



water's edge
ENVIRONMENTAL SOLUTIONS TEAM LTD.

105 Avondale Court

Channel Rehabilitation and Culvert Replacement

Preliminary Hydrology and Hydraulics Report

December 17, 2024

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1. Introduction

Water's Edge Environmental Solutions Team Ltd. (Water's Edge) was authorized by Veyron Inc. on November 21, 2024 to conduct hydrologic and hydraulic assessments for channel rehabilitation and culvert replacement. The channel passes under a driveway that is the principal access to 105 Avondale Court, Burlington, Ontario (the Property). This preliminary report is intended to support the rezoning application for the proposed residential redevelopment at the Property. A final report will further detail the hydrologic and hydraulic assessments and the accompanying channel rehabilitation and culvert replacement.

2. Background

The Property is located south of Lakeshore Road along the shore of Lake Ontario in the Shoreacres neighbourhood of Burlington. A driveway extending west from the southern terminus of Avondale Court serves as the only road access to the Property. The driveway sits atop a culvert that directs drainage from a channel that originates at a stormwater outfall on 156 Avondale Court, approximately 100 m north of the Property. The channel continues along the boundary of the Property shared with 113 Avondale Court and eventually discharges into Lake Ontario. Existing gabions compose the left bank (looking downstream) of the channel, upstream and downstream of the culvert.

The culvert and its associated upstream headwall are showing signs of deterioration. During historical intense rainfall events, overtopping of the culvert has been observed. The gabions have detached laterally from the adjacent slope and are constricting the channel. Accordingly, the City of Burlington requires assessment of the channel, culvert, and gabions along with confirmation of safe access.

The Property falls within Conservation Halton's regulation limit, based on the setback from Lake Ontario. Outside the regulation setback from Lake Ontario, the channel is not regulated by Conservation Halton.

The following documents have informed the production of this preliminary report.

- Conservation Halton*, Guidelines for Stormwater Management Engineering Submissions v2.1*, 2024.
- Wood Environment & Infrastructure Solutions*, City of Burlington Stormwater Management Design Guidelines*, 2020.
- Environmental Water Resources Group Ltd., *Technical Guidelines for Flood Hazard Mapping,* 2017.
- Englobe, *Geotechnical Assessment and Engineering Review of Slope Stability*, 2024.
- Ontario Ministry of Natural Resources, *Technical Guide, River and Stream Systems; Flooding Hazard Limit*, 2002.
- WSP, *East Burlington Creeks Flood Hazard Mapping – Hydraulics Report*, 2023.
- City of Burlington, *Recommendation report for a plan of subdivision and zoning by-law amendment for 143 Blue Water Place and 105 Avondale Court*, 2019.
- Natural Resources and Conservation Service, USDA, *National Engineering Handbook, Part 630 Hydrology*, 2019.

3. Field Assessment

Water's Edge initially visited the Property on November 11, 2024 to conduct a reconnaissance. On November 26, 2024; Water's Edge completed surveying of a section of the driveway, the channel, hydraulic structures, and overbank areas. Photos documenting the findings detailed below can be found in **Appendix A.**

The culvert is comprised of 4 sections of concrete pipe and 1 section of corrugated steel pipe (CSP). The inside diameter of the culvert is 1.2 m. Each concrete segment is separated from adjacent segments and roadbed material is migrating into the culvert. The CSP portion is rusting and corrosion holes are present. Potholes are present on the driveway where material is being sucked/washed away between the concrete

pipe joints causing further settlement of the road. The upstream headwall of the culvert is deteriorating. A portion of the right wingwall (looking downstream) has detached from the headwall structure leaving the road embankment exposed.

Upstream of the culvert, gabions are installed on the right bank of the channel which supports a wooden retaining wall. Upstream further, the right bank of the channel is armored with rip rap. Small shrubs are present on the left bank upstream of the culvert. A fence crosses the stream approximately 15 m upstream of the inlet of the culvert which delineates the boundary of 136 Avondale Court. A 2.4 m diameter willow trunk interrupts the fence line and a wooden retaining wall extends from the culvert headwall on the left bank. The overbank areas consist mostly of lawns. The channel has incised by approximately 500 mm (height of bank) and the substrate is composed of sand and small gravels.

