com>; Matthew de Wit <MdeWit@rvanderson.com>; Sadman Soumik <ssoumik@rvanderson.com>

Subject: Hwy 50 Drainage Improvements Class EA ~ Meeting Availability

Hello Jairo,



RVA IS GROWING!

Our NEW *Halton* and *Halifax*
offices are now open.



Andrew McGregor, MCIP, RPP

Senior Planner, EA & Approvals

P: (905) 685-5049 ext. 4211

C: (905) 964-4056

R.V. Anderson Associates Limited

43 Church Street, Suite 104, St. Catharines, ON L2R 7E1

rvanderson.com



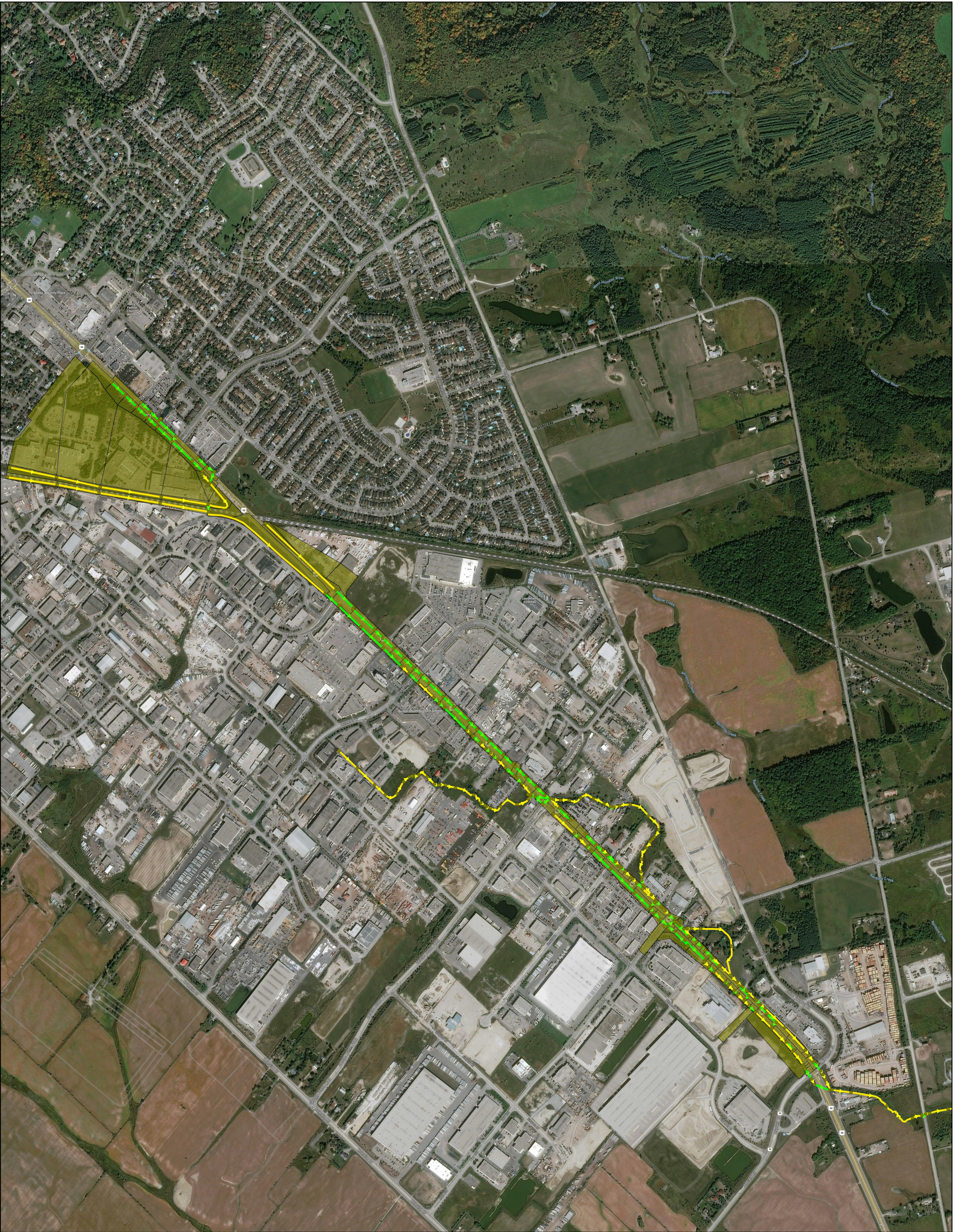
R.V. Anderson Associates Limited has been engaged in the provision of professional engineering, operations, and management services since 1948. This message is intended only for the use of the individual(s) to whom it is addressed. If you are not the intended recipient(s), disclosure, copying, distribution and use are prohibited; please notify us immediately and delete this email from your systems. Please see <http://www.rvanderson.com> for Copyright and Terms of Use.

R.V. Anderson Associates Limited has been engaged in the provision of professional engineering, operations, and management services since 1948. This message is intended only for the use of the individual(s) to whom it is addressed. If you are not the intended recipient(s), disclosure, copying, distribution and use are prohibited; please notify us immediately and delete this email from your systems. Please see <http://www.rvanderson.com> for Copyright and Terms of Use.

R.V. Anderson Associates Limited has been engaged in the provision of professional engineering, operations, and management services since 1948. This message is intended only for the use of the individual(s) to whom it is addressed. If you are not the intended recipient(s), disclosure, copying, distribution and use are prohibited; please notify us immediately and delete this email from your systems. Please see <http://www.rvanderson.com> for Copyright and Terms of Use.

Appendix B

Hydraulic Modelling Outputs



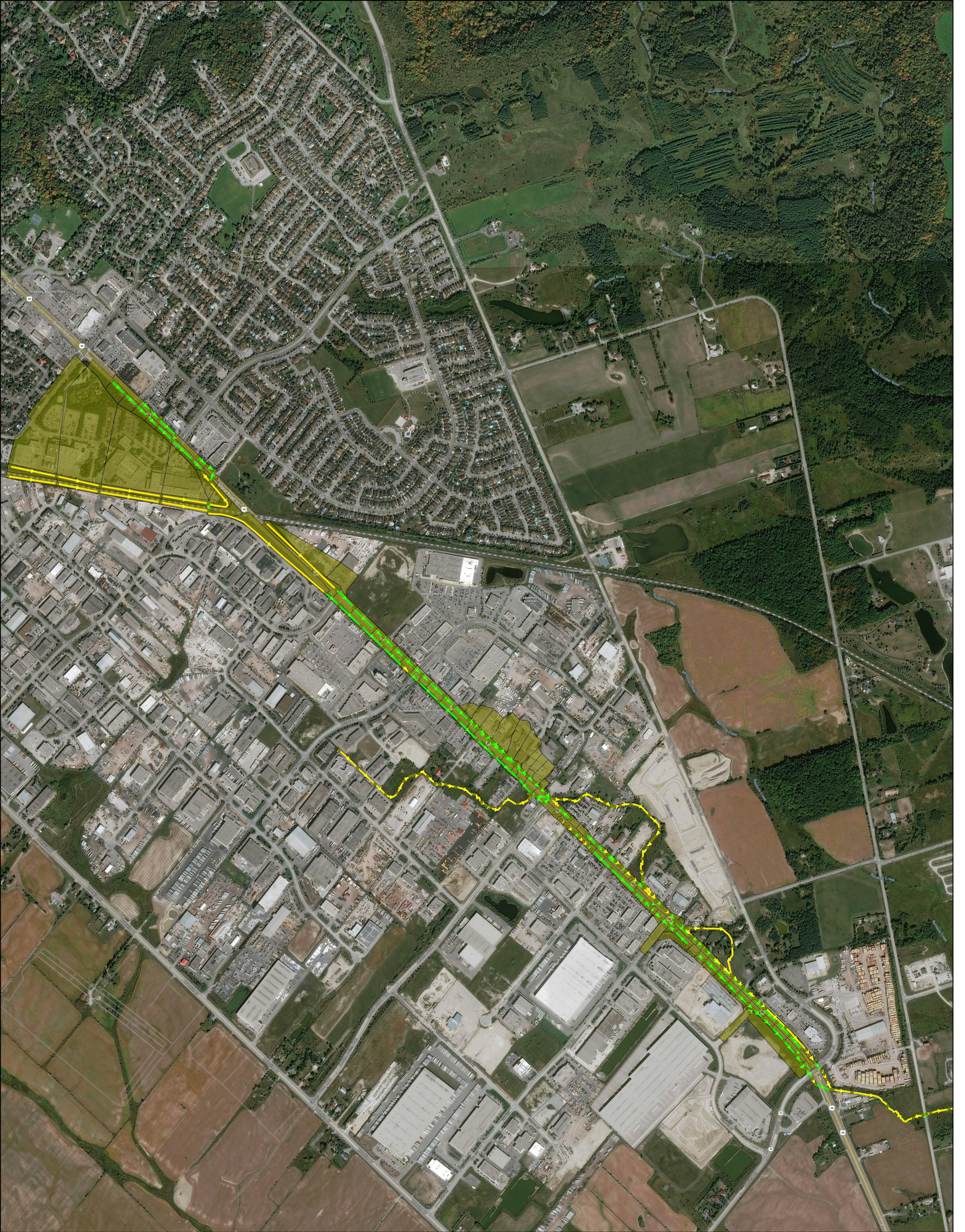
Legend

- ◻ NODES/MANHOLES
- CHANNEL/CREEK/DITCH
- STORM SEWERS/CULVERTS
- SUBCATCHMENTS

REGION ROAD 50 FROM MAYFIELD ROAD TO HEALEY ROAD EXISTING DRAINAGE OVERVIEW MAP

2

RVA PROJECT NO: 194615



Legend

- ◻ NODES/MANHOLES
- CHANNEL/CREEK/DITCH
- STORM SEWERS/CULVERTS
- SUBCATCHMENTS

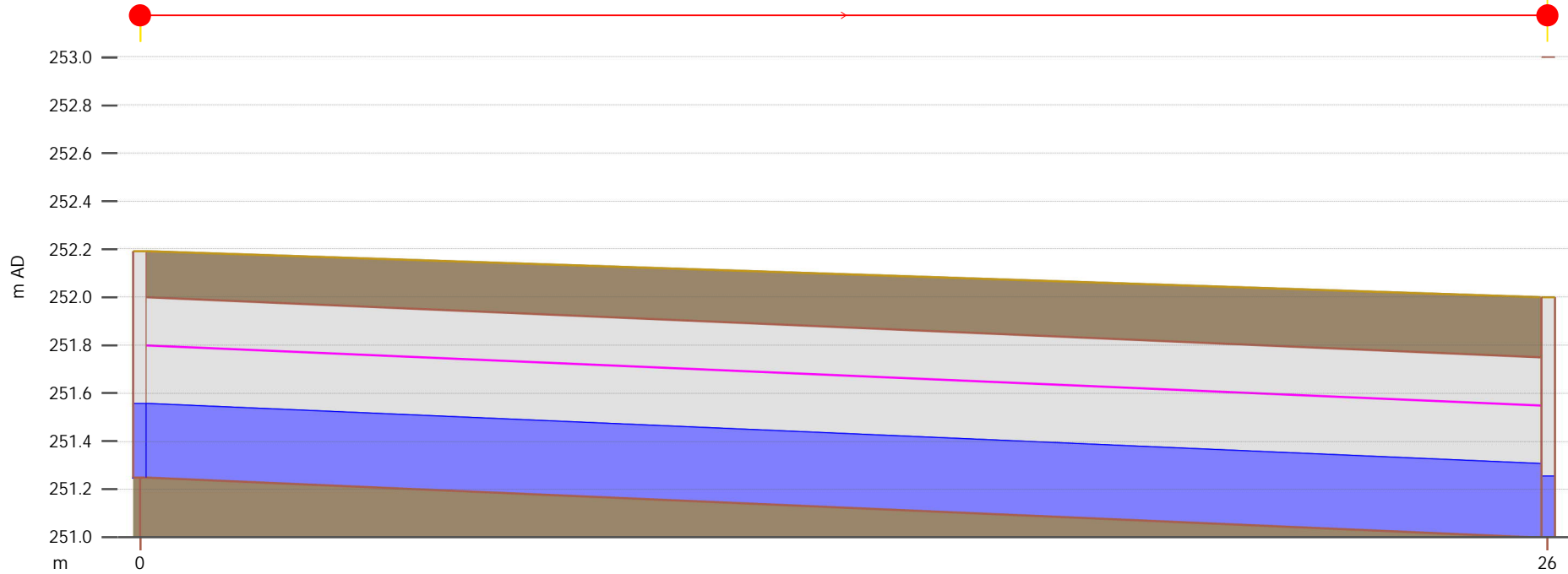
REGION ROAD 50 FROM MAYFIELD ROAD TO HEALEY ROAD PROPOSED DRAINAGE OVERVIEW MAP

2

RVA PROJECT NO: 194615



EXISTING CONDITION - 10 - YEAR - WEST SIDE PLAN 1



Link	RR-WD-1.1
US node ID	RR-WD-1
ds node	RR-WD-2
numbarrels	1
length (m)	26.3
Shape ID	CIRC
width (mm)	750
height (mm)	750
Rough type	N
us inv (m AD)	251.250
ds inv (m AD)	251.000
grad (m/m)	0.00952
r.pfc (m3/s)	1.086
US depth (m)	0.307
US flow (m3/s)	0.37046
US velocity (m/s)	2.181

Node	RR-WD-1	RR-WD-2
Node ID	RR-WD-1	RR-WD-2
ground (m AD)	252.191	252.000
level (m AD)	251.557	251.254
expr:Freeboard	0.634161	0.745789

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 1



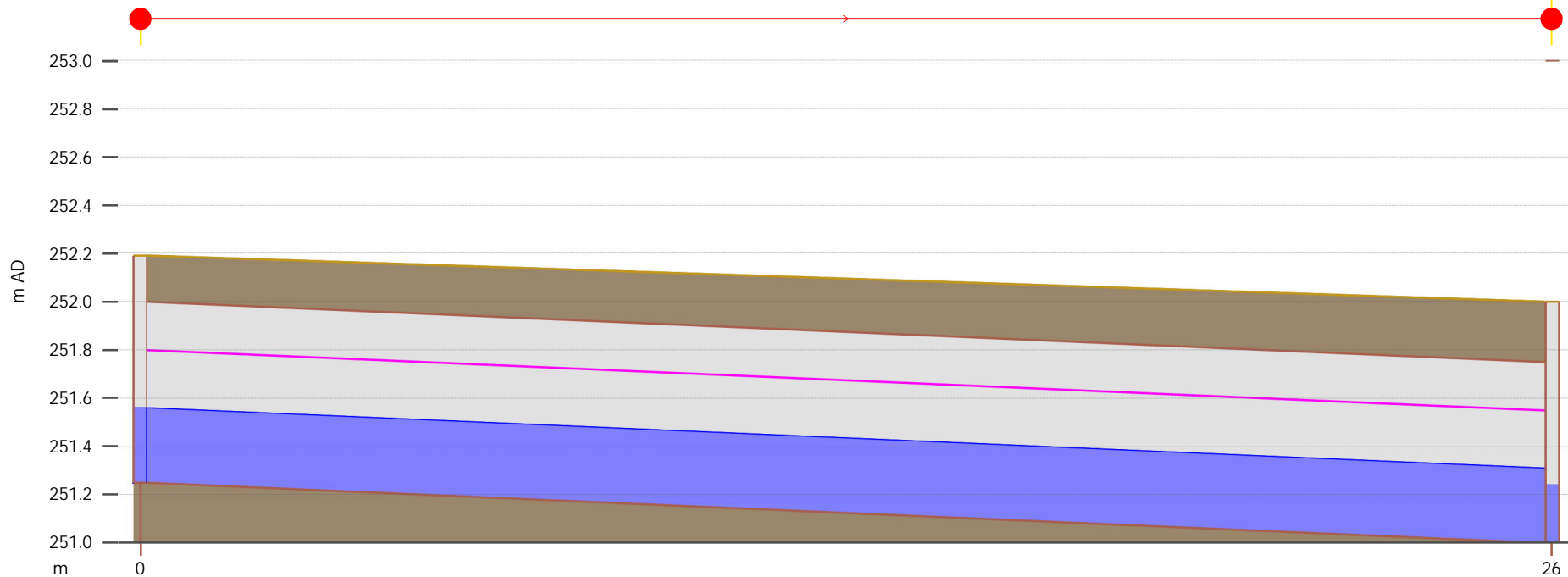
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 1

RVA PROJECT NO. 194615

FIGURE NO. 1C

AUGUST 2021





Link	RR-WD-1.1
US node ID	RR-WD-1
ds node	RR-WD-2
numbarrels	1
length (m)	26.3
Shape ID	CIRC
width (mm)	750
height (mm)	750
Rough type	N
us inv (m AD)	251.250
ds inv (m AD)	251.000
grad (m/m)	0.00952
r.pfc (m3/s)	1.086
US depth (m)	0.307
US flow (m3/s)	0.37129
US velocity (m/s)	2.183

Node	RR-WD-1	RR-WD-2
Node ID	RR-WD-1	RR-WD-2
ground (m AD)	252.191	252.000
level (m AD)	251.557	251.238
expr:Freeboard	0.633780	0.761581

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 1

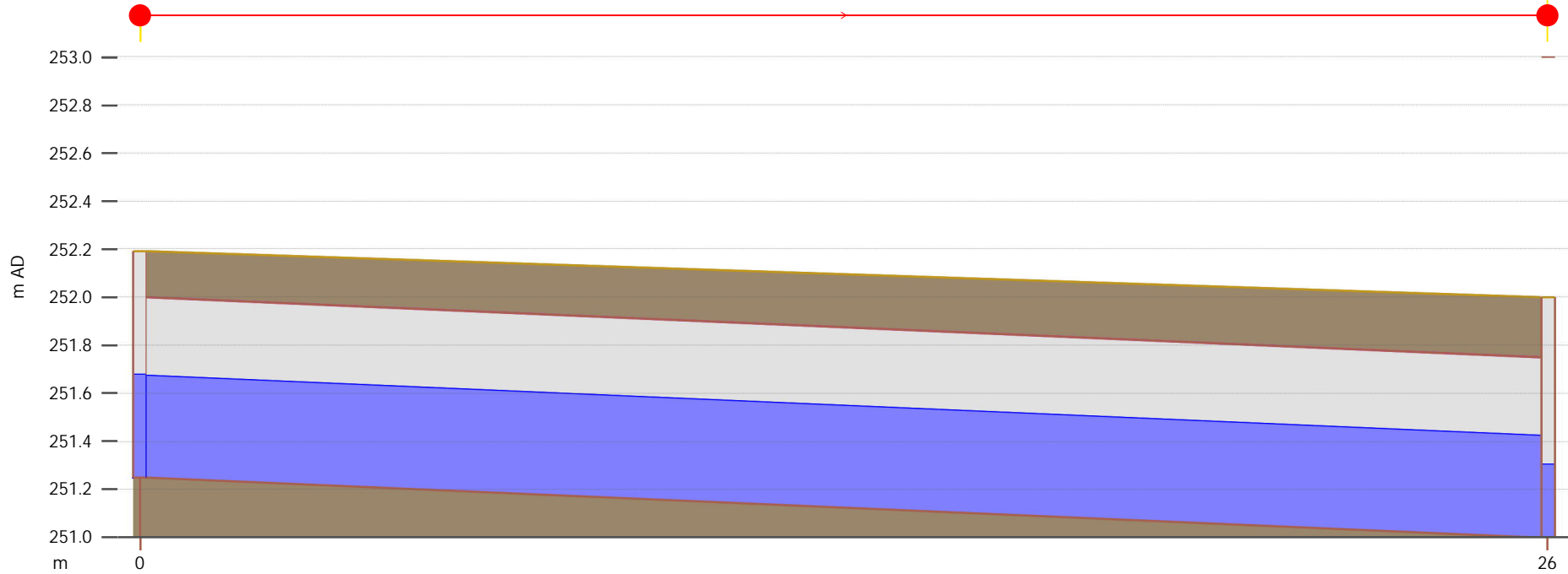


EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 1

RVA PROJECT NO. 194615

FIGURE NO. 1E

AUGUST 2021



Link	RR-WD-1.1	
US node ID	RR-WD-1	
ds node	RR-WD-2	
numbarrels	1	
length (m)	26.3	
Shape ID	CIRC	
width (mm)	750	
height (mm)	750	
Rough type	N	
us inv (m AD)	251.250	
ds inv (m AD)	251.000	
grad (m/m)	0.00952	
r.pfc (m3/s)	1.086	
US depth (m)	0.422	
US flow (m3/s)	0.64887	
US velocity (m/s)	2.532	

Node	RR-WD-1	RR-WD-2
Node ID	RR-WD-1	RR-WD-2
ground (m AD)	252.191	252.000
level (m AD)	251.677	251.303
expr:Freeboard	0.513891	0.697281

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 1



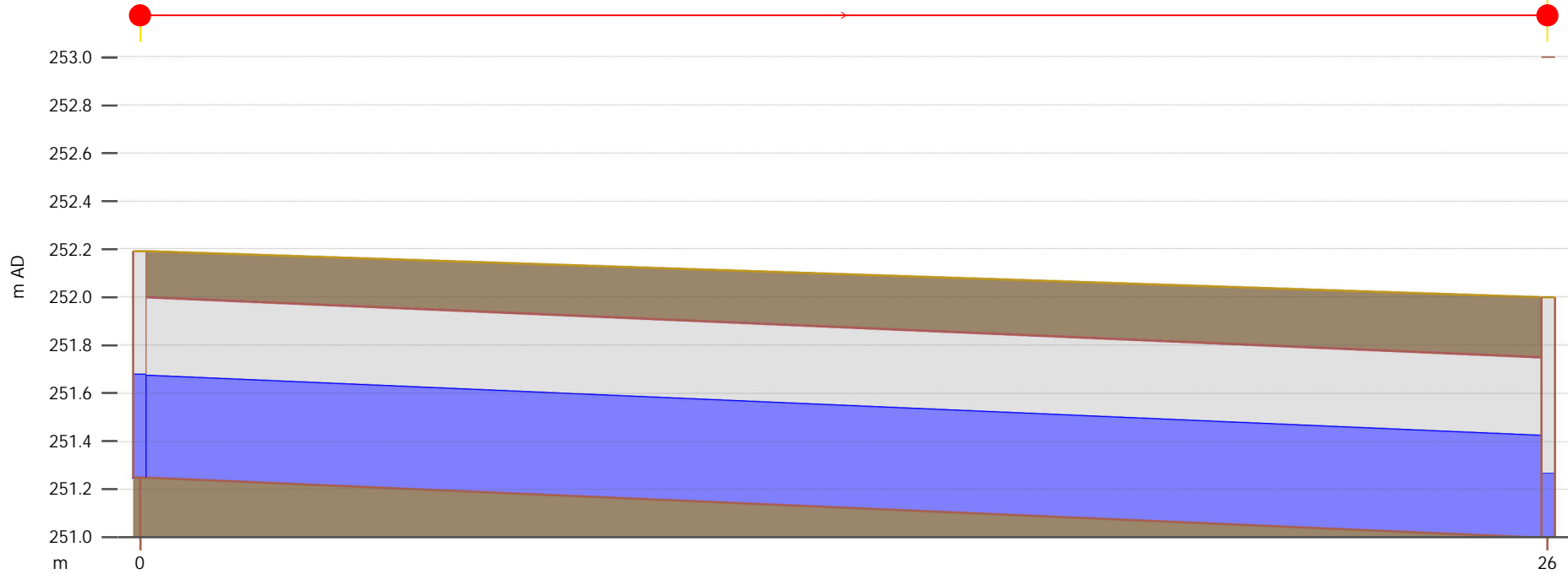
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 1

RVA PROJECT NO. 194615

FIGURE NO. 1G

AUGUST 2021





Link	RR-WD-1.1
US node ID	RR-WD-1
ds node	RR-WD-2
numbarrels	1
length (m)	26.3
Shape ID	CIRC
width (mm)	750
height (mm)	750
Rough type	N
us inv (m AD)	251.250
ds inv (m AD)	251.000
grad (m/m)	0.00952
r.pfc (m3/s)	1.086
US depth (m)	0.423
US flow (m3/s)	0.65001
US velocity (m/s)	2.534

Node	RR-WD-1	RR-WD-2
Node ID	RR-WD-1	RR-WD-2
ground (m AD)	252.191	252.000
level (m AD)	251.678	251.265
expr:Freeboard	0.513495	0.735275

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 1

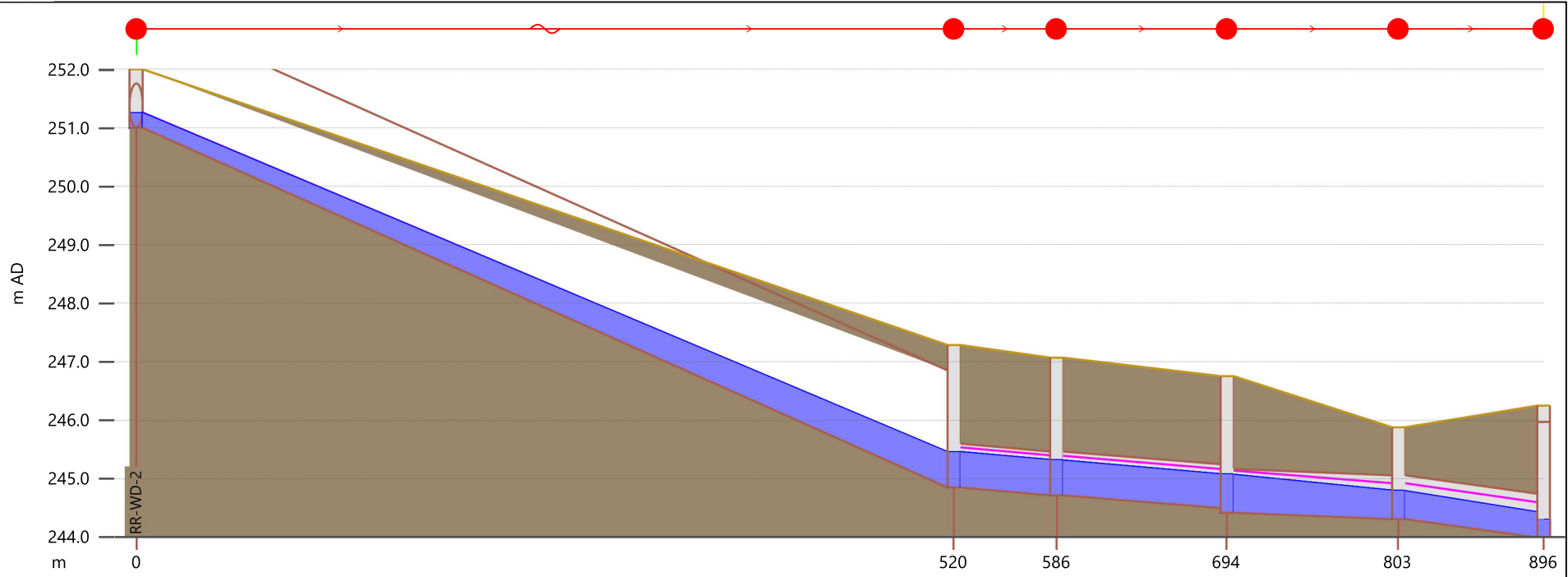


EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 2

RVA PROJECT NO. 194615

FIGURE NO. 2A

AUGUST 2021



Link	RR-WD-2.1	RR-WD-3.1	RR-WD-4.1	RR-WD-5.1	RR-WD-6.1
US node ID	RR-WD-2	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6
ds node	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6	RR-WD-7
numbarrels	1	1	1	1	1
length (m)	Channel (Assumption)	65.5	108.3	109.1	92.6
Shape ID	Channel (Assumption)	CIRC	CIRC	CIRC	CIRC
width (mm)	Channel (Assumption)	750	750	750	750
height (mm)	Channel (Assumption)	750	750	750	750
Rough type	Channel (Assumption)	N	N	N	N
us inv (m AD)	251.000	244.853	244.720	244.420	244.310
ds inv (m AD)	244.853	244.720	244.500	244.310	244.000
grad (m/m)	Channel (Assumption)	0.00203	0.00203	0.00101	0.00335
r.pfc (m3/s)	56.632	0.502	0.502	0.354	0.644
US depth (m)	0.254	0.601	0.592	0.653	0.482
US flow (m3/s)	0.52896	0.48954	0.48840	0.48626	0.48641
US velocity (m/s)	0.383	1.328	1.338	1.195	1.620
Node	RR-WD-2	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6
Node ID	RR-WD-2	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6
ground (m AD)	252.000	247.288	247.068	246.754	245.882
level (m AD)	251.254	245.460	245.318	245.079	244.797
expr:Freeboard	0.745789	1.828451	1.750114	1.674944	1.085648

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 2

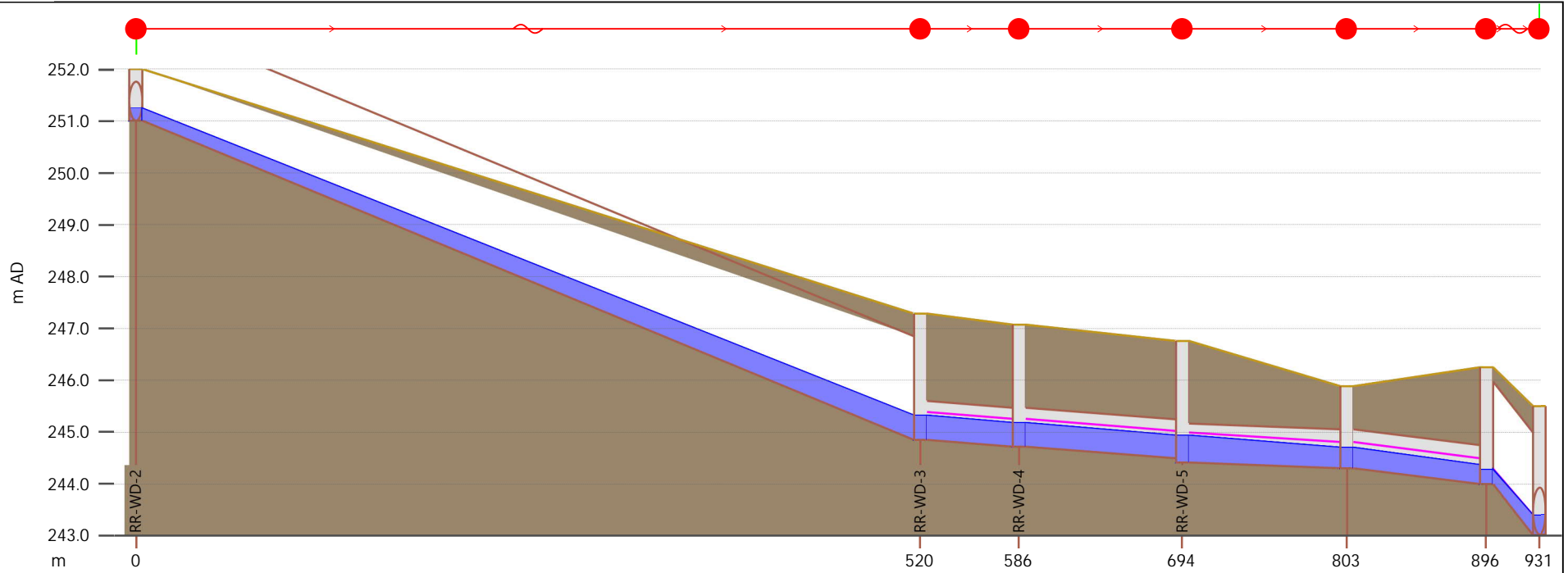


PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 2

RVA PROJECT NO. 194615

FIGURE NO. 2C

AUGUST 2021



Link	RR-WD-2.1	RR-WD-3.1	RR-WD-4.1	RR-WD-5.1	RR-WD-6.1	-
US node ID	RR-WD-2	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6	-
ds node	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6	RR-WD-7	-
numbarrels	1	1	1	1	1	1
length (m)		65.5	108.3	109.1	92.6	
Shape ID	Channel (Assumption)	CIRC	CIRC	CIRC	CIRC	-
width (mm)		750	750	750	750	
height (mm)		750	750	750	750	
Rough type		N	N	N	N	
us inv (m AD)	251.000	244.853	244.720	244.420	244.310	-
ds inv (m AD)	244.853	244.720	244.500	244.310	244.000	-
grad (m/m)		0.00203	0.00203	0.00101	0.00335	
r.pfc (m3/s)	56.632	0.502	0.502	0.354	0.644	-
US depth (m)	0.238	0.463	0.457	0.514	0.390	0.272
US flow (m3/s)	0.36168	0.34999	0.34984	0.34776	0.34808	-
US velocity (m/s)	0.280	1.246	1.256	1.083	1.500	0.711
Node	RR-WD-2	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6	RR-WD-7
Node ID	RR-WD-2	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6	RR-WD-7
ground (m AD)	252.000	247.288	247.068	246.754	245.882	246.250
level (m AD)	251.238	245.318	245.179	244.936	244.701	244.272
expr:Freeboard	0.761581	1.970266	1.888572	1.817675	1.181824	1.978470

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 2



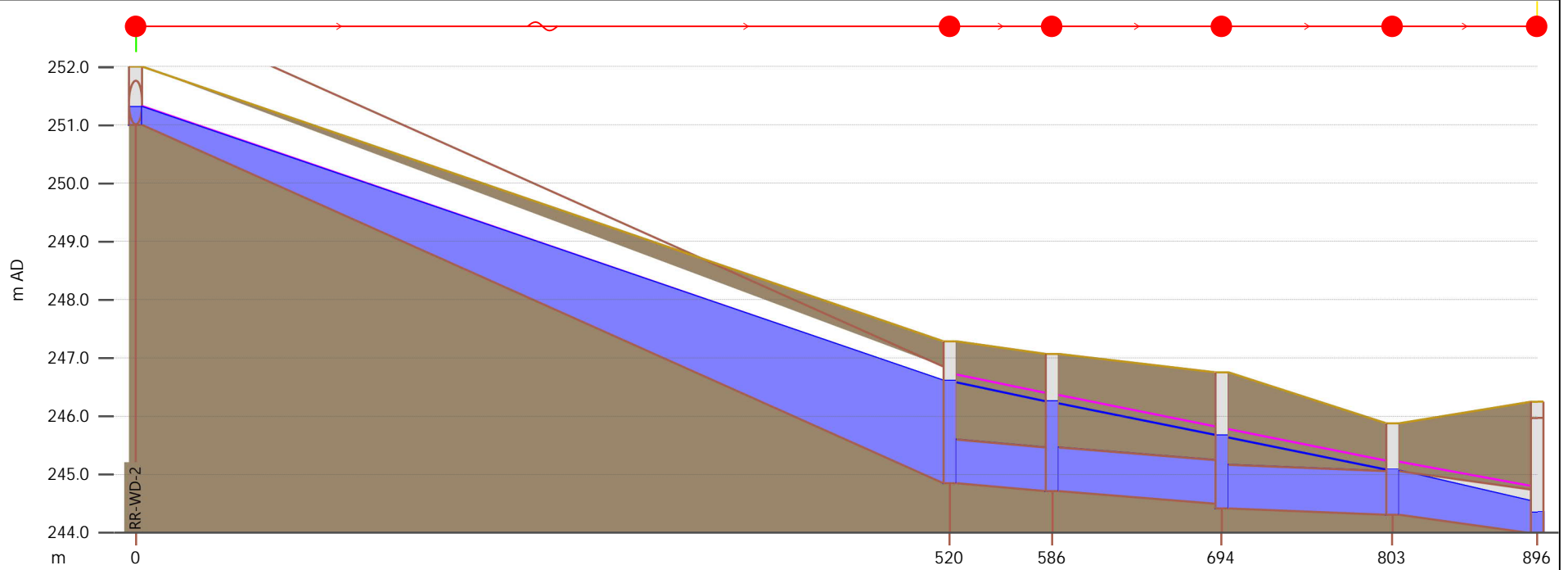
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 2

RVA PROJECT NO. 194615

FIGURE NO. 2E

AUGUST 2021





Link	RR-WD-2.1	RR-WD-3.1	RR-WD-4.1	RR-WD-5.1	RR-WD-6.1	
US node ID	RR-WD-2	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6	
ds node	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6	RR-WD-7	
numbarrels	1	1	1	1	1	
length (m)	Channel (Assumption)	65.5	108.3	109.1	92.6	
Shape ID		CIRC	CIRC	CIRC	CIRC	
width (mm)		750	750	750	750	
height (mm)		750	750	750	750	
Rough type		N	N	N	N	
us inv (m AD)	251.000	244.853	244.720	244.420	244.310	
ds inv (m AD)	244.853	244.720	244.500	244.310	244.000	
grad (m/m)		0.00203	0.00203	0.00101	0.00335	
r.pfc (m3/s)	56.632	0.502	0.502	0.354	0.644	
US depth (m)	0.303	1.731	1.504	1.220	0.758	
US flow (m3/s)	1.09942	0.77860	0.78344	0.78342	0.78670	
US velocity (m/s)	0.661	1.650	1.672	1.688	1.759	
Node	RR-WD-2	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6	-
Node ID	RR-WD-2	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6	-
ground (m AD)	252.000	247.288	247.068	246.754	245.882	-
level (m AD)	251.303	246.606	246.257	245.678	245.088	-
expr:Freeboard	0.697281	0.681631	0.811179	1.076464	0.794662	-

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 2

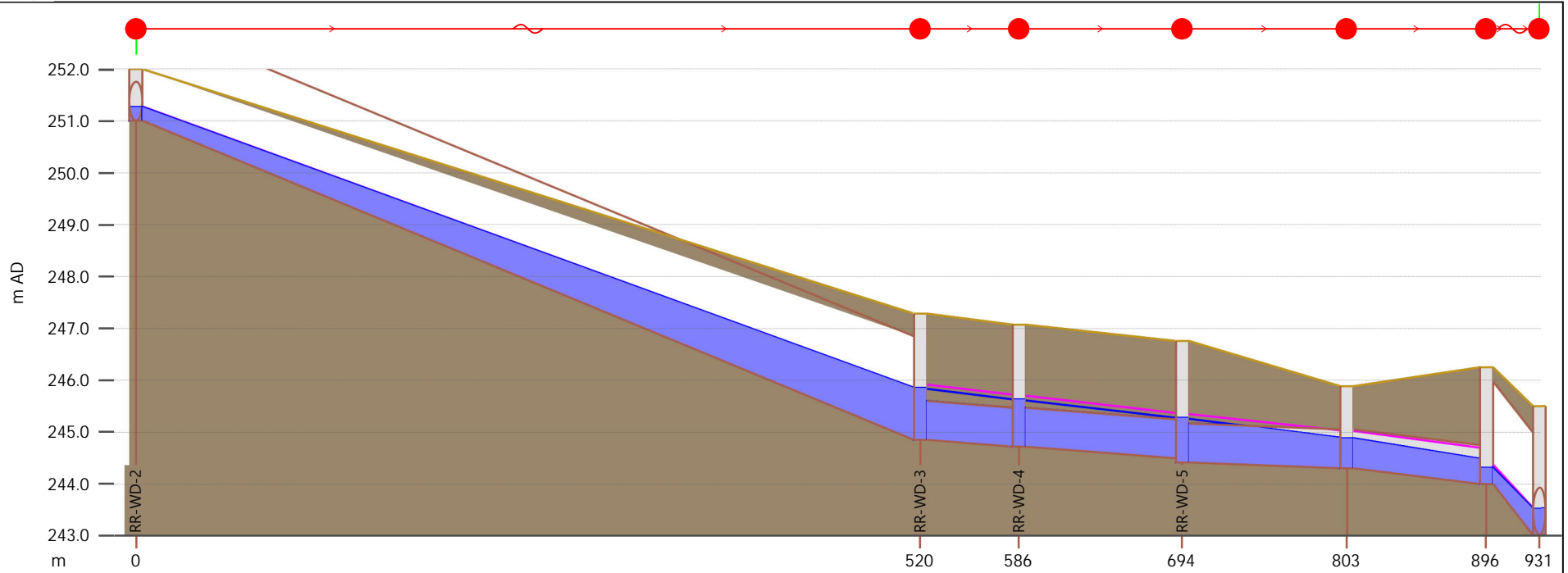


PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 2

RVA PROJECT NO. 194615

FIGURE NO. 2G

AUGUST 2021



Link	RR-WD-2.1	RR-WD-3.1	RR-WD-4.1	RR-WD-5.1	RR-WD-6.1	-
US node ID	RR-WD-2	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6	-
ds node	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6	RR-WD-7	-
numbarrels	1	1	1	1	1	1
length (m)		65.5	108.3	109.1	92.6	
Shape ID	Channel (Assumption)	CIRC	CIRC	CIRC	CIRC	-
width (mm)		750	750	750	750	
height (mm)		750	750	750	750	
Rough type		N	N	N	N	
us inv (m AD)	251.000	244.853	244.720	244.420	244.310	-
ds inv (m AD)	244.853	244.720	244.500	244.310	244.000	-
grad (m/m)		0.00203	0.00203	0.00101	0.00335	
r.pfc (m3/s)	56.632	0.502	0.502	0.354	0.644	-
US depth (m)	0.265	0.979	0.893	0.842	0.569	0.316
US flow (m3/s)	0.63929	0.60675	0.61389	0.61373	0.61861	-
US velocity (m/s)	0.443	1.381	1.397	1.339	1.724	1.036
Node	RR-WD-2	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6	RR-WD-7
Node ID	RR-WD-2	RR-WD-3	RR-WD-4	RR-WD-5	RR-WD-6	RR-WD-7
ground (m AD)	252.000	247.288	247.068	246.754	245.882	246.250
level (m AD)	251.265	245.853	245.634	245.278	244.887	244.316
expr:Freeboard	0.735275	1.434713	1.433952	1.476260	0.994995	1.933670

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 2



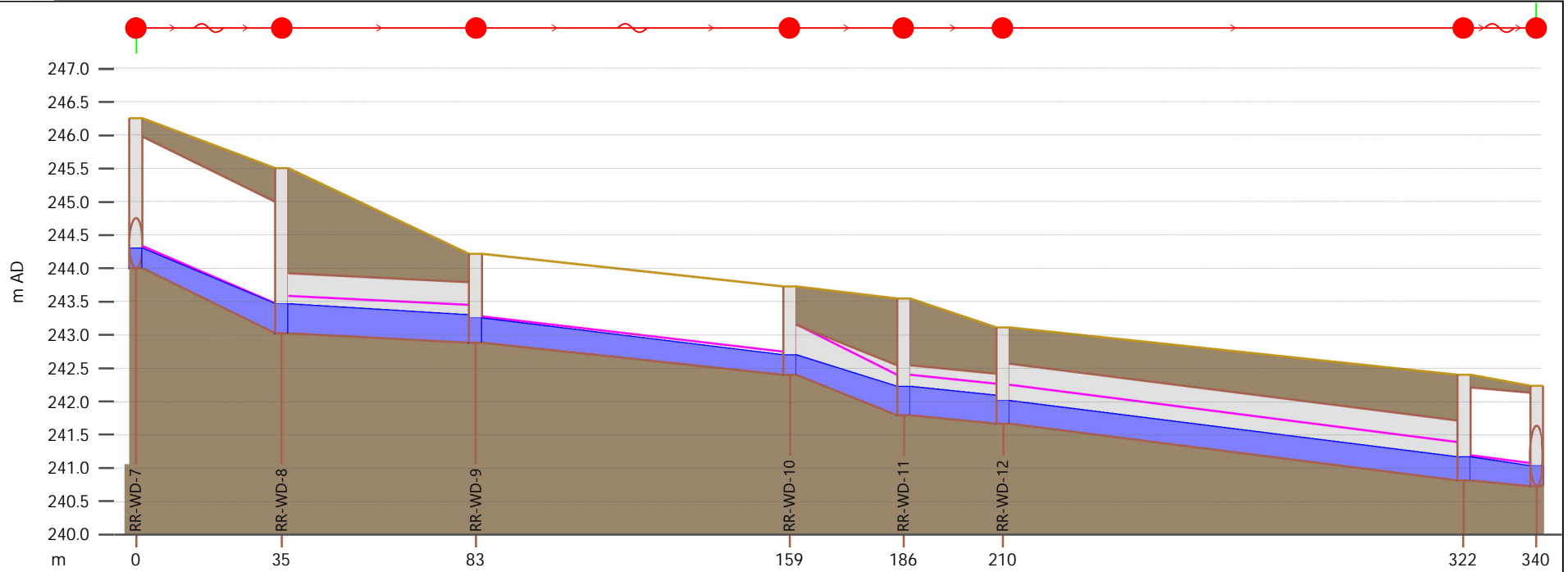
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 3

RVA PROJECT NO. 194615

FIGURE NO. 3A

AUGUST 2021





Link	RR-WD-7.1	RR-WD-8.1	RR-WD-9.1	RR-WD-10.1	-	RR-WD-12.1	-	
US node ID	RR-WD-7	RR-WD-8	RR-WD-9	RR-WD-10	RR-WD-11	RR-WD-12	-	
ds node	RR-WD-8	RR-WD-9	RR-WD-10	RR-WD-11	RR-WD-12	RR-WD-13	-	
numbarrels	1	1	1	1	1	1	1	
length (m)	-	47.2	-	27.7	24.1	111.9	-	
Shape ID	-	CIRC	-	CIRC	CIRC	CIRC	-	
width (mm)	-	900	-	750	750	900	-	
height (mm)	-	900	-	750	750	900	-	
Rough type	-	N	-	N	N	N	-	
us inv (m AD)	244.000	243.022	242.887	242.399	241.796	241.668	240.816	
ds inv (m AD)	243.022	242.887	242.399	241.796	241.668	240.816	240.733	
grad (m/m)	-	0.00286	-	0.02180	0.00531	0.00762	-	
r.pfc (m3/s)	51.110	0.969	8.878	1.644	0.811	1.580	9.679	
US depth (m)	0.293	0.440	0.358	0.292	0.421	0.343	0.351	
US flow (m3/s)	0.48713	0.48554	0.48545	0.48226	0.48243	0.48260	0.48238	
US velocity (m/s)	0.897	1.571	0.823	3.027	1.888	2.170	0.780	
Node	-	RR-WD-8	RR-WD-9	RR-WD-10	RR-WD-11	RR-WD-12	RR-WD-13	-
Node ID	-	RR-WD-8	RR-WD-9	RR-WD-10	RR-WD-11	RR-WD-12	RR-WD-13	-
ground (m AD)	-	245.500	244.218	243.730	243.548	243.114	242.400	-
level (m AD)	-	243.462	243.245	242.692	242.220	242.011	241.167	-
expr:Freeboard	-	2.037827	0.972562	1.038258	1.327846	1.102983	1.232794	-

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 3

RVA PROJECT NO. 194615

FIGURE NO. 3B

AUGUST 2021





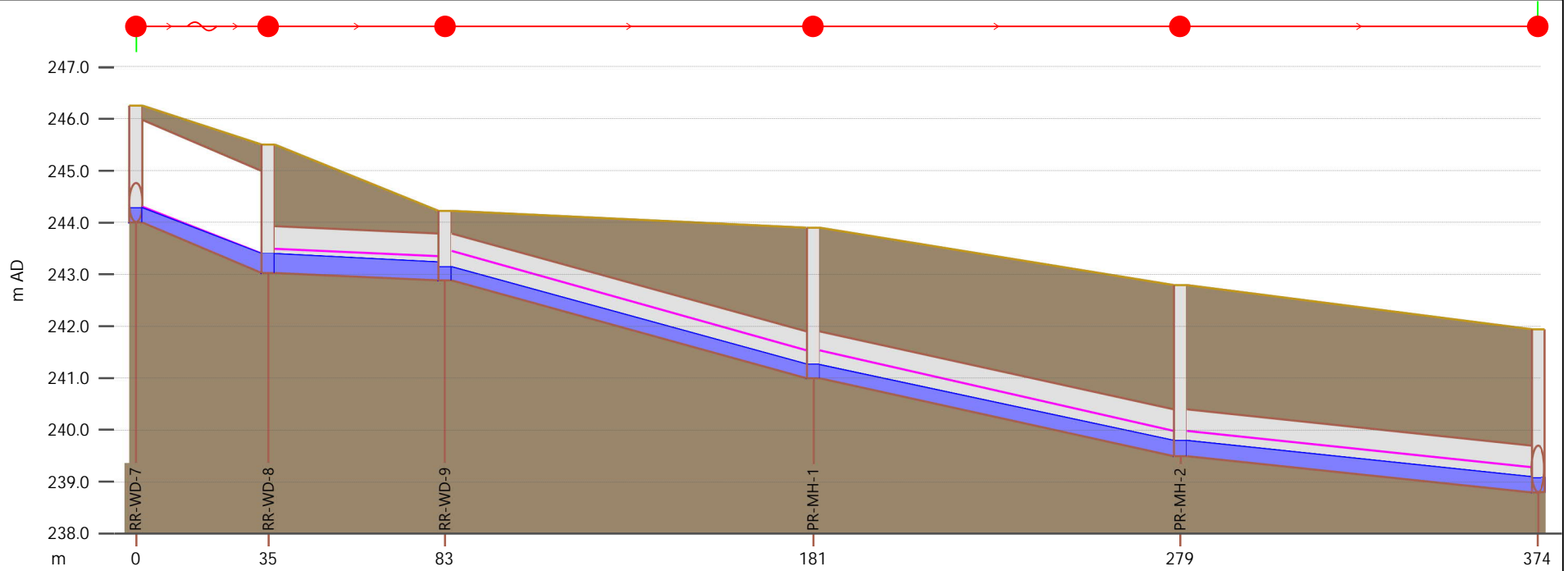
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 3

RVA PROJECT NO. 194615

FIGURE NO. 3C

AUGUST 2021





Link	RR-WD-7.1	RR-WD-8.1	RR-WD-9.1	PR-MH-1.1	PR-MH-2.1	
US node ID	RR-WD-7	RR-WD-8	RR-WD-9	PR-MH-1	PR-MH-2	
ds node	RR-WD-8	RR-WD-9	PR-MH-1	PR-MH-2	PR-MH-3	
numbarrels	1	1	1	1	1	
length (m)		47.2	98.3	98.0	95.6	
Shape ID		CIRC	CIRC	CIRC	CIRC	
width (mm)		900	900	900	900	
height (mm)		900	900	900	900	
Rough type		N	N	N	N	
us inv (m AD)	244.000	243.022	242.887	241.000	239.500	
ds inv (m AD)	243.022	242.887	241.000	239.500	238.800	
grad (m/m)		0.00286	0.01919	0.01531	0.00733	
r.pfc (m3/s)	51.110	0.969	2.508	2.240	1.550	
US depth (m)	0.272	0.368	0.245	0.256	0.295	
US flow (m3/s)	0.34897	0.34760	0.34861	0.34916	0.34887	
US velocity (m/s)	0.711	1.419	2.484	2.341	1.924	
Node	-	RR-WD-8	RR-WD-9	PR-MH-1	PR-MH-2	PR-MH-3
Node ID	-	RR-WD-8	RR-WD-9	PR-MH-1	PR-MH-2	PR-MH-3
ground (m AD)	-	245.500	244.218	243.900	242.788	241.937
level (m AD)	-	243.391	243.133	241.256	239.795	239.074
expr:Freeboard	-	2.109436	1.085462	2.643576	2.992849	2.863025

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 3



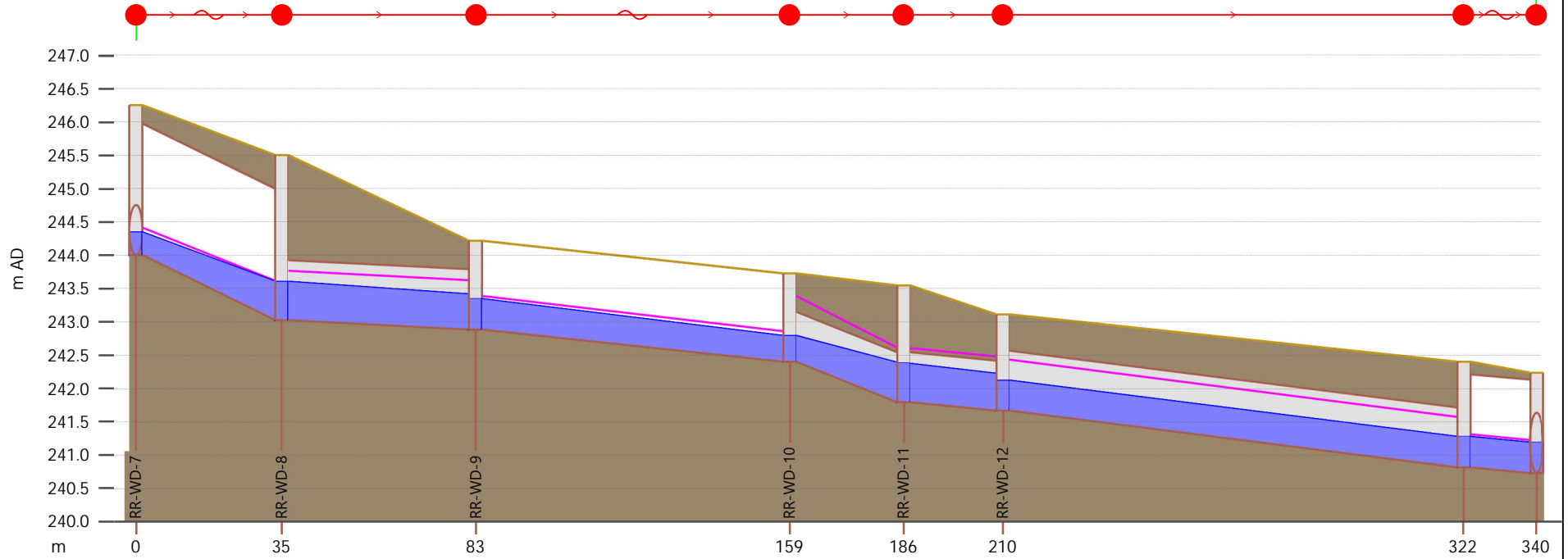
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 3

RVA PROJECT NO. 194615

FIGURE NO. 3E

AUGUST 2021





Link	RR-WD-7.1	RR-WD-8.1	RR-WD-9.1	RR-WD-10.1	-	RR-WD-12.1	-	
US node ID	RR-WD-7	RR-WD-8	RR-WD-9	RR-WD-10	RR-WD-11	RR-WD-12	-	
ds node	RR-WD-8	RR-WD-9	RR-WD-10	RR-WD-11	RR-WD-12	RR-WD-13	-	
numbarrels	1	1	1	1	1	1	1	
length (m)	-	47.2	-	27.7	24.1	111.9	-	
Shape ID	-	CIRC	-	CIRC	CIRC	CIRC	-	
width (mm)	-	900	-	750	750	900	-	
height (mm)	-	900	-	750	750	900	-	
Rough type	-	N	-	N	N	N	-	
us inv (m AD)	244.000	243.022	242.887	242.399	241.796	241.668	240.816	
ds inv (m AD)	243.022	242.887	242.399	241.796	241.668	240.816	240.733	
grad (m/m)	-	0.00286	-	0.02180	0.00531	0.00762	-	
r.pfc (m3/s)	51.110	0.969	8.878	1.644	0.811	1.580	9.679	
US depth (m)	0.345	0.577	0.451	0.387	0.571	0.451	0.462	
US flow (m3/s)	0.79021	0.78925	0.78925	0.78814	0.78857	0.78905	0.78883	
US velocity (m/s)	1.165	1.831	0.950	3.431	2.185	2.471	0.870	
Node	-	RR-WD-8	RR-WD-9	RR-WD-10	RR-WD-11	RR-WD-12	RR-WD-13	-
Node ID	-	RR-WD-8	RR-WD-9	RR-WD-10	RR-WD-11	RR-WD-12	RR-WD-13	-
ground (m AD)	-	245.500	244.218	243.730	243.548	243.114	242.400	-
level (m AD)	-	243.604	243.338	242.789	242.383	242.120	241.278	-
expr:Freeboard	-	1.895782	0.879789	0.941105	1.165493	0.994173	1.122153	-

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 3



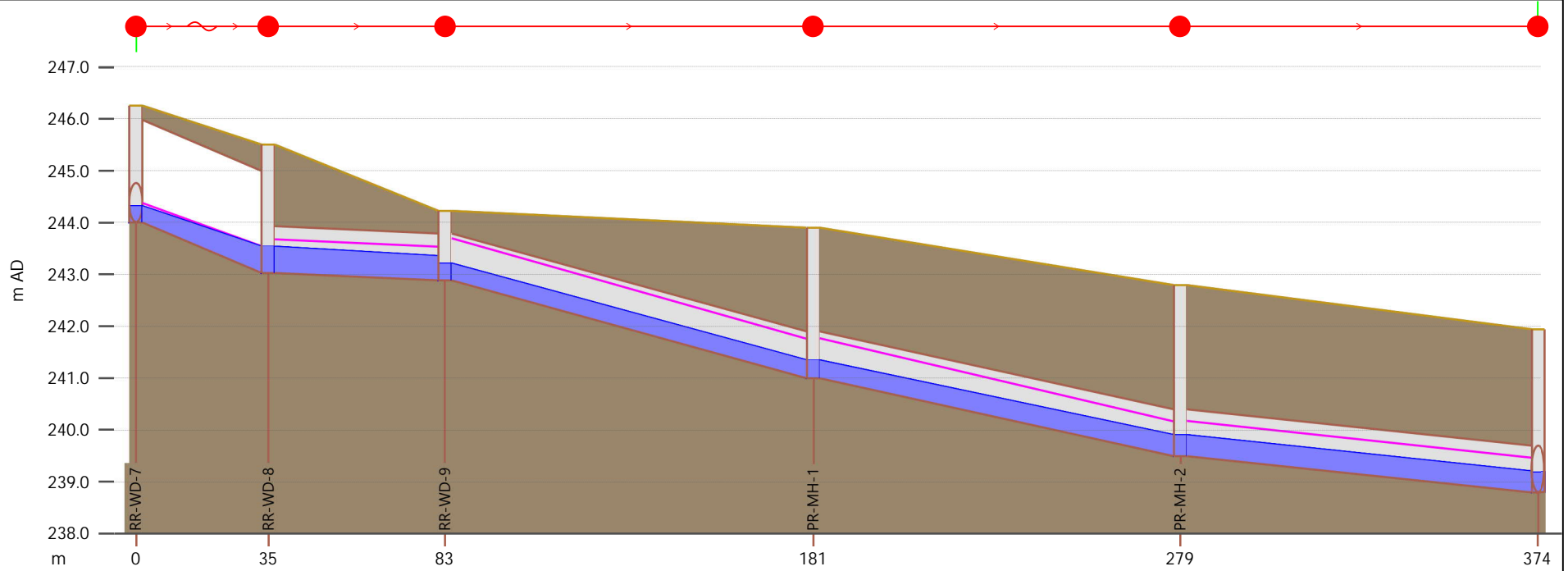
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 3

RVA PROJECT NO. 194615

FIGURE NO. 3G

AUGUST 2021





Link	RR-WD-7.1	RR-WD-8.1	RR-WD-9.1	PR-MH-1.1	PR-MH-2.1	
US node ID	RR-WD-7	RR-WD-8	RR-WD-9	PR-MH-1	PR-MH-2	
ds node	RR-WD-8	RR-WD-9	PR-MH-1	PR-MH-2	PR-MH-3	
numbarrels	1	1	1	1	1	
length (m)		47.2	98.3	98.0	95.6	
Shape ID		CIRC	CIRC	CIRC	CIRC	
width (mm)		900	900	900	900	
height (mm)		900	900	900	900	
Rough type		N	N	N	N	
us inv (m AD)	244.000	243.022	242.887	241.000	239.500	
ds inv (m AD)	243.022	242.887	241.000	239.500	238.800	
grad (m/m)		0.00286	0.01919	0.01531	0.00733	
r.pfc (m3/s)	51.110	0.969	2.508	2.240	1.550	
US depth (m)	0.316	0.505	0.321	0.337	0.400	
US flow (m3/s)	0.62354	0.62375	0.62878	0.63056	0.63047	
US velocity (m/s)	1.036	1.698	3.094	2.894	2.311	
Node	-	RR-WD-8	RR-WD-9	PR-MH-1	PR-MH-2	PR-MH-3
Node ID	-	RR-WD-8	RR-WD-9	PR-MH-1	PR-MH-2	PR-MH-3
ground (m AD)	-	245.500	244.218	243.900	242.788	241.937
level (m AD)	-	243.529	243.208	241.338	239.900	239.179
expr:Freeboard	-	1.971252	1.009962	2.562109	2.888082	2.758030

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 3



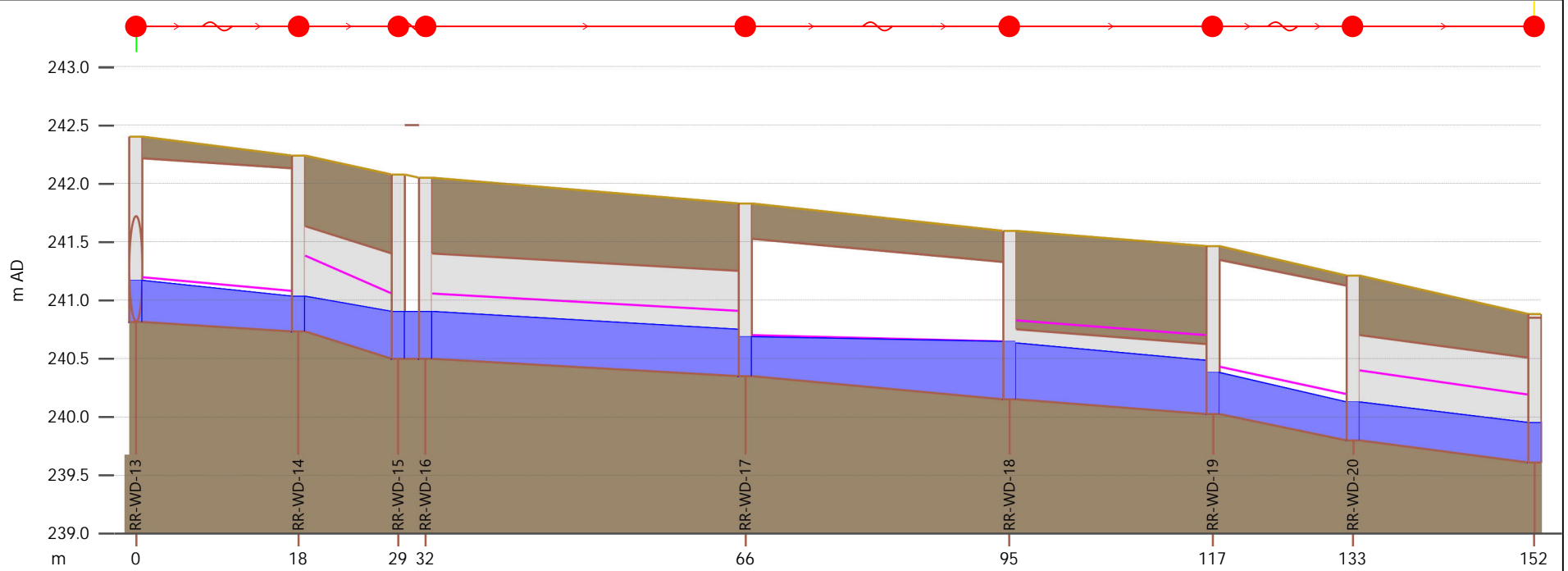
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 4

RVA PROJECT NO. 194615

FIGURE NO. 4A

AUGUST 2021





Link	RR-WD-13.1	-	-	RR-WD-16.1	RR-WD-17.1	RR-WD-18.1	RR-WD-19.1	RR-WD-20.1	
US node ID	RR-WD-13	RR-WD-14	-	RR-WD-16	RR-WD-17	RR-WD-18	RR-WD-19	RR-WD-20	
ds node	RR-WD-14	RR-WD-15	-	RR-WD-17	RR-WD-18	RR-WD-19	RR-WD-20	RR-WD-21	
numbarrels	1	1	1	1	1	1	1	1	
length (m)	-	10.9	-	34.9	-	22.1	-	19.8	
Shape ID	-	CIRC	-	CIRC	-	CIRC	-	CIRC	
width (mm)	-	900	-	900	-	600	-	900	
height (mm)	-	900	-	900	-	600	-	900	
Rough type	-	N	-	N	-	N	-	N	
us inv (m AD)	240.816	240.733	-	240.500	240.350	240.150	240.024	239.801	
ds inv (m AD)	240.733	240.500	-	240.350	240.150	240.024	239.801	239.610	
grad (m/m)	-	0.02144	-	0.00430	-	0.00569	-	0.00965	
r.pfc (m3/s)	9.679	2.651	-	1.188	9.662	0.463	10.404	1.779	
US depth (m)	0.351	0.297	-	0.399	0.334	0.480	0.352	0.324	
US flow (m3/s)	0.48238	0.48209	-	0.48185	0.48232	0.48001	0.48033	0.47995	
US velocity (m/s)	0.780	2.633	-	1.770	0.606	1.980	1.064	2.325	
Node	-	RR-WD-14	-	RR-WD-16	RR-WD-17	RR-WD-18	RR-WD-19	RR-WD-20	-
Node ID	-	RR-WD-14	-	RR-WD-16	RR-WD-17	RR-WD-18	RR-WD-19	RR-WD-20	-
ground (m AD)	242.400	242.240	-	242.049	241.827	241.594	241.461	241.213	240.881
level (m AD)	241.167	241.030	-	240.899	240.684	240.643	240.376	240.126	239.950
expr:Freeboard	-	1.209589	-	1.149861	1.142781	0.951391	1.085496	1.087435	0.931049

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 4



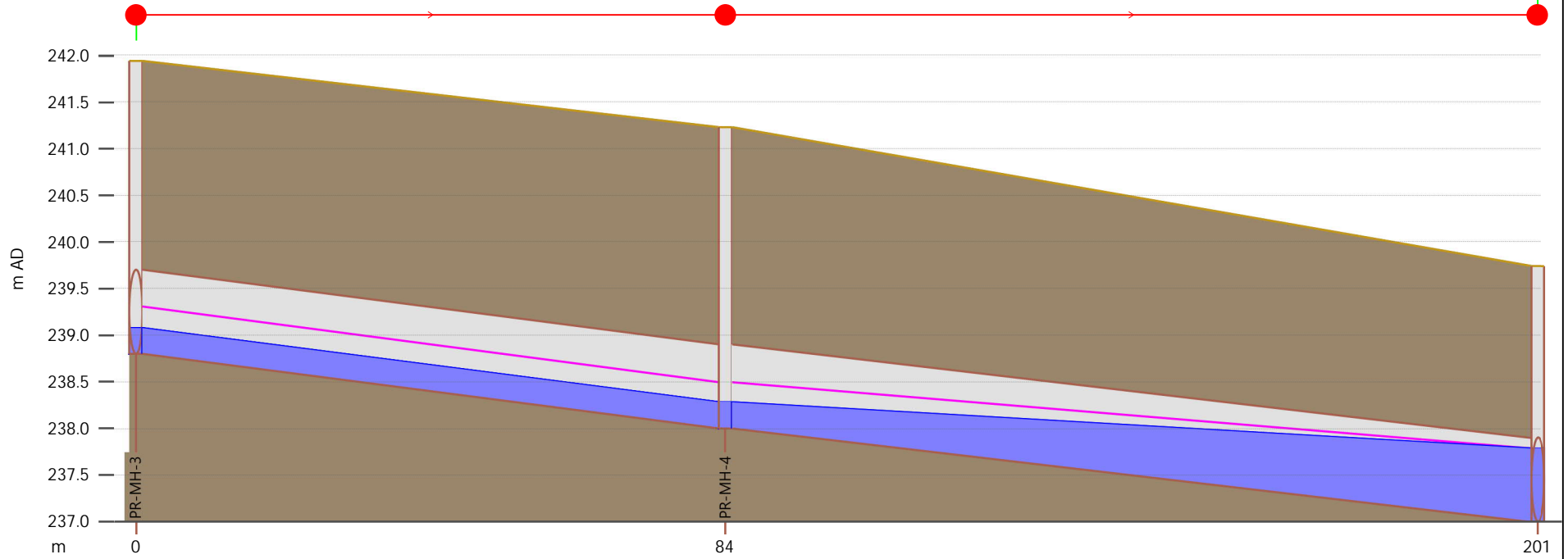
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 4

RVA PROJECT NO. 194615

FIGURE NO. 4C

AUGUST 2021





Link	PR-MH-3.1		PR-MH-4.1
US node ID	PR-MH-3		PR-MH-4
ds node	PR-MH-4		PR-MH-5
numbarrels	1		1
length (m)	84.3		116.3
Shape ID	CIRC		CIRC
width (mm)	900		900
height (mm)	900		900
Rough type	N		N
us inv (m AD)	238.800		238.000
ds inv (m AD)	238.000		237.000
grad (m/m)	0.00948		0.00860
r.pfc (m3/s)	1.763		1.679
US depth (m)	0.274		0.282
US flow (m3/s)	0.35050		0.35158
US velocity (m/s)	2.142		2.059
Node	PR-MH-3	PR-MH-4	PR-MH-5
Node ID	PR-MH-3	PR-MH-4	PR-MH-5
ground (m AD)	241.937	241.227	239.743
level (m AD)	239.074	238.283	237.787
expr:Freeboard	2.863025	2.944407	1.956318

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 4



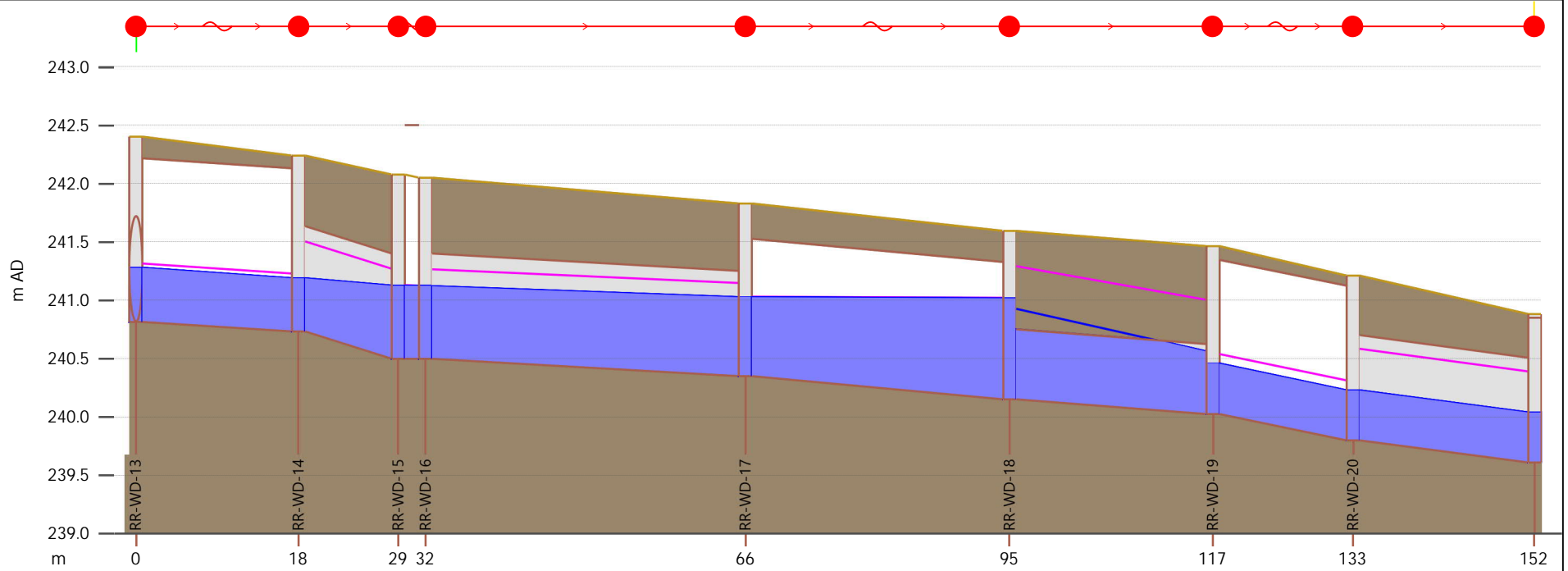
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 4

RVA PROJECT NO. 194615

FIGURE NO. 4E

AUGUST 2021





Link	RR-WD-13.1	-	-	RR-WD-16.1	RR-WD-17.1	RR-WD-18.1	RR-WD-19.1	RR-WD-20.1	
US node ID	RR-WD-13	RR-WD-14	-	RR-WD-16	RR-WD-17	RR-WD-18	RR-WD-19	RR-WD-20	
ds node	RR-WD-14	RR-WD-15	-	RR-WD-17	RR-WD-18	RR-WD-19	RR-WD-20	RR-WD-21	
numbarrels	1	1	1	1	1	1	1	1	
length (m)	-	10.9	-	34.9	-	22.1	-	19.8	
Shape ID	-	CIRC	-	CIRC	-	CIRC	-	CIRC	
width (mm)	-	900	-	900	-	600	-	900	
height (mm)	-	900	-	900	-	600	-	900	
Rough type	-	N	-	N	-	N	-	N	
us inv (m AD)	240.816	240.733	-	240.500	240.350	240.150	240.024	239.801	
ds inv (m AD)	240.733	240.500	-	240.350	240.150	240.024	239.801	239.610	
grad (m/m)	-	0.02144	-	0.00430	-	0.00569	-	0.00965	
r.pfc (m3/s)	9.679	2.651	-	1.188	9.662	0.463	10.404	1.779	
US depth (m)	0.462	0.456	-	0.619	0.676	0.779	0.435	0.426	
US flow (m3/s)	0.78883	0.78851	-	0.78825	0.78970	0.78672	0.78776	0.78733	
US velocity (m/s)	0.870	2.783	-	1.915	0.635	2.669	1.261	2.657	
Node	-	RR-WD-14	-	RR-WD-16	RR-WD-17	RR-WD-18	RR-WD-19	RR-WD-20	-
Node ID	-	RR-WD-14	-	RR-WD-16	RR-WD-17	RR-WD-18	RR-WD-19	RR-WD-20	-
ground (m AD)	242.400	242.240	-	242.049	241.827	241.594	241.461	241.213	240.881
level (m AD)	241.278	241.190	-	241.125	241.026	241.019	240.459	240.227	240.040
expr:Freeboard	-	1.049738	-	0.924153	0.801304	0.574942	1.002122	0.985781	0.841327

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 4



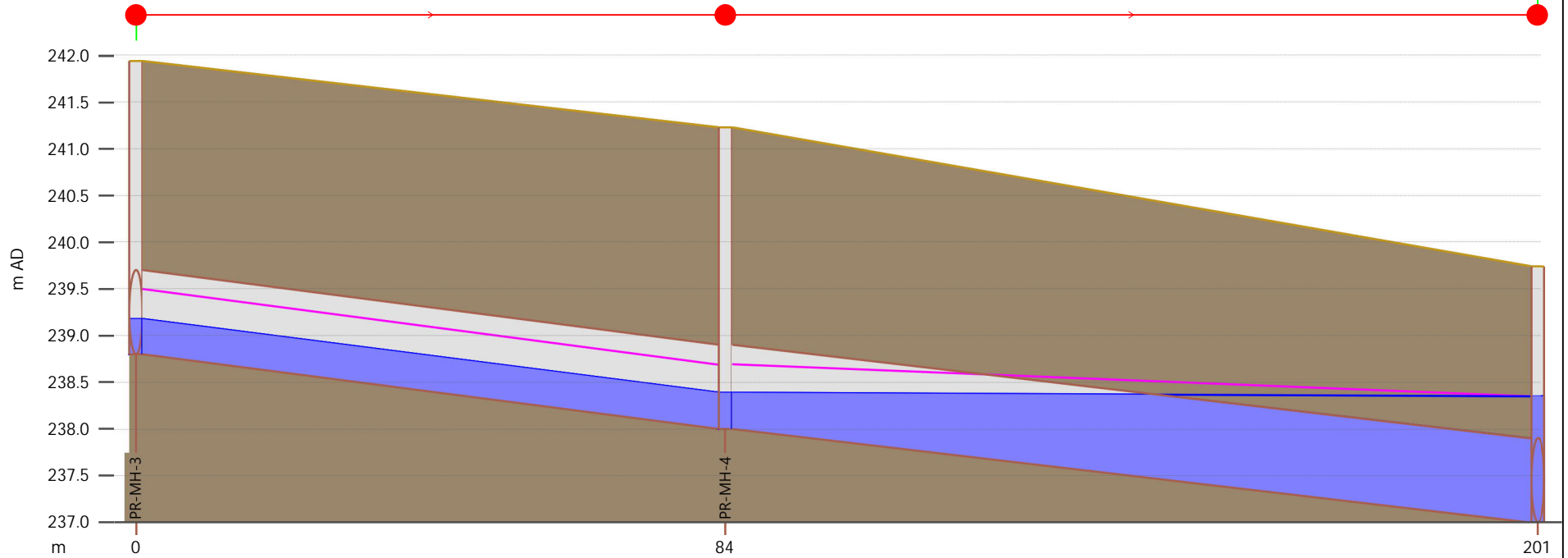
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 4

RVA PROJECT NO. 194615

FIGURE NO. 4G

AUGUST 2021





Link	PR-MH-3.1		PR-MH-4.1
US node ID	PR-MH-3		PR-MH-4
ds node	PR-MH-4		PR-MH-5
numbarrels	1		1
length (m)	84.3		116.3
Shape ID	CIRC		CIRC
width (mm)	900		900
height (mm)	900		900
Rough type	N		N
us inv (m AD)	238.800		238.000
ds inv (m AD)	238.000		237.000
grad (m/m)	0.00948		0.00860
r.pfc (m3/s)	1.763		1.679
US depth (m)	0.379		0.388
US flow (m3/s)	0.63651		0.64099
US velocity (m/s)	2.505		2.444
Node	PR-MH-3	PR-MH-4	PR-MH-5
Node ID	PR-MH-3	PR-MH-4	PR-MH-5
ground (m AD)	241.937	241.227	239.743
level (m AD)	239.179	238.388	238.349
expr:Freeboard	2.758030	2.838923	1.393513

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 4



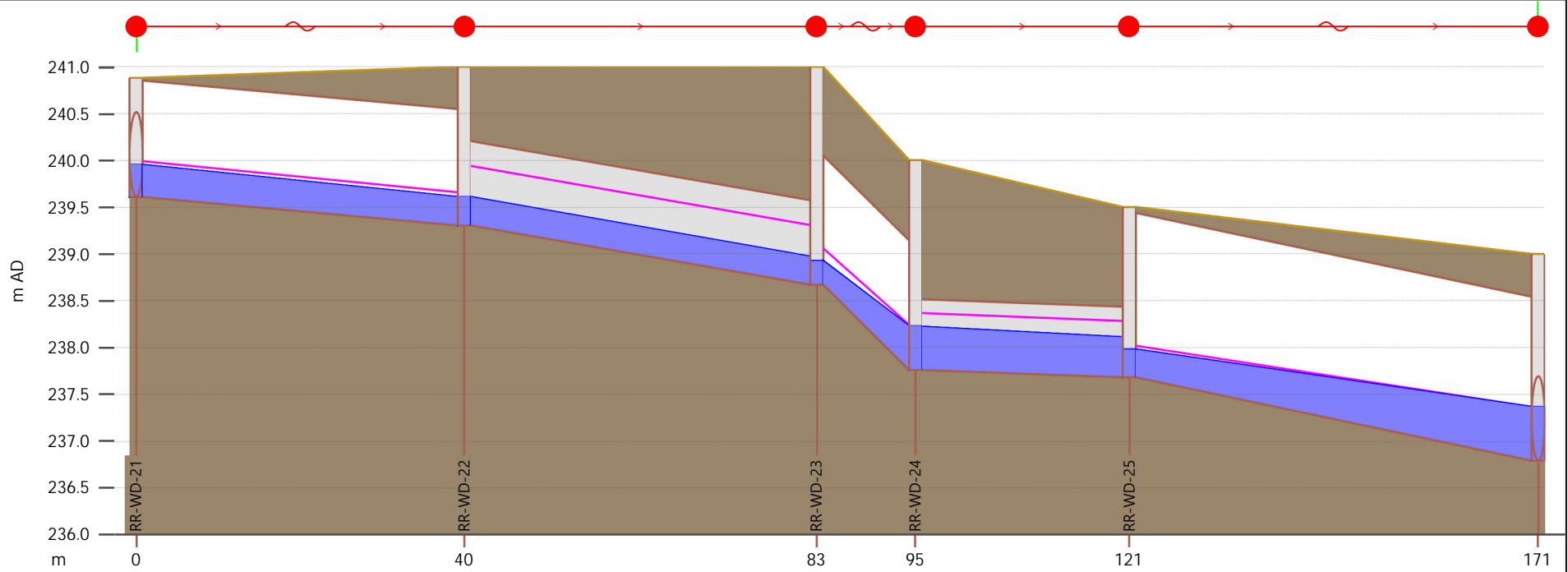
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 5

RVA PROJECT NO. 194615

FIGURE NO. 5A

AUGUST 2021





Link	RR-WD-21.1		RR-WD-22.1		-	RR-WD-24.1		RR-WD-25.1	
US node ID	RR-WD-21		RR-WD-22		RR-WD-23	RR-WD-24		RR-WD-25	
ds node	RR-WD-22		RR-WD-23		RR-WD-24	RR-WD-25		RR-WD-26	
numbarrels	1		1		1	1		1	
length (m)	43.1		43.1			26.1			
Shape ID	CIRC		CIRC			CIRC			
width (mm)	900		900			750			
height (mm)	900		900			750			
Rough type	N		N			N			
us inv (m AD)	239.610		239.305		238.672	237.763		237.685	
ds inv (m AD)	239.305		238.672		237.763	237.685		236.790	
grad (m/m)			0.01470			0.00299			
r.pfc (m3/s)	8.561		2.195		34.185	0.608		29.699	
US depth (m)	0.340		0.302		0.255	0.461		0.297	
US flow (m3/s)	0.48042		0.47917		0.47915	0.47884		0.47882	
US velocity (m/s)	0.871		2.559		1.616	1.683		0.838	
Node	RR-WD-21	RR-WD-22	RR-WD-23	RR-WD-24	RR-WD-25	RR-WD-26			
Node ID	RR-WD-21	RR-WD-22	RR-WD-23	RR-WD-24	RR-WD-25	RR-WD-26			
ground (m AD)	240.881	241.000	241.000	240.000	239.500	239.000			
level (m AD)	239.950	239.607	238.926	238.227	237.982	237.368			
expr:Freeboard	0.931049	1.392761	2.073624	1.772873	1.518265	1.632263			

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 5



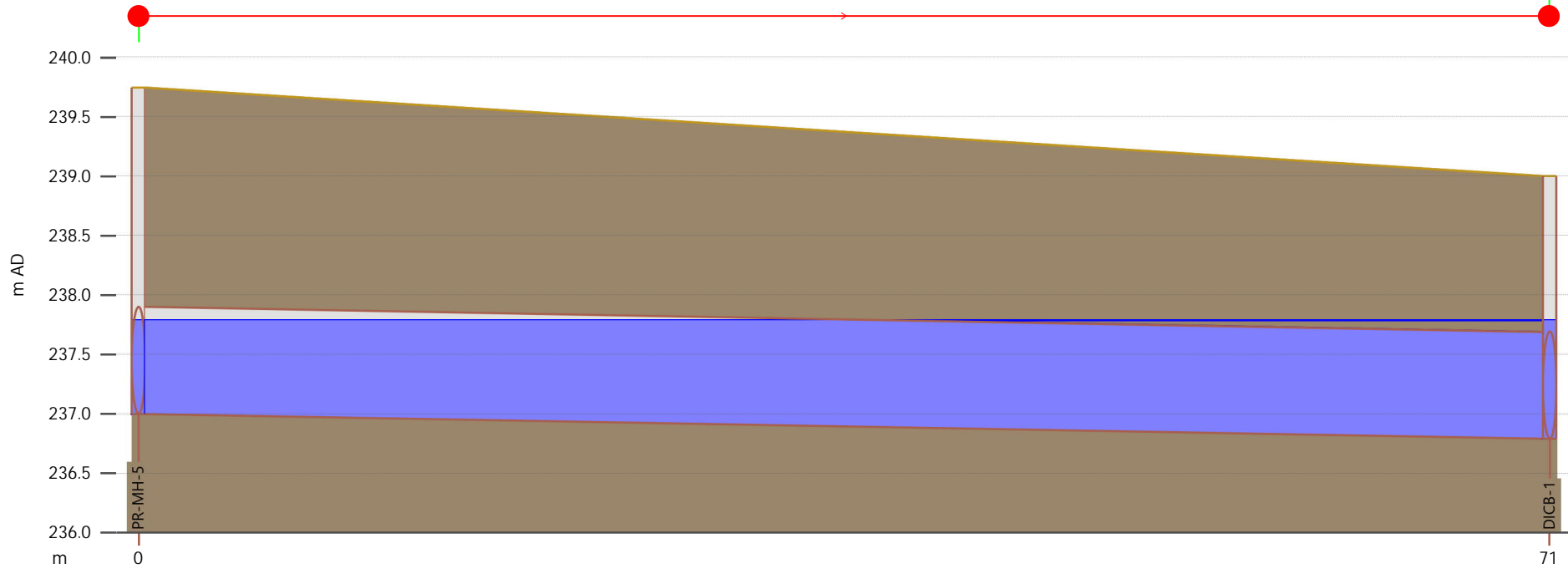
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 5

RVA PROJECT NO. 194615

FIGURE NO. 5C

AUGUST 2021





Link	PR-MH-5.1
US node ID	PR-MH-5
ds node	DICB-1
numbarrels	1
length (m)	71.0
Shape ID	CIRC
width (mm)	900
height (mm)	900
Rough type	N
us inv (m AD)	237.000
ds inv (m AD)	236.790
grad (m/m)	0.00296
r.pfc (m3/s)	0.985
US depth (m)	0.787
US flow (m3/s)	0.35155
US velocity (m/s)	1.417

Node	PR-MH-5	DICB-1
Node ID	PR-MH-5	DICB-1
ground (m AD)	239.743	239.000
level (m AD)	237.787	237.787
expr:Freeboard	1.956318	1.213318

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 5



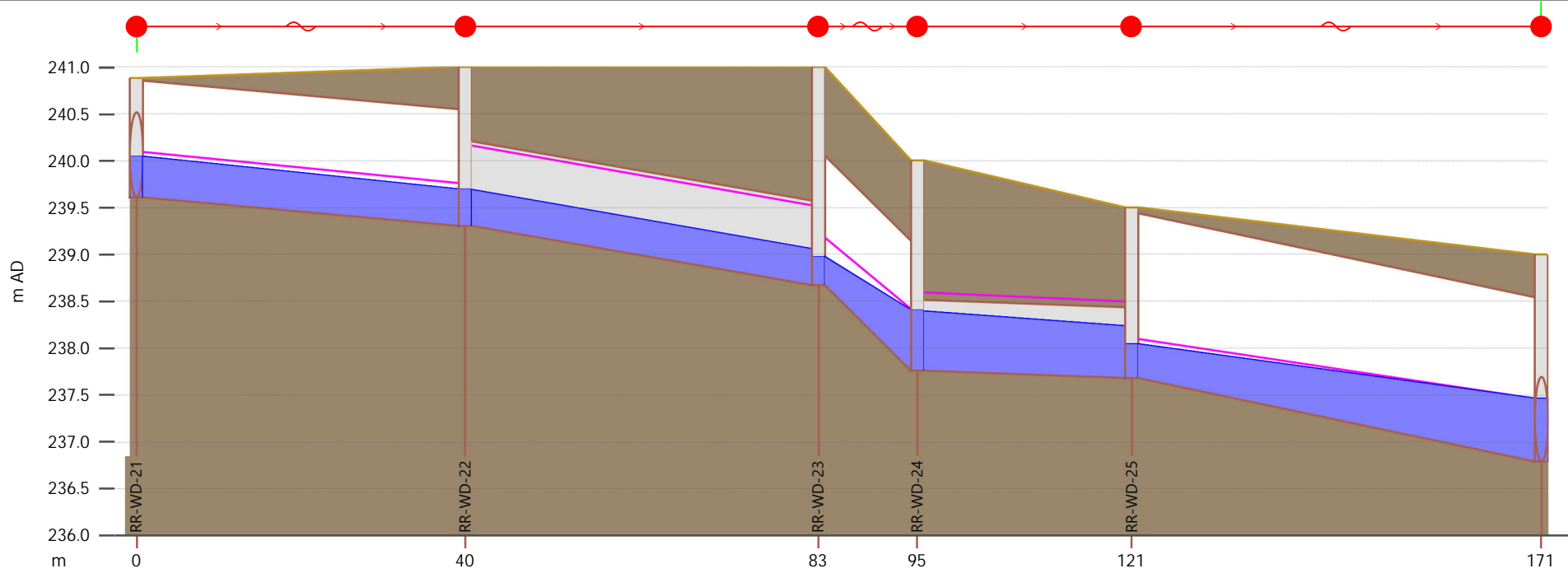
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 5