Downstream, the culvert outlet is perched by about 200 mm and a 1.8 m rock is embedded on the left bank. Extending 30 m downstream from the culvert, the left bank is armoured with rip rap, armourstone delineates the top of slope. Beyond the armourstone, the left overbank is composed mostly of lawn with the driveway and single-family dwelling of 113 Avondale Court directly adjacent to the top of slope. The right bank is composed of gabions for approximately 20 m, which have detached laterally from the bank. The overbanks are composed of a mix of mature deciduous and coniferous trees with diameters (at breast height) larger than 40 cm. The substrate of the channel is composed of rip rap dislodged from the adjacent left bank.

Further downstream, the channel has incised down to bedrock (shale) with bank heights exceeding 1.5 m on the outside bends of the channel. The right overbank is composed of mature trees and the left overbank has a small buffer of mature trees with lawns beyond. The channel discharges into Lake Ontario.

4. Hydrologic Assessment

Approximately 55 ha of sewered urban residential area that extends north to New Street, west to Wilson Avenue, and east almost to Appleby line (see **Map 1** on next page) drains into the channel running through the Property. The boundary of the drainage area was approximated using the City of Burlington Infrastructure Drawings Retrieval portal to obtain as-built drawings for storm sewers and a 2018 0.5 m resolution LiDAR derived Digital Terrain Model (DTM) from Ontario GeoHub (GTA Halton B Package).

Preliminary flows were determined using the Rational Method. Time of concentration was established through employing the Velocity Method that accounts for sheet, shallow concentrated, unpressurized pipe, and open channel flows. The time of concentration is estimated to be 32 minutes from the furthest point of the watershed (New Street) to the culvert. The resulting peak intensity is 78 mm/hr as per the 100-year return period from the 2020 City of Burlington IDF. A runoff coefficient of 0.75 was used, which is based on the runoff coefficient for the City of Burlington Single Family (between 30 and 50 ft width) area type. The runoff coefficient for this area type was increased by a factor of 1.25 to account for the 100-year storm. The estimated flow for the 100-year storm is 8.94 m^3/s. **Table 1** summarizes the parameters used in the Rational Method to estimate the 100-year flow rate.

Table 1: Rational Method Parameters for Estimated 100-year Peak Flow

T_c (min)	c	i_{100} (mm/hr)	A (ha)	Q_{100} (m^3/s)
32	0.75	78	55	8.94

Given the small drainage area and urban setting , the Keifer and Chu Synthetic Storm Pattern for Drainage Design (Chicago Storm) is most applicable. The 100-year water level of Lake Ontario is assumed to not coincide with the 100-year flows in the channel. A hydrologic model, prepared using EPA SWMM v5.2 software, is being used to confirm these assumptions and the flow. Final calculations, assumptions, and the model for the hydrologic assessment are to be submitted to the City of Burlington and Conservation Halton with the final report.

Additional runoff that will be generated by the proposed development at the Property is assumed to be discharged directly into Lake Ontario and not through the channel.



water's edge ENVIRONMENTAL SOLUTIONS TEAM	105 Avondale Court Channel Rehab & Culvert Replacement	Date: Dec. 17, 2024	Figure: Map 1
	Drainage Map Hydrologic Assessment	Checked By: FA	Drawn By: JM

5. Hydraulic Assessment

A hydraulic model of the channel was created using HEC-RAS 6.5. The channel was modelled from the storm outfall identified in **Map 1** to the outlet at Lake Ontario using a combination of survey and DTM data. The driveway crossing over the channel and the 1.2 m culvert were included in the model. Using the estimated 100-year peak flow rate, modelling showed that the culvert is overtopped and the upstream overbank areas are inundated. The water surface elevation at the road is 79.5 m as per the 2013 Canadian Geodetic Vertical Datum (CGVD2013) with approaching water velocities of 0.8 m/s. The driveway elevation directly above the culvert was surveyed at 79.25 m (CGVD2013), which results in a water depth of 0.25 m over the driveway. **Table 2** shows the existing hydraulic parameters at cross sections 67 and 45 resulting from the estimated 100-year flow. The water depth is representative of the difference in elevation between the water surface and channel bottom. **Figure 1** displays the water surface elevation and flood extent from the estimated 100-year flow, alongside the hydraulic model geometry.