RVA PROJECT NO. 194615

FIGURE NO. 5E

AUGUST 2021





Link	RR-WD-21.1		RR-WD-22.1		-	RR-WD-24.1		RR-WD-25.1	
US node ID	RR-WD-21		RR-WD-22		RR-WD-23	RR-WD-24		RR-WD-25	
ds node	RR-WD-22		RR-WD-23		RR-WD-24	RR-WD-25		RR-WD-26	
numbarrels	1		1		1	1		1	
length (m)			43.1			26.1			
Shape ID	■		CIRC		■	CIRC		■	
width (mm)			900			750			
height (mm)			900			750			
Rough type			N			N			
us inv (m AD)	239.610		239.305		238.672	237.763		237.685	
ds inv (m AD)	239.305		238.672		237.763	237.685		236.790	
grad (m/m)			0.01470			0.00299			
r.pfc (m3/s)	8.561		2.195		34.185	0.608		29.699	
US depth (m)	0.430		0.385		0.302	0.627		0.356	
US flow (m3/s)	0.78904		0.78779		0.78778	0.78762		0.78761	
US velocity (m/s)	1.011		3.035		2.020	1.995		1.060	
Node	RR-WD-21		RR-WD-22		RR-WD-23	RR-WD-24	RR-WD-25		RR-WD-26
Node ID	RR-WD-21		RR-WD-22		RR-WD-23	RR-WD-24	RR-WD-25		RR-WD-26
ground (m AD)	240.881		241.000		241.000	240.000	239.500		239.000
level (m AD)	240.040		239.690		238.973	238.405	238.041		237.463
expr:Freeboard	0.841327		1.309784		2.026627	1.595108	1.458664		1.536545

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 5



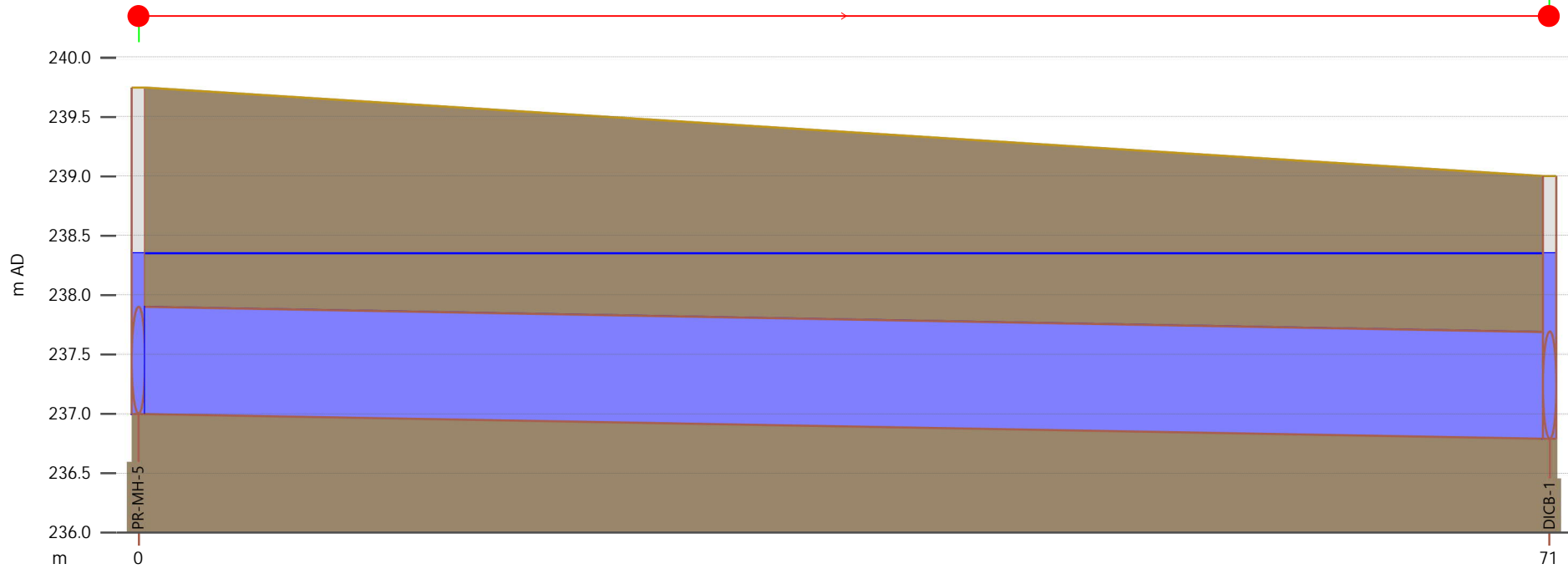
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 5

RVA PROJECT NO. 194615

FIGURE NO. 5G

AUGUST 2021





Link	PR-MH-5.1
US node ID	PR-MH-5
ds node	DICB-1
numbarrels	1
length (m)	71.0
Shape ID	CIRC
width (mm)	900
height (mm)	900
Rough type	N
us inv (m AD)	237.000
ds inv (m AD)	236.790
grad (m/m)	0.00296
r.pfc (m3/s)	0.985
US depth (m)	1.349
US flow (m3/s)	0.64181
US velocity (m/s)	1.698

Node	PR-MH-5	DICB-1
Node ID	PR-MH-5	DICB-1
ground (m AD)	239.743	239.000
level (m AD)	238.349	238.349
expr:Freeboard	1.393513	0.650513

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 5



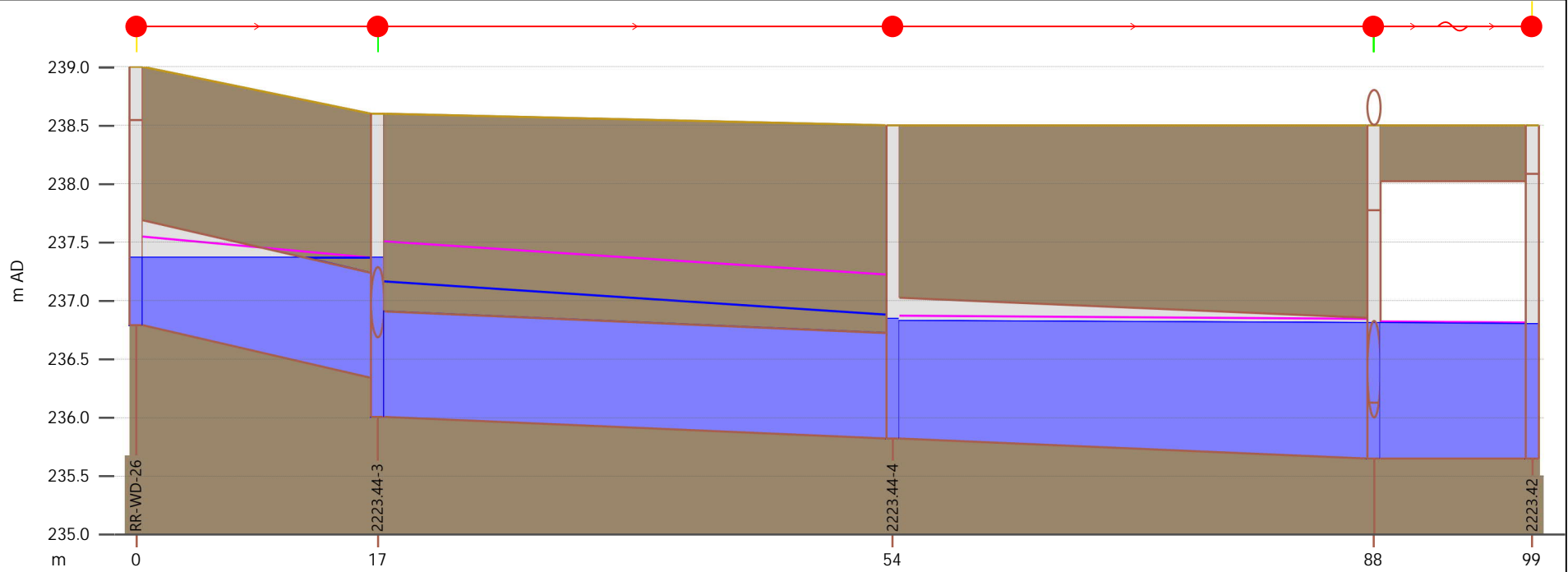
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 6

RVA PROJECT NO. 194615

FIGURE NO. 6A

AUGUST 2021





Link	RR-WD-26.1	2223.44-3.1	2223.44-4.1	2223.43C1-1.1
US node ID	RR-WD-26	2223.44-3	2223.44-4	2223.43C1-1
ds node	2223.44-3	2223.44-4	2223.43C1-1	2223.42
numbarrels	1	1	1	1
length (m)	17.2	36.6	34.2	
Shape ID	CIRC	CIRC	RECT	Matrix-2223.43
width (mm)	900	900	1800	
height (mm)	900	900	1200	
Rough type	N	N	N	
us inv (m AD)	236.790	236.008	235.825	235.653
ds inv (m AD)	236.340	235.825	235.654	235.652
grad (m/m)	0.02623	0.00500	0.00500	
r.pfc (m3/s)	2.932	1.387	5.948	20.564
US depth (m)	0.578	1.156	1.001	1.156
US flow (m3/s)	0.47643	1.80088	1.79999	5.10639
US velocity (m/s)	3.128	2.727	1.265	0.530

Node	RR-WD-26	2223.44-3	2223.44-4	2223.43C1-1	2223.42
Node ID	RR-WD-26	2223.44-3	2223.44-4	2223.43C1-1	2223.42
ground (m AD)	239.000	238.599	238.500	238.500	238.500
level (m AD)	237.368	237.368	236.847	236.809	236.801
expr:Freeboard	1.632263	1.231477	1.652847	1.690994	-

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 6



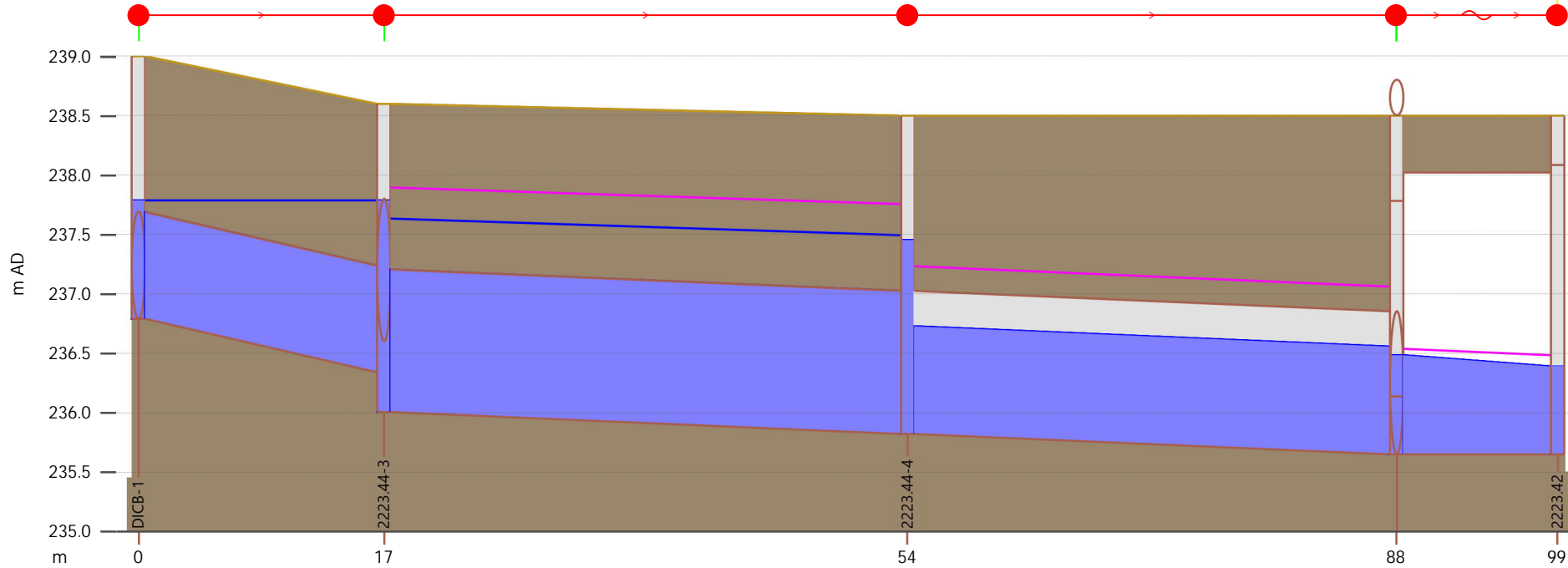
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 6

RVA PROJECT NO. 194615

FIGURE NO. 6C

AUGUST 2021





Link	DICB-1.1		2223.44-3.1		2223.44-4.1		2223.43C1-1.1	
US node ID	DICB-1		2223.44-3		2223.44-4		2223.43C1-1	
ds node	2223.44-3		2223.44-4		2223.43C1-1		2223.42	
numbarrels	1		1		1		1	
length (m)	17.2		36.6		34.2			
Shape ID	CIRC		RECT		RECT		Matrix-2223.43	
width (mm)	900		1800		1800			
height (mm)	900		1200		1200			
Rough type	N		N		N			
us inv (m AD)	236.790		236.008		235.825		235.653	
ds inv (m AD)	236.340		235.825		235.654		235.652	
grad (m/m)	0.02623		0.00500		0.00500			
r.pfc (m3/s)	2.932		5.946		5.948		20.564	
US depth (m)	0.997		1.624		0.904		0.833	
US flow (m3/s)	0.35134		5.11000		5.11000		5.10871	
US velocity (m/s)	2.751		2.638		3.147		1.042	
Node	DICB-1	2223.44-3		2223.44-4		2223.43C1-1	2223.42	
Node ID	DICB-1	2223.44-3		2223.44-4		2223.43C1-1	2223.42	
ground (m AD)	239.000	238.599		238.500		238.500	238.500	
level (m AD)	237.787	237.786		237.455		236.486	236.390	
expr:Freeboard	1.213318	0.812501		1.045303		2.014175	-	

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 6



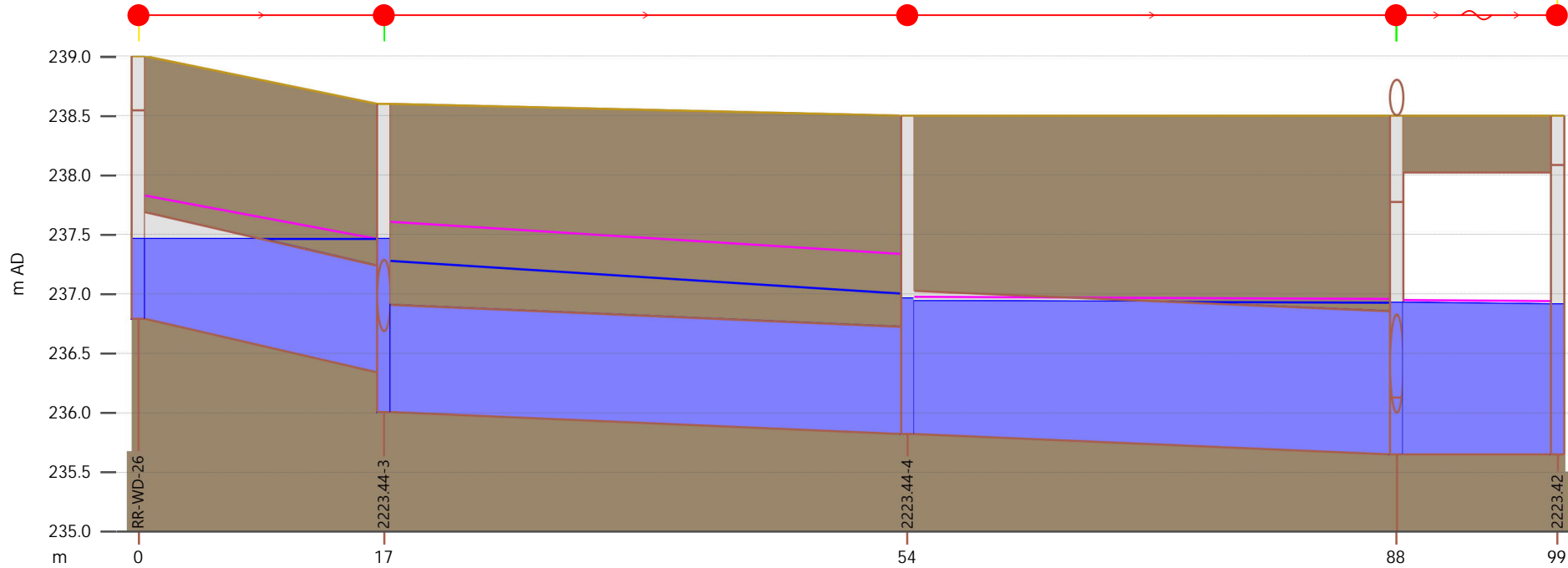
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 6

RVA PROJECT NO. 194615

FIGURE NO. 6E

AUGUST 2021





Link	RR-WD-26.1		2223.44-3.1		2223.44-4.1		2223.43C1-1.1	
US node ID	RR-WD-26		2223.44-3		2223.44-4		2223.43C1-1	
ds node	2223.44-3		2223.44-4		2223.43C1-1		2223.42	
numbarrels	1		1		1		1	
length (m)	17.2		36.6		34.2		Matrix-2223.43	
Shape ID	CIRC		CIRC		RECT			
width (mm)	900		900		1800			
height (mm)	900		900		1200			
Rough type	N		N		N			
us inv (m AD)	236.790		236.008		235.825		235.653	
ds inv (m AD)	236.340		235.825		235.654		235.652	
grad (m/m)	0.02623		0.00500		0.00500			
r.pfc (m3/s)	2.932		1.387		5.948		20.564	
US depth (m)	0.673		1.270		1.117		1.274	
US flow (m3/s)	0.78511		1.81443		1.80692		7.89588	
US velocity (m/s)	3.728		2.757		1.284		0.682	
Node	RR-WD-26	2223.44-3		2223.44-4		2223.43C1-1	2223.42	
Node ID	RR-WD-26	2223.44-3		2223.44-4		2223.43C1-1	2223.42	
ground (m AD)	239.000	238.599		238.500		238.500	238.500	
level (m AD)	237.463	237.463		236.963		236.927	236.915	
expr:Freeboard	1.536545	1.135728		1.537094		1.573349	-	

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 6



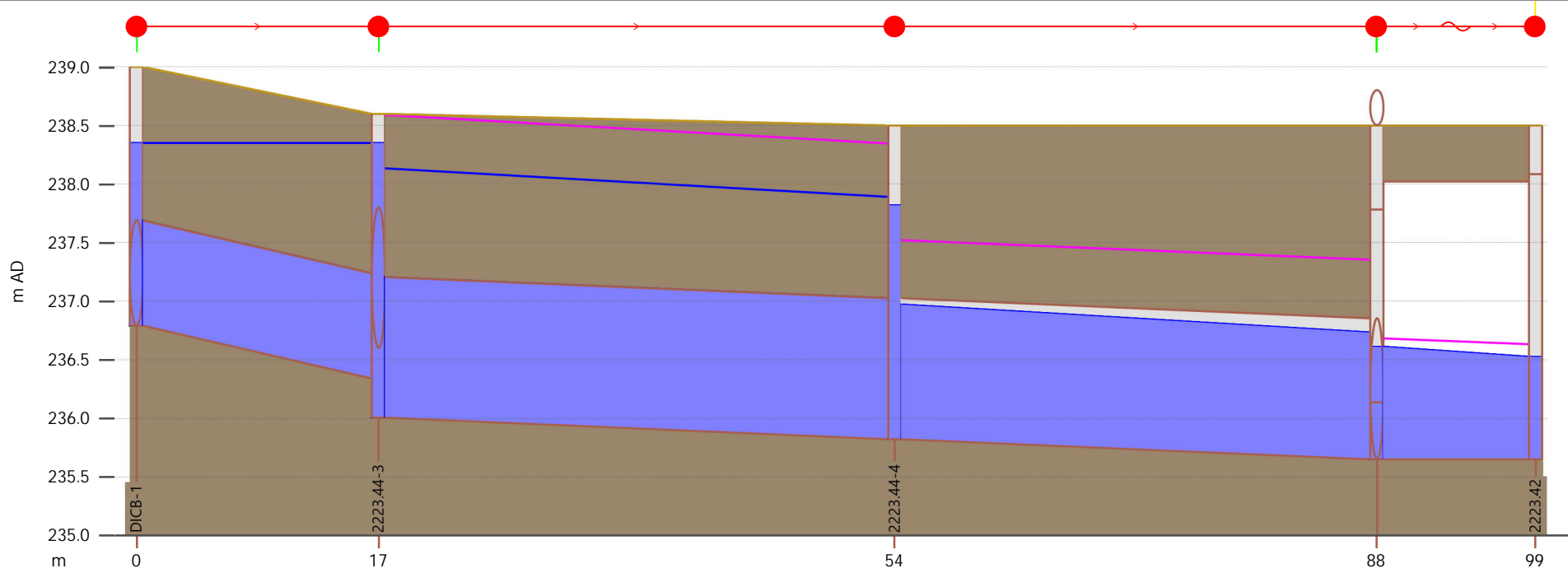
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 6

RVA PROJECT NO. 194615

FIGURE NO. 6G

AUGUST 2021





Link	DICB-1.1		2223.44-3.1		2223.44-4.1		2223.43C1-1.1	
US node ID	DICB-1		2223.44-3		2223.44-4		2223.43C1-1	
ds node	2223.44-3		2223.44-4		2223.43C1-1		2223.42	
numbarrels	1		1		1		1	
length (m)	17.2		36.6		34.2			
Shape ID	CIRC		RECT		RECT		Matrix-2223.43	
width (mm)	900		1800		1800			
height (mm)	900		1200		1200			
Rough type	N		N		N			
us inv (m AD)	236.790		236.008		235.825		235.653	
ds inv (m AD)	236.340		235.825		235.654		235.652	
grad (m/m)	0.02623		0.00500		0.00500			
r.pfc (m3/s)	2.932		5.946		5.948		20.564	
US depth (m)	1.559		2.126		1.147		0.957	
US flow (m3/s)	0.64176		6.78191		6.78191		7.89915	
US velocity (m/s)	3.421		2.989		3.290		1.195	
Node	DICB-1	2223.44-3		2223.44-4		2223.43C1-1	2223.42	
Node ID	DICB-1	2223.44-3		2223.44-4		2223.43C1-1	2223.42	
ground (m AD)	239.000	238.599		238.500		238.500	238.500	
level (m AD)	238.349	238.349		237.820		236.610	236.526	
expr:Freeboard	0.650513	0.249696		0.680161		1.889725	-	

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 6



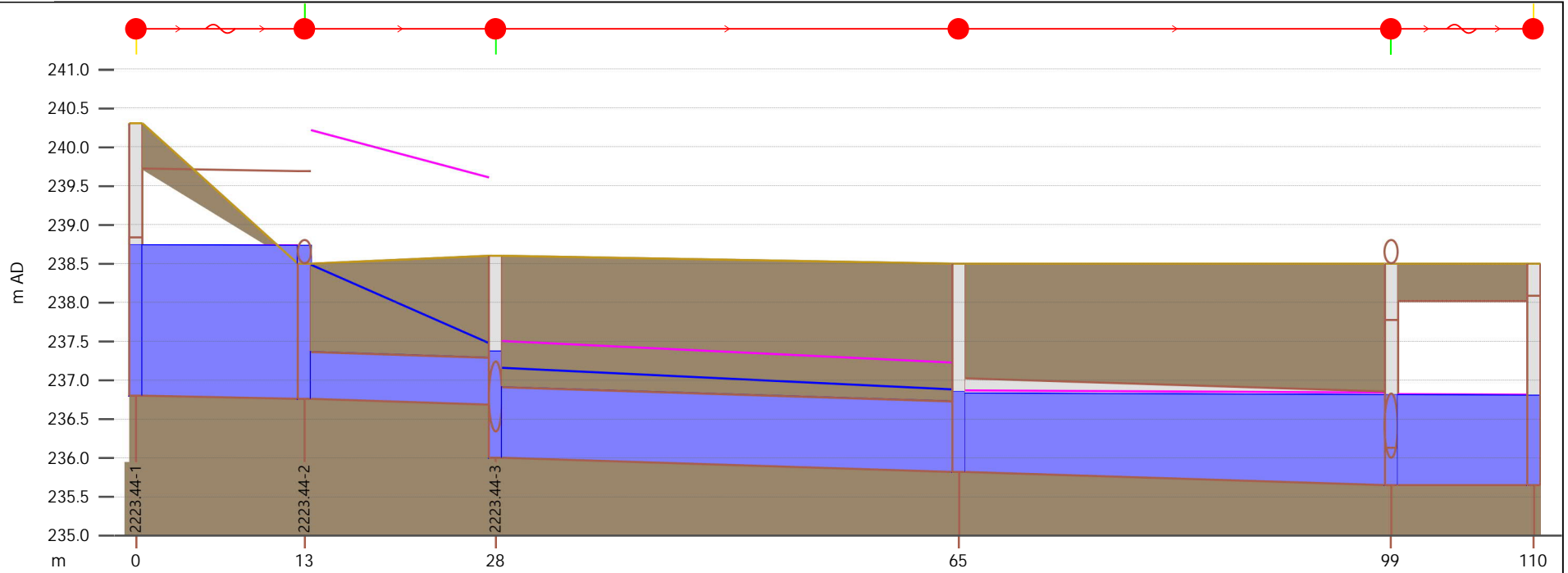
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 7

RVA PROJECT NO. 194615

FIGURE NO. 7A

AUGUST 2021





Link	2223.44-1.1	2223.44-2.1	2223.44-3.1	2223.44-4.1	2223.43C1-1.1
US node ID	2223.44-1	2223.44-2	2223.44-3	2223.44-4	2223.43C1-1
ds node	2223.44-2	2223.44-3	2223.44-4	2223.43C1-1	2223.42
numbarrels	1	1	1	1	1
length (m)		15.1	36.6	34.2	
Shape ID	Matrix-2223.44	CIRC	CIRC	RECT	Matrix-2223.43
width (mm)		600	900	1800	
height (mm)		600	900	1200	
Rough type		N	N	N	
us inv (m AD)	236.800	236.763	236.008	235.825	235.653
ds inv (m AD)	236.763	236.688	235.825	235.654	235.652
grad (m/m)		0.00500	0.00500	0.00500	
r.pfc (m3/s)	106.361	0.470	1.387	5.948	20.564
US depth (m)	1.932	1.725	1.156	1.001	1.156
US flow (m3/s)	5.11000	1.83155	1.80088	1.79999	5.10639
US velocity (m/s)	0.551	6.010	2.727	1.265	0.530
Node	-	2223.44-2	2223.44-3	2223.44-4	2223.43C1-1
Node ID	-	2223.44-2	2223.44-3	2223.44-4	2223.43C1-1
ground (m AD)	240.300	238.500	238.599	238.500	238.500
level (m AD)	238.732	238.730	237.368	236.847	236.809
expr:Freeboard	-	-0.229935	1.231477	1.652847	1.690994

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 7



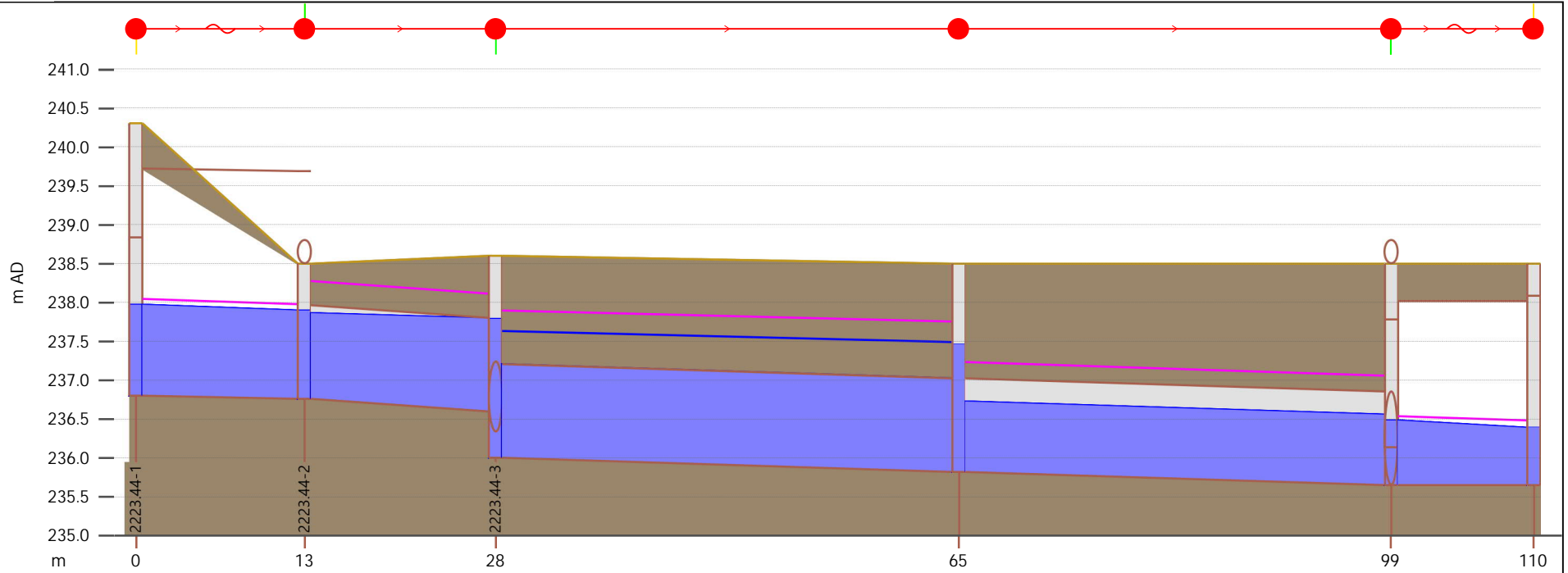
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 7

RVA PROJECT NO. 194615

FIGURE NO. 7C

AUGUST 2021





Link	2223.44-1.1	2223.44-2.1	2223.44-3.1	2223.44-4.1	2223.43C1-1.1
US node ID	2223.44-1	2223.44-2	2223.44-3	2223.44-4	2223.43C1-1
ds node	2223.44-2	2223.44-3	2223.44-4	2223.43C1-1	2223.42
numbarrels	1	1	1	1	1
length (m)		15.1	36.6	34.2	
Shape ID	Matrix-2223.44	RECT	RECT	RECT	Matrix-2223.43
width (mm)		1800	1800	1800	
height (mm)		1200	1200	1200	
Rough type		N	N	N	
us inv (m AD)	236.800	236.763	236.008	235.825	235.653
ds inv (m AD)	236.763	236.600	235.825	235.654	235.652
grad (m/m)		0.01079	0.00500	0.00500	
r.pfc (m3/s)	106.361	8.734	5.946	5.948	20.564
US depth (m)	1.172	1.102	1.624	0.904	0.833
US flow (m3/s)	5.11000	5.11000	5.11000	5.11000	5.10871
US velocity (m/s)	1.563	4.010	2.638	3.147	1.042
Node	-	2223.44-2	2223.44-3	2223.44-4	2223.43C1-1
Node ID	-	2223.44-2	2223.44-3	2223.44-4	2223.43C1-1
ground (m AD)	240.300	238.500	238.599	238.500	238.500
level (m AD)	237.972	237.895	237.786	237.455	236.486
expr:Freeboard	-	0.605255	0.812501	1.045303	2.014175

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 7



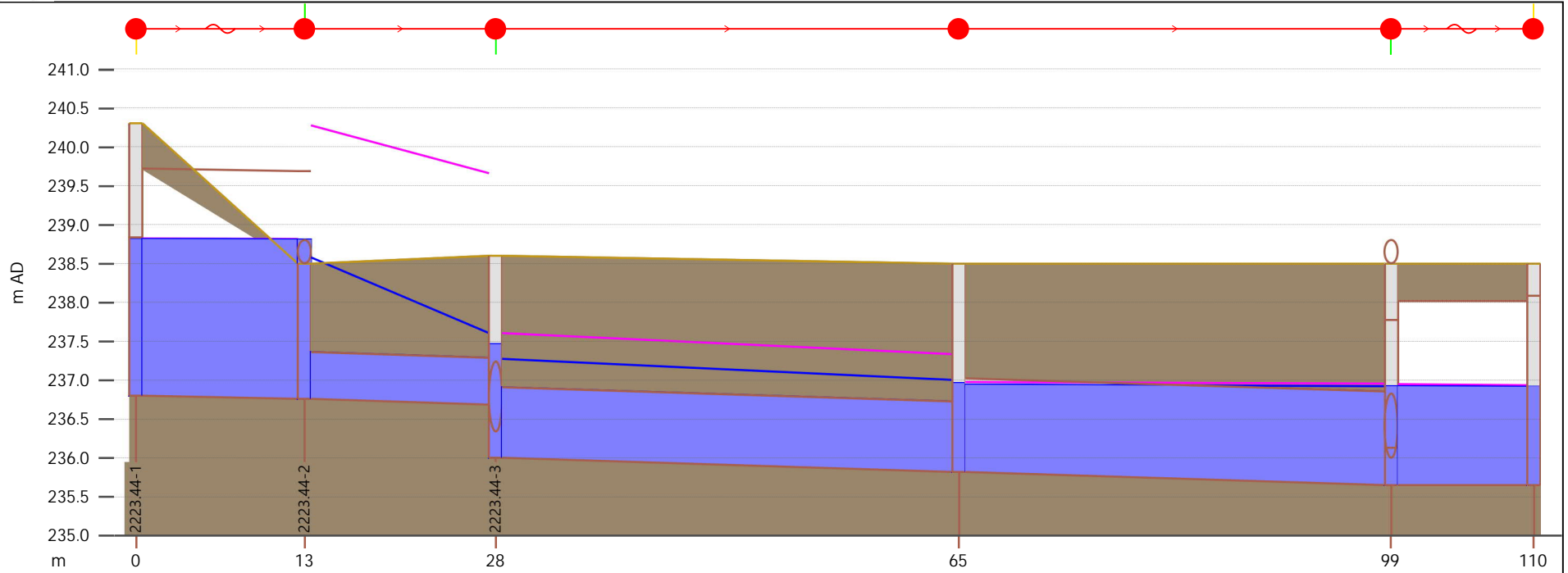
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 7

RVA PROJECT NO. 194615

FIGURE NO. 7E

AUGUST 2021





Link	2223.44-1.1	2223.44-2.1		2223.44-3.1		2223.44-4.1	2223.43C1-1.1
US node ID	2223.44-1	2223.44-2		2223.44-3		2223.44-4	2223.43C1-1
ds node	2223.44-2	2223.44-3		2223.44-4		2223.43C1-1	2223.42
numbarrels	1	1		1		1	1
length (m)		15.1		36.6		34.2	
Shape ID	Matrix-2223.44	CIRC		CIRC		RECT	Matrix-2223.43
width (mm)		600		900		1800	
height (mm)		600		900		1200	
Rough type		N		N		N	
us inv (m AD)	236.800	236.763		236.008		235.825	235.653
ds inv (m AD)	236.763	236.688		235.825		235.654	235.652
grad (m/m)		0.00500		0.00500		0.00500	
r.pfc (m3/s)	106.361	0.470		1.387		5.948	20.564
US depth (m)	2.015	1.817		1.270		1.117	1.274
US flow (m3/s)	7.90000	1.85141		1.81443		1.80692	7.89588
US velocity (m/s)	0.540	6.069		2.757		1.284	0.682
Node	-	2223.44-2	2223.44-3		2223.44-4		2223.43C1-1
Node ID	-	2223.44-2	2223.44-3		2223.44-4		2223.43C1-1
ground (m AD)	240.300	238.500	238.599		238.500		238.500
level (m AD)	238.815	238.811	237.463		236.963		236.927
expr:Freeboard	-	-0.310959	1.135728		1.537094		1.573349

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 7



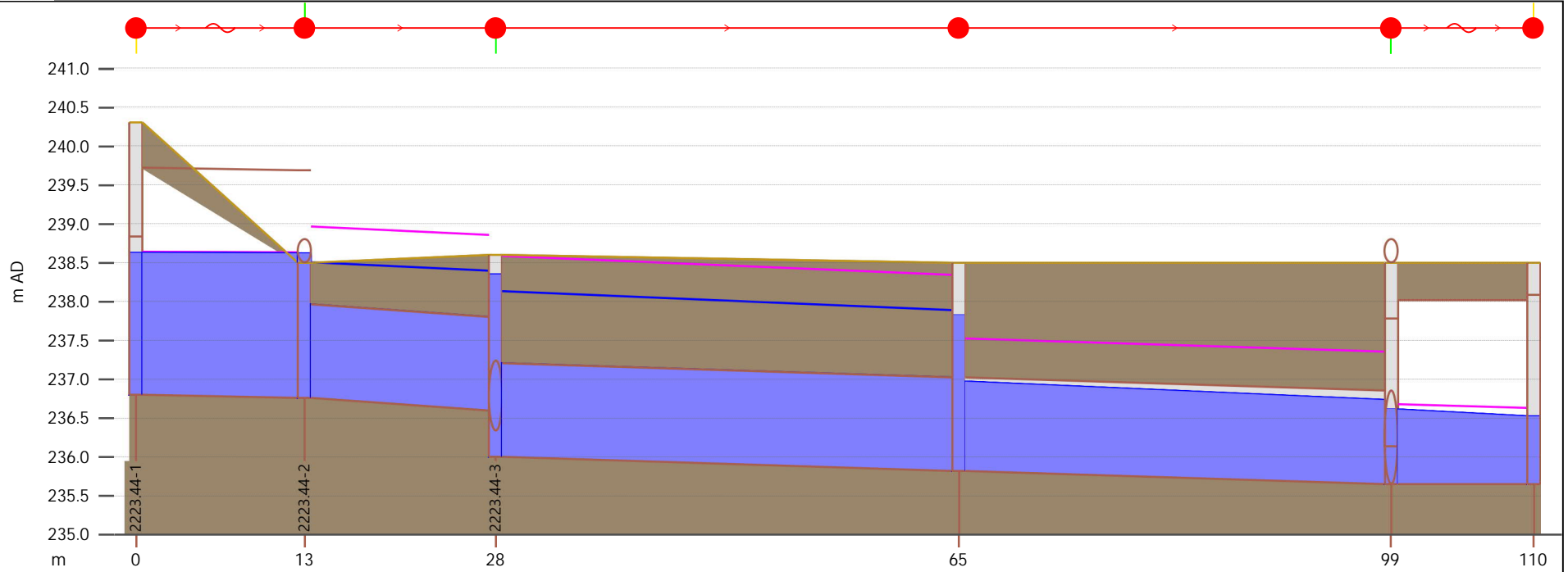
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 7

RVA PROJECT NO. 194615

FIGURE NO. 7G

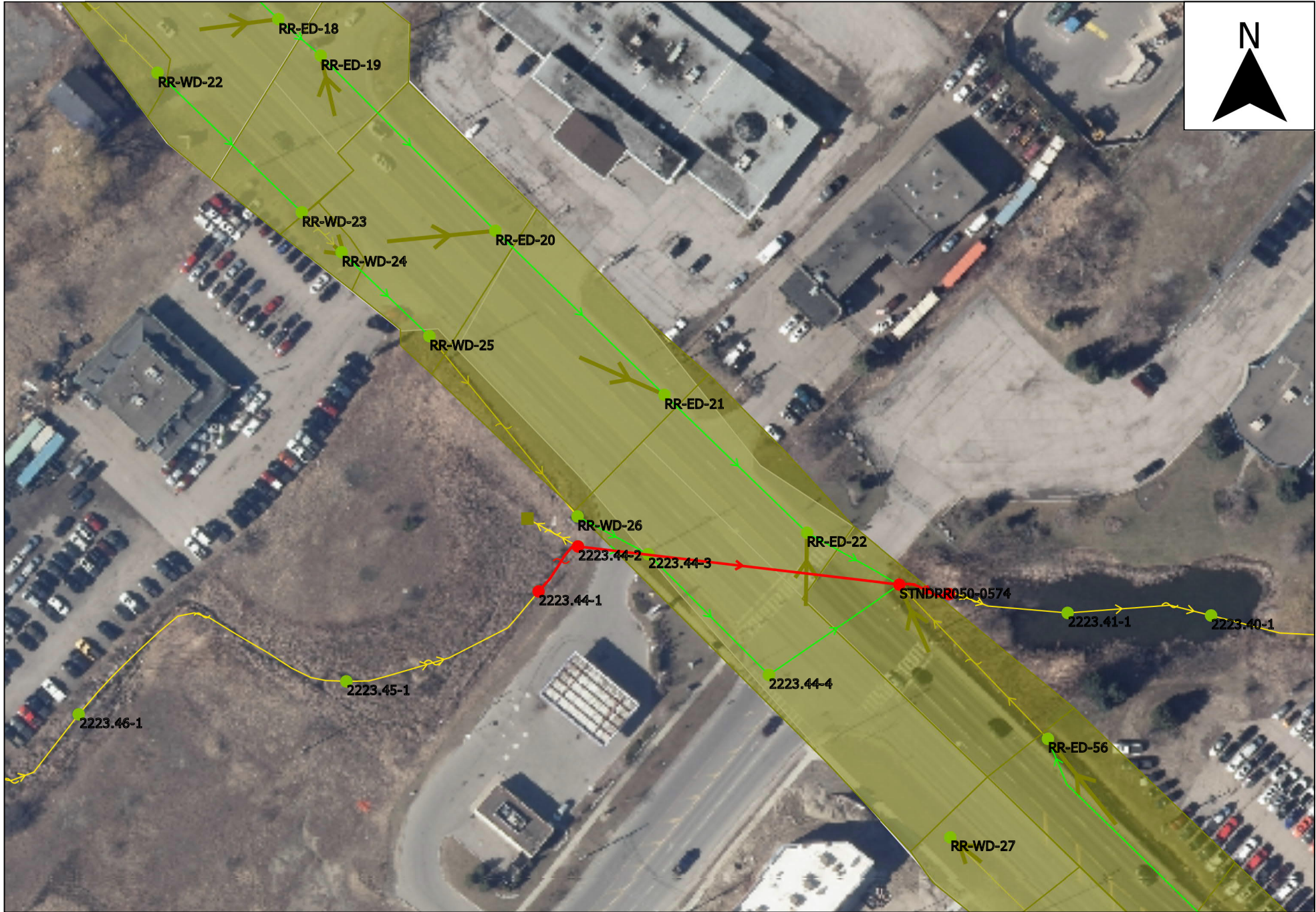
AUGUST 2021





Link	2223.44-1.1	2223.44-2.1	2223.44-3.1	2223.44-4.1	2223.43C1-1.1
US node ID	2223.44-1	2223.44-2	2223.44-3	2223.44-4	2223.43C1-1
ds node	2223.44-2	2223.44-3	2223.44-4	2223.43C1-1	2223.42
numbarrels	1	1	1	1	1
length (m)		15.1	36.6	34.2	
Shape ID	Matrix-2223.44	RECT	RECT	RECT	Matrix-2223.43
width (mm)		1800	1800	1800	
height (mm)		1200	1200	1200	
Rough type		N	N	N	
us inv (m AD)	236.800	236.763	236.008	235.825	235.653
ds inv (m AD)	236.763	236.600	235.825	235.654	235.652
grad (m/m)		0.01079	0.00500	0.00500	
r.pfc (m3/s)	106.361	8.734	5.946	5.948	20.564
US depth (m)	1.830	1.743	2.126	1.147	0.957
US flow (m3/s)	7.90000	6.78190	6.78191	6.78191	7.89915
US velocity (m/s)	1.588	4.066	2.989	3.290	1.195
Node	-	2223.44-2	2223.44-3	2223.44-4	2223.43C1-1
Node ID	-	2223.44-2	2223.44-3	2223.44-4	2223.43C1-1
ground (m AD)	240.300	238.500	238.599	238.500	238.500
level (m AD)	238.630	238.623	238.349	237.820	236.610
expr:Freeboard	-	-0.122910	0.249696	0.680161	1.889725

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 7



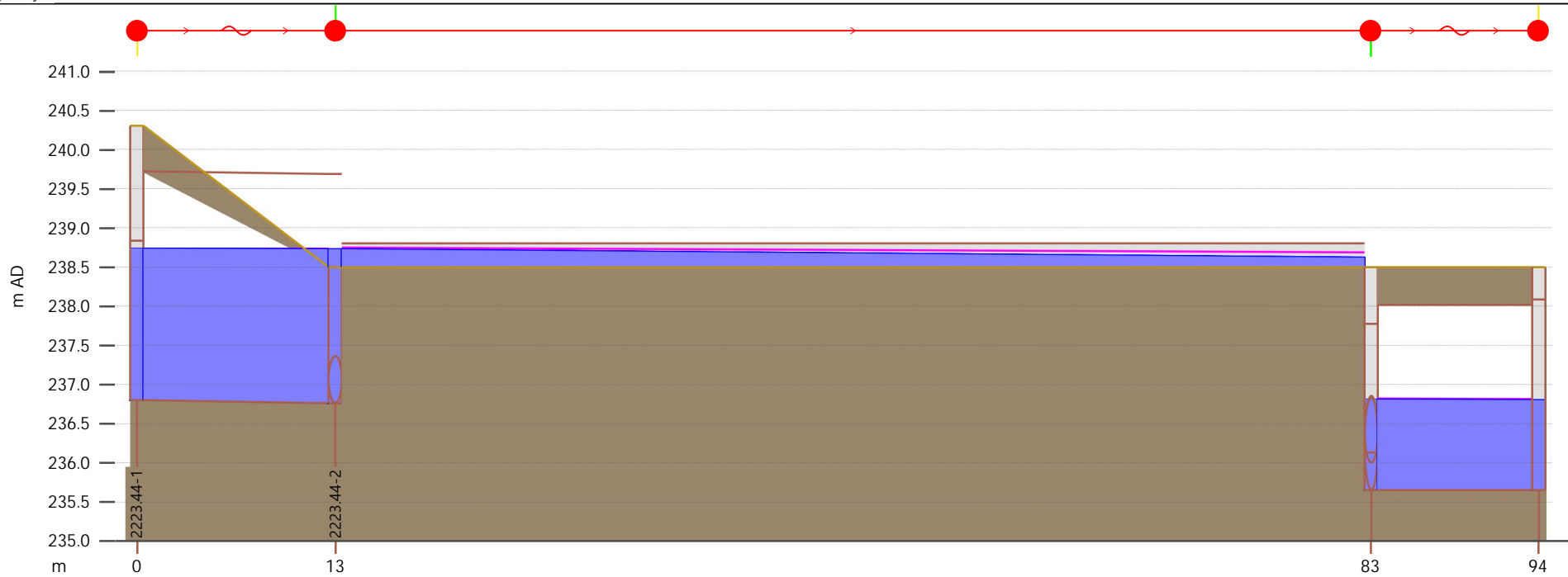
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 8

RVA PROJECT NO. 194615

FIGURE NO. 8A

AUGUST 2021





Link	2223.44-1.1		2223.44-2.2		2223.43C1-1.1	
US node ID	2223.44-1		2223.44-2		2223.43C1-1	
ds node	2223.44-2		2223.43C1-1		2223.42	
numbarrels	1		1		1	
length (m)	69.5		69.5		69.5	
Shape ID	Matrix-2223.44		OREC		Matrix-2223.43	
width (mm)	25000		25000		25000	
height (mm)	300		300		300	
Rough type	N		N		N	
us inv (m AD)	236.800		238.500		235.653	
ds inv (m AD)	236.763		238.500		235.652	
grad (m/m)	0.00000		0.00000		0.00000	
r.pfc (m3/s)	106.361		0.000		20.564	
US depth (m)	1.932		0.230		1.156	
US flow (m3/s)	5.11000		3.38957		5.10639	
US velocity (m/s)	0.551		0.590		0.530	
Node	2223.44-1	2223.44-2			2223.43C1-1	2223.42
Node ID	2223.44-1	2223.44-2			2223.43C1-1	2223.42
ground (m AD)	240.300	238.500			238.500	238.500
level (m AD)	238.732	238.730			236.809	236.801
expr:Freeboard	1.568127	-0.229935			1.690994	-

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 8



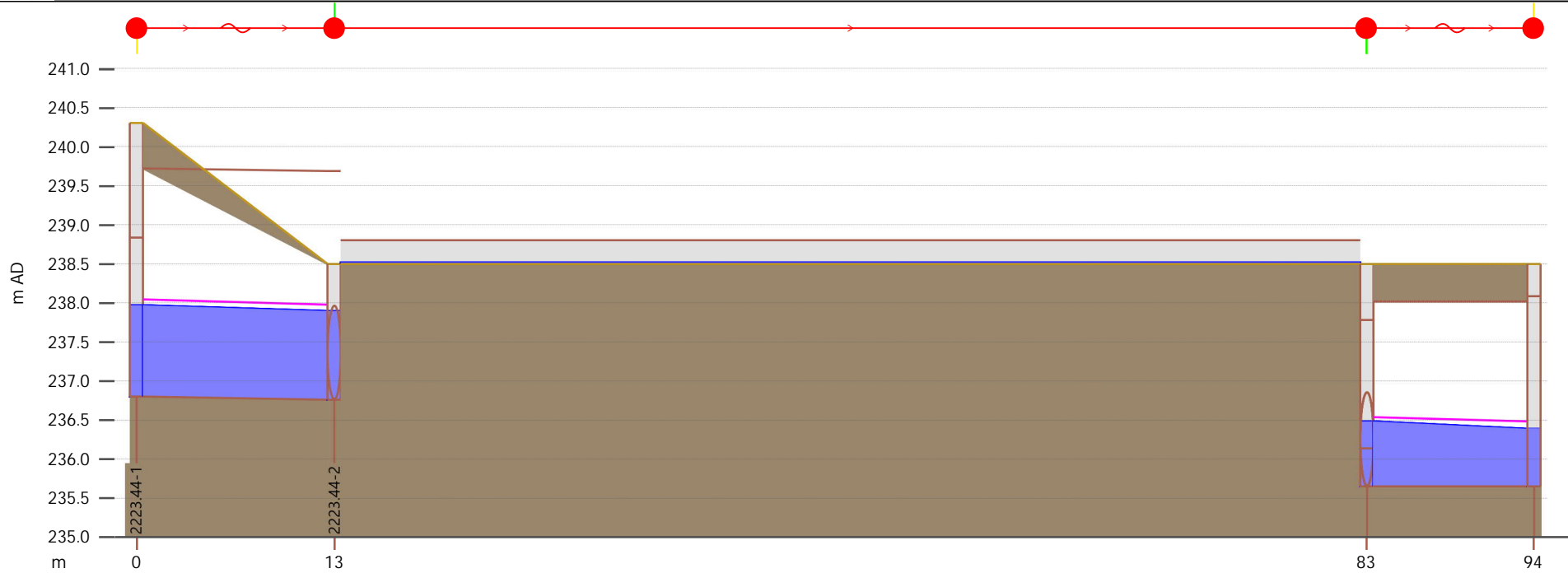
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 8

RVA PROJECT NO. 194615

FIGURE NO. 8C

AUGUST 2021





Link	2223.44-1.1		2223.44-2.2		2223.43C1-1.1	
US node ID	2223.44-1		2223.44-2		2223.43C1-1	
ds node	2223.44-2		2223.43C1-1		2223.42	
numbarrels	1		1		1	
length (m)	Matrix-2223.44		69.5		Matrix-2223.43	
Shape ID	Matrix-2223.44		OREC		Matrix-2223.43	
width (mm)	25000		25000		25000	
height (mm)	300		300		300	
Rough type	N		N		N	
us inv (m AD)	236.800		238.500		235.653	
ds inv (m AD)	236.763		238.500		235.652	
grad (m/m)	0.00000		0.00000		0.00000	
r.pfc (m3/s)	106.361		0.000		20.564	
US depth (m)	1.172		0.020		0.833	
US flow (m3/s)	5.11000		0.00000		5.10871	
US velocity (m/s)	1.563		0.000		1.042	
Node	2223.44-1	2223.44-2			2223.43C1-1	2223.42
Node ID	2223.44-1	2223.44-2			2223.43C1-1	2223.42
ground (m AD)	240.300	238.500			238.500	238.500
level (m AD)	237.972	237.895			236.486	236.390
expr:Freeboard	2.327954	0.605255			2.014175	-

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 8



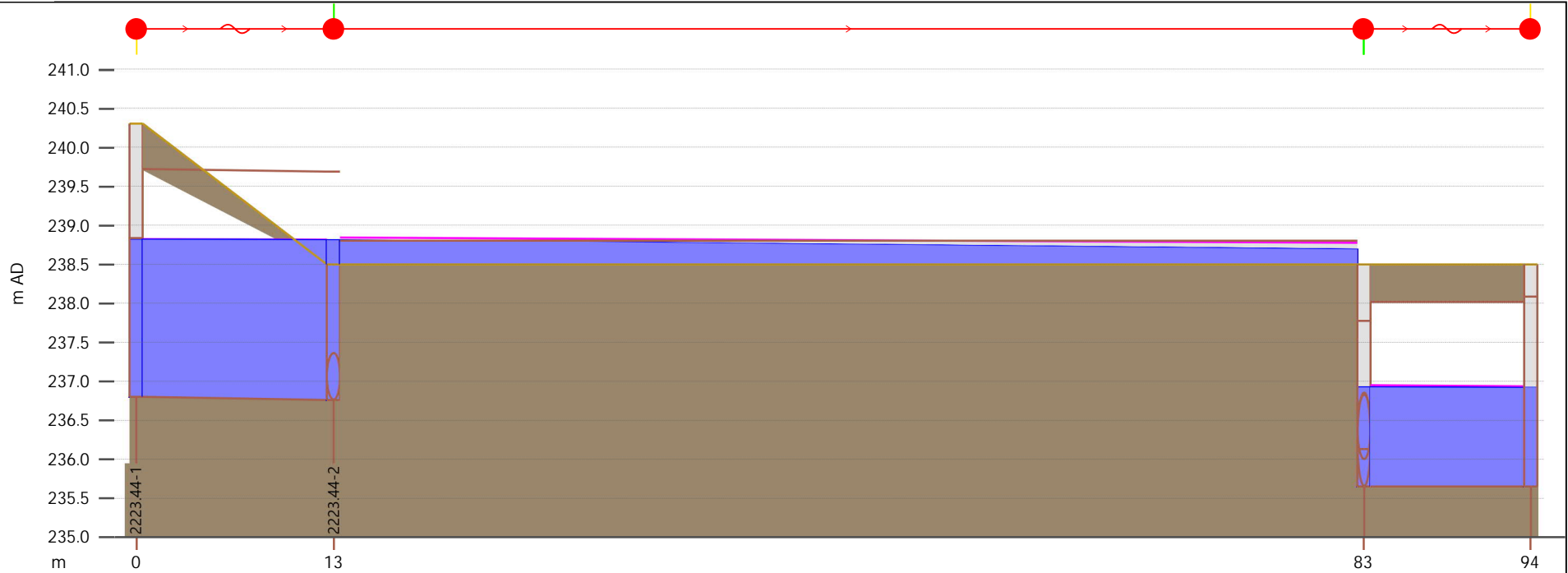
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 8

RVA PROJECT NO. 194615

FIGURE NO. 8E

AUGUST 2021





Link	2223.44-1.1		2223.44-2.2		2223.43C1-1.1	
US node ID	2223.44-1		2223.44-2		2223.43C1-1	
ds node	2223.44-2		2223.43C1-1		2223.42	
numbarrels	1		1		1	
length (m)	69.5		69.5		69.5	
Shape ID	Matrix-2223.44		OREC		Matrix-2223.43	
width (mm)	25000		25000		25000	
height (mm)	300		300		300	
Rough type	N		N		N	
us inv (m AD)	236.800		238.500		235.653	
ds inv (m AD)	236.763		238.500		235.652	
grad (m/m)	0.00000		0.00000		0.00000	
r.pfc (m3/s)	106.361		0.000		20.564	
US depth (m)	2.015		0.311		1.274	
US flow (m3/s)	7.90000		6.21168		7.89588	
US velocity (m/s)	0.540		0.799		0.682	
Node	2223.44-1	2223.44-2			2223.43C1-1	2223.42
Node ID	2223.44-1	2223.44-2			2223.43C1-1	2223.42
ground (m AD)	240.300	238.500			238.500	238.500
level (m AD)	238.815	238.811			236.927	236.915
expr:Freeboard	1.485364	-0.310959			1.573349	-

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 8



PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 8

RVA PROJECT NO. 194615

FIGURE NO. 8G

AUGUST 2021





Link	2223.44-1.1		2223.44-2.2		2223.43C1-1.1	
US node ID	2223.44-1		2223.44-2		2223.43C1-1	
ds node	2223.44-2		2223.43C1-1		2223.42	
numbarrels	1		1		1	
length (m)	69.5		69.5		69.5	
Shape ID	Matrix-2223.44		OREC		Matrix-2223.43	
width (mm)	25000		25000		25000	
height (mm)	300		300		300	
Rough type	N		N		N	
us inv (m AD)	236.800		238.500		235.653	
ds inv (m AD)	236.763		238.500		235.652	
grad (m/m)	0.00000		0.00000		0.00000	
r.pfc (m3/s)	106.361		0.000		20.564	
US depth (m)	1.830		0.123		0.957	
US flow (m3/s)	7.90000		1.11810		7.89915	
US velocity (m/s)	1.588		0.364		1.195	
Node	2223.44-1	2223.44-2			2223.43C1-1	2223.42
Node ID	2223.44-1	2223.44-2			2223.43C1-1	2223.42
ground (m AD)	240.300	238.500			238.500	238.500
level (m AD)	238.630	238.623			236.610	236.526
expr:Freeboard	1.670392	-0.122910			1.889725	-

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 8



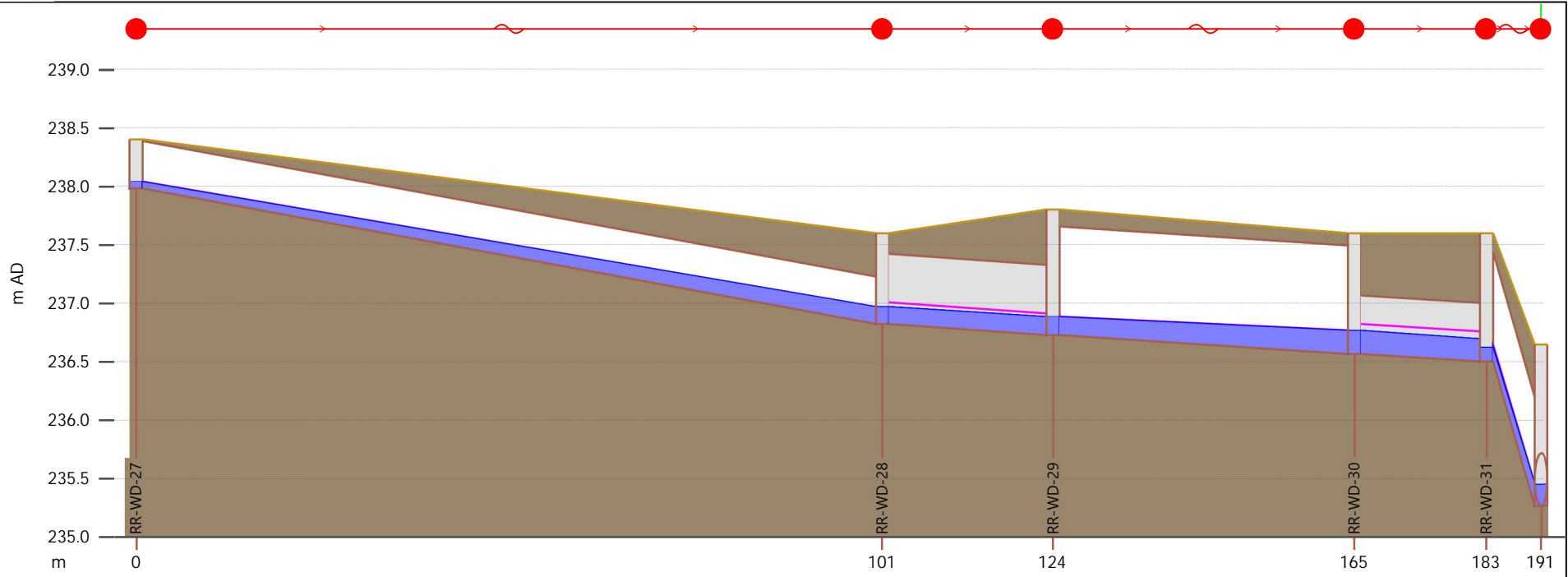
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 9

RVA PROJECT NO. 194615

FIGURE NO. 9A

AUGUST 2021





Link	RR-WD-27.1	RR-WD-28.1	RR-WD-29.1	RR-WD-30.1	-
US node ID	RR-WD-27	RR-WD-28	RR-WD-29	RR-WD-30	-
ds node	RR-WD-28	RR-WD-29	RR-WD-30	RR-WD-31	-
numbarrels	1	1	1	1	1
length (m)		23.2		17.9	
Shape ID	West Side Ditch-1 (Downstream of George Bolton Pkwy)	CIRC		CIRC	
width (mm)		600		500	
height (mm)		600		500	
Rough type		N		N	
us inv (m AD)	237.980	236.823	236.730	236.566	-
ds inv (m AD)	236.823	236.730	236.566	236.505	-
grad (m/m)		0.00401		0.00340	
r.pfc (m3/s)	1.738	0.389	3.019	0.220	-
US depth (m)	0.057	0.142	0.151	0.200	0.117
US flow (m3/s)	0.01555	0.04596	0.05712	0.07692	-
US velocity (m/s)	0.186	0.896	0.373	1.052	0.726
Node	RR-WD-27	RR-WD-28	RR-WD-29	RR-WD-30	-
Node ID	RR-WD-27	RR-WD-28	RR-WD-29	RR-WD-30	-
ground (m AD)	238.400	237.600	237.800	237.600	237.600
level (m AD)	238.037	236.965	236.881	236.766	236.622
expr:Freeboard	0.362952	0.634500	0.918774	0.834085	0.978220

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 9



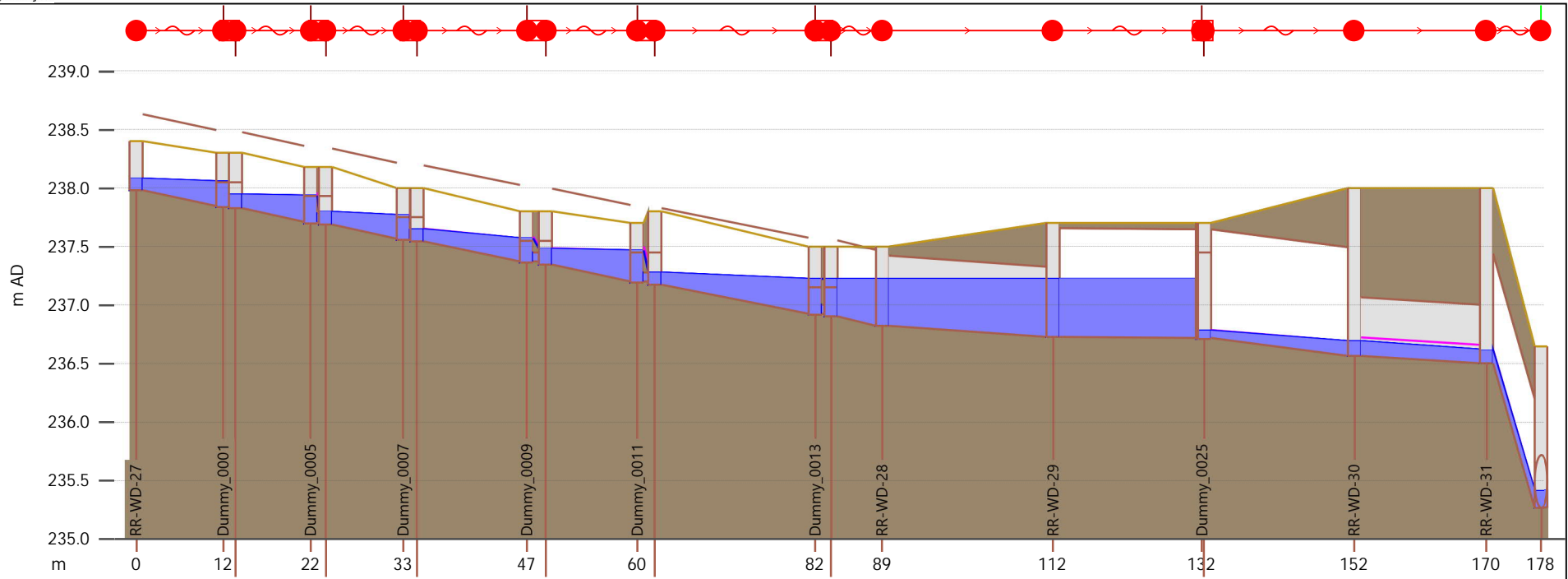
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 9

RVA PROJECT NO. 194615

FIGURE NO. 9C

AUGUST 2021





Link	-	-	-	-	-	-	Dummy_0012.1	-	RR-WD-28.1	RR-WD-29.1	Dummy_0026.1	RR-WD-30.1	-
US node ID	-	-	-	-	-	-	Dummy_0012	-	RR-WD-28	RR-WD-29	Dummy_0026	RR-WD-30	-
ds node	-	-	-	-	-	-	Dummy_0013	-	RR-WD-29	Dummy_0025	RR-WD-30	RR-WD-31	-
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1
length (m)	-	-	-	-	-	-	-	-	23.2	-	-	17.9	-
Shape ID	-	-	-	-	-	-	-	-	CIRC	-	-	CIRC	-
width (mm)	-	-	-	-	-	-	-	-	600	-	-	500	-
height (mm)	-	-	-	-	-	-	-	-	600	-	-	500	-
Rough type	-	-	-	-	-	-	-	-	N	-	-	N	-
us inv (m AD)	237.980	237.826	237.686	237.545	237.345	237.176	237.176	-	236.823	236.730	236.719	236.566	-
ds inv (m AD)	237.845	237.709	237.566	237.374	237.203	236.927	236.927	-	236.730	236.719	236.566	236.505	-
grad (m/m)	-	-	-	-	-	-	-	-	0.00401	-	-	0.00340	-
r.pfc (m3/s)	3.756	3.756	3.756	3.756	-	3.756	3.756	3.756	0.389	1.091	4.129	0.220	-
US depth (m)	0.099	0.118	0.108	0.103	-	0.138	0.101	0.322	0.401	0.494	0.065	0.126	0.107
US flow (m3/s)	0.01571	0.01446	0.01088	0.04554	-	0.04444	0.04351	-	0.03631	0.03858	0.00918	0.03093	-
US velocity (m/s)	0.106	0.121	0.064	0.284	-	0.191	0.279	0.262	0.696	0.143	0.171	0.792	0.431
Node	-	-	-	-	-	-	-	-	RR-WD-28	RR-WD-29	-	RR-WD-30	-
Node ID	-	-	-	-	-	-	-	-	RR-WD-28	RR-WD-29	-	RR-WD-30	-
ground (m AD)	-	-	-	-	-	-	237.800	237.500	237.500	237.700	-	238.000	238.000
level (m AD)	-	-	-	-	-	-	237.276	237.225	237.225	237.224	-	236.693	236.612
expr:Freeboard	-	-	-	-	-	-	0.523557	-	0.275497	0.475558	-	1.307480	1.388245

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 9



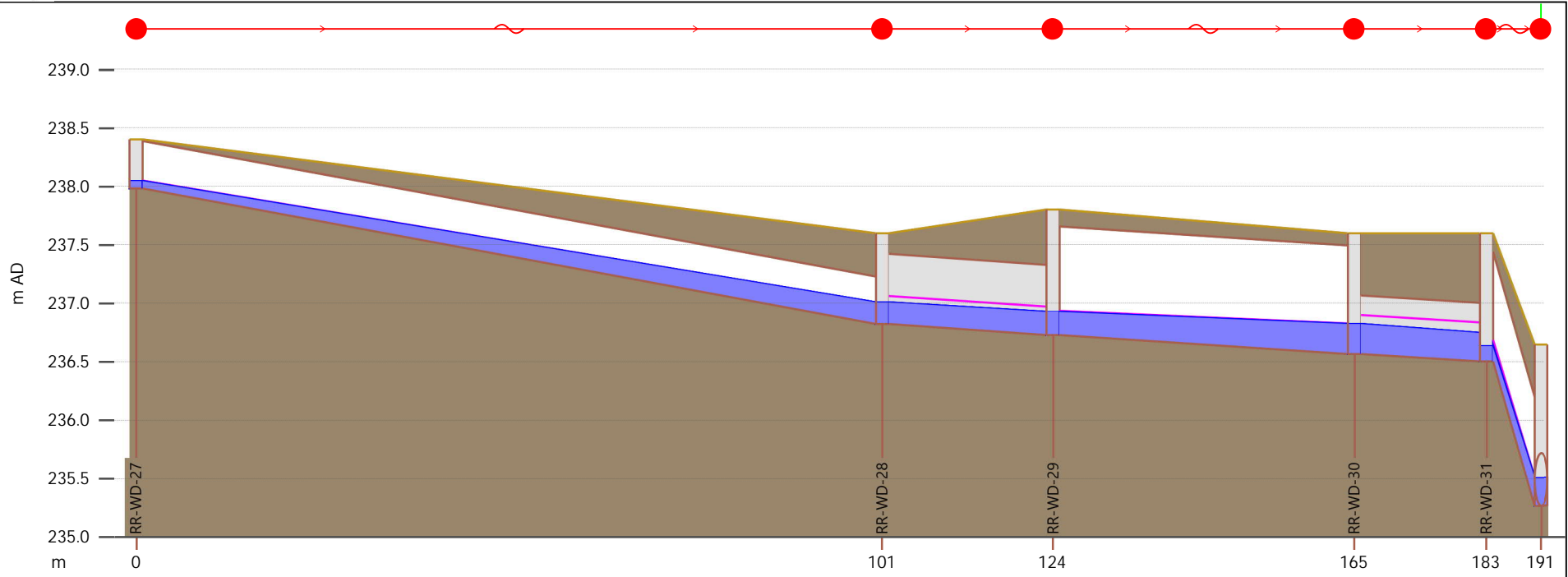
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 9

RVA PROJECT NO. 194615

FIGURE NO. 9E

AUGUST 2021





Link	RR-WD-27.1	RR-WD-28.1	RR-WD-29.1	RR-WD-30.1	-
US node ID	RR-WD-27	RR-WD-28	RR-WD-29	RR-WD-30	-
ds node	RR-WD-28	RR-WD-29	RR-WD-30	RR-WD-31	-
numbarrels	1	1	1	1	1
length (m)		23.2		17.9	
Shape ID	West Side Ditch-1 (Downstream of George Bolton Pkwy)	CIRC		CIRC	
width (mm)		600		500	
height (mm)		600		500	
Rough type		N		N	
us inv (m AD)	237.980	236.823	236.730	236.566	-
ds inv (m AD)	236.823	236.730	236.566	236.505	-
grad (m/m)		0.00401		0.00340	
r.pfc (m3/s)	1.738	0.389	3.019	0.220	-
US depth (m)	0.064	0.183	0.196	0.259	0.128
US flow (m3/s)	0.02391	0.07558	0.09345	0.12629	-
US velocity (m/s)	0.246	1.038	0.426	1.232	1.058
Node	RR-WD-27	RR-WD-28	RR-WD-29	RR-WD-30	-
Node ID	RR-WD-27	RR-WD-28	RR-WD-29	RR-WD-30	-
ground (m AD)	238.400	237.600	237.800	237.600	237.600
level (m AD)	238.044	237.006	236.926	236.825	236.633
expr:Freeboard	0.355917	0.593729	0.874127	0.774942	0.966653

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 9



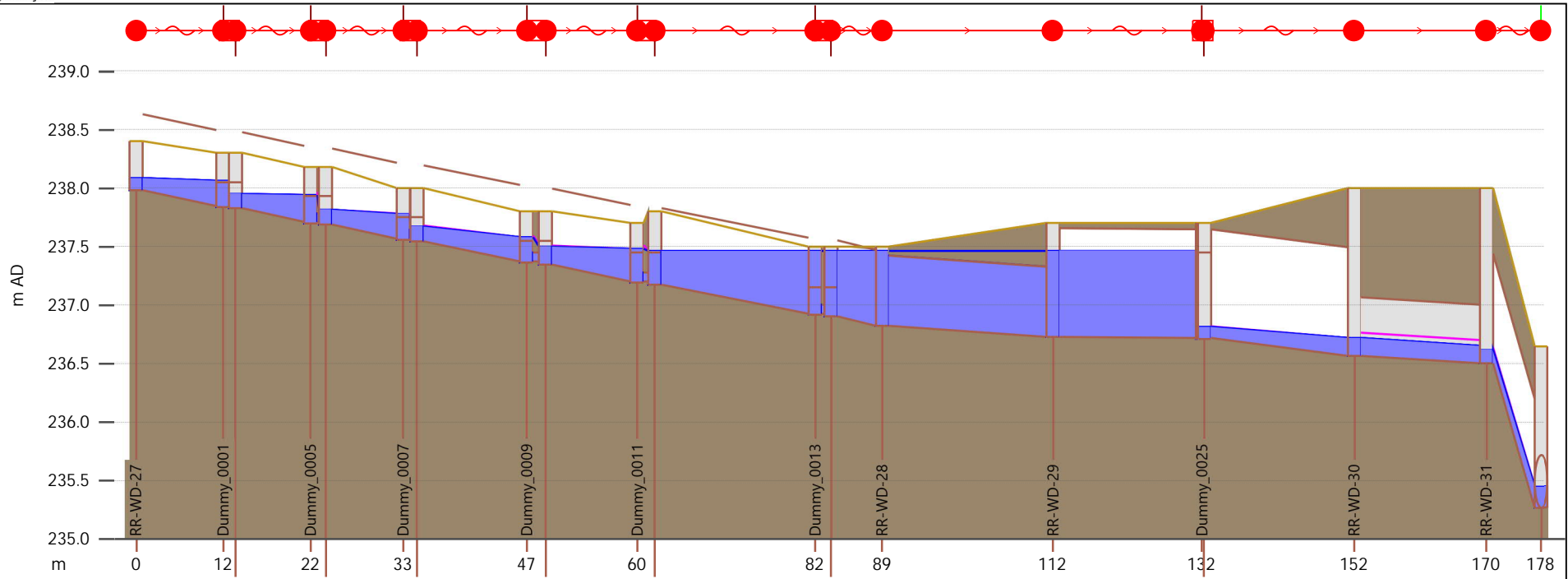
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 9

RVA PROJECT NO. 194615

FIGURE NO. 9G

AUGUST 2021





Link	-	-	-	-	-	-	Dummy_0012.1	-	RR-WD-28.1	RR-WD-29.1	Dummy_0026.1	RR-WD-30.1	-
US node ID	-	-	-	-	-	-	Dummy_0012	-	RR-WD-28	RR-WD-29	Dummy_0026	RR-WD-30	-
ds node	-	-	-	-	-	-	Dummy_0013	-	RR-WD-29	Dummy_0025	RR-WD-30	RR-WD-31	-
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1
length (m)	-	-	-	-	-	-	-	23.2	-	-	-	17.9	-
Shape ID	-	-	-	-	-	-	-	CIRC	-	-	-	CIRC	-
width (mm)	-	-	-	-	-	-	-	600	-	-	-	500	-
height (mm)	-	-	-	-	-	-	-	600	-	-	-	500	-
Rough type	-	-	-	-	-	-	-	N	-	-	-	N	-
us inv (m AD)	237.980	237.826	237.686	237.545	237.345	237.176	237.176	236.823	236.730	236.719	236.719	236.566	-
ds inv (m AD)	237.845	237.709	237.566	237.374	237.203	236.927	236.927	236.730	236.719	236.566	236.566	236.505	-
grad (m/m)	-	-	-	-	-	-	-	0.00401	-	-	-	0.00340	-
r.pfc (m3/s)	3.756	3.756	3.756	3.756	-	3.756	3.756	0.389	1.091	4.129	0.220	-	-
US depth (m)	0.105	0.125	0.127	0.127	-	0.156	0.289	0.561	0.641	0.733	0.096	0.156	0.113
US flow (m3/s)	0.02428	0.02313	0.02216	0.08643	-	0.08497	0.08410	-	0.05668	0.06077	0.02744	0.04790	-
US velocity (m/s)	0.148	0.146	0.105	0.413	-	0.309	0.408	0.294	0.735	0.177	0.313	0.918	0.620
Node	-	-	-	-	-	-	-	-	RR-WD-28	RR-WD-29	-	RR-WD-30	-
Node ID	-	-	-	-	-	-	-	-	RR-WD-28	RR-WD-29	-	RR-WD-30	-
ground (m AD)	-	-	-	-	-	-	237.800	237.500	237.500	237.700	-	238.000	238.000
level (m AD)	-	-	-	-	-	-	237.465	237.464	237.464	237.463	-	236.722	236.618
expr:Freeboard	-	-	-	-	-	-	0.335126	-	0.036255	0.236682	-	1.278244	1.381882

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 9



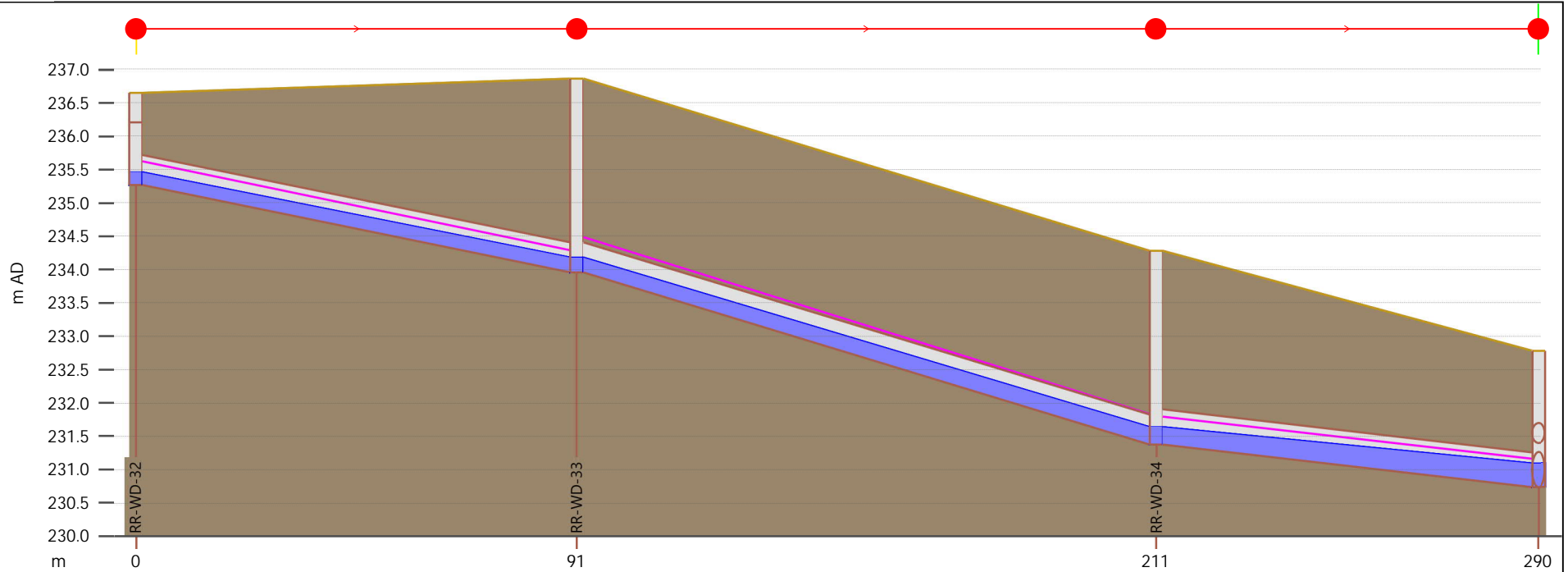
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 10

RVA PROJECT NO. 194615

FIGURE NO. 10A

AUGUST 2021





Link	RR-WD-32.1	RR-WD-33.1	RR-WD-34.1	
US node ID	RR-WD-32	RR-WD-33	RR-WD-34	
ds node	RR-WD-33	RR-WD-34	RR-WD-35	
numbarrels	1	1	1	
length (m)	91.0	119.6	79.0	
Shape ID	CIRC	CIRC	CIRC	
width (mm)	450	450	525	
height (mm)	450	450	525	
Rough type	N	N	N	
us inv (m AD)	235.267	233.958	231.377	
ds inv (m AD)	233.958	231.377	230.737	
grad (m/m)	0.01438	0.02157	0.00811	
r.pfc (m3/s)	0.342	0.419	0.387	
US depth (m)	0.184	0.219	0.260	
US flow (m3/s)	0.11063	0.18958	0.18824	
US velocity (m/s)	1.815	2.467	1.759	
Node	RR-WD-32	RR-WD-33	RR-WD-34	RR-WD-35
Node ID	RR-WD-32	RR-WD-33	RR-WD-34	RR-WD-35
ground (m AD)	236.646	236.856	234.279	232.779
level (m AD)	235.451	234.177	231.637	231.096
expr:Freeboard	1.195389	2.678741	2.642136	1.683731

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 9



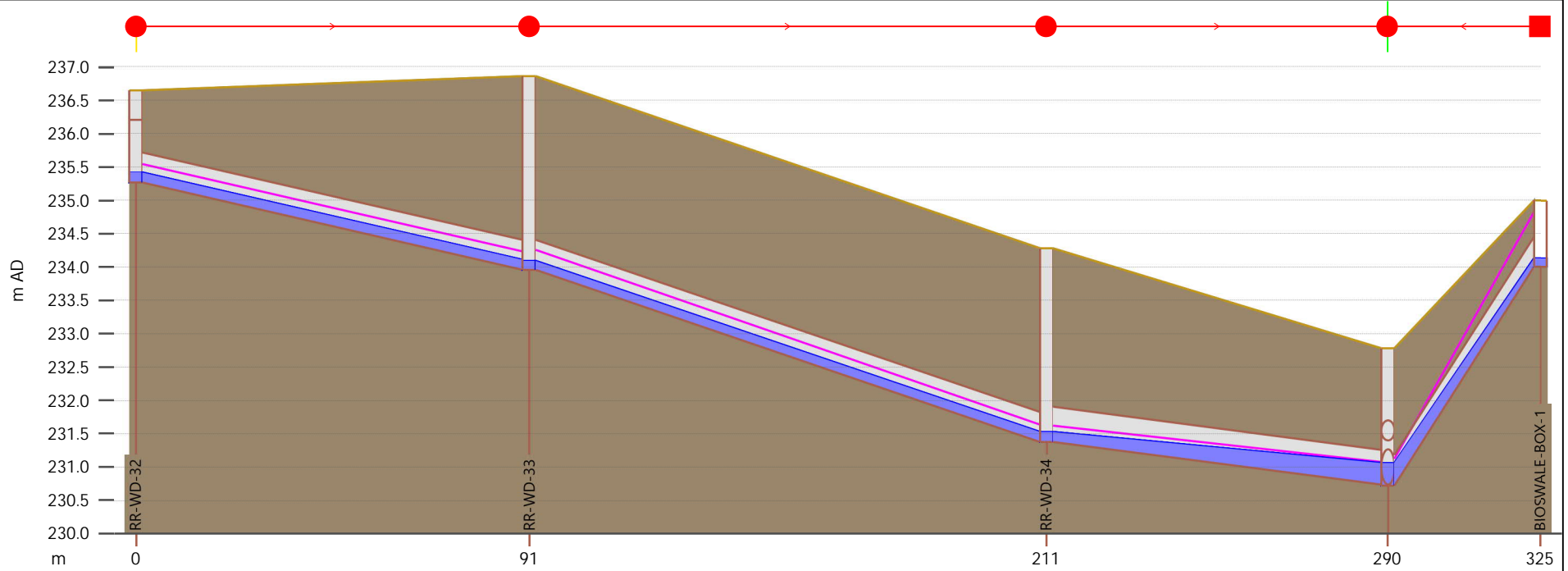
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 10

RVA PROJECT NO. 194615

FIGURE NO. 10C

AUGUST 2021





Link	RR-WD-32.1	RR-WD-33.1	RR-WD-34.1	BIOSWALE-BOX-1	
US node ID	RR-WD-32	RR-WD-33	RR-WD-34	RR-WD-35	
ds node	RR-WD-33	RR-WD-34	RR-WD-35	RR-WD-35	
numbarrels	1	1	1	1	
length (m)	91.0	119.6	79.0	35.3	
Shape ID	CIRC	CIRC	CIRC	CIRC	
width (mm)	450	450	525	450	
height (mm)	450	450	525	450	
Rough type	N	N	N	N	
us inv (m AD)	235.267	233.958	231.377	234.000	
ds inv (m AD)	233.958	231.377	230.737	230.727	
grad (m/m)	0.01438	0.02157	0.00811	0.09259	
r.pfc (m3/s)	0.342	0.419	0.387	0.868	
US depth (m)	0.148	0.132	0.152	0.130	
US flow (m3/s)	0.07240	0.07043	0.06918	0.13980	
US velocity (m/s)	1.586	1.816	1.336	3.688	
Node	RR-WD-32	RR-WD-33	RR-WD-34	RR-WD-35	-
Node ID	RR-WD-32	RR-WD-33	RR-WD-34	RR-WD-35	-
ground (m AD)	236.646	236.856	234.279	232.779	236.646
level (m AD)	235.415	234.090	231.529	231.065	231.065
expr:Freeboard	1.230789	2.766205	2.750626	1.714783	-

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 10



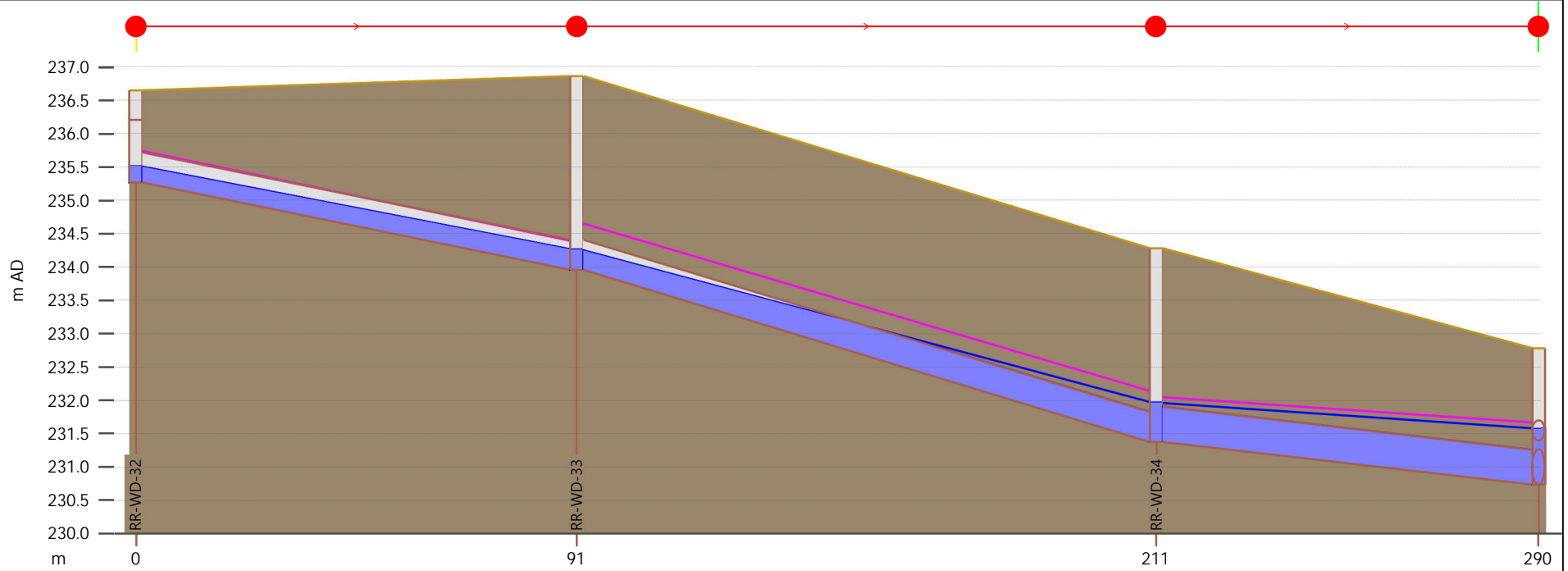
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 10

RVA PROJECT NO. 194615

FIGURE NO. 10E

AUGUST 2021





Link	RR-WD-32.1	RR-WD-33.1	RR-WD-34.1	
US node ID	RR-WD-32	RR-WD-33	RR-WD-34	
ds node	RR-WD-33	RR-WD-34	RR-WD-35	
numbarrels	1	1	1	
length (m)	91.0	119.6	79.0	
Shape ID	CIRC	CIRC	CIRC	
width (mm)	450	450	525	
height (mm)	450	450	525	
Rough type	N	N	N	
us inv (m AD)	235.267	233.958	231.377	
ds inv (m AD)	233.958	231.377	230.737	
grad (m/m)	0.01438	0.02157	0.00811	
r.pfc (m3/s)	0.342	0.419	0.387	
US depth (m)	0.237	0.289	0.581	
US flow (m3/s)	0.18076	0.30461	0.29912	
US velocity (m/s)	2.126	2.818	1.955	
Node	RR-WD-32	RR-WD-33	RR-WD-34	RR-WD-35
Node ID	RR-WD-32	RR-WD-33	RR-WD-34	RR-WD-35
ground (m AD)	236.646	236.856	234.279	232.779
level (m AD)	235.506	234.262	231.973	231.577
expr:Freeboard	1.140045	2.594254	2.306564	1.202011

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 10



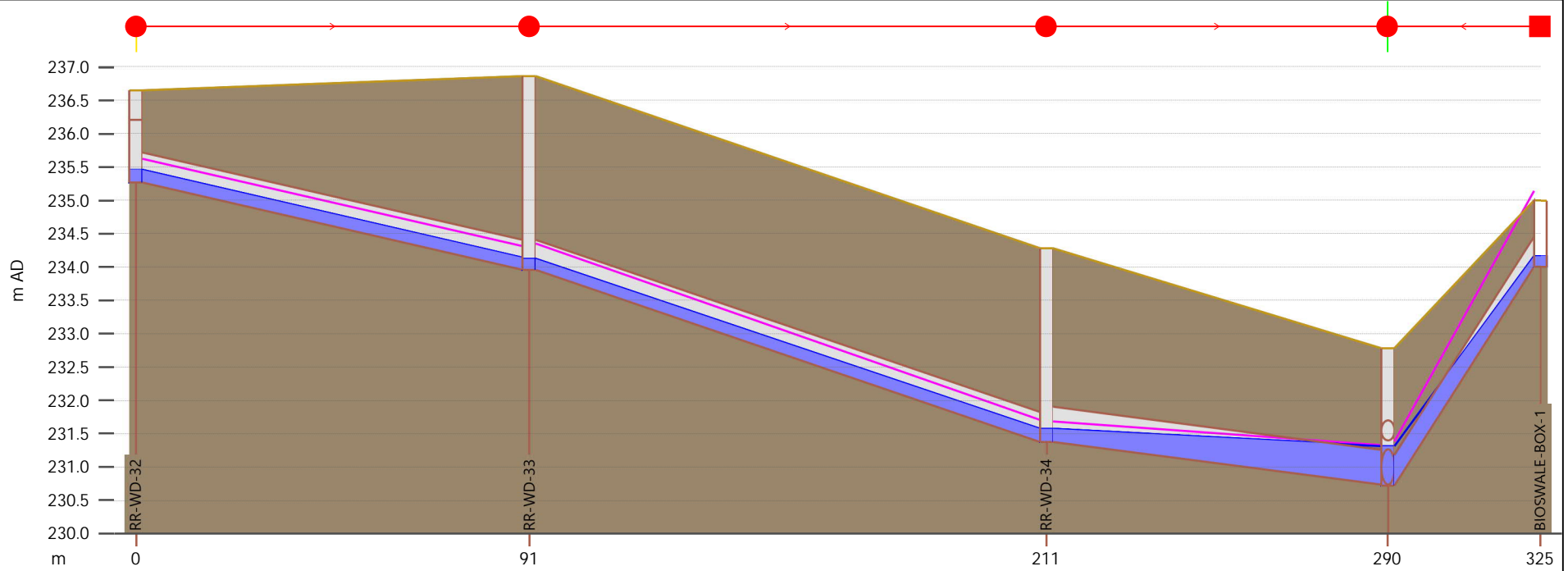
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 10

RVA PROJECT NO. 194615

FIGURE NO. 10G

AUGUST 2021





Link	RR-WD-32.1	RR-WD-33.1	RR-WD-34.1	-	
US node ID	RR-WD-32	RR-WD-33	RR-WD-34	BIOSWALE-BOX-1	
ds node	RR-WD-33	RR-WD-34	RR-WD-35	RR-WD-35	
numbarrels	1	1	1	1	
length (m)	91.0	119.6	79.0	35.3	
Shape ID	CIRC	CIRC	CIRC	CIRC	
width (mm)	450	450	525	450	
height (mm)	450	450	525	450	
Rough type	N	N	N	N	
us inv (m AD)	235.267	233.958	231.377	234.000	
ds inv (m AD)	233.958	231.377	230.737	230.727	
grad (m/m)	0.01438	0.02157	0.00811	0.09259	
r.pfc (m3/s)	0.342	0.419	0.387	0.868	
US depth (m)	0.184	0.163	0.195	0.163	
US flow (m3/s)	0.11202	0.10952	0.10764	0.22687	
US velocity (m/s)	1.826	2.110	1.496	4.371	
Node	RR-WD-32	RR-WD-33	RR-WD-34	RR-WD-35	-
Node ID	RR-WD-32	RR-WD-33	RR-WD-34	RR-WD-35	-
ground (m AD)	236.646	236.856	234.279	232.779	234.000
level (m AD)	235.452	234.121	231.572	231.315	230.727
expr:Freeboard	1.194565	2.735031	2.707413	1.464035	-

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 10



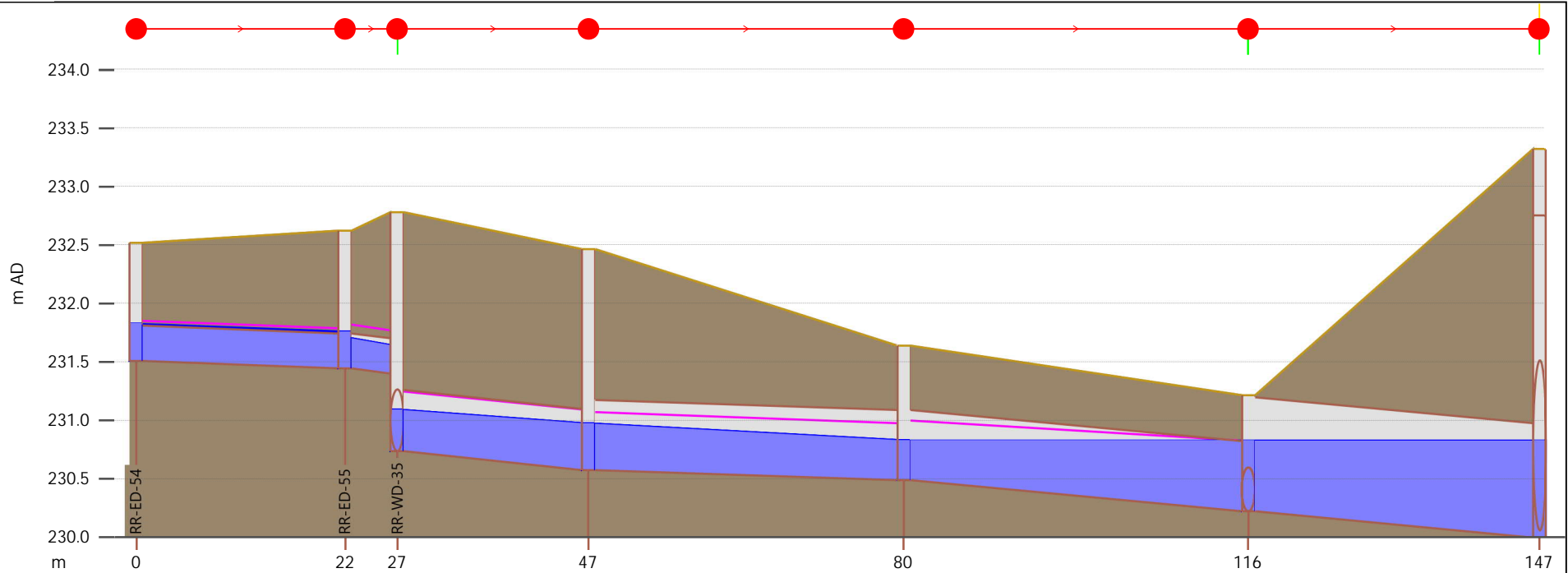
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 11

RVA PROJECT NO. 194615

FIGURE NO. 11A

AUGUST 2021

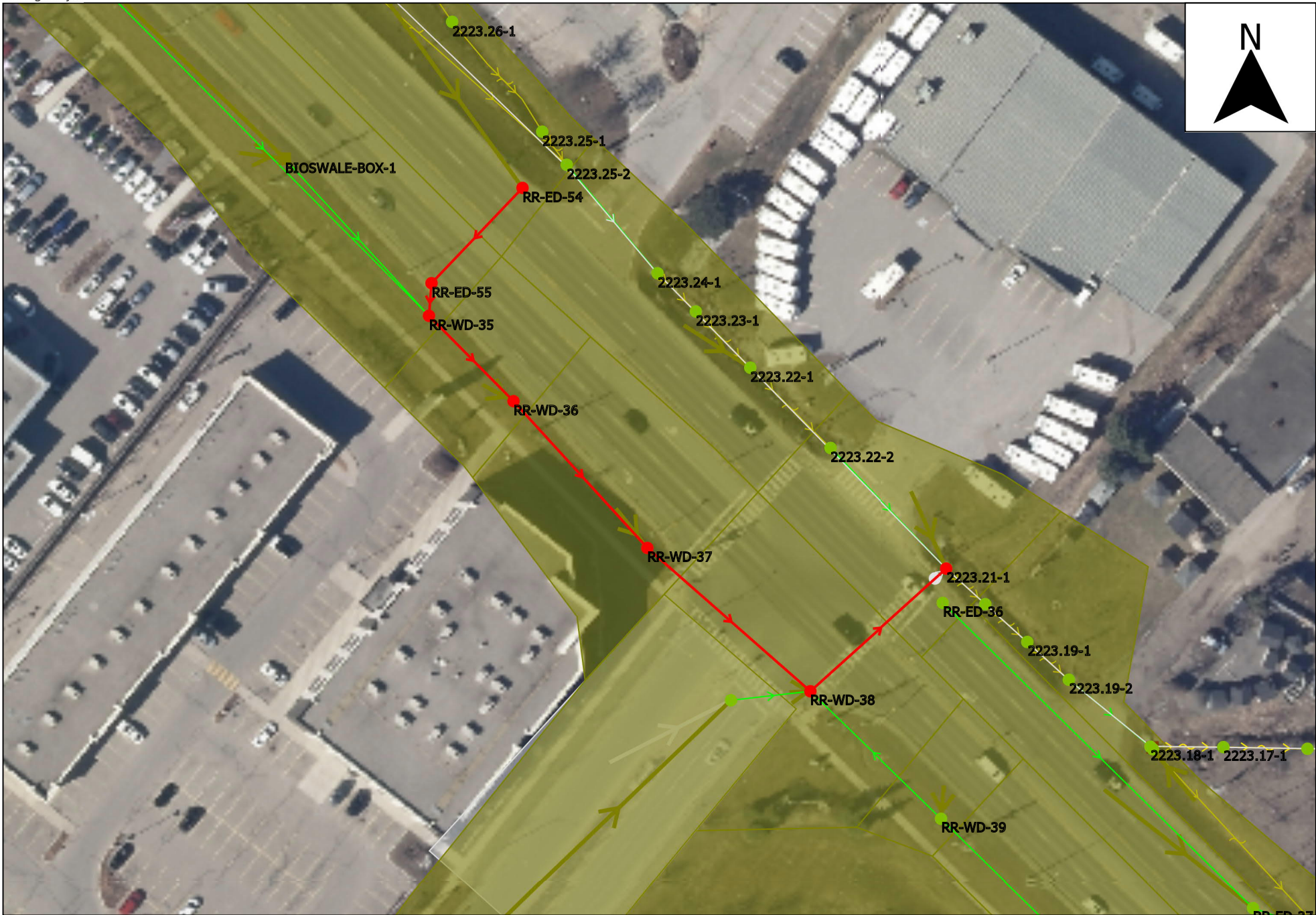




Link	RR-ED-54.1	-	RR-WD-35.1	RR-WD-36.1	RR-WD-37.1	RR-WD-38.1
US node ID	RR-ED-54	-	RR-WD-35	RR-WD-36	RR-WD-37	RR-WD-38
ds node	RR-ED-55	-	RR-WD-36	RR-WD-37	RR-WD-38	2223.21-1
numbarrels	1	1	1	1	1	1
length (m)	21.8	5.5	20.0	32.9	36.0	30.4
Shape ID	CIRC	CIRC	CIRC	CIRC	CIRC	RECT
width (mm)	300	300	525	600	600	600
height (mm)	300	300	525	600	600	975
Rough type	N	N	N	N	N	N
us inv (m AD)	231.508	-	230.737	230.575	230.488	230.223
ds inv (m AD)	231.444	-	230.575	230.488	230.223	230.000
grad (m/m)	0.00293	-	0.00811	0.00264	0.00736	0.00733
r.pfc (m3/s)	0.052	0.087	0.387	0.316	0.527	1.254
US depth (m)	0.315	0.259	0.353	0.396	0.341	0.605
US flow (m3/s)	0.05144	-	0.27052	0.27983	0.30390	0.45262
US velocity (m/s)	0.766	1.507	1.755	1.422	1.837	1.946

Node	RR-ED-54	RR-ED-55	RR-WD-35	RR-WD-36	RR-WD-37	RR-WD-38	2223.21-1
Node ID	RR-ED-54	RR-ED-55	RR-WD-35	RR-WD-36	RR-WD-37	RR-WD-38	2223.21-1
ground (m AD)	232.517	232.621	232.779	232.465	231.641	231.215	233.320
level (m AD)	231.826	231.760	231.096	230.975	230.833	230.828	230.827
expr:Freeboard	0.691620	0.861053	1.683731	1.489899	0.807510	0.387619	2.492592

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 11



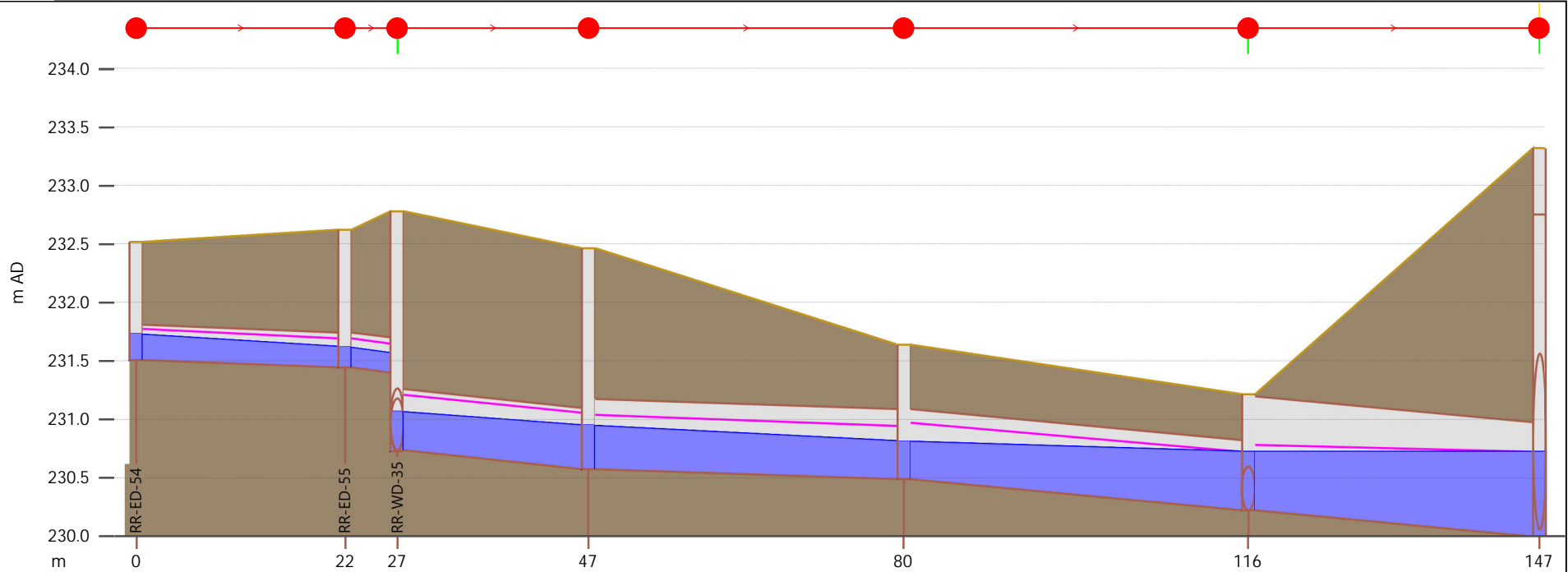
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 11

RVA PROJECT NO. 194615

FIGURE NO. 11C

AUGUST 2021





Link	RR-ED-54.1	-	RR-WD-35.1	RR-WD-36.1	RR-WD-37.1	RR-WD-38.1	
US node ID	RR-ED-54	-	RR-WD-35	RR-WD-36	RR-WD-37	RR-WD-38	
ds node	RR-ED-55	-	RR-WD-36	RR-WD-37	RR-WD-38	2223.21-1	
numbarrels	1	1	1	1	1	1	
length (m)	21.8	5.5	20.0	32.9	36.0	30.4	
Shape ID	CIRC	CIRC	CIRC	CIRC	CIRC	RECT	
width (mm)	300	300	525	600	600	600	
height (mm)	300	300	525	600	600	975	
Rough type	N	N	N	N	N	N	
us inv (m AD)	231.508	-	230.737	230.575	230.488	230.223	
ds inv (m AD)	231.444	-	230.575	230.488	230.223	230.000	
grad (m/m)	0.00293	-	0.00811	0.00264	0.00736	0.00733	
r.pfc (m3/s)	0.052	0.087	0.387	0.316	0.527	1.254	
US depth (m)	0.217	0.168	0.324	0.370	0.320	0.501	
US flow (m3/s)	0.05254	-	0.24012	0.24950	0.27537	0.42999	
US velocity (m/s)	0.958	1.257	1.719	1.379	1.818	1.938	
Node	RR-ED-54	RR-ED-55	RR-WD-35	RR-WD-36	RR-WD-37	RR-WD-38	2223.21-1
Node ID	RR-ED-54	RR-ED-55	RR-WD-35	RR-WD-36	RR-WD-37	RR-WD-38	2223.21-1
ground (m AD)	232.517	232.621	232.779	232.465	231.641	231.215	233.320
level (m AD)	231.728	231.617	231.065	230.948	230.811	230.724	230.724
expr:Freeboard	0.789703	1.004257	1.714783	1.516281	0.830276	0.490784	2.595818

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 11



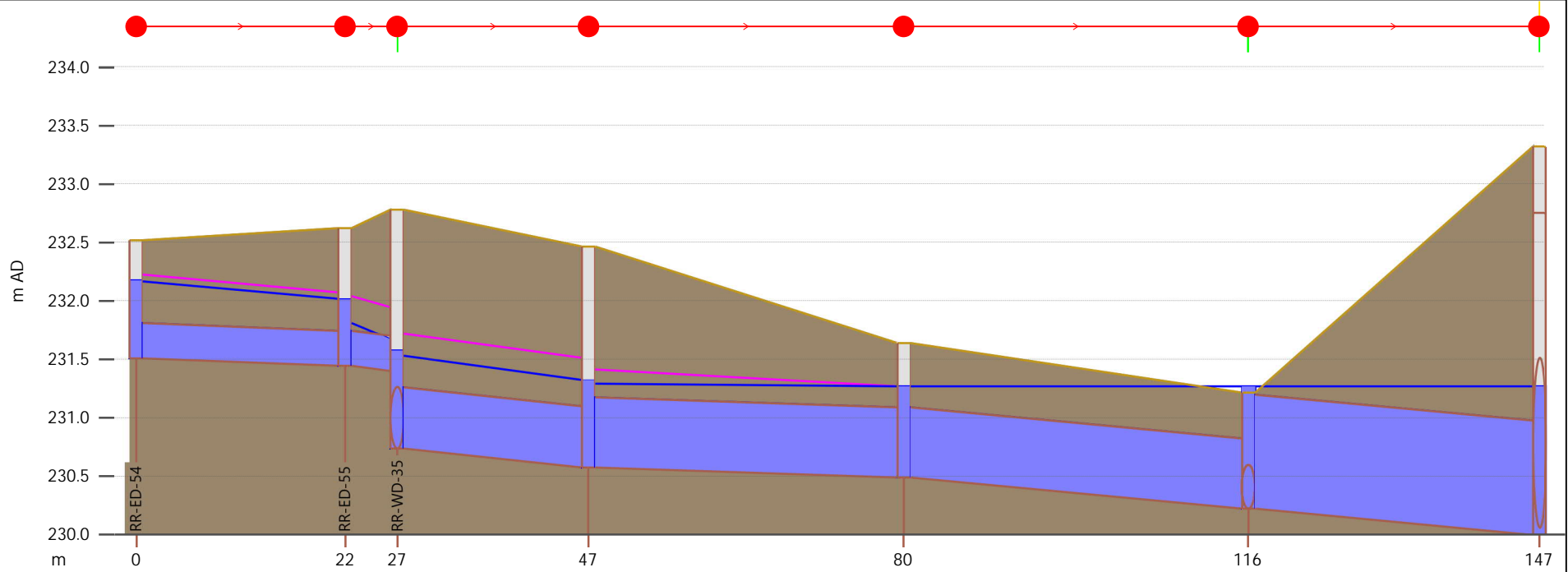
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 11

RVA PROJECT NO. 194615

FIGURE NO. 11E

AUGUST 2021





Link	RR-ED-54.1	-	RR-WD-35.1	RR-WD-36.1	RR-WD-37.1	RR-WD-38.1	
US node ID	RR-ED-54	-	RR-WD-35	RR-WD-36	RR-WD-37	RR-WD-38	
ds node	RR-ED-55	-	RR-WD-36	RR-WD-37	RR-WD-38	2223.21-1	
numbarrels	1	1	1	1	1	1	
length (m)	21.8	5.5	20.0	32.9	36.0	30.4	
Shape ID	CIRC	CIRC	CIRC	CIRC	CIRC	RECT	
width (mm)	300	300	525	600	600	600	
height (mm)	300	300	525	600	600	975	
Rough type	N	N	N	N	N	N	
us inv (m AD)	231.508	-	230.737	230.575	230.488	230.223	
ds inv (m AD)	231.444	-	230.575	230.488	230.223	230.000	
grad (m/m)	0.00293	-	0.00811	0.00264	0.00736	0.00733	
r.pfc (m3/s)	0.052	0.087	0.387	0.316	0.527	1.254	
US depth (m)	0.659	0.368	0.794	0.716	0.782	1.047	
US flow (m3/s)	0.07952	-	0.43483	0.45471	0.49572	0.75828	
US velocity (m/s)	1.056	2.111	1.917	1.547	1.922	2.231	
Node	RR-ED-54	RR-ED-55	RR-WD-35	RR-WD-36	RR-WD-37	RR-WD-38	2223.21-1
Node ID	RR-ED-54	RR-ED-55	RR-WD-35	RR-WD-36	RR-WD-37	RR-WD-38	2223.21-1
ground (m AD)	232.517	232.621	232.779	232.465	231.641	231.215	233.320
level (m AD)	232.176	232.011	231.577	231.320	231.270	231.270	231.270
expr:Freeboard	0.341217	0.610687	1.202011	1.144531	0.371262	-0.054428	2.050499

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 11



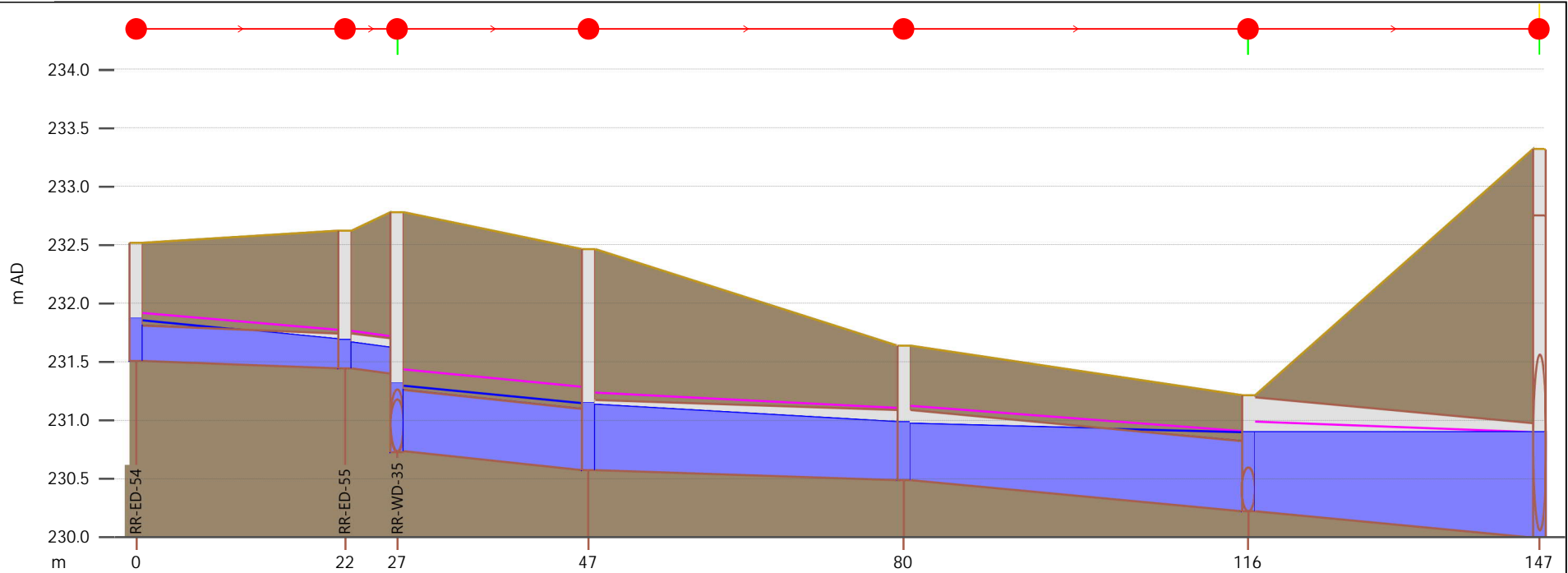
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 11

RVA PROJECT NO. 194615

FIGURE NO. 11G

AUGUST 2021

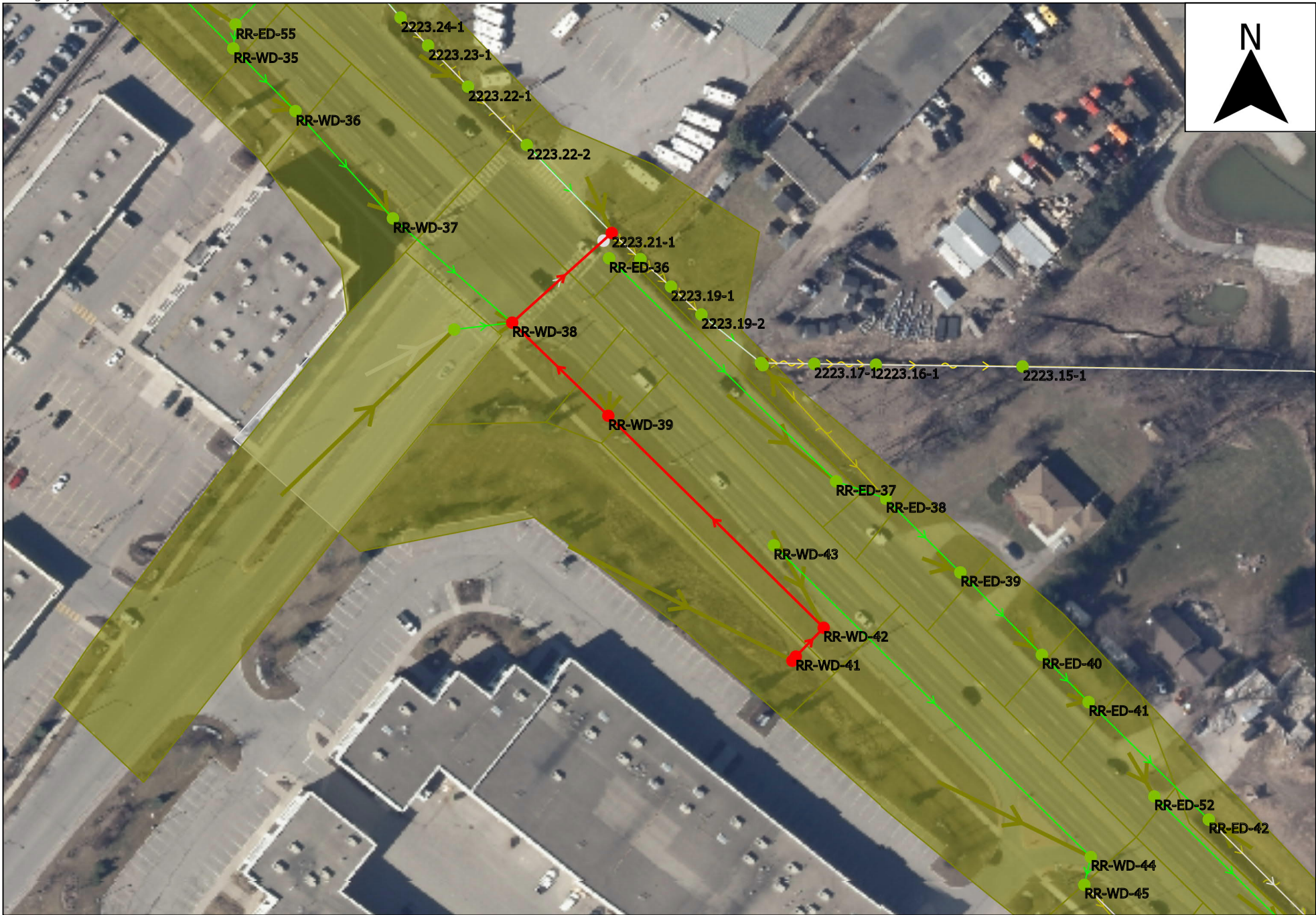




Link	RR-ED-54.1	-	RR-WD-35.1	RR-WD-36.1	RR-WD-37.1	RR-WD-38.1
US node ID	RR-ED-54	-	RR-WD-35	RR-WD-36	RR-WD-37	RR-WD-38
ds node	RR-ED-55	-	RR-WD-36	RR-WD-37	RR-WD-38	2223.21-1
numbarrels	1	1	1	1	1	1
length (m)	21.8	5.5	20.0	32.9	36.0	30.4
Shape ID	CIRC	CIRC	CIRC	CIRC	CIRC	RECT
width (mm)	300	300	525	600	600	600
height (mm)	300	300	525	600	600	975
Rough type	N	N	N	N	N	N
us inv (m AD)	231.508	-	230.737	230.575	230.488	230.223
ds inv (m AD)	231.444	-	230.575	230.488	230.223	230.000
grad (m/m)	0.00293	-	0.00811	0.00264	0.00736	0.00733
r.pfc (m3/s)	0.052	0.087	0.387	0.316	0.527	1.254
US depth (m)	0.348	0.220	0.559	0.560	0.482	0.678
US flow (m3/s)	0.07983	-	0.37219	0.39057	0.42662	0.68592
US velocity (m/s)	1.087	1.408	1.793	1.502	1.892	2.164

Node	RR-ED-54	RR-ED-55	RR-WD-35	RR-WD-36	RR-WD-37	RR-WD-38	2223.21-1
Node ID	RR-ED-54	RR-ED-55	RR-WD-35	RR-WD-36	RR-WD-37	RR-WD-38	2223.21-1
ground (m AD)	232.517	232.621	232.779	232.465	231.641	231.215	233.320
level (m AD)	231.867	231.690	231.315	231.146	230.985	230.901	230.901
expr:Freeboard	0.650635	0.930908	1.464035	1.318451	0.655350	0.313644	2.418587

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 11



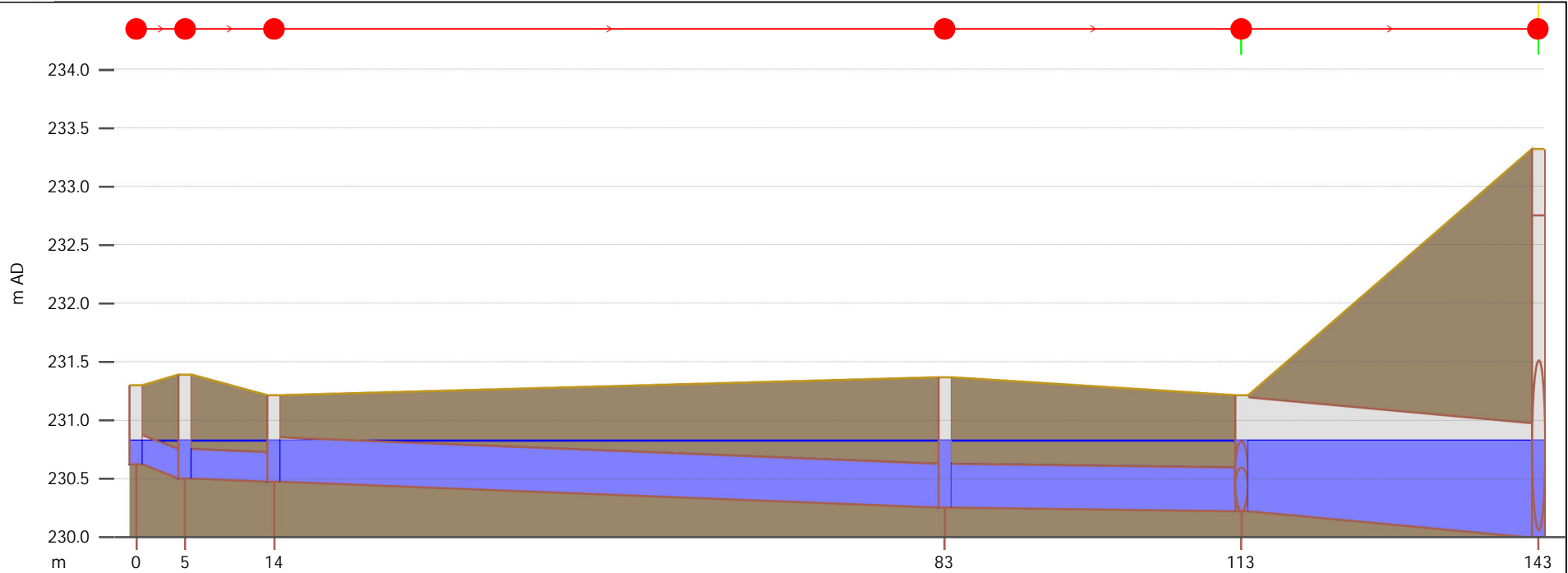
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 12

RVA PROJECT NO. 194615

FIGURE NO. 12A

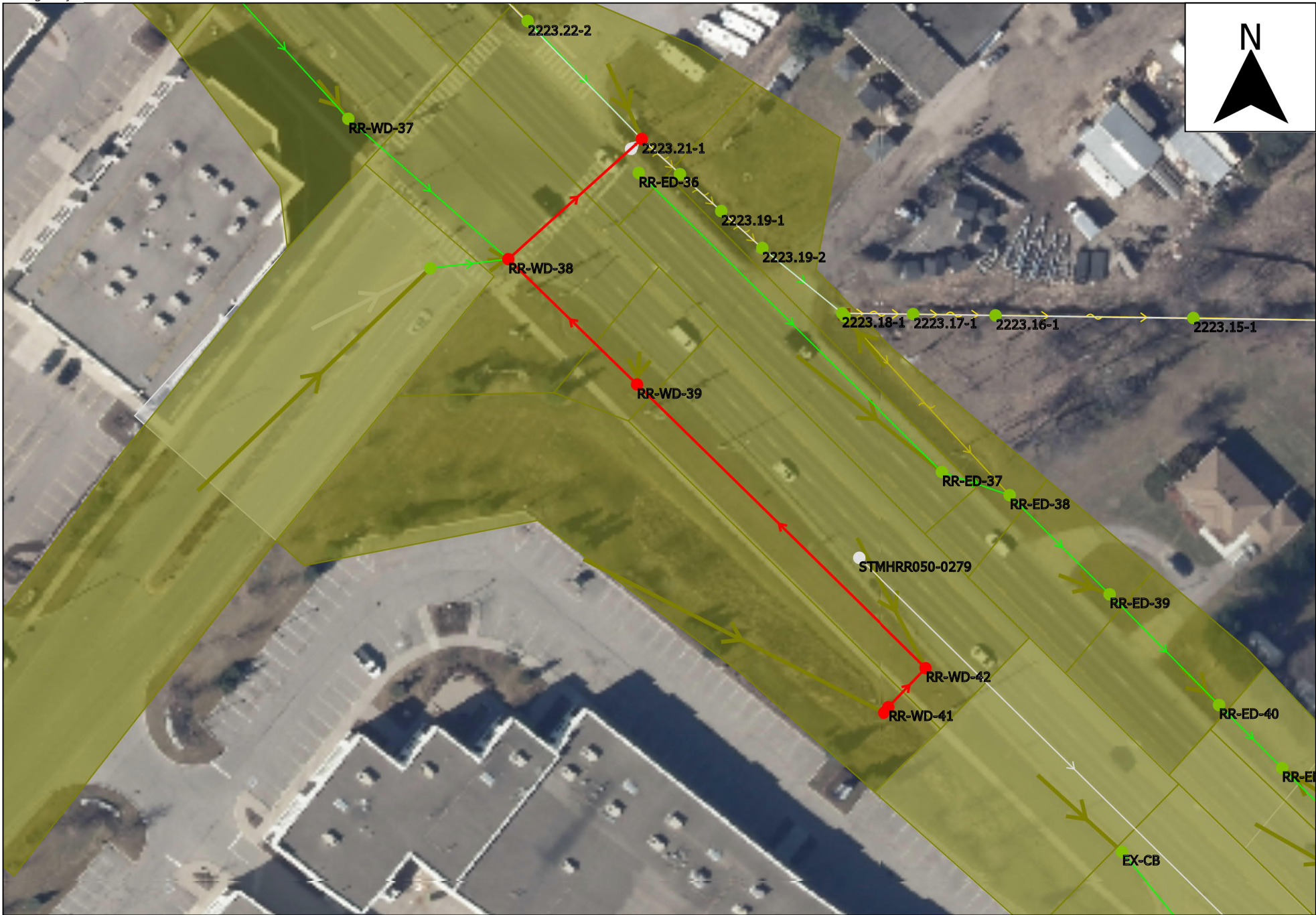
AUGUST 2021





Link	-	-	RR-WD-42.1	RR-WD-39.1	RR-WD-38.1
US node ID	-	-	RR-WD-42	RR-WD-39	RR-WD-38
ds node	-	-	RR-WD-39	RR-WD-38	2223.21-1
numbarrels	1	1	1	1	1
length (m)	5.0	9.1	68.6	30.4	30.4
Shape ID	CIRC	CIRC	CIRC	CIRC	RECT
width (mm)	250	250	375	375	600
height (mm)	250	250	375	375	975
Rough type	N	N	N	N	N
us inv (m AD)	-	230.504	230.478	230.256	230.223
ds inv (m AD)	-	230.478	230.256	230.223	230.000
grad (m/m)	-	0.00285	0.00324	0.00109	0.00733
r.pfc (m3/s)	0.093	0.032	0.100	0.058	1.254
US depth (m)	0.203	0.324	0.350	0.572	0.605
US flow (m3/s)	-	0.00657	0.04079	0.04510	0.45262
US velocity (m/s)	0.826	0.344	0.828	0.417	1.946
Node	-	RR-WD-42	RR-WD-39	RR-WD-38	2223.21-1
Node ID	-	RR-WD-42	RR-WD-39	RR-WD-38	2223.21-1
ground (m AD)	-	231.217	231.366	231.215	233.320
level (m AD)	-	230.828	230.828	230.828	230.827
expr:Freeboard	-	0.389389	0.538849	0.387619	2.492592

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 12



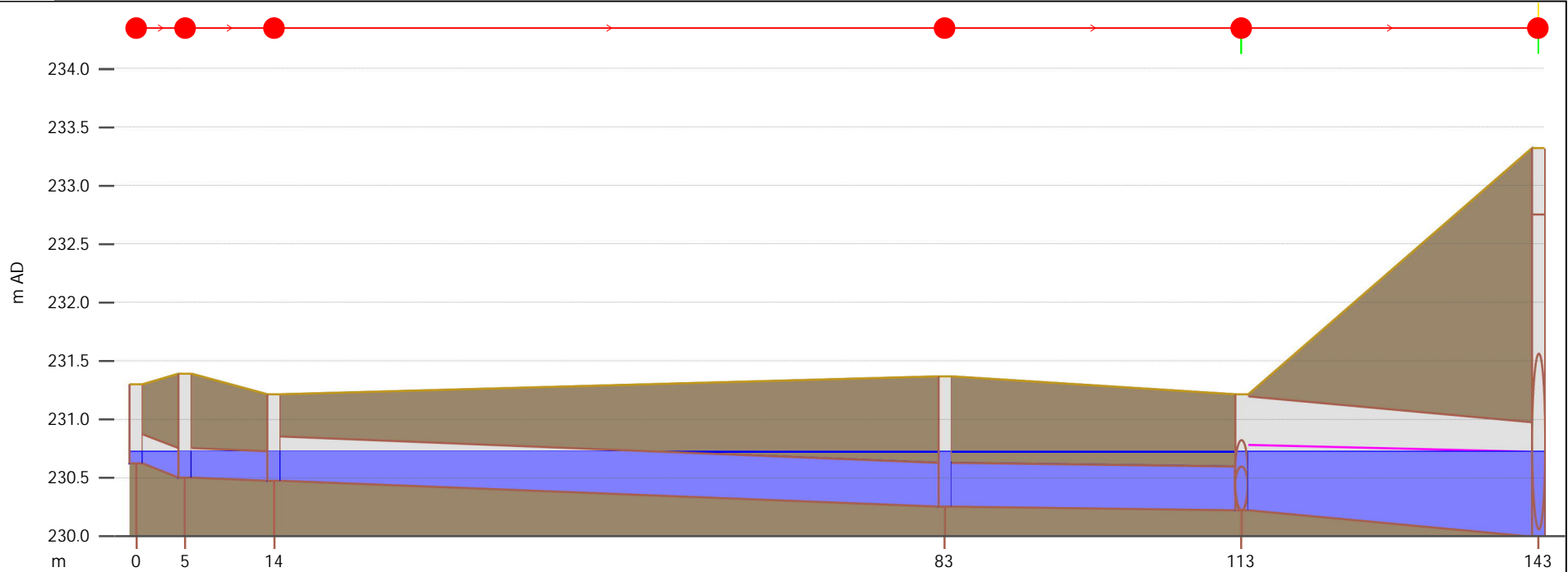
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 12

RVA PROJECT NO. 194615

FIGURE NO. 12C

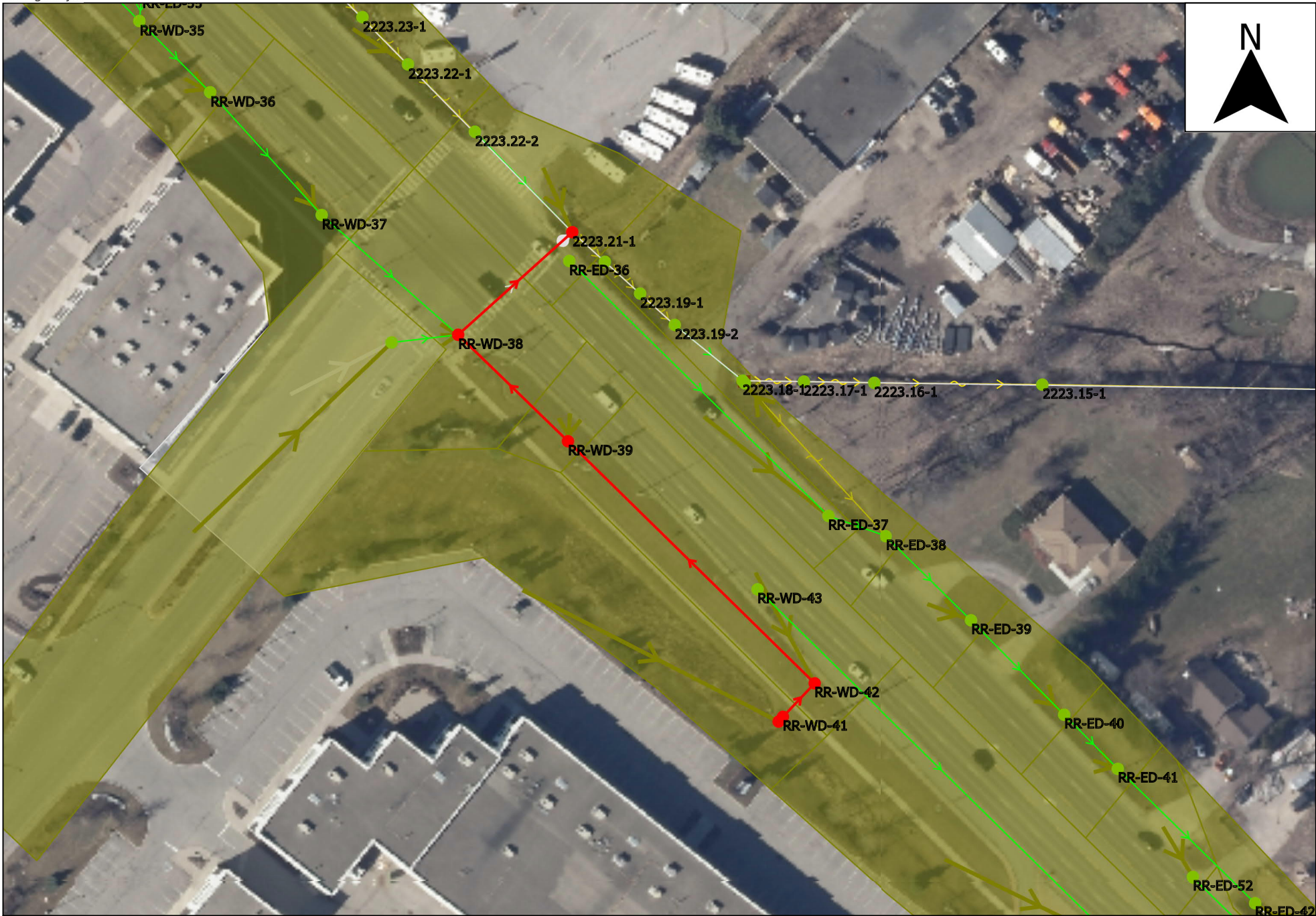
AUGUST 2021



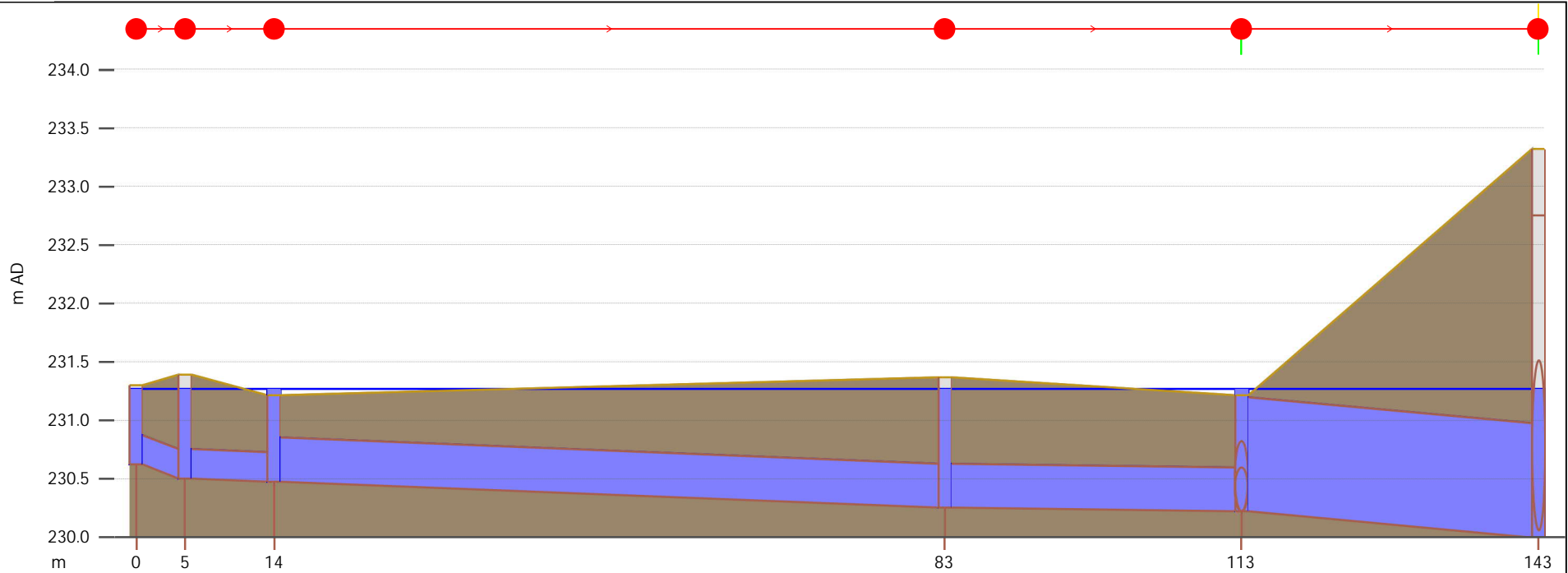


Link	-	-	RR-WD-42.1	RR-WD-39.1	RR-WD-38.1
US node ID	-	-	RR-WD-42	RR-WD-39	RR-WD-38
ds node	-	-	RR-WD-39	RR-WD-38	2223.21-1
numbarrels	1	1	1	1	1
length (m)	5.0	9.1	68.6	30.4	30.4
Shape ID	CIRC	CIRC	CIRC	CIRC	RECT
width (mm)	250	250	375	375	600
height (mm)	250	250	375	375	975
Rough type	N	N	N	N	N
us inv (m AD)	-	230.504	230.478	230.256	230.223
ds inv (m AD)	-	230.478	230.256	230.223	230.000
grad (m/m)	-	0.00285	0.00324	0.00109	0.00733
r.pfc (m3/s)	0.093	0.032	0.100	0.058	1.254
US depth (m)	0.100	0.220	0.246	0.468	0.501
US flow (m3/s)	-	0.00666	0.04063	0.04611	0.42999
US velocity (m/s)	0.840	0.344	0.826	0.434	1.938
Node	-	RR-WD-42	RR-WD-39	RR-WD-38	2223.21-1
Node ID	-	RR-WD-42	RR-WD-39	RR-WD-38	2223.21-1
ground (m AD)	-	231.217	231.366	231.215	233.320
level (m AD)	-	230.724	230.724	230.724	230.724
expr:Freeboard	-	0.492569	0.642014	0.490784	2.595818

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 12



EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 12



Link	-	-	RR-WD-42.1	RR-WD-39.1	RR-WD-38.1
US node ID	-	-	RR-WD-42	RR-WD-39	RR-WD-38
ds node	-	-	RR-WD-39	RR-WD-38	2223.21-1
numbarrels	1	1	1	1	1
length (m)	5.0	9.1	68.6	30.4	30.4
Shape ID	CIRC	CIRC	CIRC	CIRC	RECT
width (mm)	250	250	375	375	600
height (mm)	250	250	375	375	975
Rough type	N	N	N	N	N
us inv (m AD)	-	230.504	230.478	230.256	230.223
ds inv (m AD)	-	230.478	230.256	230.223	230.000
grad (m/m)	-	0.00285	0.00324	0.00109	0.00733
r.pfc (m3/s)	0.093	0.032	0.100	0.058	1.254
US depth (m)	0.645	0.766	0.792	1.014	1.047
US flow (m3/s)	-	0.03133	0.07587	0.08651	0.75828
US velocity (m/s)	1.269	0.633	0.896	0.743	2.231
Node	-	RR-WD-42	RR-WD-39	RR-WD-38	2223.21-1
Node ID	-	RR-WD-42	RR-WD-39	RR-WD-38	2223.21-1
ground (m AD)	-	231.217	231.366	231.215	233.320
level (m AD)	-	231.270	231.270	231.270	231.270
expr:Freeboard	-	-0.052643	0.096802	-0.054428	2.050499

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 12



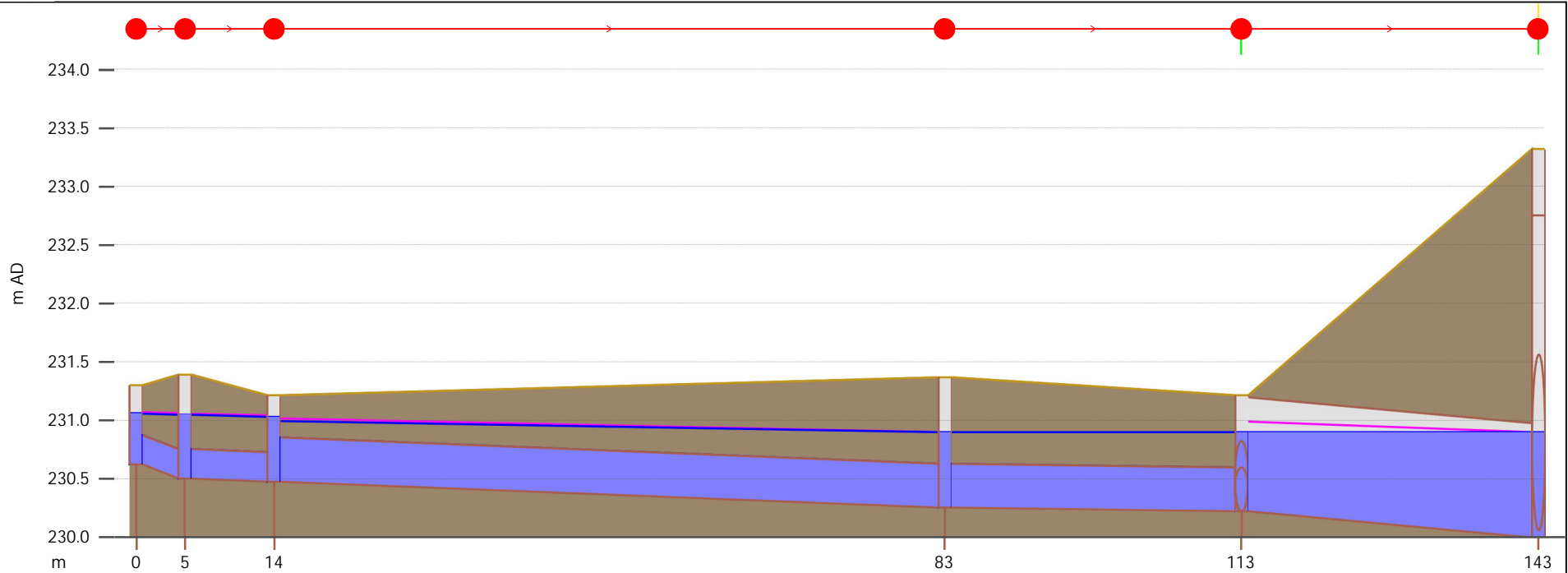
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 12

RVA PROJECT NO. 194615

FIGURE NO. 12G

AUGUST 2021





Link	-	-	RR-WD-42.1	RR-WD-39.1	RR-WD-38.1
US node ID	-	-	RR-WD-42	RR-WD-39	RR-WD-38
ds node	-	-	RR-WD-39	RR-WD-38	2223.21-1
numbarrels	1	1	1	1	1
length (m)	5.0	9.1	68.6	30.4	30.4
Shape ID	CIRC	CIRC	CIRC	CIRC	RECT
width (mm)	250	250	375	375	600
height (mm)	250	250	375	375	975
Rough type	N	N	N	N	N
us inv (m AD)	-	230.504	230.478	230.256	230.223
ds inv (m AD)	-	230.478	230.256	230.223	230.000
grad (m/m)	-	0.00285	0.00324	0.00109	0.00733
r.pfc (m3/s)	0.093	0.032	0.100	0.058	1.254
US depth (m)	0.435	0.544	0.518	0.645	0.678
US flow (m3/s)	-	0.03255	0.07513	0.08572	0.68592
US velocity (m/s)	1.239	0.632	0.894	0.739	2.164
Node	-	RR-WD-42	RR-WD-39	RR-WD-38	2223.21-1
Node ID	-	RR-WD-42	RR-WD-39	RR-WD-38	2223.21-1
ground (m AD)	-	231.217	231.366	231.215	233.320
level (m AD)	-	231.032	230.901	230.901	230.901
expr:Freeboard	-	0.185364	0.464874	0.313644	2.418587

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 12



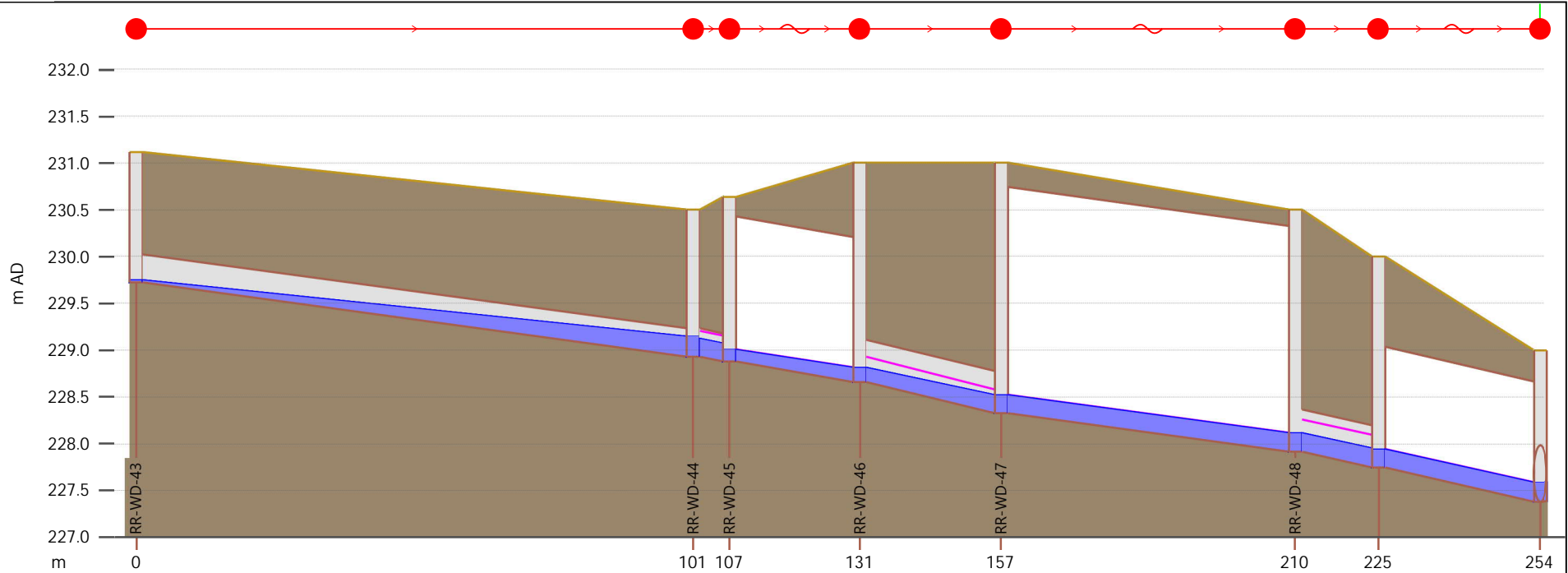
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 13

RVA PROJECT NO. 194615

FIGURE NO. 13A

AUGUST 2021





Link	RR-WD-43.1	-	RR-WD-45.1	RR-WD-46.1	RR-WD-47.1	-	RR-WD-49.1	
US node ID	RR-WD-43	-	RR-WD-45	RR-WD-46	RR-WD-47	-	RR-WD-49	
ds node	RR-WD-44	-	RR-WD-46	RR-WD-47	RR-WD-48	-	RR-WD-50	
numbarrels	1	1	1	1	1	1	1	
length (m)	100.9	6.6	-	25.6	-	15.1	-	
Shape ID	CIRC	-	-	CIRC	-	CIRC	-	
width (mm)	300	300	-	450	-	450	-	
height (mm)	300	300	-	450	-	450	-	
Rough type	N	N	-	N	-	N	-	
us inv (m AD)	229.724	-	228.880	228.659	228.328	227.915	227.749	
ds inv (m AD)	228.932	-	228.659	228.328	227.915	227.749	227.381	
grad (m/m)	0.00785	-	-	0.01294	-	0.01101	-	
r.pfc (m3/s)	0.086	-	18.684	0.324	38.570	0.299	17.863	
US depth (m)	0.020	-	0.121	0.153	0.189	0.199	0.188	
US flow (m3/s)	0.00000	-	0.06074	0.07268	0.09432	0.11553	0.12549	
US velocity (m/s)	-0.000	-	0.347	1.522	0.427	1.706	0.440	
Node	RR-WD-43	RR-WD-44	-	RR-WD-46	RR-WD-47	RR-WD-48	RR-WD-49	-
Node ID	RR-WD-43	RR-WD-44	-	RR-WD-46	RR-WD-47	RR-WD-48	RR-WD-49	-
ground (m AD)	231.112	230.501	230.637	231.000	231.000	230.500	230.000	229.000
level (m AD)	229.744	229.142	229.001	228.812	228.517	228.114	227.937	227.585
expr:Freeboard	1.368454	1.359497	-	2.187744	2.483307	2.386185	2.062790	-

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 13



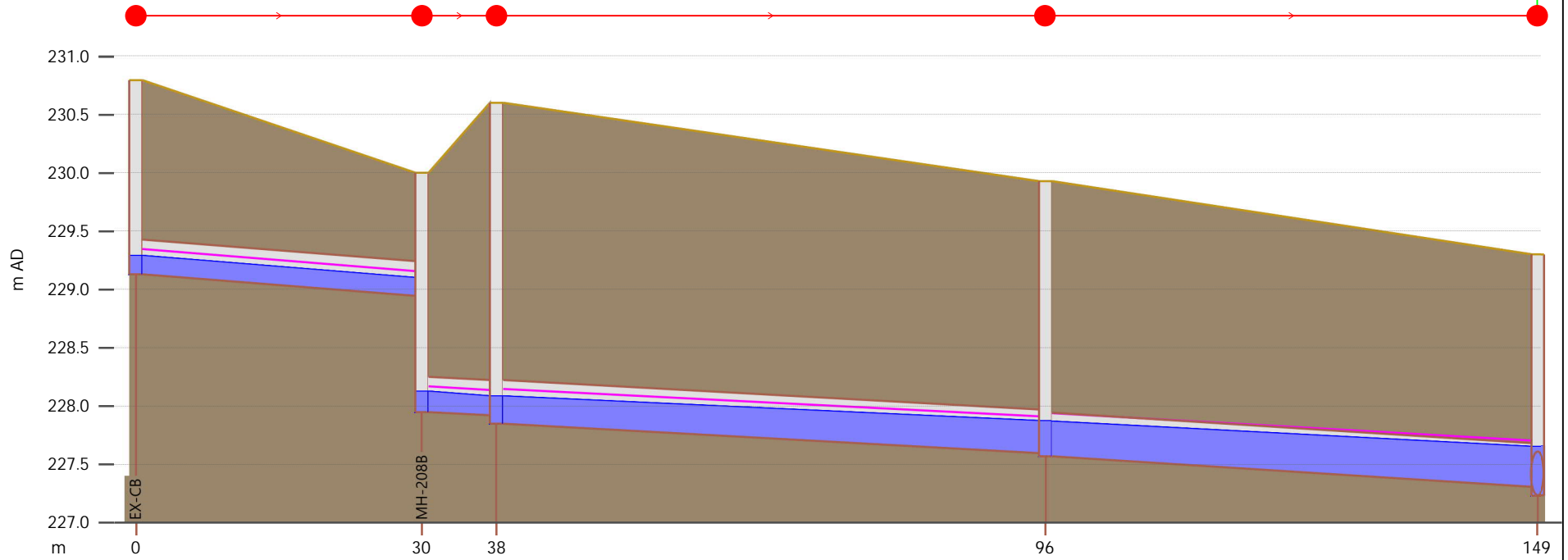
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 13

RVA PROJECT NO. 194615

FIGURE NO. 13C

AUGUST 2021





Link	EX-CB.1	-	DCBMH-208A.1	DCBMH-208.1
US node ID	EX-CB	-	DCBMH-208A	DCBMH-208
ds node	MH-208B	-	DCBMH-208	DCBMH-209
numbarrels	1	1	1	1
length (m)	30.3	7.9	58.2	52.2
Shape ID	CIRC	CIRC	CIRC	CIRC
width (mm)	300	300	375	375
height (mm)	300	300	375	375
Rough type	N	N	N	N
us inv (m AD)	229.129	227.951	227.849	227.569
ds inv (m AD)	228.943	227.924	227.599	227.309
grad (m/m)	0.00613	0.00340	0.00429	0.00498
r.pfc (m3/s)	0.076	0.056	0.115	0.124
US depth (m)	0.157	0.173	0.235	0.298
US flow (m3/s)	0.04060	0.03980	0.08201	0.11680
US velocity (m/s)	1.088	0.951	1.134	1.289

Node	EX-CB	MH-208B	DCBMH-208A	DCBMH-208	DCBMH-209
Node ID	EX-CB	MH-208B	DCBMH-208A	DCBMH-208	DCBMH-209
ground (m AD)	230.790	230.000	230.600	229.925	229.299
level (m AD)	229.286	228.125	228.086	227.871	227.651
expr:Freeboard	1.504142	1.874847	2.514276	2.053891	1.648228

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 13



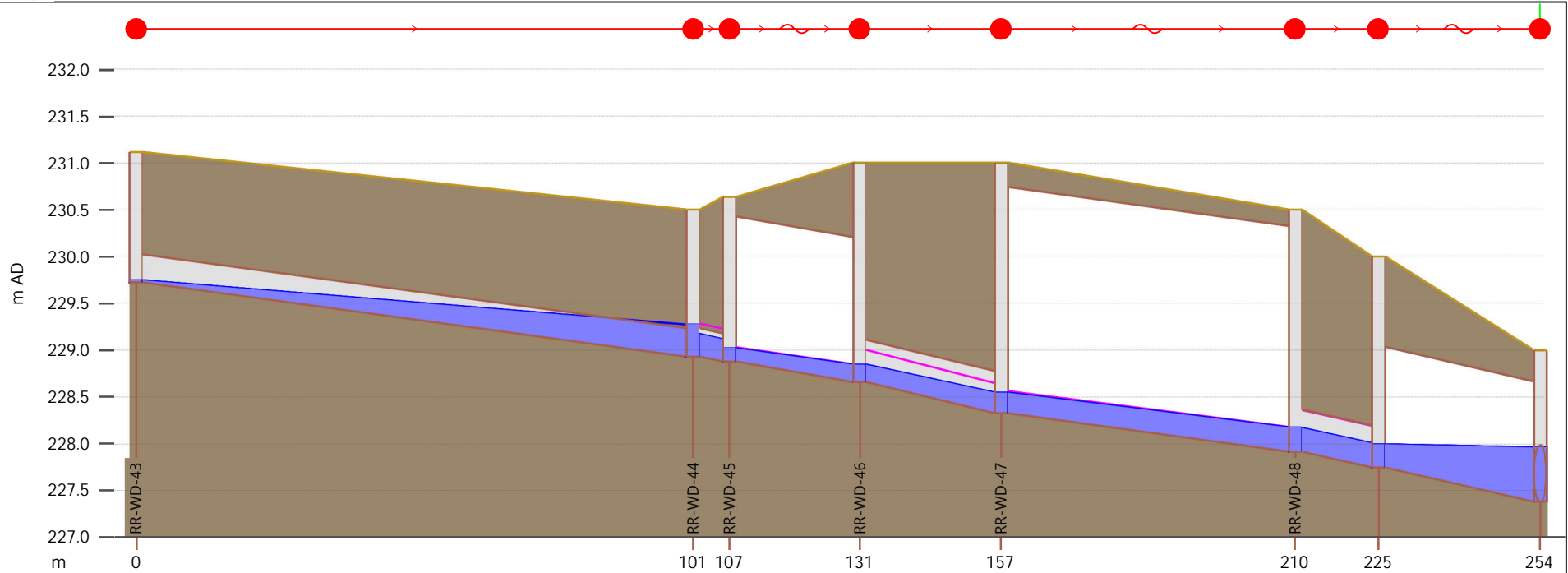
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 13

RVA PROJECT NO. 194615

FIGURE NO. 13E

AUGUST 2021





Link	RR-WD-43.1	-	RR-WD-45.1	RR-WD-46.1	RR-WD-47.1	-	RR-WD-49.1
US node ID	RR-WD-43	-	RR-WD-45	RR-WD-46	RR-WD-47	-	RR-WD-49
ds node	RR-WD-44	-	RR-WD-46	RR-WD-47	RR-WD-48	-	RR-WD-50
numbarrels	1	1	1	1	1	1	1
length (m)	100.9	6.6	-	25.6	-	15.1	-
Shape ID	CIRC	-	-	CIRC	-	CIRC	-
width (mm)	300	300	-	450	-	450	-
height (mm)	300	300	-	450	-	450	-
Rough type	N	N	-	N	-	N	-
us inv (m AD)	229.724	-	228.880	228.659	228.328	227.915	227.749
ds inv (m AD)	228.932	-	228.659	228.328	227.915	227.749	227.381
grad (m/m)	0.00785	-	-	0.01294	-	0.01101	-
r.pfc (m3/s)	0.086	-	18.684	0.324	38.570	0.299	17.863
US depth (m)	0.020	-	0.140	0.188	0.220	0.257	0.245
US flow (m3/s)	0.00000	-	0.08912	0.10936	0.14304	0.18015	0.19544
US velocity (m/s)	-0.000	-	0.426	1.739	0.523	1.917	0.561

Node	RR-WD-43	RR-WD-44	-	RR-WD-46	RR-WD-47	RR-WD-48	RR-WD-49	-
Node ID	RR-WD-43	RR-WD-44	-	RR-WD-46	RR-WD-47	RR-WD-48	RR-WD-49	-
ground (m AD)	231.112	230.501	230.637	231.000	231.000	230.500	230.000	229.000
level (m AD)	229.744	229.271	229.020	228.847	228.548	228.175	227.994	227.961
expr:Freeboard	1.368454	1.230347	-	2.152817	2.451813	2.324722	2.005768	-

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 13



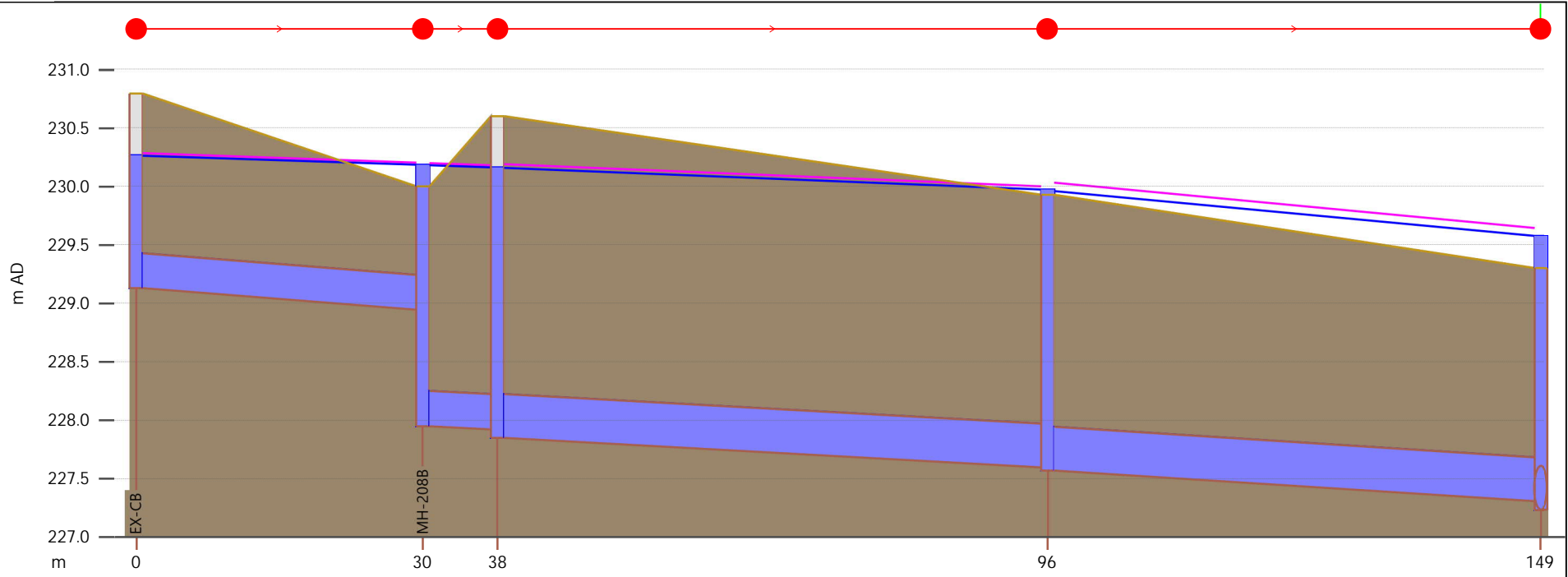
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 13

RVA PROJECT NO. 194615

FIGURE NO. 13G

AUGUST 2021





Link	EX-CB.1	-	DCBMH-208A.1	DCBMH-208.1	
US node ID	EX-CB	-	DCBMH-208A	DCBMH-208	
ds node	MH-208B	-	DCBMH-208	DCBMH-209	
numbarrels	1	1	1	1	
length (m)	30.3	7.9	58.2	52.2	
Shape ID	CIRC	CIRC	CIRC	CIRC	
width (mm)	300	300	375	375	
height (mm)	300	300	375	375	
Rough type	N	N	N	N	
us inv (m AD)	229.129	227.951	227.849	227.569	
ds inv (m AD)	228.943	227.924	227.599	227.309	
grad (m/m)	0.00613	0.00340	0.00429	0.00498	
r.pfc (m3/s)	0.076	0.056	0.115	0.124	
US depth (m)	1.133	2.230	2.307	2.391	
US flow (m3/s)	0.06086	0.05996	0.10686	0.15087	
US velocity (m/s)	1.201	0.971	1.214	1.353	
Node	EX-CB	MH-208B	DCBMH-208A	DCBMH-208	DCBMH-209
Node ID	EX-CB	MH-208B	DCBMH-208A	DCBMH-208	DCBMH-209
ground (m AD)	230.790	230.000	230.600	229.925	229.299
level (m AD)	230.265	230.183	230.161	229.971	229.576
expr:Freeboard	0.524863	-0.183014	0.439142	-0.045825	-0.276760

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 13



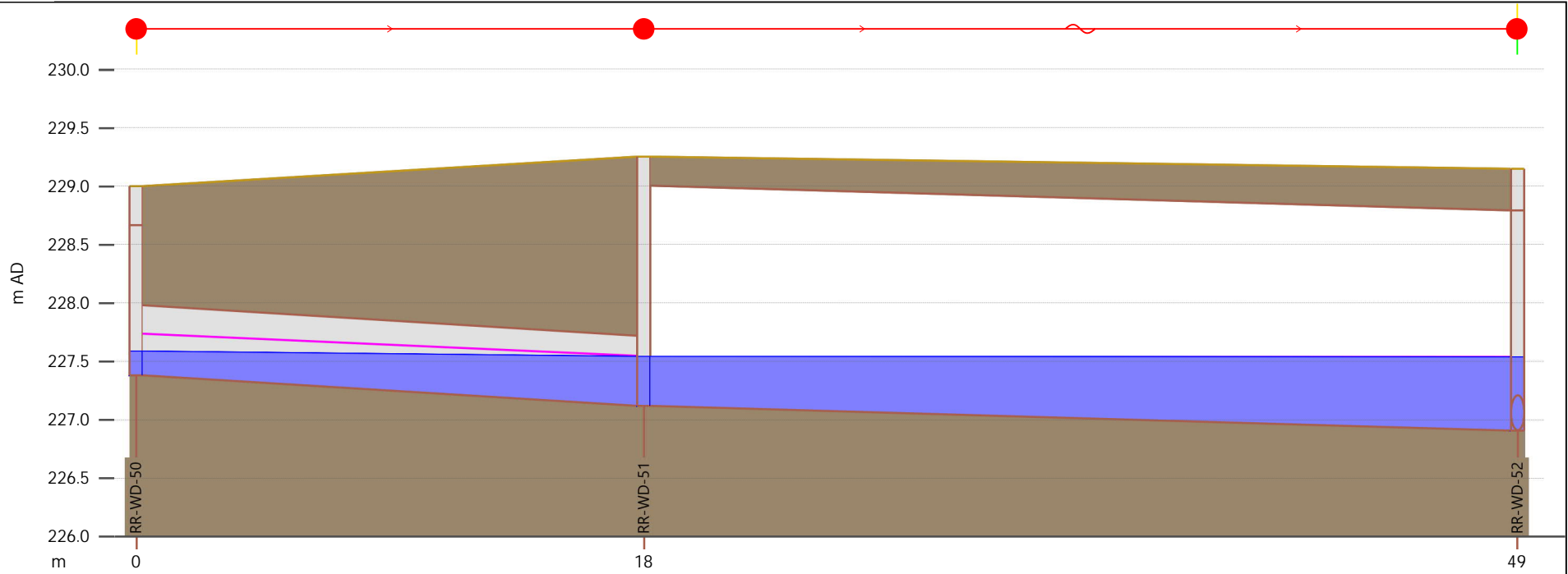
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 14

RVA PROJECT NO. 194615

FIGURE NO. 14A

AUGUST 2021





Link	RR-WD-50.1		RR-WD-51.1
US node ID	RR-WD-50		RR-WD-51
ds node	RR-WD-51		RR-WD-52
numbarrels	1		1
length (m)	18.0		
Shape ID	CIRC		
width (mm)	600		
height (mm)	600		
Rough type	N		
us inv (m AD)	227.381		227.121
ds inv (m AD)	227.121		226.910
grad (m/m)	0.01441		
r.pfc (m3/s)	0.737		15.132
US depth (m)	0.204		0.419
US flow (m3/s)	0.14187		0.15046
US velocity (m/s)	1.804		0.576
Node	RR-WD-50	RR-WD-51	RR-WD-52
Node ID	RR-WD-50	RR-WD-51	RR-WD-52
ground (m AD)	229.000	229.250	229.150
level (m AD)	227.585	227.540	227.537
expr:Freeboard	1.414673	1.709564	1.612891

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 14



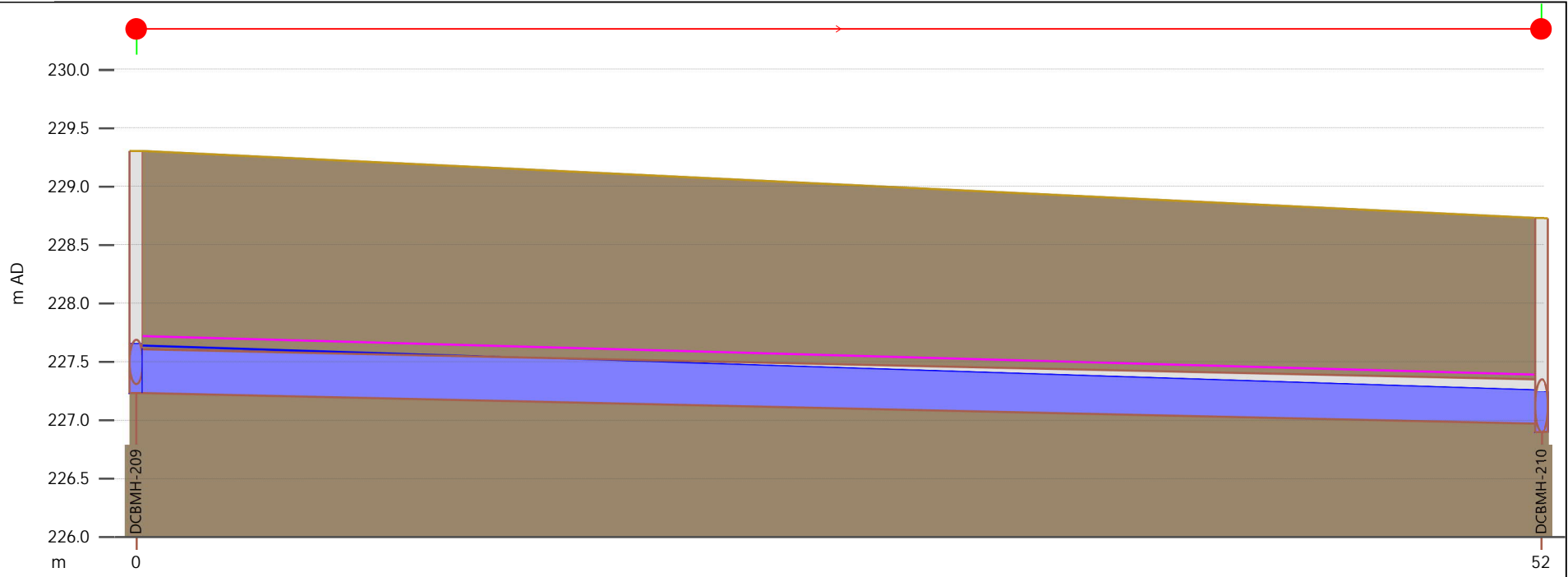
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 14

RVA PROJECT NO. 194615

FIGURE NO. 14C

AUGUST 2021





Link	DCBMH-209.1	
US node ID	DCBMH-209	
ds node	DCBMH-210	
numbarrels	1	
length (m)	51.9	
Shape ID	CIRC	
width (mm)	375	
height (mm)	375	
Rough type	N	
us inv (m AD)	227.234	
ds inv (m AD)	226.974	
grad (m/m)	0.00501	
r.pfc (m3/s)	0.124	
US depth (m)	0.405	
US flow (m3/s)	0.14718	
US velocity (m/s)	1.358	

Node	DCBMH-209	DCBMH-210
Node ID	DCBMH-209	DCBMH-210
ground (m AD)	229.299	228.728
level (m AD)	227.651	227.239
expr:Freeboard	1.648228	1.488880

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 14



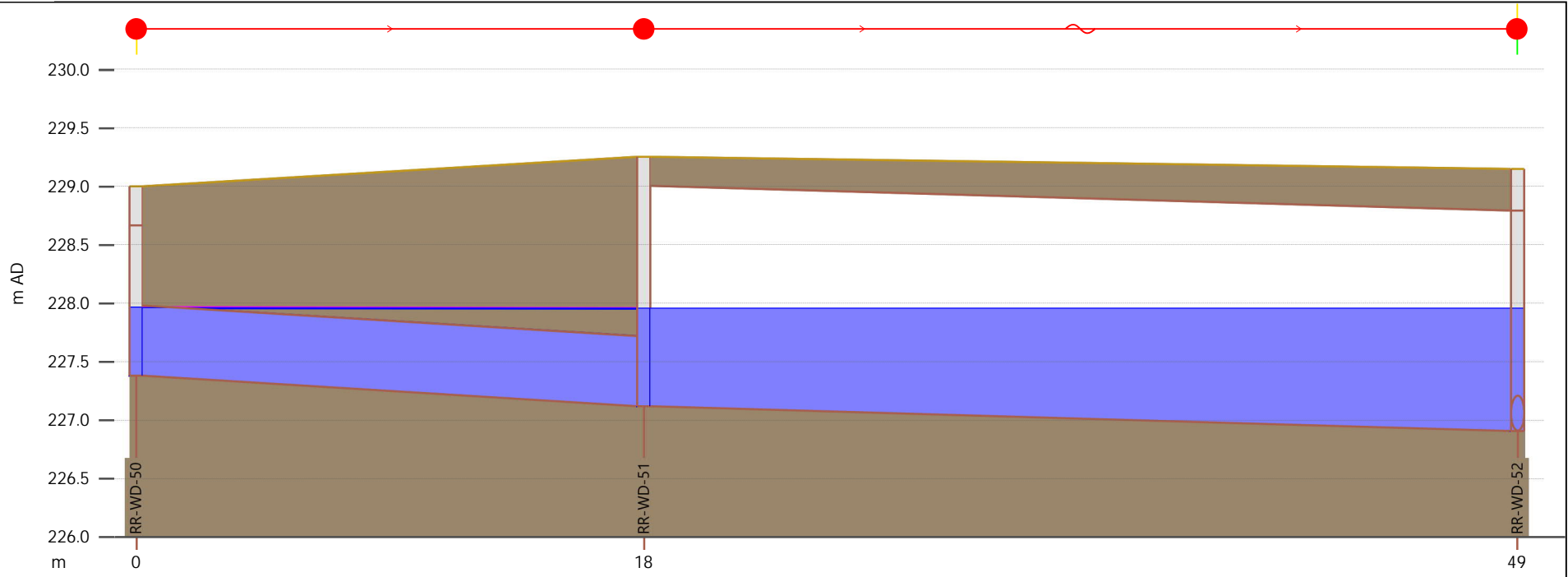
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 14

RVA PROJECT NO. 194615

FIGURE NO. 14E

AUGUST 2021





Link	RR-WD-50.1	RR-WD-51.1
US node ID	RR-WD-50	RR-WD-51
ds node	RR-WD-51	RR-WD-52
numbarrels	1	1
length (m)	18.0	
Shape ID	CIRC	West Side Ditch-7 (Downstream of George Bolton Pkwy)
width (mm)	600	
height (mm)	600	
Rough type	N	
us inv (m AD)	227.381	227.121
ds inv (m AD)	227.121	226.910
grad (m/m)	0.01441	
r.pfc (m3/s)	0.737	15.132
US depth (m)	0.579	0.831
US flow (m3/s)	0.21152	0.21727
US velocity (m/s)	1.974	0.613

Node	RR-WD-50	RR-WD-51	RR-WD-52
Node ID	RR-WD-50	RR-WD-51	RR-WD-52
ground (m AD)	229.000	229.250	229.150
level (m AD)	227.961	227.952	227.952
expr:Freeboard	1.038696	1.297989	1.198203

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 14



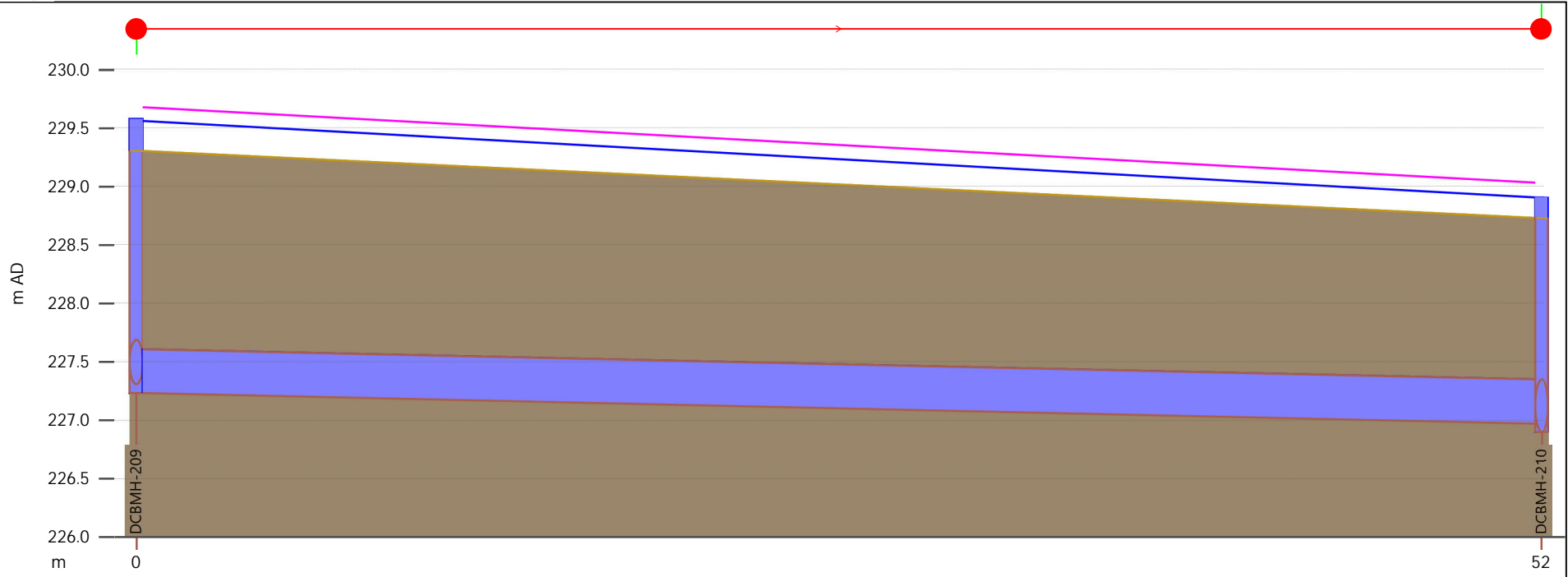
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 14

RVA PROJECT NO. 194615

FIGURE NO. 14G

AUGUST 2021





Link	DCBMH-209.1	
US node ID	DCBMH-209	
ds node	DCBMH-210	
numbarrels	1	
length (m)	51.9	
Shape ID	CIRC	
width (mm)	375	
height (mm)	375	
Rough type	N	
us inv (m AD)	227.234	
ds inv (m AD)	226.974	
grad (m/m)	0.00501	
r.pfc (m3/s)	0.124	
US depth (m)	2.324	
US flow (m3/s)	0.19580	
US velocity (m/s)	1.520	

Node	DCBMH-209	DCBMH-210
Node ID	DCBMH-209	DCBMH-210
ground (m AD)	229.299	228.728
level (m AD)	229.576	228.904
expr:Freeboard	-0.276760	-0.176312