Table 2: Estimated 100-year Flow Existing Hydraulic Parameters

Cross Section (m)	Water Surface Elevation (m, CGVD2013)	Water Depth (m)	Velocity (m/s)
67	79.5	2.2	0.8
45	77.8	1.5	3.0



Figure 1: Water surface elevations in meters (CGVD2013) and flood extent from estimated 100-year flow for existing conditions. The legend for the water surface elevation is in the bottom right of the image. Numbered green lines represent the channel cross sections, the blue line represents the channel centerline, and the red lines represent the bank lines.

Final calculations, assumptions, and the model for the hydraulic assessment are to be submitted to the City of Burlington and Conservation Halton with the final report.

6. Recommended Design

The recommended design includes approximately 50 m of channel rehabilitation, approximately 15 m of road replacement, and a culvert replacement. Vegetated riverstone banks installed at a 2H:1V slope, riffles and pools, keystones, a 1.8 m tall x 2.4 m wide box culvert complete with wingwalls under the driveway, and a driveway elevation of 79.6 m (CGVD2013) are recommended. This design necessitates the removal of the existing culvert, gabions, wooden retaining walls, and some trees. Downstream of the culvert, the rip rap on the left bank appears stable and can remain. The banks upstream of the culvert, and the right bank downstream of the culvert are to be replaced with vegetated riverstone installed at a 2H:1V slope. See **Appendix B** for concept design drawings.

Armourstone retaining walls have been considered and can be implemented where existing gabions and existing wooden retaining walls are installed as an alternative design. However, the required height of the retaining walls and the shale bedrock at or near the elevation of the invert of the channel adds complexity to this alternative design possibility.

The hydraulic modelling of the recommended design shows that safe access is achievable with the estimated 100-year flow and the extent of flooding is significantly reduced. An approximately 0.8 m reduction in water surface elevation upstream of the culvert was observed in the model. **Table 3** shows the proposed hydraulic parameters at cross sections 67 and 45 resulting from the estimated 100-year flow. The water depth is representative of the difference in elevation between the water surface and channel bottom. **Figure 2** displays the water surface elevation and flood extent from the estimated 100-year flow, alongside the proposed hydraulic model geometry.

Table 3: Estimated 100-year Flow Proposed Hydraulic Parameters

Cross Section (m)	Water Surface Elevation (m, CGVD2013)	Water Depth (m)	Velocity (m/s)
67	78.7	1.4	1.5
45	77.1	1.5	2.9



Figure 2: Water surface elevations in meters (CGVD2013) and flood extent from estimated 100-year flow for proposed conditions. The legend for the water surface elevation is in the bottom right of the image. Numbered green lines represent the channel cross sections, the blue line represents the channel centerline, and the red lines represent the bank lines. Note the reduced extent of flooding.

To finalize the recommended design, further detailing of the hydrology, hydraulics, and construction drawings is required and will be provided in the final report.

Respectfully submitted,

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Water Resources Specialist

Ferdous Ahmed, Ph.D., P. Eng.,
Sr. Water Resources Engineer

Water's Edge Environmental Solutions Team Ltd.



APPENDIX A:

Photo Inventory



Photo A1: Driveway providing access to 113 Avondale Court and the Property. The yellow arrow denotes the location of the culvert underneath the driveway, the channel flows from the right to the left under the driveway. Photo taken from 113 Avondale Court looking southwest on November 26, 2024.



Photo A2: Channel flowing (blue arrow) through fence line of 136 Avondale Court (yellow arrow). Photo taken from channel upstream of culvert looking north/upstream on November 26, 2024.



Photo A3: Right bank of channel is armoured with lawn composing the right overbank on 4342 Blue Water Place. The yellow arrow denotes a wood retaining wall whereas the blue arrow denotes the direction of flow. Photo taken from channel upstream of culvert looking south/downstream on November 26, 2024.



Photo A4: The yellow arrow denotes the gabions that line the right bank (looking downstream). An orange arrow denotes the 2.4 m diameter willow trunk on the left bank. Photo taken from channel upstream of culvert looking west/upstream on November 26, 2024.



Photo A5: Inlet of culvert underneath driveway to the Property. The right wingwall has detached and the embankment supporting the driveway is unprotected (red arrow). A yellow arrow denotes a wooden retaining wall on the left bank and flow direction is denoted with the blue arrow. Photo taken from channel upstream of culvert looking southeast/downstream on November 11, 2024.