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 14



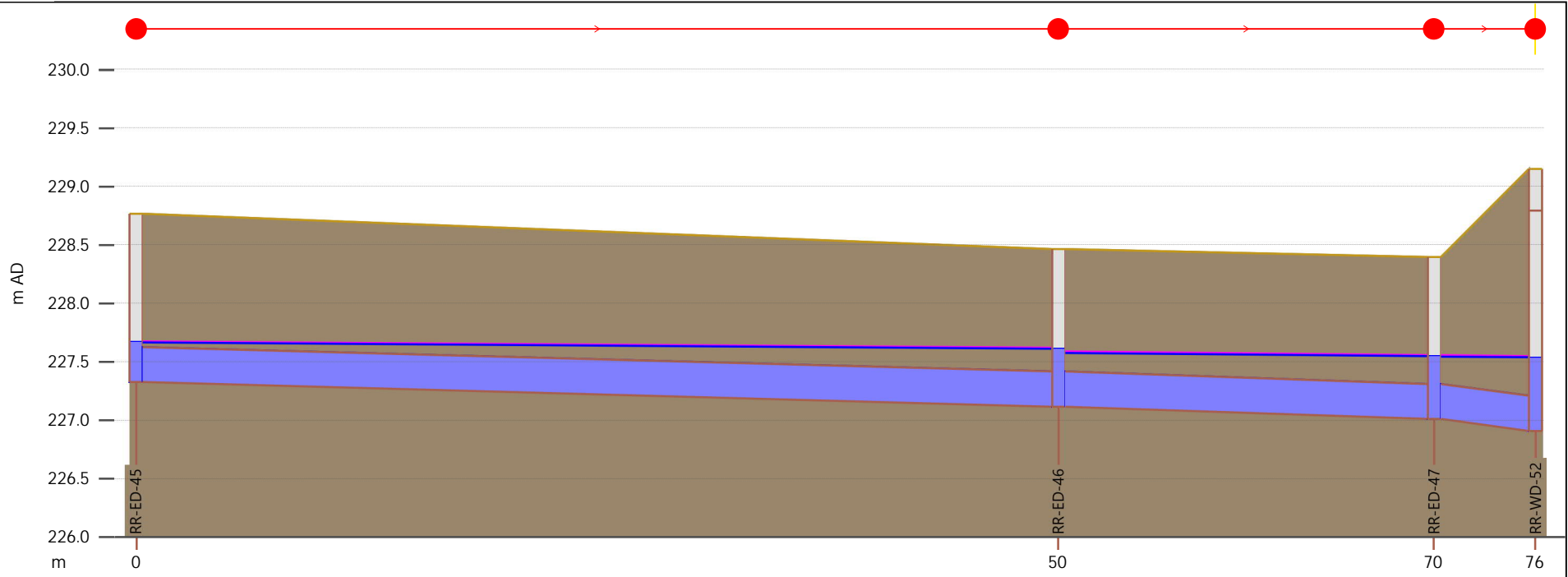
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 15

RVA PROJECT NO. 194615

FIGURE NO. 15A

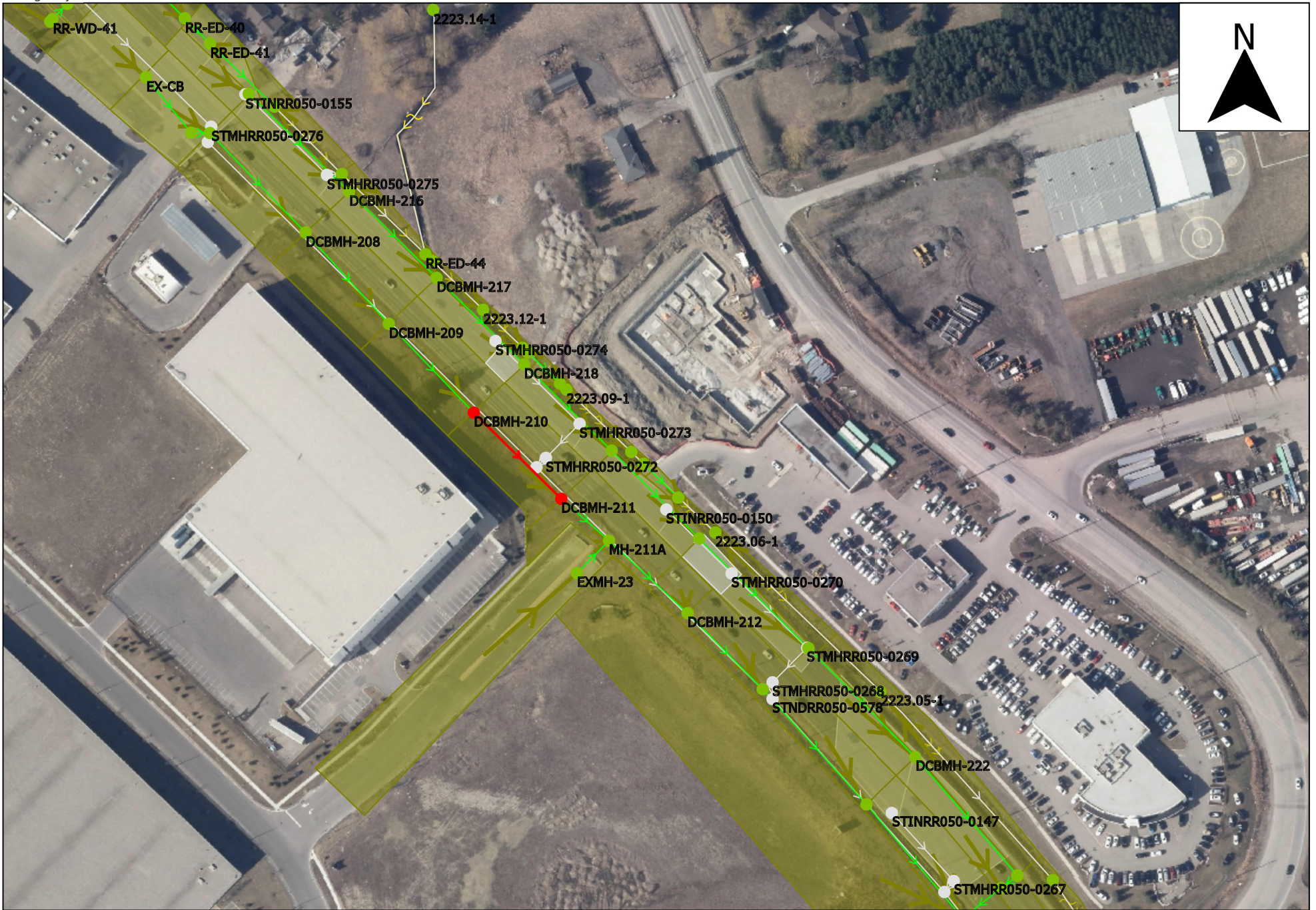
AUGUST 2021





Link		RR-ED-45.1		RR-ED-46.1		RR-ED-47.1
US node ID		RR-ED-45		RR-ED-46		RR-ED-47
ds node		RR-ED-46		RR-ED-47		RR-WD-52
numbarrels		1		1		1
length (m)		49.8		20.3		5.5
Shape ID		CIRC		CIRC		CIRC
width (mm)		300		300		300
height (mm)		300		300		300
Rough type		N		N		N
us inv (m AD)		227.327		227.116		227.011
ds inv (m AD)		227.116		227.011		226.910
grad (m/m)		0.00424		0.00518		0.01844
r.pfc (m3/s)		0.063		0.070		0.131
US depth (m)		0.340		0.459		0.535
US flow (m3/s)		0.04222		0.05606		0.04937
US velocity (m/s)		0.942		1.077		1.006
Node	RR-ED-45		RR-ED-46		RR-ED-47	-
Node ID	RR-ED-45		RR-ED-46		RR-ED-47	-
ground (m AD)	228.764		228.462		228.394	-
level (m AD)	227.668		227.610		227.549	-
expr:Freeboard	1.095627		0.852386		0.845779	-

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 15

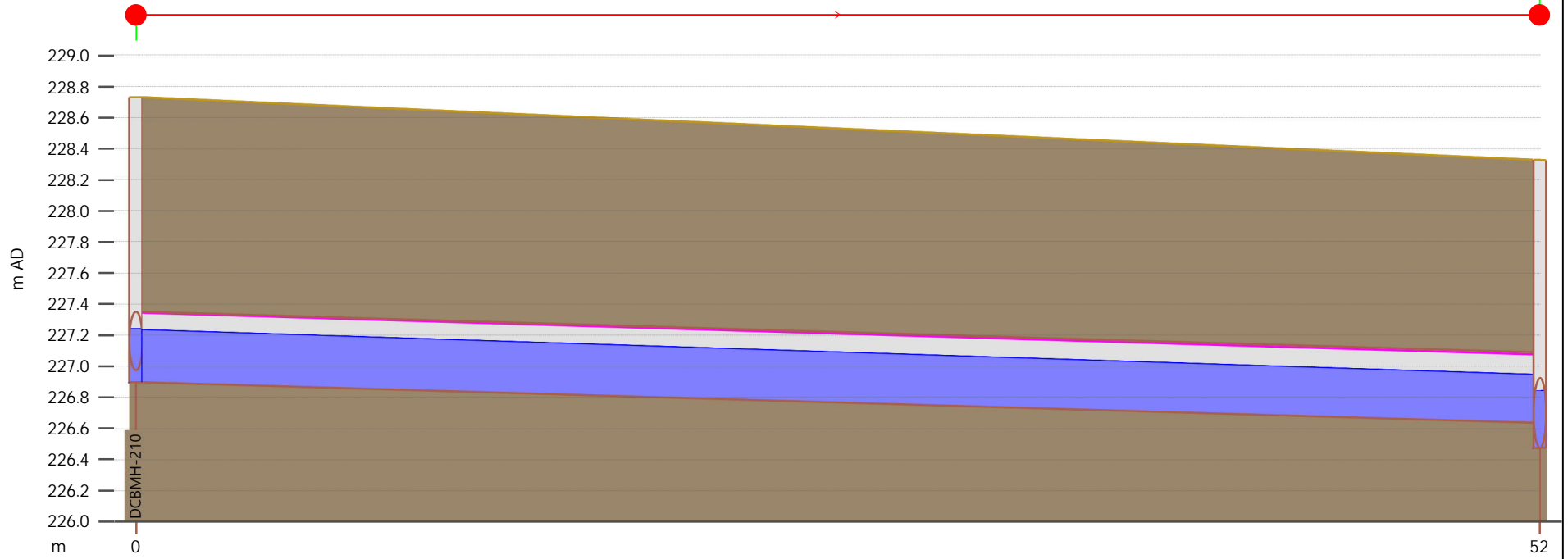


PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 15

RVA PROJECT NO. 194615

FIGURE NO. 15C

AUGUST 2021



Link	DCBMH-210.1	
US node ID	DCBMH-210	
ds node	DCBMH-211	
numbarrels	1	
length (m)	52.0	
Shape ID	CIRC	
width (mm)	450	
height (mm)	450	
Rough type	N	
us inv (m AD)	226.899	
ds inv (m AD)	226.639	
grad (m/m)	0.00500	
r.pfc (m3/s)	0.202	
US depth (m)	0.335	
US flow (m3/s)	0.18666	
US velocity (m/s)	1.486	

Node	DCBMH-210	DCBMH-211
Node ID	DCBMH-210	DCBMH-211
ground (m AD)	228.728	228.328
level (m AD)	227.239	226.841
expr:Freeboard	1.488880	1.487271

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 15



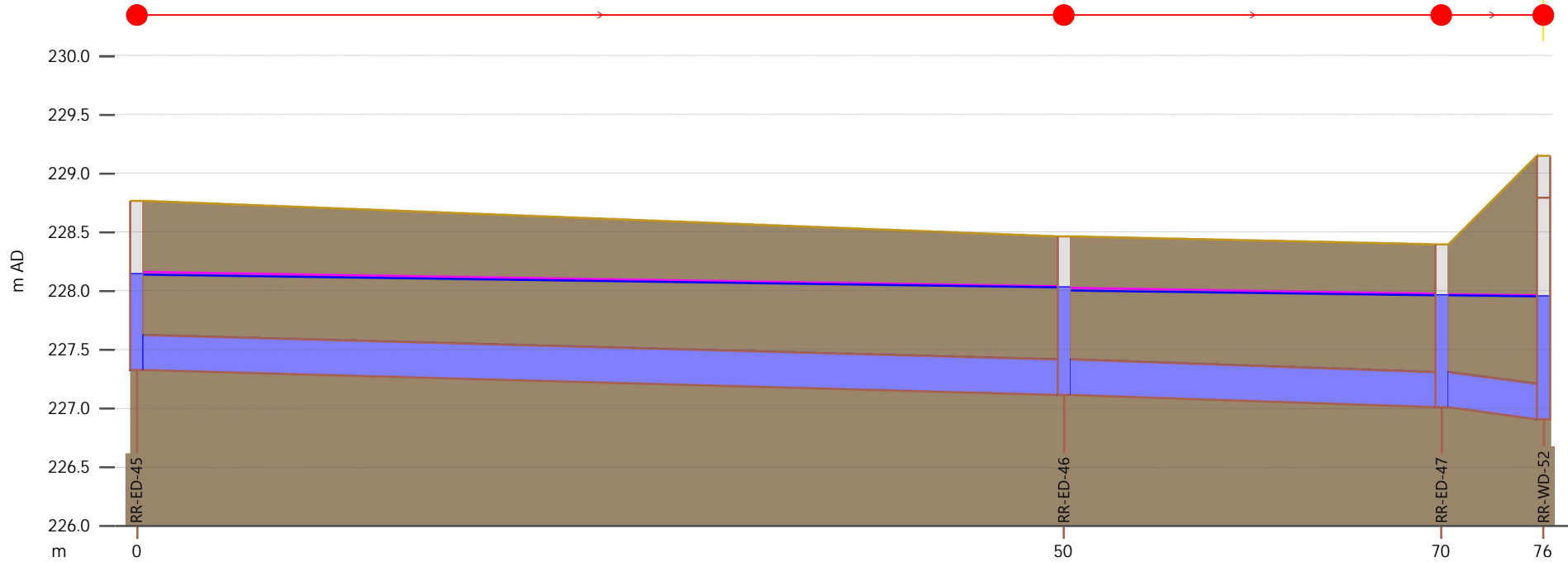
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 15

RVA PROJECT NO. 194615

FIGURE NO. 15E

AUGUST 2021





Link		RR-ED-45.1		RR-ED-46.1		RR-ED-47.1
US node ID		RR-ED-45		RR-ED-46		RR-ED-47
ds node		RR-ED-46		RR-ED-47		RR-WD-52
numbarrels		1		1		1
length (m)		49.8		20.3		5.5
Shape ID		CIRC		CIRC		CIRC
width (mm)		300		300		300
height (mm)		300		300		300
Rough type		N		N		N
us inv (m AD)		227.327		227.116		227.011
ds inv (m AD)		227.116		227.011		226.910
grad (m/m)		0.00424		0.00518		0.01844
r.pfc (m3/s)		0.063		0.070		0.131
US depth (m)		0.813		0.886		0.950
US flow (m3/s)		0.06115		0.09108		0.08938
US velocity (m/s)		0.996		1.212		1.198
Node	RR-ED-45		RR-ED-46		RR-ED-47	-
Node ID	RR-ED-45		RR-ED-46		RR-ED-47	-
ground (m AD)	228.764		228.462		228.394	-
level (m AD)	228.143		228.030		227.963	-
expr:Freeboard	0.620392		0.432220		0.431183	-

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 15



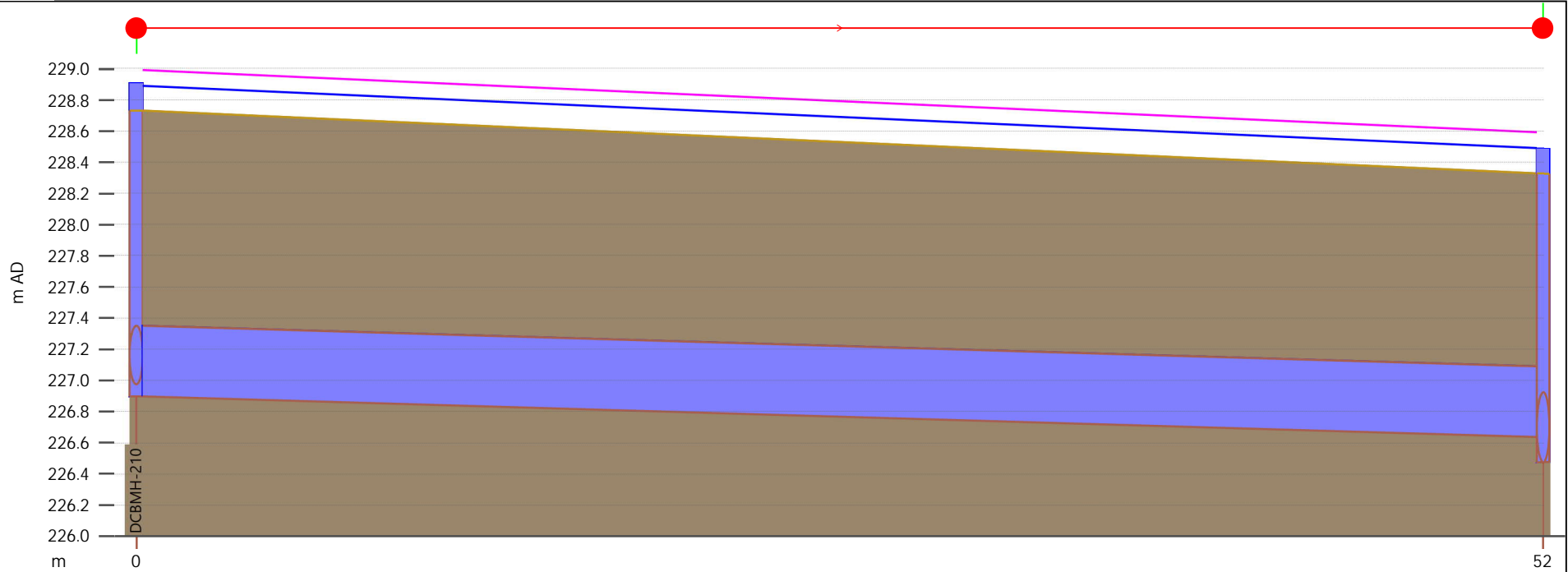
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 15

RVA PROJECT NO. 194615

FIGURE NO. 15G

AUGUST 2021





Link	DCBMH-210.1	
US node ID	DCBMH-210	
ds node	DCBMH-211	
numbarrels	1	
length (m)	52.0	
Shape ID	CIRC	
width (mm)	450	
height (mm)	450	
Rough type	N	
us inv (m AD)	226.899	
ds inv (m AD)	226.639	
grad (m/m)	0.00500	
r.pfc (m3/s)	0.202	
US depth (m)	1.990	
US flow (m3/s)	0.25036	
US velocity (m/s)	1.526	

Node	DCBMH-210	DCBMH-211
Node ID	DCBMH-210	DCBMH-211
ground (m AD)	228.728	228.328
level (m AD)	228.904	228.487
expr:Freeboard	-0.176312	-0.158694

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 15



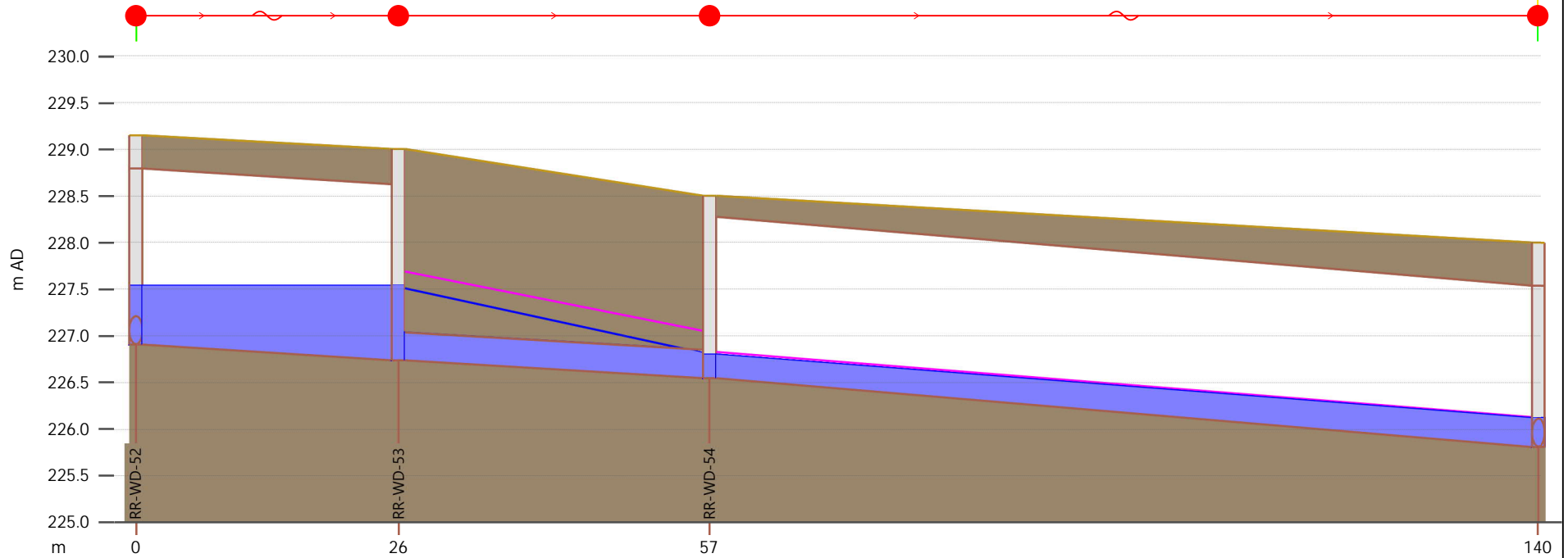
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 16

RVA PROJECT NO. 194615

FIGURE NO. 16A

AUGUST 2021

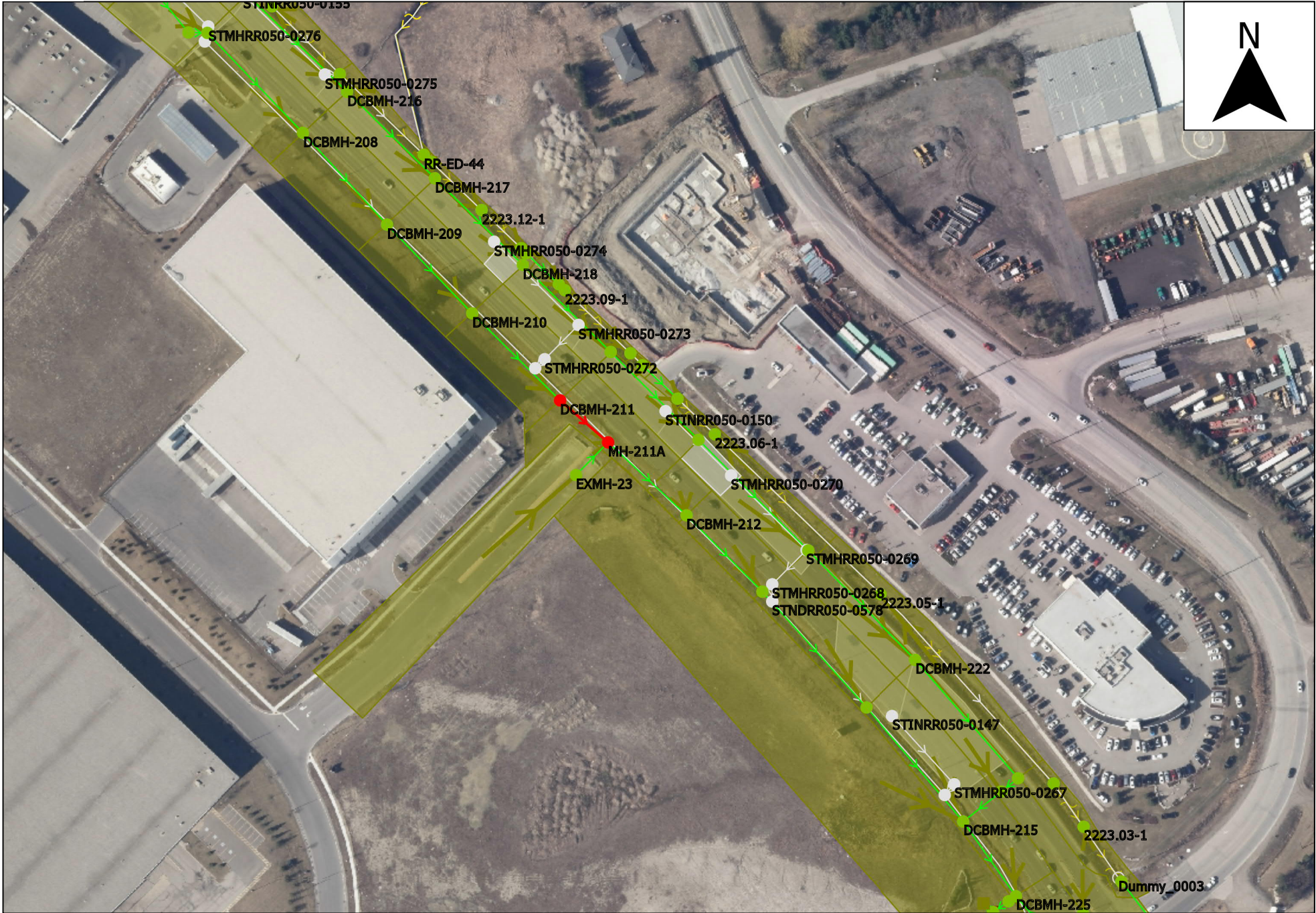




Link	RR-WD-52.1	RR-WD-53.1	RR-WD-54.1
US node ID	RR-WD-52	RR-WD-53	RR-WD-54
ds node	RR-WD-53	RR-WD-54	RR-WD-55
numbarrels	1	1	1
length (m)	-	31.0	-
Shape ID	-	CIRC	West Side Ditch-8 (Downstream of George Bolton Pkwy)
width (mm)	-	300	-
height (mm)	-	300	-
Rough type	-	N	-
us inv (m AD)	226.910	226.739	226.549
ds inv (m AD)	226.739	226.549	225.811
grad (m/m)	-	0.00613	-
r.pfc (m3/s)	14.830	0.076	14.863
US depth (m)	0.627	0.770	0.253
US flow (m3/s)	0.17389	0.14359	0.23288
US velocity (m/s)	0.564	1.890	0.736

Node	RR-WD-52	RR-WD-53	RR-WD-54	RR-WD-55
Node ID	RR-WD-52	RR-WD-53	RR-WD-54	RR-WD-55
ground (m AD)	229.150	229.000	228.500	228.000
level (m AD)	227.537	227.536	226.802	226.118
expr:Freeboard	1.612891	1.463974	1.697891	1.881989

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 16



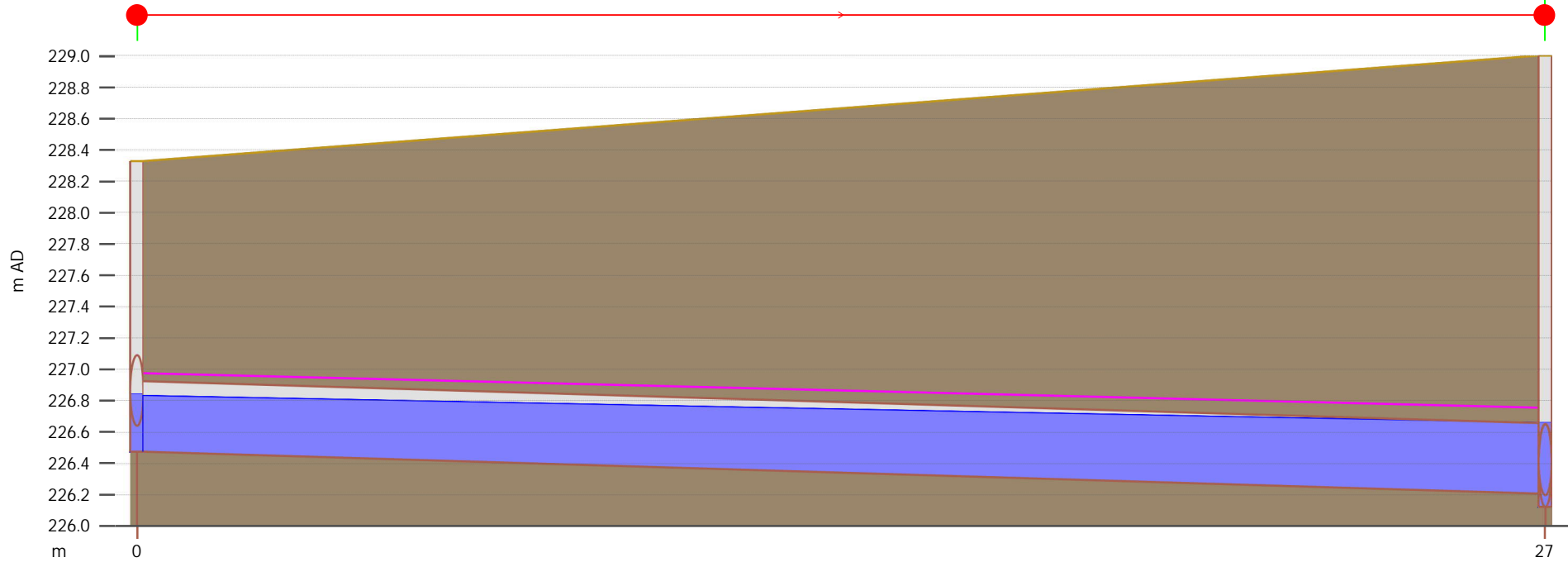
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 16

RVA PROJECT NO. 194615

FIGURE NO. 16C

AUGUST 2021





Link	DCBMH-211.1	
US node ID	DCBMH-211	
ds node	MH-211A	
numbarrels	1	
length (m)	26.9	
Shape ID	CIRC	
width (mm)	450	
height (mm)	450	
Rough type	N	
us inv (m AD)	226.474	
ds inv (m AD)	226.209	
grad (m/m)	0.00986	
r.pfc (m3/s)	0.283	
US depth (m)	0.358	
US flow (m3/s)	0.22690	
US velocity (m/s)	1.896	

Node	DCBMH-211	MH-211A
Node ID	DCBMH-211	MH-211A
ground (m AD)	228.328	229.000
level (m AD)	226.841	226.656
expr:Freeboard	1.487271	2.343567

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 16

RVA PROJECT NO. 194615

FIGURE NO. 16D

AUGUST 2021





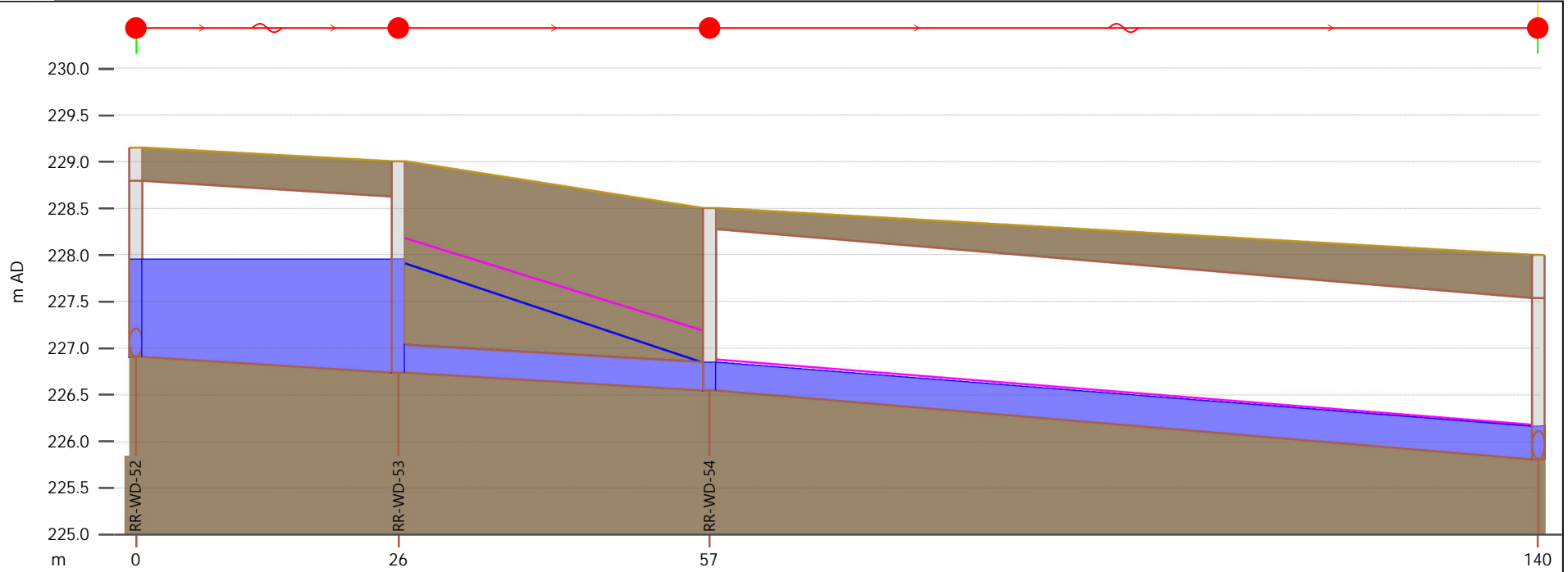
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 16

RVA PROJECT NO. 194615

FIGURE NO. 16E

AUGUST 2021

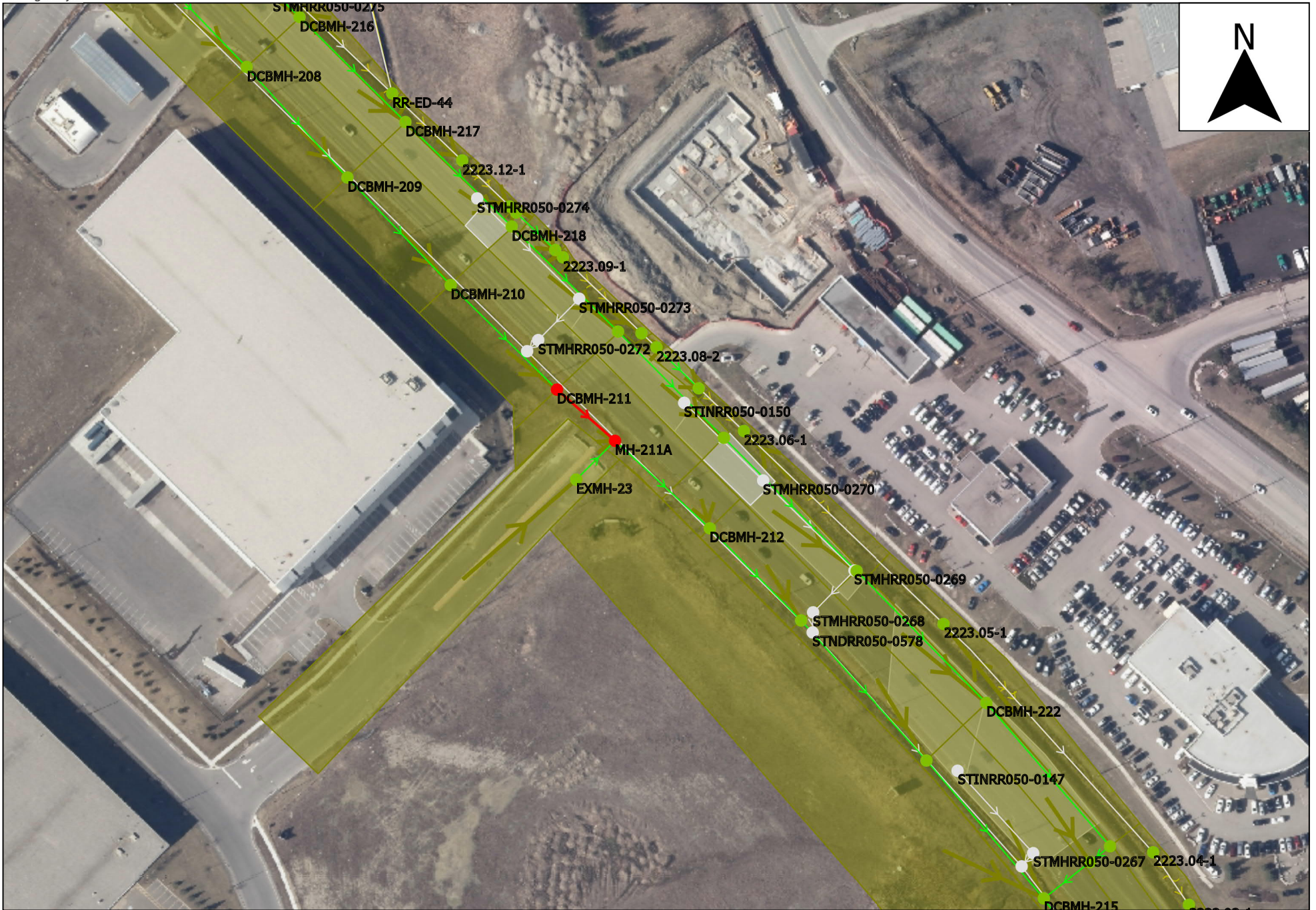




Link	RR-WD-52.1	RR-WD-53.1	RR-WD-54.1
US node ID	RR-WD-52	RR-WD-53	RR-WD-54
ds node	RR-WD-53	RR-WD-54	RR-WD-55
numbarrels	1	1	1
length (m)	-	31.0	-
Shape ID	-	CIRC	West Side Ditch-8 (Downstream of George Bolton Pkwy)
width (mm)	-	300	-
height (mm)	-	300	-
Rough type	-	N	-
us inv (m AD)	226.910	226.739	226.549
ds inv (m AD)	226.739	226.549	225.811
grad (m/m)	-	0.00613	-
r.pfc (m3/s)	14.830	0.076	14.863
US depth (m)	1.042	1.172	0.294
US flow (m3/s)	0.23029	0.18068	0.31887
US velocity (m/s)	0.514	2.305	0.816

Node	RR-WD-52	RR-WD-53	RR-WD-54	RR-WD-55
Node ID	RR-WD-52	RR-WD-53	RR-WD-54	RR-WD-55
ground (m AD)	229.150	229.000	228.500	228.000
level (m AD)	227.952	227.952	226.843	226.161
expr:Freeboard	1.198203	1.048340	1.657074	1.839249

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 16



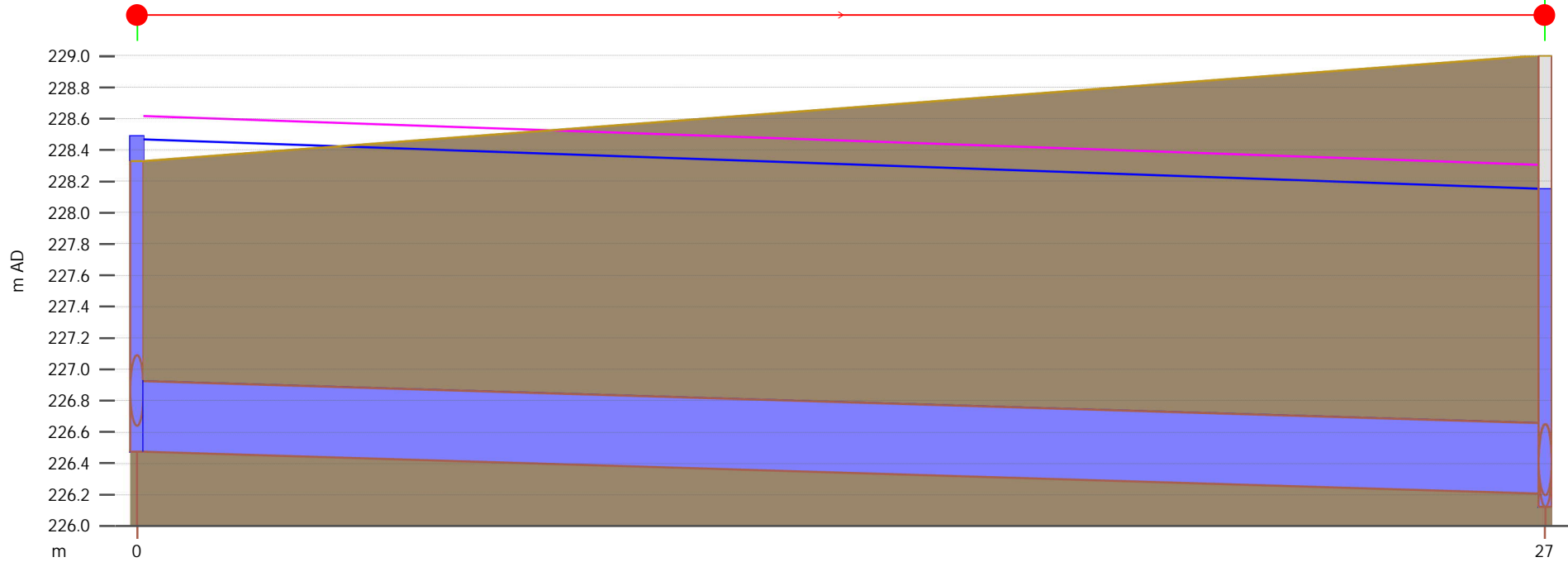
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 16

RVA PROJECT NO. 194615

FIGURE NO. 16G

AUGUST 2021





Link	DCBMH-211.1	
US node ID	DCBMH-211	
ds node	MH-211A	
numbarrels	1	
length (m)	26.9	
Shape ID	CIRC	
width (mm)	450	
height (mm)	450	
Rough type	N	
us inv (m AD)	226.474	
ds inv (m AD)	226.209	
grad (m/m)	0.00986	
r.pfc (m3/s)	0.283	
US depth (m)	1.990	
US flow (m3/s)	0.30681	
US velocity (m/s)	1.920	

Node	DCBMH-211	MH-211A
Node ID	DCBMH-211	MH-211A
ground (m AD)	228.328	229.000
level (m AD)	228.487	228.150
expr:Freeboard	-0.158694	0.850433

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 16



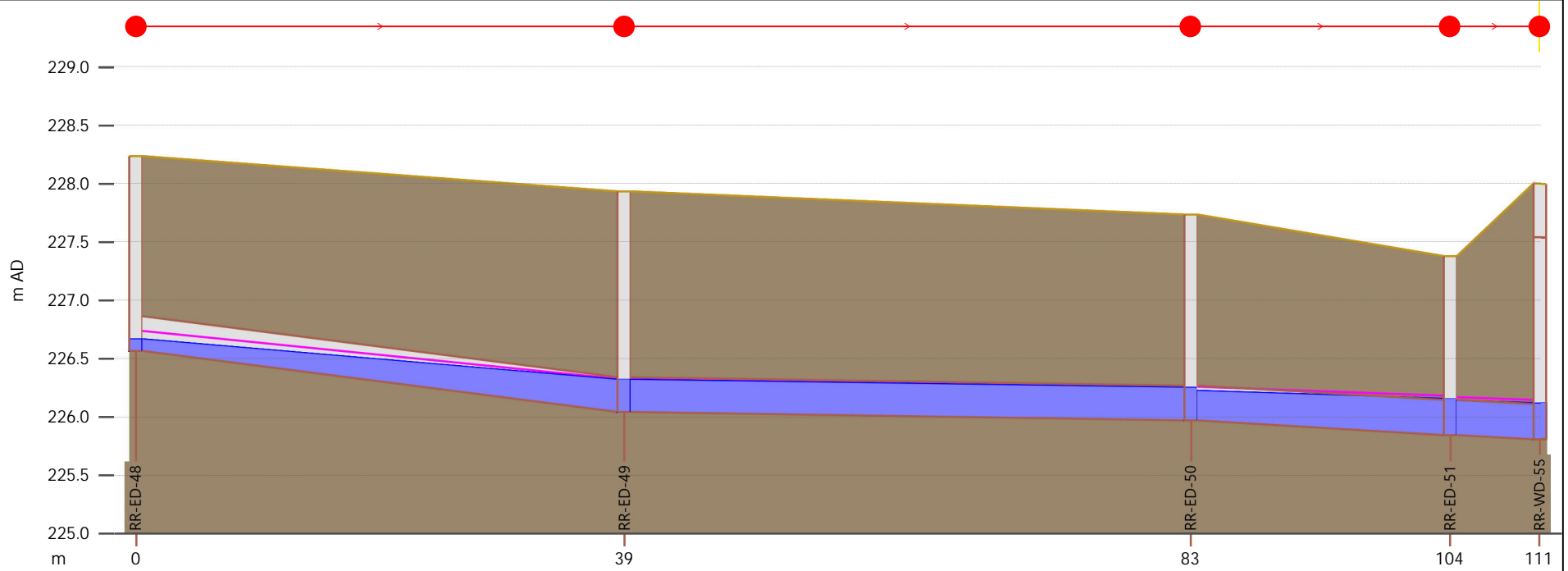
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 17

RVA PROJECT NO. 194615

FIGURE NO. 17A

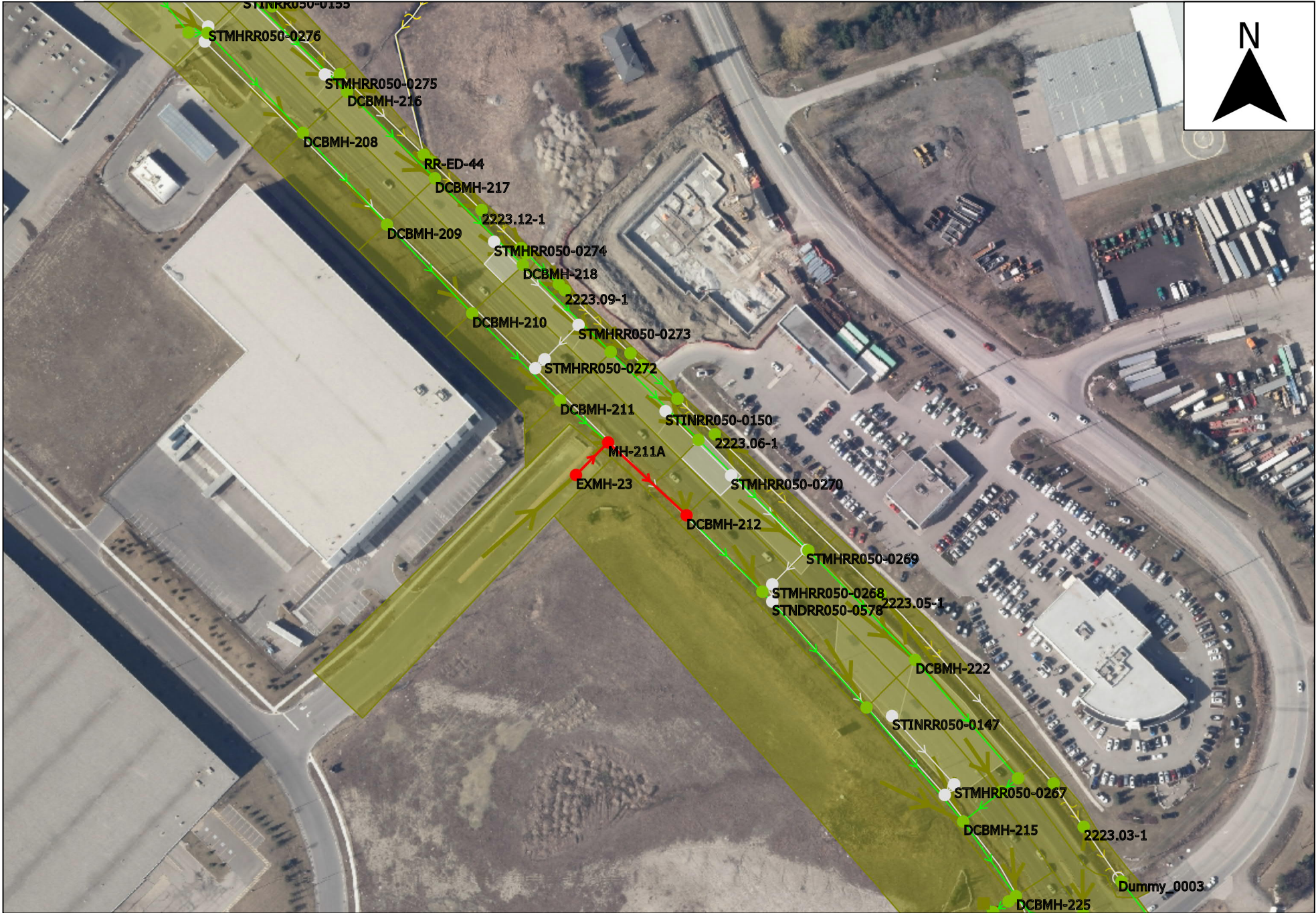
AUGUST 2021





Link	RR-ED-48.1	RR-ED-49.1	RR-ED-50.1	-	
US node ID	RR-ED-48	RR-ED-49	RR-ED-50	RR-ED-51	
ds node	RR-ED-49	RR-ED-50	RR-ED-51	RR-WD-55	
numbarrels	1	1	1	1	
length (m)	38.6	44.8	20.5	7.1	
Shape ID	CIRC	CIRC	CIRC	CIRC	
width (mm)	300	300	300	300	
height (mm)	300	300	300	300	
Rough type	N	N	N	N	
us inv (m AD)	226.565	226.042	225.970	225.848	
ds inv (m AD)	226.042	225.970	225.848	225.811	
grad (m/m)	0.01355	0.00161	0.00595	0.00522	
r.pfc (m3/s)	0.113	0.039	0.075	0.070	
US depth (m)	0.102	0.277	0.254	0.291	
US flow (m3/s)	0.02502	0.03948	0.05584	0.05479	
US velocity (m/s)	1.188	0.679	0.968	0.784	
Node	RR-ED-48	RR-ED-49	RR-ED-50	RR-ED-51	-
Node ID	RR-ED-48	RR-ED-49	RR-ED-50	RR-ED-51	-
ground (m AD)	228.231	227.930	227.733	227.379	-
level (m AD)	226.667	226.321	226.250	226.154	-
expr:Freeboard	1.564758	1.609238	1.482635	1.225525	-

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 17



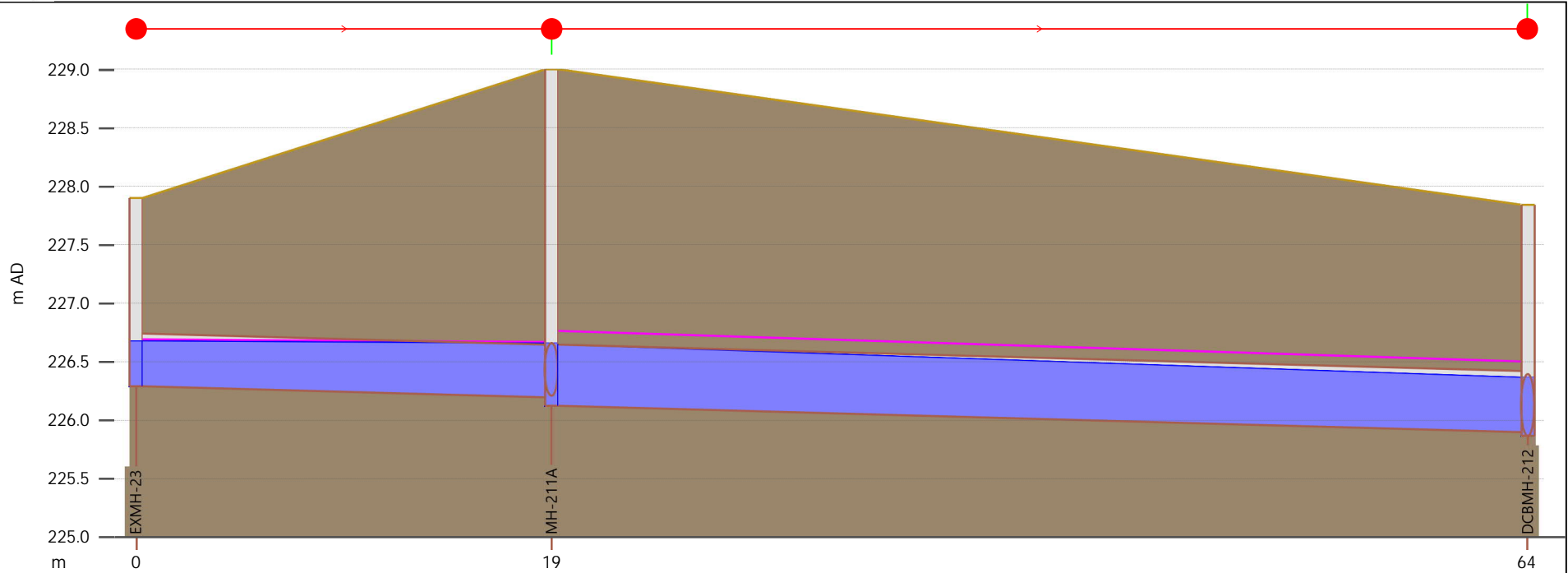
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 17

RVA PROJECT NO. 194615

FIGURE NO. 17C

AUGUST 2021

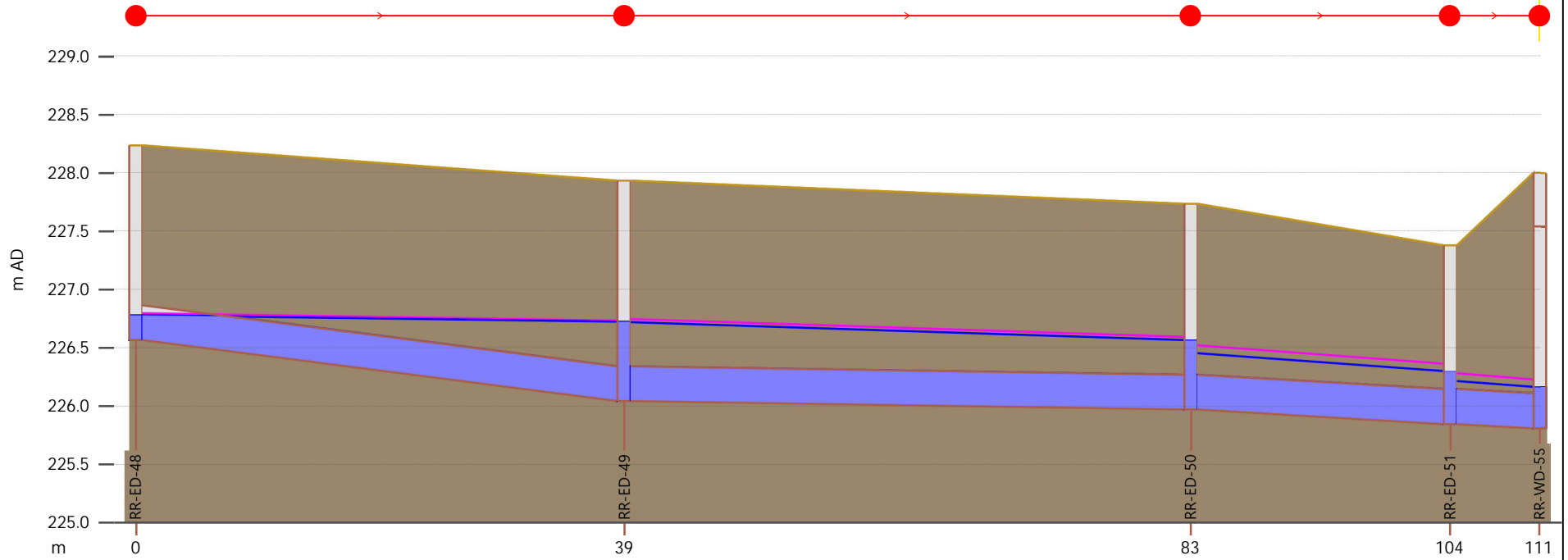




Link	EXMH-23.1	MH-211A.1
US node ID	EXMH-23	MH-211A
ds node	MH-211A	DCBMH-212
numbarrels	1	1
length (m)	19.2	45.1
Shape ID	CIRC	CIRC
width (mm)	450	525
height (mm)	450	525
Rough type	N	N
us inv (m AD)	226.294	226.123
ds inv (m AD)	226.198	225.898
grad (m/m)	0.00500	0.00499
r.pfc (m3/s)	0.202	0.304
US depth (m)	0.380	0.521
US flow (m3/s)	0.09502	0.33715
US velocity (m/s)	1.036	1.680

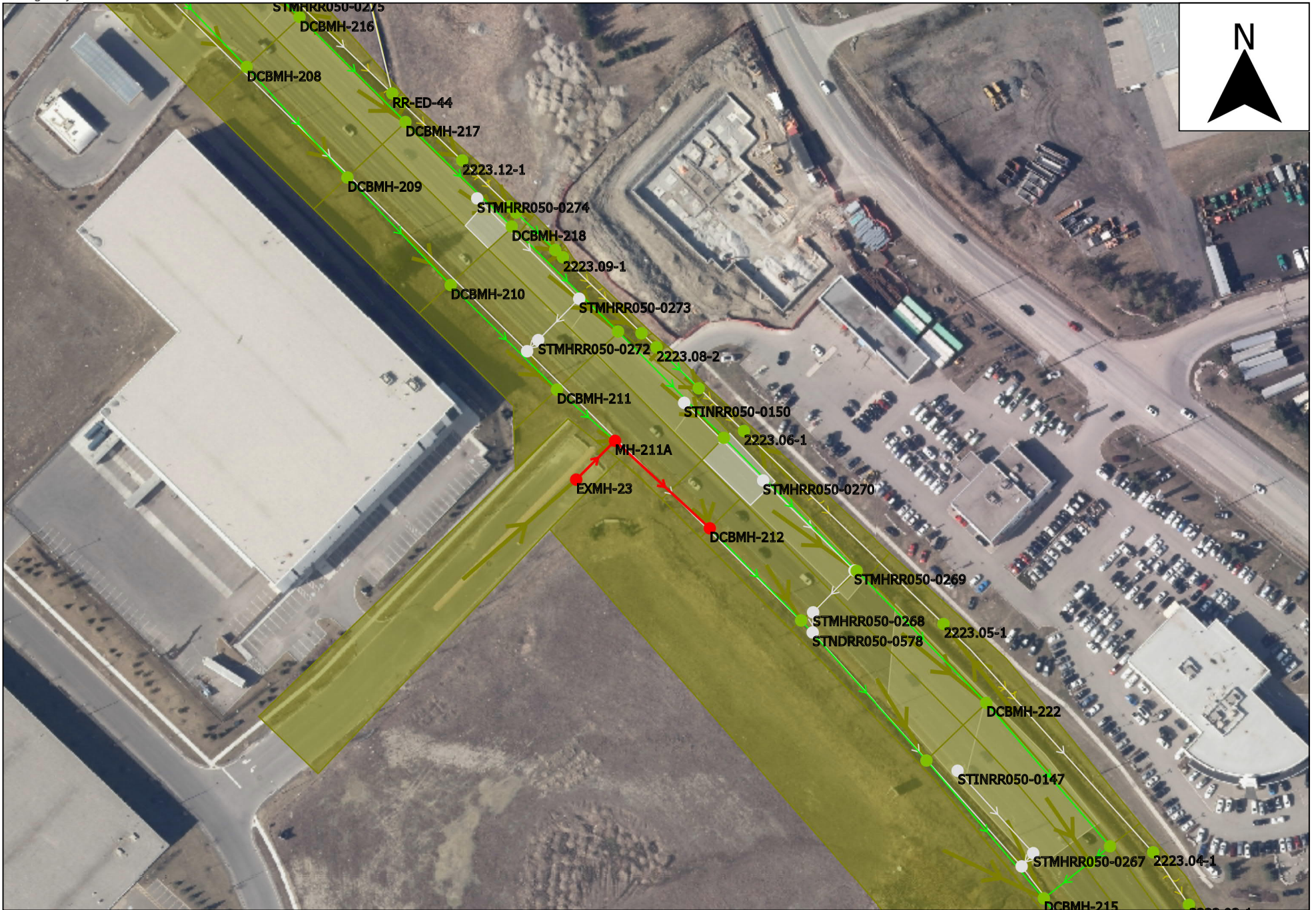
Node	EXMH-23	MH-211A	DCBMH-212
Node ID	EXMH-23	MH-211A	DCBMH-212
ground (m AD)	227.898	229.000	227.843
level (m AD)	226.676	226.656	226.365
expr:Freeboard	1.222265	2.343567	1.478162

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 17



Link	RR-ED-48.1		RR-ED-49.1		RR-ED-50.1		-
US node ID	RR-ED-48		RR-ED-49		RR-ED-50		RR-ED-51
ds node	RR-ED-49		RR-ED-50		RR-ED-51		RR-WD-55
numbarrels	1		1		1		1
length (m)	38.6		44.8		20.5		7.1
Shape ID	CIRC		CIRC		CIRC		CIRC
width (mm)	300		300		300		300
height (mm)	300		300		300		300
Rough type	N		N		N		N
us inv (m AD)	226.565		226.042		225.970		225.848
ds inv (m AD)	226.042		225.970		225.848		225.811
grad (m/m)	0.01355		0.00161		0.00595		0.00522
r.pfc (m3/s)	0.113		0.039		0.075		0.070
US depth (m)	0.214		0.678		0.485		0.368
US flow (m3/s)	0.03501		0.05657		0.08482		0.08383
US velocity (m/s)	1.319		0.750		1.142		1.140
Node	RR-ED-48	RR-ED-49	RR-ED-50	RR-ED-51	-		
Node ID	RR-ED-48	RR-ED-49	RR-ED-50	RR-ED-51	-		
ground (m AD)	228.231	227.930	227.733	227.379	-		
level (m AD)	226.779	226.724	226.563	226.292	-		
expr:Freeboard	1.451920	1.205399	1.169632	1.087479	-		

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 17



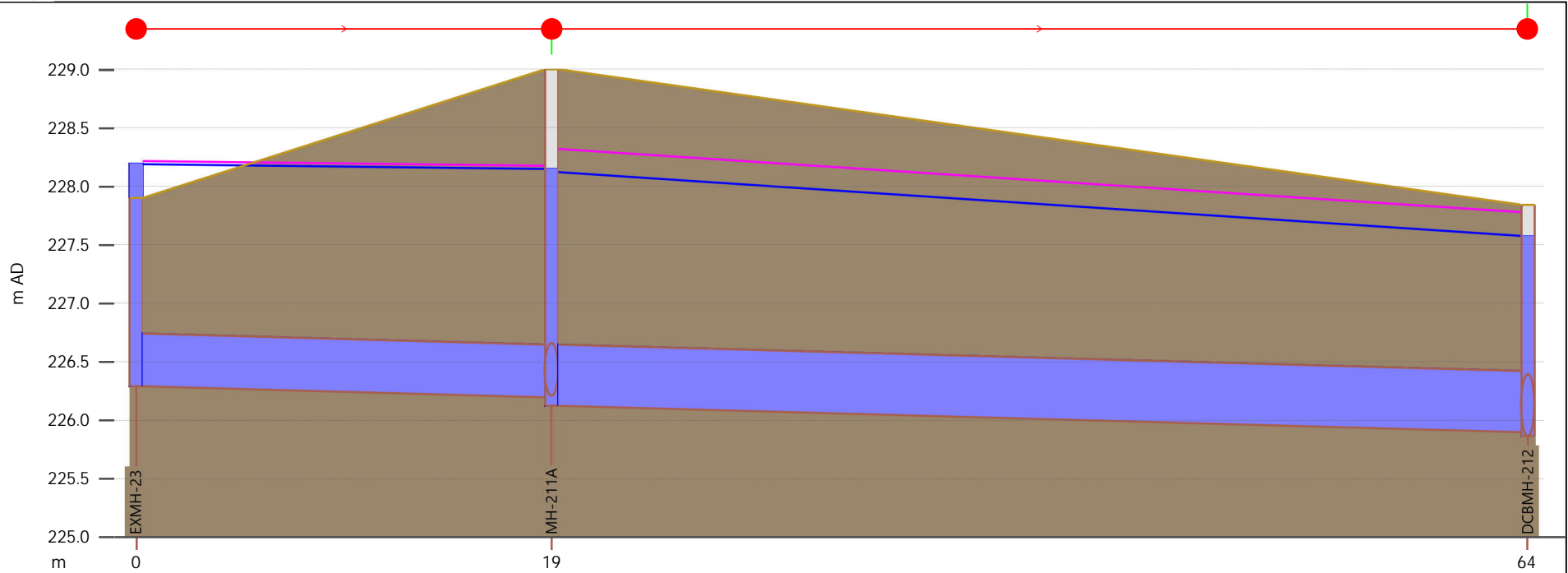
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 17

RVA PROJECT NO. 194615

FIGURE NO. 17G

AUGUST 2021





Link	EXMH-23.1		MH-211A.1
US node ID	EXMH-23		MH-211A
ds node	MH-211A		DCBMH-212
numbarrels	1		1
length (m)	19.2		45.1
Shape ID	CIRC		CIRC
width (mm)	450		525
height (mm)	450		525
Rough type	N		N
us inv (m AD)	226.294		226.123
ds inv (m AD)	226.198		225.898
grad (m/m)	0.00500		0.00499
r.pfc (m3/s)	0.202		0.304
US depth (m)	1.894		1.997
US flow (m3/s)	0.14541		0.48341
US velocity (m/s)	1.055		2.024
Node	EXMH-23	MH-211A	DCBMH-212
Node ID	EXMH-23	MH-211A	DCBMH-212
ground (m AD)	227.898	229.000	227.843
level (m AD)	228.192	228.150	227.571
expr:Freeboard	-0.293528	0.850433	0.272077

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 17



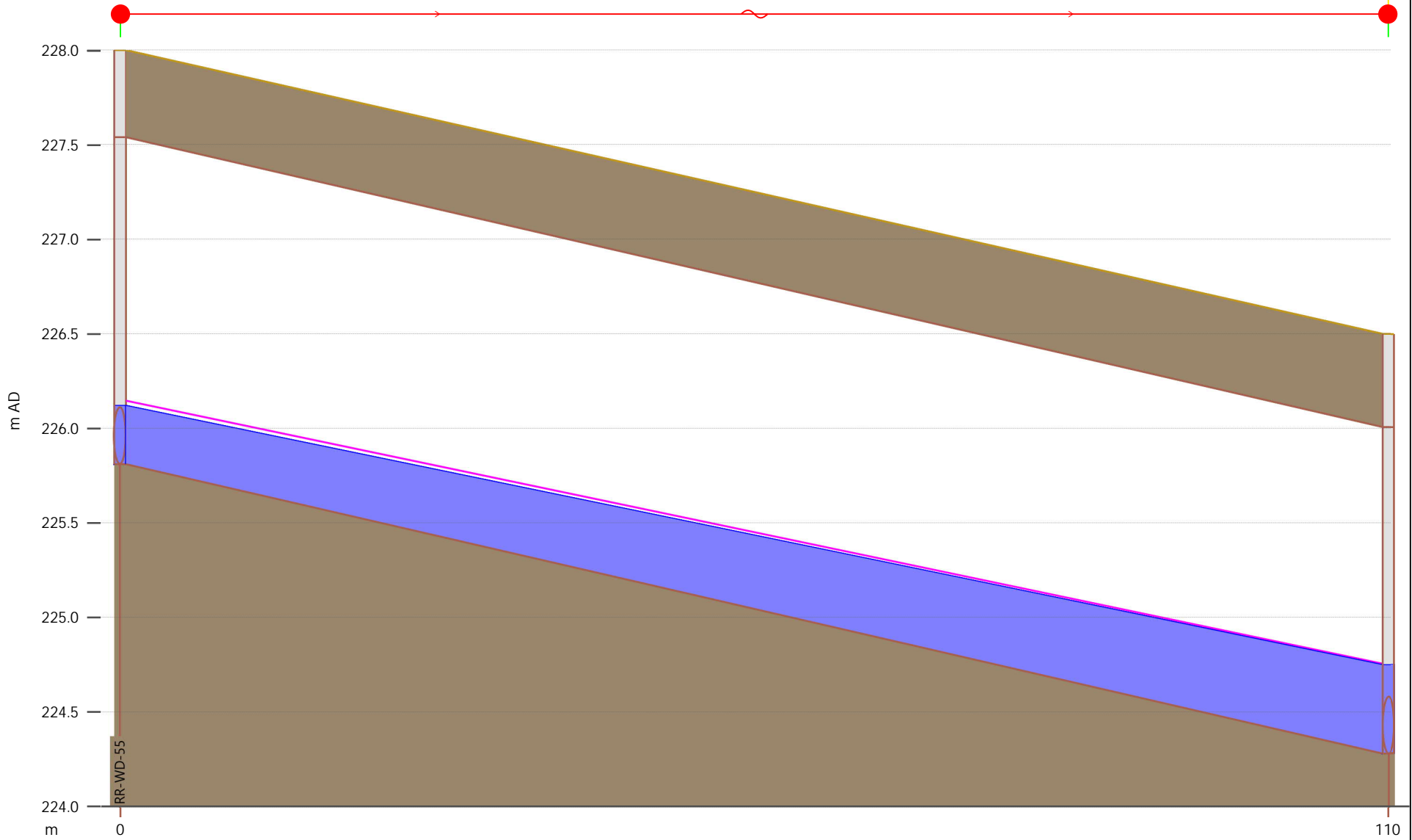
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 18

RVA PROJECT NO. 194615

FIGURE NO. 18A

AUGUST 2021





Link	RR-WD-55.1	
Node	RR-WD-55	RR-WD-56
Node ID	RR-WD-55	RR-WD-56
ground (m AD)	228.000	226.500
level (m AD)	226.118	224.749
expr:Freeboard	1.881989	1.751068

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 18

RVA PROJECT NO. 194615

FIGURE NO. 18B

AUGUST 2021





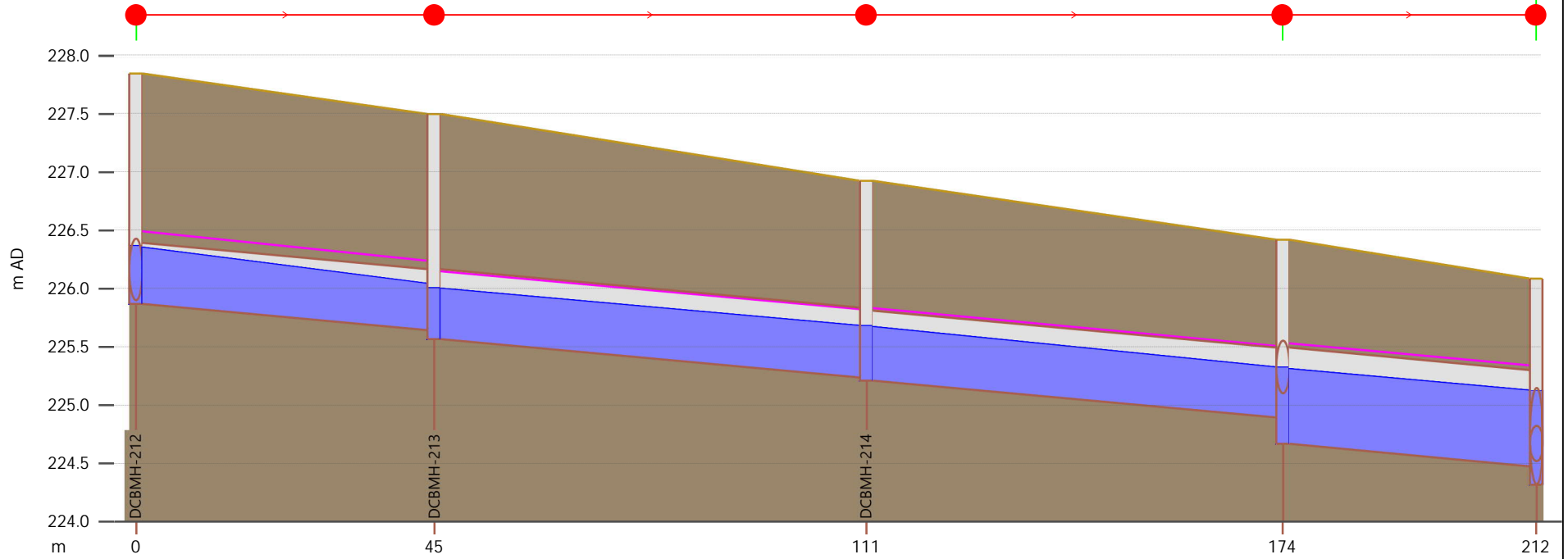
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 18

RVA PROJECT NO. 194615

FIGURE NO. 18C

AUGUST 2021





Link	DCBMH-212.1		DCBMH-213.1		DCBMH-214.1		DCBMH-215.1	
US node ID	DCBMH-212		DCBMH-213		DCBMH-214		DCBMH-215	
ds node	DCBMH-213		DCBMH-214		DCBMH-215		DCBMH-225	
numbarrels	1		1		1		1	
length (m)	45.2		65.5		63.1		38.5	
Shape ID	CIRC		CIRC		CIRC		CIRC	
width (mm)	525		600		600		825	
height (mm)	525		600		600		825	
Rough type	N		N		N		N	
us inv (m AD)	225.868		225.567		225.209		224.669	
ds inv (m AD)	225.642		225.239		224.894		224.476	
grad (m/m)	0.00499		0.00501		0.00499		0.00501	
r.pfc (m3/s)	0.304		0.435		0.434		1.017	
US depth (m)	0.484		0.431		0.462		0.639	
US flow (m3/s)	0.34551		0.37451		0.41599		0.92973	
US velocity (m/s)	1.689		1.744		1.795		2.144	
Node	DCBMH-212	DCBMH-213	DCBMH-214	DCBMH-215	DCBMH-225			
Node ID	DCBMH-212	DCBMH-213	DCBMH-214	DCBMH-215	DCBMH-225			
ground (m AD)	227.843	227.493	226.924	226.418	226.085			
level (m AD)	226.365	226.005	225.680	225.321	225.122			
expr:Freeboard	1.478162	1.487949	1.243809	1.096833	0.963130			

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 18

RVA PROJECT NO. 194615

FIGURE NO. 18D

AUGUST 2021





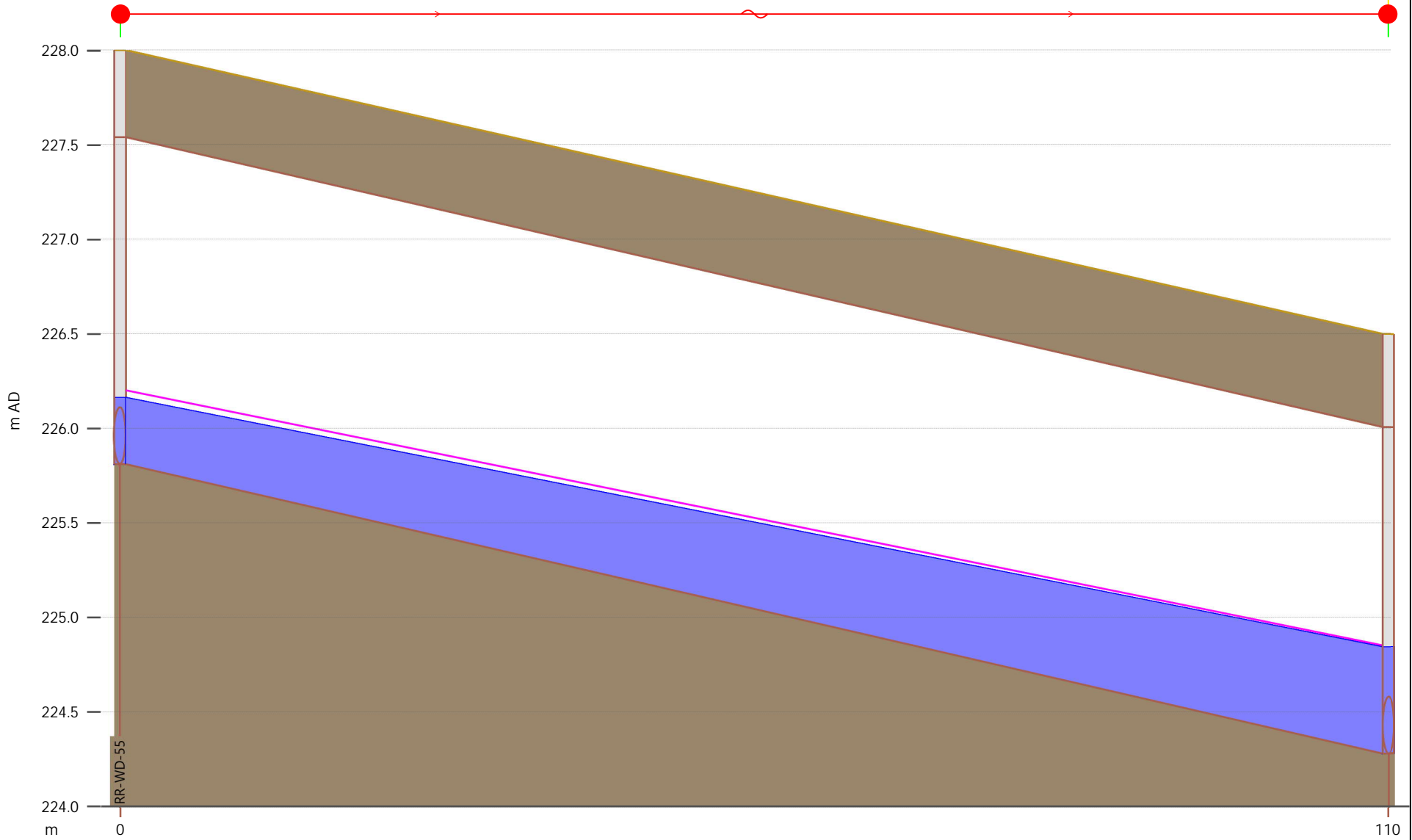
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 18

RVA PROJECT NO. 194615

FIGURE NO. 18E

AUGUST 2021





Link	RR-WD-55.1	
Node	RR-WD-55	RR-WD-56
Node ID	RR-WD-55	RR-WD-56
ground (m AD)	228.000	226.500
level (m AD)	226.161	224.843
expr:Freeboard	1.839249	1.657043

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 18

RVA PROJECT NO. 194615

FIGURE NO. 18F

AUGUST 2021





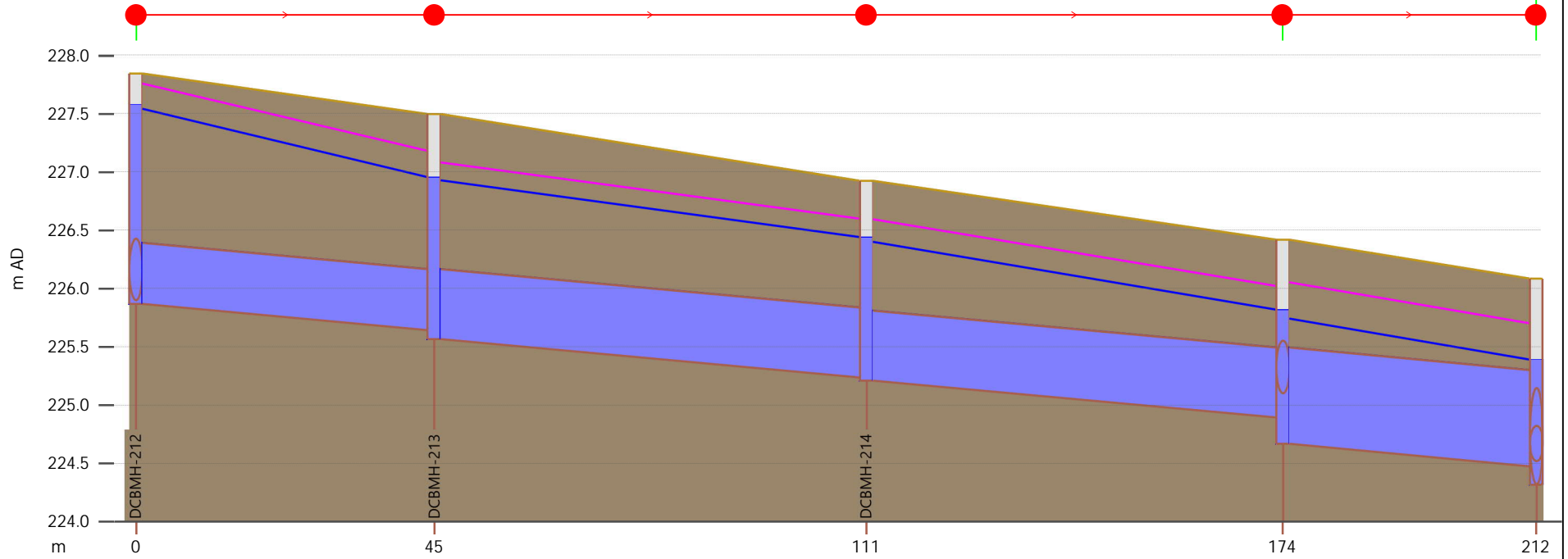
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 18

RVA PROJECT NO. 194615

FIGURE NO. 18G

AUGUST 2021





Link	DCBMH-212.1		DCBMH-213.1		DCBMH-214.1		DCBMH-215.1	
US node ID	DCBMH-212		DCBMH-213		DCBMH-214		DCBMH-215	
ds node	DCBMH-213		DCBMH-214		DCBMH-215		DCBMH-225	
numbarrels	1		1		1		1	
length (m)	45.2		65.5		63.1		38.5	
Shape ID	CIRC		CIRC		CIRC		CIRC	
width (mm)	525		600		600		825	
height (mm)	525		600		600		825	
Rough type	N		N		N		N	
us inv (m AD)	225.868		225.567		225.209		224.669	
ds inv (m AD)	225.642		225.239		224.894		224.476	
grad (m/m)	0.00499		0.00501		0.00499		0.00501	
r.pfc (m3/s)	0.304		0.435		0.434		1.017	
US depth (m)	1.670		1.359		1.190		1.074	
US flow (m3/s)	0.49755		0.53066		0.58580		1.37776	
US velocity (m/s)	2.117		1.826		1.957		2.472	
Node	DCBMH-212	DCBMH-213	DCBMH-214	DCBMH-215	DCBMH-225			
Node ID	DCBMH-212	DCBMH-213	DCBMH-214	DCBMH-215	DCBMH-225			
ground (m AD)	227.843	227.493	226.924	226.418	226.085			
level (m AD)	227.571	226.949	226.436	225.816	225.385			
expr:Freeboard	0.272077	0.543873	0.487812	0.602067	0.700373			

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 18



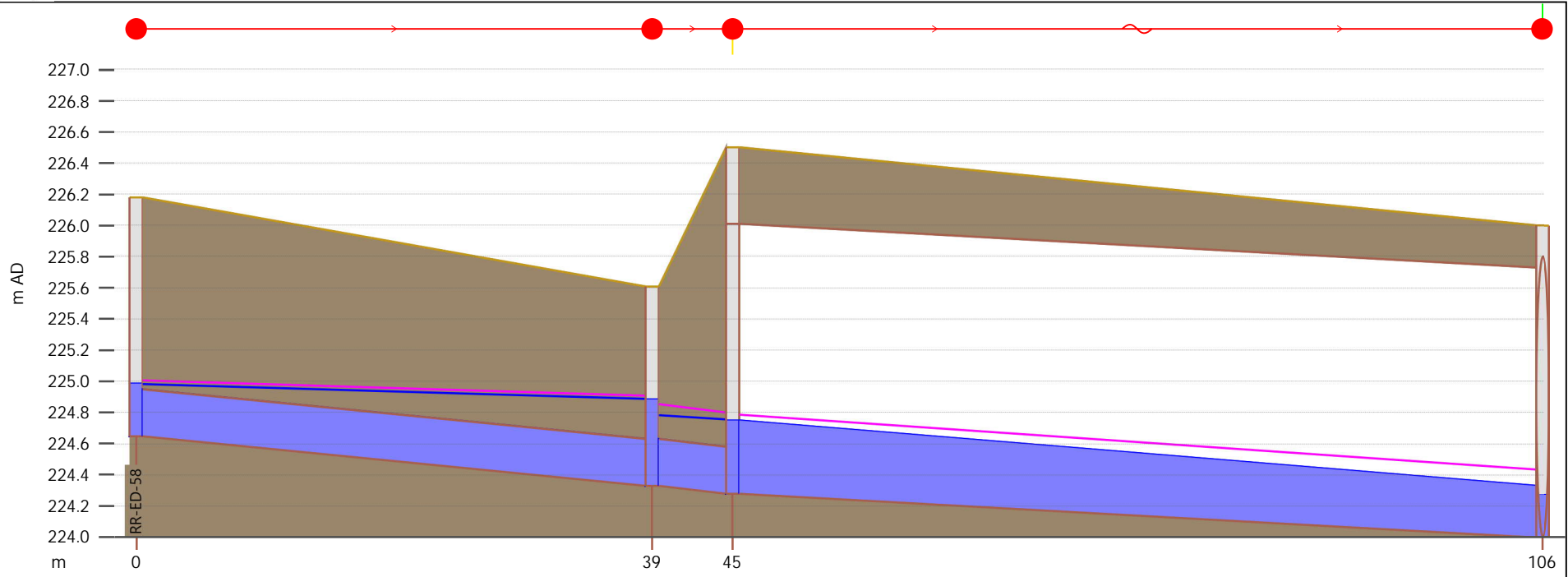
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 19

RVA PROJECT NO. 194615

FIGURE NO. 19A

AUGUST 2021





Link	RR-ED-58.1	-	RR-WD-56.1
US node ID	RR-ED-58	-	RR-WD-56
ds node	RR-ED-59	-	RR-WD-57
numbarrels	1	1	1
length (m)	38.9	6.1	
Shape ID	CIRC	CIRC	West Side Ditch-8 (Downstream of George Bolton Pkwy)
width (mm)	300	300	
height (mm)	300	300	
Rough type	N	N	
us inv (m AD)	224.648	224.330	224.280
ds inv (m AD)	224.330	224.280	224.000
grad (m/m)	0.00818	0.00818	
r.pfc (m3/s)	0.087	0.087	10.653
US depth (m)	0.336	0.452	0.469
US flow (m3/s)	0.04750	0.08912	0.66541
US velocity (m/s)	1.115	1.204	0.853

Node	RR-ED-58	RR-ED-59	RR-WD-56	RR-WD-57
Node ID	RR-ED-58	RR-ED-59	RR-WD-56	RR-WD-57
ground (m AD)	226.178	225.607	226.500	226.000
level (m AD)	224.987	224.884	224.749	224.269
expr:Freeboard	1.190598	0.722458	1.751068	1.730820

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 19



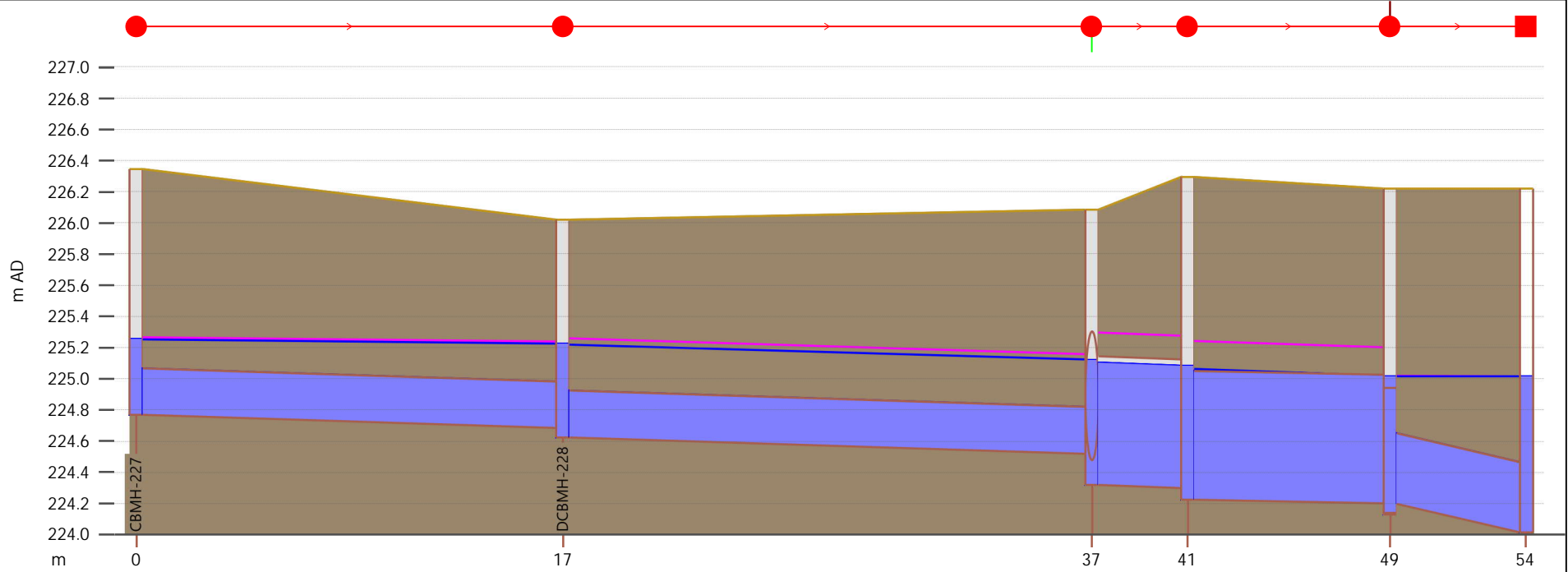
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 19

RVA PROJECT NO. 194615

FIGURE NO. 19C

AUGUST 2021





Link	CBMH-227.1		DCBMH-228.1		-	OGS-20.1		MH-229.1	
US node ID	CBMH-227		DCBMH-228		-	OGS-20		MH-229	
ds node	DCBMH-228		DCBMH-225		OGS-20	MH-229		Chamber#19	
numbarrels	1		1		1	1		1	
length (m)	16.7		20.7		3.7	7.9		5.3	
Shape ID	CIRC		CIRC		CIRC	CIRC		CIRC	
width (mm)	300		300		825	825		450	
height (mm)	300		300		825	825		450	
Rough type	N		N		N	N		N	
us inv (m AD)	224.768		224.624		224.320	224.224		224.200	
ds inv (m AD)	224.684		224.520		224.299	224.202		224.017	
grad (m/m)	0.00504		0.00503		0.00561	0.00278		0.03442	
r.pfc (m3/s)	0.069		0.069		1.075	0.757		0.529	
US depth (m)	0.485		0.595		0.784	0.838		0.817	
US flow (m3/s)	0.03865		0.07307		1.02041	1.01905		0.18723	
US velocity (m/s)	0.962		1.112		2.015	1.883		1.716	
Node	CBMH-227		DCBMH-228		DCBMH-225	OGS-20		MH-229	
Node ID	CBMH-227		DCBMH-228		DCBMH-225	OGS-20		MH-229	
ground (m AD)	226.344		226.019		226.085	226.293		226.218	
level (m AD)	225.256		225.227		225.122	225.083		225.017	
expr:Freeboard	1.087942		0.792438		0.963130	1.210007		1.201200	

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 19

RVA PROJECT NO. 194615

FIGURE NO. 19D

AUGUST 2021



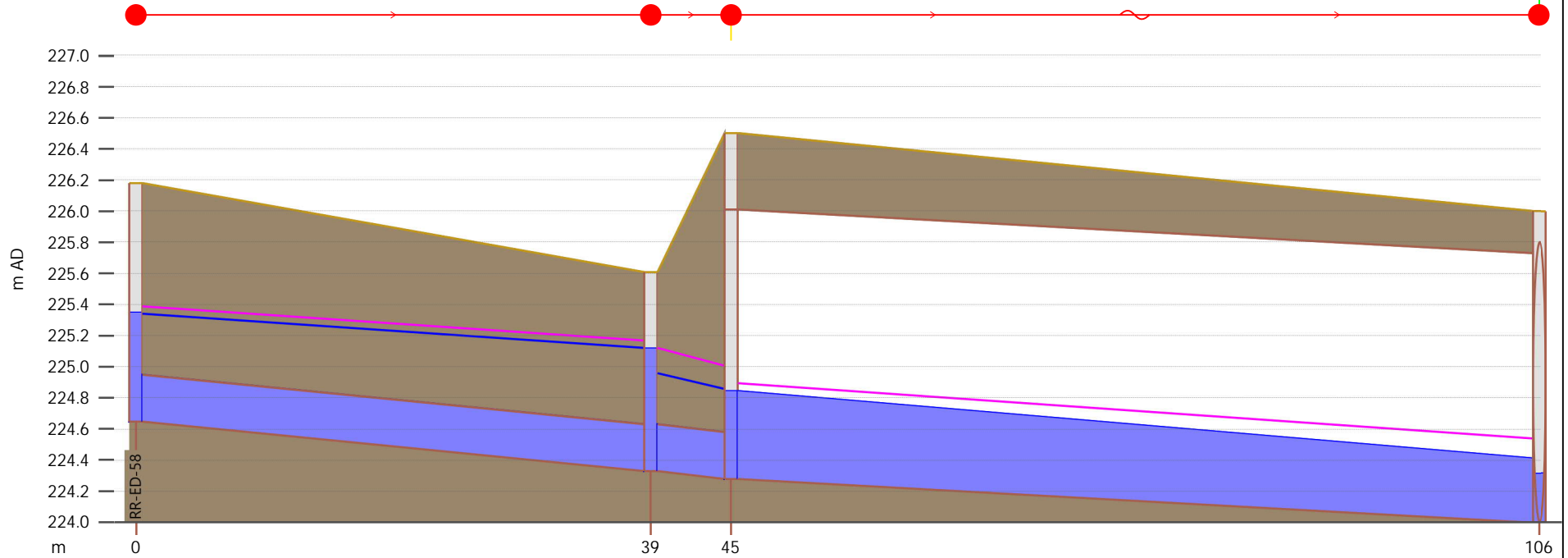


EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 19

RVA PROJECT NO. 194615

FIGURE NO. 19E

AUGUST 2021



Link	RR-ED-58.1	-	RR-WD-56.1
US node ID	RR-ED-58	-	RR-WD-56
ds node	RR-ED-59	-	RR-WD-57
numbarrels	1	1	1
length (m)	38.9	6.1	
Shape ID	CIRC	CIRC	West Side Ditch-8 (Downstream of George Bolton Pkwy)
width (mm)	300	300	
height (mm)	300	300	
Rough type	N	N	
us inv (m AD)	224.648	224.330	224.280
ds inv (m AD)	224.330	224.280	224.000
grad (m/m)	0.00818	0.00818	
r.pfc (m3/s)	0.087	0.087	10.653
US depth (m)	0.694	0.629	0.563
US flow (m3/s)	0.07227	0.13442	1.02332
US velocity (m/s)	1.042	1.789	0.999

Node	RR-ED-58	RR-ED-59	RR-WD-56	RR-WD-57
Node ID	RR-ED-58	RR-ED-59	RR-WD-56	RR-WD-57
ground (m AD)	226.178	225.607	226.500	226.000
level (m AD)	225.349	225.117	224.843	224.313
expr:Freeboard	0.829056	0.489868	1.657043	1.686722

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 19



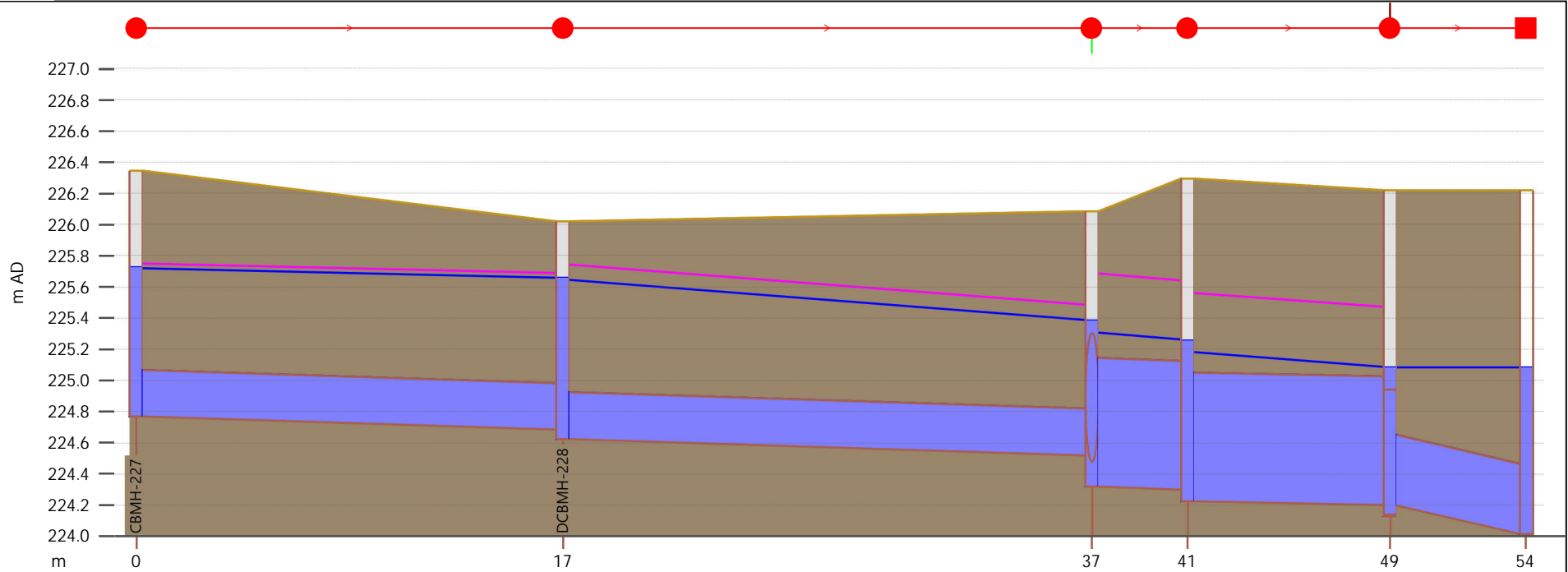
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 19

RVA PROJECT NO. 194615

FIGURE NO. 19G

AUGUST 2021





Link	CBMH-227.1		DCBMH-228.1		-	OGS-20.1		MH-229.1	
US node ID	CBMH-227		DCBMH-228		-	OGS-20		MH-229	
ds node	DCBMH-228		DCBMH-225		OGS-20	MH-229		Chamber#19	
numbarrels	1		1		1	1		1	
length (m)	16.7		20.7		3.7	7.9		5.3	
Shape ID	CIRC		CIRC		CIRC	CIRC		CIRC	
width (mm)	300		300		825	825		450	
height (mm)	300		300		825	825		450	
Rough type	N		N		N	N		N	
us inv (m AD)	224.768		224.624		224.320	224.224		224.200	
ds inv (m AD)	224.684		224.520		224.299	224.202		224.017	
grad (m/m)	0.00504		0.00503		0.00561	0.00278		0.03442	
r.pfc (m3/s)	0.069		0.069		1.075	0.757		0.529	
US depth (m)	0.952		1.019		0.986	0.958		0.883	
US flow (m3/s)	0.06202		0.11367		1.51798	1.51702		0.17335	
US velocity (m/s)	0.970		1.470		2.731	2.732		1.658	
Node	CBMH-227		DCBMH-228		DCBMH-225	OGS-20		MH-229	
Node ID	CBMH-227		DCBMH-228		DCBMH-225	OGS-20		MH-229	
ground (m AD)	226.344		226.019		226.085	226.293		226.218	
level (m AD)	225.724		225.658		225.385	225.258		225.083	
expr:Freeboard	0.619879		0.361178		0.700373	1.035477		1.134519	

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 19



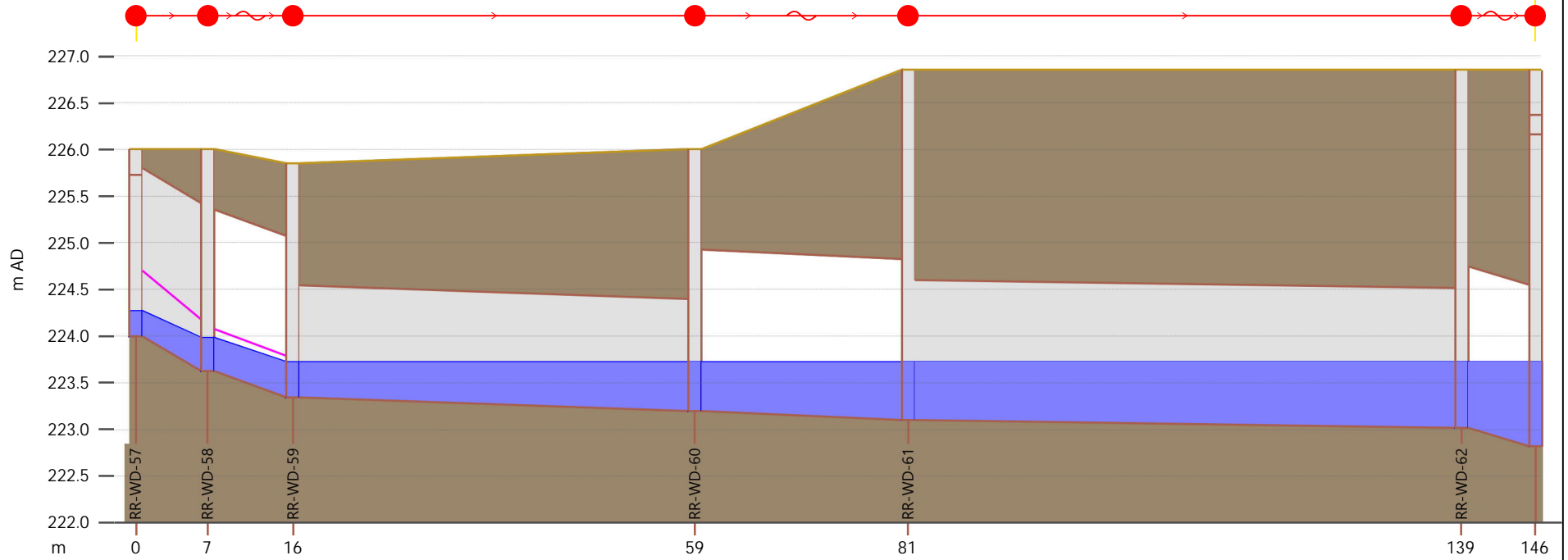
EXISTING CONDITION - 10-YEAR - WEST SIDE PLAN 20

RVA PROJECT NO. 194615

FIGURE NO. 20A

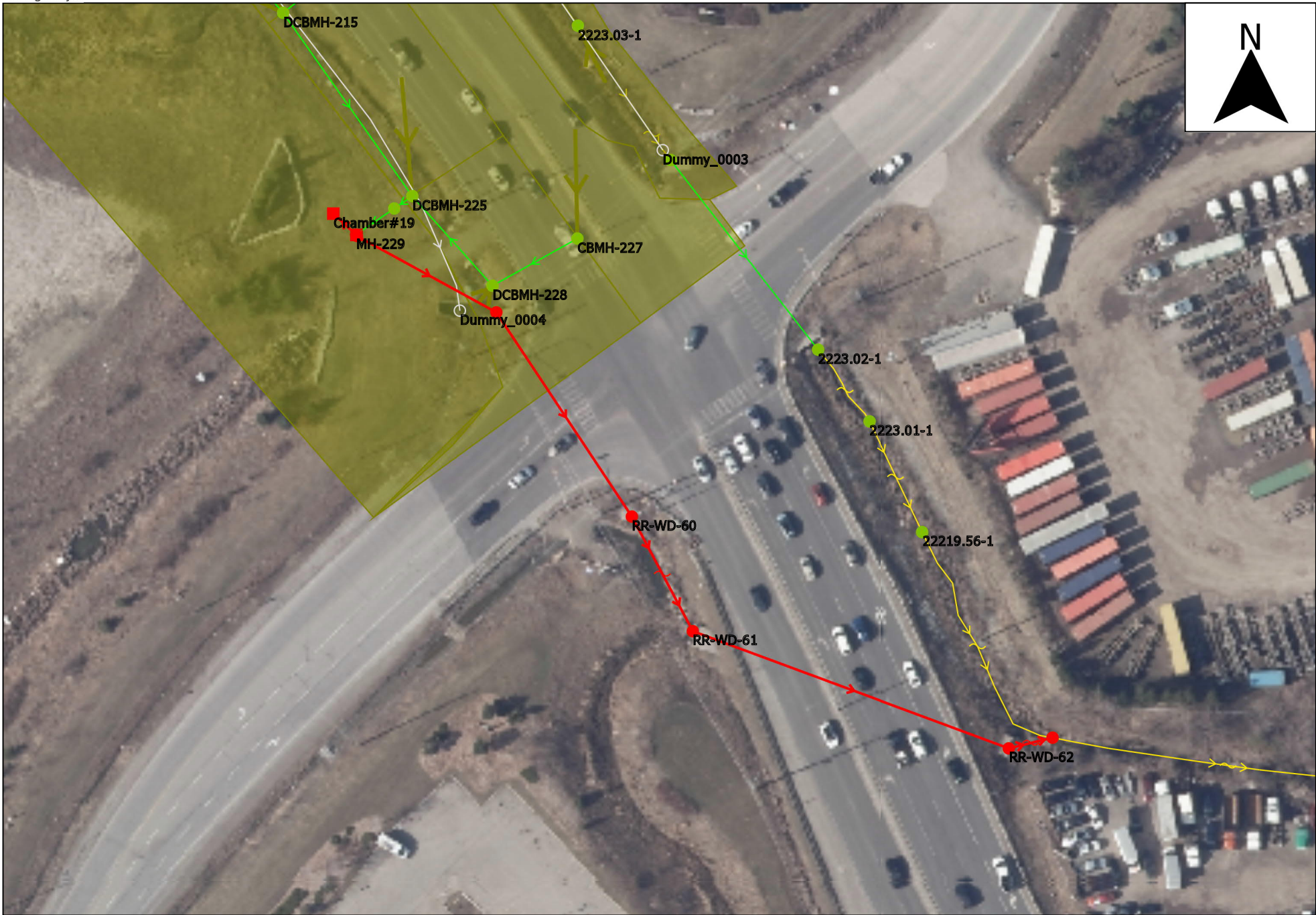
AUGUST 2021





Link	-	-	RR-WD-59.1	RR-WD-60.1	RR-WD-61.1	-
US node ID	-	-	RR-WD-59	RR-WD-60	RR-WD-61	-
ds node	-	-	RR-WD-60	RR-WD-61	RR-WD-62	-
numbarrels	1	1	1	1	1	1
length (m)	7.5		42.1		57.9	
Shape ID	CIRC		RECT		RECT	
width (mm)	1800		2500		2500	
height (mm)	1800		1200		1500	
Rough type	N		N		N	
us inv (m AD)	224.000	223.625	223.343	223.199	223.100	223.016
ds inv (m AD)	223.625	223.343	223.199	223.100	223.016	222.822
grad (m/m)	0.05001		0.00342		0.00145	
r.pfc (m3/s)	25.709	27.903	7.396	10.477	6.629	24.879
US depth (m)	0.269	0.354	0.377	0.521	0.620	0.704
US flow (m3/s)	0.69418	0.69878	0.72091	0.71743	0.71436	0.71245
US velocity (m/s)	2.916	1.367	0.849	0.953	0.842	1.212
Node	-	-	RR-WD-59	RR-WD-60	RR-WD-61	RR-WD-62
Node ID	-	-	RR-WD-59	RR-WD-60	RR-WD-61	RR-WD-62
ground (m AD)			225.850	226.000	226.850	226.850
level (m AD)	-	-	223.720	223.720	223.720	223.720
expr:Freeboard	-	-	2.130029	2.280289	3.130334	3.130380

EXISTING CONDITION - 10-YEAR - WEST SIDE PROFILE 20



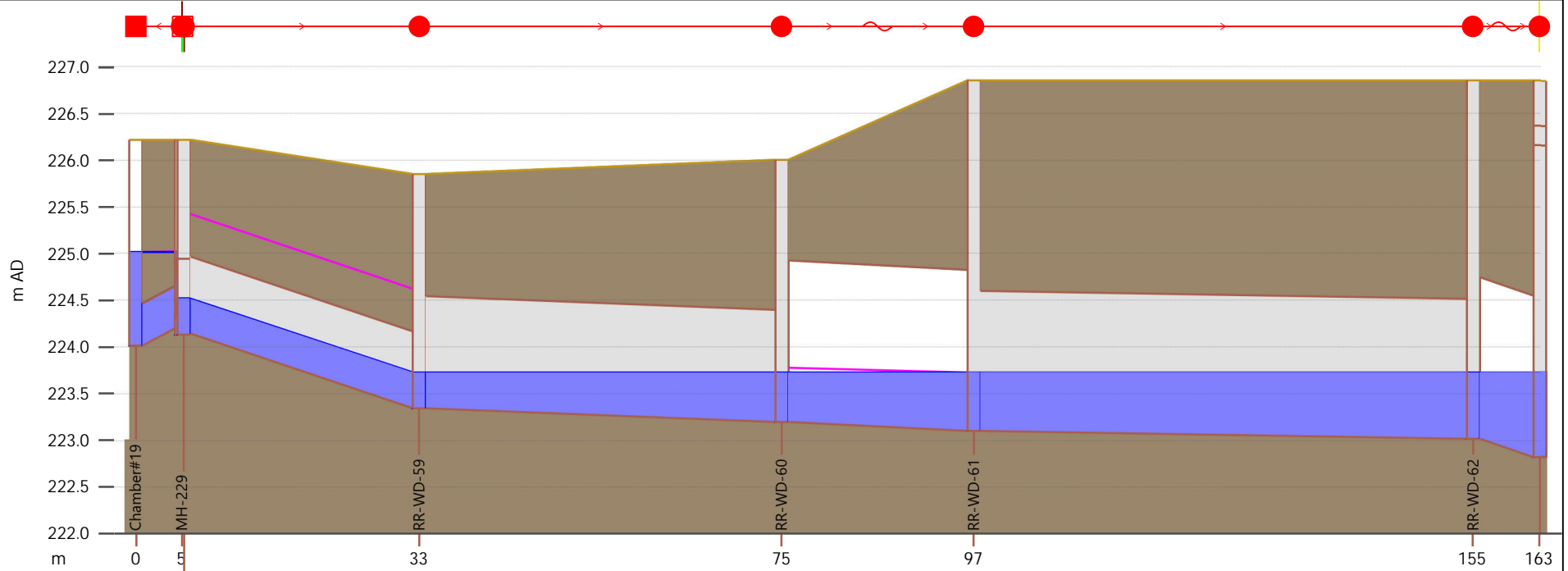
PROPOSED CONDITION - 10-YEAR - WEST SIDE PLAN 20

RVA PROJECT NO. 194615

FIGURE NO. 20C

AUGUST 2021





Link	-	MH-229_2.1	RR-WD-59.1	RR-WD-60.1	RR-WD-61.1	-
US node ID	-	MH-229_2	RR-WD-59	RR-WD-60	RR-WD-61	-
ds node	-	RR-WD-59	RR-WD-60	RR-WD-61	RR-WD-62	-
numbarrels	1	1	2	1	1	1
length (m)	5.3	27.3	42.1	-	57.9	-
Shape ID	CIRC	CIRC	RECT	-	RECT	-
width (mm)	450	825	3500	-	2500	-
height (mm)	450	825	1200	-	1500	-
Rough type	N	N	N	-	N	-
us inv (m AD)	-	224.142	223.343	223.199	223.100	-
ds inv (m AD)	-	223.343	223.199	223.100	223.016	-
grad (m/m)	-	0.02926	0.00342	-	0.00145	-
r.pfc (m3/s)	-	2.456	11.048	10.477	6.629	24.879
US depth (m)	-	0.376	0.383	0.526	0.625	0.709
US flow (m3/s)	-	0.99917	0.99642	0.96917	0.96706	-
US velocity (m/s)	-	4.216	0.438	1.067	0.996	1.425
Node		MH-229_2	RR-WD-59	RR-WD-60	RR-WD-61	RR-WD-62
Node ID		MH-229_2	RR-WD-59	RR-WD-60	RR-WD-61	RR-WD-62
ground (m AD)		226.218	225.850	226.000	226.850	226.850
level (m AD)		224.519	223.726	223.725	223.725	223.725
expr:Freeboard		1.699079	2.124399	2.274643	3.124673	3.124734

PROPOSED CONDITION - 10-YEAR - WEST SIDE PROFILE 20



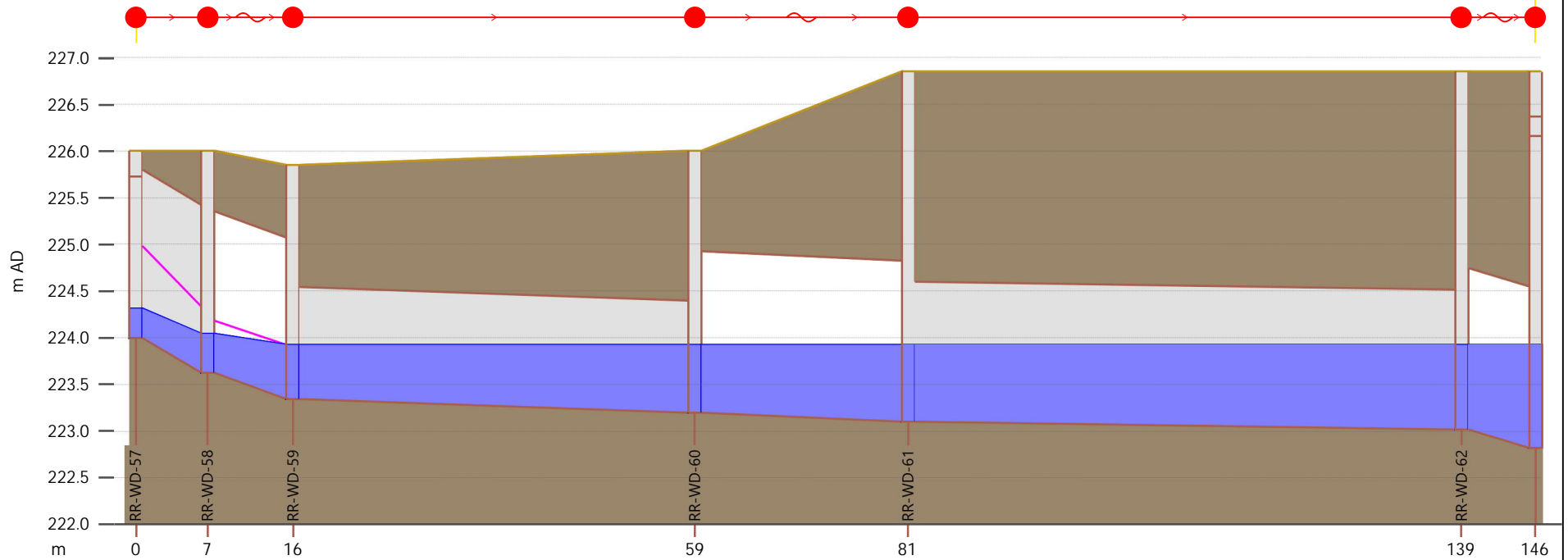
EXISTING CONDITION - 100-YEAR - WEST SIDE PLAN 20

RVA PROJECT NO. 194615

FIGURE NO. 20E

AUGUST 2021





Link	-	-	RR-WD-59.1	RR-WD-60.1	RR-WD-61.1	-
US node ID	-	-	RR-WD-59	RR-WD-60	RR-WD-61	-
ds node	-	-	RR-WD-60	RR-WD-61	RR-WD-62	-
numbarrels	1	1	1	1	1	1
length (m)	7.5		42.1		57.9	
Shape ID	CIRC		RECT		RECT	
width (mm)	1800		2500		2500	
height (mm)	1800		1200		1500	
Rough type	N		N		N	
us inv (m AD)	224.000	223.625	223.343	223.199	223.100	223.016
ds inv (m AD)	223.625	223.343	223.199	223.100	223.016	222.822
grad (m/m)	0.05001		0.00342		0.00145	
r.pfc (m3/s)	25.709	27.903	7.396	10.477	6.629	24.879
US depth (m)	0.313	0.416	0.582	0.726	0.825	0.909
US flow (m3/s)	1.07331	1.08108	1.11756	1.11554	1.11323	1.10969
US velocity (m/s)	3.625	1.662	1.022	1.125	1.062	1.488
Node	-	-	RR-WD-59	RR-WD-60	RR-WD-61	RR-WD-62
Node ID	-	-	RR-WD-59	RR-WD-60	RR-WD-61	RR-WD-62
ground (m AD)			225.850	226.000	226.850	226.850
level (m AD)	-	-	223.925	223.925	223.925	223.925
expr:Freeboard	-	-	1.924692	2.074783	2.924783	2.924814

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 20



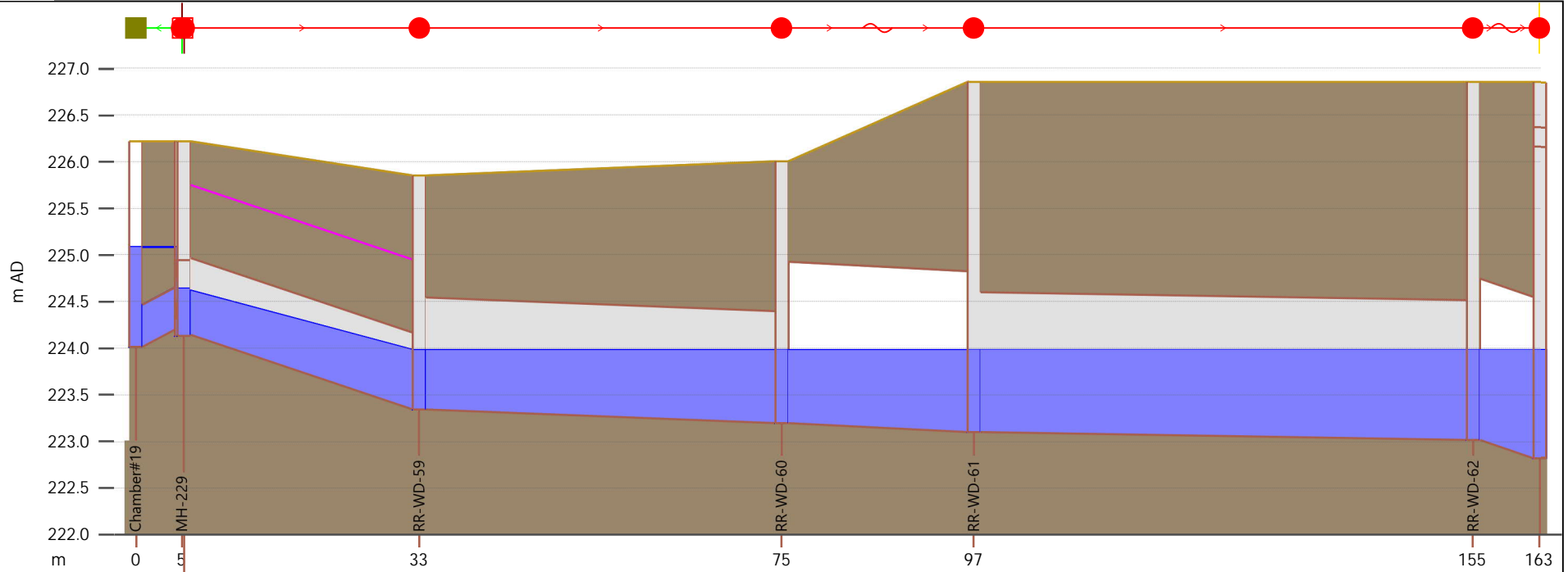
PROPOSED CONDITION - 100-YEAR - WEST SIDE PLAN 20

RVA PROJECT NO. 194615

FIGURE NO. 20G

AUGUST 2021





Link	-	MH-229_2.1	RR-WD-59.1	RR-WD-60.1	RR-WD-61.1	-
US node ID	-	MH-229_2	RR-WD-59	RR-WD-60	RR-WD-61	-
ds node	-	RR-WD-59	RR-WD-60	RR-WD-61	RR-WD-62	-
numbarrels	1	1	2	1	1	1
length (m)	5.3	27.3	42.1	-	57.9	-
Shape ID	CIRC	CIRC	RECT	-	RECT	-
width (mm)	450	825	3500	-	2500	-
height (mm)	450	825	1200	-	1500	-
Rough type	N	N	N	-	N	-
us inv (m AD)	-	224.142	223.343	223.199	223.100	-
ds inv (m AD)	-	223.343	223.199	223.100	223.016	-
grad (m/m)	-	0.02926	0.00342	-	0.00145	-
r.pfc (m3/s)	-	2.456	11.048	10.477	6.629	24.879
US depth (m)	-	0.474	0.638	0.782	0.881	0.965
US flow (m3/s)	-	1.49956	1.49705	1.48919	1.48718	-
US velocity (m/s)	-	4.718	0.485	1.254	1.251	1.750
Node		MH-229_2	RR-WD-59	RR-WD-60	RR-WD-61	RR-WD-62
Node ID		MH-229_2	RR-WD-59	RR-WD-60	RR-WD-61	RR-WD-62
ground (m AD)		226.218	225.850	226.000	226.850	226.850
level (m AD)		224.640	223.981	223.981	223.981	223.981
expr:Freeboard		1.577726	1.869226	2.019287	2.869287	2.869318

EXISTING CONDITION - 100-YEAR - WEST SIDE PROFILE 20

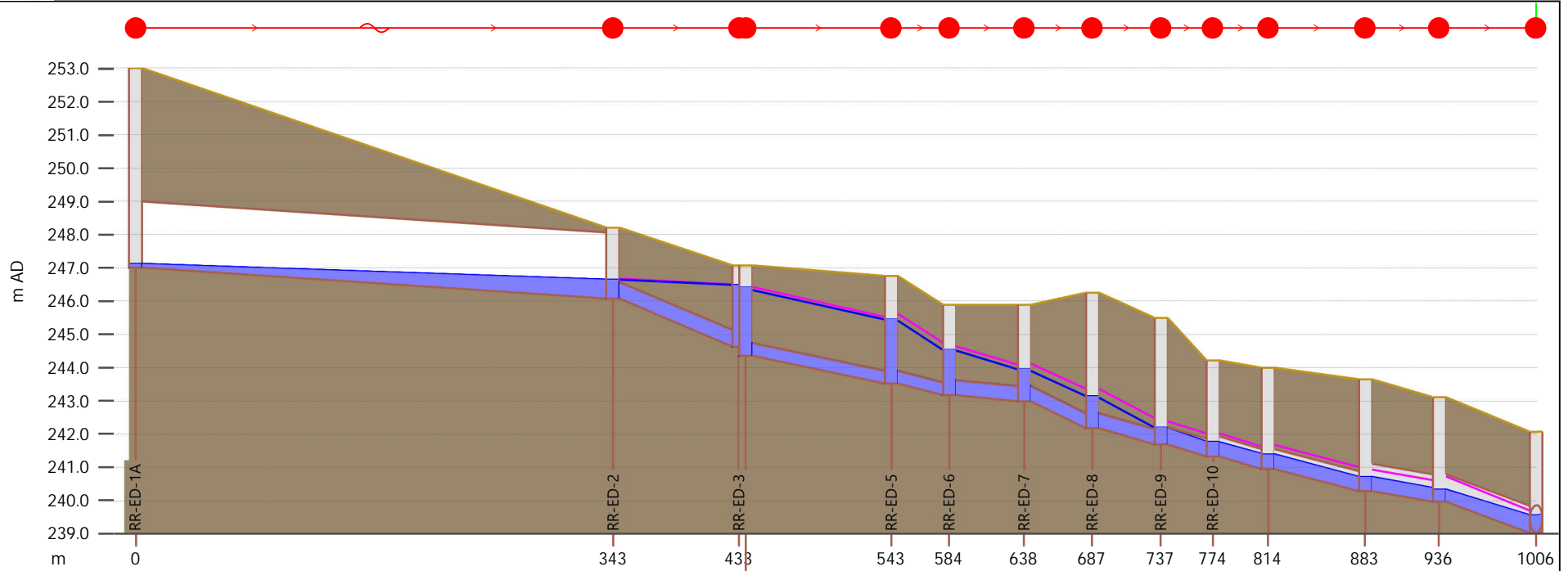


EXISTING CONDITION - 10-YEAR - EAST SIDE PLAN 1

RVA PROJECT NO. 194615

FIGURE NO. 21A

AUGUST 2021



Link	RR-ED-1A.1	RR-ED-2.1	RR-ED-4.1	-	-	-	-	-	-	-	RR-ED-11.1	-	RR-ED-13.1
US node ID	RR-ED-1A	RR-ED-2	RR-ED-4	-	-	RR-ED-6	-	-	-	-	RR-ED-11	-	RR-ED-13
ds node	RR-ED-2	RR-ED-3	RR-ED-5	-	-	RR-ED-7	-	-	-	-	RR-ED-12	-	RR-ED-14
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1
length (m)		90.4	104.4	41.5	53.8	49.0	49.3	37.5	39.6	69.7	53.1	69.9	
Shape ID	East Side Ditch-1	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC
width (mm)		500	375	375	450	450	450	525	600	600	825	825	
height (mm)		500	375	375	450	450	450	525	600	600	825	825	
Rough type		N	N	N	N	N	N	N	N	N	N	N	N
us inv (m AD)	247.000	246.068	244.358	244.358	243.173	242.988	242.176	242.176	241.695	240.956	240.291	239.970	239.970
ds inv (m AD)	246.068	244.622	243.521	243.521	242.988	242.176	241.695	-	-	240.291	239.970	239.030	239.030
grad (m/m)		0.01599	0.00801	0.00801	0.00344	0.01656	0.00977	-	-	0.00954	0.00604	0.01345	0.01345
r.pfc (m3/s)	16.699	0.478	0.157	0.161	0.167	0.367	0.282	0.421	0.601	0.600	1.116	1.665	1.665
US depth (m)	0.111	0.572	1.969	1.889	1.335	0.917	0.924	0.479	0.419	0.429	0.419	0.360	0.360
US flow (m3/s)	-0.00003	0.19957	0.20957	-	0.28792	0.34661	0.38606	-	-	0.51801	0.57414	0.62152	0.62152
US velocity (m/s)	-0.000	2.218	1.686	2.088	1.675	2.459	2.286	2.202	2.347	2.392	2.105	2.777	2.777
Node	RR-ED-1A	RR-ED-2	RR-ED-5	-	-	RR-ED-5	-	-	-	-	-	-	-
Node ID	RR-ED-1A	RR-ED-2	RR-ED-5	-	-	RR-ED-5	-	-	-	-	-	-	-
ground (m AD)	253.000	248.200	246.754	-	-	246.754	-	-	-	-	-	-	-
level (m AD)	247.111	246.646	245.441	-	-	245.441	-	-	-	-	-	-	-
expr:Freeboard	5.889252	1.554263	1.312655	-	-	1.312655	-	-	-	-	-	-	-

EXISTING CONDITION - 10-YEAR - EAST SIDE PROFILE 1



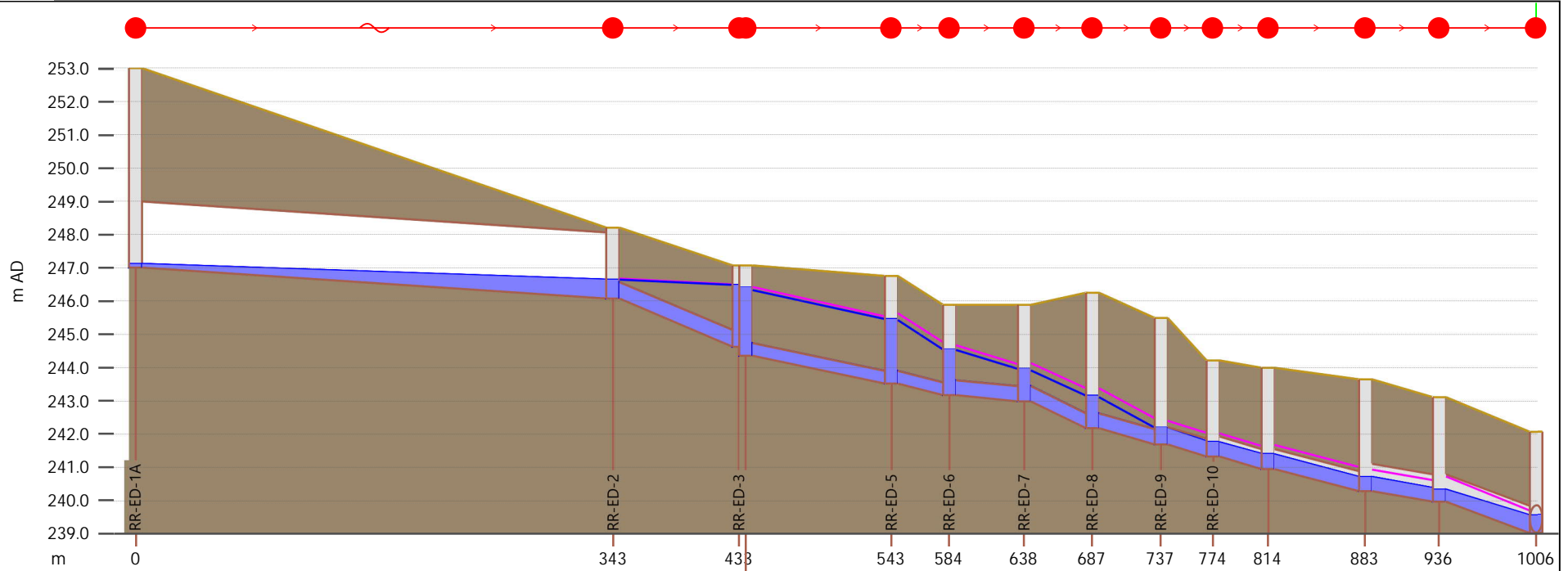
PROPOSED CONDITION - 10-YEAR - EAST SIDE PLAN 1

RVA PROJECT NO. 194615

FIGURE NO. 21C

AUGUST 2021





Link	RR-ED-1A.1	RR-ED-2.1	RR-ED-4.1	-	-	-	-	-	-	-	RR-ED-11.1	-	RR-ED-13.1
US node ID	RR-ED-1A	RR-ED-2	RR-ED-4	-	-	RR-ED-6	-	-	-	-	RR-ED-11	-	RR-ED-13
ds node	RR-ED-2	RR-ED-3	RR-ED-5	-	-	RR-ED-7	-	-	-	-	RR-ED-12	-	RR-ED-14
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1
length (m)		90.4	104.4	41.5	53.8	49.0	49.3	37.5	39.6	69.7	53.1	69.9	
Shape ID	East Side Ditch-1	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	
width (mm)		500	375	375	450	450	450	525	600	600	825	825	
height (mm)		500	375	375	450	450	450	525	600	600	825	825	
Rough type		N	N	N	N	N	N	N	N	N	N	N	
us inv (m AD)	247.000	246.068	244.358	244.358	243.173	242.988	242.176	242.176	241.695	240.956	240.291	239.970	
ds inv (m AD)	246.068	244.622	243.521	243.521	242.988	242.176	241.695	-	-	240.291	239.970	239.030	
grad (m/m)		0.01599	0.00801	0.00801	0.00344	0.01656	0.00977	-	-	0.00954	0.00604	0.01345	
r.pfc (m3/s)	16.699	0.478	0.157	0.161	0.167	0.367	0.282	0.421	0.601	0.600	1.116	1.665	
US depth (m)	0.111	0.574	1.971	1.906	1.355	0.932	0.937	0.484	0.421	0.432	0.420	0.361	
US flow (m3/s)	-0.00003	0.19937	0.20964	-	0.28793	0.34851	0.38772	-	-	0.52405	0.57648	0.62530	
US velocity (m/s)	-0.000	2.229	1.686	2.088	1.675	2.459	2.295	2.200	2.343	2.406	2.109	2.782	
Node	RR-ED-1A	RR-ED-2	-	-	RR-ED-5	-	-	-	-	-	-	-	
Node ID	RR-ED-1A	RR-ED-2	-	-	RR-ED-5	-	-	-	-	-	-	-	
ground (m AD)	253.000	248.200	246.754	243.650	243.114	-	-	-	-	-	-	-	
level (m AD)	247.111	246.648	245.459	240.712	240.331	-	-	-	-	-	-	-	
expr:Freeboard	5.889191	1.552371	1.295199	-	-	-	-	-	-	-	-	-	

PROPOSED CONDITION - 10-YEAR - EAST SIDE PROFILE 1

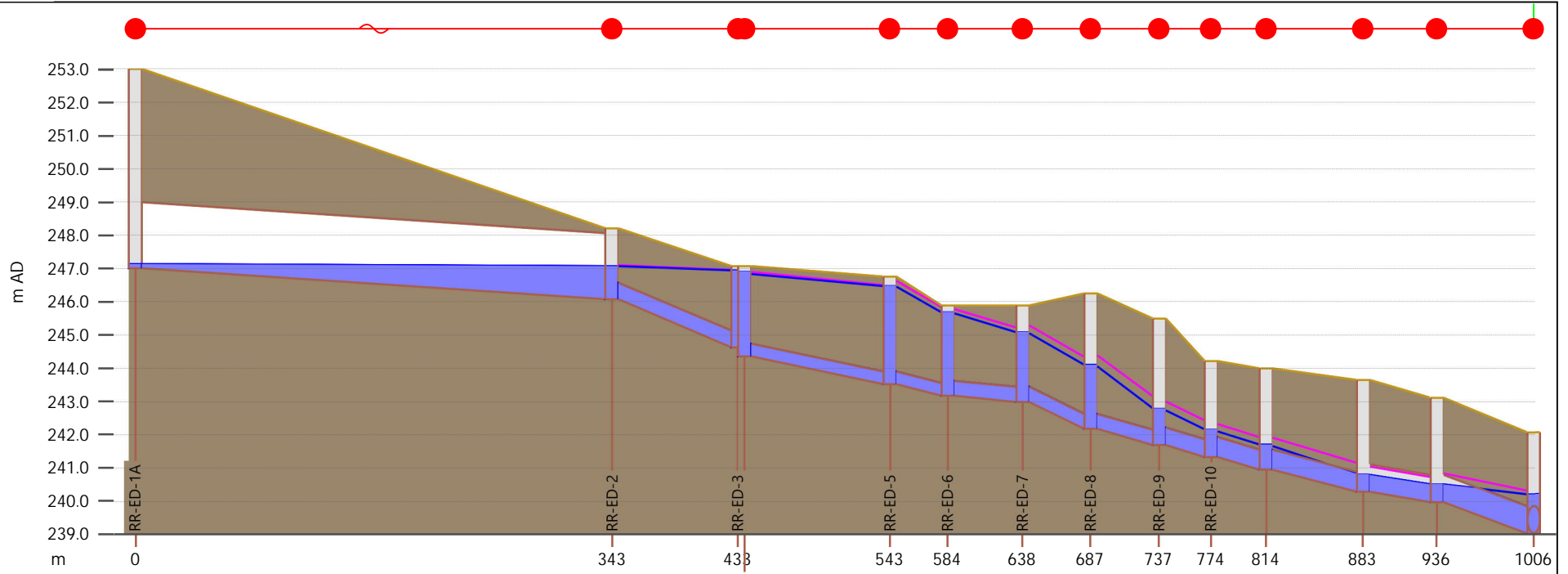


EXISTING CONDITION - 100-YEAR - EAST SIDE PLAN 1

RVA PROJECT NO. 194615

FIGURE NO. 21E

AUGUST 2021



Link	RR-ED-1A.1	RR-ED-2.1	RR-ED-4.1	-	-	-	-	-	-	-	RR-ED-11.1	-	RR-ED-13.1
US node ID	RR-ED-1A	RR-ED-2	RR-ED-4	-	-	RR-ED-6	-	-	-	-	RR-ED-11	-	RR-ED-13
ds node	RR-ED-2	RR-ED-3	RR-ED-5	-	-	RR-ED-7	-	-	-	-	RR-ED-12	-	RR-ED-14
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1
length (m)		90.4	104.4	41.5	53.8	49.0	49.3	37.5	39.6	69.7	53.1	69.9	
Shape ID	East Side Ditch-1	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC
width (mm)		500	375	375	450	450	450	525	600	600	825	825	
height (mm)		500	375	375	450	450	450	525	600	600	825	825	
Rough type		N	N	N	N	N	N	N	N	N	N	N	N
us inv (m AD)	247.000	246.068	244.358	244.358	243.173	242.988	242.176	242.176	241.695	240.956	240.291	239.970	
ds inv (m AD)	246.068	244.622	243.521	243.521	242.988	242.176	241.695	-	-	240.291	239.970	239.030	
grad (m/m)		0.01599	0.00801	0.00801	0.00344	0.01656	0.00977	-	-	0.00954	0.00604	0.01345	
r.pfc (m3/s)	16.699	0.478	0.157	0.161	0.167	0.367	0.282	0.421	0.601	0.600	1.116	1.665	
US depth (m)	0.131	0.995	2.470	2.927	2.482	2.057	1.875	1.038	0.770	0.698	0.506	0.536	
US flow (m3/s)	-0.00007	0.20793	0.22496	-	0.30730	0.38818	0.45608	-	-	0.67106	0.76581	0.84187	
US velocity (m/s)	-0.000	2.266	1.775	2.153	1.742	2.467	2.576	2.326	2.410	2.467	2.271	2.973	
Node	RR-ED-1A	RR-ED-2	-	RR-ED-5	-	-	-	-	-	-	-	-	
Node ID	RR-ED-1A	RR-ED-2	-	RR-ED-5	-	-	-	-	-	-	-	-	
ground (m AD)	253.000	248.200	246.754	246.754	243.650	243.114	240.802	240.514	-	-	-	-	
level (m AD)	247.131	247.069	246.475	246.475	-	-	-	-	-	-	-	-	
expr:Freeboard	5.869446	1.130679	0.279055	0.279055	-	-	-	-	-	-	-	-	

EXISTING CONDITION - 100-YEAR - EAST SIDE PROFILE 1

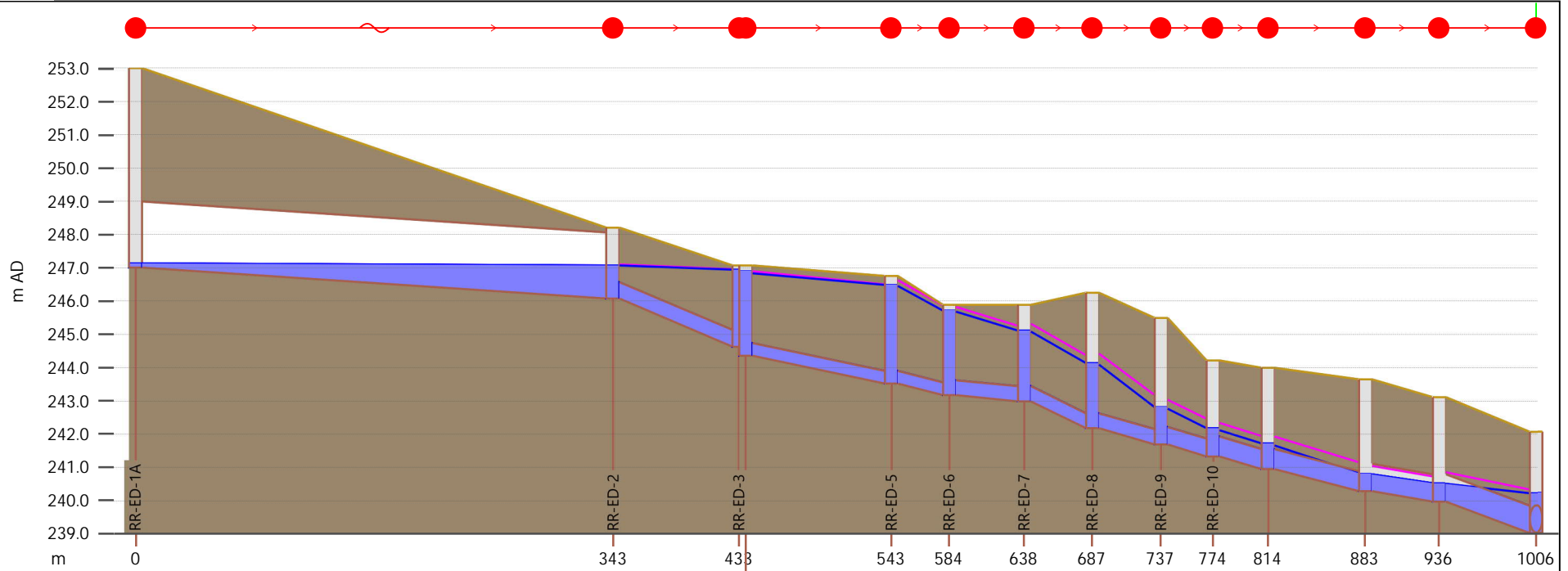


PROPOSED CONDITION - 100-YEAR - EAST SIDE PLAN 1

RVA PROJECT NO. 194615

FIGURE NO. 21G

AUGUST 2021



Link	RR-ED-1A.1	RR-ED-2.1	RR-ED-4.1	-	-	-	-	-	-	-	RR-ED-11.1	-	RR-ED-13.1
US node ID	RR-ED-1A	RR-ED-2	RR-ED-4	-	-	RR-ED-6	-	-	-	-	RR-ED-11	-	RR-ED-13
ds node	RR-ED-2	RR-ED-3	RR-ED-5	-	-	RR-ED-7	-	-	-	-	RR-ED-12	-	RR-ED-14
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1
length (m)		90.4	104.4	41.5	53.8	49.0	49.3	37.5	39.6	69.7	53.1	69.9	
Shape ID	East Side Ditch-1	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC
width (mm)		500	375	375	450	450	450	525	600	600	825	825	
height (mm)		500	375	375	450	450	450	525	600	600	825	825	
Rough type		N	N	N	N	N	N	N	N	N	N	N	
us inv (m AD)	247.000	246.068	244.358	244.358	243.173	242.988	242.176	242.176	241.695	240.956	240.291	239.970	
ds inv (m AD)	246.068	244.622	243.521	243.521	242.988	242.176	241.695	-	-	240.291	239.970	239.030	
grad (m/m)		0.01599	0.00801	0.00801	0.00344	0.01656	0.00977	-	-	0.00954	0.00604	0.01345	
r.pfc (m3/s)	16.699	0.478	0.157	0.161	0.167	0.367	0.282	0.421	0.601	0.600	1.116	1.665	
US depth (m)	0.131	0.996	2.471	2.940	2.515	2.091	1.907	1.066	0.785	0.708	0.509	0.539	
US flow (m3/s)	-0.00006	0.20798	0.22499	-	0.30731	0.38811	0.45729	-	-	0.67827	0.77059	0.84922	
US velocity (m/s)	-0.000	2.269	1.775	2.153	1.742	2.467	2.579	2.331	2.395	2.458	2.274	2.976	
Node	RR-ED-1A	RR-ED-2	-	-	RR-ED-5	-	-	-	-	-	-	-	-
Node ID	RR-ED-1A	RR-ED-2	-	-	RR-ED-5	-	-	-	-	-	-	-	-
ground (m AD)	253.000	248.200	246.754	246.754	246.485	246.485	246.485	246.485	246.485	246.485	246.485	246.485	
level (m AD)	247.131	247.070	246.485	246.485	246.485	246.485	246.485	246.485	246.485	246.485	246.485	246.485	
expr:Freeboard	5.869125	1.129626	0.268633	0.268633	0.268633	0.268633	0.268633	0.268633	0.268633	0.268633	0.268633	0.268633	

PROPOSED CONDITION - 100-YEAR - EAST SIDE PROFILE 1



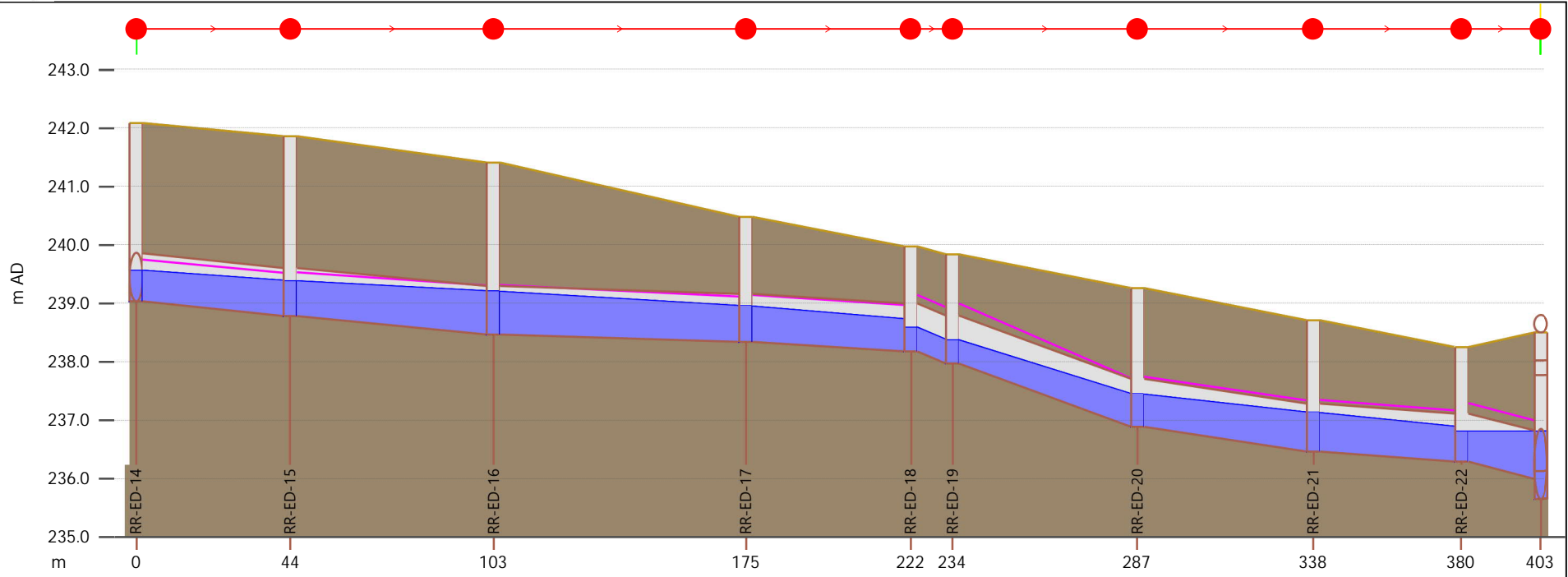
EXISTING CONDITION - 10-YEAR - EAST SIDE PLAN 2

RVA PROJECT NO. 194615

FIGURE NO. 22A

AUGUST 2021





Link	RR-ED-14.1	RR-ED-15.1	RR-ED-16.1	RR-ED-17.1	-	RR-ED-19.1	RR-ED-20.1	RR-ED-21.1	-	
US node ID	RR-ED-14	RR-ED-15	RR-ED-16	RR-ED-17	-	RR-ED-19	RR-ED-20	RR-ED-21	-	
ds node	RR-ED-15	RR-ED-16	RR-ED-17	RR-ED-18	-	RR-ED-20	RR-ED-21	RR-ED-22	-	
numbarrels	1	1	1	1	1	1	1	1	1	
length (m)	44.2	58.4	72.4	47.3	12.0	53.0	50.5	42.5	22.9	
Shape ID	CIRC	CIRC	CIRC	CIRC	-	CIRC	CIRC	CIRC	CIRC	
width (mm)	825	825	825	825	825	825	825	825	825	
height (mm)	825	825	825	825	825	825	825	825	825	
Rough type	N	N	N	N	N	N	N	N	N	
us inv (m AD)	239.030	238.781	238.469	238.336	-	237.970	236.886	236.463	236.293	
ds inv (m AD)	238.781	238.469	238.336	238.175	-	236.886	236.463	236.293	236.000	
grad (m/m)	0.00563	0.00535	0.00184	0.00340	-	0.02044	0.00837	0.00400	0.01282	
r.pfc (m3/s)	1.077	1.050	0.615	0.838	-	2.052	1.314	0.908	1.625	
US depth (m)	0.522	0.592	0.726	0.609	-	0.396	0.549	0.657	0.516	
US flow (m3/s)	0.69766	0.71717	0.75998	0.82651	-	0.89318	0.92671	0.97040	1.04332	
US velocity (m/s)	2.028	1.888	1.563	1.955	-	3.526	2.472	2.125	3.174	
Node	-	RR-ED-15	RR-ED-16	RR-ED-17	RR-ED-18	RR-ED-19	RR-ED-20	RR-ED-21	RR-ED-22	-
Node ID	-	RR-ED-15	RR-ED-16	RR-ED-17	RR-ED-18	RR-ED-19	RR-ED-20	RR-ED-21	RR-ED-22	-
ground (m AD)	-	241.856	241.407	240.476	239.970	239.836	239.262	238.713	238.252	-
level (m AD)	-	239.380	239.204	238.954	238.582	238.367	237.447	237.135	236.809	-
expr:Freeboard	-	2.475830	2.202118	1.521866	1.387787	1.469498	1.815109	1.578278	1.442688	-

EXISTING CONDITION - 10-YEAR - EAST SIDE PROFILE 2



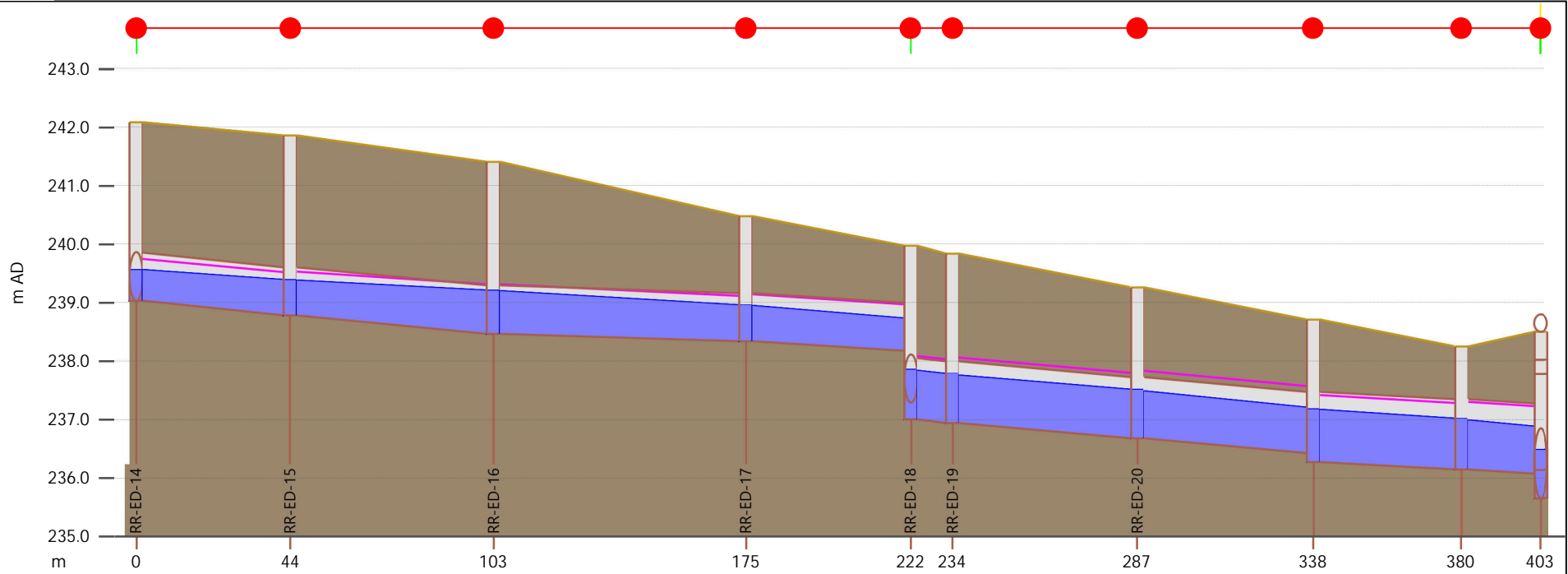
**PROPOSED CONDITION - 10-YEAR - EAST SIDE PLAN 2-1
(PROPOSED STORM SEWERS UNDERNEATH THE PROPOSED SIDEWALK)**

RVA PROJECT NO. 194615

FIGURE NO. 22C-1

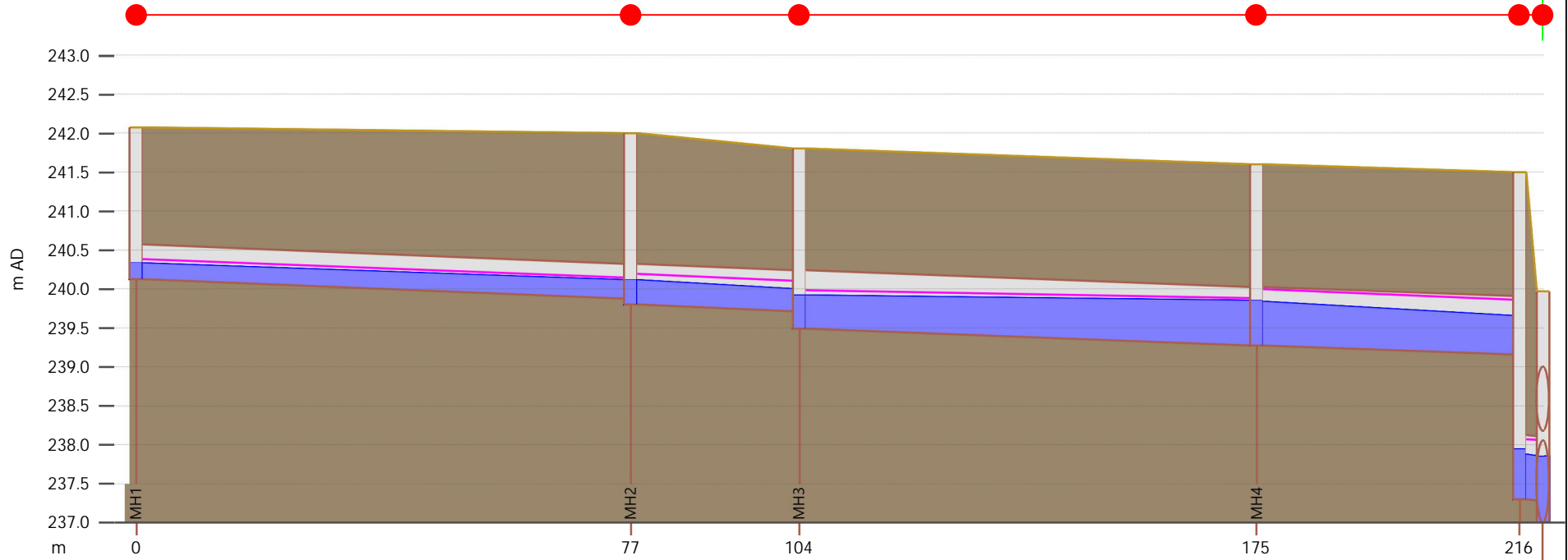
AUGUST 2021





Link	RR-ED-14.1	RR-ED-15.1	RR-ED-16.1	RR-ED-17.1	-	RR-ED-19.1	RR-ED-20.1	-	-	
US node ID	RR-ED-14	RR-ED-15	RR-ED-16	RR-ED-17	-	RR-ED-19	RR-ED-20	-	-	
ds node	RR-ED-15	RR-ED-16	RR-ED-17	RR-ED-18	-	RR-ED-20	STMHRR050-0297	-	-	
numbarrels	1	1	1	1	1	1	1	1	1	
length (m)	44.2	58.4	72.4	47.3	12.0	53.0	50.5	42.5	22.9	
Shape ID	CIRC	CIRC	CIRC	CIRC	-	CIRC	CIRC	CIRC	CIRC	
width (mm)	825	825	825	825	-	1050	1050	1200	1200	
height (mm)	825	825	825	825	-	1050	1050	1200	1200	
Rough type	N	N	N	N	N	N	N	N	N	
us inv (m AD)	239.030	238.781	238.469	238.336	-	236.945	236.680	236.278	236.150	
ds inv (m AD)	238.781	238.469	238.336	238.175	-	236.680	236.428	236.150	236.081	
grad (m/m)	0.00563	0.00535	0.00184	0.00340	-	0.00500	0.00500	0.00300	0.00301	
r.pfc (m3/s)	1.077	1.050	0.615	0.838	-	1.930	1.931	2.136	2.138	
US depth (m)	0.525	0.595	0.729	0.610	-	0.814	0.808	0.889	0.836	
US flow (m3/s)	0.70310	0.72099	0.76354	0.82912	-	1.75231	1.85792	2.02508	2.10251	
US velocity (m/s)	2.035	1.888	1.565	1.956	-	2.451	2.605	2.258	2.499	
Node	-	RR-ED-15	RR-ED-16	RR-ED-17	RR-ED-18	RR-ED-19	RR-ED-20	STMHRR050-0297	-	-
Node ID	-	RR-ED-15	RR-ED-16	RR-ED-17	RR-ED-18	RR-ED-19	RR-ED-20	STMHRR050-0297	-	-
ground (m AD)	-	241.856	241.407	240.476	239.970	239.836	239.262	238.713	238.252	-
level (m AD)	-	239.383	239.207	238.956	237.852	237.782	237.509	237.180	237.016	-
expr:Freeboard	-	2.473404	2.199310	1.520294	2.118073	2.053696	1.752762	1.533129	1.235505	-

PROPOSED CONDITION - 100-YEAR - EAST SIDE PROFILE 2



Link	MH1.1	MH2.1	MH3.1	MH4.1	-
US node ID	MH1	MH2	MH3	MH4	-
ds node	MH2	MH3	MH4	MH5	-
numbarrels	1	1	1	1	1
length (m)	77.3	26.3	71.5	41.1	-
Shape ID	CIRC	CIRC	CIRC	CIRC	-
width (mm)	450	525	750	750	-
height (mm)	450	525	750	750	-
Rough type	N	N	N	N	N
us inv (m AD)	240.125	239.800	239.493	239.275	-
ds inv (m AD)	239.875	239.718	239.275	239.159	-
grad (m/m)	0.00323	0.00314	0.00305	0.00283	-
r.pfc (m3/s)	0.162	0.241	0.615	0.592	-
US depth (m)	0.206	0.311	0.425	0.563	-
US flow (m3/s)	0.07100	0.17348	0.29497	0.63094	-
US velocity (m/s)	0.998	1.314	1.257	1.775	-
Node	MH1	MH2	MH3	MH4	MH5
Node ID	MH1	MH2	MH3	MH4	MH5
ground (m AD)	242.075	242.000	241.800	241.600	241.500
level (m AD)	240.331	240.113	239.919	239.850	237.942
expr:Freeboard	1.743594	1.886948	1.880811	1.750391	3.558243

PROPOSED CONDITION - 10-YEAR - EAST SIDE PROFILE 2



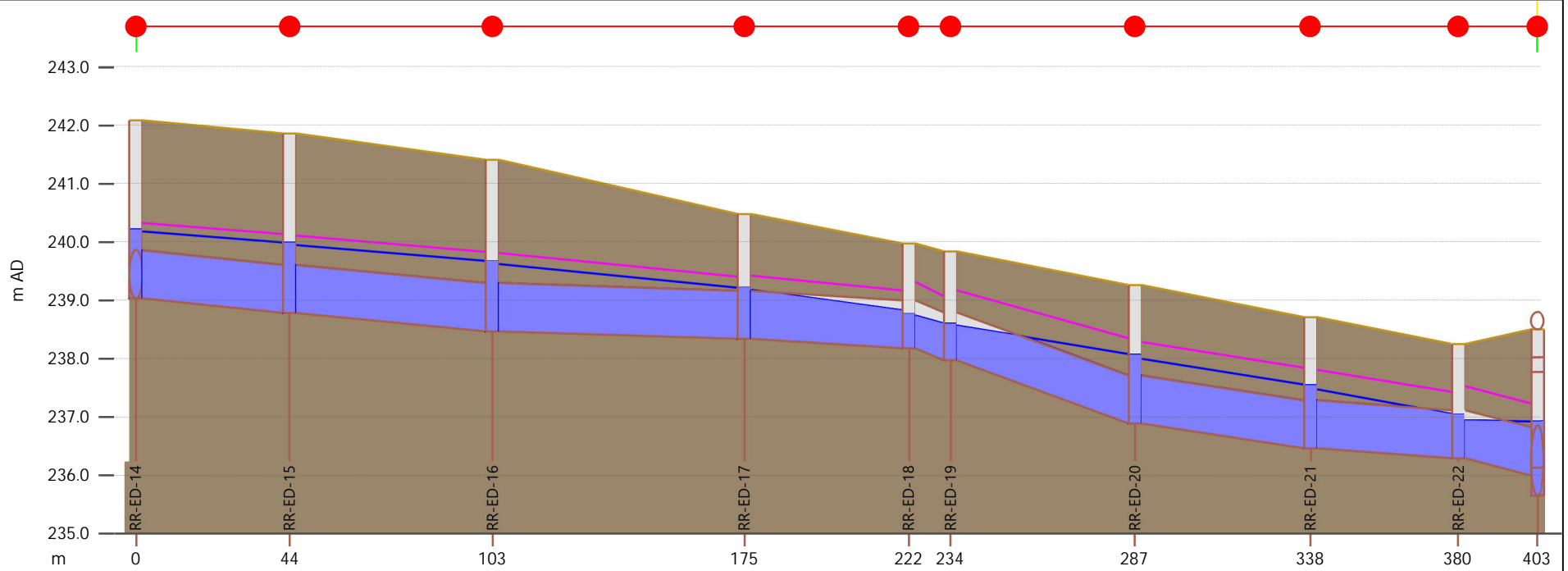
EXISTING CONDITION - 100-YEAR - EAST SIDE PLAN 2

RVA PROJECT NO. 194615

FIGURE NO. 22E

AUGUST 2021





Link	RR-ED-14.1	RR-ED-15.1	RR-ED-16.1	RR-ED-17.1	-	RR-ED-19.1	RR-ED-20.1	RR-ED-21.1	-	
US node ID	RR-ED-14	RR-ED-15	RR-ED-16	RR-ED-17	-	RR-ED-19	RR-ED-20	RR-ED-21	-	
ds node	RR-ED-15	RR-ED-16	RR-ED-17	RR-ED-18	-	RR-ED-20	RR-ED-21	RR-ED-22	-	
numbarrels	1	1	1	1	1	1	1	1	1	
length (m)	44.2	58.4	72.4	47.3	12.0	53.0	50.5	42.5	22.9	
Shape ID	CIRC	CIRC	CIRC	CIRC	-	CIRC	CIRC	CIRC	CIRC	
width (mm)	825	825	825	825	825	825	825	825	825	
height (mm)	825	825	825	825	825	825	825	825	825	
Rough type	N	N	N	N	N	N	N	N	N	
us inv (m AD)	239.030	238.781	238.469	238.336	-	237.970	236.886	236.463	236.293	
ds inv (m AD)	238.781	238.469	238.336	238.175	-	236.886	236.463	236.293	236.000	
grad (m/m)	0.00563	0.00535	0.00184	0.00340	-	0.02044	0.00837	0.00400	0.01282	
r.pfc (m3/s)	1.077	1.050	0.615	0.838	-	2.052	1.314	0.908	1.625	
US depth (m)	1.149	1.166	1.153	0.846	-	0.597	1.111	1.015	0.649	
US flow (m3/s)	0.93390	0.98049	1.06543	1.17392	-	1.28624	1.33600	1.40962	1.52962	
US velocity (m/s)	2.097	1.933	1.907	2.157	-	3.784	2.550	2.534	3.388	
Node	-	RR-ED-15	RR-ED-16	RR-ED-17	RR-ED-18	RR-ED-19	RR-ED-20	RR-ED-21	RR-ED-22	-
Node ID	-	RR-ED-15	RR-ED-16	RR-ED-17	RR-ED-18	RR-ED-19	RR-ED-20	RR-ED-21	RR-ED-22	-
ground (m AD)	-	241.856	241.407	240.476	239.970	239.836	239.262	238.713	238.252	-
level (m AD)	-	239.986	239.668	239.212	238.766	238.601	238.073	237.550	237.046	-
expr:Freeboard	-	1.869934	1.738785	1.264511	1.204330	1.234634	1.189056	1.163681	1.205948	-

EXISTING CONDITION - 100-YEAR - EAST SIDE PROFILE 2



PROPOSED CONDITION - 100-YEAR - EAST SIDE PLAN 2

RVA PROJECT NO. 194615

FIGURE NO. 22G

AUGUST 2021





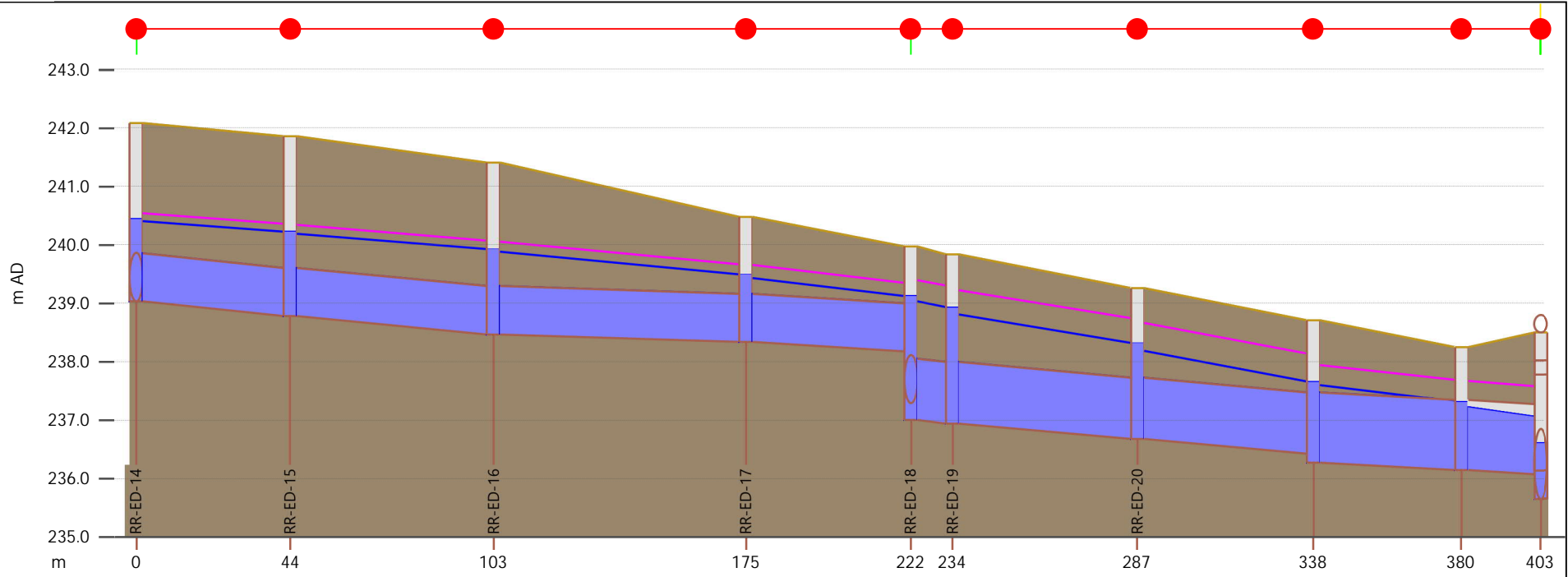
**PROPOSED CONDITION - 100-YEAR - EAST SIDE PLAN 2-1
(PROPOSED STORM SEWERS UNDERNEATH THE PROPOSED SIDEWALK)**

RVA PROJECT NO. 194615

FIGURE NO. 22G-1

AUGUST 2021

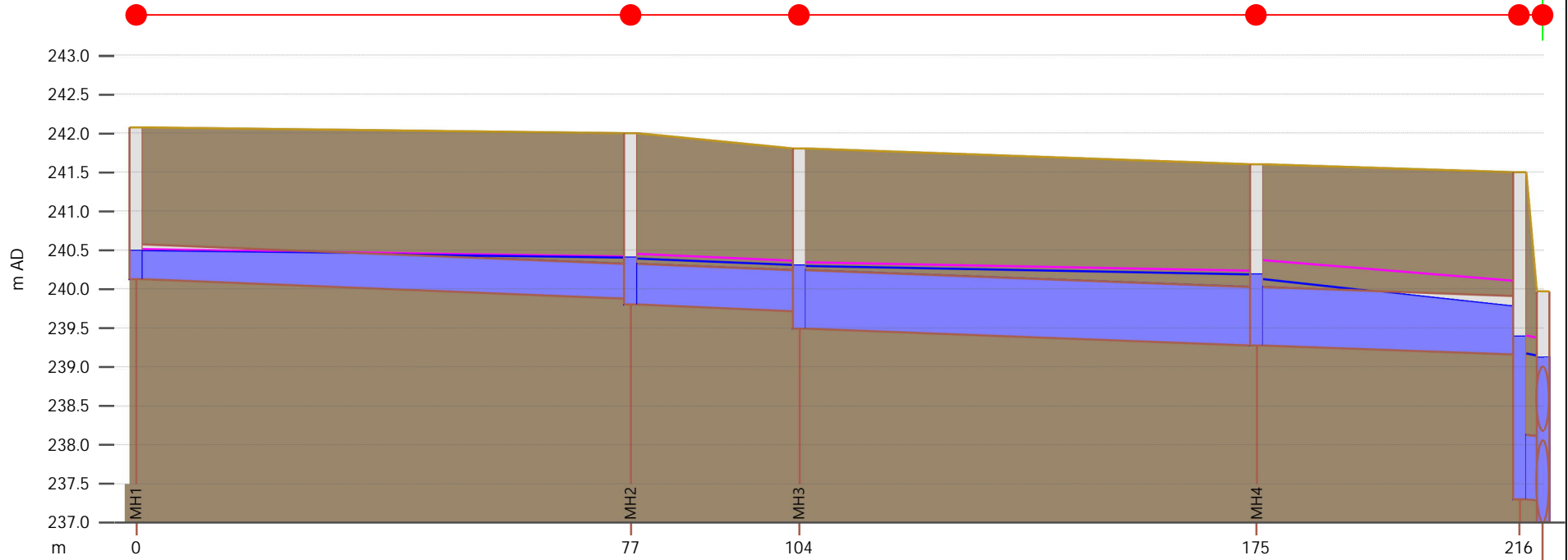




Link	RR-ED-14.1	RR-ED-15.1	RR-ED-16.1	RR-ED-17.1	-	RR-ED-19.1	RR-ED-20.1	-	-	
US node ID	RR-ED-14	RR-ED-15	RR-ED-16	RR-ED-17	-	RR-ED-19	RR-ED-20	-	-	
ds node	RR-ED-15	RR-ED-16	RR-ED-17	RR-ED-18	-	RR-ED-20	STMHRR050-0297	-	-	
numbarrels	1	1	1	1	1	1	1	1	1	
length (m)	44.2	58.4	72.4	47.3	12.0	53.0	50.5	42.5	22.9	
Shape ID	CIRC	CIRC	CIRC	CIRC	-	CIRC	CIRC	CIRC	CIRC	
width (mm)	825	825	825	825	-	1050	1050	1200	1200	
height (mm)	825	825	825	825	-	1050	1050	1200	1200	
Rough type	N	N	N	N	N	N	N	N	N	
us inv (m AD)	239.030	238.781	238.469	238.336	-	236.945	236.680	236.278	236.150	
ds inv (m AD)	238.781	238.469	238.336	238.175	-	236.680	236.428	236.150	236.081	
grad (m/m)	0.00563	0.00535	0.00184	0.00340	-	0.00500	0.00500	0.00300	0.00301	
r.pfc (m3/s)	1.077	1.050	0.615	0.838	-	1.930	1.931	2.136	2.138	
US depth (m)	1.377	1.407	1.411	1.099	-	1.863	1.503	1.321	1.077	
US flow (m3/s)	0.94631	0.98974	1.06399	1.16673	-	2.60443	2.77007	3.03042	3.15791	
US velocity (m/s)	2.097	1.939	1.902	2.105	-	2.852	3.059	2.587	2.951	
Node	-	RR-ED-15	RR-ED-16	RR-ED-17	RR-ED-18	RR-ED-19	RR-ED-20	STMHRR050-0297	-	-
Node ID	-	RR-ED-15	RR-ED-16	RR-ED-17	RR-ED-18	RR-ED-19	RR-ED-20	STMHRR050-0297	-	-
ground (m AD)	-	241.856	241.407	240.476	239.970	239.836	239.262	238.713	238.252	-
level (m AD)	-	240.222	239.920	239.486	239.122	238.925	238.312	237.654	237.317	-
expr:Freeboard	-	1.634048	1.486557	0.989929	0.848343	0.910767	0.950241	1.059283	0.934800	-

PROPOSED CONDITION - 100-YEAR - EAST SIDE PROFILE 2





Link		MH1.1	MH2.1	MH3.1	MH4.1	-
US node ID		MH1	MH2	MH3	MH4	-
ds node		MH2	MH3	MH4	MH5	-
numbarrels		1	1	1	1	1
length (m)		77.3	26.3	71.5	41.1	-
Shape ID		CIRC	CIRC	CIRC	CIRC	-
width (mm)		450	525	750	750	-
height (mm)		450	525	750	750	-
Rough type		N	N	N	N	N
us inv (m AD)		240.125	239.800	239.493	239.275	-
ds inv (m AD)		239.875	239.718	239.275	239.159	-
grad (m/m)		0.00323	0.00314	0.00305	0.00283	-
r.pfc (m3/s)		0.162	0.241	0.615	0.592	-
US depth (m)		0.362	0.590	0.805	0.855	-
US flow (m3/s)		0.11038	0.25868	0.43096	0.99206	-
US velocity (m/s)		1.103	1.467	1.315	2.163	-
Node	MH1		MH2	MH3	MH4	MH5
Node ID	MH1		MH2	MH3	MH4	MH5
ground (m AD)	242.075		242.000	241.800	241.600	241.500
level (m AD)	240.489		240.403	240.306	240.189	239.388
expr:Freeboard	1.586230		1.597244	1.494412	1.411050	2.111649

**PROPOSED CONDITION - 100-YEAR - EAST SIDE PROFILE 2
(PROPOSED STORM SEWER UNDERNEATH THE PROPOSED SIDEWALK)**

RVA PROJECT NO. 194615

FIGURE NO. 22H-1

AUGUST 2021





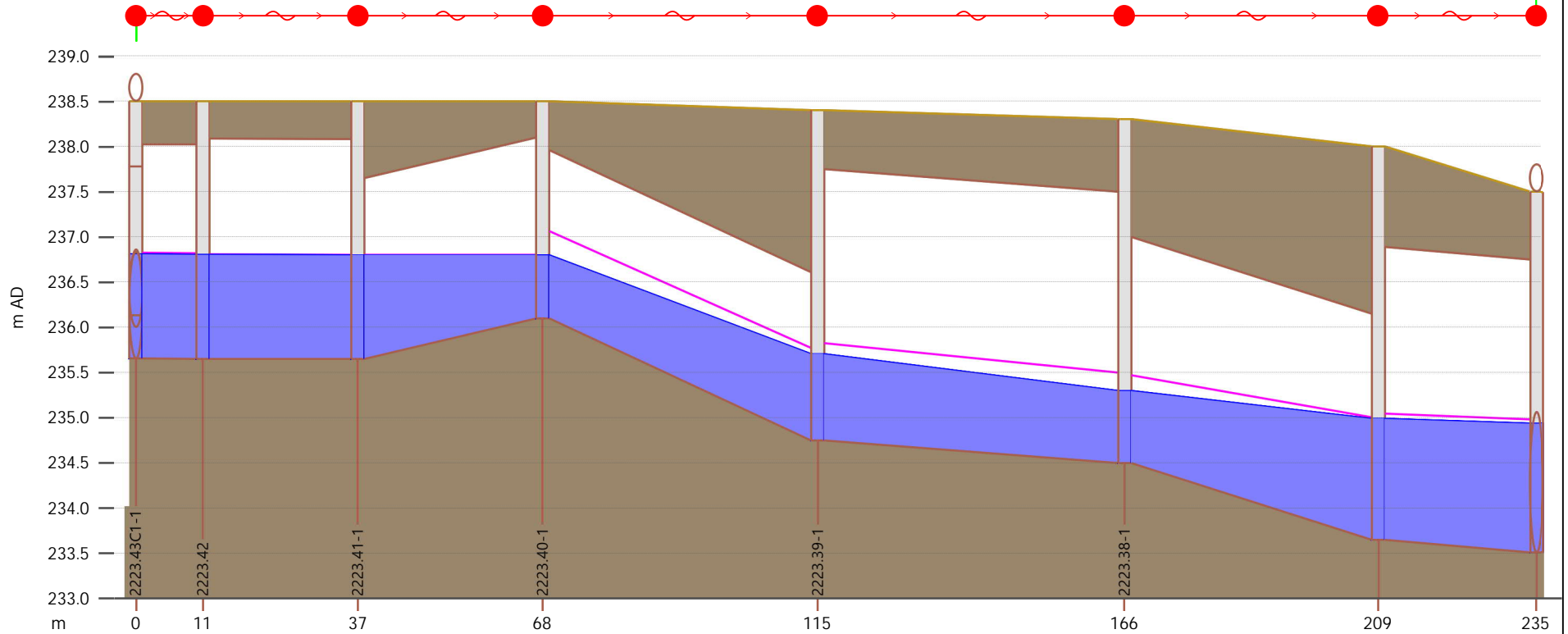
EXISTING CONDITION - 10-YEAR - EAST SIDE PLAN 3

RVA PROJECT NO. 194615

FIGURE NO. 23A

AUGUST 2021





Link	-	2223.42.1	2223.41-1.1	2223.40-1.1	2223.39-1.1	2223.38-1.1	2223.37-1.1	
US node ID	-	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	
ds node	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	2223.37-2	
numbarrels	1	1	1	1	1	1	1	
Length (m)	11.3	26.0	31.0	46.2	51.6	42.6	26.6	
Shape ID	-	Matrix-2223.42	Matrix-2223.41	Matrix-2223.40	Matrix-2223.39	Matrix-2223.38	Matrix-2223.37	
us inv (m AD)	235.653	235.652	235.651	236.100	234.750	234.500	233.650	
ds inv (m AD)	235.652	235.651	236.100	234.750	234.500	233.650	233.510	
grad (m/m)								
US depth (m)	1.156	1.149	1.147	0.698	0.951	0.798	1.337	
US flow (m3/s)	5.10639	5.10639	5.10639	5.10639	5.10639	5.10639	5.47638	
US velocity (m/s)	0.530	0.263	0.190	2.287	1.560	1.892	1.215	
r.pfc (m3/s)	20.564	18.000	-285.884	121.664	112.156	176.862	97.931	
Node	-	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	-
Node ID	-	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	-
ground (m AD)	-	238.500	238.500	238.500	238.400	238.300	238.000	237.500
level (m AD)	-	236.801	236.798	236.798	235.701	235.298	234.987	234.934
expr:Freeboard	-	1.698776	1.701767	1.701782	2.698630	3.001843	3.012772	-