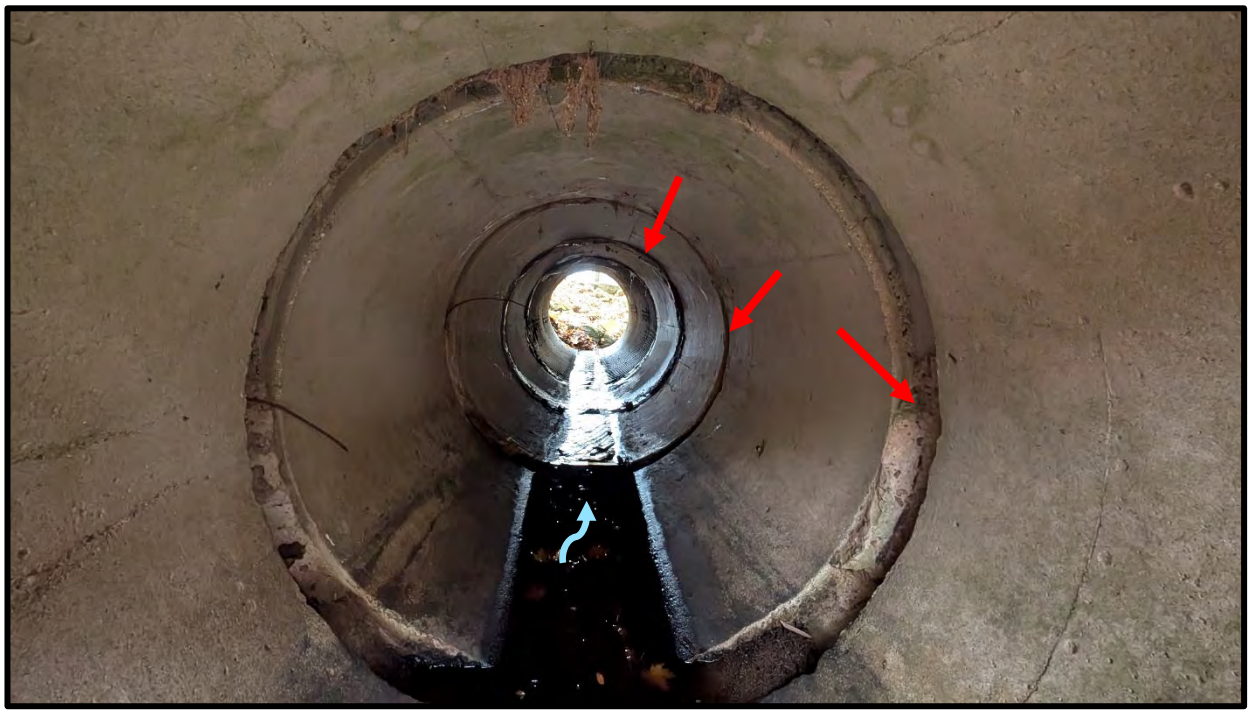


Photo A6: Detached concrete culvert pipes denoted with red arrows, the direction of flow is denoted with a blue arrow. Photo taken in culvert looking southeast/downstream on November 11, 2024.



Photo A7: Rust and corroded areas (red arrow) on the downstream CSP section of the culvert. Photo taken in culvert on November 11, 2024.



Photo A8: The yellow arrow denotes a 1.8 m rock directly adjacent to the culvert outlet. The culvert is perched by approximately 200 mm. The left bank (looking downstream) is composed of rip rap with armourstone at the top of bank. The right bank consists of gabions. Photo taken in channel downstream of culvert looking north/upstream on November 11, 2024



Photo A9: The gabions on the right bank have detached laterally from the adjacent soil (red arrow) and are constricting the channel. The left overbank is composed of lawn and the single-family dwelling (yellow arrow) on 113 Avondale Court. The right overbank is composed of mature coniferous and deciduous trees. Photo taken from outlet of culvert of culvert looking southeast/downstream on November 26, 2024.



Photo A10: The proposed channel rehabilitation will extend to the downstream extent of the armourstone on the left bank of the channel (green arrow). Photo taken from the left bank of the channel looking southeast/downstream on November 26, 2024.



Photo A11: Downstream length of channel beyond proposed extent of rehabilitation. The red arrow denotes the right bank that has incised approximately 1.5 m. The outlet of the channel into Lake Ontario is denoted with a green arrow. Photo taken in channel looking east/downstream on November 26, 2024.