EXISTING CONDITION - 10-YEAR - EAST SIDE PROFILE 3



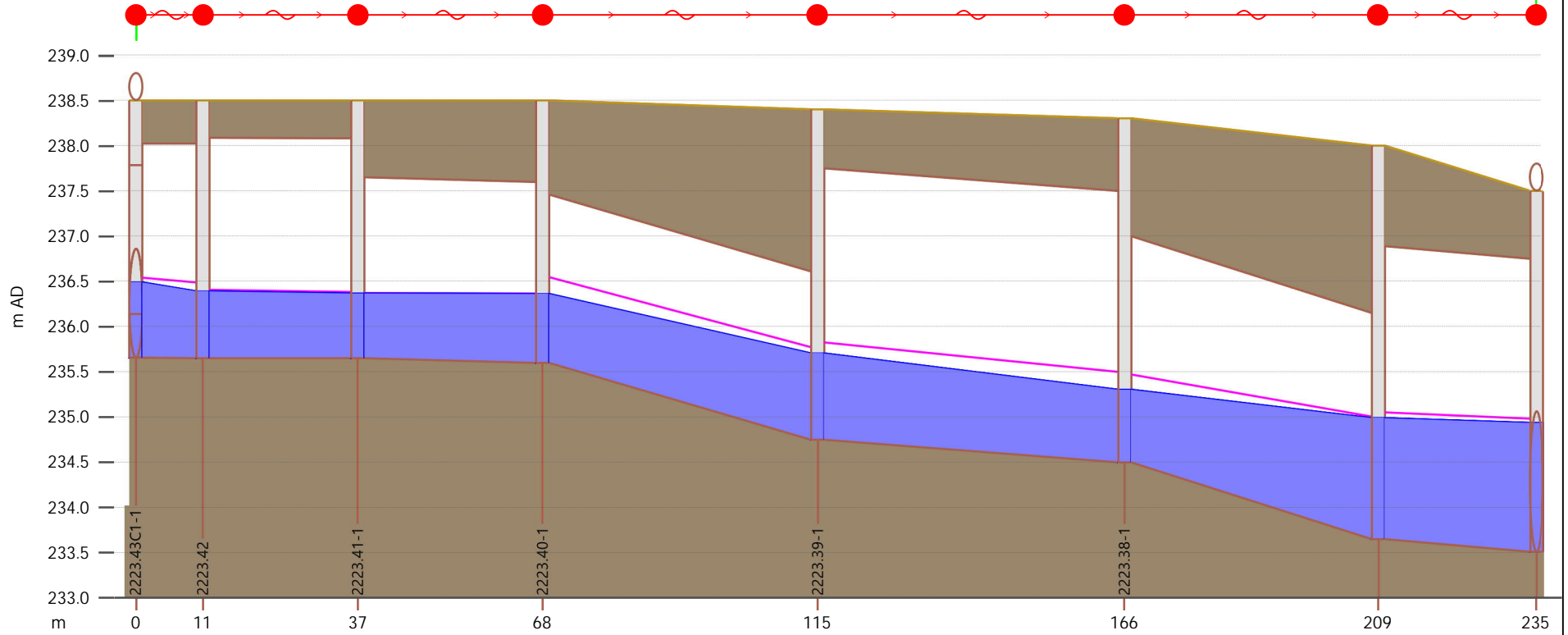
PROPOSED CONDITION - 10-YEAR - EAST SIDE PLAN 3

RVA PROJECT NO. 194615

FIGURE NO. 23C

AUGUST 2021





Link	-	2223.42.1	2223.41-1.1	2223.40-1.1	2223.39-1.1	2223.38-1.1	2223.37-1.1	
US node ID	-	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	
ds node	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	2223.37-2	
numbarrels	1	1	1	1	1	1	1	
Length (m)	11.3	26.0	31.0	46.2	51.6	42.6	26.6	
Shape ID	-	Matrix-2223.42	Matrix-2223.41	Matrix-2223.40	Matrix-2223.39	Matrix-2223.38	Matrix-2223.37	
us inv (m AD)	235.653	235.652	235.651	235.600	234.750	234.500	233.650	
ds inv (m AD)	235.652	235.651	235.600	234.750	234.500	233.650	233.510	
grad (m/m)								
US depth (m)	0.833	0.738	0.715	0.759	0.952	0.798	1.338	
US flow (m3/s)	5.10871	5.10871	5.10871	5.10871	5.10871	5.11123	5.47871	
US velocity (m/s)	1.042	0.510	0.332	1.923	1.561	1.914	1.210	
r.pfc (m3/s)	20.564	18.000	96.350	96.539	112.156	176.862	97.931	
Node	-	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	-
Node ID	-	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	-
ground (m AD)	-	238.500	238.500	238.500	238.400	238.300	238.000	237.500
level (m AD)	-	236.390	236.366	236.359	235.702	235.298	234.988	234.934
expr:Freeboard	-	2.109528	2.133652	2.140930	2.698401	3.001614	3.012329	-

PROPOSED CONDITION - 10-YEAR - EAST SIDE PROFILE 3

RVA PROJECT NO. 194615

FIGURE NO. 23D

AUGUST 2021





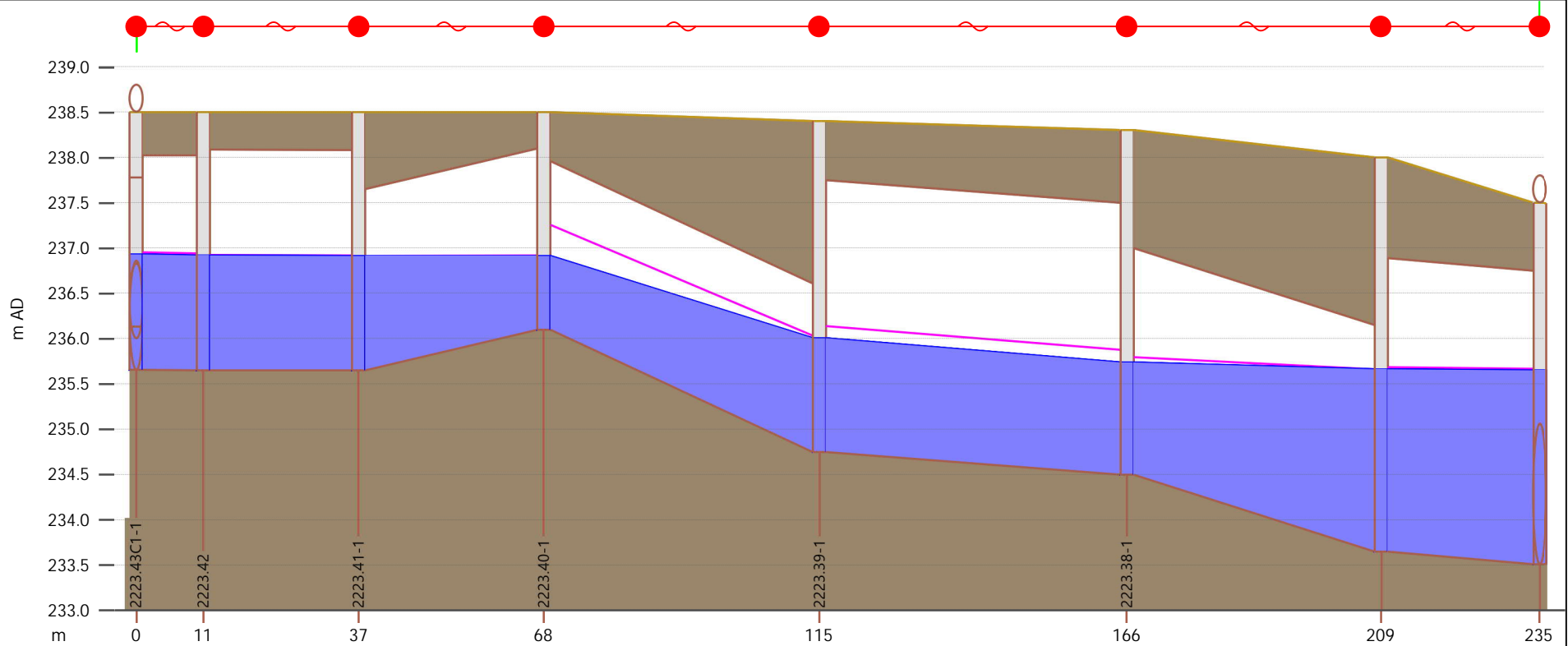
EXISTING CONDITION - 100-YEAR - EAST SIDE PLAN 3

RVA PROJECT NO. 194615

FIGURE NO. 23E

AUGUST 2021





Link	-	2223.42.1	2223.41-1.1	2223.40-1.1	2223.39-1.1	2223.38-1.1	2223.37-1.1	
US node ID	-	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	
ds node	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	2223.37-2	
numbarrels	1	1	1	1	1	1	1	
Length (m)	11.3	26.0	31.0	46.2	51.6	42.6	26.6	
Shape ID	-	Matrix-2223.42	Matrix-2223.41	Matrix-2223.40	Matrix-2223.39	Matrix-2223.38	Matrix-2223.37	
us inv (m AD)	235.653	235.652	235.651	236.100	234.750	234.500	233.650	
ds inv (m AD)	235.652	235.651	236.100	234.750	234.500	233.650	233.510	
grad (m/m)								
US depth (m)	1.274	1.263	1.260	0.810	1.255	1.238	2.012	
US flow (m3/s)	7.89588	7.89588	7.89588	7.89588	7.89588	7.90018	8.48585	
US velocity (m/s)	0.682	0.355	0.258	2.595	1.729	1.953	1.254	
r.pfc (m3/s)	20.564	18.000	-285.884	121.664	112.156	176.862	97.931	
Node	-	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	-
Node ID	-	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	-
ground (m AD)	-	238.500	238.500	238.500	238.400	238.300	238.000	237.500
level (m AD)	-	236.915	236.911	236.910	236.005	235.738	235.662	235.651
expr:Freeboard	-	1.584549	1.589371	1.590057	2.395361	2.562253	2.338242	-

EXISTING CONDITION - 100-YEAR - EAST SIDE PROFILE 3



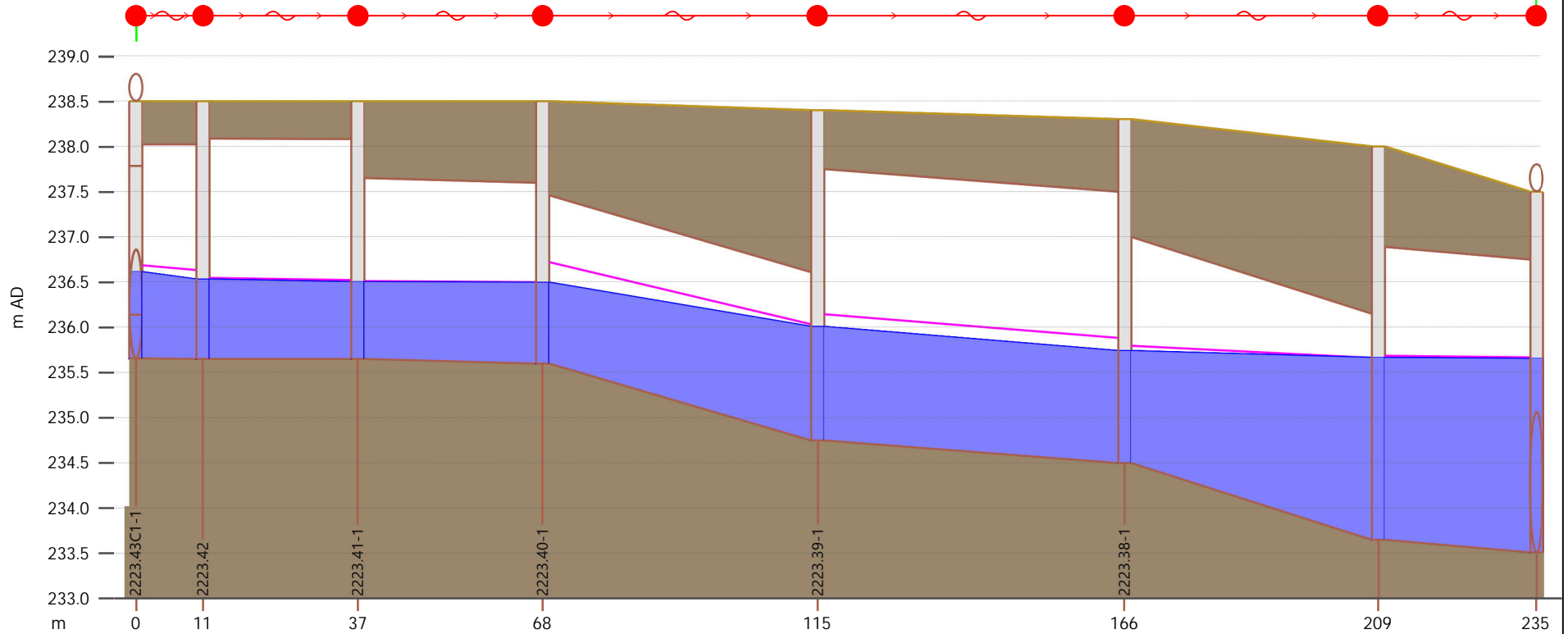
PROPOSED CONDITION - 100-YEAR - EAST SIDE PLAN 3

RVA PROJECT NO. 194615

FIGURE NO. 23G

AUGUST 2021





Link	-	2223.42.1	2223.41-1.1	2223.40-1.1	2223.39-1.1	2223.38-1.1	2223.37-1.1	
US node ID	-	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	
ds node	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	2223.37-2	
numbarrels	1	1	1	1	1	1	1	
Length (m)	11.3	26.0	31.0	46.2	51.6	42.6	26.6	
Shape ID	-	Matrix-2223.42	Matrix-2223.41	Matrix-2223.40	Matrix-2223.39	Matrix-2223.38	Matrix-2223.37	
us inv (m AD)	235.653	235.652	235.651	235.600	234.750	234.500	233.650	
ds inv (m AD)	235.652	235.651	235.600	234.750	234.500	233.650	233.510	
grad (m/m)								
US depth (m)	0.957	0.874	0.849	0.890	1.255	1.238	2.012	
US flow (m3/s)	7.89915	7.89915	7.89914	7.89912	7.89930	7.90986	8.48899	
US velocity (m/s)	1.195	0.608	0.427	2.134	1.692	1.890	1.230	
r.pfc (m3/s)	20.564	18.000	96.350	96.539	112.156	176.862	97.931	
Node	-	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	-
Node ID	-	2223.42	2223.41-1	2223.40-1	2223.39-1	2223.38-1	2223.37-1	-
ground (m AD)	-	238.500	238.500	238.500	238.400	238.300	238.000	237.500
level (m AD)	-	236.526	236.500	236.490	236.005	235.738	235.662	235.651
expr:Freeboard	-	1.974167	2.000488	2.009644	2.395010	2.561703	2.337555	-

PROPOSED CONDITION - 100-YEAR - EAST SIDE PROFILE 3



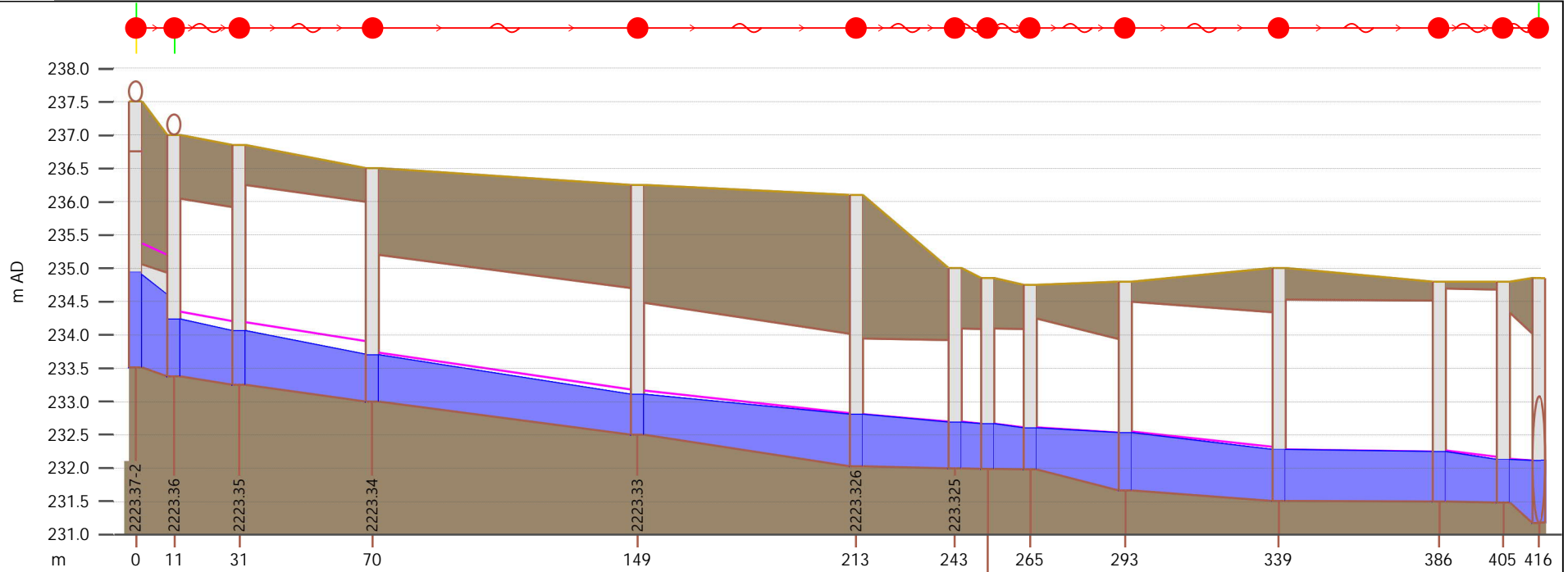
EXISTING CONDITION - 10-YEAR - EAST SIDE PLAN 4

RVA PROJECT NO. 194615

FIGURE NO. 24A

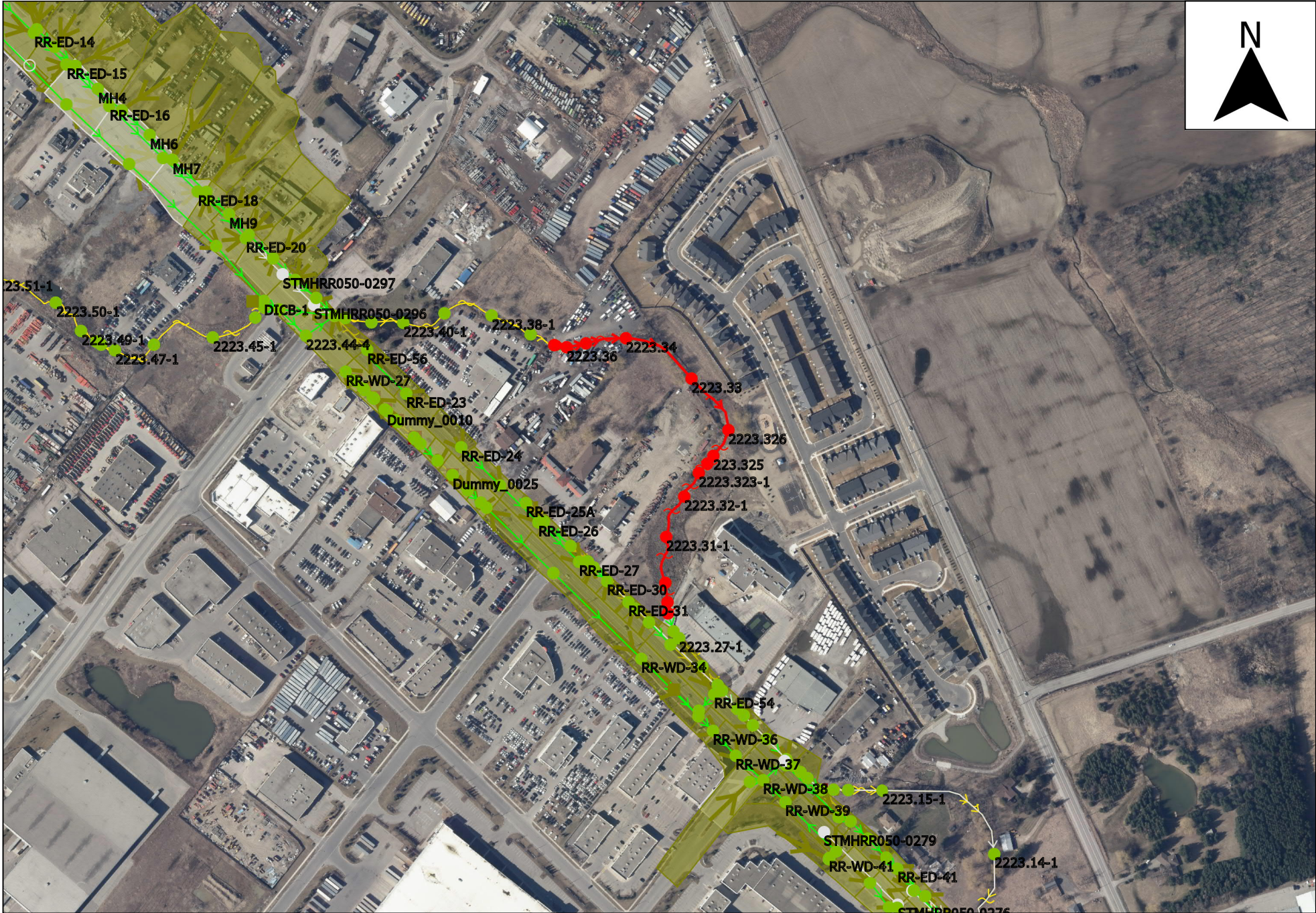
AUGUST 2021





Link	-	-	2223.35.1	2223.34.1	2223.33.1	2223.326.1	-	-	-	2223.32-1.1	2223.31-1.1	-	-
US node ID	-	-	2223.35	2223.34	2223.33	2223.326	-	-	2223.323-1	2223.32-1	2223.31-1	-	-
ds node	-	-	2223.34	2223.33	2223.326	223.325	-	-	2223.32-1	2223.31-1	2223.30-1	-	-
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1
length (m)	11.4	-	-	-	-	-	-	-	-	-	-	-	-
Shape ID	-	-	Matrix-2223.35	Matrix-2223.34	Matrix-2223.33	-	-	-	-	Matrix-2223.32	Matrix-2223.31	-	-
width (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-
height (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-
Rough type	N	-	-	-	-	-	-	-	-	-	-	-	-
us inv (m AD)	-	-	233.250	233.000	232.500	232.031	-	-	231.984	231.670	231.511	-	-
ds inv (m AD)	-	-	233.000	232.500	232.031	232.000	-	-	231.670	231.511	231.500	-	-
grad (m/m)	-	-	-	-	-	-	-	-	-	-	-	-	-
r.pfc (m3/s)	-	-	353.527	169.587	107.007	45.047	-	-	186.614	143.820	82.012	-	-
US depth (m)	-	0.847	0.810	0.695	0.606	0.773	-	-	0.611	0.856	0.762	0.744	-
US flow (m3/s)	-	-	5.47638	5.47638	5.47638	5.47638	-	-	5.47637	5.47637	5.47637	-	-
US velocity (m/s)	-	1.567	1.589	0.921	1.108	0.561	-	-	0.669	0.823	0.405	0.683	-
Node	-	2223.35	2223.34	2223.33	2223.326	-	-	-	2223.32-1	2223.31-1	2223.30-1	-	-
Node ID	-	2223.35	2223.34	2223.33	2223.326	-	-	-	2223.32-1	2223.31-1	2223.30-1	-	-
ground (m AD)	-	236.850	236.500	236.250	236.100	-	-	-	234.800	235.000	234.800	-	-
level (m AD)	-	234.060	233.695	233.106	232.804	-	-	-	232.526	232.273	232.244	-	-
expr:Freeboard	-	2.790430	2.804886	3.144180	3.296091	-	-	-	2.273755	2.726898	2.555920	-	-

EXISTING CONDITION - 10-YEAR - EAST SIDE PROFILE 4



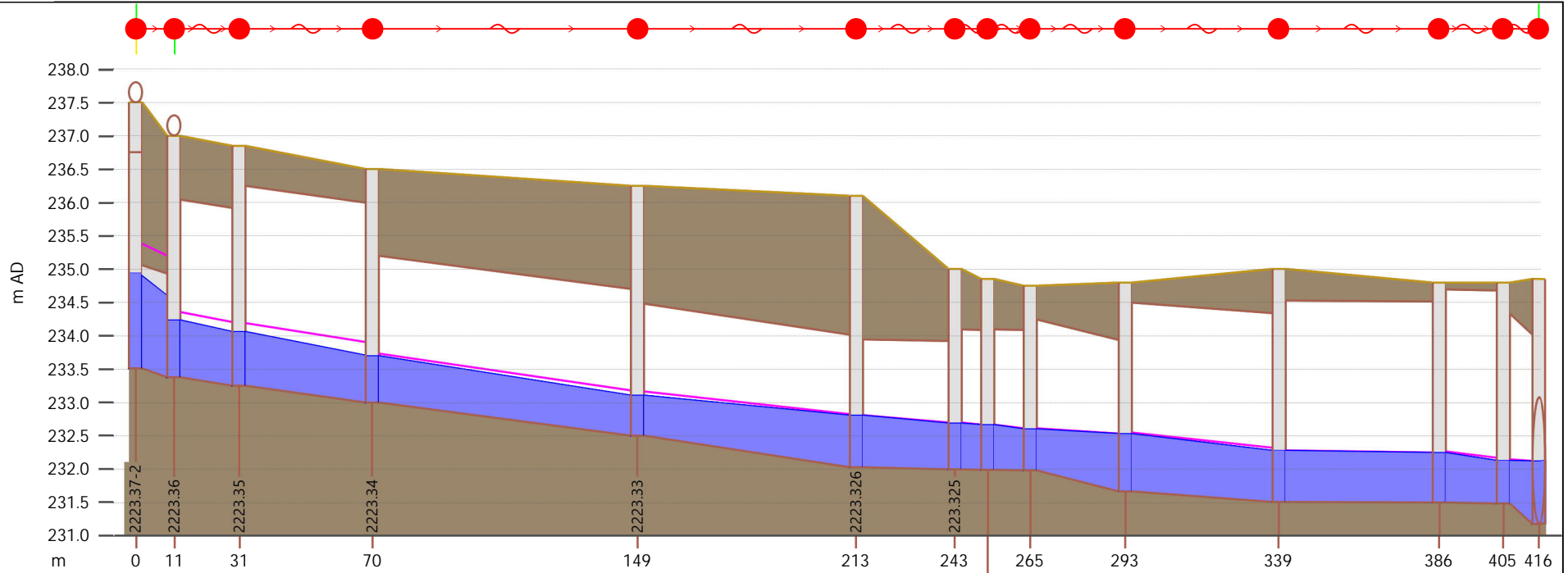
PROPOSED CONDITION - 10-YEAR - EAST SIDE PLAN 4

RVA PROJECT NO. 194615

FIGURE NO. 24C

AUGUST 2021



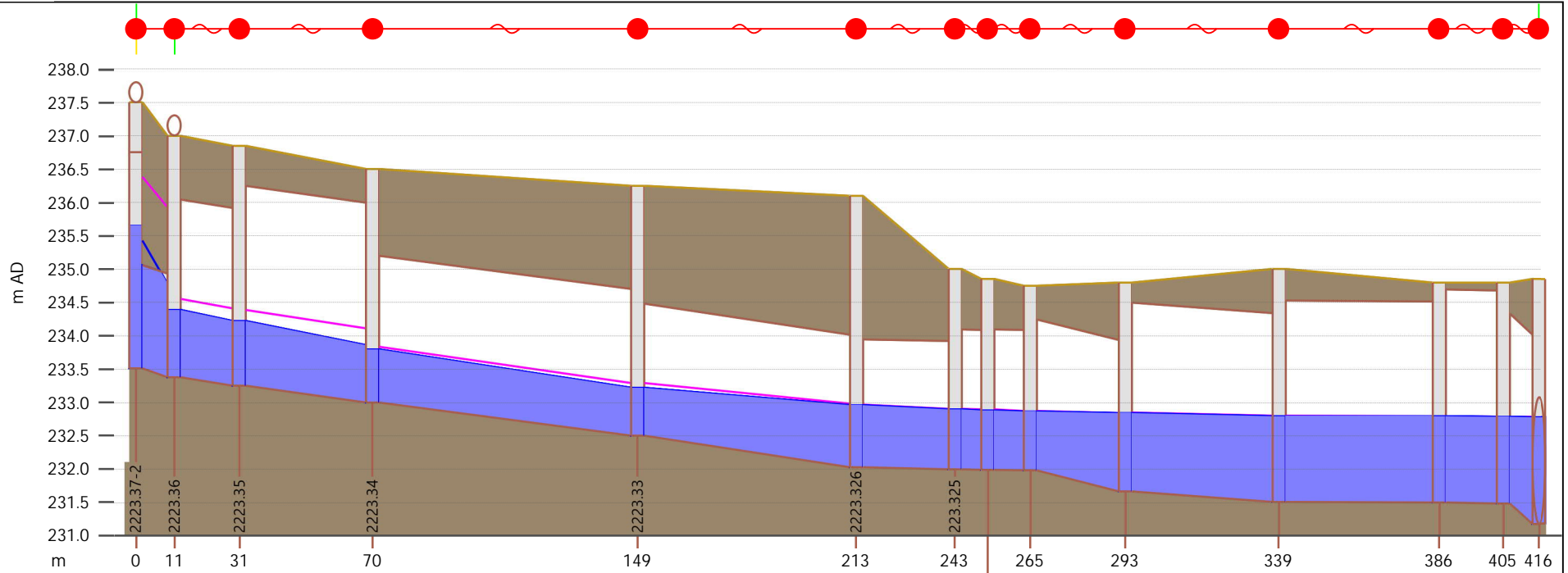


Link	-	-	2223.35.1	2223.34.1	2223.33.1	2223.326.1	-	-	-	2223.32-1.1	2223.31-1.1	-	-
US node ID	-	-	2223.35	2223.34	2223.33	2223.326	-	-	2223.323-1	2223.32-1	2223.31-1	-	-
ds node	-	-	2223.34	2223.33	2223.326	223.325	-	-	2223.32-1	2223.31-1	2223.30-1	-	-
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1
length (m)	11.4	-	-	-	-	-	-	-	-	-	-	-	-
Shape ID	-	-	Matrix-2223.35	Matrix-2223.34	Matrix-2223.33	-	-	-	-	Matrix-2223.32	Matrix-2223.31	-	-
width (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-
height (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-
Rough type	N	-	-	-	-	-	-	-	-	-	-	-	-
us inv (m AD)	-	-	233.250	233.000	232.500	232.031	-	-	231.984	231.670	231.511	-	-
ds inv (m AD)	-	-	233.000	232.500	232.031	232.000	-	-	231.670	231.511	231.500	-	-
grad (m/m)	-	-	-	-	-	-	-	-	-	-	-	-	-
r.pfc (m3/s)	-	-	353.527	169.587	107.007	45.047	-	-	186.614	143.820	82.012	-	-
US depth (m)	-	0.847	0.810	0.695	0.606	0.773	-	-	0.611	0.857	0.764	0.746	-
US flow (m3/s)	-	-	5.47871	5.47871	5.47871	5.47871	-	-	5.47871	5.47871	5.47871	-	-
US velocity (m/s)	-	1.567	1.589	0.906	1.108	0.545	-	-	0.656	0.880	0.398	0.676	-
Node	-	2223.35	2223.34	2223.33	2223.326	-	-	-	2223.32-1	2223.31-1	2223.30-1	-	-
Node ID	-	2223.35	2223.34	2223.33	2223.326	-	-	-	2223.32-1	2223.31-1	2223.30-1	-	-
ground (m AD)	-	236.850	236.500	236.250	236.100	-	-	-	234.800	235.000	234.800	-	-
level (m AD)	-	234.060	233.695	233.106	232.804	-	-	-	232.527	232.275	232.246	-	-
expr:Freeboard	-	2.790292	2.804794	3.144073	3.295984	-	-	-	2.273450	2.725113	2.553815	-	-

PROPOSED CONDITION - 10-YEAR - EAST SIDE PROFILE 4

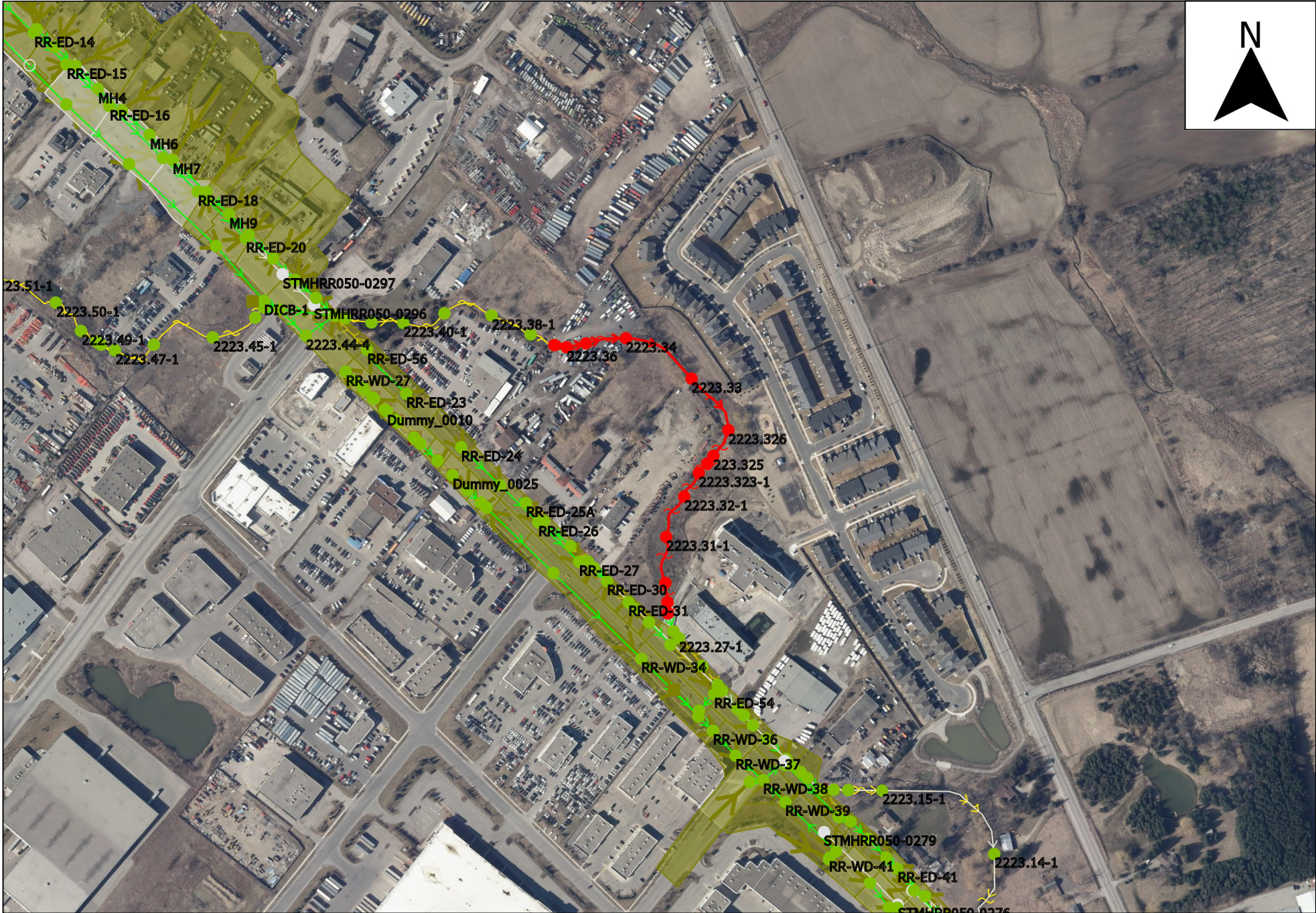


EXISTING CONDITION - 100-YEAR - EAST SIDE PLAN 4



Link	-	-	2223.35.1	2223.34.1	2223.33.1	2223.326.1	-	-	-	2223.32-1.1	2223.31-1.1	-	-
US node ID	-	-	2223.35	2223.34	2223.33	2223.326	-	-	2223.323-1	2223.32-1	2223.31-1	-	-
ds node	-	-	2223.34	2223.33	2223.326	223.325	-	-	2223.32-1	2223.31-1	2223.30-1	-	-
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1
length (m)	11.4	-	-	-	-	-	-	-	-	-	-	-	-
Shape ID	-	-	Matrix-2223.35	Matrix-2223.34	Matrix-2223.33	-	-	-	-	Matrix-2223.32	Matrix-2223.31	-	-
width (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-
height (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-
Rough type	N	-	-	-	-	-	-	-	-	-	-	-	-
us inv (m AD)	-	-	233.250	233.000	232.500	232.031	-	-	231.984	231.670	231.511	-	-
ds inv (m AD)	-	-	233.000	232.500	232.031	232.000	-	-	231.670	231.511	231.500	-	-
grad (m/m)	-	-	-	-	-	-	-	-	-	-	-	-	-
r.pfc (m3/s)	-	-	353.527	169.587	107.007	45.047	-	-	186.614	143.820	82.012	-	-
US depth (m)	-	1.006	0.976	0.794	0.723	0.931	-	-	0.880	1.172	1.288	1.293	-
US flow (m3/s)	-	-	8.48585	8.48585	8.48561	8.48527	-	-	8.48405	8.48317	8.48173	-	-
US velocity (m/s)	-	1.816	1.799	0.926	1.214	0.569	-	-	0.706	0.838	0.449	0.702	-
Node	-	2223.35	2223.34	2223.33	2223.326	-	-	-	2223.32-1	2223.31-1	2223.30-1	-	-
Node ID	-	2223.35	2223.34	2223.33	2223.326	-	-	-	2223.32-1	2223.31-1	2223.30-1	-	-
ground (m AD)	-	236.850	236.500	236.250	236.100	-	-	-	234.800	235.000	234.800	-	-
level (m AD)	-	234.226	233.794	233.223	232.962	-	-	-	232.842	232.799	232.793	-	-
expr:Freeboard	-	2.624338	2.706421	3.027313	3.138071	-	-	-	1.958127	2.200592	2.006512	-	-

EXISTING CONDITION - 100-YEAR - EAST SIDE PROFILE 4



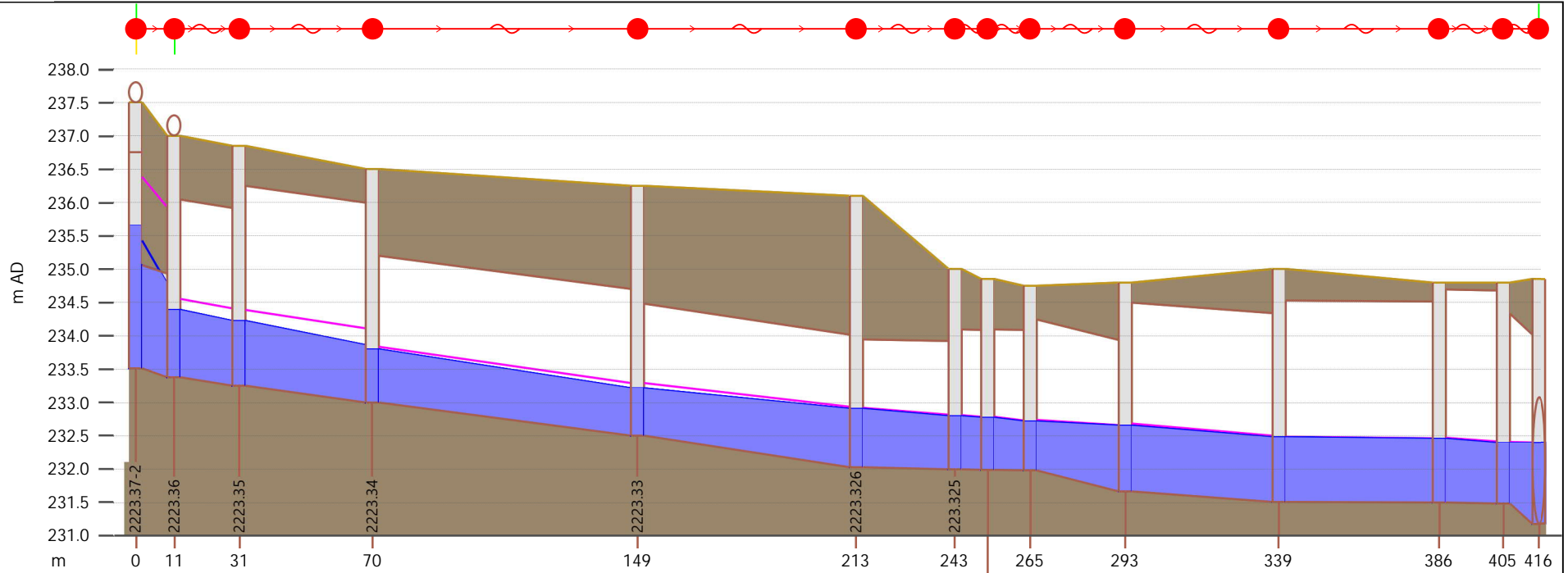
PROPOSED CONDITION - 100-YEAR - EAST SIDE PLAN 4

RVA PROJECT NO. 194615

FIGURE NO. 24G

AUGUST 2021





Link	-	-	2223.35.1	2223.34.1	2223.33.1	2223.326.1	-	-	-	2223.32-1.1	2223.31-1.1	-	-
US node ID	-	-	2223.35	2223.34	2223.33	2223.326	-	-	2223.323-1	2223.32-1	2223.31-1	-	-
ds node	-	-	2223.34	2223.33	2223.326	223.325	-	-	2223.32-1	2223.31-1	2223.30-1	-	-
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1
length (m)	11.4	-	-	-	-	-	-	-	-	-	-	-	-
Shape ID	-	-	Matrix-2223.35	Matrix-2223.34	Matrix-2223.33	-	-	-	-	Matrix-2223.32	Matrix-2223.31	-	-
width (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-
height (mm)	-	-	-	-	-	-	-	-	-	-	-	-	-
Rough type	N	-	-	-	-	-	-	-	-	-	-	-	-
us inv (m AD)	-	-	233.250	233.000	232.500	232.031	-	-	231.984	231.670	231.511	-	-
ds inv (m AD)	-	-	233.000	232.500	232.031	232.000	-	-	231.670	231.511	231.500	-	-
grad (m/m)	-	-	-	-	-	-	-	-	-	-	-	-	-
r.pfc (m3/s)	-	-	353.527	169.587	107.007	45.047	-	-	186.614	143.820	82.012	-	-
US depth (m)	-	1.006	0.976	0.793	0.714	0.876	-	-	0.734	0.986	0.965	0.954	-
US flow (m3/s)	-	-	8.48899	8.48899	8.48899	8.48899	-	-	8.48898	8.48898	8.48897	-	-
US velocity (m/s)	-	1.817	1.799	0.950	1.215	0.574	-	-	0.700	0.905	0.423	0.688	-
Node	-	2223.35	2223.34	2223.33	2223.326	-	-	-	2223.32-1	2223.31-1	2223.30-1	-	-
Node ID	-	2223.35	2223.34	2223.33	2223.326	-	-	-	2223.32-1	2223.31-1	2223.30-1	-	-
ground (m AD)	-	236.850	236.500	236.250	236.100	-	-	-	234.800	235.000	234.800	-	-
level (m AD)	-	234.226	233.793	233.214	232.907	-	-	-	232.656	232.476	232.454	-	-
expr:Freeboard	-	2.624185	2.706543	3.035660	3.192880	-	-	-	2.143826	2.523590	2.345822	-	-

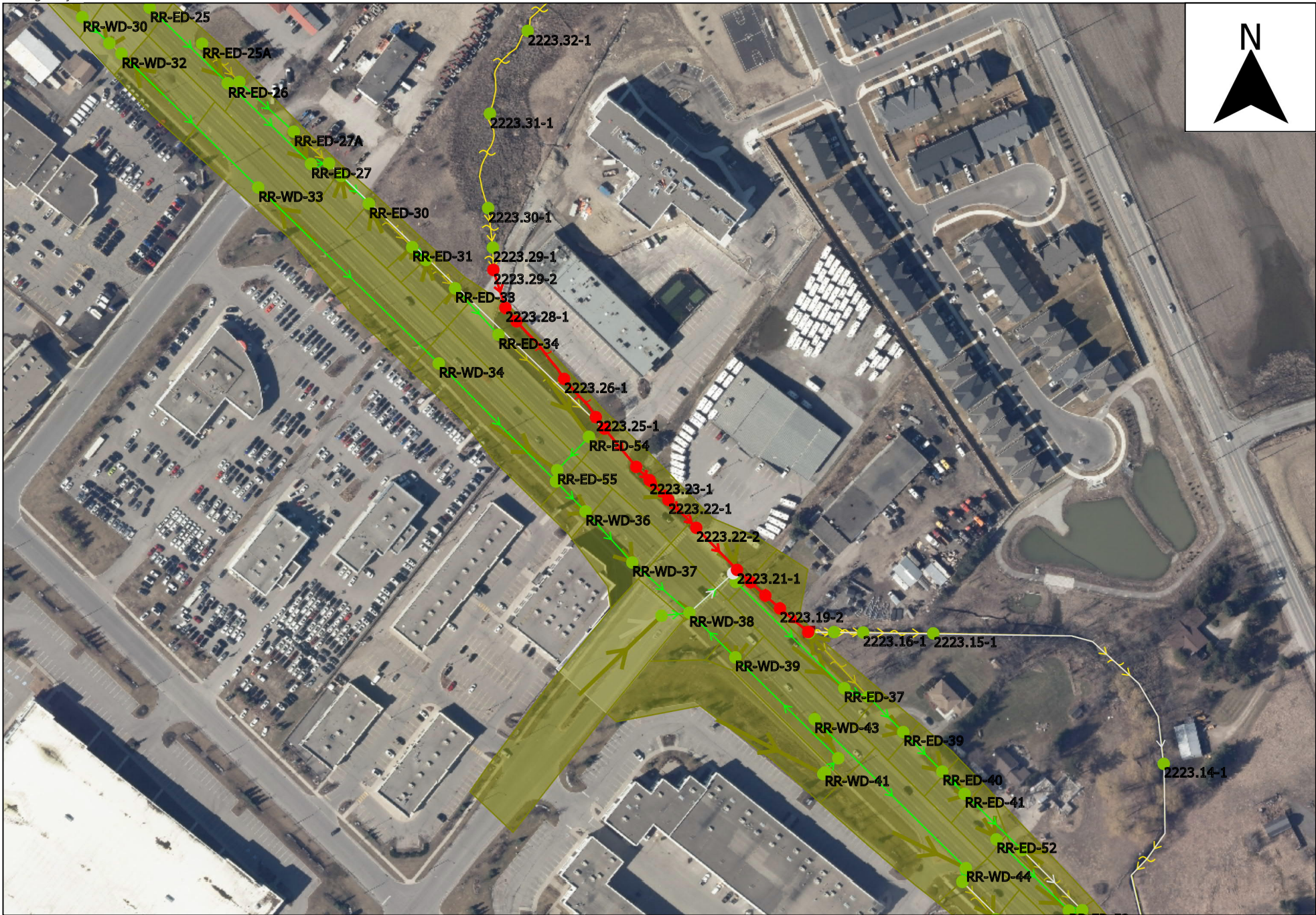
PROPOSED CONDITION - 100-YEAR - EAST SIDE PROFILE 4

RVA PROJECT NO. 194615

FIGURE NO. 24H

AUGUST 2021





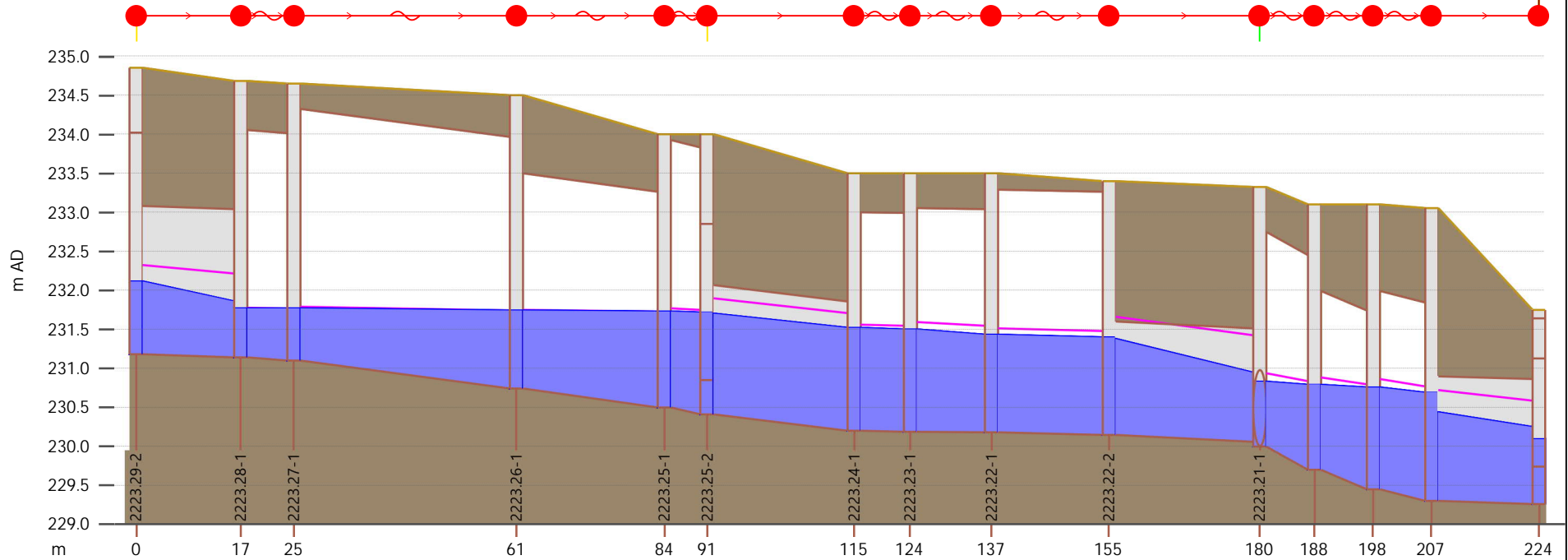
EXISTING CONDITION - 10-YEAR - EAST SIDE PLAN 5

RVA PROJECT NO. 194615

FIGURE NO. 25A

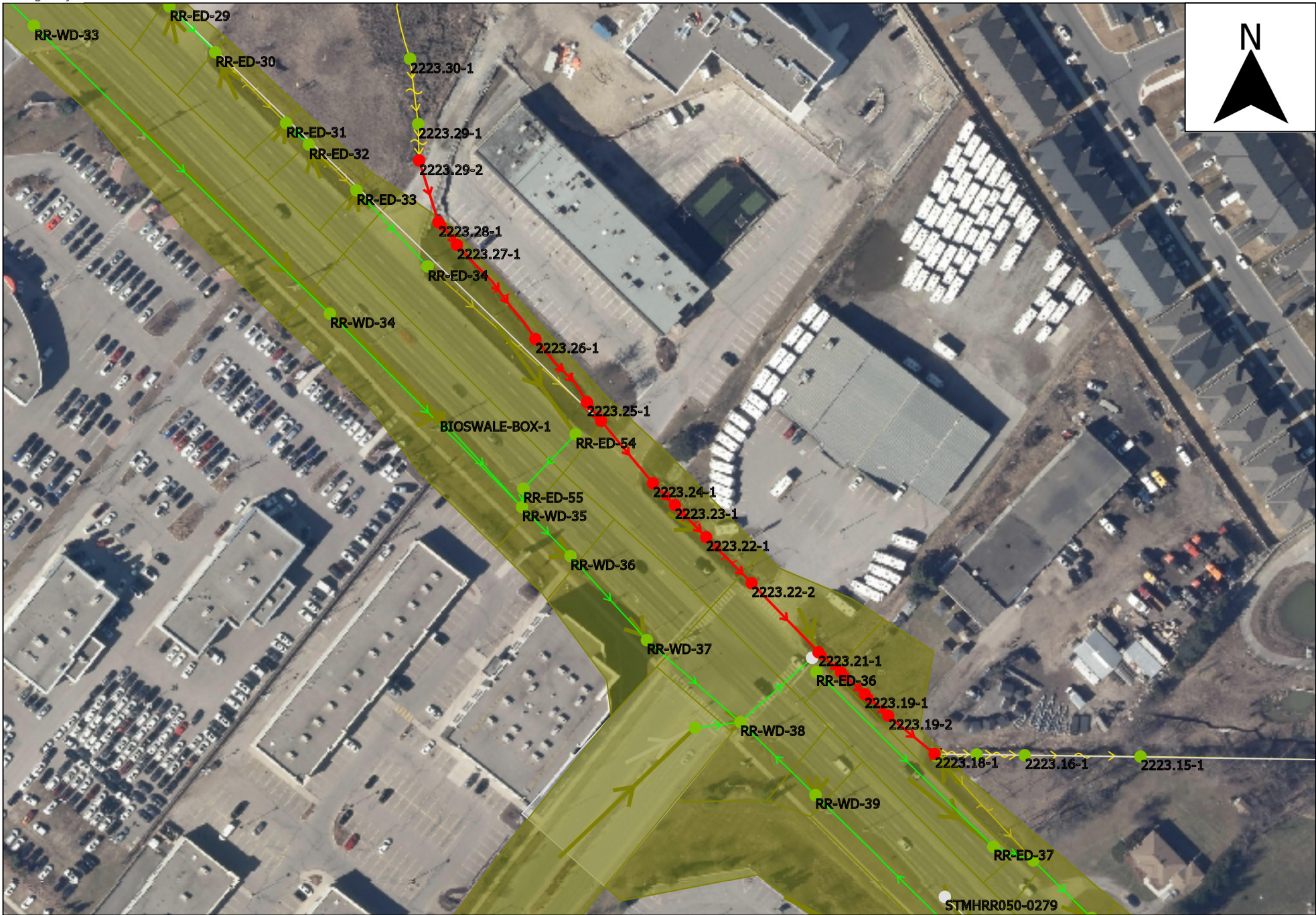
AUGUST 2021





Link	2223.29-2.1	-	2223.27-1.1	2223.26-1.1	-	2223.25-2.1	-	-	2223.22-1.1	2223.22-2.1	-	-	-	2223.19-2.1	
US node ID	2223.29-2	-	2223.27-1	2223.26-1	-	2223.25-2	-	-	2223.22-1	2223.22-2	-	-	-	2223.19-2	
ds node	2223.28-1	-	2223.26-1	2223.25-1	-	2223.24-1	-	-	2223.22-2	2223.21-1	-	-	-	2223.18-1	
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
length (m)	16.7	-	-	-	-	23.5	-	-	-	24.1	-	-	-	17.2	
Shape ID	ARCH	-	Matrix-2223.27	Matrix-2223.26	-	ARCH	-	-	-	ARCH	-	-	-	ARCH	
width (mm)	2900	-	-	-	-	2260	-	-	-	2060	-	-	-	2270	
height (mm)	1900	-	-	-	-	1660	-	-	-	1450	-	-	-	1600	
Rough type	N	-	-	-	-	N	-	-	-	N	-	-	-	N	
us inv (m AD)	231.178	-	231.102	230.740	-	230.408	-	230.190	230.180	230.150	-	-	-	229.300	
ds inv (m AD)	231.142	-	230.740	230.500	-	230.200	-	230.180	230.150	230.060	-	-	-	229.260	
grad (m/m)	0.00215	-	-	-	-	0.00886	-	-	-	0.00374	-	-	-	0.00233	
r.pfc (m3/s)	5.052	-	1393.814	756.882	-	6.393	-	59.339	196.425	3.020	-	-	-	3.093	
US depth (m)	0.934	0.628	0.667	0.999	-	1.294	1.318	1.309	1.253	1.229	0.827	1.091	1.308	1.138	
US flow (m3/s)	5.47636	-	5.47625	5.47619	-	5.47401	-	5.47401	5.47401	5.47401	-	-	-	5.84407	
US velocity (m/s)	2.041	0.271	0.810	1.204	-	1.967	0.958	1.369	1.267	2.339	1.611	1.529	1.588	2.349	
Node	-	-	2223.27-1	2223.26-1	-	-	2223.24-1	-	2223.22-1	2223.22-2	2223.21-1	-	-	-	-
Node ID	-	-	2223.27-1	2223.26-1	-	-	2223.24-1	-	2223.22-1	2223.22-2	2223.21-1	-	-	-	-
ground (m AD)	-	-	234.650	234.500	234.000	234.000	233.500	-	233.500	233.400	233.320	-	-	233.050	-
level (m AD)	-	-	231.769	231.739	231.728	231.714	231.518	-	231.433	231.400	230.827	-	-	230.691	-
expr:Freeboard	-	-	2.880591	2.760895	2.272049	2.286270	1.982422	-	2.067093	2.000342	2.492592	-	-	-	-

EXISTING CONDITION - 10-YEAR - EAST SIDE PROFILE 5



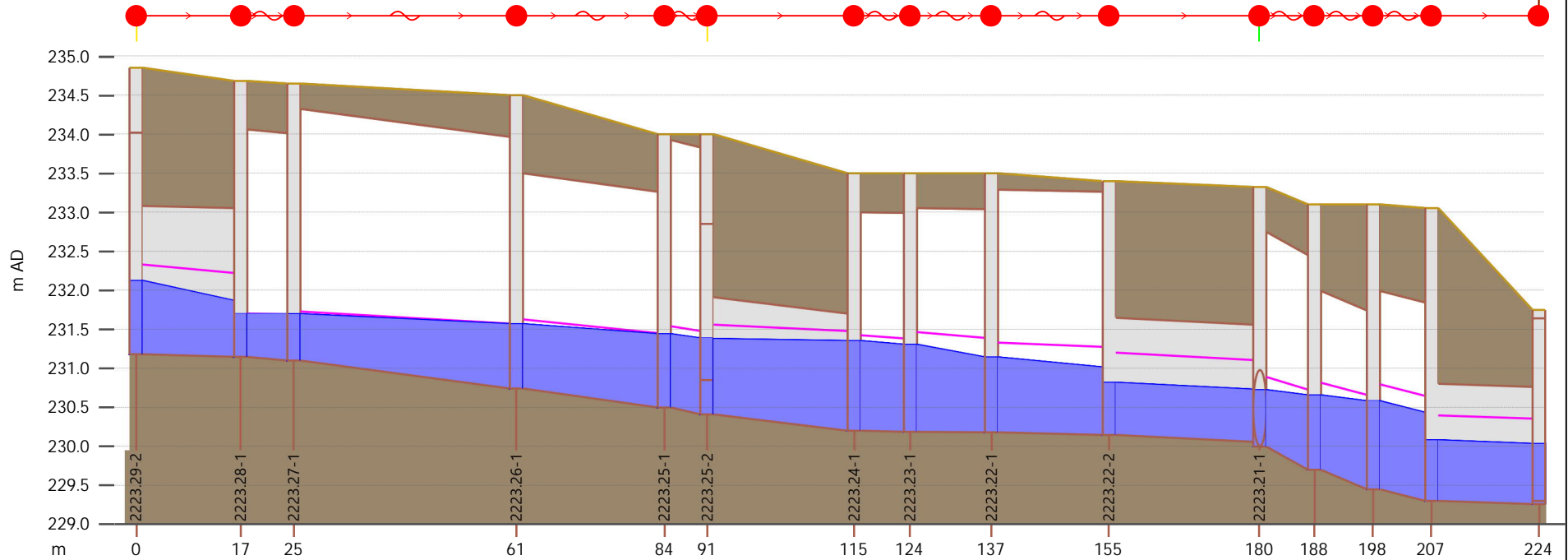
PROPOSED CONDITION - 10-YEAR - EAST SIDE PLAN 5

RVA PROJECT NO. 194615

FIGURE NO. 25C

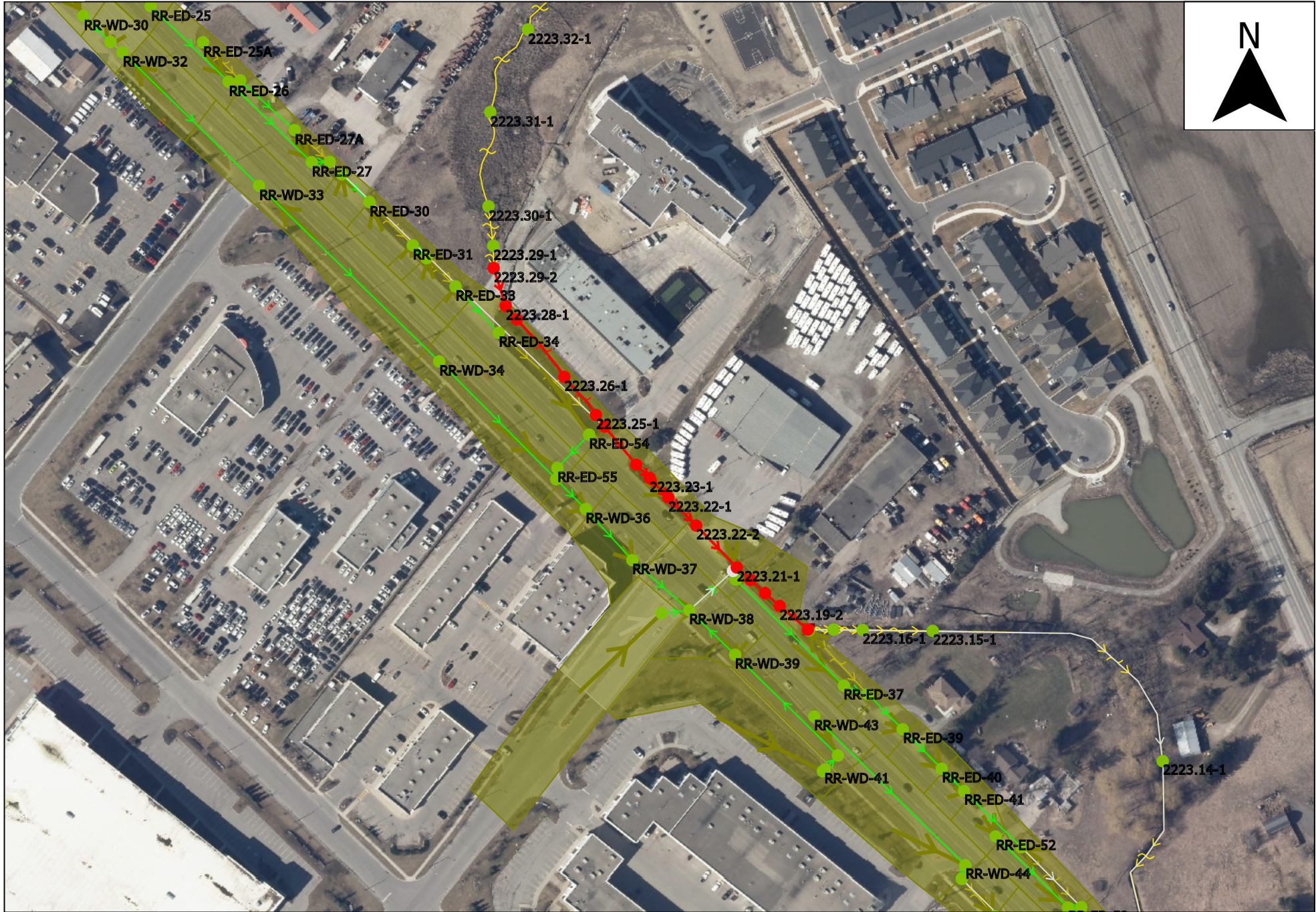
AUGUST 2021





Link	2223.29-2.1	-	2223.27-1.1	2223.26-1.1	-	2223.25-2.1	-	-	2223.22-1.1	2223.22-2.1	-	-	-	2223.19-2.1	
US node ID	2223.29-2	-	2223.27-1	2223.26-1	-	2223.25-2	-	-	2223.22-1	2223.22-2	-	-	-	2223.19-2	
ds node	2223.28-1	-	2223.26-1	2223.25-1	-	2223.24-1	-	-	2223.22-2	2223.21-1	-	-	-	2223.18-1	
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
length (m)	16.7	-	-	-	-	23.5	-	-	-	24.1	-	-	-	17.2	
Shape ID	ARCH	-	Matrix-2223.27	Matrix-2223.26	-	RECT	-	-	-	RECT	-	-	-	RECT	
width (mm)	2900	-	-	-	-	3000	-	-	-	3000	-	-	-	3000	
height (mm)	1900	-	-	-	-	1500	-	-	-	1500	-	-	-	1500	
Rough type	N	-	-	-	-	N	-	-	-	N	-	-	-	N	
us inv (m AD)	231.178	-	231.102	230.740	-	230.408	-	230.190	230.180	230.150	-	-	-	229.300	
ds inv (m AD)	231.150	-	230.740	230.500	-	230.200	-	230.180	230.150	230.060	-	-	-	229.260	
grad (m/m)	0.00167	-	-	-	-	0.00886	-	-	-	0.00374	-	-	-	0.00233	
r.pfc (m ³ /s)	4.455	-	1393.814	756.882	-	20.528	-	59.339	196.425	13.334	-	-	-	10.516	
US depth (m)	0.940	0.545	0.591	0.826	-	0.971	1.152	1.112	0.963	0.666	0.724	0.957	1.132	0.780	
US flow (m ³ /s)	5.47871	-	5.47871	5.47871	-	5.47713	-	5.47713	5.47713	5.47713	-	-	-	5.84713	
US velocity (m/s)	2.030	0.302	0.852	1.391	-	1.880	1.203	1.785	1.912	2.740	1.928	1.949	2.388	2.498	
Node	-	-	2223.27-1	2223.26-1	-	-	2223.24-1	-	2223.22-1	2223.22-2	2223.21-1	-	-	-	-
Node ID	-	-	2223.27-1	2223.26-1	-	-	2223.24-1	-	2223.22-1	2223.22-2	2223.21-1	-	-	-	-
ground (m AD)	-	-	234.650	234.500	234.000	234.000	233.500	-	233.500	233.400	233.320	-	-	233.050	-
level (m AD)	-	-	231.693	231.566	231.435	231.385	231.352	-	231.143	230.817	230.724	-	-	230.082	-
expr:Freeboard	-	-	2.957053	2.934174	2.564514	2.615494	2.147873	-	2.357025	2.583411	2.595818	-	-	-	-

PROPOSED CONDITION - 10-YEAR - EAST SIDE PROFILE 5



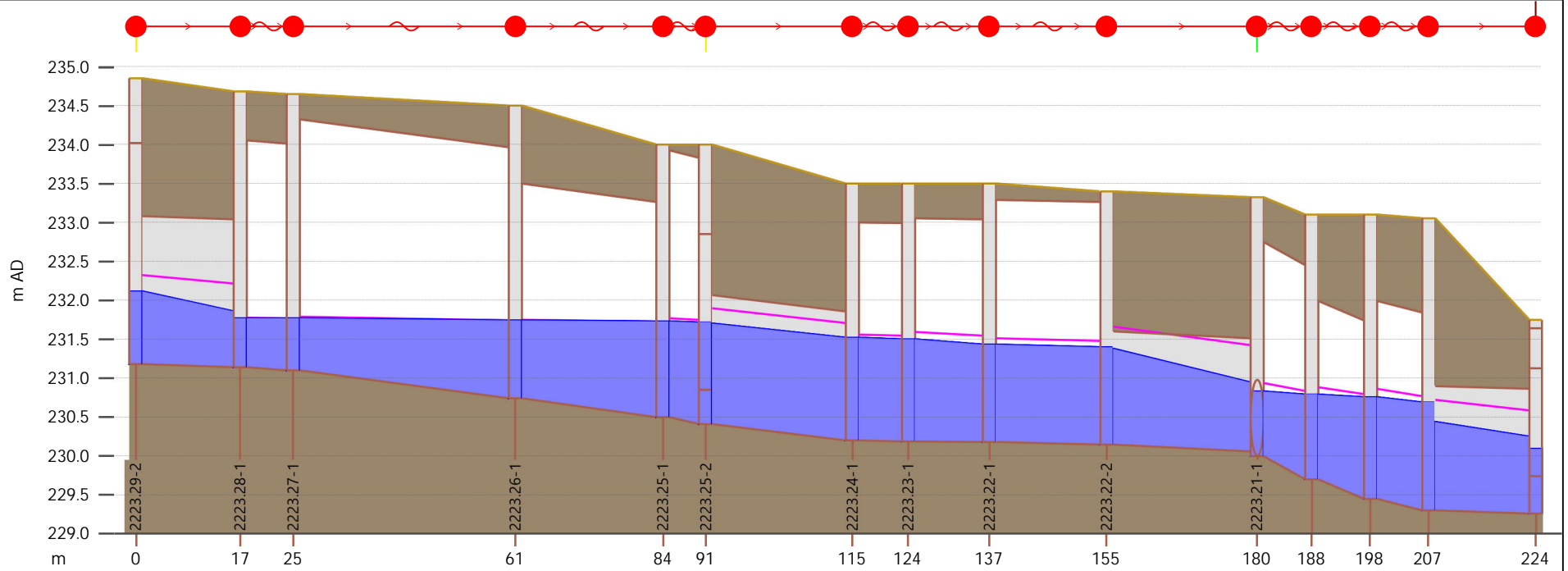
EXISTING CONDITION - 100-YEAR - EAST SIDE PLAN 5

RVA PROJECT NO. 194615

FIGURE NO. 25E

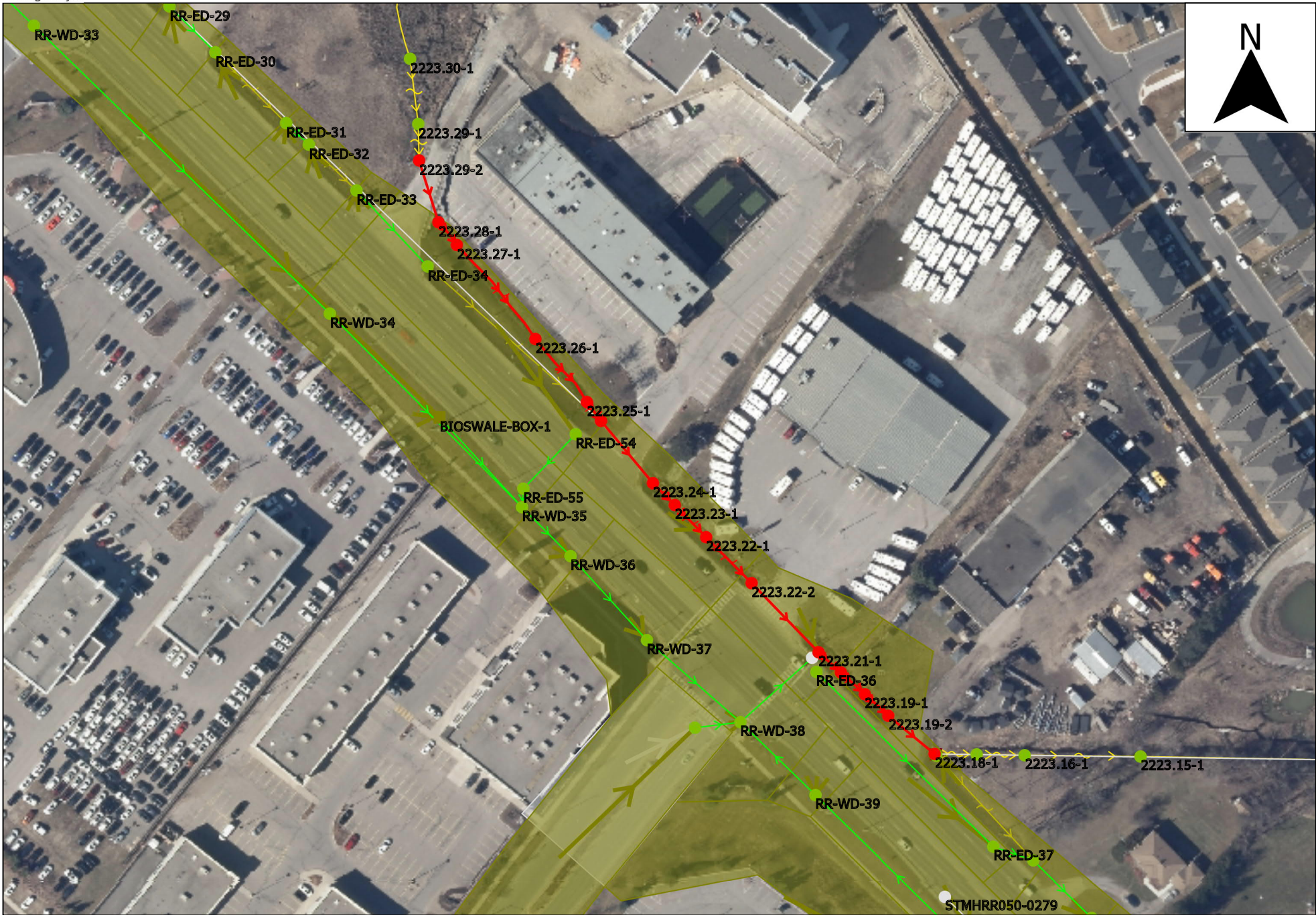
AUGUST 2021





Link	2223.29-2.1	-	2223.27-1.1	2223.26-1.1	-	2223.25-2.1	-	-	2223.22-1.1	2223.22-2.1	-	-	-	2223.19-2.1	
US node ID	2223.29-2	-	2223.27-1	2223.26-1	-	2223.25-2	-	-	2223.22-1	2223.22-2	-	-	-	2223.19-2	
ds node	2223.28-1	-	2223.26-1	2223.25-1	-	2223.24-1	-	-	2223.22-2	2223.21-1	-	-	-	2223.18-1	
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
length (m)	16.7	-	-	-	-	23.5	-	-	-	24.1	-	-	-	17.2	
Shape ID	ARCH	-	Matrix-2223.27	Matrix-2223.26	-	ARCH	-	-	-	ARCH	-	-	-	ARCH	
width (mm)	2900	-	-	-	-	2260	-	-	-	2060	-	-	-	2270	
height (mm)	1900	-	-	-	-	1660	-	-	-	1450	-	-	-	1600	
Rough type	N	-	-	-	-	N	-	-	-	N	-	-	-	N	
us inv (m AD)	231.178	-	231.102	230.740	-	230.408	-	230.190	230.180	230.150	-	-	-	229.300	
ds inv (m AD)	231.142	-	230.740	230.500	-	230.200	-	230.180	230.150	230.060	-	-	-	229.260	
grad (m/m)	0.00215	-	-	-	-	0.00886	-	-	-	0.00374	-	-	-	0.00233	
r.pfc (m3/s)	5.052	-	1393.814	756.882	-	6.393	-	59.339	196.425	3.020	-	-	-	3.093	
US depth (m)	0.934	0.628	0.667	0.999	-	1.294	1.318	1.309	1.253	1.229	0.827	1.091	1.308	1.138	
US flow (m3/s)	5.47636	-	5.47625	5.47619	-	5.47401	-	5.47401	5.47401	5.47401	-	-	-	5.84407	
US velocity (m/s)	2.041	0.271	0.810	1.204	-	1.967	0.958	1.369	1.267	2.339	1.611	1.529	1.588	2.349	
Node	-	-	2223.27-1	2223.26-1	-	-	2223.24-1	-	2223.22-1	2223.22-2	2223.21-1	-	-	-	-
Node ID	-	-	2223.27-1	2223.26-1	-	-	2223.24-1	-	2223.22-1	2223.22-2	2223.21-1	-	-	-	-
ground (m AD)	-	-	234.650	234.500	234.000	234.000	233.500	-	233.500	233.400	233.320	-	-	233.050	-
level (m AD)	-	-	231.769	231.739	231.728	231.714	231.518	-	231.433	231.400	230.827	-	-	230.691	-
expr:Freeboard	-	-	2.880591	2.760895	2.272049	2.286270	1.982422	-	2.067093	2.000342	2.492592	-	-	-	-

EXISTING CONDITION - 100-YEAR - EAST SIDE PROFILE 5



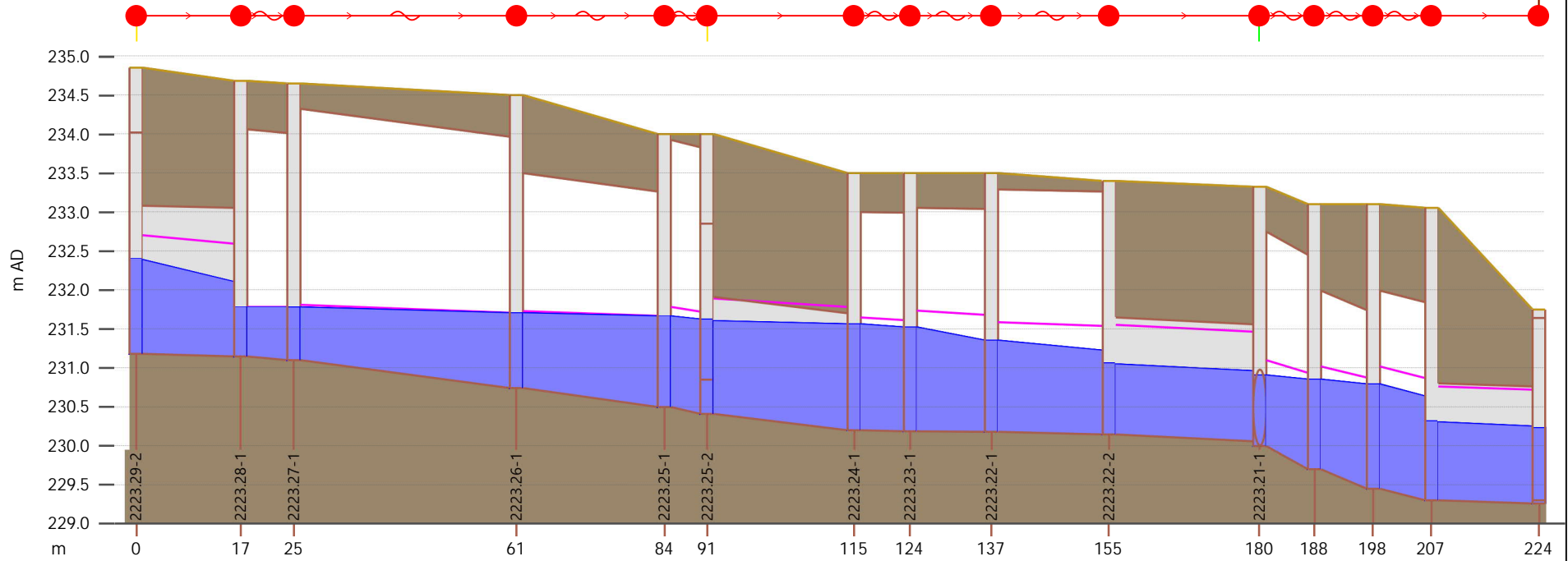
PROPOSED CONDITION - 100-YEAR - EAST SIDE PLAN 5

RVA PROJECT NO. 194615

FIGURE NO. 25G

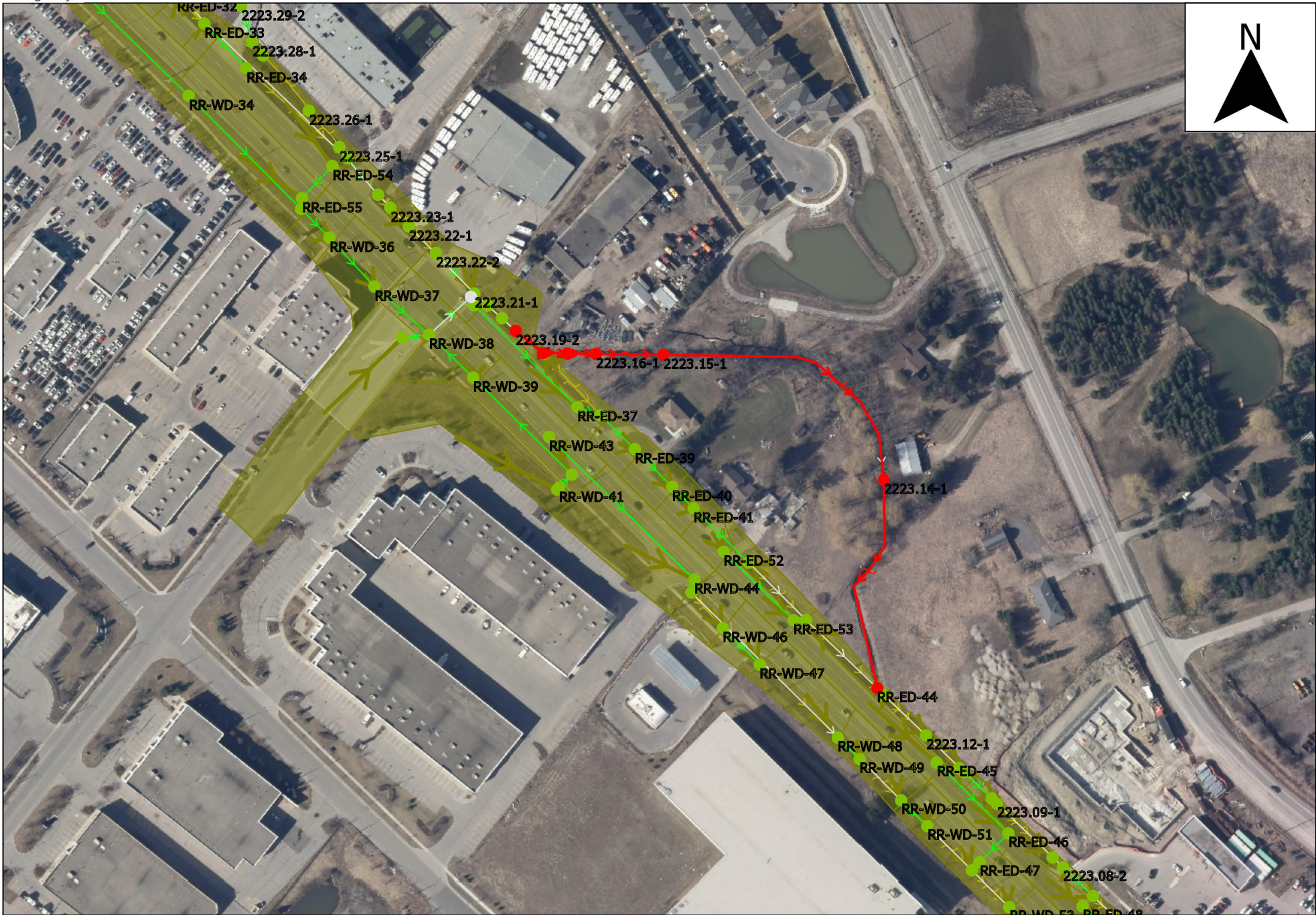
AUGUST 2021





Link	2223.29-2.1	-	2223.27-1.1	2223.26-1.1	-	2223.25-2.1	-	-	2223.22-1.1	2223.22-2.1	-	-	-	2223.19-2.1	
US node ID	2223.29-2	-	2223.27-1	2223.26-1	-	2223.25-2	-	-	2223.22-1	2223.22-2	-	-	-	2223.19-2	
ds node	2223.28-1	-	2223.26-1	2223.25-1	-	2223.24-1	-	-	2223.22-2	2223.21-1	-	-	-	2223.18-1	
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
length (m)	16.7	-	-	-	-	23.5	-	-	-	24.1	-	-	-	17.2	
Shape ID	ARCH	-	Matrix-2223.27	Matrix-2223.26	-	RECT	-	-	-	RECT	-	-	-	RECT	
width (mm)	2900	-	-	-	-	3000	-	-	-	3000	-	-	-	3000	
height (mm)	1900	-	-	-	-	1500	-	-	-	1500	-	-	-	1500	
Rough type	N	-	-	-	-	N	-	-	-	N	-	-	-	N	
us inv (m AD)	231.178	-	231.102	230.740	-	230.408	-	230.190	230.180	230.150	-	-	-	229.300	
ds inv (m AD)	231.150	-	230.740	230.500	-	230.200	-	230.180	230.150	230.060	-	-	-	229.260	
grad (m/m)	0.00167	-	-	-	-	0.00886	-	59.339	196.425	13.334	-	-	-	10.516	
r.pfc (m ³ /s)	4.455	-	1393.814	756.882	-	20.528	-	59.339	196.425	13.334	-	-	-	10.516	
US depth (m)	1.207	0.627	0.672	0.961	-	1.195	1.360	1.327	1.171	0.899	0.901	1.149	1.338	1.000	
US flow (m ³ /s)	8.48897	-	8.48897	8.48896	-	8.48700	-	8.48700	8.48700	8.48700	-	-	-	9.05705	
US velocity (m/s)	2.500	0.384	0.884	1.404	-	2.368	1.324	2.068	2.160	3.148	2.070	1.953	2.387	3.019	
Node	-	-	2223.27-1	2223.26-1	-	-	2223.24-1	-	2223.22-1	2223.22-2	2223.21-1	-	-	-	-
Node ID	-	-	2223.27-1	2223.26-1	-	-	2223.24-1	-	2223.22-1	2223.22-2	2223.21-1	-	-	-	-
ground (m AD)	-	-	234.650	234.500	234.000	234.000	233.500	-	233.500	233.400	233.320	-	-	233.050	-
level (m AD)	-	-	231.774	231.701	231.660	231.620	231.560	-	231.351	231.060	230.901	-	-	230.315	-
expr:Freeboard	-	-	2.875525	2.798584	2.339676	2.379562	1.939941	-	2.149216	2.340262	2.418587	-	-	-	-

PROPOSED CONDITION - 100-YEAR - EAST SIDE PROFILE 5



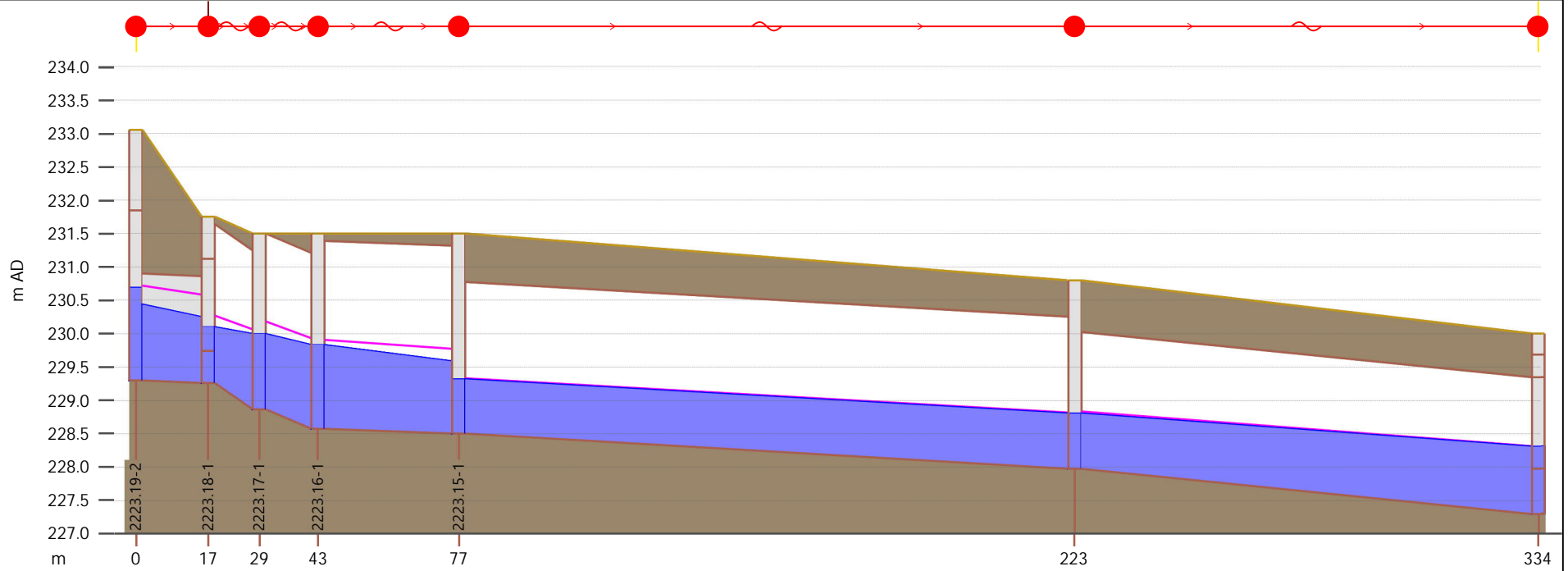
EXISTING CONDITION - 10-YEAR - EAST SIDE PLAN 6

RVA PROJECT NO. 194615

FIGURE NO. 26A

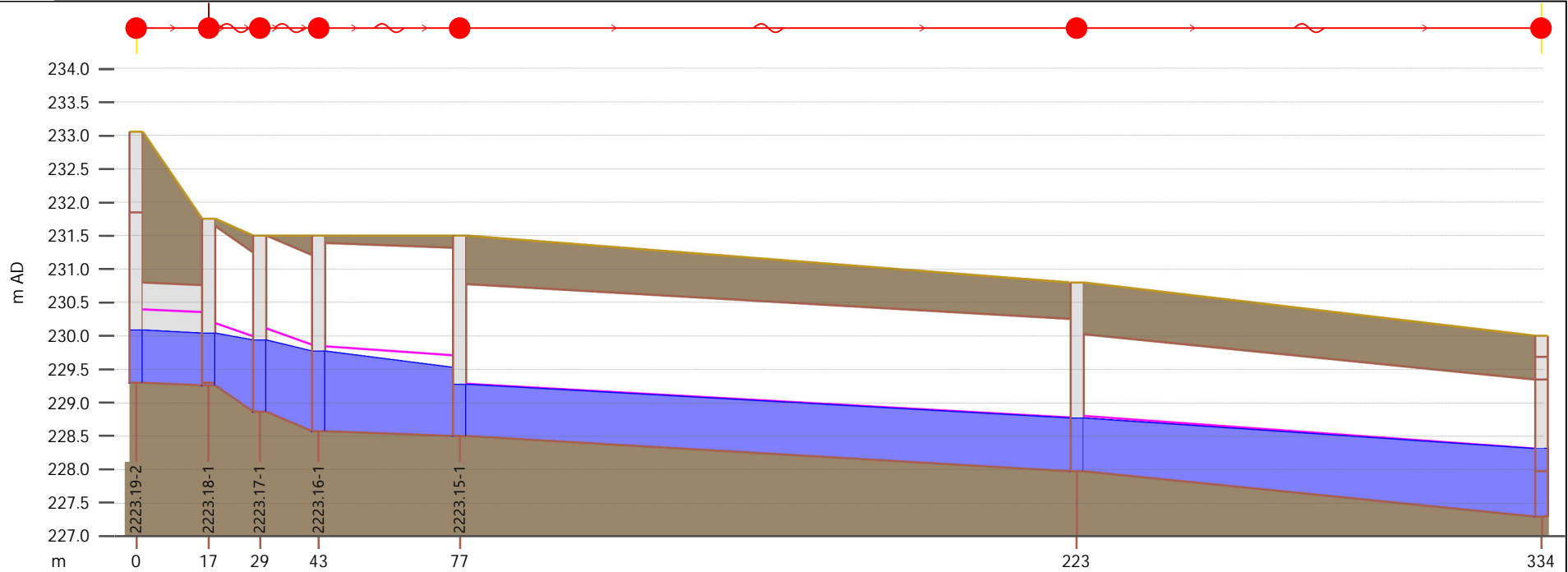
AUGUST 2021





Link	-	-	-	2223.16-1.1	2223.15-1.1	2223.14-1.1	
US node ID	-	-	-	2223.16-1	2223.15-1	2223.14-1	
ds node	-	-	-	2223.15-1	2223.14-1	RR-ED-44	
numbarrels	1	1	1	1	1	1	
length (m)	17.2	-	-	-	-	-	
Shape ID	ARCH	-	-	Matrix-2223.16	Matrix-2223.15	Matrix-2223.14	
width (mm)	2270	-	-	-	-	-	
height (mm)	1600	-	-	-	-	-	
Rough type	N	-	-	-	-	-	
us inv (m AD)	229.300	-	-	228.573	228.500	227.977	
ds inv (m AD)	229.260	-	-	228.500	227.977	227.300	
grad (m/m)	0.00233	-	-	-	-	-	
r.pfc (m3/s)	3.093	-	-	49.589	93.206	151.870	
US depth (m)	1.138	0.834	1.123	1.255	0.818	0.825	
US flow (m3/s)	5.84407	-	-	5.57059	5.57059	5.57059	
US velocity (m/s)	2.349	1.873	1.948	1.259	0.585	0.902	
Node	-	-	-	2223.16-1	2223.15-1	2223.14-1	RR-ED-44
Node ID	-	-	-	2223.16-1	2223.15-1	2223.14-1	RR-ED-44
ground (m AD)	-	-	-	231.500	231.500	230.800	230.000
level (m AD)	-	-	-	229.828	229.318	228.802	228.310
expr:Freeboard	-	-	-	1.671570	2.181549	1.997998	1.690231

EXISTING CONDITION - 10-YEAR - EAST SIDE PROFILE 6



Link	-	-	-	2223.16-1.1	2223.15-1.1	2223.14-1.1	
US node ID	-	-	-	2223.16-1	2223.15-1	2223.14-1	
ds node	-	-	-	2223.15-1	2223.14-1	RR-ED-44	
numbarrels	1	1	1	1	1	1	
length (m)	17.2	-	-	-	-	-	
Shape ID	RECT	-	-	Matrix-2223.16	Matrix-2223.15	Matrix-2223.14	
width (mm)	3000	-	-	-	-	-	
height (mm)	1500	-	-	-	-	-	
Rough type	N	-	-	-	-	-	
us inv (m AD)	229.300	-	-	228.573	228.500	227.977	
ds inv (m AD)	229.260	-	-	228.500	227.977	227.300	
grad (m/m)	0.00233	-	-	-	-	-	
r.pfc (m3/s)	10.516	-	-	49.589	93.206	151.870	
US depth (m)	0.780	0.773	1.059	1.196	0.769	0.788	
US flow (m3/s)	5.84713	-	-	4.71561	4.71561	4.71561	
US velocity (m/s)	2.498	1.766	1.916	1.229	0.568	0.916	
Node	-	-	-	2223.16-1	2223.15-1	2223.14-1	RR-ED-44
Node ID	-	-	-	2223.16-1	2223.15-1	2223.14-1	RR-ED-44
ground (m AD)	-	-	-	231.500	231.500	230.800	230.000
level (m AD)	-	-	-	229.769	229.269	228.765	228.310
expr:Freeboard	-	-	-	1.731186	2.231155	2.034711	1.690155

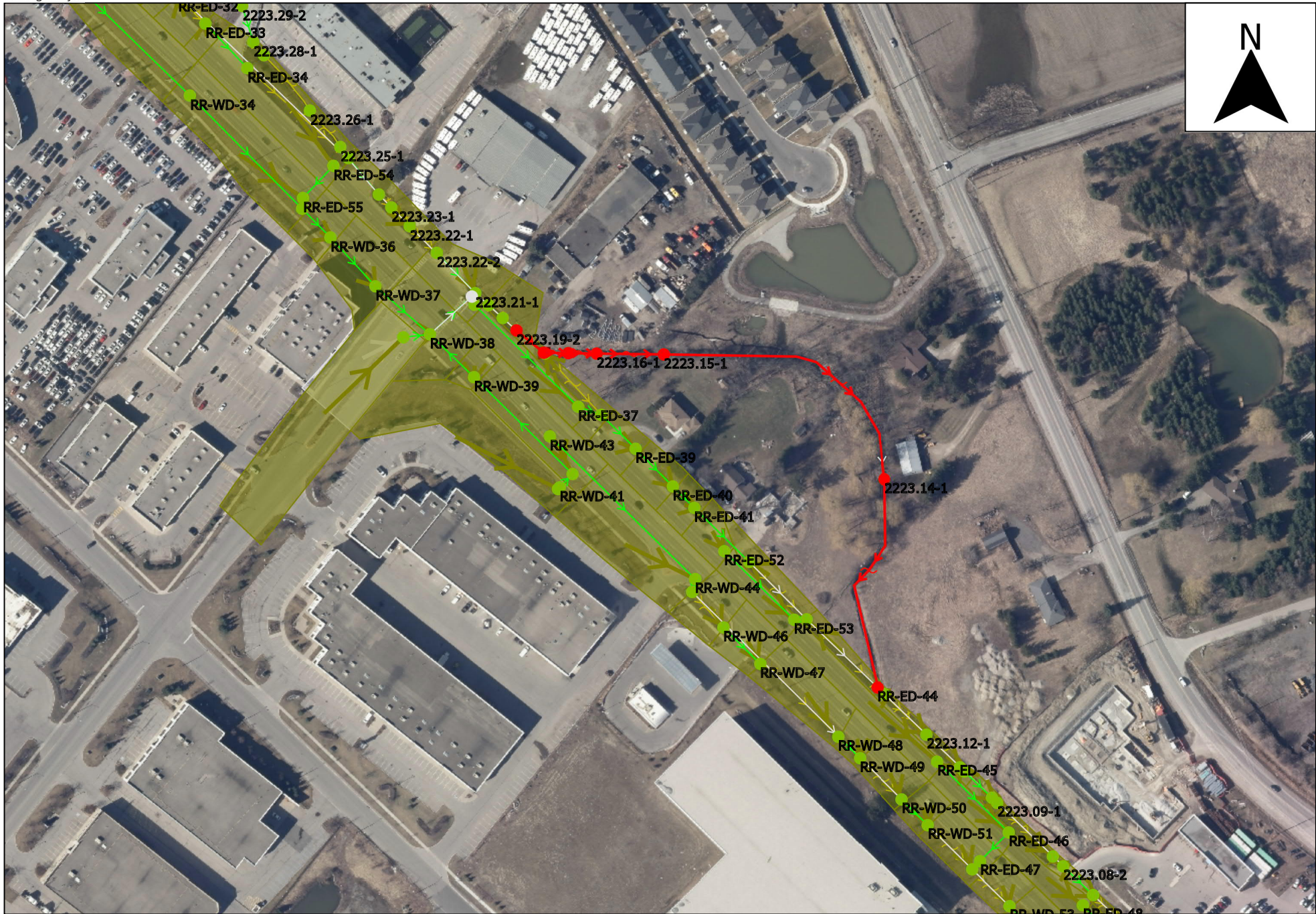
PROPOSED CONDITION - 10-YEAR - EAST SIDE PROFILE 6

RVA PROJECT NO. 194615

FIGURE NO. 26D

AUGUST 2021





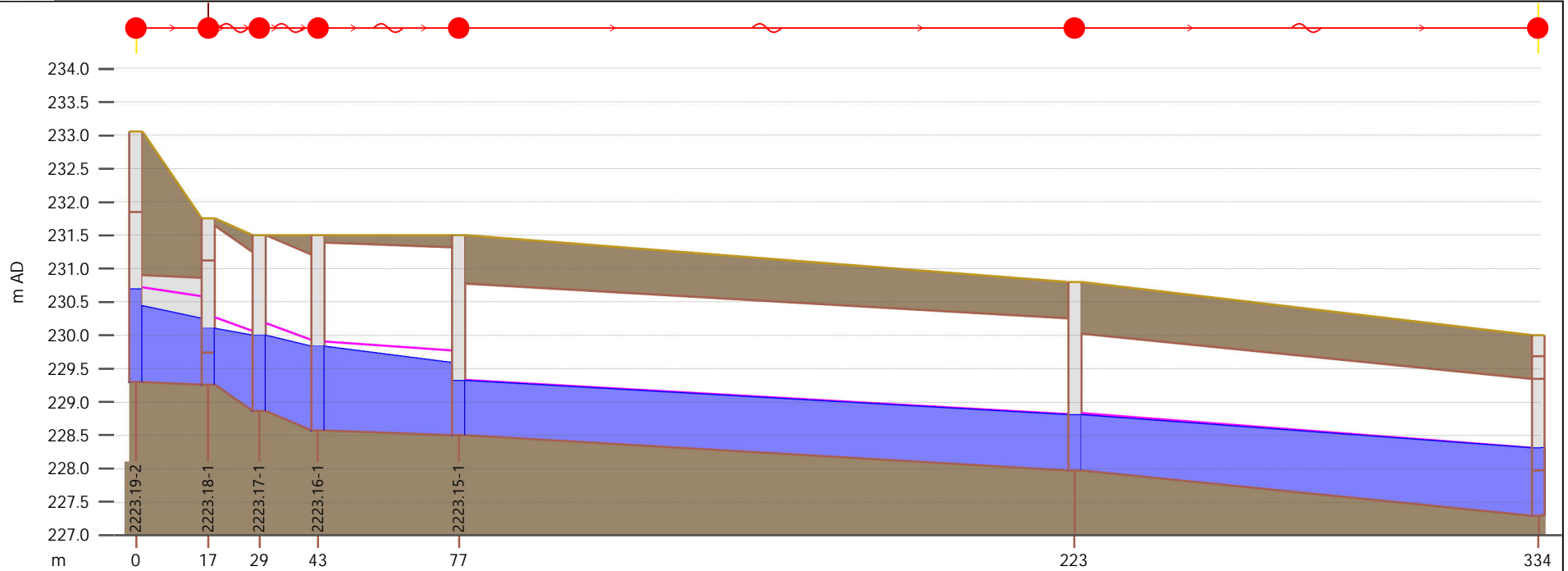
EXISTING CONDITION - 100-YEAR - EAST SIDE PLAN 6

RVA PROJECT NO. 194615

FIGURE NO. 26E

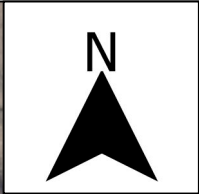
AUGUST 2021





Link	-	-	-	2223.16-1.1	2223.15-1.1	2223.14-1.1	
US node ID	-	-	-	2223.16-1	2223.15-1	2223.14-1	
ds node	-	-	-	2223.15-1	2223.14-1	RR-ED-44	
numbarrels	1	1	1	1	1	1	
length (m)	17.2	-	-	-	-	-	
Shape ID	ARCH	-	-	Matrix-2223.16	Matrix-2223.15	Matrix-2223.14	
width (mm)	2270	-	-	-	-	-	
height (mm)	1600	-	-	-	-	-	
Rough type	N	-	-	-	-	-	
us inv (m AD)	229.300	-	-	228.573	228.500	227.977	
ds inv (m AD)	229.260	-	-	228.500	227.977	227.300	
grad (m/m)	0.00233	-	-	-	-	-	
r.pfc (m3/s)	3.093	-	-	49.589	93.206	151.870	
US depth (m)	1.138	0.834	1.123	1.255	0.818	0.825	
US flow (m3/s)	5.84407	-	-	5.57059	5.57059	5.57059	
US velocity (m/s)	2.349	1.873	1.948	1.259	0.585	0.902	
Node	-	-	-	2223.16-1	2223.15-1	2223.14-1	RR-ED-44
Node ID	-	-	-	2223.16-1	2223.15-1	2223.14-1	RR-ED-44
ground (m AD)	-	-	-	231.500	231.500	230.800	230.000
level (m AD)	-	-	-	229.828	229.318	228.802	228.310
expr:Freeboard	-	-	-	1.671570	2.181549	1.997998	1.690231

EXISTING CONDITION - 100-YEAR - EAST SIDE PROFILE 6



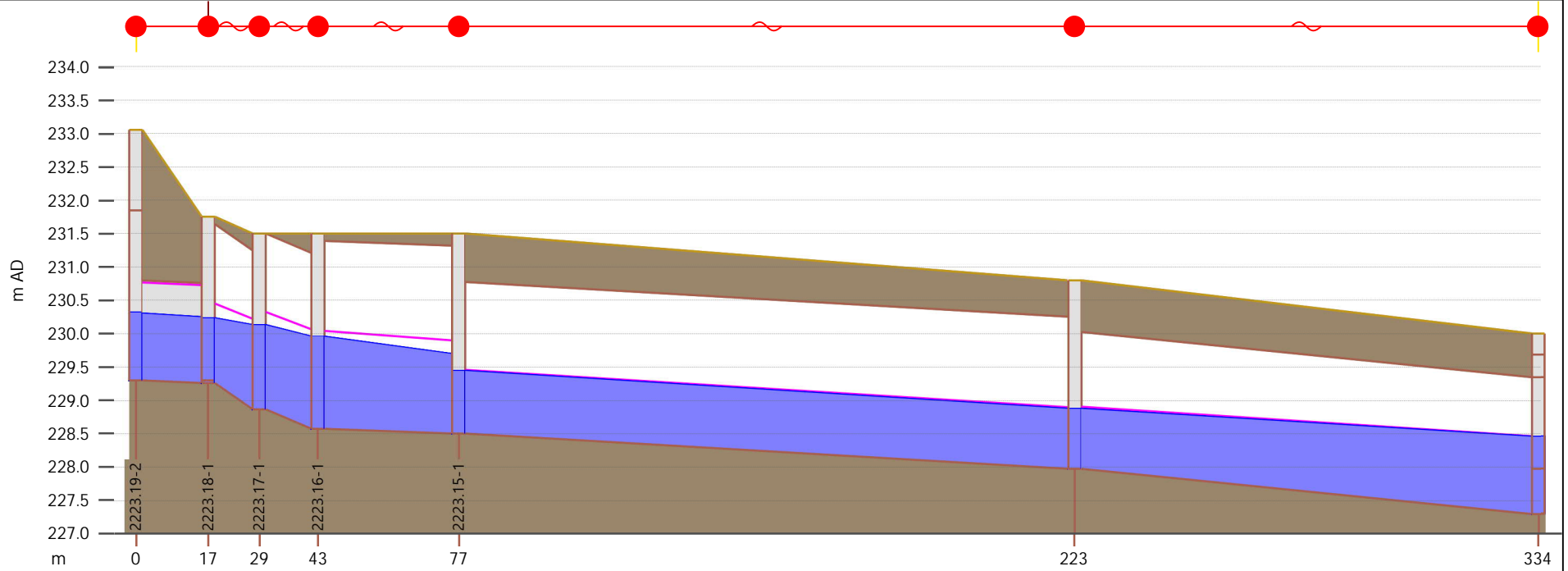
PROPOSED CONDITION - 100-YEAR - EAST SIDE PLAN 6

RVA PROJECT NO. 194615

FIGURE NO. 26G

AUGUST 2021





Link	-	-	-	2223.16-1.1	2223.15-1.1	2223.14-1.1	
US node ID	-	-	-	2223.16-1	2223.15-1	2223.14-1	
ds node	-	-	-	2223.15-1	2223.14-1	RR-ED-44	
numbarrels	1	1	1	1	1	1	
length (m)	17.2	-	-	-	-	-	
Shape ID	RECT	-	-	Matrix-2223.16	Matrix-2223.15	Matrix-2223.14	
width (mm)	3000	-	-	-	-	-	
height (mm)	1500	-	-	-	-	-	
Rough type	N	-	-	-	-	-	
us inv (m AD)	229.300	-	-	228.573	228.500	227.977	
ds inv (m AD)	229.260	-	-	228.500	227.977	227.300	
grad (m/m)	0.00233	-	-	-	-	-	
r.pfc (m3/s)	10.516	-	-	49.589	93.206	151.870	
US depth (m)	1.000	0.968	1.260	1.380	0.939	0.898	
US flow (m3/s)	9.05717	-	-	7.68312	7.68312	7.68312	
US velocity (m/s)	3.019	2.077	1.947	1.317	0.586	0.923	
Node	-	-	-	2223.16-1	2223.15-1	2223.14-1	RR-ED-44
Node ID	-	-	-	2223.16-1	2223.15-1	2223.14-1	RR-ED-44
ground (m AD)	-	-	-	231.500	231.500	230.800	230.000
level (m AD)	-	-	-	229.953	229.439	228.875	228.460
expr:Freeboard	-	-	-	1.547287	2.060944	1.924680	1.540054

PROPOSED CONDITION - 100-YEAR - EAST SIDE PROFILE 6

RVA PROJECT NO. 194615

FIGURE NO. 26H

AUGUST 2021





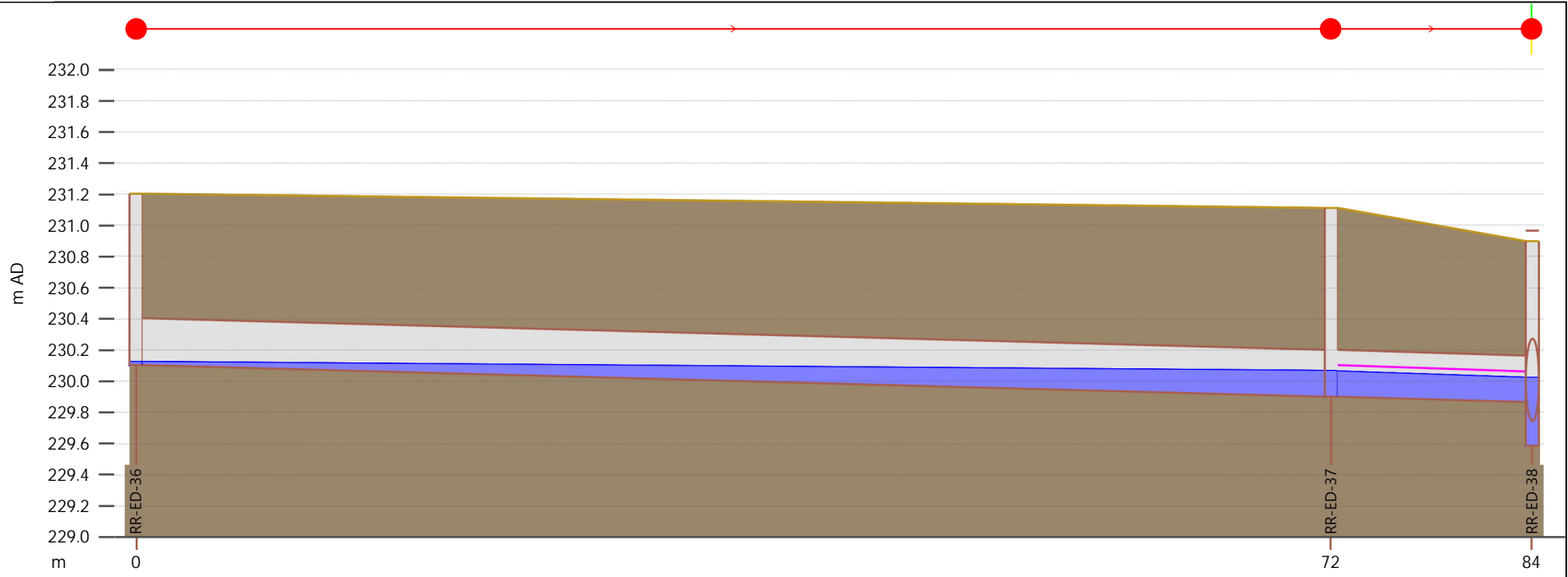
EXISTING CONDITION - 10-YEAR - EAST SIDE PLAN 7

RVA PROJECT NO. 194615

FIGURE NO. 27A

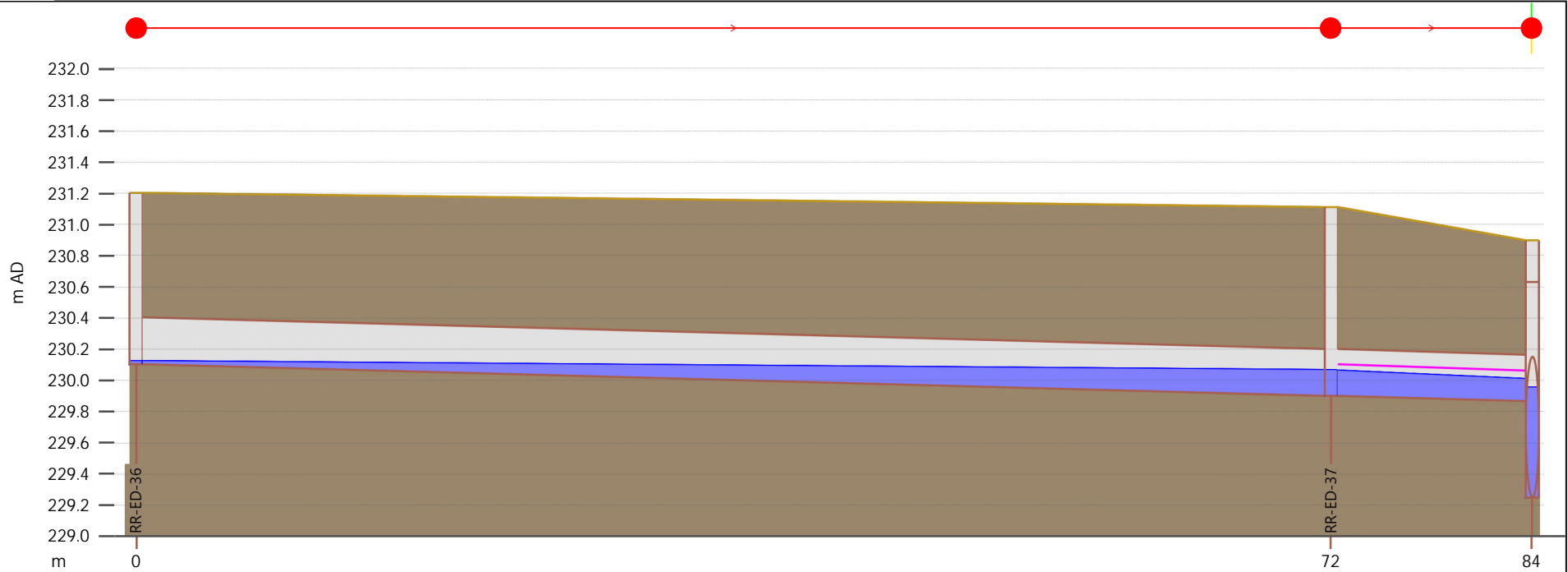
AUGUST 2021





Link	RR-ED-36.1		RR-ED-37.1	
US node ID	RR-ED-36		RR-ED-37	
ds node	RR-ED-37		RR-ED-38	
numbarrels	1		1	
length (m)	72.2		12.1	
Shape ID	CIRC		CIRC	
width (mm)	300		300	
height (mm)	300		300	
Rough type	N		N	
us inv (m AD)	230.105		229.900	
ds inv (m AD)	229.900		229.866	
grad (m/m)	0.00284		0.00284	
r.pfc (m3/s)	0.052		0.052	
US depth (m)	0.020		0.164	
US flow (m3/s)	0.00000		0.03416	
US velocity (m/s)	0.000		0.864	
Node	RR-ED-36		RR-ED-37	RR-ED-38
Node ID	RR-ED-36		RR-ED-37	RR-ED-38
ground (m AD)	231.203		231.110	230.898
level (m AD)	230.125		230.066	230.024
expr:Freeboard	1.077820		1.044617	0.873474

EXISTING CONDITION - 10-YEAR - EAST SIDE PROFILE 7



Link		RR-ED-36.1		RR-ED-37.1
US node ID		RR-ED-36		RR-ED-37
ds node		RR-ED-37		RR-ED-38
numbarrels		1		1
length (m)		72.2		12.1
Shape ID		CIRC		CIRC
width (mm)		300		300
height (mm)		300		300
Rough type		N		N
us inv (m AD)		230.105		229.900
ds inv (m AD)		229.900		229.866
grad (m/m)		0.00284		0.00284
r.pfc (m3/s)		0.052		0.052
US depth (m)		0.020		0.165
US flow (m3/s)		0.00000		0.03445
US velocity (m/s)		-0.000		0.867
Node	RR-ED-36		RR-ED-37	RR-ED-38
Node ID	RR-ED-36		RR-ED-37	RR-ED-38
ground (m AD)	231.203		231.110	230.898
level (m AD)	230.125		230.066	229.957
expr:Freeboard	1.077820		1.043854	0.941193

PROPOSED CONDITION - 10-YEAR - EAST SIDE PROFILE 7



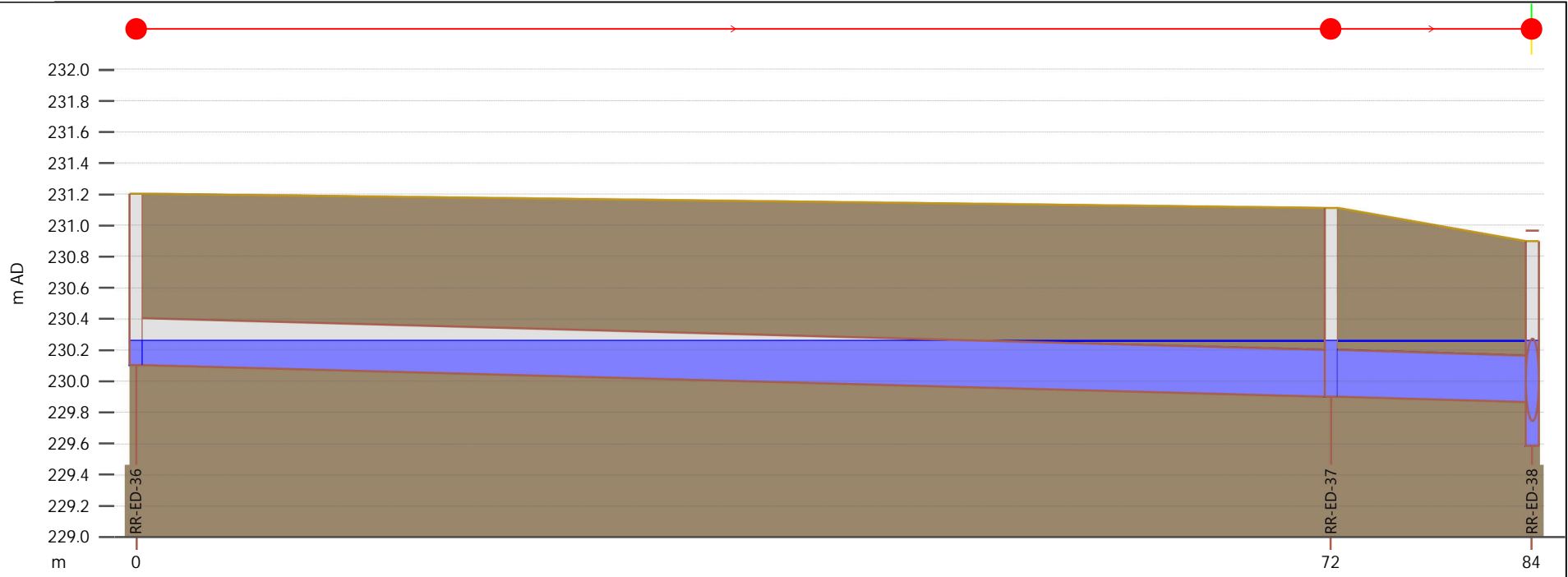
EXISTING CONDITION - 100-YEAR - EAST SIDE PLAN 7

RVA PROJECT NO. 194615

FIGURE NO. 27E

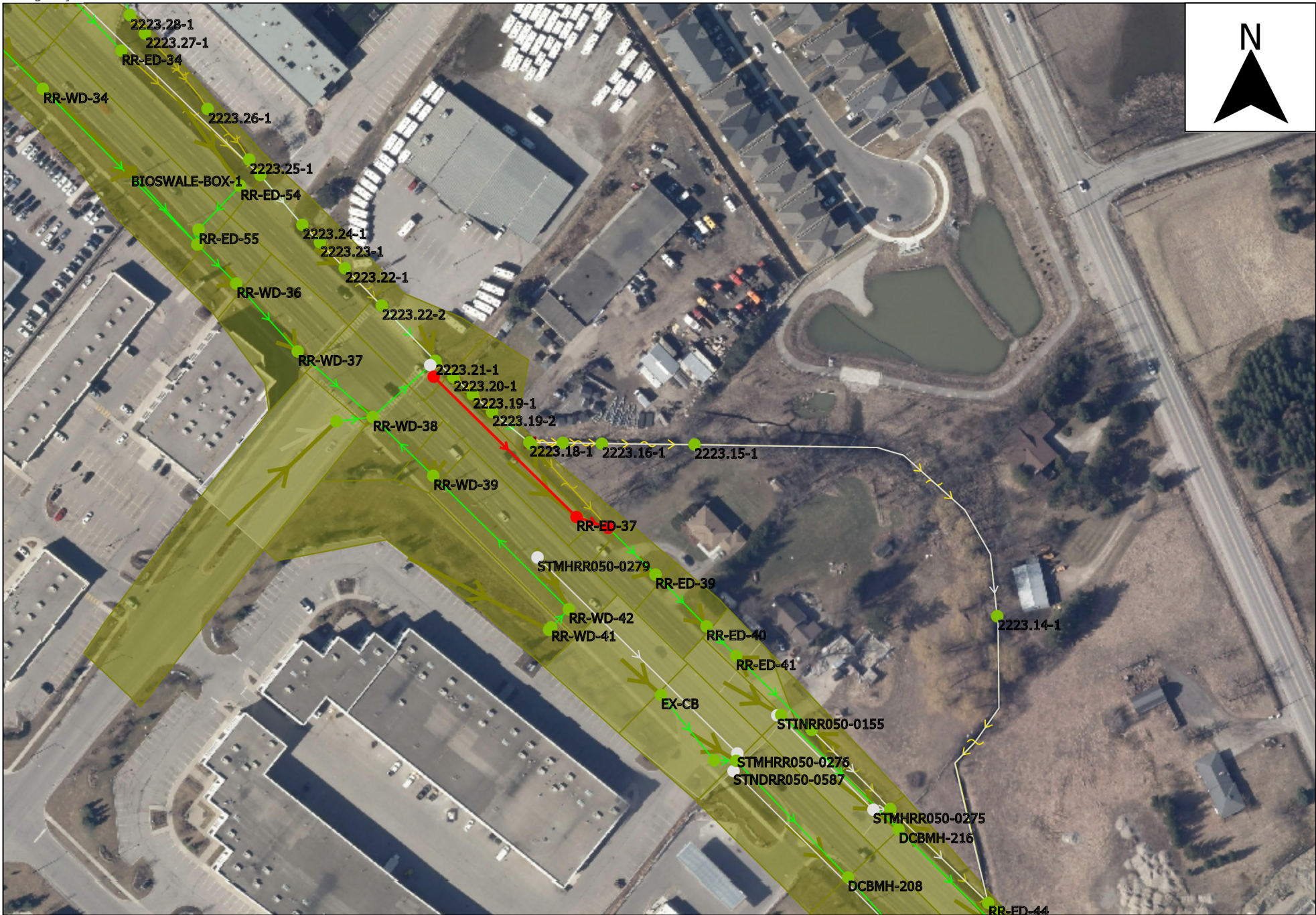
AUGUST 2021





Link	RR-ED-36.1		RR-ED-37.1	
US node ID	RR-ED-36		RR-ED-37	
ds node	RR-ED-37		RR-ED-38	
numbarrels	1		1	
length (m)	72.2		12.1	
Shape ID	CIRC		CIRC	
width (mm)	300		300	
height (mm)	300		300	
Rough type	N		N	
us inv (m AD)	230.105		229.900	
ds inv (m AD)	229.900		229.866	
grad (m/m)	0.00284		0.00284	
r.pfc (m3/s)	0.052		0.052	
US depth (m)	0.154		0.359	
US flow (m3/s)	0.00011		0.05048	
US velocity (m/s)	0.027		0.989	
Node	RR-ED-36		RR-ED-37	RR-ED-38
Node ID	RR-ED-36		RR-ED-37	RR-ED-38
ground (m AD)	231.203		231.110	230.898
level (m AD)	230.259		230.259	230.259
expr:Freeboard	0.943680		0.851074	0.638840

EXISTING CONDITION - 100-YEAR - EAST SIDE PROFILE 7



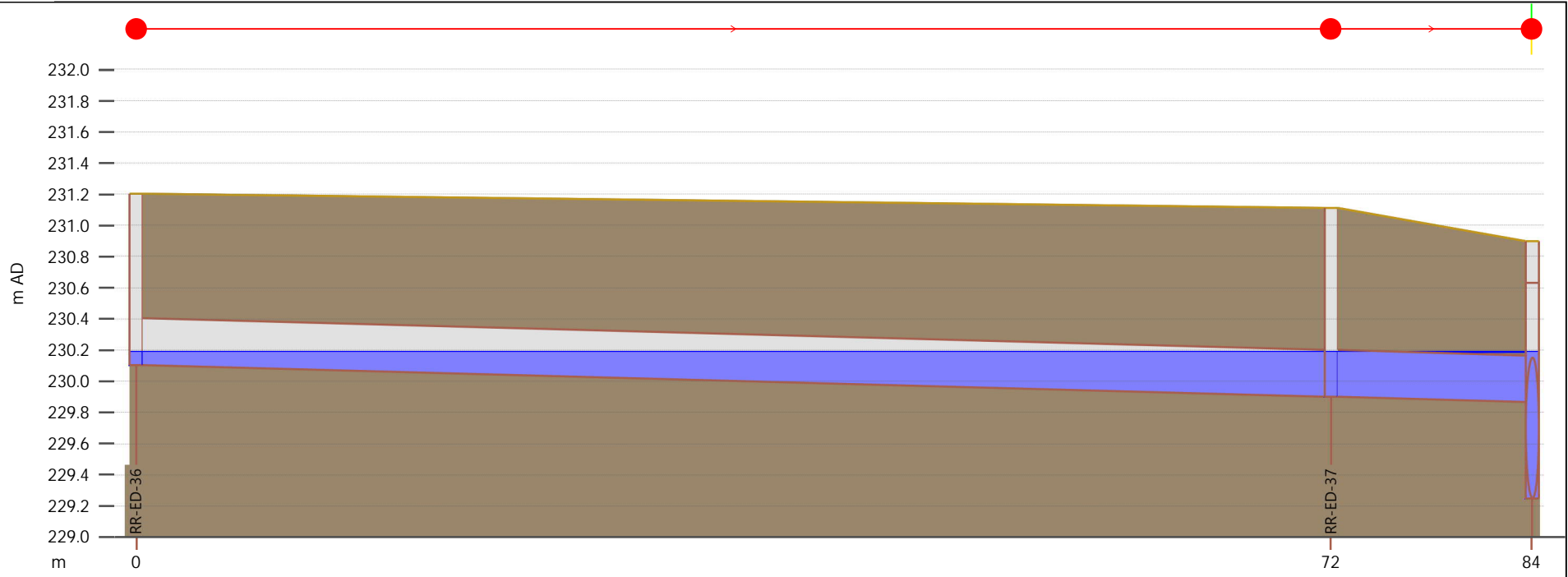
PROPOSED CONDITION - 100-YEAR - EAST SIDE PLAN 7

RVA PROJECT NO. 194615

FIGURE NO. 27G

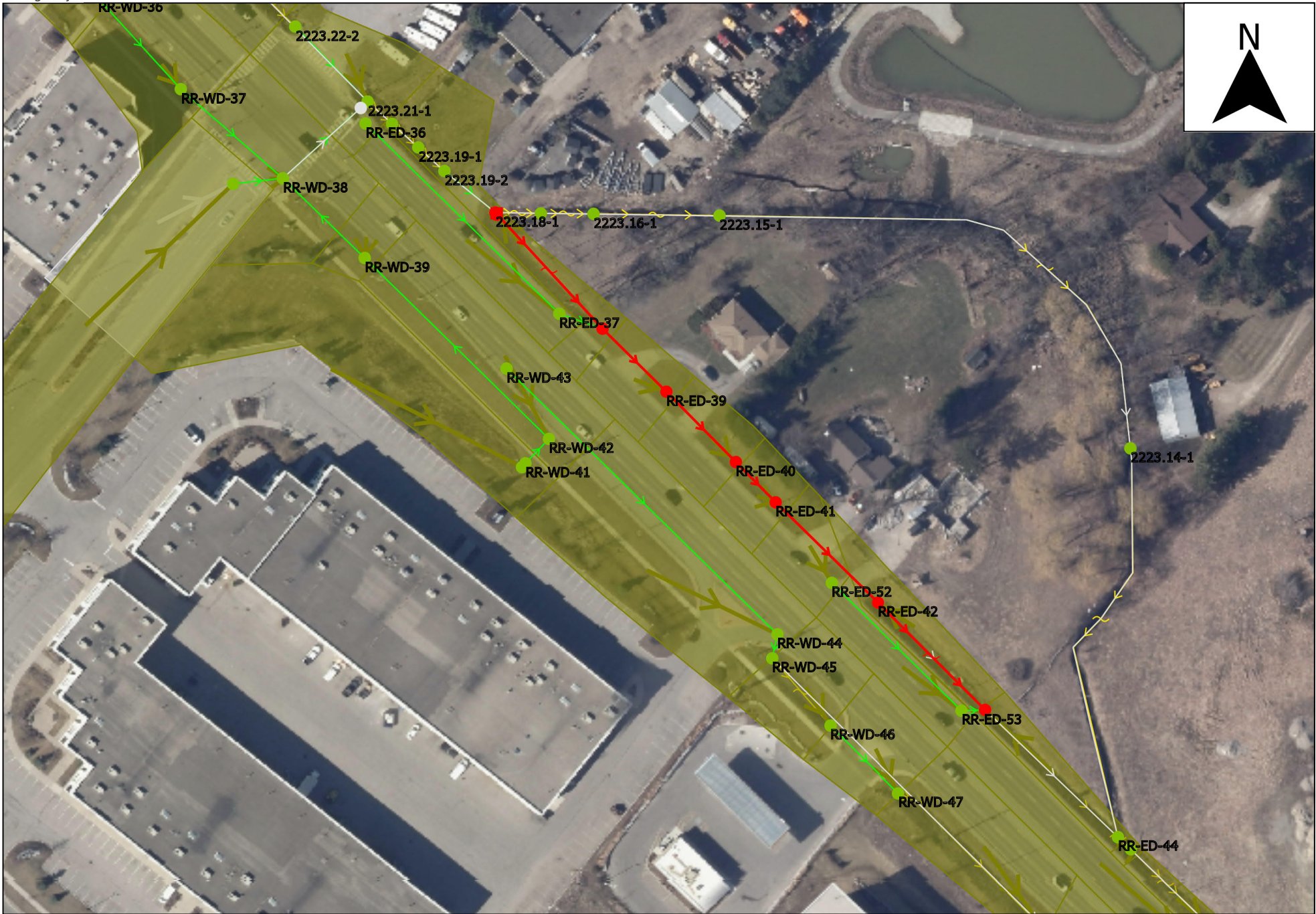
AUGUST 2021





Link	RR-ED-36.1		RR-ED-37.1	
US node ID	RR-ED-36		RR-ED-37	
ds node	RR-ED-37		RR-ED-38	
numbarrels	1		1	
length (m)	72.2		12.1	
Shape ID	CIRC		CIRC	
width (mm)	300		300	
height (mm)	300		300	
Rough type	N		N	
us inv (m AD)	230.105		229.900	
ds inv (m AD)	229.900		229.866	
grad (m/m)	0.00284		0.00284	
r.pfc (m3/s)	0.052		0.052	
US depth (m)	0.085		0.290	
US flow (m3/s)	0.00036		0.05085	
US velocity (m/s)	0.035		0.991	
Node	RR-ED-36		RR-ED-37	RR-ED-38
Node ID	RR-ED-36		RR-ED-37	RR-ED-38
ground (m AD)	231.203		231.110	230.898
level (m AD)	230.190		230.190	230.190
expr:Freeboard	1.012817		0.920258	0.708023

PROPOSED CONDITION - 100-YEAR - EAST SIDE PROFILE 7



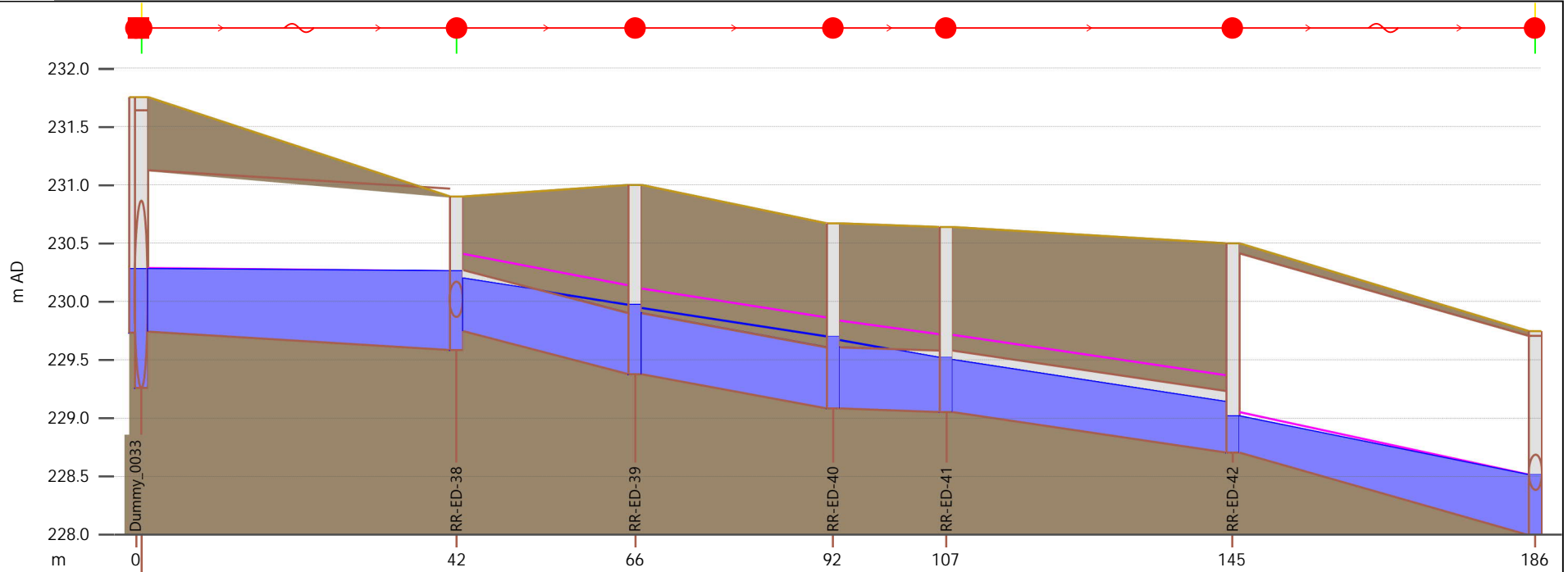
EXISTING CONDITION - 10-YEAR - EAST SIDE PLAN 8

RVA PROJECT NO. 194615

FIGURE NO. 28A

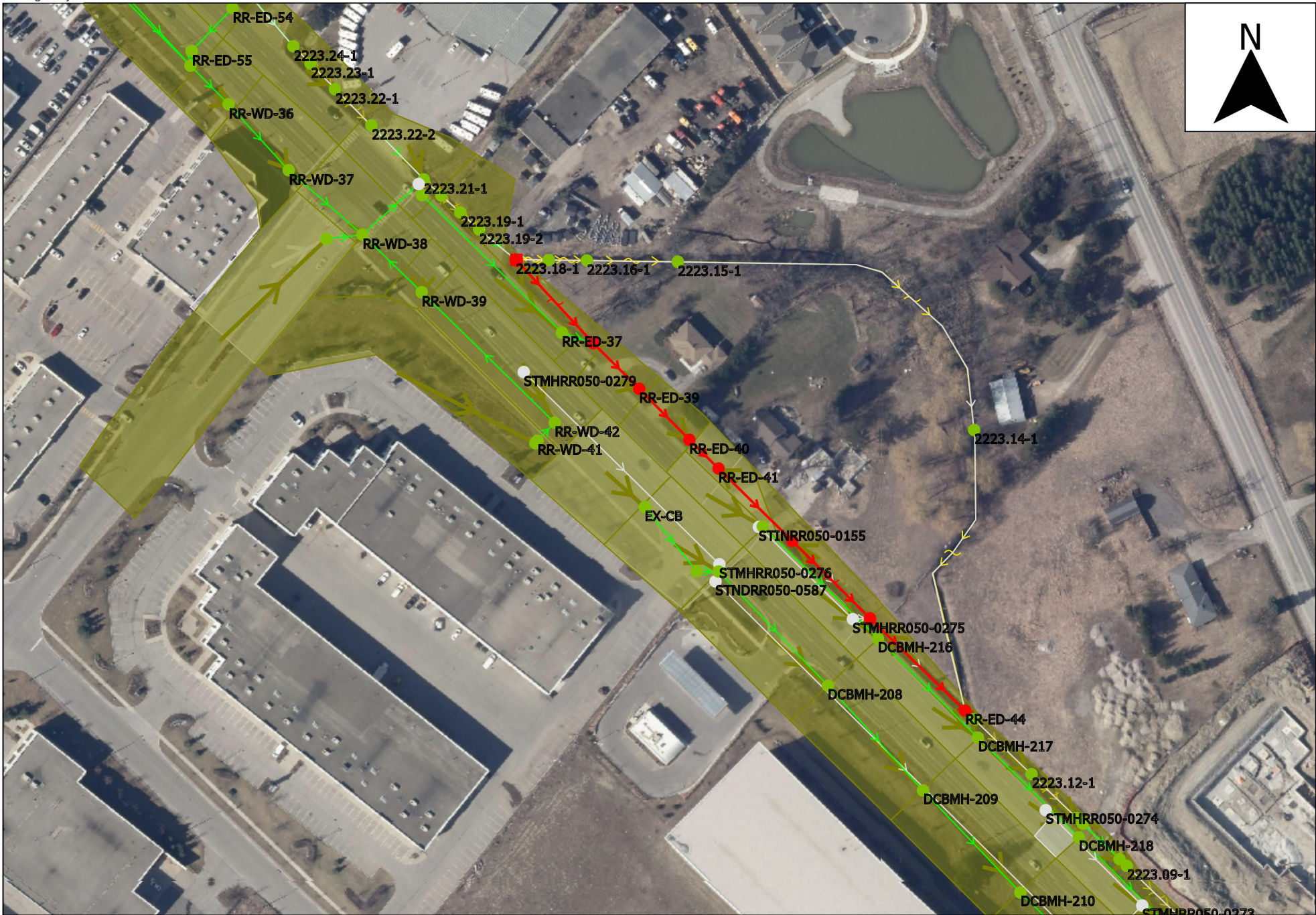
AUGUST 2021





Link	2223.18-1.2	RR-ED-38.1	RR-ED-39.1	RR-ED-40.1	RR-ED-41.1	RR-ED-42.1	
US node ID	2223.18-1	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	
ds node	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	RR-ED-43	
numbarrels	1	1	1	1	1	1	
length (m)		23.8	26.3	15.1	38.1		
Shape ID	East Side Ditch-8	CIRC	CIRC	CIRC	CIRC	East Side Ditch-9	
width (mm)		525	525	525	525		
height (mm)		525	525	525	525		
Rough type		N	N	N	N		
us inv (m AD)	229.743	229.745	229.376	229.083	229.054	228.708	
ds inv (m AD)	229.586	229.376	229.083	229.054	228.708	228.000	
grad (m/m)		0.01551	0.01114	0.00192	0.00908		
r.pfc (m3/s)	8.402	0.536	0.454	0.189	0.410	29.255	
US depth (m)	0.536	0.454	0.568	0.587	0.443	0.310	
US flow (m3/s)	0.40712	0.40410	0.40409	0.40409	0.40409	0.40409	
US velocity (m/s)	0.524	2.470	2.013	1.800	2.155	0.852	
Node	2223.18-1	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	RR-ED-43
Node ID	2223.18-1	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	RR-ED-43
ground (m AD)	231.750	230.898	230.998	230.670	230.641	230.500	229.745
level (m AD)	230.279	230.259	229.971	229.698	229.515	229.018	228.511
expr:Freeboard	1.470764	0.638840	1.027542	0.971359	1.125885	1.481842	1.233770

EXISTING CONDITION - 10-YEAR - EAST SIDE PROFILE 8



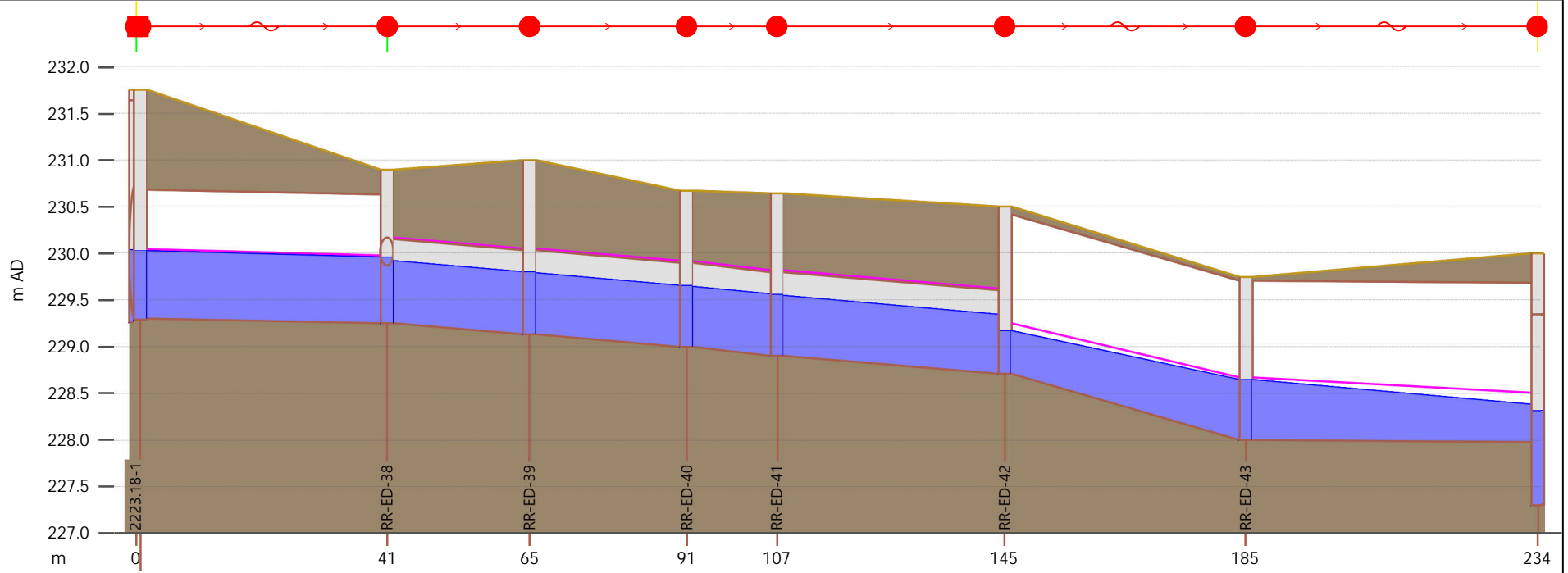
PROPOSED CONDITION - 10-YEAR - EAST SIDE PLAN 8

RVA PROJECT NO. 194615

FIGURE NO. 28C

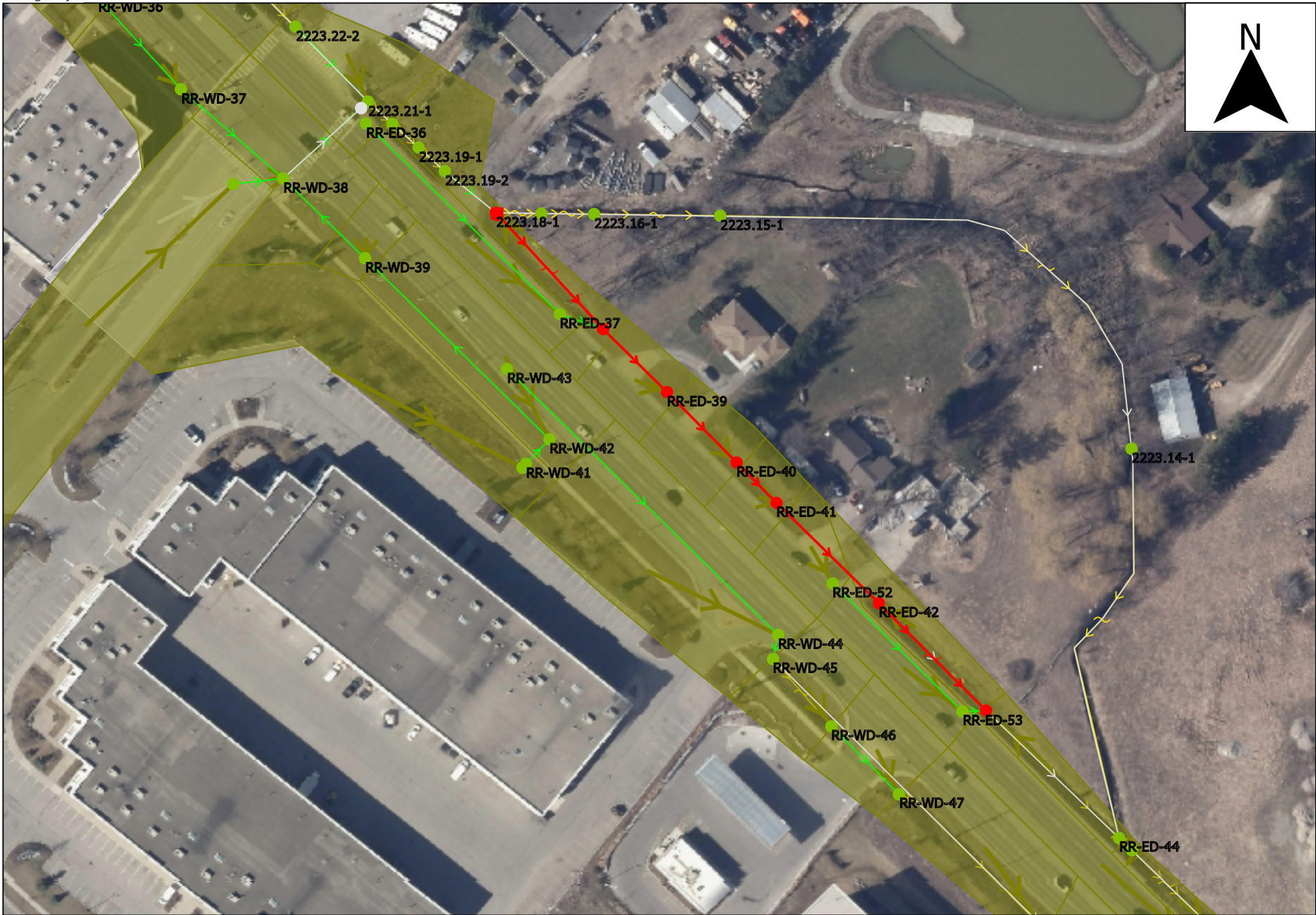
AUGUST 2021





Link	Dummy_0033.2	RR-ED-38.1	RR-ED-39.1	-	RR-ED-41.1	RR-ED-42.1	RR-ED-43.2	
US node ID	Dummy_0033	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	RR-ED-43	
ds node	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	RR-ED-43	RR-ED-44	
numbarrels	1	1	1	1	1	1	1	
length (m)		23.8	26.3	15.1	38.1			
Shape ID	East Side Ditch-8	CIRC	CIRC	CIRC	CIRC	East Side Ditch-9	East Side Ditch-9	
width (mm)		900	900	900	900			
height (mm)		900	900	900	900			
Rough type		N	N	N	N			
us inv (m AD)	229.300	229.250	229.132	229.000	228.900	228.708	228.000	
ds inv (m AD)	229.250	229.132	229.000	228.900	228.708	228.000	227.977	
grad (m/m)		0.00496	0.00502	0.00663	0.00504			
r.pfc (m3/s)	4.778	1.275	1.282	1.474	1.285	29.255	4.789	
US depth (m)	0.724	0.663	0.652	0.638	0.644	0.457	0.641	
US flow (m3/s)	1.13152	1.12830	1.12830	1.12830	1.12830	1.12830	1.12571	
US velocity (m/s)	0.651	2.245	2.286	2.339	2.314	1.313	0.761	
Node	Dummy_0033	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	RR-ED-43	RR-ED-44
Node ID	Dummy_0033	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	RR-ED-43	RR-ED-44
ground (m AD)	231.750	230.898	230.998	230.670	230.641	230.500	229.745	230.000
level (m AD)	230.024	229.957	229.797	229.651	229.558	229.165	228.641	228.310
expr:Freeboard	1.726273	0.941193	1.201004	1.018631	1.082932	1.334610	1.104146	1.690155

PROPOSED CONDITION - 10-YEAR - EAST SIDE PROFILE 8



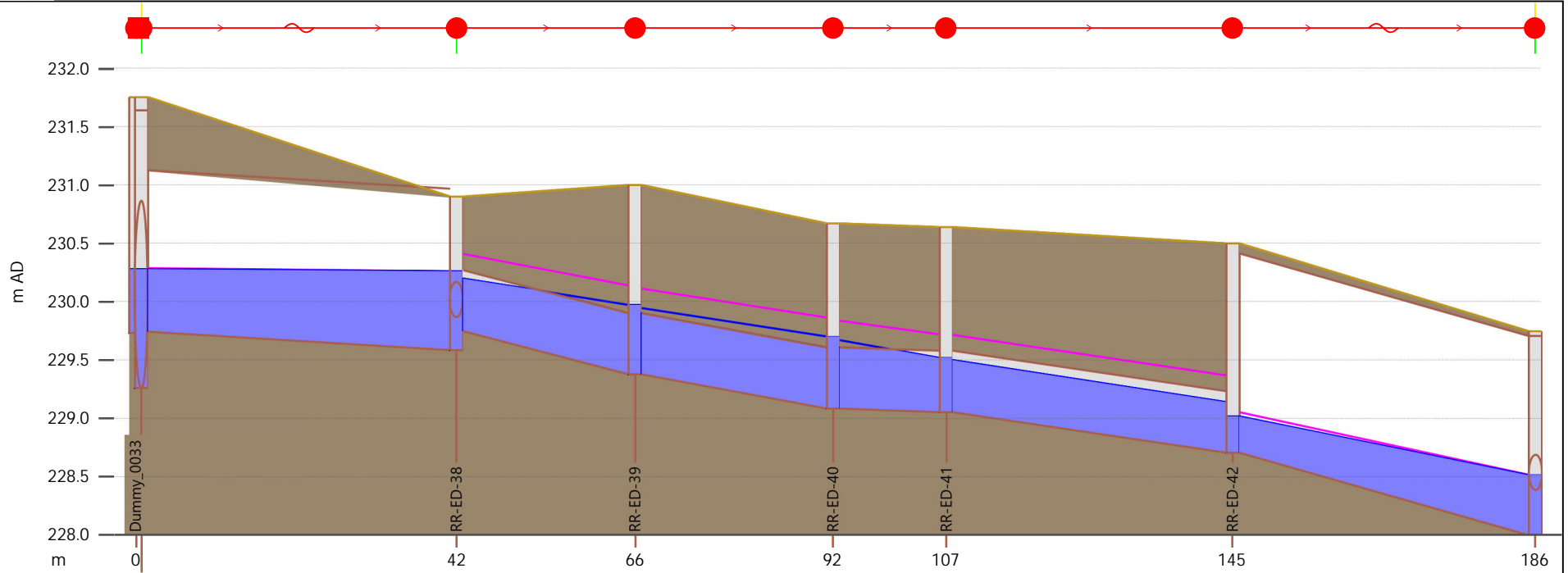
EXISTING CONDITION - 100-YEAR - EAST SIDE PLAN 8

RVA PROJECT NO. 194615

FIGURE NO. 28E

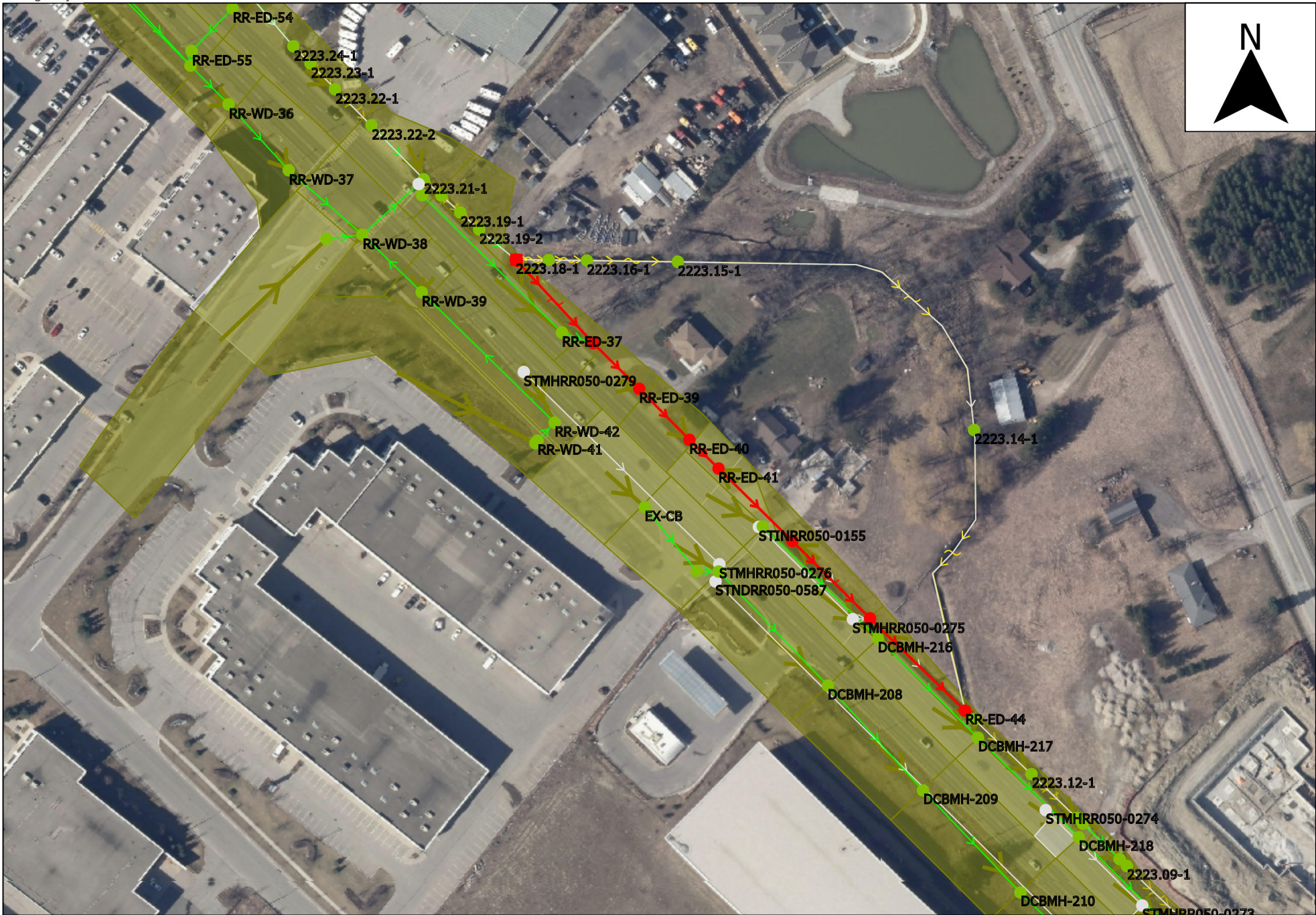
AUGUST 2021





Link	2223.18-1.2	RR-ED-38.1	RR-ED-39.1	RR-ED-40.1	RR-ED-41.1	RR-ED-42.1	
US node ID	2223.18-1	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	
ds node	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	RR-ED-43	
numbarrels	1	1	1	1	1	1	
length (m)		23.8	26.3	15.1	38.1		
Shape ID	East Side Ditch-8	CIRC	CIRC	CIRC	CIRC	East Side Ditch-9	
width (mm)		525	525	525	525		
height (mm)		525	525	525	525		
Rough type		N	N	N	N		
us inv (m AD)	229.743	229.745	229.376	229.083	229.054	228.708	
ds inv (m AD)	229.586	229.376	229.083	229.054	228.708	228.000	
grad (m/m)		0.01551	0.01114	0.00192	0.00908		
r.pfc (m3/s)	8.402	0.536	0.454	0.189	0.410	29.255	
US depth (m)	0.536	0.454	0.568	0.587	0.443	0.310	
US flow (m3/s)	0.40712	0.40410	0.40409	0.40409	0.40409	0.40409	
US velocity (m/s)	0.524	2.470	2.013	1.800	2.155	0.852	
Node	2223.18-1	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	RR-ED-43
Node ID	2223.18-1	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	RR-ED-43
ground (m AD)	231.750	230.898	230.998	230.670	230.641	230.500	229.745
level (m AD)	230.279	230.259	229.971	229.698	229.515	229.018	228.511
expr:Freeboard	1.470764	0.638840	1.027542	0.971359	1.125885	1.481842	1.233770

EXISTING CONDITION - 100-YEAR - EAST SIDE PROFILE 8



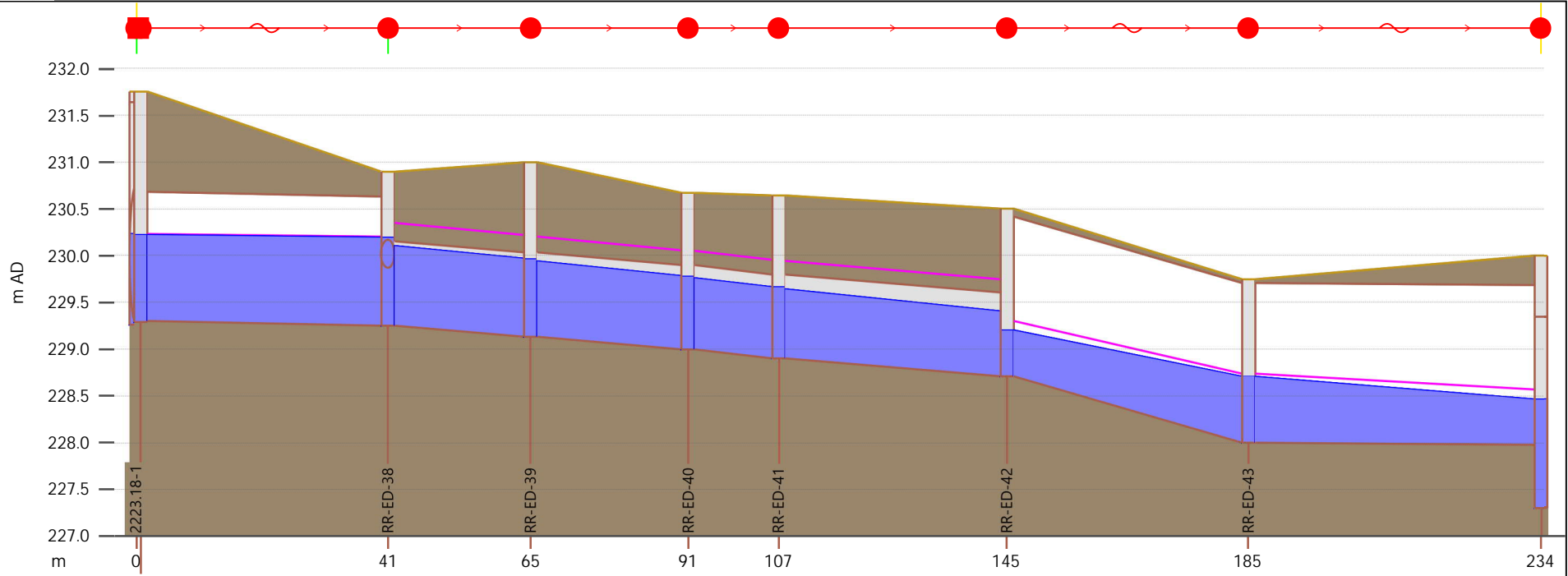
PROPOSED CONDITION - 100-YEAR - EAST SIDE PLAN 8

RVA PROJECT NO. 194615

FIGURE NO. 28G

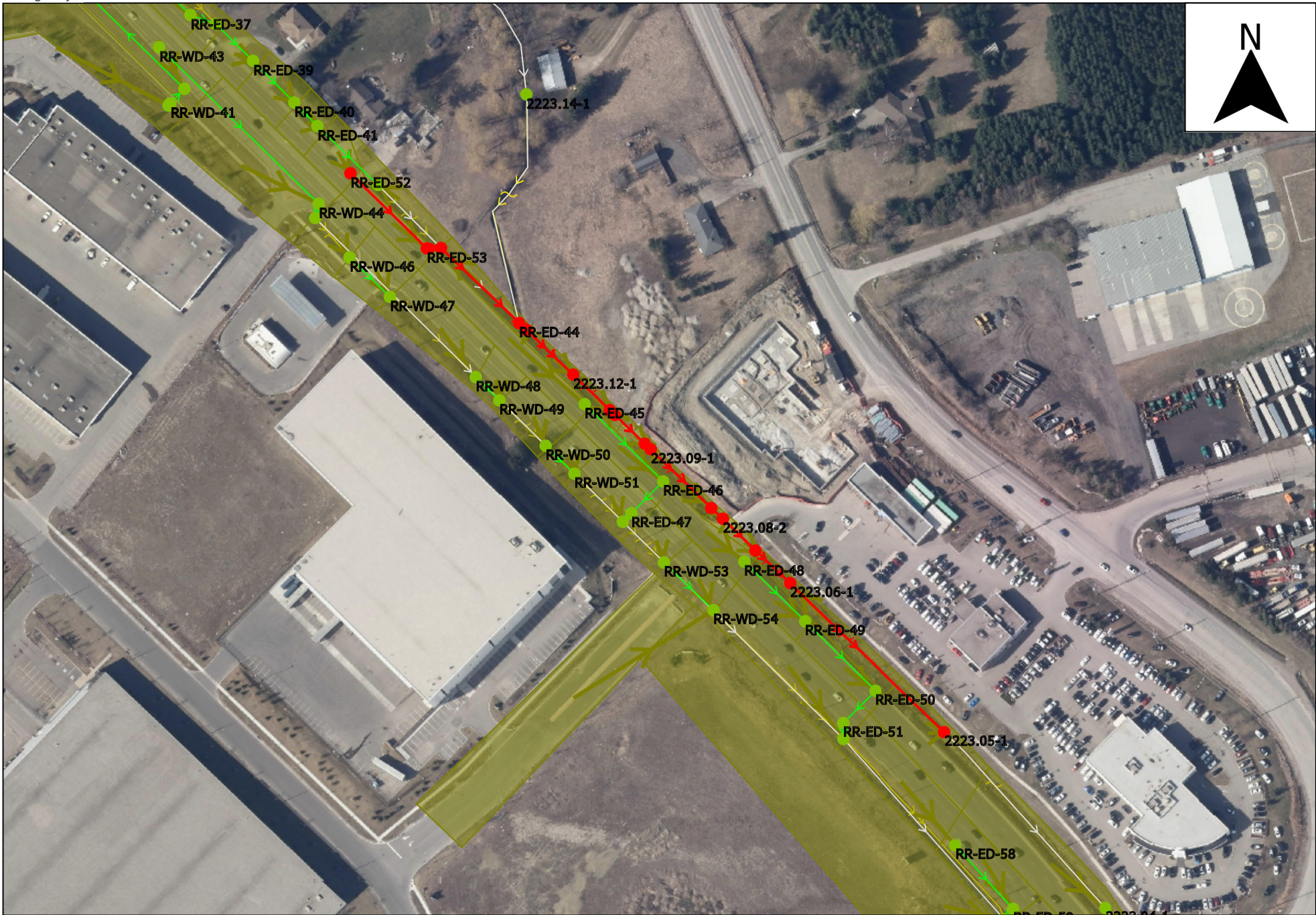
AUGUST 2021





Link	Dummy_0033.2	RR-ED-38.1	RR-ED-39.1	-	RR-ED-41.1	RR-ED-42.1	RR-ED-43.2	
US node ID	Dummy_0033	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	RR-ED-43	
ds node	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	RR-ED-43	RR-ED-44	
numbarrels	1	1	1	1	1	1	1	
length (m)		23.8	26.3	15.1	38.1			
Shape ID	East Side Ditch-8	CIRC	CIRC	CIRC	CIRC	East Side Ditch-9	East Side Ditch-9	
width (mm)		900	900	900	900			
height (mm)		900	900	900	900			
Rough type		N	N	N	N			
us inv (m AD)	229.300	229.250	229.132	229.000	228.900	228.708	228.000	
ds inv (m AD)	229.250	229.132	229.000	228.900	228.708	228.000	227.977	
grad (m/m)		0.00496	0.00502	0.00663	0.00504			
r.pfc (m3/s)	4.778	1.275	1.282	1.474	1.285	29.255	4.789	
US depth (m)	0.919	0.854	0.806	0.755	0.739	0.493	0.704	
US flow (m3/s)	1.37405	1.37030	1.37030	1.37030	1.37030	1.37030	1.36761	
US velocity (m/s)	0.658	2.252	2.307	2.406	2.453	1.419	0.807	
Node	Dummy_0033	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	RR-ED-43	RR-ED-44
Node ID	Dummy_0033	RR-ED-38	RR-ED-39	RR-ED-40	RR-ED-41	RR-ED-42	RR-ED-43	RR-ED-44
ground (m AD)	231.750	230.898	230.998	230.670	230.641	230.500	229.745	230.000
level (m AD)	230.219	230.190	229.961	229.777	229.661	229.201	228.704	228.460
expr:Freeboard	1.531158	0.708023	1.036911	0.892380	0.979858	1.299438	1.040502	1.540070

PROPOSED CONDITION - 100-YEAR - EAST SIDE PROFILE 8



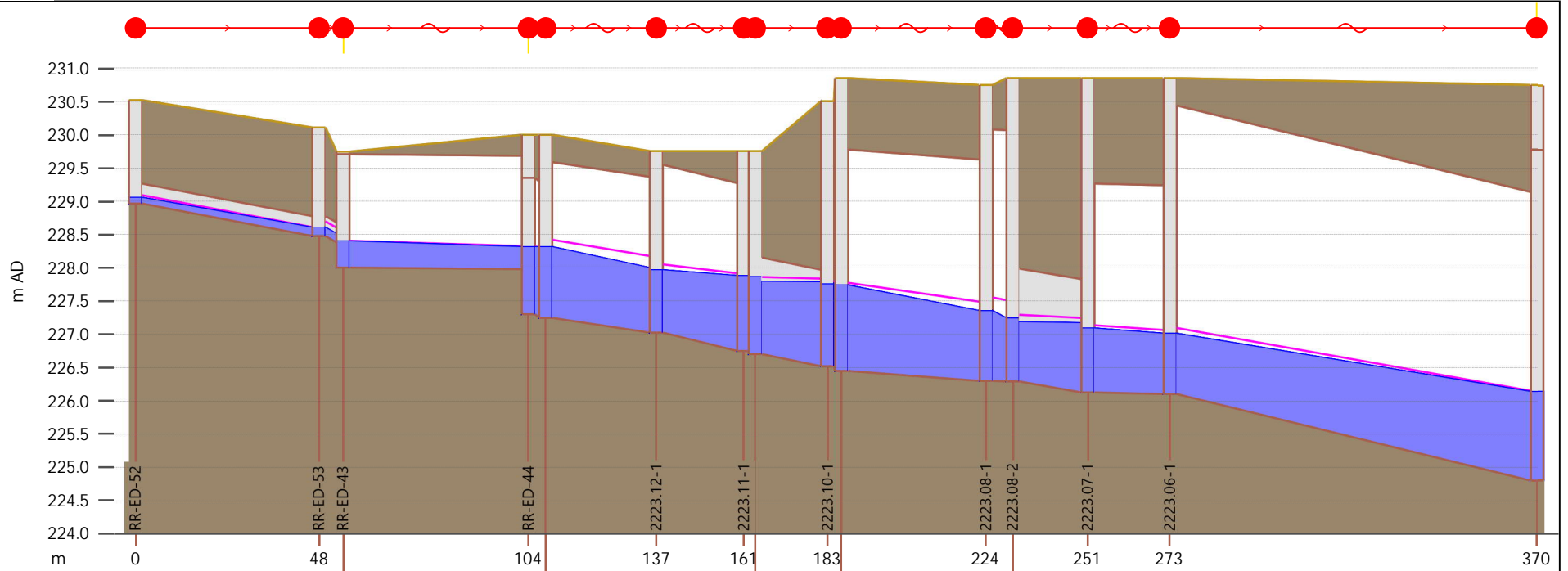
EXISTING CONDITION - 10-YEAR - EAST SIDE PLAN 9

RVA PROJECT NO. 194615

FIGURE NO. 29A

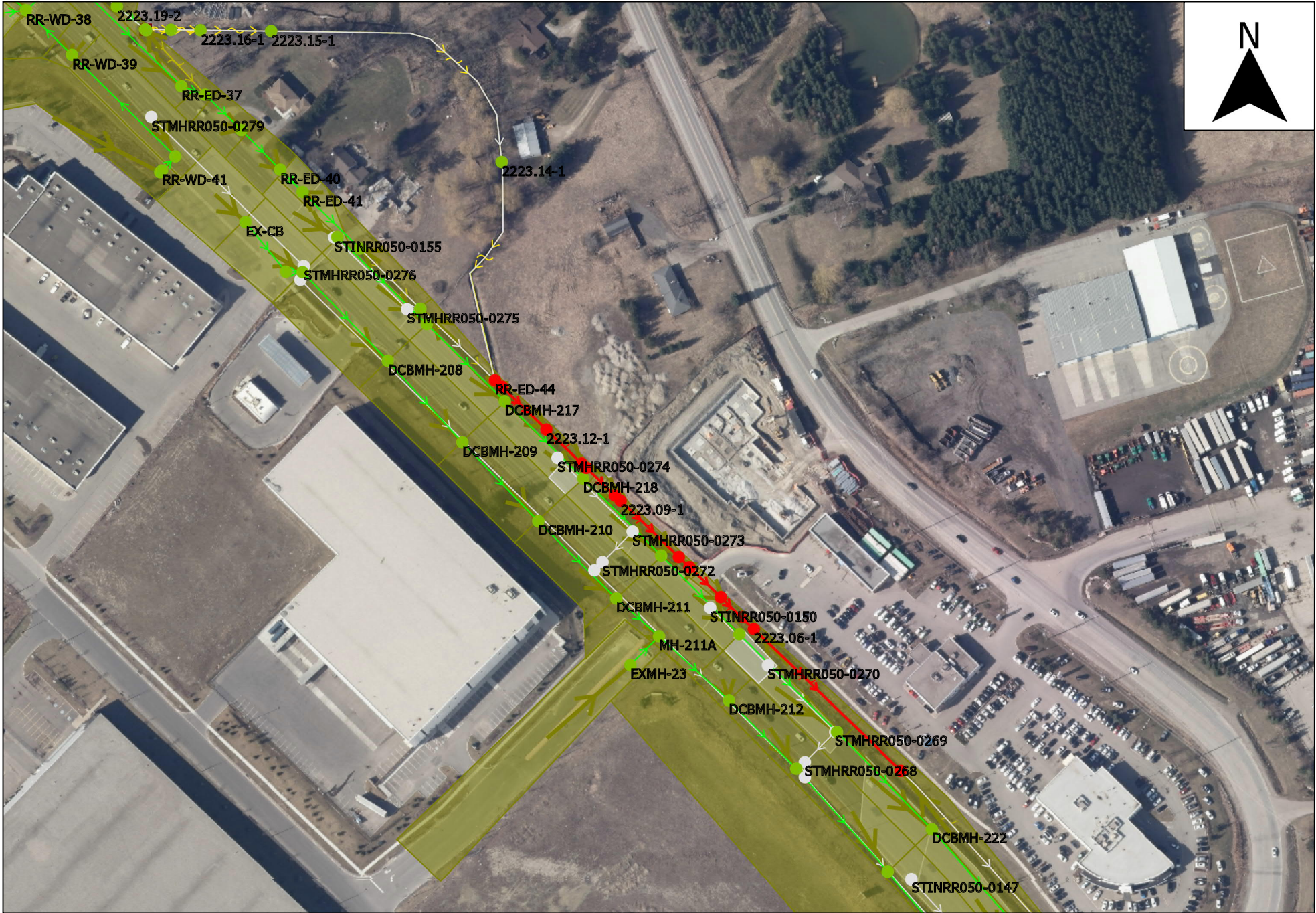
AUGUST 2021





Link	RR-ED-52.1	-	RR-ED-43.2	-	2223.13-1.1	-	-	-	2223.09-1.1	-	-	-	2223.06-1.1	
US node ID	RR-ED-52	-	RR-ED-43	-	2223.13-1	2223.12-1	-	-	2223.09-1	-	-	-	2223.06-1	
ds node	RR-ED-53	-	RR-ED-44	-	2223.12-1	2223.11-1	-	-	2223.08-1	-	-	-	2223.05-1	
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1	
length (m)	48.4	-	-	-	-	-	19.0	-	19.8	-	-	-	-	
Shape ID	CIRC	-	East Side Ditch-9	-	-	-	RECT	Matrix-2223.09	RECT	-	-	-	Matrix-2223.06	
width (mm)	300	-	-	-	-	-	4500	-	4500	-	-	-	-	
height (mm)	300	-	-	-	-	-	1450	-	1700	-	-	-	-	
Rough type	N	N	-	-	-	-	N	-	N	-	-	-	-	
us inv (m AD)	228.968	-	228.000	-	227.250	227.022	226.700	226.450	226.290	226.130	-	-	226.100	
ds inv (m AD)	228.478	-	227.977	-	227.022	226.750	226.520	226.300	226.130	226.100	-	-	224.803	
grad (m/m)	0.01012	-	-	-	-	-	0.00947	-	0.00808	-	-	-	-	
r.pfc (m3/s)	0.097	-	4.789	-	103.563	123.244	24.208	216.006	38.336	108.743	-	-	1477.149	
US depth (m)	0.083	-	0.394	-	1.057	0.938	1.092	1.288	0.892	0.959	-	-	0.911	
US flow (m3/s)	0.01416	-	0.26894	-	5.83679	5.83679	5.83679	5.83679	5.83679	5.83679	-	-	5.83679	
US velocity (m/s)	0.886	-	0.394	-	1.523	1.328	1.188	0.841	1.455	0.945	-	-	1.300	
Node	-	RR-ED-53	RR-ED-43	RR-ED-44	-	2223.12-1	-	-	-	-	-	-	2223.06-1	2223.05-1
Node ID	-	RR-ED-53	RR-ED-43	RR-ED-44	-	2223.12-1	-	-	-	-	-	-	2223.06-1	2223.05-1
ground (m AD)	230.517	230.105	229.745	230.000	-	229.750	-	230.850	230.750	-	-	230.850	230.750	
level (m AD)	229.051	228.600	228.394	228.310	-	227.960	-	227.738	227.349	-	-	227.011	226.135	
expr:Freeboard	1.466248	1.504883	1.350530	1.690231	-	1.789978	-	-	-	-	-	3.839410	4.615448	

EXISTING CONDITION - 10-YEAR - EAST SIDE PROFILE 9



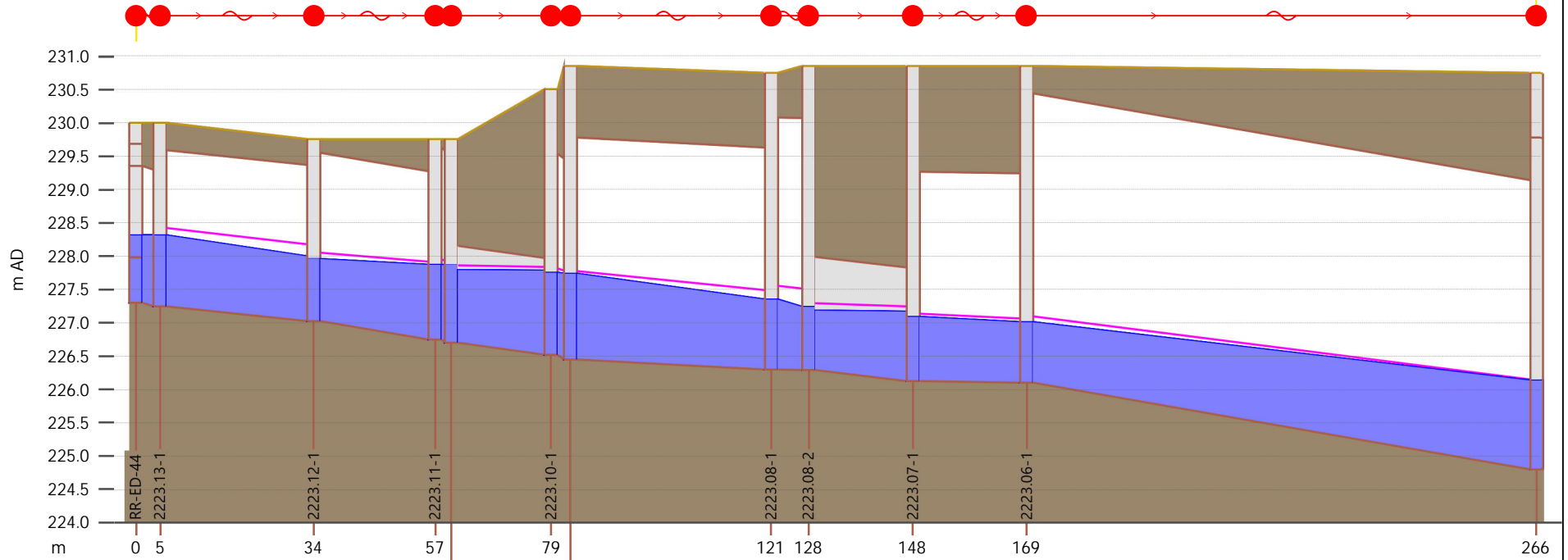
PROPOSED CONDITION - 10-YEAR - EAST SIDE PLAN 9