Photo A12: The outlet of the channel into Lake Ontario is denoted with a blue arrow. The channel discharges into cobbles deposited by wave action from Lake Ontario. Photo taken on the shoreline of Lake Ontario looking west/upstream on November 26, 2024.



Photo A13: Substrate of the channel in the downstream length. Photo taken in the channel on November 26, 2024.



APPENDIX B:

Concept Design Drawings



KEY MAP



LEGEND:

- EXISTING CULVERT
- EXISTING TOP OF BANK
- EXISTING BOTTOM OF BANK
- EXISTING TOP OF SLOPE
- EXISTING BOTTOM OF SLOPE
- IRON BAR
- EXISTING TREE
- EXISTING ARMOURSTONE ROCK
- EXISTING RIVERSTONE

NOTES:
DISTANCES AND COORDINATES SHOWN ON THIS PLAN ARE IN METRES AND CAN BE CONVERTED TO FEET BY DIVIDING BY 0.3048.

COORDINATES ON THIS PLAN ARE UTM, ZONE 17, NAD83 (CSRS-2010) ADJUSTMENT AND ARE BASED ON GPS OBSERVATIONS FROM A NETWORK OF PERMANENT GPS REFERENCE STATIONS.

ELEVATIONS ON THIS PLAN ARE CGVD2013 BASED ON GPS OBSERVATIONS FROM A NETWORK OF PERMANENT GPS REFERENCE STATIONS.

BENCHMARK:
STANDARD IRON BAR AT THE CORNER OF PROPERTY LINE UPSTREAM OF THE CULVERT
(601375.0080, 4800939.0800) ELEV: 79.97

STANDARD IRON BAR AT THE CORNER OF PROPERTY LINE SOUTH WEST OF THE SITE (CULVERT)
(601391.4340, 4800963.0280) ELEV: 77.90

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DATE: DECEMBER 17, 2024

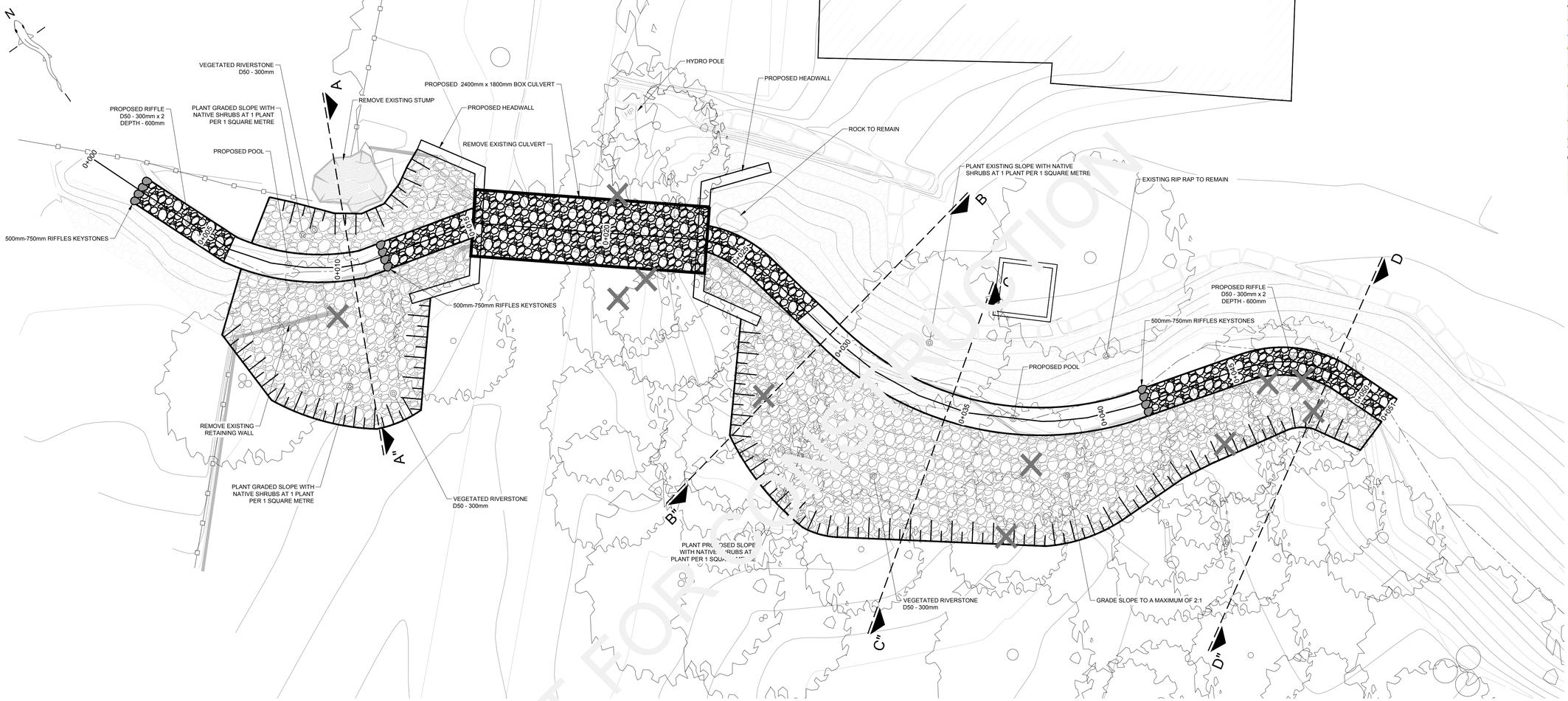
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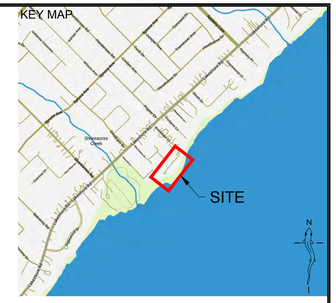
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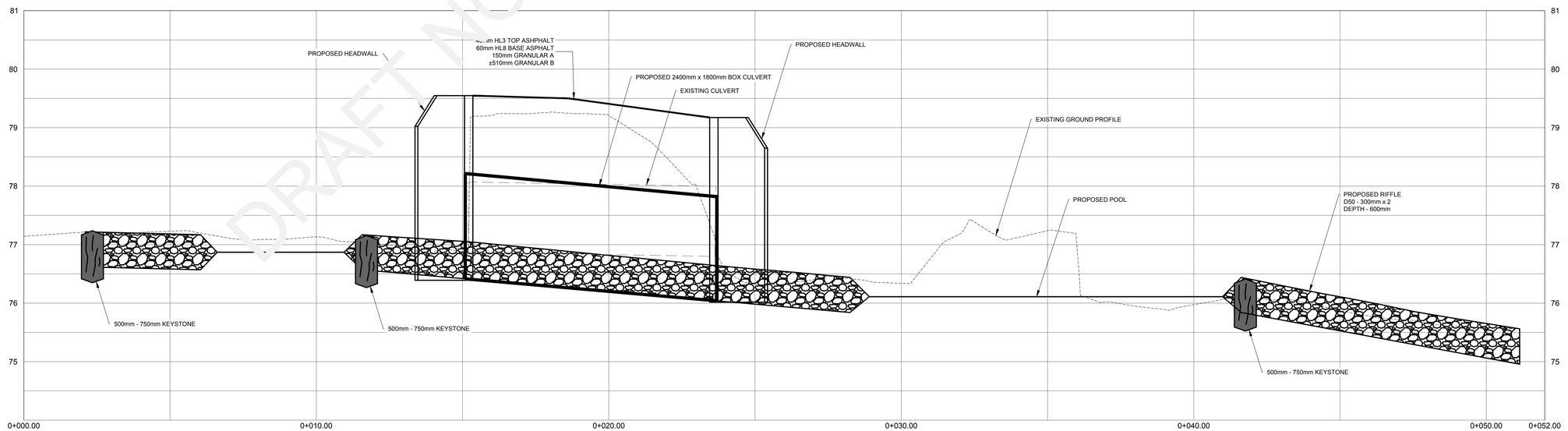
EXISTING CONDITIONS