RVA PROJECT NO. 194615

FIGURE NO. 29C

AUGUST 2021





Link	-	2223.13-1.1	2223.12-1.1	2223.11-2.1	-	2223.09-1.1	-	2223.08-2.1	2223.07-1.1		2223.06-1.1	
US node ID	-	2223.13-1	2223.12-1	2223.11-2	-	2223.09-1	-	2223.08-2	2223.07-1		2223.06-1	
ds node	-	2223.12-1	2223.11-1	2223.10-1	-	2223.08-1	-	2223.07-1	2223.06-1		2223.05-1	
numbarrels	1	1	1	1	1	1	1	1	1		1	
length (m)				19.0				19.8				
Shape ID	-	Matrix-2223.13	-	RECT	-	Matrix-2223.09	-	RECT	-		Matrix-2223.06	
width (mm)				4500				4500				
height (mm)				1450				1700				
Rough type				N				N				
us inv (m AD)	-	227.250	227.022	226.700	-	226.450	-	226.290	226.130		226.100	
ds inv (m AD)	-	227.022	226.750	226.520	-	226.300	-	226.130	226.100		224.803	
grad (m/m)				0.00947				0.00808				
r.pfc (m ³ /s)	-	103.563	123.244	32.728	-	216.006	-	38.336	108.743		1477.149	
US depth (m)	-	1.058	0.936	1.087	-	1.288	-	0.892	0.959		0.911	
US flow (m ³ /s)	-	5.83809	5.83809	5.83809	-	5.83809	-	5.83809	5.83809		5.83809	
US velocity (m/s)	-	1.524	1.334	1.193	-	0.841	-	1.455	0.945		1.300	
Node	-	2223.12-1	-	-	-	2223.09-1	2223.08-1	-	2223.07-1	2223.06-1		2223.05-1
Node ID	-	2223.12-1	-	-	-	2223.09-1	2223.08-1	-	2223.07-1	2223.06-1		2223.05-1
ground (m AD)		230.000	229.750	-	-	230.850	230.750	-	230.850	230.850		230.750
level (m AD)		228.307	227.958	-	-	227.738	227.349	-	227.089	227.011		226.135
expr:Freeboard		1.692505	1.792435	-	-	3.112131	3.400528	-	3.760614	3.839365		4.615356

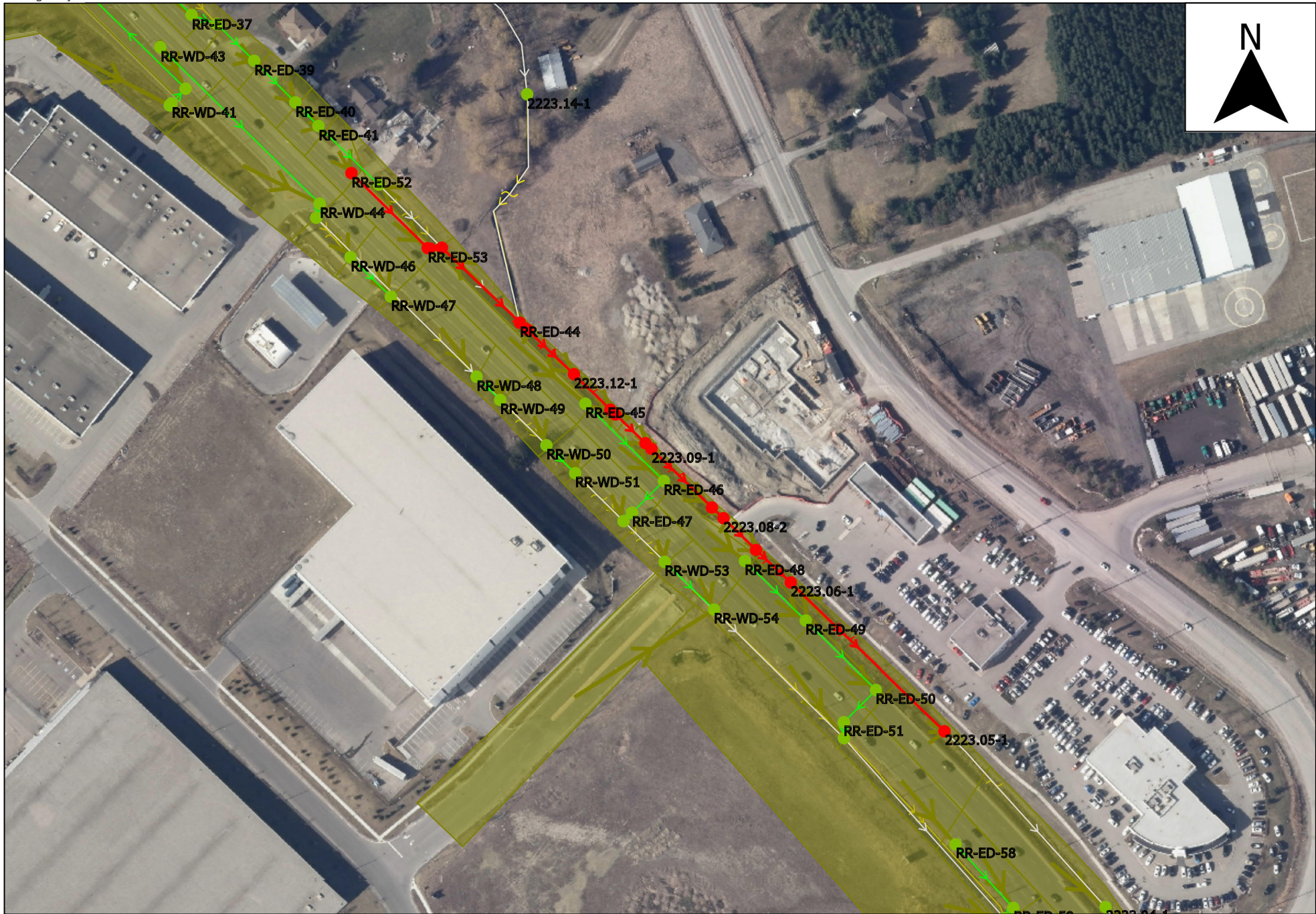
PROPOSED CONDITION - 10-YEAR - EAST SIDE PROFILE 9

RVA PROJECT NO. 194615

FIGURE NO. 29D

AUGUST 2021





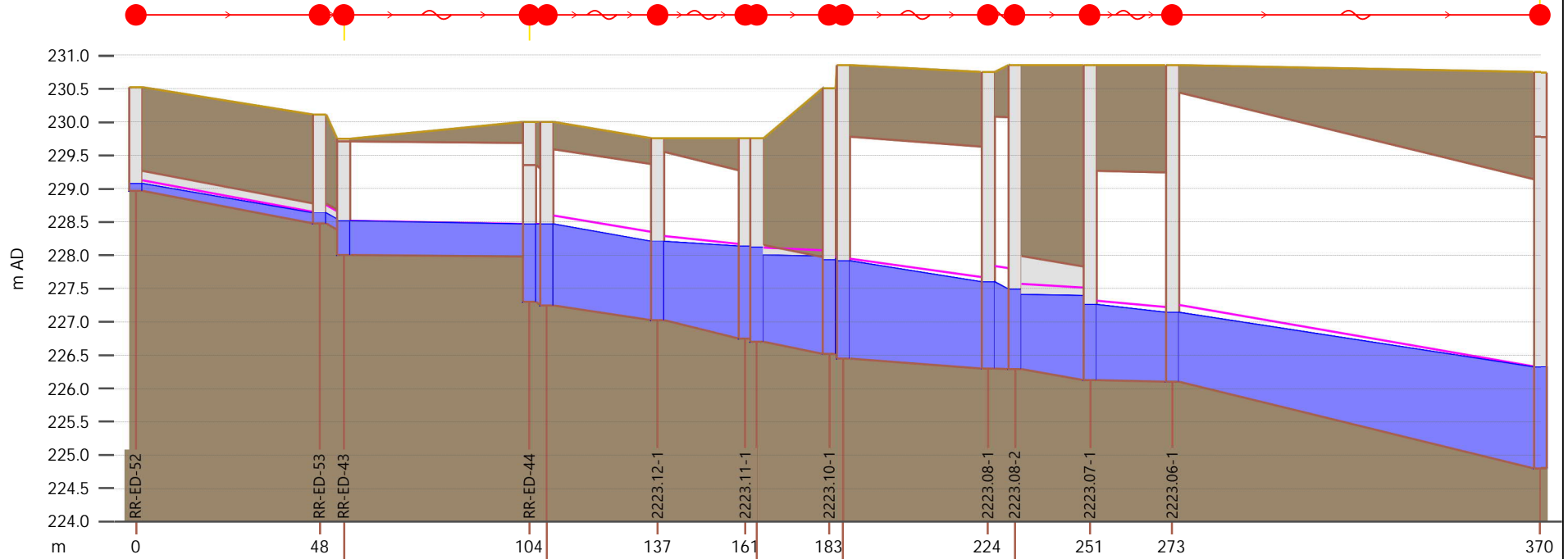
EXISTING CONDITION - 100-YEAR - EAST SIDE PLAN 9

RVA PROJECT NO. 194615

FIGURE NO. 29E

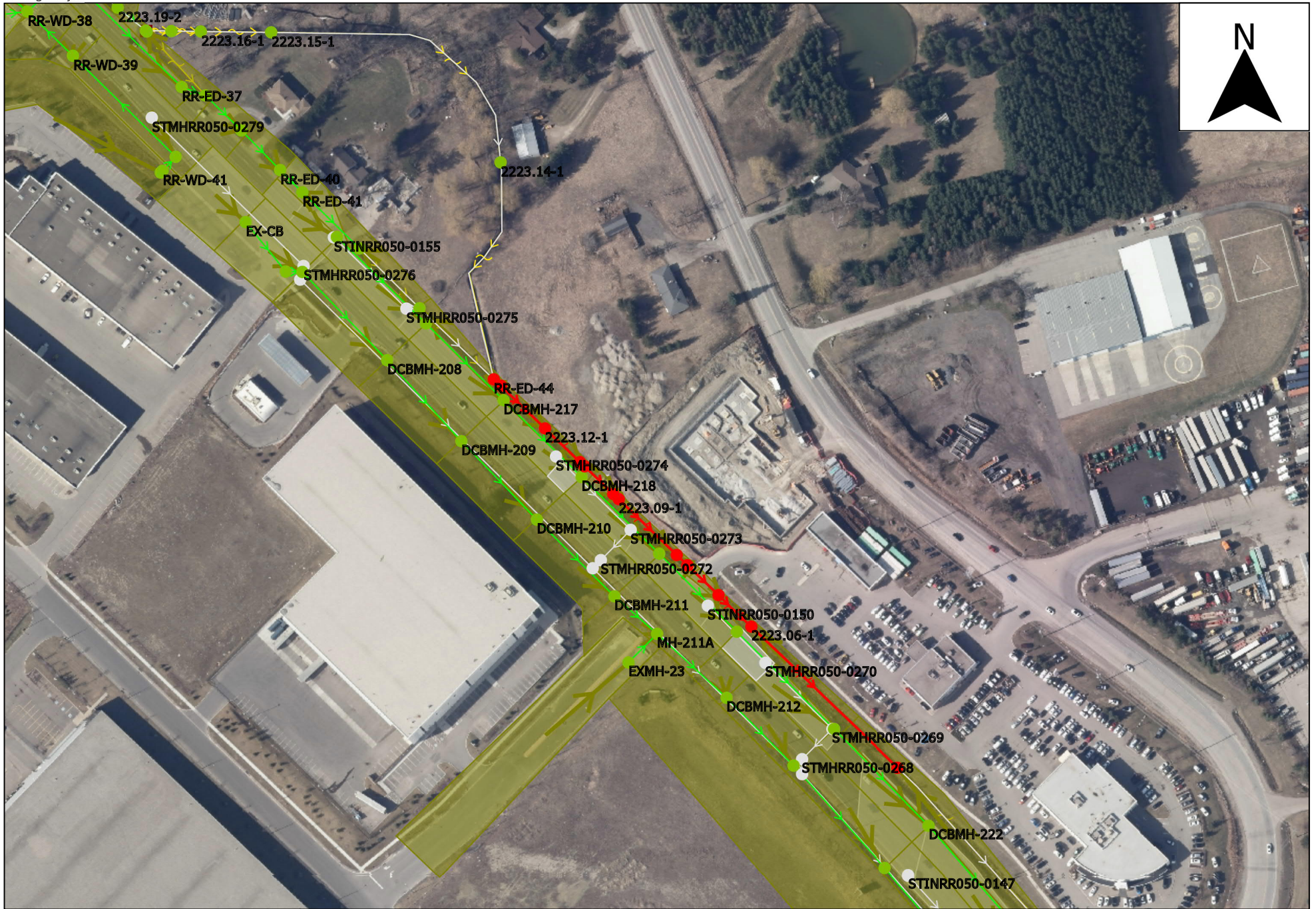
AUGUST 2021





Link	RR-ED-52.1	-	RR-ED-43.2	-	2223.13-1.1	-	-	-	2223.09-1.1	-	-	-	2223.06-1.1	
US node ID	RR-ED-52	-	RR-ED-43	-	2223.13-1	2223.12-1	-	-	2223.09-1	-	-	-	2223.06-1	
ds node	RR-ED-53	-	RR-ED-44	-	2223.12-1	2223.11-1	-	-	2223.08-1	-	-	-	2223.05-1	
numbarrels	1	1	1	1	1	1	1	1	1	1	1	1	1	
length (m)	48.4	-	-	-	-	-	19.0	-	-	19.8	-	-	-	
Shape ID	CIRC	-	East Side Ditch-9	-	-	-	RECT	Matrix-2223.09	-	RECT	-	-	Matrix-2223.06	
width (mm)	300	-	-	-	-	-	4500	-	-	4500	-	-	-	
height (mm)	300	-	-	-	-	-	1450	-	-	1700	-	-	-	
Rough type	N	N	-	-	-	-	N	-	-	N	-	-	-	
us inv (m AD)	228.968	-	228.000	-	227.250	227.022	226.700	226.450	-	226.290	226.130	-	226.100	
ds inv (m AD)	228.478	-	227.977	-	227.022	226.750	226.520	226.300	-	226.130	226.100	-	224.803	
grad (m/m)	0.01012	-	-	-	-	-	0.00947	-	-	0.00808	-	-	-	
r.pfc (m3/s)	0.097	-	4.789	-	103.563	123.244	24.208	216.006	-	38.336	108.743	-	1477.149	
US depth (m)	0.102	-	0.511	-	1.207	1.175	1.294	1.462	-	1.111	1.125	-	1.038	
US flow (m3/s)	0.02195	-	0.40184	-	9.02716	9.02712	9.02707	9.02706	-	9.02700	9.02701	-	9.02705	
US velocity (m/s)	1.034	-	0.443	-	1.629	1.351	1.550	0.861	-	1.806	1.096	-	1.485	
Node	-	RR-ED-53	RR-ED-43	RR-ED-44	-	2223.12-1	-	-	-	-	-	-	2223.06-1	2223.05-1
Node ID	-	RR-ED-53	RR-ED-43	RR-ED-44	-	2223.12-1	-	-	-	-	-	-	2223.06-1	2223.05-1
ground (m AD)	230.517	230.105	229.745	230.000	-	229.750	-	-	230.850	230.750	-	-	230.850	230.750
level (m AD)	229.070	228.628	228.511	228.459	-	228.197	-	-	227.912	227.590	-	-	227.138	226.314
expr:Freeboard	1.447281	1.477417	1.233770	1.540741	-	1.552765	-	-	-	-	-	-	3.712244	4.436066

EXISTING CONDITION - 100-YEAR - EAST SIDE PROFILE 9

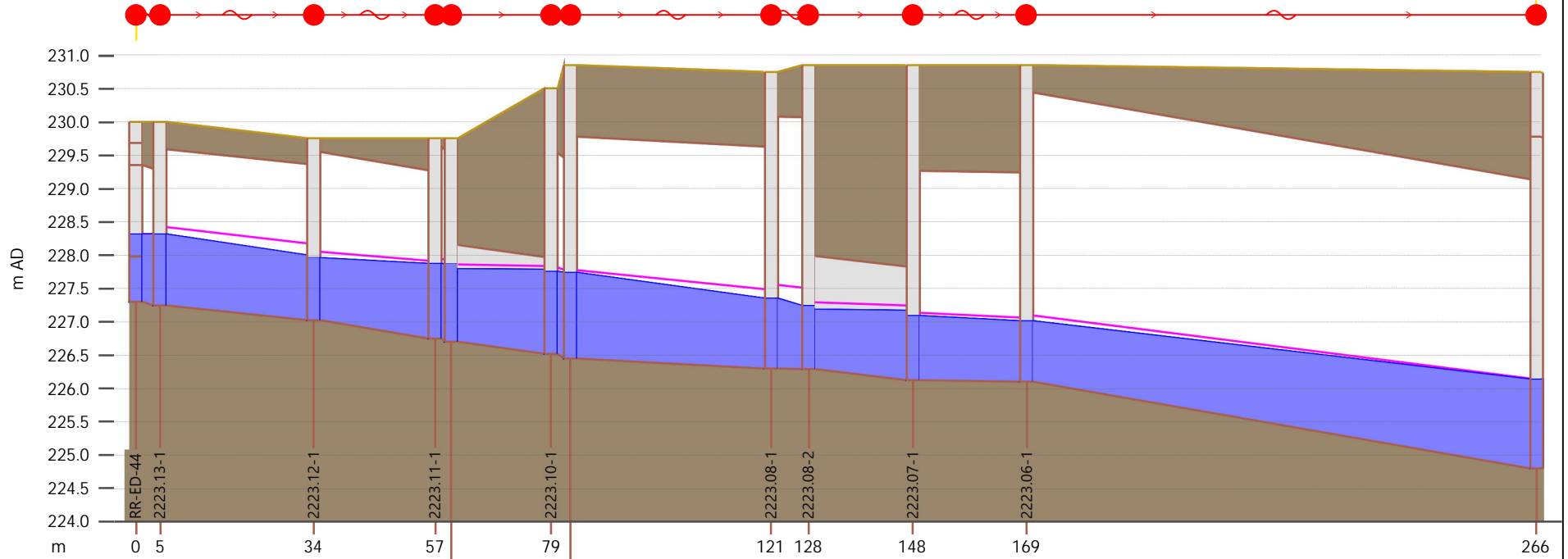


PROPOSED CONDITION - 100-YEAR - EAST SIDE PLAN 9

RVA PROJECT NO. 194615

FIGURE NO. 29G

AUGUST 2021



Link	-	2223.13-1.1	2223.12-1.1	2223.11-2.1	-	2223.09-1.1	-	2223.08-2.1	2223.07-1.1		2223.06-1.1	
US node ID	-	2223.13-1	2223.12-1	2223.11-2	-	2223.09-1	-	2223.08-2	2223.07-1		2223.06-1	
ds node	-	2223.12-1	2223.11-1	2223.10-1	-	2223.08-1	-	2223.07-1	2223.06-1		2223.05-1	
numbarrels	1	1	1	1	1	1	1	1	1		1	
length (m)				19.0				19.8				
Shape ID	-	Matrix-2223.13	-	RECT	-	Matrix-2223.09	-	RECT	-		Matrix-2223.06	
width (mm)				4500				4500				
height (mm)				1450				1700				
Rough type				N				N				
us inv (m AD)	-	227.250	227.022	226.700	-	226.450	-	226.290	226.130		226.100	
ds inv (m AD)	-	227.022	226.750	226.520	-	226.300	-	226.130	226.100		224.803	
grad (m/m)				0.00947				0.00808				
r.pfc (m ³ /s)	-	103.563	123.244	32.728	-	216.006	-	38.336	108.743		1477.149	
US depth (m)	-	1.058	0.936	1.087	-	1.288	-	0.892	0.959		0.911	
US flow (m ³ /s)	-	5.83809	5.83809	5.83809	-	5.83809	-	5.83809	5.83809		5.83809	
US velocity (m/s)	-	1.524	1.334	1.193	-	0.841	-	1.455	0.945		1.300	
Node	-	2223.12-1	-	-	-	2223.09-1	2223.08-1	-	2223.07-1	2223.06-1		2223.05-1
Node ID	-	2223.12-1	-	-	-	2223.09-1	2223.08-1	-	2223.07-1	2223.06-1		2223.05-1
ground (m AD)		230.000	229.750	-	-	230.850	230.750	-	230.850	230.850		230.750
level (m AD)		228.307	227.958	-	-	227.738	227.349	-	227.089	227.011		226.135
expr:Freeboard		1.692505	1.792435	-	-	3.112131	3.400528	-	3.760614	3.839365		4.615356

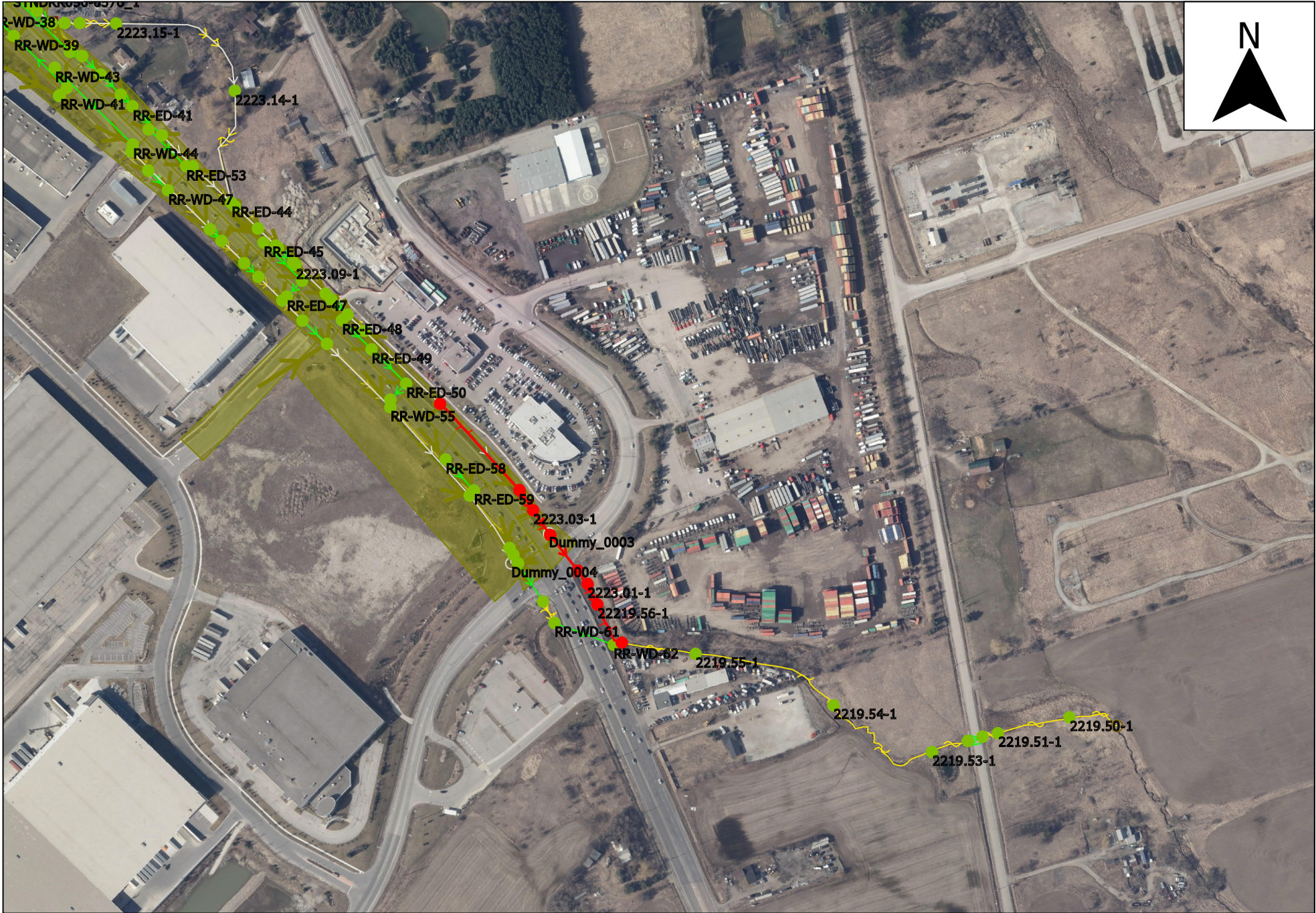
PROPOSED CONDITION - 100-YEAR - EAST SIDE PROFILE 9

RVA PROJECT NO. 194615

FIGURE NO. 29H

AUGUST 2021





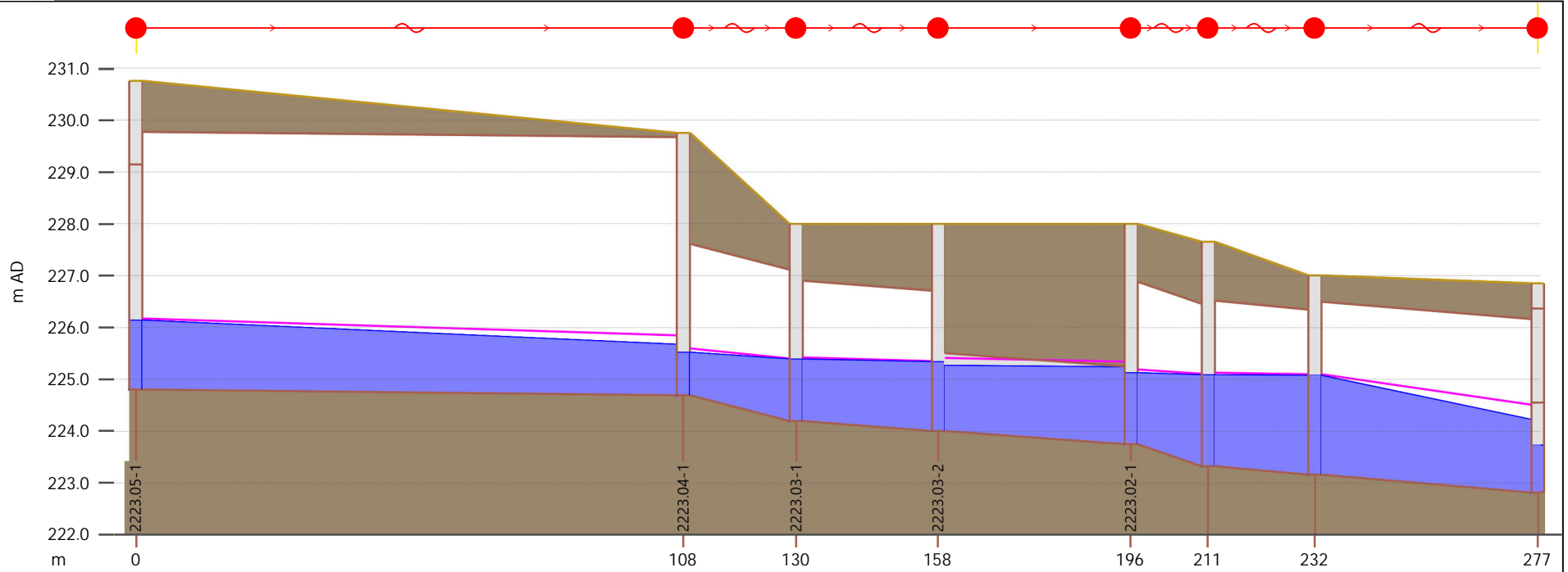
EXISTING CONDITION - 10-YEAR - EAST SIDE PLAN 10

RVA PROJECT NO. 194615

FIGURE NO. 30A

AUGUST 2021





Link	2223.05-1.1	2223.04-1.1	2223.03-1.1	2223.03-2.1	-	2223.01-1.1	22219.56-1.1	
US node ID	2223.05-1	2223.04-1	2223.03-1	2223.03-2	-	2223.01-1	22219.56-1	
ds node	2223.04-1	2223.03-1	2223.03-2	2223.02-1	-	22219.56-1	RR-WD-63	
numbarrels	1	1	1	1	1	1	1	
length (m)				38.0				
Shape ID	Matrix-2223.05	-	Matrix-2223.03	RECT	-	-	Matrix-2219.56	
width (mm)				4500				
height (mm)				1500				
Rough type				N				
us inv (m AD)	224.803	224.696	224.200	224.000	223.750	223.326	223.160	
ds inv (m AD)	224.696	224.200	224.000	223.750	223.326	223.160	222.822	
grad (m/m)				0.00658				
r.pfc (m3/s)	775.159	486.695	249.889	28.698	357.148	154.934	418.526	
US depth (m)	1.332	0.820	1.184	1.261	1.370	1.757	1.911	
US flow (m3/s)	5.83679	9.71680	9.71680	9.71680	9.71680	9.71680	10.47680	
US velocity (m/s)	0.889	1.255	1.386	1.712	1.150	0.929	0.987	
Node	2223.05-1	2223.04-1	2223.03-1	2223.03-2	2223.02-1	-	22219.56-1	RR-WD-63
Node ID	2223.05-1	2223.04-1	2223.03-1	2223.03-2	2223.02-1	-	22219.56-1	RR-WD-63
ground (m AD)	230.750	229.750	228.000	228.000	228.000	227.650	227.000	226.850
level (m AD)	226.135	225.516	225.384	225.336	225.120	225.083	225.071	223.719
expr:Freeboard	4.615448	4.234421	2.616394	2.663925	2.880203	2.567175	1.928757	3.130807

EXISTING CONDITION - 10-YEAR - EAST SIDE PROFILE 10



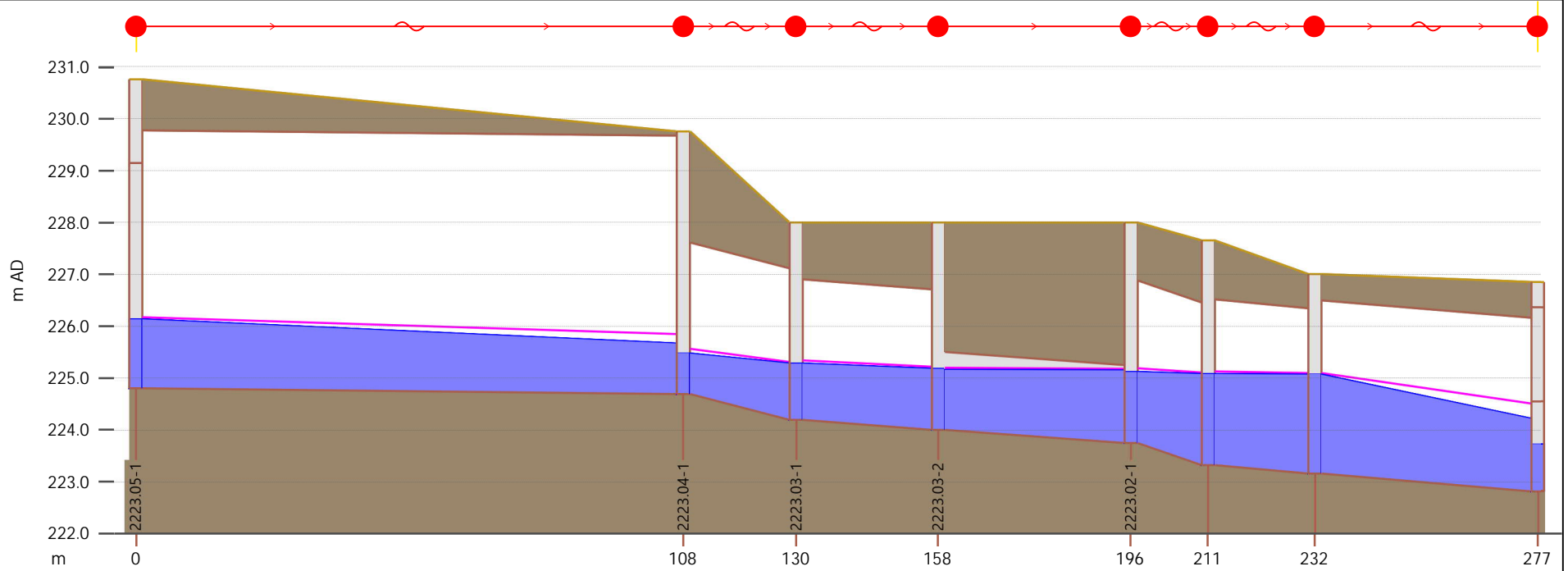
PROPOSED CONDITION - 10-YEAR - EAST SIDE PLAN 10

RVA PROJECT NO. 194615

FIGURE NO. 30C

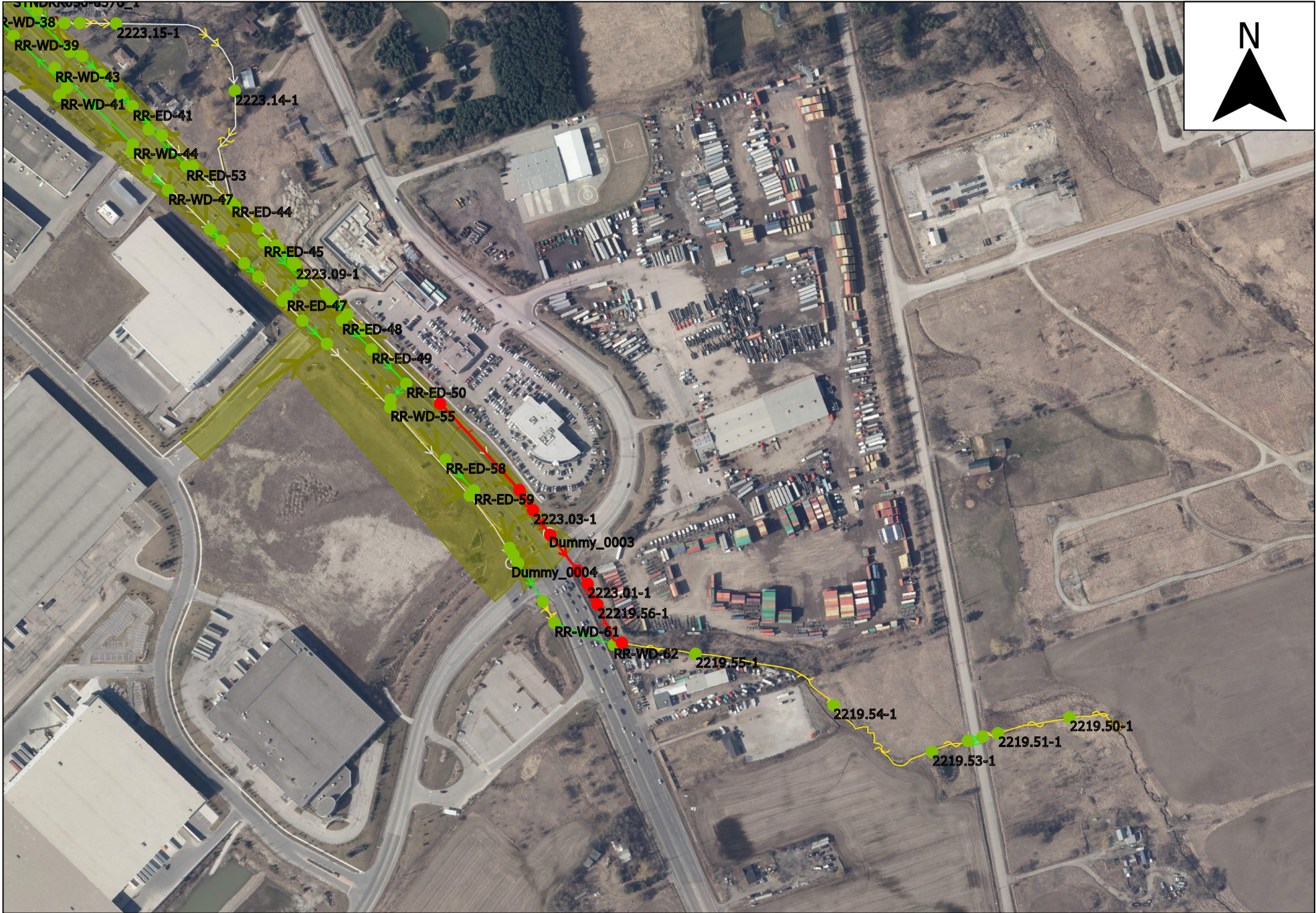
AUGUST 2021



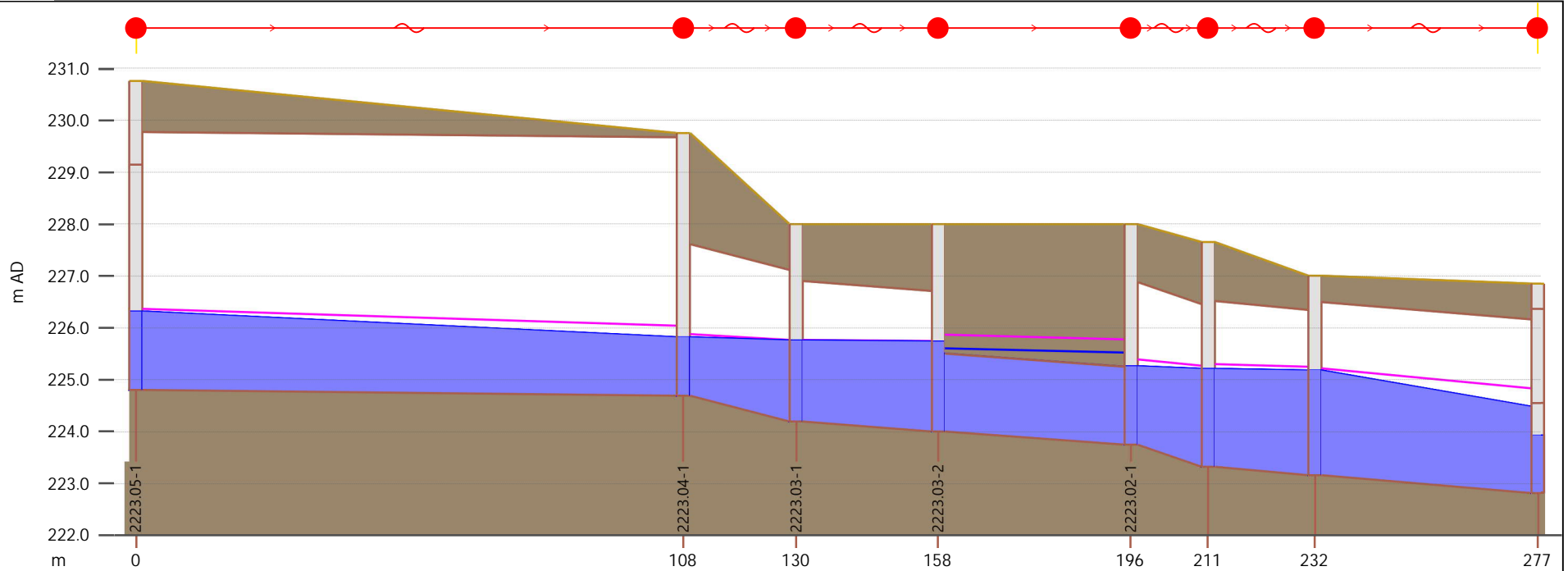


Link	2223.05-1.1	2223.04-1.1	2223.03-1.1	2223.03-2.1	-	2223.01-1.1	22219.56-1.1	
US node ID	2223.05-1	2223.04-1	2223.03-1	2223.03-2	-	2223.01-1	22219.56-1	
ds node	2223.04-1	2223.03-1	2223.03-2	2223.02-1	-	22219.56-1	RR-WD-63	
numbarrels	1	1	1	2	1	1	1	
length (m)				38.0				
Shape ID	Matrix-2223.05	-	Matrix-2223.03	RECT	-	-	Matrix-2219.56	
width (mm)				4500				
height (mm)				1500				
Rough type				N				
us inv (m AD)	224.803	224.696	224.200	224.000	223.750	223.326	223.160	
ds inv (m AD)	224.696	224.200	224.000	223.750	223.326	223.160	222.822	
grad (m/m)				0.00658				
r.pfc (m3/s)	775.159	486.695	249.889	28.698	357.148	154.934	418.526	
US depth (m)	1.332	0.778	1.082	1.159	1.370	1.757	1.911	
US flow (m3/s)	5.83809	9.71809	9.71809	9.71809	9.71809	9.71809	10.47809	
US velocity (m/s)	0.889	1.350	1.452	0.932	1.150	0.929	0.989	
Node	2223.05-1	2223.04-1	2223.03-1	2223.03-2	2223.02-1	-	22219.56-1	RR-WD-63
Node ID	2223.05-1	2223.04-1	2223.03-1	2223.03-2	2223.02-1	-	22219.56-1	RR-WD-63
ground (m AD)	230.750	229.750	228.000	228.000	228.000	227.650	227.000	226.850
level (m AD)	226.135	225.474	225.282	225.181	225.120	225.083	225.071	223.725
expr:Freeboard	4.615356	4.276352	2.717606	2.818970	2.880173	2.567145	1.928726	3.125146

PROPOSED CONDITION - 10-YEAR - EAST SIDE PROFILE 10



EXISTING CONDITION - 100-YEAR - EAST SIDE PLAN 10



Link	2223.05-1.1	2223.04-1.1	2223.03-1.1	2223.03-2.1	-	2223.01-1.1	22219.56-1.1	
US node ID	2223.05-1	2223.04-1	2223.03-1	2223.03-2	-	2223.01-1	22219.56-1	
ds node	2223.04-1	2223.03-1	2223.03-2	2223.02-1	-	22219.56-1	RR-WD-63	
numbarrels	1	1	1	1	1	1	1	
length (m)				38.0				
Shape ID	Matrix-2223.05	-	Matrix-2223.03	RECT	-	-	Matrix-2219.56	
width (mm)				4500				
height (mm)				1500				
Rough type				N				
us inv (m AD)	224.803	224.696	224.200	224.000	223.750	223.326	223.160	
ds inv (m AD)	224.696	224.200	224.000	223.750	223.326	223.160	222.822	
grad (m/m)				0.00658				
r.pfc (m3/s)	775.159	486.695	249.889	28.698	357.148	154.934	418.526	
US depth (m)	1.511	1.125	1.555	1.602	1.515	1.882	2.024	
US flow (m3/s)	9.04131	15.77637	15.77622	15.77589	15.77588	15.77587	17.15586	
US velocity (m/s)	1.024	1.379	1.524	2.279	1.597	1.324	1.027	
Node	2223.05-1	2223.04-1	2223.03-1	2223.03-2	2223.02-1	-	22219.56-1	RR-WD-63
Node ID	2223.05-1	2223.04-1	2223.03-1	2223.03-2	2223.02-1	-	22219.56-1	RR-WD-63
ground (m AD)	230.750	229.750	228.000	228.000	228.000	227.650	227.000	226.850
level (m AD)	226.314	225.821	225.755	225.735	225.265	225.208	225.184	223.925
expr:Freeboard	4.436066	3.929199	2.245102	2.265457	2.734970	2.441672	1.816269	2.924966

EXISTING CONDITION - 100-YEAR - EAST SIDE PROFILE 10



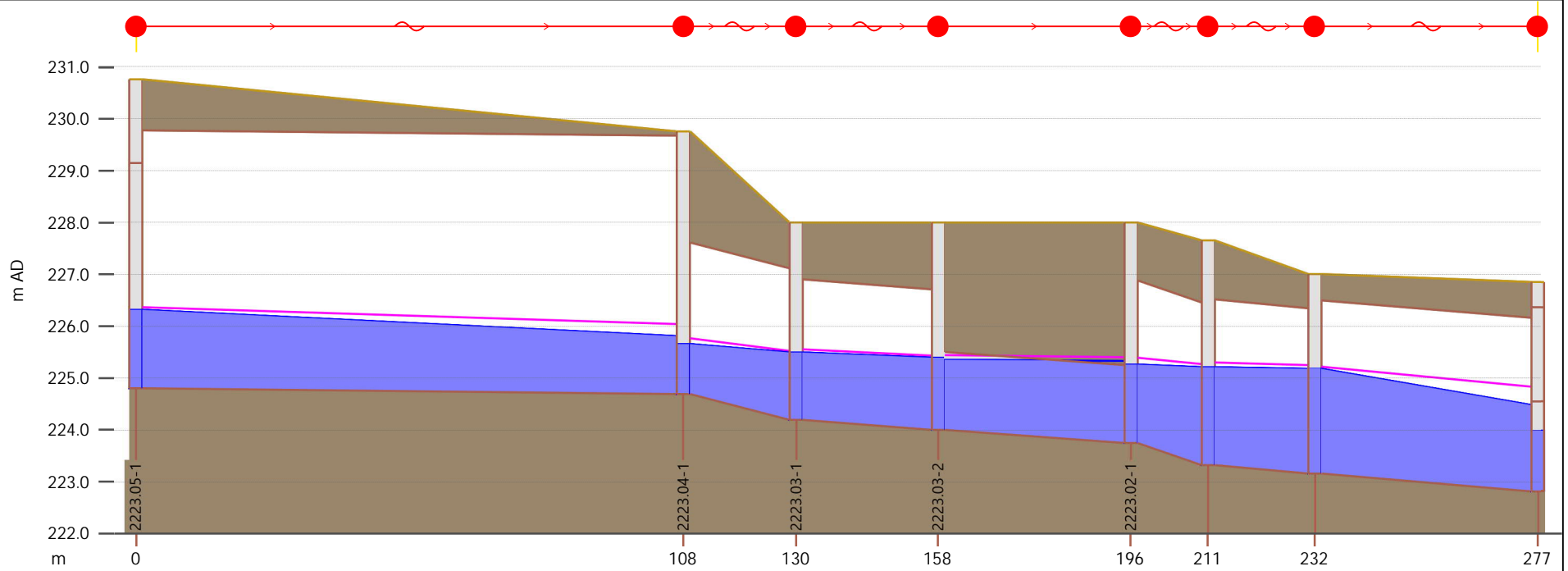
PROPOSED CONDITION - 100-YEAR - EAST SIDE PLAN 10

RVA PROJECT NO. 194615

FIGURE NO. 30G

AUGUST 2021





Link	2223.05-1.1	2223.04-1.1	2223.03-1.1	2223.03-2.1	-	2223.01-1.1	22219.56-1.1	
US node ID	2223.05-1	2223.04-1	2223.03-1	2223.03-2	-	2223.01-1	22219.56-1	
ds node	2223.04-1	2223.03-1	2223.03-2	2223.02-1	-	22219.56-1	RR-WD-63	
numbarrels	1	1	1	2	1	1	1	
length (m)				38.0				
Shape ID	Matrix-2223.05	-	Matrix-2223.03	RECT	-	-	Matrix-2219.56	
width (mm)				4500				
height (mm)				1500				
Rough type				N				
us inv (m AD)	224.803	224.696	224.200	224.000	223.750	223.326	223.160	
ds inv (m AD)	224.696	224.200	224.000	223.750	223.326	223.160	222.822	
grad (m/m)				0.00658				
r.pfc (m3/s)	775.159	486.695	249.889	28.698	357.148	154.934	418.526	
US depth (m)	1.509	0.963	1.295	1.353	1.515	1.883	2.024	
US flow (m3/s)	9.04717	15.79717	15.79717	15.79717	15.79717	15.79717	17.17717	
US velocity (m/s)	1.025	1.450	1.681	1.297	1.598	1.326	1.026	
Node	2223.05-1	2223.04-1	2223.03-1	2223.03-2	2223.02-1	-	22219.56-1	RR-WD-63
Node ID	2223.05-1	2223.04-1	2223.03-1	2223.03-2	2223.02-1	-	22219.56-1	RR-WD-63
ground (m AD)	230.750	229.750	228.000	228.000	228.000	227.650	227.000	226.850
level (m AD)	226.312	225.659	225.495	225.396	225.265	225.209	225.184	223.981
expr:Freeboard	4.438049	4.090561	2.504807	2.603760	2.734543	2.441321	1.815979	2.869440

PROPOSED CONDITION - 100-YEAR - EAST SIDE PROFILE 10



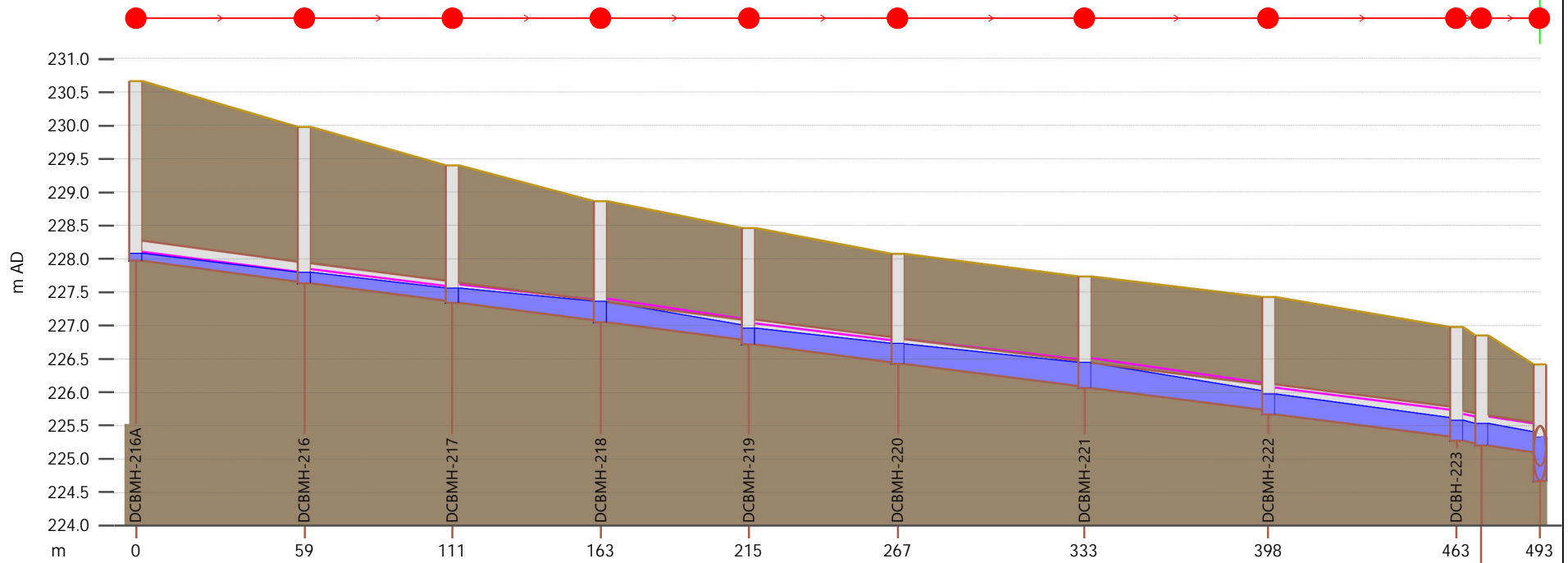
PROPOSED CONDITION - 10-YEAR - EAST SIDE PLAN 11

RVA PROJECT NO. 194615

FIGURE NO. 31A

AUGUST 2021





Link	DCBMH-216A.1	DCBMH-216.1	DCBMH-217.1	DCBMH-218.1	DCBMH-219.1	DCBMH-220.1	DCBMH-221.1	DCBMH-222.1	-	-
US node ID	DCBMH-216A	DCBMH-216	DCBMH-217	DCBMH-218	DCBMH-219	DCBMH-220	DCBMH-221	DCBMH-222	-	-
ds node	DCBMH-216	DCBMH-217	DCBMH-218	DCBMH-219	DCBMH-220	DCBMH-221	DCBMH-222	DCBH-223	-	-
numbarrels	1	1	1	1	1	1	1	1	1	1
length (m)	59.2	51.9	52.1	52.0	52.3	65.5	64.6	66.0	-	20.5
Shape ID	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	CIRC	-	CIRC
width (mm)	300	300	300	300	375	375	375	450	-	450
height (mm)	300	300	300	300	375	375	375	450	-	450
Rough type	N	N	N	N	N	N	N	N	N	N
us inv (m AD)	227.969	227.629	227.339	227.049	226.714	226.423	226.066	225.667	-	-
ds inv (m AD)	227.659	227.369	227.079	226.789	226.453	226.096	225.742	225.337	-	-
grad (m/m)	0.00524	0.00501	0.00499	0.00500	0.00499	0.00499	0.00502	0.00500	-	-
r.pfc (m3/s)	0.070	0.068	0.068	0.068	0.124	0.124	0.124	0.202	-	0.202
US depth (m)	0.104	0.163	0.215	0.298	0.242	0.295	0.371	0.300	-	0.321
US flow (m3/s)	0.01721	0.03891	0.05880	0.07540	0.09170	0.11513	0.13645	0.15939	-	-
US velocity (m/s)	0.793	0.992	1.096	1.146	1.233	1.308	1.338	1.420	-	1.498
Node	-	DCBMH-216	DCBMH-217	DCBMH-218	DCBMH-219	DCBMH-220	DCBMH-221	DCBMH-222	DCBH-223	-
Node ID	-	DCBMH-216	DCBMH-217	DCBMH-218	DCBMH-219	DCBMH-220	DCBMH-221	DCBMH-222	DCBH-223	-
ground (m AD)	230.656	229.974	229.402	228.863	228.463	228.073	227.732	227.428	226.977	-
level (m AD)	228.073	227.792	227.557	227.354	226.958	226.723	226.445	225.971	225.579	-
expr:Freeboard	-	2.181504	1.845192	1.509500	1.504916	1.350298	1.286626	1.457465	1.398417	-

PROPOSED CONDITION - 10-YEAR - EAST SIDE PROFILE 11



PROPOSED CONDITION - 100-YEAR - EAST SIDE PLAN 11

RVA PROJECT NO. 194615

FIGURE NO. 31C

AUGUST 2021

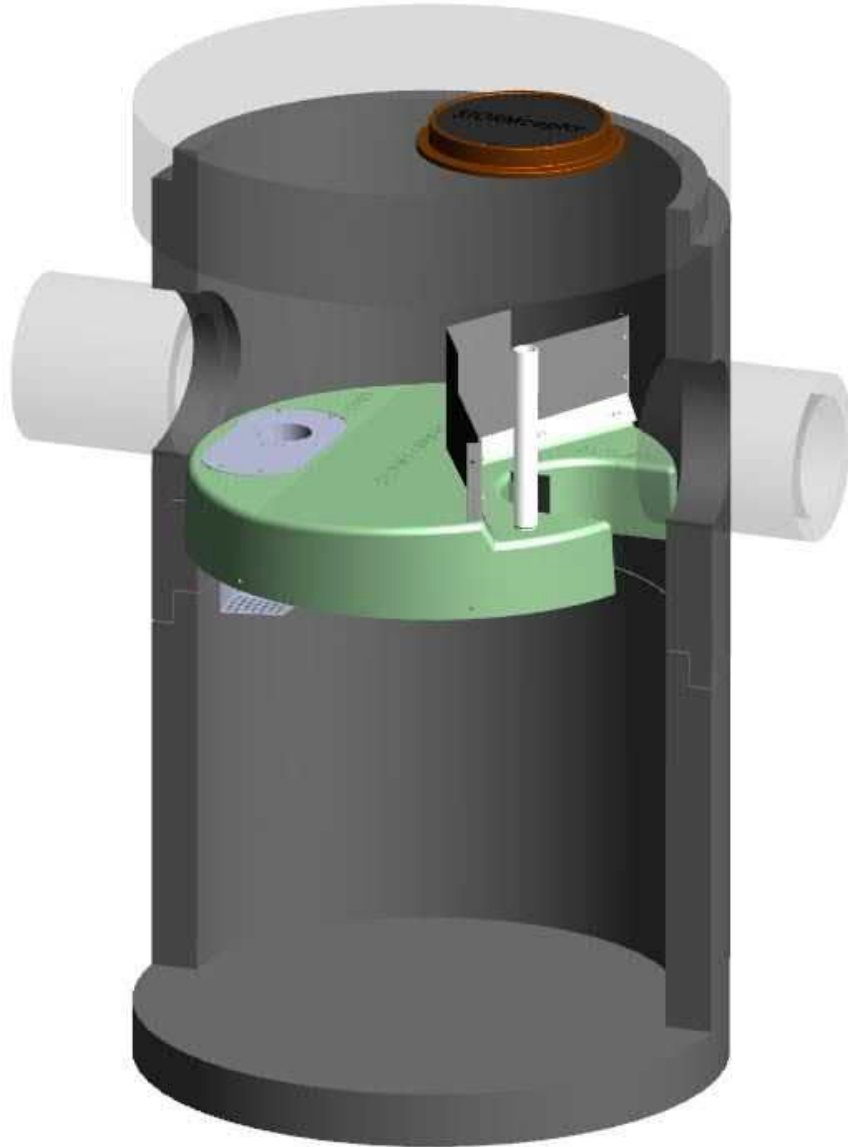


Appendix C

OGS & Catchbasin Shield Owner's Manual

Stormceptor[®] **EF**

Owner's Manual



Stormceptor is protected by one or more of the following patents:

Canadian Patent No. 2,137,942
Canadian Patent No. 2,180,305
Canadian Patent No. 2,327,768
Canadian Patent No. 2,694,159
Canadian Patent No. 2,697,287
U.S. Patent No. 6,068,765
U.S. Patent No. 6,371,690
U.S. Patent No. 7,582,216
U.S. Patent No. 7,666,303
Australia Patent No. 693.164
Australia Patent No. 729,096
Australia Patent No. 2008,279,378
Australia Patent No. 2008,288,900
Japanese Patent No. 5,997,750
Japanese Patent No. 5,555,160
Korean Patent No. 0519212
Korean Patent No. 1451593
New Zealand Patent No. 583,008
New Zealand Patent No. 583,583
South African Patent No. 2010/00682
South African Patent No. 2010/01796
Patent pending

Table of Contents:

1 - Stormceptor EF Overview

2 - Stormceptor EF Operation, Components

3 - Stormceptor EF Model Details

4 - Stormceptor EF Identification

5 - Stormceptor EF Inspection & Maintenance

6 – Stormceptor Contacts

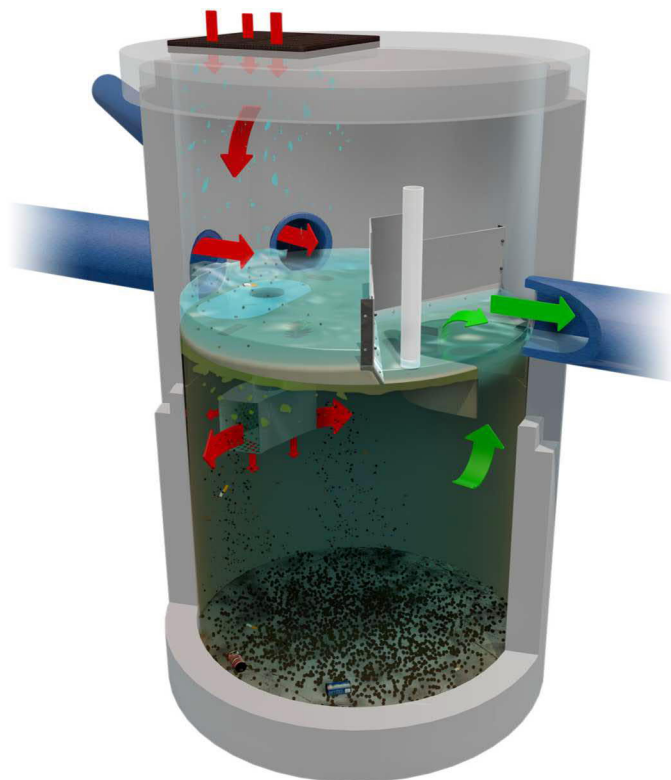
OVERVIEW

Stormceptor® EF is a continuation and evolution of the most globally recognized oil grit separator (OGS) stormwater treatment technology - **Stormceptor®**. Also known as a hydrodynamic separator, the enhanced flow Stormceptor EF is a high performing oil grit separator that effectively removes a wide variety of pollutants from stormwater and snowmelt runoff at flow rates higher than the original Stormceptor. Stormceptor EF captures and retains sediment (TSS), free oils, gross pollutants and other pollutants that attach to particles, such as nutrients and metals. Stormceptor EF's patent-pending treatment and scour prevention platform ensures sediment is retained during all rainfall events.

Stormceptor EF offers design flexibility in one simplified platform, accepting stormwater flow from a single inlet pipe, multiple inlet pipes, and/or from the surface through an inlet grate. Stormceptor EF can also serve as a junction structure, accommodate a 90-degree inlet to outlet bend angle, and be modified to ensure performance in submerged conditions. With its scour prevention and internal bypass, Stormceptor EF can be installed online, eliminating the need for costly additional bypass structures.

OPERATION

- Stormwater enters the Stormceptor upper chamber through the inlet pipe(s) or a surface inlet grate. A specially designed insert reduces the influent velocity by creating a pond upstream of the insert's weir. Sediment particles immediately begin to settle. Swirling flow sweeps water, sediment, and floatables across the sloped surface of the insert to the inlet opening of the drop pipe, where a strong vortex draws water, sediment, oil, and debris down the drop pipe cone.
- Influent exits the cone into the drop pipe duct. The duct has two large rectangular outlet openings as well as perforations in the backside and floor of the duct. Influent is diffused through these various opening in multiple directions and at low velocity into the lower chamber.
- Free oils and other floatables rise up within the channel surrounding the central riser pipe and are trapped beneath the insert, while sediment settles to the sump. Pollutants are retained for later removal during maintenance cleaning.
- Treated effluent enters the outlet riser, moves upward, and discharges to the top side of the insert downstream of the weir, where it flows out the outlet pipe.
- During intense storm events with very high influent flow rates, the pond height on the upstream side of the weir may exceed the height of the weir, and the excess flow passes over the top of the weir to the downstream side of the insert, and exits through the outlet pipe. This internal bypass feature allows for in-line installation, avoiding the cost of additional bypass structures. During bypass, the pond separates sediment from all incoming flows, while full treatment in the lower chamber continues at the maximum flow rate.
- Stormceptor EF's patent-pending enhanced flow and scour prevention technology ensures pollutants are captured and retained, allowing excess flows to bypass during infrequent, high intensity storms.



COMPONENTS

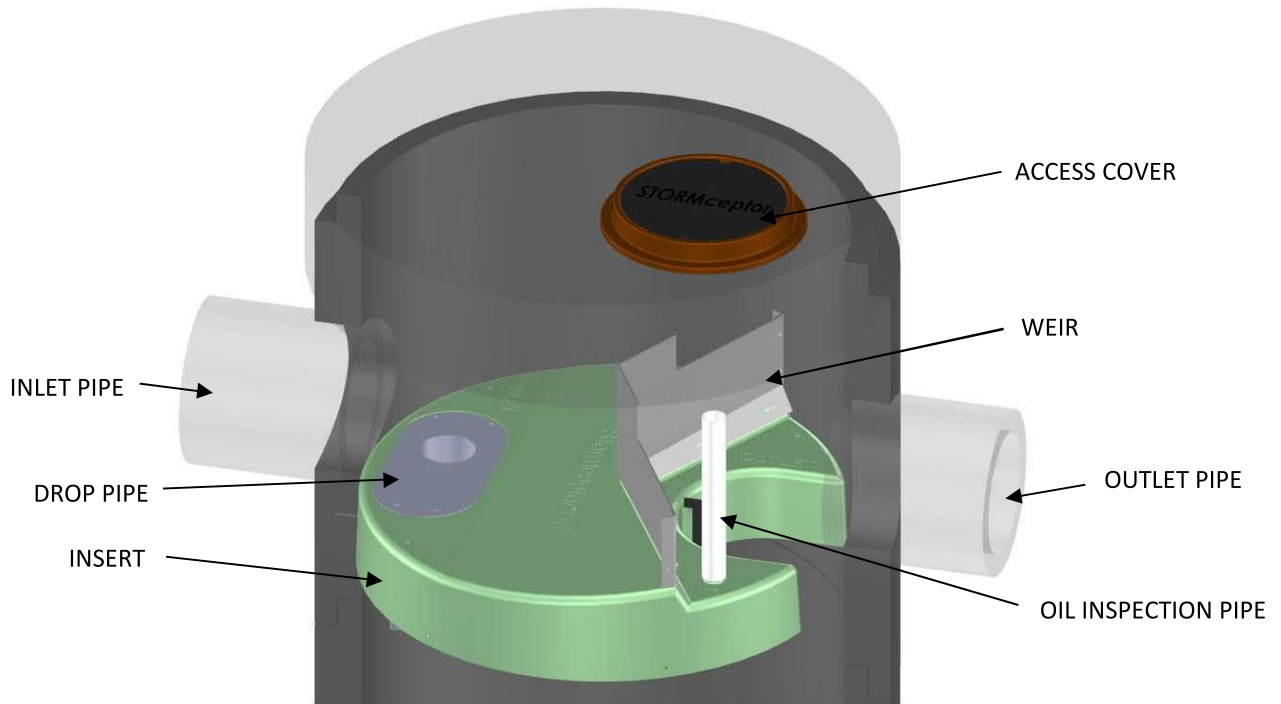


Figure 1

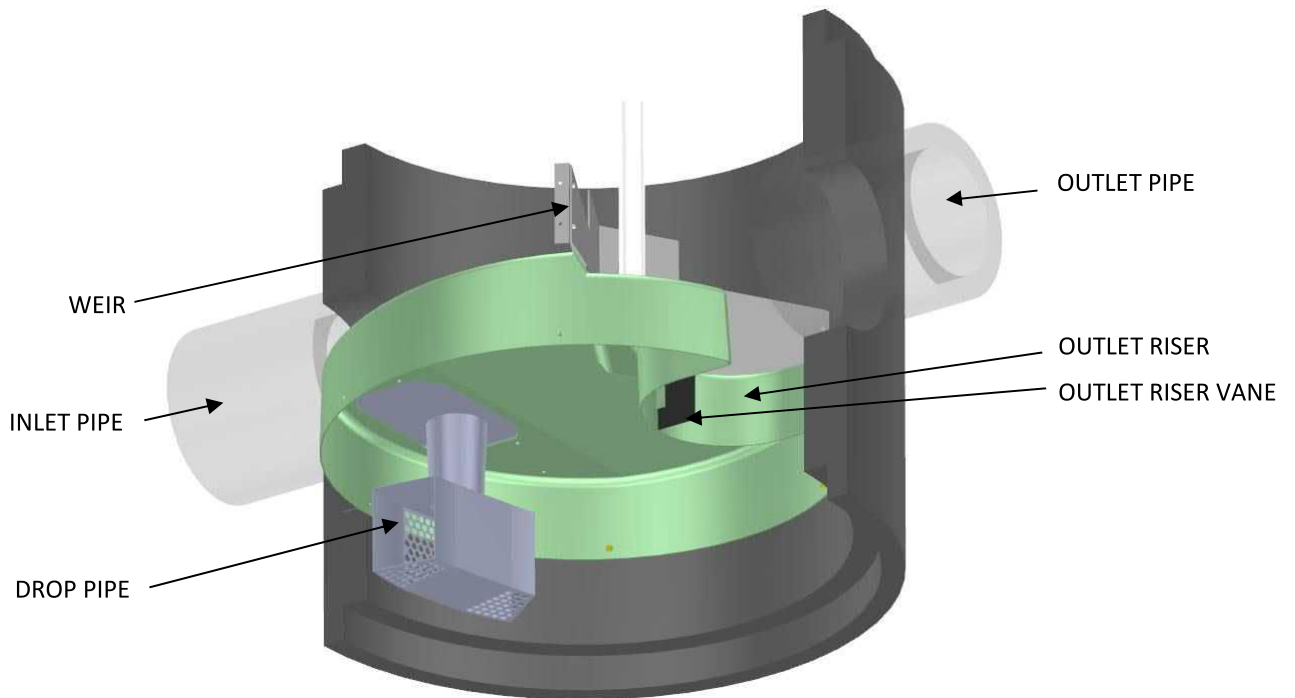


Figure 2

OUTLET PLATFORM (UP position)

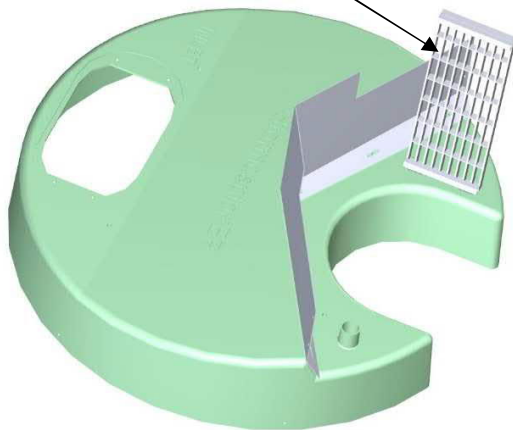


Figure 3A

OUTLET PLATFORM (DOWN position)

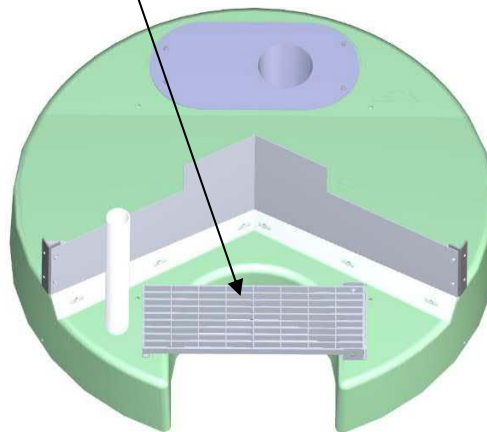


Figure 3B

- **Insert** – separates vessel into upper and lower chambers, and provides double-wall containment of hydrocarbons
- **Weir** – creates stormwater ponding and driving head on top side of insert
- **Drop pipe** – conveys stormwater and pollutants into the lower chamber
- **Outlet riser** – conveys treated stormwater from the lower chamber to the outlet pipe, and provides primary inspection and maintenance access into the lower chamber
- **Outlet riser vane** – prevents formation of a vortex in the outlet riser during high flow rate conditions
- **Outlet platform (optional)** – safety platform in the event of manned entry into the unit
- **Oil inspection pipe** – primary access for measuring oil depth

PRODUCT DETAILS

METRIC DIMENSIONS AND CAPACITIES

Table 1

Stormceptor Model	Inside Diameter (m)	Minimum Surface to Outlet Invert Depth (mm)	Depth Below Outlet Pipe Invert (mm)	Wet Volume (L)	Sediment Capacity ¹ (m ³)	Hydrocarbon Storage Capacity ² (L)	Maximum Flow Rate into Lower Chamber ³ (L/s)	Peak Conveyance Flow Rate ⁴ (L/s)
EF4 / EFO4	1.22	915	1524	1780	1.19	265	22.1 / 10.4	425
EF6 / EFO6	1.83	915	1930	5070	3.47	610	49.6 / 23.4	990
EF8 / EFO8	2.44	1219	2591	12090	8.78	1070	88.3 / 41.6	1700
EF10 / EFO10	3.05	1219	3251	23700	17.79	1670	138 / 65	2830
EF12 / EFO12	3.66	1524	3886	40800	31.22	2475	198.7 / 93.7	2830

¹ Sediment Capacity is measured from the floor to the bottom of the drop pipe cone. Sediment Capacity can be increased to accommodate specific site designs and pollutant loads. Contact your local representative for assistance.

² Hydrocarbon Storage Capacity is measured from the bottom of the outlet riser to the underside of the insert. Hydrocarbon Storage Capacity can be increased to accommodate specific site designs and pollutant loads. Contact your local representative for assistance.

³ EF Maximum Flow Rate into Lower Chamber is based on a maximum surface loading rate (SLR) into the lower chamber of 1135 L/min/m². EFO Maximum Flow Rate into Lower Chamber is based on a maximum surface loading rate (SLR) into the lower chamber of 535 L/min/m².

⁴ Peak Conveyance Flow Rate is limited by a maximum velocity of 1.5 m/s.

U.S. DIMENSIONS AND CAPACITIES

Table 2

Stormceptor Model	Inside Diameter (ft)	Minimum Surface to Outlet Invert Depth (in)	Depth Below Outlet Pipe Invert (in)	Wet Volume (gal)	Sediment Capacity ¹ (ft ³)	Hydrocarbon Storage Capacity ² (gal)	Maximum Flow Rate into Lower Chamber ³ (cfs)	Peak Conveyance Flow Rate ⁴ (cfs)
EF4 / EFO4	4	36	60	471	42	70	0.78 / 0.37	15
EF6 / EFO6	6	36	76	1339	123	160	1.75 / 0.83	35
EF8 / EFO8	8	48	102	3194	310	280	3.12 / 1.47	60
EF10 / EFO10	10	48	128	6261	628	440	4.87 / 2.30	100
EF12 / EFO12	12	60	153	10779	1103	655	7.02 / 3.31	100

¹ Sediment Capacity is measured from the floor to the bottom of the drop pipe cone. Sediment Capacity can be increased to accommodate specific site designs and pollutant loads. Contact your local representative for assistance.

² Hydrocarbon Storage Capacity is measured from the bottom of the outlet riser to the underside of the insert. Hydrocarbon Storage Capacity can be increased to accommodate specific site designs and pollutant loads. Contact your local representative for assistance.

³ EF Maximum Flow Rate into Lower Chamber is based on a maximum surface loading rate (SLR) into the lower chamber of 27.9 gpm/ft². EFO Maximum Flow Rate into Lower Chamber is based on a maximum surface loading rate (SLR) into the lower chamber of 13.1 gpm/ft².

⁴ Peak Conveyance Flow Rate is limited by a maximum velocity of 5 fps.

IDENTIFICATION

Each Stormceptor EF/EFO unit is easily identifiable by the trade name **Stormceptor®** embossed on the access cover at grade as shown in **Figure 3**. The tradename **Stormceptor®** is also embossed on the top of the insert upstream of the weir as shown in **Figure 3**.

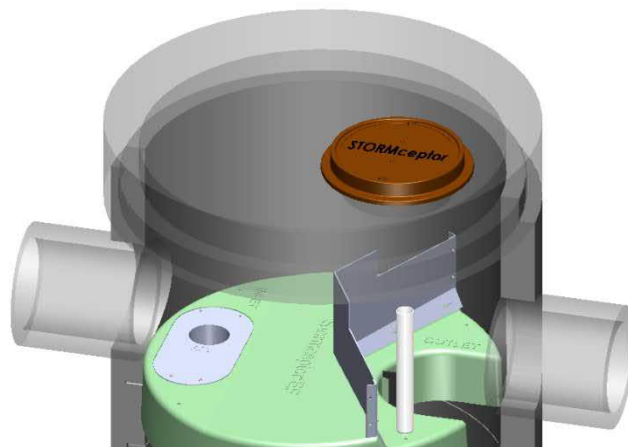


Figure 4

The specific Stormceptor EF/EFO model number is identified on the top of the aluminum Drop Pipe as shown in **Figure 4**. The unit serial number is identified on the top of the insert upstream of the weir as shown in **Figure 4**.

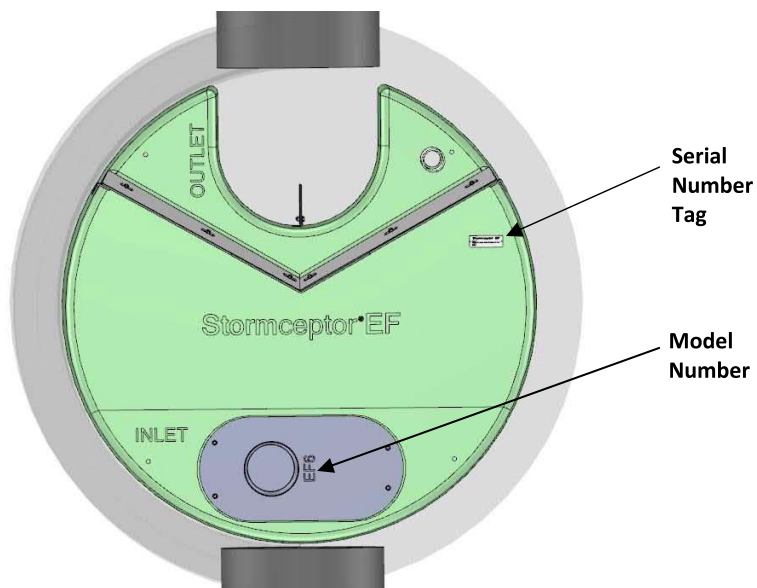


Figure 5

INSPECTION AND MAINTENANCE

It is very important to perform regular inspection and maintenance. Regular inspection and maintenance ensures maximum operation efficiency, keeps maintenance costs low, and provides continued of natural waterways.

Quick Reference

- Typical inspection and maintenance is performed from grade
- Remove manhole **cover(s)** or **inlet grate** to access insert and lower chamber
NOTE: EF4/EFO4 requires the removal of a **flow deflector** beneath inlet grate
- Use Sludge Judge® or similar sediment probe to check sediment depth through the **outlet riser**
- Oil dipstick can be inserted through the **oil inspection pipe**
- Visually inspect the **insert** for debris, remove debris if present
- Visually inspect the **drop pipe** opening for blockage, remove blockage if present
- Visually inspect **insert** and **weir** for damage, schedule repair if needed
- Insert vacuum hose and jetting wand through the outlet riser and extract sediment and floatables
- Replace flow deflector (EF4/EFO4), inlet grate, and cover(s)
- **NOTE:** If the unit has an **outlet platform**, the outlet platform is typically in the UP position (see Figure 3A) for normal treatment conditions, and for inspection and maintenance. If manned entry into the unit is required, the outlet platform must first be placed in the DOWN position (see Figure 3B). After manned entry is completed, return the outlet platform to the UP position for treatment.

When is inspection needed?

- Post-construction inspection is required prior to putting the Stormceptor into service.
- Routine inspections are recommended during the first year of operation to accurately assess pollutant accumulation.
- Inspection frequency in subsequent years is based on the maintenance plan developed in the first year.
- Inspections should also be performed immediately after oil, fuel, or other chemical spills.

What equipment is typically required for inspection?

- Manhole access cover lifting tool
- Oil dipstick / Sediment probe with ball valve (typically ¾-inch to 1-inch diameter)
- Flashlight
- Camera
- Data log / Inspection Report
- Safety cones and caution tape
- Hard hat, safety shoes, safety glasses, and chemical-resistant gloves

When is maintenance cleaning needed?

- If the post-construction inspection indicates presence of construction sediment of a depth greater than a few inches, maintenance is recommended at that time.
- For optimum performance and normal operation the unit should be cleaned out once the sediment depth reaches the recommended maintenance sediment depth, see **Table 3**.
- Maintain immediately after an oil, fuel, or other chemical spill.

Table 3

Recommended Sediment Depths for Maintenance Service*	
MODEL	Sediment Depth (in/mm)
EF4 / EFO4	8 / 203
EF6 / EFO6	12 / 305
EF8 / EFO8	24 / 610
EF10 / EFO10	24 / 610
EF12 / EFO12	24 / 610

* Based on a minimum distance of 40 inches (1,016 mm) from bottom of outlet riser to top of sediment bed

The frequency of inspection and maintenance may need to be adjusted based on site conditions to ensure the unit is operating and performing as intended. Maintenance costs will vary based on the size of the unit, site conditions, local requirements, disposal costs, and transportation distance.

What equipment is typically required for maintenance?

- Vacuum truck equipped with water hose and jet nozzle
- Small pump and tubing for oil removal
- Manhole access cover lifting tool
- Oil dipstick / Sediment probe with ball valve (typically ¾-inch to 1-inch diameter)
- Flashlight
- Camera
- Data log / Inspection Report
- Safety cones
- Hard hats, safety shoes, safety glasses, chemical-resistant gloves, and hearing protection for service providers
- Gas analyzer, respiratory gear, and safety harness for specially trained personnel if confined space entry is required (adhere to all OSHA / CCOSH standards)

What conditions can compromise Stormceptor performance?

- Presence of construction sediment and debris in the unit prior to activation
- Excessive sediment depth beyond the recommended maintenance depth
- Oil spill in excess of the oil storage capacity
- Clogging or restriction of the drop pipe inlet opening with debris
- Downstream blockage that results in a backwater condition

Maintenance Procedures

- Maintenance should be conducted during dry weather conditions when no flow is entering the unit.
- Stormceptor is maintained from grade through a standard surface manhole access cover or inlet grate.
- In the case of submerged or tailwater conditions, extra measures are likely required, such as plugging the inlet and outlet pipes prior to conducting maintenance.
- Inspection and maintenance of upstream catch basins and other stormwater conveyance structures is also recommended to extend the time between future maintenance cycles.
- Sediment depth inspections are performed through the **Outlet Riser** and oil presence can be determined through the **Oil Inspection Pipe**.
- Oil presence and sediment depth are determined by inserting a Sludge Judge® or measuring stick to quantify the pollutant depths.

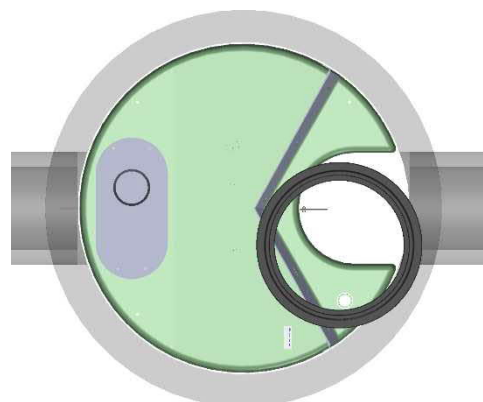


Figure 6

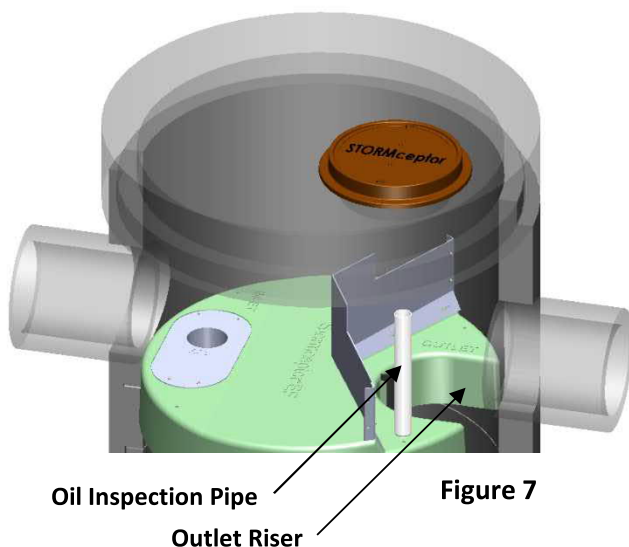


Figure 7



Figure 8

- Visually inspect the insert, weir, and drop pipe inlet opening to ensure there is no damage or blockage.
- **NOTE:** If the unit has an **outlet platform**, the outlet platform is typically in the UP position (see Figure 3A) for normal treatment conditions, and for inspection and maintenance. If manned entry into the unit is required, the outlet platform must first be placed in the DOWN position (see Figure 3B). After manned entry is completed, return the outlet platform to the UP position for treatment.

- When maintenance is required, a standard vacuum truck is used to remove the pollutants from the lower chamber of the unit through the **Outlet Riser**.



Figure 9

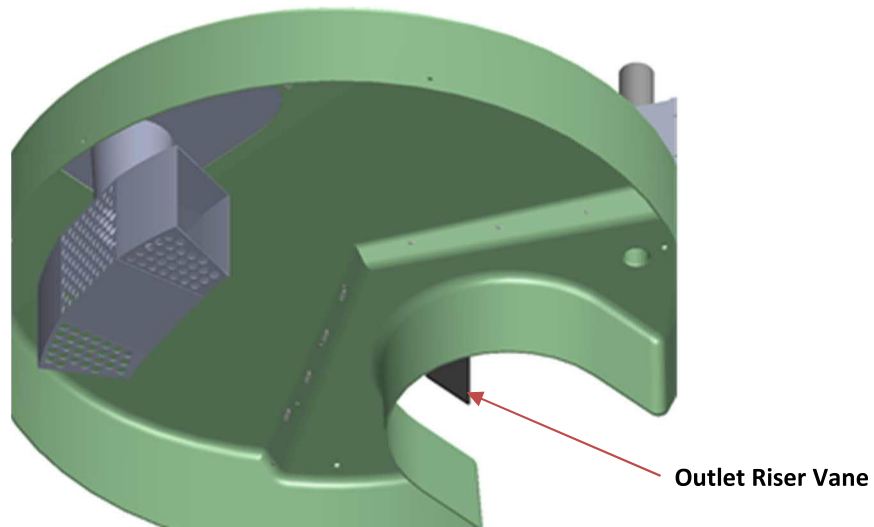


Figure 10

NOTE: The Outlet Riser Vane is durable and flexible and designed to allow maintenance activities with minimal, if any, interference.

Removable Flow Deflector

- Top grated inlets for the Stormceptor EF4/EFO4 model requires a removable flow deflector staged underneath a 24-inch x 24-inch (600 mm x 600 mm) square inlet grate to direct flow towards the inlet side of the insert, and avoid flow and pollutants from entering the outlet side of the insert from grade. The EF6/EFO6 and larger models do not require the flow deflector.

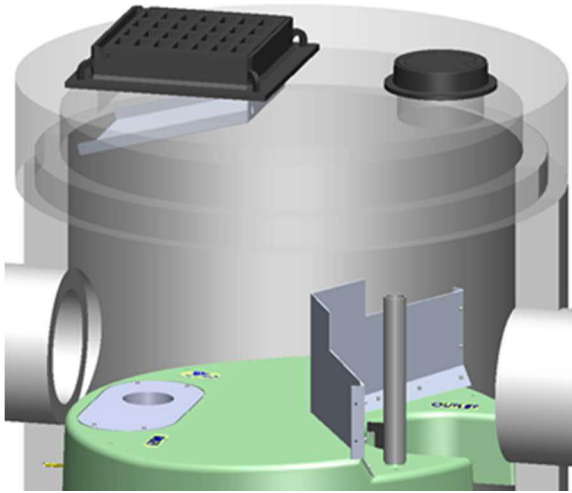
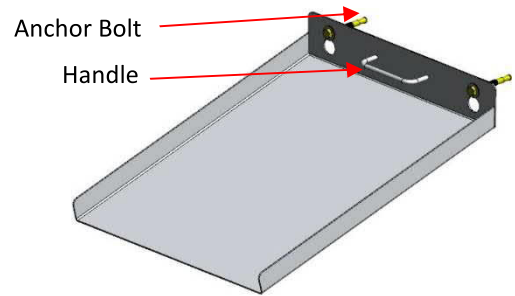


Figure 11

How to Remove:

1. Loosen anchor bolts
2. Pull up and out using the handle



Removable Flow Deflector

Hydrocarbon Spills

Stormceptor is often installed on high pollutant load hotspot sites with vehicular traffic where hydrocarbon spill potential exists. Should a spill occur, or presence of oil be identified within a Stormceptor EF/EFO, it should be cleaned immediately by a licensed liquid waste hauler.

Disposal

Maintenance providers are to follow all federal, state/ provincial, and local requirements for disposal of material.

Oil Sheens

When oil is present in stormwater runoff, a sheen may be noticeable at the Stormceptor outlet. An oil rainbow or sheen can be noticeable at very low oil concentrations (< 10 mg/L). Despite the appearance of a sheen, Stormceptor EF/EFO may still be functioning as intended.

Oil Level Alarm

To mitigate spill liability with 24/7 detection, an electronic monitoring system can be employed to trigger a visual and audible alarm when a pre-set level of oil is captured within the lower chamber or when an oil spill occurs. The oil level alarm is available as an optional feature to include with Stormceptor EF/EFO as shown in **Figure 11**. For additional details about the Oil Level Alarm please visit <http://www.imbriumsystems.com/stormwater-treatment-solutions/stormceptor-systems>.

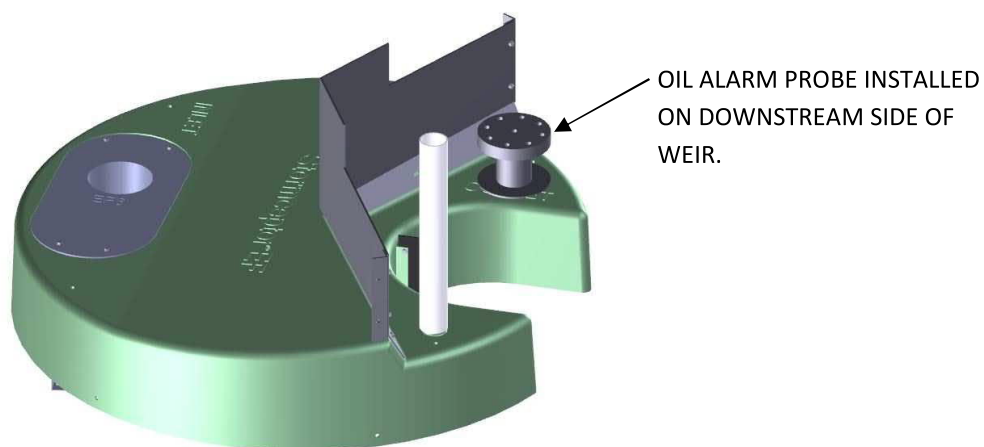


Figure 12

Replacement Parts

Stormceptor has no moving parts to wear out. Therefore inspection and maintenance activities are generally focused on pollutant removal. Since there are no moving parts during operation in a Stormceptor, broken, damaged, or worn parts are not typically encountered. However, if replacement parts are necessary, they may be purchased by contacting your local Stormceptor representative.

Stormceptor Inspection and Maintenance Log

Stormceptor Model No: _____

Serial Number: _____

Installation Date: _____

Location Description of Unit: _____

Recommended Sediment Maintenance Depth: _____

DATE	SEDIMENT DEPTH (inch or mm)	OIL DEPTH (inch or mm)	SERVICE REQUIRED (Yes / No)	MAINTENANCE PERFORMED	MAINTENANCE PROVIDER	COMMENTS

Other Comments:

Contact Information

Questions regarding Stormceptor EF/EFO can be addressed by contacting your local Stormceptor representative or by visiting our website at www.stormceptor.com.

Imbrium Systems Inc. & Imbrium Systems LLC

Canada 1-416-960-9900 / 1-800-565-4801
United States 1-301-279-8827 / 1-888-279-8826
International +1-416-960-9900 / +1-301-279-8827

www.imbriumsystems.com

www.stormceptor.com

info@imbriumsystems.com