DESIGN	PROJECT No.
JM	24048
CHECKED	SHEET No.
EG	1





TREES TO BE REMOVED



DRAFT NOT FOR CONSTRUCTION

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DATE: DECEMBER 17, 2024

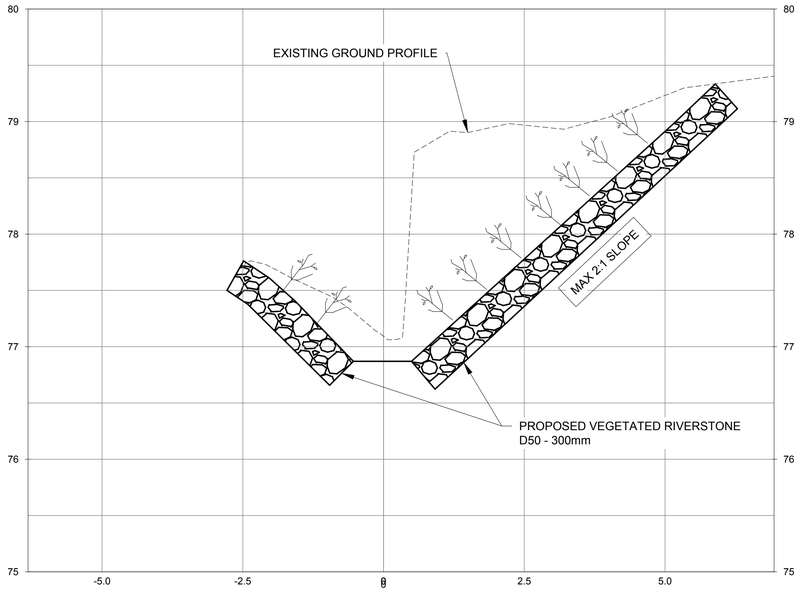
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HORIZONTAL - 1:200
VERTICAL - 1:50

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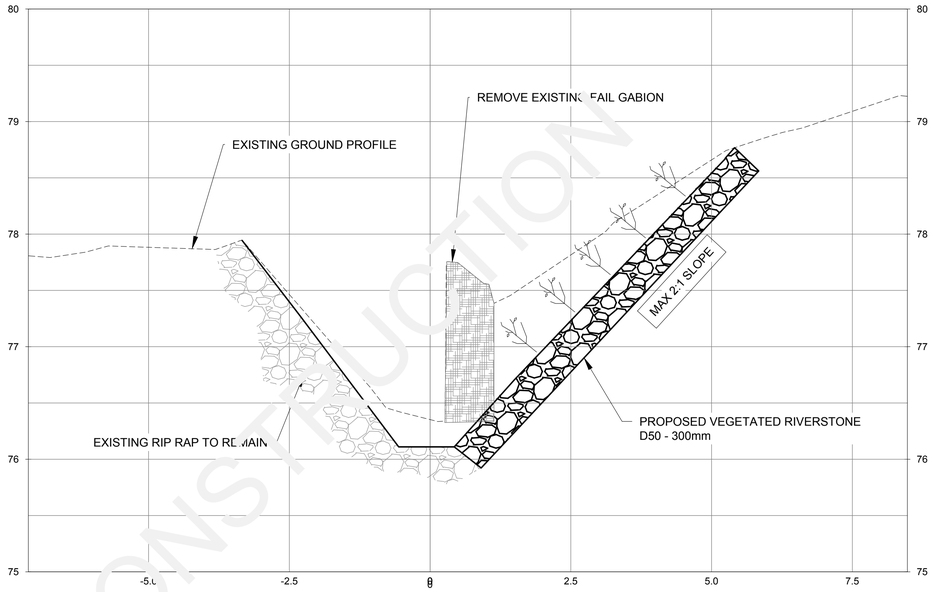
PEARLE 105 AVONDALE COURT

PLAN & PROFILE

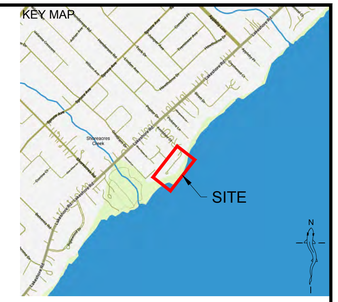
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JM	24048
CHECKED	SHEET No.
EG	2

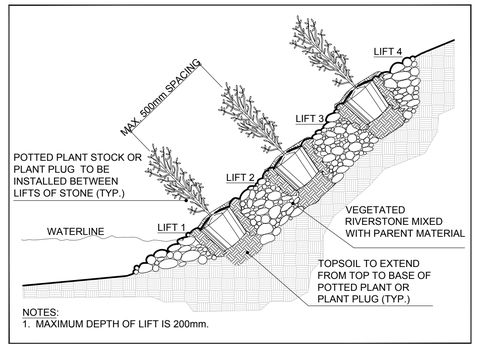


CROSS SECTION - A - A"

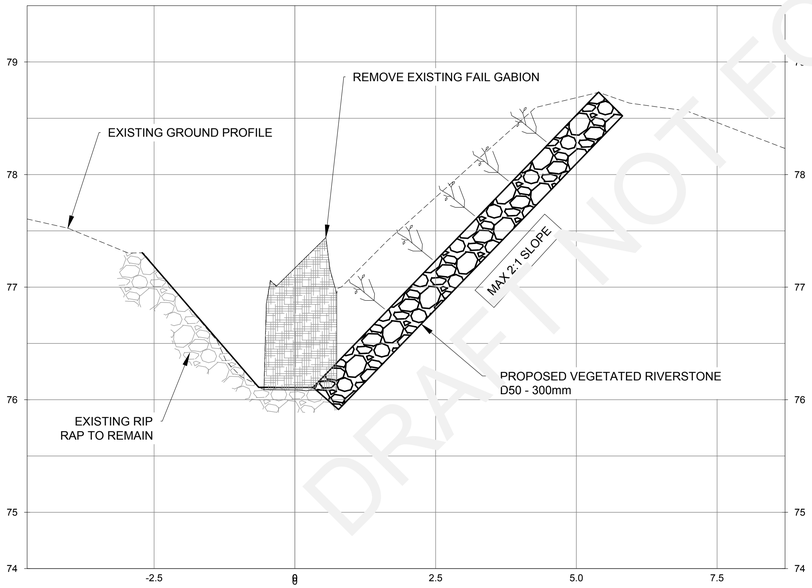


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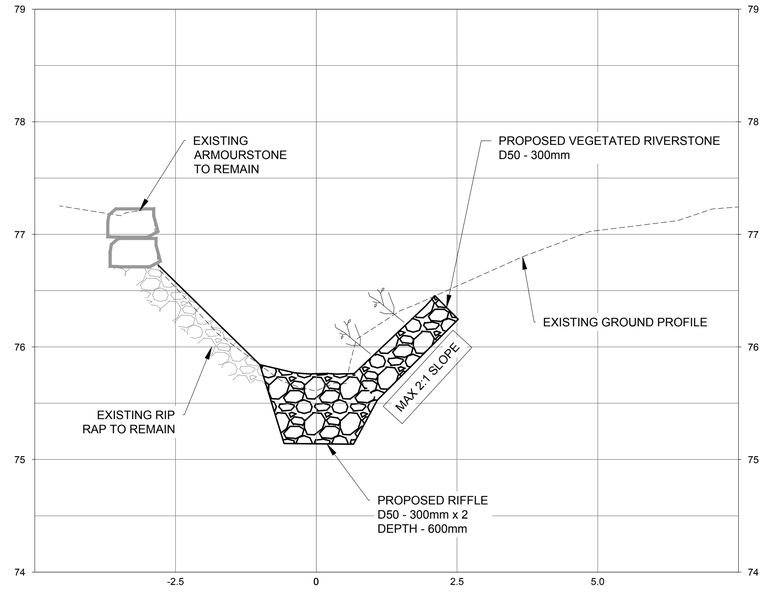




D1 VEGETATED STONE DETAIL
N.T.S.



CROSS SECTION - C - C"



CROSS SECTION - D - D"

STONE SIZING GRADATION 300mm RIFFLESTONE (mm)	
600 - 700	5%
500 - 600	10%
400 - 500	15%
300 - 400	20%
150 - 300	15%
< 150	10%
Granular "B"	25%
SUM	100%
NATIVE BANK MATERIAL TO BE MIXED WITH RIVERSTONE TO FILL INTERSTITIAL VOIDS	

NOTE:

ALL SECTIONS LOOKING DOWNSTREAM

No.	DATE	BY	REVISIONS
1.	DEC 17, 2024	EKL	ISSUED FOR RE-ZONING SUBMISSION

DATE: DECEMBER 17, 2024

SCALE:
HORIZONTAL - 1:200
VERTICAL - 1:50

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CROSS SECTIONS

DESIGN	PROJECT No.
JM	24048
CHECKED	SHEET No.
EG	3

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